CAR AUDIO
TECHNICAL MANUAL

KENWOOD CAR AUDIO CD CHANGER
PICK UP UNIT & SERVO SYSTEM

KENWOOD

【 CONTENTS 】

§ 1. CD Changer with SONY devices

1. Applied models

   KDC-C100, C200, C205, C300, C301, C302, C400, C401.

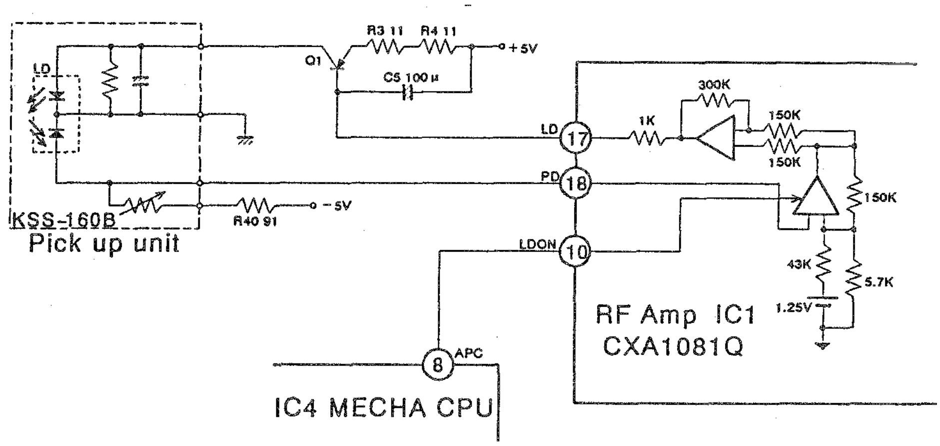
2. Basic configuration

   o Built-in DC-DC converter (±5 V power specification)
   o RF amplifier CXA1081Q
   o Servo processor CXA1082Q
   o Digital signal processor CXD1125Q or CXD1130Q
   o Pick-up mfd. by Sony, KSS-160B

3. Servo circuit description (KDC-C100)

   3-1. LDAPC circuit

   The laser diode automatic power control circuit lets the laser diode in the pick-up emit light at a stable power. It consists of the laser diode in the pick-up, laser monitoring diode, switching transistor and internal circuitry inside the RF IC. The APC circuit in the RF IC is activated when the mechanism controller transmits the laser diode ON signal to the RF IC based on the play command sent from the main CPU.



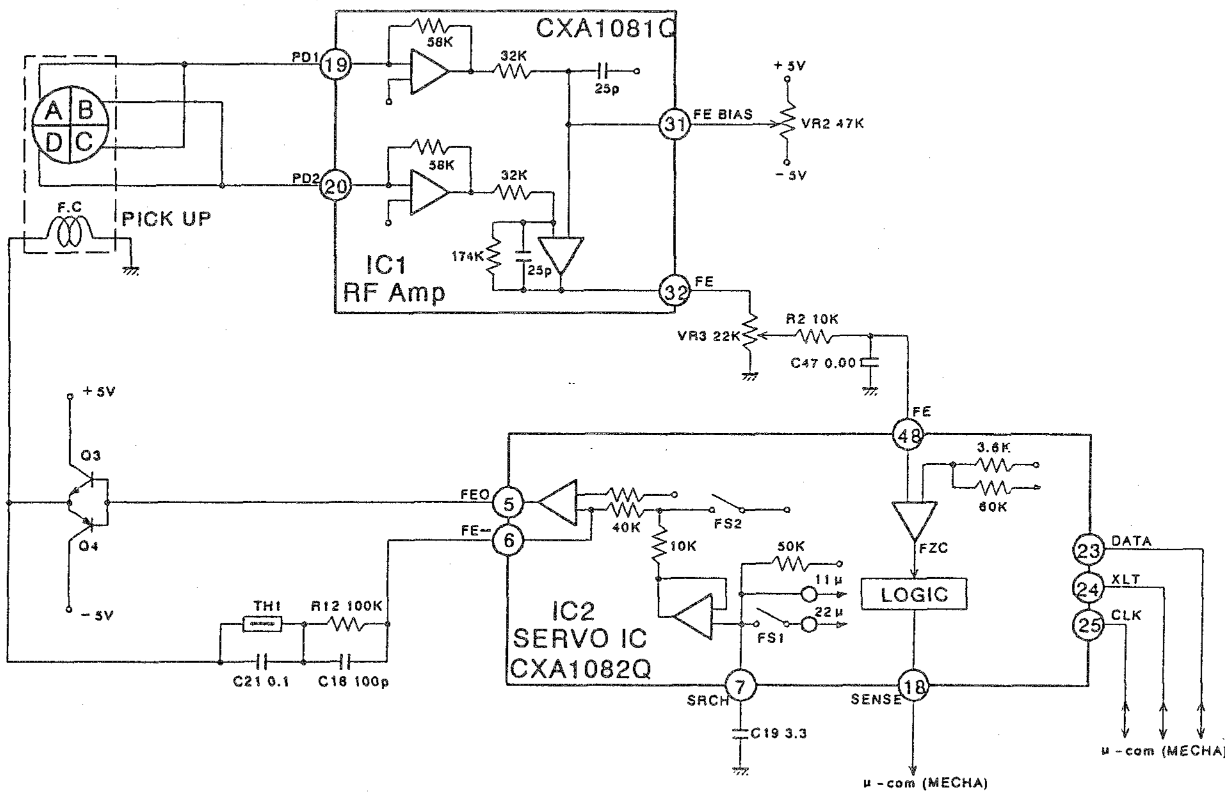
To check the laser diode drive current, measure the voltage accross R3 11 Ω, and calcurate it's crrent from them. In normal condition, the Iop would be approx.50mA±20%.

3-2. Focusing coil driver circuit

This circuit moves the objective lens built in the pick-up to focus the laser beam, which is produced by the laser diode in the pick-up, correctly on the disc's signal surface.

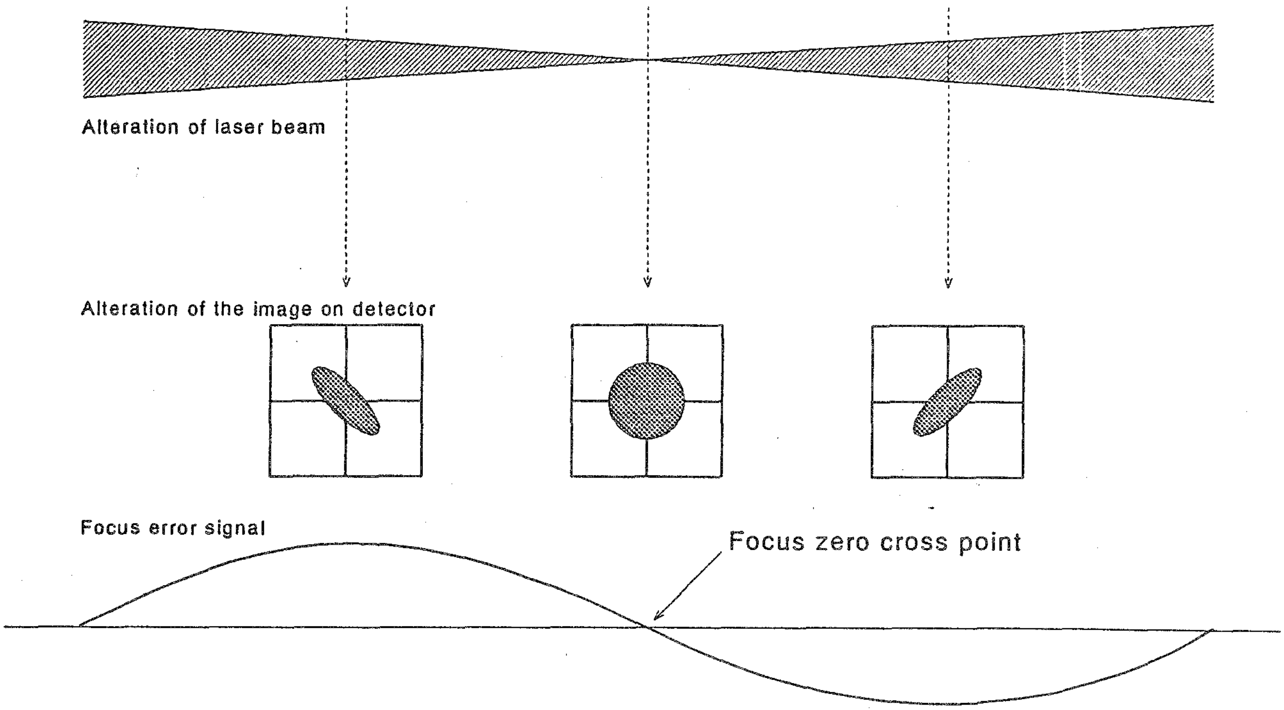
3-2-1. Focusing search

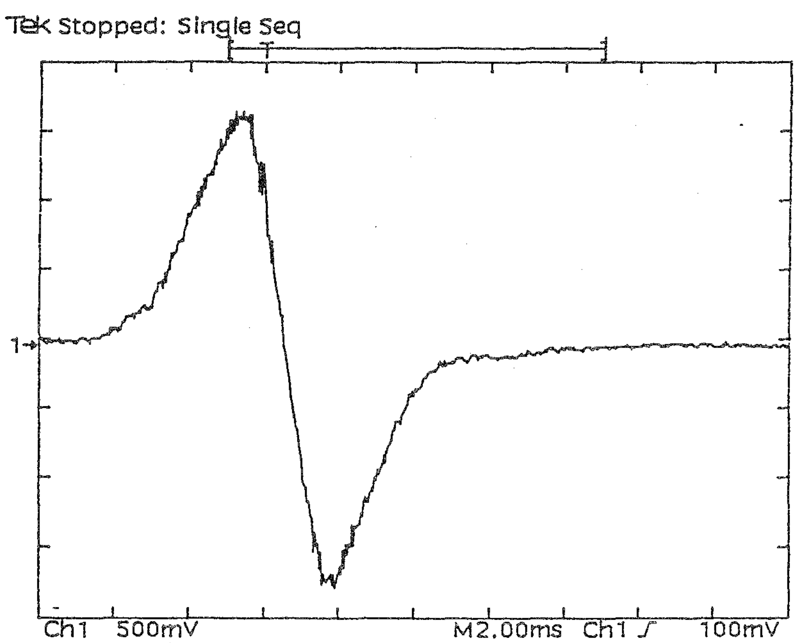
In case the laser beam cannot be focused correctly on a disc before or during playback, the focusing servo circuit is set to an open loop to force the objective lens in the pick-up to move up and down and search the focusing position.

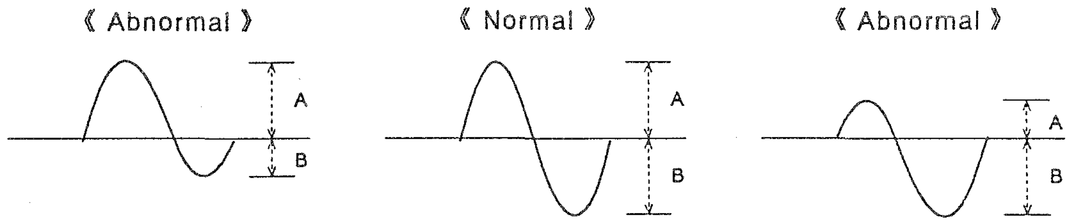


When the focusing search instruction is sent from the mechanism μ-com, the servo loops are opened and search is started. In this operation, the regulated current source in the servo IC charges and discharge the 7-pin capacitor. The charge and discharge currents are amplified for use in moving the focusing coil up and down. Since the laser diode in the pick-up is emitting light at this moment as described before, the rellected light from the disc enters the pick-up and irradiated on the 4-element photodetector. As the amount of reflected light irradiated on each detector element varies according to the up/down movement of the objective lens, current signals PD1 (A+C) and PD2 (B+D) which are supplied to the RF IC vary quantitatively following the movement of the objective lens. These signals are converted to voltages in the RF amp and the difference between these voltages is obtained as the error signal from photodetector that expresses the movement of the lens. Here, correct focusing means that a circular image is formed on the 4 detector elements and in this case the focusing error signal (A+C) -(B+D) is equal to 0. When FE = 0, the servo IC generates the focusing recognition signal, which is delivered to the μ-com through the SENSE terminal at pin 18.

Variety of the laser beam image on 4-detector

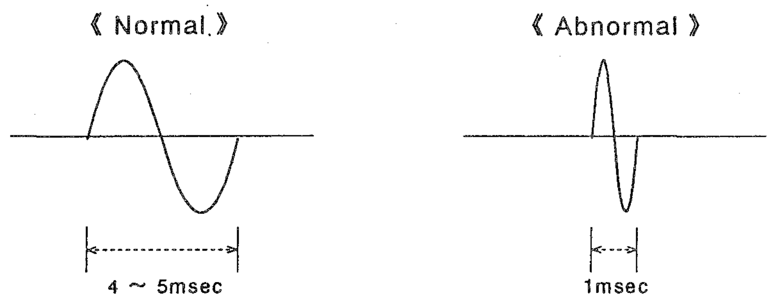






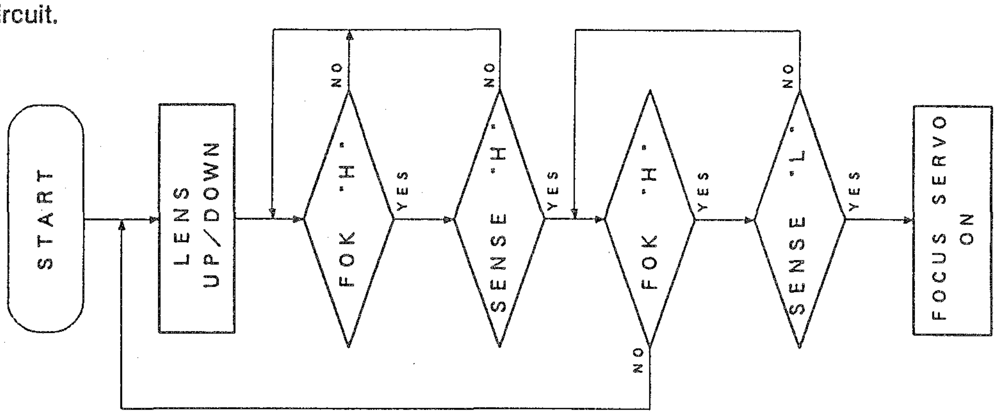
Waveforms as shown above can be observed at the FE terminal at pin 32 of the RF amp. These waveforms are called "S curves" and can be used as a reference in judging if the pick-up is normal or abnormal. If the system is operating in corresponding with the theory as described before, the waveform should be symmetrical above and below the center point as shown in the figure above (center). Should the laser light axis be deviated with respect to the photodetector or should the sensitivity of one of the detector elements is low, amplitudes A and B would be different as shown in the figure above (left, right). The total amplitude A + B of the "S curve" signal is about 3.5 Vp-p and if the amplitude is considerably smaller than this, the laser beam light emission or the sensitivity of the 4-element photodetector may be too low.

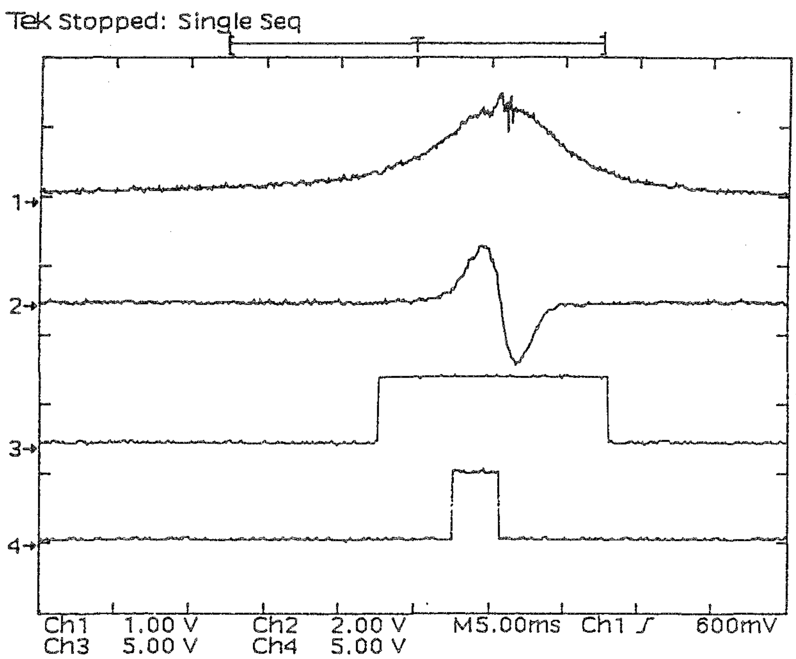
Additionally, if the period per cycle of the "S curve" signal is short as shown in the figure below (right), there may be a physical trouble of the lens moving section in the pick-up or an electrical fault of the capacitor connected to pin 8 of servo IC 7.



3-2-2. Conditions for turning focusing servo ON

To make the focusing servo loop close, the conditions shown in the flowchart below is indispensable. In the flowchart, there is a signal called FOK. Though it will be detailed later, simply speaking, the FOK signal observes the RF signal (main signal) amplitude to obtain information on whether the disc is present or not in the mechanism deck. The SENSE signal is the signal to identify the FZC (Focusing Zero Cross) point as described before. When these signals are executed in the flow shown below, the focusing servo loop becomes a closed circuit.

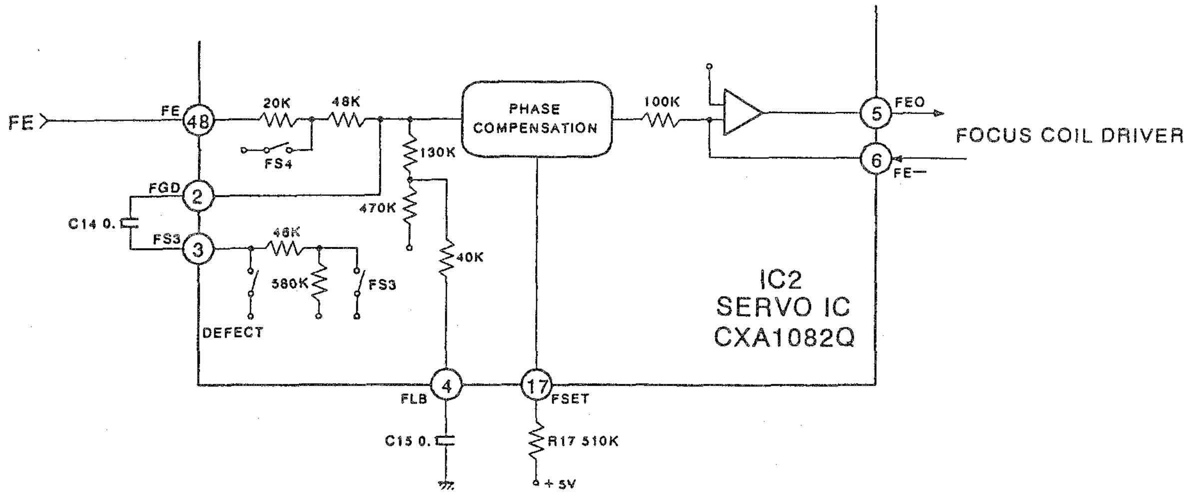




CH1 ; RE
CH2 ; FE
CH3 ; FOK
CH4 ; SENSE

3-2-3. Focusing servo circuit

The diagram below shows the circuit block diagram when the focusing servo is a closed circuit, for example during normal playback or skipping.



	Search	Play	Jump	Remarks
FS1	OFF/ON	OFF	OFF	Focus Search UP
FS2	ON	OFF	OFF	Focus Search ON
FS3	OFF	OFF	ON	Focus Gain Down
FS4	OFF	ON	ON	Focus Servo ON

3-2-4. Adjustment

【1】 Focus offset Adjustment

Connect the oscilloscope to the RF point, and adjust the VR2 to be clear and max. amplitude of RF signal.

【2】 Focus Gain Adjustment

Adjust the VR3 to check if there is not an abnormal operation noise from the 2 axis device.

◎ When the gain is too low,

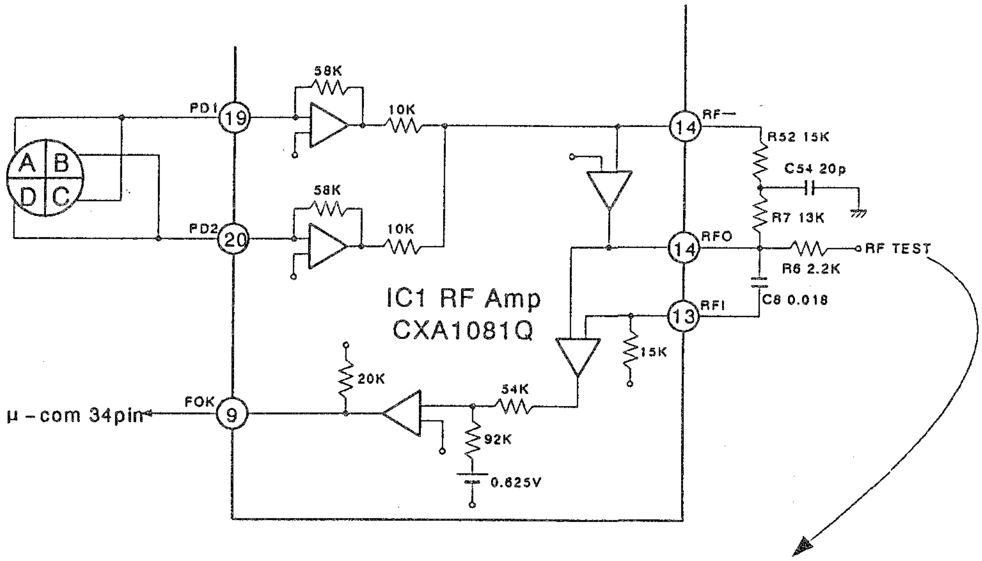
the unit would not play a disc correctly.

◎ When the gain is too high,

operation noise would be heard from the pick-up unit.
And also it will be too sensitive to a scrstch or dust on the disc.

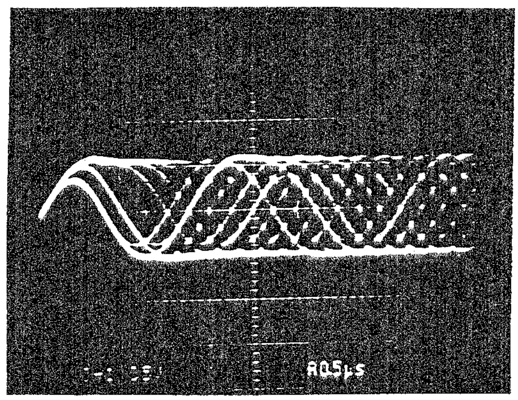
3-3. RF signal

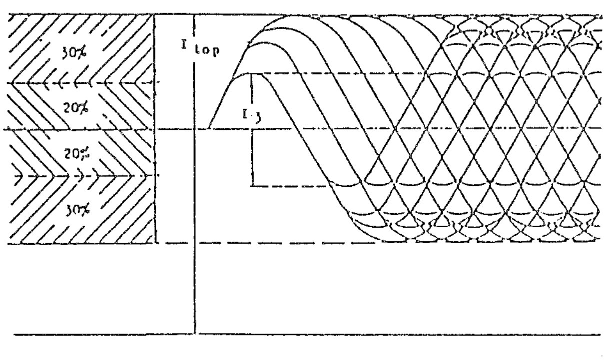
This is the main signal expressing the presence of signals on the signal data surface of a Compact Disc. It contains various recording information as well as music data. This RF signal is generated as shown below.



3-3-1. Eye pattern

During normal playback, a waveform called the eye pattern is observed as shown in the photo on the right. The length of pits on the disc can be expressed in 9 ways, from 3T to 11 T assuming that 1 T = 1/4.32 MHz. Therefore, since the data from 3T to 11T is located at 1T intervals, the grid with 1T interval can be observed as shown in the photo. One of the facts that the playback clock (PLCK) extracted from the RF signal has a frequency of 4.32 MHz.



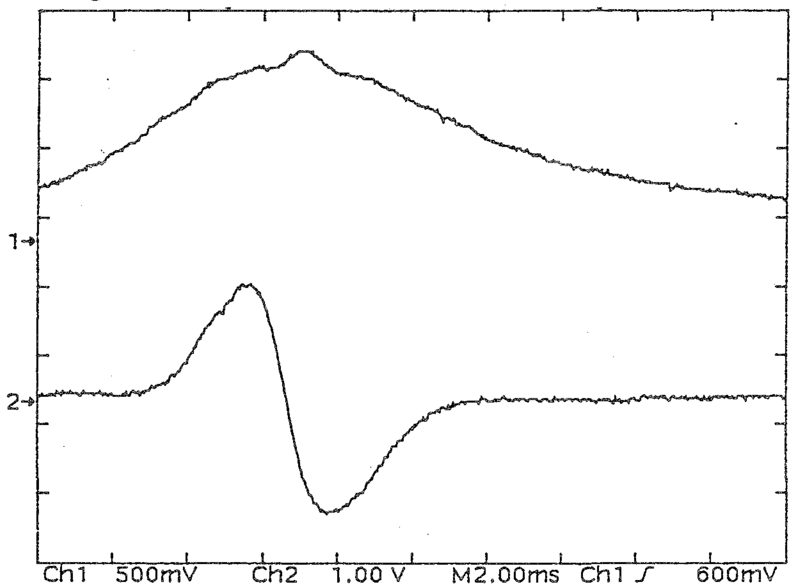


In the circuit diagram, R7, R52 and C54 form the negative feedback circuit of the RF summing amplifier. This circuit determines the gain of the amplifier as well as compensates the gain of the high frequency component in the RF signal. Should abnormality occurs in this peripheral circuit, the RF waveform changes and will contain a 3T level variation. Normally, the peak value of this 3T signal is specified as 20% of the maximum amplitude. The RF level is about 1.1 Vp-p in normal case and if it drops below 0.8 Vp-p, the disc playback operation will be unstable. The possible causes of this phenomenon include a stain of the objective lens in the pick-up or performance degradation of the laser diode or photodetector. As it could also be due to a problem in the circuit such as an FE balance adjustment error, its troubleshooting necessitates a comprehensive judgment.

