

Q&A

The Top 10 posts from our blog

November 2011



Noise Measurement Instruments

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Introduction

Top 10 Blog posts of 2011

Throughout 2011 we've been posting information and answers to questions from our customers, distributors and sales team on our blog at cirrusresearch.co.uk/blog.

This book contains the top 10 posts that you, our customers, have been reading and commenting on.

Some of the posts have been expanded with some additional information and links where appropriate. Some of the posts on the blog cover similar topics and so we've also combined some of these posts into one to cover a subject more widely.

You can stay up to date with new posts on the blog. Visit our blog and use the 'Stay informed! Sign up for our update newsletter' section on the right hand side.

You'll get a short email each time we post a new article as well as a summary of any new posts every 2 weeks. Just visit www.cirrusresearch.co.uk/blog and sign up.

Do you have any questions?

If you have any questions about noise measurement or using noise measurement instruments, let us know and we will try and find you an answer.

To post a question, either email to sales@cirrusresearch.co.uk or use the 'Ask us a question' form on our blog at cirrusresearch.co.uk/blog.

Don't forget that you can call us on 0845 230 2434 from the UK or +44 1723 891655 from outside of the UK.

Chapter 1:

Top 10 reasons why repeating a noise measurement could give different results

Your sound level meter is a precision instrument and as long as it's not damaged or misused and is calibrated regularly, it will give you accurate noise measurements for many years.

One of the questions that we get asked regularly is why, when a noise measurement is repeated, that the levels recorded can be different.

Here are some issues that you should consider.

1 A windshield was used for one measurement but not the other.

A windshield should be used to protect the microphone capsule on your sound level meter from damage and also to reduce the effects of wind noise.

If you've made your noise measurements outdoors and you've not used a windshield, can you be sure that the measurements that you've taken have not been adversely effected by wind?

If you've repeated the measurement and used a windshield, then you may find that the noise levels are lower than for the previous measurement.

We would always recommend that you use a windshield on your sound level meter to protect the delicate microphone from damage - See chapter 3 for more details.

2 Were the measurements made with the sound level meter in the same orientation and position relative to the noise being measured?

Sound can propagate differently at different frequencies and so if you've not in the same position or the sound level meter is not in the same orientation, this can make minor differences to the measurement.

These differences may not be very large but they can all add up and contribute to differences in the overall level.

3 The microphone has been damaged or is loose.

The microphone capsule on your sound level meter is delicate and damage to it can cause significant errors in measurements.

You should always calibrate your instrument before each use.

This will help to identify any problems with the microphone capsule.

4 There is a different surface covering from when the last measurement was taken.

For example:

- a. If you are measuring inside, have any absorbent or reflective materials been added or removed?
- b. If you are measuring noise outdoors, are there any significant differences in the ground covering, for example has the grass grown or has it been covered with gravel?

5 Has the environment surrounding the measurement location changed?

For example:

- a. Have other machines been switched on or off? If new machinery has been installed, is this affecting the background noise levels?
- b. Have any external noise sources such as roads or other buildings with audible noise sources been built nearby?
- c. Are there leaves on trees? - If measurements were made in spring with leaves rustling and then in autumn, this can affect noise measurements!

6 Is the noise source running at the same speed?

For example, maintenance on a machine may have increased or reduced the running speed and this can generate different noise levels.

7 If you are measuring a machine which is processing or manipulating materials, is the material the same as last time?

For example,

- a. Measuring noise during piling will vary depending on the type of ground
- b. The noise from a milling machine will vary depending on the material being worked on. Is this the same as for the last measurement.

8 What is the condition of the noise source?

If the equipment being measured is poorly maintained, it may be worn and this can create noise that was not present for the previous measurement.

9 Radios

Many workplaces have radios playing in the background. Are these louder or quieter than before?

10 Over what period were the measurements made?

The length of time over which measurement was made should always be representational.

In the case of an occupational noise measurement sample, a 2 minute measurements will possibly vary from a 5 minute measurement.

Always compare data from similar measurements.

Chapter 2:

What are A, C & Z Frequency Weightings?

Your ears are most sensitive to frequencies between about 500Hz and 6kHz and less sensitive to frequencies above and below these.

To allow the sound level meter or noise dosimeter to measure and report noise levels that represent what we hear, Frequency Weightings are used.

These are electronic filters within the instrument that are used to adjust the way in which the instrument measures the noise.

The most commonly used Frequency Weightings that you will see on a modern sound level meter or noise dosimeter are 'A', 'C' and 'Z' and below is a brief explanation of each of these.

It is very important that you measure the noise levels using the correct frequency weighting as it is not possible to convert from one to another after the measurement has been made.

This is why a sound level meter such as the Cirrus optimus will measure all three Frequency Weightings at the same time, saving you time and removing the risk of measuring the wrong parameter.

'A' Weighting

'A' Weighting is standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.

At low and high frequencies, the human ear is not very sensitive, but between 500 Hz and 6 kHz the ear is much more sensitive.

The 'A' weighting filter covers the full frequency range of 20 Hz to 20 kHz, but the shape approximates to the frequency sensitivity of the human ear.

So the A-weighted value of a noise source is an approximation to how the human ear perceives the noise.

Measurements made using 'A' weighting are usually shown with dB(A) to show that the information is 'A' weighted decibels or, for example, as LAeq, LAFmax, LAE etc where the A shows the use of 'A' Weighting.

'C' Weighting

'C' Weighting is a standard weighting of the audible frequencies commonly used for the measurement of Peak Sound Pressure level.

Measurements made using 'C' weighting are usually shown with dB(C) to show that the information is 'C' weighted decibels or, for example, as LCeq, LCPeak, LCE etc where the C shows the use of 'C' Weighting.

'Z' Weighting

Z weighting is a flat frequency response between 10Hz and 20kHz ± 1.5 dB excluding microphone response.

