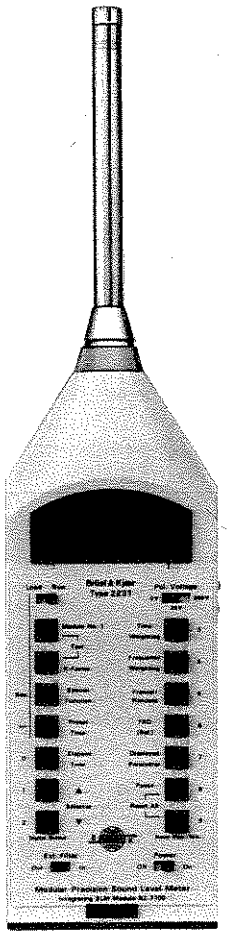
2231

Instruction Manual



Modular Precision Sound Level Meter

Plus Integrating
SLM Application Module

Brüel & Kjær

ADDENDUM

Program Retention with the 2231

For retention of application module programs the 2231 is equipped with a continuous memory. This has its own backup battery built in which is automatically recharged when the 2231 is powered by the batteries contained in its battery drawer. Full charge is obtained by keeping the 2231 switched on for 20 hours and enables programs to be retained for approximately 1 month. For continuous storage of programs, however, it is sufficient to keep the 2231 switched on for 8 hours when first using the instrument and thereafter regularly using the 2231. Provided that the backup battery is kept charged in this manner, the main batteries can be removed from the 2231 without affecting the stored data.

It should be noted that the above charge time is a typical value and applies for operation of the 2231 at room temperature. Charging at temperatures below +10°C is not recommended.

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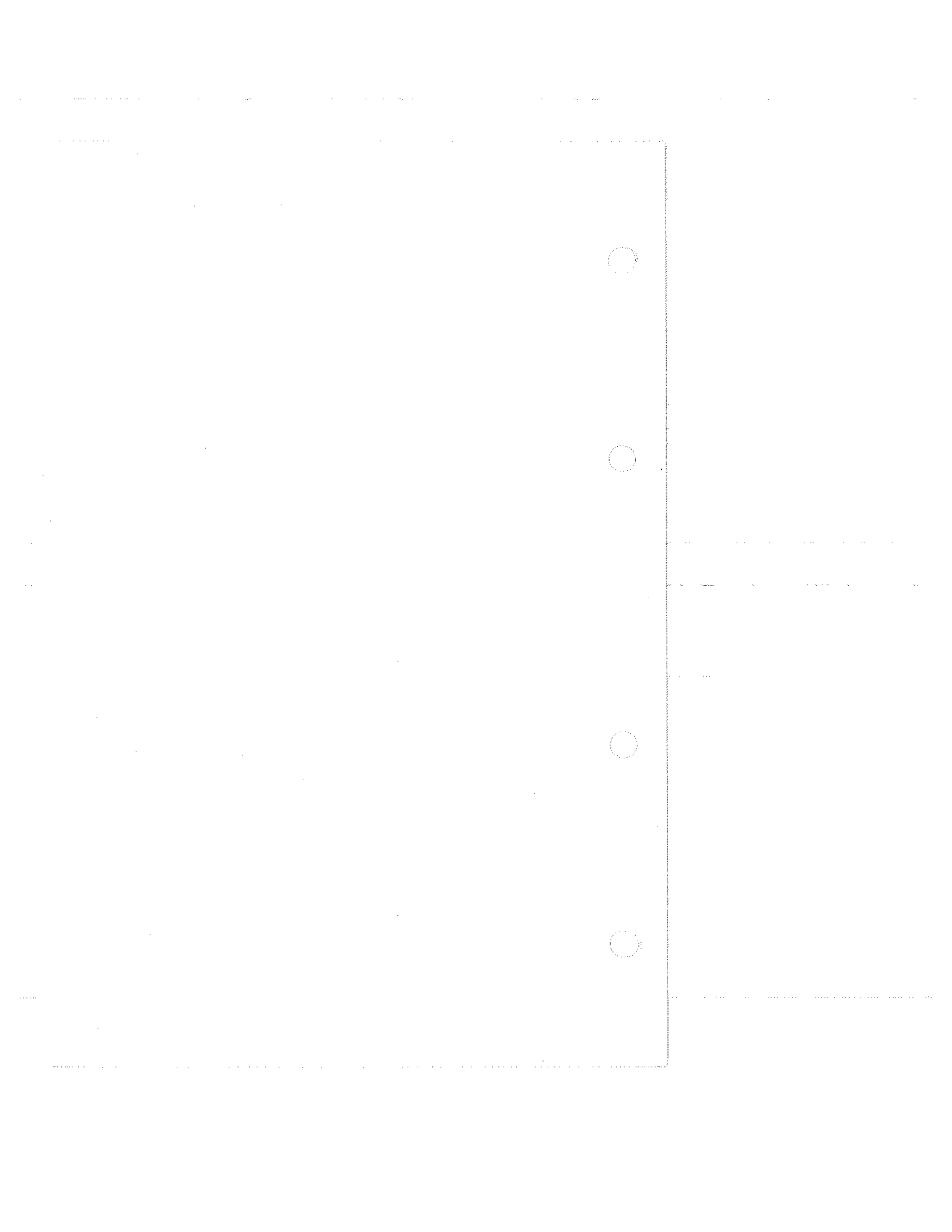


Modular Precision
Sound Level Meter Type 2231
Plus
Integrating SLM Module BZ 7100

From serial no. 1178097

Revision February 1986

1. Introduction

Modular Precision Sound Level Meter Type 2231 is a type 1 precision instrument with a wide range of measurement capabilities. It is convertible, a family of interchangeable modules enabling it to be used for numerous applications. The characteristics of the Sound Level Meter are determined by the module selected for use. The software contained in the module is loaded into the Sound Level Meter, defining the parameters that can be measured.

In general, the Type 2231 performs simultaneously a number of measurements on a signal. A unique feature is that Peak and RMS detection are carried out in parallel, allowing each portion of the same signal to be viewed at the same time. A very wide frequency range of 2 Hz to 70 kHz allows measurements in the infrasound and ultrasound regions.

A number of Special Functions can be implemented with Type 2231, including automatic printout of data at the end of preset time periods. Also, a data inhibit function ensures that sound measurements incorporating timewise integration are not spoiled by spurious events.

Since Type 2231 has a selectable polarization voltage, almost any microphone in the Brüel & Kjær range may be used. With Microphone Type 4133 plus extension cable UA 0027 it becomes a type 0 instrument, in accordance with IEC 651 recommendations.

Features of the 2231 Sound Level Meter include:

- Fulfills IEC 804 type 1, relevant sections of IEC 651 type 1 I, and ANSI S1.4 - 1983 type 1.
- Easy-to-read liquid crystal alphanumeric and quasi-analogue display.
- Selectable polarization voltage allows use of almost any microphone in the Brüel & Kjær range.
- RMS and Peak detection in parallel.
- 73 dB Pulse range; 70 dB RMS Linearity range.

1. Introduction

- 24 to 113 dB(A) * measuring range (30 to 133 dB(A) * with attenuator) in 7 overlapping sub-ranges.
- A, C, Lin. and All-pass weightings.
- Extra wide all-pass frequency range allows infrasound and ultrasound measurements.
- Internal memory has back-up battery power which prevents loss of application software and data when the instrument is switched off.
- Facility for connection of Brüel & Kjær Serial Interface communications port, allowing external control and output of measurement data.
- 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.

* Upper limit for signals of crest factor 10 (=20 dB).

1. Introduction

Considering the numerous and wide ranging capabilities of the 2231, it is very simple to operate. Just load the Application Module and attach the front plate. The pushkeys are comprehensively labeled, and prompts from the display ensure that parameters are programmed correctly and with ease.

This Instruction Manual is designed to be used as a reference guide to operation of the instrument, with easy access to the appropriate sections. Read through it quickly; it also gives a complete overview of the instrument.

Pushkey Directory: Open out the flap on the back cover and keep it open while reading the manual: it will help you to become familiar with the instrument layout in a short time. It can also be used as a quick reference guide to the function of the pushkeys of this Sound Level Meter.

Introduction: You are reading it.

Setting Up: Follow the instructions in this section carefully to ensure accurate measurement procedures.

User Instructions: This is the key section. Read it through so that you may become aware of the instruments capabilities with this module.

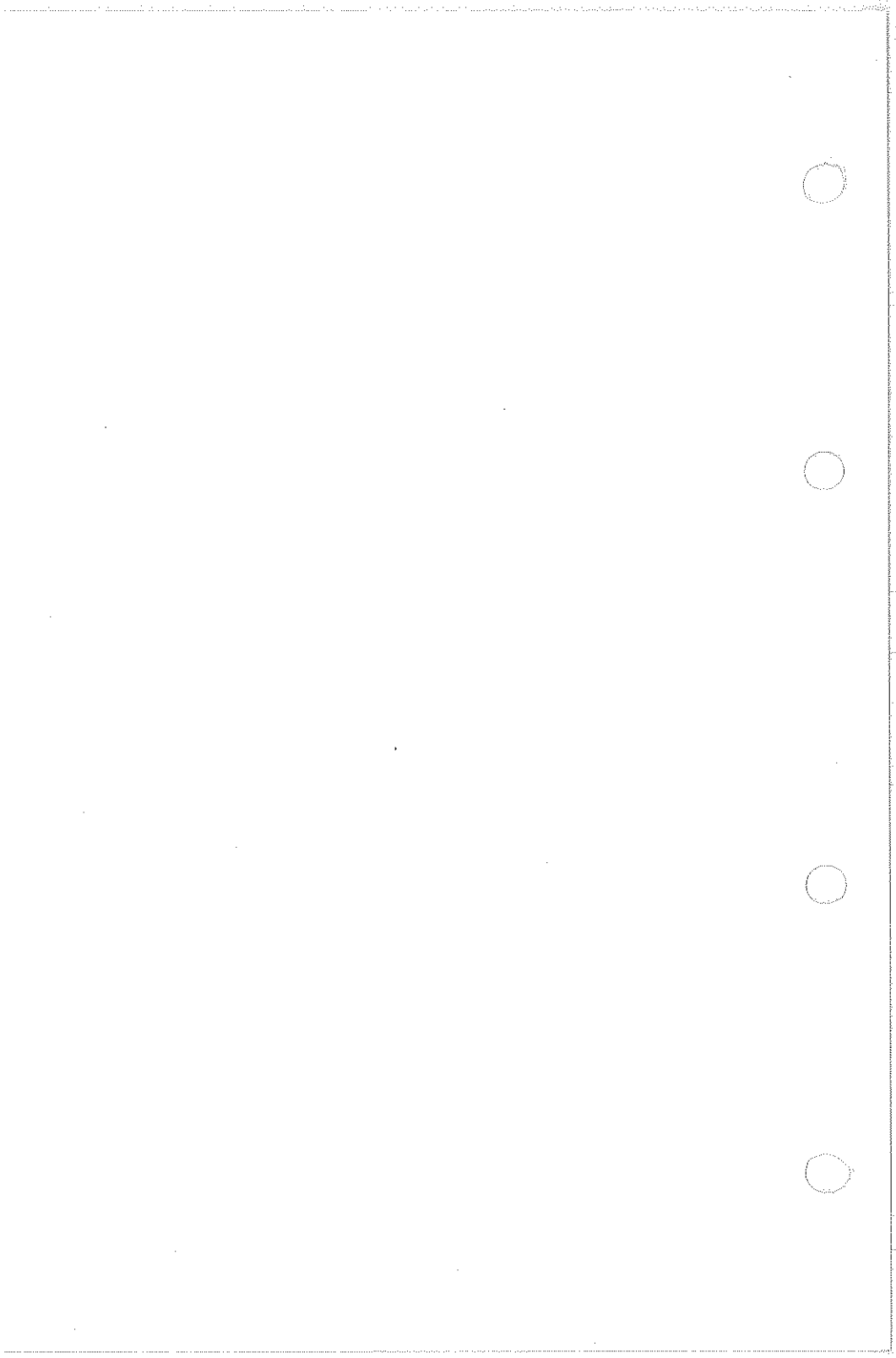
Thereafter it too may be used as a reference guide for correct setting of the necessary parameters.

Other Instruments: To get the most of this instruments measurement capabilities hook up to a recorder or data printer will be most advantageous. This section describes which instruments to use and how they should be connected.

Care and Maintenance: Hints for ensuring trouble-free service.

Specifications: The best in the industry.

Appendices: Contain information useful in understanding the finer points of the Sound Level Meter.



2. Setting up the 2231 Sound Level Meter

This chapter describes the following preliminary procedures necessary for correct setting up of the Sound Level Meter prior to measurement:

Battery installation

Mounting the microphone

Mounting the Front Plate and Inserting the Program Module

Calibration

There is also a brief discussion on the TYPE OF SOUND FIELD and its effect on the measurements to be made by the Sound Level Meter. For more general considerations on sound level measurement techniques the following texts are recommended:

»**Measuring Sound**«
Brüel & Kjær Booklet BR 0047

»**Acoustic Noise Measurements**«
Brüel & Kjær Handbook 18–243

»**Architectural Acoustics**«
Brüel & Kjær Handbook 18–242

Remember: To ensure the validity of your measurement technique and therefore your results, always follow the relevant national or international standards.

2.1. Battery Installation

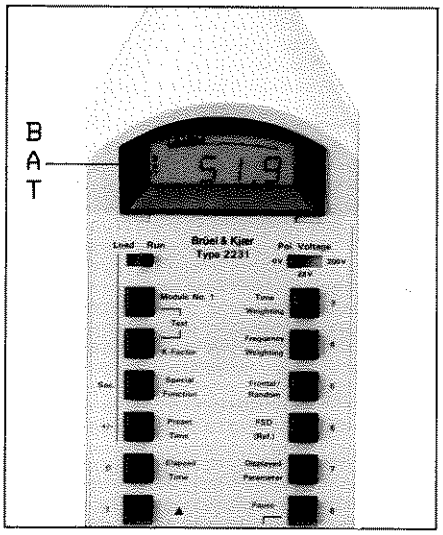


Fig. 2.1. Battery Low display

Battery Type: 1,5 V – IEC type LR6 (B & K No. QB 0013)

No. of Batteries: 4

Battery Life: Approx. 8 hours (Continuous Operation – Alkaline Batteries).

Battery Low: See Fig. 2.1. Flashing "BAT" appears in the display. Approximately 30 min. operation remaining.

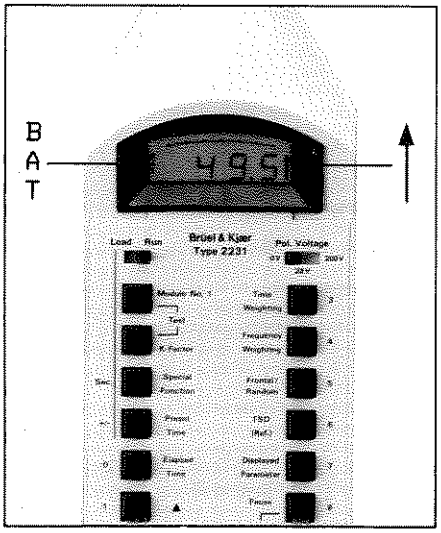


Fig. 2.2. Battery Too Low for Accurate Operation display

Battery Too Low for Accurate Operation: Flashing "BAT" plus non-resettable ↑. See Fig. 2.2. Replace batteries.

2.1. Battery Installation

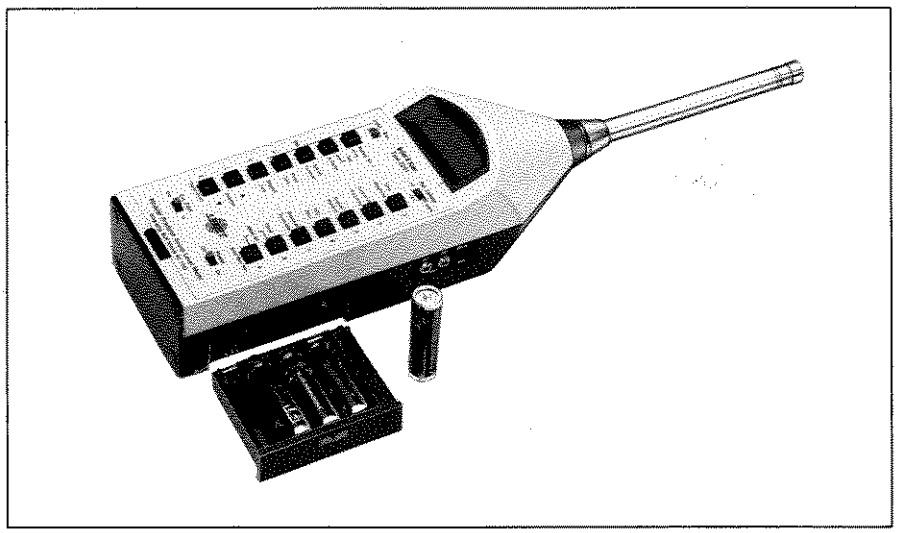


Fig. 2.3. Battery Installation

To install new batteries:

1. Slide battery drawer lock downwards.
2. Remove battery drawer.
3. Insert replacement batteries according to polarity indicated inside drawer.
4. Replace drawer: press in firmly until lock clicks into position.

When Filter Set Type 1624, 1625, or 1627 is connected to the 2231, the batteries of the Filter Set are used as a back-up power supply for the Sound Level Meter, even when **Ext. Filter** switch is in the **"Out"** position. With a Filter Set attached, batteries in the Sound Level Meter may be changed without interrupting a measurement. Replacement of these batteries is in a manner similar to that described above. Full details may be found in the appropriate instruction manual.

Note: For long term storage remove the batteries and keep the instrument in a dry place.

2.2. Microphone Mounting

Before mounting any microphone be sure to observe the following precautions:

- Use only light finger torque for attachment of microphones, input stages, protection grids, extension cables, and preamplifiers.
- Keep dust and foreign objects off the microphone diaphragm. Do not touch the diaphragm with any object. If the diaphragm must be cleaned, very lightly brush with a soft cotton wool swab.

Mounting the Standard Microphone:

1. Set **Pol. Voltage** to **0 V**.
2. Gently screw Microphone Type 4155 onto Input Stage ZC 0020.
3. Insert the Input Stage ZC 0020 into the input stage socket: make sure that the key follows the key slot correctly. (See Fig. 2.4).
4. Secure by turning the threaded retaining ring.

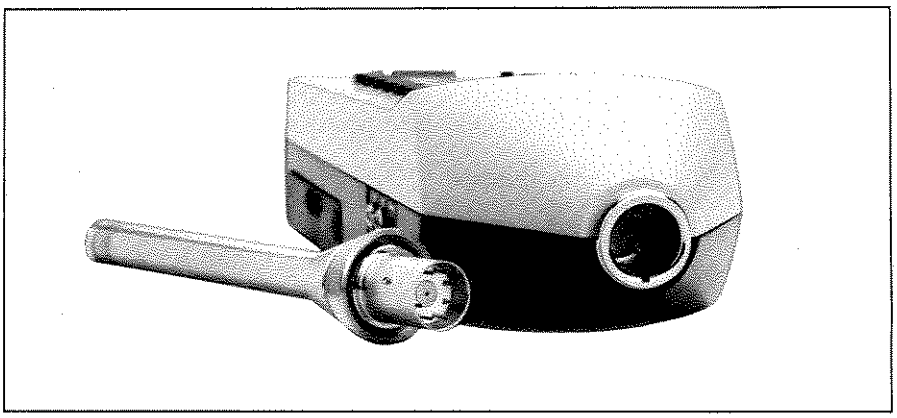


Fig. 2.4. Connection of the Input Stage ZC 0020 to the 2231

2.2. Microphone Mounting

Sound Level Meter Type 2231 can operate with almost any microphone in the Brüel & Kjær range. There are some restrictions, and special application microphones should only be used if completely justified. Appendix A gives details on the use of the different microphones, together with an application guideline, and mounting implications. One special application deserves mention here:

Type 0 Sound Level Meter: (See Fig. 2.5)

1. Gently screw Microphone Type 4133 onto Input Stage ZC 0020. For measurements according to ANSI type 0, use Microphone Type 4134.
2. Insert the Input Stage ZC 0020 into the female connection end of Extension Cable AO 0027 (or Cable AO 0134).
3. Insert the male connection end of the extension cable into the input stage socket of the Sound Level Meter.
4. Secure by turning the threaded retaining ring.
5. Set **Pol. Voltage** to **200 V**
6. Set **Frontal/Random** to "Frontal" (see section 3.12).

