



# nor**1251**

A battery operated sound calibrator complying with the IEC 60942 (2003-01) Class 1 producing 114 dB @ 1000 Hz.

The sound calibrator shuts off automatically when the microphone is removed from the coupler.



class 1 **sound calibrator**

im1251\_1Ed1R3En

**Ni** Norsonic



user **documentation**  
**nor1251**  
class 1 **sound calibrator**

**Nor-1251 – September 2004 Edition**

**im1251\_1Ed1R3En**

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If you wish to communicate with us, please feel welcome. Our address is:

Norsonic AS, P.O. Box 24, N-3421 Lierskogen,  
Norway

[www.norsonic.com](http://www.norsonic.com)

Tel: +47 3285 8900,

Fax: +47 3285 2208

e-mail: [info@norsonic.com](mailto:info@norsonic.com)

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## Finding the Information You Need

Thank you for choosing Norsonic! The Sound Calibrator Nor-1251 has been designed to provide you with many years of safe, reliable operation.

Your approach to the Nor-1251 documentation depends on what you want to do and how much you already know.

The manual has been divided into two parts – one dealing with the use of the calibrator while the other discusses the operating principles and presents the technical specifications.

Depending on your requirements and your familiarisation with technical acoustics as such, you may find that you use some parts of this manual often and others not at all.

Our main objective with this manual was to address your goals and needs. Please let us know how well we succeeded!

# What Is a Calibrator for?

When you are going to make a measurement of any kind, you need to ascertain that what you measure is indicated correctly by your measuring device. The procedure of making a measuring device measure correctly, is called calibration.

For sound level meters and -analysers, hereinafter all referred to as sound measuring instruments, calibration is no less than paramount – since sometimes legal action will be taken based on the sound and noise levels measured!

The use of calibrators date back to those days when it was easier to design a stable calibrator than a stable sound level meter. Today, sound measuring instruments generally are as stable as calibrators.

However, measuring microphones are delicate devices designed to fulfil all specifications required. Hence they are vulnerable and easily subject to damage unless great care is taken.

## Internal Reference Calibration

Some sound measuring instruments offer the ability to calibrate by means of an internal reference oscillator. Although it may sound convenient, this method is not at all recommended, neither is it regarded as sufficient when measuring according to applicable standards.

The most vulnerable part of a sound measuring instrument is always its microphone. If dropped on the floor, for instance, damage is likely. This will, however, not be detected when calibrating by means of an internal oscillator. The oscillator signal will pass through virtually every part of the measuring chain, except the microphone cartridge. Hence, the most vulnerable part will not be exposed to the calibration, which in turn is why the method should be avoided.

One may therefore say that a calibrator is just as much a device for verification of proper operation as it is a device for readjustment of the sensitivity of sound measuring instruments.

Whenever you are going to make measurements in accordance with applicable standards, calibration is always required before you start measuring. Some standards require calibration to take place after the measurement as well! The former is to ensure that correct values are acquired, while the latter serves to confirm that nothing has changed during the measurement session.

## The Calibration Process

To calibrate a sound measuring instrument we use a *sound calibrator*. A sound calibrator is designed to produce a known sound pressure level when used correctly together with the measuring microphone of the sound measuring instrument.

All sound measuring instruments of the quality levels considered here, feature some way of sensitivity adjustment. Some have a small potentiometer that can be adjusted with a screwdriver, while others do it in software.

If the level indicated by your sound measuring instrument deviates from the output level of the calibrator, the sound measuring instrument sensitivity is adjusted until the reading coincides with the calibrator's output level. The sound measuring instrument is then said to be *calibrated*.

In case the level deviates significantly from earlier or nominal values, a thorough check of the instrumentation will be needed.

**Tip:** As a general rule, use a calibrator of the same class or higher (i.e. same, or lower class/type number) than your sound measuring instrument. Otherwise, the accuracy of your acquired measurement data will be affected.

