Castle Sonus Range

Sound Level Meter
&
Dose Meter

Operating Manual

www.castlegroup.co.uk

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Sound Level & Dose Meter Operating Manual

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Thank you for buying a Castle product, I am sure you will find both the goods and the service to be of the highest quality but if not, then please feel free to write to me personally and I will ensure that your needs are dealt with immediately.

This manual is designed to show you the operation of the goods you have purchased and a very brief insight into acoustics itself. If you would like to become a competent person in the eyes of the law, then you may like to know more about our Competent Persons training course for the Noise at Work Regulations. You can visit **www.castletrainingacademy.com** to find out more.

Castle Group has become the leading supplier of solutions for health and safety, environmental compliance and plant maintenance and monitoring, with an ever expanding offer comprising equipment for sale or rent, residential or in-house training courses, consultancy services and equipment calibration. If you would like to know more about any of our other products and services then please visit **www.castlegroup.co.uk** or telephone us on **+44(0)1723 584250**.

Simon Bull
Managing Director

Note: for 'Getting Started' section please turn to Chapter 4

Precautions

- Only operate the instrument as described in this manual.
- These are precision instruments, protect from shocks and vibrations.
- Ambient conditions for the operation of the unit are as follows:-

  Temperature: -10°C to +50°C

  Relative Humidity: 25 to 90%
- Protect the unit from extremes of temperature and humidity, direct sunlight and air with a high salt or sulphur content.
- Always turn the unit off after use. Remove the batteries from the instrument when not in use.
- Do not use any solvents or cleaning agents on the instrument. Use only a soft dry cloth or a soft cloth lightly moistened with water when necessary.
- Do not allow any conductive objects, such as wire or metal particles to enter the unit.
- Do not try to disassemble the instrument or attempt any repairs as this will invalidate your warranty. Take a note of the condition of the instrument and contact your authorised Castle service station.
- To ensure continued precision performance of your instrument have it checked and serviced at regular intervals.

Contacting Castle Group

This manual contains complete operating instructions for the Castle Sonus Meter, read it carefully and you will quickly become familiar with your instrument and its operation.

If you do encounter problems with the operation of your instrument please feel free to contact customer support with your enquiry on: -

Telephone:	+44 (0)1723 584250
Fax:	+44 (0)1723 583728
Website:	www.castlegroup.co.uk
Email:	techsupport@castlegroup.co.uk sales@castlegroup.co.uk

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HEALTH AND SAFETY

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- Noise and Vibration at Work
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- Health Screening
- Air Sampling and Gas Detection
- Indoor Air Quality
- Airflow
- EMF Testing and Monitoring
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- Ground-Bourne & Building Vibration
- Stack-Emissions Monitoring
- Environmental Air Sampling
- Water Quality Testing

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Production plant needs maintenance and if this can be done only when needed, then cost savings can be huge. Condition monitoring offers the ability carry out predictive maintenance so shut-down is only when you plan it and only when it's needed. It is very simple to work out if this is the right approach for your business, so give us a call on 01723 584250 so we find out how much you could save!

- Vibration Monitoring Systems
- Vibration Meters
- Temperature Monitoring System
- Thermometers
- Thermal Imaging
- Diagnostic Vibration Analysis
- Tachometers
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- Health and Safety Compliance Courses
  - Noise, Vibration, COSHH, Asbestos
- Health Surveillance Courses
  - Audiometry, Lung Function, HAVS
- Environmental Monitoring Courses
  - Noise, Vibration, Air Quality
- Diagnostic Engineering Courses
- Maintenance and Monitoring Courses

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- Environmental Monitoring
- Expert Witness
- Diagnostic Engineering
- Engineering Control Solutions
- Risk Management
- Health Surveillance Services
- Health and Safety 'Department' Support Service

Castle Care

Maintaining calibrations on measuring equipment is absolutely essential to the integrity of your data. At Castle, we can calibrate virtually anything you have that can measure. We pride ourselves in fast-as-possible turnaround times and can normally give up-front prices for almost any equipment. Whether you have an anemometer, or a 'zero-g' accelerometer, then call us for a price on 01723 584250.

- If it Measures, and can be done - we'll Calibrate it
- UKAS Certificates Available
- Multiple levels of Calibration

Equipment Types Covered

- Air quality meters
- Air sampling pumps
- Air sampling calibrators
- Anemometers
- Audiometers
- Balances/Scales
- Barometers
- Dosemeters
- Electrical test equipment
- Force meters
- Gas Detectors
- Hygrometers
- Light meters
- Manometers
- Moisture meters
- Noise meters
- Pressure meters
- Sound level meters
- Sound Analysers
- Strain gauges
- Tachometers
- Thermometers
- Thermo-hygrometers
- Thickness meters
- Timers
- Vibration meters
- Vibration analysers
- Weighing equipment

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If peace of mind for equipment calibrations is important to you – and it should be, then check out our contract calibration deals. We will give you discounted, fixed-annual-pricing for selections of equipment and we will undertake to ensure calibration is maintained to your schedule. This is designed to take all the hassle out of equipment calibration.

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If it exists - we'll even source equipment for you!

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Chapter 1

Introduction

Thank you for purchasing your product from Castle Group Ltd. The Sonus range of pocket sound level meters brings simplicity and power to the worlds of Noise at Work and Environmental sound monitoring.

From a basic sound pressure meter to full data logging, combined sound and dose-meter, the range of systems covers a wide diversity of applications.

Portability of instrumentation is essential for effective noise measurement. As the name indicates, the Castle Sonus Pocket Meter packs all the necessary features into pocket sized proportions.

Future Proof...

The built in firmware for these meters is designed to suit future upgrading for feature enhancements, legislative changes or instrument upgrades. Details are mailed to customers as soon as they become available. With the Castle range of Sonus Pocket meters you will always be in step with the law and market requirements. Periodic enhancements or bug fixes to the software will be supplied free of charge for a period of one year from the purchase date.

Sonus Variations

Sonus L

GA116L – Class 1, Ln's, User Selectable Modes
GA216L – Class 2, Ln's, User Selectable Modes

Available in either class 1 or class 2, this top of the range model is a Noise at Work and Environmental Sound Meter boasting a combined Integrating Sound Level Meter and Dose Meter with full data logging capability.

Simply unplug the Sound Meter Microphone and plug in the Dose Meter cable to convert to a fully functional Dose Meter (Model GA116L Only).

This model also features dual measurement capability meaning two versions of applicable parameters can be measured simultaneously. This feature means you only ever need to measure once to capture all the data you need!

The instrument has user selectable operating modes for instant automatic setup of the instrument for Noise at Work or Environmental parameters. Alternatively the instrument can be configured manually to meet your exact requirements.

Analysis of recorded data can be achieved by transferring the data from the instrument into the software dBdataPro using the instruments USB port.

GA257L –Dose Meter

This model is a dedicated Dose Meter with full data logging capabilities which also features dual measurement capability meaning two versions of applicable parameters can be measured simultaneously. This feature means you only ever need to measure once to capture all the data you need!

Analysis of recorded data can be achieved by transferring the data from the instrument into the software dBdataPro using the instruments USB port.

Sonus E

GA116E – Class 1, Ln's,

Available in class 1 only, this top of the range model boasts an ultra low noise floor allowing extremely quiet noise to be measured and recorded.

This model also features dual measurement capability meaning two versions of applicable parameters can be measured simultaneously. This feature means you only ever need to measure once to capture all the data you need!

This model is ideal as a dedicated Environmental Sound Meter with full data logging capabilities recording samples with an interval period as low as one second ... even Ln's.

Analysis of recorded data can be achieved by transferring the data from the instrument into the software dBdataPro using the instruments USB port.

Sonus I

GA116I – Class 1
GA216I – Class 2

Available in either class 1 or class 2, this model is a low cost integrating sound level meter that measures simultaneous Leq and peak measurement for assessments and compliance with the Health and Safety at work Act; Noise at Work Regulations 1989.

Sonus B

GA116B – Class 1
GA216B – Class 2

Available in either class 1 or class 2, this model is a general purpose low cost non-integrating sound level meter that can assist with compliance to the Health and Safety at Work Act; Noise at Work Regulations 1989.

GA257B –Dose Meter

A low cost dedicated Dose Meter giving a simultaneous Daily Noise Exposure Level (Lep,d) and peak measurement (Zpk) for assessments to the Noise at Work Regulations 1989.

Chapter 2

Microphone

Measurement microphones by the very nature of their manufacture are precision components that are easily damaged through incorrect use. Great care must be taken when using the instrument to ensure the longevity of the microphone.

Please note that depending on your instrument model, it may be supplied with a protective white plastic cap covering the end of the microphone. If supplied this cap must be removed prior to using the instrument.

Microphone Types

Three different types of microphone are manufactured, each designed for measuring noise in different applications which is out of the scope of this manual. Each one however has a different sound incidence angle. The sound incidence angle determines the angle the instrument is held relative to the actual noise source being measured.

Free Field

Sound Incidence Angle = 0°
Point the sound meter directly towards the noise source

Pressure

Sound Incidence Angle = 90°
Point the sound meter at 90° to the noise source

Random Incidence

Point the sound meter at approximately 70° to the noise source

All Sonus meters are supplied with **Free Field** measurement microphones.

Microphone Polarisation

Microphones require a polarisation voltage to operate and are manufactured in two ways. All microphones supplied with Sonus meters are **Pre-Polarised**.

Externally Polarised

These microphones require an external charge for the microphone to operate which is generally 200V and supplied by the sound level meter.

Pre-Polarised

These microphones generate the polarisation voltage internally and do not require the externally generated 200V polarisation charge.

Microphone Sensitivity

The sensitivity of a microphone is determined by the output voltage it produces for a defined sound source.

Microphones are manufactured with numerous sensitivity levels and operate within a specified tolerance. Different microphones of the same model may therefore give slight differences in readings when used on the same sound meter. To allow for this all Sonus meters have been designed to accommodate any variations in the tolerance of the supplied microphone up to ±3dB.

Sonus models L, I and B have been designed for microphones with a sensitivity of 25mV/Pa and model E for microphones with a sensitivity of 50mV/Pa.

Great care must be taken to ensure the microphone and sound meter sensitivities match otherwise incorrect readings will occur.

Certifiable Calibration

The calibration process includes the microphone, pre-amplifier and sound level meter. Any change in this measurement chain will require a new certifiable calibration.

Castle Group Ltd offers a complete calibration service offering either a full UKAS calibration or a standard NPL traceable calibration which can be supplied with or without a test report.

It is recommended that your sound meter instrumentation is calibrated annually to ensure your measuring equipment is completely accurate and fully compliant.

Removal of Microphone

The microphone can be fitted to the pre-amplifier by screwing the microphone in a clockwise direction ensuring that the pre-amplifier spring pin is located centrally in the microphone. To remove the microphone unscrew in an anti-clockwise direction.

The microphone has a protection grid which can also be unscrewed and removed, great care must be taken to ensure that this is NOT removed. Underneath the protection grid is the microphone diaphragm which should never be touched or be subject to dust or dirt. Doing so may damage the microphone beyond repair or affect its acoustic response.

Pre-Amplifier Removal and Fitting

Models GA116L, GA116E, GA116I & GA216L-P

To attach the pre-amplifier, position the orientation key on the pre-amplifier which is identified with a RED mark, with the RED identification mark on the instrument and gently push the pre-amplifier into the connector. To remove, gently pull the pre-amplifier stem away from the instrument body. **DO NOT TWIST THE MICROPHONE STEM**.

Microphone Extension Cable (Models GA116L, GA116E & GA216L)

To attach the microphone extension cable, position the orientation key on the extension cable connector which is identified with a RED mark, with the RED identification mark on the instrument and gently push the extension cable into the connector on the instrument. To fit the pre-amplifier to the extension cable see **Attaching & Removing the Pre-Amplifier** above.

To remove, gently pull the extension cable connector by pulling on the knurled part of the stem. **DO NOT TWIST THE MICROPHONE STEM**.

Chapter 3

Measuring Sound

Always calibrate your instrument prior to, and after taking measurements using a known sound source such as the Castle GA607 sound level calibrator. The type of microphone supplied with your instrument is **Free Field** and requires an incidence angle of 0°, therefore whilst measuring always point your Sonus Pocket Meter directly towards the noise source being measured.

Sound Level – General Advice

In some environments, high levels of noise can occur. The Castle Sonus Pocket sound meter has therefore been designed for complete accuracy up to sound levels of 140dB.

Before you record measurements take the time to ensure you have chosen the optimum range for the process to be recorded. Wherever possible, the optimum range is when the average measured signal is approximately half way between the top of the range and the bottom of the range without an overload condition.

Where high levels of noise are encountered the meter may register an overload and in these circumstances the meter will display that this has occurred, it is therefore advisable to determine if an Over Load occurs on the selected range. In such cases you will need to select a higher range to accommodate the higher peak levels. See **Technical Specifications** for peak range limits on each individual range.

If the noise levels are too low for the range selected then the meter will display an under range condition. Under these circumstances you will need to select a lower range.

For more detailed information see **Overload and Under Range Conditions** and **Measuring Ranges**.

If measuring low level noise then be aware of the inherent noise levels caused by a combination of thermal and electrical noise from both the microphone and the sound level meter. Measuring data that lies within 10dB of the lowest quoted level on the lowest measuring range may be influenced by the self noise of the system. See **Technical Specifications** for inherent noise levels and range limits.

Reflections

The sound level meter operator and the sound level meter itself can interfere with the measurements being made, reflecting the noise signal. The instrument case for the Sonus range of sound level meters has therefore been designed to minimize reflections whilst also being of rugged construction.

To minimize reflections from the operator hold the sound level meter at arm's length, mount the sound meter on a suitable tripod (adapter required) or use a microphone extension cable (if applicable).

Time Weighting

The time weighting is a time constant that modifies the response of the instrument to fluctuating noise levels. Without time weighting the meter display would fluctuate following the measured noise level and would be unreadable, the selected time weighting therefore softens these fluctuations over the time periods described below and in doing so the meter has a more readable display.

Depending on your instrument type (see **Technical Specifications** for further details), the following standardised time weightings are available: -

Slow Weighting

Shows a slow rise in the Sound Pressure Level even for a sharp rise in the noise level, likewise a rapid reduction in noise will be shown as a slow decrease in Sound Pressure Level. The rise and fall times applied for Slow Weighting are 1 second.

Fast Weighting

The most commonly used time weighting which follows the noise level closer than slow weighting by displaying a fast rise and fall in the Sound Pressure Level. The rise and fall times applied for Fast Weighting are 125m Seconds.

Impulse Weighting – (Models GA116E, GA116L & GA216L Only)

Allows your meter to show rapid rises in the noise level but has a very slow decay. The rise and fall times for Impulse Weighting are 35m Seconds and 1.5 Seconds respectively.

Frequency Weighting Filters

Frequency Weightings are where the Sound Pressure Level (SPL) is modified by use of filtering. All Sonus Pocket Meters use electronic frequency weighting filters between the standardised frequencies of 10Hz and 20,000Hz. Depending on your instrument type (see **Technical Specifications** for further details), the following standardised frequency weightings are available: -

'A' Weighting

The SPL is filtered in such a manner as to reflect the hearing response of a human ear. The signal is progressively attenuated at the higher and lower ends of the audible frequency range but much more attenuation occurs at the lower end of the audible frequency range. Generally this is the most commonly used frequency weighting.

'C' Weighting

The signal is progressively attenuated at the higher and lower ends of the audible frequency range, however the attenuation at the lower end is much less than with A Weighting. The response has a flat area between 200Hz and 1250Hz and has -3dB points at 31.5Hz and 8kHz. It is generally used for the acoustic emissions of machinery and for peak sound levels.

'Z' Weighting (Zero) – (Models 'E' & 'L' Only)

Often referred to as the FLAT or LIN response, this weighting has a virtually flat response over the entire audible frequency range.

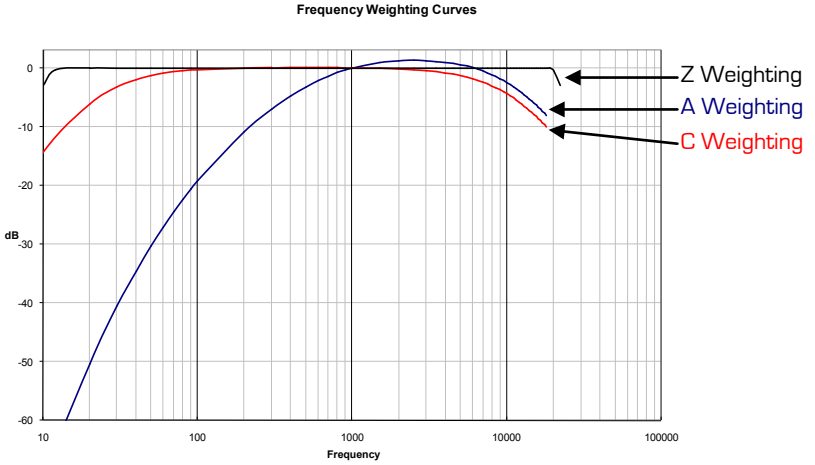


Figure 1 – Frequency Weighting Curves

Overload and Under Range Conditions

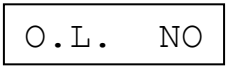
Overload Condition

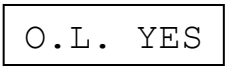
An overload condition occurs when the peak signal starts to exceed the signal handling capability of the pre-amplifier circuitry. If the noise source exceeds the linear operating range of the range selected by 0.5dB then an overload condition occurs and an overload indicator is displayed on your meter.

At 1kHz the overload condition occurs at 0.5dB above the top of each range for all frequency weightings. The overload indicator will flash for a minimum of one second or while the overload condition remains.

In such circumstances it is highly recommended you change to a higher range with a lower sensitivity (i.e. less gain) as your meter will be out of specification. An overload indication can occur in both Stop or Record Mode on 'L' and 'E' models and only in Record Mode for models 'I' and 'B'.

All models have an overload latch indicator which can be viewed by scrolling through the available parameters. Depending on whether an overload has occurred or not, the overload latch screen will display either off the following: -





On models 'I' and 'B' if an overload has been latched it can be removed in Stop Mode or Record Mode by resetting the parameters.

On models 'L' and 'E' instruments a latched overload can be removed in Stop Mode by resetting parameters and if in Record Mode it is automatically removed when the recording has been stopped.

Please be aware that the selected frequency weighting may attenuate the displayed signal level below the overload triggering point but an overload can still occur. This is because the overload operates from the unweighted input signal.

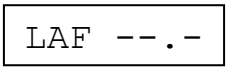
Note: In most case, if you see an overload indication on your sound meter, you should discard the measurements taken, select a higher range and re-take the measurements.

Under Range Condition

An under range condition occurs when the noise source is more than 0.1dB below the bottom of the range selected, at which point an under range indicator will flash on the display of your meter. In such circumstances it is highly recommended to change to a higher range with a higher sensitivity (i.e. more gain) as your meter will be out of specification.

The under range indicator will flash for a minimum of one second or while the under range condition remains.

Where the noise source is more than 0.5dB below the bottom of the selected range, no value or under range warning is displayed.



