INSTRUCTION MANUAL

TYPE 1564-A

SOUND AND VIBRATION ANALYZER

GENERAL RADIO COMPANY

D

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SOUND AND VIBRATION ANALYZER

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GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

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SPECIFICATIONS

FREQUENCY

Range: From 2.5 cps to 25 kc in four decade ranges.
Dial Calibration: Logarithmic.
Accuracy of Calibration: ±2% of frequency-dial setting.
Filter Characteristics: Noise bandwidth is either 1/3 octave (23%) or 1/10 octave (7%).

One-third-octave characteristic has at least 30-db attenuation at one-half and twice the selected frequency (see Figure 3-3, page 23). One-tenth-octave characteristic has at least 40-db attenuation at one-half and twice the selected frequency. Ultimate attenuation is greater than 70 db for both characteristics.

For both bandwidths peak response is uniform ±1 db from 5 cps to 10 kc and ±1.5 db from 2.5 cps to 25 kc.

INPUT

Impedance: 25 megohms in parallel with 80 pf (independent of attenuator setting).
Voltage Range: 0.3 millivolt to 30 volts full scale in 10-db steps.

OUTPUT

Voltage: At least 1 volt open circuit when meter reads full scale.
Impedance: 6000 ohms. Any load can be connected.
Meter: Three scales, 0-3 volts; 0-10 volts; −6 to +10 db.
Recording Analyzer: Automatic range switching at the end of each frequency decade allows convenient continuous recording of spectra with the Type 1521 Graphic Level Recorder.

GENERAL

Amplitude Calibration: Built-in, feedback-type calibration system permits amplitude calibration at any frequency.
Detector: Quasi-rms with three averaging times. Faster two speeds conform with ASA standard for sound-level meters.
Power Requirements: Operates from 115 (or 230) volts, 50-60 cps, or from nickel-cadmium battery supplied. Battery provides 25 hours of operation when fully charged and requires 14 hours for charging.
Accessories Supplied: Type CAP-22 Power Cord, shielded cable, and Type 1564-2020 Detented Knob-and-Dial Assembly.
Accessories Available: Type 1560-P6 Microphone Assembly or Type 1560-P5 Microphone for direct acoustic pickup; Type 1560-P52 Vibration Pickup for solid-borne vibrations; Type 1560-P41 Audio-Frequency Voltage Probe for voltage measurements; Type 1560-P40 Preamplifier and accessories.
Cabinet: Flip-Tilt; relay-rack model also is available.
Dimensions: Portable model, case closed —width 10-1/4, height 8-1/8, depth 8 inches (260 by 210 by 205 mm), over-all; rack model —panel 19 by 10-1/2 inches (485 by 270 mm), depth behind panel 6 inches (155 mm).
Net Weight: Portable model, 14-1/2 pounds (7 kg); rack model, 15-1/2 pounds (7.5 kg).
Shipping Weight: Portable model, 23 pounds (10.5 kg); rack model, 30 pounds (14 kg).

U.S. Patent Nos. 3,012,197, D187,740, 2,966,257.

General Radio *Experimenter* reference: Vol. 37, Nos. 9, 10, pp. 1-9, Sept-Oct, 1963.

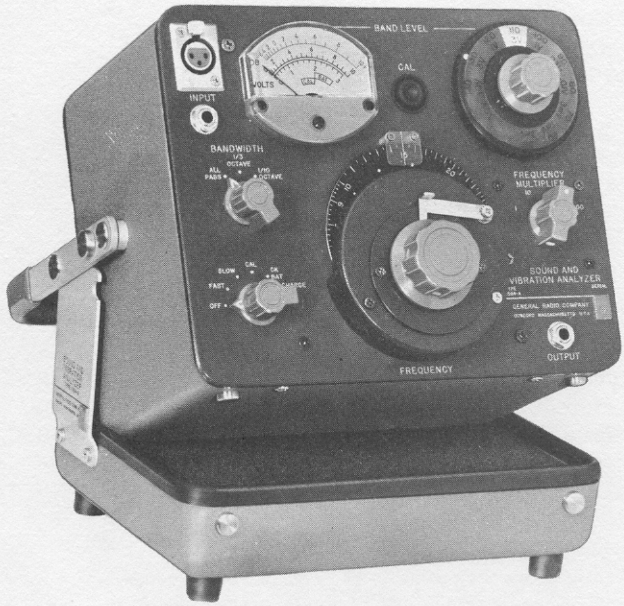
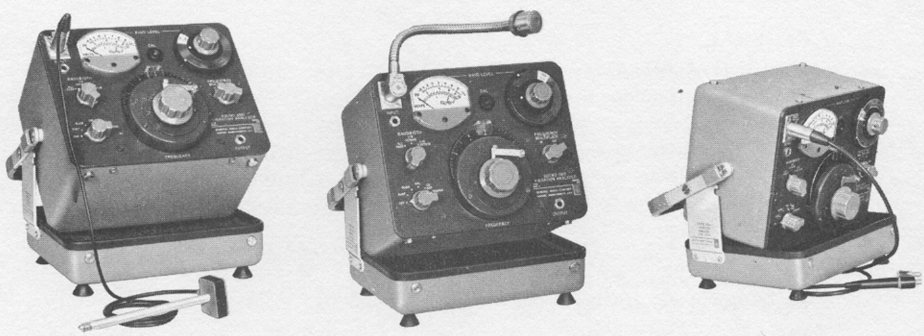
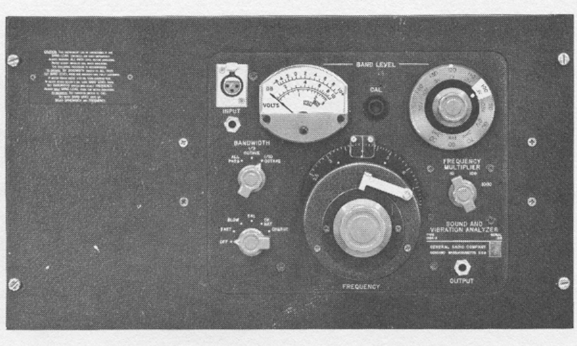


Figure 1-1. Type 1564-A Sound and Vibration Analyzer. Below are shown three views of the instrument in various positions, with some of the accessories available (see text).



Type 1564-9820 Sound and Vibration Analyzer for relay-rack mounting.



Section 1
INTRODUCTION

1.1 PURPOSE.

The Type 1564-A Sound and Vibration Analyzer, Figure 1-1, is a portable instrument for the frequency analysis of voltages having components between 2.5 cps and 25 kc. The high input impedance of the analyzer permits the direct connection of piezoelectric transducers for the analysis of high-level acoustical spectra. For low levels, the analyzer can be operated in conjunction with a sound-level meter or a vibration meter. Designed for either manual or automatic tuning, the analyzer can be used with a graphic level recorder, such as the General Radio Type 1521, to produce continuous plots of level as a function of frequency.

1.2 DESCRIPTION.

The analyzer consists of three basic sections: preamplifier, filter, and output amplifier. The preamplifier section contains the amplification and attenuation necessary to change the input signal to a level convenient for filtering. Two cascaded resonant sections are used in the filter. These are either synchronously tuned to produce a bandwidth of 1/10 octave, or frequency-staggered to give a 1/3-octave bandwidth. The output amplifier section consists of amplifiers, 10-db-step attenuators, and a meter. The signal from the filter is amplified and is then used to drive the meter and to supply an output signal to a recorder, headphones, or other device.

The analyzer is continuously tunable from 2.5 cps to 25 kc in four decade ranges. It indicates voltages between 50 μvolts and 30 volts. Used with the accessory Type 1560-P6 Microphone Assembly or Type 1560-P5 Microphone, it indicates sound-pressure levels directly, between 44 db and 150 db re 2×10^{-4} μbar. With an accessory vibration pickup, Type 1560-P52, the analyzer measures acceleration from .0007 to 100 g.

Power for the analyzer is supplied by a 115- or 230-volt, 50- to 60-cycle line or by an internal, rechargeable, nickel-cadmium battery.

Both portable (Type 1564-A) and relay-rack-adapted (Type 1564-9820) models of the analyzer are available (see Figure 1-1).

The Type 1911-A Recording Sound and Vibration Analyzer, consisting of the Type 1564-A Sound and Vibration Analyzer and the Type 1521-B Graphic Level Recorder, with accessories, is also available.

1.3 CONTROLS AND CONNECTORS.

The following controls and connectors are on the Sound and Vibration Analyzer:

NAME	TYPE	FUNCTION
BAND LEVEL (Gray knob)	6-position rotary switch	Adjusts gain of output amplifier in 10-db steps and indicates meter range.
BAND LEVEL (Knurled dial)	6-position rotary switch	Adjusts level of input to filter in 10-db steps and indicates meter range.
FREQUENCY	Continuous rotary control and dial	Adjusts and indicates the geometric center frequency of the filter.
FREQUENCY MULTIPLIER	8-position rotary switch	Selects the frequency range and indicates the frequency multiplier.
None (Detent arm)	Nickel-plated arm, with finger	Engages detent at ASA-preferred frequencies.
BANDWIDTH	3-position rotary switch	Selects filter bandwidth.
None (Function switch)	6-position rotary switch	Turns instrument on and OFF. Selects meter speed and mode of operation (CAL, CK BAT, or CHARGE).
CAL	Rotary thumbset control	Adjusts gain for calibration.
INPUT	Three-terminal Cannon Type XLR locking socket paralleled by phone jack	Input connectors for either standard microphone plug or phone plug.
OUTPUT	Phone jack	Supplies 1 volt open circuit for full-scale meter indication (6000 ohms output impedance).
Power cord receptacle 115 v, 50-60 cps	3-terminal male connector	Input connector for line voltage, to operate instrument or charge battery.

1.4 CARRYING CASE.

The portable model of the analyzer is mounted in a Flip-Tilt case. The captive, protective cover serves as a mounting base when the instrument is in use. The friction of the rubber seal keeps the instrument at any convenient angle, from horizontal to vertical. Accessories, such as the Type 1560-P52 Vibration Pickup or the Type 1560-P41 Audio Frequency Voltage Probe, can be stored in the polyurethane compartment in the cover.

1.5 ACCESSORIES SUPPLIED.

The following accessories are supplied with the Type 1564-A Sound and Vibration Analyzer:

1 Type 1560-P76 Cable Assembly to connect to the output of a sound-level meter or vibration meter;

1 Type 1564-2020 Detented Knob-and-Dial Assembly, for use when the Type 1564-A Sound and Vibration Analyzer is used with the Type 1551-C Sound-Level Meter or with the Type 1553-A Vibration Meter.

1 Type CAP-22 Power Cord.

1.6 ACCESSORIES AVAILABLE.

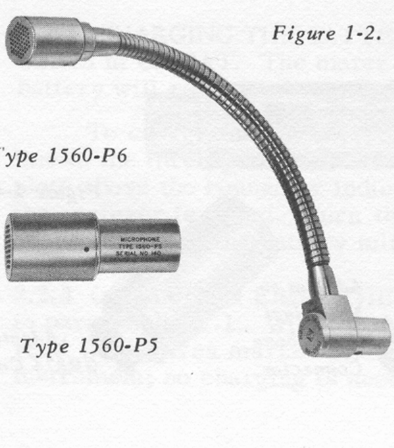
1.6.1 TYPES 1560-P5 MICROPHONE AND 1560-P6 MICROPHONE ASSEMBLY (Figure 1-2). The Type 1560-P5 Microphone is a piezoelectric ceramic unit, mounted on a standard Cannon-type male connector. It can be plugged directly into the analyzer, or it can be connected to it by means of a length of shielded cable.

The Type 1560-P6 Microphone Assembly uses the same cartridge attached to a short length of flexible conduit. The assembly plugs directly into the INPUT connector on the panel of the analyzer.

Complete specifications for the Types 1560-P5 and 1560-P6 Microphones are given in the Appendix.

1.6.2 VIBRATION PICKUP SYSTEMS. Three vibration pickup systems are available; they differ in frequency range, sensitivity and impedance. Specifications for each of these systems (Types 1560-P11B, 1560-P13, and 1560-P14) are given in the Appendix.

1.6.3 TYPE 1560-P41 AUDIO FREQUENCY VOLTAGE PROBE. The Type 1560-P41 Audio-Frequency Voltage Probe is designed to permit voltage measurements on high-impedance circuits at a distance of about four feet from the analyzer. It consists of a 10-to-1, resistance-capacitance voltage divider enclosed in an insulated aluminum casing. A shielded cable from the divider terminates in a microphone connector that mates with the connector on the panel of the analyzer. Figure 1-3 shows the probe and the various tips that are supplied with it. The input impedance of the probe is 25 megohms in parallel with 20 pf, when the probe is connected to the analyzer. The probe attenuates the applied signal by 20 db. Therefore, the indicated voltage must be multiplied by ten.



Type 1560-P6

Type 1560-P5

Figure 1-2.

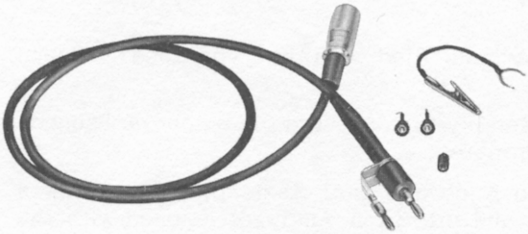


Figure 1-3. Type 1560-P41 Audio-Frequency Voltage Probe is supplied with a variety of probe tips.

1.6.4 TYPE 1560-P40 PREAMPLIFIER. The Type 1560-P40 Preamplifier (Figure 1-4) is a high-input-impedance, low-noise preamplifier. It is particularly well suited for amplifying the output of piezoelectric transducers such as microphones and vibration pickups, and for driving long connecting cables without loss in signal voltage. A switch on the preamplifier provides a voltage gain of either 1:1 or 10:1.

Complete specifications are given in the Appendix.

The amplifier is housed in a small cylindrical case. The Type 1560-P5 Microphone cartridge plugs directly on to the input end of the case. Adaptors are available for connecting the preamplifier to the cartridge of the Type 1560-P3 Microphone, to GR874 Connectors, and to 3-terminal microphone connectors. Output from the preamplifier is through a 3-terminal shielded connector. The required dc supply voltage is applied from one of these terminals to ground. This voltage can be obtained directly from the Type 1564-A Analyzer.

The preamplifier and accessories are available in various combinations (refer to the Appendix).

The Type 1560-P40H Preamplifier and Power Supply Set is self-powered and independent of any external supply.

The Type 1560-P40J Preamplifier and Adaptor Set is dependent for its power on the instrument to which it is connected, so that it should be used with the Type 1558 or 1564 Analyzer.

The Type 1560-P40K Preamplifier and Microphone Set is for use with the Types 1558 and 1564 Analyzers when an acoustical measurement is needed at low levels and the microphone must be mounted at the end of a cable.

Type 1560-P40

Figure 1-4.

Microphone Cartridge

Adaptor to 3-terminal Microphone Connector

Adaptor to GR874 Connector

Section 2

OPERATING PROCEDURE

2.1 OPENING THE FLIP-TILT CASE.

Directions for opening the Type 1564-A Sound and Vibration Analyzer are given on the handle of the Flip-Tilt case. Once open, the instrument can be tilted to any convenient angle, as shown in Figure 1-1. The instrument should be placed to give the most convenient access to the knobs and the best view of both the panel control settings and the meter indication.

The case can be locked fully open by means of the same slide pins that are used to lock it when it is closed. It can be carried in the open position, with the cover firmly in place.

2.2 POWER SUPPLY.

2.2.1 GENERAL. The Type 1564-A Sound and Vibration Analyzer can be operated from a 115-volt, 50- to 60-cycle line, from a 230-volt, 50- to 60-cycle line, or from its self-contained, rechargeable, nickel-cadmium battery. Normally supplied for 115-volt operation and charging, it is easily converted for use on a 230-volt line by changing the connections to the power transformer, as shown on the schematic diagram, Figure 4-2.

2.2.2 CHARGING THE BATTERY. To check the battery, turn the function switch to CK BAT. The meter should read in the area marked BAT. The battery will require charging after about 25 hours of operation.

To charge the battery, connect the Type CAP-22 Power Cord from the line to the three-prong connector on the right side of the case. The nameplate above the connector indicates the line voltage and frequency for which the analyzer is wired. Turn the function switch to CHARGE, and allow 14 hours to charge the battery fully.

2.2.3 OPERATION FROM THE LINE. Connect the analyzer to the line as in paragraph 2.2.1. With the function switch at CK BAT, the meter should read in the area marked BAT. The line now supplies power to operate the instrument; no charging is necessary.

CAUTION

The function switch must be used to turn off the instrument. Do not disconnect the line by external means only. If this is done, the instrument will continue to operate with battery power. Then it may be necessary to charge the battery for an hour or more before line operation can be resumed.

