Integrating-averaging Sound Level Meter Type 2240

User Guide

Sonomètre intégrateur Type 2240 – Guide de l'utilisateur Integrierende Schallpegelmesser Typ 2240 – Bedienungshandbuch Fonometro integratore-mediatore 2240 – Manuale utente Sonómetro integrador-promediador 2240 – Manual de usuario

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Part 1

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English



Chapter 1

Introduction

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Welcome

This user guide introduces you to Type 2240 Integrating-averaging Sound Level Meter, how the instrument works, which parameters you can measure, and how the instrument should be operated. In addition, some practical hints and guidelines are provided for, including all relevant technical specifications. Finally, a glossary is added to help with specific terminology found in this guide.

Summary of Contents

- **Chapter 1 Introduction:** provides a general overview of the user guide and describes Sound Level Meter Type 2240's uses and features
- Chapter 2 Getting Started: provides basic introductory information to sound level meters and your instrument, including: general terminology, description of instrument parts, display and key definitions, and battery installation
- Chapter 3 Making a Measurement: step-by-step instructions on how to take a measurement with Type 2240
- Chapter 4 Basic Operation: contains information and appropriate procedures on how to use Type 2240, including calibration, start-up, reading and key operation guides
- Chapter 5 Practical Guidelines: gives tips on how to take a successful sound level measurement, and what conditions and actions to avoid
- Chapter 6 Maintenance and Service: provides care, cleaning and storage instructions as well as information on where to go for service of your instrument
- Chapter 7 Specifications: a comprehensive listing of technical specifications of Type 2240
- Chapter 8 Glossary: a quick list of terms used in this guide and their definitions

Conventions Used in this Guide

Instructions and descriptions that refer to Type 2240 instrument keys are shown with the key icons as seen on the instrument. See Chapter 2 for a complete list of of key icons and their functions.

Instructions and descriptions that refer to Type 2240 instrument display text are indicated using Courier type face. For example, "Press () until L_{Aeq} is visible on the screen".

Terms that are defined in the Glossary (Chapter 8), are highlighted in *italic bold*.

About Type 2240

Uses and Features

Type 2240 is a Class 1 integrating-averaging sound level meter that measures time-average sound level as defined in the IEC 61672-1 standard. Its uses and features include:

- Simple sound level checks
- Control of noise levels in the workplace
- Complaint investigation
- Quick and easy to use
- Conforms with IEC 61672-1 Class 1, IEC 60651 and 60804 Type 1, ANSI S 1.4–1983 Type S1 and ANSI S 1.43–1997 Type 1
- Simultaneous RMS and Peak measurements (with independent frequency weightings)
- Measures L_{AF}, L_{Aeq}, L_{AFmax} and L_{Cpeak}
- No parameter configuration needed, the instrument is ready to measure from the start
- Large LCD display screen for easy reading
- Quasi-analogue bar graph shows current sound pressure level
- Under-range and overload indicators



Chapter 2

Getting Started

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Type 2240 is a high performance, Class 1, integrating-averaging sound level meter with an easy-to-use interface for quick and simple measurements. This chapter details the instrument's components and basic sound level parameters involved in measuring. With this information you should be able to immediately start using your sound level meter. However, it is recommended that you read the entire guide before using your Type 2240 in order to achieve the best results from your instrument.

What is a Sound Level Meter?

A sound level meter is an instrument that is designed to measure sound levels in a standardised way. A sound level meter comprises a microphone, a main processor and a read-out unit. The microphone converts sound to an equivalent electric signal, which is processed by the instrument. Processing includes applying frequency and time weightings to the signal as specified by international standards, such as IEC 61672-1 to which Type 2240 conforms.

Frequency weighting adjusts how the sound level meter responds to different sound frequencies. This is necessary because the human ear's sensitivity to sound varies according to the sound's frequency. The most common frequency weighting in use is *A-weighting*, which adjusts a signal in a way that best resembles the human ear's response at medium-range levels. It is the weighting required for nearly all environmental and workplace noise measurements, and is specified in international and national standards and guidelines. All of Type 2240's measurement parameters apply A-weighting, except for the measurement of peak levels where the 'C' frequency weighting is applied. In this case, *C-weighting* is used to take into account the energy present at low frequencies even if they are not particularly annoying.

Time weighting specifies how the sound level meter reacts to changes in sound pressure. It is an exponential averaging of the fluctuating signal, providing an easy-to-read value. Type 2240 always applies the Fast, or 'F' time weighting, which is the required weighting according to the vast majority of international and national standards and guidelines.

Once the signal is processed through the weighting filters, the resulting *sound pressure level* is displayed in *decibels (dB)* on the instrument's display. In Type 2240, the sound pressure level values are updated once per second.