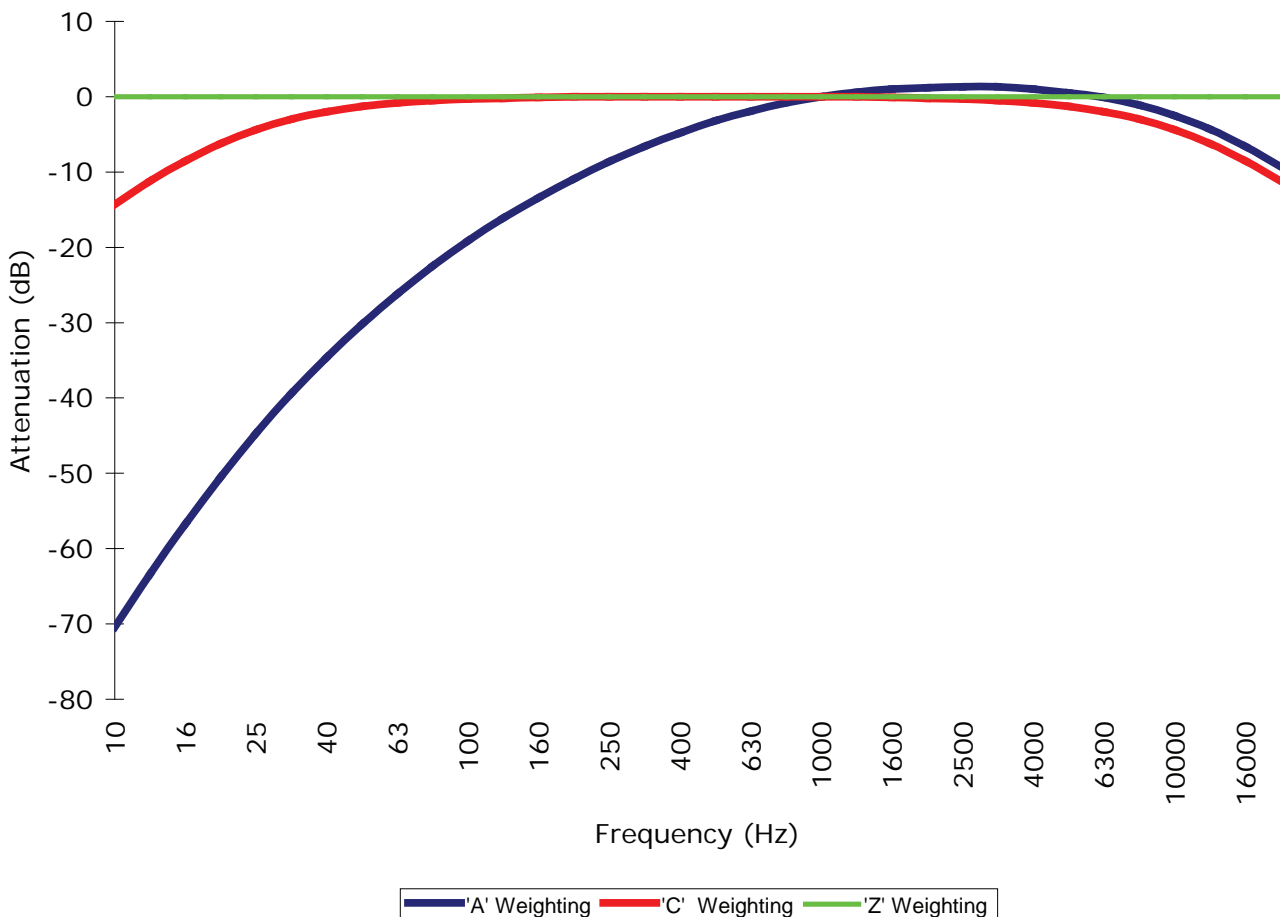
Measurements made using 'Z' weighting are usually shown with dB(Z) to show that the information is 'Z' weighted decibels or, for example, as LZeq, LZFmax, LZE etc where the Z shows the use of 'Z' Weighting.

Where are these Frequency Weightings defined?

All of these frequency weightings are defined in the standards to which a noise measurement instrument is designed. For example, the frequency weightings used on a sound level meter will be defined in IEC 61672:2003 (BS EN 61672-1:2003). This standard specifies the performance and tolerances for the frequency weighting curves to be used.

The frequency and attenuation values (relative to 1kHz) for the A, C & Z weightings are shown below.

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k	16k
A-weighting (dB)	-26.2	-16.1	-8.6	-3.2	0	+1.2	+1.0	-1.1	-6.6
C-weighting (dB)	-0.8	-0.2	0	0	0	-0.2	-0.8	-3.0	-8.5
Z-weighting (dB)	0	0	0	0	0	0	0	0	0



Chapter 3:

Why do you need a windshield on a sound level meter?

A windshield is a very useful part of your noise measurement equipment and there are several reasons why you should use a windshield when you are making noise measurements.

1 Reduce the effects of wind & air movement across the microphone

Microphone capsules are sensitive things that have been designed to react to changes in air pressure.

These changes can be very, very small when the noise levels are down to 20dB or quite large when the noise levels are over 140dB.

Making a capsule that can be sensitive across all these different levels is a challenge and makes the microphones susceptible to wind.

When you are measuring outdoors, you should use a windshield to reduce, as much as possible without affecting the results, the effects of wind upon the measurements.

The windshield that is available for your sound level meter has been designed to allow the changes in air pressure from noise through whilst reducing the turbulence that wind can create. If you don't use a windshield, are you sure that you are measuring the noise you want and not the noise from wind hitting the microphone.

An example measurement

As an example, we made some quick and rough measurements using a 30cm desk fan and an optimus sound level meter. These are not very scientific measurements and were done as an example so please bear this in mind!

The optimus sound level meter was fixed to a tripod and the distance between the fan and the microphone was set at 0.5m.

After calibration, we made four measurements.

We also made a background noise measurement to verify that the ambient noise levels without the fan running were consistent and more than 30dB below the noise of the fan.

The measurements were:

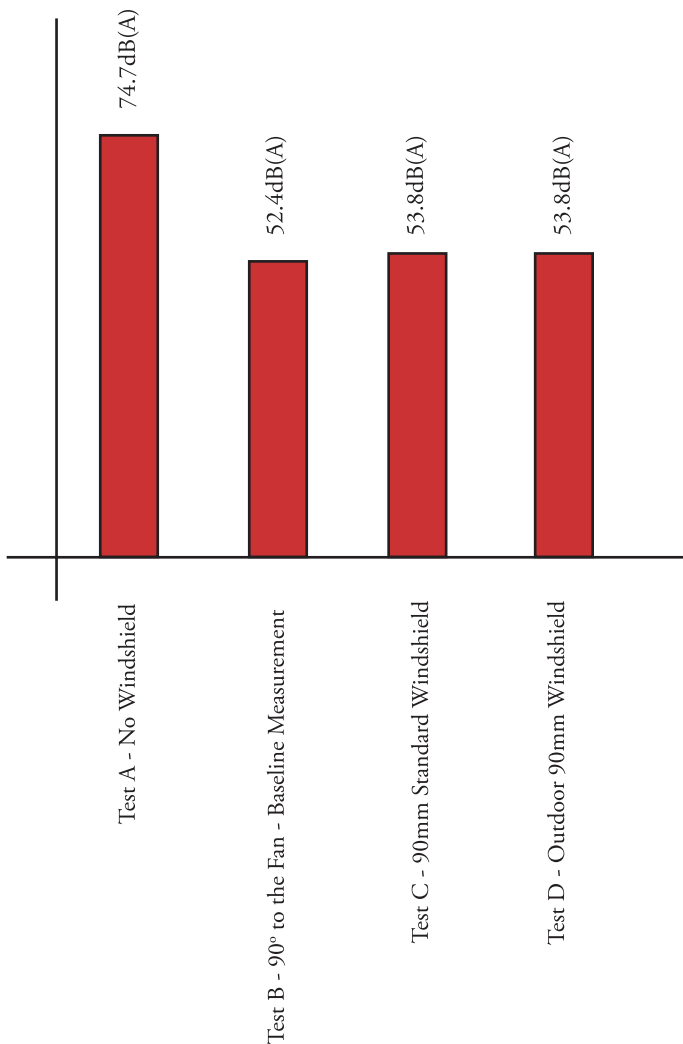
A) No windshield with the instrument in front of the fan.

