GenRad

Microphones and Accessories

Includes

Ceramic Microphones
Electret-Condenser Microphones
1560-P42 Preamplifier
1560-P62 Power Supply
1972-9600 Preamplifier/Adaptor
1560-P40 Preamplifier
1945-9730 Weatherproof Microphone

Form No. 1961-0100-I

Instruction Manual

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Contents

NOTE
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Concord, Massachusetts, 01742
July, 1979

GenRad

WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable GenRad specifications. If within one year after original shipment it is found not to meet this standard, it will be repaired or, at the option of GenRad, replaced at no charge when returned to a GenRad service facility. Changes in the product not approved by GenRad shall void this warranty. GenRad shall not be liable for any indirect, special, or consequential damages, even if notice has been given of the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

GenRad policy is to maintain product repair capability for a period of ten years after original shipment and to make this capability available at the then prevailing schedule of charges.

Handbook of Noise Measurement

This book, by Dr. A. P. G. Peterson and Ervin E. Gross, Jr., of the GenRad Engineering Staff covers thoroughly the subject of noise and vibration measurement. Copies are available from GenRad at $9.00 each, postpaid in the United States and Canada.

Specifications

1971-9601 1-INCH CERAMIC MICROPHONE, 1971-9605 1-INCH CERAMIC MICROPHONE (1560-P5) and 1971-9606 MICROPHONE ASSEMBLY (1560-P6).

Frequency: Curve shows typical response and guaranteed limits; individual response curve supplied with each microphone. Below 20 Hz, the microphone is typically flat ±1 dB down to 5 Hz. Time constant of pressure-equalizing leak is typically 0.08 s.

Sensitivity Level: NOMINAL: −40 dB re 1 V/Pa (−60 dB re 1 V/μbar); MINIMUM: −42 dB re 1 V/Pa (−62 dB re 1 V/μbar). TEMPERATURE COEFFICIENT: ≈ −0.01 dB/°C. KEY SOUND-PRESSURE LEVELS: <1% distortion at 150 dB; at −184 and +174 dB peak, microphone may fail.

Impedance: For 1971-9601 and −9605, 385 pF ±15% at 23°C; for 1560-9606, 405 pF ±15% at 23°C. TEMPERATURE COEFFICIENT of Z, for both: 2.2 pF/°C from 0 to 50°C.

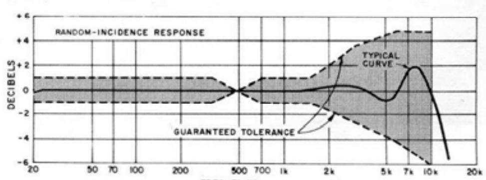
Environment: TEMPERATURE: −40 to +60°C operating. HUMIDITY: 0 to 100% RH operating.

Terminals: 1971-9601 – Coaxial with 0.46-60 thread for mounting on 1560-P42 or 1972-9600 preamplifiers. Center terminal is signal, outer terminal (shell) is ground. Threaded adaptor may be removed for mounting on 1560-P40 preamplifier.

1971-9605 – Microphone cartridge fitted with 3-terminal audio connector.

1971-9606 – Microphone cartridge with flexible conduit and 3-terminal audio connector.

Mechanical: DIMENSIONS: Cartridge only, 1.13 in. (29 mm) long, 0.936 ± .002 in. (23.7 mm ± 50 μm) dia; 1560-P5 assembly, 2.31 in. (59 mm) long, 0.94 in. (24 mm) dia; 1560-P6 assembly, 11.75 in. (298 mm) long, 0.94 in. (24 mm) dia. WEIGHT: 1560-P5, 0.2 lb (0.1 kg) net, 1 lb (0.5 kg) shipping; 1560-P6, 0.7 lb (0.3 kg) net, 2 lb (0.9 kg) shipping.



Typical performance

with the 1560-P42 and 1972-9600 Preampliers (Unity Gain)

Frequency Range	"System" Sensitivity re 1 V/Pa	Dynamic Range* re 20μPa
5 Hz to 12.5 kHz	−40 dB	22 to 145 dB

*A-weighted noise level to maximum rms sinewave signal without clipping.

1961 1-Inch Electret-Condenser Microphones

Frequency: Curves show typical response and guaranteed limits; individual response curve supplied with each microphone. Below 20 Hz, the microphone is typically flat ±1 dB down to 15 Hz. Microphone is essentially omnidirectional.

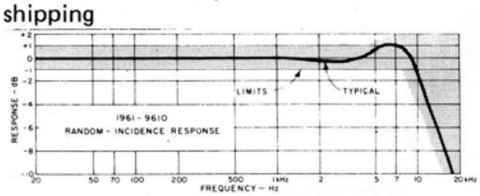
Sensitivity Level: NOMINAL: −38 dB re 1 V/Pa (−58 dB re 1 V/μbar). TEMPERATURE COEFFICIENT: ≈ + 0.01 dB/°C from 0 to +55°C. MAXIMUM SOUND-PRESSURE LEVEL: 160 dB absolute max.

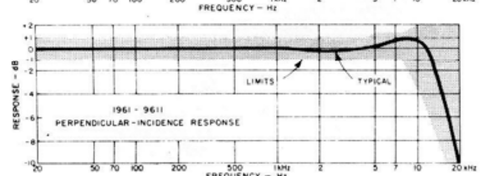
Impedance: Nominally 63 pF at 23°C and 1 kHz.

Environment: −20 to +60°C and 90% RH operating; 1-year exposure in an environment of +55°C and 90% RH causes negligible sensitivity change.

Vibration Sensitivity: 83 dB equivalent SPL from 1 g (perpendicular to diaphragm) at 20 and 100 Hz.

Mechanical: TERMINALS: Coaxial, with 0.907-60 thread, adapted to 0.460-60 (threads per in.). DIMENSIONS: 0.936 ±0.001 in. dia x 0.670 in. long (1.060 in. long with adaptor) (23.77 ±0.025 x 17 mm). WEIGHT: 1 oz (28 g) net, 1 lb (0.5 kg) shipping





Typical performance
with 1560-P42 and 1972-9600 Preamplifiers (Unity Gain)

Microphone	Frequency Range	"System" Sensitivity re 1 V/Pa	Dynamic Range* re 20 μPa
1961-9610	15 Hz to 12 kHz	−38 dB	22 to 140 dB
1961-9611	15 Hz to 15 kHz	−38 dB	22 to 140 dB

*A-weighted noise level to maximum rms sinewave signal without clipping.

Description	Catalog Number
1961 Electret-Condenser Microphones	
Flat random-incidence response, 1-inch	**1961-9610**
Flat perpendicular-incidence response, 1-inch	**1961-9611**

U.S. Patent No. 4,070,741

1962 ½-Inch Electret-Condenser Microphones

Frequency: Curves show typical response and guaranteed limits; individual response curve supplied with each microphone. Below 20 Hz, the microphone is typically flat ±1 dB down to 15 Hz. Microphone is essentially omnidirectional.

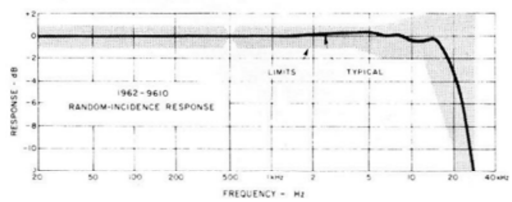
Sensitivity Level: NOMINAL: −40 dB re 1 V/Pa (−60 dB re 1 V/μbar). TEMPERATURE COEFFICIENT: +.01 dB/°C from 0 to +55°C. MAXIMUM SOUND-PRESSURE LEVEL: 170 dB absolute max.

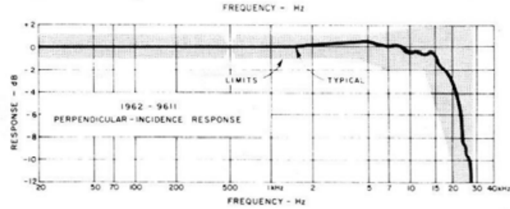
Impedance: Nominally 22 pF, at 25°C and 1 kHz.

Environment: −20 to +60°C and 99% RH operating; 1-year exposure in an environment of +55°C and 90% RH causes negligible sensitivity change.

Vibration Sensitivity: 83 dB equivalent SPL from 1 g (perpendicular to diaphragm) at 20 and 100 Hz.

Mechanical: TERMINALS: Coaxial, with 0.460-60 thread. DIMENSIONS: 0.500 ±.001 in. dia x0.615 ±(12.70 ±.012 x 15.6 mm). WEIGHT: 0.25 oz (7 g) net, 1 lb (0.5 kg) shipping.





Typical performance
with 1560-P42 and 1972-9600 Preamplifiers (Unity Gain)

Microphone	Frequency Range	"System Sensitivity re 1 V/Pa	Dynamic Range* re 20 μPa
1962-9610	15 Hz to 19 kHz	−40 dB	30 to 145 dB
1962-9611	15 Hz to 24 kHz	−40 dB	30 to 145 dB

* A weighted noise level to maximum rms sinewave signal without clipping

Description	Catalog Number
1962 Electret-Condenser Microphones	
Flat random-incidence response, ½-inch	**1962-9610**
Flat perpendicular-incidence response, ½-inch	**1962-9611**

U.S. Patent No. 4,070,741

TYPE 1560-P42 PREAMPLIFIER (CAT. NO. 1560-9642)

Gain: 1:1 or 10:1 (20 dB) ±0.3 dB at 25°C, slide-switch controlled; <±0.3-dB gain change, from that at 25°C, from −30 to +65°C.

Frequency Response (at 1-V rms open-circuit output behind 600 Ω, −30 to +55°C):

<table>
<tr><th></th><th>3 Hz – 5 Hz</th><th>5 Hz – 20 Hz</th><th>20 Hz – 100 kHz</th><th>100 kHz – 300 kHz</th><th>300 kHz – 500 kHz</th></tr>
<tr><td>1:1 gain</td><td>±3 dB</td><td>±1 dB</td><td>±0.25 dB</td><td colspan="2">±1 dB</td></tr>
<tr><td>10:1 gain</td><td>±3 dB</td><td>±1.5 dB</td><td>±0.3 dB</td><td>±2 dB</td><td></td></tr>
</table>

Impedance: INPUT: ≈ 2 GΩ in parallel with < 6 pF; driven shield reduces input-capacitance loading for condenser microphones. OUTPUT: ≈ 15 Ω in series with 10 μF.

Output: SIGNAL: Up to 11 V pk-pk to 10 kHz into open circuit with 15-V supply, decreasing to 2 V pk-pk for 1:1 gain and 1 V pk-pk for 10:1 gain at 100 kHz. Up to 10-mA rms output with 1560-P62 Power Supply. POLARIZING VOLTAGE: +200 V ±5% behind 1.2 GΩ dc source resistance; on-off slide-switch controlled; temperature coefficient 0.1%/°C; frequency >50 kHz.

Noise: <3.5-μV equivalent input with 390-pF source capacitance, C-weighted, 10-kHz effective bandwidth.

Distortion: <0.25% harmonic distortion at 1 kHz with 1-V rms open-circuit output; <1% at 10 kHz with 1-V rms output into 0.1 μF (equivalent to 2000 ft of cable).

Terminals: INPUT: 0.460 x 60 thread for direct connection to ½-in. microphones and adaptors. ACCEPTS INSERT CALIBRATION SIGNAL: 10 Ω ± 20% insert resistance, <0.5-dB nominal loss between connector and microphone terminals, 1-V rms max insert voltage. OUTPUT: 10-ft cable with 3-pin A3 mike connector, separate ground and shield reduce sensitivity to interference.

Power: +15 to +25 Vdc, 1 to 2 mA idling (200 V off) or 3 to 5 mA idling (200 V on). Available directly from 1523, 1558, 1568, 1564, 1909, 1911, 1913, 1921, or 1925 Analyzers, 1525 Recorder, 1561 Sound-Level Meter, 1934 Noise-Exposure Meter, 1566 Multichannel Amplifier, or from 1560-P62 power supply when preamplifier is to be used with 1565 or 1551 Sound-Level Meter, 1553 Vibration Meter, and 1900 or 1910 Analyzer.

Mechanical: DIMENSIONS (less cable): 6.75 in. (170 mm) long x 0.5 in. (13 mm) dia. WEIGHT (with cable): 1 lb (0.5 kg) net, 3 lb (1.4 kg) shipping.

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1972-9600 PREAMPLIFIER/ADAPTOR (CAT. NO. 1972-9600)

Gain: 0 dB, +0 −0.25 dB, at 1 kHz.
Frequency Response: ±1 dB, 5 Hz to 100 kHz; ±3 dB, 3 Hz to 500 kHz (at 0.1 V rms output into an open circuit, driven from 600-Ω source).

Input Impedance: ≈ 3 pF in parallel with 2 GΩ, at low audio frequencies.

Output Impedance: Less than 20 Ω in series with 6.8 μF.

Output: MAXIMUM VOLTAGE AVAILABLE: ≥10 V pk-pk, open circuit, at frequencies ≤100 kHz, with +15-V supply. CURRENT (available): >1 mA, pk, with +15-V supply.

Noise: <2.5 μV equivalent input noise voltage, with 390 pF source capacitance, C weighted.

Distortion: 0.1% total harmonic distortion for frequencies ≤100 kHz, at 1 V rms output level, open circuit, +15-V supply.

Terminals: INPUT: Coaxial, with 0.460 x 60 thread for direct connection to most microphones. OUTPUT: Switchcraft type A3M microphone connector, mates with 3-wire extension cables 1560-9665, -9666, -9667.
Power: 9 to 25 V (1 mA at 9 V). Available from most GR analyzers or 1560-P62 power supply. (See list with 1560-P42.)

Mechanical: DIMENSIONS: 0.75 in. dia x 3.44 in. long (19x 87 mm). WEIGHT: 3 oz (85 g) net.

1560-P62 POWER SUPPLY

Input: 100 to 125 or 200 to 250 V, 50 to 60 Hz.

Output: 18 to 21 V dc, 15 mA max; automatic limiting protects supply and prevents deep battery discharge. BATTERIES: Two rechargeable Ni-Cd batteries provide up to 225 mA-hours operation at room temperature between charges. RIPPLE: <5 mV rms in CHARGE-OPERATE mode. CHARGE TIME: 14 to 16 h for completely discharged battery, constant 22-mA battery-charging current. Rear-panel slide switch selects internal or external battery.

Interface: INPUT (from preamp): Power to, and signal from, preamplifier. Use Switchcraft type A3M microphone connector. OUTPUT (to analyzer): Signal from preamplifier and remote power control. Use Switchcraft type A3F microphone connector. ADDITIONAL OUTPUT: Miniature phone jack for connection to 1933 sound-level meter/analyzer and patch cable fitted with miniature phone plugs (listing follows).
Supplied: 1560-9665 4-ft cable to connect to 1551, 1561, 1564, etc; 1560-9668 4-ft adaptor cable to connect to 1900, 1910, etc, and cable to connect to 1561 charging terminals.
Remote Operation: With line voltage not connected, preamplifier can be set to Operate-Only mode by signal of +15 to 25 V at 300 μA.
Environmental: TEMPERATURE: −15 to +50°C operating.
Mechanical: Convertible Bench cabinet. DIMENSIONS (wxhxd): Bench, 8.5x3.84x5.5 in. (216x98x140 mm); rack, 19x3.84x6.02 in. (483x98x153 mm). WEIGHT: Bench, 3 lb (1.4 kg) net, 5 lb (2.3 kg) shipping; rack, 5.5 lb (2.5 kg) net, 8 lb (3.7 kg) shipping.

1560-P40 PREAMPLIFIER (CAT. NO. 1560-9640)

Frequency Response:

	3 Hz	5 Hz	20 Hz	250 kHz	500 kHz
1:1 gain		±1 dB	±0.25 dB		
10:1 gain	±3 dB	±1.5 dB	±0.25 dB	±1.5 dB	

Gain: 1:1 or 10:1 (20 dB) ±0.3 dB at 25°C, slide-switch controlled; <±0.3-dB gain change (from that at 25°C) from −30° to +55°C.

Impedance: INPUT: 6 pF, >500 MΩ at low audio frequencies. OUTPUT: ≈20 Ω in series with 3.3 μF at 1:1 gain, ≈100 Ω in series with 3.3 μF at 10:1 gain.

Noise: <2.5-μV equivalent input with 400-pF source capacitance. C weighted, 10-kHz effective bandwidth.

Distortion: <0.25% harmonic distortion at audio frequencies with 1 V pk-pk open-circuit output; 1% at 1 kHz with 5 V pk-pk into 0.01 μF (equivalent to 200 ft of cable); 1% at 1 kHz with 2 V pk-pk into 0.01 μF.

Available: Ceramic microphones, vibration pickups, tripod, cables, and adaptors. **1560-P96** adaptor converts input to accept 3-pin mike connectors.

Power: +15 to +25 V dc, 1 to 2 mA. Available from same sources as 1560-P42.

Mechanical: DIMENSIONS: 6.88 in. (175 mm) long × 1.56 in. (30 mm) dia. WEIGHT: 0.6 lb (0.3 kg) net, 3 lb (1.4 kg) shipping.

1945-9730 WEATHERPROOF MICROPHONE SYSTEM

The 1945-9730 is a complete weatherproof microphone system for outdoor noise monitoring. It is designed to protect its integral 1560-P42 Preamplifier and a microphone (not included) in an outdoor environment. The windscreen system provided protects the microphone from damage and reduces the effect of wind on the noise measurement. One of the following microphones should be used with the system:

1961 1-in. (23.81 mm) Electret-Condenser Microphone
1962 ½-in. (12.70 mm) Electret-Condenser Microphone
1972 1-in. (23.81 mm) Ceramic Microphone

Gain: 1:1 or 10:1 (20 dB) ±0.3 dB at 25°C, slide switch selected; <±0.3 dB change from that at 25°C, from −30 to +65°C.

Frequency: Measured at 1 V rms output into open circuit with 600 Ω source, −30°C to +55°C.

	3 Hz – 5 Hz	5 Hz – 20 Hz	20 Hz – 100 kHz	100 kHz – 300 kHz	300 kHz – 500 kHz
1:1 gain	±3 dB	±1.0 dB	±0.25 dB	±1 dB	
10:1 gain	±3 dB	±1.5 dB	±0.3 dB	±2 dB	

Input Impedance: Approximately 2 GΩ in parallel with less than 6 pF. Driven shield reduces input capacitance loading for condenser microphones.

Output Impedance: Approximately 15 Ω in series with 3.3 μF. Up to 11 V pk-pk into open circuit with 15 V supply, at frequencies up to 10 kHz. Decreasing to 2V pk-pk for 1:1 gain and 1 V pk-pk for 10:1 gain at 100 kHz. Up to 10 mA rms output (sinewave) with 1560-9575 Power Supply.

Distortion: <0.25% harmonic distortion at 1 kHz with 1 V rms into open circuit load: <1% at 10 kHz with 1 V rms into 0.1 μF (equivalent to 2000 ft. (600 m) of cable).

Polarizing Voltage: +200 V ±5% behind approximately 1.2 GΩ (DC source resistance.) slide-switch selected. Temperature coefficient approx. +0.1%/°C.

Noise: <3.5 μV equivalent input noise with 390 pF source capacitance, C-weighted (10 kHz effective bandwidth).

Insert Terminals: Accepts insert calibration signal. Insert resistance 10 Ω ±20%. Nominal loss between connector and microphone terminals <0.5 dB. Maximum insert voltage 1 V rms.

Power: +15 to 25 Vdc 1-2mA idling (200-V polarizing supply off), 3-5mA idling (200 V on).

Connectors: Input connector 0.460-60 thread for direct connection to 1/2 in. microphones and adaptors. Output (signal) connector (male) 4-pin shielded GR type 1933-0410. Supplied with 1560-10-ft (3 m) cable with switchcraft type A3, 3-terminal microphone connector on opposite end. Type 1933-9601 60-ft. (18.5 m) extension cable (not supplied) may be connected between preamplifier output and 10-ft. (3 m) cable.

Wind: 30-mph wind typically produces 65-dBA reading.
15-mph wind typically produces 55-dBA reading.

Rain: Saturation of windscreen from heavy rain typically reduces sensitivity ⩽ 2 dB for frequency ⩽ 20 kHz.

Humidity: 99% relative humidity at 50°C for a period of two weeks will not affect performance.

Mechanical Data:

HEIGHT		WIDTH		DEPTH		NET WEIGHT		SHIPPING WEIGHT	
in	mm	in.	mm	in.	mm	lb	kg	lb	kg
23.68	601	5.4	138	3.0	76	4	2	11	5

Introduction—Section 1

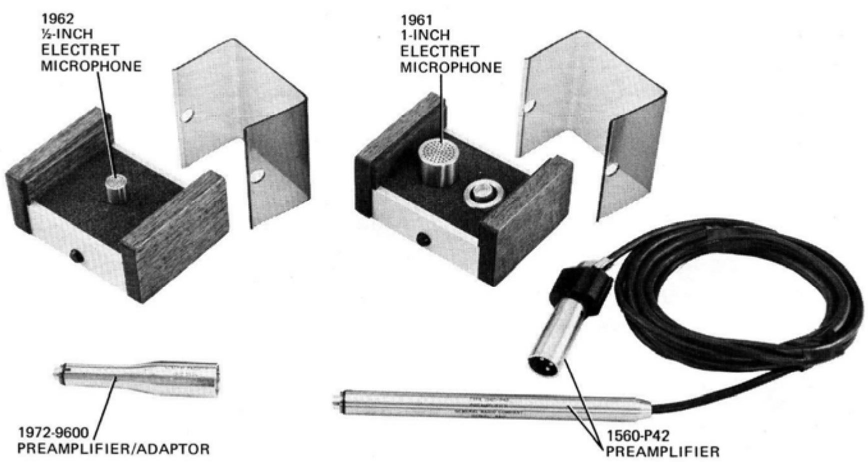

Figure 1-1. A complete line of microphones and accessories is available from GenRad. A few are shown above.

1.1 DESCRIPTION.

1.1.1 General.

This book contains a complete description of the GenRad ceramic and electret-condenser microphones (Figure 1-1). The many available accessories are also described and details of their uses are given. Among the accessories are the GR Type 1560-P42 Preamplifier and the 1560-P62 Power Supply, which is required with the Preamplifier when it is used with sound-measuring instruments that do not include a source of power to operate the Preamplifier. Other available accessories described include the 1972-9600 Preamplifier/Adaptor, 1560-P40 Preamplifier, 1560-9590 Tripod, microphone windscreens and miscellaneous adaptors and cable.

Table 1-1
TYPICAL CHARACTERISTICS FOR MICROPHONES

GR Catalog Number	Microphone Type	Response Characteristic	Open-Circuit Sensitivity −dB re 1 V/N/m²	Cartridge Capacitance pF	Lower Frequency limit Hz	Upper Frequency limit kHz
1971-9605	GR 1 in. Ceramic	Flat Random Incidence	−40	380	15	12.5
1961-9610	GR 1 in. Electret	Flat Random Incidence	−38	65	15	12
1961-9611	GR 1 in. Electret	Flat Perpendicular Incidence	−38	65	15	15
1962-9610	GR 1/2 in. Electret	Flat Random Incidence	−40	24	15	19
1962-9611	GR 1/2 in. Electret	Flat Perpendicular Incidence	−40	24	15	24

1.1.2 Ceramic Microphones.

Ceramic microphones are noted for their ruggedness, stability and reliability. Their low impedance results in low preamplifier noise and high sensitivity, and contributes to good performance under conditions of relatively high humidity. Complete details of the GR ceramic microphones are given in Section 3.

1.1.3 Electret-Condenser Microphones.

These microphones feature very uniform high-frequency performance in both flat random- and perpendicular-incidence versions. Available in 2 sizes, they do not require a polarization voltage. Thus, they can be used with inexpensive preamplifiers, such as the 1972-9600, described in Section 6. The electret-condenser microphones are fully described in Section 3.

Figure 1-2. Type 1560-P42 Preamplifier with microphone attached.

1.1.4 Preamplifier.

The Type 1560-P42 Preamplifier (Figure 1-2) is specifically designed to amplify the output from a capacitive source, such as an air-condenser, electret-condenser or

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ceramic microphone, or a piezoelectric vibration pickup. It also provides step-down impedance so that long cables can be used between the microphone/preamplifier combination and GR sound-level meters or analyzers without signal loss. It can be used to increase the sensitivity and input impedance of amplifiers, analyzers, counters, recorders, and similar instruments; it can also serve as a general-purpose audio preamplifier for resistive or capacitive sources.

The Preamplifier incorporates a 3-stage amplifier with a low-noise FET input stage and class AB output stage. Excellent stability is obtained with ac and dc feedback. A slide switch offers a choice of X1 or X10 gain, controlled by ac feedback. A self-contained oscillator/rectifier circuit supplies the polarizing voltage (+200 V) for air-condenser microphones that can be switched off when ceramic or electret condensor microphones are used. The oscillator operates at approximately 60 kHz.

The Preamplifier is housed in a stainless-steel tube 6 1/2 in. long with a 1/2-in. diameter. A detachable 10-ft output cable is furnished. Details of the Preamplifier are given in Section 4.

1.1.5 Power Supply.

Power for the Preamplifier (15-25 V dc, 15 mA maximum) can be obtained from most GR sound-level meters and analyzers, as noted in Table 1-2. The 1560-P62 shielded, battery-powered supply is available for use with other instruments or where more supply current is required for driving large signals through long cables. The 1560-P62 includes 2 nickel-cadmium batteries with charging circuitry. Load-current is limited to prevent damage to the Preamplifier in the event of shorted lines. Provision has been made to turn the -P62 power on or off from a remote analyzer.

For the description and use of the 1560-P62 Power Supply, refer to Section 5 of this book.

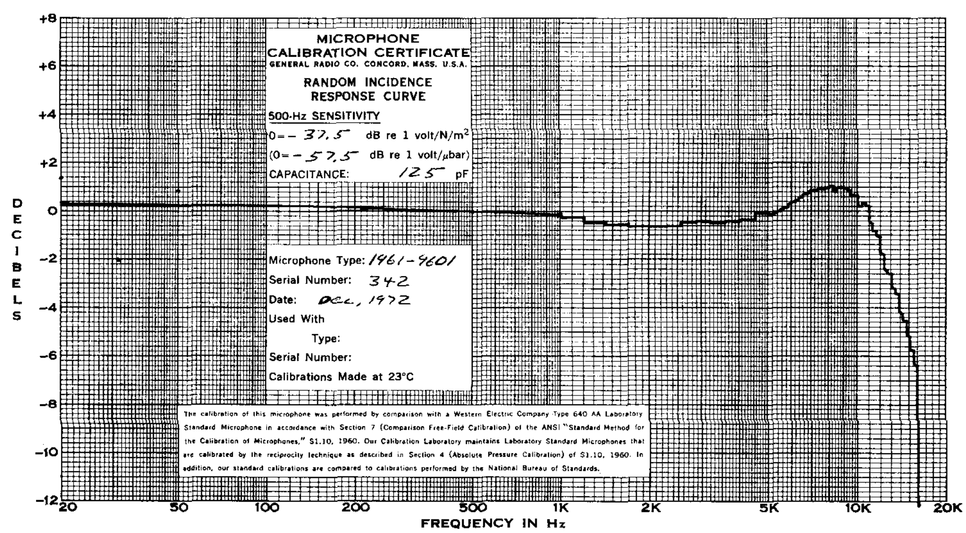

Figure 1-3. The microphone response curve is included with each GR Microphone.

Table 1-2

PREAMPLIFIER POWER FROM GR ACOUSTICAL INSTRUMENTS

Type No.	Instrument	Open-Circuit Voltage	Source	Source Resistance	Max. Available Current To -P42*	Notes
1523	Level Recorder	16 V ±5%	16 V Reg.	100 Ω	10 mA	—
1525	Data Recorder	20 V	20 V Reg.	2.5 kΩ	4 mA	
1551-C	Sound-Level Meter	Requires Power Supply	—	—	—	Use 1560-P62 Power Supply
1553	Vibration Meter	Requires Power Supply	—	—	—	*Use 1560-P62 Power Supply*
1558	Octave-Band Analyzer	—	2–9.6-V NiCd	1 kΩ	2.6-6 mA	—
1560-P62	Power Supply	—	2–9.6-V NiCd	Current Limited 15 mA	15 mA	—
1561-A, R	Precision Sound-Level Meter	—	2–9.6-V NiCd 3–9.0-V CZn	1.3 kΩ	0.85-8.3 mA	Not recommended for use with air-condenser microphones
1564	*Sound and Vibration* Analyzer	—	1–19.2-V NiCd	240 Ω	3-5 mA	—
1565	Sound-Level Meter	Requires Power Supply	—	—	—	Use 1560-P96 Adaptor and 1560-P62 Power Supply
1566	Multi-Channel Amplifier	16 V ±5%	16 V Reg.	100 Ω	10 mA	—
1568	Wave Analyzer (1% Bandwidth)	17.6 V min	2–9.6-V NiCd	820 Ω	3-5 mA	Use 1560-P62 Power Supply
1569	Automatic Level Regulator	25 V ±5%	25 V Reg	Current Limited *Less than 1 Ω*	25 mA	—
1900	Wave Analyzer	Requires Power Supply	—	—	—	Use 1560-P62 Power Supply
1921	Real-Time Analyzer	19 V ±5%	19 V Reg	300 Ω	10 mA	—
1925	Multifilter	19 V ±5%	19 V Reg	300 Ω	10 mA	—
1933	Precision Sound-Level Meter and Analyzer	9 V	—	—	—	Preamplifier included. For use with 1560-P42, requires 1560-P62 Power Supply and 1933-9602 cable.
1934	Walsh-Healey Noise-Exposure Meter	15 V ±5%	15 V Reg	< 2 Ω	20 mA	—
1981 B	Precision SLM	Require Power Supply	—	—	—	Preamplifier included. For use with 1560-P42, requires 1560-P62 Power *Supply and 1933-9602 cable.*
1982	Precision SLM	Require Power Supply	—	—	—	Preamplifier included. For use with 1560-P42, requires 1560-P62 Power *Supply and 1933-9602 cable.*
1983-9730	*Sound-Level Meter*	Require Power Supply	—	—	—	Preamplifier included. For use with 1560-P42, requires 1560-P62 Power *Supply and 1933-9602 cable.*

***Indicates range for high and low-voltage batteries.**

Note 1: For reliable performance, load current multiplied by source resistance (total supply and cable resistance) must not exceed the difference between the supply source voltage and + 15 V supply rating of the 1560-P42. In other words, $E_{source} - (I_{load} \times R_{source + cable})$ must be > 15 V.

Note 2: Refer to Figure 4-2 to relate these maximum currents to the permissible signal levels in output cables. The quiescent current of the Preamplifier (1-2 mA for ceramic microphones and 3-5 mA for condenser microphones) must be subtracted from the supply current to determine the signal current available to drive long cables.

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1.2 ACCESSORIES SUPPLIED.

1.2.1 General.

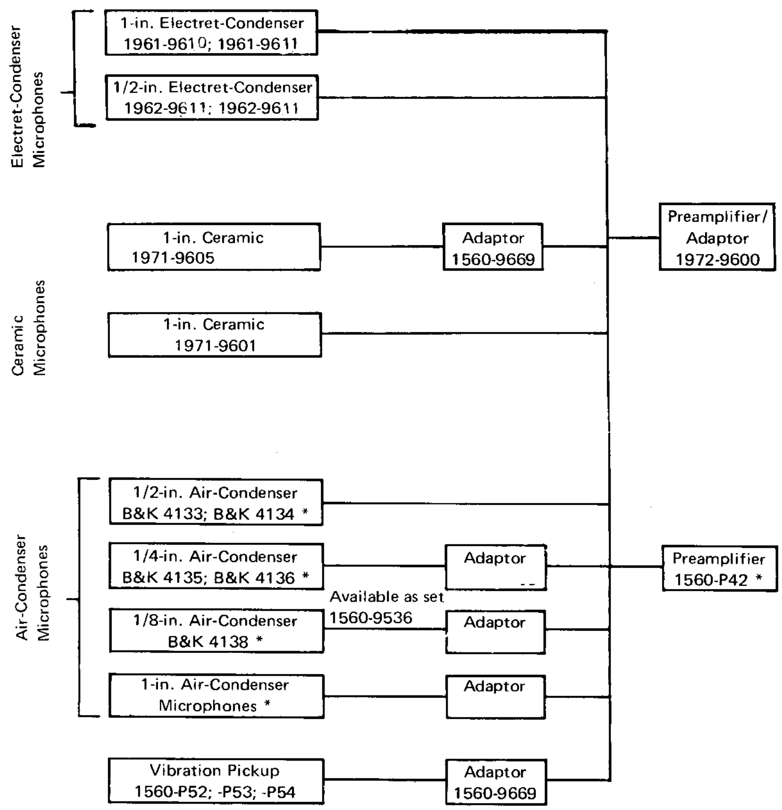
Each GR microphone is shipped with a Microphone Calibration Certificate, showing the response curve for the microphone (Figure 1-3) and the open-circuit sensitivity and capacitance of the cartridge.

The GR electret-condenser microphones are supplied with adaptors to ½-in. in addition to the above-mentioned Certificate.

The adaptors supplied and available are described in para 1.2.2.

The Preamplifier is shipped with the input connector protected by a plastic insulator cap.

A small stainless-steel clamp is provided, to serve as a hanger for the Preamplifier. The clamp is shipped attached to the output cable, ready for use. It can be placed at any desired point along the cable. The hole in the clamp is used to hang the microphone and Preamplifier (by the cable), for mounting, such as "free" suspension in an anechoic chamber.



*Air-condenser microphones can not be used with the 1972-9600 Preamplifier, because they require polarization voltage; use the 1560-P42.

Figure 1-4. Recommended combinations of transducers, adaptors and preamplifiers.

1.2.2 Adaptors.

As shown in Figure 1-4, the ½-in. microphones connect directly to the input of the Preamplifier. The 1971-9601 1-in. ceramic microphone is supplied as a cartridge with a built-in adapter for direct connection to the -P42. The 1-in. electret microphone also comes supplied with an adaptor, to convert to the ½-in. thread. This 1961-3200 adaptor is available separately from GenRad.

Adaptors are supplied with the 1562 and 1567 Sound Level Calibrators to mate with the 1- and ½-in. electret-condenser microphones and the 1-in. ceramic microphone. The calibrators are accurate self-contained devices for checking the calibration of sound-measuring instruments or systems. The 1562 supplies a known sound-pressure level at 5 different frequencies and the 1567 supplies a known level at 1 kHz.

1.3 ACCESSORIES AVAILABLE.

1.3.1 Preamplifier Cables

There are 2 types of preamplifier cable available from GenRad, namely 4-conductor and 3-conductor. The 4-conductor shielded cables are used with later model sound-level meters and analyzers to extend the distance between the preamplifier and measuring instrument. They are terminated in GR 4-pin male and female connectors.

The 3-conductor cables are used between the 1560-P40 Preamplifier, or the end of the 1560-P42 cable, and older sound-level meters, analyzers, and recorders. They also mate directly with the input and output connectors of the 1560-P62 Power Supply. They are made of shielded, 3-wire cable and are terminated in Switchraft type 3A 3-pin connectors on each end (one male, one female).

All cables contain a conductor to carry power to the preamplifier.

Table 1-3

PREAMPLIFIER CABLES

Description	Part No.
4-term. 3 m (10 ft)	1933-9600
4-term. 18 m (60 ft)	1933-9601
3-term. 1.2 m (4 ft)	1560-9665
3-term. 7.5 m (25 ft)	1560-9666
3-term. 30 m (100 ft)	1560-9667

1.3.2 Adaptors Available.

(Refer, also, to para. 1.3.3.)

The following adaptors are available separately, for use with the microphones: An adaptor is supplied with the 1971-9601 Microphone to allow direct connection to the -P42 preamplifier.

Adaptor, P/N 1560-9669, mates the Preamplifier input connector with a Switchcraft, 3-pin, female, microphone connector, for use with GR vibration pickups and the 1971-9605 Ceramic Microphone.

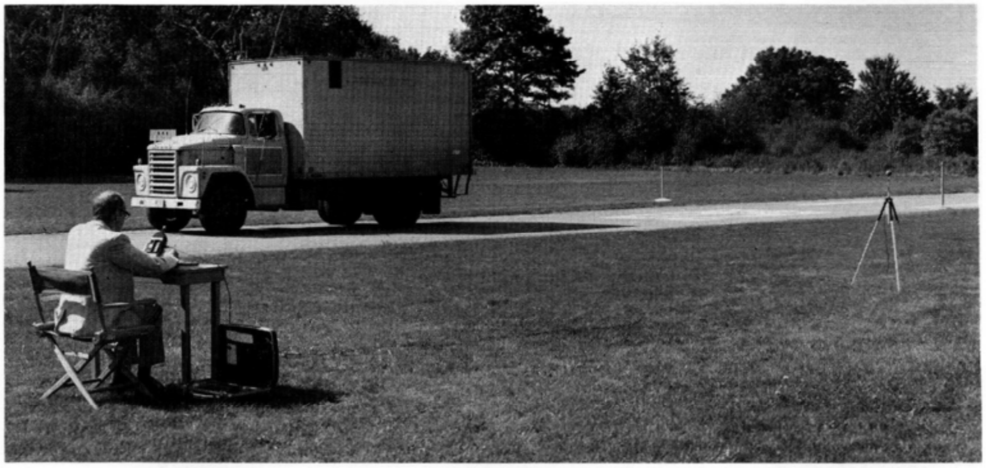


Figure 1-5. Use of Preamplifier Cables in a field application for sound-level measurements.

The 1-in. GR electret microphones come supplied with an adaptor to connect to the -P42 input. An adaptor is not needed for the ½-in. electret microphone.

The 1560-9696 Adaptor converts the inputs of the 1560-P40 Preamplifier and 1565 Sound-Level Meter to an A3, 3-pin female, microphone connector.

1.3.3 Type 1972-9600 Preamplifier/Adaptor.

This inexpensive Preamplifier/Adaptor (refer to Section 6) is used to mate GR 1-in. ceramic microphones 1971-9601 and GR 1-in., and ½-in. electret-condenser microphones (1961 and 1962, respectively) to cables connecting to the input of a measuring instrument. The Preamplifier provides unity gain and sufficient current to drive more than 50 feet of cable. The internal preamplifier can be bypassed to allow the microphone terminals to be mated directly to a standard Switchcraft A3 connector.

Complete details of the use of the 1972-9600 Preamplifier/Adaptor are given in Section 6 of this manual.

1.3.4 Patch Cables.

Shielded patch cords and adapting cables are available for general use (refer to Table 1-4). They are 3 ft long and weigh approximately 2 oz (57 g), except 1560-9680, which is 2 ft long and weighs 1.4 oz (40 g).

The microphone-plug adapting cables terminate in a microphone plug, such as the Switchcraft type 850-P2, on one end. Various versions have, at the other end, a double (in-line) banana plug or other regular-size connector, as listed in the table.

Cables with a ¼-in. phone plug at one end and a similar plug or a hammerhead double banana plug at the other end are also available (see table).

The BNC- and banana-plug cables have identical connectors on both ends, as listed.

Table 1-4
AVAILABLE PATCH CABLES

Connectors	Catalog No.
Miniature Phone-Plug Patch Cords	
1560-P77, with Double Banana Plug, 3 ft	**1560-9677**
1560-P78, with ¼-in. Phone Plug, 3 ft	**1560-9678**
1560-P79, with BNC Plug, 3 ft	**1560-9679**
1560-P80, with ¼-in. Phone Jack, 2 ft	**1560-9680**
1560-P76 Patch Cord, Phone Plug, 3 ft	**1560-9676**
1560-P95 Patch Cord, with Double Banana Plugs, 3 ft	**1560-9695**
776-C Patch Cord, with BNC plugs, 3 ft	**0776-9703**
274-NQ Patch Cord, with Double Banana Plugs, 3 ft	**0274-9860**

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1.3.5 Microphone Windscreens.

Microphone windscreens (Figure 1-6) are used to reduce the effects of ambient wind noise. Wind flowing across the surface of the microphone generates low-frequency noise, which can lead to erroneous measurements. The windscreen also protects the microphone from accumulations of vapor and dust in the work environment. Figure 1-7 shows the noise reduction for the 1-in. microphone.