## Accuracy and Tolerances

Above, we talked about the need to measure correctly. As we shall see, this is strictly speaking not absolutely true, since a measuring device can only *estimate* the real value.

An uncertainty will always be present. The aim of the calibration is then to bring this uncertainty to within given limits or tolerances. For a sound measuring instrument, the width of the interval of acceptable estimates will depend on which *class* it belongs to.

### Instrument Classes

According to the international standard called IEC61672-1, sound level meters should be divided into two classes, depending on their accuracy: Types 1 and 2 with type 1 as the best, i.e. with the most narrow tolerances, and type 2 as the least good.

Table showing the permissive tolerances as defined by IEC61672 (Sound Level Meters) and IEC 60942 (Sound Calibrators) for frequencies around 1000 Hz and close to reference conditions. Note that the numbers includes the uncertainty of measurement.

Sound Measuring Instruments		
Type	1	2
Tolerances	$\pm 1,1$ dB	$\pm 1,4$ dB
Sound Calibrators		
Class	1	2
Tolerances	$\pm 0,4$ dB	$\pm 0,75$ dB

You may experience that national and/or international standards may impose restrictions on which instrument types are considered usable for a given measurement task.

Our “problems” do not end with the uncertainties of the sound measuring instruments. Even sound calibrators are “infected” with level uncertainties! Hence, these have also been divided into types (called classes) depending on their level accuracy and level stability. This is to ensure that measurements made with your high-quality sound measuring instrument are not ruined by inaccurate calibration.

The Sound Calibrator Nor-1251



# Using the Sound Calibrator Nor-1251

The Sound Calibrator Nor-1251 is a small, battery operated sound source for the calibration of microphones and sound measuring instruments.

The microphone is placed in an acoustic coupler where the calibrator produces a regulated sinusoidal sound pressure signal. The calibrator is supplied with an output of 114dB SPL @ 1000Hz.

Due to the principle of operation<sup>1</sup>, the calibration level is virtually independent of ambient conditions like temperature, atmospheric pressure and humidity within the specified range of operation. The calibrator complies with IEC60942 Class1 and has been designed to serve one-inch and smaller microphones and sound level meters equipped with such microphones.

One-inch microphones fit directly in the calibrator coupler, while half-inch and smaller microphones are served by application of suitable adaptor rings. Adaptor for half-inch microphones are included, while adaptors for other sizes must be ordered separately.

## If you Have a Free-field Microphone

Most ½" free-field microphones (as defined by IEC 61672-1) have a pressure response which gets lower as the frequency of the input sound signal is increased.

The reason for this is that free-field microphones have been designed to compensate for their own presence in the sound field.

For example; when using the Norsonic microphone cartridge 1225, at 1000 Hz the sensitivity of your sound measuring instrument should be adjusted to a value 0.15dB lower than the nominal calibrator output level. This difference corresponds to the difference between the pressure and the free-field response of the microphone – cf. the table starting at page 15.

*To activate the sound calibrator:*

- Press the ON button to turn on the calibrator.

The calibrator shuts off by itself after about five minutes. However, if a microphone has not been inserted or if it is removed, the unit will switch off after a few seconds.

Your sound measuring device may or may not use a spectral weighting network (such as the A-weighting network). For sound calibrators with an output frequency of 1000Hz, no compensation needs to be made for this.

## Operation

Using the Sound Calibrator Nor-1251 is easy and uncomplicated.

*To calibrate with the Nor-1251, do as follows:*

1. Insert the microphone to be calibrated in the coupler of the calibrator. Use a suitable adaptor, if necessary.
2. If the background noise is high, watch the noise level and press the ON button to switch on the calibration signal.

Verify that the calibration signal is at least 20dB above the background noise floor.

3. Adjust the sensitivity of the microphone or measuring instrument to display an excitation sound pressure level corresponding to the level indicated on the calibrator itself.

When the ON button has been operated, and a microphone inserted, the sound calibrator will stay *on* for approximately five minutes. The *on*-time will be reduced as the battery-voltage decreases.

