Technical Documentation

Building Acoustics Software BZ-7228 and Dual-channel Building Acoustics Software BZ-7229

for use with
Hand-held Analyzer Type 2250 and
Hand-held Analyzer Type 2270

User Manual

Brüel & Kjær

English BE 1799 – 12

Building Acoustics Software BZ-7228 and Dual-channel Building Acoustics Software BZ-7229

for use with
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User Manual

BE 1799−12

June 2008

Safety Considerations

This apparatus has been designed and tested in accordance with IEC 61010 – 1 and EN 61010 – 1 *Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use*. This manual contains information and warnings which must be followed to ensure safe operation and to retain the apparatus in safe condition. Special note should be made of the following:

Safety Symbols

The apparatus will be marked with this symbol when it is important that you refer to the associated warning statements given in the manual.

Protective Earth Terminal Hazardous Voltage

Explosion Hazard

The equipment is not designed to be used in potentially explosive environments. It should not be operated in the presence of flammable liquids or gases.

Warnings

- Switch off all power to equipment before connecting or disconnecting their digital interface. Failure to do so could damage the equipment
- Whenever it is likely that the correct function or operating safety of the apparatus has been impaired, it must be made inoperative and be secured against unintended operation
- Any adjustment, maintenance and repair of the open apparatus under voltage must be avoided as far as possible and, if unavoidable, must be carried out only by trained service personnel

- Do not dispose of electronic equipment as unsorted municipal waste
- It is your responsibility to contribute to a clean and healthy environment by using the appropriate local return and collection systems
- Hazardous substances in electronic equipment may have detrimental effects on the environment and human health
- The symbol shown to the left indicates that separate collection systems must be used for any discarded equipment marked with that symbol
- Waste electrical and electronic equipment may be returned to your local Brüel & Kjær representative or to Brüel & Kjær Headquarters for disposal

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Chapter 1

Introduction

1.1 Welcome

Building Acoustics Software BZ-7228 and Dual-channel Building Acoustics Software BZ-7229 are just two of the many application packages available for Hand-held Analyzers. (BZ-7228 is a single-channel application that can be used on Type 2250 or Type 2270, whereas BZ-7229 is a dual-channel application that can be used on Type 2270 only).

If you are newcomer to the world of Type 2250 or 2270, you are strongly advised to study the User Manual for Hand-held Analyzers Types 2250 and 2270 (BE 1713) before reading this manual. Studying the User Manual for Hand-held Analyzers Types 2250 and 2270 will enable a better understanding of the platform concept and how the BZ-7228/7229 application packages fit into the portfolio. You will also become familiar with some terms used in this manual that apply to Types 2250 and 2270 in general.

This manual intructs you on how to set up Type 2250/2270 for building acoustic measurements, how to measure building acoustics and how to look at your results. Anything which is independent of BZ-7228/29 will be found in the User Manual for Type 2250.

This manual assumes that you are familiar with the concepts of measuring sound using a microphone and some form of sound level meter/analyzer.

1.2 How to Use this Manual

1.2.1 Conventions Used in this Manual

Instructions and descriptions that refer to Type 2250/2270 pushbuttons are shown with the pushbutton icons as seen on the instrument.

Menu Items and Buttons Used on the Screen

Menu items and buttons used on the screen are indicated by bold type face (for example, select **Calibration** from the list of options).

Parameter Text Appearing on the Screen and Tabs

Parameters, instructions and descriptions appearing on the screen (and on tabs) are indicated by italics (for example, *Measurement Mode, Overview* tab).

Path Denotations

Path denotations are indicated by capitals (for example, SETUP\BZ7222\).

1.2.2 Beginners

Before you read the rest of this manual, read Brüel & Kjær's primer on Measuring Sound. The Primer will give you a basic idea of acoustic measurements. It can be found on the www.bksv.com website, by typing 'Primer' in the search window. The website also contains other information you might find useful.

Further information is available in the On-line Help installed on Type 2250/2270.

1.2.3 Experienced Users of Acoustic Measurement Equipment

The manual is designed so that you do not have to read all of it to be able to use the instrument. It is built around the most frequently used operations, which are as follows:

- Building Acoustics Measurements (Chapter 2)
- System Connections (Chapter 3)
- Building Acoustics Software (Chapter 4)
- Specifications (Chapter 5)
- Setup Parameters (Appendix A)
- Measurement Parameters (Appendix B)

However, it is recommended that you read the entire manual for appropriate procedures on how to use Type 2250/2270 to obtain accurate building acoustics measurement results.

Chapter 2

Building Acoustics Measurements

2.1 Introduction

This chapter describes how to perform building acoustics measurements using:

- Type 2250 or Type 2270 with Building Acoustics Software BZ-7228 (single-channel)
- Type 2270 with Dual-channel Building Acoustics Software BZ-7229 (dual-channel)

Section 2.2 defines the terms used in building acoustics for familiarisation purposes and section 2.3 goes on to describe the measurement procedures.

2.2 Building Acoustics Defined

Building Acoustics is the assessment of sound insulation in buildings. The assessment is based on measured 1/1-octave or 1/3-octave spectra within the 50 – 5000 Hz range.

Measurements may be sequential (one frequency band at a time) or real-time (all bands simultaneously).

Note: 'Room Acoustics' is the assessment of sound quality inside a room and is therefore outside the scope of this document. However, it is described in the User Manual for Hand-held Analyzer Type 2250, Chapter 14 – Reverberation Time Software.

2.2.1 Tasks

There are three kinds of building acoustics measurement tasks:

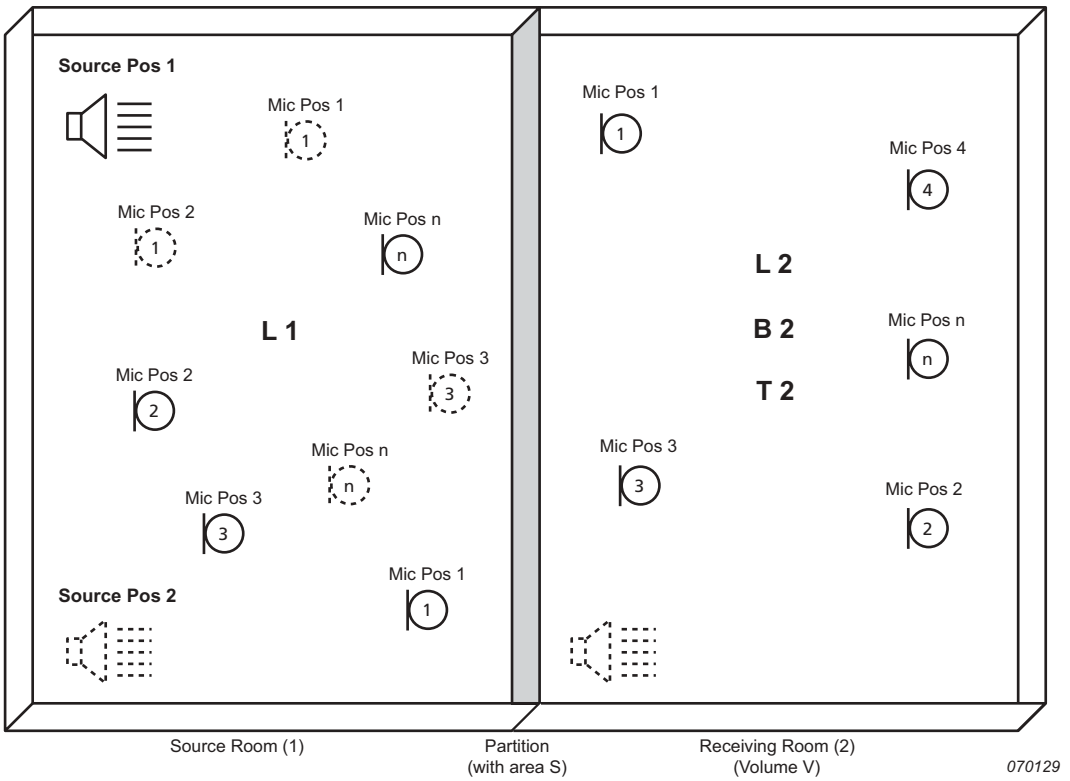
- **Airborne Sound Insulation** is the sound insulation from one room (the source room) to another room (the receiving room)
- **Façade Sound Insulation** is airborne sound insulation with the 'source room' being the space outside a building, and the receiving room being inside the building
- **Impact Sound Level** is the sound level in the receiving room from a standardised tapping machine in the source room

These tasks will be described in more detail in section 2.3.

Reverberation Time is also used in the calculation of building acoustics. Determining Reverberation Time has two purposes: determining the absorption coefficient for building materials and checking the reverberation time according to building regulations, e.g., in stairwells, classrooms and workspaces.

To aid understanding, an illustration on how to set up airborne sound insulation measurements has been provided. This will help you visualise what we will be talking about in the next sections and will help to introduce you to some of the terms used, see Fig.2.1.

Fig.2.1 *Typical setup for airborne sound insulation measurement*



L1 refers to the sound level measurements made in the Source Room (1) – these are used in airborne sound insulation calculations.

L2 refers to the sound level measurements made in the Receiving Room (2) – these are used in airborne and impact sound insulation calculations.

B2 refers to the background sound level measurements in the Receiving Room (2) – these are used for background level corrections in airborne and impact sound insulation calculations.

T2 refers to the reverberation time measurements made in the Receiving Room (2) – these are used in airborne and impact sound insulation calculations

Note: the annotations denote where the measurement was taken. For example, L1 measurements are taken in the Source Room (1) hence the L1 annotation, and the L2, B2 and T2 measurements are taken in the Receiving Room (2) hence the L2, B2 and T2 annotations.

In practice, when you are making measurements 'in the field' there are a lot of considerations to be taken into account while making building acoustic measurements. For example, is the room empty or furnished, large or small, regularly or irregularly shaped, all these things affect the reflection of sound within the room and change the sound field in the room.

This can cause variations in sound pressure level within the Source Room, so measurements are normally made at several points in the room. You might choose, for example, two sound source positions and three microphone positions, see Fig.2.1. The resulting averaged spectrum is used in the sound insulation calculations.

Similarly, a series of measurements are made at different positions in the Receiving Room to allow for sound pressure variations. The resulting averaged spectrum is used in the impact or sound insulation calculations.

The sound insulation calculations are then made, using combinations of the above values, according to a wide range of international standards, see section 2.3.1 and section 4.3.1.

Note: In some standards, the L1 and L2 levels are not averaged for each room separately, irrespective of sound source. Instead each level measurement is identified as belonging to to one particular source and averaging is made in two steps:

- averaging L1-L2 for each source
- averaging L1-L2 contributions

2.2.2 Partitions

Sound insulation refers to a specific 'separating' part of a building (for example, a wall, floor or window). Partition is the common term used in all tasks.

2.2.3 Field vs. Laboratory Measurements

Field Measurements

Measurements in the field are performed in situ on partitions of buildings. The results are used to document conformance to building regulations. In field measurements, sound and vibration propagate not just via the partition under investigation, but also via other partitions, structures and leaks. This propogation is called 'flanking' transmission.

Laboratory Measurements

Measurements in the laboratory are made on building elements such as wall panels or windows mounted in special test rooms, designed and tested to prevent 'flanking'. The measurements follow uniform and strict procedures, and the measuring equipment is usually permanently installed. The results are used by manufacturers to document the performance of their products.

2.2.4 Correction for Background Noise

If the background noise level B2 comes within 15 dB of the receiving room level L2, it starts affecting the measured L2 level. Depending on the standard, correction is made to L2 for the influence of the background noise level. The correction varies depending on the level difference L2 - B2. When the background noise level comes too close to the receiving room level, a fixed correction to L2 is made and the measurement results are marked to indicate that a correction has been made.

2.2.5 Spatial Averaging

The averaging of levels in a room may be done using a moving microphone, e.g., mounted on a rotating boom such as Type 3923, or by averaging the levels measured in a number of positions.

The average reverberation time in a room is calculated from the average result for a number of positions either by averaging the reverberation times or by averaging the decay curves and then calculating the reverberation time for the average decay (ensemble averaging).

2.3 Measurement Procedure

2.3.1 Standards

Hand-held Analyzer Type 2250/2270 with BZ-7228 software (or Type 2270 with BZ-7228 and BZ-7229 software) can measure and calculate results according to a wide range of national and international standards, which include:

- ISO (international)
- SS (Sweden)
- DIN (Germany)
- ÖNORM (Austria)
- BS (UK)
- BREW (England/Wales)
- Sia (Switzerland)
- UNI (Italy)
- NF (France)
- NBE (Spain)
- CTE (Spain)
- NEN (Netherlands)
- NEN'06 (Netherlands)
- ASTM (USA)

Further details of these standards can be found in Appendix B, Table B.1.

For practical reasons, instructions will be given for the ISO standard, which in many cases forms the basis of national standards.

2.3.2 Airborne Sound Insulation

Airborne Sound Insulation is calculated from the L_{Zeq} spectra for the average source room level, L1, average receiving room level, L2, receiving room background noise level, B2 and average reverberation time, T2, see Fig. 2.1.

The sound source should be an omnidirectional loudspeaker, emitting either pink or white noise depending on measurement conditions.

Source Room (L1) Measurements

Place the sound source in the source room to make the L1 sound level measurements, see Fig. 2.1, these are used in the airborne sound insulation calculation.

As explained earlier, several measurement points should be used, both for the sound source and the microphone. We recommend that you choose two sound source positions and a minimum of five microphone positions.

The source room level, L1, is the resulting average for positions 1 to n, and is used in the sound insulation calculations.

Receiving Room (L2) Measurements

L2 level measurements are made in the receiving room, see Fig. 2.1, and are used in impact or airborne sound insulation calculations.

As in the case of L1, a series of measurements are made at different positions in the room, for each sound source position in the source room, to allow for sound pressure variations. The resulting averaged spectrum is used in the impact or airborne sound insulation calculations, whichever are applicable.

Typical L1 and L2 Measurement Cycle

The different stages of a typical L1 and L2 measurement cycle are illustrated in Fig. 2.2 and described below:

1) After 'Start' (i.e., pressing the **Start**/**Pause** pushbutton on the analyzer) a user-defined 'Escape Time' allows you to vacate the measurement room.

2) The noise generator is switched on and the analyzer waits for the chosen 'Build-up' time to allow for the sound field to reach a steady state.

3) If you are using Type 2250 (or Type 2270 for a single-channel measurement), the analyzer starts to measure from this point.

   However, if you are using Type 2270 (with BZ-7229), it is possible to measure L1 and L2 simultaneously by connecting two microphones to your Type 2270.

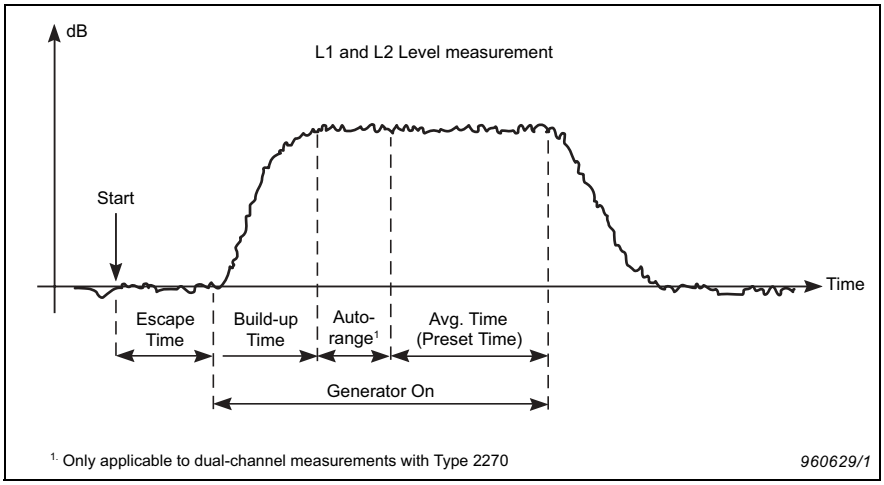
   If this is the case, the analyzer goes into '*Autorange*' (if this setup option is chosen), where the detected level is used to choose the most convenient range, either *High Range* or *Low Range*.

   Note: See User Manual for Hand-held Analyzer Type 2250, Chapter 2, for details about mounting the microphones.

4) The measured spectra are averaged by the analyzer in the chosen averaging time, 'Avg. Time'.

5) The noise generator is switched off.

Fig. 2.2 *Different stages of a typical L1 and L2 measurement cycle*



Receiving Room (B2) Measurements

Background level measurements, B2, are made in the receiving room and can be used for correcting L2 levels automatically, if this setup option is chosen. Ideally, B2 should be measured consecutively with L2 at the same measurement positions.

Typical B2 Measurement Cycle

The different stages of a typical B2 measurement cycle are described below:

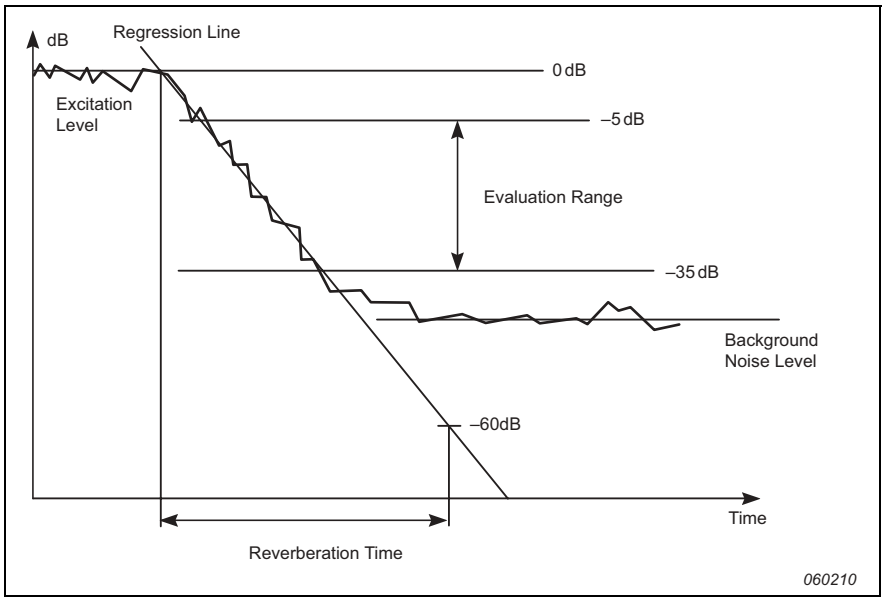
1) After 'Start' (i.e., pressing the **Start**/**Pause** pushbutton on the analyzer) a user-defined 'Escape Time' allows you to vacate the measurement room.

2) The measured spectra are averaged by the analyzer in the chosen averaging time, 'Avg. Time'.

Reverberation Time (T2) Measurements

Reverberation Time, T2, is the decay time for sound in a room after the excitation stops. It is the time for a 60 dB drop in level, but the decay is usually evaluated over a 20 or 30 dB drop, using the measurements within these ranges to make a regression line, which is then extrapolated to the 60 dB range, see Fig. 2.3.

Fig. 2.3 *Definition of Reverberation Time (T2)*



Reverberation Time used in Building Acoustics is labelled either T20 or T30, depending on which of the two evaluation ranges were used.

All measurements are made in the receiving room. As with L1, L2 and B2 measurements, a series of measurements are made at different positions in the room to allow for spatial variations of reverberation decay.