2.3 CALIBRATION.

The analyzer contains a built-in reference for gain calibration. The reference can be adjusted by means of an internal control (see Figure 2-1) which can be set in one of three ways, depending upon whether the analyzer is to be used with a microphone, with a vibration pickup, or as a voltmeter. The outer scale of this control is calibrated in db re 1 volt/μbar microphone sensitivity. Set this scale to indicate the sensitivity of the piezoelectric microphone to be used. The control is set in the General Radio laboratory to match the sensitivity of the microphone, if one is supplied with the analyzer. If the microphone is not ordered with the instrument, the control is set to the REF line. This setting is for operation with a Type 1560-P52 Vibration Pickup or for use as a voltmeter, with or without the probe. The instrument can be made direct-reading in open-circuit volts for low-capacitance piezoelectric accelerometers by setting the dial to the engraved dot that corresponds to the capacitance of the accelerometer. These dots, engraved 8, 4, and 2, Figure 2-2, correspond to capacitance values of 800, 400, and 200 pf, respectively. The REF position on the dial is used for capacitance values above 4000 pf.

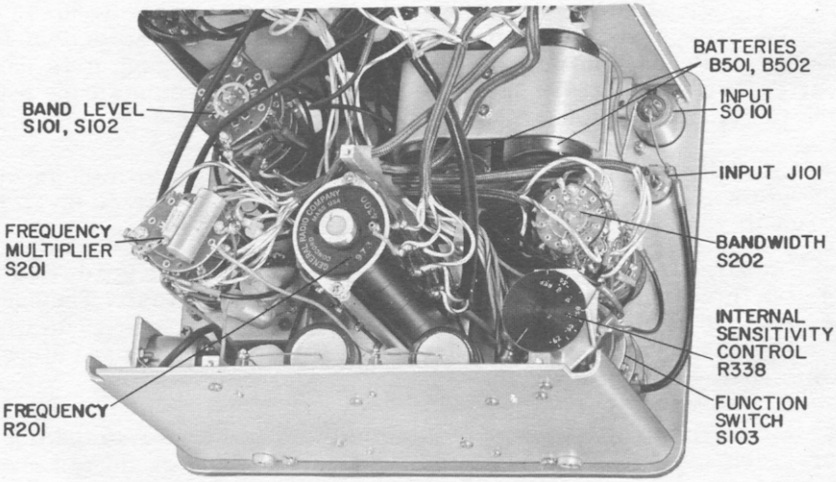


Figure 2-1. Interior view of analyzer.

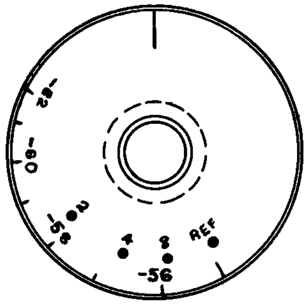


Figure 2-2. Dial for internal gain-calibration control.

2.4 OPERATION WITH TYPE 1560-P5 MICROPHONE OR TYPE 1560-P6 MICROPHONE ASSEMBLY.

2.4.1 CALIBRATION. Make the following check on the amplifier gain before using the analyzer. This check is valid only when the internal calibration control is set according to the instructions in paragraph 2.3.

a. Set the BANDWIDTH switch to ALL PASS.

b. Set the white dots on both BAND LEVEL controls (knob and dial) at the top (12 o'clock).

c. Turn the function switch to CAL and allow 30 seconds for the instrument to stabilize.

The meter should now indicate in the area marked CAL. If it does not, adjust it by means of the panel thumbset control marked CAL.

The analyzer is now calibrated for direct reading in db re 2×10^{-4} μbar, rms sound-pressure level. For some critical applications, this calibration can be repeated in a 1/3- or 1/10-octave band, at any selected frequency up to 10 kc.

NOTE

The calibration system is such that, with the function switch at CAL, a gain variation, as indicated by the meter, is ten times the actual gain variation. Therefore, when the analyzer is switched from ALL PASS to 1/3 OCTAVE or to 1/10 OCTAVE, the meter may indicate outside the CAL area. Also, tuning the analyzer in the CAL mode may cause the meter to vary over its entire scale, indicating a gain variation of about 1.5 db.

2.4.2 MEASUREMENT PROCEDURE.

a. Connect the microphone to the panel INPUT connector. Detents are provided in the connector of the Type 1560-P6 Microphone Assembly to hold it in place. The latter connector can be turned through 180°.

b. Turn both BAND LEVEL controls fully clockwise.

c. Set the BANDWIDTH switch to ALL PASS.

d. Set the function switch for the desired meter response, FAST or SLOW (refer to paragraph 2.17). Allow 30 seconds for the instrument to stabilize.

e. If the meter indicates above +10 db, turn the BAND LEVEL knurled dial to obtain an on-scale meter reading. If the meter indicates below -6 db, adjust the BAND LEVEL gray knob until a meter indication above this value is obtained. The ALL-PASS sound-pressure level, in db re 2×10^{-4} μbar, is the algebraic sum of the readings on the outer, red scales of both the meter and the BAND LEVEL indicator.

f. Select the desired BANDWIDTH and FREQUENCY. A detent arm, located above the FREQUENCY knob, can be engaged to provide detents at the ASA-preferred frequencies (indicated on the tuning dial by white dots). To engage the arm, loosen the thumbscrew that fastens it to the panel. Slide the arm toward the knob by means of its protruding finger; then rotate the knob until the arm drops into its slot and tighten the thumbscrew.

The detent can be adjusted so that it selects any desired series of frequencies that are separated by 1/3 octave. First, engage the detent arm; then push the FREQUENCY knob toward the top of the instrument as far as it will go. Hold the knob in this position and turn the dial to any frequency in the desired series. Then release the knob.

g. Adjust the BAND LEVEL gray knob to obtain an on-scale meter deflection. The sound-pressure level in the band selected, in db re 2×10^{-4} μbar, is the algebraic sum of the meter and BAND LEVEL indicator readings. Special chart paper for plotting 1/3-octave band levels is available from Codex Book Company, Inc., Norwood, Massachusetts (Codex #31,462).

CAUTION

Improper use of the BAND LEVEL controls can overload the preamplifier and introduce errors. Always measure the ALL PASS level before analyzing. Never readjust the BAND LEVEL dial when you are analyzing. The procedure given in paragraph 2.4.2 ensures that the preamplifier is not overloaded and it allows the entire potential analyzing range of the instrument to be realized.

2.5 USE OF THE TYPE 1552-B SOUND-LEVEL CALIBRATOR.

The calibrator of the Type 1564-A Sound and Vibration Analyzer does not check the microphone. For a calibration of the microphone-analyzer combination, the Type 1552-B Sound-Level Calibrator is recommended. This calibrator includes a closed coupler and a driving loudspeaker, which produce a known sound-pressure level at the microphone. (Refer to the Operating Instructions for the calibrator.)

2.6 EFFECT OF PRESENCE OF OBSERVER AND INSTRUMENT CASE.

Except in reverberant fields, the presence of the observer and the instrument case can disturb the sound field and introduce significant errors[1]. To minimize this effect when the Type 1560-P6 Microphone Assembly is used, adjust the gooseneck assembly so that the microphone is located as far as possible from the observer and the instrument. The observer should stand with the analyzer in front of him, and with the sound source at his side. For greatest accuracy, mount the microphone (Type 1560-P5 or -P6) on a tripod and connect it to the analyzer by means of an extension cable. The observer and the instrument are thus removed from the sound field. Place the microphone so that the angle of sound incidence is 70° with respect to the microphone axis. This gives a response that corresponds to the random-incidence response.

2.7 OPERATION WITH TYPE 1560-P52 VIBRATION PICKUP.

2.7.1 CALIBRATION. To calibrate the analyzer for use with the Type 1560-P52 Vibration Pickup, set the internal calibration control of the analyzer to REF and proceed as in paragraph 2.4.1. The analyzer is now set to indicate the rms value of the open-circuit pickup voltage.

2.7.2 PLACEMENT OF PICKUP. The design of the pickup enables it to be held in place against the vibrating object in any of several different ways. The preferred method is to attach it rigidly to the object with screws through the holes provided in the pickup or with a single screw threaded into the tapped center hole (1/4 - 28). Or the General Radio Type 1560-P35 Permanent-Magnet Clamp can be used. This is a disk-shaped magnet with a captive screw that can be threaded into the tapped center hole in the pickup.

If the vibrating object is flat and the level of vibration is low, the pickup can simply rest on the object.

For hand-held operation, either the round or the conical tip (both supplied with the pickup) can be used. These tips screw directly into the pickup or into the end of the six-inch probe which, in turn, screws directly into the pickup. Grasp the pickup (not the probe), and press it against the vibrating object only hard enough to prevent chatter. Hand-held operation is convenient and is recommended for exploratory measurements. However, the pickup should be firmly attached to the vibrating object if accurate results are desired.

2.7.3 MEASUREMENT PROCEDURE. Follow the instructions given in paragraph 2.4.2, steps b through g, but read the black, VOLTS, meter scale that corresponds to the setting of the BAND LEVEL control. The fullscale voltage sensitivity of the analyzer is indicated by the reading of the inner, black scale of the BAND LEVEL control. To convert the indicated voltage to acceleration in g's or inches/sec^2, divide by the sensitivity of the pickup in v/g or v/inch/sec^2, respectively. (Note: g = 386 inches/sec^2.)

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[1] R. W. Young, "Can Accurate Measurements be Made with a Sound-Level Meter Held in Hand?" SOUND, 1, 1, 17-24, January-February, 1962.

2.8 USE WITH TYPE 1557-A VIBRATION CALIBRATOR.

The Type 1557-A Vibration Calibrator can be used to obtain an overall amplitude calibration at 100 cps. The calibrator is a self-contained electromechanical shaker that produces an acceleration of one g, rms, at a frequency of 100 cps with loads ranging from zero to 300 grams. The Type 1564-A Sound and Vibration Analyzer should indicate the sensitivity of the pickup being used multiplied by g. For example, for a 75 mv/g pickup, the analyzer should indicate 75 mv/g x g = 75 mv. If it does not, use the level indicated when converting from volts to g's. That is, if the analyzer indicates 60 mv, the sensitivity of the system (pickup and analyzer) is 60 mv/g. If a measurement shows a level of 1 volt, the corresponding acceleration is

$$\frac{1000 \text{ mv}}{60 \text{ mv/g}} = 16.7 \text{ g, rms}$$

2.9 DETERMINATION OF VELOCITY AND DISPLACEMENT FROM ACCELERATION MEASUREMENTS.

The following equations can be used to determine the rms velocity, displacement, and jerk of a given frequency component in a vibration spectrum when its rms acceleration and frequency are known:

$$v = \frac{a}{2\pi f} \qquad D = \frac{a}{4\pi^2 f^2} \qquad J = 2\pi f a$$

where
- a = acceleration in inches/sec^2
- v = velocity in inches/sec
- D = displacement in inches
- J = jerk in inches/sec^3
- f = frequency of component (frequency indicated by analyzer)
- π = 3.14

The above equations are precise when used for a line (single-frequency) component; they give only approximate results for random signals.

2.10 USE WITH A STROBOSCOPE.

The Type 1564-A Sound and Vibration Analyzer can be used to trigger a stroboscope, such as the Type 1531-A Strobotac® electronic stroboscope. The analyzer is first tuned to a particular component in the vibration spectrum and the stroboscope is then synchronized with that component. The output amplifier is overdriven so that the output waveform has sharp transitions. In this way, jitter caused by variations in acceleration amplitude is minimized.

To overdrive the output amplifier, first obtain an on-scale deflection of the meter, as described in paragraph 2.7.3. Then turn the BAND LEVEL knob to its maximum counterclockwise position. Do not change the setting of the BAND LEVEL knurled dial to increase the output, as this will overload the filter and render it ineffective.

2.11 OPERATION AS A TUNED VOLTMETER.

To calibrate the analyzer for use as a tuned voltmeter, follow the procedure given in paragraph 2.7.1 for use with the Type 1560-P52 Vibration Pickup. Thus calibrated, the analyzer indicates the level of the voltage applied at its INPUT terminals. When used with the Type 1560-P41 Audio-Frequency Voltage Probe, the analyzer indicates one tenth of the level applied at the probe. Proceed as in paragraph 2.4.2, except read the lower (black) meter scales. The inner (black) scale of the BAND LEVEL control indicates full-scale voltage sensitivity. Note that when the probe is used, indicated voltages must be multiplied by ten.

2.12 OPERATION WITH A SOUND-LEVEL METER.

2.12.1 GENERAL. A sound-level meter (such as the General Radio Type 1551-C) can be used ahead of the analyzer for band levels less than 44 db, sound-pressure level. Absolute band levels can be read directly from the analyzer when the Type 1564-2020 Detented Knob-and-Dial Assembly (supplied) is used.

2.12.2 CALIBRATION. The following procedure applies specifically to General Radio sound-level meters, but others can be used.

a. Remove the BAND LEVEL gray-knob-and-plastic-dial assembly; loosen the two setscrews that fasten it to the shaft and slide it off. Substitute the detented knob-and-dial assembly. One of the two setscrews in the latter secures the knob to the plastic dial and should not be loosened. Fasten the assembly to the shaft by means of the other setscrew.

To properly reset the original gray-knob-and-plastic-dial assembly, turn both coaxial shafts fully clockwise and set the assembly to read $\frac{100}{.1v}$.

b. Connect the sound-level meter to the INPUT jack of the analyzer; use the Type 1560-P76 Shielded Cable Assembly (supplied).

c. Set the BANDWIDTH switch to ALL PASS, the BAND LEVEL gray knob fully clockwise, and the function switch to FAST.

d. Calibrate the sound-level meter according to the instructions for that particular model, or use a Type 1552-B Sound-Level Calibrator. A calibration signal from the sound-level meter is now being applied to the analyzer.

e. Adjust the BAND LEVEL knurled dial and then the CAL thumbset control on the analyzer so that its meter indication is the same as that of the sound-level meter. The analyzer is now adjusted to indicate rms sound-pressure level in db re 2×10^{-4} μbar in conjunction with the sound-level meter. Do not readjust the BAND LEVEL knurled dial during the balance of the procedure.

2.12.3 OPERATION.

a. Set the BANDWIDTH control to ALL PASS and turn the BAND LEVEL gray knob fully clockwise, as in paragraph 2.12.2. Obtain an on-scale deflection of the sound-level meter with its weighting switch at 20 KC, and turn the clear-plastic BAND LEVEL dial in a clockwise direction until the BAND LEVEL indication (outer red scale) is the same as the attenuator setting on the sound-level meter. Both instruments now indicate the ALL PASS level.

b. Select the desired bandwidth and frequency, and adjust the BAND LEVEL gray knob for an on-scale meter deflection. The algebraic sum of the BAND LEVEL and meter indications is the level in the selected band in db re 2×10^{-4} μbar.

2.13 OPERATION WITH A VIBRATION METER.

2.13.1 GENERAL. For direct reading of velocity, displacement, or jerk, or when band levels are less than 0.0007 g (0.270 inches/sec^2), a vibration meter such as the Type 1553-A can be used. The inner scale of the detented knob-and-dial assembly and the two lower meter scales can be used to read directly acceleration, velocity, displacement and jerk.

2.13.2 CALIBRATION. The following procedure applies specifically to the Type 1553-A Vibration Meter. For other types, the procedure is similar.

a. The output impedance of the Type 1553-A Vibration Meter is 75 kilohms. When this impedance is loaded with the capacitance of the connecting cable and analyzer, a substantial high-frequency roll-off results. If frequencies above 1 kc are of no interest (for example, when a Type 1560-P52 Vibration Pickup is used) this error is of no consequence. With a wide-range pickup, such as the Type 1560-P53, connect a 10- to 20-kilohm resistor across the output of the vibration meter. This is done most conveniently inside the vibration meter. Remove the case and locate the 20-kilohm resistor that is wired to the output jack. Disconnect the end of this resistor that is wired to the center terminal of the jack and transfer it to the jack terminal to which the center conductor of a shielded cable is wired.

b. Remove the BAND LEVEL gray-knob-and-plastic-dial assembly; loosen the two setscrews that fasten it to the shaft and slide it off. Substitute the detented knob-and-dial assembly. One of the setscrews in the latter secures the knob to the plastic dial and should not be loosened. Fasten the assembly to the shaft by means of the other setscrew.

