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*instructions
for*

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

211AR and 211FS REMOTE MICROPHONE METERS
CA-12 SOUND CALIBRATOR
WS 3 WINDSCREEN
RA-100MV RECORDER ADAPTOR



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**Model 211A
Sound Level Meter**



**Model 211FS
Sound Level Meter**

GENERAL DESCRIPTION

The Quest Models 211A and 211FS Sound Level Meters are special purpose noise measuring instruments for use in virtually any environment: industry, construction, law enforcement, mining, transportation, airports anywhere there is noise. The 211A meter is a quality basic instrument developed for measuring compliance with the federal Occupational Safety & Health Act (OSHA). The 211FS meter with the addition of Fast-Slow response is designed for moving vehicle noise measurements, but can also be used for OSHA measurements. Both meters meet ANSI Standard S1.4, Type S2 and IEC 651, type 2.

The 211A and 211FS meters have a fixed microphone configuration mounted directly to the top of the meter housing. The meters are also available with remote microphone capability; this is denoted by the letter "R" which is added to the meter model number (211AR, 211FSR). Remote microphone capability must be built into the meter in manufacture. A mating connector is incorporated into the removable part which also includes the microphone and pre-amplifier. Because the pre-amp is effectively an impedance reducer, any length of microphone cable up to 100 feet can be used without affecting the overall accuracy or performance of the meter. The WS-3 windscreen (see page 21) can be used with either fixed or remote microphone meter.

SPECIFICATIONS

NOISE LEVEL MEASUREMENT RANGE

Reference $20\mu\text{N}/\text{m}^2$

Model 211A: 60 to 120 dBA in 5 ranges

Model 211FS: 60 to 120 dBA or dBC in 5 ranges

Both models are accurate within 1.0 dB up to a sound pressure level of 133 dB without notable distortion. Maximum reliable dB as a function of weighting network vs. frequency is reduced by the decibel difference between flat response and the dB level of the weighting curve vs. frequency.

RESPONSE

Meets ANSI Standard S1.4-1971 for Type 2 instrumentation (S2), IEC 1.23 and IEC 651, type 2.

Model 211A: "A" scale weighted, slow response

Model 211FS: "A or C" scale weighted, fast or slow response selectable

"Slow" Response Characteristics: With a pulse of 1000 Hz sinusoidal signal applied for 0.5 seconds, the maximum reading is between 2 and 6 (typical 3.5) decibels less than steady state level. Maximum overshoot for all frequencies between 63 Hz and 8 kHz is 1.6 dB (typical 0.5) measured at 4 dB below full scale.

FREQUENCY RANGE

20 to 10,000 Hz

READOUT

1. Taut-band type meter with direct decibel readout.
2. Electrical output jack also available with approximately 1.2 volts rms at full scale behind 1K ohm. Electrical AC output jack can be shorted without causing a meter reading error greater than 0.1 dB. Connector required: Switchcraft type 780 Tiniplug or equivalent.

CREST FACTOR: 13 dB on all range positions

DETECTOR: Square Law type quasi-RMS

MICROPHONE

High quality PZT ceramic, omnidirectional, 1.125 inch diameter (equivalent impedance 510 pf).

OPERATING TEMPERATURE

-10° to +50°C, within 0.5 dB

STORAGE TEMPERATURE

-40° to +65°C (batteries removed)

HUMIDITY

0-95% RH operating, within 0.5 dB

MAGNETIC FIELD RESPONSE

The equivalent A-weighted responses to 1 oersted, 60 Hz and 400 Hz fields are negligible.

VIBRATION RESPONSE

When the sound level meter with attached microphone is placed on a surface having an acceleration of 0.1 g, the highest meter indications not influenced by background noise are 69.5 dBA at 250 Hz, and 90 dBA at 1000 Hz. No indication is obtained at 63 Hz. A similar test with the microphone replaced with an equivalent impedance yields no meter indication.

BATTERIES

Two NEDA 1601 standard type transistor batteries, Burgess 2U6, Eveready 216 or equivalent. Battery

life is approximately 80 hours. Battery life is affected by temperature and depends on battery use. Consult manufacturer's data for specific battery at 5 milliamp drain level. Temperatures at freezing or below greatly reduce effective battery life.

