CASTLE GROUP LTD

POPULAR RANGE OF SOUND LEVEL METERS

SALES SUPPORT PACK FOR

RS COMPONENTS LTD

1. What is Sound?

Sound is an Aural Sensation caused by pressure variations in the air which are always produced by some sorce of vibration. They may be from a solid object or from turbulence in a liquid of gas. These pressure fluctuations may take place very slowly, such as those caused by atmospheric changes, or very rapidly and be in the ultrasonic range

2. What are the basic Parameters?

Frequency — This is the number of vibrations or pressure fluctuations per second. The unit is the Hertz (Hz). The audible range is generally taken to be 20Hz — 20kHz.

Wavelength — This is distance travelled by the sound during the period of one complete vibration. (Range 16.5m — 0.0165m).

Velocity — Velocity = frequency x wavelength

$$V = f \times \lambda$$

Where f is frequency (Hz) and λ is wavelength (m)

This depends on the properties of the medium in which the wave is travelling.The velocity of sound in air is 330 ms^{-1}.

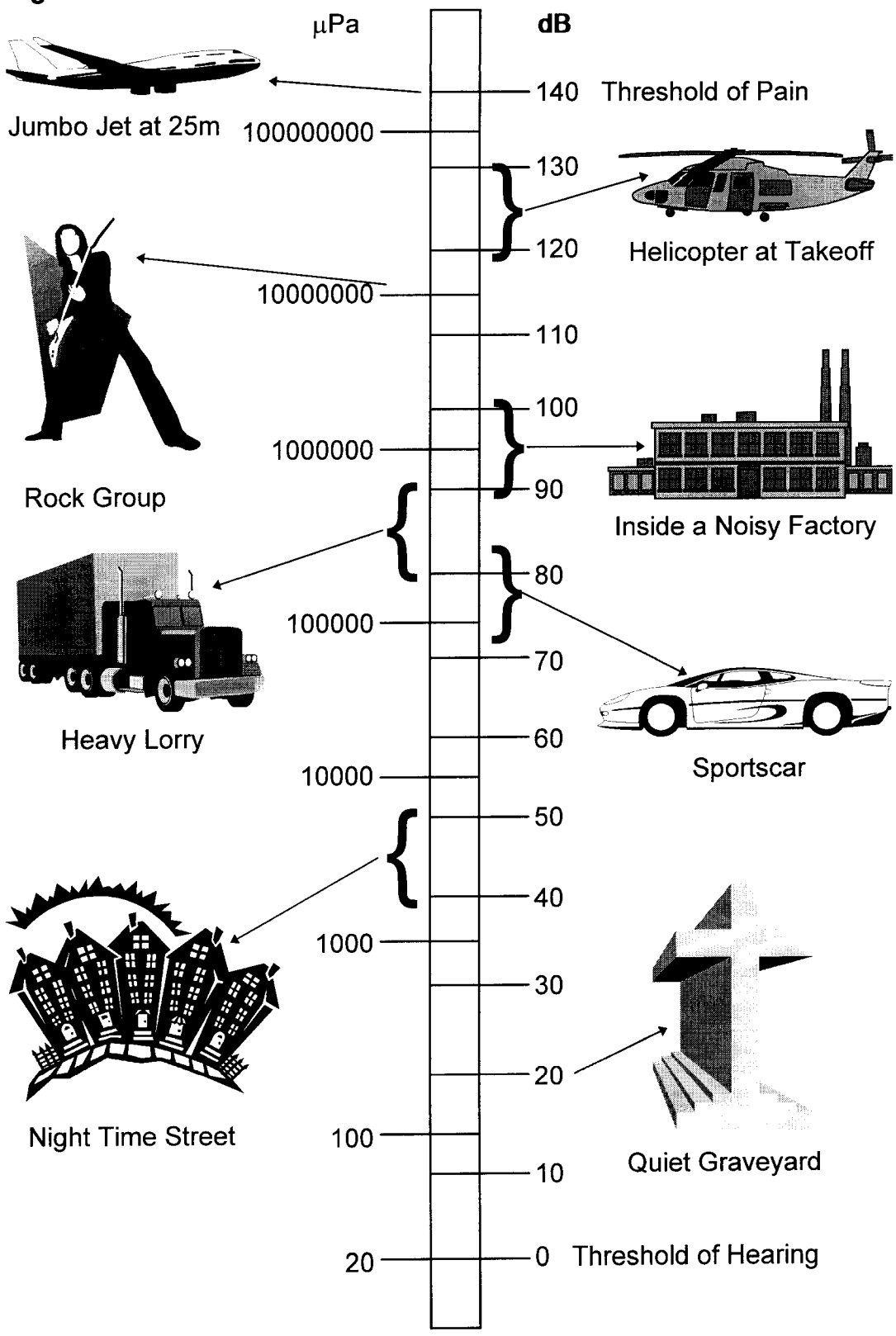
3. Where do deciBels (dB's) Come From?

Decibels are quite familiar to most people but understood by few which is something that can be used in selling sound meters because it is actually quite simple once you have grasped a few basic points.