Description of Type 2240 Sound Level Meter

Sound Level Parameters

There are four sound level parameters measured by Type 2240: L_{AF} , L_{Aeq} , L_{AFmax} and L_{Cpeak} . Once a measurement is started (using \swarrow control key), all four parameters are measured simultaneously, you just need to choose which one you want to be displayed using the parameter control key (). Press this key at any time during, or after, a particular measurement to switch to another sound level reading. The four sound level parameters are:

 L_{AF} : The 'A' frequency-weighted and 'F' time-weighted sound pressure level. This parameter is always displayed when the instrument is switched on, even if you have not started a measurement. It is an instantaneous value, which is mainly used to determine the approximate sound levels in order to select the appropriate sound level range to measure.



 L_{Aeq} : The equivalent continuous, 'A' frequency-weighted sound pressure level. L_{Aeq} is a linear average of all the varying sound pressure levels detected during a measurement. For a number of international and national standards, it is the key parameter in determining annoyance from environmental noise and assessing the risk of hearing deficiencies induced by exposure to high sound levels at the work place. Note: LAeq is not time-weighted.



LAFmax: The maximum 'A' frequency-weighted and 'F' time-weighted sound pressure level detected during a measurement. It is the maximum value of LAF detected during a measurement. It is often used in comparison with another parameter (for example: LAeq) to ensure a single noise event does not exceed a limit.



Fig.2.1



L_{Cpeak}: The maximum 'C' frequency-weighted, peak sound pressure level detected during a measurement. L_{Cpeak} is used to assess risks of hearing deficiencies induced by very high sound pressures of short durations at work places. Remember that peak levels can be very high without being harmful or even annoying, so care should be taken to use L_{Cpeak} only for its intended purpose. Such high values can be misleading in situations where they are not called for. **Note:** L_{Cpeak} is not time-weighted.

Fig.2.4 L_{Cpeak} parameter displayed



 L_{AFmax} , L_{Cpeak} , and L_{Aeq} sound level parameters begin calculation only when a measurement is started (press \searrow), and stop only when the measurement is stopped (press \searrow again). L_{AF} is calculated automatically when the sound level meter is switched on.

The measured values of L_{AFmax} , L_{Cpeak} , and L_{Aeq} are cleared whenever a new measurement is started.

Instrument Components





The following descriptions refer to the numbered instrument parts in Fig.2.5:

1) Sound Level Meter body: The main part of your instrument.

- 2) **Sliding cover:** Underneath the cover is a quick reference guide to help you use the three control keys for setup and display of measurements. Slide to open, do not press. A diagram of the quick guide is found in Fig.2.6.
- 3) **Microphone:** Brüel & Kjær's Prepolarized Free-field ¹/₂" Microphone Type 4188 is used. A robust and reliable microphone with a wide frequency range.
- 4) Preamplifier: Conditions the microphone signal before further processing.
- 5) Display screen: An LCD display showing:
 - a) the sound level parameter currently being viewed
 - b) elapsed measurement time
 - c) measurement reading in dB (decibels)
 - d) quasi-analogue bar graph representing current sound pressure level
 - e) battery level indicator
- 6) Start/Stop key 🚰 : Press to start or stop a measurement.
- 7) Sound Level Parameter key (): Press to scroll through sound level parameters that are available to display (L_A, L_{Aeq}, L_{Amax}, or L_{Cpeak}), or hold down for 3 seconds to calibrate.
- 8) Sound Level Range key \square : Press to set sound level range (30–110 dB or 60–140 dB).
- 9) Calibration switch: Adjust instrument calibration using the included screwdriver.
- 10) Power switch: Turn the instrument on and off.
- 11) **Battery compartment:** Slide the compartment's lid to replace batteries when needed. Instructions on replacing batteries follow in "Installing Batteries" on page 13.

Control Keys

Fig.2.6

Under the front panel's sliding cover is a quick guide to help you use the three control keys



Note: All keys function step-wise, as illustrated by the quick guide's use of arrows. Press a key to step through the available functions. When the last possible function comes up, the instrument will automatically scroll through the choices again as you continue to press.

Start/Stop Key 🏏

This key controls the initiation and completion of a measurement.

Quick Guide Symbol	Instructions
Ę.	To start a measurement, press / until appears on the display
Â	To stop a measurement, press / until stops flashing on the display

Sound Level Parameter Key

This key controls which sound level parameter is displayed. It is not necessary to configure any sound level parameter, as all four parameters are measured simultaneously as soon as a measurement is started.

Quick Guide Symbol	Instructions
۲ _А	To display the A-weighted sound pressure level, press $()$ until L_A appears on the display. Note: L_A is time-weighted, using Fast weighting
L _{Aeq}	To display the A-weighted, equivalent continuous sound pressure level, press $rac{1}{2}$ until L_{Aeq} appears on the display
L _{Amax}	To display the maximum A-weighted sound pressure level, press () until L_{Amax} appears on the display. Note: L_{Amax} is time weighted, using Fast weighting
L _{Cpeak}	To display the C-weighted, peak sound pressure level, press () until L_{Cpeak} appears on the display.

