

Precision Integrating Sound Level Meter

USES:

- Measurement of Sound Pressure Level (SPL)
- Determination of L_{eq} for assessment of hearing loss risk or noise annoyance.
- Measurement of cyclical machine noise
- Determination of Sound Exposure Level ($L_{EA,T}$)
- Measurement of Max. and Min. noise levels
- Spatial averaging of machine noise
- Sound power level measurements according to survey method
- Octave or $1/3$ octave frequency analysis with filters Types 1624 and 1625

FEATURES:

- RMS and Peak detector modes
- Impulse, Fast and Slow time weightings
- Fulfils IEC 804 Type 1, and relevant sections of IEC 651 Type 1I, and ANSI S1.4.1971 Type 1
- Digital and quasi-analogue liquid crystal display
- 73 dB Pulse range; 70 dB Linearity range
- 24 to 130 dB measuring range (30 to 150 dB with attenuator) in 6 overlapping sub-ranges
- A, C, Lin. and All-pass weightings

The Precision Integrating Sound Level Meter Type 2230 is a Type 1 precision instrument. Its comprehensive construction and versatility make it ideal for all kinds of sound level measurements including octave and $1/3$ octave frequency analysis using a snap-on filter set.

The Type 2230 carries out five measurements in parallel: SPL, Max., Min., L_{eq} and $L_{EA,T}$, all of which can be obtained for the same signal. A choice between 2 detector modes (RMS and Peak), 3 time weightings (Slow, Fast, Impulse), 4 frequency weightings (A, C, Lin and All pass) is available for the measurements.

A partial (Max./Min.) reset, a total reset and a pause function increase the usefulness of the instrument. A linear free or a linear diffuse field frequency response is obtained by electronic frequency weighting for measurements in accordance with IEC or ANSI standards.

The measurements are displayed with 0,1 dB resolution on a large 4 digit liquid crystal display. The SPL is continuously monitored on a quasi-analogue 60 dB scale. Indications of overload, depleted batteries and illegal settings are also displayed.

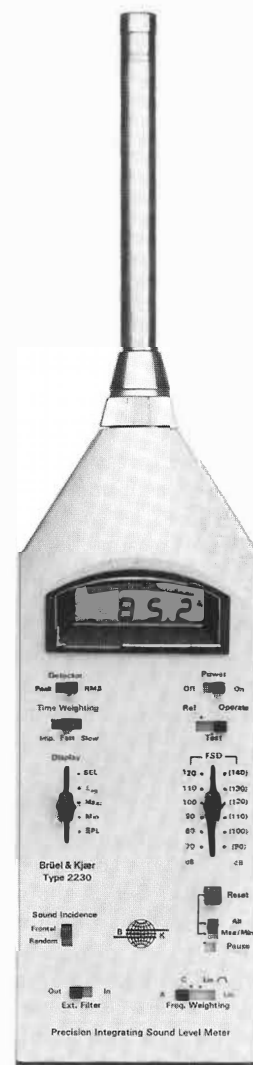
AC and DC outputs allow chart or tape recordings and audio monitoring of the SPL with the selected frequency weighting.

Despite its Type 1 performance and the numerous functions included, the Type 2230 is 37 cm long and weighs less than 1 kg. It is easily held in one hand, even when the Filter Set is connected.

The Precision Integrating Sound Level Meter Type 2230 complies with the IEC 804 Type 1 and IEC 651 Type 1I and ANSI S1.4.1971 Type 1 standards.

In addition to offering Type 1 precision, the main characteristic of the Type 2230 is versatility. Functions normally requiring several instruments have been included in this single hand-held Sound Level Meter.

