Service Information

Model: Nakamichi CR-7/7A/7E (Discrete Head Cassette Deck)
Serial No.: from –

Subject: Principle of Operation

Nakamichi

No. OOD-SI-3095 (1/44)
Date 7 May 1986

Contents

Printed in Japan

Preface

This cassette deck is designed with auto calibration, playback head azimuth fine tuning, real-time counter, and other functions. Described below for a general understanding of these functions are the MPUs (micro-processing units) on the Logic P.C.B. Ass'y.

- Mechanism control . . . . . MPU IC601
- Auto calibration . . . . . Input Port Expander IC607, MPU IC608, Latch & D/A Converter IC609
- Playback head azimuth fine tuning . . . . . MPU IC608, Latch & D/A Converter IC609
- Real-time counter . . . . . MPU IC606

1. Power Supply Circuit

When the Power switch is turned ON, the AC power is applied to the primary side of power transformer T1. The secondary side of power transformer T1 consists of the following windings: 15 V AC x 2, 5 V AC, 18 V AC x 2, and 3.5 V AC x 2. The output of each secondary winding is delivered to the Power Supply P.C.B. Ass'y to provide a regulated power supply.

(1) Output of 15 V AC x 2 winding

(a) ±12 V DC

The center tap of the 15 V AC x 2 winding is connected to ground. The output of the 15 V AC x 2 winding goes through fuses F401 and F402 to diode bridge D401 for full-wave rectification.

The positive part of the full-wave rectified voltage is

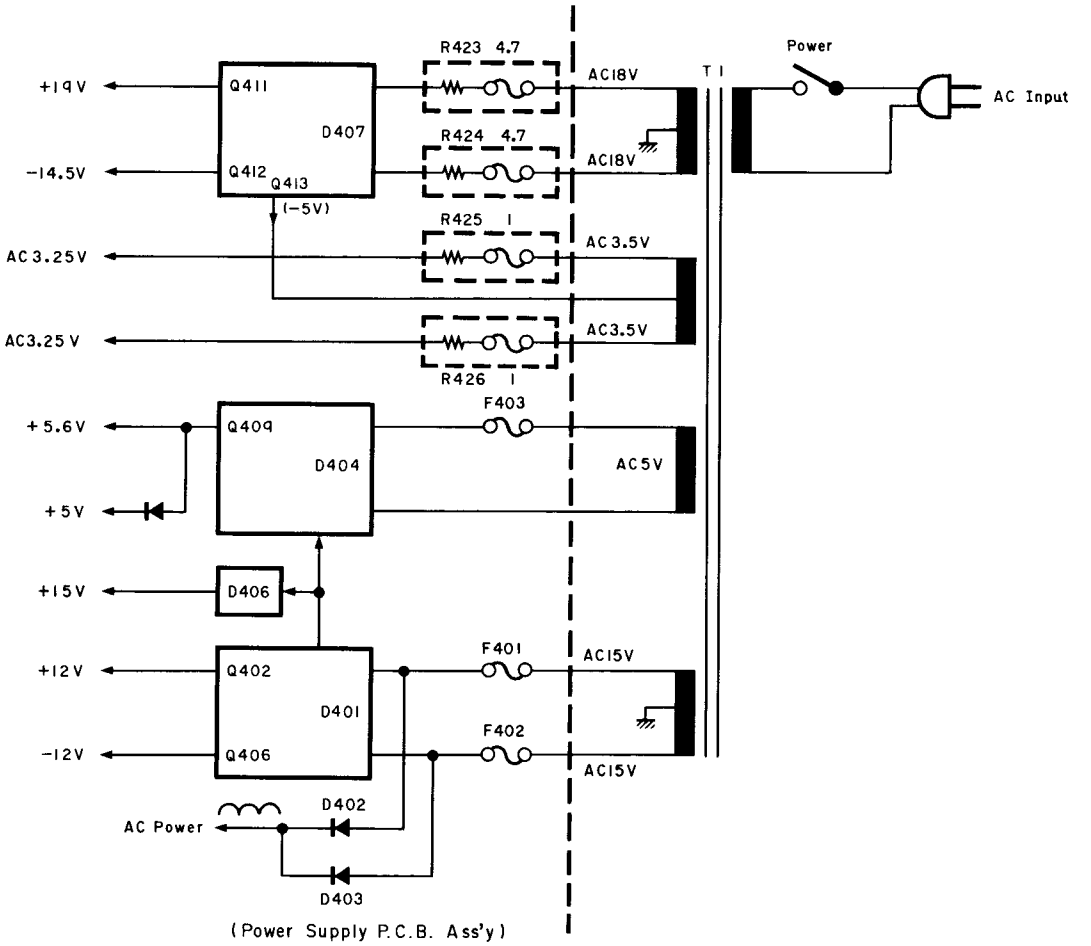


Fig. 1 Power Supply Circuit

smoothed as it passes through C401 and C402. Then it enters the +12 V voltage regulator circuit composed of IC401 (2/2), Q402–Q404, ZD401 (5.1 V), etc., where it is regulated to +12 V DC.
The negative output voltage from D401 is smoothed by C406, and enters the −12 V voltage regulator circuit consisting of IC401 (1/2), Q406–Q408, etc., so it is regulated to −12 V DC.
The ±12 V DC regulated voltages are used in the amplifier circuit, motor drive circuit, etc.

(b) +15 V DC

The positive output from D401 is passed through D406, smoothed by C412, then clamped by ZD403 (15 V) to provide +15 V DC. This voltage serves as the bias voltage to the $\overline{\text{Power Off}}$ signal circuit and Line Mute circuit.

(c) AC Power signal

The AC power supply fed through fuses F401 and F402 is full-wave rectified at D402 and D403 and, without being smoothed, sent as the AC Power signal to the $\overline{\text{Power Off}}$ signal circuit.

(2) Output of 5 V AC winding

The output of the 5 V AC winding is passed through fuse F403, full-wave rectified at diode bridge D404, smoothed at C410, then delivered into the voltage regulator circuit consisting of Q409, Q410, ZD402 (6.2 V), etc., to provide regulated +5.6 V DC. The regulated +5.6 V DC is supplied through diode on the Logic P.C.B. Ass'y and, as +5 V DC, to the MPUs and their peripheral circuits. Also, the +5.6 V DC serves to drive the control button LEDs.
The collector of Q410 in the voltage regulator circuit is connected to the positive output voltage from D401. This connection is intended to output the +5.6 V DC only when the ±12 V DC voltages have risen close to the proper levels after the Power switch is turned ON.

(3) Output of 18 V AC x 2 winding

The center tap of the 18 V AC x 2 winding is connected to ground. The output of the 18 V AC x 2 winding goes through fuse resistors R423 and R424 to diode bridge D407 for full-wave rectification.
The positive component of the full-wave rectified voltage is smoothed at C413, then it enters the voltage regulator circuit composed of Q411, ZD404 (20 V), etc., to provide +19V DC.
The negative output voltage from the full-wave rectification is smoothed by C414 and enters the voltage regulator circuit consisting of Q412 and ZD405 (15 V), to provide −14.5 V DC.
The +19 V DC and −14.5 V DC are sent to the Display P.C.B. Ass'y. This Ass'y transforms the +19 V DC input to +9 V DC in its 3-terminal regulator IC602; it also transforms the −14.5 V DC input to −9 V DC in its voltage regulator circuit composed of Q621, ZD601 (5.6 V), etc.

(4) Output of 3.5 V AC x 2 winding

The output of the 3.5 V AC x 2 winding is supplied through fuse resistors R425 and R426, and, as 3.25 V AC, to the Display P.C.B. Ass'y. The 3.25 V AC is applied to the filament of FL (fluorescent) display tube. The center tap of the 3.5 V AC x 2 winding is connected to the emitter of Q413 to fix the voltage at approx. −5 V DC.

2. Power Off Signal Circuit

Fig. 2.2 presents a timing chart of the Power Off signal when the Power switch is set to ON and OFF.

Upon closing of the Power switch, the AC Power signal (full-wave rectified AC voltage output without being smoothed) is immediately applied to the base of Q618. Consequently, Q618 is turned ON and Q617 turned OFF, so the Power Off signal becomes H.

Upon opening of the Power switch, the AC Power signal is immediately lost, turning Q618 OFF. As the current flowing through R646 charges C611 to above Vbe of Q617, Q617 turns ON and the Power Off signal becomes L. With the Power Off signal at L, the following power-off time actions take place via the diodes indicated:

(1) Via D626: Q616 turns OFF, stopping the supply of voltage to the control button LEDs.

(2) Via D684: The Bias ON signal is set to L to stop the bias oscillation.

(3) Via D635: Forces the Line Mute signal to H to mute the line output.

(4) Via D681: The signal Reset = L is sent to the MPU of the Remote Control P.C.B. Ass'y to inhibit input from the wireless Remote Control Unit RM-7C.

(5) Via D662: Sets the Motor Stop signal to L to stop the capstan motor.

(6) Via D603: Inhibits input to the tape-looseness elimination circuit.

(7) Via D601: C603 in the reset circuit is fully discharged in preparation of the next power-up.

(8) Via D655: C631 for initial resetting of FL P. Hold flip-flop is fully discharged for preparation of the next power-up.

(9) Via D665: The signal Power Off = L is sent to the auto calibration control MPU (IC608).

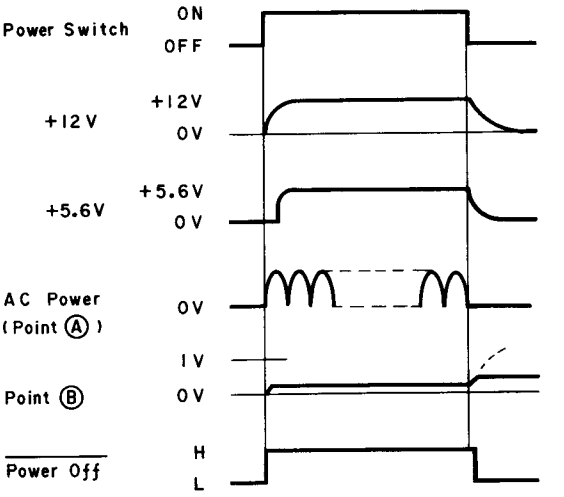


Fig. 2.2 Power Off Signal Timing Chart

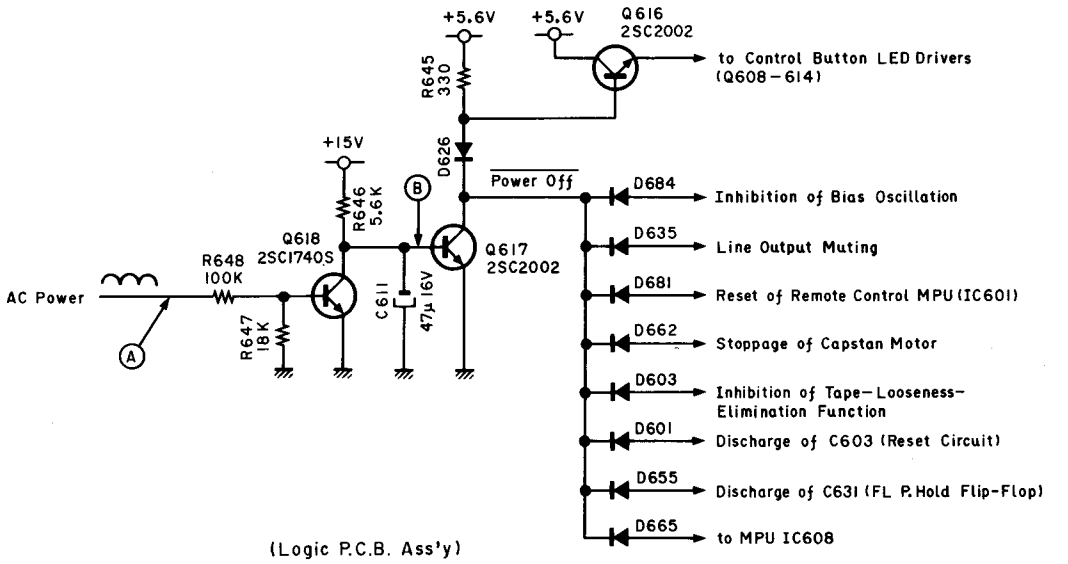


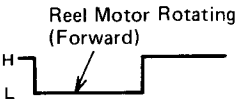
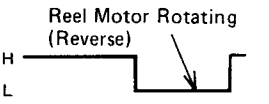
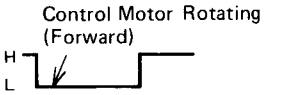
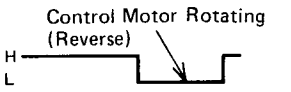
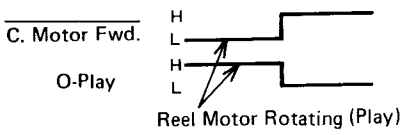
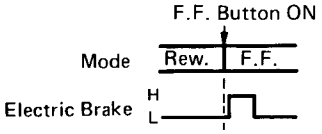
Fig. 2.1 Power Off Signal Circuit

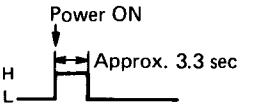
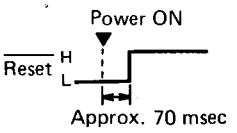
3. Mechanism Control MPU IC601 and Peripheral Circuits

3.1. Function of Mechanism Control MPU IC601

The various mechanisms are controlled by the 4-bit MPU (micro-processing unit) IC601 (TMP4315BP-1814). Table 3.1 shows the pin numbers, signal names and functions of IC601. Fig. 3.1 is a timing chart of main signals as they appear through series of control pushbutton operations.

Table 3.1 Function of IC601

Pin No.	Signal Name	In/Out	Function
1	$\overline{\text{Test}}$	In	Not used.
2 3 4	Cam (0) Cam (1) Cam (2)	In In In	Mechanism position detecting signals. Mechanism mode can be sensed according to states of Cam (0), Cam (1) and Cam (2).
5	$\overline{\text{Eject}}$	In	$\overline{\text{Eject}}$ signal. Active L. Used to detect whether the Cassette Case is open. When it is open, this signal is L. In this condition, the cassette deck is in Stop mode and no pushbutton operation is enabled.
6	$\overline{\text{R. Motor Fwd.}}$	Out	$\overline{\text{Reel Motor Forward}}$ signal. Active L. 
7	$\overline{\text{R. Motor Rev.}}$	Out	$\overline{\text{Reel Motor Reverse}}$ signal. Active L. 
8	$\overline{\text{C. Motor Fwd.}}$	Out	$\overline{\text{Control Motor Forward}}$ signal. Active L. 
9	$\overline{\text{C. Motor Rev.}}$	Out	$\overline{\text{Control Motor Reverse}}$ signal. Active L. 
10	O-Play	Out	Reel Motor Play signal. Active H. In Play mode, $\overline{\text{C. Motor Fwd.}}$ becomes L, and O-Play becomes H. 
11	Capstan Motor	Out	Not used.
12	Electric Brake	Out	Electric Brake signal. Active H. Generates H pulse upon change in mode. 

Pin No.	Signal Name	In/Out	Function
13	Source Mute	Out	Source Mute signal. Active H. Issues H pulse for 3.3 sec after power is turned ON. Used for timer recording circuit and line mute circuit. 
14	Line Mute	Out	Line Output Mute signal. Active H. Only in Play or Rec./Play mode, stays at L, i.e., deactivates mute of line outputs.
15	Rec. Mute	Out	Record Mute signal. Active H. Only in Rec./Play mode, stays at L, i.e., releases record mute.
16	$\overline{\text{L. Rew.}}$	Out	$\overline{\text{Rewind Mode}}$ signal. Active L. Used for lighting of Rewind LED.
17	$\overline{\text{L. FF}}$	Out	$\overline{\text{FF Mode}}$ signal. Active L. Used for lighting of F.F. LED.
18	$\overline{\text{L. Pause}}$	Out	$\overline{\text{Pause Mode}}$ signal. Active L. Used for lighting of Pause LED.
19	$\overline{\text{L. Play}}$	Out	$\overline{\text{Play Mode}}$ signal. Active L. Used for lighting of Play LED.
20	$\overline{\text{L. Rec.}}$	Out	$\overline{\text{Record Mode}}$ signal. Active L. Used for lighting of Record LED.
21	VSS	In	Connected to GND.
22	$\overline{\text{INT.}}$	In	$\overline{\text{Interrupt}}$ signal. Active L. Allows input of shut-off pulse (take-up counter pulse) train. Detects tape running, i.e., rotation of Take-up Reel Hub.
23	$\overline{\text{Reset}}$	In	$\overline{\text{Reset}}$ signal. Active L. Held at L for approx. 70 msec after power is turned ON. Upon change of this signal to H, IC601 starts operation. 
24 25	Xin Xout	In Out	External circuit for clock oscillation. Oscillating frequency = 550 kHz.
26	Rec. Protect	In	Record Protect signal. Active H. When a tape with record protect tabs is loaded, this signal becomes L, allowing recording.
27	$\overline{\text{A.M.S.}}$	In	Not used.
28	$\overline{\text{C. SW}}$	In	Not used.

Pin No.	Signal Name	In/Out	Function
29	$\overline{\text{Memory}}$	In	Not used.
30 31	$\overline{\text{A. Rew.}}$ $\overline{\text{A. Play}}$	In In	$\overline{\text{Auto Rewind}}$ signal. Active L. $\overline{\text{Auto Play}}$ signal. Active L. These signals are at L when Memory Stop/Auto Repeat switch is set to "Auto Repeat". (With these signals set to L during recording, playback, or fast-forward, auto repeat function is performed and playback/rewind cycle is continuously repeated between the tape end and the tape start. If Memory Stop/Auto Repeat switch is set to "Memory Stop", tape automatically stops at the tape counter indication "0000" during fast-forward or rewind.)
32	$\overline{\text{T. Rec.}}$	In	$\overline{\text{Timer Recording}}$ signal. Active L. Held at L upon setting of Timer switch to record position.
33	$\overline{\text{T. Play}}$	In	$\overline{\text{Timer Play}}$ signal. Active L. Held at L upon setting of Timer switch to Play position.
34	$\overline{\text{K. Pause}}$	In	Pause button input terminal. Becomes L upon push of Pause button.
35	$\overline{\text{K. Rec.}}$	In	Record button input terminal. Becomes L upon push of Record button.
36	$\overline{\text{K.A. Space}}$	In	Not used.
37	$\overline{\text{SEA}}$	In	Not used.
38	$\overline{\text{K. Play}}$	In	Play button input terminal. Becomes L upon push of Play button.
39	$\overline{\text{K. FF}}$	In	FF button input terminal. Becomes L upon push of FF button.
40	$\overline{\text{K. Rew.}}$	In	Rewind button input terminal. Becomes L upon push of Rewind button.
41	$\overline{\text{K. Stop}}$	In	Stop signal input terminal. When Stop button is pressed, $\overline{\text{K. Stop}}$, $\overline{\text{K. FF}}$ and $\overline{\text{K. Rew.}}$ signals become L simultaneously and IC601 stops all operations.
42	VDD	In	+5 V is supplied.

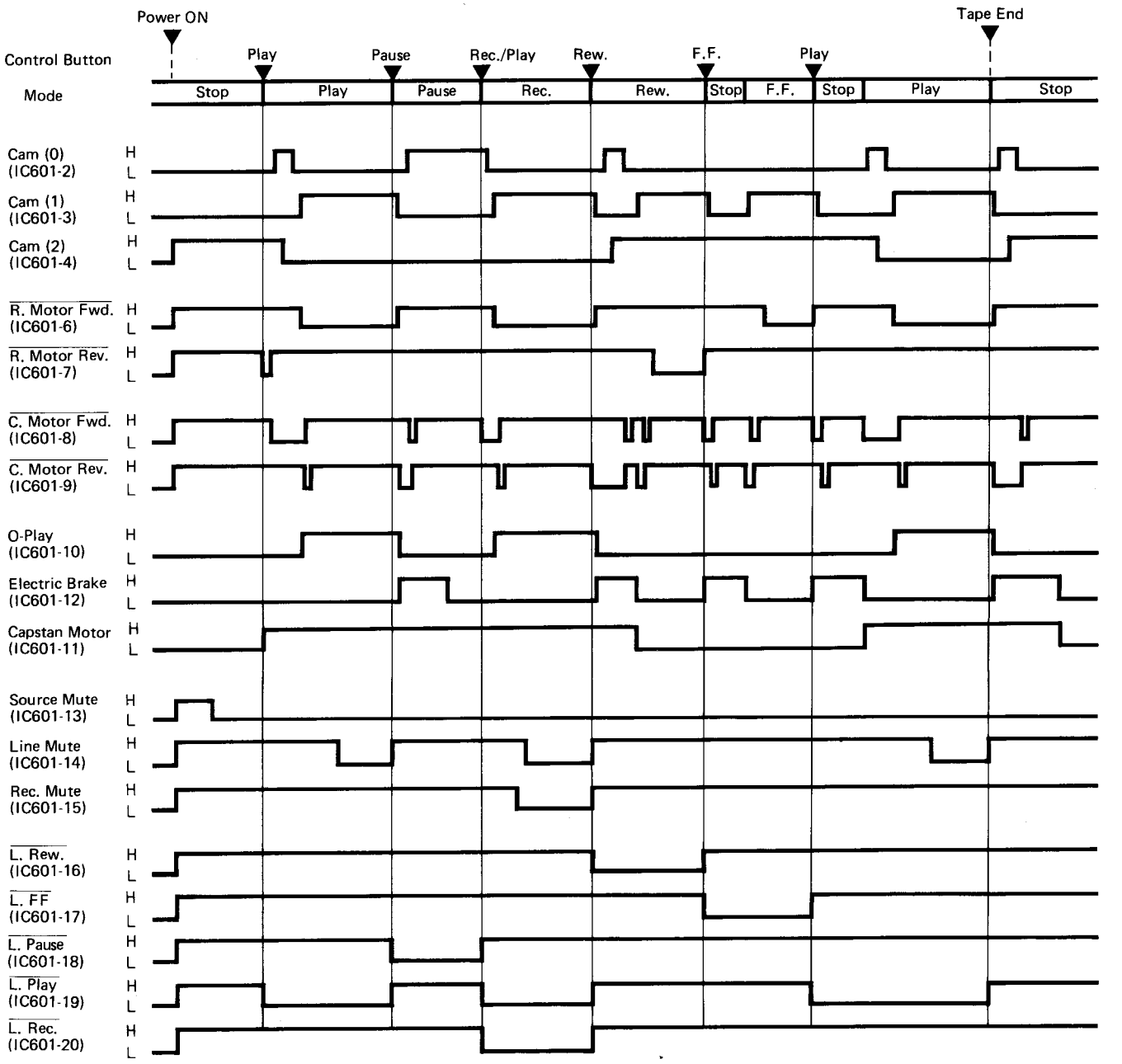


Fig. 3.1 Timing Chart of IC601 Output Signals

3.2. Initial Reset Circuit (Refer to Fig. 3.2.)

When the Power switch is turned ON, +5 V is supplied and a differentiated base current flows to Q601 via R607 and C603. Q601 subsequently turns ON and remains in the ON state for about 70 msec.

