# SOUND MEASUREMENT and ANALYSIS INSTRUMENTATION



QUEST ELECTRONICS

QUEST ELECTRONICS
DIVISION OF
LA BELLE INDUSTRIES INC.
OCONOMOWOC WI 53066
PHONE 414 567 9157

QUEST

QUEST ELECTRONICS

510 S. WORTHINGTON ST.
OCONOMOWOC, WISCONSIN 53066
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Fred Mintz, Staff Consultant-Noise
U.S. EPA
Washington, DC 20460

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| 98-74 | Customer Binder | 1 | 1 | | | |

Seller hereby certifies that these goods were produced in compliance with all applicable requirements of Sections 6, 7 and 12 of the Fair Labor Standards Act, as amended, and of regulations and orders of the United States Dept. of Labor issued under Section 14 thereof.
Claims must be made immediately upon receipt of goods. No returns will be accepted 30 days after date of invoice. Returns within 30 days will be accepted only on written authorization from Quest Electronics, and subject to a 20% handling charge. Goods returned contrary to above will be shipped back to you at your expense.

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FORM # 200-15

* to be repaired

12/23/87

Property Numbers of QUEST Model 215 SLM's

| | | | | |
|---|---|---|---|---|
| * | EPA 166641 | Serial M | 810058 | Cal U 810015 |
| * | 164553 | | 810007 | U 809033 |
| * | 164560 | | 810002 | U 809028 |
| | 164554 | | 810010 | 809036 |
| | 164051 | | 810012 | 809039 |
| * | 166647 | | 810059 | 0010134 |
| | 171424 | | 0020020 | 0010130 |
| | 171104 | | 9080128 | 9080126 |
| | 164550 | | 810008 | 809034 |
| | 164558 | | 810005 | 809031 |
| | (no property no.) | | 808022 | 808058 |

* to be repaired

12/23/87

Property Numbers of QUEST Model 215 SAM's

| | | | | | |
|---|---|---|---|---|---|
| * | EPA | 166641 | Serial M | 810058 | Cal U 810015 |
| * | | 164553 | | 810007 | U 809033 |
| * | | 164560 | | 810002 | U 809028 |
| | | 164554 | | 810010 | 809036 |
| | | 164651 (nearly battery) | | 810012 | 809039 |
| * | | 166647 | | 810059 | 0010134 |
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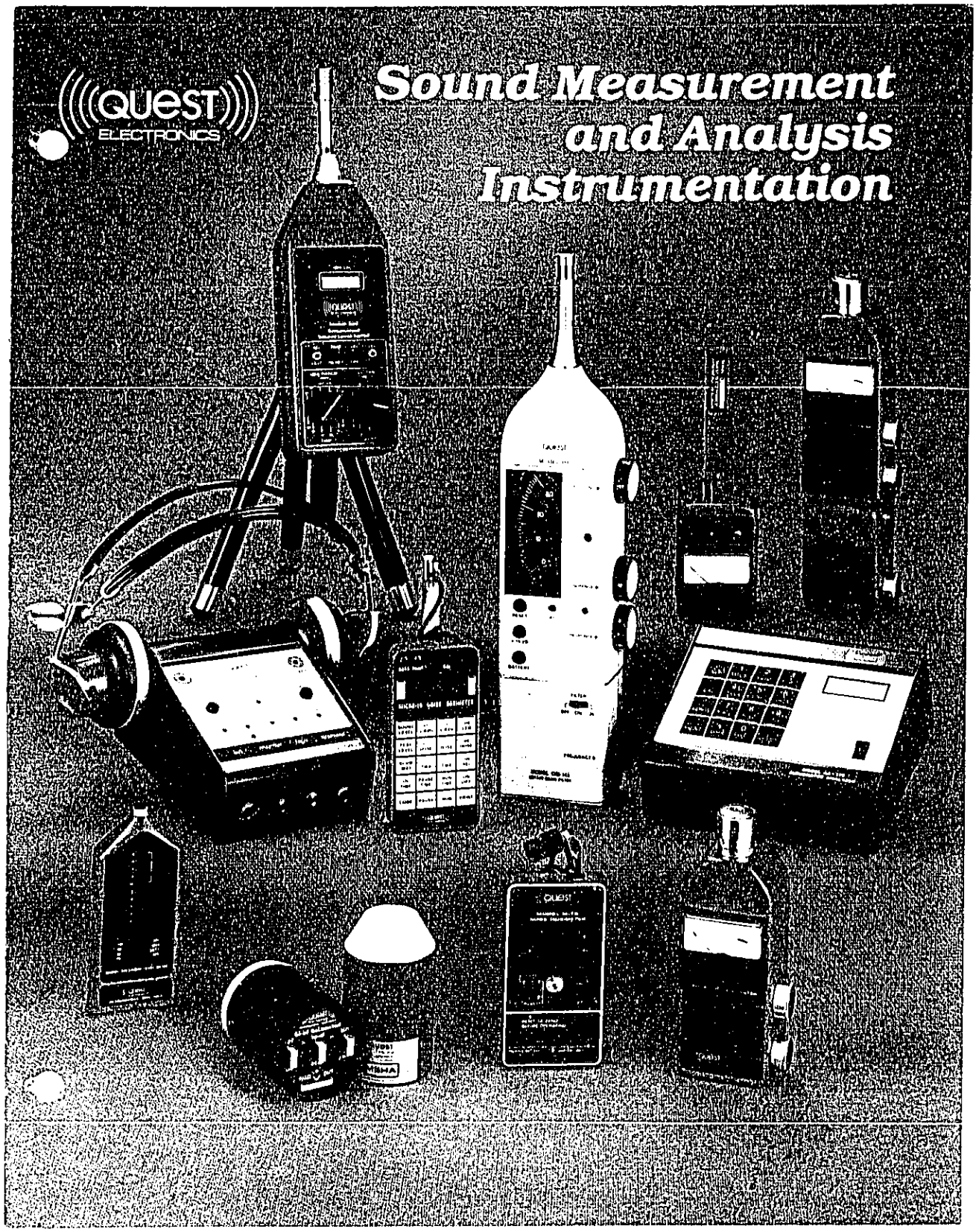
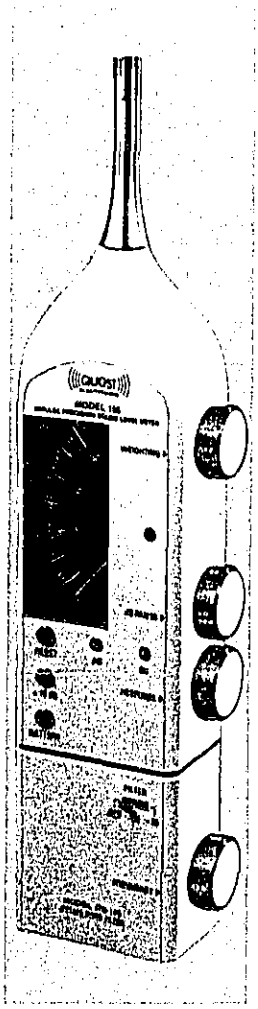

QUEST
ELECTRONICS
Sound Measurement
and Analysis
Instrumentation

# Precision Sound Level Measurement — Type 1



*Model 155-145*
*Octave Band Analyzer*

### *Microphones Available*

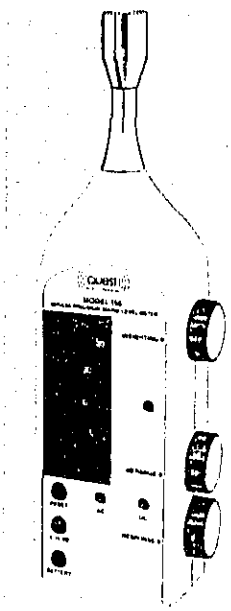
7047 1/2" condenser, random-pressure
7046 1/2" condenser, free-field
7013 1/2" condenser, low sensitivity, pressure
7023 1" condenser, pressure

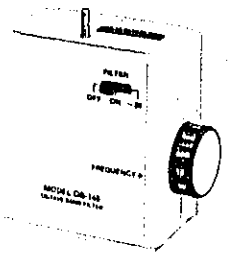
(A-63B Pre-amp Adaptor needed when using 1" microphone.)

For more detailed information see Brochure 98-109.

### *Model 155 Impulse Precision Sound Level Meter*

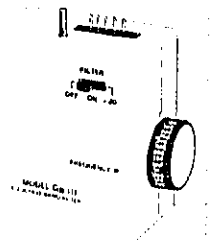
This meter exceeds ANSI Standard S1.4-1983 for Type 1 instruments and IEC Publication 651-1979 for Type 1 impulse meters. It features a dynamic range from 27 to 140 dB • a 30 dB linearized scale which is easier to read because of the equi-spaced divisions • four weighting scales — A, B, C and Linear — all of which can be used in octave band analysis • fast and slow response • provisions for tape and chart recording of all outputs • integral peak hold capability for three operating modes: fast response maximum, IEC impulse and OSHA impact peak hold. It can be used with the filters described at the right for precision measurement and analysis of sound levels in laboratory, industrial and community applications; for audiometer calibration and frequency analysis of audiometric rooms; for product noise measurement; and for structural and mechanical acoustical analysis.





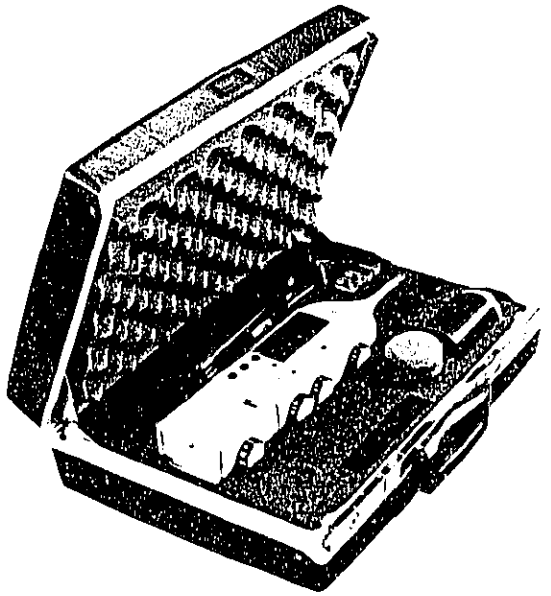
### *Model OB-145 Octave Band Filter*

Conforms to the most stringent requirements of ANSI S1.11-1971, Class II and IEC R225. It plugs into the bottom of the Meter to form the Model 155-145 Octave Band Analyzer shown at left. The Analyzer has ten selectable octave frequency ranges; center frequencies extend from 31.5 Hz to 16 KHz.



### *Model OB-133 1/3 Octave Band Filter*

Conforms to the requirements of ANSI S1.11-1971 Class III and IEC-R225. It plugs into the bottom of the 155 meter to form the 155-133 1/3 Octave Band Analyzer. The Analyzer provides thirty-three selectable filter ranges from 12.5 Hz to 20 KHz center frequencies with 1/3 octave band width.



The Meter and Octave Band Filter are available in a kit which also includes the CA-22 Sound Calibrator, the WS4 Windscreen and carrying case.

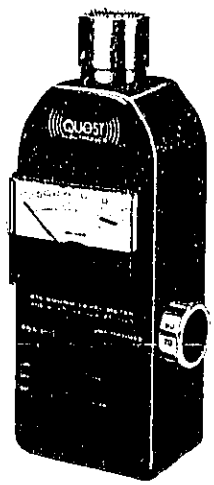
(The TP-2 Tripod and microphone cables are optional.)

# Sound Level Measurement

*Approved by the U.S. Mine Safety and Health Administration (MSHA) for intrinsic safety.

### Model 215 Sound Level Meter*

A professional full-range ANSI Type 2 general purpose meter for virtually all applications requiring precise sound pressure level measurements. Wide dynamic range — 30-140 dB, A, B, C, Linear and External weighting selection. Modular construction permits plug-in addition of Octave Band Filter or Peak-Hold Attachment. Meets ANSI Standard S1.4-1983 Type 2 and IEC 651 Type 2.

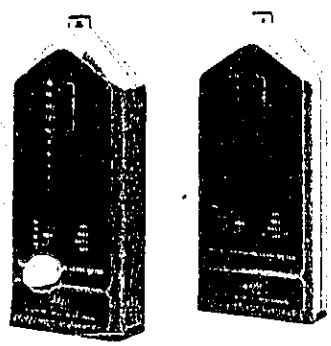


### Model 214 Sound Level Meter

Provides the same wide dynamic range as the Model 215 with A Scale weighting and fast and slow response. Other weighting scales and modular plug-in capability have been omitted to provide a cost-effective meter for applications where those features are not needed. Meets ANSI Standard S1.4-1983, Type 2 and IEC 651 Type 2.

For more detailed information see Brochure 98-73.

### Models 208 and 208L Sound Level Meters*



These low-cost, accurate pocket-size meters are used for spot checking industrial, product, community and vehicle noise levels; for insurance surveys, instructional purposes, speech level indication, and many other applications. Both measure in the A-weighted slow response mode. Range of the 208 is 70-120 dBA. Range of the 208L is 50-100 dBA. They weigh only four ounces and fit easily in a shirt pocket.

For more detailed information see Brochure 98-136.

### Model 211FS Sound Level Meter*

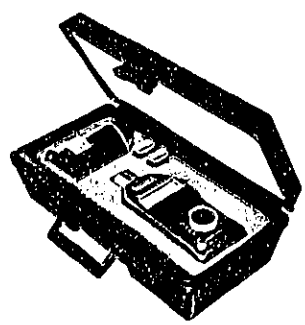
An adaptable instrument designed primarily for measuring moving vehicle noise. Other uses include enforcing noise statutes, checking OSHA compliance, measuring product noise, and general scientific use. A and C scale weighting, fast and slow response. 60-120 dB range. Meets ANSI Standard S1.4-1983, Type 2 and IEC 651 Type 2.

### Model 211A Sound Level Meter*

A general purpose instrument primarily intended for determining OSHA compliance. Also used for quick, simple measurement of noise levels in all environments. A scale weighting, slow response. 60-120 dB range. Meets ANSI Standard S1.4-1983, Type 2 and IEC 651 Type 2.

For more detailed information see Brochure 98-46.

### Sound Level Meter and Calibrator Kits Models 211A-12, 211FS-12, 214-12, 215-12, 215-15

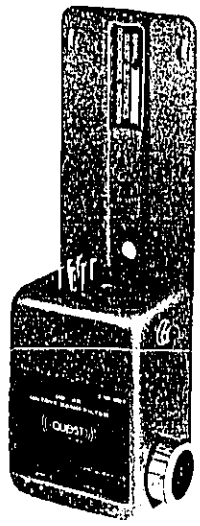


Four kits each containing a Sound Level Meter, CA-12 Calibrator plus other accessories. Model 215-15 kit contains CA-15 Calibrator and accessories. All kits complete with padded carrying case. Model 211FS-12 kit is illustrated.

### Remote Microphone

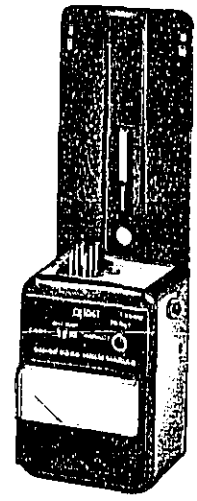
All sound level meters except Models 208 and 208L are available with a detachable microphone for remote applications. Model numbers for meters with remote microphones include the letter "R" as follows: 215R, 214R, 211FSR, etc. Microphone cables up to 75 feet long are available.

# Octave Band Analysis
# Impact Noise Measurement



### *OB-45 Octave Band Filter*

Plug-in attachment for Model 215 Sound Level Meter. Selects nine octave bands from 31 Hz to 8 KHz. Meets ANSI S1.11 Class II, the most precise and stringent class for octave filters. A +10 dB button permits making measurements down to 20 dB.



### *PH-35 Peak Hold Module*

Plug-in attachment for Model 215 Sound Level Meter. Three modes of peak hold measurement: OSHA impact hold, IEC impulse hold, and FAST response maximum hold.

### *215-4512 Octave Band Analyzer Kit*

Many uses and features make this kit an outstanding value. A precise measuring kit used for general noise analysis, product noise emissions, community noise, audiometer calibration, audiometric background noise, and many other applications. Includes the 215 Sound Level Meter, OB-45 Octave Band Filter, CA-12 Calibrator, Windscreen and padded carrying case.

For more detailed information see Brochure 98-2.

### *215-3512 Peak Hold Meter Kit*

Same as kit described and illustrated above except PH-35 module replaces OB-45 Filter.

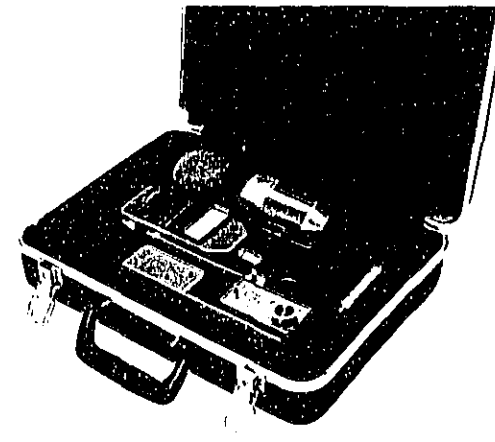
For more detailed information see Brochure 98-41.

### *215-45 Octave Band Analyzer*

Consists of 215 Sound Level Meter and OB-45 Octave Band Filter as shown below.

### *215-35 Peak Hold Meter*

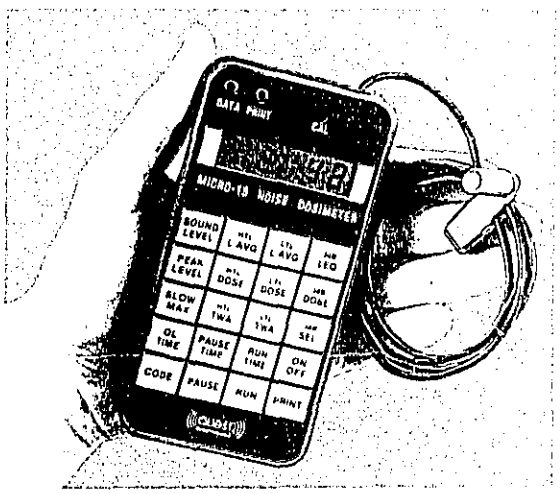
Consists of 215 Sound Level Meter and PH-35 Peak Hold Module.



### *215-345-12 Universal Kit*

This highly versatile kit is essentially a portable lab with all the analysis capability of the 215-4512 kit plus the additional impulse-impact measurement capability of the Peak Hold Module.

# Noise Dosimeters
# For Noise Exposure Measurement

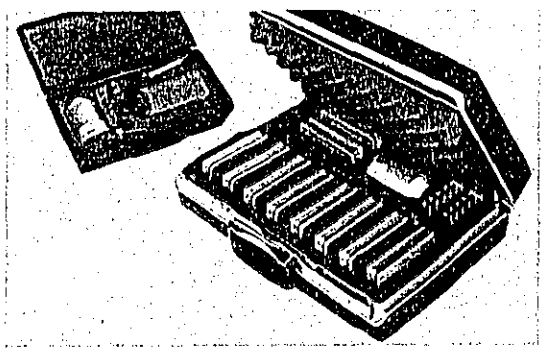



### MICRO-15

Synonymous with excellence in sound measurement. The MICRO-15 is a micro-processor-based instrument that monitors 15 functions simultaneously. (See page 6.) It provides maximum readout information, exceptional versatility in setting parameters, provides for hard copy printouts, and data for histograms and statistical study. The high crest factor permits measurements of great accuracy in extremely impulsive noise environments. With the selectable parameters the MICRO-15 can be dedicated to virtually all applications: U.S. OSHA Compliance and Hearing Conservation, U.S. DOD 4 dB Exchange Rate, Worldwide Industrial Noise Programs, and Community Noise Measurement.

UL Listed for intrinsic safety.

For more detailed information see Brochure 98-163.



### MICRO-15 Kits

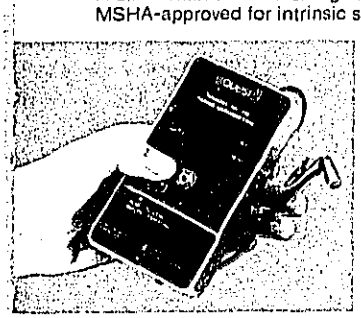
MICRO-1512. Includes MICRO-15 Dosimeter and CA-12 Calibrator in a padded carrying case, spare batteries, micro plug, 8 mm adaptor, WS-5 Windscreen and mic bracket.

Other kits with up to ten MICRO-15 Dosimeters but otherwise the same as the MICRO-1512 kit are also available.

## Models M-7B and M-8B

These two dosimeters cover a variety of needs and applications. Both are completely automatic, self-contained personal dosimeters which measure noise exposure in variable noise environments. Used for both long term (all day) and short term (brief representative sample) exposure measurements. High impulse capability — 30 dB crest factor.

A slide chart for converting short term exposure readings to equivalent decibel levels is furnished with each. Both dosimeters are MSHA-approved for intrinsic safety and meet ANSI S1.25-1978 Type 2 requirements.



### Model M-7B

For OSHA noise exposure measurements based on a 5 dBA time doubling exchange ratio. Dynamic range extends from 80 to 130 dB(A) (140 dBA peak). Threshold and 8-hour criteria level set to prevailing OSHA requirements or special user needs. Can be converted to 4 or 3 dB exchange ratio if needed in the future. Readout is an LED 5-digit display. Indicates percent of OSHA allowable exposure in increments of .01% from .01% to 999.99%. Worn in shirt pocket or on belt, or can be mounted on tripod for area study. Rugged, accurate, dependable; long 100-hour battery life.

For more detailed information see Brochure 98-102.

### Model M-8B

Equal energy dosimeter based on a 3 dBA time doubling exchange ratio. Standard range extends from 80 to 120 dBA (140 dBA peak), but other ranges can be accommodated. Calibrated to ISO R 1999 for industrial applications.

For more detailed information see Brochure 98-130.

### Model M-7B/4

A DOD type dosimeter with a 4 dBA time doubling exchange ratio. Standard range extends from 80-125 dBA (140 dBA peak) with an 8-hour criterion level of 84 dB.

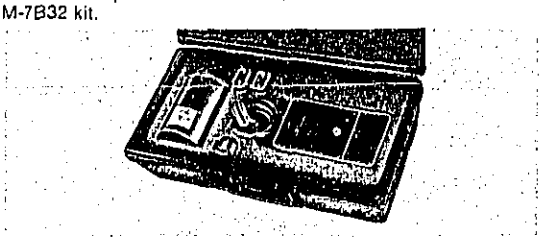
### Model M-7

An MSHA type with a 5 dBA time doubling exchange ratio. Range extends from 90-120 dBA. 10 dB crest factor capability. Full MSHA approval for use in mines.

### M-7B32 Noise Dosimeter and Calibrator Kit

Contains the M-7B Dosimeter, CA-32 Calibrator, 8 mm microphone adaptor, and two spare batteries as shown at left.

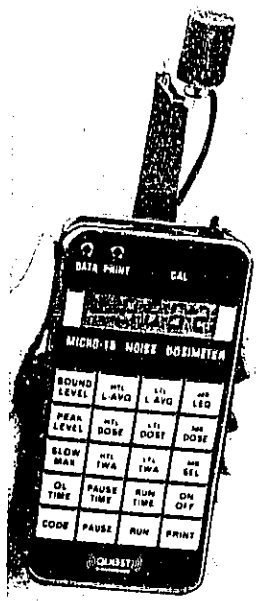
The M-7, M-7B and M-8B Dosimeters are also available in kits which have up to ten dosimeters but are otherwise similar to the M-7B32 kit.



# Digital Integrating Sound Level Measurement

### *MICRO-15 Noise Dosimeter*

A microprocessor-based multi-function meter system that measures accurately in all noise environments. It functions as a noise dosimeter that simultaneously monitors two noise doses with variable thresholds, criterion levels, exchange rates, ranges, overload levels and frequency weightings that are selected by the user. The MICRO-15 computes the integrated sound level, time-weighted average, 3 dB dose, equivalent sound level, sound exposure level, sound level, peak sound level, and maximum slow sound level. In addition three timing functions — run time, pause time and overload time — are provided. Values of each function are digitally displayed merely by pushing the appropriate button. Hard copy printouts and data for statistical analysis available.




For more detailed information see page 7 and Brochure 98-163.

### *Kit Models 228-12 and 227-12*

Each kit contains a model 228 or 227 Integrating Sound Level Meter, CA-12 Calibrator, WS-2 Windscreen and Carrying Case. (TP-2 Tripod is optional.)

### *Model 228 Integrating Sound Level Meter — Leq*

A small, hand-held instrument for measuring equivalent sound levels (Leq) in variable noise environments. Ideal for industrial and community applications where noise variations are too severe for use of a standard meter or where long term equivalent readings are desired. Covers a 90 dB(A) range in six selectable 40 dB range bands. Selectable measuring periods extend from two seconds to 16 minutes. Automatic reset and restart permit continuous measurement. Meets ANSI standard S1.4-1983, Type 2, and IEC 651 Type 2.

### *Model 227 Integrating Sound Level Meter — OSHA — 5 dBA*

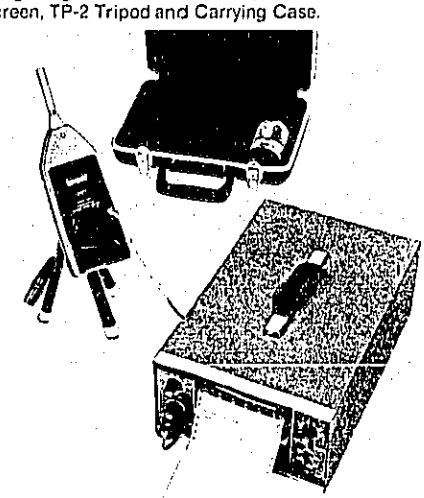
Same as Model 228 except measures on a 5 dBA exchange rate (time doubling in accordance with OSHA criteria.

Both integrating sound level meters can be used with a chart recorder to obtain TIME-HISTORY plots of the noise profile. The system can be set to record industrial noise over a full or partial work shift and can also be used for community noise recording over a 24-hour day.

For more detailed information see Brochure 98-71.

### *Kit Models 411BB-228-12T and 411L-228-12T 411BB-227-12T and 411L-227-12T*

Each Kit contains a Model 411BB or 411L Chart Recorder, 228 or 227 Integrating Sound Level Meter, CA-12 Calibrator, WS-2 Windscreen, TP-2 Tripod and Carrying Case.



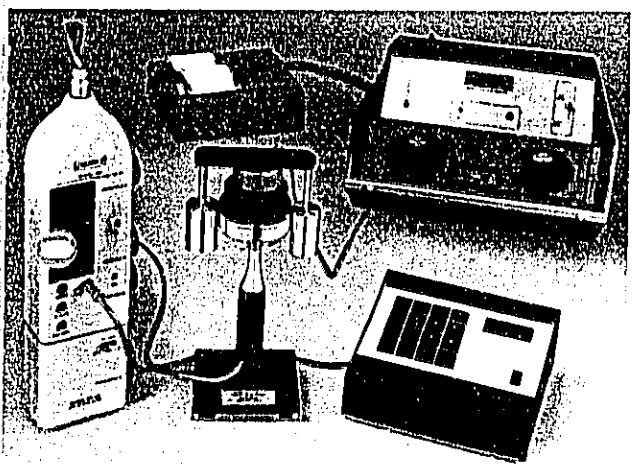
# Audiometer Calibration

Refer to Bulletin 98-97 for a complete description of these systems.

Quest audiometer calibration systems range from the sophisticated clinical, exhaustive microprocessor-controlled system to the simple meter system which replaces biological calibration.

### *Model AM-3000 System*

This system, illustrated below, is the top of the clinical line for sophisticated, precision, microprocessor-controlled analysis. It is a complete and fully portable system for exhaustive calibration of all audiometers. It measures decibel level, attenuator linearity, frequency, total harmonic distortion, pulse width, rise time, fall time, and overshoot . . . and provides hard copy printouts of the results. Electrical continuity checks down to -10 dB can be made on the audiometer. Both "brainstem click" amplitude and audiometric room background noise can be measured. The system consists of the 155 Precision Sound Level Meter, OB-145 Octave Band Filter, CA-22 Sound Calibrator, AA-175 Audiometer Analyzer, 6470 Printer, LT-20 Linearity Transformer and the necessary microphones, coupler, weight, stand, cable and chart.



### *Model AM-2000 System*

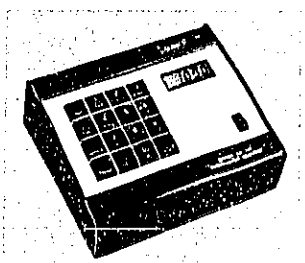
Same as the AM-3000 System except that the 6470 Printer and LT-20 Linearity Transformer are omitted.

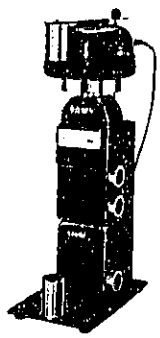
### *Model 155-14522 AM System*

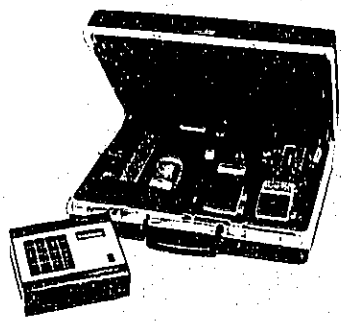
Same as the AM-2000 System except that the AA-175 Audiometer Analyzer is omitted. Harmonic distortion can be measured only from the 3rd harmonic and higher.

### *AA-175 Audiometer Analyzer*

A microprocessor-controlled analyzer that verifies audiometer calibration and performance. Calculates decibel level, linearity, harmonic distortion, frequency, overshoot, rise and fall times, and pulse width.







### *Model AM-200 System*

A complete, versatile and fully portable system for the exhaustive calibration of all audiometers. It measures decibel levels, attenuator linearity, frequency, harmonic distortion, pulse width, rise time, fall times, overshoot and audiometric room background noise. The system, at upper right, includes the 215 Sound Level Meter, OB-45 Octave Band Filter, CA-15B five-frequency Calibrator, AA-175 Audiometer Analyzer, AS-1545 Calibration Stand, and the necessary earphone coupler, weight and calibration chart. The calibration assembly is shown mounted in the Calibration Stand in the photograph at upper left.

### *Model AM-100 System*

Similar to the AM-200 except for making pulse tone measurements. The OB-245 Super Octave Band Filter and FC-3 Frequency Counter are used in place of the AA-175 Analyzer and OB-45 Filter as a cost saving measure.

### *Model 215-4512 AM System*

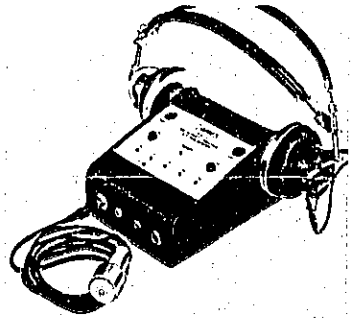
Similar to the AM-100 but significantly lower in cost. Includes the standard Octave Band Filter instead of the Super Filter and the CA-12 single frequency Calibrator instead of the CA-15 five-frequency Calibrator. Harmonic distortion measurements begin with the third harmonic. FC-3 Frequency Counter is optional.

### *Model 215-12AM System*

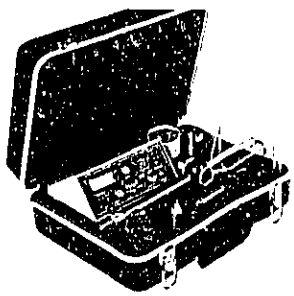
A basic system that replaces biological calibration of audiometers. Provides quick, accurate calibration checks of audiometer decibel level. Designed for those applications where simplicity and economy are major considerations.

### *Bio-Acoustic Simulators*

Two units, both of which provide a dependable alternative to calibrating audiometers biologically. The Model BA-201 is a high performance instrument for making the daily biological check of audiometers; the BA-201-25 is the same as the BA-201 but in addition continuously measures room background noise in five octave bands. Both are used with manual, automatic, and microprocessor audiometers and with standard earphones, with or without Audiocups.



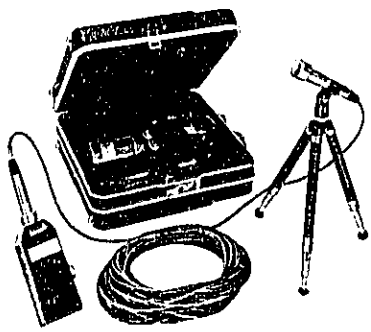
# Community Noise Measurement



### *Model 235-12WM Vehicle Noise Monitor*

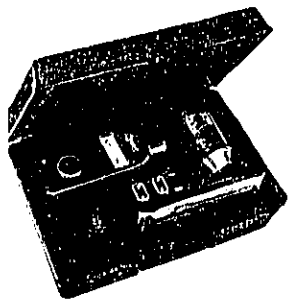
This specialized dual-purpose sound measuring system is used both for in-car monitoring of pass-by vehicles and for stationary vehicle noise testing.

The system consists of a digital read-out monitor and an adjustable window-mounted microphone and cable assembly. The monitor is readable both in direct sunlight and in complete darkness. It covers a sound range of 50 to 100 dBA.



### *214R-12WT Kit*

This kit is intended for outdoor applications which require a remote microphone and tripod system. Primary applications are measurement of drive-by vehicle noise and law enforcement. The kit contains the 214R Sound Level Meter with remote microphone, CA-12 Calibrator, windscreen, windmeter, tripod, microphone cable, and padded carrying case. Kits also available with 215R, 211FSR, and 211AR meters.

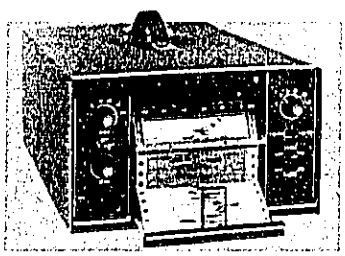


### *211A-12W Kit for Vehicle Exhaust Noise 211FS-12W Kit for Vehicle Stationary and Drive-by Noise 214-12W and 215-12W Kits for Community and General Purpose Noise*

Each kit contains a Sound Level Meter, CA-12 Calibrator, windscreen, windmeter and padded carrying case.

# Chart Recorders & Systems

### *Model 411L*



A small portable AC-powered recorder that can be used with all Quest sound level meters to provide a permanent record of measurement levels. Features multiple span input ranges from 1MV through 10 volts and a variable attenuator to 100 VDC. The drive has ten speeds from 0.5 cm/hour to 10 cm/minute. Utilizes a disposable pen cartridge and 4-inch wide chart paper roll.

### *Model 411BB*

Identical to the Model 411L except it operates on rechargeable batteries and can be used in the field where AC is not available.

### *Model 411BB-228-12T Equivalent Sound Level Recorder System*

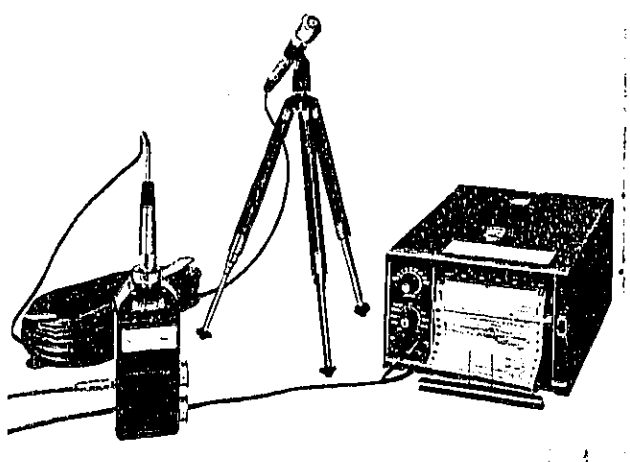
For making chart recordings of equivalent sound levels (Leq) using the 228 meter. Also includes 411BB Recorder, CA-12 Calibrator, TP-2 Tripod, WS-2 Windscreen and carrying case.

### *Model 411L-215R-12WT Sound Level Recorder System*

For making chart recordings of sound levels using the 215R meter. Also includes 411L Recorder, CA-12 Calibrator, WS-3 Windscreen, TP-2 Tripod, necessary accessories, and carrying case.

### *Recording Accessories*

59001 Z-fold Paper • 723A26-6 Red Pen • 7528201 Carrying Case • Spare Battery • Battery Charger • RM-800 Recording Module • RA-100MV Recorder Adaptor



The recorders can be used with all Quest sound level meters for making permanent records of sound level measurements.

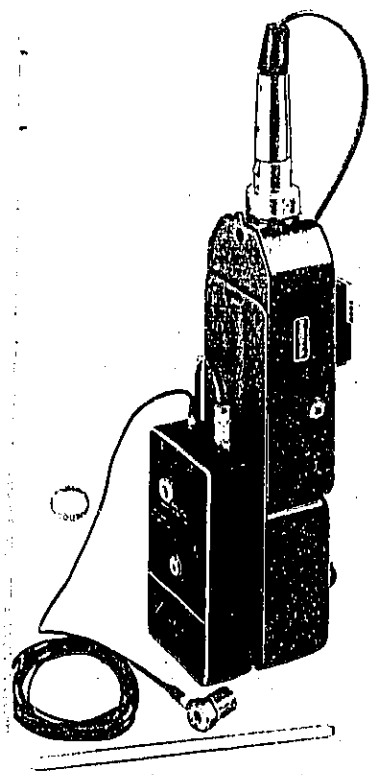
For more detailed information see Brochure 98-72.

# Vibration Measurement

For more detailed information see Brochure 98-145

Quest vibration measurement systems are used in engineering and research, noise control, machinery acceptance tests, quality control, preventive maintenance, and insurability tests.

Two systems are offered. One uses the VA-508B Assembly with the 215R Sound Level Meter as the readout. The other uses the VA-508BP Assembly with the 155 Precision Sound Level Meter as the readout.

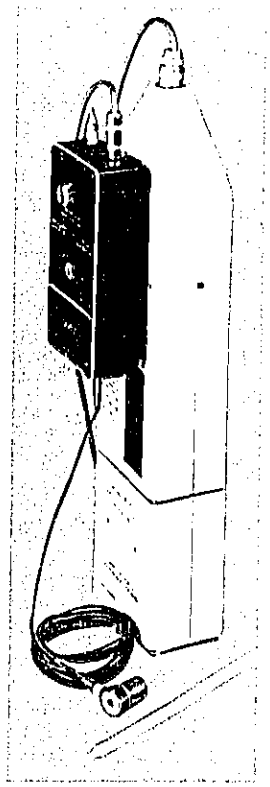


### VA-508B Assembly

*(Shown with 215R-45 Octave Band Analyzer)*

| Model No. | Unit |
|---|---|
| VI-90 | Vibration Integrator |
| 508 | Accelerometer |
| 59-72 | Probe |
| AC-5 | Accelerometer Cable |
| 58-406 | Vibration Chart |
| 59-982 | 215R Meter Input Cable |

The VA-508B Assembly uses the 215R Sound Level Meter as the readout. The OB-45 Octave Band Filter can be plugged into the meter as shown for octave band analysis.



### VA-508BP Assembly

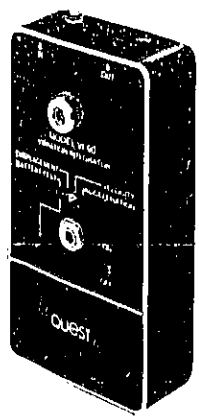
*(Shown with 155-133 1/3 Octave Band Analyzer)*

| Model No. | Unit |
|---|---|
| VI-90 | Vibration Integrator |
| 508 | Accelerometer |
| 59-72 | Probe |
| AC-5 | Accelerometer Cable |
| 58-407 | Vibration Chart |
| 58-817 | 155 Precision Meter Input Cable |

The VA-508B Assembly uses the 155 Precision Sound Level Meter as the readout. Both the OB-145 Octave Band Filter and the OB-133 1/3 Octave Band Filter can be plugged into the meter as shown for octave band and 1/3 octave band analysis.

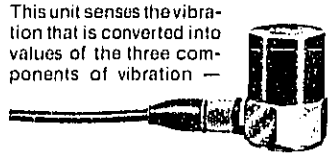
### VI-90 Vibration Integrator

This electronic module converts the accelerometer signal into values of the three vibration components — acceleration, velocity and displacement. The specific value to be read is selected by means of the 3-position slide switch. The VI-90 utilizes the latest integrated circuit technology. It is powered by a 9-volt battery and housed in a rugged aluminum housing.




### 508 Accelerometer

This unit senses the vibration that is converted into values of the three components of vibration —



acceleration, velocity and displacement — by the Vibration Integrator and the Sound Level Meter.

### 59-72 Probe

This probe is screwed into the Accelerometer. In practice the pointed end is pressed against the vibrating subject to transfer the vibration sensations to the Accelerometer.

### 58-406, 58-407 Vibration Chart

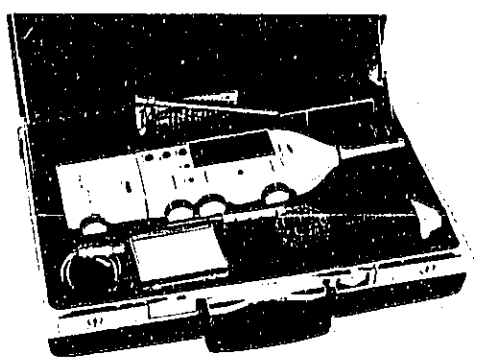
These charts are used to convert the sound level meter readings to vibration units. The vibration units used are as follows: acceleration: g's rms; velocity: meters/second rms; displacement: meters rms.

### 155-22-508BP Vibration Measurement System Kit

Illustrated below. Contains the VA-508BP Assembly plus a 155 Precision Sound Level Meter with 1/2-inch microphone, a CA-22 Calibrator, 58-817 Input Cable, and a 58-407 Vibration Chart in a 59-970 carrying case. The OB-133 Filter is optional.

### 215R-15-508B Vibration Measurement System Kit

Contains the VA-508B Assembly plus a 215R Sound Level Meter, a CA-15B Calibrator, 59-982 Input Cable, and a 58-406 Vibration Chart in a 59-925 carrying case.

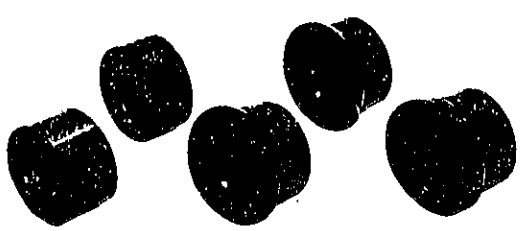


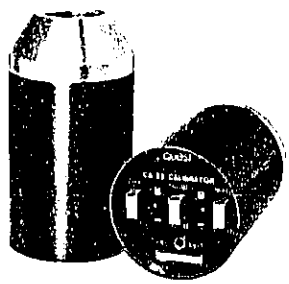
# Calibration

All Quest Sound Level Calibrators are portable units which can be used in the laboratory and in the field. The calibration of all units is traceable to U.S. National Bureau of Standards. Coupler fits the standard 1 1/8 inch diameter microphone. Adaptors for smaller microphones are available. For more detailed information see Brochure 98-17.


### *Microphone Adaptors*

Six sizes; 1", 0.72", 0.52", 0.5", 10 mm and 8 mm.



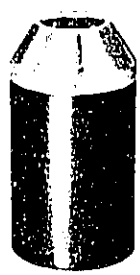


### *Model CA-22*

The CA-22 is the most precise of the calibrators with four selectable outputs: 110, 94 dB; 1000, 250 Hz. It can be used as a laboratory standard for calibrating precision type 1 instruments as well as general purpose sound level meters and other instruments with microphone inputs.

### *Models CA-12 and CA-12M*

The CA-12 is a general purpose calibrator (1000 Hz at 110 dB) that is primarily used for on-the-spot checking of sound level meters and other sound measuring instruments. The CA-12M is the same as the CA-12 except that it produces a 94 dB sound level.



### *Model CA-15B*

The CA-15B is a five-frequency calibrator (125, 250, 500, 1000 and 2000 Hz at 110 dB) intended for checking sound measuring instruments in cases where a more thorough calibration is considered necessary. It is particularly useful in checking the scale weighting of sound level meters and in determining filter skirt accuracy of octave band filter sets.

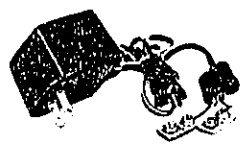
### *Model CA-32*

The CA-32 has a built-in precision timer which limits the duration of the signal to precisely 32 seconds at 1000 Hz, 110 dB. The CA-32 is designed primarily for field calibration of noise dosimeters where calibration is a function of sound level and time. The calibrator is also used to verify the accuracy of other sound measuring instruments.

# Accessories

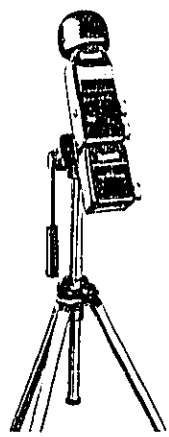
## Power Supplies

PS-95 — AC Adaptor for line operation of meters
PS-65 — For use with AA-175 Analyzer
PS-120 — For use with BA-201 and BA-201-25 Bio-Acoustic Simulators
PS-124 — For use with FC-3 Frequency Counter
PS-123 — For use with 235 Vehicle Noise Monitor



## Windscreens

WS-2 — for 1/2" dosimeter mics
WS-3 — for 1" mics
WS-4 — for 1/2" mics
WS-5 — for 8 mm mics
WM-1 — Windmeter



## Tripods

TP-1 — 20 inches closed; 55 inches extended
TP-2 — 10 inches closed; 51 inches extended
TMH-1 — Tripod Mic Holder

## Printers

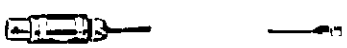
Quest instruments can be used with the Digitec Model 6470 Printer and other comparable printers.

## Cables

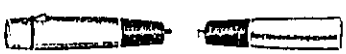
Precision Microphone Cables

(PMC-10 and PMC-50)

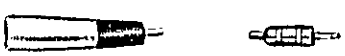
Precision Input Cable 50-817



Precision Mastoid Cable (PMC-5M)



Microphone Cables (MC-25, MC-50 and MC-75)



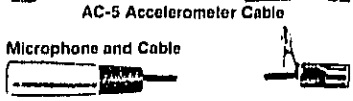
Input Cable 50-982 for 215R Meter

Mastoid Cable (MC-5M)

Microphone Cables (MCK-10 and MCK-50)

AC-5 Accelerometer Cable

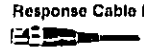
Microphone and Cable



1830HA for Hearing Aid Test Assembly

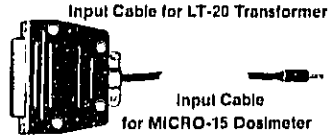
Microphone and Cable for BA-201-25 Simulator

Response Cable for

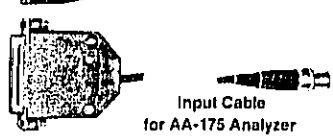


BA-201 and BA-201-25 Simulators

Input Cable for LT-20 Transformer



Input Cable for MICRO-15 Dosimeter

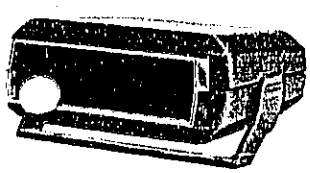


Input Cable for AA-175 Analyzer

## Audiometer Calibration Accessories

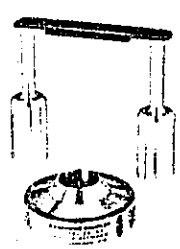
### Model FC-3 Frequency Counter

A simple, easy to use frequency counter intended for use in and around the audio range. Complete with 6-foot power cord and line converter that plugs into wall outlet.



### EC-9A Coupler and W-440 Weight

Audiometric 6CC coupler similar to the NBS, type 9A for calibration of all audiometers. The W-440 Weight provides the necesary 450 gram force to the audiometer earphone.



### LT-20 Linearity Transformer

Used with either meter system to increase signal level by 25 dB. Permits audiometer linearity check down to -10 dB.

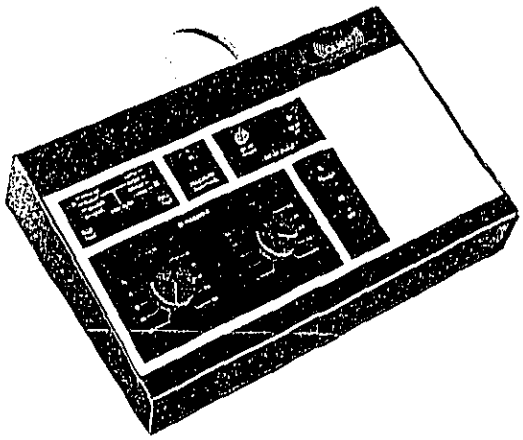
### BC-4 Bone Coupler

For bone vibrator calibration; measures relative forces. Similar to an Artificial Mastoid for the relative measurement of bone oscillator vibratory force.

