

1988 Precision Integrating Sound-Level Meter and Analyzer

- Automatically performs all integration for cumulative sound-level measurements like L_{eq} and SEL
- Ideal for measuring industrial, product, and community noise
- Lightweight (3 lb) and compact for easy handling
- Flexible power supplies for versatility
- Type 1 precision for all measurements
- 5 dB exchange rate available for OSHA
- Makes all measurements of integrating functions in addition to conventional sound-level measurements: peak and impulse readings, octave bands, and A, B, C, and flat weighting networks
- Connectable to a printer for hard-copy results

Whenever the sound-level varies with location or time: that's when an integrating sound-level meter is especially useful. The 1988 Precision Integrating Sound-Level Meter and Analyzer offers a combination of power, flexibility, and ease-of-use that is unmatched by any other integrating meter.

Basically, an integrating sound-level meter enables you to "capture" and "add up" the contributions of noise sources by averaging their levels over an extended period of time. Conventional sound-level meters, in principle, perform similar averaging, but the 1988 does so far more automatically and precisely.

The primary integrating parameters computed by the 1988 are the L_{eq} (equivalent continuous level, or average level) and the SEL (the sound exposure level). The 1988 also provides conventional sound-level readings. It incorporates 10 octave band filters, with center frequencies from 31.5 Hz to 16.0 kHz. It contains A, B, and C weighting networks, as well as a flat (no weighting) network, over a 5-Hz to 20-kHz range. Four detector-integrator characteristics provide a selection of fast, slow, peak, or impulse response in the continuous mode. In the integrating mode, fast response is normally used, but slow or impulse may be selected if desired. The 1988 provides direct readings for levels ranging from 30 to 140 dB (150-dB peak). Levels as low as 10 dB can be measured with an optional 1" microphone.

Used in virtually any application Many measurements made with conventional sound-level meters involve numerous, painstaking steps: repeated readings must be made at pre-specified intervals and locations; results must be manually recorded; antilogs computed and added; logarithms determined; and final results established. The 1988 performs such tasks automatically and precisely. Since it can integrate over a period of up to 24 hours, the 1988 can make its readings unattended. And results can be retained for later reference by connecting the 1988 to a hard-copy printer.

These 1988 features can play an important role in a broad range of measurement applications:

Product Noise Measurements 1) Measures average dBA level of equipment (such as portable air compressors or truck-mounted solid waste compactors) as required by EPA regulations.



- 2) Measures L_{eq} of cyclical noise sources (such as machinery or home appliances) to develop a single number rating which describes the noise emission.
- 3) Measures octave-band levels to determine radiated noise spectrum.
- 4) Measures vibration levels with GenRad 1933-9610 Vibration Integrator System.
- 5) Measures time-weighted average levels of machine tools as required by NMTBA guidelines.
- 6) Measures sound exposure level (SEL) to determine energy content of short duration sounds.

Community Noise 1) Measures maximum Vehicle-Passby-Level. Background can be continuously measured on analog meter.

- 2) Measures 1-hour L_{eq} for heaviest traffic period of the day, as required by some regulations.
- 3) Measures L_{eq} for 1 hour, 8 hours, or 24 hours, to establish existing levels before new plant is constructed.
- 4) Measures dBA, L_{eq} , or octave bands to meet noise codes at plant/community boundary lines.

Industrial Noise 1) Measures dBA and peak levels to determine OSHA compliance.

- 2) Measures octave-band levels to help plan noise reduction actions, evaluate hearing protectors, and select audiometric booth sites.
- 3) Measures L_{eq} (with Fast, Slow, or Impulse Detector response) and peak levels to evaluate industrial noise exposure and determine potential hearing damage.

Ease-of-Use Ease-of-use has not been sacrificed to provide the power and precision of the 1988. In fact, most tasks involve simple, pushbutton operations. Integration periods can be pre-set to run anywhere from 1 second to 24 hours. Consequently, in many cases the 1988 can be left unattended. (An optional weatherproof enclosure eliminates any need for worrying about leaving the 1988 out in inclement weather.)

A simple switch automatically locks the 1988 into operation in either the continuous (i.e., conventional) or integrating mode. In the continuous mode, operation is virtually the same as with any conventional sound-level meter. To integrate, you need only pre-enter the integration period. During operation, the results can be viewed on the digital LED display in a number of forms: L_{eq} , SEL, maximum sound level, or continuous sound level. Integration time limits as well as time remaining can also be displayed. Continuous readings are also presented on the 1988's analog meter.