During this period, the $\overline{\text{Reset}}$ signal is at L to reset the following MPUs: IC601 (mechanism control MPU), IC606 (tape/real-time counter control MPU), and IC608 (auto calibration control MPU). In the 70 msec period, the IC601 on the Remote Control P.C.B. Ass'y is also reset via Q601. When the $\overline{\text{Reset}}$ signal becomes H, the MPUs starts their operations.

When the Power switch is turned OFF, the $\overline{\text{Power Off}}$ signal becomes L, and C603 is discharged in preparation for the next power-up. With $\overline{\text{Power Off}}$ at L, Q601 turns OFF and IC601 is reset in the Remote Control P.C.B. Ass'y, thereby inhibiting input from the Remote Control Unit RM-7C.

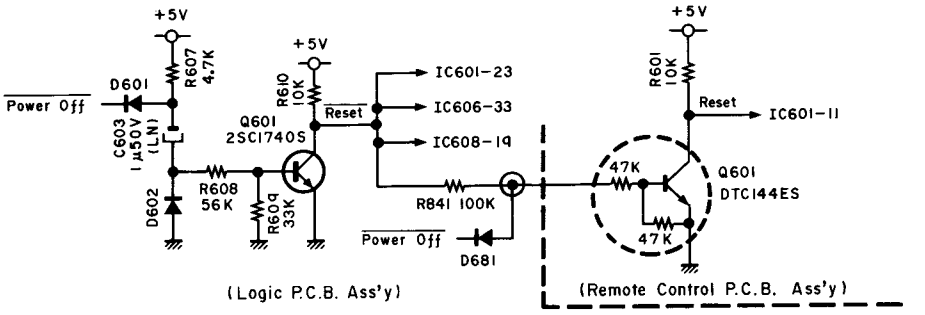


Fig. 3.2 Initial Reset Circuit

3.3. Control Button Input Circuit

(1) Stop button

Pressing the Stop button causes simultaneous setting of $\overline{\text{K.Stop}}$, $\overline{\text{K.FF}}$ and $\overline{\text{K.Rew.}}$ to L. While the Stop button is held down, the other buttons are disabled.

(2) Play, FF, Rewind and Pause buttons

As long as each of these buttons is pressed, the L level is input to IC601.

(3) Record button

At the push of the Record button, the mechanism is set into Rec./Pause mode.

The signal $\overline{\text{Mode Stop}}$ is one indicating that the mechanism is in Stop mode. It is at L in Stop mode. When a recordable cassette is loaded, the Rec. Protector switch is set to ON, and the Rec. Protector signal becomes L. In this state, therefore, IC602-13 is at L. When the Record button is pressed, IC602-12 becomes L, which sets IC602-11 and IC601-35 ($\overline{\text{K.Rec.}}$) to L.

Further, IC601-34 ($\overline{\text{K.Pause}}$) is set to L as it passes through D607 and Q606. Thus the mechanism is set into the Rec./Pause mode.

(4) Button input circuit (example of Play button)

Fig. 3.4 shows the button input circuit for the $\overline{\text{K.Play}}$ signal. The $\overline{\text{K.Play}}$ input to IC601 is one of the three outputs which are wired by ORing:

- Output of the control button on the Front Panel
- Output of the control button on the wired Remote Control RM-5 (option) connected to the Transport DIN socket labeled "System Remote".
- Output of the control button on the wireless Remote Control Unit RM-7C, as is received by the Receiver P.C.B. Ass'y then decoded by IC601 on the Remote Control P.C.B. Ass'y.

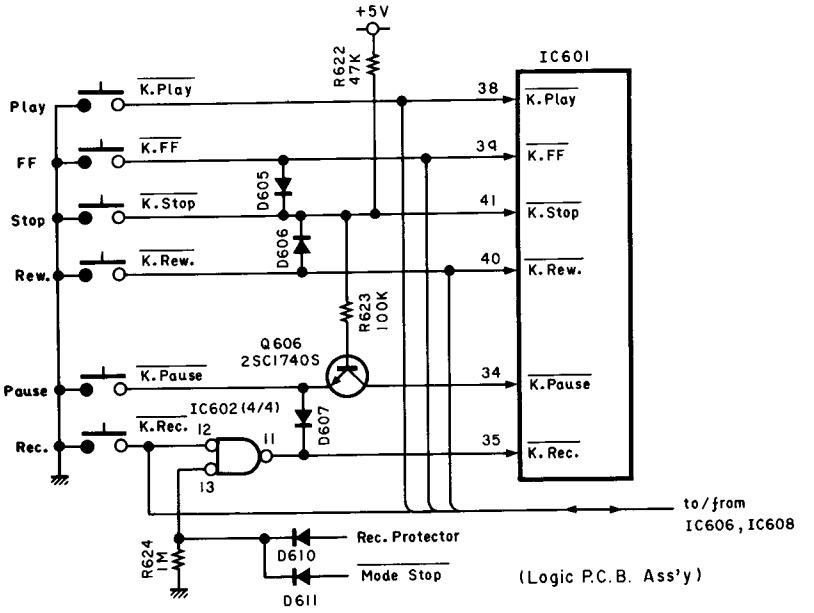


Fig. 3.3 Control Button Input Circuit

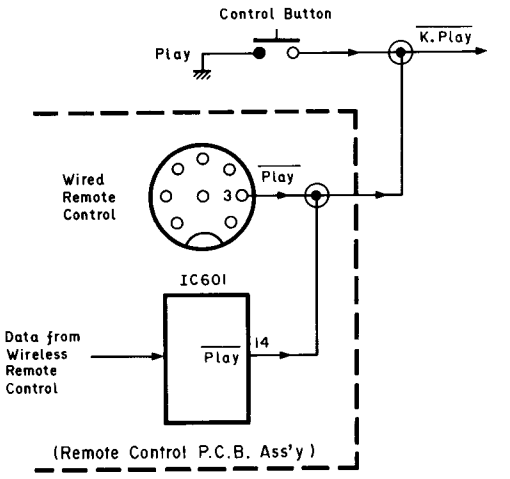


Fig. 3.4 Actual Button Input Circuit

3.4. Take-up Pulse/Supply Pulse Generator Circuit

Take-up pulses and supply pulses are generated in the Shut-off P.C.B. Ass'y; their waveforms are shaped in the shaping circuit in the next stage. Take-up pulses are then input to IC601-22 ($\overline{INT}$) so they work as shut-off pulses. Eventually, take-up pulses and supply pulses are sent to IC606 (tape/real-time counter control MPU).

(1) Take-up pulses

In the Shut-off P.C.B. Ass'y, Q602 is a photoreflector combining an LED and a phototransistor. The light emitted from the LED is reflected by a silver rear-surface of the take-up reel hub (Fig. 3.5) and arrives at the phototransistor's base to turn ON Q602 and Q601. When the light strikes black rear-surface of the hub, Q602 and Q601 are OFF.

Thus Q601's collector produces pulses as the take-up reel hub rotates. The pulses undergo waveform shaping in IC602 (2/4) on the Logic P.C.B. Ass'y before they enter IC601-22 ($\overline{INT}$). By monitoring these pulses, IC601 knows the time when the tape reaches the tape end. Take-up pulses are also sent to IC606-40.

(2) Supply pulses

Supply pulses are produced on the same principle as the take-up pulses described in (1), with the exception that they detect the rotation of the supply reel hub by means of a photoreflector Q603. That is, as the supply reel hub rotates, Q603 and Q604 alternate between ON and OFF states and generate supply pulses. The pulses are waveform shaped in IC602 (1/4) on the Logic P.C.B. Ass'y and sent to IC606-39.

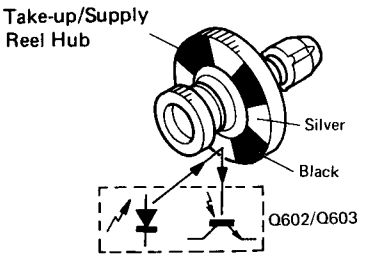


Fig. 3.5

3.5. Mute Circuit

(1) Line mute circuit

When Line Mute = H, or Source Mute = H, or Cal. Mute = H, Q626 and Q625 turn ON to set Line Mute to H. At the same time, Q117 and Q217 on the Main P.C.B. Ass'y turn ON to mute the line outputs; also, Q111 and Q211 on the Main P.C.B. Ass'y turn ON to cut off the line inputs. In addition, Q620 on the Display P.C.B. Ass'y turns ON to mute IC601 so that the level meter display on the Indicator Panel goes out.

- o Line Mute (IC601-14) = H
  . . . . . Other than Play and Rec./Play modes (See note.)
- o Source Mute (IC601-13) = H
  . . . . . For approx. 3.3 sec after power-up
- o Cal. Mute (IC609-9) = H
  . . . . . During Auto Calibration

When the power is turned OFF, $\overline{\text{Power Off}}$ becomes L, and a base current flows to Q625 via D635 and D634. As a result, Q625 turns ON to activate line muting.

Note: When the Monitor is set to Source ($\overline{\text{Source}}$ = L), the Line Mute signal becomes L as the anode of D631 is grounded via D630. Accordingly, line mute is released even if the cassette deck is set in other than Play and Rec./Play modes. This means that, with the Monitor set to Source, monitoring of input sound is possible in any mode.

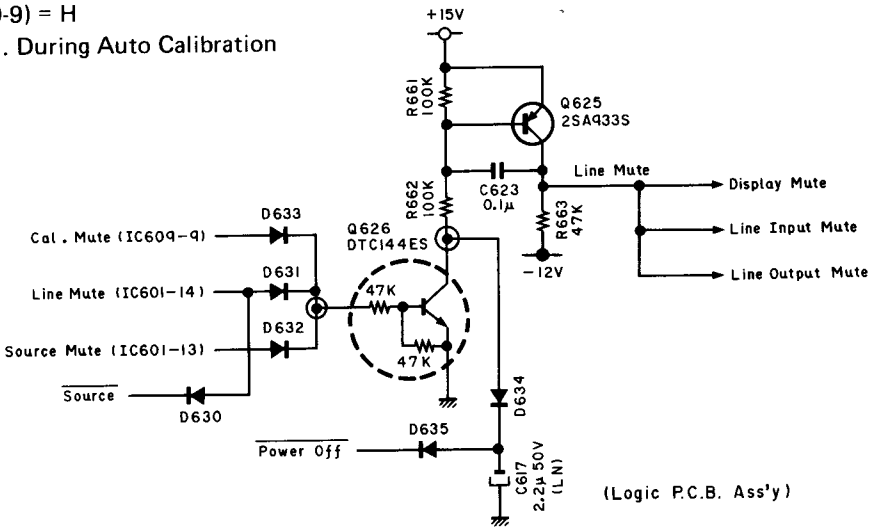


Fig. 3.6 Line Mute Circuit

(2) Rec. Mute

When Rec. Mute = H or Fader Rec. Mute = H, Q658 and Q623 turn ON so that Rec. Mute becomes H. Consequently, Q106 and Q206 on the Main P.C.B. Ass'y turn ON, which draws the rec. amp. inputs to ground to activate record mute.

- o Rec. Mute (IC601-15) = H
  . . . . . Other than Rec./Play mode
- o Fader Rec. Mute = H
  . . . . . Stays at H for a certain period after Fader-In. Then becomes L to release record mute.

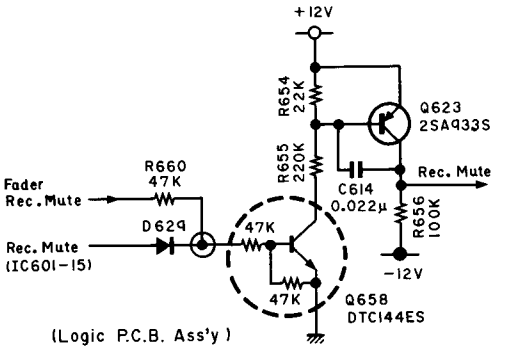


Fig. 3.7 Rec. Mute Circuit

(3) Fader Mute

When Fader Mute becomes H, the fader circuit is disabled and the line input is disabled. For Fader Mute to become H, the cassette deck must be other than Rec./Play and Rec./Pause modes and the Monitor must be set to Tape.

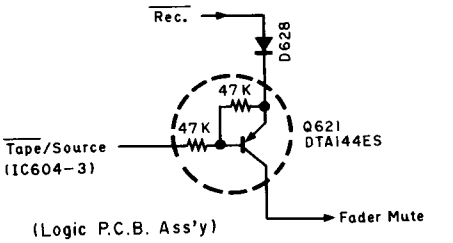


Fig. 3.8 Fader Mute Circuit

3.6. Rec. and Bias On Signal Circuit

When the cassette deck is in Rec./Play or Rec./Pause mode, L.Rec. is at L. As a result, Q620 and Q619 turn OFF, Rec. = L, and Q107 and Q207 on the Main P.C.B. Ass'y turn OFF, releasing the mute on the rec. amp. outputs. At the same time, Q622 turns ON, the Bias On signal becomes L, Q301 on the Power Supply P.C.B. Ass'y turns ON, and the bias oscillator (comprising Q302, Q303, L301, etc.) is applied with voltage to trigger erase bias oscillation. Also, the recording bias oscillation circuits for Lch and Rch are applied with voltage.

When the Power switch is set to OFF and the Power Off signal becomes L, the Bias On signal is forced to H to stop the oscillation described above.

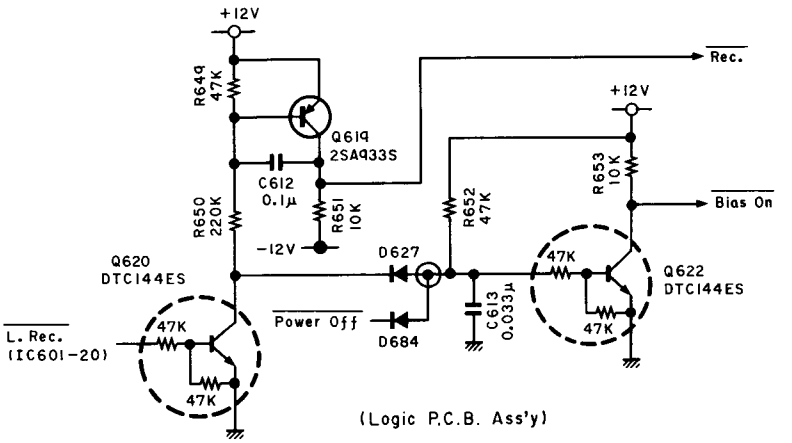


Fig. 3.9 Rec. and Bias On Signal Circuit

3.7. Timer Recording and Timer Playback Circuit

When the Power switch is turned ON after setting the Timer switch to Record and loading a recordable cassette in the Cassette Case, timer-activated recording will start.
If the Timer switch is in the Play position before power-up, timer-activated playback will start.
The circuit made up of D612, Q607, IC603, D620, etc., serves only to keep the Record Button LED lit from the time the Power switch is turned ON with the Timer switch in the Record position to the time the mechanism is set into Record mode. For approx. 3.3 sec after the Power switch is turned ON, Source Mute is set to H, Q607 to ON, and $\overline{\text{Rec. LED ON}}$ to L, so the Record Button LED is lit.

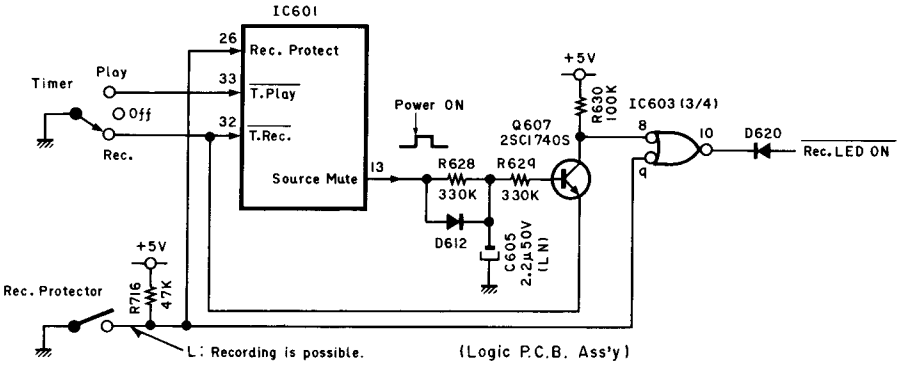


Fig. 3.10 Timer Recording and Timer Playback Control Circuit

3.8. Tape-looseness Elimination Circuit

Upon closing of the Cassette Case, the reel motor rotates for approximately 1 sec in the rewind direction to eliminate tape looseness.
Specifically, closure of the Cassette Case opens the Eject switch, turns Q602 OFF, Q603 ON and Q604 OFF. As a result, a positive differentiated pulse is input through C604 to IC602-8 (3/4) and -9. The pulse is then waveform shaped by IC602 (3/4) and applied to the base of Q605. Consequently, Q605 is turned ON in the form of a pulse for approx. 1 sec; during this period, the $\overline{\text{R. Motor Rev.}}$ signal is forced to L so that the reel motor is rotated in the rewind direction to rewind the tape.
When the Power switch is set to OFF and $\overline{\text{Power Off}}$ signal becomes L, the Eject switch input is disabled.
While the control motor is revolving, e.g., when $\overline{\text{C. Motor Rev.}}$ (IC601-9) or $\overline{\text{C. Motor Fwd.}}$ (IC601-8) is at L, IC602-8 and -9 are set to L, inhibiting the tape-looseness elimination function.

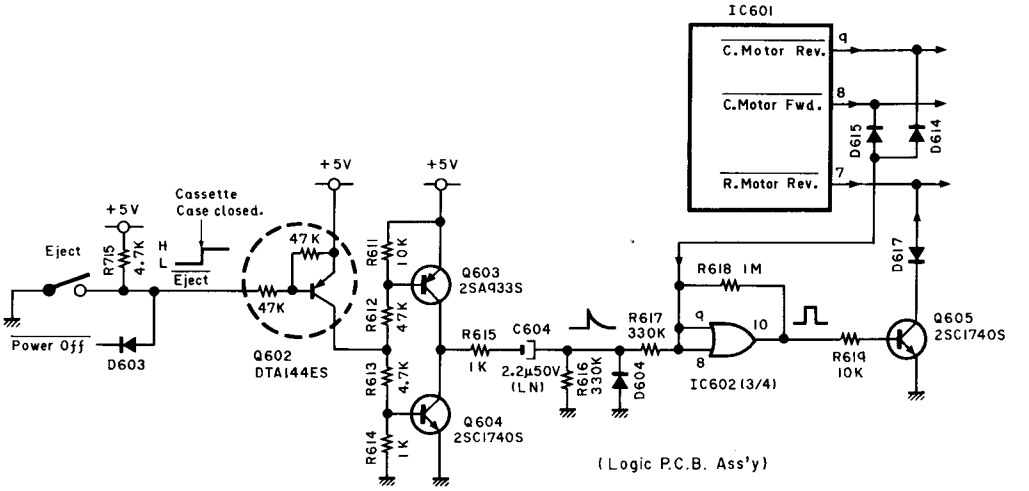


Fig. 3.11 Tape-looseness Elimination Circuit

3.9. Control Motor Drive Circuit

This circuit consists of Q651 to Q657 and their peripheral circuit.
$\overline{\text{IC601-8 (C. Motor Fwd.)}}$ and $\overline{\text{IC601-9 (C. Motor Rev.)}}$ are connected to the bases of the control motor driver transistors Q653 and Q654 via R741 and R745. These signals control the rotational direction (forward or reverse) of the control motor.
The mechanism (Head Base) is set in the appropriate mode according to the rotation of the control motor. The angle of rotation of the control motor is fed back in terms of the transfer states of Cam (0), Cam (1) and Cam (2). The ON/OFF states of these transfers, i.e., the signal levels of IC601-2, -3 and -4 (Cam (0), Cam (1) and Cam (2)), are observed to see whether the mechanism is set in the specified mode.
More specifically, to change the current mode to another

mode, the C. Motor Rev. and C. Motor Fwd. signals are set into the intended mode. As the control motor begins rotation, the input signals to Cam (0), Cam (1), and Cam (2) terminals are observed. Then, after verification that these signals have been set into the specified mode, the control motor is stopped.

Table 3.2 shows the states of Cam (0), Cam (1) and Cam (2) in each mode. Table 3.3 shows the ON/OFF states of transistors in each mode.

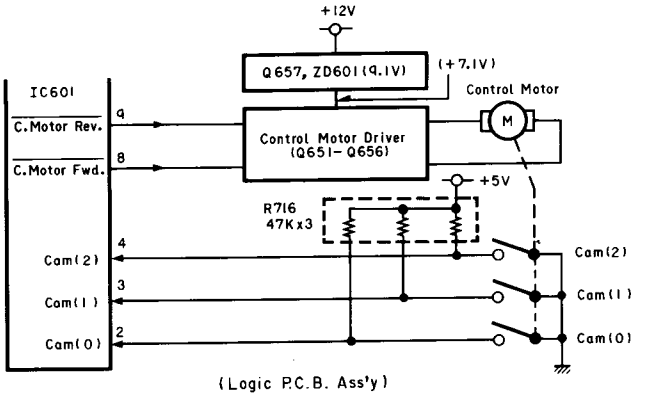


Fig. 3.12 Control Motor Drive Circuit

Table 3.2

Mode	Cam (0) IC601-2	Cam (1) IC601-3	Cam (2) IC601-4
Stop	L	L	H
Play	L	H	L
Pause	H	L	L
F.F./Rew.	L	H	H

Table 3.3

Mode	Q653	Q654	Q655	Q656	Q651	Q652
Control Motor Forward IC601-8 = L	ON	OFF	ON	OFF	ON	OFF
Control Motor Reverse IC601-9 = L	OFF	ON	OFF	ON	OFF	ON

3.10. Reel Motor Drive Circuit

This circuit consists of Q644 to Q650, Q686 and Q687, and their peripheral circuit. The input signals to the circuit are IC601-6 (R. Motor Fwd.), IC601-7 (R. Motor Rev.), and IC601-10 (O-Play). In F.F. or Rewind mode, the reel motor rotates without control by the governor; in Play mode, it rotates at a constant speed under control of the governor. Below are discussed the operations of the reel motor drive circuit in the respective modes. Table 3.4 shows the relations of each mode to IC601-6, -7, and -10. Table 3.5 shows the ON/OFF states of transistors in each mode.

(1) F.F. Mode

IC601-6 (R. Motor Fwd.) becomes L, which turns ON Q686, Q644 and Q646. The reel motor driver is supplied with approx. 6.5 V from the emitter of Q648, so current flows through Q644, the reel motor, Q646, R725 and R726.

(2) Rewind Mode

IC601-7 (R. Motor Rev.) becomes L, which turns ON Q687, Q645 and Q647. Current flows through Q645, the reel motor, Q647, R725 and R726.

