SUGGESTED PRICE $1.00

RCA

operating and
maintenance instructions

WR-52A

STEREO FM SIGNAL SIMULATOR

RCA | Electronic Components | Harrison, N.J. 07029

Safety Precautions

The metal case of this instrument is connected to the ground of the internal circuit. For proper operation, the ground lead of the instrument should always be connected to the ground of the equipment under test. The output cable has a shield throughout its entire length which is connected to the instrument ground and case. It is always best to handle the cable by the insulation.

An important point to remember is that there is always danger inherent in testing electrical equipment which operates at hazardous voltages. Therefore, the operator should thoroughly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below.

1. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be especially careful to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.

2. Filter capacitors may store a charge large enough to be hazardous. Therefore, discharge filter capacitors before attaching test leads.

3. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.

4. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.

5. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in hazard of more serious risks such as a bad fall or contact with a source of higher voltage.

6. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

Items Supplied with WR-52A

1 Instruction Booklet
1 Registration Card
1 RF Output Cable (terminated)
1 Direct Output Cable
1 Cable-holding Bracket

Description

The RCA WR-52A Stereo FM Signal Simulator is a compact, lightweight instrument designed to provide the signals necessary for complete service and maintenance of multiplex adaptors and stereo fm receivers.

A panel meter is included on the instrument to indicate the rf deviation of both stereo and mono fm signals, and for adjustment of the 19 kc pilot subcarrier level.

Signals available from the WR-52A include:

- Composite stereo output signal for either left or right channel.
- FM stereo output signal for either left or right channel. The 100 Mc fm carrier is adjustable to permit selection of a quiet point in the fm band. The rf deviation is adjustable from 0 to 75 kc.
- Monaural fm output. A switch is provided to disable the 19 kc oscillator for low-distortion mono fm output.
- 100 Mc sweep output to check receiver rf/if alignment. Sweep rate is 60 cps. Sweep width is adjustable from 0 to 750 kc.
- Audio output signals of 400 cps, 1000 cps, and 5 kc.
- Crystal-controlled 19 kc and 38 kc signals for multiplex circuit adjustments.
- 67 kc and 72 kc output signals for trap adjustments.
- Special Internal Test output to check phase adjustment of WR-52A stereo signal.

Printed in U.S.A.
WR-52A (2) 3/70

The left and right composite stereo signals, left and right fm stereo signals, and mono fm signals can be modulated with the internal 400 cps, 1000 cps, or 5 kc frequencies. Binding posts are provided so that other af modulating signals can be applied from an external source.

The WR-52A comes complete with two connecting cables. A direct, unterminated cable for use with the composite stereo signal and audio signal outputs, and a terminated cable for rf output to a 75 ohm or 300 ohm receiver antenna input.

A cable-holding bracket is provided that can be mounted on the back of the case. The instrument is readily portable, weighing only 14 pounds, and measuring 13½ inches by 10 inches by 8 inches. The WR-52A is attractively styled, with a blue-gray hammertone case and a brushed aluminum panel.

Specifications

Note: Performance figures are for a line voltage of 120 volts, 60 cps.

Electrical

RF Signal Output

Carrier	100 Mc Center frequency adjustable ±800 Kc
Subcarrier	19 Kc*
FM Modulation	Left stereo signal Right stereo signal Internal Test (L + R subcarrier modulation) Monaural FM
Deviation	Adjustable 0 to 75 Kc
Sweep Signal	
Center Frequency	100 Mc
Rate	60 cps
Sweep width	Adjustable 0 to 750 Kc
RF Output Voltage	Adjustable up to 0.01 volt, RMS (approx.)

Composite Signal

Output	Left stereo signal Right stereo signal Internal Test (L + R subcarrier modulation)
Audio Output	400 cps, 1 Kc, 5 Kc, 19 Kc,* 38Kc, 67 Kc, 72 Kc
Percent distortion of 400 cps, 1 Kc, and 5 Kc Frequencies	less than 2%
Composite Signal/Audio Output Level	Adjustable from 0 to 12 volts P-P, open circuit Output source impedance approx. 5000 ohms

Power Supply

Voltage	115 to 125 volts, 60 CPS
Power Consumption	40 watts

* 19 Kc signal is crystal-controlled. Accuracy within ±2 cps.

Tube and Crystal Complement

1 RCA 6AU8A	1 Crystal, 19 Kc
2 RCA 6FQ7/6CG7	2 Crystal Diodes, 1N192
1 RCA 12AT7	1 Silicon Rectifier, 1N1764
2 RCA 12AU7A	2 Crystal Diodes, 1N87
1 RCA 6C4	1 Varicap

Mechanical

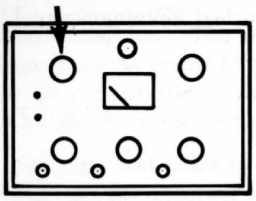
Dimensions:

Width	13¾ inches
Height	10 inches
Depth	8 inches
Finish	blue-gray Hammeroid case brushed Aluminum Panel

Weight:

Unpacked	12¾ lbs.
Packed	18 lbs.

Functions of Controls and Terminals



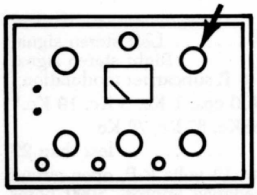
RF DEVIATION/ SWEEP WIDTH AUDIO LEVEL/ COMP SIG LEVEL

RF Deviation — Adjusts the FM deviation of the 100 Mc RF oscillator. Deviation is indicated on meter.

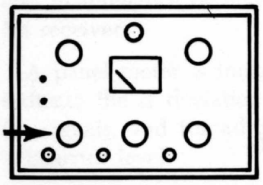
Sweep Width — (Applies only when Function Switch is set to the "RF Sweep.") Adjusts the sweep width of the 100 MC RF sweep signal from 0 to 750 Kc.

Audio Level — (Applies only when the Function Switch is set to the "Audio/Mono" position.) Adjusts the level of the audio signal obtained from the COMP SIG/AUDIO cable.

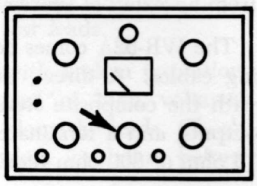
Comp. Sig. Level — (Applies only when the Function Switch is set to one of the three Stereo positions.) Adjusts the level of the composite stereo signal obtained from the COMP SIG/AUDIO cable.



19KC SUBCARRIER LEVEL — Applies power to the instrument when turned clockwise from POWER OFF position. Adjusts the level of the 19 Kc subcarrier applied to the composite stereo signal from 0 to 10%. Mark on meter is provided for setting 10% level.



FREQUENCY — Selects the various frequencies available from the internal audio oscillator. These sine-wave frequencies can be used to modulate the fm signal, or can be obtained separately from the COMP SIG/AUDIO cable. When switch is set to "EXT AF INPUT", an external audio source can be used to modulate the stereo signal. Note: When switching from one frequency to another, it is normal for a slight delay to occur before the signal reaches full amplitude.



FUNCTION — Selects the internal signals available at the output cables as described below:

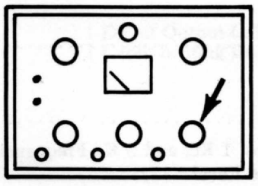
RF Sweep — Provides 60 cps RF Sweep at RF OUT cable. Sweep width is adjustable from 0 to 750 Kc.

Audio/Mono — Provides sine-wave signal at selected frequency at the "COMP SIG/AUDIO" output cable. Also provides Monaural FM at the RF OUT cable.

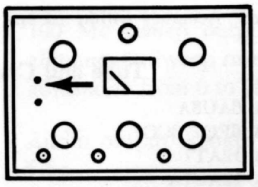
Stereo Left — Standard stereo "left" composite signal.

Stereo Right — Standard stereo "right" composite signal.

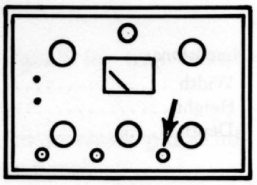
Int Test — Composite stereo (L + R) signal with 19 kc subcarrier balanced to provide zero phase reference. This pattern is provided as a phase check of the generator stereo output.



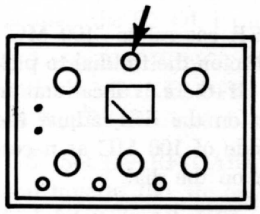
RF CARRIER — Permits center frequency adjustment of the 100 Mc oscillator signal so that a "quiet point" can be located on the fm band.



EXT AF INPUT—Binding posts for connection of external audio source to modulate mono or stereo signal. "FREQUENCY" switch must be set to "EXT AF INPUT".



RF ATTEN — Adjusts level of rf output.

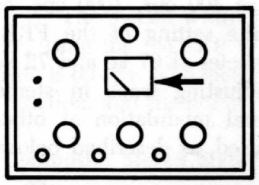


19 KC OFF — NORMAL — SET 19 KC SUBCARRIER

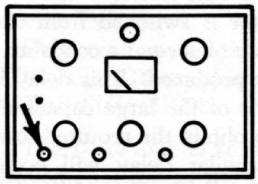
19 kc off — Disables 19 kc oscillator. Primarily for use with monaural fm signal to prevent distortion caused by the 19 kc oscillator.

Normal — Switch must be set to normal for all functions other than mono fm and a 19 kc subcarrier adjustment.

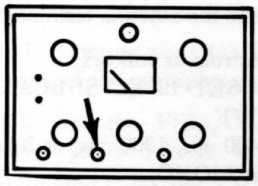
Set 19 kc Subcarrier — This switch position eliminates all modulation in the stereo signal except the 19 kc subcarrier. The Subcarrier Level control is then adjusted to bring the meter pointer to the mark on the meter scale.