This accessory fits snugly over the microphone. It is made of reticulated polyurethane foam and can be conveniently removed and washed, or replaced, if it becomes soiled. This is in addition to the obvious advantage of attenuating up to 20 dB of ambient wind noises, such as might emanate from a fan blowing cooling air or outdoor winds across the site being monitored.

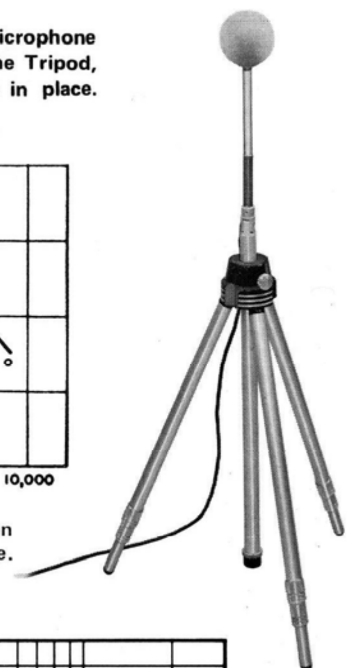

Figure 1-6. The Preamplifier and microphone mounted on the Tripod, with the windscreen in place.

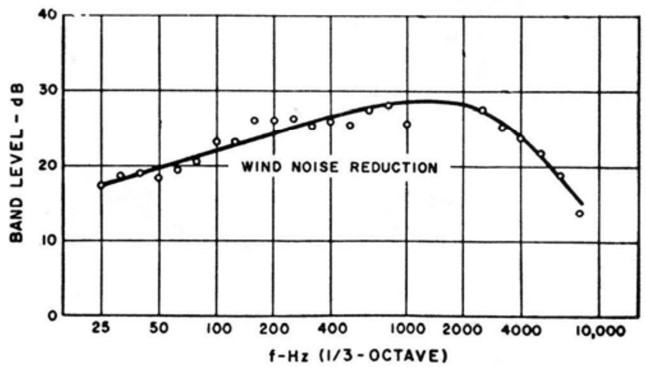

Figure 1-7. Typical noise reduction by windscreen in 25-mph breeze.

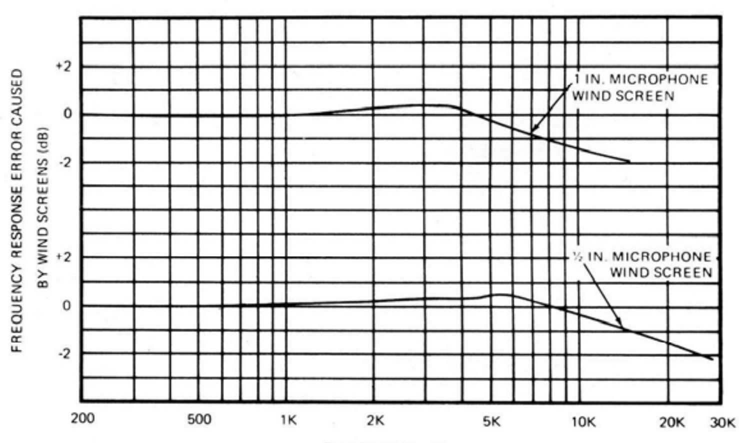

Figure 1-8. Effect of windscreens on microphone response.

Any attenuation of monitored noise resulting from use of the windscreen occurs over only a portion of the frequency spectrum being monitored. The loss of system sensitivity occasioned by use of the windscreen is 0 dB to 3 kHz, $\approx$ 0.5 dB to 5 kHz, and $\approx$ 2 dB to 12 kHz (see Figure 1-8).

The windscreens are available in packs of four, P/N 1560-9522 to fit 1/2-in. microphones and P/N 1560-9521 for 1-in. microphones.

1.3.6 Tripod.

The 1560-9590 Tripod (Figure 1-6) is designed to accept a variety of sound equipment, including the ½-in. and 1-in. microphones, the 1560-P42 Preamplifier, and the 1972-9600 Preamplifier/Adaptor. The 1-in. ceramic microphone can be mounted on the Tripod either with or without the Preamplifier. All electret-condenser microphones require either the 1560-P42 Preamplifier, the 1972-9600 Preamplifier/Adaptor, to mount them on the Tripod. The preamplifier supplied with the sound-level meter or analyzer can likewise meet this need.

The tilting head can be swiveled through 360° by rotating the center post of the tripod. The head can be tilted 90° (vertical to horizontal) in one direction and in the opposite direction as far as 20° from the vertical. The latter position is the proper mounting angle for a preamp with a flat-random-incidence microphone when the sound source is at the same elevation in a free field. (A free field is typically found outdoors away from obstructions or in an anechoic chamber.)

Height Adjustment. Each of the tripod legs and its center post are telescoping for compact storage and versatility in use. Adjust the tripod for the desired height, from 14.5 to 56 in. (37 to 140 cm) as follows:

a. Extend the legs by loosening the knurled locking nuts (smallest first) and pulling out the telescoping sections. Tighten securely (largest nut first) at the desired length.

b. Extend the center post by loosening the thumb screw at its side, pulling it up, and clamping it at the desired height with the thumb screw.

c. Keep the tilting sleeve adaptor (see below) in place to retain the inner tube of the center post as you loosen the locking nut on the center post. Swivel the very top assembly, and if necessary raise it, to the desired position before retightening this locking nut.

CAUTION

Be sure the 9 knurled locking nuts in the legs of the tripod are tightened securely so it will not collapse in use.

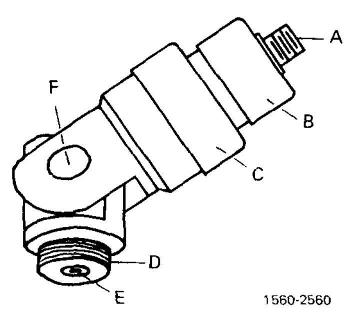

Figure 1-9. Tilting sleeve adaptor. A = top stud. B = smaller clamping nut, C = larger clamping nut, D = bottom stud which screws onto top of tripod, E = set screw for adjusting friction in: F = pivot.

Sleeve Adaptor (Head). With this tripod are included a tilting Sleeve Adaptor 1560-2560 and 2 sleeves. This adaptor usually serves as the head of the tripod center post. At the bottom end is a set screw with which you can vary the tightness of the tilting pivot. This end is threaded to fit the center post of the tripod. Mounting instructions follow:

1972-9600 Preamplifier/Adaptor.

a. Tilt Sleeve Adaptor (head) to approx 20° from vertical. In one direction of tilt there is a stop at this angle.

b. Remove each sleeve after loosening its knurled clamping nut, 1/4 turn.

c. Tighten the smaller clamping nut gently, by hand. (If inadvertently removed, be sure to replace each nut with its split locking ring oriented so beveled edge is down.) If the larger clamping nut has been tightened without its sleeve in place, loosen 1 turn.

d. Insert non-slotted end of larger sleeve into the clamping nut as far as it will go (5/8 in.). Orient slot where you want the extension cable to pass through (downward). Tighten the clamping nut.

e. Connect cable to 1972-9600 Preamplifier/Adaptor. (Always connect or disconnect with both parts in your hands, never in the tripod sleeve.) Observe the latch, which must be depressed when you disconnect.

f. With cable in slot, slide preamp backwards into sleeve about 1/2 in., with latch in slot. (Sleeve will grip cable connector as well as preamp, for added support.) DO NOT insert so far that cable is stressed.

CAUTION

Do not allow the edges of the slot to pierce the cable insulation.

1560-P42 Preamplifier.

a. Tilt Sleeve Adaptor (head) to approx 20° from vertical. In one direction there is a stop at this angle.

b. Remove larger sleeve after loosening its clamping nut 1/4 turn. Tighten nut gently by hand (see step c, above). If the smaller clamping nut has been tightened without its sleeve in place, loosen 1 turn.

c. Insert non-slotted end of smaller sleeve into clamping nut as far as it will go (3/8 in). Orient slot where you want cable to pass through (downward). Tighten clamping nut.

d. With its cable in slot, slide preamp backwards into sleeve far enough for firm support but NOT so far that its cable is stressed.

Tightness of the Pivot. The stiffness of the pivot in the sleeve adaptor is adjustable as follows:

a. Raise the inner tube of the tripod center post, so you can get a good grip on it. Unscrew the tilting Sleeve Adaptor 1560-2560 from its top.

b. Tighten or loosen the set screw, E, using a 0.125-in. hex wrench, a small fraction of a turn, until the pivot is free enough for convenience but tight enough for reliable support.

c. Replace securely on center post.

1.3.7 Miscellaneous Accessories.

The 1962-3210 Microphone Attenuator attenuates the output of the 1962 ½-in. Electret-Condenser Microphones by 10 dB, to allow operation of microphones at high levels.

Also available is the 1962-9620 Dummy Microphone, a shielded 24-pF capacitor, used to simulate a 1962 ½-in. Electret-Condenser Microphone, to determine instrument noise floor. BNC input connector is also provided to connect a signal source, simulating a sound signal. BNC shorting plug is supplied.

The 1560-9635 Permanent-Magnet Clamp can be used for firm holding of a vibration pickup to a ferrous metal surface.

Sound Fields—Section 2

2.1 FREE FIELDS.

A sound field is said to be a free field if it is uniform, free from boundaries, and is undisturbed by other sources of sound. In practice, it is a field in which the effects of the boundaries are negligible over the region of interest. At any given point in a free field, the sound wave can be approximated by plain sound waves that have a given direction of propagation; the flow of sound energy is in one direction only.

A free field can be simulated in an enclosed environment by applying acoustic absorbing materials, usually in the form of wedges, to the boundaries. These anechoic (echo-free) chambers can be built to make free-field measurements possible over much of the acoustic frequency range. The field in an anechoic chamber is a free field above the lower cut-off frequency of the absorbing wedges. (The cut-off frequency is the point at which the wavelength of the sound wave is equal to four times the depth of treatment.)

Another approximation to a free field occurs outdoors, in particular, in open spaces, well above the ground.

2.2 DIFFUSE (REVERBERANT) FIELDS.

A diffuse or reverberant sound field is one in which the time average of the mean square sound pressure is everywhere the same and the flow of energy in all directions is equally probable. The sound is reflected from the boundary surfaces; there is no particular direction of propagation to the sound wave. At any given point in the diffuse field, sound is arriving equally from all directions (random incidence).

2.3 SEMI-REVERBERANT FIELDS.

A semi-reverberant field is one in which sound energy is both reflected and absorbed. The flow of sound energy is in more than one direction. Much of the energy is truly from a diffused field; however, there are components of the field that have a definable direction of propagation from the noise source. The semi-reverberant field is encountered in the majority of noise-measurement situations.

2.4 PRESSURE FIELDS.

A pressure field is one in which the instantaneous pressure is everywhere uniform. There is no direction of propagation. The pressure field exists primarily in cavities

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(commonly called couplers), where the maximum dimension of the cavity is less than 1/6 of the wavelength of the sound. A pressure field is used in couplers for the calibration of microphones and earphones.

2.5 SOUND INCIDENCE.

2.5.1 Free-Field Sensitivity (Response)*

The free-field response of a microphone is the open-circuit output voltage caused by the free-field sound pressure in the ***undisturbed*** sound field; i.e., the pressure that existed at the location of the microphone prior to the introduction of the microphone into the sound field. For free-field sensitivity, the angle between the direction of sound propagation and the plane of the microphone diaphragm, as well as the frequency, must be specified.

2.5.2 Free-Field Response.

The free-field response of a microphone is the voltage output divided by the pressure that existed at the location of the microphone prior to the introduction of the microphone into the sound field. Free-field responses are typed according to the angle between the direction of sound propagation and the plane of the microphone diaphragm.

Perpendicular-Incidence Response (0°). With this type of response, the direction of sound propagation is perpendicular to the plane of the diaphragm (at an angle of 0° to the normal of the diaphragm). The sound wave is moving in one direction only, directly into the microphone. This condition occurs only in a free-field environment (or, under very special circumstances, in certain semi-reverberant environments).

Grazing-Incidence Response (90°). In this case, the direction of sound propagation is parallel to the plane of the microphone diaphragm (at 90° to the normal of the diaphragm). The sound wave can approach the microphone from any side, but its direction must be parallel to the diaphragm surface. This type of incidence occurs mostly in free-field environments.

The directions of sound propagation for perpendicular- and grazing-incidence responses are shown in Figure 2-1.

2.5.3 Random-Incidence Response.

The random-incidence response of a microphone is its voltage output when subjected to a diffuse sound field. The flow of energy in any direction is almost equally probable. Because of nearby reflecting surfaces, this is the most common type of sound field.

2.5.4 Pressure Sensitivity.

The pressure sensitivity of a microphone is the voltage output when the diaphragm is excited with a pressure that is uniform over the entire surface of the diaphragm. The accuracy and repeatability of a pressure calibration are more easily controlled than with free-field methods. For this reason, the standard calibrations determined by the National Bureau of Standards are pressure-sensitivity (pressure-response) calibrations.

***Technically, "sensitivity" and "response" have the same meaning. However, "sensitivity" is commonly used for a single-frequency statement, and "response" is used when the sensitivity as a function of frequency is intended.**

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2.5.5 Diffraction.

The physical size of the microphone causes diffraction of sound waves when the wavelength is not appreciably greater than the dimensions of the microphone, and gives rise to differences between the responses defined above. At low frequencies, all responses of a microphone are the same and the microphone is truly an omnidirectional receiver of sound. The various responses start to diverge at the frequency at which the diameter of the microphone is equal to approximately 1/10 of the wavelength of the sound. The curves of Figure 2-2 show typical response characteristics for a microphone of 1-in. diameter. To a first approximation, the differences between the curves would hold for any measurement microphone of this size. For the 1/2-in. microphone, the frequency scale would be approximately double that for the 1-in. microphone. For a 1/4-in. microphone, the frequency scale would be increased by approximately a factor of 4, and for a 1/8-in. microphone, by a factor of 8.

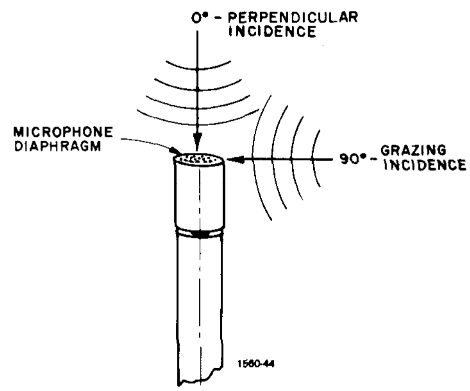

Figure 2-1. Direction of sound propagation for perpendicular- and grazing-incidence responses.

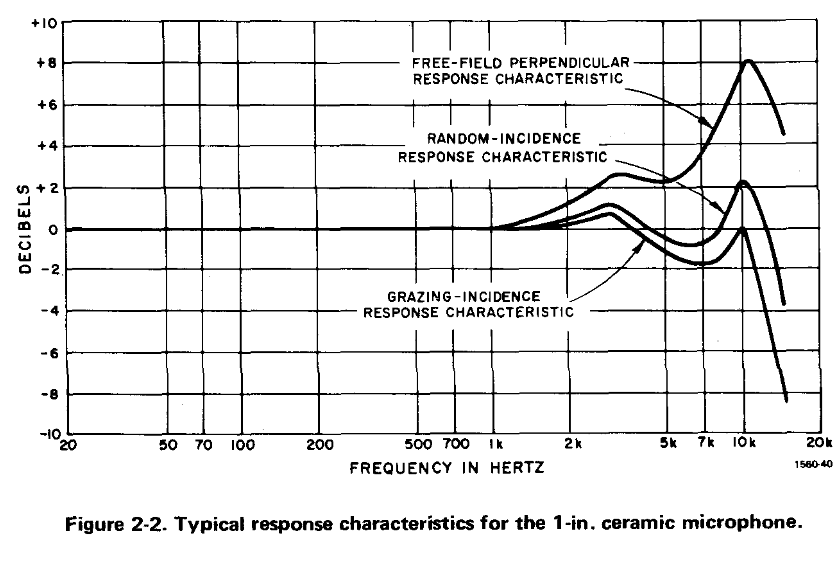

Figure 2-2. Typical response characteristics for the 1-in. ceramic microphone.

Characteristics of Microphones
Section 3

3.1 TRANSDUCERS.

A transducer transforms energy from one form to another. In the case of microphones, it changes the pressure variation of an acoustic wave into an electrical signal proportional to that pressure variation. Vibration pickups, specifically accelerometers, transform the motion of a vibrating body into an electrical signal proportional to their acceleration.

3.2 CLASSIFICATIONS OF SOUND-MEASUREMENT MICROPHONES.

3.2.1 General.

Sound-measurement microphones are divided into two main classes: condenser and ceramic microphones. Others, such as dynamic and controlled-reluctance types, lack the frequency-response control and stability necessary to make them usable as measurement microphones. The most important requirements for a measurement microphone are reliability and stability. Stated simply, this means that, between calibrations, accurate measurements can be made with a measurement microphone, and the conditions normally encountered in making sound measurements will not have a detrimental effect on the microphone or its calibration. Ceramic and condenser microphones meet these two requirements.

3.2.2 Ceramic Microphones.

Ceramic microphone use a piezoelectric ceramic (lead-titanate, lead-zirconate) as the voltage-generating element. The piezoelectric material produces a voltage when it is stressed. A diaphragm fastened to the ceramic transfers the sound-pressure variations into a corresponding varying force that bends the ceramic element.

3.2.3 Conventional Air-Condenser Microphones.

The conventional air-condenser microphone uses the variation of an electrical capacitance to generate an electrical signal. The original high-quality measurement microphone was this type, developed by Bell Telephone Laboratories. This microphone, known as the Western Electric 640AA, remains the standard of measurement and calibration.*

The advantages of air-condenser microphones are: smooth frequency-response characteristic, good sensitivity, and wide availability in various sizes and styles. However, condenser microphones of this type require a polarizing voltage, to bias them properly.

*E. C. Wente, "A Condenser Transmitter as a Uniformly Sensitive Instrument for the Absolute Measurement of Sound Intensity," *Physical Review*, Vol 10, 1917, pp 39-63.
M. S. Hawley, "The Condenser Microphone as an Acoustic Standard," *Bell Laboratories Record*, Vol 33, No 1, January 1955, pp 6-10.

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Also, their relatively high output impedance makes them more susceptible to problems caused by high humidity. The high impedance also results in greater preamplifier noise.

3.2.4 Electret-Condenser Microphones.

A more recent type is the electret-condenser microphone. Its basic design is similar to the conventional air-condenser microphone, but it has a permanently charged diaphragm and does not require a polarizing voltage. The electret-condenser microphone retains the advantages of conventional air-condenser microphones with high sensitivity, flat frequency response and wide dynamic range. It also provides some additional benefits: Its output capacitance is much higher and it does not become noisy in a humid environment, since no free electrostatic charge exists at the surface of the diaphragm. The electret charge is trapped inside a polymer film and there is an exceptionally strong bond between charged particles and molecules of the polymer.

The temperature coefficient of sensitivity of an electret-condenser microphone is fairly constant over its entire frequency range. This is a significant advantage over the air-condenser microphone, whose sensitivity changes markedly at frequencies above 16 Hz, increasing by a factor of 4-to-6 at 4 kHz and 5 kHz.

A diaphragm of an electret-condenser microphone is shown in Figure 3-1 (b). The electret layer is bonded to the backplate. The mechanical ruggedness and high stability of microphone parameters are ensured by a unique design of diaphragm supporting elements, which are bonded to the diaphragm.

3.3 EQUIVALENT CIRCUIT.

The equivalent circuit for both the condenser and ceramic microphones is shown in Figure 3-1 (a). The open-circuit voltage, e, is the single-frequency voltage appearing at the microphone terminals when working into an infinite electrical impedance. If p is the sound pressure at the diaphragm, the pressure response of a microphone is

$$M_p = \frac{e}{p}$$

The pressure response level relative to a reference response, M_r (in V/Pa) is

$$R_p = 20 \log_{10} \left(\frac{M_p}{M_r}\right) \text{ in dB}$$

Useful relationships to remember are that the value of e is 1 mV when M = –40 dB re 1 V/Pa (or–60 dB re 1 V/μbar) and P = 74 dB SPL or 1 μbar (or 1 dyne/cm^2). * At the threshold of hearing of 20 μPa, a –40 dB microphone produces a voltage output of 0.2 μV. The voltage delivered to the measuring instrument is dependent upon the instrument input impedance.

If the microphone is connected directly to a long cable (capacitive load) without a preamplifier, the long cable merely reduces the sensitivity of the microphone by

$$E_{in} = \frac{C_m}{C_{in} + C_m} \times e$$

where C_{in} = input capacitance of the instrument and the cable; E_{in} = instrument input voltage.

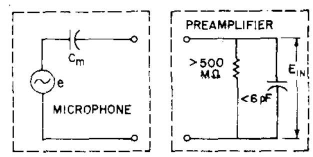
*In the international system of units (SI), the unit of pressure is the pascal (Pa); 1 Pa = 1 N/m^2 = 10 dynes/cm^2.

Ref: "The International System of Units (SI)", U.S. Dept. of Commerce, National Bureau of Standards, NBS Special Publication 330. SD Cat. No. C 13.10:330/2, U.S. GPO, Wash., D.C., 20402.

The cable does not affect the frequency response because the microphone and cable capacitances change the impedance in the same proportion with changing frequency.

A preamplifier is usually used between the microphone and measuring instrument, to provide impedance transformation (very high to very low). This results in no loss in microphone sensitivity and, hence, no cable correction. In addition, preamplifiers usually provide some gain (20 dB), thus permitting the instrument to measure to lower levels.

The high input resistance of the preamplifier makes possible good low-frequency response with a high source impedance. The low input capacitance of the preamplifier minimizes loading of the microphone, thereby maintaining good sensitivity.

a.


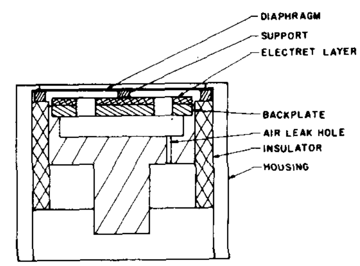
b.


Figure 3-1. a. Equivalent circuits for a microphone and preamplifier; b. Electret section view.

3.4 MICROPHONE SELECTION.

3.4.1 General.

Measurement microphones are designed to have either a flat pressure-response characteristic, a flat random-incidence response characteristic, or a flat free-field perpendicular-response characteristic. For the measurement of noise, in general, a microphone with a flat random-incidence response should be selected. The American National Standard for sound-level meters is based on a flat random-incidence response. The International Specification for precision sound-level meters permits other responses, but it stipulates that the supplier must give calculations and corrections for deriving the random-incidence response. As stated above, the random-incidence response of a microphone is its voltage output when subjected to a diffuse sound field. The fields encountered in noise measurements are not truly diffuse. However, this is the closest approximation for nearly all indoor and most outdoor applications. An exception is aircraft flyover or automotive passby noise. In these applications, the noise signature of the vehicle is best measured with a microphone having a flat grazing-incidence response. For a vehicle passby on the ground, the microphone is placed with its diaphragm facing upward, so that the angle of incidence from the sound source to the microphone remains constant at grazing incidence. For aircraft flyover, the angle of incidence is kept constant by mounting the microphone with its axis parallel to the ground and perpendicular to the surface described by the arc of the flyover.

As shown in Figure 2-2, the difference between the grazing-incidence or pressure response and the random-incidence response of a 1-in. microphone is small, so that either a flat random-incidence microphone or a flat pressure microphone gives a good approximation to a flat grazing incidence. Sound-power measurements in a diffuse room are an ideal application for a microphone with a flat random-incidence response.

If one is making sound-pressure (sound-power) measurements of a device in an anechoic chamber, the sound wave is radiating outward from the source and there are

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no reflections. For this application, use a microphone with flat perpendicular-incidence response, with the microphone pointed directly at the sound source.

If one is measuring the response in a coupler of small diameter compared with the wave length, use a microphone with a flat pressure response. Likewise, for measurement of the pressures at the ear drum, a microphone having a flat pressure response should be used.

In general, select the largest microphone that has adequate frequency response for the intended application.

Figure 3-2 is a plot of the response of various 1-in. microphones.

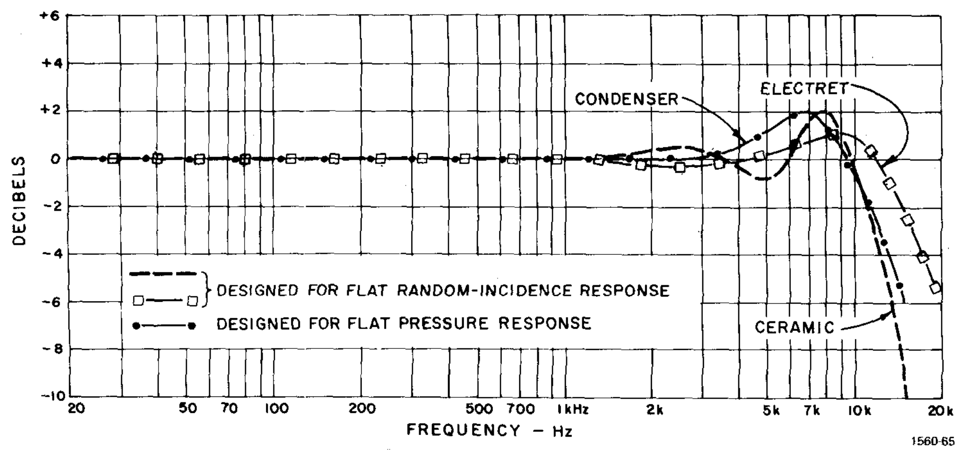

Figure 3-2. Random-incidence response of various types of microphones.

3.4.2 Sensitivity.

Until recently, the sensitivity level of a microphone was referenced to 1 V/μbar. The International System of Units (SI) has changed the reference to 1 V/Pa and Sensitivity Level = x dB re 1 V/Pa. Because 1 Pa = 10 μbar, the new reference is merely 20 dB higher than the old reference.

Say we have a microphone with a sensitivity level of –40 dB re 1 V/Pa. What output voltage will it generate for a sound pressure of 1 Pa?

For the same sound-pressure level (SPL), 40 dB gives a voltage that is 100 times smaller. Thus, the voltage for an SPL of 1 V/Pa is 10 mV.

A sound pressure of 1 Pa is an SPL of 94 dB, where

$$\text{SPL} = 20 \log_{10} \left(\frac{1\ \text{Pa}}{20\ \mu\text{Pa}} \right) \text{dB}$$

$$= 20 \log_{10} \left(\frac{1}{.00002} \right) = 94\ \text{dB}.$$

Thus, a microphone with a sensitivity level of –40 dB re 1 V/Pa will generate an output voltage of 10 mV for a sound pressure level of 94 dB.

By remembering this simple relationship, one can calculate the output voltage of any microphone, with any sensitivity, for any sound pressure. This is particularly useful for determining signal-to-noise ratio relationships.

For example, for the same sound-pressure level, a −40 dB microphone generates 3.16 times the voltage generated by a −50 dB microphone ($20 \log_{10} 3.16 = 10$ dB). A −50 dB microphone will generate 3.16 mV for a 94-dB SPL, and if we subject it to a 114-dB sound-pressure level, the voltage generated is 20 dB higher or 31.6 mV. For quick reference, these calculations are already carried out in Figure 4-11.

3.4.3 Dynamic Range.

The low end of the dynamic range of a microphone/preamplifier system is determined by the self noise of the preamplifier when its input is terminated by the capacitance of the microphone. The noise level of the preamplifier is a function of the microphone capacitance. As a result, the low end of the dynamic range is limited by both preamplifier self noise and microphone sensitivity.

The upper end of the dynamic range is usually limited by the output-voltage amplitude or the output-current level at which the preamplifier no longer amplifies linearly. The maximum voltage swing is a function of the power-supply or battery voltage for the preamplifier and the current level is a function of the length of cable attached to the preamplifier output (cable reactance). Microphone sensitivity is also a limitation here, as the more sensitive the microphone, the more voltage it generates for a given SPL.

The range for the GR 1-in. ceramic microphone is 22 to 145 dB SPL.

The A-weighted dynamic range for the GR ½-in. electret-condenser microphone with the -P42 Preamplifier is approximately 30 to 145 dB SPL. For the 1-in. electret microphone, the range is 22 to 140 dB SPL.

3.5 MINIMIZING DIFFRACTION.

The occasion often arises when one wishes to use a microphone with a smaller diameter, to provide a more omnidirectional characteristic or to enable one to select the response to be used. Another important consideration, however, is the size of all the material intercepting the sound field. This includes the microphone, preamplifier, and their supports. Figure 3-3 shows the free-field perpendicular-incidence response characteristic of a 1/2-in. microphone mounted in line on a 1/2-in. rod. This rod, in turn, connects to a 3/4-in. rod at a point 1 in. from the diaphragm of the microphone. Note that variations of approximately ±1 dB occur because of the diffraction produced by the larger-diameter rod. A good rule to follow is to maintain the diameter of the microphone for a distance equal to 5 times the larger diffracting diameter. Beyond the 5-diameters point, a gradual taper to the larger diameter should be employed. In the figure, the controlling diameter is the 3/4-in. support rod. Therefore, the 1-in. distance from the diaphragm to the larger rod should be increased to approximately 4 inches.

3.6 GR CERAMIC MICROPHONES.

3.6.1 General.

The GR ceramic microphone is offered in a 1-in. size (refer to Table 1-1).

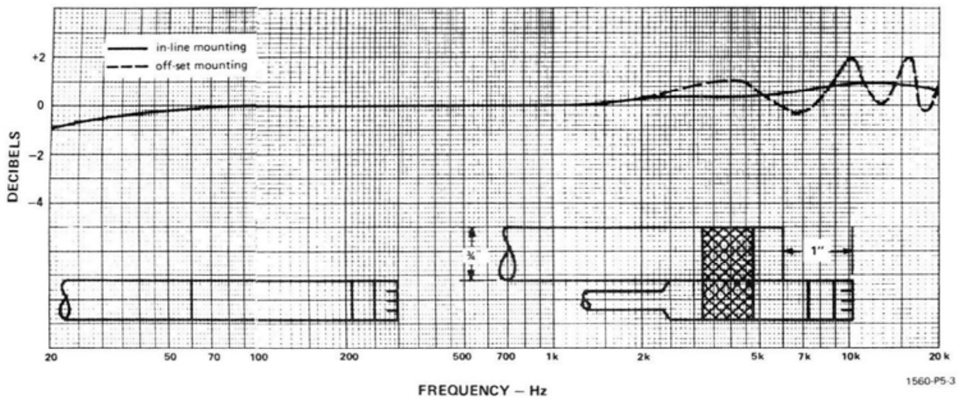

Figure 3-3. Free-field perpendicular-incidence response characteristic of a ½-in. microphone (see text).

The 1560-2131 Microphone Cartridge is used in the GR 1-in. ceramic microphones, including the 1971-9601 and 1971-9605 Microphones and the 1971-9606 Microphone Assembly (see Figures 3-4 and 3-5). In this cartridge, one lead is connected to the shell.

Figure 3-4. The 1-in. ceramic microphone 1971-9601.

The Cartridge is a high-quality, measurement-type unit, suitable for use with many high-input-impedance preamplifiers, decade amplifiers, or sensitive voltmeters. The input impedance required for response down to 20 Hz is 20 MΩ or higher.

The shell of the 1-in. Cartridge and one lead are connected together through the base or adaptor. The red dot on the Cartridge identifies the signal terminal, which is also the positive-potential terminal when a positive pressure pulse is applied to the diaphragm of the Cartridge.

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In the 1971-9605 Microphone, the Cartridge is fixed to a 3-pin, male, microphone connector. To connect the 1971-9605 Microphone Assembly to the -P42 Preamplifier, the 1560-9669 adaptor is required.

The 1971-9601 Microphone Assembly contains the Cartridge and an adaptor, thus permitting its direct connection to the 1560-P42.

3.6.2 Calibration.

The 1-in. GR ceramic microphones are designed for a flat random-incidence response (refer to Specifications). When there is a possibility that the sound wave may have some directivity, the microphone should be tipped at an angle of 70° to the direction of the sound source. This gives a flat response characteristic for any direct radiated sound. The 70°-incidence response closely approximates the random-incidence response.

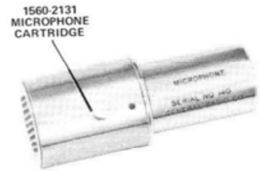

Figure 3-5. 1-in. ceramic microphone 1971-9605.

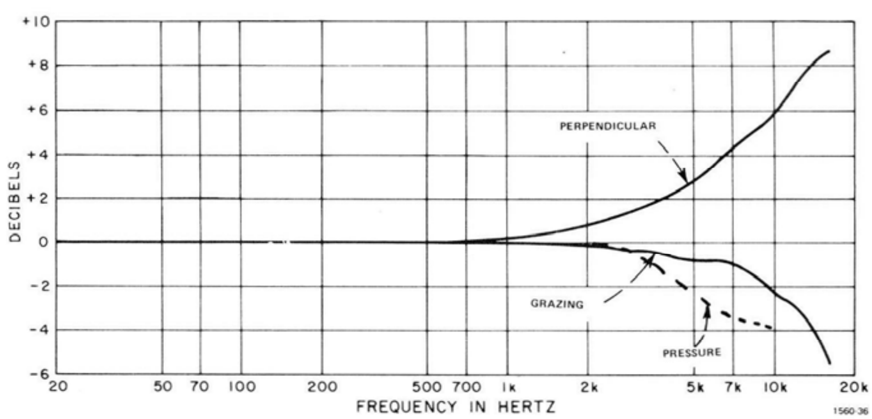

Figure 3-6. Corrections to be added to the random-incidence response of the 1-in. ceramic microphone to obtain the perpendicular- and grazing-incidence responses or pressure response.

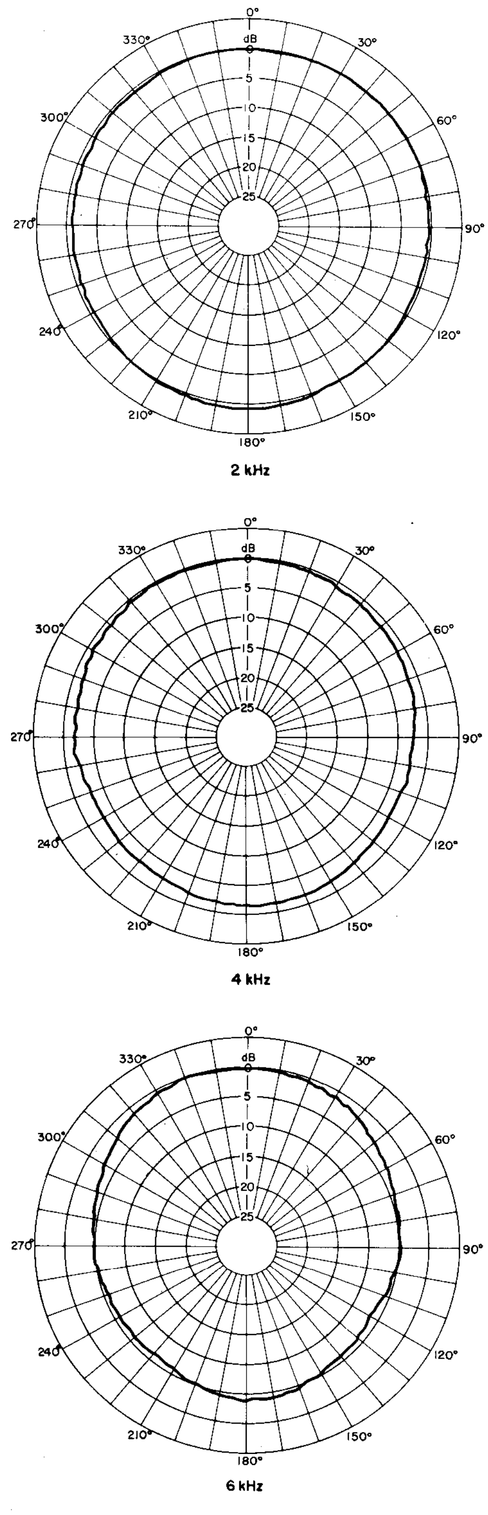

Figure 3-7. Directional patterns of the 1-in. ceramic microphones (2 – 6 kHz).

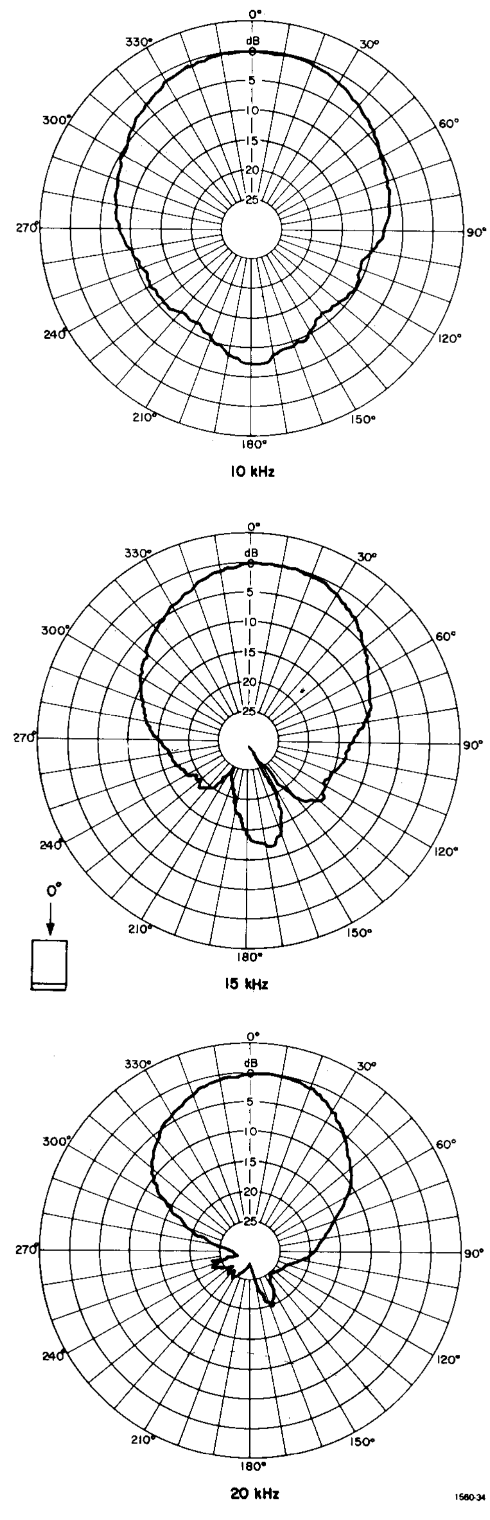

Figure 3-8. Directional patterns of the 1-in. ceramic microphones (10 – 20 kHz).

The curves given with the Specifications show the random-incidence response characteristics for the two microphones. Figure 3-6 gives the corrections to be added (algebraically) to the random-incidence responses, to obtain the perpendicular-incidence and grazing-incidence responses for the microphones.

3.6.3 Mechanical Description.

The diameter of the 1-in. Microphone is 0.936 ± .002 in. This diameter is identical to the Western Electric 640AA; thus the microphone can be used interchangeably with the 640AA in couplers designed for earphone and hearing-aid calibrations, etc. For this use, the equivalent volume of the 1-in. microphone is 0.5 cc; the equivalent volume of the 640AA is 0.7 cc with the grid off and 0.3 cc with the grid on. For practical purposes, the GR 1-in ceramic microphone is totally interchangeable with the Western Electric 640AA.

3.6.4 Diffraction Characteristics.

Diffraction of the sound waves by the 1-in ceramic microphone starts at approximately 1 kHz. Below this frequency, it is truly omni-directional. Figure 3-7 shows the directional characteristics of the microphone to 20 kHz.