The Sound Level Parameter key can also be used to electrically calibrate the instrument by holding $\langle \rangle$ down for three seconds. Actual adjustments are made using the calibration switch on the side panel, and the included screwdriver. It is a good idea to calibrate the instrument before and after a series of measurements to conform to required standards and ensure precise results each time. See "Calibration" on page 18. for more information.

Sound Level Range Key □

This key controls the sound level range to be measured.

Quick Guide Symbol	Instructions
30 – 110 dB	To measure in this range, press $\Box \Box$ until the bar graph shows a range of 30 – 110 dB
60 – 140 dB	To measure in this range, press \Box until the bar graph shows a range of 60-140 dB

Installing Batteries

Type 2240's power supply consists of two AA-size (IECR6 or LR6) alkaline batteries. To install the batteries, do the following:

- 1) Make sure the sound level meter is switched off.
- 2) The battery compartment is located in the centre of the instrument's back panel. Slide the cover off.

Fig.2.7 Type 2240 with the battery cover removed



3) Insert 2 new batteries following the +/- orientation shown at the bottom of the battery compartment.

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- 4) Slide the compartment cover back into place.
- 5) Switch the Power on. The battery symbol in the bottom left-hand corner of the instrument display should indicate a full battery level **Line**. Note: If the instrument does not turn on, check that you have inserted the batteries correctly.

The battery level has two black columns, each representing about 8 hours of remaining battery time for a total of approximately 16 continuous hours of use (at room temperature). In extremely cold or hot environments, the remaining time may be less.

Both columns will be shown in the indicator when the battery level is full. It is time to replace the batteries when the indicator is empty and flashing.

Caution:

It is possible for batteries to explode or leak if they are handled incorrectly, so:

- For long-term storage, remove the batteries and keep the sound level meter in a dry place
- Never mix different makes or types of battery
- Never mix charged and discharged batteries

Chapter 3

Making a Measurement

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There is no pre-configuration necessary before making a measurement with Type 2240. The instrument is ready as soon as you turn it on. It is suggested, however, that you calibrate your instrument before a measurement to ensure correct measurement and display values, as well as complying to specific measurement standards. Your sound level meter is delivered factory calibrated, so you can begin your first measurement immediately. Instructions for calibrating at a later time can be found in Chapter 4, "Basic Operation" on page 17.

Measurement Procedure

Setup and measurement are quick and simple:

1) Switch the sound level meter on using the Power switch on the side panel.

An L_A value is displayed and the quasi-analogue bar begins reacting, both of which reflect the instantaneous sound pressure level.

- 2) □ Select the sound level range, judging from the observed level (L_{AF} and quasi-analogue bar).
- 3) \searrow Press the start button.
- 4) Be aware of possible under-range Under and overload Over indications. It may be necessary to change the sound level range to avoid these readings. See "Selecting the Sound Level Range" on page 23.
- 5) () Scroll through sound level parameters until the required parameter is displayed.
- Fig.3.1 Examples of measurement options



- 6) ^{*} Stop the measurement as necessary. For example, when L_{Aeq} is stable or the required time has elapsed.
- 7) () Toggle between parameters for comparison, if needed.
- 8) Write down the displayed result(s).
- 9) \checkmark Press the start button to take a new measurement.

Chapter 4

Basic Operation

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Calibration

Calibration is an adjustment of your sound level meter to ensure correct measurement and display values. This is necessary because the sensitivity of the microphone and the response of the electronic circuitry can vary slightly over time or be affected by environmental conditions such as temperature and humidity. Often, calibration is required by national and international measurement standards. While you are not likely ever to experience a large drift or change in sensitivity with Type 2240, it is nevertheless good practice to perform regular calibrations, normally before each set of measurements.

Your instrument supports two types of calibration:

- **acoustical calibration** that calibrates all the instrument's components (microphone, preamplifier and electrical circuitry), wherein an acoustic signal of known magnitude and frequency is applied
- electrical calibration that does not include calibration of the microphone and preamplifier

Acoustical Calibration

Acoustical calibration is the preferred calibration method, particulary when standards and regulations require that a calibration is performed before a measurement.

To perform an acoustical calibration, use Brüel & Kjær Sound Level Calibrator Type 4231. It provides a stable sound pressure at 1 kHz and has minimal susceptibility to environmental factors. You use the calibrator's reference signal at 1 kHz to compare and adjust your sound level meter in full, including microphone, preamplifier and electronic circuitry.