Note: Under range displayed on your meter indicates that you should discard the measurements, select a lower range and re-take your measurements.

Measuring Ranges

The Sonus instrument range has been specifically designed to utilise only three measuring ranges. The three available ranges ensure complete accuracy throughout the entire dynamic range whilst ensuring the instrument remains low power to maximise operational life from one 9V (PP3) battery.

The measuring display ranges available are as follows: -

Model 116L (dB)	Model 216L (dB)	Model 116E (dB)	Models I & B (dB)
30 – 100	35 – 100	20 – 90	35 – 100
50 – 120	50 – 120	40 – 110	55 – 120
70 – 140	70 – 140	60 – 130	75 – 140

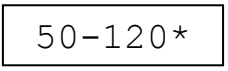
Please note that the GA257L and GA257B Dose meter models operate on the fixed range 70–140 dB and 75–140 dB respectively.

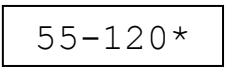
Changing Range – All models except GA257B and GA257L

To change the measuring range, press the 

key on the keypad.

The current measuring range will be shown and indicated with an asterisk *.





Use the **Up** and **Down** Arrow Keys 

to scroll through the available ranges.

Press the 

key to select the required range. The instrument briefly displays the following to confirm a change has been made and returns to the last parameter screen unless multiple screens have been accessed in which case the sound pressure level parameter screen will be displayed: -

Press the 

key to return to the previous screen without selection. If multiple screens have been accessed the sound pressure level parameter screen will be displayed.

Press the 

key to return to sound pressure level parameter screen without making a selection. Returning to the previous screen is also possible

Lock Keypad – GA257B and GA257L

The GA257B and GA257L instruments operate on a fixed range and therefore it is not possible to change the measuring range. The range key described on the previous page is therefore not needed on these models and is therefore fitted with a dedicated instrument Lock Key.

Press  to immediately place the instrument in Lock mode. The instrument will constantly display the battery status.

To UNLOCK the keypad press the following keys in the sequence shown below:-

It is also possible to LOCK the keypad on GA116L, GA216L, GA116E and GA116I models through the options available under the Main Menu. Use the same procedure as above to UNLOCK the keypad.

The LOCK feature is used to lock the instrument keypad. All keypad functions are therefore disabled including the POWER key. This function is often used to avoid inadvertent operation or tampering while the instrument is being used.

Chapter 4

Getting Started

All models of the Sonus range of instruments have two modes of operation referred to as: -

- Stop Mode
- Record Mode

Whilst the instrument is in Record Mode the noise activity is analysed and all parameters available on your instrument are calculated.

On 'L' and 'E' models only, all data captured can be saved to the internal flash memory and viewed or downloaded to Castle's noise analysis software **dBdataPro** as and when required.

Whilst the instrument is in Stop Mode, on 'I' and 'B' models noise activity is not monitored and parameter calculations are halted during this period. On 'L' and 'E' models calculations are displayed but not stored in flash memory.

Models I and B

During Stop Mode and whilst viewing parameter display screens, the display will flash between the parameter and the following: -

Models L and E

During Stop Mode and whilst viewing parameter display screens, the displayed parameter name will not blink: -

On all models when the meter is first switched on, the instrument defaults into Stop Mode.

To set the instrument into Record Mode press the  key located on your instruments keypad, see **Stop / Record Mode** in **Chapter 5** for more information.

To place the instrument back into Stop Mode press the  key again.

Changing the settings of your instrument and performing a calibration are all found under the **Main Menu**.

To activate the **Main Menu** press the MENU Key on your instruments keypad.

Use the **Up** and **Down** Arrow Keys ▲ ▼ to scroll through the available options.

Press the OK key to select the required menu option or press the C key to cancel and return to the parameter display screen.

Some options may also have further sub-menus where further options are available. Again use the **Up** and **Down** Arrow Keys to scroll through the available options.

The **Main Menu** is described in detail in **Chapter 5**.

Keypad Layout – GA116, GA216 All Models

Figure 2 – Keypad Layout (Sound Meter)

Keypad Layout – GA257L & GA257B

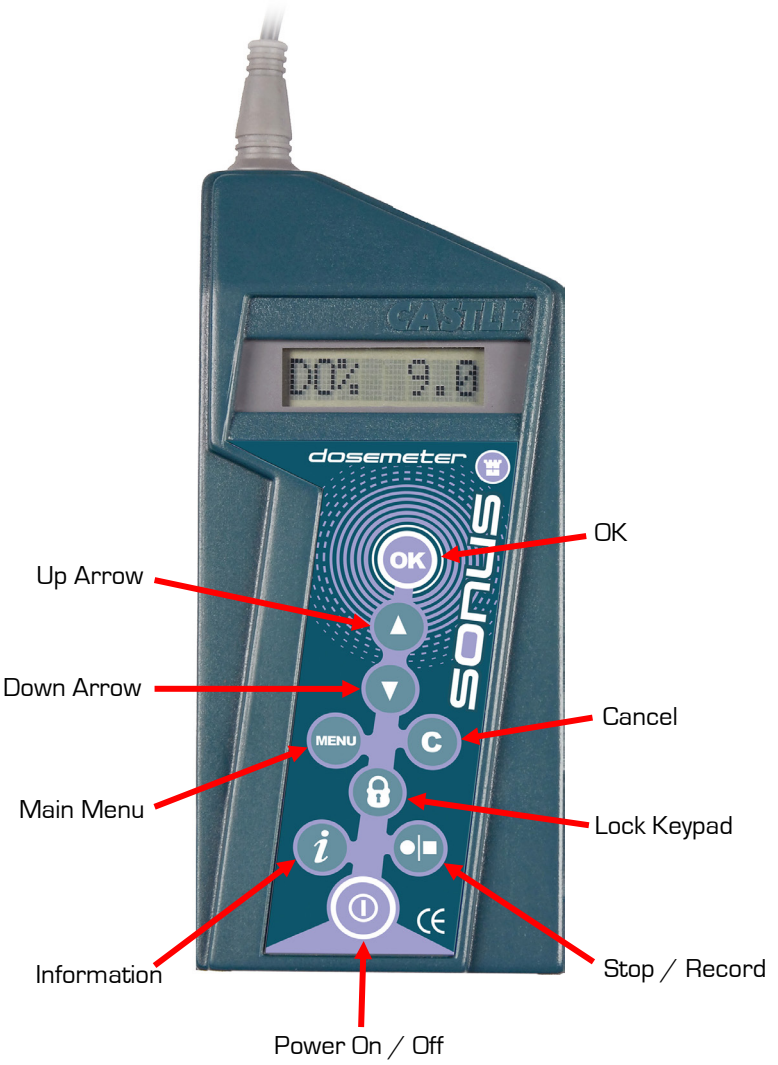


Figure 3 – Keypad Layout (Dose Meter)

Powering Your Sonus Meter

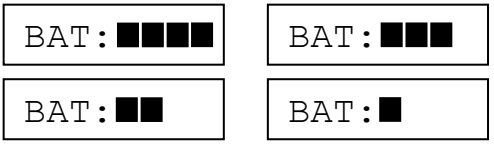
Your Sonus meter can be powered from either one 9V (PP3) battery and Models 'L' and 'E' instruments can also be powered using an external 12V DC Power Supply which can be purchased separately if required (PSU3:SONUS).

The battery compartment is located on the bottom left hand side of your instrument. Open the battery door by sliding the cover downwards towards the bottom of the instrument. The cover will now swing open exposing the battery compartment. Insert the battery observing the correct polarity as marked on the case wall inside the battery compartment.

To achieve a greater battery life from your instrument, it is strongly recommended you use alkaline type batteries.

To power the instrument via the Castle DC Power Supply (purchased separately), plug your Power Adapter Cable into the 9 pin Lemo connector located at the right side of the instrument. Ensure the red dots are aligned before insertion. Insert the DC power supply into the DC socket on the adapter cable. Ensure the DC power supply is plugged into a mains socket and switch on power to the socket.

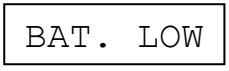
Your Sonus meter is equipped with a four stage battery level indicator; this is displayed during the power up sequence and can also be viewed using the information key.



A series of four bars indicates that the battery is fully charged whilst only one bar indicates the battery is almost flat.

It is strongly recommended that if the instrument is displarying only one bar that the battery is replaced as soon as possible.

When the battery charge is too low for the instrument to operate the instrument will flash the following message: -



All meters will shut down and Models 'L' and 'E' instruments will automatically save any data if the instrument is in **Record Mode**.

Switching Your Sonus Meter On/Off

To turn on your instrument press and hold the Power On/Off key  for approximately one second.

Your meter will display the start-up screen and initialise any saved settings.

Once the start-up sequence is complete the instrument is placed in **Stop Mode** and the parameter sound pressure level is displayed.

It is recommended that you calibrate your instrument before use, see the heading **Calibration** in **Chapter 4** for detailed information on calibration of your specific model of instrument.

Press and release the Power On/Off key  at any time to turn off Model 'I' or 'B' instruments.

Models 'I' and 'B' will now power down.

Model 'L' and 'E' instruments display the following:-

```
INS OFF?
```

Press the  key to confirm or the  key to cancel and return to the previous screen.

Please be aware that on Model 'L' & 'E' instruments, the Power On/Off key  is disabled whilst the instrument is in **Record Mode** or if the instrument is **Locked**.

On the GA116I and GA257B instruments the Power On/Off key  is disabled if the instrument is **Locked**.

To preserve instrument settings and saved data always turn your instrument off using the Power On/Off Key.

On model 'I' and 'B' instruments please ensure that all required readings have been taken from the instrument before turning off the instrument as all data is lost when the instrument is powered off.

Chapter 5

Main Menu Navigation

The **Main Menu** is activated by pressing the **MENU** Key 

once.

Pressing the 

Key again will return the instrument to the last parameter display screen unless multiple screens have been accessed in which case the sound pressure level parameter screen will be displayed.

Pressing the 

Key always returns to the sound pressure level parameter screen unless sub menus are open in which case refer to the specific function in the user manual to determine its action.

Use the **Up** and **Down** Arrow Keys 
to scroll through the available options.

Press the 

key to select the required menu option.

Some options may also have further sub-menus where further options are available. Again use the ▲ ▼Arrow Keys to scroll through the available options and use the **OK** key to accept.

Depending on your instrument model, the following Menu options are available: -

Display	Description	Instrument
CAL <OK	Calibrate Instrument	ALL
ET <OK	Set Exposure Time	GA116I/GA216I/GA257B
WTG <OK	Set Frequency & Time Weightings	GA116I/GA116B
EXCH <OK	Set Exchange Rate	GA116I/GA257B
CRIT <OK	Set Criterion Level	GA116I/GA257B
THR <OK	Set Threshold Level	GA116I/GA257B
LOCK <OK	Lock Instrument Keypad	GA116I
CONT <OK	Adjust Display Contrast	ALL

Calibration [CAL <OK]

It is recommended that the instrument's calibration is checked and adjusted where necessary with a calibrator before readings being taken. The calibration should be re-checked after taking readings to confirm the validity of the results.

The calibrators recommended for use are the Castle GA601/GA607, which supply typically 94dB/ 104dB (relative to 20µPa pressure) at a frequency of 1kHz.

Press (i) to check the battery condition, scroll to the battery indicator screen using the ▲▼ arrow keys if required. Replace the battery if the indication is low.

In the **MENU** display screen use the ▲▼ arrow keys as required until the following is displayed: -

Press (OK) and the instrument will now display the previous calibration level e.g. >94.0.

The calibration will be performed at the selected level e.g. 94.0dB but may be changed in 0.1 or 1 dB steps using the following keys: -

Key	Calibration Level Adjustment (dB)
▲	+0.1
▼	-0.1
i	-1.0
●/■	+1.0

Ensure the calibrator is attached to the microphone by gently inserting the microphone into the cavity of the calibrator. A certain amount of resistance should be felt whilst inserting the microphone as the o-ring seal on the calibrator forms a seal around the microphone.

Ensure that the calibrator is switched on and set to the chosen level and all correction factors for atmospheric pressure and microphone type have been accounted for.

The pressure to free-field correction value to be applied when used with a Castle calibrator GA601, GA607, or a B&K4231 is as follows:

Calibrator	Correction (dB)
Castle GA607	-0.2
Castle GA601	-0.2
B&K4231	-0.2

Press (OK) and the instrument will calibrate to the level of the calibrator. The display will show **CAL WAIT** while calibrating to the chosen level. When calibrated the display will show **COMPLETE** and will return to the Sound Pressure Level display.

It is recommended that the unit is then placed into **STOP** mode and data is cleared. The instrument is now ready to take measurements.

If the calibration is interrupted or the input level is not within +/- 3dB of the chosen reference level then the display will show **CAL FAIL**.

An error message of **NO INPUT** is shown if the input level is lower than approximately 70dB.

Check to make sure the calibrator is switched on and emitting the correct level before proceeding again as indicated above.

Exposure Time [ET <OK]

It is possible to select alternative exposures of an employee in hours and minutes. Exposure Time is used in the calculation of Lep,d. If a value of 00:00:00 is entered for ET then the Measurement Run Time period is used in the calculation instead. See **Function Equations** in **Chapter 11**.

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

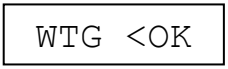
Press (OK) and the instrument will now display the currently selected exposure time in hours. Use the ▲/▼ arrow keys to alter this figure between 00 and 24.

Press (OK) again and the instrument will display the currently selected number of minutes. Use the ▲/▼ arrow keys to alter this figure between 00 and 59.

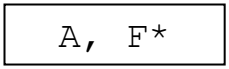
Press (OK) to confirm the changes and return to the Sound Pressure Level display screen.

Frequency / Time Weighting [WTG <OK]

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -



Press (OK) and the instrument will display the currently selected Frequency and Time Weighting, indicated with an asterisk *.



Scroll through the available options using the ▲ ▼ arrow keys: -

Display	Description
A, S	'A' Frequency Weighting, Slow Time Weighting
A, F	'A' Frequency Weighting, Fast Time Weighting
C, F	'C' Frequency Weighting, Fast Time Weighting
C, S	'C' Frequency Weighting, Slow Time Weighting

Press (OK) to confirm or (C) to cancel and return to the Sound Pressure Level display screen.

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press (OK) and the instrument will display the currently selected Exchange Rate, indicated with an asterisk *.

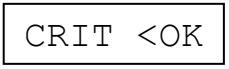
Scroll through the available options using the ▲▼arrow keys: -

Display
3dB
4dB
5dB

Press (OK) to confirm or (C) to cancel and return to the Sound Pressure Level display screen.

Criterion [CRIT <OK]

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -



Press (OK) and the instrument will display the currently selected Criterion Level, indicated with an asterisk *.

Scroll through the available options using the ▲▼arrow keys: -

Display
80dB
85dB
90dB

Press (OK) to confirm or (C) to cancel and return to the Sound Pressure Level display screen.

Threshold [THR <OK]

It is possible to select a threshold level for the lower limit of noise levels which are used to measure dose.

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

```
THR <OK
```

Press (OK) and the instrument will display the currently selected Threshold Level, indicated with an asterisk *.

```
-10dB *
```

Scroll through the available options using the ▲▼arrow keys: -

Display
-10dB
-5dB
OFF

Press (OK) to confirm or (C) to cancel and return to the Sound Pressure Level display screen.

Keypad Lock [LOCK <OK]

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

```
LOCK <OK
```

Press (OK) to confirm, the instrument is placed in Lock mode and the instrument displays the battery status.

To UNLOCK the keypad press the following keys in the sequence shown below:-

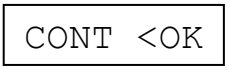
(C) (OK) (i)

The LOCK feature is used to lock the instrument keypad. All keypad functions are therefore disabled including the POWER key. The function is often used to avoid inadvertent operation or tampering while the instrument is being used.

Display Contrast [CONT <OK]

Select to adjust the contrast level of your instrument.

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -



Press (OK) and the instrument will display the following or (C) to cancel and return to the Sound Pressure Level display screen: -

Use the ▲▼arrow keys to adjust the contrast as required.

Press (OK) to confirm a change and the instrument will briefly display: -

Or press (C) to cancel and return to the Sound Pressure Level display screen.

Display	Description	Instrument
CAL	Calibrate Instrument	ALL
SETUP	Change Instrument Settings	ALL
MODE	Set Operating User Mode	GA116L/GA216L
LOGS	View Saved Log	ALL
DELETE	Delete Saved Log	ALL
DEFAULTS	Reset to Default Settings	ALL
LOCK	Lock Instrument Keypad	GA116L/GA216L/GA116E

Calibration [CAL]

It is recommended that the instrument's calibration is checked and adjusted where necessary with a calibrator before readings being taken. The calibration should be re-checked after taking readings to confirm the validity of the results.

The calibrators recommended for use are the Castle GA601/GA607, which supply typically 94dB/ 104dB (relative to 20µPa pressure) at a frequency of 1kHz.

Press (i) to check the battery condition, scroll to the battery indicator screen using the ▲▼arrow keys if required. Replace the battery if the indication is low.

In the menu display screen use the ▲▼arrow keys as required until the following is displayed: -

Press (OK) and the instrument will now display the previous calibration level e.g. 94.0.

The calibration will be performed at the selected level e.g. 94.0dB but may be changed in 0.1 or 1 dB steps using the following keys: -

Key	Calibration Level Adjustment (dB)
▲	+0.1
▼	-0.1
i	-1.0
●/■	+1.0

Ensure the calibrator is attached to the microphone by gently inserting the microphone into the cavity of the calibrator. A certain amount of resistance should be felt whilst inserting the microphone as the o-ring seal on the calibrator forms a seal around the microphone.

Ensure that the calibrator is switched on and set to the chosen level and all correction factors for atmospheric pressure and microphone type have been accounted for.

The pressure to free-field correction value to be applied when used with a Castle calibrator GA601, GA607, or a B&K4231 is as follows:

Calibrator	Correction (dB)
Castle GA607	-0.2
Castle GA601	-0.2
B&K4231	-0.2

Press (OK) and the instrument will calibrate to the level of the calibrator. The instrument will countdown from five seconds and the display will show: -

When calibrated the display will show **DONE** and will return to the Sound Pressure Level display.

The instrument is now ready to take measurements.

If the calibration is interrupted or the input level is not within +/- 3dB of the chosen reference level then the display will show **CAL FAIL**.

An error message of **NO INPUT** is shown if the input level is lower than or greater than 3dB.

Check to make sure the calibrator is switched on and emitting the correct level before proceeding again as indicated above.

In the menu display screen use the ▲▼arrow keys as required until the following is displayed: -

Press (OK) to enter the **SETUP** sub menu page.

Depending on your instrument model, the following **Setup** options are available: -

Instruments GA116L, GA216L, GA116E, GA257L

Display	Description	Instrument
FREQ WGT	Set Frequency Weighting	ALL (Mode Dependent*)
TIME WGT	Set Time Weighting	ALL (Mode Dependent*)
INTERVAL	Set Interval Period	ALL
CONTRAST	Set Display Contrast	ALL
USER Ln	Set Percentile Level	GA116L, GA216L, GA116E
CRIT	Set Criterion Level	GA116L, GA257L
THR	Set Threshold Level	GA116L, GA257L
EXCH	Set Exchange Rate	GA116L, GA257L
TIMER	Set Timer Function	ALL
DATE	Set Real Time Date	ALL
TIME	Set Real Time Clock	ALL

*See **User Mode** for further details.

