MODEL IG-37 FM Stereo Generator

HEATHKIT®

ASSEMBLY MANUAL

HEATHKIT®

595-1204-05

PRICE $2.00

INTRODUCTION

The Heathkit Model IG-37 FM Stereo Generator provides "on-the-air-type" signals for aligning monophonic and stereophonic FM receivers. It is a compact, accurate instrument which will produce the following output signals:

- A composite stereo signal for either left or right channel alignment.
- A phase test signal (left plus right channel) for accurate adjustment of subcarrier transformers.
- A pilot signal with adjustable output level for checking the lock-in range of stereo receivers.
- A monophonic FM signal that may be modulated by any one of three modulation frequencies.
- A variable RF oscillator signal with adjustable sweep width and a nominal frequency of 100 MHz.
- Four marker frequencies for RF alignment checks.
- Two SCA (Subsidiary communications authorization) signal frequencies for SCA filter adjustments.
- Completely shielded and selective RF attenuation.

The pilot signal and marker frequencies are crystal controlled for maximum accuracy and minimum frequency drift.

The IG-37 FM Stereo Generator is a precision instrument for service or engineering personnel and other individuals who need an accurate source of signals for the complete alignment of monophonic or stereophonic FM receiving equipment. The Generator is attractive, small in size, and ruggedly built, and it should provide you with many years of trouble-free operation.

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

The numbers in parentheses are keyed to the numbers in the Parts Pictorial (fold-out from Pages 3, 4, and 5). NOTE: When more than one number is on a package, disregard all but the part number, as listed below.

To order a replacement part, refer to the Replacement Parts Price List and use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual.

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
1/2 Watt		
(1) 1-123	8	100 Ω (brown-black-brown-gold)
1-66	2	150 Ω (brown-green-brown)
1-48	2	390 Ω (orange-white-brown)
1-63	3	510 Ω (green-brown-brown-gold)
1-8	2	820 Ω (gray-red-brown)
1-11	4	1500 Ω (brown-green-red)
1-14	2	3300 Ω (orange-orange-red)
1-43	6	4700 Ω (yellow-violet-red-gold)
1-20	3	10 KΩ (brown-black-orange)
1-69	1	18 KΩ (brown-gray-orange)
1-22	1	22 KΩ (red-red-orange)
1-25	2	47 KΩ(yellow-violet-orange)
1-60	1	68 KΩ (blue-gray-orange)
1-26	2	100 KΩ(brown-black-yellow)
1-27	3	150 KΩ (brown-green-yellow)
1-35	4	1 megohm (brown-black-green)
1-40	1	10 megohm (brown-black-blue)
1/2 Watt Precision 1%		
(2) 2-141	1	166 Ω
2-178	1	1470 Ω (1.47 K)
2-67	1	2725 Ω (2.725 K)
2-180	1	2940 Ω (2.94 K)
2-69	1	4590 Ω (4.59 K)
2-181	1	5490 Ω (5.49 K)
2-155	1	13.5 KΩ
2-182	1	22.1 KΩ
2-183	1	44.2 KΩ
2-184	1	110 KΩ
2-185	1	222 KΩ
2-186	1	280 KΩ
2-187	1	536 KΩ
2 Watt		
(3) 1-16-2	1	330 Ω(orange-orange-brown)
CAPACITORS		
Disc		
(4) 21-3	1	10 pf

PART No.	PARTS Per Kit	DESCRIPTION
Disc (cont'd.)		
21-6	2	27 pf
21-75	1	100 pf
21-22	1	220 pf
21-140	5	.001 μfd
21-35	2	.005 μfd, 1600 V (1.6 KV)
21-95	1	.1 μfd
21-99	1	.2 μfd

Molded Mica

NOTE: These capacitors may be color coded, or the value may be printed on them. If necessary, refer to the capacitor color code chart and example to help identify these capacitors. Capacitors with the value stamped on them may have a body that is any color.

PART No.	PARTS Per Kit	DESCRIPTION
(5) 20-39	1	220 pf (red-red-brown)
20-43	1	390 pf (orange-white-brown)
20-89	2	817 pf
20-74	2	4000 pf (yellow-black-red)
Silver Mica		
(6) 20-133	2	430 pf
20-134	1	680 pf
20-122	1	1000 pf
20-137	2	1800 pf
Mylar*		
(7) 27-27	5	.022 μfd
27-28	2	.1 μfd
Electrolytic		
(8) 25-39	1	2 μfd, 150 V
25-20	2	40 μfd, 150 V
(9) 25-178	1	100/40/40 μfd, tab mount
Other Capacitors		
(10) 26-115	1	6.2 pf, variable
(11) 31-9	1	Ceramic trimmer
(12) 31-18	1	Dual ceramic trimmer
(13) 21-142	1	100 pf (brown-black-brown) feedthrough
21-53	2	1000 pf (brown-black-red) feedthrough
(14) 23-74	1	.04 μfd tubular
(15) 28-2	1	1 pf phenolic (brown-black-white-silver)

*DuPont Registered Trademark

CONTROLS

PART No.	PARTS Per Kit	DESCRIPTION
(16)10-214	1	5000 Ω
(17)19-109	1	5000 Ω control with SPST switch
(18)10-52	1	2000 Ω tab mount
10-57	2	10 KΩ tab mount

SWITCHES

PART No.	PARTS Per Kit	DESCRIPTION
(19)60-1	1	SPST slide
60-2	3	DPDT slide
(20)63-445	1	5-position 1-wafer rotary
(21)63-446	1	6-position 2-wafer rotary

COILS-TRANSFORMERS

Coils

PART No.	PARTS Per Kit	DESCRIPTION
(22)45-39	1	RF choke
(23)40-607	1	19 kHz oscillator
40-608	2	38 kHz doubler and buffer
40-610	2	Low-pass input and output filter
40-611	1	Low-pass center-leg filter
40-612	1	100 MHz oscillator
(24)40-609	1	19 kHz phasing

Transformers

PART No.	PARTS Per Kit	DESCRIPTION
(25)52-80	2	38 kHz balanced modulator
54-117-24	1	Power

GROMMETS-INSULATORS-CLAMPS-CLIPS

PART No.	PARTS Per Kit	DESCRIPTION
(26)73-43	2	3/8" plastic grommet
73-45	1	1/2" plastic grommet
(27)73-20	1	Red test clip insulator
73-21	1	Black test clip insulator
(28)75-71	1	Line cord strain relief
75-30	1	Line cord strain relief *(for round line cord)
(29)260-1	4	Alligator clip
(30)260-7	1	Coil mounting clip
260-8	1	Clothespin antenna clip
(31)260-29	2	Crystal clip

*This strain relief is to be used in areas, mainly outside of the U.S.A., where 2 or 3-wire round line cords are required.

CONNECTORS-PLUG-SOCKETS-STRIPS

PART No.	PARTS Per Kit	DESCRIPTION
(32)432-1	1	Female connector
(33)432-3	2	Male chassis connector
(34)438-10	1	300 Ω twin lead plug
(35)434-77	5	Wafer 9-pin tube socket
(36)434-36	1	Ceramic 9-pin tube socket
(37)434-74	2	Crystal socket
(38)434-38	1	Output socket
434-23	1	Lamp socket
(39)431-15	3	1-lug terminal strip
(40)431-50	1	1-lug terminal strip
431-14	1	2-lug terminal strip
(41)431-12	1	4-lug terminal strip
(42)431-40	1	4-lug terminal strip
431-11	1	5-lug terminal strip
431-55	2	6-lug terminal strip

CRYSTALS-DIODES-LAMPS-TUBES

PART No.	PARTS Per Kit	DESCRIPTION
(43)404-245	1	5.35 MHz crystal
(44)404-244	1	19 kHz crystal
(45)56-26	2	Crystal diode
(46)57-27	1	Silicon diode
412-2	1	120 volt 3-watt lamp
(47)412-15	1	Neon pilot lamp (NE-2H)
411-68	1	6AN8 tube
411-114	1	6AU8 tube
411-25	3	12AU7 tube
411-24	1	12AT7 tube

CABLE-SLEEVING-WIRE

PART No.	PARTS Per Kit	DESCRIPTION
347-2	1	300 Ω twin lead
343-2	1	Coaxial cable
89-23	1	Line cord with plug
346-1	1	Sleeving
340-8	1	Bare wire
344-52	1	Red wire
344-53	1	Orange wire
344-55	1	Green wire
344-59	1	White wire
344-56	1	Blue wire
344-54	1	Yellow wire
344-50	1	Black wire

NOTE: The black wire is extra and is to be used if additional wire is needed. For instance, you may possibly cut one of the lengths too short. If this should occur, use the black wire for this entire length instead of splicing two pieces together.

PART No.	PARTS Per Kit	DESCRIPTION
HARDWARE		
#3 Hardware		
(48) 250-49	12	3-48 x 1/4" screw
(49) 250-133	2	3-48 x 7/16" bronze screw
(50) 250-311	1	3-48 x 5/8" screw
(51) 252-1	15	3-48 nut
(52) 254-7	15	#3 lockwasher
#6 Hardware		
(53) 250-270	4	6-32 x 3/8" black screw
(54) 250-56	17	6-32 x 1/4" screw
(55) 250-229	14	6-32 x 1/4" phillips screw
(56) 250-89	3	6-32 x 3/8" screw
(57) 250-162	4	6-32 x 1/2" screw
(58) 250-365	4	#6 x 1/4" sheet metal screw
(59) 250-8	10	#6 x 3/8" sheet metal screw
(60) 252-3	18	6-32 nut
(61) 254-1	33	#6 lockwasher
(62) 259-1	7	#6 large solder lug
(63) 259-6	1	#6 small solder lug
(64) 250-535	4	6-32 decorative head screw
(65) 250-304	4	6-32 mounting stud-spacer
#8 Hardware		
(66) 250-137	2	8-32 x 3/8" screw
(67) 252-4	2	8-32 nut
(68) 253-9	2	#8 flat washer
(69) 254-2	2	#8 lockwasher
Other Hardware		
(70) 250-3	3	4-40 x 3/16" screw
(71) 254-9	3	#4 lockwasher
(72) 252-7	6	Control nut
(73) 254-4	3	Control lockwasher
(74) 259-10	2	Control solder lug
(75) 253-10	4	Control flat washer
(76) 252-32	1	Push-on speednut
(77) 455-50	5	Knob bushing

PART No.	PARTS Per Kit	DESCRIPTION
METAL PARTS		
(78) 200-486-1	1	Chassis
(79) 203-480-1	1	Front panel
(80) 203-481-1	1	Rear panel
(81) 90-350-4	2	Cabinet half-shell
(82) 204-774-1	1	Left siderail
(83) 204-775-1	1	Right siderail
(84) 204-759-1	4	Siderail end cap
(85) 206-341	1	Oscillator shield
(86) 206-342	1	Oscillator shield cover
(87) 206-343	1	Attenuator shield
(88) 206-344	2	Attenuator shield divider
(89) 210-35	1	Bezel
GENERAL		
75-90	1	Insulating paper
(90) 206-3	1	Tube shield
(91) 211-33	2	Handle
(92) 261-30	2	Line cord retainer
(93) 261-28	4	Foot
(94) 413-10	1	Red lens
(95) 462-245	5	Knob
(96) 481-1	1	Capacitor mounting wafer
(97) 391-34	1	Blue and white label
(98) 490-1	1	Plastic alignment tool
(99) 490-5	1	Nut starter
597-260	1	Parts Order Form
597-308	1	Kit Builders Guide
	1	Manual (See front cover for part number.)
		Solder

NOTE: The prices shown on the separate "Heath Parts Price List" apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering (Michigan residents add 4% sales tax) to cover insurance, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rate of exchange.

GENERATOR ALIGNMENT

Before starting the alignment procedure, carefully study the operation of each control and switch as described in Figure 1 (fold-out from this page).

EQUIPMENT REQUIRED

1. AC VTVM.
2. FM tuner or receiver.
3. Oscilloscope.

Refer to Figure 2 (fold-out from Page 39) for the adjustment locations and to Figure 3 (fold-out from Page 39) for the test point locations. If you do not obtain the proper results in the following tests, or if improper operation occurs, refer to the In Case Of Difficulty section on Page 43.

19 kHz OSCILLATOR ADJUSTMENT

( ) Turn on the Generator with the PILOT LEVEL control. The PWR ON lamp and all tube filaments should glow. The 3 watt lamp should not light. If everything appears normal, proceed with the following steps.

( ) Place the FUNCTION switch in the AUDIO/MONO FM position and the FREQUENCY switch in the 5000 Hz position. Allow the Generator and test equipment to reach normal operating temperature.

( ) Connect either an AC VTVM or Oscilloscope (or both) to test point TP-1. A 19 kHz waveform with an amplitude of at least 1 volt rms should be present.

( ) Adjust the slug in coil L1 clockwise (viewed from the bottom of the chassis) until the 19 kHz oscillator stops oscillating as indicated by a sharp decrease in the voltage or oscilloscope signal at test point TP-1.

