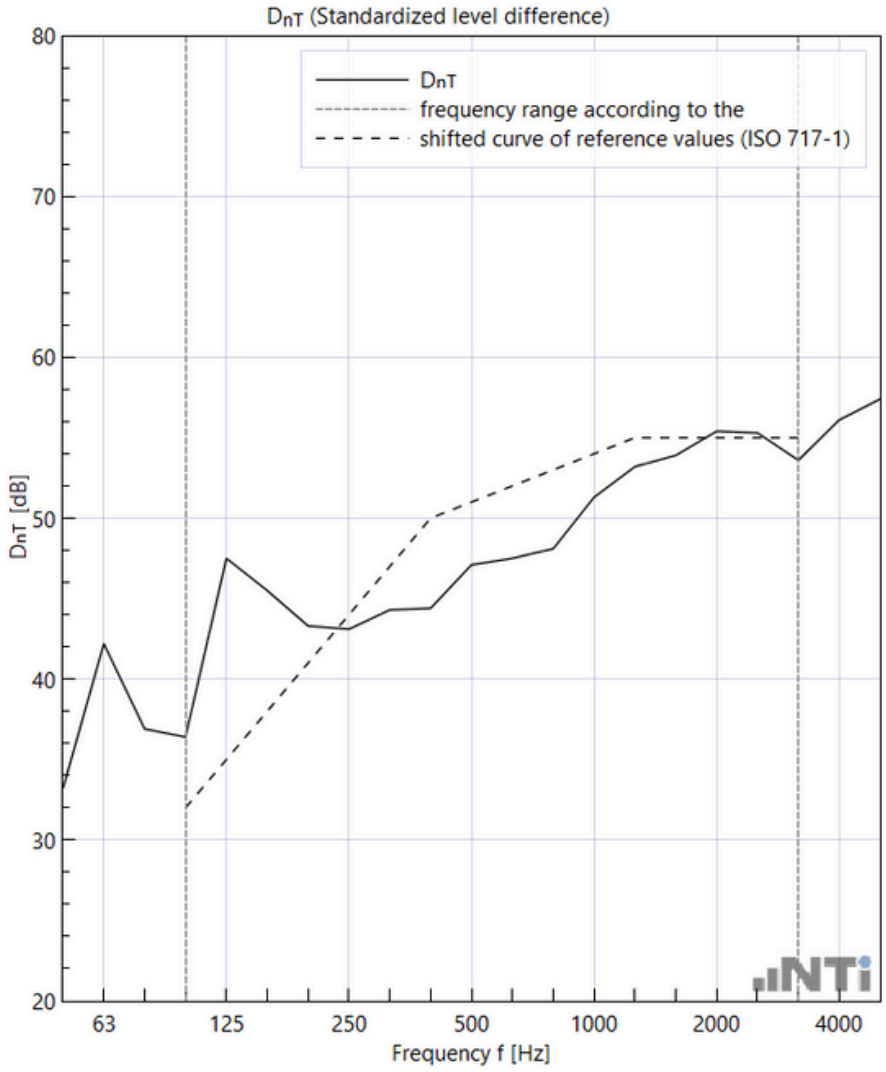
Sound Insulation Reporter

for XL3 & XL2 Acoustic Analyzer



NTi Sound Insulation Reporter 1.50

File Help

Site: Building1

Name	Standard	Type	Rating Name	Rating	Target	Compliance
Demo Test	ISO 16283	Airborne	$D_{nT,w}$	51	43	✓
Impact Test	ISO 16283	Impact	$L'_{nT,w}$	58	43	✗
Keting Bathroom	ISO 16283	Airborne	$D_{nT,w}$	18	20	✗
Keting Floor Airbour...	ISO 16283	Airborne	$D_{nT,w}$	53	43	✓
Keting Floor Impact	ISO 16283	Impact	$L'_{nT,w}$	62	64	✓
Keting Kitchen	ISO 16283	Airborne	$D_{nT,w}$	13	20	✗
Keting Room1	ISO 16283	Airborne	$D_{nT,w}$	26	20	✓
Keting Room2	ISO 16283	Airborne	D_w	19		
Keting Room3	ISO 16283	Airborne	D_w	23		
Wall Airbourne	ISO 16283	Airborne	$D_{nT,w}$	51	43	✓