Om model 'L' instruments the frequency weighting of the instrument can only be changed if the instrument has the User Mode set to ALL. See **User Mode** for further details.

Channel 1 is always ON and fixed to 'A' Weighting.

Channel 2 can either be 'A', 'C' or 'Z' weighted and can be switched OFF either by User Mode selection or selecting only 'A' weighting.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

```
FREQ WGT
```

Press (OK) and the instrument will display the currently selected Frequency Weighting, indicated with an asterisk *.

```
A, C*
```

Scroll through the available options using the ▲ ▼ arrow keys: -

Display	Description
A	Channel 1 = 'A' Frequency Weighting
A, A	Channel 1 = 'A' Frequency Weighting Channel 2 = 'A' Frequency Weighting
A, C	Channel 1 = 'A' Frequency Weighting Channel 2 = 'C' Frequency Weighting
A, Z	Channel 1 = 'A' Frequency Weighting Channel 2 = 'Z' (LIN) Frequency Weighting

Press (OK) to confirm a change and the instrument will briefly display: -

```
DONE
```

Or press (C) to cancel and return to the Sound Pressure Level display screen.

If the frequency weighting is selected for Channel 'A' only then Channel 2 is OFF. No parameters will be available, displayed or recorded for Channel 2.

On Model 'L' instruments the time weighting of the instrument can only be changed if the instrument has the User Mode set to ALL. See **User Mode** for further details.

Channel 1 is always ON and can be either Slow, Fast or Impulse time weighted.

Channel 2 can also independently be either Slow, Fast or Impulse time weighted and can be switched OFF either by User Mode selection or selecting only 'A' frequency weighting on channel 1.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

```
TIME WGT
```

Press (OK) and the instrument will display the currently selected Time Weighting, indicated with an asterisk *.

```
F, S*
```

Scroll through the available options using the ▲ ▼ arrow keys: -

Display	Description
F, F	Channel 1 = FAST Time Weighting Channel 2 = FAST Time Weighting
S, F	Channel 1 = SLOW Time Weighting Channel 2 = FAST Time Weighting
I, F	Channel 1 = IMPULSE Time Weighting Channel 2 = FAST Time Weighting
F, S	Channel 1 = FAST Time Weighting Channel 2 = SLOW Time Weighting
S, S	Channel 1 = SLOW Time Weighting Channel 2 = SLOW Time Weighting
I, S	Channel 1 = IMPULSE Time Weighting Channel 2 = SLOW Time Weighting
F, I	Channel 1 = FAST Time Weighting Channel 2 = IMPULSE Time Weighting
S, I	Channel 1 = SLOW Time Weighting Channel 2 = IMPULSE Time Weighting
I, I	Channel 1 = FAST Time Weighting Channel 2 = IMPULSE Time Weighting

If only Channel 1 is selected then only the following Time Weighting options will be available: -

Display	Description
F	Channel 1 = FAST Time Weighting
S	Channel 1 = SLOW Time Weighting
I	Channel 1 = IMPULSE Time Weighting

Press (OK) to confirm a change and the instrument will briefly display: -

DONE

Or press (C) to cancel and return to the Sound Pressure Level display screen.

For more information on Time Weighting see **Time Weighting** in **Chapter 2**.

If an interval period is selected then the instrument will record data at each interval period selected from the log start time.

Example:-

If a log interval of 1 second is selected and the start time of the log is 10:00:00 then the instrument will log data at 1 second interval periods from the start time: -

10:00:01
10:00:02
10:00:03 etc until the recording is stopped.

Approximately 2100 interval periods can be recorded on your instrument before the internal flash memory is full. Always ensure the interval period is set accordingly such that the total recording period is suitable.

Example:-

To record over a period of 10 hours:-

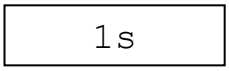
Convert period length to minutes (10h * 60m) = 600m
Convert period length to seconds (600m * 60s) = 36000s
Min Interval Period (36000 / 2100) = 17.14s

The nearest available selection above an interval period of 17.14 seconds would therefore be chosen i.e. 1 minute (5 minutes on GA257L).

The above calculation is based on an instrument with no logs stored in the internal flash memory. If logs are already stored on the instrument then these would need to be taken into account before using the calculation. See **Chapter 5** for more information.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press OK and the instrument will display the currently selected Interval Period, indicated with an asterisk *.



Scroll through the available Interval Periods using the ▲▼arrow keys: -

Display	Description
OFF	Intervals OFF – Cumulative Data Only
1s	1 second interval period *
10s	10 second interval period *
1m	1 minute interval period *
5m	5 minute interval period
10m	10 minute interval period
15m	15 minute interval period
30m	30 minute interval period
60m	1 hour interval period
8hr	8 hour interval period
12hr	12 hour interval period

* Not available on instrument GA257L

If an interval period is not required select OFF. Only cumulative data will then be displayed / recorded.

Press (OK) to confirm a change and the instrument will briefly display: -

DONE

Or press (C) to cancel and return to the Sound Pressure Level display screen.

Select to adjust the contrast level of your instrument. The selected contrast level is remembered on model 'L' and 'E' instruments.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press OK and the instrument will display the following or C to cancel and return to the Sound Pressure Level display screen: -

Use the ▲▼arrow keys to adjust the contrast as required.

Press OK to confirm a change and the instrument will briefly display: -

Or press C to cancel and return to the Sound Pressure Level display screen.

Model 'L' and 'E' instruments have one user selectable percentile level and two fixed percentile levels. Percentile is commonly abbreviated to Ln where n denotes the actual dB (A Weighted) level exceeded n% of the time, example L99.

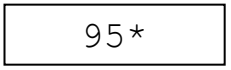
On model 'L' instruments percentiles are only available if the User Mode is set to ALL or ENV. See **User Mode** for further information.

Fixed percentile levels are:-

- L10
- L90

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press (OK) and the instrument will display the currently selected User Ln indicated with an asterisk *.



Scroll through the available User Selectable Percentiles using the ▲ ▼ arrow keys: -

Display	Description
1	L1 – dB(A) Level exceeded 1% of the time
5	L5 – dB(A) Level exceeded 5% of the time
50	L50 – dB(A) Level exceeded 50% of the time
95	L95 – dB(A) Level exceeded 95% of the time
99	L99 – dB(A) Level exceeded 99% of the time

Press (OK) to confirm a change and the instrument will briefly display: -

Or press (C) to cancel and return to the Sound Pressure Level display screen.

Percentile levels can only be accurately calculated after a given period governed by various factors, they are therefore only shown for recordings greater than 5 minutes.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press (OK) and the instrument will display the currently selected Criterion Level, indicated with an asterisk *.

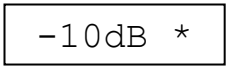
Scroll through the available options using the ▲ ▼ arrow keys: -

Display
75dB
80dB
85dB
90dB

Press (OK) to confirm or (C) to cancel and return to the Sound Pressure Level display screen.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press (OK) and the instrument will display the currently selected Threshold Level, indicated with an asterisk *.



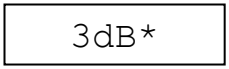
Scroll through the available options using the ▲▼arrow keys: -

Display
-10dB
-5dB
OFF

Press (OK) to confirm or (C) to cancel and return to the Sound Pressure Level display screen.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press OK and the instrument will display the currently selected Exchange Rate, indicated with an asterisk *.



Scroll through the available options using the ▲ ▼ arrow keys: -

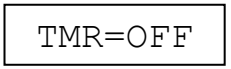
Display
3dB
4dB
5dB

Press OK to confirm or C to cancel and return to the Sound Pressure Level display screen.

The Record Timer is a user selectable time that will govern the recording length after a recording has started. For example if the Record Timer is set to 00:01:00 (hh:mm:ss) then the instrument will automatically end the recording after a period of 1 minute.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press (OK) and the instrument will display: -

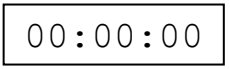


Scroll through the available options using the ▲▼arrow keys: -

Display	Description
TMR=OFF	Record Timer OFF
TMR=ON	Record Timer ON

Press (OK) to confirm your selection or (C) to cancel.

If **TMR=ON** is selected then the following time entry screen is displayed using the following 24 hour format (hh:mm:ss): -



The adjustable figure flashes, this always starts with the **HOUR** figure.

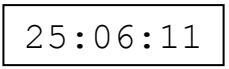
Use the ▲▼arrow keys as required until the desired hour figure is displayed.

Press (OK) to confirm your selection and proceed to **MINUTES** and then **SECONDS** using the same procedure.

Press (C) to cancel changes and return to the SETUP screen.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press (OK) and the instrument will display the following date entry screen using the following format (dd:mm:yy): -



The adjustable figure flashes, this always starts with the **DAY** figure.

Use the ▲▼arrow keys as required until the desired **DAY** figure is displayed.

Press (OK) to confirm your selection and proceed to **MONTH** and then **YEAR** using the same procedure.

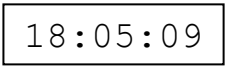
Press (C) to cancel changes and return to the SETUP screen.

If an invalid date is entered the following will be briefly displayed: -

The date entry screen will then be displayed again and a correct date must be entered.

In the **SETUP** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press (OK) and the instrument will display the following time entry screen using the following 24 hour format (hh:mm:ss): -



The adjustable figure flashes, this always starts with the **HOUR** figure.

Use the ▲▼arrow keys as required until the desired **HOUR** figure is displayed.

Press (OK) to confirm your selection and proceed to **MINUTES** and then **SECONDS** using the same procedure.

Press (C) to cancel changes and return to the SETUP screen.

The option to set a User Mode is only available on GA116L and GA216L instruments.

Selecting a User Mode is a quick and straightforward way to correctly set your instrument up for taking measurements. Parameters are only displayed and recorded where required.

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press OK and the instrument will display the currently selected User Mode, indicated with an asterisk *.

Scroll through the available options using the ▲▼arrow keys: -

Display	Description
ALL	Select MODE = ALL
N@W	Select MODE = Noise At Work
ENV	Select MODE = Environmental

Press OK to confirm a change and the instrument will briefly display: -

Or press C to cancel and return to the Sound Pressure Level display screen.

Selecting a User Mode sets the instrument as follows:-

Mode	Description
ALL	Freq Weighting=A, C Time Weighting=Fast, Fast Percentiles=ON
N@W	Freq Weighting=A, C Time Weighting=Fast, Fast Percentiles=OFF
ENV	Freq Weighting=A, C Time Weighting=Fast, Fast Percentiles=ON

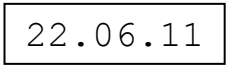
See **Parameters – Chapter 6** for further information on viewable and recorded parameters based on the selected User Mode.

Select this option to view saved logs on your instruments display. Only cumulative information is available to view on the instrument, if you wish to view this and recorded interval data then download the data via a USB port into the supplied software dBdataPro-LITE or dBdataPro if registered.

Logs are sorted by date and time, first select the date the recording was made and then select the time using the following procedure: -

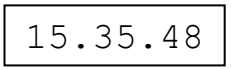
In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed (If no logs are available this option is not shown): -

Press (OK) and the instrument will display the currently saved logs in date order.



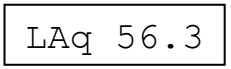
Scroll through the available dates using the ▲▼arrow keys.

Press (C) to exit without selection or (OK) to confirm the selection, the instrument will then display the currently saved logs by time recorded: -



Scroll through the available times using the ▲▼arrow keys.

Press (C) to exit without selection and return to the date list or (OK) to confirm the selection, the instrument will then view the saved cumulative information for the log selected.



Every 5 seconds the screen will flash the following display to remind the user that they are currently viewing a saved log: -

Scroll through the available data using the ▲▼arrow keys.

Press (C) to exit and return to the parameter display screen when required.

Logs saved with Exposure Time details calculate the displayed Lep,d figure using the Exposure Time value. The downloaded value of Lep,d is always based on the run time period (log length).

See also **Model 'L' & 'E' Instruments** under **Stop / Record Mode** of **Chapter 6** and also **Function Equations** of **Chapter 11**.

This option is only available if the instrument has saved logs.

Take extreme caution when deleting logs as they cannot be recovered.

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press (OK) and the instrument will display the following: -

Scroll through the available options using the ▲▼arrow keys: -

Mode	Description
ONE LOG	Delete Individual Saved Logs
ALL LOGS	Delete ALL Saved Logs

Press (OK) to confirm or (C) to cancel and return to the parameter display screen.

If **ONE LOG** is selected then the available logs are sorted by date and time, first select the date the recording was made and then select the time using the following procedure: -

Scroll through the available dates using the ▲▼arrow keys: -

Press (C) to exit and return to previous screen without selection or (OK) to confirm the selection, the instrument will then display the currently saved logs by time recorded: -

Scroll through the available times using the ▲▼arrow keys.

Press (C) to exit without selection and return to the date list or (OK) to confirm the selection.

For either ONE LOG or ALL LOGS the following is displayed: -

Press (OK) to confirm or (C) to cancel to select a different log.

When deleted, the instrument will return to the parameter display screen.

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

```
DEFAULTS
```

Press (OK) and the instrument displays the followings: -

```
CONFIRM?
```

Press (OK) to confirm or (C) to cancel and return to the parameter display screen.

Default settings are as follows (where applicable): -

Description	Default Setting
Operating Range	50-120 (Model L) 40-110 (Model E)
User Mode	ALL
Frequency Weighting	CH1 = A, CH2 = C
Time Weighting	CH1 = F, CH2 = F
Calibration Level	94.0
Recording Interval Period	OFF
User Percentile	95
Criterion	85
Threshold	-10
Exchange	3
Record Timer	OFF

In the **MENU** display screen use the ▲ ▼ arrow keys as required until the following is displayed: -

Press (OK) and the following is displayed: -

Press (OK) to confirm, the instrument is placed in Lock mode and the instrument displays the battery status.

Alternatively press or (C) to cancel and return to the parameter display screen.

To UNLOCK the keypad press the following keys in the sequence shown below:-

(C) (OK) (i)

The LOCK feature is used to lock the instrument keypad. All keypad functions are therefore disabled including the POWER key. The function is often used to avoid inadvertent operation or tampering while the instrument is being used.

Chapter 6

Stop / Record Mode

All models of the Sonus range of instruments have two modes of operation referred to as: -

- Stop Mode
- Record Mode

Whilst the instrument is in **Record** mode the noise activity is analysed and all parameters available on your instrument are calculated.

On 'L' models only, all data captured can be saved to the internal flash memory and viewed or downloaded to Castle's noise analysis software **dBdataPro** as and when required.

All instruments start in **Stop** mode. Whilst the instrument is in **Stop** mode, on 'I' and 'B' models noise activity is not monitored and parameter calculations are halted during this period. On 'L' and 'E' models calculations are displayed but not stored in flash memory.

Model 'I' & 'B' Instruments

Whilst in **Stop** mode the meter will flash between the current parameter and the following: -

To enter **Record** mode press the **STOP** / **RECORD** Key  on your instruments keypad and the following is briefly displayed: -

During **Record** mode the noise activity is analysed and all parameters available on your instrument are calculated.

All functions can be held so that they do not update by pressing the  key again. The meter is now again in **STOP** mode.

In **STOP** mode the display may be read as normal, allowing the user to take note of any required readings.

Toggle operation using the  key as required.

Always RESET data before **Record** mode is entered. See **Reset Data** for more information.

On 'L' & 'E' model instruments whilst in **Stop** mode only the parameter name and value are displayed.

To enter **Record** mode press the **STOP / RECORD** Key  on your instruments keypad and the following is briefly displayed: -

```
REC MODE
```

Data is automatically reset when a recording begins. During **Record** mode the noise activity is analysed and all parameters available on your instrument are calculated using the settings made under **SETUP**. To record data for periods greater than 24 hours an interval period must be selected. To identify you are currently in **Record** mode the parameter name flashes.

To stop the recording and enter **Stop** mode, press the  key again. The following screen is then displayed: -

```
SAVE YES
```

Scroll through the available options using the ▲▼arrow keys: -

Display	Description
SAVE YES	Save the current log
SAVE NO	Do NOT save the current log

Press  to confirm or  to cancel and return to the previous screen.

On 'E' models and if the instrument is set to **User Mode = ENV** on 'L' models then the log is automatically saved otherwise the following will be displayed: -

Display	Description
8Hr ET	Set Exposure Time period to 8 Hours
ENTER ET	Enter an Exposure Time period
NO ET	Use Measurement Run Time period (Log Length)

Exposure Time entry uses the following 24 hour format (hh:mm:ss) and the adjustable figure flashes, this always starts with the **HOUR** figure.

Use the ▲▼arrow keys until the desired **HOUR** figure is displayed. Use  to confirm your selection and proceed to **MINUTES** and then **SECONDS** using the same procedure. Exposure Time entry must be greater than the Measurement Time and the following will be shown is such cases: -

```
ET < MT!
```

The Exposure Time is used in the Lep,d and Dose calculation. If NO ET is selected then the measurement run time period (log length) is used in the calculation instead. See **Function Equations** in **Chapter 11**.

All Models

On all instruments in either **Stop** or **Record** mode it is possible to quickly view information and settings of your instrument.

Press the (i) key once to access the information screen. Use the ▲ **or** ▼ arrow keys to scroll through the available list.

Pressing the (i) key again returns to the previous screen. If multiple screens have been accessed then the sound pressure level parameter screen will be displayed.

Pressing the (C) key will always return to the Sound Pressure parameter display.

The information listings are shown below: -

Model 'I' & 'B' Instruments – Information Screen

Display	Description	Instrument
BAT:■■■■	Battery capacity remaining	ALL
GA116I	Show Instrument Model	ALL
VER 1.03	Show Instrument Firmware Number	ALL
REC MODE or STOP	Indicates that the instrument is in either Record or Stop Mode	ALL
TH: -10dB	Shows the threshold setting (relative to the criterion level)	GA116I/GA257B
CRIT: 3	Shows the Criterion Level	GA116I/GA257B
EXCH: 85	Shows the Exchange Rate	GA116I/GA257B
ET 08:00	Shows the Exposure Time period (h:m)	GA116I/GA216I /GA257B
A, F	Show the Frequency and Time Weighting	ALL

Display	Description	Instrument
BAT ■■■■	Battery capacity remaining	ALL
MODE:ALL	Indicates the current User Mode	GA116L/GA216L
CH1: A,F	Show the Frequency and Time Weightings for Channel 1	ALL
CH2: C,S	Show the Frequency and Time Weightings for Channel 2 (Can be OFF and User Mode dependent)	ALL
CRIT: 85	Shows the Criterion Level (User Mode dependent)	ALL
EXCH: 3	Shows the Exchange Rate (User Mode dependent)	ALL
THR: -10	Shows the threshold setting (relative to the criterion level) (User Mode dependent)	ALL
L95	Show the User Selectable Percentile Level	GA116L/GA216L
INT:OFF	Show the Selected Recording Interval Period	ALL
TMR: OFF	Show if Record Timer is ON or OFF	ALL
MEM: 85%	Show available memory (%)	ALL
09:15:07	Show Current Time (hh:mm:ss)	ALL
01.06.10	Show Current Date (dd.mm.yy)	ALL
SN 67000	Show Instrument Serial Number	ALL
VER 1.01	Show Instrument Firmware Number	ALL
GA116L	Show Instrument Model	ALL
CAL07.11	Show Factory Calibration Due Date (mm.yy)	ALL

Display	Description
BAT ■■■■	Battery capacity remaining
CH1: A,F	Show the Frequency and Time Weightings for Channel 1
CH2: C,F	Show the Frequency and Time Weightings for Channel 2 (Can be OFF)
L95	Show the User Selectable Percentile Level
INT:OFF	Show the Selected Recording Interval Period
TMR: OFF	Show if Record Timer is ON or OFF
MEM: 85%	Show available memory (%)
09:15:07	Show Current Time (hh:mm:ss)
01.06.10	Show Current Date (dd.mm.yy)
SN 67000	Show Instrument Serial Number
VER 1.01	Show Instrument Firmware Number
GA116E	Show Instrument Model
CAL07.11	Show Factory Calibration Due Date (mm.yy)

Reset Data

On all instruments it is possible to manually reset all current parameter data and status flags.

