SG165
AM-FM
STEREO ANALYZER

SERVICE MANUAL

SENCORE

"the all american line"

SENCORE SAFETY REMINDERS

When testing electronic equipment, there is always a danger present. Unexpected high voltages can be present at unusual locations in defective equipment. The technician should become familiar with the device that he is working on and observe the following precautions.

1. When making test lead connections to high voltage points, remove the power. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket as a safety precaution and stand on an insulated floor to reduce the possibility of shock.

2. Discharge filter capacitors before connecting test leads to them. Capacitors can store a charge that could be dangerous to the technician.

3. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose the technician to dangerous potentials.

4. Remove the test leads immediately after the test has been completed to reduce the possibility of shock.

5. Do not work alone when working on hazardous circuits. Always have another person close by in case of accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with high voltages.

6. When using the SG165 for signal injection, be sure to discharge the capacitor in the 39G43 probe to chassis before each connection. If this capacitor, charged to a large DC voltage, is connected to the base of a transistor, possible damage to the transistor will result.

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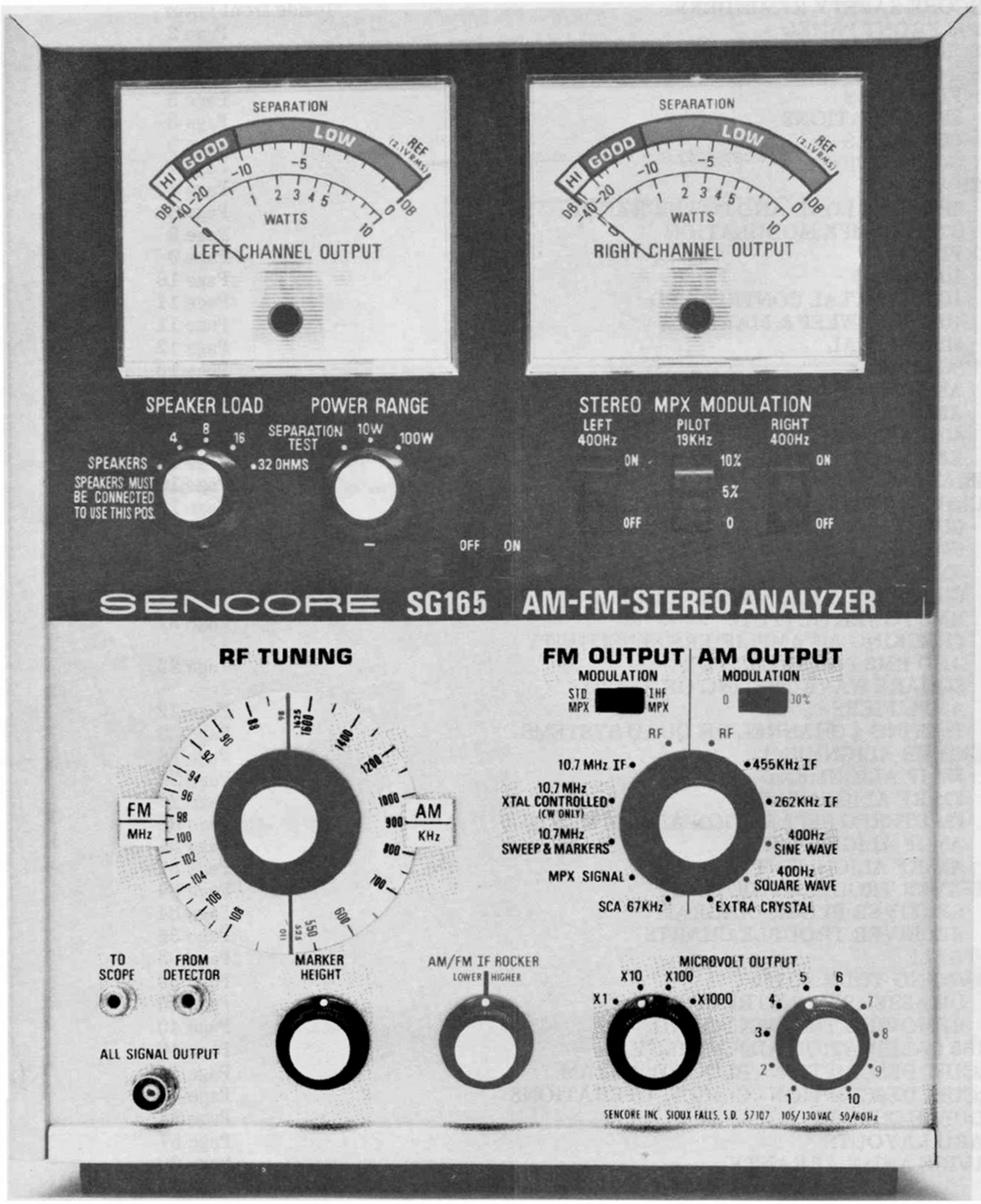


Fig. 1   SG165 Front Panel

DESCRIPTION

INTRODUCTION

The AM/FM/FM MPX receiver represents the fastest growing segment of the home entertainment electronics market. Many consumers consider the sound system, whether component or console, their first purchase after the essentials of food and shelter.

These consumers demand, and are willing to pay relatively large sums for, quality reproduction of their favorite music. When this equipment requires service they expect the repaired unit to meet the same exacting specifications it did when new. The technician who attempts to test, troubleshoot and align a stereo system, costing in some cases thousands of dollars, without proper equipment has a difficult task ahead of him. This need for a reasonably priced stereo analyzer to adequately service and test stereo units prompted Sencore to engineer the SG165 complete AM/FM/Stereo Analyzer. The SG165, with its accurate temperature compensated solid state circuitry, eliminates the guess work by providing known accurate signals needed for full troubleshooting and performance testing from antenna to speaker terminals.

FEATURES

* Complete RF coverage of the AM and FM bands, with band edge limits as recommended by receiver manufacturers.
* Troubleshooting signals for the FM IF, AM IF, MPX, and audio circuits.
* Crystal controlled as well as swept 10.7MHz with post injection crystal controlled 10.7MHz marker, and 100KHz limit markers for FM IF alignment.
* Tight shielding; no RF leakage to cause problems.
* 19KHz phase and frequency permanently locked with exclusive Sencore (patent pending) circuit.
* Built in 4, 8, 16, and 32 ohm high wattage dummy loads to eliminate the annoying howl in the shop.
* Meters calibrated in db of separation and wattage output up to 100 watts full scale. Compensated to read accurate power output for any speaker load resistor.
* Calibrated RF output for making the all important IHF sensitivity check.
* Complete with all cables and adapters including dummy auto antenna connector.

SPECIFICATIONS

NOTE: 1. All percentages are plus and minus unless otherwise noted.
2. Temperature range for specified outputs 10 - 40 degrees C unless otherwise noted.

EXTRA CRYSTAL

Holder type	HC6U
Frequency Range	3 - 12MHz
Circuit loading to crystal	15pf

400Hz SINE WAVE

Frequency	400Hz 20%
Amplitude	1V RMS 5%
Distortion	5% maximum

400Hz SQUARE WAVE

Frequency	400Hz 20%
Amplitude	2.8V p-p 30%
Rise Time	2 uSec. max.

262KHz and 455KHz IF

Frequency (in center detent)	262KHz or 455KHz 2%
Rocker frequency range	25KHz above and below center
Amplitude	.1V RMS 30%
Modulation percentage	25% to 45% 30% typical

AM RF

Frequency range	525KHz to 1625KHz
Dial calibration at 550 and 1600KHz	±5KHz at 20 degrees C; ±10KHz 10 to 40 degrees C
Amplitude	100mV 5% at 1000 KHz, 20% 525KHz to 1625KHz
Modulation percentage	25% to 45% 30% typical

FM RF

Frequency range	86 to 110MHz

Dial calibration at 88 and 108MHz	± 200KHz at 20 degrees C
Dial tracking	±300KHz any mark, 20 degrees C
Frequency change with temperature	±200KHz, 10 - 40 degrees C
Amplitude (MICRO-VOLT OUTPUT set to 10 X 10) at 98MHz	100uV 10%
Amplitude tracking	20% 86 to 110MHz
Modulation	STD: 30% (22.5KHz) 20% IHF: 100% (75KHz) 20%

10.7MHz IF

Frequency (center detent)	10.7MHz 1%
Rocker range	250KHz above and below center
Amplitude	.1V RMS 10%
Modulation percentage	STD: 30% (22.5KHz) 20% IHF: 100% (75KHz) 20%

10.7MHz CRYSTAL

Frequency	10.7MHz, .05%
Amplitude	.065V RMS 40%

10.7 SWEEP AND MARKER

Sweep width	500KHz typical
Center Frequency	Rocker will center sweep to 10.7MHz
10.7MHz marker	
Frequency	10.7MHz .05%
Amplitude	1V p-p minimum
100KHz limit markers	
Frequency	100KHz 3%
Amplitude	40% of 10.7MHz marker typical

MPX SIGNAL

Frequency of 19KHz pilot	19KHz ± 2Hz
Phase of 19KHz vs 38KHz	permanently locked to exceed FCC specifications with Sencore exclusive (patent pending) phase lock circuit.
Amplitude (modulation set to IHF)	2.5V p-p 25%

SCA 67KHz

Frequency	67KHz 3%
Amplitude	1V RMS 40%
Distortion	5% maximum

ATTENUATOR

Step attenuator	Calibrated 20db (X10) steps
Variable attenuator	
FM RF	0 to 18db typical
All other outputs	0 to 20db minimum

SG165 SPEAKER LOAD METER AND WATTS RANGE SPECIFICATIONS

The meters on the SG165 measure the voltage across the speaker load, as selected by the SPEAKER LOAD switch. The sensitivity of this voltage measurement is automatically compensated to maintain wattage calibration for the 4, 8, 16 and 32 ohm positions of the SPEAKER LOAD switch. In the SPEAKERS position of the SPEAKER LOAD switch, the meter is compensated to read the correct wattage at 8 ohms. The accuracy of this voltage measurement is ± 8% for any position of the SPEAKER LOAD or METER WATTS RANGE switches. The actual accuracy of the wattage measurement is further affected by the 5% tolerance of the high wattage speaker load resistors. The continuous power dissipation rating of the speaker load resistors is 20 watts RMS to be derated at higher power levels to 100 watts RMS per channel maximum for a maximum of 5 minutes followed by a minimum of 10 minutes cooling off time.

The SEPARATION scale on the meter uses 2.1 volts RMS as the reference and is calibrated in db (voltage ratio) to a usable 40 db of separation.

CABLES SUPPLIED

1 - BNC to "F" connector cable to connect to the SG165 ALL SIGNALS OUTPUT.

1 - Matching pad, (39G43) with 300 ohm balanced (red and green leads) and 75 ohm unbalanced (red and black leads) outputs. (Mates with "F" connector on cable.)

1 - Combination detector probe (39G45) with high impedance detector (blue lead) and isolation resistor (red lead).

1 - Auto radio dummy antenna (39G53) to mate "F" connector to auto radio antenna socket.

1 - Phono plug to alligator clip lead to connect to the TO SCOPE jack. May also be used in

conjunction with the 39G43 to inject signals into phono plug inputs of equipment under test.

CABLES OPTIONAL

1 - BNC to phono plug (39G47) for connection of TO SCOPE jack to scopes having BNC inputs. May also be used to connect ALL SIGNALS OUTPUT directly to phono plug inputs of equipment under test.

GENERAL

Height	12¼" (32.2 cm)
Width	10" (25.4 cm)
Depth	9" (22.9 cm)
Weight	18 lbs (8.2 kg)
Power requirements	105-130VAC 50/60Hz 7 watts

CONTROLS

ON-OFF - This slide switch controls the AC power input to the SG165. The ON contition is indicated by the red indicator lamp above the switch.

Fig. 2 Speaker Load and Power Range Switches

SPEAKER LOAD - This rotary switch selects the load connected across the LEFT AND RIGHT CHANNEL OUTPUT meters. The SPEAKERS position provides no load other than the meter circuitry. The SPEAKERS MUST BE CONNECTED to use this position.

POWER RANGE - This rotary switch selects the full scale sensitivity of the LEFT and RIGHT CHANNEL OUTPUT meters. The sensitivity for the SEPARATION TEST position is 2.1 volts RMS full scale. In the 10W and 100W positions, the SPEAKER LOAD switch automatically adjusts the sensitivity of the meters to maintain accurate wattage calibration for the 4, 8, 16, and 32 ohm speaker loads. In the SPEAKERS ONLY position the meters are compensated to read the correct wattage for 8 ohm speakers.

Fig. 3 Stereo MPX Modulation

STEREO MPX MODULATION - These three rocker switches control the MPX signal produced by the SG165. The LEFT 400Hz switch controls the left channel signal, and the RIGHT 400Hz switch controls the right channel signal. The 19KHz PILOT switch selects the percentage of modulation of the 19KHz pilot signal. The MPX signal as selected by the STEREO MPX CONTROLS is used to FM modulate the FM RF OUTPUT and the 10.7MHz IF signal. It is also available as an output for direct injection into the MPX decoder circuit of the receiver (MPX SIGNAL position of output control).

OUTPUT SELECTOR SWITCH

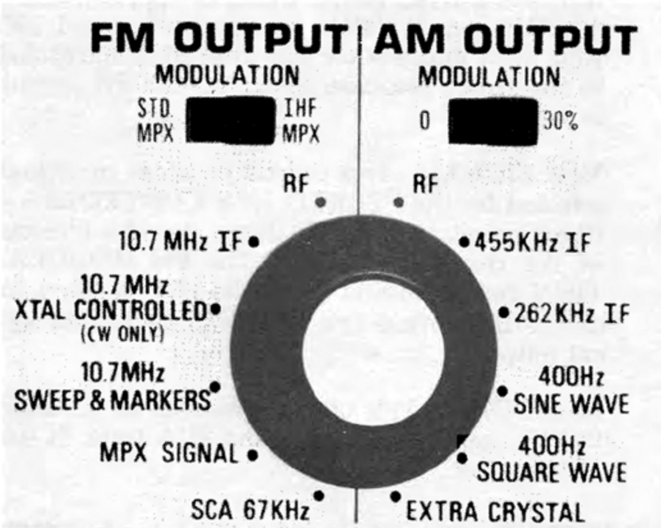


Fig. 4 Output Selector

FM OUTPUT - The left hand side of the OUTPUT SELECTOR SWITCH selects the various outputs necessary to test, troubleshoot or align an FM or FM MPX receiver.

MODULATION - This slide switch selects the percentage of modulation of the FM RF and 10.7MHz IF signals. The STD MPX position provides 30% modulation (22.5KHz deviation) as used by most FM stations, and the IHF MPX position provides 100% modulation (75KHz deviation) for the IHF sensitivity test. The setting of the MODULATION switch will also affect the level of the MPX SIGNAL output, and should be in the IHF position to provide the normal one volt RMS MPX Signal output.

RF - This output provides an FM RF signal tunable from 86MHz to 110MHz, and frequency modulated with the signal selected by the STEREO MPX CONTROLS.

10.7MHz IF - This output provides a 10.7MHz signal for injection into the IF amplifiers of the FM receiver. It is tunable from approximately 10.45MHz to 10.95MHz by the AM/FM IF ROCKER control and frequency modulated with the signal selected by the STEREO MPX CONTROLS.

10.7MHz CRYSTAL CONTROLLED (CW ONLY) - This output provides an accurate crystal controlled signal for peak alignment of standard FM IF amplifiers.

10.7MHz SWEEP AND MARKERS - This output provides a sweep signal with a center frequency tunable from approximately 10.45MHz to 10.95MHz by the AM/FM IF ROCKER control, and a fixed sweep width of approximately 500KHz. A 10.7MHz crystal marker and 100 KHz limit markers are also generated and added to the sweep response at the TO SCOPE output jack.

MPX SIGNAL - This output provides the signal selected by the STEREO MPX CONTROLS for direct injection into the stereo decoder circuits of the receiver. NOTE: The FM MODULATION switch should be in the IHF position to obtain the normal one volt RMS maximum signal output.

SCA 67KHz - This output provides an accurate 67KHz signal for aligning the SCA traps in the FM receiver.

AM OUTPUT - The right hand side of the OUTPUT SELECTOR SWITCH selects the signals necessary to test, troubleshoot, or align an AM receiver; the 400 Hz sine and square wave signals, and the signal provided by the extra crystal position (crystal not supplied).

MODULATION - This slide switch selects the percentage of amplitude modulation (0 or 30%) of the AM RF, 455KHz IF, and 262KHz IF signals.

RF - This output provides an AM RF signal tunable from 525KHz to 1625KHz and amplitude modulated at 0 or 30% by a 400Hz sine wave as selected by the MODULATION switch.

455KHz and 262KHz IF - These outputs provide signals for injection into the IF amplifiers of standard AM receivers. They can be amplitude modulated at 0 or 30% by a 400Hz sine wave as selected by the MODULATION switch, and are tunable over the range of ±25KHz by the AM/FM IF ROCKER control.

400Hz SINE WAVE and 400Hz SQUARE WAVE - These outputs provide audio signals for direct injection into the audio amplifier sections of any AM or FM receiver.

EXTRA CRYSTAL - This output selects the signal generated by a separate internal crystal oscillator (crystal not supplied) for injection into any receiver requiring a nonstandard frequency. The oscillator will accept crystals contained in an HC6U holder in the frequency range of 3 to 12MHz.

RF TUNING - This dial tunes the FM and AM RF outputs. The FM output is tunable from 86 to 110

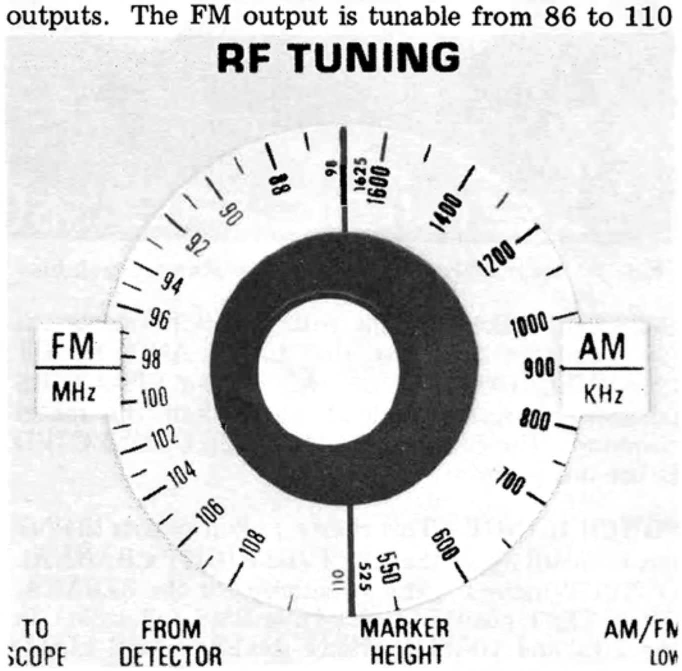


Fig. 5 RF Tuning control

MHz, and the AM from 525 to 1625KHz. A 4 to 1 drive ratio is provided for increased tuning accuracy.

Fig. 6 Marker Height Control

MARKER HEIGHT - This control is operational only in the 10.7MHz SWEEP & MKRS. output. Its function is to vary the size (amplitude) of the 10.6, 10.7, and 10.8MHz markers that are added to the response curve at the TO SCOPE jack.

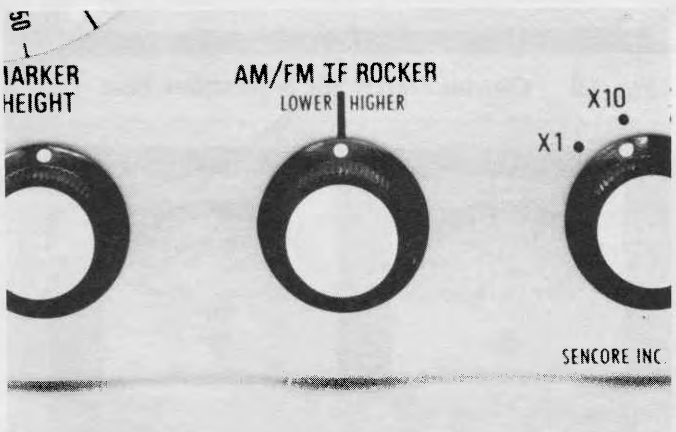


Fig. 7 AM/FM IF ROCKER control

AM/FM IF ROCKER - This control provides a variable tuning for the 262KHz IF, 455KHz IF, 10.7MHz IF, and 10.7MHz sweep to accomodate the newer receivers with crystal filter IF's. The range of control is typically ± 25KHz for the 262KHz and 455 KHz AM IF signals, and ±250KHz for the 10.7MHz FM IF and 10.7MHz sweep signals. The center detent indicates the normal calibrated output frequency.

MICROVOLT OUTPUT - The output level of the SG165 is controlled by two attenuators. The coarse control is calibrated in 20db (X10) steps, and the fine control provides an additional attenuation of approximately 20db (X10).

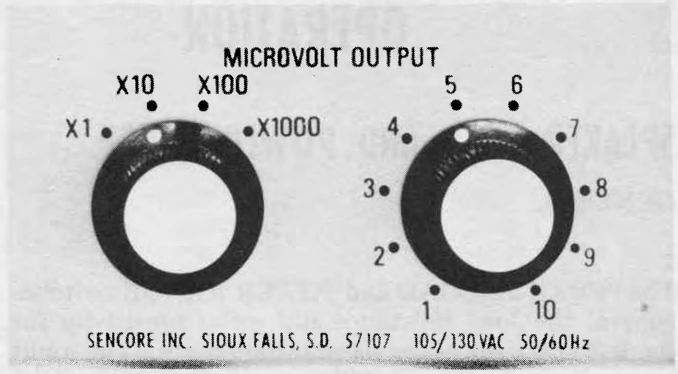


Fig. 8 Microvolt Output Controls

CONNECTIONS

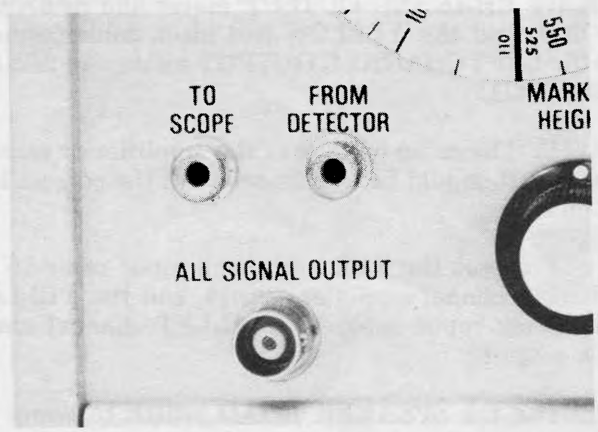


Fig. 9 Front Panel Connections

ALL SIGNALS OUTPUT - This BNC connector is the output terminal for all functions of the SG165. The SG165 should only be used with the properly terminated output cable to prevent standing waves which could result in inaccurate outputs.

FROM DETECTOR - This phono jack is the input for the response curve signal when the 10.7MHz SWEEP & MKRS. function is in use. Use the 39G45 detector input cable to couple the response curve from the receiver into this jack.

TO SCOPE - This phono jack is the output to the oscilloscope vertical input for use with the 10.7MHz SWEEP & MKRS. function. The signal leaving the SG165 at the TO SCOPE jack is the same as that applied to the FROM DETECTOR jack, with the 10.6, 10.7, and 10.8MHz markers added to it.

LEFT AND RIGHT CHANNEL OUTPUT METER Leads - The two shielded alligator clip leads attached inside the lead compartment near the line cord are the input leads for the OUTPUT METERS. The RED and black lead is for the RIGHT channel, and the YELLOW and black lead for the LEFT channel.

OPERATION

SPEAKER LOAD AND POWER RANGE

GENERAL

The SPEAKER LOAD and POWER RANGE switches control the load resistance and meter sensitivity for the left and right channels simultaneously. The input connections for the OUTPUT meters and SPEAKER LOADS are the shielded cables attached to the SG165 inside the lead compartment near the line cord and fuse. The RED and black cable connects to the RIGHT CHANNEL OUTPUT meter and SPEAKER LOAD, and the YELLOW and black cable connects to the LEFT CHANNEL OUTPUT meter and SPEAKER LOAD.

NOTE: The audio outputs of the amplifier or receiver under test should be terminated with the correct load at all times.

1. Connect the RED and black input cable to the RIGHT channel amplifier output, and the YELLOW and black input cable to the LEFT channel amplifier output.

2. Use the SPEAKER LOAD switch to select the correct load for the amplifier under test. Note that in the SPEAKERS position, no load other than the meter circuit is provided to the amplifier, and an external load such as speakers must be connected to the amplifier to prevent possible damage to the amplifier output stage. Take care to limit the input power to the SG165 speaker loads to an absolute maximum of 100 watts RMS per channel.

SEPARATION TEST

Turn the POWER RANGE switch to the SEPARATION TEST position, and read the 0 to -40db scale on the LEFT and RIGHT CHANNEL OUTPUT meters.

POWER OUTPUT TEST

Turn the POWER RANGE switch to the 10W or 100W position. Read the power output directly in watts on the 0 to 10W scale for the 10W position of the POWER RANGE switch, or multiply the meter reading by 10 for the 100W position.

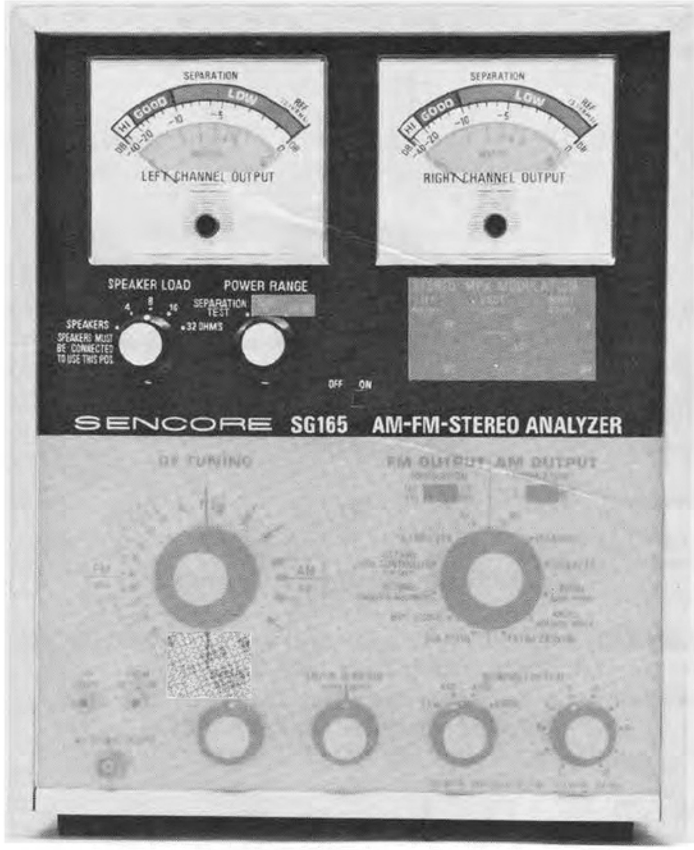


Fig. 10 Output Meters for Separation Test

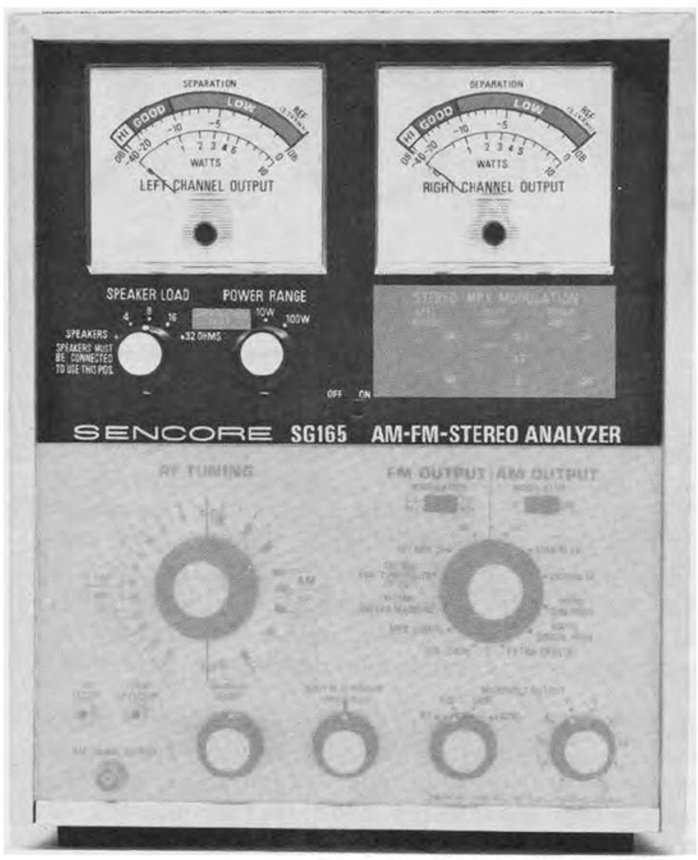


Fig. 11 Output Meters for Power Output Test

STEREO MPX MODULATION

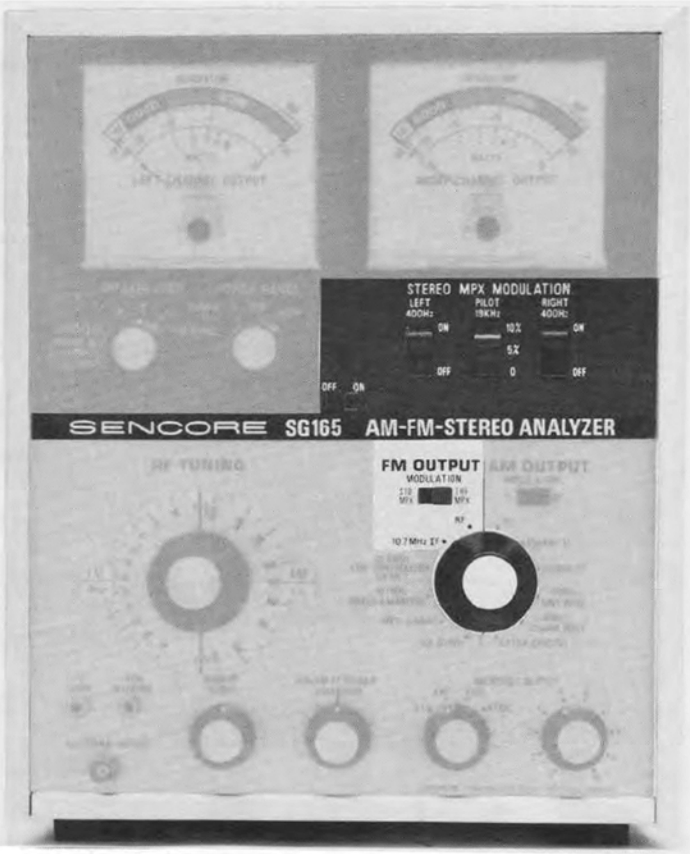


Fig. 12 Stereo MPX Modulation Controls

The STEREO MPX CONTROLS are operational only in the FM RF, 10.7MHz IF, and the MPX SIGNAL positions of the output selector switch. In the FM RF and 10.7MHz IF positions, the MPX signal selected by the MPX CONTROLS is used to frequency modulate the output carriers. In the MPX SIGNAL position, the signal selected by the controls is available as a direct output. NOTE: The FM Modulation switch must be in the IHF MPX position to produce the rated 1V RMS MPX signal. The following table specifies the switch positions necessary to produce the indicated signals with the STEREO MPX CONTROLS:

Monophonic 400Hz audio	LEFT 400Hz-ON RIGHT 400Hz-ON PILOT 19KHz-Zero
Stereo, Left channel only	LEFT 400Hz-ON RIGHT 400Hz-OFF PILOT 19KHz - 10%
Stereo, right channel only	LEFT 400Hz-OFF RIGHT 400Hz-ON PILOT 19KHz - 10%
19KHz sine wave (.1V RMS Max. in MPX SIGNAL output)	LEFT 400Hz-OFF RIGHT 400Hz-OFF PILOT 19KHz-10%

FM RF

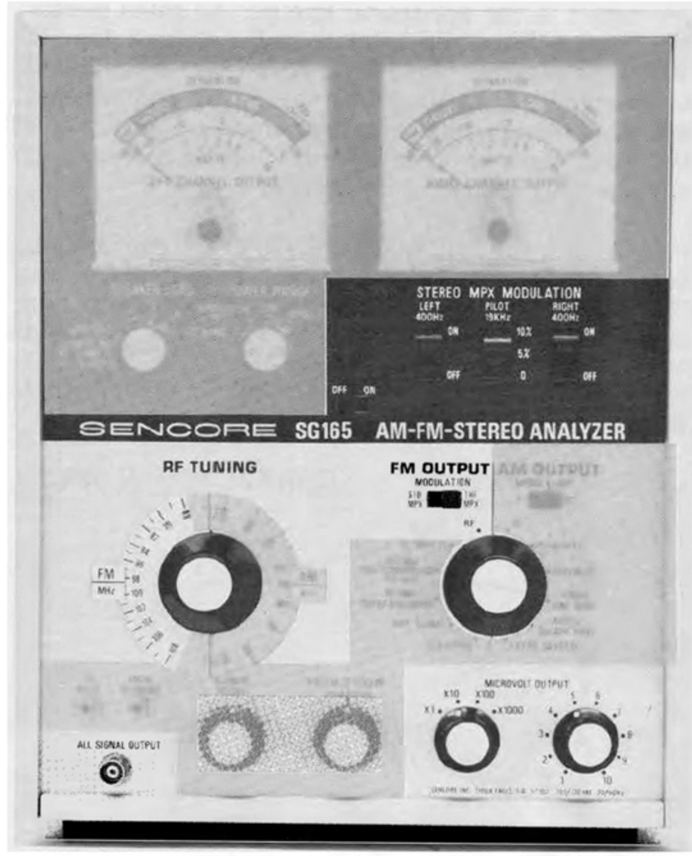


Fig. 13 Operational Controls for FM RF

The FM RF output is used to inject a signal with composite stereo modulation into the antenna input of any standard broadcast FM receiver. The tuning range of the FM RF is from 86 to 110MHz, allowing coverage of band edge limits as recommended by some manufacturers of FM receivers. To use the FM RF output, proceed as follows:

1. Set the SG165 OUTPUT selector to FM RF, and connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT BNC connector.

2. Connect either the 39G43 75/300 ohm matching pad, or the 39G53 auto radio dummy antenna to the "F" connector end of the cable. Use the red and green leads of the 39G43 for 300 ohm receiver inputs or the red and black leads for 75 ohm inputs.