To properly reset the original gray-knob-and-plastic-dial assembly, turn both coaxial shafts fully clockwise and set the assembly to read $\frac{100}{.1v}$.

c. Connect the output of the vibration meter to the INPUT of the analyzer; use the Type 1560-P76 Shielded-Cable Assembly (supplied).

d. Set the BANDWIDTH switch to ALL PASS, the BAND LEVEL gray knob fully clockwise, and the function switch to FAST.

e. Calibrate the vibration meter according to its instructions or use a Type 1557-A Vibration Calibrator. A signal from the vibration meter is now applied to the analyzer.

f. Adjust the BAND LEVEL knurled dial and then the CAL control to obtain a meter indication on the analyzer that is 11% higher* than the meter indication of the vibration meter. For example, if the vibration meter indicates 8 on the upper scale, set the analyzer to indicate 8 + (0.11 x 8) = 8.9 on its upper scale. The combination is now calibrated to allow the analyzer to indicate rms band levels in the units given by the vibration meter when its METER READS switch is set to AVE. Do not readjust the BAND LEVEL knurled dial during the balance of the procedure.

2.13.3 OPERATION.

a. Fasten the vibration pickup rigidly to the vibrating object (refer to Type 1553-A instructions or paragraph 2.7 in this book for methods of fastening the pickup).

b. Set the METER READS switch to PK TO PK. Select the desired vibration quantity (DISP, VEL, ACCEL, or JERK) with the vibration meter FUNCTION switch. Adjust the SCALE SELECTOR switch for an indication on the vibration meter that is as near full-scale (but not over full-scale) as possible. The vibration meter now indicates the peak-to-peak level of the vibration quantity given by its FUNCTION switch. Do not readjust the SCALE SELECTOR switch during the balance of the procedure. Now, set the METER READS switch to AVE.

c. With the controls of the analyzer set as in paragraph 2.13.2, observe the reading in the FULL SCALE window of the vibration meter. Turn the clear-plastic BAND LEVEL dial on the analyzer in a clockwise direction to obtain this same reading (inner black scale). The vibration meter now indicates the average level of the over-all signal, while the analyzer indicates its rms level.

d. Select the desired analyzer BANDWIDTH and frequency. Adjust only the BAND LEVEL gray knob for an on-scale meter indication. The rms level in the band selected is read on the meter with the full-scale meter range indicated by the BAND LEVEL dial (inner black scale). The units of the vibration quantity appear in the window adjacent to the FULL SCALE window on the vibration meter.

2.14 OPERATION WITH THE TYPE 1560-P40 PREAMPLIFIER.

Use of the Type 1560-P40 Preamplifier increases the sensitivity to 24 db sound-pressure level and permits remote use of the microphone. (Refer to the Appendix for specifications.) The extremely high input impedance of the preamplifier extends the low frequency range when a low-capacitance pickup such as the Type 1560-P53 is used. The analyzer supplies power for the preamplifier through terminal #2 of the INPUT socket.

*The vibration meter indicates average level; the analyzer indicates rms level. These levels differ by 11% for the sinusoidal calibration signal.

Plug the preamplifier and microphone combination directly into the INPUT socket, or make the connection by means of a two-conductor shielded cable of convenient length. (Cables are supplied with the Type 1560-P40K Preamplifier and Microphone Set; they may also be purchased separately.) Set the gain switch on the preamplifier to X1 or X10, as desired. After calibration, the analyzer is direct reading with the gain switch at X1. When the switch is at X10, subtract 20 db from the indication of the analyzer to obtain the actual sound-pressure level.

When the microphone and preamplifier are used with the Type 1564-A Sound and Vibration Analyzer, the effective microphone sensitivity is increased. This increase occurs because the voltage loss caused by the preamplifier input-capacitance load on the microphone is less than that caused by the input-capacitance load of the analyzer. Also, when a cartridge from a Type 1560-P4 or -P6 Microphone is used, the loss due to the flexible arm is not present. (The sensitivity given for a Type 1560-P4 or -P6 Microphone is for the combination of the cartridge and the flexible arm.) The Type 1552-B Sound-Level Calibrator is recommended for calibrating analyzer-preamplifier combination. However, the electrical calibrator in the Type 1564-A can be used if the internal sensitivity control, R338, is set properly. When the microphone cartridge is supplied with the Type 1560-P40 Preamplifier, or when it is removed from a Type 1560-P3 or -P5 Microphone for use with the preamplifier, set the sensitivity control to indicate 1.4 db greater than the specified sensitivity for the microphone. For example, if the sensitivity of the microphone or cartridge is -61 db, set the internal sensitivity control to -59.6 db (-61 + 1.4 db). When the microphone cartridge is removed from a Type 1560-P4 or -P6 Microphone Assembly to be used with the preamplifier, set the sensitivity control to indicate 2.1 db greater sensitivity than that specified.

2.15 BACKGROUND LEVEL.

Keep the background level as low as possible for all measurements. In any band, the level should be at least 10 db below the total measured level for that band. When this is impossible, apply the corrections given in Figure 2-3.

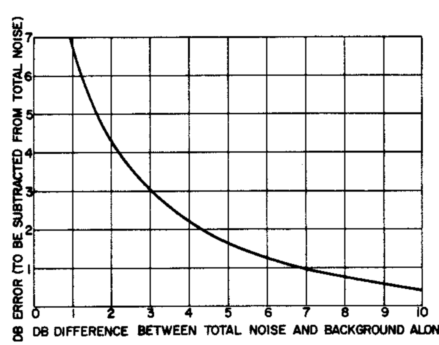


Figure 2-3. Effect of background noise on measurements.

2.16 CHOICE OF METER SPEEDS.

The averaging time of the meter depends on the settings of the BANDWIDTH and FREQUENCY MULTIPLIER controls, as well as on the setting of the function switch (FAST or SLOW). Three different detector characteristics are provided. In general, use the FAST position for measurements

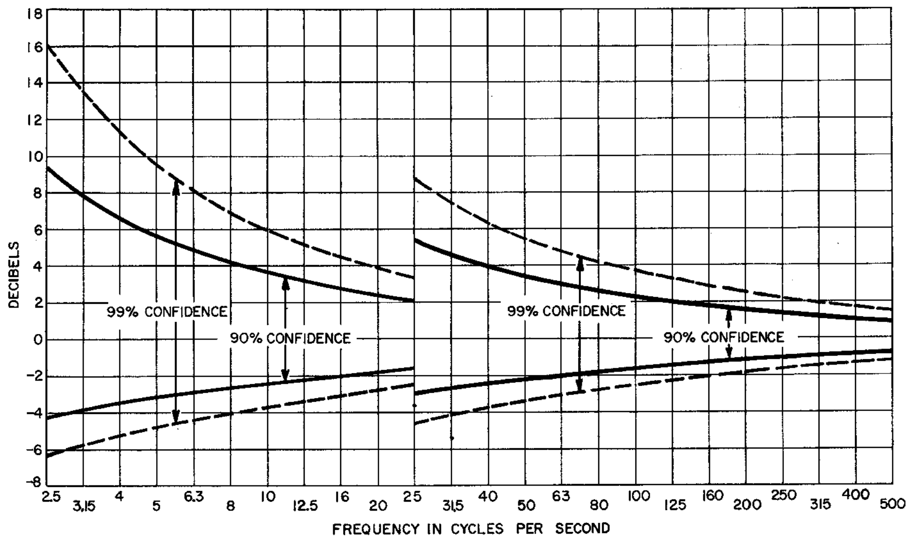


Figure 2-4, a. Confidence curves for 1/10-octave bandwidth with function switch at SLOW.

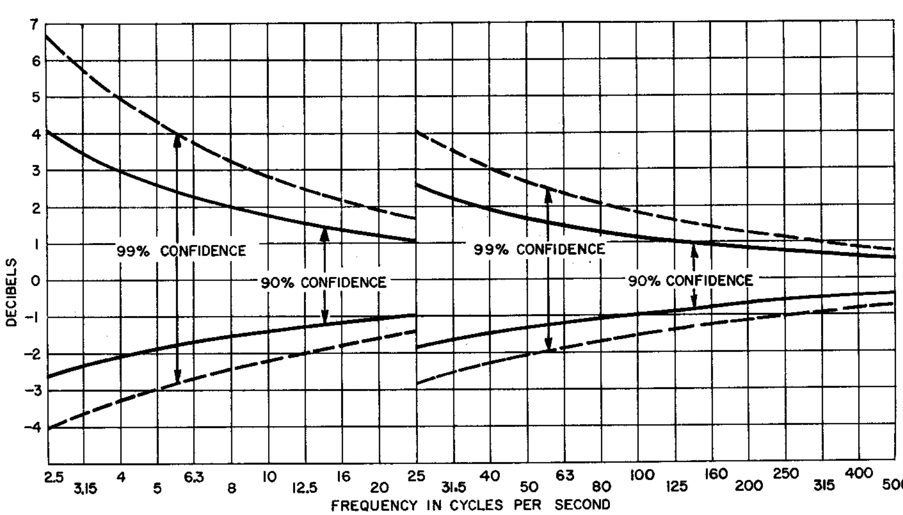


Figure 2-4, b. Confidence curves for 1/3-octave bandwidth with function switch at SLOW.

TABLE 2.

METER SPEEDS OBTAINABLE WITH VARIOUS SETTINGS OF THE FREQUENCY MULTIPLIER (See Text)

FREQUENCY MULTIPLIER SETTING	SPEED RANGE (FUNCTION SWITCH)	
	FAST	SLOW
1	2	3
10	1	2
100	1	2
1000	1	2

on line spectra, and the SLOW position for measurements involving random signals, except possibly in the 2.5- to 25-kc range. Table 2 gives the speeds obtainable with various settings of the FREQUENCY MULTIPLIER switch when the function switch is at FAST or SLOW. The values in the table apply for BANDWIDTH switch settings of 1/3 or 1/10 octave. The speeds are numbered; 1 is the fastest speed and 3 is the slowest. Speeds 1 and 2 are designated *fast* and *slow*, respectively, by the American Standards Association Specification S1.4-1961 for General Purpose Sound Level Meters. Speed 1 has the symmetrical rise-and-fall characteristics of the meter movement. The characteristics for speeds 2 and 3 are those of simple resistance-capacitance networks. For speed 2, the rise- and fall-time constants are 0.4 and 1.2 seconds, respectively; for speed 3, they are 2 and 6 seconds.

With the BANDWIDTH switch set to ALL PASS, the speeds corresponding to the FAST and SLOW positions of the function switch are 1 and 2, respectively.

Figure 2-4 can be used to determine the probable error in a given meter indication when the reading fluctuates, as it does for a random signal. The curves apply only when the function switch is set to SLOW. From the curves labelled 90% CONFIDENCE, we find that there is one chance in ten that the long-time rms level (which would be indicated if the meter did not fluctuate) is below the observed level by more than the number of decibels at the lower limit, or is above the observed level by more than the number of decibels at the upper limit. For example, assume that a random signal produces fluctuations of the meter, with the function switch at SLOW, the BANDWIDTH switch at 1/10 OCTAVE, and the analyzer tuned to 5 cps. Suppose the meter indicates a level of +4 db. Then, for a 1/10-octave band centered at 5 cps, there is one chance in ten that the long-time level is more than +9.7 db or less than +0.8 db.

The 99% CONFIDENCE curve can be used similarly to find the levels that will be exceeded only one percent of the time.

To determine, with greater confidence, the level of a fluctuation signal, a number of readings are taken at intervals of several detector time constants. These readings are then averaged. Confidence limits, in this case, can be determined by dividing the limits for a single reading by the square root of the number of readings taken.

2.17 ALL-PASS FREQUENCY RESPONSE AND EFFECTS OF MICROPHONE AND VIBRATION PICKUP.

The all-pass frequency response of the Type 1564-A Sound and Vibration analyzer for a constant applied voltage contains a slight roll-off at the frequency extremes when the function switch is set to SLOW (See Figure 2-5). In addition, when the function switch is set to FAST, the detector characteristic becomes average for frequencies below 25 cps, resulting in a 1-db step in the response curve, as shown. Neither this low-frequency step nor the high-frequency roll-off are cascaded with the filter when 1/3- or 1/10-octave bandwidths are selected.

Figure 2-5 also gives the responses of the analyzer-microphone and analyzer-pickup combinations. In each case the low-frequency roll-off is due to the loading of the capacitive impedance of the transducer by the 25-megohm input resistance of the analyzer. Deviations at high frequencies are characteristic of the transducers. Both of these response curves may be considered to cascade with the 1/3- and 1/10-octave filter characteristics.

2.18 OPERATION WITH TYPE 1521 GRAPHIC LEVEL RECORDER.

2.18.1 GENERAL. The analyzer contains an automatic range-changing device that permits continuous amplitude-versus-frequency recordings when it is used with a Type 1521-A or -B Graphic Level Recorder. These two

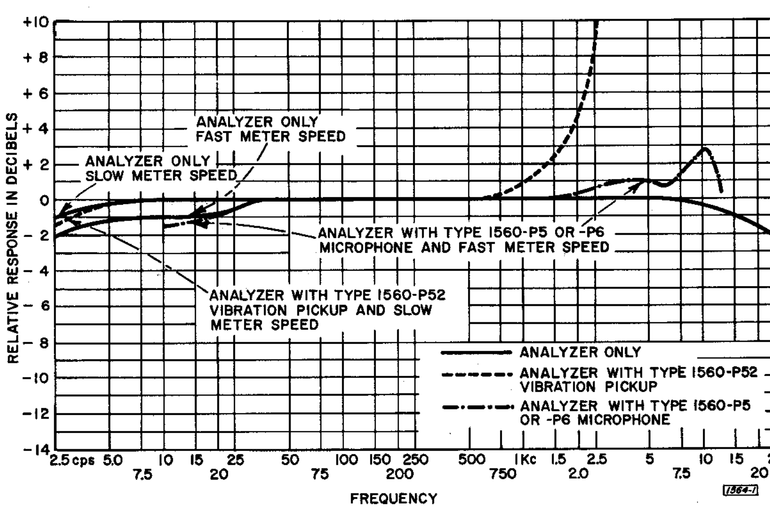


Figure 2-5. Curves of frequency response for constant applied voltage.

models differ primarily in frequency range. The Type 1521-A can be used down to 20 cps; the -B model is usable to 7 cps or lower, if a correction is applied. Two chart papers, differing in length and in scale factor (the product of db/inch on the vertical scale and inches/decade on the horizontal scale, expressed in db/decade), are available for use with either recorder. The Type 1521-9469 chart paper has a length of five inches/decade resulting in a scale factor of 50 db/decade (a proposed international standard) when the 40-db recorder potentiometer (normally supplied) is used. The Type 1521-9493 chart paper has a length of 7.5 inches/decade and a scale factor of 75 db/decade with the 40-db potentiometer. A Type 1521-P10B Drive Unit and a Type 1521-P15 Link Unit are required to couple the analyzer to the recorder. In addition, when Type 1521-9469 chart paper is used, the 24-tooth sprocket normally supplied with the Type 1521-P15 Link Unit must be replaced with a 16-tooth sprocket. The latter is available as part of the Type 1521-P16 Sprocket Kit.

The Type 1521-P2, 40-db Potentiometer is supplied with the recorder; Types 1521-P1 and -P3 potentiometers are also available for amplitude ranges of 20 db and 80 db, respectively.

Three different motors are available for the recorder, to permit various sweep rates. The medium-speed motor, Type 1521-P23 (Type 1521-P24 for 50-cycle operation), is recommended for general use with the Type 1564-A Sound and Vibration Analyzer, but the fast-speed motor, Type 1521-P19 (Type 1521-P21B for 50-cycle operation), can be used. Table 3 gives the possible recorder chart speeds and analyzer sweep speeds for each motor, with either a 24- or a 16-tooth sprocket.

The completely-assembled analyzer-and-recorder combination is available as the Type 1911-A Recording Sound and Vibration Analyzer. This assembly includes the following items:

1—Type 1564-9820 Sound and Vibration Analyzer (rack model).
1—Type 1521-B Graphic Level Recorder, with medium-speed motor.

TABLE 3.

RECORDER CHART SPEEDS AND CORRESPONDING ANALYZER SWEEP SPEEDS.

FAST-SPEED MOTOR			MEDIUM-SPEED MOTOR		
Chart Speed Inches/Minute	Sweep Speed Decades/Minute		Chart Speed Inches/Minute	Sweep Speed Decades/Minute	
	24-Tooth Sprocket With Type 1521-9493 Chart Paper (7.5 Inches/ Decade)	16-Tooth Sprocket With Type 1521-9469 Chart Paper (5 Inches/ Decade)		24-Tooth Sprocket With Type 1521-9493 Chart Paper (7.5 Inches/ Decade)	16-Tooth Sprocket With Type 1521-9469 Chart Paper (5 Inches/ Decade)
75	10	15	15	2	3
25	3 1/3	5	5	2/3	1
7 1/2	1	1 1/2	1 1/2	1/5	3/10
2 1/2	1/3	1/2	1/2	1/15	1/10

1—Type 1521-P10B Drive Unit.
1—Type 1521-P15 Link Unit, with 16- and 24-tooth sprockets.
10—Rolls, Type 1521-9469 Chart Paper.
1—Type 1560-2140 Adaptor Cable (insulated double plug to offset phone plug.