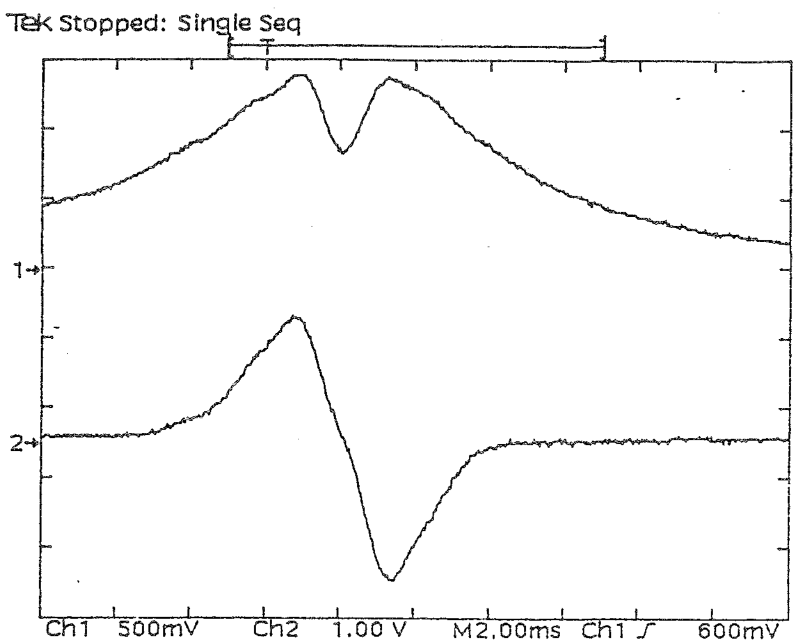
In addition, it is also necessary to confirm the articulation of the RF signal. During normal playback, a powerful disc servo functions to lock PLCK at 4.32 MHz but, in a more microscopic order, there are period variations in the time domain of waveform. This variation in time domain is referred to as jitter, which is usually specified to be within 25 nsec. when measured with a jitter meter. To identify jitter with a simpler method, an oscilloscope should be used to observe the RF signal and the judgment should be made depending on the signal articulation. If the focusing balance is deviated or the objective lens is shifted due to abnormal skew feed, the jitter level during playback will deteriorate. As the jitter level could also deteriorate due to clock noise or a scratch on disc, jitter judgment also necessitates a comprehensive checking.

3-3-2. Variety of RF signal waveforms

During focusing search, the RF signal cannot be observed as an eye pattern because the disc motor is usually not rotating. However, as described in relation with the focusing servo circuit, it can be imagined that a certain signal is generated due to the reflected light from the disc. The diagram below shows the reference waveforms for this consideration.

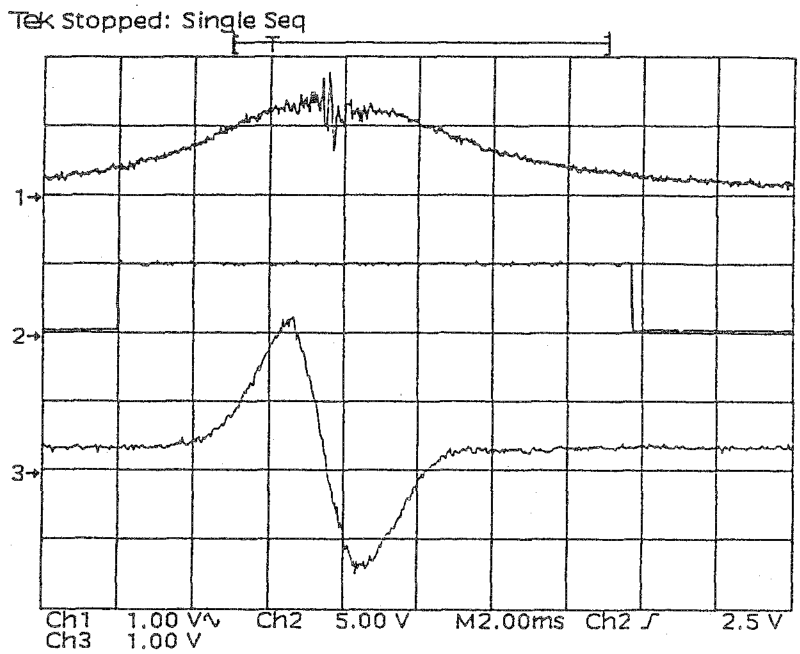


The RF signal is the sum of light incident to the 4 detector elements, and its amplitude is maximum at the focusing position (FZC point) of FE as shown with the waveforms.
However, the RF signal amplitude may sometimes not be maximum at the FAC position as shown with the waveform below. This occurs in case the reflected light decreases when the laser beam is located on a disc pit. As this case cannot be identified as a fault, observations should be repeated several times.



3-3-3. FOK

A pin called the FOK terminal is provided in the RF generator circuit described before. This pin is used to generate a window for the timing for turning focusing servo ON from focusing search operation, and produces an H level when the RF signal amplitude attains a certain level (0.37 V). This pin is connected to the μ-com and together with the SENSE signal the FOK signal is used as a condition for turning the focusing servo ON.

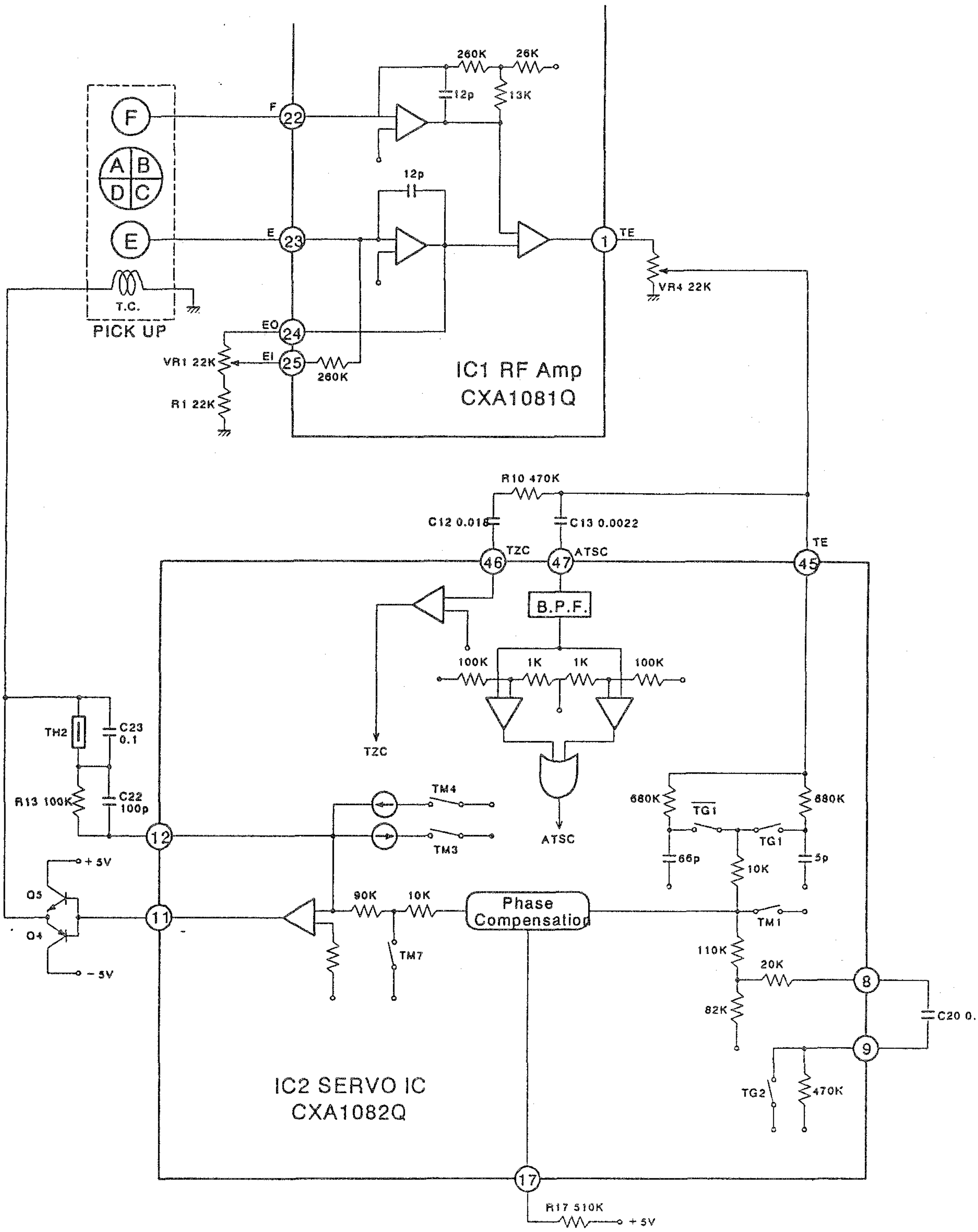


CH1 ; RF
CH2 ; FOK
CH3 ; FE

3-4. Tracking coil driver circuit

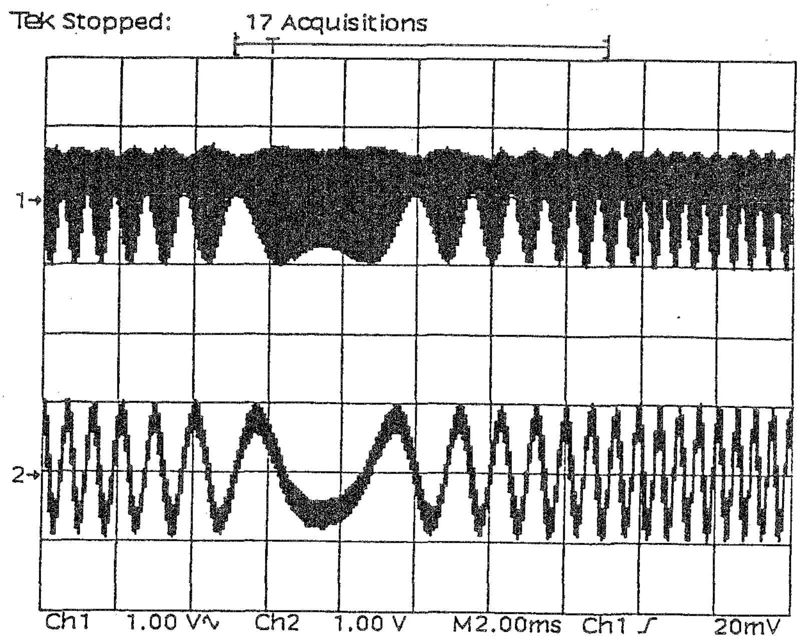
This circuit moves the objective lens in the pick-up horizontally so that the laser beam from the laser diode always traces the disc pit correctly.

3-4-1. Tracking signal generation and servo loop

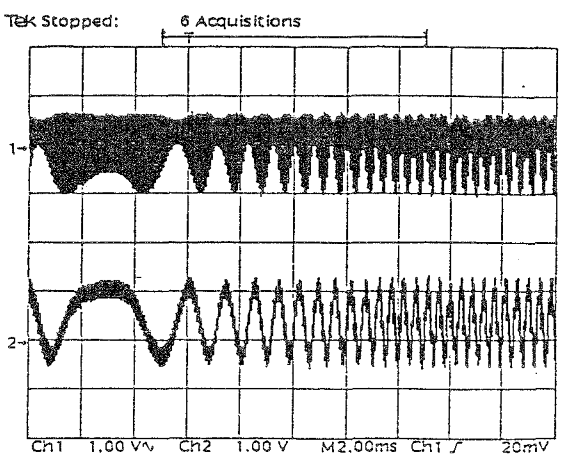


3-4-2. Tracking signal when the loop is open

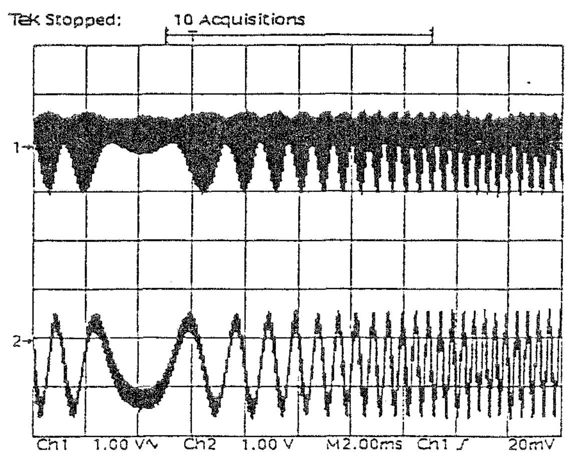
When a track is jumped or a scratch on disc is detected, the tracking servo loop is opened by turning internal switch TMI OFF. The waveform observed at pin 1 of the RF IC at this moment is as shown in the figure below. This waveform should be symmetrical in relation to the 0 V level. If not, adjust VR1 to make it symmetrical above and below 0 V. If the envelope of this waveform looks like as if it has been subjected to amplitude modulation, there may be a position error in the diffraction grating in the pick-up. (This grating cannot be adjusted.)



* Waveform in case the tracking balance is defective



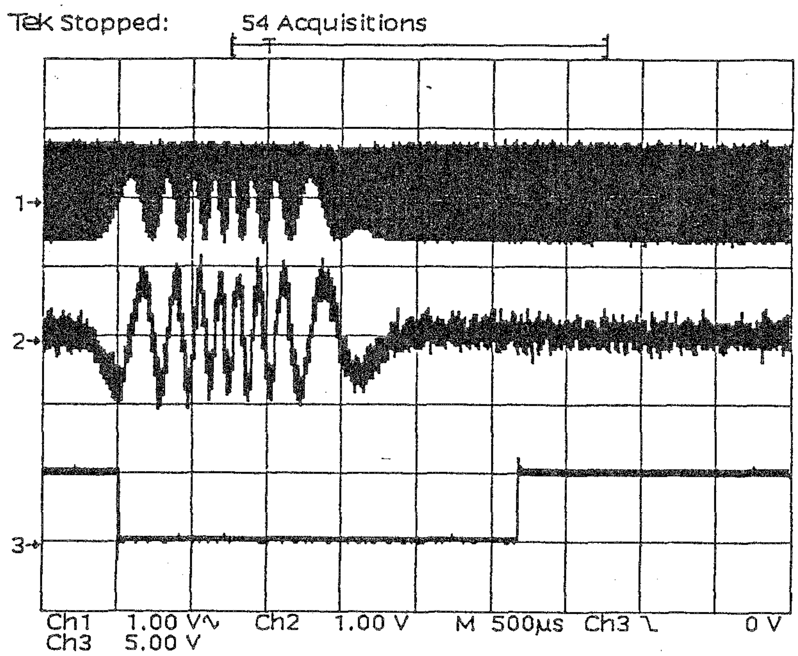
【TE waveform deviated towards the + side】



【TE waveform deviated towards the -side】

3-4-3. Tracking signal when the loop is closed

When the tracking servo loop is closed, data readout from the disc is basically possible and the clock of VCO/2 (PLCK) is 4.32 MHz. In this condition, when the signal processor IC internally confirms that the data frame sync pattern is guarded normally, it makes the GFS (Guard Frame Sync) signal to notice the μ-com. In other words, the GFS terminal can offer a H level on condition that the tracking loop is closed.



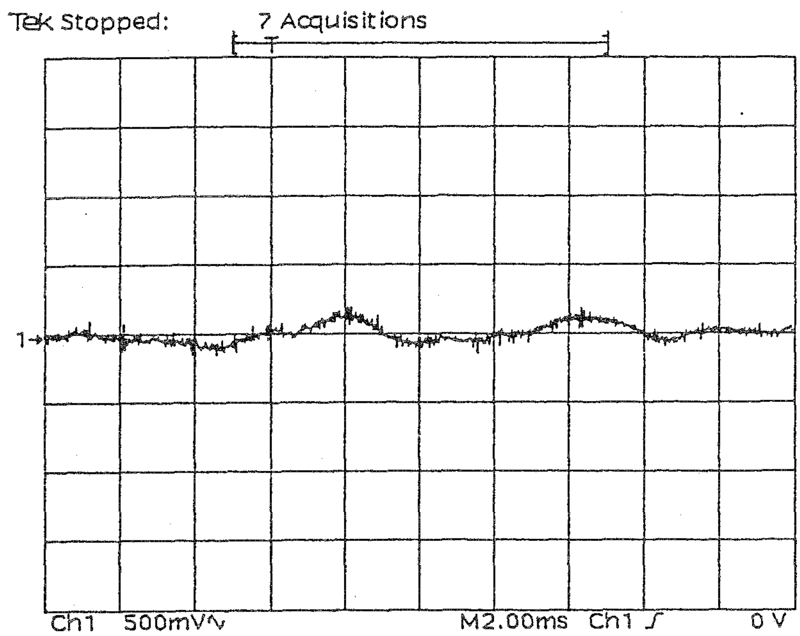
3-4-4. Tracking gain adjustment

Connect an oscilloscope to test point TRGA on the RF board, play a disc and observe the tracking error signal. Then adjust semi-fixed resistor VR4 so that the observed waveform does not contain too many low or high frequency components as shown in the figure on the next page.

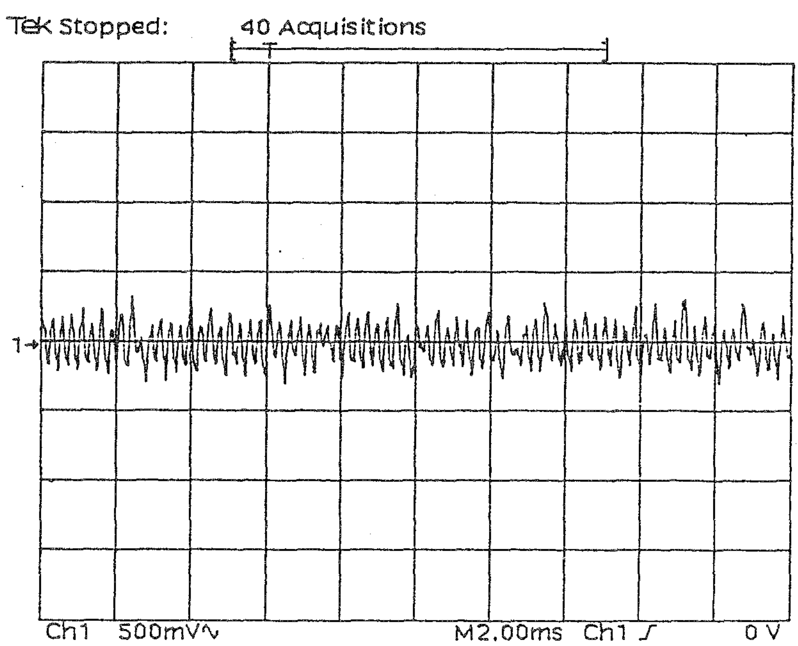
o In case it contains many low frequency components (due to low tracking gain)
External vibration or the oscillation of CD player itself may increase the probability of causing sound to skip or to be interrupted easily.

o In case it contains many high frequency components (due to high tracking gain)
More sensitive responses to disc scratch or dust may generate noise or increase the possibility of unstable operation.

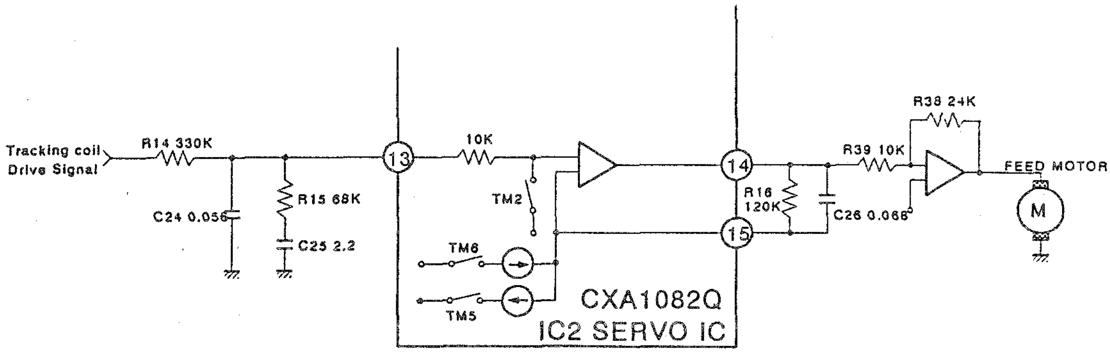
【 Tracking Gain is too low 】



【 Tracking Gain is too high 】



3-5. Sled controller circuit



When the objective lens in the pick-up unit moves during tracking, and comes to a position where it cannot move any more due to mechanical reason, DC component is generated in the tracking error signal. This DC component is extracted by the low pass filter connected to pin 13 of the servo IC for use as the sled error signal. The sled error signal is used to drive the feed motor for moving the pick-up itself so that the objective lens in it holds the mechanical center position. When the KICK signal is sent from the μ-com during search, for example, the internal regulated current source generates the feed voltage to drive the feed motor.

3-6. CLV servo

3-6-1. Types of CLV servo

(1) STOP Mode for stopping spindle motor.
MDP = FSW = MON = L, MDS = Z

(2) KICK Mode for forward rotation of spindle motor.
MDP = MON = H, MDS = Z

(3) BRAKE Mode for reverse rotation of spindle motor.
MDP = FSW = L, MDS = Z, MON = H

(4) CLV-S Rough servo mode at a start of rotation, during track jumping or when the EFM-PLL circuit is unlocked due to other reasons.
NDP = H/Z/L 3-valued output,
MDS = Z, FSW = L, MON = H

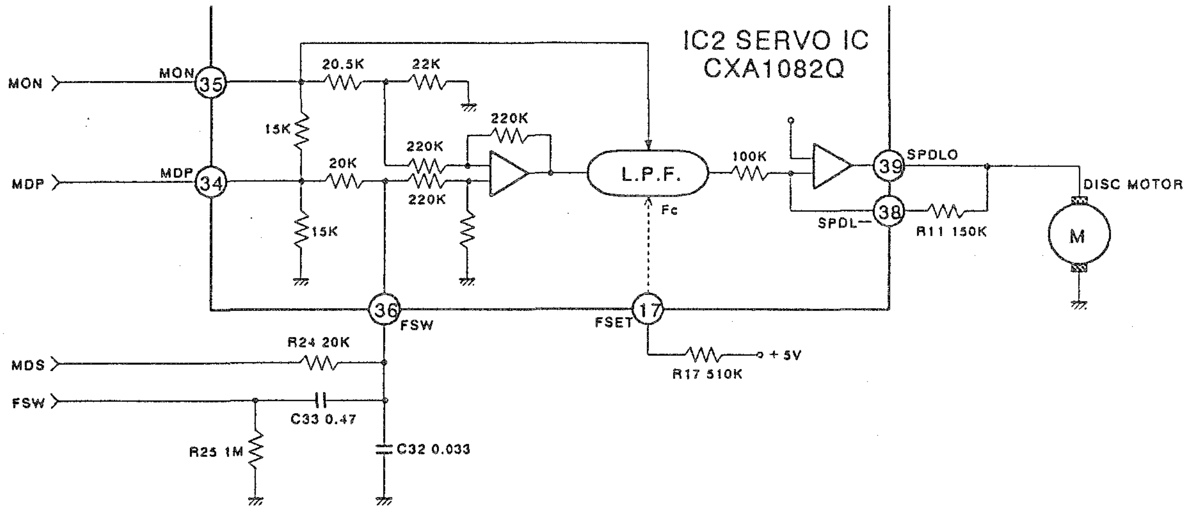
(5) CLV-H Rough servo mode during high-speed access.
NDP = H/Z/L 3-valued output,
MDS = Z, FSW = L, MON = H

(6) CLV-P PLL servo mode.
NDP = H/Z/L 3-valued output,
MDS = H/L 2-valued output, FSW = Z, MON = H

(7) CLV-A Normal play mode.
GFS signal: WFCK/16 sample H → CLV-P mode
GFS signal: WFCK/16 sample L → CLV-S mode

(8) CLV-A' Same as CLV-A mode.
In this mode, the EFM pattern is measured using VCO in place of X'tal oscillator.

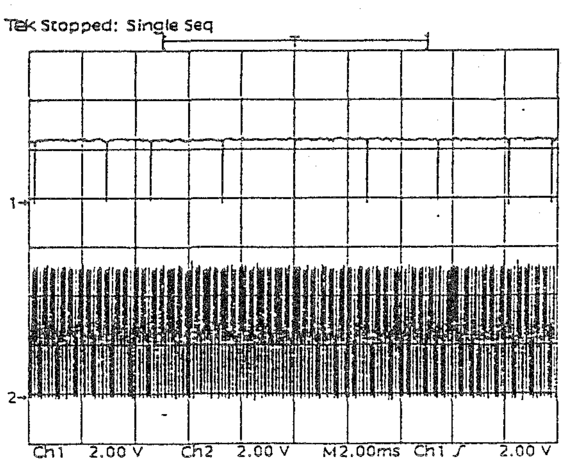
3-6-2. Spindle servo



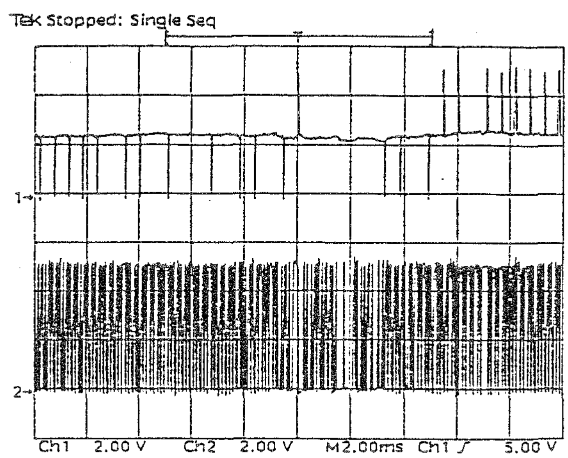
This circuit eliminates the carrier components from CLV servo signals MDS and MDP by forming a 200 Hz with R24 and C32 connected to pin 36 and a secondary filter circuit with the internal LPF.

In the CLV-S mode, FSW goes L, reducing the LPF cut-off frequency at pin 36 to enhance the further filter. The figures below show the waveforms of signals MDS and MDP in the CLV-A and CLV-S modes.

(CLV-A mode)

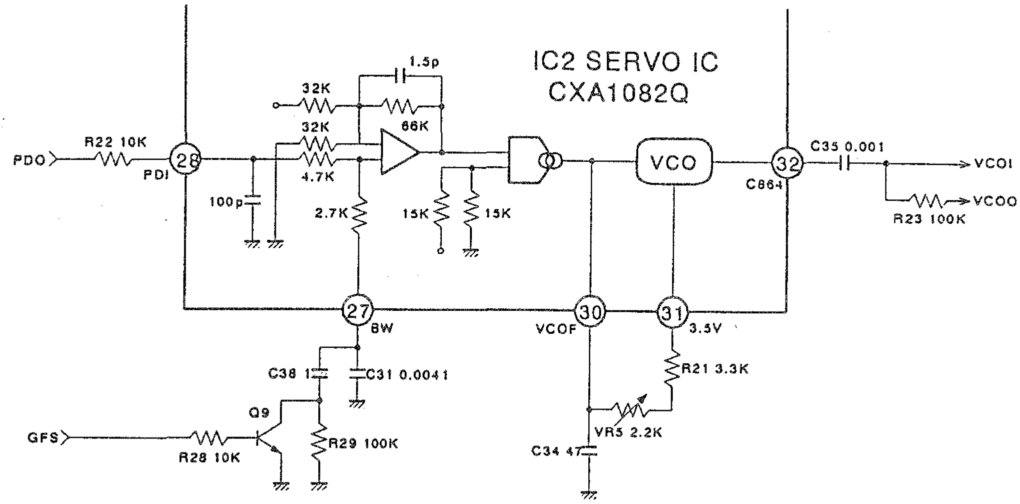


(CLV-S mode)



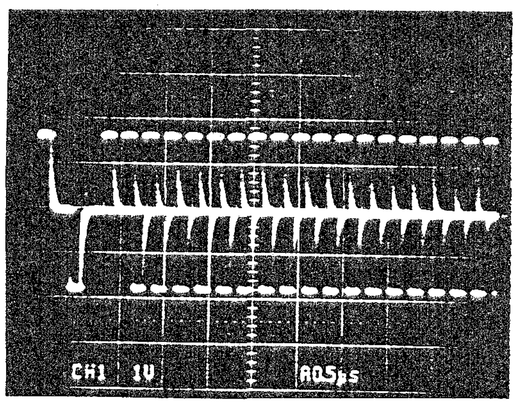
CH1 ; MDP
CH2 ; MDS

3-7. VCO loop filter



Phase comparison signal input through pin 28 is supplied to the loop filter for removing the PWM carrier component, the converted from voltage to current, and added with the free-running frequency setting current from pin 30 to control the VCO. The center of capture range of the PLL is set so that PLCK = 4.3218 MHz. The external time constant connected to pin 27 sets the loop filter and controls to expand the capture range when the frame sync is lost or in accordance with the VCO temperature changes.

