



Including Intrinsically Safe (I.S.)
Models

User Manual

HB4056-07 (EN)



Thank you for purchasing the Casella dBadge2 Personal Noise Dosimeter. We hope that you will be pleased with it and the service that you receive from us and our distributors. If you do have any queries, concerns or problems, please do not hesitate to contact us.

Casella prides itself on providing precision instrumentation since 1799, supplying eminent figures including Darwin and Livingstone. A lot has changed in our 200+ year history but what does remain is our commitment to reliable, trustworthy and credible solutions.

For more information or to find out more about Casella and our products, please visit our website at: <http://www.casellasolutions.com>

UK Office**Casella**

Regent House
Wolseley Road
Kempston
Bedford
MK42 7JY

Tel: +44 (0)1234 844100

Email: info@casellasolutions.com

United States**Casella Inc.**

415 Lawrence Bell Drive
Unit 4
Buffalo
NY 14221
USA

Phone: +1 (716) 2763040

Email: info@casellausa.com

China**Ideal Industries China**

No. 61, Lane 1000
Zhangheng Road
Pudong District
Shanghai 201203
China

Phone: +86 21 31263188

Email: info@casellasolutions.cn

India**Ideal Industries India PVT Ltd**

229-230 Spazedge
Tower B, Sohna Road, Sector 47
Gurgaon 122001
Haryana
India

Phone: +91 124 4495100

Email: Casella.Sales@ideal-industries.in

1. Introduction

Noise induced hearing loss (NIHL) remains one of the world's leading occupational diseases and it has been estimated that 16% of global hearing loss is due to occupational noise exposure. It is acute in the mining, construction, oil & gas sectors but also in a wide variety of industrial manufacturing and other commercial activities where the cumulative effects of excessive noise exposure could lead to this avoidable condition.

Noise exposure measurements using a personal noise dosimeter such as the dBadge2 is a recognised method of making an exposure assessment as required by regulations and/or standards such as *CFR 1910.95 Occupational noise exposure (USA)*, *ISO9612:2009 Acoustics – Determination of occupational noise exposure – Engineering method*, *HSE Document L108 Controlling Noise at Work – Guidance on Regulations*.

The original dBadge proved an invaluable tool in monitoring personal exposure but dBadge2 is the next generation, taking all of those features and usability and building on them; a true evolution. New features of the dBadge2 include:

- Full colour display with colour-coded screens and alarms
- Bluetooth® 4.0 wireless connectivity
- Airwave App for mobile devices such as smartphones & tablets
- Multiple simulated dosimeters (termed D1, D2 & D3)
- Motion sensor
- 1 second time history profiling
- Pause function
- Recording of audio events (Plus & Pro models)
- Real-time octave band frequency analysis (Pro model only)
- USB download via Docking Station (and combined charger)
- Updated & simplified Plug-in for Casella Insight data management software

The models and other key features of the dBadge2 range are listed below:

			
Intrinsically Safe Models Available	•	•	•
H-M-L (C-A)	•	•	•
Programmable Delay Timer	•	•	•
Fixed Run Timer	•	•	•
Pause Function	•	•	•
Wireless*	•	•	•
Time History	•	•	•
Audio Recording		•	•
Octave Band			•

Each of the above models is available with Intrinsic Safety (I.S) approval or as a standard non-I.S versions. Only instruments displaying the appropriate intrinsic safety marking label may be used in hazardous explosive environments.

The addition of Bluetooth® 4.0 wireless connectivity and the supporting Airwave App enables remote control and monitoring of the instrument's status such as battery usage, memory capacity and measurement progress without having to disturb the worker. This added confidence in the measurement minimises the likelihood of having to repeat a survey due to potentially flawed data and therefore maximises your productivity.

Personal noise exposure measurement can be confusing given the plethora of parameters available and the combination required to meet different standards and regulations, but the dBadge2 has been specifically designed to simplify the process. Like its iconic predecessor, the dBadge2 concept is to capture every possible noise exposure related parameter during a measurement run and make it available for subsequent download and analysis. The user has only to choose the most relevant parameters to display on the screen.

The dBadge2 thus uses a '*multiple simulated dosimeter*' concept to display noise exposure values according to these differing standards and regulations. The '*simulated dosimeters*' are referred to as D1, D2 and D3 throughout this user manual and they define the measurement parameters that are displayed on screen.

The primary dosimeter (D1) provides any LAVG or LEQ based noise dose parameter plus a comprehensive set of related values. LEQ based noise exposure assessment e.g. to European standards, will typically only ever require the D1 dosimeter meaning D2 and D3 may be switched off in the configuration menu available on power up.

Dosimeters D2 and D3 allow the display of additional LAVG based noise dose values based on combinations of Threshold (T), Criterion (C) and Exchange rate (Q factor). As an example, a US customer may wish to simultaneously compare noise exposure data based upon the OSHA Hearing Conservation (HC), OSHA Personal Exposure Limit (PEL) and ACGIH requirements.

A user defined custom set up is also available for those who have their own internal standards that may exceed the exposure requirements laid down by regulations. This custom set up is available from Casella Insight.

It should be noted that for every measurement run, the dBadge2 records a comprehensive data set which means that you can retrospectively analyse the results within Casella Insight, regardless of what was displayed on the instrument in D1, D2 or D3.

2. Hazardous Area Installations Specific Information

Instructions specific to hazardous area installations (reference European ATEX Directive (2014/34/EU, Annex II, 1.0.6.)

The following instructions apply to equipment covered by certificate numbers, **CML 16ATEX2007X, IECEX CML 16.0006X and QPS USA and Canadian certificate LR1409-1** for the *dBadge2* series:

The certificate number includes an 'X' suffix indicating that the following conditions of certification and special conditions of safe use apply;

- 1) No precautions against electrostatic discharge are necessary for portable equipment that has an enclosure made of plastic, metal or a combination of the two, except where a significant static-generating mechanism has been identified. Activities such as placing the item in a pocket or on a belt, operating a keypad or cleaning with a damp cloth, do not present a significant electrostatic risk. However, where a static-generating mechanism is identified, such as repeated brushing against clothing, then suitable precautions shall be taken, e.g. the use of anti-static footwear.
- 2) Do not charge the batteries or download data from the instrument in a hazardous area.
- 3) The *dBadge2* must only be charged using Docking Station, Casella part number 207107B connected to a PELV/ SELV power adapter that meets the requirements for the rated U_m (i.e. Casella part number PC18 or equivalent).
- 4) The *dBadge2* data must only be downloaded using Docking Station Casella part number 207107B. The USB circuit must only be connected to a safety extra low-voltage circuit (SELV) or protective extra low-voltage circuit (PELV).
- 5) Do not remove the microphone in hazardous area.

For details of the *dBadge2* Intrinsic Safety Classification markings, please refer to the specifications [section of this manual](#)

In addition, the following Warnings and Conditions should be noted:-



Only specific versions of this product are available with Intrinsic safety approval for use in Explosive environments. Please review the instruments markings label and the specifications section of this manual to determine I.S classification and suitability.



The CEL-120/2 acoustic calibrator must only be used to calibrate dBadge2 instruments in a non-hazardous atmosphere.



The dBadge2 contains no user serviceable parts. DO NOT open the product case, this will invalidate the warranty. Repair and calibration of this equipment shall only be carried out by the manufacturer or an authorized agent.



Use only the recommended CEL-252 microphone. To protect the microphone from wind noise and dirt ingress it is recommended that the windscreen is always fitted in normal use. Carefully locate the screw threads when fitting the microphone and only screw the microphone on 'finger tight'.



If the equipment is likely to come into contact with aggressive substances, then it is the responsibility of the user to take suitable precautions that prevent it from being adversely affected, thus ensuring that the type of protection is not compromised. Aggressive substances e.g. solvents may affect polymeric materials.



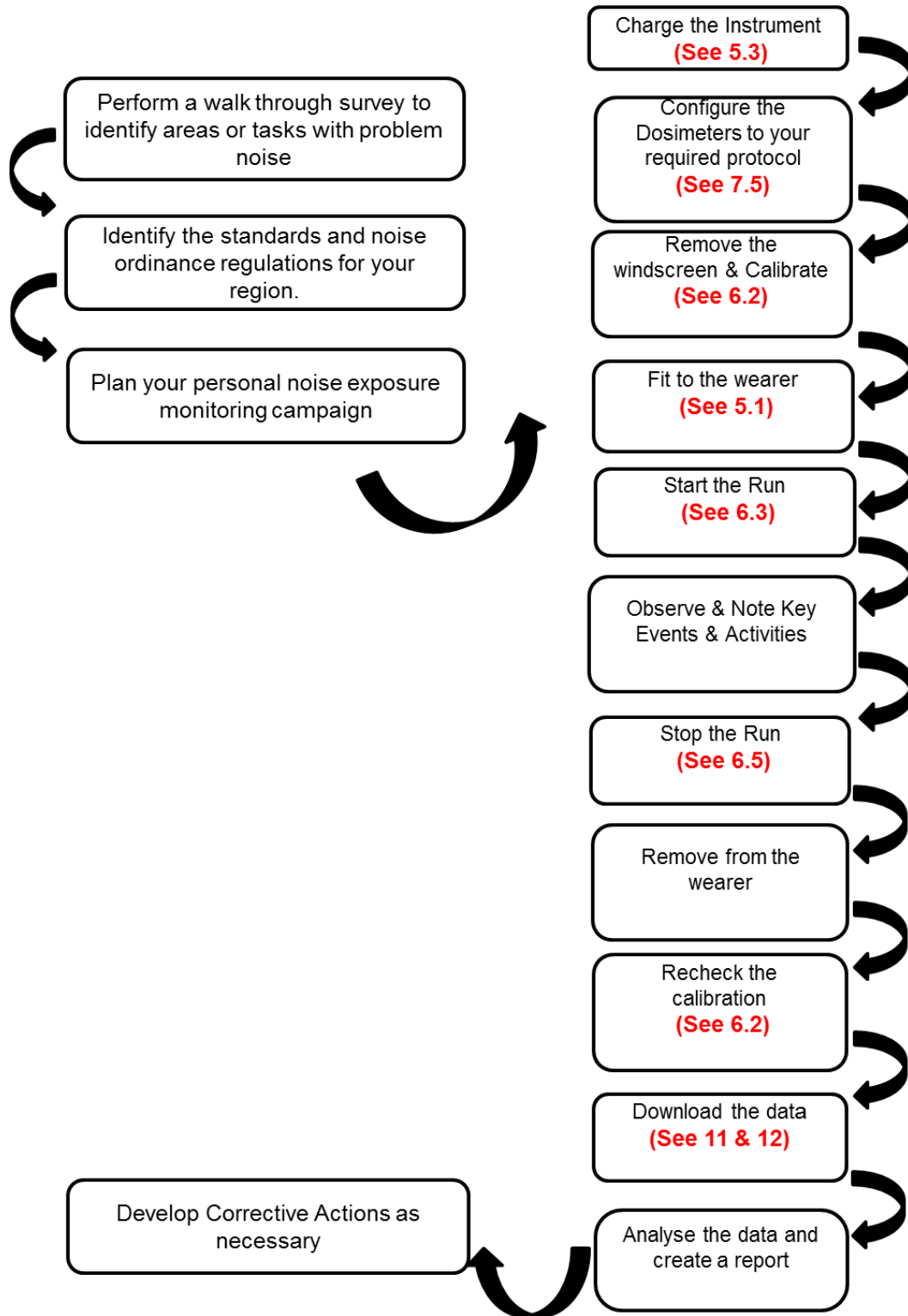
When Bluetooth® is enabled, care must be taken to avoid interference with sensitive equipment such as in medical, aviation or safety critical environments.

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4. Typical Steps in a Noise Assessment



5. Getting to know your instrument and accessories

When delivered, dBadge2 will have its microphone, windscreen and mounting clips already assembled. The following spares are available; a replacement pack of 5 Windscreens (part number DB2WS) and 5 pairs of clips (part number DB2CLIPS).

The dBadge2 serial number is located on the rear label and should be quoted in any communication with Technical Support or Service.



If purchased as a complete measuring kit it will also come supplied with a CEL-120/2 Acoustic calibrator & 2 off AAA batteries, combined Docking Station & charger, PC18 Universal Mains power supply, CMC51 USB cable, Data Download Utility software (supplied on a memory stick) and kit case suitable for up to 10 dBadge2 instruments and 3 Docking Stations.

Casella Insight is available for download from the Support section of the Casella website (www.casellasolutions.com). Please visit the support section for information on downloading the Airwave App or visit 'GooglePlay' or the 'Apple Playstore'.

5.1 Mounting the dBadge2

The recommended location for mounting a personal noise exposure meter is normally in a position close to the ear (10-15cm). The dBadge2 should therefore be mounted on the apex of the shoulder to avoid reflections from the head which might otherwise affect the measurements. Please refer to your local Legislation and Standards for more information.

Upon delivery, the dBadge2 will be fitted with crocodile-style mounting clips on flexible webbing to aid positioning. The clip assembly simply snaps in place but are designed to 'fail safe' i.e. the tab on the black plastic part that mates with the main body of the instrument has to be lifted (pulled) to remove it (in normal use it would tend to be pressed/pushed).



Should the clip assembly require replacement, hold the dBadge2 with the back uppermost in one hand and with the other hand simultaneously lift the tab with a finger whilst pulling the clip away from the dBadge2 body. There is a knack to this operation to deter tampering. A pack of spare clips (5 pairs) is available (part number DB2CLIPS). When refitting the clip assembly ensure that the tab is locked by pushing it into place and pull on the clip assembly to check that it is secured.

A pin attachment (part number CL63) is also available which can be secured directly via the clip or be attached to the webbing.



It is also possible to attach the dBadge2 to a harness (part number D8147/Z) by feeding the harness through the blank webbing buckle clip fittings (part number 207073B). For any existing harness that an employee might already be wearing, use the pin attachment. In addition, the dBadge2 may be mounted to most hard hats using the mounting kit (part number CEL-6354) and safety pins. This consists of a strap with four hooks which loop over the rim of the hard hat.