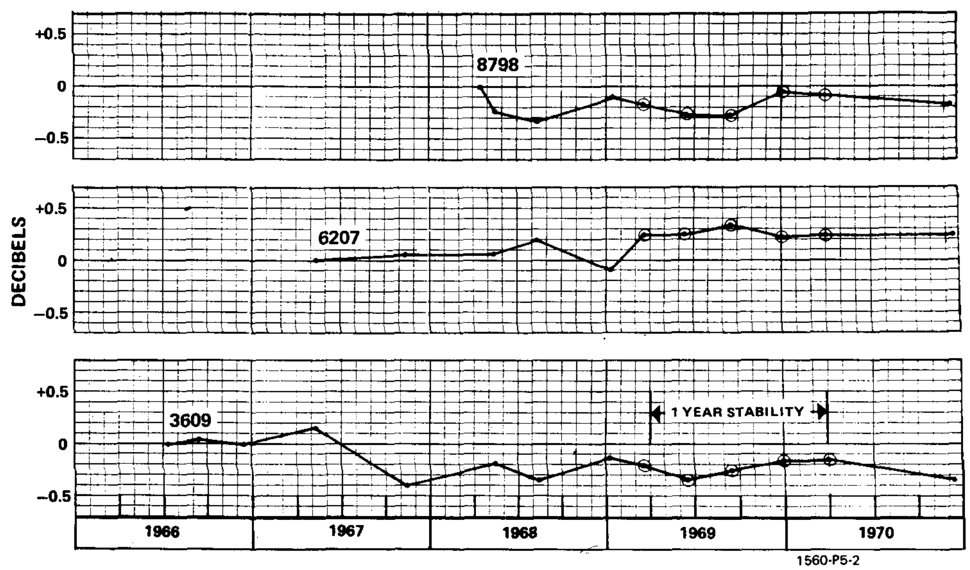

Figure 3-9. Stability record for several sample microphones.

3.6.5 Stability.

Work with the GR ceramic microphones over the years has proved that they have excellent short- and long-term stability. Figure 3-9 shows the record for several sample microphones over various periods of time, up to 4 1/2 years. Stability tests, started in

1966-1969, immediately upon production of the microphones, show a small initial drift (up to 0.3 dB), after which the microphones stabilize as shown in the figure. Other evidence indicates that this drift is completed after 5 days. The normal manufacturing and testing cycle at GR guarantees that this initial drift is completed before the microphones are calibrated for sale.

The microphones were also evaluated for stability according to the procedures outlined in the American National Standard Institute (ANSI) S1.12-1967 for Laboratory Standard Microphones. Table 3-1 shows the average results for several 1-in. ceramic GR Microphones.

Table 3-1

STABILITY RATING OF 1971 MICROPHONES

PER PROCEDURE OUTLINED IN ANSI S1.12 - 1967

	SHORT-TERM STABILITY, 5-DAY PERIOD		LONG-TERM STABILITY, 1-YEAR PERIOD	
	|m| dB/day	*S dB*	*|m| dB/yr.*	*S dB*
STANDARD REQUIREMENT	.04	0.1	0.4	0.15
TYPE 1971	.0075	.032	.085	.07

WHERE:
|m| = MAGNITUDE OF THE SLOPE OF CURVE OF SENSITIVITY VS TIME
S = STANDARD DEVIATION OF RESIDUALS.

1560-P5-6

3.6.6 Temperature Effects.

The GR ceramic microphones are stable up to 60°C (140°F). If the microphones are used above this temperature, there is a permanent loss of 1 dB in sensitivity (following the initial exposure) up to 100°C (212°F). If the microphones are to be used above 60°C, they should be heat-treated previously for several hours at the highest temperature of operation. They should then be allowed to cool to room temperature and, after 24 hours, the sensitivity should be measured. The microphones are thus stabilized for operation at any temperature up to that at which they were heat-treated. However, use of the microphones above 60°C is not recommended and when so used the warranty is no longer valid.

3.6.7 Humidity Effects.

The impedance of the ceramic microphones is approximately an order-of-magnitude lower than that of the condenser microphones of equivalent size and no polarizing voltage is required; therefore, they are much less susceptible to the effects of humidity. Under most normal conditions of humidity, the microphones are totally unaffected. However, under conditions of severe humidity with condensation of

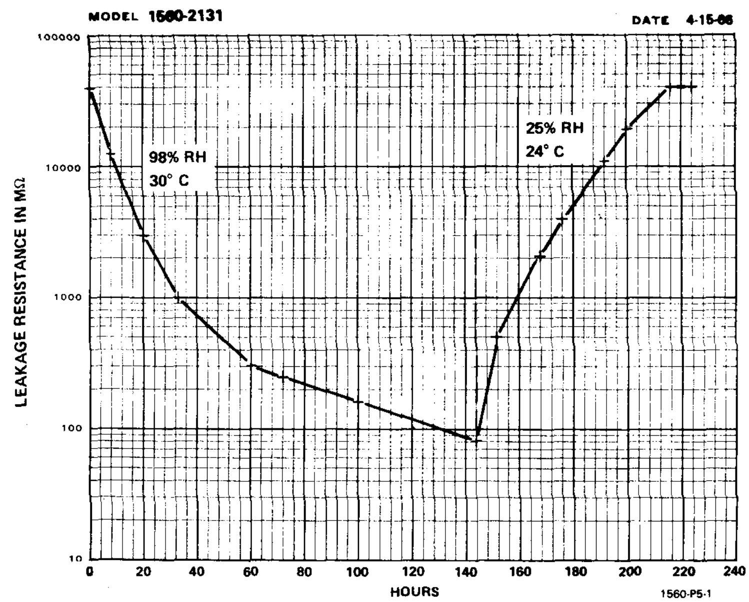

Figure 3-10. Change in leakage resistance with humidity changes.

1971 EVALUATIONS

VIBRATION SENSITIVITY:
1 g ACCELERATION AT 20 & 100 Hz ≅ 100 dB SPL

TEMPERATURE RANGE:
OPERATES AT 85°C & −55°C

THERMAL SHOCK:
−55°C FOR ½ HR; TRANSFER WITHIN 5 MIN TO +85°C FOR ½ HR.
5 CYCLES

MECHANICAL SHOCK PER MIL 202 C METHOD 202:
50 g HALF SINE SHOCK (2 AXES)

VIBRATION PER MIL 202 C METHOD 204:
60 MILS P TO P OR 10 g 10-500 Hz 15 MIN SWEEP 12 TIMES, (3 AXES)

HUMIDITY & MOISTURE PER MIL 202 C METHOD 106-B-1:

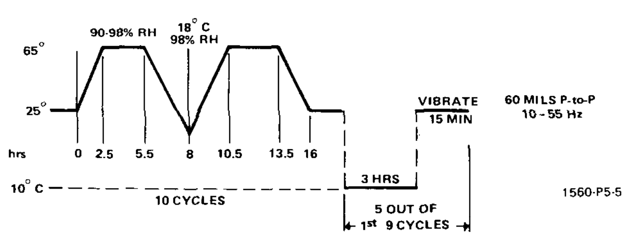

Figure 3-11. Results of environmental tests according to MIL-STD-202C, Method 106-B1.

moisture, the leakage resistance will decrease, as shown in Figure 3-10, causing a low-frequency roll-off. This roll-off is determined by the characteristic capacitance of the microphone and the value of the leakage resistance. Humidity and moisture tests were made on a 1971 1-in. ceramic microphone according to MIL-STD-202C, Method 106-B1 (see Figure 3-11), after which the leakage resistance had dropped to approximately 300 kΩ, making the microphone unusable below 1000 Hz. Within 24 hrs., under normal room conditions, the microphone had recovered.

3.6.8 Ruggedness.

The 1-in. ceramic microphone was subjected to several environmental tests, to evaluate its ruggedness. The tests are shown in Figure 3-11. The net result of the entire evaluation procedure was a negligible change in sensitivity and frequency response.

3.6.9 Pressure-Equalization Air Leak.

A controlled air leak is built into the terminal plate of the GR ceramic microphones, to equalize the static pressure on the back and front of the diaphragm when the ambient pressure changes. At very low frequencies, the air leak equalizes the sound pressure on each side of the diaphragm, thus causing a roll-off in the low-frequency response. The air leak and the total enclosed volume of the cartridge combine to form a high-pass filter whose cutoff frequency is determined by the time constant of the pressure equalization. For the GR ceramic microphones, the time constant is .08 s, which results in a low-frequency cutoff (response down 3 dB) of 2 Hz. The microphone can withstand a pressure step of approximately 0.1 atmosphere (1.5 psi, 3 in. of Hg, or 10^4 Pa). For a ramp pressure-change with time, the rate of change of pressure is 1 atmosphere/s. At sea level, this amounts to an initial rate of climb of 30,000 ft/s.

3.6.10 Vibration Sensitivity.

If the 1-in. ceramic microphone is subjected to an acceleration of 1 g at 20 and 100 Hz with the force perpendicular to the plane of the diaphragm, the microphone will generate an equivalent sound-pressure level of 100 dB.

3.7 GR ELECTRET-CONDENSER MICROPHONES.

3.7.1 General.

The GR electret-condenser microphones are available in four models: 1-in. and ½-in. microphones, each with a flat random-incidence response, and 1-in. and ½-in. microphones, each with a flat perpendicular-incidence response. Each is supplied with an adaptor to ½-in. thread and a wooden case. The accessories supplied and available are described in para. 1.2 and 1.3, respectively.

The properties of the electret-condenser microphones are noted in Section 2. A comparison of the random-incidence responses for typical electret microphones with those of other types is shown in Figure 3-2.

3.7.2 Calibration.

The electret-condenser microphones are furnished with the appropriate perpendicular-incidence or random-incidence response curve. Figures 3-12 and 3-13 give the corrections to be added algebraically to the random-incidence response to obtain the perpendicular- or grazing-incidence response or the pressure response. Similar curves in Figures 3-14 and 3-15 give the corrections to be added to obtain the random- or grazing-incidence response or the pressure response from the perpendicular-incidence response.

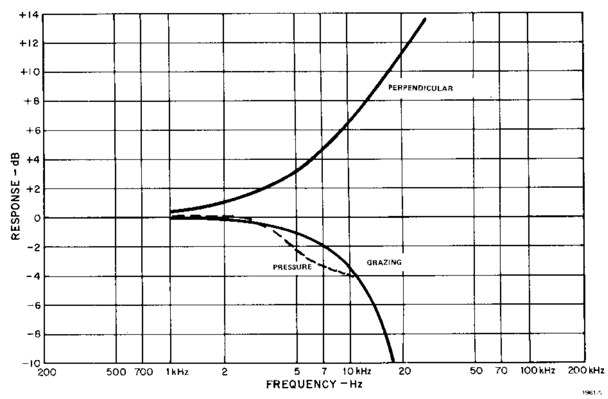

Figure 3-12. Corrections to be added algebraically to the random-incidence response to obtain the perpendicular/grazing-incidence free-field response, or pressure response for the 1-in. electret microphone, Type 1961-9601.

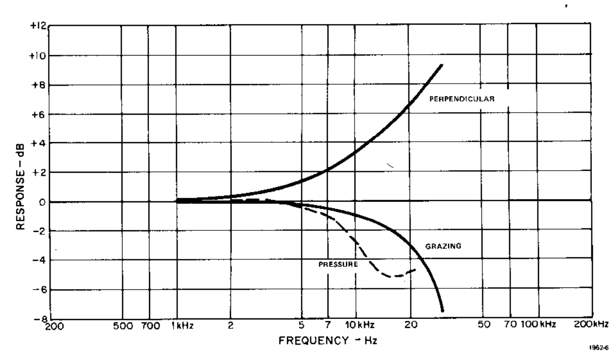

Figure 3-13. Corrections to be added algebraically to the random-incidence response to obtain the perpendicular- or grazing-incidence free-field response, or pressure response for the ½-in. electret microphone, Type 1962-9601.

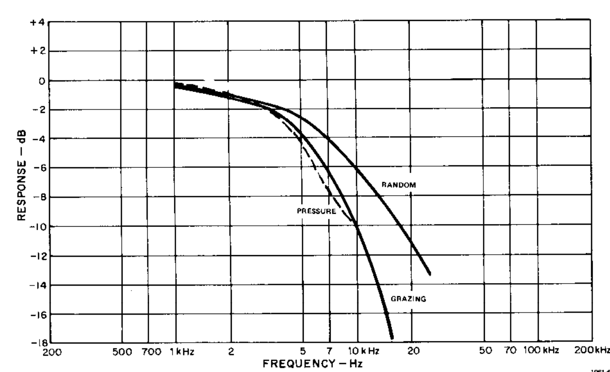

Figure 3-14. Type 1961-9602 Microphone. Correction curves for random incidence response, grazing incidence free-field response and pressure response.

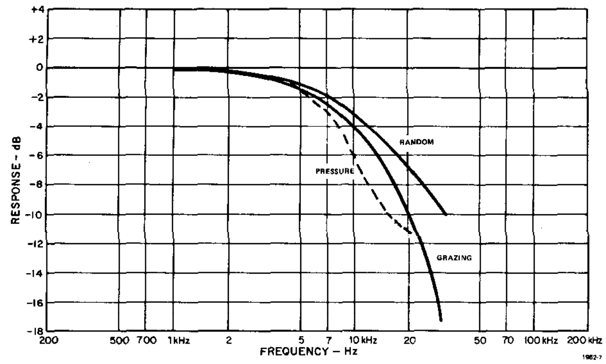

Figure 3-15. Type 1962-9602 Microphone. Correction curves for grazing incidence free-field response and random incidence response and pressure response.

3.7.3 Directional Patterns.

Typical directional patterns for the electret-condenser microphones at various frequencies are shown in Figures 3-16 and 3-17. The microphones are omni-directional within 3 dB to approximately 3 kHz for the 1-in. and 6 kHz for the 1/2-in. microphones.

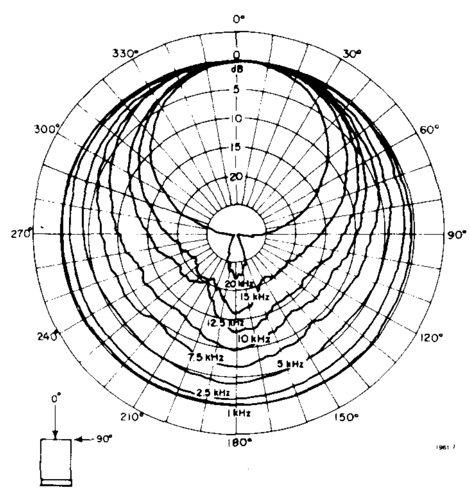

Figure 3-16. Typical directional response patterns for the GR 1-in. electret-condenser microphones.

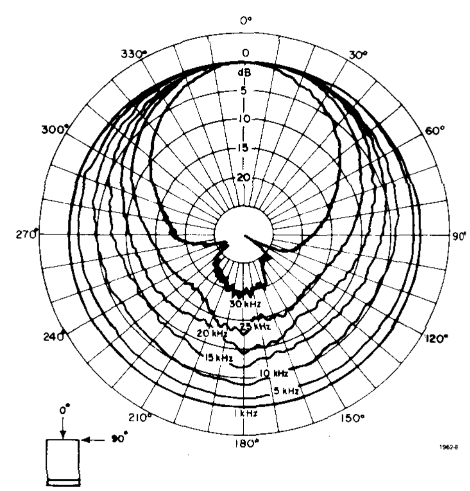

Figure 3-17. Typical directional response patte for the GR ½-in. electret-condenser micropho

3.7.4 Dynamic Range.

The limits of the dynamic range are set by the noise level of the microphone-and-preamplifier combination for the low limit and by the total harmonic distortion for the upper limit.

Microphone Only			Dynamic Range * for Microphone/ Preamplifier Combination
Microphone Size (inches)	Upper Limit for 3% Distortion (dB SPL)	Maximum Safe Limit (dB SPL)	re 20μPa (dB SPL)
1	140	160	22 – 140
½	140	170	30 – 145

*A-weighted noise level to maximum rms sinewave signal without clipping.

3.7.5 Temperature Effects

The temperature coefficient of sensitivity for both 1-in. and½-in. electret-condenser microphones is less than +0.015 dB/ °C, typically +0.010 dB/ °C.

A typical temperature-sensitivity change curve, at a low frequency of 500 Hz, based on tests of a sample of five ½-in. microphones is shown in Figure 3-18. The temperature coefficients of sensitivity is independent of frequency at frequencies below 2 kHz, and it increases slightly at higher frequencies. The frequency response changes of an electret-condenser microphone at different temperatures are shown in Figure 3-19.

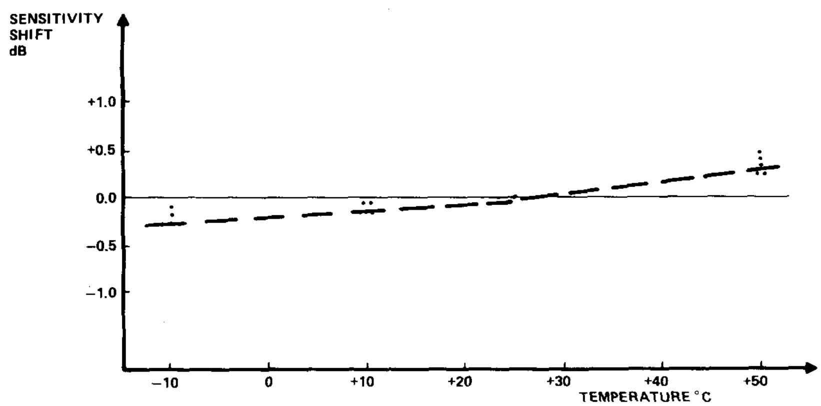

Figure 3-18. Change in sensitivity of electret-condenser microphone relative to sensitivity at 23 °C.

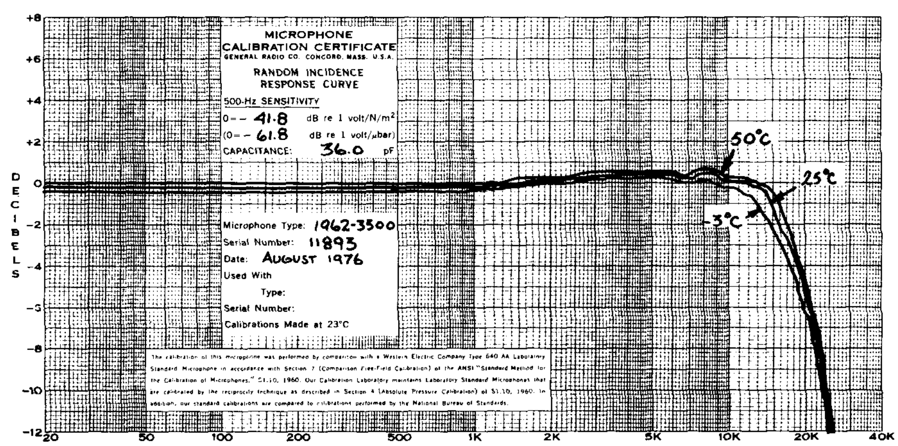

Figure 3-19. Electret Microphone Frequency Response Change With Temperature.

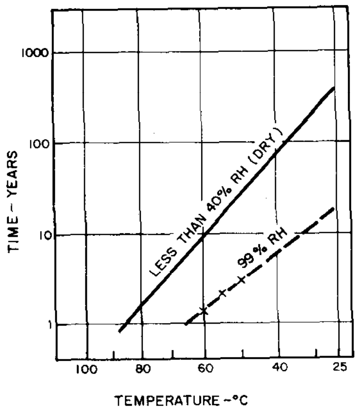

Figure 3-20. Effect of changes of temperature and humidity on the stability of electret-condenser microphones (see text).

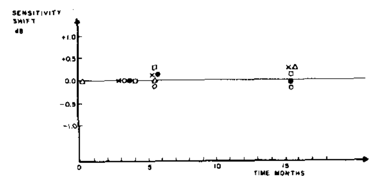

Figure 3-21. Long-term sensitivity shifts of electret-condenser microphones.

The operating temperature range for electret-condenser microphones is now +60°C to −40°C. Microphones should not be exposed to temperatures higher than +100°C or lower than −50°C.

3.7.6 Thermal Shock Effects

The electret-condenser microphones are designed to withstand adverse environmental conditions, shocks and stresses. In the Table 3-2, the data on two electret microphones exposed to a thermal shock are shown. The microphones were kept as −40°C inside a temperature chamber, and then suddenly brought out to room temperature (+22°C). They were immediately covered with frost which slowly thawed and evaporated. A calibrator was used to measure the sensitivity shifts of the microphone of 250 Hz. The maximal shift of sensitivity and the remaining shift, one-half hour after the thermal shock, are shown in the table.

Table 3-2

THERMAL SHOCK TEST
MICROPHONE SENSITIVITY CHANGE (dB)
AT 250 Hz

S/N	TEMPERATURE °C		
	+22	−40	+22*
10408	0.0	+1.0	−0.1
11656	0.0	+0.6	−0.2

*Thirty minutes after the thermal shock

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3.7.7 Humidity Effects.

A most important consideration for an electret-condenser microphone is the stability of its electrostatic charge with time under different conditions of temperature and humidity. A decrease of electrostatic charge will produce a change in sensitivity of the microphone. GR electret microphones are polarized by a unique method that, combined with carefully controlled aging, makes possible an optimal polarization of a given polymer material.

Figure 3-20 shows the stability of GR electret microphones at different temperatures and humidities. The time units of the ordinate scale show the length of time the microphones can remain at a given temperature and humidity before incurring a sensitivity loss of 1 dB. The solid line gives the time under dry conditions; the dash line shows the time-temperature relation with 99% relative humidity. For example, the sensitivity of an electret microphone will shift 1 dB, if it is continuously exposed to the severe environment of 99% relative humidity and 55°C for two years.

Because of the bound nature of electret charge, voltage breakdown across the air gap cannot occur in the electret-condenser microphone. This is a frequent mechanism of failure in the air-condenser microphone at high humidity. All measurement microphones, the air condenser, the electret condenser, and the ceramic are high-impedance devices. Their insulation resistance between the output terminals is subject to the effects of contamination. At high humidity, the change in the insulation resistance can produce a shift in microphone sensitivity. In the electret microphone, a new insulating material, less susceptible to contamination, is used between the output terminals.

A sample of five microphones was exposed for two days to 95% relative humidity. Their sensitivities at 250 Hz changed between 0.3 dB and 0.5 dB, but they recovered to 0.2 dB of the initial sensitivity within two hours when brought back to 50% relative humidity. The temperature was constant during this test.

3.7.8 Ambient Pressure Effects

The sensitivity of the electret microphone will change less than −0.2 dB for an increase of 10% in ambient pressure. The time constant of the air leak is .03, which produces a low-frequency cutoff (decrease in response of 3 dB) at 5 Hz. The allowed rate of change of ambient pressure is less than 0.2 atm/s.

3.7.9 Vibration Sensitivity.

Electret-condenser microphones are less sensitive to vibrations than any other type. When subjected to an acceleration of 1 g at 20 or 100 Hz, with the force perpendicular to the plane of the diaphragm, the 1-in. and ½-in. electret-condenser microphones will generate an equivalent sound-pressure level of 83 dB.

3.7.10 Long-Term Stability

Figure 3-21 shows the long-term stability data of a group of five electret-condenser microhones during a fifteen month period. The sensitivity shifts stayed within ±0.3 dB limits.

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Type 1560-P42 Preamplifier–Section 4

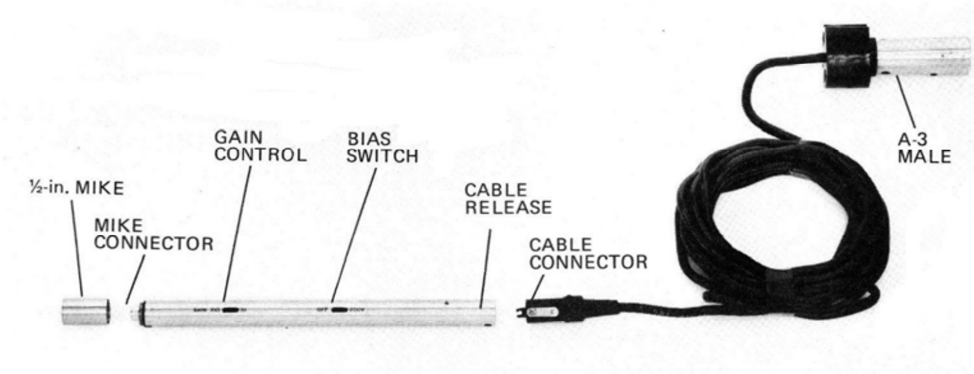


Figure 4-0. Controls and connectors.

4.1 DESCRIPTION.

A complete description of the Type 1560-P42 Preamplifier (Figures 1-1 and 1-2) is given in para. 1.1.3.

4.2 INSTALLATION.

4.2.1 Connecting the Transducer.

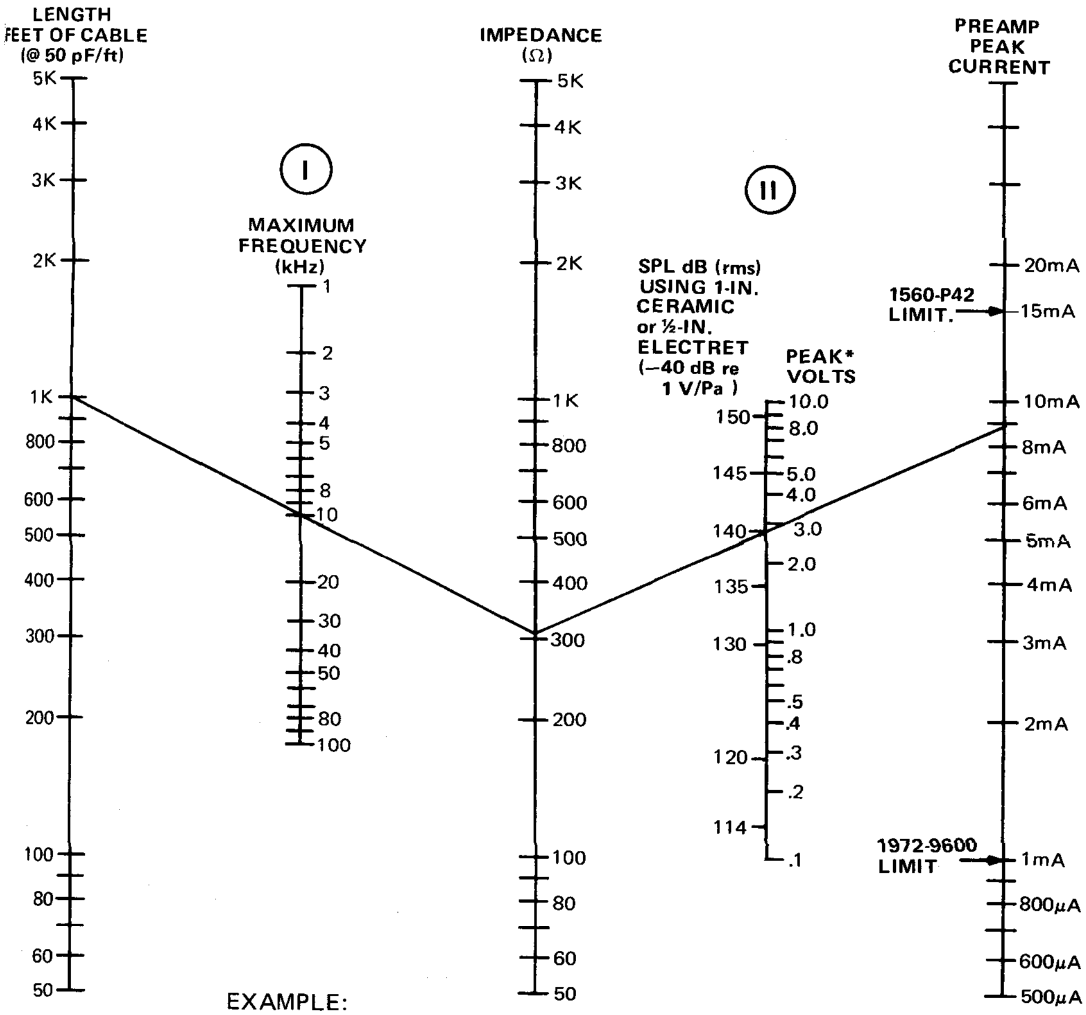
NOTE

Although it is not necessary, it is good practice to turn off the power to the 1560-P42 Preamplifier while the transducer is being connected or disconnected. (The FET is diode protected against surges.)

Connection of the transducer to the Preamplifier is made by means of a 0.460-60 threaded coaxial connector. This connector provides electrical contact between the microphone shell and the Preamplifier circuit ground. The ground connection is electrically isolated from the case of the Preamplifier, which serves as a shield.

PROCEDURE:

- Select length of cable used.
- Using chart I, draw a line from length through max. frequency to impedance.
- Using chart II, draw a line from impedance through peak volts to peak current. *Allow for crest factor.*



EXAMPLE:
1000 ft. cable at 10 kHz = 320 Ω
At 140 dB SPL peak current is 9 mA

NOTE
Leave room for crest factor of noise signals.

*(See Figure 4-11 and multiply rms volts by 1.4, assuming X1 gain for 1560-P42.)

1560-P42-9

Figure 4-1. Nomograph to calculate current requirements in long cables.

NOTE

The circuit ground of any adaptors that are used with the Preamplifier must be insulated from the shell of the Preamplifier, to preserve the 3-wire output consideration. All GR adaptors retain this feature.

The connection between circuit ground and shield is made at the analyzing instrument for all equipment. This connection must be provided to realize the full shielding capability of the -P42 Preamplifier (refer to the schematic diagram for output-connector pin destinations, Figure 4-18).

The input terminals of the Preamplifier provide a direct connection for all 1/2-in. GR microphones. To convert transducers of other sizes to this thread, the appropriate adaptor must be inserted between the transducer and the Preamplifier. The adaptors are described in para. 1.2.2 and 1.3.2 and are shown in Figure 1-4.

Because the depth of the center-pin contact of 1-in. microphone has not been standardized, standard 1-in. microphones, such as the WE 640AA and the MR 103, are supplied with a small sliding center contact. This contact should be *adjusted to the depth necessary to provide the required contact between the center pin* of the microphone and the Preamplifier.

The GR Vibration Pickups, Types 1560-P52, -P53, and P54, can be connected to the Preamplifier by use of the 1560-9669 Adaptor. Other vibration pickups will require special adaptors for this connection.

4.2.2 Tripod Mounting.

The 1560-9590 Tripod is designed to accept the 1560-P42 Preamplifier. Complete instructions for its use are given in para. 1.3.6.

4.2.3 Output Connections.

The 10-ft output cable supplied with the Preamplifier is terminated in a Switchcraft type 3A, 3-pin, male connector that mates directly with similar female connectors on the 1560-P62 Power Supply and on most GR analyzers and sound-measuring instruments. *The shield is connected to the outer shell of the Preamplifier,* but is ***not*** connected to ground except at the analyzing instrument or by the output cable of the 1560-P62 Power Supply.

The pin connections for the Preamplifier output cable are as follows:

Pin 1 – circuit ground

Pin 2 – *power-supply connection (+15 to 25 Vdc)*

Pin 3 – output signal (from Preamplifier)

Shell – shield

NOTE

The circuit ground and the shell (shield) of the Preamplifier must be connected at the analyzer.

4.2.4 Adjustments.

Adjustment of the Preamplifier consists of setting two slide-switch controls, labelled GAIN (X1, X10) and 200 V (ON, OFF). These are accessible through cutouts in the outer shell of the -P42. A notch in the slider of each switch is used to set the controls to one position or the other. Use any small tool (such as a screwdriver or ball-point pen) to set these controls.

Gain Adjustment. The gain of the Preamplifier can be set to either X1 or X10 by means of the GAIN switch. It should be set to optimize the dynamic range of the system. For low levels (such as less than 60 dB SPL for −60 dB microphone sensitivity level) and/or for long cable runs, set the GAIN switch to X10, to eliminate the influence of the analyzer noise on the measurement. With high signal levels (above 120 dB SPL for −60 dB microphone sensitivity level) set the GAIN switch to X1, so that the output signal will not be clipped because of overloading. For levels between 60 and 120 dB, either X1 or X10 can be used, the choice depending upon the reading desired on the indicating analyzer.

Polarizing Voltage. The +200-V polarizing voltage for air-condenser microphones can be turned ON and OFF by adjustment of the slide switch marked 200 V, on the Preamplifier. This voltage is generated in an internal blocking oscillator operating at approximately 60 kHz (refer to the schematic diagram). The voltage is applied to the center pin of the input connector through several decoupling networks. At least +15 V at the Preamplifier terminals is required to ensure stable generation of the 200 V. The 200-V supply is turned on by connecting the low-voltage supply to the oscillator through the 200 V (ON, OFF) switch. Set the switch ON for air-condenser microphones and OFF for ***all*** other transducers.

NOTE

The available current from the +200 V polarizing supply is extremely low and not hazardous. However, an increase in input noise due to leakage current may result if the polarizing voltage is left on with ceramic transducers. Left on with electret-condenser microphones, it will produce a temporary change in sensitivity and frequency response. The electret microphone will recover a few minutes after the polarizing voltage is turned off. Use the +200-V supply only with ordinary air-condenser microphones.

The power consumption of the Preamplifier increases slightly when the polarizing supply is ON (the current increases about 2-3 mA above the current of the amplifier circuit of the Preamplifier).

4.2.5 Power.

The Preamplifier can be powered from a number of GR sound-level meters and analyzers, as shown in Table 1-2. The power is applied via the input connector to the Preamplifier. For use with instruments that do not supply power for the Preamplifier, or where insufficient current is available to power the polarizing supply, or for runs with long cables, the 1560-P62 Power Supply is available. This integrated charger and line/battery-operated supply provides the necessary current and voltage for most applications. Refer to Table 1-2 and Figure 4-2 to determine the required current for the length of cable used. Details of the Power Supply are given in Section 5 of this manual.

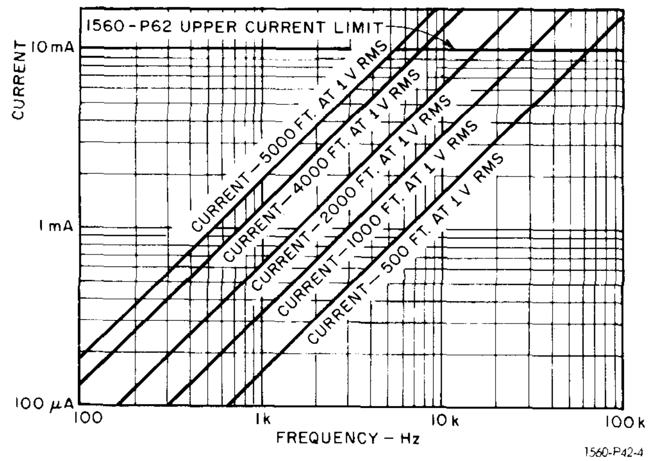


Figure 4-2. Required dc current vs cable length at 1 V, rms.

Although the 1560-P42 Preamplifier is designed to be used with GR instruments that supply the proper power, there may be instances in which the user wishes to use a different supply. This use is entirely satisfactory if certain precautions are taken:

With the class AB output stage, the power supplied to the Preamplifier must be current limited so that the output stage of the Preamplifier will not be damaged if the output is heavily loaded (such as with a short circuit) when a signal is applied to the load. Output currents above 30 mA at rated voltages should be avoided. GR analyzers and the 1560-P62 Power Supply provide this current limitation. Other supplies should be set to give a maximum short-circuit current of 15 mA. If this is not possible, insert a 100-Ω resistor in series with the supply lead (pin 2 of the -P42 output connector), to provide minimum protection (see Figure 4-18).

If the supply current is monitored with a dc milliameter, the true average current (other than the quiescent current) drawn by the 1560-P42 Preamplifier, when the load is driven by a sine wave, is actually twice the indicated current, because the current drawn from the positive lead of the power supply by the class AB output stage occurs during only the positive half of the cycle. In other words, therefore, the reading of an average-reading meter must not exceed 10 mA.

Average current to load $\simeq$ $(mA_{reading} - mA_{quiescent}) \times 2$.

Note that, in a system where cables in excess of 1000 ft are driven, the placement of the power supply will influence the capability of the system (the IR drop in the cable becomes significant). Placement of the supply near the preamplifier will avoid the loss of the powering voltage through the long cable.

4.2.6 Insert Voltage.[1]

General. Provision for connecting an insert calibration signal is provided by a type-274 double jack (PL2) built into the output plug. The insert voltage can be used

1. For a complete discussion of the theory of insert-voltage calibration, refer to Beranek, L. L., *Acoustic Measurements*, John Wiley & Sons, Inc., New York, 1949, pp 601, 602.

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to determine the system sensitivity if the open-circuit sensitivity of the microphone is known; it can be used to determine the absolute calibration of the system by direct comparison with a reference microphone; also, an operational check on a system can be made with the insert voltage. The equipment needed for these operations is listed in Table 4-1. The insert terminating resistor is 10 Ω (R20) and the maximum insert voltage is 1 V rms. The signal is applied across the insert resistor, effectively putting the insert voltage in series with the transducer.

Table 4-1

EQUIPMENT REQUIRED FOR USE IN MEASURING SENSITIVITY

Name	Requirements	Recommended*
Oscillator	1 kHz, 1 V	GR Type 1310 Oscillator
Decade Attenuator	0-100 dB in 0.1-dB steps	GR Type 1450-TB Decade Attenuator
Voltmeter	0-10 V ac ±5%	HP Type 400 EL Voltmeter
Analyzer	C or FLAT weighting, 70-100 dB	GR Type 1564 Sound and Vibration Analyzer
Power Supply	20 V, 15 mA	GR Type 1560-P62 Power Supply
Resistor	590 Ω ±1%	————
Sound Source	Stable repeatable source	GR Type 1562 Calibrator
Reference microphone with adaptor to fit input to -P42 Preamplifier	Long-term stability; calibration traceable to NBS	W.E. 640AA
Patch Cords (2)	GR 274 to GR 274, 3 ft	GR Type 274-NQ
Adaptor	Microphone cartridge to 0.460x60 thread	GR 1560-2630
Clip Leads (2)	>1 foot long	————

*Or equivalent.

Determination of System Sensitivity. The following procedure should be used to determine the sensitivity of the system when the open-circuit sensitivity of the microphone is known:

a. Make the setup of Figure 4-3. Connect the oscillator to the 274 insert terminals (the connector at the end of the Preamplifier output cable). Connect the voltmeter between the threaded portion of the input connector and the shell of the Preamplifier, i.e. across the insert resistor (clip leads can be used). Power for the Preamplifier is not needed. In the figure, R_i is the insert resistor (nominally 10 Ω) and R_W is the internal wiring resistance (typically a few tenths of an ohm).

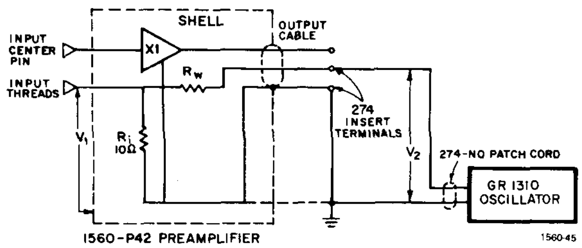

Figure 4-3. Setup for determination of system sensitivity.

b. Adjust the oscillator to 1 kHz. Set its output so that the voltmeter reads V_1 = .01 V.

c. Transfer the voltmeter to the insert terminals and read V_2. The indicated increase in voltage ($V_2 - V_1$) is caused by the drop across R_W, (typically a total of –0.3 to –0.5 dB). This is the loss that must be added to the voltage at the insert terminals to give the desired voltage across the insert resistor. Record this value for future use.

d. Install the microphone on the Preamplifier. Connect the plug on the output cable from the Preamplifier to the input of the 1564 Sound and Vibration Analyzer. Power for the Preamplifier is supplied by the 1564. The oscillator should remain connected to the insert-voltage terminals, with its output still set to the value of V_2, at 1 kHz.

e. With the Preamplifier operating on X1 gain, note the reading (V_3) of the analyzer (calibrated to read voltage). The difference in voltage ($V_1 - V_3$) is a result of the capacitive loading of the transducer by the Preamplifier and Preamplifier gain or loss.

The ratio of $\frac{V_1}{V_3}$ expressed in dB ($20 \log_{10} \frac{V_1}{V_3}$), is the value to be subtracted from the open-circuit sensitivity level of the microphone to obtain the system sensitivity level.

For example, if the sensitivity level of the microphone is –40 dB re 1 V/Pa and V_1/V_3 = 1.175 (=1.4 dB), then the system sensitivity level is

$R_s = -40 - 1.4 = -41.4$ dB re 1 V/Pa.

If a more-accurate method is required, short the input with a GR 1560-2630 adaptor (with shorted terminals) and supply power to the –P42. Note the difference

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between the voltage at the insert terminals and at the output of the -P42 cable. This method removes simultaneously the errors due to amplifier gain and the wiring loss.

