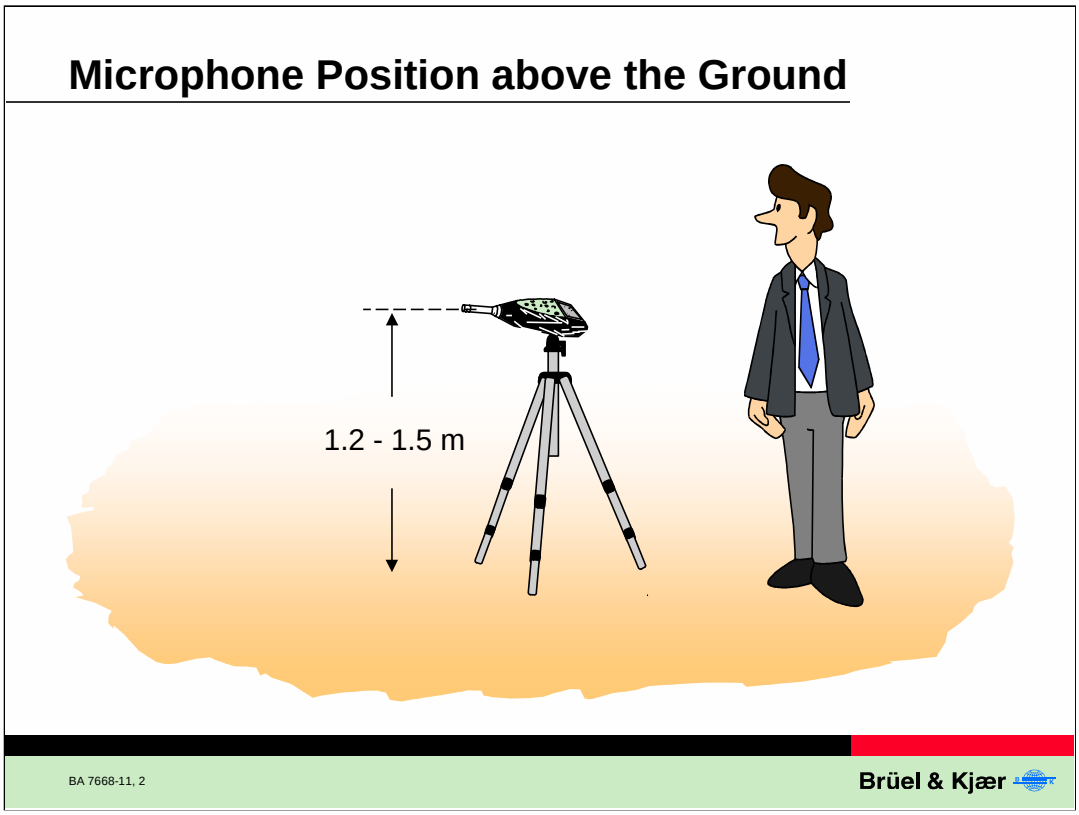
Measuring Sound in Practice

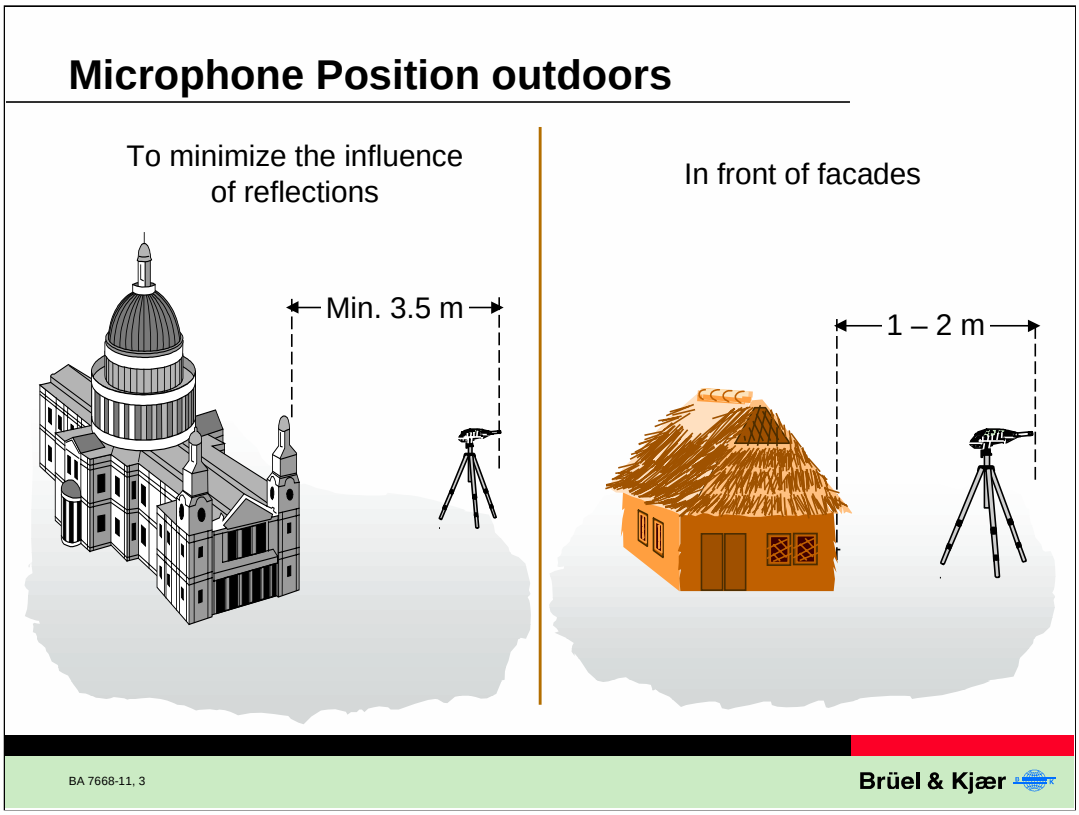
Abstract

This lecture describes how to measure sound according to standards (basically ISO 1996 & ISO 9612 which are the basis for most national environmental and occupational noise).



Positioning the Microphone

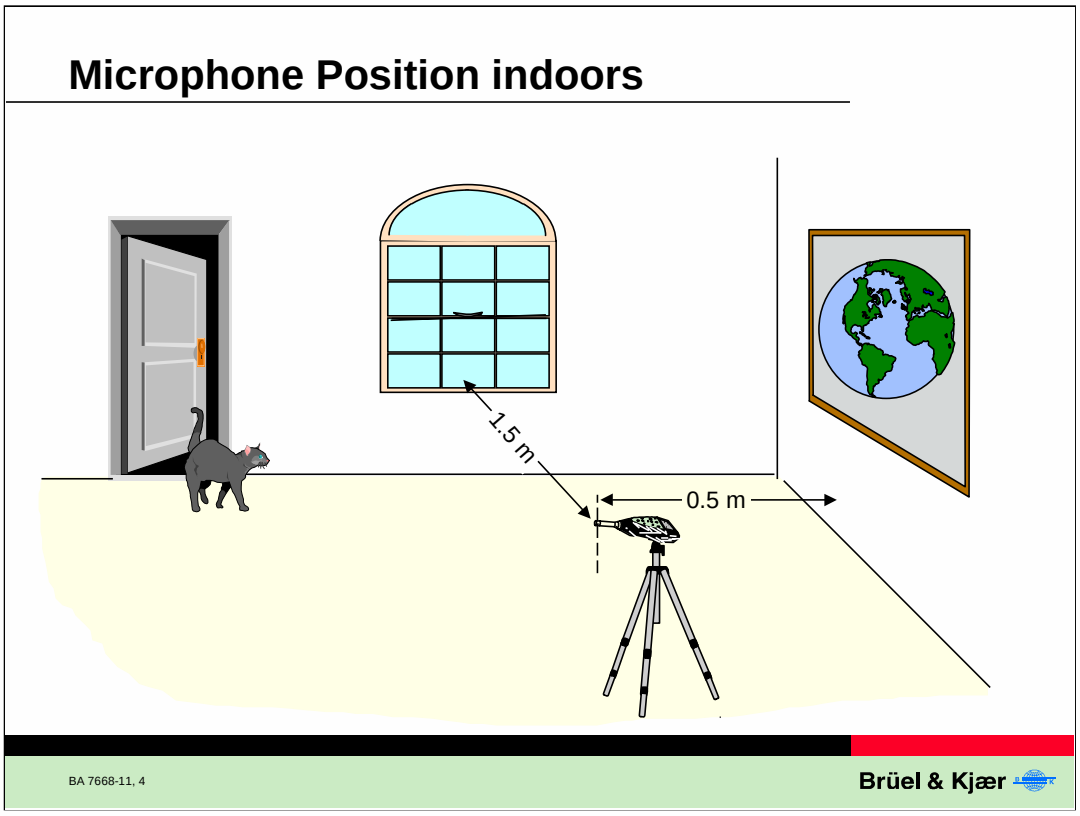
The international standard ISO 1996 gives a basic guide on placing microphones both during measurements outdoors and indoors. Of course this depends on the purpose of the measurement, but as a general rule the height of the microphone above the relevant ground level should be between 1,2 and 1,5 metres outdoor as well as indoor.