### QHA-2 and QHA-1 Couplers

2cc Couplers for impedance or hearing aid calibration. Sleeve adaptor included to fit 1/2-inch microphones only. Specify for which microphone. QHA-2 is for behind-the-ear aids. QHA-1 is for in-the-ear aids.

For more information on these accessories see Brochure 98-97.



## *Model 261 Sound Level Detector/Controller*

A sound-activated instrument that monitors noise levels and actuates warning lights, alarm bells and other signal devices. Can also be used to acoustically turn on or off any device that requires up to 10 amps and 300 volts. Used for monitoring noise in industrial workplaces, hospital and school areas, industrial equipment and processes . . . anywhere an increase in noise above a specified level should be detected.

Covers a range between 55 and 110 dB with selectable A and C scale frequency weightings and programmable reaction time. Operates on 120/240V, 50/60 Hz. Weighs 3 pounds (1.4 Kg). 10 x 7 x 3 inches (260 x 180 x 80 mm).

Unit includes microphone and 35-foot cable.

Lighted sign is optional. For more detailed information see Brochure 98-176.

## *For Your Sound Measurement and Analysis Needs*

QUEST
ELECTRONICS

**510 Worthington St., Oconomowoc, WI 53066**
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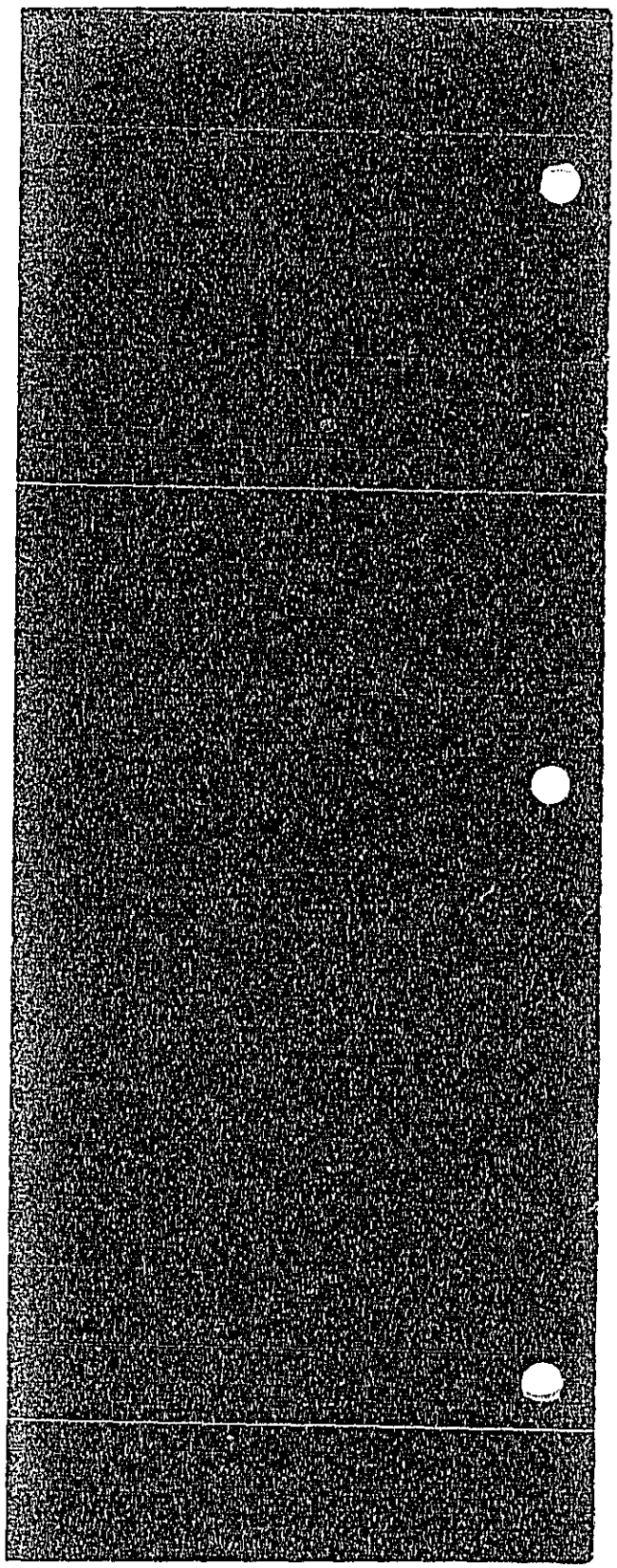

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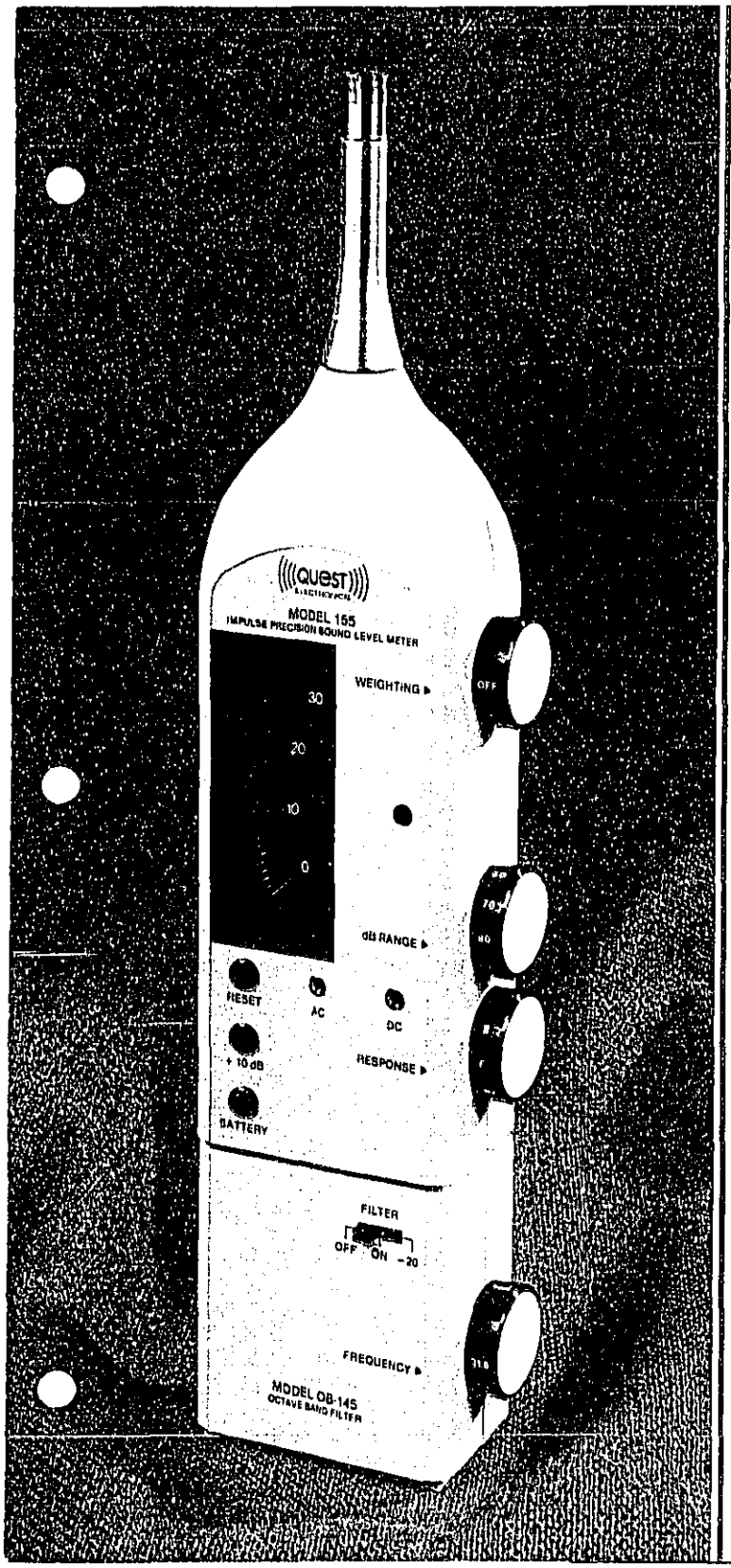



QUEST ELECTRONICS

# Model 155 Precision Type 1 Sound Level Meter

•

# Model OB-145 Octave Band Filter

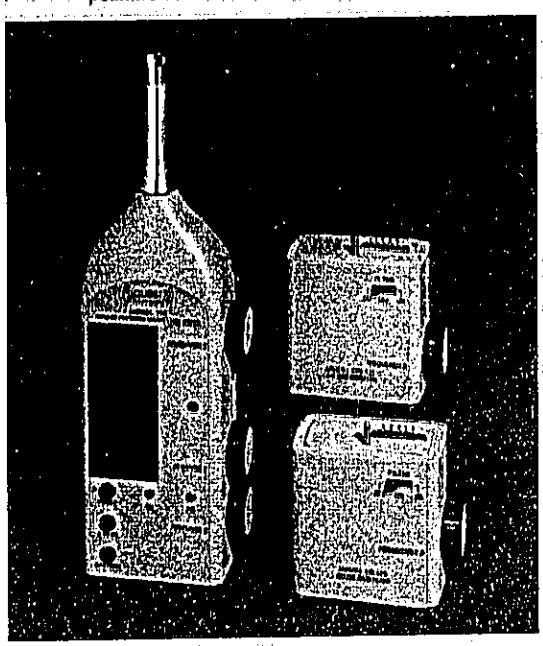
•

# Model OB-133 1/3 Octave Band Filter

**The Model 155 Impulse Precision Sound Level Meter with the plug-in Model OB-145 Octave Band Filter forms the Model 155-145 Octave Band Analyzer, and with the plug-in Model OB-133 1/3 Octave Band Filter forms the Model 155-133 1/3 Octave Band Analyzer.**

**Both analyzers are used for precision measurement and analysis of sound levels in laboratory, industrial, community and audiometric applications. The Model 155-133 is especially useful in providing detailed data in structural acoustic and vibrational analysis.**

**The 155 Meter exceeds ANSI Standard S1.4-1983 for Type 1 instruments and IEC Publication 651-1979 for Type 1 impulse meters. It features a dynamic range from 27 to 140dB ■ a 30dB linearized scale which is easier to read because of the equi-spaced divisions ■ four weighting scales — A, B, C and Linear — all of which can be used in octave band analysis ■ fast and slow response ■ provisions for tape and chart recording of all outputs ■ integral peak hold capability for three operating modes: fast response maximum, IEC impulse and OSHA impact peak hold.**

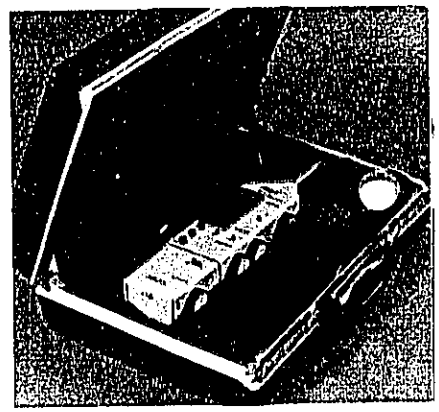


**The OB-145 Filter conforms to the most stringent requirements of ANSI S1.11-1971, Class II and IEC R225-1966. The OB-133 Filter meets the requirements of ANSI S1.11-1971 Class III and IEC-R225-1966.**

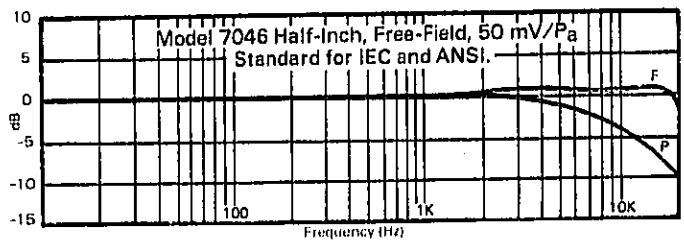
**The 155-145 Analyzer has ten selectable octave frequency ranges. Center frequencies extend from 31.5 Hz to 16 kHz. The 155-133 Analyzer has 33 selectable frequency ranges 1/3 octave band in width. Center frequencies extend from 12.5 Hz to 20 kHz.**

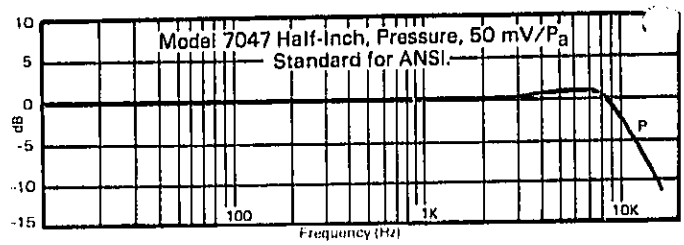
**Additional features of the Analyzers include a frequency range of 10 Hz to 25 kHz, a precision condenser microphone with 200 volt polarization, a true RMS detector with a crest factor up to 25dB, capability for use with remote microphone and up to 100 feet of cable, and lightweight construction — each Analyzer (Meter and Filter) weighs only 34 ounces.**

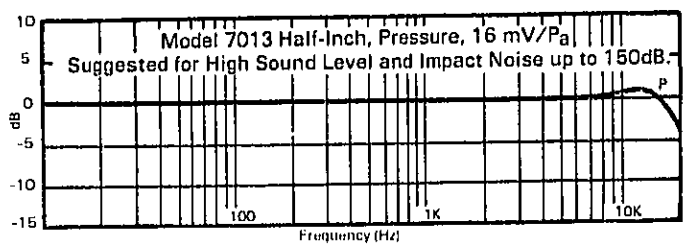
The meters and filters are available in kits which also include the CA-22 Sound Calibrator, the WS4 Windscreen and carrying case. (The TP-2 Tripod and microphone cables are optional.)

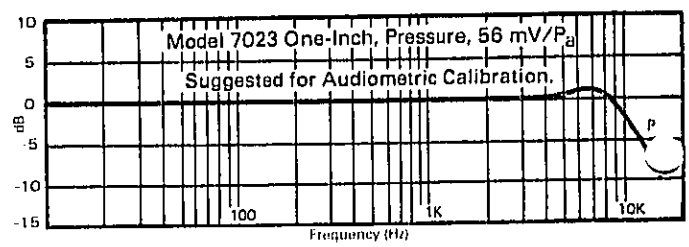


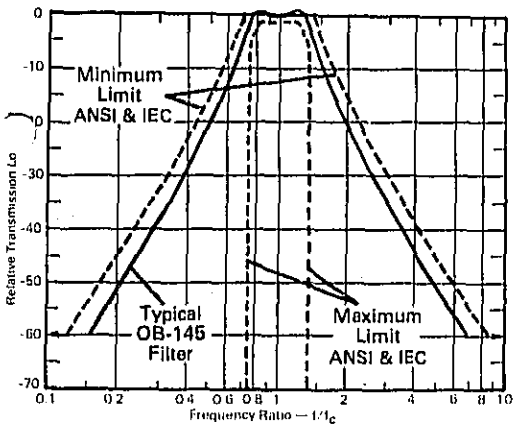
Three optional half-inch precision condenser microphones are used with the 155 Sound Level Meter. A one-inch precision condenser microphone is also available which permits measuring sound levels in the lower ranges, primarily for audiometric measurements. Typical responses of the microphones are shown in the curves below.



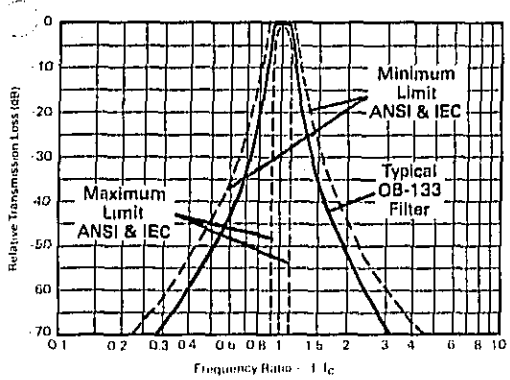






Normalized amplitude response for the OB-145 Octave Band Filter is shown above. The filters are flat within 1dB in the bandpass, with the 3dB downpoints at .707 $F_O$ and 1.414 $F_O$, where $F_O$ is center frequency of the band chosen. The $F_O/2$ and the $2F_O$ magnitudes are down by approximately 20dB with the decade points down by greater than 70dB.

The normalized passband characteristic of any frequency band of the OB-133 is shown below. The filters are flat within 0.5dB in the passband, one-sixth octave above and below the center frequency $f_c$ approximately 3dB down, one-half and 2-octave points ($.5f_c$ and $2f_c$) greater than 45dB down and one-quarter and 4-octave points ($.25f_c$ and $4f_c$) greater than 68dB down.

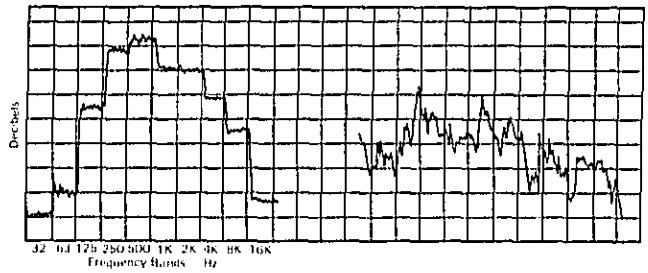



Dynamic range of the 155 Meter by itself is 27 to 140dB. When used with the OB-145 Filter, the specific minimum measurable SPL's in each octave band are as shown in the following table.

| Octave Band | Weighting Scale | | | |
|---|---|---|---|---|
| | A | B | C | LIN |
| All Pass | 27dB | 27dB | 27dB | 32dB |
| 31.5 and 63 | 7 | 10 | 20 | 22 |
| 125 and 250 | 7 | 12 | 16 | 16 |
| 500 and 1K | 9 | 10 | 10 | 10 |
| 2K and 4K | 11 | 9 | 9 | 10 |
| 8K and 16K | 11 | 9 | 9 | 14 |

Above data is for 1" microphone, Model 7023. Inherent noise level is at least 5dB below the RMS values listed in the table.

The OB-133 has similar characteristics.

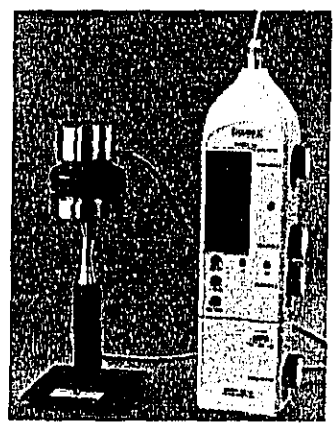



**Octave Band Recording of a Motor Drive System**

**Industrial Noise Level Recording**

A DC output provides for using the meter and both analyzers with a chart recorder to obtain precision time history plots of noise profiles. The recording system can be used in the lab, in industry, and in communities for making precision recordings of general noise levels and measurements as shown above.

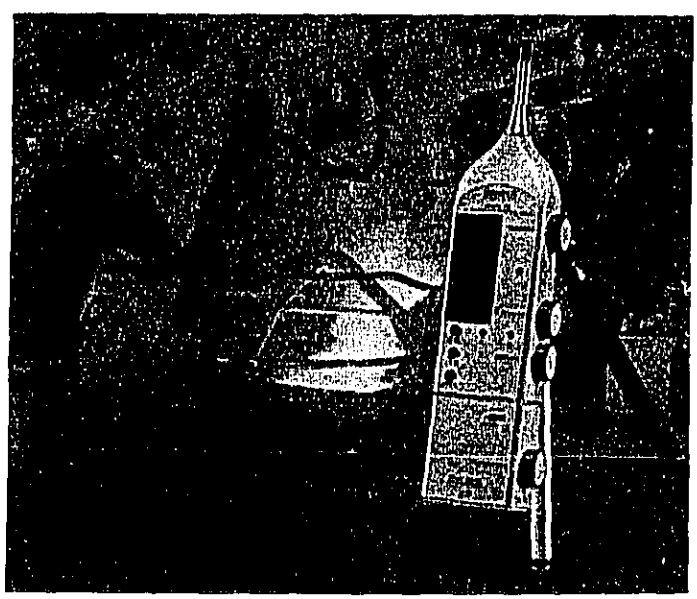
## AUDIOMETER CALIBRATION



Another primary use of both analyzers is in hearing conservation programs where they are used for audiometric room background noise measurements and for direct calibration of both manual and automatic audiometers.

Three fully portable precision audiometer calibration systems are available in kits. All systems use the Sound Level Meter and Octave Band Filter though the 1/3 Octave Band Filter can also be used. For a complete description of these systems refer to Brochure No. 98-97.

The Octave Band Analyzer and 1/3 Octave Band Analyzer are used for a variety of industrial noise and vibration applications such as product noise emissions, quality control and general sound level measurement and analysis.



# Accessories

**Model AS-1550 Calibration Stand** — for mounting microphone, coupler, earphone and weight when calibrating audiometers.

**Model TP-2 Tripod** — for mounting and positioning the 155 Meter, 155-145 Analyzer and 155-133 Analyzer.

**Microphone Adapters** — Type 58-928 for 1/2-inch microphone, Type 58-929 for 1-inch microphone.

**Model WS-4 Windscreen.**

**Model EC-9A Coupler and Weight** — audiometric 6cc earphone coupler similar to NBS, Type 9A for calibrating manual and automatic audiometers.

**Model CA-22 Calibrator** — a dual-frequency, dual-amplitude calibrator for calibrating precision type 1 as well as general purpose type 2 sound level meters. It generates four selectable reference outputs: at 250 and 1000 Hz, each at 94 and 110dB. The calibrator uses a single 9-volt transistor battery.

# Specifications

## MODEL 155 SOUND LEVEL METER

**Range — Meter Only:** 27-140dB
**with Octave Band Filter:** 7-140dB. See page 3.

**Standards:** Exceeds ANSI S1.4-1983 type 1 and IEC 651-1979 type 1 impulse.

**Microphones:** High quality half-inch condenser or optional one-inch condenser microphone.
Model 7046, 1/2" Free field microphone, 50 mv/Pa
Model 7047, 1/2" Pressure microphone, 50 mv/Pa
Model 7013, 1/2" Pressure microphone, 16 mv/Pa
Model 7023, 1" Pressure microphone, 56 mv/Pa

**Preamp:** Removable; input impedance is greater than 1G ohm in parallel with 2 pf. Preamp will drive up to 100 feet of cable.

**Polarization Voltage:** Regulated 200V DC ± 2%.

**Meter Input:** Input impedance is 1 Megohm in parallel with 100 pf. Maximum sinusoidal input voltage is 10V RMS.

**AC Output:** 1.0V RMS behind 3.2K ohms at 30dB meter deflection. (4V RMS Max.)

**DC Output:** +0.75V DC behind 3.2K ohms at 30dB meter deflection. (Approx. +1.1V DC Max.) Each 0.25 volt change represents 10dB.

**Detector:** True RMS.

**Crest Factor:** 15 (25dB) at +5dB or less meter deflection. 5 (15dB) minimum at +30dB or less meter deflection.

**Overload Indication:** Checks all points where overloads may occur; displays overload via LED.

**Frequency Range:** 4Hz (−3dB) to 27KHz (−3dB) on linear.

**Frequency Weighting Networks:** A, B, C and Linear. OB-145 Octave Band Filter is optional and can be used in conjunction with either A, B, C or Linear weighting.

**Meter Movement:** Linearized 30dB span, ruggedized high-torque taut-band movement front zero adjust.

**Meter Response:** SLOW, FAST, FAST MAX., IMPULSE, and PEAK HOLD.

**Accuracy:** ±0.5dB at 25°C; ±1.0dB over −10°C to +50°C.

**Temperature Range:** Operation: −10°C to +50°C. Storage (less batteries): −20°C to +60°C.

**Operating Humidity:** 0 to 95% Relative Humidity.

**Effect of Magnetic Fields:** A magnetic field of 1 Oersted (80A/m) at 60Hz produces a maximum reading of 40dB on Linear weighting.

**Effect of Electrostatic Fields:** Negligible as long as protection grid is kept on microphone.

**Batteries:** Two 9-volt batteries (NEDA 1604A — Alkaline) will provide approximately 25 hours of continuous operation (15 hours with optional OB-145 Octave Band Filter) as 25°C.

**Tripod Mount:** Threaded insert on back of meter accepts a standard 1/4-20 tripod mounting screw.

**Size:** 3.7 x 12.1 x 2.0 inches (94 x 307 x 51mm) including microphone height and knobs.

**Weight:** Approximately 26 oz. (740g) including batteries.

**Construction:** Solid state integrated circuitry in a rugged housing.

## MODEL OB-145 OCTAVE BAND FILTER

**Standards:** Meets ANSI S1.11-1971 Class II, Type 0, from 31.5Hz to 16KHz; meets IEC R225-1966.

**Center Frequencies:** Ten frequencies: 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, 16KHz.

**Pass Band Uniformity:** Within ± 0.5dB.

**Peak to Valley Ripple:** 1dB MAX.

**Filter Skirt Attenuation:**
Band edge frequencies (.707 $f_C$ and .1414$f_C$) — 3dB ±1dB
One octave from $f_C$ (.5 $f_C$ and 2 $f_C$) — 20dB ± 2dB
Two octaves from $f_C$ (.25 $f_C$ and 4 $f_C$) — 44dB ± 3dB

**Input Characteristics:** (From 155 Sound Level Meter) 0 to 4 Volts RMS (MAX). Input impedance is 90K in series with 16 MFD.

**Output Characteristics:** (To 155 Sound Level Meter) 0 to 4 Volts RMS (MAX). Output impedance is effectively less than 1 ohm if driving a load resistance of 1 K ohm or greater.

**Insertion Loss:** −0.1dB ± 0.3dB at center frequency.

**−20dB Gain Switch Accuracy:** Gain boost is 20dB ± 0.2dB.

**Power Source:** No internal power source. Battery voltage is obtained from the ±6.45V supplied in the Model 155 through the 5-pin connector.

**Size:** 3.7 x 3.6 x 2.0 inches. (94 x 91 x 51mm) including knob.

**Weight:** Approximately 9 oz. (255g).

**Construction:** Solid state integrated circuitry in a rugged housing.

## MODEL OB-133 1/3 OCTAVE BAND FILTER

**Standards:** Meets ANSI S1.11-1971, Class III and IEC R225-1966.

**Center Frequencies:** Thirty-three: 12.5Hz (Band #11), 16Hz, 20Hz, 25Hz, 31.5Hz, 40Hz, 50Hz, 63Hz, 80Hz, 100Hz, 125Hz, 160Hz, 200Hz, 250Hz, 315Hz, 400Hz, 500Hz, 630Hz, 800Hz, 1KHz, 1.25KHz, 1.6KHz, 2KHz, 2.5KHz, 3.15KHz, 4KHz, 5KHz, 6.3KHz, 8KHz, 10KHz, 12.5KHz, 16KHz, 20KHz (Band #43).

**Pass-Band Uniformity:** ±0.5dB.

**Peak to Valley Ripple:** ±0.5dB.

**Filter Skirt Attenuation:**
.707 $f_C$ & 1.41 $f_C$ — 25dB atten.
.5 $f_C$ & 2 $f_C$ — 45dB atten.
.25 $f_C$ & 4 $f_C$ — 68dB atten.

**Insertion Loss:** 0.0dB ± 0.5dB at $f_C$.

**−20dB Gain Switch Accuracy:** Gain boost is 20dB ± 0.2dB.

**Power Source:** Powered by 155 Sound Level Meter.

**Size:** 3.7 x 3.6 x 2.0 inches (94 x 91 x 51mm) including knob.

**Weight:** Approximately 9 oz. (255g).

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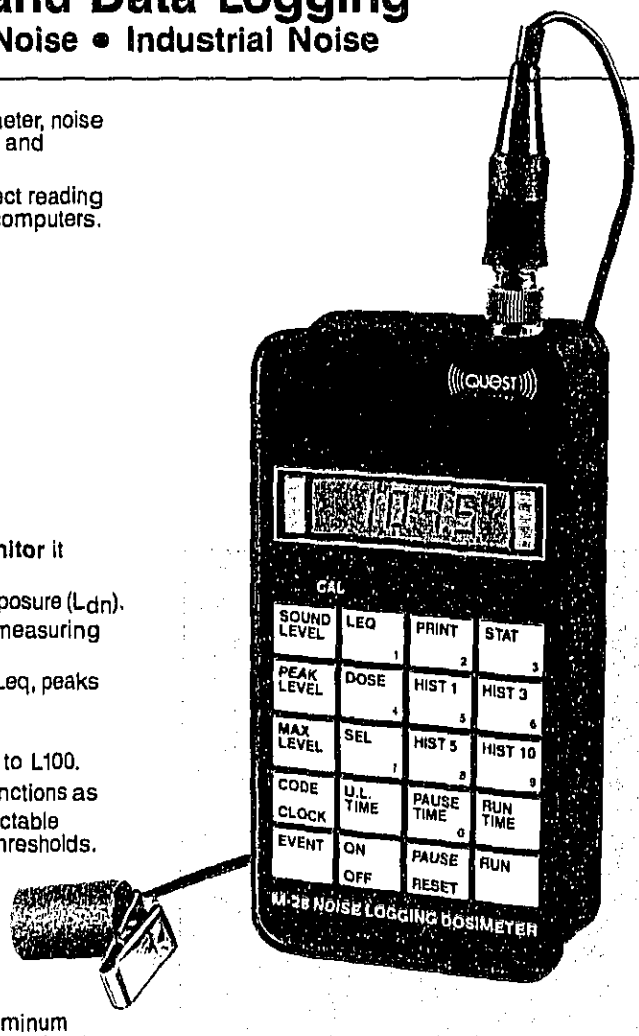
# M-28 / NOISE LOGGING DOSIMETER

## Noise Dosimetry and Data Logging

### Community and Airport Noise • Industrial Noise

- Functions as a personal noise dosimeter, noise survey instrument, events monitor, and integrating meter.
- A multi-function instrument with direct reading display and output to printers and computers.




- **As a Community and Airport Monitor** it accumulates
  - Integrated day-night averages and exposure ($L_{dn}$).
  - Data for up to 16 separate events (measuring periods).
  - 10-second or 1-minute histograms of Leq, peaks and maximum levels.
  - 1dB statistical distribution.
  - All exceedance levels ($L_n$) from L1 to L100.
- **As an Industrial Noise Monitor** it functions as
  - Personal noise dosimeter with selectable exchange rates, criterion levels and thresholds.
  - Survey instrument which estimates noise exposure from short term samples.
  - Area monitor which logs time history, statistical distributions and exceedance levels.
- Sturdy water- and dust-resistant aluminum case . . . clipped on belt or mounted on tripod.
- Field-replaceable microphone.
- (UL) Listed for intrinsic safety.

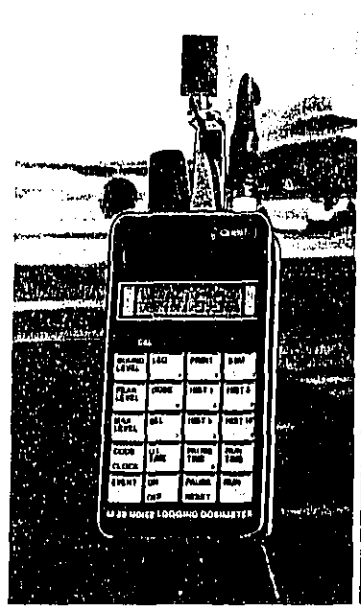
## Description

The M-28 Dosimeter is a microprocessor-based multi-function meter and data logging system.

With its versatility it is an ideal instrument for many applications. These include general industrial noise measurement as well as community and airport noise monitoring. User-settability of measuring parameters adapts the unit to the specific needs.

The M-28 displays Equivalent Sound Level (Leq), Dose, Sound Exposure Level (SEL), Peak Level, Maximum Level, Run Time, and Real or Elapsed Time for overall summary and up to 16 separate events. It also displays Sound Level, Pause Time, Upper Limit (U.L.) Time, Calibration Level, and a Code of internal switches. Display indicates 8-hour battery life, Run and Pause mode, Overload, and reading in percent or decibels.

The M-28 can be connected directly to serial or parallel printers and to computers. The printout contains a heading, a summary, events, 1 to 3 histograms of integrated average level and peak and/or maximum levels for 10-second or 1-minute increments statistical distributions, and exceedance levels. Printout can be edited during printing for a compact or extensive report. Raw data may be dumped to a computer.



User-settable switches select A or C frequency weighting, range (35 to 126dB or 50 to 146dB), upper limit, Slow or Fast response, criterion level, exchange rate, threshold, day-night operation (10dB added between 2200 and 0700), 12- or 24-hour clock, 10-second or 1-minute histogram, peaks and/or maximum histograms, serial or parallel printer, text or graphical printout, line feeds and carriage return, and baud rate.

With the selectable parameters the M-28 can be dedicated to measuring Community Noise... Airport Noise... 3dB Industrial Noise... U.S. OSHA Industrial Noise... and U.S. Department of Defense Noise.

Small size, ruggedness, long battery life and long unattended data accumulation (see chart below) add up to a very effective high performance instrument.

| | DATA LOGGING CAPACITY - HOURS | | |
|---|---|---|---|
| Mode | Leq | Leq, and Peak or Max Level | Leq, Peak and Max Levels |
| 1 minute | 120 | 60 | 40 |
| 10 second | 120 | 10 | 6.6 |

## Design Concepts and Features

The design objectives were to provide maximum readout information, maximum versatility and permanent hard copy printouts. The M-28 possesses exceptionally long battery life, long data storage, and built-in protection against accidental loss of accumulated data. The high pulse range permits measurements of exceptional accuracy in extremely impulsive noise environments.

A true RMS detector and true integrator (this is not a limited sample data system) provide accurate results. All data and time histories are printed out. Measuring up to sixteen separate events is a major feature allowing quick sample surveys. A CODE key lets the user check parameter settings without removing the rear cover.

## Construction

The M-28 has a rugged aluminum housing with a dust- and water-resistant cover seal. The microphone is durable, field-replaceable, and specially shielded against RF and magnetic interference.

## Measurement Functions

The abbreviations used are defined as follows:
LEQ – Equivalent Sound Level
SEL – Sound Exposure Level
U.L. – Upper Time Limit
HIST – Histogram
STAT – Statistical Distribution

## Keys

**SOUND LEVEL** — Reads sound level each second. Slow or Fast time constant

**PEAK LEVEL** — Reads absolute unweighted peak level attained

**MAX LEVEL** — Reads maximum sound level that occurred during measurement period. Slow or Fast time constant

**CODE CLOCK** — Produces coded display to verify internal parameter settings. Sets clock and saves calibration level

**EVENT** — Places unit in EVENT mode and will accumulate and index through 16 separate events

**LEQ 1** — Average integrated sound level during RUN time

**DOSE 4** — Accumulated dose in percent during RUN time

**SEL 7** — Sound Exposure Level is the total accumulated sound averaged over 1 second

**U.L. TIME** — Time the level was above the settable Upper Limit

**ON OFF** — Turns unit on or off (contains protection against accidental turn off)

**PAUSE TIME 0** — Time unit is on but not accumulating data

**PAUSE RESET** — Stops accumulating data (enters pause mode). Unit will reset if key is held more than 5 seconds

**RUN TIME** — Time unit is on and accumulating data

**RUN** — Starts accumulating data

## Logging Functions and Printout

The M-28 can be directly connected to a Centronics type parallel or serial 80-column printer. Various other printers can also be used but the M-28 must be internally set to printer operating conditions.

**PRINT 2** — Command key to print heading, summary, all events, histograms, statistical distribution and exceedance levels

**STAT 3** — Prints a %TIME statistical distribution and exceedance levels of all measured data

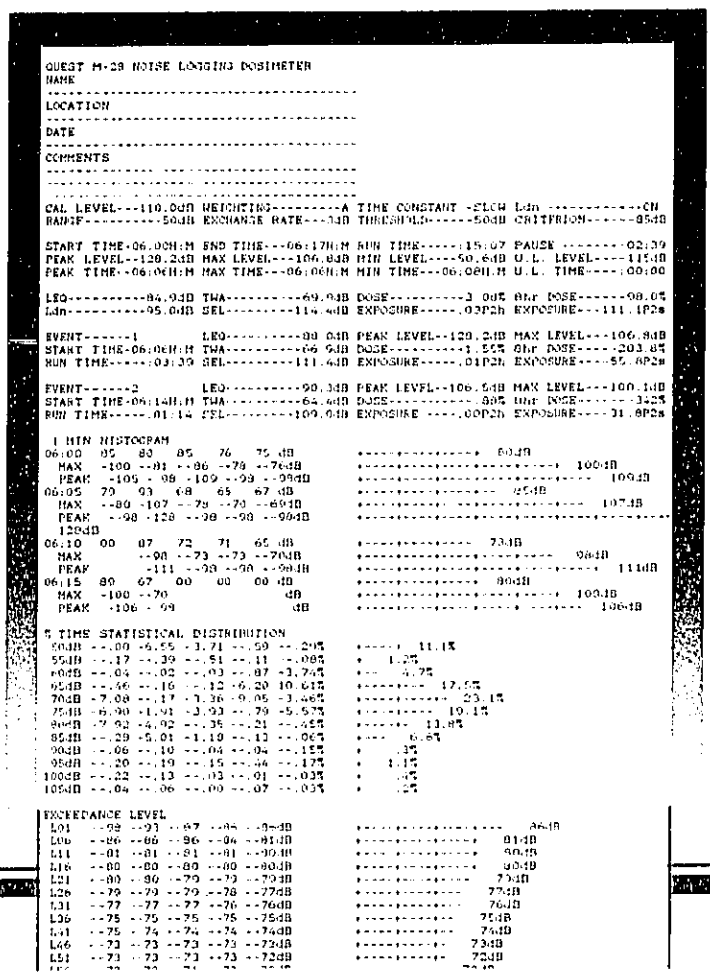
**HIST 1 5** — Prints 1-minute increment Histograms plus 5-minute increment graph display, or 10-second increment, 1-minute graph

**HIST 3 6** — Prints 3-minute increment Histograms plus 15-minute increment graph display, or 30-second increment, 3-minute graph

**HIST 5 8** — Prints 5-minute increment Histograms plus 30-minute increment graph display, or 1-minute increment, 5-minute graph

**HIST 10 9** — Prints 10-minute increment Histograms plus 1-hour increment graph display, or 2-minute increment, 10-minute graph

Numbers on keys are used to set clock.



## Specifications

**Standards:**
ANSI S1.4-1983 type 2
ANSI S1.25-1978
IEC 651 type 2
IEC 804

**Operating Range:** 35-126dB
50-146dB

**Detector:**
True RMS; 63dB pulse range
Response: Fast or Slow,
A or C weighted

**Display:**
Liquid crystal display

**Printout:**
RS-232 serial at 300, 600, 1200 or 2400 baud or Centronics parallel
Connector: 20-pin shrouded header

**Microphone:**
8-mm PZT ceramic 36-inch cable, field replaceable

**Battery:**
Single 9-volt alkaline, 80-hour battery life

**Temperature:**
-15° to 50°C operating
-40° to 60°C storage (battery removed)

**Humidity:**
0 to 95%

**Magnetic Field Effects:**
Negligible below 50 Oersted: at 50 to 60 Hz

**Size:**
5½ x 2¾ x 1⅜ inches
(140 x 70 x 40 mm)

**Weight:**
14 ounces (400 grams)

**Construction:**
Cast aluminum housing with tamper-, water-, and dust-resistant security cover

**Ⓤ Listed for intrinsic safety:**
Class I, Group C and D
Class II, Group E, F and G
Class III

## Kits

**M-2812 Kit:**
Includes M-28 dosimeter, CA-12B calibrator, WS-5 windscreen, 8-mm calibrator adaptor, printer cable, and padded carrying case. (80-column printer is optional)

**5M-2812 Kit:**
Includes 5 M-28 dosimeters, one CA-12B calibrator, WS-5 windscreens, 8-mm calibrator adaptor, printer cable, and padded carrying case. (80-column printer is optional)

**10M-2812 Kit:**
Includes same as the above but with 10 dosimeters

Other multi-pack combination kits are available.

## Accessories

**58-852** Earloop holds microphone at the ear and can be used to measure relative sound under an earmuff

**TP-2** Tripod

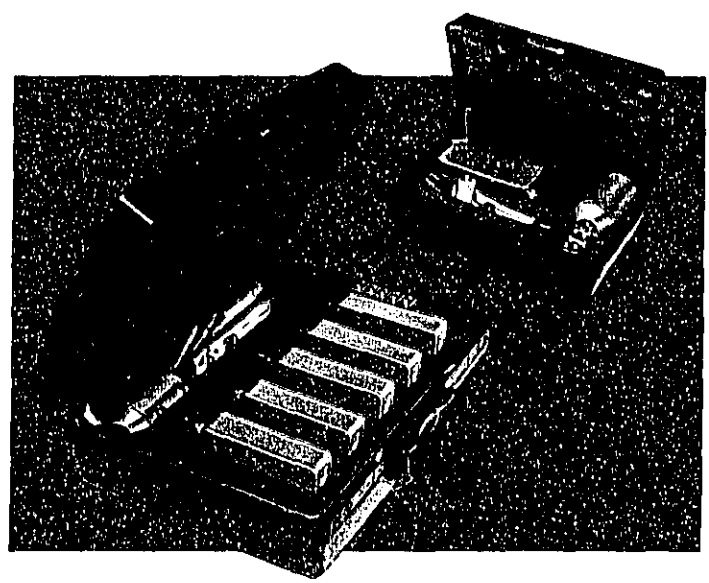
**WS-5** Windscreen for 8-mm microphone

**58-839** Microphone Adaptor

**Printer** – 80-column

**58-847** Field Replaceable Microphones

**59-848** IBM Compatible Software Package

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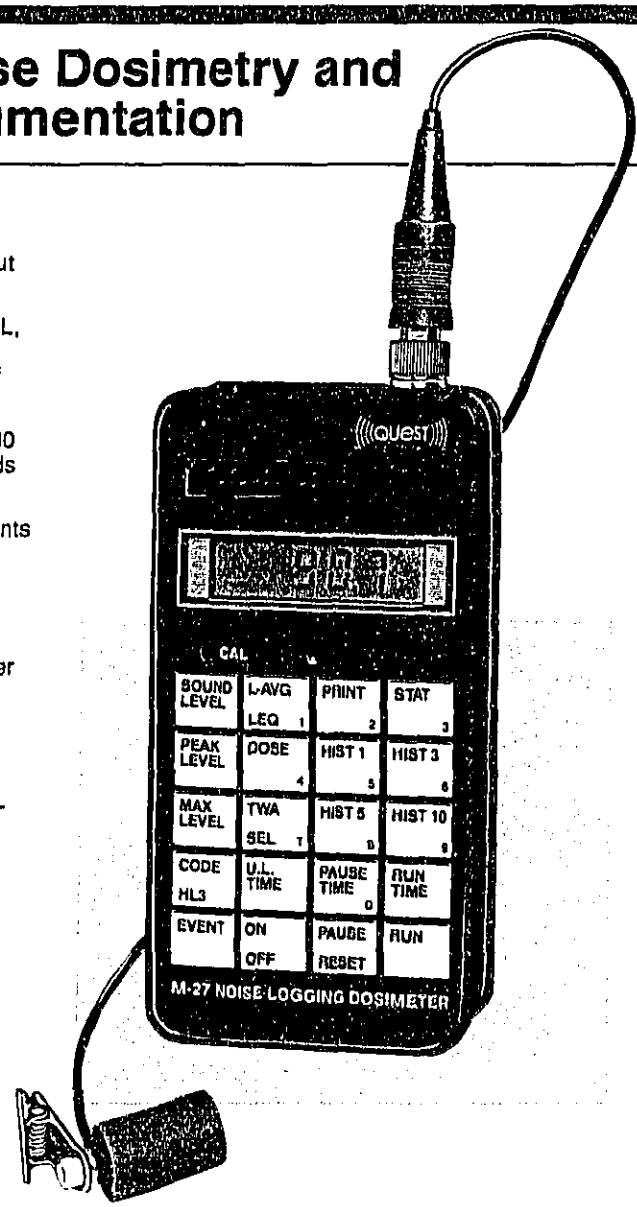
# M-27 / NOISE LOGGING DOSIMETER

## The Ultimate in Noise Dosimetry and Data Logging Instrumentation

- A compact multi-function instrument with direct data readout, printer output and computer interface.
- Measures Lavg, Dose, TWA, Leq, SEL, Sound Level, True Peak, Lmax, Run Time and Pause Time over ranges of 35-126dB and 50-146dB.
- Simultaneously measures with both 80 and 90dB thresholds. Other thresholds selectable.
- Stores data for up to 16 separate events (measuring periods). Data for each event can be recalled.
- Stored data can be
  ...viewed directly on readout
  ...printed with serial or parallel printer
  ...sent to a computer via an RS-232 port.
- Printouts provide 1-, 3-, 5-, and 10-minute histograms, 8-hour projected dose, percentage of time and percentage of dose statistical distributions. Printouts can be edited.
- Measurement parameters – exchange rates, ranges, overload levels, criteria levels, thresholds, A and C scale weightings, Fast and Slow time constants – are all user-settable.
- Used as a personal dosimeter, area monitor, and survey instrument. Microphone is field-replaceable.
- **Ⓤ Listed for intrinsic safety.**



## Description

The M-27 Dosimeter is a microprocessor-based multi-function meter and data logging system. It simultaneously measures noise doses based on 80 and 90dB thresholds. Additional thresholds are also available and user-selectable. Measurement parameters (criteria levels, exchange rates, ranges, overload levels, frequency weightings and time constants) are user-selectable.

The M-27 computes the integrated sound level, time weighted average, 3dB dose, equivalent sound level, sound exposure level, sound level, peak sound level, and maximum sound level.

It provides three timing functions: total pause time, total run time, and the time the sound level exceeded the selected overload level.

The M-27 stores minute-by-minute time history data and performs statistical analysis. Up to 16 separate measuring events can be stored to enhance short term survey analysis.

Hard copy printouts of all functions can be made by connecting the M-27 directly to a serial or parallel printer or, if desired, to a computer. The printouts can be edited.

With the selectable parameters and printing capability the M-27 can be dedicated to virtually all applications:
U.S. OSHA Compliance and Hearing Conservation
U.S. DOD 4dB Exchange Rate
Industrial ISO (non U.S.)
Community Noise

All data can be read at any time without disturbing dosimeter operation. Calibration is simple by merely checking and adjusting while reading sound level.

## Design Concepts and Features

The design objectives were to provide maximum readout information, maximum versatility and permanent hard copy printouts. The M-27 possesses exceptionally long battery life, long data storage and built-in protection against accidental loss of accumulated data. The high crest factor permits measurements of exceptional accuracy in extremely impulsive noise environments.

A true RMS detector and true integrator (this is not a limited sample data system) provide accurate results. All data and time histories are printed out. Measuring up to sixteen separate events is a major feature allowing quick sample surveys. A CODE key lets the user check parameter settings without removing the cover.

## Construction

The M-27 has a rugged aluminum housing with a dust- and water-resistant cover seal. The microphone is durable and specially shielded against RF and magnetic interference.

## Measurement Functions

The abbreviations used are defined as follows:
HTL – High Threshold Level
LTL – Low Threshold Level
L-AVG – Average Sound Level
LEQ – Equivalent Sound Level
TWA – Time Weighted Average, 8-hour
SEL – Sound Exposure Level

## Keys

| | |
|---|---|
| SOUND LEVEL | Reads sound level each second. Slow or Fast time constant |
| PEAK LEVEL | Reads absolute unweighted peak level attained |
| MAX LEVEL | Reads maximum sound level that occurred during measurement period, Slow or Fast time constant |
| CODE HL3 | Produces coded display to verify internal parameter settings. Also indexes to HTL, LTL and 3dB dosimeter readouts |
| EVENT | Places unit into EVENT mode and will accumulate and index through 16 separate events |
| L-AVG LEQ 1 | The average integrated sound level for HTL, LTL or 3dB (Leq) during RUN time |

DOSE 4 — Accumulated dose in percent for HTL, LTL or 3dB during RUN time

TWA SEL 7 — 8-hour Time Weighted Average in decibels for HTL and LTL. (It is the accumulated sound averaged over 8 hours). Sound Exposure Level (SEL) is the 3dB accumulated sound averaged over 1 second

U.L. TIME — Time the level was above the settable Upper Limit

ON OFF — Turns unit on or off (Contains protection against accidental turn off). Data is retained in memory.