5.2 The Microphone & Windscreen

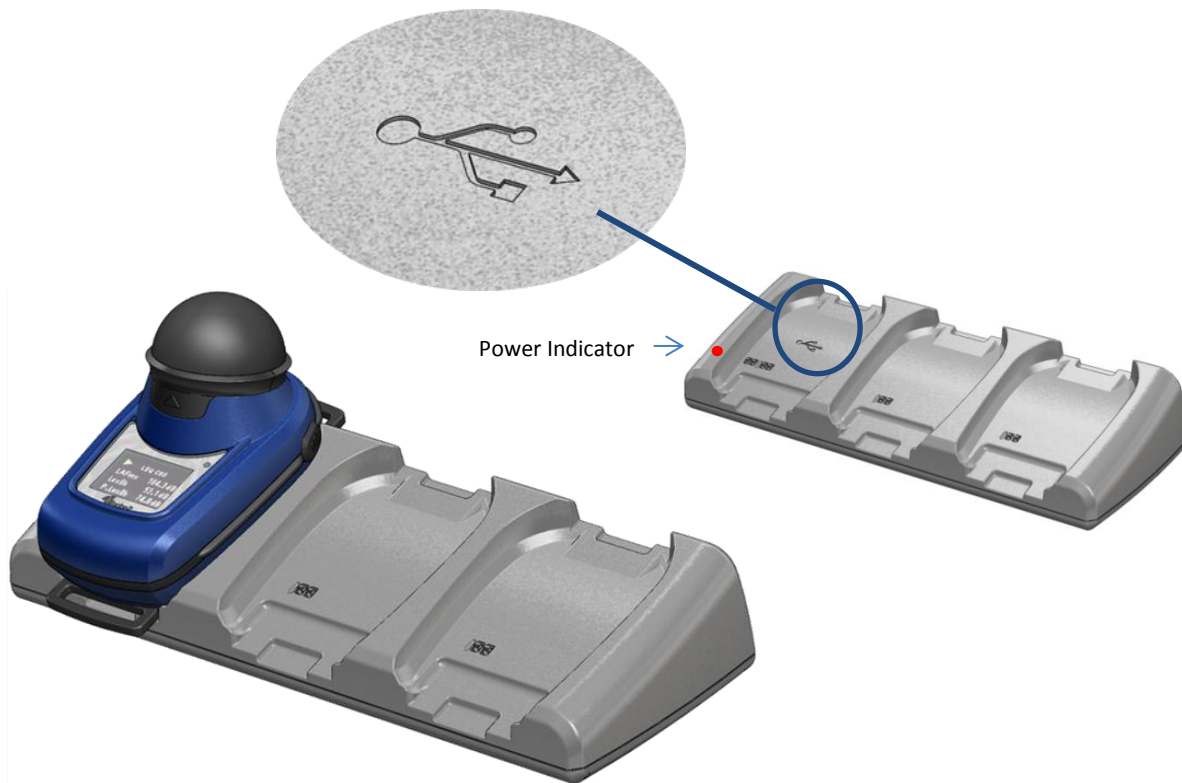
During use, it is essential that the dBadge2 is fitted with the Windscreen (part number 207069B, supplied). The Windscreen protects the microphone from potential erroneous results due to air movement passing over it but also helps to protect from dust ingress, moisture or minor impact damage. It will not normally be necessary to remove the microphone but should you wish unscrew in an 'anticlockwise' direction. When refitting take care not to overtighten as the fine thread could become damaged (finger tightening is sufficient).

To calibrate the dBadge2 it is necessary to remove the Windscreen to expose the microphone. Grip the dBadge2 body and push the windscreen in the direction of the arrow indicated on the tab of the Windscreen. Do not pull on the foam which may become detached and hence need replacing (replacement pack of 5, part number DB2WS)

Following calibration (see Section 6.2) refit the Windscreen by aligning the tab with the recess in the main body of the dBadge2. An audible "click" confirms that it is securely in place.



5.3 Charging the dBadge2



The internal Nickel Metal Hydride (NiMH) battery of the dBadge2 is charged via an intelligent combined docking station and 3-way charger (part number 207078B, 207107B for IS version), the left most pocket on the charging station is used to download data from the dBadge2 memory.

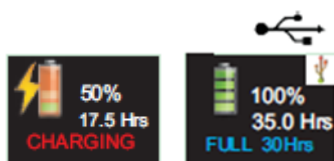
It consists of the docking station itself and a wall mounted power supply (part number PC18) which requires an appropriate plug adaptor for the country of use (a selection is supplied) and connects to either of the 12V connectors on the rear of the docking station.

The 'docking pocket' with the USB symbol is specifically reserved for downloading data (but will also charge a dBadge2). For more information please refer to Section 12 but note that to download, the docking station must be powered.

Ensure the PC18 power supply is connected and the supply is switched on; a red LED on the docking station will illuminate to show that power is on. When a dBadge2 is placed in any pocket charging will automatically start. The dBadge2 will display the battery charging status, i.e. 'charging' or 'full' and the LED will flash red. It will also show the percentage of battery charge and an estimation of battery usage time. Note: the estimation of usage time is based on the load conditions i.e. if octave band frequency analysis has been selected this will reduce the estimated run time from the maximum of approximately 35 hours. After approximately 20 seconds the display will blank and the red LED on the dBadge2 will continue to flash. Pressing either the left hand 'L' or right hand 'R' key (or tilting the docking station) will wake the display for a further 20 seconds to check progress. Once fully charged the LED will turn blue.

A charge time from empty to full is approximately 6 hours which will allow a run of circa 35 hours. Note this is with no audio recording or octave band analysis and assumes that the display is off for 95% of the time.

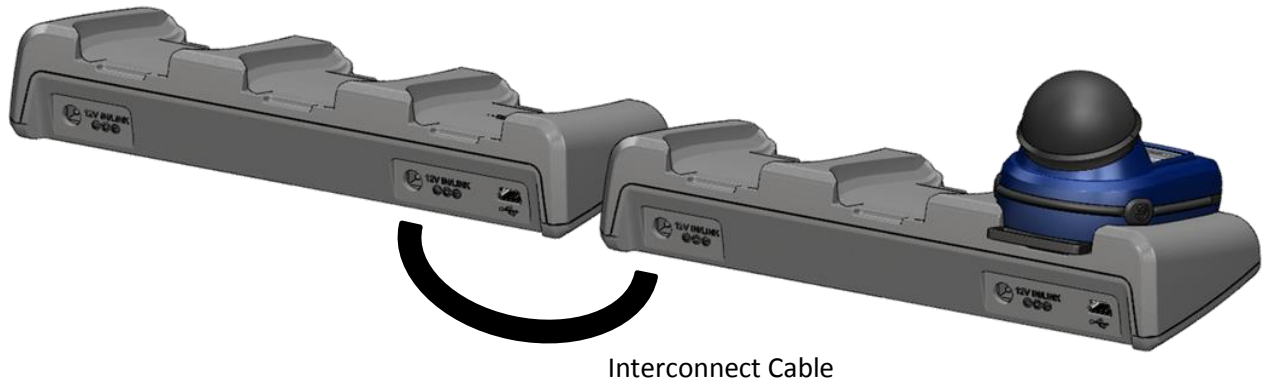
Shorter charge times will result in reduced pro-rata run times.



Estimated battery life is 1000 cycles. The NiMH battery is integral to the dBadge2 and must only be replaced by a qualified person.

5.3.1 Linking Docking Stations Together

A master docking station can be linked to another via an interconnect cable (C6359/0.2 supplied with part 207078B/EXT). Up to 3 docking stations can be linked to the master as shown below enabling up to 12 dBadge2s to be charged simultaneously from one PC18.



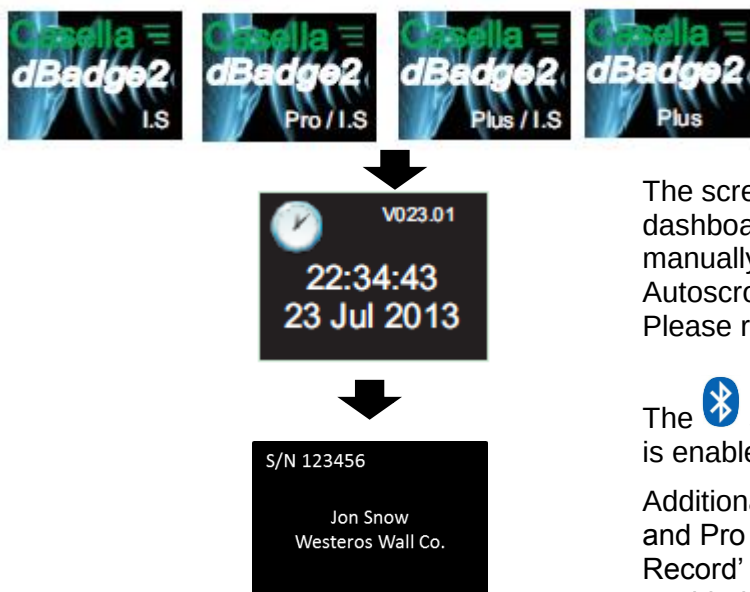
6. Using the dBadge2

6.1 Switching on the dBadge2

Press and release the left 'L' key to turn the dBadge2 on and a start-up sequence will commence.

If you wish to configure the dBadge2 manually then this must be done at this point. Please refer to Section 7 for further details.

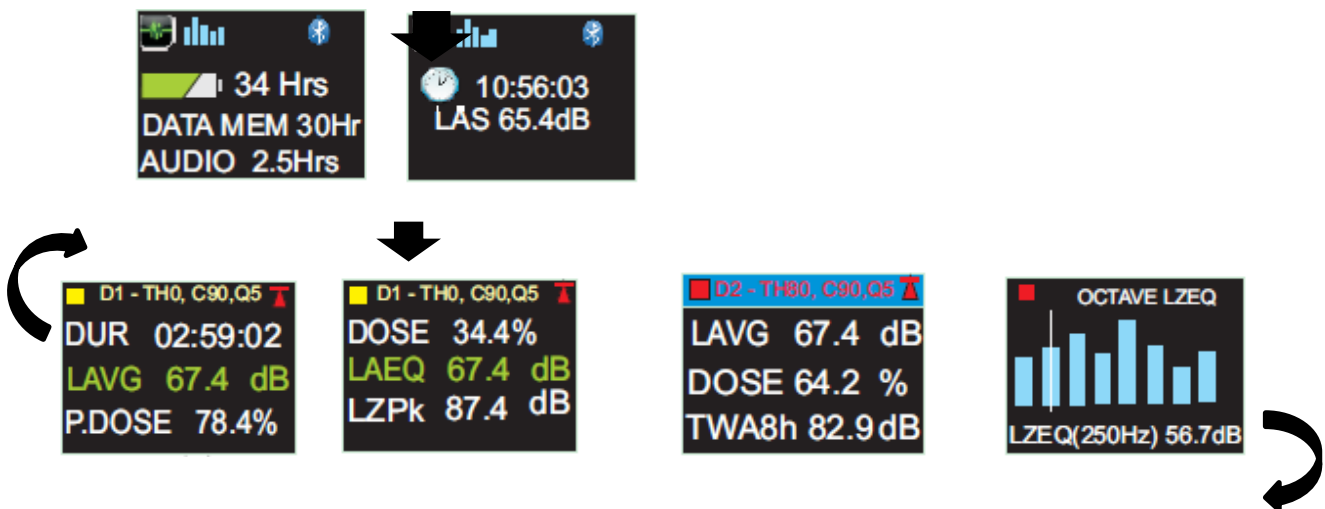
This initial start-up screen displays the dBadge2 model number. A second screen then displays the time and date and firmware version (e.g. 207.007.04.00) and a third screen displays the serial number of the dBadge2 with two lines of user-defined text. This may be up to 32 characters and is input via Casella Insight data management software.



The screen then defaults to the main dashboard screens which either auto or manually scroll depending whether the Autoscroll feature has been enabled. Please refer to Section 7.14.

The  symbol shows that Bluetooth® is enabled.

Additional symbols appear in the Plus and Pro models and denotes 'Audio Record' and/or 'Octave' modes are enabled.



If the Autoscroll feature has been disabled (see Section 7.14) pressing the right 'R' key will scroll through the available results from the last run depending upon how the dBadge2 was configured e.g. octave band results are shown above, which are only available on the Pro model and if selected in the configuration menu (see Section 7.8).

6.1.1 Error Messages At Power Up

If there are any error messages they will appear after the initial start-up screens:



Warning messages appear when there is less than 9 hours charge or less than 9 hours memory (based on standard usage). Press any key to return to the default screen or alternatively these error messages will time-out after 30 seconds. Please either re-charge, download and/or erase data as required before continuing with a new measurement run.

6.2 Calibrating the dBadge2

It is best practice (and often mandatory) to field calibrate each dBadge2 both before *and* after use. The dBadge2 records calibration levels and times which can be viewed when the data is downloaded. Using the Casella Insight data management software allows the target calibration level to be set as shown on the calibrator's own calibration certificate, nominally 114.0dB.

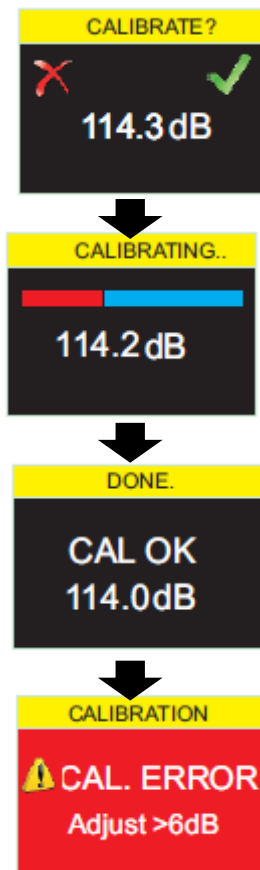


Note: the dBadge2 will not enter the calibration mode if a measurement run is taking place. If a run is in progress, stop the run according to Section 6.5.

The windscreen should be removed prior to calibration. Please refer to Section 5.2

Push the CEL-120/2 (or other approved) acoustic calibrator over the microphone as shown. The calibrator should be pushed on without twisting (which may loosen or overtighten the microphone) until fully home and switched on.

The dBadge2 will automatically recognise a 1kHz calibration tone and enter the calibration mode.



Press the right 'R' key to confirm you wish to calibrate, or the left 'L' key to cancel the operation. It will take a few seconds to automatically calibrate to 114 dB during which time a progress bar is displayed as shown.

Once the dBadge2 has successfully calibrated the 'CAL OK' message will appear.

In the unlikely event an error message is displayed please refer to the 'Troubleshooting' section.

The dBadge2 is ready to take a measurement once the calibrator has been removed and the Windscreen re-fitted.

You may need to consult local regulations or standards if the 'before' and 'after' calibration values differ by more than (typically) +/- 0.5dB e.g. section 12.2 of ISO 9612:2009 suggests that the measurement is re-taken.

6.3 Starting a Measurement Run

Before starting a measurement run, ensure the Windscreen is fitted according to Section 5.2 and ensure there is sufficient battery life and memory by looking at the default screen shown in Section 6.1.

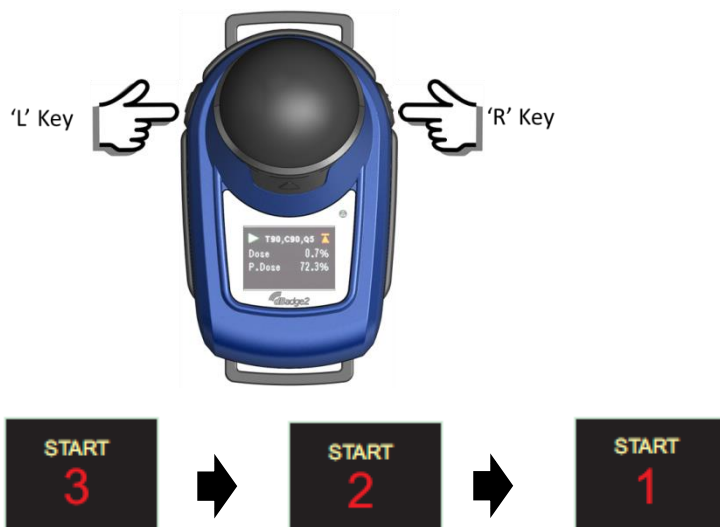
If necessary, charge the dBadge2 as described in Section 5.3. If the memory is full either clear it as described in Section 7.17 or download the data to Casella Insight data management software.

Note: if the battery or memory available is less than one hour, the run will not start.

Regardless of whether D1, D2 or D3 is selected for display purposes, ALL parameters are calculated and stored simultaneously and can be viewed when data is downloaded.

