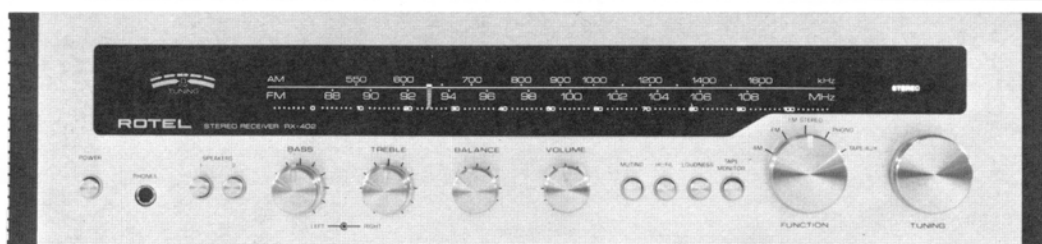


# ROTEL®

## RX-402

AM/ FM STEREO RECEIVER

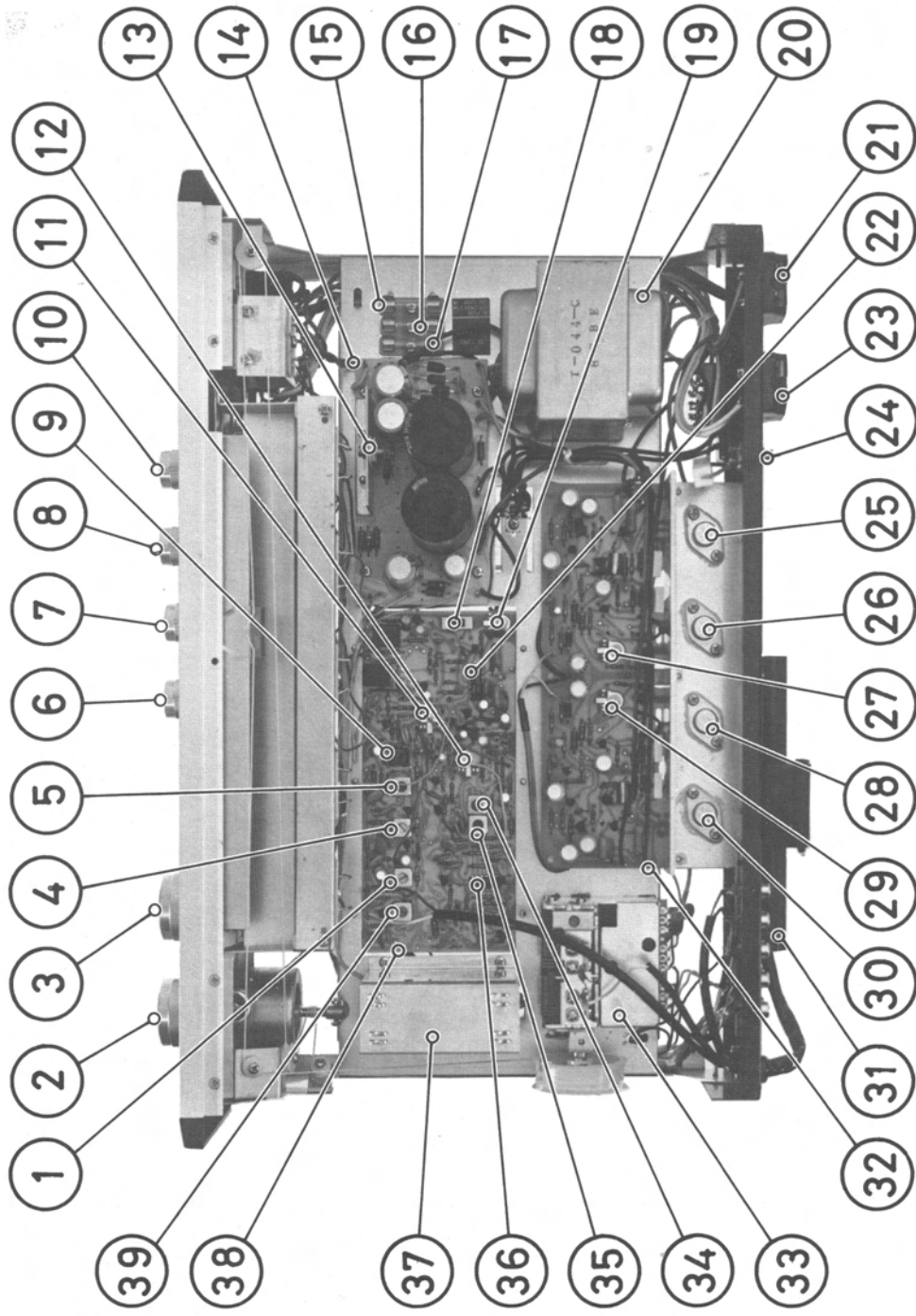


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# TECHNICAL MANUAL

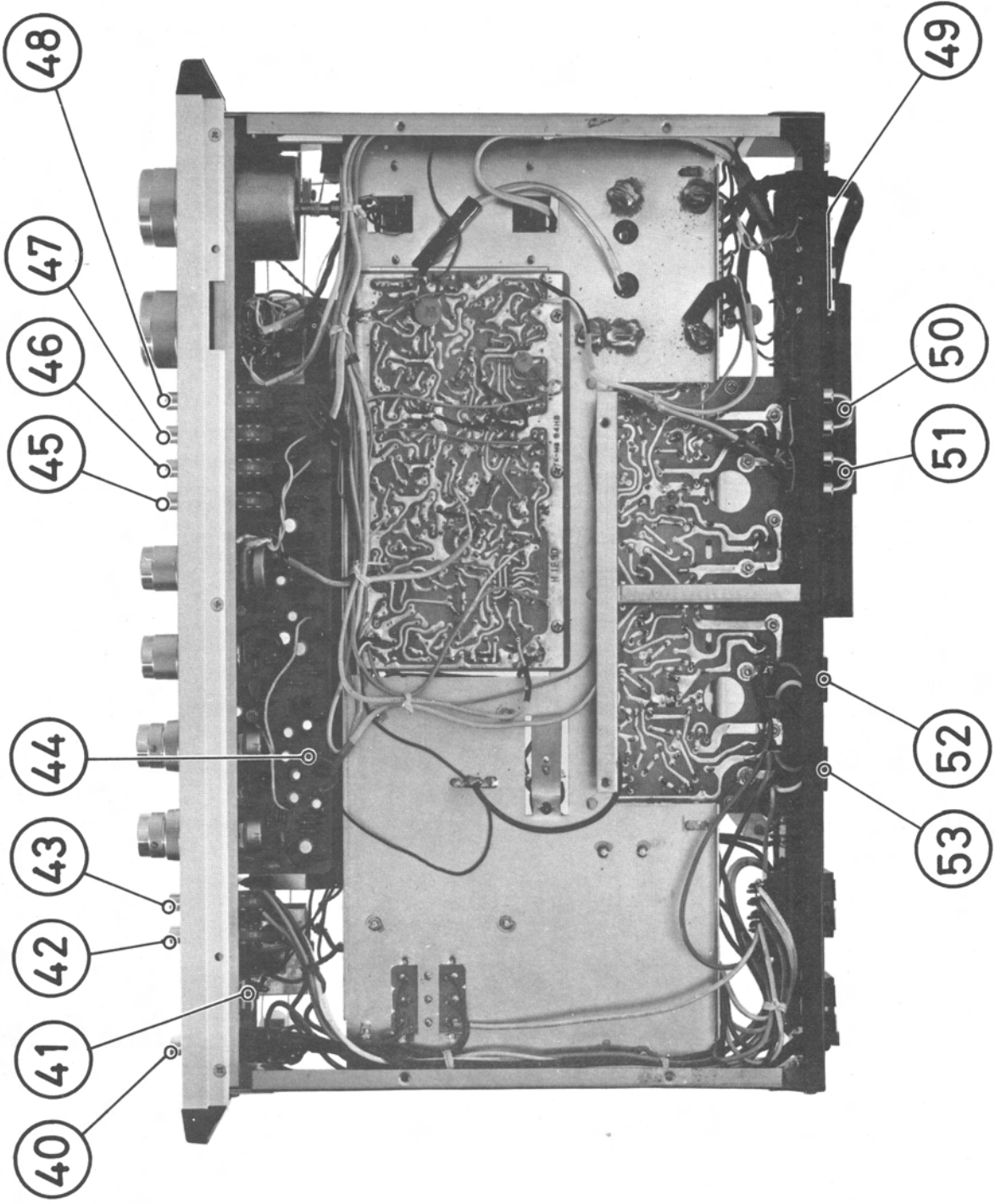
# CHASSIS LAYOUT



- 1. L102, AM IFT, 1st
- 2. Tuning Knob
- 3. Function Selector
- 4. L103, AM IFT, 2nd
- 5. L104, AM IFT, 3rd
- 6. Volume Control
- 7. Balance Control
- 8. Treble Control
- 9. L105, AM Whistle Filter
- 10. Bass Control
- 11. VR102, FM Muting Level Adj.
- 12. VR101, FM Stereo Auto-Switching Level Adj.
- 13. Q901, Stabilizer
- 14. Rectifier Circuit Board
- 15. F003, AC Fuse
- 16. F002, Speaker Fuse, R-ch.
- 17. F001, Speaker Fuse, L-ch.
- 18. S9, Deemphasis Switch
- 19. VR301, FM Stereo Separation Adj.
- 20. T001, Power Transformer
- 21. Speaker-2 Terminal Strip
- 22. IC301, FM MPX Decoder
- 23. Speaker-1 Terminal Strip
- 24. S8, Speaker Matrix Switch
- 25. Q609, Power Amp., L-ch.
- 26. Q608, Power Amp., L-ch.
- 27. VR601, Bias (Idling Current) Adj., L-ch.
- 28. Q617, Power Amp., R-ch.
- 29. VR602, Bias (Idling Current) Adj., R-ch.
- 30. Q618, Power Amp., R-ch.
- 31. L001, AM Antenna Coil
- 32. Main Amp., Circuit Board
- 33. AM/FM Front-end
- 34. L107, FM IFT, Ratio (Sec.)
- 35. L106, FM IFT, Ratio (Pri.)
- 36. IC101, FM IF Amp.
- 37. Phono Equalizer Amp., Circuit Board
- 38. AM, FM IF Amp., & MPX Dec., Circuit Board
- 39. L101, AM Osc., Coil

TOP VIEW

# CHASSIS LAYOUT



- 40. Power Supply Switch
- 41. Headphone Receptacle
- 42. Speaker-1 Switch
- 43. Speaker-2 Switch
- 44. Tone Control Amp., Circuit Board
- 45. Muting Switch
- 46. Hi-Filter Switch
- 47. Loudness Switch
- 48. Tape Monitor Switch
- 49. Antenna Terminal Strip
- 50. Pre-Main Jack, R-ch.
- 51. Pre-Main Jack, L-ch.
- 52. AC Outlet
- 53. AC Outlet

# BOTTOM VIEW

# PRECAUTIONS

1. Always disconnect the chassis from power line when soldering. Turning the power switch OFF is not enough. Power line leakage passing through the heating element may destroy the transistors.
2. Never attempt to do any work on the transistor amplifiers without first disconnecting the AC line cord and waiting until the power supply filter capacitors have discharged.