When the instrument is first switched on all data is automatically reset.

Models 'I' & 'B'

Whilst in **Stop** or **Record** mode, press the C key to display the following: -

```
CONFIRM?
```

Press OK to confirm and reset data or C to cancel and return to the parameter display screen.

WARNING: Reset data values cannot be retrieved.

Models 'L' & 'E'

Data is automatically reset whenever **Record** mode is entered.

Whilst in **Stop** mode, press the C key to display the following: -

```
CONFIRM?
```

Press OK to confirm and reset data or C to cancel and return to the parameter display screen.

WARNING: Reset data values cannot be retrieved.

Chapter 7

Parameters

On all instruments whilst in **Stop** or **Record** mode it is possible to change the parameter display screen.

Scroll through the available parameter screens using the ▲▼arrow keys: -

Available Parameters - Models 'I' & 'B'

GA116I	GA216I
Sound Pressure	Sound Pressure
Leq	Leq
Max rms Level	Max rms Level
Peak Level	Peak Level
Elapsed Time	Elapsed Time
Lep,d	Lep,d
Sound Exposure	Sound Exposure
Dose	Overload Yes / No
Dose per Hour	
Pascal Squared Hours	
Overload Yes / No	

GA116B	GA216B	GA257B
Sound Pressure	Sound Pressure	Sound Pressure
Max rms Level	Max rms Level	Leq
Peak Level	Peak Level	Peak Level
Elapsed Time	Elapsed Time	Elapsed Time
Overload Yes / No	Overload Yes / No	Lep,d
		Dose
		Dose per Hour
		Pascal Squared Hours
		Overload Yes / No

The table below is a breakdown of all the possible display parameters with a brief description. Please see the previous tables to determine which parameters your instrument displays.

Display	Description
LAF 93.7	Frequency and Time Weighted Sound Pressure Level. LAF = A Weighted, Fast LCF = C Weighted, Fast LAS = A Weighted, Slow LCS = C Weighted, Slow
LAq 93.7	Displays the Frequency Weighted Leq LAq = A Weighted Leq LCq = C Weighted Leq
Amx 97.3	Maximum rms Sound Pressure Level – Freq Weighted Amx = A Weighted Max Level Cmx = C Weighted Max Level
Cpk 100.3	Maximum Peak Level Reached – Freq Weighted (Fixed) Cpk = C Weighted Peak Level (All except GA257B) Zpk = Flat or Linear Weighted Peak Level (GA257B Only)
00:01:33	Run time duration of REC MODE (Elapsed Time) hh:mm:ss
Lep 87.1	Displays the Lep,d based on the selected Exposure Time
LAe 93.1	Sound Exposure Level - Freq Weighted LAe = A Weighted Sound Exposure Level LCe = C Weighted Sound Exposure Level
Do% 27.2	Dose (dependent on exchange and criterion)
Hr% 53.2	Dose per Hour
P2h 0.02	Indicates the energy that has been received in Pascal Squared Hours
O.L. NO O.L. YES	Overload latch that indicates if an OVERLOAD has occurred (Can only be reset by pressing the 'C' key)
—-.—	Indicates when values are 0 or significantly lower than the bottom of the current range selected e.g. when instrument is first powered on or after being reset whilst in STOP mode.

Available Parameters - Model 'L'

Parameter	Instrument
Sound Pressure - Channel 1	ALL
Sound Pressure - Channel 2	ALL (Can be OFF and User mode dependent)
Leq - Channel 1	ALL
Leq - Channel 2	ALL (Can be OFF and User mode dependent)
Max rms Level - Channel 1	GA116L / GA216L (User mode dependent)
Max rms Level - Channel 2	GA116L / GA216L (Can be OFF and User mode dependent)
Peak Level - Channel 2	ALL (Can be OFF and User mode dependent)
Lep,d	ALL (User mode dependent)
Dose	ALL (User mode dependent)
Dose per Hour	ALL (User mode dependent)
Pascal Squared Hours	ALL (User mode dependent)
Sound Exposure	GA116L / GA216L (User mode dependent)
L10	GA116L / GA216L (User mode dependent)
L90	GA116L / GA216L (User mode dependent)
User Percentile	GA116L / GA216L (User mode dependent)
Overload Yes / No	ALL
Measurement Time	ALL
Interval Period	ALL (**Record** mode Only)

The following table is a breakdown of all the possible display parameters with a brief description. Please see the previous tables to determine which parameters your instrument displays.

Display	Description
LAF 93.7	Frequency and Time Weighted Sound Pressure Level. LAF = A Weighted, Fast LAS = A Weighted, Slow LAI = A Weighted, Impulse LCF = C Weighted, Fast LCS = C Weighted, Slow LCI = C Weighted, Impulse LZF = Z Weighted, Fast LZS = Z Weighted, Slow LZI = Z Weighted, Impulse
LAq 93.7	Displays the Frequency Weighted Leq LAq = A Weighted Leq LCq = C Weighted Leq LZq = Z Weighted Leq
Amx 97.3	Maximum rms Sound Pressure Level – Freq Weighted Amx = A Weighted Max Level Cmx = C Weighted Max Level Zmx = Z Weighted Max Level
Cpk 100.3	Maximum Peak Level Reached – Freq Weighted Apk = A Weighted Peak Level Cpk = C Weighted Peak Level Zpk = Flat or Linear Weighted Peak Level
Lep 87.1	Displays the Lep,d
Do% 27.2	Dose (dependent on exchange and criterion)
Hr% 53.2	Dose per Hour
P2h 0.02	Indicates the energy that has been received in Pascal Squared Hours
LAe 93.1	Sound Exposure Level - Freq Weighted LAe = A Weighted Sound Exposure Level
L10 45.4	dB(A) level exceeded for n% of the time n = 10, 90 and user selectable (L10, L90, Lxx)
O.L. NO O.L. YES	Overload latch that indicates if an OVERLOAD has occurred (Can be reset by pressing the 'C' key in **Stop** mode)
00:01:33	Duration of **Record** mode (Measurement Time - MT) hh:mm:ss
PER 10s	Duration of the selected Recording Interval Period remaining – Only available in **Record** mode
—-.—	Indicates when values are 0 or significantly lower than the bottom of the current range selected e.g. when instrument is first powered on or after being reset whilst in STOP mode.

Available Parameters - Model 'E'

Parameter
Sound Pressure - Channel 1
Sound Pressure - Channel 2
Leq - Channel 1
Leq - Channel 2
Max rms Level - Channel 1
Max rms Level - Channel 2
Peak Level - Channel 2
Lep,d
Dose
Dose per Hour
Pascal Squared Hours
Sound Exposure
L10
L90
User Percentile
Overload Yes / No
Measurement Time
Interval Period

The following table is a breakdown of all the possible display parameters with a brief description. Please see the previous tables to determine which parameters your instrument displays.

Display	Description
LAF 93.7	Frequency and Time Weighted Sound Pressure Level. LAF = A Weighted, Fast LAS = A Weighted, Slow LAI = A Weighted, Impulse LCF = C Weighted, Fast LCS = C Weighted, Slow LCI = C Weighted, Impulse LZF = Z Weighted, Fast LZS = Z Weighted, Slow LZI = Z Weighted, Impulse
LAq 93.7	Displays the Frequency Weighted Leq LAq = A Weighted Leq LCq = C Weighted Leq LZq = Z Weighted Leq
Amx 97.3	Maximum rms Sound Pressure Level – Freq Weighted Amx = A Weighted Max Level Cmx = C Weighted Max Level Zmx = Z Weighted Max Level
Cpk 100.3	Maximum Peak Level Reached – Freq Weighted Apk = A Weighted Peak Level Cpk = C Weighted Peak Level Zpk = Flat or Linear Weighted Peak Level
LAe 93.1	Sound Exposure Level - Freq Weighted LAe = A Weighted Sound Exposure Level
L10 45.4	dB(A) level exceeded for n% of the time n = 10, 90 and user selectable (L10, L90, Lxx)
O.L. NO O.L. YES	Overload latch that indicates if an OVERLOAD has occurred (Can be reset by pressing the 'C' key in **Stop** mode)
00:01:33	Duration of **Record** mode (Measurement Time - MT) hh:mm:ss
PER 10s	Duration of the selected Recording Interval Period remaining – Only available in **Record** mode
—-.—	Indicates when values are 0 or significantly lower than the bottom of the current range selected e.g. when instrument is first powered on or after being reset whilst in STOP mode.

Parameter Explanations

Below are brief descriptions of the parameters available on all Sonus sound level instruments. Refer to the glossary for more information if required.

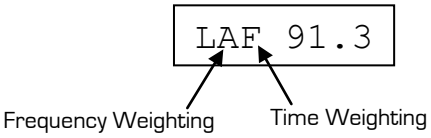
Sound Pressure Level

The instantaneous Time and Frequency weighted rms sound pressure level in decibels.

Depending on the instrument model the Time and Frequency Weighting may both be changed.

The Noise at Work Regulations 2005 requires that frequency weighting 'A' is used to determine noise exposures and that all peak values are taken using frequency weighting 'C'.

An example screen display may be: -



Equivalent Continuous Sound Level

This is more commonly known as Leq and is expressed in decibels.

It may be measured using Frequency Weighting 'A', 'C' or 'Z' and depending on the Sonus model either of these can be selected.

The Leq is a time constantless parameter which means that it is calculated with no Time Weighting applied.

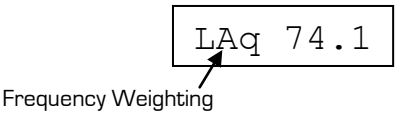
Where an instrument is regarded as an integrating sound level meter, then Leq will be available on the instrument.

To describe Leq, think of how the sound pressure level over a certain period is likely to increase and decrease as people talk or maybe as machinery is being used. Attempting to read this fluctuating sound on the meters display is awkward.

Over the same period, the Leq will settle to an easy to read single value representation having the same total sound energy of this varying noise over the same time period. Measuring over longer time periods will therefore give more accurate results.

The parameter Leq with applied 'A' weighting is essential for Noise at Work assessments and many other applications.

An example screen display may be: -



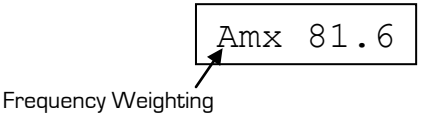
Maximum Sound Pressure Level

This is maximum sound pressure level in decibels measured over the recording period.

This parameter is an rms value and is not to be confused with the Peak which may be much higher.

As with Sound Pressure Level it is Time and Frequency weighted.

An example screen display may be: -



Peak Level

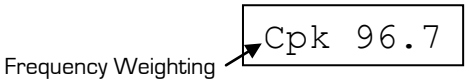
This is the frequency weighted crest (Peak) of the sound pressure level and should not be confused with the rms maximum sound pressure level.

Peak is also used for many other applications, and these should be checked to determine which weighting should be applied.

In the UK the Peak parameter with applied 'C' weighting is essential for Noise at Work assessments. The Control of Noise at Work Regulations 2005 stipulates the following Peak action and limit values: -

130dBC = Lower Action Value
135dBC = Upper Action Value
137dBC = Limit Value

An example screen display may be: -



Daily Personal Noise Exposure Level

This is more commonly known as Lep,d or Lex and is expressed in decibels.

The Lep,d represents the total noise received by an employee over the working day and is therefore not only a function of the noise level but also of the time the employee is exposed to it.

It is calculated using the Leq and is an essential parameter for Noise at Work assessments.

The time period an employee is exposed to the noise level is commonly known as the Exposure Time and this can be adjusted on your instrument to give partial Lep,d levels for the employee. Exposure Time on your Sonus instrument is displayed as ET. The Lep reading on your Sonus instrument is the Lep,d for the given Exposure Time (ET) as set on the instrument. If an ET value is not entered than the Measurement Time (MT) is used in the calculation instead.

As an example, an employee may undertake a total of 4 tasks throughout their working day and each task taking 2 hours. The noise levels for each task will therefore be recorded and the Exposure Time set to how long the employee is subject to this particular task, in this case 2 hours.

The total Lep,d can then be calculated using the 4 partial Lep,d levels. This is possible using the Exposure Calculator function within the software dBdataPro.

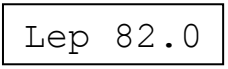
It is the total Lep,d that is used to compare with Exposure Action values and Exposure Limit Value as stated in the Noise at Work Regulations. In the UK the noise exposure limit and action values are as follows: -

80dBA = Lower Action Value
85dBA = Upper Action Value
87dBA = Limit Value

Remember that the longer the noise level is recorded over then the more accurate the result will be although it is possible to take valid Lep,d readings from short recordings of 5 minutes assuming all the variations in the noise emissions are captured.

Also be aware that low noise levels with Exposure times over a longer period may give the same Lep,d as noises with higher levels with Exposure Times over a shorter period.

An example screen display may be: -



Noise Dose

This is more commonly known as Dose and is expressed as a percentage.

The Noise Dose represents the total noise received by an employee over the working day and is therefore not only a function of the noise level but also of the time the employee is exposed to it.

Dose is similar to Lep,d but as dose is represented as a percentage the daily total dose can be calculated from partial dose values by simply adding them together or using the Exposure Calculator in dBdataPro.

Dose in general however is measured for the complete shift using a dose meter which the employee wears for the entire shift resulting in a total daily dose figure.

Alternatively if required you may measure individual partial tasks the employee undertakes throughout the shift for shorter periods and adjust the Exposure Time on the instrument. Exposure Time on your Sonus instrument is displayed as ET, if an ET is not entered then the Measurement Time MT is used instead.

Remember that the longer the noise level is recorded over then the more accurate the result will be although it is possible to take valid Dose readings from short recordings of as little as 5 minutes assuming all the variations in the noise emissions are captured.

Also be aware that low noise levels with Exposure Times over a longer period may give the same Dose as noises with higher levels with Exposure Times over a shorter period.

Noise Dose is also governed by the settings of Criterion, Threshold and Exchange Rate.

In the UK a Criterion of 85dB with a 3dB Exchange Rate is used for Noise at Work assessments. 85dBA Lep,d is also the UK Upper Action Value as stated in the Noise at Work Regulations 2005.

The Criterion is the sound level that if continually applied for the working shift (typically 8 hours) will produce a Dose value of 100%.

Therefore in the UK if an employee is subject to a noise level of 85dB continually for 8 hours then they will be subject to 100% Dose. This is the maximum allowable dose percentage an employee can be subject to before action must be taken.

The Exchange Rate is the amount by which the permitted noise level increases when the exposure time is halved or vice versa, therefore in the UK this value is 3dB.

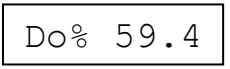
As an example, if 8 hours is the maximum period for a continuous noise level of 85dB then 4 hours is the maximum time period an employee maybe subject to a continuous noise level of 88dB.

Other countries may use different Criterion levels and Exchange Rate values for their legislation.

The Threshold is the sound level at below which the Dose is not accumulated. The threshold level is determined by (Criterion – Selected Threshold value).

Therefore if the criterion is 85 and the selected threshold value is -10 then Dose is only accumulated from noise levels greater than 85 - 10 or 75 decibels. In the UK, the Control of Noise at Work Regulations requires a threshold of -10dB (75dB).

An example screen display may be: -



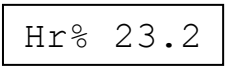
Noise Dose per Hour

This is more commonly known as Dose per Hour and is expressed as a percentage.

The Dose per Hour is the Dose value that the employee would be subject to for each hour of the working shift.

As an example, if a continuous noise level of 85dB is being subject to an employee then the Dose per Hour would be 100 / 8 = 12.5%

An example screen display may be: -

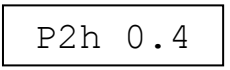


Pascal Squared Hours

This is more commonly known as Pa^2Hr and is another alternative method to show how much noise exposure an employee has been exposed to.

If an employee has been exposed to a continual noise level of 85dB for an 8 hour working shift then the employee will have been subject to 1 Pa^2Hr.

An example screen display may be: -



Sound Exposure Level

This is more commonly known as LAe or previously SEL and is expressed in decibels.

It is the sum of the 'A' weighted sound exposure over the recording period but normalised to one second.

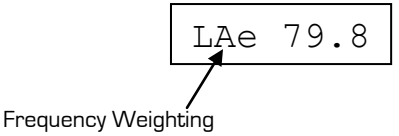
It is very useful for many applications including noise events such as an airplane fly over a train pass by and many other environmental applications.

With the total sound exposure normalised to 1 second regardless of the time period of the event, each individual sound exposure level can be compared with each other.

As the LAe is normalised to a period of 1 second, the value it produces is almost always greater than the maximum rms sound pressure level for the same noise event.

Again as this a cumulative measurement be aware that low noise events recorded over a longer period may give the same or greater sound exposure level as noise events with higher levels recorded over a shorter period of time.

An example screen display may be: -



Percentiles

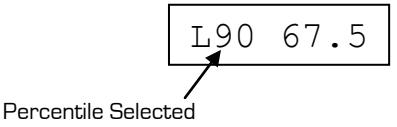
These are more commonly known as Ln's and are expressed in decibels.

The selected Ln displays the 'A' frequency weighted and time weighted sound pressure level that has been exceeded for n% of the time.

For example, if the selected Ln is L90 then the value shown is the sound pressure level that has been exceeded for 90% of the time period. In the UK standard BS 4142 L90 is described as the Background Level.

Percentiles are used widely for measuring environmental noise.

An example screen display may be: -



Chapter 8

Downloading Saved Recordings

Models 'L' and 'E'

As standard all model 'L' and 'E' instruments are shipped with Castle's noise analysis software dBdataPro – LITE.

The full version of the software is available by purchasing a license key, consult your software user manual or contact Castle for further details.

Using the software dBdataPro it is possible to download the stored recordings on your meter to your PC allowing the data to be viewed and printed in professional reports.