CONSTRUCTION

Solid state integrated circuitry in rugged aluminum housing

SIZE AND WEIGHT

Case: 2-1/2x6 x 1-1/2 inches (6.3 x 15.2x3.8 cm)

Overall: 2-3/4 x 7x2 inches (7.0 x 17.8 x 5.1 cm)

Model 211A: 16 oz. including batteries

Model 211FS: 17 oz. including batteries

OPERATION

CONTROLS

ON/OFF SWITCH -- With this switch in the BATTERY position the condition of the batteries is checked to insure correct operation of the instrument. If the batteries have sufficient capacity for accurate measurement, the meter pointer should deflect to the heavy green line on the scale marked BATTERY CHECK. If the meter deflection is below this area, the batteries must be replaced before making any measurements. With the switch in the ON position, the unit is ready for use. To avoid needless drain on the batteries, set the switch to OFF whenever the instrument is not in use.

RANGE SELECTOR -- A five position range switch permits selection of the correct range from 70 to 110 dB according to the existing noise level to be measured. Maximum readability and accuracy is obtained with the meter pointer deflected to the higher part (right side) of the meter scale. Where possible, therefore, select the range to produce a reading between 0 and +10 on the meter.

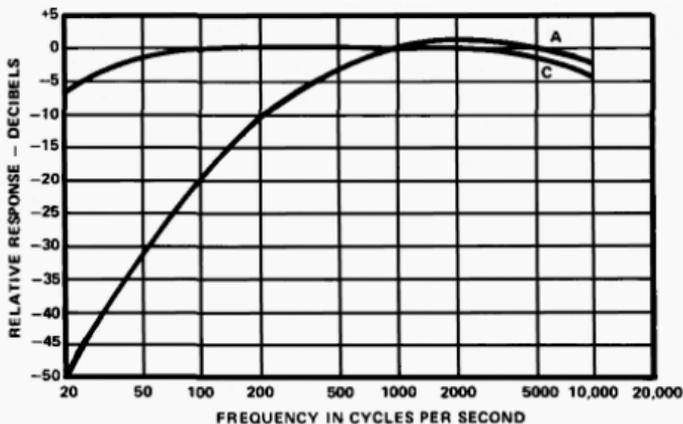
The scale readings are added to or subtracted from the dB range level selected. For example, if the range selector is set to 80 dB, and a meter reading of +8 is indicated, then the noise level measured is 88 dB. Similarly if the meter needle is at -5 for the same selector setting a noise level of 75 dB is indicated. In the latter case easier readability will result if the 70 dB selector level were used. In this case the needle will point to +5 dB again yielding the measurement of 75 dB.

AC OUTPUT-- An electrical output jack is provided for chart recording, tape recording and general analysis purposes. The output is AC and is weighted by "A" scale (or "C" scale on the 211FS meter). With a full scale reading on the meter the electrical output is approximately 1.2V rms. The meter output can be used directly with AC input chart recorders or, along with the Quest RA-100MV Recorder Adaptor, with DC Chart recorders with 100 millivolt inputs.

A-C SCALE WEIGHTING SELECTOR (211FS ONLY)

The 211A meter is internally set for "A" scale weighting whereas the 211FS meter is selectable for "A" or "C" scale weighting. "A" scale is used for

almost all noise measurement in that it measures approximately as the human ear responds. "C" scale is used for more scientific purposes since it has a relatively flat response curve.



**Frequency Response Characteristic
for A and C Scale Weighting**

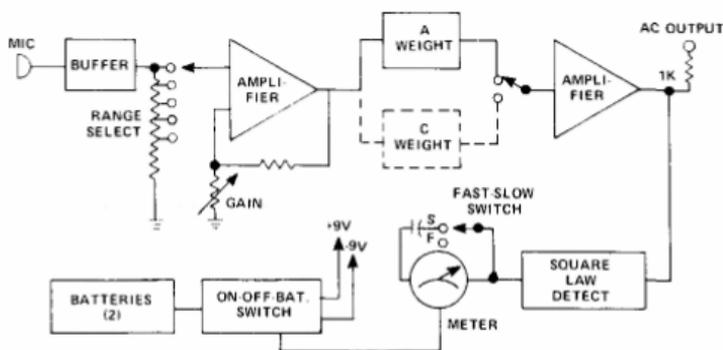
F-S (FAST-SLOW) RESPONSE SELECTOR (211FS ONLY)