Comparison with Reference Microphone to Obtain Open-circuit Sensitivity.

a. Make the setup shown in Figure 4-4. The 590-Ω resistor at the attenuator output provides the proper 600-Ω load for the attenuator when the 10-Ω insert resistor is driven. Power for the Preamplifier is furnished by the 1564.

b. Connect the reference microphone to the -P42, and place the 1562 Calibrator, set at 1 kHz, on the microphone. (The actual level of the calibrator signal is not important, but it must be repeatable.) Set the oscillator output at zero.

c. Read the voltage output from the Preamplifier on the analyzer. Record the value as V_{ref}. Remove the sound source.

d. Set the oscillator output level for maximum (approximately 10 V) at 1 kHz. Adjust the 1450-TB Attenuator to give a reading equal to V_{ref} on the 1564. Note the setting, A_1, of the attenuator.

e. Turn the oscillator output to zero. Replace the reference microphone with the unknown and place the sound source (1562) on the unknown microphone. Note the 1-kHz reading, V_{unk}, of the analyzer.

f. Remove the sound source and connect the oscillator as before, with the output setting used in step d (10 V). Adjust the 1450-TB attenuator to give a level equal to V_{unk} on the analyzer. Note the attenuator setting, A_2.

g. The open-circuit sensitivity level of the unknown microphone is then

$$S_{unk} = S_{ref} + (A_1 - A_2).$$

For example, if

$$S_{ref} = -30 \text{ dB re 1 V/Pa}$$
$$A_1 = 4.5 \text{ dB}$$
$$A_2 = 13.5 \text{ dB}$$

then

$$S_{unk} = -30 + (4.5 - 13.5)$$
$$= -30 - 9.5$$
$$= -39.5 \text{ dB re 1 V/Pa}$$

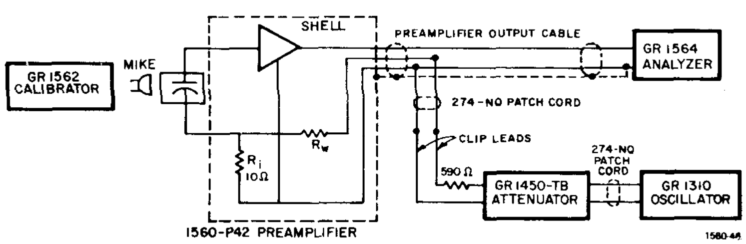

Figure 4-4. Setup for comparison of unknown with reference microphone.

Operational Check of System. When a system has been set up and calibrated, a voltage can be applied to the insert terminals to serve as a reference. Note the values of the insert voltage and the analyzer reading, for future reference. (The absolute values are not important.) As an operational check at a later date, or after system modifications, the same voltage is applied to the insert terminals. A deviation in the analyzer reading from the original reading is an indication of a change in the system response.

4.3 INPUT CONSIDERATIONS.

The equivalent INPUT circuit of the Preamplifier is determined by the FET input stage and its associated biasing and protection networks. Protection for the transistor from surges of the polarizing voltage (with condenser microphones) is supplied by very low-leakage semiconductor diodes. These diodes produce a slight increase in the input capacitance and add some leakage resistance. The 200-V polarizing voltage is supplied through a "bootstrapped" 1 GΩ resistor, which, in effect, increases its ac resistance to well above 2 GΩ. The net input resistance is approximately 2 GΩ. The input capacitance is established by the FET plus the diodes, and is typically 3-4 pF, with 6 pF maximum. (Use of the driven shield minimizes the input capacitance for small-diameter microphones.) As a result of this nominal input capacitance, there is some transducer insertion loss due to the resultant capacitive-divider effect. Figure 4-5 gives the insertion loss for microphones of various capacitances.

A low-frequency roll-off is encountered when the Preamplifier is driven from a capacitive source because of the equivalent input resistance. The "Lower" and "Upper Frequency Range" columns of Table 1-1 give the frequencies at which the response is down 3 dB, for the various microphones. Input protection diodes CR1 and CR2 utilize the signal-source impedance to limit the pk-pk input voltage to the power-supply value. If the 1560-P42 is driven from a 10-Ω or lower source impedance, such as that of a power amplifier, it is important to limit the pk-pk input voltage to the power-supply value, to avoid damaging CR1 or CR2.

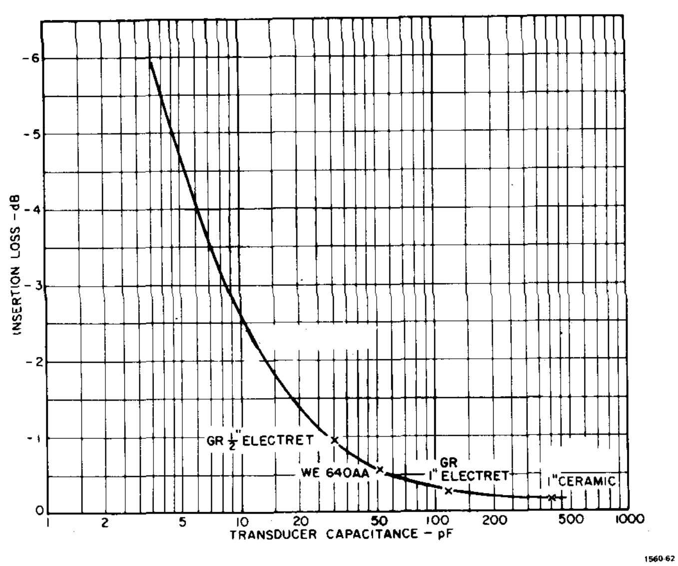

Figure 4-5. Insertion loss vs transducer capacitance.

4.4 USE OF LONG CABLES.

4.4.1 General.

The 1560-P42 Preamplifier is designed with the capability of delivering substantial signal current and signal voltage to the driven cable at the preamplifier output. Thus, longer cables can handle substantially higher signals at higher frequencies than were possible heretofore with other preamplifiers. However, to utilize this capability, the user must have a thorough understanding of the problems to be encountered.

In any system involving active amplification driving a load, the following effects, with their related causes, should be considered:

1. ***Distortion***. Insufficient current to drive the particular load at the desired signal voltage level (i.e., the signal level is too high for the load).

2. ***Change in frequency Response.*** The output characteristics of the amplifier, in conjunction with the impedance of the load, alter the frequency response of the signal.

3. ***Attenuation.*** Also brought about by the interaction of the output amplifier impedance and the load impedance, this is a modification of 2, above, but it is generally considered a flat loss of signal with respect to frequency.

4. ***Power-supply voltage drop.*** This item is a fourth effect, resulting indirectly from the use of an amplifier powered through a long cable. The voltage drop in the power lead of the cable is a function of the resistance of the cable and the current drawn by the driving amplifier. If the amplifier is operating class A-B or B, the current is a function of the output level, the frequency, and the impedance of the cable being driven.

These general problems can be circumvented if one has a thorough knowledge of their causes. It is assumed, in the appraisal of the system, that the ultimate goal is the flattest possible frequency response, with minimum attenuation and minimum distortion, over the range of interest. The following paragraphs should bring about a better understanding of the problems and their solutions.

4.4.2 Definitions.

Short Cables. A short cable is one in which no appreciable change in performance of the system or in measurement results is produced in the frequency range of interest by use of the cable. Thus, for our analysis, short cables can be excluded. In general, short cables for use with the 1560-P42 Preamplifier are those that are 500 ft or less in length.

Long Cables. Long cables are those that alter the signal appreciably when driven by the preamplifier. For our analysis, long cables are those whose driving wavelength is much longer than the cutoff wavelength of the cable. If the frequency of the driving signal is above the cutoff frequency, the attenuation in the cable decreases uniformly as the square root of the frequency. However, for audio frequencies, the cable is invariably being driven well below cutoff frequency. Typically, the wavelength is greater than 5000 ft at 150 kHz for polyethylene dielectric cables.

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4.4.3 Equivalent Circuits.

The sources of signal alteration in an amplifier/cable system can be demonstrated best by means of the equivalent circuit of the cable (see Figure 4-6) driven by the amplifier and the equivalent circuit of the output stage of the amplifier. It is the interaction of these elements that produces the alteration or degradation of the signal.

In most microphone/preamplifier applications, where low-level signals are involved, the cable is usually assumed to be an unterminated, unmatched line. It appears as a simple lumped capacitance at the output of the driving amplifier. The equivalent shunt capacitance at the output of the amplifier increases as the length of the cable increases. Thus, in conjunction with the output resistance of the amplifier, a 6-dB/octave low-pass filter is produced with the cutoff frequency decreasing as the length of the cable increases.

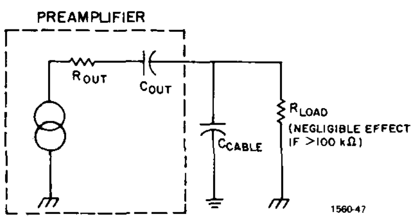

Figure 4-6. Equivalent circuits for the output stage of the Preamplifier and the cable.

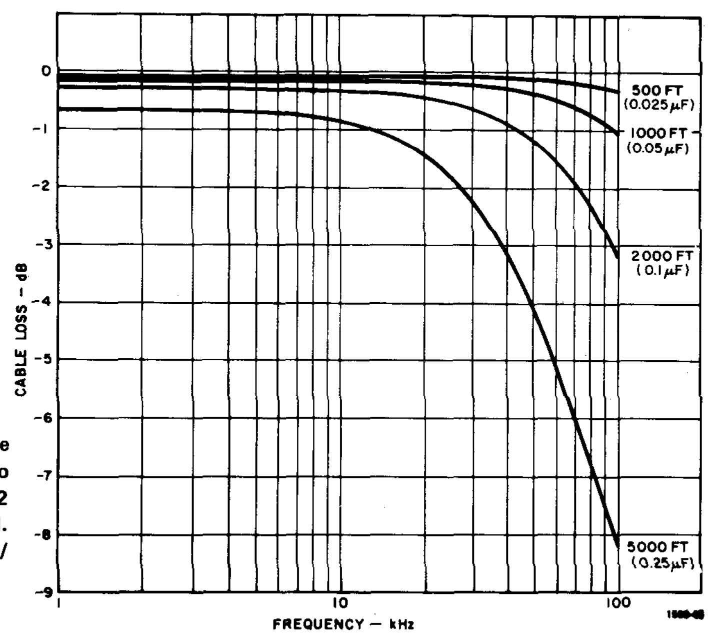

Figure 4-7. Typical cable loss vs frequency, due to output loading of 1560-P42 for a pure capacitance load. Cable capacitance is 50 pF/ ft.

Certain cables, whose resistive and inductive reactances are ***small*** with respect to their capacitive reactance, do behave according to the above simple assumption. Also, a flat loss is introduced at low frequencies by the capacitive divider effect between the output coupling capacitor of the amplifier and the lumped cable capacitance. The

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cable loss vs frequency for various lengths of 1560-9667 cable (Belden #8771)* is shown in Figure 4-7. For this curve, the capacitance only (50 pF/ft) is used as the effective impedance. In reality, with most audio cables whose effective impedance is approximately 50 Ω, the resistive and inductive reactances are not negligible. They must, therefore, be taken into account. Indeed, as the cable length increases, the effective load impedance for the amplifier never decreases to zero, but is restricted to the 50-Ω self termination of the cable.

4.4.4 Cable Response.

Figure 4-8 shows the results of these effects on the response, using the total effect of the same cables, with a 1560-P42 Preamplifier. Because the cable is driven from a low impedance rather than its natural impedance (as would be the case in a matched line) the cable appears as a distributed tank circuit driven from a short circuit. The result is a family of curves with resonant peaks. The frequency is determined by the L/C constants of the cable, and the amplitude is determined by the ratio of the cable resistance to the amplifier output resistance. It should be noted that the actual equivalent circuit of the cable as used is not an unbalanced coaxial system, but rather a balanced system, because the cable braid is a shield, not a return path. It is important, when the system response is measured, that this shield be connected to the circuit ground at one end only. In a laboratory setup, this condition must be maintained.

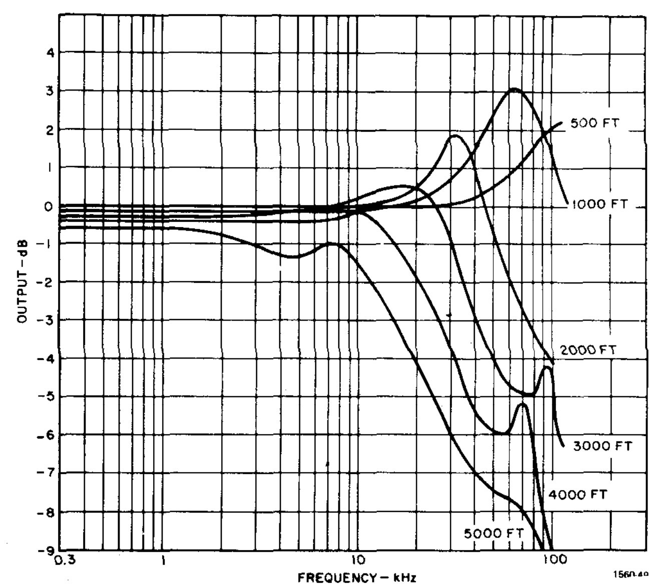

Figure 4-8. Measured cable loss of the Preamplifier vs cable length for Belden #8771 cable. Preamplifier gain is X 1, powered from the receiver end.

*Belden Corp., P.O. Box 5070-A, Chicago, Ill.

The equivalent circuit of the cable is shown in Figure 4-9. For cables up to 5000 ft and frequencies up to 10 kHz, there is little effect on the signal. For longer cables or higher frequencies, the effect must be corrected, or it must be taken into account when the results are evaluated. This can be done by using corrective equalizers or by altering the results mathematically to give a flat frequency response. In both cases, a knowledge of the cable characteristics is needed.

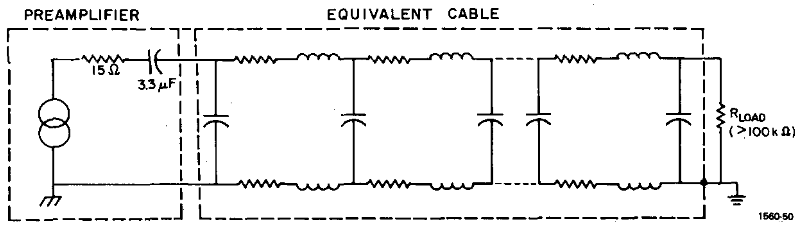

Figure 4-9. Equivalent circuit for long cables.

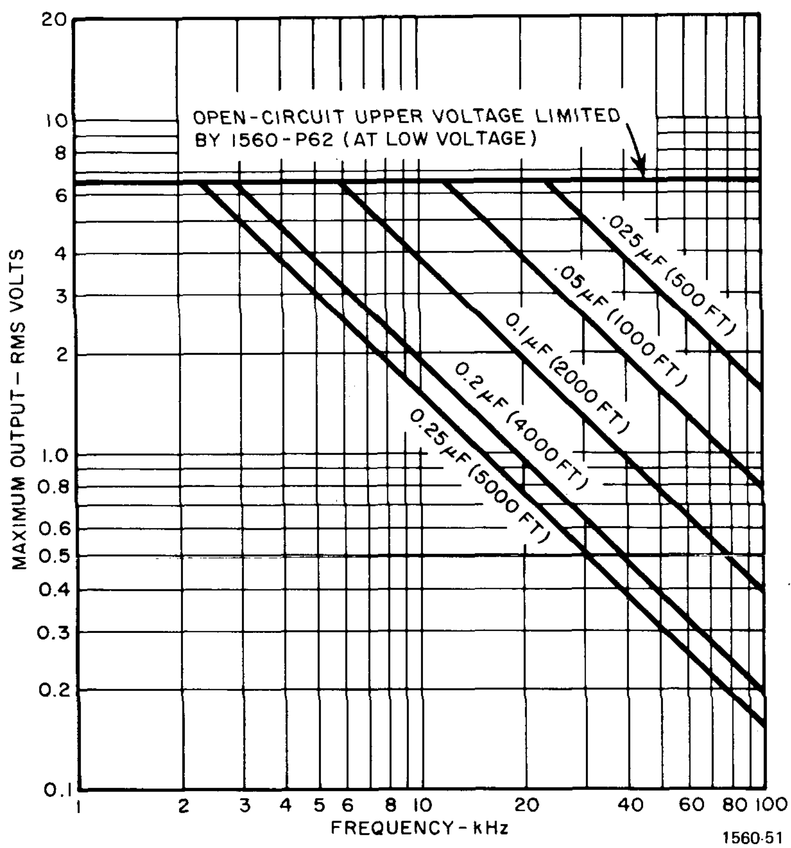

Figure 4-10. Maximum rms sine-wave output voltage for various lengths of Belden #8771 cable (50 pF/ft) at the output of the 1560-P42, using the 1560-P62 current-limited Power Supply with 1% total harmonic distortion limit.

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When a long connecting cable is used between the preamplifier and the measuring instrument, the output from the preamplifier may have to be restricted because of the low reactance load of the cable. Figure 4-10 shows the maximum rms sine-wave voltage at the output of the 1560-P42 versus frequency. The 1560-P62 current-limited Power Supply was used, and the distortion was limited to 1%. The curves are for Belden #8771 cable (50 pF/ft). Refer to Figure 4-11 to convert voltage to SPL in dB re 1 V/Pa for a particular microphone. Divide by 10 to obtain maximum output volts with X10 gain on the Preamplifier. With this value, use Figure 4-1 to obtain peak supply current required by the 1560-P42.

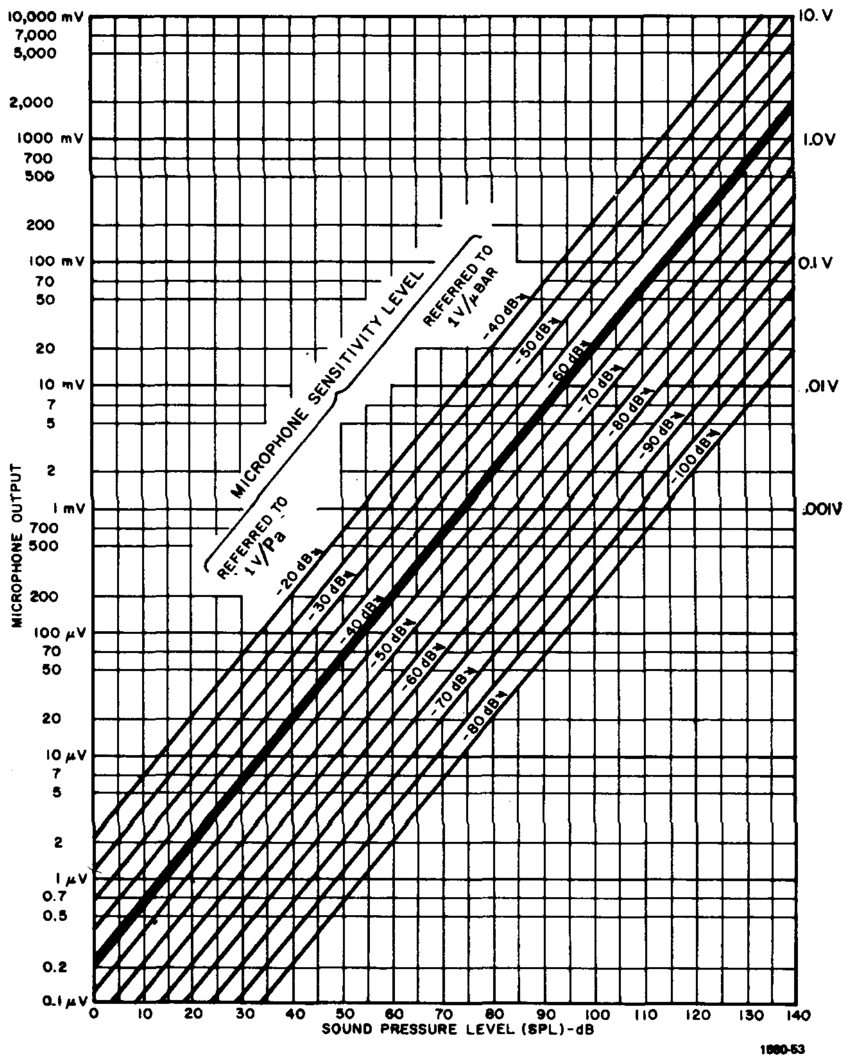

Figure 4-11. Open-circuit output voltage vs SPL vs microphone sensitivity.

4.4.5 Predicting the Resulting Response.

In general, the impedance of audio cables cannot be controlled, because of the twist of the inner conductors. The impedance may vary from 40 to 100 Ω, depending upon the make and the basic capacitance. While the resistance and capacitance of a cable can be measured quite easily, determination of the distributed inductance is more difficult. Also, once these parameters are known, it is tedious to calculate the response at all the required frequencies of interest. Even when this has been accomplished, it is well to check the results by making an actual measurement, rather than by attempting to predict the results.

4.4.6 Measuring the Cable.

To measure the cable, a stable oscillator and a wide-band voltmeter that cover the frequencies of interest are required. As noted above, the actual cable is a balanced system (i.e., the direct and return paths for the signal have practically the same resistance and inductance). Consequently, when the cable is measured, the return path of the cable must not be short-circuited by the common returns of the oscillator/analyzer combination. With this short circuit, measurements on a coiled cable in the laboratory will not be representative of the cable stretched out, in the field.

4.4.7 Using the Results.

The above measurements should be used to correct the results of the final analysis. A mathematical correction can be time consuming and too slow for real-time analysis. Corrective equalizers can be constructed and placed at the analyzer end, to return the signal to a flat frequency response.

4.4.8 Other Solutions.

Several methods are available to avoid the problem of frequency-response shift by long cables. However, they usually produce new problems:

1. Matching the Cable. This method requires matching the cable impedance at both the source and the load. There is then an automatic 6-dB loss in output level, and additional power is required by the amplifier. Most audio cables are 50 Ω impedance; this means that 20 mA is required to drive 1 V rms into the cable. Also, a large output coupling capacitor is needed to drive the cable at low frequencies.

2. Using 600-Ω Cable. This is similar to the above solution. However, the higher impedance reduces the power requirement and the size of the coupling capacitor for the matched system. With this impedance level, interference is increased. Consequently, matching transformers are used to convert the line from low-impedance unbalanced-to-ground to 600-Ω balanced-to-ground. High-quality transformers must be used to affect a good solution.

3. Using Line Drivers. With this method, amplifiers are placed in the line at such intervals that the frequency alteration is above the point of interest. This requires special feed-through amplifiers and greater power-supply capability or amplifiers with a local power-supply feed (usually an inconvenience in the field).

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4.5 NOISE.

4.5.1 Input Noise.

The major source of noise in the Preamplifier is the FET input stage[1] (refer to para. 4.6). However, some additional noise is produced by the protection diodes, CR1 and CR2. The noise spectrum is also influenced by the magnitude of the source capacitance. This capacitance, in conjunction with the real input resistance, shapes the input-noise spectrum. Bootstrapped resistor R1 behaves like a resistor many times larger with respect to the input signal, but for noise, it appears as 1 GΩ.

Figure 4-12 shows the basic 1/3-octave noise spectra from 25 Hz to 25 kHz for several typical source capacitances. The vertical coordinates are given in equivalent sound-pressure noise levels for a microphone sensitivity level of −40 dB re 1 V/Pa. Refer to Figure 4-11 to convert the levels to those for microphones of other sensitivities. For example, if the equivalent noise level with a −40 dB re 1 V/Pa microphone is 10 dB, a −50 dB re 1 V/Pa microphone would give an equivalent noise level of 20 dB.

Table 4-2 gives typical A- and C-weighted and flat-response noise levels for various source capacitances used on the 1560-P42 Preamplifier in the X1 gain position.

Table 4-2
INPUT NOISE FOR THE
1560-P42 PREAMPLIFIER

Source	Source Impedance	Noise (dB)* A Weighting	C Weighting	Flat
Line Input	600 Ω	20.5	22.5	24.5
1" Ceramic	390 pF	20.5	23.0	25.0
1" Electret	125 pF	22.5	28.0	32.0
1" West. Elec.	68 pF	23.5	30.0	34.5
1" B & K	47 pF	24.5	32.0	36.0
½" Electret	25 pF	27.0	35	38
½" B & K	18 pF	29.0	38.0	41.5
¼" B & K	6.8 pF	34.0	43.0	46.0
⅛" B & K	4.7 pF	36.0	45.0	47.0

***Equivalent sound level for a microphone with a sensitivity level of −40 dB re 1 V/Pa uncorrected for capacitance loading.**

NOTE

Although it is not necessary, it is good practice to disconnect the preamplifier power before removing or attaching the microphone.

A period of 10-20 s is required for the input capacitor to discharge through the internal circuitry after the capacitor has been charged to 200 V.

1. Johnson, J. B., *Thermal Agitation of Electricity in Conductors*, Physical Review, Vol 32, July 1928. pp 97-109.

Van Der Ziel, A., *Thermal Noise in Field Effect Transistors*, Proc IRE 50, 1962 pp 1808-1812.

Sanderson and Fulks, *A Simplified Noise Theory and Its Application to the Design of Low Noise Amplifiers*, GR Reprint A-88.

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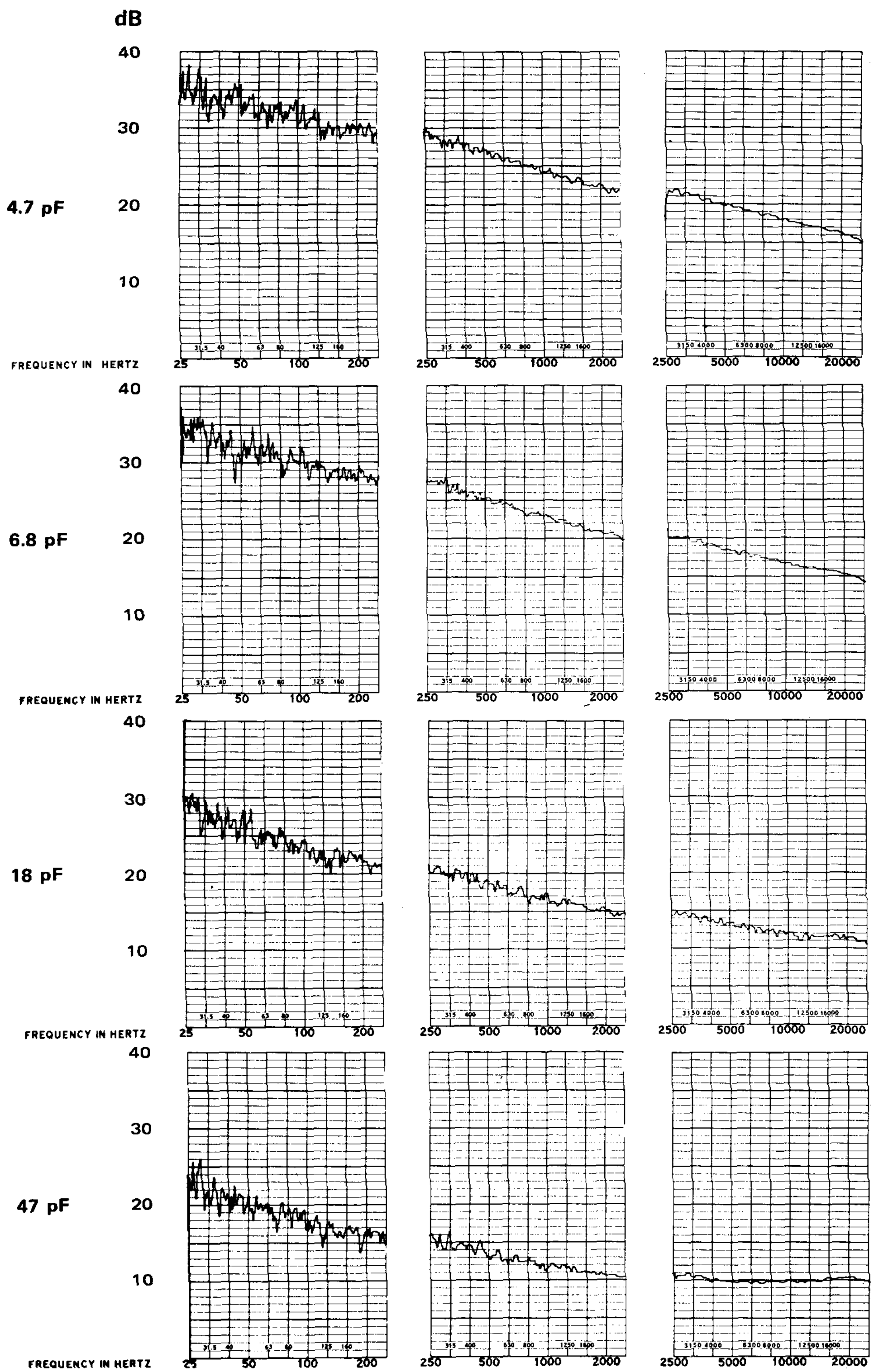

Figure 4-12. Basic 1/3-octave noise spectra for microphones of various source impedances.

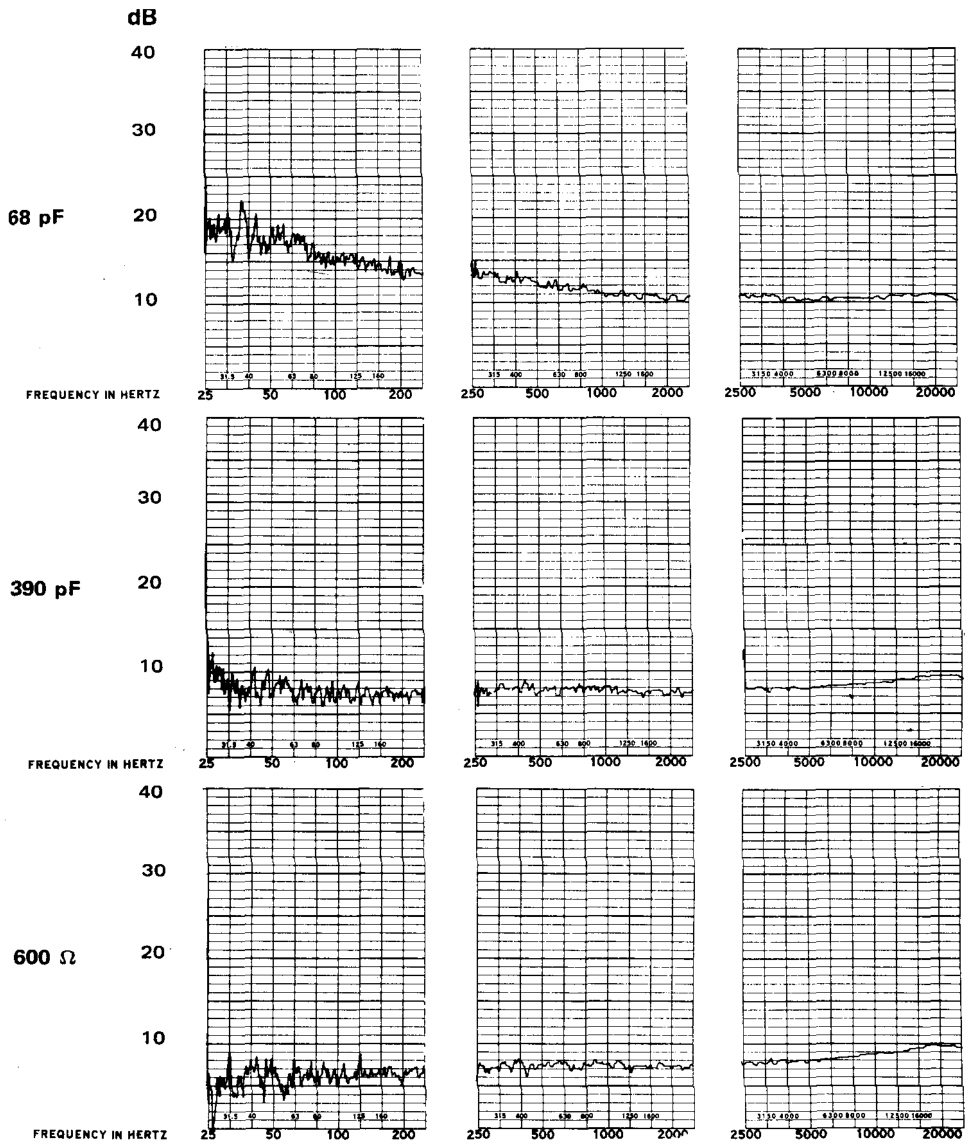

FIGURE 4-12 (cont)

In addition to providing protection for the FET, diodes CR1 and CR2 limit the peak-to-peak input signal to the power-supply voltage. Also, the recovery time for large overloads is greatly enhanced by these diodes; i.e., the amplifier will stabilize in a very short time after overloads.

The effect of the protection diodes, CR1 and CR2, and resistor R1 is to increase the C-weighted noise for 390-pF sources by 1.5 to 2.5 dB and for 18-pF sources by 5 to 7 dB.

4.5.2 Oscillator Noise.

The source of the polarizing-voltage for condenser microphones is a dc-to-dc converter consisting of a blocking oscillator and doubler-rectifier-filter circuit. The oscillator frequency is typically 60 kHz. Residual oscillator noise is filtered out by the weighting networks or by the filters in the subsequent analyzer.

An analysis using a 1/4-in. or 1/8-in. microphone may require measurements within the frequency range of the oscillator operation. The user should be aware of the magnitude of the oscillator spurs in any analysis. Equivalent input-signal peaks of approximately 6 μV on X1 gain or 18 μV on X10 gain at the fundamental oscillator frequency are typical. Upper harmonic spurs are 3-4 dB lower in magnitude. The size of the spur is relatively independent of the microphone capacitance. Refer to Figure 4-11 to relate this undesired signal level to the equivalent input sound-pressure level for the particular microphone being used.

4.5.3 Low-Supply-Voltage Noise (Oscillator Motorboating).

If the power-supply voltage drops below + 15 V dc, the 200-V polarizing supply will not regulate properly. The result is a low-frequency noise produced by changes in the polarizing voltage. To verify this cause, switch off the 200-V polarizing voltage (the switch on the 1560-P42). If, after the amplifier stabilizes, the noise disappears, a low power-supply voltage should be suspected. Note that condenser-microphone operation requires 2-3 mA more supply current than operation with ceramic microphones. With long cables, the power-supply voltage will drop as a result of quiescent and signal currents. Refer to Table 1-2 to determine whether or not the power supply is operating out of its range.

4.5.4 Power-Supply-Noise Rejection.

If the 1560-P42 Preamplifier is driven from a noisy power source (such as a dc-dc converter regulator), it is often useful to know the degree with which power-supply noise will interfere with the signal. A measure of power-supply noise attenuation vs frequency for a typical microphone/preamplifier combination is given in Table 4-3.

Table 4-3.

Attenuation of power-supply noise*

Frequency (Hz)	Rejection (dB)	
	X1 Gain	X10 Gain
2	−29	−11
10	−40	−20
100	−46	−25
1,000	−46	−25
10,000	−46	−25
100,000	−44	−17

***Measured at the output of the 1560-P42 Preamplifier. Source capacitance of microphone is 390 pF.**

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4.6 CIRCUIT DESCRIPTION.

4.6.1 Amplifier Section.

The 1560-P42 Preamplifier consists of two main sections: an amplifier, to provide the gain, and an oscillator, to furnish the polarizing voltage for condenser microphones. To provide the high impedance required for use with either ceramic or condenser microphones, the 3-stage amplifier section incorporates a low-noise FET (Q1) in the input (refer to the schematic diagram, Figure 4-18).

The incoming signal is ac coupled to the gate of Q1. The gate potential is established by the voltage divider, R2 and R3. Approximately half of the dc power-supply voltage is introduced at the gate of Q1. For maximum gain and minimum noise, Q1 should operate near its IDSS value (the value of the current through the drain when the source is shorted to the gate). Resistors R5 and R8 are factory selected, to establish a bias for Q1 such that it will operate near its IDSS value. Protection against input surges is provided by diodes CR1 and CR2.

A complete dc feedback loop gives increased stability. The 2-position GAIN switch (SW1) is located in the feedback path.

The class AB output stage (Q3, Q4) provides up to 10 mA peak and greater than 1 V rms, to feed long lengths of cable. Crossover distortion is reduced by slight bias via double diode CR3 and resistors R12 and R13. The loading of voltage amplifier Q2 is kept to a minimum by use of high-gain transistors, Q3 and Q4.

A slight roll-off at high frequencies is produced by C3 and R9, to eliminate oscillations at unity gain.

Because of the capacitive nature of the microphones, loading of the capacitive element should be minimized. This is accomplished by placing a driven shield around the input lead. The shield is driven from the source of Q1. Thus, effectively, no potential difference exists between the shield and the input lead, and, during measurements, loading is kept to a minimum.

The output impedance of the Preamplifier is very low (15 Ω in series with 3.3 μF). Normally, it should feed a 100 kΩ (or higher) impedance such as that of a sound-level meter or analyzer. Resistor R15 is inserted in series with the load and provides additional phase margin for capacitive loads. It also prevents damage to the Preamplifier if the output is inadvertently shorted. To give additional short-circuit protection ***the current from any power supply used with the Preamplifier must be limited to 15-20 mA***, as is the case with most GR analyzers and the 1560-P62 Power Supply.

4.6.2 Oscillator Section.

The oscillator section of the Preamplifier supplies the 200 V required by condenser microphones for polarization. This voltage is derived from the pulse transformer T1 and transistor Q5. The oscillator operates at approximately 60 kHz, well above the usual audio spectrum.

Capacitor C6 is charged through resistor R16, turning on transistor Q5. The feedback winding of oscillator transformer, T1, turns off Q5. The turn-on pulse is transformed by T1 to > +100 V output pulse. Diodes CR5, 6, and 7 serve as a voltage doubler and CR8 is a low-noise rectifier with a breakdown of 200 V.

4.7 SERVICE AND MAINTENANCE.

4.7.1 GR Field Service.

The 1560-P42 Preamplifier is covered by the warranty given at the front of this manual.

The warranty 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 giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial, ID, and type numbers of the instrument.

4.7.2 Instrument Return.

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

4.7.3 Minimum – Performance Standards.

The equipment listed in Table 4-4 is required for incoming inspection, periodic operational checks, or trouble analysis of the Preamplifier. The procedures are given in the following paragraphs.

The special dummy microphone used for the noise test consists of a Switchcraft 390P1 adaptor with a 390-pF capacitor inserted between terminals 1 and 3, on one end.

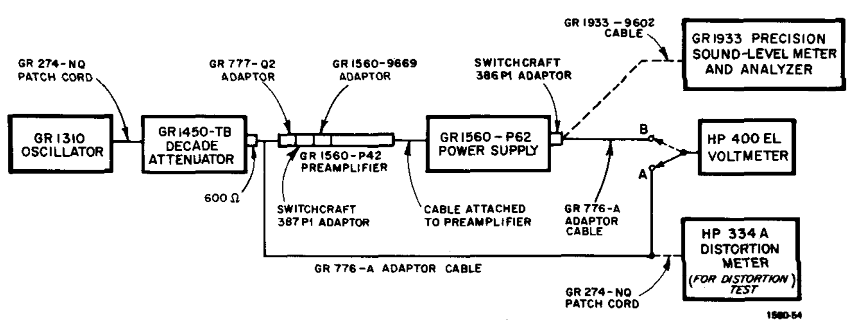

Figure 4-13. Test setup for minimum-performance checks.