Measuring sound is made particularly difficult by the vast range of energy involved. If noise were measured in its basic form as pressure (by measuring the variations in the air) then the readings would range from 20 micro Pascals to 100,000,000 micro Pascals. This scale that would be increadibly difficult to use so the deciBel scale was adopted.

The deciBel comes from the original unit for electrical power which is the Bel and was invented by Alexander Graham Bell. Due to the magnitude of the results for sound measurements, **tenths** of a Bel or **deci**Bels are used.
The way this scale has been made manageable is by making it Logarithmic. This is good for ease of reference, however it does mean that deciBels are not linear and so cannot be added together or used in any normal arithmetic. Figure one shows this .

Figure 1


µPa
dB
Jumbo Jet at 25m
100000000
140
Threshold of Pain
130
120
Helicopter at Takeoff
10000000
110
100
1000000
90
Inside a Noisy Factory
Rock Group
80
100000
70
Heavy Lorry
Sportscar
60
10000
50
40
1000
30
20
Night Time Street
100
10
Quiet Graveyard
20
0
Threshold of Hearing

4. So How do you Handle dB's?

If you have a machine in a room that measures 80dB and you add another machine that measures 80dB, you do not get a resultant level of 160dB although the energy has doubled. To get the correct result you either use a special formula or an addition graph, however, there is a simple rule you can use because doubling the sound energy causes the level to increase by 3dB, therefore:

80dB + 80dB = 83dB

Looking at this from another angle you could say that if there is a 3dB increase in the dB noise level then the actual increase in the energy received by your ears is double so the difference between 90dB and 99dB for example is in fact 8 times the energy!

5. How does this affect your hearing?

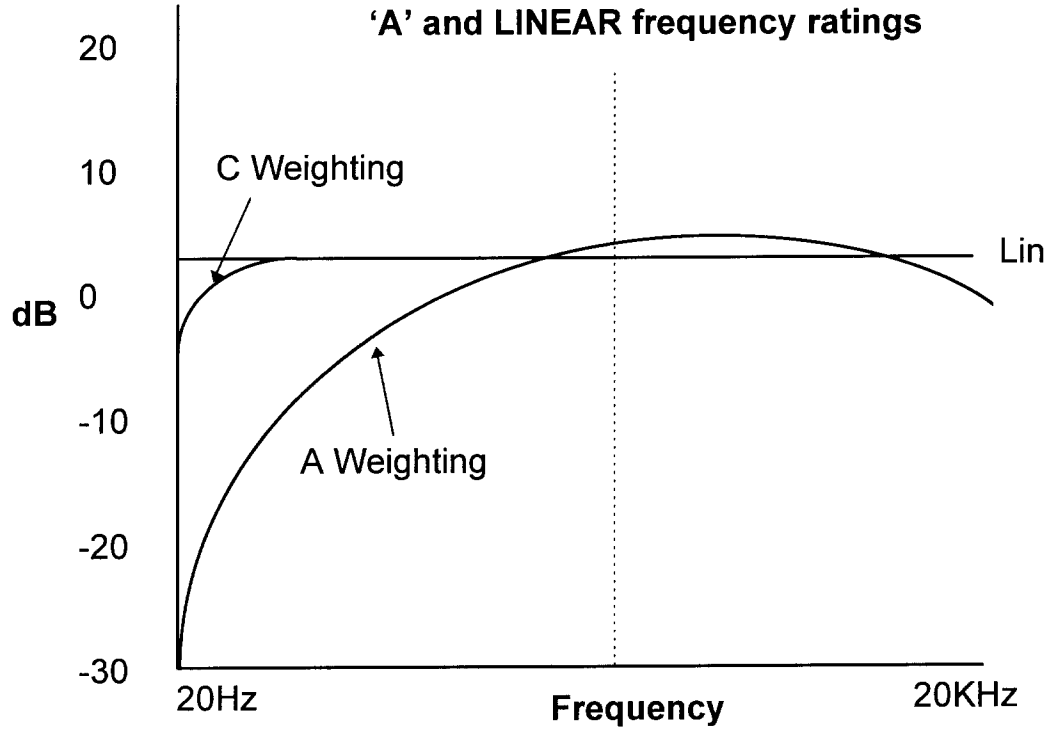
The human ear is a very clever device because it can detect noise from a faint whisper to a Jumbo Jet. Louder noises do, however, adversly effect hearing by over working the cells that convert the movement of the air into electrical signals which are read by the brain. There is a protection mechanism against this which most people will have experience of. This is where the cells stiffen up when exposed to loud noise to prevent damage. The result is a dull sensation or ringing in the ears (often noticeable after a nightclub or concert visit). This is called a Tempory Threshold Shift (TTS) and there is usually a good recovery, although never fully so each time this happens, your ears will never be the same. The loss is called a Permanent Threshold Shift (PTS). Sometimes a single event can cause quite servere PTS!!!