( ) Adjust the slug in coil L1 counterclockwise until the oscillator just starts to oscillate. Now turn the slug one full turn counterclockwise. If the voltage reading is greater than 3 volts rms, continue to turn the coil counterclockwise until the voltage decreases to 3 volts rms. If you cannot adjust the voltage down to 3 volts rms, or if the reading is below 1 volt rms, refer to the In Case Of Difficulty section.

AUDIO OSCILLATOR ADJUSTMENT

( ) Connect the AC VTVM or Oscilloscope (or both) to the COMPOSITE SIG/AUDIO connector on the front panel.

( ) Turn the FUNCTION LEVEL control fully clockwise.

( ) Adjust the OSC ADJUST control (top of chassis) until oscillation occurs as shown by a reading on the AC VTVM or a waveform on the oscilloscope.

( ) Turn the FREQUENCY switch to the 19 kHz position. The voltage should be between .95 and 2 volts rms. Note the voltage reading. Now turn the FREQUENCY switch back to the 5000 Hz position and adjust the OSC ADJUST control until the same voltage reading, as noted in the 19 kHz position, is obtained.

( ) Turn off the Generator and disconnect the AC VTVM and Oscilloscope.

AUDIO OSCILLATOR CALIBRATION

The audio oscillator calibration requires temporarily connecting two precision resistors in its circuit. After calibration, the oscillator circuit will be returned to its normal configuration.

Refer to Figure 3 for the following steps.

( ) Disconnect the white wire at lug 2 of trimmer capacitor BF. Move this wire up out of the way.

( ) Unsolder the lead of the 1000 pf silver mica capacitor connected to lug 6 on wafer B of switch AA.

( ) Locate the 4590 Ω and the 13.5 KΩ precision resistors. Twist together and solder the leads at one end of these precision resistors.

( ) Tack-solder the twisted-together leads to test point TP-2 (lug 2 of trimmer capacitor BF).

( ) Tack-solder the free lead of the 13.5 KΩ precision resistor to lug 1 of trimmer capacitor BF.

( ) Tack-solder together the free lead of the 4590 Ω precision resistor and the free lead of the 1000 pf silver mica capacitor as shown in Figure 3. This is test point TP-3.

( ) Connect the horizontal input of the oscilloscope to test point TP-1. Set the oscilloscope horizontal sweep control to the external sweep position.

( ) Connect the vertical input of the oscilloscope to the COMPOSITE SIG/AUDIO output connector on the front panel.

( ) Turn on the Generator and adjust the FREQ ADJUST trimmer, from the top of the chassis, until the oscilloscope trace becomes a circle (a type of Lissajous figure) indicating a beat of 1 Hz or less.

( ) Turn off the Generator and disconnect the oscilloscope leads. Then remove the precision resistors.

( ) Permanently reconnect the white wire to lug 2 of trimmer capacitor BF.

( ) Permanently reconnect the 1000 pf resin capacitor to lug 6 on wafer B of switch AA.

38 kHz SYNC ADJUSTMENT

( ) Connect the oscilloscope or AC VTVM to test point TP-4.

( ) Turn on the generator.

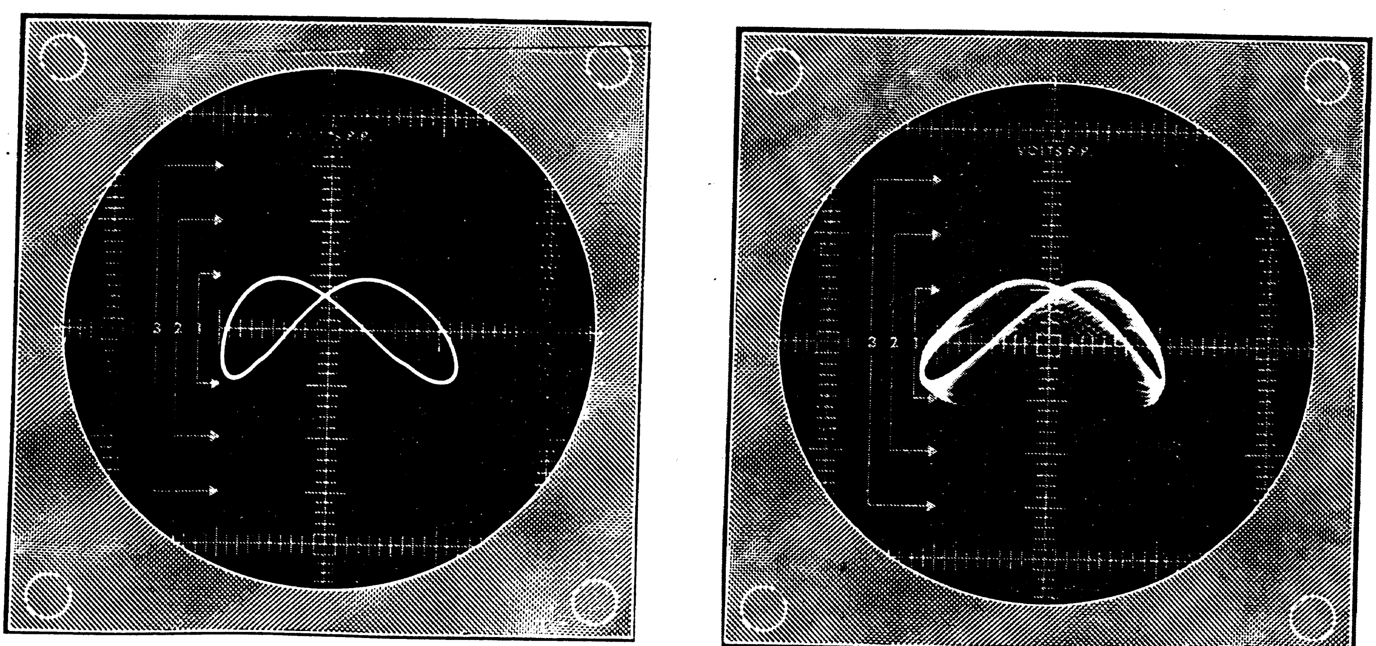
( ) Adjust the slugs in coils L2 and L3 for a maximum voltage indication. This voltage should have an amplitude of 1 to 2 volts rms.

( ) Disconnect the oscilloscope or AC VTVM that is connected to test point TP-4.

( ) Connect the oscilloscope horizontal input to test point TP-1 and the vertical input to the COMPOSITE SIG/AUDIO connector on the front panel.

( ) Turn on the Generator and place the FREQUENCY switch in the 38 kHz position.

( ) Adjust the 38 kHz SYNC trimmer capacitor (on the rear panel) until a steady trace appears on the oscilloscope. This trimmer should be adjusted to the lowest capacitance necessary to maintain a steady trace on the oscilloscope. See Figure 4. NOTE: The trimmer capacitance is decreased by turning the screw counterclockwise.



CORRECT

INCORRECT

Figure 4

( ) Connect the AC VTVM to the COMPOSITE SIG/AUDIO connector and measure the voltage obtained with the FREQUENCY switch in the 19 kHz position and then in the 5000 Hz position. The voltage should be the same for both switch positions. If the voltage is not the same, turn the FREQUENCY switch to the 5000 Hz position and readjust the OSC ADJUST control until the voltage readings are identical.

NOTE: If there is any variation in the amplitude of the waveform for any switch position (amplitude modulation), leave the switch in that position and turn the OSC ADJUST control slightly clockwise to stabilize the waveform.

BALANCED MODULATOR ADJUSTMENT

( ) Turn the PILOT LEVEL control fully counterclockwise (but do not turn the Generator off) and turn the FUNCTION switch to the PHASE TEST position. Disconnect the oscilloscope horizontal input lead from test point TP-1. Set the oscilloscope controls for internal sweep.

( ) Remove the 12AU7 tube from socket V1.

( ) Preset the BALANCE control, on the rear panel, to its center-of-rotation position.

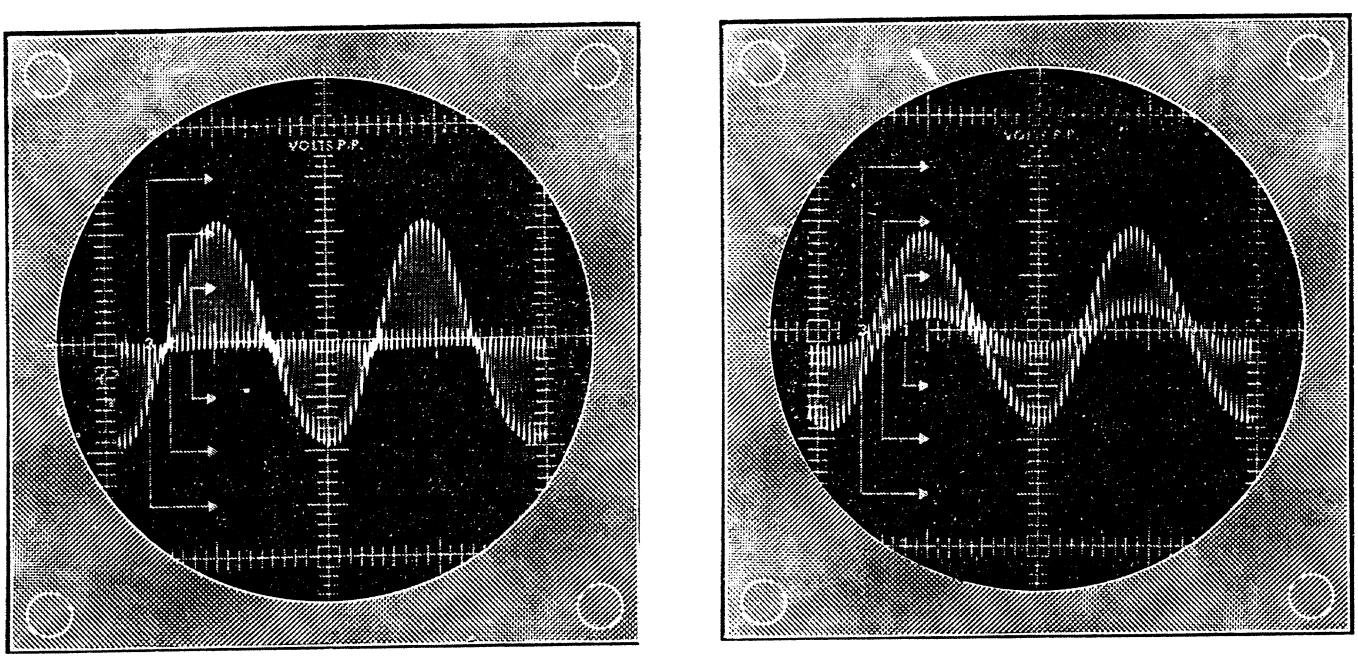
( ) Connect the AC VTVM and the oscilloscope to the COMPOSITE SIG/AUDIO connector on the front panel. Alternately adjust transformers T2, T3, and the BALANCE control for a minimum voltage indication. This minimum voltage should be between approximately .01 and .05 volts rms.

( ) Replace the 12AU7 tube in socket V1. Leave the oscilloscope connected to the COMPOSITE SIG/AUDIO connector.

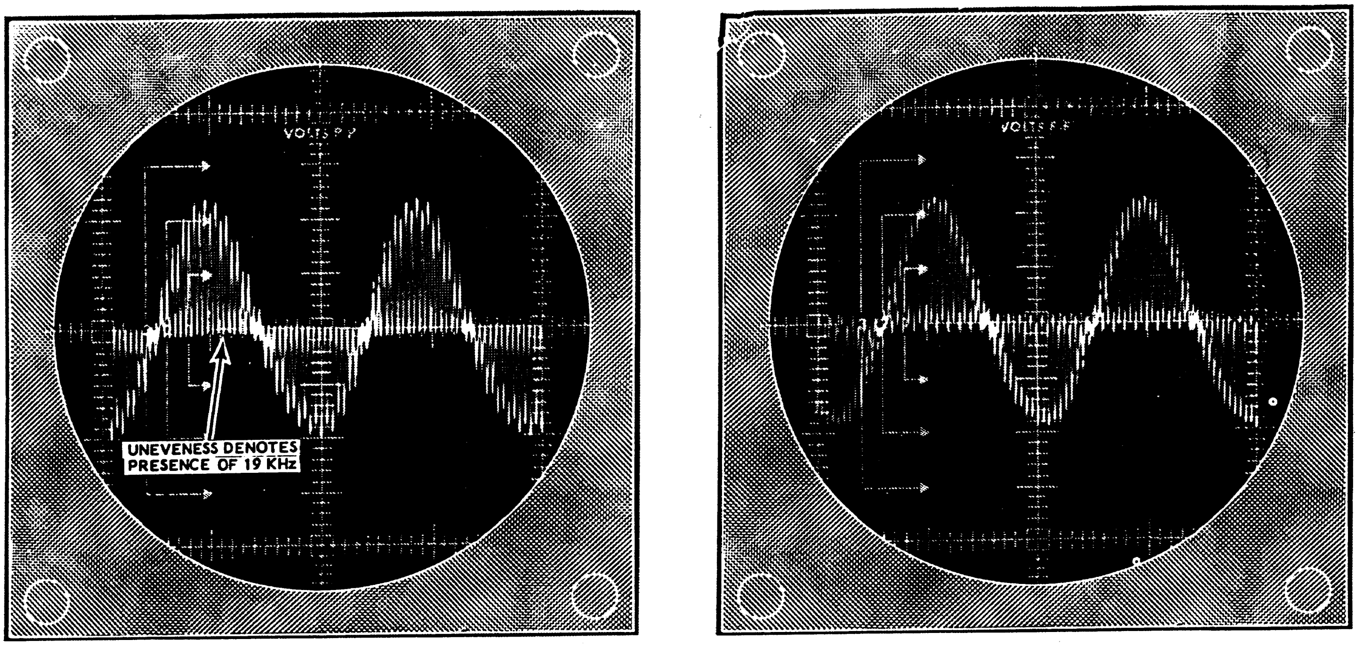
PILOT LEVEL ADJUSTMENT

( ) Turn the FREQUENCY switch to the 1000 Hz position and adjust the slugs in coils L5, L6, and L7 until the waveform shown in Figure 5 is obtained.