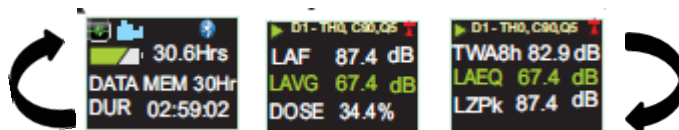
Timers are also available to automatically start and stop a measurement run or halt a run after a fixed period. These options may be selected in the Configuration menu, see Section 7.15.

To manually start a measurement run, press and hold both the left 'L' and the right 'R' keys down together which will initiate a 3 second countdown as shown.

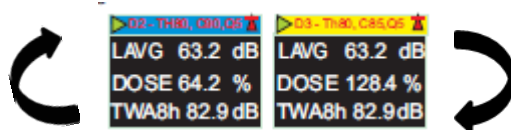


The keys must remain depressed during the countdown for the measurement run to begin; releasing during the 3-2-1 countdown will cease the operation.

Once the measurement has begun, the ► 'play' symbol will appear in the top left of the screen. The display will cycle between the following screens if the Auto-scroll mode has been selected in the configuration menu (see Section 7) or may be scrolled manually by pressing either the left 'L' or right 'R' key:

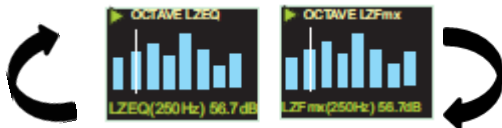


If Dosimeters D2 and D3 are enabled, the following screens will also be displayed;



D1 is the primary dosimeter which reports selected dose values plus other noise parameters (peak, max etc.) D2 and D3 offer additional. The header bar for D1 measurements is the background screen colour, D2 has a blue header bar and D3, a yellow header bar.

If the Octave mode has been enabled in the configuration menu (applicable to the dBadge2 Pro model only, see Section 7.8) subsequent presses of the right 'R' key will display the following screens and a vertical cursor will appear at the extreme right of the screen (and display the 8KHz band value). The left 'L' key will move the cursor to the left and display the other octave band values. With the cursor at the lowest 32Hz band, subsequent presses of the left 'L' key will scroll to the previous screen and similarly with the cursor on the 8KHz band, pressing the right 'R' key will scroll to the next screen.



If results are required to be pre A-weighted, this can be enabled via Casella Insight data management software.

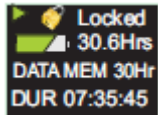
6.4 Locking and Unlocking the Keys

It is recommended that the dBadge2 is locked during a run to prevent the wearer tampering and this can be done automatically upon the start of a run having first selected 'Auto Lock' in the configuration menu (see Section 7.12) or manually as follows.

Press and hold the right 'R' key for 2 seconds then press the left 'L' key 3 times in quick succession as shown



A  padlock symbol will be displayed to indicate that the dBadge2 is locked and will not display any measured data.



Only battery and memory status will be displayed and the screen will timeout if selected but any key press will return this screen for a further 20 seconds.

If during a measurement run, the remaining battery or memory capacity falls below 2 hours, warning screens will be displayed and you may wish to instruct the wearer to report this to you.



To unlock the dBadge2, follow exactly the same procedure: press and hold the right 'R' key for 2 seconds then press the 'L' key 3 times in quick succession.

6.5 Stopping a Measurement Run

If the dBadge2 is locked, unlock as described in Section 6.4 above. To stop the current measurement run, press and hold the left 'L' and right 'R' keys simultaneously for the period of the 3 second countdown (releasing will cease the operation).



The display will then show the data from the measurement run that has just been completed. See Section 6.7.

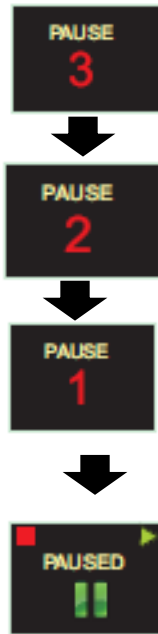
A new measurement run can be started immediately by following Section 6.3. Please ensure there is memory capacity remaining if a consecutive measurement run is to be performed.

6.6 Pausing a Measurement Run

Some measurement strategies may require a measurement run to be PAUSED e.g. during a worker's lunch break. To enable this function it must first be selected in the configuration menu (see Section 7.9).

When a measurement run is in progress, the action of pressing both left 'L' and right 'R' keys simultaneously will cause the dBadge2 to enter the pause mode (releasing during the countdown will cease the operation).

Note during PAUSED mode, all time history profile data is recorded and 'paused event' markers are saved into the data set. Cumulative values shown on the display represent the measured data and exclude the time and noise level during the paused intervals.



From the PAUSED screen:-

- to continue the run, press the right 'R' key as prompted by the 'play' symbol
- to stop the run, press the left 'L' key as prompted by the 'stop' symbol and a STOP SURE? confirmation message will appear for 3 seconds then default back to the PAUSED screen if no action is taken
- to stop the run, press the right 'R' key as prompted by the 'stop' symbol
- to return to the PAUSED mode press the left 'L' key

Note that the Airwave App described in Section 10 will override Start, Stop, Pause and Auto Lock modes.

6.7 Reviewing Measurement Run Data

As soon as a measurement run has been stopped, the dBadge2 will automatically display results from the last measurement run. The display will cycle between the following screens if the Auto Scroll mode has been selected in the configuration menu (see Section 7) or may be scrolled manually by pressing either the left 'L' or right 'R' key.

The screen contents will depend upon the setups selected for D1 (and D2, D3 and octave band analysis if selected).

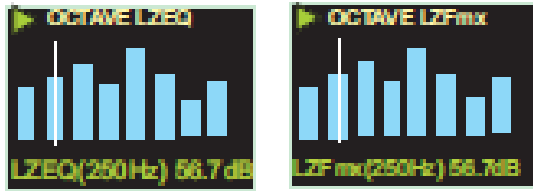
ISO View

ISO9612	
Dur 02:59:02	LAFmx 91.4dB
LAeq 82.4 dB	Lex8hr 82.4dB
LCpk 98.3 dB	P.Lex8h 79.4dB

OSHA View

OSHA HC	
Dur 02:59:02	Lavg 87.4dB
LZpk 92.4 dB	Twa8h 34.4dB
LASmx 98.3 dB	P.Lex8h 87.4dB

If octave band mode has been enabled on the Pro Model, additional screens and the cursor operates as per Section 6.3



6.8 Switching off the dBadge2

To switch off the dBadge2, press and hold the left 'L' key for the duration of the 3 second 3-2-1 countdown (releasing during the countdown will cease the operation).

Whilst in a measurement run, pressing and holding the left 'L' key for 10 seconds will force the dBadge2 to switch off irrespective of whether the Auto Lock has been enabled.

This 'system reset' feature allows the dBadge2 to be switched off in the unlikely event that the system 'hangs up'.

7. Configuring the dBadge2

To access the dBadge2 configuration menu, power up the instrument using the left key, briefly release both keys and then within 2 seconds of switching on, simultaneously press and hold the Left and Right keys. The instrument will now enter configuration mode.

The configuration menu is used to:-

- Select language
- Adjust the date and time
- Set the display's contrast
- Set the display timeout
- Specify the data to be displayed for D1 and select/deselect D2 and/or D3 (and specify the data to be displayed)
- Select/deselect the capture of Audio Notes
- Select/deselect real-time octave band analysis
- Select/deselect the Pause function
- Select/deselect audio event capture
- Select/deselect visual alarms
- Select/deselect Auto Lock of the keys
- Select large or small font
- Select/deselect Auto Scroll of the display
- Select/deselect Timers
- Select/deselect Bluetooth connectivity
- Clear the memory
- Cycle back through the configuration or exit to the default screen

Any changes made will become the default configuration, the next time that the dBadge2 is powered up.

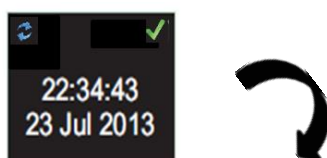
7.1 Language

The first screen in the configuration menu is the language screen. Set your preferred language from English, American English, French, German, Italian, Spanish & Portugese by scrolling through the options.

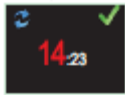


Press the right 'R' key to accept the language or the left 'L' to scroll through the options. Once the language has been accepted, the display advances to the next menu option

7.2 Date and Time



If the data and time are correct, press the right 'R' key to advance to the next menu option otherwise press the left 'L' key to make adjustments. The value to adjust will highlight in red.



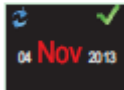
Set Hour: 'R' to accept or 'L' to scroll



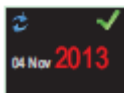
Set Minute: 'R' to accept or 'L' to scroll



Set Day: 'R' to accept or 'L' to scroll



Set Month: 'R' to accept or 'L' to scroll



Set Year: 'R' to accept or 'L' to scroll

7.3 Contrast



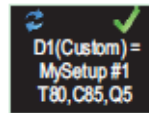
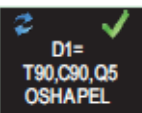
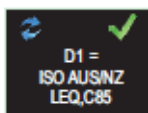
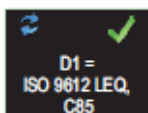
Set the display contrast by pressing 'R' to accept and 'L' to choose from 6 brightness levels

7.4 Display Timeout

The display can be left permanently on (which will reduce battery life) or will timeout after the selected interval of 5, 10, 20 seconds, 1 or 5 minutes

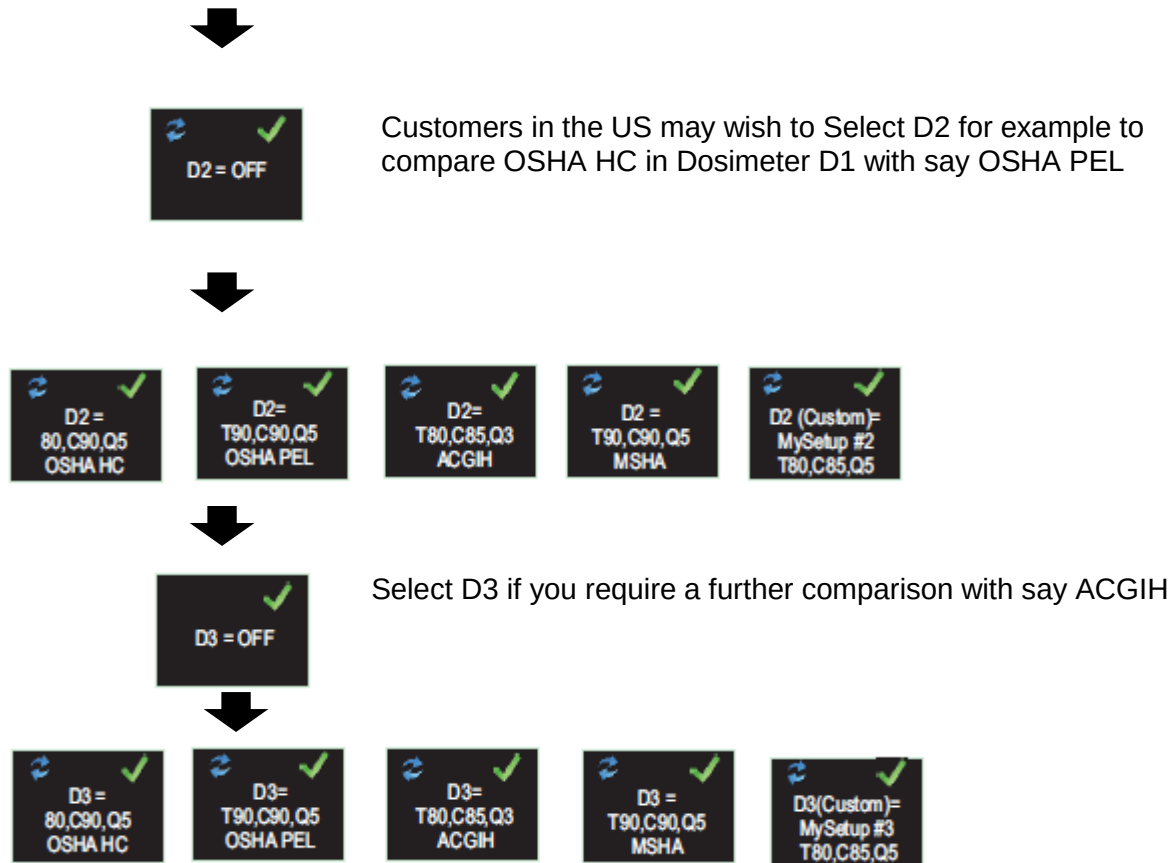
7.5 Selecting Dosimeter Setups

dBadge2 has up to 3 simultaneous dosimeters, D1 D2 and D3 which only determine what is displayed on screen and not what is calculated and saved to memory for later download and analysis. The primary Dosimeter, D1, cannot be disabled and may be configured to display any one of six configurations by choosing from the alternatives as shown below and explained in more detail in Section 7.6. There is also a fully custom configurable option which is achieved using Casella Insight data management software.



Additional dosimeters D2 and D3 may be selected to display any of the other available configurations.

Note that visual alarms are based only on D1 values.



7.6 Pre-defined Dosimeter Setups for D1, D2 and D3.

The following tables detail the parameters available for display.

7.6.1 North American Configurations (*L_Avg based Data*):-

OSHA HC - T80, C90, Q5

Displayed Parameters	Meter Settings	Notes
LAS, LZPk, LASmx LAvg (T80, Q5) TWA (8hr), Projected TWA (8hr) Dose% (T80, C90,Q5), Proj. Dose % (T80, C90, Q5, 8hr)	Threshold = 80dB Criterion level = 90dB Exchange Rate = 5dB Exceedance time based on Projected work time 8 hours	North American OSHA Conservation of Hearing setup.