6. Why do we need Sound Level Meters?

Your ears very rarely hear noise as it actually is and their perception is always changing. It is therefore impossible to gauge the level by listening alone. It also takes an approximate 10dB increase the noise for you to perceive the level to double even though the actual doubling is 3 dB.

The main reason for this is that we hear certain noises more than others. Our ears do not respond very well to high frequencies. This is evident when you use a dog whistle which is undetectable by the human ear and yet will send a dog crazy. Similarly, our low frequency response is also considerably reduced. There is a specific response curve which was derived from testing thousands of peoples hearing at different frequencies from which an average was produced. This is shown on the graph below.

Figure 2

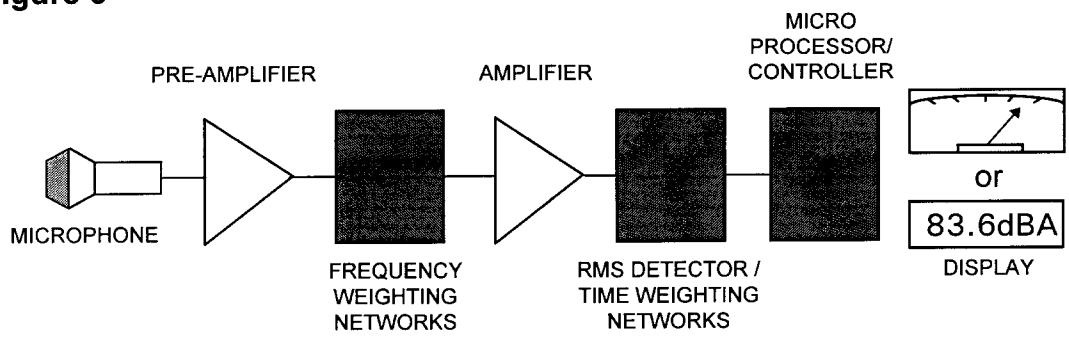


The curve is called the 'A' weighting curve and shows that the practical limit of human hearing is from about 20Hz to 20KHz. The 'Lin' line shows the actual noise that occurs if every frequency is the same level (White Noise) and in this case, the 'A' curve shows what level the human ear will actually pick up. 'C' weighting as seen on the Popular Range of Sound Level Meters is a variation on Linear which has recently been re-introduced in some European Legislation. It comes about from many years ago when Linear was a very difficult measurement to make.

7. How do Sound Level Meters Measure Noise?

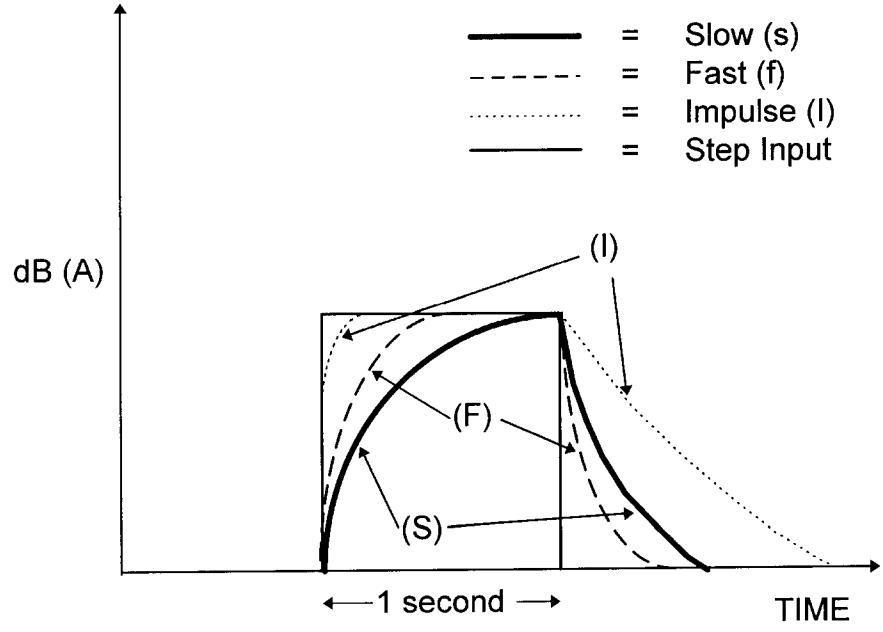
Sound Level meters generally measure noise down to 20 - 40dB to suit different applications and up to 140 - 150dB. It is very difficult to measure very low or very high noise levels which makes it quite expensive and is the reason for the variance in the limits of measurement. Such instruments often will also measure in both 'A' Weighting and 'Linear' or 'C' and usually measure from about 20Hz to 20KHz. The block diagram below shows schematically how a Sound Level Meter Works.

Figure 3



The RMS (Root Mean Squared) detector and Time weighting networks allow the response of the instrument to be 'damped' so that readings can be taken. If you imagine a needle on the speedometer of a car, it is damped so that it does not flicker about which would make a reading very difficult to take, the same applies to Sound Level Meters. The different responses are 'Slow', 'Fast', 'Impulse' and 'Peak'. Slow and Fast are simply different levels of damping and produce the rms (root mean squared) energy value and Peak is with no damping at all so that the true peak value of an impact noise can be measured. Impulse is a bit different as it will respond very quickly to an increase in noise level but will only fall slowly. This traditionally is used to determine the peak for a series of impact noises (percussive noise). Figure three shows the different responses.