( ) Connect the oscilloscope to test point TP-5 and turn the PILOT LEVEL control fully clockwise.



CORRECT Figure 5 INCORRECT



CORRECT INCORRECT

Figure 6

( ) Adjust the slug in coil L4 for minimum height of the 19 kHz signal at the center of the waveform. See Figure 6.

( ) Adjust the PILOT LEVEL trimmer capacitor on the rear panel, for minimum capacitance (maximum counterclockwise rotation without the adjustment screw becoming loose).

( ) Turn the FUNCTION switch to the LEFT CHANNEL position.

( ) Adjust the PILOT LEVEL trimmer capacitor, on the rear panel, to obtain a 19 kHz signal at the center of the waveform. The amplitude of the 19 kHz signal should be equal to 10% of the entire composite signal pattern. See Figure 7.

( ) Turn the FUNCTION switch to the PHASE TEST position and recheck the adjustment of coil L4. Readjust the slug in coil L4 if necessary.

( ) Again turn the FUNCTION switch to the LEFT CHANNEL position and recheck the setting of the PILOT LEVEL trimmer capacitor.

( ) Turn the FUNCTION switch to the RIGHT CHANNEL position. The 19 kHz signal at the center of the waveform should again be only 10% of the entire composite signal pattern. See Figure 7.

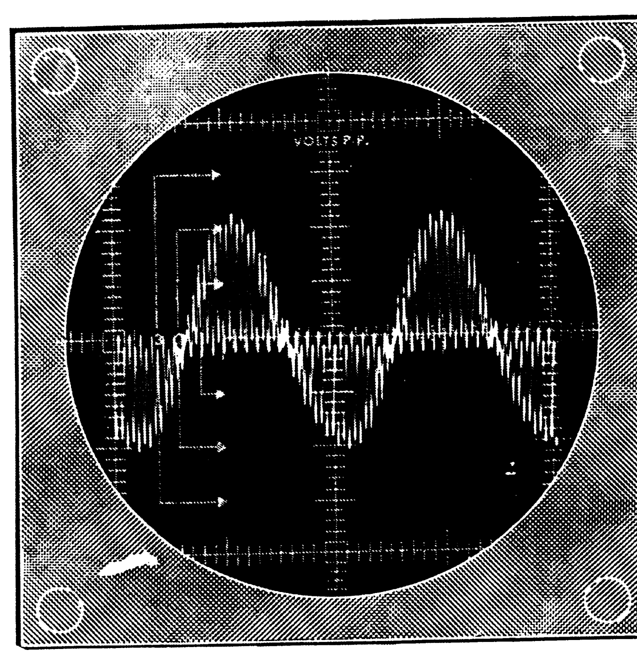


Figure 7

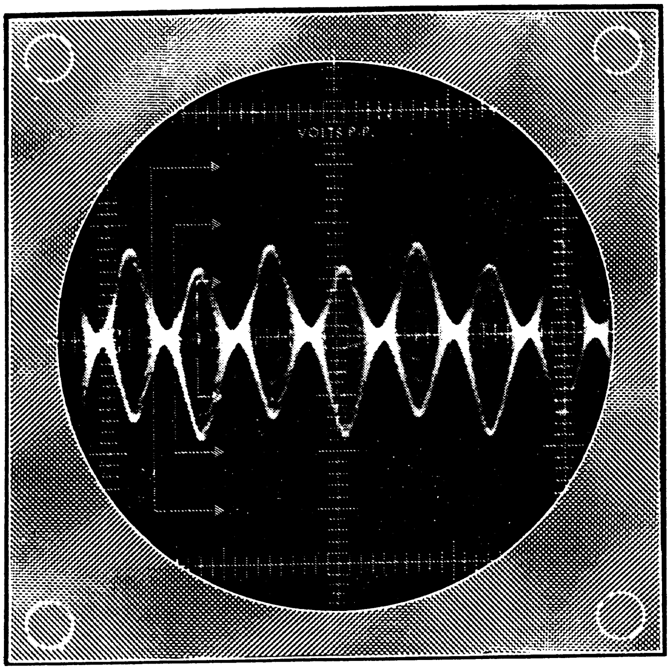


Figure 8A
PHASE TEST

OPERATION CHECK

( ) Turn the FUNCTION switch to the PHASE TEST position.

( ) Connect the oscilloscope external sync input to test point TP-1 and the vertical input to the COMPOSITE SIG/AUDIO connector on the front panel.

( ) Set the oscilloscope for external sync and the oscilloscope sweep rate to the 10-100 kHz range.

( ) Refer to the oscilloscope patterns shown in Figures 8A, 8B, and 8C. Then compare these patterns to the ones you obtain on your oscilloscope with the FUNCTION switch in the PHASE TEST, LEFT CHANNEL, and RIGHT CHANNEL positions.

( ) Disconnect the oscilloscope leads.

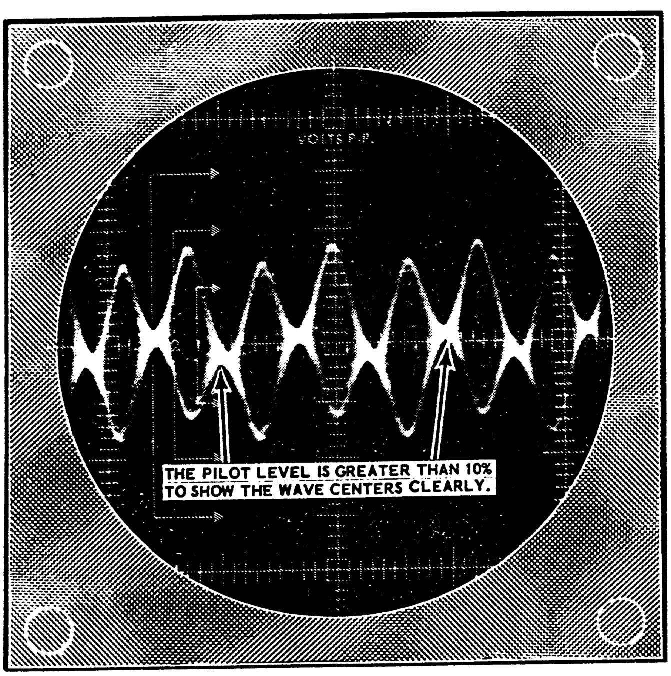


Figure 8B
LEFT CHANNEL

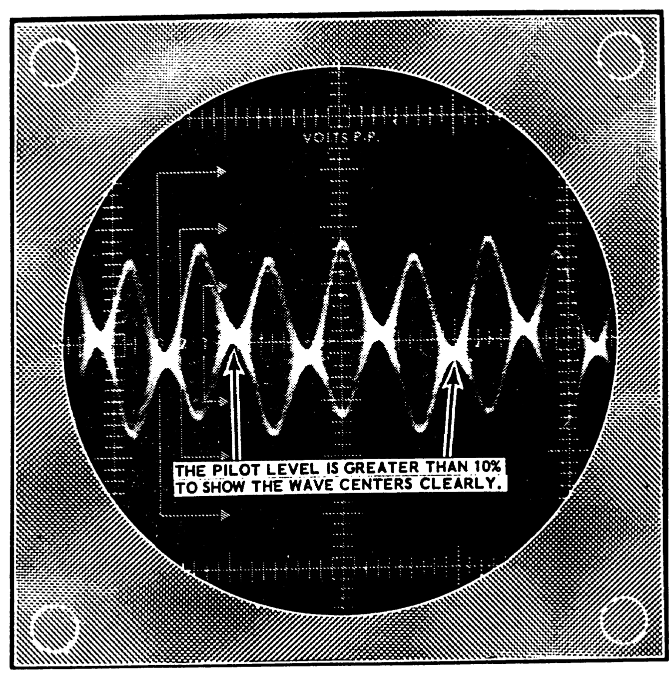


Figure 8C
RIGHT CHANNEL

MODULATION LEVEL CHECK

( ) Turn the FUNCTION switch to the AUDIO/ MONO FM position and turn the MOD ADJUST control fully counterclockwise.

( ) Connect the AC VTVM to test point TP-6, and turn the FREQUENCY switch to the 1000 Hz position.

( ) Adjust the MOD ADJUST control for a reading of .95 volts rms (2.7 volts peak-to-peak). (NOTE: This adjustment can also be made by comparison, using a known standard of 75 kHz deviation, or by using a deviation meter especially designed for this purpose.)

( ) Disconnect the AC VTVM from test point TP-6.

RF OSCILLATOR ADJUSTMENT

( ) Set the RF FREQ ADJUST control to its mid-range position.

( ) Turn on and tune an FM tuner or FM radio to 100 MHz.

( ) Adjust the slug in coil L8 until the RF output signal from the Generator can be heard coming from the FM tuner or radio. NOTE: If you cannot hear the RF signal from the Generator, plug the previously made-up twin lead cable into the RF OUT socket on the front panel of the Generator. Connect the other end of the twin lead cable to the antenna input terminals on the FM tuner or radio.

( ) Turn the RF FREQ ADJUST control on the front panel of the Generator through its full range. The RF output signal from the Generator should shift in frequency approximately plus and minus 2 MHz.

This completes the Alignment of your FM Stereo Generator. The alignment should be rechecked after a few weeks of use since it may change slightly due to aging of the components. Proceed to the Final Assembly section.

TYPE OF MULTIPLEX CIRCUIT*	ADJUSTMENT BEING MADE	CONNECT OSCILLOSCOPE TO	PI CC SE
I, II, III, IV	SCA filter adjustment.	Output of SCA filter.	Mi
I	Peaking 19 kHz and 38 kHz stages.	Output of 38 kHz doubler circuit.	Ma
II	Synchronizing 19 kHz oscillator and peaking 38 kHz doubler.	Output of 38 kHz doubler circuit.	Ma
III	Peaking 19 kHz and 38 kHz stages.	Output of 38 kHz doubler circuit.	Ma
	Synchronizing 38 kHz oscillator stages.	Output of 38 kHz oscillator circuit or left channel output.	Mi as
IV	Peaking 19 kHz amplifier stages.	Output of last 19 kHz amplifier stage.	Ma
	Synchronizing 38 kHz oscillator stages.	Output of 38 kHz oscillator or left channel output.	Mi as
I, II, III, IV	Adjusting phase of reinserted carrier to same phase as subcarrier.	Left channel output.	Ma
	Adjusting Separation control for maximum separation.	Left channel output.	Ma
I, II, III, IV	Adjusting left channel 19 kHz trap.	Left channel output.	Min
	Adjusting right channel 19 kHz trap.	Right channel output.	Min
	Adjusting left channel 38 kHz trap.	Left channel output.	Min
	Adjusting right channel 38 kHz trap.	Right channel output.	Min

NOTES:

(1) In oscillator type circuits, the oscillator may have to be shut off in order to correctly make this adjustment. This can usually be done by shorting the grid of the oscillator to ground, or in some cases by removing the tube.

(2) Some SCA filters may be stagger-tuned. In this case, refer to appropriate manufacturer's instructions for this adjustment.

* See Figure 11.