3. Adjust the STEREO MPX CONTROLS for the desired modulation signal. (Refer to the STEREO MPX CONTROLS-OPERATION section of this manual).

4. Set the FM MODULATION control to STD MPX for 30% (±22.5KHz) modulation, or to IHF MPX for 100% (± 75KHz) modulation.

5. Adjust the RF TUNING control for the desired output frequency. The dial indicator for the FM RF

frequency is the horizontal line on the small rectangle labeled FM MHz located to the left of the RF TUNING control. The RF TUNING dial is calibrated at intervals of 1MHz, with the small unnumbered marks corresponding to odd numbers. For example the small mark between 98 and 100MHz corresponds to an output frequency of 99MHz.

6. Adjust the MICROVOLT OUTPUT controls for the desired output signal level. To determine the signal output level (measured in microvolts at the ALL SIGNALS OUTPUT) for the FM RF output multiply the setting of the coarse MICROVOLT OUTPUT control by the corrected vernier control output from the table.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.1
8	6.4
7	5.1
6	4.0
5	3.0
4	2.4
3	1.8
2	1.4
1	1.2

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

10.7MHz IF

The 10.7MHz IF output is used to inject a signal with composite stereo modulation into the IF amplifiers of standard broadcast FM receivers for test and troubleshooting purposes. The frequency of the 10.7 MHz output is variable from approximately 10.45 to 10.95MHz with the AM/FM IF ROCKER control to allow injection of this signal into the IF amplifiers of receivers employing fix tuned or crystal filter IF amplifiers. The 10.7MHz IF signal is intended primarily as a troubleshooting signal. The stage gain of each IF stage can be determined by injecting 10.7 MHz IF signal into the input of each IF stage and noting the signal level required by each stage to produce a given output. To use the 10.7MHz IF output, proceed as follows:

1. Set the SG165 OUTPUT selector to 10.7MHz IF, and connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT BNC connector.

2. Connect the 39G43 75/300 ohm matching pad to the "F" connector end of the cable. Use the red and black leads of the 39G43 to inject the 10.7MHz IF signal.

Fig. 14 Operational Controls for 10.7MHz IF

3. Adjust the STEREO MPX CONTROLS for the desired modulation signal. (Refer to the STEREO MPX CONTROLS - OPERATION section of this manual.)

4. Set the FM MODULATION control to STD MPX for 30% (± 22.5KHz) modulation, or to IHF MPX for 100% (± 75KHz) modulation.

5. Adjust the AM/FM IF ROCKER control if the receiver being tested uses crystal filter or fix tuned IF's. The normal adjustment procedure for the ROCKER control is to inject the 10.7MHz IF signal into the receiver, and adjust the control for maximum undistorted signal at the output of the receiver.

6. Adjust the MICROVOLT OUTPUT controls for the desired output signal level. To determine the signal output level (measured in microvolts at the ALL SIGNALS OUTPUT) for the 10.7MHz IF output, multiply the setting of the coarse MICROVOLT OUTPUT control by 10, and the result by the correced vernier control output from the table.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.3
8	6.9

7	4.8
6	3.5
5	2.5
4	1.7
3	1.2
2	.87
1	.54

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

10.7MHz XTAL CONTROLLED

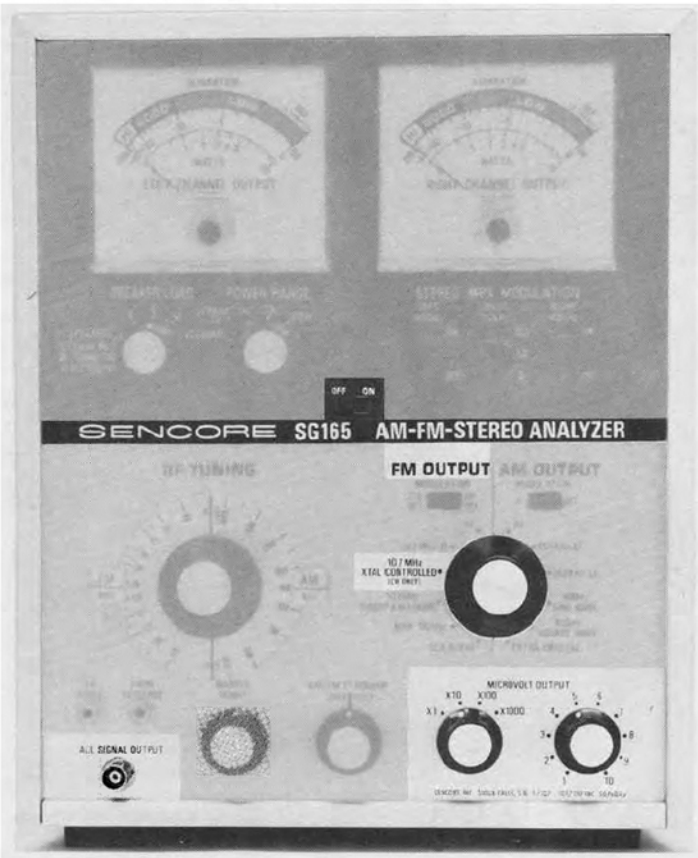


Fig. 15 Operational Controls for 10.7MHz Crystal

The 10.7MHz CRYSTAL CONTROLLED output provides an accurate 10.7MHz crystal controlled un-modulated signal for aligning the IF amplifiers of standard FM broadcase receivers. It can be used to accurately peak align the receiver IF amplifiers to 10.7MHz, or as a preliminary step to sweep alignment. The 10.7MHz crystal controlled signal also provides the most accurate method for zeroing the FM detector to exactly 10.7MHz. To use the 10.7 MHz CRYSTAL CONTROLLED signal, proceed as follows:

1. Set the SG165 OUTPUT selector to 10.7MHz CRYSTAL CONTROLLED, and connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT BNC connector.

2. Connect the 39G43 75/300 ohm matching pad to the "F" connector end of the cable. Use the red and black leads of the 39G43 pad to inject the 10.7 MHz CRYSTAL CONTROLLED signal.

3. Adjust the MICROVOLT OUTPUT controls for the desired output signal level. To determine approximately the signal output level (measured in microvolts at the ALL SIGNALS OUTPUT) for the 10.7 MHz CRYSTAL CONTROLLED output, multiply the setting of the coarse MICROVOLT OUTPUT control by 6.5, and the result by the corrected vernier control output from the table.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.3
8	6.9
7	4.8
6	3.5
5	2.5
4	1.7
3	1.2
2	.87
1	.54

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

10.7MHz SWEEP AND MARKERS

The 10.7MHz SWEEP and MARKERS function provides a 10.7MHz sweep signal, with post injection markers at 10.6, 10.7, and 10.8MHz, for accurate sweep alignment of the IF amplifiers and detector of any FM Stereo receiver. Even the newest receivers using fix tuned or crystal filter IF's are covered with the ROCKER that allows you to vary the sweep center frequency over the normal range of these fix tuned circuits. The large amplitude markers are variable with the marker height control, and because of the post injection system used will not effect the size or shape of the IF response curve. To use the 10.7MHz SWEEP and MARKERS function, proceed as follows:

1. Set the SG165 OUTPUT selector to 10.7MHz SWEEP & MARKERS. Use the phono plug to alligator clip lead (supplied) to connect the TO SCOPE jack on the SG165 to the vertical input of an oscilloscope, and set the oscilloscope vertical input controls for .5V p-p per inch (.2V p-p per cm.) Turn the oscilloscope horizontal frequency control to the internal 60Hz position, and adjust the oscilloscope phase control for a pattern with no indication of fold over.

Fig. 16 Operational Controls for 10.7MHz Sweep and Markers

2. Plug the 39G45 detector probe to the FROM DETECTOR jack on the SG165. Connect the red lead of the 39G45 to the receiver testpoint if the testpoint is after the detector (audio), and the blue lead if the test point is before the detector (10.7 MHz).

3. Connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT BNC connector, and the 39G43 75/300 ohm matching pad to the "F" connector end of the cable. Use the red and black leads of the 39G43 pad to inject the 10.7MHz sweep signal.

4. Adjust the AM/FM IF ROCKER control to center the response on the oscilloscope sweep.

5. Adjust the MICROVOLT OUTPUT controls for just enough signal to obtain a clean response curve. (It is normal for some noise to appear on the base line near the edges of the sweep.)

6. Adjust the MARKER HEIGHT control for markers of the desired amplitude. (It is normal for the amplitude of the 10.6 and 10.8MHz markers to be approximately 40% of the 10.7MHz marker).

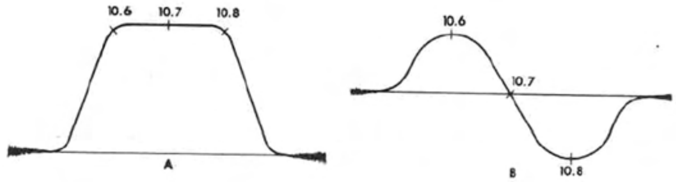


Fig. 17 IF Response and Detector Response

MPX SIGNAL

Fig. 18 Operational Controls for MPX signal

The MPX SIGNAL output provides a composite stereo signal for direct injection into the stereo multiplex circuits of FM stereo receivers and stereo adaptors. The MPX SIGNAL can either be used as an alignment signal, or as a troubleshooting signal to isolate a receiver poor stereo separation problem to the multiplex or RF/IF circuits. To use the MPX SIGNAL, proceed as follows:

1. Set the SG165 OUTPUT selector to MPX SIGNAL, and connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT BNC connector.

2. Connect the 39G43 75/300 ohm matching pad to the "F" connector end of the cable, and use the red and black leads of the pad to inject the MPX SIGNAL'

3. Adjust the STEREO MPX CONTROLS for the desired output signal. (Refer to the STEREO MPX CONTROLS - OPERATION section of this manual.)

4. Set the FM MODULATION switch to IHF MPX.

5. Adjust the MICROVOLT OUTPUT controls for the desired output signal level. To determine the signal output level (measured in milivolts at the ALL SIGNALS OUTPUT) for the MPX SIGNAL, multiply the setting of the coarse MICROVOLT OUTPUT control by .1, and the result by the corrected vernier control output from the table. (The level of the PILOT 19KHz with the switch set to 10% will be approximatly one tenth of the composite output).

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.3
8	6.9
7	4.8
6	3.5
5	2.5
4	1.7
3	1.2
2	.87
1	.54

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

SCA 67KHz

The SCA 67KHz output provides an accurate 67KHz output for alignment of SCA or 67KHz traps in FM stereo receivers. The SCA 67KHz signal would normally be injected at the detector composite audio output, and the receiver's trap adjusted for minimum 67KHz at the output of the stereo decoder. To use the SCA 67KHz output, proceed as follows:

1. Set the SG165 OUTPUT selector to SCA 67KHz and connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT BNC connector.

2. Connect the 39G43 75/300 ohm matching pad to the "F" connector end of the cable, and use the red and black leads to inject the 67KHz signal.

3. Adjust the MICROVOLT OUTPUT controls as necessary to obtain a minimum usable signal.

Fig. 19 Operational Control for 67KHz

AM RF

The AM RF output is used to inject an amplitude signal into the antenna input of any standard AM broadcast receiver. The tuning range of the AM RF is from 525 to 1625KHz, allowing coverage of the band edge limits as recommended by some manufacturers of AM receivers. To use the AM RF output, proceed as follows:

1. Set the SG165 OUTPUT selector to AM RF, and connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT BNC connector.

2. Connect either the 39G43 75/300 ohm matching pad, or the 39G53 auto radio dummy antenna to the "F" connector end of the cable. Use the red and black leads of the 39G43 for receivers with external AM antenna connections, or allow the signal from the leads of the 39G43 to radiate into the receivers rod antenna for receivers without external antenna connections.

3. Select either 30% modulated, or unmodulated carrier output with the AM MODULATION switch.

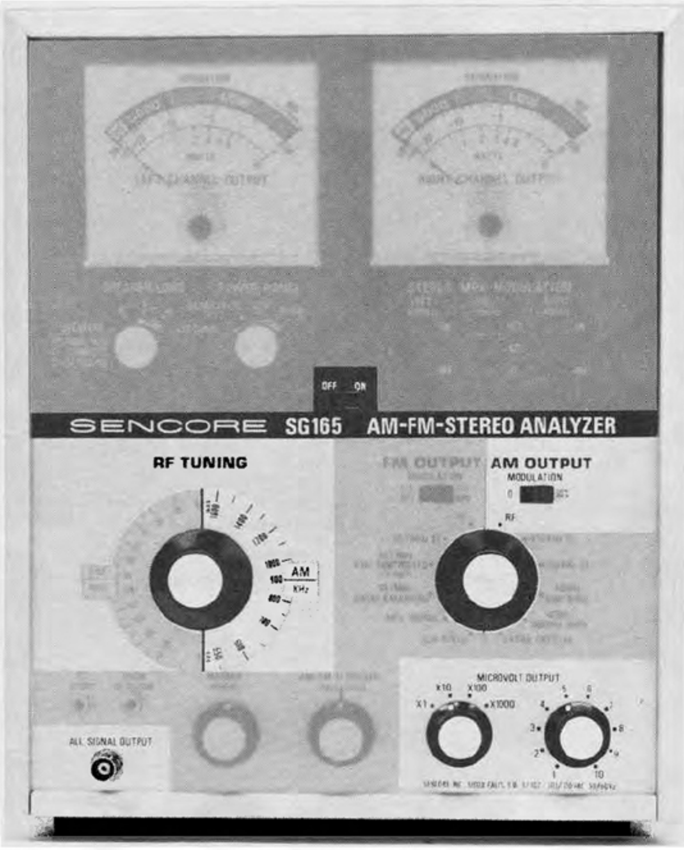


Fig. 20 Operational Control for AM RF

4. Adjust the RF TUNING control for the desired output frequency. The dial indicator for the AM RF frequency is the horizontal line on the small rectangle located to the right of the RF TUNING control. The AM side of the RF TUNING dial is calibrated at intervals of 50KHz from 550 to 1000KHz, and at intervals of 100KHz from 1000 to 1600KHz.

5. Adjust the MICROVOLT OUTPUT controls for the desired output signal level. To determine the signal output level (measured in microvolts at the ALL SIGNALS OUTPUT) multiply the setting of the coarse MICROVOLT OUTPUT control by 10, and the result by the corrected vernier control output from the table.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.3
8	6.9
7	4.8
6	3.5
5	2.5
4	1.7
3	1.2
2	.87
1	.54

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

AM IF

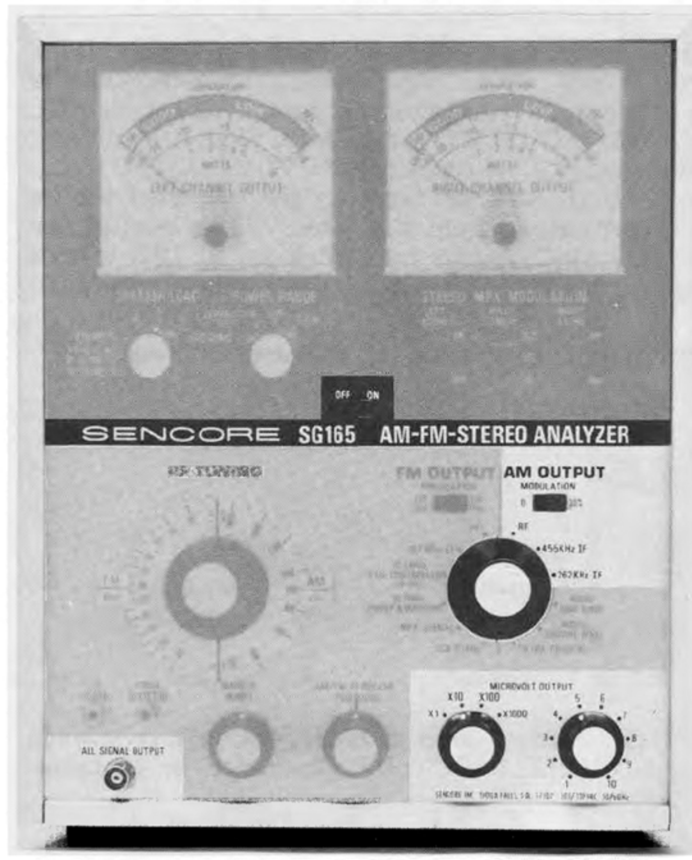


Fig. 21 Operational Control for AM IF

The 455KHz and 262KHz outputs are used to inject an amplitude modulated signal for troubleshooting or alignment into the IF amplifiers of standard AM broadcast receivers. The 262KHz output is used primarily for auto radios, and the 455KHz for most portable, and in home radios. The frequency of the 455KHz and 262KHz outputs is variable over a plus and minus 25KHz range to allow injection of these signals into the IF amplifiers of receivers employing fix tuned or crystal filter IF amplifiers. To use the 455KHz or 262KHz IF output, proceed as follows:

1. Set the SG165 OUTPUT selector to either 455 KHz IF or 262KHz IF, and connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT BNC connector.

2. Connect the 39G43 75/300 ohm matching pad to the "F" connector end of the cable. Use the red and black leads of the 39G43 to inject the AM IF signal.

3. Use the AM MODULATION switch to select either a 30% modulated or unmodulated carrier output.

4. Adjust the AM/FM IF ROCKER control if the receiver being tested uses crystal filter or fix tuned IF amplifiers. The normal adjustment procedure for the ROCKER control is to inject the AM IF signal into the receiver, and adjust the control for maximum undistorted signal at the output of the receiver.

5. Adjust the MICROVOLT OUTPUT controls for the desired output signal level. Remember to keep the level as low as possible during alignment procedures to prevent overload to the IF amplifiers. To determine the signal level (measured in microvolts at the ALL SIGNALS OUTPUT) for the AM IF outputs, multiply the setting of the coarse MICROVOLT OUTPUT control by 10, and the result by the corrected output of the vernier control from the table.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.3
8	6.9
7	4.8
6	3.5
5	2.5
4	1.7
3	1.2
2	.87
1	.54

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

400Hz AUDIO

The 400Hz audio outputs are used to inject a signal into any audio amplifier for test or troubleshooting purposes. The 400Hz SINE WAVE output is most useful for distortion and maximum power output tests, while the 400Hz SQUARE WAVE is most useful for evaluating the frequency response of the audio amplifier. To use the 400Hz audio outputs, proceed as follows:

1. Set the SG165 OUTPUT selector to either 400 Hz SINE WAVE, or 400Hz SQUARE WAVE, and connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT BNC connector.

2. Connect the 39G43 75/300 ohm matching pad to the "F" connector end of the cable. Use the red and black leads of the 39G43 for injecting the 400Hz audio signals directly into the circuitry of the amplifier, or connect the 39G43 to the phono plug to alligator clip cable (black to black lead and red lead to red lead) for injecting signals into phono plug inputs.

Fig. 22 Operational Control for Audio Signals

3. Adjust the MICROVOLT OUTPUT controls for the desired signal level. To determine the signal output level (measured in millivolts RMS at the ALL SIGNALS OUTPUT) for the 400Hz SINE WAVE, multiply the setting of the coarse MICROVOLT OUTPUT control by .1, and the result by the corrected vernier control output from the table below. To determine the signal output level (measured in millivolts peak to peak at the ALL SIGNALS OUTPUT) for the 400Hz SQUARE WAVE, multiply the setting of the coarse MICROVOLT OUTPUT control by .28 and the result by the corrected vernier control output from the table.

NOTE: When using the SG165 to drive low impedances, such as loudspeakers, the output will be somewhat lower than that indicated. The level at the ALL SIGNALS OUTPUT, loaded with 8 ohms is approximately 1V p-p, and the signal at the output of the red and black leads of the 39G43 loaded with 8 ohms is approximately .2V p-p.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.3
8	6.9
7	4.8
6	3.5
5	2.5
4	1.7
3	1.2
2	.87
1	.54

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

EXTRA CRYSTAL

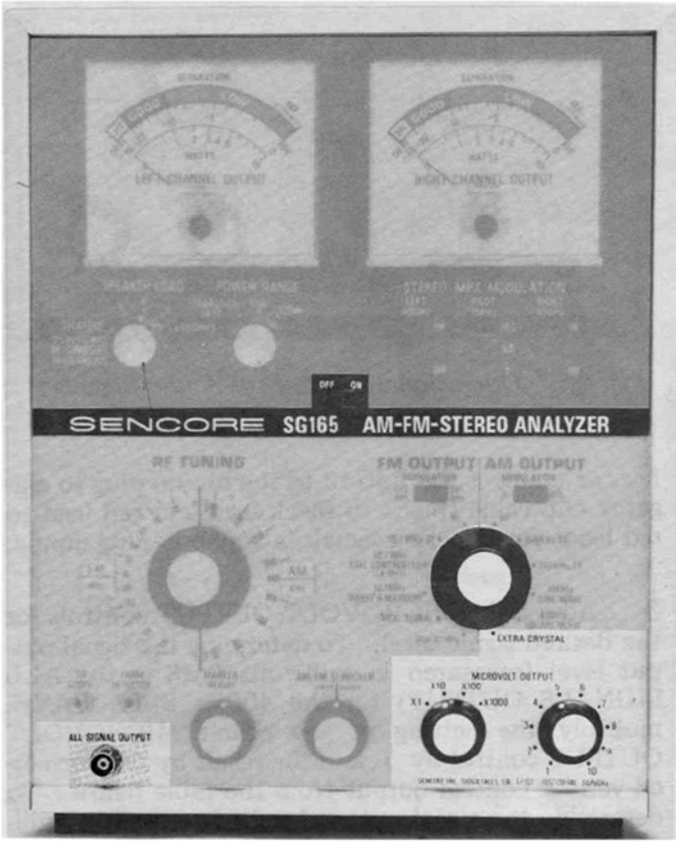


Fig. 23 Operational Control for Extra Crystal

The EXTRA CRYSTAL output provides a signal whose frequency is controlled by the crystal (not supplied) inserted into the extra crystal socket. The EXTRA CRYSTAL signal (with proper crystal installed) can be used to test, troubleshoot, and align any circuit requiring a frequency in the range of 3 to 12MHz. To use the extra crystal output, proceed as follows:

1. Install the desired crystal into the extra crystal socket. (Refer to INSTALLING EXTRA CRYSTAL in service manual)

2. Set the SG165 OUTPUT selector to EXTRA CRYSTAL, connect the BNC to "F" connector cable to the ALL SIGNALS OUTPUT, and connect the 39G43 75/300 ohm matching pad to the "F" connector end of the cable.

3. Adjust the MICROVOLT OUTPUT controls for the desired signal output. Note the output level, and frequency accuracy of the extra crystal signal will depend entirely on the crystal used.

EXPLANATION OF STEREO

Several receiver systems are currently in use, but the most common is the 4 diode full wave decoder. There are slight differences in the operation of this circuit whether it is decoding the stereo signal from the broadcast station or the simulated stereo signal from the SG165 although, the critical phase relationship between the 19KHz pilot, and the 38KHz subcarrier signal is the same.

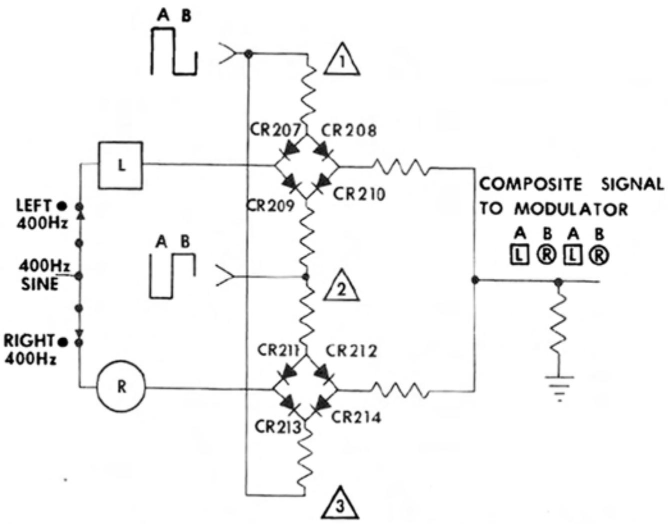


Fig. 24 How the SG165 Generates a Stereo Signal

WITH THE SG165

SG165 OPERATION

The SG165 generates its stereo signal using a simple time switching multiplexer. In other words, the SG165 transmits the left channel signal during one alternation of its 38KHz switching signal, and the right signal during the next alteration. Fig. 24 shows the circuitry used in the SG165 to produce the stereo signal. At time A, when the switching signal is positive at point 1 and negative at point 2, diodes CR207 - 210 are in the ON state, allowing the left channel signal to pass to the modulator. The positive switching signal is also present as point 3, causing diodes CR211-214 to be in the off state, blocking the right channel signal from the modulator. During time B point 1 is negative and point 2 is positive, turning diodes CR207 - 210 off, and blocking the left channel signal from the modulator. Point 3 would be negative turning on diodes CR211 to 214, and allowing the right channel signal to pass through to the modulator. The SG165 also generates a 19 KHz pilot signal that is held in exact phase with the 38KHz switching signal.

RECEIVER OPERATION

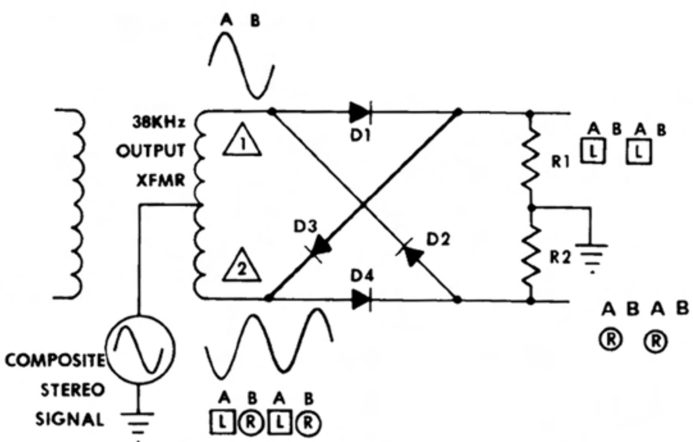


Fig. 25 How the Receiver Processes the SG165 Signal

In the receiver, the 19KHz signal is amplified and doubled, to produce a 38MHz signal that is exactly in phase with the 38KHz used in the generator. The composite stereo signal is decoded using the 38KHz to provide the original left and right signals. Fig. 25 shows the operation of the common 4 diode circuit with the signal from the SG165. The composite signal (the same as went to the modulator in the SG165) is injected into the center tap of the 38KHz transformer secondary, therefore this signal would be present at both points 1 and 2 with equal amplitude and phase. The phase of the 38KHz signal is such that at time A point 1 would be positive with respect to point 2, and diodes D1 and D3 on. With both D1 and D3 on, the left channel signal present at points 1 and 2 during time A would be coupled to the top of the left channel load resistor R1. During time B point 2 would be positive with respect to point 1, turning on diodes D2 and D4. With D2 and D4 on, the right channel signal present at points 1 and 2 would be coupled to the right channel load resistor R2.

WITH THE STATION SIGNAL

TRANSMITTER OPERATION

The system used by the FM station to generate the stereo signal is more complicated than that used by the SG165. The block diagram in Fig. 26 shows how the Stereo signal is generated at the FM transmitter. The left and right channel signals are added together in adder 1 to produce the sum of the two, or the L + R signal. (Fig. 26) The L + R signal is then applied to the mixer. Next the right channel signal is inverted and added to the left channel signal in adder 2. The result of adder 2 is the L- R signal. (Fig. 26) The L - R signal is AM modulated on a 38KHz carrier using a balanced modulator. The output of the balanced modulator (upper and lower sidebands) is applied to the mixer. A 19KHz sine wave is generated from the 38KHz used in the balanced modulator and also applied to the mixer. The output of the mixer called the composit signal is then used to modulate the RF carrier.

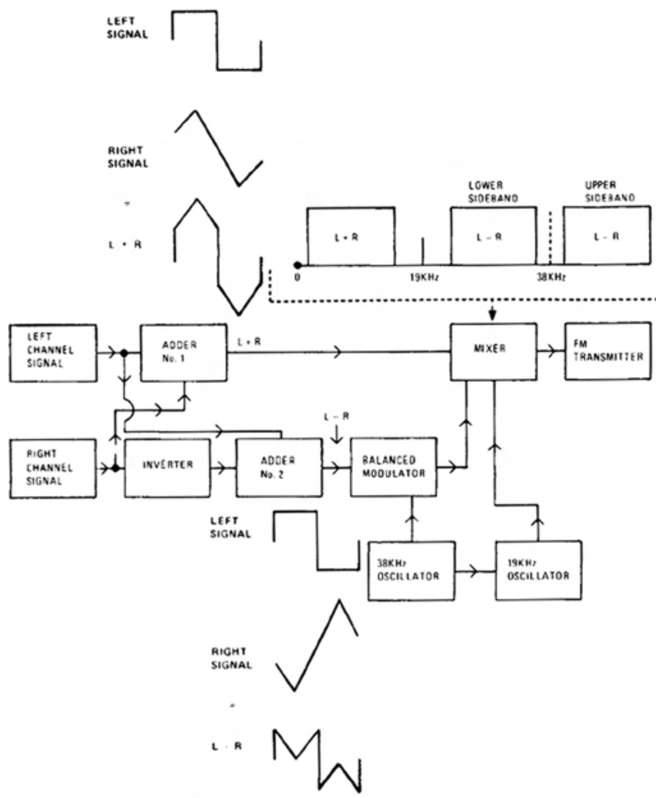


Fig. 26 Block Diagram of FM Stereo Transmitter

RECEIVER OPERATION

The operation of the receivers 19KHz and 38KHz circuits is exactly the same on the station signal as it was with the SG165. The composite signal is injected into the center tap of the 38KHz transformer where the 38KHz carrier is reinstated to the sidebands containing the L - R information.

The result of the carrier reinsertion is the modulation envelope shown in Fig. 27. Note that the positive

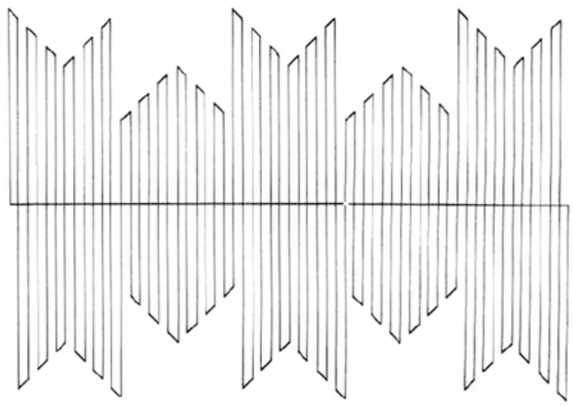


Fig. 27   38KHz Modulation Envelope

side of the modulation envelope looks exactly like the L - R signal generated at the transmitter, while the negative side of the modulation envelope is a mirror image of the L - R signal, or a -(L - R) signal.

During time A (Fig. 28) when point 1 is positive, diodes D1 and D3 will be on, allowing the positive side of the modulation envelope or the L - R signal to develop across the left channel load resistor R1. The L+R signal which is also present at points 1 and 2, would also be developed across R1, so that both L+R and L - R are present at the left channel output. The sum of L - R and L+R is 2L or the left channel signal.

During the time B (Fig. 29) when point 1 is negative and point 2 is positive, diodes D2 and D4 will be on, allowing the negative side of the modulation envelope or the -(L - R) signal to develop across the right channel load resistor R2. The L+R signal would also develop across R2 so that both L+R and -(L - R) are present in the right channel output. The sum of L+R and -(L - R) would be L+R - L+R, or 2R the right channel signal.