(3) Play Mode

IC601-6 (R. Motor Fwd.) becomes L, and IC601-10 (O-Play) becomes H. Q686, Q644 and Q646 turn ON as in F.F. mode. Further, Q650 turns OFF as it is reverse-biased and Q649 is conducted. This establishes a connection of the governor circuit (consisting of Q649 and its peripheral circuit) to the driver circuit.

The voltage across R725 and R726 is applied to the emitter of Q649 in the governor circuit. Namely, the current flowing in the reel motor is fed back to the governor circuit. The governor circuit controls the emitter voltage of Q648 (i.e., the voltage supplied to the driver) in such a way that the current flowing in the reel motor is held constant; a constant current means a constant rotational frequency of the reel motor.

In Play mode, the emitter voltage of Q648 is lower than in F.F. or Rewind mode (approx. 4.4 V). Consequently, the rotation of the reel motor is slower.

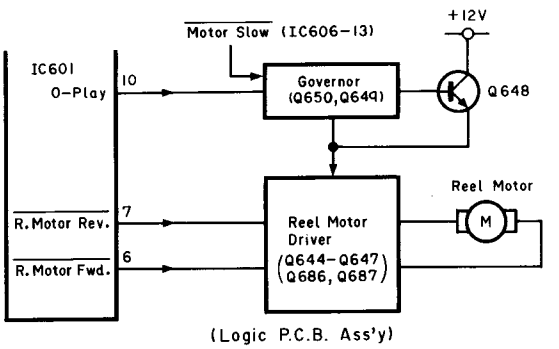


Fig. 3.13 Reel Motor Drive Circuit

Table 3.4

Mode	R. Motor Rev. IC601-7	R. Motor Fwd. IC601-6	O-Play IC601-10
Play	H	L	H
F.F.	H	L	L
Rewind	L	H	L

Table 3.5

Mode	Q686	Q687	Q644	Q645	Q646	Q647	Q648	Q649	Q650
Play	ON	OFF	ON	OFF	ON	OFF	Conducted	Conducted	OFF
F.F.	ON	OFF	ON	OFF	ON	OFF	Conducted	OFF	ON
Rewind	OFF	ON	OFF	ON	OFF	ON	Conducted	OFF	ON

Note: The $\overline{\text{Motor Slow}}$ input is normally at H. When the memory stop function (to stop tape at counter "0000") is executed, detection is made of counter "0000" during rewind, then $\overline{\text{Motor Slow}}$ (IC606-13) is set to L so that the tape speed is lowered than normal. This is to stop the tape properly.

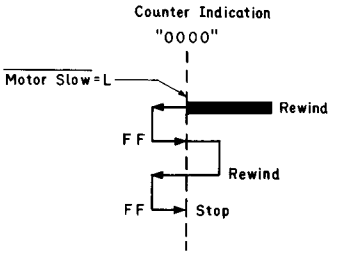


Fig. 3.14 Memory Stop Operation

4. Selector Circuits

4.1. Tape Position Selection

Pushing ON the Manual Tape/Eq. switch causes the red lamp (LED601) of the switch to light, indicating the Manual mode. When the Manual mode is entered, the $\overline{\text{A/M}}$ signal becomes H and Q641 turns ON. Then the inputs from the Auto Tape Selector switches are inhibited and the inputs from the pushbuttons ZX, SX and EX are accepted instead.

When the Manual Tape/Eq. switch is pushed OFF, the $\overline{\text{A/M}}$ signal becomes L, disabling inputs from the ZX, SX and EX pushbuttons. At the same time, Q641 turns ON and the Auto/$\overline{\text{Manual}}$ signal becomes H, so the inputs from the Auto Tape Selector switches (SX) and (ZX) located in the mechanism are accepted.

Fig. 4.2 shows the ON (closed)/OFF (open) states and locations of the Auto Tape Selector switches (SX) and (ZX) as observed when EX, SX and ZX are loaded.

Tape selector signals are input to IC607's T.Sel.1 (IC607-15) and T.Sel.2 (IC607-16), then they are output to IC608's T.Pos.1 (IC608-36) and T.Pos.2 (IC608-37). These outputs are decoded by the circuit consisting of Q628–Q630, IC604 (3/4), etc., so they provide EX, SX and ZX output signals.

Table 4.1 summarizes transistors' ON/OFF states and signal levels in relation to switch inputs.

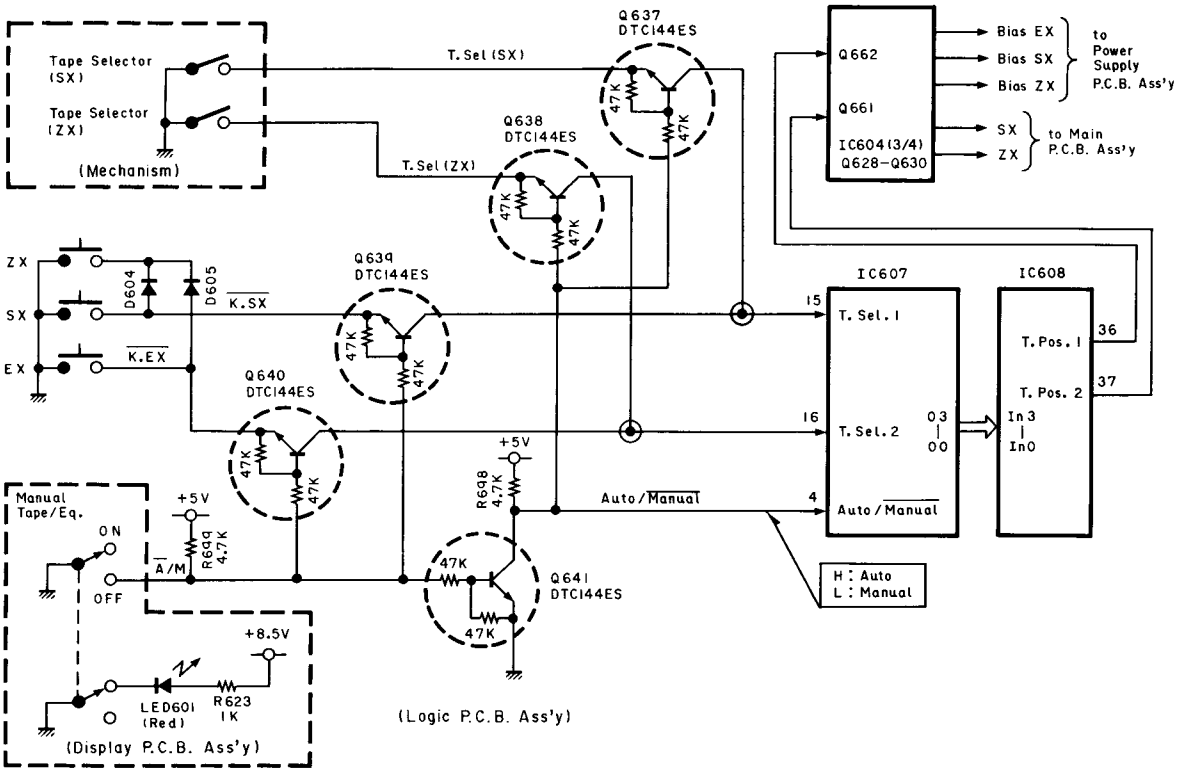


Fig. 4.1 Tape Selector Circuit

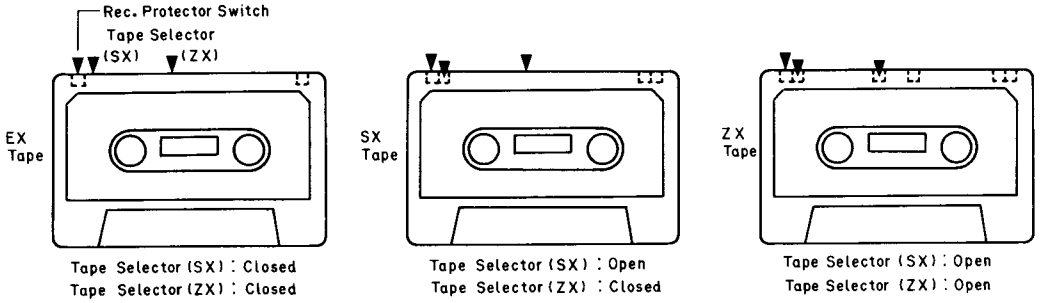


Fig. 4.2

Table 4.1

Mode		Q641	Q640	Q639	Q637	Q638	T.Sel. 1 (IC607-15)	T.Sel. 2 (IC607-16)	T.Pos. 1 (IC608-36)	T.Pos. 2 (IC608-37)	Q628 (EX)	Q629 (SX)	Q630 (ZX)
Manual $\overline{A}$/M=H	EX ($\overline{K.EX}$=L)	ON	ON	OFF	OFF	OFF	H	L	H	L	ON	OFF	OFF
	SX ($\overline{K.SX}$=L)	ON	OFF	ON	OFF	OFF	L	H	L	H	OFF	ON	OFF
	ZX ($\overline{K.EX}$=L, $\overline{K.SX}$=L)	ON	ON	ON	OFF	OFF	L	L	L	L	OFF	OFF	ON
Auto $\overline{A}$/M=L	EX (T.Sel.(SX)=L, T.Sel.(ZX)=L)	OFF	OFF	OFF	ON	ON	L	L	Same as above				
	SX (T.Sel.(SX)=H, T.Sel.(ZX)=L)	OFF	OFF	OFF	OFF	ON	H	L					
	ZX (T.Sel.(SX)=H, T.Sel.(ZX)=H)	OFF	OFF	OFF	OFF	OFF	H	H					

The signals SX and ZX going to IC301 (TC9145P) on the Main P.C.B. Ass'y from Q629 and Q630 are those having passed through the network. Their levels are approximately as follows:

Mode	SX Output	ZX Output
EX	−5 V	−5 V
SX	+5 V	−5 V
ZX	−5 V	+5 V

4.2. Dolby NR/Eq./Monitor Selections

(1) Dolby NR selection

Each time the Dolby NR button is pressed, the Dolby NR display advances to the next indication of the cycle: none → B → C → none, and so on. A push of the Dolby NR button feeds an L level to IC607-1 (K. Dolby NR). The information in IC607 is sent from IC607's output terminals O0–O3 to IC608's input terminals In0–In3. Then IC608 outputs the condition of Dolby NR selection to IC608-35 and -34 (Dolby NR C and Dolby NR B, respectively). These outputs are sent as display drive signals through Q663 and Q664 to the Display P.C.B. Ass'y; the outputs are also sent through Q635 and Q634 into the network comprising R685–R694. This network processes the Dolby NR C and Dolby NR B signal inputs to generate three signals: Dolby NR C, Dolby NR B, and Dolby NR Mode. These are summarized in Table 4.2.

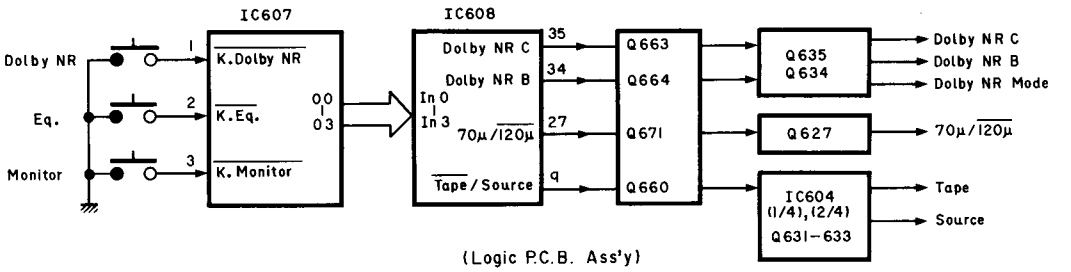


Fig. 4.3 Dolby NR/Eq./Monitor Selection Circuit

Table 4.2

Dolby NR Display	Dolby NR B (IC608-34)	Dolby NR C (IC608-35)	Q663 Q635	Q664 Q634	Dolby NR C	Dolby NR B	Dolby NR Mode
OFF	L	L	OFF	OFF	−11.9 V	−4.5 V	−8.8 V
B	H	L	OFF	ON	−11.9 V	+8 V	−4.6 V
C	L	H	ON	OFF	+7.9 V	−4.5 V	+7.9 V

(2) Eq. selection (70 μ/120 μ)

Each time the Eq. button is pressed, an L level is applied to IC607-2 (K. Eq.), causing an inversion from 70 μ to 120 μ, or vice versa. The 70 μ/120 μ signal appearing at IC608-27 is inverted by Q671 and sent through IC604 (4/4) to the display circuit. Also, the inverted signal turns ON or OFF Q627, which sends the 70 μ/120 μ signal to the amplifier circuit.

(3) Monitor selection (Tape/Source)

Each time the Monitor button is pressed, an L level is applied to IC607-3 (K. Monitor), causing an inversion from Tape to Source, or vice versa. The Tape/Source signal appearing at IC608-9 is inverted by Q660, then sent through IC604 (1/4) and (2/4), and Q633, and to the display circuit. As the inverted signal goes through IC604 (1/4) and (2/4) to Q631 and Q632, it is processed into the signals Tape and Source, which are fed to the tape/source switching circuit (composed of FETs Q114, Q115, Q214, Q215, etc., on the Main P.C.B. Ass'y) in front of line amps.

4.3. P. Hold Display Selection

Input from the Peak Hold button is taken through the filter & shaping circuit (IC605 (3/4), (4/4)), and into the flip-flop (IC605 (1/4), (2/4)). Each time the Peak Hold button is pressed, the flip-flop is inverted in state, so that the Peak Hold display alternates between [Peak Hold] and [Peak]. The display changes to [Peak Hold] when Q642 turns ON. Refer to Fig. 4.4.

Note: The signal Azimuth Direciton, which is sent from IC609, is normally at H. When the Playback Head Azimuth control is turned by hand, this signal becomes L and turns OFF the [Hold] indicator.

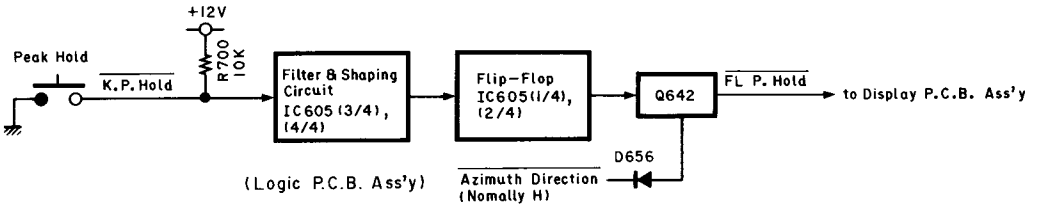


Fig. 4.4 P. Hold Display Control Circuit

5. Auto Calibration Operation

5.1. Introduction

This cassette deck has an auto calibration function.

Once a cassette tape to be recorded is loaded, auto calibration is started simply by pressing the Auto Calibration button before recording. Auto calibration operation consists of playback head azimuth correction, followed by determination and setting of the best recording level and bias current for the tape.

After auto calibration, the tape is rewound to the original position. The cassette deck then enters Rec./Pause mode, waiting for input from the Play button.

During auto calibration, test tones (400 Hz, 15 kHz) are recorded and played back. The time required for this recording and playback, plus other processes involved in auto calibration, is 15 sec on the average.

An auto calibration operation consists of six steps, as outlined in the following paragraphs. Fig. 5.1 presents a flow chart of auto calibration. Fig. 5.2 shows the states of each indicator lamp as auto calibration proceeds.

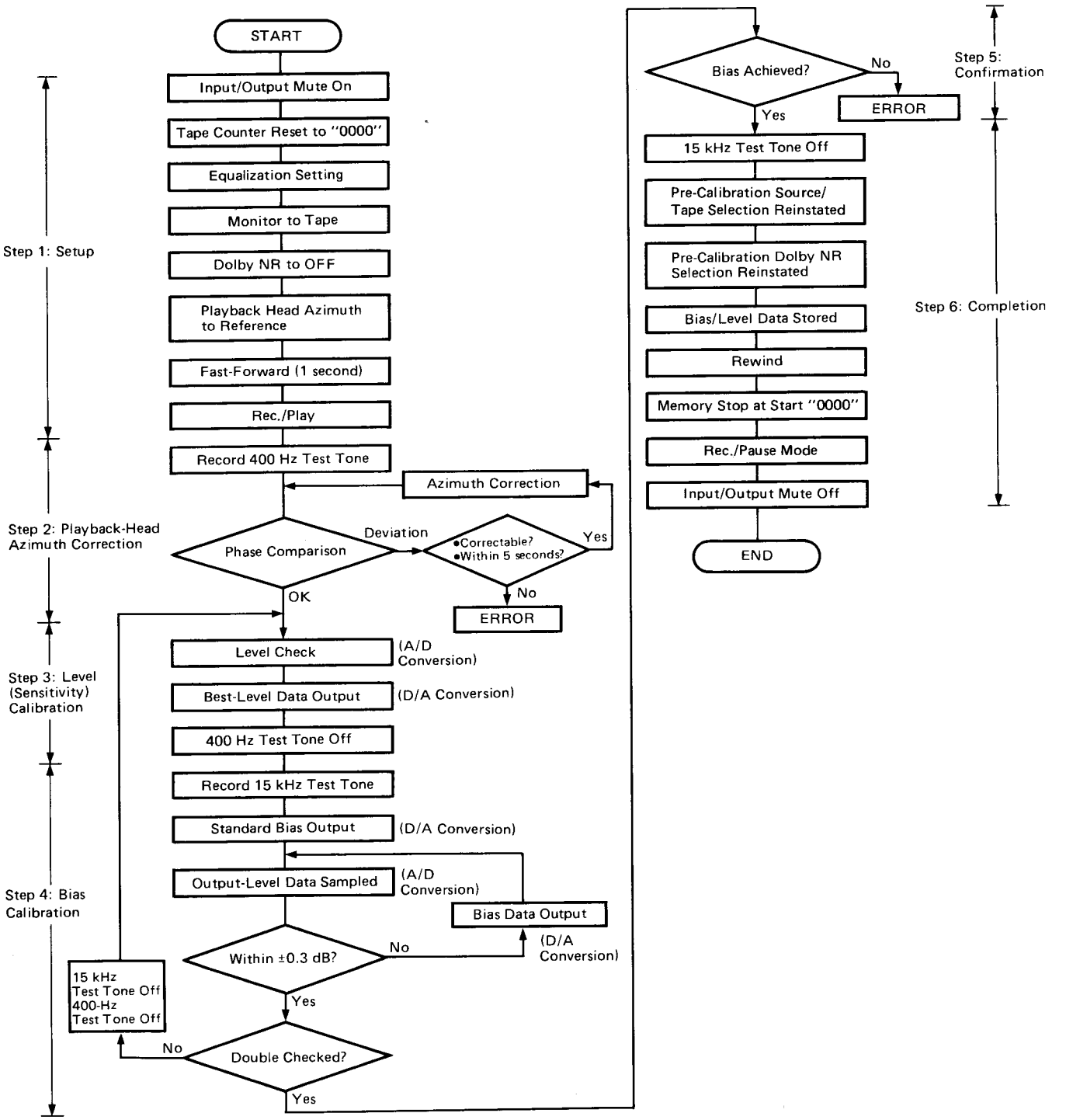


Fig. 5.1 Auto Calibration Flow Chart

(1) Step 1: Setup

- The cassette deck enters the recording mode.
- Line mute is activated (for speaker protection).
- The tape counter is reset, and the auto calibration start position "0000" is stored.
- The Manual Tape/Eq. switch state is checked (for setting Eq.).
  ON (Manual): Equalization is set to match the position selected by Manual Tape Selector.
  OFF (Auto): Equalization is set to match the position corresponding to the type of tape detected by Auto Tape Selector.
- Monitor is set to Tape (overrides manual selection).
- Dolby NR is set to OFF (overrides manual selection).
- The playback head azimuth is set to the reference position (independent of the position of the Playback Head Azimuth control on the front panel).
- The tape advances for 1 sec in F.F. mode.

(2) Step 2: Playback head azimuth correction

This cassette deck has the record head fixedly mounted and the playback head variable in azimuth (inclination). Tape travelling condition is rarely ideal for such reasons as the cassette tape being used. Therefore, a phase difference occurs between Lch and Rch signals when a 400-Hz test tone is recorded and played back on the tape, even if the record head and playback head are mechanically adjusted to the same azimuth.

This step reduces the phase difference to zero, thereby adjusting the playback head azimuth precisely to the record head azimuth via the tape. The result is optimum characteristics. See Fig. 5.3.

- A test tone of 400 Hz 0 dB is recorded and played back.
- Phase comparison of the Lch and Rch outputs is made once every 100 ms in the automatic playback head azimuth correction circuit (Fig. 5.3). If phase deviation between the channels is detected, playback head azimuth correction (in steps of approximately 1.3') is ordered; this process is repeated until the phase deviation is corrected and that correction confirmed 10 times.
- Error Message: If the tape in use is so inferior as to prevent correction within five seconds, or if the azimuth adjustments necessary to achieve correction are beyond the range of the system, auto calibration is suspended and the error message appears on the display. (The error message is accompanied by the flickering of the [Azimuth], [Level] and [Bias] indicators.)