The principle of the Type 2230, sampling of the detector output followed by analogue to digital conversion and processing by microprocessor, enables it to carry out five measurements: SPL, Min., Max., L_{eq} and $L_{EA,T}$. As all five measurements are made in parallel, the five values can be read successively for the same signal. Min. and Max. can be reset without resetting the other measurement values. L_{eq} and $L_{EA,T}$ measurements must be carried out in "RMS" mode with a Fast time weighting. All other measurements can be carried out in either "RMS" mode with "Slow", "Fast" or "Impulse" time weightings, or "Peak" mode. All these measurements, with the various time weightings and detector modes, can be made in accordance with either IEC or ANSI standards, i.e. with either a linear free field or a linear diffuse field frequency response for the microphone. The change in fre-



frequency response is obtained electronically.

A, C, Lin (20 Hz to 20 kHz) or All Pass (10 Hz to 50 kHz) frequency weightings can be used for all measurements. For increased versatility the SLM directly accepts the plug-in Filter Sets Type 1624 or 1625 for octave/third octave frequency analysis. Semi- or fully automatic recording of the analysis is possible using portable Level Recorder Types 2317 or 2309.

DC and AC outputs permit chart or tape recording as well as audio monitoring. A test mode allows a check of the complete display. A reference mode allows a quick electrical calibration of the SLM (excluding microphone and input stage) and connected recording equipment.

SPL measurements

The Type 2230 carries out measurements of SPL over the range 24 to 130 dB (30 to 150 dB with supplied Attenuator ZF 0020). The measured SPL values are displayed on the digital display with a resolution of 0.1 dB and on the quasi-analogue display with a resolution of 2 dB. The digital display is updated once a second while the quasi-analogue display is updated 64 times per second allowing continuous monitoring of the measured SPL

Max./Min.

The maximum or minimum SPL since the last time the instrument was reset is currently displayed. Max/Min detectors may be reset without resetting the other measurement functions.

L_{eq}

L_{eq} is the sound pressure level averaged over the measurement period. It can be considered as the continuous steady sound pressure level which would have the same total acoustic energy as the real fluctuating noise over the same time period. The measurement of L_{eq} is based on the equal energy principle:

$$L_{eq} = 10 \text{Log}_{10} \frac{1}{T} \int_0^T \left(\frac{p(t)}{p_0} \right)^2 dt$$

where p_0 is the reference sound pressure (20 μPa), $p(t)$ is the time varying sound pressure and T is the time interval over which it is measured.

The Type 2230 allows L_{eq} measurements over periods of any length up to approximately 8 hours (limited only by battery life).

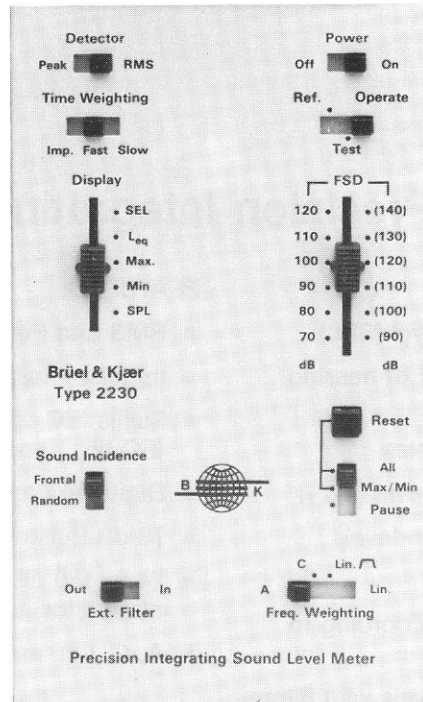


Fig. 1. Front panel of Type 2230

The digital display gives the current L_{eq} value which is updated every second while the quasi-analogue display indicates the current SPL. Warnings of "Overload occurring, †" and "Overload has occurred, ^" are also displayed. The measurement time is obtained using the L_{eq} and $L_{EA,T}$ values and the conversion table on the back of the instrument. Indication (†) is also given in cases of incorrect settings i.e. other than "RMS" "Fast". A pause function permits exclusion of unwanted noise events from the measurement.

