

The Sound Level Meter for every application.....

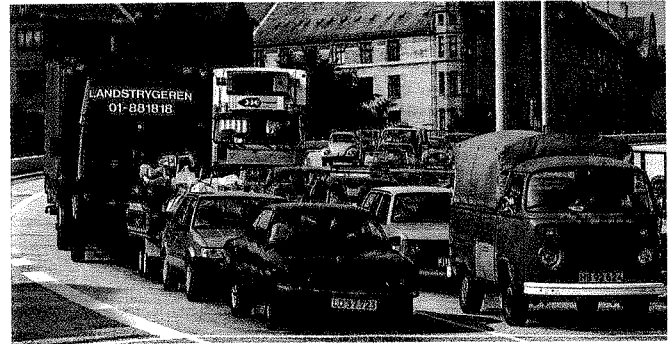
Industrial

- Enables noise level surveys of industrial environments
- Performs sound power level measurements on industrial equipment
- Measures vibration levels to which operator is exposed
- Measures (with Attenuator ZF 0020) overall RMS noise levels up to 130 dBA (with 20 dB crest factor) and Peak levels up to 150 dBA



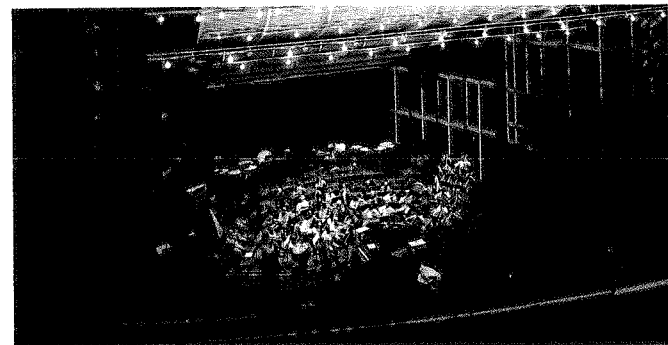
Community

- Measures L_{eq} and 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 provides, for a given measurement period, L_N , Cumulative Distribution, and Probability Distribution
- With Application Module BZ 7102, performs Taktmaximal noise measurements according to TA Lärm



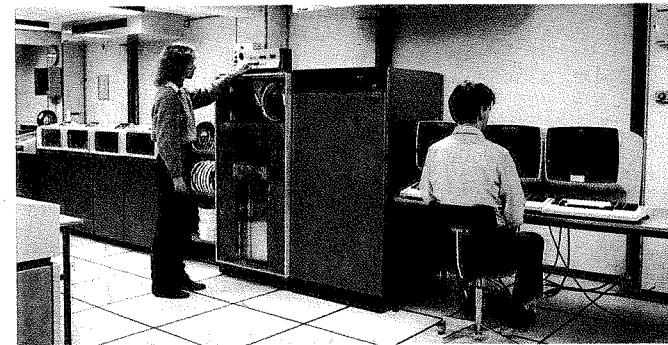
Architectural

- Measures ambient background noise levels in $1/1$ octave bands with Filter Set Types 1624 or 1625, and $1/3$ octave bands with Filter Set Type 1625
- Acoustical modelling facilitated by the exceptional high frequency response



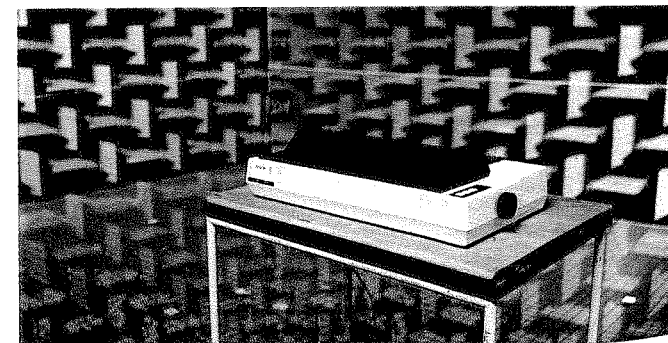
Commercial

- Performs sound reduction tests in octave bands (with Filter Set Types 1624 or 1625) or $1/3$ octave bands (with Filter Set Type 1625) according to international standards
- Rates the noisiness of business machines according to standards
- Determines noise impact due to commercial production processes
- Enables the assessment of loudness and potential annoyance of work environments