B) No windshield with the instrument at 90 degrees to the fan (we tried this to see what the level of noise from the actual fan was).

C) A standard 90mm windshield supplied with the optimus directly in front of the fan.

D) A high performance 90mm outdoor measurement windshield with a hydro-scopic coating with the optimus directly in front of the fan.





Measurement A

74.7dB(A) - Leq over 20 seconds

Measurement B

52.4dB(A) – Leq over 20 second

Measurement C

53.8dB(A) – Leq over 20 seconds

Measurement D

53.8dB(A) – Leq over 20 seconds

This is a very simple and crude set of measurements but it is clear that the two windshields reduce the noise levels from the fan by just over 20dB(A).

The noise measured without a windshield is a combination of the noise of the mechanics of the fan, such as the motor and the aerodynamic noise of the blades as they spin round, and the noise generated by the moving air hitting the microphone.

What we are interested in is the noise from the fan

and not the noise of the air.

By using a windshield we reduce the effects of the turbulence over the microphone.

2 Protect the microphone from damage

The microphone capsule on your sound level meter is the most important part of the instrument.

It's the microphone that converts the changes in air pressure into an electrical signal. If this delicate part of your sound level meter is damaged in any way, your noise measurements could be incorrect.

Using a windshield can protect the microphone capsule from being knocked or banged when you are carrying the sound level meter around or when you are making measurements.

It's always good practice to use a windshield even when you are measuring noise indoors as this can often be the place where you are likely to damage the microphone.

If you're using your sound level meter on a tripod, again always use a windshield.

Don't forget to remove the windshield before you calibrate your sound level meter.

This may sound a bit obvious but we do get phone calls and emails asking how to calibrate the instrument with the windshield fitted.

3 Keep the microphone capsule clean

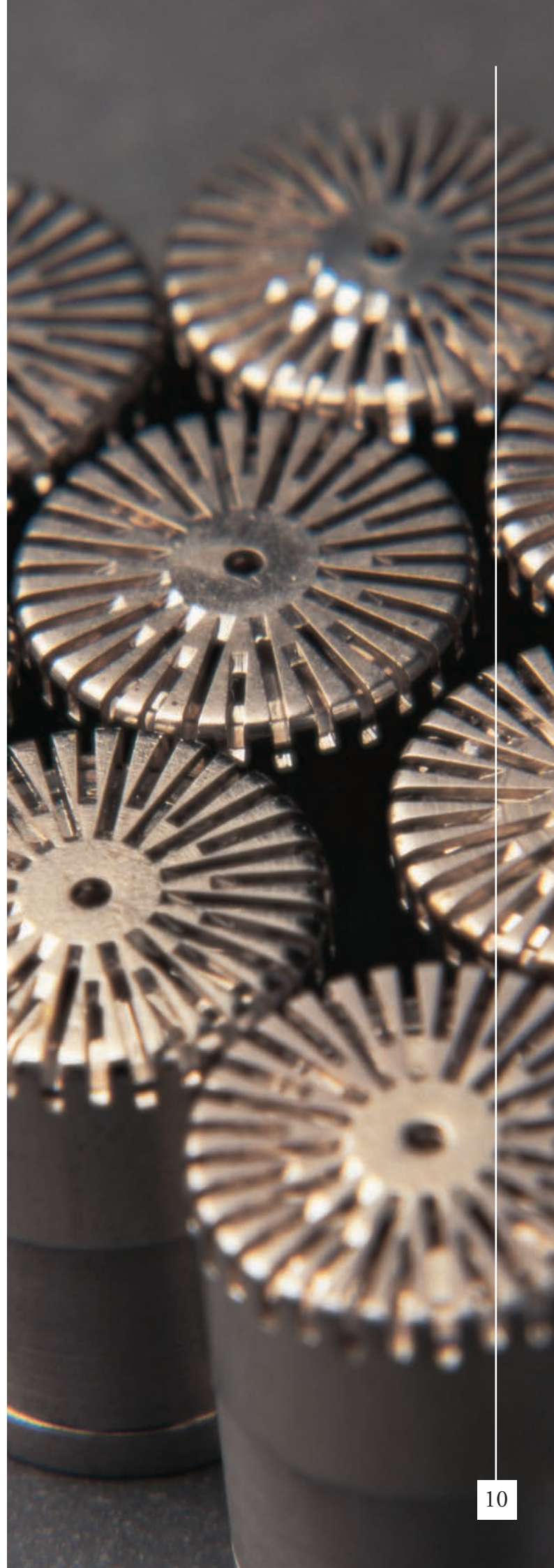
The moving parts of a microphone capsule are very delicate and very light in weight.

Any contamination of the thin microphone diaphragm*, such as drops of water or dirt, can affect the way in which the microphone and the sound level meter measure noise.

Using a windshield for all noise measurements helps to keep these potential contaminants away from the delicate bits and keeps your microphone measuring accurately and as intended when it was designed.

Most microphones that are used on sound level meters use a protective grill above the diaphragm and this helps to prevent damage but using a windshield gives more protection.

*The diaphragm is the thin, light skin at the top of the microphone that moves with changes in air pressure.



Chapter 4:

What is the difference between Class and Type for Sound Level Meters?

The sound level meters and noise dosimeters that Cirrus manufactures are designed to meet the performance criteria laid down in various standards.

For example, the optimus sound level meters are designed to meet the requirements of BS EN 61672-1:2003 which is also known as IEC 61672-1:2002.

Within these standards there are many different performance criteria that the instrument must meet along with tolerances that are allowed.

It may not be possible for the instrument to meet the exact requirements all of these criteria but as long as it is within the tolerances that is acceptable.

The older standards for sound level meters had different levels of tolerances with the tightest known as Type 0, with Type 1, Type 2 and Type 3 progressively looser in terms of the tolerances allowed.

It is generally easier to make a measurement instrument meet wider tolerances and this is usually reflected in the price.

A Type 1 sound level meter would usually have been more expensive than the equivalent Type 2 version.

Type 0 was often only used for very accurate laboratory standard instruments whereas Type 3 was considered potentially too inaccurate for use in any situation where measurements may need to be repeated.

For example, the 1989 Noise at Work Regulations specified that sound level meters should have met Type 2 or Type 1 of BS EN 60804.

When the new standard for sound level meters, IEC 61672, was developed, Class was replaced by Type and the levels of 0 and 3 were dropped (IEC 61672-1:2002 supersedes the previous standards IEC 60651 and IEC 60804 which have been withdrawn).