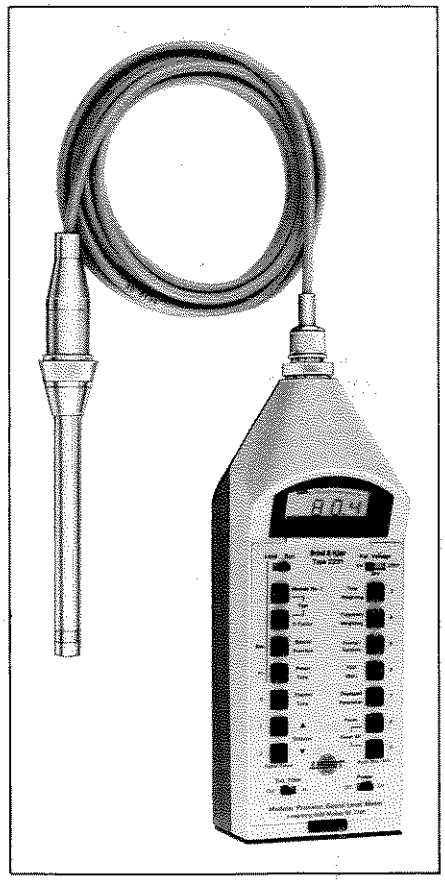


Fig. 2.5. Type 0 Sound Level Meter

2.3. Attaching Front Plate and Application Module

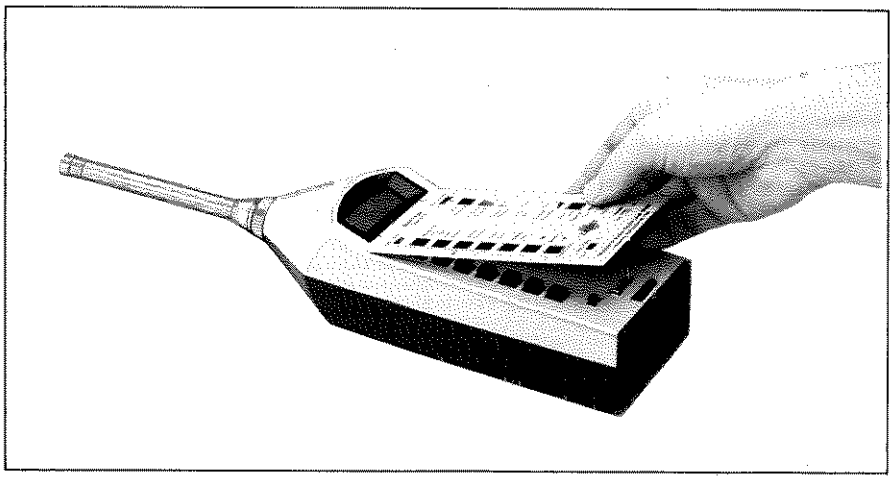


Fig. 2.6. Mounting the Front Plate

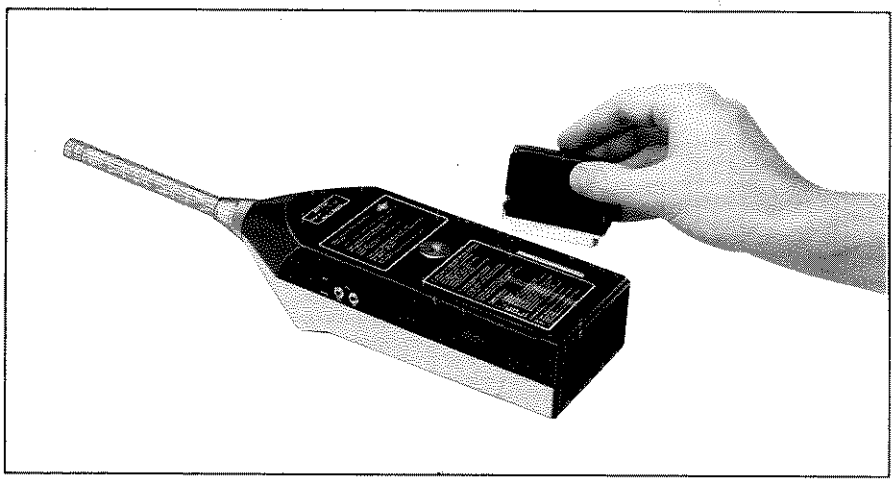


Fig. 2.7. Inserting the Module

Note: When not in use ensure that the module terminals are fitted with the black plastic discharge template. This will protect the module from static electricity.

2.4. Calibration

The calibration instructions in this section require that the 2231 is loaded with an Application Module and that certain programmable parameters such as K-factor and measuring range FSD are selected. Full details on how this is done are given in Chapter 3 – User Instructions.

Calibration Using Internal Generator:

1. Key in the correct K-factor for the microphone (see section 3.5).
2. Set the measuring range **FSD** to "REF".
3. Set **Displayed Parameter** to "SPL".
4. Using the **Sens. Adj.** potentiometer on the side of the instrument (see Fig. 2.8) adjust the sensitivity until the display shows a value of 94,0 dB + K-factor.

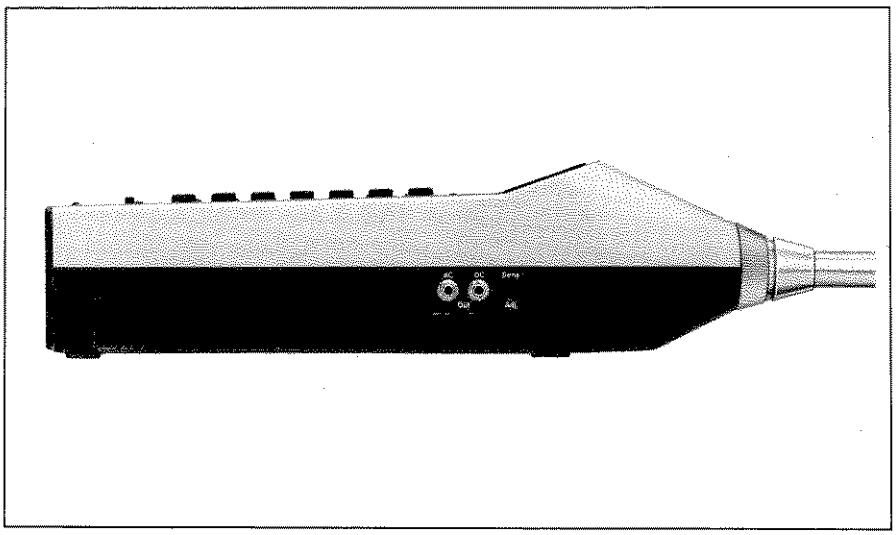


Fig. 2.8. Side view of the 2231 showing the Sens. Adj. potentiometer

2.4. Calibration

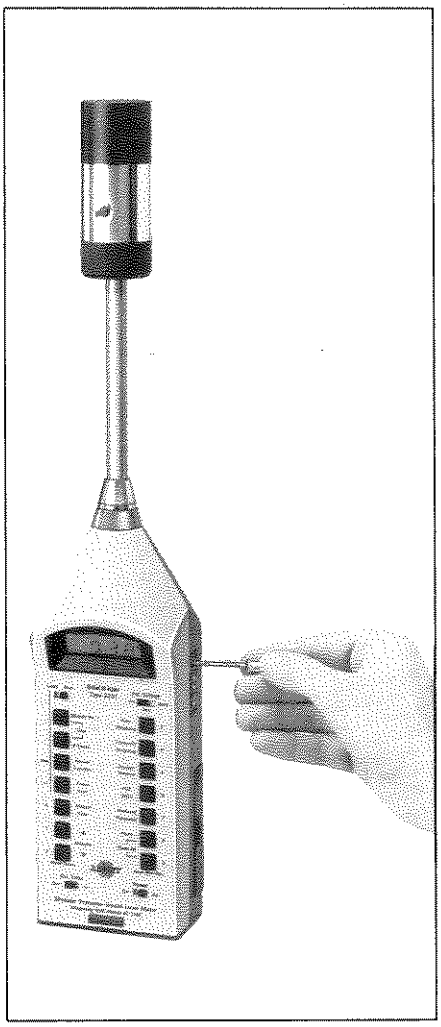


Fig. 2.9. Calibration with Sound Level Calibrator Type 4230

Calibration Using Sound Level Calibrator Type 4230:

1. Key in the correct K-factor for the microphone (see section 3.5).
2. Set the measuring range **FSD** to 110 dB + K-factor.
3. Set **Displayed Parameter** to "SPL".
4. Fit the Calibrator with the appropriate Microphone Adaptor and place it over the microphone so that it makes a snug, steady fit. See Fig. 2.9.
5. Switch on the Calibrator and adjust the **Sens. Adj.** potentiometer on the Sound Level Meter (see Fig. 2.8) until the display shows a value of 93,8 dB for Microphone Type 4155. For other microphones see the 4230 Instruction Manual.

Calibration with Pistonphone Type 4220:

1. Key in the correct K-factor for the microphone (see section 3.5).
2. Set **Frequency Weighting** to "C", "Lin." or "All-Pass".
3. Set the measuring range **FSD** according to the microphone chosen. See Table 2.1.

2.4. Calibration

4. Set **Displayed Parameter** to "SPL".
5. Fit the Pistonphone with the appropriate Microphone Adaptor and place it over the microphone so that it makes a snug, steady fit. See Fig. 2.10.
6. Switch on the Pistonphone and adjust the **Sens. Adj.** potentiometer on the Sound Level Meter (see Fig. 2.8) until the display shows 124,0 dB. (This is the nominal level. The actual level will depend on the ambient conditions*).

Microphone Type	Full Scale Deflection
4155 4165, 4166 4144, 4145, 4160 4129, 4176	120 dB + K-Factor
4155 + ZF 0020 4133, 4134, 4149 4135, 4136 4138	110 dB + K-Factor

T90678GB0

Table 2.1. FSD settings on the 2231 when used with various microphones

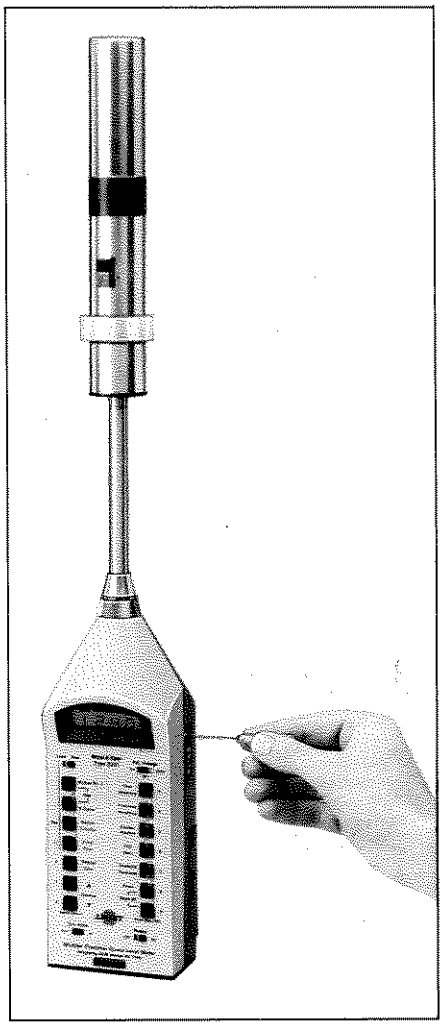


Fig. 2.10. Calibration with Pistonphone Type 4220

* See calibration chart for the 4220

2.5. Type of Sound Field

Microphone Type 4155, which is the standard microphone fitted to the 2231 Sound Level Meter, is designed to have a linear free-field response for 0° sound incidence. Using the **Frontal/Random** pushkey the microphone output may be corrected to obtain a linear response under diffuse-field conditions. The procedure for selecting the correct sound incidence correction parameter is given in section 3.12. The correct application of this facility is outlined in Fig. 2.11: the central issue is whether the measurements should be in accordance with IEC or ANSI standards.

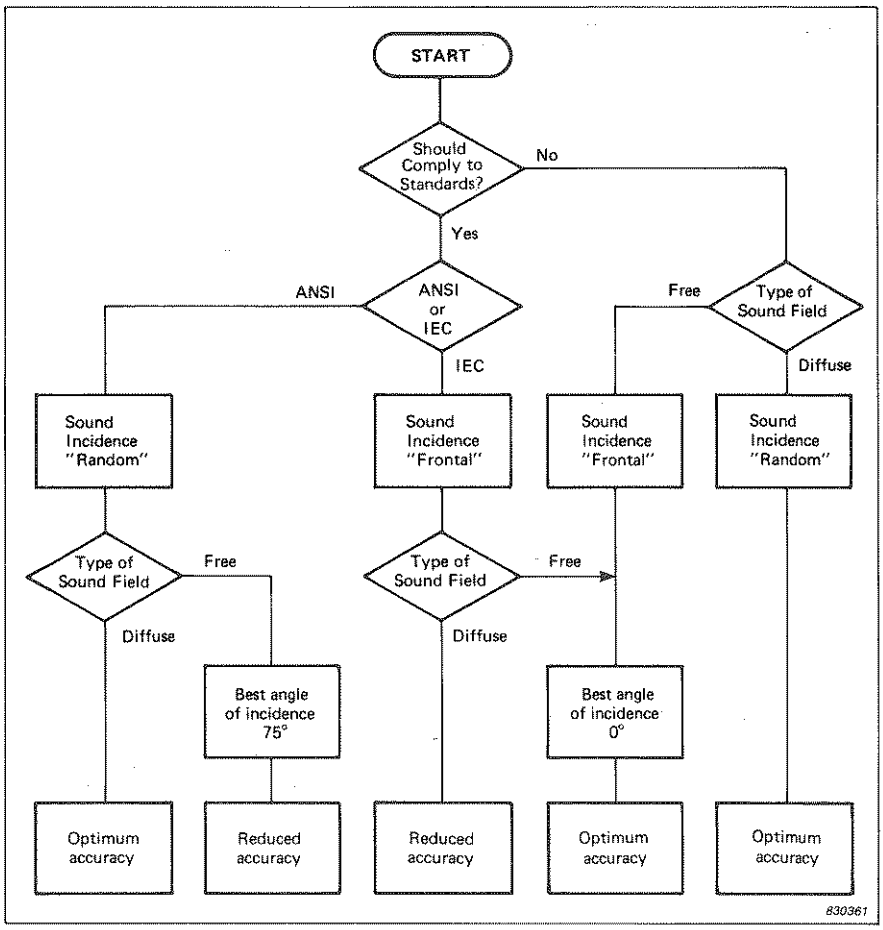


Fig. 2.11. Flow chart to assist in the determination of the Frontal/Random setting

2.5. Type of Sound Field

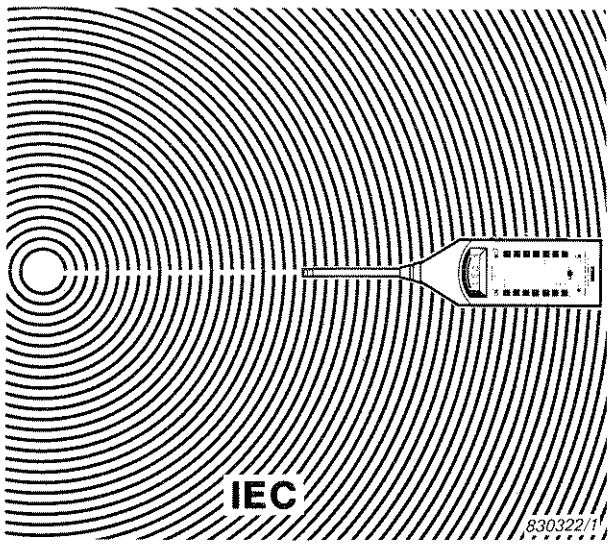


Fig. 2.12. Free-field measurements according to IEC recommendations

IEC Standard:

- Select "Frontal" sound incidence correction.
- Point Sound Level Meter directly at the source if a free-field condition is assumed to exist (See Fig. 2.12).

2.5. Type of Sound Field

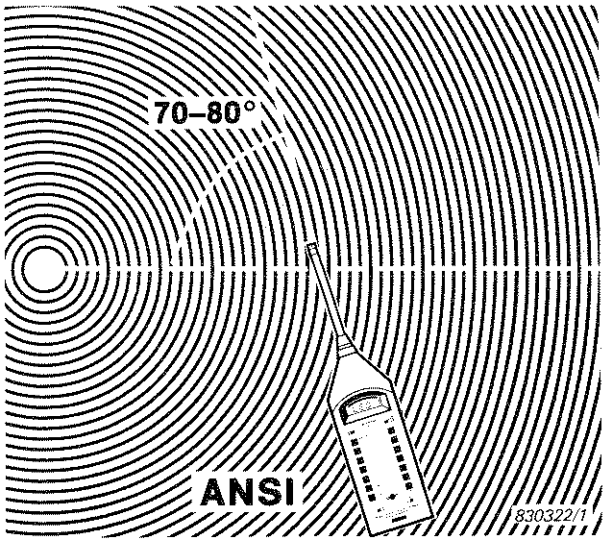


Fig. 2.13. Free-field measurements according to ANSI recommendations

ANSI Standard:

- Select "Random" sound incidence correction.
- For diffuse-field conditions the Sound Level Meter may be oriented in any direction.
- Under ideal free-field conditions optimum response is obtained by orienting the Sound Level Meter as shown in Fig. 2.13.

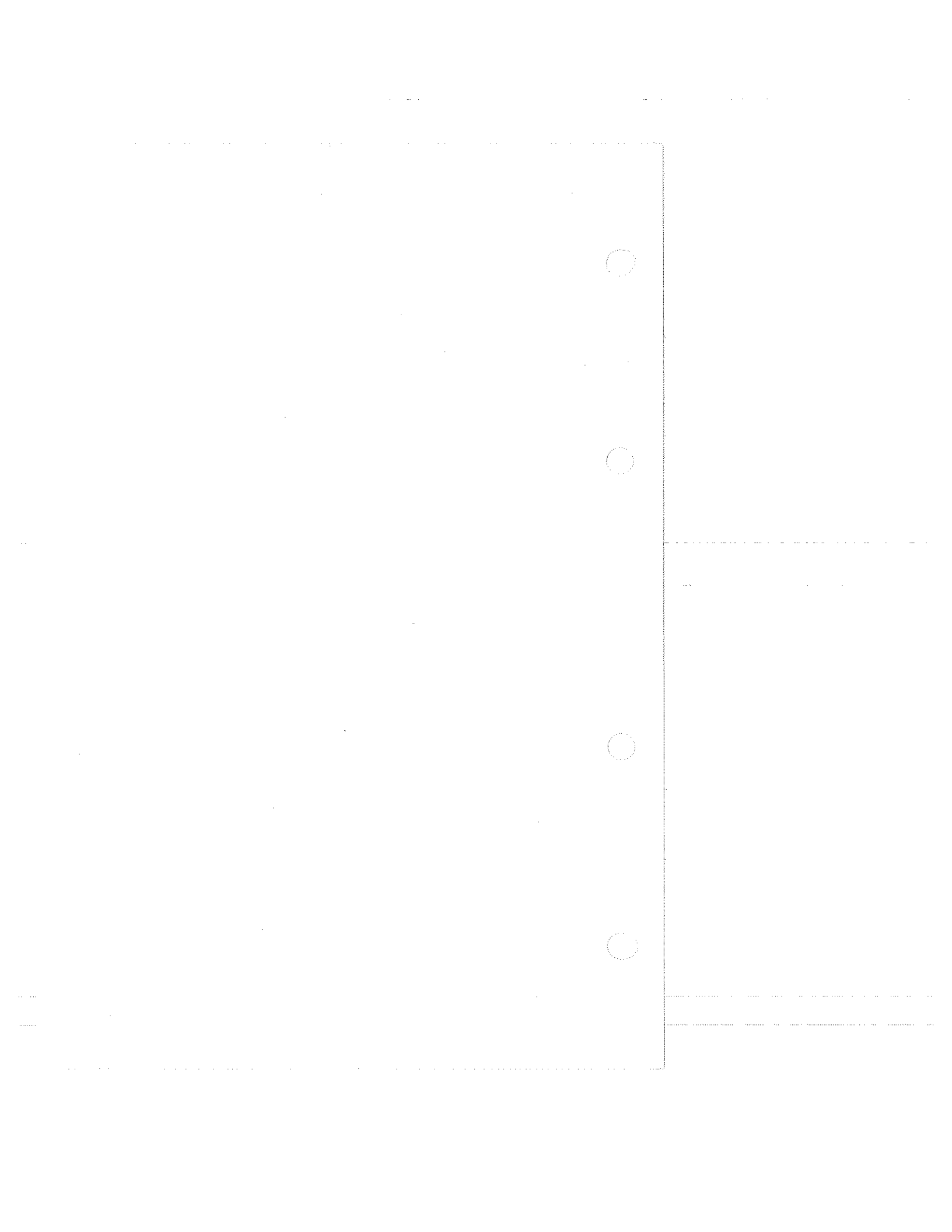
2.5. Type of Sound Field

Measurements Not Requiring IEC or ANSI Standards:

- Select "Frontal" sound incidence correction under free-field conditions or when the source can be located.
- Select "Random" sound incidence correction under diffuse-field conditions or when the Sound Level Meter is moved around during L_{eq} measurements.

IMPORTANT:

1. For each setting of the Frontal/Random parameter there will be certain conditions under which reduced accuracy can be expected, as compared to using the alternative setting. For optimum accuracy, follow the guidelines given in Fig. 2.11.
2. The Frontal/Random correction networks are only valid for ½ inch free-field corrected microphones. When using other type microphones with the 2231 "Frontal" should be selected.



3. Module BZ 7100 – User Instructions

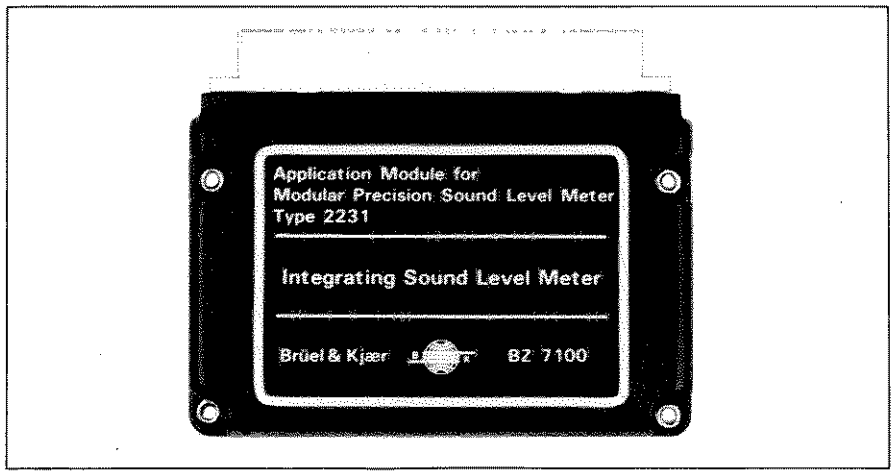


Fig. 3.1. Application Module BZ 7100

With Application Module BZ 7100 the 2231 is an Integrating Sound Level Meter. Some of the potential uses in this configuration are:

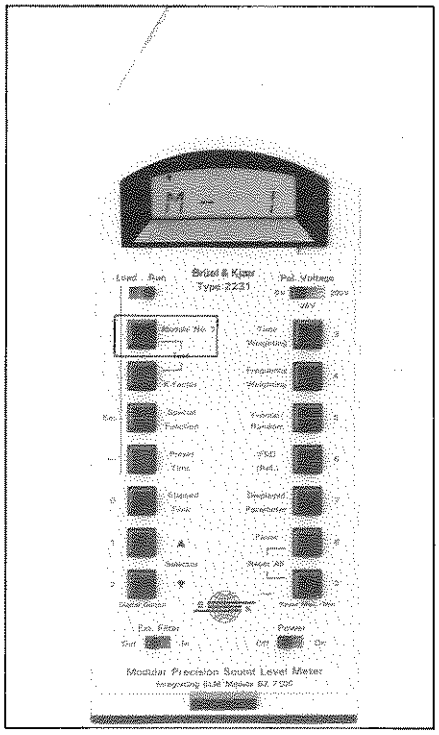
- Measurement of Sound Pressure Level (SPL).
- Determination of L_{eq} for assessment of hearing loss risk or noise annoyance.
- Measurement of cyclical machine noise.
- Determination of Sound Exposure Level SEL (= L_{EA}, in accordance with IEC 804).
- Measurement of Max. and Min. noise levels.
- Spatial 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.
- Infrasound and ultrasound measurements with Filter Type 1627.

