Sound Level Meters, Filters & Calibrators

Modular Precision Sound Level Meter

type 2231 with BZ 7100, BZ 7101 and BZ 7102

FEATURES:

- Interchangeable application modules allow measurement of wide range of acoustical parameters

- Selectable polarization voltage allows use of almost any microphone in the Brüel and Kjær range

- RMS and Peak detection in parallel

- Fulfills IEC 804 Type 1, and relevant sections of IEC 651 Type 1 I, and ANSI S 1,4 (1983) Type 1

- Digital and quasi-analogue liquid crystal display. Each digital character is constructed from 14 elements, allowing alphanumerics to be displayed

- 24 to 130 dB measuring range with standard microphone (30 to 150 dB with attenuator) in 7 overlapping sub-ranges

- Extra wide all pass frequency range allows infra- and ultrasound measurements

- Accepts Brüel & Kjær Serial Interface Module ZI 9101 for external control and communication

- When used with Microphone Type 4133 and Extension Cable AO 0027, fulfills IEC 804 Type 0 and relevant sections of IEC 651 Type 0 I.

USES:

- Measurement of L_{eq} and $L_{EA,T}$ (SEL)

- With Application Module BZ 7101, performs statistical noise measurements (L_1, L_{10}, L_{50}, L_{90}, L_{99})

- With Application Module BZ 7101 it can provide, for a given measurement period, L_N, Cumulative Distribution, and Probability Distribution

- With Application Module BZ 7102, performs Takt-maximal noise measurements according to TA Lärm

- Analysis in $^1/_1$ or $^1/_3$ octave bands with Filter Sets Type 1624 or 1625

- Infrasound and ultrasound analysis with Filter Set Type 1627

- Sound power level measurements according to the survey method

- Impulsive noise emission rating of business machines according to international standards

- Measurement of low sound levels, below 10 dB in certain $^1/_3$ octave bands

- Calibration standard Sound Level Meter

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 allow it to perform a 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 AO 0027 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 alphanumerics 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 or audio monitoring 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.
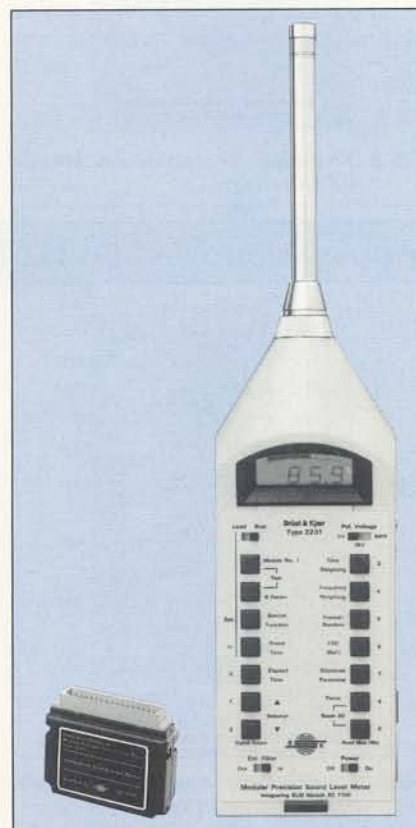
Application Module BZ 7100: Integrating Sound Level Meter

Fig. 1. Frontplate for Application Module BZ 7100

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

Special Functions include:
- Automatic digital readout after predetermined interval (Interface Module ZI 9101 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 4 s.

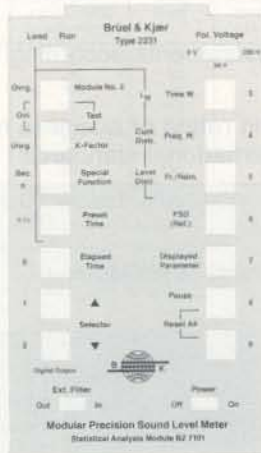# Application Module BZ 7101: Statistical Analyzer

Fig. 2. Frontplate for Application Module BZ 7101

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
Cumulative Distribution
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 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.
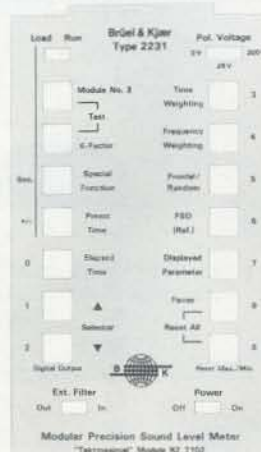
Application Module BZ 7102: "Taktmaximal"