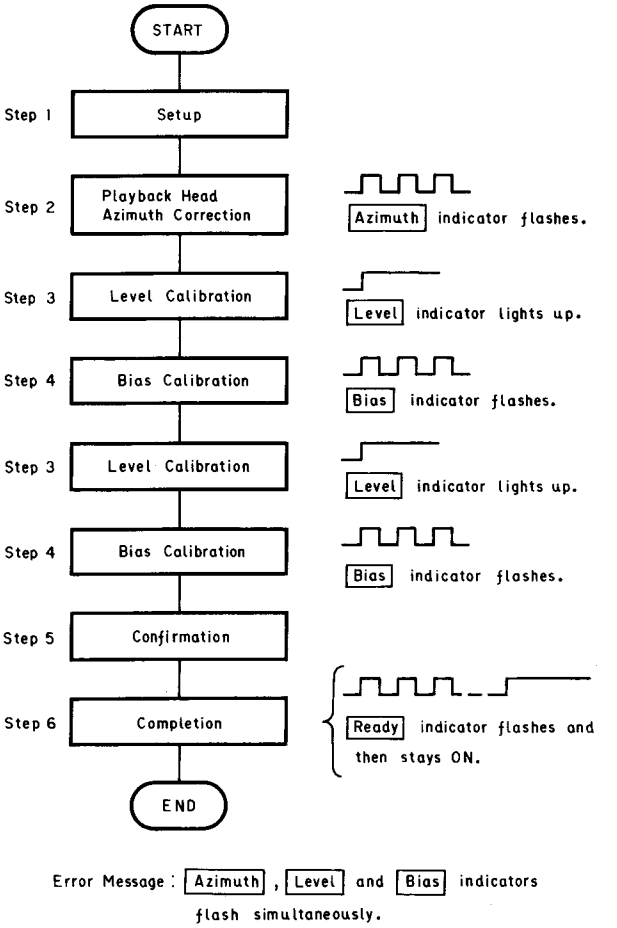


Fig. 5.2

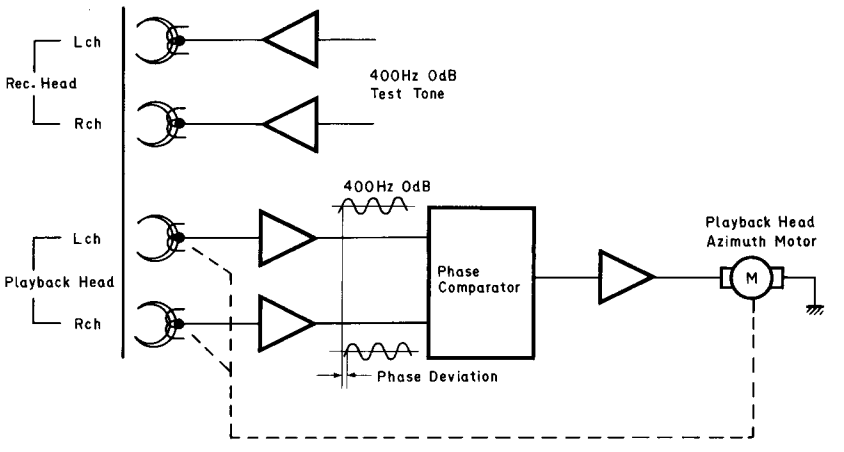


Fig. 5.3 Playback Head Azimuth Correction Circuit

(3) Step 3: Level (Sensitivity) calibration

– The 400-Hz test tone is again recorded and playback output level is sampled at 15 points independently in the L and R channels. The point at which level is the highest becomes the sensitivity value for the tape; that value is digitized by the MPU IC608 which compares it to the digitized value for the level of the input. The difference, if any, is converted from digital to analog and sent as a voltage to the recording amplifier to adjust its gain in compensation.

Refer to Fig. 5.4 and its signal flow.

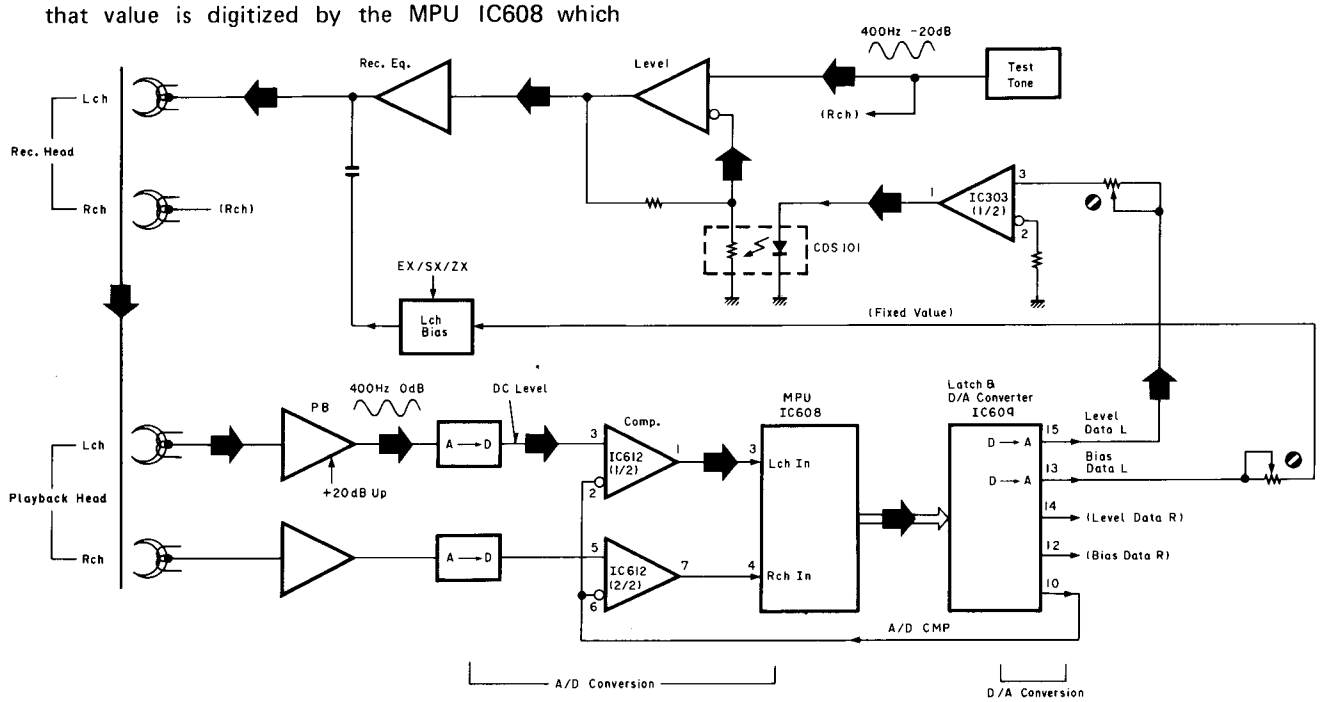


Fig. 5.4 Level Calibration

(4) Step 4: Bias calibration

At the level determined in Step 3, a 15-kHz test tone is recorded at the standard bias for the tape in use, and playback output level is sampled at 15 points independently in the L and R channels. The output level is digitized by the MPU IC608 where it is compared with the digitized value for the test tone. If a difference is detected between them, a bias adjustment is ordered in the appropriate channel and the process is repeated (up to six times in all) until the difference in analog terms is within ±0.3 dB.

Then, because even a slight change in bias can affect output level, Steps 3 and 4 are again carried out.

Refer to Fig. 5.5 and its signal flow.

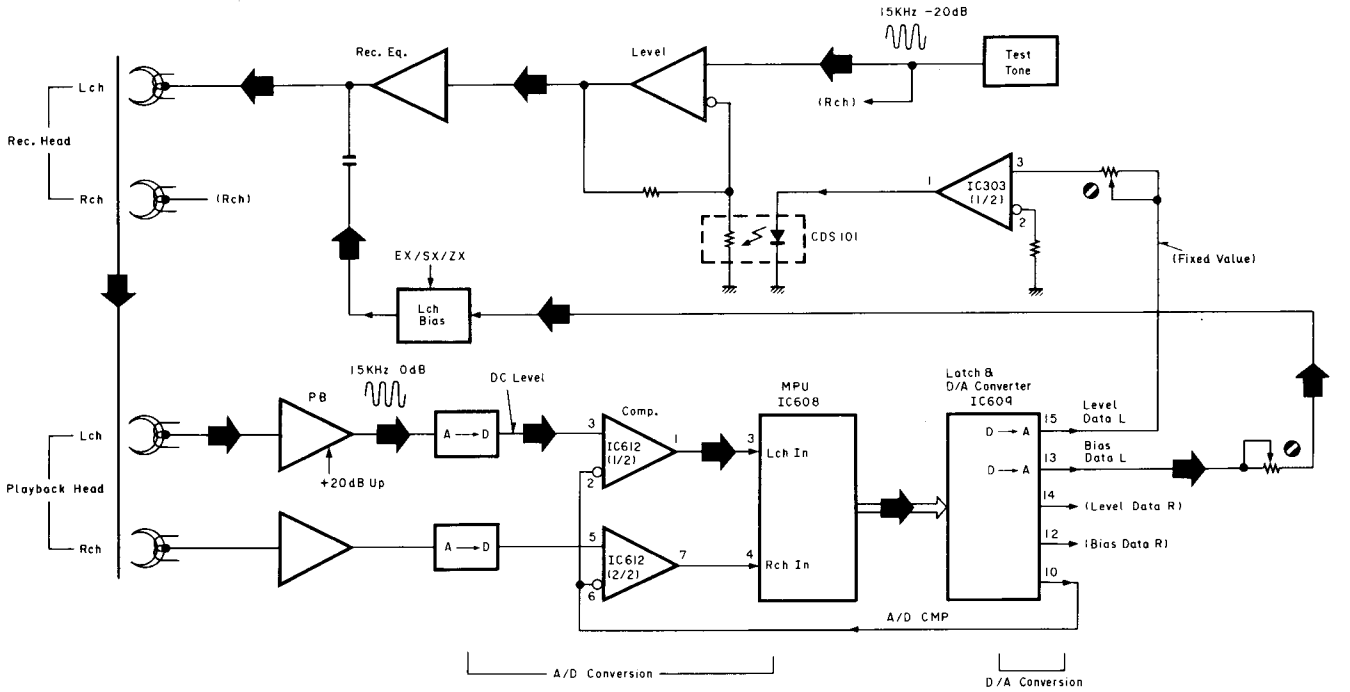


Fig. 5.5 Bias Calibration

(5) Step 5: Confirmation

If, after carring out Steps 3 and 4 twice, as explained above, the ±0.3-dB criterion for output on bias cannot be attained, or the bias value is determined to be beyond the range of adjustment provided (for example, if the wrong tape position has been set manually by the user), auto calibration is suspended and the error message is displayed. The entire auto calibration process must be reinitiated by pushing Reset button and starting over.

(6) Step 6: Completion

When confirmation is completed, the obtained data for the L/R-channel level and bias calibrations are stored in the deck's memory (with battery backup) and will be recalled the next time a tape of that type is loaded and sensed by the Automatic Tape Selector. The Source/Tape and Dolby NR selections made manually are reinstated. The tape is then automatically rewound to the start "0000" point at which auto calibration was begun, and the deck is set in the Rec./Pause mode, with automatic muting off, ready for recording.

5.2. Functions of Auto Calibration Control ICs

5.2.1. Introduction

The ICs that control auto calibration operation are input port expander IC607 (LC7800), MPU IC608 (IC6510C) and latch & D/A converter IC609 (μPD6326C) which are mounted on the Logic P.C.B. Ass'y. Of these, IC608 assumes major control.

IC607 senses and processes the states of switches, modes, etc. Its output is sent to IC608. In IC608, data is processed in digital form; the resultant data is stored and is also sent to IC609 in serial form. IC609 converts the incoming serial data to parallel data and stores it in the latch circuit. The latched parallel data goes through D/A conversion to provide analog outputs (voltages). Detailed discussions of data transfer between the above ICs are given in Section 5.2.5.

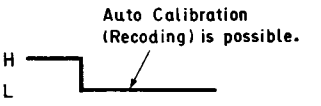
The data in IC608 is backed up by a lithium battery, so it is held after the power is turned OFF.

5.2.2. Description of IC607 (Input Port Expander)

Refer to Table 5.1.

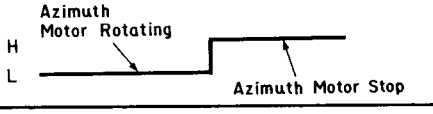
Table 5.1

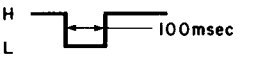
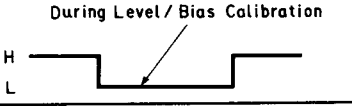
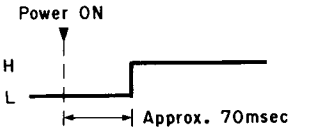
Pin No.	Signal Name	In/Out	Function
1	$\overline{\text{K. Dolby NR}}$	In	Dolby NR button input terminal. Becomes L upon push of Dolby NR button.
2	$\overline{\text{K. Eq.}}$	In	Eq. button input terminal. Becomes L upon push of Eq. button.
3	$\overline{\text{K. Monitor}}$	In	Monitor button input terminal. Becomes L upon push of Monitor button.
4	Auto/$\overline{\text{Manual}}$	In	Auto/$\overline{\text{Manual}}$ signal. Becomes L when Manual Tape/Eq. switch is set to ON (Manual). Becomes H when Manual Tape/Eq. switch is set to OFF (Auto).
5	$\overline{\text{Azimuth Up}}$	In	$\overline{\text{Azimuth Up}}$ signal. Active L. Becomes L upon push of Azimuth Up button of wireless Remote Control Unit.
6	$\overline{\text{Azimuth Down}}$	In	$\overline{\text{Azimuth Down}}$ signal. Active L. . Becomes L upon push of Azimuth Down button of wireless Remote Control Unit.
7 8	PD1 PD2	In In	Phase Detector Output 1 and Phase Detector Output 2 signals. Phase deviation between L and R channel playback signals is determined by PD1 and PD2 signals as follows: No Signal: PD1 L, PD2 L L > R: PD1 H, PD2 L L < R: PD1 L, PD2 H L = R: PD1 H, PD2 H
9 10 11	$\overline{\text{Mode Stop}}$ $\overline{\text{Mode Play}}$ $\overline{\text{Mode Rec.}}$	In In In	Mode input signals. Active L.

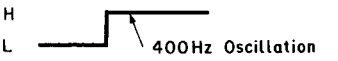
Pin No.	Signal Name	In/Out	Function
12	Rec. Protect	In	Record Protect signal. Active H. When a tape with record protect tabs is loaded, this signal becomes L, allowing recording. 
13	INH	In	Not used.
14	VSS	In	Connected to GND.
15 16	T. Sel. 1 T. Sel. 2	In In	Tape Selector 1 and Tape Selector 2 signals. See Table 4.1 on page 15 for detailed description.
17	$\overline{\text{K. Cal. Reset}}$	In	Auto Calibration Reset button input terminal. Becomes L upon push of the button. (Error message is cleared.)
18	$\overline{\text{K. Cal.}}$	In	Auto Calibration button input terminal. Becomes L upon push of the button.
19 20 21 22 23 24 25 26	SA SB SC SD O0 O1 O2 O3	In In In In Out Out Out Out	SA – SD are address input terminals. Address signals are transmitted from IC608. IC607 outputs signals to output terminals O0 – O3 according to SA – SD input signals.
27	VDD	In	+5 V is supplied.
28	INH	In	Not used.

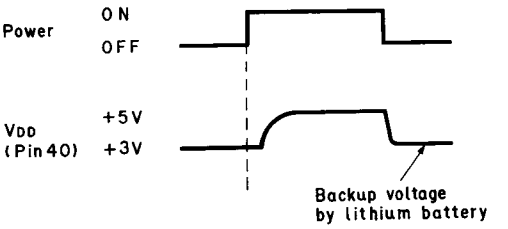
5.2.3. Description of IC608 (Auto Calibration Control MPU)

Table 5.2

Pin No.	Signal Name	In/Out	Function
1 2	In 1 In 0	In In	Input terminals to receive O1 and O0 output signals from IC607.
3	Lch In	In	Lch Input signal. Lch comparator output signal (either H or L) is input.
4	Rch In	In	Rch Input signal. Rch comparator output signal (either H or L) is input.
5	$\overline{\text{Motor Slow}}$	In	When memory stop function is activated at the end of Auto Calibration operation, this signal goes L after tape counter passes "0000" during rewinding. See Fig. 3.14.
6	Motor Monitor	In	Motor Monitor signal. Used to check for azimuth motor rotating. 

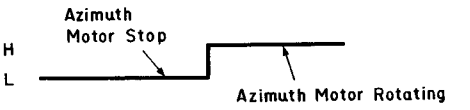
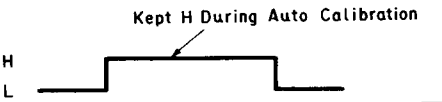
Pin No.	Signal Name	In/Out	Function
7	$\overline{\text{M. Stop}}$	Out	$\overline{\text{Memory Stop}}$ signal. Active L. Memory stop function is activated when this signal becomes L. (Tape is rewound and stops at tape counter indication "0000".)
8	$\overline{\text{C. Reset}}$	Out	$\overline{\text{Counter Reset}}$ signal. Active L. A 100 msec negative going pulse is issued and tape counter is reset to "0000" when Auto Calibration is started. 
9	$\overline{\text{Tape}}$/Source	Out	Monitor mode (either Tape or Source) output terminal. L indicates Tape mode, while H shows Source mode. During Auto Calibration operation, Tape mode is ordered regardless of manual monitor setting.
10 11 12 13	$\overline{\text{K. Rec.}}$ $\overline{\text{K. Rew.}}$ $\overline{\text{K. FF}}$ $\overline{\text{K. Play}}$	Out Out Out Out	Mechanism control signals. Active L. Used to control mechanism during Auto Calibration operation.
14	$\overline{\text{+20 dB}}$	Out	$\overline{\text{+20 dB Up}}$ signal. Active L. Stays at L during Level/Bias Calibration. Line amp. gain increases by 20 dB. 
15 16 17 18	SD SC SB SA	Out Out Out Out	Output signals fed to IC607. When these signals are fed to IC607, IC607 sends output signals to In3 – In0 of IC608.
19	$\overline{\text{Reset}}$	In	$\overline{\text{Reset}}$ signal. Active L. Held at L for approx. 70 msec after power is turned ON. Upon change of this signal to H, IC608 starts operation. 
20	Test	In	Not used.
21	VSS	–	Connected to GND.
22 23	Osc. 1 Osc. 2	In In	External circuit for clock oscillation. Crystal oscillation frequency = 800 kHz
24 25 26	Load Clock Data	Out Out Out	Output terminals to transmit serial data to IC609. See 5.2.5 for detailed description.

<table>
<tr><th>Pin No.</th><th>Signal Name</th><th>In/Out</th><th>Function</th></tr>
<tr><td>27</td><td>70μ/120μ</td><td>Out</td><td>Eq. mode output terminal. H indicates 70μ and L indicates 120μ.
During Auto Calibration operation, this signal is forcedly set as follows regardless of manual eq. setting.
<table><tr><th>Tape Position</th><th>70μ/120μ</th></tr><tr><td>EX</td><td>L (120μ)</td></tr><tr><td>SX</td><td>H (70μ)</td></tr><tr><td>ZX</td><td>H (70μ)</td></tr></table></td></tr>
<tr><td>28</td><td>Azimuth</td><td>Out</td><td>Azimuth Indicator ON signal. Active H.
Lights up Azimuth indicator at H.</td></tr>
<tr><td>29</td><td>Level</td><td>Out</td><td>Level signal. Active H.
Lights up Level indicator at H.
Decreases 400 Hz test tone output level by 20 dB.</td></tr>
<tr><td>30</td><td>Bias</td><td>Out</td><td>Bias Indicator ON signal. Active H.
Lights up Bias indicator at H.</td></tr>
<tr><td>31</td><td>Ready</td><td>Out</td><td>Ready Indicator ON signal. Active H.
Lights up Ready indicator at H.</td></tr>
<tr><td>32</td><td>400 Hz</td><td>Out</td><td>400 Hz Test Tone ON signal. Active H.
  </td></tr>
<tr><td>33</td><td>15 kHz</td><td>Out</td><td>15 kHz Test Tone ON signal. Active H.
  </td></tr>
<tr><td>34
35</td><td>Dolby NR B
Dolby NR C</td><td>Out
Out</td><td>Dolby NR signals. These signals are set according to Dolby NR modes as follows:
<table><tr><th>Mode</th><th>Dolby NR B</th><th>Dolby NR C</th></tr><tr><td>OFF</td><td>L</td><td>L</td></tr><tr><td>B</td><td>H</td><td>L</td></tr><tr><td>C</td><td>L</td><td>H</td></tr></table></td></tr>
<tr><td>36
37</td><td>T. Pos. 1
T. Pos. 2</td><td>Out
Out</td><td>Tape Position 1 and Tape Position 2 signals. These signals are set according to tape positions as follows:
<table><tr><th>Tape Position</th><th>T. Pos. 1</th><th>T. Pos. 2</th></tr><tr><td>EX</td><td>H</td><td>L</td></tr><tr><td>SX</td><td>L</td><td>H</td></tr><tr><td>ZX</td><td>L</td><td>L</td></tr></table></td></tr>
<tr><td>38</td><td>Power Off</td><td>In</td><td>Power Off signal. Active L.
When Power switch is turned to OFF, Power Off signal becomes L, then IC608 performs power off operation.</td></tr>
</table>

Pin No.	Signal Name	In/Out	Function
39	$\overline{\text{Test Mode}}$	In	$\overline{\text{Test Mode}}$ signal input terminal. This terminal is effective only when Test Unit is connected to CN-11 of Logic P.C.B. Ass'y. Test mode is entered when TEST button on Test Unit is pressed.
40	VDD	In	+5 V is supplied. At power OFF, approx. +3 V is supplied by lithium battery. 
41 42	In3 In2	In In	Input terminals to receive O3 and O2 output signals from IC607.

5.2.4. Description of IC609 (Latch and D/A Converter)

Table 5.3

Pin No.	Signal Name	In/Out	Function
1	VCC	In	+5 V is supplied.
2 3 4	Data In Clock Load	In In In	Input terminals to receive serial data from IC608. See 5.2.5 for detailed description.
5	Azimuth Direction	Out	Azimuth Direction signal. Active H. Becomes H when Playback Head Azimuth control is turned, resulting in level meters switched to Azimuth Display mode.
6	Data Out	Out	Not used.
7	$\overline{\text{Motor Off}}$	Out	$\overline{\text{Azimuth Motor Off}}$ signal. Active L. Controls azimuth motor rotating. 
8	VSS	–	Connected to GND.
9	Cal. Mute	Out	Cal. Mute signal. Active H. During Auto Calibration, this signal is kept H. Line Mute signal becomes H and line input and line output signals are muted. 
10	A/D CMP	Out	A/D CMP signal (analog output (level)). This signal is used to carry out A/D (analog-to-digital) conversion. Analog output corresponds to the digital data set by IC608.
11	Az Motor	Out	Azimuth Motor Drive signal (analog output (level)). Analog output corresponds to the digital data set by IC608.

Pin No.	Signal Name	In/Out	Function
12 13	R Bias L Bias	Out Out	R and L Channel Bias Output signals (analog outputs (levels)). Analog output corresponds to the digital data set by IC608.
14 15	R Level L Level	Out Out	R and L Channel Level Output signals (analog outputs (levels)). Analog output corresponds to the digital data set by IC608.
16	VDD	In	+12 V is supplied.

5.2.5. Data Transfer

(1) Data transfer between input port expander IC607 and MPU IC608 (Refer to Fig. 5.6.)

IC608 sends 4-bit address selection signals to SA–SD. Upon receipt of these signals, IC607 responds with the selected address contents (switches' ON/OFF states, etc.) from its O0–O3 to IC608's In0–In3. IC608 looks at the data at In0–In3 to know switches' ON/OFF states, etc.