RF DEVIATION METER — Indicates rf deviation up to 75 kc. Separate scales are provided for stereo and mono signals. Reference mark provided for setting the 19 kc subcarrier.



COMP SIG/AUDIO OUTPUT CABLE — Provides composite signal output when the FUNCTION Switch is set to the Stereo positions. Provides sine wave output when FUNCTION Switch is set to the "Audio/Mono" position.



RF OUT Cable — Provides signal output for rf sweep, and stereo or monaural fm.

Cable-Holding Bracket Installation

A cable-holding bracket is supplied separately with each WR-52A. If desired, this bracket can be mounted on the rear of the instrument, as shown in the photograph.

Loosen the two screws indicated by arrows in Figure 1. Pass the power cord through the hole provided in the bracket, then position the bracket as shown, with the mounting slots in the bracket under the heads of the two screws. Tighten these screws securely.

Figure 1. Rear View of WR-52A Showing Cable-Holding Bracket

Operation

General

Before using the WR-52A, read pages 4 and 5 describing the functions of the controls.

The following procedures describe the method for connecting the Simulator to an fm receiver and for obtaining the various signals available from the instrument.

Apply power to the WR-52A by turning the 19 KC SUBCARRIER LEVEL switch clockwise. Allow a few minutes for the unit to warm up.

NOTE: When the Simulator is switched from one function to another, a delay of several seconds may occur before the signal is produced. This delay is caused by the charge time of the large capacitors used in various circuits to obtain the required low-frequency response. A similar delay will occur when the FREQUENCY switch is reset from one frequency to another.

Stereo FM Output (RF)

1. Remove the antenna from the fm receiver. Connect the RF OUT cable to the antenna terminals of the receiver.

2. Set the FREQUENCY switch to either "400 cps", "1000 cps", or "5 KC", as desired for audio modulation. Set the FUNCTION switch to either "STEREO LEFT" or "STEREO RIGHT". Set the RF ATTEN control fully counterclockwise.

3. Turn the 19 KC SUBCARRIER LEVEL control fully clockwise, and set the 19 KC OFF-NORMAL-SET 19 KC SUBCARRIER switch to "NORMAL". Adjust the RF DEVIATION control to bring the meter pointer to "75 KC" on the red "STEREO" scale. 75 kc deviation represents 100% modulation of the rf carrier.

4. Set the 19 KC OFF-NORMAL-SET 19 KC SUBCARRIER switch to "SET 19 KC SUBCARRIER". Adjust the 19 KC SUBCARRIER LEVEL control to align the meter pointer with the "SET 19 KC SUBCARRIER" mark on the red meter scale. This setting of the control provides a subcarrier amplitude that is 10% of the total composite stereo waveform.

5. Return the 19 KC OFF—NORMAL—SET 19 KC SUBCARRIER switch to the "NORMAL" position.

6. Set the RF CARRIER control to "100 MC". Tune the receiver to 100 Mc on the fm dial to pick up the Simulator signal. If there is local station interference at that point on the dial, adjust the RF CARRIER to either side of 100 MC as necessary to find a quiet point on the dial.

7. Stereo fm output for either left or right channel can be obtained by setting the FUNCTION switch to "STEREO LEFT" or to "STEREO RIGHT". The signal can be modulated with internal audio frequencies of 400 cps, 1000 cps, or 5 kc as determined by the setting of the FREQUENCY switch. Frequencies of 67 kc and 72 kc are also provided for adjusting traps in stereo multiplex circuits. External modulation at other frequencies may also be used, as described below.

Monaural FM Output (RF)

1. Remove the antenna from the receiver, and connect the RF OUT cable to the antenna terminals.

2. Set the Simulator controls as follows:

19 KC OFF—NORMAL—SET 19 KC SUBCARRIER ....19 kc OFF
FREQUENCY....either 400 cps, 1000 cps, or 5 kc
FUNCTION ....AUDIO/MONO
RF ATTEN ....fully counterclockwise

3. Adjust the RF DEVIATION control to bring the meter pointer to "75 KC" on the black MONO scale. 75 kc deviation represents 100% modulation of the rf carrier.

4. Set the RF CARRIER control to "100 Mc", and tune to 100 Mc on the fm dial of the receiver to pick up the Simulator signal. If there is local station interference at that point on the dial, adjust the RF CARRIER to either side of 100 Mc as necessary to find a quiet point on the dial.

5. The monaural fm signal can be modulated with the internal frequencies on the FREQUENCY switch, or can be modulated with an external signal as described in "Using External Modulation". To use internal 19 kc modulation, however, the 19 KC OFF—NORMAL—SET 19 KC SUBCARRIER switch must be set to "NORMAL".

NOTE: The 19 KC OFF switch position is used in the mono fm function to disable the 19 kc oscillator, thus preventing the 19 kc signal from causing distortion in other modulation frequencies.

RF Sweep Output

1. Remove the antenna from the receiver, and connect the RF OUT cable to the antenna terminals.

2. Set the FUNCTION switch to RF SWEEP, and the 19 KC OFF—NORMAL—SET 19 KC SUBCARRIER switch to "NORMAL".

3. Set the RF CARRIER control to "100 MC", and tune to 100 Mc on the fm dial to pick up the Simulator signal. If there is local station interference at that point on the dial, adjust the RF CARRIER to either side of 100 Mc as necessary to find a quiet point on the dial.

4. The sweep width is adjustable from 0 to 750 kc, using the SWEEP WIDTH control. The sweep rate is 60 cps. The meter is not used in the rf sweep function, and the pointer will remain at "0".

Composite Stereo Signal Output

The composite stereo signal is equivalent to the detected stereo signal available at the output of an fm tuner. This composite signal can be connected directly to the input of a multiplex circuit.

1. Connect the COMP SIG/AUDIO cable to the input of the multiplex circuit.

2. Set the FREQUENCY switch to 400 cps, 1000 cps, or 5 kc, to select the audio modulation frequency. Set the FUNCTION switch to either "STEREO LEFT" or "STEREO RIGHT".

3. Set the 19 KC OFF—NORMAL—SET 19 KC SUBCARRIER switch to "SET 19 KC SUBCARRIER". Adjust the 19 KC SUBCARRIER control to align the meter pointer with the "SET 19 KC SUBCARRIER" mark on the red scale. The adjustment establishes the 19 kc subcarrier at 10% of the total stereo waveform. Reset the switch to the "NORMAL" position.

4. Composite stereo signal output for either left or right channel can be obtained by setting the FUNCTION switch to "STEREO LEFT" or "STEREO RIGHT". The level of the composite signal output can be adjusted with the COMP SIG LEVEL control. The signal can be modulated with audio frequencies of 400 cps, 1000 cps, or 5 kc as determined by the setting of the FREQUENCY switch. Frequencies of 67 kc and 72 kc are also provided for adjusting traps in stereo multiplex circuits. External modulation at other frequencies may also be used, as described under "Using External Modulation", below.

Audio Output

Output at any of the frequencies listed on the FREQUENCY switch can be obtained through the COMP SIG/AUDIO cable.

The 19 kc and 38 kc frequencies are crystal controlled. Set the 19 KC OFF—NORMAL—SET 19 KC SUBCARRIER switch to "NORMAL", and the FUNCTION switch to AUDIO/MONO.

The level of the audio output can be adjusted with the AUDIO LEVEL control.

Using External AF Modulation

The stereo fm signal, mono fm signal, and stereo composite signal can be modulated from an external af signal source, using the following procedure.

1. Adjust the Simulator to obtain a stereo or mono fm output, as described above. With the FREQUENCY switch set to "1000 CPS", adjust the rf deviation to 75 kc as indicated on the meter.

2. Set the FREQUENCY switch to "EXT AF INPUT". Connect the external AF signal source to the binding posts on the panel. Adjust the level of the external input signal so that the rf deviation on the meter again reads "75 KC".

Stereo FM

The Transmitted Signal

Monaural fm signals are produced by using the monaural audio signal to frequency-modulate an rf carrier. Stereo fm however, must contain two separate audio signals, comprising the left and right channels. This two-channel audio information has to be transmitted in a manner that enables reception as a stereo signal by a stereo fm receiver, or as a monaural signal by a monaural fm receiver. A technique called "multiplexing" is used to obtain this stereo fm signal. Multiplexing permits additional signals to be transmitted on an rf carrier through the use of a modulated subcarrier.

The drawing in Figure 2 indicates the composite signal that frequency-modulates the rf carrier to produce a stereo fm signal.

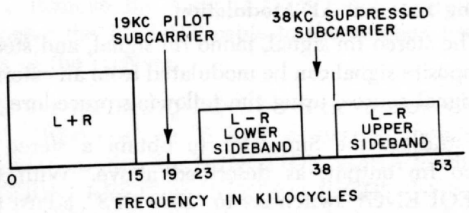


Figure 2.
Chart Showing Composite Stereo Modulation

The L+R portion of the stereo multiplex signal is formed by combining the left and right channels in phase. This L+R signal corresponds to a regular monaural audio signal with a frequency range from 50 cps to 15 kc. It is this portion of the stereo fm signal that is received and detected as a monaural fm transmission by a monaural fm receiver.

The left and right audio signals are also combined with the right signal shifted 180 degrees out-of-phase. This in effect subtracts the right signal from the left signal, producing a difference signal called L—R. This L—R information is used to amplitute-modulate a 38 kc subcarrier in such a manner that two sidebands are formed, with the 38 kc subcarrier supressed, or removed. These sidebands containing the L—R information extend from 23 kc to 53 kc.