Communication between a PC and your Sonus meter is made via the 9 pin connector at the right side of your instrument to a free USB port on your PC or laptop. The cable is supplied as standard with all Sonus 'L' and 'E' instruments.

Your Sonus 'L' or 'E' Instrument has specialised USB drivers that MUST be installed correctly for the instrument to successfully download.

For comprehensive instructions please refer to the dBdataPro user manual.

The instrument does not need to be placed in any special mode or any menu option selected to download, simply follow the operational instructions for the software and also ensure the following: -

- Supplied USB drivers are installed correctly
- Instrument is ON
- Communication cable attached to instrument and PC
- dBdataPro software Version 3.2 or higher is installed

It is highly recommended that data is not downloaded whilst the instrument is currently in **Record** mode and recording data. Under such circumstances it is possible that transferred data may become corrupt.

Chapter 9

Accessories

Available Accessories

GA607	Dual Level Calibrator (Class 1)
GA601	Single Level Calibrator (Class 2)
PC007	dBdataPro Noise Analysis Software
ZL1107-02	USB Download Cable (1.8m)*
KA020	Weatherproof System*
MW402	Weatherproof Microphone Housing*
PSU3:SONUS	Power Supply*
ZL1094-01	Microphone Extension Cable (1m)
ZL1064-01	AC Output Cable (1m)*
KG205	Windshield 60mm
MK75	ACO 7146 50mV/Pa Microphone Capsule (Class 1) GA116E
MK79	ACO 7052 25mV/Pa Microphone Capsule (Class 2) GA216L, GA216I, GA216B, GA257L, GA257B
MK80	ACO 7146A 25mV/Pa Microphone Capsule (Class 1) GA116L, GA116I
MK579DP1B	Dose Meter Plug-in Microphone Capsule and Assembly
KG204	Dose Meter Windshield
KG205	Windshield 60mm
KA010	Small Attaché Case (Holds Instrument and Calibrator)
6LR61	9V Battery (Pack of 12)

* Only available for model 'L' and 'E' instruments

Chapter 10

Technical Specification

The individual characteristic applies to each instrument unless specifically worded otherwise.

Instrument Standards

GA116I, GA116L
IEC 61672-1 : 2002 Class 1 Group X
BS EN 61672-1 : 2003 Class 1 Group X
IEC 61252 : 1993
BS EN 61252 : 1997 + A1:2001

GA116E
IEC 61672-1 : 2002 Class 1 Group X
BS EN 61672-1 : 2003 Class 1 Group X

GA116B
IEC 61672-1 : 2002 Class 1 Group X
BS EN 61672-1 : 2003 Class 1 Group X

GA216I, GA216B, GA216L
IEC 61672-1 : 2002 Class 2 Group X
BS EN 61672-1 : 2003 Class 2 Group X

GA216L-P
IEC 61672-1 : 2002 Class 2 Group X
BS EN 61672-1 : 2003 Class 2 Group X
IEC 61252 : 1993
BS EN 61252 : 1997 + A1:2001

GA257B, GA257L
IEC 61252 : 1993
BS EN 61252 : 1997 + A1:2001

Measurement Parameters

GA116I

Lp, Leq, Lmax, Cpeak, LE, Pa^2h, Lep,d, Noise Dose, Noise Dose Per Hour, Measurement Run Time, Overload

GA116L

Lp, Leq, Lmax, A Peak, Cpeak, Zpeak, LE, Pa^2h, Lep,d, Noise Dose, Noise Dose Per Hour, L10, L90, L[user], Measurement Run Time, Overload, Interval Duration

GA116E

Lp, Leq, Lmax, Apeak, Cpeak, Zpeak, LE, L10, L90, L[user], Measurement Run Time, Overload, Interval Duration

GA216I

Lp, Leq, Lmax, Cpeak, LE, Lep,d, Measurement Run Time, Overload

GA216L, GA216L-P

Lp, Leq, Lmax, Apeak, Cpeak, Zpeak, LE, Pa^2h, Lep,d, Noise Dose, Noise Dose Per Hour, L10, L90, L[user], Measurement Run Time, Overload, Interval Duration

GA116B, GA216B

Lp, Lmax, Cpeak, Measurement Run Time, Overload

GA257B

Lp, Leq, Zpeak, Pa^2h, Lep,d, Noise Dose, Noise Dose Per Hour, Measurement Run Time, Overload

GA257L

Lp, Leq, Apeak, Cpeak, Zpeak, LE, Pa^2h, Lep,d, Noise Dose, Noise Dose Per Hour, Measurement Run Time, Overload, Interval Duration

Time Weighting

GA116I
SLOW and FAST according to IEC 61672-1 Class 1

GA116L, GA116E
SLOW, FAST and IMPULSE according to IEC 61672-1 Class 1

GA216I, GA216B
SLOW and FAST according to IEC 61672-1 Class 2

GA216L
SLOW, FAST and IMPULSE according to IEC 61672-1 Class 2

GA257L
SLOW and FAST according to IEC 61672-1 Class 2

GA257B
SLOW according to IEC 61672-1 Class 2

Frequency Weighting

GA116I
A and C weightings according to IEC 61672-1 Class 1

GA116L, GA116E
A, C and Z weightings according to IEC 61672-1 Class 1

GA216I, GA216B
A and C weightings according to IEC 61672-1 Class 2

GA216L, GA216L-P, GA257L
A, C and Z weightings according to IEC 61672-1 Class 2

GA257B
A weighting according to IEC 61672-1 Class 2

Peak Frequency Weighting

GA116I
C weighted to IEC 61672-1 Class 1

GA116L, GA116E
A, C and Z weighted to IEC 61672-1 Class 1

GA216I, GA216B
C weighted to IEC 61672-1 Class 2

GA216L, GA21L-P, GA257L
A, C and Z weighted to IEC 61672-1 Class 2

GA257B
Z weighted to IEC 61672-1 Class 2

Typical Electrical Self Generated Noise Level

Model	'A' Weighting (dB)	'C' Weighting (dB)	'Z' Weighting (dB)
GA116E	12.0	12.0	14.5
GA116L	18.6	18.2	20.6
GA216L	25.3	35.7	39.6
GA257L	56.9*	56.5*	56.8*
GA116I	32.0	38.0	N.A
GA216I	32.0	38.0	N.A
GA216B	32.0	38.0	N.A
GA257B	54.5*	54.5*	N.A

* Taken on GA257L operating range of 70-140dB and 75-140dB for GA257B

The lower limit of measurement and the actual noise floors are a function of the microphone sensitivity.

Linear Operating Range: (IEC 61672:2002)

Model 'L' Instruments

Test start point for frequencies 31.5Hz, 1kHz, 4kHz and 8kHz:

GA116L

Display Range	Start Point (dB)
30 – 100 dB	74.0
50 – 120 dB	94.0
70 – 140 dB	114.0

GA216L

Display Range	Start Point (dB)
35 – 100 dB	74.0
50 – 120 dB	94.0
70 – 140 dB	114.0

A Weighted – GA116L

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
30 – 100 dB	32.0 – 60.6	32.0 – 100.0	32.0 – 100.0	32.0 – 100.0
50 – 120 dB	50.0 – 80.6	50.0 – 120.0	50.0 – 120.0	50.0 – 119.0
70 – 140 dB	70.0 – 100.6	70.0 – 140.0	70.0 – 140.0	70.0 – 140.0

C Weighted – GA116L

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
30 – 100 dB	33.0 – 60.6	33.0 – 100.0	33.0 – 100.0	33.0 – 100.0
50 – 120 dB	50.0 – 80.6	50.0 – 120.0	50.0 – 120.0	50.0 – 119.0
70 – 140 dB	70.0 – 100.6	70.0 – 140.0	70.0 – 140.0	70.0 – 140.0

Z or LIN Weighted – GA116L

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
30 – 100 dB	34.0 – 60.6	34.0 – 100.0	34.0 – 100.0	34.0 – 100.0
50 – 120 dB	50.0 – 80.6	50.0 – 120.0	50.0 – 120.0	50.0 – 119.0
70 – 140 dB	70.0 – 100.6	70.0 – 140.0	70.0 – 140.0	70.0 – 140.0

A Weighted – GA216L

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
35 – 100 dB	35.0 – 60.6	35.0 – 100.0	35.0 – 100.0	35.0 – 100.0
50 – 120 dB	50.0 – 80.6	50.0 – 120.0	50.0 – 120.0	50.0 – 119.0
70 – 140 dB	70.0 – 100.6	70.0 – 140.0	70.0 – 140.0	70.0 – 140.0

C Weighted – GA216L

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
35 – 100 dB	40.0 – 60.6	40.0 – 100.0	40.0 – 100.0	40.0 – 100.0
50 – 120 dB	50.0 – 80.6	50.0 – 120.0	50.0 – 120.0	50.0 – 119.0
70 – 140 dB	70.0 – 100.6	70.0 – 140.0	70.0 – 140.0	70.0 – 140.0

Z or LIN Weighted – GA216L

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
35 – 100 dB	45.0 – 60.6	45.0 – 100.0	45.0 – 100.0	45.0 – 100.0
50 – 120 dB	50.0 – 80.6	50.0 – 120.0	50.0 – 120.0	50.0 – 119.0
70 – 140 dB	70.0 – 100.6	70.0 – 140.0	70.0 – 140.0	70.0 – 140.0

Test start point for frequencies 31.5Hz, 1kHz, 4kHz and 8kHz:

Display Range	Start Point (dB)
20 – 90 dB	74.0
40 – 110 dB	94.0
60 – 130 dB	114.0

A Weighted

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
20 – 90 dB	22.0 – 60.6	22.0 – 90.0	22.0 – 90.0	22.0 – 90.0
40 – 110 dB	40.0 – 80.6	40.0 – 110.0	40.0 – 110.0	40.0 – 109.0
60 – 130 dB	60.0 – 100.6	60.0 – 130.0	60.0 – 130.0	60.0 – 130.0

C Weighted

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
20 – 90 dB	22.0 – 60.6	22.0 – 90.0	22.0 – 90.0	22.0 – 90.0
40 – 110 dB	40.0 – 80.6	40.0 – 110.0	40.0 – 110.0	40.0 – 109.0
60 – 130 dB	60.0 – 100.6	60.0 – 130.0	60.0 – 130.0	60.0 – 130.0

Z or LIN Weighted

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
20 – 90 dB	24.0 – 60.6	24.0 – 90.0	24.0 – 90.0	24.0 – 90.0
40 – 110 dB	40.0 – 80.6	40.0 – 110.0	40.0 – 110.0	40.0 – 109.0
60 – 130 dB	60.0 – 100.6	60.0 – 130.0	60.0 – 130.0	60.0 – 130.0

If full verification of the level linearity of the 20-90 range is required then the instrument should be set to the nominal sensitivity prior to testing.

Test start point for frequencies 31.5Hz, 1kHz, 4kHz and 8kHz:

Display Range	Start Point (dB)
35 – 100 dB	74.0
55 – 120 dB	94.0
75 – 140 dB	114.0

A Weighted

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
35 – 100 dB	41.0 – 60.6	41.0 – 100.0	41.0 – 100.0	41.0 – 100.0
55 – 120 dB	55.0 – 80.6	55.0 – 120.0	55.0 – 120.0	55.0 – 119.0
75 – 140 dB	75.0 – 100.6	75.0 – 140.0	75.0 – 140.0	75.0 – 140.0

C Weighted

Display Range	Frequency (Hz)			
	31.5 (dB)	1000 (dB)	4000 (dB)	8000 (dB)
35 – 100 dB	41.0 – 60.6	41.0 – 100.0	41.0 – 100.0	41.0 – 100.0
55 – 120 dB	55.0 – 80.6	55.0 – 120.0	55.0 – 120.0	55.0 – 119.0
75 – 140 dB	75.0 – 100.6	75.0 – 140.0	75.0 – 140.0	75.0 – 140.0

For the GA257B instrument refer only to the display range 75-140dB.

Total Measuring Range

The difference between the lowest possible measurement on the most sensitive range and the highest level on the least sensitive range at a frequency of 1kHz.

GA116E

A Weighted	22.0 – 130.0 (dB)
C Weighted	22.0 – 130.0 (dB)
Z Weighted	24.0 – 130.0 (dB)

GA116L

A Weighted	32.0 – 140.0 (dB)
C Weighted	33.0 – 140.0 (dB)
Z Weighted	34.0 – 140.0 (dB)

GA216L

A Weighted	35.0 – 140.0 (dB)
C Weighted	40.0 – 140.0 (dB)
Z Weighted	45.0 – 140.0 (dB)

GA257L

A Weighted	70.0 – 140.0 (dB)
C Weighted	70.0 – 140.0 (dB)
Z Weighted	70.0 – 140.0 (dB)

GA116I, GA216I, GA116B, GA216B

A Weighted	41.0 – 140.0 (dB)
C Weighted	41.0 – 140.0 (dB)

GA257B

A Weighted	75.0 – 140.0 (dB)
C Weighted	75.0 – 140.0 (dB)

Peak Operating Range @ 1kHz

GA116E

20 – 90 dB	30.0 – 93.0 (dB)
40 – 110 dB	50.0 – 113.0 (dB)
60 – 130 dB	70.0 – 133.0 (dB)

GA116L

30 – 100 dB	40.0 – 103.0 (dB)
50 – 120 dB	60.0 – 123.0 (dB)
70 – 140 dB	80.0 – 143.0 (dB)

GA216L

35 – 100 dB	40.0 – 103.0 (dB)
50 – 120 dB	60.0 – 123.0 (dB)
70 – 140 dB	80.0 – 143.0 (dB)

GA257L

70 – 140 dB	80.0 – 143.0 (dB)

GA116I, GA216I, GA116B, GA216B

35 – 100 dB	63.0 – 103.0 (dB)
55 – 120 dB	83.0 – 123.0 (dB)
75 – 140 dB	103.0 – 143.0 (dB)

GA257B

75 – 140 dB	103.0 – 143.0 (dB)

Acoustic Frequency Range

Microphone	Frequency Range (Hz)
ACO 7146A	10 to 20000
ACO 7052	20 to 8000

Electrical Characteristics

Frequency Range (Hz)
1 to 20000

Reference Points

Model E

Description	Value
Sound Pressure Level	94.0dB
Range	40 - 110
Frequency	1kHz

Model L

Description	Value
Sound Pressure Level	94.0dB
Range	50 - 120
Frequency	1kHz

Models I, B

Description	Value
Sound Pressure Level	94.0dB
Range	55 - 120
Frequency	1kHz

Electrical Signal Input

Electrical signals can be applied to the Castle Sonus range of sound level meters by removing the acoustical microphone and replacing with a dummy microphone having a series capacitance of 19pF ±2%. The BNC termination is then used to interface with a suitable signal generator with an output impedance of 600Ω at 1kHz.

Maximum Peak to Peak Electrical Signal Input For No Damage

Model	Max Input Voltage (V)
'I' & 'B'	7.0
'L'	21.0
'E'	21.0

Upper Frequency for Periodic Acoustic Testing

4kHz - (IEC 61672-3:2006)

Windshield

The effects of using the KG205 (60mm) windshield			
31.5Hz	0.0	1kHz	0.2
63Hz	0.1	2kHz	0.2
125Hz	0.1	4kHz	0.7
250Hz	0.1	8kHz	0.0
500Hz	0.2		

The meter conforms to the Standards quoted when fitted with the specified windshield.

Microphone [GA116I, GA116L]

ACO ½" Electret Condenser Microphone Cartridge Type 7146A. Microphone reference point is the centre of the diaphragm.

Type MK80 (ACO 7146A)	Specification
Diameter (inch)	0.5
Response Type	Free-Field
Polarization (V)	0.0
Frequency Range (Hz)	10 - 20000
Sensitivity (mV/Pa)	25.0
Sensitivity (dB re 1V/Pa)	-32.0 ±1.5dB
Capacitance (pF)	18.0
Max. Sound Pressure Level (dB)	146.0
Temperature Coefficient (dB/°C)	-0.01

The pressure to free-field correction value to be applied when used with a Castle calibrator GA601/GA607 or B&K4231 is as follows: **-0.2dB**

The capsule can be removed by unscrewing anti-clockwise although great care must be taken when doing this to avoid damage to either the capsule or the instrument. Re-fitting is a reverse of the above.

Type MK80 (ACO 7146A) Typical Microphone Response			
16Hz	0.0	1kHz	0.0
31.5Hz	0.0	2kHz	0.0
63Hz	0.0	4kHz	-0.1
125Hz	0.0	8kHz	-0.7
250Hz	0.0	16kHz	1.0
500Hz	0.0		

Typical Actuator to free field correction factors(dB) of an MK80 (ACO 7146A) microphone (Based on 500Hz = 0)			
250Hz	0.0	2.5kHz	1.0
315Hz	0.0	3.15kHz	1.2
400Hz	0.0	4kHz	1.5
500Hz	0.0	5kHz	2.0
630Hz	0.0	6.3kHz	2.5
800Hz	0.0	8kHz	3.8
1kHz	0.0	10kHz	4.6
1.25kHz	0.2	12.5kHz	6.8
1.6kHz	0.4	16kHz	8.8
2kHz	0.5	20kHz	10.0

Microphone [GA116E]

ACO ½" Electret Condenser Microphone Cartridge Type 7146. Microphone reference point is the centre of the diaphragm.

Type MK75 (ACO 7146)	Specification
Diameter (inch)	0.5
Response Type	Free-Field
Polarization (V)	0.0
Frequency Range (Hz)	10 - 20000
Sensitivity (mV/Pa)	50.0
Sensitivity (dB re 1V/Pa)	-26.0 ±1.5dB
Capacitance (pF)	18.0
Max. Sound Pressure Level (dB)	146.0
Temperature Coefficient (dB/°C)	-0.01

The pressure to free-field correction value to be applied when used with a Castle calibrator GA601/GA607 or B&K4231 is as follows: **-0.2dB**

The capsule can be removed by unscrewing anti-clockwise although great care must be taken when doing this to avoid damage to either the capsule or the instrument. Re-fitting is a reverse of the above.

Type MK75 (ACO 7146) Typical Microphone Response			
16Hz	0.0	1kHz	0.0
31.5Hz	0.0	2kHz	0.0
63Hz	0.0	4kHz	-0.1
125Hz	0.0	8kHz	-0.7
250Hz	0.0	16kHz	1.0
500Hz	0.0		

Typical Actuator to free field correction factors(dB) of an MK75 (ACO 7146) microphone (Based on 500Hz = 0)			
250Hz	0.0	2.5kHz	1.0
315Hz	0.0	3.15kHz	1.2
400Hz	0.0	4kHz	1.5
500Hz	0.0	5kHz	2.0
630Hz	0.0	6.3kHz	2.5
800Hz	0.0	8kHz	3.8
1kHz	0.0	10kHz	4.6
1.25kHz	0.2	12.5kHz	6.8
1.6kHz	0.4	16kHz	8.8
2kHz	0.5	20kHz	10.0

Microphone [GA216I, GA216B, GA216L, GA257B, GA257L]

MK79 ACO ½" Electret Condenser Microphone Cartridge Type 7052. Microphone reference point is the centre of the diaphragm.