PAUSE TIME 0 — Time unit is on but not accumulating data

PAUSE RESET — Stops accumulating data (enters pause mode). Unit will reset if key is held more than 5 seconds

RUN TIME — Time unit is on and accumulating data

RUN — Starts accumulating data

# Logging Functions and Printout

The M-27 can be directly connected to a Centronics type parallel or serial 80-column printer. Various other printers can also be used but the M-27 must be internally set to printer operating conditions.

PRINT 2 — Command key to print heading, summary, all events, histograms and statistical distributions

STAT 3 — Prints a % TIME and % DOSE statistical distribution of all measured data

HIST 1 6 — Prints 1-minute increment Histograms plus 5-minute increment graph display

HIST 3 0 — Prints 3-minute increment Histograms plus 15-minute increment graph display

HIST 5 8 — Prints 5-minute increment Histograms plus 30-minute increment graph display

HIST 10 9 — Prints 10-minute increment Histograms plus 1-hour increment graph display

Numbers on keys are used to set clock time into unit

```
QUEST M-27 NOISE LOGGING DOSIMETER
NAME
----------------------------------------
I.D. #
----------------------------------------
WORK STATION
----------------------------------------
COMMENTS
----------------------------------------
----------------------------------------


CAL LEVEL---110 0dB UNIT--------D
START TIME-08:15H:M END TIME---09:30H:M RUN TIME----1:00:01 PAUSE-------- 00:00
PEAK LEVEL--138.7dB MAX LEVEL---118.8dB MIN LEVEL----87.8dB UPPER LIMIT---115dB
PEAK TIME--09:10H:M MAX TIME---08:15H:M MIN TIME---08:55H:M U.L.--------00:00

EXCHANGE RATE---5dB --90dB THRESHOLD    --80dB THRESHOLD     3dB EXCHANGE RATE
CRITERION------90dB LAVG---------87.8dB LAVG---------90.3dB LEQ----------95.0dB
RANGE----------50dB TWA----------73.8dB TWA----------75.3dB SEL----------120.0dB
TIME CONSTANT -SLOW DOSE----------9.26% DOSE----------13.05% DOSE----------25.30%
WEIGHTING------A 8hr DOSE-------74.0% 8hr DOSE------104.4% 8hr DOSE------202.3%

EVENT-------1
START TIME-08:31H:M --90dB THRESHOLD    --80dB THRESHOLD     3dB EXCHANGE RATE
RUN TIME----- 00:27 LAVG---------91.9dB LAVG---------93.3dB LEQ----------93.9dB
PEAK LEVEL---135.6dB DOSE---------- 67% DOSE---------- 81% DOSE----------1.25%
MAX----------96.0dB 8hr DOSE------131.3% 8hr DOSE------159.2% SEL----------115.9dB

EVENT-------2
START TIME-08:55H:M --90dB THRESHOLD    --80dB THRESHOLD     3dB EXCHANGE RATE
RUN TIME----- 11:53 LAVG---------93.3dB LAVG---------93.9dB LEQ----------96.5dB
PEAK LEVEL---138.7dB DOSE----------3.96% DOSE----------4.87% DOSE----------11.17%
MAX----------107.6dB 8hr DOSE------160.4% 8hr DOSE------172.9% SEL----------125.0dB

 --80dB THRESHOLD      3dB EXCHANGE RATE
  1 MIN HISTOGRAM
08:15  98  88  84  99  00dB                +----------+----------+  93dB
08:20  00  91  95  86  00dB                +----------+----------+  89dB
08:25 103  90  75  90  92dB                +----------+----------+  94dB
08:30  90 100  92  79  81dB                +----------+----------+  94dB
08:35  80  80  00  87  82dB                +----------+----------+  82dB
08:40  85  85  90  92  87dB                +----------+----------+  88dB
08:45  87  87  87 100 102dB                +----------+----------+  96dB
08:50  90  81  83  84  80dB                +----------+----------+  86dB
08:55  86  83  77  84  77dB                +----------+----------+  82dB
09:00  70  70  86  82  87dB                +----------+----------+  82dB
09:05  85  85  85  85  85dB                +----------+----------+  85dB
09:10  85  82  80  80  80dB                +----------+----------+  83dB
09:15  80  81  80  80  80dB                +----------+----------+  81dB
09:20  00  00  00  00  00dB              3dB

 --80dB THRESHOLD      3dB EXCHANGE RATE
% TIME STATISTICAL DISTRIBUTION
 50dB   --.00 -- 00 -- 00 --.00 -- 00%  +      0%
 55dB   --.00 -- 00 -- 00 --.00 -- 00%  +      0%
 60dB   --.00 -- 00 -- 00 --.00 -- 00%  +      0%
 65dB   --.00 -- 00 -- 00 --.21 -- 02%  +      5%
 70dB   -1.64 -4.02 --.97 --.93 -1.69%  +-----    9.3%
 75dB   -1.43 -1.33 --.40 --.62 --.21%  +-    3.9%
 80dB   -1.98 10.16 -3.65 -3.33 -1.40%  +----------+----------+  31.5%
 85dB   13.65 -4.35 -1.14 -8.39 -2.81%  +----------+----------+  30.7%
 90dB   -2.23 --.38 -2.24 -1.02 -1.07%  +----    7.5%
 95dB   -2.26 -4.22 --.13 --.13 --.22%  +---     6.6%
100dB   -3.56 -3.02 --.71 -1.00 --.01%  +-----   8.3%
105dB   --.02 --.03 --.18 --.52 --.00%  +       7%
110dB   --.00 --.00 --.00 --.00 --.00%  +       0%
% DOSE STATISTICAL DISTRIBUTION
 30dB   --.00 -- 00 -- 00 --.00 -- 00%  +      0%
 35dB   --.00 -- 00 -- 00 --.00 -- 00%  +      0%
 40dB   --.00 -- 00 -- 00 --.00 -- 00%  +      0%
```

## Specifications

**Standards:**
ANSI S1.4-1983 type 2
ANSI S1.25-1978
IEC 651 type 2

**Detector:**
True RMS; 63dB pulse range

**Display:**
Liquid crystal display

**Printout:**
RS-232 serial at 300, 600, 1200 or 2400 baud or Centronics parallel
Connector: 20-pin shrouded header

**Microphone:**
8-mm PZT ceramic 36-inch cable, field replaceable

**Battery:**
Single 9-volt alkaline, 80-hour battery life

**Temperature:**
-15° to 50°C operating: -40° to 60°C storage (battery removed)

**Humidity:**
0 to 95%

**Magnetic Field Effects:**
Negligible below 50 Oersteds at 50 to 60 Hz.

**Size:**
5½ x 2¾ x 1⅜ inches
(140 x 70 x 40 mm)

**Weight:**
14 ounces (400 grams)

**Construction:**
Cast aluminum housing with tamper-, water-, and dust-resistant security cover.

(UL) **Listed for intrinsic safety:**
Class I, Groups C and D
Class II, Groups E, F and G
Class III.

## Kits

**M-2712 Kit:**
Includes M-27 dosimeter, CA-12B calibrator, WS-5 windscreen, 8-mm calibrator adaptor, printer cable, and padded carrying case. (80-column printer is optional)

**5M-2712 Kit:**
Includes 5 M-27 dosimeters, one CA-12B calibrator, WS-5 windscreens, 8-mm calibrator adaptor, printer cable, and padded carrying case. (80-column printer is optional)

**10M-2712 Kit:**
Includes same as the above but with 10 dosimeters

Other multi-pack combination kits are available

## Accessories

**58-052** Earloop holds microphone at the ear and can be used to measure relative sound under an earmuff

**TP-2** Tripod

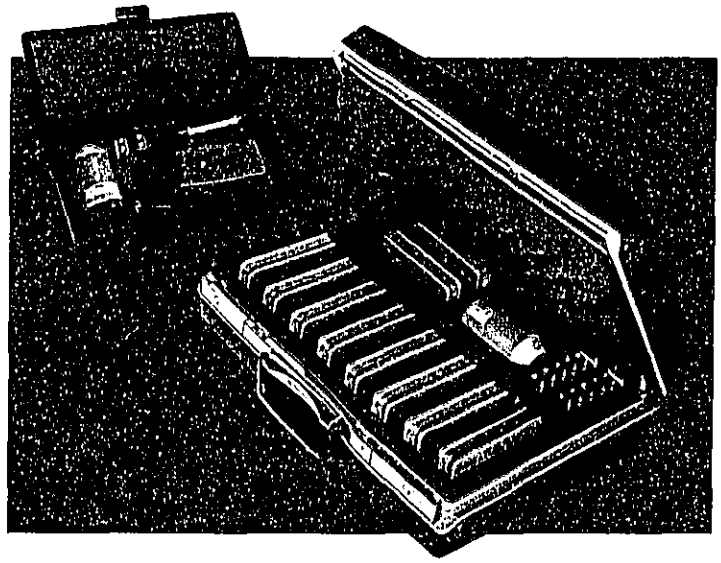
**WS-5** Windscreen for 8-mm Microphone

**58-039** Microphone Adaptor

**Printer** – 80-column

**58-047** Field Replaceable Microphones

**59-039** IBM Compatible Software Package



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Revised 1-87
98-224

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QUEST ELECTRONICS

# Micro-15 Noise Dosimeter

## Sound Level Meter & Integrating Sound Level Meter

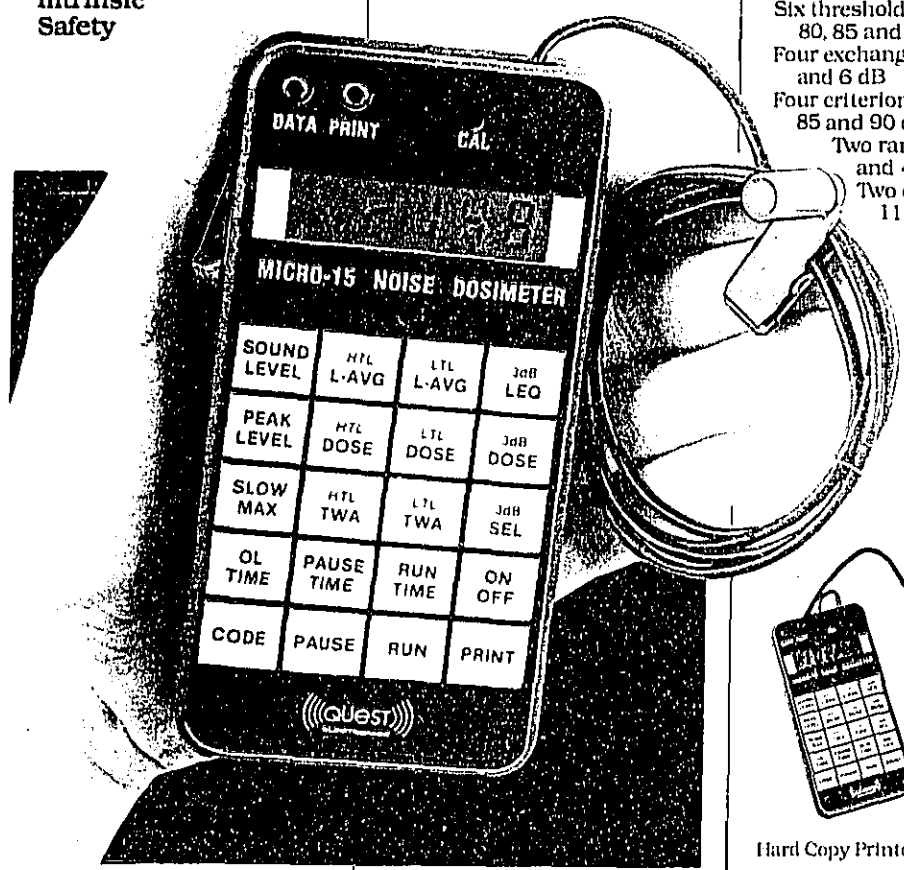
- Monitors 15 Functions Simultaneously
- Provides for Hard Copy Printouts
- Measures Accurately in all Noise Environments — Continuous, Intermittent, Impulsive
- (UL) Listed for Intrinsic Safety
- MSHA Approved
- RS-232 Computer Interface

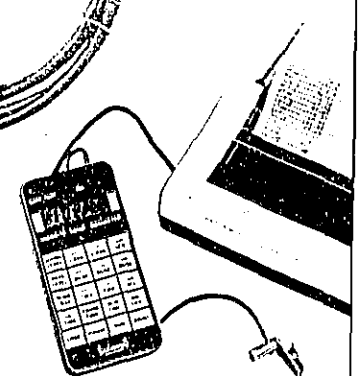
With the simple push of a button you can read

Three Different Noise Dosages
Three Average Sound Levels
Two Time-Weighted Averages
Sound Exposure Level
Sound Level with Slow Time Constant
Peak Sound Level
Maximum Slow Sound Level
Run Time
Pause Time
Overload Time

With the user-settable internal switches you can expand the capacity of the MICRO-15 by selecting from

Six threshold levels — 0, 70, 75, 80, 85 and 90 dB
Four exchange rates — 3, 4, 5 and 6 dB
Four criterion levels — 70, 84, 85 and 90 dB
Two ranges — 50-146 dB and 40-126 dB
Two overload levels — 115 and 140 dB on high range, 90 and 115 dB on low range
Two frequency weightings — A and C



Hard Copy Printouts of all Functions

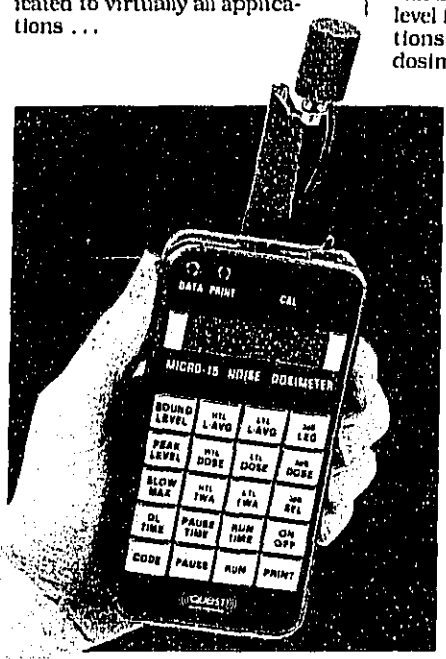
## DESCRIPTION

The MICRO-15 Dosimeter is a microprocessor-based multi-function meter system. It functions as a noise dosimeter that simultaneously monitors two noise doses with variable thresholds, criterion levels, exchange rates, ranges, overload levels and frequency weightings that are selected by the user. The MICRO-15 computes the integrated sound level, time-weighted average, 3 dB dose, equivalent sound level, sound exposure level, sound level, peak sound level, and maximum slow sound level.

Three timing functions are provided: total pause time of the instrument; total run time; and the time the sound level exceeded the selected overload level.

Hard copy printouts of all 15 functions can be made. Expansion capability for histograms and statistical analysis is provided through a data output jack.

With the selectable parameters the MICRO-15 can be dedicated to virtually all applications . . .




U.S. OSHA Compliance and Hearing Conservation Applications: Measurements based on a 5 dB exchange rate and two different thresholds (80 and 90 dB) can be made simultaneously. The TWA-8 hour equivalent is automatically computed.

U.S. DOD 4 dB Exchange Rate Applications: 80 dB threshold and 84 dB-8 hour criterion level — or other settings as needed — can be made. Readouts of dose, average sound level, and time weighted average are provided.

Industrial Noise Applications (Worldwide other than U.S.) with 3 dB Exchange Rate: The threshold level and 8-hour criterion level are easily selected. Readouts of both dose and equivalent sound level are produced.

Community Noise Applications: Measurements can be made within two ranges: 40-126 dB or 50-146 dB. Readouts of equivalent sound level and sound exposure level (SEL) based on a one-second equivalent are provided.

At any time, with the MICRO-15 functioning as a dosimeter, it can be switched to check sound level functions and clock functions without disturbing the dosimeter operation.

The MICRO-15 can be calibrated with any Quest calibrator merely by checking and adjusting while reading the sound level.

## DESIGN CONCEPTS AND FEATURES

The design objectives of the MICRO-15 were threefold: to give the user maximum readout information, maximum versatility in setting parameters, and capability for making permanent hard copy printouts of all 15 functions.

There is built-in protection against accidental loss of accumulated data. The ON-OFF switch must be depressed for

five seconds in order to deactivate the circuits. However, accumulated data is retained even though the circuits are deactivated. Accumulated data is also retained when the PAUSE switch is depressed to stop the accumulation of data. The only way that data can be removed from memory is to depress two switches simultaneously for five seconds.

The high crest factor permits measurements of exceptional accuracy in extremely impulsive noise environments.

The MICRO-15 is not merely a sampling system. It utilizes a true integrator to insure accurate accumulation of data. The C-MOS microprocessor circuitry provides for a long battery life (80 hours) and reliable operation.

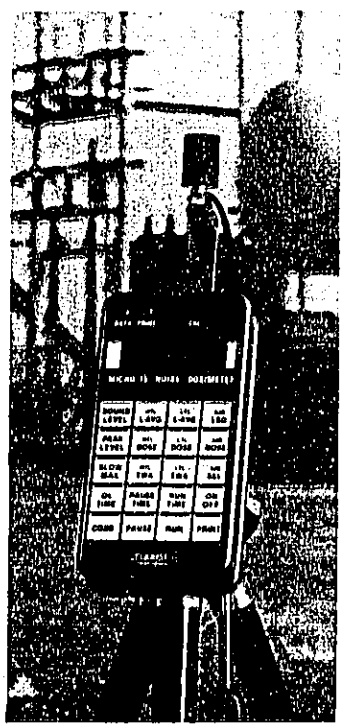
A CODE switch lets the user check the internal parameter switch settings without removing the back cover.

A DATA jack permits transfer of internal data to the NL-15 Noise Data Logger for histogram and statistical analysis. A PRINT jack provides for making hard copy printouts of the internal data. (See sample printout on next page.)

## CONSTRUCTION

The MICRO-15 has a rugged aluminum housing. Covers are water- and dust-resistant. The microphone is specially constructed to resist cable breakage and is also specially shielded against RF or magnetic field interference.

The instrument is used in several ways. It can be held in the hand, carried in a shirt pocket, hooked on a belt, or mounted on a tripod. When used as a hand-held instrument, the microphone is mounted on a bracket as illustrated.



## MEASUREMENT FUNCTIONS

The abbreviations used are defined as follows:

HTL — High Threshold Level
LTL — Low Threshold Level
L-AVG — Average Sound Level
LEQ — Equivalent Sound Level
TWA — Time Weighted Average
SEL — Sound Exposure Level

| | |
|---|---|
| HTL L-AVG | LTL L-AVG |
| HTL DOSE | LTL DOSE |
| HTL TWA | LTL TWA |

All parameters of above functions — threshold, exchange rate, criterion level, range, overload level, and weighting — are settable.

Following 3 functions have 3 dB Exchange Rate

**3 dB LEQ** — Continuous averaging. Can be read at any time.

**3 dB DOSE** — No threshold. Settable 8-hour criterion level.

**3 dB SEL** — Total sound exposure expressed in decibels and compressed into a 1-second equivalent.

**SOUND LEVEL** — Reads sound level each second. Slow time constant.

**PEAK LEVEL** — Reads peak level of impulses 100 milliseconds or longer.

**SLOW MAX** — Reads maximum sound level that occurred during the measuring period. Slow time constant.

**RUN TIME** — Length of time unit has been collecting data.

**PAUSE TIME** — Length of time unit has been in pause mode.

**OL TIME** — Length of time sound level has exceeded the overload level.

### Controls

**ON OFF** — Turns unit on and off without erasing memory.

**CODE** — Produces coded display to verify internal parameter settings.

**PAUSE** — Places unit in holding mode. Sound level reading is active.

**RUN** — Starts, or continues, accumulation of dose data.

**PRINT** — Permits stored information of all 15 functions and 7 parameters to be transferred to external printer. All information remains stored in MICRO-15.

DATA Jack — for connecting MICRO-15 to the NL-15 Data Logger.

PRINT Jack — for connecting MICRO-15 to a printer.

## PRINTOUT

The printout identifies the unit number of the MICRO-15 used, the parameter settings, and the values of the 15 functions being monitored. Hard copy printouts are effective to verify survey results for legal and regulatory purposes.

The MICRO-15 will accept a variety of printers with RS-232C serial interface operating at 600 baud.

```
QUEST  MICRO-15
NOISE DOSIMETER
UNIT----------6
RANGE--------50
E.R.----------5
HTL----------90
LTL----------80
CRIT---------90
O.L.--------115
WEIGHT--------A
---------------
---------------
---------------
---------------
SPL--------78.5
PEAK------122.2
MAX--------117.7
HLAVG-----90.31
HDOSE-----12.69
HTWA------75.15
LLAVG-----91.40
LDOSE-----14.73
LTWA------76.25
LEQ-------93.66
3DOSE-----28.25
SEL------129.09
PTIME------5:13
RTIME-----58:09
OLTIME-------:10
```

## SPECIFICATIONS

Standards:
- ANSI S1.4-1983 type 2
- ANSI S1.25-1978 type 2
- IEC 651 type 2 (Sound level meter mode reads instantaneous slow response level once each second)

Detector: True RMS; 63 dB Pulse Range and Crest Factor

Readout:
- 4-1/2 Digit Liquid Crystal Display
- Dose: .01% to 19999.%
- Time: hours, minutes, seconds
- Decibels: dBA or dBC; 0.1 dB increments

Microphone: 8 mm, Omnidirectional PZT ceramic with collar clip and 36-inch cable

Battery: Single 9-volt Alkaline; 80-hour battery life

Battery Indicator: Shows that at least 8-hour operating life is still available

Calibration: External Calibrator

Temperature: -10° to +50°C operating; -40° to +60°C storage (battery removed)

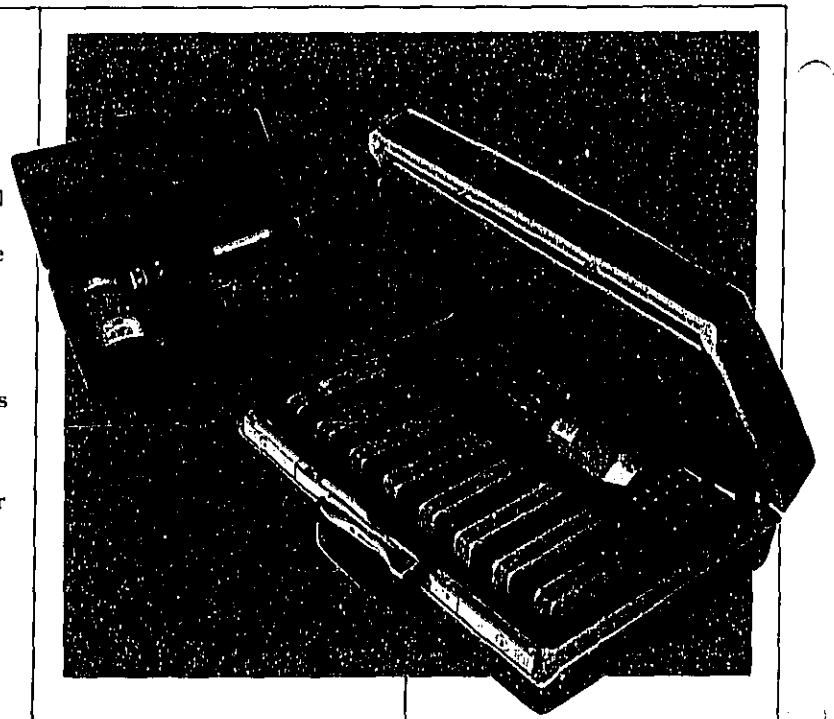
Humidity: 0-95% R.H.

Magnetic Field Effects: Dosimeter will accumulate equivalent to a level less than 70 dB in a magnetic field of 4000 A/M (50 oersteds) at 50 or 60 Hz

Size: 2.5 x 5.1 x 1.3 inches (64 x 130 x 33 mm) overall

Weight: 11 ounces (315 grams) including battery and coverplate

Construction: C-MOS, microprocessor circuitry in rugged aluminum housing with tamper-, water- and dust-resistant security cover



## KITS

MICRO-1512 Kit: Includes MICRO-15 Dosimeter and CA-12B Calibrator in a padded kit case, spare batteries, micro plug, 8mm adaptor, WS-5 windscreen and mic bracket.

5MICRO-1512 Kit: Includes 5 MICRO-15 Dosimeters and one CA-12B Calibrator in a padded carrying case, with spare batteries, micro plug, 8mm adaptor, WS-5 windscreens and mic brackets.

10MICRO-1512 Kit: Same as 5MICRO-1512 but with 10 Dosimeters.

## ACCESSORIES

NL-15 Noise Data Logger

Software for MICRO-15 to:
- Radio Shack TRS-80, Models III & IV — 58-518
- IBM Personal — 58-519
- Epson HX-20 — 58-520

58-852 Earloop holds microphone at the ear and can be used to measure relative sound under an earmuff.

TP-2 Tripod

WS-5 Windscreen for 8mm microphone

58-839 Microphone adaptor

Printer, RS TRP-100, 80-column

Printer Paper, 59-250 Thermal Roll for 80-column

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QUEST ELECTRONICS

# NL-15 Noise Data Logger
## . . . a Micro-15 Noise Dosimeter Accessory

### Time-History and Statistical Analysis of Industrial and Community Noise Measurements

**Expands the capability of the MICRO-15 Noise Dosimeter . . .**

- Logs minute-by-minute histograms, percent time distributions and percent dose distributions.
- Calculates 19 different noise functions.
- Printout to serial or parallel printers.
- Editing capability during printout 1-, 3-, 5-, or 10-minute histograms. Tabular and/or graphic printout. Print all or selected data.
- 12- or 24-hour clock.

**Additional Capabilities**

Dual threshold one-minute HISTOGRAMS; selectable threshold and exchange rate.

True Leq, 3 dB exchange rate, one-minute HISTOGRAM.

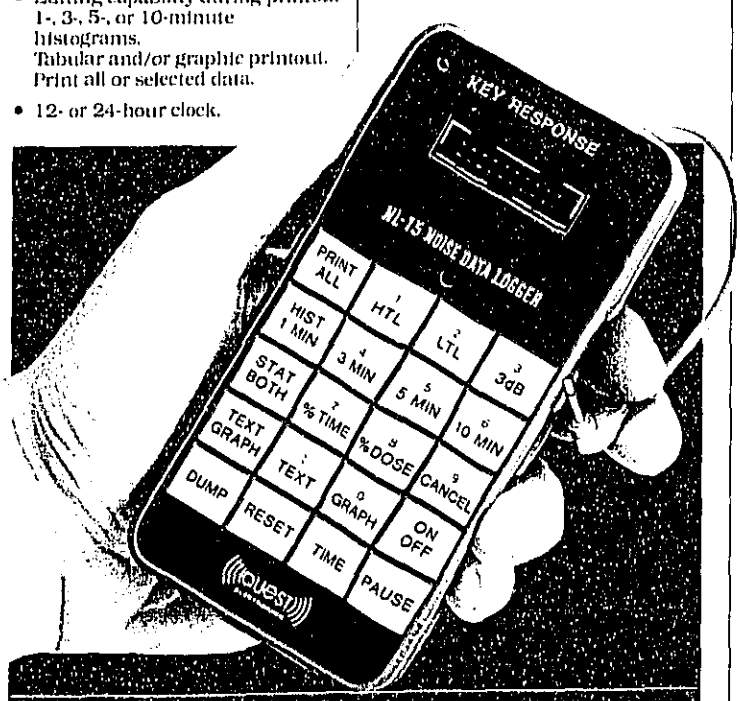
Percentage of TIME and percentage of DOSE STATISTICAL DISTRIBUTIONS.

AVERAGE SOUND LEVEL, DOSE, TWA, and SOUND EXPOSURE LEVEL (SEL).

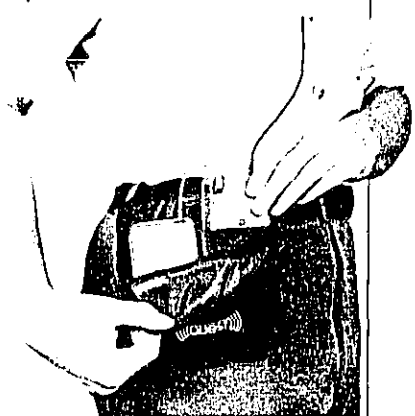
PEAK level, SLOW MAX level and time events occurred.

START time, RUN time, END time, PAUSE time and OVERLOAD time.

Direct connection to printers and computers: Centronics type parallel or RS-232 serial inputs with selectable baud rates.




The NL-15 comes with security cover, canvas carrying pouch, cable connection to MICRO-15 and printer cable.



**SPECIFICATIONS**

Key Response Indicator: LED

Printer Output: Centronics parallel or RS-232 serial

Histogram Time: 17 hours

Connector: 20-pin low profile shrouded header; AMP103308-5 or equivalent

Battery: Single 9-volt alkaline, 80-hour battery life

Battery Indicator: Key response indicates at least 8-hour battery life available

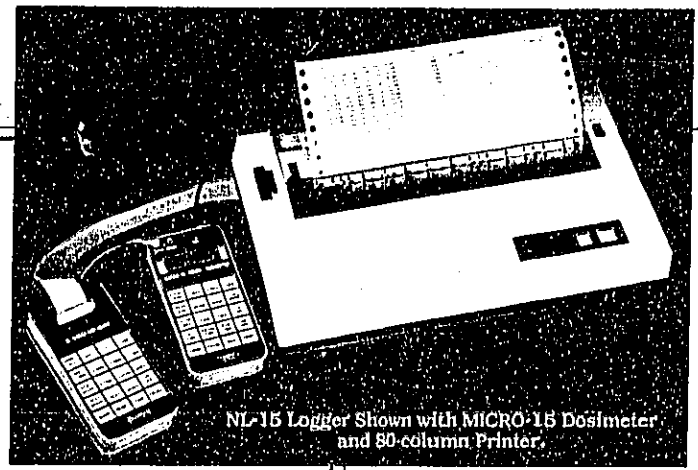
Operating Temperature: −10 to +50°C

Humidity: 0 to 95% R.H.

Size: 2.5 × 5.1 × 1.3 inches (64 × 130 × 33 mm)

Weight: 11 ounces (315 grams) including battery and coverplate

Construction: CMOS microprocessor in rugged aluminum housing. Security cover provides tamper-, water- and dust-proof operation




```
QUEST NL-15 NOISE DATA LOGGER
NAME
-----------------------------------------
I.D. #
-----------------------------------------
WORK STATION
-----------------------------------------
COMMENTS
-----------------------------------------
-----------------------------------------
-----------------------------------------

EXCHANGE RATE---5DB   THRESHOLD---90DB
CRITERION------90DB   LAVG-----97.94DB
RANGE----------50DB   TWA------83.47DB
WEIGHT---------"A"    DOSE------40.15%
CODE-------0E 0E 01

RUN TIME----1:05HRM   THRESHOLD---90DB
PAUSE TIME---:11HRM   LAVG-----98.53DB
START TIME-12:30HRM   TWA------84.06DB
END TIME---01:45HRM   DOSE------43.63%


PEAK LEVEL--125.6DB   3DB NO THRESHOLD
PEAK TIME--01:05HRM   LEQ------104.97DB
SLOW MAX----120.7DB   TWA------96.26DB
SLOW TIME--01:12HRM   SEL------140.81DB
OVERLOAD-------115DB  DOSE------419.5%
O.L. TIME---3:38MIN

90DB  THRESHOLD  EXCHANGE RATE---5DB
 1 MIN. HISTOGRAM
12:30  85  86  86  86  89dB          +----+----+----+--- 87.0dB
12:35  86  86  86  87  87dB          +----+----+----+--- 87.0dB
12:40  95  81  00  84  85dB          +----+----+----+--- 87.5dB
12:45 112 112 111  86  85dB          +----+----+----+----+----+----+---108.7dB
12:50  69  00  00  00  00dB          +--- 57.4dB
12:55  69  88  85  90  90dB          +----+----+----+--- 87.5dB
01:00  92  90  90  90  92dB          +----+----+----+--- 91.4dB
01:05  95  85  88  65  61dB          +----+----+----+--- 87.7dB
01:10  00 102 120 109  64dB          +----+----+----+----+---111.9dB
01:15  99 104  98  90  85dB          +----+----+----+----+--- 98.3dB
01:20  85  85  85  85  92dB          +----+----+----+--- 87.9dB
01:25  85  80  69  67  57dB          +----+----+--- 78.0dB
01:30  53  00  00  64  63dB          +---- 50.2dB
01:35  67  80  83  92  91dB          +----+----+----+--- 87.4dB
01:40  00  00  00  00  00dB          dB
01:45  00  00  00  00  00dB          dB

90DB  THRESHOLD  EXCHANGE RATE---5DB

% TIME STATISTICAL DISTRIBUTION
 50dB  ---.00---.00---.00---.00---.00%  +    .00%
 55dB  ---.00---.00---.00---.00---.00%  +    .00%
 60dB  ---.00---.00---.00---.00---.00%  +    .00%
 65dB  ---.00---.00---.00---.00---.00%  +    .00%
 70dB  ---.07---.38--2.06--1.53--1.85%  +-   5.89%
 75dB  --3.92--1.20--1.05--3.86--9.07%  +----+---- 19.10%
 80dB  --3.07--1.11--2.53---.34--1.37%  +----  8.42%
 85dB  -17.03--6.95-12.59--2.39---.63%  +----+----+----+---- 39.50%
 90dB  --2.00--7.83---.38--3.07---.25%  +----+- 13.50%
 95dB  ---.19---.21---.49---.37---.21%  +  1.47%
100dB  ---.20---.23---.37---.34---.86%  +-  2.00%
105dB  --1.06---.53---.34---.21---.46%  +-  2.60%
110dB  --1.18---.10---.05--3.84---.11%  +-  5.28%
115dB  ---.02---.00---.01---.01---.02%  +   .06%
120dB  ---.53--1.14---.00---.00---.00%  +  1.67%

% DOSE STATISTICAL DISTRIBUTION
 50dB  ---.00---.00---.00---.00---.00%  +    .00%
 55dB  ---.00---.00---.00---.00---.00%  +    .00%
 60dB  ---.00---.00---.00---.00---.00%  +    .00%
 65dB  ---.00---.00---.00---.00---.00%  +    .00%
 70dB  ---.00---.00---.02---.01---.02%  +    .05%
 75dB  ---.06---.02---.02---.09---.26%  +    .45%
 80dB  ---.10---.04---.11---.01---.07%  +    .33%
 85dB  --1.13---.53--1.10---.24---.07%  +-  3.07%
 90dB  ---.26--1.19---.06---.62---.05%  +-  2.18%
 95dB  ---.05---.06---.17---.14---.10%  +   .52%
100dB  ---.11---.14---.26---.27---.79%  +  1.57%
105dB  --1.13---.64---.48---.35---.85%  +-  3.45%
110dB  --2.52---.25---.16-12.42---.42%  +------+- 15.70%
115dB  ---.09---.03---.08---.09---.19%  +    .48%
120dB  --4.55-11.21---.00---.00---.00%  +----+-- 15.70%
```

**Biographical Data**

**Summary Data**

SAMPLE PRINTOUT

**1-Minute Histogram Tabular and Graphic**

**Percent of Time Accumulated at Each dB Level Tabular and Graphic**

**Percent of Dose Accumulated at Each dB Level Tabular and Graphic**

**A Total Sound Measurement and Analysis System . . .**

When used with the MICRO-15 Dosimeter and a compatible printer, the microprocessor-controlled NL-15 Noise Data Logger provides a wealth of printout information. The sample printout illustrates only a selected portion of the printout available.

**KITS**

Single Kit, Model M15-NL15-12 includes MICRO-15 Dosimeter, NL-15 Logger, CA-12B Calibrator and printer cable. (80-column printer is optional.)

Other multi-pack combination kits are available.

**ACCESSORIES**

Printer, RS TRP-100 (80 column)
59-818 Cable, NL-15 to 80 column printer
59-250 Thermal Paper (80 column)
59-249 Impact Paper (80 column)

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DATA SHEET JANUARY 1987

# SOFTWARE FOR THE M-27 NOISE LOGGING DOSIMETER

## GENERAL DESCRIPTION

The computer program for the M-27 DOSIMETER:

1. Reads data from the M-27.
2. Saves data on disk files.
3. Writes new files and existing disk files to the computer's printer.
4. Enables easy access to word processing programs for personalization of your M-27 disk files.
5. Calculates exceedance levels.
6. Calculates and displays unlimited interruptable histograms with one to sixty minute integration times.
7. Communicates via RS-232C serial port.

The M-27 software is written in BASIC to allow for modification by the advanced programmer.

Along with the M-27 software you also receive a sample TEXT file and a sample DATA file. These are provided to help the user become familiar with the program operation.

The M-27 software is currently available for IBM Personal computers and IBM compatables.

## SAMPLE OF IBM SCREEN AND PRINTOUTS

M-27 DATA SUMMARY

| | | | |
|---|---|---|---|
| CAL LEVEL--- 49.9dB | UNIT------ 3 | | |
| START TIME-11:25H:M | END TIME--11:51H:M | RUN TIME- 0H:21M:24S | PAUSE- 0H: 5M: 4S |
| PEAK LEVEL--145.5dB | MAX LEVEL--120.0dB | MIN LEVEL----- 50.25 | UPPER LIM.--115dB |
| PEAK TIME--11:46H:M | MAX TIME--11:29H:M | MIN TIME----11:46H:M | U.L.-- 0H: 0M:26S |
| | | | |
| EXCHANGE RATE- 5 dB | 90 dB THRESHOLD | 80 dB THRESHOLD | 3dB EXCHANGE RATE |
| CRITERION---- 90 dB | LAVG-------104.3dB | LAVG---------104.4dB | LEQ-------107.2dB |
| RANGE-------- 50 dB | TWA-------- 81.9dB | TWA---------- 82.0dB | SEL-------138.3dB |
| TIME CONSTANT--slow | DOSE------- 32.35% | DOSE--------- 32.87% | DOSE------22e.61% |
| WEIGHTING---------A | 8HR DOSE---725.35% | 8HR DOSE-----737.02% | 8HR DOSE--999.99% |
| | | | |
| EVENT------ 1 | | | |
| START TIME-11:26H:M | 90 dB THRESHOLD | 80 dB THRESHOLD | 3dB EXCHANGE RATE |
| RUN TIME---- 1M: 9S | LAVG-------106.2dB | LAVG---------106.2dB | LEQ-------107.4dB |
| PEAK LEVEL--120.4dB | DOSE-------- 2.30% | DOSE--------- 2.30% | DOSE------ 13.1% |
| MAX---------110.3dB | 8HR DOSE---948.33% | 8HR DOSE-----949.25% | SEL-------125.7% |

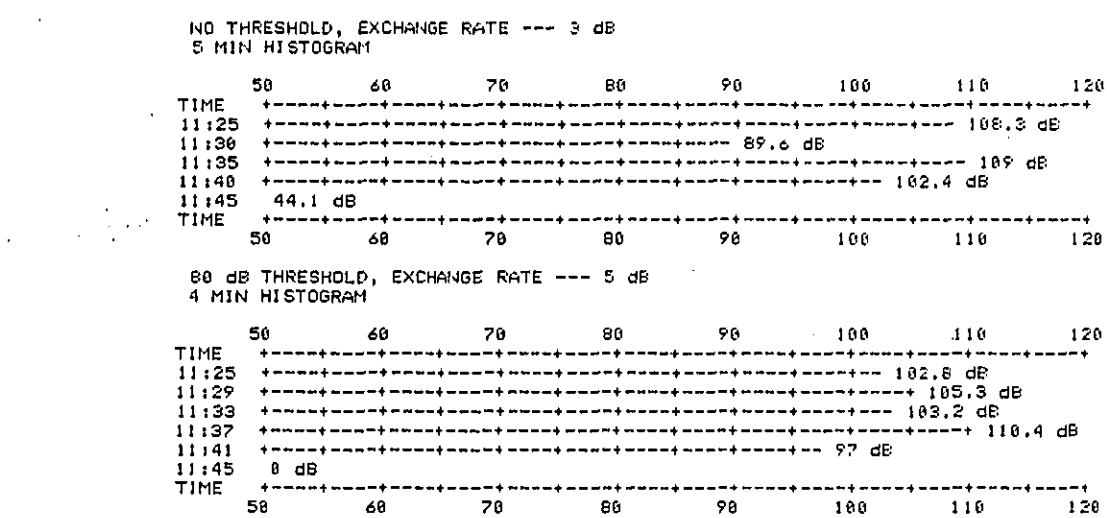
SAMPLE OF EXCEEDANCE LEVELS

EXCEEDANCE LEVELS

L 33.33 IS EQUAL TO, OR EXCEEDS 110 DECIBELS
L 35.00 IS EQUAL TO, OR EXCEEDS 110 DECIBELS
L 40.00 IS EQUAL TO, OR EXCEEDS 101 DECIBELS
L 50.00 IS EQUAL TO, OR EXCEEDS 86 DECIBELS
L 90.00 IS EQUAL TO, OR EXCEEDS 50 DECIBELS

L 33.33, L 35.00, etc.= percentages of RUN TIME.
33.33% of the run time, the sound level was equal to or exceeded 110 decebels.
40% of the run time, the sound level was equal to or exceeded 101 decibels.

SAMPLE OF HISTOGRAMS



QUEST ELECTRONICS

510 South Worthington
Oconomowoc, WI 53066 USA
Phone: 414-567-9157

DATA SHEET JULY 1984

SOFTWARE PROGRAMS FOR MICRO-15 NOISE DOSIMETER

GENERAL DESCRIPTION

The computer program for the Micro-15 noise dosimeter:

1. Reads the Micro-15.
2. Formats data for full screen and wide printers.
3. Allows user to add headings and comments.
4. Estimates the dose, time weighted average, and sound exposure level based on actual work day.
5. Inserts the date.
6. Saves multiple dosimeter records on floppy or cassette.
7. Reads records from floppy or cassette.
8. Prints on the computer's printer.
9. Communicates via RS-232 port.

The programs are written in BASIC on a floppy or cassette.

Computer programs are currently available for the Radio Shack Model III and IV, the IBM Personal Computer, and the Epson HX-20.

SAMPLE OF RADIO SHACK SCREEN AND PRINT OUT

```
     QUEST  MICRO-15 NOISE DOSIMETER     DATE 4/26/84
NAME MAGGIE JONES                        I. D.# 123-45-6789
WORK STATN  SHOP LEADER   COMMENTS  N.C. DRILL ROOM
UNIT    5          50- 146DB RANGE       90DB CRITERION
5DB EXCHANGE RATE   'A' WEIGHTING        115DB OVERLOAD
SPL         50.9DB   PEAK       122.6DB  SLOW MAX  115.5DB
RUN TIME     6:32    PAUSE TIME  45:06   O.L. TIME      :02
90DB THRESHOLD       80DB THRESHOLD       3DB NO THRESHOLD
L-AVG       86.38DB  L-AVG       89.04DB  LEQ         95.42DB
DOSE          .82 %  DOSE         1.19 %  DOSE         4.74 %
TWA         55.44DB  TWA         58.10DB  SEL        121.34DB
EST DOSE     57.1 %  EST DOSE    82.87 %  EST DOSE   330.1 %
EST TWA     85.95DB  EST TWA     88.64DB  EST SEL    139.77DB
WORK DAY (HR:MN) 7:35              TYPE 1=NEW, 2=FROM DISK
3=TO DISK, 4=PRINT, 5=WORK DAY, 6=COMMENTS, 7=DIR
```

The print out shows that if the 6 minute and 32 second sample taken on 4/26/84 for Maggie Jones in the N.C. Drill Room is representative for her 7 hour and 35 minute work day then:

1. She should be placed in the Hearing Conservation Program because, the estimated time weighted average with an 80 dB threshold is over 85 dB.
2. Engineering controls are not required because, the estiminated time weighted average with a 90 dB threshold is less than 90 dB.
3. She is exposed to noise levels above 115 dB for part of the time.

Price of above programs with interconnect cable - $195.00

510 South Worthington
Oconomowoc, WI 53066 USA
Phone: 414-567-9157

DATA SHEET JUNE 1986

SOFTWARE FOR THE NL-15 DATA LOGGER

GENERAL DESCRIPTION

The computer program for the NL-15 Data Logger:

1. Reads data from the NL-15.
2. Saves data on disk files.
3. Writes new files and existing disk files to the computer's printer.
4. Enables easy access to word processing programs for personalization of your NL-15 disk files.
5. Calculates exceedance levels.
6. Calculates and displays unlimited interruptable histograms with one to sixty minute integration times.
7. Communicates via RS-232C serial port.

The NL-15 software is written in BASIC to allow modification by the advanced programmer.

Computer programs are currently available for the IBM Personal Computer and IBM compatables.

SAMPLE OF IBM SCREEN AND PRINTOUTS

NL-15 DATA SUMMARY

| | | | |
|---|---|---|---|
| EXCHANGE RATE | 5 DB | THRESHOLD | 80 DB |
| CRITERION | 90 DB | LAVG | 99.43 DB |
| RANGE | 30 DB | LAVG | 303.34 DB |
| WEIGHT | (A) | DOSE | 303.34% |
| RUN TIME | 6HR:33M:50S | THRESHOLD | 80 DB |
| PAUSE TIME | 0HR: 1M:16S | LAVG | 99.44 DB |
| START TIME | 8:00 | TWA | 98.03 DB |
| END TIME | 2:33 | DOSE | 303.47% |
| PEAK LEVEL | 130.18 DB | 3DB DOUBLING | NO THRESHOLD |
| PEAK TIME | 12:56 | LEQ | 109.54 DB |
| SLOW MAX | 110.39 DB | TWA | 102.99 DB |
| SLOW TIME | 11:23 | SEL | 147.27 DB |
| OVERLOAD | 115 DB | DOSE | 1353.56% |
| O.L. TIME | 0HR: 0M: 0S | | |

SAMPLE OF EXCEEDANCE LEVELS

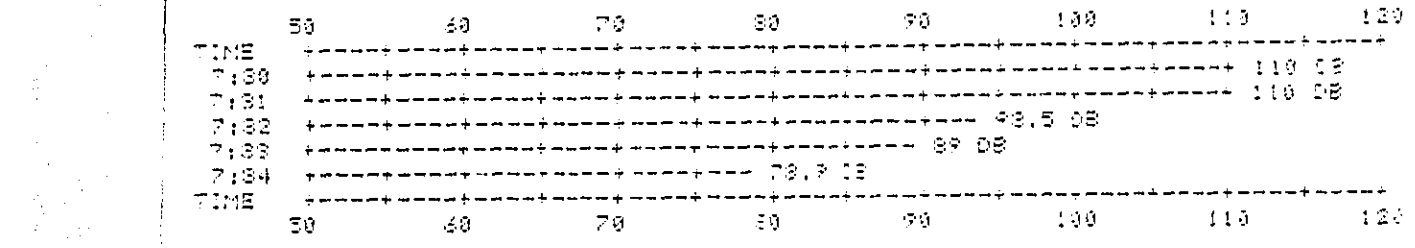
EXCEEDANCE LEVELS

L 10.00 IS EQUAL TO, OR EXCEEDS 110 DECIBELS
L 25.00 IS EQUAL TO, OR EXCEEDS 94 DECIBELS
L 33.33 IS EQUAL TO, OR EXCEEDS 90 DECIBELS
L 50.00 IS EQUAL TO, OR EXCEEDS 82 DECIBELS
L 75.00 IS EQUAL TO, OR EXCEEDS 91 DECIBELS

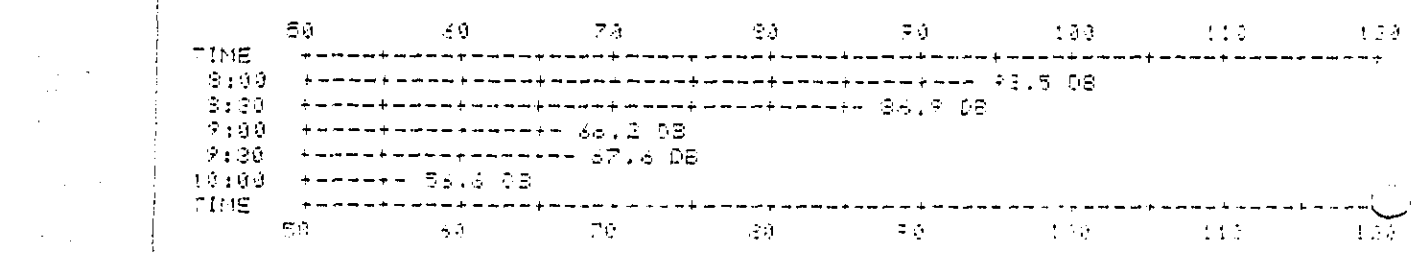
L 10.00, L 25.00, etc.= percentages of RUN TIME.
10% of the run time, the sound level was equal to or exceeded 110 decibels.
25% of the run time, the sound level was equal to or exceeded 94 decibels.

