



MOTOROLA PRECISION INSTRUMENTS

S1067A

Transistorized Audio Oscillator

MOTOROLA

TRANSISTORIZED AUDIO OSCILLATOR

MODEL S1067A



MOTOROLA INC.

Communications Division

ENGINEERING PUBLICATIONS

4501 WEST AUGUSTA BOULEVARD

CHICAGO, ILLINOIS 60651

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Printed in U. S. A.

12/2/66-CP

68P81043A40

Issue - A

GUARANTEED PERFORMANCE SPECIFICATIONS

FREQUENCY RANGE	20 cps-200 kc, in 4 overlapping ranges.
DIAL ACCURACY	±5%
FREQUENCY RESPONSE	±1 db into 150 ohms or more (resistive load).
OUTPUT VOLTAGE	1.5 v rms ±1 db into 150 ohms 1.0 v rms (min.) into 50 ohms
SOURCE IMPEDANCE	Less than 50 ohms at any output voltage level.
DISTORTION	less than 1.0% *
TRANSISTOR COMPLEMENT	One silicon field effect transistor and six silicon transistors.
BATTERY LIFE AND TYPE**	100 hours: 600 ohms or higher loads 80 hours: 150 ohms 50 hours: 50 ohms Battery: 1 Burgess type 4156 (22-1/2V) dry cell or equiv.
AC INPUT REQUIREMENTS	105-130 v a-c, 50 cps-400 cps at 6 ma approx. can be operated with 230 v a-c, 50-400 cps by using SKN6009A 230/117 VAC Adapter Cable Kit (optional).
FILTER (1 KC DISTORTION ANALYZER) CHARACTERISTICS	frequency accuracy = ±5% 1 kc rejection = more than 50 db input resistance = 600 ohms (approx.)
OPERATING TEMPERATURE	0° to +50°C (32°F to 122°F)
DIMENSIONS	10-1/4 x 6-1/2" x 5-3/4" (approx.)
WEIGHT	7-3/4 pounds

*50 cps to 200 kc with 150 ohm or higher load at 1.5 v rms maximum and 50 ohm load at 1 v rms maximum.

**Based on discharge time of 4 hours per day at room temperature.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

FOREWORD

CLAIM FOR DAMAGE IN SHIPMENT

If any damage to the shipping container is apparent upon receipt, the delivering driver should be requested to note such damage on all copies of the freight bill. This is for your protection should the material have sustained damage.

The equipment should be unpacked immediately, examined for damage and tested. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. The claim should be filed within forty-eight hours after receipt, if possible, or during a period not to exceed fifteen days.

A full report of such damage should be obtained from the claim investigator, who will call upon you. For the purpose of this report, the shipping container and all packing materials should be retained for the investigator to examine.

The investigator's report should then be forwarded to:

Motorola Communications & Electronics, Inc.
Parts and Service Department
1875 Greenleaf Ave.
Elk Grove Village, Illinois. 60007

Include model number and serial number when referring to the instrument for any reason. Arrangements for repair or replacement will be made and you will be advised of the disposition of the instrument.

REPAIR AND/OR RECALIBRATION

If desired the instrument may be returned to:

Motorola Communications & Electronics, Inc.
Parts and Service Department
1875 Greenleaf Ave.
Elk Grove Village, Illinois 60007

for repair and/or recalibration. Refer to the instrument by model number and serial number in all correspondence. If requested, an estimate of the charges will be made before work begins, if the instrument is not covered by the warranty.

SHIPPING

The instrument should be surrounded by two or three inches of excelsior or similar shock absorbing material and then packed in a strong exterior container. It should be shipped via Truck, Railway Express, Air Freight or Air Express.

WARRANTY

Motorola instrument equipment other than fuses, and batteries, is guaranteed by Motorola for a period of one year after delivery to the original purchaser against defects in design, material, and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory Service Department for that purpose and to replace any defective parts thereof.

This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at the net price of necessary parts and a service charge at Motorola's then prevailing labor rate. In this case, an estimate will be submitted before the work is started.

This warranty is in lieu of all other warranties, expressed or implied and all

other obligations or liabilities on Motorola's part.

If any fault develops, the following steps should be taken:

1. Notify us at the following address:

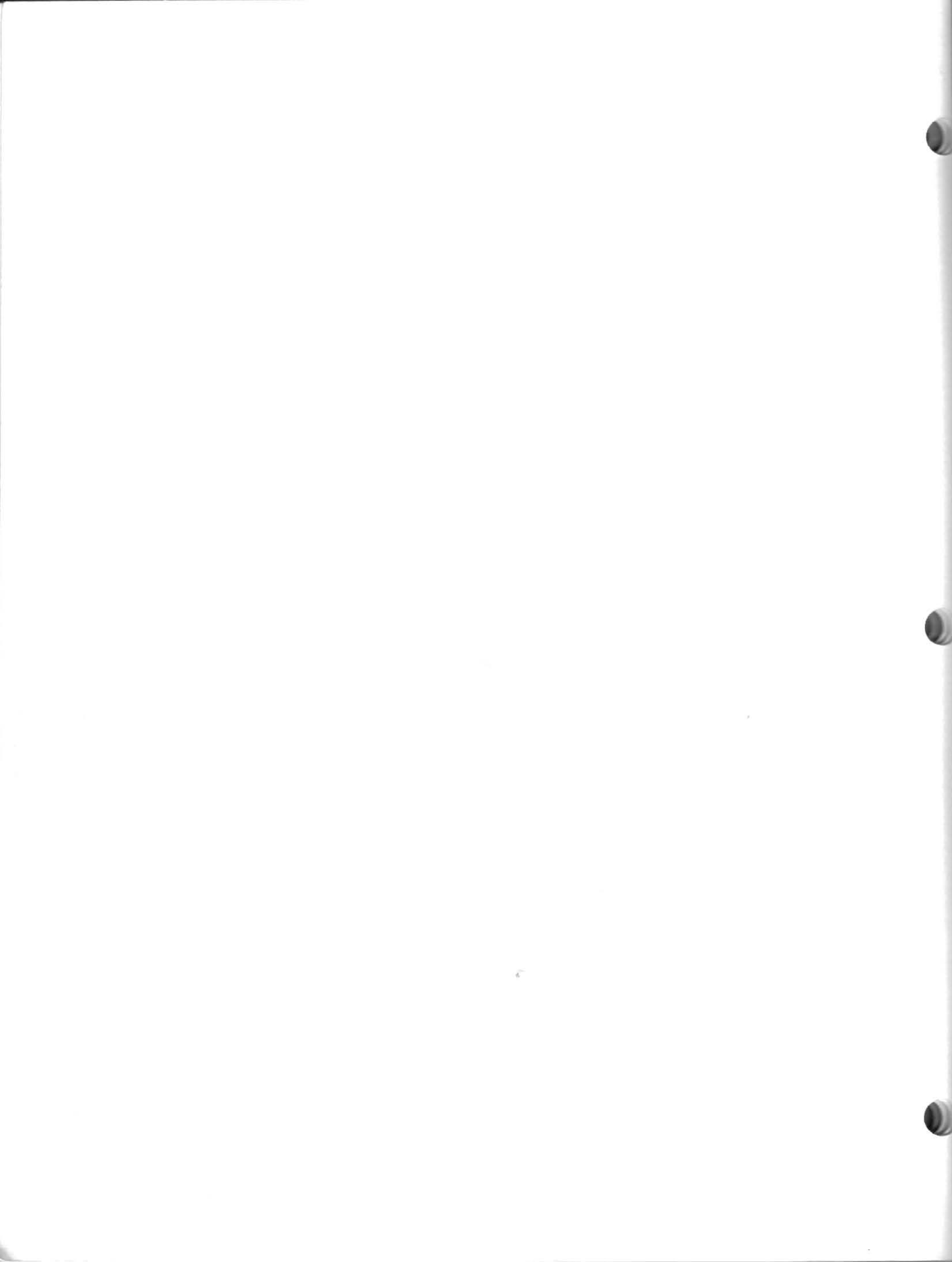
Motorola Communications &
Electronics, Inc.
Parts and Service Department
1875 Greenleaf Ave.
Elk Grove Village, Illinois 60007

Give full details of the difficulty, and include model number and serial number. Upon receipt of this information, we will give you service data or shipping instructions.

2. Upon receipt of shipping instructions, forward the instrument prepaid to the above address or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, if the instrument is not covered by the warranty.

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1. INTRODUCTION

The Model S1067A Audio Oscillator is a transistorized, compact, lightweight instrument that provides laboratory-quality performance. Its construction assures high reliability and accuracy with a minimum of maintenance. The instrument is ideally suited for the maintenance of "Private-Line", "Quik-Call", single-tone, and similar tone-operated two-way radio equipment. It can also be used to check the frequency response of audio amplifiers.

The unit is equipped with a unique 1 kc distortion analyzer that is used with a Motorola AC Voltmeter (or equivalent) to simplify and reduce the time required to check the distortion level in receiver audio circuits and amplifiers. This feature is used when making EIA SINAD sensitivity and quieting checks specified for most two-way mobile and base station equipment.