Sound Insulation Reporter

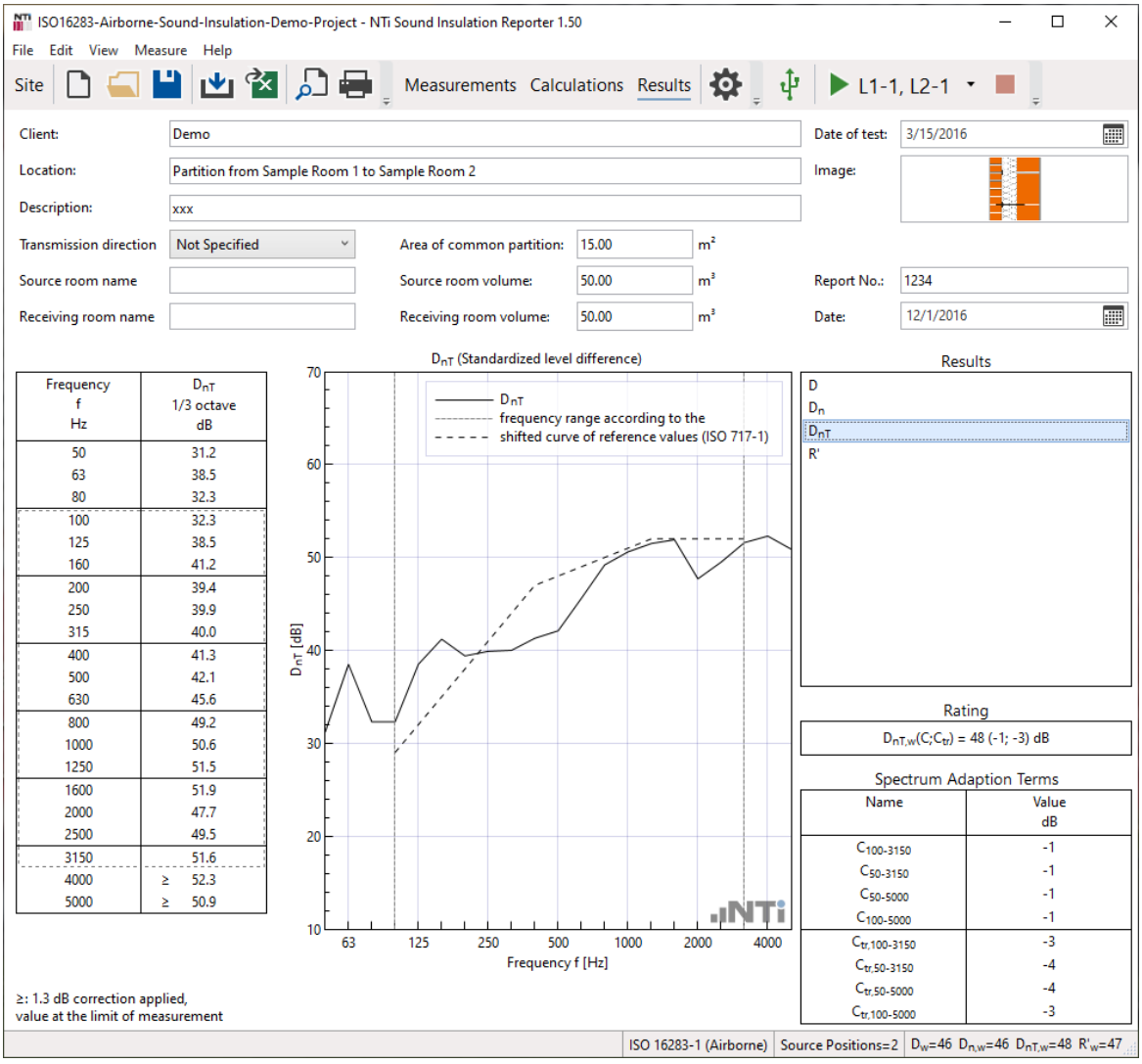
for XL3 and XL2 Acoustic Analyzer

Table of Contents

1 Introduction, Standards and Specifications

1.1 Introduction

Thank you for purchasing the permanent Sound Insulation Option or the annual Sound Insulation Reporter 365 license for the XL2 Acoustic Analyzer and XL3 Acoustic Analyzer. This enables the import of the measurement data into the Sound Insulation Reporter PC-software. The Sound Insulation Reporter is a PC-based software application that provides all the reports for airborne, impact and facade sound insulation measurements.