Type MK79 (ACO 7052)	Specification
Diameter (inch)	0.5
Response Type	Free-Field
Polarization (V)	0.0
Frequency Range (Hz)	20 - 8000
Sensitivity (mV/Pa)	25.0
Sensitivity (dB re 1V/Pa)	-32.0
Capacitance (pF)	18.0
Max. Sound Pressure Level (dB)	146.0
Temperature Coefficient (dB/°C)	-0.01

The pressure to free-field correction value to be applied when used with a Castle calibrator GA601/GA607 or B&K4231 is as follows: **-0.2dB**

The capsule can be removed by unscrewing anti-clockwise although great care must be taken when doing this to avoid damage to either the capsule or the instrument. Re-fitting is a reverse of the above.

Type MK79 (ACO 7052) Typical Microphone Response			
31.5Hz	0.2	1kHz	0.0
63Hz	0.1	2kHz	0.0
125Hz	0.0	4kHz	0.0
250Hz	0.0	8kHz	0.5
500Hz	0.0		

Typical Actuator to free field correction factors(dB) of an MK79 (ACO 7052) microphone (Based on 500Hz = 0)			
20Hz	0.0	500Hz	0.0
25Hz	0.0	630Hz	0.0
31.5Hz	0.0	800Hz	0.0
40Hz	0.0	1kHz	0.1
50Hz	0.0	1.25kHz	0.2
63Hz	0.0	1.6kHz	0.3
80Hz	0.0	2kHz	0.4
100Hz	0.0	2.5kHz	0.5
125Hz	0.0	3.15kHz	0.8
160Hz	0.0	4kHz	1.2
200Hz	0.0	5kHz	1.6
250Hz	0.0	6.3kHz	2.3
315Hz	0.0	8kHz	3.6
400Hz	0.0		

Typical Microphone Self Generated Noise Level

Model	Level (dBA)
7146	17.0
7146A	17.0
7052	18.0

Maximum SPL at the Microphone for No Damage

ACO 7146	ACO 7146A	ACO 7052
146.0 dB	146.0 dB	146.0 dB

Calibration Reference Conditions

	Models 'I' & 'B'	Model 'L'	Model 'E'
Sound Field	Free Field	Free Field	Free Field
Air Temperature	23°C (73°F)	23°C (73°F)	23°C (73°F)
Relative Humidity	50%	50%	50%
Atmospheric Pressure	101.325 kPa	101.325 kPa	101.325 kPa
Sound Pressure Level	94.0dB	94.0dB	94.0dB
Reference Level Range	55 – 120dB	50 – 120dB	40 – 110dB
Reference Frequency	1kHz	1kHz	1kHz

The reference direction of incidence for all microphones is perpendicular to the front face (diaphragm surface) of the microphone.

Display

Digital 1 x 8 alphanumeric, digit size 7mm x 5mm Liquid Crystal Display

Display Refresh Rate

250ms

Detector Characteristics

RMS and Peak

Warm up time

< 2 minutes

Environmental Stabilization Time

30 minutes

Operating range

Class 1: -10°C to +50°C
Class 2: 0°C to +40°C

Warning: DO NOT subject the instrument to temperatures greater than 70°C or less than -20°C for any length of time.

Effect of Temperature

Class 1: Accuracy better than ± 0.5 dB over the range -10 to +50°C
Class 2: Accuracy better than ± 0.5 dB over the range 0 to +40°C

Effects of Humidity

Less than 0.5 dB over the range 25 to 90% relative humidity (provided there is no Condensation), relative to the value at 50% relative humidity and 40°C.

Storage range: 0 to 90% relative humidity in the absence of condensation.

Effects of Vibration

From 20Hz to 1kHz at $1ms^2$ no noticeable effect.

Magnetic Field

No noticeable effect.

Radio Frequency Fields

The Sonus Pocket meter range falls into classification X for the susceptibility to Radio Frequency Fields.
Operator Presence in Free Field:
No noticeable effect when operator standing more than 2m behind the instrument.

Overload

Positive overload warning when the input circuit saturates.

Log Interval Periods: Models 'L' & 'E' Only

User Selectable with a minimum integrating period of one second.

Maximum potential log size approximately 2100 intervals.

Timer Function: Models 'L' & 'E' Only

An adjustable countdown timer to stop recordings with a user defined total measurement period.

Time & Date: Models 'L' & 'E' Only

Battery backed Real time clock and calendar.

Overall Dimensions

210mm x 60mm x 35mm (approx.)

Batteries

1 x 9V PP3 Alkaline Cell

Life Expectancy:	12 hours continuous use (approx.)
Min Battery Level:	5.4V DC
Max Battery Level:	9.4V DC

Overall Weight including Batteries

220g

Manufacturers Data

Uncertainty figures for all manufacturers' data are under review at the time of going to print. Please contact Castle Group Ltd for up-to date information.

Case Reflections

Stalk length 62mm from top of case body to base of microphone			
Frequency (Hz)	Case Effect (dB)	Frequency (Hz)	Case Effect (dB)
31.5	0.0	800	0.2
40	0.0	1000	0.0
50	0.0	1250	-0.3
63	0.0	1600	-0.2
80	0.0	2000	-0.5
100	0.0	2500	0.4
125	0.0	3150	-0.2
160	0.0	4000	-0.2
200	0.0	5000	0.1
250	0.1	6300	0.1
315	0.1	8000	0.0
400	0.1	10000	0.0
500	0.1	12500	-0.2
630	0.1	16000	0.0

Output Socket

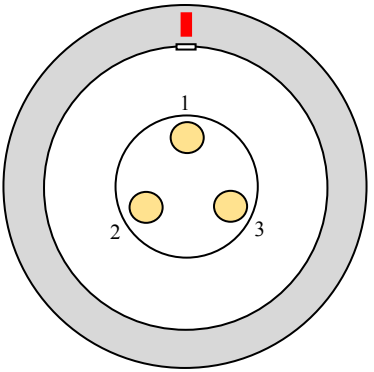
GA116I

Wiring Configuration

Both AC and DC outputs require load impedance's to exceed 10kΩ, however load impedance's > 100KΩ are recommended.

Output Socket	
Pin Number	Description
1	Ground
2	DC Output
3	AC Output

External View



AC Output

Vout ≈ 16.4mV rms at 94.0dB
The output is un-weighted and not affected by the measurement range.

DC Output

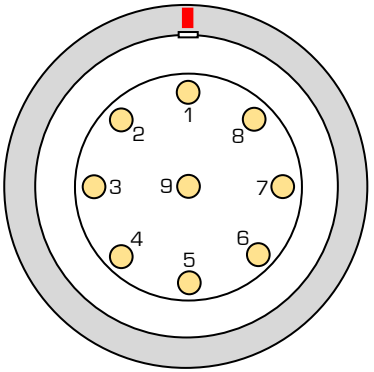
Vout ≈ 40mV/dB
Vout ≈ 3.3 – [[(top of range +3) - (reading in dB)] x 0.04]
Output affected by: -
Frequency Weighting
Measurement Range

Wiring Configuration

The AC output (pins 5 & 6) require the load impedance to exceed 10kΩ, however load impedance's > 100KΩ are recommended.

Output Socket	
Pin Number	Description
1	USB VCC
2	USB D-
3	USB D+
4	USB Ground
5	Analogue Ground
6	AC Output
7	Digital Ground
8	External PSU
9	Not Used

External View



AC Output

Vout ≈ 41.0mV rms at 94.0dB on the reference range

The output is un-weighted.

EC Declaration of Conformity

CE The CE marking of this Castle Product indicates compliance with the EMC Directive.

Castle Group Ltd declares that the: -

- *GA116, GA216, GA257 Pocket Sound Level Meters*

have in accordance with the following Electromagnetic Compatibility Directives: -

- *89/336/EEC*

been designed and manufactured to the following specification:

- *EN61326-1:1997 + A1:1998*

with the following Tests:

- *Radiated Emissions: EN55022:1995 Class: B*
- *ESD: EN61000-4-2:1995 Levels: ±4kV (C) , ± 8kV (A)*
- *Radio-frequency EM field amplitude mod: EN61000-4-3:1996 Level: 3V/m*

No differences in radio frequency emissions are apparent between the available operating ranges where applicable on the Sonus range of instruments.

Approved cables for use with the Castle Sonus Range of instruments to comply with these standards:-

Cable	Order Code	Length
USB Download – Models L, E	ZL1107-02	1.8m
Microphone Extension	ZL1094-01	1m
Microphone Extension	ZL1094-10	10m

I hereby declare that the instruments named above have been designed to comply with the relevant sections of the above referenced specifications, and that the above named instruments comply with all essential requirements of the specified Directives.

Simon Bull
Managing Director

EMC tests conducted at the standard test level of 74dB

Chapter 11

Function Equations

The following tables describes mathematically how the functions available on the range of Sonus Pocket Meters are calculated.

All calculations displayed are subject to rounding and/or truncation and are based on the equations from the IEC standard 61672-1 where applicable.

Function	Equation
Equivalent Continuous A-weighted Sound Pressure Level	$L_{AeqT} := 20 \cdot \log \cdot \left[\frac{\left[\left[\left(\frac{1}{T} \right) \int_{t-T}^{t} (P_A)^2(\xi)\, d\xi \right]^{\frac{1}{2}} \right]}{Po} \right] dB$ $L_{AeqT} := 10 \cdot \log \cdot \frac{\left[\left(\frac{1}{T} \right) \int_{0}^{T} (P_A)^2(t)\, dt \right]}{(P_o)^2} dB$ ξ is a dummy variable of time integration over the averaging time interval ending at the time observation t T is the averaging time interval $P_A(\xi)$ is the instantaneous A-weighted sound pressure P_o is the reference sound pressure of 20μPa In the equation above, the numerator of the argument of the logarithm is the root-mean-square, frequency-weighted sound pressure over averaging time interval T

Function	Equation
Equivalent Continuous C-weighted Sound Pressure Level	$L_{CeqT} := 20 \cdot \log \cdot \left[\frac{\left[\left(\frac{1}{T} \right) \int_{t-T}^{t} (P_C)^2(\xi)\, d\xi \right]^{\frac{1}{2}}}{P_o} \right] dB$ $L_{CeqT} := 10 \cdot \log \cdot \frac{\left[\left(\frac{1}{T} \right) \int_{0}^{T} (P_C)^2(t)\, dt \right]}{(P_o)^2} dB$ ξ is a dummy variable of time integration over the averaging time interval ending at the time observation t T is the averaging time interval $P_C(\xi)$ is the instantaneous C-weighted sound pressure P_o is the reference sound pressure of 20μPa In the equation above, the numerator of the argument of the logarithm is the root-mean-square, frequency-weighted sound pressure over averaging time interval T
Equivalent Continuous Z-weighted Sound Pressure Level	$L_{ZeqT} := 20 \cdot \log \cdot \left[\frac{\left[\left(\frac{1}{T} \right) \int_{t-T}^{t} (P_Z)^2(\xi)\, d\xi \right]^{\frac{1}{2}}}{P_o} \right] dB$ $L_{ZeqT} := 10 \cdot \log \cdot \frac{\left[\left(\frac{1}{T} \right) \int_{0}^{T} (P_Z)^2(t)\, dt \right]}{(P_o)^2} dB$ ξ is a dummy variable of time integration over the averaging time interval ending at the time observation t T is the averaging time interval $P_Z(\xi)$ is the instantaneous Z-weighted sound pressure P_o is the reference sound pressure of 20μPa In the equation above, the numerator of the argument of the logarithm is the root-mean-square, frequency-weighted sound pressure over averaging time interval T

Function	Equation
Daily Personal Noise Exposure Level	$L_{epd} := 10 \cdot \log \cdot \left[\frac{1}{T_n} \cdot \int_{T_1}^{T_2} \frac{P^2(t)}{(P_o)^2} \, dt \right] dB$ $L_{epd} := L_{AeqT} + 10 \cdot \log \cdot \left[\frac{(T_2 - T_1)}{T_1} \right] dB$ $L_{epd} := L_{AeqT} + 10 \cdot \log \cdot \left(\frac{ExposureTime}{8} \right) dB$ P(t) is the instantaneous A-weighted sound pressure in Pascal's P_o is the reference sound pressure of 20μPa T_n is the normalization period governed by the Criterion duration (8 hours typical) L_{AeqT} is the equivalent continuous A-weighted time-average sound level (re 20 μPa) in dB Exposure Time or ET is set on the instrument in hours and is the period in which the recipient is exposed or subject to the noise source

Noise Dose Using Measurement Time	$Dose := \left(\frac{100}{T_C} \right) \cdot \int_0^T 10^{\left[\frac{(L - L_C)}{\frac{Q}{\log 2}} \right]} dt$ $Dose_{(MT)} := \frac{100 \cdot T}{T_C} \cdot 10^{\left[\frac{(L - L_C)}{\frac{Q}{\log 2}} \right]}$ T_C is the Criterion duration in hours (8 hours typical) L is the Slow (or Fast) frequency (A) weighted sound level L_C is the Criterion level in dB T is the Log Length (Measurement period) in hours Q is the Exchange Rate constant

Function	Equation
Noise Dose Using Exposure Time	$Dose_{(ET)} := Dose_{(MT)} \cdot \left(\frac{ET}{MT}\right)$ ET is the Exposure Time in hours MT is the Log Length (Measurement period) in hours

Noise Dose per Hour	$DoseHour := \frac{Dose}{LogLength}$ Log Length is the Measurement period in hours Dose is the calculated Noise Dose determined over the Log Length (Measurement period)

Sound Exposure Level	$L_{AE} := 10 \cdot \log\left[\frac{\left[\int_{t1}^{t2} (P_A)^2(t)\, dt\right]}{(P_o)^2 T_o}\right] dB$ $L_{AE} := 10 \cdot \log\left(\frac{E_A}{E_o}\right) dB$ $L_{AE} := L_{AeqT} + 10 \cdot \log\left(\frac{T}{T_o}\right) \cdot dB$ E_A is the A-weighted sound exposure in Pascal-squared hours E_o is the reference sound exposure of: - $(20\mu Pa)^2 \cdot (1s) := 400 \cdot 10^{-12} Pa^2 s$ T_o = 1s and T = t_2-t_1 which is the time interval for measurement, in seconds, for sound exposure level and time-average sound level L_{AeqT} is the equivalent continuous A-weighted sound pressure level (re 20 µPa) in dB

Function	Equation
Peak sound Pressure Level C-weighted	$L_{Cpeak} := 20\log\left(\frac{P_{Cpeak}}{P_o}\right) dB$ P_{Cpeak} is the maximum C-weighted sound pressure value in Pascal's P_o is the reference sound pressure of 20µPa
Peak sound Pressure Level Z-weighted	$L_{Zpeak} := 20\log\left(\frac{P_{Zpeak}}{P_o}\right) dB$ P_{Zpeak} is the maximum Z-weighted sound pressure value in Pascal's P_o is the reference sound pressure of 20µPa
Pascal Squared Hours	$Pa^2h := \left(20 \cdot 10^{-6}\right)^2 \cdot LogLength \cdot 10^{\left(\frac{L_{AeqT}}{10}\right)}$ Log Length is the Measurement period in hours L_{AeqT} is the equivalent continuous A-weighted time-average sound level (re 20 µPa) in dB

Chapter 12

Glossary

A-weighting

See 'Frequency Weighted Filter'.

Action Values

The Control of Noise at Work Regulations 2005 stipulates the following action values: -

Lower Action Values (LAV)

- A daily or weekly personal noise exposure (Lep,d) of 80dB (A-weighted)
- A peak sound pressure of 130dB (C-weighted)

Upper Action Values (UAV)

- A daily or weekly personal noise exposure (Lep,d) of 85dB (A-weighted)
- A peak sound pressure of 137dB (C-weighted)

Exposure Limit Values (ELV)

- A daily or weekly personal noise exposure (Lep,d) of 87dB (A-weighted)
- A peak sound pressure of 140dB (C-weighted)

Action values are the levels of exposure to noise at which you are required to take certain actions to protect your employees.

The limit value is the level of exposure to noise above which an employee must not be exposed to, taking into account the use of hearing protection.

The use of hearing protectors is a last resort for employees to take to reduce employee exposure. Reasonable steps should be taken to reduce the noise at source beforehand.

If an exposure limit value is exceeded when taking account of hearing protection then exposures must be reduced immediately, with work stopping if necessary.

See a copy of the 'Control of Noise at Work Regulations 2005' for further information if required.

Ambient Noise

Commonly used for environmental noise purposes, this is the sound pressure level in dB that is due to the ambient noise.

Generally it is the noise that exists under normal conditions at any given time and can be with or without specific noise sources included. For the purposes of the standard BS 4142 ambient noise is the totally encompassing sound including all noise sources. See also 'Residual Noise'.

Audio Frequency Range

This is the frequency range over which a normal human ear can detect sound. The normal sound range usually decays with age and is approximately 20Hz to 20kHz.

Frequencies below 20Hz are known as infra sound and frequencies above 20kHz are known as ultra sound.

Audiometer

An electronic instrument that is used to apply known sound pressure levels to a subject's ear. These will be at various frequencies and levels and monitored one ear at a time in order to determine a person's hearing threshold.

It is intended to be used in an area with a very low ambient noise level such as an audiometric booth and all tests should be conducted in accordance with the standard BS EN ISO 8253-1.

Castle Group Ltd offers a range of audiometers and audiometric booths which can be found at www.castlegroup.co.uk

Background Noise

This is the unwanted part of a measurement for a measured signal which is caused by noise. For the purposes of the standard BS 4142 it is usually measured as L90. See also 'Ambient Noise', 'Residual Noise' and 'Percentile Sound Levels'.

C-weighting

See 'Frequency Weighted Filter'.

Criterion Duration (Tc)

The Criterion Duration is the time required for a constant sound level that is equal to the Criterion Level to produce a Noise Dose of 100%. Typically the Criterion Duration is 8 hours.

For example, if: -

Criterion Sound Level = 85dB
Criterion Duration = 8 Hours

Then a sound level of 85dB for an 8 hour period will produce a Noise Dose of 100%.

Criterion Sound Level (Lc)

The Criterion Sound Level is the sound level that if continually applied for the Criterion Duration will produce a Noise Dose of 100%.

Castle instruments are defaulted to the upper exposure action value of 85dB for the Criterion Sound Level but this is generally user selectable to allow for legislation changes with selections available of 75, 80, 85 or 90dB.

See also 'Exchange Rate'.

Daily Personal Noise Exposure Level (Lep,d)

Lep,d represents the total noise received by an employee at work and is normalized to an 8 hour day. It is an essential requirement for the Noise at Work Regulations 2005.

The overall Lep,d can be determined using partial exposures for different locations and different exposure times of the employee or the employee can wear a dose meter for the whole working day.

Normally the Lep,d is calculated from using the equivalent continuous 'A' weighted sound pressure level LAeq.

See 'Function Equations' to see how Lep,d is described mathematically.