The unit will operate equally well from a 117 v a-c, 60 cps, power source or from its self-contained 22-1/2-volt battery. Battery life is more than 100 hours at a 600-ohm or higher load. Refer to the performance specifications for other battery life values. When operated from a 117 v a-c power source, a detachable shielded power cord is used. This cord includes a short-circuit-proof transformer molded into the larger plug housing that reduces the input voltage to 12 volts rms. The 12 volts rms is fed to the audio oscillator power supply via the shielded cord, thereby minimizing the danger of electric shock and hum pickup normally encountered in conventional 117 v a-c power supplies.

The instrument will also operate from a 230 v a-c, 50-400 cps, power source when the optional Model SKN6009A 230/117 VAC Adapter Cable Kit (must be separately ordered) is used.

2. MODEL COMPLEMENT

The Model S1067A Audio Oscillator consists of the following items.

- SLN6211A Audio Oscillator
- SKN6010A Power Cable Kit
- SLN6212A Battery Kit

3. ACCESSORY ITEMS

The following accessory items are available for use with the audio oscillator.

- SKN6009A 230/117 VAC Adapter Cable Kit
- SLN6214A Matching Transformer

4. OPERATION

To operate the Model S1067A Audio Oscillator, remove the front cover and proceed as follows:

a. Battery Installation

(1) Loosen the four captive screws in the back housing panel and separate the housing from the audio oscillator.

(2) Loosen the captive screw holding the battery mounting clamp to the housing and remove the clamp.

(3) Insert the battery in the housing with its positive (+) terminal to the left and replace the mounting clamp.

(4) Connect the unterminated RED and BLK leads to the battery. OBSERVE POLARITY -- red lead to the battery positive (+) terminal, black lead to the negative (-) terminal. To the battery positive (+) terminal also connect the short RED lead from the battery test jack on the back of the instrument housing.

(5) Replace the instrument housing.

b. Operating Power

(1) If the unit is to operate from a 117 v a-c power source, mate the power receptacles of the SKN6010A Power Cable Kit to the audio oscillator and the 117 v a-c power source receptacle. Turn the RANGE switch on the front panel until the word LINE on the control knob can be read right side up. To turn on the audio oscillator, turn the OFF-AMPLITUDE control clockwise until a click is heard. Allow at least 10 seconds for frequency stabilization and capacitor charging.

(2) If the unit is to operate on its self-contained battery, turn the RANGE switch until the word BATT. can be read right side up. To turn on the audio oscillator, turn the OFF-AMPLITUDE control clockwise until a click is heard. Allow at least 10 seconds for capacitor charging and frequency stabilization.

To completely isolate the audio oscillator from the a-c line and possible hum pickup, disconnect the SKN6010A Power Cable Kit from the instrument.

When the instrument is not in use, the RANGE control should be left in the LINE position. In this position, the battery is disconnected, thereby preventing its discharge if the oscillator is inadvertently left on or accidentally turned on.

c. Frequency Selection

Frequency selection is achieved by turning two controls, the FREQUENCY selector control and the RANGE control.

The RANGE control is used to select the FREQUENCY dial setting multiplier range. It is divided into four ranges (x1, x10, x100 and x1K) each of which when multiplied with the FREQUENCY select dial setting indicates the frequency output of the audio oscillator. The same setting on the FREQUENCY select dial provides four different output frequencies depending upon the RANGE switch setting. For example, a setting of 20 on the FREQUENCY select dial provides the following output frequencies through the four RANGE switch settings:

x1	=	20 cps
x10	=	200 cps
x100	=	2,000 cps
x1K	=	20,000 cps

When setting the desired frequency output, first turn the FREQUENCY select dial control knob, in the center of the dial, to the digits corresponding to the first two digits of the desired frequency. Now turn the RANGE switch to the multiplier position which, when multiplied with the setting on the FREQUENCY dial, provides the desired output frequency.

The small control knob that slightly overlaps the frequency select dial on the lower right side is used as a fine adjustment control to more closely adjust the FREQUENCY dial setting.

To avoid possible r-f pickup through the oscillator housing, keep the instrument as far from high power transmitters as possible.

d. Amplitude

In addition to its function as the power on-off switch, the AMPLITUDE control also adjusts the output amplitude.

e. Output Terminals

The audio oscillator output is brought out to the red and black dual binding post jack located to

the right of the AMPLITUDE control. Connections to this jack are made with a mating double banana type plug, tipped plugs, spade lugs, alligator clips or bare wire.

f. Distortion Analyzer

(1) Connect the output of the audio oscillator to the input of the amplifier under test. Refer to Figure 1.

(2) If the output power of the circuit under test is not known, connect a rated resistive load or speaker across the output of that circuit. Across this load connect an a-c voltmeter (Motorola Model S1051C, S1053C or equivalent).

When a Motorola AC Voltmeter is used with the Model S1067A Audio Oscillator, distortion measurements can be made on circuits having a floating output. The Motorola AC Voltmeter and the audio oscillator are grounded to their respective housings and not to line ground. The common lead of the 1 kc distortion analyzer is not grounded to the audio oscillator housing.

(3) With the audio oscillator set to 1 kc, increase the output amplitude to the point where the a-c voltmeter reading is equivalent to the rated or desired output power of the circuit under test.

For example: If the circuit under test is a 5-watt amplifier working into a 3.2 ohm speaker, the a-c voltmeter reading will be 4 volts rms. This reading is obtained from the formula $P = \frac{V^2}{R}$.

Where:

$$P = 5 \text{ watts}$$

$$R = 3.2 \text{ ohm}$$

$$V = \sqrt{5 \times 3.2} = \sqrt{16.0} = 4 \text{ volts rms}$$

(4) Disconnect the a-c voltmeter from the circuit under test and connect it to the OUTPUT binding posts of the distortion analyzer filter. OBSERVE POLARITY.

(5) Connect the output load of the circuit under test to the INPUT binding posts of the distortion analyzer filter. OBSERVE POLARITY.

(6) Place the LEVEL-BALANCE slide switch on the audio oscillator in the LEVEL position.

(7) If the output voltage of the circuit under test is more than 10 volts but less than 50 volts, set the a-c voltmeter to the 10-volt range and

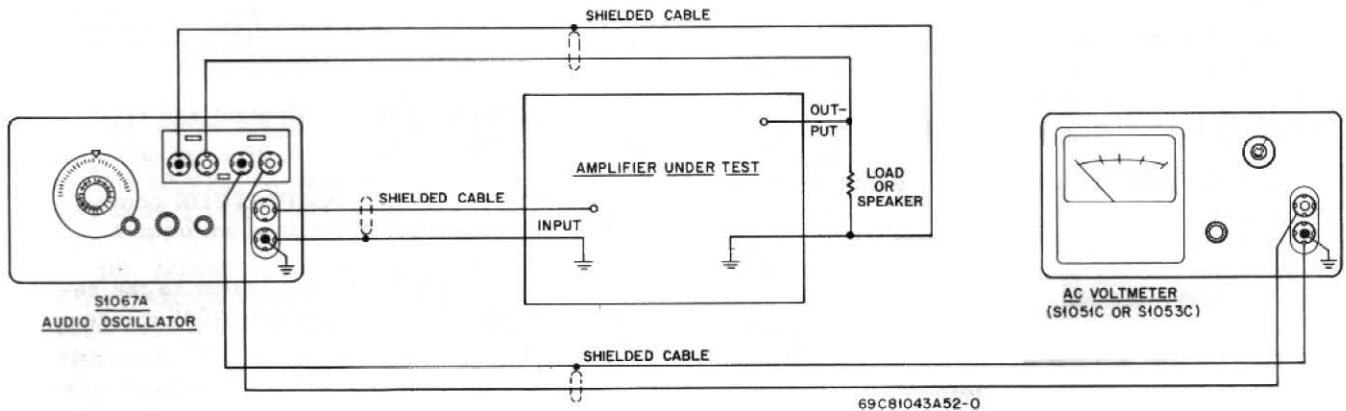


Figure 1.
Interconnection Block Diagram

adjust the LEVEL control on the audio oscillator for a full scale reading.

If the output voltage of the circuit under test is more than 1 volt but less than 10 volts, set the a-c voltmeter to the 1-volt range and adjust the LEVEL control for a full scale reading.

(8) Set the LEVEL-BALANCE switch on the audio oscillator to the BALANCE position.

(9) Adjust the BALANCE control to obtain a dip or minimum reading on the a-c voltmeter. This adjustment should be made on a mid-scale meter reading. Change the a-c voltmeter full scale range accordingly.

(10) Slowly turn the FREQUENCY dial fine-adjust control to obtain a dip or minimum reading on the a-c voltmeter. This adjustment should also be a mid-scale meter reading.

(11) Repeat steps (9) and (10).

(12) Where greater distortion accuracy or a low distortion figure (approximately 1%) is expected, repeat Steps (9) and (10) again.

(13) Distortion percentage is read on the a-c voltmeter in terms of a full scale reference. If for example, after completing Step (11) or (12), the reading on the a-c voltmeter is 3.5 volts on the 10-volt full scale range, the 10-volt full scale range represents 100% distortion and the 3.5 volts reading, therefore, represents 35% distortion.

If the distortion figure is 30% or less, change the full scale meter range from 10 volts to 3 volts. This range represents 30% distortion at full scale. A 1-volt reading on this scale represents 10% distortion. Refer to the following Distortion Percentage Table for other voltage/distortion percentage equivalents.

NOTE

Use only the 10-volt or 1-volt ranges for setting the LEVEL control in distortion measurements.