Research and Development

- Use as a calibration standard Sound Level Meter
- Measures low sound levels, below 10 dB in certain $1/3$ octave bands with Filter Set Type 1625
- Allows accurate measurements over a very wide frequency range
- Gives type 0 accuracy, as defined in IEC 651, with appropriate microphone and extension cable
- Makes measurements in the infrasound and ultrasound regions with Filter Set Type 1627

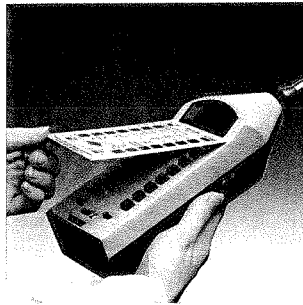


.....made possible by its unmatched versatility,

A system of interchangeable modules allows the 2231 Sound Level Meter to perform a wide variety of measurement tasks not previously possible with a single hand-held instrument. Each module effects a conversion of the Sound Level Meter, creating a new instrument capable of measuring a different set of acoustical parameters. Indeed the 2231 is more than just a sound level meter: it is a sophisticated acoustical analyzer with capabilities normally associated with multi-instrument set-ups.

There are many practical advantages in using a system of application modules rather than having a single self-contained instrument. For one, the modular system allows the same

internal memory space to be used for a number of different applications, keeping the size of the instrument to a minimum. In addition, the functions enabled by each pushkey on the faceplate can be limited to 1 or 2, avoiding the use of numerous "shift" keys. (A convoluted hierarchy of functions assigned to one pushkey may save space, but can lead to considerable confusion and operational difficulties.) Furthermore, the future capabilities of the instrument are greatly expanded by the potential for development of more application modules. The instrument literally grows along with your needs, and is not limited by the confines of its own hardware.



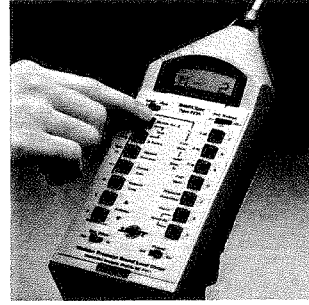
1) Attach the faceplate.

The function of the pushkeys on the front of the Sound Level Meter is determined by the contents of the module to be used. Each module has a dedicated faceplate which identifies the pushkey functions. The inscriptions on the faceplate are very comprehensive, making use of the instrument almost self explanatory.



2) Insert the module

Each Application Module for Sound Level Meter Type 2231 is a firmware package (the software is implemented in a ROM) which enables the sound level meter to perform specific measurement functions. The module of choice is inserted into the connector slot on the rear of the instrument.



3) Load the program

The software contained in the module is transferred into the central memory of the Sound Level Meter by pressing the pushkey marked **Module No. -**, while the **Run/Load** switch is set to the **Load** position. The loading process takes less than one second, and when proper loading is completed the module number is shown on the display.



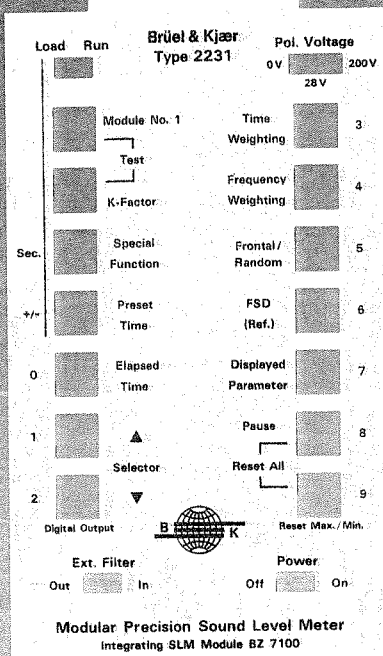
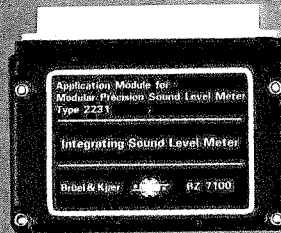
4) Remove the module.