2.18.2 INSTALLATION.

NOTE

The Type 1911-A Recording Sound and Vibration Analyzer is fully assembled when delivered. The following installation procedure applies only when the analyzer and recorder are ordered separately.

Figure 2-6 shows the portable Type 1564-A Sound and Vibration Analyzer in its Flip-Tilt case, mounted above the Type 1521 Graphic Level Recorder. The relay-rack-model analyzer (Type 1564-9820) can also be mounted over the recorder. To couple the two instruments, proceed as follows:

(a) Remove the FREQUENCY control knob-and-plate assembly that is fastened to the dial cover with a screw on each side of the knob. Also remove the detent-arm assembly (held by a thumbscrew, 4, Figure 2-6).

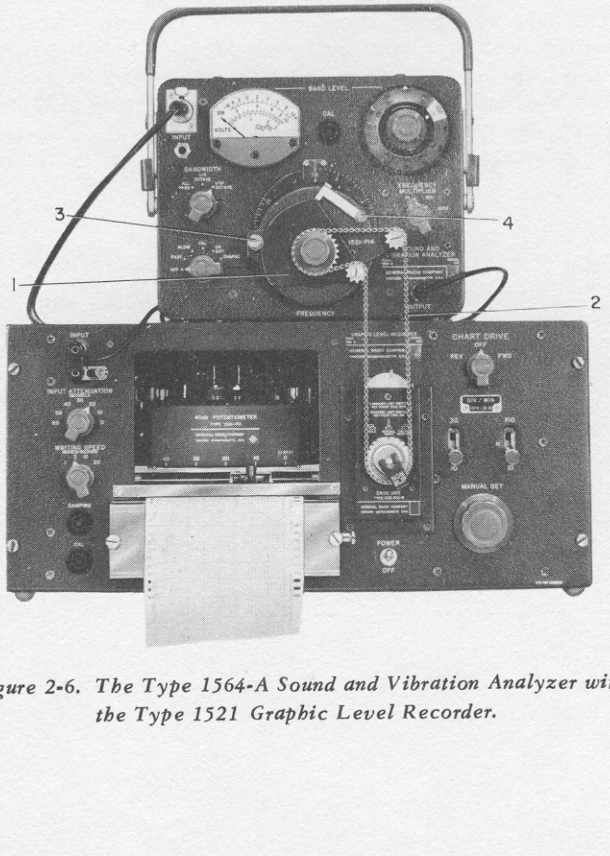


Figure 2-6. The Type 1564-A Sound and Vibration Analyzer with the Type 1521 Graphic Level Recorder.

(b) Using the screws removed in (a) (omit the washers), fasten the Type 1521-P15 Link Unit (1) in place of the knob assembly. Adjust the unit to allow slight backlash when the sprocket is turned. Replace the detent-arm assembly.

(c) Install the chain (2) as shown in the figure. Two chains are supplied with the link unit. Use the short chain with the analyzer in its Flip-Tilt case; the long chain must be used with the relay-rack model. To tighten the chain, loosen the locking screw (3), rotate the sprocket plate to take up most of the slack, and retighten the screw.

2.18.3 OPERATION. The Operating Instructions for the Type 1521 Graphic Level Recorder include a complete discussion of its operation with an analyzer. Set the external-motor switch to the position toward the rear of the instrument, for continuous operation of the recorder.

If the analyzer-recorder combination is to resolve faithfully the complex variations in a spectrum which it is capable of resolving, certain rules regarding sweep speed (chart speed) and writing speed must be observed. A sweep speed that is too fast will cause errors in the recorded amplitude, center frequency, and bandwidth of the filter. If the writing speed is too slow, errors may result due to the inability of the recorder to follow sharp contours in the spectrum. Table 4 gives the recommended maximum sweep speeds and corresponding minimum writing speeds for the various ranges of the analyzer. For the Type 1521-B Graphic Level Recorder, the low cut-off frequency is raised as the writing speed is increased; therefore a maximum writing speed is also imposed for each frequency range, and these are included in the table. Note, also, that the 20-cps low-frequency cut-off of the Type 1521-A Recorder prohibits its use in the lowest (X1) frequency range. Slower chart speeds and correspondingly slower sweep speeds are recommended when a faithful time-averaged plot of the spectrum is desired.

TABLE 4.

MAXIMUM SWEEP SPEEDS AND CORRESPONDING MINIMUM WRITING SPEEDS FOR ANALYZER-RECORDER COMBINATIONS.

	Range (Frequency Multiplier)	Maximum Sweep Speed (Decades/Minute)	Minimum Writing Speed (Inches/Second)	Maximum Writing Speed Type 1521-B Recorder Only (Inches/Second)
Type 1521-B Recorder Only	1	1/5	1	3
	10	1 1/2	3	10
	100	5	10	20
	1000	5	10	20

Section 3
PRINCIPLES OF OPERATION

3.1 GENERAL.

The various sections of the Type 1564-A Sound and Vibration Analyzer are described in the following paragraphs. Reference should be made to the elementary schematic diagram, Figure 3-1.

3.2 PREAMPLIFIER SECTION.

The high input impedance of the preamplifier section permits the amplifier to be driven by any of a variety of transducers, including piezoelectric microphones and accelerometers. The first stage of this section uses two transistors (one of which is a field-effect transistor) to produce an amplifier with an input impedance of 25 megohms, a low output impedance, and a stable gain of about 3 db. Directly before and after the preamplifier are the step attenuators, which are operated by the BAND LEVEL knurled dial. Their purpose is to change the input signal to a level convenient for analyzing.

The continuously adjustable attenuator, operated by the CAL control, is included in this section. A Cannon female connector and a phone jack, connected in parallel, provide convenient connections to various sources.

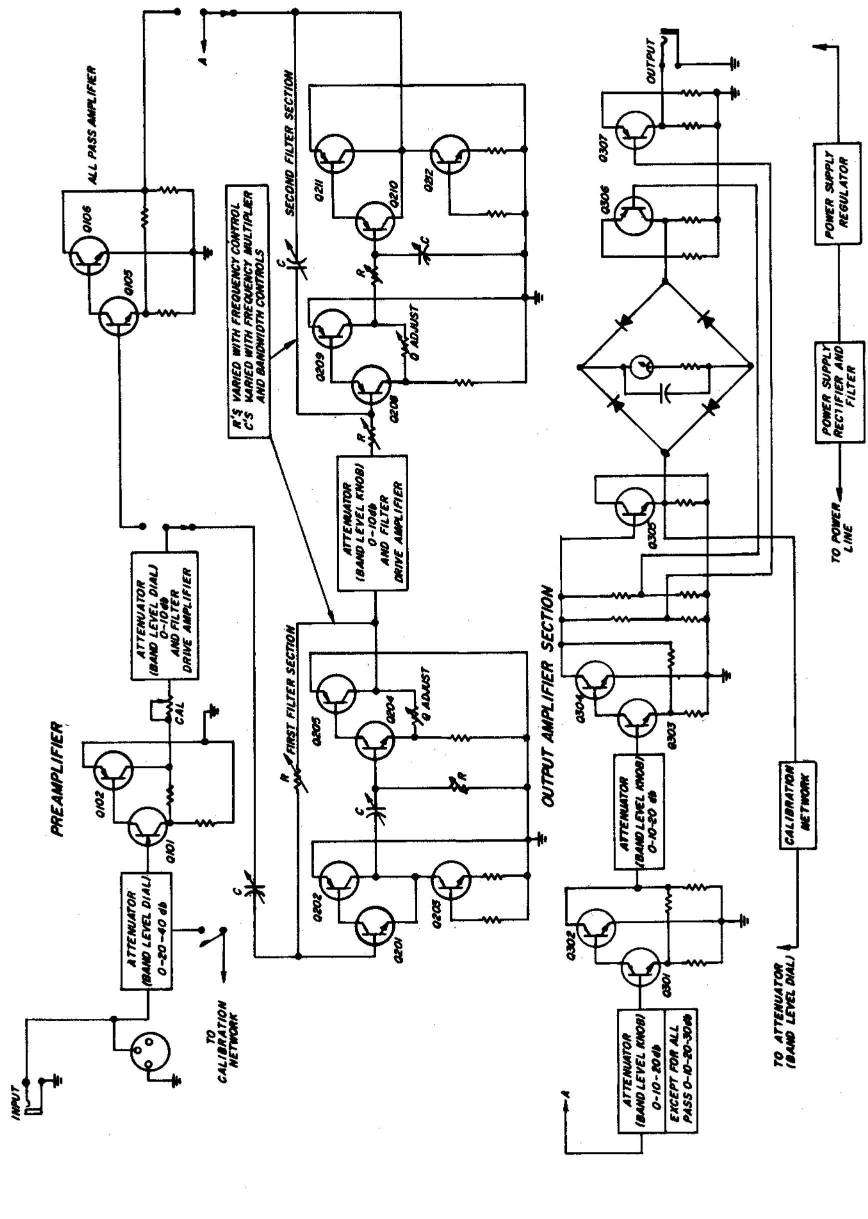


Figure 3-1. Elementary schematic diagram of the Type 1564-A Sound and Vibration Analyzer.

3.3 FILTER SECTION.

The filter is synthesized as an isolated cascade of two resonant (second-order) sections. The resonant frequencies of the sections are staggered about the selected center frequency to produce a filter having a noise bandwidth of one-third octave. To obtain a one-tenth-octave response, the sections are synchronously tuned. A functional diagram is given in Figure 3-2, and Figure 3-3 shows the amplitude-versus-frequency response for each bandwidth. The plot was produced automatically by a Type 1521 Graphic Level Recorder and Type 1304-B Beat-Frequency Audio Generator.

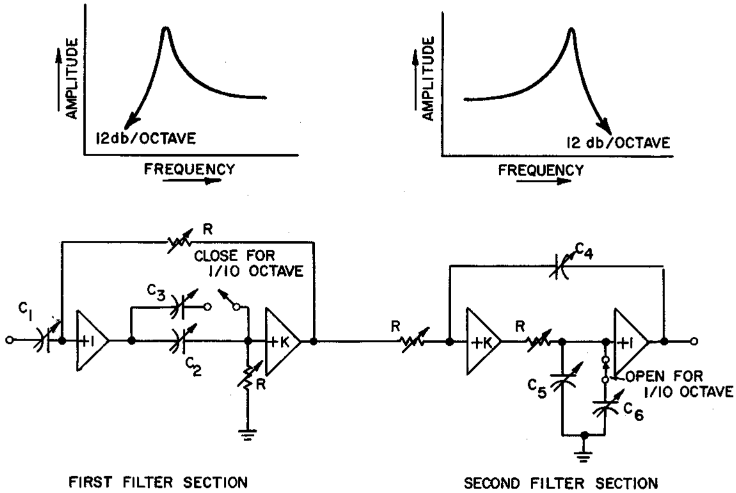


Figure 3-2. Elementary schematic diagram of the filter sections.

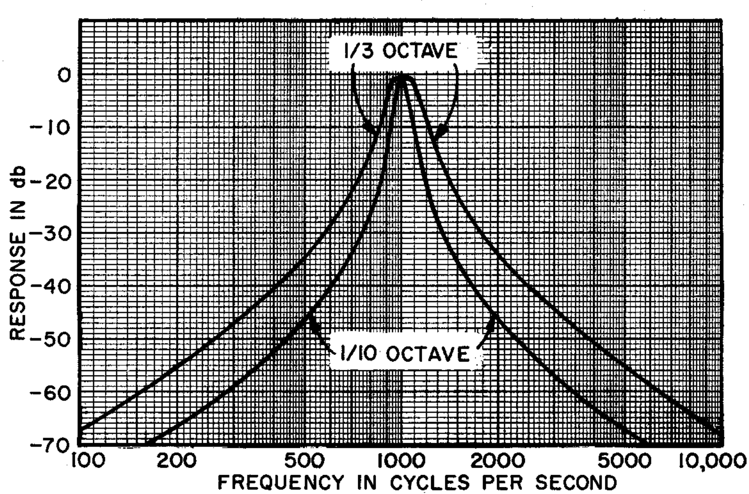
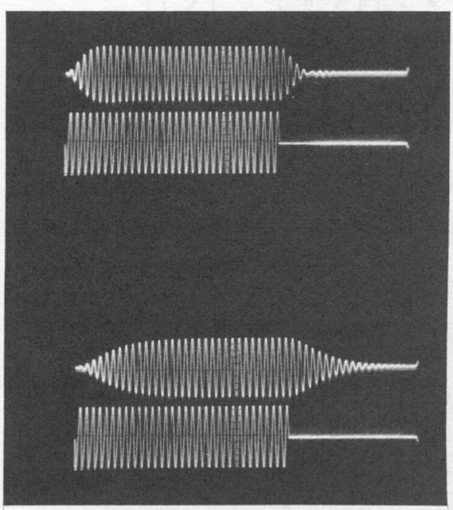


Figure 3-3. Filter response characteristics.

The capacitors C1 through C6 are switched by the FREQUENCY MULTIPLIER control and determine the tuning range. The four resistors, R, are adjusted simultaneously by the FREQUENCY control to span the ten-to-one range selected. Frequency responses that are mirror images of each other are the result of interchanged placement of resistors and capacitors for the two sections. Attenuation rates approach 12 db/octave at low and high frequencies for the first and second filter sections respectively. A symmetrical over-all filter response is thus obtained. For one-third octave operation, the resonant frequency of the first filter section is 16% higher than that of the second. When the one-tenth octave bandwidth is selected, C3 is added in parallel with C2, and C6 is removed from across C5. These changes bring the resonant frequencies of the sections together and increase the Q's.

The response of the filter to a transient is shown in Figure 3-4. The input signal consisted of a burst of 32 cycles at 1 kc. The filter was tuned to 1 kc for both the 1/3- and 1/10-octave bandwidths. The rise time (time required for the output signal to rise from 10% to 90% of its steady-state value) and the fall time (time for the signal to fall from 90% to 10%) were 4 milliseconds for the 1/3-octave filter and 9 milliseconds for the 1/10-octave filter, at the test frequency of 1 kc. Figure 3-5 is a plot of the rise and fall times versus the center frequency, for the two bandwidths.



Top curve: Output for 1/3-octave bandwidth

Second curve: Input

Figure 3-4. Response of filter to a transient.

Third curve: Output for 1/10-octave bandwidth

Lower curve: Input

3.4 ALL-PASS AMPLIFIER.

A separate broad-band amplifier (Figure 3-1) is substituted for the filter when the BANDWIDTH switch is set to ALL PASS. This permits measurement of the unfiltered signal level so that the coaxial attenuator can be adjusted for the greatest signal-to-noise ratio of the filtered signal.

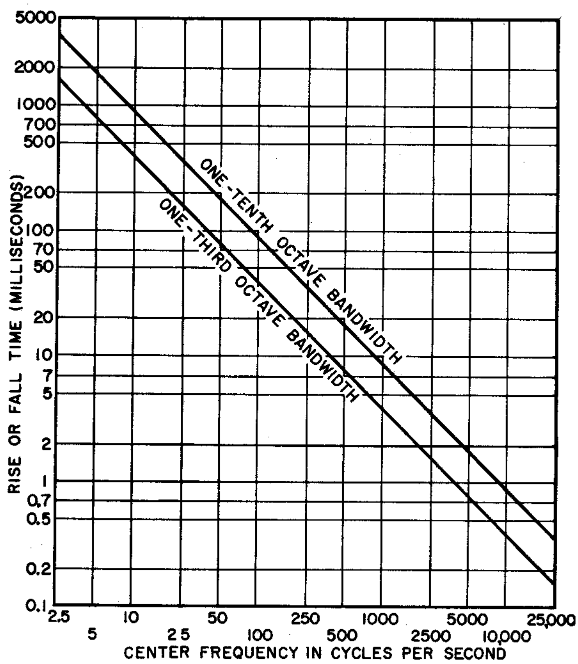


Figure 3-5. Rise and fall times for the filter.

3.5 OUTPUT AMPLIFIER SECTION.

In this section, the signal from the filter is amplified to a level sufficient to drive the meter circuit. This section also provides a one-volt output signal corresponding to a full-scale meter indication.

The meter detector circuit is push-pull driven to provide good linearity and stability. The detector characteristic has been called quasi-rms[2]. The conduction angle for sinusoidal excitation is chosen to give a detector output nearly rms, for various types of input signals, including noise and square waves.