3.1. Function Index

3.2. Module Commands

3.3. Loading the Module

- Attach the Front Plate as shown in section 2.3
- Insert the Application Module into the back of the instrument as shown in section 2.3



1. Set to **Load** .
2. Press **Module No. 1** .
   The program is loaded from the Application Module into the internal program- and data-memory. Once loaded, the program number M-1 is displayed as shown. The module may now be removed, and the black plastic dust cap replaced.
3. Set to **Run** to begin execution.

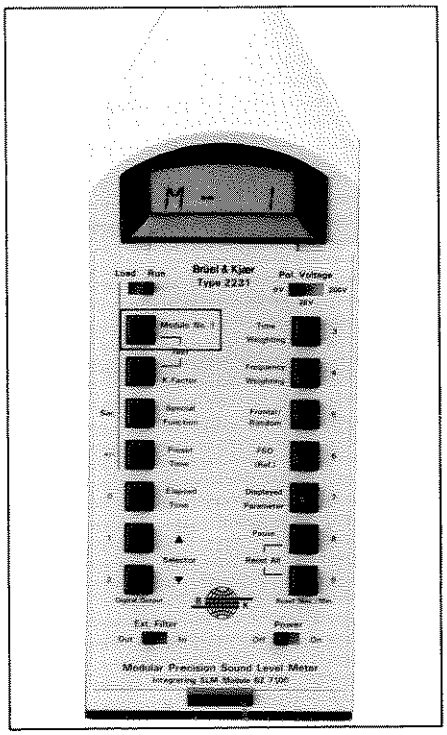
Note: Once a new Module is loaded, the K-Factor, Special Function, and Preset Time are reset. Other parameters are initialized by the instrument as follows:

Time Weighting	: "Fast"
Frequency Weighting	: "A"
Frontal/Random	: "Frontal"
FSD (Meas. Range)	: Highest Range
Displayed Parameter	: "SPL"

3.4. Checking the Module Status

1. Set to **Run**.
2. Press **Module No. 1**.

The display should read M-1 as shown. This signifies that the program currently residing in the central memory was loaded from Application Module BZ 7100. Other numbers (such as "M-2", "M-3" etc.) are assigned to programs which may be loaded from alternative modules in the series. The software from one Module only may be stored at any one time. When a new Application Module is loaded, its software replaces the software existing in the Sound Level Meter memory.

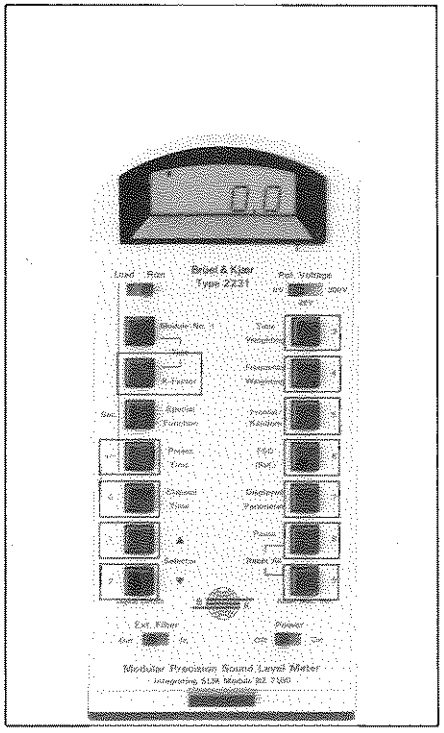


Note: When using Front Plate BZ 7100, always ensure that software "M-1" is loaded. The functions associated with each pushkey are defined by the software in the central memory, and are not the same for each module.

3.5. K-Factor

The K-factor of the microphone that is to be used with the Sound Level Meter must be entered. The K-factor for the microphone may be found on the calibration sheet supplied with it.
Remember: When entering K-factors, the K-factor must be keyed-in with the *same sign* as given on the microphone calibration chart.

Keying in the K-Factor:



1. Set to **Load**.
2. Press **K-Factor**.
   The value of the K-factor currently stored in the memory is displayed (after loading the software **0.0** is displayed as shown).
3. Use pushkeys **0** to **9** and **+/−** to key-in the correct K-factor.

Three significant digits must be keyed-in; the most significant digit is keyed in first. The digits are shifted along the display from right to left, thereby allowing corrections to be made. The sign is changed by pressing the **+/−** key.

Note: The Attenuator ZF0020 should only be used with Microphone Type 4155. When fitted to the 4155, 20 dB should be added to the K-factor.

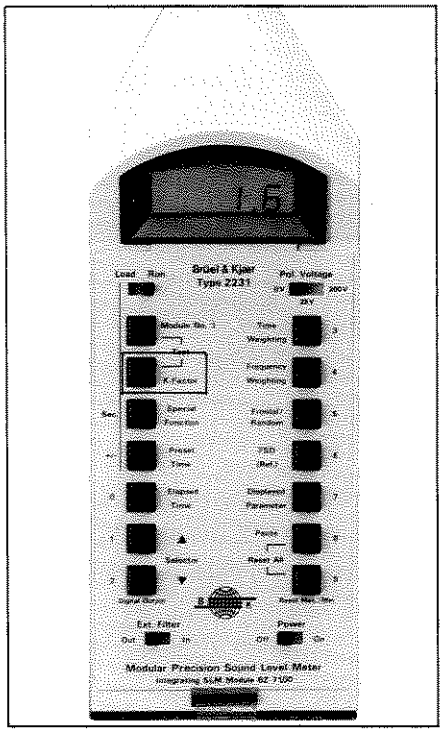
3.5. K-Factor

The K-factor that has been entered is handled by the instrument as a digital correction to the display. This approach accommodates an adjustment range for the K-factor of −60 dB to +99 dB, which cannot be handled at the amplifier stage (as is the traditional method). The extended K-factor adjustment range allows the use of any Brüel & Kjær microphone, but **the DC/AC output signals do not include the microphone K-factor**. This should be remembered when analyzing data on a chart or magnetic tape recorder: all data must be corrected by the measuring range and the K-factor. (See Chapter 4 – Use with Other Equipment).

Checking the Status of the K-Factor:

1. Set to **Run**.
2. Press **K-Factor**.

The value of the K-factor currently stored in the memory is displayed. A typical example (for a Type 4155 microphone) is shown.



Note:

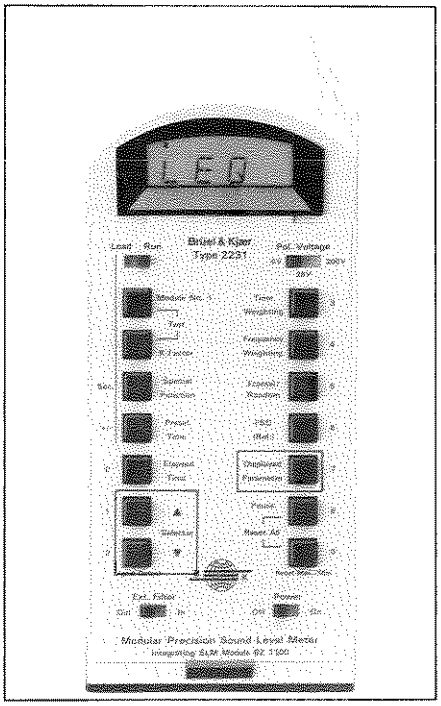
1. Checking the status of the K-factor does not interrupt nor affect the measurement in progress.
2. It is possible to change the K-factor value while the measurement is already in progress. Press **Pause** and proceed as described in section 3.5 – Keying in the K-Factor. To resume the measurement set slide switch to **Run**. The K-factor is added digitally to the FSD value as well as all measurement values shown on the display.

3.6. Displayed Parameter

With Application Module BZ7100, the 2231 Sound Level Meter can display any of the following parameters associated with the incoming acoustic signal:

MAXP	: Max. Peak level
PEAK	: Max. Peak level in 1 second interval
INST	: Sampled RMS level in 1 second interval
SPL	: Max. RMS level in 1 second interval (in accordance with IEC 651)
MAXL	: Max. RMS level
MINL	: Min. RMS level
LEQ	: L_{eq} (in accordance with IEC 804) (L_{Im} with Impulse time weighting)
SEL	: SEL (= L_{EA}, in accordance with IEC 804) (IEL with Impulse time weighting)

Changing the Displayed Parameter:



Press **Displayed Parameter** plus **Selector ▲** or **Selector ▼** simultaneously.

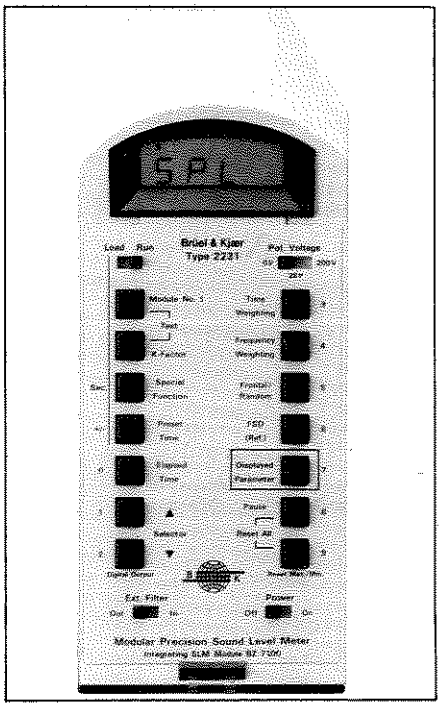
The selected Displayed Parameter is displayed as long as the **Displayed Parameter** push-key is depressed. Once the **Displayed Parameter** key is released, the corresponding measured value for that function is displayed.

Note: Any change in the Displayed Parameter does not interrupt nor affect the measurement in progress.

3.6. Displayed Parameter

Checking the Status of the Displayed Parameter:

Press **Displayed Parameter**.
The status of the currently selected Displayed Parameter is displayed as shown in the example.



Note: Checking the status of the Displayed Parameter does not interrupt nor affect the measurement in progress.

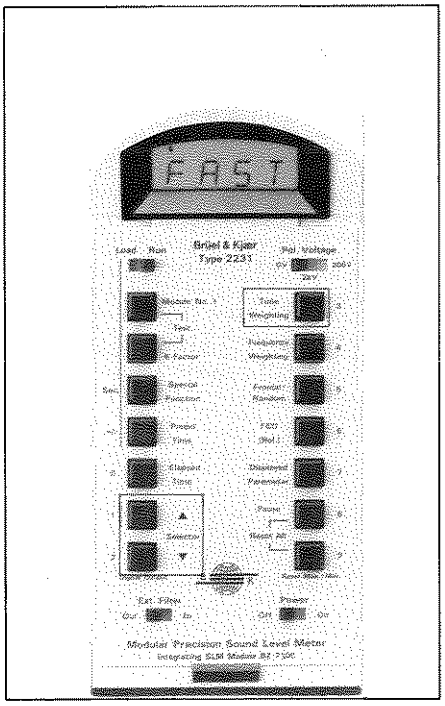
3.7. Time Weighting

The following Time Weightings may be applied to the incoming signal:

"Impulse" "Fast" "Slow"

These Time Weightings are all in accordance with IEC 651.

Changing the Time Weighting:



Press **Time Weighting** plus **Selector ▲** or **Selector ▼** simultaneously.

The selected Time Weighting is displayed as long as the **Time Weighting** key is depressed.

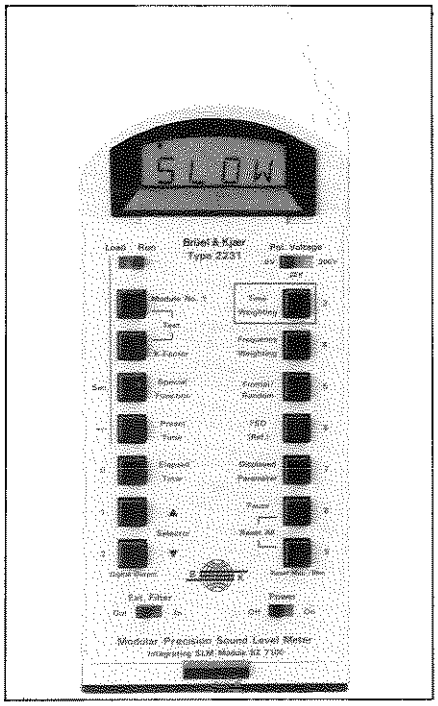
Note: If the Time Weighting status is changed, a new measurement is started automatically. It is not possible to change the Time Weighting half way through an L_{eq} or SEL measurement.

3.7. Time Weighting

Checking the Status of the Time Weighting:

Press **Time Weighting**.

The status of the currently selected Time Weighting is displayed as shown in the example.



Note: Checking the status of the Time Weighting does not interrupt nor affect the measurement in progress.

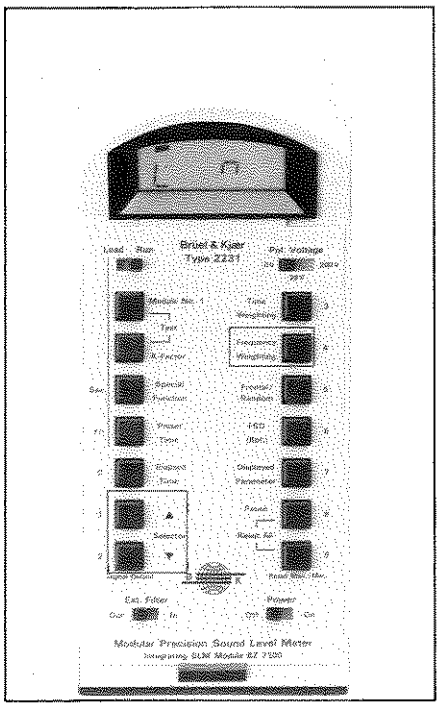
3.8. Frequency Weighting

Four built-in frequency filters give the following Frequency Weightings (see also Figs. B.5 and B.6 in Appendix B):

"A"	: as per IEC 651
"C"	: as per IEC 651
"Lin."	: 10 Hz to 20 kHz
"All Pass"	: 2 Hz to 70 kHz

The AC and DC output signal and the signal sent to the external filter set are also frequency weighted.

Changing the Frequency Weighting:



Press **Frequency Weighting** plus **Selector ▲** or **Selector ▼** simultaneously.

The selected Frequency Weighting is displayed as long as the **Frequency Weighting** pushkey is depressed.

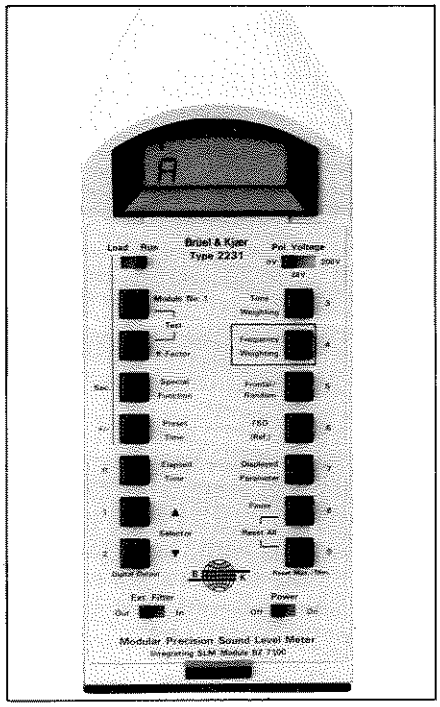
Note: If the Frequency Weighting status is changed, a new measurement is started automatically. It is not possible to change the Frequency Weighting half way through an L_{eq} or SEL measurement.

3.8. Frequency Weighting

Checking the Status of the Frequency Weighting:

Press **Frequency Weighting**.

The status of the currently selected Frequency Weighting is displayed as shown in the example.



The following codes are used to indicate the selected Frequency Weighting:

A	: "A" weighted
C	: "C" weighted
L ⊓	: Linear 10 Hz to 20 kHz
L ⌐ ¯ ¬	: All Pass 2 Hz to 70 kHz

Note: Checking the status of the Frequency Weighting does not interrupt nor affect the measurement in progress.

3.9. Full Scale Deflection (FSD)

7 overlapping 70 dB measuring ranges are available as follows:

Without ZF 0020	With ZF 0020
60 to 130 dB (120 dB FSD)	80 to 150 dB (140 dB FSD)
50 to 120 dB (110 dB FSD)	70 to 140 dB (130 dB FSD)
40 to 110 dB (100 dB FSD)	60 to 130 dB (120 dB FSD)
30 to 100 dB (90 dB FSD)	50 to 120 dB (110 dB FSD)
20 to 90 dB (80 dB FSD)	40 to 110 dB (100 dB FSD)
10 to 80 dB (70 dB FSD)	30 to 100 dB (90 dB FSD)
0 to 70 dB (60 dB FSD)	20 to 90 dB (80 dB FSD)

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Table 3.1. Measuring Ranges of Type 2231

These ranges allow measurements from 24 to 113 dB(A)*. Use of the supplied 20 dB attenuator ZF 0020 gives a measuring range from 30 to 133 dB(A)*. When ZF 0020 is used, an additional +20 dB must be keyed-in along with the K-factor of the microphone (see section 3.5 – Keying in the K-Factor). This ensures that the readings on the digital display show a sound level which is corrected for the presence of the attenuator.

Use of Filter Sets 1624 or 1625 allows measurement of levels well below 24 dB in many of the octave and 1/3-octave bands. The actual noise floor of the 2231 plus microphone in each bandwidth is shown in Figs. B.9 and B.10 of Appendix B.

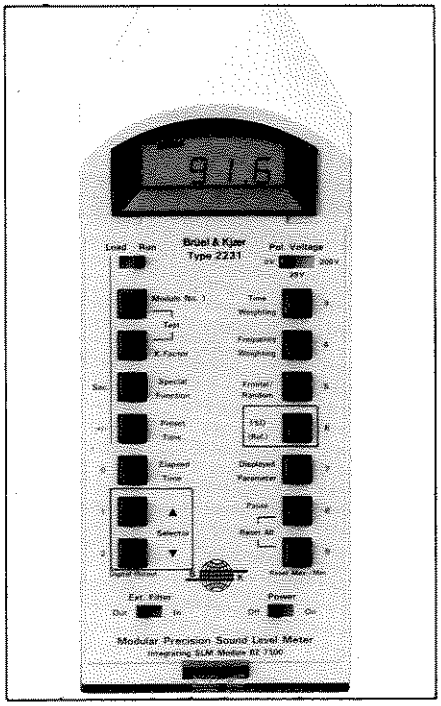
* Upper limit for signals of crest factor 10 (=20 dB).

3.9. Full Scale Deflection (FSD)

Changing the FSD:

Press **FSD** plus **Selector ▲** or **Selector ▼** simultaneously.

The selected Full Scale Deflection is displayed as long as the **FSD** pushkey is depressed.

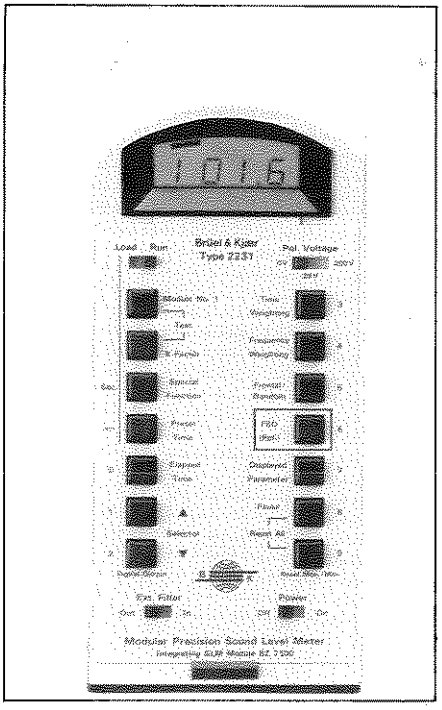


Note:

1. The internal reference signal (94 dB at 1000 Hz) is activated by the FSD pushkey. To do so, simply press **FSD** plus **Selector ▲** simultaneously, until the largest FSD value is displayed. One more press of the **Selector ▲** key activates the internal reference. The value shown on the display is equal to 94,0 dB + K-factor.
2. If the Full Scale Deflection status is changed, a new measurement is started automatically. It is not possible to change the Full Scale Deflection half way through an L_{eq} or SEL measurement.

3.9. Full Scale Deflection (FSD)

Checking the Status of the FSD:



Press **FSD** .

The status of the currently selected Full Scale Deflection is displayed as shown in the example.

Note:

1. Checking the status of the Full Scale Deflection does not interrupt nor affect the measurement in progress.
2. The number displayed is not necessarily a whole integer number, since the K-factor is added digitally to the FSD value as well as all measurement values shown on the display.