Once the application software has been loaded into the internal memory, the module may be removed. The Sound Level Meter has sufficient memory capacity to store the program and perform the necessary processing. A back-up battery retains memory contents when the Sound Level Meter is turned off, eliminating the need to reload every time it is used.

.....and its outstanding features.

- Selectable polarization voltage allows use of almost any microphone in the Brüel and Kjær range
- RMS and Peak detection in parallel
- Fulfills proposed IEC standard for Integrating Sound Level Meters Type 1, and relevant sections of IEC 651 Type 1 I, and ANSI S1,4 (1983) Type 1
- Extra wide all pass frequency range allows infra- and ultrasound measurements
- 24 to 130 dB measuring range with standard microphone (30 to 150 dB with attenuator) in 7 overlapping sub-ranges
- Digital and quasi-analogue liquid crystal display. Each digital character is constructed from 14 elements, allowing unambiguous alphanumeric characters to be displayed
- Choice of Impulse, Fast and Slow time weightings, depending on the application module being used
- 73 dB Pulse range; 70 dB Linearity range
- A, C, Lin. and All-pass weightings
- 16 kbyte RAM for programs and data storage: back-up battery power maintains software storage while the instrument is turned off
- Can accept a Brüel & Kjær Serial Interface communications port for external control and digital interface
- Displays status of any parameter without interruption of measurements
- When used with Microphone Type 4133 and Extension Cable Type AO 0027, fulfills proposed IEC standard for Integrating Sound Level Meters Type 0 and relevant sections of IEC 651 Type 0 I.

The 2231 provides the framework: a family of Application Modules

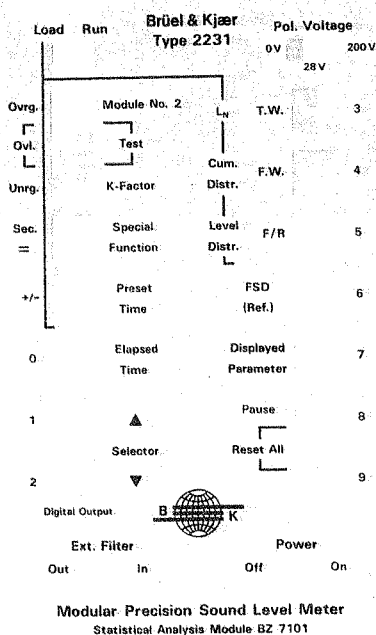
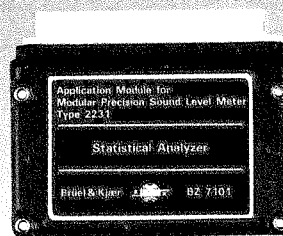


Standard module supplied with the 2231 for which basic specifications are appropriate. Fast data sampling rate ensures optimum accuracy. Displays any of the following 8 parameters:

- 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)

The DC Output may be used to obtain plots of any of these parameters

SPECIAL FUNCTIONS include: automatic digital readout after predetermined interval, data inhibit facility (including deletion of set amount of data prior to activation), display PEAK on quasi-analogue scale.