The 211A meter is internally set for Slow response whereas the 211FS meter is selectable for Fast or Slow. When the selector switch is depressed at the "F" position, the meter movement is fast. This position is intended for moving vehicle measurements or impulsive sound where the noise is not present sufficiently long to obtain the maximum reading in the slow response mode. Keep in mind that for very short duration impulse noise even the fast response meter mode may not be fast enough to indicate the true peak noise level.

PRINCIPLES OF OPERATION

General

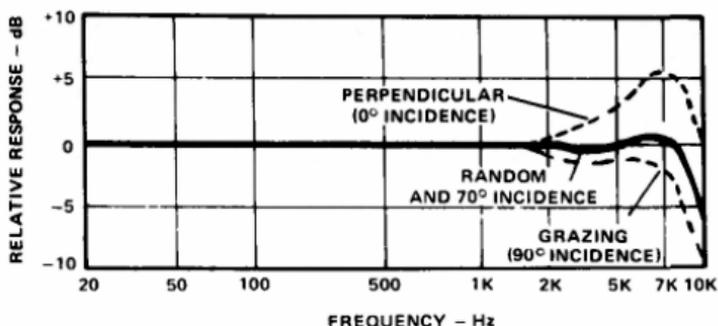
The 211A and 211FS Sound Level Meters use an omnidirectional ceramic microphone buffered by a high impedance FET input stage. The electronics utilize solid state integrated circuitry for maximum stability, reliability and low noise operation. A block diagram of both meters is shown below.



Block Diagram 211FS Sound Level Meter
(The 211A diagram is the same except "C" weighting
and Fast-Slow switch are deleted)

Microphone Characteristics

The microphone used in the 211A and 211FS Sound Level Meters is a Shure type 401 ceramic omnidirectional unit. Overall diameter is 1.125 inches (2.86 cm). Typical sensitivity is 59 dB below 1 volt per microbar measured at 400 Hz. A diagram of typical microphone response for perpendicular, grazing and random incidence as shown at top of page 9.



**Type 401 Microphone Response –
Perpendicular, Grazing and Random Incidence**

Internal Electrical Noise

The internal electrical noise levels of the 211A and 211FS Sound Level Meters are typically more than 60 dB below full scale, measured in octave bands, on all range settings when measured with "C" weighting. The noise levels are determined by subtracting the actual noise readings from the full scale reading of the meter on each range as measured in octave bands. Flat response broadband (all pass) noise level is typically 57 dB below full scale on the most sensitive range. Noise levels with "A" scale weighting are further reduced because of its attenuation characteristic.

OPERATING PROCEDURE

To obtain readings of maximum accuracy, hold the instrument away from the operator at an angle of approximately 70° from the horizontal. Under certain conditions slightly less accurate readings may result from pointing the microphone directly at the noise source.

The instrument is designed to be hand-held. If the unit is placed on any hard surface such as a table-top, check to see that no significant mechanical vibration exists which might yield false meter readings. The microphone will pick up vibration as if it were sound.

Measure noise levels as follows:

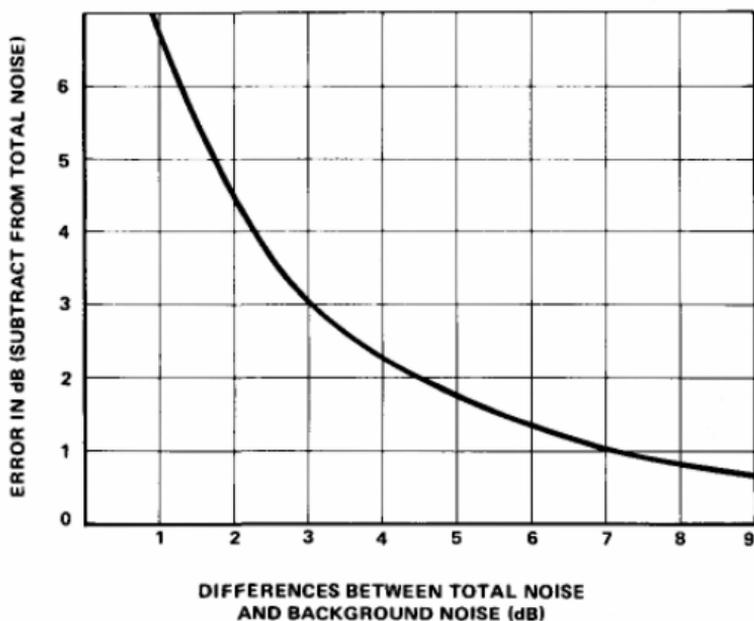
1. Select the range position that is higher than the expected noise environment.
2. Slide ON-OFF switch to BATTERY position. Meter pointer should be in green BATTERY CHECK area. Replace batteries if pointer is below proper level.
3. Slide switch to ON.
4. Change range selection as necessary to obtain meter readings at the upper end of the scale without exceeding the meter limit.
5. Read sound level results.
6. Slide switch to OFF when reading is completed.

EFFECTS OF OPERATOR PRESENCE

When the sound to be measured is directional, the sound level reading can be affected by the relative position of the meter and observer. The meter should not be held between the noise source and close to the observer because of sound reflections from the body. The meter should be held away from the body or mounted on a tripod with microphone pointed upward almost perpendicular to the noise source (70° from path), keeping your body out of the noise path.

EFFECTS OF BACKGROUND NOISE

If the sound level from a particular source is to be determined, all surrounding sources of noise should, as nearly as possible, be reduced or eliminated. When it is not possible to eliminate surrounding noise, the curve shown below may be used to correct for the presence of such noise.



Effect of Background Noise on Measurements

EXAMPLE OF OSHA NOISE EXPOSURE MEASUREMENT

Using a Sound Level Meter to determine OSHA compliance in a constant noise environment is a simple task. Merely read the sound level at each worker's station. Record the date, reading and worker-station. From Table 1 determine the permissible time of exposure for the measured noise level.

For a varying noise environment continuous measurements must be taken over the work day, and the following formula must be solved to determine worker exposure:

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \dots + \frac{C_n}{T_n} < 1 \text{ for total permissible exposure}$$

where C is the length of time at a particular measured noise level T is the time per day permitted at that noise level. The length of time permitted at various noise levels is shown in Table 1.

TABLE 1 OSHA PERMISSIBLE NOISE EXPOSURE

Length of Exposure - T (Hrs/Day)	Equivalent Maximum Noise Level (dBA)
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

In order to use a Quest or any other sound level meter in a varying noise environment, many noise measurements should be made at the worker's station — enough so that the readings are representative of the workers exposure. All noise levels must be read, and the duration at each level noted. As many as 30 or more readings may be necessary to account for all the noise variations. However, in the example we assume that only four basic noise levels are present, and that the duration of each is as follows:

Measurement Interval (C)	Average dBA Measurement
1 Hr.	92
1 Hr.	100
4 Hrs.	90
2 Hrs.	83

It is assumed that the noise levels remain relatively constant during the intervals between measurements. Some judgment may be required in making such an assumption.

Substituting these values in the formula gives the following result:

$$1 \text{ Hr @ } 92 \text{ dBA} = 1/6; 1 \text{ Hr @ } 100 \text{ dBA} = 1/2; 4 \text{ Hrs @ } 90 \text{ dBA} = 4/8; 2 \text{ Hrs @ } 83 \text{ dBA} = 0.$$

Summing all the exposure fractions yields

$$1/6 + 1/2 + 4/8 + 0 = 1.17$$

Since 1.0 is the maximum allowable value, the computation indicates that workers in this area were overexposed by 17%.

It is obvious that in a changing noise environment the above procedure can be very complex, time-consuming, and costly. For these conditions it is suggested that the Quest M-7 Noise Dosimeter be used rather than a sound level meter. The M-7 automatically accumulates all variations in noise. It produces a continuous readout of the percentage of permissible exposure. No operator or calculations are required.