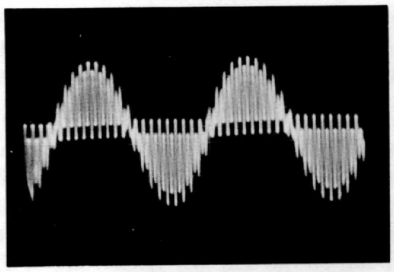


Figure 3. Composite Stereo Waveform.
Right Channel Modulation Only

An unmodulated 19 kc pilot subcarrier is also included in the stereo signal. This pilot signal is used in the stereo fm receiver to synchronize the stereo detector circuit. Note that the 38 kc subcarrier is the second harmonic of this 19 kc pilot signal.

In both monaural and stereo fm transmission, some stations also include "storecasting" or SCA (subsidiary carrier assignment) information. The SCA modulation extends from 60 kc to 74 kc, with a center subcarrier frequency of 67 kc. This SCA signal must be removed, or "trapped", in a stereo fm receiver since it would interfere with the operation of the stereo detector circuit.

Thus, while a monaural fm transmission consists simply of an rf carrier frequency-modulated by the audio program material, a stereo fm transmission consists of an rf carrier frequency-modulated with a complex waveform that includes an L+R, or monaural signal, two L—R sidebands around a 38 kc supressed carrier, and a 19 kc pilot signal.

Figure 3 illustrates a composite stereo waveform produced by a signal source such as the RCA Stereo FM Signal Simulator, with right channel modulation only. This is the waveform as it would appear at the output of the fm detector stage of the receiver.

The Stereo FM Receiver

In addition to the fm detector which demodulates the rf signal, a stereo fm receiver must have a stereo detector or "multiplex" circuit. This circuit must be capable of recovering the left and right audio signals from the composite stereo signal.

There are two basic types of stereo detectors in use; the matrix or envelope detection circuit, and the synchronous bridge, or switching bridge detector.

Matrix-Type Stereo Detector

In the matrix type stereo detector circuit, the 19 kc pilot signal is doubled, then reinserted into the composite waveform as the 38 kc subcarrier. The envelopes of the L—R 38 kc sidebands are then demodulated, providing a L—R audio signal. A —L+R signal is obtained by passing the L—R signal through a phase inverter. The L—R and —L+R signals are combined with the L+R signal in a matrix circuit which provides separate R and L outputs.

Figure 4 illustrates a multiplex circuit using a matrix-type stereo detector. The composite stereo signal is applied to this circuit from the fm tuner. Any SCA information in the stereo signal is removed by the L-2 and L-3 trap networks. The entire stereo signal is amplified by V-1A, and applied to V-2A. The signal is connected from the cathode of V-2A to the phase detector circuit.

The 19 kc pilot signal is amplified by V-2A, and connected to a frequency doubler stage, CR-1 and CR-2, where it is doubled to 38 kc. This 38 kc signal is amplified by V-2B then applied to transformer T-2, where it is re-inserted into the stereo signal.

The L—R sidebands, now with the 38 kc subcarrier restored, are demodulated within the crystal detector circuit, CR-3 and CR-4, and passed to a phase inverter, V-1B.

L—R signal is obtained at the cathode of the tube, while the signal is shifted 180 degrees at the plate, forming a —L+R signal.

These signals are fed to the four 100K matrix resistors where they are combined with the L-R signal taken from the cathode of V-2A. The matrix circuit adds the signals algebraically in the following manner: —L+R is added to L+R. The L voltages cancel, leaving only R information as the right channel output.

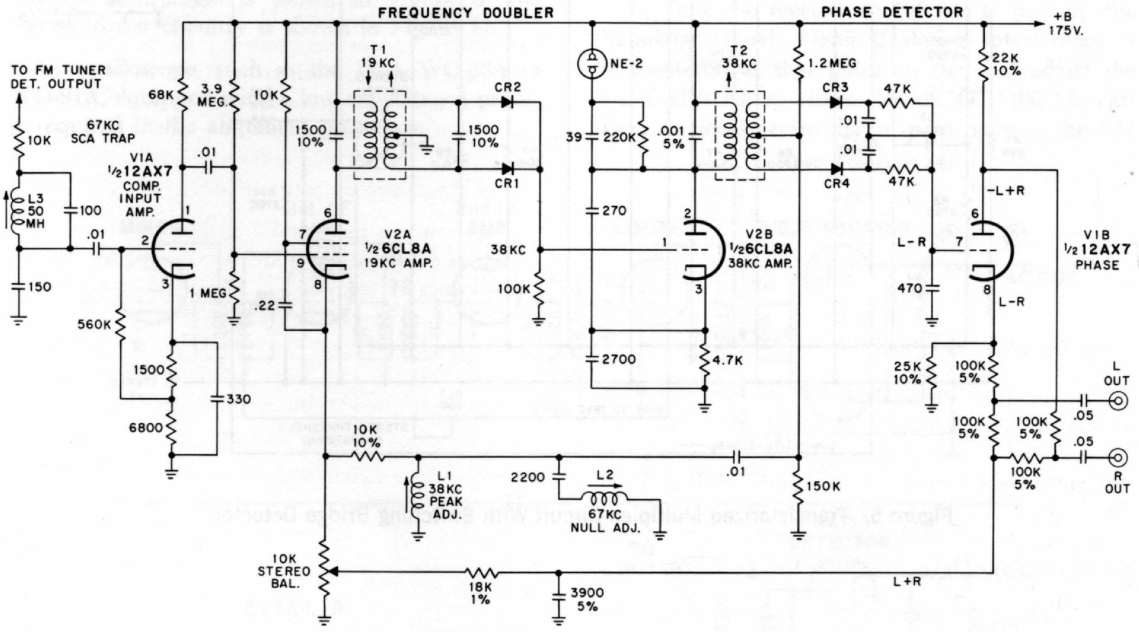


Figure 4. Matrix-Type Multiplex Circuit

Switching Bridge Detector

In this method of detection, the 19 kc pilot signal is doubled, and the resulting 38 kc is used as a switching signal. The composite stereo signal is alternately sampled at a 38 kc rate for left and right output.

Figure 5 illustrates a multiplex circuit using a transistorized switching bridge detector.

The composite stereo signal is connected to the circuit from the output of the fm detector. The 19 kc pilot signal is amplified by transistors Q-1 and Q-2, then doubled to 38 kc by the CR-1 and CR-2 diode network. This 38 kc signal is amplified by Q-3, and fed through transformer T-3 to the detector network formed by diodes CR-3, CR-4, CR-5, and CR-6. Transistor Q-4 acts as a stereo switch, activating the detector circuit when a stereo signal is present.

The stereo signal is connected from the emitter of Q-1 to the detector bridge network. The 38 kc switching signal causes the detector bridge to sample the left and right audio signals contained in the composite stereo signal. At a 38 kc alternating rate, the instantaneous voltage of the left channel signal will appear at point A in the bridge, and the instantaneous voltage of the right channel will appear at point B.

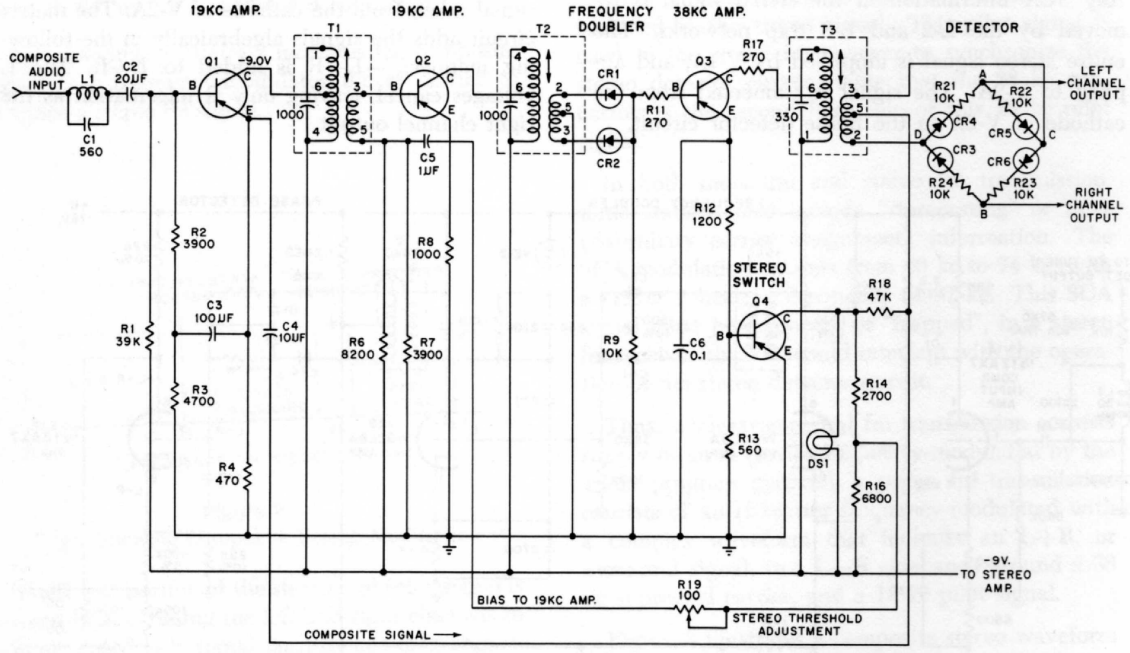


Figure 5. Transistorized Multiplex Circuit With Switching Bridge Detector

Aligning Stereo FM Multiplex Circuits With The WR-52A

Many different types of stereo fm receiver circuits are used by various manufacturers. For this reason, it is not practical to give a complete alignment procedure that will apply to all receivers. In each case, the manufacturer's service information should be followed, using the RCA Stereo FM Simulator as a source of the required signals.