$L_{EA,T}$ (SEL)

Sound Exposure Level ($L_{EA,T}$) is the constant level which if maintained for

a period of 1 second would have the same acoustic energy as the A-weighted measured noise event:

$$L_{EA,T} = 10 \text{log}_{10} \frac{1}{\tau_{ref}} \int_0^T \left(\frac{p_A(t)}{p_0} \right)^2 dt$$

$$\tau_{ref} = 1 \text{ s}$$

The measurement time limit for the $L_{EA,T}$ is determined only by the battery life. The instantaneous $L_{EA,T}$ value is given by the digital display while the current SPL is given by the quasi-analogue indicator.

Microphone

The Type 2230 is equipped with a 1/2" prepolarized condenser microphone Type 4155. It has a linear 0° incidence free field frequency response which is well suited for measurements in free field conditions e.g. for outdoor measurements. The frequency response of the microphone can be electronically weighted to obtain a linear diffuse field frequency response well suited for diffuse field condition measurements. When measuring in accordance with IEC or ANSI standards simply select the appropriate microphone frequency response, i.e. "Frontal" or "Random".

The removable preamplifier, with very high input impedance and very low output impedance, allows use of extension cables between the microphone and the Sound Level Meter body. A Dehumidifier UA 0308 is available for use in humid environments.

An Input Adaptor JJ 2614 accepting different types of plugs may be fitted instead of the microphone to connect other signal sources.