3.10. Preset Time

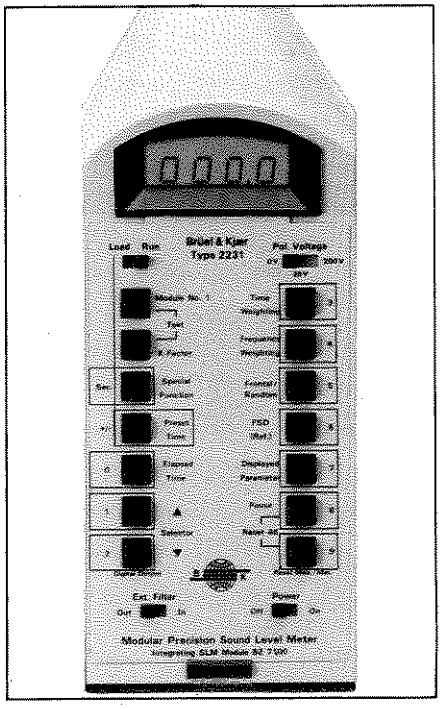
The Preset Time function may be used to set in advance a measurement period. This period may range from 1 second up to 100 hours (99 h 59 min 59 s). At the end of the measurement period the Sound Level Meter enters the pause condition.

Examples of different settings and possible uses are:

30 s	:	Spatial average in a room
1 h	:	Traffic hourly L_{eq}
24 h	:	SPL_{min}, SPL_{max} during 24 h period

Setting the Preset Time:

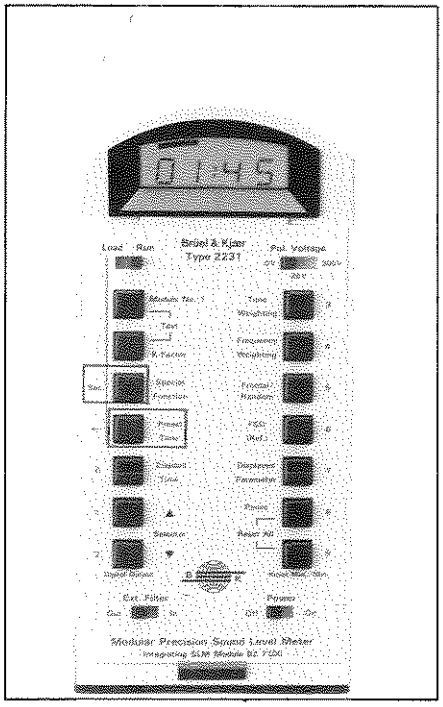
1. Set to **Load**.
2. Press and release **Preset Time**. (Display shows **00.00** –Hours, Minutes–)
3. Use keys **0** to **9** to key-in hh.mm of the Preset Time.
4. Press and hold **Sec.**. (Display shows **00** –Seconds–).
5. Use keys **0** to **9** to key-in ss of Preset Time.



If, for example, 65 minutes is keyed-in this will be corrected to 1 hour 5 minutes on switching to **Run**.

3.10. Preset Time

Checking the Status of the Preset Time:



1. Set to **Run** .
2. Press **Preset Time** . (Display shows current Preset Time –hours.minutes–).
3. While keeping **Preset Time** depressed, press **Sec.** . (Display shows current Preset Time –ss–).

Note: Checking the status of the Preset Time does not interrupt nor affect the measurement in progress.

3.11. Elapsed Time

The Elapsed Time function allows you to determine the amount of time elapsed since starting the measurement, i.e. activation of one of the following:

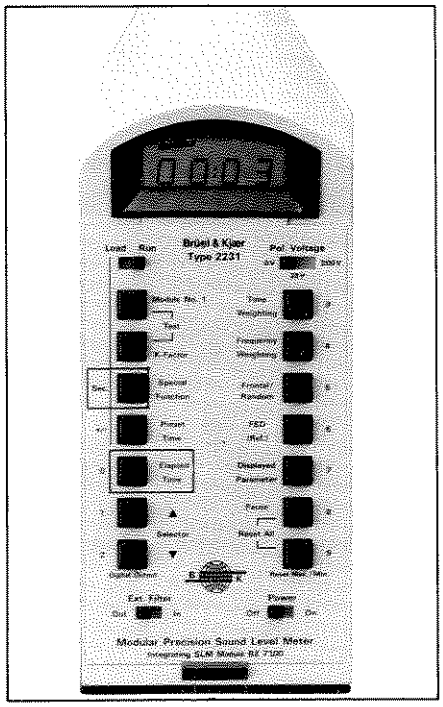
— Resetting K-Factor or Special Function (unless the instrument is in the Pause mode, see section 3.5 – K-Factor)

— Pressing **Reset All** or

— Resetting certain parameters such as Time Weighting, Frequency Weighting, FSD etc.

Checking the Elapsed Time:

1. Press **Elapsed Time**. (Display shows Elapsed Time –hours.minutes–).
2. While keeping **Elapsed Time** depressed, press **Sec.**. (Display shows Elapsed Time –ss–).

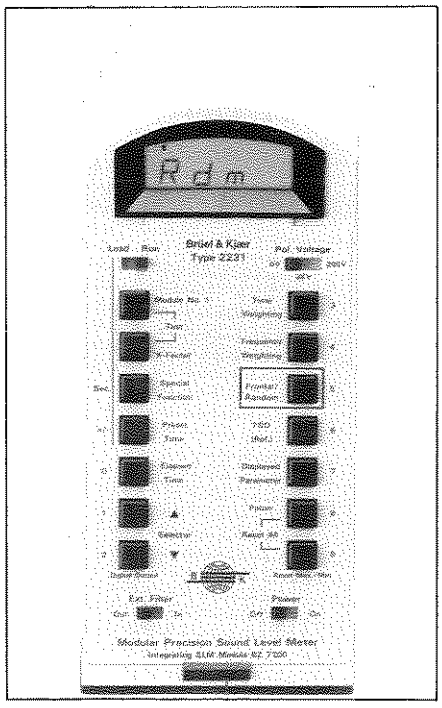


Note: Checking the Elapsed Time does not interrupt nor affect the measurement in progress.

3.12. Frontal/Random

Section 2.5 – Type of Sound Field, describes the correct use of the Frontal/Random facility. Remember, the Random incidence correction is only valid when using ½ inch free-field corrected microphones. For all other microphones the Sound Level Meter must remain in the "Frontal" mode.

Checking the Frontal/Random Status:



Press **Frontal/Random**.

The Frontal/Random status currently stored in the program memory is displayed as shown.

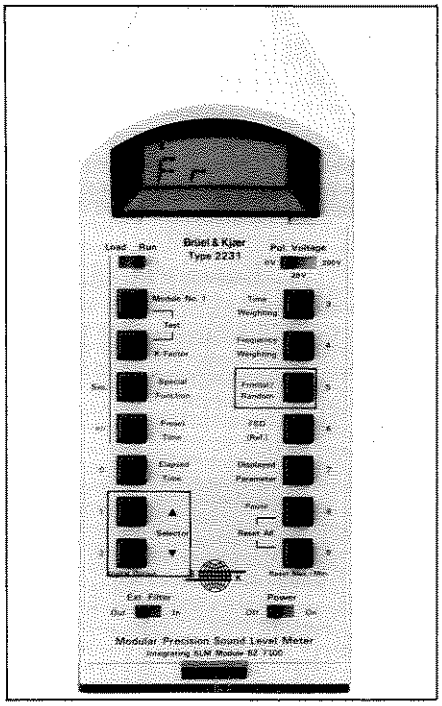
Note: Checking the status of the Frontal/Random function does not interrupt nor affect the measurement in progress.

3.12. Frontal/Random

Changing the Frontal/Random Status:

Press **Frontal/Random** plus **Selector ▲** or **Selector ▼** simultaneously.

The selected Frontal/Random status is displayed as long as the **Frontal/Random** pushkey is depressed.



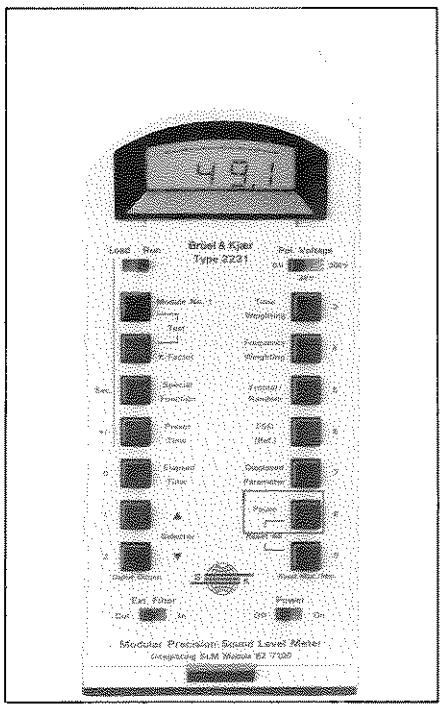
Note: If the Frontal/Random status is changed, a new measurement is started automatically. It is not possible to change the Frontal/Random function half way through an L_{eq} or SEL measurement.

3.13. Pause

Press **Pause** while a measurement is in progress and the Sound Level Meter, after completion of the current 1 sec. measurement cycle, will enter a Pause or idling condition. While in Pause, no updating of measurement values or measurement time will take place. Press **Pause** again: the Pause condition is cancelled and the measurement resumes.

If a change is made to the status of **Time Weighting**, **Frequency Weighting**, **Frontal/Random**, or **FSD** while the Sound Level Meter is in Pause, the Pause condition is cancelled and a new measurement is started automatically. If the instrument is switched off while in the Pause condition, it reverts to its previous status on being switched on again. All measured data (e.g. SPL, SEL, Elapsed Time etc.) is retained as long as the back-up battery is operational.

Enter Pause / Resume Measurements:



1. Press **Pause**.
   While in the Pause mode, the display shows the value of the measured parameter when **Pause** was pressed.
2. Press **Pause** again to resume measurements.

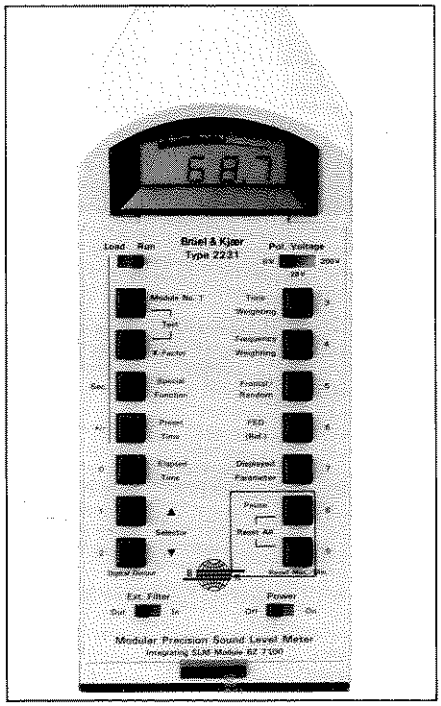
3.14. Reset All

Reset the Sound Level Meter and all measurement, calculation, and measurement time memories are reset and a new measurement is initiated. The status of **K-Factor**, **Special Function**, **Preset Time**, **Time Weighting**, **Frequency Weighting**, **Frontal/Random**, and **FSD** are NOT changed.

To Reset the Sound Level Meter:

Press **Reset All**.

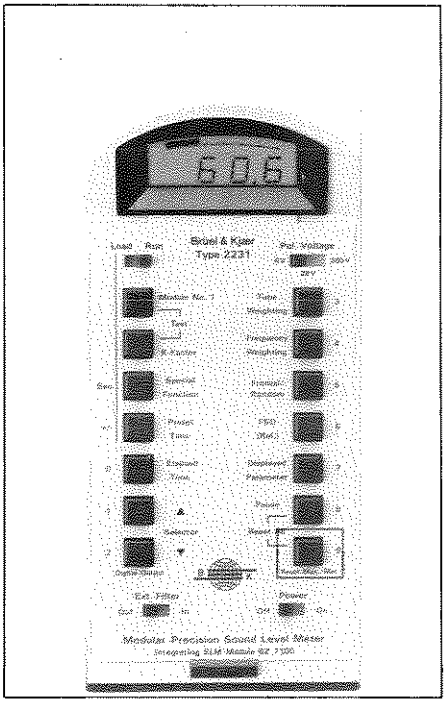
Reset All is activated by pressing both pushkeys that are linked with the **Reset All** logo (the pushkeys are also numbered **8** and **9**).



3.15. Reset Max./Min.

It is possible to reset only Max. Peak, Max. RMS, and Min. RMS during a measurement procedure, without having to reset other parameters. L_{eq} and SEL measurements continue without interruption.

To Reset Max./Min:



Press **Reset Max./Min.**.

Reset Max./Min. is activated by pressing only the lower pushkey of the two that are linked with the **Reset** logo (the pushkey is specifically labeled and is also numbered **9**).

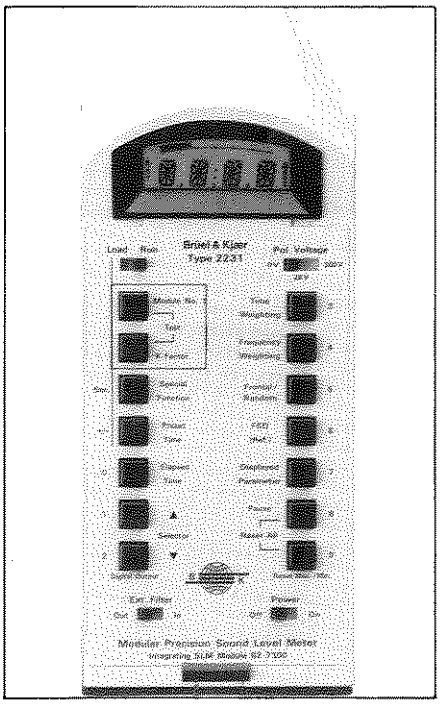
3.16. Test

Test initiates a test of the digital display. Each segment of each digital character is displayed, along with the Overload symbol (↑) and the Battery Low symbol (BAT). The quasi-analogue portion of the display is unaffected by **Test** and continues to register the level of the incoming signal.
Test can be activated without disturbing a measurement in progress.

To Initiate Test:

1. Set to **Run** .
2. Press **Test** .

Test is activated by pressing both pushkeys that are linked with the **Test** logo (the pushkeys are also labeled **Module No. 1**, and **K-Factor**).



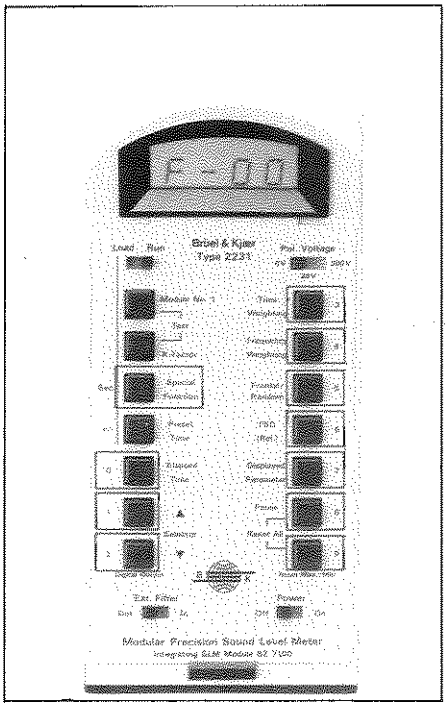
3.17. Special Functions

The Special Function facility on Sound Level Meter Type 2231 allows the user to make minor modifications to the standard program. These modifications are implemented by keying-in a two digit Special Function code. The types of modification that can be implemented can be conveniently grouped as follows:

1. Selection of a mode and format for the digital read out,
2. Selection of additional measurement facilities,
3. Alteration of internal parameters.

The list of available modifications and the appropriate code for each are given overleaf.

Keying-in a Special Function:



1. Set to **Load** .
2. Press and release **Special Function** (displays F-00 as shown).
3. Use keys **0** to **9** to enter the Special Function code. When the digits are keyed-in, the digits are shifted along the display from right to left, thereby allowing corrections to be made.
4. Set to **Run** .

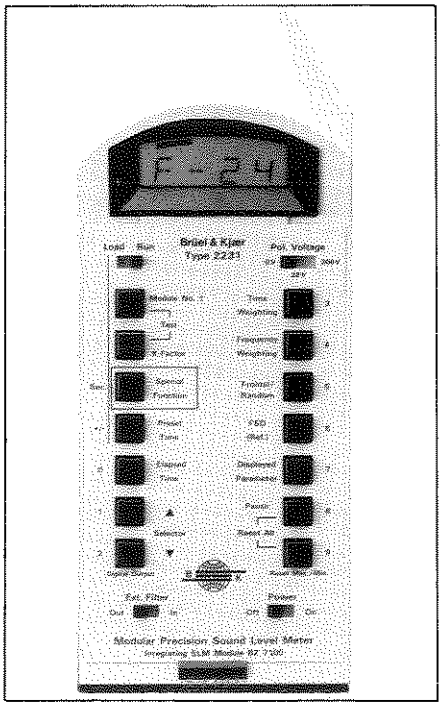
3.17. Special Functions

Note:

1. Switching to **Load** and pressing **Special Function** automatically resets the Special Function to **F - 0 0**.
2. The Special Function can be changed in the Pause mode if resetting the Sound Level Meter is to be avoided.

Checking the Special Function Status:

1. Set to **Run**.
2. Press **Special Function** (Displays currently selected Special Function as shown).



Note: Checking the status of the Special Function facility does not interrupt nor affect the measurement in progress.

3.17. Special Functions

3.17.1. Special Function Directory

A two digit code (e.g. 27 or 04) is used to enable a Special Function. The first digit (**2**7 or **0**4) sets a digital output characteristic, allowing a choice of mode and format of the output. This facility will only be operational when the Interface Module ZI 9100 is inserted. See footnote.

0X
Digital Output Inactive.

1X, **2**X, **3**X, **4**X, **5**X, **6**X, **7**X, **8**X, **9**X
These codes are used to select a digital read-out mode and format. The actual modes and formats that are available are described in full detail in section 3.17.3 – Digital Output.

Note: Interface Module ZI 9100 must be connected for this facility to work. The Module is basically a device which allows the connection of the Sound Level Meter to a terminal, microprocessor or printer. It is inserted into the same receptacle as the Application Module BZ 7100, but does not affect the instrument software in any way. The Module is described in section 4.4 – Interface Module ZI 9100.

3.17. Special Functions

The second digit (**27** or **04**) sets a display mode characteristic or allows alteration of certain parameters.

X0
Normal Operation. Quasi-analogue scale displays RMS value.

X1
All parameters remain the same as for **X0**, but the Peak value is displayed on the quasi-analogue display scale.

X2
The entire measurement is divided into time intervals according to the value set as **Preset Time**. At the end of each measurement interval, the L_{eq} is output via the DC output. SEL, L_{eq}, LMAX, LMIN, and MAXP are reset and a new measurement is started. See also section 4.2.1 – Plotting L_{eq} vs. Time.

X3
Equivalent to **X1** + **X2**.

X4
Manual activation of **Pause** causes the last 4 seconds of the completed measurement interval to be disregarded. In fact, 1 to 4 seconds can be set as the measurement period to be disregarded, according to the procedure given in section 3.17.2 – Modification of Internal Parameters. 4 seconds is the default value.

X5
Equivalent to **X1** + **X4**.

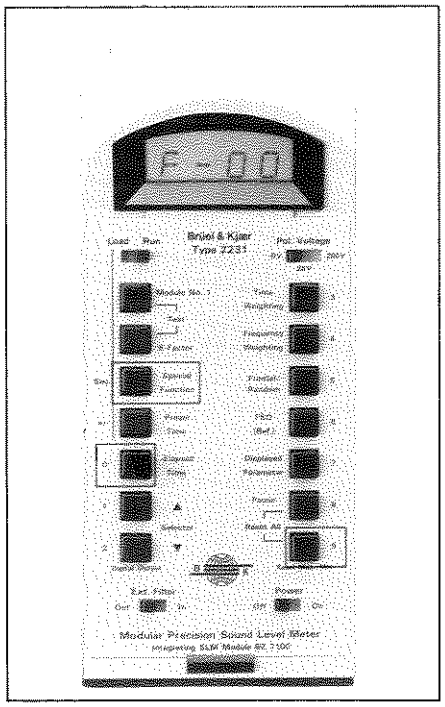
X6, X7, X8
Same as **X0**.

X9
Initiates the special procedure for modifying internal parameters.

3.17. Special Functions

3.17.2. Modification of Internal Parameters

Certain internal parameters (for example the number of seconds of last input-data which are disregarded using the Pause function) can be changed using the following procedure:



1. Set to **Load**.
2. Press and release **Special Function** (F - 0 0 is shown on the display).
3. Key-in **0 9** (Press **0** followed by **9**).
4. Momentarily set to **Run** and then return to **Load**.
5. Key-in the code number of the parameter to be changed to, as indicated below.
6. Set to **Run** so that the 2231 is once again ready for measurements.

When set as in step 4, the display shows * - # #. The last (#) digit indicates that the last # seconds of input data are disregarded by pressing **Pause**. The first (#) digit indicates the conditions under which the measurement is resumed after read-out of the digital output.

Use the pushkeys to set the value of these two parameters. Simply press the code number corresponding to the parameter setting you require. The numbers enter the display screen from right to left, with a roll-out facility allowing for corrections.

3.17. Special Functions

First Digit:

The first digit can be assigned a value from 0 to 4 as follows:

0 Re-start: the Sound Level Meter resets and starts a new measurement after the read-out from the digital output.

1 The measurement in progress is resumed after read-out from the digital output.

2 The Sound Level Meter returns to the Pause status: the user may decide on further processing as appropriate.

3 The Sound Level Meter returns to a Monitor status: the user can start a new measurement using the command **Run** or can continue the current measurement using the command **Run-Continue**.

4 Equivalent to 3, except that the command **Run-Continue** returns the Sound Level Meter to the Pause condition.

Keying-in a value from **5** to **9** is equivalent to keying-in 0 (Re-start).

Last Digit:

Assign a value from **1** to **4**, and correspondingly the last 1 to 4 seconds of input data are ignored on pressing **Pause**. Keying-in a value of **0** or **5** to **9** will have no effect: the Sound Level Meter will not ignore data when **Pause** is pressed.