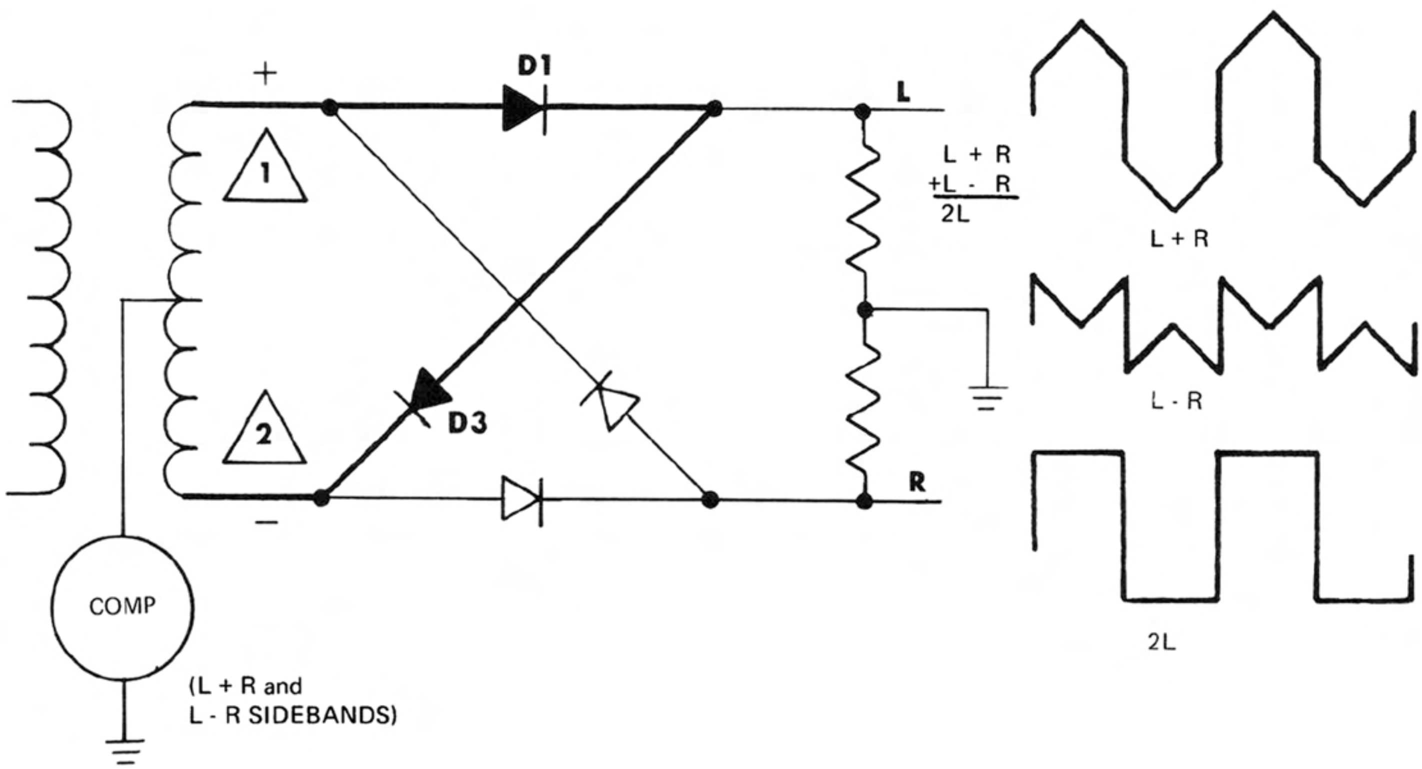


Fig. 28   Decoder Operation During Time A

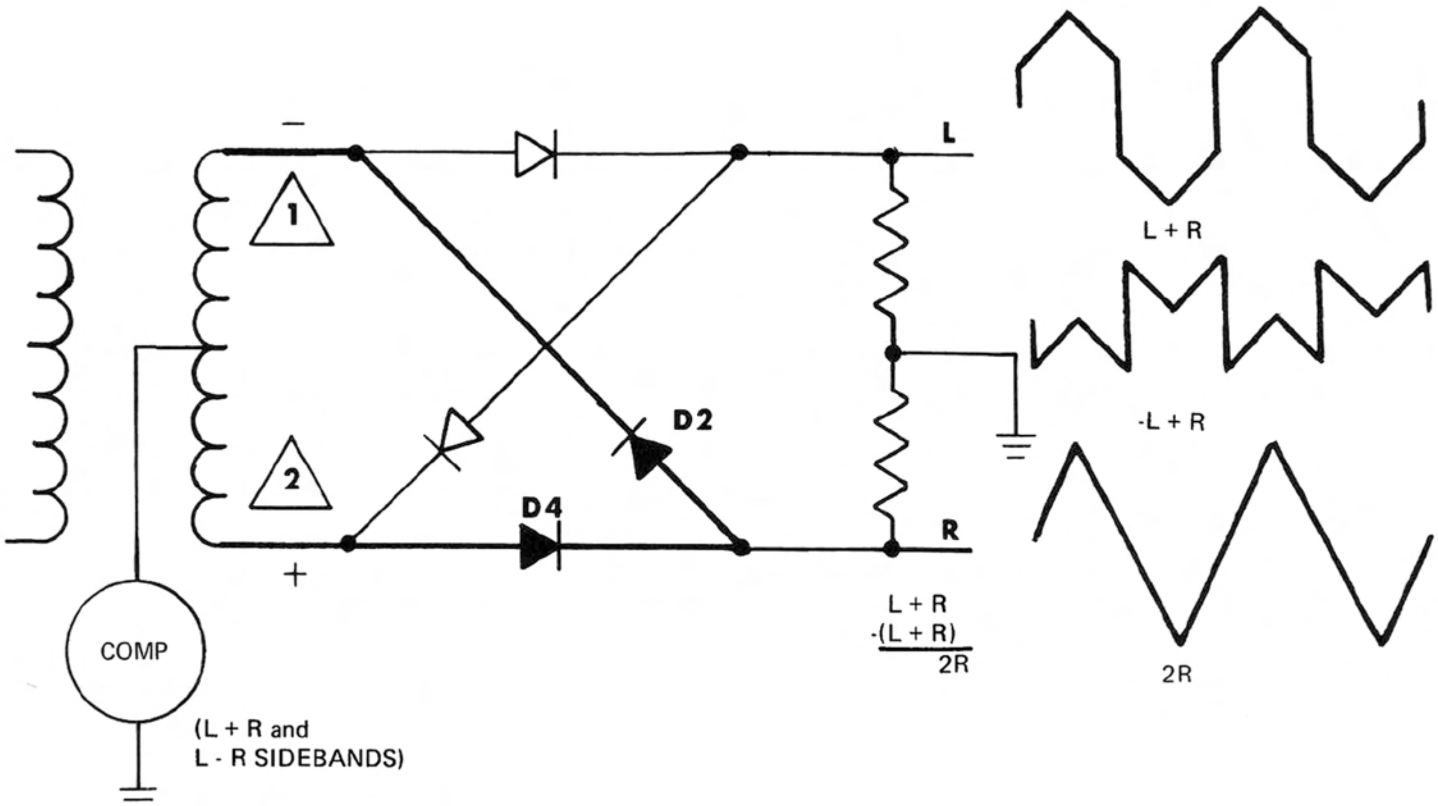


Fig. 29 Decoder Operation During Time B

RECEIVER TESTS

CHECKING STEREO SEPARATION

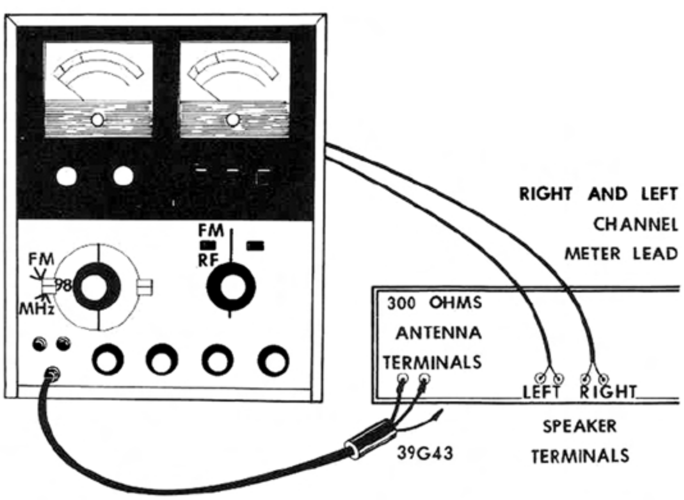


Fig. 30 SG165 Connected to Receiver for Separation Test

Many factors can influence a receivers stereo separation. Antenna signal, IF alignment, stereo decoder alignment, and even power supply can in some cases, be responsible for a complaint of poor stereo. The on the air signal is a poor way of determining a receivers performance, while a check with SG165 will quickly indicate the extent of the problem. In most cases it is not even necessary to remove the receiver from its cabinet to check its stereo separation with the SG165.

1. Remove the antenna from the receiver, but leave the speakers connected. Turn the receiver volume or loudness control up so that even a weak signal is audible, and with the receiver's AFC off, and all other controls set for a flat audio response, tune the receiver to a quiet spot on the dial near 98MHz.

2. Turn the receiver power off, remove the speakers, and connect the SG165 left and right channel meter leads to the receiver speaker terminals. Set the SG165 SPEAKER LOAD switch to the load required by the receiver. If the load requirements are not given, set the switch to the 16 ohm position. Set the METER WATTS RANGE switch to SEPARATION TEST position.

3. Connect the SG165 ALL SIGNALS OUTPUT to

the antenna terminals of the receiver using the 39G43 matching pad. For auto radios, use the dummy antenna 39G53. Set the SG165 OUTPUT SELECTOR to FM RF, and the MODULATION to STD MPX.

4. Adjust the SG165 MICROVOLT OUTPUT controls for 500uV (7 X 100).

5. Switch the LEFT and RIGHT 400Hz switches ON, and set the PILOT 19KHz switch to 10%.

6. Turn the receiver power on, and adjust the SG165 RF TUNING control for a maximum indication on the LEFT and RIGHT CHANNEL OUTPUT meters. Reduce the receiver volume or loudness control as necessary to keep the OUTPUT meters below full scale.

7. Fine tune the receiver as follows:
   a. For receivers with a zero center tuning indicator: Adjust the receivers control tuning for zero center indication.
   b. For receivers with a peak tuning meter: Adjust the receiver tuning control for a maximum indication of the tuning meter.

NOTE: On receivers with both a zero center and peak tuning meter, both indications should coincide. If they do not, misalignment of the receiver IF amplifiers or detector is indicated.

   c. For receivers with no visible tuning indicator: Adjust the receiver tuning control for a maximum indication on the SG165 OUTPUT meters.

8. Adjust the receiver volume or loudness control and balance control for a full scale (0db REF) indication of the LEFT and RIGHT CHANNEL OUTPUT meters. NOTE: If it is necessary to adjust the receiver balance control more than 20% from center, a defect is indicated either in one of the audio channels, or in the MPX decoder circuit.

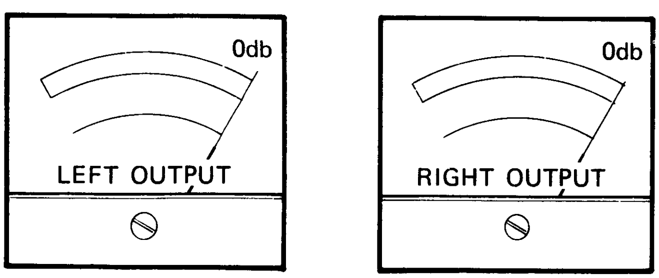


Fig. 31 Both Channels On Receiver Adjusted For Reference

NOTE: If a receiver or tuner is not capable of a full scale indication on the output meters, refer to the db section of this manual to measure separation.

9. Alternately turn on and off the LEFT and RIGHT 400Hz switches, and observe the LEFT and RIGHT CHANNEL OUTPUT meters. Read the separation directly in db for the channel with the 400Hz off. The readings for both channels should be at least 20db, with a maximum difference between readings of 10db. If poor separation is indicated, refer to Receive Troubleshooting section.

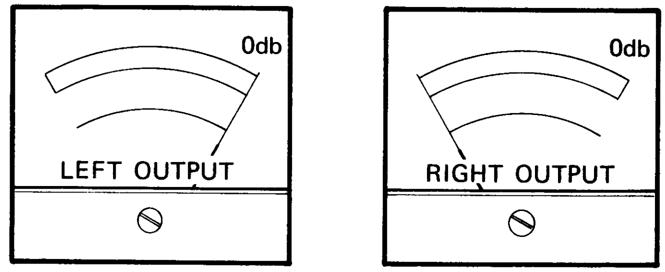


Fig. 32 Right Channel Off, Measure Separation

10. Check the effect of the receiver tuning control on the separation. If better separation is obtained at some tuning point other than that obtained in step 7, misalignment of the receiver IF's or detector is indicated.

11. Check the "lock in range" of the receiver MPX circuits by switching the PILOT 19KHz to 5%, and observing the effect on the receiver separation. A properly operating receiver should produce nearly the same separation with the PILOT 19KHz at 5% as it did with 10% pilot. If difficulty is encountered, refer to the section of this manual on ALIGNING A RECEIVERS 19KHz and 38KHz CIRCUITS.

12 You may wish to further evaluate the performance of the receiver by repeating the separation check at 90 and 106MHz.

CHECKING THE SENSITIVITY OF AN FM RECEIVER

The sensitivity test as made with the SG165 is a measurement of the signal (measured in microvolts) necessary to produce a 30db signal plus noise to noise ratio. Results of this test will be of sufficient accuracy to compare with the published IHF sensitivity of the receiver for test and troubleshooting purposes.

The graph in Fig. 33 shows the effect on the level of the noise and signal outputs of a receiver with respect to the input signal. Note that the noise decreases and the signal increases as the input signal increases. At some point, while the output signal is increasing and the noise is decreasing, the ratio between them will be

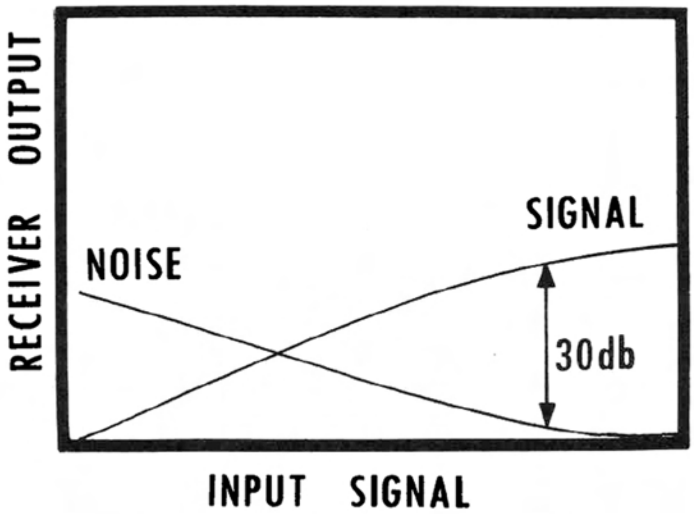


Fig. 33 Effect of Input Signal on Receiver Outputs

31 to 1 (30db). This is the point at which the sensitivity measurement is made. To make the sensitivity test, proceed as follows:

1. Set up the receiver and the SG165 by making the connections as detailed in the first three steps of CHECKING STEREO SEPARATION.

2. Switch the LEFT and RIGHT 400Hz ON and the PILOT 19KHz to 10%. Set the FM MODULATION to IHF MPX.

3. With the MICROVOLT OUTPUT controls set for a low signal level of 100uV or less, fine tune the receiver as in steps 6 and 7 of CHECKING STEREO SEPARATION.

NOTE: If it is not possible to eliminate the third harmonic distortion from the output signal by careful fine tuning, insufficient FM IF band width is indicated. Refer to the FM IF Alignment section of this manual.

4. Turn the SG165 AC power OFF. Adjust the receiver volume control for an indication of -30db on the OUTPUT meters of the SG165.

5. Turn the SG165 AC power ON. Without changing the control settings of the receiver, adjust the MICROVOLT OUTPUT controls of the SG165 to produce a full-scale indication of 0db on the OUTPUT meters.

6. Note the setting of the MICROVOLT OUTPUT controls, and multiply the setting of the coarse control times the corrected output of the fine control from Fig. 34. When using the 39G43 pad, or the 39G53 dummy antenna, multiply the result by .5 to find the actual input signal to the receiver. This is the sensitivity in microvolts.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.1
8	6.4
7	5.1
6	4.0
5	3.0
4	2.4
3	1.8
2	1.4
1	1.2

Fig. 34 Corrected Microvolt Output

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

CHECKING A RECEIVERS MAXIMUM RMS POWER OUTPUT

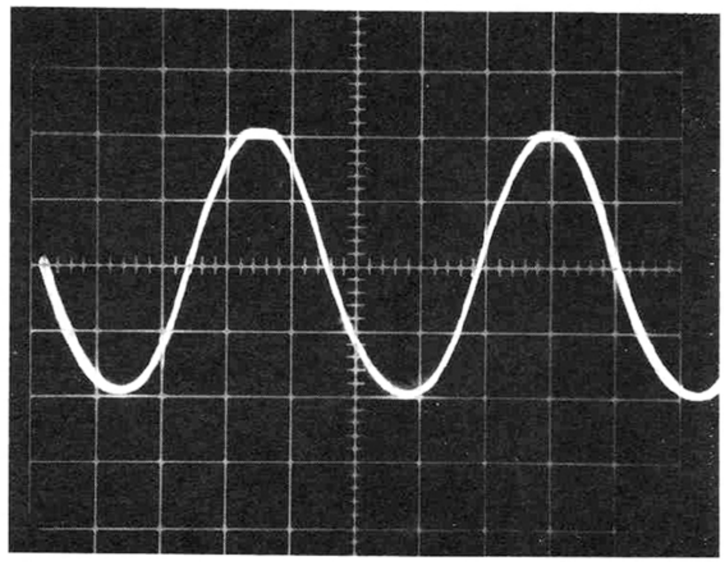


Fig. 35 Point of Amplifier Distortion

The power output measured with the SG165 is the RMS or true power. There is no 100% accurate formula for converting RMS power to the various measurements used in rating different receivers, however a good rule of thumb is to multiply the RMS power for one channel by 4 to find the peak power rating. The 400Hz audio signal may be injected in a variety of ways; FM RF, FM IF, AM RF, AM IF, MPX signal or audio. The following procedure is given since it does not require removal of the chassis, or any internal chassis connections.

1. Set up and connect the receiver and SG165 as in steps 1 through 8 in the CHECKING A RECEIVERS SEPARATION section, except turn the METER WATTS RANGE to 10 or 100W. (use AM RF for checking AM receivers).

2. Connect an oscilloscope to one of the speaker outputs, and increase the setting of the receiver volume or loudness control while observing the output waveform, to just below the point where distortion appears. The SG165 meters indicate the RMS power. Read the 1 to 10W scale directly for the 10W range, or multiply by 10 for the 100W range.

CHECKING AN AMPLIFIERS SENSITIVITY AND RMS POWER OUTPUT

If an amplifier has more than one input (phono, tape, auxiliary, etc.) each input should be tested for proper sensitivity separately. If the sensitivity is not specified, the following table can serve as a guide for test purposes:

Magnetic phono or tape head	1 - 5mV
Tape, Tape Monitor, Tuner auxiliary	150 - 250mV
Crystal phono	250 - 750mV

To test an amplifiers sensitivity, proceed as follows:

1. Set the SG165 OUTPUT selector switch to 400Hz SINE WAVE, and the MICROVOLT OUTPUT controls fully counterclockwise (1 X1).

2. Turn the receivers volume or loudness control to maximum, the input selector to the input to be tested, and all other controls for a flat audio response as indicated by front panel markings.

3. Use the 39G43 matching pad and phono plug to alligator clip leads (supplied) or the optional 39G47 BNC to phono plug cable to connect the ALL SIGNALS OUTPUT of the SG165 to the input being tested. Connect the SG165 meter leads and the vertical input of an oscilloscope to the amplifiers speaker terminals. Select the correct SPEAKER LOAD, and POWER RANGE for the amplifier.

4. Gradually increase the MICROVOLT OUTPUT from the SG165, while observing the speaker output waveform on the oscilloscope, to just below the point where noticeable distortion occurs. The SG165 meter now indicates the RMS power output of the amplifier.

5. To find the input signal in millivolts RMS to produce this output, multiply the setting of the coarse MICROVOLT OUTPUT control by .1 and the result by the corrected output of the vernier MICROVOLT OUTPUT control from the table below. If the 39G43 pad is being used, multiply this result by .5.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.3
8	6.9
7	4.8
6	3.5
5	2.5
4	1.7
3	1.2
2	.87
1	.54

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

SQUARE WAVE TESTING OF AUDIO AMPLIFIERS

For a complete evaluation of an audio system, some method of determining frequency response, and effectiveness of tone controls is necessary. This evaluation can take the form of a complete plot of the sine wave frequency response, which is time consuming, or the analysis of the systems response to a square wave input. The 400Hz square wave output of the SG165 is ideal for testing any audio system. High frequency performance is indicated by the response to the leading edge of the square wave, and low frequency performance by the tilt to the top of the square wave. The following drawings and explanations are normal for the amplifier control settings indicated. All front panel controls that would affect the audio response are adjusted for a flat response, as indicated by front panel markings, unless otherwise noted.

Fig. 36 shows an amplifier response to the 400Hz square wave through the normal uncompensated inputs such as tuner, auxiliary, or tape monitor. Note that the square wave is nearly perfect indicating a flat amplifier response.

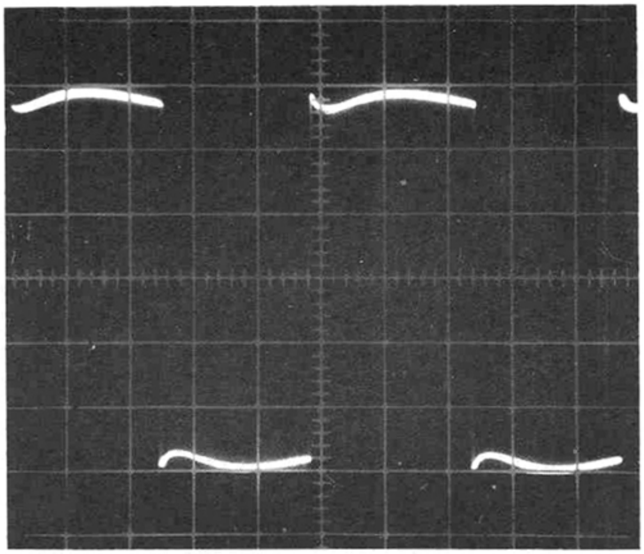


Fig. 36 Auxiliary Input

Fig. 37 shows an amplifiers response through a magnetic phono input. Note that the square wave has a definite slope. This is the normal response for a magnetic phono input compensated for the standard RIAA playback curves.

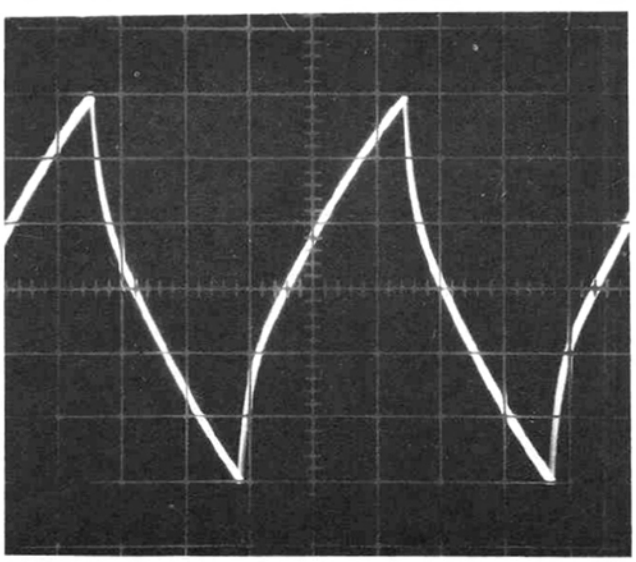


Fig. 37 Magnetic Phone Input

Fig. 38 shows an amplifiers response through a crystal phono input. Note that the square wave has the slope of the RIAA playback curve, and that in addition there is a peak on the leading edge. The peak on the leading edge indicates a high frequency boost to compensate for the normally lower high frequency response of the crystal type of cartridge.

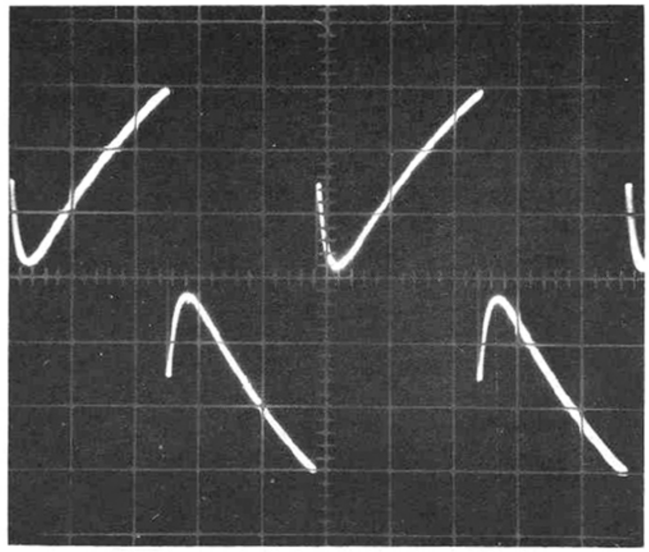


Fig. 38 Crystal Phono Input

Fig. 39 shows an amplifiers response through the auxiliary input with the base control adjusted for maximum boost. Note that the square wave has an upward slope, indicating greater amplification to lower frequencies. Also note that the corner of the leading edge is square, indicating normal high frequency response.

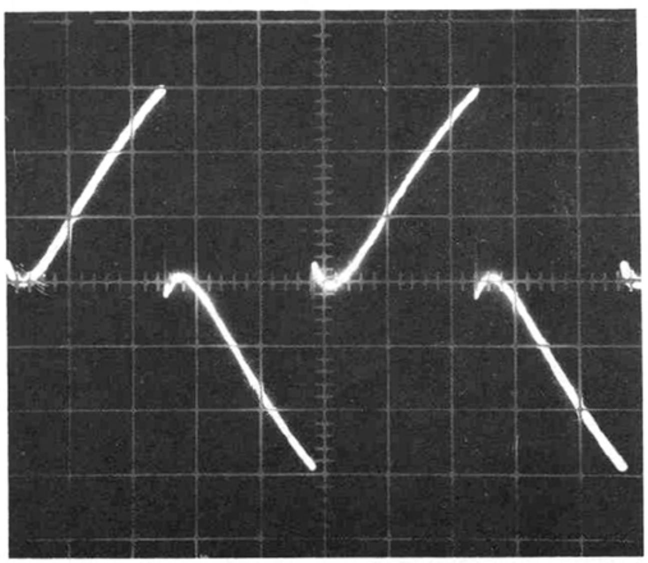


Fig. 39 Auxiliary Input, Base Control Adjusted For Maximum Boost

Fig. 40 shows an amplifiers response through the auxiliary input with the base control adjusted to minimum. Note that the square wave has an exponential downward slope indicating less amplification to lower frequencies. Also note that the leading edge is square indicating normal high frequency response.

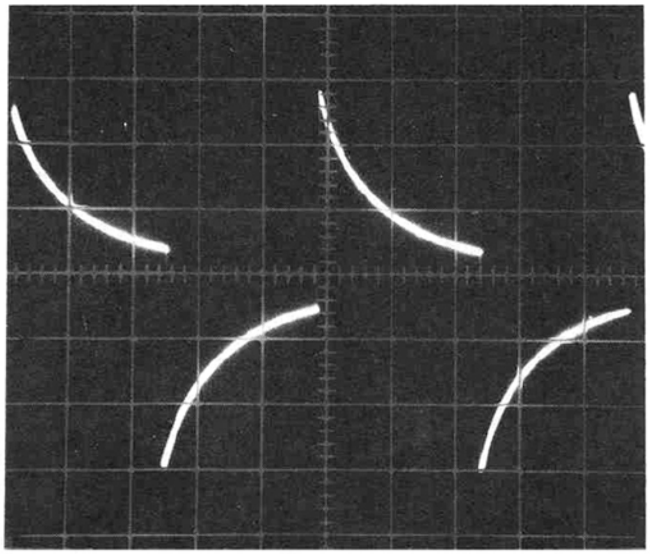


Fig. 40 Auxiliary Input, Base Controls Adjusted to Minimum

Fig. 41 shows an amplifiers response through the auxiliary input, with the treble control adjusted for maximum boost. Note that the square wave has a large spike on the leading edge, indicating increased amplification to higher frequencies. Also note that the top of the square wave is flat, indicating normal response to low frequencies.

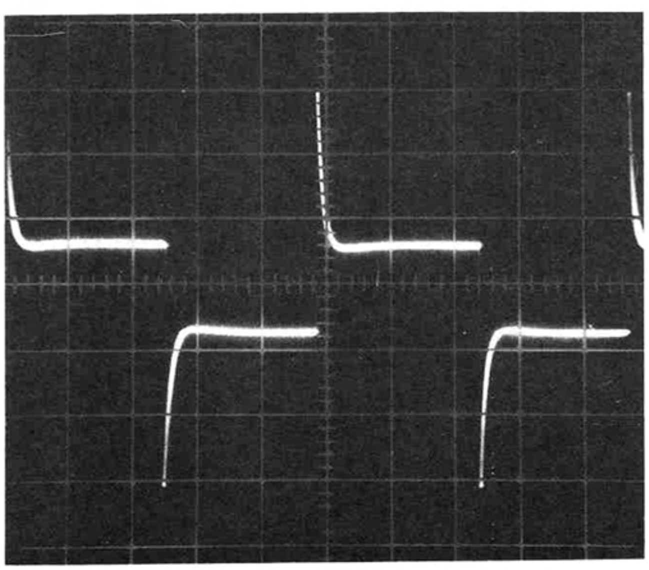


Fig. 41 Auxiliary Input, Treble Control Adjusted for Maximum Boost

Fig. 42 shows an amplifiers response through the auxiliary input with the treble control adjusted to minimum. Note that the leading edge of the square wave is rounded, indicating less amplification to higher frequencies. Also note that the top of the square wave is flat, indicating normal response to low frequencies.

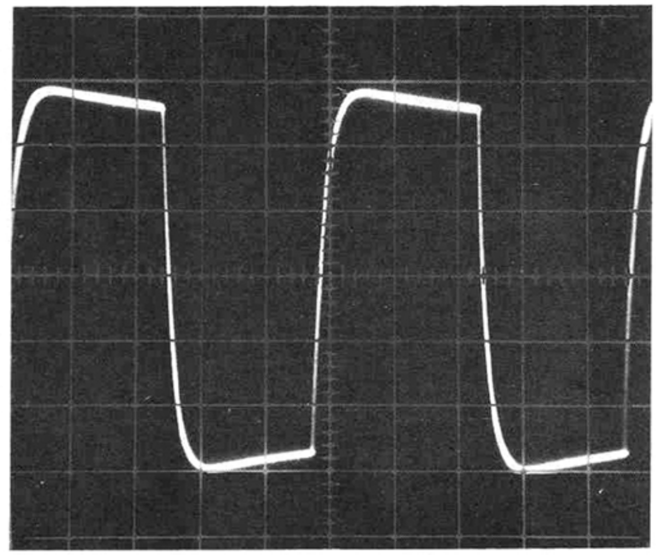


Fig. 42 Auxiliary Input, Treble Control Adjusted to Minimum

Fig. 43 shows an amplifiers response through the auxiliary input, with the low or "rumble" filter engaged. Note that the top of the square wave has a downward slope, that extends nearly to the zero reference line indicating that the low filter effects lower frequencies than the base tone control.

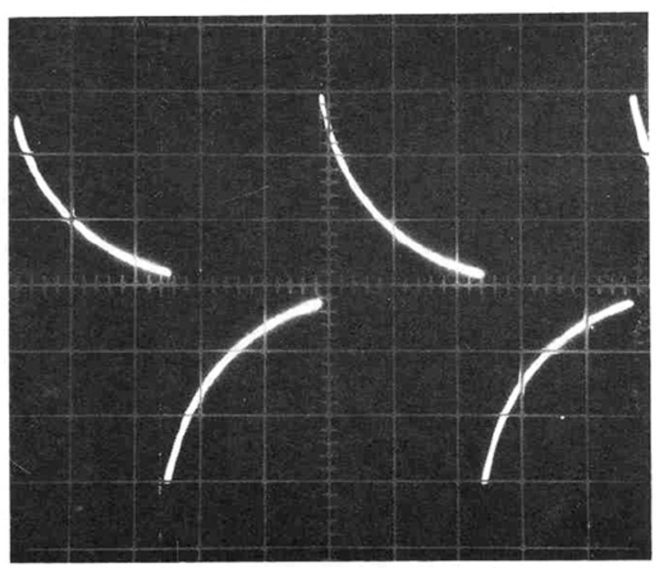


Fig. 43 Auxiliary Input, Low Filter On

Fig. 44 shows an amplifiers response through the auxiliary input, with the high or "hiss" engaged. Note that just the very corner of the leading edge of the square wave is rounded, indicating that the high filter effects higher frequencies than the treble control.

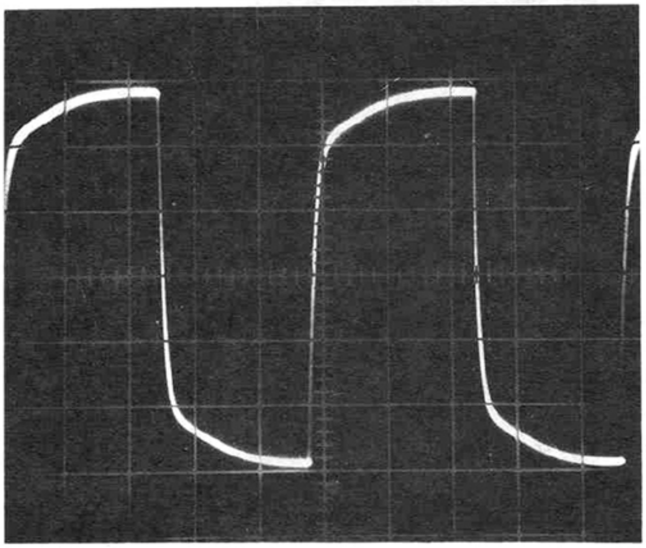


Fig. 44 Auxiliary Input, High Filter On

Fig. 45 and Fig. 46 show an amplifiers response through the auxiliary input with the loudness contour on, at two different volume control settings. Note that in Fig. 45 with the volume control at 25% the top of the square wave has an upward slope, indicating increased response to low frequencies. Note also that the leading edge of the square wave retains its normal rise, indicating a normal or slightly increased response to higher frequencies. The loudness contour is intended to compensate for the human ears reduced sensitivity to low frequencies at low volume levels. As the volume control is advanced toward maximum, the effect of this control diminishes until with the volume control at maximum (Fig. 46) the normal square wave indicated a flat amplifier response.