Figure 4



8. How accurate are they?

The British Standards governing Sound Level meters are numerous and stringent. More so that for almost all other areas of measurement instrumentation. The outcome is that you cannot

simply say how accurate a sound Level meter is as there are different tolerances at different frequencies and at different levels

The new European standards, BSEN60651 and BSEN60804 which are taken from the original British Standards, split up the accuracy of Sound Level Meters and Integrating, Averaging Sound Level Meters into 4 types

Type three Survey Meters. minimum accuracy required and these instruments are no longer used in industry

Type two Industrial grade. This is the entry level for industrial surveys and covers the GA208 and the GA214

Type one Precision grade. This is a higher level of accuracy and is normally used where there is a potential for litigation and only the best will do. It is also true that most manufacturers only put the best features on Type one instruments!

Type zero Laboratory grade. Only used for research type applications and require a controlled environment to meet the spec.

This doesn't apply to dosemeters which have there own standard (BS6402 - 1994).

9. How does the Castle Popular Range Fit in with this?

The specifications of the different instruments in the Popular range related to the above points are as follows.

Figure 5

INSTRUMENT	RANGE(S)	FREQUENCY WEIGHTING	TIME WEIGHTING
GA208 RS 229-9325	40 - 100 60 - 120 80 - 140	'A' and 'C'	'Slow', Fast and 'Peak
GA214 RS 229-9331	40 - 100 60 - 120 80 - 140	'A' and 'C'	'Slow', Fast and 'Peak
GA255 229-9347	75 - 135	'A'	'Slow' and 'Peak'

The measuring range is often split into more than one span due to the fact that it is still very difficult indeed, even with modern technology, to make an instrument with only one range, this is because of the vast range of energy that we mentioned earlier.

10. What about Calibration?

Virtually all the relevant British Standards and codes of practice recommend any sound level meter to be calibrated before any measurements are taken and checked after measurments are taken. The **GA601** Sound Level Calibrator is ideal for use with the Popular range instruments.

11. What Does The Legislation Say?

The Noise at Work Regulations (NAWR) 1989 is the current, relevant legislation and basically says that all employers must reduce any risk of causing damage to employees hearing to a bare minimum. It then goes on to say that a Risk Assessment must be made and different courses of action should be taken if the noise exceeds certain 'Action Levels' which are explained later.

Carrying out a Risk Assessment noise survey along the lines of the legislation can be broken down into 3 initial stages. The individual customers situation will determine which of the stages they need to carry out and therefore which of the instrument they need.

11.1 Stage One

Every Company throughout the European Union should carry out a Noise at Work Risk Assessment. In a lot of cases, it is absolutely clear that there are no high noise levels, however, this should still be written down in a report! In other cases it may not be quite so clear that there is no excessive noise. In this case, Spot check measurements should be taken at various representative points around the factory. In this case it is only necessary to take the very basic of Sound Pressure Level (SPL) as descibed below.

The best instrument from the Popular Range for this task is the **GA208**

SPL, Sound Pressure Level

SPL is the instantaneous sound level measured on the simplest of sound level meters (SLMs) such as the GA208 and is measured in dBs. If the measurement was taken with "A frequency weighting" the SPL would have units of dB(A) or simply dBA.

Figure 4.1A shows what a typical SPL time history would look like.

Figure 6

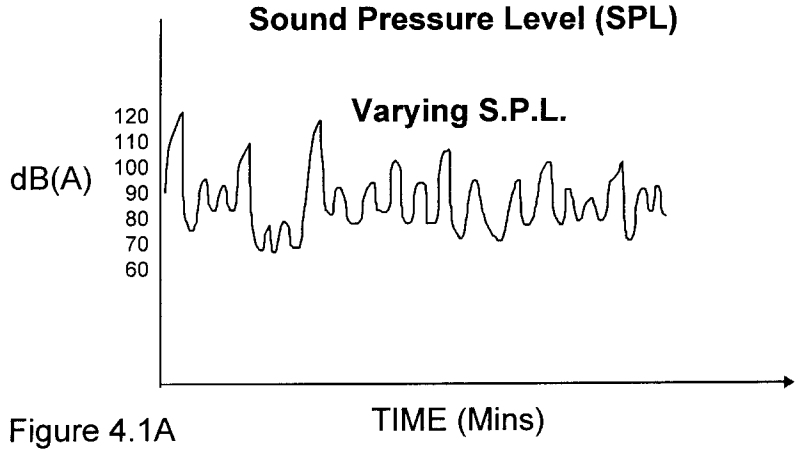


Figure 4.1A

If any areas are found where the level could possibly rise above 85dBA ('A' Weighted deciBels.) then further measurements must be taken; 85dB is refered to in the legislation as the **First Action Level**.