3. Replacements for output and driver transistors, if necessary, must be made from the same beta group as the original type.
4. If one output transistor burns out (open or short),

always remove all output transistors in that channel and check the bias adjustment, the control and other parts in the network with an ohm-meter before inserting a new transistor. All transistors in one channel will be destroyed if the base biasing circuit is open on the emitter end.

5. When mounting a replacement power transistor, be sure the bottom of the flange, the mica insulators and the surface of the heat sink are free of foreign matter, for they may cause transistors failure.
6. Silicon grease must be applied between the transistor and the mica insulator, and between the mica insulator and the heat sink for better heat conduction.

## POWER AMPLIFIER BIAS ADJUSTMENT

**Instrument:** DC milli-volt meter

- Set volume Control to minimum position.
- Set potentiometers VR601 and 602 to CCW position before starting this procedure.

1. Connect the plus lead of a DC milli-volt meter to test point 5 (on main amp., pcb) and minus lead to test point 7.

2. Adjust the potentiometer VR601 to obtain a 7.5mV reading on the DC milli-volt meter (see Figure 1.).
3. Repeat the above steps 1 and 2 for Right Channel. (use test points Pin No.6, 8 and potentiometer VR602.)

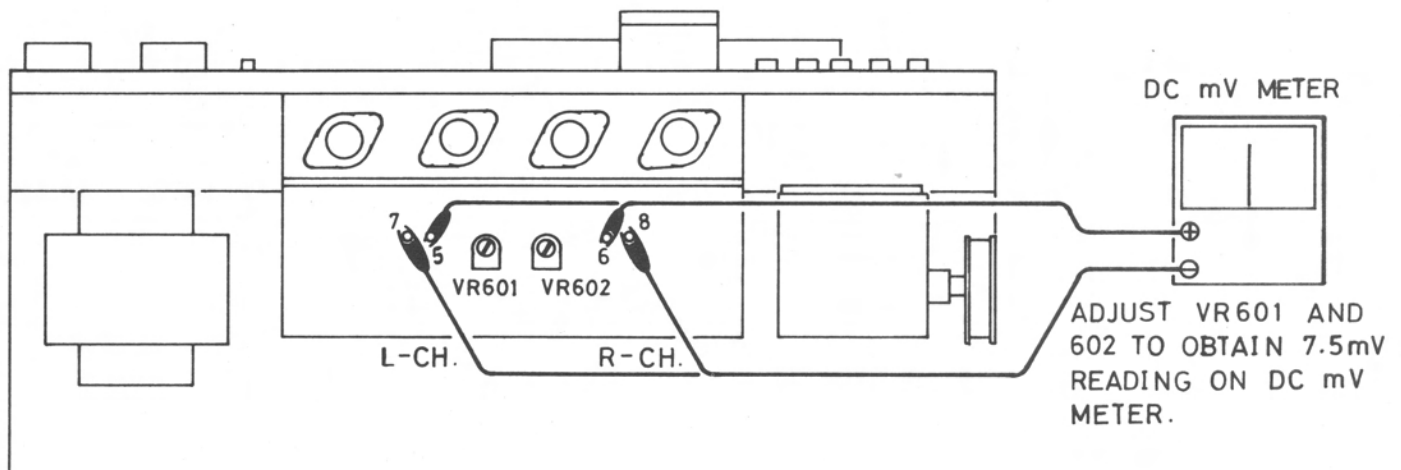


Figure 1. Bias (Idling Current) Adjustment Hook-up

# AM ALIGNMENT PROCEDURE

**Instruments:** AM Signal Generator and AC VTVM.

**NOTES:** Set Selector switch to AM position.

Input signal must be kept as low as possible to avoid AVC action.

Step	Generator		Turning Dial Setting	Output Indicator Connected to	Adjust	Adjust for
	Coupling	Frequency				
1	Pin No. 5 on IF board through a 0.01 mfd capacitor.	455 KHz (400 Hz 30% Mod.)	Non interfering at low end of scale.	AC VTVM to TAPE OUT jack	L104,103 and 102 (on IF board)	Maximum reading on VTVM.
2	Connect to short loop of wire. Radiate signal into ferrite loopstick antenna.	600 KHz (400 Hz 30% Mod.)	600 KHz		L101 (OSC) (on IF board) and L001 (ANT)	
3		1400 KHz (400 Hz 30% Mod.)	1400 KHz		CT5 (OSC) and CT4 (ANT) (on Front end)	
4	Repeat steps 2 and 3 until no further improvement is noticed.					