(3) If there are separate coils for the
indicator, they may be peaked at this

(4) Observe the scope to make sure the 3
output is synchronized with the 19
sync signal, as evidenced by an amp
difference of adjacent peaks, an inc
in amplitude or by listening to the o

MULTIPLEX ALIGNMENT CHART

SCOPE TO	PILOT LEVEL CONTROL SETTING	SET GENERATOR FUNCTION SWITCH TO	SET GENERATOR FREQUENCY SWITCH TO	ADJUSTMENT MADE IN TU
	Minimum	AUDIO and MONO FM	SCA (6) (9)	Adjust SCA filter coil for m put. (1) (2)
bler circuit.	Maximum (6)	LEFT CHANNEL	1000 Hz	Peak all 19 kHz and 38 kHz
bler circuit.	Maximum	LEFT CHANNEL	1000 Hz	Sync the 19 kHz oscillator kHz pilot signal. Then peal doubler circuit. (3) (4)
bler circuit.	Maximum (6)	LEFT CHANNEL	1000 Hz	Peak the 19 kHz and 38 kHz stages. (3)
illator cir- utput.	Minimum, or as low as possible.	LEFT CHANNEL	1000 Hz	Sync the 38 kHz oscillator w kHz sync signal. (4) (7)
z ampli-	Maximum (6)	LEFT CHANNEL	1000 Hz	Peak the 19 kHz amplifier st
illator t.	Minimum, or as low as possible.	LEFT CHANNEL	1000 Hz	Sync the 38 kHz oscillator w kHz sync signal. (4) (7)
	Maximum	LEFT CHANNEL	1000 Hz	Phase of 38 kHz reinserted for maximum audio output. (
	Maximum	RIGHT CHANNEL	1000 Hz	Adjust separation control fo mum audio output.
	Minimum	AUDIO and MONO FM	19 kHz	Adjust left channel trap for output. (7) (8)
.	Minimum	AUDIO and MONO FM	19 kHz	Adjust right channel trap fo output. (7) (8)
	Minimum	AUDIO and MONO FM	38 kHz	Adjust left channel trap for output. (7) (8)
.	Minimum	AUDIO and MONO FM	38 kHz	Adjust right channel trap fo output. (7) (8)

parate coils for the stereo nay be peaked at this time.

pe to make sure the 38 kHz ronized with the 19 kHz evidenced by an amplitude jacent peaks, an increase by listening to the output.

(5) This should be done according to specific manufacturer's recommendations. This is usually done by making a slight change in the tuning of a 19 kHz or 38 kHz coil located in either an amplifier or oscillator circuit.

(6) Reduce the level if the scope indicates that the stages are being overdriven.

(7) If an automatic stereo switching c used, lock per the manufacturer's mended method in the absence of t pilot signal.

(8) In some circuits these traps ma adjustable.

(9) Place the SCA FREQUENCY switc rear apron, to the frequency spec the SCA filter coil used.

IGNMENT CHART

	SET GENERATOR FUNCTION SWITCH TO	SET GENERATOR FREQUENCY SWITCH TO	ADJUSTMENT MADE IN TUNER
	AUDIO and MONO FM	SCA (6) (9)	Adjust SCA filter coil for minimum output. (1) (2)
	LEFT CHANNEL	1000 Hz	Peak all 19 kHz and 38 kHz coils. (3)
	LEFT CHANNEL	1000 Hz	Sync the 19 kHz oscillator with the 19 kHz pilot signal. Then peak the 38 kHz doubler circuit. (3) (4)
	LEFT CHANNEL	1000 Hz	Peak the 19 kHz and 38 kHz amplifier stages. (3)
s low	LEFT CHANNEL	1000 Hz	Sync the 38 kHz oscillator with the 38 kHz sync signal. (4) (7)
	LEFT CHANNEL	1000 Hz	Peak the 19 kHz amplifier stages. (3)
s low	LEFT CHANNEL	1000 Hz	Sync the 38 kHz oscillator with the 19 kHz sync signal. (4) (7)
	LEFT CHANNEL	1000 Hz	Phase of 38 kHz reinserted carrier for maximum audio output. (5)
	RIGHT CHANNEL	1000 Hz	Adjust separation control for minimum audio output.
	AUDIO and MONO FM	19 kHz	Adjust left channel trap for minimum output. (7) (8)
	AUDIO and MONO FM	19 kHz	Adjust right channel trap for minimum output. (7) (8)
	AUDIO and MONO FM	38 kHz	Adjust left channel trap for minimum output. (7) (8)
	AUDIO and MONO FM	38 kHz	Adjust right channel trap for minimum output. (7) (8)

(5) This should be done according to specific manufacturer's recommendations. This is usually done by making a slight change in the tuning of a 19 kHz or 38 kHz coil located in either an amplifier or oscillator circuit.

(6) Reduce the level if the scope indicates that the stages are being overdriven.

(7) If an automatic stereo switching circuit is used, lock per the manufacturer's recommended method in the absence of the 19 kHz pilot signal.

(8) In some circuits these traps may not be adjustable.

(9) Place the SCA FREQUENCY switch, on the rear apron, to the frequency specified for the SCA filter coil used.

APPLICATIONS

This section gives a detailed description of how your Generator can be used to align a stereo FM tuner. The IF and detector sections are of a general nature and can be used with most FM tuners and receivers. For FM front end alignment, you should refer to the alignment information in the service manual for the tuner being aligned.

The multiplex alignment section contains several preparatory steps and a Multiplex Alignment Chart is arranged to accommodate each of the four basic types of multiplex circuits. Although this multiplex alignment procedure refers to the alignment of a stereo FM tuner, it will also apply to the alignment of a separate multiplex adapter used with an FM tuner. The main difference in this case would be that the output would be taken from the COMPOSITE SIG/AUDIO connector instead of the RF OUT connector.

IF ALIGNMENT

( ) Connect the RF OUT connector of the Generator to the antenna input terminals of the tuner.

( ) Use a demodulator probe to connect the vertical input of the oscilloscope to the input of the last limiter circuit.

( ) Loosely couple the IF MARKER output from the Generator to the first IF stage in the tuner to produce a 10.7 marker signal.

( ) Adjust the oscilloscope for a 60 Hz line sweep.

( ) Set the Generator FUNCTION switch to the AUDIO and MONO FM position.

( ) Turn on the tuner and tune in the Generator signal on the tuner at approximately 100 MHz.

( ) When you have tuned in the Generator signal, place the Generator FUNCTION switch in the RF SWEEP-IF MARKER position. Turn the FUNCTION LEVEL control fully clockwise. A response curve similar to Figure 9 should appear on the oscilloscope. Adjust the IF transformers for the best response curve as described in the tuner manual. Turn off the tuner and connect the vertical input of the oscilloscope to the output of the tuner detector stage.

( ) Disconnect the IF marker cable.

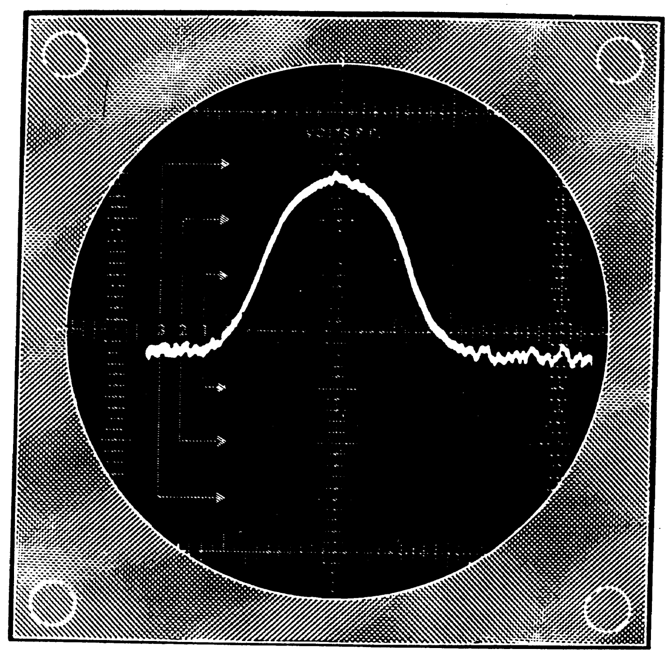


Figure 9

DETECTOR ALIGNMENT

( ) Connect the COMPOSITE SIG/AUDIO output of the Generator to the horizontal input of the oscilloscope. Set the oscilloscope for external sweep. Connect the vertical input of the oscilloscope to the output of the tuner detector circuit.

( ) Turn on the tuner. A response curve similar to Figure 10 should appear on the oscilloscope.

( ) Adjust the detector coil as described in the tuner manual for the best response curve.

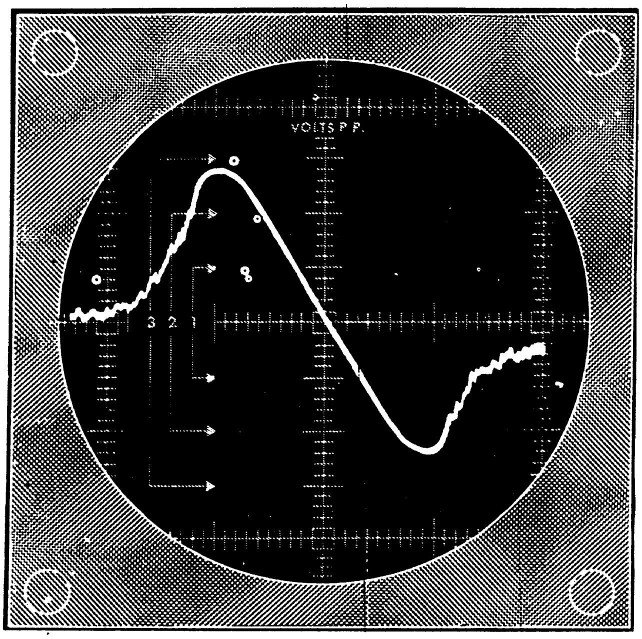


Figure 10

FRONT END ALIGNMENT

( ) Connect the Generator's IF MARKER output to the antenna terminals of the tuner.

( ) Place the FUNCTION switch in the RF SWEEP IF MARKER position.

( ) RF marker signals now can be tuned in at 90.95 MHz, 96.3 MHz, 101.65 MHz, and 107 MHz for adjustment of the RF and oscillator coils in the tuner front end.

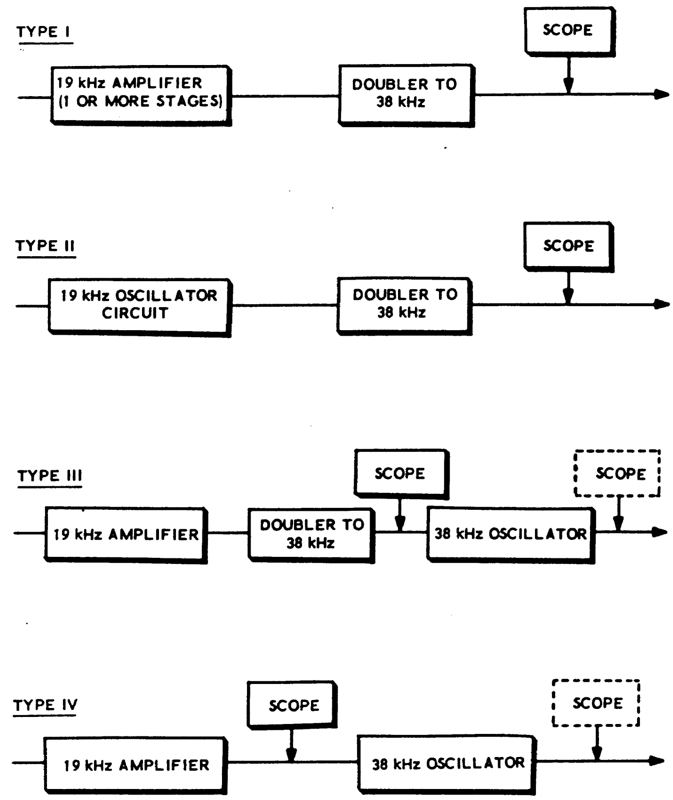


Figure 11

FM STEREO MULTIPLEX ALIGNMENT

Figure 11 shows the four different types of multiplex circuits in simplified block diagram form. Refer to this Figure and determine which of these types of multiplex circuit is in the tuner you are about to align. Then align the tuner by following the instructions in the FM Multiplex Alignment Chart. Refer also to the alignment instructions in the tuner service manual.

Refer to the "Type of Multiplex Circuit" column (fold-out from Page 40). NOTE: Make use of the same first step, SCA filter adjustment. Then, perform only one of the next four steps; use the step that corresponds to the type of multiplex circuit you are aligning.

( ) Set the Generator front panel controls as follows:

PILOT LEVEL - as directed in the chart.

FUNCTION LEVEL - fully clockwise.

FREQUENCY - as directed in the chart.

FUNCTION - as directed in the chart.

RF FREQ ADJUST - adjust to produce a signal in the tuner at a clear spot in the FM band near 100 MHz.

( ) Set the tuner controls as follows:

Function - stereo.

Phase Control (if provided) - center of its range.

Separation Control (if provided) - center of its range.

AFC - off.

Squelch (if available) - off.

Tuning - tuned to Generator output near 100 MHz.

( ) Connect the 300 Ω cable from the RF OUT connector on the Generator to the tuner antenna terminals. For adapters only, connect the coaxial cable from the composite SIG/AUDIO connector to the input of the adapter.