Proper operation of the calibrator is indicated by the green LED indicator – see Fig. to the right for details.

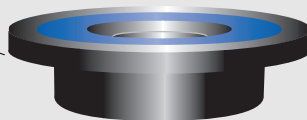
If the battery-voltage is too low to guarantee operation within the specifications, the calibrator will switch off as soon as the

<sup>1)</sup> Patent DE 4294875 CE



## Vital parts of the Sound Calibrator Nor-1251...

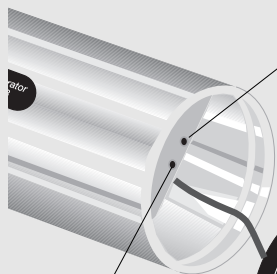
Adaptor to facilitate the calibration of half-inch cartridges in addition to full-inch is included, while adaptors for other sizes must be ordered separately



A green LED illuminates when the sound pressure level inside the coupler cavity is correct.

The power button. Depress to start generating the sound pressure level. The sound calibrator switches itself off automatically if the required sound pressure level cannot be established, for example if the microphone to be checked has not been inserted.

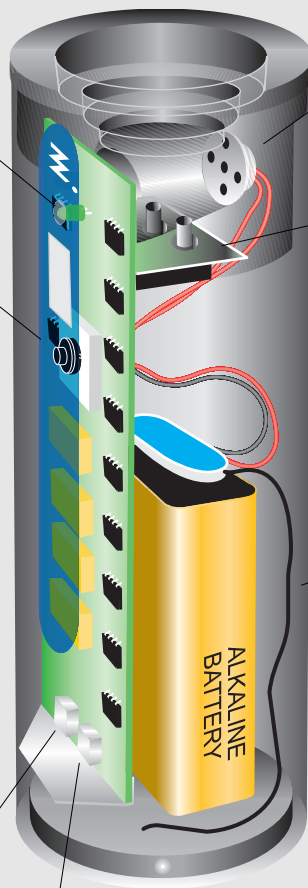
The unit also switches itself off after approximately five minutes.



Level adjustment potentiometer (do not adjust unless you know what you are doing!)



Frequency adjustment potentiometer (do not adjust unless you know what you are doing!)



Miniature loudspeaker generating the sound pressure level inside the coupler.

Silicone microphone monitoring the sound pressure level inside the coupler. One side of the microphone diaphragm is exposed to the sound pressure inside the coupler while the rear side of the diaphragm is located in a separate vented cavity to prevent pick-up of extaneous noise signals.

The cord is attached to the battery connector and the bottom lid. Remove the lid and pull the cord to get the battery out.

Potentiometer for frequency adjustment

Potentiometer for level adjustment

ON button is released. However, you may still use the type 1251 for calibration by keeping the ON button depressed while you calibrate, provided that the LED is illuminated.

### Background Noise Considerations

The high sound pressure level generated in the coupler makes the calibrator virtually insensitive to external noise. Nevertheless, care should always be taken when calibration is made in places with high extraneous noise levels.

It is always good practice to verify that the background noise level measured with the microphone mounted in the calibrator—but prior to switching it on—is sufficiently below the calibration level (20dB or more below).

Due to the power-cords, you will not be able to mount the rear cover while at the same time having the calibrator connected to an external power source.

Without the rear cover, the stated calibrator output level and the frequency will be altered slightly. The sound from the rear side of the loudspeaker will be less attenuated and the calibration process will also be more sensitive to extraneous noise. We therefore recommend that you always cover the rear side or compensate for the variation in level and frequency whenever the rear cover is removed

### Battery Replacement

Remove the battery as soon as it is discharged or if the Sound Calibrator is stored for a prolonged period of time. Leakage from the battery may otherwise destroy the electronic components.