## AM SIGNAL GENERATOR

## STEP 1

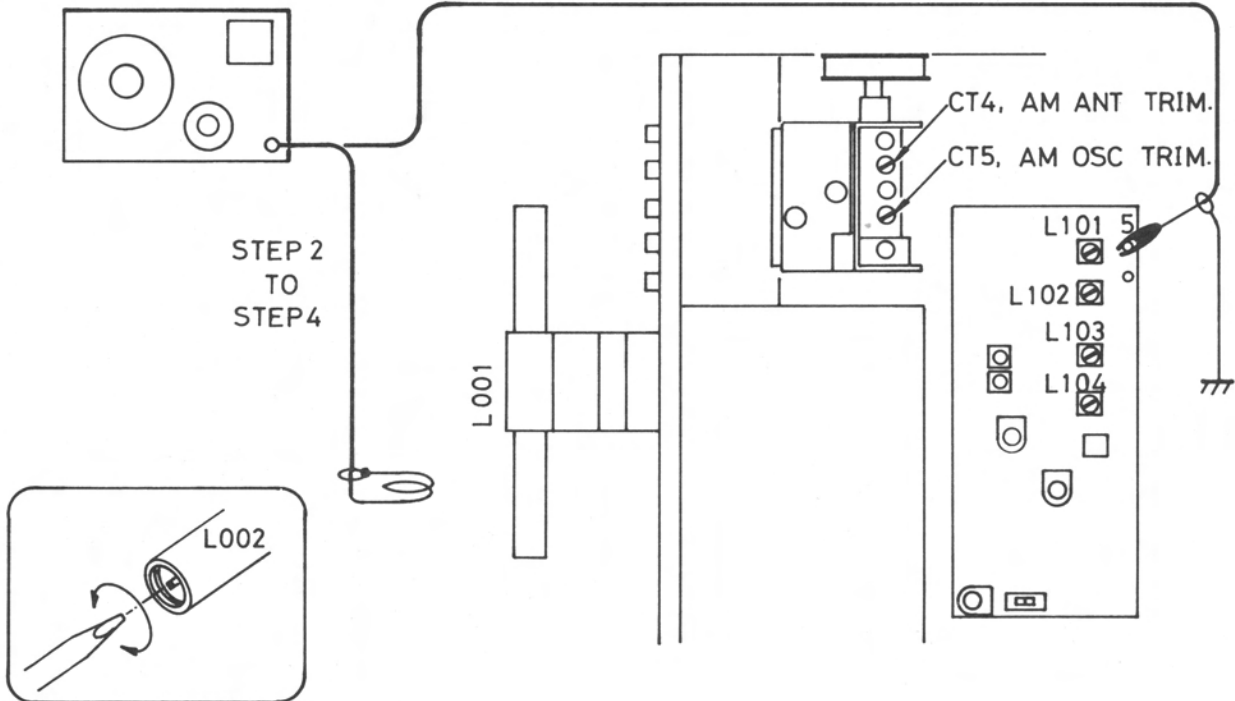


Figure 2. AM Alignment Hook-up

# FM IF & RF ALIGNMENT PROCEDURE

**Instruments:** FM Signal Generator, Oscilloscope and H.D. Analyzer

- Set Function Selector Switch to "FM" position.
- Connect FM Signal Generator to FM antenna terminals.
- Connect Oscilloscope and H.D. Analyzer to Tape Out jack.

## A. FM IF Alignment

1. Set Signal Generator Frequency at 98 MHz (400 Hz, 100% Mod.) and tune the receiver to maximum output point. (The antenna terminal voltage should be 1 mV).
2. Adjust FM IFT, L107 and T1 (on Front-end) to obtain maximum deflection on scope.
3. Adjust FM IFT, L106 to obtain minimum reading on H.D. Analyzer.

## B. FM RF Alignment

1. Set Signal Generator Frequency at 106 MHz and also the receiver at 106 MHz on the dial scale. Then adjust FM OSC trimmer CT3 (on Front-end) to obtain maximum deflection on scope.
2. Set the receiver at 90 MHz on the dial scale, and change the frequency of Signal Generator so that the output of the receiver becomes maximum. Then make sure Signal Generator frequency stays within 90 MHz  $\pm$  150 kHz.

3. Sensitivity on this alignment must be attempted at 106 MHz by adjusting CT1 and CT2 (on Front-end) to obtain maximum deflection on scope, and fine adjust to balance sensitivity at 90 MHz and 106 MHz.

**Caution:** Bandpass Filters (X101 and X102) incorporated in FM IF circuit are classified into 5 divisions according to their center frequencies. It is thus necessary to use the same frequency division in case of exchanging the Bandpass Filters. Divisions of band-pass frequencies are indicated by colored dots as shown in the following chart.

COLOR	CENTER FREQ.	TOLERANCE
Red	10.70MHz	$\pm$ 30KHz
Blue	10.67MHz	$\pm$ 30KHz
Orange	10.73MHz	$\pm$ 30KHz
Black	10.64MHz	$\pm$ 30KHz
White	10.76MHz	$\pm$ 30KHz

## FM SIGNAL GENERATOR

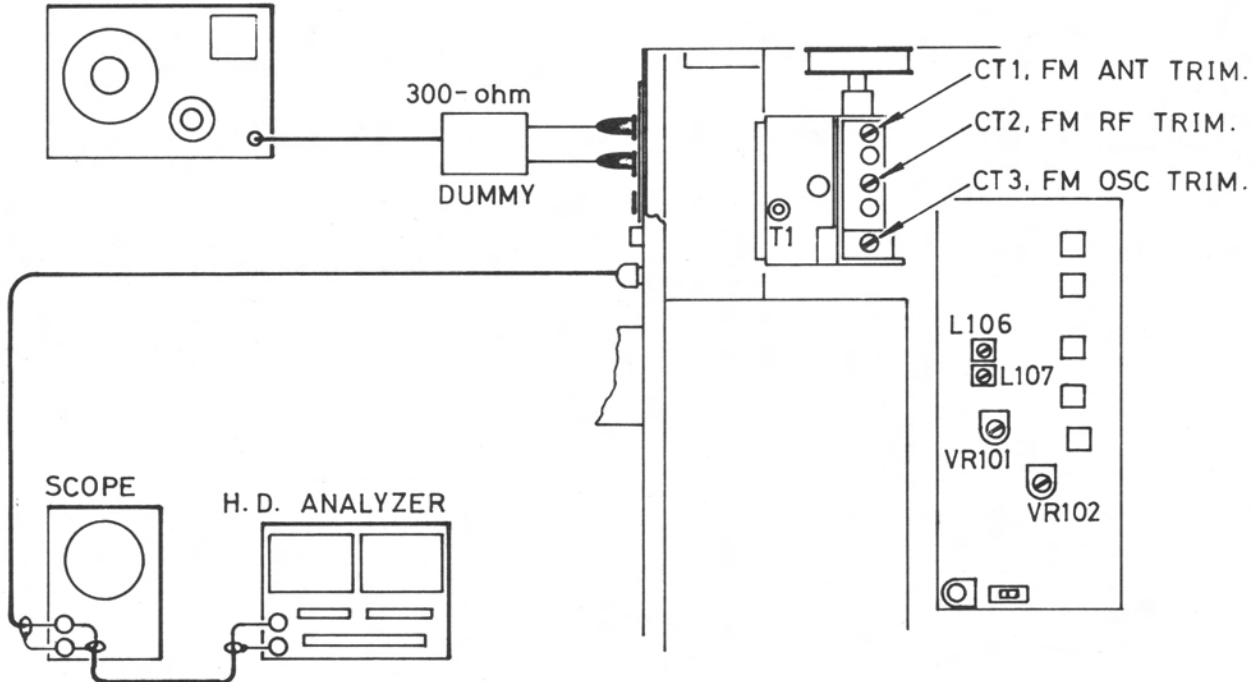


Figure 3. FM IF & RF Alignment Hook-up

# FM MPX ALIGNMENT PROCEDURE

**Note:** Be sure the FM IF alignment is in the best state before attempting the FM MPX alignment. If FM IF is not properly aligned, FM MPX alignment may give inferior result.

**Instruments:** FM Stereo Generator, AC VTVM and Oscilloscope

1. Set Function Selector to FM STEREO position and Muting switch to OFF position.
2. Set Potentiometer VR301 to mid-position.
3. Connect FM Stereo Generator to FM antenna terminals and AC VTVM and Oscilloscope to Tape Out (R-ch) jack.
4. Set the frequency at 98 MHz (if a disrupting signal appears, select another frequency). FM Stereo Generator modulation is as follows:  
 Pilot 9%  
 Modulation Frequency 1 KHz (L-ch. Signal) 90%

5. Turn and adjust the Potentiometer VR301 so that the leakage signal on the Oscilloscope and AC VTVM is minimum.
6. Then, change the connections of Oscilloscope and AC VTVM from R-ch. to L-ch. Tape Out jack, as well as the modulation signal from L-ch. to R-ch. At the same time, check that the leakage signal is minimum. If the difference in leakage signals between R-ch. and L-ch. is large, adjust the VR301 precisely so as to obtain equal levels between leakage signals.
7. Make sure the Stereo can be operated normally even when the modulation degree of pilot signal of FM Stereo Generator is reduced from 9% to 6%.