SAMPLE OF HISTOGRAMS

80 DB THRESHOLD, EXCHANGE RATE ---5DB
1 MIN HISTOGRAM




3 DB, NO THRESHOLD
30 MIN HISTOGRAM



QUEST ELECTRONICS

# M-7B Noise Dosimeter

## The Industrial Hearing Conservation Instrument . . . measures noise exposure based on OSHA criteria . . . for quick surveys and long term monitoring


- 80-130dB(A) range; 140dB peak
- 30dB Crest Factor; true RMS detector
- Daylong monitoring or short term sample surveys
- Simple conversion to OSHA equivalent decibel level
- Memory unit stores exposure data — even if switch is turned off
- Rapid, accurate calibration
- 80-90dB(A) jumper-adjustable threshold
- U.S. MSHA approved for intrinsic safety
- Tamper-proof security cover
- One small, light, sturdy package — with one 9-volt battery and long battery life — easily carried in shirt pocket or on belt.

# M-7B NOISE DOSIMETER

The M-7B Noise Dosimeter is a completely automatic personal noise exposure monitor that measures daily exposure as a percentage of the maximum allowed by OSHA. The M-7B is self-contained with both the accumulating monitor and the readout unit combined in a single housing. The exposure is indicated in a 5-digit LED digital readout that extends from 000.01 (.01% of maximum) to 999.99 (999.99% of maximum). A reading of 100.00 signifies that there has been 100% exposure and corresponds to OSHA criterion number 1.

To insure compliance with OSHA requirements, total noise exposure must be measured. In industrial environments where noise levels vary continually, manual computation of noise dose involves tedious day-long measurements with a sound level meter and stop watch in order to determine the noise exposure as computed by the formula

$$D = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots \frac{C_n}{T_n}$$

Where D is noise dose, C is the actual duration of time at a given noise level, and T is the noise exposure time limit per day for that noise level as shown in the OSHA table below. The M-7B Noise Dosimeter automatically performs the entire task of measuring, timing, and computing. The computed dose is directly read at the end of the measurement period.

**Sound level, dB(A)**

| 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 |
|---|---|---|---|---|---|---|---|---|
| 32 | 16 | 8 | 4 | 2 | 1 | 1/2 | 1/4 | 1/8 |

**Maximum exposure time, hours**

The high speed counting and high resolution capability of the M-7B permit accurate day-long exposure determinations from representative short term sample exposure measurements — even periods less than a minute in length. The count rate also permits extremely rapid and accurate calibration of the M-7B.

Accumulated exposure data is stored in the memory unit and will be retained even if the switch is turned off.

If changes are made in OSHA requirements, they can be accommodated with the M-7B. With only minor internal changes the range can be adjusted or extended and the time-dB exchange ratio can be converted from 5dB to 4 or 3dB.

The M-7B is conveniently worn in a shirt pocket or hung on a belt — with the microphone clipped to a shirt collar near the ear. A removable cover over the face of the instrument provides tamper-proof security of accumulated data.

## SPECIFICATIONS

**NOISE LEVEL RANGE:** 80 to 130dB(A), (140dB(A) peak) ref. 20μPa. Threshold and 8-hour criteria level are set to prevailing OSHA requirements or to special user needs.

**TIME-dB EXCHANGE RATIO:** 5dB can be converted internally to 3 or 4dB).

**STANDARD:** ANSI S1.25-1978 type 2.

**FREQUENCY RANGE:** 20Hz to 10KHz. A scale weighted.

**DETECTOR:** True RMS; 30dB Crest Factor.

**THRESHOLD:** Field adjustable — 80 or 90dB.

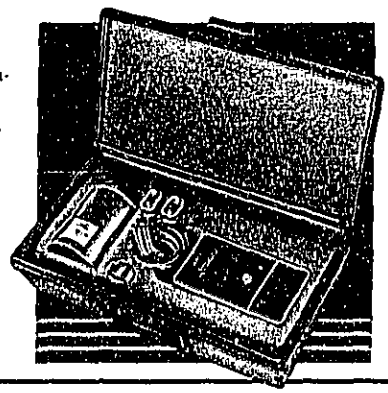
**ACCURACY:** ±0.5dB at 1KHz, 23°C; ±1.0dB at 1KHz, -10 to ±50°C.

**LINEARITY:** ±0.5dB at 1KHz, full range 80-120dB(A).

**READOUT:** Integral LED 5-digit display. Indicates percent of OSHA allowable exposure in increments of .01% from .01% to 999.99%.

**115dB(A) INDICATION:** An internal latch is activated when a noise level above 115dB(A) is received. A light indicator shows that 115dB(A) has been exceeded when pressing the display button.

**BATTERY INDICATOR:** Shows that at least an 8-hour operating life is still available.



**CALIBRATION:** Externally by recessed adjustment.

**MICROPHONE:** High quality, 8 mm diameter PZT ceramic microphone with collar clip and 30 inch cable.

**TEMPERATURE:** -10° to +50°C operating; -40° to +60°C storage (battery removed).

**HUMIDITY:** 0-95% R.H.

**MAGNETIC FIELD EFFECTS:** Dosimeter will accumulate equivalent to a level less than 80dB in a magnetic field of 4000A/M (50 oersteds) at 50 or 60Hz.

**BATTERY:** One 9V alkaline transistor battery. Battery life is approximately 100 hours with normal use.

**SIZE:** 2-1/2 x 4-3/4 x 1-1/4 inches, (6.4 x 12 x 3.2 cm).

**WEIGHT:** 9 oz. including battery (255 grams).

**CONTROLS:**
1. On-Off slide switch.
2. Reset push button (recessed).
3. Display, battery check and 115dB indicator push button.

## KITS AND ACCESSORIES

**M-7B32 Kit,** includes M-7B Dosimeter and CA-32 Field Calibrator (kit illustrated at left).

**5M-7B32 Kit,** includes 5 M-7B Dosimeters and a CA-32 Field Calibrator.

**10M-7B32 Kit,** includes 10 M-7B Dosimeters and a CA-32 Field Calibrator.

**CA-32 Calibrator** with precision solid state timer.

**TP-2 Tripod** for supporting dosimeter when making work area measurements.

Represented by

QUEST ELECTRONICS

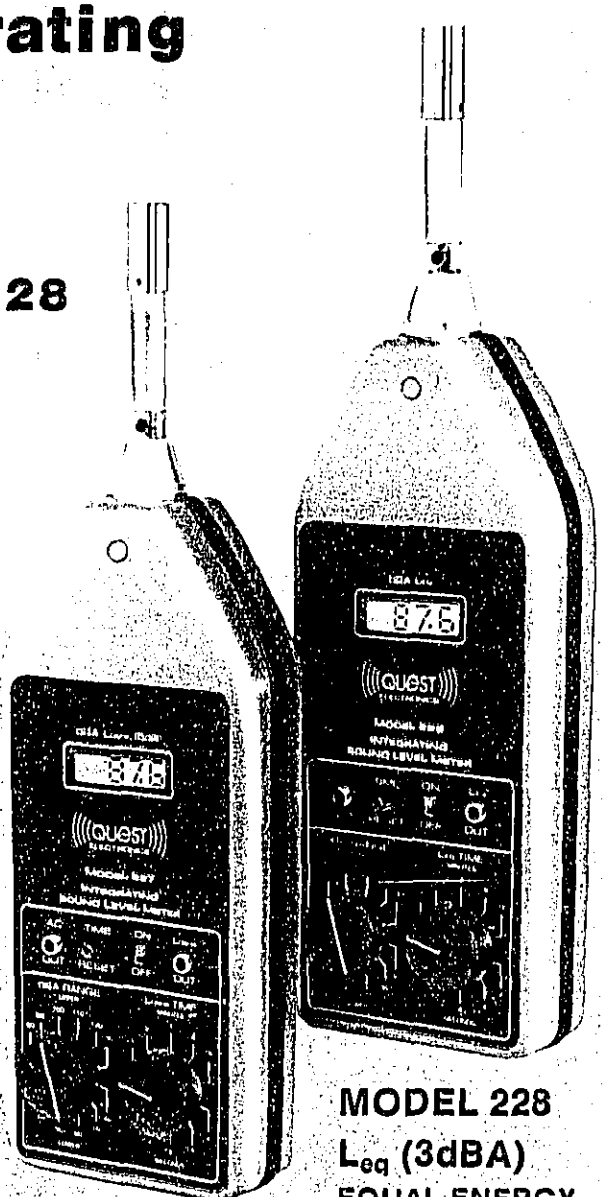
**510 Worthington Street**
**Oconomowoc, Wisconsin 53066**
***Phone (414) 567-9157***
**TWX 910-2601438 LA BELLE**

QUEST ELECTRONICS

# Digital Integrating Sound Level Meters

## MODELS 227 and 228

FOR INDUSTRIAL AND COMMUNITY VARIABLE NOISE APPLICATIONS



**MODEL 227**

**$L_{OSHA}$ (5dBA)**

INCLUDES SINGLE 80-130dBA DYNAMIC RANGE

**MODEL 228**

**$L_{eq}$ (3dBA)**

EQUAL ENERGY MEASUREMENT

**EQUIVALENT SOUND LEVEL MEASUREMENT 40-130dBA**

# Digital Integrating Sound Level Meters

## Models 227 and 228

- Precise direct display of $L_{eq}$ (228) and $L_{OSHA}$ dBA (227)
- High resolution equivalent-average sound level — 0.1dBA increments
- Automatic incremental TIME-HISTORY chart recordings
- High Crest Factor for Impulse Noise
- DC and AC recording outputs
- Remote microphone capability
- True RMS detector
- Used as digital sound level meters in 2-second mode
- Wide selectable range — 40-130dBA
- Determine $L_{AX}$ single event noise level (228)
- Produces hourly noise level (HNL) data
- Small and light weight — weighs only 19 ounces.

Both the model 228 "$L_{eq}$" Integrating Sound Level Meter and the 227 $L_{OSHA}$ (5dBA) Meter are light weight, hand-held instruments for automatic measurement of equivalent (average) sound levels in variable noise environments. The instruments are ideal for industrial and community applications where noise variations are too severe to permit a proper reading with a standard sound level meter or where long term equivalent levels are necessary.

### MODEL 228

The measurement of $L_{eq}$ is based on the equal energy principle where sound intensity is doubled for every 3dB increase in sound pressure level.

The unit features selectable sound level ranges and integration periods. The meter contains a true RMS detector system, and covers a 90dB(A) range in six selectable 40dB range bands. Selectable integrating time periods of 2 seconds to 16 minutes with automatic reset and restart permit measurement for a wide range of applications and environments. The meter can also be used as a standard sound level meter, slow response, when used in the short term integration mode (2 second period).

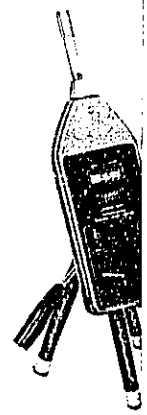
$L_{eq}$ decibel level is digitally displayed and held at the conclusion of each selected measuring period. Recording outputs provide for magnetic tape recording or long term recording on a strip chart recorder. Recording $L_{eq}$ provides a history profile of the average sound level for the period selected; $L_{eq}$ can be recorded over short term or up to a 24-hour day as needed.

Typical applications include measuring industrial noise, product noise emission, community and boundary noise; airport and highway monitoring; mining and general scientific use.

### MODEL 227

The model 227 meter is identical to the 228 except that the measured sound levels are based on the OSHA 5dB rule of doubling the permitted noise exposure time for each 5dB decrease in the sound level. The average dBA readings on the meter can thus be used to determine quickly the allowable OSHA exposure time permitted for the worker.

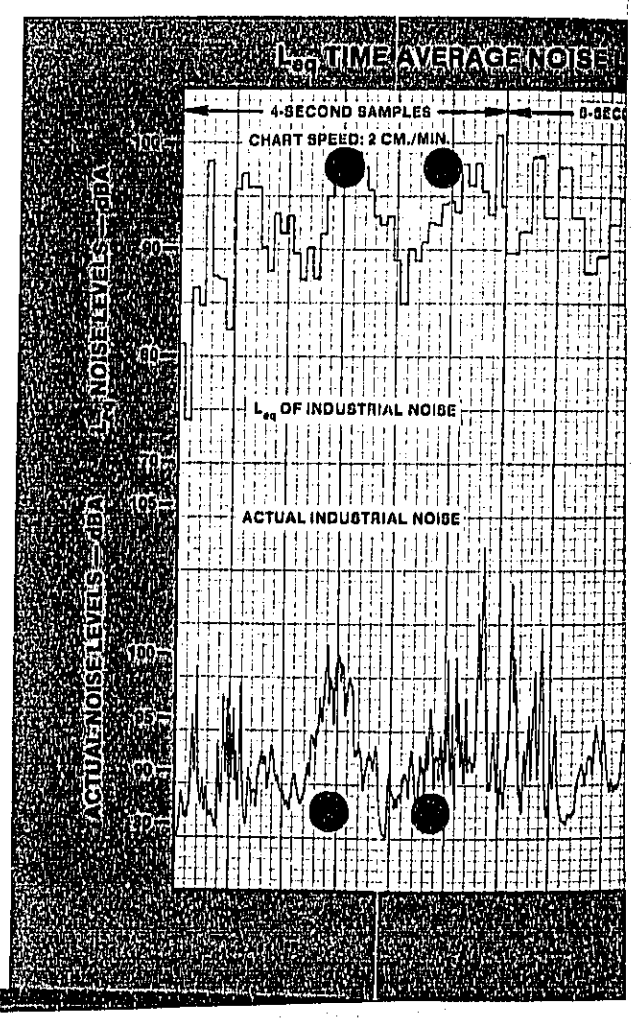
## Time-History Chart Recording

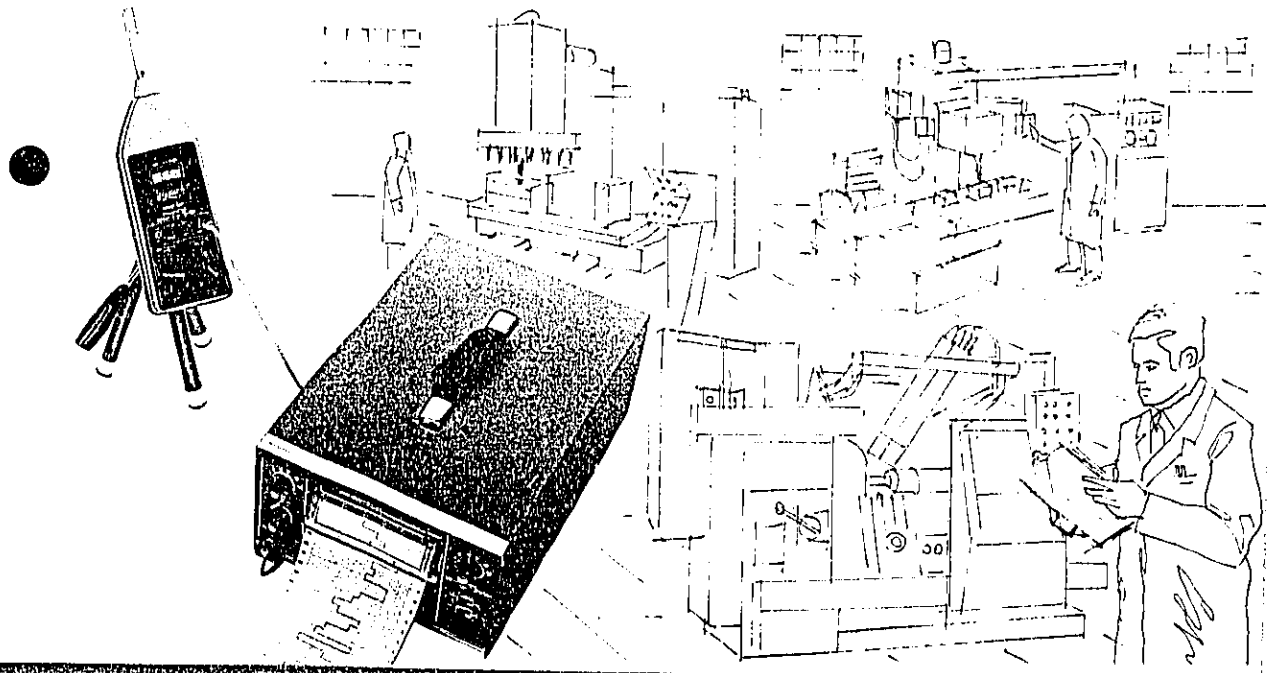


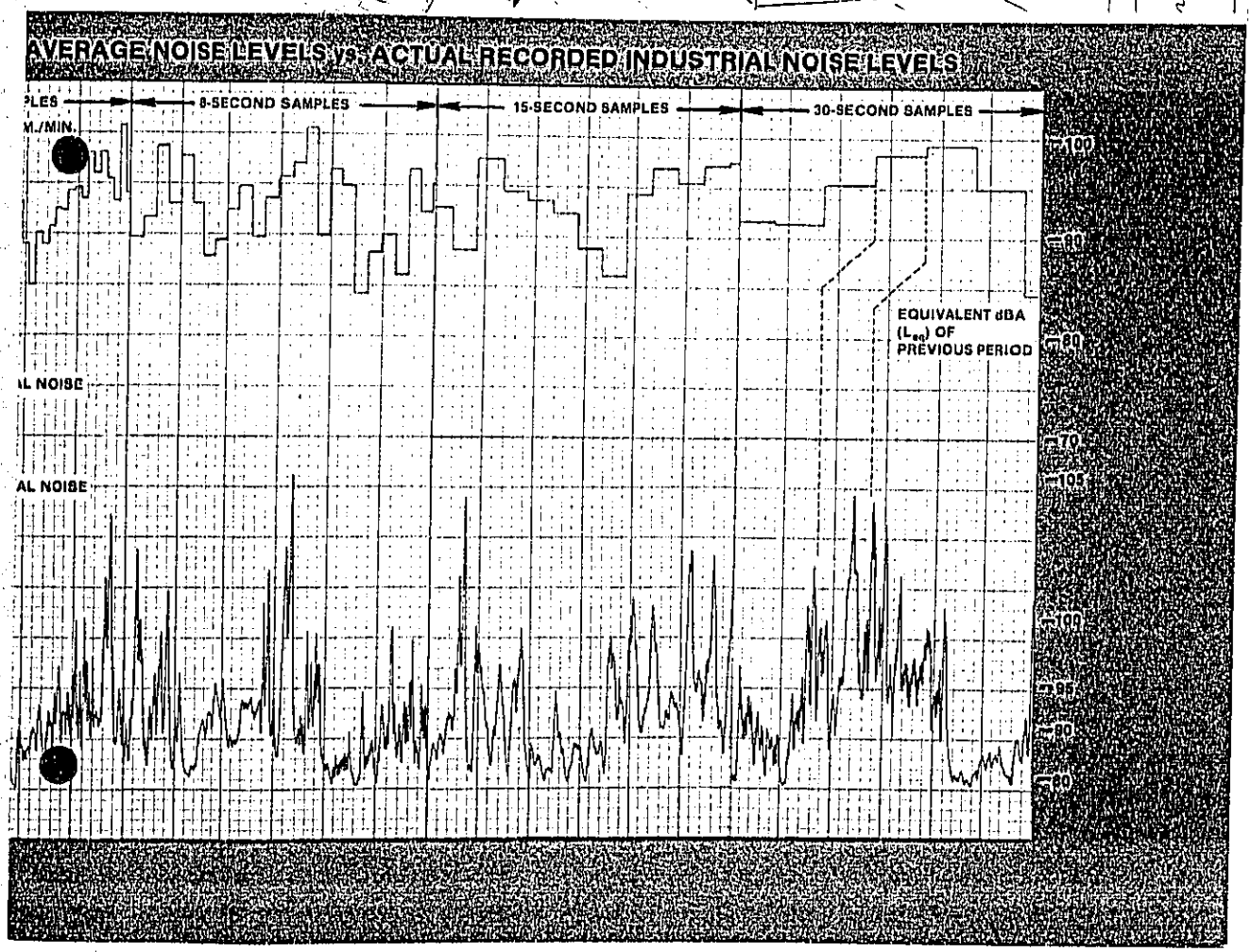
Both integrating sound level meters can be used with a chart recorder to obtain TIME-HISTORY plots of the noise profile. The system can be set to record industrial noise over a full or partial work shift and can also be used for community noise recording over a 24-hour day.

The illustration at the right shows the Quest model 411BB Chart Recorder.

In the chart recording below direct sound level recording (lower trace) is compared with the more simplified $L_{eq}$ or $L_{OSHA}$ recording. With this method of recording, long time spans can be plotted in an easy to read format. Each flat or square section of recording represents the equivalent selected period of measurement.







# Specifications

**Sound Level Range:** Six selectable overlapping ranges: 40-80, 50-90, 60-100, 70-110, 80-120, and 90-130dBA, (re 20$\mu$N/M$^2$).
**Standards:** Meets ANSI S1.4-1971, type 2 and IEC 651, type 2 where applicable.
**Frequency Weighting Network:** "A" Weighting.
**Frequency Range:** 10Hz to 10KHz.
**Integration** — 228: Continuous Equal Energy (3dB)
227: Continuous OSHA Level (5dB)

**Integration Periods:** Selectable time periods of 2, 4, 8, 15 and 30 seconds; 1, 2, 4, 8 and 16 minutes. Automatic reset-restart at the end of each period. Display holds the previous period $L_{eq}$ or $L_{OSHA}$ value while integrating the next period.

**Reset button:** Resets time to beginning of integration period and resets display to approximately 1dB less than the lower limit of the range.

**Display:** Digital Liquid Crystal Display (LCD). 4-digit reading in 0.1dB increments plus overrange, underrange, and battery test indications.

**AC Recording Output:** 1.0V RMS at full scale (3.2V RMS Max.) behind 3.2K ohms. For connection use a Switchcraft type 780 Tini-plug or equivalent.

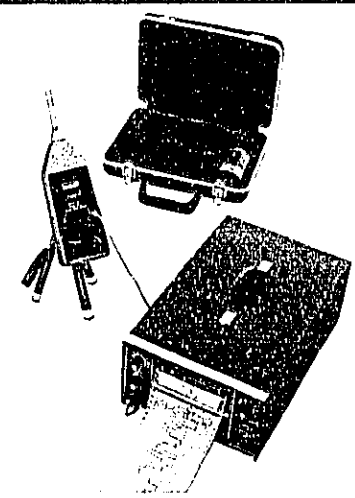
**DC Recording Output:** 1.0V D.C. at full scale (MAX.) behind 3.2K ohms. For connection use a Switchcraft type 780 Tini-plug or equivalent.
**Detector:** True RMS, 30dB crest factor, each range has 50dB dynamic span.
**Microphone:** High quality PZT ceramic, 1/2 inch diameter, omnidirectional.
**Temperature Range:** Operation: -10°C to +50°C. Storage (Less Batteries): -20°C to +60°C.
**Accuracy:** ±1.0dBA over temperature range.
**Operating Humidity:** 0% to 95% Relative Humidity.
**Effect of Magnetic Field:** Meter is not influenced by a magnetic field of 4000 A/M (60 oersteds) at 50 or 60Hz on any of the 6 ranges.
**Battery:** One 9-Volt Alkaline transistor battery (NEDA 1604 or NEDA 1604D); approximately 40 hours of operation at 25°C.
**Tripod Mount:** Standard 1/4-20 tripod mounting screw.
**Size:** 3.3 x 11.7 x 1.4 inches (8.4 x 30 x 3.6 cm) including microphone height.
**Weight:** Approximately 19 oz. (540 g) including battery.
**Construction:** Solid state integrated circuitry in a rugged aluminum housing.

# Accessories

Model 411L Chart Recorder, line operated
120V 60 Hz/240V 50 Hz
Model 411BB Chart Recorder, battery operated, self-contained with charger
Model CA-12 Sound Calibrator, 110dB, 1000 Hz
Model CA-16B Sound Calibrator, 110dB, selectable 125, 250, 500, 1K and 2KHz
Model CA-22 Sound Calibrator, selectable 94 or 114dB and 250 or 1000 Hz
Model TP-1 Tripod
Model TP-2 Tripod

# Kits

**Kit Models 228-12 and 227-12**
Each Kit contains a Model 228 or 227 Integrating Sound Level Meter, CA-12 Calibrator, WS-2 Windscreen and Carrying Case. (TP-2 Tripod is optional).



**Kit Models 411BB-228-12T and 411L-228-12T**
**411BB-227-12T and 411L-227-12T**
Each Kit contains a Model 411BB or 411L Chart Recorder, 228 or 227 Integrating Sound Level Meter, CA-12 Calibrator, WS-2 Windscreen, TP-2 Tripod and Carrying Case.

QUEST ELECTRONICS
510 Worthington St., Oconomowoc, WI 53066
Telephone 414-567-9157

Represented by:

Printed in U.S.A.

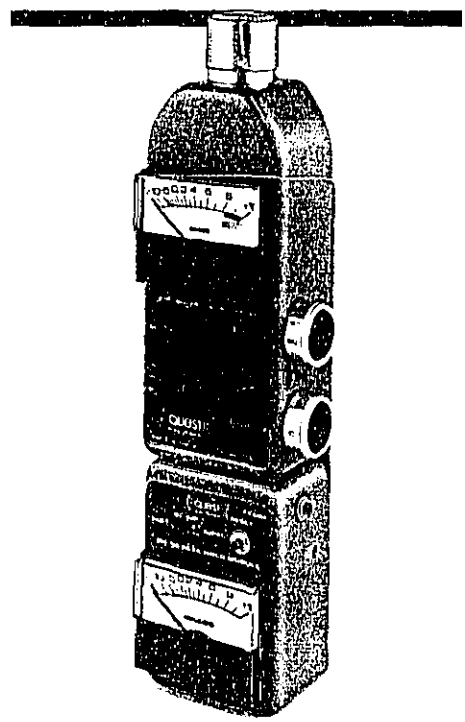
QUEST ELECTRONICS

## MODEL 215-45 OCTAVE BAND ANALYZER

(215 Sound Level Meter with Plug-In OB-45 Octave Band Filter Module)

## MODEL 215-35 PEAK HOLD METER

(215 Sound Level Meter with Plug-In PH-35 Peak Hold Module)



***With Quest's modular design you don't need a separate analyzer and peak hold meter. You can have both with just a 215 meter and the filter and peak hold plug-in modules.***

The accuracy, ease of use, and distinctive features of the 215-45 Octave Band Analyzer make it an outstanding instrument for many applications. It's the ideal analyzer for identifying and classifying industrial and community noise sources . . . measuring product noise emissions and the effectiveness of noise absorption materials . . . general purpose noise analysis . . . and audiometric applications (see Brochure 98-97).

It features a measuring range of 30-140dB; A, B, C, linear, and external scale weighting; fast and slow response; and the nine frequency ranges, with full octave band width, that extend from 31Hz to 8KHz. A 10dB gain switch permits reading dB levels in octaves down to 20dB.

The 215-35 Peak Hold Meter is specifically designed to measure peak noise levels in three different applications: impact or impulse noises as governed by OSHA regulations, the noise of passing vehicles as required by Department of Transportation and Environmental Protection Agency regulations, and peak rms levels of noise impulses having rise times as defined by IEC. The low hold-decay rate of less than .01dB per second and high resolution readings insure that peak noise levels are easily and accurately monitored.

A unique feature is the dual readout which permits simultaneous readings of both continuous and impact noise levels. Also featured is an over-range button which provides readings of 10dB over full scale.

***For optional remote microphone capability specify the 215R-45 Octave Band Analyzer and the 215R-35 Peak Hold Meter.***

# SPECIFICATIONS

## 215 Sound Level Meter

Measuring Range: 30-140dB re 20$\mu$N/m$^2$.
Response: A, B, C, Linear and External scale weighting, fast or slow response.
Standards: Meets ANSI S1.4-1983, Type 2 and IEC 651 Type 2.
Frequency Range: 20Hz to 10kHz.
Output Display: Meter type with direct decibel readout.
Record Output: Approximately 1.2V rms AC at full scale behind 1K ohms. Adapted to DC recorders with a Quest RA-100MV Recording Adaptor or RM-800 Recording Module.
Microphone: High quality PZT omnidirectional ceramic, 1-1/8 inches dia.
Battery Supply: Two 9V transistor batteries, NEDA 1604.
Operating Temperature: -10° to +50°C.
Humidity: 0-95% RH.
Overall Size: 3 x 7 x 2-1/8 inches (76 x 178 x 54 mm).
Weight: 19 oz (540 grams).
Construction: Solid state integrated circuitry in rugged aluminum housing.

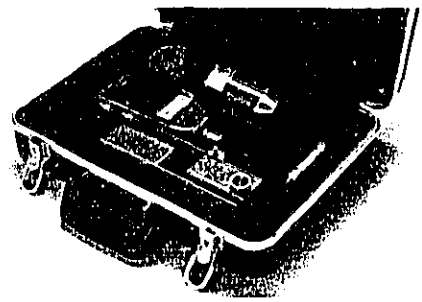
## OB-45 Octave Band Filter

Frequency Range: Nine ranges 31Hz to 8kHz center frequencies, full octave band width.
Standards: Meets ANSI S1.11-1983 for Class II Filter Sets.
Input: (from 215 SLM) 1.2V rms plus 10dB crest factor, 20Hz to 10kHz.
Output: 0 to 4V rms, output impedance less than 1 ohm.
Power Supply: None, uses battery power from 215 SLM.
Operating Temperature: -10° to +50°C.
Humidity: 0-95% RH.
Size: 3 x 3-1/2 x 2-1/8 inches (76 x 89 x 54 mm). With back cover, length is 8 inches (203 mm).
Weight: 9 oz (257 grams).
Construction: Solid state integrated circuitry in rugged aluminum housing.

## PH-35 Peak Hold Module

Peak Hold Range: 30-146dB (set by 215 Sound Level Meter).
Operating Modes: Peak Impact — Hold; Peak rms fast response — Hold; Peak IEC Impulse — Hold.
Rise Time — OSHA Impact Mode: less than 50 $\mu$sec.
— FAST Response Mode: 125 millisec.
— IEC Impulse Mode: 35 millisec.
Hold-Decay Rate: Less than .01dB per sec. (all modes).
Power Source: ± 9 volts (from 215 SLM).
Input Voltage: 0-6 volts peak.
Weight: 10 oz (184 grams).
Size: 2-1/2 x 3-1/2 x 2-1/8 inches (64 x 89 x 54 mm). With extended back cover, length is 8 inches (203 mm).
Construction: Solid state integrated circuitry in rugged aluminum housing.

# KITS



## Universal Kit

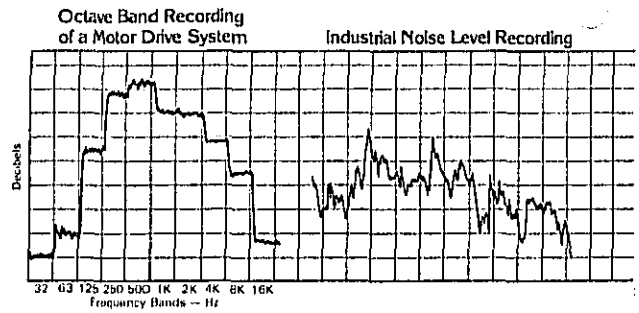
The meter, filter and peak hold module are included in the 215-345-12 Universal Kit — literally a portable sound measurement and analysis lab. Also included in the kit (illustrated above) are the CA-12 Calibrator described in detail in Brochure 98-17) and the WS-3 Wind Screen.

## Individual Kits

Model 215-4512 Octave Band Analyzer Kit . . . contains the 215 Sound Level Meter, OB-45 Octave Band Filter, CA-12 Calibrator and WS-3 Wind Screen.

Model 215-3512 Peak Hold Meter Kit . . . same as the 215-4512 kit except the PH-35 Module replaces the OB-45 Filter.

## Recording Capabilities




A DC output from the RA-100MV Recorder Adaptor or the RM-800 Recording Module provides for using the Octave Band Analyzer with a chart recorder to obtain precision time history plots of noise profiles. The recording system can be used in the lab, industry, and in community areas for making recordings of general noise levels and measurements as shown above.

The linearized output of the RM-800 Module (20mv/dB over a 50dB span) permits recording over a wide dynamic range on any standard chart recorder with a 1-volt DC full scale input.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# Sound Level Meters

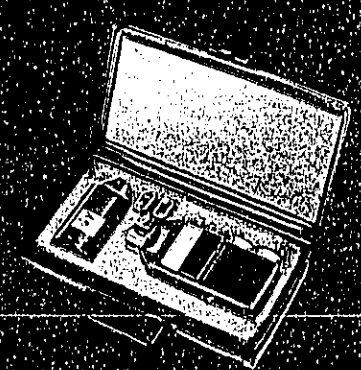
## Model 215 meter

A professional all-purpose wide range sound level meter for precise measurement of sound pressure levels in virtually all applications.

- Meets ANSI S1.4-1971 Type 2 and IEC 651 Type 2.
- Wide dynamic range from 30 to 140 dB.
- Fast and slow response.
- A, B, C, Linear and External scale weighting.
- Ruggedly constructed . . . small in size.
- Used with Octave Band Filter and Peak Hold plug-in modules.
- US MSHA approved for intrinsic safety.

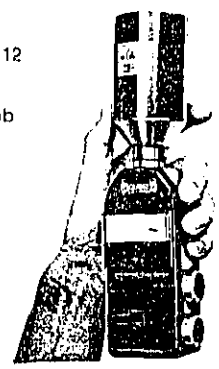
MODEL 215R METER

Identical to 215 meter but has a detachable microphone for remote measurement of sound pressure levels.



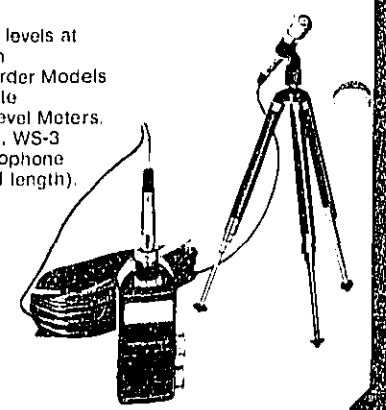
## CALIBRATION

Calibrating the 214 or 215 Meter — or other sound measuring instruments — is quickly and simply done with the Model CA-12 Calibrator. The CA-12 is small, portable, and operates on batteries; it's ideal for on-the-job calibration.

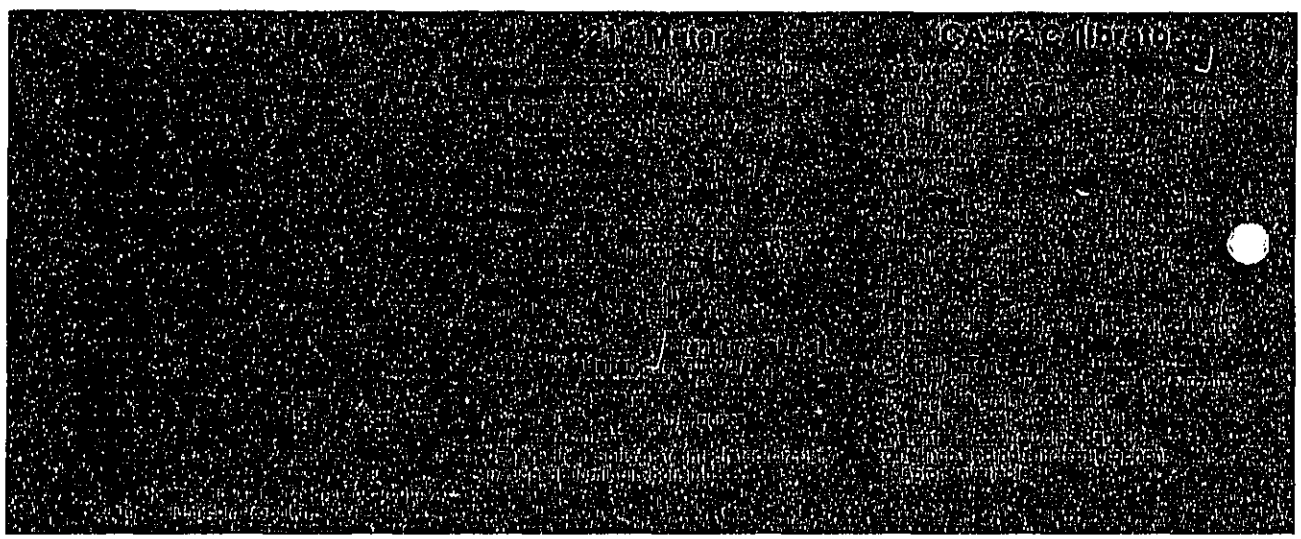


## REMOTE MICROPHONE MODELS

For measuring sound levels at remote locations or in inconvenient areas, order Models 214R and 215R Remote Microphone Sound Level Meters. Also available: Tripod, WS-3 Windscreen and microphone cable (specify desired length).



# SPECIFICATIONS



# ACCESSORIES

### 215 METER

- OB-45 OCTAVE BAND FILTER SET (with the 215 Meter becomes the 215-45 Octave Band Analyzer).
- PH-35 PEAK HOLD MODULE — for peak rms or impact noise measurements.
- WS-3 WINDSCREEN.
- TP-1 TRIPOD.
- RM-800 OR RA-100MV RECORDER ADAPTOR — for use with DC chart recorders.
- EC-9A EARPHONE COUPLER (6cc) and WEIGHT — for audiometric calibration.

### 214 METER

- WS-3 WINDSCREEN.
- TP-1 TRIPOD.
- RM-800 OR RA-100MV RECORDER ADAPTOR — for use with DC chart recorders.

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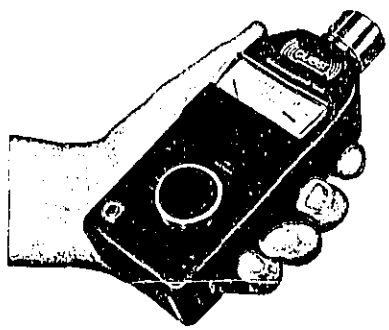
# SOUND LEVEL METERS
## MODELS 211FS and 211A



### 211FS METER

For checking OSHA compliance . . . measuring vehicle noise . . . enforcing municipal, state and federal noise statutes . . . evaluating product noise emissions . . . general scientific applications . . .

Features fast-slow response selection - fast response mode for vehicle noise measurements, slow response mode for OSHA and other measurements. 60-120dBA and 60-120dBC selectable measurement ranges. Meets ANSI standard S1.4-1983 for Type 2 instruments and IEC 651 Type 2.

### 211A METER

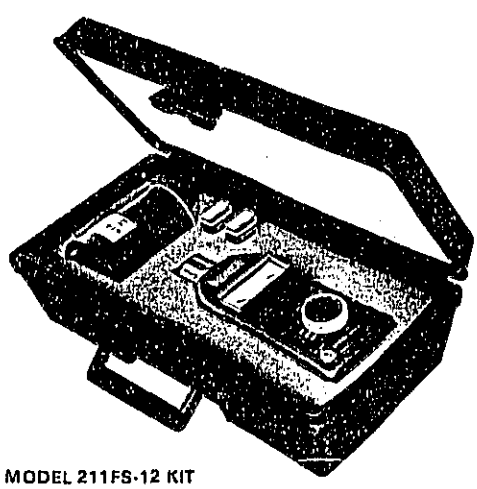
**For checking OSHA compliance . . . evaluating product noise emissions . . . general scientific applications . . . quick, simple measurement of noise levels.**

Features 60-120dBA selectable measurement range, slow response. Meets ANSI standard S1.4-1983 for Type 2 (S2A) instruments and IEC 651 Type 2.

## BOTH METERS AVAILABLE IN KITS

**MODEL 211FS-12 KIT** - contains the 211FS Meter and the portable CA-12 Calibrator for on-site calibration of the meter.

**MODEL 211A-12 KIT** - contains the 211A Meter and the portable CA-12 Calibrator for on-site calibration of the meter.



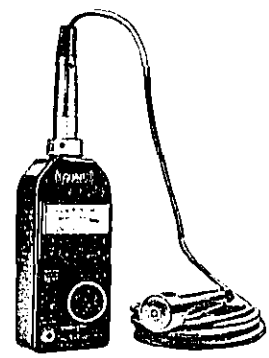
MODEL 211FS-12 KIT

## METER ACCESSORIES

- WS-3 Wind Screen - for outdoor use of sound level meters
- RM-800 or RA-100MV Recorder Adapter - converts AC electrical output of sound level meter to DC input for chart recorders for making visual record of sound level measurements.
- WM-1 Wind Meter
- Tripod

## CALIBRATION

Calibrating the 211FS or 211A Meter - or other sound measuring instruments - is quickly and simply done with the Model CA-12 Calibrator. The CA-12 is small, portable, and operates on batteries; it's ideal for on-the-job calibration.



## REMOTE MICROPHONE (OPTIONAL)

For measuring sound levels at remote locations or in inconvenient areas, order Models **211AR** and **211FSR** Remote Microphone Sound Level Meters. Also available: Tripod, WS-3 Windscreen and microphone cable (specify desired length).

# SPECIFICATIONS

**211FS METER**

MEASURING RANGE: 60-120 dBA or dBC in five selectable ranges
RESPONSE: "A" and "C" scale weighted, fast or slow response selection. Meets ANSI Standard S1.4-1983 for Type 2 instrumentation and IEC 651, type 2
FREQUENCY RANGE: 20 Hz to 10 kHz
OUTPUT: Meter type with direct decible readout
ELECTRICAL OUTPUT: Approximately 1.2 V rms at full scale, behind 1000 ohms
CONSTRUCTION: Solid state integrated circuitry in rugged aluminum housing
MICROPHONE: High quality PZT omnidirectional ceramic
BATTERY SUPPLY: Two 9-volt standard transistor type batteries (NEDA 1604)
OPERATING TEMPERATURE: -10° to +50°C
SIZE: 2-1/2" x 7" x 1-7/8"
WEIGHT: 16 ounces including batteries

**211A METER**

MEASURING RANGE: 60-120 dBA in five selectable ranges
RESPONSE: "A" scale weighted, slow response. Meets ANSI Standard S1.4-1983 for Type 2 instrumentation (S2A) and IEC 651, type 2
FREQUENCY RANGE: 20 Hz to 10 kHz
OUTPUT: Meter type with direct dBA readout
ELECTRICAL OUTPUT: Approximately 1.2 V rms at full scale, behind 1000 ohms
CONSTRUCTION: Solid state integrated circuitry in rugged aluminum housing
MICROPHONE: High quality PZT omnidirectional ceramic
BATTERY SUPPLY: Two 9-volt standard transistor type batteries (NEDA 1604)
OPERATING TEMPERATURE: -10° to +50°C
SIZE: 2-1/2" x 7" x 1-7/8"
WEIGHT: 16 ounces including batteries

**CA-12 CALIBRATOR**

FREQUENCY: 1000 Hz ±3%
SOUND PRESSURE LEVEL: 110 dB, reference 20$\mu$N/m$^2$; calibration traceable to U.S. National Bureau of Standards
ACCURACY (23°C, 760 mm Hg): ±0.4 dB
TEMPERATURE COEFFICIENT: 0 to 0.01 dB/°C maximum

ALTITUDE EFFECTS: 0.1 dB decrease for each 2,000 feet increase in altitude from sea level.

POWER SOURCE: Two 9-volt transistor batteries (NEDA 1604). Battery life approximately 100 hours

OPERATING TEMPERATURE: -10° to +50°C
CONSTRUCTION: Solid state integrated circuitry in rugged aluminum housing
CASE SIZE: 4" high x 2-3/8" dia
WEIGHT: 13 oz. including batteries

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Represented by:

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# Two Low-Cost, Accurate, Pocket-Size SOUND LEVEL METERS

## Model 208 — 70-120dB Range

- OSHA industrial noise measurement.
- Monitoring production and product noise emissions.
- Field service testing of engines and other equipment.
- Measuring audio-speaker systems.
- Insurance carrier surveys.

## Model 208L — 50-100dB Range

- General community noise measurement.
- For law enforcement and municipal officials.
- Checking noise levels of vehicles.
- Monitoring speech levels for the hearing impaired.
- Instructional use in schools.

Both meters measure sound levels in an "A"-weighted SLOW response mode as required by OSHA and other noise regulations. Ten light-emitting diodes display the sound level measurement in 2dB steps on four overlapping 20dB ranges. The maximum measurement can be automatically captured and held on the display. The meters can be calibrated to maintain accuracy.

These lightweight 4-ounce instruments are housed in a high impact plastic case. They slip easily into a shirt pocket and are readily available for spot checking of noise levels. They are powered by a single 9-volt transistor battery. Battery life is 70 hours of continuous use.

Manufactured in U.S.A.

# SPECIFICATIONS

Display: 10 LED with 2dB separation

Measurement Range: Four selectable 20dB overlapping ranges (re 20 µPa)

Model 208: 70-90, 80-100, 90-110, 100-120dBA

Model 208L: 50-70, 60-80, 70-90, 80-100dBA

Functions: Sound Pressure Level (SPL)
Maximum SLOW Level (MAX)
Battery Check (BATT)

Standards: Meets ANSI S1.4-1971 (R1976) and IEC 651 for type 2 special purpose meters where applicable (2dB display steps)

Frequency Response: 20-10,000 Hz

Frequency Weighting: A scale

Time Constant: SLOW (One second)

Detection: Square law type, true RMS

Microphone: 0.5mm electret condenser

Temperature Range: Operation: -10 to +50°C
Storage: -40 to +85°C

Temperature Coefficient: Less than 0.1dB/°C

Humidity: 0-95%

Magnetic Field: Negligible at 0.4T AC at 50-60 Hz

Battery: One 9 volt transistor battery (NEDA 1604)

Battery Life: Approximately 70 hours continuous use

Construction: Solid state circuit and display housed in high impact plastic case

Size: 5.5" x 2.5" x 1" inches (139 x 50 x 23mm)

Weight: 5 ounces (150 grams)

Calibration: Model 208: Use Any Quest Calibrator
Model 208L: Use Quest CA12M or CA22 Calibrator
Both meters require 1/2 inch adaptor for calibration

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QUEST ELECTRONICS

# SOUND LEVEL CALIBRATORS

## For Sound Level Meters, Noise Dosimeters and Other Sound Measuring Instruments

- **For both precise laboratory and field calibration**
- **Self-contained . . . battery operated**
- **Accurate and stable . . . rugged construction**
- **1⅛" microphone coupler . . . various size adapters available**


**Model CA-22** . . . Precision calibrator with four selectable outputs — 110, 94 dB; 1000, 250 Hz

**Model CA-15B** . . . Five-frequency calibrator — 125, 250, 500, 1000 and 2000 Hz at 110 dB

**Model CA-32** . . . Calibrator with precision timer for noise dosimeters — 1000 Hz at 110 dB

**Model CA-12B** . . . General purpose calibrator — 1000 Hz at 110 dB

**Model CA-12M** . . . General purpose calibrator — 1000 Hz at 94 dB

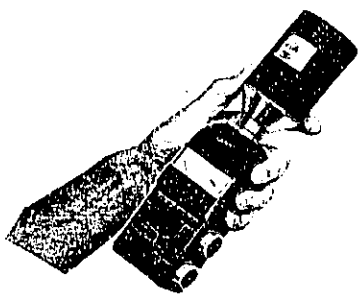
All five calibrators are portable field instruments for on-the-job use.

The CA-22 is the most precise of the calibrators. It can be used as a laboratory standard for calibrating precision type 1 instruments as well as general purpose sound level meters and other instruments with microphone inputs.

The CA-15B is intended for checking sound measuring instruments in cases where a more thorough calibration is considered necessary. It is particularly useful in checking the scale weighting of sound level meters and in determining filter skirt accuracy of octave band filter sets.

The CA-32 has a built-in precision timer which limits the duration of the signal to precisely 32 seconds. The CA-32 is designed primarily for field calibration of noise dosimeters where the readout is a function of the duration and amplitude of the acoustic input. The calibrator is also used to verify the accuracy of other sound measuring instruments.

The CA-12B is a general purpose calibrator that is primarily used for on-the-spot checking of sound level meters and other sound measuring instruments. The CA-12M is the same as the CA-12B except that it produces a 94 dB sound level.