Distortion Percentage Table

100%	30%	10%	3%	1%
10 volts*	3 volts	1 volt	.3 volt	.1 volt
1 volt*	.3 volt	.1 volt	.03 volt	.01 volt

*Starting range for setting the LEVEL control.

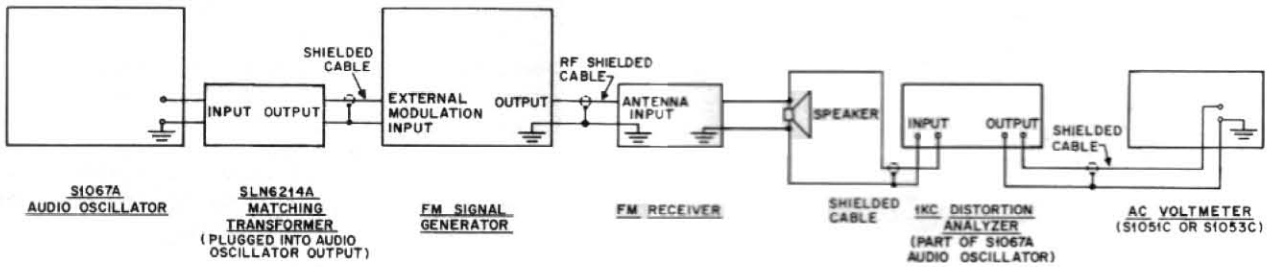
g. EIA SINAD Sensitivity Measurement

Since the EIA SINAD sensitivity and quieting measurement is specified for most two-way mobile and base station equipment, the set-up and test procedure using the Model S1067A Audio Oscillator and related Motorola test equipment (or equivalents) is outlined herein. Refer to Figure 2 for a typical test set-up in making an EIA SINAD receiver sensitivity measurement.

To make an EIA SINAD receiver sensitivity measurement, the following Motorola test equipment (or equivalent) is required:

- Model S1067A Audio Oscillator
- Model SLN6214A Matching Transformer
- Model T1034C, T1035C or T1036A FM Signal Generator
- Model S1051C or S1053C AC Voltmeter

- (1) Connect the test equipment to the receiver as indicated in Figure 2.
- (2) Turn on all test equipment and apply power to the receiver.
- (3) Adjust the OFF-AMPLITUDE control on the audio oscillator for minimum output.
- (4) Set the FM signal generator to the receiver frequency and its output to 1000 microvolts.
- (5) Set the audio oscillator output frequency to 1 kc and adjust the OFF-AMPLITUDE control for a deviation reading on the FM signal generator of 2/3 of the maximum rated receiver deviation.



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Figure 2.
Typical Test Set-Up
For
EIA SINAD Receiver
Sensitivity Measurement

(6) Adjust the receiver volume control to obtain the rated audio output. The a-c voltmeter can be used to measure the audio output voltage if the power output rating and speaker impedance are known by using the formula $V = \sqrt{PR}$. For example, if the audio output rating is 5 watts and the speaker impedance is 3.2 ohms, then $V \text{ (rms)} = \sqrt{5 \times 3.2} = 4 \text{ volts}$.

(7) Move the LEVEL-BALANCE slide switch on the audio oscillator to the LEVEL position. Adjust the LEVEL control for an a-c voltmeter reading of 1 volt, full scale.

(8) Move the LEVEL-BALANCE slide switch to the BALANCE position. Adjust the BALANCE control for a dip or minimum reading on the a-c voltmeter. Use the meter scale of the a-c voltmeter that will provide a mid-scale reading.

(9) Adjust the audio oscillator fine-frequency adjust control to obtain a dip or minimum reading on the a-c voltmeter.

(10) Repeat Steps (8) and (9), in that order.

The a-c voltmeter reading obtained in Step (10) is the receiver distortion level in percentage. This figure is not used for the sensitivity measurement, however, the control settings to obtain this figure are used, therefore, DO NOT disturb the BALANCE control setting or the audio frequency setting after completing Step (10).

(11) Set the a-c voltmeter to its 1-volt full scale range. Move the LEVEL-BALANCE slide switch on the audio oscillator to the LEVEL position. Note the a-c voltmeter reading in db (+2.3 db is equal to 1 volt).

(12) Reduce the output signal level of the FM signal generator (generator output reduced to be approximately equal to 12 db of the SINAD sensitivity of the receiver) so that the difference in a-c voltmeter reading between the LEVEL-BALANCE slide switch in the LEVEL position and BALANCE position is 12 db. This function is represented by the expression:

$$\frac{\text{LEVEL}}{\text{BALANCE}} = \frac{\text{Signal} + \text{Noise} + \text{Distortion}}{\text{Noise} + \text{Distortion}} = 12 \text{ db}$$

NOTE

To more quickly obtain the results of Step (12), use the left hand to adjust the signal level of the FM generator and the right hand to move the slide switch back and forth between the LEVEL and BALANCE positions.

(13) Read the FM signal generator output in microvolts. At this input level, if the receiver output level is 50% of the rated audio output without readjustment of the receiver volume control (set in Step (6)), the r-f input level is the EIA 12 db SINAD sensitivity of the receiver. If the audio output is less than 50% of the rated audio output, increase the r-f signal input until 50% of full rated audio output is obtained. This level of r-f signal is the EIA 12 db SINAD sensitivity of the receiver.

5. CIRCUIT DESCRIPTION

The Model S1067A Audio Oscillator is an overlapping four range unit providing output frequencies from 20 cps to 200 kc. Its circuitry consists of a Wien bridge network, an oscillator-amplifier, a push-pull output stage, a 1 kc filter and an a-c power supply.

The Wien bridge network basically consists of variable capacitors $C_a - C_b$ and resistors R_a and R_b . $C_a - C_b$, $R_a - R_b$ are used in this instance for explanatory purposes only, not for referencing as shown on Schematic Diagram 63D81043A41. These components are used as the frequency selection element in the positive feedback path. Thermistor RT-1 and resistor R_x are connected into the negative feedback path. These components provide constant output voltage amplitude across the audio oscillator frequency band. The use of negative feedback also minimizes internal distortion (see Figure 4) and provides extremely high stability, independent of transistor characteristics or voltages. The output of the Wien bridge has maximum voltage and zero phase shift at the resonant frequency which is the frequency of oscillation. The resonant frequency (f_o) is expressed by the formula:

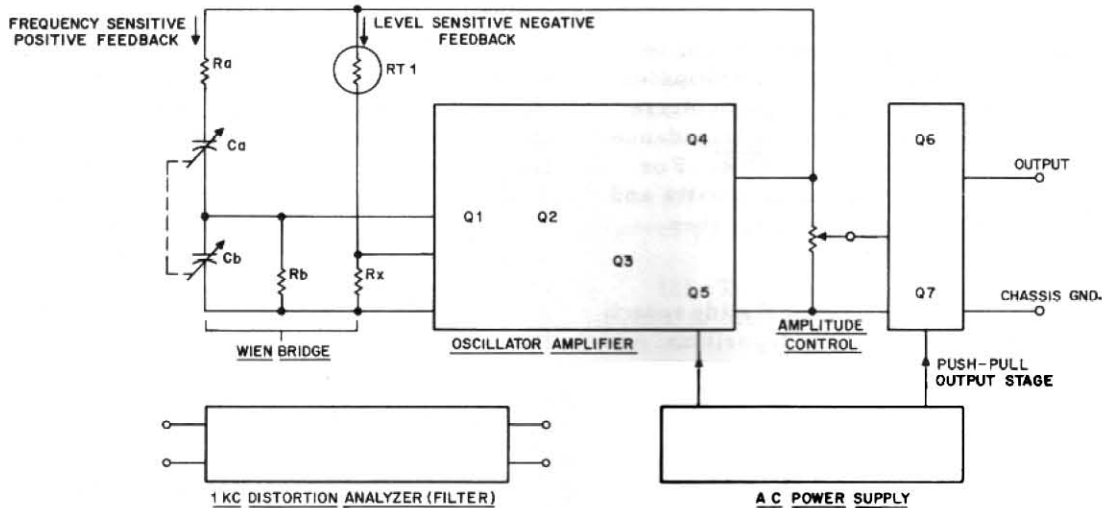
$$f_o = \frac{1}{2\pi RC}$$

$$\text{When: } R_a = R_b$$

$$C_a = C_b$$

Ganged capacitors $C_a - C_b$ (equal in value) are used as the frequency tuning elements. Resistors $R_a - R_b$ are equal in value. A different set of these resistors is used in each of the four frequency ranges.

The oscillator-amplifier consists of transistor Q1, a common source field effect amplifier, followed by Q2, a d-c coupled emitter-follower



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Figure 3. Functional Block Diagram

stage. Transistor Q1 has an extremely high input impedance due to its field effect characteristics and the negative voltage feedback. Q2 matches the high load impedance of Q1 to the low input impedance of Q3, a common emitter amplifier. Transistor Q3 drives the push-pull emitter-follower feedback pair, (Q4 and Q5). The audio oscillator feedback voltage is obtained from the output of Q4 and Q5. It is fed to the input of Q1 through the Wien bridge network. The positive feedback voltage is fed through the RC network. The negative feedback voltage is fed through the thermistor-resistor network.