Basically, the alignment procedure of any FM stereo circuit consists of adjusting the amplitude and phase of the 19 Kc pilot signal and the 38 Kc signal, adjusting the SCA trap for minimum response, and setting the internal stereo balance control.

The following example is provided as an aid in understanding the use of the Simulator in checking the tuner and aligning the multiplex circuit of a stereo fm receiver. The multiplex alignment procedure given is for one particular receiver. The schematic diagram for the IF limiter and discriminator stages is shown in Figure 6, and the multiplex circuitry is shown in Figure 11.

An oscilloscope, such as the RCA WO-33A or WO-91A, equipped with a low capacitance probe, is required in the alignment procedure.

The RF, IF, limiter, and detector stages of the stereo FM receiver should be serviced according to the manufacturer's instructions, and using the test equipment specified in the instructions. However, the Simulator can be used to check the overall performance of these stages, and to determine whether alignment or service is needed.

1. Remove the antenna from the receiver, and connect the RF OUT cable from the Simulator to the antenna terminals.

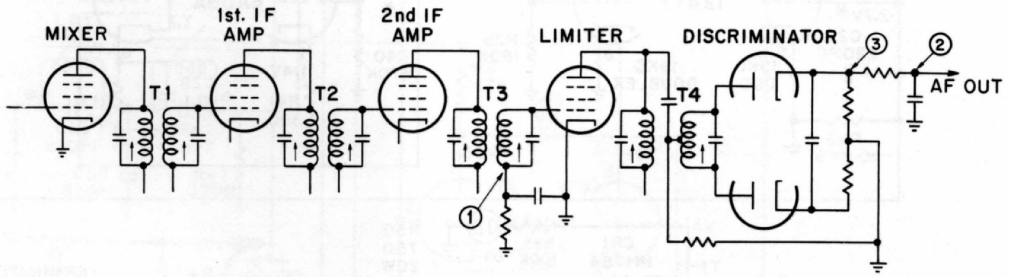
Checking the Tuner Portion of the Receiver

2. Adjust the Simulator controls as follows:

FUNCTION "RF SWEEP"
SWEEP WIDTH "6" (equivalent to 600 Kc)
RF ATTENUATOR fully counterclockwise
19 KC SUBCARRIER LEVEL "O"
FREQUENCY any position

3. Tune the receiver to 100 Mc to pick up the Simulator signal. Note: If station interference is encountered at that point on the dial adjust the RF CARRIER to either side of "O" (100 Mc carrier) as necessary to find a quiet point in the FM

(Cont'd on Page 14)



DETAIL A

Note: Use this schematic to locate test point if receiver uses a ratio detector.

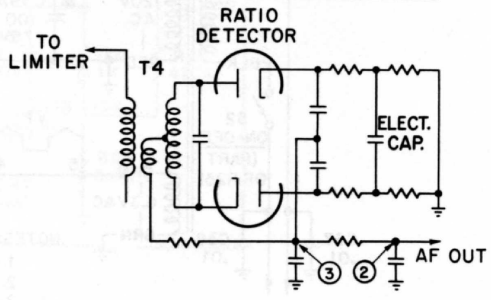
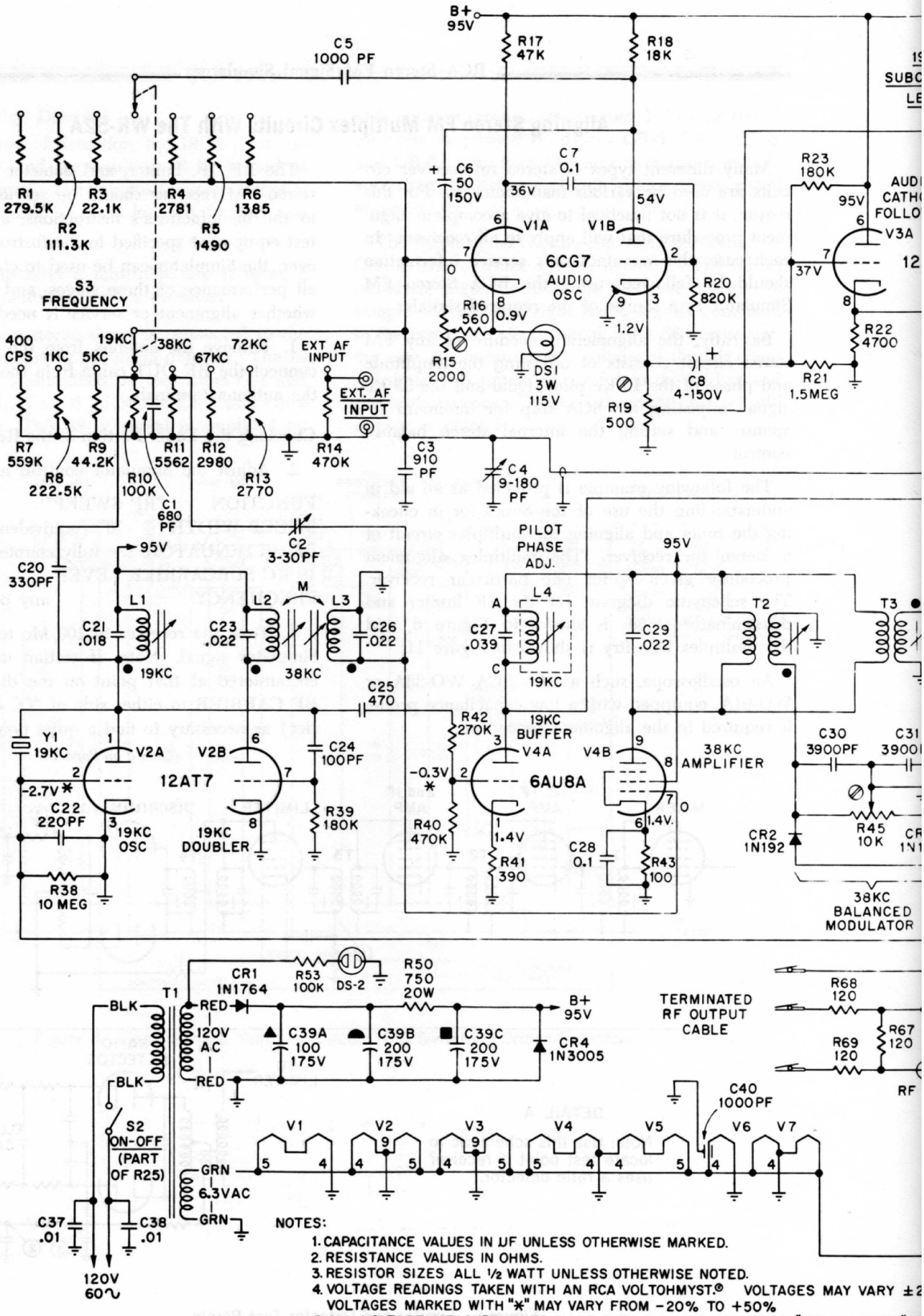
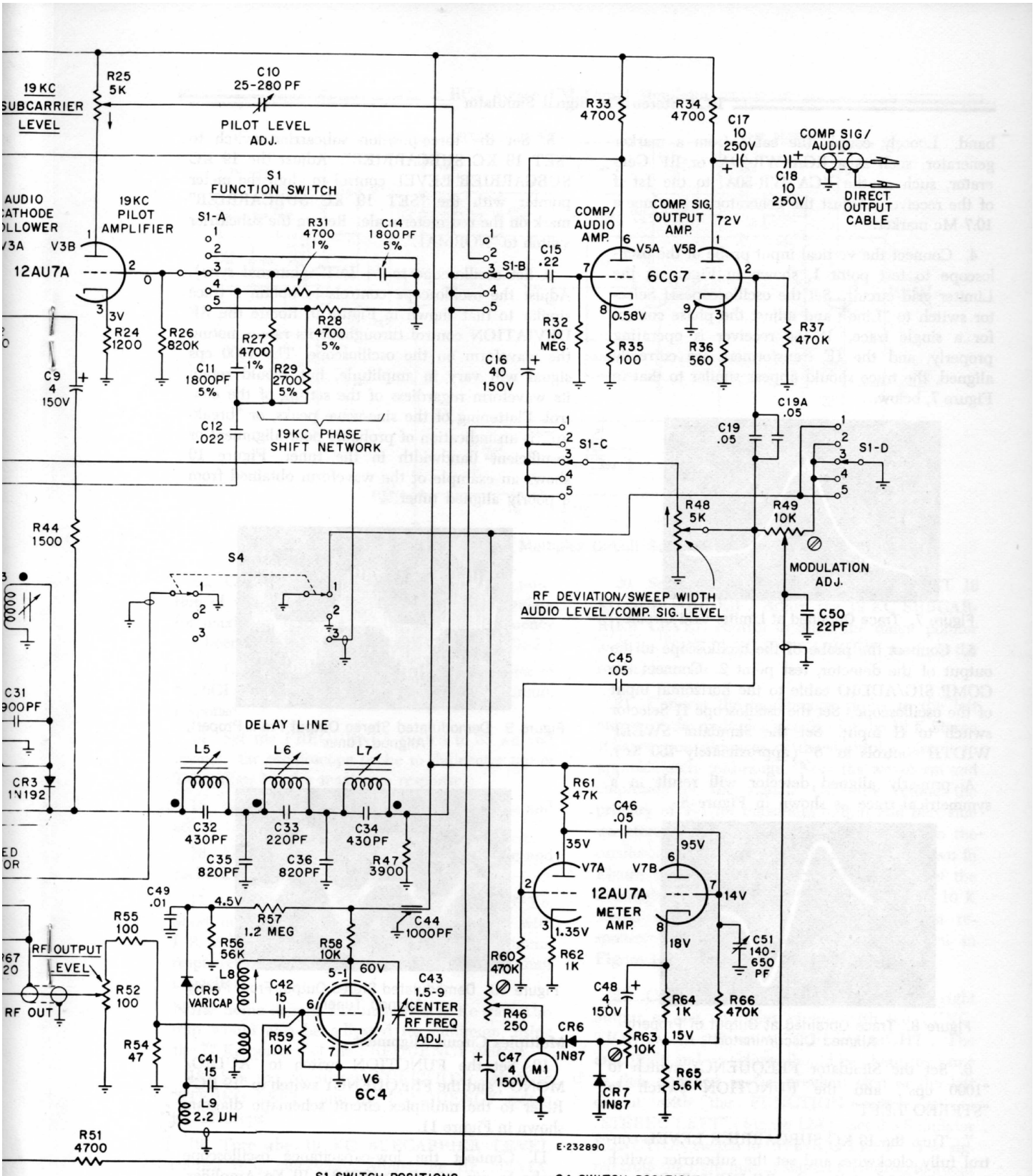