Designed for acoustic consultants, this comprehensive tool uses data gathered by the XL2 Acoustic Analyzer or XL3 Acoustic Analyzer and quickly returns graphical analysis of all measurement positions. Analyzing the measurement data and producing reports is straightforward using the Sound Insulation Reporter software. Simply drag & drop the measurement data from your XL2 Acoustic Analyzer or XL3 Acoustic Analyzer into the software and print the report.

Additionally, the software offers remote measurements, allowing direct control of one or multiple XL2 or XL3 Acoustic Analyzers connected via USB or wireless. This allows for parallel measurements of sending and receiving room onsite, offering significant time saving.

The following tutorial provides a step-by-step instruction. The appendix includes more details on a typical onsite measurement procedure.

1.1.1 My First Steps

Sound Insulation is the measurement of the influence that a partition (usually a wall or ceiling) has on sound; in other words, how efficiently a partition insulates the sound between rooms. To evaluate this, a reference sound signal is generated in the sending room, and the noise spectrum is measured in both the sending and the receiving room. Additionally, a room correction of the receiving room is applied based on the measurement of the reverberation time.

The Sound Insulation Reporter software offers the following measurement modes:

- With XL3 Acoustic Analyzer:
  - Measurement using XL3 Acoustic Analyzer Sound Insulation Option:
    - The measurements are performed with the XL3 Acoustic Analyzer Sound Insulation Option. ISO 16283, Document E, and ASTM standards are implemented, allowing results to be displayed directly on the XL3 Acoustic Analyzer. All data is later on imported into the Sound Insulation Reporter software.
  - Manual Measurement using XL3 Acoustic Analyzer :
    - The measurements are performed manually with the XL3 Acoustic Analyzer. All data is later on imported into the Sound Insulation Reporter software.
- With XL2 Acoustic Analyzer:
  - Manual Measurement using XL2 Acoustic Analyzer:
    - The measurements are performed manually with the XL2 Acoustic Analyzer. All data is later on imported into the Sound Insulation Reporter software.
- Automated Measurement (remote controlled):
  - One or more Acoustic Analyzers may be controlled directly by the software connected via USB or wireless. This offers parallel measurements of sending and receiving room onsite.

1.1.2 Software Installation

- Install the Sound Insulation Reporter software on your PC.

1.1.3 XL3 Acoustic Analyzer Requirements

- Sound Insulation Bundle that includes:
  - Sound Insulation Option for XL3 Acoustic Analyzer (Optional);
  - Sound Insulation Reporter Software License.

- Install the Sound Insulation Option on the XL3 Acoustic Analyzer and request the online activation of the annual Sound Insulation Reporter 365. This enables the data import into the Sound Insulation Reporter software;
- Install the XL3 Acoustic Analyzer firmware V 1.46, or a more recent version.

1.1.4 XL2 Acoustic Analyzer Requirements

- Installed optional Extended Acoustic Pack to measure the reverberation time in 1/3 octave band resolution.
- Installed Remote Measurement Option to measure sending and receiving room simultaneously with two connected instruments controlled directly within the Sound Insulation Reporter software.
- Install the permanent Sound Insulation Option on the XL2 Acoustic Analyzer and request the online activation of the annual Sound Insulation Reporter 365. This enables the data import into the Sound Insulation Reporter software;
- Install the latest XL2 Acoustic Analyzer firmware V4.84. For XL2-TA Sound Level Meters use the latest certified firmware V4.71 - Austria and France requires V4.21.