11.2 Stage Two

If Stage one shows that there are any areas over 85dBA or if it is fairly apparent that the noise exceeds this level then more detailed measurements must be taken looking at the Leq (Level equivalent) in various, representative areas. This should then be used to produce a noise map of the factory highlighting areas of concern. The best instrument from the Popular Range to do this is the **GA214.**

What is Leq (Level equivalent)?.

"Leq is the constant Noise level that is equivalent to the same acoustic energy of a measurement period". It is normally measured in dBA (with A weighting frequency response).

In plain terms, and for most practical circumstances, the Leq can be said to be the average noise level over a period of time. Having said that, it is not, strictly speaking an arithmetic average but an rms (energy) average.

Figure 4.1A shows and explains Leq.

Figure 7

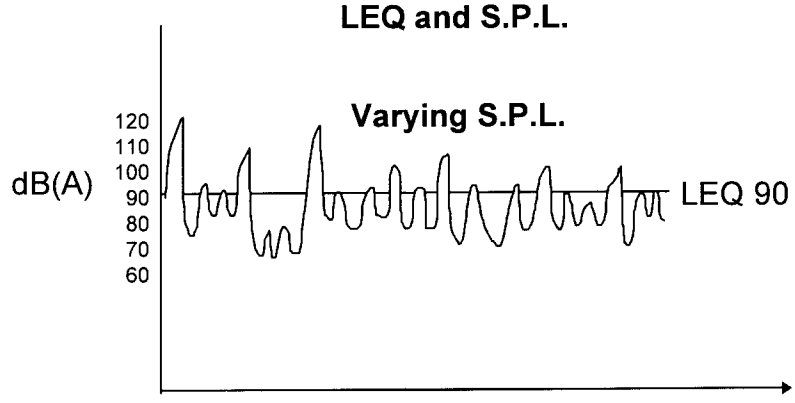


Figure 4.1A

Once a Noise map has been completed, it should give a clear indication as to any areas in which the noise is up around the 85 dB mark. If these areas have people working in them, either on a regular or infrequent basis then it is important to carry out further assessments for those individuals.

11.5 Stage Three

This involves looking at Personal Noise Exposure levels for individuals who work in any of the areas highlighted in stage two. The only way to acurately assess any form of personal exposure measurements is to attach the measuring device to the person and leave it there for a time which is representative of their working day. The type of instrument to use here is a Noise Dosemeter (often written as Dosimeter by the Americans).

This type of instrument has it's microphone on a cable which can be attached close to the wearers ear. Any measurements will be a good representation of the noise actually received by the person as the Dosemeter goes with the worker through the different noise environments. The instrument from the Popular Range is the **GA255** Dosemeter.

An extra selling point about this instrument is that when the microphone is attached to a collar, it stands perpendicular to to the material. There are many dosemeters where the microphone lies flat against the material and this causes unwanted noise through rubbing.

The measurement parameters are also different for Sound Exposure measurements

What are Sound Exposure Measurements?

The important point to remember about exposure measurements is that they are directly related to time

Dose: Noise Dose is a percentage number where:

100% DOSE = 90dBA for 8 hours

The reason that 90dB is chosen is that this is the **Second Action Level** from the legislation

Note that not only is the sound level important (90dBA) but also the time a person was exposed to the noise (8 hours).

Someone who has been exposed to an equivalent continuous SPL (LEQ) of 90dBA for 8 hours will have received a 100% DOSE of sound exposure. Note that in many countries the criterion is different. Most of Europe use a voluntary criterion of 85dBA for 8hrs = 100% Dose and it is proposed that Legislation will soon make this mandatory, forcing the UK to adopt this safer level.

The table below shows the 8 hour DOSE as a % or the length of time that will result in 100% DOSE (90dBA Lep'd) at various continuous noise levels.

Because the reference time is 8 hours, it is possible to measure the DOSE or Lep'd for as little as 1 hour and project what the 8 hour figure would be. The GA255 shows this as **PROJ** for projected DOSE and **PLe** for projected Lep'd

Figure 8: The relationship between Dose, LEQ and TIME.

8 Hr Dose %	dB(A)	Permissible exposure (100% Dose)		
		Hours	Mins	Secs
1,984,000	132			1 ¾
992,000	129			3 ½
496,000	126			7
248,000	123			14
124,000	*120*			*28*
51,200	117			56
25,600	114		1	52
12,800	111		3	45
6,400	108		7	30
3,200	105		15	
1,600	102		30	
800	99	1		
400	96	2		
200	93	4		
100%	90	8		
50	87	16		
25	84	32		

The Legislation doesn't actually refer to DOSE but to it's dB equivalent which is called **Lep'd** which literally stands for **L**evel **e**quivalent for a **P**erson per **d**ay

90dBA Lep,d = 100% DOSE = 90dBA for 8 hours.

For an example of how to use the table, you can see that a constant noise of 120dB over 8 hours would give you a DOSE of 124,000% or that 100% DOSE would be reached in only 28 seconds.