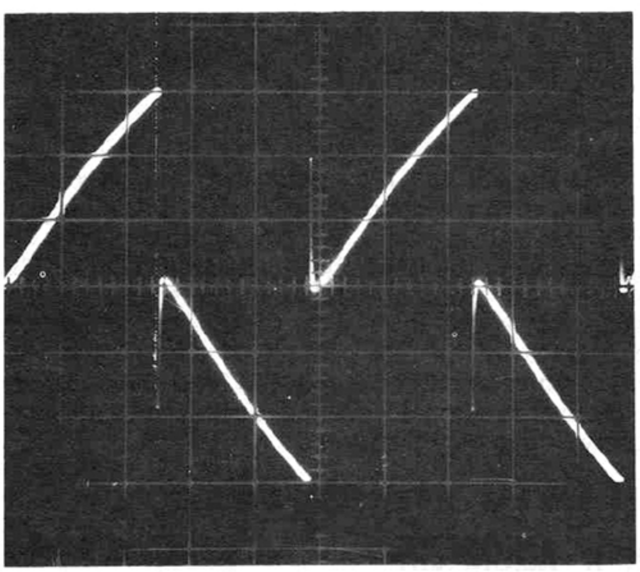


Fig. 45 Auxiliary Input, Loudness Contour On, Volume Control at 25%

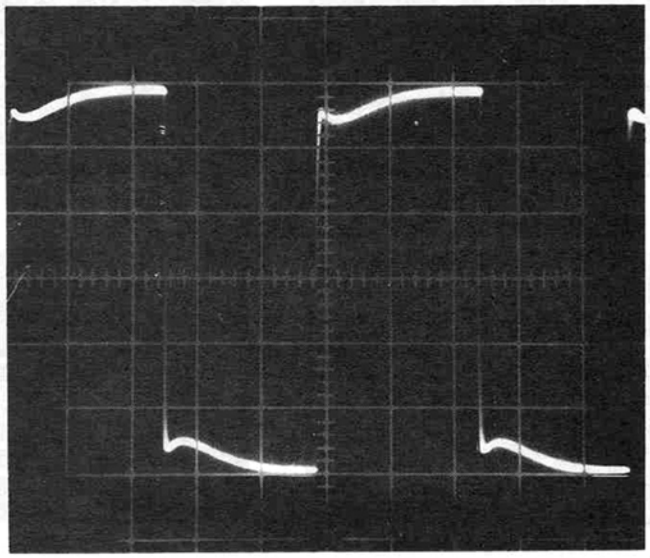


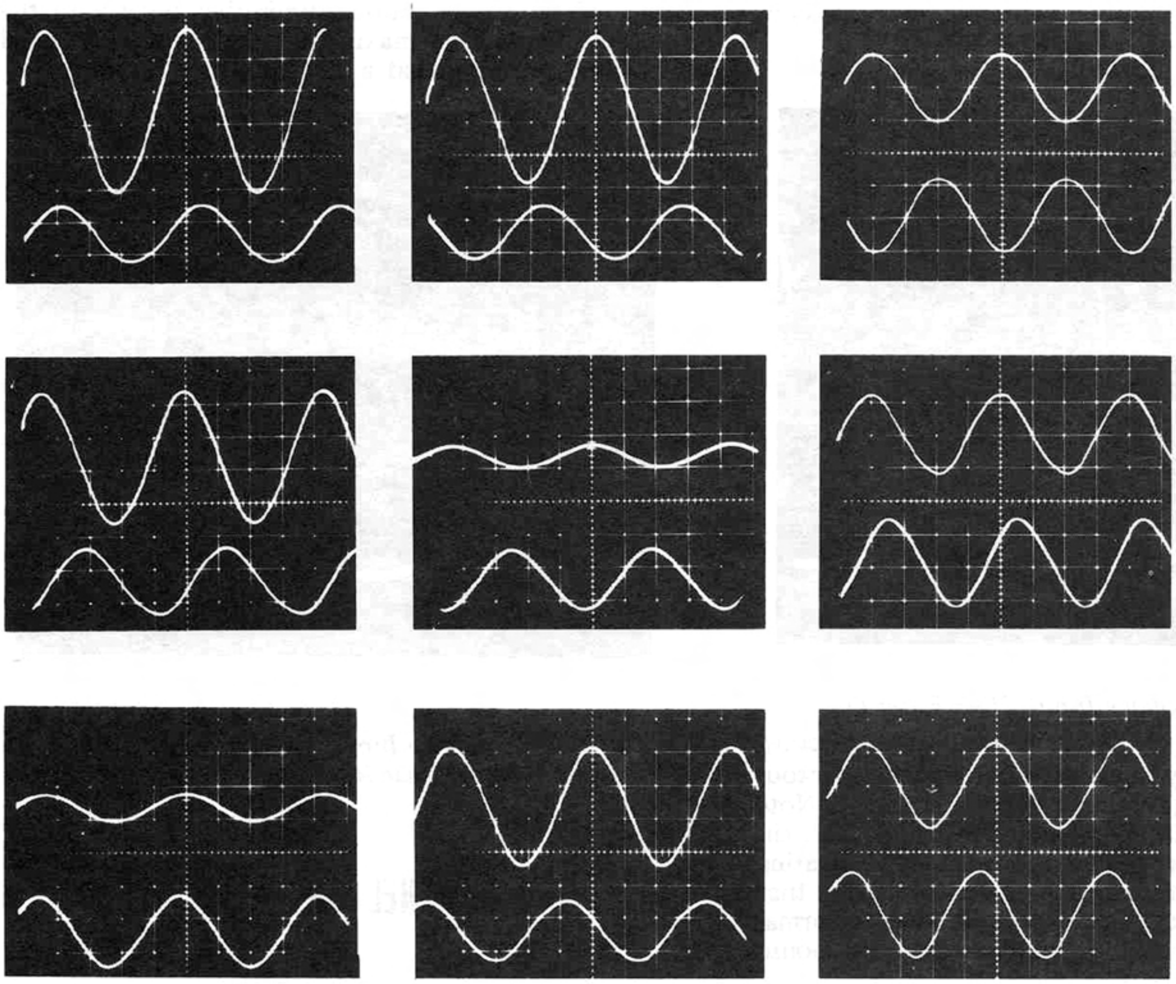
Fig. 46 Auxiliary Input, Loudness Contour On, Volume Control Near Maximum

TESTING 4 CHANNEL OR QUAD SYSTEMS

At present, all four channel systems are either discrete four channel tape, or some form of audio matrix or phase shift circuit. The discrete four channel systems may be tested using the same square wave, sensitivity, and maximum power output tests as conventional audio amplifiers. Just remember to load all four channels with speakers or load resistors of the proper impedance.

To demonstrate the ability of the SG165 in testing four channel systems the waveforms in Fig. 47 were taken from the speaker terminals of a receiver using the SQ system. The SG165 was set to FM RF and connected to the receivers antenna terminals. For comparison purposes, the oscilloscope vertical input controls remain identical and unchanged for this series of photos.

NOTE: Other systems will produce different outputs. Check manufacturers literature for specific information.



A - RF, B - RR
1. R - ON
L - ON
2. R - ON
L - OFF
3. R - OFF
L - ON

A - LF, B - LR
4. R - ON
L - ON
5. R - ON
L - OFF
6. R - OFF
L - ON

A - RR, B - LR
7. R - ON
L - ON
8. R - ON
L - OFF
9. R - OFF
L - ON

Fig. 47 Outputs of SQ Quad system

In the first column of photos, Channel A (upper trace) is connected to the Right Front (RF) speaker, and channel B (lower trace) is connected to the Right Rear (RR). In the second column, Channel A is connected to Left Front (LF), and Channel B to Left Rear (LR). In the third column, Channel A is connected to Right Rear (RR), and Channel B is connected to Left Rear (LR). For the first photo in each column, both the LEFT and RIGHT 400Hz signals are ON, for the second, the RIGHT is ON and the LEFT is OFF, and for the third, the RIGHT is OFF and the LEFT is ON.

The third column of photos (rear channels) would be best for evaluating the performance of the SQ matrix. Note that in the first photo (LFET and RIGHT 400 Hz ON) the RR and LR signals are 180 degrees out of phase, in the second photo (RIGHT ON, LEFT OFF) the LR lags the RR by approximately 30 degrees, and in the third photo, (RIGHT OFF, LEFT ON) the LR leads the RR by approximately 30 degrees. It is also interesting to note by comparing the A trace in the first column of photos that the front channel separation is reduced from the 35db of the receiver in normal 2 channel operation to approximately 8db in SQ operation.

RECEIVER ALIGNMENT

FM IF ALIGNMENT

The alignment of the IF amplifiers in the Stereo FM receiver is much more critical than in the mono

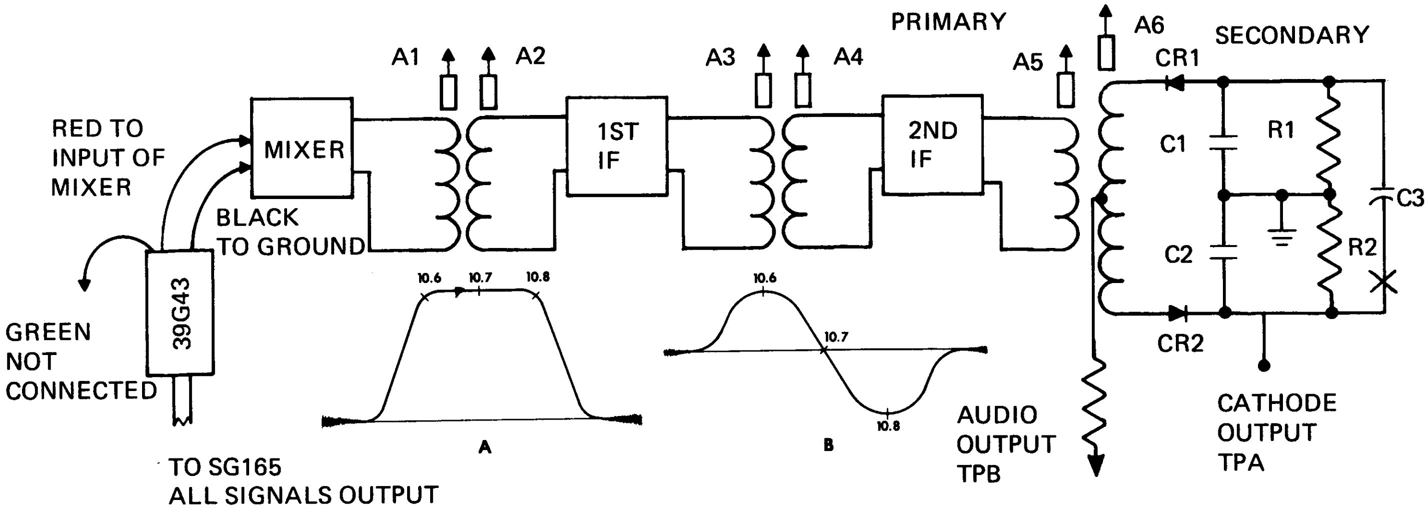


Fig. 48 Standard 10.7MHz IF Circuit

receiver. The difference is much the same as in color TV versus black and white TV. The multiplexed stereo signal requires a greater receiver band width, and more linear phase and frequency response than was required by the mono receiver. The SG165 provides both a 10.7MHz crystal signal for peak alignment and a 10.7MHz sweep signal with markers for sweep alignment of the FM IF amplifiers.

FM IF ALIGNMENT USING 10.7MHz CW (NOT RECOMMENDED FOR STEREO RECEIVERS)

1. Tune the receiver to a quiet spot on the dial, connect the SG165 SPEAKER LOAD in place of the receiver speaker, and set the SG165 OUTPUT selector switch to the 10.7MHz CRYSTAL CONTROLLED position.

2. Use the 39G43 pad to connect the ALL SIGNALS OUTPUT of the SG165 to the input of the mixer. Connect the red lead to the input of the mixer and the black lead to ground.

3. Connect the positive input lead of a FET meter to the audio output (TPB). Use a 100K resistor in series with the lead.

4. Detune the secondary of the detector transformer to produce a positive indication on the FET meter. Reduce the SG165 MICROVOLT OUTPUT controls as necessary to produce a maximum indication of .5 volts on the FET meter.

5. Adjust the FM IF inter-stage transformers (A1 - A4) and the primary of the detector transformer (A5) for a maximum positive indication on the FET meter. Reduce the setting of the SG165 MICROVOLT OUTPUT controls as necessary to maintain a .5 volt indication.

6. Momentarily disconnect the FET meter and adjust it for a zero center indication on the plus and minus .5 volt range.

7. Reconnect the FET meter to the audio output test point, and adjust the secondary of the detector transformer (A6) for a zero center indication on the FET meter. An approximately equal positive and negative indication should appear on either side of the correct setting.

FM IF ALIGNMENT USING 10.7MHz SWEEP AND MARKERS (BEST FOR STEREO) (Refer to Fig.48)

1. Tune the receiver to a quiet spot on the dial, connect the SG165 SPEAKER LOADS in place of the receivers speakers, and adjust the receiver volume or loudness control to minimum. Set the SG165 OUTPUT selector switch to the 10.7MHz SWEEP and MARKERS position.

2. Use the phone plug to clip lead to connect the TO SCOPE jack on the SG165 to the vertical input of an oscilloscope, and set the scope vertical gain controls for .5 volts per inch, or .2 volts per cm. Turn the oscilloscope horizontal frequency switch to the 60 cycle line sweep position, and adjust the scope's line sweep phase control for a pattern with no indication of foldover. Adjust the AM/FM IF ROCKER to center the markers on the trace. NOTE: A BNC to phone plug cable (39G47) is available from any Sencore regional office to connect the TO SCOPE jack directly to the vertical input of any scope with a BNC input connection. The price of the cable is $8.00.

3. Temporarily disconnect the electroyltic capacitor, C3, from across the detector load resistors, con-

nect the red lead of the 39G45 detector probe to the cathode output of one of the detector diodes (TPA), and the black lead to ground. Plug the 39G44 detector cable into the FROM DETECTOR jack on the SG165.

4. Use the 39G43 pad to connect the ALL SIGNALS OUTPUT of the SG165 to the input of the mixer. Connect the red lead to the input of the mixer and the black lead to ground.

5. Adjust the IF interstage transformers, A 1 to A4, and the primary of the detector transformer, A5, for a response curve as shown in Fig. 48A. The peak of the curve should fall at 10.7MHz, and the 10.6MHz and 10.8MHz limit markers should be at least 90% on the curve. Adjust the MICROVOLT OUTPUT controls to inject just enough signal for a noise free response curve.

6. Reconnect the electrolytic capacitor and connect the red lead of the 39G45 detector probe to the audio output test point. (TPB)

7. Adjust the secondary of the detector transformer A6, for the Symetrical "S" curve as shown in Fig. 48B. Retouch the primary of the detector transformer, A5, to obtain the best possible curve.

ALIGNING FM IF'S CONTAINING CRYSTAL FILTERS

The tuner shown in Fig. 49, is a good example of the latest trend in FM receivers. In place of the 3 or 4 IF stages followed by a ratio detector, this receiver uses a transistor as the first IF followed bv a ceramic filter to determine band width, and an IC that is a combination detector, limiter, and 50db gain IF amplifier. The alignment procedure for this system is actually simpler, as it contains fewer adjustments than the standard system. The major difference from an alignment standpoint is that the operating frequency of the system may not be exactly 10.7MHz. The actual operating frequency will fall between 10.625 MHz and 10.775MHz, and is determined by the production variations in the ceramic filter. The IC itself presents no alignment difficulties, as the circuit contains only one adjustment. This coil, connected externally to the IC, performs the same detector balance adjustment as the secondary of the ratio detector transformer and is adjusted for the proper "S" curve.

1. Tune the receiver to a quiet spot on the dial, connect the SG165 SPEAKER LOADS in place of the receivers speakers, and set the SG165 OUTPUT selector switch to the 10.7MHz SWEEP and MARKERS position.

2. Use the 39G43 matching pad to connect the SG165 ALL SIGNALS OUTPUT to the input of the mixer (red lead to the input, black to ground). Adjust the SG165 MICROVOLT OUTPUT controls for approximately 10mV. (10X100)

3. Use the phono plug to alligator clip lead provided to connect the TO SCOPE jack to the vertical input of an oscilloscope. Set the oscilloscope horizontal frequency control to the internal 60Hz position, and adjust the oscilloscope phase control for a pattern with no indication of fold over.

4. Plug the 39G45 detector cable into the FROM DETECTOR jack on the SG165, and connect the blue lead (detector) to test point V, black lead to ground.

5. Us the AM/FM IF ROCKER to center the response on the sweep and adjust T1 for maximum gain and symmetry similar to Fig. 48A.

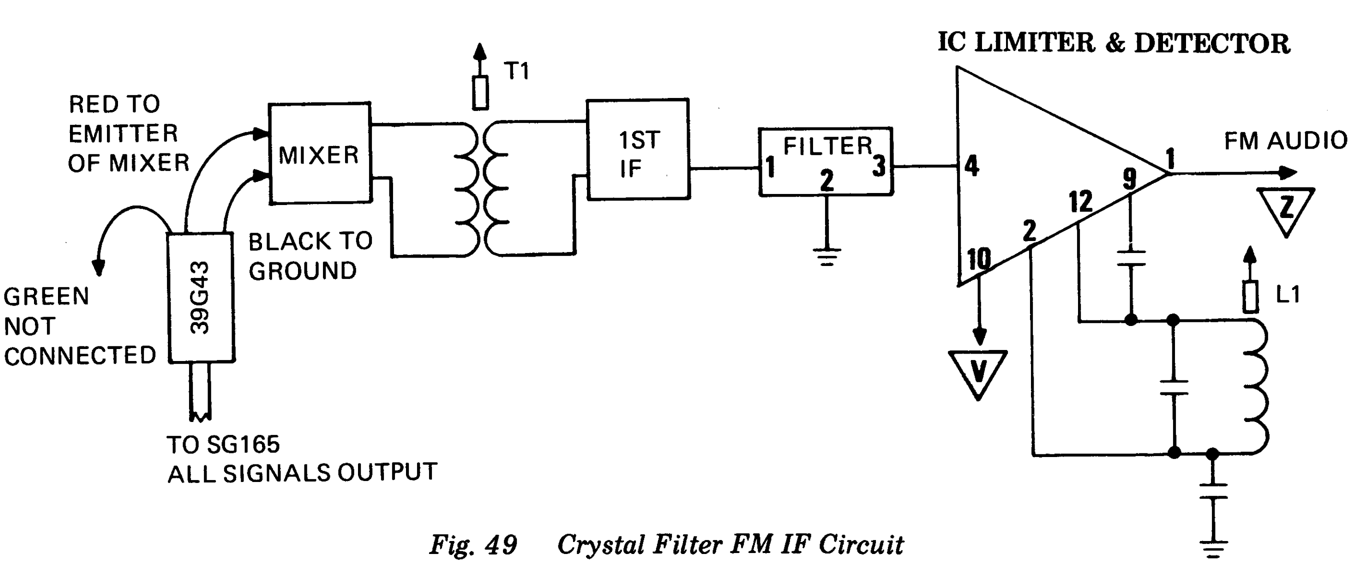


Fig. 49 Crystal Filter FM IF Circuit

6. Adjust the oscilloscopes horizontal position control to center the peak of the response on the major vertical grid line. Do this carefully, as this establishes the IF center frequency for step 7.

7. Remove the 39G45 from test point V, and connect the red lead to test point Z, the composite FM audio output. Adjust L1 for maximum "S" curve amplitude and symmetry similar to Fig. 48B, so that the curve crosses the base line at the major vertical grid line that was established as the center frequency of the IF in step 6.

FM RF ALIGNMENT

There are as many variations in FM RF circuits as there are receivers on the market. FM RF adjustments are usually located in three places: on the input of the RF amplifier, the input of the mixer, and the local oscillator. The adjustments take the form of a trimmer capacitor and/or an adjustable coil slug. Either or both forms of adjustment may be found in any of the three locations. If both forms of adjustment are present at a given location, the coil should be adjusted at a frequency near the low end of the band and the trimmer adjusted at a frequency near the high end of the band. If only one adjustment is present in a given location, it will be necessary to optimize its adjustment for best receiver performance across the band. Though it is best to follow the manufacturers procedure if available, the procedure below is typical for most popular FM receivers.

HOOK UP

1. Connect the SG165 ALL SIGNALS OUTPUT to the receivers antenna terminals using the red and green leads of the 39G43 matching pad. For auto radios, use the 39G53 dummy antenna.

2. Connect the SG165 SPEAKER LOADS in place of the receiver speakers, set the SPEAKER LOAD switch to the correct load resistance, and set the POWER RANGE switch to the SEPARATION TEST position. Switch the receiver AFC off.

3. Set the SG165 OUTPUT Selector to FM RF, the FM MODULATION switch to STD MPX, switch the LEFT and RIGHT 400Hz on, and set the 19KHz PILOT to zero. Use the lowest output setting of the MICROVOLT OUTPUT control that will produce a usable indication on the output meter.

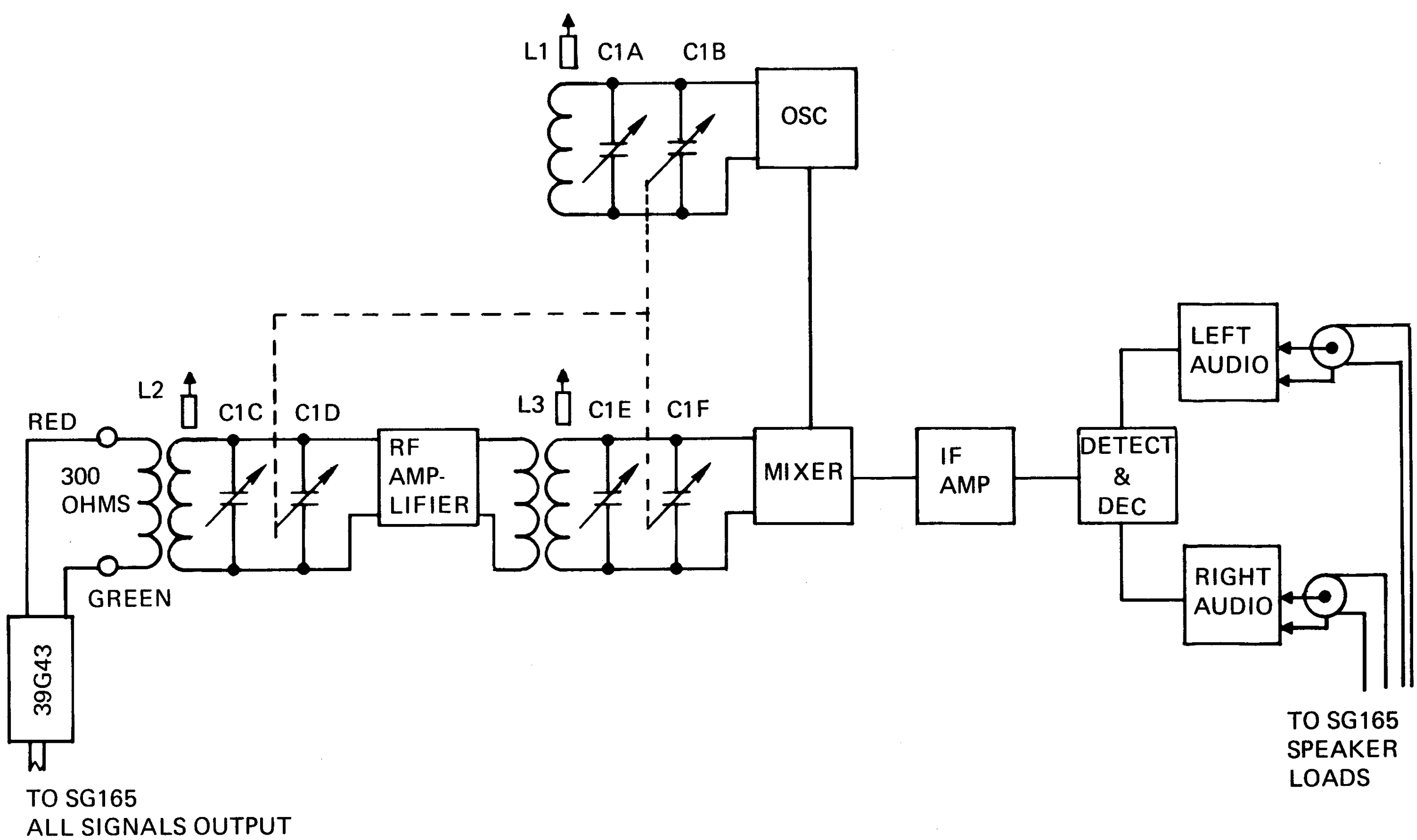


Fig. 50 Typical FM RF Circuit

STEP	RECEIVER TUNING	SG165 FREQUENCY	ADJUSTMENT	ADJUST FOR
OSCILLATOR ADJUSTMENTS				
4	108MHz	108MHz	C1A	Maximum indication on LEFT and RIGHT CHANNEL OUTPUT meters.
5	88MHz	88MHz	L1	Maximum indication on LEFT and RIGHT CHANNEL OUTPUT meters.
6.	Repeat steps 4 and 5 until the receiver tunes properly at 88 and 108MHz.			
RF SENSITIVITY ADJUSTMENTS				
7	108MHz	108MHz	C1C, C1E	Maximum indication on LEFT and RIGHT CHANNEL OUTPUT meters.
8	88MHz	88mHz	L2,L3	Maximum indication on LEFT and RIGHT CHANNEL OUTPUT meters.
9	Repeat steps 7 and 8 until no further improvement can be obtained in the receiver sensitivity.			

FM STEREO SEPARATION ADJUSTMENTS

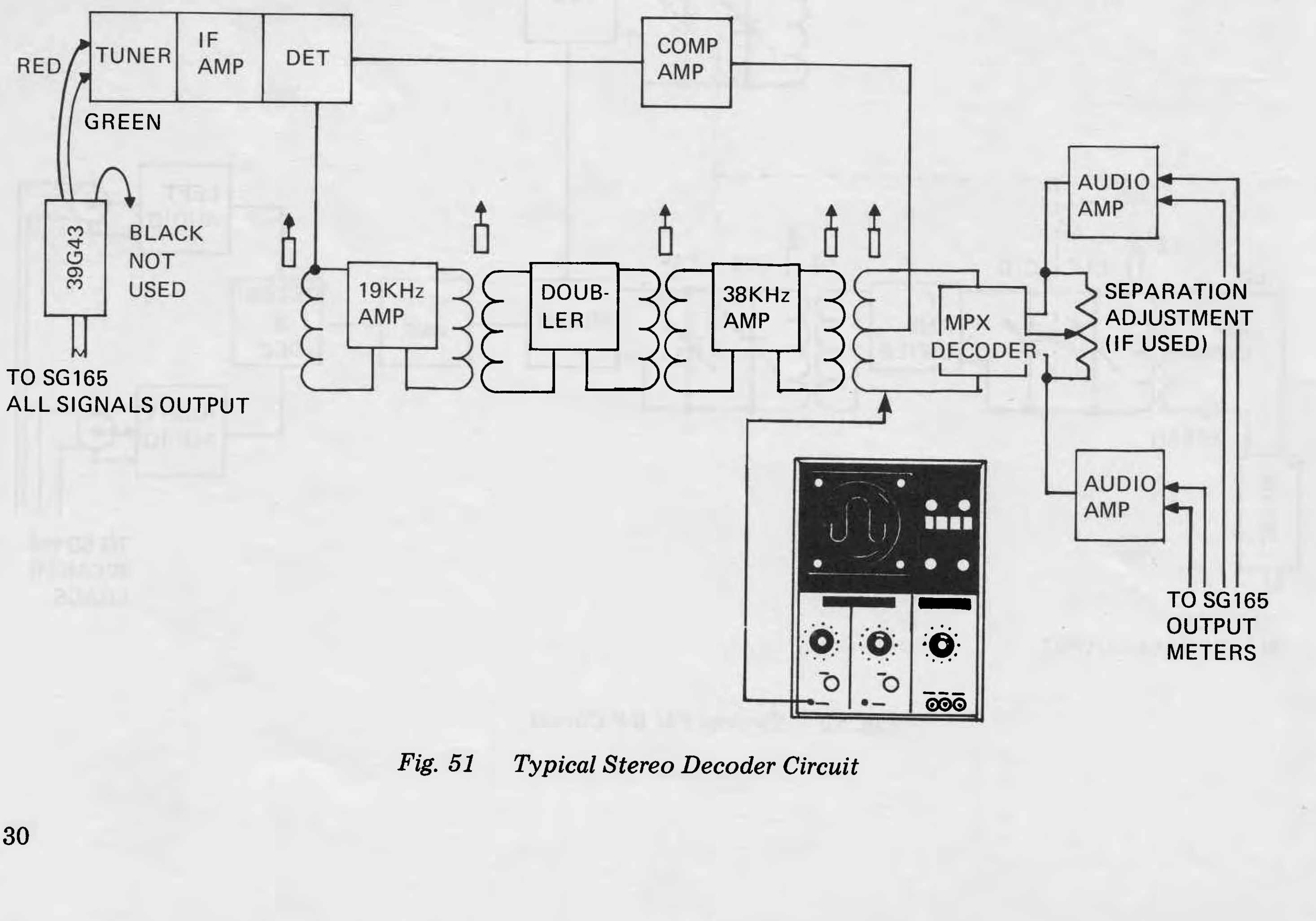


Fig. 51 Typical Stereo Decoder Circuit

The most common reason for poor stereo separation is misadjustment of the receivers 19KHz and 38KHz circuits. The phase relationship for proper stereo is very important, and even a 10% phase error on the 38KHz signal will nearly eliminate the stereo effect. The SG165 provides a quick concise way to accurately adjust these circuits.

1. Set up the SG165 and adjust the receiver the same as for checking separation.

2. Connect an oscilloscope, or FET meter set to measure AC volts to the output of the secondary of the last 38KHz transformer.

3. Adjust the receiver 19KHz and 38KHz coils for a maximum indication on the scope or meter. Remove the scope or meter from the output of the 38KHz transformer.

4. Turn the SG165 LEFT 400Hz off and the RIGHT 400Hz on, and observe the LEFT CHANNEL OUTPUT meter. Adjust the receiver 19KHz and 38KHz coils for a minimum indication on the meter. Make these adjustments carefully, turning all adjustments a small amount, rather than one a great deal.

5. Turn the LEFT 400Hz on and the RIGHT 400 Hz off, and observe the RIGHT CHANNEL OUTPUT meter. Adjust the receiver 19KHz and 38KHz coils for a minimum meter indication. Make these adjustments carefully, turning all adjustmenst a small amount, rather than one a great deal.

6. Repeat steps 4 and 5 until equal and maximum separation between channels is obtained.

7. If the receiver has a separation or balance adjustment in the decoder, adjust this control for optimum separation on both channels.

8. If proper separation cannot be obtained, refer to section on Receiver Troubleshooting.

AM IF ALIGNMENT

The hook-up for aligning the IF amplifiers of any AM receiver is basically the same. Most receivers require a simple, all stages tuned to the same frequency "peak" alignment, however, some may require stagger tuning to obtain the required band width and prevent oscillation. If service information is not available, the best procedure is to peak align the receiver, and then check the receiver performance. If the receiver exhibits poor high frequency response, and tends to motorboat or oscillate, the receiver should be realigned using the stagger tuning procedure. Stagger tuning involves tuning the input and output of a stage to slightly different frequencies, thereby increasing the band width of the stage, and preventing the stage from acting as a tuned plate, tuned grid oscillator. Other receivers that require special treatment of the IF alignment are those using ceramic or crystal filters. The filter used in these receivers may operate at a slightly different frequency than the standard 455 or 262KHz, and the receiver IF adjustments must be adjusted to the natural resonant frequency of the particular filter used.

HOOK UP FOR AM IF ALIGNMENT

1. Tune the receiver to a quiet spot on the band, connect the SG165 speaker loads in place of the speakers, and turn the POWER RANGE switch to SEPARATION TEST. Set the SG165 OUTPUT selector switch to either 455KHz or 262KHz position as required.

2. Loosely couple the output of the SG165 to the input of the AM mixer stage. Loose coupling may be accomplished either by clipping the red lead of the 39G43 to the body of a resistor in the input of the mixer, or by connecting a 1000 ohm resistor in series with the red lead of the 39G43 to the input of the mixer. Set the SG165 AM OUTPUT MODULATION switch to 30%

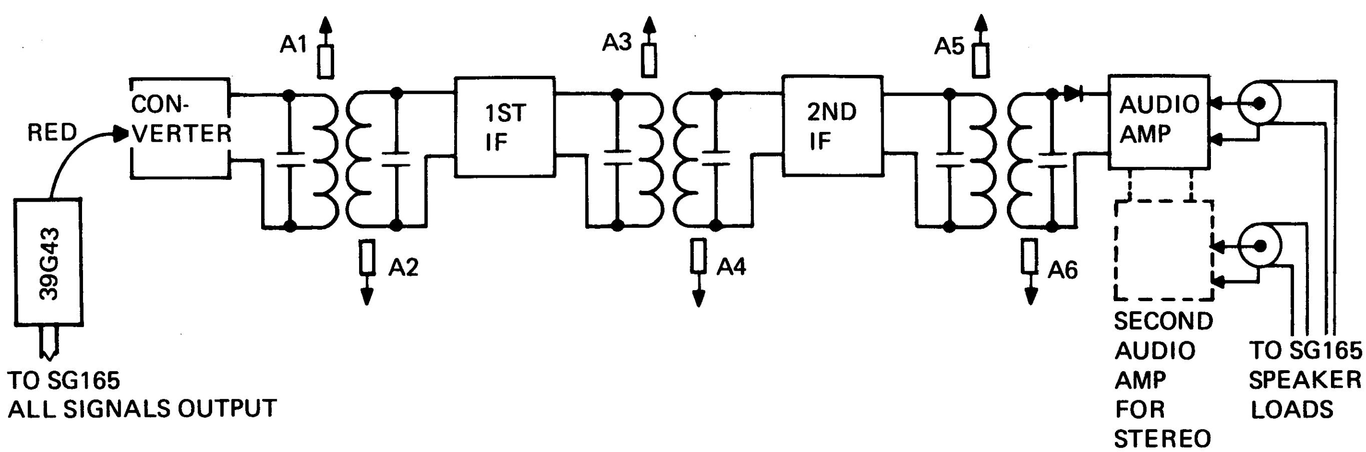


Fig. 52 Typical AM IF circuit

3. Turn the receiver volume or loudness control to mid-range and adjust the SG165 MICROVOLT OUTPUT controls for a mid scale indication on the SG165 OUTPUT meters.

PEAK ALIGNMENT

1. Set the SG165 AM/FM IF ROCKER control to the normal center position.

2. Adjust the receiver mixer output transformer, A1 and A2, and IF interstang transformers, A3, A4, A5 and A6, for a maximum indication on the SG165 OUTPUT meters. Reduce the SG165 MICROVOLT OUTPUT controls as necessary to maintain a near mid scale indication of the meters.

STAGGER TUNING

1. Set the SG165 AM/FM Rocker control 15 degrees clockwise from the normal center position (approximately 5KHz above normal IF frequency).

2. Adjust all stage input transformers, A2, A3, and A6, for a maximum indication on the SG165 OUTPUT meters. Use the SG165 MICROVOLT OUTPUT controls to maintain a near mid scale indication on the meters.