(PDO waveform)



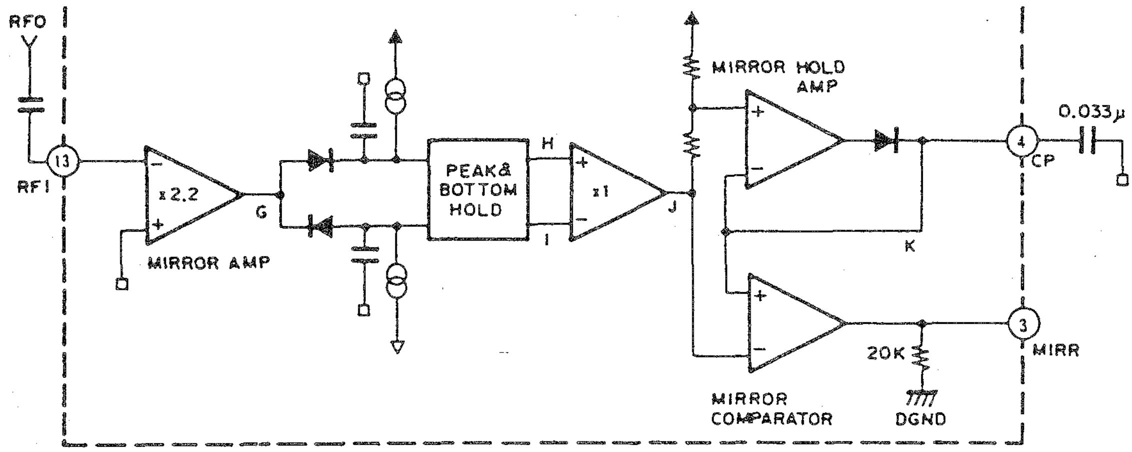
3-7-1. VCO adjustment

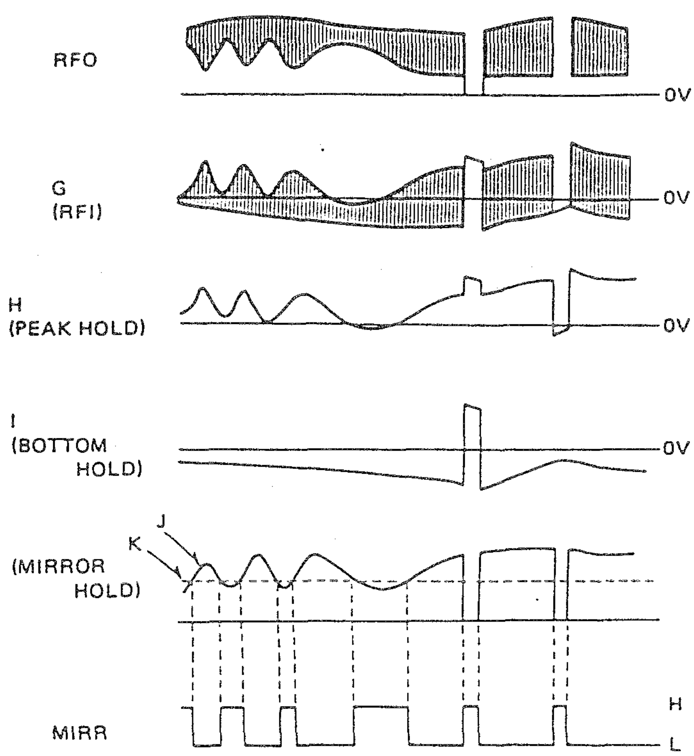
Apply 2.5 V to the PDO terminal at pin 28 and place the VCO operating point at the center of the capture range. With this condition, shut off the signal input to the EFM terminal and adjust VR5 so that PLCK becomes 4.3218 MHz.

3-8. Other servo-related circuitry

3-8-1. Mirror circuit

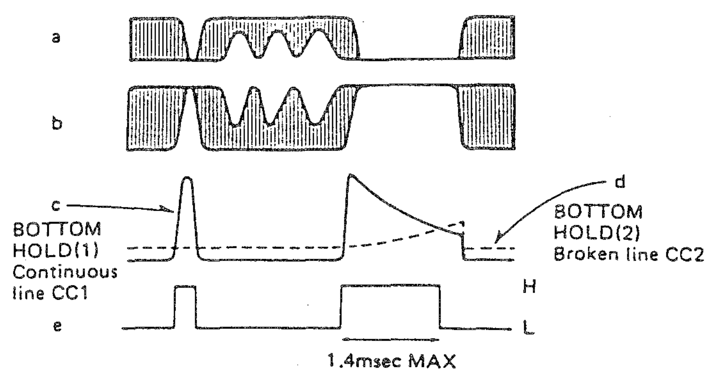
The mirror circuit amplifies the input signal and holds its peak and bottom envelopes. It then applies differential amplification of the peak and bottom hold signals to obtain a DC-reproduced envelope signal. The mirror output is obtained by comparing this signal with the signal obtained by peak holding of the 2/3 level of its peak signal level with large time constant. The mirror output is L level on disc tracks, H level between tracks (mirror sections) and H level when a defect is detected.

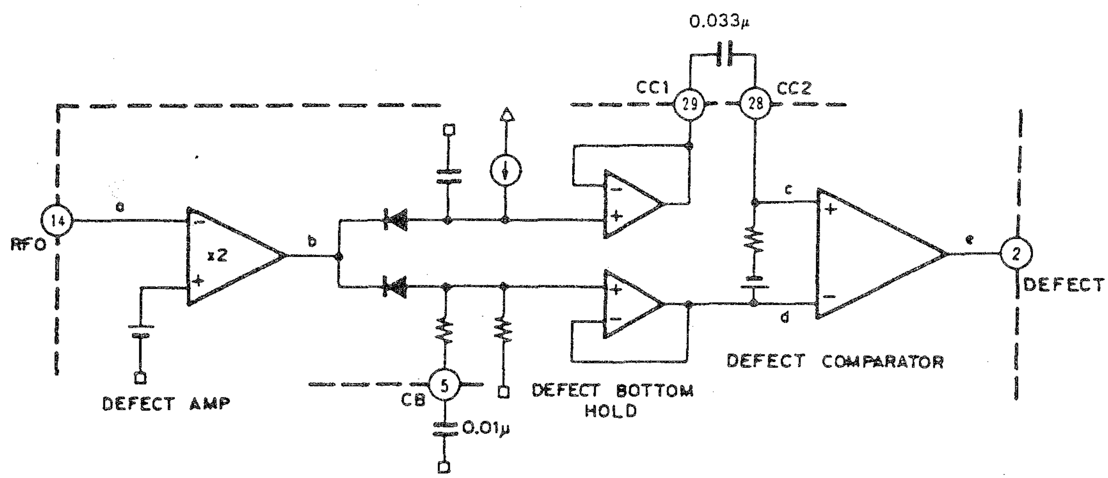




3-8-2. Defect circuit

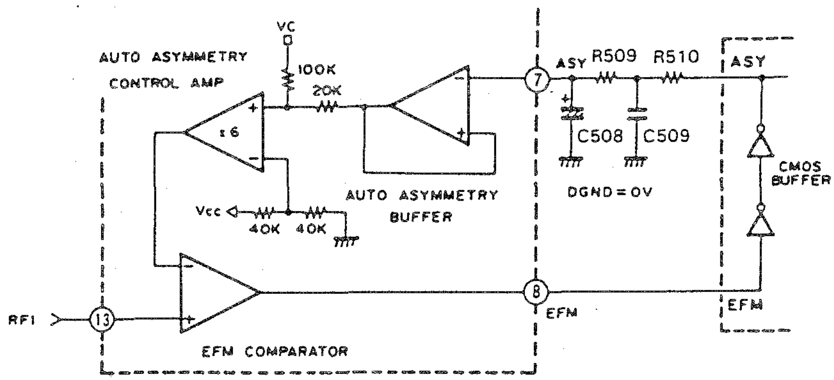
This circuit inverts the RFI signal and holds the bottom with two type of long and short time constants. The bottom-held signal with the short time constant responds with defects of 0.1 msec. or more on the disc mirror surface, while the bottom-held signal with the long time constant holds the level on the mirror surface immediately before the occurrence of the defect. This circuit integrates these signals with C coupling, shifts their levels and compares them to generate the mirror defect signal.



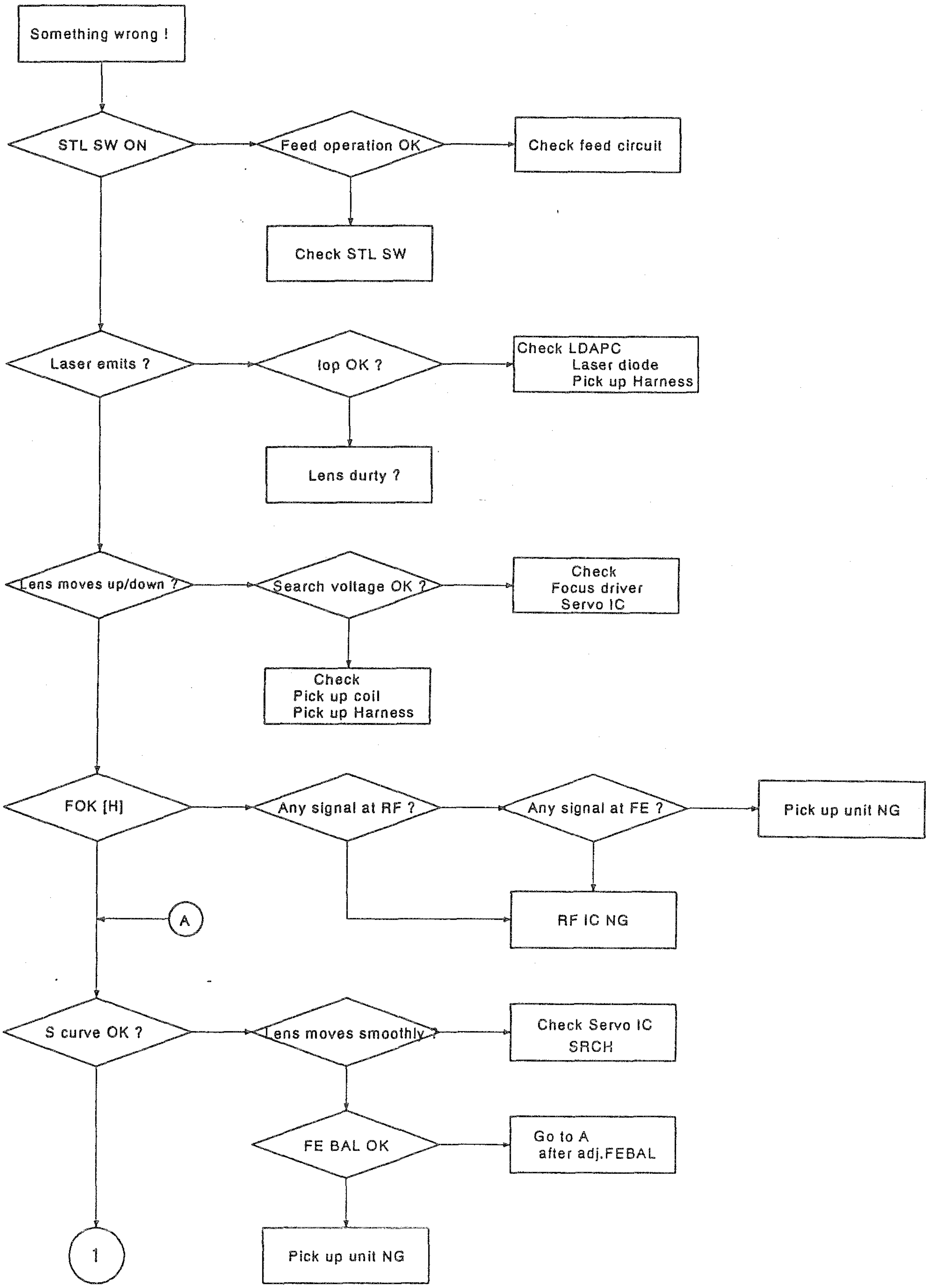


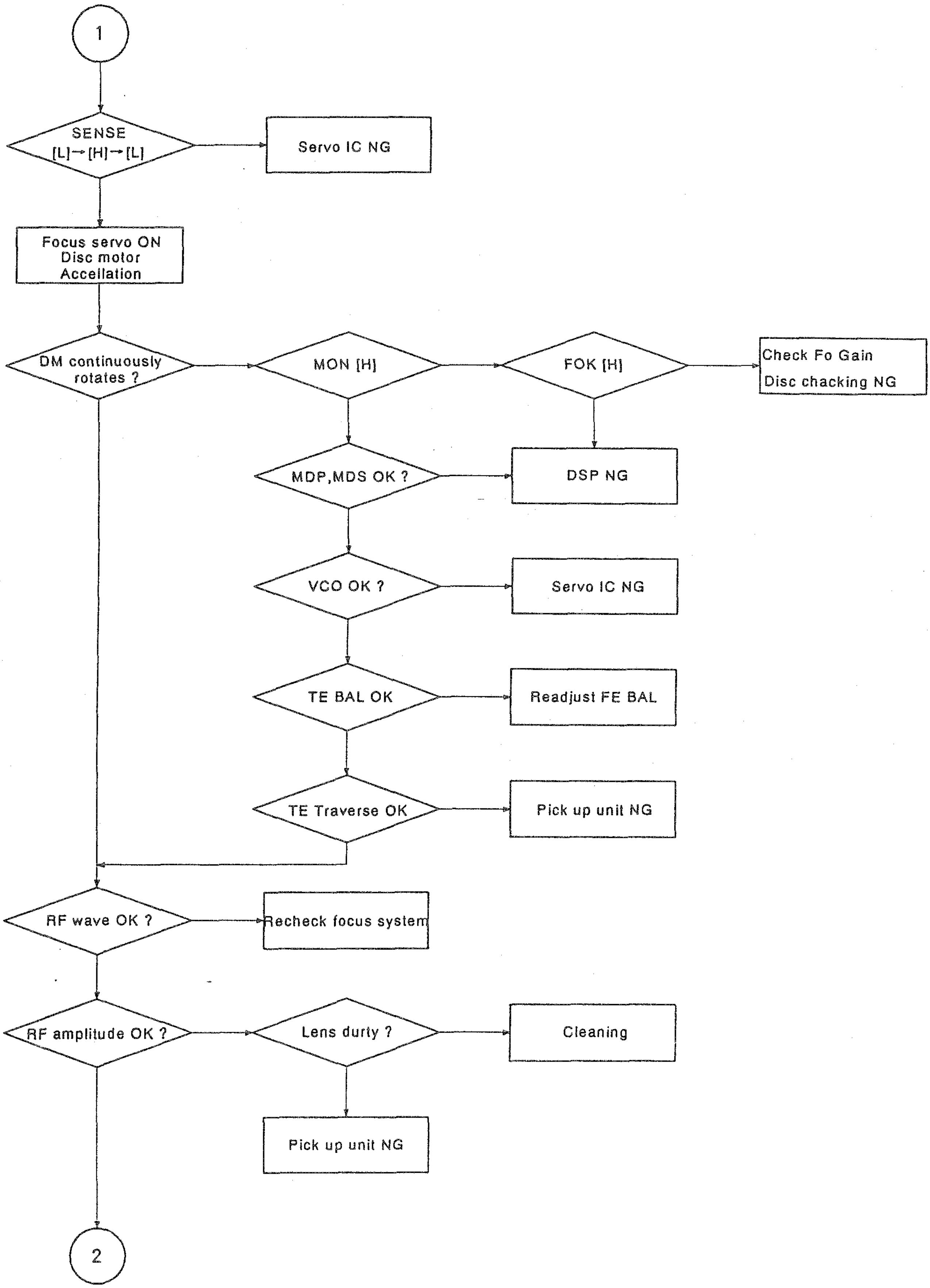
3-8-3. EFM comparator and ASY circuit

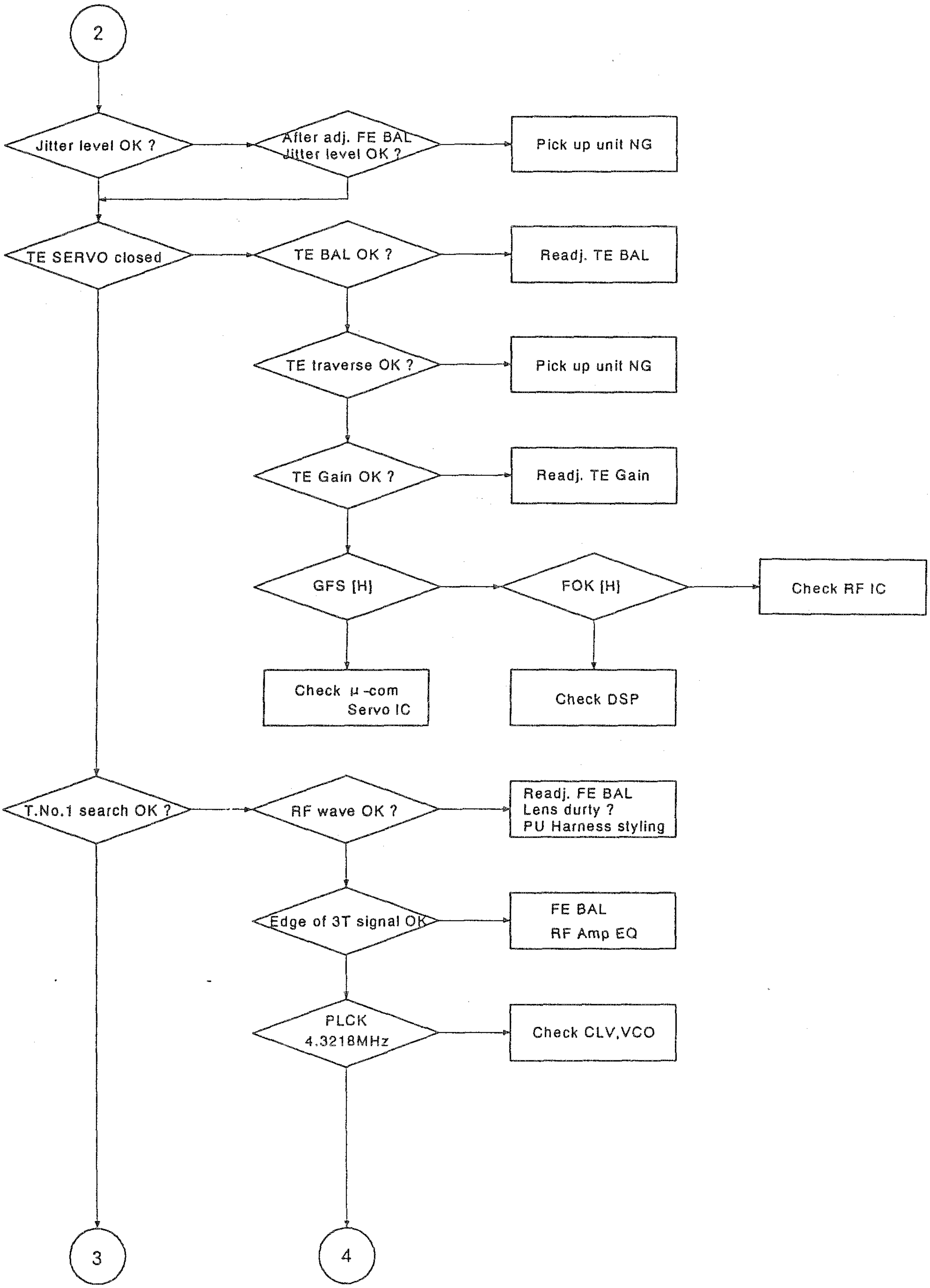
The EFM comparator turns the RF signal into binary signal. As asymmetry produced due to variances during disc production cannot be eliminated with AC coupling along, the reference voltage of the EFM comparator is controlled by utilizing the fact that the occurrence percentages of 1 and 0 in binary EFM signals are 50% each.

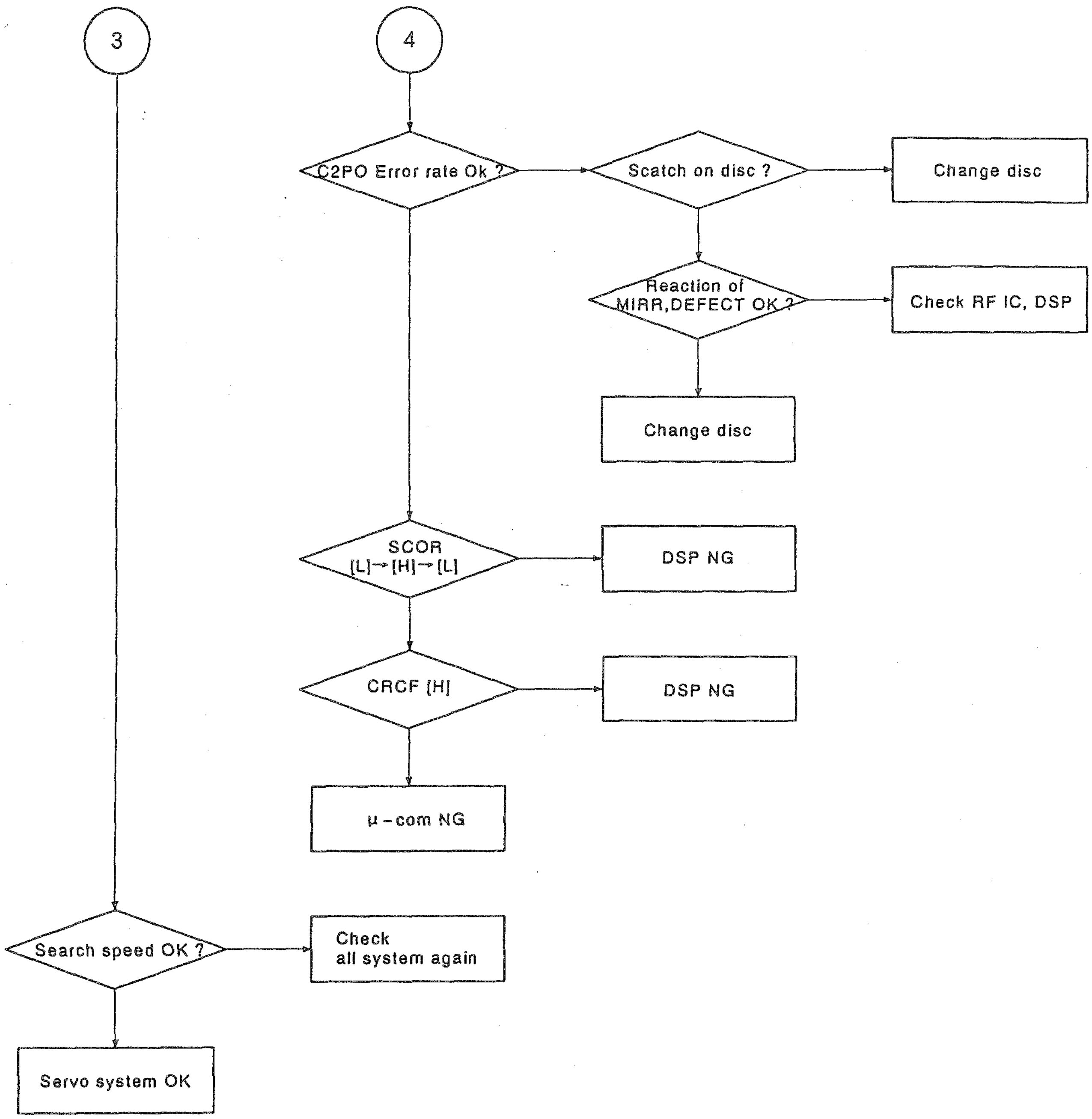


4.Troubleshooting for the servo circuit




1
SENSE
[L]→[H]→[L]
Servo IC NG
Focus servo ON
Disc motor
Accellation
DM continuously rotates ?
MON [H]
FOK [H]
Check Fo Gain
Disc chacking NG
MDP,MDS OK ?
DSP NG
VCO OK ?
Servo IC NG
TE BAL OK
Readjust FE BAL
TE Traverse OK
Pick up unit NG
RF wave OK ?
Recheck focus system
RF amplitude OK ?
Lens durty ?
Cleaning
Pick up unit NG
2


2
Jitter level OK ?
After adj. FE BAL Jitter level OK ?
Pick up unit NG
TE SERVO closed
TE BAL OK ?
Readj. TE BAL
TE traverse OK ?
Pick up unit NG
TE Gain OK ?
Readj. TE Gain
GFS [H]
FOK [H]
Check RF IC
Check μ-com Servo IC
Check DSP
T.No.1 search OK ?
RF wave OK ?
Readj. FE BAL
Lens durty ?
PU Harness styling
Edge of 3T signal OK
FE BAL
RF Amp EQ
PLCK
4.3218MHz
Check CLV,VCO
3
4


3
4
C2PO Error rate Ok ?
Scatch on disc ?
Change disc
Reaction of
MIRR,DEFECT OK ?
Check RF IC, DSP
Change disc
SCOR
[L]→[H]→[L]
DSP NG
CRCF [H]
DSP NG
μ-com NG
Search speed OK ?
Check
all system again
Servo system OK

§ 2. CD Changer with TOSHIBA devices

1. Applied models

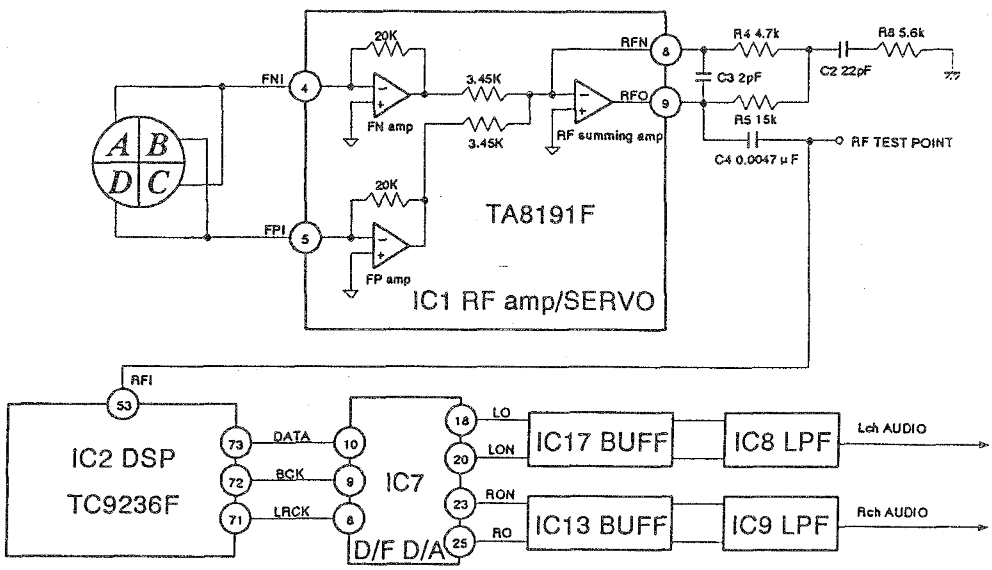
    KDC-C50, C55, C600, C601, C800

2. Basic configuration

    o Single 5 V power supply for entire servo circuitry
    o RF servo device TA8191F
    o Digital signal and servo processor TC9236F
    o Pick-up mfd. by Sanyo, SF-89.5KE2

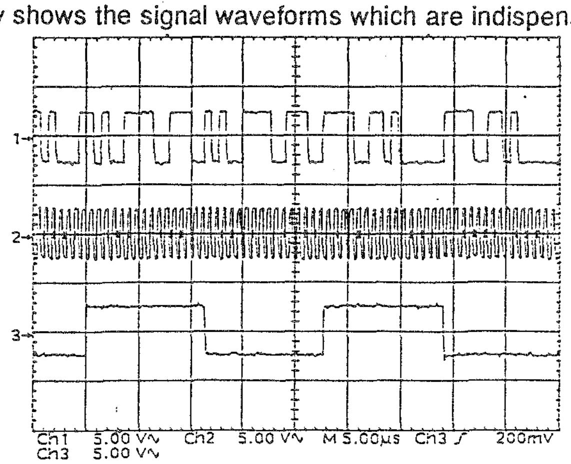
3. Servo circuit description (KDC-C55)

    3-1. RF signal and EFM signal



The basic operations of the RF signal generator and EFM signal demodulator circuits are almost identical to the Sony's device described before.