Positioning the Microphone Outdoors

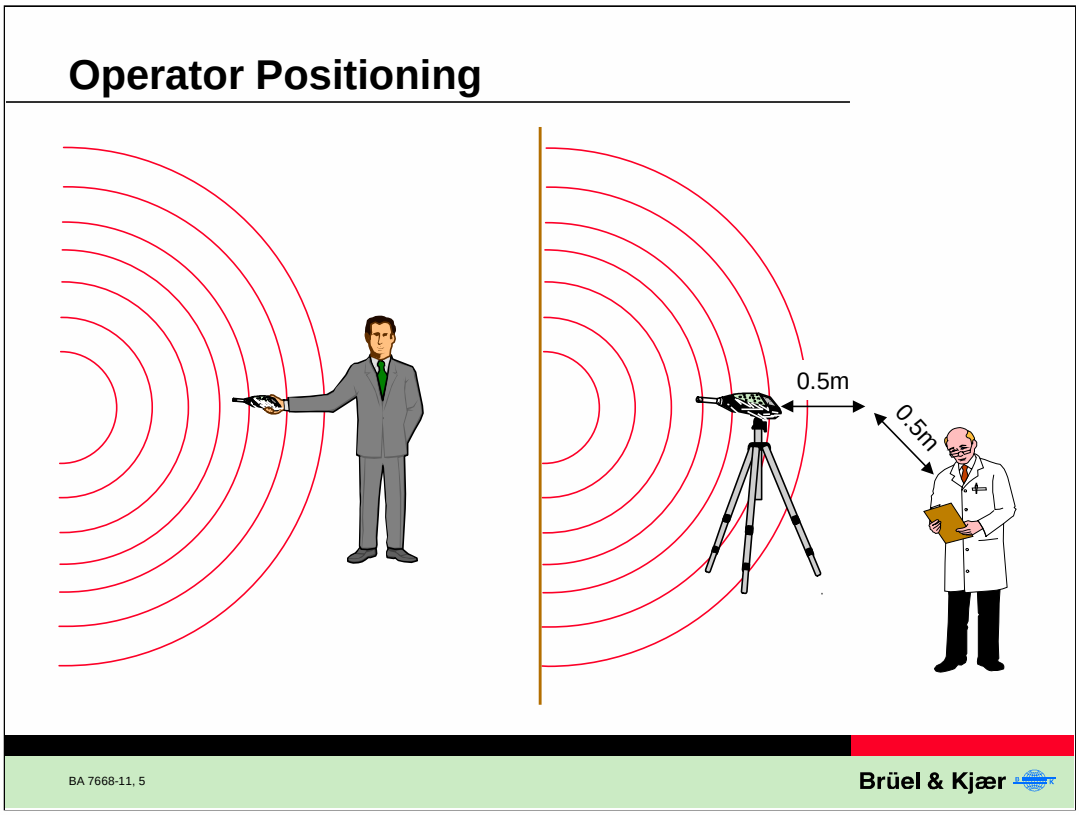
For outdoor measurements, the microphone should in general be at least 3.5 metres away from any reflecting structure, to minimize the influence of reflections.