Fig. 3. Frontplate for Application Module BZ 7102

With this Application Module the 2231 is an Integrating Sound Level Meter with special facility for measuring Taktmaximalpegel as outlined in TA Lärm. 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 1 s period)
INST (samp. RMS in 1 s period)
SPL (max. RMS in 1 s period)
L_T (3 s and 5 s Takt)
MAXL (max. SPL hold)
MINL (min. SPL hold)
LEQ (or LIm with I time weighting)
L_{Tm3} and L_{Tm5}

SEL (or IEL with I time weighting)

The DC Output may be used to obtain plots of L_{Tm3} or L_{Tm5}.

Special Functions include:
- Automatic digital readout after predetermined interval (Interface Module ZI 9101 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 0 V, 28 V and 200 V allows the use of almost any microphone in the Brüel & Kjær range. Although the standard supplied microphone (Prepolarized 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 ½ inch Microphone Type 4133 (or, to meet ANSI standards, Type 4134) is used in conjunction with Extension Cable Type AO 0027. For high frequency sound measurements ¼ inch Microphones Types 4135 and 4136, or ⅛ 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 2 Hz to 70 kHz. 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, alphanumerics 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.
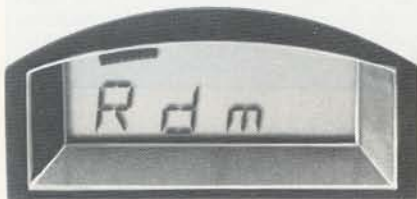

Fig. 4. Display of Type 2231

External Filters

Three Filter Sets may be used with the Type 2231: The Octave Filter Set Type 1624, ¹/₁ and ¹/₃ 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 ¹/₃ octave or ¹/₁ octave (with ¹/₁ 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 Ouput 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 that the 2231 (with the Application Module) can display. This is most convenient for chart recording of L_{eq} or, with Module BZ 7102, L_{Tm3}
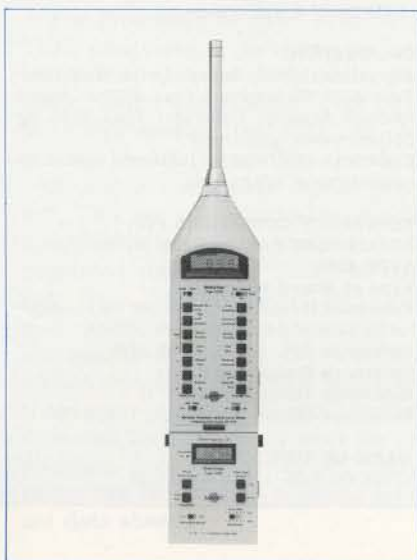

Fig. 5. Sound Level Meter Type 2231 with ¹/₁ – ¹/₃ Octave Filter Set Type 1625

and L_{Tm5}. The DC Output signal is updated at the same rate as the parameter is updated on the display.

Digital Interfacing

The Interface Module ZI 9101 allows the Sound Level Meter to be connected to the Graphics Printer Type 2318 with a Brüel and Kjær Serial Interface. Additionally, RS 232 C 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 measureable noise.


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-- B&K SLM TYPE 2231 --

Set Up: F. F. A.

MAXP        92.9 dB
MAXL        73.0 dB
MINL        42.8 dB
SEL         73.3 dB
LEQ         55.6 dB

No overload.

No reset of Max/Min.