The figure below shows the signal waveforms which are indispensable for demodulation of digital data.

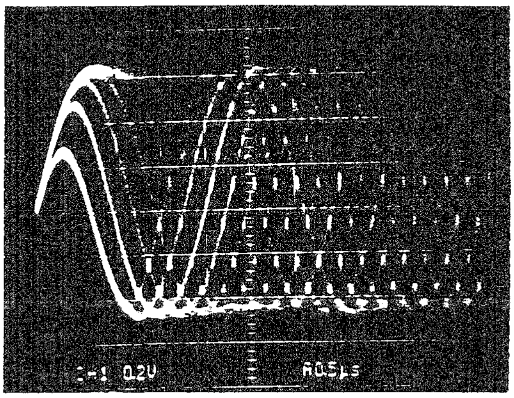


CH1:DATA → Digital data for music signal, DSP pin 73

CH2:BCK → Bit clock for demodulation of digital data, DSP pin 72

CH3:LRCK → Clock for L/R channel determination, DSP pin 71

3-1-1. RF signal and pick-up

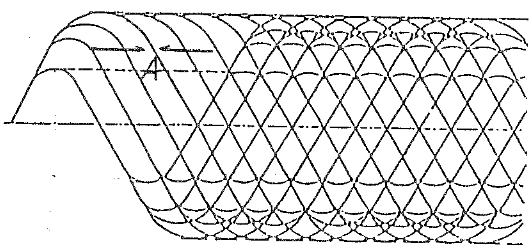


(1) RF signal (focusing offset)

Aiming at observing the RF signal as shown in the photo on the left, connect an oscilloscope between the RF check land and Vref (virtual mid-point) or GND. Be sure to use the test disc in this measurement. Do not use ordinary marketed discs, for their reflectivity (RF level) is not controlled well and the data obtained may not be suitable for use in judgment.

Judgment criterion: Should be 1.20 Vp-p or more.

When the set left the factory, the RF level has been controlled to at least 1.30 Vp-p on the mechanism assembly line. If the RF level of a set is below 1.20 Vp-p, the objective lens may be dirty or the laser diode drive current has altered considerably. In case the measured RF level is below 1.20 Vp-p, be sure to perform the focusing offset adjustment before pick-up replacement to check if the RF amplitude can be increased or not.



(2) RF waveform articulation (jitter)

When observing the RF signal, check if there is any waveform with which the width of part A shown in the figure on the left is abnormally large or which is not articulated. The fluctuation of RF waveform in the time domain is referred to as the jitter. The jitter value can be measured with a jitter meter.

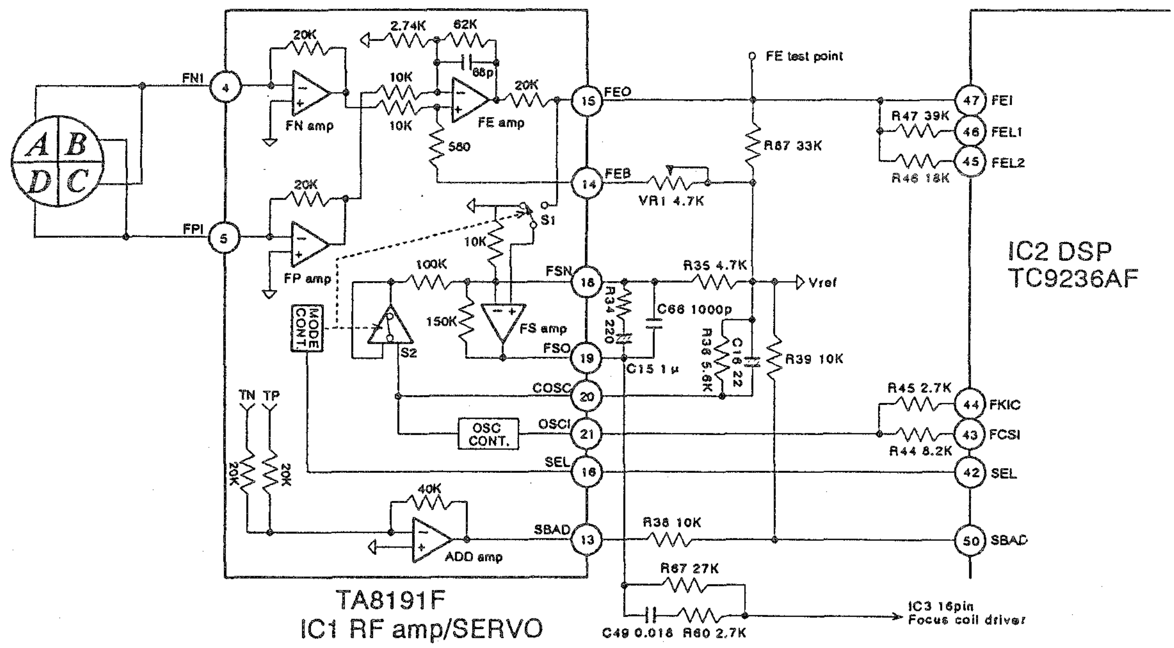
Judgment criterion: Below 25 nsec. (Sigma value)

Be sure to use the test disc in this measurement. Do not use ordinary marketed discs, for the jitter values of these discs are of deteriorated and the data obtained may not be suitable for use in judgment.

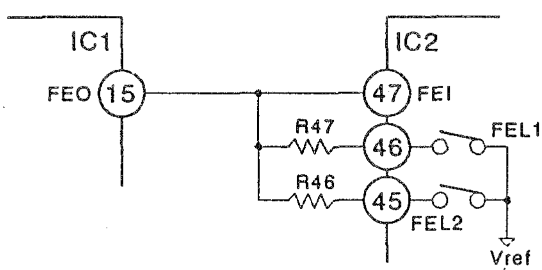
However, in most of actual fields of servicing, the jitter meter may not be available and visual judgment may be required. For example, when the observed waveform is abnormally dirty or the width is large, it is probably due to a jitter defect in the optics. However, the waveform also looks thick or inarticulate in case the objective lens is shifted due to abnormal skew feed during playback or in case the synchronization is incorrect due to incorrectly adjusted focusing offset. The visual judgment requires greatest care, and it is desirable that the result is used just as a reference in OK/NG judgment of the pick-up.

3-2. Focusing servo system

The basic operation is almost identical to the Sony's device, but this Toshiba device features the automatic servo gain adjustment function. The following description deals with the block diagram and operation description of this function.



SEL	S1	S2	SYSTEM MODE
L	Vref	ON	LD OFF
HiZ	Vref	ON	Focus search
H	FEO	OFF	Focus OK



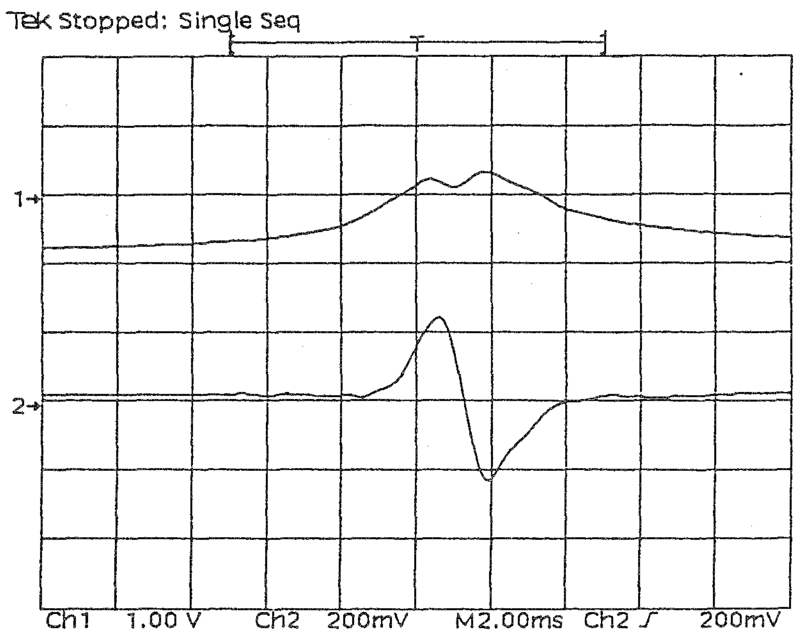
To start focusing search, the SEL terminal goes HiZ as shown in the table on the left. At this time, H/L rectangular wave is sent to pin 21 of the RF amp. With this signal, the oscillation control circuit inside the RF IC causes capacitor C16 connected to pin 20 to charge or discharge potential. The sawtooth wave produced by the charging and discharging is amplified to drive the focusing coil and an S curve signal will be at pin 15.

The signals irradiated on the sub-beam detectors in the pick-up are usually subtracted between them to become the TE signal, but they are also added and converted into the SBAD signal in IC1. This signal plays a similar role to the FOK signal in the Sony's device and is used as the focusing servo ON condition signal of the Toshiba's device.

The S curve signal at pin 15 is applied to the servo and signal processor device. The analog switches inside IC2 shown in the figure above are switched so that the S curve signal has a maximum amplitude of 0.8 Vp-p. This is the operation of the automatic focusing servo gain adjustment. After the gain adjustment, the S curve signal is used in IC2 to find the focusing zero cross (FZC) position and, if the SBAD condition is also confirmed, the SEL terminal is switched to the H level to close the focusing servo loop.

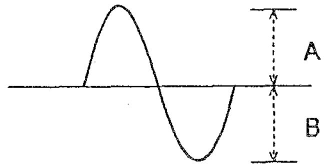
3-2-1. S curve signal

Connect an oscilloscope, storage oscilloscope if possible, between Vref (virtual mid-point) and the Focusing Error terminal. Play the test disc and observe the first FE waveform which appears when TOC search is started. Since this CD changer adjusts gain automatically as described before, an S curve can be observed at least once. Observe the S curves for a few times; if they appear symmetrically above and below the center with sufficient amplitude and in a correct period, the focusing search operation can be judged to be OK. The figure below shows waveforms observed in actual measurement.



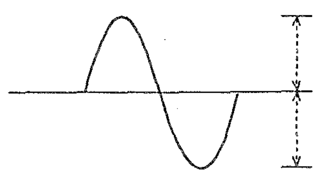
The disc used in actual measurements of optics pick-up is an expensive disc called the glass disc featuring the reflectivity, warp and deformation controlled with high precisions, and the TOC section of the test disc is used as a simplified means. If the disc surface contains fingerprint or scratch, the data may vary in every measurement and the data reliability degrades.

Amplitude of S Curve Generally Used as Reference (KDC-C50, C55, C600, C601, C800)



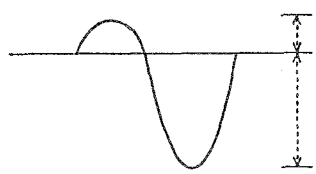
A peak value (upper half of waveform): 250 ±80 mV
B peak value (lower half of waveform): 250 ±80 mV
(Note) The measurement must be performed in horizontally level positioning.

O K



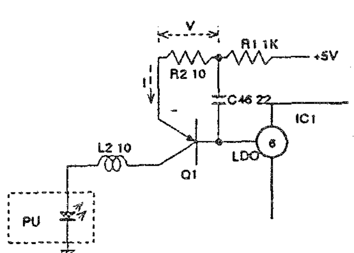
Usually, the peak value on the PC board should be +250 mV/−250 mV. Although these values are normal value, the values are variable depending on the variances in disc and pick-up. What is most important here is the balance between the voltages above and below the virtual mid-point.

N G



If the ratio between the voltages above and below are largely deviated from 1:1 as shown in the example in the figure on the left where the + voltage is 50 mV and −voltage is 250 mV, the optical axis of the pick-up may be deviated. With sets using this device, it has been observed that the voltage values above are sometimes slightly smaller than specified. However, values in the class of +190 mV/-250 mV or like cannot be judged as No Good.

For this measurement, the mechanism deck must be placed in a level position and a tolerance of about ±30% should be allows for the error in the ratio between voltages above/below the center. As these values are also affected slightly by the focusing offset adjustment, be sure to adjust the focusing offset again after a NG condition is identified in the first measurement. (Nevertheless, according to the past trend, the focusing offset re-adjustment has not varied the voltages by more than 100 mV.)



3-3. Laser diode drive current

The laser diode drive circuit is also basically identical to the Sony's device. However, there may be still cases in which checking the laser diode drive current is necessary to judge whether the pick-up is OK or NG.

The actual circuit configuration is as shown in the figure on the left. With this circuit, connect a voltmeter across resistor R2 and measure the voltage during CD playback. Then calculate the current flowing through the laser diode.

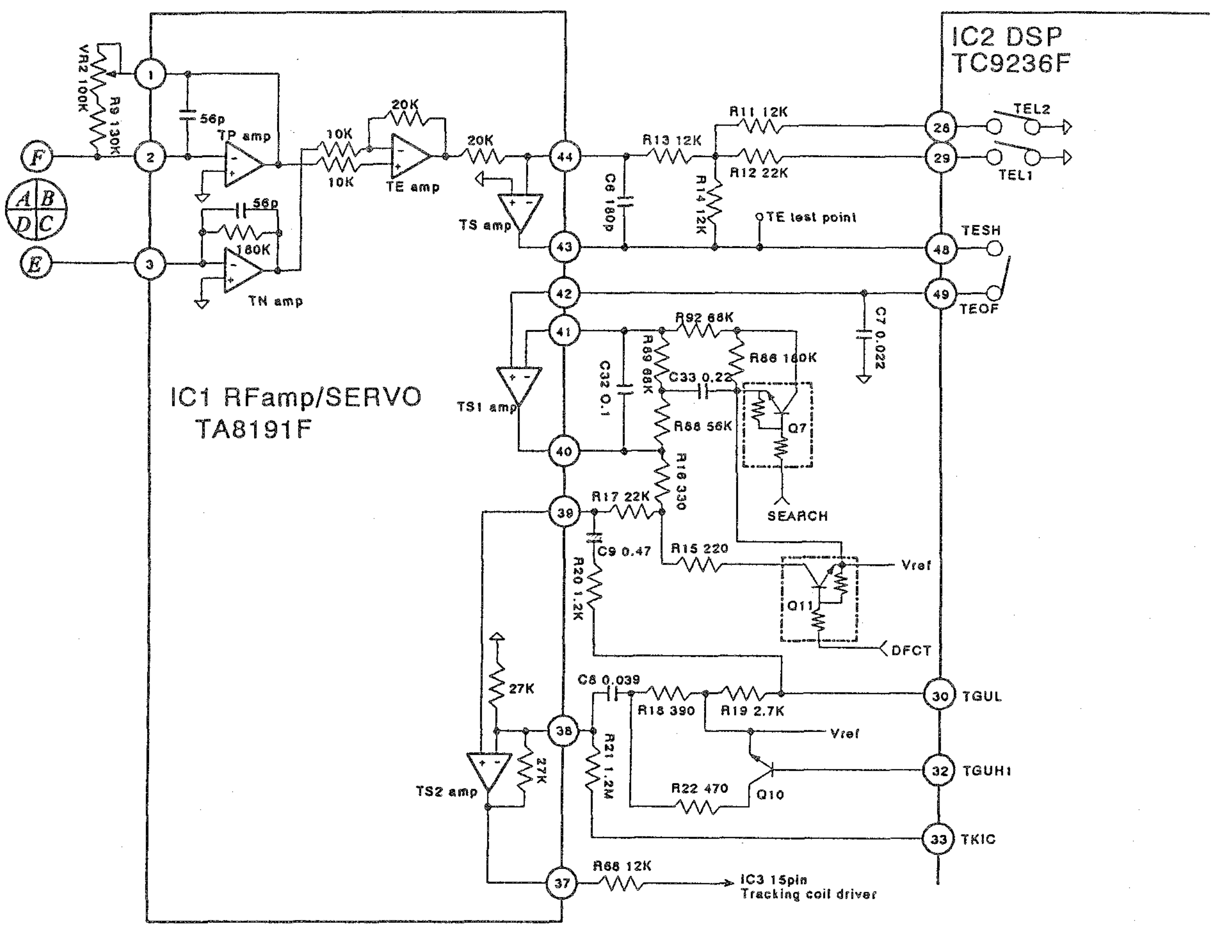
$$\text{Iop (A)} = \frac{V}{R2} = \frac{\text{Measured value}}{10\ \text{ohms}}$$

Standard ; Within ±20% of initial value

Normally, the measured voltage value is around 0.4 V thus the laser diode current is around 40 mA. The initial value of the current is indicated by the first 2 digits of the number shown on the lot number plate attached on the back of the pick-up body. For example, if the lot number is 39A22de5 the initial current of the pick-up is 39 mA.

3-4. Tracking servo system

Similarly to the focusing servo system, the tracking servo system is also basically identical to the Sony's device except for the automatic gain adjustment function. The figure below shows its circuit blocks.



The tracking error signal is controlled by the analog switches inside IC2 so that the TE traverse signal at pin 43 of IC3 is 0.8 Vp-p. During search, transistor Q7 is switched to decrease the low-frequency gain of tracking servo, Q10 functions to increase the high-frequency gain of tracking system due to an external disturbance, etc., and Q11 functions to decrease the tracing gain when a scratch is detected on the disc.

3-4-1. Countermeasure against higher resonance

The set may generate an oscillation sound in case shock is applied to the set due to external disturbance, etc. To avoid this, try constants changing as listed below. These measures are intended to reduce the higher-order resonance by delaying the phase relatively earlier through reduction of high frequency gain of the tracking system in anti-shock operation.

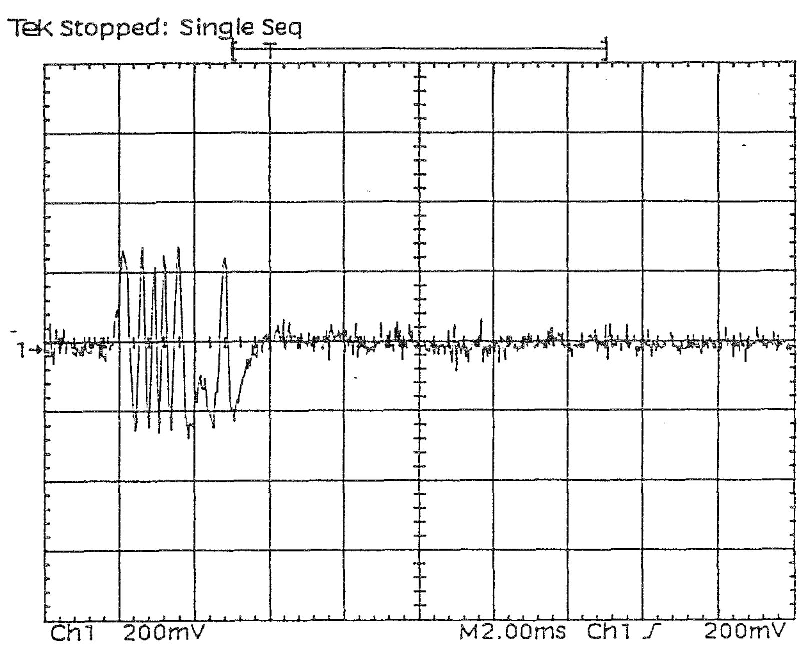
As can be identified from the circuit diagram, this countermeasure changes the high frequency gain compensator circuit to maintain the high frequency of the tracking system constantly in a low level in case shock is detected as well as during normal playback. This countermeasure is also expected to have a certain effect sometimes during playback of a disc containing scratches.

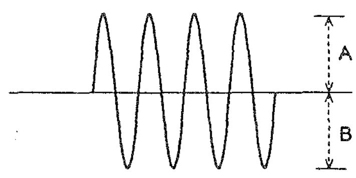
Countermeasure against higher resonance of tracking system
o Delete Q10 and R22.
o R19: 2.7KΩ → 2.4KΩ
o R18: 390Ω → 620Ω

3-4-2. Tracking offset

The figure below shows a sample of tracking traverse signal.

This signal can be observed by connecting an oscilloscope between the TE check land and Vref (virtual mid-point) and entering the specified test mode (for the test mode, refer to the service manuals). The disc used here is also the specified test disc. As a simplified method without engaging the test mode, the similar waveform can be generated by activating track search from No.1 to No.16. If the oscilloscope can be synchronized properly, the waveform can also be observed in FF or REW operation. By the way, the waveform shown below was obtained during FF operation.





It is not possible to adjust to a specific value in ± percentage because there is no measuring jig available, The value of A should be as close as possible to that of B. The imbalance between A and B is visually noticeable when it is ±5% or more. When A and B after adjustment seems to be perfectly identical, the balancing accuracy is around ±3%.

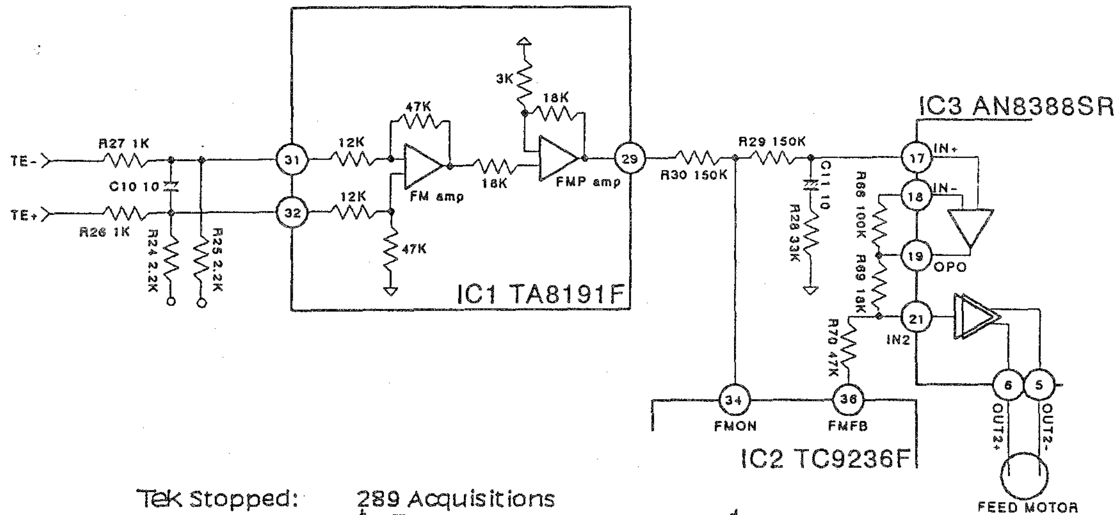
Standard: A should be as close as possible to B.

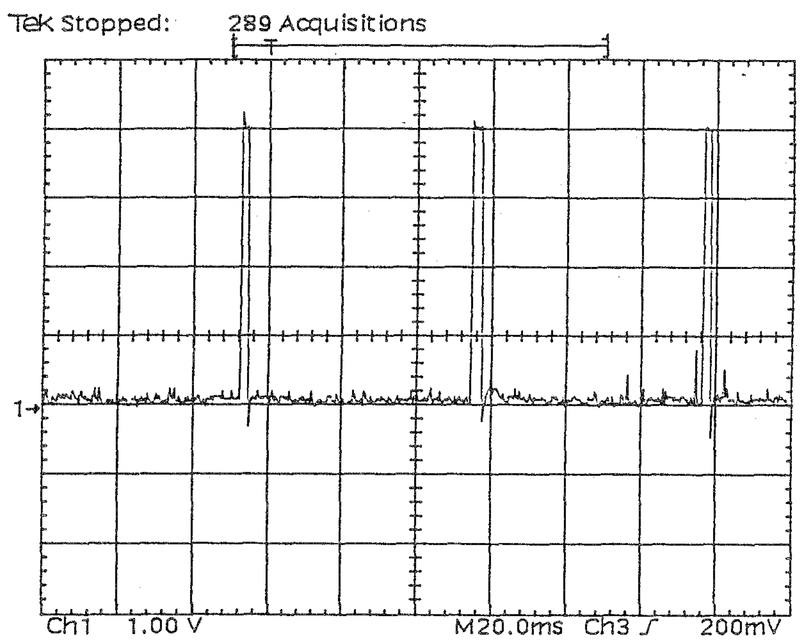
【IMPORTANT】

The objective lens of the Sanyo-made pick-up used in this changer is supported by wires, so it presents a shifting characteristic with which the TE offset is variable depending on the operating angle (vertical or horizontal installation).Therefore, the set must be placed in the level position before check or adjustment.

3-5. Sled servo

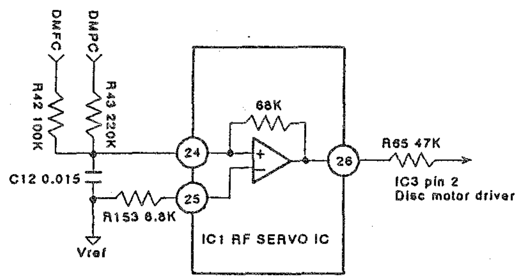
The basic operation is almost identical to the Sony's device. The figure below shows the circuit blocks and the drive waveform for fast feed of the pick-up.





3-6. Disc servo

The figure on the left below shows the actual disc servo circuit and the figures below show the waveforms of disc servo data DMFC and DMPC during search and the drive waveforms during search and normal playback.