When the 2005 Control of Noise at Work Regulations were introduced, this new standard was introduced as the preferred option and so the requirement now reads:

“Your sound level meter should meet at least Class 2 of BS EN 61672-1:2003 (the current instrumentation standard for sound level meters), or at least Type 2 of BS EN 60804:2001 (the former standard)“.

In terms of accuracy, a Class 2 and Type 2 instrument are roughly equivalent and a Class 1 and Type 1 instrument are also roughly equivalent although there are technical differences in the standards.

An instrument that was designed to meet the older standards may not be able of meeting the requirements of the new standard.

Chapter 5:

What is the difference between a Class 1 and a Class 2 sound level meter?

We've covered the differences between Class and Type in sound level meter standards in the previous chapter and so in this post we'll cover the differences between a Class 1 and a Class 2 sound level meter.

Instrument Standards

The standards that we work to, such as IEC 61672-1:2002 or BS EN 61672-1:2003, define a wide range of performance criteria that the instrument must meet.

These criteria are often quite technically complex and detailed and have tolerances associated with them.

In the current standard, IEC 61672-1:2002, there are two levels of tolerance and these are known as Class 1 and Class 2.

In an ideal situation, the instrument would meet the centre point or design goal of these criteria exactly and every sound level meter would measure exactly the same.

However, every component in the sound level meter will have some form of tolerance or variation from one component to the next.

All of the electronic components used in a sound level meter such as resistors, capacitors and even microprocessors will have very slight differences and these all add up to give each instrument its own variation from the ideal.

There are also other factors such as the uncertainty of the measurements made when an instrument is being designed or verified. The equipment used to test a sound level meter will itself have some level of tolerance and all of these factors add up.

Because of these variations, manufacturers are allowed tolerances from the design goal.

An example of this is in the frequency weighting and tolerance limits defined in IEC 61672-1:2002.

At the reference frequency of 1kHz, the tolerance limits for Class 1 are ± 1.9 dB and for Class 2 the tolerance is ± 2.2 dB.

At the lower and upper extremities of the frequency range, the tolerances are wider.

At 20Hz, the tolerances are ± 3.2 dB for Class 1 and ± 4.2 dB for Class 2.

At 16Hz, the tolerances are $+3.2$ dB, -5.2 dB for Class 1 and $+6.2$ dB and $-\infty$ dB for Class 2.

At higher frequencies, the same applies.

The tolerances for a Class 1 instrument are tighter at frequencies above 8kHz with the tolerances at 10kHz being $+2.9$ dB, -3.9 dB for Class 1 and ± 6.4 dB for Class 2.

At a higher frequency of 16kHz, the tolerances are $+4.5$ dB, -18 dB for Class 1 and $+7.0$ dB, $-\infty$ dB for Class 2.

As you can see, at the extremities of the frequency range, a Class 1 instrument must have a better response and must meet the tighter tolerances.

It is quite difficult to give a simple answer to how accurate a Class 1 instrument would be versus a Class 2 instrument as there are many different points at which they would differ, but in simple terms, a Class 1 sound level meter will need to measure over a wider frequency range than a Class 2 instrument and meet tighter tolerances for all of its performance criteria.

Which do you need?

Whether you need a Class 1 or a Class 2 instrument will depend largely upon the application that you will be using the instrument for.

As an example, the 2005 Control of Noise at Work Regulations state that a sound level meter should meet

“at least Class 2 of BS EN 61672-1:2003 (the current instrumentation standard), or at least Type 2 of BS EN 60804:2001 (the former standard)”.

If the instrument that you were using for noise at work met Class 1 of BS EN 61672-1:2003, then it would be suitable as a Class 1 sound level meter would have a better performance specification than a Class 2 instrument.

If you are working to an environmental noise standard then this may specify that the instrument should be Class 1.

For example, ISO 20906:2009 “Unattended monitoring of aircraft sound in the vicinity of airports” states that “..shall conform to the electroacoustical performance specifications of IEC 61672-1 for a class 1 sound level meter.”

Chapter 6:

Why don't Noise Dosemeters have a Class or Type designation?

All of the noise measurement instruments that you use should comply with one or more standards which specify the accuracy that the unit should have.

There are many different standards for noise measurement instruments such as sound level meters, noise dosemeters and acoustic calibrators and these will each have their own specific requirements, tolerances and performance criteria.

In the UK, the requirements for instruments that will be used to measure noise at work are defined in the Noise at Work Regulations [1].

This lists the standards that instruments should meet and for personal sound exposure meters, or noise dosemeters, this is given as BS EN 61252:1997[2].

BS EN 61251:1997[2] and the corresponding International version IEC 61252:1993[3] lay out the performance required from a noise dosimeter along with the tolerances that are allowed.

Both of these have a single level of performance that the instrument must meet and as such there are no references to Class or Type.

The Noise at Work regulations [1] state

“Your dosimeter should meet the requirements of BS EN 61252:1997. Dosemeters have no type or class number”.

This is in contrast to the standards for sound level meters, IEC 61272:2002, which has different levels of performance for Class 1 and Class 2 instruments.

For example, the Cirrus doseBadge noise dosimeter is marked as meeting IEC 61252:1993 and as such is



suitable for use in meeting the Noise at Work regulations [1].

If a noise dosimeter has been designed to be used to meet the OSHA standard, or others that require compliance with ANSI standards, additional marking will be required.

The ANSI standard S1.25-1991[4] required different marking and a noise dosimeter that meets this standard will be marked along the lines of 2AS-90/80-5.

This indicates that the unit has tolerances that correspond to a Type 2 sound level meter (ANSI S1.4-1983), with an A Frequency weighting network, an exponential averager with a Slow time constant, a criterion level of 90dB, a threshold of 80dB and an exchange rate of 5dB.

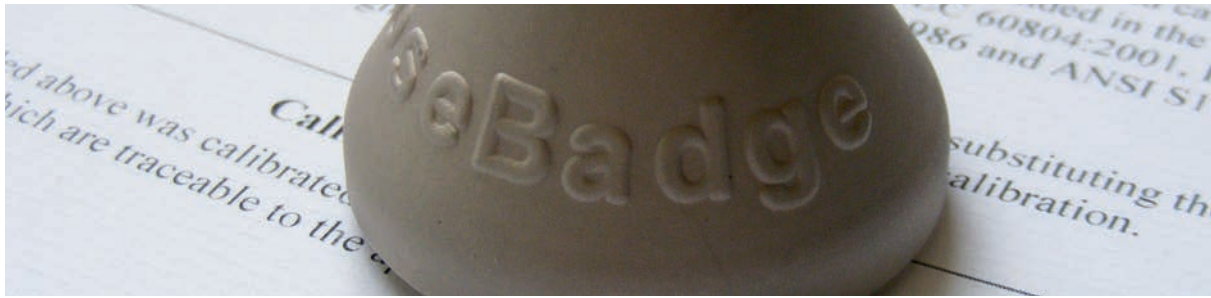
This is different to the requirements of BS EN 61252:1997 and is not applicable to instruments used to comply with Noise at Work Regulations.