Where the aim is to measure the noise to which a building is exposed, this should preferably be made at a distance of 1 to 2 metres away from the facade. This would, for example, be the situation in connection with an investigation of traffic noise.



Positioning the Microphone Indoors

When measurements are carried out indoors, it is recommended to measure at least 1 metre from walls or any other major reflecting surface e.g. large pieces of furniture, and 1.5 metres away from windows. When filling in the measurement report, it is important that the position of the microphone is recorded both for outdoor and indoor measurements.

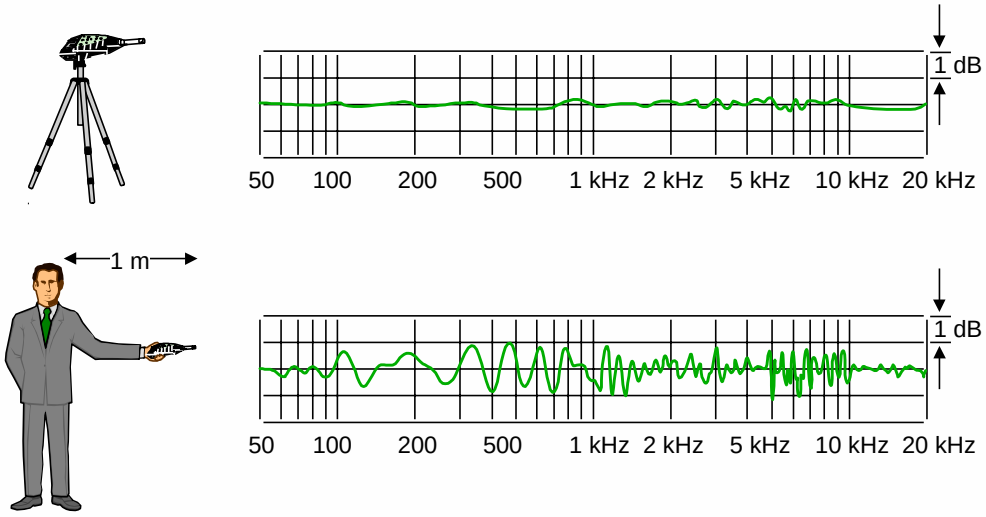


During a measurement, the sound level meter should either be held in the hand or placed on a tripod. ISO 1996 states how to minimize the effects of reflected sound from the operator.

When held in the hand, hold the sound level meter at arms length (about 1 m) and reduce reflections from the operator's torso by standing side-on.

When placed on a tripod, the operator should be at least 0 ,5 m behind and 0,5 m to one side of the microphone.

Influence from Sound Level Meter and Operator



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Here you can see typical effects on the noise measured by the microphone due to the influence of a typical sound level meter on a tripod (above) and due to the influence of holding the sound level meter at arms length (below).

The influence is less than 1 dB - within the tolerances for a Type 1 instrument (according to IEC 651 and IEC 804 - see below).

Standards

Standards for Sound Level Meters

- IEC 651/804 – International
- ANSI S 1.4 – America

Standards for Measurement Procedures

- ISO 1996

  Description and measurement of environmental noise
- ISO 9612

  Guidelines for the measurement and assessment of exposure to noise in a working environment