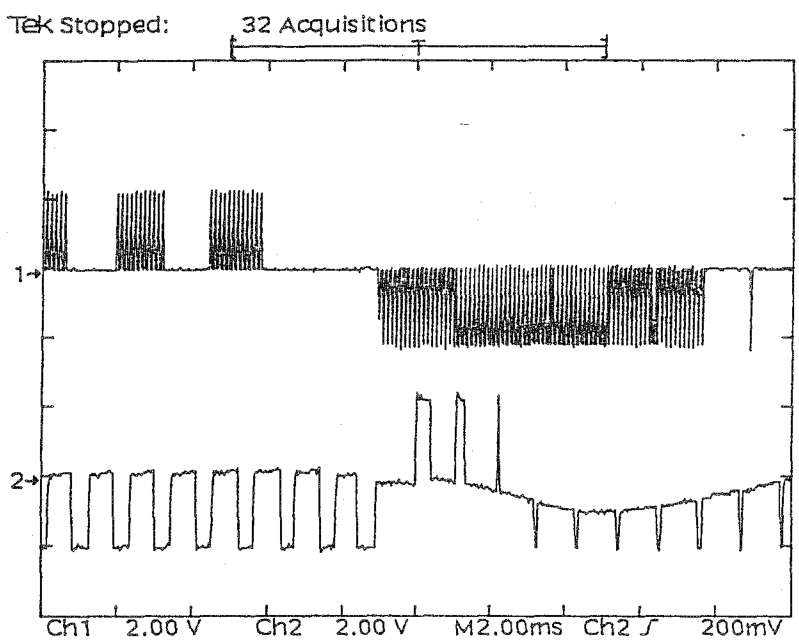


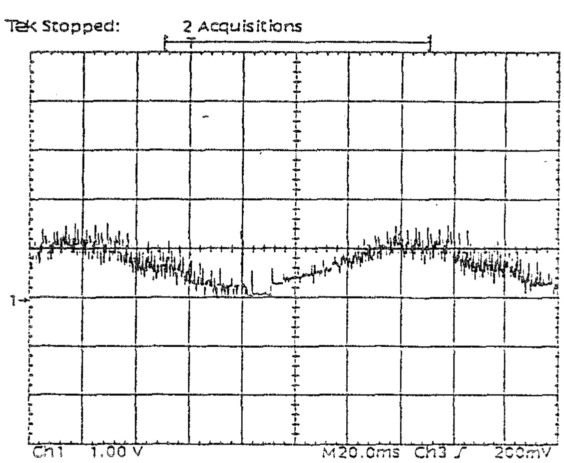
Dynamic range of spindle motor circuit

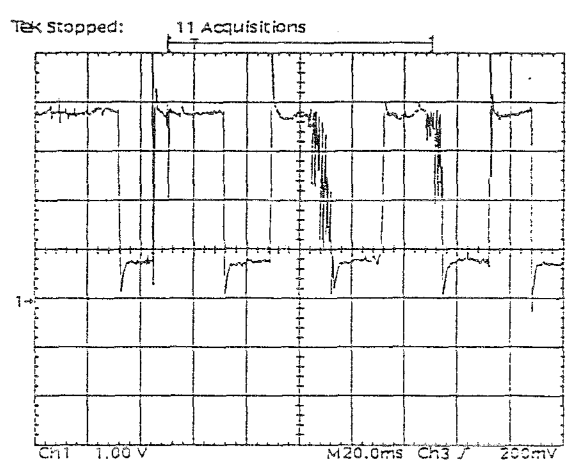
In case the disc servo system operation is strangely unstable, for example if sound skips suddenly during playback and returns to normal playback again, take the measures listed below. This countermeasure is intended to expand the dynamic range of the disc servo circuit.

R65: 47KΩ → 33KΩ

R153: 6.8KΩ → 10KΩ







3-7. Disc simulations

In this section, the features of the pick-up and mechanism system will be demonstrated by using a special disc designed for the product evaluation purpose. The evaluation achievements described in the following are limited only to those obtained with KENWOOD CD changers incorporating the Toshiba's device and Sanyo's pick-up.

3-7-1. Simulation of scratched disc

The following is the playback capability standard tested using test disc TDC-725 manufactured by A-BEX. The results mentioned below should be used only as one of references in servicing.

o INTERRUPTION IN INFORMATION LAYER

This is a simulation of a case in which on the disc signal surface (pit surface) is interrupted.

o BLACK DOT

This is a simulation of a case in which foreign object is attached on the disc read-out surface or a black dot is contained in the resin inside the disc.

o FINGERPRINT

This is a simulation of a case in which fingerprint is attached on the disc read-out urface.

	T.No	Scratch Size	Capability	Standard	Note
INTERRUPTION	T.No2	0.5mm	○	○	
	T.No3	0.7mm	○	○	
	T.No4	0.8mm	○	×	Sound Skip
	T.No5	0.9mm	○	×	Sound Skip
	T.No6	1.0mm	○	×	Sound Skip
BLACKDOT	T.No7	ϕ0.4mm	○	○	
	T.No8	ϕ0.6mm	○	○	
	T.No9	ϕ0.8mm	○	×	Noise occur
	T.No10	ϕ1.0mm	○	×	Noise occur
	T.No11	ϕ1.0mm	○	×	Noise occur
FINGERPRINT	T.No13	$\phi 65 \mu m$	○	○	
	T.No15	$\phi 75 \mu m$	○	×	Noise occur

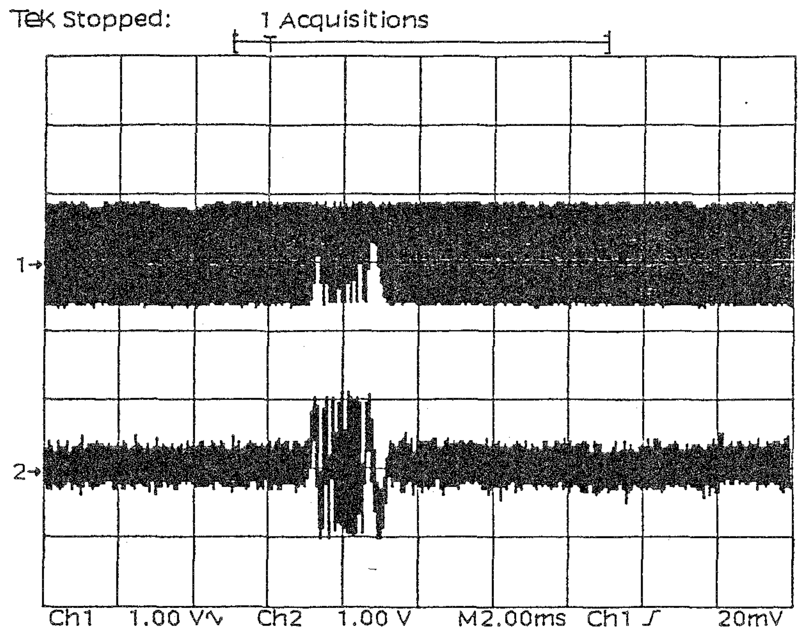
o Scratch test

This testing checks the tracking servo characteristic and error correction capability of the product by simulating scratches on the disc signal surface by using the scratch test disc (TCD-721R) manufactured by A-BEX.

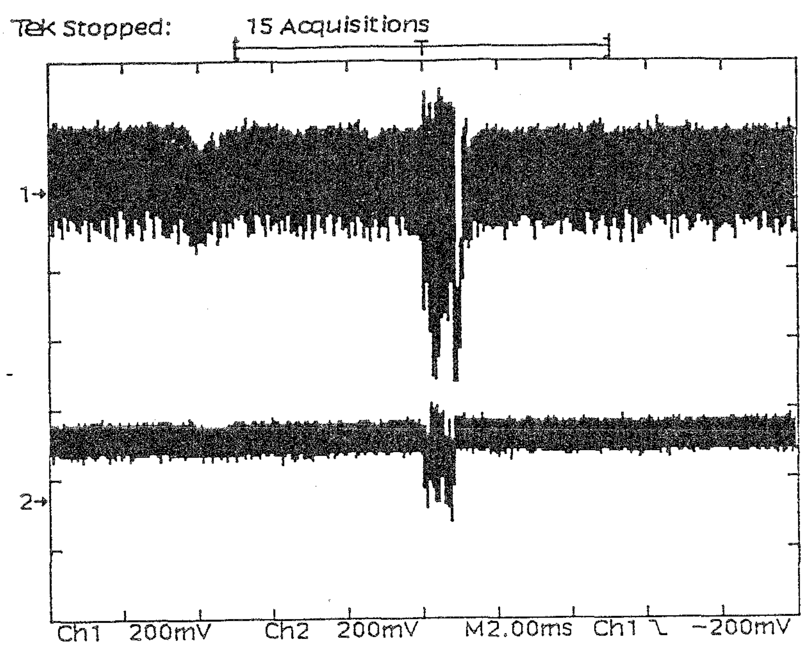
TRACK No.	Capability	Standard
T.No1 0.0mm	○	○
T.No2 0.4mm	○	○
T.No3 0.6mm	○	○
T.No4 0.8mm	○	○
T.No5 1.0mm	○	○
T.No6 1.2mm	○	×
T.No7 1.4mm	○	×
T.No8 1.6mm	×	×
↓	↓	↓
T.No15 3.0mm	×	×

【 Interruption 1.0mm 】

CH1 ; RF
CH2 ; TE

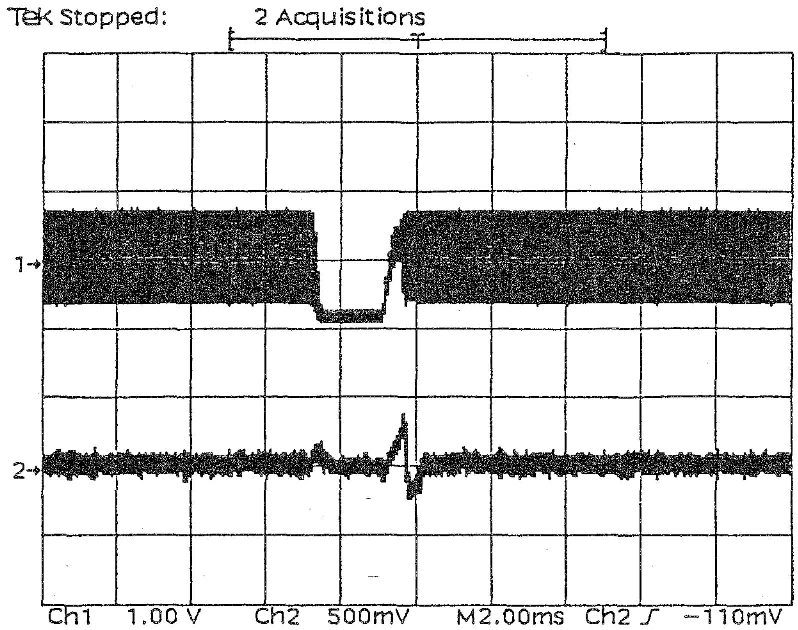


CH1 ; RFRP
CH2 ; SBAD

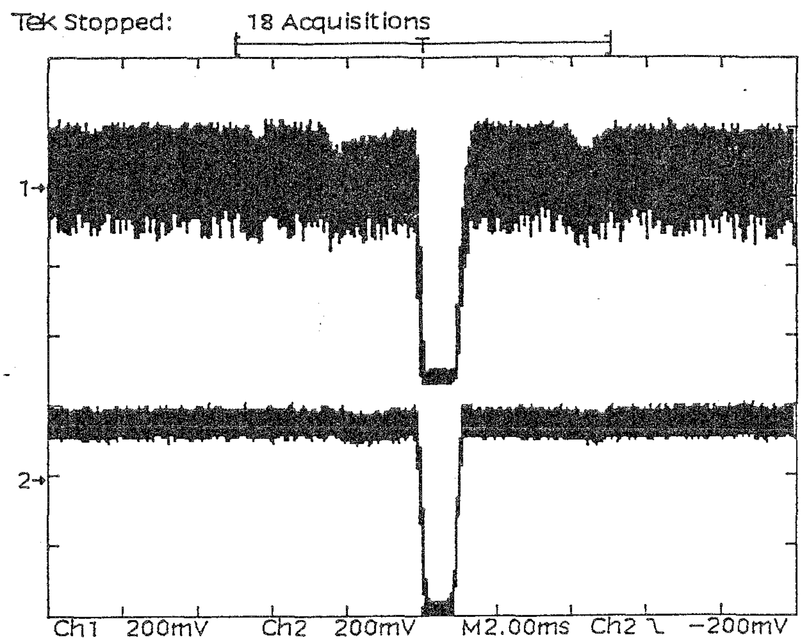


【 Black Dots ϕ1.0mm 】

CH1 ; RF
CH2 ; TE



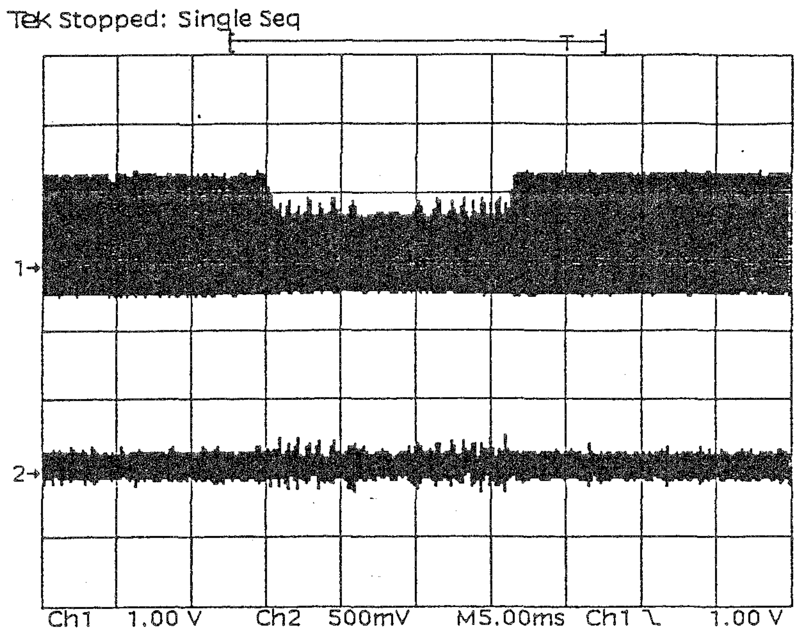
CH1 ; RFRP
CH2 ; SBAD



【 Finger Print ϕ75μm 】

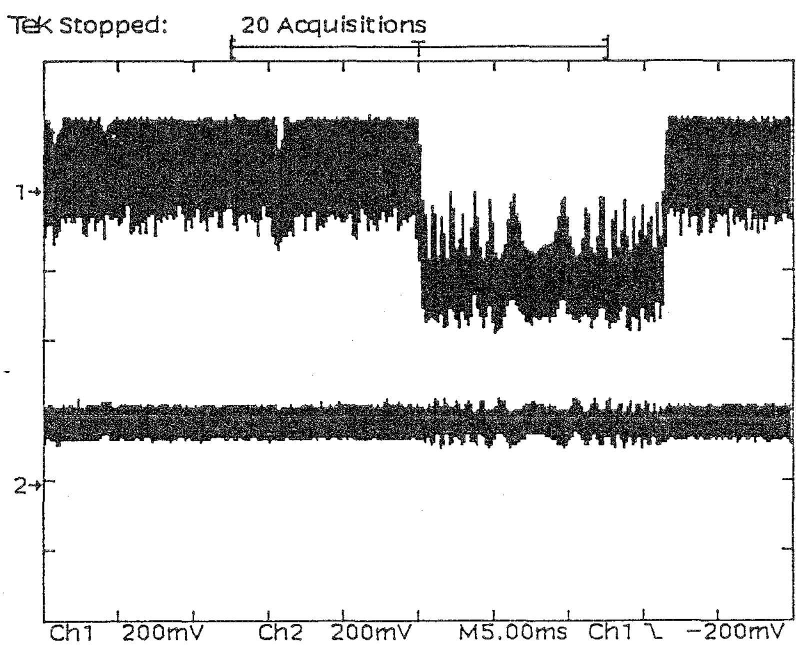
CH1 ; RF

CH2 ; TE



CH1 ; RFRP

CH2 ; SBAD



3-7-2. Simulation of eccentric disc

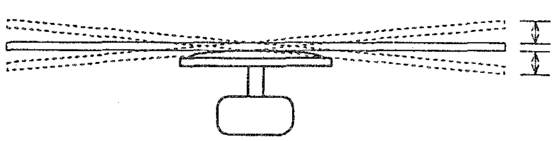
Use test disc TCD-713R manufactured by A-BEX. This test disc has been developed specially to measure and adjust the tracking servo characteristic with respect to the eccentricity of CD player. For the eccentricity, a deviation of 210 um has been produced intentionally.

First play a normal disc (zero eccentricity) to use it as the reference for making sure that there is no trouble with normal disc, then check the following;
- -if the sound does not skip during normal playback;
- -if tracks can be searched in normal period;
- -if the player does not generate strange noise;
- -if the CD does not turn at too high speed;
- -if the TOC can be read correctly.

3-7-3. Simulation of disc surface undulation

Use test disc TCD-731RA manufactured by A-BEX. This test disc has been developed specially to measure and adjust the focusing servo characteristic and error correction with respect to the surface undulation of the disc in the CD player. The maximum surface undulation height of ±0.5 mm has been provided by bonding the chucking surfaces intentionally in a deviated manner.

Track 1: ±0.215 mm	9: ±0.325 mm
2: ±0.225 mm	10: ±0.335 mm
3: ±0.240 mm	11: ±0.360 mm
4: ±0.250 mm	12: ±0.380 mm
5: ±0.265 mm	13: ±0.405 mm
6: ±0.280 mm	14: ±0.445 mm
7: ±0.290 mm	15: ±0.470 mm
8: ±0.305 mm	16: ±0.500 mm

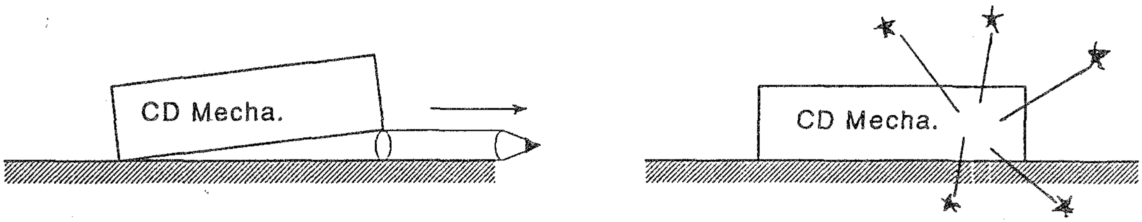


Play track No. 15 as reference and check the following;
- -if noise is produced;
- -if sound skips;
- -if the CD does not turn at too high speed;
- -if the actuator (pick-up) produce noise.

3-8. Other characteristics

3-8-1. Vibration tolerance

Basically, this cannot be measured precisely without a vibration feeder machine. But a simplified checking method as described below can be used.



Separate the CD mechanism as shown in the figure above, play the test disc in it, then insert a ball-point pen or like below it and pull out the pen so that the CD mechanism falls by itself. In this testing, place a rubber sheet (thickness of about 1 mm) below the mechanism to prevent generation of higher-order frequencies due to the shock. The sound should not skip with a vibration of this level. If sound does skip, there may be trouble in the pick-up, servo system or mechanism.

3-8-2. Time for searching disc innermost and outermost positions

This item consists of measurements of the long access times to the outermost and innermost positions of the disc. If an access takes considerably long time or if focusing servo is disengaged temporarily causing intermittence search, there could be a defect in the pick-up or servo system.

There may be following symptoms;

- the beginning of the selected track cannot be searched even after 5 seconds or more have elapsed;
- the track search itself is normal but, when the tracking is going to end after the target position has been located, the set generates hissing noise and the beginning of the track will not start;
- defocusing occurs during search.

3-8-3. TOC read-out time

This is usually measured as the time after a disc is inserted until the TOC is read out and the beginning of the first track starts.

-There may be following symptoms;

- data cannot be read out even after 7 seconds or more have elapsed;
- the sound of focusing search is heard several times;
- hissing noise is generated internally and playback will not start.

In such cases, there may be a trouble in the pick-up or servo system.

【 Supplement 】 The next section is intended to provide supplementary information on the checking related to section 3-8.

3-9. Symptoms of troubles related to each defect item

RF level

- Playback is normal but the set tends to be sensitive to scratches, etc.
- The recovery after an occurrence of sound skip tends to be delayed.
- The time required for TOC read-out is delayed with some discs.
- During TOC search, the disc rotates but tracking is unstable.
- During TOC search, the beginning of the first track will not start easily and the sled moves around. Sometimes the track starts to be played from the middle.
- The disc is kicked but tracking is impossible.

Tracking offset

- Normal playback is possible but playback becomes impossible at high temperatures above 60 ℃.
- Playback capability of scratched discs degrades.
- Even a fine dust causes sound to be played at a high speed.
- The tracking ending operation during search gets dull.
- The tracking does not end properly during search.
- Eccentric discs cannot be played at all.
- The tracking servo will not be activated during TOC search and playback is not possible.

Laser current

- The laser diode does not emit light and clicking noise is heard. (At above 100 mA)
- The laser diode lights only dimly.
- Performance alteration is not observed in most cases. (initial value of 45 mA, measured value of 60 mA, etc.) However, it is highly probable that long-term reliability cannot be guaranteed.

CLV jitter

- At around 20 nsec., almost no practical problem.
  However, care is required because jitter sometimes deteriorates on the disc position.
- Above 25 nsec., the playback become sensitive to scratches or tracking is easily disengaged.
- Above 30 nsec., playback becomes difficult with almost all discs.

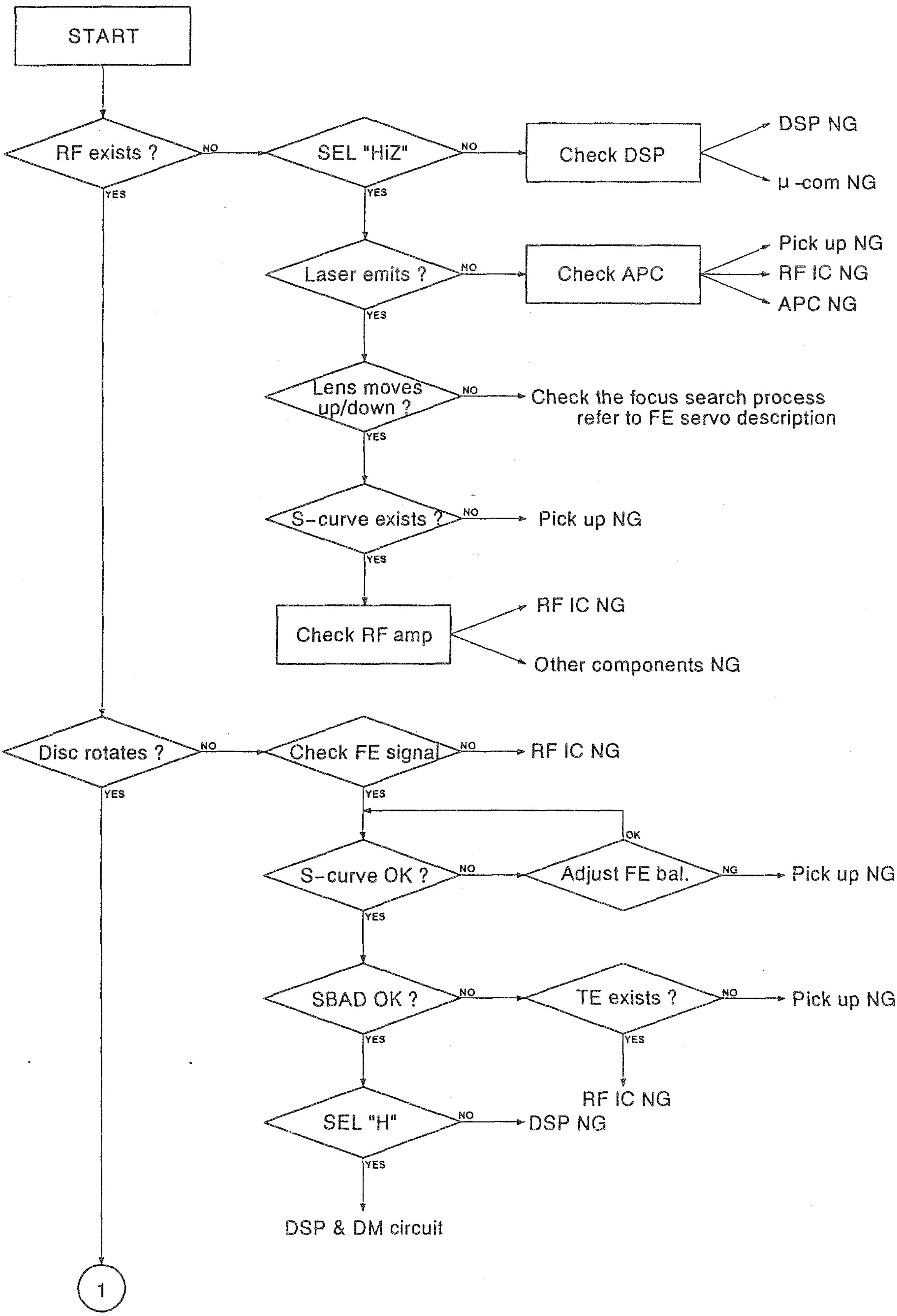
S curve (asymmetry level)

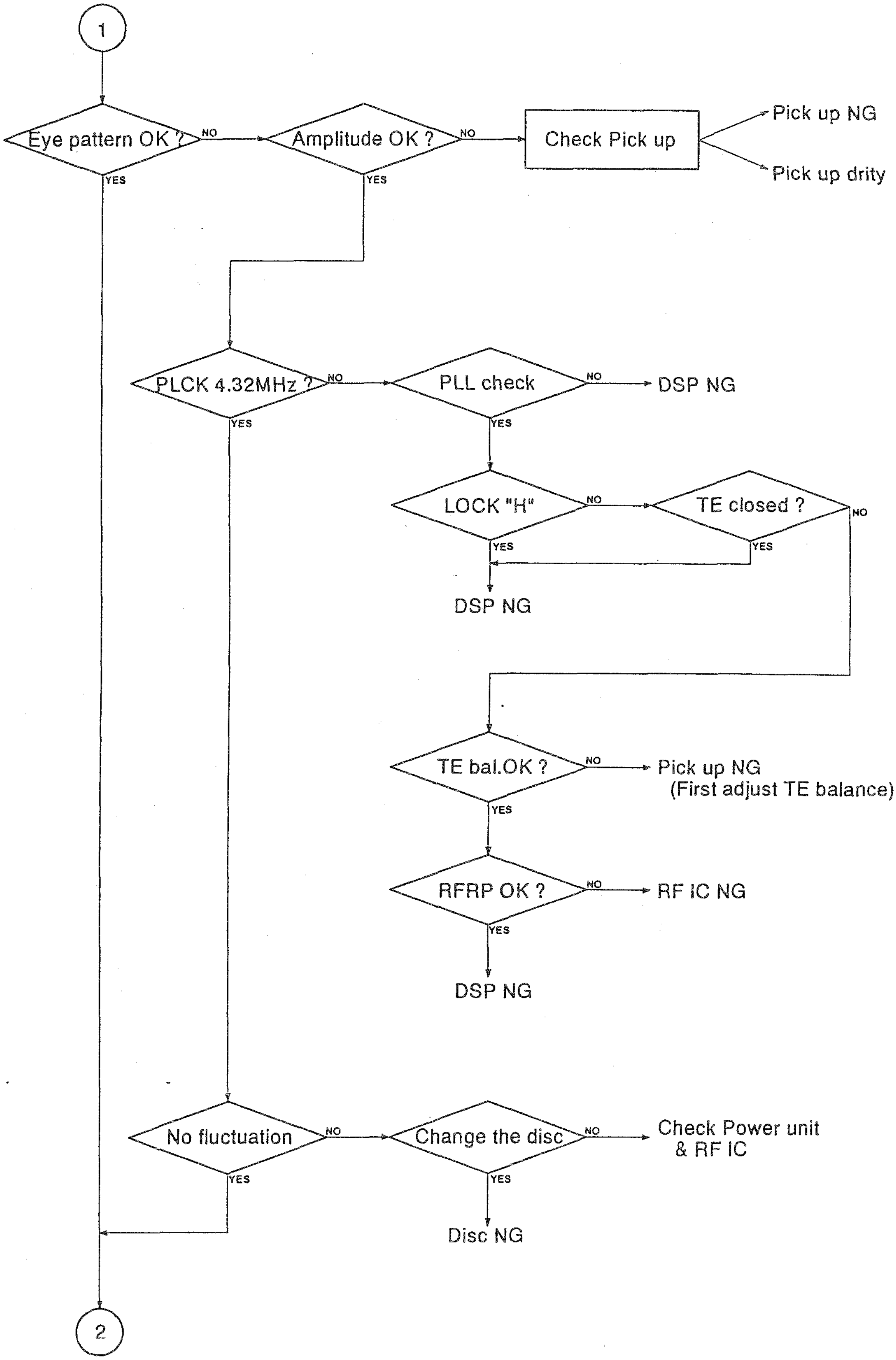
- The player performance changes little, but it becomes sensitive to scratches. (Degraded performance against fingerprint, etc.)
- Tracking becomes difficult during TOC read-out.
- Focusing search mistakes often.
- The disc does not rotate and RF signal is not output.