The flat frequency response (see Figure 5) of this oscillator is obtained by an automatic level control circuit using thermistor RT-1 in the negative feedback path. Should the output voltage of the Q4-Q5 amplifier increase because of gain changes, unbalance in the Wien bridge, or for any other reason, the voltage across the thermistor increases, thereby causing the component temperature to rise. A rise in temperature lowers the thermistor resistance allowing the negative feedback voltage to increase. The increased feedback lowers the oscillator-amplifier output voltage to its original or proper level. If the output voltage of the Q4-Q5 amplifier decreases, the reverse effect on the RT-1 thermistor takes place, thereby causing the opposite condition to re-establish the original output voltage level. Normally, the thermistor operates at a very high temperature so that ambient temperature variations have very little effect on its operation. In addition, the component is vacuum sealed to further minimize ambient temperature effects.

The audio oscillator amplitude control is connected between the oscillator-amplifier output and the push-pull output stage made up of Q6 and Q7. It adjusts the oscillator-amplifier output voltage linearly at any voltage level setting.

A common collector (emitter-follower) push-pull amplifier (Q6 and Q7) is used in the output stage, providing a very low output impedance and isolating the oscillator-amplifier from the load (circuit under test).

The a-c power supply uses a voltage doubler and RC filter network in providing the operating voltage for the audio oscillator. Its input power is obtained from a 117 v a-c, 60 cps source through the shielded SKN6010A Power Cable Kit.

The 1 kc filter used in making distortion measurements consists of a bridge "T" circuit that rejects the 1 kc tone component and passes all remaining frequencies. A high "Q" audio choke and mylar capacitors form a tuned circuit that provides filter rejection of more than 50 db. When the LEVEL-BALANCE slide switch is placed in the LEVEL position the choke is shorted out, thereby allowing all frequencies to pass. At this point in a distortion measurement, the LEVEL control is adjusted so that the filter output provides a full scale reading on the a-c voltmeter. When the LEVEL-BALANCE switch is placed in the BALANCE position, the short across the high "Q" choke is removed. At this point, the amplitude of the 1 kc rejection (steepness of filter curve) is adjusted by turning the BALANCE control.

Being a passive network, the 1 kc distortion analyzer filter does not require power from the power supply. It is independent of the oscillator circuitry.

6. ACCESSORY DESCRIPTION

a. SKN6009A 230/117 VAC Adapter Cable Kit

This cable kit is an optional accessory item that reduces a 230 v a-c power source to 117 v a-c. It is used with the SKN6010A Power Cable Kit supplied with the Model S1067A Audio Oscillator which reduces 117 v a-c to 12 volts rms. One end of the optional SKN6009A Adapter Cable mates with the potted transformer end of the SKN6010A Cable Kit.

The SKN6009A Adapter Cable consists of approximately six feet of three conductor cable, a small cylindrical housing containing a potted step-down transformer and a three pin connector that mates with the plug on the transformer end of the SKN6010A Power Cable Kit. An a-c line plug is not provided since 230 v a-c source power receptacles are not standardized. When connecting the a-c line plug, connect the BLK and WHT leads to the 230 v a-c line terminals of the plug and the GRN lead to ground.

b. SLN6214A Matching Transformer Kit

This kit is used to step up the audio oscillator output voltage to approximately 10 volts rms. The voltage step up is necessary when it is required to audio modulate an FM signal generator that has an external modulation input impedance of approximately 10 k-ohms at 1 kc.

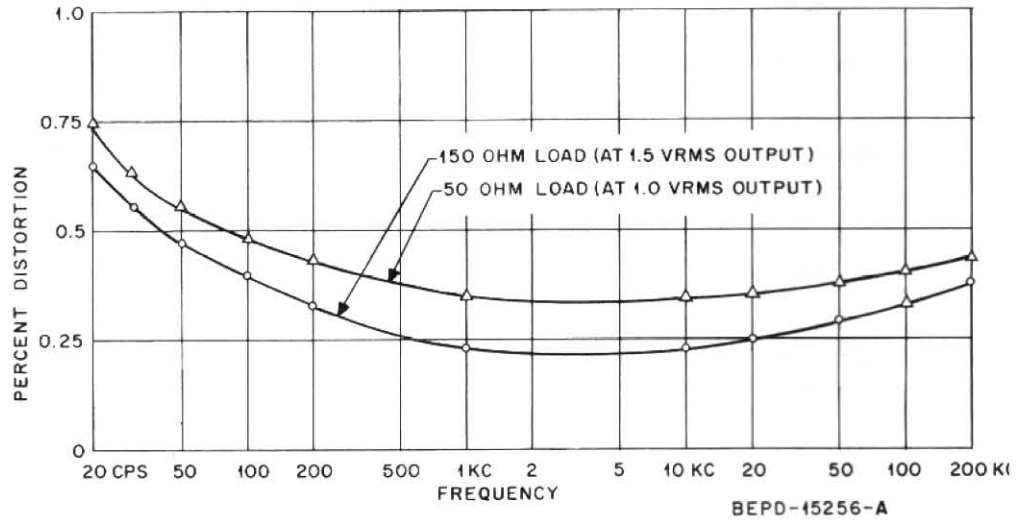


Figure 4. Typical Audio Oscillator Distortion Versus Frequency

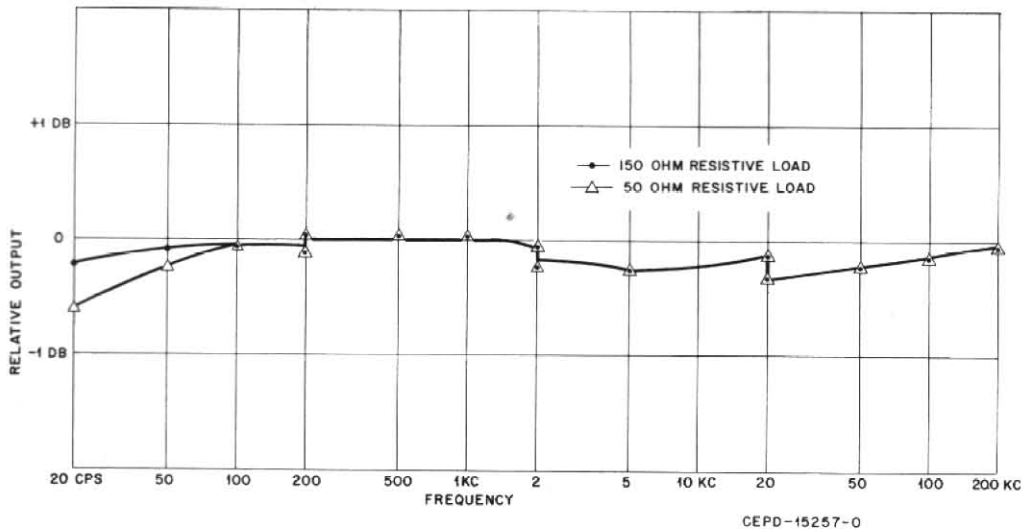


Figure 5. Typical Audio Oscillator Frequency Response

The transformer is housed in a miniature phenolic box. It has a double banana plug that is inserted into the OUTPUT terminals of the audio oscillator and a dual banana jack for connecting a cable to the FM signal generator or other circuitry. Refer to Figure 2 for a typical transformer hookup.

7. MAINTENANCE AND CALIBRATION

a. Battery Replacement

(1) To determine the need for battery replacement, insert the positive probe of a Motorola DC Multimeter into the battery test jack on the back of the instrument housing. Connect the ground lead to the BLACK binding post of the audio oscillator OUTPUT terminal.

(2) Turn the instrument "on" and increase the amplitude to maximum.

(3) The d-c voltmeter should not read less than 15 v d-c.

(4) If the meter reading is less than 15 v d-c the battery is weak and should be replaced.

(5) Loosen the four captive screws in the back housing panel and separate the housing from the audio oscillator.

(6) Loosen the captive screw holding the battery mounting clamp to the housing.

(7) Remove the battery mounting clamp and battery from the housing.

(8) Disconnect the terminal leads from the old battery and connect them to the fresh battery (SLN6212A Battery Kit or Part No. 60B82457B01). OBSERVE POLARITY - red leads to positive (+) terminal, black lead to negative (-) terminal.

(9) Reverse the disassembly procedure to install the fresh battery in the housing.

NOTE

If the instrument is to be operated only on a-c line voltage it is suggested that the battery be removed to prevent corrosion due to possible battery leakage.

b. Calibration

(1) General

Accuracy of the S1067A Audio Oscillator is maintained by periodic calibrations performed

by qualified personnel and adequate test facilities. If desired, the instrument may be returned to the factory for this service. Refer to the FOREWORD of this manual for shipping information.

The calibration procedure outlined herein is intended for general maintenance only. If any electrical component changes are made, such as the replacement of transistors, trimmer capacitors etc., it is suggested that the instrument be returned to the factory for calibration.

(2) Frequency Dial Calibration

(a) Loosen the four captive screws at the back of the instrument housing. Separate the housing from the instrument.

(b) Connect the oscillator output to a 150-ohm resistive load and to a Motorola Model S1075B Digital Frequency Meter, or equivalent.

(c) With the instrument operating on 117 v a-c, set the AMPLITUDE control to maximum and the RANGE switch to the x10 LINE position.

(d) Loosen the two set-screws on the dial knob.

(e) Using the finger tips, turn the ceramic coupler on the two-section air dielectric tuning capacitor to its full clockwise position (maximum capacity).