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Table 4-4

TEST EQUIPMENT

Name	Minimum Requirements	Recommended*
Oscillator	3 Hz-500 kHz 100 mV – 1 V open circuit	GR Type 1310 GR Type 1309
Decade Attenuator	0-40 dB in 10-dB steps	GR Type 1450-TB
Precision Sound-Level Meter and Analyzer	40-140 dB C Weighting	GR Type 1933
Distortion Analyzer	To measure <0.25% distortion	Hewlett Packard Distortion Meter, Model 334A
Ac Voltmeter	100 mV – 1 V	HP Type 400 EL
Voltmeter	0.2 – 2 V 3 – 20 Hz	Ballantine 316
Power Supply	20 V dc, 15 mA	GR Type 1560-P62
Resistor	600 Ω ±1% (termination)	
Patch cord (2 needed)	GR274 to GR274, 3 ft	GR Type 274-NQ
Adaptor cable (2 needed)	GR274 to BNC plug (male)	GR Type 776-A
Shielded cable	3-pin microphone connector (male) to 3-pin microphone connector (female)	GR Type 1560-9665
Adaptor	GR274 to phone jack	GR 777-Q2
Adaptor	Phone plug to 3-pin female microphone connector	Switchcraft 387P1
Adaptor	3-pin microphone connector	GR 1560-9669
Adaptor	3-pin female microphone connector to BNC plug	Switchcraft 386P1
Dummy Microphone	390 pF	
DVM	Range 0-200 V dc, accuracy ±2%	Data Prec. 2540
Oscilloscope	Bandwidth – 50 MHz Rise Time – 1 ns	Tektronix Model 547 with 1A1 plug-in unit

*or equivalent

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Gain Check (X1). Make the setup shown in Figure 4-13. The 400 EL Voltmeter is to be connected alternately at the output of the 1450-TB Decade Attenuator (connection A in the diagram) and the output of the 1560-P62 Power Supply (connection B).

Use the following procedure:

Set

1450-TB	Attenuation – 0 dB
1310-B	FREQUENCY – 1 kHz
	OUTPUT – ≈ 1 V rms
1560-P42	200 V switch – OFF
	GAIN switch – X1
1560-P62	Switch – LINE ON
400 EL	METER RANGE – 1 V

a. Adjust the 1310 output for a reading of 0 dB on the meter at the output of the 1450 attenuator (connection A).

b. Change to connection B. The 400 EL must now read 0 ±0.3 dB.

Gain Check (X10). Change the above settings of Figure 4-13 as follows:

1450-TB	Attenuation – 20 dB
1560-P42	GAIN switch – X10

The 400 EL must read 0 ±0.3 dB.

Frequency Check. Using either the HP 400 EL Voltmeter or the Ballantine 316 Voltmeter in the setup of Figure 4-13, make the frequency measurements indicated in Table 4-5. In each case, perform step A with the voltmeter at Point A, then step B, voltmeter at point B.

Table 4-5

FREQUENCY CHECKS

			Step A			Step B	
				Reference On Voltmeter			
1310 Frequency	1560-P42 Gain	Voltmeter Used	1450-TB Attenuation (dB)	Range	dB Setting	1450-TB Attenuation	1560-P42 Output (dB)
3 Hz	X1	316	20	2 V	10	20	7 to 13
5 Hz	X1		20	2 V	10	20	9 to 11
20 Hz	X1		20	2 V	10	20	9.75 to 10.25
3 Hz	X10		20	2 V	10	40	7 to 13
5 Hz	X10		20	2 V	10	40	8.5 to 11.5
20 Hz	X10		20	2 V	10	40	9.7 to 10.3
100 Hz	X1	400 EL	20	1 V	0	20	0 ± 0.25
10 kHz	X1		20	1 V	0	20	0 ± 0.25
100 kHz	X1		20	1 V	0	20	0 ± 0.25
500 kHx	X1		20	1 V	0	20	0 ± 1.0
100 Hz	X10		20	1 V	0	40	0 ± 0.3
10 kHz	X10		20	1 V	0	40	0 ± 0.3
100 kHz	X10		20	1 V	0	40	0 ± 0.3
300 kHz	X10		20	1 V	0	40	0 ± 2.0

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Noise Check. In the setup of Figure 4-13, connect the 400 EL Voltmeter to point A and the 1933 Sound-Level Meter to point B (the output from the 1560-P62 Power Supply). The procedure is given below.

a. Set:

1450-TB	Attenuation – 20 dB
400 EL	METER RANGE – 100 mV
1310-B	FREQUENCY – 1 kHz
	OUTPUT – 100 mV (read on 400 EL)
1560-P42	GAIN – X10
	200 V – OFF
1560-P62	Switch – BAT ON (no power cord connected)
1933	RANGE – 130 dB Full Scale
	WEIGHTING – C
	METER – SLOW

b. Adjust the CAL control on the 1933 so that its meter reads 130 dB.

c. Remove the input to the 1560-P42 at the output of the 387-P1 adaptor. Install the 1560-P9 Dummy Microphone, with shorting cap, on the 1560-P42 input.

d. Change the 1933 attenuation to 50 dB Full Scale

The 1933 must now read less than 41 dB.

Distortion Check. Make the setup of Figure 4-13. Connect the 334A Distortion Meter to point B. Replace 1310 with 1309 oscillator.

a. Set:

1450-TB	Attenuation – 0 dB
1309	FREQUENCY – 1 kHz
	OUTPUT – 1 V rms
1560-P42	GAIN – X1
	200 V – OFF
1560-P62	Switch – BAT ON
334A	FUNCTION – DISTORTION

b. Measure the distortion on the 334A to be less than 0.25%.

c. Change the output from the 1309 to 0.1 V rms (at the input to the 1560-P42) and set the GAIN switch on the 1560-P42 at X10. Again the distortion must be less than 0.25%. If the distortion is higher, check the oscillator distortion (at point B).

4.7.4 Trouble Analysis.

The following details should be helpful in locating the faulty component, if trouble develops in the Preamplifier. When components are disconnected or replaced, use good soldering technique. Use a small tip on the iron and fine-gauge solder. Keep the heat to a minimum.

Amplifier Section. Terminate the input of 600 Ω and turn the 200 V switch off. Table 4-6 gives the transistor voltages with a power-supply voltage of 20 V. Use the 400 EL Voltmeter (or equivalent) for the measurements. Connect the negative terminal to the ground of the power supply (not to the Preamplifier shield). Be sure pin #1 is connected to ground.

Also, check the + terminal of capacitor C4. With the GAIN switch on X10, this should be approximately 10 V (1/2 of the power-supply voltage). If C4 is at B+, Q2 is probably shorted, and should be replaced (see base connections on the schematic diagram). A short circuit between the drain and source of Q1 will cause Q2 to conduct too heavily, in which case, replace Q1.

Current Q1 Configuration. *The device used in current production units for Q1 is a* type 2N3958, a selected dual FET that can be most easily identified by observation that 3 of the 6 leads coming out of the base have been snipped off. In this circuit, the bias resistors, R5 and R8 are 3K and 36K, respectively; no selection is required.

Early Q1 Configuration. In early production units, Q1 was a type 2N3457 that required careful selection of bias resistors for proper operation. If it is replaced, resistors R5 and R8 must be selected according to the IDSS value of Q1, the value of the current through the drain when the source is shorted to the gate. Determine the IDSS value by using the circuit of Figure 4-14. Then select Allen Bradley 1/8-W, 5% resistors as shown by Table 4-7.

CAUTION

When changing Q1, use a small soldering-iron tip and fine-gauge solder, with only enough heat to produce good connections. Overheating diode CR1 or CR2 may produce noise, requiring its replacement.

Table 4-6

TRANSISTOR VOLTAGES

Location		**Volts**
Q1	—— gate	——
	—— source	11.5
	—— drain	+19.4
Q2	—— emitter	20.0
	—— base	19.4
	—— collector	12.0
Q3	—— emitter	11.4
	—— base	12.0
	—— collector	20.0
Q4	—— emitter	11.4
	—— base	10.8
	—— collector	gnd

Table 4-7

SELECTION OF BIAS RESISTORS FOR Q1.

IDSS Value of Q1 (μA)	**R5 (kΩ)**	**R8 (kΩ)**
50-100	12	150
100-175	6.2	75
175-250	3.3	43

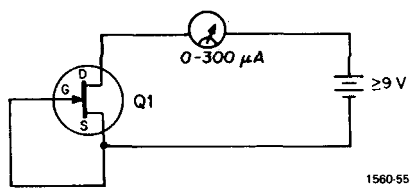

Figure 4-14. Circuit for the determination of the IDSS value of Q1.

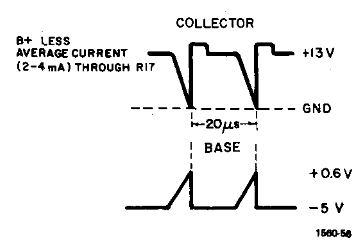

Figure 4-15. Waveforms at transistor Q5.

Oscillator Section. Check the waveforms at Q5, using the fast-rise-time pulse oscilloscope. The waveforms are shown in Figure 4-15.

A dc check for continuity can be made on the transformer windings.

Observation of the output pulse at transformer T1, pin 1, will yield an erroneous amplitude measurement because of scope-probe loading.

To check for 100 V at the junction of CR5 and CR6, use the 1806 Voltmeter on OPEN GRID. There should be 200 V at the anode of CR7. Diodes CR5, 6, and 7 are very fast rise- and recovery-time diodes, rated at 225 V. Replacements should be made only with type 1N661 diodes, from Texas Instruments Incorporated (Dallas, Texas).

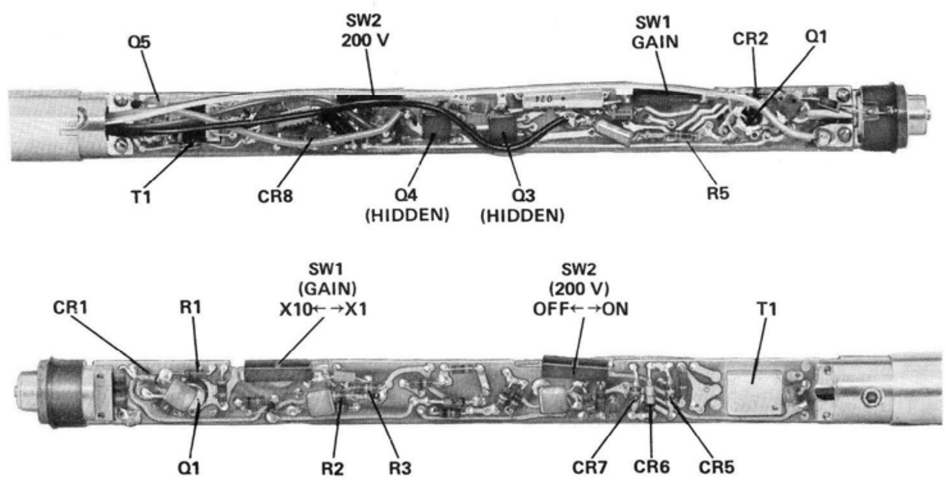

Figure 4-16. Interior views of the 1560-P42 Preamplifier; (top) circuit side of etched-circuit board; (bottom) component side.

1560-P42 PREAMPLIFIER

ELECTRICAL PARTS LIST

ef Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C1	Ceramic, .001 μF, 10%, 200 V	4400-6440	72982	8121-026-X5RO-102K	
C2	Electrolytic, 80 μF, 20%, 15 V	4450-6300	37942	MTP, 80 μF, 20%	
C3	Ceramic, .001 μF, 10%, 200 V	4400-6440	72982	8121-026-X5RO-102K	
C4	Electrolytic, 10 μF, 20%, 30 V	4450-6320	37942	MTP, 10 μF, 20%	
C5	Electrolytic, 10 μF, 20%, 30 V	4450-6320	37942	MTP, 10 μF, 20%	
C6	Ceramic, 330 pF, 10%, 200 V	4400-6441	72982	8111-026-X5RO-331K	
C7	Electrolytic, 1 μF, 20%, 35 V	4450-6400	56289	162-D, 1 μF, 20%	
C8	Ceramic, .001 μF, 10%, 200 V	4400-6440	72982	8121-026-X5RO-102K	
C9	Ceramic, .001 μF, 10%, 200 V	4400-6440	72982	8121-026-X5RO-102K	
C10	Ceramic, .001 μF, 10%, 200 V	4400-6440	72982	8121-026-X5RO-102K	
C11	Ceramic, .022 μF, ±20%, 200 V	4400-6449	72982	8121-M200-651-223M	
C12	Ceramic, .001 μF, 10%, 200 V	4400-6440	72982	8121-026-X5RO-102K	
CONNECTORS					
PL1	4 Pin Connector on Board	1560-2370	24655	1560-2370	
DIODES					
CR1	Type DHD707	6082-1009	07910	DHD707	5961-929-9967
CR2	Type DHD707	6082-1009	07910	DHD707	5961-929-9967
CR3	MPD200	6082-1033	06751	MPD-200	
CR4	Type DHD707	6082-1009	07910	DHD707	5961-929-9967
CR5	Type 1N661/TI-UNI-G Package	6082-1032	06751	1N661	
CR6	Type 1N661/TI-UNI-G Package	6082-1032	06751	1N661	
CR7	Type 1N661/TI-UNI-G Package	6082-1032	06751	1N661	
CR8	Type CSR-1758D	6083-1079	07910	CSR1758D	
RESISTORS					
R1	Comp., 1 GΩ, ±20%, 1/8 W	6098-8108	01121	BB, 1 GΩ, ±20%	
R2	Comp., 100 kΩ, 5%, 1/8 W	6098-4105	01121	BB, 100 kΩ, 5%	

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ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.
RESISTORS (Cont)				
R3	Comp., 100 kΩ, 5%, 1/8 W	6098-4105	01121	BB, 100 kΩ, 5%
R4	Comp., 2.2 GΩ ±20%, 1/8 W	6098-8228	01121	BB, 2.2 GΩ ±20%
R5	Comp., 3 kΩ ±5%, 1/8 W	6098-2305	01121	BB, 3 kΩ ±5%
R6	Comp., 3.0 kΩ, 5%, 1/8 W	6098-2305	01121	BB, 3.0 kΩ, 5%
R7	Film, 1.06 kΩ ±1%, 1/10 W	6619-3102	91637	MF-50, 1.06 kΩ ±1%, 1/10 W
R8	Comp., 36 kΩ ±5%, 1/8 W	6098-3365	01121	BB, 36 kΩ ±5%
R9	Comp., 100 Ω, 5%, 1/8 W	6098-1105	01121	BB, 100 Ω, 5%
R10	Film, 10.2 kΩ ±1%, 1/10 W	6619-3101	91637	MF-50, 10.2 kΩ ±1%, 1/10 W
R11	Comp., 10 kΩ, 5%, 1/8 W	6098-3105	01121	BB, 10 kΩ, 5%
R12	Comp., 27 Ω, 5%, 1/8 W	6098-0275	01121	BB, 27 Ω, 5%
R13	Comp., 27 Ω, 5%, 1/8 W	6098-0275	01121	BB, 27 Ω, 5%
R14	Comp., 100 kΩ, 5%, 1/8 W	6098-4105	01121	BB, 100 kΩ, 5%
R15	Comp., 10 Ω ±5%, 1/8 W	6098-0105	01121	BB, 10 Ω ±5%
R16	Comp., 240 kΩ, ±5%, 1/8 W	6098-4245	00912	BB, 240 kΩ, ±5%
R17	Comp., 220 Ω, ±5%	6098-1225	01121	BB, 220 Ω, ±5%
R18	Comp., 10 MΩ, ±5%, 1/8 W	6098-6105	00912	BB, 10 MΩ. ±5%
R19	Comp., 100 MΩ, 10%, 1/8 W	6098-7109	01121	BB, 100 MΩ, 5%
R20	Comp., 10 Ω, 5%, 1/8 W	6098-0105	01121	BB, 10 Ω, 5%
R21	Comp., 3 kΩ, 5%, 1/8 W	6098-2305	01121	BB, 3 kΩ, 5%
R22	Comp., 100 MΩ, 10%, 1/8 W	6098-7109	01121	BB, 100 MΩ, 10%
SWITCHES				
SW1	Switch (Actuator)	1560-7620	24655	1560-7620
	(Contact)	1560-8700	24655	1560-8700
SW2	Switch (Actuator)	1560-7620	24655	1560-7620
	(Contact)	1560-8700	24655	1560-8700
TRANSFORMERS				
T1	Transformer Asm.	1560-4141	24655	1560-4141
TRANSISTORS				
Q1	Special	8210-1260	24655	8210-1260
Q2	Type D30A3	8210-1204	24454	D30A3
Q3	Type 2N4124	8210-1154	04713	2N4124
Q4	Type 2N3906	8210-1112	.04713	2N3906
Q5	Type D26E1	8210-1205	24454	D2GE1

Front End ASM 1560-2613

Contact ASM 1560-2550

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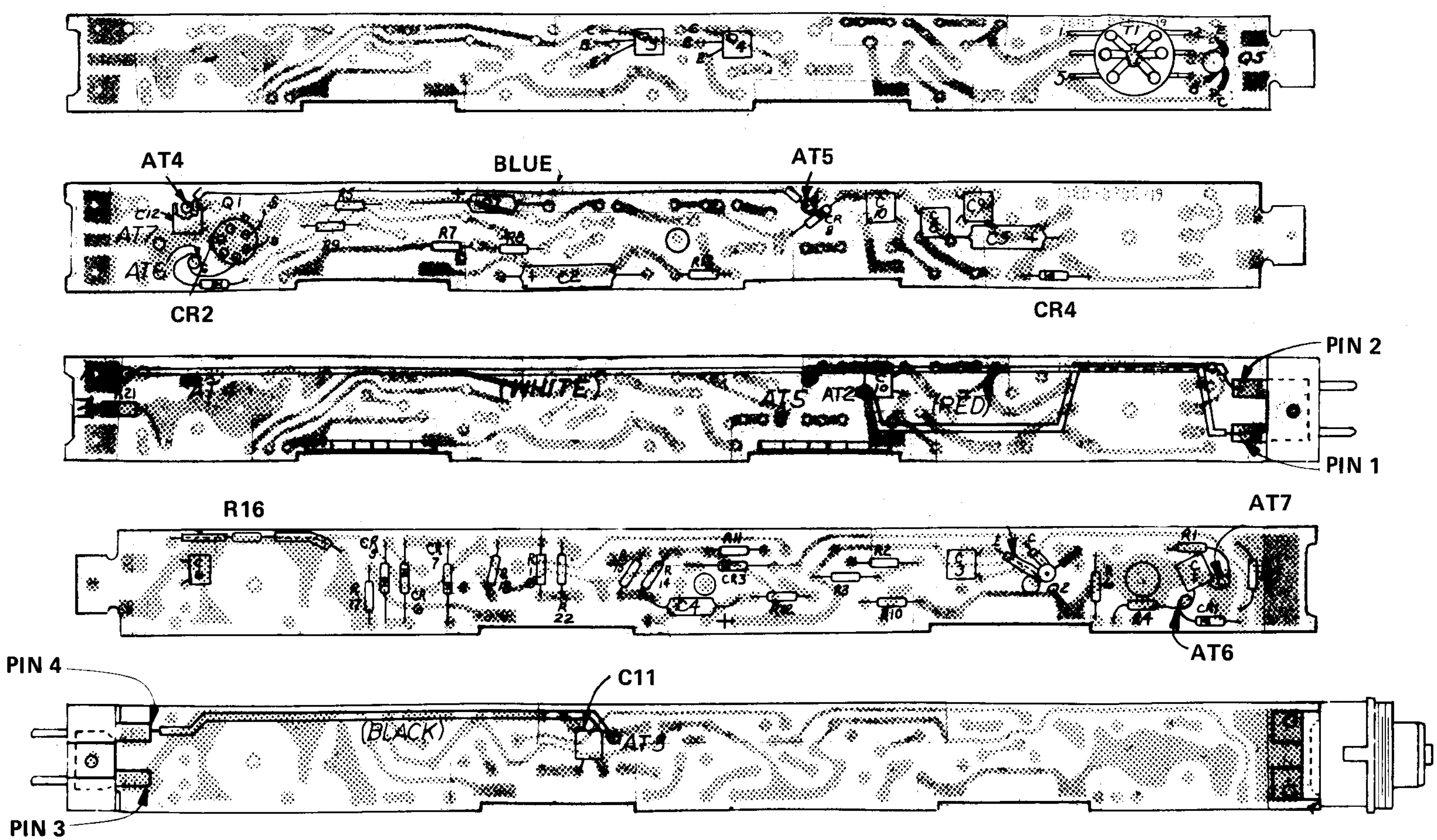

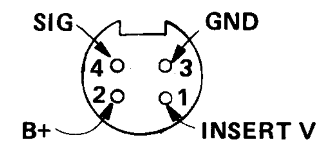

Figure 4-17. Etched circuit board (P/N 1560-2791) for the 1560-P42 Preamplifier. Top 3 views are from etched side of board, bottom 2 views from component side. Preamplifier pinout functions are shown in bottom-right corner.

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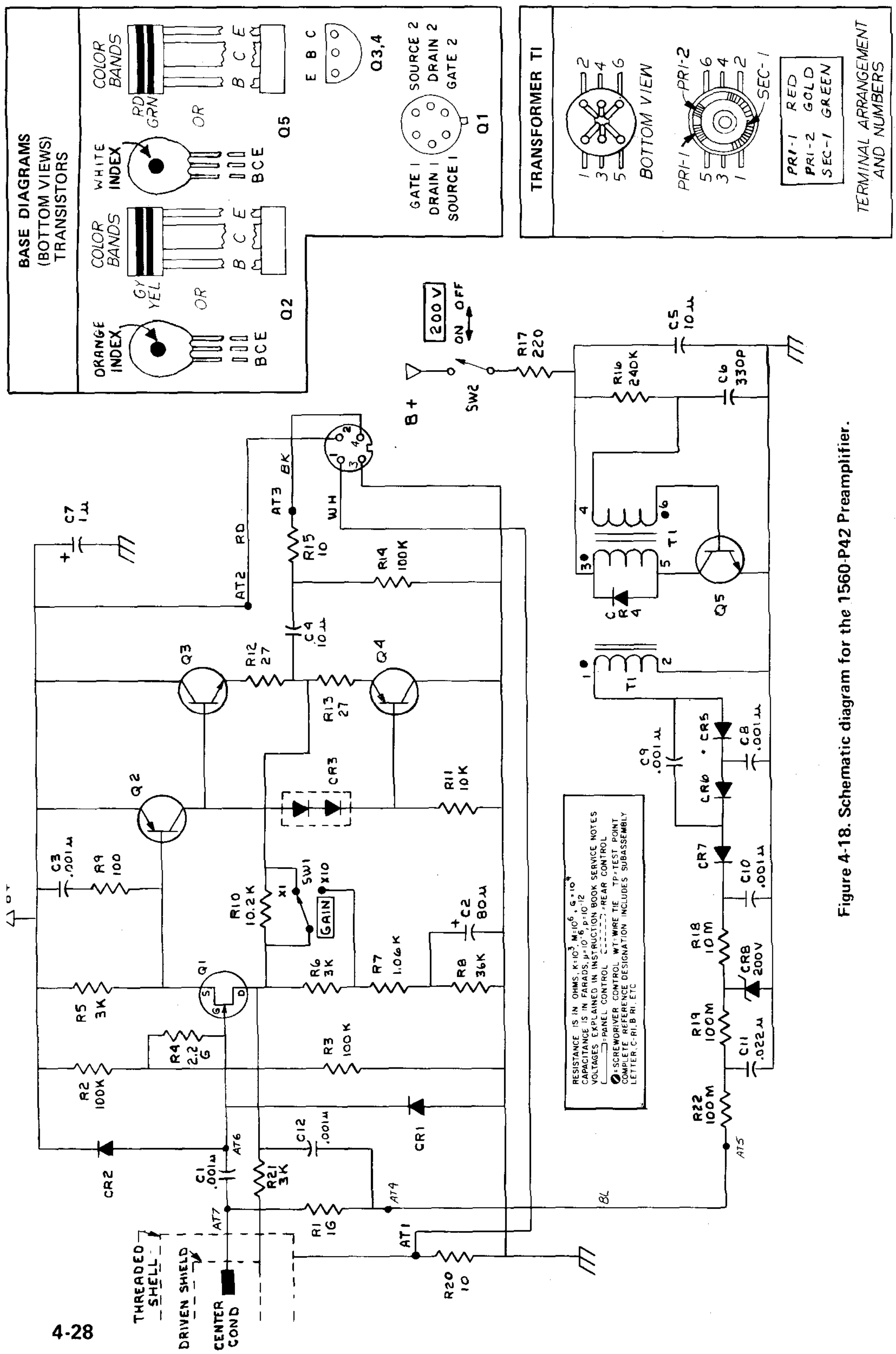

Figure 4-18. Schematic diagram for the 1560-P42 Preamplifier.

Type 1560-P62 Power Supply
Section 5

5.1 DESCRIPTION.

The 1560-P62 Power Supply (Figure 5-1) is intended to supply power to the 1560-P42 Preamplifier when the latter is used with instruments that do not include the necessary source of power (refer to Table 1-2). The Power Supply can also be used when long cables are to be driven at high levels. It can serve as a charger for rechargeable batteries in other instruments, such as the 1561 Sound-Level Meter and the 1952 Universal Filter.

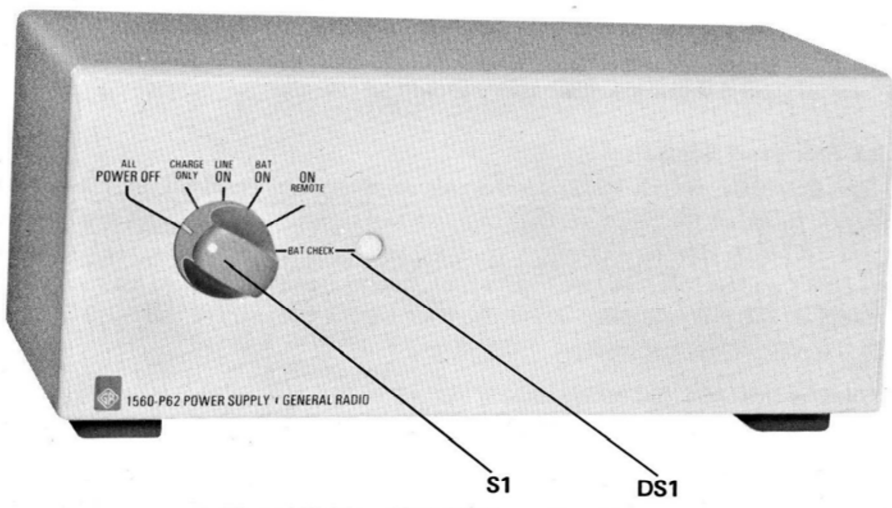

Figure 5-1. Type 1560-P62 Power Supply.

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Included in the Power Supply are two nickel-cadmium rechargeable batteries, a battery-charging circuit, and a battery-checking circuit. The batteries are held in a slide-out clip, for easy removal.

Specifications for the 1560-P62 Power Supply are given at the front of this manual.

5.2 CONTROLS, CONNECTORS, AND INDICATORS.

5.2.1 Front-panel Controls and Indicators.

The front panel contains one selector switch (S1) and a battery-test light (DS1). The switch turns off the power to the unit in the ALL POWER OFF (ccw) position.

In the CHARGE ONLY position, with the line connected to the power line, the batteries accept current only from the line. In this mode, a full 22-mA charging current is applied to the batteries.

In the LINE ON position, the batteries are again charged with 22 mA, but battery voltage is also applied to the output connector from the preamplifier. (Some increase in ripple will be noted in this position.) The batteries act as a filter to the line, and any loading from the preamplifier reduces the charging current to the batteries (the current is limited to 22 mA).

In the BATtery ON mode, the line is disconnected from the unit; there is no line current in the transformer and the batteries are connected to the load.

With the switch in the ON, REMOTE position, the batteries are connected to the load when the instrument to which it is connected has at least 1 mA at 15 V on pin 2 of its input connector. In this mode, the on-off switch of the analyzing instrument becomes the on-off switch for the Power Supply.

The BAT CHECK position gives a spring-loaded momentary test of the battery. The front-panel pilot lamp (DS1) will light if the battery is charged sufficiently for operation. The light is used as a measure of the state of charge of the battery. It will not light if the battery voltage drops below 17 V. Since the change of illumination with voltage is rather sharp, the relative intensity of the light can be used as a measure of the state of charge of the batteries. For the test, the switch is held in the BAT CHECK position for several seconds. If the light intensity gradually diminishes somewhat during that time, the battery should be charged.

5.2.2 Rear-panel Controls.

The CHARGE switch (AS2) on the rear panel permits connection of the charging circuitry to either the INTernal BATtery (normal operation) or an EXTernal BATtery. In the EXTernal BATtery position, charging voltage is applied to the TO EXTERNAL BATTERY connector, AJ4 (see Figure 5-2). Connection from AJ4 to instruments such as the GR 1561 Sound-Level Meter is made by the cable (P/N 1560-0491) supplied with the -P62 Power Supply.

Slide switch AS1 (50-60 Hz, 100 V – 125 V, 200 V – 250 V) is used to select the proper line voltage, either 100-125 or 200-250 V.

Connection for the INPUT (FROM PREAMP) is made at connector AJ2, a 3-contact female Switchcraft type A3 connector, and connection for the OUTPUT

(TO ANALYZER) is made at AJ3, a 3-contact male type A3 connector. The signal passes directly from pin 3 of the INPUT to pin 3 of the OUTPUT. Note that the shield of the connectors is not connected to the circuit ground, but is connected to the case of the -P62 Power Supply. ***Ultimate connection of the ground to the connectors must be made at the final analyzing instrument.*** Connector AJ5 is a subminiature phone jack, Switchcraft, Type TR-2A in parallel with AJ3.

5.3 ACCESSORIES SUPPLIED.

The accessories supplied with the Power Supply are listed in Table 5-1.

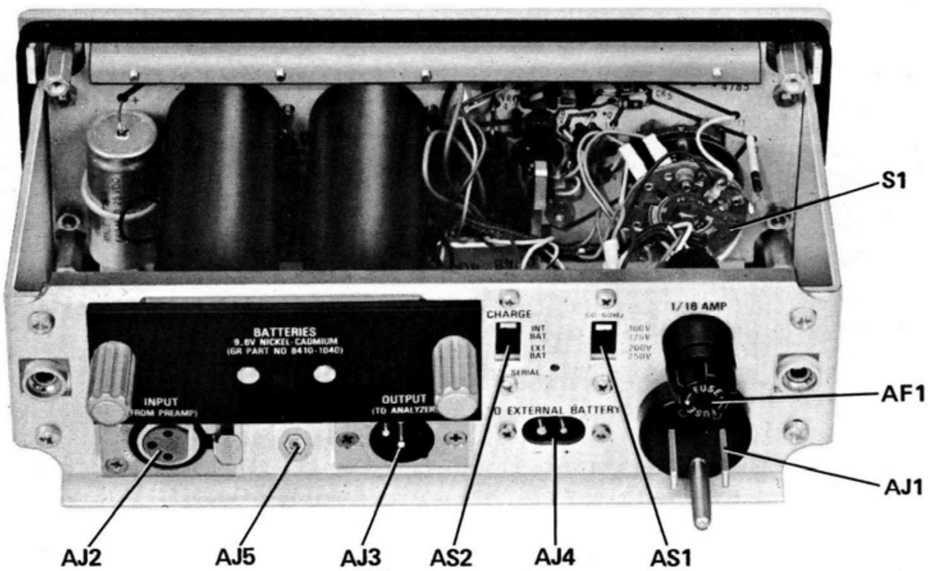

Figure 5-2. Controls and connectors on the rear panel of the Power Supply.

Table 5-1

ACCESSORIES SUPPLIED

Quantity Supplied	Item	Use	GR Part No.
1	Charging cable (20 in.)	Connects TO EXTERNAL BATTERY socket to 1561 charging terminals.	1560-0491
1	Extension cable (4 ft)	Connects OUTPUT socket to an analyzer with female Switchcraft type A3 input connector.	1560-9665
1	Adaptor cable (3 ft)	Connects OUTPUT socket to an analyzer or recorder with type 274 double-plug input connector.	1560-9677

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5.4 INSTALLATION.

5.4.1 Power.

The power cable (P/N 4200-9622, supplied) connects to AJ1, a polarized male plug. Line-power protection is afforded by a 1/16-A slow-blow fuse in an extraction-post fuse holder, AF1.

5.4.2 Dimensions.

The dimensions of the 1560-P62 are shown in Figure 5-3.

5.4.3 Mounting.

The 1560-P62 Power Supply may be ordered completely assembled in a metal cabinet, ready for bench use (P/N 1560-9575). The instrument is locked in the cabinet by two captive 10/32 screws in the rear panel.

To mount the -P62 in an EIA standard 19-inch relay rack, order a rack-adaptor set (P/N 0480-9742), consisting of the parts listed in Table 5-2. The method of mounting is shown in Figure 5-4 and the procedure is as follows:

a. Loosen the two captive 10/32 screws in the rear of the cabinet until the instrument is free; slide the instrument forward, out of the cabinet.

b. Remove the four rubber feet from the cabinet. Be sure to save all parts as they are removed, for possible reconversion of the instrument to bench mounting.

c. Pierce and push out the plugs from the four bosses (C) in the sides of the cabinet, near the front. The blank panel can be attached to either side of the cabinet, as desired. Use the holes in the side toward the blank panel. Do not damage the threads in the holes.

d. Press the subpanel (D) into the blank panel (E), to form a liner for the latter.

e. Place the blank panel so that the short flange of the subpanel is toward the cabinet. Attach the blank panel (E) and subpanel (D) to the cabinet, using two 5/16-in. screws (F) as shown. Note that the screws enter in opposite directions – one from inside the cabinet and one from the flange side, as shown.

f. Attach one Rack Adaptor Assembly (handle) to the side of the cabinet opposite the blank panel, using two 5/16-inch screws (L). Again, note that the screws enter in opposite directions one from inside the cabinet and one from outside. Use the upper and lower holes in the Assembly.

g. Attach the other Rack Adaptor Assembly (handle) to the wide flange on liner (D) and the flange on the blank panel (E). Use two 5/16-in. screws (M) through the two holes in the flange that are nearest the panel and through the upper and lower holes in the Assembly. Again, the screws enter in opposite directions.

h. Install the instrument in the cabinet and lock it in place with the two captive screws through the rear panel that were loosened in step a.

i. Slide the entire assembly into the relay rack and lock it in place with the four 9/16-in. screws (N) with captive nylon cup washers. Use two screws on each side and tighten them by inserting a screwdriver through the holes (P) in the handles.

To reconvert the instrument for bench use, reverse the above procedures, first re-

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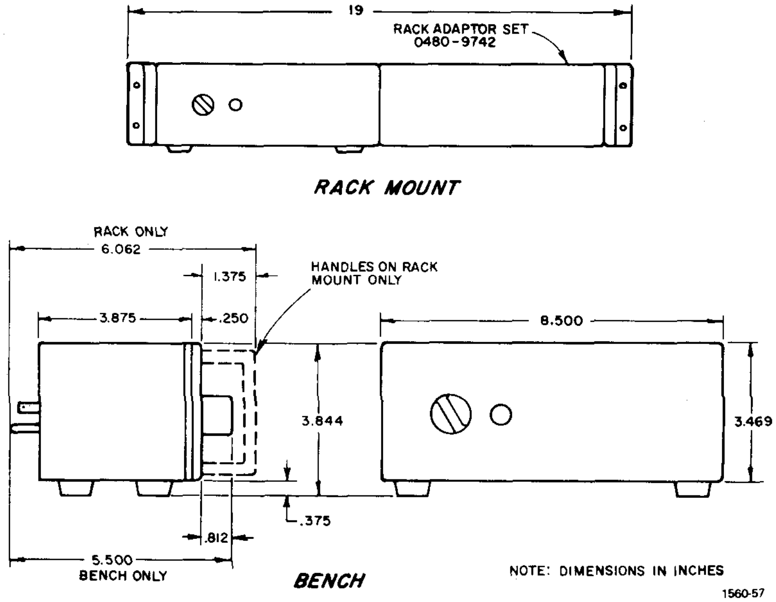

Figure 5-3. Dimensions of the Power Supply.

Table 5-2

PARTS INCLUDED IN THE RACK ADAPTOR SET
P/N 0480-9742 (see Figure 5-4)

Fig. 5-4 Ref.	No. Used		GR Part No.
E	1	Blank Panel	0480-8932
D	1	Sub-Panel	0480-8952
—	2	Rack Adaptor Assembly	0480-4902
H	1	Support Bracket	0480-8523
—	1	Hardware Set	0480-3080
		Includes	
F,J,K,L,M,		8 Screws, BH 10-32, 5/16"	
N		4 Screws, BH 10-32, 9/16"	
		w. nylon cup washers	

Note: Discontinued

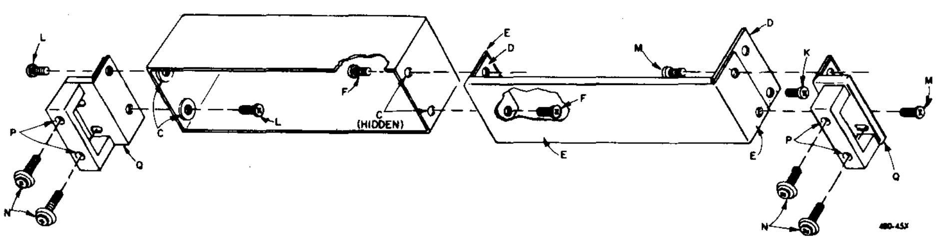

Figure 5-4. Method of mounting the Power Supply and a blank panel in a relay rack.

moving the entire assembly of instrument, cabinet, and blank panel from the rack. Next remove:

1. The instrument from its cabinet.
2. The blank panel (E) (with handle attached) from one side of the cabinet;
3. The Rack Adaptor Set (handle) from the other side of the cabinet.

Push the four rubber feet into the cabinet. Install the instrument in its cabinet and lock it in place with the two captive screws through the rear panel.

5.5 OPERATION.

Set the external charging switch to INTERNAL BATTERY and the front panel control to LINE ON. The instrument will now provide sufficient current and voltage to the INPUT (FROM PREAMP) connector to operate a 1560-P42, 1972-9600 (or 1560-P40) Preamplifier for upwards of 100 hours of continuous operation. The actual time will vary, depending upon the amount of signal current that the preamplifier presents to the load, and whether or not the -P42 is used for ceramic or condenser microphones. If the Power Supply is not plugged into the ac line, the LINE ON and BATTERY ON modes are identical. In the LINE ON position and if the Supply is plugged into the ac line, however, depending upon the state of charge of the batteries, some small ripple component may be seen as dc output that drives the Preamplifier. If there is a hum problem, setting the front-panel control to BATTERY ON will remove any connection to the ac line.

5.6 REMOTE OPERATION.

Set the front-panel switch to REMOTE. Connect the output of the -P62 Power Supply to any instrument that normally supplies at least 1 mA and at least 15 V at pin 2 of the connector to which the output of the -P62 is connected. Turning the analyzing instrument on and off will now turn the 1560-P62 on and off. No remote charging is provided by this remote connection.

5.7 BATTERY TEST.

Without connecting the power supply to 110-V (220-V) source, check that the batteries are inserted in the power supply and the battery switch on the rear panel is set to INTernal BATtery. Rotate front panel switch to BATtery CHECK position. The front panel lamp (DS1) should light. If not, the batteries need charging.

5.8 CHARGING THE BATTERY.

Before connecting the Power Supply to the line, be sure to set the power-voltage switch to the proper position. Connect the line voltage to the input-power connector. Set the front-panel switch to either CHARGE ONLY or LINE ON, depending on how

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the instrument will be used. If the batteries have been fully discharged, they should be recharged for approximately 12 to 14 hours (overnight is usually satisfactory). If the -P62 is going to be used in the LINE ON position to recharge the batteries, some allowance must be made for the nominal load.

CAUTION

DO NOT overcharge the batteries by leaving the instrument in the charge mode for more than several days. Long-term (weeks) charges should be strictly avoided. Also, the batteries should be fully discharged occasionally so that they will maintain their capacity.

Charging an External Battery. To charge an external battery, connect the cable supplied (P/N 1560-0491) to battery terminal AJ4, EXTERNAL BATTERY. Connect the other end to the instrument whose batteries are being charged, such as the 1561. Set the 1561 to CHARGE. Set the rear-panel charge switch on the Power Supply to EXT BAT and the front-panel switch to CHARGE ONLY. The charging current will now be applied to the 1561 batteries. The 1561 batteries can be used in the OPERATE or LINE ON modes in the -P62.

5.9 THEORY.

The schematic diagram of the Power Supply is given at the end of this Section, in Figure 5-7.

The 1560-P62 Power Supply consists of two nickel-cadmium rechargeable batteries and related charging, testing, and overload-protection circuitry. The charging circuitry consists of power transformer T1, rectifiers CR1 through CR4, and either R1 or R2. These elements compose a constant-current charging circuit for the batteries. The current-limiting resistor is R1 or R2, which is connected to the line voltage (R1 or R2 depending on whether line switch S1 is connected to 110 or 220 V). This resistor, in conjunction with the winding resistance of the T1 primary winding, provides the constant-current charging for the batteries.