( ) Allow the Generator and tuner to thoroughly warm up before performing the alignment. Check and be sure that the FM tuner is still tuned to the Generator output.

IN CASE OF DIFFICULTY

Refer to the Kit Builders Guide for Service and Warranty information.

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the builder.

2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Soldering section of the Kit Builders Guide.

3. Check to be sure that all tubes are in their proper locations. Make sure that all tubes light up properly.

4. Check the tubes with a tube tester or by substitution of tubes of the same types that are known to be good.

5. Check the values of the parts. Be sure the proper parts have been wired into each circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.

6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring.

7. If after careful checks the trouble is still not located, and a suitable meter is available, check resistance and voltage readings against those shown in Figures 18 and 19 on Pages 54 and 55. NOTE: All voltage readings were taken with an 11 megohm input vacuum tube voltmeter. Voltage and resistances may vary as much as ±10%.

8. A review of the Circuit Description will help you determine where to look for trouble.

In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover.

Troubleshooting Chart

SYMPTOM	CAUSE	CURE
Neon lamp does not glow.	1. Generator line cord plug not inserted into AC outlet. 2. Neon lamp wires shorted. 3. Power supply wired wrong. 4. Defective power supply components.	1. Plug unit into AC outlet. 2. Check wiring of neon lamp. 3. Check power supply wiring and correct any errors. 4. Replace defective components.
Tube filaments do not glow.	1. Incorrect filament wiring. 2. Defective tube.	1. Correct filament wiring.
3 watt lamp glows.	1. Incorrect lamp wiring. 2. Shorted capacitor C4.	1. Correct the lamp wiring. 2. Replace capacitor C4.
19 kHz waveform not present at TP-1.	1. 19 kHz oscillator V2A not oscillating.	1. Check all wiring around tube socket V2. Also check tube V2. 2. Make sure the 19 kHz crystal is in its socket. 3. Check for open coil L1 or other defective components.
19 kHz voltage at TP-1 is low.	1. Incorrect operation of 19 kHz oscillator tube V2A.	1. Check for correct parts values and wiring around tube socket V2.
Osc Adjust control has little or no effect.	1. Defective audio oscillator or incorrect control wiring. 2. Defective audio amplifier or incorrect wiring of Function switch.	1. Recheck all wiring around tube socket V1 and check tube V1. 2. Recheck all wiring around tube socket V5 and check tube V5. 3. Recheck Function switch wiring. 4. Check Function Level control wiring.
19 kHz voltage at Composite Sig/Audio connector is lower than .95 volts rms.	1. Incorrect wiring of Frequency switch. 2. Incorrect wiring of 390 $\mu\mu$f mica capacitor C1.	1. Recheck wiring of Frequency switch. 2. Recheck wiring of capacitor C1.
Adjustment of Freq Adjust trimmer has no effect.	1. Incorrect wiring of Freq Adjust trimmer or Frequency switch. 2. Incorrect scope connections.	1. Check wiring of Freq Adjust trimmer and Frequency switch. 2. Recheck scope connections.

SYMPTOM	CAUSE	CURE
Adjustment of 38 kHz Sync trimmer has no effect.	1. Incorrect wiring of 38 kHz Sync trimmer of Frequency switch. 2. Incorrect wiring of tube socket V2 and associated circuitry.	1. Check wiring of 38 kHz Sync trimmer and Frequency switch. 2. Check wiring around tube socket V2. Also check L2 and L3 for open circuits, and other components for short circuits.
Not able to obtain voltage minimum with adjustment of T2, T3, and Balance control.	1. Incorrect wiring of tube socket V4 and associated circuitry. 2. Defective diodes D2 or D3. 3. Defective coils T2, T3, L5, L6, or L7. 4. Tube V4 defective.	1. Check wiring of tube socket V4. 2. Check diodes. 3. Check coils for open circuits or short circuits. 4. Replace tube V4.
Waveform of Figure 5 cannot be obtained.	1. Improper adjustment of T2 and T3. 2. Faulty coils L5, L6, or L7 or improper wiring.	1. Recheck balance adjustment of Balance control, T2, and T3. 2. Check L5, L6, and L7 for short circuits or open circuits. Also check wiring around them.
Unable to obtain proper waveform with adjustment of L4 as in Figure 6.	1. Coils L2 or L3 wired wrong. 2. Diodes D2 and D3 reversed. 3. Tube socket V4 incorrectly wired. 4. Defective tube V4A.	1. Check wiring of L2 and L3. 2. Check wiring of diodes D2 and D3. 3. Check wiring of tube socket V4. 4. Check V4A.
Unable to obtain 10% value of 19 kHz as in Figure 7.	1. Incorrect wiring of Pilot Level trimmer. 2. Incorrect wiring of tube socket V3 or Pilot Level control.	1. Check wiring of Pilot Level trimmer capacitor. 2. Check wiring of tube socket V3 and Pilot Level control.
Unable to adjust Mod Adjust control properly.	1. Improper wiring of Function Level control. 2. Improper wiring of Mod Adjust control. 3. Improper wiring of tube socket V6.	1. Check wiring of control. 2. Check wiring of control. 3. Check wiring of tube socket V6.
Unable to hear RF output signal from the Generator.	1. Improper wiring of tube socket V6 or associated components. 2. Improper wiring of RF attenuator switches.	1. Check all wiring around tube socket V6. 2. Check wiring of RF attenuator switches.

SYMPTOM	CAUSE	CURE
Improper operation of RF Freq Adjust control.	1. Improper wiring of variable capacitor in RF compartment.	1. Check wiring of variable capacitor.
Unable to obtain 10.7 MHz IF marker or 90.95 MHz, 96.3 MHz, 101.65 MHz, or 107 MHz markers.	1. Improper wiring of tube socket V5B or Function switch.	1. Check wiring around tube socket V5B and around Function switch. 2. Check tube V5. Interchange with tube V1 or V3.

SPECIFICATIONS

RF Signal Output	
Center Frequency.	100 MHz adjustable by approximately ±2 MHz.
Pilot Modulating Frequency.	19 kHz ±2 Hz.
FM Modulation.	Left channel (stereo). Right channel (stereo). Phase test (left plus right channel in phase). Monophonic FM.
Deviation.	Adjustable to 75 kHz.
Sweep Rate.	60 Hz.
Sweep Width.	Adjustable to 750 kHz.
RF Attenuator Range.	60 db in 20 db steps.
Crystal-Controlled Markers.	10.7 MHz. 90.95 MHz. 96.30 MHz. 101.65 MHz. 107.00 MHz.
Composite Signal Output.	Left channel (stereo). Right channel (stereo). Phase test (left plus right channels, in phase).

Audio Output	400 Hz. 1000 Hz. 5000 Hz. 19 kHz 38 kHz. SCA (65 kHz or 67 kHz).
Maximum Distortion at 400, 1000, and 5000 Hz	5%.
Front Panel Controls	PILOT LEVEL and ON/OFF switch. FUNCTION LEVEL control. FUNCTION switch. FREQUENCY switch. RF ATTENUATOR switches. RF FREQ ADJUST control.
Rear Panel Adjustments	BALANCE control. 38 kHz SYNC trimmer. PILOT LEVEL trimmer. SCA FREQUENCY switch.
Chassis Adjustments	OSCILLATOR ADJUST. FREQUENCY ADJUST. MODULATION ADJUST.
Tube Complement	12AT7 - 19 kHz oscillator and 19 kHz doubler. 6AU8 - 19 kHz buffer and 38 kHz amplifier. 6AN8 - Reactance tube modulator and 100 MHz oscillator. 12AU7 - Audio oscillator. 12AU7 - Audio cathode follower and 19 kHz pilot amplifier. 12AU7 - Composite/audio amplifier and 5.35 MHz crystal oscillator.
Power Requirements	105-125 volts, 50/60 Hz AC, or 210-240 volts. 50/60 Hz AC, 35 watts.
Dimensions	5-3/8" high x 9-1/2" deep x 13-3/8" wide.
Net Weight	9 lbs.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

THEORY OF OPERATION

Operation of the FM Stereo Generator is similar to that of a simple stereo (multiplex) FM transmitter. To clearly understand the operation of the Generator, an understanding is needed of how an FM multiplex signal is developed in an FM transmitter. How this signal is used in an FM stereo receiver to provide stereo reception will also be explained. The following description contains a brief explanation of: an FM stereo transmitter; the Heathkit FM Stereo Generator; and an FM stereo receiver. Simplified Block Diagrams are provided for clarity. Figure 12 shows the complete FM-Multiplex Frequency Spectrum. It is included to help you understand the relationship of the various frequencies involved.

FM STEREO TRANSMITTER

Figure 13 is a simplified Block Diagram of an FM stereo transmitter. Two separate audio signals are applied to the matrix circuit. One of these signals represents the left channel (L) and the other the right channel (R). In Figure 13, a sine wave is applied to the matrix circuit as the left channel audio signal; no right channel signal is applied. (Even though the right channel signal input is zero, it is used as a reference point to develop output signals from the matrix circuit.) The matrix circuit combines the L and R signals into L+R and L-R signals. The L+R signal is the main channel and is applied directly to the mixer circuit. The L-R signal is the subchannel, and is combined with a 38 kHz subcarrier to provide an L-R double-sideband, suppressed-carrier signal. This is done in the 38 kHz balanced modulator circuit.

The 38 kHz subcarrier frequency is derived from a 19 kHz oscillator signal which is doubled to 38 kHz by the frequency doubler circuit. A small portion of the 19 kHz oscillator signal is also applied directly to the mixer circuit to be transmitted as a synchronizing signal for the receiver. This is known as a 19 kHz pilot signal. The 38 kHz double-sideband, suppressed-carrier signal from the 38 kHz balanced modulator is also applied to the mixer circuit.

The mixer circuit combines the L+R signal, the L-R double-sideband, suppressed-carrier signal, and the 19 kHz pilot signal to produce a modulating signal that contains (L+R) + (L-R suppressed carrier) + (19 kHz pilot). This composite signal is applied to the modulator of the FM transmitter. The resulting FM stereo signal is then transmitted.

STEREO GENERATOR

The Generator operation is similar to that of a FM multiplex transmitter. Since the important function of the Generator is to provide a multiplex signal for tuner alignment, it is possible to simplify the circuit and still obtain the desired results. This is done by obtaining the final (L+R) + (L-R) signal directly at the balanced modulator, thereby eliminating the mixer circuit used in the transmitter.

Figure 14 is a simplified Block Diagram of the FM Stereo Generator. A 19 kHz signal is generated in the 19 kHz oscillator section and is doubled to 38 kHz. In the 38 kHz balanced modulator, an audio signal from the audio

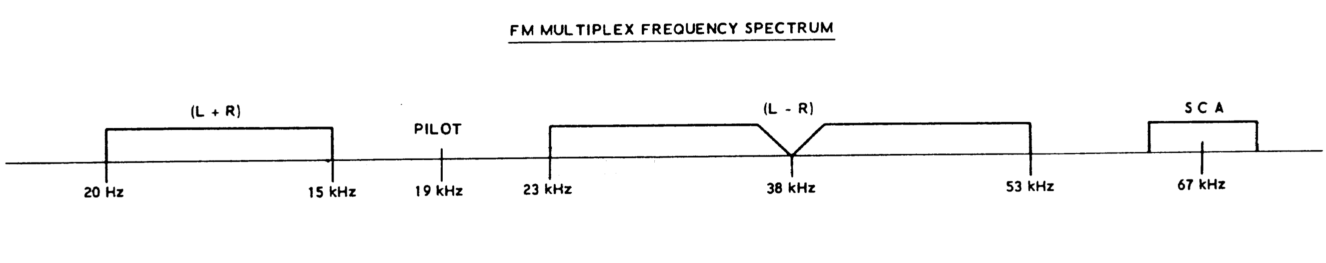


Figure 12

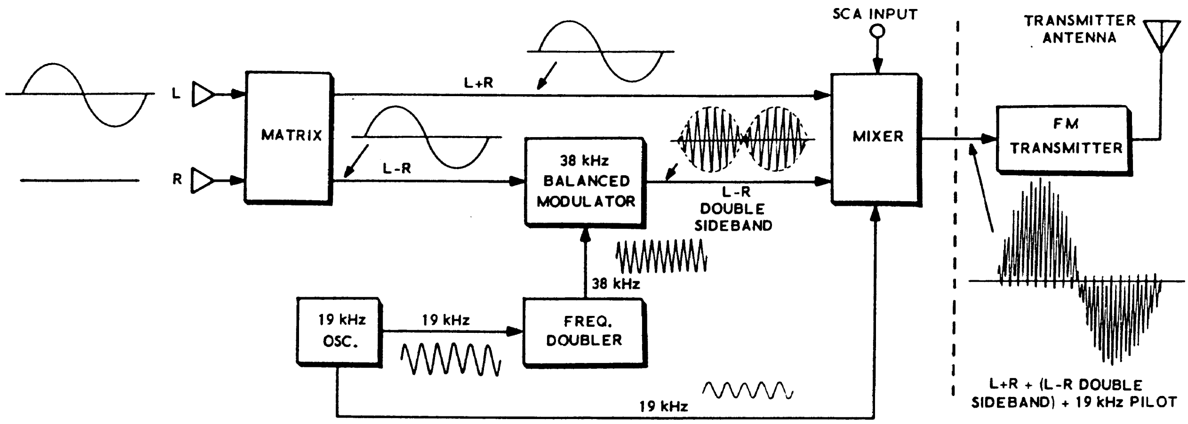


Figure 13

oscillator circuit is added to the 38 kHz subcarrier. The subcarrier is then nulled out, leaving the (L+R) + (L-R suppressed carrier) signal. This signal is then applied to the composite signal amplifier circuit.