Note:

1. The parameters described here are only relevant in connection with the corresponding Special Function which must be implemented separately.
2. The status of the internal parameters is not accessible while a measurement is in progress. The status cannot be checked without first setting the Special Function to **F-09**, and when a Special Function is set (or reset) the measurement is automatically reset.

3.17. Special Functions

3.17.3. Digital Output

For a digital output from Application Module BZ 7100, the Interface Module ZI 9100 must be connected where BZ 7100 was previously inserted. See section 4.4.

Three print-out modes and three print-out formats are accessible with the BZ 7100 application software. The mode you select determines the way in which the print-out is initiated: the format you select determines the way in which the data is presented. There are nine mode/format combinations which may be selected by keying-in the Special Function code as follows:

		MODE		
		1	2	3
FORMAT	1	F-1X	F-4X	F-7X
	2	F-2X	F-5X	F-8X
	3	F-3X	F-6X	F-9X

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Table 3.2. Mode/Format selection codes for Digital Printout

The Digital Output may be interrupted by switching the Sound Level Meter to **Load**. On switching back to **Run**, the instrument resumes the status that it would normally resume after completion of the output, as defined by the selected Print-out Mode (see next section).

3.17. Special Functions

3.17.4. Print-out Modes

Mode 1: Manual Control

Print-out can only be started in the Pause mode. Pause can be activated manually by pressing **Pause** or automatically using the Preset Time function. Once in the Pause mode, initiate print-out by pressing **Digital Output**.

When print-out is completed, the instrument returns to the Pause condition. The measurement in progress can then be continued by cancelling Pause, or a new measurement can be started by pressing **Reset All**.

Mode 2: Automatic Control

Print-out is started automatically at the end of the Preset Time period. Once the print-out is completed a new measurement is started automatically.

The conditions for restart in this mode may be varied by the operator using the procedure outlined in section 3.17.2 – Modification of Internal Parameters.

Mode 3: External Control

Print-out is started by sending any character (e.g. <CR>) from the connected computer. After print-out the previous function is resumed according to the setting of the internal parameters.

The conditions for restart in this mode may be varied by the operator using the procedure outlined in section 3.17.2 – Modification of Internal Parameters.

3.17. Special Functions

3.17.5. Print-out Formats

Format 1.

The print-out format presents all the relevant information in a comprehensive fashion, using unambiguous language.

```
BRUEL & KJÆR

 MODULAR SLM TYPE 2231

========================

REMARKS:
.......................
Date:.....Time:.....
.......................                MEASUREMENTS:
.......................                -------------------------
.......................                 MAXP        88.8 dB
.......................                 MAXL        71.7 dB
.......................                 MINL        38.6 dB
                                        SEL         75.7 dB
SET UP:                                 LEQ         48.0 dB
-------------------------
 Module #: 1 (BZ 7100)                  No overload.
 Mic.Corr: + 0.5 dB
 S.I.Corr: "FRONTAL"                    No reset of Max/Min.
 Pr. Time: 00:10:00
 Time W. : "FAST"                       ELAPSED TIME:
 Freq.W. : "A"                          -------------------------
 Rg. (dB): 30.5 - 103.5                   Hours    Min.    Sec.
                                            00       10      00

                                        No. of interrupts: 0
                                                                  E50351
```

Fig. 3.2. Example of Long Format Print-out

Note: If the Time Weighting "Impulse" is selected the designations LEQ and SEL are changed to LmI and IEL respectively.

3.17. Special Functions

Format 2.

The print-out format contains all the measurement results in unambiguous language, and all the instrument settings in code.

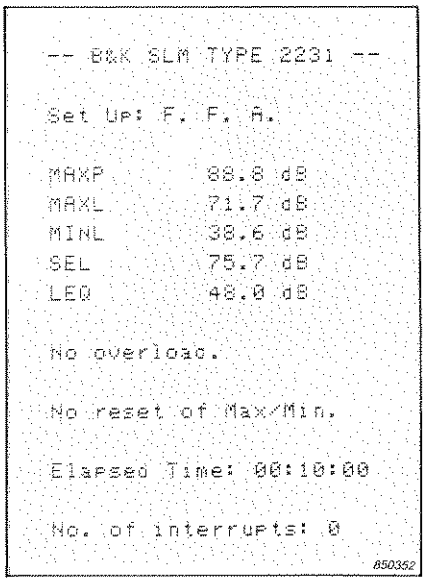


Fig. 3.3. Example of Medium Format Print-out

Note: If the Time Weighting "Impulse" is selected the designations LEQ and SEL are changed to LmI and IEL respectively.

3.17. Special Functions

Format 3.

This is a one line print-out format containing the primary instrument settings in code, and the measurement results for Max. Peak, Max. RMS and L_{eq} together with an indication whether overload has occurred or not.

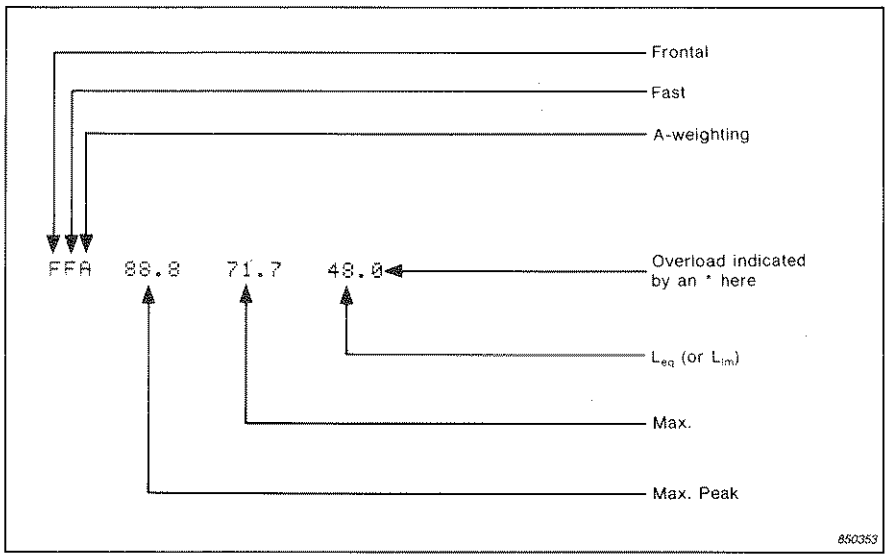


Fig. 3.4. Example of Short Format Print-out

3.18. Interfacing the 2231

3.18.1. The Monitor Program

All communication via the Interface Module ZI 9100 is carried out by the Monitor program. The Monitor program is used for:

1. sending data to a printer,
2. external control of the 2231,
3. access to the internal parameters and special functions.

Control of Sound Level Meter Type 2231 over the interface requires a terminal or microcomputer with a compatible interface. The 2231 transmits data through a Brüel and Kjær Serial Interface, which is structured close to RS 232 C. The built-in monitor has a limited set of commands, but full control of all instrument settings is possible.

The Monitor can operate at 110, 150, 300, 600 or 1200 baud, with or without echo. The baud rate is read from the connected interface module. Data format: 8 bit word, 1 stop bit, no parity.

Control via the Monitor is achieved as follows:

1. Connect the terminal (or computer) to the 2231 Sound Level Meter via the Interface Module ZI 9100.
2. Set the terminal (or computer) and the Interface Module to the same baud rate (the factory-set baud rate is 1200 baud without echo). Remember the echo function (full- or half-duplex) and set the terminal's "CAPS LOCK"-key to "on".
3. Set the **Load/Run** switch to **Load**.
4. Press and release **Module No. 1**. (The display now shows M-Mo).
5. Set the **Load/Run** switch to **Run**.

3.18. Interfacing the 2231

The Monitor now transmits:

```
2231 MONITOR [Bel] [Bel] [Bel]
[Bel] [Bel] [Bel] [Bel] [Bel]
[CR] [LF]
: [CR]
```

after which, the Monitor is ready to receive commands. Messages from the Monitor are always terminated by " `: [CR]` ", indicating that the Monitor is ready to accept commands.

With the Interface Module ZI 9100 attached, there are three other methods of achieving control via the Monitor:

1. The signal input (Received Data) to the Interface Module is maintained at low level while the 2231 is switched on.
2. The signal input to the Interface Module is maintained at low level while both the **Reset** keys are depressed.
3. If an appropriate Special Function is selected, the Sound Level Meter automatically returns to the Monitor status after digital printout (see section 3.17 – Special Functions).

3.18. Interfacing the 2231

3.18.2. Monitor Commands

The following commands are used to control the 2231 via the Monitor:

R (Run)	Starts program execution from the beginning.
RC (Run Continue)	Measurement already in progress is continued.
SH (Show Set-up)	Reads out that part of the data memory where the set-up parameters of the 2231 are to be found. The read-out is given in Hexadecimal code.
SE (Set-up)	After sending SE, the Monitor responds with: `> [CR]` Sending codes for new parameters may now take place.
P (Print)	Data is transferred to terminal (or computer) for print out. The print out is made in Format 1 regardless of the current Special Function selection.

Note: Only commands in capital letters are accepted.

3.18. Interfacing the 2231

3.18.3. Set-up Codes

An example of a set-up parameter read-out in Hexadecimal code is:

```
5E00 0202 0000 120B 0800 0C0B 0304 0A00 0000;
5E10 0000 0000 0000
```

The meaning of the codes is as follows:

```
5E00 0202 0000 120B 0800 0C0B 0304 0A00 0000;
5E10 0000 0000 0000
```

Start address for parameter field.

```
5E00 0202 0000 120B 0800 0C0B 0304 0A00 0000;
5E10 0000 0000 0000
```

Parameter address = 5E00.
Measuring Range. Codes 00 to 07 can be used as follows:

00 : FSD = 60 dB
01 : FSD = 70 dB
02 : FSD = 80 dB
03 : FSD = 90 dB
04 : FSD = 100 dB
05 : FSD = 110 dB
06 : FSD = 120 dB
07 : "Ref."

```
5E00 0202 0000 120B 0800 0C0B 0304 0A00 0000;
5E10 0000 0000 0000
```

Parameter address = 5E01.
Time Weighting. Codes 01 to 03 can be used as follows:

01 : Impulse
02 : Fast
03 : Slow

3.18. Interfacing the 2231

5E00 0202 [00]00 120B 0800 0C0B 0304 0A00 0000;
5E10 0000 0000 0000

Parameter address = 5E02.
Frequency Weighting. Codes 00 to 03 can be used as follows:

00 : "A"
01 : "C"
02 : "Lin." (10 Hz to 20 kHz)
03 : "All Pass" (2 Hz to 70 kHz)

5E00 0202 00[00] 120B 0800 0C0B 0304 0A00 0000;
5E10 0000 0000 0000

Parameter address = 5E03.
Frontal/Random. Use codes 00 and 01:

00 : Frontal
01 : Random

5E00 0202 0000 [120B] 0800 0C0B 0304 0A00 0000;
5E10 0000 0000 0000

Parameter address = 5E04.
Text code for F - (Special Function). Should not be changed.

3.18. Interfacing the 2231

```
5E00 0202 0000 120B [0800] 0C0B 0304 0A00 0000;
5E10 0000 0000 0000
```

Parameter address = 5E06.
Special Function.

1. First two digits select the way in which digital print-out is obtained. These correspond to the first digit of a Special Function selection. Codes 00 to 09 can be used as follows:

   00 : Digital print-out inactive
   01 : Digital print-out format 1, mode 1
   02 : Digital print-out format 2, mode 1
   03 : Digital print-out format 3, mode 1
   04 : Digital print-out format 1, mode 2
   05 : Digital print-out format 2, mode 2
   06 : Digital print-out format 3, mode 2
   07 : Digital print-out format 1, mode 3
   08 : Digital print-out format 2, mode 3
   09 : Digital print-out format 3, mode 3

2. Last two digits correspond to the second digit of a Special Function selection. Codes 00 to 09 can be used:

   00 : Normal function
   01 : } See section 3.17 – Special Functions
   02 :
   03 :
   04 :
   05 :
   06 :
   07 :
   08 :
   09 :

3.18. Interfacing the 2231

```
5E00 0202 0000 120B 0800 0C0B 0304 0A00 0000;
5E10 0000 0000 0000
```

Parameter address = 5E08.
Text code for * - (Special Function 09). Should Not be changed.

```
5E00 0202 0000 120B 0800 0C0B 0304 0A00 0000;
5E10 0000 0000 0000
```

Parameter address = 5E0A.
Internal Parameters.

1. First two digits correspond to the first digit of the Internal Parameter code. Codes 00 to 09 can be used as follows:

   00 : Reset and restart after digital read-out.
   01 : Continue current measurement after read-out.
   02 : Enter **Pause** condition after read-out.
   03 : Return to Monitor control after read-out. Measurement is continued on the command RUN_CONTINUE.
   04 : Return to Monitor control after read-out. **Pause** is entered on the command RUN_CONTINUE.
   05 to 09 : = 00

2. Last two digits correspond to the second digit of an Internal Parameter code. Codes 00 to 09 can be used:

   00 : Delete 0 s prior to activation of **Pause**
   01 : Delete 1 s prior to activation of **Pause**
   02 : Delete 2 s prior to activation of **Pause**
   03 : Delete 3 s prior to activation of **Pause**
   04 : Delete 4 s prior to activation of **Pause**
   05 to 09 : = 00

3.18. Interfacing the 2231

5E00 0202 0000 120B 0800 0C0B 0304 0A00 0000;

5E10 0000 0000 0000

Parameter address = 5E0C (first block), 5E0E (second block).
K-Factor. Codes 0A/0B and 00 to 09 are used as follows:

0A : "+"
0B : "–"
0# : "Tens"
0# : "Units"
0# : "Tenths"

For example:

0B 00 02 04 = –2,4

5E00 0202 0000 120B 0800 0C0B 0304 0A00 0000;

5E10 0000 0000 0000

Start address for parameter field. Should not be changed.

5E00 0202 0000 120B 0800 0C0B 0304 0A00 0000;

5E10 0000 0000 0000

Parameter address = 5E10, 5E11 (first block); 5E12, 5E13 (second block); 5E14, 5E15 (third block).
Preset Time. Codes 00 to 09 can be used.
For example:

0001 0200 0401 = 1h 20min 41s

3.18. Interfacing the 2231

3.18.4. Alteration of Set-up Parameters

Changing parameters takes place according to the following sequence of commands and prompts *:

: [CR]	"Prompt" character transmitted from the Monitor to indicate that the Monitor is ready to accept commands.
SE [CR]	Command transmitted to the Monitor to prepare it for parameter changes.
> [CR]	"Prompt" character transmitted from the Monitor to indicate that the Monitor is ready to accept the set-up codes.
SE03_01 [CR]	Example of a character string transmitted to the Monitor to effect the required parameter changes (see actual examples below).
: [CR]	"Prompt" character transmitted from the Monitor to indicate that the Monitor is ready to accept further commands.

Examples:

1. Changes Frontal to Random:

```
:SE [CR]
>SE03_01 [CR]
:
```

2. Changes several parameters at one time:

```
:SE [CR]
>SE00_0301 [CR]
:
```

changes the Measuring Range (FSD) and Time Weighting.

* The "Space"-symbol ("_") is the separater character between address and data (set-up parameter). "Spaces" inserted between data (set-up parameters) have no effect.

3. "." inserted one or more times between the keyed-in parameter values increments the parameter address a corresponding number of times. For example, after changing the parameter at address 5E01, address 5E06 is accessed by inserting "...." after the new parameter at address 5E01. If ";" is keyed-in after a parameter value, the next code to be entered is interpreted as an address.

```
:SE [CR]
>5E01_03 ....07;5E13_01 [CR]
:
```

changes the **Time Weighting** (address 5E01) to "Slow" (code 03); sets Digital Print-Out (address 5E06) to "Mode 3/Format 1" (code 07); sets **Preset Time** (address 5E13) to 1 minute.

The result of keying-in operations can be checked using the SH (i.e. Show Set-up) command.

3.18.5. Error Messages

The Monitor reacts to syntax errors with the message `: S-ERR` and clears for corrected data to be keyed-in. However there is NO check for errors incurred by keying-in values which lay outside the permissible ranges. Therefore, if control is via a computer program, the program must perform these checks. In some circumstances keying-in can be aborted using CTR-C (control-C):

```
:SET "CTR-C"
:

:SHOW "CTR-C"
:

:SET [CR]
> "CTR-C"
:
```

3.19. Display Symbols

U_ _ _	**Underrange:** The level of the sound reaching the Sound Level Meter is below the current measuring range. Set Full Scale Deflection (FSD) accordingly.
O‾ _ _	**Overrange:** The level of the sound reaching the Sound Level Meter is above the current measuring range. Set Full Scale Deflection (FSD) accordingly.
* * * *	**Selected Value outside allowed range:** The requested parameter is outside the allowed range. For example, selection of Preset Time > 99 h 59 min 59 s.
↑	**Overload occurring:** The level of the sound reaching the sound level meter is overloading the instrument's circuits.
▲	**Overload has occurred:** The instrument's circuits have been overloaded during the measurement (i.e. since the last activation of **Reset All**).
BAT	**Battery Low:** Flashing "BAT" appears in the display. With alkaline batteries approximately 30 min operation remaining.
BAT plus ↑	**Battery Too Low for Accurate Operation:** Flashing "BAT" plus non-resettable ↑. Replace batteries.
REF.	**Reference signal activated:** The internal reference signal, 94 dB at 1000 Hz, is activated. To deactivate it, select an appropriate FSD.

3.19. Display Symbols

M-E1 **No Application Module inserted:**
If there is no application software stored in the Sound Level Meter memory, and no Application Module inserted, this message will appear if loading of a module firmware is attempted.

M-E2 **Application Module software not yet stored:**
There is no application software stored in the Sound Level Meter memory.

M-E3 **Error in software copy:**
The application software stored in the Sound Level Meter contains an error. Reload with the appropriate Application Module.

M--- **Ready to load Module firmware:**
If there is no application software stored in the Sound Level Meter memory, this message appears when the Sound Level Meter is ready to load software from the inserted Application Module.

M- 1 **Application Module number:**
The identifying number of the Application software is shown at the end of a successful loading, or by pressing **Module No. 1** when in the **Run** position.

M-Mo **Monitor:**
This message indicates that the Monitor program is enabled and the Sound Level Meter is set up to communicate across the interface.

4. Use with Other Equipment

4.1. Filter Sets

Compatible Filters:

1624 Octave Filter Set
1625 Octave and 1/3 Octave Filter Set
1627 Infrasound and Ultrasound Filter Set

Connection:

Via 15 pin connector at the base of the Sound Level Meter

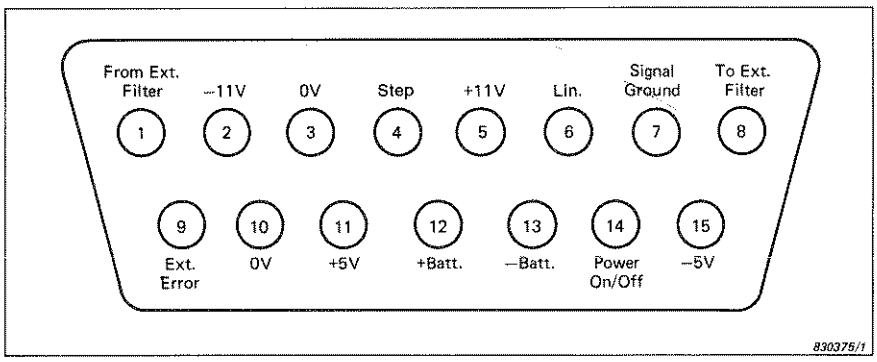


Fig. 4.1. 15 pin connector for Filter Set attachment

To Insert Filter:

1. Remove plastic cover at the base of the Sound Level Meter.

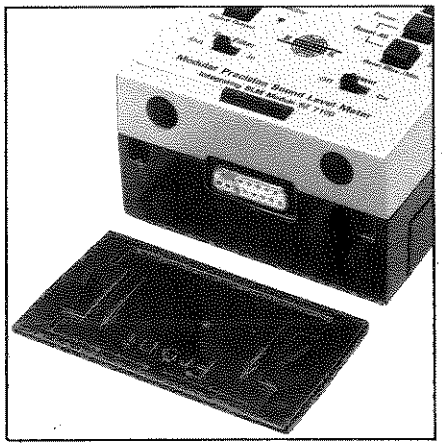


Fig. 4.2. Removal of plastic base cover

4.1. Filter Sets

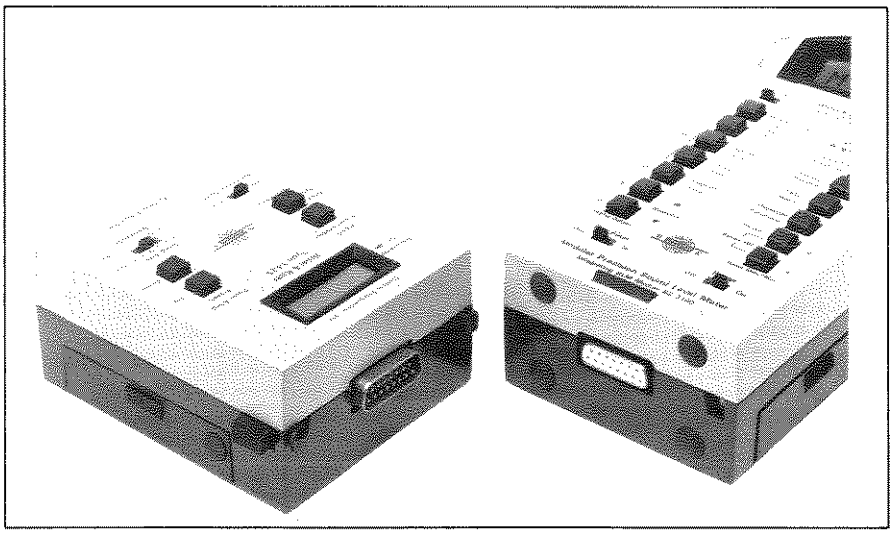


Fig. 4.3. Attachment of Filter Set (Type 1625 is shown; the same procedure is used with Filter Sets 1624 and 1627)

2. Squeeze the buttons on the sides of the Filter Set and insert the Filter Set connector into the Sound Level Meter connector. Release the buttons; the Filter Set remains locked in position.