Precision Sound-Level Measurement The 1988's conformance to ANSI Type 1 and IEC Sound-Level Meter Standard 651, Type 1, is your assurance of the most accurate performance offered in a sound-level meter. To make a measurement you simply switch to the weighting and meter response (fast or slow) you desire, switch on the meter, and set the attenuator to the range that gives you an on-scale reading. Then you read the measured levels from either the digital display or analog meter.

Octave-band analysis The octave-band filters in the 1988 are the most accurate offered in a portable instrument. This assures a high degree of confidence in your octave-band measurements. In addition, the 1988 eliminates the often confusing two-attenuator system used in other instruments. The 1988 features a single attenuator which allows you to set the range desired, switch on the instrument, and read the measured level from either display. Should the range level be set too low, an overload light on the meter face alerts you to change to a higher level, thus avoiding incorrect readings.

Peak and impulse measurement The 1988's peak detector is the fastest available for measuring impact- or impulse-type noise. With a 50-microsecond rise time, the detector ensures reading the true peak of the signal, up to 140 dB. An accessory 10-dB microphone attenuator extends this range to 150 dB. An impulse detector which meets IEC 651 is also built-in.

A significant feature of the 1988 allows you to capture and hold the peak or rms reading on the digital display without inhibiting successive readings on the analog meter. This lets you take ambient level readings immediately after the impact occurs without losing the peak reading. Also, in this mode it is not necessary to wait for the peak detector to decay before reading a lower peak. A press of the capture button resets the long decay time of the peak detector allowing you to read a lower peak immediately following the previous



measurement. This is especially useful when making measurements of forging hammers, metal stamping, and similar operations.

Easy, accurate reading The digital display allows quick, accurate, error-free reading with a resolution of 0.1 dB. Set the display mode to continuous and the digital display tracks the analog meter. Other operating modes allow you to "capture and hold" a reading on the digital display and to display the integration time limits and time remaining. You can automatically capture and hold the highest level measured during a measurement period or push a button to capture the level at a specific moment during the period. In any of these modes, the analog meter continues to track the ambient level. You will find the analog meter easy to read, too. It is calibrated linearly in 1-dB increments and the dB levels are clearly visible on the meter face.

Flexible power supplies The instrument's power system adds to its flexibility, too. As supplied, the 1988 operates from a 100-125 volt or 200-250 volt, 50-60 Hz power line. It can also draw power from its internal battery pack, which permits at least two hours of continuous operation. For battery operation up to 24 hours, an extended life battery and charger is available. The accessory auto-power cable can also be used to operate the 1988 from a standard 12-volt automobile battery.

Accessories available The 1988 and a calibrator will satisfy most measurement requirements. For those contemplating noise measurements where a remote microphone location is required, a calibrator, carrying case, tripod, and extension cable should be ordered to provide a complete system.

Specifications

Integration Characteristics: The 1988 measures and displays sound-pressure level (SPL or L_{eq}) or sound-exposure level (SEL) integrated over selectable times ranging from 1 sec to 24 hr. Integration can be timed manually or automatically. Two time ranges are available: 1 sec to 600 sec in 1-sec steps and 10 min to 24 hr in 1-min steps. A PAUSE feature permits exclusion of events not wanted in the integrated result. Short-time standard FAST and SLOW sound levels over range of more than 70 dB are included in integrated result. Long-time integrated sound-pressure levels (L_{eq}) ranging from 25 to 150 dB and sound-exposure levels (SEL) ranging from 25 to 190 dB are displayed. The maximum detected level (Fast, Slow or Impulse) during integration period can be displayed at any time.

Standards: Meets the following (use 1987 or 1986 Sound-Level Calibrator):

ANSI Standard Specifications for Sound-Level Meters S1.4-1971, Type 1 (Precision).

IEC Standard 651-1979, Sound-Level Meters (Type 1).

ANSI Standard Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets S1.11-1966, Type E, Class II.

IEC Recommendation Publication 225-1966, Octave, Half-Octave, and Third-Octave Band Filters for the Analysis of Sound and Vibration.

Reference Conditions: Reference conditions as required by IEC Standard 651-1979 are as follows:

Reference Direction of Incidence:

1988-9700—random

1988-9710—perpendicular to plane of diaphragm

Reference Sound Pressure Level: 94 dB

Reference Range: 100 dB full scale

Reference Frequency: 1 kHz

Level Range (Preamplifier GAIN set to x 1):

30 to 130 dB re 20 μ Pa* (140 dB pk). May be extended to 140 dB rms (150 dB pk) using 10-dB microphone attenuator (1962-3210) supplied. Typical minimum measureable level, 32 dBA, lower in octave bands. Noise floor at least 5 dB below minimum measurable levels.