The procedure for performing an acoustical calibration is simple:

- 1) Stand away from loud sound sources that may interfere with the calibrator's signal.
- 2) Fit Sound Level Calibrator Type 4231 carefully onto the sound level meter and rest the assembly on a table or other flat surface as shown in Fig.4.1.

Fig. 4.1 Sound Level Calibrator Type 4231 fitted onto your sound level meter



Ensure that the calibrator fits snugly on the microphone.

- 3) Switch on the sound level meter. The L_{AF} parameter is displayed (L_A , Fast). If the meter is already switched on and another parameter displayed, press () until L_A is displayed.
- 4) Press □[] to select the 30–110 dB sound level range (if not already displayed). This is the sound level meter's reference range and should be used for calibration.
- 5) Switch on the calibrator. Type 4231 automatically emits a 1 kHz signal at 94 dB. Wait approximately 5 seconds for all levels to stabilise.
- 6) Using the supplied screwdriver on the calibration switch located on Type 2240's side panel, adjust your sound level meter to display 93.9 dB¹.



Fig.4.2

Adjusting calibration using the screwdriver on the calibration switch located on Type 2240's side panel

¹The reading should be 93.9 dB (not 94 dB) to agree with your sound level meter's microphone (Type 4188 free-field microphone). The 94 dB level specified for the calibrator is the pressure field in the coupler when the calibrator is fitted to the sound level meter. A slight correction must, therefore, be applied. This is explained in the calibrator's manual and the calibration chart supplied with your microphone.

Note: Type 4231 can also provide a 114 dB signal (see Type 4231 User Manual BB 0910). Normally, this signal should not be used; however, if a calibration must be performed in a very noisy environment, you can use this level for calibration. In such a case you must select the 60-140 dB range and adjust the reading to 113.9 dB.

7) Remove the calibrator. It switches off automatically after a few seconds.

Electrical Calibration

An electrical calibration calibrates your sound level meter's electronics only (not the microphone and preamplifier) and is based on a built-in reference signal.

The procedure is as follows:

- 1) Switch on the sound level meter.
- 2) Press () for 3 seconds until you see the following display:

Fig. 4.3 Electrical calibration display within the 30– 110 dB range



If Type 2240 is set in the $60-140 \,\text{dB}$ sound level range, the display will instead be like this:





Note: In both cases, the calibration level is 6 dB below the top of the measurement range, i.e., 104 dB and 134 dB, respectively, as indicated on the display.

- 3) Now use the supplied screwdriver to adjust the reading to the required value (104.0 dB or 134.0 dB).
- 4) Press () once to leave the electrical calibration mode.

Operation

Display

During normal operation, you use the display screen to view your measurements. The information provided is described below.





- 1) Mark for calculating: This symbol is displayed and flashes when the instrument is measuring.
- 2) **Elapsed time:** Displays the amount of time that has passed since measurement began (from 1 second to 60 minutes). After the 60-minute maximum has elapsed, all measurements automatically stop.
- 3) The bottom end of the measurement range (in decibels): Sounds 0.5 dB or more below this level register as under range. To change the measurement range, stop the measurement and press \Box .
- 4) **Quasi-analogue bar graph:** Shows a graphical representation of the current sound pressure level. It is updated 10 times per second.
- 5) The upper end of the measurement range (in decibels): Sounds 0.3 dB or more above this level trigger an overload warning. To change the measurement range, stop the measurement and press \Box .

- 6) Under-range indicator: Any sound detected during the measurement that is 0.5 dB or more under the bottom end of the measurement range prompts the indicator. You may want to change the measurement range to the lower level (30-110 dB), if applicable, by pressing ∩ [], otherwise your measurement results will reflect under range conditions.
- 7) **Calibration value:** When you press $\langle \rangle$ for 3 seconds, you start an electrical calibration of the instrument. The calibration value is based on the sound level range Type 2240 is presently set up to measure (30–110 dB or 60–140 dB). Use the included screwdriver to adjust your instrument to match this value.
- 8) **Overload indicator:** Sounds detected are 0.3 dB or more over the upper end of the measurement range. If an overload has occurred in the last second, **Over** is displayed with a black background. If an overload has occurred at any time during a measurement in progress, then the word Over has a plain background this is called a latched overload. Latched overloads are cleared with the start of a new measurement and are not applicable with the L_{A} parameter.

You many want to change the measurement range to the higher level (60-140 dB), if applicable, by pressing $\Box \Box$, otherwise your measurement results will reflect overload conditions.

- 9) Parameter display: Shows the type of sound level reading displayed (L_A, L_{Aeq}, L_{Amax}, or L_{Cpeak})
- 10) **Sound pressure level value:** The sound pressure level applies to the current parameter being displayed. It is updated once per second.
- 11) **Battery level:** When the batteries are new, this indicator displays two black level columns. As the batteries are used, the level falls. Replace the batteries when this indicator is empty and flashing.
- 12) **Peak or Time weighting:** Peak is displayed together with the L_C parameter to denote that the peak level for this parameter is displayed. Fast is displayed with L_A and L_{Amax} parameters to denote that the 'F' time-weighting is used.