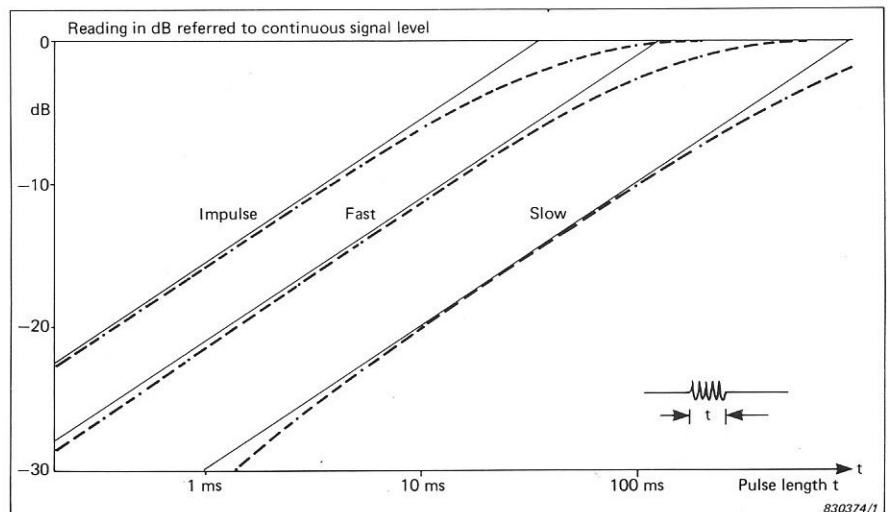


Fig. 2. Response of rectifier to tone burst of varying duration

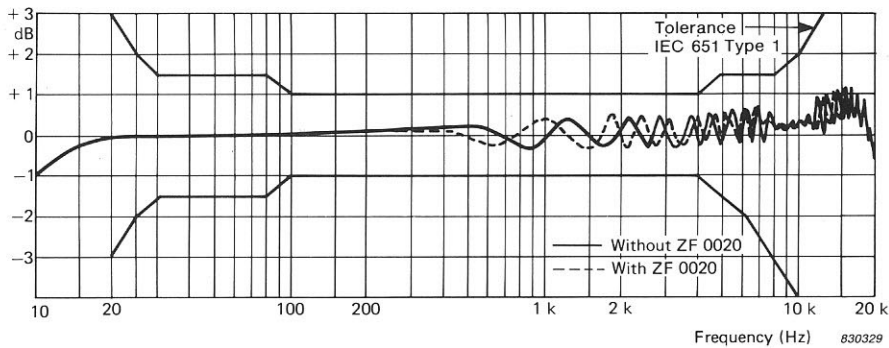


Fig. 3. Typical 0° free field frequency response of the complete instrument

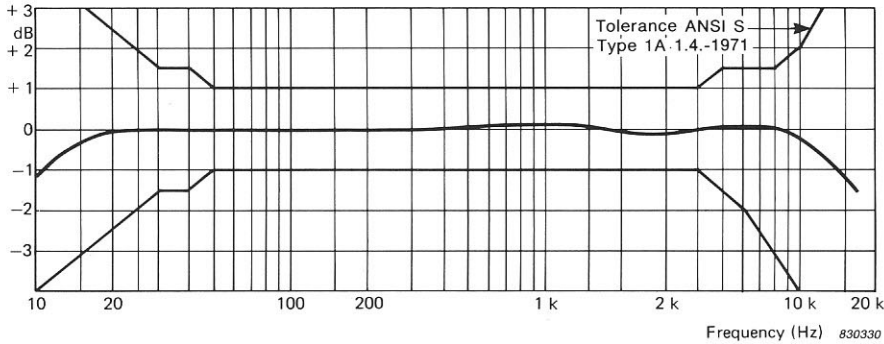


Fig. 4. Typical diffuse field frequency response of the complete instrument

Frequency weighting

Four built-in frequency filters give "A" and "C" weightings in accordance with IEC 651, and "Lin" (20 Hz to 20 kHz) and "All-pass" (10 Hz to 50 kHz). The AC and DC output signal and the signal sent to the external filter set are also frequency weighted.

Measuring range

Six attenuator settings give 6 overlapping 70 dB measuring ranges from 24 dB to 130 dB. Use of the supplied 20 dB Attenuator ZF 0020 gives a measuring range from 30 to 150 dB. The displayed value is automatically corrected to take in account the presence of this attenuator.

Display

The comprehensive liquid crystal display comprises four digits giving a 0,1 dB resolution for display of the selected measured value and a 60 dB quasi-analogue display with 2 dB resolution for continuous visual monitoring. The digital and quasi-analog displays are respectively updated once and 64 times per second.

The following warnings are also displayed:

↑: overload is occurring

↑: overload has occurred

BAT (flashing): battery near low level

BAT (flashing) & ↑ (non-resettable): battery depleted

↑ (non-resettable): illegal setting

↑ (non-resettable): illegal setting

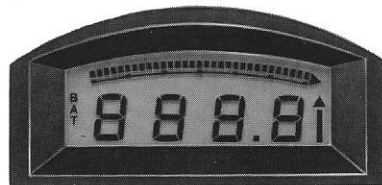


Fig. 5. Display of Type 2230

External Filters

Two Filters sets are specially designed for use with the Type 2230: The Octave Filter Set Type 1624 and the $1/1$ and $1/3$ Octave Filter Set Type 1625. These Filters are connected directly to the bottom of the Sound Level Meter (Fig.6). In situ frequency analysis can be obtained using these Filters, and recorded using Level Recorders Types 2317 or 2309. The Type 1624 enables octave band analysis, which can be recorded semi-automatically, and the Type 1625 enables $1/3$ octave or octave (with octave or $1/3$ octave stepping) band analysis which can be recorded fully automatically.

The Filter Set Type 1624 includes 10 octave filters with centre frequency from 31,5 Hz to 16 kHz. The Filter Set Type 1625 includes 31 third-octave filters and 31 overlapping octave filters from 20 Hz to 20 kHz.

Operating mode

The Sound Level Meter can be set to "Operate" (normal mode), to "Test" and "Ref." modes. The test mode al-



Fig. 6. Sound Level Meter Type 2230 with $1/1 - 1/3$ Octave Filter Set Type 1625

lows a complete check of the display by turning on all the segments. In "Ref." mode a reference signal is applied to the input amplifier for electrical calibration of the SLM (excluding microphone and input stage), and for calibration of chart or tape recorders.

AC and DC outputs

AC and DC outputs allow precise chart and level recording of the measured SPL. The AC output also allows audio monitoring of the input signal.