References:

1. Controlling noise at work – The Control of Noise at Work Regulations 2005 – Appendix 1, Section 16
2. BS EN 61252:1997 – Electroacoustics – Specifications for personal sound exposure meters
3. IEC 61252:1993 + A1:2000 – Electroacoustics – Specifications for personal sound exposure
4. ANSI S1.25 – 1991 – Specification for personal noise dosimeters

Chapter 7:

Why do I need to calibrate my noise measurement instruments?



If you are using your noise measurement instrument to meet any Standards, Regulations or Guidelines it is essential that your equipment is measuring accurately.

If you are working to the Noise at Work Regulations 2005, or any ISO or BS EN standard that requires the use of noise measurement equipment, the standards to which the equipment must comply will be clearly stated.

If you are going to continue to use your noise measurement instruments it is vital that they continue to meet these same standards.

Each time your instrument is used it should be calibrated using an Acoustic Calibrator before and after each measurement to check that it is working as correctly. This is field calibration.

However, as noise instruments are precision measurement instruments, they should be subject to routine verification to ensure that they continue to perform accurately.

This is why you should have your instruments calibrated regularly by an appropriate laboratory.

Think of this as being like an MOT for your Sound Level Meter. Without this, are you sure that your instrument is performing to its original specifications?

We also often get asked why an instrument needs to be calibrated every time it is used.

A sound level meter or noise dosimeter is a precision instrument and so should be treated with care.

Any damage may not be immediately obvious and so using an Acoustic Calibrator before you make any measurements helps to check that the instrument will measure correctly.

However, using an Acoustic Calibrator only checks one level and one frequency and so regular servicing and calibration (Periodic Verification) is essential to ensure that all of the features and functions of your instrument are working correctly.

Chapter 8:

Service and calibration of your noise measurement instruments

We've combined some of the posts about service and calibration into a single chapter to cover more of the information.

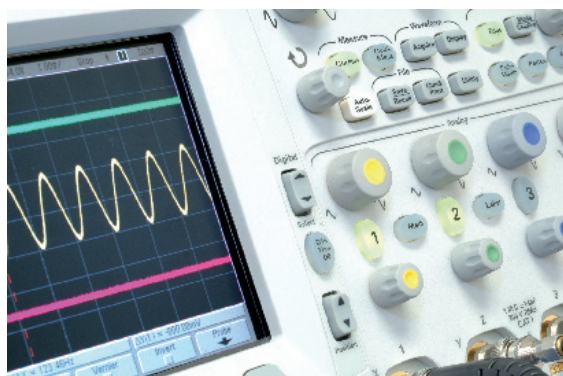
1 What should you check before you send your instrument for calibration?

Before you send your instrument for calibration, check the following. Any test or calibration laboratory must be able to give you this information. Without it, you should question if they are capable of calibrating your instrument correctly.

1. Are you sending your instrument to the original manufacturer?

If not, and you are using an independent test laboratory, do they have all of the test information from the manufacturer?

This includes freefield-to-pressure corrections for the microphone, calibration procedures for the specific instrument, how to make adjustments or corrections if these are required, any software required to communicate with and test the instrument.



2. Against what standards will your instrument be tested?

The standards to which the instrument was designed may specify the minimum set of tests that should be carried out. The Certificate of Calibration should state what tests have been carried out along with any standards to which these relate, ie IEC 61672-2002.

3. Will the calibration be sub-contracted to a third party?

If so, make sure that the third party can provide all of the above information.

4. Ensure that you provide paperwork with your instrument

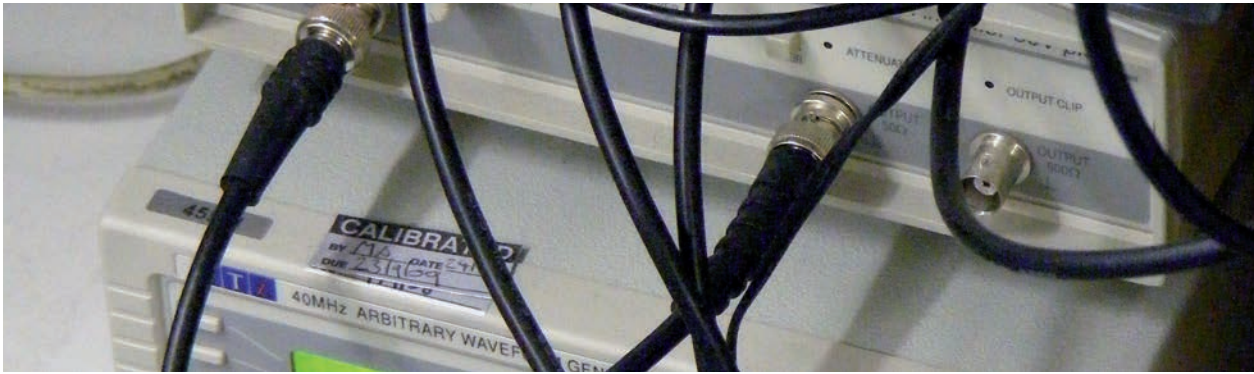
Please make sure that your contact details and any comments are clearly stated.

2 What happens during a service and calibration?

When your instrument comes to Cirrus for calibration, we carry out a comprehensive check of the performance of the unit. The exact number of tests that will be carried out will depend upon the functions that your instrument can provide such as Octave Band Filters or Data Logging.

Every function that is available on your instrument is checked to ensure that it meets the same specifications as when the instrument was new.

Some instruments will have over 350 separate performance checks carried out.



3 What to check after noise measurement equipment has been calibrated?

When you get your noise equipment back after calibration, check that the work has been done correctly. It is vital that the calibration work has been done in accordance with the standards to which the instrument was designed.

What this means is that it is not sufficient to just check the instrument using an Acoustic Calibrator. Follow this check list to make sure that the instrument has been calibrated correctly and that you have the information you need for your records.

1. Has the microphone capsule been checked for its sensitivity and frequency response?

Microphone capsules are very sensitive and fragile. Even if the microphone appears to be undamaged, it may have lost sensitivity or the frequency response may be compromised. Cirrus will check the sensitivity and frequency response of the microphone separately from the Sound Level Meter using an electrostatic calibration system.

2. Is there a calibration chart for the microphone capsule with this information?

Cirrus will provide a calibration chart for Class 1 microphone capsules which states the sensitivity and frequency response. This information is available on request for Class 2 microphones.