OSHA PEL - T90, C90, Q5

Displayed Parameters	Meter Settings	Notes
LAS, LZPk, LASmx LAvg (T90, Q5) TWA (8hr), Projected TWA (8hr) Dose% (T90, C90,Q5), Proj. Dose % (T90, C90, Q5)	Threshold = 90dB Criterion level = 90dB Exchange Rate = 5dB Exceedance time based on Projected work time 8 hours	North American OSHA Personal Exposure Limit

ACGIH - T80, C85, Q3

Displayed Parameters	Meter Settings	Notes
LAS, LZPk, LASmx LAvg (T80, Q3) TWA (8hr), Projected TWA (8hr) Dose% (T80, C85, Q3), Proj. Dose % (T80, C85, Q3)	Threshold = 80dB Criterion level = 85dB Exchange Rate = 3dB Exceedance time based on Projected work time 8 hours	American Conference of Industrial Hygienists

MSHA - T90, C90, Q5

Displayed Parameters	Meter Settings	Notes
LAS, LZPk, LASmx LAvg (T90, Q5) TWA (8hr), Projected TWA (8hr) Dose% (T90, C90, Q5), Proj. Dose % (T90, Q90, Q5) Exceedance Time (LAS >105dB)	Threshold = 90dB Criterion level = 90dB Exchange Rate = 5dB Exceedance time based on LAS>105dB Projected work time 8 hours	North American Mine Safety and Health Administration

7.6.1 UK, European, Australian Configurations

ISO9612 - LEQ, C85

Displayed Parameters	Meter Settings	Notes
LAF, LAEQ, LAFmx LEX, 8Hr Pro. LEX, 8Hr LC Pk	LEQ based Dose data. (3dB doubling) Projected work time 8 hours	Parameters common to majority of European monitoring requirements based on ISO9612 and LAeq

ISO AUS/NZ - LEQ, C85

Displayed Parameters	Meter Settings	Notes
LAF, LAEQ, LAFmx LEX, 8Hr Pro. LEX, 8Hr LZPk	LEQ based Dose data. (3dB doubling) Projected work time 8 hours	Australian variation using LZpk

7.6.2 Customised Dosimeter Configurations

Any of the general noise parameters listed below may also be configured in Casella Insight for display in D1, D2 or D3

Threshold	(Tnn) Adjustable 70 to 90dB in 1dB steps
Criterion	(Cnn) Adjustable 70 to 90dB in 1dB steps
Exchange Rate	(Qn) Q=3db or Q=5dB
LAS Exceedance level	70 to 140dB in 5dB steps
ISO Dose Criterion	70 to 90dB in 1dB steps
Projected Work duration	1 to 24 Hrs in 10min steps

7.6.3 Dose Data Parameters available for display on dBadge2

LAvG based Dose Parameters (North America):

LAvG (Tnn, Qn)
TWA 8Hrs (Tnn, Qn)
Projected TWA 8Hrs (Tnn, Qn)
DOSE % (Tnn, Cnn, Qn)
Projected DOSE % (Tnn, Cnn, Qn, Work time)
Exceedance time (LAS> Exceedance Level)
Time to 100 % Dose (for LAvG based meter)

* Dosimeter setups D2 and D3 may be used to display additional LAvG base dose parameters shown using alternative T,C and Q values)

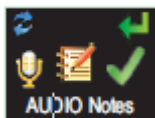
LEQ/ISO Based Dose Parameters (Europe, Australia, etc.):

LEPd / LEX 8Hrs
Projected LEPd /Projected LEX 8Hrs
Pa²Hrs
Pa²Sec
ISO Dose % (using ISO Criterion Level)
Projected ISO DOSE % (using ISO Criterion Level)
ISO Exposure Points (using ISO Criterion Level)
Projected ISO Exposure Points (using ISO Criterion Level)

General Noise Parameters:

LAS	LAF	
LAEQ	LCEQ	LAIEQ
LAPk	LCPk	LZPk
LAFmx	LASmx	
HML (LCeq-LAeq)		
Motion Index (0-100%)		

7.7 Audio Notes



Available in Plus & Pro Models Only. The Audio Notes function allows you to record 15 seconds worth of further information at the beginning of every measurement run e.g. task and location. When this function is enabled, a prompt will appear at the beginning of the run requiring the right 'R' button to be held for the duration of the audio note recording. Note that if no button is pressed within 30 seconds the run will commence as normal. Press the right 'R' key to accept or left 'L' to change.

7.8 Octave Mode



Available in Pro Model Only. The Octave Mode will enable real-time octave band analysis from 31.5Hz to 8kHz. LEQ and LMax data is provided for each Octave band. NOTE: having the Octave Mode enabled reduces battery life therefore you may wish to disable it to extend the run time. Press the right 'R' key to accept or left 'L' to change.

7.9 Pause Mode



Enable the Pause mode so that you may temporarily stop a measurement run, for example, during the worker's break. During a Pause, all time history profile data is recorded and a 'Pause Event' marker will be saved in the data set. Cumulative values will represent the measured data and will exclude the paused intervals. Press the right 'R' key to accept or left 'L' to change

7.10 Event Mode



Available in Plus and Pro Models Only. An audio recording of triggered events when certain criteria are exceeded which can be set within Casella Insight data management software. Press the right 'R' key to accept or left 'L' key to change

7.11 Alarms



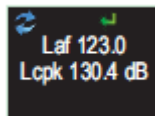
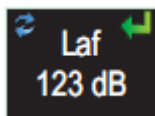
Alarm criteria can be set within Casella Insight – see Section 8. Press the right 'R' key to accept or left 'L' key to change

7.12 Auto Lock



Selecting Auto Lock 'locks' the display in run mode and limits the data presented (see Section 6.4). Press the right 'R' key to accept or left 'L' to change

7.13 Large Font mode



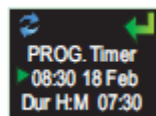
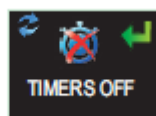
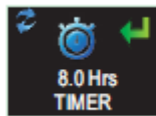
Data can be presented in small (multiple values) or large (single value) fonts. Press the right 'R' key to accept or left 'L' key to change

7.14 Autoscroll



If selected the display will automatically scroll from one screen to the next (otherwise the screen has to be advanced manually). Press the right 'R' key to accept or left 'L' key to change

7.15 Timers



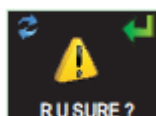
To select a timed run (rather than starting and stopping a run manually) press the left 'L' key to select fixed or programmable timers. The latter are set using Casella Insight data management software which will start and stop the dBadge2 automatically whilst the fixed timer will halt a run after 8 hours, initiated manually as per Section 6.3.

7.16 Bluetooth®



dBadge2 connects to the Airwave App using Bluetooth® low energy. This may be permanently disabled using the Upgrade Utility supplied and this screen will no longer appear as an option. Press the right 'R' key to accept or left 'L' key to change.

7.17 Clear Memory



To prevent inadvertently clearing the memory, the keys are reversed i.e. Press the left 'L' key to accept and the right 'R' key to decline but there is an additional screen to check that you wish to progress since once cleared all stored runs will be lost.

7.18 Cycle through configuration?

These final screens provide an opportunity to cycle back through the configuration menu or proceed to the start-up screens as per Section 6.1.

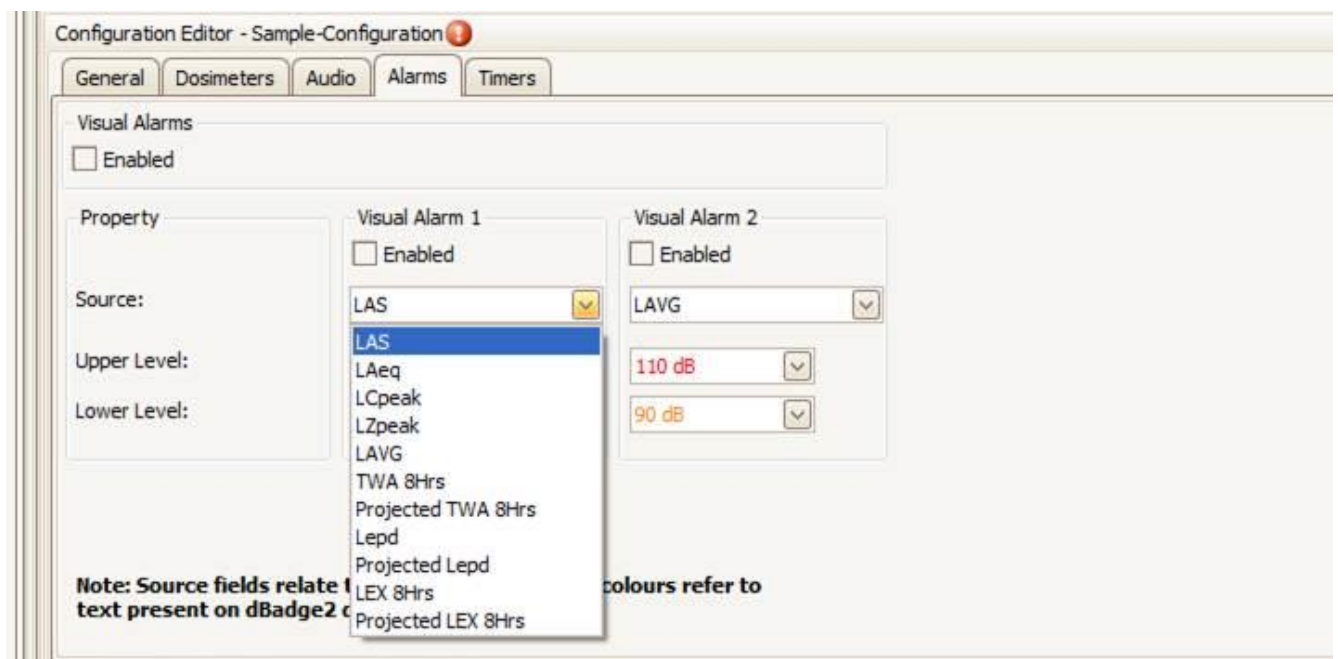
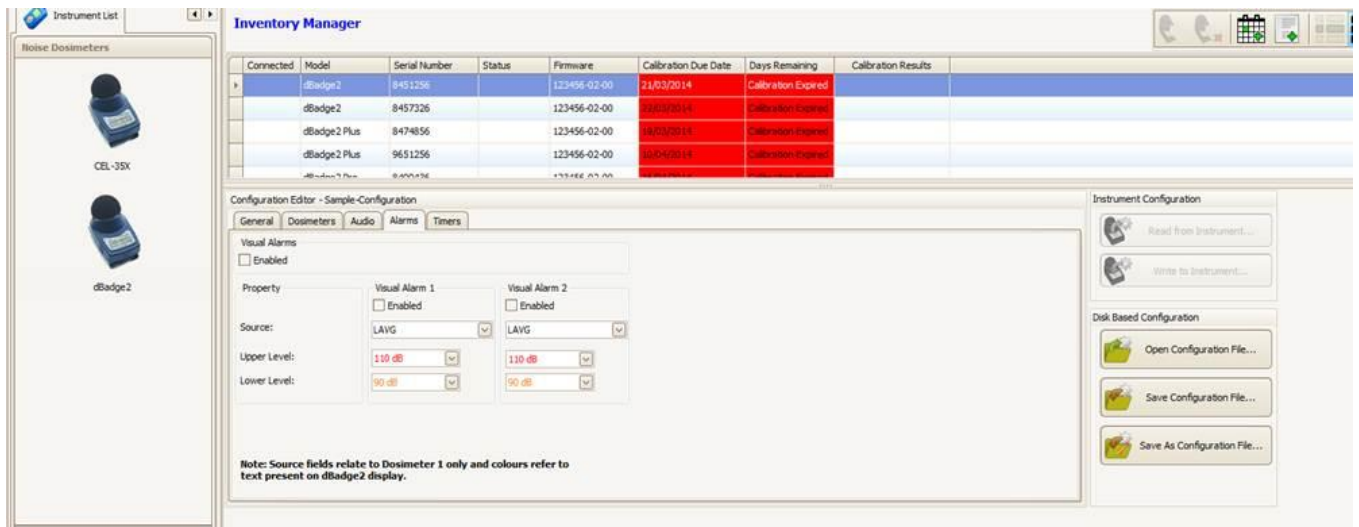
8. Visual Alarm Warnings

The dBadge2 has the ability to define colour coded and LED visual alarm warnings (as selectable in Section 7.11) based on up to two source data parameters (LAS, LAeq<LCPk, LZPk, LAVG, TWA, Projected TWA, Lepd, Projected Lepd, LEX8h, Projected LEX 8h). Lower and upper trigger levels may be specified for each alarm.

When a data parameter has been specified as an alarm source, the parameter will be shown in a green font for levels below the lower limit. Above the lower and upper trigger levels the Alarm parameter will be displayed using yellow and then red coloured fonts respectively as shown. It is recommended that the display is always on to take full advantage of this facility (see Section 7.4).



The dBadge2's high intensity LED also flashes blue at a slow rate when a lower level exceedance is active and at a fast rate whenever an upper level alarm has been triggered. The following Casella Insight data management software screens show the alarm source and level settings



9. Motion sensing

Due to the unattended nature of noise dosimetry it is important for workers to be fully engaged with the risk assessment process. In some cases they may be tempted to tamper with the instrument or try to influence the results, the worst case scenario being that it is taken off for the majority of the time. In order to check for 'wearer compliance' and decide if the sample is valid or not, dBadge2 has a sensor that reports a Motion Index as the percentage of time that movement has been detected during a measurement run, which is reported by Casella Insight data management software or the Download Utility.

10. Airwave Application

The Airwave Application allows an instrument's status and measurement progress to be checked discretely without having to disturb the worker who may be performing a critical task or be inaccessible.

It must be installed on a suitable mobile device which supports Bluetooth® 4.0 connectivity and is running Android operating system version 4.3 or higher.

Please download the latest version of the Airwave App from the download section of the dBadge2 web page.

It is recommended that the dBadge2 is in Lock Mode to discourage the wearer from tampering and is described in Section 7.12.

Tap the  icon to open the Airwave App.

10.1 Bluetooth Connection & Security

With Bluetooth enabled, Airwave compatible products will always broadcast their basic status and dashboard data and will be visible on any number of local mobile devices running the Airwave App.

However, it should be noted that Airwave compatible instruments such as the dBadge2 will only accept connection and control requests from a single known or 'linked' mobile device. This prevents an 'unknown' mobile device making a connection and then interrupting an active measurement run. The truth table below shows the possible scenarios and outcomes.

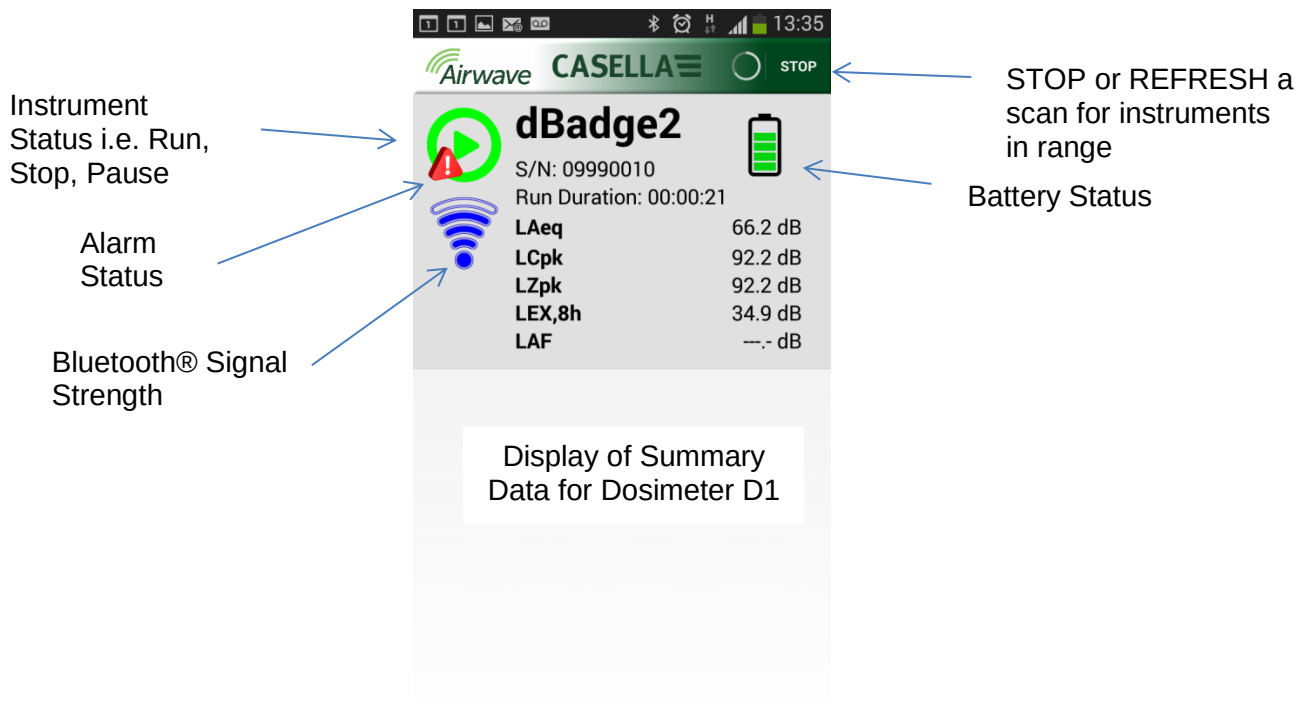
dBadge2 Mode	App Control	App Screen	View by others?	Control by others?
STOP	Linked Device	Broadcast	Yes	Yes
STOP	Linked Device	Monitor	No	No
RUN	Linked Device	Monitor	No	No
RUN	Linked Device	Broadcast	Yes	No

To 'link' a mobile device with a specific instrument, the Airwave App must be activated on that mobile device and then used to connect to a dBadge2 instrument whilst it is in 'stop' mode. The identity of the last mobile device to connect during stop mode is saved within the instrument and only this mobile device can connect to the instrument whilst a run is active.