*To change the battery:*

1. Remove the rear cover by pulling it straight backwards
2. Pull out the battery from the battery compartment and unclip the battery connector
3. Replace the battery with a fully charged battery of the type IEC type 6LR61 (nine-volt alkaline)

4. Alternatively, a nine-volt lithium battery of identical physical dimensions may be used
5. Install the battery and the rear cover

See also the Fig. on the previous page for details.

### Consider Locking the On Button

If the application requires excitation signal for longer periods of time, you may apply adhesive tape to lock the ON button in its *on* position. In this case no indication of proper power supply voltage will be given as the battery comparator will not be able to switch the calibrator off.

### External Supply of Power

For some applications it may be required to power the calibrator from an external voltage in the range 8–15V to the battery connector.

Due to the power-cords, you will not be able to mount the rear cover while at the same time having the calibrator connected to an external power source. See also *Noise Considerations* on the previous page spread for more on this.

The calibrator's aluminium casing is connected to a voltage between the positive and negative battery terminals. An external supply must therefore be electrically floating relative to the casing of calibrator.

### Recalibration

At regular intervals – at least once per year – proper operation of the sound calibrator should be verified, preferably by an accredited acoustic calibration laboratory or the Norsonic factory. The calibration should be carried out at room temperature and should cover:

- Frequency accuracy
- Level accuracy
- Harmonic distortion
- Level stability

If the level or frequency needs to be re-adjusted, this can be done by adjusting the corresponding potentiometer. The location of the adjustment potentiometers are shown in the Fig. on page 9. Note that the access to the potentiometers may have been blocked by a sealing mark.

The level should be measured with a working standard microphone type WS2 (according to IEC61094-4) where the pressure sensitivity at the working frequency of your calibrator is known with a sufficiently high accuracy.

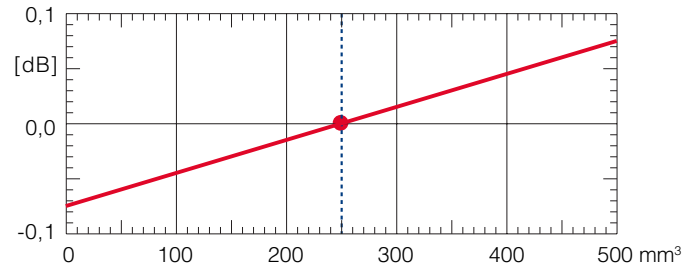
### Microphone Effective Front Volume Corrections

Various types and makes of microphones may have different effective front volume. Due to its working principle, the Nor-1251 has a large effective coupler volume. The variations in sound pressure level due to variations in effective front volume among microphones is therefore for most applications insignificant.

The calibrator is adjusted with the ½" adaptor for an equivalent microphone volume of 250 mm<sup>3</sup>, which corresponds to most ½" measuring microphones with protecting grid mounted like the Norsonic types 1220, 1225 and 1230. If the actual microphone has a volume deviating from this reference volume, the accuracy may be improved by applying a volume correction. The typical sensitivity for the level change is +0.0003 dB/mm<sup>3</sup> at 1000 Hz. Hence, if a ½" microphone with an effective front volume of 150 mm<sup>3</sup> is used, the level in the coupler will typically decrease by 0.03dB because of the 100mm<sup>3</sup> volume reduction.

If no adaptor rings are used, the nominal effective front volume for no correction is 1333 mm<sup>3</sup>. This corresponds to most 1" measuring microphones with the protection grid mounted.

Calibrator sound pressure level change [dB] as a function of the microphone load volume for ½" microphones



