Modular Precision Sound Level Meter

Type 2231 is a Type 1 precision instrument. Its comprehensive construction and extreme accuracy make it ideal for measurements according to the most stringent standards. In addition, a system of interchangeable application modules allows it to perform a wide variety of measurements not previously possible with a single hand-held instrument.

The versatility of the instrument is further enhanced by its selectable polarization voltage. This allows it to be used with almost any B&K microphone and extends the measurement possibilities. For example, with Microphone Type 4133 and Extension Cable AO0027 the 2231 is a Type 0 instrument in accordance with IEC 651.

Measurements are displayed on a four digit Liquid Crystal Display. Each digit comprises 14 segments, allowing alphanumericics to be displayed clearly. The SPL (RMS or Peak) is continuously monitored on a quasi-analogue display. An AC output allows chart or tape recording of the signal. The DC output allows chart recording of any parameter shown on the digital portion of the display.

Sound Level Meter Type 2231 derives its many measurement capabilities from a series of interchangeable application modules. Each application module has its own faceplate. When a module is inserted, the loaded software defines the functions of the pushkeys of the instrument. Once the software is loaded, the module itself may be removed. The software is maintained even when the Sound Level Meter is turned off.

For every Application Module, the Sound Level Meter undergoes a conversion, allowing it to measure a new set of acoustical parameters. The different application modules also enable the 2231 to control the different instruments needed for that particular application.

Nine Application Modules are currently available for use with Sound Level Meter Type 2231. Only Modules BZ 7100, BZ 7101 and BZ 7102 are described here. See the separate data sheets for the other Modules.
Application Module BZ7100: Integrating Sound Level Meter

With this Application Module the 2231 is a general purpose Integrating Sound Level Meter. There are three time responses available (Fast, Slow, and Impulse), and four frequency weightings (A, C, Lin. 10 Hz to 20 kHz, and All Pass). It can display any of the following 8 parameters:

- MAXP (max. peak hold)
- PEAK (max. peak in 1s period)
- INST (samp. RMS in 1s period)
- SPL (max. RMS in 1s period)
- MAXL (max. SPL hold)
- MINL (min. SPL hold)
- LEQ (or L1m with 1 time weighting)
- SEL (or IEL with I time weighting)

Special Functions include:
- Automatic digital readout after predetermined interval (Interface Module ZI9101 is necessary for this facility to be operative).
- The quasi-analogue scale may be set to display Peak sound levels.
- The DC Output may be used to obtain a histogram of $L_{eq}$ vs. time.
- Data inhibit on activation of the Pause pushkey. Data obtained within a set period prior to activation may also be deleted. This set period is selectable between 2, 3, and 4s.

Application Module BZ7101: Statistical Analyzer

With this Application Module the 2231 is able to perform a statistical analysis on the incoming sound signal. There are two time responses available (Fast and Slow), and four frequency weightings (A, C, Lin. 10 Hz to 20 kHz, and All Pass). In addition to the 8 parameters mentioned above, it can display:

- $L_{99.0}$
- $L_{90.0}$
- $L_{50.0}$
- $L_{10.0}$
- $L_{1.0}$

It also calculates and displays:

- $L_N$ Integrated Distribution
- $L_{ Cumulative Distribution}$
- $L_{ Probability Distribution}$

with 0.5 dB resolution, for any measurement period.

Special Functions include:
- $L_N$ may be displayed immediately for any value of $N$ (in 0.1 steps). Five different values of $N$ may be stored at any one time, replacing the standard values of 1.0; 10.0; 50.0; 90.0; and 99.0.
- Calculation of Cumulative Distribution and Level Distribution with variable resolution (ranging from 0.5 dB to 10.0 dB).
- Data inhibit on activation of the Pause pushkey. Data obtained within a set period prior to activation may also be deleted. This set period is selectable up to 9 s.

Application Module BZ7102: "Takimaximal"

With this Application Module the 2231 is an Integrating Sound Level Meter with special facility for measuring Takimaximalpegel as outlined in TA Larm. There are three time responses available (Fast, Slow, and Impulse), and four frequency weightings (A, C, Lin. 10 Hz to 20 kHz, and All Pass). It can display any of the following 10 parameters:

- MAXP (max. peak hold)
- PEAK (max. peak in 1s period)
- INST (samp. RMS in 1s period)
- SPL (max. RMS in 1s period)
- $L_T$ (3s and 5s Takt)
- MAXL (max. SPL hold)
- MINL (min. SPL hold)
- LEQ (or L1m with I time weighting)
- SEL (or IEL with I time weighting)

The DC Output may be used to obtain plots of $L_{Tn\theta}$ or $L_{Tn\beta}$.