BATTERY REPLACEMENT

Batteries should be replaced whenever a battery test gives a low indication on the meter. To replace batteries, remove the rear cover plate by unscrewing the retaining screws. The batteries are located directly below the microphone in the upper section of the unit. Carefully remove the used batteries and replace with two 9 volt transistor batteries, Burgess 2U6, or equivalent.

CAUTION

The batteries must be replaced with the ON/OFF switch in the OFF position to avoid damage to the unit.

CALIBRATION

GENERAL

The 211A and 211FS meters are factory calibrated and with proper care should retain their accuracy. It is recommended, however, that the meter be checked periodically with the CA-12 Calibrator, preferably in the same environment in which sound level measurements are to be made (OSHA specifies daily calibration if you use the results for record).

CALIBRATION PROCEDURE

1. First turn on both the sound level meter and CA-12 calibrator and check battery level indicators. Replace batteries if below green "good battery" level.

2. Slide the meter switch to ON and select the 100 dB range position.

3. Carefully insert the meter microphone into the calibrator coupler as shown. (While the 215 meter is shown in the photograph, the 211A and 211FS meters are inserted in the same manner). Be sure microphone is



inside coupler resting flush on the inner rim. The 110 decibel output of the calibrator should produce a full scale +10 reading on the meter. If the Model 211AR or 211FSR Sound Level Meters are used with a microphone extension cable, then calibration is performed with the microphone mounted on the extension cable. Note the correction in calibrator output due to altitude effects on page 21.

4. If reading is off slightly insert a tiny screwdriver in the small hole on the bottom of the meter and slowly adjust the slotted pot until the meter reads correctly.

5. Change the selector switch to the 110 dB position on the meter and note the needle should drop to the zero position on the meter dial.

6. Meter is now calibrated and ready for use.

NOTES

Calibrator sound levels are affected by elevation above sea level. The actual sound output of the calibrator is 0.1 dB less than the 110 dB rating for each 2000 feet of elevation above sea level. For example, at 6000 feet elevation the calibrator produces only 109.7 dB. The meter should then be set at 109.7 dB.

The small adaptor ring furnished with the CA-12 or 211-12 Kit is used only for checking other sound level meters with 1" microphones. This adaptor is not used with the 211A or 211FS.

If another calibrator is used with a frequency other than 1000 Hz, the equivalent "A" scale sound level must be known to set the 211A or 211FS meter properly.

ACCESSORIES

MODEL CA-12 SOUND LEVEL CALIBRATOR

DESCRIPTION

The Quest CA-12 Sound Level Calibrator is a self-contained unit that quickly and precisely verifies the accuracy of microphones and sound measuring instruments. The Calibrator generates a reference sound level at precisely 110 dB and 1000 Hz.

The unit is battery operated and therefore fully portable. The CA-12 is primarily a field instrument

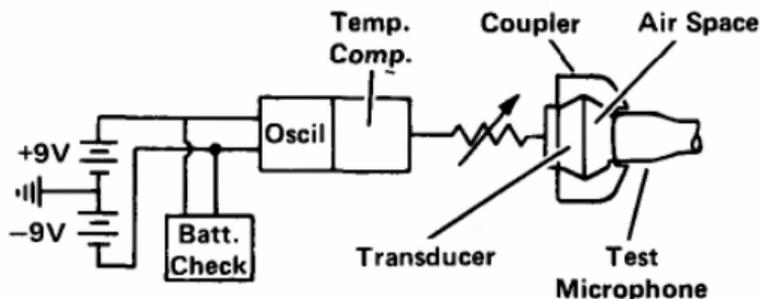
for on-the-spot accuracy checks of sound level meters, noise dosimeters and other microphone instruments.

The CA-12 consists of a stable 1000 Hz oscillator, amplifier stage, magnetic acoustic transducer, and a coupler that accepts the standard 1-1/8 inch diameter microphone. A separate adaptor is also provided to accommodate a 15/16 (one inch) diameter microphone. Other adaptors to accommodate smaller microphones can also be used.