3. Set the SG165 AM/FM ROCKER control 15 degrees counterclockwise from the normal center position (approximately 5KHz below the normal IF frequency).

4. Adjust all stage output transformers, A1, A3, and A5, for a maximum indication on the SG165 OUTPUT meters. Use the SG165 MICROVOLT OUTPUT controls to maintain a near mid scale indication on the meters.

AM RF ALIGNMENT

The front ends of AM receivers range from the very simple single transistor oscillator mixer combination to more elaborate systems involving one or more RF amplifiers, and separate oscillator and mixer stages. AM RF adjustments are located in three places: The antenna circuit, the output of the RF amplifier (if used), and the local oscillator. The adjustments can take the form of a trimmer capacitor and/or an adjustable coil. If both forms of adjustment are present in a given location, then the capacitor is adjusted for best response to a frequency near the high end of the band, and the coil adjusted for a frequency near the low end of the band. If only one adjustment is present in a given location, it will be necessary to

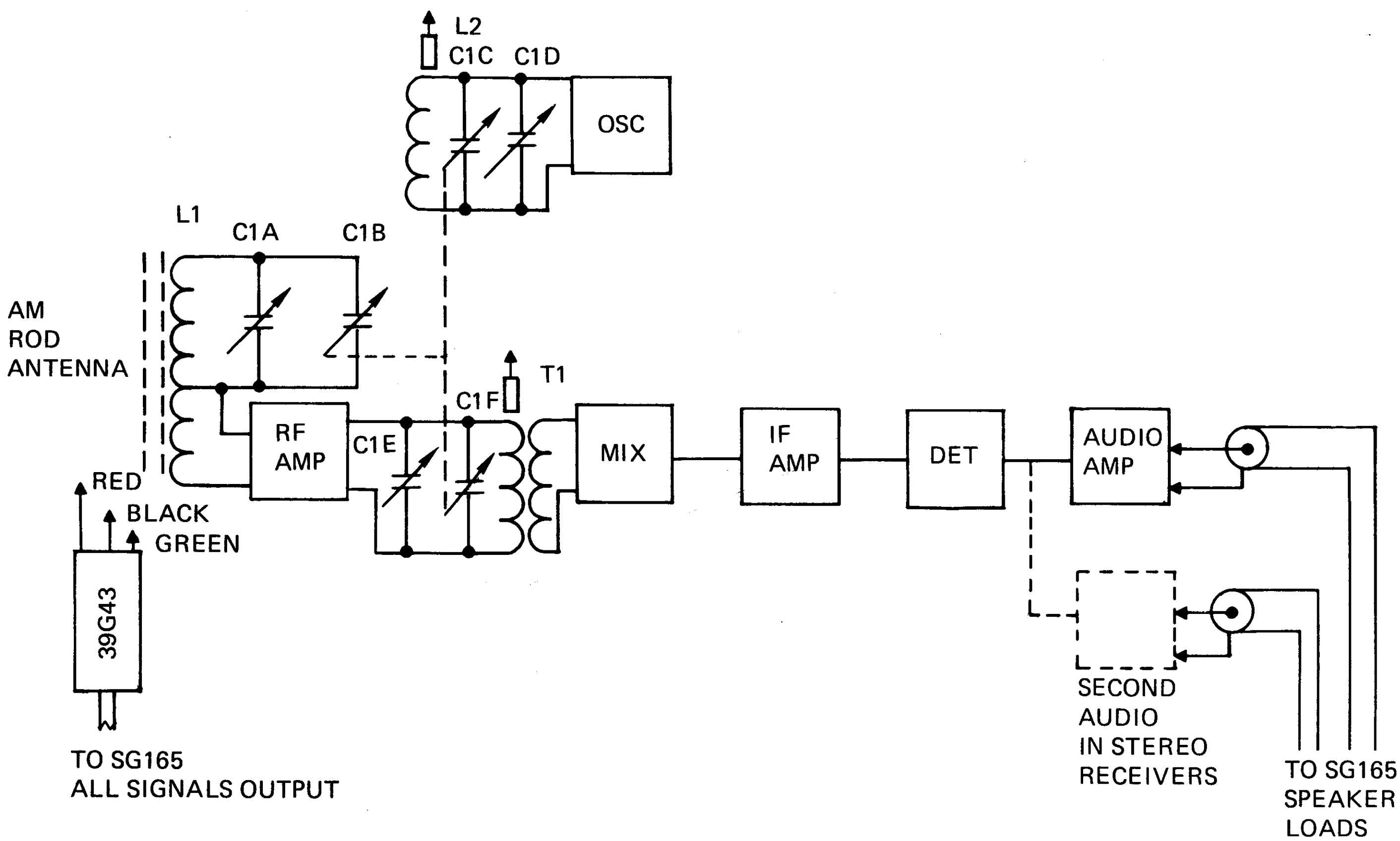


Fig. 53 Typical AM RF Circuit

optimize its adjustment for best performance across the band. The best procedure in all cases is to follow the manufacturers instructions.

HOOK UP

1. Set the SG165 OUTPUT selector switch to the AM RF position, and the AM MODULATION switch to 30%.

2. Allow the signal from the SG165 to radiate into the receiver by laying the 39G43 matching pad near the receiver rod antenna and set the SG165 MICRO-VOLT OUTPUT controls fully clockwise. For auto radios, plug the 39G53 dummy antenna connector into the antenna jack, and set the SG165 MICRO-VOLT OUTPUT controls for 500uV (5 X 10).

3. Connect the SG165 SPEAKER LOADS in place of the receiver speakers, turn the POWER RANGE switch to the SEPARATION TEST position, and set the receiver volume control to maximum. (Even though the SG165 meters will ~~bot~~ not be damaged by momentary overloads, it is a good idea to reduce the setting of the receiver volume control when tuning across strong local stations). Use the SG165 MICRO-VOLT OUTPUT controls to maintain a near midscale indication during the alignment procedure.

STEP	RECEIVER TUNING	SG165 FREQUENCY	ADJUSTMENT	ADJUST FOR
OSCILLATOR ADJUSTMENTS				
4	1600KHz	1600KHz	C1D	Maximum indication on LEFT and RIGHT CHANNEL OUTPUT meters.
5	550KHz	550KHz	L2	Maximum indication on LEFT and RIGHT CHANNEL OUTPUT meters.
6	Repeat steps 4 and 5 until the receiver tunes properly at 550KHz and 1600KHz.			
RF SENSITIVITY ADJUSTMENTS				
7	550KHz	550KHz	T1	Maximum indication on LEFT and RIGHT CHANNEL OUTPUT meters
8	1000KHz	1000KHz	~~C1B~~ C1A	Maximum indication on LEFT and RIGHT CHANNEL OUTPUT meters.
9	1600KHz	1600KHz	C1E	Maximum indication on LEFT and RIGHT CHANNEL OUTPUT meters.
10	Repeat steps 7, 8, and 9 until no further improvement in the receivers sensitivity can be obtained.			

RECEIVER TROUBLESHOOTING

RECEIVER BLOCK DIAGRAM

The following block diagrams, waveforms, and tables provide a quick reference to the waveforms at different locations in AM and FM receivers, along with the correct settings of the SG165 to inject signals at the various points. No attempt has been made to indicate signal levels, except that in general the signal level necessary to maintain the same audio output should decrease for each additional stage of amplification between the point of injection and the output. For example, it should take less signal to drive the input of the second FM IF than it took to drive the input of the third FM IF.

The numbered waveforms are taken at the numbered testpoints in the receiver block diagrams.

The following table indicates the correct settings of the SG165 controls for injection into the numbered points on the block diagram.

POINT	SG165 OUTPUT	MODULATION	STEREO MPX CONTROLS	NOTES
1	FM RF	STD MPX	LEFT 400Hz OFF; RIGHT 400Hz ON 19KHz PILOT 10%	1
2	10.7MHz IF	STD MPX	LEFT 400Hz OFF; RIGHT 400Hz ON 19KHz PILOT 10%	1
3	MPX SIGNAL	IHF MPX	LEFT 400Hz OFF; RIGHT 400Hz ON 19KHz PILOT 10%	2
4	MPX SIGNAL	IHF MPX	LEFT 400Hz OFF; RIGHT 400Hz OFF 19KHz PILOT 10%	2
5&6	400Hz SINE WAVE or 400Hz SQUARE WAVE			
7	AM RF	30%	NOT USED	1
8	455KHz IF or 262KHz IF	30%	NOT USED	1

NOTES:

1. Both RF and IF signals should pass through the input of the mixer stage.

2. When using the MPX SIGNAL output of the SG165, the output level will be 30% of normal if the MODULATION switch is in the STD MPX position.

3. The level of the OFF channel signal will be lower than the ON channel depending on the stereo separation of the receiver.

4. The waveform shown for point 9 would be for the input of the AM detector.

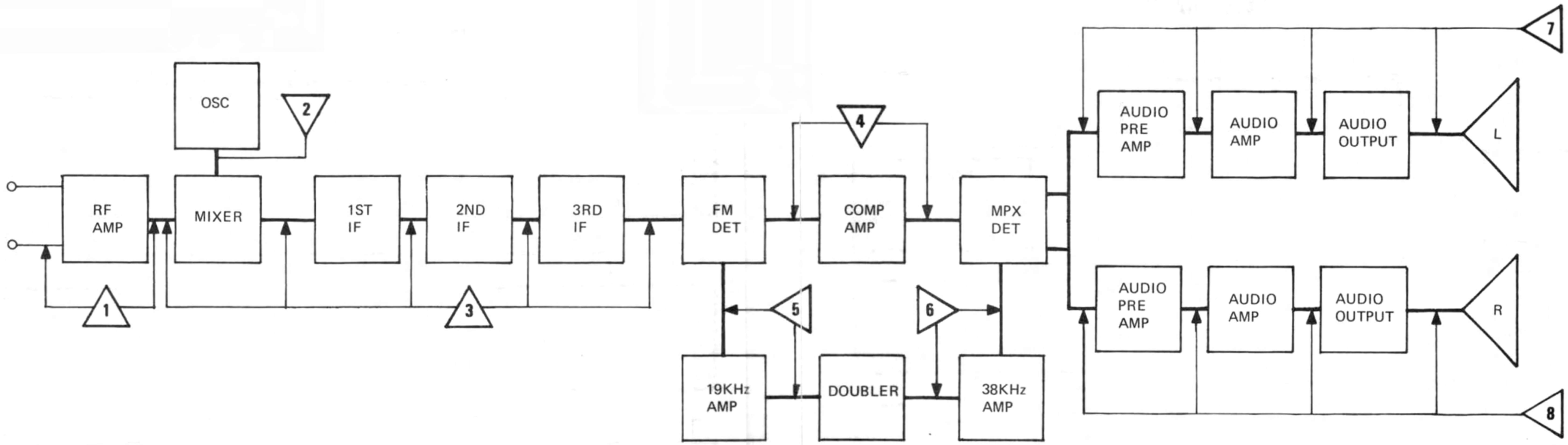


Fig. 54A Block Diagram FM Stereo Receiver

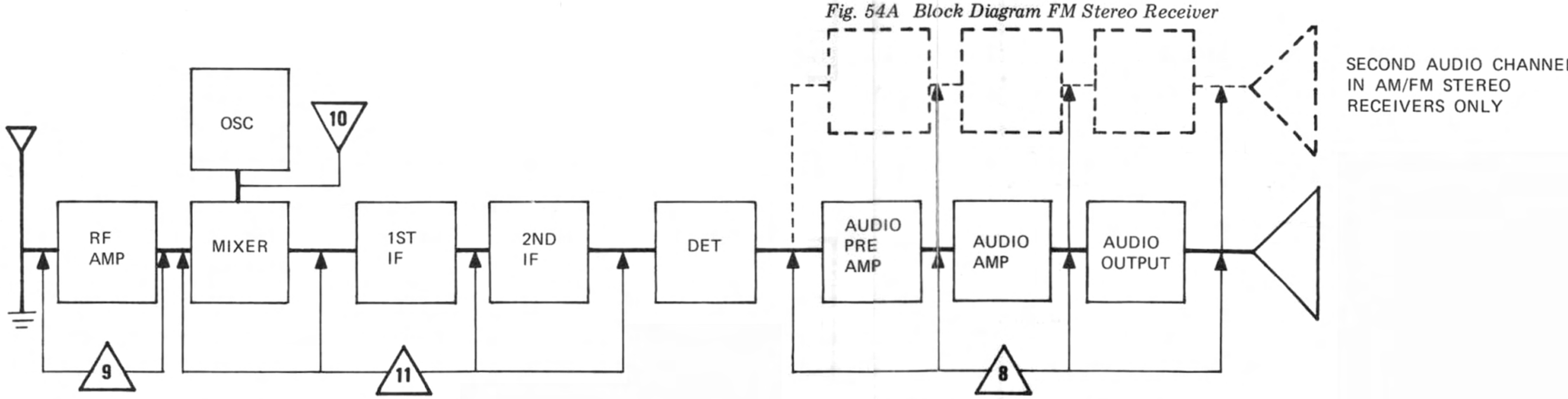
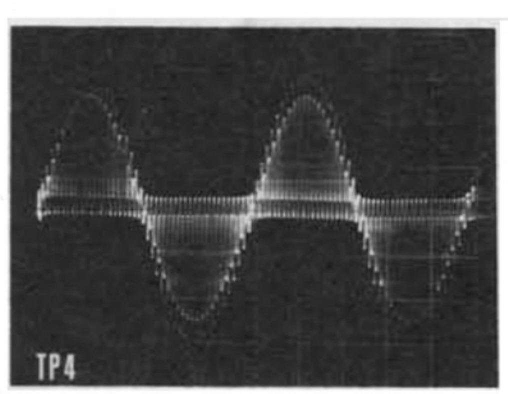
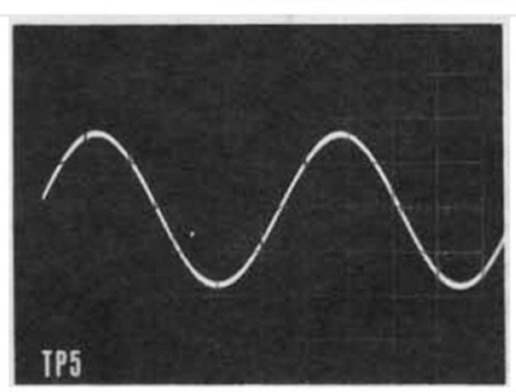
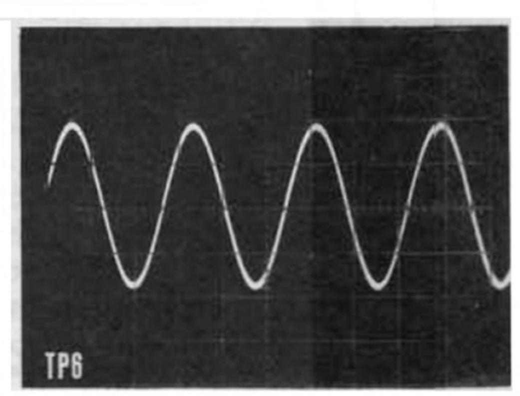
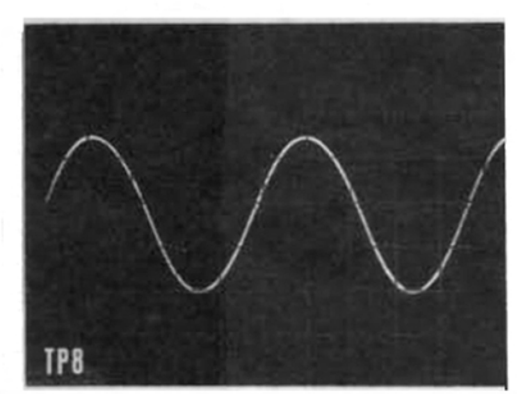


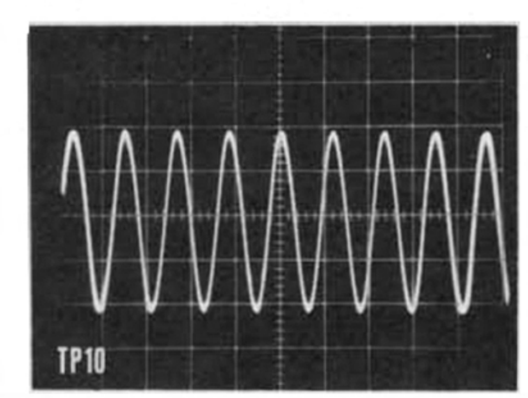
Fig. 54B Block Diagram AM Receiver

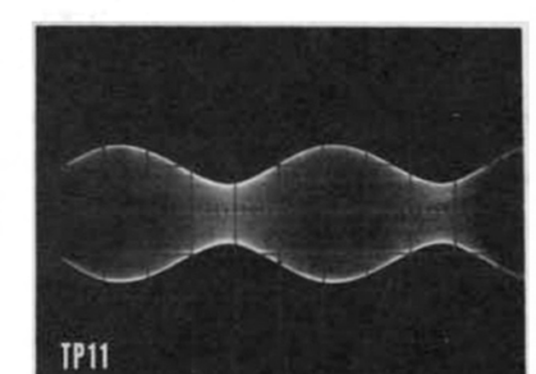












RECEIVER TROUBLE CHARTS

RECEIVER DEAD

DO PILOT LIGHTS LIGHT?

NO
Conclusion:
Check Fuse and AC power connections

YES
Check B+ and/or B- voltages; are they OK?

NO
Conclusion:
Troubleshoot power supply

YES
Inject 400Hz sine at input of audio output stage. Do you hear sound from speaker?

NO
Conclusion:
Check and replace as necessary output, driver, pre-driver or speaker

YES
Inject 400Hz sine at output of DET. Do you hear tone?

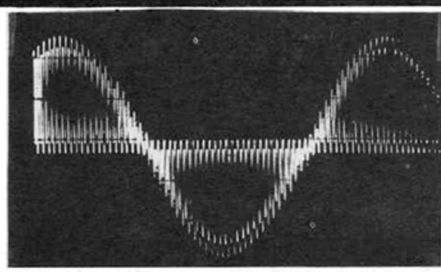
Conclusion:
Follow procedure for AM or FM dead

NO STEREO RECEPTION

Follow procedure for ADJUSTING RECEIVER 19KHz & 38KHz circuits. Do you have 38KHz signal?

NO

Starting with 19KHz take off coil; troubleshoot with scope to locate problem



YES

Is composite signal (photo at left) present at center tap of 38KHz output transformer. (1 channel ON)

NO

Conclusion:
Suspect composite amp

YES

Suspect decoder.

(FOLD OUT FOR BLOCK DIAGRAM)

AM OR FM DEAD OR VERY WEAK

Inject 400Hz audio into output of detector. Is signal present at output of receiver?

- **NO**

  Conclusion:
  Check wiring to function switch or preamplifier if used

- **YES**

  Inject IF signal to input of detector. Is signal (weak) observed at output receiver?

  - **NO**

    Check and replace detector or detector transformer as necessary

  - **YES**

    Inject IF signal into input of last IF stage. Is signal much stronger?

    - **NO**

      Conclusion:
      Defect in last IF stage

    - **YES**

      Reduce SG165 MICROVOLT OUTPUT until signal is weak at output, and inject into input of preceeding IF stage. Repeat for each IF stage and the mixer stage. Do all IF stages including the mixer have gain?

      - **NO**

        Conclusion:
        Repair defective IF stage

      - **YES**

        Inject an RF signal into input of mixer, and tune the receiver. Is signal present at amplifier and receiver?

        - **NO**

          Set the receiver dial to a station near the low end of the band, and inject the SG165 set for a frequency equal to the station frequency plus the ~~oscillation~~ IF frequency with the modulation OFF into mixer. If station signal is received, defect is in receiver local oscillator.

        - **YES**

          Inject RF signal into input of RF amplifier (if used). Does RF amp have normal gain?

(Cont. on next page)

NO

Conclusion:
Repair RF amplifier

YES

Conclusion:
Check antenna and input circuits

NOTE: In some cases a defective local oscillator will be shocked into oscillation during troubleshooting procedures. If this happens, turn the receiver off and on to see if it will quit again.

POOR FREQUENCY RESPONSE

Is problem evident in all functions?

NO

Conclusion:
If problem is in AM or FM function check RF & IF alignment of affected section. If alignment proves correct, inject 400Hz square wave at input of affected function, and use scope to locate stage causing problem. (Refer to Square Wave Testing of Audio Amplifiers)

YES

Do substitute speakers cure problem?

NO

Are power supply output voltages and ripple normal?

YES

Replace speakers

NO

Conclusion:
Repair power supply

YES

Inject 400Hz square wave into Aux. or TAPE MON input, and use scope to locate defective stage.

DB TABLE

HOW TO USE THE DB TABLE:

The db table of Fig.   shows the relationship between db and the ratio of two voltages across a fixed impedance. The db values are listed in the center column, the ratios corresponding to a decrease in signal level (-db) are listed in the left hand column, and the ratios corresponding to an increase in signal level (+db) are listed in the right hand column.

FOR 30db SIGNAL PLUS NOISE TO NOISE MEASUREMENT (Increase in signal)

1. Measure the peak to peak amplitude of the noise signal.

2. Since this measurement is a 30db increase, refer to the +db column to find the ratio of 31.62 to 1.

3. Multiply the amplitude of the noise signal measured in step 1 by the ratio from step 2.

For example if the noise signal measures .2v p-p, the signal level necessary for a 30db increase would be .1 X 31.62 or 3.162v p-p.

FOR SEPARATION MEASURE (decrease in signal)

1. Measure the peak to peak amplitude of the amplifier or tuner output signal with both channels on.

2. Switch one channel off, and measure the peak to peak amplitude of the off channel output signal.

3. Divide the amplitude measured with the signal off (small number) by the amplitude measured with the signal on (large number).

4. Find the -db voltage ratio in the left column of the db table closest to the ratio calculated in step 3. The db listing corresponding to this ratio is the separation of the receiver or tuner, measured in db.

DB VOLTAGE OR CURRENT

—	DB	+
1.000	0	1.000
.9441	.5	1.059
.8913	1.0	1.122
.7943	2.0	1.259
.7089	3.0	1.413
.6310	4.0	1.585
.5623	5.0	1.778
.5012	6.0	1.995
.4467	7.0	2.239
.3981	8.0	2.412
.3548	9.0	2.818
.3162	10.0	3.162
.2512	12.0	3.981
.1995	14.0	5.012
.1585	16.0	6.310
.1259	18.0	7.943
.1	20.0	10
.05623	25.0	17.78
.03162	30.0	31.62
.01778	35.0	56.23
.01	40.0	100
.005623	45.0	177.8
.003162	50.0	316.2

SERVICING YOUR SG165

DISASSEMBLY INSTRUCTIONS

CASE WRAP

1. Remove the two screws from the top of the case wrap, and the two from each side of the wrap near the bottom.

2. Remove the cables from the lead compartment, and dress them so that they are hanging free from the back of the instrument.

3. Spread the bottom front of the case wrap slightly, and lift the wrap straight up. Guide the cables through the opening in the floor of the lead compartment one at a time.

SHIELD COVER
(case wrap removed)

1. Disconnect the molex plug carrying the power supply outputs from the feedthrough capacitors on the side of the main shielded assembly.

2. Leave the power supply and fuse bracket mounted to the shield cover, and remove the four sheet metal screws that secure the cover to the shielded assembly.

3. Spread the bottom of the shield cover, and lift it straight up. Take care that the shield cover clears the MPX PC board, SPEAKER LOAD switch, and the POWER RANGE switch.

4. Place the shield cover next to the SG165 so that the fuse holder bracket faces in the same direction as the front of the SG165, and reconnect the molex plug disconnected in step 1. Take care to plug the supply output cable into the feed through terminals correctly. The SG165 is now ready to troubleshoot using the coil and component side PC board layouts.

5. When replacing the shield cover, take care that the spring fingers mounted to the shield cover line up properly with the edge of the shielded assembly.

REMOVING THE MAIN RF BOARD FOR COMPONENT CHANGE
(case wrap and shield cover removed)

1. Remove the knobs from the OUTPUT selector switch, the AM/FM IF ROCKER control, and the MICROVOLT OUTPUT controls.

2. Use a long, small, thin bladed screwdriver to loosen both set screws that secure the shaft of the RF TUNING capacitor to the front panel mounted 4 : 1 drive.

3. Remove the molex connectors from the side of the shield assembly and the phono plug from the front of the assembly.

4. Remove the four screws that secure the shielded assembly from the bottom of the case.

5. Pull the shield assembly straight back until the shaft of the RF TUNING capacitor clears the front panel drive, and then lift it up and out of the case.

6. Remove the screw, nut and spacer that secure the 2,000mfd electrolytic capacitor to the shield assembly. Reassemble the screw, nut and spacer to the capacitor mounting strap to prevent loss of the individual pieces.

7. Remove all molex connectors and the phono plug from the RF board.

8. Remove the four screws that secure the RF board to the shield assembly, and the three machine screws that secure the RF TUNING capacitor to the front of the shield assembly.

9. Lift the rear of the RF board, and pull back until the shafts of the OUTPUT selector switch and the RF TUNING capacitor clear the holes in the shield assembly.

REMOVING THE ATTENUATOR
(case wrap, shield cover and RF board removed)

1. Remove the three sheet metal screws that secure the cover of the attenuator, and remove the cover.

2. Unsolder the wires from the phone plug to the input of the stepped attanuator and from the variable attenuator to the output of the stepped attenuator.

3. Remove the ½" nut and lock washer that secure the stepped attenuator to the shield assembly, and lift the stepped attenuator up and out of the shield. Take care that the wire from the output of the stepped attenuator clears the hole in the shield.

4. Unsolder the wire from the output of the variable attenuator to the output phono jack, and remove the ½" nut and lockwasher that secure the variable attenuator to the shield. Remove the variable attenuator.

REMOVING THE MPX BOARD

(case wrap removed)

1. Unplug the molex connector that connects the MPX board to the feed through capacitors on the side of the shield assembly, and dress this cable over the top of the power supply PC Board.

2. Remove the two screws that secure the MPX board to the front panel mounted stand offs.

3. Remove the two ¼" nuts that secure the MPX board bracket to the two lower meter mounting studs, and pull the top of the MPX board off the studs. Lift the MPX board up and away from the front panel.

SG165 CALIBRATION INSTRUCTIONS

NOTE: ADJUSTMENTS MARKED WITH AN * REQUIRE SPECIAL EQUIPMENT TO ADJUST, AND SHOULD NOT BE ATTEMPTED UNLESS THIS EQUIPMENT IS AVAILABLE.

POWER SUPPLY

1. Measure voltage on positive lead of C105.

2. Adjust R113 for a negative voltage of equal value as measured at the negative lead of C106.

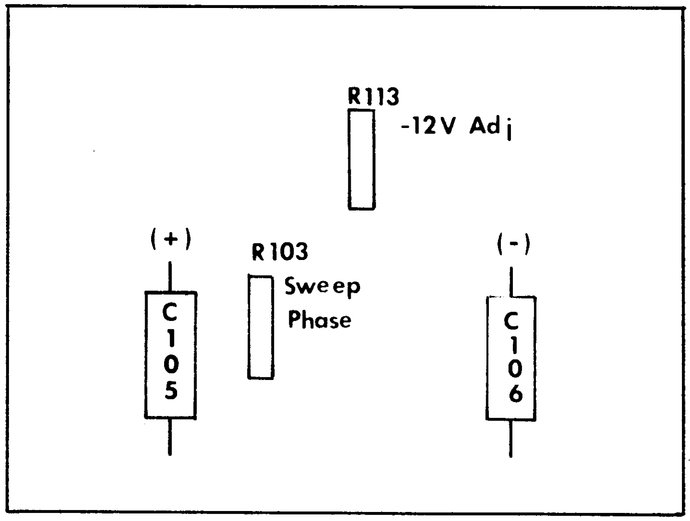


Fig. 54 SG165 Power Supply Adjustments

400Hz SINE WAVE

1. Turn the OUTPUT selector switch to the 400Hz SINE WAVE position.

2. Connect an oscilloscope or meter set to measure AC volts to the ALL SIGNALS OUTPUT of the SG165. Set the MICROVOLT OUTPUT controls for maximum output.

3. Adjust R375 (PC control on board mounted to side of tuning capacitor) for 1 V RMS (2.8v p-p).

67KHz*

1. Turn the OUTPUT selector switch to the 67KHz position.

2. Connect a frequency counter to the ALL SIGNALS OUTPUT of the SG165. Set the MICROVOLT OUTPUT controls for maximum output.

3. Adjust L307, the 67KHz oscillator coil, for an output frequency of 67KHz.

MPX (STEREO SEPARATION ADJUSTMENT)

1. Turn the SG165 OUTPUT selector switch to the MPX SIGNAL position.

2. Connect an oscilloscope to the ALL SIGNALS OUTPUT jack, and set the MICROVOLT output controls to maximum.

3. Turn the LEFT 400Hz on, the RIGHT 400 Hz off, and set the 19KHz pilot to zero.

4. Adjust R250 the MPX balance adjustment on the MPX board for a straight base line.

10.7MHz IF

FREQUENCY*

1. Set the OUTPUT selector switch to 10.7 MHz IF and turn the AM/FM IF ROCKER control to the center detent. Switch the LEFT and RIGHT 400Hz off, and set the PILOT 19KHz to zero.

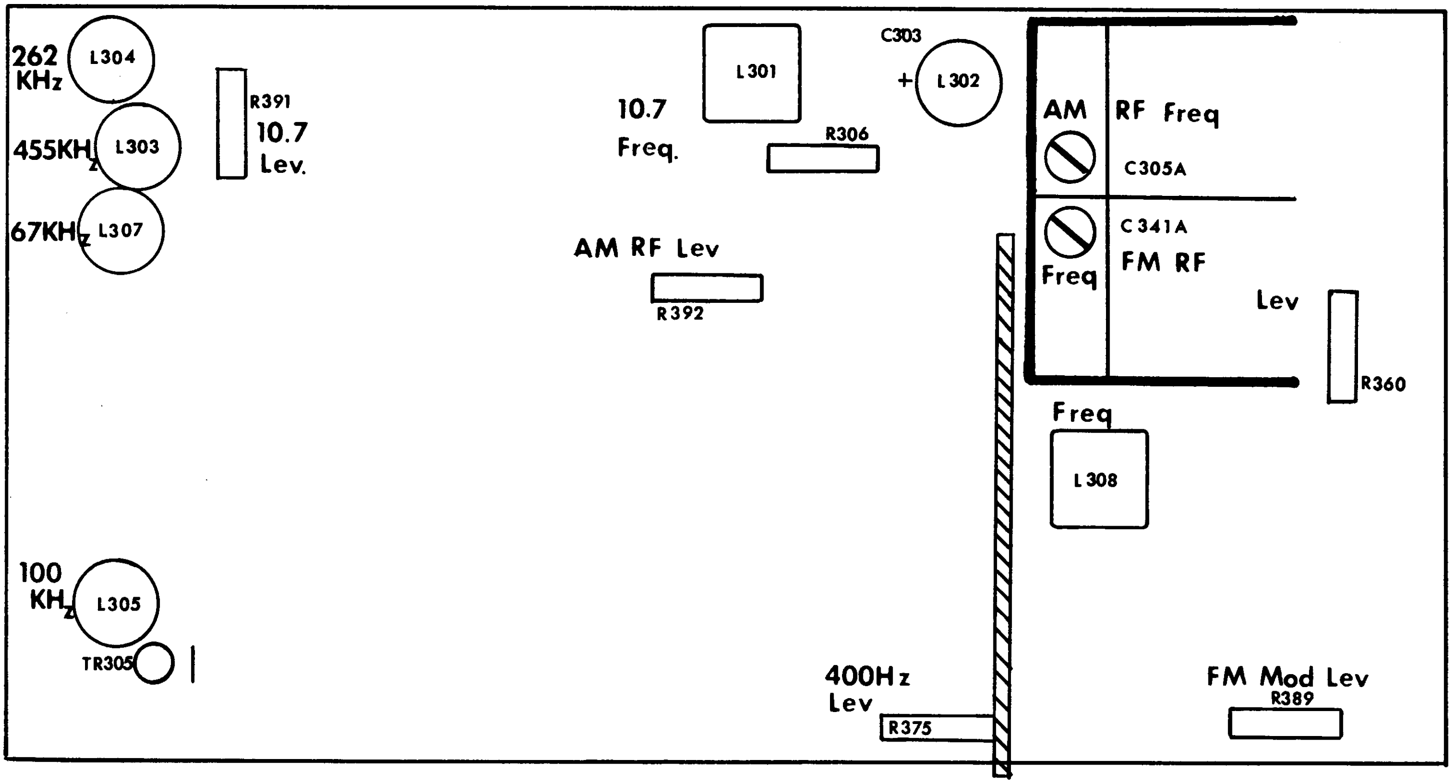


Fig. 55 SG165 Output Calibration Adjustments

2. Connect an accurate DC voltmeter to the positive lead of C303, and adjust R306 for 6 volts DC with respect to chassis.

3. Connect a frequency counter to the ALL SIGNALS OUTPUT jack and set the MICRO-VOLT OUTPUT controls for maximum. (A broad band instrument amplifier will be necessary if the counter does not trigger reliably with the 100mV signal available from the SG165).

4. Adjust L301 for exactly 10.7MHz as measured on the frequency counter.

LEVEL*

1. Remove the frequency counter from the ALL SIGNALS OUTPUT, and connect an accurate RF volt meter.

2. Adjust R391 for 100mV RMS as measured on the RF volt meter.

10.7MHz SWEEP AND MARKERS

MARKER FREQUENCY

1. Set the OUTPUT selector switch to the 10.7MHz SWEEP AND MARKERS position.

2. Connect a frequency counter or an oscilloscope with a calibrated time base to the jumper wire on the main RF board near TR305, and adjust L305 for an indication of 100KHz.

10.7MHz SWEEP PHASE

1. Connect the vertical input of an oscilloscope to pin 3 of the main RF board (blanking input), and the horizontal input to pin 2 of the RF board (60Hz sweep). Adjust the scope to display a lissajous pattern between the vertical and horizontal inputs. NOTE: The VECTOR input of the Sencore PS163 is ideal for this application. If some other scope is used, be sure to check it for zero phase shift to the 60Hz signal.