Frequency Weighting and Filters: A, B, and C weighting per reference standards. Flat response from 5 Hz to 20 kHz. Response is down -3 dB \pm 3 dB at 5 Hz and 20 kHz relative to 1-kHz level (electrical only, microphone not included). Ten octave-band filters ranging from 31.5 Hz to 16 kHz (center frequencies).

Detector Characteristics: Detector Response: Fast, Slow, Impulse (per IEC 651) and absolute peak (>50- μ sec detector rise time) switch selectable. Precise rms detection for signals with crest factors up

to 20 dB at 120 dB,† (10 dB at 130 dB). Crest-factor capacity increases below full scale.

Detection of Overload and Underload: Signal peaks monitored at 2 critical points to provide positive indication of peak overload on panel LED. If, during integration, upper limit of detector range is exceeded for more than 0.1% of integration period, overload warning on digital display indicates that result may be in error. If integrated level is less than lower limit corresponding to 5 dB below bottom scale on panel meter, underload warning is given on digital display.

Display: ANALOG: 3-in panel meter graduated in 1-dB increments; four ranges: 30-80 dB, 50-100 dB, 70-120 dB, and 90-140 dB; displays continuous level (i.e., Fast, Slow, Impulse and Peak). DIGITAL: Display is 4-digit LED type with 0.1-dB resolution for level display; can display continuous level, maximum level, integrated sound level (L_{eq}) or sound-exposure level (SEL); display is updated once per second when integrating, 7 times per second in continuous mode.

Filters: Octave-band filters have attenuation of 3.5 ± 1 dB at nominal cutoff frequency, more than 18-dB attenuation at $\frac{1}{2}$ and 2 x center frequency, and more than 70-dB ultimate attenuation.

Microphone and Preamplifier: TYPE: $\frac{1}{2}$ -in. Electret-Condenser Microphone with Flat response to random (-9700) or perpendicular (-9710) incidence; response curve supplied. MOUNTING: Detachable preamplifier (1560-3410) that plugs into nose of instrument or can be removed with 10-ft cable (1933-0220) supplied or 60-ft cable (1933-9601) available. Preamplifier has selectable x 1 or x 10 gain, normally set for x 1. INPUT IMPEDANCE: Approximately 2 G Ω in parallel with <6 pF. Switchable 200-V polarizing supply allows use with air-condenser microphones.

Outputs: AC OUTPUT: 0.4 V rms nominal, behind 5 k Ω , corresponding to full-scale deflection; any load permissible. DC OUTPUT: 3 V nominal, behind 30 k Ω , corresponding to full-scale meter deflection. Output is linear in dB at 60 mV/dB over 70-dB range (50-dB panel-meter display range plus 20-dB crest-factor allowance). Any load permissible. OUTPUT TO PRINTER: RS232C with TTL-logic levels (0-5 V), 25-pin-connector optional printer cable available for use with most TTL-compatible printers. Serial output rate at EIA standard 110 baud. Dwell time of 4 sec permits use with buffered-input printers. Elapsed integration time, selected integration level (L_{eq} or SEL) and maximum level during each integration period are printed.

*In the international system of units (SI) the unit of pressure is the pascal (Pa; 1 Pa = 1 N/m² = 10 dynes/cm² = 10⁻² mbar. REF: "The International System of Units (SI)," U.S. Dept. of Commerce, National Bureau of Standards, NBS Special Publication 3320, SD Cat. No. C13.10:330/2, U.S. GPO, Washington, D.C. 20402.

† 10 dB higher when 10-dB microphone attenuator is used.

Calibration: FACTORY: Calibrated and fully tested to all specifications. Sensitivity measured in free field by comparison with laboratory-standard microphone that has calibration traceable to U.S. National Bureau of Standards. FIELD: GR 1987 or 1986 Sound-Level Calibrators are available for field calibration.

Environment: TEMPERATURE: -10 to +50°C operating, -40 to +60°C storage with batteries removed, +15°C during battery charging. HUMIDITY: 0-95% RH operating. MAGNETIC FIELD: 1-oersted (80 A/m) 60-Hz field causes 50-dB, C-weighted indication and negligible A-weighted indication, when meter is oriented for maximum sensitivity to field. Equivalent A-weighted response to 1-oersted 400-Hz field is approximately 55 dBA with meter oriented for maximum sensitivity to field. VIBRATION: When sound-level meter, with attached microphone, is vibrated at acceleration of 1 m/sec² (0.1/G) in direction perpendicular to plane of microphone diaphragm, the indicated flat-weighted level does not exceed 80 dB in frequency range from 20 Hz to 1 kHz. Reference instrument that is not being vibrated indicates maximum level of 65 dB.