10.2 The Broadcast Screen

The dashboard shows the operating status plus the vital measurement results from all instruments in range. Each instrument will update and broadcast its dashboard data approximately every 3 seconds.

When the Airwave app is first opened it will automatically scan for any Casella Airwave compatible products within range (typically up to 25m line of sight with no solid obstructions in the path). For an instrument to appear in the list it must of course have the Bluetooth® feature enabled within its power-up configuration menu, see Section 7.16.



To save power, the Airwave App stops scanning once all instruments within range have been detected. To scan for new instruments, press 'REFRESH' in the top right corner of the mobile device display.

10.3 Monitor Screen

From the dashboard view, 'tap' a specific instrument to initiate a direct connection with that instrument.

Whilst connected to an instrument, a comprehensive set of measurement results, as defined by the instrument's setup for D1, D2 and D3, will be shown where selected. Note this may require you to scroll up and down to view all available data

  		  	
 dBadge2 S/N: 09990010		 dBadge2 S/N: 09991112	
Run State	1	Proj. Dose	52.0%
Battery Hours Remaining	97	OSHA HC T80,C90,Q5	
Memory Free	100%	LAVG	41.0dB
Run Start Time	2015-02-19,12:34:56	TWA 8Hrs	54.0dB
Run Duration	0:00:41	Projected TWA 8Hrs	54.0dB
ISO 9612 LEQ C85		Dose	53.0%
LAF	60.0dB	Proj. Dose	9999E9%
LAEQ	66.1dB	OSHA PEL T90,C90,Q5	
LCPk	92.2dB	LAVG	49.0dB
LAFmx	76.2dB	TWA 8Hrs	45.0dB
LEX8Hrs	37.7dB	Projected TWA 8Hrs	57.0dB
Proj. LEX8Hrs	66.1dB	Dose	58.0%
		Proj. Dose	41.0%
  		  	

Example data is shown for ISO D1 settings (left) and OSHA D1 & D2 (right)

From this screen it is also possible to Start, Stop or Pause a measurement run. Touch and hold the appropriate icon in the lower part of the mobile device's display for 3 seconds during which time a countdown will be displayed. If a measurement run is started and the dBadge2 display has timed-out, the display will turn on to indicate that a run has started but time-out as per the setting in Section 7.4 (and similarly when a run is stopped).

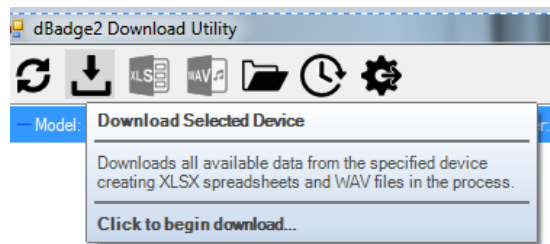
10.4 Connection menu

MENU (shown top right in the monitor screen contains a number of options to facilitate the convenient transfer of the measurement results via the device's email or clipboard services.

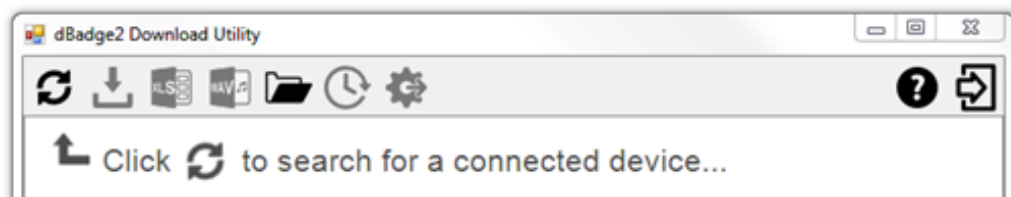
11. Download Utility

The download utility is a simple download solution for those who just want their data in an .XLS format. It is delivered with instrument kits on a USB flash drive or can be downloaded from the support section of the Casella website.

Click on the program icon to launch the program and tool tips will explain the functionality of each 'key' e.g.



With the dBadge2 to be downloaded in the left most 'pocket' of the Docking Station, powered and connected by the USB cable, click on the icon as shown below to search for connected devices

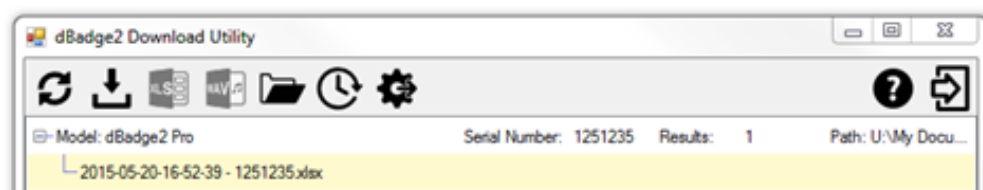


This will display the connected dBadge2.....



.....and clicking  will show stored results.

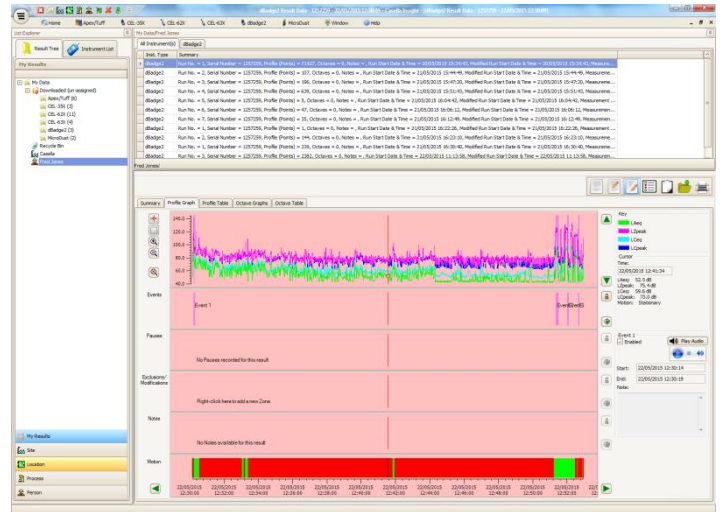
Further clicking on the highlighted file (or by clicking ) will open the data in Excel.



12. Casella Insight Data Management Software

The Casella Insight data management software provides a convenient solution to the downloading, storage, management and analysis of measurement results.

dBadge2 can also be custom configured (see section 7.6.2) by and downloaded to PC using the Docking Station and Casella Insight Data Management Software. Once downloaded, data can be stored under a worker's name, location or process so that a database of noise exposure can be built up.



A colour coded system can be used to highlight workers who have been exposed to specific action levels. Graphs can be modified by adding exclusion zones, which subsequently provides exposure data with and without these zones. Data can also be viewed according to different measurement protocols e.g. either ISO or OSHA or alternatively the data can be customised to a user's own requirements.

Furthermore, a multi-track approach to displaying time history, events, pauses, exclusions and modifications, pauses, analysing data because it allows you to view all the data tagged to the same time-line e.g. view profile data, listen to an audio file associated with an event (PLUS & PRO models) or read/write descriptive notes.

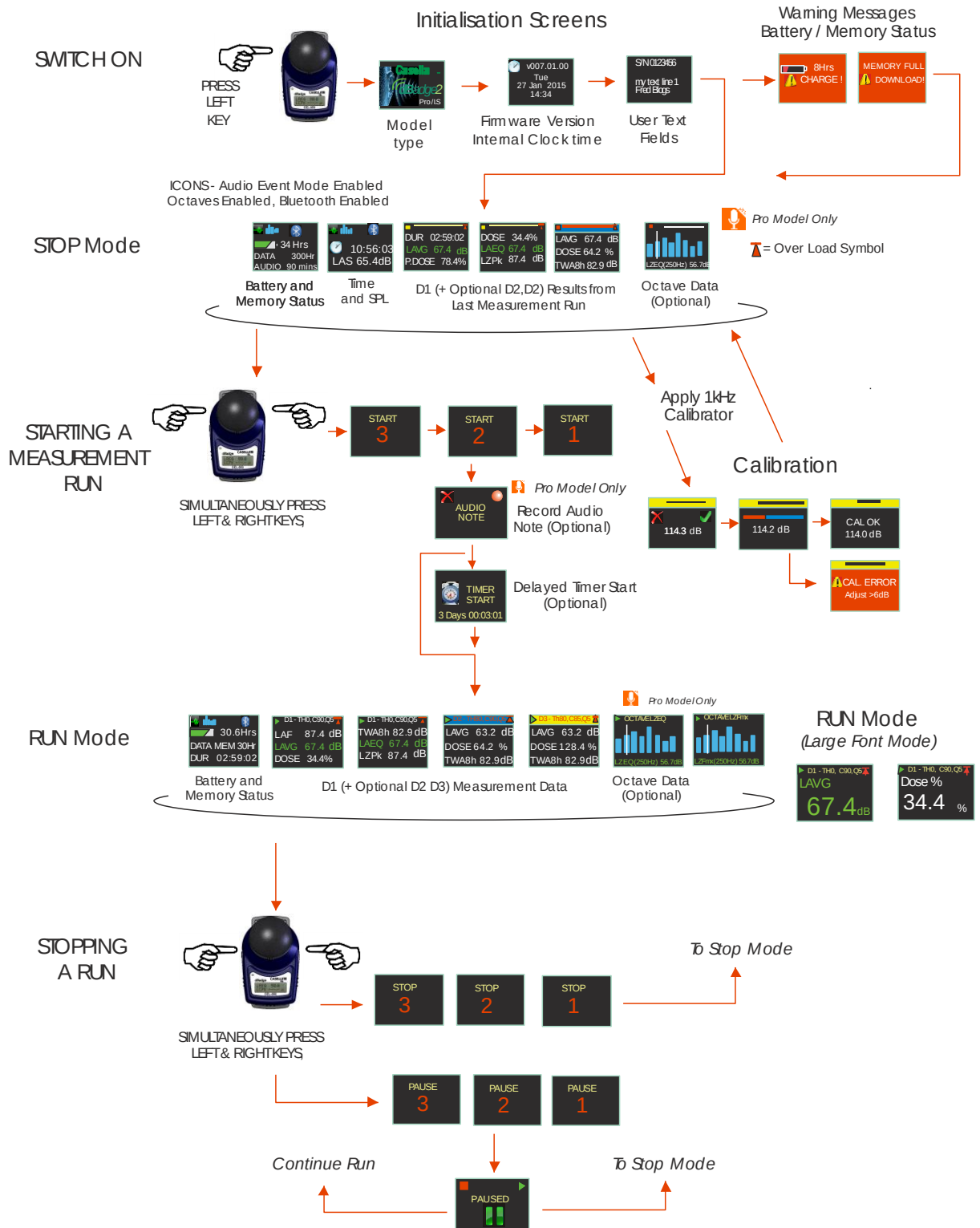


Reports can summarise the required dose data and any information about the worker's working day, together with the time history and other 'tagged' data. To create (or tailor) a report, simply select the view icon to select your personal report template and it's just a one button press to generate a report. As an audit trail original and modified data can be specified.

The Casella website offers a number of 'How to' videos explaining the various features and operations within the software.

13. User Interface Diagrams

13.1 Operation Screens



13.2 Configuration Menu Structure

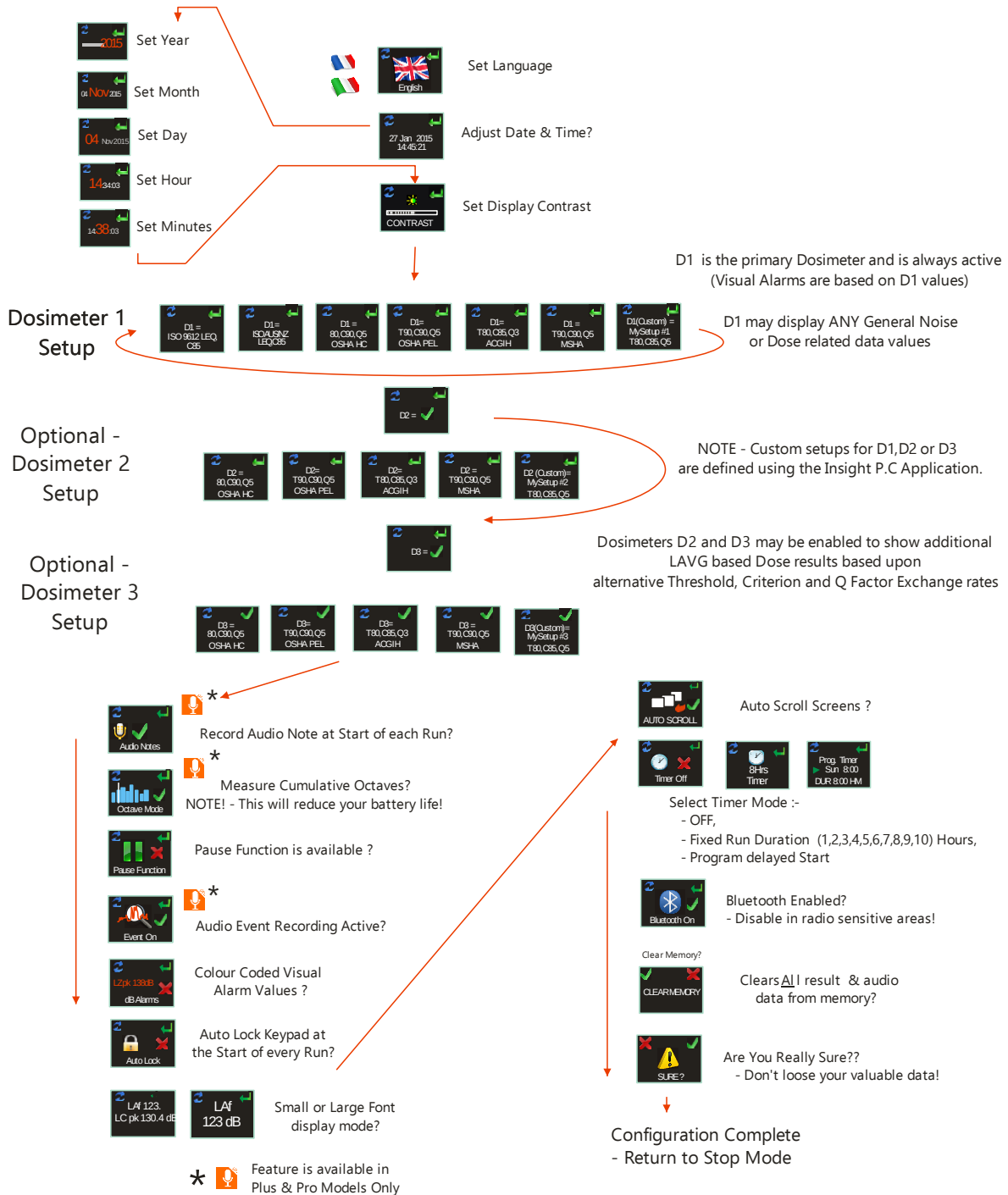
Configuration Mode



Press and then release the L Key to turn the dBadge2 ON



Within 1 second of turning the unit ON, Press and hold BOTH L and R Keys to enter the configuration mode



14. Technical Specifications

14.1 Sound Exposure Meter/Dosimeter Standards:

IEC 61252 Ed. 1.1 b: 2002, ANSI S1.25 – 1991 (R2007) for dosimeters and sound exposure meters.

