THE GENERAL RADIO
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A COMPACT, INEXPENSIVE SOUND-LEVEL METER

TYPE 1565-A
SOUND-LEVEL METER

Basic sound-measuring instruments have generally fallen into two easily distinguishable classes. One class included sound-survey meters (or sound meters), whose size and price were right but which couldn't pass muster as approved (i.e., by recognized standards) arbiters of sound level. In the other class were the sound-level meters, which carried the credentials specified by the standards but whose pedigrees came at a price. Also, although smaller than breadboxes, most sound-level meters were unmistakably in the two-hands class. Faced with a choice between the two types, many would-be sound measurers were forced by a tight budget to settle for second best.

A combination of recent developments now gives us the TYPE 1565-A Sound-Level Meter, which is a bona fide *sound-level meter* but whose dimensions and price are more like those of a sound-survey meter. The new sound-level

ALSO IN THIS ISSUE

meter snuggles easily into the palm of your hand partly through the use of all-solid-state circuitry, partly through an ingeniously designed package that includes a new GR-made ceramic microphone. The instrument weighs just 1¾ pounds and runs for 35 hours on a single C battery.

DESCRIPTION

Packaging

The aluminum-and-plastic case of the new sound-level meter is tapered at the microphone end to minimize the effect of diffraction. Two knobs are prominent on the front panel. The right-hand knob indicates sound-level range; the left-hand knob selects weighting and meter speed and allows the battery to be checked. The output jack, which takes a standard telephone plug, is in the lower left-hand corner of the panel. A threaded insert in the bottom of the case can be used for tripod mounting. A carrying cord (supplied) can also be fastened to this insert.

Microphone

General Radio's new lead-zirconate-titanate ceramic microphone was developed as a measurement-grade microphone. With a diameter of 0.936 inch, it fits in any fixture designed to accept the current industry-standard Western Electric 640-AA Condenser Microphone. A typical free-field frequency-response curve for the new microphone is shown in Figure 2. The meter can be pressure-calibrated at 400 c/s by means of the TYPE 1552-B Sound-Level Calibrator or at any frequency from 20 to 2000 c/s with the TYPE 1559-B Microphone Reciprocity Calibrator.

Figure 1. Case and controls are designed for one-hand operation.

Circuit

The all-solid-state circuit (see Figure 3) uses a total of seven transistors in

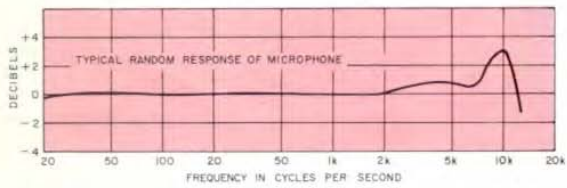

Figure 2. A typical free-field frequency-response curve for the new General Radio Microphone.

CONTENTS OF THIS ISSUE

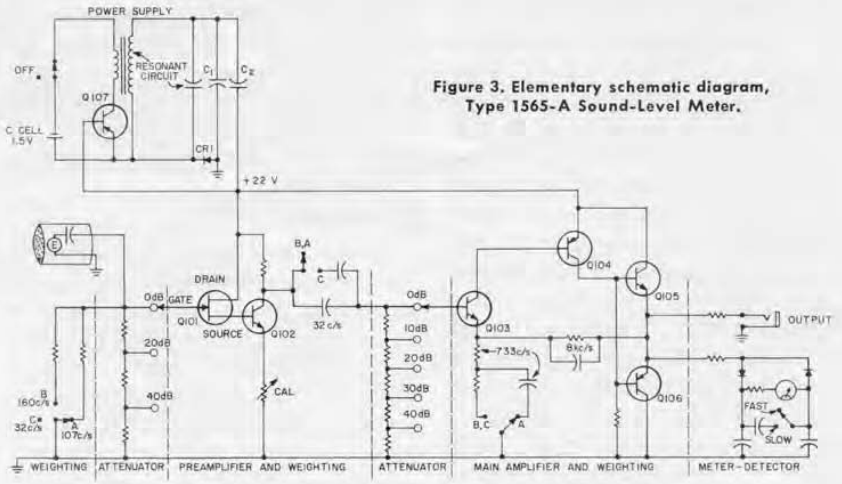

Figure 3. Elementary schematic diagram, Type 1565-A Sound-Level Meter.

two amplifier stages and a power supply.

Transistors *Q101* and *Q102* comprise the preamplifier. *Q101* is a special N-channel field-effect transistor, operating as a "source follower." The gain of the second transistor (*Q102*) can be adjusted by means of a panel screwdriver control to calibrate the instrument. The main amplifier uses four transistors, including a complementary pair (*Q105* and *Q106*) at the output. Feedback is applied to the emitter of transistor *Q103* to stabilize voltage gain. This amplifier drives both the meter-detector circuit and the output terminals.