The open-circuit voltage at the secondary of T1 is approximately 60 V. However, when loaded with the batteries, a constant current of approximately 22 mA is fed into the batteries. In the event that the batteries are removed, diodes VR1 and VR2 behave as voltage-limiting devices so that, in the charge-operate mode, 25 V maximum will appear at the dc output terminals of the Power Supply. It should be noted that, because there is constant current in the batteries, the batteries should not be left in the charge mode constantly, as damage will probably result.

Transistor Q1, in conjunction with R3, R4 and VR3, behaves as a sensing device to denote whether or not the battery is adequately charged. It does this by loading the batteries with a modest discharge and sensing the voltage at the battery terminals. If the voltage is sufficiently high, pilot light DS1 will be illuminated.

The load current of the Power Supply is limited to 20-mA peak as a result of the current limiting action of Q1 and Q2 in conjunction with R39, CR5 and CR6. The

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nominal maximum current limit is 15 mA. The true nominal is in the vicinity of 20 mA to allow for normal tolerances in semiconductor elements and temperature variations. Q2 is turned on via transistors Q3 and Q4. This circuitry provides the additional feature that a short-circuit continuously applied to the output of the Power Supply will not drain the batteries to the point where they will become dead. This is done by sensing the voltage at the battery terminals. If the voltage drops below 16 V, then the current supplied to Q2 to turn it on is removed. This is done via Zener diode VR4 and transistor Q3. This feature lengthens the life of the batteries many times over, because excessive discharge may reverse-polarize one of the batteries and thus damage it. The dc output of the Supply is applied to pin 2 of AJ2, which is the jack into which the preamplifier is connected. No voltage is applied to the output connector AJ3 of the Power Supply. However, AJ3 is used so that, for remote applications, where it is desirable to utilize a second instrument to turn on and off the Power Supply, pin 2 of AJ3 provides the sensing terminal. Such instruments as the 1564, 1921, 1558 and many other GR instruments, have nominal 1 or 2 mA at 16 V available at pin 2 of their connections. This small current and voltage is used to turn on Q4 of the -P62 Power Supply and affords a remote turn-on and turn-off feature. It must be noted, however, that in the remote mode the battery-low sensing circuitry is not operative.

5.10 SERVICE AND MAINTENANCE.

5.10.1 GR Field Service.

The 1560-P62 Power Supply is covered by the warranty given at the front of this manual.

The warranty 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 giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial, ID, and type numbers of the instrument.

5.10.2 Instrument Return.

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

5.10.3 Trouble Analysis.

Table 5-3 shows the dc voltages at various points in the circuitry. The cabinet on the instrument is removed by unscrewing the two captive Phillips-head screws through the back panel.

Two general problems that might arise are no charging of the batteries, or no output voltage. The transformer and rectifier diodes are seldom at fault, but the

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batteries may be dead. Either remove the batteries or set the battery switch to EXT BAT. With the line connected and the switch at CHARGE ONLY, +20 to +26.5 V should appear from wire tie 5 (WT5) to WT2. If this voltage is incorrect, determine and replace the faulty component in the charging network. If the voltage is correct, re-install the batteries and again observe the voltage at WT5 in the CHARGE mode. If the voltage drops to zero, the batteries are probably shorted and should be replaced. If the voltage at the output of AJ2 (pin 2) is less than 18 V with good batteries, check that the turn-on circuitry is operating. Check the voltages on Q3 and Q4 according to Table 5-3. If they are correct, the trouble is probably a faulty Q2; if they are not, check Q3 or Q4 or Zener diode VR4. As a final check, short pin 2 of AJ3 to ground. The voltage across R9 should be approximately 0.6 V. This assures proper current limiting through Q2.

Table 5-3

DC VOLTAGES*

	C	B	E	S1 Position
Q_1	6.9	7.2	6.8	BAT CHECK
Q_2†	20.8	20.4	21.0	BAT ON
Q3	6.9	7.2	6.8	BAT ON
Q4	7.2	7.8	7.2	BAT ON

*Measured between point noted and WT2.

†Depends on battery voltage. Table based on fully charged battery of 21 V and no load.

1560-P62 POWER SUPPLY

MECHANICAL PARTS LIST

Fig Ref 5-5/5-6	Qnt	Description	GR Part No.	Fed Mfg Code	Mfg Part No.
FRONT PANEL					
1.	1	Cabinet, convertible bench:	4181-2911	24655	4181-2911
	1	Cabinet gasket	5331-3086	24655	5331-3086
	4	Foot	5260-2060	24655	5260-2060
2.	1	Knob asm. ALL POWER OFF/CHARGE ONLY/LINE ON/BAT ON/BAT ON REMOTE/BAT CHECK, including retainer 5220-5402	5500-5321	24655	5500-5321
REAR PANEL					
1.	2	Nuts for battery cover asm.	1521-6610	24655	1521-6610
2.	1	Battery cover asm.	1560-1350	24655	1560-1350
3.	2	Slide switch, A-S1, LINE VOLTAGE SELECTOR; A-S2, CHARGE	7910-0832	82389	11A-1118
4.	1	Fuse mounting device	5650-0100	71400	HKP-H
5.	1	Power plug, A-J1	4240-0210	24655	4240-0210
6.	1	Plug asm., A-J4, TO EXTERNAL BATTERY	1561-2040	24655	1561-2040
7.	1	Multiple plug, A-J3, OUTPUT (TO ANALYZER)	4220-3100	71468	XLR-3-32
8.	1	Subminiature phone jack AJ5	4260-1110	82389.	TR-2A
9.	1	Multiple socket, A-J2, INPUT (FROM) PREAMP)	4230-2600	82389	D3F

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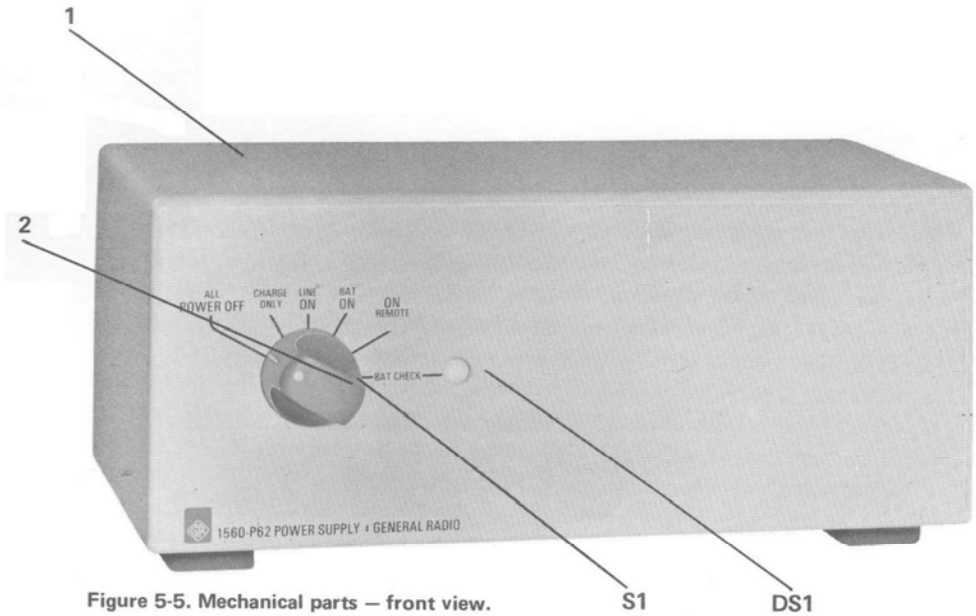


Figure 5-5. Mechanical parts — front view.

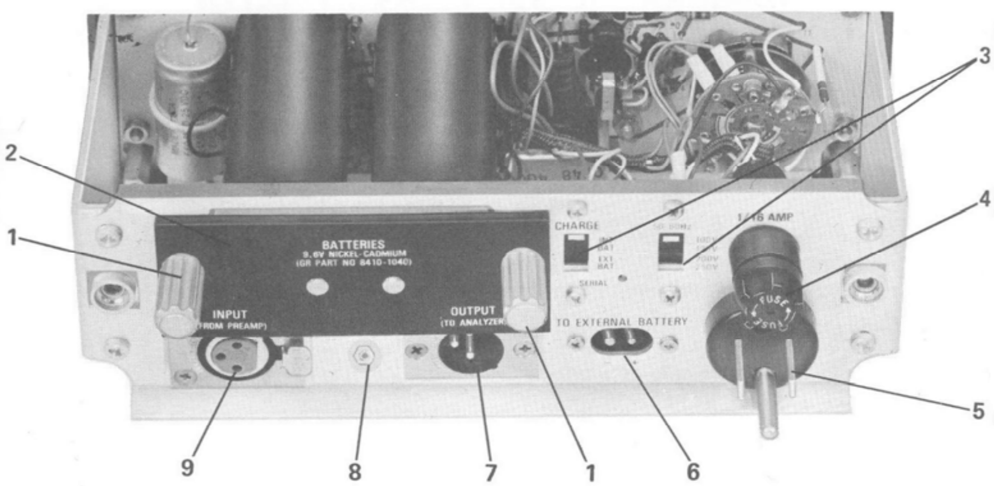
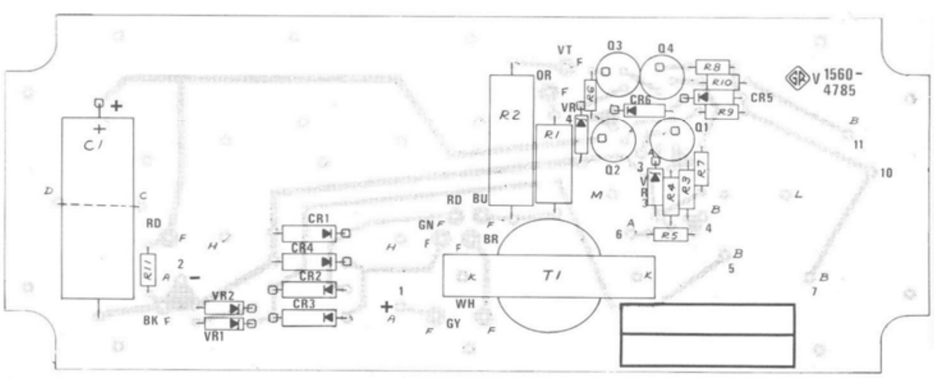


Figure 5-6. Mechanical parts — rear view.



ELECTRICAL PARTS LIST

1560-P62 POWER SUPPLY P/N 1560-4200

REFDES		DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
BT	1	BATTERY 9.6V NICAD	8410-1040	24655	8410-1040
BT	2	BATTERY 9.6V NICAD	8410-1040	24655	8410-1040
F	1	FUSE SLO-BLOW 1/16A 250V	5330-0300	75915	313 .062
J	1	RECEPTACLE POWER IEC STD 6A 250V	4240-0210	24655	4240-0210
J	2	RECPT AUDIO 3 CONT FEMALE	4230-2600	82389	D3F
J	3	RECPT AUDIO 3 CONT MALE	4220-3100	82389	D3M
J	4	PLUG ASM	1561-2040	24655	1561-2040
J	5	MINATURE PHONE 2 CKT SW	4260-1110	82389	TR-2A
S	1	SWITCH SLIDE 2 POS DPDT STEADY	7910-0832	82389	11A-1266
S	2	SWITCH SLIDE 2 POS DPDT STEADY	7910-0832	82389	11A-1266

POWER SUPPLY PC BOARD " V " P/N 1560-4785

REFDES		DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C	1	CAP ALUM 660 UF 25V	4450-6125	56289	30D667G025
CR	1	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR	2	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR	3	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR	4	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR	5	DIODE DHD-707 30PIV IR.001UA SI	6082-1009	07910	CD81172
CR	6	DIODE DHD-707 30PIV IR.001UA SI	6082-1009	07910	CD81172
DS	1	LAMP FLANGE BASE 10V .015A 10000	5600-0314	71744	CM-344
Q	1	TRANSISTOR 2N3414	8210-1290	56289	2N3414
Q	2	TRANSISTOR 2N3638	8210-1278	07263	PN3638
Q	3	TRANSISTOR 2N3414	8210-1290	56289	2N3414
Q	4	TRANSISTOR 2N3414	8210-1290	56289	2N3414
R	1	RES COMP 2.7 K 5PCT 2W	6120-2275	81349	RCR42G272J
R	2	RES WW AX LEAD 6.8K OHM 5 PCT 5W	6660-2685	75042	AS-5 6.8K 5PCT
R	3	RES FLM 7.68K 1 PCT 1/8W	6250-1768	81349	RN55D7681F
R	4	RES FLM 7.15K 1 PCT 1/8W	6250-1715	81349	RN55D7151F
R	5	RES COMP 300 OHM 5PCT 1/4W	6099-1305	81349	RCR07G301J
R	6	RES COMP 30 K OHM 5PCT 1/4W	6099-3305	81349	RCR07G303J
R	7	RES COMP 39 K 5PCT 1/4W	6099-3395	81349	RCR07G393J
R	8	RES COMP 100 K 5PCT 1/4W	6099-4105	81349	RCR07G104J
R	9	RES COMP 33 OHM 5PCT 1/4W	6099-0335	81349	RCR07G330J
R	10	RES COMP 30 K OHM 5PCT 1/4W	6099-3305	81349	RCR07G303J
R	11	RES COMP 100 K 5PCT 1/4W	6099-4105	81349	RCR07G104J
R	12	RES COMP 22 K 5PCT 1/4W	6099-3225	81349	RCR07G223J
S	1	SWITCH ROTARY ASM	7890-5341	24655	7890-5341
T	1	TRANSFORMER POWER	0748-4000	24655	0748-4000
VR	1	ZENER 1N758A 10V 5PCT .4W	6083-1012	14433	IN758A
VR	2	ZENER 1N965B 15V 5PCT .4W	6083-1015	14433	IN965B
VR	3	ZENER 1N957B 6.8V 5PCT .4W	6083-1009	07910	IN957B
VR	4	ZENER 1N957B 6.8V 5PCT .4W	6083-1009	07910	IN957B

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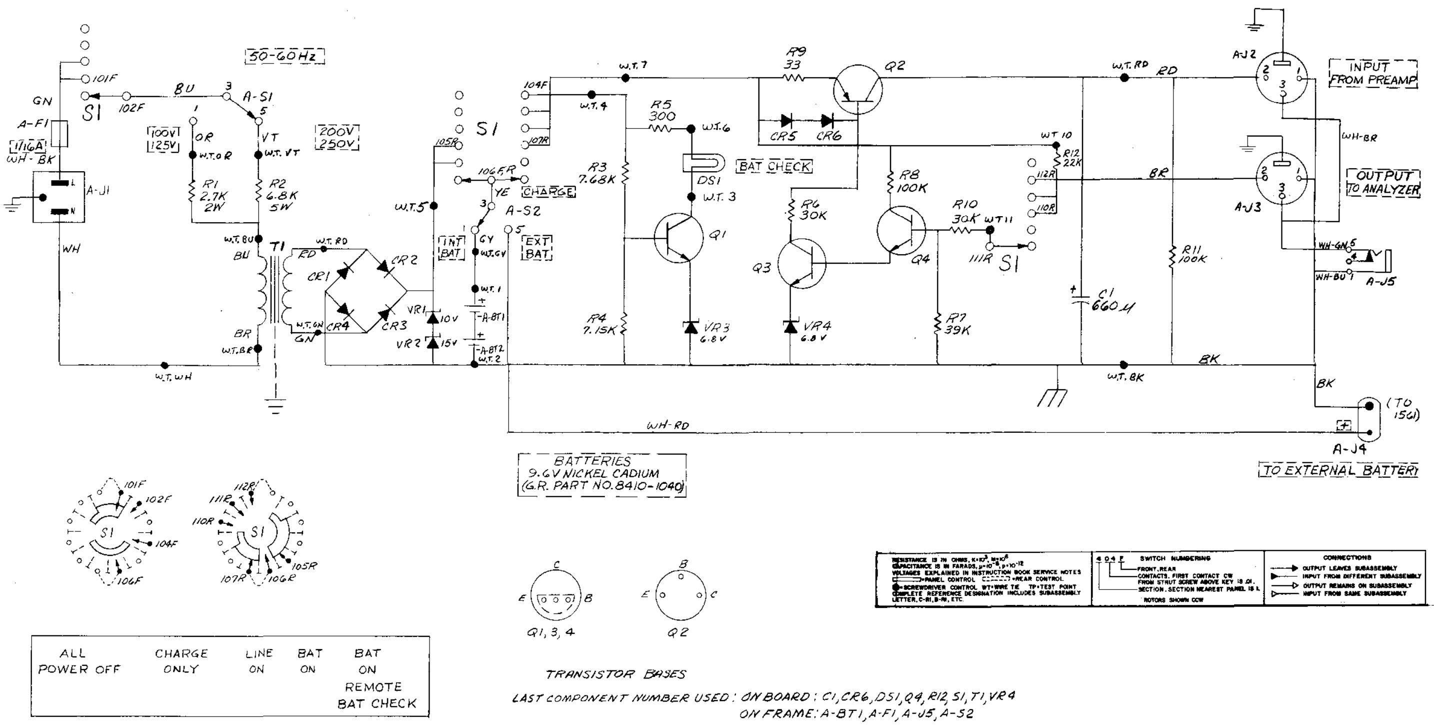

Figure 5-7. Schematic circuit diagram of the 1560-P62 Power Supply.

Type 1972-9600 Preamplifier/Adaptor
Section 6

6.1 GENERAL.

An inexpensive interface between a GR ceramic or electret microphone and the measuring instrument is the 1972-9600 Preamplifier/Adaptor (Figure 6-1). This simple, easy-to-use preamplifier is designed to satisy less-demanding requirements than those met by the 1560-P42 Preamplifier: It has reduced output voltage and current capabilities, offers only unity gain, and does not supply the polarizing voltage required to operate condenser microphones. In effect, the 1972-9600 serves as an impedance converter for ceramic microphones and vibration pickups. It provides a nominal input impedance of 2.2 GΩ in parallel with less than 3 pF. It has an output impedance of approximately 10 Ω. The schematic diagram is given in Figure 6-4.

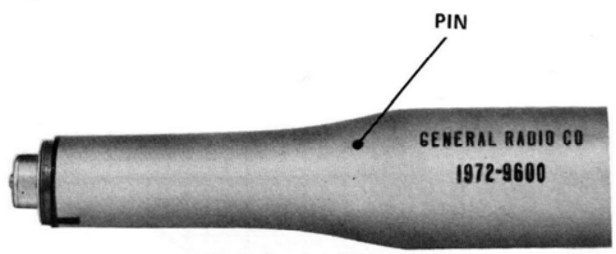

Figure 6-1. Type 1972-9600 Preamplifier/Adaptor.

6.2 INSTALLATION.

6.2.1 Power.

The Preamplifier is powered through the 3-wire (plus shield) output cable from the analyzing instrument or power supply. Table 1-2 lists the GR instruments that can provide the necessary power for the Preamplifier. The 1560-P62 Power Supply is also available to supply this power (refer to Section 5). With the 1972-9600 Preamplifier, the current is limited to 4 mA. The output stage is operating class A, so that the average supply current drawn is the measured dc supply current, regardless of the load. The measured (indicated) dc supply current is the average current drawn.

6.2.2 Mounting.

The 1560-9590 Tripod is recommended for mounting the 1972-9600 Preamplifier. Refer to para. 1.3.5 for a discussion of the use of this Tripod.

6.2.3 Connections.

The Preamplifier is terminated in a .460-60 male screw thread at the input and a male Switchcraft type A3 connector at the output. Thus, it mates directly with the GR ceramic microphones. The 1" ceramic cartridge can be adapted to the Preamplifier by using a 1560-2630 adaptor. Vibration pickups require a 1560-9669 adaptor.

When the Preamplifier is used with a microphone, its output can be connected directly to the input of the analyzing instrument. However, to reduce acoustical reflections from and diffractions around the body of the analyzer, a short length of cable should be used between preamplifier and analyzer. As much as 50 ft. of cable can be used before signal loss or distortion occurs. Refer to Figure 4-2 for permissible frequency limits of available current versus cable length.

If the Preamplifier/Adaptor is to be used as an adaptor (i.e., the prongs not used) with a sound-level meter that uses the microphone-plus-cable capacitance as part of the weighting network (e.g., the GR 1565), the use of an extension cable will change the weighting characteristics. To compensate for this, a capacitor, C, Figure 6-3, must be added from high to ground (WT2 to pin 3) of the Preamplifier. Also, cable losses will cause the meter to read low by an amount that varies with the cable length. Figure 6-2 shows the value of the compensating capacitor for cable capacitances between 150 and 1500 pF and the loss to be added to the reading of the sound-level meter. This is often a convenient means of extending the upper sound-pressure measuring range of the sound-level meter.

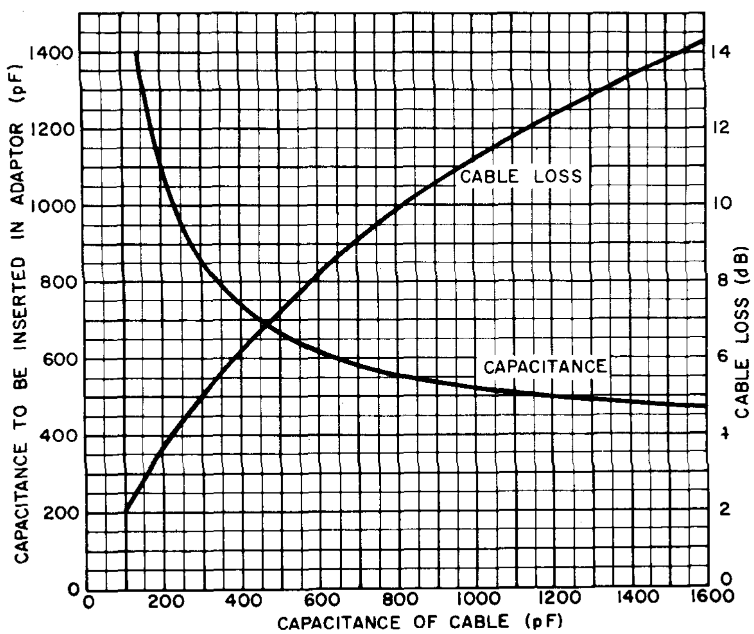

Figure 6-2. Compensation required for the capacitance of various extension cables and the corresponding cable loss.

6.2.4 Internal Bypass.

To use the Preamplifier/Adaptor as an adaptor only, the output lead can be connected directly to the input by means of a jumper. This will also allow the operator to realize fully the high-level capabilities of the ceramic microphones without distortion. No change in frequency response is encountered, but a flat loss occurs due to the capacitance loading of the cable. The procedure for bypassing is as follows:

a. Remove the circuitry (on board P/N 1933-4795) from the housing. To do this, push out the pin through the housing (see Figure 6-1) and slide the circuitry out the INPUT end. The output connector (P/N 1972-2000) will remain in the housing.

b. Carefully unsolder and remove the coupling capacitors, C1 and C2 (see Figure 6-3).

c. Disconnect the power wire (B+) at pin 2.

d. Solder an insulated wire from the input terminal (WT1, Figure 6-3) to the output terminal (pin 4).

e. Slide the circuitry into the housing until the four leads are properly inserted in the output connector. The circuitry is keyed to prevent incorrect insertion. Replace the pin removed in step a.

f. Place the microphone on the Preamplifier/Adaptor and use the 1562 Calibrator and the 1551, 1561, or 1933 Sound-Level Meter to check the alterations. Use a short connecting cable to the sound-level meter.

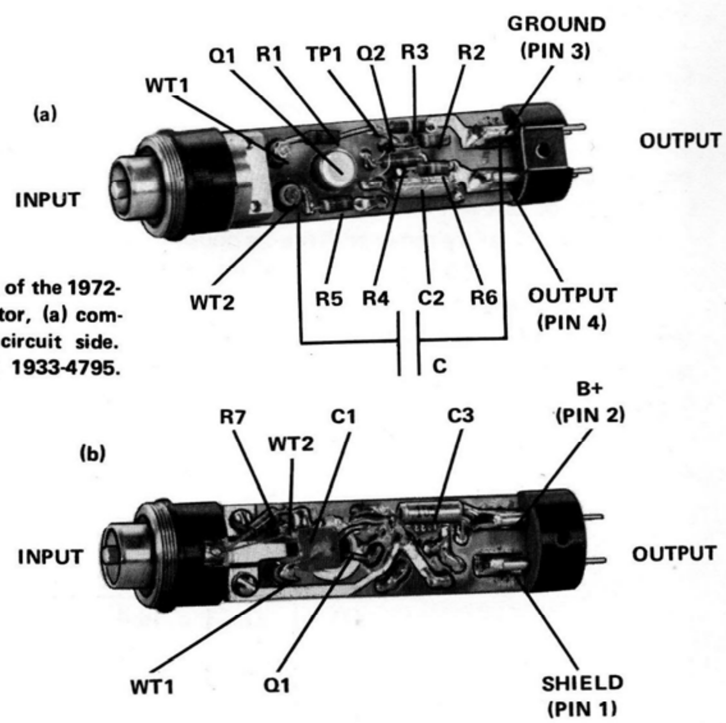

Figure 6-3. Interior views of the 1972-9600 Preamplifier/Adaptor, (a) component side, and (b) circuit side. Complete board is P/N 1933-4795.

6.3 NOISE.

The input noise of the 1972-9600 is similar to that of the 1560-P42, except that, with the former, the low-frequency noise is reduced because the protection diodes and "bootstrapping" circuit have been omitted. For high-capacitance microphones, the

1/3-octave noise curves for the 1560-P42 (Figure 4-12) are representative of the noise curves for the 1972-9600, except in the 20-100 Hz region, where the latter are several dB lower.

6.4 SERVICE AND MAINTENANCE.

6.4.1 GR Field Service.

The 1972-9600 Preamplifier /Adaptor is covered by the warranty stated at the front of this manual.

The warranty 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 Serivce Department giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial, ID, and type numbers of the instrument.

6.4.2 Instrument Return.

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

6.4.3 Operational Test.

To remove the Preamplifier/Adaptor from its housing, follow the procedure given under "Internal Bypass," para. 6.2.4, above. Re-install the circuitry by reversing this procedure.

A simple dc test will indicate whether or not the Preamplifier is operating:

a. With the circuitry removed from its housing, resolder the output connection.

b. Apply power (15 V dc) to pin 2 of the output connector.

c. The voltage at the FET (Q1) source should be half the supply voltage plus a few tenths of a volt, as shown in Table 6-1. If it is not, the FET or Q2 or a related component is probably defective. Do not measure the gate voltage on Q1 (high impedance). The voltage at TP1, Figure 6-4, should be half of the supply voltage.

Table 6-1

TRANSISTOR VOLTAGES

	(With 15-V Supply)	
Q1	D	14.4
	S	7.8
	G	—
Q2	E	15.0
	B	14.4
	C	7.8

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1972-9600 PREAMPLIFIER/ADAPTOR

ELECTRICAL PARTS LIST

ADAPTOR ASM P/N 1972-3100

REFDES		DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
P	3	CONNECTOR ASM	1972-2000	24655	1972-2000

PREAMPLIFIER PC BOARD ASM " D " P/N 1933-4795

REFDES		DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C	1	CAP CER SQ .001UF 10PCT 200V	4400-6440	72982	8121-A200-X5R-102K
C	2	CAP TANT 6.8UF 20PCT 15V EPOXY	4450-6401	56289	162D685X0015BA2
C	3	CAP TANT 10 UF 20PCT 30V WET	4450-6320	90201	MTP 10UF 20PCT 30V
P	1	FRONT END ASM	1560-2680	24655	1560-2680
Q	1	TRANSISTOR DN1330	8210-1260	17856	DN1330
Q	2	TRANSISTOR	8210-1204	24655	8210-1204
R	1	RES COMP 2.2 G 20PCT 1/8W	6098-8228	81349	RCR05G228
R	2	RES COMP 100 K 5PCT 1/8W	6098-4105	81349	RCR05G104J
R	3	RES COMP 75 K OHM 5PCT 1/8W	6098-3755	81349	RCR05G753J
R	4	RES COMP 3.0 K OHM 5PCT 1/8W	6098-2305	81349	RCR05G302J
R	5	RES COMP 4.7 K 5PCT 1/8W	6098-2475	81349	RCR05G472J
R	6	RES COMP 100 K 5PCT 1/8W	6098-4105	81349	RCR05G104J
R	7	RES COMP 3.0 K OHM 5PCT 1/8W	6098-2305	81349	RCR05G302J
R	8	RES COMP 22 OHM 5PCT 1/8W	6098-0225	81349	RCR05G220J

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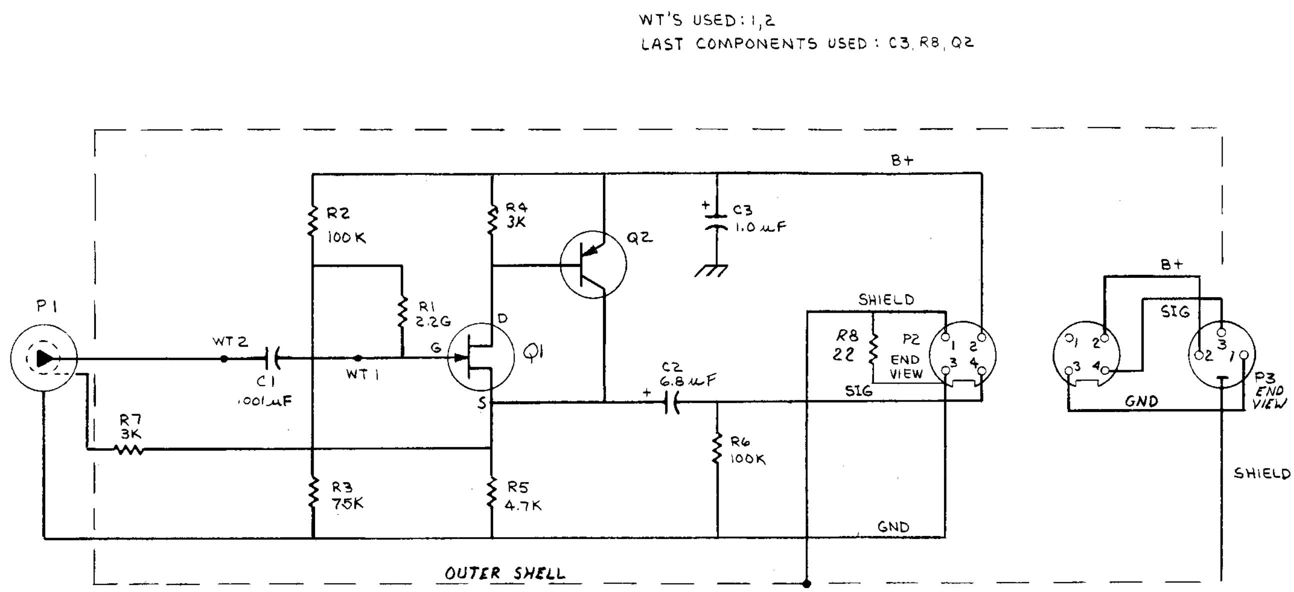

Figure 6-4. Schematic circuit diagram for the 1972-9600 Preamplifier/Adaptor.

Type 1560-P40 Preamplifier
Section 7

Figure 7-1. Type 1560-P40 Preamplifier.

7.1 INTRODUCTION.

7.1.1 Purpose.

The Type 1560-P40 Preamplifier (Figure 7-1) is a low-noise amplifier designed to couple a microphone to a coaxial cable without loss or with a voltage gain of 10 to 1. It is also useful as a calibrated preamplifier of signals to analyzers, voltmeters, recorders, sound-level meters, and other such instruments. With the adaptors supplied and available, nearly all types of connectors can be connected to the input of the preamplifier.

7.1.2 Mechanical Description.

The preamplifier is housed in a 1-in.-diameter tube that is finished in brushed chrome. A 1-inch hexagonal section on one end prevents the preamplifier from rolling when it is placed on a flat surface. When a microphone is mounted directly on the input end of the preamplifier, diffraction and reflection of acoustic energy are minimized by the small diameter of the tube.

The cartridge of the General Radio 1971-9605 Microphone can be attached directly to the input end of the preamplifier.

7.1.3 Electrical Description.

Two pins of a 3-terminal microphone connector at the output end of the preamplifier connect to the preamplifier output; the third pin is used to feed power to the circuit.

The active elements of the preamplifier are: one N-channel, field-effect transistor and two conventional transistors. The field-effect transistor, specially selected for low noise, is connected as a source follower and feeds the two conventional transistors, which are connected as a negative-feedback pair. The feedback is switched to provide a voltage gain of either 1 or 10.

7.2 SUPPLYING POWER FOR THE PREAMPLIFIER.

7.2.1 General.

The power required by the preamplifier is 15 to 25 volts at 1 or 2 milliamperes. Types 1558-A, -AP, and -BP Octave-Band Noise Analyzers, and the Type 1564-A Sound and Vibration Analyzers of current manufacture are designed to provide the power necessary for the Type 1560-P40 Preamplifier from their three-terminal input connectors. The preamplifier can be plugged directly into the connector, or a two-conductor shielded cable, such as those of the Type 1560-P72 series, can be used. Older instruments of the above types, and the Type 1551-C Sound-Level Meter and the Type 1553-A Vibration Meter do not ordinarily supply the required power, but they can be modified as described below (refer to paragraphs 7.2.2 through 7.2.4).

7.2.2 Power Supplied By Type 1551-C Sound-Level Meter or Type 1553-A Vibration Meter.

The Type 1551-C Sound-Level Meter and the Type 1553-A Vibration Meter are not normally provided with this power capability. However, it can be added if required, preferably by a General Radio service facility. For more detailed information about this modification, write or phone the nearest General Radio sales-engineering office.

7.2.3 Power Supplied by Type 1558 Octave-Band Noise Analyzer.

Type 1558-A or -AP Octave-Band Noise Analyzers supplied prior to August, 1964, are not wired to provide power for the preamplifier. These instruments can be modified at any General Radio sales office that includes a service facility, to provide the required power at the input connector. The modification can be made by connecting a lead from the positive end of capacitor C501 to terminal #2 of the MIKE socket (refer to the Operating Instructions for the Type 1558 Octave-Band Noise Analyzers, Figure 4-3 and 4-7).

7.2.4 Power Supplied by Type 1564-A Sound and Vibration Analyzer.

Type 1564-A Sound and Vibration Analyzers supplied prior to February, 1965, are not wired to supply power for the preamplifier. It is recommended that these instruments be returned to a General Radio sales-engineering office that includes a service facility, for modification to provide the required power. However, a modification kit consisting of a lead, a resistor (240 ohms ±5%, 1/2 watt), and a transistor (Type 2N697) will be supplied without charge by any General Radio sales-engineering office.

Figure 7-2 shows the placement of the resistor and lead. Solder one end of the resistor to terminal #2 of the INPUT socket. Connect the lead from the other end of the resistor to the etched-board lead that connects to the emitter of transistor Q505. Replace this transistor with the Type 2N697 transistor supplied in the modification kit.

7.2.5 Power Supplied by Type 1568 Wave Analyzer.

The dc power to operate the Preamplifier can be obtained directly from the Type 1568 Wave Analyzer. Does not apply to 1568-9000.

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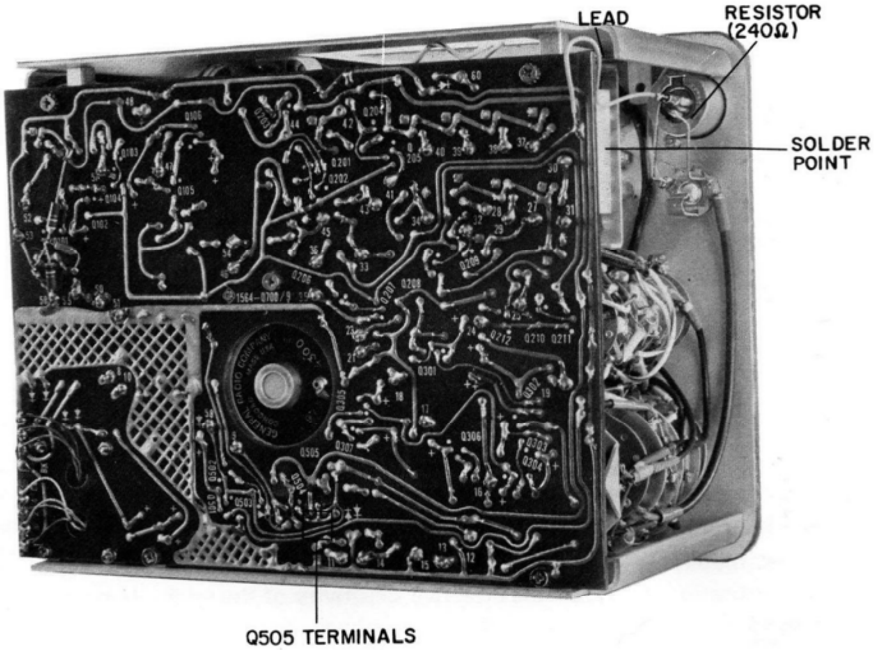

Figure 7-2. Modification of Type 1564-A Sound and Vibration Analyzer for use with the preamplifier.

CAUTION

Terminal #2 is connected to ground (terminal #1) on the connectors of some microphones, accelerometers, control boxes, and cables supplied by General Radio prior to January, 1962. If necessary, remove the connection between pins #1 and #2 before the above connectors are plugged into any other connector that supplies power through pin #2.

7.3 OPERATING PROCEDURE.

7.3.1 Microphone or Adaptor Attachment.

The cartridge of the Type 1971-9601 Microphone and the 1560-9696 Adaptor can be locked to the preamplifier by backing out two shouldered screws against the cartridge or the adaptor. Use the following procedure:

a. Turn in the two screws (A, Figure 7-3), using the hexagonal wrench provided.

b. Plug the microphone or adaptor onto the preamplifier so that the red dots (engraved on the sides of each) are aligned.

c. Back out the two screws so that their tips extend through the holes in the microphone or adaptor and their shoulders press firmly against the shell to hold the microphone firmly and to ground the shell.

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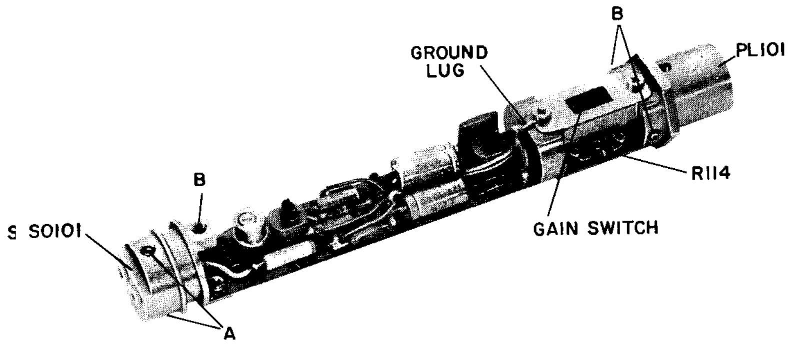

Figure 7-3. Interior view of the preamplifier.

7.3.2 Microphone-Sensitivity Correction.

When a microphone and preamplifier are used in conjunction with a Type 1551-C Sound-Level Meter, a Type 1558 Octave-Band Noise Analyzer, or a Type 1564-A Sound and Vibration Analyzer, the effective sensitivity of the microphone is increased. This increase is brought about 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 above instruments. Also, when a cartridge from a Type 1971-9606 Microphone Assembly is used, the loss caused by the capacitance of the flexible arm is not present. (The sensitivity given for a 1971-9606 Microphone Assembly is for the combined microphone cartridge and flexible arm.)

To calibrate a system of microphone, preamplifier, and one of the above-named instruments, a Type 1562 Sound-Level Calibrator is recommended. Alternatively, the correction data given in Table 7-1 can be used to correct the sensitivity value given for the particular microphone being used. Add the correction algebraically to the specified microphone sensitivity value to obtain the effective sensitivity value. This corrected value can then be used to calibrate the measuring instrument, as directed in the Operating Instructions for the latter. If a Type 1562 Sound-Level Calibrator is used to calibrate the system, the gain of the preamplifier should be set at X1, to prevent its possible overload (see Figure 7-4).