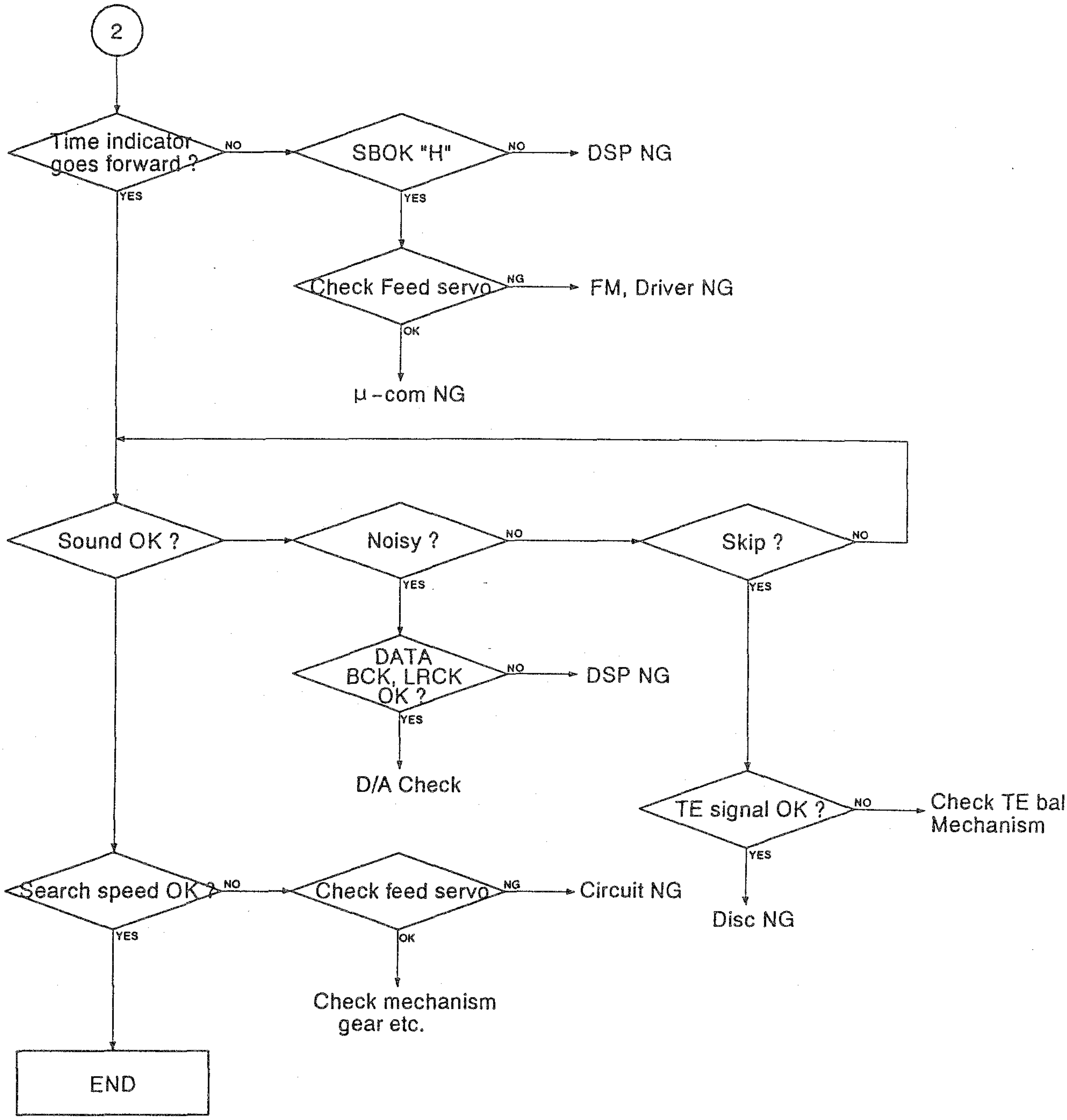
Disc motor defect

- During disc playback, interpolation noise is generated while there is no scratch on disc.
- Sound skips suddenly during playback but normal playback resumes after it.
- Intermittent sound is heard or the disc drive waveform is disturbed during playback of inner side of disc.
- Rotation does not start immediately, high-speed rotation starts suddenly or the rotation direction changes between forward and reverse repeatedly.
- Rotation is difficult and can only be started when the disc is pushed by hand.
- The disc does not rotate at all.

4. Trouble shooting for servo block




1
Eye pattern OK ?
NO
YES
Amplitude OK ?
NO
YES
Check Pick up
Pick up NG
Pick up drity
PLCK 4.32MHz ?
NO
YES
PLL check
NO
YES
DSP NG
LOCK "H"
NO
YES
TE closed ?
NO
YES
DSP NG
TE bal.OK ?
NO
YES
Pick up NG
(First adjust TE balance)
RFRP OK ?
NO
YES
RF IC NG
DSP NG
No fluctuation
NO
YES
Change the disc
NO
YES
Check Power unit
& RF IC
Disc NG
2


2
Time indicator goes forward ?
NO
YES
SBOK "H"
NO
DSP NG
YES
Check Feed servo
NG
FM, Driver NG
OK
μ-com NG
Sound OK ?
Noisy ?
NO
YES
Skip ?
NO
YES
DATA BCK, LRCK OK ?
NO
DSP NG
YES
D/A Check
TE signal OK ?
NO
Check TE bal. Mechanism
YES
Disc NG
Search speed OK ?
NO
YES
Check feed servo
NG
Circuit NG
OK
Check mechanism gear etc.
END

§ 3 . CD Changer with PANASONIC devices

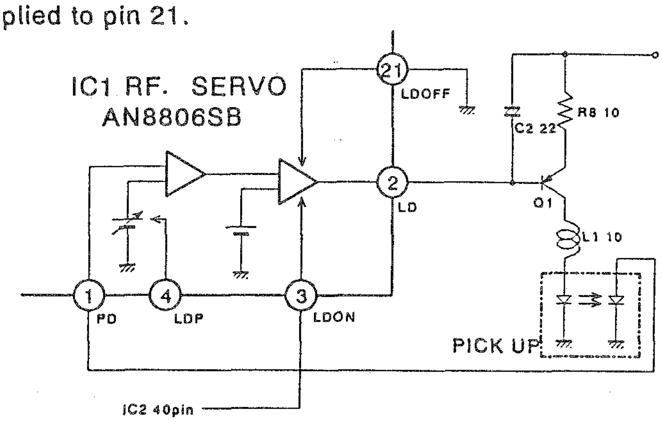
1. Applied models
   KDC-C10, C602.

2. Basic configuration
   - o Single 5 V power supply for the servo circuitry
   - o RF servo device AN8806SB
   - o Digital signal processor/servo processor MN662720RB
   - o Pick-up mfd. by Sony, KSS-401A

3. Servo circuit description (KDC-C10)

   3-1. APC circuit

The scheme of the actual circuit is shown below. The operation are basically identical to the devices described before. In this circuit, the reference voltage of the laser diode is set to approx. 170 mV by opening pin 4. Pins 3 and 21 are LD ON/OFF control terminals. The LD is turned ON when "High" is applied to pin 3, and OFF when "High" is applied to pin 21.

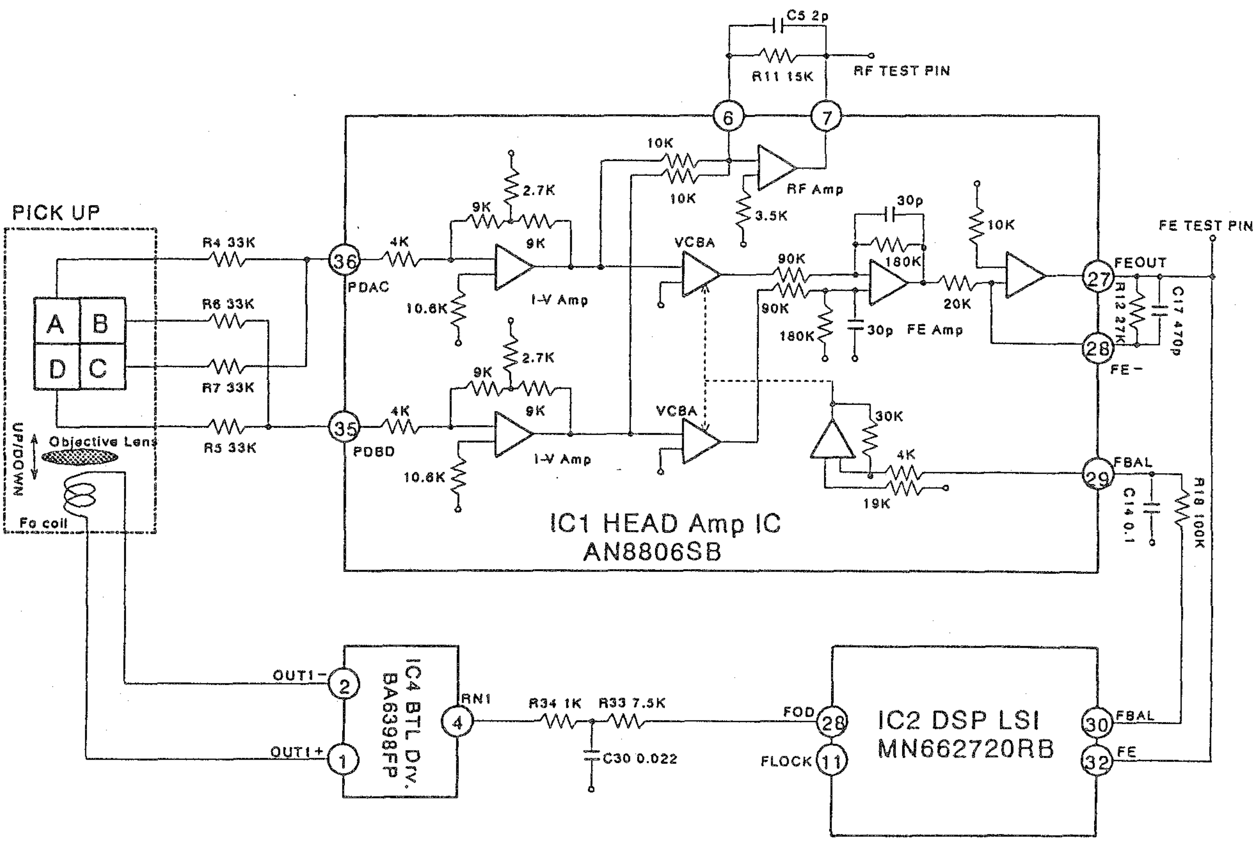


3-1-1. LD drive current

The LD drive current of the pick-up is obtained from the voltage across R8 shown above during CD playback. The initial value of the LD drive current is indicated on the label attached on the back of the pick-up body. For example, if the figures shown on the label is "RB473", the initial LD drive current is 47 mA, with a tolerance of approx. ±20%.

3-2. Focusing servo and disc sensing

All of the adjustment items which have been necessary with focusing system (offset, balance, gain) are controlled with auto adjustments and about 70% of the servo system circuitry is digitalized. The actual circuit and operation sequences are as described in the following.



3-2-1. Focusing offset adjustment

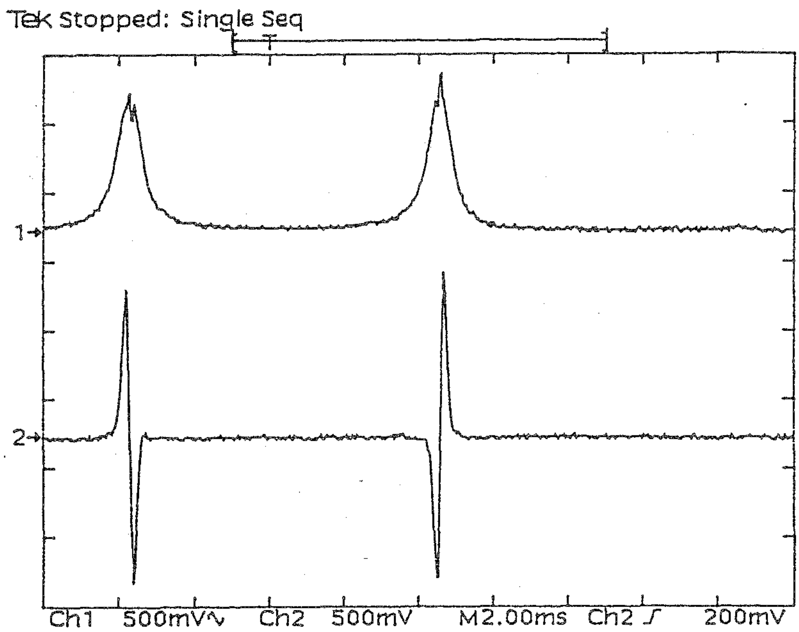
After the Play command is issued, the focusing lens is moved to the lowermost position and the value of focusing error at this time is stored as the offset value. Hereafter, the focusing error value is obtained by subtracting the offset value from the focusing error signal input through the FE terminal.

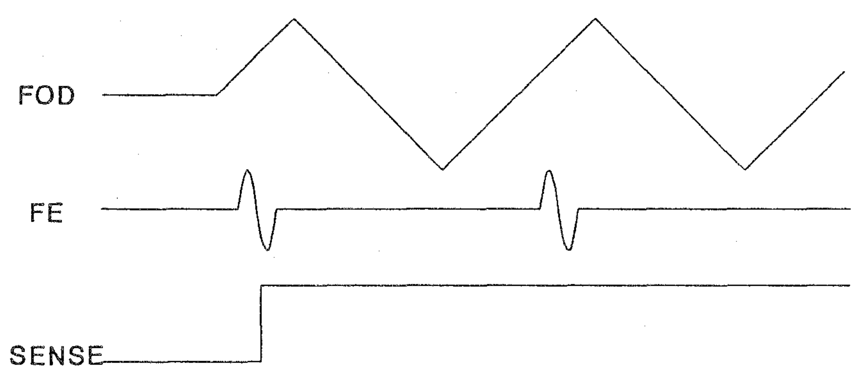
3-2-2. Disc sensing

The FOD terminal generates a triangular wave of approx. 5.4 Hz to generate the disc sensing gate and turn the SENSE terminal at pin 10 of the signal processor device. The focusing servo is not locked at this time. The disc sensing operation will not complete unless the μ-com has confirmed that SENSE is "H" and transmitted another command.

Example of disc sensing operation

The following diagram shows the waveforms of RF and FE during disc sensing operation. As described before, the presence of disc is sensed when the S-shaped waveform of the FE signal is delivered to the signal processor/servo processor device.



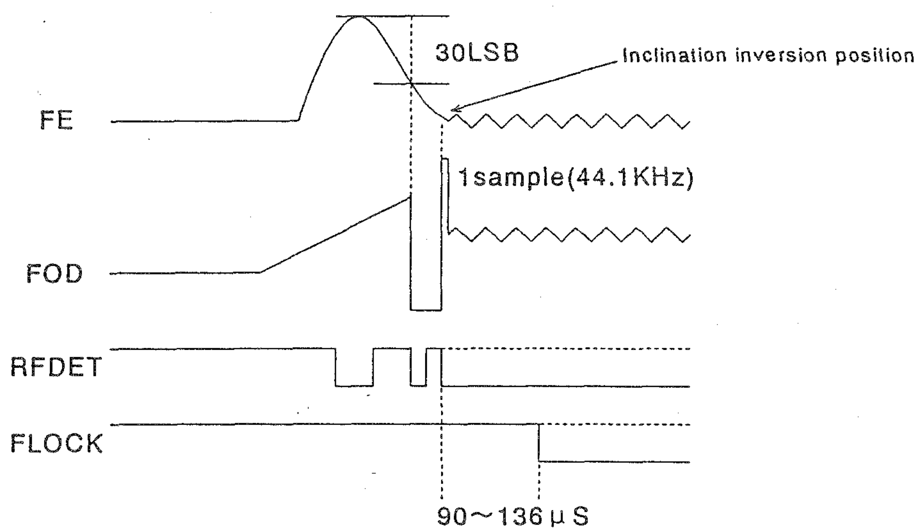


3-2-3. Focusing system coarse gain adjustment

The amount of the external disturbance signal to be injected for the focusing gain adjustment is determined from the amplitude of the focusing error signal (S curve) generated during focusing search. This operation does not alter the focusing gain itself.

3-2-4. Auto focusing search

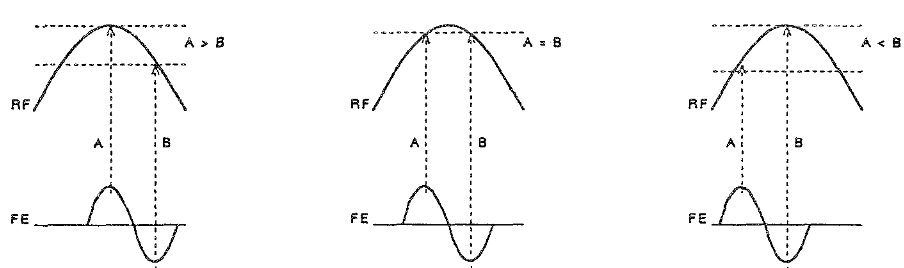
When the servo signal processor IC receives the Focusing ON command, the FOD terminal generates a triangular wave of approx. 1.3 Hz to drive the focusing coil and lock the focusing servo automatically based on detection of the S waveform of the focusing error signal. When the focusing is locked, the FLOCK terminals goes "L" level.



The "just-in-focus" point of focusing servo is detected from the error signal gone through the FE terminal. This operation consists of stopping the lens by full-force driving to the opposite direction to the previous drive direction when a value which is by 30 LSB below the value of the S curve peak of the FE signal. Then, by identifying the stoppage of the lens from the inversion of the inclination of the error signal at the FE terminal from the inclination before the full-force driving, the servo loop is closed. In case focusing could not be locked due to a certain reason or when the FLOCK terminal goes "H", focus search operation will be carried automatically.

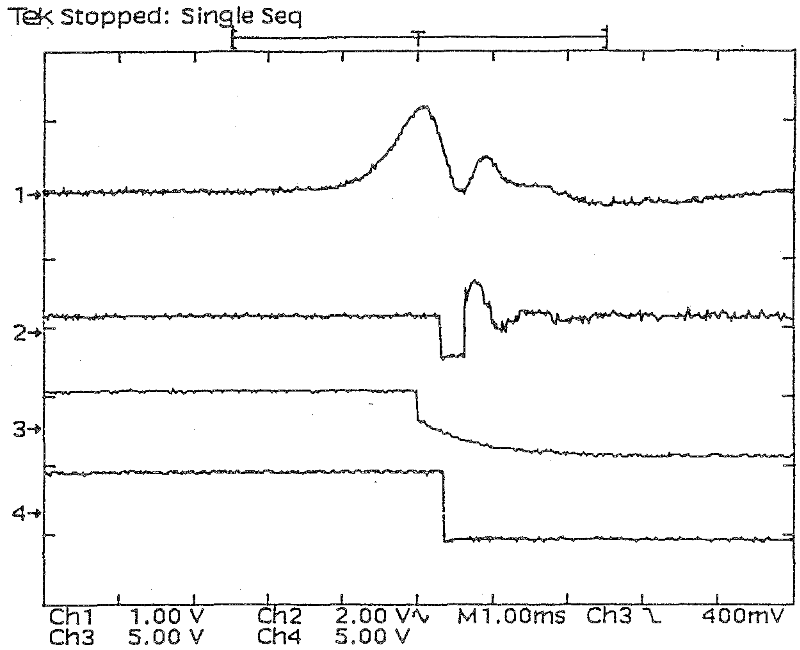
3-2-5. Auto focusing balance adjustment

By injecting an external disturbance signal (689 Hz, amplitude input during focusing coarse gain adjustment) in the focusing servo loop, focus balancing output FBAL is generated so that the maximum values of the 3T envelope of RF signal in the negative and positive sections of the FE signal (S curve) after offset adjustment become identical.



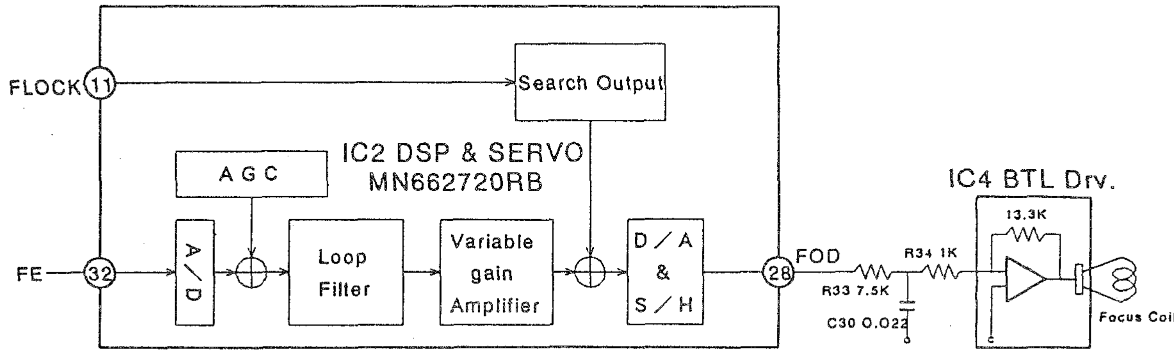
Fo BAL. NG Fo BAL. OK Fo BAL. NG

The following diagram shows the waveforms actually observed in the auto focus search operation of 3-2-4 before. The waveform of the FOD signal of the 2nd channel is not as described before. This waveform is not expressed as theoretically expected because the frequency of the signal output from the FOD terminal during lens drive is very low and the oscilloscope response speed is high. Thus, there is no trouble or mistake involved in this case.

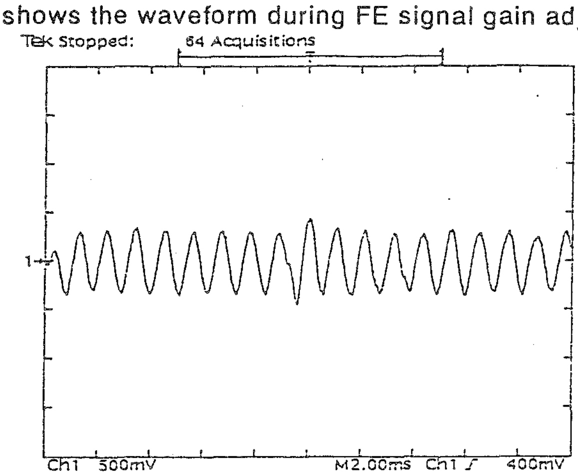


CH1 ; FE
CH2 ; FOD
CH3 ; RFDET
CH4 ; FLOCK

3-2-6. Focusing gain fine adjustment



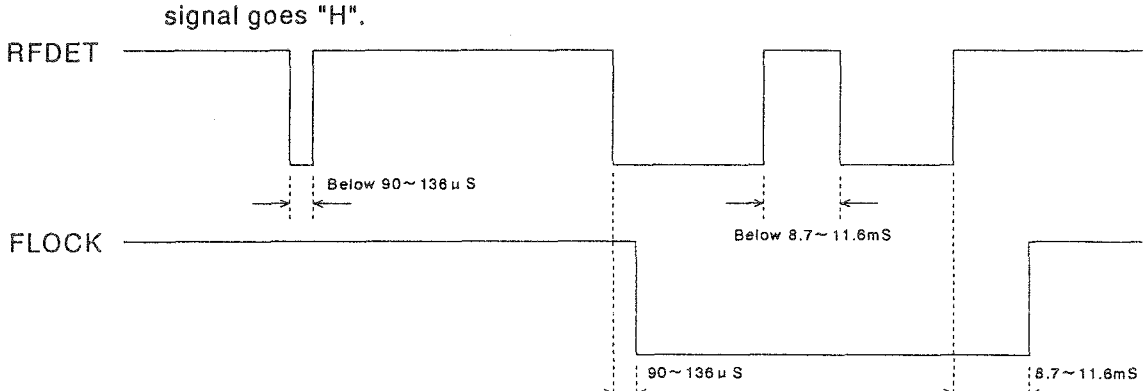
As shown in the block diagram above, the error signal come through the FE terminal is sent through a loop filter and variable-gain amplifier, converted from digital to analog and appeared at the FOD terminal. For the auto gain control, an external disturbance signal (amplitude obtained during coarse gain adjustment) is injected in the focusing servo loop and the variable-gain amp is adjusted so that the gain-crossover frequency becomes identical to the frequency preset in the RAM (956 Hz). The following diagram shows the waveform during FE signal gain adjustment.