### Removing the rear cover will alter both the level and the frequency!

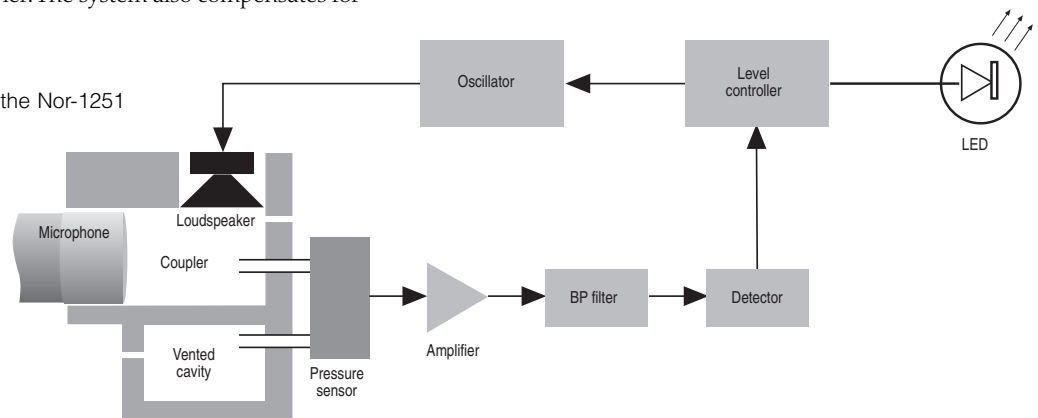
Note that the level and frequency will be altered slightly when the sound calibrator is operated without its rear cover. Whenever adjusting the level and/or the frequency, this must be taken into account.

# Operating principles and Characteristics

The Sound Calibrator Nor-1251 principles of operation is shown in the below block diagram and is as follows:

- The microphone to be calibrated is placed in the coupler of the calibrator where the sound pressure signal is generated by a miniature loudspeaker.
- The electric signal—driving the loudspeaker—is generated by an electronic oscillator.
- The sound pressure generated is measured with a pressure sensitive silicon sensor<sup>1</sup>. This signal is used to adjust the level of the oscillator signal. The rear side of the silicon sensor is located in a separate vented cavity to prevent pick-up of extraneous noise signals. Noise pick-up is also limited by a bandpass filter in the feedback path.
- Because of the high stability of the silicon sensor and the electronic controller, the acoustic signal generated, is virtually independent of battery voltage and ambient conditions such as temperature, humidity and atmospheric pressure. The feedback principle automatically compensates for variation in the equivalent volume of the microphones. Hence, it creates an effective coupler volume many times the volume given by the mechanical dimensions of the coupler. The system also compensates for drift in the loudspeaker.
- The acoustic coupler is vented to the inside of the calibrator, which in turn is vented to the outside for equalization to the atmospheric pressure. A separate channel vents the rear side of the reference transducer to the outside of the calibrator.
- A Light Emitting Diode (LED) is illuminated whenever the level control is in balance. When no microphone is placed in the coupler, the loudspeaker will generally not be able to generate and maintain the correct pressure in the coupler. This situation will be indicated by extinguished LED.
- An electronic circuit inside the calibrator will switch off the power at approximately five minutes after the ON button was operated. If you need that the calibrator stays on for a longer time, keep the ON button depressed—either by depressing it manually, or by use of adhesive tape.
- If the calibrator fails to establish the correct sound pressure level (an extinguished LED), or if the battery voltage is too low, the automatic switch-off circuitry will be activated. Hence the calibrator will switch off a few seconds after the microphone has been removed.

A simplified block diagram of the Nor-1251



<sup>1)</sup> Patent DE 4294875 CE

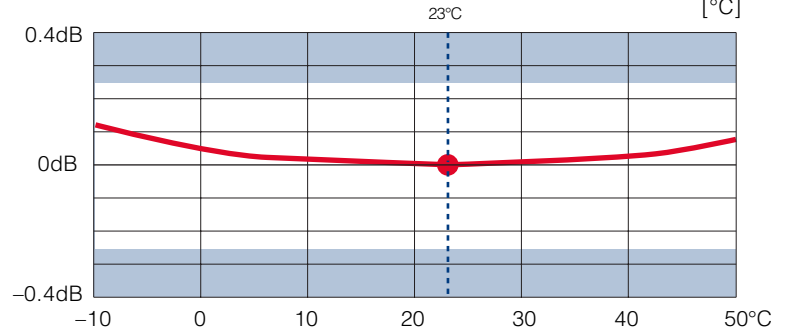
## Influence of Ambient Conditions

The applied operating principles and the careful selection of critical components ensures that the Sound Calibrator Nor-1251 exhibits a low sensitivity to variations in the ambient conditions.