7.3.3 Electrical-Signal Measurements.

Connect the preamplifier to its source of power (refer to para. 7.2) and connect the input signal to the preamplifier by means of the correct adaptor. Set the gain

Table 7-1
MICROPHONE-SENSITIVITY CORRECTION IN DECIBELS

Microphone	Measuring Instrument		
	Type 1551-C	Type 1558	Type 1564-A
Type 1971-9605	0.9	1.0	1.4
Type 1971-9606		1.6	2.1

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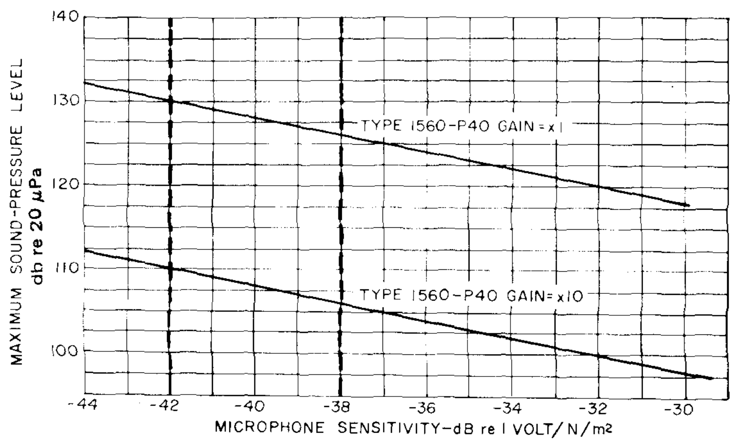

Figure 7-4. Maximum sound-pressure level that can be measured with a Type 1560-P40 Preamplifier-and-microphone combination. The sensitivities of Types 1971-9605 and -9606 Microphones will fall between the dotted lines. Allowance is made for a peak-to-rms ratio of 14 dB. For a sine-wave acoustic signal, the maximum level can be increased by 11 dB.

switch (see Figure 7-3) to the desired gain, either X1 or X10, as engraved on the switch.

NOTE

> When power is applied to the preamplifier, about one-half minute is required for the input stage to stabilize and for the preamplifier to operate.

With a high-impedance load on the preamplifier, audio-frequency voltage up to 0.5 volt peak-to-peak at X10 gain or 5 volts peak-to-peak at X1 gain can be applied to the preamplifier input.

Because of the low output impedance of the preamplifier, a long cable can be used between the preamplifier and the measuring instrument. At X10 gain, up to one-half mile of cable can be used; at X1 gain, up to one mile is satisfactory. Figure 7-5 shows the attenuation versus frequency for three different lengths of cable. The fixed loss for each length is caused by the divider formed by the preamplifier output coupling

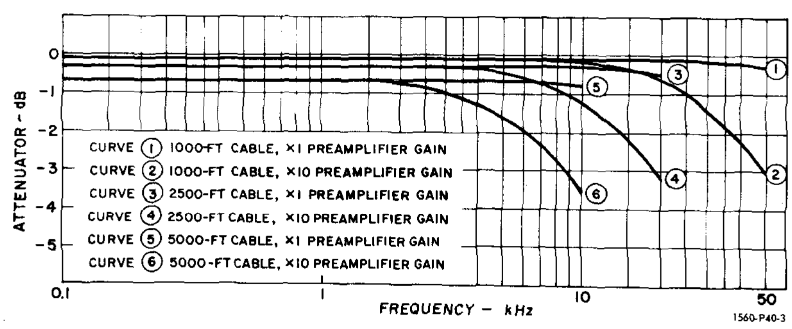

Figure 7-5. Attenuation of the preamplifier output signal caused by the capacitance of the cable between the preamplifier and the measuring instrument.

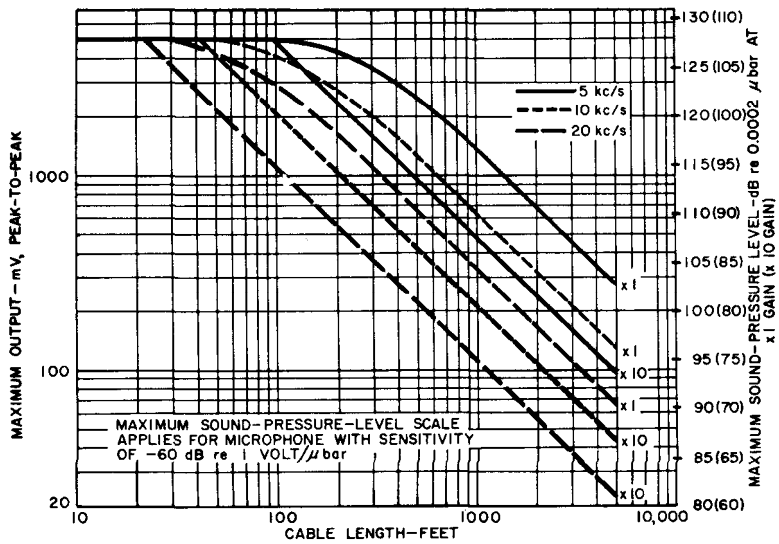

Figure 7-6. Curves showing the maximum output for a maximum distortion of one percent when a long cable terminated in a high-impedance load is driven. Allowance is made on the maximum sound-pressure level scale for an acoustic waveform having a peak-to-rms ratio of 14 dB. With a sine-wave signal, the maximum sound-pressure level can be increased by 11 dB.

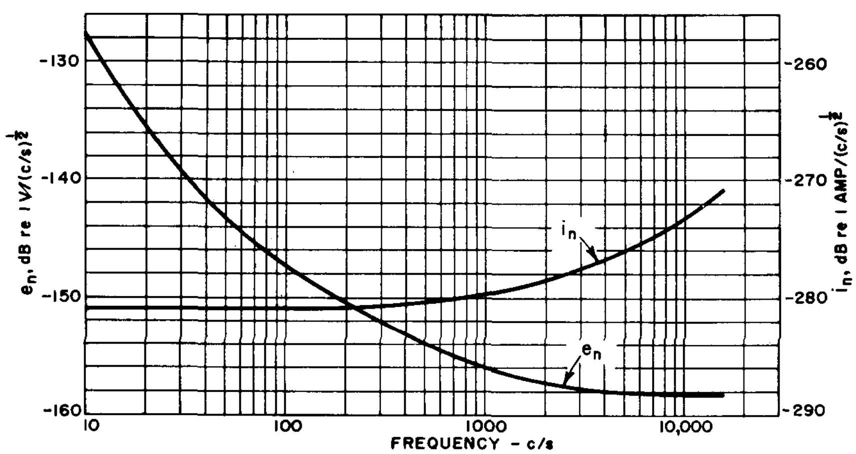

Figure 7-7. Typical frequency spectra of internal noise.

capacitor and the cable capacitance. When a long connecting cable is used, output from the preamplifier may have to be restricted because of the low reactance load of the cable. Figure 7-6 shows cable length versus maximum voltage output at three different frequencies, for a maximum distortion of 1%. The maximum sound-pressure level that should be measured is also shown.

A restricting factor in the use of long cables is the fact that as the length of a cable terminated in a high impedance approaches 1/4 wavelength of the electrical-signal

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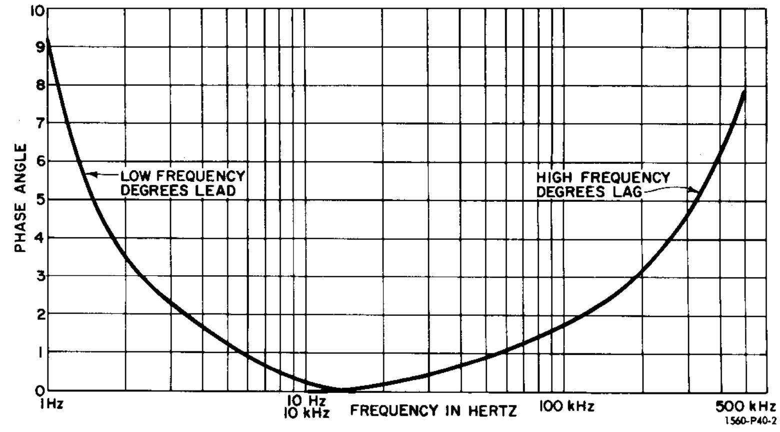

Figure 7-8. Phase shift in the 1560-P40 Preamplifier at 0-dB gain. High-impedance load.

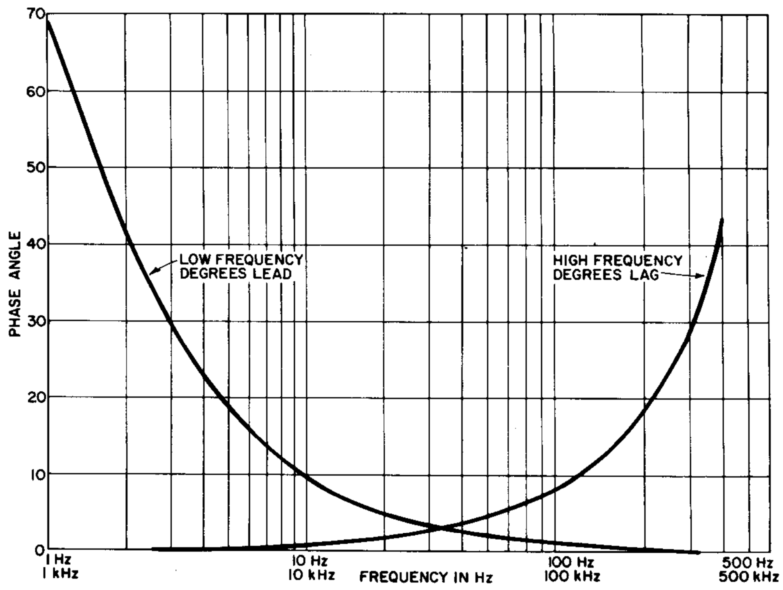

Figure 7-9. Phase shift in the 1560-P40 Preamplifier at 20-dB gain. High-impedance load.

frequency, the amplitude and transient response at the output end will be considerably distorted.

Figure 7-7 gives the noise level of the preamplifier in the form of curves of typical values for the e_n and i_n generators versus frequency.

Figures 7-8 and 7-9 give the phase shift in the amplifier as a function of frequency.

Normally, the low side of the preamplifier circuit is connected to the shell, which may be grounded by the ground of the measuring system. Occasionally, however, problems arise from multiple ground loops caused by grounds at different points in a system. As an aid in solving such special problems, the grounding connection from the preamplifier circuit to the shell can be disconnected easily. Remove the cylindrical tube from the preamplifier (refer to paragraph 7.4.2). Then remove the screw holding the ground lug at the end of the gain switch (see Figure 7-3). Bend the connecting lead so that the lug can not contact the shell or any part of the circuit. Then replace the screw. Also, be sure that the circuit is not grounded to the shell by the input or output connector. If cable connections are used, a two-conductor shielded cable for the input and a three-conductor shielded cable for the output are required. The shields must connect to the shell. The low side of the preamplifier circuit connects to terminal #1 of the three-terminal output plug.

7.3.4 Acoustic Measurements.

In acoustic measurements, the preamplifier can be used to increase by 20 dB the sensitivity of the Types 1558-A, 1558-AP, -BP, and 1564 Analyzers. In conjunction with the preamplifier, these instruments can be used for measurements down to a sound-pressure level of 24 dB re .0002 μbar.

The preamplifier is also useful with the Type 1551-C Sound-Level Meter, as well as with the above instruments, when a long cable must be used. The preamplifier eliminates the loss caused by a long cable used directly after a microphone (refer to paragraph 7.3.3).

The 1569 Automatic Level Regulator can also be used with the preamplifier.

Attach the microphone to the preamplifier as described in paragraph 7.3.1. Connect the preamplifier to its power source and to the measuring instrument (which may also be the power source; refer to paragraphs 7.2.2 through 7.2.5). Slide the gain switch (see Figure 7-3) to the desired gain, X1 or X10, as engraved on the switch. When the gain is X10, subtract 20 dB from the decibel reading of the measuring instrument to obtain the noise level at the microphone.

When a cable is used to connect them to the measuring instrument, the preamplifier and microphone can be mounted on the Type 1560-9590 Tripod. The measuring instrument and the observer can then be located at the other end of the cable, far enough removed from the acoustic field to have little or no effect on the accuracy of the measurement.

When a short connecting cable, or none at all, is used, the maximum noise level that can be measured without the possibility of overloading the amplifier is given in Figure 7-4. Allowance is made for a peak-to-rms ratio of 14 dB, which is adequate for normal noise.

When a long connecting cable is used, the maximum noise level that should be measured is given in Figure 7-6. The maximum value obtained from the figure will usually be pessimistic for broadband noise measurements, since the high-frequency components of such noise usually are of lower level than the low-frequency components.

NOTE

When the preamplifier-and-microphone assembly is used, particularly when low sound levels are measured, the assembly should be protected from mechanical vibration, such as that caused by rubbing against another object. The vibration is transmitted through the mechanical structure to the microphone, and the resulting electrical signal from the microphone may cause a large error in the measurement.

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For a complete discussion of the techniques of noise measurement, refer to the General Radio *Handbook of Noise Measurement.*

7.3.5 Vibration Measurements.

The preamplifier can be used to advantage with the Type 1553 Vibration Meter and the Type 1564-A Sound and Vibration Analyzer for vibration measurement and analysis. It permits the use of long cables without loss and increases the sensitivity of the measuring instrument by 20 dB.

Attach the Type 1560-9696 Adaptor to the preamplifier as described in paragraph 7.3.1. Plug the vibration-pickup cable into the adaptor. Connect the preamplifier to its power source and to the measuring instrument (refer to paragraphs 7.2.2 through 7.2.5). Slide the gain switch to the desired gain (X1 or X10). If the preamplifier is used at X10 gain, divide the readings of the measuring instrument by 10. If readings are taken in decibels, subtract 20 dB. Allowance is made for a peak-to-rms ratio of approximately 15 dB. For a sine-wave vibration signal, the maximum g values given can be multiplied by 4.

Table 7-2 lists the maximum vibration acceleration that should be measured when General Radio vibration pickups are used with the Type 1560-P40 Preamplifier.

The Type 1557-A Vibration Calibrator can be used to calibrate the Types 1560-P52 and -P53 Pickups with either X1 or X10 preamplifier gain. The Type 1560-P54 Pickup should be calibrated only with X1 gain.

7.4 SERVICE AND MAINTENANCE.

7.4.1 Service.

The warranty stated at the front of this book 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, giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest sales-engineering 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.

Table 7-2
MAXIMUM VIBRATION ACCELERATION
TO BE MEASURED WITH VARIOUS PICKUPS

Pickup	X1 Preamplifier Gain	X10 Preamplifier Gain
Type 1560-P52	5.5 g	0.55 g
Type 1560-P53	5.5 g	0.55 g
Type 1560-P54	0.7 g	0.070 g

7.4.2 Servicing.

Using the hexagonal wrench provided, screw in the three shouldered screws (B, Figure 7-3) until the cylindrical tube can be removed from the preamplifier. Figures 7-3 and 7-10 show the locations of the components.

Table 7-3 lists normal voltages from each transistor to ground. Measure the voltages with a vacuum-tube voltmeter and with a battery voltage of 21 volts. A 10-percent deviation from the listed values is allowable.

Before making measurements, short-circuit the preamplifier input terminals. Install a resistor of about 10 megohms across resistor R101 (see Figures 7-10 and 7-11). If such a resistor is not available, momentarily short-circuit R101 before any voltages are measured. Do not attempt to measure the voltage from the gate of Q101 to ground without a shunt across resistor R101.

Table 7-3

PREAMPLIFIER TRANSISTOR VOLTAGES

Transistor	Terminal	Dc Volts to Ground
Q101	DRAIN	21.0
	SOURCE	8.0
	GATE	8.1
Q102	COLLECTOR	16.6
	BASE	8.0
	EMITTER	7.5
Q103	COLLECTOR	11.5
	BASE	7.9
	EMITTER	7.3

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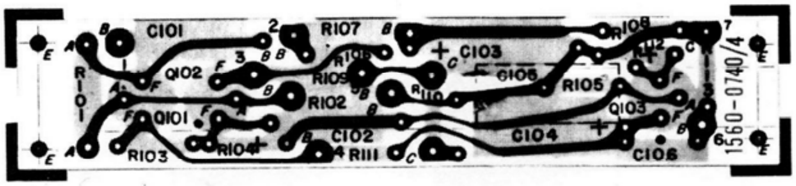


Figure 7-10. Etched-board layout for the Type 1560-P40 Preamplifier.

NOTE

The number shown on the foil side of the board is not the part number for the complete assembly. The assembly number is 1560-2741.

TYPE 1560-P40 PREAMPLIFIER PARTS LIST

ELECTRICAL PARTS LIST

1560-P40 PREAMPLIFIER ASM P/N 1560-3400

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
PL 101	INSERT AUDIO 3 CONT MALE	4220-5306	82389	3C1086
Q 101	TRANSISTOR 2N3457	8210-1082	17856	2N3457
Q 102	TRANSISTOR PN3391A	8210-1292	56289	PN3391A
Q 103	TRANSISTOR 2N6008	8210-1291	56289	2N6008
R 114	RES COMP 15 OHM 5PCT 1/4W	6099-0155	81349	RCR07G150J
S 101	SWITCH SLIDE 2POS DPDT STEADY	7910-0830	24655	7910-0830
SO 101	SOCKET ASM	1560-1400	24655	1560-1400

PC BOARD ASM P/N 1560-2741

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 101	CAP MYLAR .0022UF 2 PCT 200V	4860-7326	56289	410P .0022 UF 2PCT
C 102	CAP TANT 22 UF 20PCT 15V	4450-5300	56289	150D226X0015B2
C 103	CAP TANT 120 UF 20PCT 10V	4450-5616	56289	150D127X0010R2
C 104	CAP TANT 120 UF 20PCT 10V	4450-5616	56289	150D127X0010R2
C 105	CAP TANT 120 UF 20PCT 10V	4450-5616	56289	150D127X0010R2
C 106	CAP TANT 3.3 UF 20PCT 15V	4450-4600	56289	150D335X0015A2
R 101	RES COMP 1.0 G 20PCT 1/2W	6100-8108	81349	RCR20G108
R 102	FACTORY SELECT	****-****		
R 103	RES COMP 20 K OHM 5PCT 1/4W	6099-3205	81349	RCR07G203J
R 104	RES COMP 56 K 5PCT 1/4W	6099-3565	81349	RCR07G563J
R 105	RES COMP 51 K OHM 5PCT 1/4W	6099-3515	81349	RCR07G513J
R 106	RES COMP 3.0 K OHM 5PCT 1/4W	6099-2305	81349	RCR07G302J
R 107	FACTORY SELECT	****-****		
R 108	RES COMP 150 K 5PCT 1/4W	6099-4155	81349	RCR07G154J
R 109	RES FLM 9.53K 1 PCT 1/8W	6250-1953	81349	RN55D9531F
R 110	FACTORY SELECT	****-****		
R 111	RES COMP 8.2 K 5PCT 1/4W	6099-2825	81349	RCR07G822J
R 112	RES COMP 6.2 K OHM 5PCT 1/4W	6099-2625	81349	RCR07G622J
R 113	RES COMP 470 K 5PCT 1/4W	6099-4475	81349	RCR07G474J

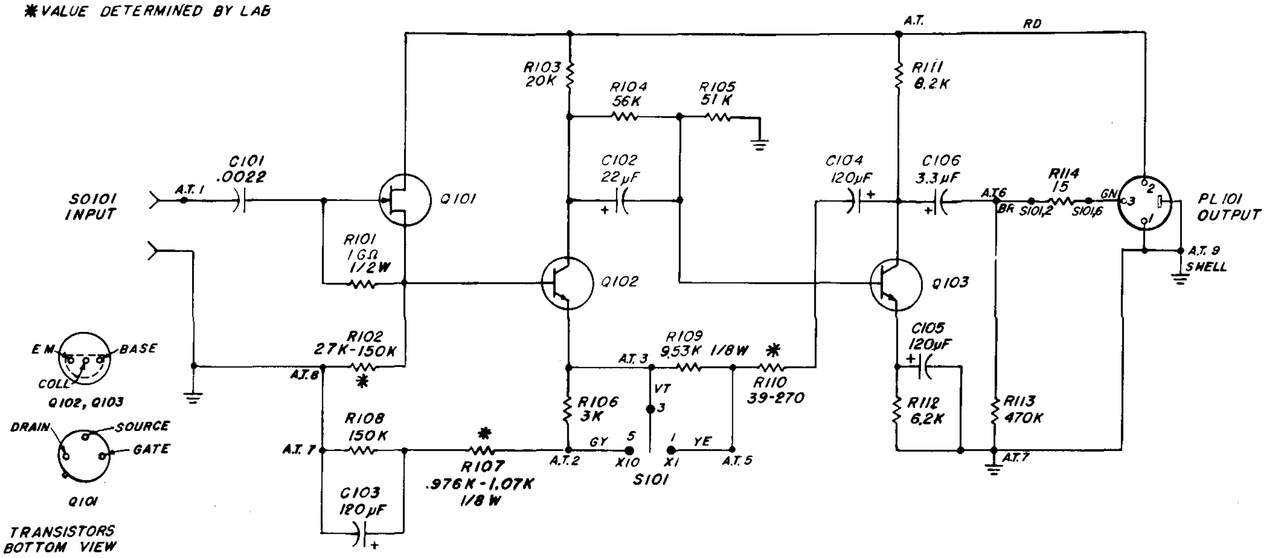
*Value determined by General Radio Laboratory.

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 1/4 WATT
5. RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM G 1 GIGOHM 1000 MEGOHMS
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

ANCHOR TERMINALS USED A.T. 1-9

✱ VALUE DETERMINED BY LAB



* Value determined by General Radio Laboratory.

Figure 7-11. Schematic diagram for the Type 1560-P40 Preamplifier.

FEDERAL SUPPLY CODE
FOR MANUFACTURERS
From Defense Logistics Agency Microfiche
H4-2 SB 708-42 GSA-FSS H4-2

Ref FMC Column in Parts Lists

Code	Manufacturer
00136	McCoy Elctrns.,Mt.Holly Springs,PA 17065
00192	Jones Mfg.,Chicago,IL 60181
00194	Walsco Elctrns.,Los Angeles,CA 90018
00327	Welwyn Intntl.,Westlake,OH 44145
00434	Schweber Elctrns.,Westbury,NY 11590
00656	Aerovox.,New Bedford,MA 02745
00779	AMP Inc.,Harrisburg,PA 17105
01009	Alden Products.,Brockton,MA 02413
01121	Allen Bradley.,Milwaukee,WI 53204
01255	Litton Inds.,Beverly Hills,CA 90213
01281	TRW.,Lawndale,CA 90260
01295	TI.,Dallas,TX 75222
01526	GE.,Waynesboro,VA 22980
01930	Amerock.,Rockford,IL 61101
01963	Cherry Elctrc.,Waukegan,IL 60085
02111	Spectrol Elctrns.,City of Industry,CA 91745
02114	Ferroxcube.,Saugerties,NY 12477
02606	Fenwall Lab.,Morton Grove,IL 60053
02639	GE.,Schenectady,NY 12307
02660	Amphenol.,Broadview,IL 60153
02735	RCA.,Somerville,NJ 08876
02768	Fastex.,Desplains,IL 60016
03042	Carter Ink.,Cambridge,MA 02142
03508	GE.,Syracuse,NY 13201
03550	Vanguard Elctrns.,Inglewood,CA 90302
03636	Grayburne.,Yonkers,NY 10701
03877	Transitron Elctrns.,Wakefield,MA 01880
03888	KDI Pyrofilm.,Whippany,NJ 07981
03911	Clairex.,New York,NY 10001
04009	Arrow Hart.,Hartford,CT 06106
04643	Digitronics.,Albertson,NY 11507
04713	Motorola.,Phoenix,AZ 85008
04919	Component Mfg.,W.Bridgewater,MA 02379
05079	Tansistor Elctrns.,Bennington,VT 05201
05245	Corcom.,Chicago,IL 60639
05276	ITT Elctrns.,Pomona,CA 91766
05402	Controls Co.of Amer.,Melrose Pk,IL 60160
05574	Viking Inds.,Chatsworth,CA 91311
05624	Barber Colman.,Rockford,IL 61101
05748	Barnes Mfg.,Mansfield,OH 44901
05820	Wakefield Eng.,Wakefield,MA 01880
06383	Panduit.,Tinley Pk,IL 60477
06406	Truelove & Maclean.,Waterbury,CT 06708
06665	Precision Monolith.,Santa Clara,CA 95050
06743	Clevite.,Cleveland,OH 44110
06795	WLS Stamp.,Cleveland,OH 44104
06915	Richco Plstc.,Chicago,IL 60646
06928	Teledyne Kntcs.,Soland Bch,CA 92075
06978	Aladdin Elctrns.,Nashville,TN 37210
07047	Ross Milton.,Southampton,PA 18966
07126	Digitran.,Pasadena,CA 91105
07127	Eagle Signal.,Baraboo,WI 53913
07233	Cinch Graphik.,City of Industry.CA 91744
07261	Avnet.,Culver City,CA 90230
07263	Fairchild.,Mountain View,CA 94040
07387	Birtcher.,N.Los Angeles,CA 90032
07595	Amer.Semicond.,Arlington Hts,IL 60004
07699	Magnetic Core.,Newburgh,NY 12550
07707	USM Fastener.,Shelton,CT 06484
07828	Bodine.,Bridgeport,CT 06605
07829	Bodine Elctrc.,Chicago,IL 60618
07910	Cont Device.,Hawthorne,CA 90250
07983	State Labs.,New York,NY 10003
07999	Borg Inst.,Delavan,WI 53115
08524	Deutsch Fastener.,Los Angeles,CA 90045
08556	Bell Elctrc.,Chicago,IL 60632
08730	Vemaline Prod.,Franklin Lakes,NJ 07417
09213	GE.,Buffalo,NY 14220
09353	C&K Components.,Watertown,MA 02172
09408	Star-Tronics.,Georgetown,MA 01830
09823	Burgess Battery.,Freeport,IL 61032
09856	Fenwal Elctrns.,Framingham,MA 01701
09922	Burndy.,Norwalk,CT 06852
10025	Glasseal Prod.,Linden,NJ 07036
10389	Chicago Switch.,Chicago,IL 60647
11236	CTS of Berne.,Berne,IN 46711
11599	Chandler Evans.,W.Hartford,CT 06101
11983	Nortronics.,Minneapolis,MN 55427
12040	National.,Santa Clara,CA 95051
12045	Elctrc Transistors.,Flushing,NY 11354
12498	Teledyne.,Mountain View,CA 94043
12617	Hamlin.,Lake Millis,WI 53551
12672	RCA.,Woodbridge,NJ 07095
12697	Clarostat.,Dover,NH 03820
12856	Micrometals.,City of Industry,CA 91744
12954	Dickson Elctrns.,Scottsdale,AZ 85252
12969	Unitrode.,Watertown,MA 02172
13094	Electrocraft.,Hopkins,MN 55343
13103	Thermalloy.,Dallas,TX 75234
13148	Vogue Inst.,Richmond Hill,NY 11418
13150	Vernitron.,Laconia,NH 03246
13327	Solitron Devices.,Tappan,NY 10983
13715	Fairchild.,San Rafael,CA 94903
13919	Burr Brown.,Tucson,AZ 85706
14010	Anadex Inst.,Van Nuys,CA 91406
14195	Elctrc Controls.,Wilton,CT 06897
14196	American Labs.,Fullerton,CA 92634
14332	Relton.,Arcadia,CA 91006
14433	ITT.,W.Palm Beach,FL 33402
14482	Watkins & Johnson.,Palo Alto,CA 94304
14608	Corbin.,Berlin,CT 06037
14655	Cornell Dubilier.,Newak,NJ 07101
14674	Corning Glass.,Corning,NY 14830
14749	Acopian.,Easton,PA 18042
14752	Electrocube.,San Gabriel,CA 91776
14889	R&G Sloan.,Sun Valley,CA 91352
14908	Elctrc Inst & Spclty.,Stoneham,MA 02180
14936	General Inst.,Hicksville,NY 11802
15238	ITT.,Lawrence,MA 08142
15476	Digital Equip.,Maynard,MA 01754
15605	Cutler Hammer.,Milwaukee,WI 53202
15782	Houston Inst.,Bellaire,TX 77401
15801	Fenwal Elctrns.,Framingham,MA 01701
15819	Sinclair & Rush.,St.Louis,MO 63111
16037	Spruce Pine Mica.,Spruce Pine,NC 28777
16068	Intntl Diode.,Jersey City,NJ 07304
16179	Omni Spectra.,Farmington,MI 48024
16301	Astrolab.,Linden,NJ 07036
16352	Codi.,Fairlawn,NJ 07410
16485	Sterling Inst.,New Hyde Park,NY 11040
16636	Indiana General.,Oglesby,IL 61348
16758	Delco.,Kokomo,IN 46901
16950	Precision Dynamics.,Burbank,CA 91504
16952	Amer Micro Devices.,Summerville,SC 29483
17117	Elctrc Molding.,Woonsocket,RI 02895
17540	Mohawk Spring.,Schiller Park,IL 60176
17745	Angstrohm Precsn.,Hagerstown,MD 21740
17771	Singer.,Somerville,NJ 08876
17850	Zeltex.,Concord,CA 94520
17856	Siliconix.,Santa Clara,CA 95054
18324	Signetics.,Sunnyvale,CA 94086
18542	New Prod Eng.,Wabash,IN 46992
18677	Scanbe.,El Monte,CA 91731
18736	Computer Diode.,S.Fairlawn,NJ 07936
18795	Cycon.,Sunnyvale,CA 94086
18911	Durant.,Watertown,WI 53094
19178	Zero.,Monson,MA 01057
19209	GE.,Gainesville,FL 32601
19373	Eastron.,Haverhill,MA 01830
19396	Paktron.,Vienna,VA 22180
19617	Cubtron.,Chicago,IL 60622
19644	LRC Elctrns.,Horseheads,NY 14845
19701	Electra.,Independence,KS 67301
20093	Elect Inds.,Murray Hill,NJ 07974
20754	KMC.,Long Valley,NJ 07853
21335	Fafnir Bearing.,New Britian,CT 06050
21688	Raytheon.,Norwood,MA 02062
21759	Lenox Fugle.,Watchung,NJ 07060
22526	Berg Elctrcs.,New Cumberland,PA 17070
22589	Electro Space Fabrctrs.,Topton,PA 19562
22753	UID Elctrcs.,Hollywood,FL 33022
23338	Wavetek.,San Diego,CA 92112
23342	Avnet Elctrcs.,Franklin Park,IL 60131
23936	Pamotor.,Bulingham,CA 94010
24351	Indiana Gnrl Elctrc.,Keasby,NJ 08832
24355	Analog Devices.,Cambridge,MA 02142
24444	General Semicond.,Tempe,AZ 85281
24446	GE.,Schenectady,NY 12305
24454	GE.,Syracuse,NY 13201
24455	GE.,Cleveland,OH 44112
24602	EMC Technlgy.,Cherry Hill,NJ 08034
24655	Gen Rad.,Concord,MA 01742
24759	Lenox Fugle.,S.Plainfield,NJ 07080
25008	Vactite.,Berkeley,CA 94710
25289	EG&G.,Bedford,MA 01730
26601	Tri-County Tube.,Nunda,NY 14517
26805	Omni Spectra.,Waltham,MA 02154
26806	American Zettler.,Costa Mesa,CA 92626
27014	National.,Santa Clara,CA 95051
27545	Hartford Universal Ball.,Rocky Hill,CT 06067
28480	HP.,Palo Alto,CA 94304
28520	Heyman Mfg.,Kenilworth,NJ 07033
28875	IMC Magnetics.,Rochester,NH 03867
28959	Hoffman Elctrcs.,El Monte,CA 91734
30043	Solid State Devices.,LaMirada,CA 90638
30646	Beckman Inst.,Cedar Grove,NJ 07009
30874	IBM.,Armonk,NY 10504
30985	Permag Magnetics.,Toledo,OH 43609
31019	Solid State Scntfc.,Montgomerville,PA 18936
31514	Standford Appld Engs.,Costa Mesa,CA 92626
31814	Analogic.,Wakefield,MA 01880
31951	Triridge.,Pittsburgh,PA 15231
32001	Jensen.,Chicago,IL 60638
33095	Spectrum Control.,Fairview,PA 16415
33173	GE.,Owensboro,KY 42301
34141	Koehler.,Marlboro,MA 01752
34156	Semicoa.,Costa Mesa,CA 92626
34333	Silicon Genrl.,Westminster,CA 92683
34335	Advanced Micro Devices.,Sunnyvale,CA 94086
34649	Intel.,Santa Clara,CA 95051
34677	Solitron Devices.,Jupiter,FL 33458
35929	Constanta.,Montreal,QUE,CAN
36462	National Ltd.,Montreal,QUE,CAN
37942	Mallory.,Indianapolis,IN 46206
38443	Marlin Rockwell.,Jamestown,NY 14701
39317	McGill Mfg.,Valpariso,IN 46383
40931	Honeywell.,Minneapolis,MN 55408
42190	Muter.,Chicago,IL 60638
42498	National.,Melrose,MA 02176
43334	New Departure-Hyatt.,Sandusky,OH 44870
43991	Norma Hoffman.,Stanford,CT 06904
49671	RCA.,New York,NY 10020
49956	Raytheon.,Waltham,MA 02154
50088	Mostek.,Carrollton,TX 75006
50101	GHZ Devices.,S.Chelmsford,MA 01824
50507	Micro Networks.,Worcester,MA 01606
50522	Monsanto.,Palo Alto,CA 94304
50721	Datel Systems.,Canton,MA 02021
51167	Aries Elctrcs.,Frenchtown,NJ 08825
51553	Diablo Systems.,Hayward,CA 94545
51642	Centre Eng.,State College,PA 16801
52648	Plessey.,Santa Ana,CA 92705
52676	SKF Inds.,Philadelphia,PA 19132
52763	Stettner Trush., Cazenovia, NY 13035
53021	Sangamo Elctrc.,Springfield,IL 62705
53184	Xciton.,Latham,NY 12110
53421	Tyton.,Milwaukee,WI 53209
54294	Shallcross.,Selma,NC 27576
54297	Assoc Prec Prod.,Huntsville,AL 35805
54715	Shure Bros.,Evanston,IL 60202
56289	Sprague.,North Adams,MA 01247
57771	Stimpson.,Bayport,NY 11705
58553	Superior Valve.,Washington,PA 15301
59730	Thomas & Betts.,Elizabeth,NJ 07207
59875	TRW.,Cleveland,OH 44117
60399	Torrington.,Torrington,CT 06790
61007	Townsend.,Braintree,MA 02184
61637	Union Carbide.,New York,NY 10017
61864	United Carr Fast.,Boston,MA
63060	Victoreen.,Cleveland,OH 44104
63743	Ward Leonard.,Mt.Vernon,NY 10550
65083	Westinghouse.,Bloomfield,NJ 07003
65092	Weston.,Newark,NJ 07114
70106	Acushnet Cap.,New Bedford,MA 02742
70109	Adams & Westlake.,Elkhart,IN 46514
70417	Chrysler.,Detroit,MI 48231
70485	Atlantic India Rubber.,Chicago,IL 60607
70563	Amperite.,Union City,NJ 07087
70611	Ark-Les Switch.,Watertown,MA 02172
70892	Bead Chain.,Bridgeport,CT 06605
70903	Belden.,Chicago,IL 60644
71126	Bronson.,Beacon Falls,CT 06403
71279	Cambridge Thermionic.,Cambridge,MA 02138
71294	Canfield.,Clifton Forge,VA 24422
71400	Bussmann.,St.Louis,MO 63107
71450	CTS.,Elkhart,IN 46514
71468	Cannon.,Los Angeles,CA 90031
71482	Clare.,Chicago,IL 60645
71590	Centralab.,Milwaukee,WI 53212
71666	Continental Carbon.,New York,NY
71707	Coto Coil.,Providence,RI 02905
71729	Crescent Box.,Philadelphia,PA 19134
71744	Chicago Min Lamp.,Chicago,IL 60640
71785	Cinch.,Chicago,IL 60624
71823	Darnell.,Downey,CA 90241
72136	Electromotive.,Willimantic,CT 06226
72228	Continental Screw.,New Bedford,MA 02742
72259	Nytronics.,Berkeley Hts,NJ 07922
72619	Dialight.,Brooklyn,NY 11237
72699	General Inst.,Newark,NJ 07104
72765	Drake.,Chicago,IL 60631
72794	Dzus Fastener.,W.Islip,NY 11795
72825	Eby.,Philadelphia,PA 19144
72962	Elastic Stop Nut.,Union,NJ 07083
72982	Erie.,Erie,PA 16512
73445	Amperex Elctrcs.,Hicksville,NY 11801
73559	Carling Elctrc.,Hartford,CT 06110
73690	Elco Resistor.,New York,NY
73803	TI.,Attleboro,MA 02703
73899	JFD Elctrcs.,Brooklyn,NY 11219
73957	Groov-Pin.,Ridgefield,NJ 07657
74193	Heinemann.,Trenton,NJ 08602
74199	Quam Nichols.,Chicago,IL 60637
74445	Holo-Krome.,Hartford,CT 06110
74545	Hubbell.,Stratford,CT 06497
74861	Industrial Cndnsr.,Chicago,IL 60618
74868	Amphenol.,Danbury,CT 06810
74970	Johnson.,Waseca,MN 56093
75042	IRC(TRW).,Burlington,IA 52601
75376	Kurz-Kasch.,Dayton,OH 45401
75382	Kuka.,Mt Vernon,NY 10551
75491	Lafayette.,Syosset,NY 11791
75608	Linden.,Providence,RI 02905
75915	Littelfuse.,Des Plains,IL 60016
76005	Lord Mfg.,Erie,PA 16512
76149	Mallory Elctrc.,Detroit,MI 48204
76241	Maurey.,Chicago,IL 60616
76381	3 M Co.,St.Paul,MN 55101
76385	Minor Rubber.,Bloomfield,NJ 07003
76487	Millen.,Malden,MA 02148
76545	Mueller Elctr.,Cleveland,OH 44114
76684	National Tube.,Pittsburg,PA
76854	Oak Inds.,Crystal Lake,IL 60014
77132	Dot Fastener.,Waterbury,CT 06720
77147	Patton MacGuyer.,Providence,RI 02905
77166	Pass Seymour.,Syracuse,NY 13209
77263	Pierce Roberts Rubber.,Trenton,NJ 08638
77315	Platt Bros.,Waterbury,CT 06720
77339	Positive Lockwasher.,Newark,NJ
77342	AMF.,Princeton,IN 47570
77542	Ray-o-Vac.,Madison,WI 53703
77630	TRW.,Camden,NJ 08103
77638	General Inst.,Brooklyn,NY 11211
78189	Shakeproof.,Elgin,IL 60120
78277	Sigma Inst.,Braintree,MA 02184
78429	Airco Speer.,St Marys,PA 15867
78488	Stackpole.,St Marys,PA 15867
78553	Tinnerman.,Cleveland,OH
78711	Telephonics.,Huntington,NY 11743
79089	RCA.,Harrison,NJ 07029
79136	Waldes Kohinoor.,New York,NY 11101
79497	Western Rubber.,Goshen,IN 46526
79725	Wiremold.,Hartford,CT 06110
79727	Continental Wirt.,Philadelphia,PA 19101
79840	Mallory Controls.,Frankfort,IN 46041
79963	Zierick.,Mt Kisco,NY 10549
80009	Tektronix.,Beaverton,OR 97005
80030	Prestole Fastener.,Toledo,OH 43605
80048	Vickers.,St Louis,MO 63166
80103	Lambda.,Melville,NY 11746
80183	Sprague.,N.Adams,MA 01247
80211	Motorola.,Franklin Pk,IL 60131
80251	Formica.,Cincinnati,OH 45232
80258	Standard Oil.,Lafeyette,IN 47902
80294	Bourns Labs.,Riverside,CA 92506
80368	Sylvania.,New York,NY 10017
80431	Air Filter.,Milwaukee,WI 53218
80583	Hammarlund.,New York,NY 10010
80740	Beckman Inst.,Fullerton,CA 92634
80756	TRW Ramsey.,St Louis,MO 63166
80894	Pure Carbon.,St Marys,PA 15857
81030	Int'l Inst.,Orange,CT 06477
81073	Grayhill.,LaGrange,IL 60525
81143	Isolantite.,Stirling,NJ 07980
81312	Winchester.,Oakville,CT 06779
81349	Military Specifications
81350	Joint Army-Navy Specifications
81483	Int'l Rectifier.,El Segundo,CA 90245
81741	Chicago Lock.,Chicago,IL 60641
81831	Filtron.,Flushing,NY 11354
81840	Ledex.,Dayton,OH 45402
81860	Barry Wright.,Watertown,MA 02172
82219	Sylvania.,Emporium,PA 15834
82227	No.Amer.Philips.,Cheshire,CT 06410
82273	IN Pattern & Model.,LaPort,IN 46350
82389	Switchcraft.,Chicago,IL 60630
82567	Reeves Hoffman.,Carlisle,PA 17013
82647	Metals & Controls.,Attleboro,MA 02703
82807	Milwaukee Resistor.,Milwaukee,WI 53204
82877	Rotron.,Woodstock,NY 12498
82901	IN General Magnet.,Valparaiso,IN 46383
83003	Varo.,Garland,TX 75040
83014	Hartwell.,Placentia,CA 92670
83033	Meissner.,Mt Carmel,IL 62863
83058	Carr Fastener.,Cambridge,MA 02142
83186	Victory Eng.,Springfield,NJ 07081
83259	Parker Seal.,Culver City,CA 90231
83330	H.H.Smith.,Brooklyn,NY 11207
83361	Bearing Spclty.,San Francisco,CA
83587	Solar Elctrc.,Warren,PA 16365
83594	Burroughs.,Plainfield,NJ 07061
83740	Union Carbide.,New York,NY 10017
83766	Mass Engrg.,Quincy,MA 02171
83781	National Elctrcs.,Geneva,IL 60134
84411	TRW.,Ogallala,NB 69153
84835	Lehigh Metals.,Cambridge,MA 02140
84970	Sarkes Tarzian.,Bloomington,IN 47401
84971	TA Mfg.,Los Angeles,CA 90039
85604	Kepco.,Flushing,NY 11352
86420	Payson Casters.,Gurnee,IL 60031
86577	Prec Metal Prod.,Stoneham,MA 02180
86684	RCA.,Harrison,NJ 07029
86687	REC.,New Rochelle,NY 10801
86800	Cont Elctrcs.,Brooklyn,NY 11222
88140	Cutler Hammer.,Lincoln,IL 62656
88204	GTE Sylvania.,Ipswitch,MA 01938
88219	Gould Nat Battery.,Trenton,NJ 08607
88419	Cornell Dubilier.,Fuquay Varina,NC 27526
88627	K&G Mfr.,New York,NY
89265	Potter & Brumfield.,Princeton,IN 47671
89482	Holtzer Cabot.,Boston,MA 02119
89665	United Transformer.,Chicago,IL
89870	Berkshire Transformer.,Kent,CT 06757
90201	Mallory Cap.,Indianapolis,IN 46206
90303	Mallory Bat.,Tarrytown,NY 10591
90634	Gulton Inds.,Metuchen,NJ 08840
90750	Westinghouse.,Boston,MA 02118
90952	Hardware Prod.,Reading,PA 19602
91032	Continental Wire.,York,PA 17405
91146	Cannon.,Salem,MA 01970
91210	Gerber.,Mishawaka,IN 46544
91293	Johanson.,Boonton,NJ 07005
91417	Harris.,Melbourne,FL 32901
91506	Augat Bros.,Attleboro,MA 02703
91598	Chandler.,Wethersfield,CT 06109
91637	Dale Elctrcs.,Columbus,NE 68601
91662	Elco.,Willow Grove,PA 19090
91719	General Inst.,Dallas,TX 75220
91836	Kings Elctrcs.,Tuckahoe,NY 11223
91916	Mephisto Tool.,Hudson,NY 12534
91929	Honeywell.,Freeport,IL 61032
92519	Electra Insul.,Woodside,NY 11377
92678	Edgerton Germeshuasen.,Boston,MA 02115
92702	IMC Magnetics.,Westbury,NY 11591
92739	Ampex.,Redwood City,CA 94063
92966	Hudson Lamp.,Kearny,NJ 07032
93332	Sylvania.,Woburn,MA 01801
93346	Amer Elctrcs Labs.,Lansdale,PA 19446
93618	R&C Mfg.,Ramsey,PA 16671
93916	Cramer.,New York,NY 10013
94144	Raytheon.,Quincy,MA 02169
94154	Wagner Elctrc.,Livingston,NJ 07039
94271	Weston.,Archibald,PA 18403
94322	Tel Labs.,Manchester,NH 03102
94589	Dickson.,Chicago,IL 60619
94696	Magnecraft.,Chicago,IL 60630
94800	Atlas Ind.,Brookline,NH 03033
95076	Garde.,Cumberland,RI 02864
95121	Quality Comp.,St Marys,PA 15857
95146	Alco Elctrcs.,Lawrence,MA 01843
95238	Continental Conn.,Woodside,NY 11377
95275	Vitramon.,Bridgeport,CT 06601
95348	Gordos.,Bloomfield,NJ 07003
95354	Methode.,Rolling Meadow,IL 60008
95794	Amer Brass.,Torrington,CT 06790
95987	Weckesser.,Chicago,IL 60646
96095	Aerovox Hi Q.,Olean,NY 14760
96341	Microwave Assoc.,Burlington,MA 01801
96906	Military Standards
97918	Linemaster Switch.,Woodstock,CT 06281
98291	Sealectro.,Mamaroneck,NY 10544
98474	Compar.,Burlingame,CA 94010
98821	North Hills.,Glen Cove,NY 11542
99017	Protective Closures.,Buffalo,NY 14207
99117	Metavac.,Flushing,NY 11358
99313	Varian.,Palo Alto,CA 94303
99378	Atlee.,Winchester,MA 01890
99800	Delevan;E.Aurora,NY 14052
99934	Renbrandt.,Boston,MA 02118
99942	Centralab.,Milwaukee,WI 53201