In addition to the 8 parameters mentioned above, it can display:

$$L(99.0) - L(90.0) - L(50.0)$$

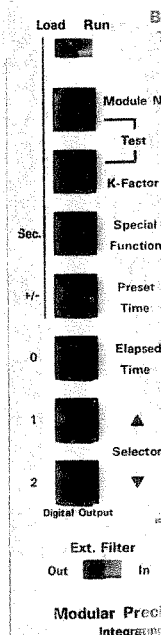
$$L(10.0) - L(1.0)$$

It also calculates and displays:

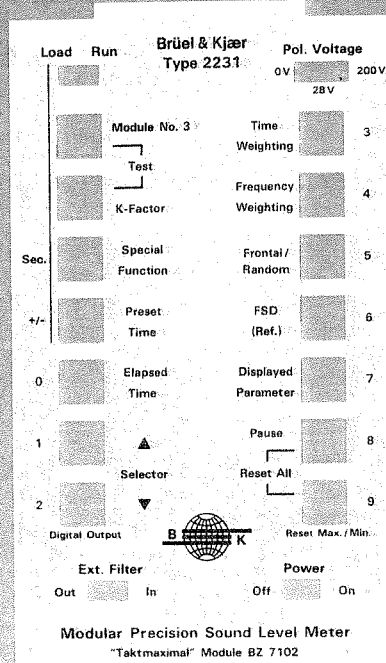
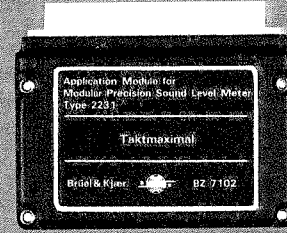
- L(N)
 - Cumulative Distribution
 - Level Distribution
- with 0.5 dB resolution, for any measurement period.

Data sampling is performed four times slower than in the standard module. Impulse weighting is not available.

SPECIAL FUNCTIONS include: display L(N) for any value of N (in 0.1 % steps), calculate Cum. Dist. and Level Dist. with variable resolution, data inhibit including deletion of set amount of data prior to activation.



Modules enables an entire range of measurement possibilities.



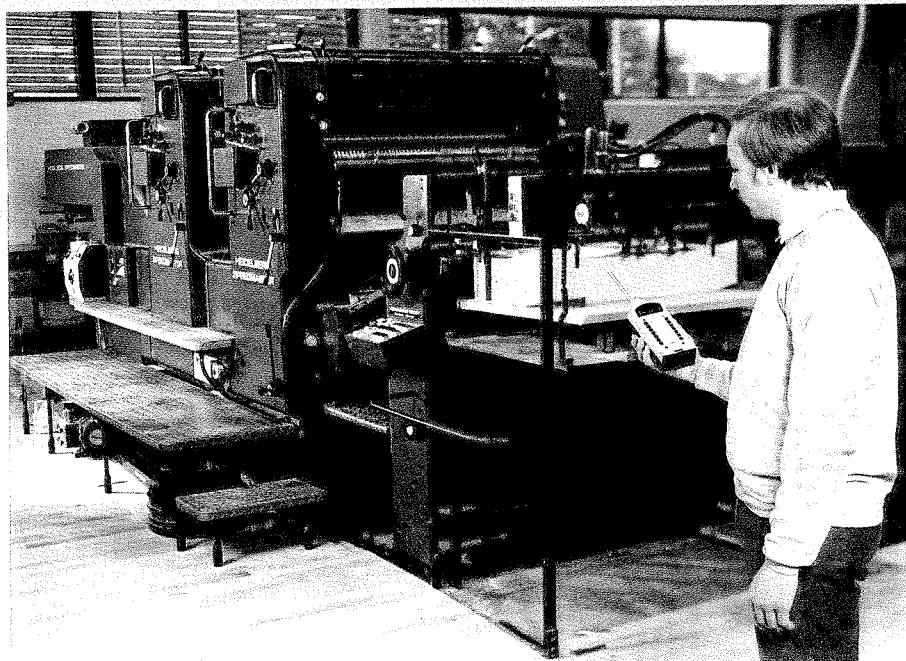
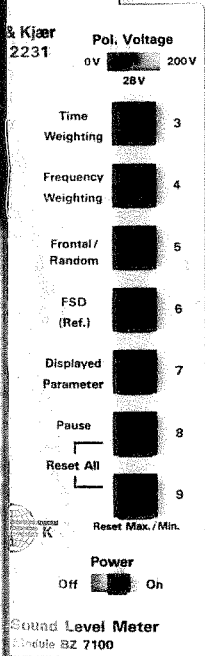
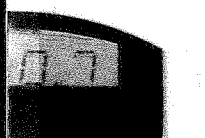
Displays any of the following 10 parameters:

- MAXP (max. peak hold)
- PEAK (max. peak in 1s period)
- INST (samp. RMS in 1s period)
- SPL (max. RMS in 1s period)
- LT (3s and 5s Takt)
- MAXL (max. SPL hold)
- MINL (min. SPL hold)
- LEQ (or LIm with I time weighting)
- LTm3, LTm5
- SEL (or IEL with I time weighting)

The DC Output may be used to obtain plots of any of these parameters

Data sampling is performed at half the rate of that in the standard module.

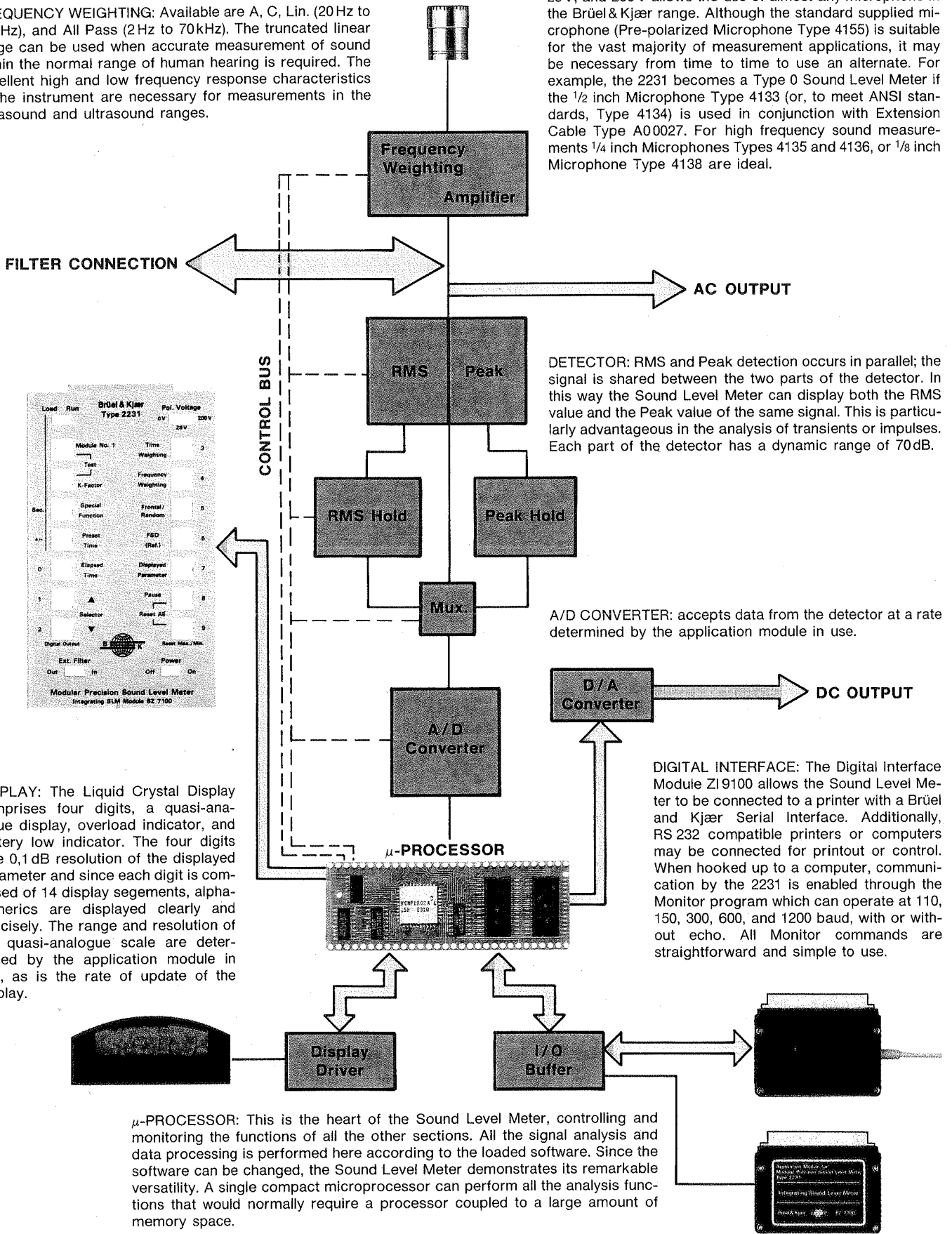
SPECIAL FUNCTIONS include: digital readout after predetermined interval, data inhibit facility (including deletion of set amount of data prior to activation), display PEAK on quasi-analogue scale, change quasi-analogue scale from 2dB to 1dB resolution.