# specifications

Keeping your sound level meters, noise dosimeters and other sound measuring instruments calibrated is essential to obtain accurate readings. The calibration of all Quest Calibrators is traceable to the U.S. National Bureau of Standards.

| | CA-12B, CA-12M & CA-32 | CA-15B | CA-22 |
|---|---|---|---|
| **ACOUSTIC OUTPUT** | | | |
| Frequency | 1000 Hz ± 3% | 125, 250, 500, 1000, 2000 Hz ± 3% | 250 and 1000 Hz ±1.5% |
| Sound Pressure Levels | CA-12B and CA-32: 110 dB ref. 20μ N/M²<br>CA-12M: 94dB | 110 dB ref. 20μ N/M² | 94 and 110 dB ref. 20μ N/M² (20μ Pa) |
| Accuracy (20° C, 760 mm Hg) | ± 0.4 dB | ± 0.4 dB | ± 0.3 dB |
| Temperature Coefficient | 0 to 0.01 dB/°C max. | 0 to 0.015 dB/°C max. | 0 to 0.01 dB/°C max. |
| Altitude Effects | 0.1 dB decrease for each 2000 ft. increase in altitude from sea level to 12,000 ft. | See Instruction Manual | See Instruction Manual |
| **ELECTRICAL OUTPUT** | | | |
| Voltage | None | 1.0 volt rms nominal behind 1000 ohms at each frequency | 1.0 volt rms nominal behind 10K ohms at each frequency |
| Distortion | 1.0% max. | 1.0% max. | 1.0% max. |
| Connection | None | Switchcraft 760 Tini-plug or equal | Switchcraft 760 Tini-plug or equal |
| **GENERAL** | | | |
| Power Source | CA-12B and CA-12M, and CA-32: 9-volt transistor battery, NEDA 1604, with life of 50 hours | One 9-volt transistor battery, NEDA 1604, with life of 50 hours | One 9-volt transistor battery, NEDA 1604, with life of 50 hours |
| Operating Temperature Range | -10 to + 50°C | -10 to + 50°C | -10 to + 50°C |
| Relative Humidity Range | 0-95% | 0-95% | 0-95% |
| Construction | Rugged aluminum housing | Rugged aluminum housing | Rugged aluminum housing |
| Size | 10.1 cm long x 6.0 cm dia. | 11.2 cm long x 6.0 cm dia. | 11.2 cm long x 6.0 cm dia. |
| Weight | CA-12B and CA-12M: 340 grams<br>CA-32: 310 grams | 410 grams | 380 grams |
| Timer | CA-32 only. Pushbutton start, 32-second "on" time ± 0.5%, crystal time base | None | None |
| Operating Modes | CA-12B Continuous<br>CA-32: Precision timed | Continuous | Continuous |

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DATA SHEET

VIBRATION ASSEMBLY
MODELS VA-508B and VA-508BP
--- for use with the Quest Models 215R and 155 Sound Level Meters

The VA-508B Vibration Assembly (VA-508BP for the 155 Precision Meter) is an attachment to a Sound Level Meter for the measurement of vibration of structures and machinery. The system is used for general vibration analysis and monitoring of potential machinery failure.

The Assembly consists of a miniature accelerometer, Model VI-90 Vibration Integrator, and interconnecting cables. Measurement of acceleration, velocity, or displacement is obtained by a mode switch on the VI-90. A conversion chart is provided to convert the dB values on the Sound Level Meter to vibration units. The use of an Octave Band filter set with the system will futher enhance frequency analysis of the vibration. Calibration is obtained using a 1 volt rms, 1 KHz electrical signal provided by the Models CA-15 or CA-22 Sound Calibrators.

System Consists of:
- Model 508 Accelerometer
- Model AC-5 Accelerometer Cable
- Model VI-90 Vibration Integrator
- Model 59-982 215R Input Cable -or-
  58-817 155 Input Cable
- Model 59-72 Probe

Specifications:

System
- Dynamic Range:
  - Acceleration - $3 \times 10^{-3}$ to 150g's (rms)
  - Velocity - $3 \times 10^{-5}$ to 3 meters/sec (rms)
  - Displacement - $3 \times 10^{-8}$ to $3 \times 10^{-3}$ meters (rms)
- Frequency Range: 10 Hz to 10 KHz
- Temperature: -10°C to +50°C (less accelerometer)

Accelerometer
- Model: 508, piezoelectric
- Sensitivity: 10mv/g rms ± 5%
- Mounting Thread: 10-32 Tapped Hole, 0.12 in. deep
- Connector: Microdot S-50, Female
- Weight: 12 grams
- Transverse Sensitivity: Less than 5%
- Power: 0.5 ma (provided by VI-90)
- Temperature Range: -50°C to +120°C

Model VI-90 Vibration Integrator
- Input Impedance: 50K ohms with 0.5 ma current source
- Output Impedance: Effectively 0 ohms at less than 3 ma
- Gain Accuracy: ±0.5dB at 25°C, ±1.0dB over temperature range
- Power: 9 Volt transistor battery, 100 hour battery life.
- Construction: Active electronic integrator in a rugged aluminum housing
- Size: 4.7 x 2.5 x 1.2 inches (120 x 64 x 30 mm)
- Weight: 8 ounces (227 grams)



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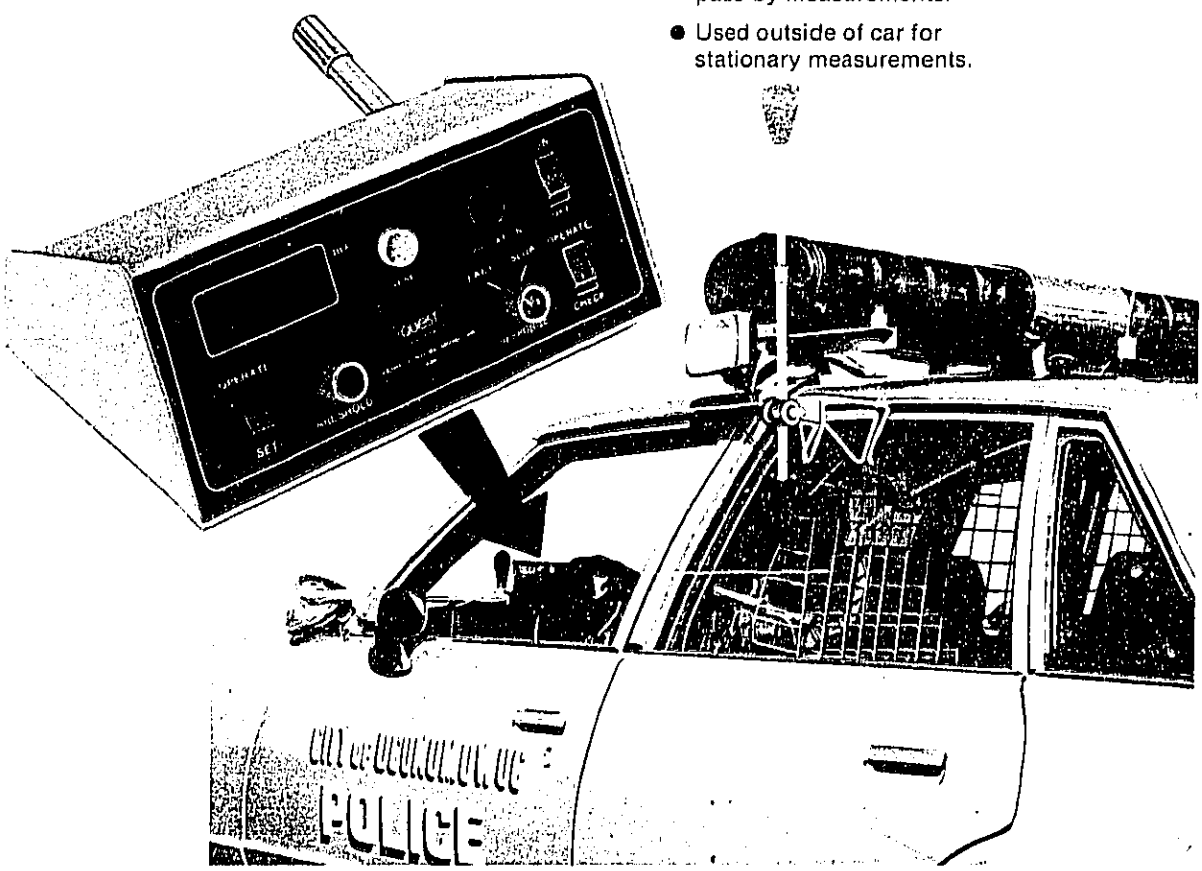
# MODEL 235-12WM
# VEHICLE NOISE MONITOR SYSTEM

**Monitors noise levels of both PASS-BY and STATIONARY vehicles to determine compliance with community noise regulations.**

- Mounts in patrol car for pass-by measurements.
- Used outside of car for stationary measurements.



- Designed for both pass-by and stationary vehicle noise monitoring.
- In-car measurement of vehicle noise . . . similar in use to radar.
- Easily installed . . . monitor is set on dashboard or seat; microphone mounts on window.
- Simple acoustic calibration and internal calibration check.
- Readable in direct sunlight and complete darkness.
- Maximum violation signal automatically locked in memory.
- Remote locking of noise levels for stationary test with either manual or automatic tachometer input control.
- Portable for general community measurements.

# DESCRIPTION

The 235 Monitor is fully portable for making general community noise measurements such as residential-industrial boundary lines, disco and tavern noise, aircraft noise and general neighborhood complaints.

The Model 235-12WM Vehicle Noise Monitor is a specialized dual-purpose sound measuring system. It is used both for in-car monitoring of pass-by vehicles and for stationary vehicle noise testing.

The system consists of a digital readout monitor and an adjustable window-mounted microphone and cable assembly. The monitor is readable both in direct sunlight and in complete darkness. It covers a sound range of 50 to 100 dBA.

### PASS-BY MEASUREMENTS

The monitor is primarily used in patrol cars and plugs into the electrical system through the cigarette lighter. The violation — or threshold — sound level is adjustable by the officer from 55 to 97 dB. In use the system is similar to radar. When the threshold level is exceeded, the monitor produces both an aural and visual alarm. The unit then automatically locks the maximum violation noise signal in the memory and instantaneously checks background noise levels. Only one officer and one car are needed. While the officer performs his normal duties, the noise monitor automatically checks for excessive noise levels.

### STATIONARY MEASUREMENTS

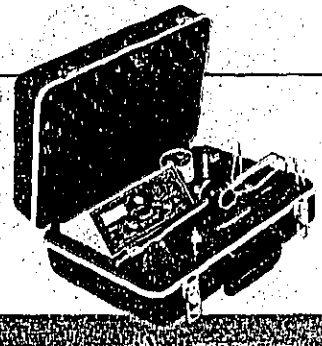
The monitor can be set up at a test station or the officer can keep it with him for on-the-spot checking of stationary vehicle noise. As the unit is monitoring the noise emission, the noise level at the specified engine speed can be locked into the monitor either automatically through a tachometer input or manually by pushing a button.

Because the monitor is light in weight it can easily be carried to any location. An internal 9-volt battery provides power for out-of-car use.

Both fast and slow response are provided. An internal calibration circuit verifies operation to assure validity of the data. The monitor is mounted in a durable aluminum housing.

# SPECIFICATIONS

**Sound Level Range:** 50-100 dBA single range. Maximum input before overload: 106 dB.
**Standard:** Meets ANSI S1.4, 1971 type S2A.
**Response:** A-weighted, Fast/Slow response, true RMS.
**Frequency Response:** 10Hz to 10KHz.
**Display:** Liquid Crystal, 3-1/2 digit, 0.1dB resolution, 1/2" high, back-lit for night use.
**Threshold:** 55-97 dB. Selectable by user.
**Plug-In Capability:** For remote locking of noise levels and for tachometer input.
**Microphone:** High quality PZT, 1/2" diameter ceramic.
**Operating Temperature Range:** -10° C to +65° C.
**Power:** 9 to 16 volts DC, 2 watts with external 12-volt battery, 0.1 watts with internal 9-volt battery.
**Size:** 7-1/4W x 5-1/2D x 3-1/2H inches.
**Weight:** 2 lbs. (monitor).
**Construction:** Durable aluminum housing.



# MODEL 235-12WM KIT

Contains the 235 Vehicle Noise Monitoring System (readout monitor, microphone, mounting mast and cables), CA-12M Calibrator and microphone adaptor, windscreen, and spare batteries.

### OPTIONAL

• Remote pushbutton locking cable • Line-operated Power Supply, PS 123, for classroom demonstrations • Tripod TP-1

QUEST ELECTRONICS
610 Worthington St.
Oconomowoc, WI 53066
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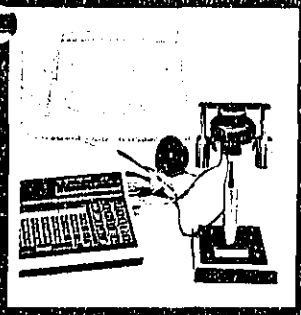
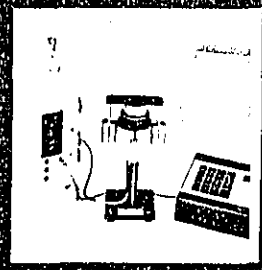
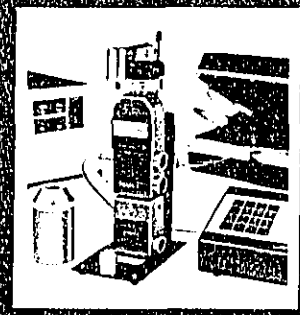
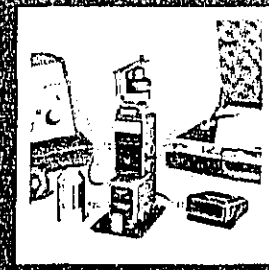
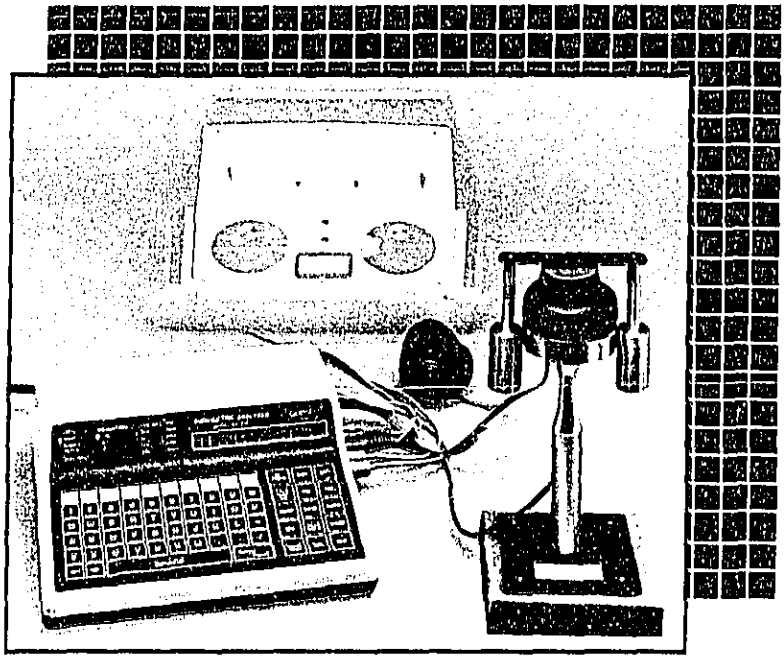
# Calibration Systems

# TABLE OF CONTENTS

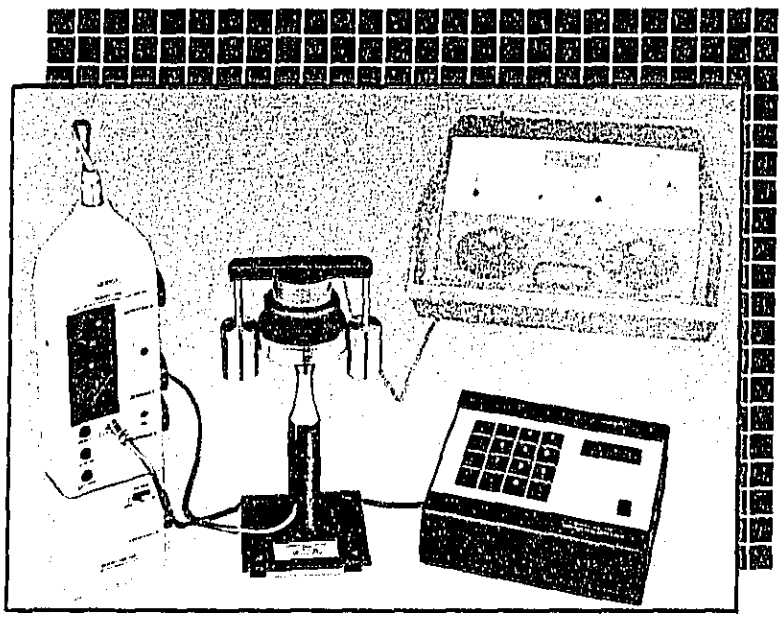
Audiometers which are accurately calibrated are essential to detect hearing loss at an early stage and to protect against needless industrial compensable hearing loss. Calibrating audiometers is a necessary part of the OSHA hearing conservation program. Quest calibration systems thus meet an important need in hearing conservation programs. The systems perform accurate acoustical calibration of all types of audiometers and insure that the audiograms taken for record are proper and accurate. All systems are portable. They are used by both audiometric technicians and clinical personnel.

Quest calibration systems range from the sophisticated clinical, exhaustive microprocessor-controlled systems to simple meter systems which replace biological calibration. (Printer is optional)

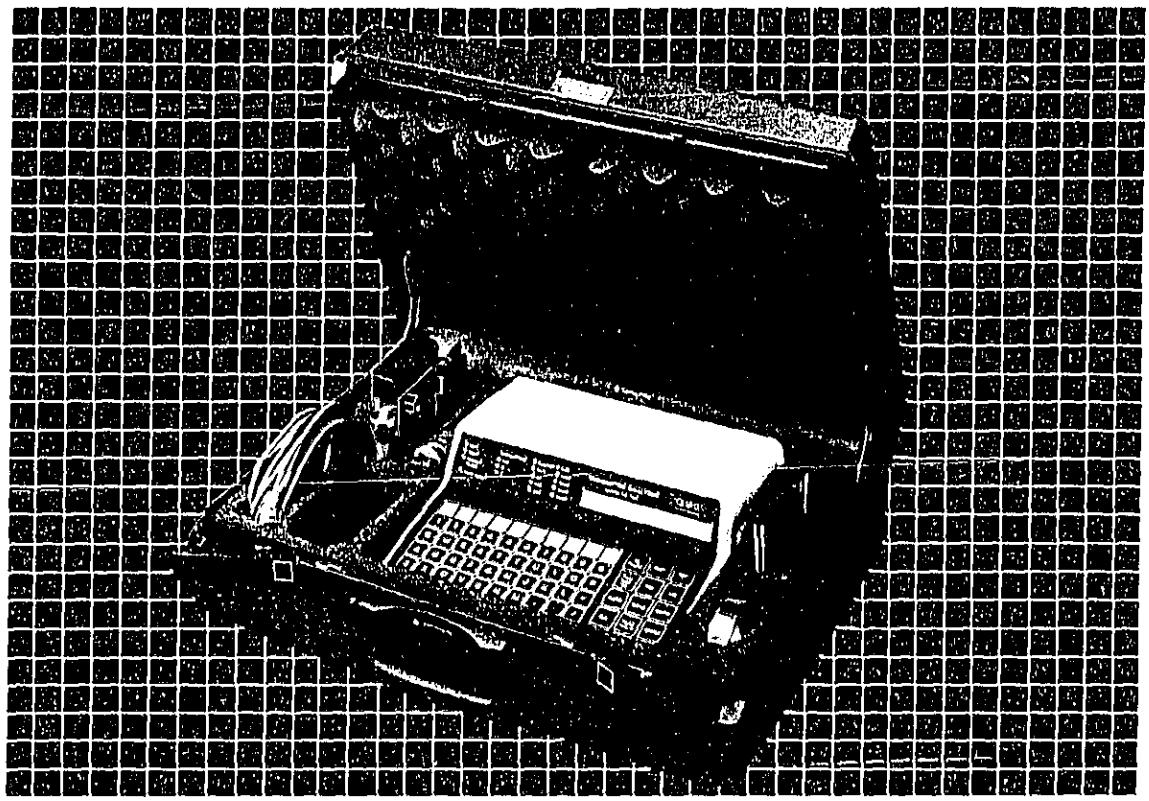


AA-188AM System Setup

- Precise measurement of decibel level, linearity, frequency, pulse width, overshoot, rise and fall times, and harmonic distortion of manual, automatic and microprocessor audiometers.
- Performs monthly, yearly and exhaustive audiometer calibration.
- Portability and modular concept permit measurement of room background noise and other acoustic analysis.
- Adaptable to impedance audiometers, hearing aids and artificial mastoid calibration.
- Calibration of Brainstem audiometer "click" impulse peaks.
- Calibration traceable to U.S. National Bureau of Standards.



AM-2000 System Setup



# MODEL AA-188AM SYSTEM

**AA-188 Audiometer Analyzer**
**58-913 Preamp**
**7023 1 inch condensor mic**
**A-63B Preamp Adaptor**
**58-929 1" Mic Adaptor**
**EC-9A Coupler**
**W-440 Weight**
**AS-1550 Calibration Stand**
**PMC-10 Mic Cable**
**Patch Cords**
**58-819 Carrying Case**
**(CA-22 Calibrator is Optional)**

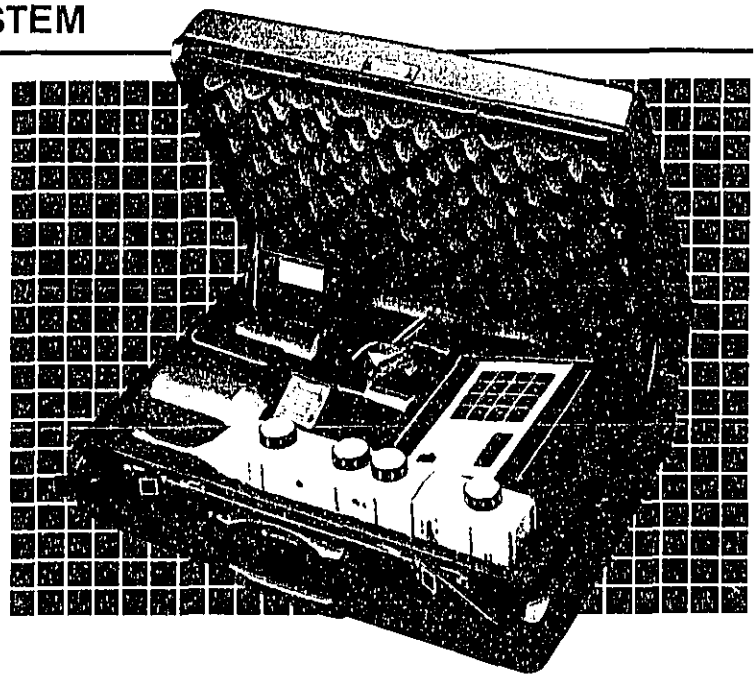
The AA-188 Audiometric Analyzer is a microprocessor controlled audiometer calibration system with alpha/numeric keyboard control, digital display and printout capability of all measured data. The user simply places the earphone onto the earphone coupler. All critical values and tolerances are measured without having to plug and unplug a myriad of cables and separate instruments. A simple press of a button switches between acoustical input via the headphone or direct electrical input from the audiometer.

The AA-188 measures consistant with ANSI S3.26 hearing level, frequency, total harmonic distortion, linearity, warble tone, rise time, fall time, pulse-width, overshoot, on/off ratio, crosstalk, and SISI tones. This system will accommodate TDH-39, 49, 50 and Telex 1470 transducers, and has connection for mastoid input. The Analyzer contains an autoranging precision type 1 Sound Level Meter with Octave Band Filters, thus adapting the system to also measure audiometer room background noise. A single key distortion measurement feature frees the user from the need of tuning or nulling filters. The unit can be used on its own or can be completely computer controlled via an RS-232 port. A report is generated on a Centronics parallel printer port.

For more detailed information on the AA-188 see brochure #98-211.

## MODEL AM-2000 SYSTEM

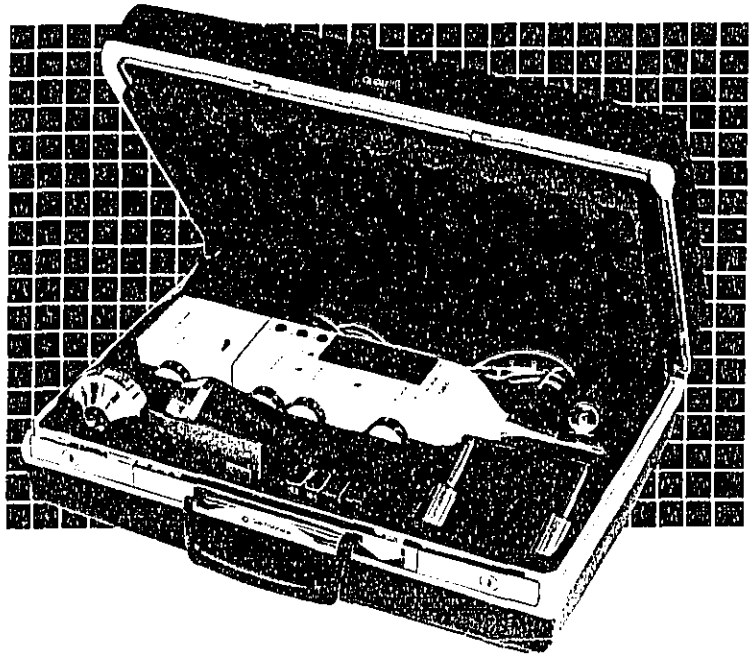
- 155 Precision Sound Level Meter
- OB-145 Octave Band Filter
- 7023 One-Inch Condenser Microphone
- CA-22 Sound Calibrator
- EC-9A Earphone Coupler and Weight
- AS-1550 Calibration Stand
- A-63B Adapter for 1-Inch Microphone
- PMC-10 Microphone Cable, Ten feet
- Calibration Chart
- AA-175 Audiometer Analyzer
- LT-20 Linearity Transformer
- 59-998 Carrying Case



## MODEL 155-14522AM SYSTEM

- 155 Precision Sound Level Meter
- OB-145 Octave Band Filter
- 7023 One-Inch Condenser Microphone
- CA-22 Sound Calibrator
- EC-9A Earphone Coupler and Weight
- AS-1550 Calibration Stand
- A-63B Adapter for 1-Inch Microphone
- PMC-10 Microphone Cable, Ten feet
- Calibration Chart
- 59-970 Carrying Case

This system is the same as the AM-2000 system except that the AA-175 Audiometer Analyzer and LT-20 Transformer are omitted. Harmonic distortion can be measured only from the 3rd harmonic and higher. The Octave Band Analyzer, as in the AM-2000 System, can be used separately for room background noise measurements and general analysis applications. (An optional OB-133 1/3-Octave Band Filter can be used to measure complete harmonic distortion.)



# MODEL AM-200 SYSTEM

**215 Sound Level Meter**

**OB-45 Octave Band Filter**

**CA-15B Five-Frequency Calibrator**

**EC-9A Earphone Coupler and Weight**

**AS-1545 Calibration Stand**

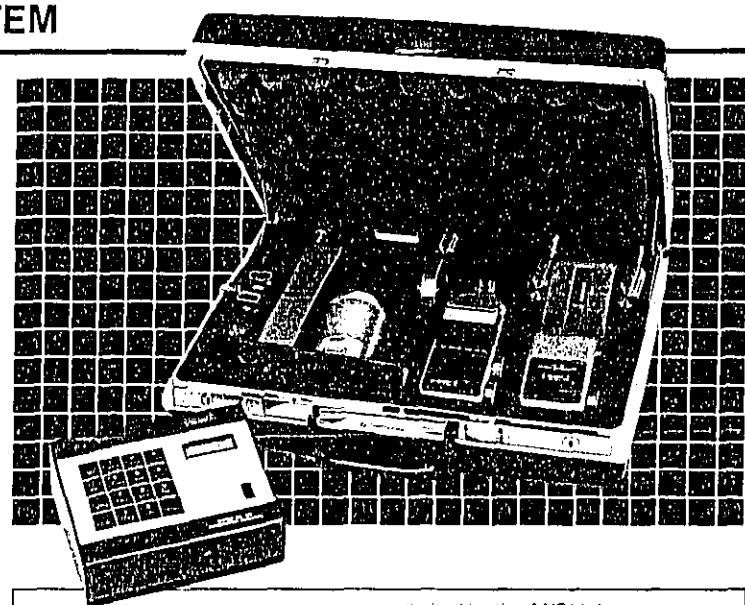
**AA-175 Audiometer Analyzer**

**Microphone Calibration Chart**

**59-932 Carrying Case**

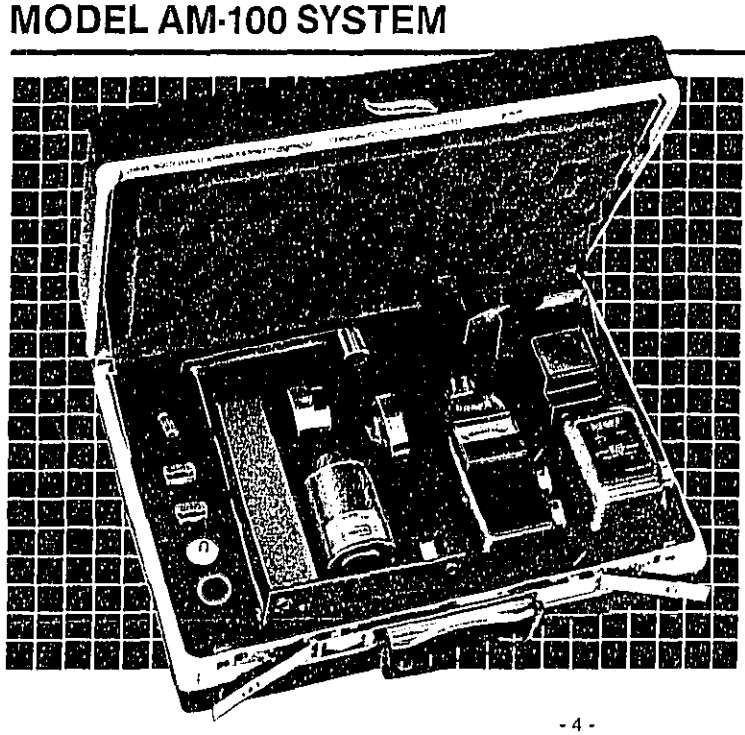
**(LT-20 Transformer optional)**

A complete, versatile and fully portable system for the exhaustive calibration of all audiometers. Using the AA-175 Microprocessor Audiometer Analyzer the system measures decibel levels, attenuator linearity, frequency, harmonic distortion, pulse width, rise time, fall times and overshoot. The AS-1545 Stand Assembly provides a lever arm for easily applying the necessary 450 gram force to the earphone. The Octave Band Analyzer (215 Meter with OB-45 Octave Band Filter) can also be used separately for checking audiometric room background noise and for general industrial noise analysis.



*NOTE: It is important to note that the high accuracy of the calibration systems described on pages 4 and 5, when using the calibration chart supplied with each meter, is in essence "perfect" and is no longer limited by the ANSI tolerances normally associated with meters and microphones. These systems, when used in the closed coupler calibration mode, are therefore much more accurate than the accuracy defined by precision type 1 tolerances.*

# MODEL AM-100 SYSTEM



**215 Sound Level Meter**

**OB-245 Super Octave Band Filter**

**CA-15B Five-Frequency Calibrator**

**EC-9A Earphone Coupler and Weight**

**AS-1545 Calibration Stand**

**Microphone Calibration Chart**

**FC-3 Frequency Counter**

**59-932 Carrying Case**

Similar to the AM-200 except for making pulse tone measurements. The OB-245 Super Octave Band Filter and FC-3 Frequency Counter are used in place of the AA-175 Audiometer Analyzer and OB-45 Octave Band Filter as a cost saving measure. Total harmonic distortion can be measured. As with the AM-200 system, separate use of the Octave Band Analyzer permits measurement of room background noise as well as general noise analysis.

## MODEL 215-4512AM SYSTEM

**215 Sound Level Meter**

**OB-45 Octave Band Filter**

**CA-12B Single Calibrator**

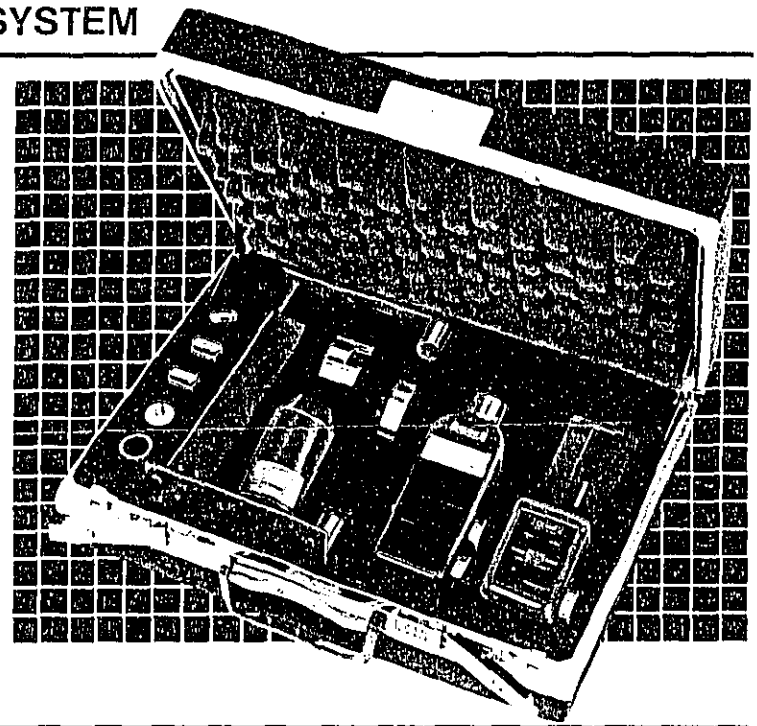
**EC-9A Earphone Coupler and Weight**

**AS-1545 Calibration Stand**

**Microphone Calibration Chart**

**59-932 Carrying Case**

An audiometer calibration system similar to the AM-100 but with significant savings in cost. Contains the standard Octave Band Filter instead of the Super Filter and the CA-12B single frequency Calibrator instead of the CA-15B five-frequency Calibrator. The system performs most of the functions of the AM-100; however harmonic distortion measurement begins with the 3rd harmonic. The Calibration Stand is also included in this kit to provide the same easy means of applying the earphone force as the AM-100 and AM-200 kits.



## MODEL 215-12AM SYSTEM

**215 Sound Level Meter**

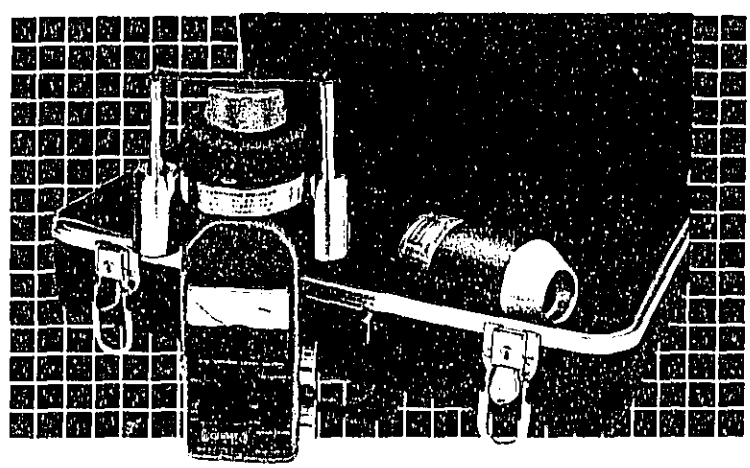
**CA-12B Sound Calibrator**

**EC-9A Earphone Coupler and Weight**

**Microphone Calibration Chart**

**59-925 Carrying Case**

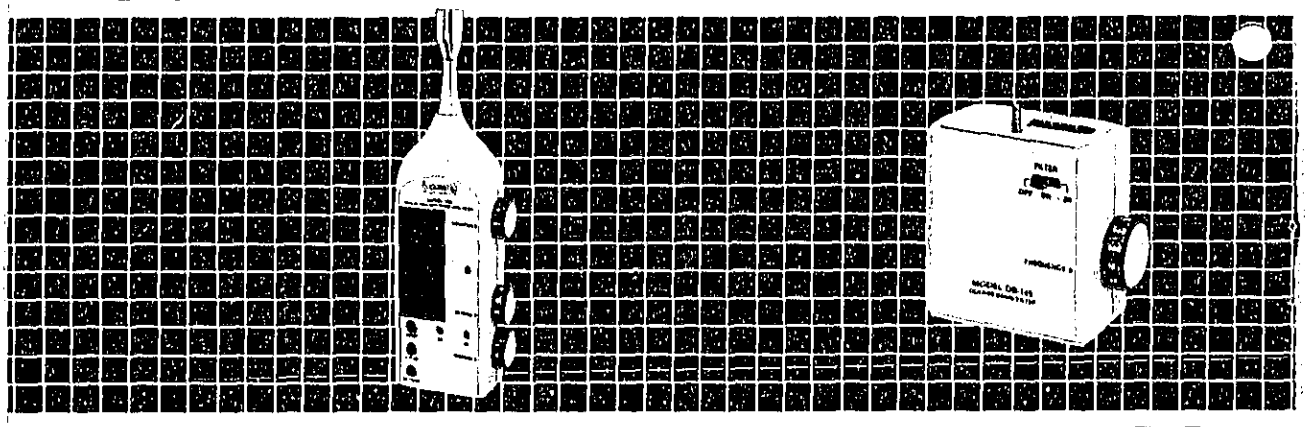
A basic system that replaces "Biological Calibration" and provides quick, accurate calibration checks of audiometer decibel level. This is the system for applications where simplicity and economy are prime considerations. Without the use of the Octave Band Filter it is more important to calibrate in a quiet area since small floor vibrations and background noise can affect the readings.



## REMOTE MICROPHONE OPTION

The 215 Meter can be furnished with detachable microphone for use in all the 215 systems described above. When so furnished, the meter is designated as the 215R. It can then receive electrical inputs. With an optional 1/2-inch microphone (as provided in the HA-200 Test Assembly) the meter accommodates a 2cc coupler for impedance or hearing aid measurements.

# MODEL 155 PRECISION SYSTEMS COMPONENTS



## 155 Precision Sound Level Meter

An ANSI-IEC Type 1 Impulse Precision Sound Level Meter. A versatile instrument with a wide range and a full line of features. A, B, C and Linear weighting scales. Built-in capability for impulse and peak measurements. Can be used with the plug-in octave band filter and other accessories described on this page.

### SPECIFICATIONS

Range — Meter Only: 27-140dB re 20$\mu$Pa. With Octave Band Filter: 7-140dB.

Standards: Exceeds ANSI S1.4-1983 type 1 and IEC651-1979 type 1 impulse.

Microphones: High quality half-inch condenser or optional one-inch condenser microphone.

- Model 7046, 1/2" Free field microphone, 50 mv/Pa
- Model 7047, 1/2" Pressure microphone, 50 mv/Pa
- Model 7013, 1/2" Pressure microphone, 16 mv/Pa
- Model 7023, 1" Pressure microphone, 56 mv/Pa

Preamp: Removable; input impedance is greater than 1G ohm in parallel with 2 pf. Preamp will drive up to 100 feet of cable.

Polarization Voltage: Regulated 200 V DC ± 2%.

Meter Input: Input impedance is 1 Megohm in parallel with 100 pf. Maximum sinusoidal input voltage is 10V RMS.

AC Output: 1.0 V RMS behind 3.2K ohms at 30dB meter deflection. (4V RMS Max.)

DC Output: +0.75V DC behind 3.2K ohms at 30dB meter deflection. (Approx. +1.1V DC Max.) Each 0.25 volt change represents 10dB.

Detector: True RMS.

Crest Factor: 15 (25dB) at +5dB or less meter deflection, 5 (15dB) minimum at +30dB or less meter deflection.

Overload Indication: Checks all points where overloads may occur; displays overload via LED.

Frequency Range: 4Hz (-3dB) to 27KHz (-3dB) on linear.

Frequency Weighting Network: A, B, C and Linear. OB-145 Octave Band Filter and OB-133 1/3-Octave Band Filter are optional and can be used in conjunction with either A, B, C or Linear weighting.

Meter movement: Linearized 30dB span, ruggedized high-torque taut-band movement from zero adjust.

Meter Response: SLOW, FAST, FAST MAX., IMPULSE, and PEAK HOLD.

Accuracy: ±0.5dB at 25°C; ±1.0dB over 10°C to +50°C.

Temperature Range: Operation: 10°C to +50°C. Storage (less batteries): 20°C to +60°C.

Operating Humidity: 0 to 95% Relative Humidity.

Effect of Magnetic Fields: A magnetic field of 1 Oersted (80A/m) at 60Hz produces a maximum reading of 40dB on Linear weighting.

Effect of Electrostatic Fields: Negligible as long as protection grid is kept on microphone.

Batteries: Two 9-volt batteries (NEDA 1604A — Alkaline) will provide approximately 25 hours of continuous operation (15 hours with optional OB-145 Octave Band Filter) at 25°C.

Tripod Mount: Threaded insert on back of meter accepts a standard 1/4-20 tripod mounting screw.

Size: 3.7 x 12.1 x 2.0 inches (94 x 307 x 51mm) including microphone height and knobs.

Weight: Approximately 26 oz. (740g) including batteries.

Construction: Solid state integrated circuitry in a high impact Cycolac T-shielded housing.

## OB-145 Octave Band Filter

A plug-in attachment for 155 Sound Level Meter. Selects ten octave bands from 31Hz to 16KHz. A 20dB gain switch permits reading decibel levels below 10dB in octaves.

### SPECIFICATIONS

Standards: Meets ANSI S1.11-1971 Class II, Type 0, from 31.5Hz to 16KHz; meets IEC R225-1966.

Center Frequencies: Ten frequencies: 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, 16KHz.

Pass Band Uniformity: Within ± 0.5dB.

Peak to Valley Ripple: 1dB MAX.

Filter Skirt Attenuation:

- Band edge frequencies (.707 $f_c$ and 1.414 $f_c$) -3dB ± 1dB
- One octave from $f_c$ (.5$f_c$ and 2$f_c$) -20dB ± 2dB
- Two octaves from $f_c$ (.25 $f_c$ and 4$f_c$) -44dB ± 3dB

Input Characteristics: (From 155 Sound Level Meter) 0 to 4 Volts RMS (MAX). Input impedance is 90K in series with 16MFD.

Output Characteristics: (To 155 Sound Level Meter) 0 to 4 Volts RMS (MAX). Output impedance is effectively less than 1 ohm if driving a load resistance of 1 K ohm or greater.

Insertion Loss: -0.1dB ± 0.3dB at center frequency.

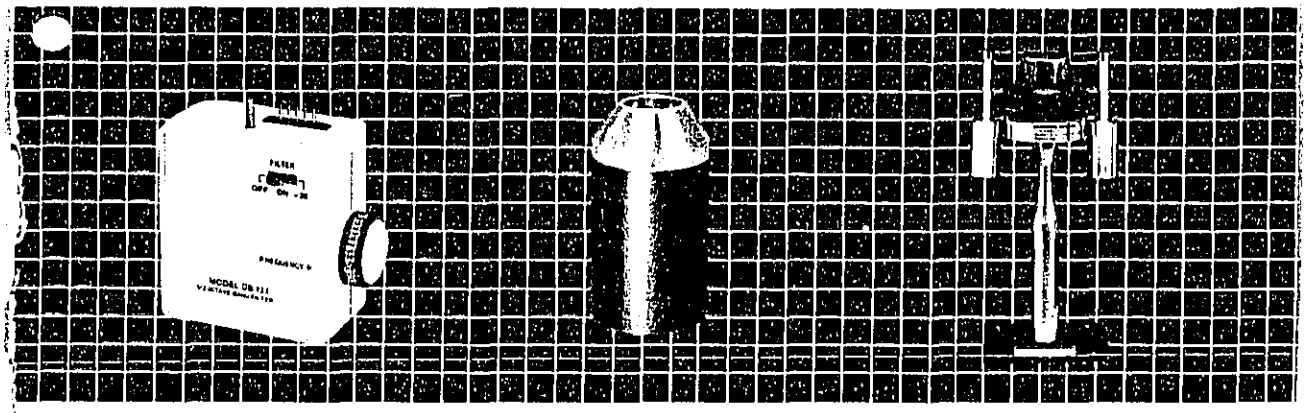
-20dB Gain Switch Accuracy: Gain boost is 20dB ± 0.2dB.

Power Source: No internal power source. Battery voltage is obtained from the ±6.45V supplied in the Model 155 through the 5-pin connector.

Size: 3.7 x 3.6 x 2.0 inches. (94 x 91 x 51mm) including knob.

Weight: Approximately 9 oz. (255g).

Construction: Solid state integrated circuitry in a high impact Cycolac T-shielded housing.



## OB-133 1/3-Octave Band Filter

A plug-in attachment for the 155 Sound Level Meter. Selects 33 1/3-octave bands from 12.5Hz to 20KHz. A 20dB gain switch permits reading decibel levels below 10dB in 1/3 octaves.

### SPECIFICATIONS

Standards: Meets ANSI S1.11-1971, Class III and IEC R225-1966.

Center Frequencies: Thirty-three: 12.5Hz (Band #11), 16Hz, 20Hz, 25Hz, 31.5 Hz, 40Hz, 50Hz, 63Hz, 80Hz, 100Hz, 125Hz, 160Hz, 200Hz, 250Hz, 315Hz, 400Hz, 500Hz, 630Hz, 800Hz, 1KHz, 1.25KHz, 1.6KHz, 2KHz, 2.5KHz, 3.15KHz, 4KHz, 5KHz, 6.3KHz, 8KHz, 10KHz, 12.5KHz, 16KHz, 20KHz (Band #43).

Pass-Band Uniformity: ±0.5dB

Peak to Valley Ripple: ±0.5dB

Filter Skirt Attenuation:
$.707f_c$ & $1.41f_c$ — 25dB atten.
$.5f_c$ & $2f_c$ — 45dB atten.
$.25f_c$ & $4f_c$ — 68dB atten.

Insertion Loss: 0.0dB ± 0.5dB at $f_c$

−20dB Gain Switch Accuracy: Boost 20dB ± 0.2dB.

Power Source: Powered by 155 Sound Level Meter.

Size: 3.7 x 3.5 x 2.0 inches (94 x 91 x 51mm)

Weight: 9 oz. (255g)

For more detailed information on the 155, and accessories see brochure #98-109.

## CA-22 Sound Calibrator

A dual-frequency (250 and 1000Hz) and dual amplitude (94 and 110dB) calibrator. Generates four selectable reference outputs with accuracy of ± 0.3dB.

### SPECIFICATIONS

Frequency: 250 and 1000Hz ± 1.5%

Sound Pressure Levels: 94 and 110dB ref. 20$\mu$N/M$^2$ (20$\mu$Pa).

Accuracy (20°C, 760mm Hg): ±0.3dB

Temperature Coefficient: 0 to 0.1 dB/°C maximum.

Altitude Effects: See instruction manual.

Voltage: 1.0 volt rms nominal behind 1000 ohms at each frequency.

Distortion: 1.0% maximum

Connection: Switchcraft 780 TINI-Plug® or equal.

Power Source: One 9-volt transistor battery, NEDA 1604, with life of 50 hours.

Operating Temperature Range: −10° to +50°C

Relative Humidity Range: 0-95%

Construction: Rugged aluminum housing.

Size: 4.4 in. long x 2.3 in. dia. (112 x 60mm)

Weight: Approximately 13 oz. (380g)

## AS-1550 Calibration Stand

Used with 155 meter calibration systems to hold microphone. EC-9A Coupler and Weight assembly and earphone as illustrated above.

## PMC-10 Cable

A 10-foot cable for remotely using the 155 Sound Level Meter microphone in the AS-1550 Calibration Stand when calibrating audiometers and for other remote measurement applications.

## 58-817 Precision Input Cable

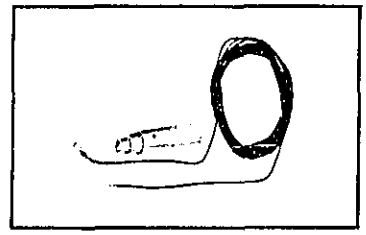
A 5-foot cable is available that connects the 155 meter to the LT-20 Linearity Transformer.