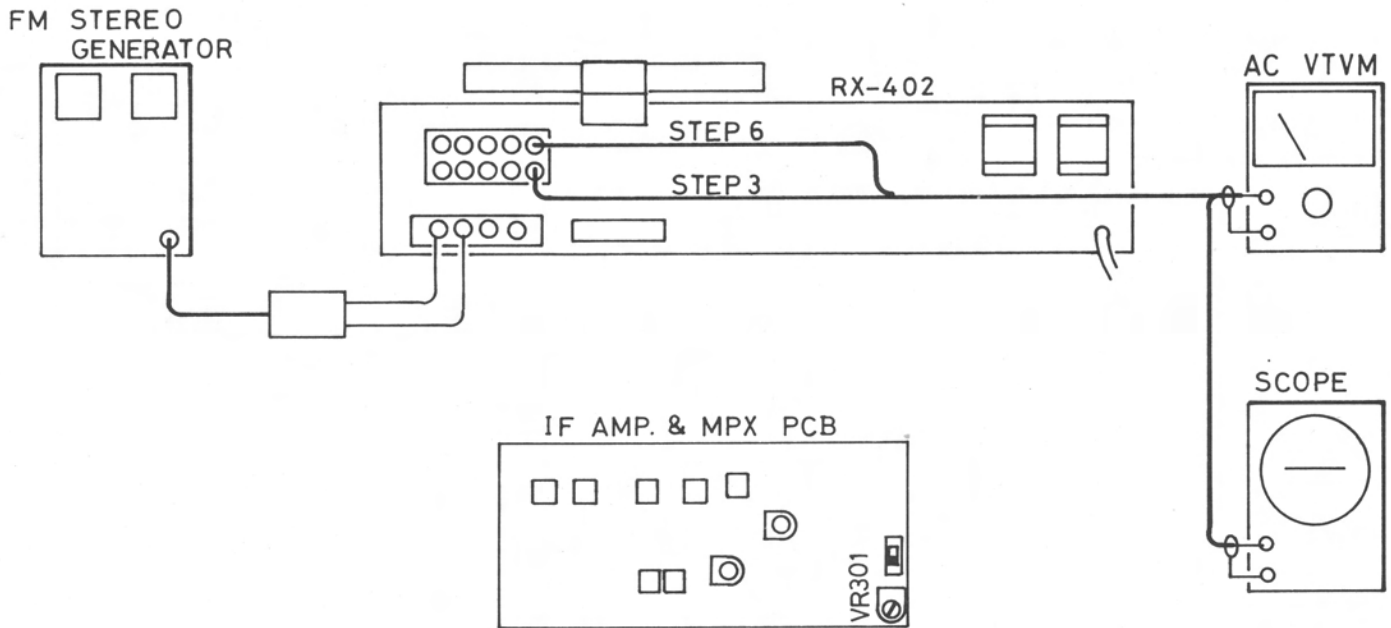


Figure 4. FM MPX Alignment Hook-up

# FM MONO-STEREO AUTOMATIC SWITCHING LEVEL ADJUSTMENT PROCEDURE

1. Connect a VTVM and an Oscilloscope to the Tape Out jack (Left or Right).
2. Feed the FM signal whose MPX has been varied into the FM antenna terminals.
  - MPX Variation
    - Pilot Signal      9%
    - Modulation Frequency    1KHz (L-ch. or R-ch.)
    - RF Deviation       $\pm 45$ KHz
3. Set the Frequency at 98 MHz (when there is a disrupting signal, choose another setting).
4. Set the Function Selector to FM STEREO position.
5. Set the potentiometer VR102 to counterclockwise position; this is a condition at which Auto-switching does not function.
6. Adjust the VR102 so that when the antenna input level is  $10\mu\text{V}$ , Stereo will switch in.
7. After adjustment, check to make sure that, indeed, when the antenna input level is below  $5\mu\text{V}$ , Mono will switch in.

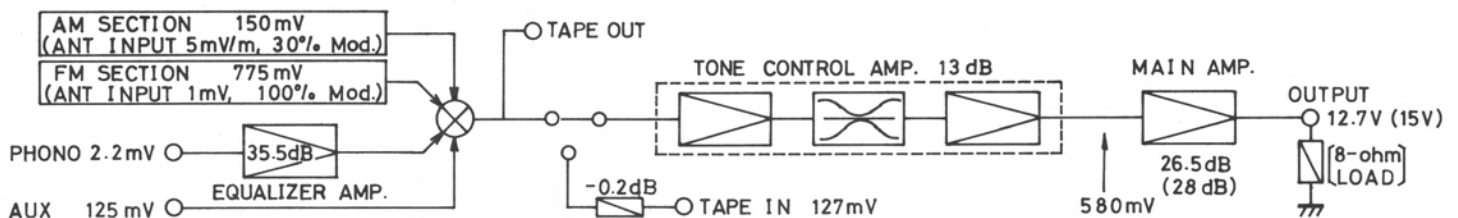
## FM MUTING LEVEL ALIGNMENT PROCEDURE

Be sure the FM IF and RF circuits are properly aligned before attempting the FM Muting Level alignment.

**Instruments:** FM Signal Generator (FMSG) and Oscilloscope (Scope)

1. Set the Function Selector to FM position and Muting switch to ON position.
2. Connect FMSG Output to FM antenna terminals and Scope to Tape Out jack (L-ch. or R-ch.)
3. Set the frequency at 98 MHz (when a disrupting signal appears, select another frequency)
4. Turn Potentiometer VR102 fully clockwise, then adjust the FMSG attenuator so that the antenna terminal voltage is  $10\mu\text{V}$ .
5. Turn and adjust Potentiometer until the signal on Scope just vanishes.
6. Check that the signal appears on Scope (at distortion less than 1%) when the antenna terminal voltage is set to  $20\mu\text{V}$ , and disappears when the voltage is reduced from  $20\mu\text{V}$  to  $10\mu\text{V}$ .
  - a. When there is high distortion, expedite the FM IF & RF alignment and start again.
  - b. When the signal is not vanished at the  $10\mu\text{V}$  input, repeat the steps 4 and 5.

## GAIN DIAGRAM





# TROUBLE SHOOTING

## Unit inoperative

- I. If the pilot lamp does not light, check the flow at the AC Outlet and
  - A. If no voltage across,
    1. The AC cord may be broken, or
    2. Connections in the Power Switch may be faulty.
  - B. If there is proper voltage across, check the AC fuse F003 and if the AC fuse is blown,
    1. Capacitor C904, 905, 906, 907 or 908 may be shorted, or
    2. Rectifier D903, 904, 905, 906 or 907 may be shorted, or
    3. Primary or secondary winding of the Power Transformer T001 may be shorted.
- II. If the pilot lamp does light, measure voltage across +B, -B and B1 (see the schematic diagram) and
  - A. If no voltage across,
    1. Rectifier D903, 904, 905, 906 or 907 may be opened, or
    2. Secondary winding of the Power Transformer may be opened.

## Left or Right channel inoperative

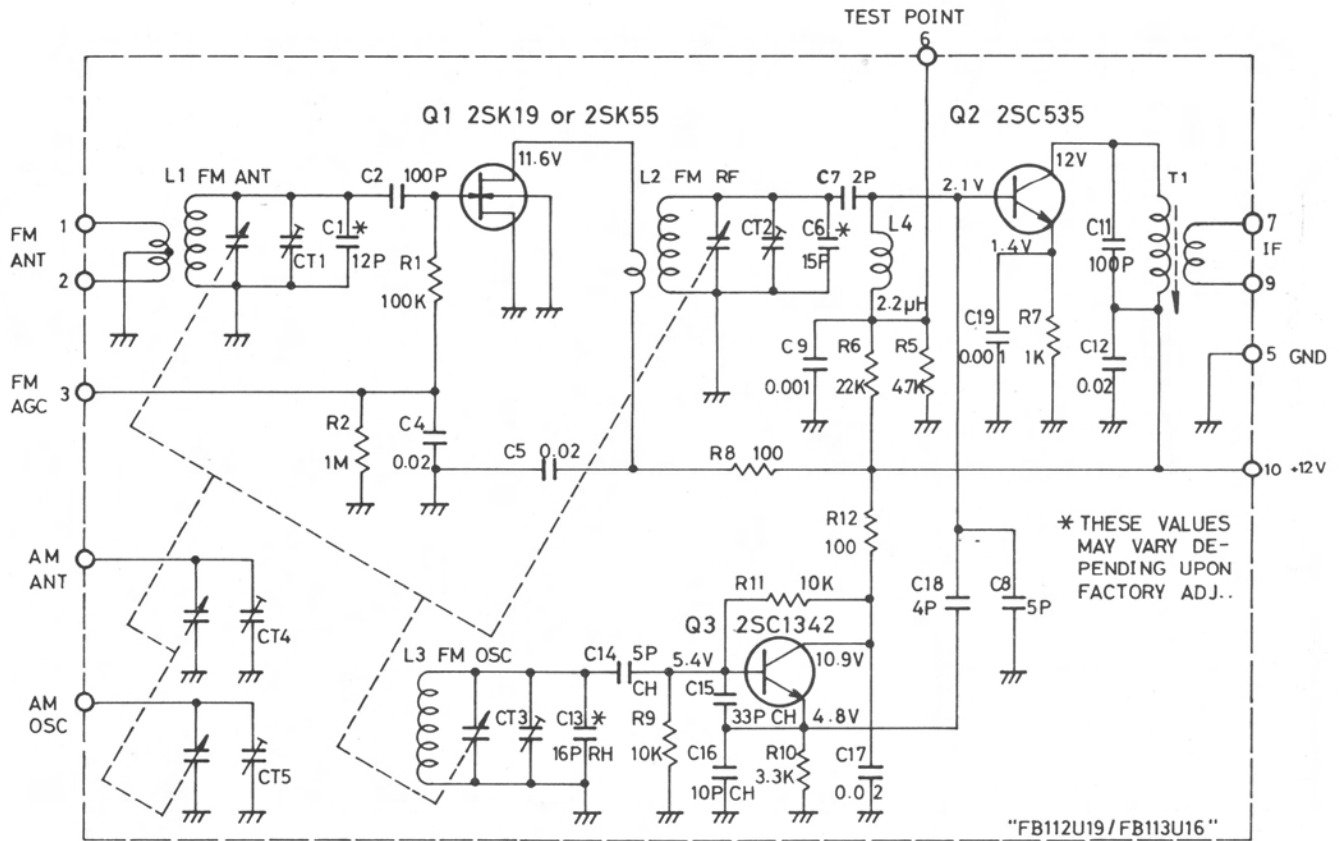
- I. If the Left channel is inoperative, check to see if there is a signal at Main Amp. pcb Pin 1.
  - A. If there is a signal,
    1. Capacitor C601 may be faulty, or
    2. Transistor Q601, 602, 603, 606, 607, 608 or 609 may be faulty.
  - B. If there is no signal,
    1. Capacitor C504, 509, 514 or 517 may be faulty, or
    2. Transistor Q501, 502 or 503 may be faulty.