Figure 6. Limiter and Detector Test Points



NOTES:

1. CAPACITANCE VALUES IN µF UNLESS OTHERWISE MARKED.
2. RESISTANCE VALUES IN OHMS.
3. RESISTOR SIZES ALL ½ WATT UNLESS OTHERWISE NOTED.
4. VOLTAGE READINGS TAKEN WITH AN RCA VOLTOHMYST.® VOLTAGES MAY VARY ±2
   VOLTAGES MARKED WITH "*" MAY VARY FROM −20% TO +50%
5. ALL VOLTAGE MEASUREMENTS MADE WITH FUNCTION SWITCH IN "STEREO LEFT" P
6. ● ON COILS INDICATES FINISH OF WINDING.



±20%

" POSITION EXCEPT WHERE NOTED.

S1 SWITCH POSITIONS
1. RF SWEEP
2. AUDIO / MONO
3. LEFT
4. RIGHT
5. INT. TEST

S4 SWITCH POSITIONS
1. 19 KC OFF
2. NORMAL
3. SET 19KC SUBCARRIER

A Schematic Diagram

band. Loosely couple the cable from a marker generator, such as a RCA WR-99A, or RF Generator, such as the RCA WR-50A, to the 1st if of the receiver. Adjust the generator to produce a 10.7 Mc marker.

4. Connect the vertical input probe of the oscilloscope to test point 1, shown in Figure 6, the Limiter grid circuit. Set the oscilloscope H Selector switch to "Line", and adjust the phase control for a single trace. If the receiver is operating properly, and the IF transformers are correctly aligned, the trace should appear similar to that in Figure 7, below.

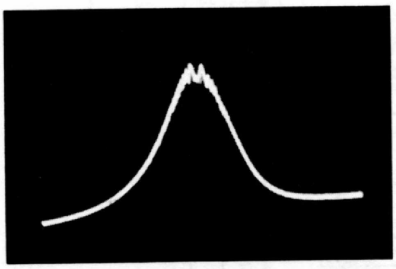


Figure 7. Trace Obtained at Limiter Grid Circuit

5. Connect the probe of the oscilloscope to the output of the detector, test point 2. Connect the COMP SIG/AUDIO cable to the horizontal input of the oscilloscope. Set the oscilloscope H Selector switch to H input. Set the Simulator SWEEP WIDTH controls to "8" (approximately 750 Kc).

A properly aligned detector will result in a symmetrical trace as shown in Figure 8.

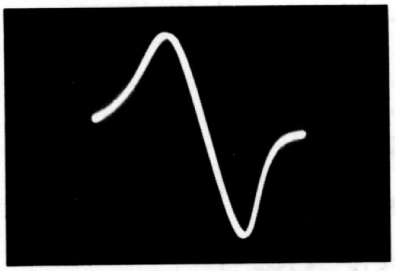


Figure 8. Trace Obtained at Output of Properly Aligned Discriminator

6. Set the Simulator FREQUENCY switch to "1000 cps", and the FUNCTION switch to "STEREO LEFT".

7. Turn the 19 KC SUBCARRIER LEVEL control fully clockwise, and set the subcarrier switch to "NORMAL". Adjust the RF DEVIATION control to bring the meter pointer to "75 KC" on the red "STEREO" scale.

8. Set the three-position subcarrier switch to "SET 19 KC SUBCARRIER". Adjust the 19 KC SUBCARRIER LEVEL control to align the meter pointer with the "SET 19 KC SUBCARRIER" mark on the red meter scale. Return the subcarrier switch to "NORMAL".

9. Set oscilloscope to "+ INT" (internal sync). Adjust the oscilloscope controls to obtain a trace similar to that shown in Figure 9. Rotate the RF DEVIATION control throughout its range, noting the waveform on the oscilloscope. The 1000 cps signal will vary in amplitude, but should retain its waveform regardless of the setting of the control. Flattening of the sine-wave peaks, or "break-up", is an indication of probable poor alignment or insufficient bandwidth in the tuner. Figure 10 shows an example of the waveform obtained from a poorly aligned tuner.

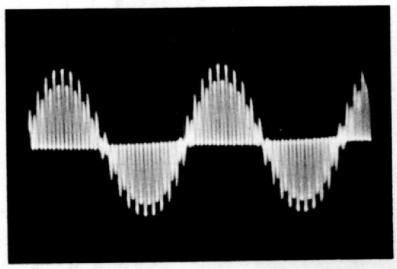


Figure 9. Demodulated Stereo Output From Properly Aligned Tuner

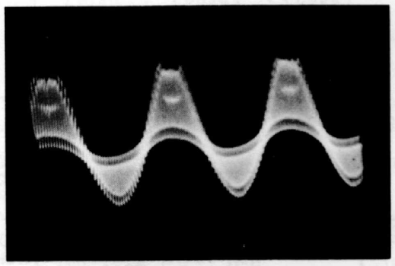


Figure 10. Demodulated Stereo Output From Poorly Aligned Tuner

Multiplex Circuit Alignment

10. Set the FUNCTION switch to "AUDIO/MONO", and the FREQUENCY switch to "19 KC". Refer to the multiplex circuit schematic diagram shown in Figure 11.

11. Connect the low-capacitance oscilloscope probe to pin #6 of the 6CL8A 19 Kc Amplifier. Align the primary of T-1 for maximum response on the oscilloscope.

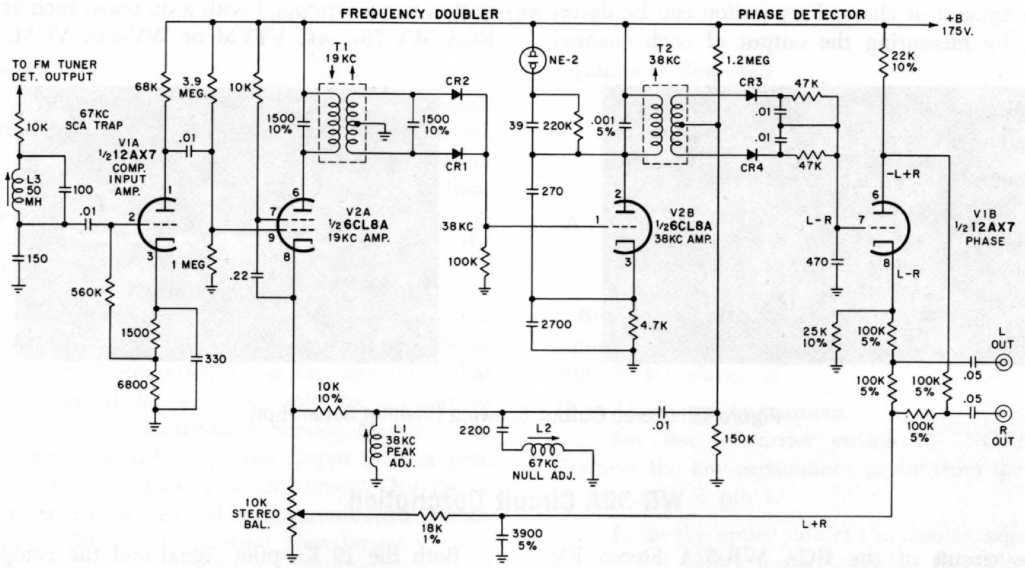


Figure 11. Multiplex Circuit Schematic

12. Connect the oscilloscope probe to the junction of CR-1 and CR-2. Align the T-1 secondary for maximum response. (Note that the frequency has been doubled in the network CR-1 and CR-2.)

13. Connect the oscilloscope probe to pin #2 of the 6CL8A 38 Kc amplifier. Align T-2 for maximum response.

14. Set the FREQUENCY switch to 38 Kc and connect the oscilloscope probe to the center tap of T-2. Align L-1 for maximum response.

15. Set the FREQUENCY switch to 67 Kc and adjust L-2 for *minimum* response.

16. Set the FREQUENCY switch to 38 Kc and recheck alignment of L-1 as in step 14.

17. Again set the FREQUENCY switch to 67 Kc. Short out the 2200 mmf capacitor in series with L-2. Adjust L-3, the 67 Kc SCA trap for minimum response. Remove the short across the 2200 mmf capacitor.