3. Is there a certificate of calibration for the Sound Level Meter showing the serial number and date of calibration?

4. Does the certificate state against which standards the instrument has been checked?

The Certificate of Calibration should state the standards against which the instrument has been tested, ie IEC 61672-2002, IEC 60942:2003, BS7580 Part 1 etc

5. Does the instrument have a calibration sticker showing the correct date and has the internal calibration due date been adjusted?

If the instrument is not calibrated by Cirrus, the internal calibration due date will not be changed and this will appear in any reports that you print. Note that the doseBadge and Reader units have an internal calibration date and do not have an external sticker.

Chapter 9:

What do you need to measure for the Noise at Work Regulations?

“When making measurements to estimate the noise exposure of a person at work, you need to ascertain the equivalent continuous A-weighted sound pressure level (LAeq) that represents the noise the person is exposed to during the working day. You also need to ascertain the maximum C-weighted peak sound pressure level or levels to which the person is exposed.”

(The 2005 Control of Noise at Work Regulations.)

The action levels described in the regulations are given as daily (LEP,d) or weekly (LEP,w) exposure values along with peak sound pressure levels, all in dB.

A sound level meter cannot measure LEP,d or LEP,w directly as these are calculated from two other parameters which are recorded during the measurement.

These are:

- The equivalent continuous A-weighted sound pressure level in decibels that represents the sound the person is exposed to during the working day

This is commonly known as the Leq and may be shown as LAeq or LAeq,t

- The duration over which the Leq is measured

With this information, you can calculate the LEP,d using the formula given in the Noise at Work Regulations

You should also measure the maximum C-weighted peak sound pressure level:

- This will usually be displayed on your sound level meter as Peak(C) dB or LCPeak
- In accordance with the regulations, this should always be measured with C-weighting

With these two measurements for each different activity to be assessed, you can calculate the LEP,d and where required the LEP,w values.

If you will need to provide PPE or hearing protection, you may also need to record additional values such as the C-weighted Leq (LCeq) or the Leq of the noise in Octave Bands.

This information can be used to assess the effectiveness of hearing protection. The optimus red sound level meters can provide these functions in addition to the LAeq and C-weighted peak values.

What do you need to measure these values?

How you make these measurements will depend upon different factors but in most noise measurements are made with either a Sound Level Meter such as the optimus red or a personal noise dosimeter such as the doseBadge.

1 Sound level meters

Your sound level meter should:

- At a minimum be capable of measuring
 - Equivalent Continuous Sound Pressure Level (LAeq)
 - C-Weighted Peak Sound Pressure (LCPeak)
- Optionally be capable of measuring
 - C-Weighted Leq for selection of PPE using the HML method
 - Octave band Leq values for selection of PPE using the Octave Band method
- Meet at least the requirements of
 - Class 2 of BS EN 61672-1:2003 (the current standard for sound level meters or
 - Type 2 of BS EN 60804:2001 (the former standard)

You should be able to calibrate your sound level meter using an Acoustic Calibrator which meets the requirements of at least Class 2 of BS EN 60942:2003.

To ensure that your equipment is calibrated correctly, you should not use a sound level meter and acoustic calibrator from different manufacturers unless you have very specific information and instructions as to how these two units will work together.

It is possible to create large errors in the calibration level which should be avoided wherever possible.

The optimus red sound level meters will provide all of these functions and are the ultimate tool for noise at work measurements.



2 Noise Dosemeters or Personal Sound Exposure Meters

A noise dosimeter may be very useful for measuring noise exposures of workers who are mobile, driving vehicles, working in environments where access is difficult or where their working pattern varies significantly and may be difficult to predict.

A noise dosimeter should:

- measure the LAeq and LCPeak values over the measurement
- be calibrated in the same way as a sound level meter before, and ideally after, each measurement
- meet the requirements of BS EN 61252:1997 (Note that noise dosimeters have no class or type number)

The doseBadge is the ideal noise dosimeter for this type of noise measurements.

3 Acoustic Calibrators

An acoustic calibrator should be used to check the meter each day before and after making any measurements.

An acoustic calibrator will generate a tone at a specified level and frequency for a specified microphone.

This is the reason that you should not use an acoustic calibrator and sound level meter from different manufacturers without some very detailed and specific information.

Some sound level meters may have an internal electrical calibration.

Be aware that this type of calibration does not check the microphone capsule which is the most commonly damaged part of a noise meter.

Your acoustic calibrator should meet at least Class 2 of BS EN 60942:2003.

We would recommend a CR:514 Class 2 Acoustic Calibrator for use with our Class 2 optimus sound level meters and the CR:515 Class 1 Acoustic Calibrator for use with our Class 1 optimus sound level meters.

The Reader unit supplied with the doseBadge features an acoustic calibrator that meets these specifications.



Chapter 10:

What to look for when choosing noise measurement equipment for Noise at Work

Noise legislation, designed to protect hearing and prevent noise nuisance, is becoming tougher and more widespread.

It's a response to our increased understanding of the damage that noise can do to hearing, and the negative impact it can have on quality of life in the wider community. It has resulted in a growing need to measure noise and rising demand for noise measurement equipment.

However in order to gather accurate and meaningful information about noise levels in your workplace, or the impact you might be having on your neighbours, it is essential that you invest in the right measurement equipment for the task in hand.

This article aims to provide advice on how to choose the best noise measurement tools for your application, and outlines one or two issues for consideration after the equipment has been purchased.

1 Choosing a noise measurement instrument

Noise measurement instruments, and Sound Level Meters in particular, can vary hugely in cost as well as in complexity.

It is possible to find instruments, usually via the Internet, for little as £20 and it is possible to spend well over £5,000 on a sound level meter.

Deciding which to buy can therefore be confusing, and expensive if the wrong choice is made.

A simple instrument may require less training to operate, but might not give the measurement parameters needed.

An expensive instrument may provide the data required, but the level of training and understanding needed to use it could turn it into an expensive bookend.

Although there are many professionals who are using noise measurement instruments every day, the majority of users are those for whom noise is just a part of their jobs.

For this type of user, there is a strong case to be made for choosing an instrument that meets the practical requirements of any regulations, standards or guidelines whilst keeping the instrument as simple as possible.

Before choosing a supplier or instrument, consider a few points.

2 What measurements are required?

As a rule of thumb, the more expensive the Sound Level Meter, the more functions the instrument will provide.

However, these functions should not get in the way of making the noise measurements needed to comply with regulations and guidelines.

The level of training and experience required to operate complex Sound Level Meters can often get in the way of making good quality noise measurements.

For example, the Control of Noise at Work Regulations 2005 requires the following measurements for compliance:

- The equivalent continuous A-weighted sound pressure level (LAeq)
- The maximum C-weighted peak sound pressure level (LCPeak)

There may also be a need to measure other metrics such as the equivalent continuous C-weighted sound pressure level (LCeq), or the Leq in octave frequency bands, if there is a need to provide suitable hearing protection, but the basic measurements needed are the LAeq and LCPeak values.

Most Sound Level Meters that can provide these measurements will also be able to display the basic Sound Level, which can be useful for quick noise level checks.