- C. If the speaker fuse is blown,
  1. Transistor Q606, 607, 608 or 609 may be shorted, or
  2. The protection circuit does not work effectively against abnormality such as a shorted output circuit.
    - a. Diode D603 or 604 may be faulty, or
    - b. Transistor Q604 or 605 may be faulty.
  3. The fuse may be worn out.

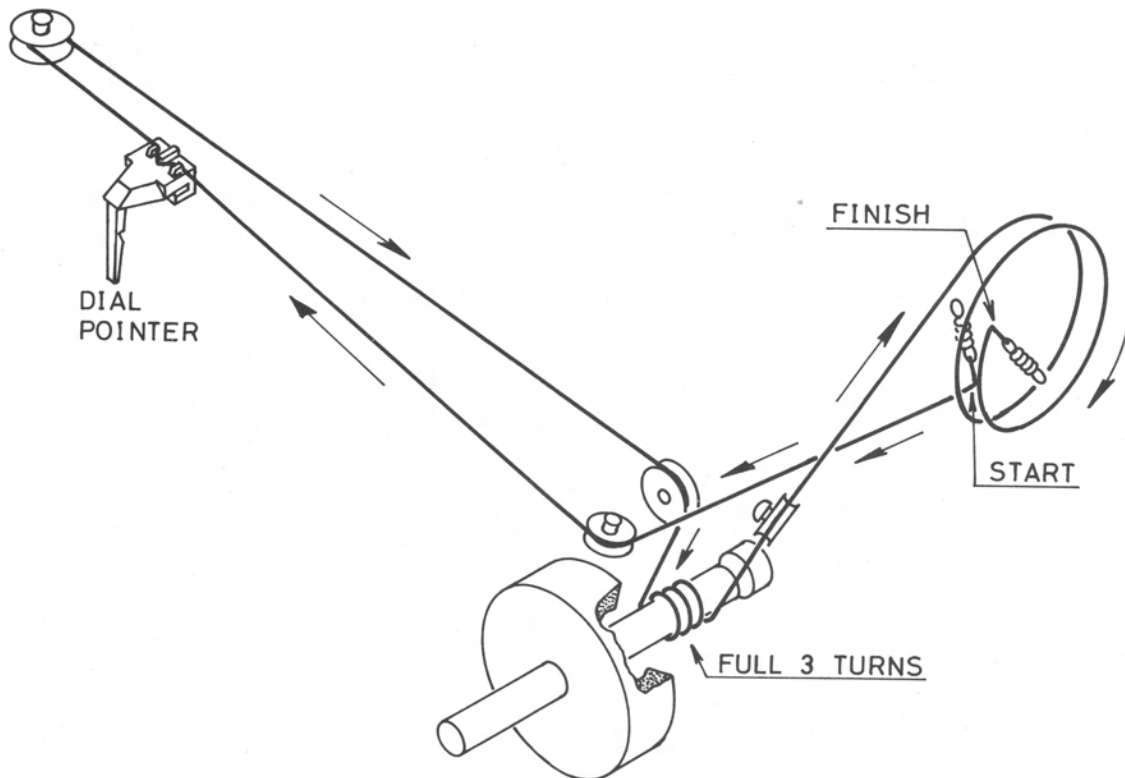
## Radio Section inoperative

- I. AM is inoperative.
  - A. If there is proper voltage at IF pcb Pin B2,
    1. Transistor Q109, 110, 111 or 112 may be faulty, or
    2. Coil L101, 102, 103, 104 or 002 may be faulty.
- II. FM is inoperative.
  - A. If there is proper voltage at IF pcb Pin B1,
    1. Transistor Q101, 106 or 107 may be faulty, or
    2. IC101 or 301 may be faulty, or
    3. Coil L106 or 107 may be faulty, or
    4. Capacitor C123 or 301 may be faulty, or
    5. Front-end may be faulty.
  - B. At FM Stereo broadcast, the set only receives in Mono.
    1. Auto-switching circuit is inoperative.
      - a. Alignment may become faulty, or
      - b. Diode D103 or 104 and transistor Q102 or 104 may be faulty, or
    2. Stereo separation may be miss-aligned, or
    3. IC301 may be faulty.