2. Adjust R103 on the POWER SUPPLY board to obtain a circular pattern on the scope, indicating a 90 degree phase shift between pins 2 and 3. (Refer to Fig. 54)

AM RF

FREQUENCY

1. Tune a good quality AM receiver to a station with a known frequency near the lower edge of the band.

2. Set the SG165 OUTPUT selector to AM RF, the MICROVOLT OUTPUT controls to maximum, and the AM modulation switch to 30%.

3. Loosely couple the output of the SG165 to the receivers antenna by laying the open leads of the 39G43 pad near the antenna.

4. Set the SG165 RF tuning to the frequency of the station tuned in step 1, and adjust L302 and AM RF oscillator slug that the signal from the SG165 "zero beats" with the station signal.

5. Tune the receiver to a station with a known frequency near the high end of the band, and set the SG165 RF tuning to the frequency of that station.

6. Adjust C305A the trimmer across the AM section of the tuning capacitor so that the signal from the SG165 "zero beats" with the station signal.

7. Repeat steps 1 - until the SG165 tunes properly at the low and high end of the AM band.

LEVEL*

1. Connect an accurate RF voltmeter to the ALL SIGNALS OUTPUT jack.

2. Adjust R392 for 100mV as measured on the RF volt meter.

455KHz

FREQUENCY*

1. Set the SG165 OUTPUT selector switch to the 455KHz IF position, slide the AM MODULATION switch to zero, and set the MICROVOLT OUTPUT controls for maximum output and center the ROCKER in the detent.

2. Connect a frequency counter to the ALL SIGNALS OUTPUT jack, and adjust L303 the 455KHz oscillator coil for an output frequency of 455KHz (a broad band instrument amplifier will be necessary if the counter does not trigger reliably on the 100mV output of the SG165).

262.5KHz FREQUENCY*

Follow the same procedure as for 455KHz, except turn OUTPUT selector switch to 262KHz IF position, and adjust L304 for an output frequency of 262.5KHz.

FM RF

FREQUENCY

NOTE: For accurate results these adjustments should be performed with all shields in place.

1. Connect a good antenna to a good quality FM receiver, and with the receivers AFC off, tune a station with a known frequency near the high end of the band.

2. Remove the antenna from the receiver, and without changing the receivers tuning connect the SG165 to the antenna terminals of the receiver. Set the SG165 RF tuning to the frequency of the station tuned in step 1, and the OUTPUT selector switch to FM RF.

3. Adjust C341A the trimmer across the FM section of the tuning capacitor so that the output frequency is exactly the same as the station tuned in step 1.

4. Disconnect the SG165 from the receivers antenna terminals and reconnect the antenna. Tune the receiver to a station with a known frequency near the low end of the band.

5. Disconnect the antenna, and without changing the receivers tuning connect the SG165 to the antenna terminals. Set the SG165 RF TUNING to the same frequency as the station tuned in step 4.

6. Adjust L308 and FM oscillator coil so that the SG165 output frequency is exactly the same as the station tuned in step 4.

7. Repeat steps 1 -6 until the SG165 tunes accurately at the low and high end of the FM band.

LEVEL*

1. Set the MICROVOLT OUTPUT controls to maximum, and connect an RF voltmeter with 10mV sensitivity to the ALL SIGNALS OUTPUT jack.

2. Adjust R360 for an indication of 10mV on the RF volt meter.

MODULATION PERCENTAGE*

1. Set the RF TUNING to 98MHz, and connect a calibrated FM deviation meter to the ALL SIGNALS OUTPUT.

2. Switch the LEFT and RIGHT 400Hz on, the PILOT 19KHz to Zero, and the FM MODULATION switch to IHF MPX.

3. Adjust R389 for 100% modulation (75KHz deviation).

CIRCUIT DESCRIPTION
BLOCK DIAGRAM

The circuit description of the SG165 is divided into two sections. The first section refers to the block diagram in Fig. 56, and is broken down by output. to show how the blocks are interrelated to produce a given output. The second section is a transistor by transistor explanation of the operation of each block.

OUTPUTS USING BLOCK DIAGRAM

67KHz - The 67KHz oscillator TR312 output is selected by position 1 of SW301E, and coupled to the output buffer (TR316 - TR321). The buffer output provides current amplification to the 67KHz signal and couples it to the MICROVOLT OUTPUT controls and ALL SIGNALS OUTPUT jack through terminal 14 on the main RF board.

MPX SIGNAL - The composite stereo signal generated by the MPX board is coupled from the output of the MPX board (pin 5) into pin 1 of the main RF board. Position 2 of SW301E selects the composite stereo signal and couples it to the output buffer, where it is current amplified and connected to the MICROVOLT OUTPUT controls and the ALL SIGNALS OUTPUT through pin 14 of the main RF board.

10.7MHz SWEEP AND MARKERS - The 10.7MHz sweep is generated in the main oscillator (TR301 - 304), switched to operate at 10.7MHz. 60Hz sweep voltage for the variable capacity diode in the main oscillator is provided by a 60Hz sine wave that originates at pins 4 and 5 of the power supply board, and is coupled into the main oscillator through pins 2 and 3 of the main RF board. Control of the sweep center frequency is provided by the ROCKER control. The sweep output of the main oscillator is coupled through the isolation buffer (TR308 - 311), position 3 of SW301E, and the output buffer to pin 14 of the main RF board. From pin 14, the signal is coupled to the MICROVOLT OUTPUT controls and then to the ALL SIGNALS OUTPUT.

Markers are generated by first modulating the 10.7 MHz CW signal from TR313 with the 100KHz signal generated in TR305. The output of modulator TR303 (a 10.7MHz signal with 100KHz side bands) is then coupled along with a sample of the 10.7MHz sweep taken from the output of the isolation buffer to the input of the birdy amplifier TR306 and 307. The amplified markers from the birdy amplifier are coupled through pin 6 of the main RF board to the MARKER HEIGHT control. Retrace blanking (provides a clean base line) is provided by TR1. The 60 Hz blanking signal coupled to the base of TR1 effectively shorts the TO SCOPE jack to ground during the retract time.

10.7MHz XTAL CONTROLLED - The output of the 10.7MHz crystal oscillator (TR313) is selected by position 4 of SW301E. The output of SW301E is amplified by the output buffer, and coupled through pin 14 of the main RF board to the MICROVOLT OUTPUT controls and then to the ALL SIGNALS OUTPUT.

10.7MHz IF - The 10.7MHz IF signal is generated in the main oscillator (TR301 - 304) switched to operate at 10.7MHz, with fine frequency adjustment provided by the ROCKER control. The main oscillator is frequency modulated by the composite stereo signal that enters the main RF board through pin 1. The output of the mian oscillator is current amplified by the isolation buffer, and coupled through position 5 of SW301E to the output buffer. The current amplified signal from the output buffer is coupled through pin 14 of the main RF board to the MICROVOLT OUTPUT controls and then to the ALL SIGNALS OUTPUT.

FM RF - The FM RF signal is generated in the FM RF oscillator (TR314 - 315) and coupled directly to pin 14 of the main RF board and then through the MICROVOLT OUTPUT controls to the ALL SIGNALS OUTPUT. The FM RF oscillator is frequency modulated by the composite stereo signal that enters the main RF board through pin 1.

AM RF - The AM RF signal is generated in the main oscillator (TR301 - 304) switched to operate over the AM broadcast band. Amplitude modulation is provided by the 400Hz signal entering the main RF board through pin 12. The output of the main oscillator is current amplified by the isolation buffer, and coupled through position 7 of SW301E to the output buffer. The current amplified signal from the output buffer is coupled through pin 14 of the main RF board to the MICROVOLT OUTPUT controls and then to the ALL SIGNALS OUTPUT.

455KHz and 262KHz IF - The operation for the AM IF frequencies is the same as for the AM RF except that the main oscillator is switched to operate at 455KHz or 262KHz, and fine frequency adjustment is provided by the ROCKER control.

400Hz SINE AND SQUARE WAVE - The sine and square wave outputs of the 400Hz oscillator board are coupled to the input of the output buffer through positions 10 and 11 respectively of SW301E. The current amplified signal from the output buffer is coupled through pin 14 of the main RF board to the MICROVOLT OUTPUT controls, and then to the ALL SIGNALS OUTPUT.

EXTRA CRYSTAL - The EXTRA CRYSTAL function operates exactly the same as the 10.7MHz XTAL CONTROLLED, except that TR313 oscillates at a frequency determined by the crystal, (not supplied) inserted in the extra crystal socket.

CIRCUIT DESCRIPTION
CIRCUIT OPERATION

MAIN OSCILLATOR 10.7MHz SWEEP, 10.7MHz IF, AM RF AND AM IF

GENERAL

The main oscillator comprised of TR301 and TR302 is used to generate the 10.7MHz swept signal, the 10.7MHz frequency modulated IF signal, the AM RF signal, and the AM IF signals. Feed back to sustain oscillation is provided by cross-coupling capacitor C308. TR303 effectively shorts the collector of TR302 to ground during retrace in the 10.7MHz SWEEP & MARKERS function, producing zero output from the main oscillator during retrace. TR304 provides amplitude modulation for the AM outputs by varying the emitter current to the main oscillator transistors. The output of the main oscillator is coupled from the base of TR301 through C357 to the input of the isolation buffer.

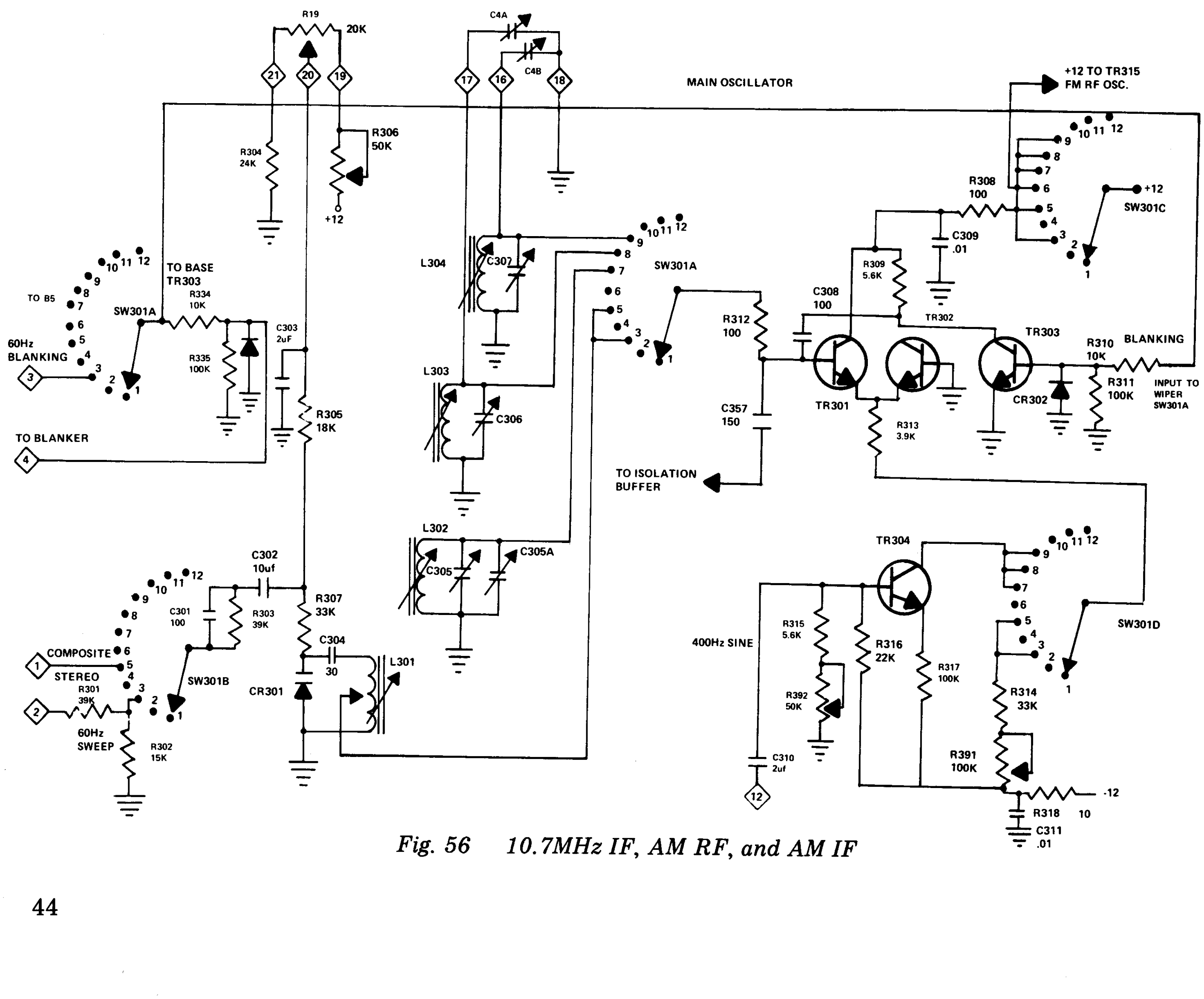


Fig. 56 10.7MHz IF, AM RF, and AM IF

10.7MHz SWEEP AND MARKERS

For the 10.7MHz Sweep output the resonant circuit comprised of L301 and varicap diode CR301 is connected to the base of TR301 by position 3 of SW301A causing TR301 and TR302 to oscillate at 10.7MHz. The resonant frequency of L301 and CR301 is varied (swept) by the change in capacity of CR301 caused by the 60Hz sine wave coupled to it through the series path of terminal 2 of the main RF board, position 3 of SW301B, R303 in parallel with C301 C302, and R307. The DC bias, and therefore the steady state capacity of CR301, is controlled by a voltage divider comprised of R306, R19 (front panel ROCKER control), and R304. R306 is factory adjusted for positive 5 volts bias, with R19 in its center detent. R19 varies the bias voltage, providing front panel adjustment of the 10.7MHz sweep center frequency.

A 60Hz blanking signal to turn off the oscillator during the retrace of the 10.7MHz sweep is coupled through pin 3 on the main RF board position 3 of of SW301A to the base of TR303. When the signal at the base of TR303 goes positive, TR303 turns on effectively shorting the collector of TR302 to ground and killing the oscillator.

The emitter current for TR301 and TR302 flows from the minus 12 volt supply through R391, R314, R318 and position 3 of SW301D. R391 is a calibration adjustment adjusted for 100mV output at the ALL SIGNALS OUTPUT with the OUTPUT selector in the 10.7MHz IF position.

The 10.7MHz IF function uses the same oscillator circuitry as the 10.7MHz sweep. The only differences are that the blanking signal is not applied to the base of TR303, and a composite stereo signal is applied to CR301 in place of 60Hz sweep voltage.

AM RF

For the AM RF output, the resonant circuit comprised of L302, C305, and C305A is connected to the base of TR301 by position 7 of SW301A, TR301 and 302 oscillate at an AM RF frequency as determined by the setting of the front panel RF TUNING control C305. C305A (a trimmer mounted on C305) is a calibration adjustment adjusted for the correct output frequency at the high end of the AM RF band. L302 is a calibration adjustment adjusted for the correct output frequency at the low end of the AM RF band. The 400Hz modulating signal switched by a switch on the MPX board and coupled into the main RF board through pin 12 varies the base voltage on TR304. TR304 actually functions as a variable constant current source whose output current is varied by the 400Hz modulation signal at its base. The modulated output of the constant current source provides the emitter current for the oscillator transistors, resulting in a 30% amplitude modulated output from the oscillator. R392 is a calibration adjustment adjusted for 100mV at the ALL SIGNALS OUTPUT in the AM RF function.

(FOLD OUT FOR BLOCK DIAGRAM)

455KHz IF

For the 455KHz IF output, the resonant circuit comprised of L303 and C306 is connected to the base of TR301 by position 8 of SW301A, causing TR301 and TR302 to oscillate at 455KHz. TR304 provides modulation the same as it did for the AM RF output.

262KHz IF

For the 262KHz IF output, the resonant circuit comprised of L304 and C307 is connected to the base of TR301 by position 9 of SW301A, causing TR301 and TR302 to oscillate at 262KHz. TR304 provides modulation the same as it did for the AM RF output.

ISOLATION AND OUTPUT BUFFERS

The isolation buffer (TR308 - TR310) and the output buffer (TR316 - TR321) are nearly identical high gain current amplifiers. The isolation buffer amplifies the signals from the main oscillator, and provides a low impedance drive for the output selector switch SW301E. The output buffer amplifies the signal selected by SW301E (all except FM RF), and provides a low impedance drive for the MICROVOLT OUTPUT controls and ALL SIGNALS OUTPUT.

The input FET (TR308 or TR316) provides the initial impedance change from a high impedance voltage sensing input that does not load the preceeding circuit to a low impedance voltage source to drive the following circuitry. TR310 in the isolation buffer and TR318 in the output buffer operate in conjunction with TR308 and TR316 as modified darlington pairs.

If the drain current in TR308 or TR316 tends to increase in drive at the gate, the increased voltage drop across R343 and R370 will cause TR310 and TR318 to conduct more heavily. The increased collector current through TR310 and TR318 will act to make the source voltage of TR308 and TR316 more positive which in turn will lower the gain of the two FET stages. The overall effects then of the compound connection are to provide an FET source follower of extremely high Gm and low output impedance.

The only differences between the buffers are: the output buffer uses larger coupling capacitors to pass the lower audio frequencies, and the output buffer

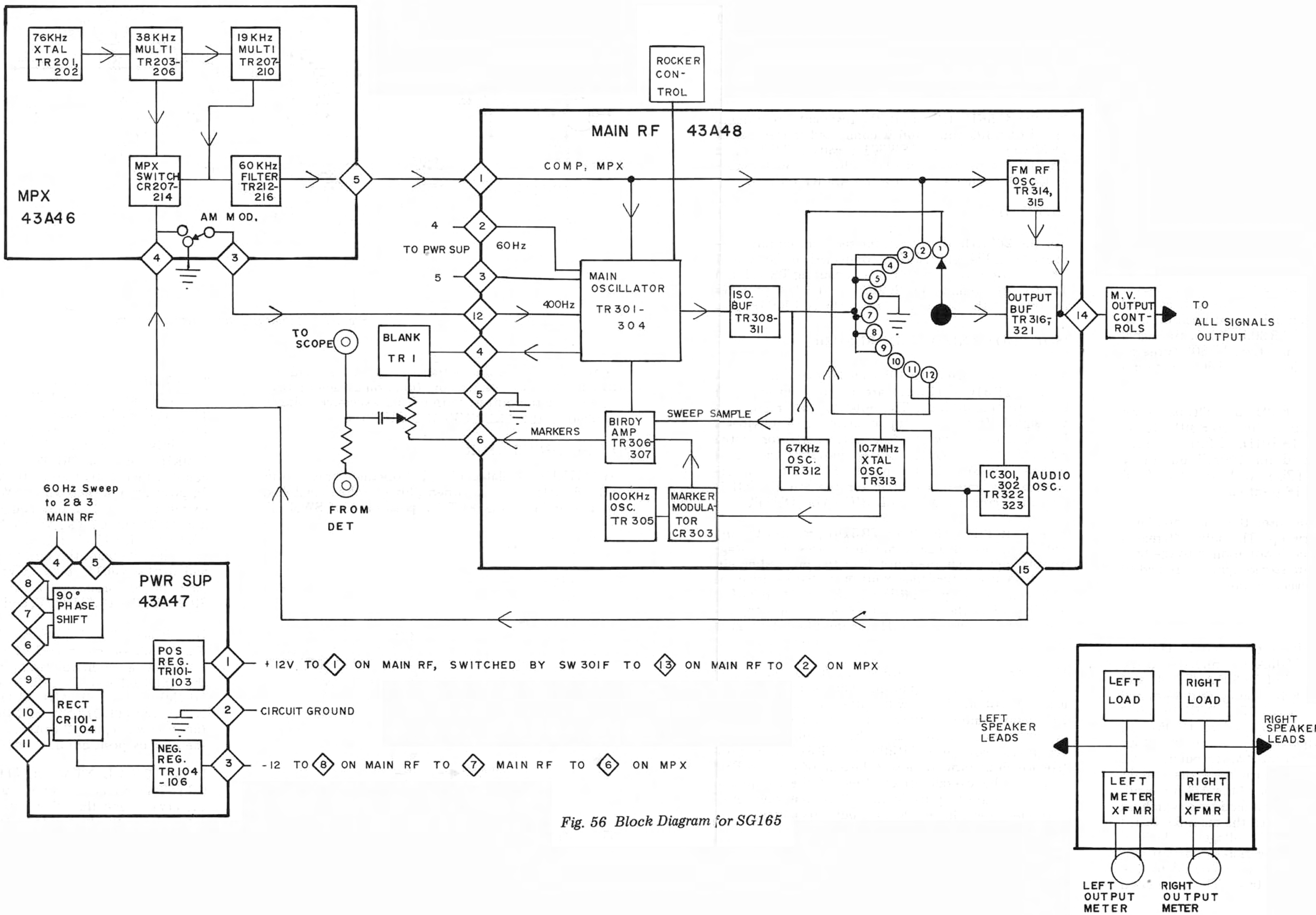


Fig. 56 Block Diagram for SG165

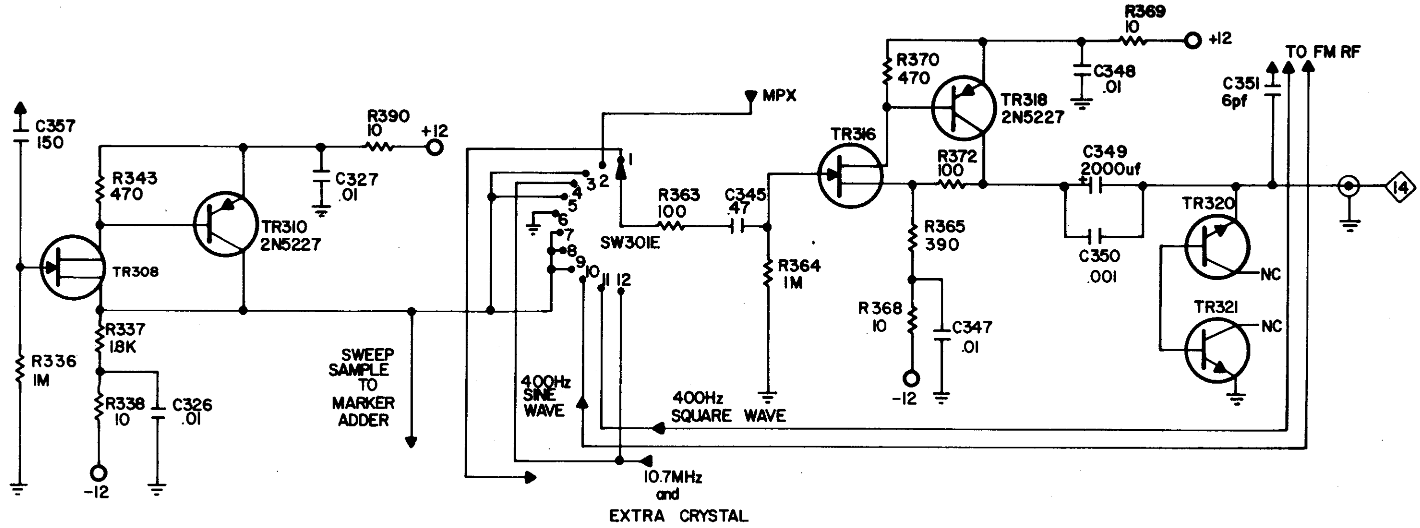


Fig. 57 Isolation and Output Buffers

contains two additional transistors (TR320 and TR 321.) These two transistors function as zener diodes to protect the output buffer from excessive voltages applied to the ALL SIGNALS OUTPUT.

67KHz OSCILLATOR

The 67KHz oscillator (TR312) operates only in the SCA 67KHz function, when plus 12 volts is switched to the drain of the FET by position 1 of SW301F.

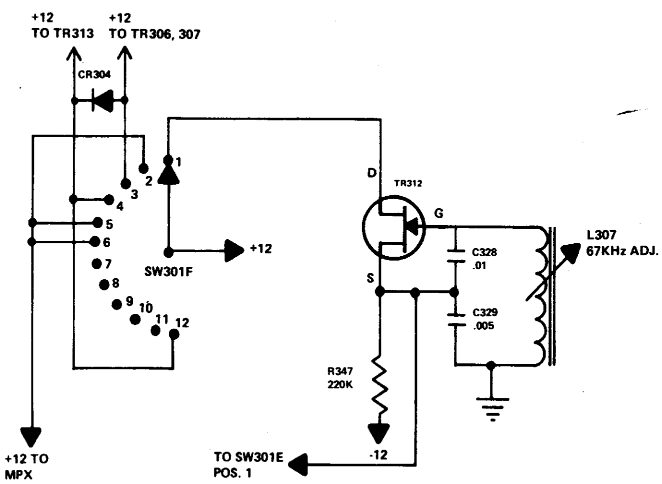


Fig. 58 67KHz Oscillator

The output of the 67KHz oscillator is taken from the source of TR312, and coupled directly to position 1 of the output selector SW301E. L307 is a calibration adjustment adjusted for an output frequency of 67KHz.

The 67KHz oscillator current also contains the plus 12 volt switching for the MPX board, the 10.7MHz/EXTRA CRYSTAL oscillator, and the birdy amplifier. In position 3 of SW301F, plus 12 volts is switched to the birdy amplifier transistors TR306 and TR307 and 100KHz oscillator TR305. This plus 12 volts is also coupled by CR304 to the 10.7MHz oscillator TR313. In position 3, 4, and 12 of SW301F, plus 12 volts is switched to TR313, producing the 10.7MHz marker the 10.7MHz CRYSTAL CONTROLLED, and the EXTRA CRYSTAL functions. CR304 blocks the plus 12 volts from the birdy amp. In positions 2, 5, and 6 of SW301F, plus 12 volts is switched to the MPX board, producing a MPX signal for the MPX SIGNAL, the 10.7MHz IF, and the FM RF functions.

10.7MHz/EXTRA CRYSTAL OSCILLATOR

This oscillator, comprised of TR313 and TR322 connected as a modified darlington pair as outlined in the ISOLATION BUFFER, operates only in the 10.7MHz. SWEEP AND MARKERS, the 10.7MHz XTAL CONTROLLED, and the EXTRA CRYSTAL function when plus 12 volts is switched to the drain of the FET by positions 3, 4, and 12 of SW301F.

In the 10.7MHz XTAL CONTROLLED and EXTRA CRYSTAL functions, one wiper of SW301G selects the crystal, and the other wiper connects the output taken from the high side of the crystal, to a capacitive voltage divider comprised of C331 and C330. The junction of C331 and C330 is the output of the oscillator for the 10.7MHz and EXTRA CRYSTAL functions, and is connected to positions 4 and 12 of output selector switch SW301E.

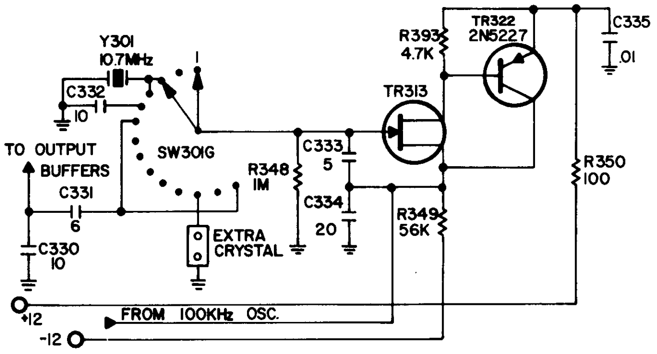


Fig. 59 10.7MHz - Extra Crystal Oscillator

In the 10.7MHz SWEEP & MARKERS function, one wiper of SW301G selects the 10.7MHz crystal, and the other connects a 10pF capacitor in parallel with the crystal. This 10pF closely approximates the capacity across the crystal in the 10.7MHz XTAL CONTROLLED function. The output of the oscillator for the 10.7MHz SWEEP & MARKERS function is taken from the source of the transistor, and coupled through C317 to the 100KHz modulator (CR303).

MARKER GENERATOR

During the 10.7MHz SWEEP & MARKERS function, plus 12 volts is switched to TR305 - TR307 by position 3 of SW301F. TR305 oscillates at 100KHz, with L305 a calibration adjustment adjusted for a 100KHz output frequency. The 100KHz output of TR305 is coupled through C315 and R322 to the modulator diode CR303. The 10.7MHz crystal signal is also coupled to the input of the modulator diode through C317 and R325. The output of this modulator actually a 10.7MHz carrier with sidebands 100KHz above and below (10.6 and 10.8MHz), is coupled through C318 and R326 to the input of the birdy amplifier. Also coupled into the input of the birdy amplifier is a sample of the 10.7MHz sweep signal taken from the output of the isolation buffer. At the base of TR306 (input of birdy amplifier) the 10.6, 10.7, and 10.8MHz signals (markers) from the modulator mix with the 10.7MHz sweep signal. As the frequency of the sweep signal approaches each of the marked frequencies in turn, an audio difference frequency is generated. This audio difference frequency is amplified by TR306 and TR307 and added to the response curve at the TO SCOPE jack to produce the "birdy" post injection markers.

FM RF OSCILLATOR

The FM RF oscillator transistor TR314 runs only in position 6 of SW301C when plus 12 volts is connected to the base of TR315, turning TR315 on, and supplying emitter current to TR314. R360 is a calibration adjustment that controls the emitter current of TR 314, and therefore the output level of the FM RF oscillator. The effective resonant circuit for the FM RF oscillator is L308 and the parallel combination of C341, C341A, and varicap diode CR307. C341 is a tuning capacitor connected to the RF TUNING control, and varies the frequency of the FM RF oscillator from 86 to 110MHz. L307 is a calibration adjustment adjusted for the correct output frequency at 88MHz, and C341A is a calibration adjustment adjusted for the correct output frequency at 108MHz. CR307 changes capacity in proportion to the composite stereo signal applied to it, resulting in the desired frequency modulation. The level of the composite signal applied to CR307 is controlled by

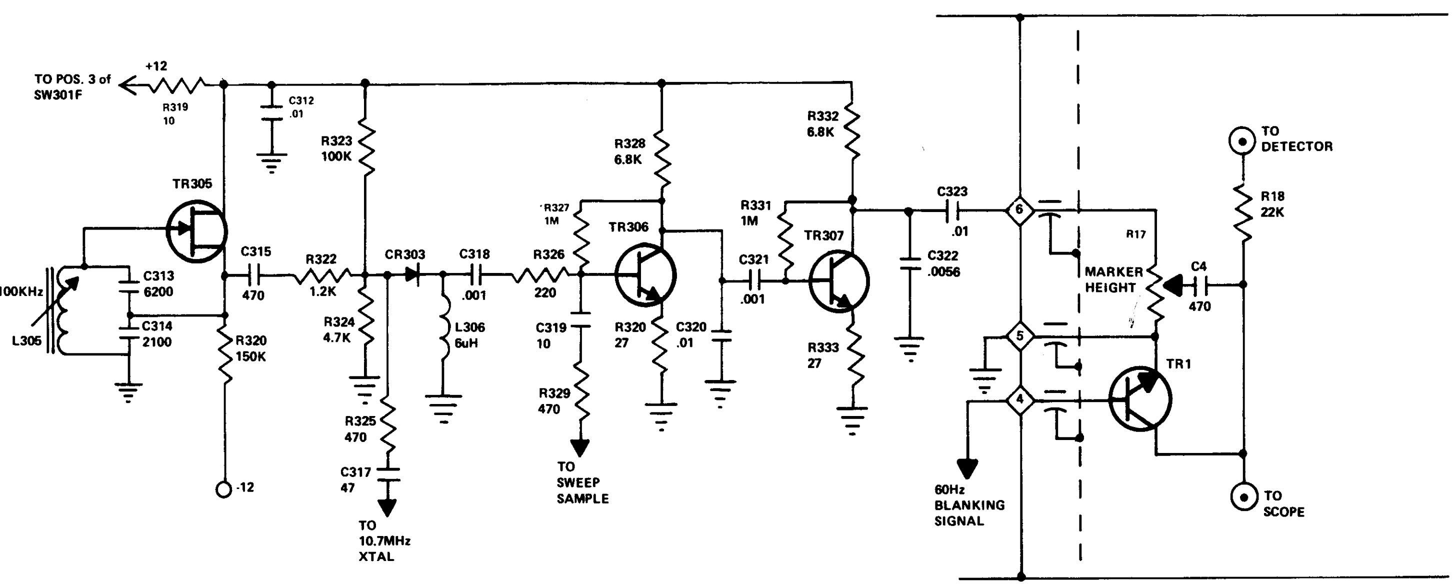


Fig. 60 Marker Generator

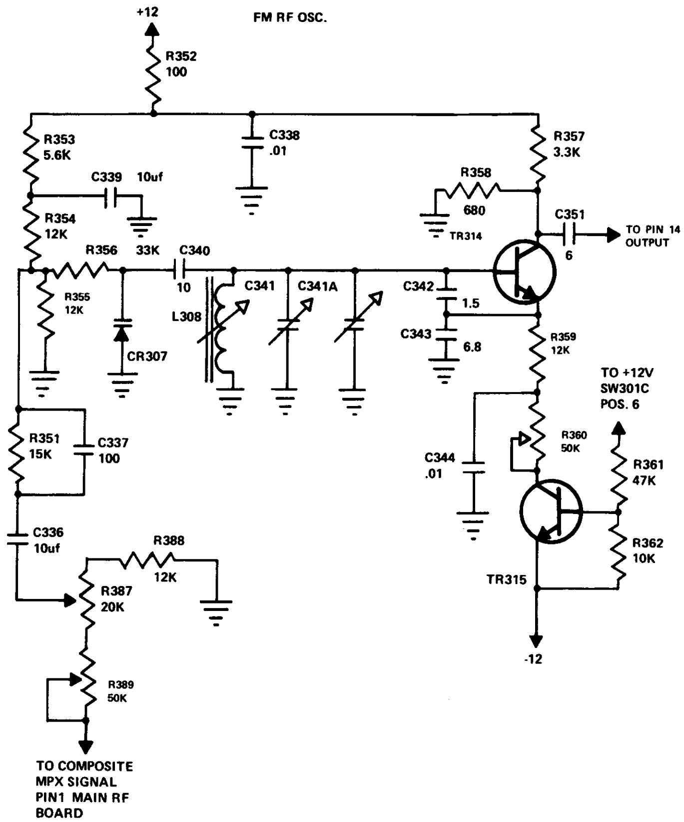


Fig. 61 FM RF Oscillator

R387 and R389. R389 is a calibration adjustment adjusted for the correct percentage of modulation. R387 is connected to the RF TUNING control, and adjusts the level of the composite signal to maintain a constant ratio between the capacity change of CR 307 and the changing value of C341, resulting in a constant modulation percentage across the FM F band.

