

Sound Level Meter

(Order Code SLM-BTA)



The Sound Level Meter measures sound level in decibels. It can be used for activities such as

- environmental noise studies
- sound level comparisons
- investigating room acoustics
- sound isolation modeling
- sound propagation modeling

Inventory of Items Included with the Sound Level Meter

Check to be sure that each of these items is included in your Sound Level Meter package:

- Sound Level Meter
- Wind screen (black foam cover for the sensing element)
- 4 AAA batteries (preinstalled in the meter)
- Cable to connect the sensor to a data-collection interface (order code CB-SLM)

NOTE: Vernier products are designed for educational use. Our products are not designed nor recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

Sound Level Meter Description

The sensing microphone on the Sound Level Meter is located at the end of the silver barrel at the top of the meter. Below the LCD, you will find three switches labeled S/F, MAX/RESET, A/C. Below these switches you will find the power/measurement range switch. Further description of these switches follows. The battery compartment is located on the back of the Sound Level Meter. A signal output terminal is located on the bottom of the meter. The output of this terminal is sent to data collection interface.

The LCD panel displays noise levels in dB. A low battery level indicator and an upper/lower range indicator are also displayed.

The sensor comes with a foam windscreen. The windscreen helps reduce the detection of false high signals caused by wind blowing across the microphone. It also protects the microphone from dust and debris.

Panel Switches



Power/Measurement Range Switch—This slide switch, labeled “O/35–90/75–130,” turns the sensor on and sets the measurement range. When set to the 35–90 range (LO), the sensor is designed to measure sound levels in the range of 35 to 90 dB. When the switch is set to the 75–130 range (HI), the sensor is designed to measure sound levels in the range of 75 to 130 dB. A range warning will appear if the measured sound is beyond the range of the current setting. If this warning appears continuously, set the switch to the appropriate range.

Time Weighting—The S/F switch just below the LCD sets the time weighting. For normal measurements set the switch to the slow setting “S.” For fluctuating noise, set the weighting to fast “F.” In the classroom, you will probably set it to “S.”

Maximum Level Hold—Setting the MAX/RESET button to MAX sets the sensor meter to show the maximum, weighted sound level. In the classroom you will probably set it to RESET, in which case the display will continually display the sampled reading. Setting this switch to MAX does not affect the output signal sent to the data-collection interface.

Frequency Weighting—The A/C switch is used to set the weighting scale. “A” weighted setting is the sound level value that most closely matches that of the human hearing range. It is the weighting scale most commonly used for Occupational Safety and Health Administration (OSHA) and Department of Environmental Quality (DEQ) regulatory measurements. The “C” weighted scale is useful for monitoring sources such as engines, explosions and machinery. This setting would also be used if you wish to use the Sound Level Meter to get the total unweighted sound level of the noise source.

Operating the Sound Level Meter

Here are the general operating procedures:

1. Slide the power switch to the appropriate range.
2. Set the time weighting switch to “S.”
3. Set the maximum level hold switch to “RESET.”
4. Set the frequency weighting to “A.”

The Sound Level Meter functions as a standalone device, and you can monitor sound levels¹ by reading the LCD panel. If you want to collect sound level data, you need to connect the Sound Level Meter to a data-collection interface.

Connecting the Sound Level Meter to Vernier Products

The Sound Level Meter package includes a removable cable (order code CB-SLM). Connect the mini-plug end of the cable into the bottom of the sensor. Connect the other end to the data-collection interface, e.g., Vernier LabQuest[®] 2, Go![®]Link, CBL 2[™], or EasyLink[®].

Collecting Data with the Sound Level Meter

This sensor can be used with the following interfaces to collect data.

- Vernier LabQuest 2 or original LabQuest[®] a standalone device or with a computer
- Vernier LabQuest[®] Mini with a computer
- Vernier LabPro[®] with a computer or TI graphing calculator
- Vernier Go! Link
- Vernier EasyLink
- Vernier SensorDAQ[®]
- CBL 2
- TI-Nspire[™] Lab Cradle

Here is the general procedure to follow when using the Sound Level Meter:

1. Connect the Sound Level Meter to the interface.
2. Start the data-collection software.
3. The software will identify the Sound Level Meter and load a default data-collection setup. You are now ready to collect data.

Data-Collection Software

This sensor can be used with an interface and the following data-collection software.

- **Logger Pro 3** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go!Link.
- **Logger Lite** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go!Link.