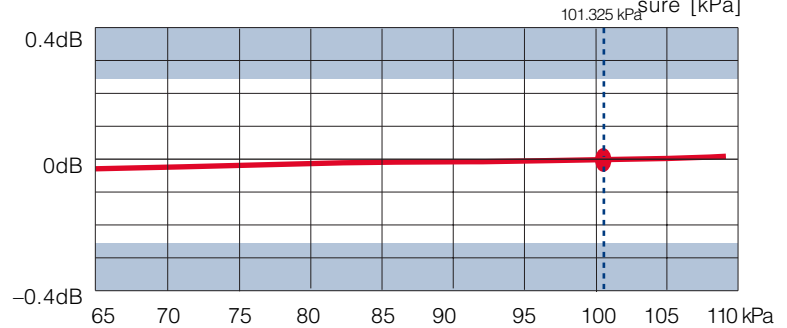
The diagrams to the right show typical sensitivity to variations in the ambient (atmospheric) pressure, the ambient temperature and the relative humidity. The requirements as given by the international standard IEC60942 (2003-1) are also shown together with the headroom for uncertainty of measurement.

Nor-1251 is checked at three temperatures ( $-10^{\circ}\text{C}$ ,  $+23^{\circ}\text{C}$  and  $+45^{\circ}\text{C}$ ) to ensure that the output level is well within the requirements set by IEC 60942 and ANSI S 1.40 over the specified temperature range.

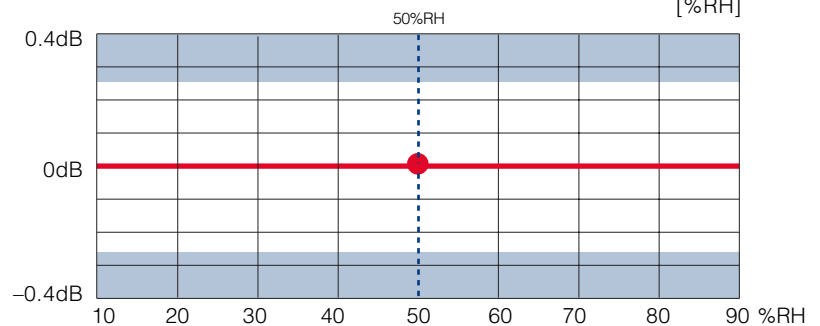
Calibrator sound pressure level change [dB] as a function of temperature



Calibrator sound pressure level change [dB] as a function of the ambient pressure



Calibrator sound pressure level change [dB] as a function of the relative humidity



## Specifications

### OUTPUT SIGNAL

**Sound pressure level:** 114dB (re. 20 $\mu$ Pa) @ 1000Hz

**SPL accuracy at reference conditions:**  $\pm 0.2$ dB

**Frequency accuracy:**  $\pm 0.2\%$ .

**Accuracy:** Complies with IEC60942 (2003-01) Class 1 and ANSI S 1.40. Typical change in SPL per year:  $< 0.01$ dB/year

### REFERENCE CONDITIONS

**Temperature:** 23°C

**Ambient pressure:** 101.325kPa

**Humidity:** 50% RH

**Effective load volume:** 250mm<sup>3</sup> with adaptor Nor-1443

**Reference direction for EMC test:** Microphone coupler facing the source.

### GENERAL

**Sensitivity to change in load volume:** 0.0003dB/mm<sup>3</sup> (typical) @ 1000Hz

**Time for level to stabilise:** Max 2 sec.

**Microphone size:** 1", 1/2" (Adaptor Nor-1443 – included) and 1/4" (Adaptor Nor-1444 – available separately) according to IEC61094-4