NOTE: Some circuits also include a 72 Kc trap. This trap would also be adjusted for minimum, using the 72 Kc position of the FREQUENCY switch.

18. Set the Simulator FUNCTION switch to "STEREO LEFT", and the FREQUENCY switch to "1000 cps".

19. Turn the 19 KC SUBCARRIER LEVEL control fully clockwise. Adjust the RF DEVIATION control to bring the meter pointer to "75 KC" on the red scale.

20. Set the SUBCARRIER switch to "SET 19 KC SUBCARRIER". Adjust the 19 KC SUBCARRIER LEVEL control to align the meter pointer with the "SET 19 KC SUBCARRIER" mark on the red meter scale.

21. Connect the oscilloscope probe to the left output of the multiplex circuit. Set the 10 K Stereo Balance potentiometer of the multiplex circuit to approximately mid-range. Note the waveform and amplitude of the signal. Carefully retune the primary of T-1 for maximum output and best sine waveform of the 1000 cps signal as noted on the oscilloscope. The trace should appear as shown in Figure 12A. Turn the FUNCTION switch of the Simulator to "STEREO RIGHT". Adjust the 10 K Stereo Balance potentiometer for mimimum response. The trace should appear as shown in Figure 12B.

22. Connect the oscilloscope probe to the right output of the multiplex circuit with the FUNCTION switch still set to "STEREO RIGHT". The amplitude and waveform should be about the same as that obtained in the previous step at the left output with the FUNCTION switch set to "STEREO LEFT" (Figure 12A). Set the Simulator FUNCTION switch to "STEREO LEFT". The signal from the right output should then drop to about the same level as was noted at the left output with the FUNCTION Switch set to "STEREO RIGHT".

The amount of channel separation can be determined by measuring the output of each channel with a meter equipped with a db scale, such as the RCA WV-76A AC VTVM or WV-38A VOM.

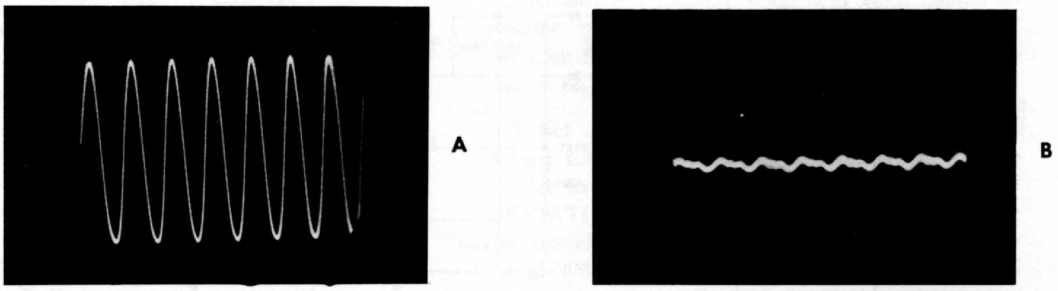


Figure 12. Stereo Output Showing Channel Separation

WR-52A Circuit Description

The circuit of the RCA WR-52A Stereo FM Signal Simulator incorporates six tubes and seven diodes. A block diagram of the instrument is shown in Figure 13, and a complete schematic diagram is on page 10.

An audio oscillator, V-1A, provides seven frequencies, selected by the FREQUENCY switch, S-3. This audio output is amplified by V-1B, and is available through the COMP SIG/AUDIO connector on the front panel of the instrument. This audio signal is also applied to the 38 Kc balanced modulator through the V-3A audio cathode follower.

The output of the 19 Kc crystal oscillator, V-2A, is fed to a buffer stage, V-4A. The output from this buffer stage is then sent through a phase shift network. By the particular setting of the FUNCTION switch, S-1, a resulting change is made in the phase relationship of the 19 Kc signal to provide the selected stereo output.

The 19 Kc output of V-2A is also coupled to a doubler stage, V-2B, which produces a 38 Kc signal. This 38 Kc output is amplified by V-4B, then fed to the 38 Kc balanced modulator. The 38 Kc carrier and the audio signal are combined to produce the main audio modulation, along with 38 Kc AM sidebands. The balanced modulation suppresses the 38 Kc carrier.

A low-pass type filter (L-5, L-6, and L-7) is used to filter all upper order harmonics of the 38 Kc signal. This filter is specifically designed to maintain the amplitude and proper phase relationships of the composite signal.

Both the 19 Kc pilot signal and the composite stereo signal are amplified by V-5A, then brought to the COMP SIG/AUDIO cable on the front panel as composite output for use in servicing multiplex circuits apart from the tuner.

The amplified audio output signal from V-5A is also connected to the reactance modulator, CR-5, which determines the deviation (up to 75 Kc) of the 100 Mc oscillator, V-6. By adjusting the front panel RF DEVIATION control, R-48, the amplitude of this modulating signal can be varied, causing the reactance modulator to vary the frequency of the 100 Mc oscillator. (Note that in frequency modulation, the *amplitude* of the modulating frequency determines the output *frequency swing* of the oscillator.) The center frequency of the 100 Mc carrier can be varied approximately ± 800 Kc with C-43, the CENTER RF FREQUENCY ADJUSTMENT on the front panel. The 100 Mc RF signal (about 0.1 volt) is fed through an attenuator control to the RF OUTPUT cable.

The 1 ma meter, M1, measures the voltage of the modulating signal, and is calibrated in terms of the resulting rf deviation.

The three-position switch, S-4, in the "19 KC OFF" position disables the 19 kc oscillator. This permits use of the monaural fm output without the distortion caused by 19 kc oscillator interference. In the "SET 19 KC SUBCARRIER" position, the audio oscillator is disconnected so that the only rf carrier modulation is the 19 kc subcarrier.

Maintenance

General

The performance of the RCA WR-52A depends on the high quality of the components employed. If it becomes necessary to replace any of the component parts, only RCA replacement parts or their equivalents should be used. When ordering replacement parts for the instrument, consult the Replacement Parts List on page 21.

Since the internal adjustments of the Stereo FM Signal Simulator require the use of laboratory-type test equipment, it is recommended that the instrument be serviced only by authorized RCA Electronic Instrument Service Depots. For the name and address of the Depot nearest you, contact the RCA Electronic Instrument Distributor in your area, or write to RCA Electronic Instruments, 415 South 5th Street, Harrison, New Jersey.

To remove the instrument from the case, take out the two screws from the under side of the front bezel and remove the bezel from the case. Remove the screws from the front panel, and from the rear of the case. Slide the instrument out through the front of the case.

Refer to figure 20 on page 20 showing location of internal adjustments. The schematic diagram is on pages 12 and 13.

Equipment Required

Oscilloscope, with low-capacitance probe RCA WO-91A, or equivalent.*

RF Crystal Calibrated Marker Generator, such as the RCA WR-99A

67 Kc (± 10 cps) signal source

19 Kc (±1 cps) signal source

FM tuner or receiver, with limiter stage

Before making any adjustments, turn on all equipment including the WR-52A, and allow 15 minutes for warm-up.

19 kc Oscillator Adjustment

1. Set the subcarrier switch to "NORMAL". Connect the low-capacitance probe from the oscilloscope to V-2, pin 1.

2. From the upper side of the chassis, adjust the core of L-1 fully counterclockwise, then clockwise until the circuit oscillates, as indicated by the oscilloscope trace. Adjust for maximum trace amplitude. Turn core an additional ¼-turn clockwise.

38 kc Adjustment

Connect the oscilloscope to the V-4, pin 7. Adjust L-2 and L-3 for maximum trace amplitude.

* The frequency compensating adjustments in the input of the oscilloscope must be properly set prior to using the instrument in the following procedure.

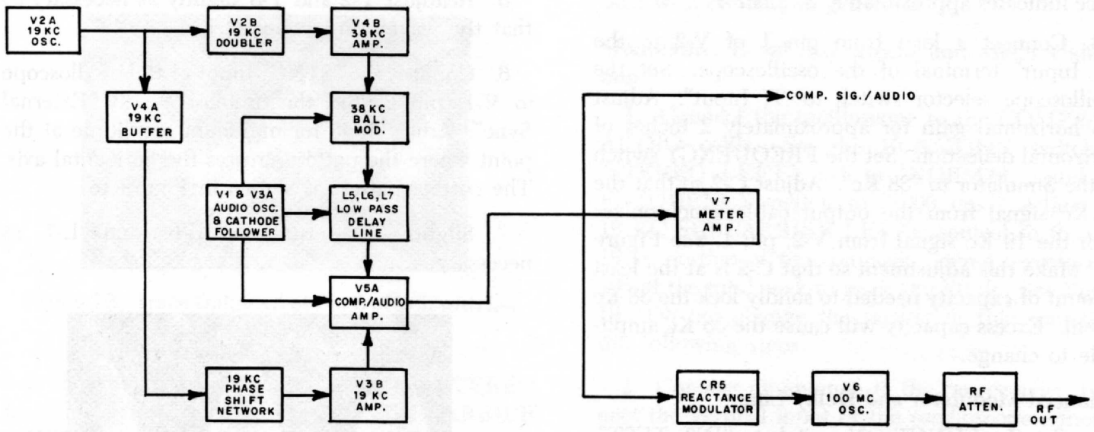


Figure 13. WR-52A Block Diagram

Audio Oscillator Adjustment

1. Set the FREQUENCY switch to "72 KC". Connect the oscilloscope to V-1, pin 3. Adjust R-15 for a trace amplitude of approximately 1.6 volts P-P. It is normal for the trace to jump and become intermittent while R-15 is being adjusted.