Measurement Start and Stop

When you switch on the instrument, the instantaneous sound pressure level is displayed (L_A) . Monitoring the L_A for a short period gives you an idea which sound level range to choose.

While L_{AF} is automatically measured, calculation of the other three parameters (L_{Aeq} , L_{AFmax} and L_{Cpeak}) must be initiated by pressing \checkmark . Once a measurement is started, the arrow \blacktriangleright in the upper left-hand corner of the display flashes to denote calculations are being made. Throughout the measurement time, you can view the various sound level parameters and their current values by scrolling through the parameter menu (\checkmark). To stop a measurement, press \checkmark . The flashing arrow \blacktriangleright in the display stops.

All results are cleared when the instrument is switched off.

Selecting the Sound Level Parameter \bigcirc

Selecting the right sound level parameter to display and report is dependent on the regulations and standards to which you must comply.

Selecting the Sound Level Range

Sound Level Meter Type 2240 can measure sound pressure levels spanning from 30 dB to 140 dB, separated in two ranges: 30 to 110 dB, and 60 to 140 dB. For any measurement task, you have to select one of the ranges by pressing \Box .

The L_{AF} parameter (L_A) and the quasi-analogue bar are useful tools to help you decide which range to choose. Switch between the two ranges as you read the bar graph. Ideally your signal should fluctuate around the middle graph without indications of under-range **Under** or overload **Over**. If there are very large fluctuations in the sound pressure, for example, because impulsive sounds are present, you may find it difficult to completely avoid at least one of these indicators. If you have to choose between seeing under-range or overload conditions, select the higher measurement range in order to avoid the overloads.¹ This type of situation indicates that the signal fluctuates heavily, so be sure to use a sufficiently long averaging time to obtain a stable level of L_{Aeg} .

Measuring LAeq

 L_{Aeq} is always calculated for a specific duration, often due to standardised requirements, which demands a report of the measurement duration. L_{Aeq} durations are recorded as: $L_{Aeq,10min}$ or in elongated form as "the 10 minute L_{Aeq} was xx.x dB".

Type 2240 can calculate L_{Aeq} over durations ranging from 1 second to 60 minutes (in 1 second steps), with a built-in timer for accuracy. The current measurement time is displayed in the upper right-hand corner of the display. If regulations require measurements of a specific duration, follow this regulation and pay attention to the instrument's timer. If no specific measurement time is required by regulation, you can determine the length of time on your own. Below are some practical guidelines on how to make a proper L_{Aeq} measurement:

- After a significant amount of time, even considerable fluctuations in sound pressure will average out and L_{Aeq} will stabilise around a value. If you start a measurement and press () until L_{Aeq} is displayed, you can easily observe this effect. Continue measuring until the value of L_{Aeq} becomes stable.
- All measurement subjects exhibit some fluctuation. Depending on the fluctuation, you should select a measurement time that can limit the short variations of L_{Aeq} to one or a few tenths of a dB. The time required for this to happen depends on the amount of fluctuation. Remember that the L_{Aeq} averaging (measurement) time should always be reported.

¹This is because you will then have values for L_{Amax} and L_{Cpeak} that are not affected by an overload. With sufficient averaging time, the under-range conditions have only a negligible influence on the L_{Aeq} value.

Making a Measurement of a Specified Duration

Regulations may require you to take a measurement of a specified duration (this duration may be 1 second, 10 seconds, 5 minutes or some other value). In any case, it is normally required that the specified duration is strictly adhered to.

When making a measurement of specified duration, simply watch the timer at the upper righthand corner of the display screen. For example, to make a 10-second measurement from a starting time of 00 m 00 s, simply press the stop button \swarrow when the timer displays 00 m 10 s at most 1 second after it displays that time. You can then scroll through the sound level parameters using the \checkmark key to get a report of all the values for that 10-second period.

Side Panel Functions

Lifting the side panel flap, you find two functions: the power switch and calibration switch.

Fig.4.6 Type 2240's side panel



- 1) **Power Switch:** Turn the instrument on and off. The instrument automatically begins calculating L_{λ} when it is switched on. Switch the power off when the instrument is not in use.
- Calibration switch: Using the enclosed mini-screwdriver, electrically adjust the instrument's calibration. See "Electrical Calibration" on page 20. for more information.

Note: The connector found on the side panel is for factory test purposes only.

Chapter 5

Practical Guidelines

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When taking measurements, you will often find instructions in local regulations concerning the particular measurement, which of course, you must always follow. This chapter provides general hints and guidelines that are useful when no specific instructions are available.