Figure 9

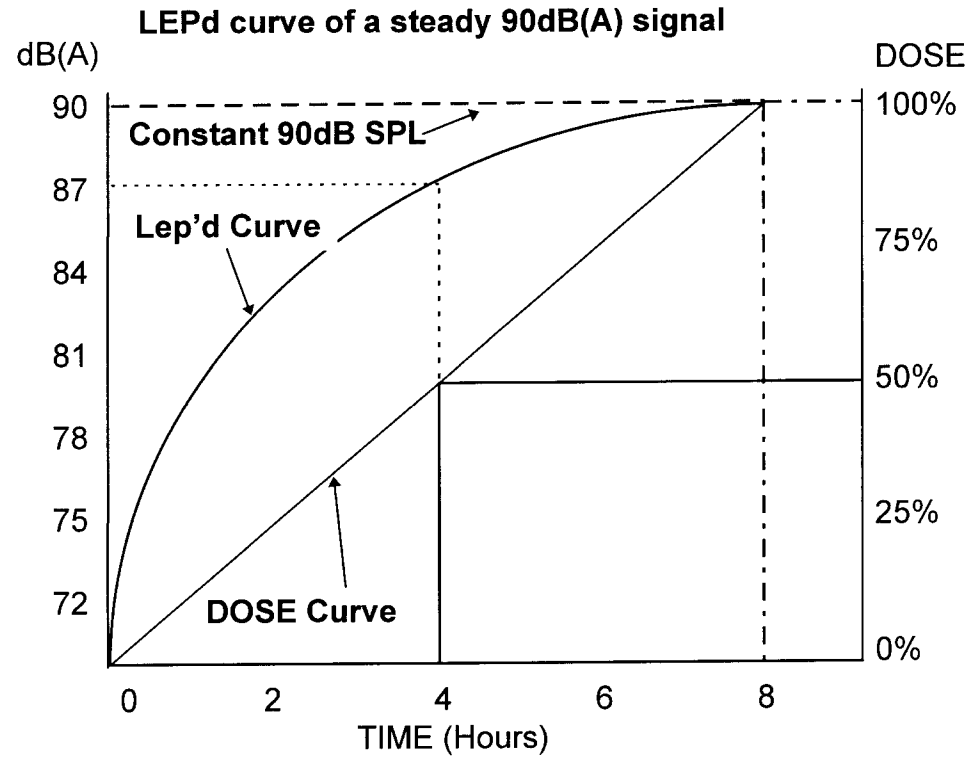


Figure 4.2B Personal Exposure Levels (LEPd and DOSE)

12. Is that it?

There is one other consideration at every stage of the survey and that is whether the Linear Peak (Lpeak) noise is ever likely to reach 140dB as this can cause instant hearing damage. This is called the **Peak Action Level.**

13. What Next?

If any of the Personal Exposure readings come out as being over the first or second action level, then different courses of Action must be adopted. Essentially, the Exposure must be reduced as much as possible either by Engineering it out or with the use of enclosures or, as a last resort, hearing protection.

14. Can this all be summerised?

The tables below summarises all of the above points.

Figure 10

Noise at Work Risk Assessment Summary		
Stage 1	Function	Spot checking for possible excessive noise levels
	Action Levels	85dBA (First Action Level) and 140dB (peak Action Level)
	Measurement parameters	Sound Pressure Level (SPL)
	Instrument	**GA208** RS 229-9325
Stage 2	Function	Noise Mapping to determine in detail which areas have excessive noise levels
	Action Levels	85dBA (First Action Level) and 140dB (peak Action Level)
	Measurement parameters	SPL and Leq
	Instrument	**GA214** RS 229-9331
Stage 3	Function	determine Personal Noise Exposure levels for any employees working in areas highlighted above
	Action Levels	85 dBA (First Action Level) and 90dBA (Second Action Level) and 140dB (Peak Action Level)
	Measurement parameters	DOSE, projected DOSE (PROJ), Lep'd and Projected Lep'd (PLe)
	Instrument	**GA255** RS 229-9347

CALIBRATOR RS 229-9448

Figure 11

Detailed Product Feature Summary			
Feature	**GA208**	**GA214**	**GA255**
Measuring Range	40 -140dB	40 - 140dB	75 - 135dB
Number of Ranges	3	3	1
Dynamic Range	60dB	60dB	60dB
8 Character LCD Display	✓	✓	✓
Minimum Battery Life	40 Hours	40 Hours	40 Hours
Tough pocket clip			✓
Tactile Keypad	✓	✓	✓
Relevant British Standard	BSEN60651-1994	BSEN60804-1994	BS6402-1994
CE Mark	✓	✓	✓
Sound Pressure Level	✓	✓	
Leq		✓	
Lmax (maximum SPL)	✓	✓	
Lpeak (maximum peak)	✓	✓	✓
% DOSE			✓
Selectable Criterion			85 or 90dB
Selectable Exchange rate			3 or 5dB
Projected 8 hour DOSE			✓
Lep'd		✓	✓
Projected 8 hour Lep'd			✓
Pa2Hrs (DOSE%x0.032)			✓
Frequency Weighting	'A' & 'C'	'A' & 'C'	'A'
Time Weighting	Slow, Fast & Peak	Slow, Fast & Peak	slow &Peak
Elapsed Time	✓	✓	✓
115dB RMS Flag		✓	✓
Overload indication	✓	✓	✓
Battery condition monitor	✓	✓	✓
Battery low indication	✓	✓	✓
Software calibration	✓	✓	✓