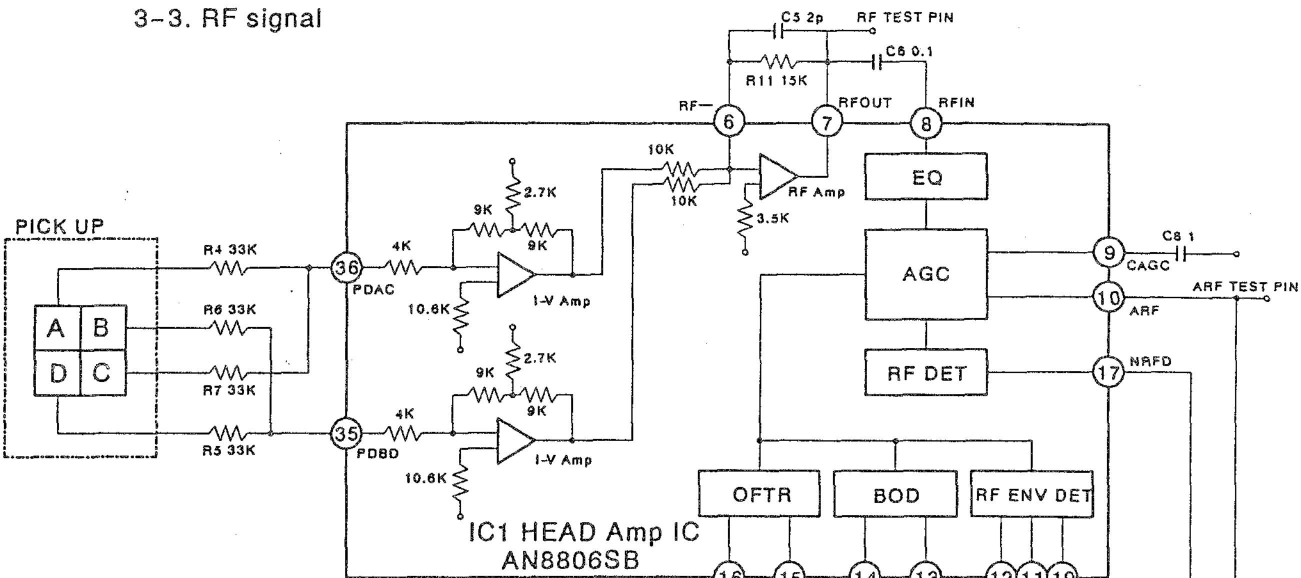
3-2-7. Focusing lock

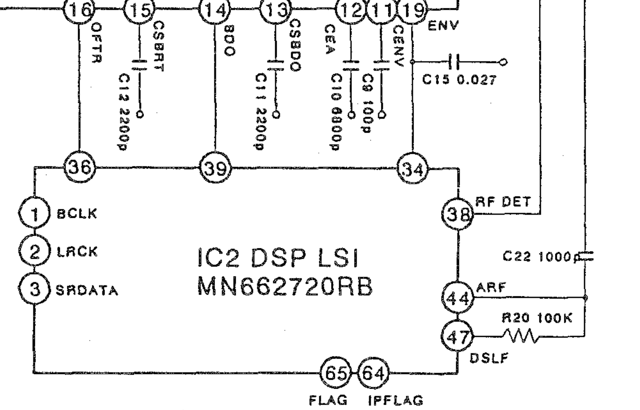
The focusing servo lock signal is generated from the RF detection signal delivered through RFDET. "H" of the FLOCK terminal indicates the out-of-focus state and "L" indicates the focusing locked state.

1) When the RFDET signal remains "L" for 90 to 136 μs or more?, the FLOCK signal goes "L".
2) When the RFDET signal remains "H" for 8.7 to 11.6 ms or more?, the FLOCK signal goes "H".

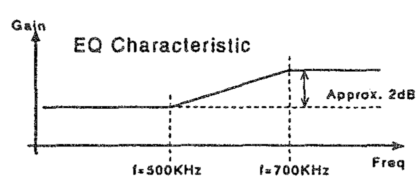


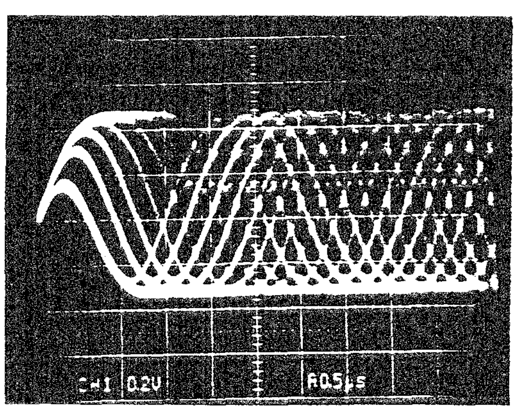
3-3. RF signal

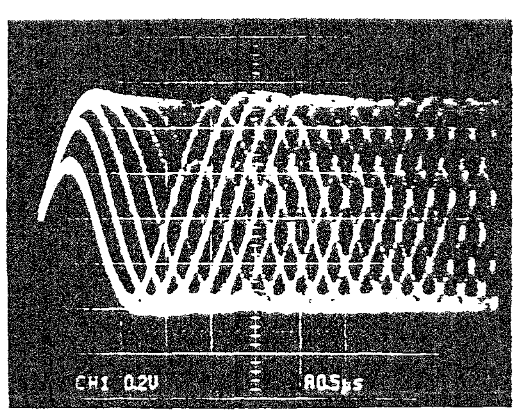




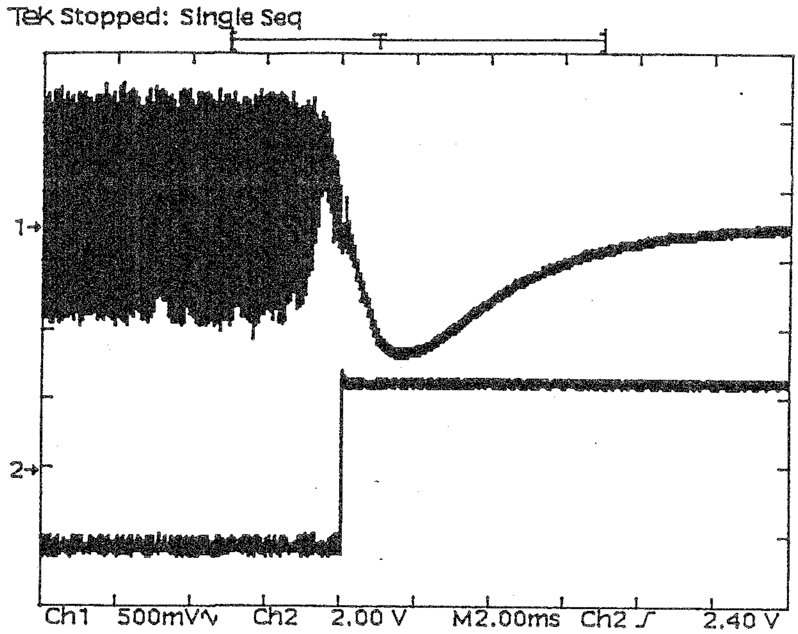
The signals come from the PD terminals are mixed by the RF amp into a single RF signal, which is appeared at pin 7. Here, the RF signal is set to have an amplitude between 0.5 and 1.0 Vp-p. The RF signal is sent through a capacitor and led to the EQ and AGC circuits in the head amp again. The diagram below shows the characteristics of the EQ circuit.
The ARF signal is amplified by the AGC circuit so that its amplitude is approx. 1.0 to 1.5 Vp-p when it is applied from the AGC circuit. The AGC-controlled RF signal goes via a capacitor of the data slice filter to the signal processing stage for demodulation.





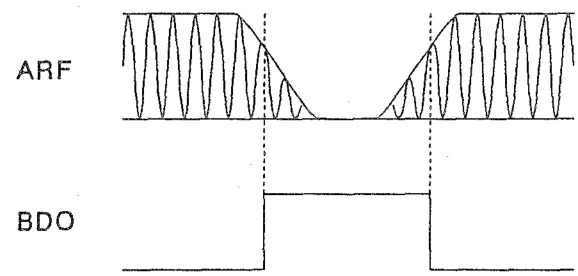


On the other hand, the RF signal come from the AGC circuit is also sent to the RF signal amplitude detection stage for use in generating the RFOK signal. The following diagrams show the ARF signal and the NRFD signal which is amplitude detection signal.



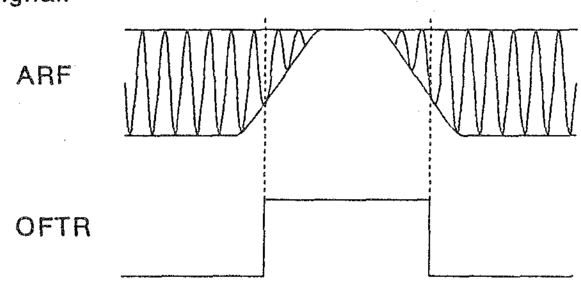
3-3-1. BDO detection

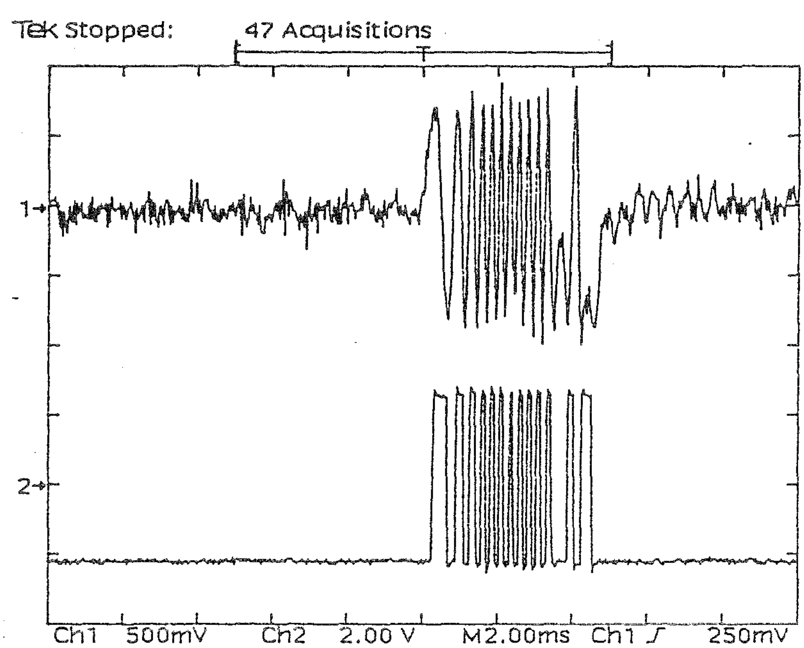
The circuit for detecting a blank in RF signal detects BDO by high and low speed detection of RF signal and produces "H" level signal from the BDO terminal. The scheme is shown below, but the actually observed waveforms should be confirmed in the section on the disc simulation which is described later. BDO is detected when the RF signal amplitude decreases by approx. 25% if the external capacitor C11 is 2200p.



3-3-2. OFTR detection

The basic structure is identical to the BDO detector circuit and the mirror surface of disc is detected by high and low speed detection. The OFTR state is detected when the RF signal amplitude decreases by approx. 65% if external capacitor C12 is 2200p. The scheme is shown below together with the waveforms showing the actual operation with the TE signal.

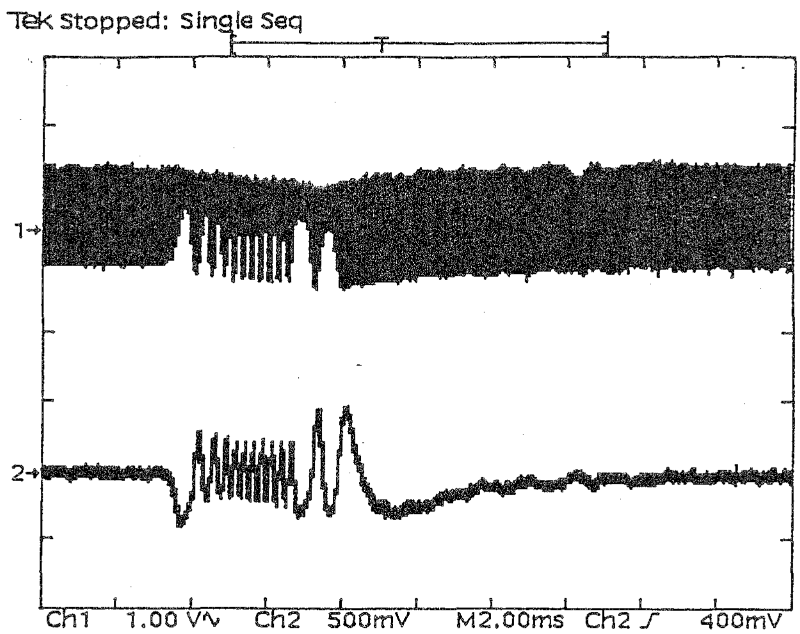




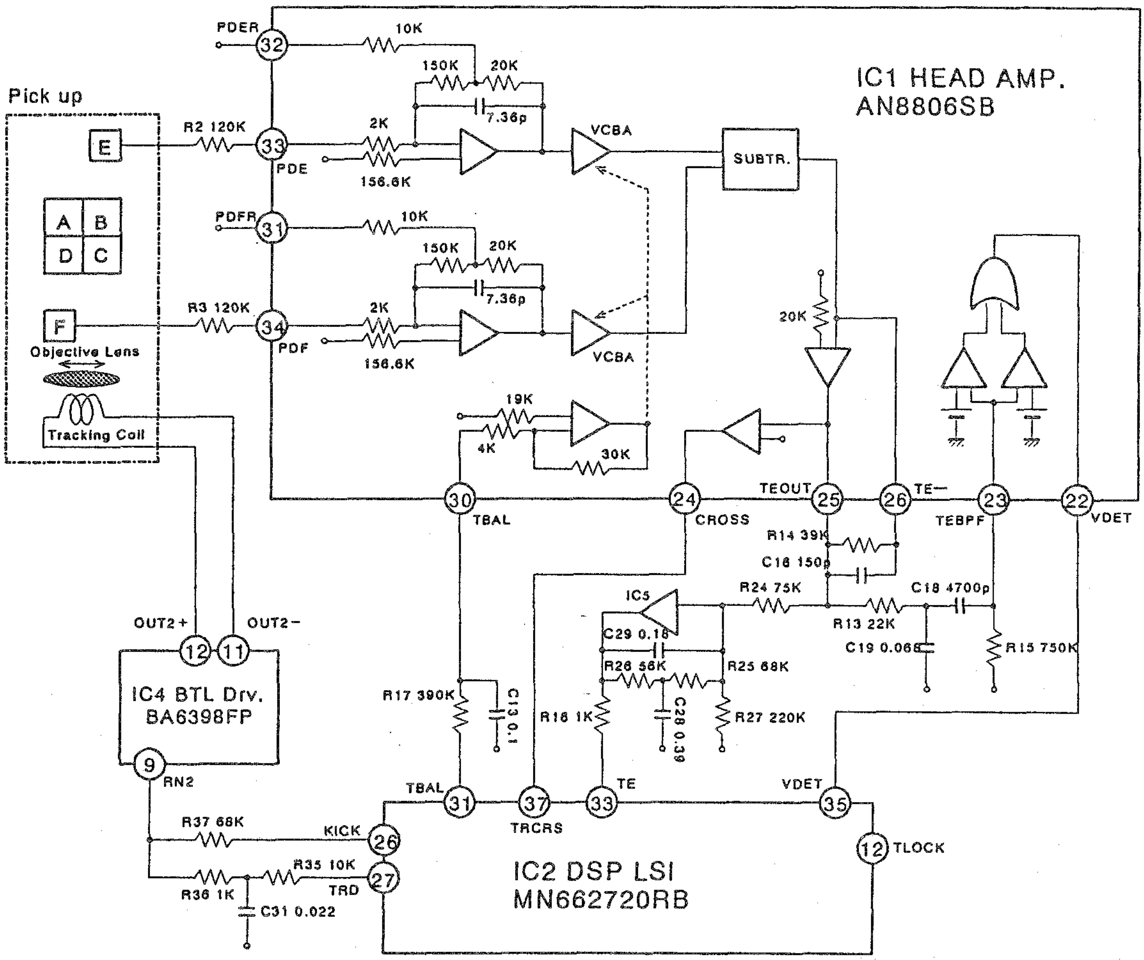
3-3-3. Envelope detection

The 3T component of the RF signal required for the adjustment described in section 3-2-5 "Auto focusing balance adjustment" is extracted in this circuit block. If the ENV terminal does not make signal, the operation goes on without balance adjustment and troubles such as sound skipping may result.

The following diagrams show the ARF and ENV signals. These waveforms were sampled during disc FF operation to check the operation.



3-4. Tracking servo



The tracking servo is also a digital servo with which all of the adjustment items (offset, balance, gain) are controlled with auto adjustments like the focusing servo system. The operations of the auto adjustment system are as described in the following.

3-4-1. Tracking offset adjustment

By turning the LD OFF and shunting the tracking error output from the head amp, the tracking error value at this time is stored as the offset value. Hereafter, the tracking error value is obtained by subtracting the offset value from the tracking error signal from the TE terminal. Similarly to the focusing servo system, these adjustments are made indispensable by a very large offset of the voltage-variable amp (VCBA) in the head amp.

3-4-2. Tracking coarse gain adjustment

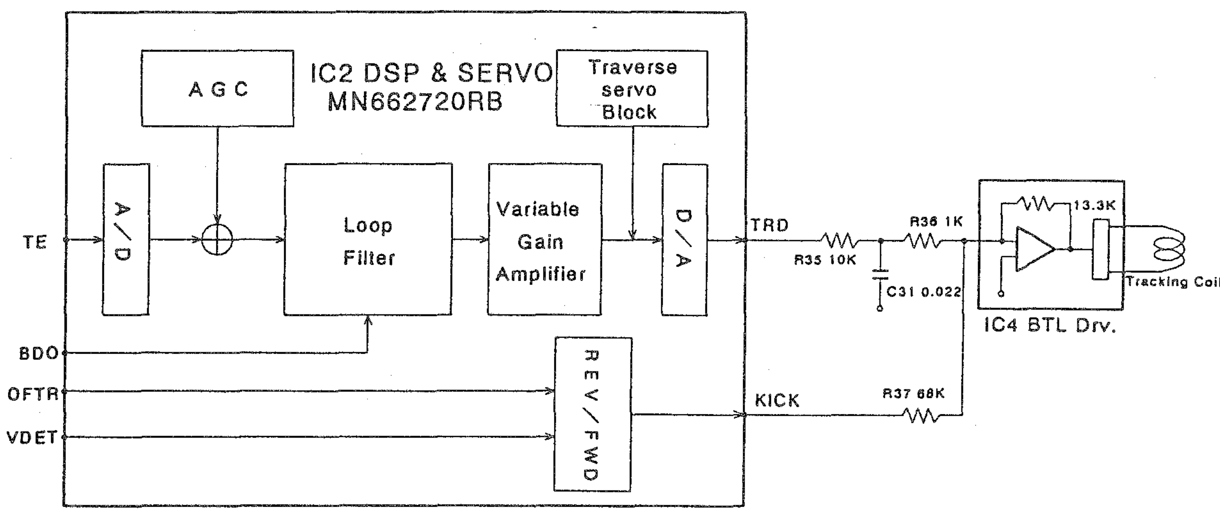
The amount of the external disturbance signal to be injected is determined from the amplitude of the tracking error signal generated when the sled is stopped. This operation does not alter the tracking gain itself. The disc motor servo is in 6T mode (rough servo) during this operation.

3-4-3. Tracking balance adjustment

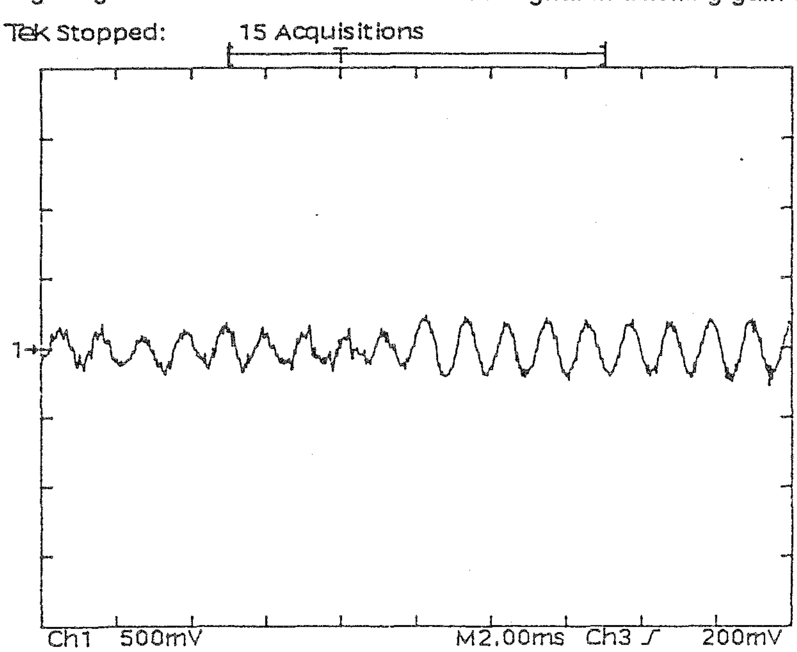
By stopping the sled, tracking balancing output TBAL is generated so that the average of the tracking error values is almost 0. With the TBAL signal, the signal ratio of the VCBA is variable from approx. 0.14 to 7 with a variable input of ±1 V to the reference voltage Vref. During the variation of the input from +1 V to -1 V, the signal polarity varies in the direction to increase the TEOUT signal. When the variable input is equal to Vref, the signal ratio of the VCBA becomes 1.

3-4-4. Tracking fine gain adjustment

With the sled stopped, an external disturbance signal with a previously-determined amplitude is injected in the tracking servo loop and the variable-gain amp is adjusted so that the gain-crossover frequency becomes identical to a preset frequency (1129 Hz). The D/A converter unit has an output resolution of ±128 LSB, and the output from the TRD terminal is equal to the voltage Vref when the D/A converter output value is 0 LSB.

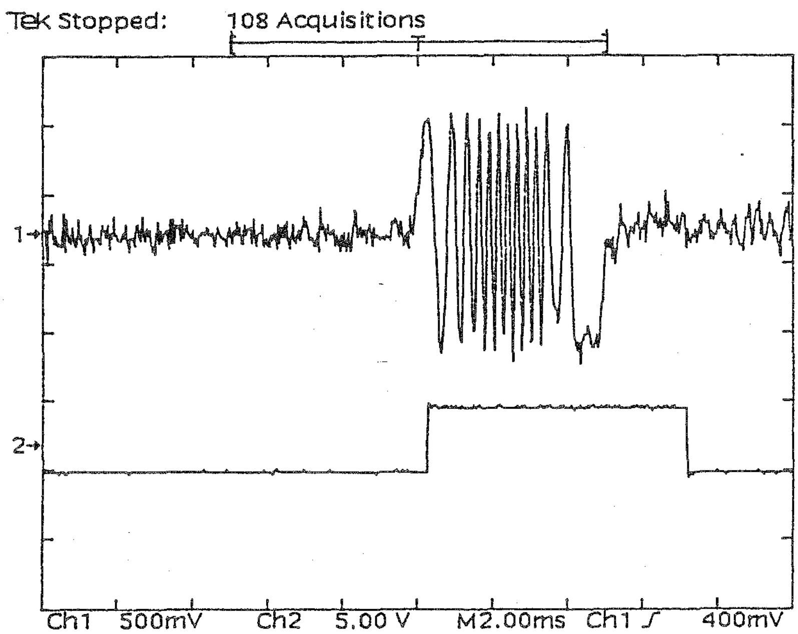


The following diagram shows the waveform of TE signal in tracking gain adjustment.

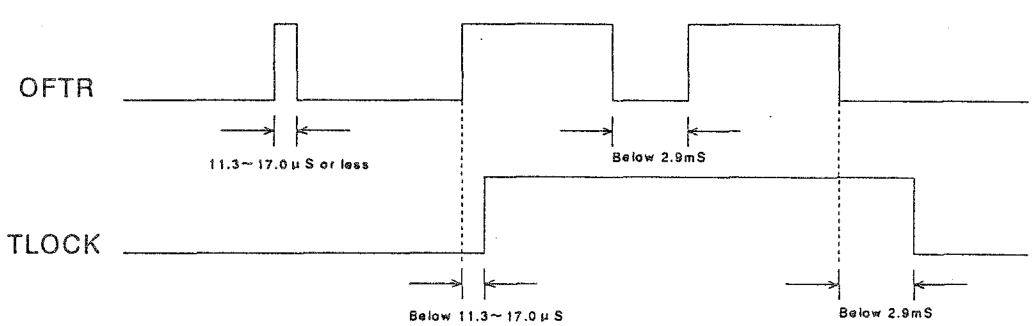


3-4-5. Auto tracking lock

When the Tracking ON command is delivered from the μ-com interface, locking to the nearest track is performed while monitoring tracking error signal TE and off-track signal OFTR (H: Off-track). For locking to a track, the loop filter output is basically held and the kick pulse is applied from the KICK terminal to drive the tracking coil. If off-track signal OFTR remains "L" for approx. 5.8 ms, the kick pulse generation is stopped and the operation changes to the normal servo. When tracking is locked, the TLOCK terminal at pin 12 of the signal processor device goes "L". The following diagrams show the observed waveforms of the TE and TLOCK signals.



By the way, the tracking locking operations is carried to forcing the pick-up to the on-track position of the target track and locking the servo when the relative velocity has slowed down enough.



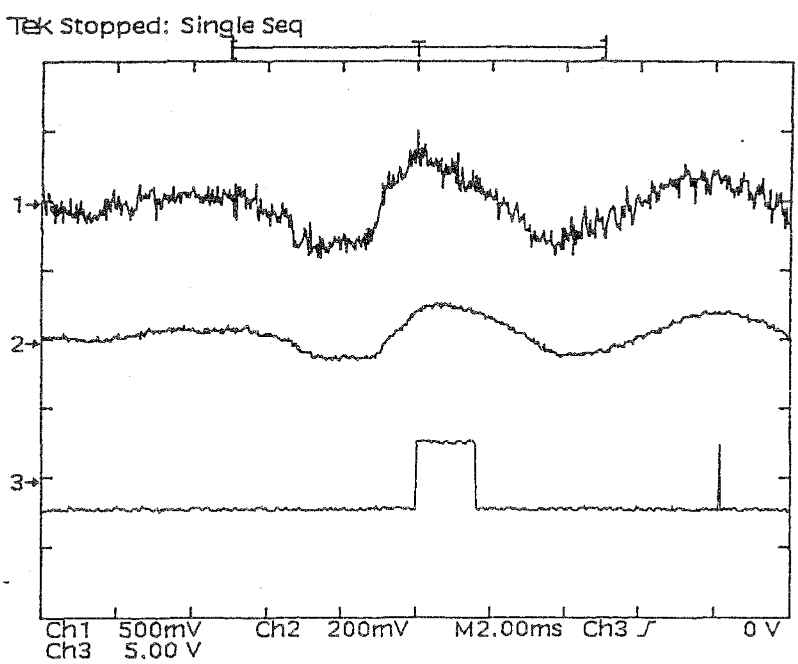
3-4-6. Anti-shock processing

When an external vibration or shock is applied to the set during disc playback, a relatively large low-frequency component is usually generated in the tracking error signal. This low-frequency component is extracted with a BPF to detect the vibration. The actual processing includes the following two processes.

1) When vibration detection signal VDET has gone to "H" level (during vibration appplied) and returned to the "L" level, forced braking signal is applied for a certain period. If off-track signal OFTR goes "H" level (which indicates that the beam is located on the mirror surface) in this period, a kick pulse is generated to turn the OFTR signal to "L" level to improve the vibration resistance.

2) The servo system gain can be increased for a certain period when vibration detection signal VDET goes "H" level. This function has already been programmed in the µ-com and, with the products (KDC-C10, C602), the tracking gain is increased by approx. 6 dB for 23.2 ms. (The anti-shock processing is not applied to the focusing system.)

The following diagrams shown the TE waveform, the TE waveform after passing through the BPF and the VDET waveform when vibration is detected.