CA-12 Calibrator

The Calibrator employs solid state integrated circuitry that provides accurate and stable performance. The block diagram shows the basic operating sections of the unit. Regulation against battery drain is inherently provided in the electronics.



CA-12 Calibrator Block Diagram

SPECIFICATIONS

Acoustic Output

Frequency: 1000 Hz \pm 3%

Sound Pressure Level: 110 dB reference 20 μ N/m²

Accuracy: \pm 0.5 dB (23°C, 760 mm Hg) Temperature

Range: 0 to +50°C operating, -40 to +65°C storage (with batteries removed)

Temperature Coefficient: 0 to 0.01 dB/°C

Altitude Effects: Approximately 0.1 dB decrease for each 2000 feet increase in altitude from sea level to 12,000 feet elevation, or comparable atmospheric pressure change (approximately every 50 mm of Hg decrease).

General

Power Source: Two 9V transistor batteries NEDA 1604, Burgess 2U6 or equivalent. Battery life approximately 100 hours

Construction: Rugged aluminum housing

Case Size: 4 inches by 2-3/8 inches diameter

Weight: 13 oz. including batteries

OPERATION

The CA-12 Calibrator is designed to check the accuracy of many types of sound instruments, not only Quest manufactured equipment. Quest instruments commonly use the standard 1-1/8-inch diameter ceramic microphone which fits directly into the calibrator coupler cavity. For other microphones with smaller diameters, an adaptor must be used. The next most common size microphone is the 1-inch (actually 15/16 inch). When testing an instrument with a 1-inch microphone, the adaptor ring (furnished) must first be inserted in the coupler. This keeps a close tolerance fit around the microphone head. Be sure the microphone fits down inside the adaptor and rests on the lower rim. This rim supports the microphone and forms the necessary inner seal.

OPERATING PROCEDURE

1. Set Calibrator ON-OFF switch to ON. A 1000 Hz tone should be heard. Turn on the sound level meter which is to be calibrated.
2. Check battery indicating meter of the calibrator to be sure needle enters into the green "good battery" area. If needle stays in red area, replace batteries. Likewise, check the condition of the sound level meter batteries.

3. (Skip this step if the microphone to be measured is 1-1/8 inch diameter.) Insert the proper sized microphone adaptor, inner rim down, into the calibrator coupler cavity.

4. Carefully insert the microphone into the calibrator coupler. Be sure microphone is down inside the coupler resting flush on the lower coupler rim. If the Model 211AR or 211FSR sound level meters are used with a microphone extension cable, then calibration is performed with the microphone mounted on the extension cable.

CAUTION

Rapid insertion or withdrawal of the microphone may damage the microphone or the transducer in the coupler because of the rapid change in pressure on the diaphragms.

5. Proceed to verify the instrument accuracy by comparing the 110 dB output level of the calibrator to the sound level meter reading. Note the correction in calibrator output due to altitude effects given at top of next page. Adjust the sound level meter sensitivity as necessary.

6. When calibration has been made, carefully remove the microphone and turn calibrator to OFF.

BATTERY REPLACEMENT

To replace batteries, remove two screws from face plate on bottom of calibrator. Slide off face plate and outer shell to expose batteries.

ALTITUDE EFFECTS

Most calibrators including the CA-12 are affected by altitude. The transducer diaphragm within the calibrator creates the sound as it vibrates against the air. When the air is thinner (at higher elevations) a lower sound level is produced.

The CA-12 is calibrated to produce 110 dB at sea level. When the unit is operated above sea level a slightly lower sound level is emitted depending on altitude. For each 2000 feet of elevation above sea level the CA-12 produces 0.1 dB less than the 110 dB rating. As an example, the calibrator will only emit 109.7 dB at an elevation of 6,000 feet. Therefore, a sound level meter should be set at 109.7 dB, not at the rated 110 dB.