Advanced construction: enhanced capabilities

FREQUENCY WEIGHTING: Available are A, C, Lin. (20Hz to 20kHz), and All Pass (2Hz to 70kHz). The truncated linear range can be used when accurate measurement of sound within the normal range of human hearing is required. The excellent high and low frequency response characteristics of the instrument are necessary for measurements in the infrasound and ultrasound ranges.

MICROPHONE: A selectable polarization voltage of 0V, 28V, and 200V allows the use of almost any microphone in the Brüel & Kjær range. Although the standard supplied microphone (Pre-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.



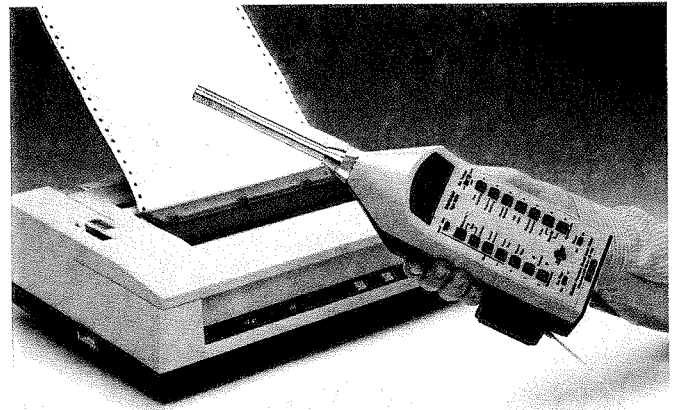
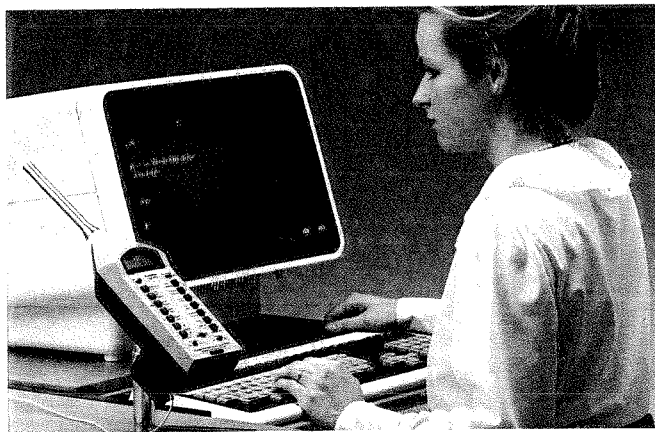
Accessories - expand the measurement possibilities.

INTERFACE MODULE ZI9100.

Since the 2231 can be left to operate automatically, printed results may be very useful. Interface Module ZI9100 is required for the transmission of data to a printer. A compatible printer must be able to receive data over an RS232C interface, and respond to the signal voltage levels which are generated by the 2231.

Printout can be obtained manually, automatically, or under the control of a computer. Automatic printout is normally initiated at the end of a preset time period, allowing for a hard copy of the measured data to be obtained at preset intervals during a long measurement.