(f) Slowly turn the ceramic coupler counterclockwise approximately 18° to obtain a frequency counter reading of 200 cps using the 1 second count (1 cps resolution).

NOTE

A \pm one count reading on the frequency counter is allowed since counter accuracy is normally \pm one count.

(g) Hold the ceramic coupler and gently rotate the frequency dial until the 20 mark is aligned with the frequency indicator index mark. Lightly tighten one of the frequency knob set screws.

(h) Turn the frequency dial knob counterclockwise until the 200 mark on the dial is aligned with the index mark.

(i) With an insulated tuning tool, adjust the 3-12 uuf trimmer capacitor C7 on the printed circuit board for a 2000 cps reading on the frequency counter using the 1 second count (1 cps resolution).

(j) With the frequency dial in the same position as in step (h), change the RANGE switch setting to x1K LINE. Tilt the audio oscillator chassis backwards and with an insulated tuning tool adjust the trimmer capacitor C1 at the bottom of the RANGE switch to obtain a frequency counter reading of 19980-20020 using the 0.1-second counter or 199,800-200,200 cps if the 1 second count is used.

(k) Change the RANGE switch setting to x10 LINE and replace the oscillator housing using only one captive screw to hold it in place. Use the captive screw nearest the battery. This screw provides the electrical connection required between the housing and the audio oscillator circuits.

(l) Align the 20 mark on the frequency dial with the indicator index mark. Adjust the frequency dial fine adjustment control to obtain a frequency counter reading of 2000 using the 10 second count. At this setting the frequency will be 200 cps.

If the frequency counter is not equipped with a 10 second count, the 1 second count may be used. In this instance the counter will read 200 cps. The 200 cps calibration error using the 10 second count will be 0.05% plus the counter error. The calibration error using the 1 second count will be 0.5% plus the counter error.

(m) If the 20 mark on the frequency dial is not in line with the indicator index mark, loosen the set screw in the knob and turn the dial until these marks are aligned. Tighten both set screws.

(n) If the frequency changes in the performance of Step (m), repeat Steps (l) and (m).

(o) Align the 200 mark on the frequency dial with the indicator index mark. Using the 1 second count, the frequency counter reading should be approximately 2000 cps. If this reading is not within the tolerance limits of the counter (\pm one count) separate the housing from the audio oscillator and adjust the 3-12 uuf trimmer capacitor C7 on the printed circuit board to obtain the 2000 cps (\pm one count) counter reading after the housing is replaced. There is a slight difference in frequency between the "housing off" and "housing on" condition. The frequency counter reading with the housing off is approximately 1% higher than with the housing on. Therefore, when adjusting trimmer capacitor C7, adjust for a counter reading of 2020 cps. If, after replacing the housing the counter does not read 2000 cps \pm one count,

repeat the trimmer capacitor adjustment procedure compensating for the "housing off - housing on" frequency difference, maintaining the 200 mark frequency dial setting. It may be necessary to repeat this procedure several times to obtain the proper setting.

(p) Change the RANGE switch setting to x1K LINE. Using the 0.1 second count, the frequency counter should read 19900-20100. If the counter reads less than 19900 or more than 20100, remove the housing and readjust trimmer capacitor C1 on the RANGE switch. Use the same frequency compensation procedure outlined in step (o).

(q) Replace and tighten the remaining three housing screws.

c. Troubleshooting

To properly troubleshoot the Model S1067A Audio Oscillator, the following Motorola test equipment (or equivalent) is required.

- DC Multimeter
- AC Voltmeter
- Oscilloscope

Tables are provided to aid the serviceman in locating troubles quickly. TABLE 1 indicates symptoms and possible causes. TABLE 2 provides typical d-c voltages. To locate components, refer to the COMPONENT LOCATION DETAILS. For schematic information and component values, refer to Schematic Diagram 63D81043A41.

TABLE 1

SYMPTOM	POSSIBLE CAUSE
No Output, Low Output or Intermittent Output	Dead or Weak Battery
Distorted or Excessive Output Voltage*	Open Negative Feedback Loop

*As observed on an oscilloscope the output voltage waveform should be a pure sine wave. The 1 kc distortion analyzer can be checked by feeding the oscillator output into the 1 kc distortion analyzer input, connecting the a-c voltmeter to the distortion analyzer output and performing Steps (8) through (12) outlined under e. Distortion Analyzer in the OPERATION section. Check the audio oscillator distortion at full output amplitude where distortion is maximum.

TABLE 2

TRANSISTOR	TYPICAL DC VOLTAGES*		
	EMITTER	BASE	COLLECTOR
Q1	3.4 (source)	0 (gate 1 or 2)	15.5 (drain)
Q2	14.9	15.5	
Q3	1.7	2.3	9.5
Q4	10.3	10.9	22.5
Q5	10.1	9.5	0
Q6	9.1	9.7	22.5
Q7	9	8.4	0

*Voltages are measured with a Motorola DC Multimeter, Model S1052B or S1063A (11 megohm input resistance) with respect to chassis ground using the internal 22-1/2 volt battery supply.

It is suggested that troubleshooting be limited to voltage readings rather than resistance readings. However, if it becomes necessary to take resistance measurements, use an ohmmeter that has a probe voltage not greater than 200 millivolts. This will prevent damage to transistors, diodes, thermistors, etc.

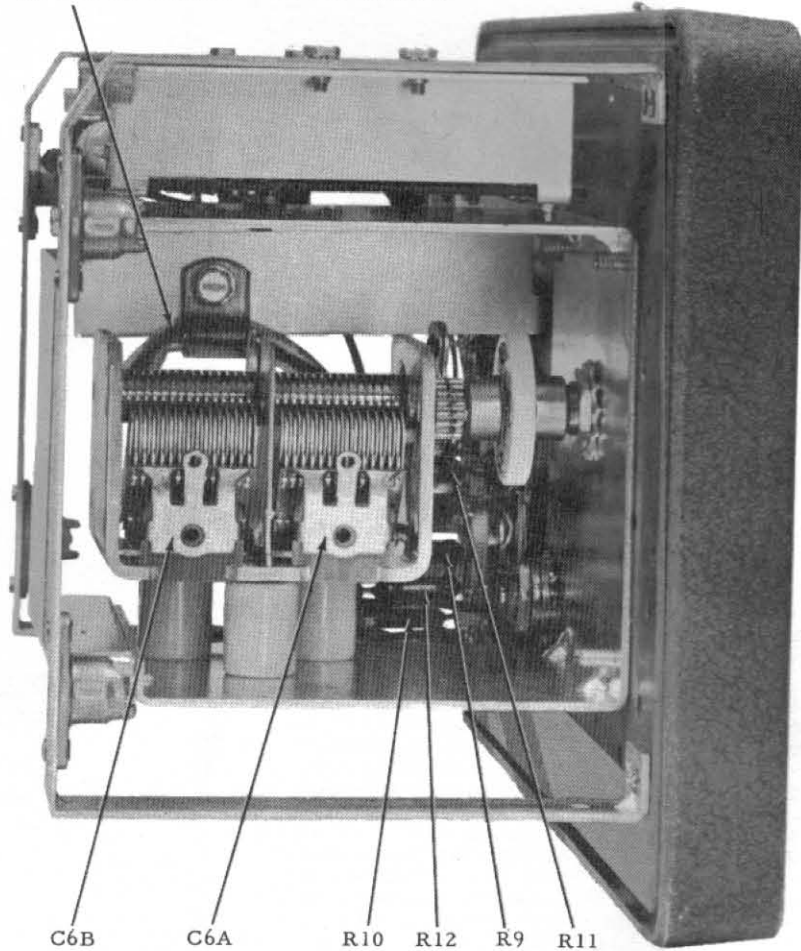
CAUTION

Do NOT replace any component with the power on. Disconnect the battery while replacing components.

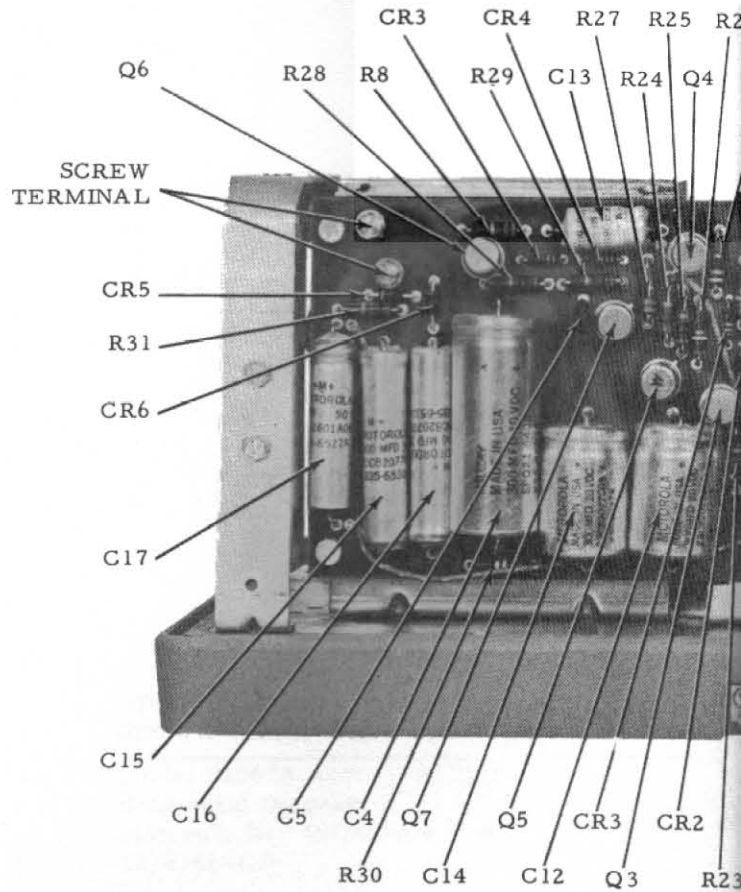
If it becomes necessary to replace a transistor or diode, keep a pair of long nose pliers between the component and the circuit board while soldering. The pliers will absorb enough heat to protect the component from damage.