Special Functions include:
- Automatic digital readout after predetermined interval (Interface Module ZI9101 is necessary for this facility to be operative).
- The quasi-analogue scale may be set to display Peak sound levels.
- The quasi-analogue scale may be set for 1 dB resolution.
- Data inhibit on activation of the Pause pushkey. Data obtained within a set period prior to activation may also be deleted. This set period is selectable up to 9 s.
Interchangeable Microphones

A selectable polarization voltage of 0V, 28V and 200V allows the use of almost any microphone in the Briel & Kjaer range. Although the standard supplied microphone (Polarized Microphone Type 4155) is suitable for the vast majority of measurement applications, it may be necessary from time to time to use an alternate. For example, the 2231 becomes a Type 0 Sound Level Meter if the 1/2 inch Microphone Type 4133 (or to meet ANSI standards, Type 4134) is used in conjunction with Extension Cable Type A00027. For high frequency sound measurements 1/4 inch Microphones Types 4135 and 4136, or 1/8 inch Microphone Type 4138 are ideal.

Detector

A unique feature of the 2231 Sound Level Meter is that RMS and Peak detection occurs in parallel. The signal is shared between the two parts of the detector, each part having a dynamic range of 70 dB. In this way the Sound Level Meter can display both the RMS value and the Peak value of the same signal. This is particularly advantageous in the analysis of transients or impulses.

Frequency Range

When set to the All Pass frequency weighting, the 2231 Sound Level Meter (without microphone) has a flat frequency response from 2Hz to 70kHz. The excellent high and low frequency response characteristics of the instrument make measurements in the infra- and ultra-sound ranges possible.

Display

The Liquid Crystal Display contains four digits, a quasi-analogue display, overload indicator, and battery low indicator. The four digits give 0.1 dB resolution of the displayed parameter and since each digit is comprised of 14 display segments, alphanumericics are displayed clearly and concisely. The range and resolution of the quasi-analogue scale are determined by the application module in use, as is the rate of update of the display.

External Filters

Three Filter Sets may be used with the Type 2231: The Octave Filter Set Type 1624, 1/3 and 1/6 Octave Filter Set Type 1625, and Infrasound and Ultrasound Filter Set Type 1627. These filters are connected directly to the bottom of the Sound Level Meter (Fig. 5).

In-situ frequency analyses can be obtained using these Filters, and recorded using Level Recorder Type 2317. The Type 1624 enables octave band analysis from 31.5 Hz to 16 kHz, which can be recorded semi-automatically, and the Type 1625 enables 1/6 octave or 1/3 octave (with 1/6 octave or 1/3 octave stepping) band analysis from 20 Hz to 20 kHz which can be recorded fully automatically. See also the Product Data for Frequency Analysis Module BZ 7103.

Filter Set Type 1627 incorporates 6 filter networks (plus Lin.) including a 12.5 kHz highpass filter and a 20 Hz lowpass filter. Other networks provide infrasound and ultrasound weightings for measurements in accordance with IEC recommendations.

DC Output

The DC Output signal is an analogue version of what is shown in the digital portion of the display, except that it does not include the correction for the range and the microphone K-factor. In this way it is possible to record all the parameters of the 2231 (with the Application Module) can display. This is most convenient for chart recording of L eq or, with Module BZ 7102, L Tn

Digital Interfacing

The Interface Module ZI 9101 allows the Sound Level Meter to be connected to the Graphics Printer Type 2318 with a Briel and Kjaer Serial Interface. Additionally, RS 232C compatible printers or computers may be connected for printout or control. Communication by the 2231 is enabled through the Monitor program which can operate at various baud rates, with or without echo. All Monitor commands are straightforward and simple to use.

Printout of data from Type 2231 may be obtained in one of various formats. Fig. 6 shows an example of the printout in medium format from Type 2231 with Application Module BZ 7100. The printout may be obtained automatically at the end of a preset time period, or manually while the Sound Level Meter is in its Pause mode.

Front Plate Controls

The front plate pushkeys activate the associated function via membrane contact. They give full tactile feedback to the operator without producing any noise. This is of particular advantage when measuring low level L eq values where instrument operation can produce spurious measurable noise.

--- B & K SLM TYPE 2231 ---

Set Up: F. F. R.

MAXP 92.9 dB

MINL 73.0 dB

SEL 73.3 dB

L eq 55.6 dB

No overload.

No reset of Max/Min.

Elapsed Time: 00:01:08

No. of Interrupts: 0

Fig. 4. Display of Type 2231

Fig. 5. Sound Level Meter Type 2231 with 1/3 - 1/6 Octave Filter Set Type 1625

Fig. 6. Printout from Type 2231 with Module BZ 7100, Graphics Printer Type 2318 and Interface ZI 9101
Specifications Type 2231

MEASURING RANGE:

With standard microphone (Type 4155):

<table>
<thead>
<tr>
<th>FSD</th>
<th>Lower limit for S/N ratio = -6 dBA</th>
<th>Measuring Range</th>
<th>Max. peak level</th>
<th>Upper limit for signals of crest factor = 10 (20) dB</th>
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<tr>
<td>60</td>
<td>24</td>
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<td>160</td>
<td>90</td>
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</tbody>
</table>

1 FSD on quasi analogue display
2 Only with attenuator ZF 020 employed
3 Values may diverge slightly from nominal value depending on microphone K0 factor