A small portion of the signal from the 19 kHz oscillator is applied through the 19 kHz buffer and 19 kHz amplifier to the composite audio signal amplifier. Here, this 19 kHz pilot signal is mixed with the output from the balanced modulator. NOTE: For monophonic FM applications, the audio signal only is applied to the composite amplifier directly from the audio oscillator. The resulting composite or audio signal is then applied directly to the reactance-tube modulator for the 100 MHz RF oscillator. The modulated output of the 100 MHz RF oscillator is applied through an attenuator network to the RF Out connector on the front panel of the Generator. The composite or audio signal without the RF signal is applied directly to the Composite Signal/Audio connector on the front panel of the Generator.

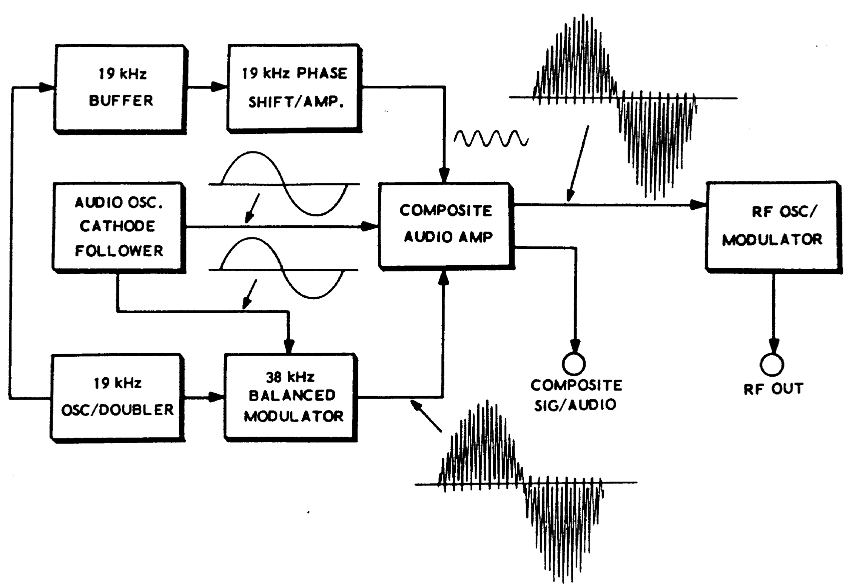


Figure 14

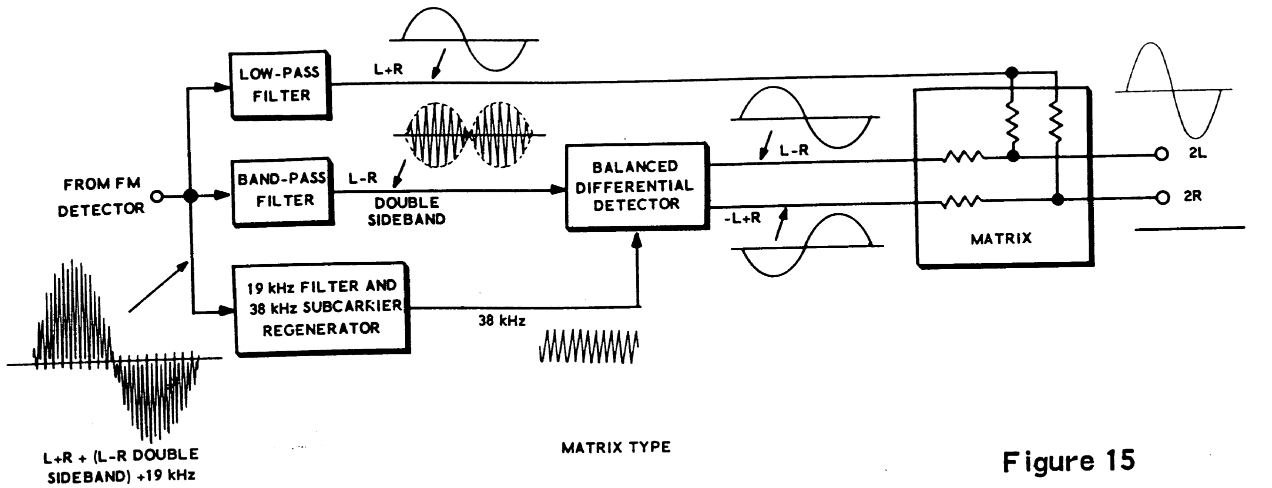


Figure 15

FM STEREO RECEIVER

There are basically two different types of stereo converters used in FM stereo receivers: the matrix type and the switching type. Figures 15 and 16 show simplified Block Diagrams of these two basic circuits; they will be explained separately.

Matrix Type

The FM multiplex signal is received by an FM receiver and is passed through the front end and IF circuits to the detector. For monophonic operation the detected FM signal is applied through a de-emphasis network, (which rolls off all but the L+R part of the signal) to the monophonic circuits of the FM receiver. For stereo operation the detected signal, still consisting of (L+R) + (L-R) + (19 kHz pilot), is applied to the low-pass filter, a bandpass filter, and to the 19 kHz filter and 38 kHz subcarrier regenerator. See Figure 15. The low-pass filter permits only the L+R signal to pass through. The L-R signal passes through the band-pass filter and is applied to the balanced differential detector.

In the 19 kHz filter and 38 kHz subcarrier regenerator circuit, the 19 kHz pilot signal is used to synchronize the 38 kHz oscillator of the receiver with the 38 kHz subcarrier used in the transmitter. The 19 kHz pilot signal is then filtered out. The 38 kHz oscillator signal is applied to the balanced differential detector circuit.

In the balanced differential detector circuit, the 38 kHz oscillator signal is reinserted in the L-R double-sideband signal. The resulting signal is then demodulated to produce L-R and -L+R signals. The L-R, -L+R, and the L+R signals are applied to the matrix circuit. The matrix circuit combines the L+R and the L-R signals. The -R and +R signals cancel, leaving a 2L signal for the left channel output. When the L+R and the -L+R signals are combined in the matrix network, the +L and -L signals cancel, leaving a 2R signal for the right channel output.

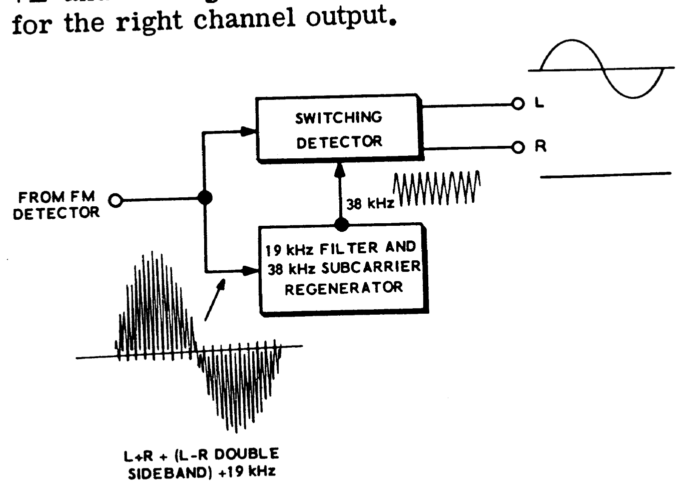


Figure 16

Switching Type

The switching type circuit is shown in simplified Block Diagram form in Figure 16. The signal from the FM detector, (L+R) + (L-R) + (19 kHz pilot signal), is applied to the switching detector circuit and to the 19 kHz filter and 38 kHz subcarrier regenerator circuit. The 19 kHz pilot signal is used to synchronize the 38 kHz oscillator signal of the receiver with the 38 kHz subcarrier of the multiplex signal. The 19 kHz pilot signal is then filtered out. The 38 kHz oscillator signal is applied to the switching circuit. Here it is used to synchronize the left and right channel switching detectors with the incoming waveform. This causes the switching detectors to alternately turn on and off. The left channel detector operates only when the incoming signal carries left channel information and the right channel detector operates only when the incoming signal contains right channel information. This produces an R and L signal output.

CIRCUIT DESCRIPTION

The following description of the FM Stereo Generator describes each circuit in detail. Refer to Block Diagram, Figure 17, and to the Schematic (fold-out from Page 59) while reading this section.

19 kHz CIRCUITS

A Pierce crystal-controlled oscillator, consisting of tube V2A and its associated circuitry, is used to generate the 19 kHz signal. Coil L1, in the plate circuit of V2A, is used to tune the circuit to resonance. A small portion of the 19 kHz signal is coupled through capacitor C36 and isolation resistor R58 to the grid of the 19 kHz buffer stage, V4A. The buffer stage is used to isolate the 19 kHz oscillator circuit from the phase shift circuit and the 19 kHz pilot amplifier. The plate circuit of V4A is tuned by coil L4. The output of the 19 kHz buffer stage is coupled through capacitor C46 to a phase shift network in the grid circuit of 19 kHz pilot amplifier V3B. The phase shift circuit is made up of capacitors C9 and C10 and resistors R25, R26, R27, and R28. To simulate a left channel and a right channel signal, it is necessary to shift the phase of the 19 kHz pilot signal by 45 degrees to each side of zero phase. This is done by selecting different combinations of resistors and capacitors in the phase shift circuit with the Function switch. The 19 kHz pilot amplifier increases the pilot signal level and applies it to the Function switch through R24, C11, and C12 to the grid of V5A, the composite audio amplifier. Here it will be mixed with the output of the balanced modulator circuit.

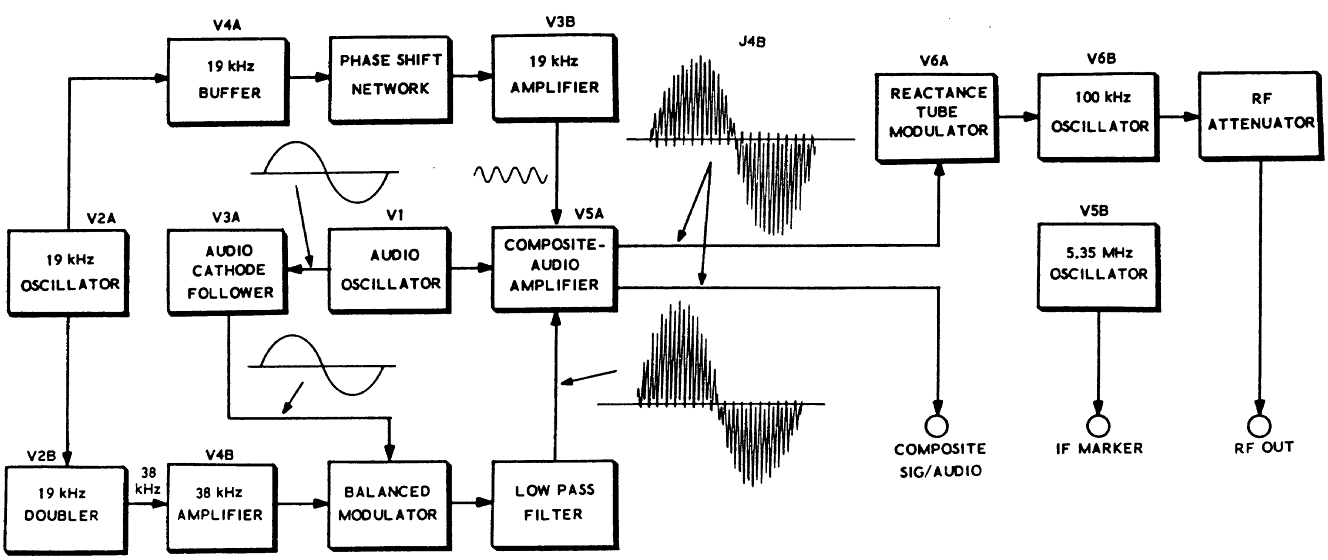


Figure 17

The output of 19 kHz oscillator V2A is also applied through capacitor C37 to the grid of 19 kHz doubler V2B. Plate coil, L2, of the doubler circuit is tuned to 38 kHz (twice the 19 kHz signal). The 38 kHz signal from V2B is inductively coupled from coil L2 to coil L3 in the grid circuit of 38 kHz amplifier tube V4B. V4B increases the 38 kHz signal level and applies it to the balanced modulator circuit, through transformers T2 and T3.