The format of the printout is selectable, ranging from detailed, fully annotated readouts to concise, single line information. Even in the shortest format, measured data and primary instrument settings are given so that all the necessary information is at hand.



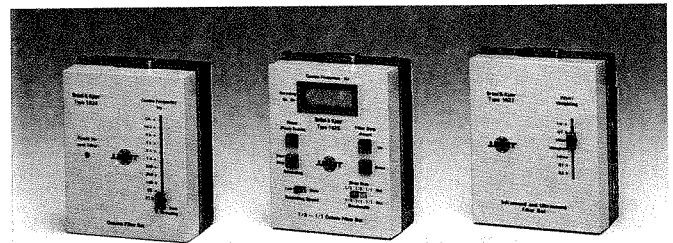
Control of Sound Level Meter Type 2231 over the interface requires a computer or terminal with a compatible interface. The 2231 transmits data through a Brüel & Kjær Serial Interface, which is structured close to RS232C.

The 2231 is equipped with a Monitor program, through which all communication via the interface is carried out. The Monitor program allows full control of all instrument settings.

The Interface Module ZI9100 is inserted into the socket at the rear of the Sound Level Meter (the same socket as is used for the Application Modules) and remote control is established in a number of ways depending on the user's requirements. The communication process is facilitated by the ease with which the few Monitor commands can be used.

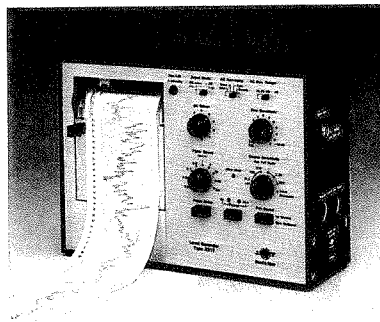
EXTERNAL FILTERS:

Three filter sets may be used with the 2231: Octave Filter Set Type 1624, $1/3$ - $1/1$ Octave Filter Set Type 1625, and Infrasound and Ultrasound Filter Set Type 1627. Each filter set snaps directly to the bottom of the Sound Level Meter. Filter Sets Types 1624 and 1625 may be used in conjunction with a level recorder such as Type 2317 to obtain plots of octave or $1/3$ octave levels. Filter Set Type 1627 contains several infra- and ultra-sound filters in accordance with IEC recommendations.



LEVEL RECORDERS:

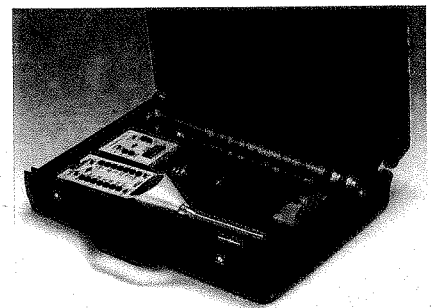
The 2231 has two signal outputs (AC and DC) for level recording. For laboratory and field work Type 2317 Level Recorder is ideal. Weighing only 3,5kg, it nevertheless satisfies IEC 651 precision Type 1 for documenting measurements by the 2231. Typical uses of the 2317 plus 2231 (depending on the Application Module used) include direct recording of the signal, octave and $1/3$ octave analysis recording, and plotting of sound level decays for the direct measurement of reverberation time.

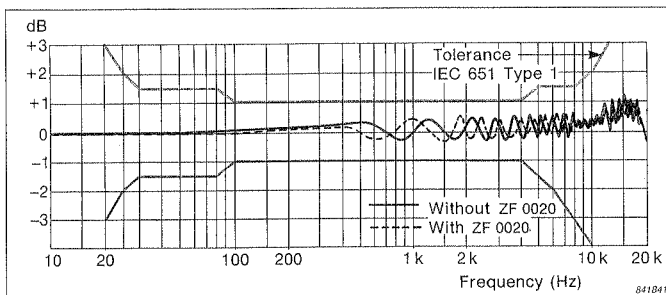


FIELD MEASURING SET:

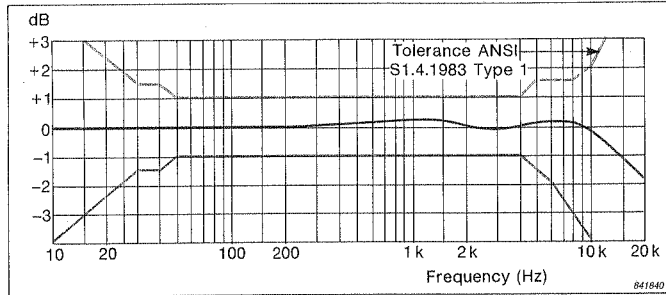
A combination of Sound Level Meter Type 2231 with a Filter Set (e.g. Type 1624 or Type 1625) and some of the more commonly used accessories in a practical Carrying Case KE 0226, results in a compact field measuring set.

The addition of extra application modules will significantly expand the measurement capabilities of the set without increasing the amount of equipment to be transported. For the first time, a complete acoustical analysis system is available in a lightweight, truly portable package.





Typical 0° free field frequency response of the complete instrument.



Typical diffuse field frequency response of the complete instrument.

SPECIFICATIONS TYPE 2231 / BZ 7100

MEASURING RANGE:

With standard microphone (Type 4155):

FSD ¹	Measuring Range		
	Lower limit for S/N ratio >5 dB (A-weighting)	Max. peak level	Upper limit for signals of crest factor =10 (20 dB)
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 ³
140 ²	80	153 ³	133 ³

T00633GB0

¹ FSD on quasi-analogue display

² Only with attenuator ZF 0020 employed

³ Max values may diverge slightly from nominal value depending on microphone K₀ factor

FREQUENCY WEIGHTING:

A, C weighting in acc. with IEC 651 Type 1 (and Type 0)

Linear (10 Hz to 20 kHz)

All-pass (2 Hz to 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

CONVERTABILITY:

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 ZI9100. Open circuit signal level ± 5V (min. Send level ± 2V, min. Receive level ± 1V).

DISPLAY:

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

Quasi-analogue: 60 dB scale with 2 dB resolution for monitoring current SPL (RMS or Peak)

Additional functions:

Overload occurring: ↑

Overload has occurred: ^

Battery near low level: BAT flashing

Battery low level: BAT flashing plus ↑ (non-resettable)

Overrange: □ - - -

Underrange: □ - - -

Selected value outside allowable range: * * * *

Error code: M E - -

AC OUTPUT:

1 V RMS for full scale, output impedance < 120 Ω, short circuit protected, mini-jack socket.

DC OUTPUT:

3 V for full scale, 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}, SEL 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: 0V, 28V, 200V.

Allows use of almost any microphone in the Brüel & Kjær range.

CALIBRATION:

Acoustical: With Sound Level Calibrator Type 4230 or Pistonphone Type 4220 by potentiometer adjustment

Electrical: With internal reference source by potentiometer adjustment

REFERENCE CONDITIONS FOR

ACOUSTICAL CALIBRATION

(AS OBTAINED 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 dBFS

WARM-UP TIME: <5 s

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 (x2)..... JP 0213

Windscreen..... UA 0237

Input Adaptor..... JJ 2614

Screwdriver..... QA 0001

Cells (x4)..... QB 0013

20 dB Attenuator..... ZF 0020

Integrating SLM Module..... BZ 7100

ACCESSORIES AVAILABLE:

Sound Level Calibrator..... Type 4230

Level Recorder Cable..... AO 0173

3 m Microphone Extension cable..... AO 0027

Carrying case..... KE 0226

Statistical Analysis Module..... BZ 7101

"Taktmaximal" Module..... BZ 7102

Interface Module..... ZI 9100



Brüel & Kjær

DK-2850 NÆRUM, DENMARK · Telephone: + 45 2 80 05 00 · TELEX: 37316 bruka dk