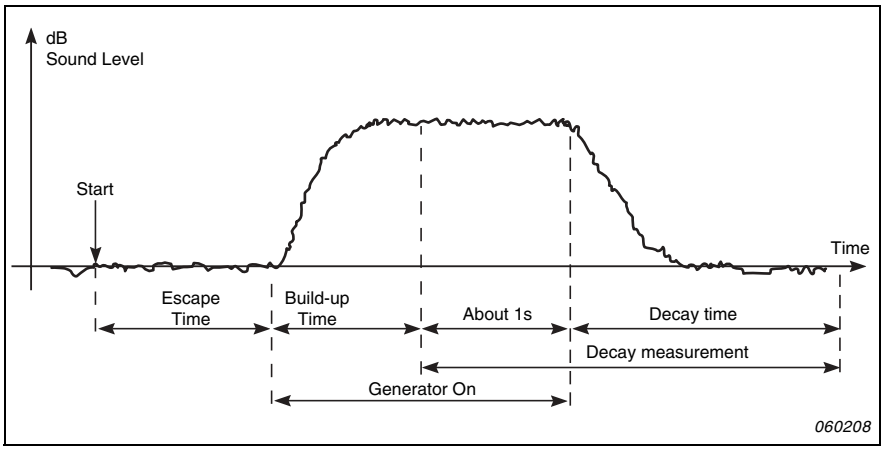
A reverberation time measurement is made using the 'interrupted noise' or 'impulse excitation' methods, as follows:

Interrupted Noise Method

1) After 'Start' (i.e., pressing the **Start**/**Pause** pushbutton on the analyzer) a user-defined 'Escape Time' allows you to vacate the measurement room, see Fig. 2.4.

2) The noise generator is switched on and the analyzer waits for the chosen 'Build-up' time, to allow for the sound field to reach a steady state.

Fig. 2.4 *Typical Reverberation Time (T2) measurement cycle for interrupted noise method*



3) The decay measurement starts. The level for the first second, or so, is used to identify the excitation sound level as the 0 dB reference level.

4) The noise generator is switched off and the sound level begins to decay.

5) The decay measurement ends when only the background noise level is measured (automatically detected by the analyzer).

6) Steps 2) to 5) are automatically repeated a chosen number of times and the measured decays are averaged together to reduce the uncertainty of the measurement.

7) The reverberation time spectra T20 and T30 are calculated and displayed on the screen.

Impulsive Excitation Method

1) After 'Start', the analyzer waits for the level to exceed the 'Trigger Level' (indicated on the analyzer by the Traffic Light giving a short green flash every second).

2) The impulse excitation (e.g., a starting pistol is fired or a balloon is burst) is made.

   Caution: the use of hearing protection is highly recommended.

3) The impulse measurement is started 1 s before the level exceeds the 'Trigger Level'.

4) The impulse measurement stops after the analyzer detects the background noise level again (automatically measured by the analyzer).

5) The analyzer performs backward integration of the impulse measurement (according to the Schroeder method).

6) The reverberation time spectra T20 and T30 are calculated and displayed on the screen.

The measurement is in octaves or 1/3-octaves in parallel over a selectable frequency range. In each frequency band, the decay is sampled 200 times each second.

In theory, the resulting decay will be equivalent to the average of a large number of decays made with the interrupted noise method. Therefore, the decay will be smooth using just a single shot.

2.3.3 Façade Sound Insulation

Façade sound insulation is airborne sound insulation with the 'source room' being the space outside a building and the receiving room being inside the building, see Fig. 2.5.

The loudspeaker sound source should be positioned at an angle of 45° to the centre of the partition (or wall) and generating pink or white noise.

The outdoor level, L1, is the resulting average for positions 1 to n, placed at the partition, and is used in the sound insulation calculations.

Façade sound insulation is then calculated from the L_{eq} spectrum for the average outdoor level, L1, average receiving room level, L2, average receiving room background noise level, B2 and average reverberation time, T2.

The B2 and T2 measurements are performed in a similar way to those described previously in Section 2.3.2.

Traffic Noise

Owing to the varying character of traffic noise, L1 and L2 need to be measured simultaneously for each set of L1/L2 positions, and the L1-L2 differences are then averaged. For this reason you will need a dual-channel Type 2270 to perform this task.

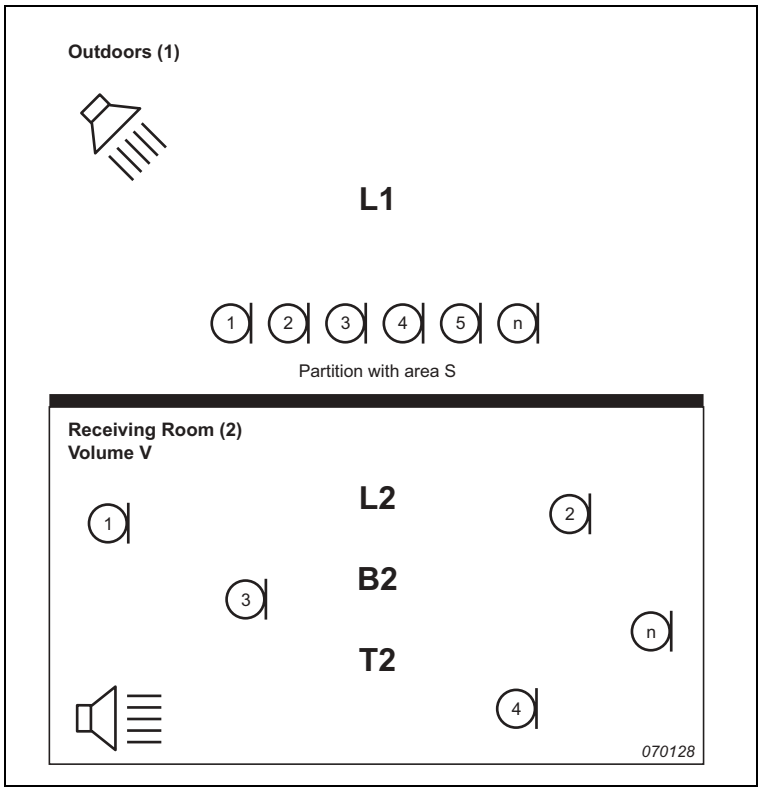


Fig. 2.5
Typical setup for façade sound insulation measurement

2.3.4 Impact Sound Level

Impact Sound Level is the sound level in the receiving room from a standardised tapping machine in the source room, see Fig. 2.6.

The sound source for L2 is a standardised tapping machine (for example, Brüel & Kjær's Type 3207), which is placed in the source room to simulate footsteps. The sound source used for T2 is interrupted noise or impulsive noise.

Impact Sound Level is then calculated from the L_{Zeq} spectra for average receiving room level, L2, reverberation time, T2 and receiving room background noise level, B2).

Note: All spectra (average L2, B2 and T2) are measured as the average of several source/receiver positions.

The L2, B2 and T2 measurements are performed in a similar way to those described previously in Section 2.3.2.

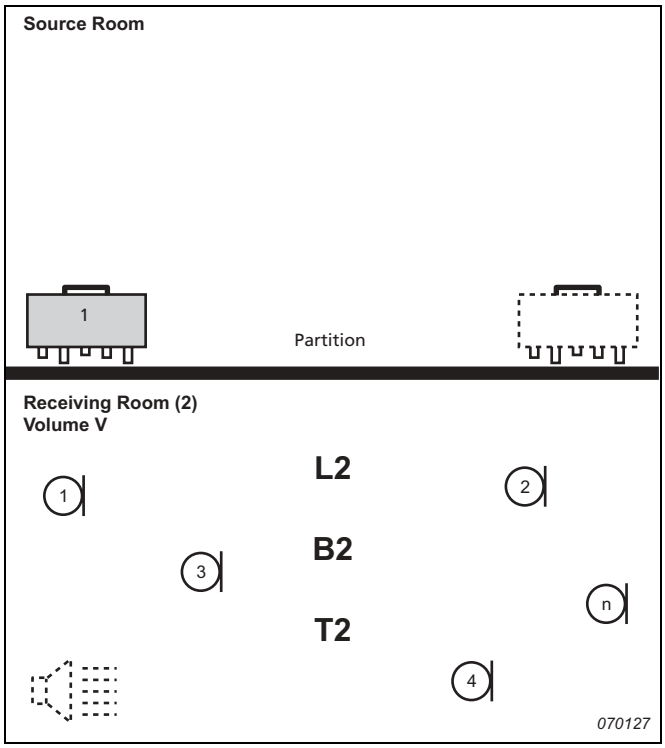


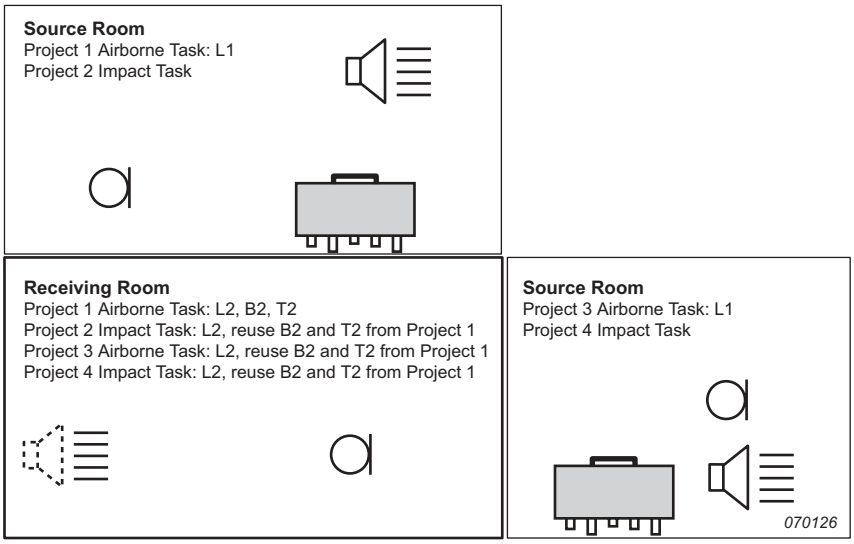
Fig. 2.6
Typical setup for impact sound level measurement

2.3.5 Combined Tasks and Measurements

Often more than one partition in a room is investigated, more than one task performed for the same room or partition, or several physically identical rooms in a building are measured. This means some parameters need be measured only once then reused in the calculations for several partition, tasks or rooms. An example is shown in Fig. 2.7.

The need for good ‘bookkeeping’ is evident. Type 2250/2270 supports bookkeeping as well as the re-use of partitiion data.

Fig. 2.7 *Typical example showing how you can combine tasks and measurements*



Chapter 3

System Overview

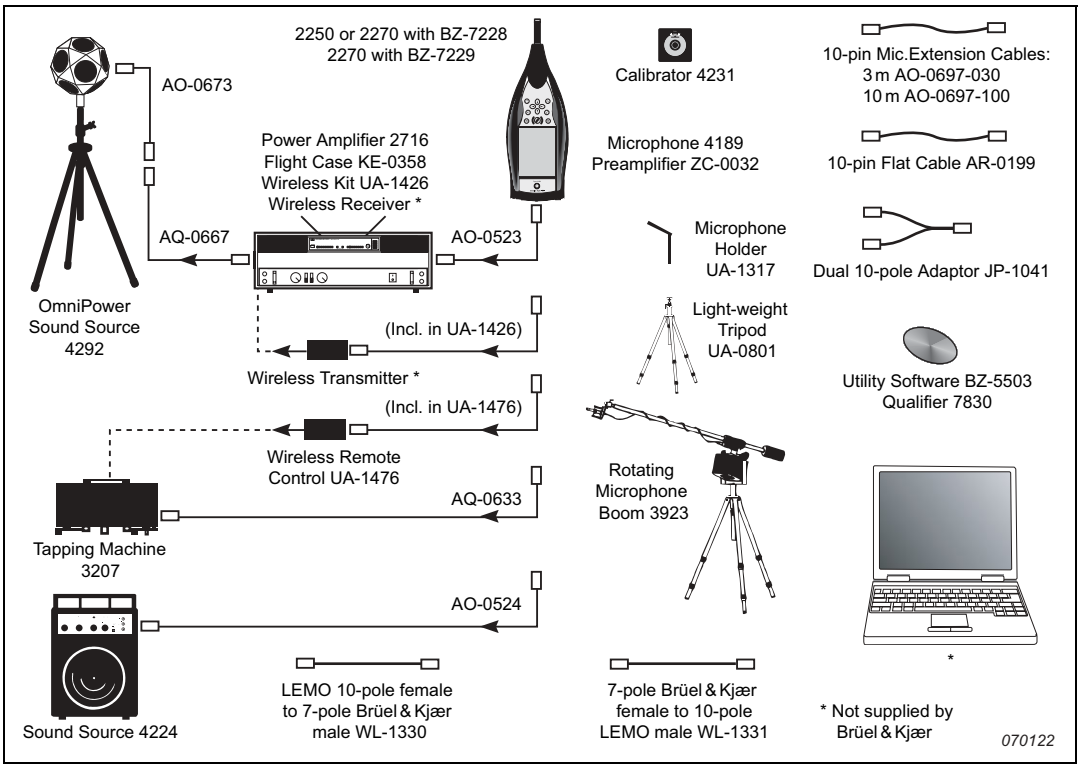
3.1 System Overview

This chapter provides an overview of the equipment and accessories used to perform building acoustics measurements using:

- Type 2250 or Type 2270 with Building Acoustics Software BZ-7228 (single-channel)
- Type 2270 with Dual-channel Building Acoustics Software BZ-7229 (dual-channel)

Please refer to the System Overview Diagram in Fig. 3.1.

Fig. 3.1 *System overview diagram*



For further details, see the "Ordering Information" on page 67.

Chapter 4

Building Acoustics Software

4.1 Introduction

Building Acoustics Software BZ-7228 and Dual-channel Building Acoustics Software BZ-7229 enable you to measure building acoustics using your Hand-held Analyzer Type 2250, or your dual-channel Hand-held Analyzer Type 2270.

Check the **About** Menu on your analyzer to see whether you have the license to run the relevant building acoustics software. (The **About** Menu is accessed from built-in help – tap ? on the shortcut bar, then select **About**.)

4.2 What is a Building Acoustics Project?

When using Building Acoustics Software BZ-7228/7229, it will be useful to know what a building acoustics project consists of, before you start to measure.

A Building Acoustics project contains data for one 'Partition' and one 'Task', i.e., setup parameters, a number of L_{eq} sound level spectra, background level spectra and reverberation time spectra. The data are categorised by means of type and location (for example, room 1 – source room, room 2 – receiving room, etc).

In a project there are up to four categories of data:

- L1: source room sound level spectrum
- L2: receiving room sound level spectrum
- B2: receiving room background noise sound level spectrum
- T2: receiving room reverberation time spectrum

The four categories of data are referred to as 'Functions', so to measure, for example, L1, you select the 'L1 Function', and if L1 and L2 data are measured simultaneously (dual-channel measurements on Type 2270 only), then the function is called 'L1&L2'.

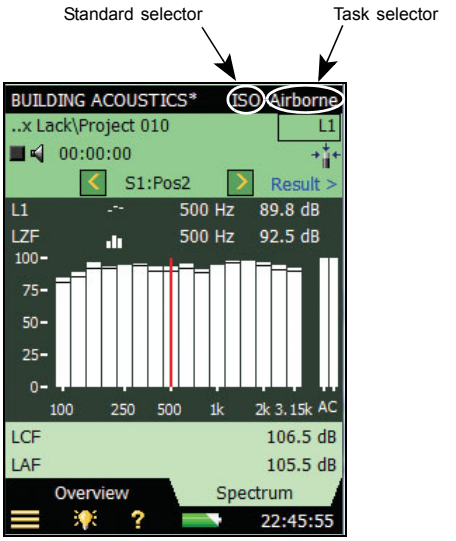
4.3 Navigating Building Acoustics Software

Building Acoustics software is similar to the rest of the software applications available on Hand-held Analyzers Types 2250 and 2270 in that navigation is possible using the stylus or using the arrow keys and the Accept ✓ pushbutton. This section describes all the standard drop-down menus, the status panel and general navigation features of BZ-7228/7229 software.

4.3.1 Standard Selector

A Standard selector is provided in the Project Template bar, see Fig.4.1:

Fig.4.1
Standard selector



The Standard selector is used to select the supported standard on which the measurements and calculations are based, see “Setting the Relevant Standard and Task” on page 28 and “Building Acoustics Standards” on page 83.

The options are:

- ISO
- SS
- DIN
- ÖNORM
- BS
- Sia
- UNI
- NF
- NBE
- CTE
- BREW
- NEN
- NEN'06
- ASTM

When a project contains data, then the available 'Standard' options are reduced to those compatible with the data.

4.3.2 Task Selector

Next to the Standard selector in the Project Template bar there is a Task selector (an example of an Airborne task is shown in Fig. 4.1), see also "Setting the Relevant Standard and Task" on page 28. The options are as follows:

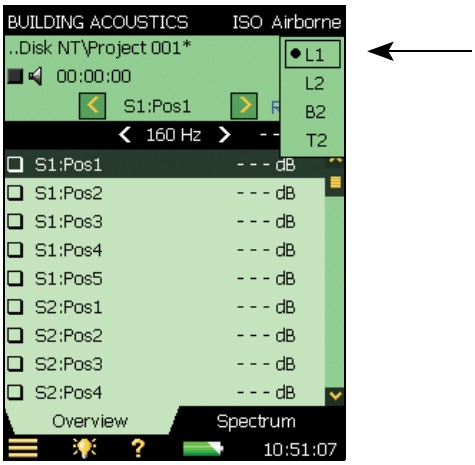
- Airborne
- Impact
- Façade

When a project contains data, then the available 'Task' options are reduced to those compatible with the data.

4.3.3 Function Selector

The Function Selector is located in the first line of the Status Field (see Fig.4.2). The options are determined by the selected task and whether L1 and L2 are measured simultaneously (Type 2270 only):

Fig.4.2
Function Selector options



If the selected task is *Airborne* or *Façade* and L1 and L2 are measured separately, then the options are:

- L1
- L2
- B2
- T2

If the selected task is *Airborne* or *Façade* and L1 and L2 are measured simultaneously (Type 2270 only), then the options are:

- L1&L2
- B2
- T2

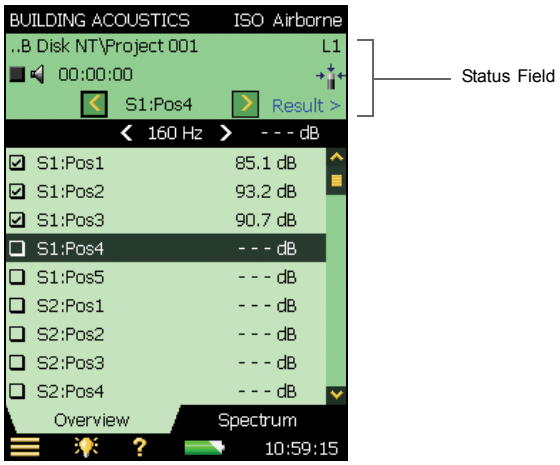
If the selected task is *Impact*, the options are:

- L2
- B2
- T2

4.3.4 Status Field

The status field contains various information regarding the current measurement:, see Fig.4.3:

Fig.4.3
Status Field



Line 1:

- Project name and data path (tapping on data path opens the Explorer – see section 4.11)
- Smiley for the Project (if applicable)
- Annotation icon with link to list of annotations (if applicable)
- 'Connected to PC' icon (if applicable)
- Recording icons for Sound or Commentary (if applicable)
- The Function Selector

Line 2:

- Measurement Status
- Generator On/Off (Loudspeaker icon)
- Elapsed Time of measurement
- Feedback on measurement keys
- 'Uncal' – status on calibration
- Overload/Underrange indication
- Transducer icons – one per channel (linked to **Setup**)

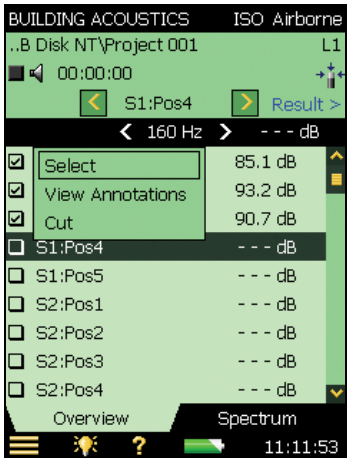
Line 3:

- Position Selector (drop-down menu)
- Icons for stepping backwards or forwards in positions (or)
- Smiley for the position
- Link to results (Result >), see section 4.8.