The attenuator is separated into two sections for best signal-to-noise ratio. One section is located directly at the input and the other between the amplifier stages. The panel control, calibrated from 50 to 130 dB, adjusts attenuation in 10-dB steps.

Each coupling and feedback path in the TYPE 1565-A Sound-Level Meter serves double duty to form a part of the weighting network. To achieve the A-weighting characteristic, for example, the feedback network in the main amplifier provides 6-dB/octave roll-off at both 733 c/s and 8 kc/s. The coupling network between the preamplifier and the main amplifier adds roll-off starting at 32 c/s, and the combination of the input resistance of the instrument and the microphone capacitance yields an additional 6-dB/octave slope starting at 107 c/s.

Since the equivalent microphone capacitance serves as part of the weighting network, the spectrum is partly weighted before it is introduced to the preamplifier. Therefore, the likelihood of amplifier overload is reduced. Source capacitance cannot be changed, however, without affecting the weighting characteristic.

Power Supply

The unique power supply includes a simple dc-to-dc converter to permit

operation from a single 1.5-volt C cell. The circuit is basically a tuned, self-biased, class-C oscillator, operating at a frequency of 130 kc/s. The ac output voltage from the transformer is applied to a full-wave voltage-doubler rectifier consisting of diode *CR1*, the transistor base-emitter junction, and the capacitors *C1* and *C2*. Half of the dc output voltage biases the transistor in the cut-off region, affording the desired class-C operation with a conversion efficiency of about 70 percent. The high efficiency of power supply and amplifier makes possible a battery life of 35 hours, and it is therefore unnecessary to turn the instrument on and off during a series of measurements to conserve the battery.

STANDARDS FOR A SOUND-LEVEL METER

The American[1] and International[2] standards on sound-level meters are written to ensure that measurements made with sound-level meters of various makes and models will be accurate and will agree closely with one another. The American standard specifies seven basic characteristics for a sound-level meter (the International standard is similar). These involve weighting, directionality, crest-factor capacity, attenuator accuracy, detector characteristic, dynamic characteristic of the meter, and internal noise level.

Weighting

Three frequency-response curves, called A, B, and C weighting, are specified. In general, a 1-dB deviation from these weighting curves is allowed for frequencies below 1 kc/s. The tolerance broadens somewhat at high frequencies, where microphone behavior is difficult to control. A meter that does not comply with this specification will yield erroneous readings when presented with an acoustic spectrum much of whose energy is concentrated in the range where the weighting deviates from standard.

Directionality

A sound-level meter, to conform to the American standard, must be equally responsive, within specified limits, to sound waves arriving from all directions. A directional sound-level meter could, of course, be supplied with orientation and calibration data so that, for a given incidence, accurate results could be obtained. But the user might not, for a variety of reasons, be able to duplicate the calibration conditions. The only sure solution to this problem is a true sound-level meter — one whose response does not vary appreciably with incidence.

Crest Factor Capacity

A sound-level meter is designed to measure the rms level of the variation in atmospheric pressure, which is called sound. The peak amplitudes of some sounds are very much greater than their rms amplitudes. Electronic circuits used in a sound-level meter must be able to pass signals whose crest factor (ratio of peak amplitude to rms amplitude) is as high as 13 dB. Obviously, a signal that is distorted by an amplifier of insufficient crest-factor capacity will not produce a correct meter indication.

Attenuator Accuracy

To satisfy both the American and the International standards, the attenuator used in a sound-level meter must be accurate within ±1 dB at all frequencies in its range. The importance of attenuator accuracy is evident,

[1] ASA S1.4-1961.
[2] IEC Publication 123, 1961.

since the attenuator setting figures directly in the instrument readout.

Detector Characteristic

The detector response must be essentially rms to satisfy several requirements of the standards. Average-response detectors, used in survey meters, yield significant errors when subjected to any waveform other than a simple sinusoid.

Dynamic Characteristic of Meter

The rise time and overshoot of the panel meter are specified for two speeds designated "fast" and "slow." (Both speeds are available in the new sound-level meter.) The "fast" speed allows a short-time average level of a signal to be observed. The "slow" speed gives a long-time average indication and is used when fast-speed fluctuations exceed 3 or 4 dB.

Internal Noise Level

An important requirement for a sound-level meter whose output is to drive an analyzer or other apparatus is low internal noise. In this respect, as indeed in all the above respects, the TYPE 1565-A meets or exceeds the specifications given in the American and International standards.

USES

A sound-level meter is the basic sound-measuring instrument. Almost any noise study begins with elementary sound-level measurements to determine what further investigation will be needed. Industrial and governmental test codes specify test limits and procedures for making sound-level measurements.