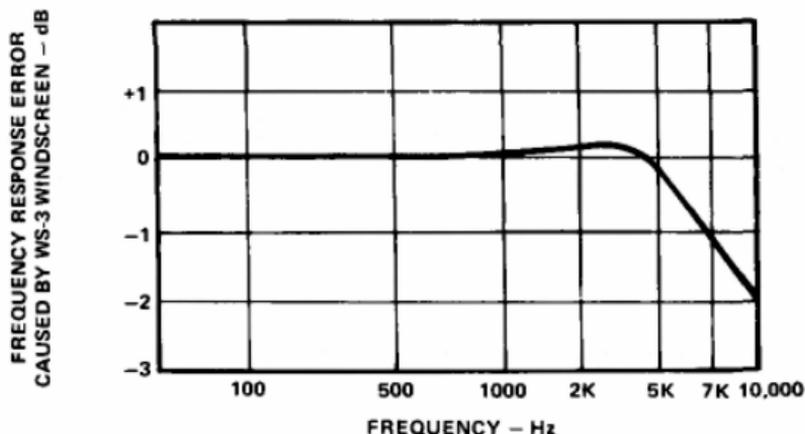
CA-12 CALIBRATION

The CA-12 Calibrator was precisely calibrated in the Quest laboratory with special acoustical instrumentation traceable to the U.S. Bureau of Standards. The CA-12 is very stable, but since it is used to calibrate other equipment, it should be periodically checked with laboratory standards. It is recommended that the Calibrator be returned to the factory at least once each year for recalibration, or whenever there is a question about its accuracy.

MODEL WS-3 WINDSCREEN

The WS-3 microphone windscreen is made of reticulated polyurethane foam for the reduction of ambient wind noise effects in outdoor environments. The screen also protects the microphone under dusty, oily or humid conditions.

The screen is simply pushed onto the microphone when needed. Acoustic attenuation effect of the windscreen on the meter reading is shown in the following figure.



**WS-3 Windscreen Acoustic Effects
On Model 211A and 211FS SLM**



**Model WS-3 Windscreen
Installed on Model 211FS
Sound Level Meter**

MODEL RA-100MV RECORDER ADAPTOR FOR DC INPUT CHART RECORDERS

The model RA-100MV Recorder Adaptor converts the AC output electrical signal from the Quest 211 A, 211FS or 215 Sound Level Meters to a DC signal for chart recording purposes. With this adaptor module the sound level meters can be used with 100 millivolt high impedance input DC recorders for such purposes as short or long term industrial noise monitoring, scientific analysis or vehicle noise level monitoring.



Model RA-100MV Recorder Adaptor

RA-100MV SPECIFICATIONS

Input voltage: 0-1.8v RMS AC from Quest 211 A, 211FS, or 215 Sound Level Meters

Output voltage: 100 millivolts DC, adjustable

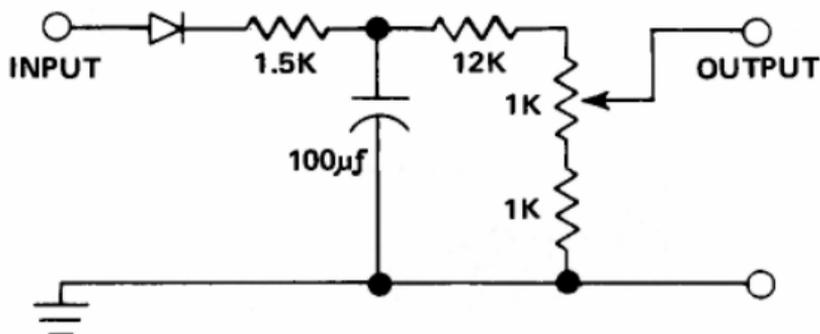
Response: Slow

Range: Approximately 25 dB

Tracking linearity: near log; tracks same as Sound Level Meter scale

Power source: None, passive module

Size: 2 x 1-1/8 dia. inches



Model RA-100MV Schematic Diagram

USING THE RA-100MV ADAPTOR

Insert RA-100MV adaptor directly into the AC output jack of the Quest 211A, 211FS or 215 Sound Level Meter. A separate output plug and cable is furnished, but a longer cable may be installed by user if desired. Use twisted pair cable. For long runs in excess of 10 feet use shielded cable. Attach cable to the DC recorder input. Switch units on and calibrate the system using a known noise source or an acoustic calibrator