4.3.5 Overview (L1, L2, L1&L2, B2 and T2)

The *Overview* tab shows the measurement positions in a table – one position per row, see Fig.4.4.

Fig.4.4
Overview options



When tapping on a position in the table (i.e., *Pos1*), you get the following options on the drop-down that appears:

- *Select* (selects the 'active' position, which is highlighted by black bar)
- *View Annotations* (displays the list of annotations for the measurement)
- *Cut* (cuts the measurement for pasting at another position).
- *Paste* (pastes the cut measurement)

  Note: 'Cut' and 'Paste' are only available in Planned measurements (see section 4.5.1) where data already exists.

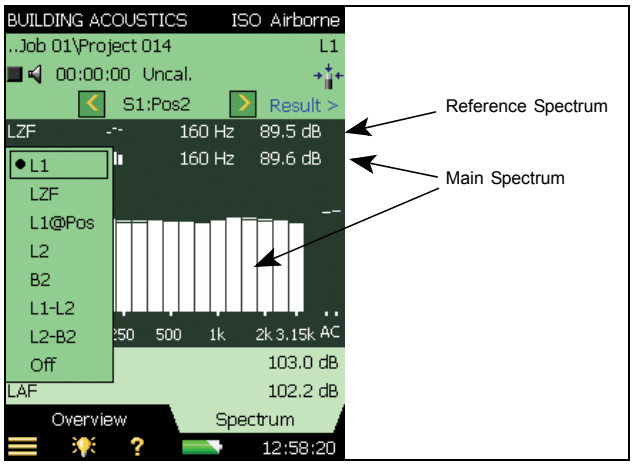
When viewing the *T2* function, it is possible to choose between two averages by tapping the top line in the overview. The options are:

- T20
- T30

4.3.6 Spectrum View (L1, L2, L1&L2 and B2)

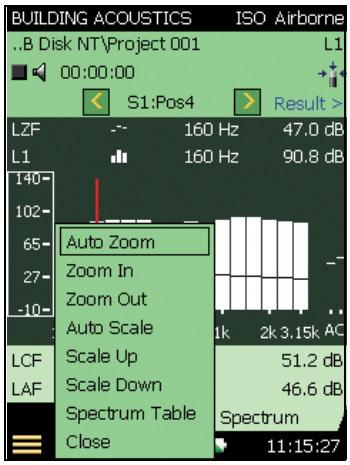
The *Spectrum* tab shows the sound pressure level spectrum for a single measurement position, but you can switch between the main spectrum view and a reference spectrum. The spectra options are shown in Fig.4.5.

Fig. 4.5
The spectrum drop-down



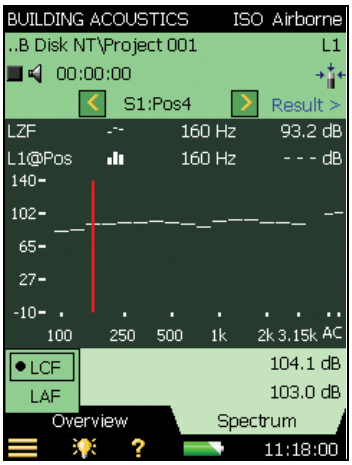
The Y-axis can be changed to suit your measurements, see the options in Fig. 4.6.

Fig. 4.6
The Y-axis drop-down menu



In the area below the Spectrum, two parameters can be shown – both can be selected from drop-down lists, see Fig. 4.7.

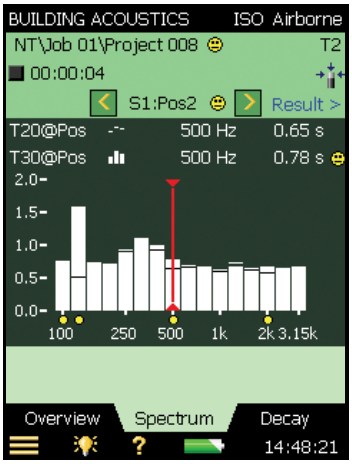
Fig. 4.7
The parameter drop-down menu



4.3.7 Spectrum View (T2)

The *Spectrum* tab for T2 measurements shows the reverberation time spectrum from a position (i.e., *T20@Pos* or *T30@Pos*, see Fig.4.8), the average reverberation time (i.e., *T20* or *T30*), or both. The sound level is displayed during measurements. For more information refer to section 4.6.4.

Fig. 4.8
The Spectrum view



4.3.8 Decay View (T2)

The *Decay* tab for T2 measurements shows the reverberation time decay from a position, the average of positions (if Ensemble Averaging is used), or both. For more information refer to section 4.6.5.

4.4 Things to Remember

Before you start your building acoustics measurements, you may find the following few rules useful to bear in mind:

Display

- Smileys in the spectrum refer to the combined smileys of both selected spectra
- A useful selection of displayed parameters is:

L1	L2	B2	T2
L1@Pos	L2@Pos	B2@Pos	T2@Pos

  You can then check the spectrum for the latest position, as well as the average spectrum, for any function. (For T2 measurements, you need to set the *Automatic Save* parameter to *Off*).

Reverberation Time

- Reverberation Time: Curvature C% is displayed when *Show Regression Line* is selected from the Y-axis drop-down on the *Decay* tab
- With *Ensemble Averaging* selected, manual entry should be made in the average T2 spectrum to take effect. With no *Ensemble Averaging* selected, manual entry may be made in any spectrum
- Decay for the average T2 measurement is shown only with *Ensemble Averaging* selected

Measurement Control

- After a Planned measurement, the next position may be automatically or manually selected
- After an Unplanned measurement, the next position will be selected when starting the next measurement

Type 2270 Dual-channel Setup

- In dual-channel setup, assign different transducers to the two channels, to ensure correct operation. This also applies to Direct inputs
- Microphone icons: the left icon is Ch.1, the right one is Ch.2
- Measuring L1 and L1 Simultaneously:
  - High Range for L1 and Low Range for L2 works for most measurements
  - In case of 'Underrange' indication during the averaging time (High Range only), change to Low Range. (Or use Autorange which takes a few extra seconds)
- Dual-channel software simultaneously assigns L1 to Ch.1 and L2 to Ch.2. You may then want to assign B2 and T2 to Ch.2. If you change the *Measure L1 and L2* parameter to *Separately*, check that the assignments are as desired
- Dual-channel L1&L2 Overview: L1 or L2 shown, click on L1 to see L2, and vice versa

Data

- Cut and paste in Overview: for Planned measurements only
- Reuse: from project in Explorer into the current project
- The date of the projects in Explorer is the date when the project was last saved (e.g., after being opened and reviewed)

4.5 Level Measurements (L1, L2 and B2)

4.5.1 Planned vs. Unplanned Measurements

This section contains descriptions on how to set up your analyzer and how to control your level measurements. It also gives examples of how to perform 'Planned' as well as 'Unplanned' measurements.

The Planned measurement setup is required for the BREW and NEN/NEN'06 standards and optional for the other standards. It guides you through each stage of the measurement process in a logical sequence, which means that you can see where you are in the process at any given time. This helps to avoid confusion and can be reassuring when you are dealing with multiple microphone and sound source positions.

The Unplanned measurement setup is the one you should use if you are not working to a particular standard, or you do not have to keep track of several sound source positions. Or perhaps you have some previous building acoustics measurement experience and like the flexibilty to follow your own procedures.

4.5.2 Trial Measurement

To familiarise yourself with the measurement procedure quickly and to see how easy it is to measure building acoustics, you might like to try an unplanned 'trial measurement' using the default setup and settings in the **BUILDING ACOUSTICS** Project Template. This template contains the setup and parameters that Brüel & Kjær consider necessary to perform a basic, unplanned building acoustics measurement, starting with the L1 measurements. (For example, the ISO standard and Airborne task are selected, the microphone is selected, L1 is selected, etc). All you have to decide is where to position your sound source and your microphone(s) in the source room.

You should not have to change the default settings for your first trial measurements, but later when you have gained more measurement experience, you can change them according to your requirements.

Note: The default setup and settings are only available immediately after the programme has been installed on your analyzer, these settings are overwritten every time a user saves the **BUILDING ACOUSTICS** Project Template. So please be aware that the may have been edited by a previous user and check the settings if you are not sure!

Simply select the **BUILDING ACOUSTICS** Project Template (if not already displayed tap on the black bar at the top of the screen and select **BUILDING ACOUSTICS** from the drop-down menu that appears) then press **Start**/**Pause** pushbutton to perform the first measurement, and view the result. Finally, press the **Save** pushbutton to save your level measurement at the first position.

Note: For more detailed information on saving setups and templates and organising your measurements, please refer to the following sections in the User Manual for Hand-held Analyzer Type 2250 (BE 1713):

- Section 3.4 – Save your Measurement
- Section 6.1 – Organising Measurements
- Section 4.4.8 – How to Manage Templates
- Section 4.4.7 – How to Personalise your Setup

4.5.3 About this Section

The reasoning behind the layout of this section is that, if you are not familiar with building acoustic measurements, you should read through the sections on setting up and controlling the instrument (section 4.5.4 and section 4.5.5 that follow) and then work through the planned procedure (section 4.5.6). These sections (together with the instrument itself) will guide you through the level measurement procedures.

However, if you are already familiar with building acoustic measurements and have a rough idea of the procedure, you can skip the planned procedure and go straight to the unplanned procedure (see section 4.5.7), and read as much of the preceding sections as you need to.

Note: you can perform single- or dual-channel building acoustic measurements with Type 2270, and single-channel measurements with Type 2250.

Please refer to the following section for single-channel measurements, otherwise see “Dual-channel Measurements (Type 2270 Only)” on page 47.

4.5.4 Setting up the Instrument (for Single-channel Measurements)

1) Select the **BUILDING ACOUSTICS** Project Template. The Project Template is displayed at the top of the screen. If it does not display **BUILDING ACOUSTICS**, tap on the black bar at the top of the screen and select **BUILDING ACOUSTICS** from the drop-down menu that appears.

2) Tap the **Main Menu** icon and select **Setup** from the list of options, then select the *Full* tab.

Input Selections

For single-channel measurements, set the Input parameters to those shown in Fig. 4.9.

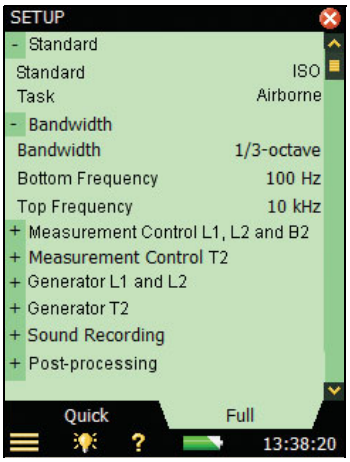
Fig. 4.9
Single-channel Input setup for measuring building acoustics using Types 2250/2270

Setting the Relevant Standard and Task

The 'Standard' parameter allows you to set the relevant standard for your building acoustic measurement; various options are available (see Appendix A for details).

3) Set the *Standard* parameter as required, in the example in Fig. 4.10, *ISO* has been selected:

Fig. 4.10
Setting the 'standard' and 'task' for building acoustics measurements



The measurement 'task' you are about to perform should now be selected, either *Airborne*, *Impact* or *Façade* (for example, *Airborne* has been selected in Fig. 4.10). The task can also be changed by tapping on the task name in the black bar at the top of the measurement screen, and selecting the required task from the drop-down list that appears.

4) Set the *Task* parameter to either *Airborne*, *Impact* or *Façade*, whichever is appropriate.

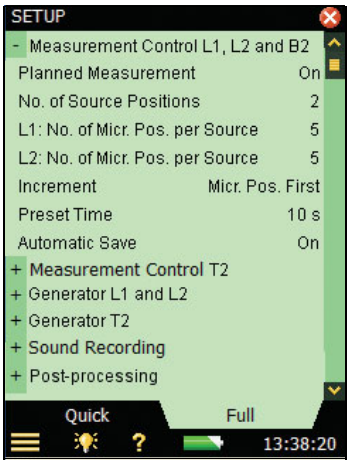
Setting the Bandwidth and Frequency Range

5) Set the *Bandwidth* and *Bottom* and *Top Frequency* of the measurement as required, see the example in Fig. 4.10. These parameters are set automatically by the selected standard; however, you can select a wider frequency range than required by the standard. Some standards also allow 1/1-octave or 1/3-octave measurements.

Measurement Control Setup – L1, L2 and B2

6) Set the measurement control parameters as required, see Fig. 4.11:

Fig. 4.11
Measurement control setup



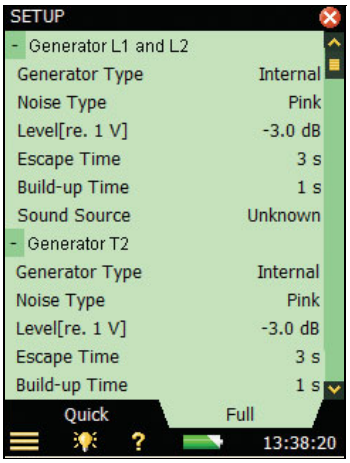
- *Planned Measurement* – set to *On* if you want to perform the measurement in a planned sequence (and define the number of source positions and microphone positions per source), or set to *Off* if you want to perform the measurements manually from Pos. 1 onwards[a].
- *No. of Source Positions* – set to the number of sound source positions you are using (only available if the *Planned Measurement* parameter is set to *On*).
- *L1/L2:No of Micr. Pos. per Source* – set to the required number of microphone positions you are using with each source (only available if the *Planned Measurement* parameter is set to *On*)
- *Increment* – this parameter allows you to define the order in which you want to do your measurements, either *Source First*, *Mic. Position First* or manually (*Manual*).
- *Preset Time* – sets the averaging time (in hours, minutes and seconds), see also Fig. 2.2
- *Automatic Save* – set to *Off* if you want to inspect the measurement before manually saving it, or set to *On* if you want to save the measurement automatically.

a. Some standards require a planned measurement and for those standards, *Planned Measurement* is automatically selected.

Generator Setup for L1 and L2

7)*Generator Type* – set the generator as required *Generator Type = External* if you want to control an external generator (see details in Appendix A, Table A.9) – otherwise leave it at *Internal* to use the internal generator, see Fig.4.12.

Fig.4.12
Generator setup for L1 and L2



8) *Noise Type* – choose the type of noise for the internal generator, *Pink* noise is typically used.

9) *Level [re. 1 V]* – Adjust the level of the internal generator output to match the input of the power amplifier used.

Note: You can manually turn the generator on and off by tapping on the loudspeaker icon in the status field.

10) *Escape Time* – set this to allow you to leave the room before the generator is turned on during the measurement.

11) *Build-up Time* – set this to allow the excitation noise to reach a steady state before the measurement starts. One second is adequate in ordinary rooms but should be increased for larger halls.

12) *Sound Source* – select a type matching your sound source. Select *Unknown* if you are using a non- Brüel & Kjær sound source or do not want to make a correction to the frequency response.

For Brüel & Kjær sound sources, you may linearise the power frequency response in two steps by selecting *Optimum* or *Flat* (from the *Sound Source* drop-down), which is at the expense of a decrease (by two steps) of the total power.

Setup for Sound Recording

13) *Sound Recording* – set *Recording Control* to *Automatic* if you want to record the microphone signal during the measurement. The recordings can be played back afterwards, so

you can investigate why the measurements differed from each other and what the cause was (for example, background noise).

14) *Recording Quality* – this parameter determines the quality of the recording by adjusting the sampling rate. The amount of space required for the recording on the memory card will depend on the selected quality – see Table A.8 on page 76.

15) *Peak Recording Level* – set this parameter to fit the signal – see Table A.8 on page 76.

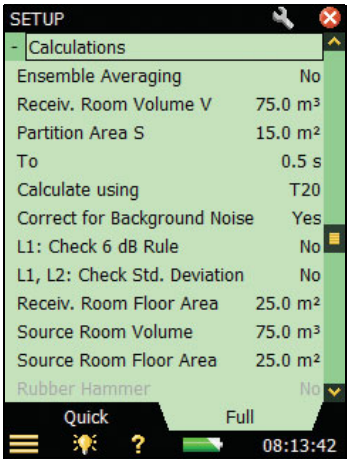
The recordings will contain the microphone signal from when you press the **Start**/**Pause** pushbutton until the measurement stops. The recording will be attached to the measurement as an annotation.

Note: Sound Recording requires a license for the Sound Recording Option BZ-7226, and you may also need a memory card for storing the data.

Setup Calculations

Calculation parameters (Fig.4.13) can be set as required, they are as follows:

Fig.4.13
Setup for Calculations



16) *Ensemble Averaging* – set to *Yes* to average decays from all positions. Average parameters (such as T20) are then calculated based on the ensemble averaged decay, so you can display the average decay. If set to *No,* the 'Avg' parameters are just averages of reverberation times and no average decay is available.

17) *Receiv. Room Volume V* – the value you insert here is used in calculation of results.

18) *Partition Area S* – the value you insert here is used in calculation of results.

19) *To* – the reference reverberation time – typically 0.5 s, but it may vary with standards

20) *Calculate Using* – use this parameter to specify which of the measured reverberation time values to use in the calculations. If T30 is specified and available, then T30 is used, otherwise T20 is used.

21) *Correct for Background Noise* – use this parameter to specify whether L2 should be corrected for the background noise, B2, or not.

22) L1: Check 6 dB Rule – select *Yes* if you want to check whether the sound spectrum in the source room has differences in level greater than 6 dB between adjacent 1/3-octave bands, or not. The check is done according to the method specified in ISO 140-4:1998, 6.2. If a difference greater than 6 dB is found, then the lowest of the two bands is marked with a yellow smiley. When the smiley is tapped, the following explanation appears: "*L1: >6 dB difference to next band*".

23) L1, L2: Check Std. Deviation – select *Yes* if you want to check whether the standard deviation of the averaged sound spectra in the source and receiving rooms is too big, or not. The check is done according to the method specified in ISO 140-14:2004, A.5. If the standard deviation in a frequency band is greater than twice the theoretical expected value, then the band is marked with a yellow smiley. When the smiley is tapped, the following explanation appears: "*L1 or L2: High Standard Deviation*".

24) *Receiv. Room Floor Area* – the value you insert here, which is optional, is needed for reports in some standards.

25) *Source Room Volume* – the value you insert here, which is optional, is needed for reports in some standards.

26) *Source Room Floor Area* – the value you insert here, which is optional, is needed for reports in some standards.

27) *Rubber Hammer* – select *Yes* if you are measuring to the NEN or NEN'06 standard, otherwise select *No*. (Only available if the *Impact* task is selected).

28) *Floor* – select *Wood* or *Stone*, whichever is applicable. (Only available if the *Impact* task and *Rubber Hammer* parameter are selected and you are measuring to the NEN or NEN'06 standard).

29) *Cr* – set the dB level for Cr here, if you are measuring to the NEN or NEN'06 standard. (Only available if the *Façade* task is selected).

30) *Traffic Type* – select *Road*, *Rail*, *Air* or *Other*, whichever is applicable, when you are measuring to the NEN or NEN2006 standard. (Only available if the *Façade* task is selected).

31) *CL* – set the dB level for CL here, if you are measuring to the NEN'06 standard. (Only available if the *Façade* task is selected).

32) *OILR Correction* – set the dB level for OILR correction here, if you are measuring to the ASTM standard. (Only available if the *Façade* task is selected)

33) *OITL Correction* – set the dB level for OITL correction here, if you are measuring to the ASTM standard. (Only available if the *Façade* task is selected)

34) To exit the setup screen, tap on the  icon.

4.5.5 Controlling the Measurement

The measurement is controlled in the same way you would control a level measurement, using **Start**/**Pause**, **Continue**, **Reset** and **Save** pushbuttons.