In practice when measuring noise it is possible to take Lep,d readings with your instrument of short duration i.e. less than five minutes (providing all variations of noise emissions are covered). If the measured environment changes greatly, then the longer the Lep,d reading is taken, the more accurate the measurement will be.

dB is simply an abbreviation for the term decibel and one decibel is one tenth of a Bel. The unit Bel is named after the scientist Alexander Graham Bell, but is not widely used. A decibel value is dimensionless and is therefore not a value of the measured quantity, it is a ratio of the measured quantity to a reference quantity.

Choosing the reference quantity to be the quietest sound that can be detected by a human ear (20μPa) we obtain a scale that expresses the measured sound pressure level relative to the threshold of hearing.

It is a logarithmic form of a measurement that expresses the magnitude of a physical quantity relative to a reference and is used commonly in electronics, science and acoustics to measure the sound pressure level. The threshold of hearing is therefore 0dB.

$$Lp := 20 \cdot \log\left(\frac{P}{P_o}\right) \text{dB(SPL)}$$

The term dB(SPL) is generally abbreviated to just dB incorrectly giving the impression that the dB is a unit in itself: -

$$Lp := 20 \cdot \log\left(\frac{P}{P_o}\right) \text{dB}$$

Where Po is the reference sound pressure of 20μPa and P is the rms value of the sound pressure measured.

One of the main benefits of using the decibel is its ability to represent very large numbers with smaller more manageable ones.

The table below highlights this and shows the ratio of the measured quantity to a reference, its scientific exponential form and its corresponding dB value using the equation given above:-

Measured Ratio	Exponential Form	$20 \cdot \log\left(\frac{P}{P_o}\right)$ dB
1	10^0	0
10	10^1	20
100	10^2	40
1000	10^3	60
10000	10^4	80
100000	10^5	100
1000000	10^6	120
10000000	10^7	140
100000000	10^8	160
1000000000	10^9	180
10000000000	10^{10}	200

It is worth noting that a doubling or halving of the sound pressure causes a 6dB change in the sound pressure level.

Example: -

If the sound pressure doubles in value as an example from 1Pa to 2Pa then the sound pressure level will increase by 6dB: -

$$Lp := 20 \cdot \log \cdot \left(\frac{1}{20 \cdot 10^{-6}} \right) dB \qquad Lp := 20 \cdot \log \cdot \left(\frac{2}{20 \cdot 10^{-6}} \right) dB$$

$$Lp := 94dB \qquad Lp := 100dB$$

Although an increase of 6dB represents a doubling of the sound pressure, an increase of approximately 10dB is required before the sound is perceived as being twice as loud. Approximately 3dB in sound pressure level is the smallest change we can detect.
If however the sound power doubles or halves then the sound power level change will be 3dB. This is commonly referred to as 3dB doubling.

Example: -

If the sound power doubles in value as an example from 1W to 2W then the sound power level will increase by 3dB: -

$$L_w := 10 \cdot \log \left(\frac{1}{10^{-12}} \right) dB \qquad L_w := 10 \cdot \log \left(\frac{2}{10^{-12}} \right) dB$$

$$L_w := 110 \cdot dB \qquad L_w := 113 \cdot dB$$

It is worth noting that a doubling or halving of the sound power level causes a 3dB change in the sound pressure level.

As decibels are logarithmic it is not possible to directly add or subtract decibel values.

Use the equation below to add or subtract decibel values (for subtractions simply replace the plus sign with a minus sign): -

$$10 \cdot \log \cdot \left(10^{\frac{A}{10}} + 10^{\frac{B}{10}} \right) dB$$

Example: -

To add 60dB and 65dB replace A and B with the 60 and 65 and then calculate the equation to give: -

$$60dB + 65dB := 66.2dB$$

Digital Signal Processor (DSP)

A digital signal processor is form of microprocessor with an optimized architecture required for the very fast mathematical processes used in digital signal processing.

The tremendous mathematical processing power available allows for much greater accuracy in the computed results than any other method.

Most modern Castle instruments implement the use of digital signal processors.

Doppler Effect

This is the apparent change of frequency of a sound wave due to relative motion between the source of the sound wave and the observer.

Imagine an observer is located on a Formula 1 race track and an F1 car approaches the observer at a constant speed and so the frequency the car produces is the same.

The observer hears the car approaching but as the car approaches it is getting nearer to the source and as such the sound waves apparent frequency gets higher which is noticed by a higher pitch sound from the car.

When the car passes by the observer this effect is reversed, hence the sound wave frequency decreases which is results in a lower pitch sound from the car.

Dose

See 'Noise Dose'.

Dynamic Range

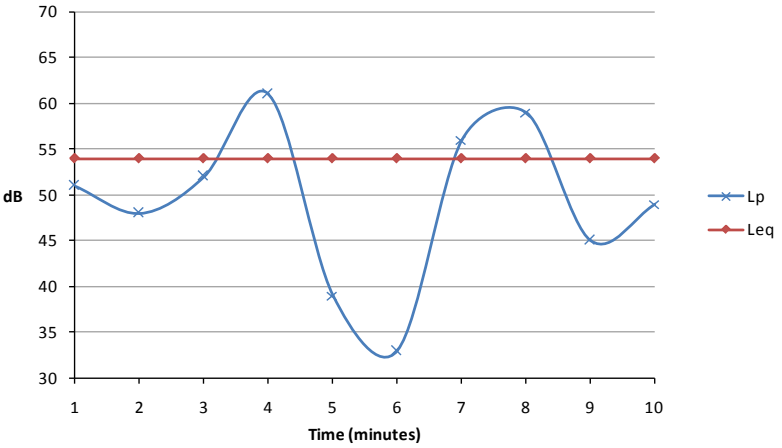
This is the total range of signal levels that an instrument can utilize between the upper and lower operating boundaries.

Lower operating boundaries are generally governed by electrical noise, whereas the upper operating boundary is generally governed by non-linearity due to signal clipping.

See also 'Noise Floor', 'Under Range' and 'Overload'.

Equivalent Continuous Sound Level (Leq)

Leq is the constant sound level over a given time that has the same sound energy of the varying noise source over the same time period. It can be measured using 'A', 'C' or 'Z' frequency weighting LAeq, LCeq, LZeq.



See 'Function Equations' to see how Leq is described mathematically.

In practice when measuring noise it is possible to take Leq readings with your instrument of short duration i.e. less than five minutes (providing all variations of noise emissions are covered). If the measured environment changes greatly, then the longer the Leq reading is taken, the more accurate the measurement will be.

Exchange Rate

As the sound pressure level increases above the criterion level then the allowed exposure time must be decreased. The allowed maximum exposure time is calculated by incorporating an exchange rate value. The exchange rate value is the amount by which the permitted sound level may increase if the exposure time is halved.

Castle instrumentation generally allows a user selection of exchange rate to allow for different legislation of 3dB, 4dB or 5dB.

Having an exchange rate of 3dB is more severe in terms of allowable exposure times, and an exchange rate of 3dB is currently used in the UK.

The following tables show the relationship between the exchange rate, the criterion level and the noise exposure limits: -

Noise Exposure Limits (Criterion Level = 75dB)			
Max Permitted Daily Duration (Hours)	3dB Exch Rate Allowable Level (dB)	4dB Exch Rate Allowable Level (dB)	5dB Exch Rate Allowable Level (dB)
8	75	75	75
4	78	79	80
2	81	83	85
1	84	87	90
0.5	87	91	95
0.25	90	95	100

Noise Exposure Limits (Criterion Level = 80dB)			
Max Permitted Daily Duration (Hours)	3dB Exch Rate Allowable Level (dB)	4dB Exch Rate Allowable Level (dB)	5dB Exch Rate Allowable Level (dB)
8	80	80	80
4	83	84	85
2	86	88	90
1	89	92	95
0.5	92	96	100
0.25	95	100	105

Noise Exposure Limits (Criterion Level = 85dB)			
Max Permitted Daily Duration (Hours)	3dB Exch Rate Allowable Level (dB)	4dB Exch Rate Allowable Level (dB)	5dB Exch Rate Allowable Level (dB)
8	85	85	85
4	88	89	90
2	91	93	95
1	94	97	100
0.5	97	101	105
0.25	100	105	110

Noise Exposure Limits (Criterion Level = 90dB)			
Max Permitted Daily Duration (Hours)	3dB Exch Rate Allowable Level (dB)	4dB Exch Rate Allowable Level (dB)	5dB Exch Rate Allowable Level (dB)
8	90	90	90
4	93	94	95
2	96	98	100
1	99	102	105
0.5	102	106	110
0.25	105	110	115

Fast Fourier Transform (FFT)

The French mathematical physicist Jean Baptiste Joseph Fourier found that it was possible to represent any waveform in the time domain as a sum of infinitely many sine and cosine terms.

FFT analysis can be performed on certain sound meter instrumentation and is where the instrument takes the time varying input signal and displays the calculated frequency spectrum. The frequency spectrum can then be examined to determine exactly which frequencies are causes for concern regarding noise levels or for preventative maintenance.

Feedback

A very simplified public address system will consist of a microphone an amplifier and a speaker. If sound from the speaker is detected on the microphone then this sound will be amplified again and output to the speakers. If the gain of this amplification is greater than one then the system becomes unstable and a high pitch squealing noise is heard.

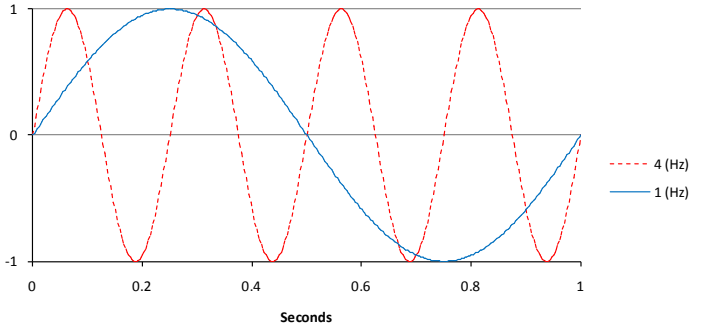
Frequency (Hz)

The number of cycles per unit of time measured in cycles per second (cps) and associated with the unit symbol Hz (Hertz) after the German physicist Heinrich Hertz.

1 cps = 1 Hz

The graph below shows the solid line having one complete cycle in one second and therefore having a frequency of 1Hz whereas the dotted line has four complete cycles in one second and therefore has a frequency of 4Hz.

Frequency is universally given the descriptor f, therefore the graph below shows f = 1Hz and f = 4Hz.



The audible hearing frequency range over which a normal human ear can detect is approximately 20Hz to 20kHz.

The range usually decays with age and generally this is of the higher frequencies.

If the level of a signal is sufficient and is of a frequency below 20Hz then it is generally felt and not heard.

Frequency Weighted Filter

This refers to a special filter that weights or adjusts the spectral component of a signal according to a specified function of frequency.

The specified functions of frequency are: -

A-Weighting

This is the most commonly used frequency weighted filter and was originally developed to adjust the signal frequency spectrum to match the sensitivity of an average human ear for sound pressure levels below approximately 50dB.

Now, this frequency weighting is used for all levels of sound pressure levels which progressively attenuate the signal at the upper and lower ends of the audible frequency range. It is widely used to measure environmental or industrial noise.

B-Weighting

This frequency weighting was originally intended to adjust the signal frequency spectrum to match the sensitivity of an average human ear for sound pressure levels between approximately 50 and 90dB.

It attenuates progressively at the upper and lower ends of the audible frequency range however the attenuation of the signal is less than with A-weighting.

This frequency weighting is not commonly used. As this weighting filter is not required for noise assessments it is not available on Castle instrumentation.

C-Weighting

Another commonly used frequency weighted filter and was originally intended to adjust the signal frequency spectrum to match the sensitivity of an average human ear for sound pressure levels above approximately 90dB.

It attenuates progressively at the upper and lower ends of the audible frequency range however the attenuation of the signal at low frequencies is much greater than with A-weighting.

This frequency weighting is commonly used for peak sound levels plus entertainment and machinery noise.

D-Weighting

This frequency weighting is intended to adjust the signal frequency spectrum to match the sensitivity of an average human ear for sound pressure levels between approximately 50 and 90dB.

It is similar in response to B-weighting but is improved upon by including an allowance for ear canal resonance at frequencies between approximately 2kHz and 5kHz.

This frequency weighting is generally used for the high level measurement of aircraft noise.

Like B-weighting it is not commonly used and is not available on Castle instrumentation.

Flat-Weighting

This frequency weighting does not adjust the signal frequency spectrum and has been superseded by Z-weighting because the flat frequency pass band is not governed meaning different responses between manufacturers of sound meter instrumentation.

Z-Weighting

Another commonly used frequency weighting filter that has a very flat frequency response only adjusting the signal frequency spectrum below approximately 10Hz and above approximately 20kHz.

This weighting replaces Flat-weighting so that sound meter manufacturers all had the same pass band limits.

A common use for this weighting is to determine adequate hearing protection as well as for peak measurement.

The following table shows the weighting required across the audible frequency range: -

Nominal Frequency (Hz)	Frequency Weighting Response (dB)		
	A	C	Z
10	-70.4	-14.3	0.0
12.5	-63.4	-11.2	0.0
16	-56.7	-8.5	0.0
20	-50.5	-6.2	0.0
25	-44.7	-4.4	0.0
31.5	-39.4	-3.0	0.0
40	-34.6	-2.0	0.0
50	-30.2	-1.3	0.0
63	-26.2	-0.8	0.0
80	-22.5	-0.5	0.0
100	-19.1	-0.3	0.0
125	-16.1	-0.2	0.0
160	-13.4	-0.1	0.0
200	-10.9	0.0	0.0
250	-8.6	0.0	0.0
315	-6.6	0.0	0.0
400	-4.8	0.0	0.0
500	-3.2	0.0	0.0
630	-1.9	0.0	0.0
800	-0.8	0.0	0.0
1000	0	0	0
1250	0.6	0.0	0.0
1600	1.0	-0.1	0.0
2000	1.2	-0.2	0.0
2500	1.3	-0.3	0.0
3150	1.2	-0.5	0.0
4000	1.0	-0.8	0.0
5000	0.5	-1.3	0.0
6300	-0.1	-2.0	0.0
8000	-1.1	-3.0	0.0
10000	-2.5	-4.4	0.0
12500	-4.3	-6.2	0.0
16000	-6.6	-8.5	0.0
20000	-9.3	-11.2	0.0

Frequency Band Filter

A frequency band is all the frequencies between an upper and lower frequency limit.

When a signal is passed through a frequency band filter the signal remains unaltered for the selected frequency band whilst all other frequencies are filtered out.

A common frequency band filter on sound meter instrumentation is an octave band filter. Here the frequency band is one octave (1/1) and the upper and lower limits are a factor of 2 apart.

The octave band can be further divided for greater resolution into one third octave bands (1/3) where the upper and lower limits are a factor of $2^{1/3}$ apart.

When one octave or one third octave bands are selected, the frequency that describes the band is the centre frequency.

In general sound meter instruments of higher specification have frequency band filtering and various Castle sound meter models have this facility.

To determine the degree of protection given by hearing protection, measurements using octave band analysis are generally required, however another method known as the HML method is also available allowing lower specified sound meter models without frequency band filtering to be used for this very important procedure. See also 'Hearing Protection'.

Hearing Protection

Hearing protection is generally more effective at higher frequencies, hence the performance of a given ear defender in a given noise environment must take into account the frequency content of the noise source.

Hearing protectors are either ear muffs (or defenders), which cover the ears, or ear plugs, which are inserted into the ear canals. Within these two groups there are several sub-divisions. Ear muffs can have several degrees of attenuation, whilst the ear plugs can be of a variety of materials, both disposable and re-usable.

Ear Muffs:
These consist of a cup shaped cover over each ear, held in place by a spring loaded headband. To ensure a good seal around the ear, the cups are edged with a cushion filled with liquid or foam. The degree of attenuation is affected by the material of the cup and its lining and the quality of the seal around the ear.

Ear Plugs:
These can be either disposable or re-useable and are made from a variety of materials.

Disposable plugs can be manufactured from glass down, plastic coated glass down and wax impregnated cotton.

Re-usable plugs can be made from permanent moulded plastic, paste filled rubber and paste filled plastic. (All re-usable plugs require washing after use and a sterile place for storage).

Semi-inserts:
These are pre-moulded ear caps attached to a headband which presses them against the entrance to the ear canal. This type of protector can be useful for those who spend short periods of time in ear protection zones.

Special types of protector:
Sophisticated ear protectors are now available which provide additional noise control facilities, for example built-in electronic active control systems.

Protection Calculation - Octave Band Analysis Method
To calculate the degree of protection given by hearing protectors to the highest accuracy it is necessary to measure the sound spectrum of the noise emitted at the workplace, using octave band analysis.

If the result is required in dBA, the A-weighting values at each octave frequency should be subtracted from the measured sound (Z-weighted) to find the 'corrected level'. Each corrected level can then be added together logarithmically to find the estimated noise level: -

	Unit	Octave Band Levels							
	Hz	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Measured LP (Z-weighted)	dB	92	96	102	101	98	97	94	93
A- weighting correction	dB	-26	-16	-9	-3	0	1	1	-1
Corrected level	**dB**	**66**	**80**	**93**	**98**	**98**	**98**	**95**	**92**
Estimated noise level	**104 dBA**								

The assumed protection of the hearing protector is given by the mean attenuation minus one standard deviation.

So, for example, at 500 Hz the assumed protection is 33 – 6 = 27 dB.

The assumed protection level should then be subtracted from the corrected levels (as above) to produce the estimated dBA at the wearer's ear and the octave band results logarithmically added as before to give the predicted level of noise with the hearing protection.

	Unit	Octave Band Levels							
	Hz	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Ear muff, mean attenuation	dB	-	13	20	33	35	38	47	41
Standard Deviation	dB	-	6	6	6	6	7	8	8
Assumed protection	dB	-	7	14	27	29	31	39	33
Corrected level	**dB**	**66**	**80**	**93**	**98**	**98**	**98**	**95**	**92**
Levels at ear	dB	66	73	79	71	69	67	56	59
Predicted level of noise with protection	**81 dBA**								
4dB correction	**85 dBA**								

In accordance with the Control of Noise at Work Regulations 2005, the predicted level of noise with hearing protection must be increased by 4dB, therefore the quotable predicted noise level taking into account the worn hearing protection is 85dBA.

Protection Calculation - HML Method (High Medium Low)
Not as accurate as the octave band method but can be used on instrumentation that do not have octave band analysis. This method can also be used for noise at work assessments.

Simply measure the A-weighted and C-weighted energy equivalent sound level (LAeq and LCeq) simultaneously.

LAeq = 103.2 dBA
LCeq = 103.4 dBC

Take the manufacturers ear protector data: -

H = 25 dB
M = 19 dB
L = 13 dB

Determine (LCeq – LAeq) and then enter the manufacturer's data into the relevant equation to find the predicted noise rating PNR: -

If (LCeq – LAeq) <= 2 then :-

$$PNR := M - \left(\frac{H - M}{4}\right) \cdot \left(L_{Ceq} - L_{Aeq} - 2\right)$$

If (LCeq – LAeq) > 2 then :-

$$PNR := M - \left(\frac{M - L}{8}\right) \cdot \left(L_{Ceq} - L_{Aeq} - 2\right)$$

Therefore as (LCeq – LAeq) = 0.2

$$PNR := 19 - \left(\frac{25 - 19}{4}\right) \cdot (103.4 - 103.2 - 2)$$

PNR = 21.7 dB

To find the A-weighted level at the ear subtract the PNR from LAeq: -

A-weighted level at ear = LAeq - PNR
A-weighted level at ear = 103.2 – 21.7 = 82 dBA
4dB Correction applied = 86dBA

In accordance with the Control of Noise at Work Regulations 2005, the predicted level of noise with hearing protection must be increased by 4dB, therefore the quotable predicted noise level taking into account the worn hearing protection is 86dBA.