1.2 Standards and Specifications

The Sound Insulation Reporter is a PC-based software application that provides all the standard reports for Airborne, Impact and Facade sound insulation measurements. Designed for acoustic consultants, this comprehensive tool uses data gathered by the Acoustic Analyzer, and quickly returns graphical analysis for all measurement positions in accordance with the following standards and specifications:

Airborne Sound Insulation	
Standards	• ASTM E336-20 • ASTM E413 • DIN 4109 • England/Wales: Approved Document E(2003) • BB93 • GB/T 19889.4 - 2005 • ISO 10140:2021 • ISO 140-4:1998 • ISO 717-1:1996 • ISO 16283-1:2014 incl. Rooms < 25m3 • ISO 717-1:2021 • ISO 12999-1:2014 • NEN 5077:2019 • SIA181:2006 • SIA181:2020

Results	• ASTM:
	  • NR, NIC
	  • NNR, NNIC
	  • ATL,ASTC
	• ISO:
	  • Dw
	  • Dn,w
	  • DnT,w
	  • R'w
	  • Spectrum adaption terms C, Ctr

Impact Sound Insulation	
Standards	• ASTM E1007 • ASTM E989 • DIN 4109 • England/Wales: Approved Document E(2003) • BB93 • GB/T 19889.7 - 2005 • ISO 10140:2021 • ISO 140-7:1998 • ISO 717-2:1996 • ISO 16283-2:2018 incl. Rooms < 25m3 • ISO 717-2:2020 • ISO 12999-1:2014 • NEN 5077:2019 • SIA181:2006 • SIA181:2020

Results	• ASTM:
	  • ISPL,ISR
	  • RTNISPL,AIIC
	  • ANISPL,NISR
	• ISO:
	  • L'n,w
	  • L'nT,w
	  • Spectrum adaption terms CI

Facade Sound Insulation	
Standards	• ASTM E966 • ASTM E1332 • DIN 4109 • GB/T 19889.5 - 2006 • ISO 140-5:1998 • ISO 717-1:1996 • ISO 16283-3:2016 incl. Rooms < 25m3 • ISO 717-1:2021 • ISO 12999-1:2014 • NEN 5077:2019 • SIA181:2006 • SIA181:2020

Results	• ASTM:
	  • OINR, OINIC
	  • AOITL, AOITC
	• ISO:
	  • Dw
	  • R'45°,w
	  • Dxx,2m,w
	  • Dxx,2m,n,w
	  • Dxx,2m,nT,w
	  • Spectrum adaption terms C, Ctr

Specifications	

Sound Sources	• Airborne Sound Insulation:
	  • Speaker
	• Impact Sound Insulation:
	  • Tapping Machine
	  • Rubber Ball
	• Facade Sound Insulation:
	  • Speaker
	  • Road Traffic
	  • Railway Traffic
	  • Aircraft Traffic

Specifications	
Measurement Uncertainty	In situ standard deviation in accordance with ISO 12999-1 for the standards BB93, DIN 4109, ISO 16283, ISO 10140, NEN 5077 and SIA 181
Reporting	• PDF via PDF-printer • XPS • Copy/paste data into User Reports
Languages	• English, German and Chinese • Report: Czech, Dutch, French, Italian, Korean, Swedish
Operating System	• Windows Vista, 7, 8, x and 10
Licensing	• Install Sound Insulation Option into XL3 Acoustic Analyzer or XL2 Acoustic Analyzer or activate Sound Insulation Reporter 365 online at my.nti-audio.com; this enables the import of measurement data into the Sound Insulation Reporter software • Sound Insulation Reporter can be installed on multiple computers

XL3 Acoustic Analyzer Requirements	• Sound Insulation Bundle that includes:
	  • Sound Insulation Option (permanent)
	  • Optional but not mandatory
	  • Sound Insulation Reporter Software License (permanent)

XL2 Acoustic Analyzer Requirements	• Optional but not mandatory Installed optional Extended Acoustic Pack to measure the reverberation time in 1/3 octave band resolution. • Installed Remote Measurement Option to measure sending and receiving room simultaneously with two connected instruments controlled directly within the Sound Insulation Reporter software.

Order Information	• XL3 Acoustic Analyzer:
	  • Sound Insulation Bundle
	  NTi Audio # 600 000 742
	• XL2 Acoustic Analyzer:
	  • Sound Insulation Option
	  NTi Audio # 600 000 432
	  • Sound Insulation Reporter 365 (annual subscription service)
	  NTi Audio # 600 000 433

All information is subject to change without notice.

2 Measurement with XL3 Acoustic Analyzer

2.1 Measurement Configurations

Sound insulation measurements may be performed in various configurations.