Use with other instruments

Level recordings of noise events or frequency analysis can easily be carried out in situ with the portable Level Recorders Types 2317 or 2309. For laboratory analysis the signal can be recorded with the portable Tape Recorders Type 7005, 7006 or 7007.

Calibration

Acoustical calibration of the complete instrument is carried out using the Sound Level Calibrator Type 4230 or the Pistonphone Type 4220. Type 4220 gives a reference level of 124 dB re. 20 μ Pa, while Type 4230 gives a reference level of 94 dB re. 20 μ Pa.



Fig. 7. Sound Level Calibrator Type 4230 and Pistonphone Type 4220

For electrical calibration of the Type 2230 and connected instruments such as chart or tape recorders, a reference oscillator is built-in. The sensitivity adjustment of the Type 2230 is made using the potentiometer located on the side panel

Reset

The instrument is reset completely either by pressing RESET "All" or when changing the measurement range. When the instrument is reset manually, two types of resetting are possible: a reset of the complete instrument, or a reset of the max. and min. detectors, i.e. without interruption of L_{eq} and $L_{EA,T}$ measurements.

Pause

A pause function allows exclusion of unwanted noise events from L_{eq} , $L_{EA,T}$ or Max./Min. measurements. The Pause function also permits spatial averaging of the SPL.

Power supply

The power is supplied from 4 alkaline cells (IEC LR 6) which will provide approximately 8 hours of continuous operation. A warning is displayed when the batteries are low. Alternatively, the Mains Power Supply and Charger ZG 0254 (option), including a drawer with rechargeable cells, can be used. ZG 0254 can power the Sound Level Meter and recharge the cells simultaneously.



Fig. 8. Field Measuring Set

Specifications 2230

MEASURING RANGE:

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

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 RESPONSE:

See Figs.3 and 4

FREQUENCY WEIGHTING:

A, C weighting to IEC 651 Type 1
Linear (20 Hz -20 kHz)
All-pass (10 Hz -50 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
"F": to IEC 651 Type 1
"S": to IEC 651 Type 1
"Peak": rise time <50 μ s
Max. Hold decay rate: 0 dB/s (digital)

L_{eq} RESPONSE TIME FOR CONSTANT INPUT SIGNAL:

1 s after reset

MAXIMUM MEASUREMENT PERIOD:

Only limited by battery life

DISPLAY:

Digital: 4 digits 7 segments, liquid crystal, 8 mm high, resolution 0,1 dB
Quasi-analogue: 60 dB scale with 2 dB resolution for monitoring current SPL

Additional functions:

Overload occurring: \uparrow
Overload has occurred: \wedge
Battery near low level: BAT flashing
Battery low level: BAT (flash.) \uparrow (non-reset.)
Illegal setting: \uparrow

AC OUTPUT:

1 V RMS for full scale, output impedance $\leq 120 \Omega$, short circuit protected, mini-jack socket

DC OUTPUT:

3 V for full scale, 0 V bottom scale, 50 mV/dB, output impedance $\leq 500 \Omega$, short circuit protected, mini-jack socket

RESET FUNCTION:

Automatic reset all occurs when changing FSD setting.
Reset all: Max./min. detectors, L_{eq} , $L_{EA,T}$ and overload detector are reset
Reset max./min.: Only max./min detectors are reset

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

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 WITH TYPE 4230:

Type of Sound Field: Free
Reference Incidence Direction: Perpendicular to microphone diaphragm
Reference SPL: 94 dB (re 20 μ Pa)
Reference Frequency: 1 kHz
Reference Temperature: 20°C
Reference Measuring Range: 110 dB FSD

WARM-UP TIME:

<5 s for 0,5 dB; <10 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 \varnothing sted) 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 x 85 x 47 mm (14,7 x 3,3 x 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

ACCESSORIES AVAILABLE:

Carrying case KE 0226
Tripod UA 0801
Sound Level Calibrator Type 4230
Level Recorder Cable AO 0173
3 m Microphone Extension cable AO 0134
Mains Power Supply and Charger ZG 0254