FREQUENCY WEIGHTING:
A, C weighting to IEC 651 Type 1 (Type 0)
Linear (10 Hz - 20 kHz)
All-pass (2 Hz - 70 kHz)

DETECTOR:
Characteristics: RMS, peak
Linearity range: 70 dB
Pulse range: 73 dB
Crest factor capability: 13 dB at FSD

TIME WEIGHTING CHARACTERISTICS:
"F": to IEC 651 Type 1 (Type 0)
"F": to IEC 651 Type 1 (Type 0)
"B": to IEC 651 Type 1 (Type 0)
"A": linear, rise time <50 μs
Max. Hold decay rate: 0 dB/s (digital)

L<sub>eq</sub> RESPONSE TIME FOR CONSTANT INPUT SIGNAL:
1 s after reset

CONVERTIBILITY:
Loading: Enabled by module insertion; module removed after loading into internal memory. Every application module has its own face plate.
Capacity: 4 kbyte ROM for general routines, tables etc. 16 kbyte RAM for application software and data storage.
Interface: Via optional Bruel & Kjaer Serial Interface Module 219101.

DISPLAY:
Digital: 4 digits 14 segments, liquid crystal, 8 mm high, resolution 0.1 dB

Quasi-analogue: 80 dB scale, 2 dB resolution for monitoring current SPL (RMS or Peak)
Warnings: Overload occurring: Overload has occurred; Battery near low level; Battery low level; Overrange; Underrange; Selected value outside allowable range

AC OUTPUT:
1 V RMS for full scale (3.16 V RMS for full range), output impedance 120 Ω, short circuit protected, mini-jack socket.

DC OUTPUT:
3 V for full scale (3.5 V for full range), 0 V bottom scale, 50 mV/DB, output impedance <100 kΩ, short circuit protected, mini-jack socket.

RESET FUNCTION:
Reset all: Max./min. detectors, L<sub>eq</sub>, L<sub>max</sub>, L<sub>min</sub> and overload detector are reset
Reset max./min.: Only max./min detectors are reset
Automatic Reset occurs when certain key settings are changed

MICROPHONE:
Type: 7/8 inch B & K Prepolarized Condenser Microphone Type 4155
Sensitivity: 50 mV/Pa
Capacitance: 15 pF
Windscreen effect: <0.9 dB up to 10 kHz

CALIBRATION:
Acoustical: With Sound Level Calibrator Type 4230, Pistonphone Type 4220 or Multi-functional Acoustic Calibrator Type 4226 by potentiometer adjustment
Electrical: With internal reference source by potentiometer adjustment

REFERENCE CONDITIONS FOR ACOUSTICAL CALIBRATION WITH TYPE 4230:
Type of Sound Field: Free
Reference Incidence Direction: Perpendicular to microphone diaphragm
Reference SPL: 96 dB (re 20 μPa)
Reference Frequency: 1 kHz
Reference Temperature: 20°C
Reference Measuring Range: 110 dB FSD
WARM-UP TIME:
<10 s for 1 dB, <15 s for 0.1 dB

EFFECT OF HUMIDITY (AT 40°C AND 1000 Hz):
<0.5 dB for 30% < RH < 90%

EFFECT OF TEMPERATURE:
Microphone: -0.006 dB/°C typically
Complete instrument: <0.5 dB -10 to +50°C
Operating range: -10 to +50°C (+14 to 122°F)
Storage without batteries: -20 to +70°C (-4 to 158°F)

EFFECT OF MAGNETIC FIELD:
80 A/m (1 Orsted) at 50 Hz gives: <25 dB (A) or <44 dB (Lin)
VIBRATION SENSITIVITY: 72 dB max. at 40 Hz and 1 ms<sup>2</sup>

BATTERIES:
Type: Four 1.5 V Alkaline cells IEC type LR 6 (BKX order No. 06 0013)
Life: approx. 8 hours

OVERALL DIMENSIONS AND WEIGHT:
370 x 85 x 47 mm (14.7 x 3.3 x 1.6 in)
860 g (1.9 lb) with batteries

ACCESSORIES INCLUDED:
Half-inch Prepolared Condenser
Microphone Type 4155
2.5 mm mini-jack plug (×2) JP 0213
Windscreen: UJ 0237
Screwdriver QA 0001
Cells (x4) QB 0013
20 dB Attenuator ZF 0200
Integrating SLM Module BZ 7100
Instruction Manual

ACCESSORIES AVAILABLE:
Statistical Analysis Module BZ 7101
“Taktmaximal” Module BZ 7102
Frequency Analysis Module BZ 7103
Reverbation Processor Module BZ 7104
Human-Vibration Module BZ 7105
Short Term L<sub>eq</sub> Module BZ 7106
Noise Event Recording Module BZ 7107
Room Acoustics Module BZ 7109
Interface Module ZI 9101
3 m Mic. Extension cable AO 0027
Sound Level Calibrator Type 4230
Multifunction Acoustic Calibrator Type 4226
Level Recorder Cable AO 0173
Carrying case ZG 0256
Power Supply ZG 0256
Service Manual