Figure 12

Features and Benefits analysis	
Features	**Benefits**
Crack resistant Fbre-Filled ABS Plastic Body	Super tough and light weight for ease of use in harsh environments
Recessed Keypad and display	Protection against drops an knocks
Tactile Keypad	positive feedback to key presses
Drop-in battery compartment design	Very quick and simple to change the battery
Tough Dosemeter pocket clip with unique design	fixes instrument to a belt or in a pocket with confidence
State of the art 'micro-controller' electronic design	Ultra - reliable products at highly competitive prices
Simple to service	Reduced running costs and faster turnaround than the competition
4 Year Extended Warranty	Assurance that the Manufacturer has complete confidence in the products
40 hour battery life (Using Alkaline Batteries BS6LR61)	Longer operation that the competition leads to lower running costs
One button to read all measurements	reduced learning time, simple handbook.
Software Calibration	simple to calibrate using the **GA601** Calibrator.
Current as well as projected DOSE and Lep'd calculations	Gives the Exposure for shifts of various lengths.
Small and lightweight KA010 Attache case available	provides protection for the instrument and the calibrator in an easy to carry case - The **KA010**

15 What do the customers ask?

It is quite common that customers enquiring for this type of product have never looked into noise before and do not really know what they are looking for. This is why it is important to have a basic grasp of the points mentioned in this document. It is also important to give them an indication of the type of subject they are looking at.

Which one should I buy?

To answer this question it is important to assess the customers situation by asking a few simple questions in return:

What does your company do?
How big is the factory?
What would you say are the noisiest processes in your factory?
How many people work on the shop floor or in noisy areas?

Once you have asked these few questions, you will soon be able to see at what stage of the legislation they need to start.