2.1.1 Measurement of Sending- and Receiving Room

The Dodecahedron Speaker Set provides the test signal at continuous sound pressure level for long time; e.g. 1 hour. This supports precise sound insulation readings at measuring the sending and receiving room sequentially. This is the recommended configuration:

Measurement with Sound Insulation Option

Measurements are performed by one person. All measurement data is loaded into Sound Insulation Reporter software after completed measurement

- 1x Dodecahedron Speaker Set;
- 1x XL3 Acoustic Analyzer;
- 1x M2230 Measurement Microphone;
- 1x Sound Insulation Option;
- 1x ASD Cable 5m (alternatively 10m or 20m);
- 1x Mains Power Adapter XL3 Acoustic Analyzer;
- 1x Exel System Case;
- 1x Windows Computer, Laptop or Tablet (to analyze data in Sound Insulation Reporter after completed measurements).

Manual Sequential Measurement

Measurements are performed by one person. All measurement data is loaded into Sound Insulation Reporter software after completed measurement

- 1x Dodecahedron Speaker Set;
- 1x XL3 Acoustic Analyzer;
  - For Reverberation Time measurements using a 1/3 octave filter, the Sound Insulation Option or the Reverberation Time Option is required. Without these options, you can only perform octave measurements, which limits the standards available in the Sound Insulation Reporter.
- 1x M2230 Measurement Microphone;
- 1x ASD Cable 5m (alternatively 10m or 20m);
- 1x Mains Power Adapter XL3 Acoustic Analyzer;
- 1x Exel System Case;
- 1x Windows Computer, Laptop or Tablet (to analyze data in Sound Insulation Reporter after completed measurements).

2.1.2 Simultaneous Measurement in Sending- and Receiving Room

The simultaneous measurement configuration reduces the measurement uncertainty; the noise level is measured in both rooms at the same time. This is the recommended configuration:

Manual Simultaneous Measurement

Measurements are performed by two persons - one in each room. All measurement data is loaded into Sound Insulation Reporter software after completed measurement.

- 1x Dodecahedron Speaker Set;
- 2x XL3 Acoustic Analyzer;
  - For Reverberation Time measurements using a 1/3 octave filter, the Sound Insulation Option or the Reverberation Time Option is required. Without these options, you can only perform octave measurements, which limits the standards available in the Sound Insulation Reporter.
- 2x M2230 Measurement Microphone;
- 2x ASD Cable 5m (alternatively 10m or 20m);
- 2x Mains Power Adapter XL3 Acoustic Analyzer;
- 2x Exel System Case;
- 1x Windows Computer, Laptop or Tablet (to analyze data in Sound Insulation Reporter after completed measurements).

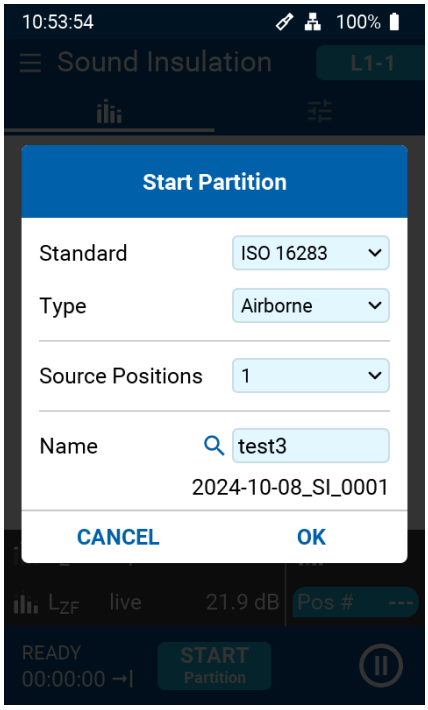
2.2 Measurement with XL3 Acoustic Analyzer Sound Insulation Option

Effective sound insulation is a crucial factor in building design, and the XL3 Acoustic Analyzer provides extensive support for measuring various procedures in the application of building acoustics. This includes:

- Airborne sound insulation;
- Impact sound insulation;
- Facade sound insulation.

Users can access the measurement function by tapping the menu icon in the upper left corner and selecting “Sound Insulation”. The XL3 Acoustic Analyzer allows for continuous recording and display of the individual measurements needed to assess the desired sound attenuation.