How to Hold the Instrument

All objects present in the sound field where you are taking measurements exert some influence on the sound field and, to some extent, have an effect on the values you measure. One of the objects present is your body, which can either reflect or block sounds. To minimise the effect of your own presence:

- 1) Point the sound level meter towards the sound source.
- 2) Hold the instrument away from your body, at arm's length.

Measuring in Free or Diffuse Sound Fields

There are two types of sound fields you should be aware of: free and diffuse. In a free sound field – for example, out of doors away from reflecting surfaces – sounds arrive from one principal direction. In a diffuse sound field, such as in a reverberant room, sounds arrive randomly from all angles (random incidence). Specific microphones are used in each condition to ensure accurate measurements and a uniform response at all frequency ranges. For free-field measurements, the sound level meter should be fitted with a microphone with a free-field response. During diffuse-field measurements, a microphone with a random-incidence response should be used. However, you must always follow the relevant standard's requirements to ensure complete measurement compliance, for example: IEC standards specify the use of sound level meters with a free-field response, while the American ANSI standards call for a random-incidence response.

Your Type 2240 is fitted with a free-field microphone. However, if your local standards require the use of a random-incidence response, it is possible to fit your microphone with the supplied Random-incidence Corrector DZ 9566 (Fig. 5.7).

Fig.5.7 DZ 9566 Randomincidence Corrector



Under free-field or near free-field conditions you simply point the sound level meter towards the sound source. However, if you have fitted the Random-incidence Corrector and want to measure with a free-field response, you must orient the instrument at an angle of $70-80^{\circ}$ to the sound source; if pointed directly at the source, the result will be too high, especially if high frequencies are prominent. Conversely, if you use a free-field response in a diffuse sound field the sound pressure will be underestimated.

Where to Place the Instrument

Legislation often specifies where measurements should be made, for example, at property boundaries or at the complainant's property. Other factors also need to be taken into account when measuring, because sound levels vary at different heights above ground level. They will also vary depending on the distance between the measurement point and facades and obstacles. These requirements must be noted and applied.

This will often mean making measurements:

- away from reflecting surfaces (for example, facades)
- with the microphone 1.2 1.5 m above ground level
- downwind
- in dry conditions with a wind speed of less than 5 m/s

Reflective Objects

When sound waves impact upon a surface, part of their acoustic energy is reflected from it, part is transmitted through it, and part is absorbed by it. Generally in the case of buildings, most of the sound energy is reflected, which makes the measured sound pressure level higher. Regulations often require the exclusion of the effect of reflection from reported measurement results (free-field conditions). Therefore, in both indoor and outdoor situations, you should try to keep a distance of 3 m or more from reflective surfaces such as walls or large objects. Hold the sound level meter at a natural position of 1.2 to 1.5 m above the ground/floor, since it also reflects sound.

Special Considerations for Measurements of Noise at Work

If you are to measure the noise level exposure at a workplace, it may not be easy to stay away from reflective surfaces, nor may you want to as you need to measure the sound levels to which the workers are actually exposed – this includes reflections. General guidelines are as follows (from the ISO 9612 standard):

- Place the microphone where an operator's head would normally be positioned
- If measurements cannot be made without an operator present, place the microphone close to (approximately 10 cm from) the ear of the operator. Do this at the ear receiving the highest noise levels

Wind, Temperature and Humidity

Type 2240 operates within the tolerances of the applicable standards over a wide range of temperature and relative humidity. You will seldom have any problem staying within the limits required. Always check with the relevant standards and guidelines to see which measurement conditions must be followed. If no guidelines exist, good rules of thumb for outdoor measurements are as follows:

- Measure in relatively calm conditions such as a light breeze wind speeds of 5 m/s or less are often required
- Always measure in downwind conditions, especially if you are at a considerable distance from the sound source (50 m or more)

Chapter 6

Maintenance and Service

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Service and Repair

Type 2240 is designed and constructed to provide many years of reliable operation. However, if a fault occurs that impairs the sound level meter's correct function, then remove the batteries to prevent risk of further damage.

For more information about preventing faults or damage to your sound level meter, please read the Care, Cleaning and Storage section below.

For repair, contact your local Brüel & Kjær representative. Brüel & Kjær provides a high level of support and after-sales service to assist customers in the handling and operation of their instruments.

Care, Cleaning and Storage

Type 2240 is a delicate precision instrument. When handling, storing or cleaning your instrument, please take the following precautions.