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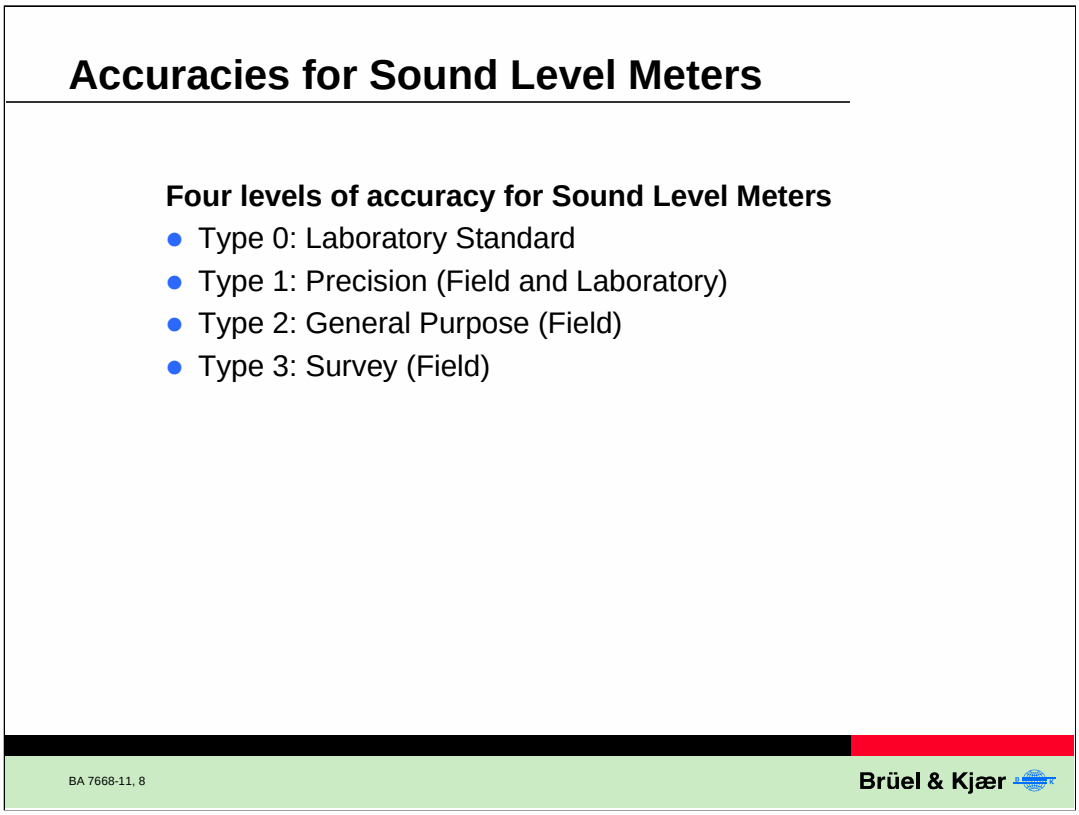
There are standards for equipment used to measure noise and for how to measure noise.

From the group of standards concerned with equipment two should be mentioned:

• IEC Standard 651: Sound Level Meters

• IEC Standard 804: Integrating Sound Level Meters

These standards specify four grades of sound level meters according to their degree of precision and give detailed specifications for the four grades including fundamental properties, tolerances, frequency and time weighting characteristics, and sensitivity to various environments. IEC 804 concentrates on the specification of the integrating circuitry for calculation of L_{eq}. They are currently (1998) being combined into 1 common standard (IEC 1672).



The four grades, designated Types 0, 1, 2 and 3 sound level meters, differ only in the tolerances allowed. Tolerances generally broaden as the type number increases. The different grades are intended for different applications as follows:

• Type 0: Intended for use as a laboratory standard. This type has technical specifications with the most narrow tolerances

• Type 1: Designated Precision. Intended for laboratory as well as field use. In some countries and in some situations, they are required for authorized measurements.

• Type 2: Designated General Purpose. Intended for general field applications. In some countries and in some situations, they are required for authorized measurements.

• Type 3: Intended primarily for field noise survey applications to establish whether a noise limit has been significantly violated. Due to its low accuracy and because of the advances in electronic components this type has nearly disappeared from the market.

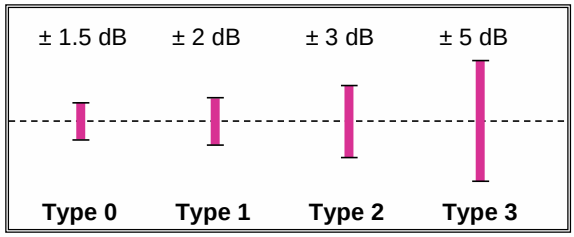
Brüel & Kjær sound level meters are all type 1 or 2. Type 0 specification sound level meters are normally based on modified type 1 sound level meters with a special microphone and extension cable.