Two amplifier stages and two attenuators permit a high signal-to-noise ratio, when little over-all gain is required. The attenuators are controlled by the BAND LEVEL knob.

To suit the wide frequency range of the analyzer, three detector-averaging times are used (refer to paragraph 2.17). These ensure that the user is not burdened with either a slow-acting meter for high-frequency measurements or a widely fluctuating meter for noise analyses at low frequencies.

2
E. E. Gross, "Improved Performance Plus A New Look for the Sound-Level Meter," 32, 17, EXPERIMENTER, October, 1958.

3.6 CALIBRATION NETWORK.

To amplitude-calibrate the analyzer, the output is connected to the input through a diode limiter and a calibrated attenuator. A 1-kc, RC filter is also included when the BANDWIDTH switch is set to ALL PASS. The attenuation of this feedback network is the calibration reference; it is adjustable by means of a calibrated internal control (refer to paragraph 2.3). When the over-all gain of the instrument is adjusted to equal the attenuation of the calibration network, the system will oscillate, as indicated by the panel meter.

3.7 POWER SUPPLY.

The Type 1564-A Sound and Vibration Analyzer can be operated from its rechargeable nickel-cadmium battery or from a 115- (or 230-) volt, 50- to 60-cycle line. A simplified diagram of the power supply is given in Figure 3-6. For line operation, the transformer feeds a conventional bridge-rectifier and filter-capacitor circuit. The smoothed DC supplies both the circuits of the instrument and the battery. The latter serves to refilter the DC and receives a small charging current (about 5 ma for normal line voltage). Conventional series regulators, with zener diode references, supply 7, 12, and 15 volts for various sections of the instrument. The unregulated battery voltage supplies the final stage of the output amplifier.

The battery automatically supplies current for the instrument when the line is interrupted. The rectifier diodes prevent the current from flowing back through the transformer.

To charge the battery, the load is removed from the instrument and Switch S is closed (Figure 3-6).

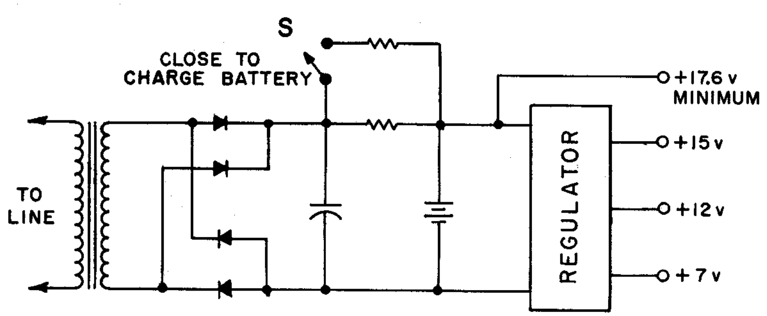


Figure 3-6. Elementary schematic diagram of power supply.

Section 4
SERVICE AND MAINTENANCE

4.1 GENERAL.

We warrant that each new instrument sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, district office, or authorized repair agency personnel, will be repaired, or, at our option replaced without charge, except for tubes or batteries that have given normal service.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the type and serial numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

4.2 REMOVAL OF INSTRUMENT FROM CASE.

To remove the Type 1564-A from its Flip-Tilt case, turn the panel function switch to OFF and remove the four screws near the front panel, two through the top and two through the bottom of the case.

4.3 TRANSISTOR VOLTAGES.

Table 5 gives the normal voltage from the indicated transistor terminal to ground. Allow a deviation of 10 percent from these figures. Set the panel controls as follows:

BANDWIDTH switch - - - - - - - - - - - 1/10 OCTAVE
Function switch - - - - - - - - - - - - - - FAST

FREQUENCY dial - - - - - - - - - - - - - 10
FREQUENCY MULTIPLIER - - - - - - - - 100
BAND LEVEL gray knob - - - - - - - - - - maximum clockwise
BAND LEVEL knurled dial - - - - - - - - - maximum clockwise

Measurements should be made with a vacuum-tube voltmeter with the battery fully charged (approximately 21 volts).

TABLE 5

TRANSISTOR VOLTAGES

TRANSISTOR	TERMINAL	DC VOLTS TO GROUND	TRANSISTOR	TERMINAL	DC VOLTS TO GROUND
Q101	K	6.0	Q210	E	5.6
(TR-32/C620A)	A	11.9	(TR-42/2N930)	C	11.9
Q102	E	12.0	Q211	E	12.0
(TR-23/2N520A)	C	8.5	(TR-10/2N1374)	C	5.6
Q103	E	6.7	Q212	E	1.2
(TR-31/2N445A)	C	11.9	(TR-31/2N445A)	C	5.6
Q104	E	12.0	Q301	E	0.9
(TR-10/2N1374)	C	6.7	(TR-21/2N338)	C	3.1
Q105	E	0.9	Q302	E	3.0
(TR-31/2N445A)	C	3.0	(TR-31/2N445A)	C	6.4
Q106	E	2.9	Q303	E	1.4
(TR-31/2N445A)	C	7.5	(TR-21/2N338)	C	4.1
Q201	E	7.2	Q304	E	4.0
(TR-2/2N929)	C	11.9	(TR-31/2N445A)	C	13.6
Q202	E	12.0	Q305	E	13.5
(TR-10/2N1374)	C	7.2	(TR-31/2N445A)	C	21.0
Q203	E	1.1	Q306	E	19.8
(TR-31/2N445A)	C	7.2	(TR-23/2N520A)	C	12.0
Q204	E	7.4	Q307	E	20.0
(TR-2/2N929)	C	11.9	(TR-23/2N520A)	C	10.5
Q205	E	12.0	Q501	E	15.0
(TR-10/2N1374)	C	7.8	(TR-31/2N445A)	C	21.0
Q206	E	6.4	Q502	E	12.0
(TR-31/2N445A)	C	11.9	(TR-31/2N445A)	C	21.0
Q207	E	12.0	Q503	E	6.5
(TR-10/2N1374)	C	6.4	(TR-31/2N445A)	C	12.1
Q208	E	5.9	Q504	E	6.5
(TR-42/2N930)	C	11.9	(TR-31/2N445A)	C	15.1
Q209	E	12.0	Q505	E	15.0
(TR-10/2N1374)	C	6.2	(TR-31/2N445A)	C	21.0

4.4 INTERNAL NOISE.

Typical noise levels at the OUTPUT jack are given in Figure 4-1 for each setting of the BAND LEVEL control. The noise levels in decibels are referred to the output voltage corresponding to a full-scale meter indication (approximately db re 1 volt) for the 1/3-octave bandwidth with the INPUT terminals shorted. Levels will be approximately the same for the 1/10-octave bandwidth or with other source impedances.

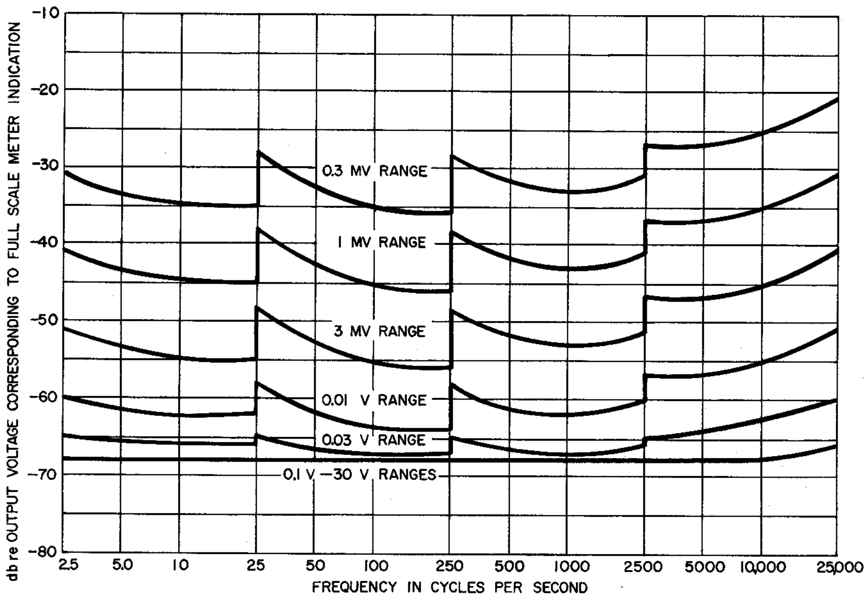


Figure 4-1. Typical noise levels at the OUTPUT of the analyzer.

4.5 SERVICEABILITY TEST.

Follow the procedure outlined below to determine that the gain of the analyzer is normal and that its filters are operating properly. An oscillator covering the range from 20 cps to 25 kc and an accurate voltmeter (to monitor the output level of the oscillator) are required.

a. ALL-PASS FREQUENCY RESPONSE CHECK. Connect the oscillator to the INPUT terminals of the analyzer and apply a level of 0.5 v at a frequency of 20 cps. Turn the function switch to SLOW, the BANDWIDTH switch to ALL PASS, the BAND LEVEL gray knob fully clockwise, and the BAND LEVEL knurled dial to $\frac{120}{1v}$. Adjust the CAL thumbset control so that the meter indicates +4 db. Change the oscillator frequency to 25 kc, keeping its level constant at 0.5 volt. The analyzer should now indicate between +1 and +3 db.

b. CHECK FOR UNIFORMITY OF PEAK RESPONSE WITH 1/10-OCTAVE BANDWIDTH. With the function switch and BAND LEVEL controls set as in a., above, turn the BANDWIDTH control to 1/10 OCTAVE, the FREQUENCY MULTIPLIER switch to 10, and the FREQUENCY control to 2.5. Adjust the oscillator frequency (at a 0.5-volt level) to give a peak indication on the analyzer meter, and note the reading. This peak indication should occur at a frequency of 25 cps ±2%. (If the oscillator is accurately calibrated, or if a suitable frequency-measuring instrument is available, the frequency of the analyzer can be checked.) Set the function switch to FAST and repeat the procedure, noting the peak amplitude at each of the following frequencies: 20 cps (FREQUENCY MULTIPLIER at 1), 100 cps, 250 cps, 1 kc, 2.5 kc, 10 kc, and 25 kc. Maintain the oscillator level at 0.5 v for each frequency. The difference between the maximum and minimum peak amplitudes, at frequencies up to 10 kc, should not exceed 2 db. Considering all frequencies, the variation should not exceed 3 db.

c. CHECK FOR UNIFORMITY OF CENTER-FREQUENCY RESPONSE WITH 1/3-OCTAVE BANDWIDTH. Set the BANDWIDTH switch at 1/3 OCTAVE and follow the procedure outlined in b.

d. CHECK FOR AMPLITUDE AGREEMENT AT CENTER FREQUENCY OF 1/3- AND 1/10-OCTAVE FILTER. At any frequency, adjust the oscillator for a peak meter indication, using the 1/10 OCTAVE BANDWIDTH switch position. Set the switch to 1/3 OCTAVE, maintain the 0.5-volt oscillator level, and note the change in meter indication. This change should not exceed 2 db at frequencies up to 10 kc; it should not exceed 3 db for frequencies above 10 kc.

4.6 FILTER REALIGNMENT.

The filter in the analyzer may require realignment when:

a. one or more tuning capacitors have been changed (mylar capacitors, one- or two-percent tolerance, selected by switches S201 and S202),

b. the tuning potentiometer has been changed,

c. transistor Q201, Q202, Q204, Q205, Q208, Q209, Q210, or Q211 has been replaced.

The serviceability test outlined in paragraph 4.5 should be used in any case, to determine whether or not realignment of the filter is necessary. The following instruments are required for this test:

An oscillator, covering the range from 20 cps to 25 kc, with some means of monitoring its level at approximately 0.5 v.

A sensitive ac voltmeter, for levels down to 30 mv having a uniform (±2%) frequency response from 25 cps to 25 kc.

A frequency meter or equivalent, to measure frequencies of 250 cps and 2.5 kc, with an accuracy of ±0.5%.

Use the procedure outlined below to realign the filter.

a. Remove the instrument from its cabinet. The etched-circuit board is hinged and must be swung out. To do this, remove the three screws near the bottom edge of the board and the screw just above the tuning potentiometer. Swing the board out until it is perpendicular to the panel. Set the analyzer on its right side (with switch S202 at the top).

b. Set the following alignment potentiometers near the center of their ranges: R202, R209, R214, R215, R216, R217, R228, R234, R235, R236, R237, and R239.

Set the panel controls of the analyzer as follows:

BAND LEVEL gray knob	fully clockwise
BAND LEVEL knurled dial	1 v (12 o'clock)

FREQUENCY switch	2.5
FREQUENCY MULTIPLIER switch	100
BANDWIDTH switch	1/10 OCTAVE

Both BAND LEVEL controls should be left in the above respective positions for steps b through g.

The BANDWIDTH switch should be left at 1/10 OCTAVE for steps b through n.

Remove the two screws that hold the cover over the FREQUENCY dial (the two nearest the lower edge of the panel).

c. Connect the sensitive ac voltmeter to terminal 308R on switch S202. Be sure the terminal is not shorted to ground or to any other terminal, as this may result in damage to transistor Q205 or Q502. Connect the oscillator to the INPUT jack and set it for a frequency of 250 cps ±0.5% at an amplitude of 0.5 v. Set the function switch to FAST and adjust the CAL control for an indication of about 300 mv on the sensitive ac voltmeter. Turn the FREQUENCY dial of the analyzer until a peak indication on the voltmeter is obtained. This peak should occur at 250 cps ±0.5% as indicated by the FREQUENCY dial. If it does not, loosen the two setscrews that secure the dial to the shaft. Set the dial so that it indicates exactly 250 cps and tighten both setscrews.

d. Maintain the 0.5-volt oscillator level for all the adjustments in steps d through g.

With the oscillator set at 2.5 kc, adjust the CAL control on the analyzer for a voltmeter indication of 30 mv. Then adjust the frequency of the oscillator to give a peak indication on the voltmeter at 250 cps. Using potentiometer R216, set this peak level to 270 mv.

e. Set the FREQUENCY dial to 25, and adjust the oscillator frequency for a peak indication on the voltmeter, which will occur near 2.5 kc. Then adjust potentiometers R202 and R209 to obtain a peak voltmeter indication of 270 mv at 2.5 kc, as indicated by the frequency meter. A clockwise rotation of R202 decreases both the amplitude and the frequency of the peak. A clockwise rotation of R209 increases the peak amplitude and decreases the peak frequency.

f. Set the FREQUENCY dial to 2.5 and the FREQUENCY MULTIPLIER to 1000. The peak amplitude should occur at about 2.5 kc. Adjust potentiometer R217 for a voltmeter indication of 270 mv. Repeat this procedure at 25 cps (with the FREQUENCY MULTIPLIER set to 10). Use potentiometer R215 to again obtain the voltmeter indication of 270 mv.

g. Set the FREQUENCY dial to 25, the FREQUENCY MULTIPLIER to 1, and adjust potentiometer R214 for a peak amplitude of 270 mv.

h. Turn the function switch to OFF and unsolder the orange-gray shielded lead connected to terminal 308R of switch S202. Select an electrolytic or paper capacitor with a value of 1 μf or higher and a voltage rating of at least 15 volts. Solder the positive terminal of this capacitor to terminal 308R. Connect the oscillator to the analyzer through the capacitor (with the low oscillator terminal connected to the chassis) and adjust the oscillator level to about 0.4 volt.

i. Set the FREQUENCY dial to 2.5, the FREQUENCY MULTIPLIER to 100, the function switch to SLOW and the BAND LEVEL knob to $\frac{100}{.1v}$. The indicator on the BAND LEVEL knurled dial should remain at 12 o'clock. With the frequency of the oscillator at 25 cps, adjust its level for a full-scale indication on the analyzer meter and note this level.

Change the BAND LEVEL knob setting to $\frac{120}{1v}$, the function switch to FAST, and adjust the frequency of the oscillator for a peak indication on the analyzer. Set the oscillator amplitude to the level noted above and maintain this level for the remainder of the procedure. Adjust potentiometer R236 for an indication of 9 on the meter (10-volt scale).

j. Set the FREQUENCY MULTIPLIER to 10, the function switch to SLOW, and adjust the peak amplitude at 25 cps for an indication of 9, using R235. Change the function switch to FAST and the FREQUENCY dial to 25. Adjust R228 and R329 to obtain a peak meter indication of 9 at a frequency of 250 cps, as indicated by the frequency meter. A clockwise rotation of R228 increases the amplitude and decreases the frequency; a clockwise rotation ot R239 decreases both the amplitude and the frequency of the peak.

k. Set the FREQUENCY MULTIPLIER switch to 1 and adjust potentiometer R234 for a peak amplitude indication of 9.

l. Set the FREQUENCY dial to 2.5 and the FREQUENCY MULTIPLIER to 1000. Adjust potentiometer R237 for a peak amplitude indication of 9.

m. Turn the function switch to OFF. Disconnect the oscillator and the capacitor connected to terminal 308R of switch S202, and resolder the orange-gray shielded lead.

n. Connect the oscillator to the INPUT terminals of the analyzer and set the input level to 0.5 v at 1 kc. Turn the function switch to FAST, the FREQUENCY MULTIPLIER to 100, and tune the FREQUENCY dial to obtain a peak indication on the meter. Note the level.