Handling the Instrument

- Do not try to remove the microphone grid as you can easily damage the microphone in this way
- Do not attempt to open the instrument. There are no user-serviceable parts inside. If you think your instrument requires service, please contact your Brüel & Kjær representative
- Do not allow the instrument to get wet
- Never mix different makes or types of battery
- Never mix fresh and partially-used batteries
- · Do not allow fully discharged batteries to remain inside the instrument
- · Protect the instrument from impact. Do not drop it. Transport it in the supplied carrying pouch

Storing the Instrument

- Keep the sound level meter in a dry place, preferrably within its carrying pouch
- For long-term storage, remove the batteries
- Do not exceed storage temperature limits of -25 to +60° C (-13 to +140° F)

Cleaning the Instrument

If the instrument casing becomes dirty, then wipe it with a lightly dampened cloth. Do not use abrasive cleansers or solvents. Do not allow moisture to enter the microphone, connectors or casing.

Chapter 7

Specifications

Compliance with Standards		
(E C	CE-mark indicates compliacne with: EMC Directive and Low Voltage Directive. C-Tick mark indicates compliance with the EMC requirements of Australia and New Zealand	
Safety	EN 61010–1 and IEC 61010–1: Safety requirements for electrical equipment for measurement, control and laboratory use. UL 3111–1: Standard for Safety – Electrical measuring and test equipment	
EMC Emission	EN/IEC 61000–6–3: Generic emission standard for residential, commercial and light industrial environments EN/IEC 61000–6–4: Generic emission standard for industrial environments CISPR 22: Radio disturbance characteristics of information technology equipment. Class B Limits FCC Rules, Part 15: Complies with the limits for a Class B digital device	
EMC Immunity	EN/IEC 61000–6–1: Generic standards – Immunity for residential, commercial and light industrial environments EN/IEC 61000–6–2: Generic standards – Immunity for industrial environments EN/IEC 61326: Electrical equipmentfor measurement, control and laboratory use – EMC requirements FCC Rules, Part 15: Complies with the limits for a Class B digital device	

STANDARDS

Conforms with the following:

- IEC 61672-1:2002 Class 1
- IEC 60651 Type 1 (1979) with amendments 1 and 2
- IEC 60804 Type 1 (2000)
- ANSI S1.4 1983 Type S1
- ANSI S1.43 1997 Type 1

PARAMETERS

Four parameters are measured simultaneously:

- LAF, instantaneous sound pressure level, frequency weighting 'A' and time weighting 'F'
- LAFmax, maximum sound pressure level, frequency weighting 'A' and time weighting 'F'
- · LAeq, equivalent continuous sound pressure level. frequency weighting 'A'
- · L_{Cpeak}, maximum peak sound pressure level, frequency weighting 'C'

Resolution: 0.1 dB for all four parameters

MEASUREMENT CONTROL

Measurements are manually controlled Measurement times between 1s and 60 min

MEASURING RANGES

RMS: Total range: 30 - 140 dB Two manually selected ranges: 30 - 110 dB and 60 -140 dB Peak: 60 - 143 dB

NOISE FLOOR

Below measurement range, <22 dB

DETECTORS

Simultaneous RMS and Peak with independent frequency weightings Linear Operating Range: 80 dB

FREQUENCY RANGE

20 Hz to 16 kHz

FREQUENCY WEIGHTINGS

A-weighting (RMS) C-weighting (Peak) Relative Response:See Fig.7.1 below.

TIME WEIGHTING

'F' (Fast)

OVERLOAD AND UNDER-RANGE INDICATORS

Overload is indicated at full-scale +0.3 dB An overload detected during a timed measurement latches and is displayed with the relevant parameters until these are cleared Under-range is indicated at scale lower limit -0.5 dB

MICROPHONE

Type 4188 Prepolarized Free-field 1/2" Condenser Microphone Sensitivity: -30 dB re 1 V/Pa ± 2 dB (corresponding to 31.6 mV/Pa)

Frequency Range: 8 Hz to 16 kHz ±2 dB

DISPLAY

LCD showing:

- Input signal level indicated with a guasi-analogue bar
- · Selected parameters with level
- · Warnings for: low battery, measurement in progress, overload and under-range
- · Measuring range
- Frequency and time weighting
- · Elapsed measurement time

Update Cycle: 1 s (numeric), 0.1 s (bar graph)

SETTLING TIME

Less than 5s

REFERENCE CONDITIONS

Reference Frequency: 1000 Hz Reference Sound Pressure Level: 94 dB Reference Temperature: 20°C (68°F) Reference RH: 65% Reference Range: 30–110 dB Reference Direction of Incidence: Frontal

ENVIRONMENTAL EFFECTS

Storage Temperature: -25 to 60° C (-13 to 140° F) Operating Temperature: -10 to 50° C (14 to 122° F) Effect of Magnetic Field: 80 A/m (1 oersted) at 50 Hzgives less than 30 dB (A-weighted)

BATTERIES

Two 1.5 V LR 6/AA-size alkaline batteries **Power Consumption During Normal Operation:** Less than 300 mW Lifetime (at room temperature): Approximately 16 h