Besides being in accordance with the international standards the Brüel & Kjær sound level meters follow most national standards e.g. the American National Standard ANSI S1.4. For detailed information refer to the specifications for the individual sound level meters.

Accuracies of Sound Level Meters

- Practical accuracies (Non reference conditions) calculated from allowed tolerances for
  - warm-up
  - directional effects
  - frequency weightings
  - range control
  - time weighting
  - ambient pressure
  - humidity
  - temperature
  - calibrator
  - operator influence

Practical Accuracies



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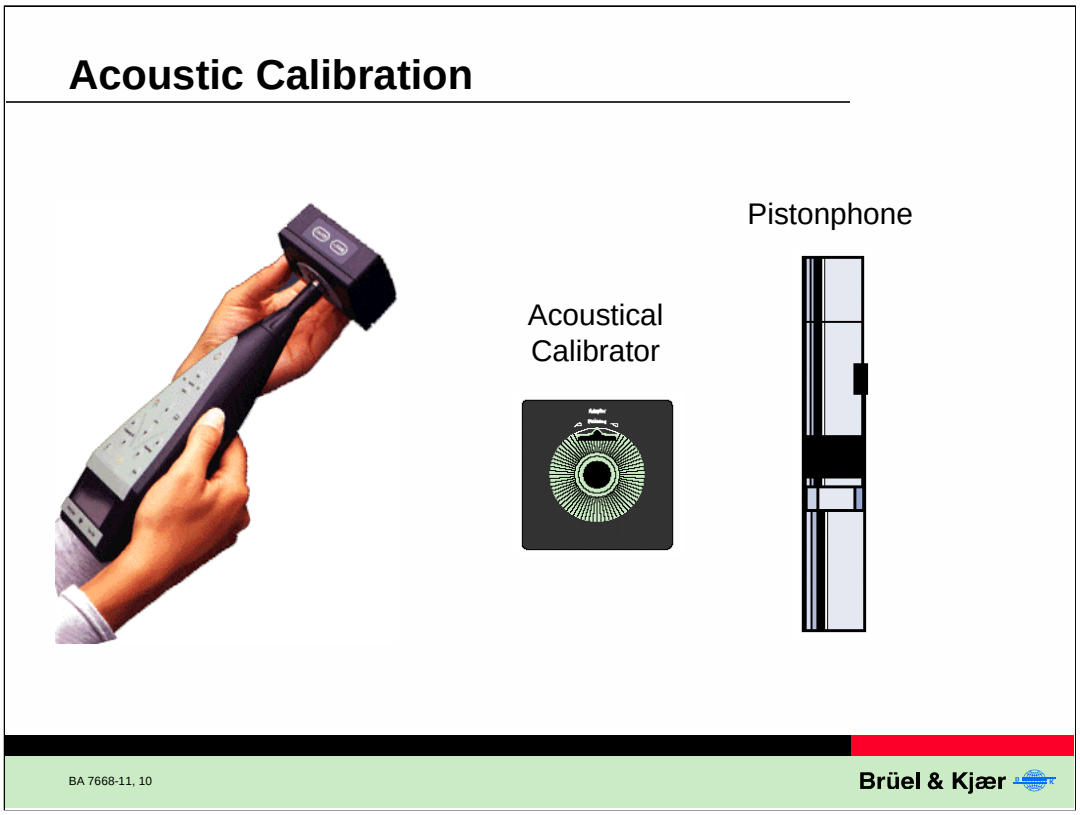
Effects of factors on accuracy (+/-)*

	Type 0	Type 1	Type 2	Type 3
Accuracy at reference conditions:	0.4	0.7	1.0	1.5
warm-up:	0.2	0.3	0.5	0.5
directional effects	0.5	1.0	2.0	4.0
frequency weightings	0.7	1.0	1.5	2.0
range control	0.3	0.5	0.7	1.0
time weighting	0.5	0.5	1.0	1.5
ambient pressure	0.3	0.3	0.5	0.5
temperature	0.5	0.5	0.5	0.5
humidity	0.5	0.5	0.5	1.0
calibrator	0.2	0.2	0.2	0.2
operator influence	0.5	0.5	0.5	0.5