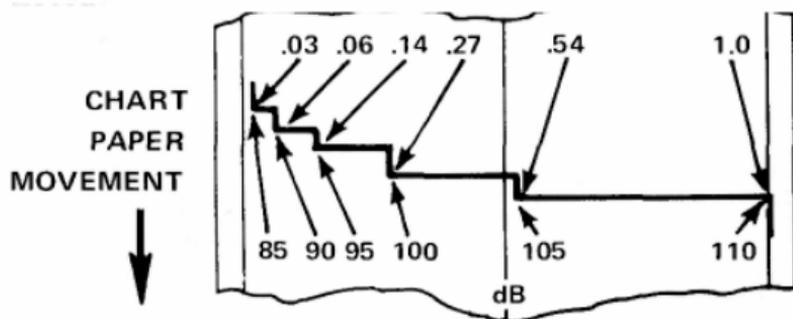
such as the Quest CA-12 or, preferably the CA-10 or CA-11. The CA-10 and CA-11 have 8 selectable sound levels from 85 to 115 dB, and a calibration trace can thus be obtained at 5 dB increments across the entire chart.



**211FS Meter Connected to DC Recorder
Through RA-100MV Adaptor**

Assuming you are using a CA-10 Calibrator insert the microphone of the Sound Level Meter into the calibrator. Set the range switch on the meter to 100 dBA and set the CA-10 to 110 dB position. Chart recorder should deflect to full scale reading. If it does not, adjust RA-100MV recorder adaptor with small screwdriver to obtain exactly full scale deflection on the chart. Next switch the CA-10 to 105 dB. The trace should move down to almost 1/2 scale (.54). Wait a few seconds to record and then switch CA-10 to 100 dB.

Repeat for the 95, 90, and 85 dB positions. The resulting calibration trace should look approximately as follows with tracing displacement as noted:



This calibration trace is from a sound level meter with full scale deflection on the 100 dB range position.

YOU CAN NOW SET ANY RANGE POSITION DESIRED ON THE SOUND LEVEL METER NOTING THAT FULL SCALE DEFLECTION ON THE CHART WILL BE WHATEVER FULL SCALE DEFLECTION IS ON THE METER.

If you are calibrating with the CA-12 Field Calibrator simply use the 100 dB range position on the sound level meter. This will produce full scale reading on the meter, and should also produce full scale deflection on the chart recorder. Adjust RA-100MV if necessary. When the chart recorder reads full scale your calibration trace is now as shown in the diagram above.

If you are using the Quest 211A Sound Level Meter, you will be recording dBA slow. If you are using the 211FS or 215

meters you will be recording dBA, dBC slow, or whatever weighting is selected.

Recommended 100 millivolt Chart Recorders for use with the RA-100MV adaptor are as follows:

Rustrac series 400, Gulton Industries
Esterline-Angus series 601 or "Miniservo" MS401
MFE Corp series M-12
and many others

Suggested chart speed for most applications is approximately 1/2 inch per minute.

Service Policy

The Quest product you have purchased is one of the finest acoustic instruments available. It is backed by our full one year warranty which seeks complete customer satisfaction. This is your assurance that you can expect prompt courteous service for your equipment from the entire Quest service organization.

Should your Quest equipment need to be returned for repair or recalibration, please contact the Service Department at (800)245-0779 (USA) or Fax (262)567-4047 for a Return Authorization Number. The RA number is valid for 30 days, and must be shown on the shipping label and purchase order/cover letter. If you are unable to return instruments in that time call for a new RA number. Send it prepaid and properly packed in the original shipping carton directly to Quest Technologies, 1060 Corporate Center Drive, Oconomowoc, WI 53066 U.S.A.

Repair or replacement work done under warranty will be performed free of charge, and the instrument will be returned to you prepaid. Your copy or a photocopy of the Quest Registration Card will serve as proof of warranty should the factory require this information.

If for any reason you should find it necessary to contact the factory regarding service or shipping damage, please direct your calls or letters to the attention of the Service Manager, Quest Technologies, (262) 567-9157 or (800) 245-0779. Office hours are from 7 AM to 6 PM (Central Standard Time) Monday through Friday.

For service or recalibration outside the U.S.A., please contact your local Quest Dealer or fax Quest U.S.A. at 1-262-567-4047.