- **LabQuest App** This program is used when LabQuest 2 or LabQuest is used as a standalone device.
- **EasyData App** This calculator application for the TI-83 Plus and TI-84 Plus can be used with CBL 2[™], LabPro, and Vernier EasyLink. We recommend version 2.0 or newer, which can be downloaded from the Vernier web site, www.vernier.com/easy/easydata.html, and then transferred to the calculator. See the Vernier web site, www.vernier.com/calc/software/index.html for more information on the App and Program Transfer Guidebook.
- **DataMate program** Use DataMate with LabPro or CBL 2[™] and TI-73, TI-83, TI-84, TI-86, TI-89, and Voyage 200 calculators. See the LabPro and CBL 2[™] Guidebooks for instructions on transferring DataMate to the calculator.
- **DataQuest[™] Software for TI-Nspire[™]** This calculator application for the TI-Nspire can be used with the EasyLink or TI-Nspire Lab Cradle.
- **LabVIEW** National Instruments LabVIEW[™] software is a graphical programming language sold by National Instruments. It is used with SensorDAQ and can be used with a number of other Vernier interfaces. See www.vernier.com/labview for more information.

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Specifications

Sensor:	½" electret (prepolarized) condenser microphone
Power:	four AAA batteries
Battery life:	50 hours typical
Display:	3½" LCD
Measurement range:	Low: 35 dB to 90 dB High: 75 dB to 130 dB
Frequency range:	31.5 Hz to 8000 Hz
Resolution:	0.1 dB
Accuracy:	1.5 dB (ref 94 dB @ 1 kHz)
Output:	DC: 10 mV/dB AC: 1.0 Vrms corresponding to the top of the selected range
Stored calibrations	
slope:	100 dB/V
intercept:	0 dB/V

¹ A table of common sources of noise appears in the Additional References section of this manual.

How the Sound Level Meter Works

The Sound Level Meter uses an electric condenser microphone mounted on the end of a shaft. The output of this microphone is fed into a series of filters, amplifiers, integrators, and adder circuits to produce a single sound pressure level measurement. The Sound Level Meter uses a directional microphone, which requires the instrument be pointed in the direction of the noise source unless ambient noise levels are being monitored.

Acoustical engineers organize the audio spectrum into sound octave bands.³ The weighting switch on your Sound Level Meter is used to add or subtract different values to the octave band components. The “A” weighted sound level discriminates against low frequencies, in a manner similar to the response of the ear. In this setting the meter primarily measures in the 500 to 10,000 Hz range. It is the weighting scale most commonly used for OSHA and DEQ regulatory measurements. The “C” weighted sound level does not discriminate against low frequencies and measures uniformly over the frequency range of 30 to 10,000 Hz. This weighting scale is useful for monitoring sources such as engines, explosions and machinery. The sound levels measured with these two weightings have units of “dBA” and “dBC”, respectively.

Calibration Information

You should not need to calibrate the Sound Level Meter for classroom use. Calibration is possible, but it will require access to a special calibrator, not commonly available in the classroom.

This sensor is equipped with circuitry that supports auto-ID. When used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, Go! Link, SensorDAQ, TI-Nspire™ Lab Cradle, EasyLink, or CBL 2™, the data-collection software identifies the sensor and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor.

Suggested Experiments

Sound Level Studies

You can collect sound level data in many real-world situations; for example, you can

- collect sound levels before, during and after a concert or dance.
- collect sound levels throughout the day in a school hallway or shopping mall.
- use the Sound Level Meter to judge cheering contests at pep rallies.
- collect data outside and inside a car equipped with a stereo system.
- make a model of an ear and ear canal. Measure sound levels at the “ear drum” when a headset is placed over the ear. Repeat the experiment but place an earplug between the headset and the meter.
- Set up the Sound Level Meter to collect readings in a variety of situations. Use the following chart to determine the acceptable duration for exposure to the sound level you measure.

³ A table of the frequency bands for each octave band appears in the Additional References section of this manual.

The following chart⁴ shows the sound level exposure rates set by the OSHA Occupational Noise Exposure Standard. In a work environment, for example, it is acceptable to be exposed to 90 dB for eight hours as measured on the “A” weighted scale. If the sound level is 100 dB, the acceptable duration is two hours.