2.2.1 Start partition



Tap the button START Partition to start.

> Wear appropriate hearing protection before activating the sound source!

- Standard:
  - ISO 16283;
  - Document E;
  - ASTM.
- Type:
  - Airborne;
  - Impact;
  - Facade.
- Source Positions:
  - 1 to 4.

2.2.2 Page selection by means of page key

Press the page key to toggle between the numerical and spectral display. This change is possible without restriction even during a running measurement.

2.2.3 Page selection via the display

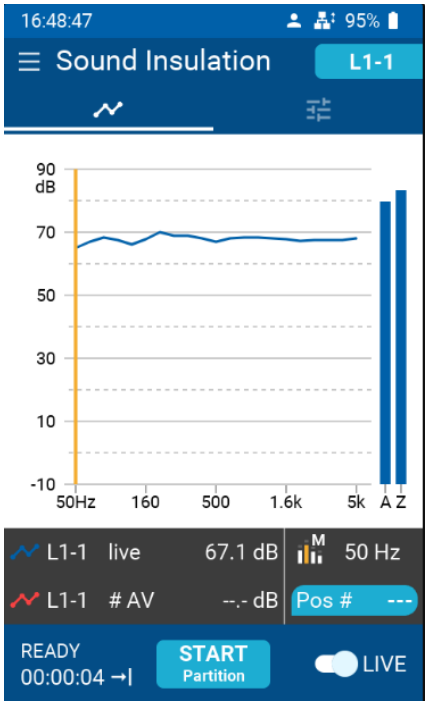
You can also select the desired display with a swiping motion, or by tapping the corresponding icons.

Shows the Sound Insulation measured values and displays the spectral results

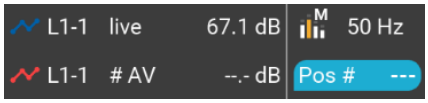
In this menu the sound level meter is configured and the layout of the numerical display can be adjusted. These settings are detailed under Settings display.

L1-1 The menu Select measurement display shows the measurements required for each of the available standards and for each partition. You can complete these measurements in any order, allowing you to import data from previous measurements. This feature helps to save time and optimize a series of measurements.

2.2.4 Spectral display



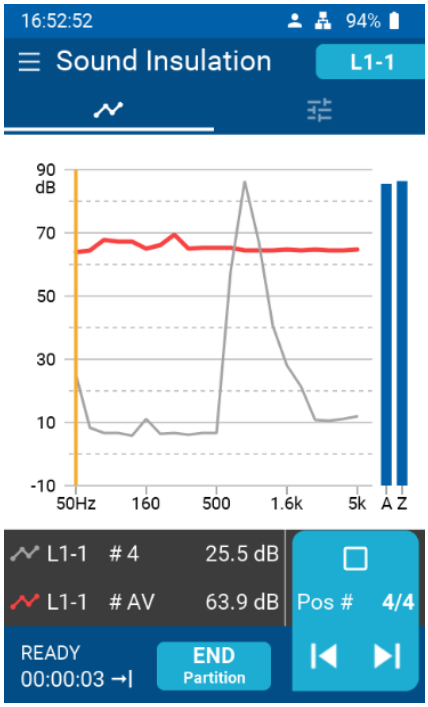
- If you tap on, for example, L1-1, the page displaying the current sound level spectrum in third octave band resolution will appear.
- The display allows to navigate through the single band values of Live and average results using the cursor, arrow keys ← and →;



- Moreover, at any time, you can tap the Pos # 0/0 button at the bottom right to view the measured results up to that point or their average value “AV”;
- Live data LIVE can be switched on and off manually, but no longer interferes when it is switched off.
- To start the measurement, tap the button START Partition .

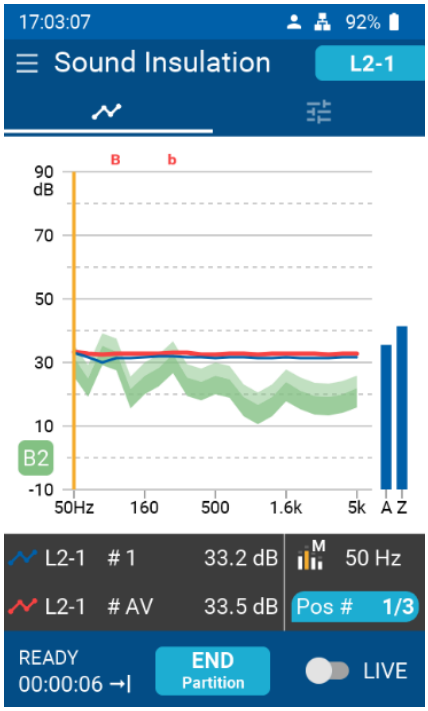
- The average of the active position is shown in red.