At this point, an audio signal is also fed to the balanced modulator circuit. The audio oscillator is a Wien bridge type, using tube V1. The operating frequency of the audio oscillator is determined by the resistance value switched into the grid circuit of V1A by frequency selector switch S1 and capacitors C2, C3, and C5. The output of the audio oscillator circuit is coupled through capacitor C7 to the grid of audio cathode follower stage V3A. The output of the audio cathode follower is coupled through capacitor C8 and resistor R55 to the balanced modulator circuit.

BALANCED MODULATOR

Diodes D2 and D3, Balance control R54, transformers T2 and T3, and capacitors C28 and C29 make up the balanced modulator circuit. The function of the balanced modulator circuit is to eliminate the 38 kHz subcarrier frequency and produce the double sideband signal.

When a positive half cycle of the 38 kHz signal is applied to the primary of transformers T2 and T3, a positive half cycle is produced in the secondary of T2 and T3. With no audio voltage from audio cathode follower V3A applied to the junction of D2 and D3, a positive signal appears at the anode of D3 and a negative signal at the cathode of D2. These voltages cause D2 and D3 to conduct. Balance control R54 is adjusted for maximum total voltage across the two diodes. Because of the conduction, however, the voltage at the junction of D2 and D3 is essentially zero.

When the 38 kHz signal at the primary of transformers T2 and T3 is at its negative half cycle, the polarity of the voltage across the two diodes is reversed. That is, a negative voltage is present at the anode of D3, and a positive voltage is present at the cathode of D2. With this condition, no conduction takes place, and again the voltage at the diode junction is essentially zero.

When audio voltage from V3A is applied to the junction of D2 and D3, the conduction of the two diodes becomes controlled not only by the 38 kHz signal but also by the audio voltage. The two diodes alternately conduct, in accordance with the positive and negative excursions of the audio voltage. This modulation process produces upper and lower sidebands with the 38 kHz carrier suppressed. This is the L-R signal. The L+R signal is the audio voltage from V3A. Therefore, the entire composite signal, except for the 19 kHz pilot carrier, appears at the junction of diodes D2 and D3.

This L+R plus L-R (double sideband) signal is then applied through the low-pass filter to the grid of composite signal audio amplifier V5A. The low-pass filter, consisting of coils L5, L6, and L7 and their associated circuitry, removes any undesirable harmonic frequencies that may have been generated in the balanced Modulator Circuit.

19 kHz PHASE SHIFT

The 19 kHz pilot signal and the 38 kHz signal from the balanced modulator are both present at the grid of composite amplifier V5A. When the Function switch is in the Phase Test position, the 19 kHz pilot signal is exactly in phase with the 38 kHz balanced modulator signal. The resulting operation of the multiplex circuit in an FM stereo receiver is such that the left and right signals appear at the left and right channel outputs of the receiver.

When the Function switch is in the Left Channel position, the combination of resistance and capacitance in the phase shift circuit is such that the 19 kHz pilot signal lags the 38 kHz balanced modulator signal, in phase, by 45 degrees. When this signal reaches the FM stereo receiver, the pilot signal is doubled and the 45 degree phase shift becomes 90 degrees. When this signal reaches the matrix or switching network in the receiver, the effect is to subtract the two signals: (L+R) - (L+R) which becomes L+R+L-R =2L. This results in an output signal from the left channel only.

When the Function switch is in the Right Channel position, the opposite condition occurs. The phase shift network produces a 19 kHz pilot signal which leads the 38 kHz balanced modulator signal in phase by 45 degrees, causing a 90 degree leading signal in the FM stereo receiver. The signals in the matrix network are then added: (L+R)+(-L+R) = L+R-L+R = 2R. This results in an output signal from the right channel only.

COMPOSITE SIGNAL/AUDIO AMPLIFIER

Composite amplifier V5A mixes and amplifies the audio, plus the 38 kHz double sideband suppressed carrier signal and the 19 kHz pilot signal. The output of V5A is coupled through capacitor C46, the Function switch, and control R34 to a connector on the front panel of the Generator. This composite signal is used with external multiplex adapters when the FM RF signal output is not used. The amount of composite signal available at this connector is adjustable by control R34 (Function Level).

The composite signal from V5A is also applied through R35, the Mod Adjust control, to the grid circuit of V6A, the reactance-tube modulator. The reactance tube modulator varies the frequency of the 100 MHz oscillator in accordance with the frequency of the composite signal. The signal from the reactance-tube modulator is applied to 100 MHz carrier oscillator V6B, causing its frequency to shift at the audio rate of the composite signal. The amount of frequency shift caused by the modulator depends on the setting of Modulation Adjust control R35.

The grid circuit of the 100 MHz carrier oscillator is tuned to resonance by coil L9. The center frequency of the 100 MHz carrier oscillator can be shifted plus or minus 2 MHz by adjusting the RF Freq Adjust capacitor C22. The FM RF output from the 100 MHz carrier oscillator is applied through C21 and the attenuator circuit to the RF Out connector on the front panel.

The attenuator circuit consists of switches S3, S4, and S5 and their associated resistors. Each attenuator switch represents a 20 dB attenuation of the RF signal; that is, the attenuator circuit provides up to 60 dB of attenuation.

A 10.7 MHz marker frequency is provided by Pierce crystal-controlled oscillator V5B. The 5.35 MHz crystal frequency is doubled to 10.7 MHz and is applied to a front panel connector for use as an IF marker. Other harmonics of this signal also provide markers in the 88 to 108 MHz FM band for FM tuning circuit alignment.

POWER SUPPLY

Power transformer T1 has dual primary windings. These windings are are connected in parallel for operation from a 105-125 volt AC, 50/60 Hz power source. For operation from a 210-230 volt AC, 50/60 Hz power source, they would be connected in series. The same secondary voltage and current will be produced in both cases.

A transformer-operated half-wave rectifier circuit supplies B+ voltage to all stages of the Generator. Resistors R61 and R62 with capacitors C42, C43, and C44 make up the filter network and remove 60 Hz ripple from the B+ voltage. A filament winding on the power transformer provides 6.3 volts AC for the tube filaments. The neon lamp indicates the presence of B+ voltage and is used as a pilot lamp.