For optimum performance when replacing transistors, diodes, capacitors or the thermistor, use only Motorola replacement parts. It is highly recommended however, that when these components, or any other electrical components other than carbon resistors are replaced, the instrument be returned to the factory for recalibration.

BATTERY LEADS AEPD-15125-O



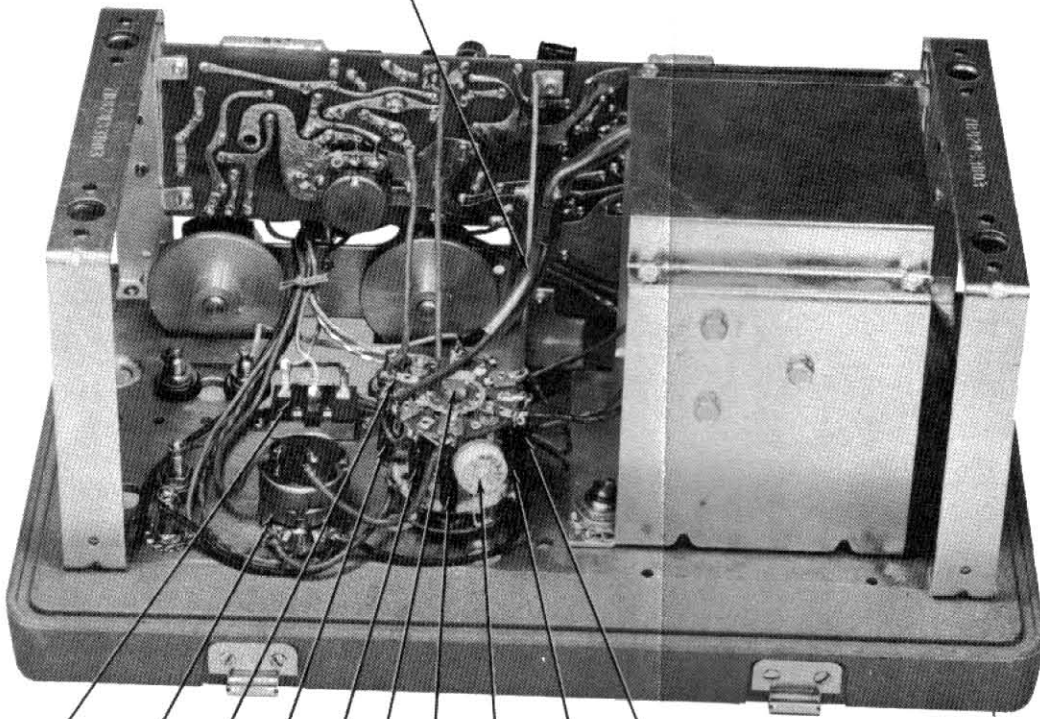
C6B C6A R10 R12 R9 R11



SCREW TERMINAL

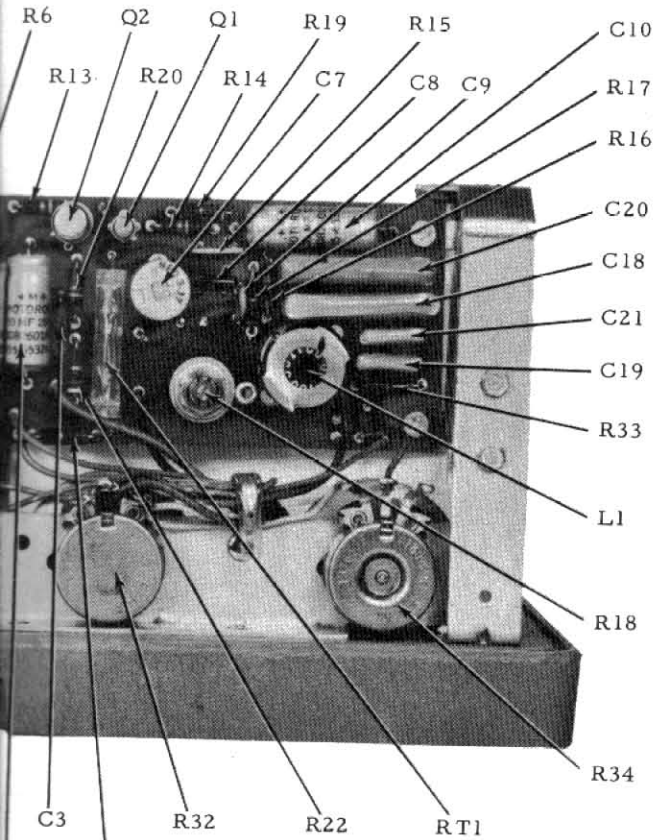
CR3 CR4 R27 R25 R2
Q6 R28 R8 R29 C13 R24 Q4
CR5 R31 CR6
C17
C15
C16 C5 C4 Q7 Q5 CR3 CR2
R30 C14 C12 Q3 R23