Protection Calculation – SNR Method
This is the easiest but generally the least accurate method for calculating hearing protection.

Simply measure the C-weighted energy equivalent sound level.

LCeq = 101.0 dBC

Take the manufacturers ear protector data: -

SNR = 28 dB

To find the C-weighted level at the ear subtract the SNR from LCeq: -

C-weighted level at ear = LCeq - SNR
C-weighted level at ear = 101.0 – 28 = 73 dBC
4dB Correction applied = 77dBC

Note: As the SNR method requires C-weighted Leq (LCeq) and A-weighted Leq (LAeq) is a requirement of risk assesments then the HML method should be used in preference to the SNR method.

Leq

See 'Energy Equivalent Sound Level'.

Minimum rms Level (L_{min})

This is the lowest root-mean-square sound pressure level measured over the measurement time period.

The minimum rms level is widely recognised as LAmin, LCmin or LZmin depending on the frequency weighting selected and is measured in decibels (dB).

Maximum rms Level (L_{max})

This is the highest root-mean-square sound pressure level measured over the measurement time period.

The maximum rms level is widely recognised as LAmax, LCmax or LZmax depending on the frequency weighting selected and is measured in decibels (dB).

It is not to be confused with peak levels, which are very different.

Microphone

A microphone is the transducer that detects sound and creates an electrical image of it. The image created is a voltage level which is proportional to the sound pressure at the microphone.

A condenser microphone operates like a charging / discharging capacitor and is therefore also referred to as a capacitor microphone. The condenser microphone has a thin diaphragm and a solid back plate both of which construct the two plates required to form a capacitor. When a sound wave hits the diaphragm it vibrates and the distance between the diaphragm and back plate change. This variation in distance is realised as a capacitance change. A decrease in distance results in a charge current as the capacitance is higher and an increase in distance between the plates results in a discharge current as the capacitance decreases.

An external polarisation voltage must be applied across the condenser microphone for it to operate.

Electret condenser microphones operate using the same principle as condenser microphones with the exception that they do not need an external power source which is created during manufacture by using permanently charged materials.

All current Castle sound meters use electret condenser microphones.

Noise

Noise is generally regarded as unwanted sound.

See also 'Ambient Noise', 'Background Noise', 'Pink Noise', 'White Noise' and 'Sound'.

This is the amount of noise a person is subject to over a work shift and is expressed as a percentage.

The noise dose is calculated using the criterion level (LC), criterion duration (TC) which is 8 hours, exchange rate (Q) and the total measurement time (T).

$$Dose := \frac{100 \cdot T}{T_C} \cdot 10^{\left[\frac{(L - L_C)}{\frac{Q}{\log 2}}\right]}$$

In the UK the criterion level is 85dBA and therefore: -

100% dose = 85dBA for an 8 Hour Shift

Each time the sound level increases by 3dB the dose doubles given the same measurement time, similarly if the sound level decreases by 3dB the dose will halve for the same measurement time. See the following table: -

Lp dBA	Measurement Time (Hours)	Dose %
94	8	800
91	8	400
88	8	200
85	8	100
82	8	50
79	8	25

Doubling the measurement time doubles the dose and halving the measurement time halves the dose given the same sound level. See the table below: -

Lp dBA	Measurement Time (Hours)	Dose %
85	32	400
85	16	200
85	8	100
85	4	50
85	2	25
85	1	12.5

See also 'Criterion Level (LC)', Criterion Duration (TC)', 'Exchange Rate' and 'Function Equations' for a mathematical description of noise dose.

Noise Floor

This is the lowest sound pressure level that the meter can display on its operating range.

The instrumentation itself by its very nature of operation has some internal electrical noise which can be minimised only. The electrical noise therefore contributes to the noise floor on the lower ranges of the instrumentation.

Generally sound meters which are capable of reading very low sound pressure levels of 25 to 30dBA levels are of higher specification using specially designed low noise circuitry, guard rings on the pre-amplifier and higher sensitivity microphones.

See also 'Overload', 'Pre Amplifier' and 'Under Range'.

Overload

When the peak sound pressure level starts to exceed the signal handling capability of the pre-amplifier circuitry then an overload condition occurs and a warning is displayed on the instrumentation.
This value is generally specified by the manufacturer and usually just above the top of linearity range of the meter. When an overload condition occurs your instrumentation is likely to be operating out of specification with any results becoming invalid for noise assessments.

Where appropriate change to a higher range on your instrumentation. See also 'Noise Floor', 'Pre-Amplifier' and 'Under Range'.

Pre-Amplifier

This is a special low noise electronic amplifier to amplify the low level signals produced by the microphone.

Some pre-amplifiers are fitted with a special guard ring which surrounds the signal connector of the microphone and encapsulates the signal until it reaches the input stage of the amplifier. The guard ring is used to reduce the capacitance effects of inserting the pre-amplifier and in doing so reduces the instruments electrical noise which allows lower level signals to be measured.

Sound meter instruments are supplied with fixed or removable pre-amplifiers, where the pre-amplifier is removable it should have should have a unique serial number which is identified on the calibration certificate along with microphone and instrument serial numbers.

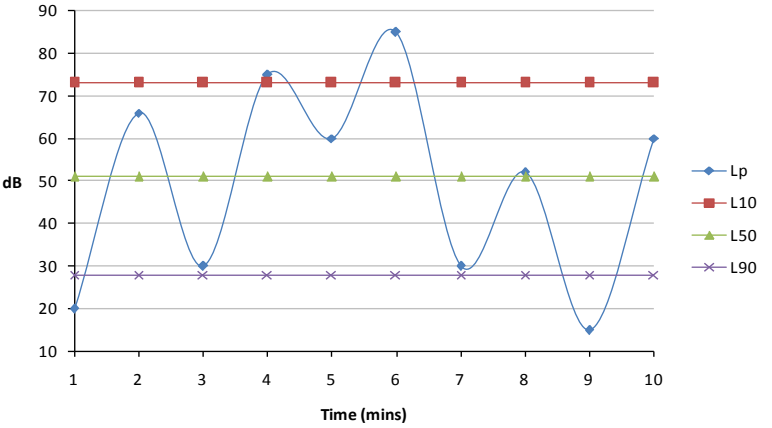
See also 'Noise Floor', Overload' and 'Under Range'.

Percentile Sound Levels

This is the sound pressure which has been subject to the A-weighting frequency filter and Fast response time weighting that is exceeded for n percent of the time.

Percentile levels are used greatly when measuring environmental noise and referred to as Ln. The value of n may be anything from 1 to 99 and is the noise level exceeded for n% of the measurement time.

By definition of percentiles, L1 must be greater than or equal to L2 which must be greater than or equal to L3 etc. It is often the case that only a few Ln values are ever used.



The figure above shows indicative L10, L50, L90 and the Sound Pressure Level (Lp) values.

L10 is the noise level exceeded for 10% of the measurement duration. This is often used to give an indication of the upper limit of fluctuating noise, such as that from road traffic.

L50 is the noise level exceeded for 50% of the measurement duration. It is simply the 'middle point' exceeded for 50% of the measurement duration and has been incorporated in some American Community Noise Assessments.

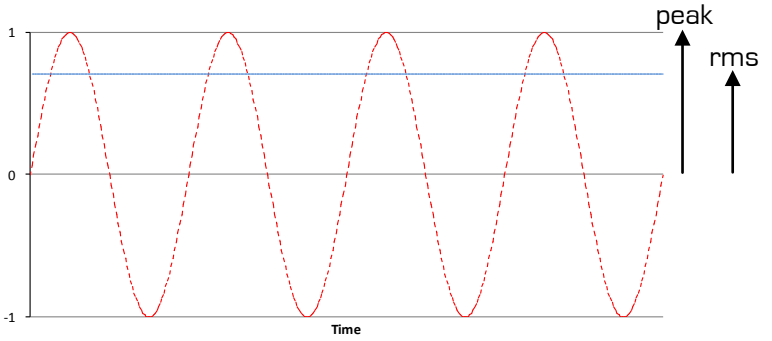
L90 is typically taken as the ambient or background noise level. As an example, it can be used in BS4142: 'Rating industrial noise affecting mixed residential and industrial areas'.

(L10 - L90) known as the Traffic Noise Index is used in the UK to measure annoyance responses to traffic:-

$$TNI := \left[4 \cdot \left(L_{10} - L_{90}\right) + \left(L_{90} - 30\right)\right] dB$$

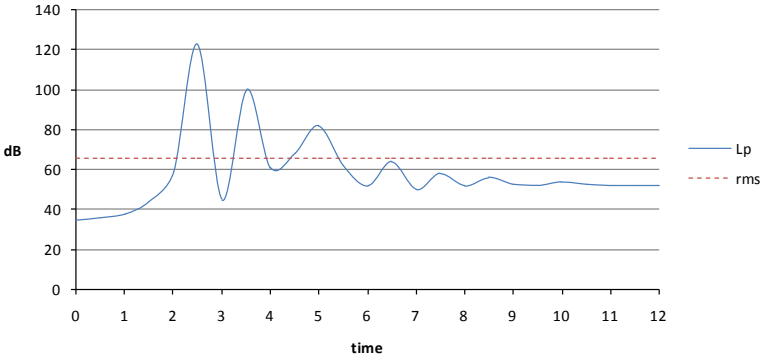
Peak Level

The peak level is the crest of the signal or sound pressure wave. The figure below shows the peak level and its corresponding rms level: -



Peak levels are commonly measured incorporating the C-weighted and Z-weighted frequency weighting filters and can be much higher than the rms sound pressure level.

See the indicative image below which shows a peak level of 123dB but the rms value is only 66dB.



See also 'Root Mean Square (rms)' and 'Action Values'.

Pink Noise

This is a random signal where each octave contains equal energy. Low frequencies will be more dominant with pink noise due to its power spectrum decay of a constant -3dB per octave as the frequency increases.

Residual Noise

This is the ambient noise remaining under normal conditions when any specific noise sources under investigation (for assessing the likelihood of complaints) are suppressed to a degree such that it does not contribute to the ambient noise. See also 'Ambient Noise'.

Root Mean Square (rms)

The abbreviated term rms is identified from the expanded term root mean square, also known as the quadratic mean.

The root mean square of a value is calculated by finding the **square Root** of the **Mean** of the **Squares** of the values.

Sound meter instruments use the rms sound pressure level for function calculations other than when the peak level is required.

See also 'Peak Level'.

Sound

This is a travelling wave or a disturbance in pressure which propagates through mediums such as solids, liquids or gases. Sound cannot travel through a vacuum.

The wave will compose of frequencies within the audible frequency range and be of sufficient amplitude for detection by the ear. See also 'Audio Frequency Range'.

Sound Exposure (SE)

This is a measure of the total A-weighted sound energy of the sound produced over a specified period of time.

It is specifically defined as the time integral of the square of sound pressure over a stated period of time and expressed in Pascal squared seconds if the A-weighted sound pressure is in Pascal's and the time period is in seconds.

$$SE := \int_{t1}^{t2} (P_A)^2[t]\, dt$$

where PA is the A-weighted sound pressure and t2-t1 is the time interval for the measurement or specified time period, in seconds.

Sound Exposure Level (LAE)

Like sound exposure it is a measure of the total A-weighted sound energy of the sound produced over a specified period of time, however it is expressed in dB.

The sound exposure level is used to describe the amount of noise from a single event such as an aircraft flying overhead or a train pass by.
It is the integration of all the acoustic energy contained within this single event over the time period t2-t1 with reference to a sound pressure of 20μPa consistent over a reference time period of 1 second.

See 'Function Equations' to see how LAE is described mathematically.

Sound Power (W)

This is the rate of flow of acoustic energy emitted from a specific sound source.

Sound power is expressed in watts (W).

Sound Power Level (LW)

Like sound power this is the rate of flow of acoustic energy emitted from a specific sound source, however the sound power level is expressed in decibels (dB).

$$L_w := 10 \cdot \log\left(\frac{W}{W_o}\right) dB$$

where Wo is the reference power of 1 Pico watt (10^{-12} watts) and W is the sound power.

It is often quoted on machinery to indicate the total sound energy radiated per second.

Sound Pressure

This is the difference between the ambient sound pressure and the instantaneous sound pressure caused by a noise source.

The sound pressure is expressed in Pascal's (Pa).

Sound Pressure Level (Lp)

Like sound pressure this is the difference between the ambient sound pressure and the instantaneous sound pressure caused by a noise source, however the sound pressure level is expressed in decibels (dB).

$$L_p := 20\log\left(\frac{P_{rms}}{P_o}\right)\text{dB}$$

where Prms is the root mean square sound pressure and Po is the reference sound pressure of 20μPa.

Specific Noise

This is the equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval.

Speed of Sound (c)

The speed at which sound travels through a given medium.

The speed of sound in air is determined by the air itself, it is not dependent on the amplitude or frequency of the sound wave and can be calculated using the following equation: -

$$c_{air} := 331.3\cdot\sqrt{1+\frac{\text{temp[degC]}}{273.15}}\,\text{ms}^{-1}$$

Threshold Sound Level (Lt)

This is the level at below which the noise dose is not accumulated.

Where available, Castle instrumentation has selections of OFF, -5dB or -10dB.

As an example if the threshold is set at -5dB, then arithmetically subtract 5dB from the selected criterion level to determine the level at below which sound pressure levels can be ignored and not included in the dose accumulation: -

If Criterion Level = 85dB and Threshold = -5dB then the threshold sound level is 80dB.

This only affects %Dose calculations.

Time Weighting

This refers to a special filter that applies an exponentially decaying weighting factor to the signal. Several rates are available:-

Slow-Weighting

The rise and fall times applied for Slow Weighting are both 1 second.

Fast-Weighting

The rise and fall times applied for Fast Weighting are both 125m seconds.

Impulse-Weighting

The rise and fall times for Impulse Weighting are 35m Seconds and 1.5 seconds respectively.

Under Range

When the sound pressure level tends towards the noise floor for the selected range of the instrumentation then an under range condition occurs and a warning is displayed on the instrumentation.

This value where the warning is displayed is generally specified by the manufacturer and usually just the below the bottom of the selected range.

When an under range condition occurs your instrumentation is likely to be operating out of specification.

Where appropriate change to a lower range on your instrumentation. See also 'Noise Floor', 'Overload' and 'Pre-Amplifier'.

White Noise

This is a random signal where each frequency contains equal energy and whose power spectrum remains constant.

Z-weighting

See 'Frequency Weighted Filter'.

Chapter 13

Customer Instrument Support

Warranty and After Sales Service

Castle Group Ltd design and manufacture precision instruments, which if treated with reasonable care and attention should provide many years of trouble free service.

In the event of a fault occurring, during the warranty period, the instrument should be returned to Castle Group Ltd, in its original packaging, or to an authorized agent. Please enclose a clear description of the fault or symptom.

Details of the warranty cover are available from Castle Group Ltd or an authorized agent.

All instruments are designed to meet rigid British and International Standards. An annual calibration is recommended to ensure that these high standards are maintained. This is particularly important for cases in which instrument readings are to be used in litigation or compliance work.

For warranty and service return to: -

The Service Department
Castle Group Ltd
Salter Road
Cayton Low Road Industrial Estate
Scarborough
North Yorkshire
YO11 3UZ
United Kingdom

Telephone:	+44 (0)1723 584250
Fax:	+44 (0)1723 583728
Email:	techsupport@castlegroup.co.uk
Web:	www.castlegroup.co.uk

Any misuse or unauthorized repairs will invalidate the warranty.

Damage caused by faulty or leaking batteries is not covered by the warranty.

Question	Answer
My instrument will not turn on?	Check that there is a battery fitted to the instrument and of correct polarity. Check that the battery is not flat.
What is the white plastic cap fitted to the top of the microphone?	This is a protective cover for the sensitive microphone. You must remove it before using the instrument.
Where have my results gone?	Models I or B do not have a backup memory so all readings are lost when the instrument is switched off. Always take a note of important readings before switching off the instrument.
My instrument is on but will not respond to keypad presses?	Have you locked the keypad ?
I keep getting CAL FAIL when trying to calibrate my instrument – what am I doing wrong?	Is the instruments microphone properly inserted in the calibrator? Is the calibrator switched on and working? Has the instrument and/or calibrator been knocked or moved as the calibration routine is taking place? Has the microphone been damaged?
What is the black o-ring inside my calibrator's cavity for?	The o-ring is essential to seal around the microphone stabilizing the pressure in the calibrator's cavity. If the o-ring is missing and/or damaged the instrument will not calibrate properly (see above).
When taking readings the display is constantly flashing **UR** – what does this mean?	This means that the noise you are measuring is below the bottom of the range you have the instrument selected to. Try selecting a lower range
My readings are within range but I keep getting OVERLOAD flashing on the screen – why is this?	The overload is triggered by the Peak reading whereas Lp and Leq are rms figures which are lower. Some noises feature very high peaks compared to the rms.

Instrument Disposal

The symbol shown to the left can be found on your instrument and means that the product is classed as electrical or electronic equipment and should be disposed of at the end of its life separately to your commercial or household waste.

The Waste of Electrical and Electronic Equipment Directive (2002/96/EC) has been established to help reduce the influx on landfill sites and effectively treat hazardous substances by using best practices for the recovery and recycling of products.

Over 75% of waste electrical goods end up in landfill, where lead and other toxins contained in the electrical goods can cause soil and water contamination.

This can have a very harmful effect on natural habitat, wildlife and also human health. When situated near populated areas these toxins can cause problems to communities as their water and soil is polluted.

Many of the electrical items that we throw away can be repaired or recycled. Recycling items helps to save natural finite resources and also reduces the environmental and health risks associated with sending waste electrical goods to landfill.

To minimise our impact on this earth and to protect the environment for future generations it is important that we are all aware of the consequences of our actions and how we can make a difference.

There are various collection systems in place within the EU for the disposal of your product. To find the nearest UK waste recycling point in your area, enter your postcode in the website **www.recycle-more.co.uk**

For more information please contact your local authority, the dealer where you purchased your product or Castle Group Ltd

Disclaimer

Whilst every effort is made to ensure the accuracy and reliability of both the instrument described and the associated documentation, Castle Group Ltd makes no representation or warranties as to the completeness or accuracy of this information.

Castle Group Ltd assumes no responsibility or liability for any injury, loss or damage incurred as a result of misinterpreted or inaccurate information.

Any documentation supplied with your product is subject to change without notice.

Instrument Details

For your records and for future correspondence with Castle Group Ltd regarding your instrument, please complete the following details: -

Instrument Model

Instrument Serial Number

Pre-Amplifier Serial Number (GA116 I, L & E Only)

Microphone Serial Number

Purchase Date

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