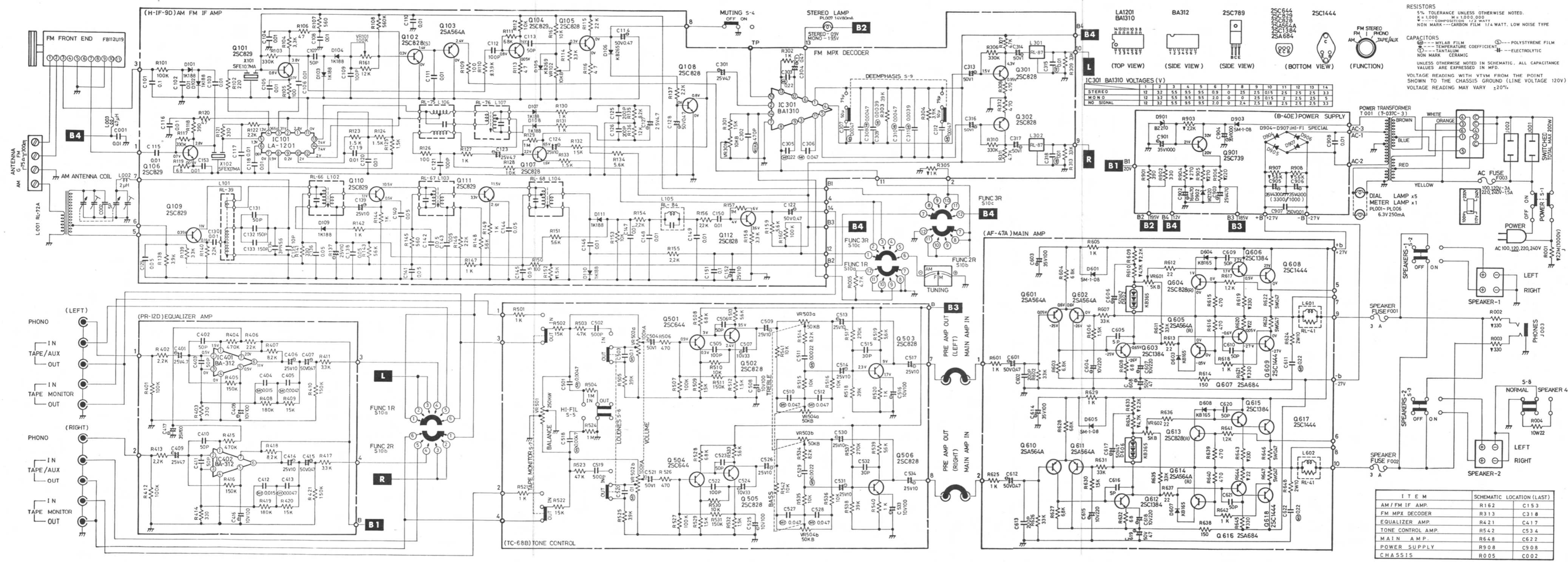
# FRONT-END SCHEMATIC DIAGRAM



# DIAL STRINGING DIAGRAM

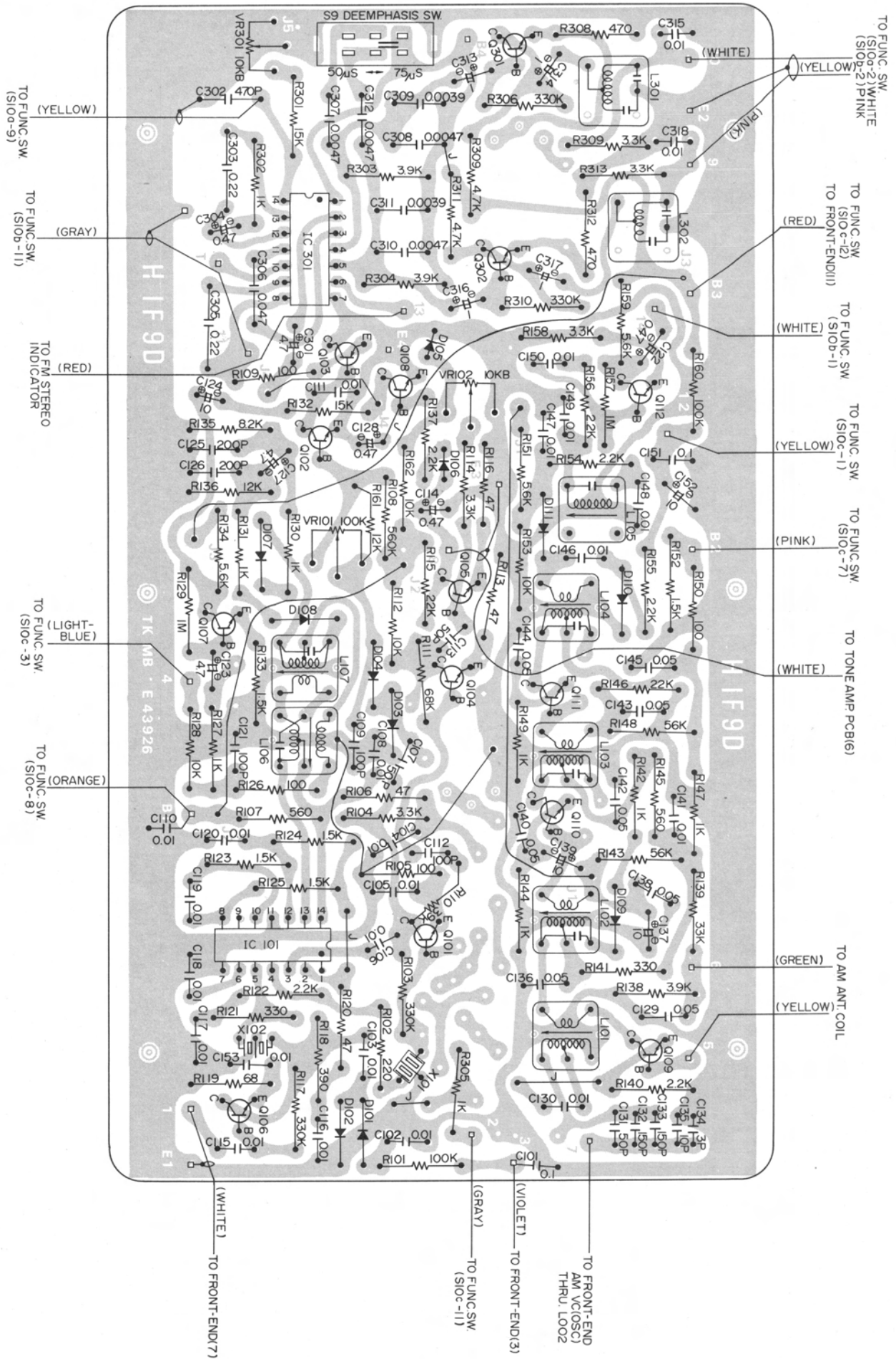


# SCHEMATIC DIAGRAM

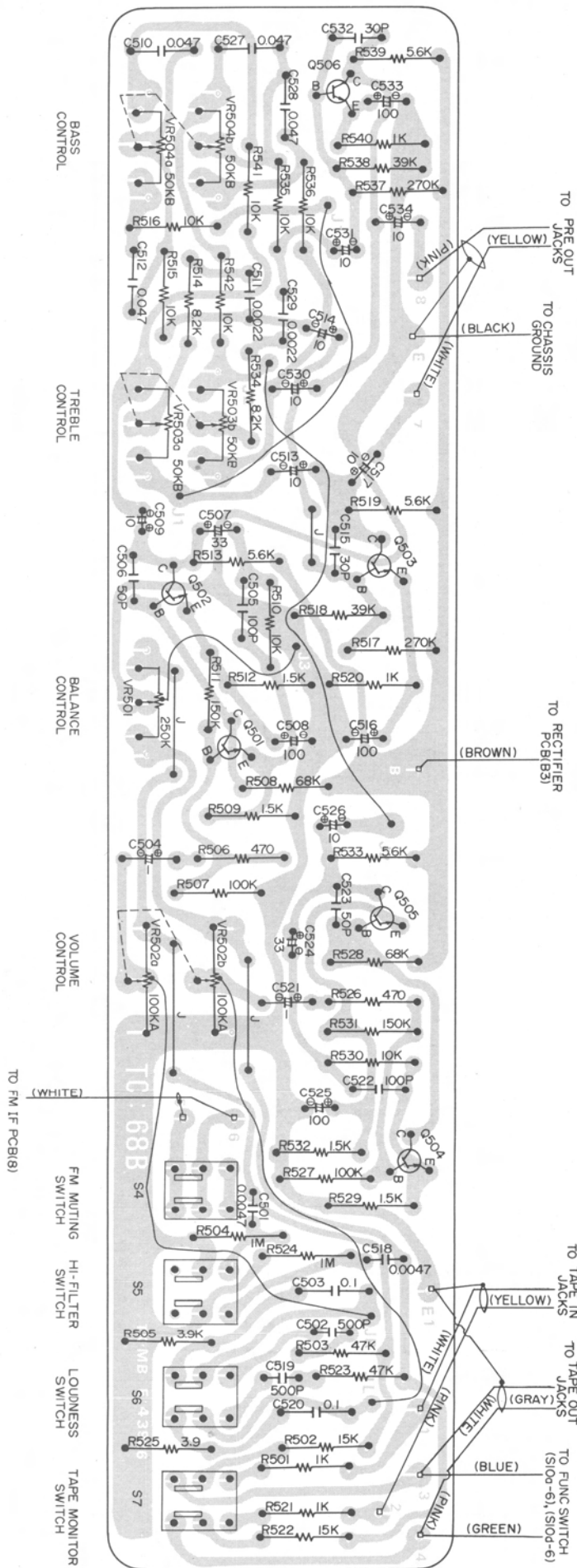


ITEM	SCHEMATIC LOCATION (LAST)	
AM / FM IF AMP.	R162	C153
FM MPX DECODER	R313	C318
EQUALIZER AMP.	R421	C417
TONE CONTROL AMP.	R542	C534
MAIN AMP.	R648	C622
POWER SUPPLY	R908	C908
CHASSIS	R005	C002