As sound level meters become more sophisticated, other functions will be available in addition to these two basic parameters.

These may be useful for other measurement applications and to deal with more complex noise risk assessments. One of the most useful of these additional functions is data logging or storage of measurements in the instrument. Downloading measurements to a software program allows measurements to be stored for later reference, to be used in risk assessment reports or for more detailed analysis and noise exposure calculations.

It is becoming increasingly common for those responsible for occupational noise measurements also to be charged with the recording of environmental noise.

So an instrument that provides additional measurement parameters such as Lmax, L10 and L90, may be appropriate provided of course that

the user understands the difference between these functions and those required for occupational noise measurements.

And I would stress once again that for occasional users, an instrument which provides a large number of functions and features may not be the best solution, due to the high degree of training and understanding required.

3 Noise Dosemeters

Measurements made using a Sound Level Meter would typically be short term LAeq and LCPeak values which would then be used to calculate a daily or weekly exposure value in terms of an LAEP,d or LEX,8h.

However, there are many situations where using a handheld Sound Level Meter is not possible for both practical and safety reasons.

For example, assessing the noise exposure of fork lift truck drivers or employees with complex working patterns would be problematic using a sound level meter and this is where a noise dosemeter becomes the ideal measurement tool.

A major advantage of using a noise dosemeter is that if they are worn for the whole working shift, then the noise dose will have been measured in full and no further calculations will be required.

Noise dosemeters typically measure both the overall LAeq and LCPeak values as well as calculating the daily exposure value in terms of LAEP,d or LEX,8h. One of the most useful features that a noise dosemeter can provide is a display of the noise level throughout the day.

Although the overall noise exposure is the most important data, and the one that is used to check against any regulations and noise limits, being able

to see the times when the noise was high and to be able to identify unusual or unexpected noise levels can be vital in understanding the pattern of noise recorded.

For example, the Control of Noise at Work Regulations 2005[1] which is in force in the UK uses a 3dB Exchange Rate (Q) and requires no threshold time weighting to be used, whereas the OSHA Regulations[2] in force in the US, as well as a number of other countries, uses a 5dB Exchange Rate, an 80dB Threshold and Slow time weighting.

Whilst these may seem to be relatively small differences, they can produce significantly different results.

As an example, the following measurement was taken at an American Football game. Noise levels were recorded in accordance with the UK and US methods and although the noise level was the same, the information presented by the noise dosemeter was very different:

EU Configuration	US (OSHA) Configuration
LAeq,t 92.6 dB(A)	LAVG 88.9 dB(A)
LEP,d 92.1 dB(A)	TWA 88.1 dB(A)
% Dose 511%	% Dose 75%

The most obvious difference is that the US OSHA configuration records the noise exposure as 75% of the daily level whilst the UK configuration records the same noise as being 511% i.e. over 5 times the daily exposure limit.

It is vital therefore to ensure that if a noise dosemeter is to be used, that it has been configured and calibrated correctly so that you record the measurements you need.



4 What accessories are required?

It is always advisable to purchase a sound level meter or noise dosemeter as a complete kit. This typically contains the instrument, a suitable acoustic calibrator, a windshield and a protective carrying case.

By purchasing a kit, you will have all of the accessories needed to use the equipment in the way specified by the manufacturer.

One of the most important accessories is an acoustic calibrator. Without this, the noise measurement instrument cannot be calibrated and therefore any measurements made would have to be considered questionable.

All noise measurement standards, regulations and guidelines will state that an instrument must be calibrated before and after each use.

Acoustic calibrators are designed to work with specific microphone capsules and using a combination of units from different manufacturers can introduce unknown errors to the calibration of the instrument.

As the microphone capsule on the instrument is the most delicate part and is easily damaged, special care should be taken when carrying a sound level meter.

It is common for microphone capsules to cost many hundreds of pounds and so damaging this part of the instrument can be very costly indeed.

Using the windshield supplied with the instrument, even when the measurements are being made indoors, will help to protect the microphone from accidental damage.

Noise dosimeters are usually more robust as their microphone capsules are either housed inside the instrument or are protected by a windshield or cover.

This helps to protect the unit from damage as well as stopping dust and other contaminants getting on to the microphone.

Again, as with Sound Level Meters, it is advisable to purchase a dosimeter as a complete measurement kit which would include the accessories needed.

5 Does the equipment meet the required standards?

The performance of sound level meters, noise dosimeters and acoustic calibrators are set out in national, European and international standards.

These standards are produced initially through the International Electro-technical Commission (IEC), before being adopted as European and then as National Standards.

For example, the current standard for Sound Level Meters is IEC 61672-1:2002. This has been adopted as a European Harmonised standard, an EN, which is then adopted as a British Standard with the title BS EN 61672-1:2003.

The date at the end of the standard shows when it was adopted and this may be different from the original IEC standard. Similarly, the IEC standard is adopted in Germany as a DIN-EN standard, France as NF-EN standard and Spain as an UNE-EN standard.

The table below shows the current standards for Sound Level Meters, Integrating Sound Level Meters (i.e. those that measure Leq), Noise Dosimeters and Acoustic Calibrators which apply in the UK.

Instrument Type	Current Standards	Superseded Standards
Sound Level Meter	BS EN 61672-1:2003 Also published as IEC 61672-1:2002	BS 5569:1981 IEC 60651:1979 (previously known as IEC 651)
Integrating Sound Level Meter	BS EN 61672-1:2003 Also published as IEC 61672-1:2002	BS EN 60804:2001 BS 6698:1986 IEC 804:1985
Noise Dosimeter	BS EN 61252:1997 Also published as IEC 61252:1993	BS 6402:1994 (Previously numbered as IEC 1252:1993 and BS 6402:1994)
Acoustic Calibrator	BS EN 60942:2003 Also published as IEC 60942:2003	BS EN 60942:1998 IEC 60942:1997

6 How accurate is a Sound Level Meter?

This is difficult to answer with a quick and simple number.

Within the standards are many specification points, requirements and tolerances.

The latest Sound Level Meter standard gives two levels of accuracy, Class 1 and Class 2 which have replaced the previous Type 1 and Type 2 tolerances.

It is usually sufficient to say that an instrument is Class 1 or Class 2 rather than looking for a percentage or dB figure to quote.

If a noise measurement instrument, such as a Sound Level Meter, is to be used to meet the requirements of a measurement standard, then it is likely that the standard specifies what Class or Type of instrument is suitable.

The Control of Noise at Work Regulations 2005 which are in force in the UK states the following with regard to Sound Level Meters:

“Your sound level meter should meet at least Class 2 of BS EN 61672-1:2003 (the current instrumentation standard for sound level meters), or at least Type 2 of BS EN 60804:2001 (the former standard).”

7 Noise Dosemeters

Personal Noise Dosemeters have their own standard with which they must comply and these are different to those required for sound level meters.