Set the BANDWIDTH switch to 1/3 OCTAVE. The change in level must not exceed 2 db. Note this level.

Change the BANDWIDTH switch to ALL PASS and use potentiometer R125 to adjust the ALL PASS level so that it is midway between the 1/10- and 1/3-octave levels.

o. Check the analyzer according to the procedure given in paragraph 4.5. If an oscillator with a range to 2.5 cps is available, the four checks in paragraph 4.5 can be extended to the lower decade. Both the 1/3-octave and the 1/10-octave peak levels should be uniform ±1 db down to 5 cps and uniform ±1.5 db down to 2.5 cps. The center-frequency amplitudes for the 1/3- and the 1/10-octave bandwidths should agree within 2 db down to 2.5 cps. The all-pass amplitude should be down 1, ±1 db (referred to the level at 1 kc) at 2.5 cps, when the function switch is at SLOW.

PARTS LIST

REF. NO.	RESISTORS	PART NO.
R101	FILM, 22.6 MΩ ±1% 1 w	6189-5226
R102	FILM, 255 KΩ ±1% 1/8 w	6250-3255
R103	FILM, 2.55 MΩ ±1% 1/2 w	6450-4255
R104	COMPOSITION, 470 KΩ ±5% 1/2 w	6100-4475
R105	COMPOSITION, 300 KΩ ±5% 1/2 w	6100-4305
R106	COMPOSITION, 47 MΩ ±5% 1/2 w	6100-6105
R107	COMPOSITION, 6.2 KΩ ±5% 1/2 w	6100-2625
R108	POTENTIOMETER, COMPOSITION, 50 KΩ ±20%	6040-0900
R109	COMPOSITION, 47 MΩ ±5% 1/2 w	6100-6475
R110	COMPOSITION, 10 KΩ ±5% 1/2 w	6100-3105
R111	COMPOSITION, 6.2 KΩ ±5% 1/2 w	6100-2625
R112	COMPOSITION, 100 KΩ ±5% 1/2 w	6100-4105
R113	POTENTIOMETER, 100 KΩ ±10%	6010-1700
R114	FILM, 22.6 KΩ ±1% 1/8 w	6250-2226
R115	FILM, 15.4 KΩ ±1% 1/8 w	6250-2154
R116	FILM, 71.5 KΩ ±1% 1/8 w	6250-2715
R117	FILM, 61.9 KΩ ±1% 1/8 w	6250-2619
R118	COMPOSITION, 15 KΩ ±5% 1/2 w	6100-3155
R119	COMPOSITION, 30 KΩ ±5% 1/2 w	6100-3305
R120	COMPOSITION, 10 KΩ ±5% 1/2 w	6100-3105
R121	COMPOSITION, 120 KΩ ±5% 1/2 w	6100-4125
R122	COMPOSITION, 20 KΩ ±5% 1/2 w	6100-3205
R123	COMPOSITION, 10 KΩ ±5% 1/2 w	6100-3105
R124	COMPOSITION, 36 KΩ ±5% 1/2 w	6100-3365
R125	POTENTIOMETER, COMPOSITION, 50 KΩ ±20%	6040-0900
R126	COMPOSITION, 91 KΩ ±5% 1/2 w	6100-3915
R127	COMPOSITION, 18 KΩ ±5% 1/2 w	6100-3185
R128	COMPOSITION, 8.2 KΩ ±5% 1/2 w	6100-2825
R129	COMPOSITION, 300 KΩ ±5% 1/2 w	6100-4305
R130	COMPOSITION, 100 KΩ ±5% 1/4 w	6099-4105
R201 A	POTENTIOMETER, 30.7 KΩ	0973-4300
R201 B	POTENTIOMETER, 30.7 KΩ	0973-4300
R201 C	POTENTIOMETER, 30.7 KΩ	0973-4300
R201 D	POTENTIOMETER, 30.7 KΩ	0973-4300
R202	POTENTIOMETER, COMPOSITION, 500 Ω ±20%	6040-0300
R203	PRECISION, 2.74 KΩ ±1% .3 w	6730-1274
R204	COMPOSITION, 30 KΩ ±5% 1/2 w	6100-3305
R205	COMPOSITION, 91 KΩ ±5% 1/2 w	6100-3915
R206	COMPOSITION, 13 KΩ ±5% 1/2 w	6100-3135
R207	COMPOSITION, 1 KΩ ±5% 1/2 w	6100-2105
R209	POTENTIOMETER, COMPOSITION, 500 Ω 20%	6040-0300
R210	PRECISION, 2.74 KΩ ±1% .3 w	6730-1274
R211	COMPOSITION, 15 KΩ ±5% 1/2 w	6100-3155
R212	PRECISION, 10 KΩ ±1% .3 w	6730-2100
R213	COMPOSITION, 30 KΩ ±5% 1/2 w	6100-3305
R214	POTENTIOMETER, COMPOSITION, 250 Ω ±20%	6040-0200
R215	POTENTIOMETER, COMPOSITION, 250 Ω ±20%	6040-0200

REF. NO.	RESISTORS, Continued	PART NO.
R216	POTENTIOMETER, COMPOSITION, 250 Ω ±20%	6040-0200
R217	POTENTIOMETER, COMPOSITION, 500 Ω ±20%	6040-0300
R218	PRECISION, 432 Ω ±1% .3 w	6730-0432
R219	FILM, 1.40 KΩ ±1% 1/8 w	6250-1140
R220	COMPOSITION, 4.7 KΩ ±5% 1/2 w	6100-2475
R221	FILM, 90.9 KΩ ±1% 1/8 w	6250-2909
R222	FILM, 9.53 KΩ ±1% 1/8 w	6250-1953
R223	FILM, 20.5 KΩ ±1% 1/8 w	6250-2205
R224	COMPOSITION, 15 KΩ ±5% 1/2 w	6100-3155
R225	COMPOSITION, 30 KΩ ±5% 1/2 w	6100-3305
R226	COMPOSITION, 10 KΩ ±5% 1/2 w	6100-3105
R227	COMPOSITION, 8.2 MΩ ±5% 1/2 w	6100-5825
R228	POTENTIOMETER, COMPOSITION, 500 Ω ±20%	6040-0300
R229	PRECISION, 2.74 KΩ ±1% .3 w	6730-1274
R230	COMPOSITION, 4.7 KΩ ±5% 1/2 w	6100-2475
R231	COMPOSITION, 30 KΩ ±5% 1/2 w	6100-3305
R232	PRECISION, 10 KΩ ±1% .3 w	6730-2100
R233	PRECISION, 432 Ω ±1% .3 w	6730-0432
R234	POTENTIOMETER, COMPOSITION, 250 Ω ±20%	6040-0200
R235	POTENTIOMETER, COMPOSITION, 250 Ω ±20%	6040-0200
R236	POTENTIOMETER, COMPOSITION, 250 Ω ±20%	6040-0200
R237	POTENTIOMETER, COMPOSITION, 500 Ω ±20%	6040-0300
R239	POTENTIOMETER, COMPOSITION, 500 Ω ±20%	6040-0300
R240	PRECISION, 2.74 KΩ ±1% .3 w	6730-1274
R241	COMPOSITION, 30 KΩ ±5% 1/2 w	6100-3305
R242	COMPOSITION, 91 KΩ ±5% 1/2 w	6100-3915
R243	COMPOSITION, 13 KΩ ±5% 1/2 w	6100-3135
R244	COMPOSITION, 1 KΩ ±5% 1/2 w	6100-2105
R245	COMPOSITION, 100 KΩ ±5% 1/2 w	6100-4105
R246	COMPOSITION, 1 KΩ ±5% 1/2 w	6100-2105
R301	COMPOSITION, 160 KΩ ±5% 1/2 w	6100-4165
R302	FILM, 3.83 KΩ ±1% 1/8 w	6250-1383
R303	FILM, 10 KΩ ±1% 1/8 w	6250-2100
R304	FILM, 20.5 KΩ ±1% 1/8 w	6250-2205
R305	COMPOSITION, 120 KΩ ±5% 1/2 w	6100-4125
R306	COMPOSITION, 10 KΩ ±5% 1/2 w	6100-3105
R307	FILM, 60.4 KΩ ±1% 1/8 w	6250-2604
R308	FILM, 60.4 KΩ ±1% 1/8 w	6250-2604
R309	COMPOSITION, 330 KΩ ±5% 1/2 w	6100-4335
R310	COMPOSITION, 20 KΩ ±5% 1/2 w	6100-3205
R311	COMPOSITION, 8.2 KΩ ±5% 1/2 w	6100-2825
R312	COMPOSITION, 100 KΩ ±5% 1/2 w	6100-4105
R313	FILM, 20.5 KΩ ±1% 1/8 w	6250-2205
R314	FILM, 10 KΩ ±1% 1/8 w	6250-2100
R315	FILM, 3.83 KΩ ±1% 1/8 w	6250-1383
R316	COMPOSITION, 62 KΩ ±5% 1/2 w	6100-3625
R317	FILM, 60.4 KΩ ±1% 1/8 w	6250-2604
R318	COMPOSITION, 5.1 KΩ ±5% 1/2 w	6100-2515
R319	FILM, 60.4 KΩ ±1% 1/8 w	6250-2604

REF. NO.	RESISTORS, Continued	PART NO.
R320	COMPOSITION, 6.8 KΩ ±5% 1/2 w	6100-2685
R321	COMPOSITION, 150 KΩ ±5% 1/2 w	6100-4155
R322	COMPOSITION, 5.1 KΩ ±5% 1/2 w	6100-2515
R323	COMPOSITION, 20 KΩ ±5% 1/2 w	6100-3205
R324	COMPOSITION, 20 KΩ ±5% 1/2 w	6100-3205
R325	COMPOSITION, 5.1 KΩ ±5% 1/2 w	6100-2515
R326	COMPOSITION, 7.5 KΩ ±5% 1/2 w	6100-2755
R327	COMPOSITION, 13 KΩ ±5% 1/2 w	6100-3135
R328	COMPOSITION, 47 KΩ ±5% 1/2 w	6100-3475
R329	COMPOSITION, 680 Ω ±5% 1/2 w	6100-1685
R330	COMPOSITION, 6.2 KΩ ±5% 1/2 w	6100-2625
R331	COMPOSITION, 820 Ω ±5% 1/2 w	6100-1825
R332	COMPOSITION, 6.2 KΩ ±5% 1/2 w	6100-2625
R333	COMPOSITION, 20 KΩ ±5% 1/2 w	6100-3205
R334	COMPOSITION, 220 KΩ ±5% 1/2 w	6100-4225
R335	FILM, 34.8 KΩ ±1% 1/8 w	6250-2348
R336	POTENTIOMETER, COMPOSITION, 50 KΩ ±20%	6040-0900
R337	COMPOSITION, 47 KΩ ±5% 1/2 w	6100-3475
R338	POTENTIOMETER, 10 KΩ ±5%	0971-4240
R339	FILM, 3.01 KΩ ±1% 1/8 w	6250-1301
R340	FILM, 100 KΩ ±1% 1/8 w	6250-3100
R341	FILM, 100 KΩ ±1% 1/8 w	6250-3100
R342	FILM, 68.1 KΩ ±1% 1/8 w	6250-2681
R343	FILM, 140 KΩ ±1% 1/8 w	6250-3140
R344	COMPOSITION, 300 KΩ ±5% 1/2 w	6100-4305
R345	COMPOSITION, 47 KΩ ±5% 1/2 w	6100-3475
R346	FILM, 3.01 KΩ ±10% 1/8 w	6250-1301
R501	COMPOSITION, 1 KΩ ±10% 1 w	6110-2109
R502	COMPOSITION, 390 Ω ±5% 1/2 w	6100-1395
R503	COMPOSITION, 390 Ω ±5% 1/2 w	6100-1395
R504	COMPOSITION, 390 Ω ±5% 1/2 w	6100-1395
R505	COMPOSITION, 5.1 KΩ ±5% 1/2 w	6100-2515
R506	FILM, 33.2 KΩ ±1% 1/8 w	6250-2332
R507	FILM, 23.7 KΩ ±1% 1/8 w	6250-2237
R508	COMPOSITION, 2 KΩ ±5% 1/2 w	6100-2205
R509	COMPOSITION, 6.2 KΩ ±5% 1/2 w	6100-2625
R510	FILM, 38.3 KΩ ±1% 1/8 w	6250-2383
R511	FILM, 33.2 KΩ ±1% 1/8 w	6250-2332
R512	COMPOSITION, 6.8 K ±5% 1/2 w	6100-2685
R513	COMPOSITION, 240 Ω ±5% 1/2 w	6100-1240
R514	COMPOSITION, 510 Ω ±5% 1/2 w	6100-1515
R515	COMPOSITION, 510 Ω ±5% 1/2 w	6100-1515
R516	COMPOSITION, 100 Ω ±5% 1/2 w	6100-1105

CAPACITORS

C101	TRIMMER, 0.8 - 8.5 pf	4910-1101
C102	MICA, 24.9 pf ±2% 500 dcwv	4650-0024
C103	PLASTIC, 0.00261 μf ±2% 200 v	4860-7331
C104	TRIMMER, 8 - 50 pf	4910-1170

REF. NO.	CAPACITORS, Continued	PART NO.
C105	MICA, 215 pf ±2% 500 dcwv	4650-0321
C106	PLASTIC, 0.022 µf ±10% 100 v 100 dcwv	4860-7860
C107	ELECTROLYTIC, 15 µf +100 - 10% 15 dcwv	4450-3700
C108	ELECTROLYTIC, 60 µf +100 - 10% 25 dcwv	4450-2900
C109	ELECTROLYTIC, 15 µf +100 - 10% 15 dcwv	4450-3700
C110	ELECTROLYTIC, 200 µf +100 - 10% 12 dcwv	4450-0400
C111	ELECTROLYTIC, 5 µf +100 - 10% 50 dcwv	4450-3900
C112	ELECTROLYTIC, 15 µf +100 - 10% 15 dcwv	4450-3700
C200	MICA, 30 pf ±10%	4620-0650
C201	MICA, 56 pf ±5%	4640-0321
C202	MICA, 10 pf ±10%	4620-0100
C203	MICA, 556 pf ±1%	4710-0628
C204	PLASTIC, 0.589 µf ±1% 100 v	4860-7992
C205	PLASTIC, 0.0589 µf ±1% 100 v	4860-7866
C206	PLASTIC, 0.00589 µf ±1% 200 v	4860-7502
C207	PLASTIC, 0.00589 µf ±1% 200 v	4860-7502
C208	PLASTIC, 0.0589 µf ±1% 100 v	4860-7866
C209	PLASTIC, 0.589 µf ±1% 100 v	4860-7992
C210	PLASTIC, 2.94 µf ±1% 100 v	4860-8380
C211	PLASTIC, 2.94 µf ±1% 100 v	4860-8380
C212	MICA, 930 pf ±2%	4700-1130
C213	PLASTIC, 0.93 µf ±2% 100 v	4860-7997
C214	PLASTIC, 0.0930 µf ±2% 100 v	4860-7885
C215	PLASTIC, 0.00930 µf ±2% 100 v	4860-7590
C216	MICA, 10 pf ±10%	4620-0100
C217	MICA, 56 pf ±5%	4640-0321
C218	ELECTROLYTIC, 15 µf +100 - 10% 15 dcwv	4450-3700
C219	MICA, 10 pf ±10%	4620-0100
C220	MICA, 56 pf ±5%	4640-0321
C221	MICA, 508 pf ±1%	4710-0579
C222	PLASTIC, 0.00589 µf ±1% 200 v	4860-7502
C223	PLASTIC, 0.0589 µf ±1% 100 v	4860-7866
C224	PLASTIC, 0.589 µf ±1% 100 v	4860-7992
C225	MICA, 930 pf ±2%	4700-1130
C226	MICA, 93 pf ±2%	4650-0180
C227	PLASTIC, 0.0930 µf ±2% 100 v	4860-7885
C228	PLASTIC, 0.00930 µf ±2% 100 v	4860-7590
C229	PLASTIC, 0.00682 µf ±1% 200 v	4860-7506
C230	PLASTIC, 0.0682 µf ±1% 100 v	4860-7867
C231	PLASTIC, 0.682 µf ±1% 100 v	4860-7993
C232	PLASTIC, 3.41 µf ±1% 100 v	4860-8410
C233	PLASTIC, 3.41 µf ±1% 100 v	4860-8410
C234	ELECTROLYTIC, 15 µf +100 - 10% 15 dcwv	4450-3700
C235	MICA, 10 pf ±10%	4620-0100
C236	MICA, 56 pf ±5%	4640-0321
C237	MICA, 47 pf ±10%	4620-0700
C238	MICA, 30 pf ±10%	4620-0650
C239	MICA, 30 pf ±10%	4620-0650
C240	MICA, 30 pf ±10%	4620-0650
C241	CERAMIC, .0047 µf ±20%	4405-2470