IEC 61260:2014 Electro acoustics, Octave-Band and Fractional-Octave-Band Filters; Class 2
ANSI/ASA S1.11-2014 Octave-Band and Fractional-Octave-Band Analog and Digital Filters; Class 2

14.2 Electromagnetic and electrostatic compatibility:

The dBadge2 conforms to the requirements for EMC emissions and immunity as specified in IEC61000-4-2/6-1, 61000-4-6/6-2, 61000-4-3/CISPR 61000-6-3.

The dBadge2 was tested with a pink noise acoustic source of 85dB and complies with the immunity requirements of clause 15 (IEC 61252). No additional devices are connected during normal use.

All settings and orientations of the instrument have similar radio-frequency emissions. These radio-frequency emissions are within the specified limits of the above standard. All modes of operation have similar immunity to power and radio frequency fields.

Electrostatic Discharge (ESD): there is no degradation in performance or loss of functionality following the application of electrostatic discharges.

14.3 Microphone Specification (CEL-252)

Classification:	Type 2
Nominal Open-Circuit Sensitivity (250Hz):	-30.5dB $\pm$ 3.0dB (31.6mV/Pa)
Polarization voltage:	0V
Capacitance (polarized, 250Hz):	17pF
Operating temperature range:	0 to +40°C
Cartridge thermal noise:	<20dB (A)
Dimensions:	IEC 61094-4 Type WS 2

14.4 Instrument Specifications

Linear Operating Range:	54.0-140.3 dB (A) RMS,
Dynamic Range:	96dB
Peak Measurement Range:	90.0-143.3dB (C or Z),
Sound exposure Range:	0.0- 6,100.0 Pa ² Hours 0.00 – 22,000,000.00 Pa ² Sec 0.0-100,000.0% Dose
Frequency Weightings:	A, C and Z, Type 2
Time Weightings:	Fast, Slow and Impulse
Exchange Rate:	Q=3 or Q=5dB exchange rates
Threshold:	70-90dB in 1dB steps (Set via Casella Insight Data Management Software)
Criterion Level:	70-90dB in 1dB steps (Set via Casella insight Data Management Software)
Real Time Clock:	Accuracy better than 1min per month
Under Range Indication:	<54 dB
Overload Indication:	140.4dB RMS
Peak Overload Value:	143.4dB Peak Linear
Stabilisation Time:	<3 seconds after power up,
Operating Temperature Range:	0°C to +40°C (For IEC61252 Standard Compliance) -10 to +50°C (for ± 0.8 dB error limit) -20 to +45°C (Intrinsic Safety ambient ta range) 5°C to +45°C (for battery charging)
Ambient Pressure Range:	< ± 0.5 dB over 85 - 112kPa,
Humidity range	< ± 0.5 dB over 30% - 90% (non-condensing),
Magnetic Fields:	Negligible
Storage Temperature Range:	-10°C to +50°C,
Battery:	Internal NiMH, 800mAH
Run time:	Typically 55 hours using Broadband Mode Typically 35 hours using Octave mode <i>(Note: Increased display usage, audio recording and Octave modes will reduce the available run time. The internal fuel gauge reports estimated run time based upon the current operating status)</i>
Charge Time:	~10 Hours from fully discharged
Maximum Run Duration:	24 hours
Maximum number of Runs:	100
Storage Capacity:	Internal micro SD Flash memory - 300 hours of run data (including 1 second profile data) and up to 90 minutes of event audio recording.
P.C Interface:	USB 2.0 Full speed 12Mbps via charging base.
Dimensions:	85Lx54Wx55H mm
Weight:	117g
Ingress Protection (IP) Rating:	IP65 (with permeable air vent)
Construction Materials	Plastic Case/ Charger – PC/ABS Mounting Clips – POM Gasket - Silicone

Display window - Acrylic
Foam Windscreen – Polyester foam
Microphone – Brass / Nickel

Motion Sensor

Motion sensor detects any non- stationary motion. The index represents the percentage of measurement time that movement is detected during an entire measurement run.

Audio events recording (Plus & Pro)

15 second (including 3 second pre-trigger) level triggered sources include LAF, LAS, LCPk, LZPk. 8kHz sampling rate, 16 bit compressed wav format.

Audio Notes (Plus and Pro)

An audio note up to 15 seconds duration for each measurement run.

Recorded Data Parameters

The dBadge2 simultaneously records and computes ALL noise data and for EVERY measurement run. The comprehensive set of data containing all of the below parameters is available to view and analyse within the Casella Insight PC application. The Dosimeter Setups D1, D2 and D3 simply define which parameters are displayed on the instrument itself but all values are automatically stored in the memory of the dBadge2 for download.

LAVg		
TWA (8hr)	Projected TWA 8hr	
Dose%	Proj Dose %	
LAEQ	LCEQ	LAIEQ
LEPd / LEX, 8h	Proj LEPd/LEX, 8h	
LAPk + Time	LCPk + Time	LZPk + Time
Pa ² Hrs	Pa ² Secs	
ISO Dose% <i>(using ISO Criterion level)</i>		
ISO Proj Dose% <i>(using ISO Criterion level)</i>		
Projected Exposure Points <i>(using ISO Criterion level)</i>		
Exposure Points <i>(using ISO Criterion level)</i>		
Exceedance time <i>(LAS > Exceedance level)</i>		
*HML (LC-LA)		
LCpk >135 (count)	LCpk. >137 (count)	LCpk. >140 (count)
LAFmx + Time	LAFmin + Time	
LASmx + Time	LASmin + Time	
LAImx + Time	LAImin + Time	
LAE		
Cumulative Motion Index		

Profile 'Time-history' Data Sets

The following time-history data is saved at an interval of once a second for every run and are available following download:

LCpk	LZpk
LAeq	LCeq
LAvg (Q5, T=0)	LAvg (Q3, T=0)
LAFmx	LASmx
Motion Index	(0/1 status of motion detection)

Octave Analysis (Pro Model Only)

Nine Octave bands with centre frequencies from 31.5Hz to 8kHz are provided. Octave filter results may be A or Z weighted. LEQ (nHz) and Lmax (nHz) cumulative Octave data is saved for each run. A Fast or Slow time constant can be selected for the maximum Sound Pressure Level parameter.

Bluetooth Connectivity

All models support wireless connection via Bluetooth 4.0 (Low energy or Smart). This connectivity is compatible with mobile and PC devices that support Bluetooth 4.0 only.

TX power: 0 dBm to -23 dBm
Receiver sensitivity: -93 dBm
Range: Typically >25m line-of-sight and depending on local RF conditions.

Display

The display is a 96x64 dots full colour OLED display. It wakes upon key press or an alarm event. Brightness is adjustable.

User Interface

Two button operation, menu driven user interface.

Model Variants

			
Intrinsically Safe Models Available	•	•	•
H-M-L (C-A)	•	•	•
Programmable Delay Timer	•	•	•
Fixed Run Timer	•	•	•
Pause Function	•	•	•
Wireless*	•	•	•
Time History	•	•	•
Audio Recording		•	•
Octave Band			•

Each of the above models is optionally available with Intrinsic Safety (I.S) approval. Only instruments displaying the intrinsic safety marking label may be used in hazardous explosive environments.

14.5 Intrinsic Safety Markings – ATEX, IECEx, USA and Canadian Certificates

For the latest revision of the ATEX certificate **CML16ATEX2007X**, IECEx certificate **IECEx CML 16.0006X**, or **QPS USA and Canadian certificate LR1409-1**, please refer to the products support page at :-

www.casellasolutions.com

Intrinsically Safe ATEX and IECEx variants of the dBadge2 instrument are marked:

I M1
II 1GD
Ex ia I Ma
Ex ia IIC T4 (135 °C) Ga
Ex ia IIIC T135°C Da
(T_a = -20°C to +45°C)

NTRL certification markings for USA and Canada:

	Canada	US
Standards coding:	Ex ia IIC T4 Ga Ex ia IIIC T135°C Da	Class I Zone 0, AEx ia IIC T4 Ga Zone 20, AEx ia IIIC T135°C Da
Ambient range	-20°C to +45°C	-20°C to +45°C

QPS File no:- LR1409-1

NOTE: *The North America QPS certification does not include Mines.*

Ingress protection: **IP65**

The dBadge2 I.S is certified for intrinsically safe operation over an ambient temperature range of -20°C to +45°C and must not be used outside this range. **Please refer to operating temperature specifications for other temperature limits.**

During battery charging, the standard ambient temperature should be 5 to +45°C.

A Um of 60V is specified for the USB and DC power inputs of the Docking station. This is ensured by connection to safety extra low-voltage circuits (SELV) or protective extra low-voltage (PELV) circuits.

Only charge the dBadge2 I.S using the approved charger / docking station, Casella part number 207107B with a 12VDC PELV SELV power adapter such as Casella part number PC18 (*Manufactures Model Number 6A-181WP12 or equivalent*)

15. Glossary of Terms

A-Weighting	is the standard weighting of the audible frequencies designed to approximate the response of the human ear to noise.
Acoustic Calibrator	is an instrument that provides a reference noise source with a standard level and frequency. This is used to calibrate and check the performance of sound level meters and noise dosimeters.
ANSI S1.25 - 1991	is the U.S. Standard for Noise Dosimeters.
C-Weighting	is the frequency response of the human ear which varies with the sound intensity. At high noise levels typically greater than 100 dB, the ear's frequency response becomes flatter and is represented by the C weighting filter shape. C weighting is primarily used for Peak measurements (LCPk) or for C weighted equivalent Level (LCeq).
Criterion Level (CL)	is the normalised eight hour average weighted sound level in dB that corresponds to the maximum permitted daily exposure or 100% noise dose.
Criterion Time (CT)	is the time, in hours, used in the calculation of the %Dose.
dB(A)	is the <i>A-weighted</i> sound level in decibels.
dB(C)	is the <i>C-weighted</i> sound level in decibels
dB(Z)	is the <i>Z-weighted</i> sound level in decibels
Decibel (dB)	is the standard physical unit for measuring sound level and noise exposure.
Estimated Exposure	is a calculated estimate of the exposure of the wearer if the average level measured continues for the period defined by the <i>Criterion Time</i> . Estimated exposure is expressed in Pascal Squared Hours (Pa ² h).
Fast Time Weighting	is a standard time weighting applied by the sound level measurement instrument.
IEC 61252	is the International Standard for Personal Sound Exposure Meters.
LAE	is the <i>A-weighted</i> exposure level. It is the level that would contain the same amount of energy in one second as the actual noise has during the whole measurement period.
LAeq	is the <i>A-weighted</i> equivalent level, i.e. the <i>A-Weighted</i> average noise level over the measurement period. According to ISO procedures, a doubling in energy results in a 3dB change in the <i>Leq</i> or an 'exchange rate' of Q=3. There is no <i>Threshold value</i> taken into account.
LAF	is the <i>A-weighted</i> sound level measured with <i>Fast Time Weighting</i> .

LAS	is the <i>A-weighted</i> sound level measured with <i>Slow Time Weighting</i> .
LASmax	is the maximum <i>A-weighted</i> sound level measured with <i>Slow Time Weighting</i>
LAvg	is a parameter used in predominately in OSHA measurements. It is the average sound level over the measurement period (equivalent to <i>Leq</i>). Normally the term is used when the exchange rate “Q” is some value other than 3, e.g. for the OSHA Hearing Conservation Amendment where $Q=5$. A <i>Threshold Value</i> is also used during the calculation of LAvg where any levels below the <i>Threshold Value</i> are not included. For example, if the <i>Threshold Value</i> is set to 80dB and the exchange rate is 5dB ($Q = 5$). If a one hour measurement was taken in an environment where the noise levels vary between 50 and 70dB, the sound level would never exceed the <i>Threshold Value</i> so the instrument would record no value for the LAvg. However, if the sound level exceeds the 80dB <i>Threshold Value</i> for only a few seconds, only these seconds will contribute to the LAvg, giving a level of around 40dB. This is much lower than the actual ambient sound levels in the measured environment. For a constant level noise signal above the threshold, the LAvg values based on exchange rates of 3 or 5dB will be identical. In an environment of changing noise levels then the energy will be accumulated according to 3 or 5dB exchange rates and so LAvg ($Q3$) and LAvg($Q5$) will then differ (<i>with LAvg($Q5$) being the lower of the two results</i>)
LCpk	is the peak <i>C-weighted</i> sound level.
LEP,d	is the daily personal noise exposure defined by ISO 1999. It is the <i>LAeq</i> normalised to an 8 hour <i>Criterion Time</i> , i.e. a ‘standard day’. For example, if a noise measurement was made for 4 hours and the <i>LAeq</i> value was 90dB(A), the LEP,d value would be calculated to be 87dB(A) as the measurement duration is half the 8 hour <i>Criterion Time</i> and the exchange rate is 3dB. Also LEX,8Hr. LEP,d is calculated from the measured Sound Exposure, the Exposure Time and a Reference Time of 8 h.
LCeq	is the <i>C-weighted</i> equivalent level i.e. the <i>C-weighted</i> average level over the measurement period. According to ISO procedures, doubling the energy results in a 3dB change in the <i>Leq</i> or an ‘exchange rate’ of $Q=3$. There is no <i>Threshold Value</i> taken into account.
Peak	is the maximum level in dB reached by sound pressure at any instant during the measurement period. With the dBadge2, Peak can be measured with <i>C, Z or A Weighting</i> .
Slow Time Weighting	is a standard time weighting applied by the sound level measurement instrument.
SPL	is the sound pressure level. This is the basic physical measure of noise, and is normally expressed in dB.

Threshold Value	is the threshold below which sound levels are excluded from calculation. OSHA measurements use an 80 dB threshold and call for a hearing conservation program to be implemented when the eight hour TWA exceeds 85 dB (50% dose).
TWA	is the Time Weighted Average. Used in OSHA measurements, the TWA is the daily personal exposure level calculated from the <i>L_{Avg}</i> and measurement duration.
Z-Weighting	is a linear or un-weighted measurement. In the <i>dB</i> Badge2 system it is used for the measurement of peak sound pressure level against the OSHA standard.

16. Projected and Normalised Noise Measurements

Noise exposure limits are normally set nationally or more locally. These limits would define that a worker/person is allowed to be exposed to a certain noise level (criterion level, L_c) for a certain time (criterion duration, T_c).

A possible measurement for this is also to use percentage dose. 100% noise dose equates to a noise level at L_c for a duration of T_c . E.g. if $L_c = 90$ dB and $T_c = 8$ hours; then 100% dose equates to 90 dB for 8 hours.

16.1 Normalised Noise Measurements

Normalised noise values refer to measurements made over differing durations, but are then normalised to a standard duration. The energy measured over a particular duration is equal to the energy when the duration is changed to the normalised value. E.g. 90 dB measured over 4 hours is equivalent to 85 dB over 8 hours (using a Q5 exchange rate). Therefore, 90 dB over 4 hours is 85 dB when normalised to 8 hours.