The measurement control procedures for sound pressure level look very similar to those for measuring reverberation time (see also section 4.6). The only difference between the displays is that the time units (s) are replaced by sound level units (dB) and the reverberation time average (for example T20) is replaced by a sound pressure level average (for example, L1). (The reverberation software also has an extra *Decay* tab, which contains a Decay view, see also section 4.6).

In this section, two examples have been used: one to illustrate how to perform a planned measurement task, and the other to illustrate how to perform an unplanned measurement task (i.e., the *Planned Measurement* parameter is set to *Off*).

Changing Function

You can change the function (L1, L2, B2 or T2) at any time during the measurement sequence; you do not have to follow a certain sequence if it doesn't suit you. For instance, you might want to do the L2 measurement before L1, or perform the measurements in a completely random order depending on site conditions.

4.5.6 Example of a Planned Measurement Task

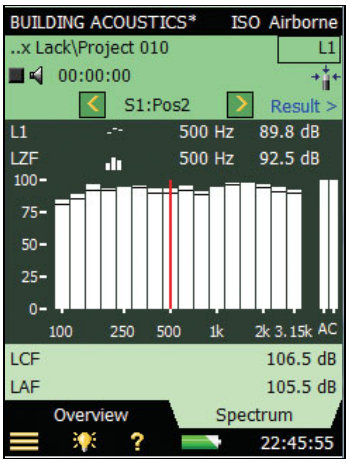
The task is to determine the airborne sound insulation between two rooms according to ISO 140.

1) Connect the cables, amplifier and sound source (please refer to Fig. 3.1).

2) Under *Standard* parameters, set *Standard* to *ISO*, and task to *Airborne* (both indicated next to the template selector, see example in Fig. 4.14).

Note: Only those parameters noted below need to be set up for a Planned Measurement task, the remaining parameters should be left at their default settings.

Fig.4.14
Typical ISO/Airborne spectrum display



3) Firstly, the sound level of the source room will be determined (indicated below the Template Selector by the Function Selector *L1*).

4) Start with an empty Building Acoustics template, and under the *Measurement Control L1, L2* parameters set *Planned Measurement* to *On*, set *Number of Sources (Positions)* to 2, and choose three receivers for each source.

5) Check the levels by tapping on the lower parameter of the two parameter selectors shown above the graph, and select the instantaneous level *LZF*, see Fig.4.14. You can check the level of the sound source by switching it on and off using the loudspeaker icon .

Note: LAF and LAC broadband readouts are shown to the right in the spectrum.

Ready for First Measurement

6) The third line of the status field shows *S1:Pos1*, this is the position selector and it indicates the current source and microphone position. (The current source and microphone position are also displayed in a list on the *Overview* tab, see Fig.4.15).

7) Select *L1@Pos* instead of *LZF* in the lower parameter and *L1* in the upper parameter. This will allow you to monitor the average level of L1 and the level of the current position throughout the measurement, see Fig.4.15.

8) Press **Start/Pause** pushbutton to perform the first measurement, indicated by *S1:Pos1** being displayed in the status field. The '*' indicates that the measurement has not been saved.

9) After the measurement the measurement data are shown in the black line below the position selector (see Fig.4.15, left).

   Note: If a smiley appears during the measurement, it will appear in the black line below the Status Field/Position Selector. Two smileys have been shown for illustration purposes in Fig.4.15: one is applicable to the 100 Hz band in the black line, and the other smiley above it is for the complete position *S1:Pos1**. Small smileys are set below each frequency band with a potential problem. The smileys are also available at the cursor readouts. Tap on the smiley at the cursor readout to get detailed information about the warning. (For a description of status indicators and smileys, see "Quality Indicators" on page 53.) The Spectrum is shown in Fig.4.15, right.

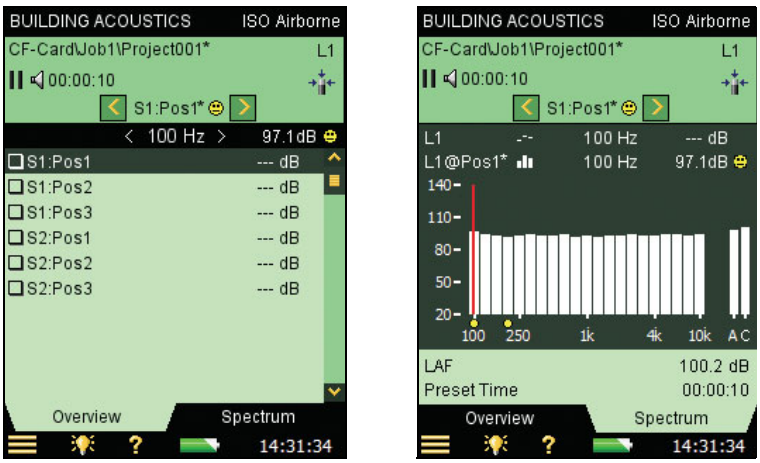
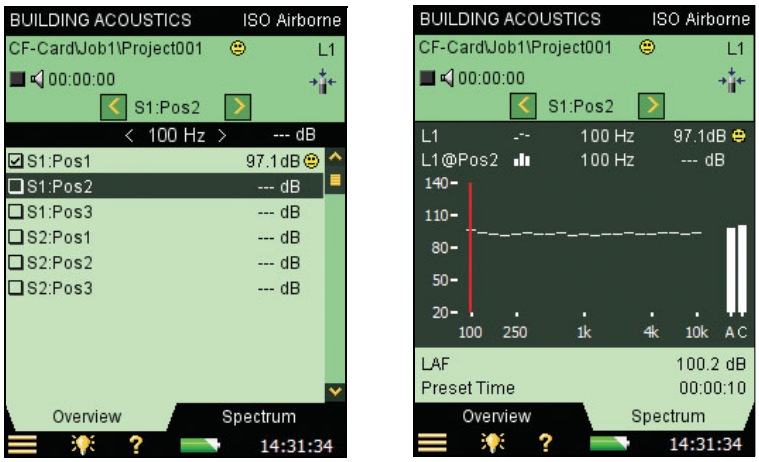


Fig.4.15
Overview and Spectrum tabs after the first measurement

10) Press the **Save** pushbutton. The measurement is saved as *S1:Pos1*. The smiley is updated for the complete project on the upper line. *S1:Pos2* is automatically selected to indicate the next measurement position, see Fig.4.16.

Fig.4.16 *Overview and Spectrum tabs just before the second measurement*



11) Press **Start**/**Pause** pushbutton to measure in sequence at *Pos2*, *Pos3*, etc.

The selection possibilities for spectrum parameters on the measurement display are listed in Table 4.1

Table 4.1 *Spectrum parameters – measurement display*

Function	Graph
L1, L2, B2, T2	LZF
L1	L1@Pos
L2	L2@Pos
B2	B2@Pos
T2	T20@Pos
T2	T30@Pos
L1, L2, B2	L1
L1, L2, B2	L2
L1, L2, B2	B2
L1, L2, B2	L1 - L2
L1, L2, B2	L2 - B2
L1, L2, B2, T2	Off
T2	T20
T2	T30

The Overview position selector has the following options available:

- *S1:Pos1*
- *S1:Pos2*
- *S1:Pos3*
- *S2:Pos1**
- *S2:Pos2*
- *S2:Pos3*

(The '*' indicates unsaved data – in this example for *S2:Pos1*.)

12) When the L1 measurements have been done, change the function to L2, B2 or T2 and continue measuring in the same way as described above until all functions have been measured.

    Note 1: The B2 function has no 'planned' source/receiver sequence, you just measure it in a number of positions.

    Note 2: With T2 measurements, LZF is displayed while measuring, and the selected 'T' parameters (in s) are displayed when paused, (see section 4.6 for details on T2 measurements).

Automatic Increment

The *Increment* parameter (under *Measurement Control T2* parameters) defines the order in which you want to do your planned measurement: source room first (*Source First*) or microphone positions first (*Mic. Pos. First*). You can also decide to choose each subsequent position manually, see 'Manual Selection of Measurement Position' that follows.

Automatic Save

Set the *Automatic Save* parameter to *On* to automatically save the measurement and increment the position counter to be ready for measuring at the next position.

Manual Selection of Measurement Position

If you select another measurement position, the **Save** ⑫ pushbutton will save at this position and select the next position as defined by the *Increment* parameter (under *Measurement Control T2* parameters). This might be a position where some data have already been saved.

An extra pop-up warning will appear if you try to save the data in a position already containing data.

If the *Increment* parameter is set to *Manually* then the position will not automatically change after you save. You have to select a new position before every save operation.

Changing the Number of Sources and Microphone Positions

For Planned measurements, you can increase and decrease the number of source positions and the number microphone positions per source in the setup. (Note that you cannot delete any positions you already have).

4.5.7 Example of an Unplanned Measurement

Set the *Planned Measurement* parameter to *Off* if you just want to measure at a number of positions without keeping track of the relation between source and microphone positions, and just want to measure from *Pos1* and forwards.

Note: This is not available for the standards BREW, NEN and NEN'06.

13) Press **Start**/**Pause** pushbutton to make a *Pos1* measurement. The result of the measurement is shown in the black line above the table, see Fig.4.17.

Fig.4.17
Unplanned measurement

Left: Before pressing ***Start/Pause*** *pushbutton on a Pos1 measurement*

Right: The result of the Pos1 measurement before saving

Note: If a smiley appears during the measurement, it will appear in the black line below the Status Field/Position Selector. Two smileys have been shown for illustration purposes in Fig.4.17: one is applicable to the 100 Hz band in the black line, the other smiley above it is for the complete position *Pos1**. Small smileys are set below each frequency band with a potential problem. The smileys are also available at the cursor readouts. Tap on the smiley at the cursor readout to get detailed information about the warning. (For a description of status indicators and smileys, see "Quality Indicators" on page 53.) The Spectrum is shown in Fig.4.15, right.

14) An empty *Pos1** has been created and selected in the table. Press the **Save** pushbutton and the measurement is saved at *Pos1*. The smiley is updated for the complete project in the upper line.

15) Press **Start**/**Pause** pushbutton to make a *Pos2* measurement. The result of the measurement is shown in the black line above the table, see Fig.4.18.

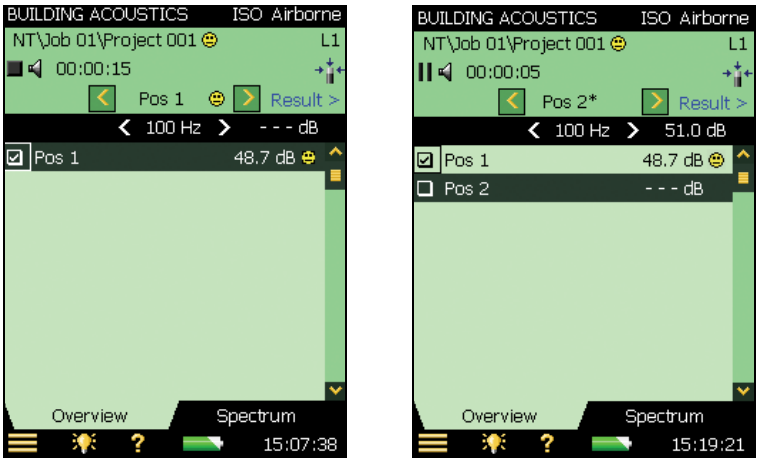


Fig. 4.18
Unplanned measurement

Left: Before pressing ***Start/Pause*** *pushbutton on a Pos2 measurement*

Right: The result of the Pos2 measurement

16) An empty *Pos2** has been created and selected in the table. Press the **Save** pushbutton and the measurement is saved at *Pos2*. The smiley is updated for the complete project in the upper line.

This will be repeated for every other position in your measurement sequence.

Unlike the Planned Measurement, the next position is not selected when pressing the **Save** pushbutton. (With a Planned Measurement, pressing **Start** will always suggest a new position one higher than the number of measured positions.)

Manual Selection of Measurement Position

If you select another measurement position and *Automatic Save* is *Off*, the **Save** pushbutton will save at that position. This will always be at a position that was measured earlier and contains data. A pop-up window will then appear to warn you about overwriting data.

4.6 Reverberation Time Measurements (T2)

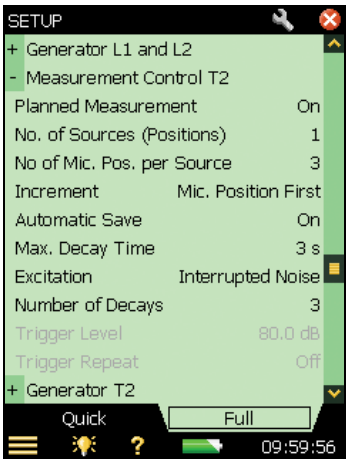
4.6.1 Setting up the Instrument

We have assumed in this section that you followed the procedure in section 4.5 (Level Measurements, L1, L2 and B2), so most of the default settings are already set up. The following parameters need to set before performing T2 measurements:

1) Set the Function Selector to *T2* and check that the Standard and Task Selectors are still set as required, see Fig.4.1.

2) If you want to define the number of source positions and microphone positions per source, set *Planned Measurement* to *On* in the **Measurement Control T2** setup (see Fig.4.19); otherwise, the measurements are made manually from *Pos 1* onwards.

Fig. 4.19
Measurement control setup for T2



3) Set *No. of Sources (Positions)* parameter to the number of sound source positions you require for your T2 measurement. (Only available if *Planned Measurement is set* to *On*.)

4) Set *No. of Micr. Pos. per Source* parameter to the number of microphone positions per sound source that you require for your T2 measurement. (Only available if *Planned Measurement is set* to *On*.)

5) Set the *Increment* parameter depending on the order in which you want to do your measurements: either *Source First*, *Mic. Positions First*, or manually (*Manual*). (Only available if *Planned Measurement is set* to *On*.)

6) Set *Automatic Save* to *Off* if you want to inspect the reverberation time and decays before manually saving the measurement; otherwise, select *On* to automatically save the decays after each measurement.

7) The analyzer automatically detects the end of the decay; however, under special conditions (for example, when measuring with high background noise) the end of the decay cannot be detected and the measurement will run up to 20 s. To minimise the measurement time and memory requirement for the measurement, you can limit the measurement by setting the *Max Decay Time*. Five seconds is adequate for most ordinary rooms but should be increased for larger halls or reverberation rooms.

8) If you are using a loudspeaker source, set *Excitation* to *Interrupted Noise* and go to step 9). Otherwise, if you want to measure using the impulse method (i.e., using a balloon burst or a starting pistol), set *Excitation* to *Impulsive* and go to step 11). (For a description of these two methods, please refer to the User Manual for Hand-held Analyzer Type 2250, BE 1713, Chapter 14).

Interrupted Noise Method

9) Set the number of decays you want to measure per position. The analyzer automatically controls the generator, measurement of the decays and averaging the decays. (Only available if the *Excitation* parameter is set to *Interrupted Noise*).

10) Set the Generator as required. These parameters are the same as those described in the Level Measurements section. See "Generator Setup for L1 and L2" on page 30. Go to step 13).

Impulsive Method

11) Set *Trigger Level* low enough to be sure the impulse will be triggered, but high enough to avoid triggering on the background noise – between 80 and 100 dB is normally adequate. (Only available if the *Excitation* parameter is set to *Impulsive*.)

12) If you have selected *Automatic Save = yes*, then *Trigger Repeat* can be set to *yes* to automatically start a new measurement when a measurement has been saved. (Only available if the *Excitation* parameter is set to *Impulsive*.) This allows you to go to another position and make a new impulse without the need for controlling Type 2250/2270 between the measurements. Observe how the Traffic Light indicates the status of the measurement, making it easy for you to change position and generate the impulse synchronised with the measurement procedure. Press the **Start**/**Pause** pushbutton to stop the measurement when the last measurement has been saved.

Generator Setup for T2

The parameters for setting up the generator for Reverberation Time measurements (T2) are identical to those for the generator setup of L1 and L2 (see Fig. 4.12 and "Generator Setup for L1 and L2" on page 30).

Sound Recording

The parameters for setting up sound recording are identical to those described in "Setup for Sound Recording" on page 30).

Controlling the Measurement

The measurement is controlled in the same way you would control a level measurement, using **Start**/**Pause**, **Continue**, **Reset** and **Save** pushbuttons.

Planned Measurements

- Press the **Start**/**Pause** pushbutton when the first measurement position (*S1:Pos1*) is highlighted in the Overview table. When the measurement is finished *S1:Pos1** will be displayed
- Press the **Save** pushbutton to save the measurement at the *S1:Pos1* position. *S1:Pos2* will be selected automatically. Press the **Start**/**Pause** pushbutton to measure in sequence at Pos2, Pos3, etc.

Unplanned Measurements

- Press the **Start**/**Pause** pushbutton to make a *Pos1* measurement. An empty *Pos1** has been created and selected in the Overview table
- Press the **Save** pushbutton to save the measurement at *Pos1*
- Press the **Start**/**Pause** pushbutton to make a *Pos2* measurement and repeat the above procedure for the remaining positions in your measurement sequence

4.6.2 Displaying the Results

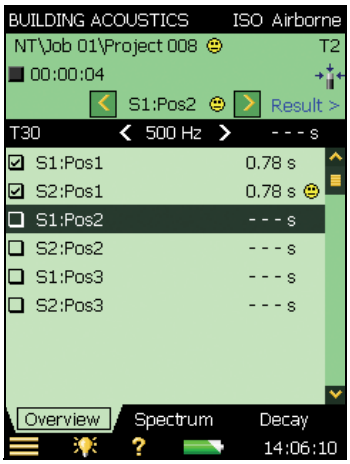
The Reverberation Time measurement screen includes three tabs at the bottom: *Overview*, *Spectrum* and *Decay*. You can view the measurement results in three different ways using the tabs at the bottom of the screen:

- *Overview*: Shows the measurement positions in a table – one position per row. Use this to get an overview of your measurements, to include/exclude positions from the spatial average of all positions in the room, and to manage annotations/sound recordings at the positions
- *Spectrum*: Shows the reverberation spectra graphically, or as a table, for one position, or for the room average. Alternatively, it can show the instantaneous sound pressure level while measuring
- *Decay*: Shows the reverberation decay at a single frequency, for one position, or for the room average (*Ensemble Average* parameter set to *Yes*, under *Calculations* in the **Setup** menu)

4.6.3 Overview

The *Overview* tab shows the measurement positions in a table – one position per row.

Fig. 4.20
Overview tab



The header row contains (from left to right):

- The T2 selector (T20 or T30), which determines which T2 to display in the table rows below. It is also linked to the main Spectrum selector and main Decay selector
- The Frequency selector (which includes decrement and increment buttons), determines the frequency of the readouts in the table rows below. The frequency selector is linked to the Spectrum cursor and the frequency of the selected decay
- Readout of the T2 value for the current measurement, before it is saved to a position

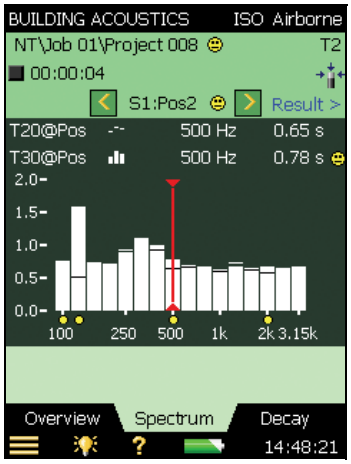
Each row of the table contains (from left to right):

- A checkmark controlling whether the position is included or excluded from the average. Tap on the checkbox to include (check) or exclude (uncheck) the position. All positions are by default included in the average
- Tap on the position to get a drop-down menu with two options: *Select* and *View Annotations*. Use *Select* to select a position other than the one (automatically) selected if you need to go back and redo a measurement, for example. Use *View Annotations* to view the list of annotations for the position. You can add annotations on the position from this view
- Possible annotation indicated by . Tap on it to view the list of annotations for the position
- The readout of the T2 parameter at the frequency determined by the T2 selector and Frequency selector in the table header row. There might be a smiley to the right of the readout warning about the quality of the readout. Tap on the smiley to get more detailed information about the warning

4.6.4 Spectrum

The *Spectrum* tab shows the reverberation time spectrum from a position, the average reverberation time, or both. The instantaneous sound level is displayed during measurements.