The A-weighted sound level is becoming increasingly popular as a measure of the disturbing effect of noise on people. Young[3] has recently shown that subjective ratings of office noise are as well correlated with A-weighted sound level as with other previously used, but more complicated, measures of office noise. Traffic noise laws[4] are now enforced in many cities with the aid of sound-level meters, usually set to indicate A-weighted sound level.

A sound-level meter is useful not only for noise acceptance tests with a single weighting network but also, when measurements are made with all three weighting networks, for determining the approximate shape of a spectrum. A method[5] of determining approximate spectrum shape from sound-level measurements is given in the General Radio *Handbook of Noise Measurement*.*

Sound-level meters are used by industrial hygienists to help ensure personal comfort and safety in factories and to detect conditions that might result in hearing loss. Hearing and speech research is conducted by psychologists with the aid of sound-level meters. Engineers concerned with the quiet and normal operation of machinery use the sound-level meter as a basic tool. Sound-level measurements are made by architects and musicians to ensure best production of music, by police and other officials to detect unacceptable levels of neighborhood and traffic noise, and on board naval vessels to help maintain quiet operation and thus avoid detection.

AUXILIARY EQUIPMENT

The TYPE 1565-A Sound-Level Meter was designed primarily for convenient

[3] R. W. Young, *Journal of the Acoustical Society of America*, Vol. 36, pp. 289–295 (1964).
[4] D. P. Loye, *Noise Control*, Vol. 5, pp. 230–235, July, 1959.
*Available from General Radio Company at $1.00 per copy, postpaid.

Figure 4. Sound-Level Meter with Type 1560-P52 Vibration Pickup.

operation and low cost, and the Type 1551-C Sound-Level Meter[6], with its greater versatility, will undoubtedly continue to be the recognized standard for all types of sound measurements. For the many applications that do not require the greater sensitivity, additional 20-kilocycle (flat frequency response) weighting, or lower distortion of the Type 1551-C, the new sound-level meter will provide performance comparable to that of the larger instrument. On the other hand, where a sound-level meter is required as a preamplifier for a narrow frequency analyzer or is to be used with a variety of transducers and other accessories, the Type 1551-C is the better choice.

[5] The method was developed by J. R. Cox, Jr.
[6] E. E. Gross, "Improved Performance Plus a New Look for the Sound-Level Meter," *General Radio Experimenter*, 32, 17, October, 1958.
E. E. Gross, "Type 1551-C Sound-Level Meter," *General Radio Experimenter*, 35, 8, August, 1961.

Use with Analyzers

The Type 1565-A Sound-Level Meter can be used to drive the Type 1556-B Impact-Noise Analyzer to determine the peak amplitude and time duration of impact sounds. It can also be used to drive an octave-band filter set for frequency analysis. However, owing to its higher distortion, it is not recommended for use with analyzers having bandwidths narrower than one octave.

Use as Vibration Meter

Figure 4 shows the Type 1565-A fitted with a Type 1560-P96 Adaptor and a Type 1560-P52 Vibration Pickup. The high capacitance of this pickup provides a low-frequency response extending to less than 20 c/s. The upper frequency limit, determined by the pickup, is 1 kc/s.* Acceleration levels from 0.0005 to 30 g can be measured.

The remarkably good performance obtained in such a compact, low-cost instrument brings to sound-level measurements a new order of convenience and expands the range of application of true sound-level measurements.

— W. R. Kundert

CREDITS

The writer acknowledges the work of G. E. Neagle, who was responsible for the mechanical design and packaging of the meter.

The microphone was designed by B. B. Bauer and A. L. Di Mattia of the CBS Laboratories and developed for production by B. A. Bonk of General Radio.

SPECIFICATIONS

Sound-Level Range: 44 to 140 dB (re 0.0002 μbar).

Weighting: A, B, and C weighting in accordance with American Standard ASA S1.4-1961 and IEC Publication 123, 1961.

Microphone: Lead-zirconate-titanate ceramic unit.

Output: At least 1.5 V behind 20 kΩ when meter reads full scale. Output is intended primarily for driving a Type 1556-B Impact-Noise Analyzer, a graphic level recorder, or headphones. Harmonic distortion, 2% or less for frequencies above 200 c/s and 5% or less for frequencies below 200 c/s (panel meter at full scale).

Meter: Rms response, and fast and slow meter speeds, in accordance with ASA S1.4-1961 and IEC Publication 123, 1961.

Auxiliary Input Provision: A Type 1560-P96 Adaptor is available to allow connection to any

6 + with 'special' 1560-P96 adaptor with built-in compensation — up to 2kc with approx. 1dB error

source fitted with a male 3-terminal microphone connector. Input impedance is approximately 13 MΩ in parallel with 25 pF. For correct weighting, source impedance must be 380 pF ± 5%.