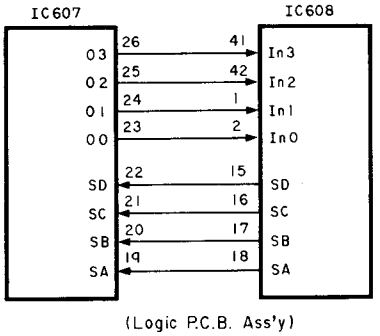


Fig. 5.6 Data Transfer Between IC607 and IC608

(2) Data transfer between MPU IC608 and IC609

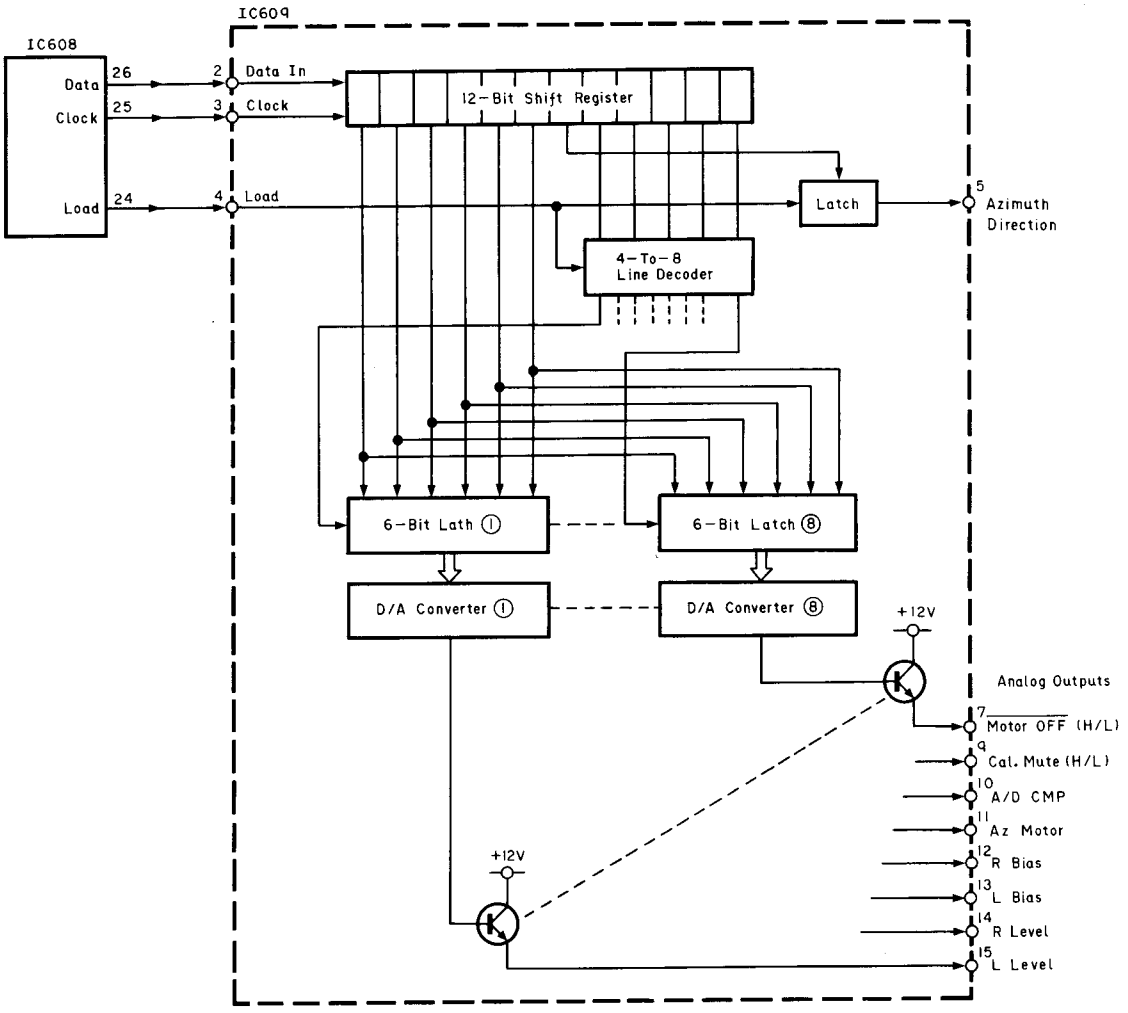


Fig. 5.7 Block Diagram of IC609

As data of 12-bit length is sent synchronized with the clock from IC608, it is stored in IC609's 12-bit shift register. Acutally, however, 4-bit data is sent three consecutive times. The 12-bit data has the following contents:

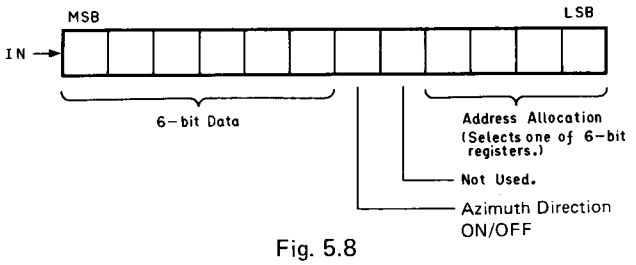


Fig. 5.8

The lower 4 bits stored in the 12-bit shift register determine which 6-bit latch to select. The upper 6 bits are data to be stored in the 6-bit latch selected.
In the example of Fig. 5.9, as the Load signal rises, the address of 6-bit latch ① is selected, so the upper 6-bit data is latched and stored in 6-bit latch ①. The output of 6-bit latch ① is put through D/A conversion in the next stage, developing its analog output (level) at the "L Level" terminal. Thus, each time another 6-bit data is latched in 6-bit latch ①, the "L Level" terminal changes in level.
When the Load signal rises the next time, the upper 6-bit data is latched in 6-bit latch ②, changing the output (level) at the "R Level" terminal. At this time, the "L Level" output remains unchanged because 6-bit latch ① for L level stays intact and still holds the previously latched data.
Through the processes illustrated above, eight independent sets of data are stored in respective registers: for L Level, R Level, L Bias, R Bias, Az Motor, A/D CMP, Cal. Mute, and $\overline{\text{Motor Off}}$. The terminals Cal. Mute and $\overline{\text{Motor Off}}$ are used for judgment between H and L.

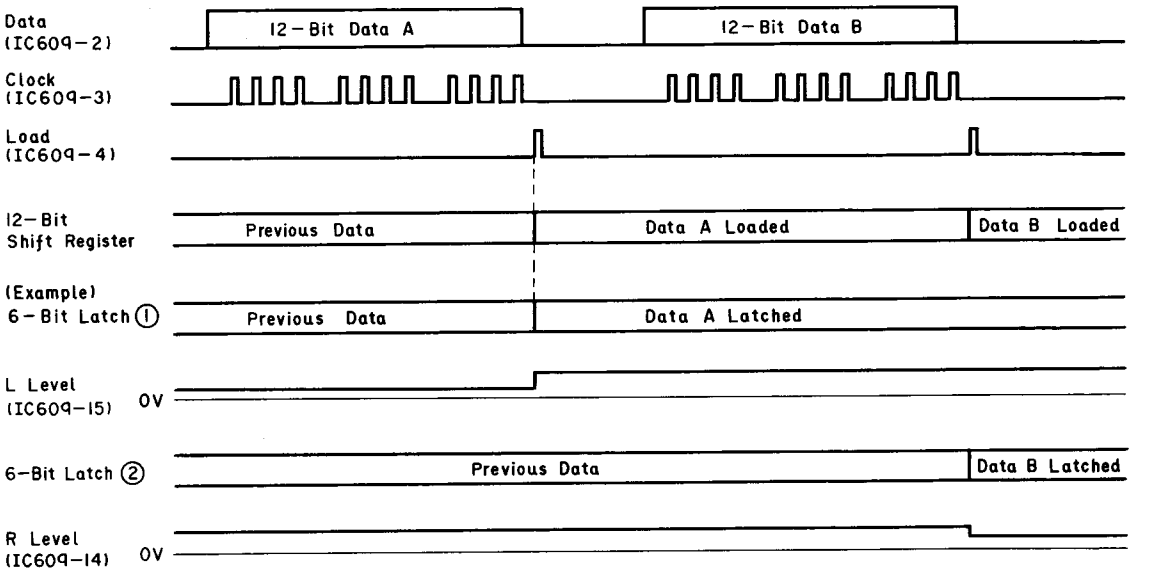
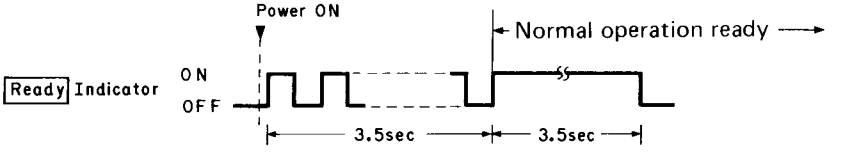


Fig. 5.9 Data Transfer Example (IC608 to IC609)

5.3. Processing at Power-up Time

When the $\overline{\text{Reset}}$ signal is cleared (to H level) after the power is turned ON, IC608 (for auto calibration control performs initialization in the sequence shown in Table 5.4).

Table 5.4 Initialization at Power-up Time

Step	Item	Explanation
1	Initial values of data	IC608's RAM (random access memory) contains the Level L/R data, Bias L/R data, and modes (Eq., Dolby NR, and Monitor), for respective tape positions (EX, SX, and ZX), as they had been stored at power-down time. Note: When the power is turned ON at the first time, or when the power is turned ON in the absence of data backup by the lithium battery, predetermined Level L/R data and Bias L/R data will be set for each tape position. Also, Eq. will be set to 70 μs, Dolby NR to OFF, and Monitor to Tape.
2	Initialization of IC608 outputs	L: IC608-28 to 30, 32, 33 (Azimuth, Level, Bias, 400 Hz, 15 kHz) H: IC608-7, 8, 10 to 14 ($\overline{\text{M. Stop}}$, $\overline{\text{C. Reset}}$, $\overline{\text{K. Rec.}}$, $\overline{\text{K. Rew.}}$, $\overline{\text{K. FF}}$, $\overline{\text{K. Play}}$, $\overline{+20\text{ dB}}$)
3	$\overline{\text{Dolby NR Mode}}$, $\overline{\text{Tape/Source}}$	The states effective at the previous power-down time are output and displayed.
4	Setting of tape position and Eq.	The state of Manual Tape/Eq. switch is sensed (ON = Manual, OFF = Auto) to determine the tape position and Eq. ON = Manual The tape position and Eq. states effective at the previous power-down time are output and displayed. OFF = Auto The type of loaded cassette is detected by Auto Tape Selector switches (SX) and (ZX) to determine the tape position. Eq. is automatically determined according to the tape position. 70 μ for SX and ZX 120 μ for EX If the power is turned ON with no tape loaded, the ZX position and 70 μ are selected.
5	Setting of IC609 outputs	With data received from IC608, signals are set as follows: Azimuth Direction (IC609-5) = L $\overline{\text{Cal. Mute}}$ (IC609-9) = L $\overline{\text{Motor Off}}$ (IC609-7) = H
6	Setting of Level L/R and Bias L/R data	The Level L/R data and Bias L/R data for the selected tape position are sent to IC609. IC609 performs D/A conversion of the data and issues analog outputs of Level L/R and Bias L/R.
7	Start of [Ready] indicator flashing	A pulse is sent to Ready (IC608-31), causing the [Ready] indicator to flash.
8	Setting of playback head azimuth	The playback head azimuth is matched to the Playback Head Azimuth control position set at power-up time.
9	Lighting and going off of [Ready] indicator	The [Ready] indicator is switched from flashing to continuous lighting. This indicates the completion of initialization at power-up time and therefore the readiness for normal operation. The [Ready] indicator goes off after approx. 3.5 sec of continuous lighting. 

5.4. Playback Head Azimuth Correction

The following sections provide detailed explanations for Section 5.1, "(2) Step 2: Playback Head Azimuth Correction".

5.4.1. Correction System

(1) When the cassette deck has entered the auto calibration operation, playback head azimuth correction is performed after "Step 1: Setup (line muting, tape counter resetting to "0000", etc.)".

(2) The signal 400 Hz (IC608-32) = H is supplied to the test tone circuit in the Main P.C.B. Ass'y, which generates a sine wave of 400 Hz, 0 dB and sends it to the line inputs of both channels. On the other hand, IC608 has already set prespecified reference data of Level L/R and Bias L/R into IC609, so the reference analog outputs for azimuth correction have been sent to the recording level amplifier circuit and bias current control circuit of each channel. At these settings of recording level and bias current, the 400 Hz signal is recorded and played back.

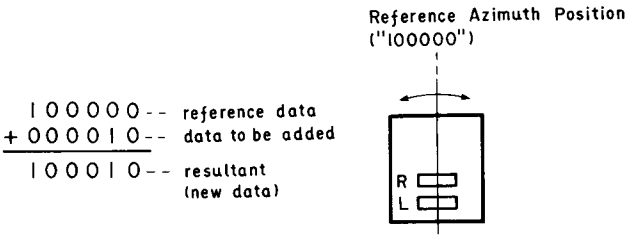
(3) The played back signals (Tape L and Tape R) enter the azimuth phase detector, which detects the phase shift between Tape L and Tape R. The detector's outputs PD1 and PD2 take the following levels:

	PD1 (IC607-7)	PD2 (IC607-8)
No signal	L	L
L > R	H	L
L < R	L	H
L = R	H	H

(4) IC608 senses the states of PD1 and PD2. If the phases of the two channels are not matched, that is, if both PD1 and PD2 are not at H, IC608 executes azimuth correction in the following procedure:

(a) At "Step 1: Setup", the Az Motor Latch circuit in IC609 has read in the 6-bit reference data "100000". Therefore, the azimuth motor has been stopped at the reference position (i.e., the position at which the record head and playback head are mechanically matched in azimuth).

(b) When PD1 = H and PD2 = L, for example, IC608 adds a decimal "2", which is "000010" in binary, to the reference data "100000". The sum "100010" is sent as new data to the Az Motor Latch circuit in IC609.
Consequently, the analog output of the Az Motor Latch circuit is increased by the equivalent of digital "2", thus starting the azimuth motor. The revolution of the azimuth motor causes the azimuth potentiometer to rotate, and then the motor stops.



(c) IC608 checks PD1 and PD2 again and performs the operation of step (b) until both PD1 and PD2 become H, i.e., until both phases are matched. The azimuth correction process is completed when the state that both phases are being matched is conformed 10 times (for 1 sec) with a period of 0.1 sec.
After each correction of data (addition of "2"), the playback head is tilted by 1.3'. When PD1 = L and PD2 = H, the reference data is subtracted by "2" at each correction to decrease the analog output at the "Az Motor" terminal.

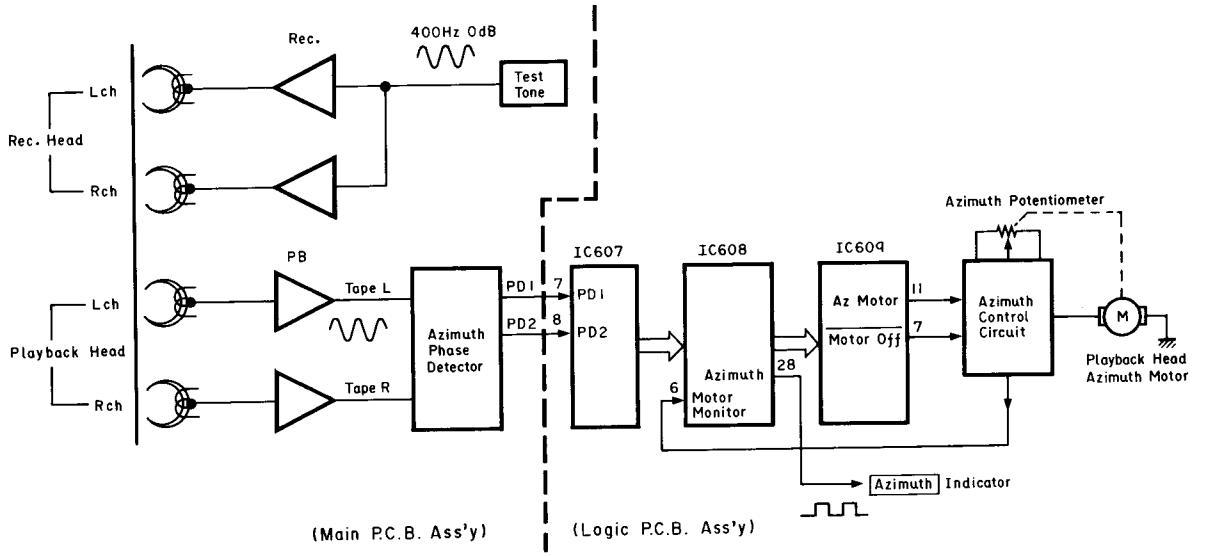


Fig. 5.10 Playback Head Azimuth Correction System Block Diagram

5.4.2. Test Tone Circuit

The 400 Hz/15 kHz square wave oscillation circuit consists of IC310 (1/2), IC314 (3/4), Q306, and their peripheral circuits, which are mounted on the Main P.C.B. Ass'y. When Q306 is turned ON and C317 (0.018μF) is connected in parallel with C318 (330pF), a 400 Hz square wave is delivered to IC314-10 (3/4). When Q306 is turned OFF and C317 is disconnected, the output frequency changes to 15 kHz.

(1) 400 Hz (IC608-32) = H (During playback head azimuth correction (400 Hz, 0 dB)):

The 400 Hz square wave from IC314-10 (3/4) is brought to IC314-11(4/4). From there, the square wave passes through the 400 Hz filter, composed of resistors, capacitors and IC310 (2/2), so that the wave is converted to a 400 Hz sine wave which goes to the line inputs of both channels.

(2) 400 Hz (IC608-32) = H, Level (IC608-29) = H (During level calibration (400 Hz, −20 dB)):

This process is basically the same as in (1) above. However, with Level = H, Q304 is turned ON, and the 400 Hz output is voltage-divided by R329 and R328 to produce a sine wave output of 400 Hz, −20 dB.

(3) 15 kHz (IC608-33) = H (During bias calibration (15 kHz, −20 dB)):

The 15 kHz square wave from IC314-10 (3/4) is output to IC314-3 (1/4), passed through the filter in the next stage, converted to a 15 kHz sine wave, then sent to the line inputs of both channels.

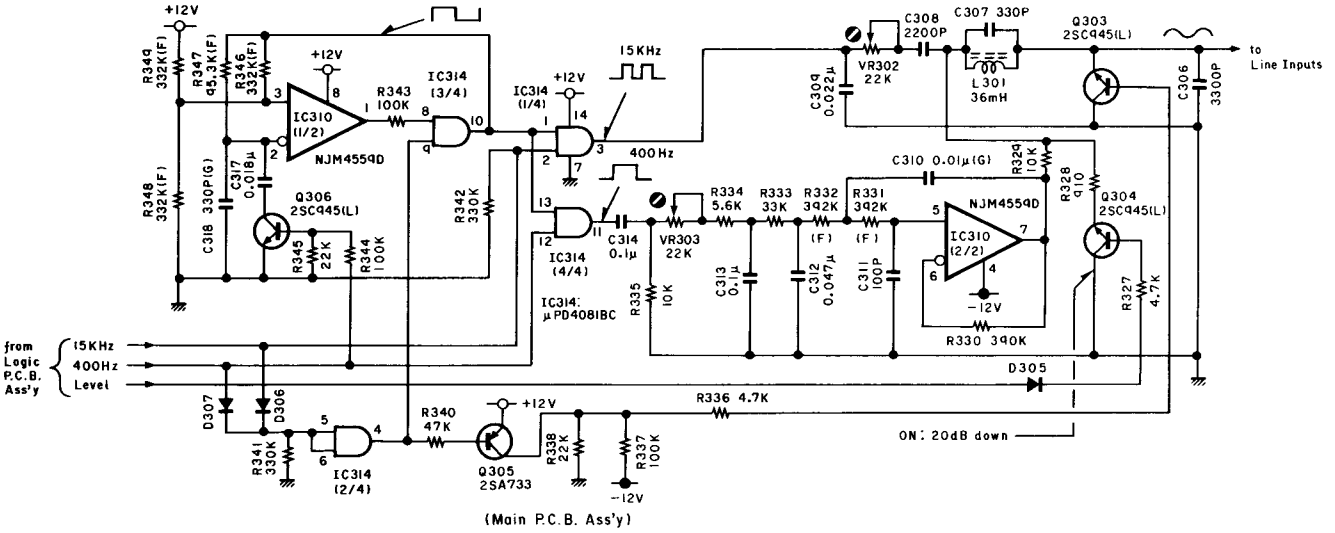


Fig. 5.11 Test Tone Circuit

5.4.3. Playback Azimuth Phase Detector Circuit

During playback head azimuth correction, the 400 Hz signal is recorded and played back. The 400 Hz Lch and Rch signals played back enter the playback azimuth phase detector circuit on the Main P.C.B. Ass'y.

This detector circuit detects the phase difference between Tape L and Tape R signals. It then outputs the detection results to PD1 and PD2. The signals PD1 and PD2 are sent to the IC607-7 and -8 (PD1 and PD2) on the Logic P.C.B. Ass'y.

Tape L and Tape R are amplified in IC311 (2/2) and (1/2), respectively, and passed through the BPF (band pass filter) consisting of resistors and capacitors in the next stage. Then the signals are shaped into square waves by IC312 (2/2) and (1/2). These square waves are changed in level, then sent to the D input terminal and C (clock) terminal on IC313 (D-type flip-flop), respectively. Depending on the phase difference between Lch and Rch, PD1 and PD2 take the levels shown in Fig. 5.13.

(1) When Lch is ahead of phase of Rch:
IC313-1 (Q output) is H and IC313-2 ($\overline{Q}$ output) is L, so that PD1 = H and PD2 = L.

(2) When Rch is ahead of phase of Lch:
IC313-1 (Q output) is L and IC313-2 ($\overline{Q}$ output) is H, so that PD1 = L and PD2 = H.

(3) When Lch and Rch are in phase:
IC313-1 and -2 (Q and $\overline{Q}$ outputs) output pulsed waveforms. As $\overline{Q}$ rises from L to H, a differentiated base current flows via C319 to Q309, turning Q309 ON in the form of a pulse. At the same time, Q310 is also turned ON. Q310 is held ON by the C320 connected to the Q309 collector. The ON state of Q310 forces the application of H to PD1 and PD2 via D312 and D313.

(4) Transistor Q311 serves to reset IC313. In the OFF state, Q311 resets IC313; in the ON state, it clears the resetting.
If the signals Tape L and Tape R are large enough, a sufficient base current flows into Q311 via D107 and D207, turning Q311 ON. Consequently, the IC313 resetting is cleared so phase detection is done. The ON switching of Q311 turns Q308 from ON to OFF. As a result, the PD1 and PD2 signals are grounded via D308 and D309 now develop the Q and $\overline{Q}$ outputs from IC313.