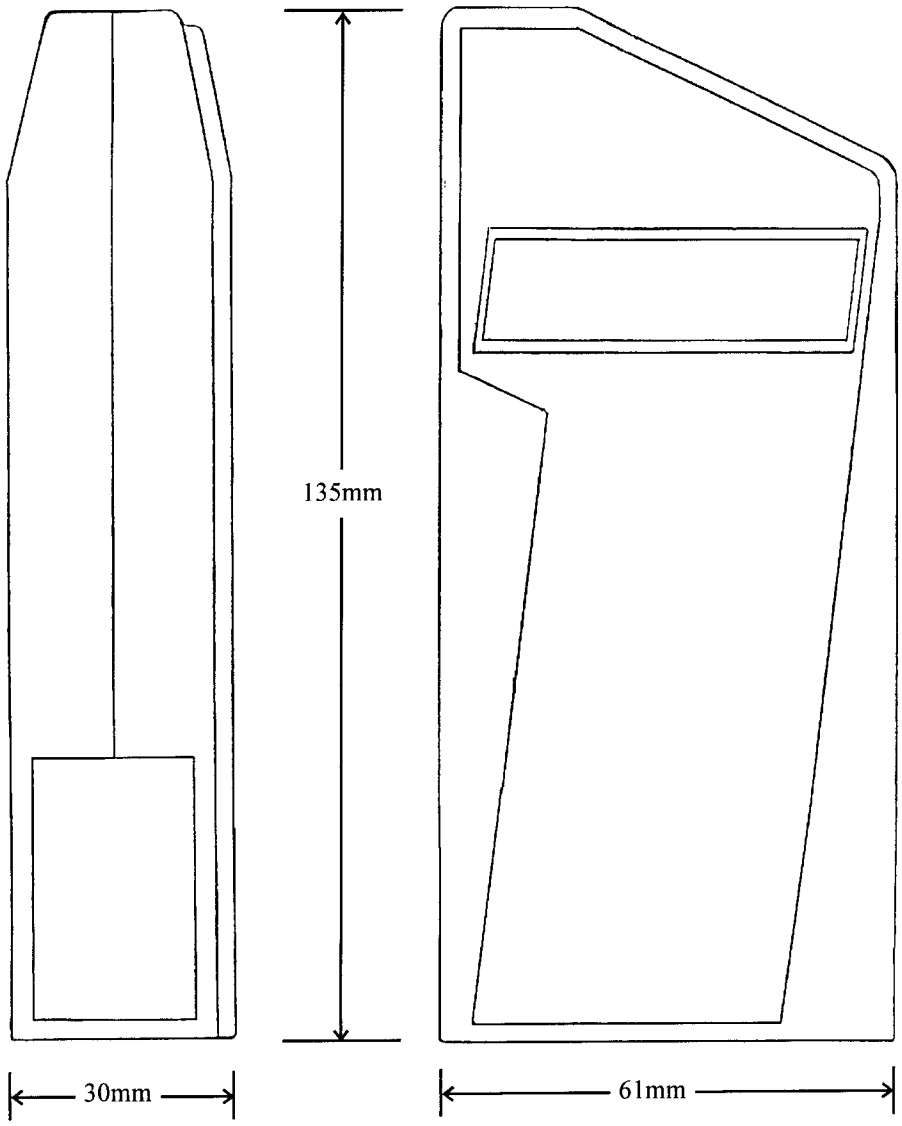
GA208
GA214
GA255

TECHNICAL DATA SHEET

The "Popular" Range of Sound Level Meters

CASTLE

A COMPANY WORTH LISTENING TO



TENDER SPECIFICATIONS

GA208

To measure sound pressure, maximum & peak levels. 8 character alpha-numeric LCD. To fit into small shirt or jacket pocket. Lockable Key pad. True Peak.To be constructed of tough crack resistance plastic. Single battery operation for 40 hours.

GA214

To measure SPL, LEQ, projected Lepd, Max & Peak. Pa^2 H.8 character alpha-numeric LCD.
To fit into small shirt or jacket pocket. Lockable Key pad. True Peak.
To be constructed of tough crack resistance plastic
Single battery operation for 40 hours

GA255

To measure dose, projected dose, projected Lepd 115dB RMS Flag. 8 character alpha - numeric LCD. To fit into small shirt or jacket pocket. Lockable Key pad. True Peak. To be constructed of tough crack resistance plastic. Single battery operation for 40 hoursTo have strong clip for attaching to a belt or shirt pocket

GA208 GA214 GA255

SPECIFICATION

SPECIFICATIONS FOR GA208
Sound Pressure Level Meter

Measuring range 40-140 dB.
Dynamic range 60 dB.
8 character LCD display.
Minimum battery life of 40 hrs.
Designed to meet the requirement of the EMC regulations.
Small, lightweight case of fibre-filled, ABS plastic.
Micro-controlled operation.
Tactile keypad operation.
Comply with BS EN 60651 Type 2.
State of the art electronic design.

Display parameters to include :-

Sound Pressure Level to 0.1dB resolution
Lmax (Maximum of SPL reading) + Hold
Lpeak (Maximum linear peak hold)
'A' and 'C' frequency weighting (Toggle)
'Slow' and 'Fast' time weighting (Toggle)
Elapsed time (Running time hrs, mins, secs)
Overload indication (Flashing alternate display)
Over range and under range display indication
Battery condition indication
Low battery (Flashing alternate display)
Software calibration

SPECIFICATIONS FOR GA214
Integrating Sound Level Meter

Measuring range 40-140 dB.
Dynamic range 60 dB.
8 character LCD display.
Minimum battery life of 40 hrs.
Designed to meet the requirement of the EMC regulations.
Small, lightweight case of fibre-filled, ABS plastic.
Micro-controlled operation.
Tactile keypad operation.
Compliance with BS EN 60651 and IEC 804 Type 2.
State of the art electronic design.

Display parameters to include :-

Leq
Sound Pressure Level
Lmax (Maximum of SPL reading)
Lpeak (Maximum linear peak hold)
'A' and 'C' frequency weighting (Toggle)
'Slow' and 'Fast' time weighting (Toggle)
Elapsed time (Running time hrs, mins, secs, 1%)
Overload indication (Flashing alternate display
Over range and under range display indication
Battery condition indication
Low battery (Flashing alternate display)
115 dB Flag: + Time of first occurrence
(may be changed to 105 dB)
Software calibration

SPECIFICATIONS FOR GA255
Personal Sound Exposure Meter

Measuring range 75 -135 dB (Fixed).
Dynamic range 60 dB.
8 character LCD display.
Minimum battery life of 40 hrs.
Designed to meet the requirement of the EMC regulations.
Small, lightweight case of fibre-filled, ABS plastic.
Micro-controlled operation.
Tactile keypad operation.
Compliance with BS 6402 and IEC 651 Type 2.
State of the art electronic design.

Display parameters to include :-

Projected Lep'd 75dB to 135dB
Pa2Hrs (Dose % x 0.032)
Sound Pressure Level for calibration only to 0.1dB resolution
Lpeak (Maximum linear peak hold)
Dose count 1% to 9999% with Variable exchange rate of
3dB/5dB and criterion level 85dB/90dBfor Dose calculations.]
Projected Dose 1% to 9999%
'A' frequency weighting
'Slow' time weighting
Elapsed time (Running time hrs, mins, secs, 1%)
Overload indication (Flashing alternate display)
Battery condition indication
Low battery (Flashing alternate display)
115 dBA Flag and Time of first occurrence (may alter to 105 dBA)
Software calibration

ORDERING INFORMATION

GA208 **RS 229-9325**
Digital SPL Meter

GA214 **RS 229-9331**
Pocket Integrating SLM

GA255 **RS 229-9347**
Industrial Dosemeter

CALIBRATOR RS 229-9448
Single Level Calibrator

KA010 **RS 229-9454**
Small Atache Kit Case