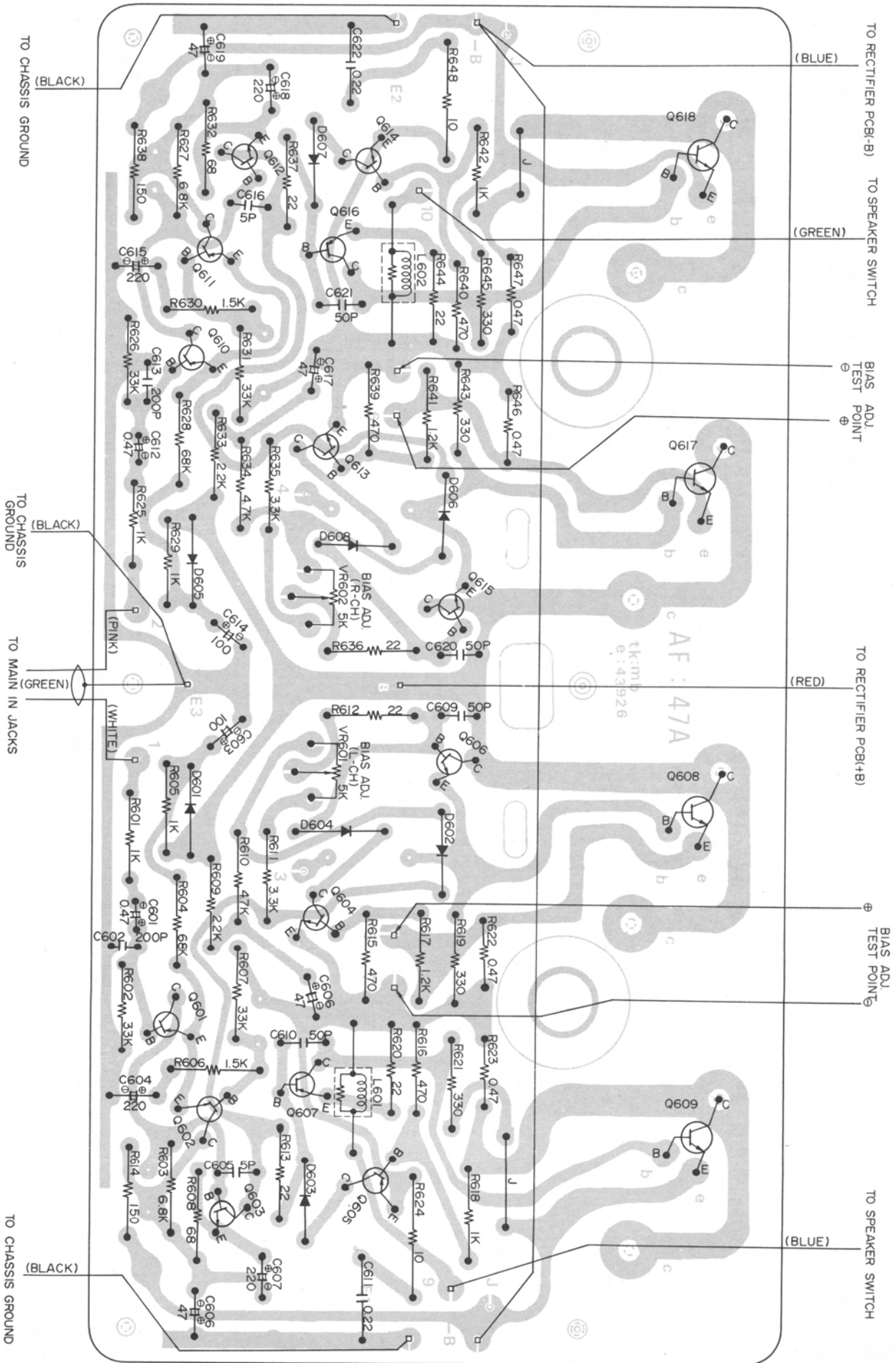
# AM FM IF AMP. MPX DECODER CIRCUIT BOARD DIAGRAM



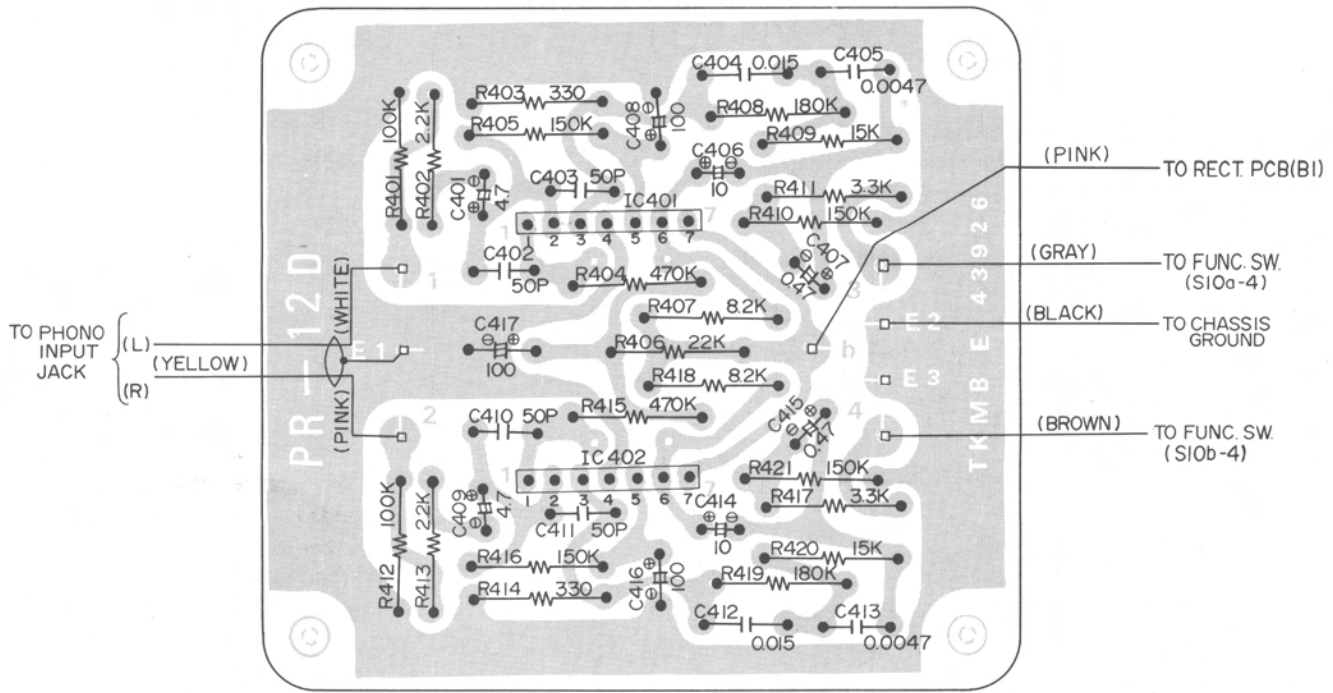
# TONE CONTROL AMPLIFIER CIRCUIT BOARD



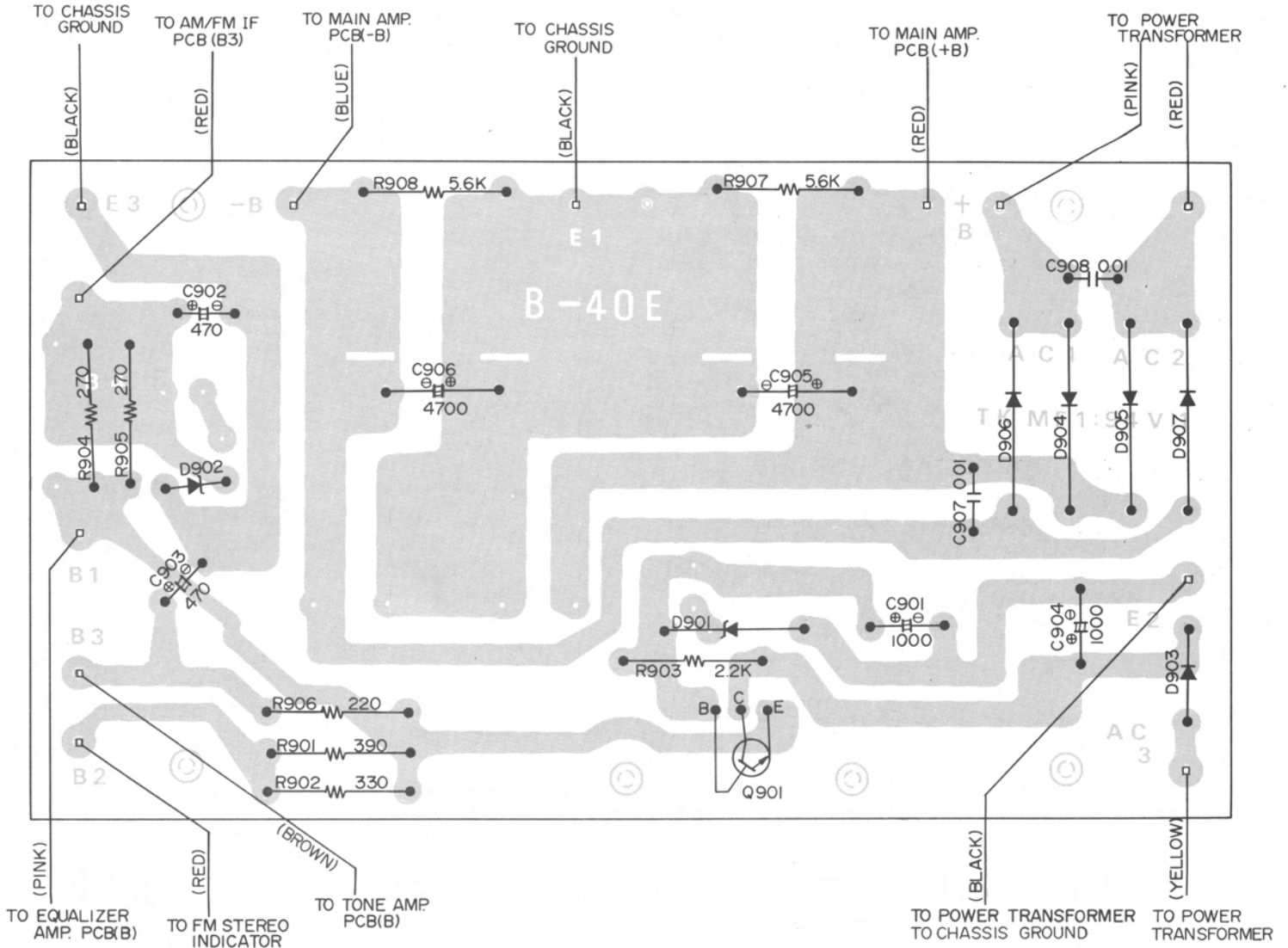
# MAIN AMPLIFIER CIRCUIT BOARD DIAGRAM



# EQUALIZER AMPLIFIER CIRCUIT BOARD DIAGRAM



# RECTIFIER CIRCUIT BOARD DIAGRAM



# ADDENDUM

I. The following changes in specifications are applied to the units marked with the numbers "1046" at the bottom part of serial number plate on the rear panel.