3. Set the **Ext. Filter** switch to **In**. When the Sound Level Meter is switched on the Filter Set is powered at the same time.

When a Filter Set is connected, the batteries from the Filter Set are used as a back-up power source for the Sound Level Meter. This can double the measurement life of the Sound Level Meter if the Filter Set is not used. The Filter Set is only powered when the **Ext. Filter** switch on the Sound Level Meter is set to **"In"**.

4.1. Filter Sets

Uses:

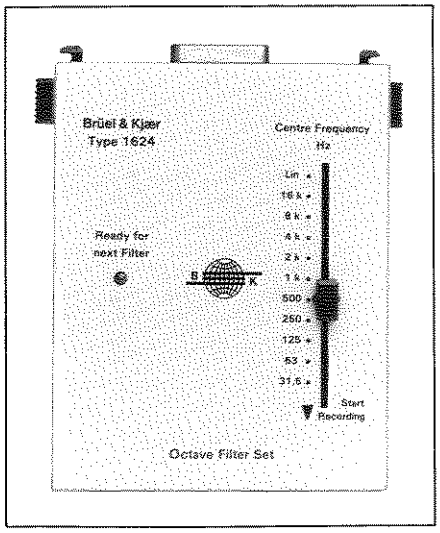


Fig. 4.4. Filter Set Type 1624

Filter Set Type 1624 has 10 active octave band filters with center frequencies from 31,5 Hz to 16 kHz and a "Lin." position. Graphs can be plotted by hand, or more conveniently semi-automatically with Level Recorder Type 2317 or 2309.

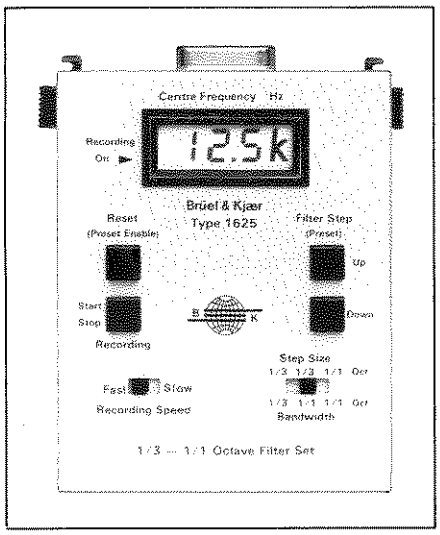


Fig. 4.5. Filter Set Type 1625

Use of the Filter Set Type 1625 permits octave and 1/3 octave frequency analysis with either octave or 1/3 octave frequency steps. The center frequencies for the octave or 1/3 octave filters are from 20 Hz to 20 kHz. The Type 1625 has 31 active overlapping octave filters and 31 active 1/3 octave filters and a "Lin." position. Analysis can be hand plotted or recorded using Level Recorder Type 2317 or 2309. The recording is fully automatic, and optimized to obtain an accurate recording in a minimum time. The center frequency of the filter used is shown on the digital liquid crystal display.

4.1. Filter Sets

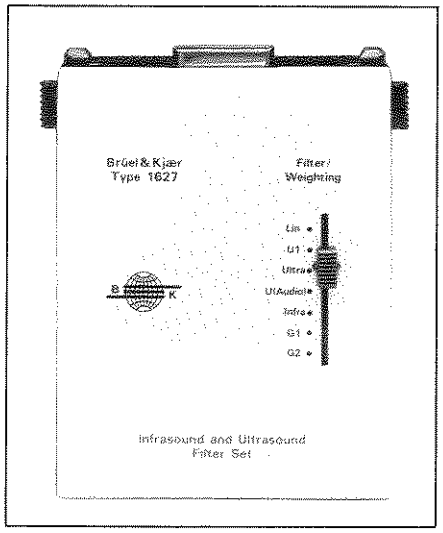


Fig. 4.6. Filter Set Type 1627

Filter Set Type 1627 incorporates 6 filter networks, together with a Lin. position. The filter characteristics are as follows:

U1: 16 kHz Ultrasound weighting

Ultra: 12,5 kHz Highpass Filter

Audio: 10 Hz to 12,5 kHz Bandpass including U-Weighting in accordance with IEC TC 29-169/WG 16.

Infra: 20 Hz Lowpass Filter

G1,G2: 20 Hz Infrasound Weighting in accordance with ISO/DIS 7196.

This Filter Set may be used for measurement in the infrasound and ultrasound ranges, and utilizes the extended frequency range characteristics of the 2231 Sound Level Meter. For Microphone Types 4155 and 4165, the frequency range can be extended down to less than 1 Hz by use of Adaptor UC 5265 supplied with Filter Set Type 1627.

Full details on the use of Filter Sets 1624, 1625, and 1627 for frequency analysis with the 2231 Sound Level Meter may be found in the Instruction Manuals for these Filter Sets.

4.2. Level Recorder Type 2317

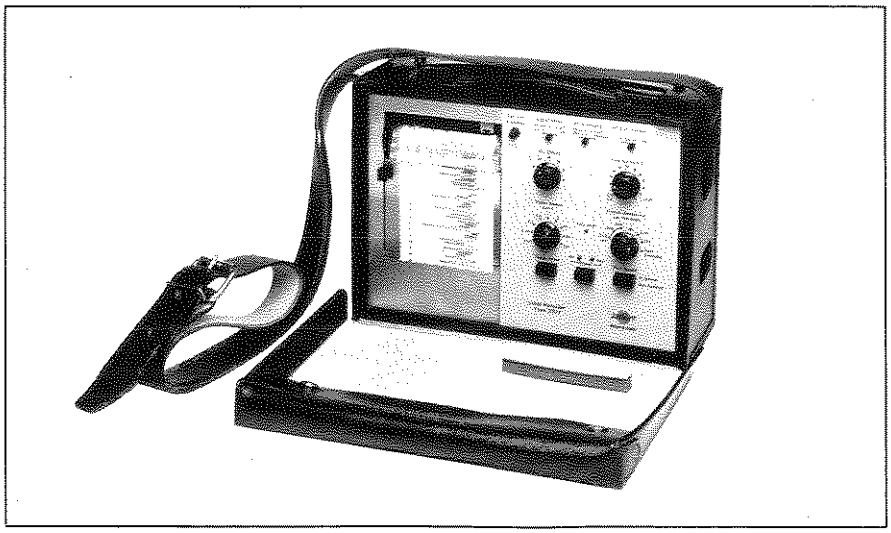


Fig. 4.7. Level Recorder Type 2317

Two signal outputs (AC and DC) are available for level recording. In AC recording the signal is frequency weighted and amplified by the Sound Level Meter and then fed directly to the Level Recorder. It is here that the signal is rectified for level recording.

In DC recording the signal that is output by the Sound Level Meter is an analogue version of what is shown on the digital portion of the display. However, the DC Output does not include the correction for the microphone K-factor, and an appropriate adjustment needs to be made on the 2317 Level Recorder. As with the digital display, the DC output signal is updated once per second. The result is a "stepped" recording which does not follow faithfully the true RMS fluctuations. The advantage of this method is that every parameter which can be shown on the digital portion of the display can also be recorded on a Level Recorder.

Examples of recordings made with Sound Level Meter Type 2231 and Level Recorder Type 2317 are shown in Figs. 4.8 to 4.10 overleaf.

4.2. Level Recorder Type 2317

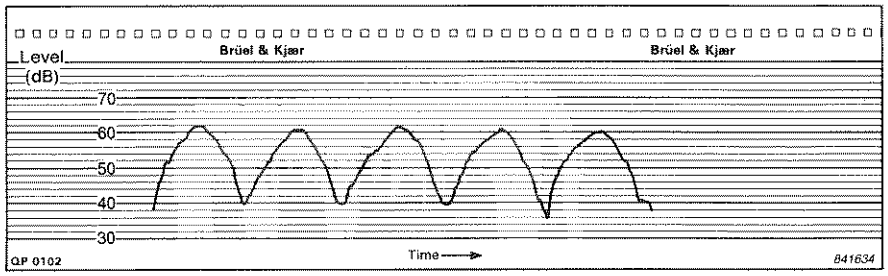


Fig. 4.8. Sound signal recording using the AC output of the 2231 Sound Level Meter. The AC Averaging switch on the 2317 Level Recorder is set to "Fast", and the Paper Speed is set to 3 mm/s

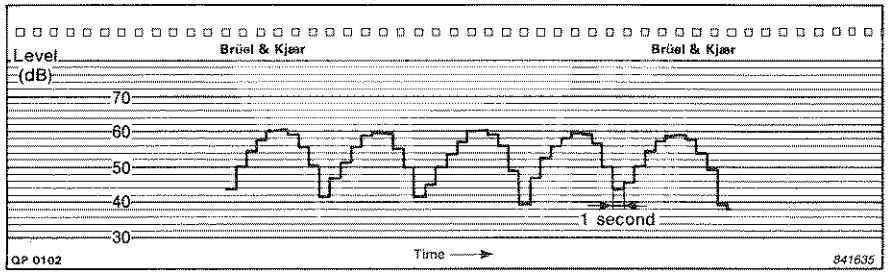


Fig. 4.9. Recording of the same sound signal using the DC output of the 2231 Sound Level Meter. The Time Weighting of the 2231 is set to "Fast" and the Displayed Parameter is set to "SPL". Note how the recorded signal is stepped in appearance. This is due to the fact that the DC output of the 2231 is updated only once per second. Each step represents the highest sound pressure level measured in the previous second

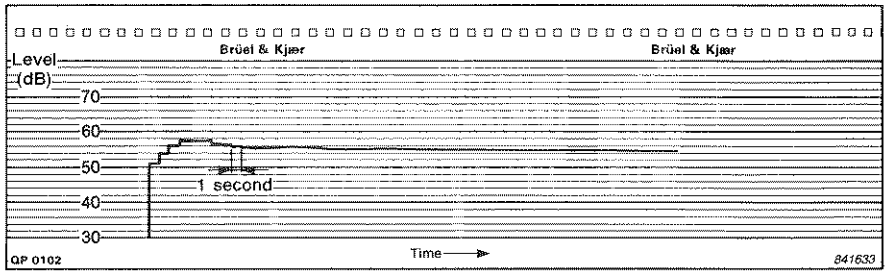


Fig. 4.10. Recording of the same sound signal using the DC output of the 2231 Sound Level Meter. The Time Weighting of the 2231 is set to "Fast" and the Displayed Parameter is set to "LEQ". The fluctuations of the recorded signal are minimal due to the integration of the sound signal over the measurement period

4.2. Level Recorder Type 2317

4.2.1. Plotting L_{eq} vs. Time

The Special Functions F–02 and F–03 (see section 3.17.1) allow the L_{eq} value to be output at the end of the Preset Time period. By selecting a Level Recorder paper speed suitable for the Preset Time period a histogram of L_{eq} vs. Time may be obtained. (See Fig. 4.11).

1. Set **Special Function** on the 2231 Sound Level Meter as required. (See section 3.17.1 – Special Function Directory).
2. Set **Preset Time** on the 2231 Sound Level Meter to an appropriate value. (See section 3.10 – Preset Time).
3. Set to **Run**.

At the end of each Preset Time interval the L_{eq} value is output via the DC Output. This output level is maintained until the end of the next Preset Time interval, when the new L_{eq} value is output. If no overload has occured during a measurement the DC Output voltage momentarily drops to zero prior to output of the L_{eq} value. On the recording this results in a vertical delineation between consecutive L_{eq} values. If an overload has occured during a measurement the DC Output voltage is momentarily raised to approximately 5 V prior to output of the L_{eq} value. This appears as a vertical line from the L_{eq} value to the top of the recording paper (see Fig. 4.11).

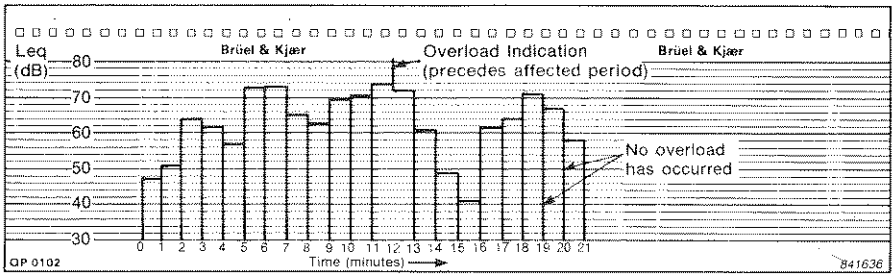


Fig. 4.11. Plot of L_{eq} vs. time. The paper speed on the 2317 Level Recorder is set to 1 mm/s and the Preset Time on the 2231 Sound Level Meter is set to 1 minute

4.2. Level Recorder Type 2317

4.2.2. Calibration using Internal Reference

1. Key in the correct K-factor for the microphone (see section 3.5).
2. Set the measuring range **FSD** to "Ref". The analogue output voltage (DC-output) will now change between 0 and 2,5 V.
3. Set the Level Recorder to its "1 V", "DC-Lin" range and adjust the **Fine Sensitivity** and **DC Offset** controls to give a deflection of 0 to 50 dB. (With 50 dB division of the recording paper, only part of the normal 70 dB dynamic range will be used. If a range greater than 50 dB is desired, adjust the recorder so that the 0 to 50 dB deflection is correspondingly smaller.
4. Use the **FSD** key to set the appropriate measuring range. The uppermost line on the recording paper corresponds to FSD – 10 dB. If whole numbers corresponding to the paper divisions are required, shift the trace on the chart paper using the **DC Offset** control on the 2317.

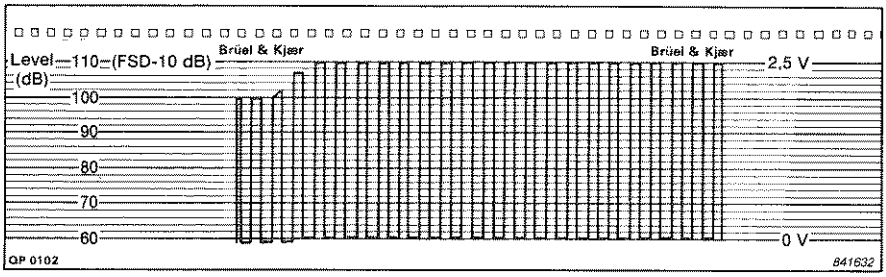


Fig. 4.12. DC output voltage varies between 0 and 2,5 V (0 to 50 dB) when the FSD on the 2231 is set to "Ref"

4.2. Level Recorder Type 2317

4.2.3. Calibration using Sound Level Calibrator Type 4230

1. Key in the correct K-factor for the microphone (see section 3.5).
2. Set the measuring range **FSD** to "Ref". The analogue output voltage (DC-output) will now change between 0 and 2,5 V.
3. Set the Level Recorder to its "1 V", "DC-Lin" range and adjust the **Fine Sensitivity** and **DC Offset** controls to give a deflection of 0 to 50 dB. (With 50 dB division of the recording paper, only part of the normal 70 dB dynamic range will be used. If a range greater than 50 dB is desired, adjust the recorder so that the 0 to 50 dB deflection is correspondingly smaller.
4. Set the measuring range **FSD** to the next least sensitive range (FSD = 110 dB + K-factor).
5. Mount the 4230 onto the microphone and activate.
6. Using the **DC Offset** control on the 2317 adjust the pen downwards to the nearest division on the chart paper corresponding to the 4230's Sound Pressure Level (see the calibration chart for the 4230).

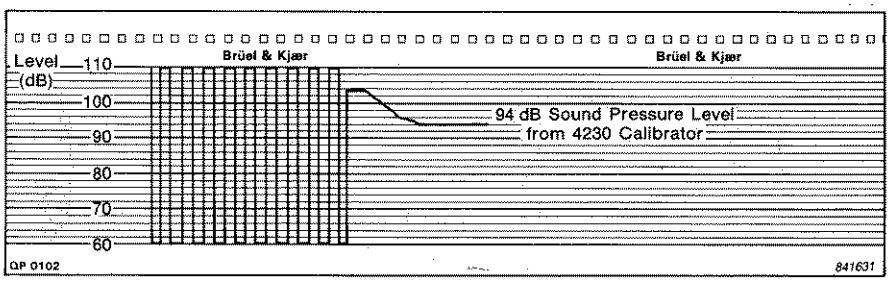


Fig. 4.13. The DC Offset on the 2317 Level Recorder is adjusted until an appropriate pen deflection corresponding to the sound pressure level output of the 4230 is achieved

4.3. Tape Recorder Type 7005/06

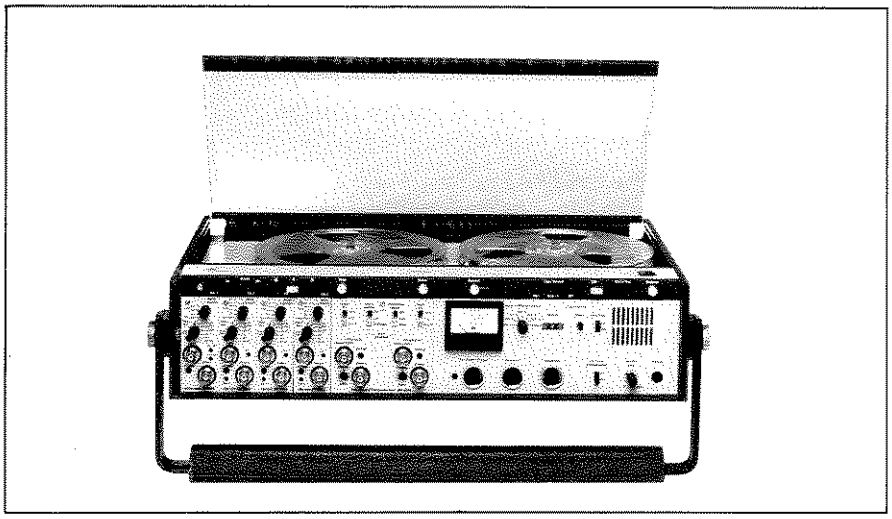


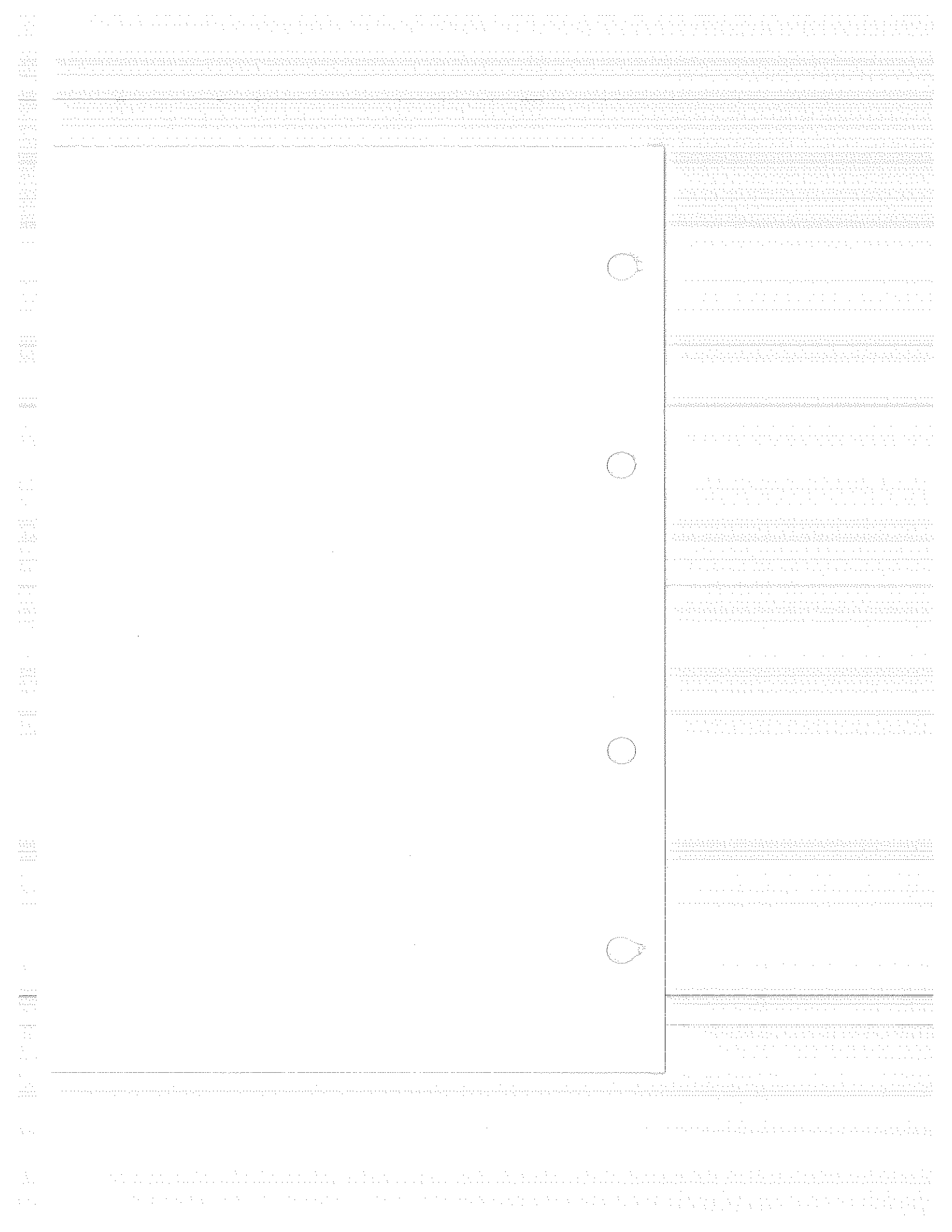
Fig. 4.14. Tape Recorder Type 7005 / 7006

In this section only the specific settings for recording with the 2231 are given. For further explanation and characteristics of the recording, please consult the 7005/06 Instruction Manual.