Supplied: Battery pack assembly; power pack and charger, microphone extension cable (10 ft); 10-dB microphone attenuator; calibration screwdriver; wrist strap; miniature phone plug (2); carrying pouch; microphone windscreen; power cable; support; instruction manual.

Available: Carrying case (includes space for calibrator, cable, tripod, miscellaneous accessories); battery pack assembly; microphone extension cables (10 ft, 60 ft); calibrators, 1986 and 1987; dummy microphones, 22 and 35 pF with BNC female input; tripod—will mount either 1982 or preamplifier; windscreen (package of 4); adaptor cables for connection to outputs, all 3 ft (0.9 mm) long; 1560-9619 Audiometer Calibration Accessory Kit; Vibration Integrator System; weatherproof enclosure adaptor; extended-life battery and charger set; printer cable; auto power cable.

Power: May be operated from any of the following 4 sources of power. 1) 100-125 or 200-250 V line with power pack supplied. 2) Supplied AA-size rechargeable battery pack provides at least 2-hr continuous operation. Battery pack is recharged in about 4 hr from power pack. 3) Three AA-size alkaline (non-rechargeable) batteries in place of rechargeable AA battery pack. 4) Remote 12-V battery or any remote battery of sufficient capacity and voltage in range from 3.3 to 14 V. Cable and plug for connection are supplied.

Mechanical: 1988-9700, 1988-9710 DIMENSIONS (W x H x D): 3.9 x 20.2 x 2.3 in. (99 x 513 x 59 mm). WEIGHT: 3 lb (1.36 kg) net, 11 lb (5.0 kg) shipping.

1988-9610. Extended Life Battery and Charger Set.

An optional rechargeable battery, charger, and battery cable provide greater than 24-hour operation of the 1988-9700 or 1988-9710 instruments at locations remote from AC sources.

12.6 V, 5 aH rechargeable battery in simulated leather case, plus shoulder strap.

Mechanical: DIMENSIONS (W x H x D): 3.50 x 7.88 x 4.12 in. (89 x 202 x 105 mm). WEIGHT: 6.13 lb (2.77 kg).

Electrical Connection: Universal automotive cigar-lighter socket provided on one end of carrying case. Socket accepts cigar-lighter plug for charging the battery, or an adapter cable for supplying power to the instrument.

Protection: 5 ampere, type 3AG, normal blow fuse provided in in-line fuse-holder mounted within carrying case.

AC Charger: 12.6 V, 520 mA charger to charge the 12.6 V Battery Pack. Comes in plastic case and is switchable from 120 VAC to 220 VAC 50/60 Hz.

Charging Times:

	120V	220V
	104V 24 hrs	198V 24hrs
	127V 8 hrs	242V 8 8 hrs

Mechanical: DIMENSIONS (W x H x D): 2.4 x 5.1 x 2.2 in (61 x 130 x 56 mm). WEIGHT: 1.06 lb (0.48 kg).

Electrical Connections: INPUT: IEC Universal socket. OUTPUT: 6-ft (1.8-m) cord with automotive cigar-lighter plug.

Cable: Retractable cable with cigar-lighter plug at one end. Provides connection between 1988 and 12.6 V Battery Pack. Cable is extended from coiled length of approximately 1 ft (0.3 m) to 4 ft (1.2 m).

Description	Catalog Number
Precision Integrating Sound-Level Meter and Analyzer (with random-incidence microphone)*	1988-9700
Precision Integrating Sound-Level Meter and Analyzer (with perpendicular-incidence response microphone)**	1988-9710
Printer Cable	1988-9605
Weatherproof Enclosure Adapter	1988-9600
Extended Life Battery and Charger Set	1988-9610
Auto Power Cable	1988-9606
Carrying Case (1988, 2986, tripod, etc.)	1982-9630
1986 Omnical Sound-Level Calibrator	1986-9700
1987 Minical Sound-Level Calibrator	1987-9700
Dummy Microphone	1982-9620
Tripod	1560-9590
Windscreen (package of 4 for 1" microphone)	1560-9521
Windscreen (package of 4 for 1/2" microphone)	1560-9522
Microphone Extension Cable (10 ft)	1933-9600
Microphone Extension Cable (60 ft)	1933-9601
Vibration Integration System	1933-9610
1" Ceramic Microphone	1971-9601
1" Electret Condenser Microphone (random-incidence response)	1961-9810
1" Electret Condenser Microphone (perpendicular-incidence response)	1961-9611
OSHA Conversion Kit (5 dB)	1988-9002

* Conforms to ANSI S1.4 1971 Type 1 and IEC 651
 ** Conforms to IEC 651