Fig. 4.21
Spectrum tab



Spectrum Graph

The Spectrum Graph is the same as in the L1, L2 and B2 measurements: Two 1/1-octave or 1/3-octave spectra superimposed with cursor readouts. The displayed frequency range is automatically adjusted for the measured frequency range.

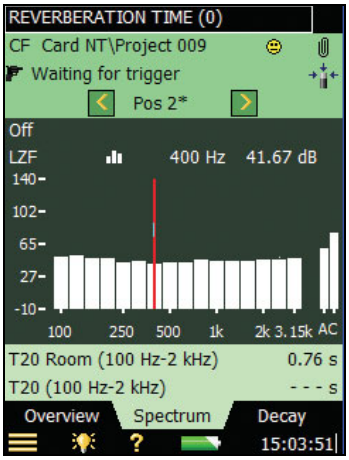
Small smileys are set below each frequency band with a potential problem. The smileys are also available at the cursor readouts. Tap on the smiley at the cursor readout to get detailed information about the warning.

The Spectrum Parameter Selectors above the graph select which spectra to display. You can choose to display: *T20@Pos*, *T30@Pos*, *T20* or *T30*. If you only want one graph, you can set the other to *Off*.

In addition to choosing which parameter to display, you can also select *Display Sound Level*, which will display the Z-weighted spectrum LZF together with the A- and C-weighted broadband levels – see Fig.4.22. When displaying LZF you can tap on the LZF selector and select *Display Reverberation Time* to display the reverberation time spectra.

When starting a measurement the graph will automatically display the sound level spectrum, and when finished it will display the reverberation time spectrum.

Fig.4.22
Spectrum view when measuring



The main spectrum graph on the display (the one with bars) is selected using the parameter selector on the second line of the two shown above the graph (LZF in Fig.4.22). The parameter selector for the main spectrum is linked to the selector on the *Overview* tab and the parameter selector for the main decay on the *Decay* tab.

The other spectrum on the display (the one displayed as small lines above and below the bars in Fig.4.21) is selected using the parameter selector on the first line of the two shown above the graph (*T20@Pos* in Fig.4.21). This spectrum can be used as a reference when comparing it to the main spectrum, and it is linked to the parameter selector for the reference decay curve in the *Decay* view.

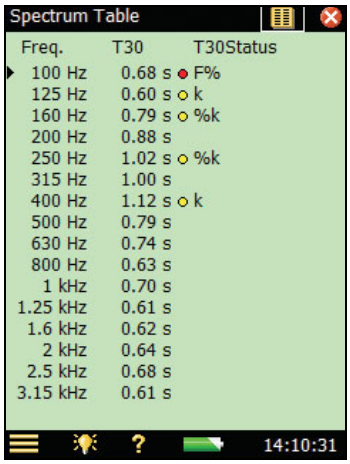
Smileys below the spectra (if there are any) are set if a smiley is present for at least one of the spectra.

The cursor is linked to the frequency selectors on the *Overview* and *Decay* tabs.

Tap on the Y-axis to select:

- *Auto Zoom* to adjust the range of the Y-axis for best fit of the measured spectrum
- *Zoom In/Zoom Out* to adjust the zoom
- *Spectrum Table* to display the spectrum in a table, see an example in Fig.4.23
- *Close* to exit the drop-down

Fig. 4.23
Spectrum table



Auxiliary Parameters

Below the graphics are two lines containing parameters for displaying the L_{CF} and L_{AF} broadband values.

4.6.5 Decay

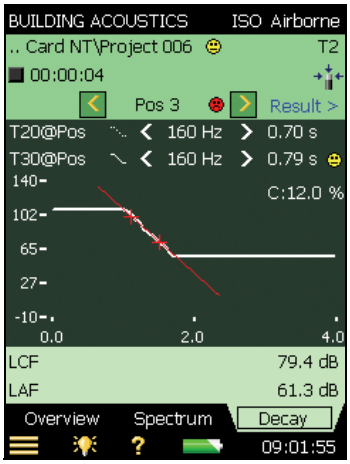
The *Decay* tab shows the reverberation time decay from a position, the average of positions, or both, see Fig. 4.24.

Decay Graph

The Decay Graph shows the decay of one frequency band for the selected position, the decay of the same frequency band for the average of positions (requires Ensemble Averaging), or both.

The Decay Parameter Selectors above the graph select which decay to display: *T20@Pos* or *T30@Pos*. Each of these selections show the decay for the measurement at the selected position together with the readout of *T20@Pos* and *T30@Pos* resp. *T20* and *T30* show the decay for the current position. If you only want one graph you can set the other selector to *Off*.

Fig. 4.24
Decay view



The main decay on the display (displayed as a continuous line) is selected using the parameter selector in the second line of the two shown above the display (*T30@Pos* in Fig. 4.24). The parameter selector for the main decay is linked to the selector on the *Overview* tab and the parameter selector for the main spectrum on the *Spectrum* tab.

The other decay on the display (displayed as a dashed line) is selected using the parameter selector in the first line of the two shown above the display (*T20@Pos* in Fig. 4.24). This decay can be used as a reference when comparing it to the main decay, and it is linked to the parameter selector for the reference spectrum on the *Spectrum* tab.

The Frequency band selector (with decrement and increment buttons as well) determines the frequency band of the decay curves. The frequency band selector is linked to the spectrum cursor and the frequency band selector on the *Overview* tab.

Just below the parameter selectors on the right side of the view area, the value of a single status indicator is displayed: C: xx%. This is the curvature indicator, and if it shows above 10%, the status indicator '%' is set, meaning 'Decay is bent'.

For more details on status indicators and smileys, see "Quality Indicators" on page 53.

Tap on the Y-axis to select:

- *Auto Zoom* to adjust the range of the Y-axis for best fit of the measured spectrum
- *Zoom In/Zoom Out* to adjust the zoom
- *Auto Scale* to select the best scaling for viewing the spectra without adjusting the zoom
- *Scale Up/Scale Down* to adjust the full scale value on the Y-axis
- *Show/Hide Regression Line* to show/hide the regression line and the evaluation range for the main decay together with the status indicator C
- *Close* to exit the drop-down menu

4.7 Dual-channel Measurements (Type 2270 Only)

4.7.1 Setting up the Instrument (for Dual-channel Measurements)

1) Select the **2-Ch. B. ACOUSTICS** Project Template. The Project Template is displayed on the black bar at the top of the screen. If it does not display **2-Ch. B. ACOUSTICS**, tap the top of the screen and select **2-Ch. B. ACOUSTICS** from the drop-down menu that appears.

   Note: Dual-channel measurements require a license for BZ-7229.

2) Tap the **Main Menu** icon and select **Setup** from the list of options then select the *Full* tab.

Input Selections

For dual-channel measurements, setting up the instrument is exactly the same as for single-channel measurements (see section 4.5.4), apart from the following input parameters:

3) Set the *Measure L1 and L2* parameter to either *Simultaneously* or *Separately*, depending on whether you want to measure L1 and L2 at the same time in the source and receiving room or one after the other, see Fig.4.25.

4) Set the *Input for L1*, *Input for L2*, *Input for B2* and *Input for T2* parameters to the required input channel: either *Ch. 1* or *Ch. 2*, depending on which one you are using.

5) Set the *Autorange* to *On* for autoranging Ch.1 and Ch.2, or set it to *Off* for manually setting the range. This is only relevant if the *Measure L1 and L2* parameter has been set to *Simultaneously*.

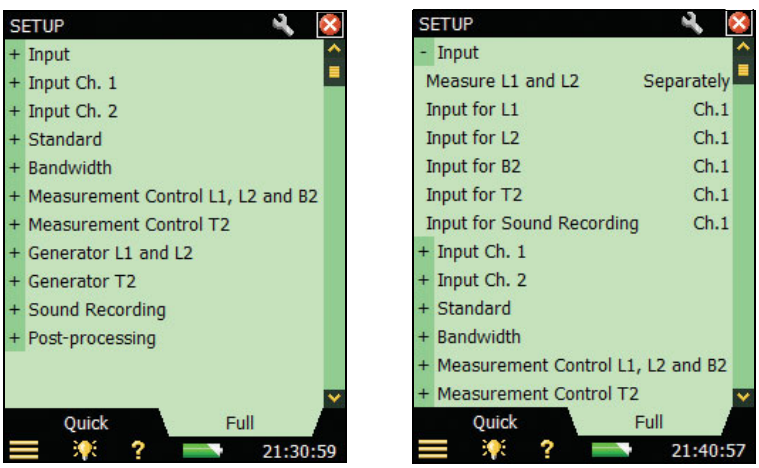


Fig. 4.25
Dual-channel Input setup for measuring building acoustics using Type 2270

6) For dual-channel measurements, there are also two independent sets of input selections you can set: one for channel 1 (*Input Ch. 1*) and one for channel 2 *(Input Ch. 2)*. They are set as follows:

Set the *Range Setting* to *High Range*, or *Low Range* as required. The difference between the two settings is 30 dB. High Range can be used to measure up to the maximum input level. This is only relevant if the *Measure L1 and L2* parameter is set to *Simultaneously* and *Autorange* is set to *Off*.

Fig. 4.26
Dual-channel input selections for measuring building acoustics using Type 2270

4.7.2 Controlling the Measurement

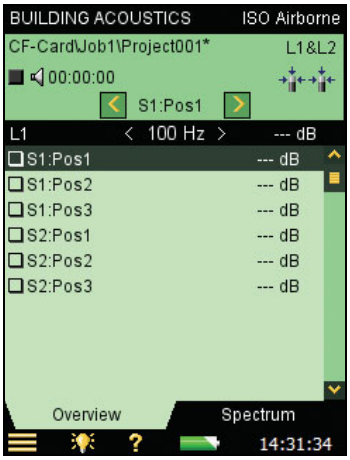
Using two channels in Type 2270 has a couple of advantages over single-channel measurements, these are as follows:

- Measurements of Façade sound insulation, with traffic noise as a sound source, require that the source measurement (outdoors) and receiving room measurements are taken at the same time – this requires dual-channel capability
- Using two channels allows you to measure L1 and L2 simultaneously, which speeds up the measurement process

Measure L1 and L2 Simultaneously

7) Set the *Measure L1 and L2* parameter to *Simultaneously* under Input selections. When you then select the *L1&L2* function (see Fig. 4.27), the analyzer will measure L1 using Ch. 1 and L2 using Ch. 2.

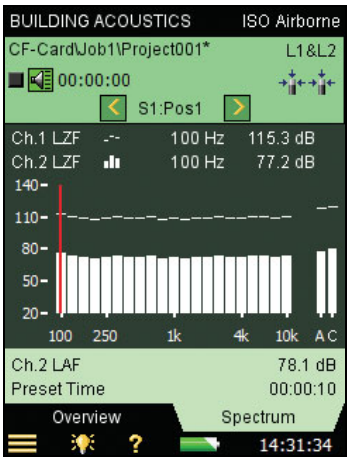
Fig. 4.27
Measuring L1 and L2 simultaneously (Planned measurement)



8) The *Overview* tab still shows either the L1 or the L2 measurements; you select which one to display by the leftmost parameter on the black frequency selection line.

9) Select the *Spectrum* tab to check the levels by selecting the instantaneous levels *Ch.1 LZF* and *Ch.2 LZF*, see Fig.4.28.

Fig. 4.28
Checking the instantaneous levels – during an L1 and L2 measurement



Note: *Ch.1 LZF* can only be selected in the upper graph and *Ch.2 LZF* can only be selected in the lower graph.

10) You can check sound source level by switching it on and off using the loudspeaker icon .

Note: LAF and LAC broadband readouts are always shown to the right in the spectrum.

Ready for First Measurement

11) The third line of the status field shows *S1:Pos1*. This is the position selector, and it indicates the current source and microphone position. (The current source and microphone position are also displayed in a list on the *Overview* tab, see Fig.4.16).

12) On the *Spectrum* tab, select *L1@Pos* as the upper graph and *L2@Pos* as the lower graph, see example in Fig.4.29.

Note: If you would like be able to monitor the average level of L1 and L2 throughout the measurement, you can select *L1* as the upper graph and *L2* as the lower graph.

13) Press **Start**/**Pause** pushbutton to perform the first measurement, this is indicated by *S1:Pos1** being displayed in the status field. The '*' indicates that the measurement has not been saved, see Fig.4.29.

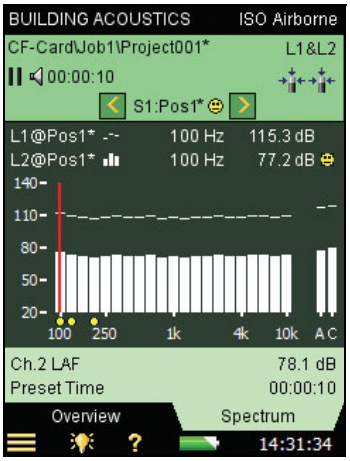
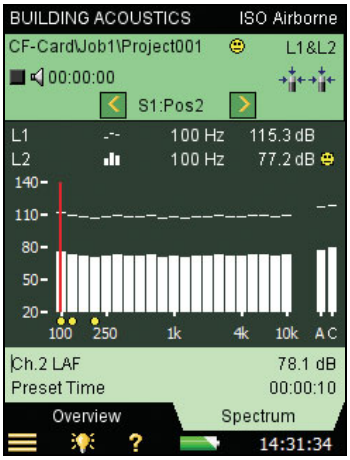


Fig.4.29
Measurement not yet saved after a simultaneous dual-channel measurement

14) Press the **Save** pushbutton and the measurement is saved as '*S1:Pos1*'. The smiley is updated for the complete project on the upper line. S1:Pos2 is automatically selected to indicate the next measurement position, see Fig.4.30. (L1 and L2 are selected again, as they were before pressing the **Start**/**Pause** pushbutton.)

Fig. 4.30
S1:Pos2 automatically selected to indicate next measurement position



15) Press **Start/Pause** pushbutton to measure in sequence at *Pos 2*, *Pos 3*, etc.

The selection possibilities for spectrum parameters (in a Planned measurement) are listed in Table 4.2.

Table 4.2
Spectrum parameters – Result display

Function	Upper Graph	Lower Graph
L1&L2	Ch. 1 LZF	Ch. 2 LZF
B2, T2	LZF	LZF
L1&L2	L1@Pos	L1@Pos
L1&L2	L2@Pos	L2@Pos
B2	B2@Pos	B2@Po
T2	T20@Pos	T20@Pos
T2	T30@Pos	T30@Pos
L1&L2, B2	L1	L1
L1&L2, B2	L2	L2
L1&L2, B2	B2	B2
L1&L2, B2	L1 - L2	L1 - L2
L1&L2, B2	L2 - B2	L2 - B2
L1&L2, B2, T2	Off	Off
T2	T20	T20
T2	T30	T30

The position selector has the following options available for L1, as well as L2:

- *S1:Pos1*
- *S1:Pos2*
- *S1:Pos3*
- *S2:Pos1**
- *S2:Pos2*
- *S2:Pos3*

(The '*' indicates unsaved data – in this example for *S2:Pos1*.)

4.8 Displaying Results

Measurement results are selected using the Result > link in the Status Field (Line 3).

There are two displays: one to get an overview of the measurement results and one for calculation results (including a spectrum).

4.8.1 Overview

The *Overview* tab displays all the results of measurements in the project, see Fig.4.31. It is possible to include or exclude measurements, get details on smileys, and view annotations.

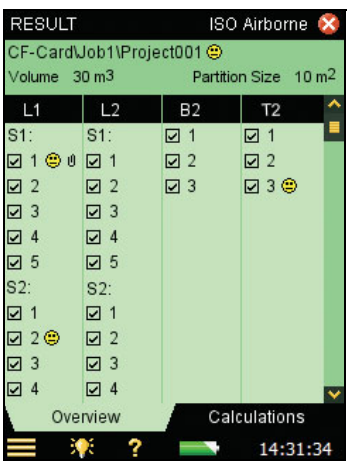


Fig.4.31 *Viewing results using the Overview tab*

The Status Field consists of the following information when viewing results:

Line 1: shows the same information as that described in "Status Field" on page 21

Line 2:

- Receiving Room Volume (linked to **Setup** menu)
- Partition Area (linked to **Setup** menu)

4.8.2 Calculations

The *Calculations* tab allows you to view the calculation results, including a spectrum, see Fig.4.32.

The Status Field consists of the same information as the *Overview* tab, see previous section.

The options for the Reference Spectrum -·- parameter on the results view are:

- Reference Curve
- Deviations (between the reference curve and the main spectrum)
- Off

The options for the main spectrum parameter on the results view depend on the selected standard and task. For example, if the *Standard* parameter is set to *ISO* and the *Task* parameter is set to *Airborne*, the options are:

- D
- Dn
- D_nT
- R'
- R

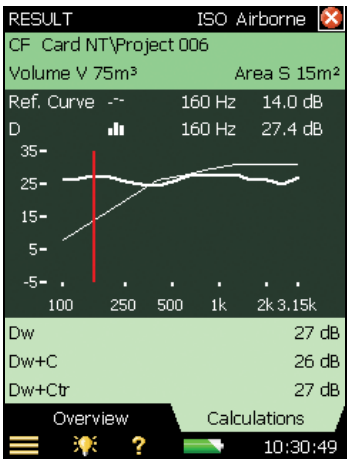


Fig.4.32
Viewing calculation results using the Calculations tab

In the area below the graph area, three single values can be shown. The options for these lines depend on the standard selected and the selection for the main spectrum parameter.

4.9 Quality Indicators

Building acoustics software offers a wide range of status indicators and smileys. They are listed in Table 4.3.

Table 4.3 *Overview of Status Indicators and Smileys*

Status Code	Smiley	Explanation	Description
M		Manual data input	RT entered by user
B		Maximum background noise correction used	High background noise
N		No decay end found	The end of the decay cannot be determined because it does not end in the background noise
y		Background noise too high	Background noise is above the upper evaluation point
t		No decay start found	No decay start found
Y		Background noise too high	Background noise is above the lower evaluation point
T		Maximum decay time too short	The lower evaluation point is beyond the decay time
Z		No decay found	The slope of the decay is positive, i.e., the reverberation time is negative
P		Reverberation time too short	Less than two points in evaluation range
O		Excitation sound level too high	Overload (or wrong L1 and L2 level range)
F		Short reverberation time	B×T below 16 (B = filter bandwidth and T = reverberation time of detector)
R		T20 used (T30 unavailable)	T20 used (T30 unavailable)
n		High background noise	Background noise too close to level at lower evaluation point
p		Short reverberation time	Less than four points in evaluation range
%		Decay is bent	The difference between T20 and T30 is greater than 10%. (Recommended quality indicator from ISO 3382-2 Annex B)
k		Decay is non-linear	Correlation coefficient in linear regression is too low (less than 0.005 or ξ (Xi) > 10%
b		Background noise correction used	Background noise correction used
m		Affected by manual input	Reverberation time entered by user

Status Code	Smiley	Explanation	Description
G		Receiving room volume limited in calculation	Used on the SS standard only
H		No B2 measurements available	No B2 measurements available
~		L1: >6 dB difference to next band	Try other source or microphone positions, or change the optimisation of the frequency response for the internal generator (**Setup** menu, under *Generator L1 and L2*, *Sound Source* parameters)
^		L1 or L2: High Standard Deviation	The standard deviation in a frequency band is greater than twice the theoretical expected value.

If there is no status code, there is no smiley.

If any one of the status codes (there may be several) requires a red smiley, the red smiley will be displayed. If any one of the status codes requires a yellow smiley, but no red smiley, the yellow smiley will be displayed.

The explanation is shown if you tap on a smiley, see Fig. 4.33.