## PA-4 Probe Microphone

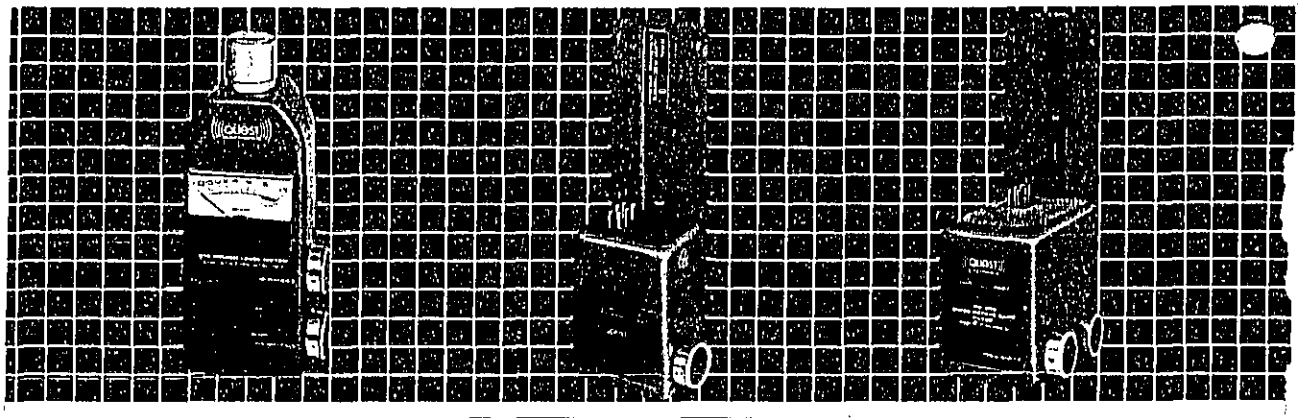
This microphone system makes it possible to determine the sound level at very discrete locations in the sound field such as at a hearing aid or cochlear implant.

As an example, this system can measure the sound pressure level at the microphone of a hearing aid directly within 1.5dB. This measurement technique improves the reliability and validity of sound pressure measurements.

The probe system includes: an electret microphone and cable, a PA-4 preamplifier with built-in Quest microphone connector, and calibrator adaptor.



# MODEL 215 METER SYSTEMS COMPONENTS



### Model 215 Sound Level Meter

A professional full-range ANSI Type 2 general purpose meter for virtually all applications requiring precise sound pressure level measurements. Wide dynamic range — 30-140dB, A, B, C, Linear and External weighting selection. Modular construction permits plug-in addition of Octave Band Filter or Peak-Hold Attachment. Meets ANSI Standard S1.4 Type 2 and IEC 651 Type 2.

SPECIFICATIONS

Measuring Range: 30-140dB re 20μPa

Response: A, B, C, Linear and External scale weighting, fast or slow response.

Standards: Meets ANSI S1.4-1971, Type 2 and IEC 651 Type 2.

Frequency Range: 20Hz to 10KHz

Output Display: Meter type with direct decibel readout.

Record Output: Approximately 1.2V rms AC at full scale behind 1K ohms. Adapted to DC recorders with Quest RM-800 Recorder Module.

Microphone: High quality PZT omnidirectional ceramic, 1-1/8" diameter.

Battery Supply: Two 9V transistor batteries, NEDA 1604. Battery life, 70 hours.

Operating Temperature: −10° to +50° C

Humidity: 0-95% RH

Overall Size: 3 x 7 x 2-1/8 in. (76 x 178 x 54mm)

Weight: 19 oz. (539g)

Construction: Solid state integrated circuitry in rugged aluminum housing.

### OB-45 Octave Band Filter

Plug-in attachment for Model 215 Sound Level Meter. Selects nine octave bands from 31Hz to 8KHz. Meets ANSI S1.11 class II, the most stringent class for octave filters. A 10dB gain switch permits reading dB levels down to 20dB in octaves.

SPECIFICATIONS

Frequency Range: Nine ranges 31Hz to 8KHz center frequencies, full octave band width.

Standards: Meets ANSI S1.11-1971 for Class II Filter Sets.

Input: (from 215 SLM) 1.2V rms plus 10dB crest factor, 20Hz to 10KHz.

Output: 0 to 4V rms, output impedance less than 1 ohm.

Gain Button: 10dB signal boost

Power Supply: None; uses battery power from 215 SLM.

Operating Temperature: −10° to +50° C.

Humidity: 0-95% RH

Size: 3 x 3-1/2 x 2-1/8 inches; back plate extends to 8 inches.

Weight: 9 oz. (255g)

Construction: Solid State integrated circuitry in rugged aluminum housing.

### Remote Microphone Capability Option

Can be built into the 215 Sound Level Meter during manufacture to provide for the use of an extension cable or Hearing Aid Cable. Meters with remote microphone capability are designated Model 215R. Calibration systems with this capability are designated as Models 215R-4512AM and AM-100R.

### OB-245 Super Octave Band Filter

A special filter set with a high degree of isolation between frequency bands — nominally 40dB/octave rolloff. Nine selectable ranges from 31Hz to 8KHz. In addition to improved performance for all standard uses of octave filters, the unit is specially designed for measuring full harmonic distortion of audiometers — including the difficult-to-measure 2nd harmonic. The Super Filter far exceeds the most stringent requirements of ANSI S1.11.

SPECIFICATIONS

Frequency Range: Nine ranges 31Hz to 8KHz center frequencies, full octave band width.

Standards: Meets ANSI S1.11-1971 for Class II Filter Sets.

Band Roll Off: Minimum 36dB per octave with both filters engaged.

Input: (from 215 SLM) 1.2V rms plus 10dB crest factor, 20Hz to 11KHz.

Output: 0 to 4V rms, output impedance less than 1.0 ohm.

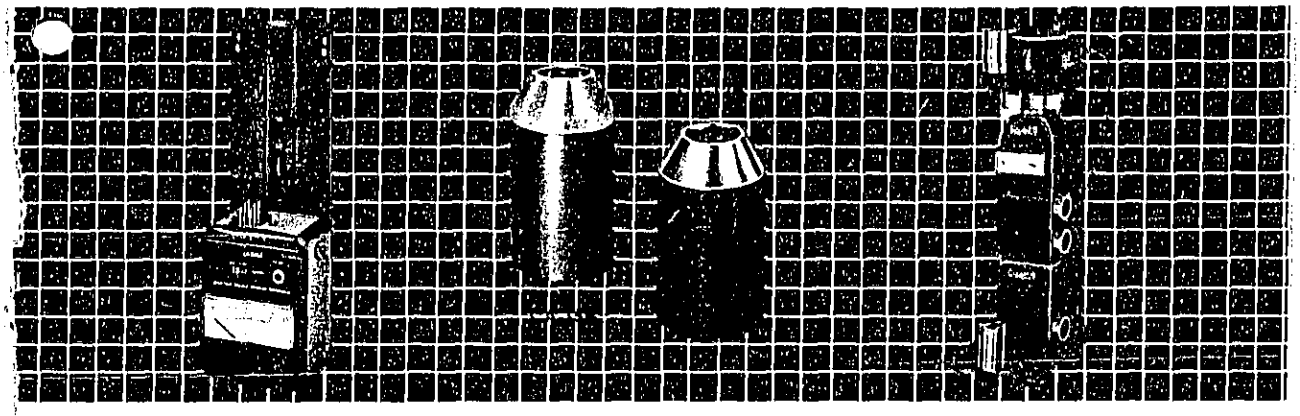
Power Supply: None; uses battery power from 215 SLM.

Operating Temperature: −10° to +50° C

Humidity: 0-95% RH

Size: 3 x 3-1/2 x 3-1/4 inches; back plate extends to 8 inches.

For more detailed information on the 215, and accessories see brochure #98-194.



### PH-35 Peak Hold Module

Any of the 215 meter Audiometer Calibration Systems can be used with the PH-35 Peak Hold Module for the calibration of Brainstem Audiometer Click impulses. Peak levels are measured for both absolute peak and 35 ms risetime peak.

SPECIFICATIONS

Peak Hold Range: 30-146dB (Set by 215 Sound Level Meter).

Operating Modes: Peak Impact — Hold; Peak rms fast response — Hold; Peak IEC Impulse — Hold.

Rise Time —
- OSHA Impact Mode: Less than 50μsec.
- FAST Response Mode: 125 millisec.
- IEC Impulse Mode: 35 millisec.

Hold-Decay Rate: Less than .01dB per sec. (all modes).

Power Source: ±9 volts (from 215)

Input Voltage: 0-6 volts peak

Size: 2-1/2 x 3-1/2 x 2-1/8 inches; back plate extends to 8 inches.

Construction: Solid state integrated circuitry in rugged aluminum housing.

### Model CA-15B Calibrator

A five-frequency portable field calibrator. 110dB; 125, 250, 500, 1K and 2KHz frequency selection; ±0.4dB accuracy. 1-1/8-inch coupler cavity, optional adaptors.

SPECIFICATIONS

Frequency: Selectable. 125, 250, 500, 1000 and 2000 Hz, ±3%.

Sound Pressure Level: 110dB, re 20μPa

Accuracy (23° C, 760mm Hg): ± 0.4dB

Temperature Coefficient: 0 to .015 dB/° C

Altitude Effects: See instruction manual.

Power Source: 9-volt transistor battery (NEDA 1604). Battery life approximately 50 hours.

Operating Temperature: −10° to 50° C

Construction: Solid state integrated circuitry in rugged aluminum housing.

Case Size: 4 in. long x 2.3 in. dia. (102 x 58mm)

Weight: 12 oz. (340g) including battery.

### AS-1545 Calibration Stand

Used with the 215 meter calibration systems to support the 215-45 Octave Band Analyzer, earphone, coupler and weight as illustrated above.

### Model CA-12B Calibrator

A portable, self-contained field type calibrator. 110dB sound level at 1000 Hz, ±0.4dB accuracy. 1-1/8-inch coupler cavity, optional adaptors.

SPECIFICATIONS

Frequency: 1000Hz ± 3%

Sound Pressure Level: 110dB re 20μPa

Accuracy (23° C, 760mm Hg): ±0.4dB

Temperature Coefficient: 0 to 0.1dB/° C maximum.

Altitude Effects: 0.1dB decrease for each 2,000 foot increase in altitude from sea level to 12,000 feet elevation.

Power Source: 9-volt transistor battery (NEDA 1604). Battery life approximately 50 hours.

Operating Temperature: −10° to +50° C

Construction: Solid state integrated circuitry in rugged aluminum housing.

Case Size: 4 in. long x 2.3 in. dia. (102 x 58mm)

Weight: 12 oz. (380g) including battery.

### HA-100 or HA-200 Impedance/Hearing Aid Test Assembly

Adapting the Calibration System for impedance audiometer or hearing aid tests requires the use of the 215R Remote Microphone Meter. A 2cc coupler is necessary to connect the impedance probe or hearing aid to the meter microphone. The standard Quest 401 microphone is too large to fit the 2cc coupler, and therefore the model 1830, 1/2-inch microphone and cable with connector, are necessary as accessories. The following additional parts are needed for tests:

Model 215R Remote Microphone Sound Level Meter
QHA-1 or QHA-2 2cc Coupler
1830HA 1/2-inch Microphone with 32-inch cable and connector
1/2-inch Microphone Adaptor

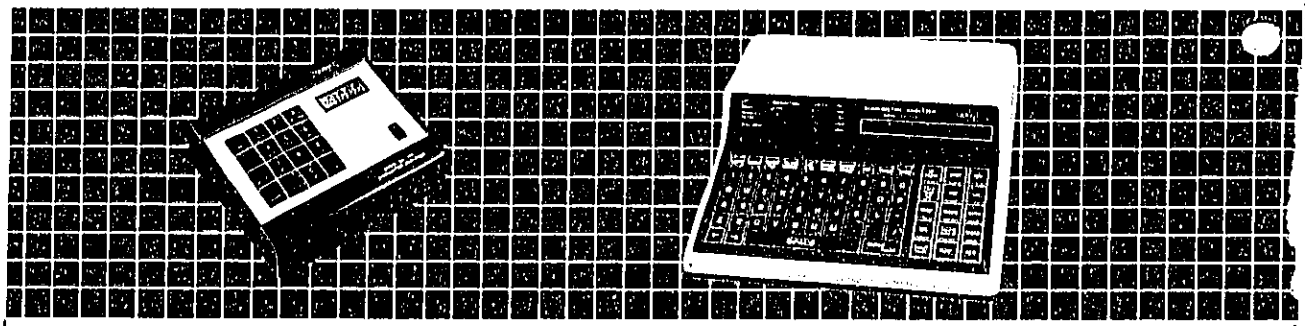
### 59-982 Input Cable

A 5-foot cable that connects the 215 meter to the LT-20 Linearity Transformer.

### PA-5 Probe Microphone

This microphone system is the same as the PA-4 System (see page 7) only designed to work with the 215R Remote Mic Sound Level Meter in the same fashion as the PA-4 does with the 155 meter.

# AUDIOMETER ANALYZERS



## AA-175 Audiometer Analyzer

A microprocessor-controlled analyzer that verifies audiometer calibration and performance. Calculates decibel level, linearity, harmonic distortion, frequency, overshoot, rise and fall times, and pulse width.

### SPECIFICATIONS

Display: 4-1/2 digit liquid crystal.

Functions: Frequency, Calibrate, dB Level, Linearity, Distortion, Fall Time, Rise Time, Pulse Width, Overshoot. Additional keyboard controls: Range, Left, Right, Print, Title and Reset.

Input: From SLM: 0.5 to 2.0Vrms. (0.16 to 0.63 Vrms with 10dB boost.)

Input Impedance: Approximate 0.01 MFD capacitor in series with 100K ohms.

Frequency: Measures from 25Hz to 12KHz. Accuracy: 0.01% ± 1 count.

Linearity: Accuracy: ±0.1dB. System accuracy is primarily dependent on the SLM attenuator.

Distortion: From 250Hz to 8000Hz: Range is 15 to 50dB down (approximately 18% to 0.3% THD). At 125Hz:

Range is 15 to 33dB down (approximately 18% to 2.2% THD). Harmonics above 20,000Hz are suppressed. Accuracy: ±2dB.

Rise/Fall Time: Accuracy: 1 cycle ± 1msec. From 5msec. to 1999msec.

Pulse Width: Accuracy: 2 cycles ± 1msec. From 20msec to 1999msec.

Overshoot: Accuracy ±0.1dB.

Output: For printer: 2 wire, serial data per RS-232.

Battery: 2 NEDA 1604A 9-volt alkaline. Life: Approximately 10 hours continuous use.

External Power: Model 65 Power Pack. (Provides 6.3 VAC @ 500mA.)

Temperature: Operating: 15° to 35°C
Storage: −10° to 50°C

Humidity: 0-95% RH

Size: 3-1/4 x 7 x 6-1/4 in. (175 x 160 x 83mm)

Weight: 1-3/4 lbs. (0.8 Kg)

Construction: Aluminum housing.

For more detailed information see brochure #98-143.

## AA-188 Audiometer Analyzer

The Quest AA-188 Audiometer Analyzer is similar to the AA-175 but does not require a sound level meter to operate it. It also has the added features of: Alpha-Numberic Keyboard, Auto Ranging, Warble measurements, Computer Interface, and is Program Flexible.

### GENERAL SPECIFICATIONS

Keyboard: 69 key membrane with tactile feedback.

Display: 16 character alphanumeric liquid crystal.

Printer Output: Centronics Compatible with 36 pin connector parallel.

Serial Port: RS-232 compatible with switchable baud rates via a dB-25 female connector.

Battery Life for Non-volatile Memory: Better than 2 years.

### MEASUREMENT SPECIFICATONS

Frequency: Measures from 5Hz to 20kHz. Accuracy: 0.01% ± 1 count.

Fall/Rise Time: Accuracy: 1 cycle ± 0.1msec. From 1.0msec. to 6.5sec.

Pulse Width: Accuracy: 1 cycle ± 0.1msec. From 1.0msec. to 6.5sec.

Overshoot: Accuracy: ± 0.1dB.

## OCTAVE FILTERS:

Standards: Meets ANSI S1.11-1971 Class II Type O IEC R225-166 from 31.5Hz to 8kHz and self-centering band and Center Frequencies: 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1kHz, 2kHz, 4kHz, 8kHz, and self-centering. (Locks onto the incoming frequency.)

### PHYSICAL

Power Requirements: 120/240Vac, 50/60 Hz. (240Vac is factory-set option)

Temperature: Operating: 15 to 35°C Storage: -10 to 50°C.

Humidity: 0-95% RH.

Size: 10 x 10 x 4 inches (254 x 254 x 102mm).

Weight: Approx. 5 lbs. (2.27Kg).

Construction: Solid state integrated circuitry in a rugged electrically shielded molded plastic housing.

### ANALOG SPECIFICATIONS

Standards: Meets all pertinent sections for audiometer calibration of ANSI S1.4-Type 1 and IEC 651-1979 Type 1.

Input: Minus 12dB to 130dB.

Preamp: On remote stand; Input is greater than 1G ohm in parallel with 2pf. Preamp will drive up to 100 feet of cable.

Microphone: 1 inch condenser precision.

Polarization Voltage: Regulated 200v ± 2% over temperature range.

Microphone Input: Input impedance is 1 Megohm in parallel with 100pf. Maximum sinusoidal input voltage is 1v RMS.

Attenuator Type: Autoranging via microprocessor control.

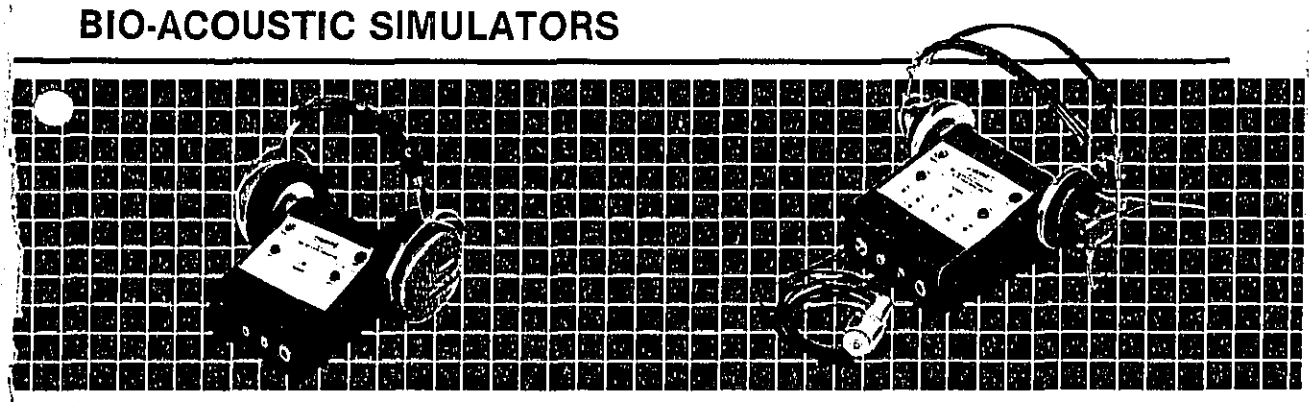
Attenuator Accuracy: ± 0.3dB over entire frequency range.

Frequency Response: 4Hz (-3dB) to 27kHz (-3dB) on Linear.

Frequency Weighting Networks: A, C, and Linear.

For more detailed information see brochure #98-211.

# BIO-ACOUSTIC SIMULATORS



## BA-201 Bio-Acoustic Simulator

The Quest Model BA-201 is a high quality measuring device used to fulfill the requirements of daily biological tests of audiometers.

It is simply substituted for a test subject, thus eliminating the need to use the same person with a known hearing threshold level.

The unit can be used with manual, automatic, and microprocessor audiometers, and that use either standard earphone or audiocups.

### SPECIFICATIONS

Test Frequencies: 125Hz to 8kHz

Calibration: 60dB HL ± 1dB at 1kHz continuous tone with TDH-39, 49, or 50 headphones.

Accuracy: Repeatable to within 2dB at all test frequencies when used in sound room.

Indicators: 3 LED's; Left, Right and Power.

Transducers: Two, Electret elements, each with internal FET preamplifier.

Response Output: Normally open and normally closed relay contacts. (SPDT 3 wire output.) Capable of switching up to 30 volts AC or DC.

Hysteresis: 10dB + 1dB between ON and OFF indication when used with continuous tone input.

Relay Specifications: 250mA current, 30 volts AC or DC. 20 million operations.

Frequency Output: with audiometer at 60dB HL, output is 1.2V P-P square wave for use with frequency counter.

Power: 9 volt alkaline battery. (optional 120 volt power adapter Model 120.) Low battery indicator when used in the battery mode.

Size: 170 x 165 x 100 mm (6.8 x 6.5 x 4 inches)

Weight: BA-201 is 560g (1.25 lb.)

Construction: Aluminum Housing.

For more detailed information on the BA-201's, see brochure 98-160.

## BA-201-25 Bio-Acoustic Simulator

Same as the BA-201 but in addition continuously measures room background noise in five octave bands in accordance with OSHA and other criteria.

### SPECIFICATIONS: OCTAVE MONITOR SECTION

Test Octaves: 0.5kHz, 1kHz, 2kHz, 4kHz, and 8kHz.

Test Levels: 40dB at .5kHz and 1kHz, 47dB at 2kHz, 57dB at 4kHz, and 62dB at 8kHz (per OSHA).

Indicators: 5 LED's for Test Levels above.

Filter: ANSI S1.11-1971, Class II, limited to – 30dB.

Microphone: Cable-mounted ceramic with Built-in FET preamplifier.

Calibration: 110dB, 1kHz acoustic calibration feature.

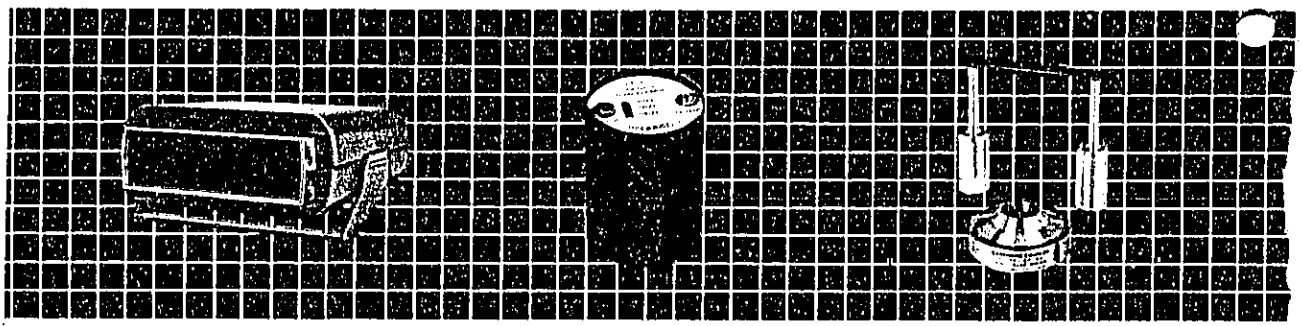
Weight: BA-201-25 is 690g (1.5 lb.) without remote microphone.

## RESPONSE DELAY MODIFICATIONS AVAILABLE

Both the BA-201 and the BA-201-25 Bio-Acoustic Simulators can be used to check the calibration of a Besserman, Tracor 400 and Tracor 410N Audiometers. We have installed in these new models a Response Delay Control. The units will cost slightly more than the standard units. To order these units specify the following:

#59-816 BA-201 Response Delay Mod. Unit
#59-817 BA-201-25 Response Delay Mod. Unit.

# COMPONENTS USED IN ALL SYSTEMS



### Model FC-3 Frequency Counter

A simple, easy to use frequency counter intended for use in and around the audio range. Complete with 6-foot power cord and line converter that plugs into wall outlet.

SPECIFICATIONS

Display: L.E.D., 5-digit, 1/2" high. Updated every 2 seconds.

Frequency Range: 10Hz to 100KHz

Input Impedance: 100K ohms over frequency range.

Sensitivity: 100 mv rms over frequency range.

Maximum Input Voltage: 150 V rms

Accuracy: .01%

Power Supply: Model PS-124, 120 VAC to 12 VDC, 12 VDC, 450 MA

Size: 4 x 4-1/2 x 1-3/4 in. (102 x 114 x 44mm)

### LT-20 Linearity Transformer

Used with either meter system to increase signal level by 25dB. Permits audiometer linearity check down to −10dB.

SPECIFICATIONS

Signal Gain: Approximately 20dB

Input Impedance: Selectable; 10, 50 or 100 ohms

Input and Output Jack: TINI-Plug™

Suggest Output Load: Greater than 140K ohms

Connection Cable: Use Cable #58-817 for connection to Model 155 Precision Sound Level Meter. Use Cable #59-982 for connection to Model 215 Sound Level Meter.

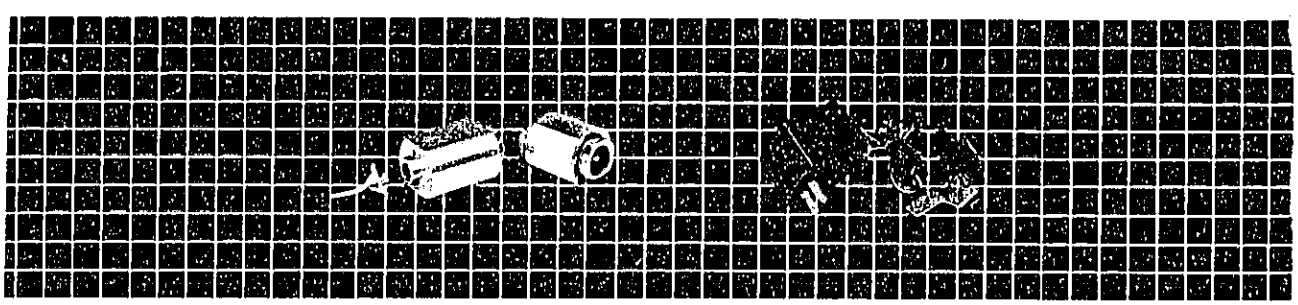
Size: 3.2 in. long x 2.4 in. dia. (80 x 60mm)

Weight: 6 oz. (170g)

Construction: Aluminum housing

### EC-9A Coupler and W-440 Weight

Audiometric 6cc coupler similar to the NBS, Type 9A for calibration of all audiometers. The W-440 weight provides the necessary 450 gram force to the audiometer earphone.



### QHA-2 and QHA-1 Couplers

2cc Couplers for impedance or hearing aid calibration. Sleeve adaptor included to fit 1/2-inch microphones only. Specify for which microphone.

### PS-95 Power Supply

AC line adaptor for operating the 215 and 155 meters instead of batteries, +9 and −9 volt.

# SYSTEM SELECTION GUIDE

### Which System is Right for You?

The chart below shows the calibration components that are available and the systems in which they are used. Because of the many component combinations that are possible, we suggest you contact your local instrument dealer or our home office to help you select the proper system for your needs.

| | | AA-188AM | AM-2000 | 155-14522AM | AM-200 | AM-100 | 215-4512AM | 215-12AM |
|---|---|---|---|---|---|---|---|---|
| AA-188 | Audiometer Analyzer | X | | | | | | |
| 155 | Sound Level Meter | | X | X | | | | |
| OB-145 | Octave Band Filter | | X | X | | | | |
| 7023 | One-Inch Condenser Microphone | X | X | X | | | | |
| CA-22 | Sound Calibrator | | X | X | | | | |
| AS-1550 | Calibration Stand | X | X | X | | | | |
| PMC-10 | Ten-foot Cable | X | X | X | | | | |
| 59-970 | Carry Case | | | X | | | | |
| 7046 | Half-Inch Condenser Microphone | * | * | * | | | | |
| 58-817 | Precision Input Cable | | X | * | | | | |
| OB-133 | 1/3 Octave Band Filter | | * | * | | | | |
| 59-819 | Carrying Case | X | | | | | | |
| EC-9A | Coupler and Weight | X | X | X | X | X | X | X |
| | Microphone Calibration Chart | X | X | X | X | X | X | X |
| AA-175 | Audiometer Analyzer | | X | | X | * | * | * |
| | Printer (for AA-175) | * | * | * | * | * | * | * |
| FC-3 | Frequency Counter | | | * | | X | * | * |
| †LT-20 | Linearity Transformer | | X | * | * | * | * | * |
| †QHA-1 or QHA-2 | 2cc Coupler (Specify for which meter; requires half-inch microphone) | * | * | * | * | * | * | * |
| PS-95 | Line Power Supply | | * | * | * | * | * | * |
| 59-998 | Carrying Case | | X | * | | * | * | * |
| 215 | Sound Level Meter | | | | X | X | X | X |
| 215R | Sound Level Meter (Remote microphone option) | | | | * | * | * | * |
| OB-45 | Octave Band Filter | | | | X | | X | * |
| OB-245 | Super Octave Band Filter | | | | | X | | |
| CA-12B | Sound Calibrator | | | | | | X | X |
| CA-15B | Sound Calibrator | | | | X | X | | |
| AS-1545 | Calibration Stand | | | | X | X | X | |
| PH-35 | Peak Hold Module | | | | * | * | * | * |
| 59-932 | Carrying Case | | | | X | X | X | |
| 59-925 | Carrying Case | | | | | | | X |
| †HA-100 or HA-200 | Impedance/Hearing Aid Test Assembly | | | | * | * | * | * |
| †59-982 | Input Cable | | | | * | * | * | * |

X = Included in Kit  * = Optional

† = In 215 meter systems 215R remote microphone option is required.



Printed in U.S.A.

QUEST ELECTRONICS

Model AA-175 Audiometer Analyzer

# A Unique Microprocessor-Controlled Analyzer for Calibrating Audiometers Conveniently, Accurately and Automatically.

- **Sound Pressure Level**
- **Frequency**
- **Harmonic Distortion**
- **Linearity**
- **Rise and Fall Times**
- **Pulse Width**
- **Overshoot**
- **Hard copy printout using optional printer.**

The Quest Model AA-175 Audiometer Analyzer is a microprocessor-controlled module that is used with all Quest Audiometer Calibration systems to verify the calibration and performance of audiometers.

It can also be used with Bruel & Kjaer and Gen‡ad systems.

The AA-175 calculates harmonic distortion, frequency, overshoot, rise and fall times, and pulse width. In conjunction with the sound level meter attenuator it calculates decibel levels and linearity. The computations are shown on an LCD digital display. An optional printer provides a hard copy print-out for record purposes.

The unit is automatic. The operator need only select the test desired and operate the audiometer and the keyboard to calibrate the audiometer. There are no filters to tune, no levels to adjust, and no calculations to make.

The analyzer operates on internal 9-volt batteries and is portable. It also operates on AC line power when used with the Model 65 Power Pack.

<<QUEST>>
ELECTRONICS
AUDIOMETER ANALYZER

**********

OWNER
---

---

MODEL
---

---

SERIAL #
---

CAL.BY
---

---

DATE
---

NOTES
---

**********

| | |
|---|---|
| RIGHT | |
| FREQ | 501HZ |
| SPL | 114.1DB |
| THD | -41.4DB |
| FALL | 29.0MS |
| RISE | 48.0MS |
| OS | 0.0DB |
| PW | 210.0MS |
| RIGHT | |
| FREQ | 997HZ |
| SPL | 112.0DB |
| THD | -43.7DB |
| FALL | 28.0MS |
| RISE | 47.0MS |
| OS | 0.0DB |
| PW | 206.0MS |
| RIGHT | |
| FREQ | 1503HZ |
| SPL | 112.2DB |
| THD | -38.5DB |
| FALL | 31.0MS |
| RISE | 51.0MS |
| OS | 0.0DB |
| PW | 206.0MS |

| | |
|---|---|
| FREQ | 501HZ |
| SPL | 92.0DB |
| FREQ | 1001HZ |
| SPL | 77.0DB |
| FREQ | 1503HZ |
| SPL | 76.6DB |
| FREQ | 2010HZ |
| SPL | 78.5DB |

| | |
|---|---|
| LIN | |
| SPL | 117.4DB |
| SPL | 107.5DB |
| DIFFR | - 9.9DB |
| SPL | 97.1DB |
| DIFFR | -10.4DB |
| SPL | 87.5DB |
| DIFFR | - 9.7DB |
| SPL | 77.7DB |
| DIFFR | - 9.8DB |

*Audiometer Analyzer and Printer Shown in a Complete Audiometer Calibration System.*

# Specifications

**Display:** 4-1/2 digit liquid crystal.

**Keyboard Controls:** REPeat, FREQuency, LEFT, RIGHT, CALibrate, LEVEL, LINearity, DISTortion, RANGE, FALL, RISE, Pulse Width, PRINT, TITLE, OS, RESET, ., 0-9.

**Input:** From SLM: 0.5 to 2.0Vrms. (0.16 to 0.63Vrms with 10dB boost.)

**Input Impedance:** Approximate 0.01MFD capacitor in series with 100K ohm.

**Frequency:** Measures from 25Hz to 12KHz. Accuracy: 0.01% ± 1 count.

**Linearity:** Accuracy: ± 0.1dB. System accuracy is primarily dependent on the SLM attenuator.

**Distortion:** From 250Hz to 8000Hz: Range is 15 to 50dB down (approximately 18% to 0.3% THD). At 125Hz: Range is 15 to 33dB down (approximately 18% to 2.2% THD). Harmonics above 20,000Hz are suppressed. Accuracy: ± 2dB.

**Rise/Fall Time:** Accuracy: 1 cycle ± 1msec. From 5msec to 1999msec.

**Pulse Width:** Accuracy: 2 cycles ± 1msec. From 20msec to 1999msec.

**Overshoot:** Accuracy: ± 0.1dB.

**Output:** For printer: 2 wire, serial data per RS-232.

**Battery:** 2 NEDA 1604A 9-volt alkaline. Life: Approximately 10 hours continuous use.

**External Power:** Model 65 Power Pack. (Provides 6.3 VAC @ 500mA.)

**Temperature:** Operating: 15° to 35°C
Storage: −10° to 50°C

**Humidity:** 0-95% RH

**Size:** 175 x 160 x 83 mm (3-1/4 x 7 x 6-1/4 inches)

**Weight:** 0.8 Kg (1-3/4 lbs.)

**Construction:** Aluminum housing

# Accessories

- **6470 Digitec Printer**
- **LT-20 Linearity Transformer**


(QUEST) ELECTRONICS

510 S. Worthington St.
Oconomowoc, WI 53066
Telephone 414-567-9157


Represented by


98-143
3-83

# Tomorrow's Calibration System Is Available Today.


## The AA-188 Audiometric Analyzer

QUEST
ELECTRONICS

# Specifications

## GENERAL SPECIFICATIONS

**Keyboard:** 69 key membrane with tactile feedback.
**Display:** 16 character alphanumeric liquid crystal.
**Printer Output:** Centronics compatible with 36 pin connector parallel.
**Serial port:** RS-232 compatible with switchable baud rates via a DB-25 female connector.
**Battery Life for Nonvolital Memory:** Better than 2 years.

## MEASUREMENT SPECIFICATIONS

**Frequency:** Measures from 5Hz to 20 KHz. Accuracy: 0.01% ±1 count.
**Fall/Rise Time:** Accuracy: 1 cycle ±0.1msec. From 1.0msec to 6.5sec.
**Pulse width:** Accuracy: 1 cycle±0.1msec. From 1.0msec to 6.5sec.
**Overshoot:** Accuracy: ±0.1dB.

## ANALOG SPECIFICATIONS

**Standards:** Meets all pertinent sections for audiometer calibration of ANSI S1.4 - Type 1 and IEC 651-1979 Type 1.
**Input:** Minus 12dB to 130 dB.
**Preamp:** On remote stand; Input is greater than 1G ohm in parallel with 2pf. Preamp will drive up to 100 feet of cable.
**Microphone:** 1 inch condensor - precision.
**Polarization Voltage:** Regulated 200v±2% over temperature range.
**Microphone Input:** Input impedance is 1 Megohm in parallel with 100pf. Maximum sinusoidal input voltage is 1v RMS.
**Attenuator Type:** Autoranging via microprocessor control.
**Attenuator Accuracy:** ±0.3dB over entire frequency range.
**Frequency Response:** 4Hz (-3dB) to 27KHz (-3dB) on Linear.
**Frequency Weighting Networks:** A, C, and Linear.

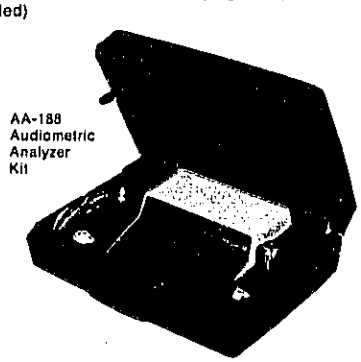
## OCTAVE FILTERS

**Standards:** Meets ANSI S1.11-1971 Class II, Type O, from 31.5Hz to 8KHz and self-centering band and IEC R225-1966.
**Center Frequencies:** 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, and self-centering. (Locks onto the incoming frequencies.)

## PHYSICAL

**Power Requirements:** 120/240Vac, 50/60Hz.
**Temperature:** Operating: 15 to 35°C Storage: -10 to 50°C
**Humidity:** 0-95% RH
**Size:** 10 x 10 x 4 inches (254 X 254 x 102mm) **Weight:** Approx 5 lbs. (2.27 Kg)
**Construction:** Solid state integrated circuitry in a rugged electrically shielded molded plastic housing.

AA-188 Precision Audiometric Analyzer can be purchased alone (mic, carrying case and accessories are not included) or can be purchased as a kit; AA-188AM Precision Audiometric Analyzer Kit which contains AA-188, 58-913 preamp, 7023 mic, A-63B adaptor, 1 inch mic adaptor, EC-9A coupler, W-440 weight, AS-1550 calibration stand, PMC-10 mic cable, and 819 carrying case (calibrator is not included)



AA-188
Audiometric
Analyzer
Kit

ACCESSORIES:

58-913 Preamp
7023 1 inch condensor microphone
A-63B Preamp Adaptor
58-929 1" Mic Adaptor
EC-9A Coupler
W-440 Weight
AS-1550 Calibration Stand
PMC-10 Mic Cable
819 Carrying Case

ADDITIONAL ACCESSORIES:

CA-22 Precision Sound Calibrator
58-883 Input Cable to "Centronics" Type 80 Column Printer

88-211
2-86

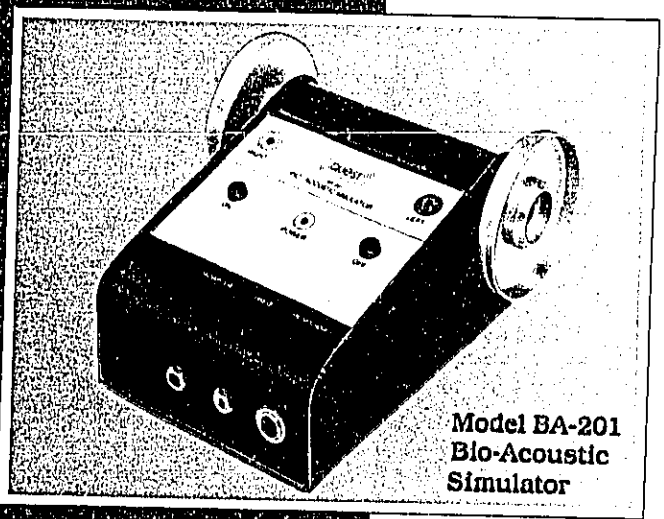
Represented by:

Printed in USA

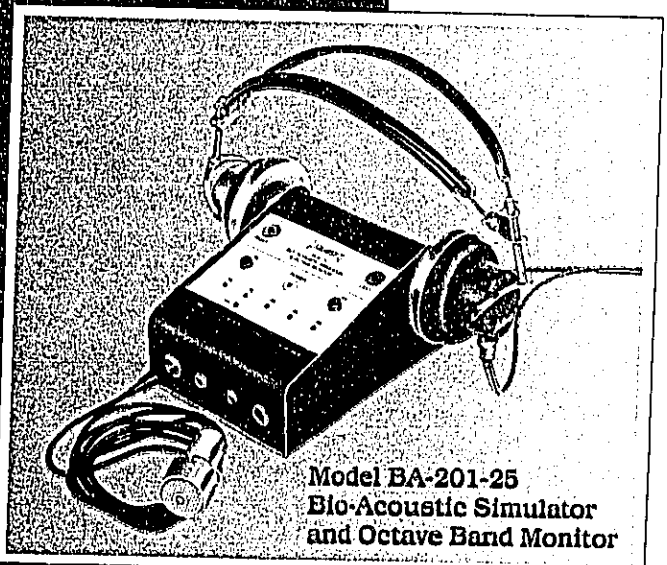
QUEST ELECTRONICS

# Bio-Acoustic Simulators

## the dependable alternative to biological calibration of audiometers



Model BA-201
Bio-Acoustic
Simulator



Model BA-201-25
Bio-Acoustic Simulator
and Octave Band Monitor

## Eliminate the Uncertainties of Using Human Subjects

## Monitor Room Background Noise in Octaves

Model BA-201 . . . A high performance measuring instrument for making the daily biological check of audiometers as required by OSHA. Shown without headset.

Model BA-201-25 . . . Same as the Model BA-201 but in addition continuously measures room background noise in five octave bands in accord with OSHA and other criteria. Shown with headset.

### FEATURES

- Eliminate the cost and uncertainty of using human subjects.
- Used with manual, automatic and microprocessor audiometers.
- Continuously monitors room background noise in octaves (Model BA-201-25).
- Used with standard earphones, with or without Audiocups.
- Easy-to-read color-coded LED display.
- Simulate patient switch with normally open or normally closed contacts.
- Battery- or line-powered.
- Portable . . . can be wall-mounted.

Performance of the Model BA-201 — nicknamed Bio-Betty — and the Model BA-201-25 is consistent and dependable. They eliminate the problems and disadvantages inherent in using a human test subject for making the daily biological check of audiometers, though they do not eliminate the need for the operator to check for clicks, scratches and other extraneous noises. Both simulators will check manual, automatic and microprocessor audiometers. In addition the BA-201-25 measures audiometric room background noise in five octave bands from 0.5 kHz to 8 kHz. Refer to the specifications for the complete operating characteristics of both simulators.

Model BA-201 Simulator with Audiocup headset.

# SPECIFICATIONS

## Bio-Acoustic Simulator Section

**Test Frequencies:** 125 Hz to 8 kHz.
**Calibration:** 60 dB HL ± 1 dB at 1 kHz continuous tone (61 dB HL with pulsed tone) with TDH-39, TDH-49, or TDH-50 earphone.
**Accuracy:** Repeatable to within 2 dB at all test frequencies when used in sound room.
**Indicators:** 3 LED's: Left, Right, and Power.
**Transducers:** Two, electret elements, each with internal FET preamplifier.
**Response Output:** Normally open and normally closed relay contacts. (SPDT 3 wire output.) Capable of switching up to 30 volts AC or DC.
**Hysteresis:** 10 dB ± 1 dB between ON and OFF indication when used with continuous tone input.
**Relay Specifications:** 250 mA current, 30 volts AC or DC. 20 million operations.
**Frequency Output:** With audiometer at 60 dB HL, output is 1.2V P-P square wave for use with frequency counter.
**Application:** For use with manual, automatic, or computer-controlled audiometers with pulsed or continuous tones. Will measure all earphones equipped with either MX-41/AR cushions or Model 51 cushions, with or without Audiocups or similar earmuffs.

## Octave Monitor Section (BA-201-25 only)

**Test Octaves:** 0.5 kHz, 1 kHz, 2 kHz, 4 kHz and 8 kHz.
**Test Levels:** 40 dB at .5 kHz and 1 kHz, 47 dB at 2 kHz, 57 dB at 4 kHz, and 62 dB at 8 kHz (per OSHA, Fed. Reg. March 8, 1983). Other levels down to 25 dB can be set.
**Indicators:** 5 LED's: 0.5 kHz, 1 kHz, 2 kHz, 4 kHz, and 8 kHz.
**Filter:** ANSI S1.11-1971, Class II, limited to -30 dB.
**Microphone:** Cable-mounted ceramic with built-in FET preamplifier.
**Calibration:** 110 dB, 1 kHz acoustic calibration feature.

## General Features

**Power:** 9 volt alkaline battery. (Optional 120 volt power adapter, Model 120.) Low battery indicator when used in the battery mode.
**Size:** 170 x 165 x 100 mm (6.8 x 6.5 x 4 inches).
**Weight:** BA-201 is 560 g (1.25 lb.); BA-201-25 is 690 g (1.5 lb.) without remote microphone.
**Construction:** Aluminum housing.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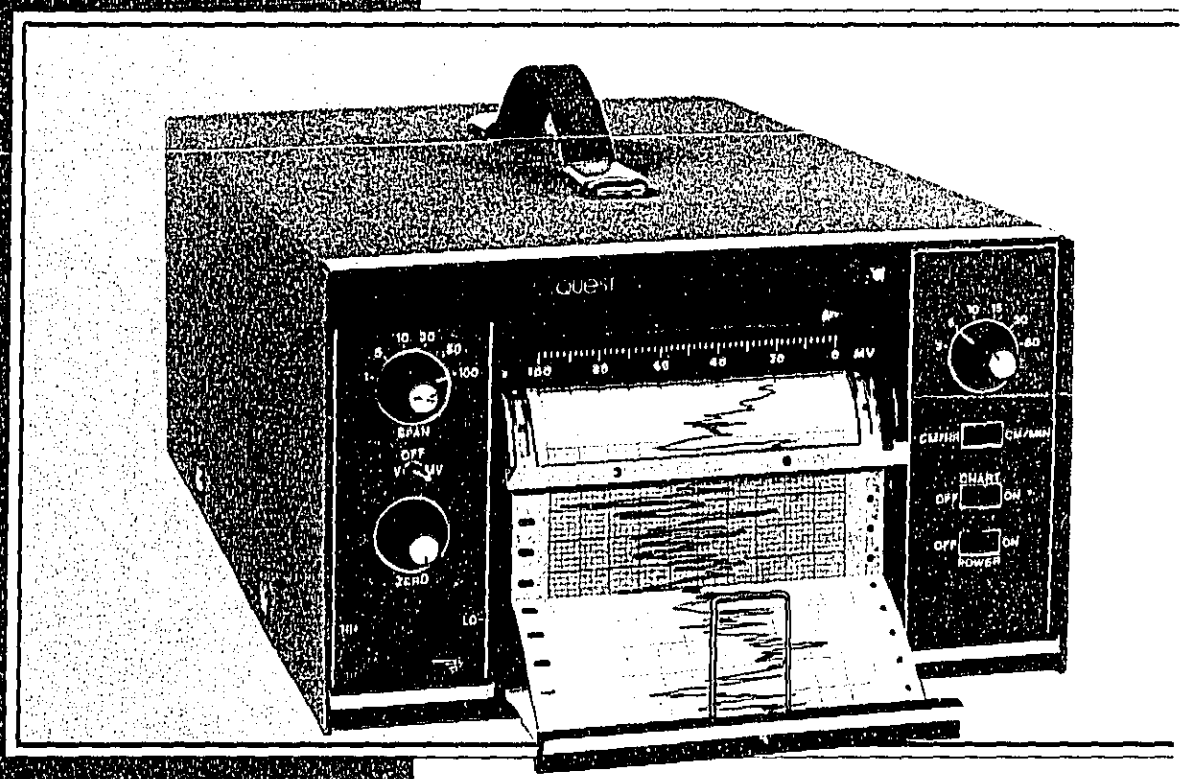
# CHART RECORDERS




## MODEL 411BB
BATTERY OPERATED

## MODEL 411L
LINE OPERATED

- Multi-range, multi-speed servo recorders.
- 1/2 Second response full scale.
- Used with sound level meters and other instruments for time-history recording.
- For long and short term industrial noise surveys, vehicle noise level monitoring and scientific analysis.
- Optional vinyl-covered wood carrying case holds recorder, charger, 12 charts, spare ink cartridges with stylus and pouch for instructions and records.