	PD1 (IC607-7)	PD2 (IC607-8)
No signal	L	L
L > R	H	L
L < R	L	H
L = R	H	H

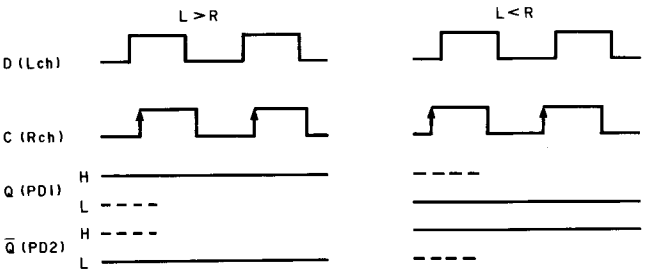


Fig. 5.13 Output Signal Levels

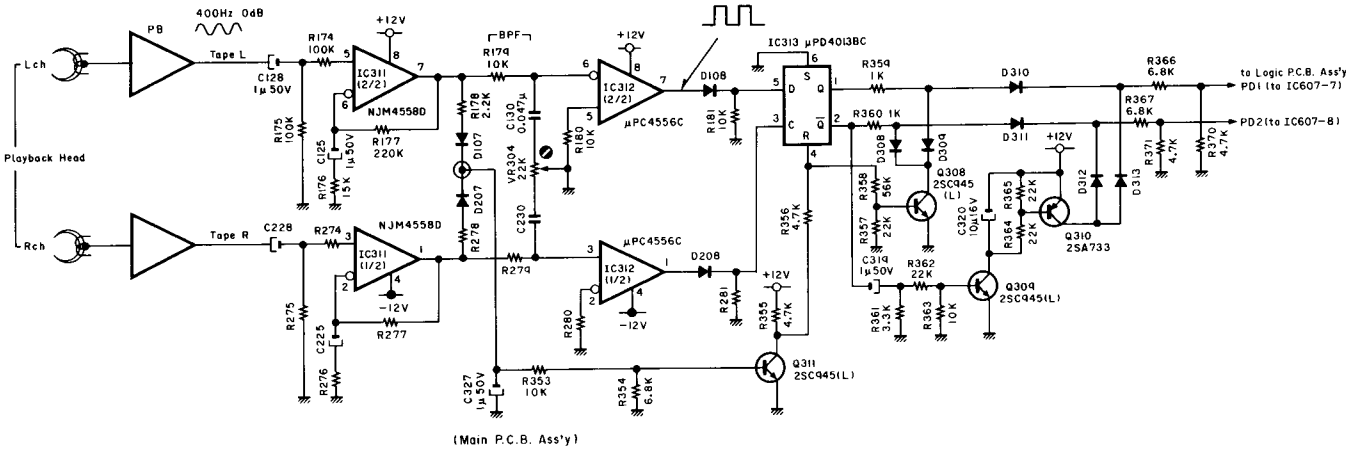


Fig. 5.12 Playback Azimuth Phase Detector Circuit

5.4.4. Azimuth Motor Control Circuit

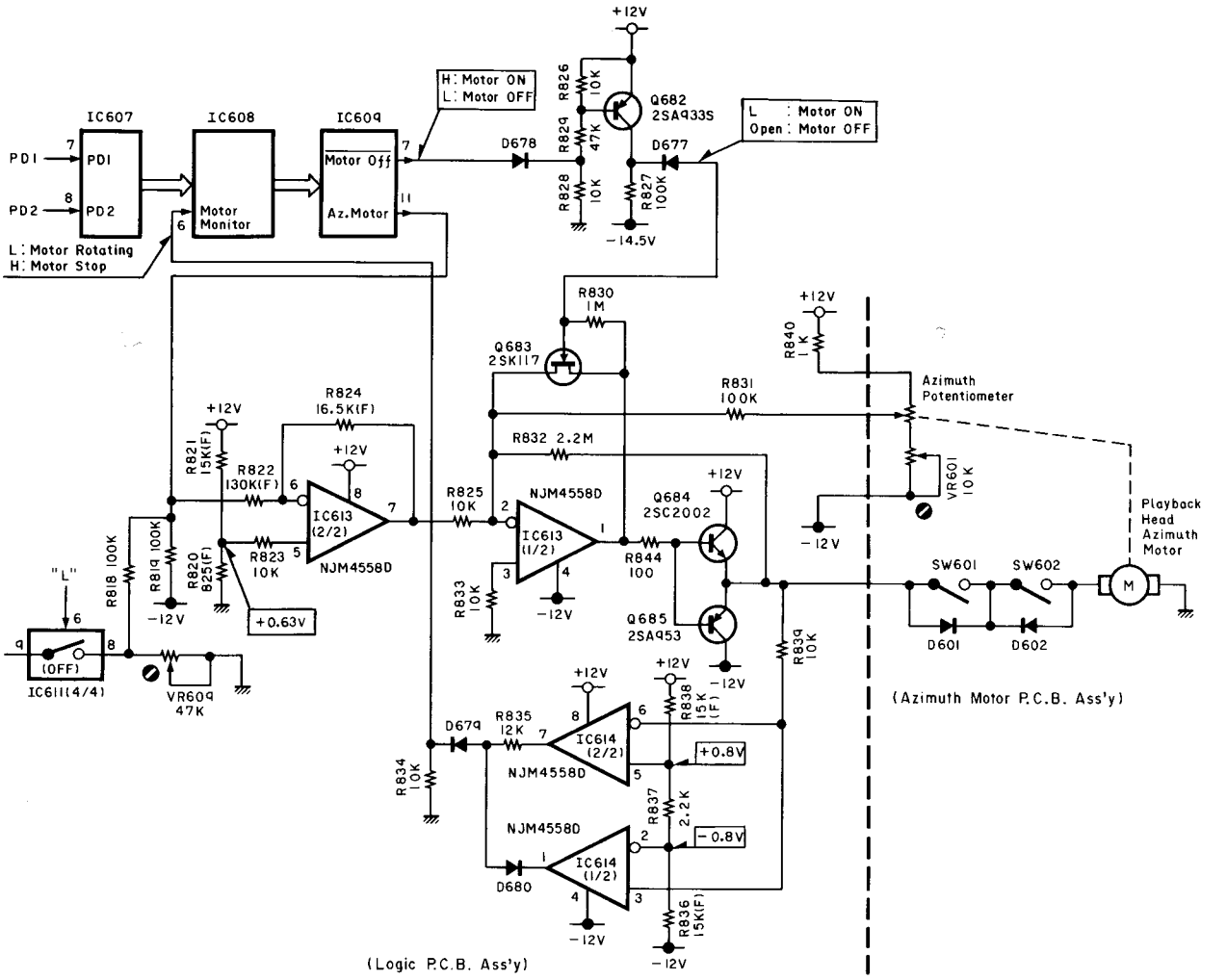


Fig. 5.14 Azimuth Motor Control Circuit

(1) After auto calibration has started, playback head azimuth correction is preceded by the following events in "Step 1: Setup".
   (a) The signal $\overline{\text{Motor Off}}$ (IC609-7) becomes H, making the motor ready to rotate.
   (b) The reference data "100000" from IC608 is stored in IC609's 6-bit latch circuit allocated for azimuth motor. This data is put through D/A conversion in IC609, so the reference analog output (level) is sent to the azimuth motor control circuit. This causes the azimuth motor to rotate to the reference position and stop there.

(2) Then the cassette deck enters into playback head azimuth correction. If an azimuth shift is detected (i.e., PD1 or PD2 is at L), correction data "2" is added to or subtracted from the reference data, as explained in 5.4.1. "Correction System".

An example will be used to illustrate the circuit operations involved. We assume that PD1 = H, PD2 = L, i.e., Lch is ahead of the phase of Rch.

   (a) IC608 adds "2" to the reference data and sends the sum as the new data to the 6-bit Az Motor Latch circuit in IC609. This adds to the analog output (level) of Az Motor (IC609-11).
   (b) Amp. IC613-6 (2/2) (inverting input), because it receives the Az Motor output, increases in voltage, which decreases the voltage of IC613-7 (2/2).
   (c) As the voltage of IC613-2 (1/2) (inverting input) decreases, the amplifier IC613 (1/2) loses the input balance; IC613-1 (1/2) goes negative in voltage. Consequently, Q685 turns ON, and the azimuth motor is applied with approx. −12 V so it rotates in the phase-shift correcting direction. The rotation of the azimuth motor causes rotation of the azimuth potentiometer. The voltage at the sliding terminal of the azimuth potentiometer is fed back via R831 to IC613-2 (1/2). The potentiometer follows the rotation of the azimuth motor, and when IC613-2 (1/2) is balanced with the voltage (0 V) at IC613-3, the motor stops.

(d) A mechanical illustration is shown in Fig. 5.15. As the azimuth motor rotates, the rotation is transferred via the worm gear (mounted on the motor shaft), the azimuth idler gear, and to the azimuth cam. The azimuth potentiometer's shaft, because it is directly linked with the azimuth cam, rotates with the azimuth cam. The azimuth arm is swung by the azimuth cam, thus changing the inclination (azimuth) of the playback head. The data per correction operation (addition or subtraction of data "2") causes a 1.3' inclination.

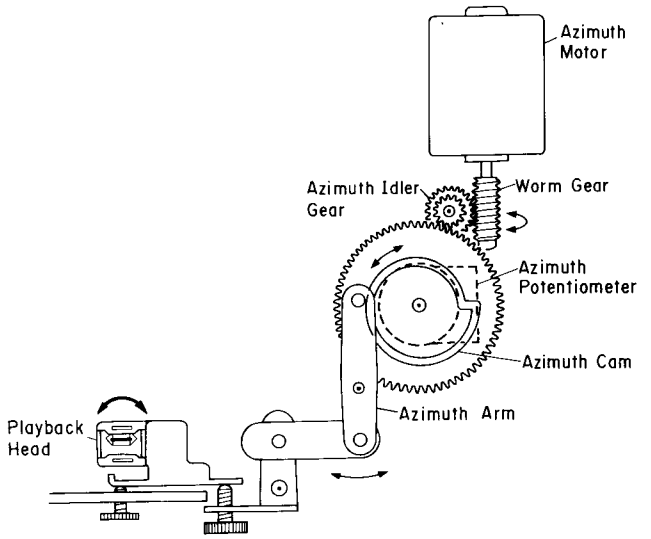


Fig. 5.15 Playback Head Azimuth Correction Mechanism

(e) When PD1 = L and PD2 = H, circuit operation proceeds as follows: Az Motor output level lowers → voltage of IC613-7 (2/2) rises → voltage of IC613-1 goes positive → Q684 turns ON → approx. +12 V is applied to azimuth motor → azimuth motor rotates in reverse direction.

(3) Azimuth motor stop detection circuit

This circuit consists of IC614 (1/2), (2/2), and their peripherals. When the voltage (±12 V) applied to the azimuth motor has fallen to within approx. ±0.8 V, the Motor Monitor signal becomes H to notify IC608-6 (Motor Monitor) of the azimuth motor stop. From the change of the Motor Monitor signal to H, IC608 knows the completion of data "2" corrections.

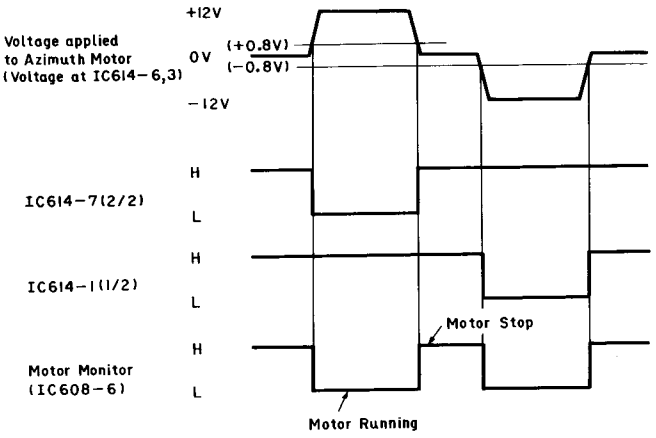


Fig. 5.16

5.5. Level Calibration and Bias Calibration

5.5.1. Level/Bias Calibration System

(1) DC level digitizing method

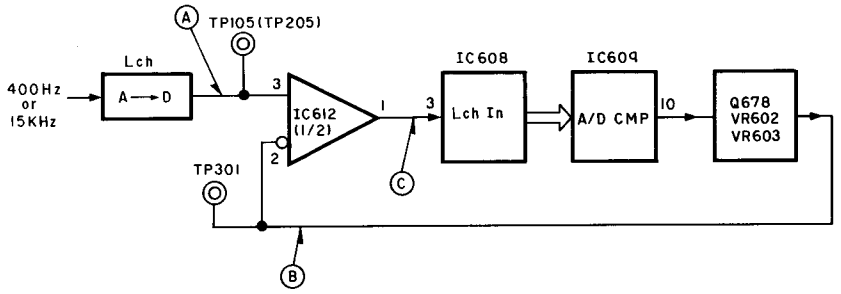


Fig. 5.17 Level/Bias Calibration System Block Diagram

Level calibration and bias calibration use a method which converts the input DC levels to digital data. This method is also used when the Playback Head Azimuth control is turned by hand (described later). The digitizing process is carried out separately for Lch and Rch signals. For purposes of convenience, the following discussion concerns the Lch signal only.

(a) Voltages at respective points

Point Ⓐ : DC output level (approx. 1 VDC) after A/D conversion of 400 Hz or 15 kHz playback signal

Point Ⓑ : Analog voltage corresponding to the digital data set by IC608

Point Ⓒ : H or L output, as determined by comparison between points Ⓐ and Ⓑ :
H if Ⓐ point voltage > Ⓑ point voltage, or
L if Ⓐ point voltage < Ⓑ point voltage.

(b) Digitizing

1) IC608 stores the 6-bit initial data "100000" into IC609's 6-bit latch allocated for A/D CMP. "100000" is the central value of the 6-bit data "000000" to "111111".
2) The set initial data "100000" is converted to an equivalent analog output (voltage) by the D/A converter circuit in IC609. This output passes through the level control circuit consisting of amp. Q678, VR602 and VR603, so that it appears as the voltage at point Ⓑ . This voltage is at a level corresponding to the digital data "100000".
3) Fig. 5.18 and Table 5.2 present examples of compensations applied when the voltage at point Ⓐ is higher than at point Ⓑ. The levels at point Ⓑ shown in Fig. 5.18 are represented by the corresponding digital data values. In the first step, IC608 outputs the data "100000", so that a comparison is made as to the levels at points Ⓐ (DC input level) and Ⓑ (level corresponding to "100000"). In this example, point Ⓐ is at a higher level than point Ⓑ . At the second step, therefore, IC608 outputs the data "100000" added by "010000" (fifth bit), or "110000". A comparison is made again between points Ⓐ and Ⓑ. Since point Ⓐ is lower than point Ⓑ this time, IC608 outputs the data "110000" subtracted by "001000" (fourth bit), or "101000". The above process is repeated for each subsequent bit. Eventually, the data "101011" is obtained, which is the value digitized from the DC input level (voltage at point Ⓐ), i.e., from the 400 Hz or 15 kHz playback level.

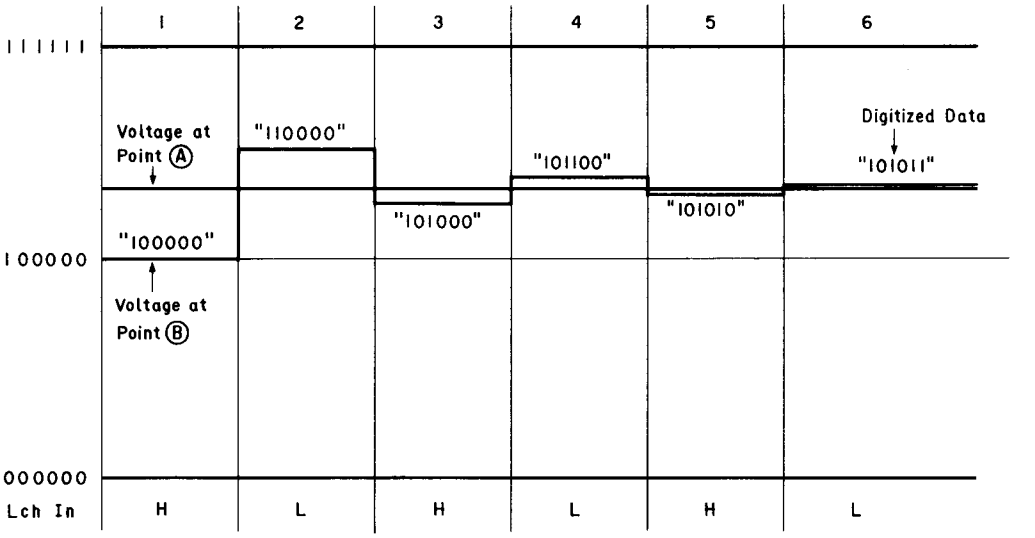


Fig. 5.18 Digitizing Example

Table 5.2 Digitizing Example

Step	Data before correction	Lch In	Data correction	Bit subject to correction
1	100000	H (A > B)	100000 +010000 110000	5th bit
2	110000	L (A < B)	110000 −001000 101000	4th bit
3	101000	H (A > B)	101000 +000100 101100	3rd bit
4	101100	L (A < B)	101100 −000010 101010	2nd bit
5	101010	H (A > B)	101010 +000001 101011	LSB
6	101011 (resultant)			

(2) Level calibration

(a) Signal setting

Level calibration is performed twice in all. During level calibration, signals are set as follows:

Level (IC608-29) = H . . . . . .

Turns [Level] indicator ON. Decreases test tone level by 20 dB.

400 Hz (IC608-32) = H . . . . . .

Oscillates 400 Hz test tone (400 Hz, −20 dB).

$\overline{+20\ dB}$ (IC608-14) = L . . . . . .

Increases line amp. gain by 20 dB. Specifically, Q659 turns ON, +20 dB signal becomes H, Q118 and Q218 on Main P.C.B. Ass'y turn ON, and line amp. gain increases by 20 dB.

(b) Level L/R data setting

Whether in the first or second level calibration, IC608 stores the reference level data "010110" in the IC609's 6-bit latches allocated for Level L and R. These data are changed to analog data (level) by the respective D/A converters in IC609. Therefore, L Level (IC609-15) and R Level (IC609-14) output the reference analog voltage.

(c) Values of Bias L/R data

1) In the first level-calibration, the reference bias data "010110" has been stored beforehand (in "Step 1: Setup") as Bias L/R data in IC609.

2) In the second level-calibration, the new Bias L/R data obtained through the first bias calibration has been stored beforehand in IC609.

(d) Level calibration

The record level amp. gain and bias current are fixed by analog outputs corresponding to the level and bias data which have been set in steps (b) and (c) above. In this condition, the 400 Hz test tone is recorded and played back. Playback levels are digitized for Lch and Rch, individually by the method explained in (1) "DC level digitizing method". The maximum values obtained through 10 digitizing operations are reserved as the Level L and Level R data.

(e) Level data correction

For the level data obtained in step (d), level correction amounts are determined from the level correction table held in IC608's ROM (read only memory). These amounts are added to the level data obtained in step (d), and the sums are set as new level data in IC609's 6-bit latches for Level L and R.

(f) In summary, the level data in IC608 are processed as follows:

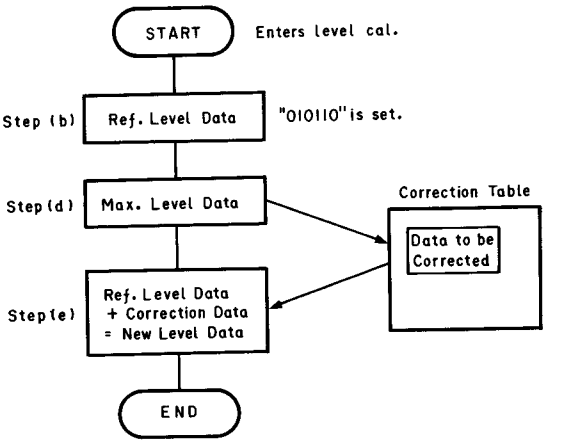


Fig. 5.20

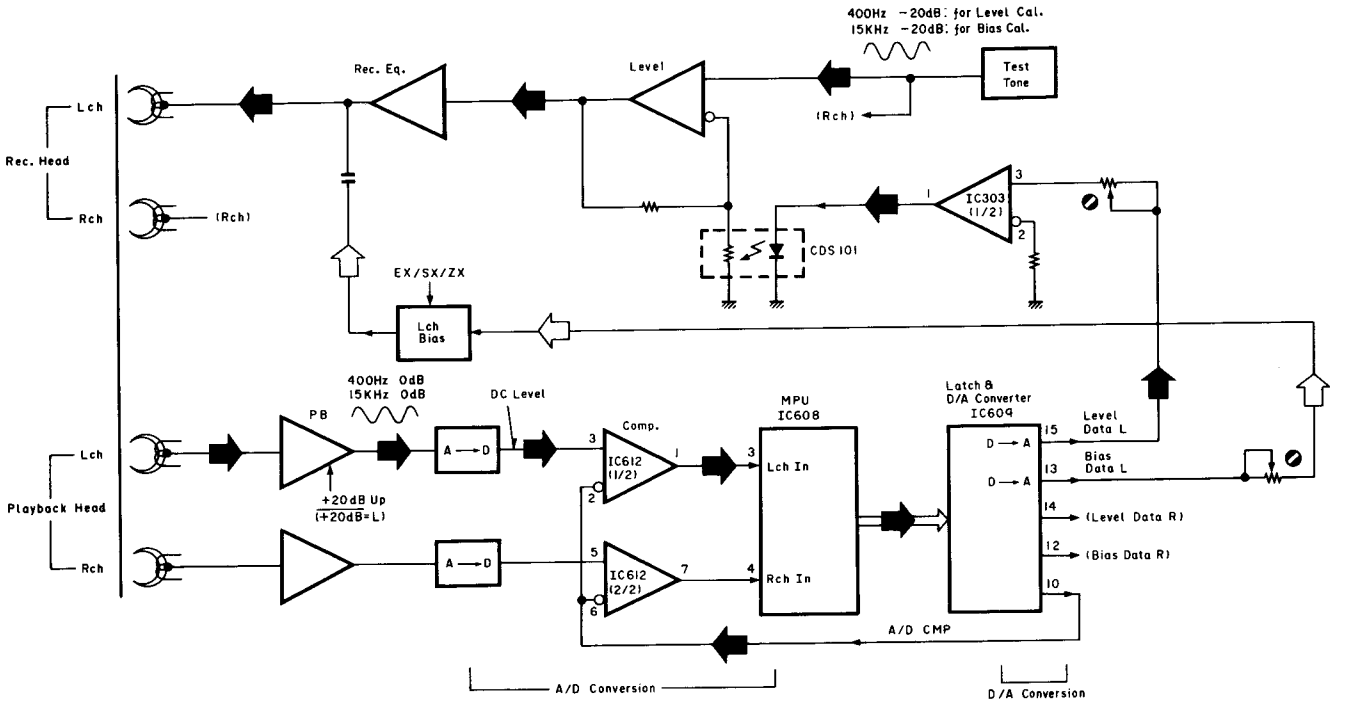


Fig. 5.19 Level/Bias Calibration System Block Diagram

(3) Bias calibration

(a) Signal setting

Bias calibration is carried out twice in all. During bias calibration, signals are set as follows:

Bias (IC608-30) . . . . . Sends pulsed output to flash Bias indicator.