For the spectrum, small smileys are shown below the relevant frequency bands. Select the frequency band with the cursor and tap on the smiley in the cursor readout to see the explanation.

You can also view the spectrum table to get an overview of all the status codes, tap the y-axis and select *Spectrum Table* from the drop-down menu – see Fig. 4.23.

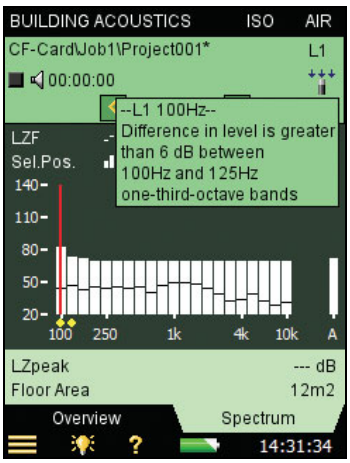


Fig. 4.33
Viewing smiley explanation

4.10 Creating a New Project

You create a new project by selecting a Building Acoustics template.

If you already have a Building Acoustics project open and no unsaved data, you can press the **Reset** pushbutton and create a new project based on the current project template.

4.11 Re-using Data from an Existing Project

With Explorer it is possible to copy one or more functions from one project to the current project.

For example, if you want to re-use or copy T2 from Project 001 to the current project:

1) Ensure your current project is a building acoustics project (single or dual-channel).
2) Select Explorer to get a list of all projects.
3) Locate the Building Acoustics project from which you want to re-use data (in this example Project 001).
4) Tap on *Project 001* in the Explorer list and select *Re-use Data* from the drop-down list that appears, see Fig.4.34 (left).
5) A new drop-down list appears, showing the functions that are possible to re-use. Select *Copy T2* from the list, see Fig.4.34 (right). The function you copied (*T2*) appears in the current project.

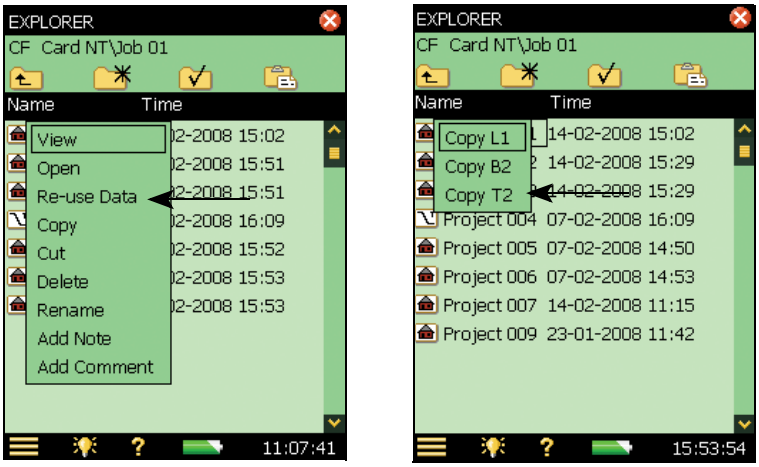


Fig.4.34
Re-using data

Left: Tapping on Project 001 in the Explorer list

Right: Selecting the function to copy into your project

Note: If you are using the *Airborne* or *Façade* tasks, the following functions are available for copying:

- L1
- B2
- T2

If you are using the Impact task, only the following functions are available:

- B2
- T2

If the project already contains data for the function that you want to replace with re-used data, then the re-used function will overwrite the current data.

If the project already contains data for other functions, then the re-used data you want to replace it with must match the data already there, e.g., the frequency range must be the same, otherwise you will get an error message.

4.12 Annotations and Sound Recording

4.12.1 Project Annotations

The project can be annotated like other types of projects by clicking on it (in Explorer) and using the *Add Note to current Measurement* option from the drop-down menu that appears, or by pressing the **Commentary** pushbutton. A paperclip icon is displayed in the top line with access to the list of project annotations, see the example in Fig.4.35.

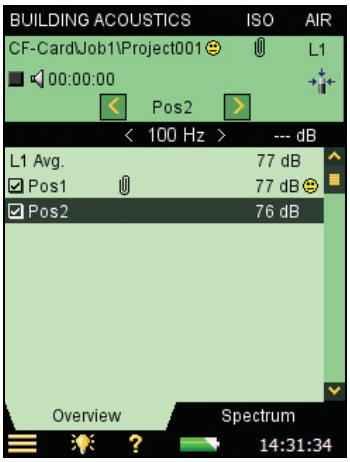


Fig.4.35
Example of an overview display showing annotations and/or sound recordings

4.12.2 Annotations on Measurement

In addition to the project annotation, you can annotate each measurement in the Overview. Tap the measurement in the Overview and select *View Annotations* for a list of annotations for the measurement in question. Using this list you can create, edit and delete annotations in the same way as you can on the Project Annotation list.

Measurements with annotations are indicated with a paperclip icon in the Overview display, and with a small paperclip icon in the Result Overview display.

4.12.3 Adding Images to a Measurement

You can also attach an image (Type 2270 only). Similar to adding notes or comments, adding an image can also be done before, during or after saving the measurement by a tap on **Main Menu** icon and then a tap on **Add Image** (to the current measurement) in the list of options. The Viewfinder display will then appear showing what is coming through the camera lens. The camera has fixed focus and automatically adjusts the light sensitivity; you just have to position the analyzer so that the object you want to capture is visible in the Viewfinder and press the **Manual Event** pushbutton or tap on the icon to capture the image.

When captured, the image is presented as a still picture (see Fig.4.36) and you can save the captured image by pressing the **Sav**e pushbutton (or by closing the Images view), or you can reject the image by pressing the **Back-erase** pushbutton.

Fig.4.36
Example of an image used to document a measurement position

When finished, tap on the icon to return to the measurement screen. A paperclip icon appears in the status field of the measurement and next to your project in Explorer. Tap on the paperclip icon to see a list of all annotations in the project, and tap on the camera icon in the annotation to view the image.

4.12.4 Sound Recording

If you record sound while making the measurements (*Recording Control* set to *Automatic* under *Sound Recording* parameters) then the sound recording is saved together with the annotations on each measurement. This is also indicated with a paperclip icon in the Overview display (in the line for the measurement) and a small paperclip icon in the Result Overview display.

From the **Main Menu**, under *Preferences*, *Image Settings*, you can also specify to capture images each time you press the **Manual Event** pushbutton. (The other setting (*Viewfinder*) displays what is coming through the camera lens).

Sound Recording is only possible in one channel. (It will be *Ch. 2* if the measurement is setup for a dual-channel measurement).

In the overview in Fig.4.35 there are annotations and/or a sound recording on the first measurement (*Pos1*). Tap on the paperclip icon to get a list of annotations and/or sound recordings attached to the measurement on *Pos1*.

4.13 Exporting, Post-processing and Reporting

Utility Software for Hand-held Analyzers BZ-5503 is used for all communication between PC and analyzer. Connect the analyzer to the PC using the supplied USB Cable AO-1476.

Use this software to:

- Transfer measurement data and templates from the analyzer to your PC, and vice versa
- Control measurements on the analyzer from the PC and display them on-line using the same user interface on the PC as on the analyzer
- View Building Acoustics results in the Archives
- Edit the project templates
- Organise data on the analyzer
- Export your building acoustics projects from archives to Qualifier Type 7830 for further post-processing and for reporting
- Create users on the analyzer
- Upgrade software on the analyzer
- Install software licenses on the analyzer

Data transferred to the PC are organised in Archives.

For further information, please refer to the on-line help included with the relevant PC Software. This software is supplied on the Environmental Software CD-ROM (BZ-5298), which is included with the analyzer.

Chapter 5

Specifications

This chapter comprises the specifications that are needed for evaluation of instrument performance characteristics and proper use of the instrument. Some of the applicable sound level meter standards require additional technical documentation, in particular for pattern evaluation (type approval) purposes, but have no bearing on normal use. The additional technical documentation is given in a separate Brüel & Kjær instruction manual (BE 1712).

Type 2250/2270 Platform

Specifications apply to Type 2250/2270 fitted with Microphone Type 4189 and Microphone Preamplifier ZC-0032 and used as a single channel instrument, indicated as Single Range, unless otherwise stated. For Type 2270 used as a dual-channel instrument measuring both channels simultaneously, the full measuring range is covered in two ranges. High Range indicates the least sensitive range and Low Range indicates the most sensitive range

SUPPLIED MICROPHONE
Type 4189: Prepolarized Free-field ½″ Microphone
Nominal Open-circuit Sensitivity: 50 mV/Pa (corresponding to
−26 dB re 1 V/Pa) ± 1.5 dB
Capacitance: 14 pF (at 250 Hz)

MICROPHONE PREAMPLIFIER ZC-0032
Nominal Preamplifier Attenuation: 0.25 dB
Connector: 10-pin LEMO
Extension Cables: Up to 100 m in length between the microphone preamplifier and Type 2250/2270, without degradation of the specifications
Accessory Detection: Windscreen UA-1650 can be automatically detected when fitted over ZC-0032

MICROPHONE POLARIZATION VOLTAGE
Selectable between 0 V and 200 V

SELF-GENERATED NOISE LEVEL
Typical values at 23°C for nominal microphone open-circuit sensitivity:

Weighting	Microphone	Electrical	Total
"A"	14.6 dB	12.4 dB	16.6 dB
"B"	13.4 dB	11.5 dB	15.6 dB
"C"	13.5 dB	12.9 dB	16.2 dB
"Z" 5 Hz–20 kHz	15.3 dB	18.3 dB	20.1 dB
"Z" 3 Hz–20 kHz	15.3 dB	25.5 dB	25.9 dB

KEYBOARD
Pushbuttons: 11 keys with backlight, optimised for measurement control and screen navigation

ON-OFF BUTTON
Function: Press for 1 s to turn on; press for 1 s to enter standby; press for more than 5 s to switch off

STATUS INDICATORS
LEDs: Red, amber and green

DISPLAY
Type: Transflective back-lit colour touch screen 240 × 320 dot matrix
Colour Schemes: Five different – optimised for different usage scenarios (day, night, etc.)
Backlight: Adjustable level and on-time

USER INTERFACE
Measurement Control: Using pushbuttons on keyboard
Setup and Display of Results: Using stylus on touch screen or pushbuttons on keyboard
Lock: Keyboard and touch screen can be locked and unlocked

USB INTERFACE
USB 1.1 OTG Mini B socket

MODEM INTERFACE
Hayes compatible GSM or standard analogue modems connected through the Compact Flash slot

COMPACT FLASH SOCKET
For connecting CF memory card, CF modem or CF LAN Interface

LAN INTERFACE SOCKET (TYPE 2270 ONLY)
Connector: RJ45
Speed: 10 Mbps
Protocol: TCP/IP

INPUT SOCKET (2 - TYPE 2270 ONLY)
Connector: Triaxial LEMO
Input Impedance: ≥ 1 MΩ
Direct Input: Max. input voltage: ± 14.14 V_{peak}
CCLD Input: Max. input voltage: ± 7.07 V_{peak}
CCLD Current/voltage: 4 mA/25 V

TRIGGER SOCKET
Connector: Triaxial LEMO
Max. Input Voltage: ± 20 V_{peak}
Input Impedance: > 47 kΩ

OUTPUT SOCKET
Connector: Triaxial LEMO
Max. Peak Output Level: ± 4.46 V
Output Impedance: 50 Ω

HEADPHONE SOCKET
Connector: 3.5 mm Minijack stereo socket
Max. Peak Output Level: ± 1.4 V
Output Impedance: 32 Ω in each channel

MICROPHONE FOR COMMENTARY
Microphone, which utilises Automatic Gain Control (AGC), is incorporated in underside of instrument. Used to create voice annotations for attaching to measurements

CAMERA (TYPE 2270 ONLY)
Camera with fixed focus and automatic exposure is incorporated in underside of instrument.
Used to create image annotations for attaching to measurements
Image Size: 640 x 480
Viewfinder size: 212 x 160
Format: jpg with exif information

EXTERNAL DC POWER SUPPLY REQUIREMENTS
Used to charge the battery pack in the instrument
Voltage: 8 – 24 V DC, ripple voltage < 20 mV
Current Requirement: min. 1.5 A
Power Consumption: < 2.5 W, without battery charging, < 10 W when charging
Cable Connector: LEMO Type FFA.00, positive at centre pin

BATTERY PACK
Type: Li-Ion rechargeable
Typical Operating Time: > 8 hours

STORAGE SYSTEM
Internal Flash-RAM (non-volatile): 20 Mbyte for user setups and measurement data
External Secure Digital Memory Card (SD-card): For store/recall of measurement data
External Compact Flash Memory Card (CF-card): For store/recall of measurement data

CLOCK
Back-up battery powered clock. Drift < 0.45 s per 24 hour period

WARM-UP TIME
From Power Off: < 2 minutes
From Standby: < 10 seconds for prepolarized microphones

TEMPERATURE
IEC 60068–2–1 & IEC 60068–2–2: Environmental Testing. Cold and Dry Heat.
Operating Temperature: –10 to + 50°C (14 to 122°F), < 0.1 dB
Storage Temperature: –25 to +70°C (–13 to +158°F)

HUMIDITY
IEC 60068–2–78: Damp Heat: 90% RH (non-condensing at 40°C (104°F)).
Effect of Humidity: < 0.1 dB for 0% < RH < 90% (at 40°C (104°F) and 1 kHz)

MECHANICAL
Environmental Protection: IP44
Non-operating:
IEC 60068–2–6: Vibration: 0.3 mm, 20 m/s^2, 10 – 500 Hz
IEC 60068–2–27: Shock: 1000 m/s^2
IEC 60068–2–29: Bump: 4000 bumps at 400 m/s^2

WEIGHT AND DIMENSIONS
650 g (23 oz.) including rechargeable battery
$300 \times 93 \times 50$ mm ($11.8 \times 3.7 \times 1.9''$) including preamplifier and microphone

USERS
Multi-user concept with login. Users can have their own settings with jobs and projects totally independent of other users

PREFERENCES
Date, Time and Number formats can be specified per user

LANGUAGE
User Interface in Catalan, Chinese, Croatian, Czech, Danish, English, Flemish, French, German, Hungarian, Japanese, Italian, Polish, Portuguese, Romanian, Serbian, Slovenian, Spanish, Swedish and Turkish

HELP
Concise context-sensitive help in Chinese, English, French, German, Italian, Japanese, Polish, Portuguese, Romanian, Serbian, Slovenian and Spanish

Software Specifications – Building Acoustics Software BZ-7228 and Dual-Channel Building Acoustics Software BZ-7229

Specifications apply to BZ-7228 and BZ-7229 unless otherwise stated.
Dual-Channel Building Acoustics Software BZ-7229 is for Type 2270 only

Conforms with the relevant parts of the following:
- IEC 61672 – 1 (2002 – 05) Class 1
- IEC 60651 (1979) plus Amendment 1 (1993 – 02) and Amendment 2 (2000 – 10), Type 1
- ANSI S1.4 – 1983 plus ANSI S1.4A – 1985 Amendment, Type 1
- IEC 61260 (1995 – 07) plus Amendment 1 (2001 – 09), 1/1-octave Bands and 1/3-octave Bands, Class 0
- ANSI S1.11 – 1986, 1/1-octave Bands and 1/3-octave Bands, Order 3, Type 0 – C
- ANSI S1.11 – 2004, 1/1-octave Bands and 1/3-octave Bands, Class 0

- ISO, SS, DIN, Önorm, BS, BREW, Sia, UNI, NF-S31, NBE, CTE, NEN, NEN'06, ASTM, see tables 1 and 2

Note: The International IEC Standards are adopted as European standards by CENELEC. When this happens, the letters IEC are replaced with EN and the number is retained. Type 2250/2270 also conforms to these EN Standards

CHANNELS (TYPE 2270 ONLY)
All measurements are made from either Ch. 1 or Ch. 2 or both simultaneously

TRANSDUCERS
Transducers are described in a transducer database with information on Serial Number, Nominal Sensitivity, Polarization Voltage, Free-field Type, CCLD required, Capacitance and additional information.
The analogue hardware is set up automatically in accordance with the selected transducer

CORRECTION FILTERS
For microphone Types 4189, 4190, 4191, 4193, 4950 and 4952, BZ-7228/7229 are able to correct the frequency response to compensate for sound field and accessories:

Broadband Measurements

DETECTORS
A- and C-weighted broadband detectors with Fast exponential time weighting
Overload Detector: Monitors the overload outputs of all the frequency weighted channels
Under range Detector: Monitors the under range of all the frequency weighted detectors when set to High Range. Under range is set if level is below lower limit of Linear Operating Range
Type 2270: Detectors available for both Ch. 1 and Ch. 2

MEASUREMENTS
L_{AF} and L_{CF} for Display as Numbers or Quasi-analogue Bars

MEASURING RANGES
When using Microphone Type 4189:
Dynamic Range: From typical noise floor to max. level for a 1 kHz pure tone signal, A-weighted:
Single Range: 16.6 to 140 dB
High Range: 28.5 to 140 dB
Low Range: 16.6 to 110 dB
Primary Indicator Range: In accordance with IEC 60651, A-weighted:
Single Range: 23.5 to 123 dB
High Range: 41.7 to 123 dB
Low Range: 23.5 to 93 dB
Linear Operating Range: In accordance with IEC 61672, A-weighted: 1 kHz:
Single Range: 24.8 to 140 dB
High Range: 43.0 to 140 dB
Low Range: 24.8 to 110 dB

Frequency Analysis

CENTRE FREQUENCIES
1/1-octave Band Centre Frequencies: 63 Hz to 8 kHz
1/3-octave Band Centre Frequencies: 50 Hz to 10 kHz

MEASURING RANGES
When using Microphone Type 4189:
Dynamic Range: From typical noise floor to max. level for a pure tone signal at 1 kHz 1/3-octave:
Single Range: 1.1 to 140 dB
High Range: 11.3 to 140 dB
Low Range: 1.1 to 110 dB
Linear Operating Range: In accordance with IEC 61260:
Single Range: ≤ 20.5 to 140 dB
High Range: ≤ 39.1 to 140 dB
Low Range: ≤ 20.5 to 110 dB

Internal Generator

Built-in pseudo-random noise generator
Spectrum: Selectable Pink or White
Crest Factor:
Pink noise: 4.4 (13 dB)
White noise: 3.6 (11 dB)
Bandwidth: Follows measurement frequency range
Lower Limit: 50 Hz (1/3-oct.) or 63 Hz (oct.)
Upper Limit: 10 kHz (1/3-oct.) or 8 kHz (oct.)
Output Level: Independent of bandwidth
Max.: 1 V_{rms} (0 dB)
Gain Adjustment: –80 to 0 dB
When bandwidth is changed, the level for all bands is automatically adjusted to comply with the set output level
Correction Filters for sound sources Type 4292, Type 4295 and Type 4296: Flat or Optimum
Turn-on time and Turn-off Time: Equivalent to RT = 70 ms
Repetition Period: 175 s
Output Connector: Output Socket
Control: See Measurement Control

External Generator

Selectable as alternative to Internal Generator
For controlling external noise generator
Levels: 0 V (Generator off), 3.3 V (Generator on)
Rise-time and Fall-time: 10 µs
Control: See Measurement Control

MEASUREMENTS
Measurements are done at a number of positions and categorised in functions (L1 for Source Room levels, L2 for Receiving Room levels, B2 for Receiving Room Background noise levels and T2 for Receiving Room Reverberation Time measurements)

LEVELS L1, L2 AND B2
L_{ZF} spectrum for display only
L_{Zeq} in 1/1-octave or 1/3-octave bands
L1 and L2 simultaneously or as single channels
Averaging time: 1 s to 1 hour
Range (L1 and L2 simultaneously only): Autorange or manually set to High Range or Low Range
Averaging: Up to 10 source positions each with up to 10 measurement positions or up to 100 measurements may be averaged
Status indications: Overload, under range, etc.
Crosstalk:
5 Hz – 10 kHz < –110 dB
10 kHz – 20 kHz < –100 dB