Weatherproof Microphone-Section 8

8.1 PURPOSE.

The 1945-9730 Weatherproof Microphone System provides uniform performance characteristics, combined with rugged dependability, under adverse weather conditions. For instance, operating this system under conditions of 50°C and 99% RH for a period of two weeks will not affect performance.

This Weatherproof Microphone System is particularly well suited for use with GR 1945 Community Noise Analyzer Systems. It performs equally well in high humidity and under very dry conditions.

8.2 GENERAL DESCRIPTION.

The 1945-9730 as shown in Figure 8-1, is a complete weatherproof microphone system for outdoor noise monitoring. It is designed to protect its integral 1560-P42 Preamplifier and a microphone (not included) in an outdoor environment. The windscreen system protects the microphone from damage and reduces the effect of wind on the noise measurement.

Each operating 1945-9730 system consists of two functional units, the microphone/preamplifier assembly (See Figure 8-2) with its weatherproof housing and the mast (See Figure 8-3) with mounting hardware. All components are listed in Table 8-1. The microphone is not supplied but may be selected from those listed in Table 8-2.

8.2.1 Microphone/Preamplifier and Weatherproof Housing.

Refer to Figure 8-2 for a cutaway drawing that shows all of the components. The outer cover is a boot made of vinyl material. It is held in place by a reusable plastic fastener which is easily removed and reattached.

The protective metal shield (perforated) is threaded and fits securely on the housing assembly. The spike is inserted into the threaded spike holder atop this shield.

O-rings are used at both ends of the adaptor to ensure a waterproof seal. The microphone selected determines the particular adaptor to be used. Only the 1-in. (23.81 mm) microphones require adaptors.

The preamplifier and desiccant cartridge can be easily removed for inspection. Step-by-step procedures for assembly and disassembly appear in Para. 8.4.5.

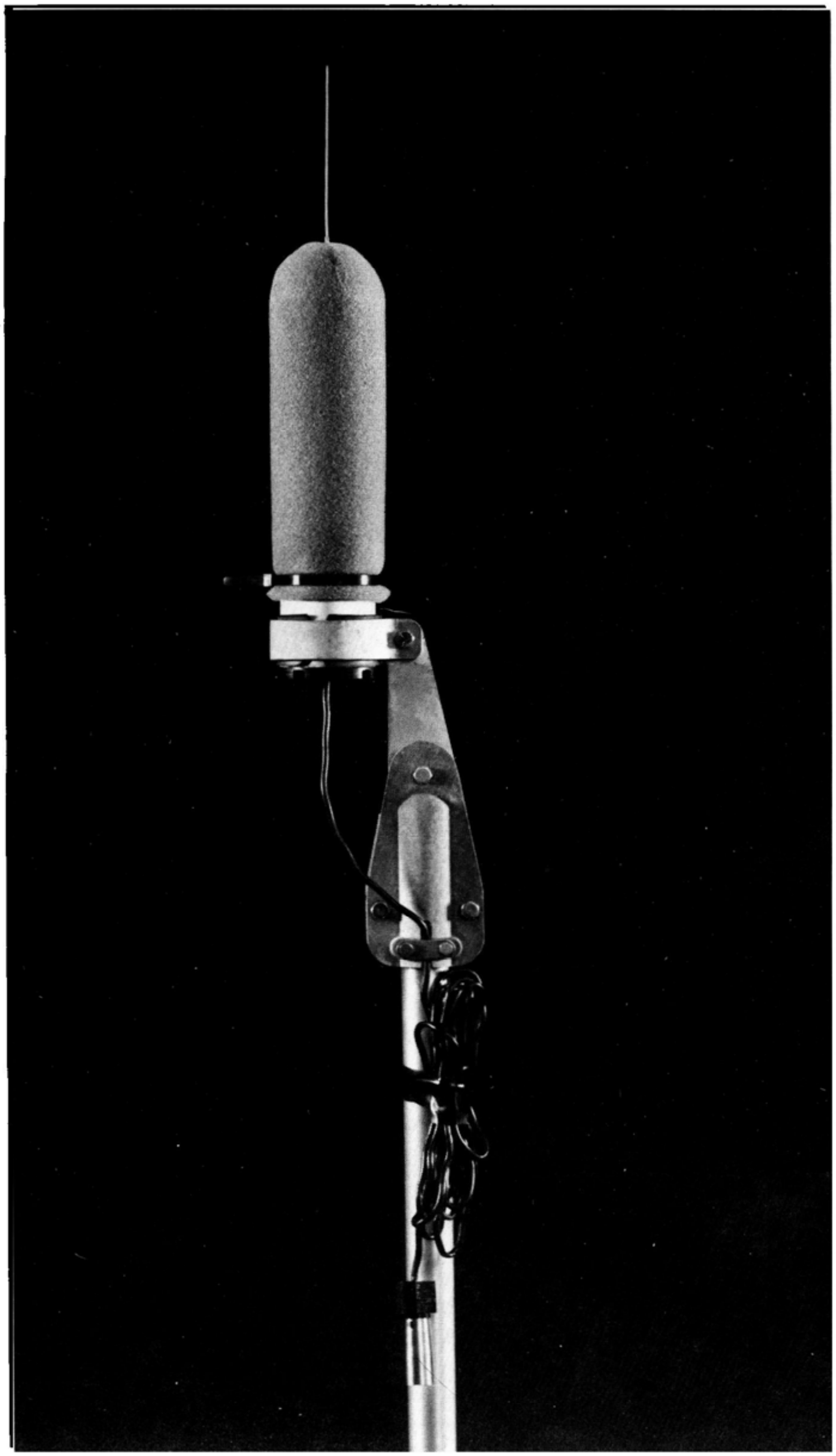
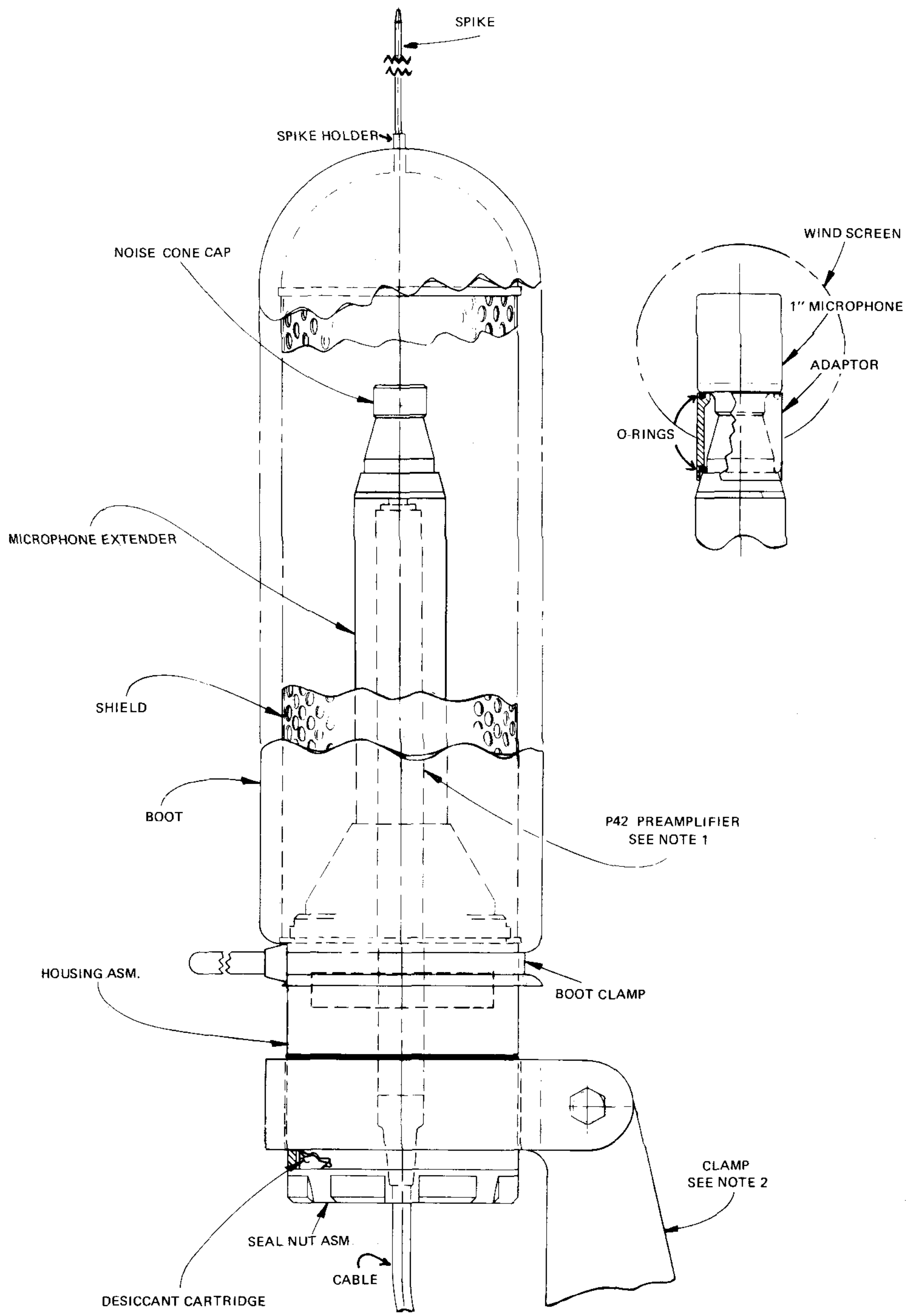


Figure 8-1. Weatherproof Microphone 1945-9730.

GenRad Microphones and Accessories.max



NOTES

1. P42 PREAMPLIFIER SWITCHES TO BE IN "X1" and OFF POSITIONS WHEN USED WITH THE 1945 COMMUNITY NOISE ANALYZER SYSTEM
2. MAST CLAMPS WILL ACCOMODATE TUBING FROM 1 IN. TO 2 IN. DIA. (MAST CLAMPS NOT SHOWN)

Figure 8-2. Microphone and Weatherproof Housing Assembly.

8.2.2 Mast with Mounting Hardware

Figure 8-1 illustrates the mast, with mounting hardware in position to hold the microphone assembly atop the supporting mast. Two cap screws (See Figure 8-3) are used to secure the assembly to the mast (supplied). Two longer cap screws are supplied for use with a 2-in. (50 mm) mast (not supplied).

The system is shipped with a 1 1/4-in. (32 mm) mast. For other needs it is recommended that the user obtain standard TV-type masts and associated hardware. The shorter screws will accommodate 1-1 5/8-in. (25-42 mm) diameter masts and the longer screws 1 1/2-2-in. (40-50 mm) diameter masts.

The microphone can be operated in any of three fixed positions: perpendicular to the horizon, parallel to the horizon, and at a 45° angle. A free standing tripod is available (P/N 1560-9590).

Vertical is normally the operating mode for the randomly incident sound field to be expected in the community environment. A random incidence microphone is recommended.

The output cable can be attached to the supporting bracket by the cable clamp. The bracket assembly is made of heavy-duty cast aluminum that should withstand any climatic conditions likely to be encountered. The 5-ft. mast (supplied) is constructed of heavy-gauge galvanized steel with a resin coating.

8.3 ACCESSORIES.

The following tables list the accessories supplied and the accessories available.

Table 8-1
ACCESSORIES SUPPLIED

Description	GR Catalog No.
Adaptor (short), to 1-in. (23.81 mm) Ceramic Microphone	1945-6210
Adaptor (long), to 1-in. (23.81 mm) Electret Microphone	1945-6340
Adaptor, to Tripod Mount	1945-6280
Boot (2 supplied)	1945-7210
Desiccant Cartridge	1945-9600
Instruction Manual	1961-0100
Mast Assembly	1945-1540
O-rings	5855-6750
Windscreen, for 1-in. (23.81 mm) microphone	1560-7552
Windscreen, for 1/2-in. (12.70 mm) microphone	1560-7553
Cap screws, 2, for up to 2-in. (50 mm) mast	7110-0300

Table 8-2.
ACCESSORIES AVAILABLE

Description	GR Catalog No.
Microphones:	
Electret-condenser, 1 in., (23.81 mm) random incidence	1961-9601
Electret-condenser, 1 in., (23.81 mm) perpendicular incidence	1961-9602
Electret-condenser, 1/2 in. (12.70 mm) random incidence	1962-9601
Electret-condenser, 1/2 in. (12.70 mm) perpendicular incidence	1962-9602
Ceramic, 1 in. (23.81 mm)	1971-9601
Windscreen Replacement Kit	1945-9650
Desiccant Kit	1945-9600
Extension cable, 60 ft (18.5 m)*	1933-9601

*Extension cables of various lengths are available to fit several types of connectors.

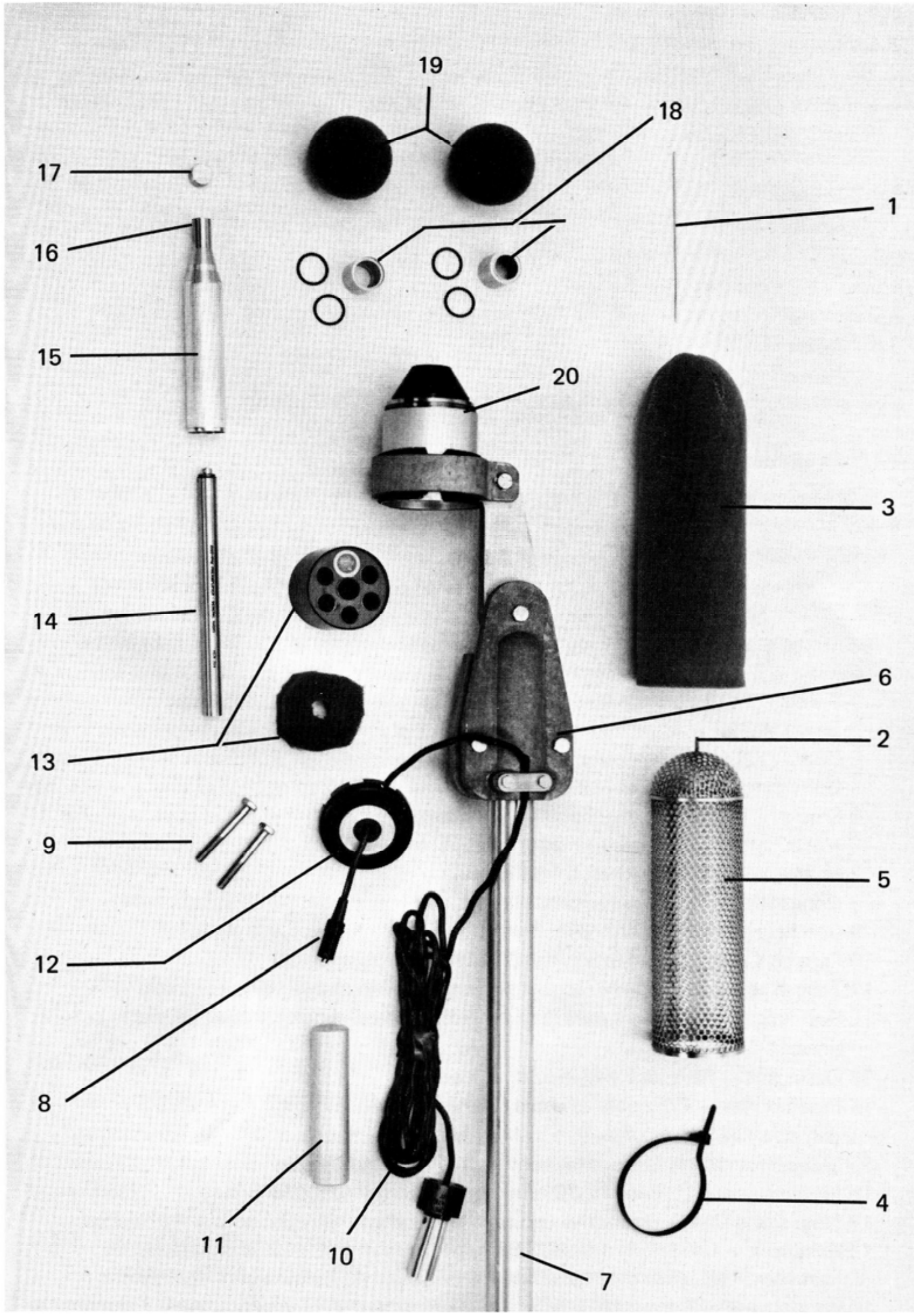


Figure 8-3. System Components.

8.4 PREPARATION FOR USE.

8.4.1 Inspection.

Although your 1945-9730 was carefully tested, inspected and packed for shipping, it is a good practice to examine the outside of the container for any signs of damage. Notify your carrier of any damage.

8.4.2 Unpacking.

Carefully remove your 1945-9730 from its shipping container. If any component appears to have suffered mechanical damage, notify the carrier immediately so that a proper claim can be made. Be certain to save all packing material so that the claim adjuster can inspect it as well. As soon as the carrier has completed the inspection, notify your GR Representative.

If the system must be returned, repack it carefully in the original container if possible and return it prepaid to the factory for necessary adjustments.

8.4.3 Equipment Supplied.

Check that all equipment and accessories ordered were received in good condition. If any accessories are missing, your GR Representative or the factory should be notified immediately.

8.4.4 System Components.

All items are illustrated in Figure 8-3. The numbers refer to the identifiers in the figure.

1 Spike – To discourage birds
2 Spike Holder – Threaded to accept spike
3 Boot – External windscreen
4 Boot Clamp – Secures boot to Housing Assembly
5 Shield – Protects microphone and preamplifier
6 Mast Clamp – attaches to mast (1 1/4-in. mast shown)
7 Mast – mast 1 1/4 inches, 5 feet long
8 Connector – Keyed preamplifier connector
9 Cap Screws – Used with 2-in. mast
10 Output Cable – Connects preamplifier output to analyzer
11 Tripod adaptor – Permits use of the system with the GR Tripod (1560-9590).
12 Seal Nut Assembly – Keeps desiccant cartridge and output cable properly positioned
13 Desiccant – Cartridge and insulating pad
14 Preamplifier – Connects to cable (10) and indirectly to microphone (17), described in Section 4
15 Microphone Extender – Houses the preamplifier and connects to microphone
16 Microphone – (1/2-in. 12.70 mm) threads to microphone extender
17 Nose Cone Cap – Protective cap used only when microphone is not attached
18 Adaptors – Used with 1-in. (23.81 mm) ceramic and electret microphones (not identical). Use short adaptor for ceramic and long adaptor for electret.
19 Windscreen – One each for 1-in. (23.81 mm) and 1/2-in. (12.70 mm) microphones
20 Housing Assembly – Encloses the desiccant cartridge and attaches to microphone extender

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8.4.5 System Assembly.

a. Identify all components of the system before beginning the assembly procedure. Arrange parts in somewhat the same order as that shown in Figure 8-3. Refer also to Figures 8-1 and 8-2. The numbers in parentheses refer to the identifiers in Figure 8-3.

b. Select the output cable (10). Insert the smaller cable connector through the seal nut assembly (12), the desiccant cartridge and insulating pad (13). Attach connector (8) to preamplifier (14); observe positioning key on connector and preamplifier. On some models the insulating pad is attached to the housing assembly.

c. Set the 1560-P42 Preamplifier gain and polarizing voltage as required. Set 200 V switch OFF for all GR microphones. Set to ON position when used with air-condenser microphones. Unity gain (X1) is used with the 1945 system.

d. Hold housing assembly (20) in one hand and insert the preamplifier (14) into the large end of the housing.

e. Turn the microphone extender upside down to let the center pin drop down. Push the preamplifier (14) forward and thread into microphone extender (15). Thread other end of extender into housing assembly (20). The center pin should protrude about 1/8-in. (3 mm) from the extender.

f. Fit insulating pad (if not attached) and desiccant cartridge (13) into the housing assembly (20) and secure with the threaded seal-nut assembly (12).

g. At the base of the housing (20) pull the cable gently to make a good seal.

h. Thread the protective cap (17) or a 1/2-in. microphone (16) to the connector on the microphone extender (15). The 1/2-in. (12.70 mm) microphone does not require an adaptor.

i. If a 1-in. (23.81 mm) microphone is to be used, install the appropriate adaptor (18) with 0-rings before installing microphone. (Refer to para. 8.8)

j. Install proper size windscreen (19).

k. Thread shield (5) to housing assembly (20). Pull on boot (3) and secure with boot clamp (4). Thread spike (1) into spike holder (2).

l. Secure output cable (10) to bracket (6) with cable clamp as shown.

8.4.6 Disassembly.

This procedure is primarily the reverse of the assembly procedure. Refer to Figures 8-2 and 8-3 and para. 8.4.5.

CAUTION

Routine maintenance procedures must be performed before the system can be used effectively.

8.5 OPERATION.

8.5.1 Microphone Placement and Orientation.

The placement and orientation of microphones is entirely dependent upon the task to be performed. The directional patterns shown should make this task somewhat less complicated.

8.5.2 Typical Directional Patterns.

Typical directional patterns for the electret-condenser microphones at various frequencies are shown in Figures 8-4 through 8-7. The 1-in. microphones are essentially omnidirectional within about 3 dB to 2 kHz and within 4 dB to 6 kHz for the 1/2-in. (12.70 mm) microphone.

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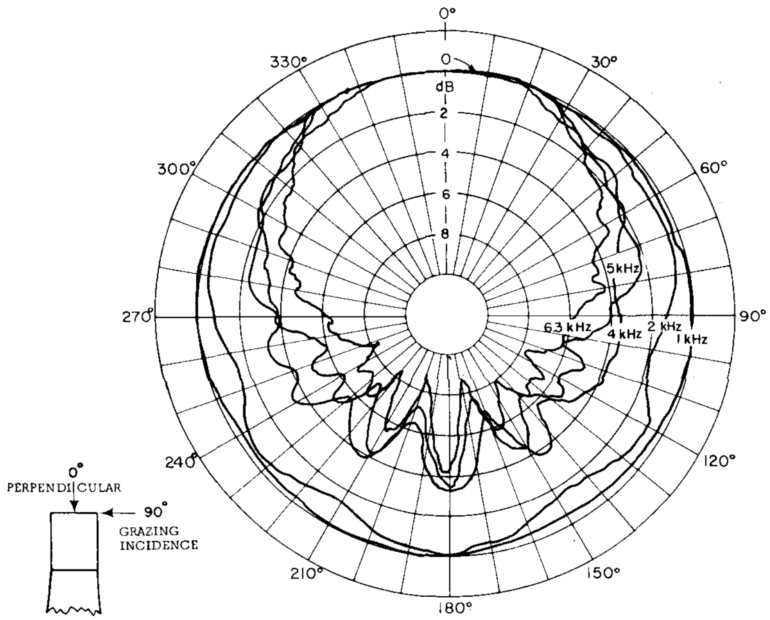

Figure 8-4. Typical directional response patterns for the weather-proof microphone assembly with 1-in. microphone (lower frequencies).

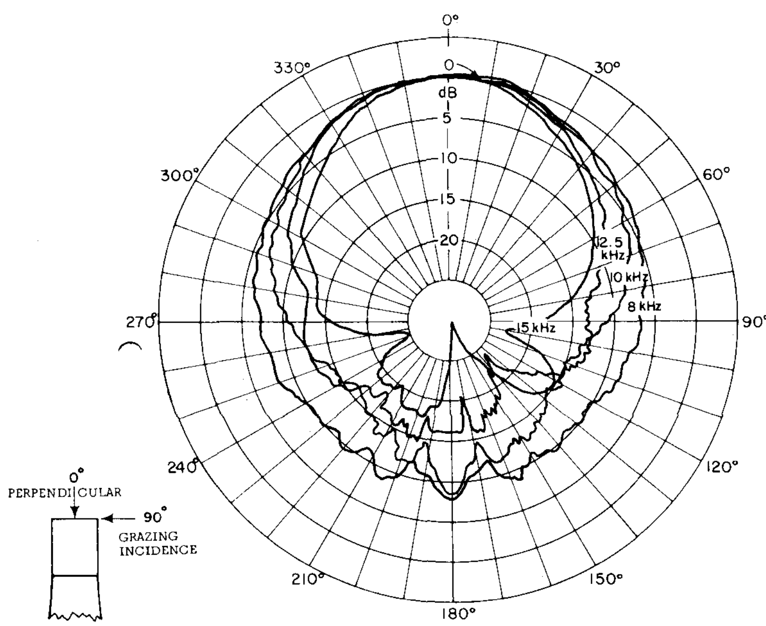

Figure 8-5. Typical directional response patterns for the weather-proof microphone assembly with 1-in. microphone (higher frequencies).

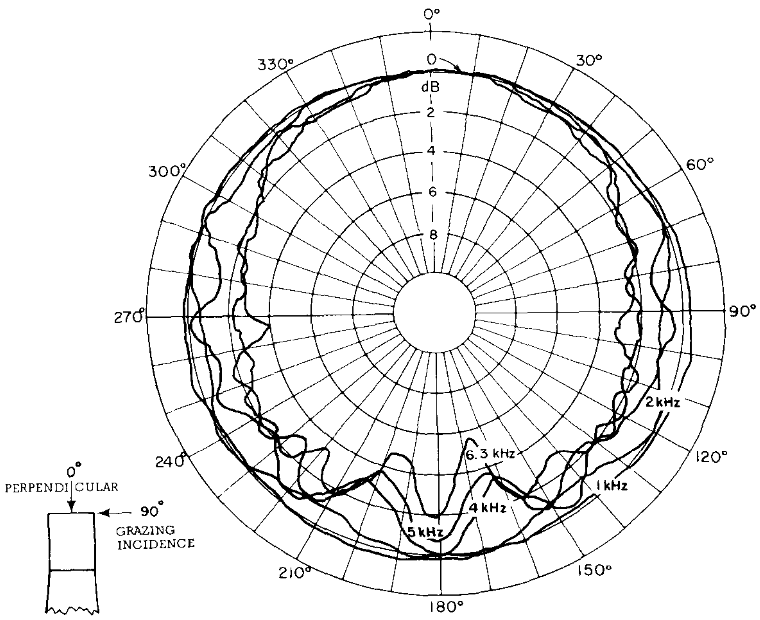

Figure 8-6. Typical directional response patterns for the weatherproof microphone assembly with ½-in. microphone (lower frequencies).

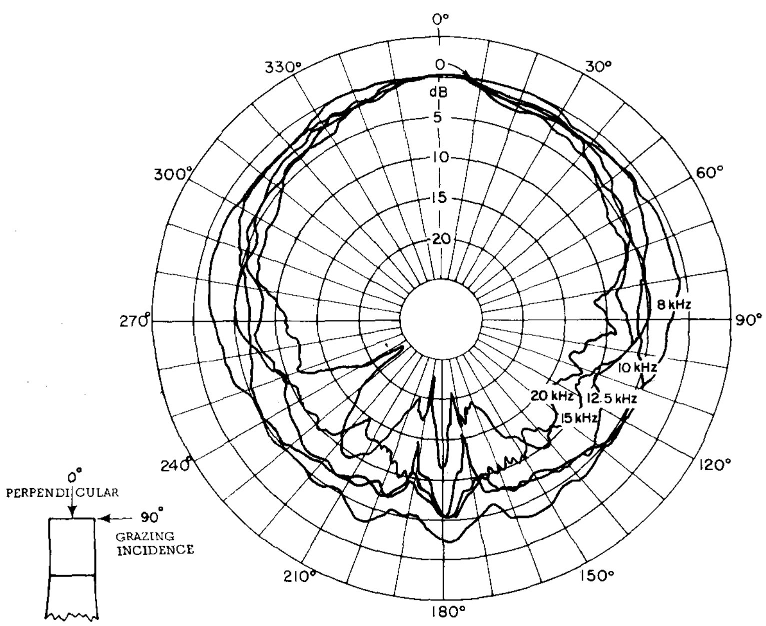

Figure 8-7. Typical directional response patterns for the weatherproof microphone assembly with ½-in. microphone (higher frequencies).

8.6 ROUTINE MAINTENANCE.

This weatherproof Microphone System requires virtually no routine maintenance except the occasional inspection of the desiccant cartridge and system calibration.

8.6.1 Desiccant.

The desiccant cartridge helps to keep the system dry by absorbing moisture. This cartridge should be inspected periodically, as dictated by weather conditions. In dry climates an inspection need not be made more frequently than twice a year, however, in a humid climate, an inspection may be required as often as once each month.

A blue color in the cartridge window indicates a satisfactory condition. When the desiccant color turns pink, it has absorbed a maximum amount of moisture and must be removed.

The desiccant can be rejuvinated by baking the cartridge in an oven at 50°C (122°F) until it turns blue. This process can take as long as 48 hours.

CAUTION

Oven temperatures of 75°C (167°F) and above can cause softening and deformation of desiccant cartridge.

8.6.2 Inspection of Desiccant Cartridge.

a. Simply grasp the housing assembly (near boot clamp) with one hand and unscrew the base. This exposes the cartridge.

b. Observe that the desiccant, which can be seen through the clear plastic inspection window, is basically blue in color. A pink color indicates that the desiccant is saturated with moisture and is no longer effective. This should be replaced or rejuvinated as detailed in para. 8.6.1.

8.6.3 Calibration Procedures.

This procedure should be performed during initial installation and whenever it is suspected that the system may not be operating at peak efficiency.

Many users, however, routinely calibrate before and after every measurement.

a. This system should be calibrated to a sound-level meter or analyzer, using accepted acoustic calibration procedures and a sound-level calibrator (GR Type 1562 or equivalent).

b. Before the 1562 calibrator can be placed on the system microphone, the boot, the perforated shield, and the windscreen must be removed. The selected microphone must be attached to the preamplifier and the preamplifier GAIN and polarizing voltage switches must be set to accommodate the levels being measured. Refer to para. 4.2.4 for a detailed description of preamplifier adjustments.

c. Adjust the microphone sensitivity of the analyzer (to which the microphone is connected) for an indication which corresponds to the output level from the calibrators (114 dB for GR 1562).

d. Acoustic calibration should be performed to verify that the system is operating properly. Refer to analyzer instructions for additional details.

8.6.4 Typical System Calibration Procedure.

A typical analyzer-microphone combination (GR 1945 Community Noise Analyzer) calibration procedure is presented here for reference purposes only.

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Turn on the 1945 Analyzer and proceed:

a. Set the MIC/AUX switch to MIC and WEIGHTING to FLAT.

b. Press the DISPLAY LEVEL button.

c. Using a GR 1562 or 1567 Sound-Level Calibrator, supply the microphone with 1-kHz sound as described in the calibrator instruction manual.

d. Determine whether the calibrating level should be nominal (114 dB) or, perhaps, a small correction is required for temperature or atmospheric pressure. (Refer to the calibrator instruction manual.)

e. Set the 1945 CAL adjustment, using the screwdriver supplied, for the corresponding DISPLAY reading.

f. Remove the calibrator and press DISPLAY OFF.

The complete 1945 Community Noise Analyzer System is described in GR publication 1945-0100.

8.7 SERVICE NOTES AND PARTS LIST.

Whenever trouble is suspected with an analyzer system using the weatherproof microphone, an operation check should be performed to ensure that the analyzer is operating properly. Reference to the analyzer instruction manual should provide the information needed to verify performance.

After it has been determined that the microphone system is at fault, reference should be made to Section 4. This section deals with the 1560-P42 preamplifier, the heart of the Weatherproof Microphone System.

When the trouble is with the microphone itself, an instrument calibration check should be performed with another microphone (preferably one known to be operating properly).

If replacement or repair of the microphone is indicated, contact your nearest GR repair facility.

This section (front) also provides a complete parts list of replaceable components of the microphone system.

8.8 WEATHER SEAL

If the 1-in. microphone is a ceramic unit, a seal is needed to exclude moisture from the interior of the microphone-extender/preamplifier assembly.

Check to see if the base adaptor has a .040-in. dia. hole drilled through it near the center terminal. If not, then this hole must be drilled before proceeding with the next step. (Remove microphone from adaptor before drilling).

To seal interface between the microphone and adaptor, free the lock-screws and separate the units, without disconnecting the leads. Apply a continuous bead of silicone sealant (Silastic 731 RTV or equivalent) around the adaptor flange as shown. Reassemble adaptor to microphone and secure lock-screws. Wipe off sealant that has squeezed out of joint. Apply sealant over lock screws and let cure per instructions for sealant.

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1945-9730 Weatherproof Microphone System
PARTS LIST

Weatherproof Housing Assembly 1945-3210

Item	Part No.
Shield Assembly	1945-1560
Clamp, Housing Assembly	1945-1500
Seal Nut Asm	1945-1220
Microphone Extender Asm	1945-2000
Housing Asm	1945-2010
Clamp, Mast	1945-5011
Clamp, Mast (w/cable clamp holes)	1945-5021
Nose Cone Cap	1981-6060
Pad, Foam	1945-7220
Cable Clamp	1945-8560
Spike	1945-6290
Clamp, Insulated	4320-1200
Screw Cap 0.190-32, 0.500 SS (2 required)	7110-1899
Screw Cap 0.250-28, 0.750	7110-0175
Screw Cap 0.250-28, 1.000	7110-0210
Screw Cap 0.250-28, 2.000 (2 required)	7110-0300
Assembly, Mast	1945-1540
Adaptor 1-in. Cer.	1945-6210
Adaptor Tripod	1945-6280
Adaptor 1-in. Elect.	1945-6340
"0" Rings, 0.875 x 0.750 x .062 (4 required)	5855-6750
Preamplifier, Complete (Detailed parts information can be found elsewhere in the publication.)	1560-9642

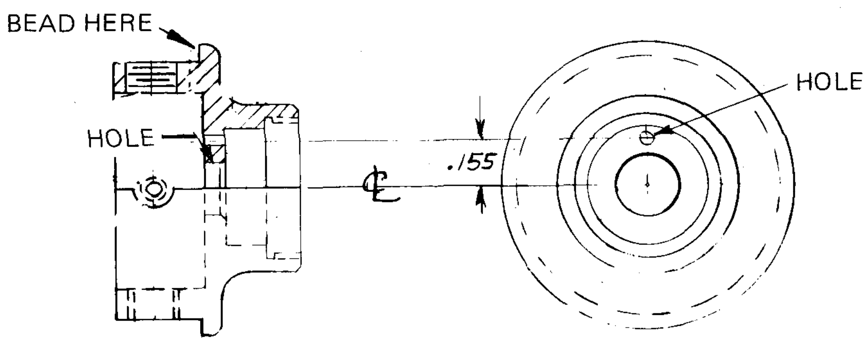

Figure 8-8. Weather Seal Adaptor detail.

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Printed in U.S.A.

300 Baker Avenue, Concord, MA 01742