Check calibration of the 2231 and carry out the preliminary checks on the Tape Recorder as described in the 7005/06 Instruction Manual.

4.3.1. Recording with Direct or FM Units

1. Calibrate the Sound Level Meter and the Tape Recorder (see 7005/06 Instruction Manual). Connect the **AC Out** socket of the Sound Level Meter to the **Input** socket of the FM or Direct Unit chosen for recording using Cable AO 0173.



2. Set the controls of the Sound Level Meter as follows:

Power :	"On"
Load/Run :	"Run."
FSD :	As necessary
Freq. Weighting :	"Lin" (All-Pass)
Ext. Filter :	"Out"
Frontal/Random :	"Frontal"
Displayed Parameter :	"SPL"
Time Weighting :	"Fast"

3. Set the controls of the recording channel of the Tape Recorder as follows:

Mode Switch :	"AC"
Input Attenuator :	"30 dB" (i.e. 1 V)
Meter-Monitor Switch :	to the corresponding channel

Make sure the **Input Switch** on the Compander Unit is set to "Off" position.

Reapply the calibration source. A deflection of approximately −6 dB is obtained for the recording channel. Record this level for reference when playing back. This reference level corresponds to the SPL indicated on the Sound Level Meter.

With the Tape Recorder calibrated as above, "0 dB nominal record-reproduce" level will always correspond to the FSD selected on the Sound Level Meter. Provided that an indicating instrument with 1 V RMS range is chosen for measurement of the recorded signal on playback, then full scale meter deflection on playback will correspond to the measurement range chosen for recording the original signal.

Prior to recording measurements it is recommended that the reference used for calibrating the Sound Level Meter is recorded on tape. On playback this will allow accurate adjustment of the Sens. Adj. potentiometer of the indicating instrument to compensate for small differences between the recorded and reproduced signal amplitudes. For further information, the 7005/06 Instruction Manual should be consulted.

4.3. Tape Recorder Type 7005/06

4.3.2. Recording with the Compander Unit

Connect the Cable AO 0173 to **Direct Input** of the relevant channel of the Compander Unit.

1. Set the controls of the Sound Level Meter as described in the previous section – Recording with Direct or FM Units.
2. Set the controls of the recording channel of the Tape Recorder as follows:

Input Switch:	"Lin."
Compander Mode:	see 7005/06 Instruction Manual
Input Attenuator:	"1 V"
Meter-Monitor Switch:	to the corresponding channel

3. The reference signal gives a deflection on the Tape Recorder monitor of approximately –16 dB. Record this signal for reference when playing back. This reference level corresponds to a SPL level of 94 dB + K_0.

Provided an indicating instrument with a 1 V RMS range is chosen for measurement of the recorded signal on playback, its full scale deflection will correspond to the FSD selected on the Sound Level Meter during the recording.

4.4. Interface Module ZI 9100

Function:

Allows communication between Sound Level Meter Type 2231 and other digital devices.

Compatibility:

Communication can be established between Type 2231 and most terminals, microcomputers and printers with an RS 232 C interface which is structured close to the B & K Serial Interface.

Uses:

1. Connection to a printer for the transmission and hard copy output of data as described in section 3.17 – Special Functions.
2. Connection to a terminal or microcomputer for remote control of the Type 2231 instrument settings as described in section 3.18 – Interfacing the 2231.

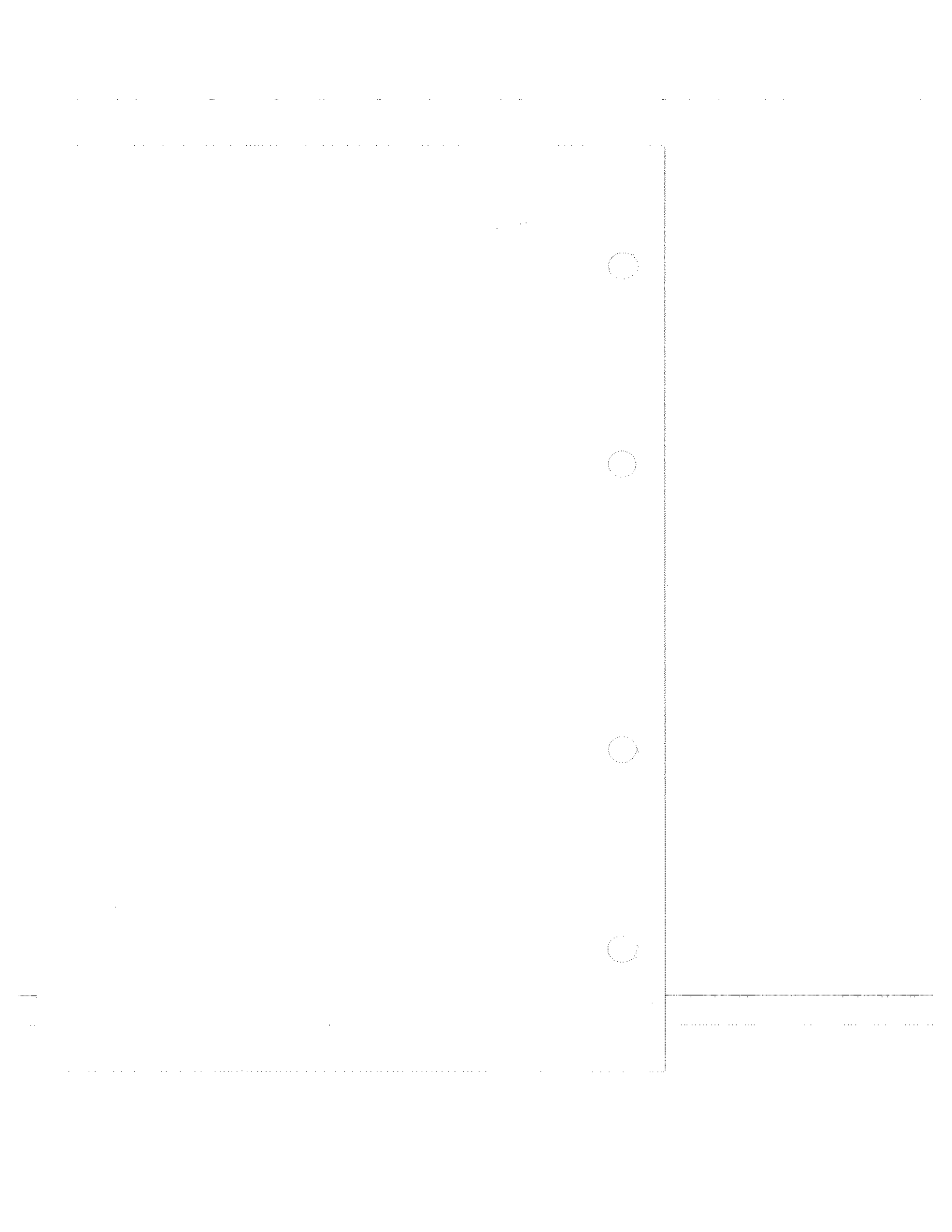
5. Care and Maintenance

Hints for Trouble-free Use:

- Always handle the microphone carefully, and try to keep dust and foreign objects off the diaphragm. Never touch the diaphragm: if it is necessary to clean it, use (very lightly) a soft brush or cotton wool swab.
- Never attach the microphone with the Sound Level Meter power on.
- Apply only light finger torque to the microphone, extension cables, input stage etc.
- Avoid exposure of the Sound Level Meter and accessories to excessive damp, cold, and heat.
- Ensure the batteries are maintained in good condition. Leaking batteries may damage the Sound Level Meter.
- Keep the Sound Level meter stored in a dry environment, preferably in the special carrying case (B&K order No. KE 0226).

Service and Repair:

The Type 2231 is designed and constructed to provide the user with many years of reliable operation. However, should a fault occur which impairs its correct function, then its internal batteries should be removed to prevent risk of further damage. For repair consult the separate Service Instruction Manual available for the Type 2231 or contact your local Brüel&Kjær service representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.



6. Specifications 2231

MEASURING RANGE:
With standard microphone (Type 4155):

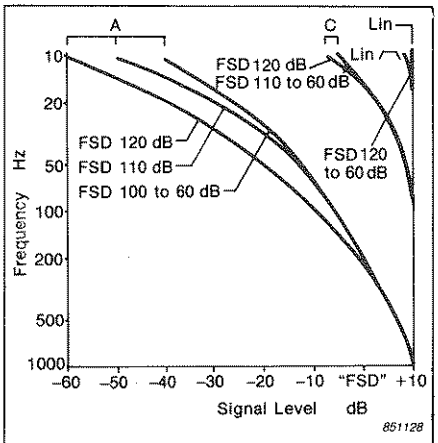
FSD[1]	Measuring Range		
	Lower limit for S/N ratio > 5 dB (A-weighting)	Max. peak level	Upper limit for signals of crest factor 10 (= 20 dB)
60	24	73	53
70	24	83	63
80	24	93	73
90	30	103	83
100	40	113	93
110	50	123	103
120	60	133	113
130[2]	70	143	123
140[2]	80	153[3]	133[3]

T00633GB1

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 K_D factor

FREQUENCY WEIGHTING:
A, C weighting in accordance with IEC 651 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



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Lowest frequency for which the error resulting from non-linear distortion generated between the sound input and the signal output is less than ± 1 dB (and no overload is indicated). The lowest frequency is given as a function of the measured signal level.

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

CONVERTIBILITY:
Loading: Enabled by module insertion: module removed after loading into internal memory. Every application module has its own frontplate.
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 9100. Open circuit signal level ± 5 V (min. Send level ± 2 V, min. Receive level ± 1 V).

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)

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 (5 V to indicate overload condition), 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
Nominal Sensitivity: 50 mV/Pa
Capacitance: 15 pF
Windscreen effect: <0,9 dB up to 10 kHz

6. Specifications 2231

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 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 dB FSD

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/K 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}.

ELECTROMAGNETIC COMPATIBILITY:
Complies with Class B computing device of the American FCC (Federal Communications Commission) Rules.

BATTERIES:
Type: Four 1,5 V, LR6 or AA size Alkaline cells (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
Alkaline Cells (×4)	QB 0013
20 dB Attenuator	ZF 0020
Integrating SLM Module	BZ 7100

ACCESSORIES AVAILABLE:

Sound Level Calibrator	Type 4230
Pistonphone	Type 4220
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

Appendix A: Choice of Microphone

The 2231 can accommodate almost any microphone in the Brüel & Kjær range, since the polarization voltage it supplies is selectable between 0 V, 28 V, and 200 V. The standard microphone supplied with the Sound Level Meter, prepolarized Microphone Type 4155, is probably suitable for almost every application that the Sound Level Meter will be used for. Unless you intend to use the instrument for the following applications, do not change the microphone:

High frequency, high level sound measurements.
1/4 inch microphones Type 4135 and 4136 are ideal for high level, high frequency measurements and model work.

Very high frequency, high level sound measurements.
1/8 inch microphone Type 4138 is ideal for this application together with pulse measurements. Being so small, Type 4138 is especially suitable for situations which require a high degree of spatial resolution or where space is limited, e.g. model testing.

Type 0 Sound Level Meter.
1/2 inch microphone Type 4133, together with Extension Cable Type AO 0027 enables the Sound Level Meter to fulfill IEC 804 (Integrating-averaging sound level meters) type 0 and relevant sections of IEC 651 type 0 I. This is possible because the frequency characteristics of the 4133 are flatter than those of the 4155, and the use of the extension cable eliminates the reflection effects of the Sound Level Meter body on the immediate sound field. Type 0 measurements in accordance with ANSI S 1.4 (1983), are possible using Random Incidence Microphone Type 4134 together with the same Extension Cable. The Sound Level Meter must remain in the "Frontal" setting if type 0 measurements are to be performed.

Appendix A: Choice of Microphone

Artificial Ear measurements.
Artificial Ear Types 4152 and 4153 use 1 inch Microphone Type 4144 and ½ inch Microphone Type 4134 respectively. These microphones both require 200 V polarization voltage and must be used since their dimensions and acoustic impedances are an integral part of the correct functioning of the Artificial Ears.

Of course it is not absolutely necessary to use the standard supplied microphone with the Sound Level Meter. However, before using any other microphone type, consult the B&K Data Sheet "Condenser Microphone Cartridges", or the B&K Data Handbook "Condenser Microphones" to ensure that the microphone is suitable for your application. Please note the following restrictions:

Type 4147 cannot be used with the 2231 to measure sound down to frequencies of 0,01 Hz, because the 2231 cannot provide the 10 MHz carrier signal which must be modulated in order to detect such low frequency sound.

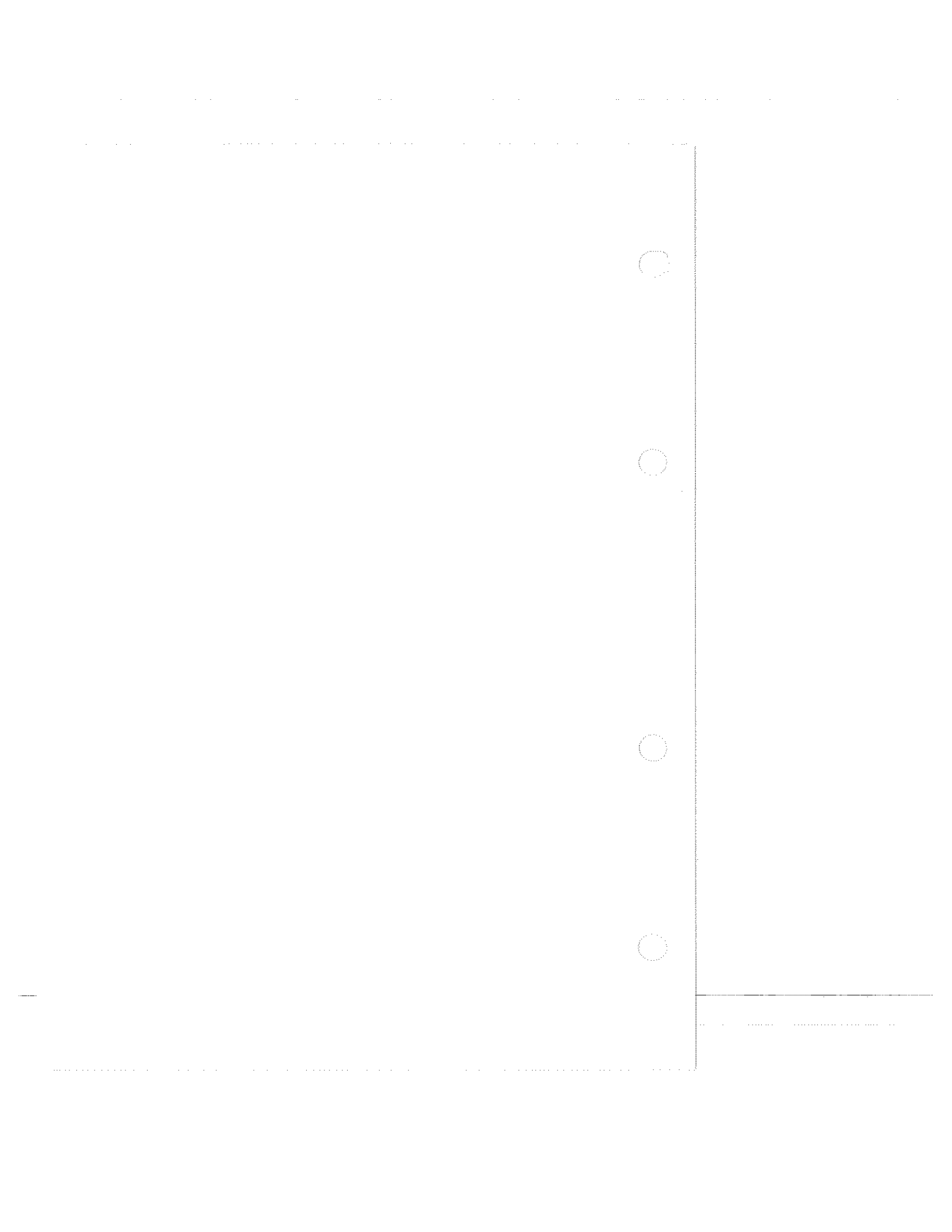
Type 4149 is designed for use in situations where a permanent outdoor set-up is required. The 2231 Sound Level Meter has not been designed for situations where it may be exposed to excessive heat, cold, or moisture.

Type 4179 is designed specifically for very-low-level sound measurements in connection with Preamplifier Type 2660. Due to its low resonance frequency it can not be used as a replacement for the standard Microphone Type 4155.

Appendix A: Choice of Microphone

The **directivity** of the Sound Level Meter is only given for the standard microphone (Type 4155) with Input Stage ZC 0020. Use of another microphone size will change these directivity characteristics.

The **Frontal/Random** setting on the 2231 must be set at "Frontal" for any microphone that is not a 1/2 inch free-field corrected microphone. The "Random" correction is only valid for 1/2 inch free-field corrected microphones such as the 4155.



Appendix B: Instrument Characteristics

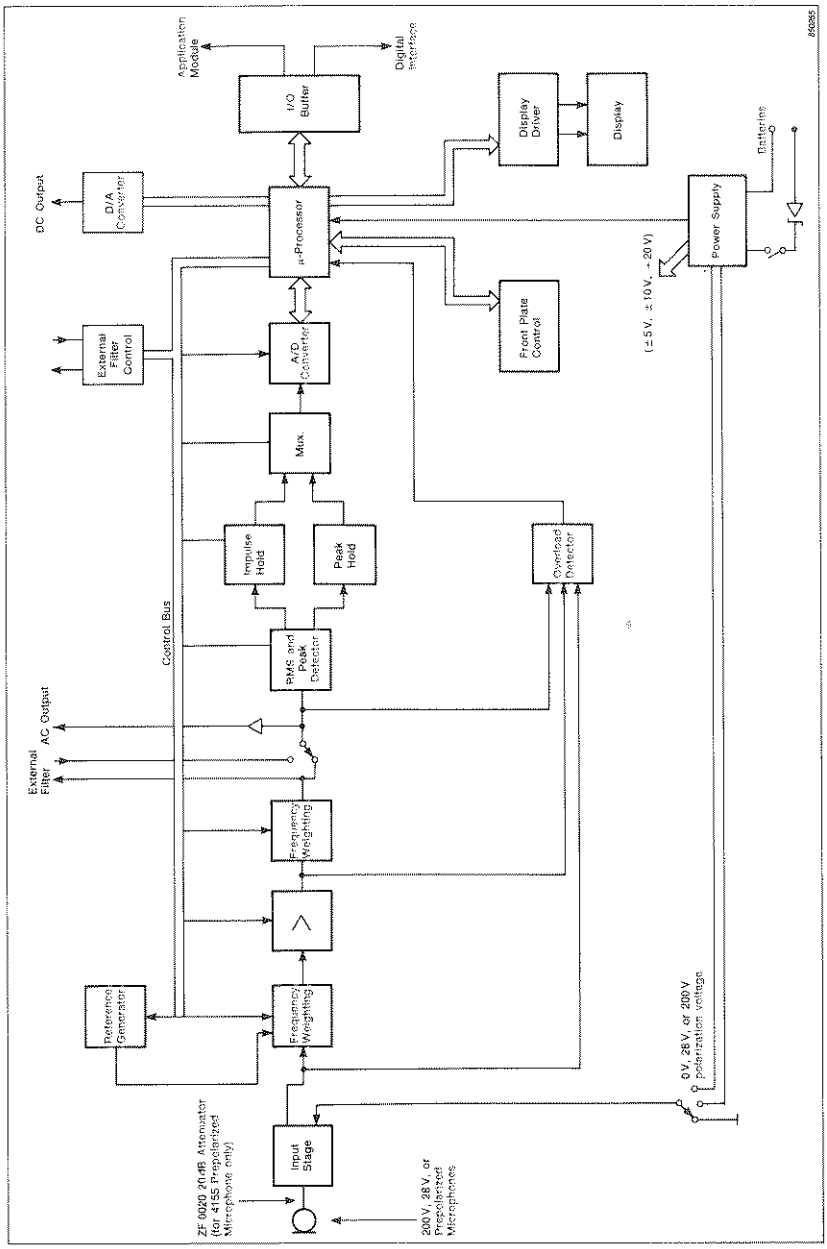


Fig. B.1. 2231 Block Diagram

Appendix B: Instrument Characteristics

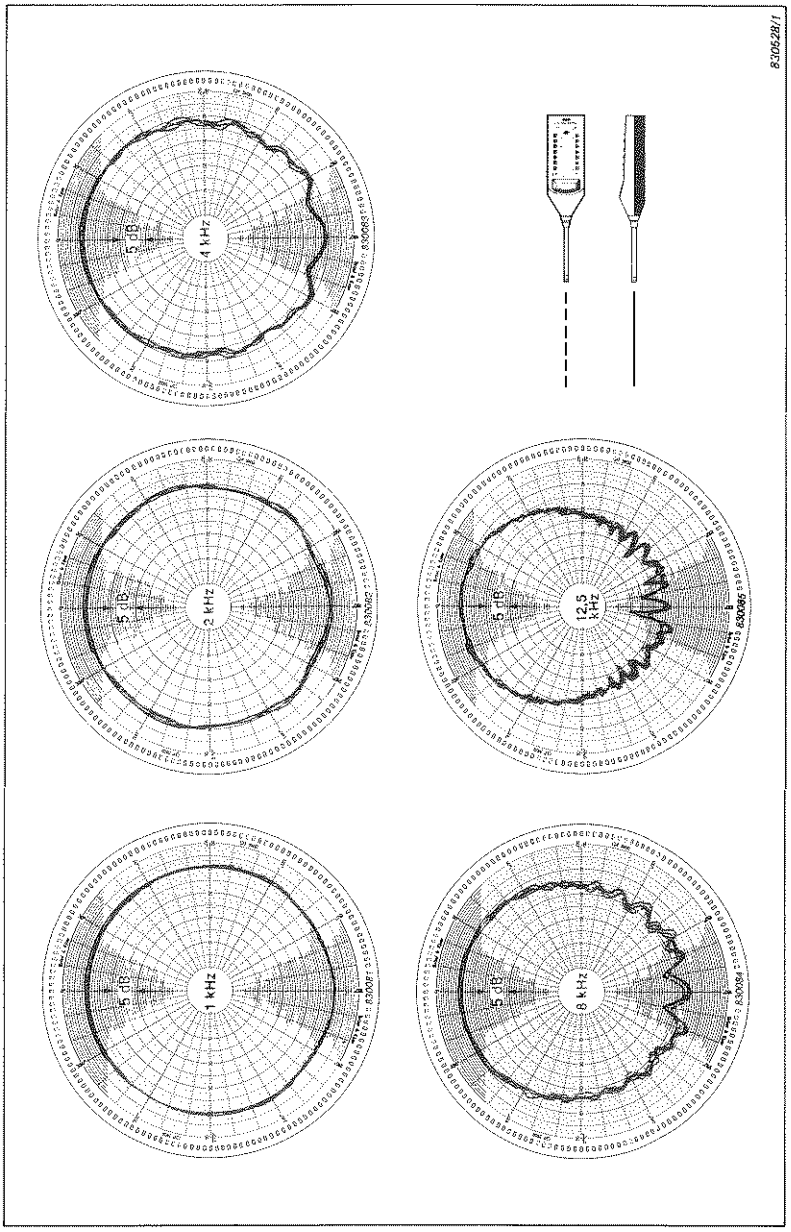


Fig. B.2. Directional characteristics of the complete instrument at 0,8/1,2kHz; 1,8/2,1kHz; 3,85/4,1kHz; 7,8/8,2kHz and at 12,5/13,0kHz