Duration per day (hrs)	Sound level, slow-response (dBA)
8.0	90
6.0	92
4.0	95
2.0	100
1.0	105
0.5	110
0.25	115

Environmental Measurements

Environmental measurements can be made anywhere people spend significant amounts of time, such as their residence. The DEQ noise standard uses statistical sound level values that are applied to residential measurements. One of these measurements is the equivalent hourly sound level, L_{eq} . You can collect sound level data with the Sound Level Meter set on “A” weighting and slow response. If you collect data for an hour and determine the average, you will have an estimate of L_{eq} . These values can then be compared to the local DEQ standards.

Room Acoustics

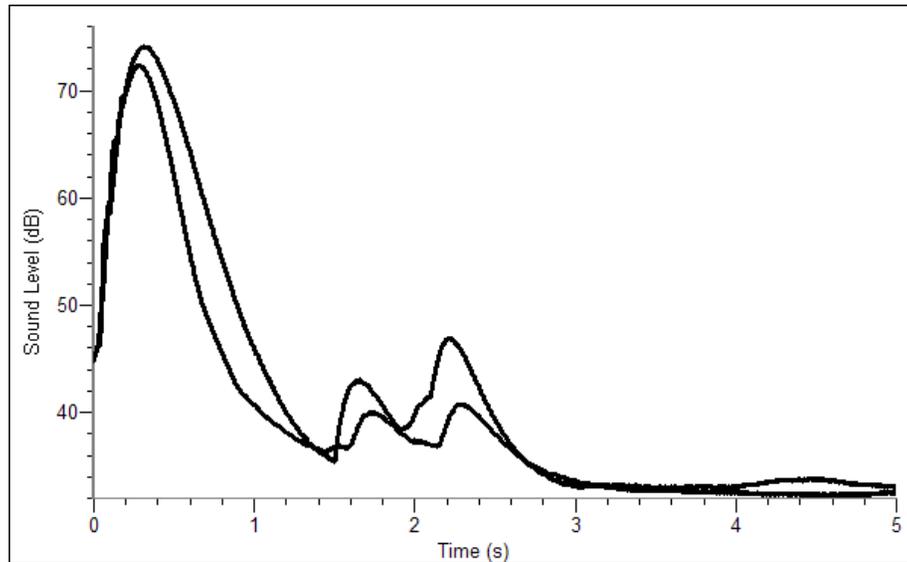
One goal of acoustic engineers is to “tune” a room for a specific purpose. A room tuned for lecture will be tuned differently than a library. The Sound Level Meter can be used to investigate acoustics in a room. One of the indicators of good room acoustics is the length of time sound stays in the room. Hard surface in a room allow sound to “reverberate” for relatively long periods of time. Soft surfaces dampen the reverberation. For example, if you clap your hands in an empty gymnasium, you will hear a relatively long echo. Repeat the experiment in a library, music room, or concert hall, and you will hear a shorter echo. Use the Sound Level Meter and a computer or calculator to try this experiment:

1. Set the equipment up to collect data for 5 seconds.
2. Use the triggering feature of the software so the data collection is initiated with a loud sound.
3. Collect a set of data and examine the graph.

⁴ Paragraphs 29 CFR 1910.95, Table G-16 of the OSHA Occupational Noise Exposure Standard.

- Determine how long it takes the sound level to fall by a specific dB level from the peak level.
- Repeat the experiment in a different room.

In this example, room acoustics were investigated in a sound booth and in a large room with hard, flat surfaces. Two boards were struck together to produce a loud sound. The sound level in the sound booth dropped 20 dB in 0.35 s. In the room with bare walls, it took 0.51 s for the sound level to drop 20 dB.