15 kHz (IC608-33) = H . . Oscillates 15 kHz test tone (15 kHz, −20 dB).

$\overline{+20\ dB}$ (IC608-14) = L . . Increases line amp. gain by 20 dB.

(b) Bias L/R data setting

Whether in the first or second bias calibration, IC608 stores "100000", the central value of the 6-bit data, in the IC609's 6-bit latches allocated for Bias L and R. These data are changed to equivalent analog outputs by the respective D/A converters in IC609. Therefore, L Bias (IC609-13) and R Bias (IC609-12) have analog outputs (voltages). The L Bias and R Bias signals pass through the level control circuits (consisting of amp. Q679, VR604, VR605, and of amp. Q680, VR606 and VR607, respectively). From there on, the signals are sent as Bias data L and R signals to the bias oscillation circuit on the Power Supply P.C.B. Ass'y.

(c) Values of Level L/R data

The final data obtained in the process explained under "(2) Level calibration" is held stored.

(d) Bias calibration

The bias current and record level amp. gain are fixed at the bias and level data values which have been set in steps (b) and (c) above. In this condition, the 15 kHz test tone is recorded and played back. Playback levels are digitized for Lch and Rch, individually by the method explained in (1) "DC level digitizing method". The maximum values obtained through 15 digitizing operations are reserved as the Bias L and Bias R data.

(e) No correction is required if the maximum values obtained in step (d) coincide with the reference bias data "010110" or "010101". If not, correction is made in the following procedure (similar to the procedure described before under "(1) DC level digitizing method"):

1) The initial bias setting "100000" is increased or decreased by "010000" (fifth bit). Specifically, if the maximum value digitized from the playback level is larger than the reference bias data, the value "100000" is set to "110000". Otherwise, "100000" is set to "010000".
2) The new bias data (new bias current) obtained in step 1) is used to record and play back the 15 kHz test tone once again. Then, as in 1), the maximum digitized value is compared with the reference bias data, and depending on the comparison result, the fourth bit is added or subtracted.
3) The above comparison and correction process is repeated for the third, second and then least significant bits, to make the bias data equal to the reference value. The resultant bias data is one that provides the optimum bias current.

Level calibration and bias calibration are executed alternately and twice each. During this process, the data set in IC608's RAM change as shown in Fig. 5.21.

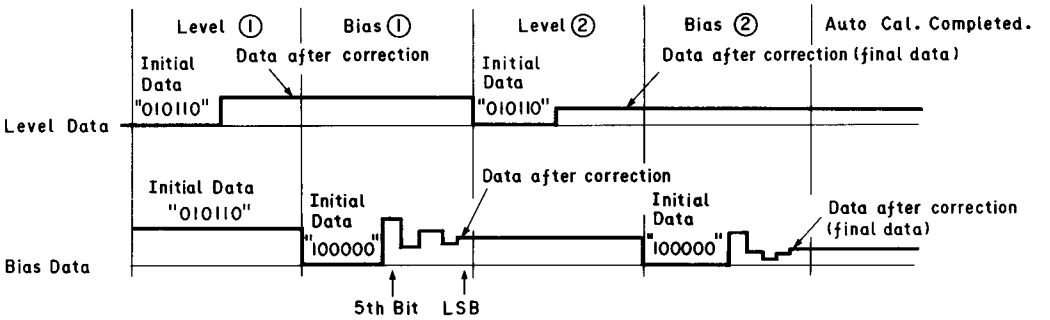


Fig. 5.21 Change of Level/Bias Data

(4) Processing after level/bias calibration (Step 5)

(a) As level data L/R and bias data L/R are obtained at the completion of two each operations of level and bias calibrations, these data are stored in IC608's RAM allocated for the tape position being selected.

(b) The Monitor and Dolby NR signals are restored to the states which were manually selected.

(c) The [Ready] indicator flashes.

(d) Because the tape has advanced during auto calibration, it is rewound to the counter position "0000" as follows:

- o $\overline{\text{M. Stop (Memory Stop)}}$ (IC608-7) is set to L, causing memory stop operation.
- o Rec./Play mode is switched to Rewind mode to rewind the tape.
- o Upon detection of counter "0000", IC606-13 issues $\overline{\text{Motor Slow}}$ = L to slow down the reel motor speed.
- o Rewind mode is switched to F.F. mode, then back to Rewind mode. At the counter "0000" position, the motor stops.

(e) Rec./Pause mode is entered.

(f) The [Ready] indicator becomes continuously lit, indicating the completion of auto calibration.

(g) The data corresponding to the present position of the Playback Head Azimuth control is read and simply stored in IC608's RAM. Note that, the playback head tilt does not correspond to the present position of the Playback Head Azimuth control, but it is set to the position determined by the playback head azimuth correction.

(h) The Cal. Mute (Line Mute) signal is deactivated.

(5) Error processing

In case of failure to set the azimuth, level or bias correctly because of faulty tape, etc., the three indicators, [Azimuth] [Level] and [Bias], flashes simultaneously to indicate the error. The auto calibration operation will be aborted. To clear the error, press the Auto Calibration Reset button or Eject button.

5.5.2. A/D Converter Circuit

During auto calibration, the Cal. Mute signal is at H; bilateral switch IC611 (1/4) is ON and IC611 (2/4) is OFF. The recorded and played back signal of 400 Hz 0 dB or 15 kHz 0 dB is amplified in IC610 (1/2) and smoothed in the RC circuit. This causes TP105 (TP205) to develop a DC voltage of approx. 1 V, which is applied to comparator IC612-3 (non-inverting input).

On the other hand, the analog output (voltage) from IC609-10 (A/D CMP) is amplified in Q678 in the next stage, and it is sent through VR602, VR603 to IC612-2 (inverting input), i.e., TP301.

When voltage is higher at IC612-3 than at IC612-2, IC608-3 (Lch In) becomes H. Otherwise, IC608-3 becomes L. By monitoring the Lch In state (H or L), IC608 knows whether the data it sent to the 6-bit latch for A/D CMP in IC609 is greater or smaller in value than the playback input.

5.5.3. Record Level Amp. Circuit (Refer to Fig. 5.23.)

The analog output (voltage), Level Data L, is amplified by IC303 (1/2) on the Main P.C.B. Ass'y to drive CDS101's LED. A higher level of Level Data L causes a greater current to LED.

On the other hand, the 400 Hz test tone is put through the Record Dolby NR circuit to IC304-3 (1/2).

Suppose that the Level Data L output has increased. Then the LED current increases and the resistance in CDS101 decreases. Consequently, the gain of IC304 (1/2) rises and the output voltage of IC304-1 (1/2) builds up, boosting the record level. On the contrary, when the Level Data L output decreases, the record level lowers.

5.5.4. Bias Current Control Circuit (Refer to Fig. 5.24.)

The analog output, L Bias (IC609-13), is amplified by Q679, then it is put through VR604, VR605 and to IC301-3 (non-inverting input). Q101, Q102 or Q103 turns ON depending on the selected tape position EX, SX or ZX, respectively. When the EX position is selected, for example, Q101 turns ON, and IC301-2 (inverting input) is grounded through R104 and VR101.

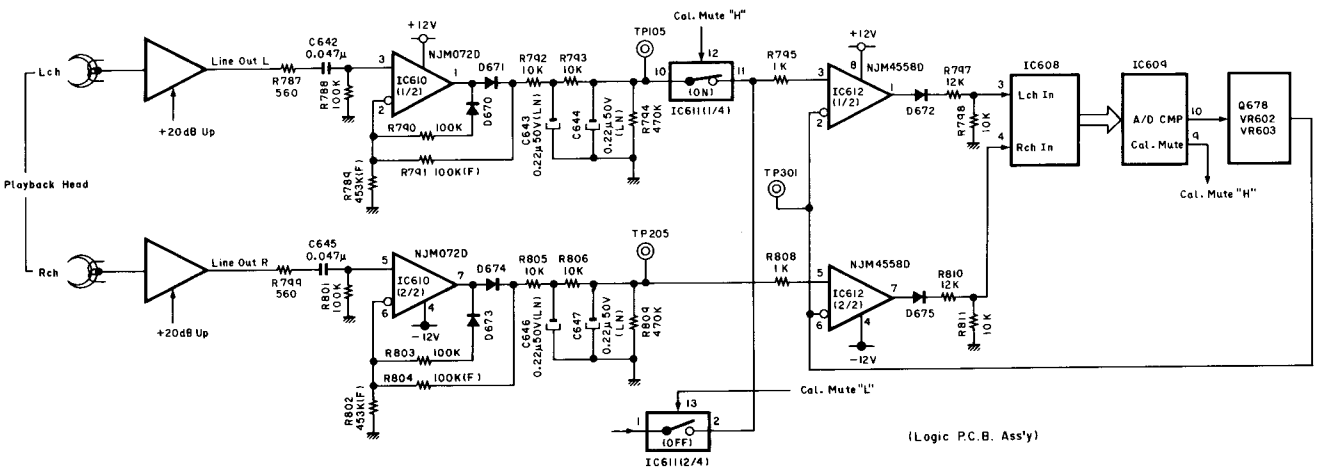


Fig. 5.22 A/D Converter Circuit

As an example, we consider the case where the differential amplifier is balanced. When the bias data becomes larger and the Bias data L voltage increases, the following sequence occurs.

IC301-3 increases →IC303-1 sink current decreases → Q104 base current increases →Q104 emitter voltage increases until IC301-2 voltage gets equal to IC301-3 voltage →Supply voltage to Lch bias circuit increases →bias current increases.

When Record mode is entered, the $\overline{\text{Bias On}}$ signal becomes L, Q301 turns ON, and the bias voltage is applied to the bias oscillation circuit, thus starting oscillation at 105 kHz. Since the 105 kHz output is connected to the Lch bias circuit, the 105 kHz oscillation also occurs in the Lch bias circuit.

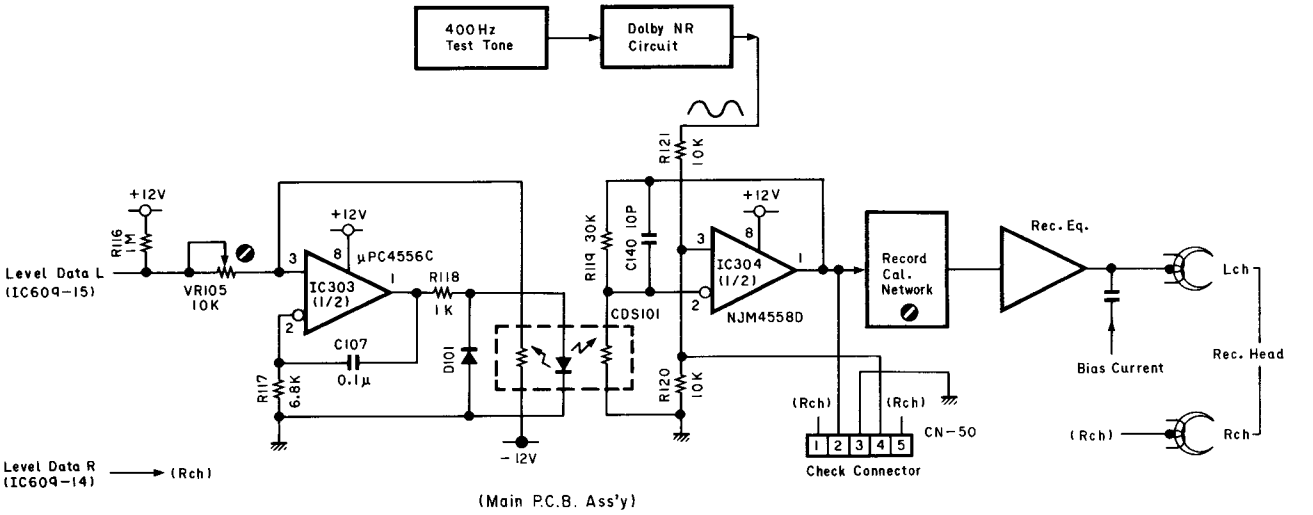


Fig. 5.23 Record Level Amp. Circuit

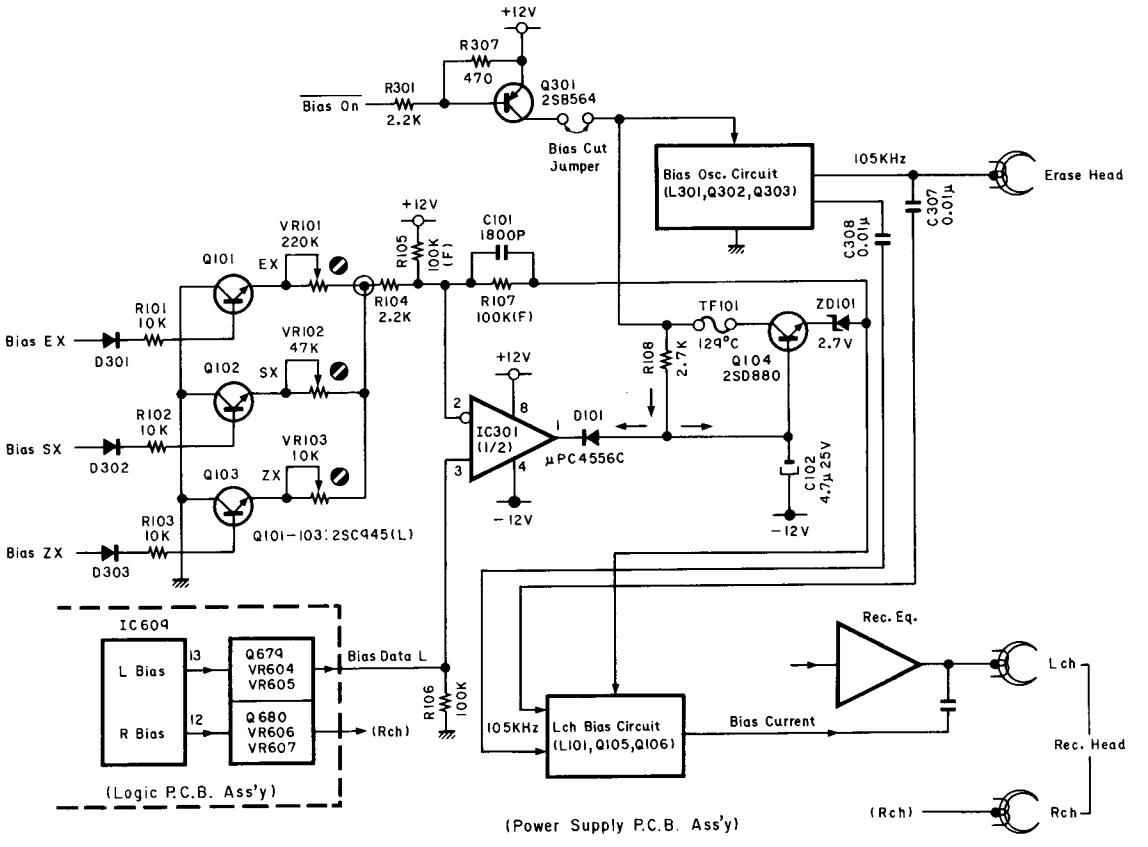


Fig. 5.24 Bias Current Control Circuit

6. Playback Head Azimuth Fine Tuning Control Circuit

6.1. Introduction

Fine tuning of playback head azimuth becomes available by either turning the Playback Head Azimuth control on the Front Panel or pressing the Azimuth Adjustment buttons (Up/Down) on the wireless Remote Control Unit (RM-7C).

Playback Azimuth control: Works in any mode.
Azimuth Adjustment button: Works in Play or Rec./Play mode only.

When the control is turned or the button is pressed in Play or Rec./Play mode, i.e., when the azimuth is adjusted while the user is listening to the music, the parts that will work in the level meter section on the Indicator Panel are limited to the red Azimuth Center Position indicator and the upper segments (for Lch). The Azimuth Center Position indicator shows the position at which the playback head azimuth mechanically matches the record head azimuth.

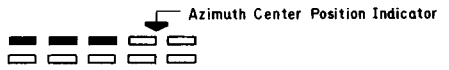


Fig. 6.1

When the Playback Head Azimuth control is turned in a mode other than Play or Rec./Play, i.e., when the control is used for presetting purposes, the control works although the indications in the level meter section stay unchanged.

Section 6.2 describes the sequence that occurs when the control is turned in Play or Rec./Play mode. (The same sequence applies to other modes, except for indication.)

Section 6.3 outlines the case where the remote control unit is used.

6.2. Sequence Triggered by Turning of Playback Head Azimuth Control in Play or Rec./Play mode

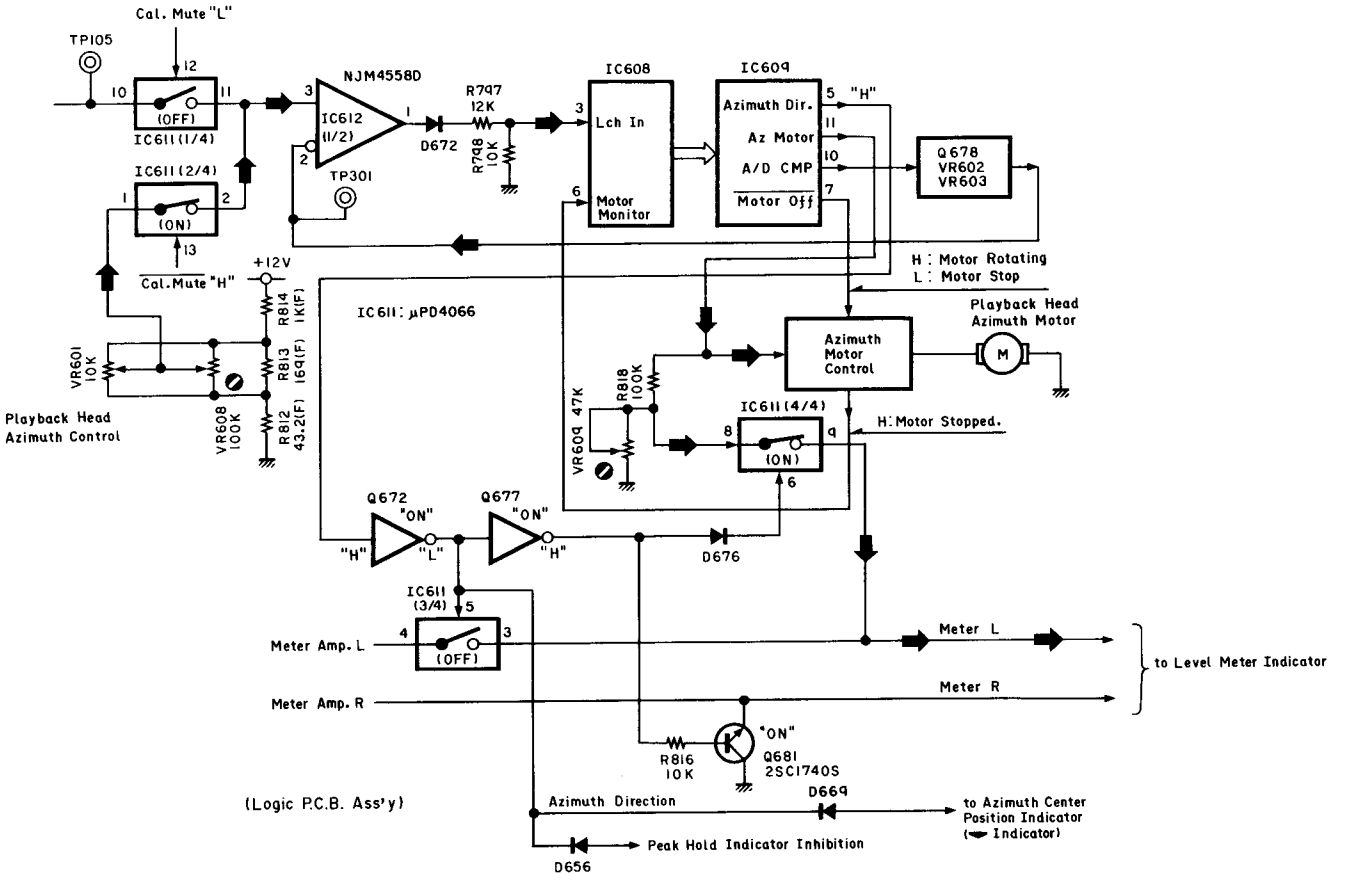


Fig. 6.2 Playback Head Azimuth Control Circuit (Manual Control)

(1) When the power is turned ON, the position of the Playback Head Azimuth control is digitized and stored in IC608.
(2) The control position is digitized periodically. Specifically, a comparison is made between the DC voltage at the Playback Head Azimuth Control sliding terminal of IC612-3 (1/2) and the A/D CMP analog output of IC612-2 (1/2), thereby digitizing the voltage at the sliding terminal by the technique described in 5.5.1 (1) "DC level digitizing method".
(3) When the control is turned, the voltage at the control's sliding terminal changes, updating the data. If the updated data has deviated more than ±2 (in decimal value) relative to the old data, the playback head azimuth is corrected as follows:
   (a) Azimuth motor rotation.
      – The $\overline{\text{Motor Off}}$ signal (IC609-7) becomes H, permitting rotation of the azimuth motor.
      – The analog output (voltage), Az Motor (IC609-11), increases or decreases by the amount equal to the change of the data. Thus, the azimuth motor revolves until the balance is restored, to correct the playback head azimuth. (See 5.4.4, "Azimuth Motor Control Circuit".)
   (b) Indication
      – The Azimuth Direction signal (IC609-5) becomes H, Q672 turns ON, Q677 turns ON, and Q681 turns ON.
      – Because Q672 is ON and Q677 is ON, bilateral switch IC611 (3/4) turns OFF and IC611 (4/4) turns ON. Consequently, the Meter L output has the Az Motor (IC609-11) output corresponding to the playback head azimuth control position via R818 and VR609. In response to the Meter L output, the Lch segments of the level meter light up.
      – Because Q681 is ON, the Meter R output is grounded so the Rch segments of the level meter give no indication.
      – Because Q672 is ON, the Azimuth Center Position indicator is lit through D669. As Q642 is turned OFF via D656, the Hold indicator goes OFF.

   The Azimuth mode indication remains ON for about 3 sec after the control is turned. If in this period the control is turned, the Azimuth mode indication extends another 3 sec.

6.3. Azimuth Adjustment via Remote Control Unit

Pressing the Azimuth Up or Down button on the wireless Remote Control Unit sets IC607-5 ($\overline{\text{Azimuth Up}}$) or IC607-6 ($\overline{\text{Azimuth Down}}$) to L. If the Azimuth Up or Down button is held depressed, IC608 increments or decrements the data for Az Motor (IC609-11) output in steps of "2" to rotate the azimuth motor. The motor revolution and the indication are as explained in Section 6.2.