Reverberation Time T2

T20 and T30 in 1/1-octave or 1/3-octave bands
Decays: L_{Zeq} spectra sampled at 5 ms intervals
Evaluation Range: –5 to –25 dB for T20 and –5 to –35 dB for T30
Measurement Time: Automatic selection of measurement time for the decays based on the actual reverberation time of the room
Maximum Measurement Time: from 2 to 20 s
Averaging: T20 and T30 measurements can be averaged (arithmetic averaging or ensemble averaging)
T20 and T30 Calculation: From slope in evaluation range
Slope Estimation: Least squares approximation
Quality Indicators: Quality Indicators with status information like Overload, Curvature in %, etc.; extensive list of Status information
Quality Indicators are available on reverberation time spectra for each frequency band, and as overall quality indicators for each measurement position and for the averaged result
Reverberation Time Range: Max. 20 s, min. 0.1 – 0.7 s, depending on bandwidth and centre frequency
Manual Data Entry: A T2 value may be entered in any frequency band of a measured spectrum

Measurement Displays

OVERVIEW
Table of measurement positions for each function (L1, L2, B2 or T2) with readout for selectable frequency band on each position together with quality indicator. Positions can be included/excluded from average

SOUND LEVEL SPECTRUM
LZF spectrum plus A and C broadband bars
L_{Zeq} spectrum for L1@Pos, L2@Pos, B2@Pos, L1, L2, B2, L1-L2, L2-B2
Y-axis: Range: 5, 10, 20, 40, 60, 80, 100, 120, 140 or 160 dB. Auto zoom or auto scale available
Cursor: Readout of selected band Quality indicator for each frequency band

REVERBERATION TIME SPECTRUM
One or two spectra can be displayed
Y-axis: Range: 0.5, 1, 2, 5, 10 or 20 s. Auto zoom available
Cursor: Readout of selected band Quality Indicator for each frequency band

SPECTRUM TABLE
One or two spectra can be displayed in tabular form

DECAY
Decay curve for a position or the room average available for each frequency band (if Ensemble Average selected)
Display of evaluation range and regression line
Readout of Curvature in %
Y-axis: Range: 5, 10, 20, 40, 60, 80, 100, 120, 140 or 160 dB. Auto zoom or auto scale available

Result Displays

OVERVIEW
Table of measurement positions for all functions (L1, L2, B2 or T2) with readout of quality indicators. Positions can be included/excluded from result

CALCULATIONS
Shows the sound reduction index (spectrum and weighted) according to the selected standard, along with the reference curve (if any), or deviations (from the reference curve). See Table B.2

MEASUREMENT CONTROL
Measurement Sequence: Supports measuring:
- at all microphone positions before using another source
- at a microphone position for all sources before measuring at a new position
- at subsequent microphone positions without source information
- at manually selected source and microphone positions

Measurements are started manually and can be automatically stored on completion of measurement
Generator (L1, L2 and T2): The noise generator is turned on and off automatically
Escape Time: 0 to 60 s
Build-up Time: 1 to 10 s

The generator can be turned on and off manually for checking equipment and sound levels
Excitation T2:
Interrupted Noise: Measurements are started manually and can be automatically stored on completion of measurement
Number of Decays per Measurement: 1 to 100, ensemble averaged into one decay
Impulse: Manual start of first measurement. When level (say from starter pistol) exceeds the user-selected trigger level, the decay is recorded and backwards integration performed (Schroeder method). The trigger can then be armed automatically for measuring at the next position
Sound Recording: Recording of the Z-weighted measured signal can be done at each position
Sound Recording requires a CF- or SD-Card for data storage
Sound Recording requires license for Sound Recording Option BZ-7226

Measurement Status

On Screen: Information such as *overload*, *awaiting trigger* and *running/paused* are displayed on screen as icons or text
Traffic Light: Red, yellow and green LEDs show measurement status and instantaneous overload as follows:

- Yellow LED flashing every 5 s = stopped, ready to measure
- Green LED flashing slowly = awaiting trigger or calibration signal
- Green LED on constantly = measuring
- Yellow LED flashing slowly = paused, measurement not stored
- Red LED flashing quickly = intermittent overload, calibration failed

Calibration

Initial calibration is stored for comparison with later calibrations
Acoustic: Using Sound Calibrator Type 4231 or custom calibrator. The calibration process automatically detects the calibration level when Sound Calibrator Type 4231 is used
Electrical: Uses internally generated electrical signal combined with a typed-in value of microphone sensitivity
Calibration History: Up to 20 of the last calibrations made are listed and can be viewed on the instrument

Signal Monitoring

Input signal A-, C- or Z-weighted can be monitored using an earphone/headphones connected to the headphone socket
Headphone Signal: Input signal can be monitored using this socket with headphones/earphones
Gain Adjustment: –60 dB to 60 dB

Voice Annotations

Voice annotations can be attached to the Building Acoustics Project and to measurements at each Position
Playback: Playback of voice annotations or sound recordings can be listened to using earphone/ headphones connected to the headphone socket
Gain Adjustment: –60 dB to 0 dB

Text & Image Annotations

Text and image (Type 2270 only) annotations can be attached to the Building Acoustics Project and to measurements at each Position

Data Management

Project Template: Defines the display and measurement setups
Project: Measurement data for all positions defined in source room (L1) and in receiving room (L2, B2 and T2) are stored with the Project Template
Re-use of data: Data for L1, B2 or T2 in one project can be re-used in another project
Job: Projects are organised in Jobs
Explorer facilities for easy management of data (copy, cut, paste, delete, rename, view data, open project, create job, set default project name)

Note: For specifications and details on Type 7830, please refer to Product Data BP 1691

Software Specifications – Sound Recording Option BZ-7226

Sound Recording Option BZ-7226 is enabled with a separate license. Sound Recording requires a CF- or SD-Card for data storage

RECORDED SIGNAL
Z-weighted signal from the measurement transducer

SAMPLING RATE AND PRE-RECORDING
Sound is buffered for the pre-recording of sound. This allows the beginning of events to be recorded even if they are only detected later.

Sampling Rate (kHz)	Maximum Pre-recording (s)	Sound Quality	Memory (KB/s)
8	100	Low	16
16	50	Fair	32
24	30	Medium	48
48	10	High	96

FUNCTIONS WITH BZ-7228 AND BZ-7229
Automatic Control of Recording: Start of recording when measurement is started

PLAYBACK
Playback of sound recordings can be listened to using the earphone/headphones connected to the headphone socket

RECORDING FORMAT
The recording format is 16-bit wave files (extension .wav) attached to the data in the project, easily played-back afterwards. Calibration information is stored in the wav file, allowing PULSE to analyse the recordings

Software Specifications – Utility Software for Hand-held Analyzers BZ-5503

BZ-5503 is included with Type 2250/2270 for easy synchronisation of setups and data between PC and Type 2250/2270. BZ-5503 is supplied on CD-ROM BZ-5298

ON-LINE DISPLAY OF TYPE 2250/2270 DATA
Measurements on Type 2250/2270 can be controlled from the PC and displayed on-line with the PC, using the same user interface on the PC as on Type 2250/2270

DATA MANAGEMENT
Explorer: Facilities for easy management of Instruments, Users, Jobs, Projects and Project Templates (copy, cut, paste, delete, rename, create)
Data Viewer: View measurement data (results of projects)
Template Editor: Editor for changing setups in Project Templates
Synchronisation: Project Templates and Projects for a specific user can be synchronised between PC and Type 2250/2270

USERS
Users of Type 2250/2270 can be created or deleted

EXPORT FACILITIES
Excel: Projects (or user specified parts) can be exported to Microsoft® Excel
Type 7830: Building Acoustics Projects can be exported to Qualifier Type 7830

TYPE 2250/2270 SOFTWARE UPGRADES AND LICENSES
The utility software controls Type 2250/2270 software upgrades and licensing of the Type 2250/2270 applications

INTERFACE TO TYPE 2250/2270
USB ver. 1.1 or Hayes compatible GSM or standard analogue modem

PC REQUIREMENT
Operating System: Windows® 2000/Windows® XP/ Windows Vista®, Microsoft®.NET
Recommended PC: Pentium® III (or equivalent) processor, 1024 Mbyte RAM, SVGA graphics display/ adaptor, sound card, CD ROM drive, mouse, USB, Windows® XP

Ordering Information

Type 2250-J	Hand-held Analyzer Type 2250 with Sound Level Meter Software BZ-7222 and Building Acoustics Software BZ-7228
Type 2270-J	Hand-held Analyzer Type 2270 with Sound Level Meter Software BZ-7222 and Building Acoustics Software BZ-7228
Type 2270-K	Hand-held Analyzer Type 2270 with Sound Level Meter Software BZ-7222 and Dual-channel Building Acoustics Software BZ-7229
Type 2250-J-001	Building Acoustics System including Type 2250-J, OmniPower Sound Source and Amplifier
Type 2270-J-001	Building Acoustics System including Type 2270-J, OmniPower Sound Source and Amplifier
Type 2270-K-001	Dual-channel Building Acoustics System including Type 2270-K,

	OmniPower Sound Source and Amplifier
BZ-7228-200	Building Acoustics Kit as per Type 2250-J-001, or Type 2270-J-001, excluding Hand-held Analyzer (for Types 2250 & 2270 users intending to upgrade to a full Building Acoustics measurement system)
BZ-7229-200	Dual-channel Building Acoustics Kit as per Type 2270-K-001, excluding Type 2270 (for Type 2270 users intending to upgrade to a full Dual-channel Building Acoustics measurement system)

COMPONENTS INCLUDED WITH TYPES 2250-J, 2270-J AND 2270-K HAND-HELD ANALYZERS

BZ-7222	Sound Level Meter Application
BZ-7228	Building Acoustics Software
Type 4189	Prepolarized Free-field 1/2″ Microphone
ZC-0032	Microphone Preamplifier
AO-1476	USB Standard A to USB Mini B Interface Cable, 1.8 m (6 ft)
BZ-5298	Environmental Software, including BZ-5503 Utility Software for Hand-held Analyzers
UA-1650	90 mm dia. Windscreen with AutoDetect
UA-1651	Tripod Extension for Hand-held Analyzer
UA-1673	Adaptor for Standard Tripod Mount
DH-0696	Wrist Strap
KE-0440	Travel Bag
KE-0441	Protective Cover
FB-0699	Hinged Cover for Type 2270 (FB-0679 for Type 2250)
HT-0015	Earphones
UA-1654	Five Extra Styli
AO-1449	LAN Interface Cable (Type 2270 only)
QB-0061	Battery Pack
ZG-0426	Mains Power Supply

Note: For Type 2270-K, BZ-7228 is replaced by BZ-7229 Dual-channel Building Acoustics Software

COMPONENTS INCLUDED WITH TYPE 2250-J-001 AND 2270-J-001 SYSTEMS

Type 2250-J or 2270-J plus the following:

Type 4292	OmniPower Sound Source (Tripod included)
Type 2716	Power Amplifier
Type 4231	Sound Calibrator Class 1 and LS, 94 and 114 dB, 1 kHz
KE-0358	Carrying case for Type 2716 Amplifier, Hand-held Analyzer and Wireless Receiver
KE-0449	Flight Case for Type 4292 OmniPower Sound Source
KE-0364	Carrying Bag for Type 4292 Loudspeaker Tripod
UA-0801	Lightweight Tripod
UA-1426	Mounting Kit for wireless transmission with Hand-held Analyzer, Type 2716 and Type 4292, requires receiver/pocket transmitter
UA-0237	Windscreen for 1/2″ microphones, 90 mm diameter
AQ-0667	Bridging Cable for Type 2716
AO-0523-D-100	Signal cable, Triaxial LEMO to XLR3M, 10 m (33 ft)
Type 7830	Qualifier – software for reporting of results on PC

Note: These systems do not include a wireless transmitter receiver unit. Please contact your local Brüel & Kjær office for further information.

COMPONENTS INCLUDED WITH TYPE 2270-K-001 SYSTEM

Type 2270-K	Hand-held Analyzer Type 2270 with BZ-7229 Dual-channel Building Acoustics Software
Type 4292	OmniPower Sound Source (Tripod included)
Type 2716	Power Amplifier
Type 4231	Sound Calibrator Class 1 and LS, 94 and 114 dB, 1 kHz
KE-0358	Carrying case for Type 2716 Amplifier, Hand-held Analyzer and Wireless Receiver
KE-0449	Flight Case for Type 4292 OmniPower Sound Source
KE-0364	Carrying Bag for Type 4292 Loudspeaker Tripod
UA-1426	Mounting Kit for wireless transmission with Hand-held Analyzer, Type 2716 and Type 4292, requires receiver/pocket transmitter
AQ-0667	Bridging Cable for Type 2716
AO-0523-D-100	Signal cable, Triaxial LEMO to XLR3M, 10 m (33 ft)
3 × UA-0801	Lightweight Tripod
Type 4189	Prepolarized Free-field 1/2″ Microphone
ZC-0032	Microphone Preamplifier (for Type 2270)
JP-1041	Dual 10-pole Adaptor

AR-0199	Flat cable, 10-pin LEMO, 1 m (3.3 ft)
2 × UA-1317	1/2″ Microphone Holder
2 × UA-0237	Windscreen for 1/2″ microphones, 90 mm diameter
2 × AO-0697-100	Microphone Extension Cable, 10-pin LEMO, 10 m (33 ft)
Type 7830	Qualifier – software for reporting of results on PC

Note: This system does not include a wireless transmitter receiver unit. Please contact your local Brüel & Kjær office for further information

SOFTWARE MODULES AVAILABLE SEPARATELY

BZ-7228	Building Acoustics Software for Types 2250 and 2270
BZ-7228-100	Upgrade of BZ-7227 Reverberation Time application to BZ-7228 Building Acoustics Software
BZ-7229	Dual-channel Building Acoustics Software for Type 2270
BZ-7229-100	Upgrade of BZ-7228 to BZ-7229 Dual-channel Building Acoustics for Type 2270
BZ-7223	Frequency Analysis Software
BZ-7224	Logging Software
BZ-7225	Enhanced Logging Software
BZ-7225-UPG	Upgrade from Logging Software BZ-7224 to Enhanced Logging Software BZ-7225 (does not include memory card)
BZ-7226	Sound Recording Option (requires SD or CF memory card for Analyzer)
BZ-7227	Reverberation Time Software
BZ-7230	FFT Analysis Software
BZ-7231	Tone Assessment Option

PC SOFTWARE

Type BZ-5503	2250 Utility software (supplied as standard with Type 2250 and 2270 Hand-held Analyzers)
Type 7830	Qualifier – software for reporting of results on PC

MEASUREMENT ACCESSORIES

AO-0440-D-015	Signal cable, LEMO to BNC, 1.5 m (5 ft)
AO-0646	Sound Cable, LEMO to Minijack, 1.5 m (5 ft)
AO-0697-030	Microphone Extension Cable, 10-pin LEMO, 3 m (10 ft)
AO-0697-100	Microphone Extension Cable, 10-pin LEMO, 10 m (33 ft)
AR-0199	Flat cable, 10-pin LEMO, 1 m (3.3 ft)
JP-1041	Dual 10-pole Adaptor
UA-0587	Tripod
UA-0801	Lightweight Tripod
UA-1317	Microphone Holder
UA-1404	Outdoor Microphone Kit
UL-1009	SD Memory Card for Hand-held Analyzers
UL-1013	CF Memory Card for Hand-held Analyzers
ZG-0444	Charger for QB-0061 Battery Pack
Type 3923	Rotating Microphone Boom

SOUND SOURCES

Type 4292	OmniPower Sound Source
Type 4295	OmniSource Sound Source
Type 4224	Portable, Battery & Mains Powered Sound Source
Type 3207	Tapping Machine
Type 2716	Power Amplifier

For further information on sound sources and accessories please refer to the ‘Sound Sources for Building Acoustics’ Product Data, BP 1689.

Service Products

ACCREDITED CALIBRATION

2250/2270-CAI	Accredited Initial Calibration of Types 2250/2270
2250/2270-CAF	Accredited Calibration of Types 2250/2270
2250/2270-CTF	Traceable Calibration of Types 2250/2270

HARDWARE MAINTENANCE

2250/2270-EW1	Extended Warranty, one year extension (Types 2250/2270)

CALIBRATORS AND PISTONPHONES

Type 4231	Sound Calibrator
Type 4226	Multifunction Acoustic Calibrator
Type 4228	Pistonphone

Brüel & Kjær supplies a wide range of microphones and microphone accessories. Please contact your local Brüel & Kjær office for more information regarding the different types and their use, or visit the website at www.bksv.com.

Compliance with Standards

CE C-Tick	CE-mark indicates compliance with the EMC Directive and Low Voltage Directive. C-Tick mark indicates compliance with the EMC requirements of Australia and New Zealand.
Safety	EN/IEC 61010–1, ANSI/UL 61010–1 and CSA C22.2 No.1010.1: Safety requirements for electrical equipment for measurement, control and laboratory use.
EMC Emission	EN/IEC 61000–6–3: Generic emission standard for residential, commercial and light industrial environments. CISPR 22: Radio disturbance characteristics of information technology equipment. Class B Limits. FCC Rules, Part 15: Complies with the limits for a Class B digital device. IEC 61672–1, IEC 61260, IEC 60651 and IEC 60804: Instrumentation standards. Complies with Canadian standard ICES–001
EMC Immunity	EN/IEC 61000–6–2: Generic standard – Immunity for industrial environments. EN/IEC 61326: Electrical equipment for measurement, control and laboratory use – EMC requirements. IEC 61672–1, IEC 61260, IEC 60651 and IEC 60804: Instrumentation standards

Appendix A

Setup Parameters

This appendix describes all the setup parameters included in a template. The parameters are applicable to Types 2250 and 2270, unless otherwise stated.