A type of measurement for noise exposure is the 8 hour time weighted average (TWA (8h)); or the European equivalent metric noise exposure level over 8 hours (L_{ex8h}). The measurements basically normalise the actual measurements to a standard 8 hour period. This means that any measurements or calculations based on times other than 8 hours can then be normalised to 8 hours, which allows for a direct comparison between different measurement intervals.

Normalising the values to 8 hours, it can be seen that as the working shift duration increases then the TWA(8h) also increases. Assuming exposure a constant noise of 90 dB, the TWA(8h) increases up to 90 dB when the working shift reaches 8 hours and then increases over this as the shift exceeds 8 hours.

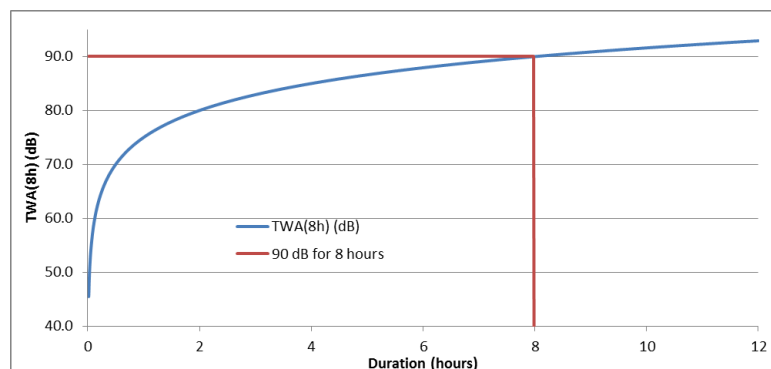


Figure 1 shows how the TWA(8h) value changes as working shift changes

When the working shift is less than 8 hours the TWA(8h) will be less than 90 dB. E.g. if the working shift is only 5 hours, then the TWA(8h) will be 86.6 dB. In Figure 2 this can be seen

where the vertical green line (representing the working shift duration) crosses the blue line (representing the TWA(8h) as the shift duration increases). This is shown by the dashed line.

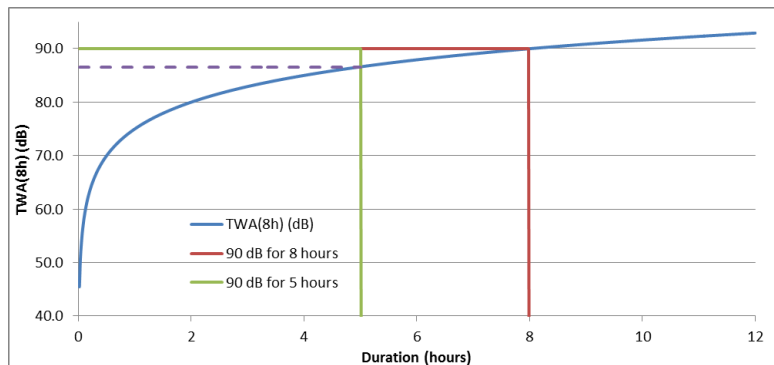


Figure 2 shows the TWA(8h) value is less than 90 dB when working shift is 5 hours (TWA(8h) value is where blue line crosses green line)

Likewise, if the working shift is longer (e.g. 10 hours), then the resultant TWA(8h) would be 91.6 dB. This is shown in Figure 3, where once again the dashed line shows the TWA(8h) at the level where the vertical line of the working shift (green line) would cross the blue line (if extended).

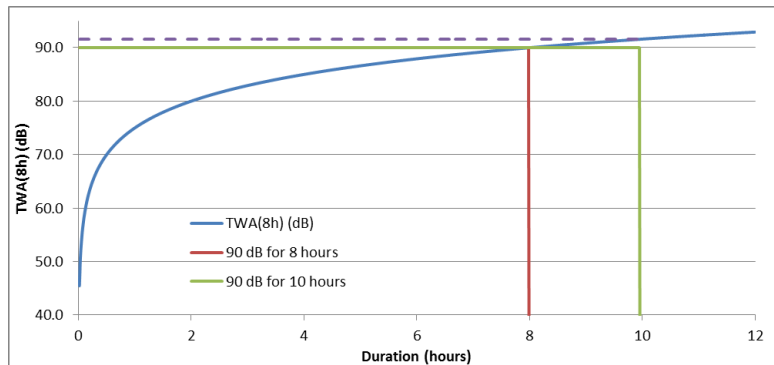


Figure 3 shows the TWA(8h) value is greater than 90 dB when working shift is 10 hours (TWA(8h) value is where blue line crosses the vertical green line, assuming this green line is extended)

16.2 Projected Values

It is quite rare that a measurement would be carried out for exactly 8 hours. Also, it is possible that a measurement is not carried out for the entire working shift (which equally may not necessarily be 8 hours). It is therefore possible to use projected calculations. This basically assumes that the worker is exposed to the same sound level for the remainder of a particular time.

Projected values allow a shorter measurement to establish the noise level representative of the workers full shift. The assumption is made that the level representing the energy accumulated at a point in time (e.g. the Leq or Lavg value) will continue at the same level for the remainder of the workers full shift.

The projected energy at the end of the workers shift is kept constant, but the time is changed from the duration of the workers full shift to the standard 8 hours. Therefore, if the workers shift is greater than 8 hours then the TWA(8h) will have a larger value in comparison to the Lavg at the end of the full working shift. Likewise, if the full shift is less than 8 hours then the TWA(8h) will be smaller than the Lavg at the end of the full shift.

From the above, it can be demonstrated that if the working shift is exactly 8 hours and a measurement is carried out for less than this time; the Lavg at the end of the measurement will equal the TWA(8h).

The projected values are only appropriate when the measurement duration is less than the full working shift duration. When the measurement duration occurs over the entire working shift then the standard TWA(8h) (as calculated by the instrument) would be used.

As an example, assume that a working shift is 7 hours. However, the actual measurement was only carried out over 5 hours. At the end of the 5 hour measurement the Lavg was 90.0 dB. It is assumed that this level remains constant for the remainder of the 7 hour working shift. Therefore, the measurement is projected forward to the end of the working shift. This level (90.0 dB for 7 hours) can now be used to calculate the TWA(8h), which results in 89.0 dB.

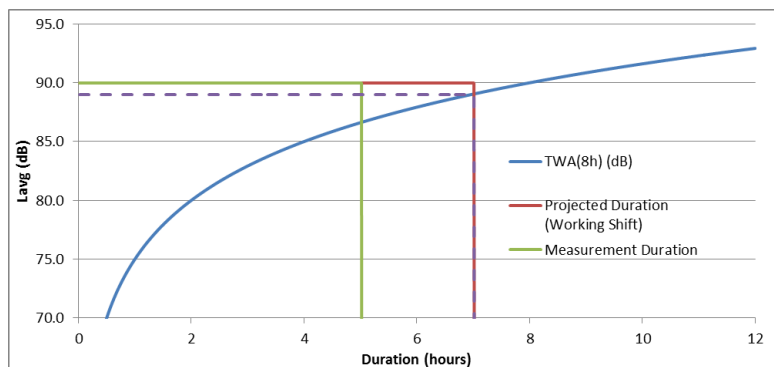


Figure 4 shows a measurement of 5 hours (green line); this is then projected forward to the end of the 7 hour working shift (red line); where the projected value crosses the original TWA(8h) (blue line) is the actual TWA(8h), shown by the dashed line. (NOTE this is based on using levels of 90 dB and are only for illustration. In practice the TWA(8h) would be calculated mathematically from the Lavg at the end of the projected 7 hour working shift)

Another example is using a working shift of 10 hours. This time a measurement was carried out for 6 hours. Therefore, the Lavg at the end of the 6 hours (90.0 dB in this example) is projected forward to the end of the 10 hour working shift. This level (90.0 dB for 10 hours) can now be used to calculate the TWA(8h), which results in 91.6 dB.

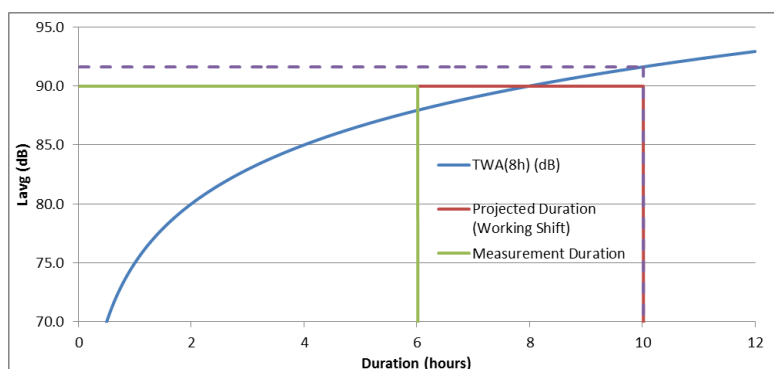


Figure 5 shows a measurement of 6 hours (green line); this is then projected forward to the end of the 10 hour working shift (red line); where the projected value crosses the original TWA(8h) (blue line) is the actual TWA(8h), shown by the dashed line.

17. Noise Measurements – A Simple Analogy

In order to try and help explain some of the above concepts, an analogy can be used. Taking a possible requirement of 100% noise dose equates to 90 dB for 8 hours (this is a TWA(8h) of 90 dB), this could be considered as running water from a tap. The sound level can be considered to be how fast the water is running from the tap. If this water is collected in a container, then this can be equated to the noise dose. So, using this analogy, running the water at a flow rate of 10 litres per hour for a duration of 8 hours will result in 80 litres of water being collected. Therefore, a volume of 80 litres equates to 100% dose.

If the water was run at the same flow rate but only for 4 hours, it can be seen that only 40 litres would be collected. This would result in 50% dose. This would mean that if a worker was exposed to a noise of 90 dB but only for 4 hours then they would receive 50% noise dose. This is a TWA(8h) of 85 dB (NOTE the TWA(8h) figure is not halved due to sound being logarithmic; as the exchange rate used in this example is 5 dB this means that doubling or halving the energy will cause a 5 dB increase or decrease).

Likewise, if the water was run at the same flow rate for 16 hours then 160 litres would be collected. This results in 200% dose (and a TWA(8h) value of 95 dB).

The length of time that the water is run for is effectively the working shift. Therefore, a shift duration of something other than 8 hours would mean that the flow rate of the water (i.e. the sound level) would have to change to ensure that 80 litres of water is collected by the end of the working shift (to represent 100% dose).

If the flow rate of the water was now 20 litres per hour, then it would only take 4 hours to collect the full 80 litres. This means that if the average sound level was 95 dB then a worker could only be exposed to this sound for 4 hours, at which point they would then have been exposed to 100% of their allowable noise dose.

The dose can be thought of as taking the total volume of water collected over the measurement duration and comparing it to the total volume which is allowable. In terms of noise, dose is the total amount of noise energy that a worker is exposed to in comparison to a defined allowable limit.

The TWA(8h) figure can be thought of as taking the total volume collected and then calculating what flow rate would be required such that the same volume of water would be collected if the tap had been running for 8 hours. In noise terms, TWA(8h) is the average sound which after 8 hours gives the same amount of noise energy that a worker is exposed to during their working shift.

This analogy can be extended to cover the concept of projected values.

If the water was run at a flow rate of 5 litres per hour for a duration of 5 hours, then 25 litres would have been collected. If it is then assumed that the water is run at the same flow rate for another 2 hours then this would suggest that an additional 10 litres will be collected. The first 5 hours can be thought of as being the measurement duration. The total duration (5 + 2 hours) of 7 hours can be thought of as being the working shift duration. Therefore, a projected total of 35 litres can be derived. This is effectively measuring the volume of water for a certain duration (5 hours) and then assuming that the flow rate of the water (that would give this volume in that time) has been occurring for the entire working shift (7 hours). Once the projected volume is known (in this case 35 litres) this value can then be normalised to the 8 hour duration. This is the same as saying what flow rate would be required to collect the same volume (35 litres) in 8 hours (as opposed to the 7 hours of the working shift).

Therefore, 35 litres divided by 8 hours equals 4.375 litres per hour. This would be the analogous to the TWA(8h) value.

Using the same values the projected dose can also be calculated. 25 litres of water has been collected after 5 hours. If the working shift was 5 hours this would be a dose of 25/80 litres which equals 31.25% dose (this is what the dose at the end of the measurement would be). However, as the working shift carries on for another 2 hours then a total of 35 litres would have been run. This means the projected dose is 35/80 litres which equals 43.75%.

18. Examples of Possible Measurement Scenarios

In order to simplify these discussions, the equivalent continuous sound level (i.e. Leq or Lavg) is used.

- 18.1** Scenario 1: Criterion duration (T_c) = 8 hours; measurement duration (T_m) = 5 hours; shift duration (T_s) = 8 hours

The noise which the worker is exposed to is measured for 5 hours. However, the worker is exposed to the same noise levels for the remainder of the shift (such that the worker is exposed to this noise level for the entire 8 hours).

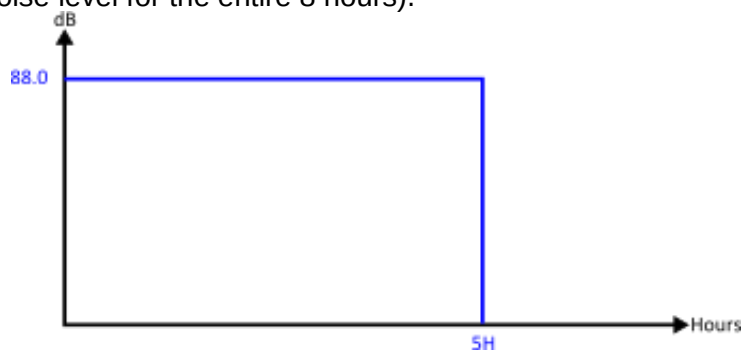


Figure 6 shows the 5 hour measurement

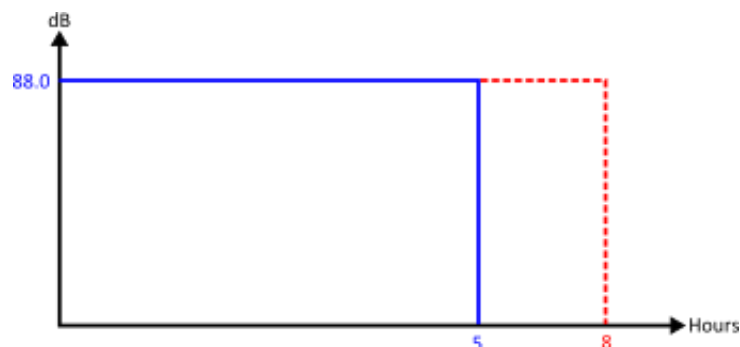


Figure 7 shows the 5 hour measurement (blue line); but also the same noise level continued for the rest of the 8 hour shift (red line)

In this situation, the measured level is projected forward using the assumption that the noise level is the same as that measured during the 5 hour measurement.

This means that the Lavg measured over the hours would have the same value after 8 hours. This results in a projected TWA(8h) being equal to the measured Lavg (i.e. Proj TWA(8h) = 88.0 dB).

- 18.2** Scenario 2: Criterion duration (T_c) = 8 hours; measurement duration (T_m) = 5 hours; shift duration (T_s) = 5 hours

The noise which the worker is exposed to is measured for 5 hours, which is the entire shift duration. This is the same situation as a worker who has a shift duration of 8 hours, but is only exposed to noise during 5 hours of this shift.