REF. NO.	CAPACITORS, Continued	PART NO.
C242	CERAMIC, .0047 µf ±20%	4405-2470
C243	CERAMIC, .0022 µf ±20%	4405-2229
C300	MICA, 390 pf ±10%	4700-0576
C301	ELECTROLYTIC, 15 µf +100 - 10% 15 dcwv	4450-3700
C302	ELECTROLYTIC, 5 µf +100 - 10% 50 dcwv	4450-3900
C303	ELECTROLYTIC, 15 µf +100 - 10% 15 dcwv	4450-3700
C304	ELECTROLYTIC, 200 µf +100 - 10% 6 dcwv	4450-2610
C305	ELECTROLYTIC, 15 µf +100 - 10% 15 dcwv	4450-3700
C306	ELECTROLYTIC, 5 µf +100 - 10% 50 dcwv	4450-3900
C307	ELECTROLYTIC, 200 µf +100 - 10% 6 dcwv	4450-2610
C308	ELECTROLYTIC, 60 µf +100 - 10% 25 dcwv	4450-2900
C309	ELECTROLYTIC, 1 µf ±20% 35 v	4450-4300
C310	ELECTROLYTIC, 60 µf +100 - 10% 25 dcwv	4450-2900
C311	ELECTROLYTIC, 200 µf +100 - 10% 15 dcwv	4450-2610
C312	ELECTROLYTIC, 60 µf +100 - 10% 25 dcwv	4450-2900
C313	ELECTROLYTIC, 60 µf +100 - 10% 25 dcwv	4450-2900
C314	PLASTIC, 0.00154 µf ±1% 200 v	4860-7317
C315	PLASTIC, 0.00154 µf ±1% 200 v	4860-7317
C316	MICA, 48.7 pf ±2%	4650-0090
C501	ELECTROLYTIC, 25 µf +100 - 10% 100 dcwv	4450-5596
C502	ELECTROLYTIC, 50 µf +100 - 10% 50 dcwv	4450-2200
C503	ELECTROLYTIC, 25 µf +100 - 10% 50 dcwv	4450-3000
C504	ELECTROLYTIC, 10 µf +100 - 10% 25 dcwv	4450-3800
C505	ELECTROLYTIC, 22 µf ±20% 15 w	4450-5300
C506	ELECTROLYTIC, 5 µf +100 - 10% 50 dcwv	4450-3900
C507	ELECTROLYTIC, 6.8 µf ±20% 35 dcwv	4450-5000

REF. NO.	DIODES AND RECTIFIERS	PART NO.
CR301	IN34AS	6082-1003
CR302	IN34AS	6082-1003
CR303	IN34AS	6082-1003
CR304	IN34AS	6082-1003
CR305	IN645	6082-1016
CR306	IN645	6082-1016
CR307	IN645	6082-1016
CR308	IN645	6082-1016
CR309	IN645	6082-1016
CR501	IN3253	6081-1001
CR502	IN3253	6081-1001
CR503	IN3253	6081-1001
CR504	IN3253	6081-1001
CR505	IN965B	6083-1015
CR506	IN957B*	6083-1038
CR507	IN959B*	6083-1037

* 30 µv max. noise in 40 kc band with 0.5 ma bias.

REF. NO.	TRANSISTORS	PART NO.
Q101	C6601	8210-1032
Q102	2N520A	8210-5200
Q103	2N445A	8210-4451
Q104	2N1374	8210-1374
Q105	2N445A	8210-4451
Q106	2N445A	8210-4451
Q201	2N929	8210-1002
Q202	2N1374	8210-1374
Q203	2N445A	8210-4451
Q204	2N929	8210-1002
Q205	2N1374	8210-1374
Q206	2N445A	8210-4451
Q207	2N1374	8210-1374
Q208	2N930	8210-1042
Q209	2N1374	8210-1374
Q210	2N930	8210-1042
Q211	2N1374	8210-1374
Q212	2N445A	8210-4451
Q301	2N2349	8210-1021
Q302	2N445A	8210-4451
Q303	2N2349	8210-1021
Q304	2N445A	8210-4451
Q305	2N445A	8210-4451
Q306	2N520A	8210-5200
Q307	2N520A	8210-5200
Q501	2N445A	8210-4451
Q502	2N445A	8210-4451
Q503	2N445A	8210-4451
Q504	2N445A	8210-4451
Q505	2N697	8210-1040

REF. NO.	MISCELLANEOUS	PART NO.
B501	BATTERY, Gould Nat. 9.6v/450B	8410-2800
B502	BATTERY, Gould Nat. 9.6v/450B	8410-2800
J101	JACK	4260-1500
J301	JACK	4260-1500
M301	METER	5730-1371
PL501	POWER PLUG	4240-0702
SO101	SOCKET	4230-2850
S101	SWITCH	7890-3180
S102	SWITCH	7890-3180
S103	SWITCH	7890-3181
S201	SWITCH	7890-3182
S202	SWITCH	7890-3183
S301	SWITCH	1564-1710
T501	TRANSFORMER	0746-4420

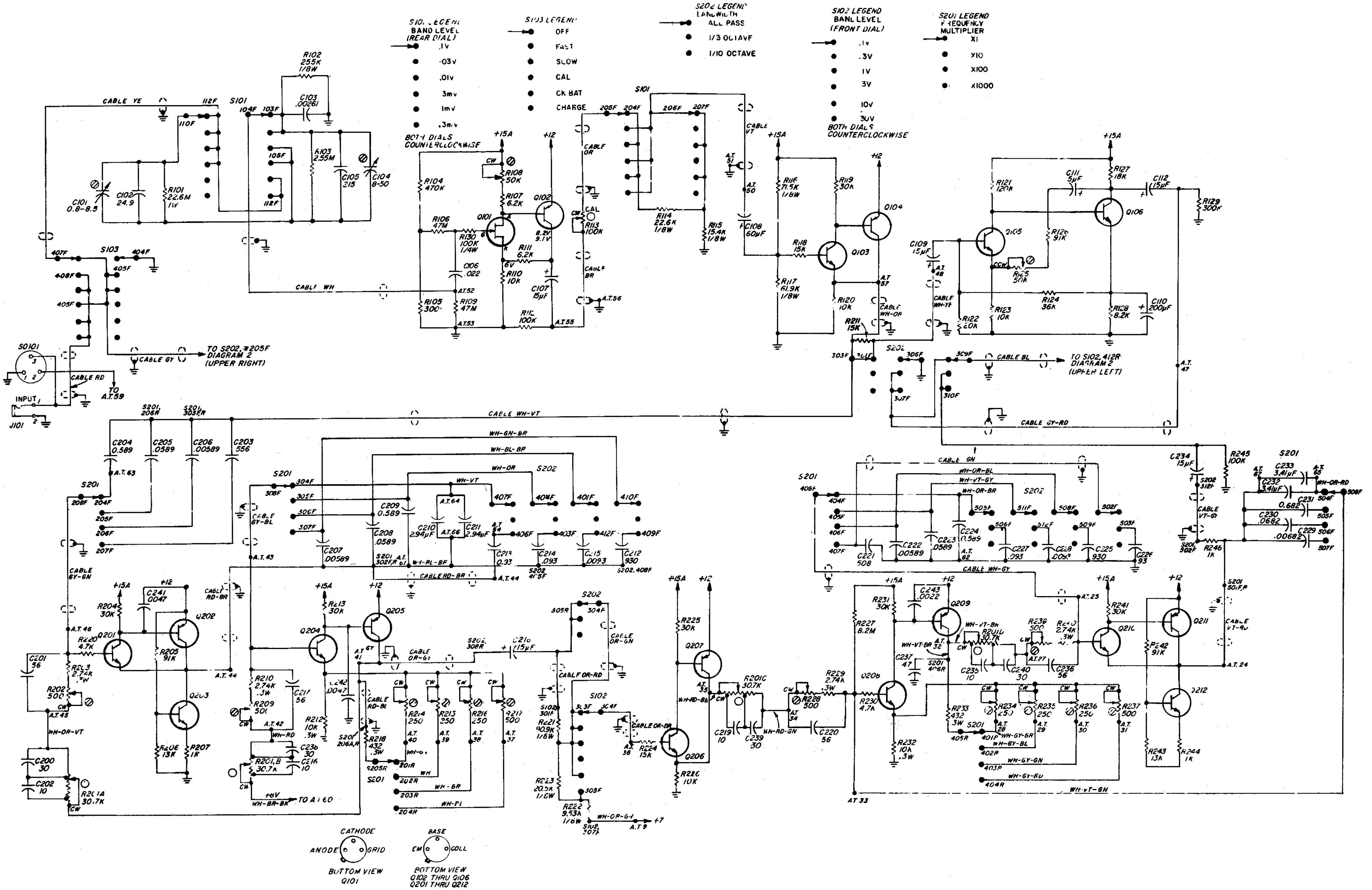
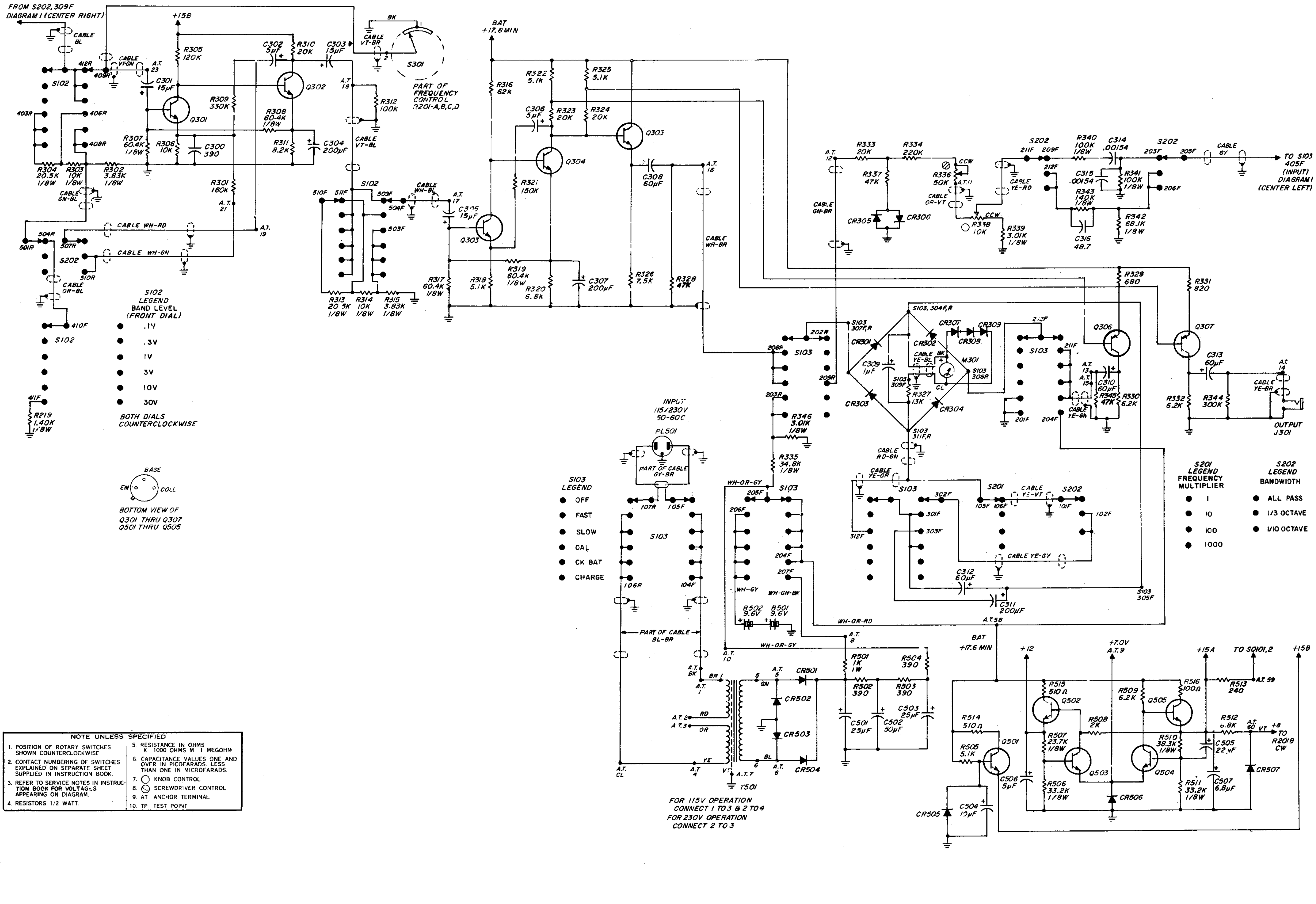


Figure 4-2. Schematic diagram of Type 1564-A Sound and Vibration Analyzer.



NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS. LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT ANCHOR TERMINAL
10. TP TEST POINT

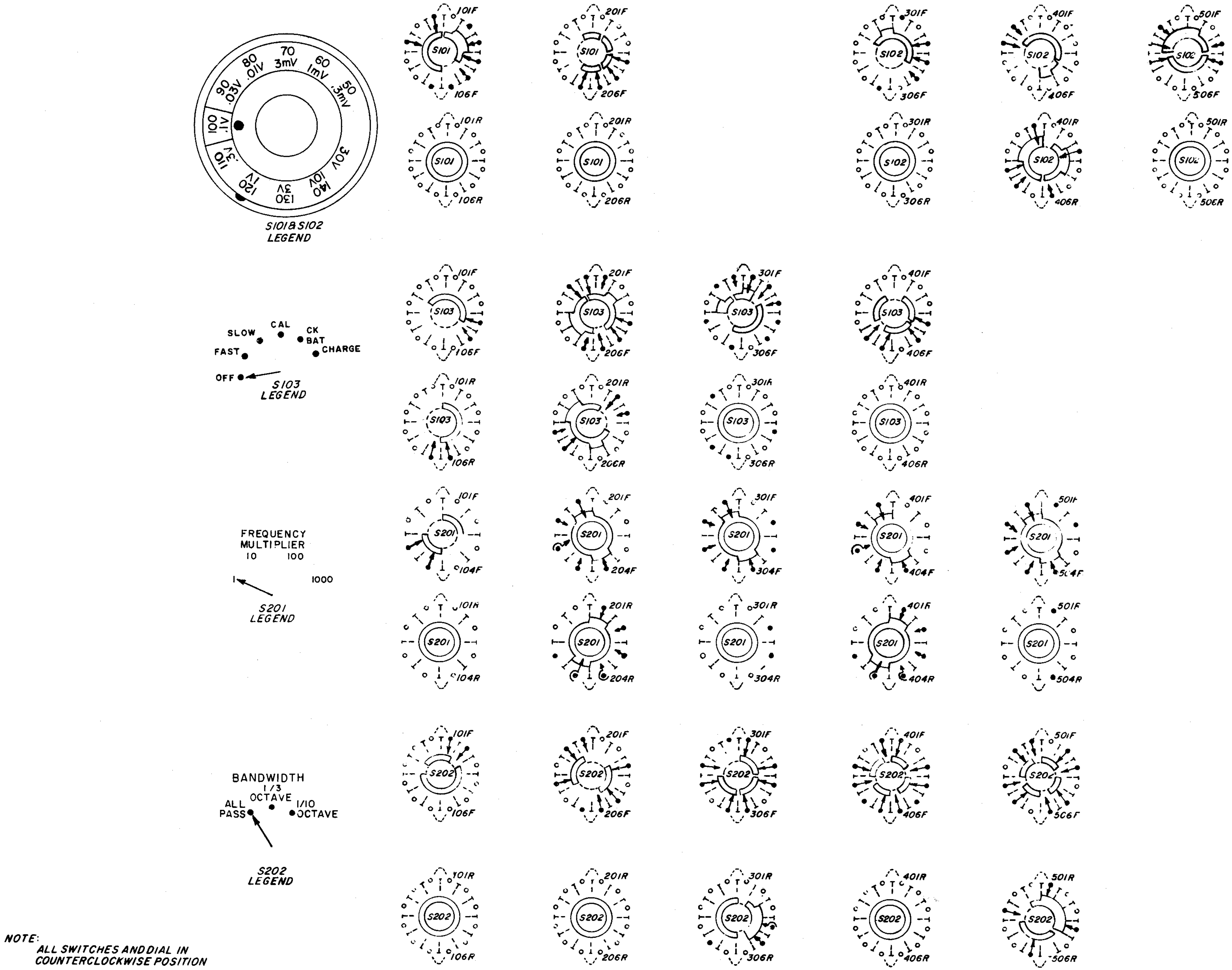


Figure 4-3. Rotary switch detail drawing.