This standard, IEC 61252:1997 has just one level of accuracy and so noise dosemeters have no Class or Type associated with them. If a noise dosemeter is quoted as having a Class or Type, then this is for compliance with standards other than the Noise Dosemeter standard.

The Control of Noise at Work Regulations 2005 which are in force in the UK states the following with regard to Noise Dosemeters:

“Your dosemeter should meet the requirements of BS EN 61252:1997.”

8 Acoustic Calibrators

The calibration of all noise measurement equipment using an acoustic calibrator is a very important part of making measurements and ensuring that the data gathered is as accurate as possible.

As with the actual noise measurement instrument itself, an Acoustic Calibrator must meet the requirements of a standard.

Again, the Control of Noise at Work Regulations 2005 which are in force in the UK states the following with regard to Acoustic Calibrators:

“Your calibrator should meet at least Class 2 of BS EN 60942:2003.”

9 Can the equipment be serviced and recalibrated?

One aspect of noise measurement that is often overlooked is the question of service and calibration. All measurement standards, regulations and guidelines require that an instrument is calibrated before and after each use using an Acoustic Calibrator.

For example, the Control of Noise at Work Regulations 2005 states that “A sound calibrator should be used to check the meter each day before and after making measurements” as well as “Some meters have an internal electronic calibration.

The internal calibration only checks the instrument’s electronics and does not provide a check of the microphone.”

The accuracy of low cost noise measurement instruments can vary dramatically with $\pm 4\text{dB}$ often quoted as the accuracy.

Calibrating this level of sound level meter also using a low cost acoustic calibrator with $\pm 2\text{dB}$ accuracy could allow the instrument to be 45B away from the true noise level.

Using this type of Sound Level Meter without calibrating it first would introduce an unknown level of error.

10 Calibration & Recalibration

Noise measurement instruments are precision tools and the level of accuracy required from them is very high.

Manufacturers spend considerable time and effort to ensure that their instruments meet these standards. Calibration and recalibration are an important part of using a noise measurement tool.

Every noise measurement instrument should be calibrated both before and after every measurement and also on a regular basis by an external sound source. A good quality Sound Level Meter should be either sold with a suitable Acoustic Calibrator or one should be available from the manufacturer.

The certificate of calibration supplied with any noise measurement instrument will state the standards to which it has been designed. In addition to this, instruments must also be clearly marked with the information showing the Standard and Class (where appropriate) that the unit meets.

If an instrument is supplied either without a certificate of calibration from the manufacturer or, where there is a charge for a calibration certificate, then this should be viewed with caution.

An instrument produced by a reputable manufacturer, and especially one which meets the latest standards, will have been calibrated and verified and so this information should be provided, as standard, with the instrument. This applies to all types of noise measurement equipment.

If this is not the case then the question should be asked “Does this instrument meet the standards that are required for me to meet my regulations and guidelines?”

Two questions that are commonly asked are:

“If I use an Acoustic Calibrator to check my meter every time it is used, why do I need to have it recalibrated?”

“Why do I need to calibrate my meter each time it is used if it is supplied to me already calibrated?”

If a Sound Level Meter, Noise Dosemeter or Acoustic Calibrator is to continue to provide the same performance that it did when it was new, regular servicing and recalibration is essential.

The calibration information supplied with a new instrument states that at a point in time, usually at the end of the manufacturing process, the instrument was verified and that it met the specifications claimed.

Noise measurement instruments are sensitive and knocks, impacts or tampering can affect the measurements and over a period of time.

Components such as the microphone for example can alter in their performance over long periods. Regular servicing and recalibration can help in monitoring these issues and ensure that the equipment continues to operate reliably and accurately.

When an instrument is recalibrated, the performance of both the microphone and the electronics of the instrument should be checked against the original specifications and standards.

Simply using an Acoustic Calibrator to do this does not provide enough information about the performance of the instrument.

To carry out a full verification, the microphone capsule must be removed from the Sound Level Meter and this is often where low cost instruments fail.

Many low cost instruments have microphones which cannot be removed and so cannot be subjected to a full calibration.

As the microphone capsule is probably the single most important part of a sound level meter or noise dosimeter, this type of calibration should be considered as insufficient and possibly inaccurate.

The standards to which the instruments are designed contain many pages of tables, equations and requirements and instruments should be tested against these specification points or to another relevant procedure.

Recalibration of noise measurement equipment should be carried out either by the original manufacturer or by a suitable accredited or qualified calibration laboratory. If the user chooses not to use the manufacturer to carry out this recalibration, then the laboratory chosen must be able to calibrate noise measurement equipment to the requirements of the standards involved.

If in doubt, ask for information about what standards the instrument will be tested to, and request a certificate of calibration that states that the instrument was tested to the appropriate noise instrument standards.

Checklist

1. Does the instrument give the measurement functions needed to comply with any Standards, Regulations or Guidelines?

» For the Noise at Work Regulations in the UK and Europe, the essential measurements are LAeq,t and LCPeak

2. Is the instrument available with all of the accessories needed to operate it according to the manufacturer's instructions?

» A Sound Level Meter should be supplied with a suitable Acoustic Calibrator, Windshield and Protective Case

3. Does the instrument meet the specifications required by the Standards, Regulations or Guidelines?

From the 2005 Control of Noise at Work Regulations[1]:

» Your sound level meter should meet at least Class 2 of BS EN 61672-1:2003 (the current instrumentation standard for sound level meters), or at least Type 2 of BS EN 60804:2001 (the former standard).

» Your dosimeter should meet the requirements of BS EN 61252:1997.

» Your calibrator should meet at least Class 2 of BS EN 60942:2003.

4. Can the equipment be recalibrated and serviced according to both the manufacturer's recommendations and the requirements of any Standards, Regulations or Guidelines?

References

1. Control of Noise at Work Regulations 2005

<http://www.hse.gov.uk/noise/regulations.htm>

2. U.S. Department of Labor Occupational Safety & Health Administration

<http://www.osha.gov/SLTC/noisehearingconservation/index.html>

More information?

If you have a question about noise measurement or using your noise measurement instruments, you can email it to us through our website at www.cirrusresearch.co.uk or post it on our blog at cirrusresearch.co.uk/blog

You can call us directly on 0845 230 2434 from the UK or +44 1723 891655 from outside of the UK.



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For over 40 years, Cirrus has been manufacturing noise measurement instruments. All of our instruments are designed, manufactured and supported from our head office in the UK.



You can find out more about us at www.cirrusresearch.co.uk or you can call us and we will be happy to talk to you.

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Trojan Noise Nuisance Recorder	www.cirrus-trojan.co.uk
doseBadge Noise Dosemeter	www.dosebadge.co.uk
Noise at Work	www.noiseatwork.co.uk
Construction Noise Monitoring	www.construction-noise.co.uk



ISO 14001:2004
EMS 552104



ISO 9001:2008
FM 531001

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