A.1 Input (For Type 2270 Only)

Table A.1 *Input parameters*

Parameter	Values	Comment
Measure L1 and L2	*Simultaneously* *Separately*	**Note:** If *Task* = *Façade* and *Generator Type* = *Off* (Traffic Noise) then *Simultaneously* is the only option. This parameter is for BZ-7229 only
Input for L1	*Ch. 1* *Ch. 2*	Select input channel for L1 measurements. **Note:** If *Measure L1 and L2* = *Simultaneously* then *Ch.1* is the only option
Input for L2	*Ch. 1* *Ch. 2*	Select input channel for L2 measurements. **Note:** If *Measure L1 and L2* = *Simultaneously* then *Ch. 2* is the only option
Input for B2	*Ch. 1* *Ch. 2*	Select input channel for B2 measurements.
Input for T2	*Ch. 1* *Ch. 2*	Select input channel for T2 measurements.
Autorange	*Off* *On*	Set to *On* for autoranging Ch.1 and Ch.2 or set to *Off* for manually setting the range. This is relevant for *Measure L1 and L2* = *Simultaneously* only (available for BZ-7229 only)

A.2 Input (Type 2250 and 2270 Ch. 1)

Table A.2 *Input parameters*

Parameter	Values	Comment
Input	*Top Socket* *Rear Socket*	Determines whether the input is taken from the top socket or the rear socket ('Input' on connector panel). Connect your transducer to this socket **Note:** *Sound Field* and *Windscreen* corrections can be added to both the *Top Socket* and the *Rear Socket* (*Input* parameters)
Sound Field Correction	*Free-field* *Diffuse-field*	Select a correction matching the sound field of your measurements, i.e., you can make correct measurements in a diffuse-field using a Type 4189 free-field microphone, by selecting *Diffuse-field* correction. Building Acoustics measurements require the *Diffuse-field* setting. No correction is made for unknown transducers
Windscreen Auto Detect	*On* *Off*	Automatic detection of UA-1650 windscreen when mounted on the ZC-0032 microphone preamplifier. The preamplifier should be connected to the top socket, if necessary using a microphone extension cable. This parameter is only available for microphone types using ZC-0032
Windscreen Correction	*None* *UA-1650* *UA-1404*	If *Windscreen Auto Detect* is set to *Off*, you can manually select a windscreen correction suitable for the windscreen in use. Correction is automatically made for the windscreen on Type 4952. No correction is made for unknown transducers
Range Setting	*High Range* *Low Range*	Set *Range Setting* to *High Range* or *Low Range* as required. The difference between the two settings is 30 dB. High Range can be used to measure up to the max. input level. This setting is relevant for *Measure L1 and L2 = Simultaneously* and *Autorange = Off* only (available in BZ-7229 only)

A.3 Input (Type 2270 Ch. 2)

Table A.3 *Input parameters*

Parameter	Values	Comment
Input	*Top Socket* *Rear Socket*	Determines whether the input is taken from the top socket or the rear socket ('Input' on connector panel). Connect your transducer to this socket **Note:** *Sound Field* and *Windscreen* corrections can be added to both the *Top Socket* and the *Rear Socket* (*Input* parameters)
Sound Field Correction	*Free-field* *Diffuse-field*	Select a correction matching the sound field of your measurements, i.e., you can make correct measurements in a diffuse-field using a Type 4189 free-field microphone, by selecting *Diffuse-field* correction. Building Acoustics measurements require the *Diffuse-field* setting. No correction is made for unknown transducers
Windscreen Auto Detect	*On* *Off*	Automatic detection of UA-1650 windscreen when mounted on the ZC-0032 microphone preamplifier. The preamplifier should be connected to the top socket, if necessary using a microphone extension cable. This parameter is only available for microphone types using ZC-0032
Windscreen Correction	*None* *UA-1650* *UA-1404*	If *Windscreen Auto Detect* is set to *Off*, you can manually select a windscreen correction suitable for the windscreen in use. Correction is automatically made for the windscreen on Type 4952. No correction is made for unknown transducers
Range Setting	*High Range* *Low Range*	Set *Range Setting* to *High Range* or *Low Range* as required. The difference between the two settings is 30 dB. High Range can be used to measure up to the max. input level. This setting is relevant for *Measure L1 and L2 = Simultaneously* and *Autorange = Off* only (available in BZ-7229 only)

A.4 Standard

Table A.4 *Standard parameters*

Parameter	Values	Comment
Standard	*ISO* *SS* *DIN* *ÖNORM* *BS* *BREW* *SIA* *UNI* *NF* *NBE* *CTE* *NEN* *NEN'06* *ASTM*	
Task	*Airborne* *Impact* *Façade*	

A.5 Frequency Range

Table A.5 *Frequency Range parameters*

Parameter	Values	Comment
Bandwidth	*1/1-octave* *1/3-octave*	Bandwidth of frequency analysis
Bottom Frequency	*50 Hz to Top Frequency*	1/1-octave: 63 Hz – 8 kHz 1/3-octave: 50 Hz – 10 kHz **Note:** The settings of Bottom and Top Frequency control the frequency range of the frequency analysis and the internal noise generator.
Top Frequency	*Bottom Frequency to 10 kHz*	1/1-octave: 63 Hz – 8 kHz 1/3-octave: 50 Hz – 10 kHz

The Frequency Range parameters are automatically set in accordance with the chosen standard; however, the range can be set wider than that required by the standard.

A.6 Measurement Control L1, L2 and B2

Table A.6 *Measurement Control L1, L2 and B2 parameters*

Parameter	Values	Comment
Planned Measurement	*Off* *On*	For *Planned Measurement* = *On*, you can define the number of source positions and microphone positions per source – otherwise the measurements are made from *Pos. 1* and forward
No. Of Source Positions	*1 to* *10*	Only for *Planned Measurement* = *On*
L1: No. of Micr. Pos. per Source	*1 to* *10*	Only for *Planned Measurement* = *On*. The number can be increased after the first measurements have been saved – but not decreased below the last measurement position
L2: No. of Micr. Pos. per Source	*1 to* *10*	Only for *Planned Measurement* = *On* The number can be increased after the first measurements have been saved – but not decreased below the last measurement position
Increment	*Source First* *Mic. Position First* *Manually*	Only for *Planned Measurement* = *On*. Defines the order in which you want to do your measurements
Preset Time	*00:00:00 to* *01:00:00*	
Automatic Save	*Off* *On*	

A.7 Measurement Control T2

Table A.7 *Measurement Control T2 parameters*

Parameter	Values	Comment
Planned Measurement	*Off* *On*	For *Planned Measurement* = *On*, you can define the number of source positions and microphone positions per source – otherwise the measurements are made from *Pos. 1* and forward
No. Of Sources (Positions)	*1 to* *10*	Only for *Planned Measurement* = *On*
No. of Micr. Pos. per Source	*1 to* *10*	Only for *Planned Measurement* = *On*. The number can be increased after the first measurements have been saved, but not decreased below the last measurement position
Increment	*Source First* *Mic. Position First* *Manually*	Only for *Planned Measurement* = *On*. Defines the order in which you want to do your measurements

Table A.7 *(Cont.) Measurement Control T2 parameters*

Parameter	Values	Comment
Max. Decay Time	*2 s to 20 s*	The decay is based on spectra sampled every 5 ms. An algorithm determines when the decay is finished and then stops the measurement. Under difficult measurement conditions where the automatic stop cannot be found, *Max. Decay Time* determines when to stop
Automatic Save	*Off* *On*	
Excitation	*Impulsive* *Interrupted Noise*	
Number of Decays	*1 to 100*	Parameter only available if *Excitation* = *Interrupted Noise*
Trigger Level	*0 to 140 dB*	Parameter only available if *Excitation* = *Impulsive*
Trigger Repeat	*Off* *On*	Parameter only available if *Excitation* = *Impulsive*

A.8 Sound Recording

Table A.8 *Sound Recording parameters*[a]

Parameter	Values	Comment
Recording Control	*Off* *Automatic*	Determines how recording of the measured signal is controlled. Set to *Automatic* to start the recording when the measurement is started and record throughout the measurement
Recording Quality	*Low* *Fair* *Medium* *High*	This setup determines the quality of the recording by adjusting the sampling rate. The amount of space required for the recording on the memory card will depend on the selected quality: Quality / Sampling freq. / Upper freq. / Memory Low 8 kHz 3 kHz 16 KB/s Fair 16 kHz 6 kHz 32 KB/s Medium 24 kHz 10 kHz 48 KB/s High 48 kHz 20 kHz 96 KB/s

Table A.8 *(Cont.) Sound Recording parameters*[a]

Parameter	Values	Comment
Peak Recording Level	*140 dB* *130 dB* *120 dB* *110 dB* *100 dB* *90 dB* *80 dB* *70 dB*	The recorded signal is stored as a 16-bit wave file, which has a dynamic range of up to 96 dB. When playing back on Type 2250, the dynamic range of the output is approx. 75 dB. When playing back on a PC, it might be even lower. Set *Peak Recording Level* to fit the signal. The values for *Peak Recording Level* take the sensitivity of the attached transducer into account. The values shown in the list here are nominal values for a Type 4189 microphone

a. Requires license for Sound Recording Option BZ-7226.

A.9 Generator for L1 and L2

Table A.9 *Generator for L1 and L2 Parameters*

Parameter	Values	Comment
Generator Type	*Internal* *External* *Off (Traffic Noise)*	Set to *Internal* to use the internal noise generator as specified below. Set to *External* to switch an external generator on/off using a logic signal: On = 3.3 V; Off = 0 V. The generator signal appears at the Output Socket. **Note 1:** If *Task* = *Façade* and *Measure L1 and L2* = *Simultaneously*, then *Generator Type* = *Off (Traffic Noise)* will set the analyzer for averaging the differences L1-L2 (BZ-7229 only)
Noise Type	*Pink* *White*	The type of noise from the internal generator. The bandwidth of the noise will be adjusted to the frequency range from *Bottom Frequency* to *Top Frequency*
Level [re. 1 V]	*–80.0 to 0.0 dB*	This sets the internal noise generator attenuation in dB, referenced to 1 V. This level stays at the set level irrespective of the frequency range
Escape Time	*0 to 60 s*	Set the *Escape Time* to allow the operator to leave the room before the generator is turned on and the measurement starts

Table A.9 *(Cont.) Generator for L1 and L2 Parameters*

Parameter	Values	Comment
Build-up Time	*1 to 10 s*	Set the *Build-up Time* to allow the sound pressure in the room to settle after the sound source is switched on
Sound Source	*Unknown* *Type 4292 Optimum* *Type 4295 Optimum* *Type 4296 Optimum* *Type 4292 Flat* *Type 4295 Flat* *Type 4296 Flat*	This setting optimises the frequency response of the internal generator output to the connected sound source. The 'Flat' setting optimises the output for a flat power response, and the 'Optimum' setting optimises the power difference between adjacent 1/1- or 1/3-octave bands while maintaining a 'boost' at low frequencies. Select a type matching your sound source: • Type 4292 or 4296 OmniPower Sound Source • Type 4295 OmniSource Sound Source • Select *Unknown* if you are using another sound source, or do not want to correct the frequency response

A.10 Generator for T2

Table A.10 *Generator for T2 Parameters*

Parameter	Values	Comment
Generator Type	*Internal* *External*	Set to *Internal* to use the internal noise generator as specified below. Set to *External* to switch an external generator on/off using a logic signal: On = 3.3 V; Off = 0 V. The generator signal appears at the Output Socket. **Note 1:** Set *Measurement Control*, *Excitation* = *Interrupted Noise* to enable the generator parameters
Noise Type	*Pink* *White*	The type of noise from the internal generator. The bandwidth of the noise will be adjusted to the frequency range from *Bottom Frequency* to *Top Frequency*
Level [re. 1 V]	*–80.0 to 0.0 dB*	This sets the internal noise generator attenuation in dB, referenced to 1 V. This level stays at the set level irrespective of the frequency range

Table A.10 *(Cont.) Generator for T2 Parameters*

Parameter	Values	Comment
Escape Time	*0 to 60 s*	Set the *Escape Time* to allow the operator to leave the room before the generator is turned on and the measurement starts
Build-up Time	*1 to 10 s*	Set the *Build-up Time* to allow the sound pressure in the room to settle after the sound source is switched on
Sound Source	*Unknown* *Type 4292 Optimum* *Type 4295 Optimum* *Type 4296 Optimum* *Type 4292 Flat* *Type 4295 Flat* *Type 4296 Flat*	This setting optimises the frequency response of the internal generator output to the connected sound source. The 'Flat' setting optimises the output for a flat power response, and the 'Optimum' setting optimises the power difference between adjacent 1/1- or 1/3-octave bands, while maintaining a 'boost' at low frequencies. Select a type matching your sound source: • Type 4292 or 4296 OmniPower Sound Source • Type 4295 OmniSource Sound Source • Select *Unknown* if you are using another sound source, or do not want to correct the frequency response

A.11 Calculations

Table A.11 *Calculation Parameters*

Parameter	Values	Comment
Ensemble Averaging	*No* *Yes*	Set to *Yes* to average each of the position decays into an average decay (called the ensemble average or Room average). The averaged decays of the room can then be displayed in the Decay View. T20 and T30 will be calculated from the Room average. Set to *No* for no ensemble averaging. There will be no decays available for the room. T20 and T30 will be calculated as averages of the T20@Pos and the T30@Pos resp. for all the positions
Receiving Room Volume	*0.1 to 100000 m^3*	Used in calculation of results
Partition Area S	*0.1 to 1000 m^2*	Used in calculation of results

Table A.11 *Calculation Parameters*

Parameter	Values	Comment
To	*0.01 to 10 s*	The reference reverberation time – typically 0.5 s, but it may vary with standards
Calculate Using	*T30* *T20*	Use this parameter to specify which of the measured reverberation time values to use in the calculations. If T30 is specified and available, then T30 is used, otherwise, T20 is used
Correct for Background Noise	*Yes* *No*	Use this parameter to specify whether L2 should be corrected for the background noise B2 or not
L1: Check 6 dB Rule	*Yes* *No*	Select *Yes* if you want to check whether the sound spectrum in the source room has differences in level greater than 6 dB between adjacent 1/3-octave bands, or not. The check is done according to the method specified in ISO 140-4:1998, 6.2. If a difference greater than 6 dB is found, then the lowest of the two bands is marked with a yellow smiley. When the smiley is tapped, the following explanation appears: "*L1: >6 dB difference to next band*"
L1, L2: Check Std. Deviation	*Yes* *No*	Select *Yes* if you want to check whether the standard deviation of the averaged sound spectra in the source and receiving rooms is too big, or not. The check is done according to the method specified in ISO 140-14:2004, A.5. If the standard deviation in a frequency band is greater than twice the theoretical expected value, then the band is marked with a yellow smiley. When the smiley is tapped, the following explanation appears: "*L1 or L2: High Standard Deviation*"
Receiving Room Floor Area	*0.1 to 10000 m^2*	Used to determine quality of L2 measurements
Source Room Volume	*0.1 to 100000 m^3*	Needed for report in some standards
Source Room Floor Area	*0.1 to 10000 m^2*	Used to determine quality of L1 measurements
Rubber Hammer	*Yes* *No*	NEN and NEN '06 – Impact only

Table A.11 *Calculation Parameters*

Parameter	Values	Comment
Floor	*Wood* *Stone*	NEN and NEN '06 – Impact, Rubber Hammer only
Cr	*–10 to 10 dB*	NEN and NEN '06 – Façade only
Traffic Type	*Road* *Rail* *Air* *Other*	NEN and NEN '06 – Façade only
CL	*–3 to 20 dB*	NEN '06 – Façade only
OILR	*–10 to 10 dB*	If you are measuring to the ASTM standard, set the dB level for the Outdoor-Indoor Level Reduction parameter here. (Only available if the Façade task is selected)
OITL	*–10 to 10 dB*	If you are measuring to the ASTM standard, set the dB level for the Outdoor-Indoor Transmission Loss parameter here. (Only available if the Façade task is selected)

Appendix B

Measurement Parameters

B.1 Building Acoustics Standards

B.1.1 Overview

For a complete overview of building acoustic standards see Table B.1 and Table B.3. For an overview of the calculated parameters see Table B.3 and Table B.4.

Table B.1 *Building Acoustics Standards – Part 1*

			Sweden	Germany	Austria	UK	England Wales	Switzerland
Measurement		**ISO**	**SS**	**DIN**	**ÖNORM**	**BS**	**BREW**	**Sia**
Typical Parameters		*R´ L´n*	*R´ L´n*	*R L´n*	*DnT L´nT*	*DnT L´nT*	*DnT*	*DnT L´nT*
Airborne	**Lab**	140-3	EN 20140-3	EN 20140-3	S 5101	EN 20140-3		
	Field	140-4	EN 20140-4	52210-1	S 5100-1	2750-4	BREW	181
	Façade	140-5	EN 20140-5	52210-5	S 5100-3	2750-5		181
Impact	**Lab**	140-6	EN 20140-6	52210-1	S 5101	2750-6		
	Field	140-7	EN 20140-7	52210-1	S 5100-2	2750-7		181
RT		3382-2		52212				
Rating	**Airborne**	717-1	SS-ISO717-1	52210-4	S5100-1	5821-1,-3	BS EN 717-1	181
	Impact	717-2	SS-ISO717-2	52210-4	S5100-2	5821-2		181

Table B.2 *Building Acoustics Standards – Part 2*

		Italy	**France**	**Spain**		**Netherlands**		**USA**
Measurement		**UNI**	**NF-S31**	**NBE**	**CTE**	**NEN**	**NEN'06**	**ASTM**
Typical Parameters		*Dn Ln*	*DnAT LnAT*	*DnAT LnAT*	*DnT,A L´nT*	*Ilu Ico*	*DnT,A LnT,A*	*FTL Ln*
Airborne	**Lab**	8270-1	051	74-040-84/3	CTE 2008			
	Field	8270-4	054, -057	74-040-84/4	CTE 2008	5077	5077	E336-90
	Façade	8270-5	055, -057	74-040-84/5	CTE 2008	5077	5077	E966-90
Impact	**Lab**	8270-6	-052	74-040-84/6	CTE 2008			
	Field	8270-4	056, -057	74-040-84/7	CTE 2008	5077	5077	E1007-90
RT						5077	5077	
Rating	**Airborne**	8270-7	-057	NBECA-88	CTE 2008	5077	NPR 5079	E413-73 E1332-90
	Impact	8270-7	-057	NBECA-88	CTE 2008	5077	NPR 5079	E989

Table B.3 *Calculated Parameters – Part 1*

Standard	ISO, DIN, ÖNorm, UNI, BS, BREW	SS	Sia	NF
Basic Standards	ISO 140 ISO 717	ISO 140 ISO 717	ISO 140 ISO 717	NF S31-05x
Airborne: **Calculated parameters**	D Dn DnT R´ R --- Dw Dw+C Dw+Ctr Dnw Dnw+C Dnw+Ctr DnTw R´w or Rw +C +Ctr $+C_{50\text{-}3150}$ $+C_{50\text{-}5000}$ $+C_{100\text{-}5000}$ $+Ctr_{50\text{-}3150}$ $+Ctr_{100\text{-}5000}$ $+Ctr_{50\text{-}5000}$	ISO plus: --- Dw8 DnTw8 R´w8 Rw8	ISO plus: --- DnTw+C–Cv	D DnT R --- DnATrose DnATroute Rrose Rroute
Facade: **Calculated parameters**	R´45° R´tr,s Dls,2m Dls,2m,n Dls,2m,nT Dtr,2m Dtr2m,n Dtr,2m,nT --- Dls,2m,w Dls,2m,n,w Dls,2m,nT,w Dls,2m,nT,w+C Dls,2m,nT,w+Ctr Dtr,2m,w Dtr,2m,n,w Dtr,2m,nT,w+C Dtr,2m,nT,w+Ctr R´45°w or R´tr,s,w +C +Ctr $+C_{50\text{-}3150}$ $+C_{50\text{-}5000}$ $+C_{100\text{-}5000}$ $+Ctr_{50\text{-}3150}$ $+Ctr_{100\text{-}5000}$ $+Ctr_{50\text{-}5000}$	See ISO	ISO plus: D45°nT --- Dls,2m,nT,w+Ctr–Cv Dtr,2m,nT,w+Ctr–Cv D45°nT,w+Ctr–Cv	DnT45° DnTtr --- DnATroute45° DnATroute
Impact: **Calculated parameters**	L´n L´nT Ln --- L´nw L´nTw or Lnw +Ci $+Ci_{50\text{-}2500}$	ISO plus: --- L´nw8 L´nTw8 Lnw8	See ISO	LnT Ln --- LnAT LnA

Table B.4 *Calculated Parameters – Part 2*

Standard	NBE	CTE	NEN	NEN'06	ASTM
Basic Standards	ISO 140	ISO 140	NEN 5077	NEN 5077-2006	ASTM E336, 1007, E966, E1332
Airborne: **Calculated parameters**	ISO plus: --- DA DnAT RA R´A	ISO plus: --- DA DnA DnT,A RA R´A	DnT --- Ilu Ilu;k	DnT --- DnT,A DnT,A,k	NR NNR FTL --- NIC NNIC FSTC
Facade: **Calculated parameters**	ISO plus: --- R´A45° Dls,2m,nAT Dtr,2m,nAT Dtr,2m,A Dls,2m,A Dls,2m,n,w+C Dls,2m,n,w+Ctr	ISO plus: --- R´45°A R´45°Atr R´A R´Atr D2m,A D2m,Atr D2m,n,A D2m,n,Atr D2m,nT,A D2m,nT,Atr Dls,2m,n,w+C Dls,2m,n,w+Ctr	Gi --- G_A $G_{A;K}$	Gi --- G_A $G_{A;K}$	OILR OITL --- OITC
Impact: **Calculated parameters**	ISO plus: --- LnAT LnA	See ISO	LnT --- Ico	LnT,A	Ln --- IIC

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