Elapsed Time: 00:01:00

No. of interrupts: 0
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Fig. 6. Printout from Type 2231 with Module BZ 7100, Graphics Printer Type 2318 and Interface ZI 9101
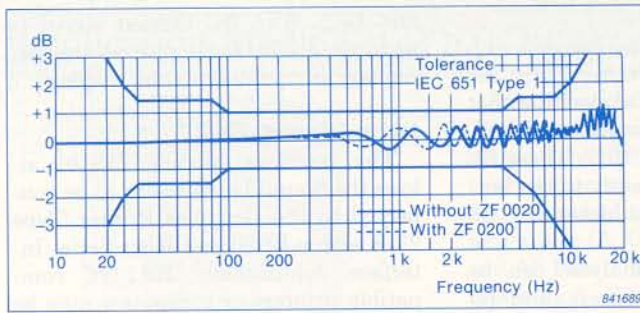
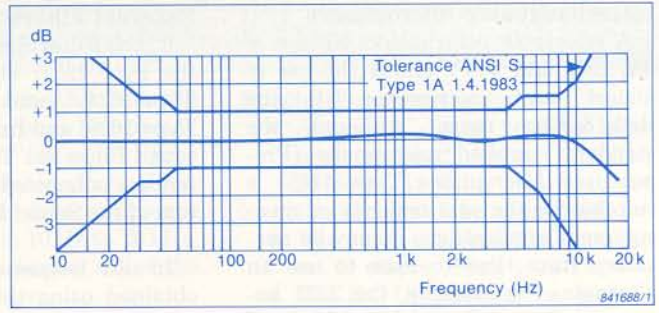Fig. 7. *Typical 0° free field frequency response of the complete instrument*

Fig. 8. *Typical diffuse field frequency response of the complete instrument*

Specifications Type 2231

MEASURING RANGE:
With standard microphone (Type 4155):

FSD[1]	Measuring Range		
	Lower limit for S/N ratio >5dB (A-weighting)[3]	Max. peak level[3]	Upper limit for signals of crest factor =10 (20 dB)[3]
60	24	73	53
70	24	83	63
80	24	93	73
90	30	103	83
100	40	113	93
110	50	123	103
120	60	133	113
130[2]	70	143	123
140[2]	80	153	133

T00624GB1

[1] FSD on quasi analogue display

[2] Only with attenuator ZF 0020 employed

[3] Values may diverge slightly from nominal value depending on microphone K_0 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:
"I": to IEC 651 Type 1 (Type 0)
"F": to IEC 651 Type 1 (Type 0)
"S": to IEC 651 Type 1 (Type 0)
"Peak": rise time <50 μs
Max. Hold decay rate: 0 dB/s (digital)

L_{eq} 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 Brüel & Kjær Serial Interface Module ZI 9101.

DISPLAY:
Digital: 4 digits 14 segments, liquid crystal, 8 mm high, resolution 0,1 dB

Quasi-analogue: 60 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 Ω, short circuit protected, mini-jack socket.

RESET FUNCTION:
Reset all: Max./min. detectors, L_{eq}, $L_{EA,T}$ 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: 1/2 inch B & K Prepolarized Condenser Microphone Type 4155
Sensitivity: 50 mV/Pa
Capacitance: 15 pF
Windscreen effect: <0,9 dB up to 10 kHz
Polarization Voltage: Selectable—0 V, 28 V, 200 V. Allows use of almost any microphone in the Brüel & Kjær range.

CALIBRATION:
Acoustical: With Sound Level Calibrator Type 4230, Pistonphone Type 4220 or Multifunction 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: 94 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 Ørsted) at 50 Hz gives:
<25 dB (A) or <44 dB (Lin)

VIBRATION SENSITIVITY: 72 dB max. at 40 Hz and 1 ms⁻².

BATTERIES:
Type: Four 1,5 V Alkaline cells IEC type LR 6 (B&K order No. QB 0013)
Life: approx. 8 hours

OVERALL DIMENSIONS AND WEIGHT:
370 × 85 × 47 mm (14,7 × 3,3 × 1,8 in)
860 g (1,9 lb) with batteries

ACCESSORIES INCLUDED:
Half-inch Prepolarized Condenser
Microphone...Type 4155
2,5 mm mini-jack plug (×2) ....JP 0213
Windscreen...UA 0237
Input Adaptor ....JJ 2614
Screwdriver..QA 0001
Cells (×4)...QB 0013
20 dB Attenuator...................................ZF 0020
Integrating SLM Module.....................BZ 7100
Instruction Manual

ACCESSORIES AVAILABLE:
Statistical Analysis Module................BZ 7101
"Taktmaximal" Module.......................BZ 7102
Frequency Analysis Module...............BZ 7103
Reverberation Processor Module ......BZ 7104
Human-vibration Module ....BZ 7105
Short Term L_{eq} 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..KE 0226
Power Supply ....ZG 0254
Service Manual