# SPECIFICATIONS

## Model 411BB — Battery Operated

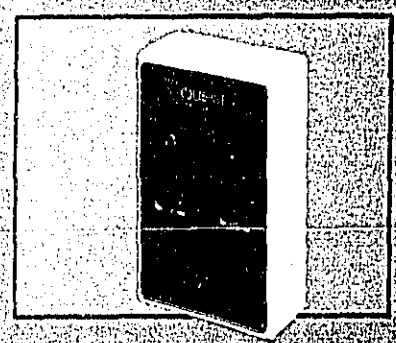
**Recorder type:** Potentiometric, rotary servo.
**Input spans:** 1, 5, 10, 20, 50, 100 MVDC; 1, 5, 10, 20, 50, 100 VDC.
**Measurement accuracy:** ±0.5% span. Offset drift 2.0 μV/°C maximum.
**Input overload:** Continuous. 1 MV to 100 MV spans is 60 VDC; 1 V to 100 V spans is 100 VDC.
**Input impedance:** Potentiometric to 100 MV; 1 megohm on 1 V and above.
**Source impedance:** 10,000 ohms maximum on all spans.
**Response:** 0.5 second full scale.
**Deadband:** 0.3% of span maximum, included in measurement accuracy.
**Ambient temperature limits:** 0 to 50°C.
**Servo life:** Minimum $10^7$ complete cyles.
**Amplifier adjustments: Span:** Accessible inside case at left side of chassis; ±10% adjustment.
**Servo gain:** Accessible inside case at left side of chassis.
**Zero:** ±100% front panel multiturn knob adjust.
**Operating controls: Front left panel:** Rotary span switch with toggle switch to select MV, V, or OFF and Zero adjust knob.
**Right front panel:** Rotary switch to select chart speeds, slide switches for CM/HR-CM/MIN, CHART ON-OFF, and POWER ON-OFF.
**Rear Panel:** Power mode, three position slide switch selects internal battery, AC or external battery, or internal battery charge.
**Scale:** 100.0 uniform, right-hand zero.
**Chart:** 10 cm calibrated width; Z-fold chart. Chart has 5 cm folds and is 20 meters long. (One Z-fold chart furnished with recorder.)
**Writing system:** Disposable cartridge contains stylus and red ink supply.
**Chart speeds:** 2, 5, 10, 15, 30 and 60 cm/hr and cm/min. Pulse input proportional (PIP) chart drive is standard. 120 Hz (Max.) = 60 cm/min.
**Chart speed accuracy:** ±1%, 23°C ±10°; on DC with battery voltage between 10.5 and 15 VDC. ±2%, 0-50°C.
**Power requirements:** 12 VDC, 0.5 ampere normal operation, 0.75 ampere with signal overload.
**Internal battery:** Rechargeable gelled lead-acid 12 VDC battery of 4.5 ampere hour capacity. Operates minimum of 8 hours after full charge which requires 16 hours at nominal 115 V line voltage. Probable battery life is 200 charge-discharge cycles.
**External battery:** User provides.
**External AC:** AC to DC power rectifier/ charger is provided to operate recorder or charge internal battery from 115 to 230 V, ±10%, 50-60 Hz.
**Battery charge check:** Front panel meter shows continuous charge level of battery.
**Weight:** 12.5 pounds (5.7 kg).
**Size:** 10 x 6-1/2 x 14-7/8 inches (254 x 165 x 378 mm).
**Options: Carrying case:** P/N 752B201. Vinyl covered wooden case with space for instrument, charger, 12 charts, 12 ink cartridges and pouch for instructions and records.
**12 VDC power input plug:** Separate plug, P/N JAC17, to fit rear panel jack. Primarily for use with external battery.
**A slide switch selects the power mode as follows:** 1 — internal battery; 2 — external battery or AC adapter; 3 — internal battery charging. Built-in circuits protect the battery against overcharge and assure maximum number of battery charge-discharge cycles.

## Model 411L — Line Operated

Specifications are the same as for the Model 411BB except as follows:
**Power requirements:** Operates on 115 or 230 V, switch selectable, 60 Hz with optional 5/6 ratio chart drive sprocket available for 50 Hz operation.
**Weight:** 11.5 pounds (5.2 kg).

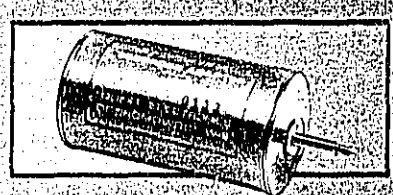
# Accessories

The RM-800 Recording Module and the RA-100MV Recorder Adaptor are connected between a sound level meter and the 411BB or 411L Recorder. Both convert the AC signal from the meter to a DC voltage for use by the recorder. The RM-800 and RA-100MV are used with Quest sound level meters, Models 215, 214, 211FS and 211A.



### SPECIFICATIONS — RM-800

**DC Output Voltage:** 0 to 1 volt.
**Dynamic Range:** 50 dB on "50" range; 25 dB on "25" range.
**Tracking:** Linear decibel scale.
**Input Level Range:** 0.6 V RMS to 2.1 V RMS.
**Input Impedance:** 275 ohms.
**Detector:** True RMS; "SLOW" response per ANSI S1.4-1983 Type 2 and IEC 651-1979 Type 2.
**Power:** 9-volt transistor battery, NEDA 1004.
**Size:** 4.3 x 2.7 x 1.3 inches (110 x 69 x 33 mm).
**Weight:** 6 ounces (170 grams).



### SPECIFICATIONS — RA-100MV

**Input voltage:** 0-1.8V RMS AC from Quest 215, 214, 211FS and 211A sound level meters.
**Output voltage:** 100 millivolts DC, adjustable.
**Response:** Slow.
**Range:** Approximately 25 dB.
**Tracking linearity:** Near log scale; tracks same as Sound Level Meters.
**Power Source:** None; passive module.
**Size:** 2 x 1-1/8 dia. inches (51 x 29 mm).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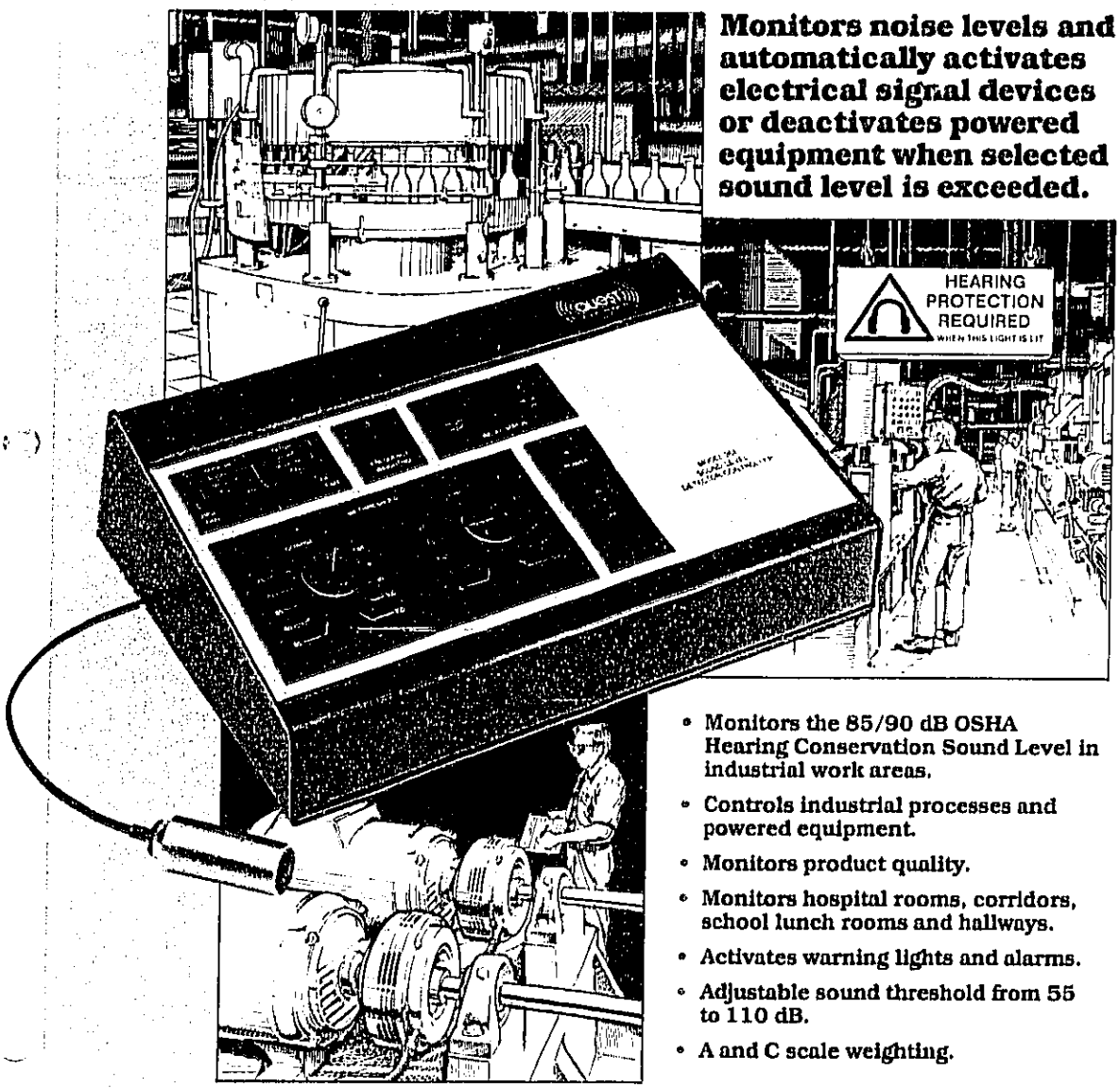
# Model 261 Sound Level Detector/Controller




**Monitors noise levels and automatically activates electrical signal devices or deactivates powered equipment when selected sound level is exceeded.**

- Monitors the 85/90 dB OSHA Hearing Conservation Sound Level in industrial work areas.
- Controls industrial processes and powered equipment.
- Monitors product quality.
- Monitors hospital rooms, corridors, school lunch rooms and hallways.
- Activates warning lights and alarms.
- Adjustable sound threshold from 55 to 110 dB.
- A and C scale weighting.

The Model 261 Sound Level Detector/Controller is the heart of a noise monitoring system. It continuously measures noise levels in a specified area and automatically activates (or deactivates) an electrical signal device when a specified noise level is exceeded.

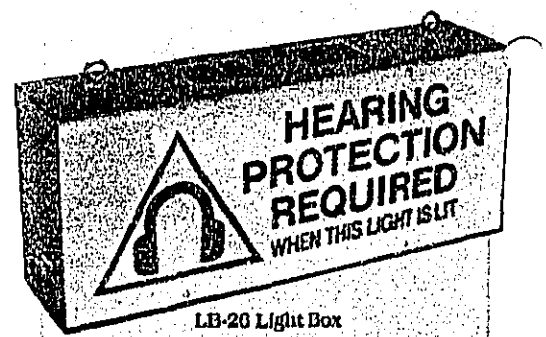
Signal devices commonly used are buzzers, lights, and signs such as the Quest Model LB-26. However, any electrical device that uses up to 10 amps and 300 VDC or AC can be used.

The Model 261, along with the LB-26 Light Box, is especially useful in monitoring the 85/90 dB OSHA Hearing Conservation sound level in industrial work areas. It is widely used to monitor production processes and power equipment for exceptional noises which would indicate a malfunction. It is also used to monitor product quality and general noise levels in hospital, school and other areas.

Up to three microphones can be used to monitor a given area. The standard microphone cable is 30 feet long but an optional cable extends this length to 80 feet. The noise level at which the warning circuit is activated — the threshold — is easily adjustable from 55 to 110 dB in 1/2 decibel increments on the panel of the Detector/Controller. The reaction time — the interval between the time when the threshold is exceeded and the time when the warning circuit is activated — is also adjustable.

## SPECIFICATIONS

**dB Threshold Activation Range:** 55 dB to 110 dB in 0.5 dB steps.
**Microphone:** Electret. Built-in FET preamp., 30-foot cable. Optional 50-foot cable extends cable length to 80 feet.
**Area Coverage:** Will monitor an area with up to three microphones.
**Frequency Weighting:** A and C.
**Reaction Time:** 4 Rise and 4 Fall Times, easily selectable on the front panel. The Latch Fall Time permits the relay to remain closed once activated. RELAY RESET or REMOTE RESET is used to deactivate the relay.
**Relay Contact Rating:** 10 Amp Fused, 300 Volts Max, DPDT.
**Accuracy:** +1 dB at 20°C.
**Temperature:** −10° to +50°C.
**Power Requirements:** 120/240V, 50/60 Hz.
**Construction:** Low power integrated circuitry in a rugged aluminum housing.
**Size:** 10 x 7 x 3 inches (260 x 180 x 80 mm).
**Weight:** 3 lbs (1.4 kg).




LB-26 Light Box

Model 261 Detector/Controller includes one microphone with 30-foot cable.

## ACCESSORIES

**LB-26** Light Box, 120 or 240 volt, 20 x 8¼ x 5 inches (508 x 216 x 127 mm).
**DMC-50** 50-foot microphone extension cable. (Power cord and extension cords are not furnished.)
**58-874** Extra 30-foot fixed microphone and cable assembly.

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January 1987

DATA SHEET
BROTHER M-1109
Impact Dot Matrix Printer

The Brother M-1109 impact dot matrix personal printer combines high quality and performance features in a compact, lightweight and affordable design that makes it ideal for computer applications or use with the Quest Sound Instrumentation.

The M-1109 features a miniaturized impact dot print head and a fabric ribbon cassette (included). It accepts single sheets as well as fanfold. It can also print up to two carbon copies at the same time.

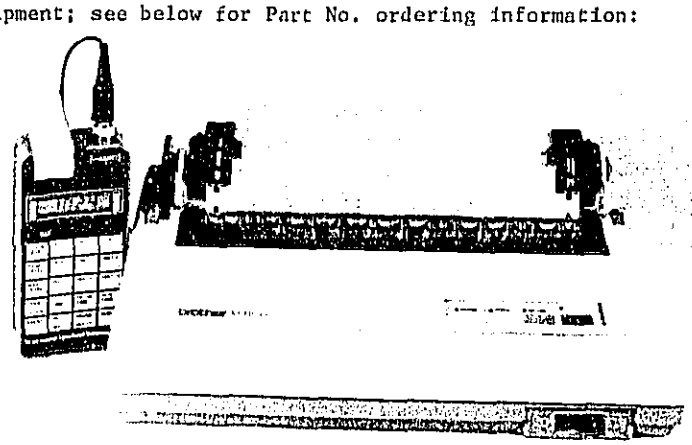
The M-1109 offers two separate modes of operation - Mode I and Mode II - controlled with a DIP Switch. The range of print functions available is thereby widen; fourteen different character sets (including sets for 10 different countries), all 96 ASCII characters, italics, and various print modes.

Brother has added quiet operation (less than 60dB) and an impressive print speed (100 cps), or you can get Near Letter Quality print at a fast 25 cps.

| | |
|---|---|
| Interfaces: | Centronics parallel - 36 pin |
| | RS-232C Serial |
| Dimensions: | 13.1" x 2.8" x 7.6" |
| Weight: | 7.8 lbs. |

Price from Quest Electronics includes printer with built-in power supply, ribbon cassette and pin feed unit. Paper is not included; it is standard 80 - column printer paper (Radio Shack part #26-1387). Price also does not include any input cable to Quest equipment; see below for Part No. ordering information:

59-272 Printer M-1109
59-273 Cassette Ribbon
58-847 MICRO Input Cable
59-818 M-27/M-28 Input Cable
58-883 AA-188 Input Cable
59-829 AA-175 Input Cable
59-818 NL-15 Input Cable



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DATA SHEET
MODEL PA-4 PROBE MICROPHONE SYSTEM

FREE FIELD MEASUREMENTS FOR
COCHLEAR IMPLANT AND HEARING AID EVALUATION

July, 1984

The Quest MODEL PA-4 probe microphone system is designed to accurately measure open field sound level without disturbing the field itself using the Quest 155 Sound Level Meter. This microphone system makes it possible to determine the sound level at very discrete locations in the sound field such as at a hearing aid or cochlear implant.

As an example, this system can measure the sound pressure level at the microphone of a hearing aid directly within 1.5 dB. This measurement technique improves the reliability and validity of sound pressure measurements when compared to the more conventional substitution methods of measurements.

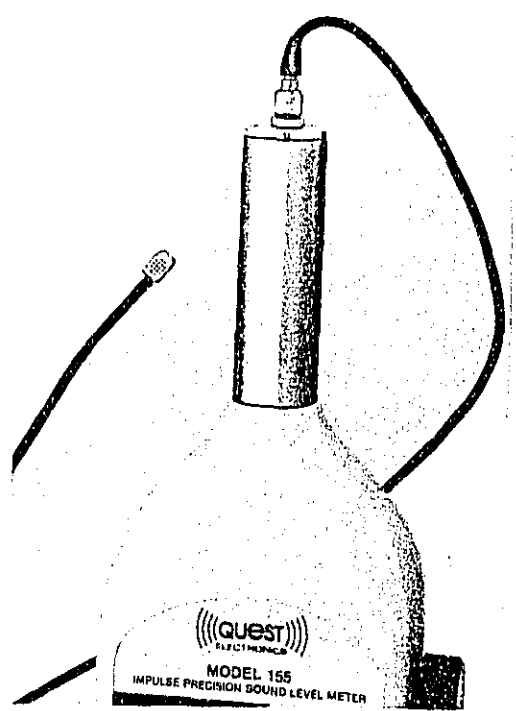
The probe system includes: an electret microphone and cable, a PA-4 preamplifier with built in Quest microphone connector, and calibrator adapter.

SPECIFICATIONS

MICROPHONE
TYPE Electret condenser
MODEL Knowles Electric Inc. BT-1759
SENSITIVITY -60 dB re 1 volt/microbar
FREQUENCY RESPONSE Flat 50 Hz to 10,000 Hz
OUTPUT IMPEDANCE 2000 - 6000 Ohms
"A" WEIGHTED NOISE FLOOR 25 dB
SIZE .35 x .22 x .1 inches (8.9 x 5.6 x 2.5 mm)
WEIGHT .01 oz (.28 g)

PREAMPLIFIER
GAIN 4.5 TO 22 dB
FREQUENCY RESPONSE Flat 25 Hz to 7,000 Hz
INPUT IMPEDANCE 90,000 Ohms
OUTPUT IMPEDANCE 1000 Ohms
HOUSING 1/16 inch aluminum tube
SIZE 4.2 x .87 inches (106 x 23)
WEIGHT 1.75 oz (50 g)

PA-4 PROBE MICROPHONE SYSTEM
NOISE FLOOR "A" Weighted < 27 dB
"C" Weighted < 35 dB
Lin < 38 dB
TEMPERATURE RANGE -10 to 50 C Operating
-40 to 65 C Storage
RELATIVE HUMIDITY 0 to 95% non condensing
POWER 17 volts at 0.7 milliamps
(powered by 155 SLM)
CABLE flexible .069 inches x 19 feet (1.75 mm x 5.8 m)




For use with the Quest Model 155 Sound Level Meter

510 South Worthington
Oconomowoc, WI 53066 USA
Phone: 414-567-9157

DATA SHEET
MODEL PA-5 PROBE MICROPHONE SYSTEM

FREE FIELD MEASUREMENTS FOR
COCHLEAR IMPLANT AND HEARING AID EVALUATION

January 1985

The Quest Model PA-5 probe microphone system is designed to accurately measure open field sound level without disturbing the field itself using the Quest 215R Sound Level Meter. This microphone system makes it possible to determine the sound level at very discrete locations in the sound field such as at a hearing aid or cochlear implant.

As an example, this system can measure the sound pressure level at the microphone of a hearing aid directly within 2dB. This measurement technique improves the reliability and validity of sound pressure measurements when compared to the more conventional substitution methods of measurements.

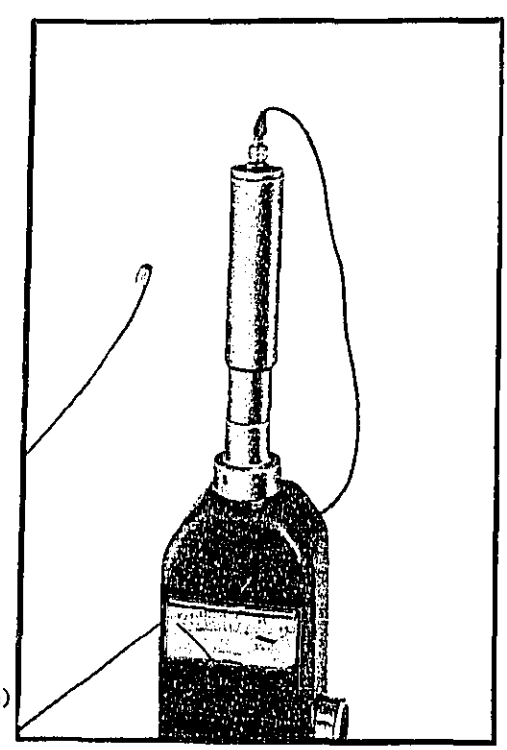
The probe system includes: an electret microphone and cable, a PA-5 preamplifier with built in Quest microphone connector, and calibrator adapter.

SPECIFICATIONS

MICROPHONE:
TYPE: Electret condenser
MODEL: Knowles Electric Inc, BT-1759
SENSITIVITY: -60dB re 1 volt/microbar
FREQUENCY RESPONSE: Flat 50 Hz to 10,000Hz
OUTPUT IMPEDANCE: 2000 - 6000 Ohms
"A" WEIGHTED NOISE FLOOR: 25dB
SIZE: .35 x .22 x 0.1 inches (8.9 x 5.6 x 2.5 mm)
WEIGHT: 0.1 oz (.28g)

PREAMPLIFIER:
GAIN: -3.5dB to +6.5dB
FREQUENCY RESPONSE: Flat 25Hz to 7,000Hz
INPUT IMPEDANCE: 90,000 Ohms
OUTPUT IMPEDANCE: 1000 Ohms
HOUSING: 1/16 inch aluminum tube
SIZE: 4.5 x .875 inches (106 x 23 mm)

PA-5 PROBE MICROPHONE SYSTEM:
NOISE FLOOR: "A" Weighted < 27dB
"C" Weighted < 35dB
Lin < 38dB
TEMPERATURE RANGE: -10 to 50°C Operating
-40 to 65°C Storage
RELATIVE HUMIDITY: 0 to 95% non condensing
POWER: 9 volts at 0.7 (powered by 215R)
CABLE: Flexible 0.69 inches x 19 feet (1.75mm x 5.8m)



Model PA-5 Probe Microphone
for use with the Quest Model 215R Sound Level Meter



Division of La Belle Industries
CABLE ADDRESS: "LABELLE", OCONOMOWOC, WISCONSIN • TWX 9102601438 LA BELLE

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Oconomowoc, WI 53066 USA

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# HEARING CONSERVATION FILMS

Two films available for rent or purchase concerning Hearing Conservation. Both films are available in three formats; slide carrousel with cassette, video cartridge (VHS, Beta 1 & 2, U-Matic), and La Belle Commpak Cartridge.

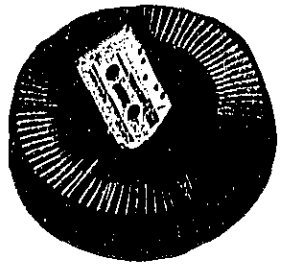
The first film is entitled, "Industrial Hearing Conservation", and covers step by step the new OSHA Hearing Conservation requirements for industry. This film is primarily aimed at management of a company and explains the noise surveys, audiometric testing, training requirements, etc. Run time: 15 minutes.

The second film is entitled, "Sound and Hearing", and is aimed at the employee. This film covers all the requirements needed to fulfill the training program required by OSHA, and emphasizes the effect of noise on hearing. Run time: 10 minutes.

The rental and purchase price of our two programs is as follows:

Weekly rental/preview charge - $50.00 each

Purchase Price - $160.00 each



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# "Hear's" What It's All About

## A Guide to Industrial Hearing Conservation

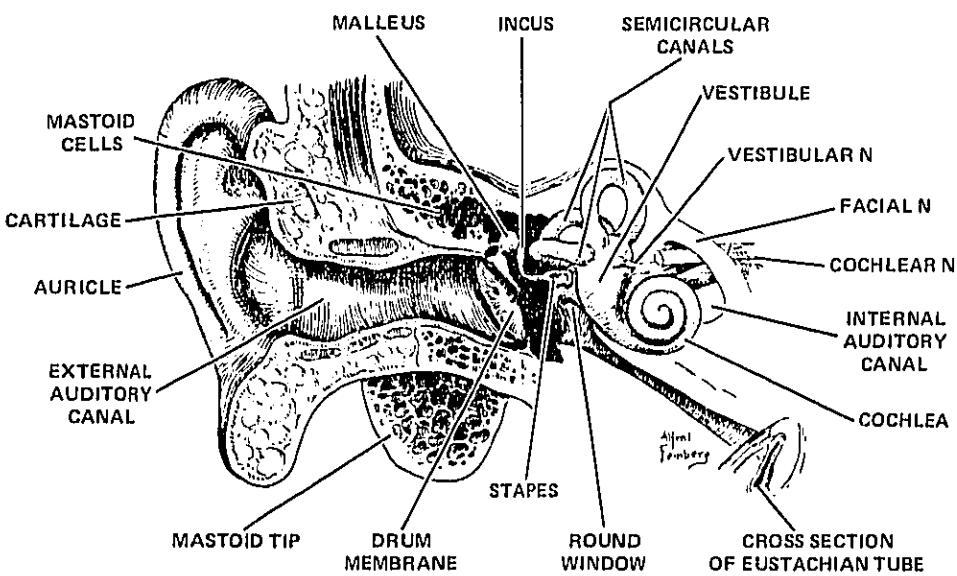
BY

James D. Banach, OHC
R-Hearing Service, Inc.

Alice Berger, R.N.
Rexworks, Inc.

Marilyn R. Mullarky, M.A., CCC-A
Occupational Hearing Services, Inc.

Elizabeth A. Regan, R.N., MSN

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## Hearing

The human ear is an extremely delicate, highly sensitive instrument with astonishing efficiency that would put most machines to shame in terms of its design and operation. It is so sensitive that in a very quiet environment one can almost hear the random collision of air molecules bouncing against the eardrum. Yet the ear can also withstand sounds that are powerful enough to set the entire body into vibration. The ear also has a frequency range of sensitivity from 20 to 20,000 Hz. It is truly a remarkable organ. Figure 1 on the cover shows a cross section of the ear.

Our hearing, unlike our vision, is operative at all times, for it cannot be turned off as can our vision when we close our eyes. In addition, our hearing enables us to hear all around us — 360 degrees — whereas our peripheral vision enables us to see at only a range of about 180 degrees. The fact that our hearing constantly is "on" is what enables us to be alerted to a strange sound or the baby's cry in the midst of a deep sleep — even during a thunderstorm.

Selectivity in listening is another unique aspect of our hearing, due to our having balanced hearing in our two ears. It enables us to "tune out" a speaker or background music, for example, and "tune in" someone or something else. The deer hunter may not be able to "hear" his wife from across the room, but he can detect the snap of a twig a mile away from his tree stand.

Unfortunately, our ears and our remarkable hearing sensitivity are taken for granted, unappreciated, ignored and abused — until there is a problem or a loss of hearing. Daily our ears are exposed to loud sounds — at home, at work and at play. Too much exposure to certain sounds at too loud a level can damage the ear, initially causing a temporary threshold shift and finally a hearing loss that is permanent. Often the hearing loss is accompanied by intermittent or constant tinnitus (ringing in the ears), which can be extremely annoying.

A hearing loss due to noise exposure affects the high frequency sounds first, causing the person to have difficulty *understanding* what is heard. If the hearing loss increases, the understanding difficulties become worse, often resulting in immeasurable social, psychological and emotional problems. Not only does the noise-induced hearing loss create problems for the person with the loss, it also creates problems for his or her family, friends, co-workers and employer.

A noise-induced hearing loss cannot be corrected through any type of medical or surgical intervention. It usually can be helped or "aided" through the use of personal amplification (i.e., a hearing aid). However, a hearing aid is simply a mechanical device; it cannot replace our normal hearing sensitivity. A noise-induced hearing loss, however, *can be prevented. It need never occur.*

Our ears and our hearing are what keep us in contact with the rest of the world around us. Many years ago, Helen Keller stated that it is our sense of hearing that enriches our mind and keeps us in the company of man. It is the responsibility of anyone and everyone who is involved with noise and hearing conservation to gain knowledge and understanding of and an appreciation for the human ear — how it works, how it can be damaged and how it can be protected.

The following pages give a brief review of the current OSHA Hearing Conservation/Noise Amendment, a document which was designed to conserve and protect hearing.

## Who Is Required To Be Protected

The Occupational Safety and Health Act of 1970 was passed by the U.S. Congress ". . . to assure so far as possible every working man and woman in the nation safe and healthful working conditions, and to preserve our human resources." Coverage of the Act extended to all private sector employers and their employees in the fifty states, the District of Columbia, Puerto Rico, the canal zone and all other territories under Federal Government jurisdiction; however, it was limited only to those companies which had Federal contracts.

During the ensuing years, Congress worked to define more clearly and specifically the OSHAct section which concerned workplace noise. Thousands of hours and pages of testimony finally resulted in the promulgation of the Hearing Conservation/Noise Amendment.

This Amendment provides coverage for all employees exposed to a Time-Weighted Average of 85 dBA, with the exception of construction and agricultural workers. In addition, the Amendment outlines in some detail the following components of a Hearing Conservation Program:

1. Noise Assessment
2. Hearing Testing
3. Hearing Protection
4. Education and Training
5. Record Keeping

## Noise Exposure Determination

Determining the level of noise exposure to which the workers are exposed is a vital part of the Hearing Conservation Program; in fact, it is the point at which the Program begins. A Noise Assessment will identify those employees who must be included in the total Hearing Conservation Program. Several criteria may suggest the need for the Noise Assessment:

1. Any area with a past record of excessive noise
2. Employee complaints of discomfort or temporary hearing loss
3. Inability to converse easily, without shouting, at a distance of two feet.

There are several pieces of equipment which can be utilized in obtaining a Noise Assessment. The Sound Level Meter (Figure 2) which must meet at least Type 2 status under ANSI S1.4-1971, is an instrument which may be used to spot check for excessive noise. If it is coupled with an octave band filter, it also can be used to check the accuracy of your audiometer, check the noise level of the test environment and evaluate engineering programs.

The Impulse Meter is available for the evaluation of impulsive noise, such as that produced by a punch press. This unit will hold peak levels which cannot be read on standard meters.

Figure 2. Sound Level Meter

An Integrating or Leq Meter (Figure 3) is useful for the evaluation of rapidly changing environments. This unit averages the sound over time and presents a direct dBA reading.

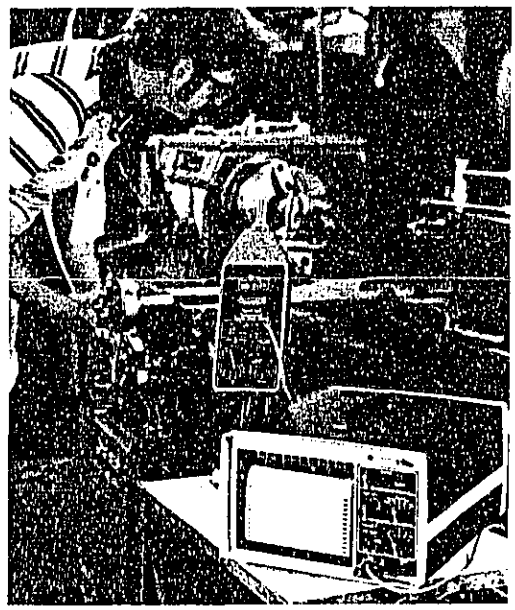


Figure 3. Leq Meter

The Dosimeter (Figure 4) is probably the most important instrument in the Noise Assessment, for it determines the noise level to which the employees are exposed by measuring sound over time and analyzing the information to produce a Noise Dose, expressed in a percentage. If the dosage should equal 50% or greater (i.e., 85 dBA TWA for an 8 hour day), the affected employees must be included in the Hearing Conservation Program. Of course, a larger margin than 1% is suggested for those who are not to be protected.

The dosimeter must meet certain requirements, including ANSI S1.25-1978. Additionally, it shall have an 80-130 dB range, impulse capability (a 25 dB crest factor or better is suggested), a 5 dB doubling rate and be "A" weighted. The "A" weighting causes the unit to analyze sound much as the human ear does. Other vital features of a dosimeter are a battery life indicator, non-volatile memory and short-term test capability. The dosimeter is a small unit which may be attached to a belt or placed in a shirt pocket. The microphone, however, must be placed at ear level, about 3-5 inches away from the head, to avoid error.

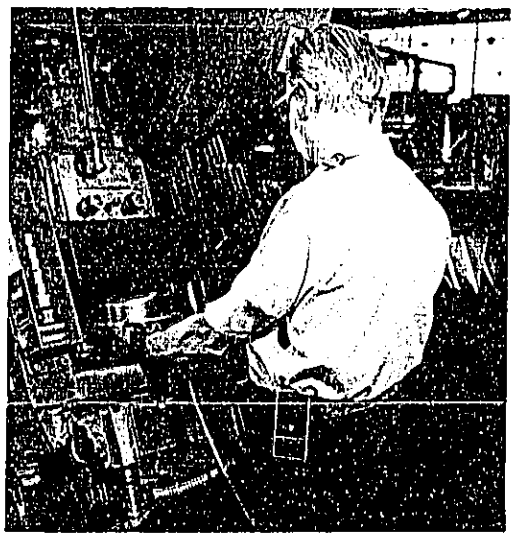


Figure 4. Noise Dosimeter

A representative test of a work area may be made as long as the test procedure assures accurate results. Written explanation of the test and the test results must be made available to the affected employees and their representatives.

The combined use of dosimeters, sound level meters, octave band filters, and impulse and integrating meters will provide for accurate measurement of the many varying sounds in the industrial setting.

## Administrative and Engineering Controls

The most satisfactory method of noise exposure control is the reduction of the noise at its source; however, this is not always practical. It often involves redesign of machinery and in many situations is a long-term objective. A balanced program approach, utilizing engineering controls that represent the most efficient use of capital expenditures in terms of noise reduction and employee protection could be the key. These improvements would then be supplemented where necessary with administrative controls as part of the Hearing Conservation Program.

ENGINEERING CONTROLS
(Redesign of Plant and Equipment)

1. Process Modification
2. Equipment Changes
   a. Redesign
   b. Proper Maintenance
3. Automation (New equipment which meets requirements of reduced noise output)
4. Effective Containment of Noise Sources
5. Shielding or Isolation of the Operators

DETERMINATION OF FEASIBILITY OF ENGINEERING CONTROLS

1. The solution is possible. The technology exists, and no scientific or technological breakthroughs are required.
2. The solution is practical and can be applied to a particular situation without disrupting the operation, deteriorating work quality or making impossible human supervision or control necessary.
3. The solution is economical and can be used without such cost penalties that would make the operation uneconomical (not simply that the solution might increase costs to some degree).

There are some industrial noise problems which cannot be solved by engineering controls alone. In these instances administrative controls must be utilized.

ADMINISTRATIVE CONTROLS
(Individual Worker Exposure is Limited to the Prescribed OSHA Schedule)

1. Combine and limit noisy operations to specific periods during the workday, preferably to no more than the permissible exposure periods, rather than having them at random, unscheduled distributions throughout the day.
2. Provide quiet periods throughout the day and and quiet environments throughout the plant: rest periods, lunch periods, quiet rest areas, vending and eating areas, locker and washroom areas, etc. There is considerable evidence that frequent, short breaks from the noise reduce threshold shift (although complete recovery time apparently is not shortened by this approach).
3. Limit each worker's exposure to only his own noise.

Feasible engineering controls and administrative controls that would limit exposure to excessive levels could frequently solve industrial noise problems without unacceptable cost or interference with production. When combined with a compre-

hensive Hearing Conservation Program that is endorsed and supported by top management, a balanced program utilizing Engineering and Administrative Controls would therefore seem to be the most satisfactory approach.

## Audiometric Testing

All employees exposed to a Time-Weighted Average of 85 dBA must be included in the Hearing Conservation Program, which includes an initial Baseline audiogram and subsequent Annual audiograms, at no cost to the affected employees.

## Who Is Qualified to Test

According to the current Noise Amendment, "The tests shall be performed by a licensed or certified audiologist, otolaryngologist or other physician, or by a person who is certified by the Council of Accreditation in Occupational Hearing Conservation, or by an audiometric technician who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining and calibrating audiometers. A technician who performs audiometric tests must be responsible to the audiologist, otolaryngologist or physician." In terms of cost effectiveness, a person (or persons) within the company who has been certified by the Council is the most logical choice.

From the viewpoint of learning, it is important that the individual selected by industry to qualify for Occupational Hearing Conservationist (OHC) training have these capabilities: the ability and desire to comprehend a large amount of information in a short time; adeptness in motor skills; interest and concern for the preservation of workers' hearing; ability to apply new learning on the job to benefit management and workers; and good communication skills.

The Occupational Noise requirements of the OSHAct have created a demand for properly trained and motivated OHC's; therefore, a uniform method for checking employees' hearing throughout industry is essential for valid, accurate and reliable audiometry. The Council of Accreditation in Occupational Hearing Conservation (CAOHC), a voluntary agency with representation from audiology, safety, industrial hygiene, industrial medicine and nursing, was created to meet this demand. A twenty-hour course, whose content must be approved by the Council and whose faculty must be certified by the Council, is required for certification. Upon completion of the course work, a passing grade on the written examination and a passing grade on the practical examination (which utilizes manual audiometry), the individual may apply to the Council for certification. When certified, the individual is privileged to use the title of Occupational Hearing Conservationist. Certification remains current for five years, at which time the OHC must participate in an eight-hour Refresher course. Since the Council is a national agency, certification is recognized anywhere in the United States and in all territories governed by the Federal government.

## Audiometric Testing Equipment

Cost effectiveness and practicality are essential to the success of a Hearing Conservation Program; therefore, all testing avenues should be investigated before any monetary commitment is made. The employer has three options for providing audiometric testing: (1) sending the affected employees to a hospital or clinic; (2) having a testing service come to the plant; and (3) performing in-house audiometric testing with company personnel. All three options have pros and cons; therefore, factors such as cost, time consumed, production interruption, follow-up procedures and responsibility should be considered. No matter which of the three options is chosen, a quiet test environment and a calibrated audiometer are essential.

The most practical method of achieving a quiet test environment is through the use of a prefabricated audiometric test booth (Figure 5). Prior to purchasing a booth, however, an area which is low in noise and distraction must be selected. While the booth will keep out ambient noise significantly, it cannot be placed in a noisy area. Valid audiograms are only as good as the test environment in which they were conducted.

The audiometer is the electronic instrument used to test human hearing. It produces frequencies of 500 to 8000 Hz at varying intensity levels, measured in deciBels (dB) Hearing Level (HL). There are three basic types of audiometers utilized in the industrial setting: (1) manual, (2) self-recording and (3) microprocessor.

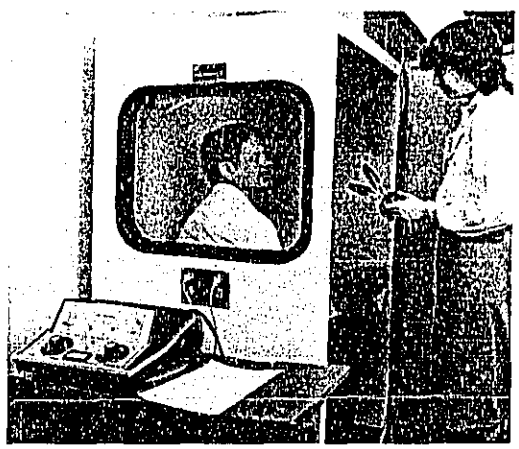


Figure 5. Audiometric Test Booth

The manual audiometer (Figure 6) requires an operator to change the frequencies being tested and to vary the intensity levels at each frequency. All the data obtained must be recorded by hand by the operator. This unit's low cost may justify its selection, but the down time of the operator and the potential for "human error" make it impractical, especially if a large number of employees is to be tested.

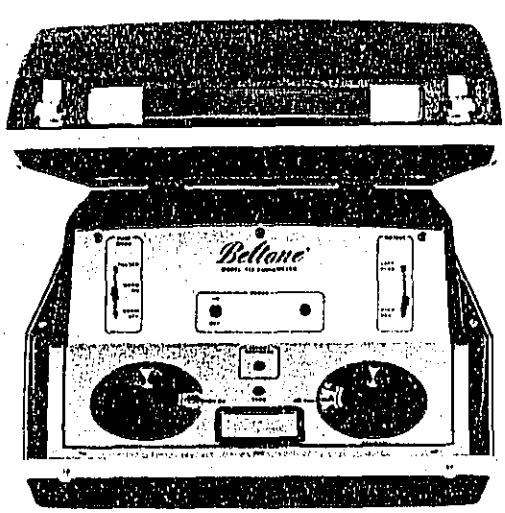



Figure 6. Manual Audiometer

If there are approximately 300 or more employees involved in the Hearing Conservation Program, the self-recording audiometer (Figure 7), though more expensive, may prove to be more efficient and cost effective. This unit is controlled by the person being tested, in that the employee response switch changes the intensity and the machine itself is programmed to change the frequency. The operator is responsible for instructing the employee, monitoring the testing and turning the machine on and off; therefore, while the testing is being done, the operator is able to answer the telephone, prepare the next employee for the test or assist others within the department. The major advantage of the self-recording audiometer is that the record produced cannot be marked in error, as it can with the manual audiometer.

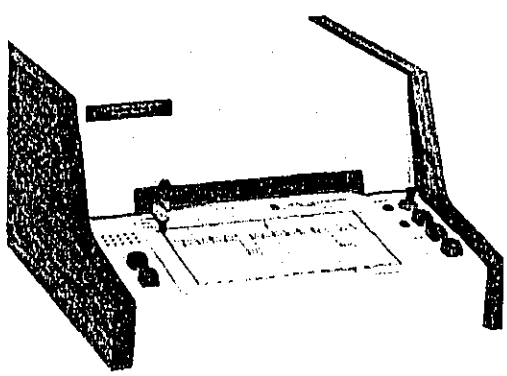


Figure 7. Self-recording Audiometer

The most productive audiometer is the microprocessor audiometer (Figure 8). It will conduct the test, compare the results to the Baseline and perform validity checks during the testing. Although this audiometer is the most expensive of the three, its capabilities make it extremely valuable and may prove to be far more cost effective. The ideal microprocessor audiometer is one that not only provides digital data as most do, but also provides the graphic audiogram which may be used for employee education. The data from these units may be communicated to the company computer where the data may be filed, analyzed and used. The microprocessor unit thus provides service well beyond its cost.

All audiometers must meet ANSI S3.6-1969 (R71) specifications and must have daily biological calibration checks, annual electronic and acoustic calibrations and biennial exhaustive calibrations by factory approved personnel.

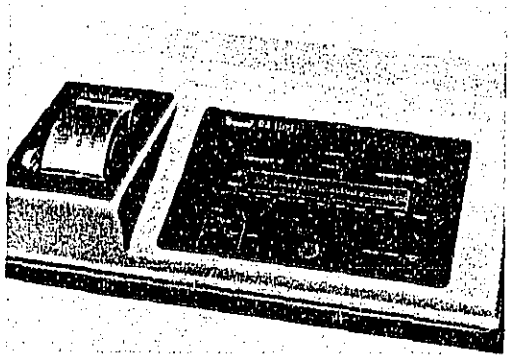


Figure 8. Microprocessor Audiometer

## The Audiogram

The graph or record which shows an employee's Hearing Levels as a function of frequency is called an audiogram. (See Figure 9.) This may be in the form of a graph showing frequency and intensity, a table upon which the person's thresholds are recorded numerically, or a computerized printout sheet. Regardless of the type of audiogram form used, each must contain results for a minimum of the following test frequencies: 500, 1000, 2000, 3000, 4000 and 6000 Hz. Although not required by OSHA regulations, the inclusion of 8000 Hz could assist in the differentiation between a hearing loss due to noise exposure and one associated with aging (presbycusis). Tests at each frequency must be taken separately for each ear. Specific requirements for audiograms obtained with self-recording audiometers are outlined in Appendix C of the OSHA regulations.

Each audiogram must include at least the following statistical information: name and job classification of the employee, date of the audiogram, the examiner's name, date of the last acoustic/electronic or exhaustive calibration, and the employee's most recent noise exposure assessment level. It is suggested that the time of the audiogram, the examiner's qualifications (e.g., CAOHC certification number), and the make, model and serial number of the audiometer also be included.

All audiograms must be retained for the duration of the affected employee's employment; however, it is suggested that all audiograms be considered medical documents and, therefore, should be retained for an additional thirty years. Employees, former employees and representatives designated by the individual employee may have access to the audiograms upon request. It is suggested that every employee not only be shown his or her audiogram, but that the test results and their implications be discussed in detail. An informed employee is a cooperative employee, and the best teaching tool for the importance of Hearing Conservation is the employee's own audiogram.

*Baseline* audiograms are to be obtained for all employees exposed to a Time-Weighted Average of 85 dBA. Testing to establish the Baseline audiogram must be preceded by at least 14 hours without exposure to workplace noise; however, the use of hearing protection in place of the 14 hours of quiet has been established. It is suggested, however, that hearing protection not be used as a substitute for the 14 hours of quiet. It is further suggested that all Baseline audiograms for new employees be considered "pre-hire" audiograms and should be obtained prior to the employee's first day on the job. This would enable the employer to know about any pre-existing hearing loss. All subsequent audiograms must be compared to the initial Baseline audiogram.

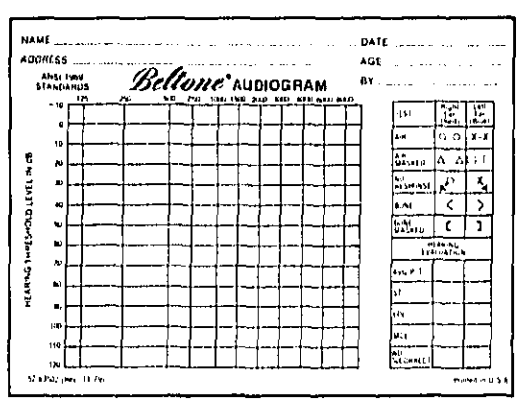



Figure 9. Audiogram

Annual audiograms, which must be performed on every employee included in the Hearing Conservation Program, can be obtained at any time during the work shift. It is suggested, however, that the 14 hours of quiet and/or the use of supervised hearing protection, be implemented for annual testing. As stated above, these audiograms are to be compared to the Baseline. Should a "standard threshold shift" be present, specific follow-up procedures must be enacted. The Noise Amendment lists these in detail.

"Standard Threshold Shift" is defined as "a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000 and 4000 Hz in either ear." The comparison for shift identification may be performed by the technician; however, it is suggested that this be overseen by a hearing health professional.

A re-test 30 days after the annual audiogram may be performed to assure that a shift is permanent. If the shift is substantiated, review and follow-up by an audiologist, otolaryngologist or physician is called for.

All audiograms are medico-legal documents and must be regarded as such by everyone who is involved with the Hearing Conservation Program, including the employee. To ensure the validity of the audiograms, they must be obtained by the properly trained and certified personnel using properly calibrated and maintained equipment in the properly quiet test environment.

## Hearing Protection

Employers shall make hearing protectors available to all employees exposed to 85 dB of noise or greater at no cost to the employees. Hearing protectors shall be replaced as necessary. In addition, the employer is responsible for providing a selection of hearing protection devices and is responsible for training the affected employees in the use and care of the hearing protection. Finally, the employer is responsible for determining the attenuation characteristics of the hearing protection devices.

The best hearing protection device is the one that is actually used and worn faithfully by the employee. To implement and ensure this, *comfort* is of prime importance. The effectiveness of the hearing protective device depends upon the following factors which are related to the manner in which the sound energy is transmitted through or around the device.

1. Seal Leaks. Small leaks in the seal between the hearing protector and the skin which can significantly reduce the low frequency attenuation; as the air leak becomes larger, attenuation becomes reduced at all frequencies.
2. Material Leaks. Leaks which permit transmission of sound directly through the material of the device.
3. Device Vibration. Vibration of the hearing protective device itself caused by exposure to external sound energy.
4. Bone Conduction. The level of sound reaching the inner ear by bone conduction would be about 50 dB below the level of air conduction; therefore, a perfect hearing protective device worn in or over the ear cannot provide more than 50 dB reduction below the level of air conduction.

The amount of attenuation provided by ear plugs and ear muffs on the market today ranges between 20-35 dBA with the greatest attenuation in the higher frequencies.

Ear Plugs (Figure 10) should be made of pliable materials. *Disposable* plugs are intended to be used

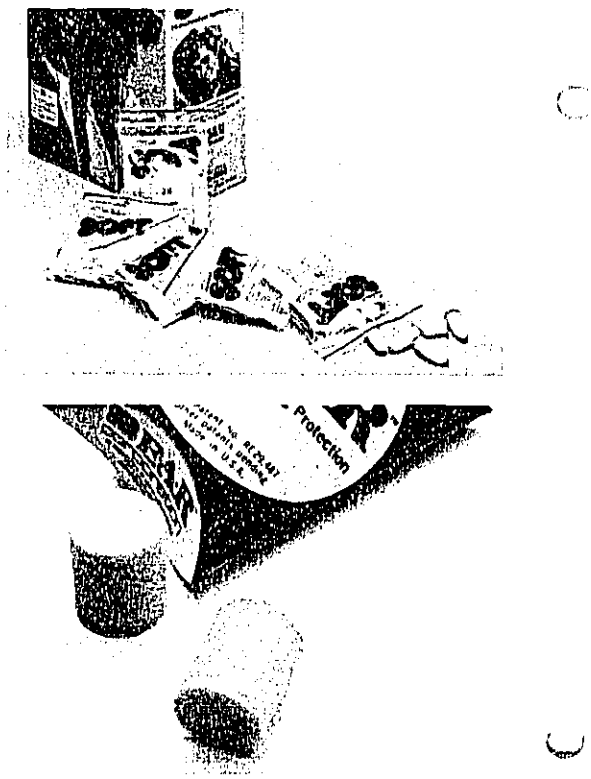


Figure 10. Ear Plugs

once and then discarded. These are considered to be more hygienic than permanent, reusable plugs. Size is of critical importance with *reusable, permanent* plugs because ear canals are different, even in the same person. All insert plugs initially should be fitted to the individual by a well-trained person. It is essential that reusable plugs be kept clean. The user should wash them with mild soap and water before inserting them, and should store them in a clean place when they are not being used. A record should be kept of the type and size of the ear plug issued to every employee so that replacements and exchanges or substitutions can be issued easily.