BATTERY LEADS



S3 R26 R1 R3 R2 S1 R4 C1 R10 R12

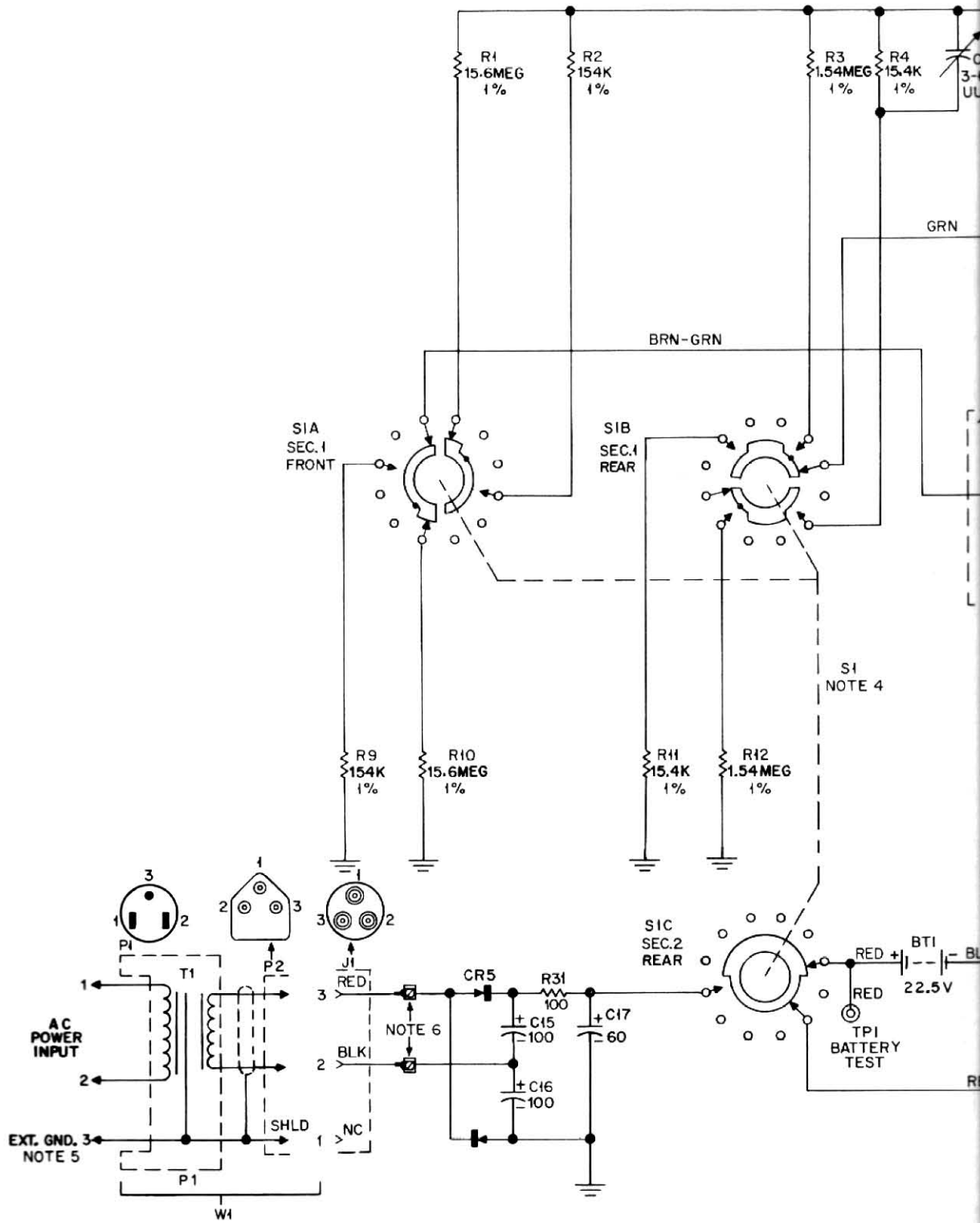
AEPD-15124-O

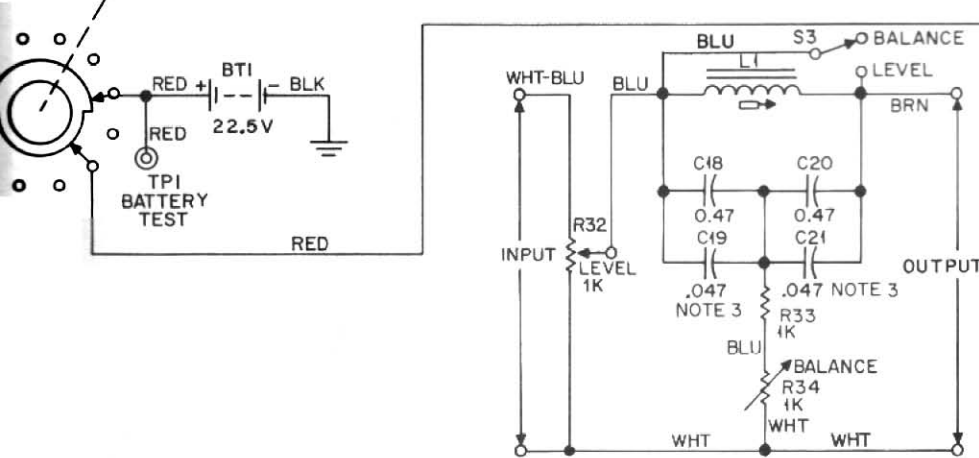
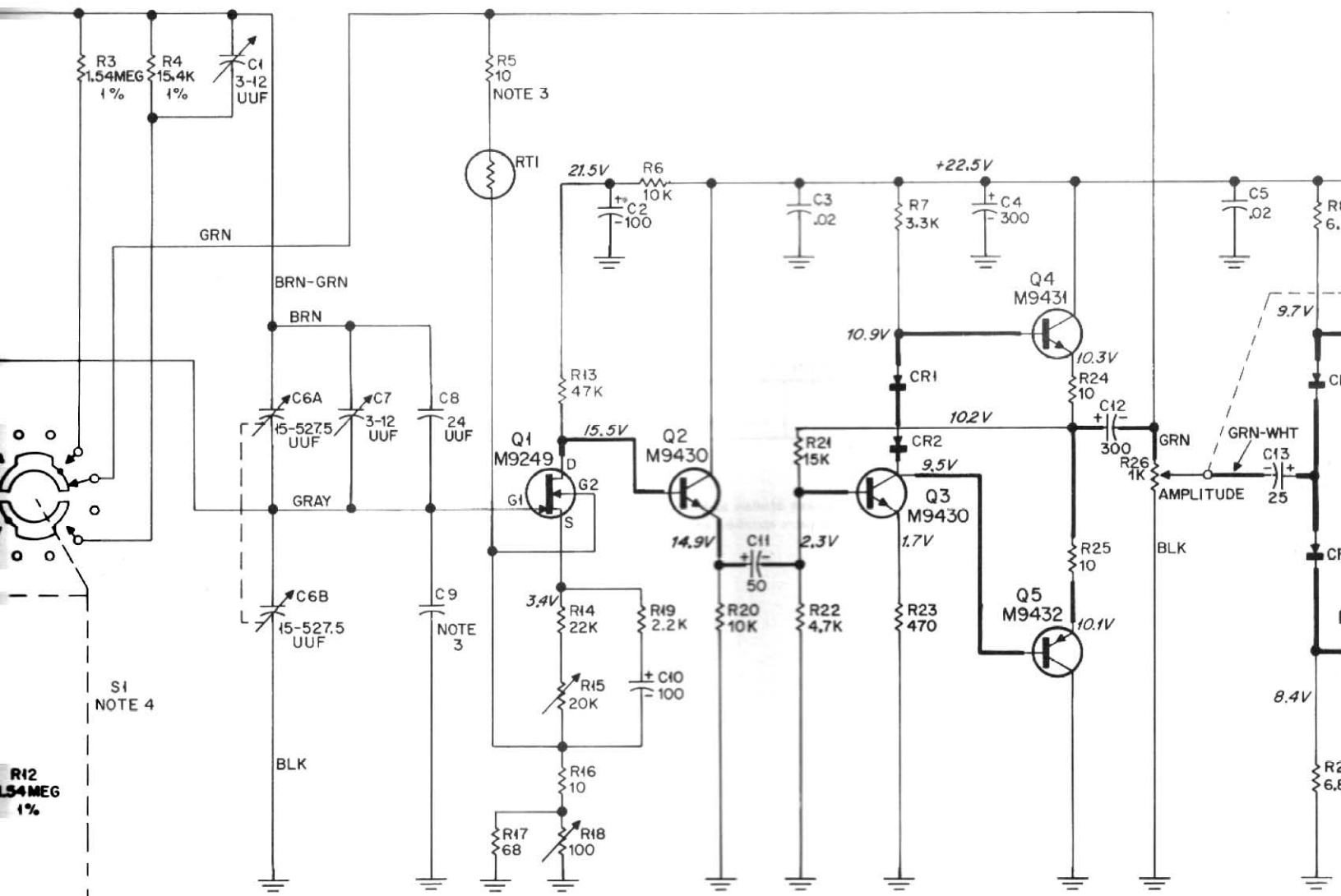


R6 Q2 Q1 R19 R15 C10
R13 R20 R14 C7 C8 C9 R17
R16
C20 C18 C21 C19 R33
L1 R18
R34
C3 R5 R32 R22 RT1

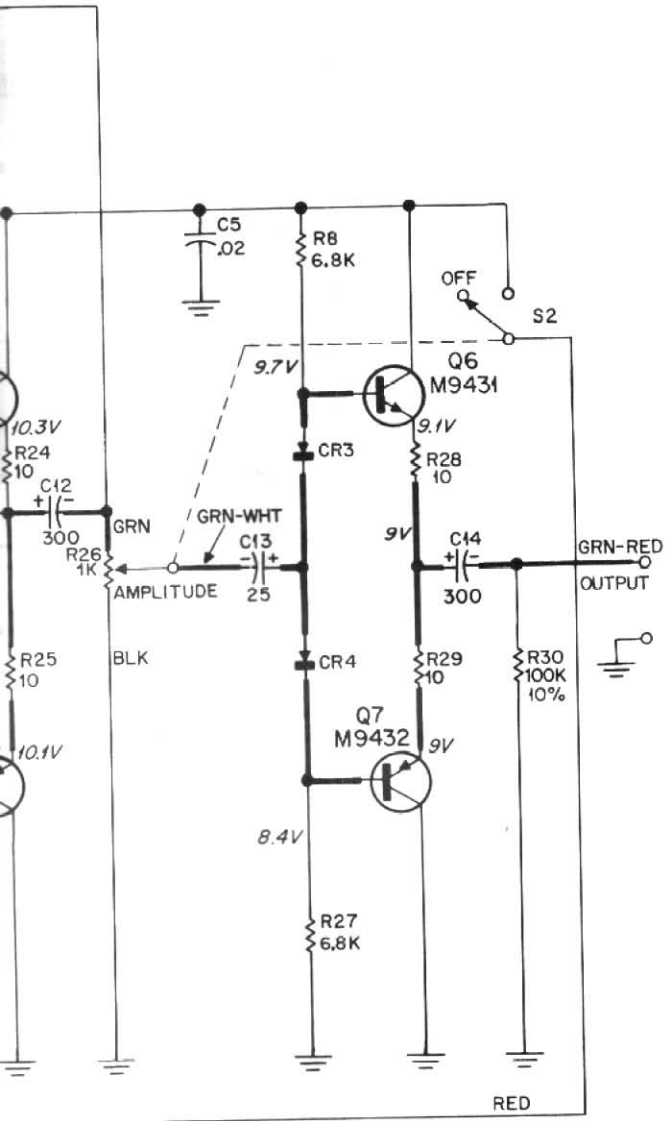
AEPD-15123-O

Component Location Detail
Motorola No. EPD-15269-C
5/6/66-CP





63081043A41-01



NOTES:

1. UNLESS OTHERWISE INDICATED ALL CAPACITOR VALUES ARE IN MICROFARADS AND RESISTOR TOLERANCES ARE 5%, 1/2 WATT.
2. VOLTAGE READINGS ARE TYPICAL VALUES MEASURED WITH A MOTOROLA DC MULTIMETER (11 MEGOHM INPUT RESISTANCE) WITH RESPECT TO CHASSIS AND USING 22-1/2 VOLT INTERNAL BATTERY.
3. COMPONENT VALUES SELECTED AT FACTORY (IF COMPONENT IS USED). VALUES, WHEN SHOWN, ARE TYPICAL.
4. RANGE SWITCH IS SHOWN IN $\times 1$ POSITION AND IN BATT. OPERATION. DOTS SHOWN ON ROTORS ARE THROUGH CONNECTIONS FROM FRONT TO REAR ROTORS.
5. EXTERNAL GROUND MUST BE USED FOR LINE OPERATION.
6. SCREW TERMINALS. RED OR BLACK LEAD MAY BE CONNECTED TO EITHER TERMINAL.