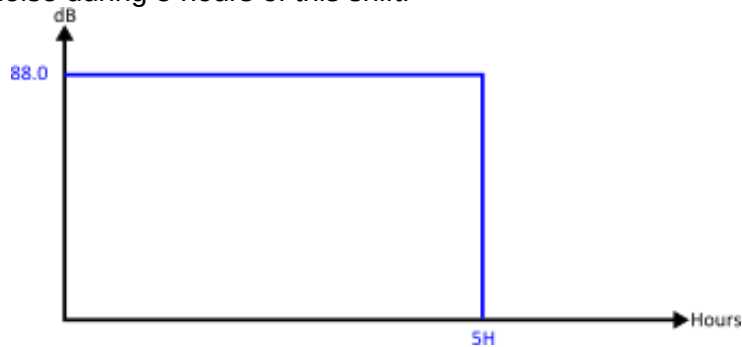


Figure 8 shows the 5 hour measurement

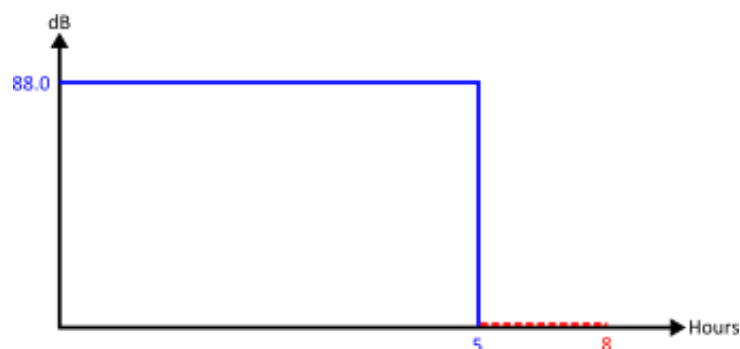


Figure 9 shows the 5 hour measurement (blue line); there is no further noise exposure for the remainder of the 8 hours (red line)

In order to calculate the TWA(8h), it is necessary to keep the measured energy (represented by the blue line) constant, but change the duration from 5 hours to 8 hours. This will result in the level decreasing. In this case a worker exposed to 88.0 dB for 5 hours is equivalent to one exposed to 84.6 dB over 8 hours (therefore, normalised to 8 hours).

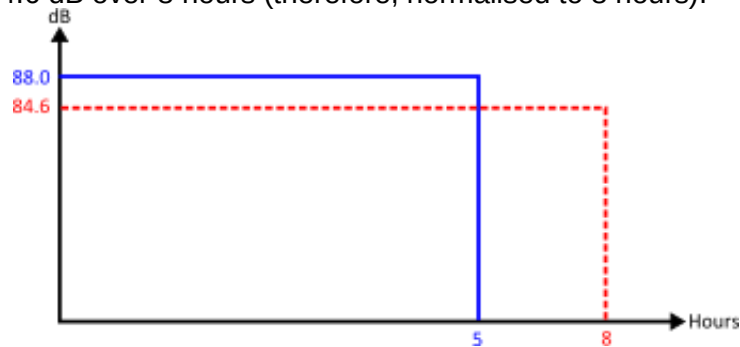


Figure 10 shows the 5 hour measurement (blue line); the TWA(8h) is shown by the red line. The measured energy represented by the blue line is equal to the measured energy represented by the red line.

18.3 Scenario3: Criterion duration (T_c) = 8 hours; measurement duration (T_m) = 12 hours; shift duration (T_s) = 12 hours

The noise which the worker is exposed to is measured for 12 hours, which is the entire shift duration.

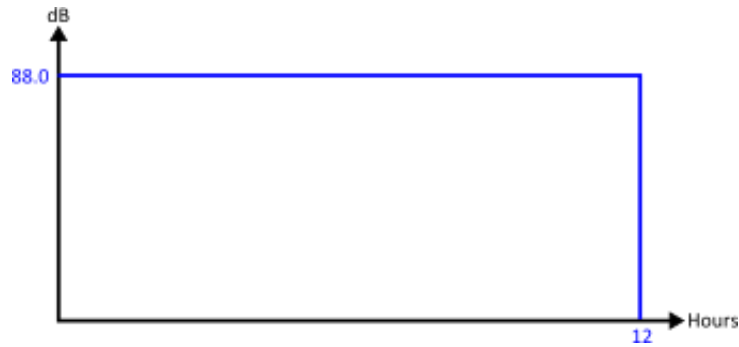


Figure 11 shows the 12 hour measurement

It is now possible to calculate the value normalised to 8 hours, i.e. TWA(8h). This is effectively achieved by keeping the measured energy (represented by the blue line) constant, but changing the duration from 12 hours to 8 hours. This will have the effect of the TWA(8h) value being higher than the 12 hour Lavg value. Therefore, a 12 hour Lavg of 88.0 dB is equivalent to an 8 hour Lavg of 90.9 dB.

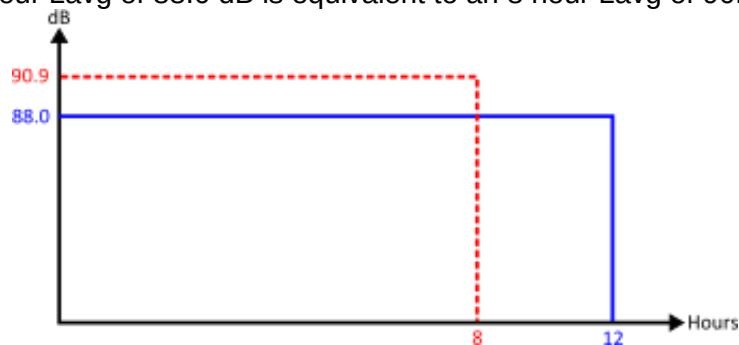


Figure 12 shows the 12 hour measurement (blue line); the TWA(8h) is shown by the red line. The measured energy represented by the blue line is equal to the measured energy represented by the red line.

18.4 Scenario 4: Criterion duration (T_c) = 8 hours; measurement duration (T_m) = 10 hours; shift duration (T_s) = 12 hours

The noise which the worker is exposed to is measured for 10 hours, which is the entire shift duration. However, the worker is exposed to the same noise levels for the remainder of the shift (such that the worker is exposed to this noise level for the entire 12 hours).

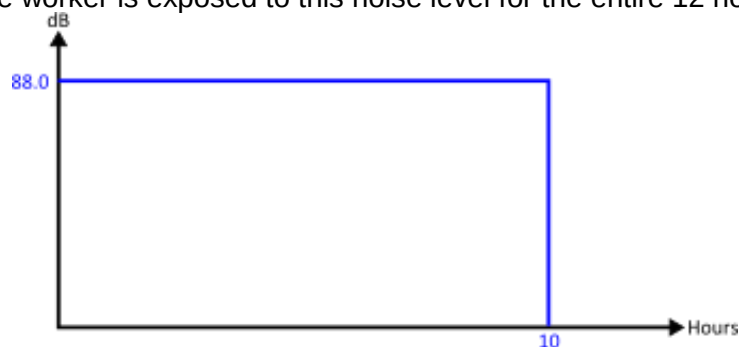


Figure 13 shows the 10 hour measurement

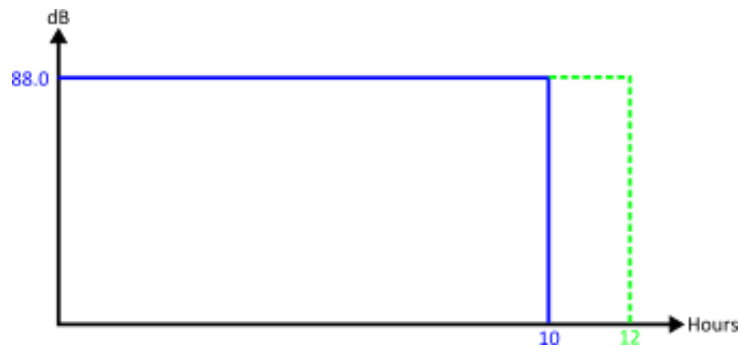


Figure 14 shows the 10 hour measurement (blue line); but also the same noise level continued for the rest of the 12 hour shift (green line)

Projecting the 10 hour measurement for the remainder of the 12 hour shift means that the Lavg for the 12 hours equals the Lavg for the 10 hours = 88.0 dB. In order to calculate the normalised TWA(8h), this time the measured energy represented by the green line is kept constant. Once again the duration was changed (from 12 hours) to 8 hours.

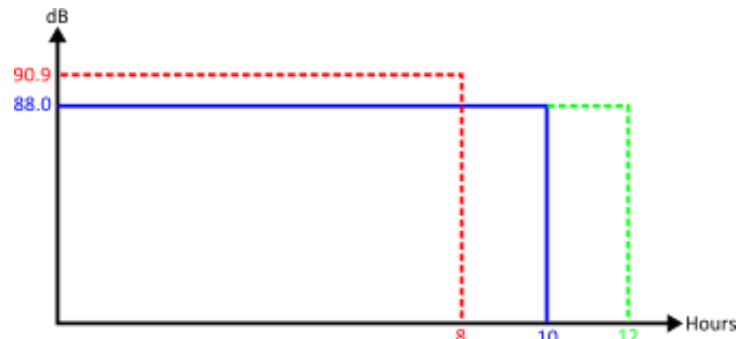


Figure 15 shows the 10 hour measurement (blue line); but also the same noise level continued for the rest of the 12 hour shift (green line). The TWA(8h) is also shown (red line) which has the same measured energy as that represented by the green line

This has assumed that effectively the level was 88.0 dB for the entire 12 hours and this was then normalised back to 8 hours (which ends up the same situation as scenario 3 above).

Additional Considerations

It is also possible to use other durations for normalising to (e.g. TWA(12h)). However, care should be taken with this as this effectively changes the criterion duration from the standard 8 hours to 12 hours. In order to ensure that the amount of allowable noise exposure is not increased then it is necessary to reduce the criterion level. This ensures that 100% noise dose is the same amount of energy, regardless of the duration.

Using the standard 90 dB for 8 hours gives 100% dose; then changing the duration to 12 hours results in an allowable level of 97.1 dB (which keeps the 100% dose the same).

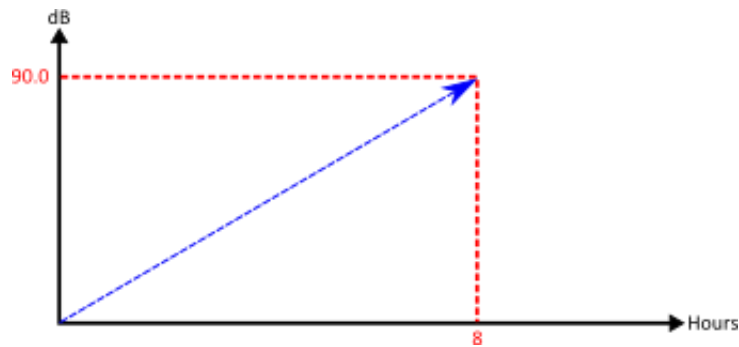


Figure 16 when the standard TWA(8h) is calculated, the value effectively increases as the measurement duration increases

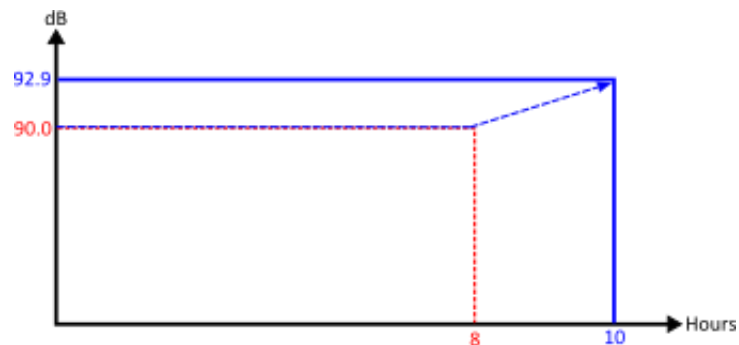


Figure 17 when the projected TWA(8h) is calculated, the value effectively equals the L_{avg} whilst the measurement time is not greater than 8 hours. Once the duration exceeds 8 hours then the TWA(8h) will start increasing.

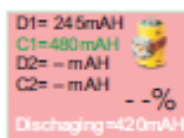
19. Fault Finding & Diagnostics

19.1 Cycle Battery Mode

Unfortunately rechargeable Batteries do not last for ever and their storage capacity will reduce depending on usage, storage conditions and age.

The dBadge2 includes a battery diagnostic check which fully cycles the battery and determines its storage performance. This may be used to condition new batteries and also to determine the state of older and possibly degraded batteries.

To initiate a Cycle Battery Mode place the dBadge2 in the charger pocket, press and hold the right 'R' key within 10 seconds of placing the dBadge2 in the charger pocket. The dBadge2 will show a confirmation screen as shown below:



The 'cycle battery mode' will then commence.

The unit carries out two discharge/charge cycles and displays the actual charge and discharge capacities (mAHr) of each cycle.

If there is no confirmation within 10 seconds, the mode will be exited and standard charging will commence.

Re-seat the dBadge2 on its charging Port and repeat holding down the right 'R' Key for 2 seconds.

Once the Cycle battery mode has begun it will go through two charge and discharge cycles, this will take approximately 4 days to complete.

Once completed, remove the dBadge2 from its charging station, this will clear the cycle battery mode. Place back on the charger port to carry out a standard charge, ensure dBadge2 is fully charged and no error messages are seen during the standard charge process.

Once charge is full and complete without any error messages, remove the dBadge2 from the charger port before doing a sample 'RUN'.

If a charge error message is seen then repeat the 'cycle battery mode' test again.

The D2 capacity value indicates the batteries storage capacity following a full charge. It is suggested that this should exceed 70% of the cells nominal capacity (i.e. 560mAh)

20. Declarations

WIRELESS BLUETOOTH 4.0 CONNECTIVITY

All models support wireless connection via Bluetooth® 4.0 (Low energy or Smart). This connectivity is compatible with mobile and PC devices that support Bluetooth® 4.0 only.

TX power:	0 dBm to -23 dBm
Receiver sensitivity:	-93 dBm
Range:	Typically >25m line-of-sight and depending on local RF conditions.

The instrument contains a Bluetooth® Low energy wireless transmission module, **BLE113** from Bluegiga technologies. The Bluetooth® Qualified Design IDs for this module are:-

Bluetooth Controller QDID: B021015, **Bluetooth Smart Software:** QDID B018942

Copies of the modules regional approvals certificates may be obtained from Casella or Bluegiga.



This product contains an FCC and Industry Canada certified Bluetooth® Low energy wireless transmission module:-

FCC IDENTIFIER:	QOQBLE113
Industry Canada	IC:5123A-BGTBLE113(Single)

Producer: BlueGiga Technologies Inc.
Model: BLE113 Bluetooth smart module
Modular Type: Single Modular

FCC CONFORMITY STATEMENT

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation

RADIATION EXPOSURE STATEMENT:

The product complies with the FCC portable RF exposure limit set forth for an uncontrolled environment and is safe for intended operation as described in this manual.

**CE DECLARATION OF CONFORMITY**

Casella declares that this product is in compliance with the essential requirements and other relevant provisions of applicable EC directives. A copy of the EU Declaration of Conformity for this product may be obtained by clicking on the Product compliance documentation link at www.casellasolutions.com.

**WEEE - INFORMATION FOR EU MEMBER-STATES ONLY**

The use of the WEEE symbol indicates that this product may not be treated as household waste. By ensuring this product is disposed of correctly, you will help prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. For more detailed information about recycling of this product, please contact your local waste disposal service or contact the agent where you purchased the product.