A. RMS output power per channel is increased from 20W/8-ohm to 25W/8-ohm, both channels driven.

1. Accordingly, the power transformer rating is changed as DC (+B, -B) voltage is increased from 27V to 29.5V. Also, the schematic designation and Part number of the transformer is changed as follows:

from T-037C-3 [205001364]

to T-044C [205001372]

(Note: T-044A [201001372] has only 120V primary voltage).

B. Values of the smoothing capacitors C905 and C906 are changed from 4,300 mfd. (3300//1000) to 6,800 mfd.

C. Values of the SPEAKER fuses F001 and F002 are changed from 3A to 5A.

D. According to the item A above, the Values of components of the main amplifier protection circuit is partially changed as follows:

1. R615,616,639 and 640 – from 470 ohms to 560 ohms
2. R617 and 641 – from 1.2K ohms to 1.5K ohms
3. R618 and 642 – from 1K ohms to 1.2K ohms

E. According to the item A, the voltages of each transistor in the main amplifier are changed as shown in the table below.

Channel		Voltage		
L-ch.	R-ch.	Emitter	Base	Collector
Q601	Q610	0.6V	0.04V	-23V
Q602	Q611	0.6V	0.39V	-29V
Q603	Q612	-28.7V	-23V	-0.6V
Q604	Q613	0.02V	0.02V	0.8V
Q605	Q614	0.02V	-0.02V	-0.3V
Q606	Q615	0.52V	1.1V	29V
Q607	Q616	-0.05V	-0.8V	-29.1V
Q608	Q617	0.02V	0.52V	29.5V
Q609	Q618	-0.02V	-29.1V	-29.5V

II. In addition to the preceding changes, the following items apply to the units marked with the numbers "2149" at the bottom part of serial number plate on the rear panel.

A. The shape and dimension of the power transformer are changed (Electrical characteristics remained the same as previous T-044C). However, the difference

in fitting dimension, etc. does not permit the interchange with T-044C.

Schematic location and part number of the transformer is:

from T-044C [205001372]

to T-049C [205001377]

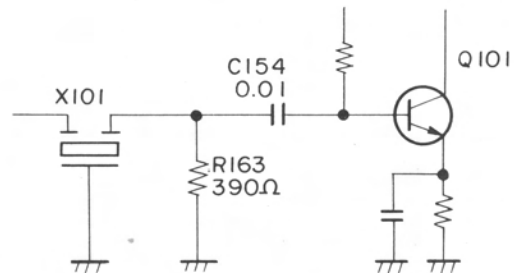
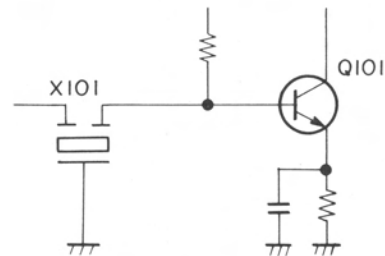
B. According to the item A above, the fitting dimension of chassis for power supply section is partially modified.

C. The components and the values of components in FM IF circuit are partially changed as follows:

1. Components are added to the input circuit of Q101. (See figures below)

a. C154, 0.01 mfd (440100985), added.

b. R163, 390 ohms,  $\pm 5\%$  [552039122], added.



2. Specification of FM IFT L107 is changed from RL-76 to RL-88, which effects the change to the surrounding components as follows:

a. R102 – from 220 ohms to 0 ohm (i.e. short-circuited)

b. R122 – from 2.2K ohms to 330K ohms

c. R128 – from 10K ohms to 6.8K ohms

d. R133 – from 1.5K ohms to 1K ohms

e. R135 – from 8.2K ohms to 10K ohms

f. R136 – from 12K ohms to 10K ohms

g. R161 – from 12K ohms to 15K ohms

III. Among the items in the section II, only C is applicable (A and B are not applicable) to the units marked with "1049" at the bottom part of serial number plate on the rear panel.



# REPAIR PARTS LIST

Schematic Location	Part No.	Description
<b>COILS and TRANSFORMERS</b>		
L101	223301124	AM Local Oscillator
L102	225301125	AM IFT, 1st
L103	225301126	AM IFT, 2nd
L104	225301127	AM IFT, 3rd
L105	228641119	AM Low Pass Filter
L106	225501125	FM IFT, Ratio (Pri)
L107	225501126	FM IFT, Ratio (Sec.)
L301,302	228641117	FM MPX Low Pass Filter
L601,602	220401120	Anti-parasitic
L001	222391121	AM Loop Stick Antenna
L002	220001122	RF Choke, 2 $\mu$ H
L003	220001121	RF Choke, 47 $\mu$ H
T001	205001364	Power Supply (Pri. 100-120-220-240V)
	201001372	Power Supply (Pri. 120V only)* <sup>1</sup>
	202001373	Power Supply (Pri. 220V only)* <sup>2</sup>
		(*1 UL and CSA Approved)
		(*2 SEMKO Approved)
X101,102	229101134	FM IF Bandpass Filter
<b>TRANSISTORS, DIODES and IC'S</b>		
Q101,104	301201117	2SC829(C), FM IF Amp., AM Conv., etc.
Q106,109		
Q110,111		
Q102	301201149	2SC828(S), FM Stereo Switching Amp.
Q103,601	301001117	2SA564A, FM Stereo Switching Gate, Differential Amp., etc.
Q602,610		
Q611		
Q105,107	301201115	2SC828(R), FM Audio Amp., AM Audio Amp., Tone Amp. etc.
Q108,112,		
Q301,302		
Q502,503		
Q505,506		
Q604,613	301201114	2SC644(S), Tone Amp.
Q501,504		
Q603,606	301201132	2SC1384, Pre-driver, Driver
Q612,615		
Q604,614	301001118	2SA564A(R), Overload Protector
Q607,616	301001123	2SC684, Driver
Q608,609	301201141	2SC1444, Power Amp.
Q617,618		
Q901	301201142	2SC789, Stabilizer
D101,102	300111008	1K188, AM Det., FM Det., FM AGC Rect., etc.
D103,104		
D107,108		
D109,110		
D111		

Schematic Location	Part No.	Description
D105	300212004	KB-269, FM Muting Bias Compensator
D106	300212002	KB-265, FM Muting Bias Compensator
D601,605	300919016	SM-1-08, Rectifier for Pre-amp., & Radio Section
D903		
D602,606	300212007	KB-365, Power Amp. Bias Compensator
D603,604,	300212008	KB-165, Overload Protector
D607,608		
D901	300313007	BZ-210, Zener, 21V
D902	300313013	WZ-120, Zener, 12V
D904,905	300919017	Hi-Fi Special, Rectifier for Main Amp.
D906,907		
IC101	303452148	LA-1201, FM IF Amp.
IC301	303452151	BA1310, FM MPX Decoder
IC401,402	303452150	BA-312 Phono Equalizer Amp.
<b>VARIABLE RESISTORS</b>		
VR101	510502130	100KB, FM Mono-Stereo Switching Level Adj.
VR102,301	510502126	10KB, FM Muting Level Adj., FM Stereo Separation Adj.
VR501	515121121	250KW, Balance Control
VR502	525121123	100KAT x 2, Volume Control
VR503,504	525101130	50KB x 2, Bass, Treble Control
VR601,602	510502128	5KB, Bias Adj.
<b>MISCELLANEOUS</b>		
PL001-006	352063025	6.3V, 0.25A, Dial Lamp
PL007	351140005	14V, 50mA, FM Stereo Indicator
	321304368	AM/FM Front-end
	231310031	Tuning Meter
S10	601011256	Switch, Function Selector
S1	614010107	Switch, Power Supply
S4,5,6,7	614040812	Switch, Push 4-Key (Loudness, Hi-Filter, FM Muting, Tape, Monitor)
S2,3	614020403	Switch, Push 2-Key, Speakers
S8	613000022	Switch, Slide 6P, Speaker Matrix
S9	613000024	Switch, Slide 6P, Deemphasis
	141510147	Phono Equalizer Amp. Circuit Assembly
	141710257	Tone Control Amp. Circuit Assembly
	141610260	Main Amp. Circuit Assembly (without Power Tr's & Heat Sink)