VOLTAGE MEASUREMENT CHART

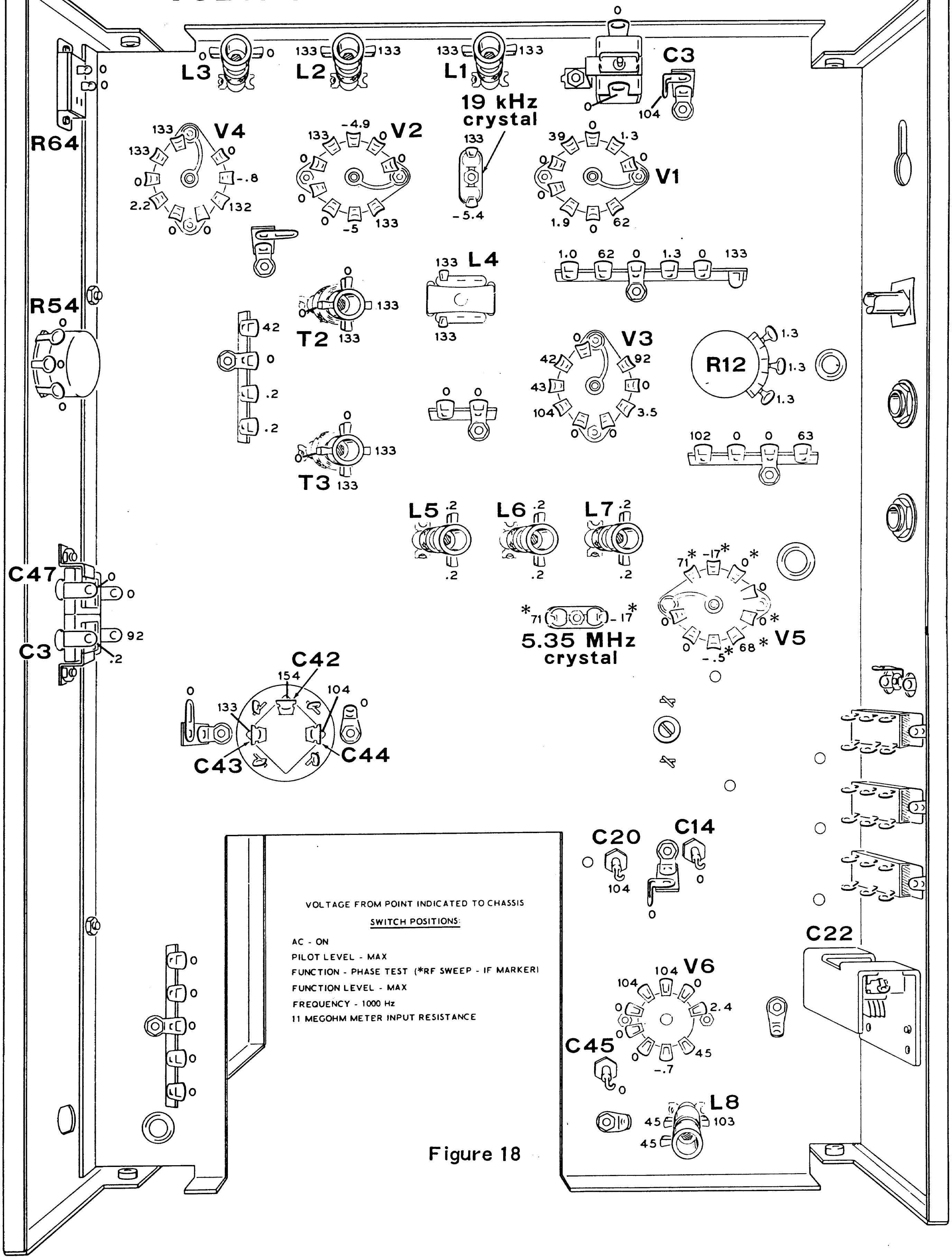


Figure 18

RESISTANCE MEASUREMENT CHART

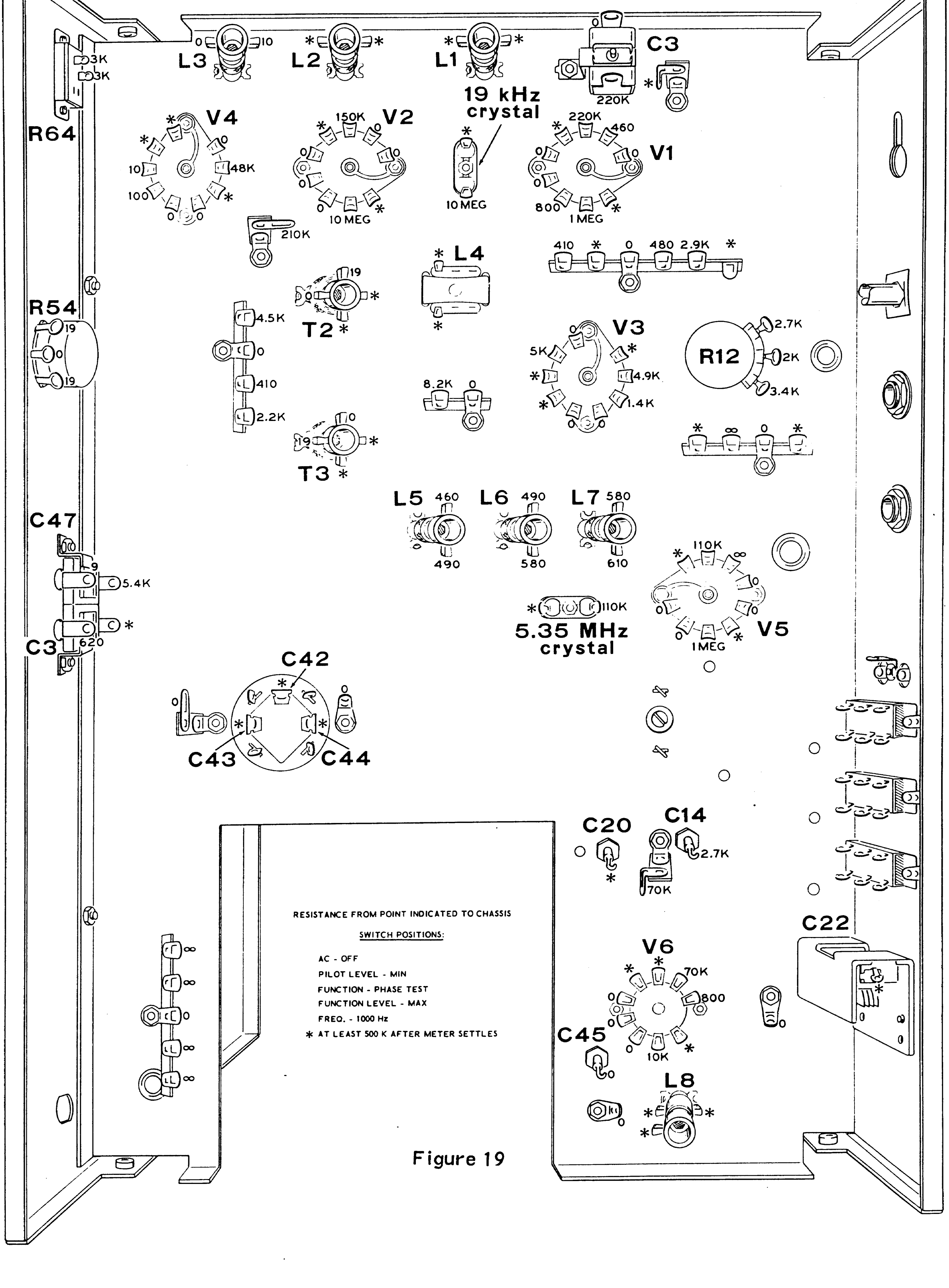
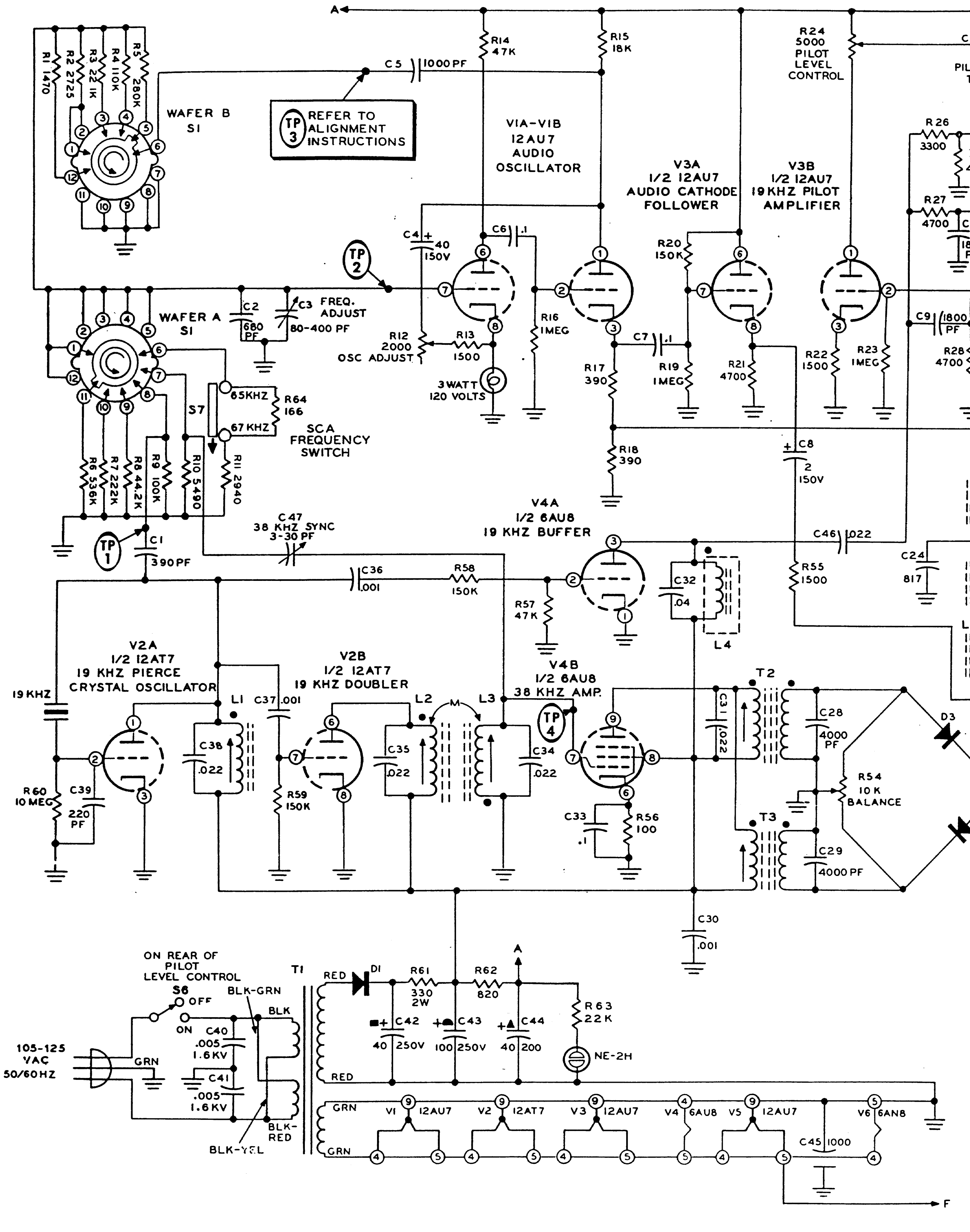
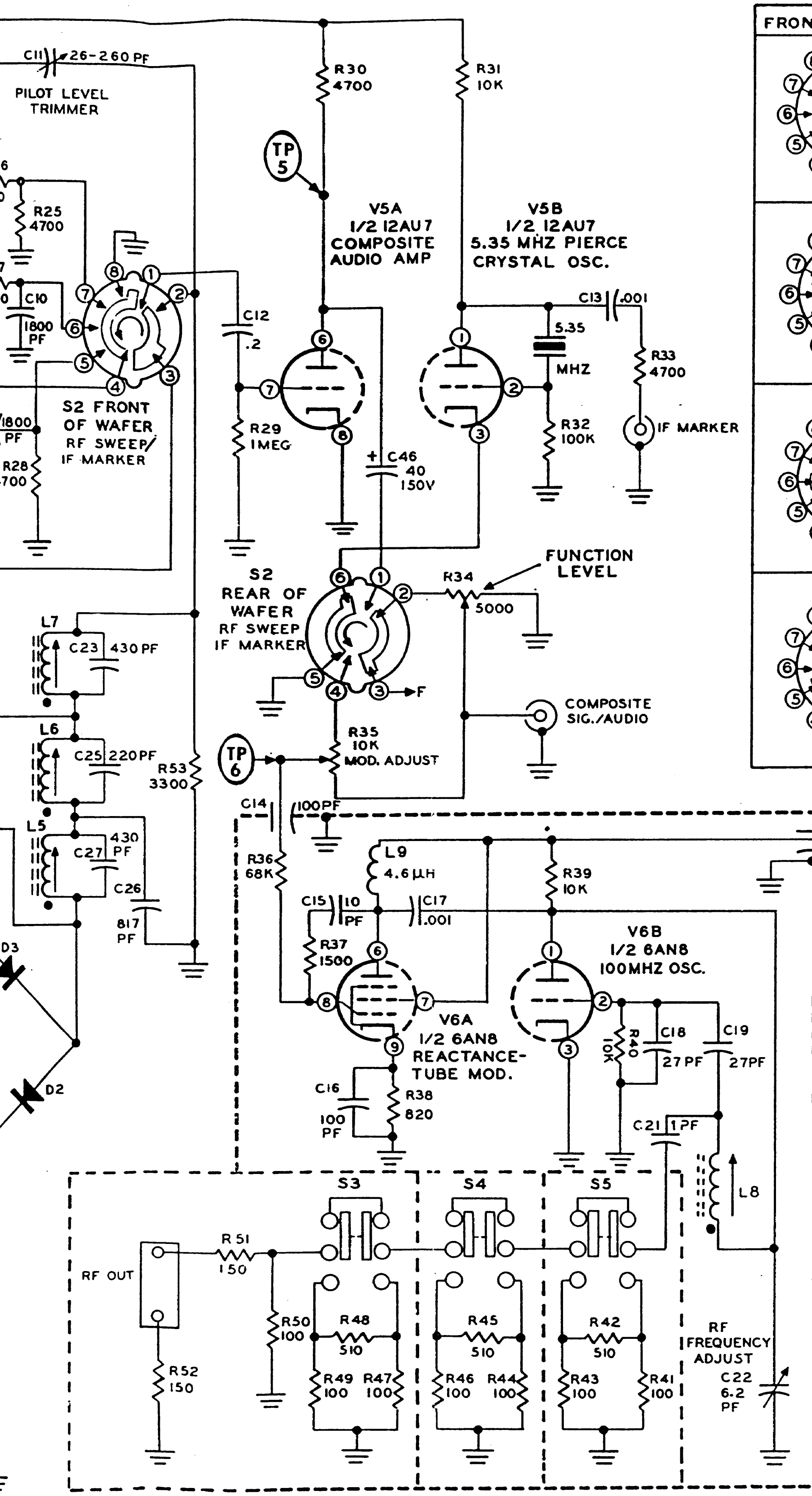


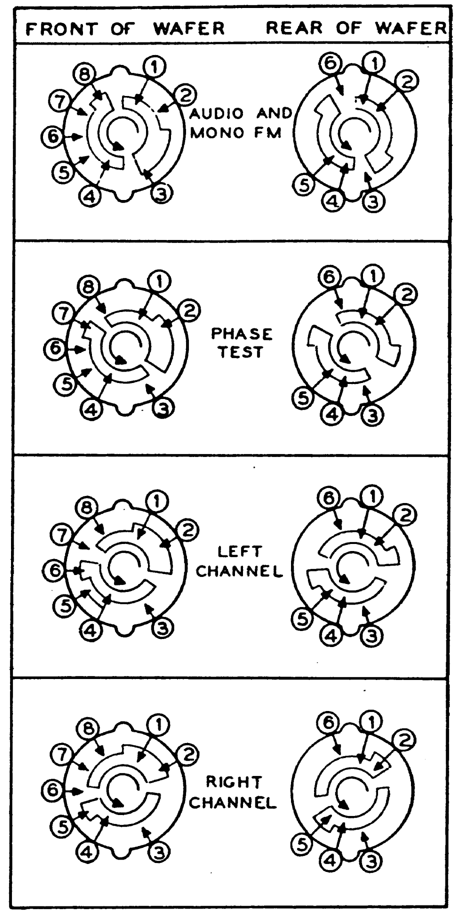
Figure 19



A
R14 47K
R15 18K
R24 5000 PILOT LEVEL CONTROL
C5 1000 PF
R1 1470
R2 2725
R3 22.1K
R4 110K
R5 280K
WAFER B S1
TP 3 REFER TO ALIGNMENT INSTRUCTIONS
V1A-V1B 12AU7 AUDIO OSCILLATOR
V3A 1/2 12AU7 AUDIO CATHODE FOLLOWER
V3B 1/2 12AU7 19KHZ PILOT AMPLIFIER
R26 3300
R27 4700
C4 40 150V
C6 .1
TP 2
R20 150K
WAFER A S1
C2 680 PF
C3 FREQ. ADJUST 80-400 PF
R12 2000 OSC ADJUST
R13 1500
R16 1MEG
C7 .1
R17 390
R19 1MEG
R21 4700
R22 1500
R23 1MEG
C9 1800 PF
R28 4700
3WATT 120 VOLTS
65KHZ
R64 166
S7
67 KHZ
SCA FREQUENCY SWITCH
R11 2940
R6 536K
R7 222K
R8 44.2K
R9 100K
R10 5490
R18 390
C8 2 150V
V4A 1/2 6AU8 19 KHZ BUFFER
TP 1
C1 390PF
C47 38 KHZ SYNC 3-30 PF
C36 .001
R58 150K
R57 47K
C32 .04
L4
C46 .022
R55 1500
C24 817
V2A 1/2 12AT7 19 KHZ PIERCE CRYSTAL OSCILLATOR
V2B 1/2 12AT7 19 KHZ DOUBLER
V4B 1/2 6AU8 38 KHZ AMP.
TP 4
19 KHZ
L1
C37 .001
L2
M
L3
T2
C31 .022
C28 4000 PF
D3
C38 .022
C35 .022
C34 .022
R54 10 K BALANCE
R60 10 MEG
C39 220 PF
R59 150K
C33 .1
R56 100
T3
C29 4000 PF
C30 .001
ON REAR OF PILOT LEVEL CONTROL
S6 OFF
ON
T1
RED
D1
R61 330 2W
R62 820
BLK-GRN
BLK
C40 .005 1.6KV
C41 .005 1.6KV
105-125 VAC 50/60HZ
GRN
C42 40 250V
C43 100 250V
C44 40 200
R63 22K
NE-2H
BLK-RED
BLK-YEL
V1 12AU7
V2 12AT7
V3 12AU7
V4 6AU8
V5 12AU7
V6 6AN8
C45 1000
F



FUNCTION SWITCH S2



SCHEMATIC OF THE HEATHKIT® FM STEREO GENERATOR MODEL IG-37

NOTE:

ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE.

ALL RESISTOR VALUES ARE IN OHMS (K = 1000, M = 1,000,000).

ALL CAPACITOR VALUES ARE IN µfd UNLESS MARKED OTHERWISE.

SCA SWITCH (S7) IN 67 kHz POSITION.

FREQUENCY AND FUNCTION SWITCHES VIEWED FROM THE REAR, AT FULL COUNTERCLOCKWISE ROTATION.

M - MUTUAL COUPLING.