* Typical values



CALIBRATION

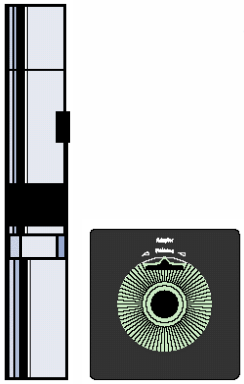
Before measurements are undertaken, it is important to calibrate the microphone and instrument together. This will check the function of the measurement system and ensure that high accuracy can be obtained allowing comparison to be made between measurements taken at different times. Calibration ought therefore to be made before each series of measurements and it is recommended that the calibration is repeated after a series of measurements as a double check.

Acoustic Calibration

Acoustic calibration is normally to be preferred, since the whole system from microphone to indicating device will be checked. To carry out acoustic calibration, fit the calibrator on the microphone, making sure it fits snugly. Switch on the calibrator and adjust the read out on the indicating device to the sound level produced by the calibrator being used. Two different calibrators are available for acoustic calibration: a pistonphone and an acoustical calibrator.

Calibration according to ISO 1996

- Before and after each series of measurements:
  - use a Sound Level Calibrator or a Pistonphone
  - record the results of calibration



- In addition, if measurements are made over a prolonged period, verify the calibration at least twice daily using:
  - either the method described above
  - or by using an integral calibration system

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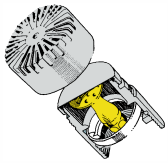
ISO 1996 recommends the following:

Before and after each series of measurements apply an acoustic calibrator or pistonphone complying with Class 2 of IEC 942 or ANSI S1.40, or better, to the microphone to verify the correct operation of the measuring equipment and to allow adjustments if necessary. Record the results of such tests. This is sometimes done by the sound level meter.

In addition, if measurements are made over a prolonged period, verify the calibration at least twice daily using either the method described above or by using an integral calibration system (e.g. CIC).

In addition, several countries require that instruments be regularly (for example, annually) calibrated by an accredited, traceable body.

Hints for Trouble-free use



- When connecting the sound level meter to any other device, switch **OFF** all equipment
- Handle the microphone carefully and try to keep dust and foreign objects off the diaphragm
- Never touch the microphone diaphragm
- Never attach the microphone with the sound level meter power on
- Be very *gentle* when attaching a microphone, extension cable or input stage
- Do not expose the sound level meter and accessories to excessive damp, cold or heat. Store in a dry place, preferably in its case

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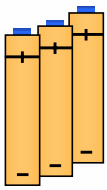
Sound level meters are electronic measurement instruments and, as such, should be treated with some care. No matter how robust the manufacturer claims that they are, they contain several delicate components which can be damaged by static, damp, dust, etc.

Batteries



- Always use good quality Alkaline or Rechargeable batteries
- Never mix different types or makes of battery
  - and Never mix charged and discharged batteries
- Always label the outside of the battery compartment with an indication of the type of battery fitted. i.e.. DO NOT CHARGE
- Beware the accuracy of battery checks on instruments
- Check battery condition regularly. Leaks can be very costly!
- Remove batteries if the meter is to be stored for long periods

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In order to get the best out of your sound level meter, follow the above rules for handling batteries.

Conclusion

- Your measurement position should, in general, be far enough away from reflecting surfaces such as the ground, walls and the operator
- For most practical purposes, a type (class) 1 sound level meter is the most versatile
- You should calibrate your sound level meter before and after each measurement

Literature for Further Reading

- Acoustic Noise Measurements
  Brüel & Kjær (BT 0010-12)
- Noise Control - Principles and Practice
  Brüel & Kjær (188-81)
- Specifications for Sound Level Meters
  IEC 651/804
- Specifications for Sound Level Meters
  ANSI S 1.4
- Description and measurement of environmental noise
  ISO 1996
- Guidelines for the measurement and assessment of exposure to noise in a working environment
  ISO 9612

The Brüel & Kjær publications can be obtained from your local Brüel & Kjær representative.

Measurement and instrumentation standards can be obtained from your local standards authority.