PHYSICAL CHARACTERISTICS

Dimensions: 230 \times 78 \times 31 mm including microphone **Weight:** 245 g (8.64 oz) including batteries

ORDERING INFORMATION

Type 2240 Integrating-averaging Sound Level Meter Type 2240 A Integrating-averaging Sound Level Meter plus Type 4231 Sound Level Calibrator Included Accessories:

- Type 4188 Prepolarized Free-field 1/2["] Condenser Microphone
- DZ 9566 Random-incidence Corrector
- KE 0443 Pouch
- UA 1236 Protective Cover
- QA 0229 Screwdriver
- Two alkaline batteries
- **Optional Accessories:**
- Type 4231 Sound Level Calibrator (included with Type 2240 A)

Fig.7.1 Relative response of 'A' and 'C' frequency weightings



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Note: This chapter comprises the specifications that are needed for evaluation of instrument performance characteristics and proper use of the instrument. Some of the applicable sound level meter standards require additional technical documentation, in particular for pattern evaluation (type approval) purposes, but have no bearing on normal use. The additional technical documentation is given in a separate Brüel & Kjær instruction manual (BE 1694). For a copy, contact your local Brüel & Kjær representative.

Chapter 8

Glossary

A-weighting filter:

C-weighting filter:

decibel (dB):

Frequency weighting corresponding approximately to the 40 dB equal loudness curve, that is to say, the human ear's response at low to medium sound levels. It is by far the most commonly applied frequency weighting. See also *C*-*weighting* and *frequency weighting*.

Frequency weighting corresponding to the 100 dB equal loudness curve, that is to say, the human ear's response at fairly high sound levels. Mainly used when assessing peak values of high sound pressure levels. See also *A*-*weighting* and *frequency weighting*.

The measurement unit for expressing the relative intensity of sound. A direct application of linear scales (in Pa) to the measurement of sound pressure leads to large and unwieldy numbers. As the ear responds logarithmically rather than linearly to stimuli, it is more practical to express acoustic parameters as a logarithmic ratio of the measured value to a reference value. This logarithmic ratio is called a decibel or dB. The advantage of using dB can be clearly seen in the below illustration. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing ($20 \mu Pa$) to 130 dB at the threshold of pain (~100 Pa).



Our hearing covers a surprisingly wide range of sound pressures – a ratio of over a million to one. The dB scale makes the numbers manageable

'F' time weighting:

A time weighting (sometimes called a 'time constant') defines how the exponential averaging in root-mean-square (RMS) measurement is done. It defines how the heavily fluctuating sound pressure variations are smoothed or averaged to allow useful readings. The standards define three time weightings: F (Fast), S (Slow) and I (Impulse). Most measurements are carried out using the 'F' time weighting, which uses a 125 ms time constant.

The number of pressure variations per second. Frequency is measured in hertz (Hz). The normal hearing for a healthy young person ranges from approximately 20 Hz to 20000 Hz (20 kHz).

frequency:

frequency weighting:

Our hearing is less sensitive at very low and very high frequencies. In order to account for this, weighting filters can be applied when measuring sound. The most commonly used weighting is the 'A-weighting', which approximates the human ear's response to low – medium noise levels. A 'C-weighting' curve is also used, particularly when evaluating very loud or very low-frequency sounds.



A widely used noise parameter that calculates a constant level of noise with the same energy content as the varying acoustic noise signal being measured. The letter 'A' denotes that the A-weighting has been included and 'eq' indicates that an equivalent level has been calculated. Hence, L_{Aeq} is the A-weighted equivalent continuous noise level.

The instantaneous sound pressure level. 'A' denotes that the A-frequency weighting is used. 'F' denotes that the Fast time-weighting is used.

Maximum A-weighted noise level measured with Fast time weighting. It is the highest level of environmental noise occurring during the measurement time. It is often used in conjuction with another noise parameter (for example L_{Aeq}) to ensure a single noise event does not exceed a limit.

Maximum peak sound pressure level during a measurment. The 'C' frequency weighting is applied. Used for assessing possible damages to human hearing caused by very high short-duration noise levels.

L_{Aeq:}

L_{AF:}

LAFmax:

L_{Cpeak}:

sound:	Any pressure variation that the human ear can detect. Just like dominoes, a wave motion is set off when an element sets the nearest particle of air into motion. This motion gradually spreads to adjacent air particles further away from the source. Depending on the medium, sound extends and affects a greater area (propagates) at different speeds. In air, sound propagates at a speed of approximately 340 m/s. In liquids and solids, the propagation velocity is greater – 1500 m/s in water and 5000 m/s in steel.
sound pressure level:	The level in decibels of the pressure variation of a sound. See also decibel .

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