Power Supply: One 1½-V size C flashlight cell. Battery life approximately 35 hours for 2 h/day service.

Environmental Effects:

Operating Temperature Range: 0 to 50°C.

Storage Temperature Range: —20 to +70°C (battery removed).

Operating Humidity Range: 0 to 90% RH.

Temperature Coefficient of Sensitivity: +0.03 dB/°C.

Sensitivity to Magnetic Fields: Equivalent C-weighted sound level of a 1-oersted (80 A/m) 60-cycle field is about 47 dB when meter is oriented for maximum meter indication.

Calibration: Sound-level meter can be pressure calibrated at 400 c/s with a TYPE 1552-B Sound-Level Calibrator or at any frequency in the range from 20 to 2000 c/s with a TYPE 1559-B Microphone Reciprocity Calibrator.

Accessories Available: TYPE 1565-P1 Leather Carrying Case. TYPE 1560-P96 Adaptor to adapt input to mate with 3-terminal male microphone connector necessary for connection to vibration pickup. TYPE 1560-P95 Adaptor Cable to connect output to TYPE 1521-B Graphic Level Recorder or other devices fitted with jack-top binding posts on ¾-in centers.

Dimensions: Width 3⅛, height 7⅜, depth 2⅛ inches (78 by 190 by 54 mm), over-all.

Net Weight: 1¾ pounds (0.8 kg).

Shipping Weight: 5 pounds (2.3 kg).

Type		*Price*
1565-A	Sound-Level Meter	$240.00
1565-P1	Leather Carrying Case	15.00
1560-P95	Adaptor Cable	3.00
1560-P96	Adaptor to 3-terminal male microphone connector	11.00

NEW METERED VARIAC® AUTOTRANSFORMERS

The latest additions to our line of metered Variac® autotransformers are two 20-ampere units with built-in voltmeters and ammeters: the TYPE W20MT3A, for 120-volt inputs, and the TYPE W20HMT3A, for 240-volt service. Metered Variac assemblies are now available in 5-, 10-, and 20-ampere sizes.

SPECIFICATIONS

	W20MT3A	W20HMT3A
Input Voltage	120 V	240 V
Frequency	50–60 c/s	
Output Voltage	0-140 V	0-280 V
Current Rating	18 A	8 A
No-Load Loss (60 c/s)	27 W	
Voltmeter Range	0-150 V	0-300 V
Ammeter Range	0-20 A	0-10 A
Meter Accuracy	±3% of full scale	
Switching	2-pole, OFF-ON switch at input from line	
Fusing	20 A	10 A

Both Models	
Terminals	
Line	3-wire cord and plug
Load	3-wire outlet receptacle
Angle of Rotation	320°
Driving Torque	45 to 90 oz-in
Dimensions	
Width	8⅝ in (220 mm)
Height	11⅞ in (300 mm)
Depth	5¼ in (135 mm)
Net Weight	27½ lb (12.5 kg) 25 lb (11.5 kg)
Price	$140.00

SALES ENGINEERING NOTES

NEREM

The new sound-level meter featured in this issue will be on display at NEREM (Northeast Electronics Research and Engineering Meeting), November 4, 5, and 6 at Boston's Commonwealth Armory. So will a number of other new GR products, including an automatic capacitance bridge, frequency standard, coherent decade frequency synthesizer, digital time comparator, recording wave analyzer, megohm bridge, counters, and many other instruments and devices. Our booth number is 211-213.

PHILADELPHIA OFFICE MOVES

Our Philadelphia Sales Engineering Office has just moved a few miles west into brand-new quarters at Fort Washington Industrial Park, adjacent to the Pennsylvania Turnpike at Fort Washington, Pennsylvania. The new diggings are larger than the old and include better parking facilities, all the better to accommodate the burgeoning business at "PHO." The numerology of the situation is as follows: phone number 215-646-8030, TWX number 215-646-7996, and Zip Code 19034. Manager John Snook and Sales Engineer Carl Alsen stand ready as ever (but even better equipped) to serve.

ALABAMA, GEORGIA ADDED TO FLORIDA OFFICE TERRITORY

Our Florida Sales Engineering Office in Orlando now includes in its territory Alabama and Georgia, and thus may be considered our Southeastern States Office. Sales Engineer Richard G. Rogers joins manager John Held of that office to help serve this large and important area. Dick, an electrical engineering graduate of M.I.T., has been with GR since 1960, both at our West Concord headquarters and at our Washington, D.C., Sales Engineering Office.

J. E. Snook

C. W. Alsen

R. G. Rogers

J. C. Held

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