2. Turn the FREQUENCY switch to the other positions and check for oscillation. It is normal for a delay in oscillation to occur as the switch is turned from one position to another. The P-P voltage at 1000 cps should be no less than 1.6 volts.

3. If a distortion meter is available, check the distortion of the signal at the output cable. The distortion should not exceed 1.5% at 1000 cps.

Frequency Calibration

1. With the oscilloscope low-capacitance probe connected to pin 3 of V-1, connect the output of the 67 Kc signal source to the "H Input" terminals of the oscilloscope. Set the oscilloscope selector switch to "H Input". Set simulator FREQUENCY switch to "67 KC." Adjust C-4 for a circular pattern.

2. Remove the 67 Kc signal from the horizontal input of the oscilloscope. Connect the vertical probe (in direct position) to the COMP SIG/ AUDIO output cable, and set the oscilloscope selector switch to internal sync. Set the FREQUENCY switch to the "5 Kc" position. Adjust the AUDIO LEVEL control so that the oscilloscope trace indicates approximately 2 volts P-P.

3. Connect a lead from pin 1 of V-2 to the "H Input" terminal of the oscilloscope. Set the oscilloscope selector switch to "H Input". Adjust the horizontal gain for approximately 2 inches of horizontal deflection. Set the FREQUENCY switch of the Simulator to "38 Kc". Adjust C-2 so that the 38 Kc signal from the output cable synchronizes with the 19 Kc signal from V-2, pin 1. See Figure 14. Make this adjustment so that C-2 is at the least amount of capacity needed to solidly lock the 38 Kc signal. Excess capacity will cause the 38 Kc amplitude to change.

Balanced Modulator and Delay Line

1. Set the FUNCTION switch to "INT TEST", the 19 KC SUBCARRIER LEVEL control in minimum, and the COMP SIG LEVEL control to maximum. Connect the oscilloscope to the COMP SIG/ AUDIO output cable.

2. Remove V-1, 6CG7, from its socket. Set the sweep selector of the oscilloscope to "line", and adjust for a trace approximately 1 inch high.

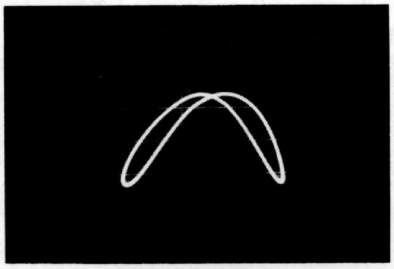


Figure 14. Proper Adjustment of C-2 Showing Synchronized 19 kc and 38 kc Signals

3. Pre-set the cores of T-2 and T-3 so that they are in the middle of their range, centered inside the coil windings. Adjust R-45 for minimum amplitude of the trace. Increase the vertical gain of the oscilloscope as necessary. Alternately adjust R-45 and T-3 for minimum signal amplitude. Replace the tube, V-1.

4. Set the FREQUENCY switch to "1000 cps". Set the oscilloscope sync selector switch to "+INT". Adjust coils L-5, L-6, and L-7 to obtain a waveform as shown in Figure 15. Figure 16 is shown as an example of misadjustment of these coils. The base line, or horizontal axis, of the waveform must be straight. Curving or tilting of this base line will result in a loss of separation in the stereo signal.

5. Readjust T-2 and T-3 slightly as necessary so that the waveform is symmetrical.

6. Connect the "SYNC" input of the oscilloscope to V-1, pin 2. Set the oscilloscope to "External Sync". Adjust R-45 for minimum amplitude at the point where the pattern crosses the horizontal axis. The correct pattern is shown in Figure 15.

7. Slightly readjust L-5, L-6, and L-7 as necessary.

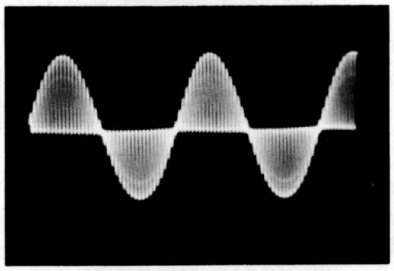


Figure 15. Trace Obtained at Output Cable With L-5, L-6, and L-7 Properly Adjusted

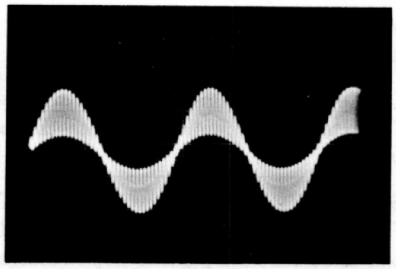


Figure 16. Trace Showing Improper Adjustment of L-5, L-6, and L7

19 KC Subcarrier Level Adjustment

1. Connect oscilloscope direct probe to pin 6 of V-5. Set the 19 KC SUBCARRIER LEVEL control fully clockwise, and the FUNCTION switch to "INT TEST". Adjust L-4 to obtain minimum 19 kc signal in the center of the trace. See Figure 17.

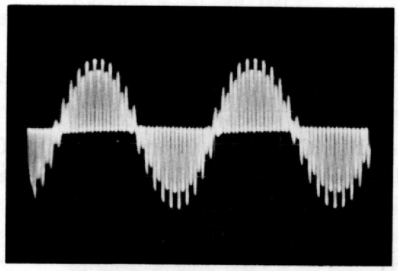


Figure 17. Trace Obtained at Pin 6 of V-5, with L-4 Adjusted For Minimum 19 Kc Signal

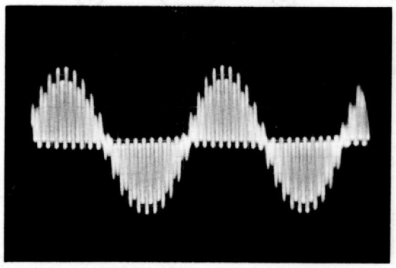


Figure 18. Trace Obtained at Pin 6 of V-5, with L-4 Improperly Adjusted

2. Set the FUNCTION switch to "STEREO LEFT", and turn the 19 KC SUBCARRIER LEVEL control clockwise to the eighth reference mark on the panel.

Connect the low-capacitance probe to the COMP SIG/AUDIO cable.

3. Adjust trimmer capacitor C-10 so that the 19 kc subcarrier is 10% of the entire composite signal. See Figure 19.

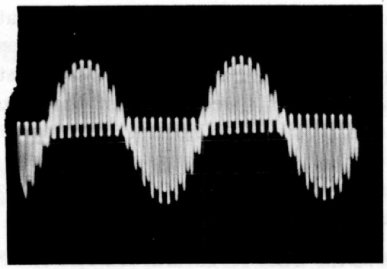


Figure 19. Trace Showing Proper Adjustment of C-10. 19 Kc Signal Is 10% of Entire Composite Signal

4. Reset the FUNCTION switch to "INT TEST" and check the adjustment of L-4 for minimum 19 kc signal as in step 1.

5. Set the FUNCTION switch to "STEREO RIGHT". The 19 kc signal level should be the same as in the "STEREO LEFT" position.

RF Carrier Adjustment

1. Set the FUNCTION switch to "AUDIO/MONO". Connect the RF OUT cable from the Simulator to the RF IN and GND inputs of the crystal-calibrated marker generator. Calibrate the marker generator to 100 Mc using the internal 10 Mc crystal. Turn the CAL/MOD switch of the generator to OFF, and the AF GAIN to maximum.

2. Adjust the RF CARRIER control of the Simulator to "0". Carefully adjust L-8 for a zero beat with the marker generator.

Modulation Level Adjustment and Meter Calibration.

1. Connect the oscilloscope to the COMP SIG/AUDIO cable. Set the FUNCTION switch to "STEREO LEFT", S-4 to "NORMAL", and the FREQUENCY switch to "1000 cps". Adjust the 19 KC SUBCARRIER LEVEL control so that the 19 kc portion of the composite stereo waveform is 10% of the total peak-to-peak amplitude. See Figure 19. Do not change the setting of this control in the following steps.

2. Connect an antenna to the fm receiver. Connect the vertical input of the oscilloscope either to the output of the tuner stage of the fm receiver at the fm detector, or to the speaker output of the amplifier, whichever is more convenient. Set the oscilloscope selector switch to "H Input". When a station is tuned in on the receiver, the receiver output will cause a vertical line on the oscilloscope screen, varying in amplitude with the modulation level of the signal being received.

3. Tune along the fm band and select the station that causes the most vertical deflection of the oscilloscope trace. The station should be broadcasting full volume music or speech. Adjust the volume control of the receiver for normal listening level. Adjust the oscilloscope for a trace with at least one inch of vertical deflection, and centered vertically on the screen.

4. Observe the trace for several minutes to determine the maximum amount of total vertical deflection (peak-to-peak voltage) caused by the extreme upper and lower peaks in the signal. These peaks will occur when the transmitted signal is close to 100% modulation, or 75 kc deviation of the rf carrier.

5. Remove the antenna from the receiver, and connect the RF OUT cable from the Simulator to the receiver antenna terminals. Set the FUNCTION SWITCH to "AUDIO/MONO", the FREQUENCY switch to "1000 cps", and the subcarrier switch to "19 KC OFF". Set the RF DEVIATION control to the eighth reference dot on the panel.

6. Tune the receiver to the 100 Mc signal from the Simulator. Adjust potentiometer R-19 to the center of its range. Adjust R-49 so that the oscilloscope trace has the same vertical amplitude (peak-to-peak voltage) as noted from the station signal in step 4.

7. Connect the oscilloscope probe to the center lug of potentiometer R-49, and note the peak-to-peak voltage.

8. Set the FUNCTION switch to "STEREO LEFT" and the subcarrier switch to "NORMAL". Adjust R-49 so that the peak-to-peak voltage at the center lug of R-49 is the same as that obtained in step 7.