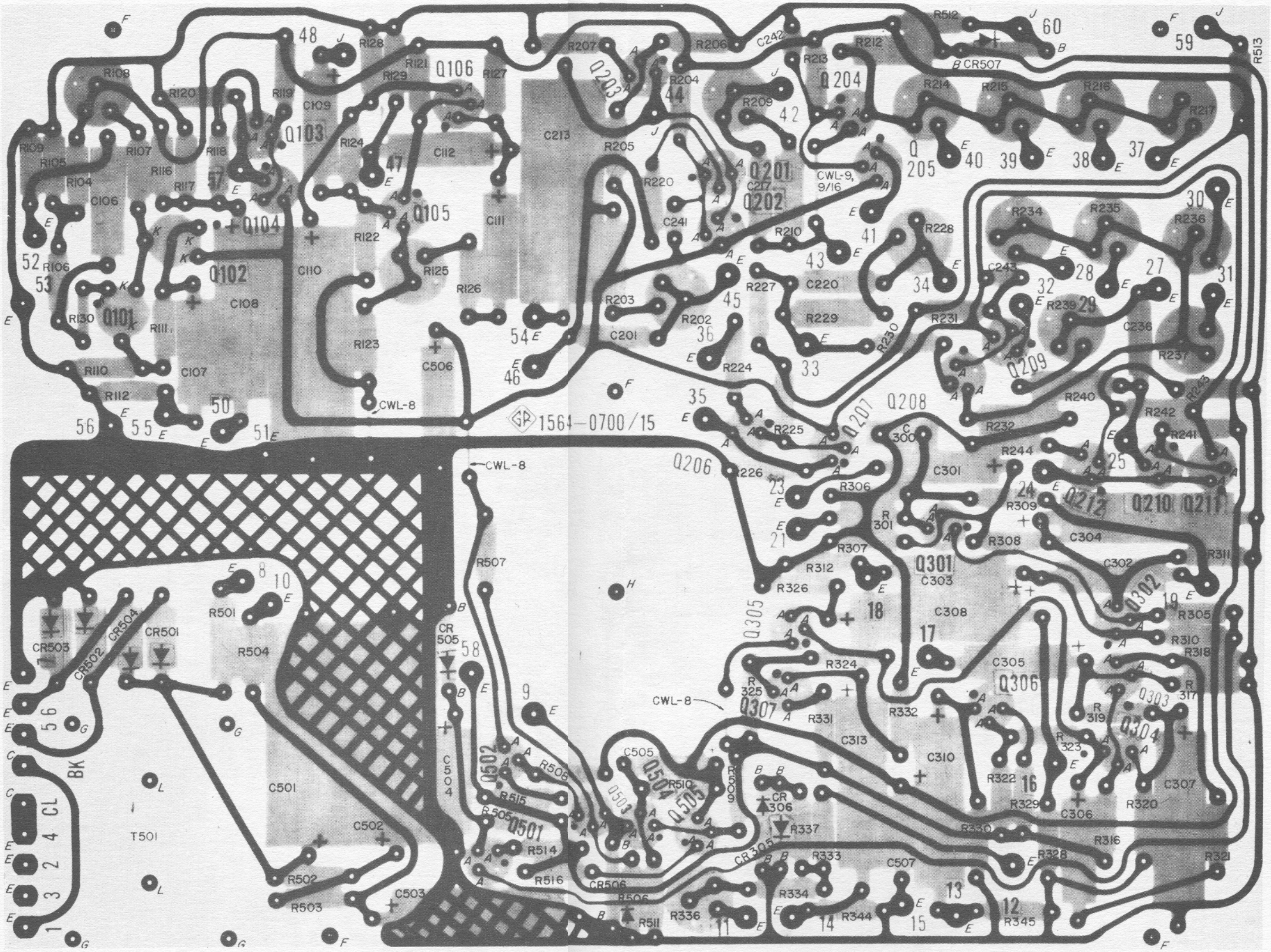


Figure 4-4. Etched-circuit board for Type 1564-A Sound and Vibration Analyzer.

APPENDIX

TYPE 1560-P5 MICROPHONE AND TYPE 1560-P6 MICROPHONE ASSEMBLY

SPECIFICATIONS

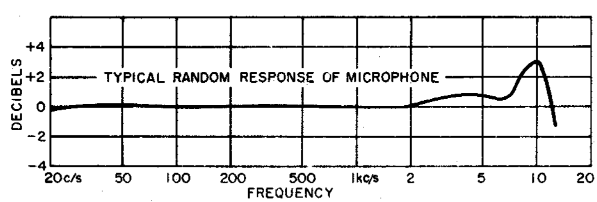
(See Figure 1-2 and paragraph 1.6.1)

Frequency Response: Typical response is shown in the accompanying plot. Deviations of individual units from the typical response are approximately ±0.3 dB from 20 to 1000 c/s and ±1 dB up to about 7000 c/s.

Sensitivity: −60 dB re 1 V/μbar nominal.

Temperature Coefficient of Sensitivity: Approximately −0.01 dB/°C.

Internal Impedance: Capacitive; Type 1560-P5, 390 pF at 25°C, nominal; Type 1560-P6, 425 pF at 25°C, nominal. Temperature coefficient of capacitance: 2.2 pF/°C over range of 0 to 50°C.



Environmental Effects: Microphone is not damaged by temperatures from −30 to +95°C and relative humidities of 0 to 100%.

Terminals: Microphones fit 3-terminal microphone cable connector. For hum reduction both microphone terminals may be floated with respect to ground.

Cartridge Dimensions: Diameter 0.936 ± 0.002 in (23.7 mm), length 1⅛ in (29 mm).

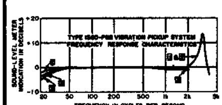
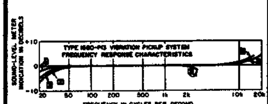
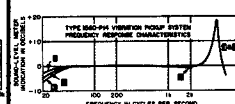
Net Weight: Type 1560-P5, 2 oz (60 g); Type 1560-P6, 8 oz (0.3 kg).

Shipping Weight: Type 1560-P5, 1 lb (0.5 kg); Type 1560-P6, 3 lb (1.4 kg).

TYPES 1560-P11B, 1560-P13, AND 1560-P14 VIBRATION PICKUP SYSTEMS

SPECIFICATIONS

(Refer to paragraph 1.6.2)

	Type 1560-P11B Vibration Pickup System	Type 1560-P13 Vibration Pickup System	Type 1560-P14 Vibration Pickup System
Ranges of Measurement **Rms Acceleration (in/s²)**	0.1 to 39,000 (100 g)†	0.3 to 390,000 (1000 g)†	0.01 to 3900 (10 g)†
Rms Velocity (in/s)	0.001 to *	0.001 to 1000	0.0001 to *
Rms Displacement (in)	0.00003 to *	0.00003 to 30	0.000003 to *
Frequency Range Response characteristics for constant applied (1) acceleration, (2) velocity, and (3) displacement.			
Net Weight of System (lb)	1¾ (0.8 kg)	1¾ (0.8 kg)	2 (1 kg)
Shipping Weight (lb)	5 (2.3 kg)	5 (2.3 kg)	5 (2.3 kg)
Catalog Number	1560-9922	1560-9613	1560-9614

Pickup Characteristics

Pickup Type Number	Type 1560-P52	Type 1560-P53	Type 1560-P54
Sensitivity (mV/g), nominal	75	72	580
Temp Coeff of Sens (dB/°C)	0.06	<0.02	0.01
Resonant Frequency (c/s)	3200	35,000	5000
Capacitance (pF)	10,000	350	700
Temperature Range (°C)	0 to 75	−18 to 120	−18 to 120
Relative Humidity Range (%)	0 to 100	0 to 100	0 to 100
Cable Length (ft)	5 (1.55 m)	8 (2.5 m)	8 (2.5 m)
Dimensions (in)	1⅝ by 1⁷⁄₁₆ by ⁹⁄₁₆	⅝ hex by 0.7	1³⁄₁₆ dia by 1¹⁄₁₆
(mm)	42 by 37 by 15	15.5 by 18	31 by 27
Net Weight (oz)	1.6 (45 grams)	1.1 (31 grams)	3.1 (90 grams)
Catalog Number	1560-9652	1560-9653	1560-9654

* Upper limit of displacement and velocity measurements depends upon frequency and is determined by the maximum acceleration possible before nonlinearity occurs (100 g for Type 1560-P11B, 10 g for Type 1560-P14).
† g = acceleration of gravity.

TYPE 1560-P40 PREAMPLIFIER

SPECIFICATIONS

(See Figure 1-5 and paragraph 1.6.4)

Gain: 1:1 or 10:1 (20 dB) ± 0.3 dB.

Input Capacitance: 6 pF.

Input Resistance: >500 MΩ at low audio frequencies.

Output Resistance: 1:1 gain – approx 5 Ω.
10:1 gain – approx 100 Ω.

Noise: ≤2.5 μV equivalent input voltage (400-pF source impedance, C-weighted, 8-kc effective bandwidth).

Frequency Response: ±0.3 dB from 5 c/s to 500 kc/s.

Harmonic Distortion at Audio Frequencies:

Open circuit, at 1 V, peak-to-peak: <0.25%.

Capacitor load of 0.01 μF (equivalent to a cable over 200-ft long): Maximum output (peak-to-peak) at 1% distortion is 5 V for 1 kc/s, 2 V for 10 kc/s.

Accessories Available (in combinations listed below): Power supply, includes two 9.6-volt nickel-cadmium rechargeable batteries, a charging circuit, a battery-check light, and a power cord.

Types 1560-P96, 1560-P97, and 1560-P98 Adaptors for converting the input pin connections to 3-terminal shielded microphone connectors, to the pin sockets necessary for the cartridge of a Type 1560-P3 Microphone, and to a General Radio Type 874 Connector, respectively.

Types 1560-P72 (25-ft) and 1560-P72C (4-ft) cables for supplying power to and transferring the signal from the preamplifier.

Type 1560-P95 Adaptor Cable for connecting the signal from the power supply through a cable to a Type 274 Double Plug.

Type 1560-P99 Adaptor Cable for connection from phone plug to microphone plug.

Power Supply: 15 V to 25 V, 1 mA to 2 mA, dc.

Dimensions: length 6⅞, diameter 1.155 by 1 in (175, 30, 26 mm).

Net Weight: 9 oz (0.3 kg).

Shipping Weight: 3 lb (1.4 kg).

TYPE 1560-P40H PREAMPLIFIER AND POWER SUPPLY SET

Consists of:
- Type 1560-P40 Preamplifier
- Type 1560-P96 Adaptor
- Type 1560-P98 Adaptor
- Type 1560-P95 Adaptor Cable
- Type 1560-P99 Adaptor Cable
- Type 1560-P72C Cable (4 ft)
- Type 874-Q2 Adaptor
- Power Supply

Shipping Weight: 10 lb (4.6 kg).

TYPE 1560-P40J PREAMPLIFIER AND ADAPTOR SET

Consists of:
- Type 1560-P40 Preamplifier
- Type 1560-P96 Adaptor
- Type 1560-P97 Adaptor
- Type 1560-P98 Adaptor
- Type 1560-P72C Cable (4 ft)

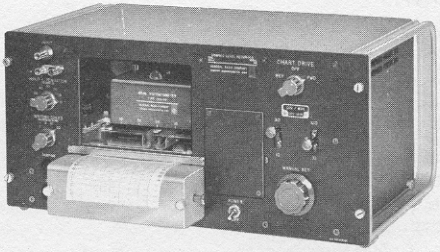
Shipping Weight: 4 lb (1.9 kg).

TYPE 1560-P40K PREAMPLIFIER AND MICROPHONE SET

Consists of:
- Type 1560-P40 Preamplifier
- Type 1560-P72C Cable (4 ft)
- Type 1560-P72 Cable (25 ft)
- Type 1560-P32 Tripod
- Microphone Cartridge

Shipping Weight: 14 lb (6.5 kg).

ACCESSORY INSTRUMENTS

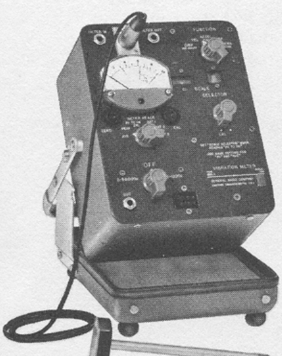


TYPE 1521 GRAPHIC LEVEL RECORDER

Plots linearly in db on 4-inch chart paper the rms level of a-c voltages from 20 cps to 200 kc. Ideal for plotting the responses of electro-acoustical devices as a function of frequency. Can be coupled to oscillators and analyzers for automatic plotting. Recorder range is 40 db full scale with plug-in potentiometer supplied (20-db, 80-db, and dc potentiometers also available). Recorder sensitivity is 1 mv (0-db point) and can be varied from 1 mv to 1 v in 6 steps with input attenuator. Writing speed is 20 in./sec with 40-db pot (200 db/sec) with less than 1-db over-shoot. Slower speeds (1, 3, or 10 in./sec) can be selected by switch to provide filtering of rapidly varying levels. Four paper speeds: 2.5, 7.5, 25 and 75 in./min. (Optional models available with speeds from either 2.5 to 75 in./hr or 0.5 to 15 in./min.)

TYPE 1557-A VIBRATION CALIBRATOR

Provides simple, accurate, and rapid calibration of vibration pickups. This battery-operated instrument makes possible single-frequency calibration of a wide variety of accelerometers ranging in mass up to 300 grams. G-R Types 1560-P51, 759-P35 and 761-P1 Vibration Pickups may be easily calibrated with this instrument as well as accelerometers of other manufacture.



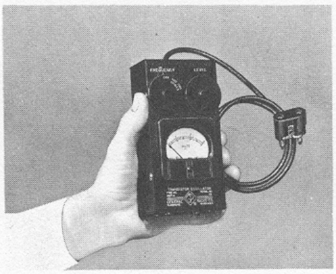
TYPE 1553-A VIBRATION METER

Basically, the Vibration Meter is a vtvm specifically designed to amplify and measure the outputs from a wide variety of vibration pickups. The pickup delivers a voltage proportional to the acceleration of the vibrating body. Integrating networks convert the pickup's output to a voltage proportional to either velocity or displacement.

A differentiating network converts the pickup's output to a voltage proportional to time rate of change of acceleration (jerk) which no other instrument can do.

TYPE 1552-B SOUND-LEVEL CALIBRATOR

A convenient accessory for making acoustical checks on the over-all sensitivity of a sound-level meter, including microphone (whether ceramic, crystal, dynamic or condenser) and circuitry, operating as a unit.



TYPE 1307-A TRANSISTOR OSCILLATOR

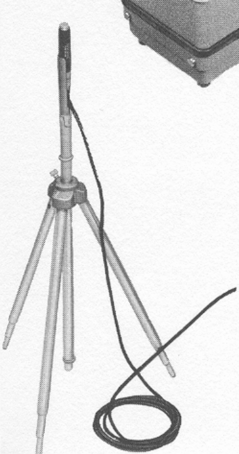
Type 1307-A Transistor Oscillator especially designed for use with the Calibrator above. Serves as both the oscillator and input voltmeter in calibrations.

TYPE 1551-C SOUND-LEVEL METER

Meets all specifications of the American Standards Association. Range is 24 to 150 db above 0.0002 μbar with better than 1-db accuracy. Completely self-contained calibration circuit (no 115-volt line needed). A new sensitivity adjustment, calibrated directly in terms of microphone sensitivity, makes for convenient use of accessory microphones for specialized measurements. Uses new ceramic microphone that withstands temperatures from -30° to 95°C and humidities to 100%.

1531-A STROBOTAC® ELECTRONIC STROBOSCOPE

New long-throw, narrow-beam light reaches into interior of operating equipment. Flash duration only one to six millionths of a second -- freezes rapidly rotating objects (practically no blur) permitting observation of fine details impossible to see with other stroboscopes. 110 to 25,000 rpm using multiple image techniques. Unit is completely self-contained and operates from 115-volt ac power.



TYPE 1560-P34 TRIPOD AND EXTENSION CABLE

To mount the Type 1560-P3 PZT Microphone. It includes the Type 1560-P32 Tripod and the Type 1560-P73 25-foot Extension cable. A 100-foot cable (Type 1560-P73B) is also available separately.

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