**Harmonic distortion:** Max. 1%

**Controls:** Power-on push button. Automatic shut-off

**CE classification:** EMC: EN 61000-6-1, EN 61000-6-3. Safety: EN 61010-1, 1993 for portable equipment, pollution category 2

### AMBIENT REQUIREMENTS FOR SPECIFIED OPERATION

**Temperature range:** -10 to +50°C Class 1

**Ambient pressure range:** 65–108kPa

**Humidity range:** 10–90% RH

### POWERING

**Battery type:** 9V 6LR61

**Battery lifetime:** Approx. 20 hours. Use of a 6F22G battery will yield a shorter battery lifetime, while a 9V lithium battery will yield an extended operating time

**External supply voltage:** 7.5–15V. Automatic shut-off when  $V_{\text{Batt}} < 7.5$ V.

### OVERALL WEIGHT AND DIMENSIONS

**Weight:** 185g with battery

**L:** 109.5mm; **D:** 40mm

# Microphone Cartridge Calibration Values

Microphone cartridges should be calibrated in accordance with their size and working principle. The table lists some commonly used microphone cartridges and their corresponding calibration values applicable with the protection grid mounted.

Manufacturer	Microphone Type	Calibration Level	Manufacturer	Microphone Type	Calibration Level
<i>Norsonic</i>	1220	113,85dB	<i>G.R.A.S. cont...</i>	40AF	113,85dB
	1221	113,85dB		40AG	114,00dB
	1223	113,85dB		40AI	114,00dB
	1225	113,85dB		40AN	113,85dB
	1226	113,85dB		40AP	114,00dB
	1227	113,85dB		40AQ	114,00dB
	1228	113,85dB		40AR	114,00dB
	1230	114,00dB		40BD	114,00dB
	1233	114,00dB		40BE	114,00dB
	1234	114,00dB		40BF	114,00dB
	1235	114,00dB		40BP	114,00dB
	1236	114,00dB	<i>Rion</i>	UC-53	113,85dB
	1237	114,00dB		<i>B&amp;K</i>	4144
	1245	114,00dB	4145		113,70dB
1246	114,00dB	4179	113,70dB		
<i>Microtech</i>	MK102	113,70dB	4133		113,85dB
	MK103	113,70dB	4134		114,00dB
	MK202	113,85dB	4147		114,00dB
	MK221	113,85dB	4149		113,85dB
	MK222	113,85dB	4155		113,85dB
	MK231	114,00dB	4165		113,85dB
<i>G.R.A.S.</i>	MK250	113,85dB	4166		114,00dB
	40AC	113,85dB	4180	113,94dB <sup>1)</sup>	
	40AD	114,00dB	4188	114,84dB	
	40AE	113,85dB	4936	114,84dB	

<sup>1)</sup> without protection grid

## Declaration of Conformity

We, Norsonic AS, Gunnersbråtan 2, Tranby, Norway, declare under our sole responsibility that the product:

### Sound Calibrator type 1251

to which this declaration relates, is in conformity with the following standards or other normative documents:

Product Standard      IEC 60942 (2003-01) Class 1  
                                  ANSI S1.40-1997

Safety:                    EN61010-1:1993 for portable equipment and pollution category 2.

EMC:                      EN 61000-6-1  
                                  EN 61000-6-3

following the provisions of the LVD- and EMC-Directive.

This product has been manufactured in compliance with the provisions of the relevant internal Norsonic production standards. All our products are tested individually before they leave the factory. Calibrated equipment—traceable to national and international standards—has been used to carry out these tests.

This Declaration of Conformity does not affect our warranty obligations.

Tranby,  
September 2004

A handwritten signature in black ink, appearing to read 'Dagfinn Jahr'.

Dagfinn Jahr  
Quality Manager

The declaration of conformity is given according to EN 45014 and ISO/IEC Guide 22.  
Norsonic AS, P.O. Box 24, N-3421 Lierskogen, Norway