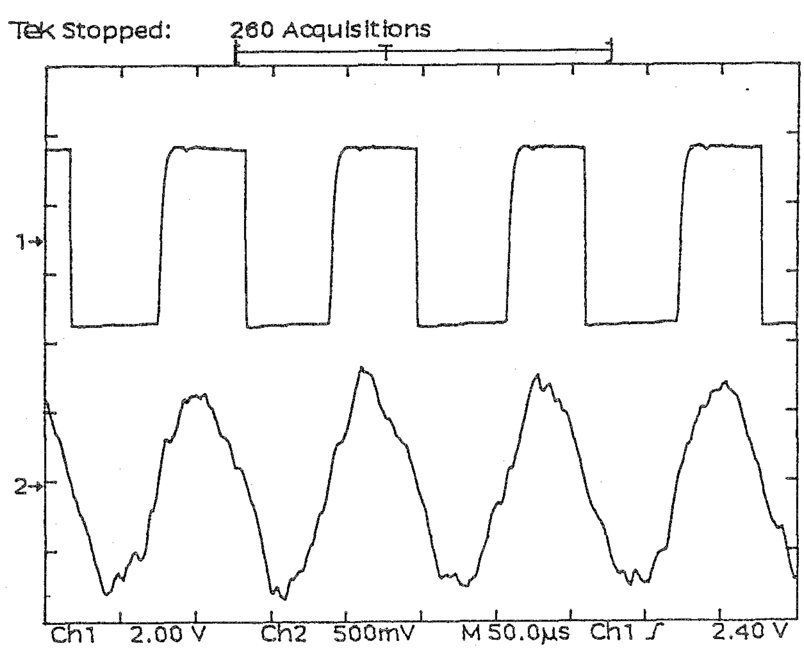


CH1 ; TE
CH2 ; TE after BPF
CH3 ; VDET

3-4-7. Track crossing signals (CROSS, TRCRS PORT)

The signal processor/servo device incorporates a 16-bit track counter, which is used to count track crossing signals TRCRS from the head amp while moving the pick-up. When the Track Count Move command is applied to the signal processor/servo IC, the TRCRS signals are counted for the specified count between 1 and 32767 and, after a certain period has elapsed, the tracking servo is locked. This wait period is set while checking the playability because there is a possibility that lens, etc., are vibrating at the resonance frequency after fast movement with the track counter and it is very difficult to lock the tracking servo stably in this status. The wait period has already been preset in the μ-com, and it is 50 ms with this products. The diagrams below show the waveforms of TE and TRCRS during search.

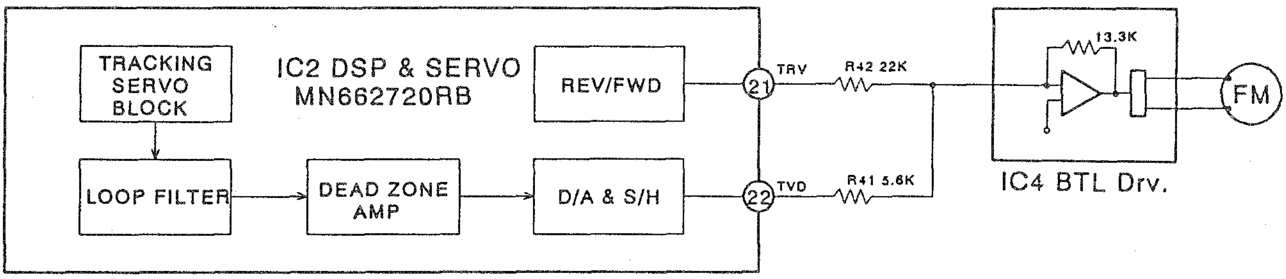
o Use the following care in checking the TRCRS signal:
1) The spike noise should not be noticeable during traverse movement.
2) The rising edge of the TRCRS signal should not be excessive.
3) The TRCRS signal should not be absent during traverse movement.
4) The duty ratio of the TRCRS during traverse movement should be approx. 50%.



CH1 ; TRCRS
CH2 ; TE

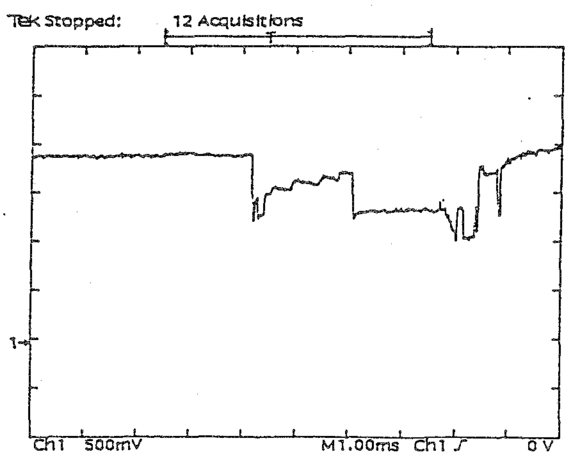
3-5. Feed servo

The block diagram of the traverse servo circuit is shown below. The traverse error signal come from the tracking servo block is sent through the loop filter and dead zone amp, converted from digital to analog and applied at the TRV terminal. In case the feed system has a traverse feed mechanism using rack-and-pinion, etc., the dead zone setting of the deed zone amp can be varied with the system. The output resolution of the D/A converter is ±128 LSB, and the TVE terminal makes voltage Vref when the output value is 0 LSB.

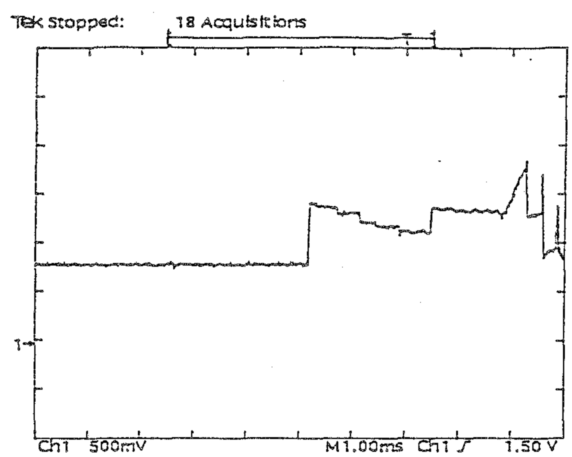


The diagrams below show the feed motor drive waveforms in FF and REW operations.

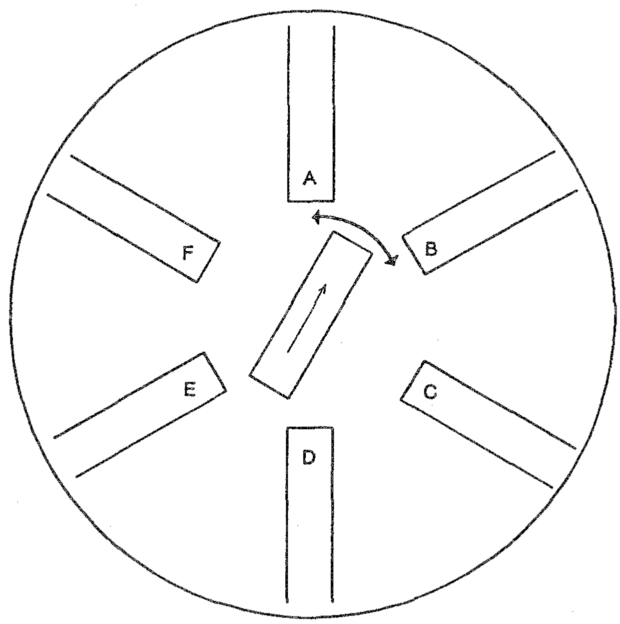
[Feed drive waveform during FF]



[Feed drive waveform during REW]



【Supplement】 Hunting and cogging



Assuming that a 6-pole motor as shown in the diagram is used as a coarse motor, the rotor can stop only in 6 point from A to F. The distance that the traverse moves when the rotor turns by 1/6 turn is referred to as the cogging amount. In case the point where the traverse error signal is 0, is located between points A and B of the motor, traverse error occurs because the rotor can only stop in point A or B. If the rotor stops at point A, it moves to point B when the output power exceeds the potential of the motor, but a negative traverse error signal is generated point B inversely to point A so the motor returns to point A again. When such an operation is repeated, the rotor will vibrate between points A and B, and the playability will be degraded. This operation is referred to as hunting.

3-6. Disc servo

The disc servo of this device has five modes; Play, Access, Accelerate, Brake and Stop modes. The following description deals with the play and access modes.

3-6-1. Play mode

The play mode uses two systems.

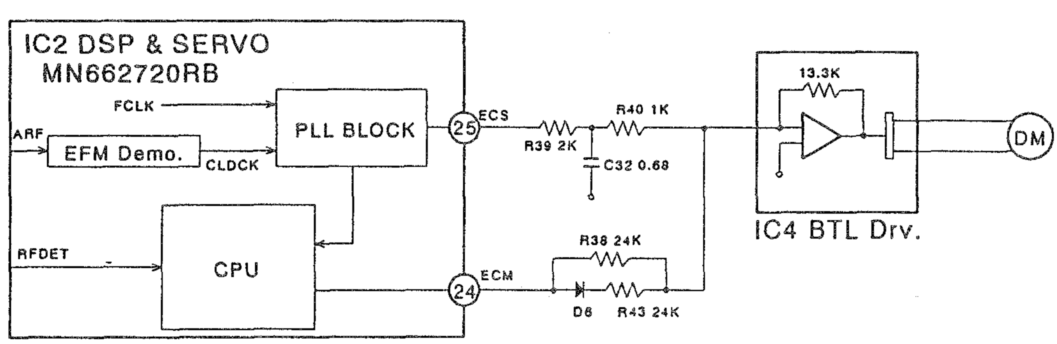
1) 11T mode

This mode is selected when the μ-com gives the Tracking command to the optics servo (TLOCK = L) and PLL circuit is unlocked. The maximum pulse duration of the EFM signal in the PLL circuit is 11T, which is usually 43 clocks when counted with XCK (16.9344 MHz). Therefore, in this mode, the maximum pulse duration of EFM signal is counted and an analog voltage is produced from the ECS terminal according to the counter value N11.

Counter	ECS terminal
N11=43	Vref. Voltage Output
N11>43	$\left(Vref.-\frac{2.5\times(N11-43)}{256}\right)$ [V]
N11<43	$\left(Vref.-\frac{2.5\times(43-N11)}{256}\right)$ [V]

2) CLV mode

This mode is selected when the rotation speed is within approx. ±4.6% of the normal speed and PLL circuit is locked. In this mode, the value of the RAM read side counter which is synchronized with the frame sync signal FCLK generated by the reference X'tal, FCLK, and the value of the RAM write side counter which is synchronized with the frame sync signal generated from the EFM signal, CLDCK, are compared, and a signal according to the error output is produed from the ECS terminal.



3-6-2. Access mode

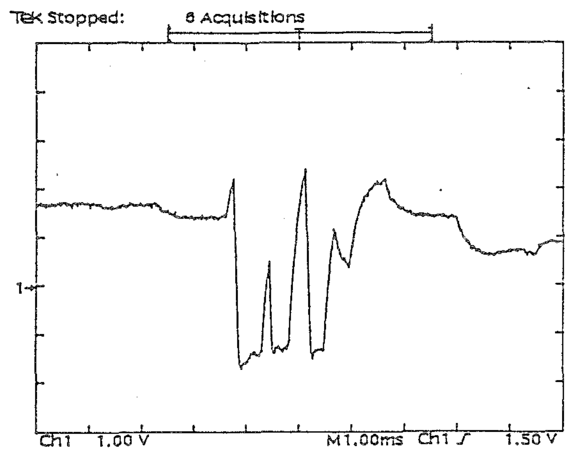
1) 6T mode

This is the rough servo mode used in high-speed access. The 11T mode cannot be used during high-speed movement because the RF signal lacks between tracks for more than 11T. Therefore, the pulse duration of the EFM signal is divided by 2, the divided signal is counted with a clock of XCK/2 and the minimum value is obtained every 8 frames for use as the speed information.

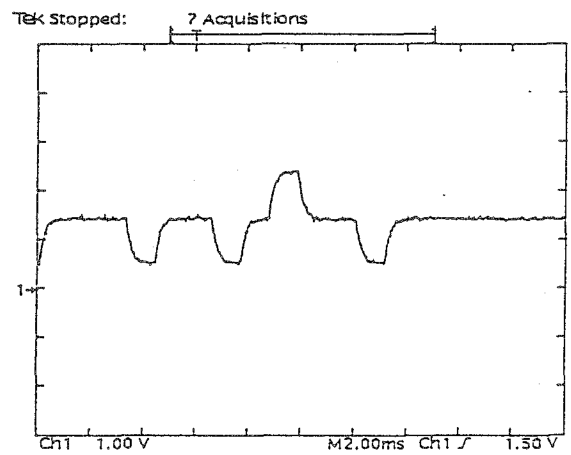
Counter	ECS terminal
N6=11	Vref. Voltage Output
N6>11	$\left(\text{Vref.} - \frac{2.5\times(11-N6)}{256} \right)$ [V]
N6<11	$\left(\text{Vref.} - \frac{2.5\times(N6-11)}{256} \right)$ [V]

3-6-3. Disc motor drive waveforms

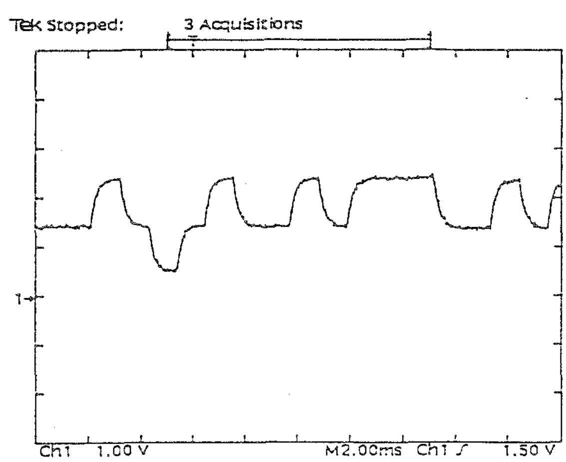
[Drive waveform during FF]



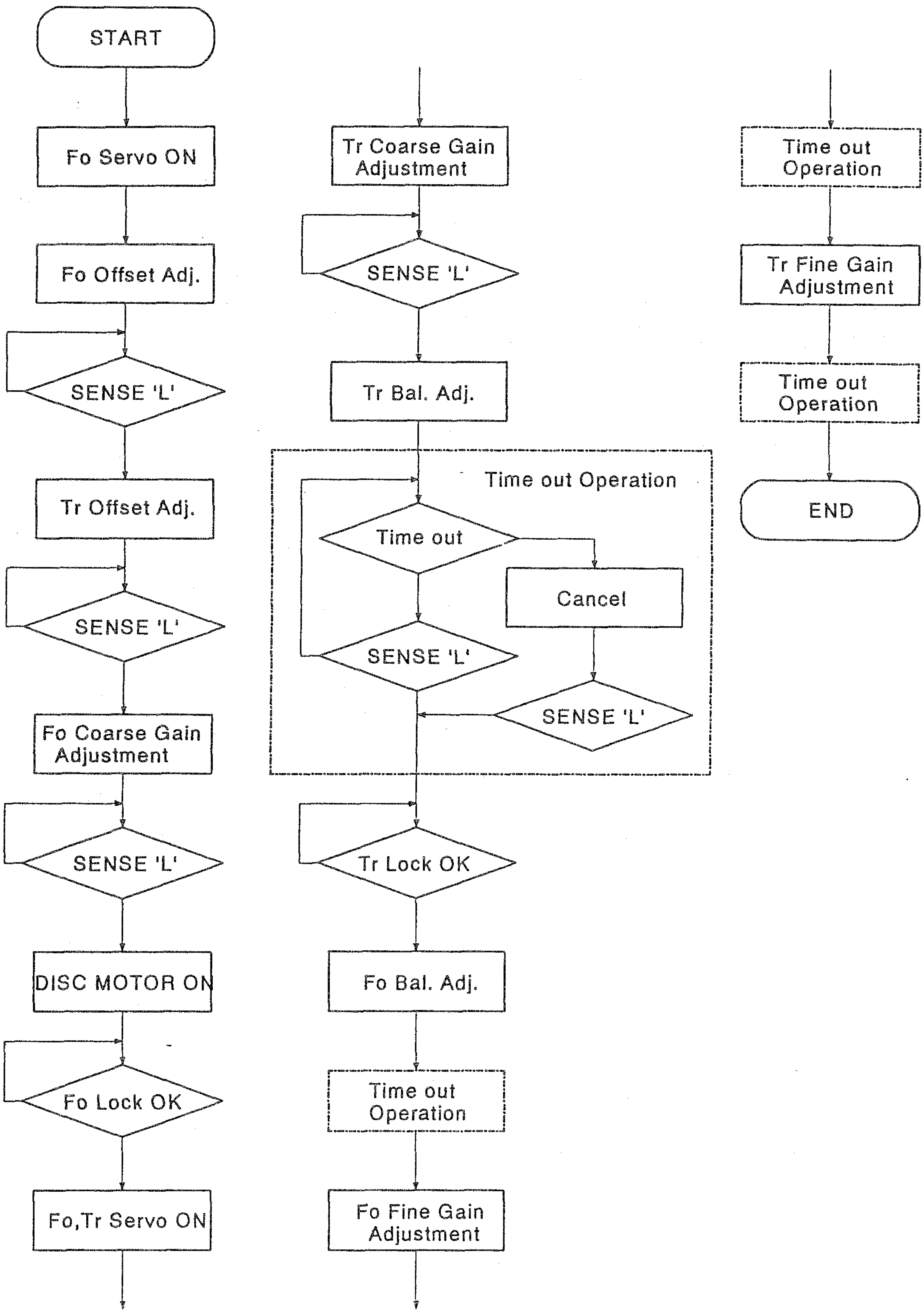
[Drive waveform during search from the innermost to the outermost position of disc]



[Drive waveform during search from the outermost to the innermost position of disc]



3-7. Flow of auto servo adjustments



4. Playability

4-1. Disc simulation

4-1-1. TCD-725 (A-BEX)

	T.No	Scratch Size	Capability	Standard	Note
INTERRUPTION	T.No2	0.5mm	○	○	
	T.No3	0.7mm	○	○	
	T.No4	0.8mm	○	×	Sound Skip
	T.No5	0.9mm	○	×	Sound Skip
	T.No6	1.0mm	○	×	Sound Skip
BLACKDOT	T.No7	ϕ0.4mm	○	○	
	T.No8	ϕ0.6mm	○	○	
	T.No9	ϕ0.8mm	○	×	Noise occur
	T.No10	ϕ1.0mm	○	×	Noise occur
	T.No11	ϕ1.0mm	○	×	Noise occur
FINGERPRINT	T.No13	$\phi 65\mu m$	○	○	
	T.No15	$\phi 75\mu m$	○	×	Noise occur

4-1-2. TCD-721R (A-BEX)

Scratch test → See table on the right.

TRACK No.	Capability	Standard
T.No1 0.0mm	○	○
T.No2 0.4mm	○	○
T.No3 0.6mm	○	○
T.No4 0.8mm	○	○
T.No5 1.0mm	○	○
T.No6 1.2mm	○	×
T.No7 1.4mm	○	×
T.No8 1.6mm	×	×
↓	↓	↓
T.No15 3.0mm	×	×

4-1-3. Eccentric disc test

TCD-713R (A-BEX, 210 um)

4-1-4. Disc surface undulation test

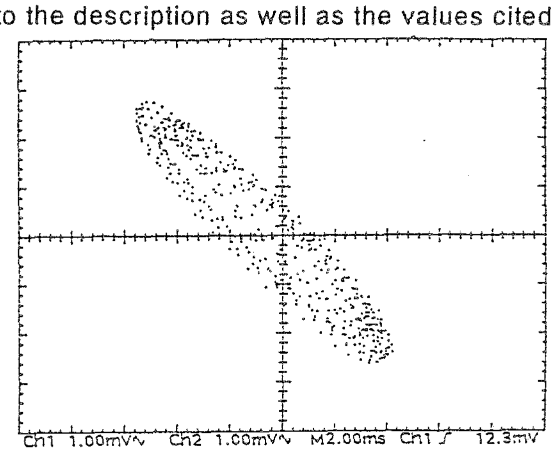
TCD-732RA (A-BEX), Tr.No.15

4-2. Vibration resistance Basically, this shall be evaluated to meet the criterion described with the device manufactured by Toshiba.

4-3. Pick-up

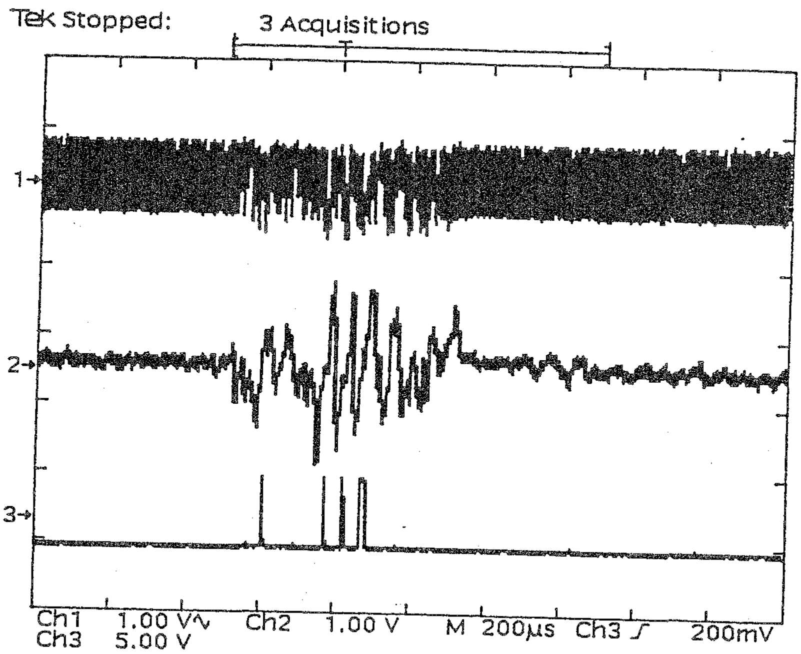
The pick-up used with the products KDC-C602 is the KSS-401A manufactured by Sony, which incorporates an I-V conversion amp. Therefore, it is capable of checking the phase difference between spots E and F which has not been possible to be checked on the previous model. For the OK/NG judgments of the RF amplitude, FE amplitude, S curve, TE level, etc., refer to the description as well as the values cited in the text of this section.

E-F Phase Difference ; 180° ±30°

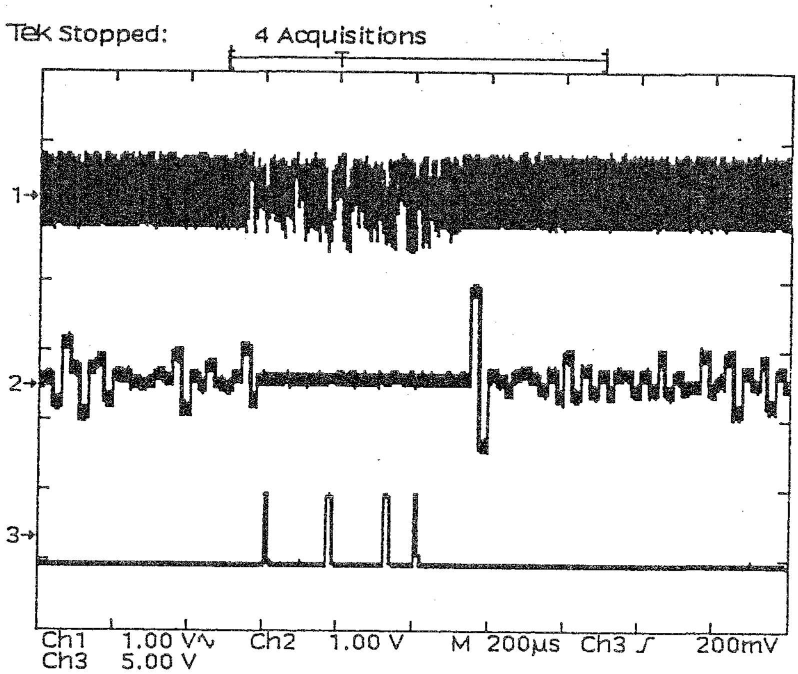


【 Interruption 0.7mm 】

CH1 ; RF
CH2 ; TE
CH3 ; BDO

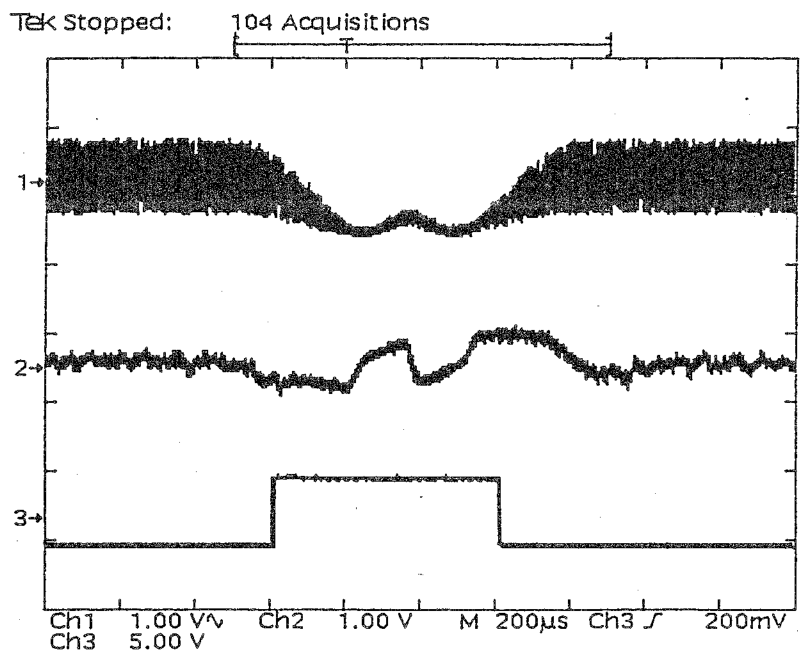


CH1 ; RF
CH2 ; TRD
CH3 ; BDO

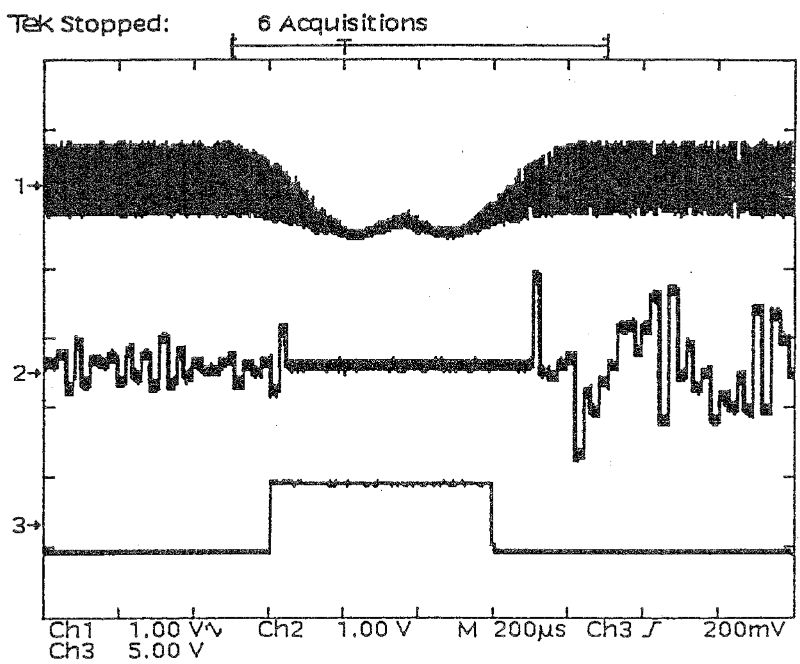


【 Black Dots φ 0.4mm 】

CH1 ; RF
CH2 ; TE
CH3 ; BDO



CH1 ; RF
CH2 ; TRD
CH3 ; BDO



【 Finger Print φ65μm 】

CH1 ; RF

CH2 ; TE

CH3 ; BDO