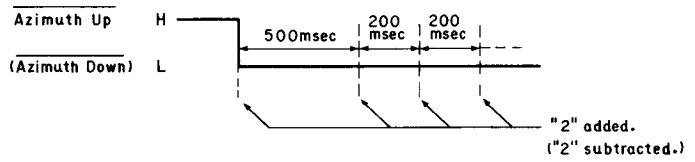


Fig. 6.3

7. Fader Control Circuit

The auto fader circuit consists of three blocks:

– Flip-flop circuit: IC309 (1/2) and its peripheral circuitry
– Integration circuit: IC309 (2/2) and its peripheral circuitry
– CDS301 drive circuit: Q302 and its peripheral circuitry

(1) Fade-In/Fade-out

The Fader Up button is connected to +12 V, while the Fader Down button is connected to GND. The input signals K. Up and $\overline{\text{K. Down}}$ from these buttons are connected via R307 and R308, respectively, to IC309-3 (1/2) (non-inverting input).

Once the K. Up signal has risen to +12 V upon push of the Fader Up button, the output of IC309-1 (1/2) is held at approx. +12 V until the $\overline{\text{K. Down}}$ signal is set to 0 V by the push of the Fader Down button. With IC309-1 (1/2) at approx. +12 V, the charge in C305 of the integration circuit is integrated via R317, and the output of IC309-7 (2/2) slowly decreases at a linear rate. This causes Q302 base current to increase gradually, so Q302 collector current increases gradually. The result is greater emission from the LED in CDS301, causing fade-in operation. During fade-in operation, the Up LED on the Control Switch P.C.B. Ass'y stays lit.

If the Fade Up button is held depressed, C305 receives current via R315 as well, so the fade-in operation speeds up.

When the Fader Down button is pressed, IC309-1 (1/2) is held at approx. 0 V, the voltage at IC309-7 (2/2) gradually builds up, and Q302 base current gradually goes down, thus accomplishing fade-out operation. After the fade-out operation is completed, Q302 is OFF, no current flows in CDS301's LED, and therefore the line input is cut off. During fade-out operation, the Down LED on the Control Switch P.C.B. Ass'y stays lit.

(2) Mute function

(a) Line Mute input
When at H, turns Q302 OFF to cut off the line input.

(b) $\overline{\text{Rec.}}$ input
Stays at L in Rec./Play or Rec./Pause mode to permit fade-in and fade-out. In other modes, stays at H, so that H is forced through D303 to K. Up to set the fader circuit into fade-in completion state.

(c) Fader Mute input
In other than Rec./Play and Rec./Pause modes and with Monitor set to Tape, turns Q302 OFF to cut off the line input.

(d) Fader Rec. Mute output
When at H, i.e., with Q301 ON, sets Rec. Mute to H in the Logic P.C.B. Ass'y, so that the input to record eq. amp. is grounded to activate record mute.

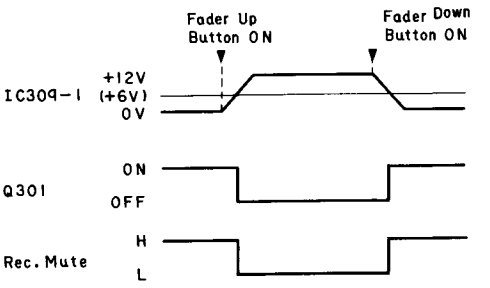


Fig. 7.2

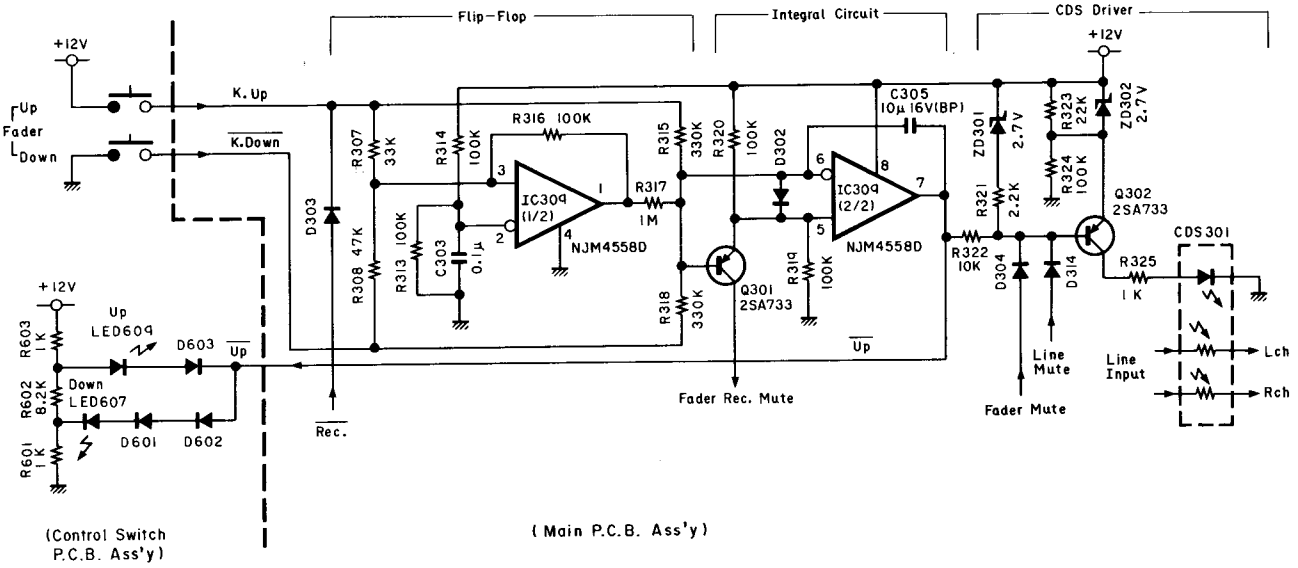


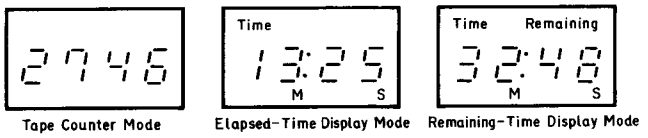
Fig. 7.1 Fader Control Circuit

8. Tape/Real-Time Counter

8.1. Introduction

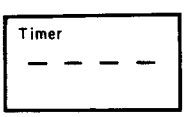
Counter operates in three modes:

Tape Counter Mode:	Serves as the ordinary tape counter of 4 digits.
Elapsed-Time Display mode:	Indicates the time elapsed from the start of tape winding.
Remaining-Time Display mode:	Indicates the time left until the tape end.



Tape Counter Mode | Elapsed-Time Display Mode | Remaining-Time Display Mode

Note: The counter takes about 8 sec of processing before it provides the elapsed time or remaining time display. During the 8 sec period, the counter appears as follows:



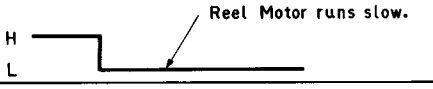
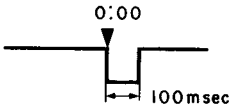
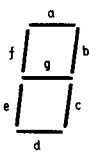
The Elapsed time and Remaining Time modes provide the correct indication whether the tape being loaded is at the tape start or intermediate position.

The counter diaplay is controlled by MPU IC606. This IC counts the take-up pulses and supply pulses input from the external circuit. To output the information for the display mode in effect, the IC performs various arithmetic operations on these inputs according to the procedure preprogrammed in it.

Processing for display is done all in IC606. As the input and output of IC606 are limited to switch input, mechanism mode input, take-up pulse input, supply pulse input, display segment drive output, display digit drive output, etc., the following sections will provide only a brief description of the counter operation.

8.2. Functions of IC606

Table 8

Pin No.	Signal Name	In/Out	Function
1	$\overline{\text{K.M. Stop}}$	In	$\overline{\text{Memory Stop}}$ signal. Active L. Enters memory stop mode at L.
2	$\overline{\text{Memory}}$	In	$\overline{\text{Memory}}$ mode signal. Active L.
3	$\overline{\text{Eject}}$	In	$\overline{\text{Eject}}$ signal. Active L. Becomes L when Cassette Case is open.
4	–	–	Not used.
5	$\overline{\text{K. Tape Length}}$	In	Tape Length button input terminal. Becomes L upon push of the button.
6	$\overline{\text{K.C. Mode}}$	In	Counter Mode button input terminal. Becomes L upon push of the button.
7	$\overline{\text{K.C. Reset}}$	In	Counter Reset button input terminal. Becomes L upon push of the button.
8	–	–	Not used. Connected to +5 V.
9	$\overline{\text{D1}}$	Out	The 4th (leftmost) digit select signal. Active L.
10	$\overline{\text{D2}}$	Out	The 3rd digit select signal. Active L.
11	$\overline{\text{D3}}$	Out	The 2nd digit select signal. Active L.
12	$\overline{\text{D4}}$	Out	The 1st (rightmost) digit select signal. Active L.
13	$\overline{\text{Motor Slow}}$	Out	$\overline{\text{Motor Slow}}$ signal. Active L. Becomes L upon entry into motor slow mode. Reel motor speed is reduced. 
14	$\overline{\text{TE 0 Sense}}$	Out	$\overline{\text{Time 0:00 Detect}}$ signal. Active L. When remaining time reaches 0:00 internally during playback, a 100 msec L pulse is output. This pulse is issued in any display mode.  When Auto Fade switch is set to ON, fade-out operation begins automatically upon receipt of this L pulse. (As Q643 is ON, $\overline{\text{K. Down}}$ becomes L for 100 msec and fade-out operation begins.)
15 16 17 18 19 20	$\overline{\text{Seg. j}}$ $\overline{\text{Seg. i}}$ $\overline{\text{Seg. a}}$ $\overline{\text{Seg. b}}$ $\overline{\text{Seg. c}}$ $\overline{\text{Seg. d}}$	Out Out Out Out Out Out	Display Segment Drive signals. Lights the respective segments at L.  i, j: Other segments (Time, C-46, etc.)
21	VSS	In	Connected to GND.
22 23 24	$\overline{\text{Seg. e}}$ $\overline{\text{Seg. f}}$ $\overline{\text{Seg. g}}$	Out Out Out	Display Segment Drive signals. Lights the respective segments at L.
25	$\overline{\text{Seg. h}}$	Out	Not used.

Pin No.	Signal Name	In/Out	Function
26 27 28 29	$\overline{\text{Mode Stop}}$ $\overline{\text{Mode Play}}$ $\overline{\text{Mode FF}}$ $\overline{\text{Mode Rew.}}$	In In In In	Mechanism Mode signals. Active L.
30	Test	In	Not used.
31 32	Xin Xout	In Out	Crystal is connected. Oscillating frequency = 4.194304 MHz
33	$\overline{\text{Reset}}$	In	$\overline{\text{Reset}}$ signal. Active L. Maintains L for approx. 70 msec after power is turned ON.
34	VHH	In	Supplied with +5 V.
35 36 37	$\overline{\text{K. Play}}$ $\overline{\text{K. FF}}$ $\overline{\text{K. Rew.}}$	In/Out In/Out In/Out	Act as switch input terminals or switch output terminals. (Bidirectional terminal.)
38	Source Mute	In	Not used. Connected to GND.
39	S.C. Pulse	In	Supply Counter Pulse signal. A pulse train proportional to the rotational frequency of Supply Reel Hub is generated.
40	T.C. Pulse	In	Take-up Counter Pulse signal. A pulse train proportional to the rotational frequency of Take-up Reel Hub is generated.
41	–	–	Not used.
42	VDD	In	Supplied with +5 V.

8.3. Mode Selection

(1) Counter mode

Each push of the Counter Mode button sets IC606-6 to L, switching the counter cyclically to the next mode:

Tape Counter → Elapsed-Time Display → Remaining-Time Display → Tape Counter →. . . . .

At power-up time, the Tape Counter mode is selected.

(2) Tape length

Each push of the Tape Length button sets IC605-5 to L, cyclically switching to the next mode:

C60 → C90 → C46 → C60 →. . .

At power-up time, C60 is selected.

8.4. Display Drive

The counter is displayed dynamically. Segment signals ($\overline{\text{Seg. a}}$ – $\overline{\text{Seg. j}}$) are connected in parallel to the four digits. Digit-select signals ($\overline{\text{D1}}$ – $\overline{\text{D4}}$) are generated in pulses as shown in Fig. 8.1. The segments a–j of the selected digit by $\overline{\text{D1}}$ – $\overline{\text{D4}}$ emit light according to the states of $\overline{\text{Seg. a}}$ – $\overline{\text{Seg. j}}$.

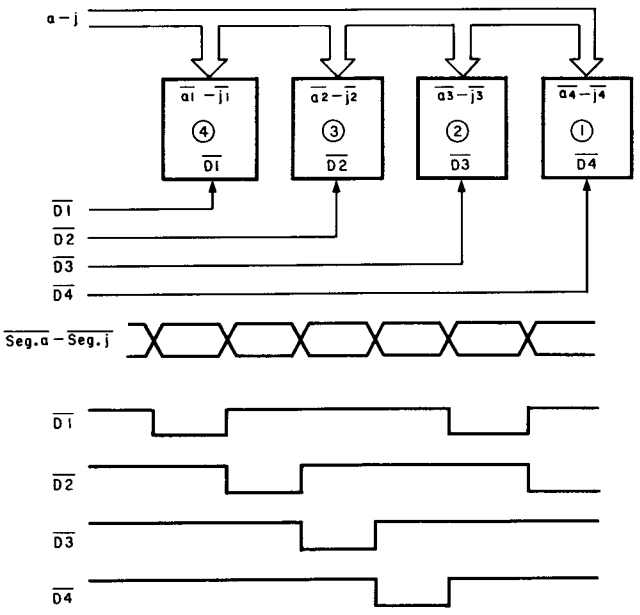


Fig. 8.1 Display Drive

8.5. Display

(1) Tape Counter mode

Arithmetic Operational Range	Min. −9999 — 0000 — 9999 Max.
Counter Display	−999 — 0000 — 9999

Notes: 1. Negative values are displayed in three digits preceded by a minus sign.
2. If the count exceeds 9999 or −9999, the counter rolls over to 0000.

(2) Elapsed-Time or Remaining-Time Display mode

See Fig. 8.2. The allowances of approx. 5—30 sec are to accommodate variances among tapes.

Elapsed time and remaining time are complementary to each other. When a C-60 tape (30 min one way) is loaded, for example, if the elapsed time is 5:00, the remaining time is approx. 30:00 − 5:00 = 25:00. That is, the relations between the two are

Elapsed time + Remaining Time ≅ 30:00

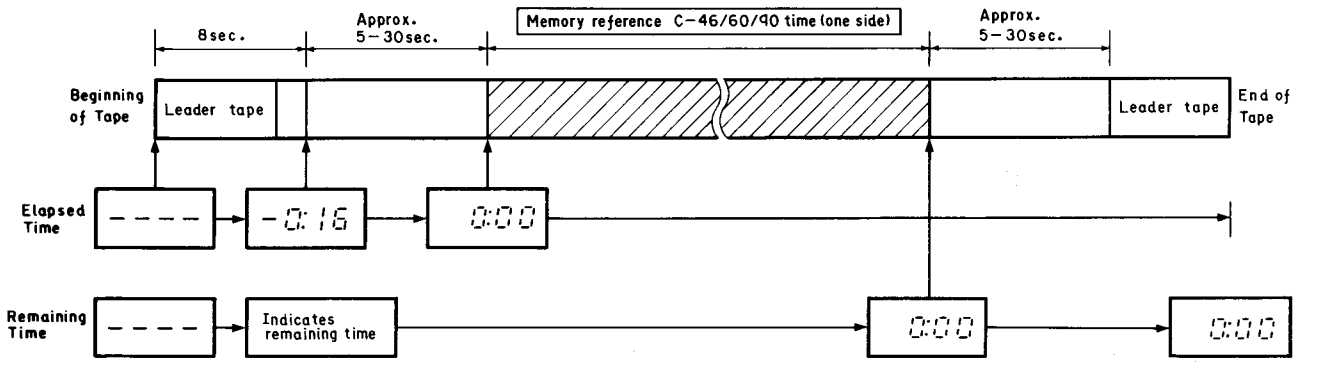


Fig. 8.2

8.6. Counting

(1) Count pulse input

As explained in Section 3.4, "Take-up Pulses/Supply Pulse Generator Circuit", the take-up reel hub and supply reel hub have their rear surface coated alternately in silver (for light reflection) and black (for no reflection).This alternate coloring provides the means of generating take-up counter pulses and supply counter pulses during tape travelling.

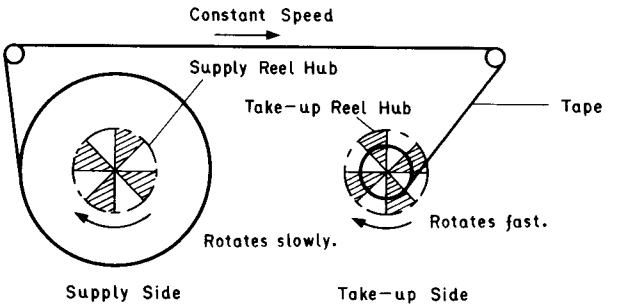


Fig. 8.3

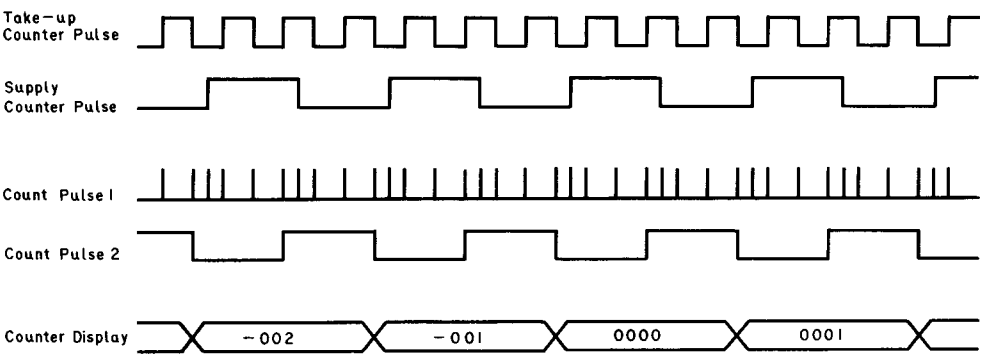


Fig. 8.4

(2) Counting

Fig. 8.3 shows the reel hubs and an example of tape travelling condition, while Fig. 8.4 indicates the pulses produced when the remaining tape is as shown in Fig. 8.3. Although take-up counter pulses and supply counter pulses are generated asynchronously with each other, the following equation holds:

$$T_T^2 + T_S^2 = \text{constant}$$

in which T_T and T_S are the cycle times of take-up and supply counter pulses, respectively. Hence, the count of counter pulses 1 (Fig. 8.4) per unit time is fixed regardless of whether the tape is at the beginning, end or anywhere between the ends. Thus the count pulses 1 are used as counter pulses to determine the tape run time.

Inside the IC606, the leading and trailing edges of take-up and supply counter pulses are taken as count pulses 1, which are then divided by eight, and then they are input to the 4-digit BCD Up/Down counter.

In the 4-digit Tape Counter mode, the display simply counts up or down from "0000". In the Elapsed-Time or Remaining-Time Display mode, IC606 determines the current position from the count pitch, then it executes arithmetic operation, correction, etc., to display the result.

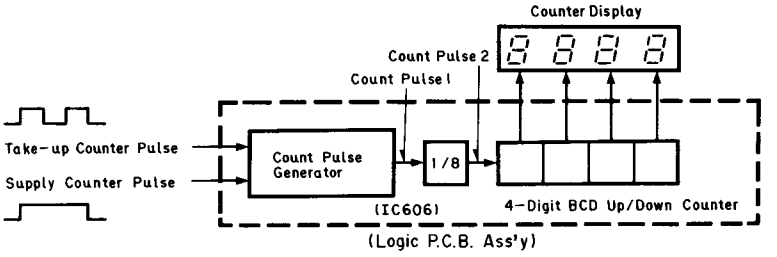


Fig. 8.5

9. Display Drive Circuit

The display drive circuit is located on the Display P.C.B. Ass'y. The display uses an FL (fluorescent) display tube which are applied with a filament voltage of 3.25 V AC. Each indicator in the FL display tube is driven by driver LB1240.

(1) Display example: Tape

When $\overline{\text{FL Tape}}$ becomes L, +19 V is fed from IC605-18 (LB1240) to the Tape indicator, so the Tape indicator goes ON.

(2) Level meter display

The voltages appearing at Meter L and Meter R inputs are sent to IC601-43 and -42. In IC601, the voltages are converted to digital value and then processed to light the segments corresponding to the input levels of Meter L and R.

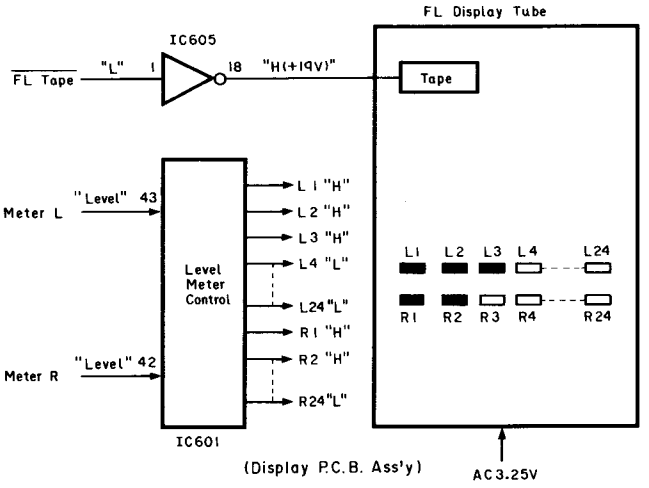


Fig. 9

10. Wireless Remote Control Signal Receiver Circuit

The pushbutton data transmitted in infrared rays from the wireless Remote Control Unit is received by D601 on the Receiver P.C.B. Ass'y. In IC601, the data goes through amplification, detection and shaping, before it is sent to the Remote Control P.C.B. Ass'y. In this Ass'y, MPU IC601 decodes the incoming data (pulse train) and outputs the results as pushbutton signals. The output signals are $\overline{\text{Stop}}$, $\overline{\text{Pause}}$, $\overline{\text{Play}}$, $\overline{\text{FF}}$, $\overline{\text{Rew.}}$, $\overline{\text{Rec.}}$, $\overline{\text{Azimuth Up}}$, and $\overline{\text{Azimuth Down}}$.

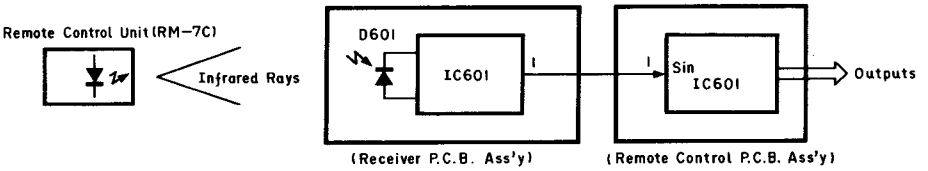


Fig. 10

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