Appendix B: Instrument Characteristics

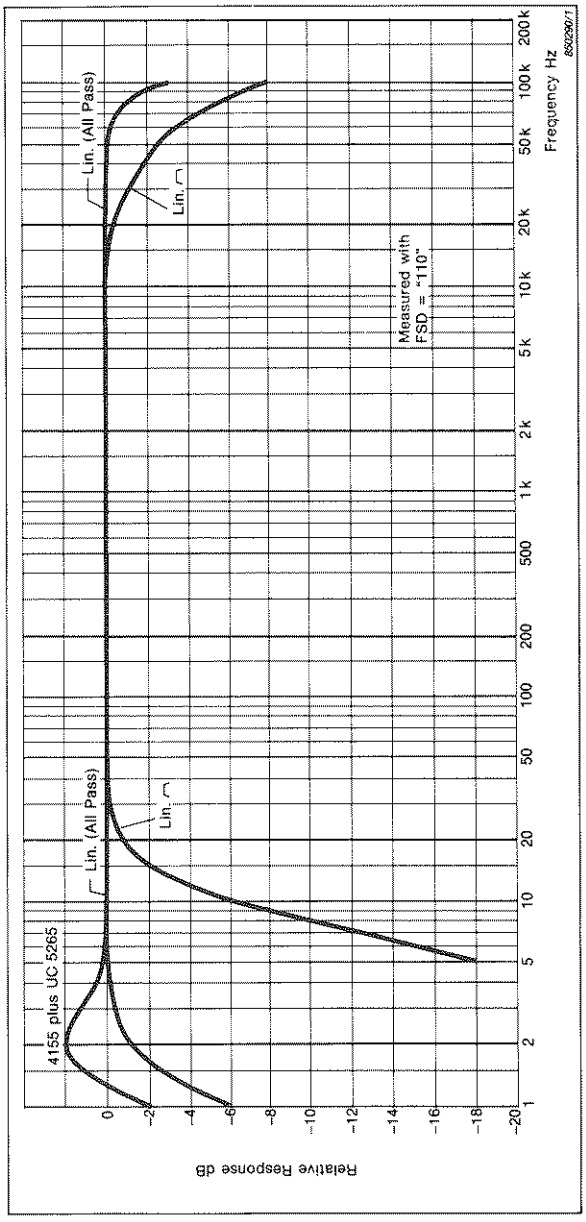


Fig. B.3. Lin. (10 Hz to 20 kHz) and All-Pass (2 Hz to 70 kHz) frequency characteristics

Appendix B: Instrument Characteristics

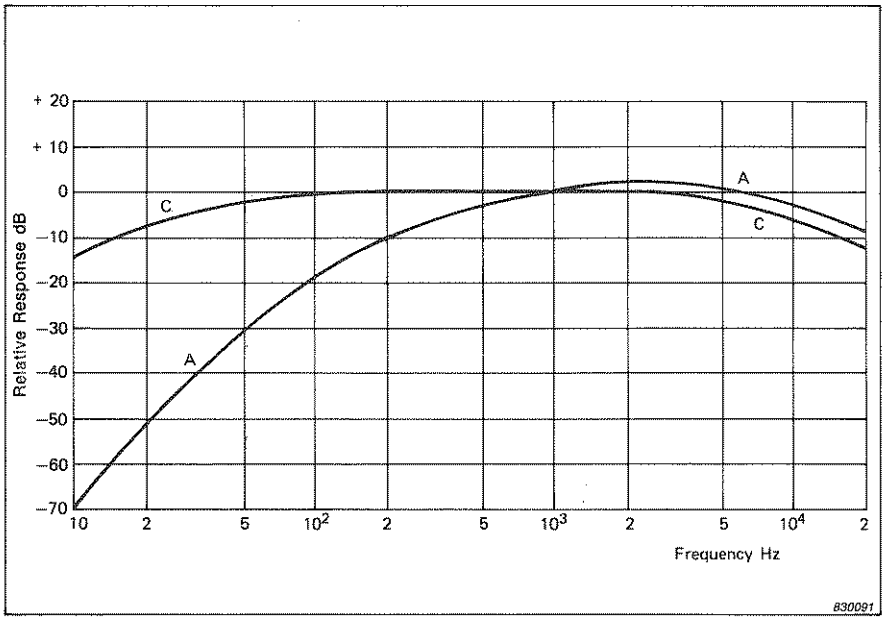


Fig. B.4. Nominal "A" and "C" weighting frequency characteristics

Appendix B: Instrument Characteristics

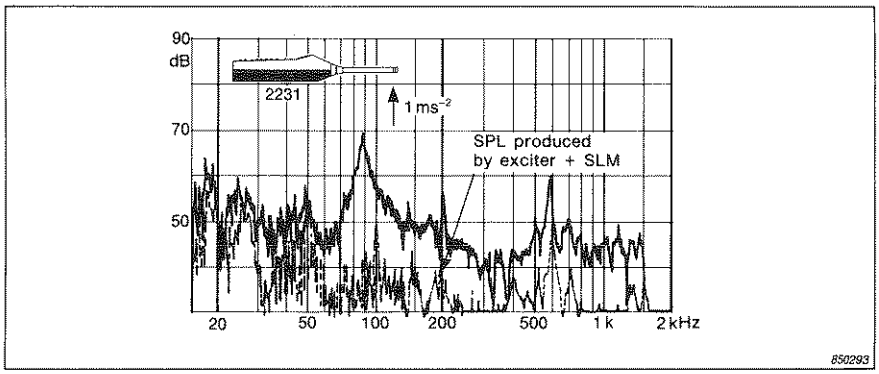


Fig. B.5. Equivalent sound pressure level when the complete Sound Level Meter is excited horizontally at 1 ms^{-2}

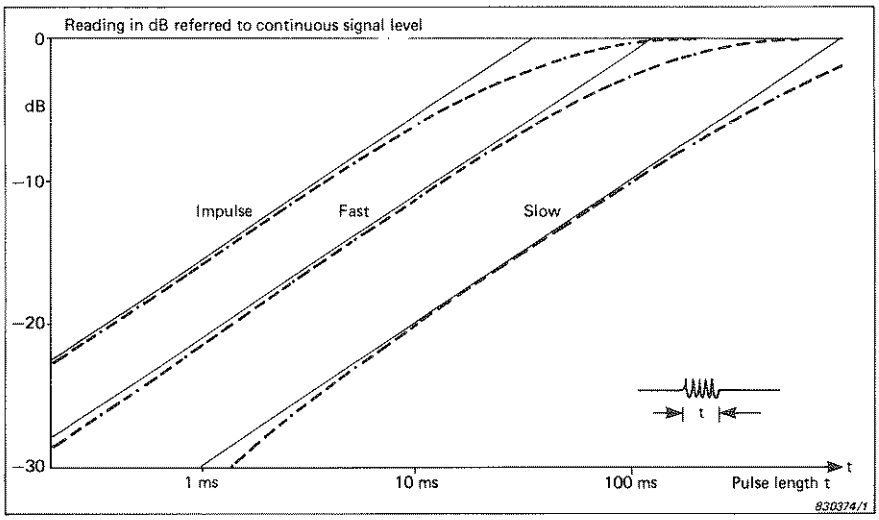


Fig. B.6. Response of rectifier to tone bursts of varying characteristics

Appendix B: Instrument Characteristics

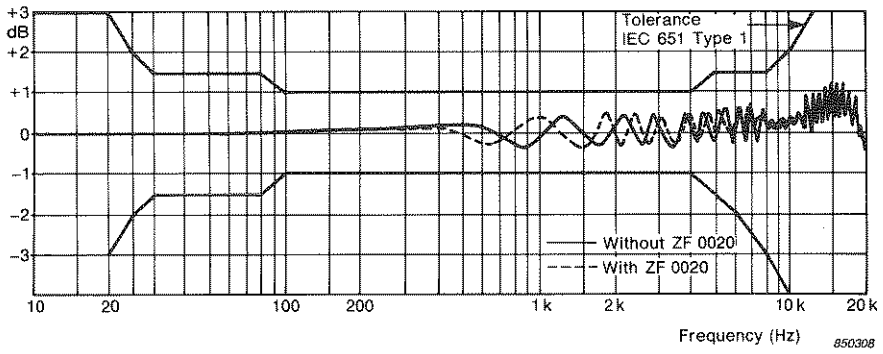


Fig. B.7. Typical 0° free field frequency response of the complete instrument

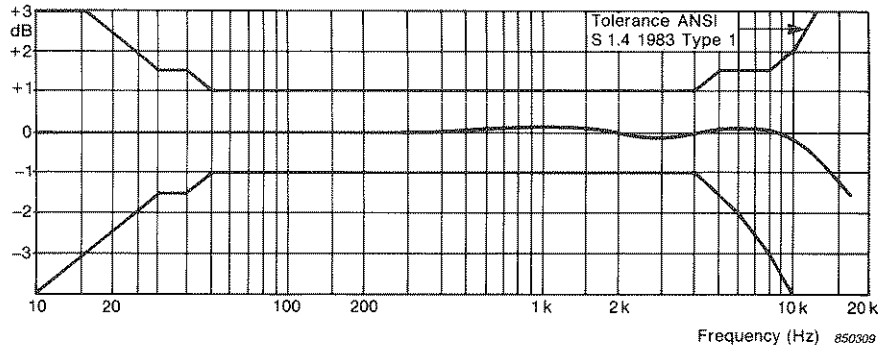


Fig. B.8. Typical diffuse field frequency response of the complete instrument

Appendix B: Instrument Characteristics

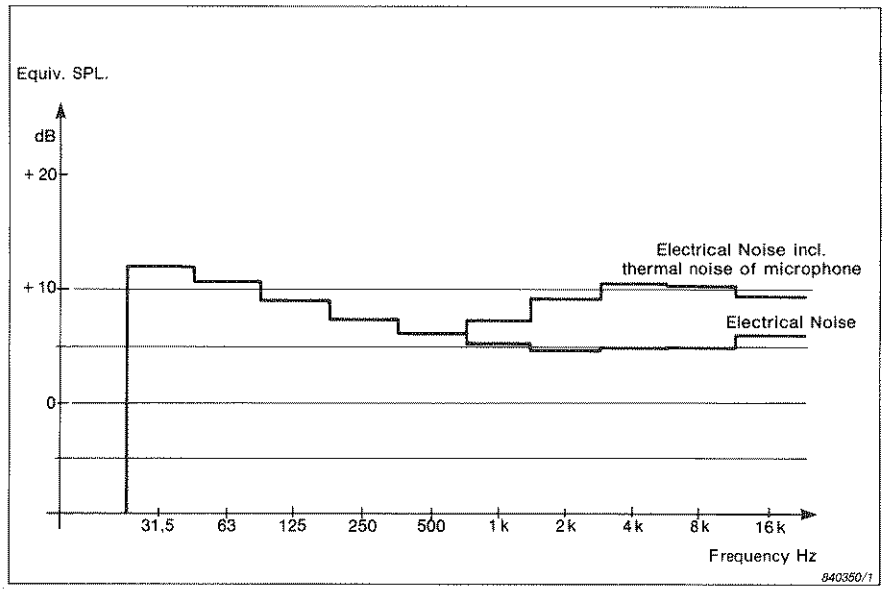


Fig. B.9. 2231 noise floor in octave bands

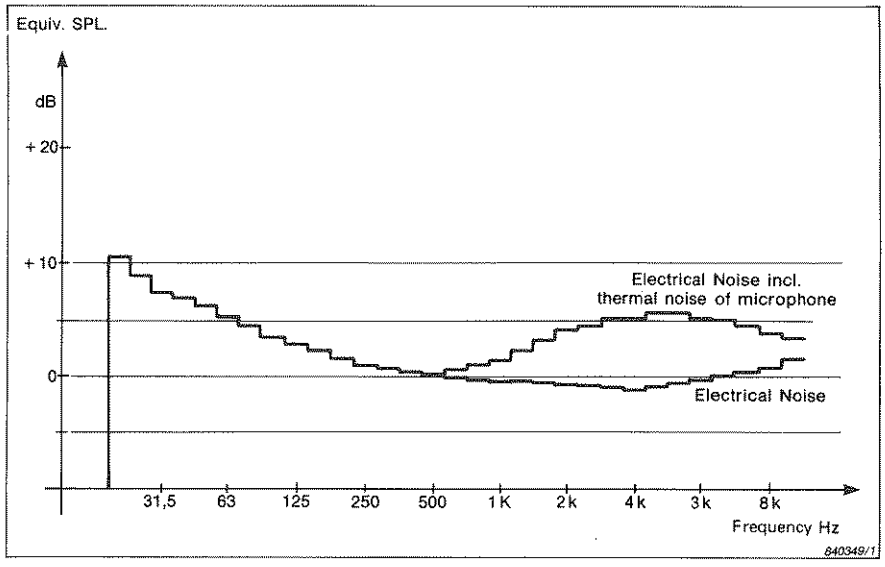


Fig. B.10. 2231 noise floor in 1/3 octave bands

Appendix B: Instrument Characteristics

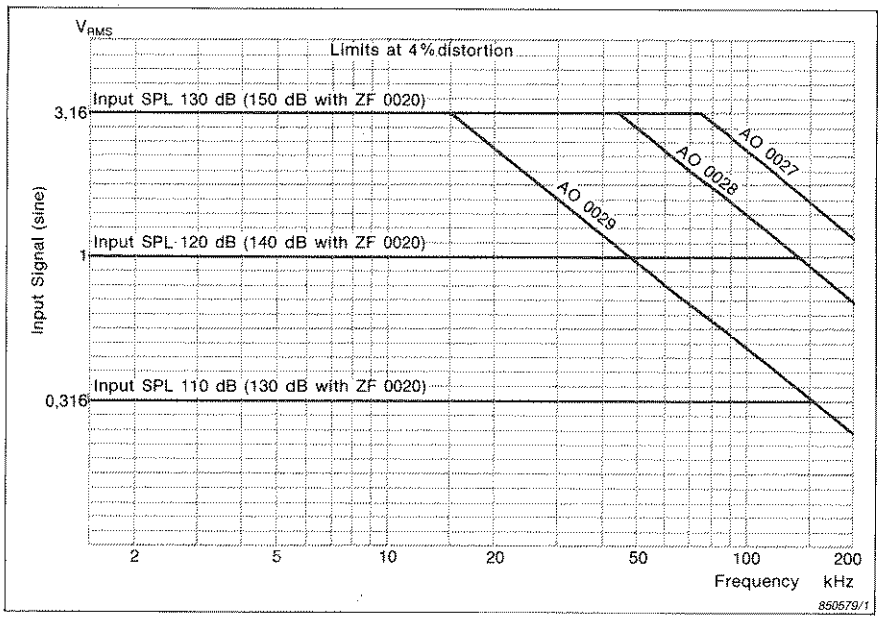


Fig. B.11. Attenuation of the measured signal due to different extension cables

Pushkey Directory

Note: The command initiated by some pushkeys depends upon whether the Sound Level Meter is in the **Load** *(L)* status or in the **Run** *(R)* status, selected with the **Load/Run** slider switch.

Load/Run: Select Load status – program accepts initialization commands – or Run status – program is executed.

Module No. 1: *(L)* – Loads module software into memory. *(R)* – Displays status of currently loaded software.

Test: Activates Display test.

K-Factor: *(L)* – Initiates entry of microphone K-factor. *(R)* – Displays currently entered K-factor.

Special Function: *(L)* – Initiates entry of Special Function code which implements a minor modification to the standard program. *(R)* – Displays status of currently selected Special Function.

Sec.: *(L)* – Initiates entry of "seconds" part of Preset Time. *(R)* – Displays status of "seconds" part of Preset Time or Elapsed Time.

Preset Time: *(L)* – Initiates entry of Preset Time which is used to set in advance a measurement period of up to 100 hours. *(R)* – Displays currently programmed Preset Time.

+/–: *(L)* – Used to select the sign of numbers being entered for the setting of K-factor.

Elapsed Time: *(R)* – Displays the time elapsed since the start of the measurement.

0: *(L)* – Zero.

Selector ▲: *(R)* – Used in conjunction with Time Weighting, Frequency Weighting, Frontal/Random, FSD, and Display Function commands. Selects the next pre-programmed weighting, range or function "up" in the series appropriate to the command.

Selector ▼: *(R)* – Ditto, except that the next pre-programmed parameter "down" in the series is selected.

1: *(L)* – One.

2: *(L)* – Two.

Digital Output: *(R)* – Activates data readout via the Digital Output Interface Module.

Ext. Filter Out/In: Enables the External Filter if attached.

Pol. Voltage: Select appropriate Polarization Voltage (0 V, 28 V, or 200 V) for the attached microphone.

Time Weighting: – Select Impulse, Fast or Slow Time Weighting in conjunction with **Selector ▲** or **Selector ▼**. Check the status of the Time Weighting.

3: *(L)* – Three.

Frequency Weighting: – Select "A", "C", "Lin." or "All Pass" Frequency Weighting. Check the status of the Frequency Weighting.

4: *(L)* – Four.

Frontal/Random: – Select appropriate weighting network for Frontal or Random sound fields. Check status of Frontal/Random weighting network.

5: *(L)* – Five.

FSD: – Select one of 7 overlapping 70 dB measuring ranges, plus activation of internal reference signal. Check status of selected Full Scale Deflection.

6: *(L)* – Six.

Displayed Parameter: – Select one of 8 Display Functions (SPL, Peak, L_{eq} etc.). Check status of selected Display Function.

7: *(L)* – Seven.

Pause: *(R)* – Sound Level Meter goes into an idling mode where no updating of measurement values, time, or dose will occur.

8: *(L)* – Eight.

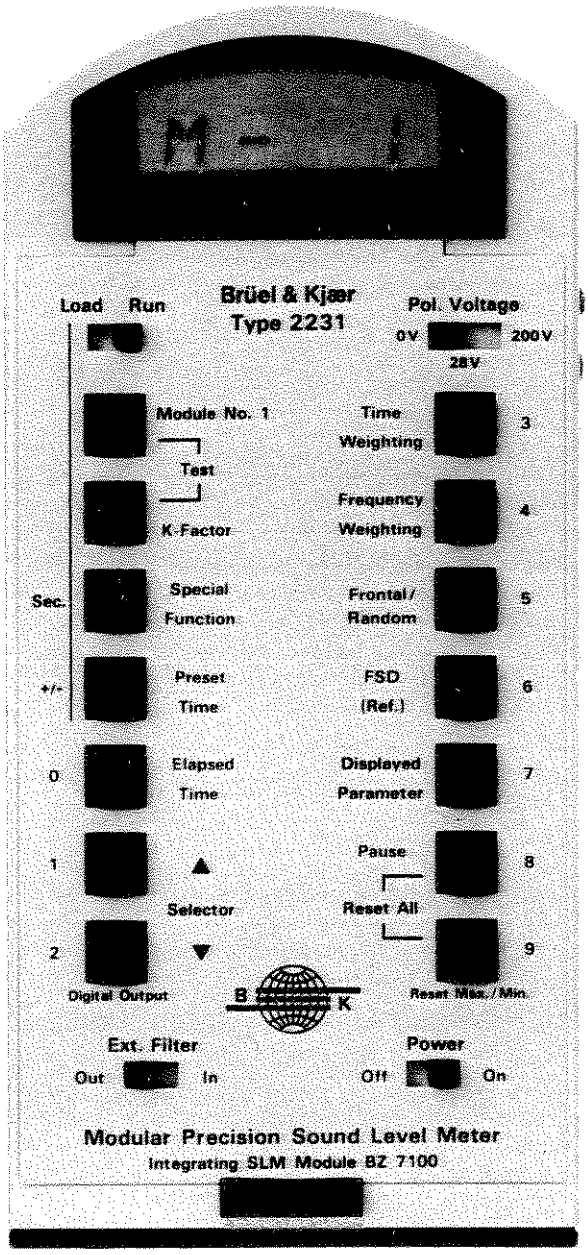
Reset All: *(R)* – Resets all measurement, time and calculation memories and initiates a new measurement.

9: *(L)* – Nine.

Reset Max./Min.: *(R)* – Resets only $Peak_{max.}$, $SPL_{max.}$ and $SPL_{min.}$ without interrupting the measurement of other parameters.

Power Off/On: Switches Sound Level Meter on or off.

Front Plate



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