9. Adjust potentiometer R-63 so that the meter pointer indicates 75 kc (full-scale deflection).

10. Set the FUNCTION switch to "AUDIO/MONO", and S-4 to "19 KC OFF". Adjust R-19 so that the peak-to-peak voltage obtained at the center lug of R-49 is the same as that obtained in step 7.

11. Adjust R-46 so that the meter pointer indicates 75 kc (full-scale deflection).

12. Set the FUNCTION switch to "STEREO LEFT", and the subcarrier switch to "SET 19 KC SUBCARRIER". Adjust trimmer capacitor C-51 so that the meter pointer is aligned with the "SET 19 KC SUBCARRIER" mark on the meter.

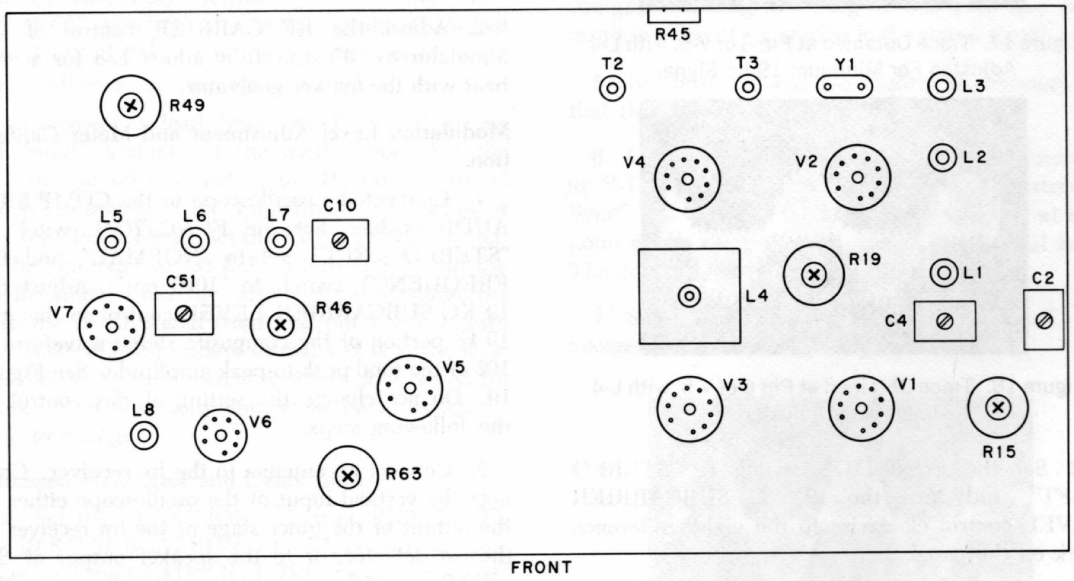


Figure 20. Location of Adjustments On Underside of WR-52A Chassis

Replacement Parts List

WR-52A

When ordering replacement parts, include serial number and code number of instrument. Order parts by stock number, through a local RCA Distributor.

Symbol No.	Description	Stock No.
	Capacitors	
C1	Ceramic Disc, 680 pf	
C2	Trimmer, 3-30 pf	
C3	Mica, 910 pf, 100 v, 2%	260053
C4	Trimmer, 9-180 pf	210133
C5	Mica, 1000 pf, 100 v, 2%	219195
C6	Electrolytic, 50 mfd, 150 v.	109227
C7	Molded, .1 mfd, 200 v.	228040
C8, C9, C47, C48	Electrolytic, 4 mfd, 150 v	
C10	Trimmer, 25-280 pf	228036
C11, C14	Mica, 1800 pf, 500 v, 5%	215380
C12	Molded, .022 mfd, 600 v.	228042
C15	Ceramic Disc, .22 mfd, 10 v.	218461
C16	Molded, 40 mfd, 150 v.	228035
C17, C18	Electrolytic, 10 mfd, 250 v.	233914
C19	Molded, .1 mfd, 400 v	
C20	Ceramic Disc, 330 pf	
C21	Molded, .018 mfd, 600 v.	228045
C22	Ceramic Disc, 220 pf, 1000 v, 10%	228037
C23, C26	Molded, .022 mfd, 400 v, 10%	228034
C24	Ceramic Disc, 100 pf	
C25	Ceramic Disc, 470 pf	
C27	Molded, .039 mfd, 600 v, 10%	228039
C28	Ceramic Disc, .1 mfd, 10 v, −80% +20%	218457
C29	Molded, .022 mfd, 600 v.	228042
C30, C31	Mica, 3900 pf, 500 v, 5%	921796
C32, C34	Mica, 430 pf, 500 v.	106944
C33	Mica, 220 pf, 500 v.	300187
C35, C36	Mica, 820 pf, 500 v, 10%	219743
C37, C38	Ceramic Disc, .01 mfd, GMV 1400 v. DC	220880
C39	Electrolytic, 100/200/200 mfd, 175 v.	228043
C40, C44	Ceramic "feed-thru" 1000 pf, 500 v.	225758
C41, C42	Ceramic 15 pf, 400 v	
C43	Variable, 3.3—7.9 mfd.	228044
C45, C46, C19, C19A	Ceramic Disc, .05 mfd	
C49	Ceramic Disc, .01 mfd	
C50	Ceramic Disc, 22 pf	
C51	Trimmer, 140-650 pf	233913
	Resistors	
R1	279.5k, ½ watt, 1%	228015
R2	111.3k, ½ watt, 1%	228016
R3	22.1k, ½ watt, 1%	921331
R4	2781 ohms, ½ watt, 1%	
R5	1490 ohms, ½ watt, 1%	
R6	1385 ohms, ½ watt, 1%	
R7	559k, ½ watt, 1%	228022
R8	222.5k, ½ watt, 1%	228023
R9	44.2k, ½ watt, 1%	228024
R10	100k, ½ watt, 10%	
R11	5562 ohms, ½ watt, 1%	
R12	2980 ohms, ½ watt, 1%	
R13	2770 ohms, ½ watt, 1%	
R14	470k, ½ watt, 1%	
R15	Variable, 2000 ohms	233901
R16	560 ohms, ½ watt, 10%	
R17, R61	47k, ½ watt, 10%	
R18	18k, ½ watt, 10%	
R19	Variable, 500 ohms, 20%	233902
R20	820k, ½ watt, 20%	
R21	1.5 meg., ½ watt, 10%	
R22, R33, R34, R51	4700 ohms, ½ watt, 10%	
R23, R39	180k, ½ watt, 10%	
R24	1200 ohms, ½ watt, 10%	
R25	Variable 5k, w/switch S-2	228032
R26	820k, ½ watt, 20%	
R27, R28	4700 ohms, ½ watt, 5%	502247
R29	2700 ohms, ½ watt, 5%	
R31	4700 ohms, ½ watt, 5%	
R32	1 meg., ½ watt, 5%	
R35, R43	100 ohms, ½ watt, 10%	
R36	560 ohms, ½ watt, 10%	
R37, R40	470k, ½ watt, 10%	

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Replacement Parts List (Continued)

Symbol No.	Description	Stock No.
R38	10 meg., ½ watt, 20%	
R41	390 ohms, ½ watt, 10%	
R42	270k, ½ watt, 10%	
R44	1500 ohms, ½ watt, 10%	
R45	Variable, 10k	233904
R46	Variable, 250 ohms, 20%	233905
R47	3900 ohms, ½ watt, 5%	
R48	Variable, 5k	228423
R49	Variable, 10k	233905
R50	750 ohms, 20 watts, 10%	
R52	Variable, 100 ohms, 20%	233908
R53	100k, ½ watt, 10%	
R54	47 ohms, ½ watt, 10%	
R55	100 ohms, ½ watt, 10%	
R56	56k, ½ watt, 10%	
R57	1.2 meg., ½ watt, 10%	
R58, R59	10k, ½ watt, 10%	
R60, R66	470k, ½ watt, 10%	
R62, R64	1000 ohms, ½ watt, 10%	
R63	Variable, 10k	233907
R65	5.6k, ½ watt, 10%	
R67, R68, R69	120 ohms, ½ watt, 10%	
	Switches	
S1	Function Switch, 5-position	228046
S2	Part of R-25, AC-off	
S3	Frequency Switch, 8-position	228047
S4	Slide Switch, 3-position	233921

Symbol No.	Description	Stock No.
	Coils	
L1	Adjustable Coil, 8 mh	
L2, L3	Adjustable Coil, 800 mh	
L4	Adjustable Coil, 2.6 mh	
L5, L7	Adjustable Coil, 4-30 mh	
L6	Adjustable Coil	
L8	RF Coil	233920
L9	Coil, 2.2 mh	233922
	Miscellaneous	
M1	Meter, 0 to 1 MA	233910
T1	Transformer, power	228059
T2, T3	Transformer, w/slug	228060
CR1	Silicon Diode, 1N1764	106379
CR2, CR3	Crystal Diode, 1N192	228050
CR4	Silicon Diode, 1N3005	
CR5	Varicap	227514
CR6, CR7	Crystal Diode, 1N87	230099
Y1	Crystal, 19 kc.	228048
DS1	Lamp, 3 watt, 115 v, type 3S6	51462
DS2	Pilot Lamp, neon	229727
	Panel	233909
	Handle	211885
	*Knob, blue plastic, large	211953
	*Knob, blue plastic, small	98481
	**Knob, black, large	418552
	**Knob, black, small	418551
	Shell, for output cables	219486
	Binding Post, black	249524

*For units with serial numbers below 3000.
**For units with serial numbers over 3000.