Ear Muffs (Figure 11) are sealed to the head with cushion seals, which may be filled with liquid or plastic foam. The cushions should be soft and easily replaced when damaged or soiled. The headband should maintain a comfortable but firm pressure on the head, and must withstand any attempt to reduce pressure by bending it out of shape. A reduced pressure could cause seal leaks and reduced attenuation of the muff. The muff should be as light as possible without sacrificing attenuation.

Some work situations may require the use of double protection (ear plugs and ear muffs) to ensure a margin of safety. Both plugs and muffs have their advantages and disadvantages; therefore, a selection for the affected employees is recommended.

When the initial audiogram is done, a variety of hearing protective devices should be available to the employee. At this time, a choice should be made by the employee who then is fitted by a trained person. Use and care of the device should be explained carefully, and a follow-up check done within a month or sooner if problems occur.

Figure 11. Ear Muffs

Hearing protective devices may be checked each time an employee has an audiogram. The user must be reinstructed each time in terms of care and use to ensure maximum attentuation and comfort.

## Education Training

It is the responsibility of the employer to provide an annual education and training program for all employees included in the Hearing Conservation Program. The training program must include the following topics:

1. Hearing Protection — its proper use, care and attenuation characteristics
2. The Effects of Noise on Humans — especially the hearing mechanism
3. The Purpose of Audiometric Testing — and the actual hearing test itself

In addition, it is suggested that a review of the OSHA Noise Regulations be included in the training program, as well as a brief review and discussion of every employee's own hearing test results. As was stated previously, the audiogram is an excellent teaching tool and can be utilized for this purpose quite effectively.

The education and training program can be accomplished on an individual basis as part of the Baseline/Prehire testing or the Annual testing. It also could be presented on a group basis in the form of short inservice programs utilizing outside consultants, current films or slide presentations. Remember: an informed employee is a cooperative employee!

## Record Keeping

The employer is required to keep and maintain accurate records of the following:

1. Noise Exposure Assessments — for all employees who may be exposed to a Time-Weighted Average of 85 dBA. This determination is to be based upon all information, observations and calculations which indicate that exposure may be at or above this level. These records must be maintained for two years.
2. Audiometric Tests — these are to be maintained for the length of the person's employment; however, it is suggested that they be kept for that length of time plus 30 years.

3. Audiometric Test Rooms — these records must include the sound pressure level measurements at the octave bands of 500, 1000, 2000, 3000, 4000 and 8000 Hz. It is suggested that these records be maintained for the same suggested length of time for the audiometric tests.
4. Calibration of Audiometers — must include the type of calibration performed (and by whom), the date performed and the numerical results of the calibration. Once again it is suggested that these records be maintained for the same suggested length for the audiometric tests.

All employees, former employees and their designated representatives shall have access to any of these records upon request (usually in writing).

If an employer ceases to do business, the employer shall transfer to the successor employer all records required to be maintained and the successor employer shall retain them for the remainder of the period required.

## Compensation

The original Workmen's Compensation laws were intended to protect workers only if on-the-job accidents, injuries or disease deprived them of their weekly paycheck. Since noise-induced hearing loss ordinarily produced little or no wage loss, it was not compensable even though it was known to be permanent.

During the last years, the "wage loss concept" is being replaced by a fast-growing trend to recognize loss of function or disability as the basis of indemnity or liability claims. The law in most states is titled Workers' Compensation as opposed to the former Workmen's Compensation in recognition of this change in thinking.

Today, industries' potential compensable cost for noise-induced hearing loss is soaring. Workers' claims for loss of normal hearing function are increasing significantly, particularly in those industries in which unions are active, although workers themselves are more knowledgeable regarding their rights.

A few states, along with the Federal government, have liberalized payment schedules and claims procedures for compensating noise-induced hearing loss when it occurs. Nevertheless, effects of noise on performance, efficiency, mental effort and stress are difficult to quantify or even qualify. Several legal questions asked are: "What constitutes loss of hearing caused by noise?" "What is that loss worth in dollars and cents?" "Who makes the final determination regarding the degree of loss and compensation?" Final evaluation of the degree of industrial noise-induced hearing loss is a medical function, with the financial worth of the loss being a community/state decision. Cooperation between management, labor and the medical profession can result in legislation that is fair and equitable.

The Occupational Hearing Conservationist employed by industry is the preserver of the human faculty, hearing, but needs also to have working knowledge of the state's Workers' Compensation law and claims practices and procedures in view of the fact that hearing loss is a reality.

Of course, the ultimate goal of the Noise Amendment is to conserve all workers' hearing and to prevent noise-induced hearing loss from occurring in the first place.

# Glossary

Audiogram: The chart, graph or table showing Hearing Level in dB as a function of frequency.

Audiologist: A professional who holds a minimum of a Master's degree in Audiology and is concerned with the complete evaluation of auditory function and the habilitation of persons with hearing impairment.

Audiometer: An electronic instrument for measuring objectively the sensitivity of hearing in intensity and frequency.

Audiometric Technician: A person who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining and calibrating audiometers, and who is responsible to an audiologist, otolaryngologist or qualified physician.

Base Audiogram: The initial audiogram against which all future audiograms are to be compared.

Calibrate: The procedure used to check an audiometer for uniformity or accuracy.

Decibel (dB): The unit of measurement of sound level.

Hearing Level: The deviation in dB of a person's threshold from the zero reference of the audiometer.

Hearing Protectors: Personal ear plugs or ear muffs designed to keep noxious noise from the ear to preserve hearing.

Hertz (Hz): The unit of measurement of frequency, numerically equal to cycles per second.

High Frequency Loss: Usually a deficit starting with 2000 Hz and beyond.

Noise: Any unwanted sound.

Noise-Induced Hearing Loss: The term used to describe the slowly progressive and permanent inner ear hearing loss which results from exposure to loud continuous noise over a long period of time.

Occupational Hearing Conservationist: A person who is certified by the Council of Accreditation in Occupational Hearing Conservation.

Otolaryngologist: A medical doctor specializing in the diagnosis and treatment of disorders of the ear, nose and throat.

Presbycusis: The loss of hearing associated with aging.

Sound: The sensation produced through the organs of hearing by vibrations transmitted in a material medium, usually air.

Sound Level Meter: An instrument for the measurement of sound.

Temporary Threshold Shift: A loss of hearing resulting from noise exposure, all or part of which is recovered during an arbitrary period of time when the person is removed from the noise.

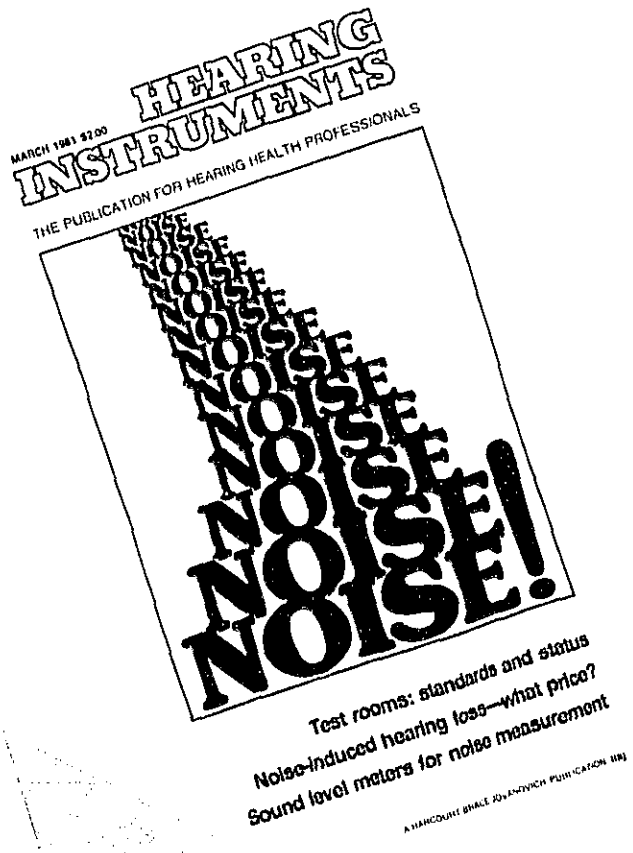
Threshold: The point at which a person just begins to notice the tone is becoming audible.

Tinnitus: A ringing sound in the ears.

# Industrial Noise Measurement

by

**Robert J. Wurm**
General Manager,
Quest Electronics

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# Industrial noise measurement

By Robert J. Wurm

*Industry is under pressure to establish and maintain a formal hearing conservation program, not only from OSHA, but also because workman's compensation claims continue to rise. Many companies are already deeply involved in such a program, while others are just beginning. An understanding of noise measurement as pertains to instrumentation versus type of noise (continuous, variable or impulsive) is important to a proper program.*

The type of noise with which one must deal determines the type of instrument needed for its proper measurement. The sound level meter is the most basic and most used sound instrument in the world today. It is used literally in most all applications, such as, general industry, community, vehicle, airport construction, mining, product noise evaluation and for calibrating audiometers and hearing aids.

The sound level meter also forms the basis of most other sound measuring devices. Many of the more specialized and complicated sound instruments merely consist of a sound level meter with additions or adaptations. A noise dosimeter is essentially a sound level meter with an added integrator. An octave band analyzer is formed merely by adding a frequency filter set, and a peak hold meter, by adding a peak hold module. Chart recorders can be plugged into the meter for making permanent records. Add an earphone coupler and an audiometer calibration system is made.

ANSI (American National Standards Institute) as well as International standards specify that a general full purpose sound level meter contains a switch for A, B and C weighting scales, a fast-slow response switch and a means to check battery strength (Fig. 1).

***Fig. 1. Type 2 sound level meter with A, B, C and LIN weighting, fast-slow response.***

*Robert J. Wurm is general manager, Quest Electronics, Oconomowoc, WI.*

The A scale is the most commonly used measurement. With A scale weighting the meter measures sound essentially as it is heard. The human ear does not respond well to low frequencies or tones. The meter electronically alters the measured sound to approximate the sound heard by the ear. The alteration is accomplished by suppressing the lower frequencies so that the meter reading usually is less than the actual sound pressure level, but essentially equal to how the ear is affected. The change in indicated decibels on the A scale from the actual decibel level at various frequencies is shown in Fig. 2.

B scale rarely is used today unless there is a necessity to compare readings of perhaps 20 years ago. B scale might occasionally be used today in audiometer calibration where no octave band filter is available to isolate the tones. B scale produces some attenuation to often bothersome low frequency vibrations that can disturb the meter reading in closed 6 cc coupler tests.

C scale (also shown in Fig. 2) is a near linear (flat) response weighting used for more scientific measurements or for comparison to A scale readings. This comparison will give some relative frequency content information. Actually a true Linear scale measurement is replacing C scale readings for most applications. Some newer meters are offering only A and Linear scales. Linear is used for true sound pressure readings (unweighted), and for plotting frequency response curves for such things as microphones, speakers and hearing aids.

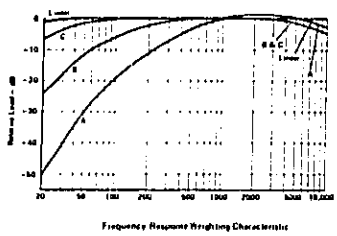

***Fig. 2. Frequency response weighting characteristics.***

The term fast-slow response refers to the speed of the meter needle in indicating changes in sound levels. When the meter is set to slow response, the needle deflection is damped to produce a more stable deflection which is easy to read. When a meter is set for fast response, the needle moves quickly in variable noise environments and can be difficult to read. The effective steady state meter indication is not affected by the response selection, but with slow response is easier to read.

## Sound level meter types

The present ANSI Standard S1.4-1971 categorizes sound level meters into 3 types: type 1, 2 and 3. (In two or three years, ANSI will likely adopt most of the new International IEC standard and categorize meters into 4 types: 0, 1, 2 and 3).

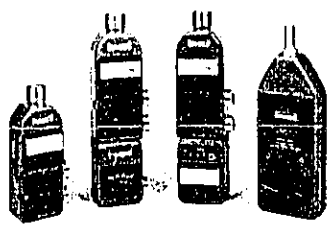

***Fig. 3. Measuring instruments (l to r): sound level meter, octave band analyzer, impact-impulse hold meter and integrating sound level meter.***

Type 1 is a precision meter; type 2 is a general purpose meter; and type 3 is a survey meter. Essentially type 1 is the most accurate and is intended primarily for laboratory use and other critical measurements. Type 2 is intended for most all field or plant use (OSHA requires type 2). Type 3 has the lowest accuracy and generally should not be used for accurate measurements.

A sound level meter which does not utilize a meter needle is the digital sound level meter. This meter has a number display of decibel level instead of a meter needle. The display may be of the LCD or LED type. Fixed number displays are ideal and easy to read when the number stands still as in constant noise, impact or impulse hold or in an averaging type meter (Leq). However, a digital readout used in a standard sound level meter becomes difficult to read in a variable noise environment. Changing numbers flashing at the operator are confusing. A moving needle type meter is considered to be easier to visually understand and average than are rapidly changing numbers.

The types of noise environments encountered in industry include: continuous, variable, impulsive or special application such as audiometer calibration.

## Continuous noise

In relatively constant noise environments a sound level meter is very adequate to obtain good readings. A rule of thumb is that the meter needle should not vary more than about 3 dB. For sounds that stay within this 3 dB span, the higher value is the closest to the actual average. Remember that decibels are log functions, and you do not arithmetic

average them. As noise variations become more severe it becomes increasingly difficult to eyeball average values, particularly when also trying to apply OSHA's 5 dB rule.

## Variable noise

When noise variations become the rule rather than the exception, use of a sound level meter to determine workers exposure becomes a tedious task and produces questionable results. Most often the results are underestimated. A noise dosimeter of an integrating sound level meter affords the only practical alternative. Dosimeters are basically the same in performance as sound level meters with the added integrating circuit providing the advantage of eliminating the human error in trying to interpolate a moving meter needle and also attempting to assess the 5 dB time weighting of sound levels. In the presence of impulsive noise the actual energy is picked up and integrated in a dosimeter as long as the slow response time constant permits the signal level to exceed the dosimeter threshold level. In a sound level meter, the meter ballistics and judgment factor generally cause a person to read the meter low, particularly with high impulsive, low duty cycle noise.

In the new OSHA requirements for hearing conservation (Federal Register Jan. 16, 1981), the noise dosimeter has its threshold level set down to 80 dB (8 hour criteria level is still 90 dB). This effectively removes the abrupt discontinuity of the 90 dB threshold setting and permits direct conversion of percent exposure to OSHA equivalent decibel level.

The alternative instrument to a noise dosimeter is the integrating sound level meter (Fig. 3); either equal energy (Leq) type or the OSHA equivalent $L_{OSHA}$ (5dB) integrating meter. The only basic difference between the dosimeter and the $L_{OSHA}$ meter is that the dosimeter reads out in percent exposure while the integrating meter reads directly in average decibels. Both instruments measure impulse noise correctly to the extent of their crest factor capability (peak noise compared to average level). Some Leq meters will produce a single average noise level over any period of time. But other meters will automatically measure equal time increment periods and can be plotted on a recorder to produce a time-history profile of noise throughout a work shift or even over a 24 hour day. This is shown in Fig. 4, where in this case average industrial noise is chart recorded in two minute increments over a workshift.

*Fig. 4. Measurement and chart recording of industrial noise with an integrating sound level meter.*

## Impulsive-impact noise

Repetitive, impulsive noise, where true averages or exposure levels are to be measured, are covered above. Where actual peak magnitudes are to be measured, a special meter with this capability is necessary. This is an impulse or peak-hold feature added to some meters (Fig. 3). The normal response of a meter even set to fast response is still far too slow to capture and read impulsive noise. The peak-hold addition to the meter captures the impact level electronically, drives the meter reading up to that level and holds it to take the reading.

Absolute impact peak noise levels can be read, and also the international impulsive method based on 35 millisecond risetime can be read.

## Special applications

Often a more detailed understanding of a noise problem is needed requiring the use of an octave band analyzer. This type of instrument provides a convenient means to analyze noise in frequency bands to aid in determining methods to control noise. Generally, the results of measuring sound levels in octave frequency bands are plotted on a chart for analysis to visually see the noise profile of the noisy environment or object (Fig. 5). If the intent is to quiet an industrial machine, then another octave band analysis can be taken after application of the sound suppression methods to determine the effectiveness of the techniques.

The octave band analyzer has an additional major role in the hearing conservation program. The new regulation requires audiometric testing of all employees exposed to 85 dBA or more. These tests must be given in a room or sound booth that has specific background room noise limitations spelled out in octave bands. Any company that sets up their own testing program must measure and record background noise levels. Therefore, the octave band analyzer now has a triple role to play in industry. The same octave band analyzer can now perform:

1) Octave band analysis of all noisy machines and plant areas to aid in engineering quieting efforts.

2) Measurement of audiometric room background noise.

3) Actual audiometric calibration of the audiometer to insure its continued accuracy.

Audiometer decibel levels are accurately checked with the octave band analyzer with the addition of a 6 cc earphone coupler to match the microphone. A pressure response plot of the particular microphone characteristic is also necessary for accuracy.

## Conclusion

The field of sound measurement instrumentation continues each year to grow more complex and more sophisticated. Implementation of a good hearing conservation program will involve a good understanding of noise measurement, of the types of noise being measured and of the various sound measuring devices available. □

OCTAVE BAND ANALYSIS CHART

DATE January 16, 1980

ANALYZER & S/N Quest 215-45, 908102M,908118N

CALIBRATED Jan. 16, 1980, Quest CA-12,908123U

By K.J.B.

PROJECT/COMMENTS Noise Suppression Analysis of compressor motor, 3 ft. from shaft axis, perpendicular measurement.

| TEST | #1 | #2 | #3 |
|---|---|---|---|
| dBA | 82 | 83 | |
| dB LIN | 83 | 83 | |
| 31 Hz | 66 | 65 | |
| 63 | 69 | 69 | |
| 125 | 70 | 70 | |
| 250 | 72 | 73 | |
| 500 | 75 | 74 | |
| 1k | 81 | 81 | |
| 2k | 74 | 72 | |
| 4k | 74 | 74 | |
| 8k | 65 | 64 | |

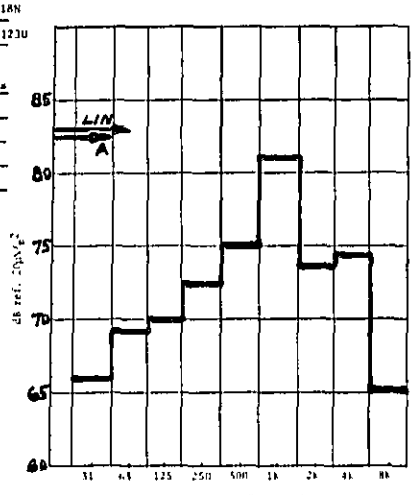


*Fig. 5. Octave band analysis plot of a compressor motor system.*

# SOUND INSTRUMENT PRICE LIST

**Effective: April 1, 1987**
PRICES SUBJECT TO CHANGE WITHOUT NOTICE.
THIS PRICE SUPERSEDES ALL PREVIOUS PRICE LISTS.

WARRANTY:

Quest Electronics warrants its instruments to be free from defects in materials and workmanship under normal conditions of use and service. Should unit prove to be defective within one (1) year after delivery to the original purchaser, we will replace or repair the unit at Quest option, free of charge. (Exception: Model 208 and 208L — 90 days warranty.) **Chart Recorders, Printers and field replaceable microphones for M-27 are not warranted by Quest.**


**MAIN OFFICE AND FACTORY**

ORDERING INFORMATION: Quest Electronics
510 S. Worthington St.
MINIMUM ORDER: $50.00 Oconomowoc, WI 53066 USA
414/567-9157 TWX 9102601438 La Belle

**REGIONAL OFFICES**

| MIDWEST (Oconomowoc) | EAST (Baltimore) | SOUTH (Atlanta) | WEST (Los Angeles) |
|---|---|---|---|
| Quest Electronics | Quest Electronics | Quest Electronics | Quest Electronics |
| 414/567-9157 | 301/252-3347 | 404/979-6281 | 714/836-5087 |


| | U.S. List Price |
|---|---|
| **PRECISION SOUND LEVEL METERS — OCTAVE BAND FILTERS — TYPE 1** | |
| 155 PRECISION (IMPULSE) SOUND LEVEL METER: ANSI and IEC type 1, A, B, C, LIN. weighting, 30-140dB range, impulse-impact, 7046 ½ inch condenser microphone-detachable, 999 carrying case | 1830.00 |
| OB-145 OCTAVE BAND FILTER SET: ANSI Class II, IEC, 31Hz to 16KHz center frequency (10 bands), 20 dB gain switch | 785.00 |
| OB-133 1/3 OCTAVE BAND FILTER SET: ANSI Class III, IEC, 12.5 Hz to 20 KHz (33 bands) 20dB gain switch | 985.00 |
| **MICROPHONES FOR ABOVE** | |
| 7047 ½ inch condenser, 200v polar, 50 mv/Pa, random-pressure | 525.00 |
| 7046 ½ inch condenser, 200v polar, 50 mv/Pa, free field | 525.00 |
| 7013 ½ inch condenser, 200v polar, 16 mv/Pa, random-pressure | 525.00 |
| 7023 1 inch condenser, 200v polar, 56 mv/Pa, pressure (A-63B Adaptor needed, see below) | 525.00 |
| **PRECISION SOUND LEVEL METER AND OCTAVE BAND KITS** | |
| 155-22 PRECISION SOUND LEVEL METER & CALIBRATOR KIT: contains 155 meter with ½ inch mic, CA-22 calibrator, and 999 carrying case | 2175.00 |
| 155-14522 OCTAVE BAND ANALYZER & CALIBRATOR KIT: contains 155 meter with ½ inch mic, OB-145 filter, CA-22 calibrator, WS-4 windscreen, 970 carrying case (mic cables are optional) | 3040.00 |
| 155-14522AM AUDIOMETRIC CALIBRATION KIT: (see Audiometer Calibration Kits) | — — |
| **ACCESSORIES FOR ABOVE** | |
| A-63B ADAPTOR, 1 INCH TO PREAMP (for 1 in. mic. only) | 50.00 |
| PMC-10 MICROPHONE CABLE, 10 ft. | 120.00 |
| PMC-50 MICROPHONE CABLE, 50 ft. | 140.00 |
| WS-4 WINDSCREEN (for ½ inch microphones) | 10.00 |
| WS-3 WINDSCREEN (for 1 inch microphones) | 5.00 |
| CC59-970 CARRYING CASE with foam inserts | 155.00 |
| CC59-999 CARRYING CASE with foam inserts | 85.00 |
| VA-508BP VIBRATION ASSEMBLY - for use with 155 meter (see Vibration & Sound Measuring Kits) | — — |
| 817 PRECISION INPUT CABLE, 5 ft. w/tini-jack | 75.00 |
| PS-95 AC ADAPTOR power supply (for line operation of meters) | 95.00 |
| PA-4 PROBE MIC ASSEMBLY (see audiometer calibration accessories) | — — |
| **SOUND LEVEL METERS & KITS — TYPE 2** | |
| 208L SOUND LEVEL METER: special purpose, 50-100 dBA, slow, max-hold, w/pouch | 145.00 |
| 208 SOUND LEVEL METER: special purpose, 70-120dBA, slow, max-hold, w/pouch | 145.00 |
| 211A SOUND LEVEL METER: ANSI type S2, A scale, 60-120dBA range, slow response, w/carrying case | 375.00 |
| 211FS SOUND LEVEL METER: ANSI type S2, A-C scale, 60-120dB range, fast-slow response, w/carrying case | 395.00 |
| 214 SOUND LEVEL METER: ANSI type S2, A scale, 30-140dBA range, fast-slow, w/carrying case | 455.00 |
| 215 SOUND LEVEL METER: ANSI type 2, A-B-C-Lin.-Ext. scale, 30-140dB range, fast-slow, w/carrying case | 595.00 |
| 227 INTEGRATING SOUND LEVEL METER (LOSHA-5dB): ANSI type S2, A scale, 40-130dBA range, remote mic (cable not included), WS-2 windscreen, 918 carrying case | 990.00 |
| 228 INTEGRATING SOUND LEVEL METER (Leq-3dB): ANSI type S2, A scale, 40-130dBA range, remote mic, (cable not included), WS-2 windscreen, 918 carrying case. | 990.00 |
| 211A-12 SOUND LEVEL METER & CALIBRATOR KIT: contains 211A meter and CA-12B calibrator w/carrying case | 570.00 |
| 211FS-12 SOUND LEVEL METER & CALIBRATOR KIT: contains 211FS meter and CA-12B calibrator w/carrying case | 590.00 |
| 214-12 SOUND LEVEL METER & CALIBRATOR KIT: contains 214 meter and CA-12B calibrator w/carrying case | 650.00 |
| 215-12 SOUND LEVEL METER & CALIBRATOR KIT: contains 215 meter and CA-12B calibrator w/carrying case | 790.00 |
| 215-15 SOUND LEVEL METER & CALIBRATOR KIT: contains 215 meter and CA-15B calibrator w/carrying case | 990.00 |
| 227-12 INTEGRATING SOUND LEVEL METER & CALIBRATOR KIT: contains 227 meter, CA-12B calibrator, WS-2 windscreen, 918 carrying case (TP-2 tripod is optional) | 1185.00 |
| 228-12 INTEGRATING SOUND LEVEL METER & CALIBRATOR KIT: contains 228 meter, CA-12B calibrator, WS-2 windscreen, 918 carrying case (TP-2 tripod is optional) | 1185.00 |
| 261 SOUND LEVEL DETECTOR/CONTROLLER: sound activated switch for monitoring noisy areas (can be used with optional LB-26 light box) | 540.00 |

NOTE: REMOTE MICROPHONE CAPABILITY: is available on any of the above meters and is denoted by adding the letter "R" following the sound level meter model number, i.e., 211AR, 215R, etc. The microphone will now be detachable with a pre-amp built into the microphone assembly. (price does not include cables) — 110.00

NOTE: 227, 226 & 155 meters already have remote mic capability. (Units sent in for modification would be subject to labor charges.)

## ACCESSORIES FOR ABOVE

| | |
|---|---|
| WS-3 WINDSCREEN (for 1 inch mic) | 5.00 |
| VA-508B VIBRATION ASSEMBLY - for use with 215R meter (see Vibration & Sound Measuring kits) | — — |
| WS-2 WINDSCREEN (for ½ inch mic) Package of 5 | 15.00 |
| CC58-918 CARRYING CASE with foam inserts and lid pocket | 85.00 |
| CABLES AND TRIPODS (see Community Noise Kits) | — — |
| PS-95 AC ADAPTOR, power (for line operation of meters) | 95.00 |
| LB-26 Light Box (accessory to the 261 Detector) | 195.00 |
| DMC-50 MICROPHONE CABLE: 50 ft with connectors (for use with 261 Detector) | 75.00 |
| 58-874 30 ft. fixed mic & cable assembly for 261 | 95.00 |

## OCTAVE BAND, PEAK-HOLD & KITS for TYPE 2 METERS

| | |
|---|---|
| OB-45 OCTAVE BAND FILTER SET: ANSI S1.11 Class II, 31Hz to 8KHz center frequencies (9 bands) w/ + 10dB gain button | 590.00 |
| PH-35 PEAK-HOLD MODULE: meter hold for fast response, IEC impulse, OSHA impact | 335.00 |
| 215-4512 OCTAVE BAND ANALYZER & CALIBRATOR KIT: contains 215 meter OB-45 octave band filter, CA-12B calibrator, WS-3 windscreen, 925 carrying case | 1480.00 |
| 215-3512 SOUND LEVEL METER/PEAK-HOLD KIT: contains 215 meter, PH-35 peak-hold module, CA-12B calibrator, WS-3 windscreen, 925 carrying case | 1225.00 |
| 215-345-12 UNIVERSAL SOUND MEASURING KIT: contains 215 meter, OB-45 octave band filter, PH-35 peak-hold module, CA-12B calibrator, WS-3 windscreen 925 carrying case | 1815.00 |
| 215-345-M7B32 UNIVERSAL & DOSIMETER KIT: contains 215 meter, OB-45 octave band filter, PH-35 peak-hold module, CA-32 calibrator, WS-3 windscreen, M-7B noise dosimeter, 925 carrying case | 2615.00 |
| 215-345-3M7B32 UNIVERSAL & DOSIMETER KIT: contains 215 meter, OB-45 octave band filter, PH-35 peak-hold module, CA-32 calibrator, WS-3 windscreen, three M-7B noise dosimeters, 931 carrying case | 4145.00 |

## ACCESSORIES FOR ABOVE

| | |
|---|---|
| CC59-925 CARRYING CASE with foam inserts and lid pocket | 95.00 |
| CC59-931 CARRYING CASE with foam inserts and lid pocket | 155.00 |

## NOISE DOSIMETERS AND KITS

| | |
|---|---|
| M-27 NOISE LOGGING DOSIMETER: Micro processor dosimeter with data logging, hard copy print-out capability, includes WS-5 windscreen, 8mm calibrator adaptor, #59-818 printer cable and carrying case | 1395.00 |
| M-28 NOISE LOGGING DOSIMETER: Micro processor dosimeter with data logging, hardcopy print-out capability includes WS-5 windscreen, 8 mm calibrator adaptor, #59-818 printer cable and carrying case | 1395.00 |
| MICRO-15 NOISE DOSIMETER: Microprocessor Monitor which provides 15 simultaneous functions w/hard copy print-out capability, includes WS-5 windscreen, 8mm calibrator adaptor, and carrying case | 995.00 |
| M-7B NOISE DOSIMETER, OSHA type (or Model M-7, MSHA approved): 5dBA exchange ratio, self-contained readout, includes WS-5 windscreen, noise exposure calculator, mic adaptor and carrying case | 735.00 |
| M-7B/4 NOISE DOSIMETER: 4dBA exchange ratio, DOD type, self-contained readout, includes same as above | 735.00 |
| M-8B NOISE DOSIMETER: 3dBA exchange ratio, equal energy, ISO R1999, self-contained readout, includes same as above | 735.00 |
| M-2712 NOISE LOGGING DOSIMETER & CALIBRATOR KIT: contains M-27 dosimeter, CA-12B calibrator, WS-5 windscreen, 8mm calibrator adaptor, #59-818 printer cable, and carrying case | 1590.00 |
| MICRO-1512 NOISE DOSIMETER & CALIBRATOR KIT: contains MICRO-15 dosimeter, CA-12B calibrator, WS-5 windscreen, 8mm calibrator adaptor, and carrying case | 1190.00 |
| M-7B32 NOISE DOSIMETER & CALIBRATOR KIT: contains M-7B dosimeter, CA-32 calibrator, WS-5 windscreen, noise exposure calculator, 8mm calibrator adaptor, and carrying case | 995.00 |
| 5M-2712 NOISE LOGGING DOSIMETER & CALIBRATOR KIT: contains five M-27 dosimeters, CA-12B calibrator, five WS-5 windscreens 8mm calibrator adaptor, #59-818 printer cable, and 59-851 carrying case | 7165.00 |
| 5MICRO-1512 NOISE DOSIMETER & CALIBRATOR KIT: contains five MICRO-15 dosimeters, CA-12B calibrator, five WS-5 windscreens, 8mm calibrator adaptor, 865 carrying case | 5145.00 |
| 5M-7B32 NOISE DOSIMETERS & CALIBRATOR KIT: contains five M-7B dosimeters, CA-32 calibrator, five WS-2 windscreens, five noise exposure calculators, 8mm calibrator adaptor, 959 carrying case | 3910.00 |
| 10M-2712 NOISE LOGGING DOSIMETER & CALIBRATOR KIT: contains ten M-27 dosimeters, CA-12B calibrator, ten WS-5 windscreens, 8mm calibrator adaptor, #59-818 printer cable, and 59-852 carrying case | 13640.00 |
| 10MICRO-1512 NOISE DOSIMETER & CALIBRATOR KIT: contains ten MICRO-15 dosimeters, CA-12B calibrator, ten WS-5 windscreens, 8mm calibrator adaptor, 866 carrying case | 9900.00 |
| 10M-7B32 NOISE DOSIMETERS & CALIBRATOR KIT: contains ten M-7B dosimeters, CA-32 calibrator, ten WS-5 windscreens, ten noise exposure calculators, 8mm calibrator adaptor, 968 carrying case | 7465.00 |
| 5M15-NL15-12 NOISE DOSIMETER/LOGGER & CALIBRATOR KIT: includes five MICRO-15 dosimeters, one NL-15 data logger, CA-12B calibrator, canvas carrying pouch, interconnect cables, 8mm calibrator adaptor, WS-5 windscreen, and 865 carrying case | 5840.00 |

**NOTE: The M-28 can be substituted in any of the M-27 kits at the same price.**

## ACCESSORIES FOR THE ABOVE

| | |
|---|---|
| NL-15 NOISE DATA LOGGER: (for use with MICRO-15 only) includes canvas carrying pouch, cable to MICRO-15 and cable to printer | 695.00 |
| 59-847 FIELD REPLACEABLE MICROPHONE FOR M-27 or M-28 | 145.00 |
| 58-852 EARLOOP | 2.00 |
| SOFTWARE FOR MICRO-15 to: (Includes Interconnect Cables)<br>58-518 Radio Shack TRS-80, Model, III, IV<br>58-519 IBM Personal or Compatible<br>58-520 Epson HX-20 | 195.00 |
| SOFTWARE FOR MICRO-15/NL-15 COMBINATION (for IBM PC or Compatible) includes interconnect cables | 360.00 |
| SOFTWARE FOR 27 #59-839 (for IBM PC or Compatible) includes interconnect cable | 295.00 |
| SOFTWARE FOR M-28 #59-856 (for IBM PC or Compatible) includes interconnect cable | 295.00 |
| WS-5 WINDSCREEN Package of 5 (for 8mm mic) | 10.00 |
| WS-2 WINDSCREEN Package of 5 (for ½ in. mic) | 15.00 |
| CC58-959 CARRYING CASE with foam inserts and lid pocket (holds up to 6 M-7B's and 1 calibrator) | 95.00 |
| CC58-968 CARRYING CASE with foam inserts and lid pocket (holds up to 10 M-7B's and 1 calibrator) | 155.00 |
| CC58-865 CARRYING CASE with foam inserts and lid pocket (holds up to 6 MICRO-15's and 1 calibrator) | 95.00 |
| CC58-866 CARRYING CASE with foam inserts and lid pocket (holds up to 10 MICRO-15's and 1 calibrator) | 155.00 |

CC59-851 CARRYING CASE with foam inserts and lid pocket (holds 5 M-27's, 1 calibrator) ..... 155.00
CC59-852 CARRYING CASE with foam inserts and lid pocket (holds 10 M-27's, 1 calibrator) ..... 155.00

## AUDIOMETER CALIBRATION

215-12 AM AUDIOMETER CALIBRATION KIT: contains 215 meter, CA-12 calibrator, EC-9A coupler, W-440 weight, calibration chart, 925 carrying case ..... 1060.00
215-4512 AM AUDIOMETER CALIBRATION KIT: contains 215 meter, OB-45 octave band filter, CA-12B calibrator, EC-9A earphone coupler, W-440 weight, AS-1545 calibration stand, calibration chart, 932 carrying case ..... 1795.00
AM-100 AUDIOMETER CALIBRATION KIT: contains 215 meter OB-245 super octave band filter, CA-15B calibrator, EC-9A earphone coupler, W-440 weight, AS-1545 calibration stand, FC-3 frequency counter, calibration chart, 932 carrying case ..... 2660.00
AM-200 AUDIOMETER CALIBRATION KIT: contains 215 meter, OB-45 octave band filter, CA-15B calibrator, EC-9A coupler, W-440 weight, AS-1545 calibration stand, AA-175 audiometer analyzer, calibration chart, 932 carrying case ..... 3290.00
155-14522AM PRECISION AUDIOMETER CALIBRATION KIT: contains 155 precision meter with 1 inch mic, A-63B adaptor, OB-145 filter, CA-22 calibrator, PMC-10 mic cable, EC-9A coupler, W-440 weight, AS-1550 calibration stand, calibration chart, 970 carrying case (FC-3 frequency counter is optional) ..... 3400.00
AM-2000 PRECISION AUDIOMETER CALIBRATION KIT: contains 155 precision meter with 1 inch mic, A-63B adaptor, OB-145 filter, CA-22 calibrator, PMC-10 mic cable, EC-9A coupler, W-440 weight, AS-1550 calibration stand, AA-175 audiometer analyzer, LT-20 linearity transformer calibration chart, 998 carrying case (Printer not included) ..... 4915.00
AA-188AM PRECISION AUDIOMETRIC ANALYZER KIT: contains AA-188 precision analyzer, 58-913 preamp, 7023 mic, A-63B adaptor, 58-929 1" mic adaptor, EC-9A coupler, W-440 weight, AS-1550 calibration stand, PMC-10 mic cable, 819 carrying case (CA-22 calibrator is optional) ..... 4095.00
AA-188 PRECISION AUDIOMETRIC ANALYZER: (mic, carrying case, & accessories are not included) ..... 3850.00
AA-175 AUDIOMETER ANALYZER (with Model 65 Power Supply) ..... 1295.00
BA-201 BIO-ACOUSTIC SIMULATOR (for replacement of biological calibrations) ..... 430.00
BA-201-25 BIO-ACOUSTIC SIMULATOR w/Octave Monitor ..... 780.00
BA-201 RESPONSE DELAY SIMULATOR to check the Besserman and Tracor 410N ..... 525.00
BA-201-25 RESPONSE DELAY SIMULATOR w/Octave Monitor ..... 875.00

## ACCESSORIES FOR ABOVE

PA-4 PROBE MIC ASSEMBLY (for cochlear implant & hearing aid evaluation) — **for 155 only** ..... 490.00
PA-5 PROBE MIC ASSEMBLY (for 215 only) ..... 490.00
OB-133 1/3 OCTAVE BAND FILTER SET ..... 985.00
MODEL 65 POWER SUPPLY ..... 45.00
FLOPPY DISK COMPUTER PROGRAM for Radio Shack TRS-80 Computer — to analyze, edit & format data from the Model AA-175 Analyzer w/58-849 Input Cable to TRS-80 ..... 195.00
LT-20 LINEARITY TRANSFORMER (see input cables needed below) for use w/remote mic meters only ..... 145.00
59-982 215 input cable ..... 40.00
58-817 precision input cable ..... 75.00
MODEL 120 POWER SUPPLY for above BA 201's ..... 60.00
59-995 RESPONSE CABLE for BA-201's ..... 20.00
FC-3 FREQUENCY COUNTER (with PS-124 line power supply) ..... 325.00
PS-124 POWER SUPPLY: 12 volt regulated, (for use w/FC-3 line operated) ..... 60.00
HA-100 HEARING AID TEST ASSEMBLY (for use with 215R meter) (in-the-ear aids) ..... 310.00
Includes: QHA-1 2cc coupler with ½ in. sleeve adaptor (only need for 155) ..... 175.00
1830HA ½ inch microphone & cable assembly ..... 125.00
58-927 ½ inch microphone adaptor ..... 10.00
HA-200 HEARING AID TEST ASSEMBLY (for use with 215R meter) (behind-the-ear aids) ..... 310.00
Includes: QHA-2 2cc coupler with ½ in. sleeve adaptor (only needed for 155) ..... 175.00
1830HA ½ inch microphone & cable assembly ..... 125.00
58-927 ½ inch microphone adaptor ..... 10.00
EC-9A 6cc EARPHONE COUPLER ..... 95.00
W-440 WEIGHT ..... 50.00
AS-1545 AUDIOMETRIC CALIBRATION STAND (for use with 215-45) ..... 85.00
AS-1550 AUDIOMETRIC CALIBRATION STAND (for use with 155 meter) ..... 55.00
PMC-10 MICROPHONE CABLE, 10 ft. (for use with 155 meter) ..... 120.00
CC59-925 CARRYING CASE with foam inserts and lid pocket ..... 95.00
CC59-998 CARRYING CASE with foam inserts and lid pocket holds 155 & AA-175 ..... 155.00
CC59-932 CARRYING CASE with foam inserts and lid pocket for 215 meter kits ..... 155.00
CC59-970 CARRYING CASE with foam inserts and lid pocket for 155 meter kits ..... 155.00
CC59-854 CARRYING CASE with foam inserts and lid pocket holds AA-188, calibrator and accessories ..... 155.00

## COMMUNITY NOISE MEASURING KITS — TYPE 2

235 VEHICLE NOISE MONITOR: ANSI type S2, A scale, 50-100 dBA range, threshold set-alarm, 339 carrying case ..... 1080.00
235-12WM VEHICLE NOISE MONITOR KIT: contains 235 monitor, CA-12M calibrator, MT-5 window mount with mic. cable, WS-4 windscreen, 339 carrying case ..... 1365.00
214-12W COMMUNITY NOISE KIT: contains 214 meter, CA-12B calibrator, WS-3 windscreen, WM-1 windmeter, w/carrying case ..... 675.00
215-12W COMMUNITY NOISE KIT: contains 215 meter, CA-12B calibrator, WS-3 windscreen, WM-1 windmeter, w/carrying case ..... 815.00
214R-12WT REMOTE MIC COMMUNITY NOISE KIT: contains 214R remote mic meter, CA-12B calibrator, WS-3 windscreen, WM-1 windmeter, TP-2 tripod, TMH-1 mic holder, 50 ft. mic cable (other lengths available), 925 carrying case ..... 1035.00
215R-12WT REMOTE MIC COMMUNITY NOISE KIT: contains 215R remote mic meter, CA-12B calibrator, WS-3 windscreen, WM-1 windmeter, TP-2 tripod, TMH-1 mic holder, 50 ft. mic cable (other lengths available), 925 carrying case ..... 1175.00
411L-215R-12WT SOUND LEVEL RECORDER SYSTEM: contains same as above with addition of 411L Chart Recorder and RM-800 ..... 2450.00
411BB-228-12T INTEGRATING SOUND LEVEL CHART RECORDER SYSTEM: contains 411BB recorder, 228 integrating meter, CA-12B calibrator, TP-2 tripod, WS-2 windscreen, 918 carrying case ..... 2540.00

## ACCESSORIES FOR ABOVE

WS-3 WINDSCREEN (for 1 inch mic) ..... 5.00
TP-1 TRIPOD: 20 inch closed, 55 inch extended ..... 60.00

| | |
|---|---|
| TP-2 TRIPOD: 10 inch closed, 51 inch extended | 60.00 |
| TMH-1 TRIPOD MICROPHONE HOLDER | 20.00 |
| MC-25 MICROPHONE CABLE: 25 ft. with connectors (for one inch mic) | 65.00 |
| MC-50 MICROPHONE CABLE: 50 ft. with connectors (for one inch mic) | 75.00 |
| MC-75 MICROPHONE CABLE: 75 ft. with connectors (for one inch mic) | 85.00 |
| MCK-10 MICROPHONE CABLE: 10 ft. with connectors (for ½ inch mic) | 60.00 |
| MCK-50 MICROPHONE CABLE: 50 ft. with connectors (for ½ inch mic) | 75.00 |
| WM-1 WIND VELOCITY METER | 20.00 |

**ACCESSORIES FOR 235-12 WM VEHICLE NOISE MONITOR**

| | |
|---|---|
| MT-5 WINDOW MOUNT with mic boom, connectors and cable | 80.00 |
| WS-4 WINDSCREEN (for ½ inch mic) | 10.00 |
| PS-123 POWER SUPPLY: 12 volt, line operated | 45.00 |
| CC58-339 CARRYING CASE with foam inserts and lid pocket | 95.00 |
| VMCK-50 MICROPHONE CABLE: 50 ft. with connectors | 75.00 |

## PRINTERS AND ACCESSORIES

| | |
|---|---|
| 59-272 Printer — 80 Column | 425.00 |
| 59-273 Cassette ribbons | 6.50 |
| 58-847 MICRO INPUT CABLE to 80 column printer | 65.00 |
| 59-818 NL-15 INPUT CABLE to 80 column printer | 65.00 |
| 58-849 AA-175 INPUT CABLE to 80 column printer | 65.00 |
| 58-883 AA-160 INPUT CABLE to 80 column printer | 65.00 |
| 59-818 M-27 INPUT CABLE to 80 column printer | 65.00 |

## CHART RECORDERS

| | |
|---|---|
| 411L CHART RECORDER: line operated, selectable chart speed and sensitivity, 1 z-fold chart paper, 1 pen, and input cable | 1090.00 |
| 411BB CHART RECORDER: battery operated, selectable chart speed and sensitivity, includes battery, charger, 1 z-fold chart paper, 1 pen, and input cable | 1295.00 |

### ACCESSORIES FOR ABOVE

| | |
|---|---|
| 59001 Z-FOLD PAPER — each (20 meters long) | 8.00 |
| 723A26-6 RED PEN | 4.00 |
| 11464-1 BLACK PEN | 4.00 |
| 7528201 CARRYING CASE | 225.00 |
| 58-948 RECORDER INPUT CABLE | 25.00 |
| RM-800 RECORDER MODULE: 1 volt DC output, 50dB linearized span | 185.00 |

## VIBRATION AND SOUND MEASURING KITS

| | |
|---|---|
| VA-508B Vibration Assembly (for use with 215R meter) | 695.00 |
| Includes: 508 accelerometer | 385.00 |
| VI-90 vibration integrator | 210.00 |
| AC-5 accelerometer cable | 45.00 |
| 59-72 probe | 15.00 |
| 58-406 vibration chart | N/C |
| 59-982 input cable | 40.00 |
| VA-508BP Vibration Assembly (for use with 155 meter) | 730.00 |
| Includes: 508 accelerometer | 385.00 |
| VI-90 vibration integrator | 210.00 |
| AC-5 accelerometer | 45.00 |
| 59-72 probe | 15.00 |
| 58-407 vibration chart | N/C |
| 58-817 precision input cable | 75.00 |
| 215R-15-508B VIBRATION AND SOUND MEASURING KIT: (OB-45 optional) contains: 215R remote mic meter, CA-15B calibrator, VA-508B vibration assembly, 925 carrying case | 1690.00 |
| 155-22-508BP VIBRATION AND PRECISION SOUND MEASURING KIT (OB-145 optional) contains: 155 meter with ½ inch mic, CA-22 calibrator, VA-508BP vibration assembly, 970 carrying case | 2975.00 |
| 155-13322-508BP VIBRATION AND PRECISION SOUND MEASURING ANALYZER KIT: contains: 155 meter with ½ inch mic, OB-133 1/3 octave band filter, CA-22 calibrator, VA-508BP vibration assembly, WS-4 windscreen, 970 carrying case | 3970.00 |

**PLEASE NOTE:** Calibration of the VA-508 Vibration Systems require a 1v RMS, 1000Hz signal, as provided by Model CA-15B and CA-22 Calibrators.

## CALIBRATORS

| | |
|---|---|
| CA-12B SOUND CALIBRATOR: 110dB; 1000Hz, battery operated | 195.00 |
| CA-12M SOUND CALIBRATOR: 94dB; 1000Hz, battery operated | 195.00 |
| CA-15B SOUND CALIBRATOR: 110dB; 125, 250, 500, 1000, 2000Hz, battery operated | 395.00 |
| CA-22 SOUND CALIBRATOR: precision, 110-94dB; 1000-250Hz, battery operated | 345.00 |
| CA-32 SOUND CALIBRATOR WITH PRECISION TIMER: for dosimeters, 110dB, 1000Hz, battery operated | 260.00 |

**NOTE:** Quest Calibrators have a 1-1/8 inch coupler diameter.
For use with other size microphones, see adaptor rings listed below.

### ACCESSORIES FOR ABOVE

| | |
|---|---|
| 58-927 CALIBRATOR ADAPTOR for .50 inch diameter microphone | 10.00 |
| 58-928 CALIBRATOR ADAPTOR for .52 inch diameter microphone | 10.00 |
| 58-929 CALIBRATOR ADAPTOR for 1.0 inch diameter microphone | 10.00 |
| 58-386 CALIBRATOR ADAPTOR for 10mm diameter microphone (for 208's) | 10.00 |
| 58-839 CALIBRATOR ADAPTOR for 8mm diameter microphone | 10.00 |
| 58-526 CALIBRATOR ADAPTOR for .725 diameter microphone (for 261) | 10.00 |