EPD-15291-O

01043A41-01

PREVIOUS REVISIONS AND PARTS LIST
SHOWN ON BACK OF THIS DIAGRAM

Model S1067A Audio Oscillator
Schematic Diagram
Motorola No. 63D81043A41-01
12/2/66-CP

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
01	SLN6211A	R19	WAS 470 OHM	OSCILLATOR AMPLIFIER

REFERENCE SYMBOL	MOTOROLA PART NO.	
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PARTS LIST

SLN6211A Audio Oscillator Kit

C1, 7	20K848635	CAPACIT
C6	19C83731D01	3-12 uuf;
C6A		2 section;
C6B		15-527.5
		15-527.5
		CAPACIT
C2, 15, 16	23C82077C01	100 uf +15
C3, 5	21B82428B01	.02 uf +60
C4	23C82077C14	300 uf +15
C8	21K859937	24 uf +5%
C9		(factory s
C10	23D82601A21	100 uf +10
C11	23D82601A05	50 uf +150
C12, 14	23C82077C05	300 uf +15
C13	23D82601A26	25 uf +150
C17	23D82601A29	60 uf +150
C18, 20	8D82905G06	0.47 uf ±1
C19, 21	8D82905G03	.047 uf ±1
		SEMICON
CR1, 2, 3, 4	48C82392B03	diode: (NO
CR5, 6	48C82466H03	silicon
		silicon
		CONNECT
J1	9B82137E01	female: 3
		REACTOR
L1	24V80902A88	tunable
		TRANSIST
Q1	48R869429	F. E. T. ;
Q2, 3	48R869430	N-P-N; ty
Q4, 6	48K869431	N-P-N; ty
Q5, 7	48R869432	P-N-P; ty
		RESISTOR
R1, 10	6D82475B67	unl stated
R2, 9	6D82672B46	15.6 meg
R3, 12	6D82475B66	154K ±1%
R4, 11	6D82672B45	1.54 meg
R5, 16, 24, 25, 28, 29	6S114018	15.4K ±1%
R6, 20	6S5556	10
R7	6S2003	10K
R8, 27	6S2001	3.3K
R13	6S5772	6.8K
R14	6S6480	47K
R15	18C82567D01	22K
R17	6S400424	variable:
R18	18C82676B01	68
R19	6R2028	variable:
R21	6S5726	2.2K
R22	6S3924	15K
R23	6S400812	4.7K
R26	18C82810C06	470
R30	6S6031	1K ±30%;
R31	6S6408	100K
R32, 34	18D82515B01	100
R33	6S400459	1K
		1.5K
RT1	6B83728D01	THERMIS
		1.2K ±20%
		SWITCH,
S1	40C83730D01	rotary: 3
S2		(spst; p/o
S3	40A11589	slide; spd
		TEST POI
TP1	9K833983	single con

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
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TS LIST

1A Audio Oscillator Kit EPD-15282-A

	20K848635 19C83731D01	<u>CAPACITOR, variable:</u> 3-12 uuf; NP0 2 section; consist of: 15-527.5 uuf; 350 v 15-527.5 uuf; 350 v
5, 16	23C82077C01 21B82428B01 23C82077C14 21K859937	<u>CAPACITOR, fixed:</u> 100 uf +150-10%; 35 v .02 uf +60-40%; 100 v 300 uf +150-10%; 40 v 24 uuf ±5%; 500 v (factory selected)
14	23D82601A21 23D82601A05 23C82077C05 23D82601A26 23D82601A29	100 uf +100-0%; 10 v 50 uf +150-10%; 25 v 300 uf +150-10%; 20 v 25 uf +150-10%; 20 v 60 uf +150-10%; 50 v
20 21	8D82905G06 8D82905G03	0.47 uf ±10%; 50 v .047 uf ±10%; 50 v
2, 3, 4 6	48C82392B03 48C82466H03	<u>SEMICONDUCTOR DEVICE,</u> <u>diode; (NOTE)</u> silicon silicon
	9B82137E01	<u>CONNECTOR, receptacle:</u> female; 3 contact
	24V80902A88	<u>REACTOR:</u> tunable
	48R869429 48R869430 48K869431 48R869432	<u>TRANSISTOR; (NOTE)</u> F. E. T.; type M9429 N-P-N; type M9430 N-P-N; type M9431 P-N-P; type M9432
0 2 1 6, 24, 8, 29 0 7	6D82475B67 6D82672B46 6D82475B66 6D82672B45 6S114018	<u>RESISTOR, fixed; ±5%; 1/2 w;</u> unl stated 15.6 meg ±1% 154K ±1% 1.54 meg ±1% 15.4K ±1% 10
	6S5556 6S2003 6S2001 6S5772 6S6480	10K 3.3K 6.8K 47K 22K
	18C82567D01 6S400424 18C82676B01 6R2028 6S5726 6S3924 6S400812 18C82810C06 6S6031 6S6408 18D82515B01 6S400459	variable: 20K ±20%; 1/8 w 68 variable: 100 ±20%; 0.2 w 2.2K 15K 4.7K 470 1K ±30%; incl. S2 100K 100 1K 1.5K
34	6B83728D01	<u>THERMISTOR:</u> 1.2K ±20% @ 25°C
	40C83730D01 40A11589	<u>SWITCH,</u> rotary; 3 section; special type (spst; p/o R26) slide; spdt
	9K833983	<u>TEST POINT:</u> single contact; RED

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
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SKN6010A Power Cable Kit EPD-15283-O

P1 P2	28C82138E01	<u>CONNECTOR, plug; male;</u> 3 contact (p/o W1) 3 contact
T1		<u>TRANSFORMER, power:</u> 117 v; 50-400 cps (p/o W1)
W1	SKN6010A	<u>CABLE ASSEMBLY, power:</u> incl. P1, P2, T1 and CABLE; 2 conductor; shielded; 6 ft. long

SLN6212A Battery Kit EPD-15284-O

BT1	60B82457B01	<u>BATTERY, dry;</u> 22.5 volt
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NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
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PARTS LIST

1A Audio Oscillator Kit EPD-15282-A

7	20K848635 19C83731D01	<u>CAPACITOR, variable:</u> 3-12 uuf; NP0 2 section; consist of: 15-527.5 uuf; 350 v 15-527.5 uuf; 350 v
15, 16	23C82077C01 21B82428B01 23C82077C14 21K859937	<u>CAPACITOR, fixed:</u> 100 uf +150-10%; 35 v .02 uf +60-40%; 100 v 300 uf +150-10%; 40 v 24 uuf ±5%; 500 v (factory selected)
14	23D82601A21 23D82601A05 23C82077C05 23D82601A26 23D82601A29	100 uf +100-0%; 10 v 50 uf +150-10%; 25 v 300 uf +150-10%; 20 v 25 uf +150-10%; 20 v 60 uf +150-10%; 50 v
20	8D82905G06	0.47 uf ±10%; 50 v
21	8D82905G03	.047 uf ±10%; 50 v
2, 3, 4	48C82392B03	<u>SEMICONDUCTOR DEVICE,</u> <u>diode: (NOTE)</u> silicon
6	48C82466H03	silicon
	9B82137E01	<u>CONNECTOR, receptacle:</u> female; 3 contact
	24V80902A88	<u>REACTOR:</u> tunable
	48R869429 48R869430 48K869431 48R869432	<u>TRANSISTOR: (NOTE)</u> F. E. T.; type M9429 N-P-N; type M9430 N-P-N; type M9431 P-N-P; type M9432
	6D82475B67 6D82672B46 6D82475B66 6D82672B45 6S114018	<u>RESISTOR, fixed: ±5%; 1/2 w;</u> unl stated 15.6 meg ±1% 154K ±1% 1.54 meg ±1% 15.4K ±1% 10
0	6S5556	10K
2	6S2003	3.3K
1	6S2001	6.8K
6, 24,	6S5772	47K
8, 29	6S6480	22K
0	18C82567D01	variable: 20K ±20%; 1/8 w
7	6S400424	68
	18C82676B01	variable: 100 ±20%; 0.2 w
	6R2028	2.2K
	6S5726	15K
	6S3924	4.7K
	6S400812	470
	18C82810C06	1K ±30%; incl. S2
	6S6031	100K
	6S6408	100
34	18D82515B01	1K
	6S400459	1.5K
	6B83728D01	<u>THERMISTOR:</u> 1.2K ±20% @ 25°C
	40C83730D01	<u>SWITCH,</u> rotary; 3 section; special type (spst; p/o R26)
	40A11589	slide; spdt
	9K833983	<u>TEST POINT:</u> single contact; RED

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
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SKN6010A Power Cable Kit EPD-15283-O

P1 P2	28C82138E01	<u>CONNECTOR, plug: male;</u> 3 contact (p/o W1) 3 contact
T1		<u>TRANSFORMER, power:</u> 117 v; 50-400 cps (p/o W1)
W1	SKN6010A	<u>CABLE ASSEMBLY, power:</u> incl. P1, P2, T1 and CABLE; 2 conductor; shielded; 6 ft. long

SLN6212A Battery Kit EPD-15284-O

BT1	60B82457B01	<u>BATTERY, dry;</u> 22.5 volt
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NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

K4XL's **BAMA**

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