AUDIO OSCILLATOR

IC301 and IC302 form a function generator with simultaneous triangle and square wave outputs. When power is first applied current enters the positive (noninverting) input of IC301. This positive input is amplified by IC301, and coupled back to its input by positive feedback resistors R375 and R376. This feedback causes the output of IC301 to go maximum positive almost instantaneously. The output of IC301 is coupled to the negative (inverting) input of IC302 by R380. IC302 functions as an integrator, charging C352 with a linear negative going ramp. This negative ramp is coupled back to the input of IC301 by R377. When the negative signal coupled to the input of IC301 reaches a high enough value to overcome the positive feedback, the input of IC301 starts to go negative. This negative going signal is amplified by IC301, and coupled back to the input through R375 and R376, causing the output of IC301 to go to max-

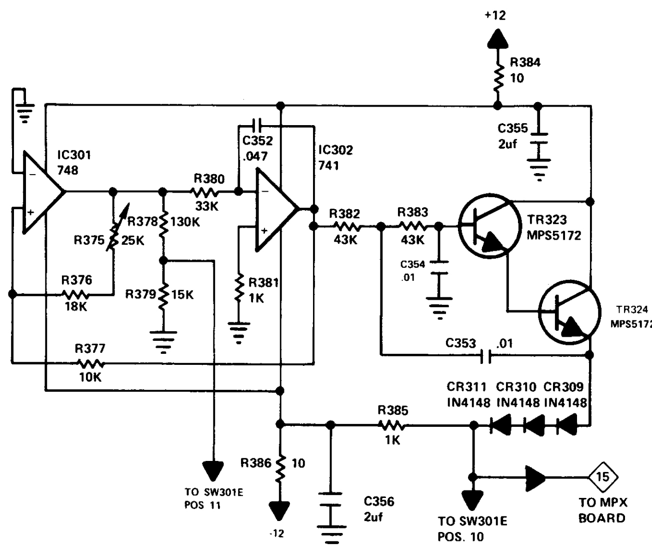


Fig. 62 Audio Oscillator

imum negative almost instantly. This negative signal is coupled to the input of IC302, causing IC302 to charge C352 with a linear positive going ramp. When the amplitude of this positive ramp coupled back to the input of IC302 reaches a high enough value to overcome the negative signal from its output, IC301 again switches to a positive output, completing one cycle of oscillation.

The square wave from the output of IC301 is taken from the junction of R378 and R379, and coupled to position 11 of SW301E for the 400Hz SQUARE WAVE output.

The triangular wave (positive and negative going ramps) is coupled from the output of IC302 to the active filter comprised of TR324 and TR323. The output of the filter (400Hz sine wave) is coupled to the input of the MPX board through pin 15 on the main RF board and pin 4 on the MPX board. The 400Hz sine wave is also coupled to position 10 of SW301E for the 400Hz SINE WAVE output. CR309 - 311 are used to insure that the DC component of the sine wave output will be slightly negative insuring the proper polarity voltage on C220 and C221 on the input of the MPX board.

R375 is a calibration adjustment that controls the amount of feedback from the output of IC301 to its input, and therefore the level of the ramp on the output of IC301 necessary to cause IC301 to change states. In practice, this control is adjusted for a one volt RMS output in the 400Hz sine wave position.

76KHz OSCILLATOR AND SHAPER

TR201 and its associated circuitry from a crystal controlled oscillator controlled by the 76KHz crystal connected from collector to base. The output of this

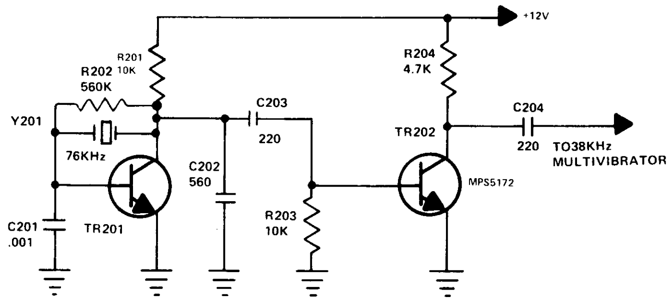


Fig. 63 76KHz Oscillator and Shaper

oscillator (a clipped sine wave) is coupled through C203 to the base of TR202. C203 and R203 form a differentiating network so that only the leading and trailing edges of the sine wave are coupled to the base of TR202. TR202 has no DC bias voltage applied to its base, so it will only conduct when it receives a positive pulse from TR201. The positive pulse is amplified, and inverted by TR202, producing a 12 volt negative pulse at the collector. This negative pulse is coupled by C204 to the trigger input of the 38KHz bi-stable multivibrator.

38KHz MULTI-VIBRATOR

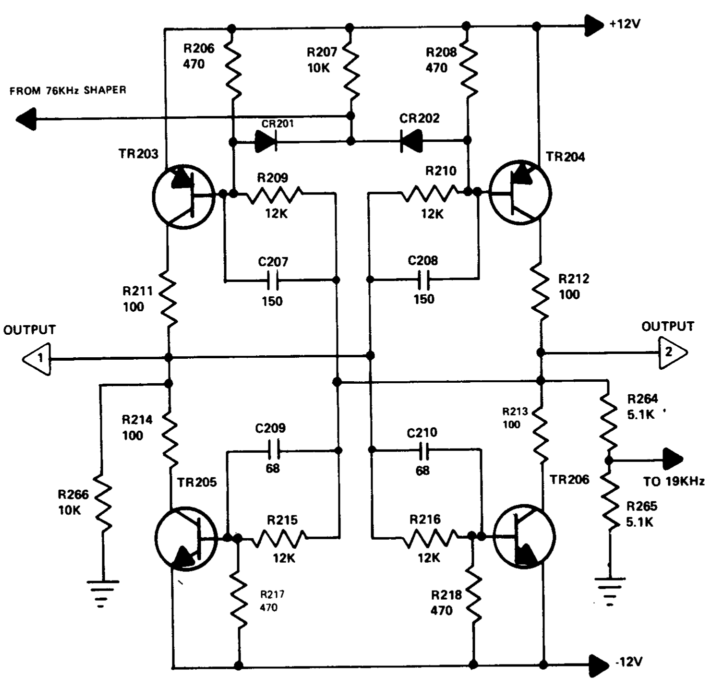


Fig. 64 38KHz Multi-Vibrator

TR203 - 206 and their associated circuitry function as a cross coupled bi-stable multi-vibrator that actively switches plus or minus 12 volts to its outputs. In normal operation, one pair of cross coupled transistors (either TR203 and TR206 or TR204 and TR205) will be on, and the other pair will be off. When the multi-vibrator receives a negative trigger pulse at the junction of CR201 and CR202, both pairs of transistors change states, causing the output that was positive to switch negative, and the output that was negative to switch positive.

When power is first applied, one pair of transistors will turn on, and the other off as a result of the slight differences in transistors. If TR206 is on, it connects minus 12 volts to output 2. The minus 12 volts at output 2 is coupled to the base of TR203, turning it on, and to the base of TR205, turning it off. With TR203 on, and TR205 off, plus 12 volts is connected to output 1. The plus 12 volts at output 1 is coupled to the base of TR204, turning if off, and the base of TR206, insuring that it stays on.

A negative trigger pulse at the junction of CR201 and CR202 would have no effect on TR203 because the base of TR203 is already negative. The pulse would be coupled through CR202 to the base of TR204. TR204 would amplify and invert the negative pulse, resulting in a positive pulse at output 2. The positive pulse at output 2 would be coupled to the base of TR205, turning it on, and to the base of TR203, turning it off, resulting in output 1 switching negative.

The negative signal at output 1 would be coupled to the base of TR206, turning it off, and to the base of TR204, reinforcing the negative trigger pulse, and turning TR204 on, resulting in output 2 switching positive. The next negative trigger pulse would turn TR203 back on, returning the multi-vibrator to its original state. In other words it takes two trigger pulses to cause the multi-vibrator to go through one complete cycle, resulting in two 38KHz outputs that alternately switch from plus to minus 12 volts.

STEREO SWITCH

Diodes CR207 - CR214 perform the actual stereo switching. When output 1 of the 38KHz multivibrator is positive, and output 2 is negative, diodes CR 107 - CR210 (left channel switch) are forward biased, and couple the left signal to the FM MODULATION switch. When output 1 is negative, and output 2 is positive, diodes CR211 - CR214 (right channel switch) (SW202) and the RIGHT 400Hz switch (SW203) select the left and right channel signals.

When both the LEFT and RIGHT 400Hz switches are on, as shown on the main schematic, the 400Hz sine wave coupled through C220 is connected to both the left and right channel switching diodes. If one channel is off, the on channel receives the 400Hz sine wave from C220. The off channel receives a small amplitude 400Hz sine wave that is 180 degrees out of phase with the 400Hz sine wave to the on channel. This out of phase signal compensates for any 400Hz that may be coupled to the off channel from the on

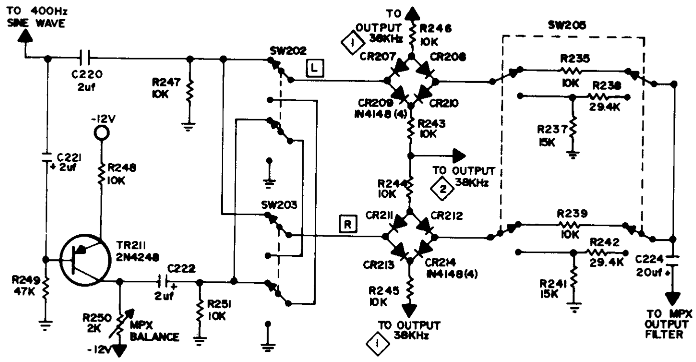


Fig. 65 Stereo Switch

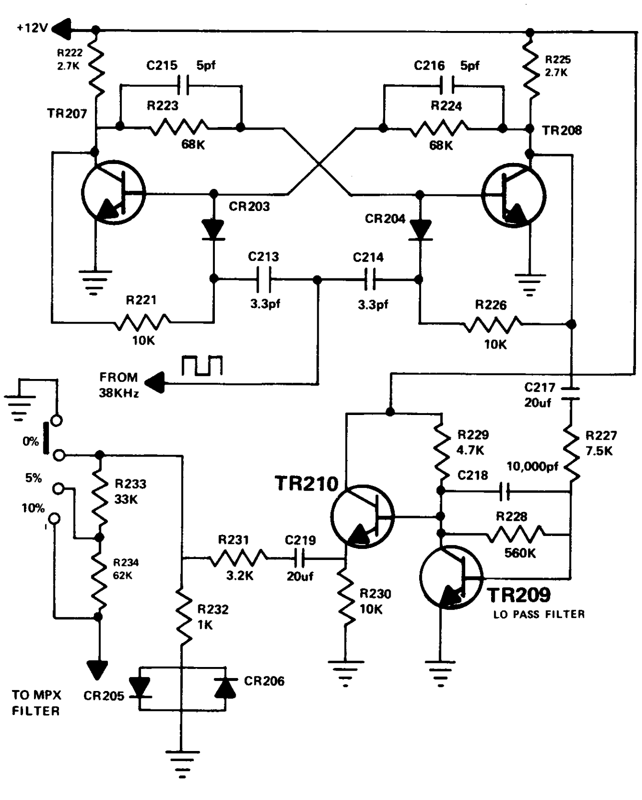


Fig. 66 19KHz Multivibration and Filter

channel. R250 is a calibration adjustment that controls the amplitude of the out of phase 400Hz, and is adjusted to exactly cancel any of the in phase 400Hz that may appear in the off channel. When both the LEFT and RIGHT 400Hz switches are off, the inputs of both diode switches are grounded resulting in zero 400Hz on the output of the switches.

19KHz MULTIVIBRATOR AND FILTER

TR207, TR208 and their associated circuitry form a bistable multi-vibrator that divides the 38KHz input from the 38KHz multivibrator by 2 resulting in a 19 KHz output. TR209 and TR210 provide active filtering for the 19KHz square wave from the multi-vibrator producing a 19KHz sine wave that is phase locked to the 38KHz multi-vibrator. The PILOT 19KHz switch (SW201) selects the level of 19KHz sine wave. In the "0" position the 19KHz sine wave is connected to ground. In the 5% position, R233 (33K) is shorted and R234 (62K) is in series with the 19KHz. In the 10% position, R234 is shorted, and R233 is in series with the 19KHz.

MPX OUTPUT FILTER

TR212 - 216 form a very linear low pass filter with a cutout frequency of approximately 60KHz. This allows the filter to pass the fundamental of the composite stereo signal, but block the switching transients of the 38KHz switching signal.

The composite stereo signal at the input of the filter is amplified and inverted by TR212. The signal at the collector of TR212 is also present at the base of emitter follower TR213, which couples its base signal unchanged to its emitter. R254 provides negative feedback and DC bias to the input of TR212. This negative feedback fixes the input impedance of TR 212 at 10K.

The two active filters are basically the same, with the only difference being that the second uses two transistors connected as a Darlington amplifier to achieve the required current gain to drive the output. The cutoff frequency is determined by the values of the two resistors in series with the base, and the value of the capacitor from base to ground and from the emitter to the junction of the resistors in series with the base. The sharpness of the filter is determined by the ratio of the values of the two resistors. An understanding of how the resistor and capacitor values effect the filter characteristics can be obtained by comparing the filter on the 400Hz audio PC board with the MPX filter. The 400Hz filter operates at a much lower frequency, therefore the resistor and capacitor values are larger. The 400Hz filter is also designed for a sharp frequency cutoff with equal

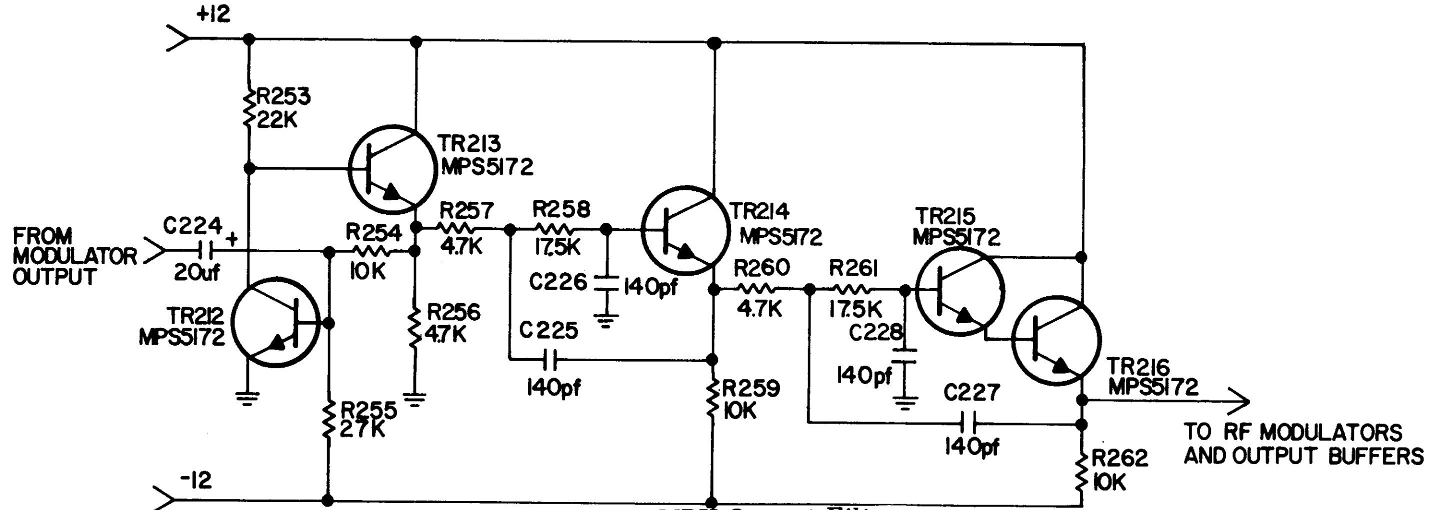


Fig. 67 MPX Output Filter

values of resistors. The MPX filter with approximately a 4 to one ratio of resistor values is designed for a much smoother frequency cutoff. This smoother cutoff is necessary to prevent any phase shift that would degrade the separation of the MPX signal.

SPEAKER LOAD AND OUTPUT METERS

The circuitry for the left and right channel is identical, so for simplicity sake we will only discuss the

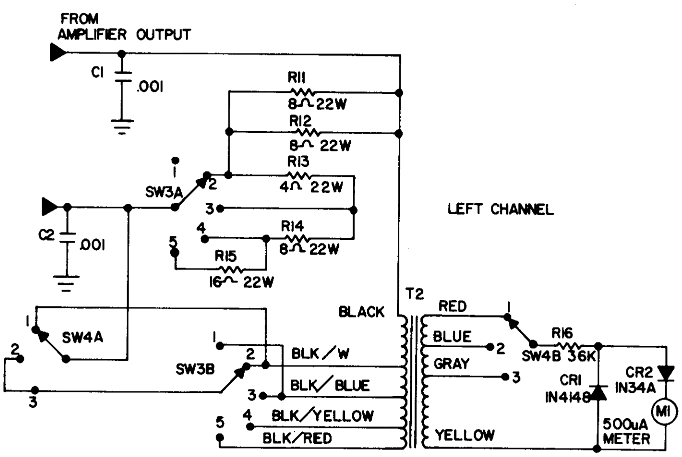


Fig. 68 Speaker Load and Output Meters

operation of the left channel. SW3A selects the load resistor connected across the input leads. For the four ohm position of the SPEAKER LOAD switch, two 8 ohm resistors are paralled, for the 8 ohm position an additional 4 ohm resistor is switched in series, for the 16 ohm position, an additional 8 ohm resistor is switched in series. In the SPEAKERS position there is no load other than the meter circuit.

In the 10W and 100W positions of the POWER RANGE switch SW4A switches the input to the wiper of SW3B. SW3B is ganged to SW3A, and selects the correct primary tap on the meter transformer T2 to maintain correct wattage calibration for the speaker load selected. In the SPEAKERS position, the 8 ohm tap is selected. When the POWER RANGE switch is in the SEPARATION TEST position, SW4A bypasses SW3B, and connects the input directly to the 4 ohm tap of T2. This provides maximum meter sensitivity, and allows the separation scale to be used for even low power receivers. The meter circuit, with a sensitivity of 2.1V RMS full scale is switched to the taps of T2 by SW6B. In the SEPARATION TEST position, the full secondary voltage is selected, providing maximum sensitivity. In the 10W and 100W position, lower secondary voltages are selected, providing the necessary range switching.

POWER SUPPLY

The reference for the plus 12 volt output is zener diode CR105. TR103, the error amplifier for the positive supply, senses the voltage at the junction of R110 and R111. If this voltage increases, the current through TR103 increases, making its collector more negative. This negative change is coupled to the base of pass transistor TR101, reducing its forward bias, increasing its resistance, and bringing the output voltage back down to 12 volts. If the sense voltage decreases, the current through TR103 decreases, and its collector becomes more positive. This positive change is coupled to the base of TR101, increasing its forward bias, decreasing its resistance, and bringing the output voltage back up to 12 volts. TR102 provides current limiting by sensing the output current through R107. When the current through R107 reaches 125mA, the voltage drop across R107 is .6 volts. This voltage turns on TR102, removing the forward bias from TR101.

TR105, the error amplifier for the negative supply, senses the voltage at the junction of R113 and R114. The voltage at this point will reflect any change in either the positive or negative supply. If the negative output decreases, or if the positive increases, forward bias on TR105 decreases, causing its collector voltage to change in a negative direction. This negative change is coupled to the base of pass transistor TR104 increasing its forward bias, decreasing its resistance, and maintaining the negative supply voltage equal and opposite the positive supply. If the negative output increases, or the positive decreases, forward bias on TR105 will increase, causing its collector voltage to change in a positive direction. This positive charge is coupled to the base of the pass transistor, decreasing its forward bias, increasing its resistance, and again maintaining the negative supply voltage equal and opposite the positive supply.

Outputs 4 and 5 of the power supply provide the 60Hz sine waves for the 10.7MHz SWEEP and MARKERS function. Output 5 is the blanking output that turns on the sweep when it is negative. Output 4 supplies the voltage that is applied to the varicap diode to produce the sweep. The phase of output 4 leads output 5 by 90 degrees, so that when the sweep is on (output 5 negative), output 4 is changing from maximum negative to maximum positive. R103 is a calibration adjustment adjusted for exactly 90 degrees between output 4 and 5.

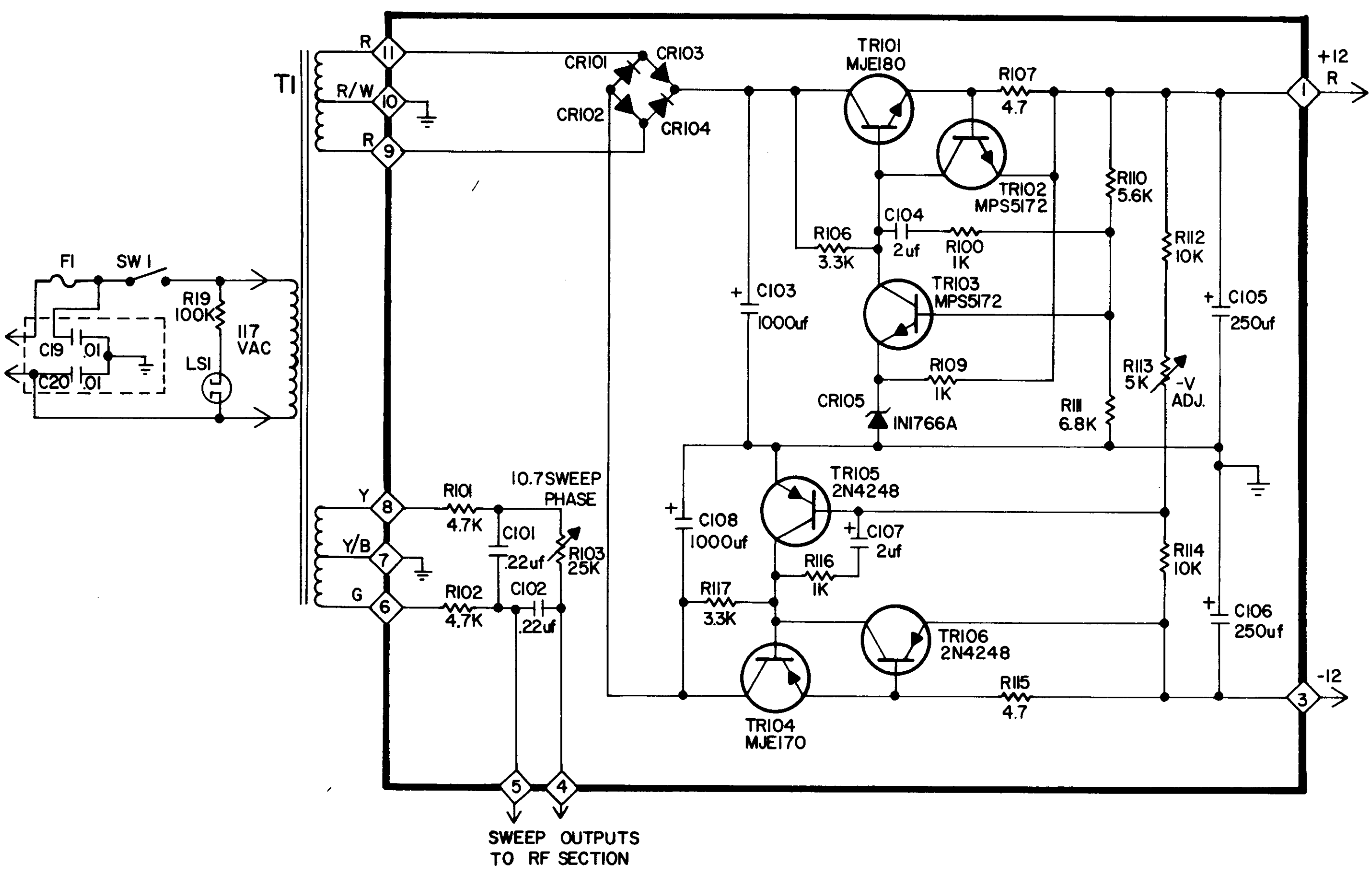


Fig. 69 Power Supply

TROUBLE CHARTS

SG165 COMPLETELY DEAD

Check matching pad, and output cable. Check internal molex connectors for proper installation. Turn unit on. Does pilot light light?

NO

CONCLUSION:
Check and replace as necessary line cord, or fuse. If new fuse opens, disconnect power transformer from power supply board. If fuse still open, replace T1. If fuse remains good, check power supply board, especially CR101 - CR104.

YES

Check all outputs. If all are dead, is plus 12 volts present at positive end of C105, and negative 12 volts at negative end of C106?

NO

CONCLUSION:
Remove power supply output plug from side of shielded assembly; if power supply voltages return to normal, a short exists in the power supply distribution system. If still incorrect troubleshoot power supply, starting at output of rectifiers.

YES

Disconnect main RF board output phono plug from the PC board (near the rear of RF tuning control). Are proper signals present at PC board output?

NO

Are output signals present at gate of TR316 (lead of large .47 capacitor)? Check all output functions. Only the FM RF is not connected through this point. Scope probe will load some outputs, so if any are present conclusion is yes.

YES

CONCLUSION:
Check connecting cables and attenuator for shorts or opens.

(Cont. on next page)

NO

CONCLUSION:
Make DC voltage checks on main RF board. Note that some stages receiver power only when output selector is turned to that function

YES

Are signals present on output source of TR316?

NO

CONCLUSION:
Problem is in TR316 or associated components.

YES

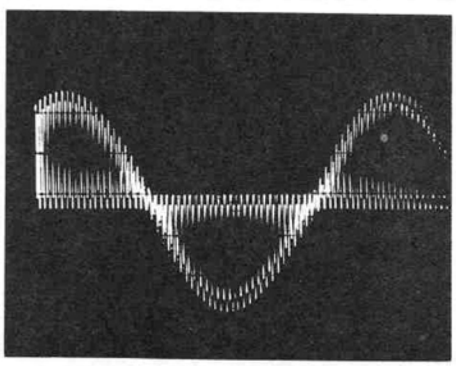
CONCLUSION:
Check all connections in output attenuator and wiring from main RF P.C. Board.

STEREO MPX MODULATION MISSING OR INCORRECT

Turn output selector to MPX SIGNAL and connect scope to ALL SIGNALS OUTPUT, MICROVOLT OUTPUT CONTROLS to maximum. Switch LEFT 400Hz ON, RIGHT 400Hz OFF, PILOT 19KHz to 10%. Is 2.8V p-p wave form below present at output. Pay particular attention to 19KHz riding on outside of 400Hz envelope. NOTE: If 19KHz is missing, check first at collector of TR208. If multivibrator is not running suspect TR207 and TR208.

NO

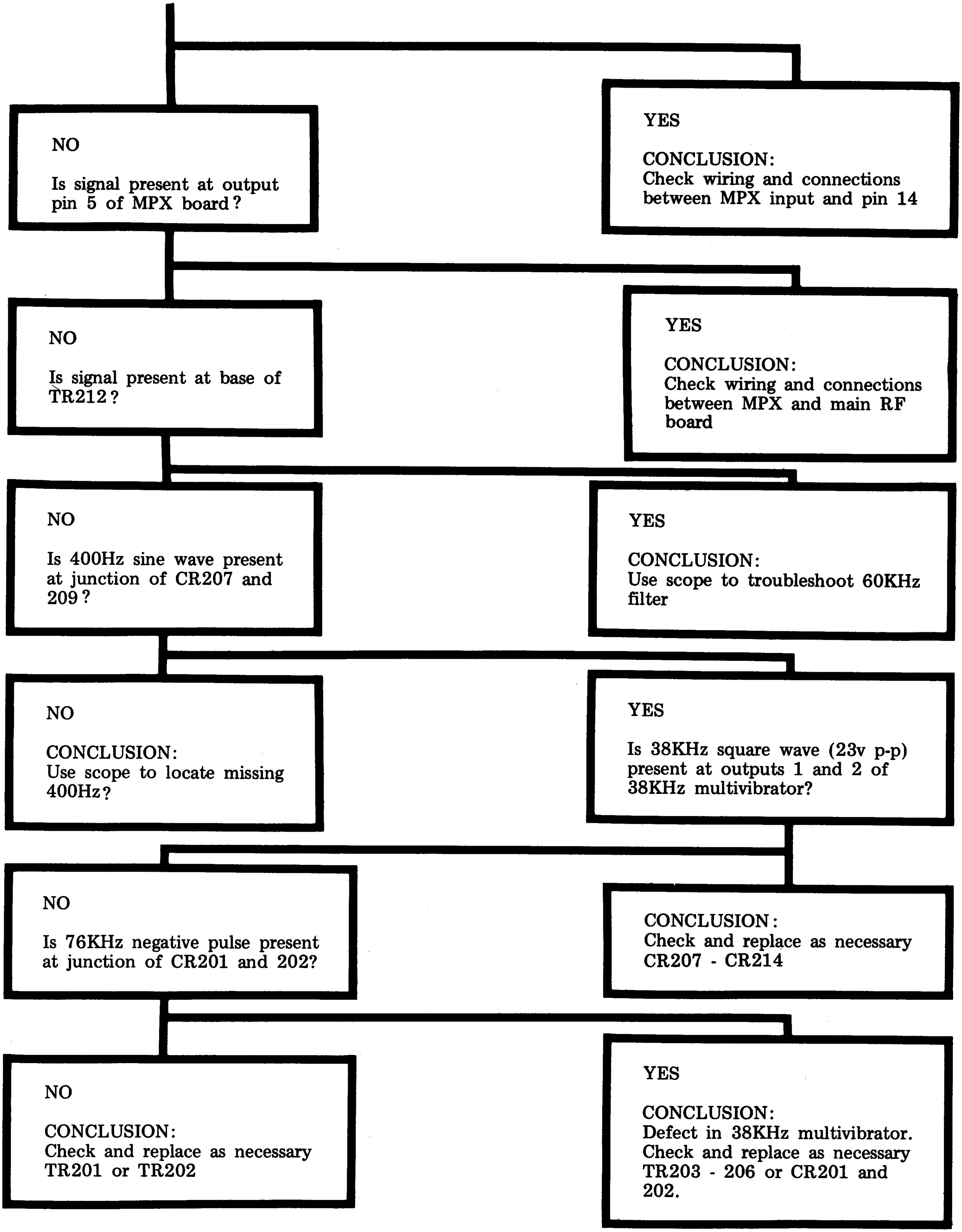
Is wave form correct at pin 1 (MPX input) or main RF board?



YES

CONCLUSION:
Problem is on main RF board, check for waveform above on varicap diodes, with output selector turned to that output. Also check DC voltages and diodes themselves.

(Cont. on next page)


NO
Is signal present at output pin 5 of MPX board?
YES
CONCLUSION:
Check wiring and connections between MPX input and pin 14
NO
Is signal present at base of TR212?
YES
CONCLUSION:
Check wiring and connections between MPX and main RF board
NO
Is 400Hz sine wave present at junction of CR207 and 209?
YES
CONCLUSION:
Use scope to troubleshoot 60KHz filter
NO
CONCLUSION:
Use scope to locate missing 400Hz?
YES
Is 38KHz square wave (23v p-p) present at outputs 1 and 2 of 38KHz multivibrator?
NO
Is 76KHz negative pulse present at junction of CR201 and 202?
CONCLUSION:
Check and replace as necessary CR207 - CR214
NO
CONCLUSION:
Check and replace as necessary TR201 or TR202
YES
CONCLUSION:
Defect in 38KHz multivibrator. Check and replace as necessary TR203 - 206 or CR201 and 202.

TROUBLE	PROCEDURE AND PROBABLE CURE
All outputs clipped or distorted	Follow trouble tree for no outputs. Likely cause: shorted TR318 - TR321
Bad ringing or slow rise to 400Hz square wave	Check for proper square wave at output of IC301. Likely cause, defective IC301 (748)
10.7MHz SWEEP & MARKERS, 10.7MHz IF, AM RF, 455KHz IF, 262KHz IF outputs missing or distorted.	Defect in either main oscillator, or isolation buffer. If outputs are present at source of TR308, suspect TR309 - TR311. If not, suspect TR301 - TR303, and TR308. Make DC voltage measurements, and check transistors with an in circuit tester.
No markers at to scope jack in 10.7 sweep output.	Check for 100KHz at source of TR305, if not there, suspect TR305 or L305. If 100KHz is present, use scope to troubleshoot birdy amp, also suspect TR1.
One output only missing	Check oscillator transistor(s), and coil. For 10.7MHz SWEEP, also suspect TR1.