Dampening of Sound in Two Rooms

The Color of Noise

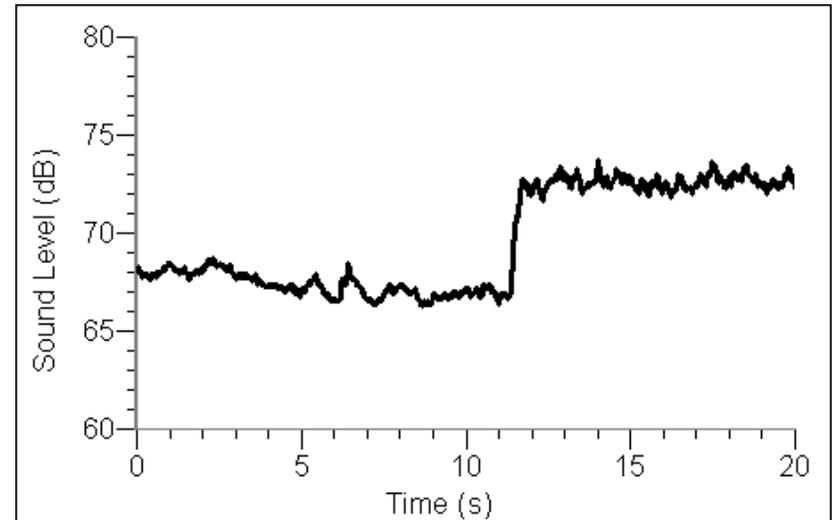
You have probably heard the terms pink noise and white noise. You probably cringe when you hear fingernails being drawn across a chalkboard but think nothing of lawn mower noise. These sounds may all have the same sound level, but the frequency content is vastly different.

White noise is a sound that has a uniform spectral level over the range of human hearing. This means that every frequency between 20 Hz and 20,000 Hz has an equal energy level. White noise sounds like it is rich in high frequencies, but this is not the case. This perception occurs because each successive octave is twice as wide as the one preceding it. For example, the 500 Hz octave band has width of 354 Hz. The next octave, the 1000 octave band, has a width of 707 Hz. The net result is that there is more energy in the high frequency components. The sound of water and wind resemble white noise.

Pink noise is a variant of white noise. Pink noise is white noise that has been filtered so that each octave has equal energy. This is done to compensate for the increase in the number of frequencies per octave.

You can demonstrate the difference between pink and white noise using the Sound Level Meter. Set the Sound Level Meter to measure “C” weighted sounds. Pick

several sounds that have the same “C” weighted sound level. Now measure these same sounds with the “A” weighting. Compare the difference between the two weightings for each sound.



Static with an AM radio using “A” Weighting and “C” Weighting

Sound Isolation

Sound isolation is important in everyone’s life. People living near a freeway or an airport hear that difference when they go inside and close the door. Acoustical engineers work with architectural engineers to select materials that attenuate sound. For example, a wall constructed with gypsum board on a wooden frame will attenuate sound differently than a cinder block wall with the same area. A window with a single pane of glass will attenuate sound differently than a window with two panes of glass separated by an air space.

You can test this by doing the following experiment. Place a radio in a room that has an outside wall and a window. Tune the radio to an unused AM frequency so that you hear only static. Turn the volume up so that you can just hear the sound through the wall. Measure the sound level at the wall. Next measure the sound level at the window, and then measure the sound level within the room. How much did the sound level change? Did you notice a difference in frequency content?

Additional References

Web Sites

Here are some web sites that provide additional information on sound level measurement:

www.tir.com/~ms/	This site provides a brief introduction to acoustics.
www.nonoise.org/library/whonoise/whonoise.htm	This site expands on the topics presented above.

Example Sound Levels

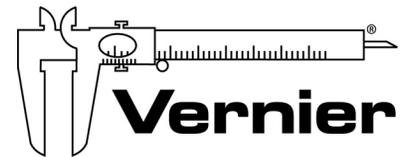
Source	Sound Pressure Level (dBA)
Large Rocket (nearby)	180 to 194
Jet Aircraft	150
Shotgun Blast	145
Propeller Aircraft	140
Pneumatic Riveter, Threshold of Pain	130
Rock Concert, Thunder	120
Construction Noise	110
Subway Train	100
Heavy Truck	90
Noisy Restaurant	80
Busy Traffic, Normal Radio	70
Normal Conversation, Dishwasher	60
Quiet Office	50
Library	40
Soft Whisper	30
Rustling Leaves	20
Normal Breathing	10
Threshold of Hearing	0

Standard Octave Band Frequencies Ranges with Corresponding A and C Weighting Values

Center Frequency (Hz)	Effective Band (Hz)	A Weighting (dB)	C Weighting (dB)
31.5	22.1–44.2	–39.4	–3.0
63	44.2–88.4	–26.2	–0.8
125	88.4–177	–16.1	–0.2
250	177–354	–8.6	0
500	354–707	–3.2	0
1000	707–1,414	0	0
2000	1,414–2,828	1.2	–0.2
4000	2,828–5,657	1.0	–0.8
8000	5,657–11,314	–1.1	–3.0

Warranty

This product is manufactured by OMEGA Engineering. OMEGA warrants it to be free from defects in materials and workmanship for a period of 13 months from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use.



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