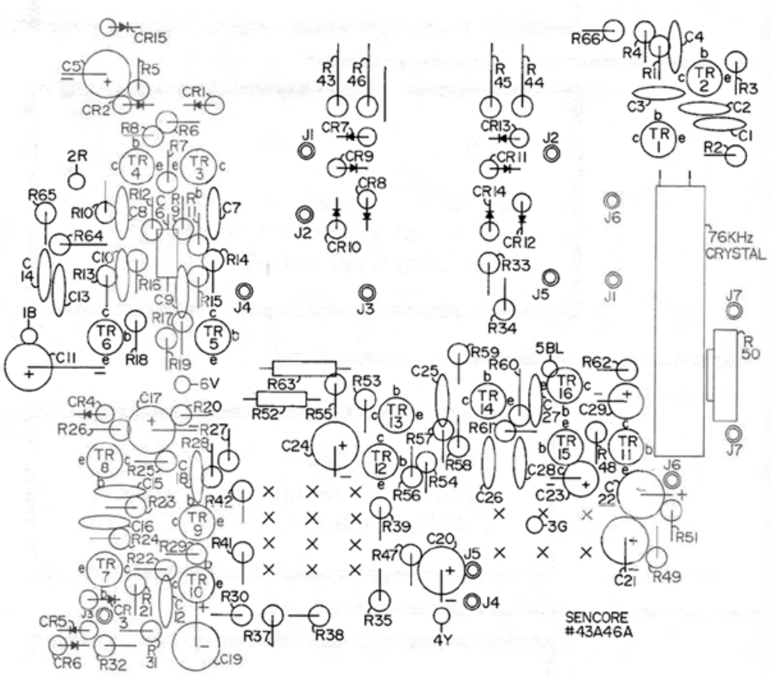


Fig. 70A MPX Board, Component Side

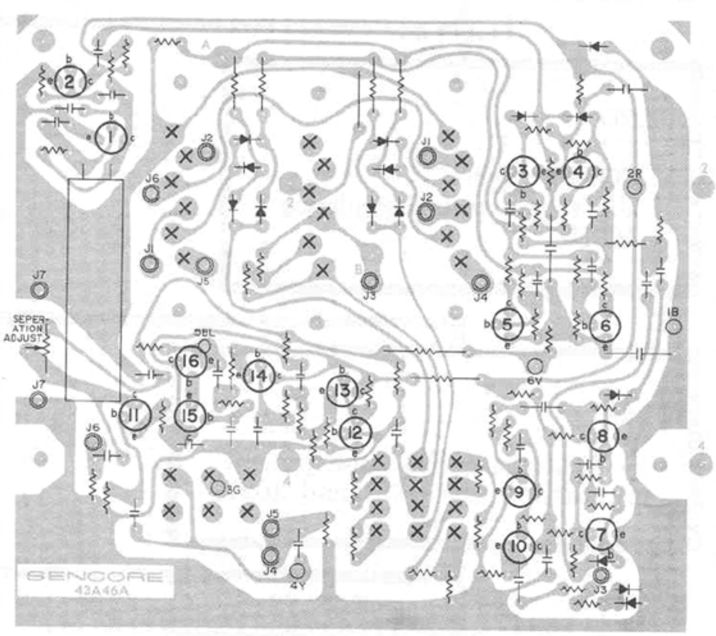


Fig. 70B Foil Side

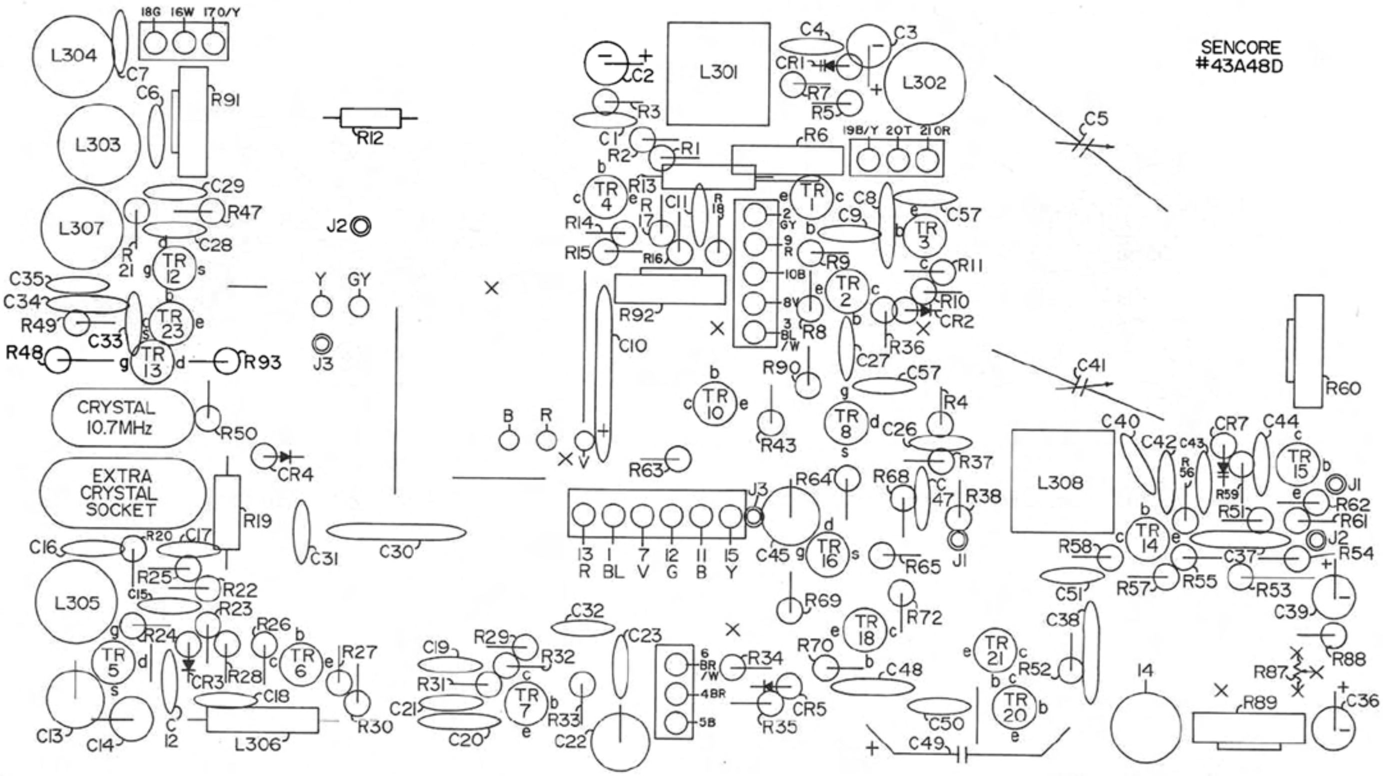


Fig. 71A Main RF Board, Component Side

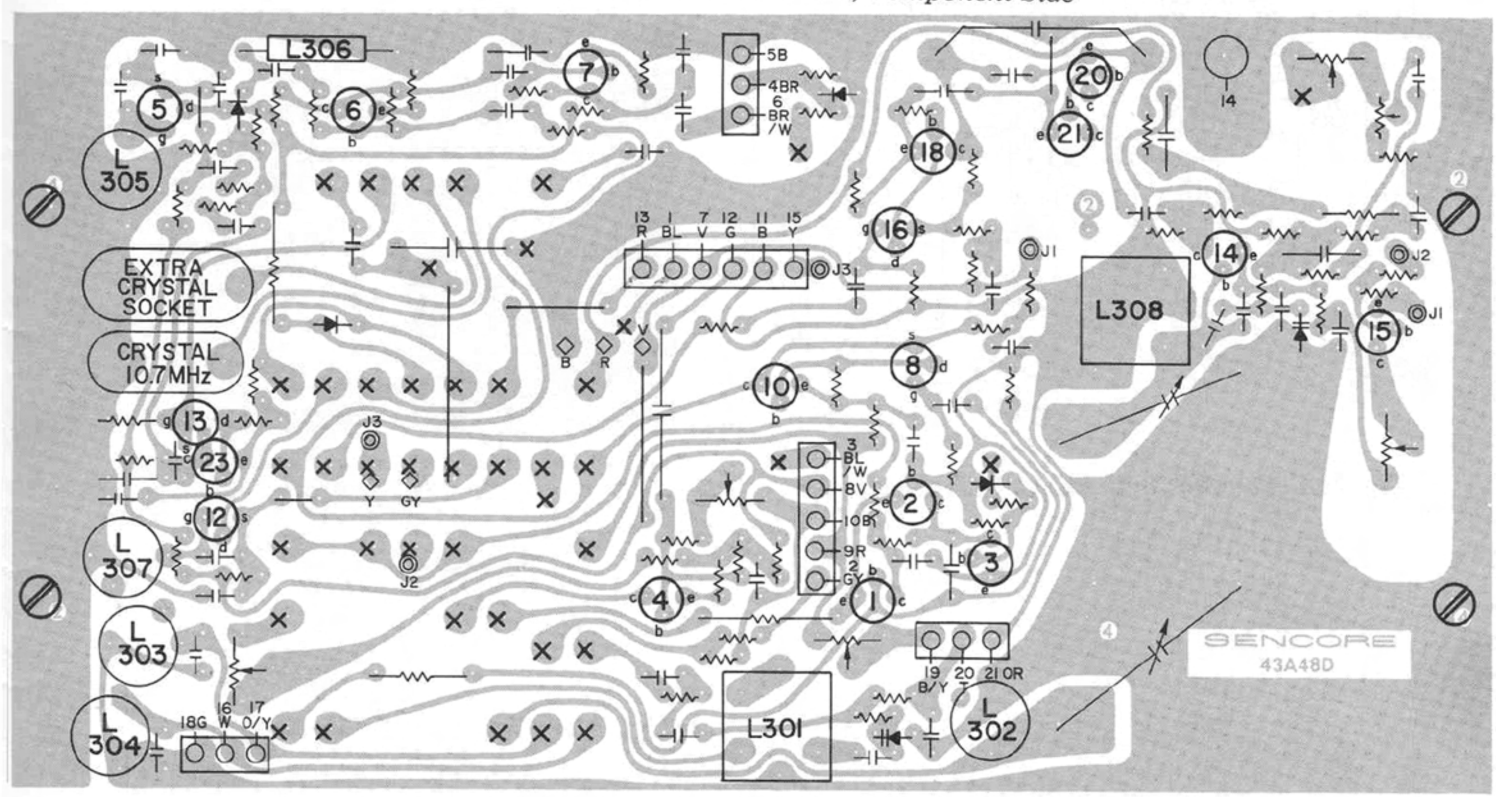


Fig. 71B Foil Side

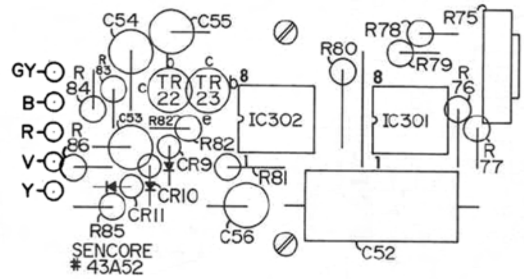


Fig. 72A Audio Osc. Board, Component Side

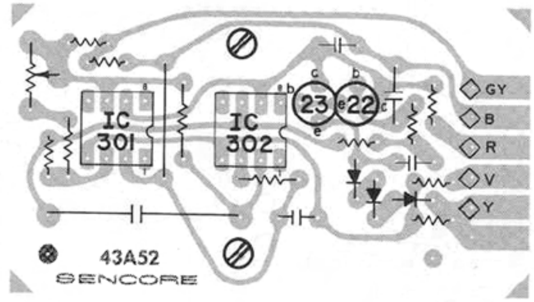


Fig. 72B Foil Side

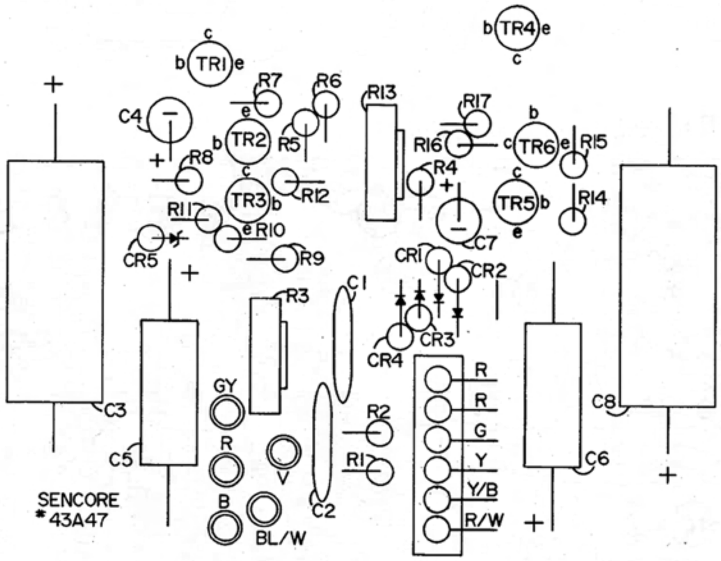


Fig. 73A Power Supply Board, Component Side

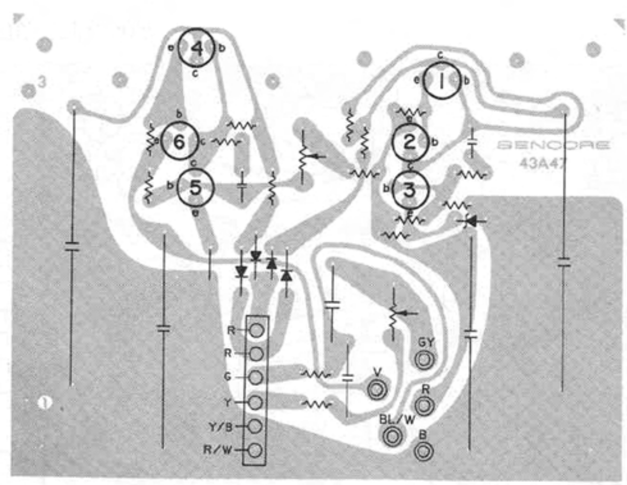


Fig. 73B Foil Side

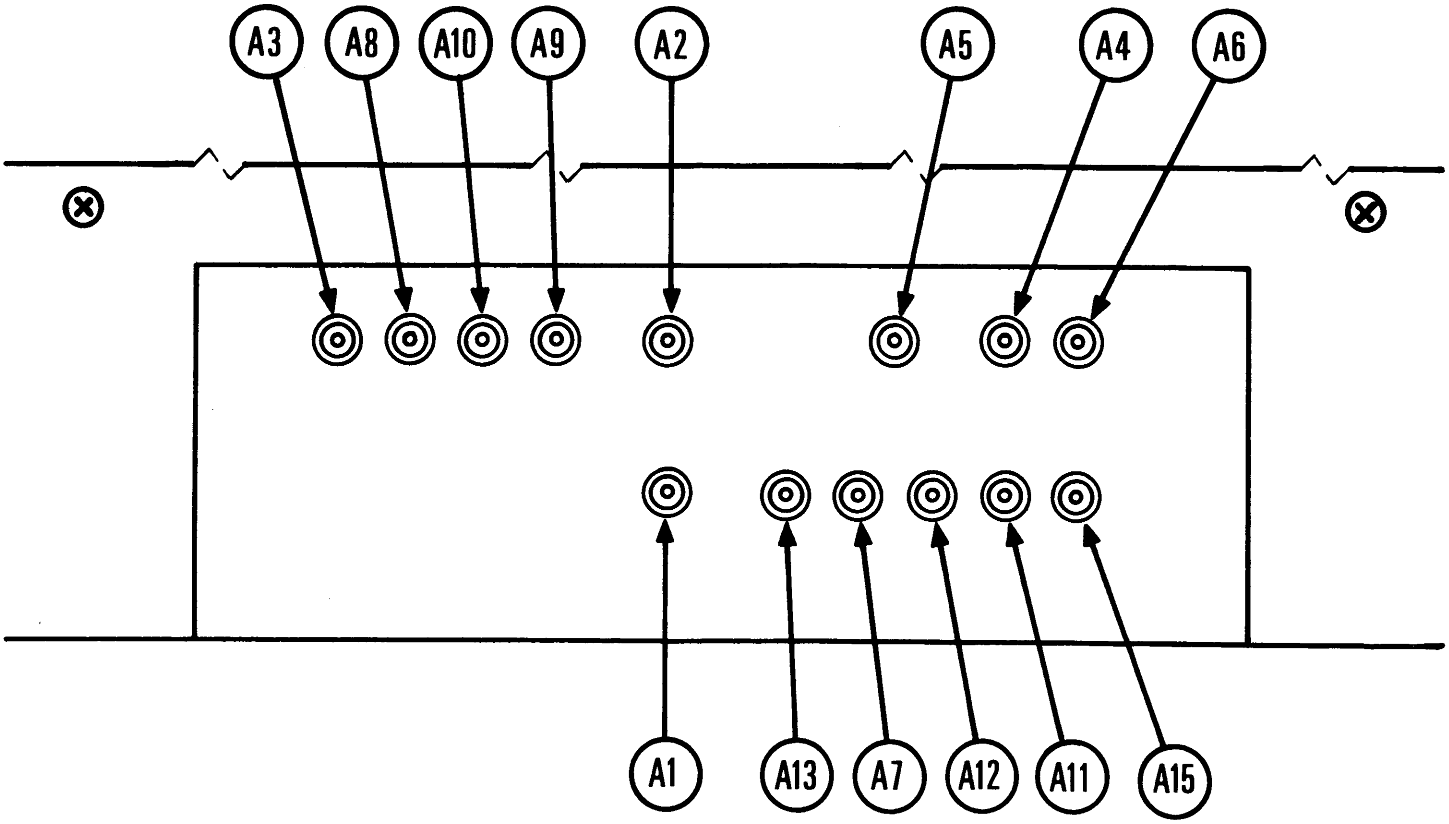


Fig. 74 *Feedthrough Test Points (Main RF numbers)*

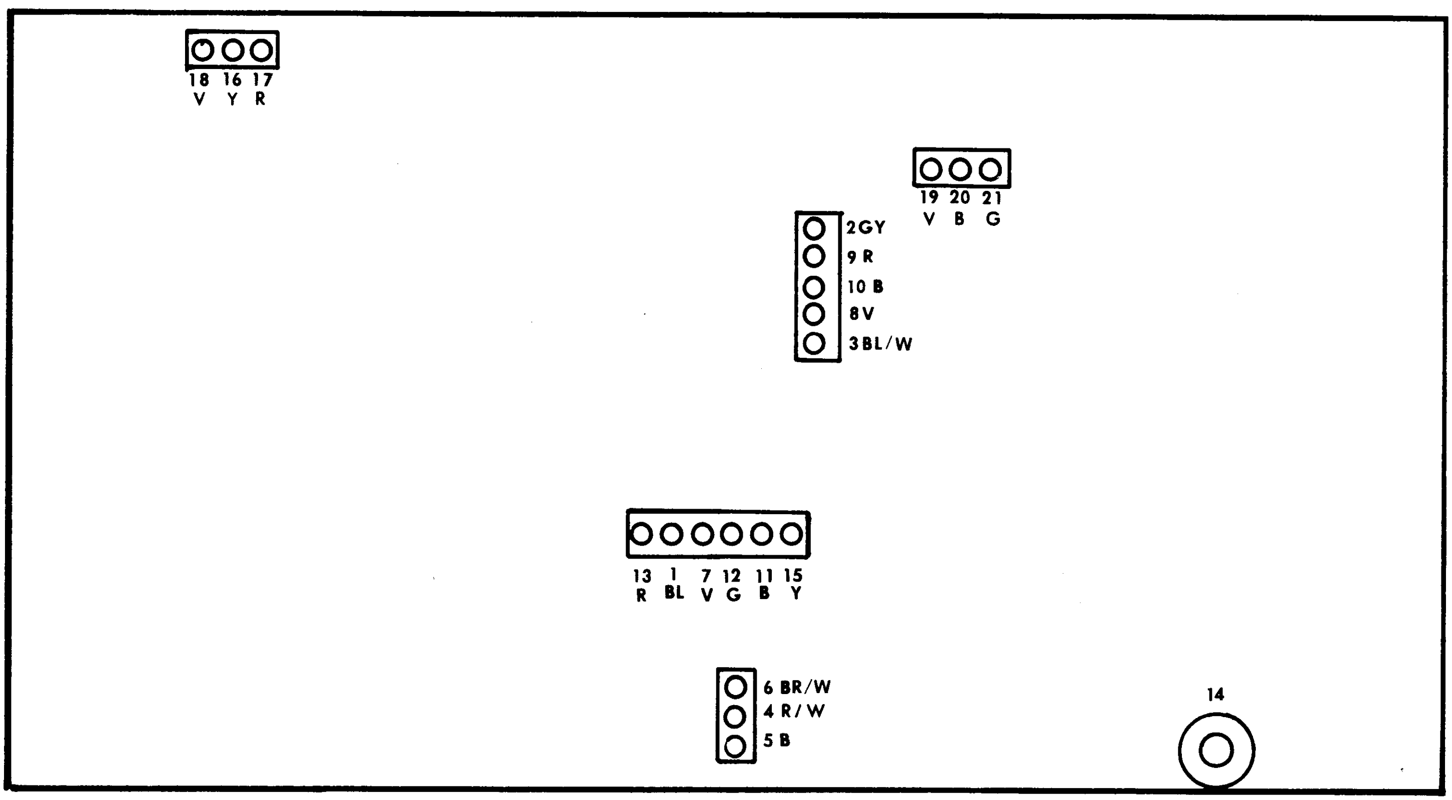


Fig. 75 *Main RF Board Connections*

SERVICE AND WARRANTY

You have just purchased the only AM-FM Stereo Analyzer on the market today. The Sencore SG165 has been inspected and tested twice at the factory and has passed a rugged use test by our Quality Assurance Department to insure the best quality instrument to you. If something should happen, the SG165 is covered by a standard 90 day warranty as explained on the warranty policy enclosed with your instrument.

Sencore has six regional offices to serve you. Instruments to be serviced should be returned to the nearest regional office by UPS if possible. Parcel post should only be used as a last resort. Instruments should be packed with the original packing materials or equivalent, and double boxed to insure safe arrival at the regional office. The blue and white display carton IS NOT an acceptable shipping container. When returning an instrument for service, be sure to state the nature of the problem to insure faster service.

If you wish to repair your own SG165 AM-FM Stereo Analyzer, we have included a schematic, trouble chart, and parts list. Any of these parts may be ordered directly from the regional office nearest you.

We reserve the right to examine defective components before an in warranty replacement is issued.

SENCORE REGIONAL OFFICES:

East Central Sales & Service
4105 Duke Street
Alexandria, Va. 22304
703 751-3556

Central West Sales & Service
3200 Sencore Drive
Sioux Falls, South Dakota 57107
605 339-0100

Western Coast Sales & Service
833 Mahler Road
Burlingame, California 94010
415 697-5854

Northeastern Sales & Service
1593H Central Avenue
Albany, New York 12205
518 869-0996

Southeastern Sales & Service
2459 Roosevelt Hway Suite B-9
College Park, Ga. 30337
404 768-0606

Central Sales & Service
2711 B Curtis St.
Ellsworth Industrial Park
Downers Grove, Illinois 60515
312 852-6800

Form 845

Printed in U.S.A.

THE IDEA PEOPLE

SENCORE

3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107

SCHEMATIC AND PARTS LIST

SG165 AM-FM STEREO ANALYZER

SENCORE

THE IDEA PEOPLE

3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107

SG165 PARTS LIST

REFERENCE	DESCRIPTION	PART NO.	PRICE
CHASSIS MOUNTED COMPONENTS			
C4	Capacitor, variable, Rkr	24B285	8.75
CR1	Diode, 1N4148	50C5-2	.25
CR2	Diode, 1N34A	50C3-1	.25
M1	Meter, LEFT OUTPUT	23B45	15.75
M2	Meter, RIGHT OUTPUT	23B46	15.75
R10	Control, 75 ohm, L-pad	15C11-1	7.25
R11, 12, 14	Resistor, 8 ohm, 5%, 22W	14A72-2	.25
R13	Resistor, 4 ohm, 5%, 22W	14A72-1	.25
R15	Resistor, 16 ohm, 5%, 22W	14A72-3	.25
R16	Resistor, 36K, 1%, ½W	14C29-3604	.75
R17	Control, 200K, Mrk Ht.	15C1-3	1.00
R19	Control, 20K, 10%, Rkr	15C3-26	1.25
SW1	Switch, slide, DPDT	25G3	.50
SW2	Switch, rotary, 4 section	25A168	4.75
SW3	Switch, speaker load	25A174	2.25
SW4	Switch, power range	25A181	2.25
T1	Transformer, power	28B50	5.75
T2, 3	Transformer, 400Hz Audio	28B53	5.75
TR1	Transistor, SE3002	19A7-1	.50
POWER SUPPLY BOARD COMPONENTS			
	Power supply board assembly	143A47	25.25
C101, 102	Capacitor, .22uF, 100V	24G168	.25
C103, 108	Capacitor, 1000uF, 25V	24G272	2.00
C104, 107	Capacitor, 2uF, 15V	24G133	.25
C105, 106	Capacitor, 250uF, 15V	24G111	.25
CR101, 102, 103, 104	Rectifier, 1A, 800 PIV	16G5	.50
CR105	Diode, 6.2V Zener, 1N1766A	50C2-1	.50
R103	Control, 25K, Vert, PC Mt.	15C7-12	.75
R113	Control, 5K, Vert, PC Mt.	15C7-14	.75
TR101	Transistor, MJE180	19A29	.50
TR102, 103	Transistor, 2N5172	19A28	.50
TR104	Transistor, MJE170	19A30	2.50
TR105, 106	Transistor, 2N4248	19A14-1	.50
MPX BOARD COMPONENTS			
	Multiplex board assembly	143A46-A	56.50
C201	Capacitor, .001uf, 5%, 160V	24G188	.25
C202	Capacitor, 560pF, 5%, 125V	24G257	.25
C206	Capacitor, .1uF, 10%, 100V	24G104	.50
C218	Capacitor, .01uF, 5%, 33V	24G183	.25
C225, 226, 227, 228	Capacitor, 150pF, 5% 125V	24G262	.25
CR201, 202	Diode, 1N34A	50C3-1	.25
CR203-206	Diode, 1N4148	50C5-2	.25
CR207-214	Diode, 1N4148, (2 matched quads) price for 4 diodes	50C5-2	1.50

R231	Resistor, 3.2K, 2% ½W	14C30-3203	
R235, 239, 243, 244, 245, 246, 248, 254	Resistor, 10K, 1%, ½W	14C29-1004	.75
R238, 242	Resistor, 29.4K, 1%, ½W	14C29-2944	.75
R250	Control, 2K, Vert., PC mt.	15C7-10	.75
R257, 260	Resistor, 4.7K, 1%, ½W	14C29-4703	.75
R258, 261	Resistor, 17.5K, 1%, ½W	14C29-1754	.75
SW201	Switch, rocker, 2P3P	25G170	1.25
SW202, 203	Switch, rocker, DPDT	25G169	1.00
SW204	Switch, slide, 2PDT	25B171	.75
SW205	Switch, slide, 4PDT	25B172	1.00
TR201, 202, 205, 206, 209, 210, 212, 213, 214, 215, 216	Transistor, 2N5172	19A28	.50
TR203, 204, 211	Transistor, 2N4248	19A14-1	.50
TR207, 208	Transistor, 2N4274	19A18	.50
Y201	Crystal, 76KHz	47G4-1	9.00

MAIN RF BOARD AND AUDIO OSC. BOARD COMPONENTS

	Audio Osc. Board Assembly	43A52-A	14.00
	RF Board Assembly	143A48-A	100.00
C301	Capacitor, 100pF, 5%	24G283	.25
C305 & 341	Capacitor, variable, RF TUN	24B264	10.25
C306, 307	Capacitor, 390pF, 5%, 125V	24G105	.25
C308, 337	Capacitor, 100pF, 5%, NPO	24G70	.25
C314	Capacitor, 2100pF, 5%, 125V	24G174	.25
C313	Capacitor, .0062uF, 5%, 33V	24G261	.25
C322	Capacitor, .0056uF, 5%, 33V	24G179	.25
C324	Capacitor, 150pF, 5%, 125V	24G262	.25
C328, 353, 354	Capacitor, .01uF, 5%, 33V	24G183	.25
C329	Capacitor, .005uF, 5%, 33V	24G259	.25
C331, 343, 351	Capacitor, 6.8pF, 10% NPO	24G138	.25
C333	Capacitor, 5pF, 5%, NPO	24G153	.25
C334	Capacitor, 20pF, 5%, NPO	24G77	.25
C342, 357	Capacitor, 1.5pF, 20%	24G132	.25
C345	Capacitor, .47uF, 200V	24G146	1.00
C349	Capacitor, 2000uF, 25V	24G240	2.25
C352	Capacitor, .047uF, 5%, 33V	24G237	.25
CR301, 307	Diode, varicap, BA141	50C11-1	2.75
CR302, 304, 305, 309, 310, 311	Diode, 1N4148	50C5-2	.25
CR303	Diode, 1N34A	50C3-1	.25
IC301	Linear IC, No. 748	69A2	2.00
1C302	Linear IC, No. 741	69A1	1.75
L301	Coil, 10.7MHz, Adj	46A53	1.50
L302, 303	Coil, AM RF, Adj	46A54	1.00
L304	Coil, 455KHz, 262KHz, Adj	46A55	1.25
L306	Coil, 5uH	46G6	.25
L305, 307	Coil, 100KHz, 67KHz, Adj	46G11	1.25
L308	Coil, FM RF, Adj	56A56	1.50
R306, 360, 389 392	Control, 50K, Vert, PC Mt.	15C7-11	.75
R375	Control, 25K, Vert, PC Mt.	15C7-12	.75
R387	Control, 20K, Mod Tracking	15C3-25	1.25
R391	Control, 100K, Vert, PC Mt.	15C7-13	.75
SW301	Switch, Output selector	25C173	11.25

TR301, 302, 303 314, 315	Transistor, SE3002	19A7-1	.50
TR304, 306, 307 320, 321, 323, 324	Transistor, 2N5172	19A28	.50
TR305, 308, 312, 313, 316	FET, MPF102	19A19	.75
TR310, 318, 322	Transistor, 2N5227	19A16-1	.50
Y301	Crystal, 10.7MHz	47A18	4.00

MISCELLANEOUS

	Front panel escutcheon	8B68	.50
	RF TUNING dial	8A69	1.00
	Dial marker, AM	8A70	.50
	Dial marker, FM	8A71	.50
	Indicator Lamp and Holder	20A7	.50
	Knob, speaker load, power range, microvolt output rocker	21A37	1.00
	4:1 drive, RF TUNING	21A56	2.50
	Knob, Output selector	21G52	2.25
	Knob, RF TUNING	21G53	2.25
	Line cord	27G12	1.25
	75/300 ohm matching pad and cable	39G43	15.50
	Scope vertical lead	39G44	2.00
	Detector probe	39G45	4.00
	Auto radio dummy antenna	39G53	2.00
	Fuse holder	64G28	1.00
	Case wrap assembly	110C275	22.75

Prices in effect at date of printing and are subject to change without notice.
When ordering parts, please specify model number, part number and description. Service and parts invoices are C.O.D. Please include remittance (check or money order) with your order to save C.O.D. charges. Minimum billing $3.00.

FORM 846

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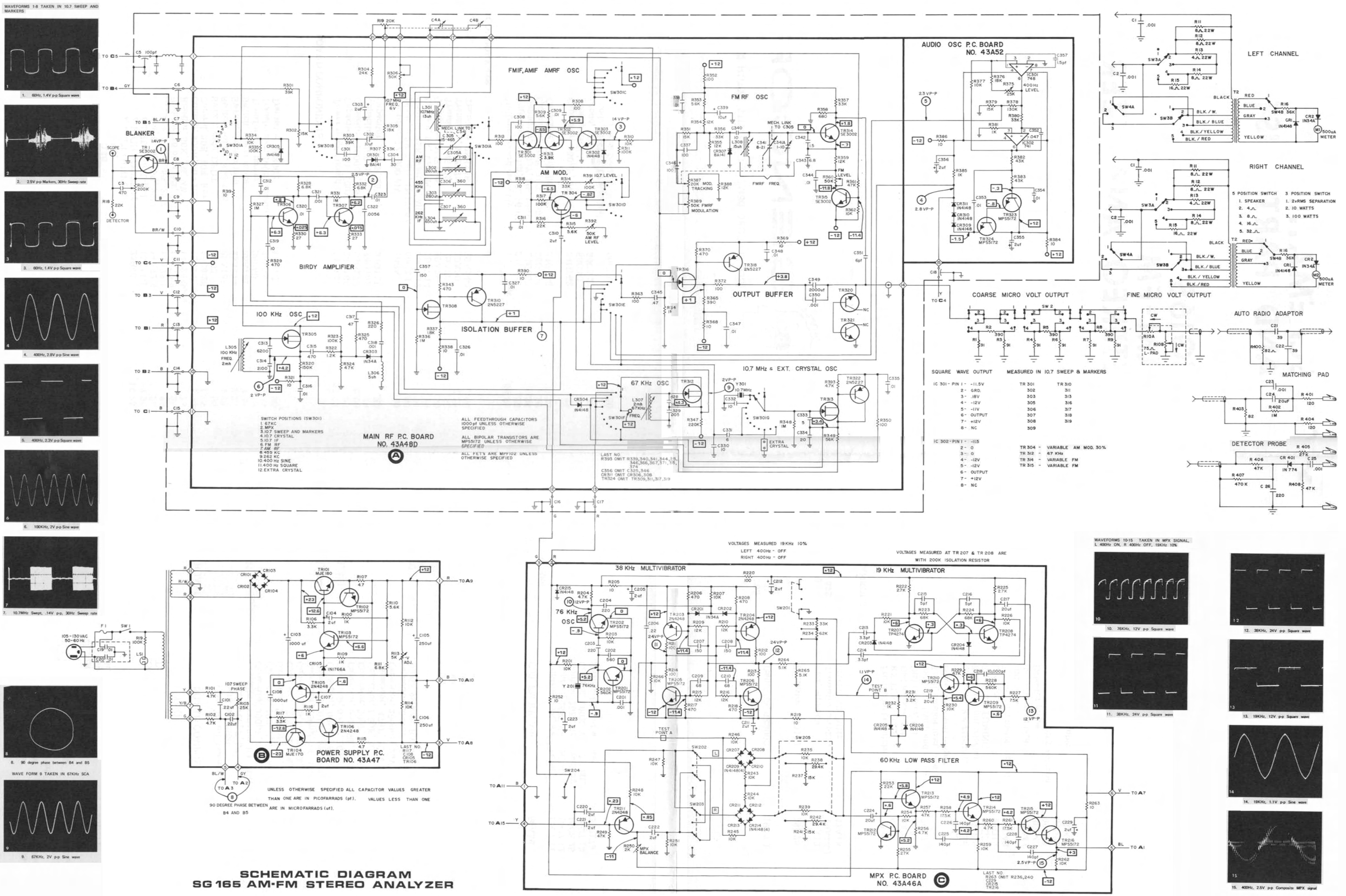

SCHEMATIC DIAGRAM
SG 165 AM-FM STEREO ANALYZER