> ⚠ When displaying the sending room level, the maximum difference between neighboring bands of the sound soruce are checked acccording the the applied standard. Exceedings are marked with an A .



- When a position is disabled, the result is updated immediately.

> Disabled measurements are indicated as grey in the "Select Measurement" screen L1-1 .

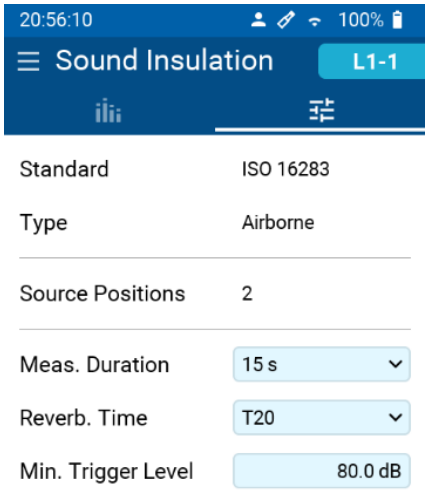


The background noise level B2 is shown in the L2 results screen to allow identifying potential conflicts.

> If an L2 band is less than 6 dB or 10 dB above the corresponding B2 band, it is labelled b or B respectively in the SIR display.

2.2.5 Settings display

To select the desired page, tap the corresponding button at the top right of each page.

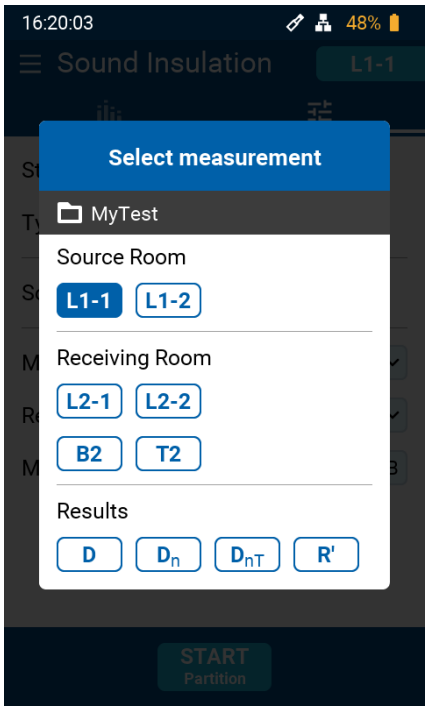


On the "**Settings**" page you can make the following settings:

- SLM measurement duration: 6, 15, 30 or 60 seconds;
- Reverb. Time: T20 or T30;
- Min. Trigger Level: 80 dB.

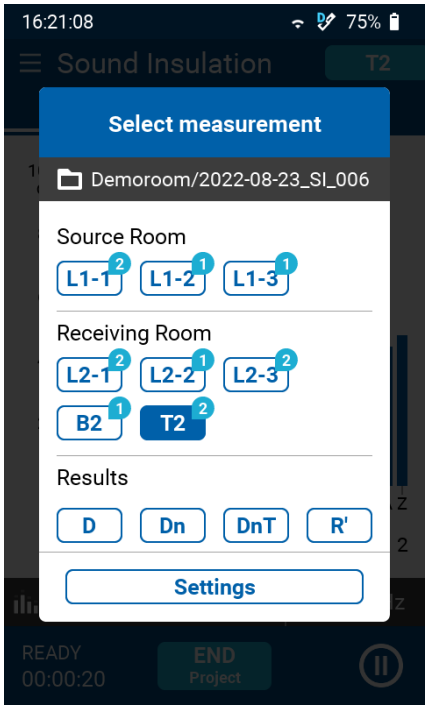
> Select the appropriate settings before starting measurements!

2.2.6 Select measurement display

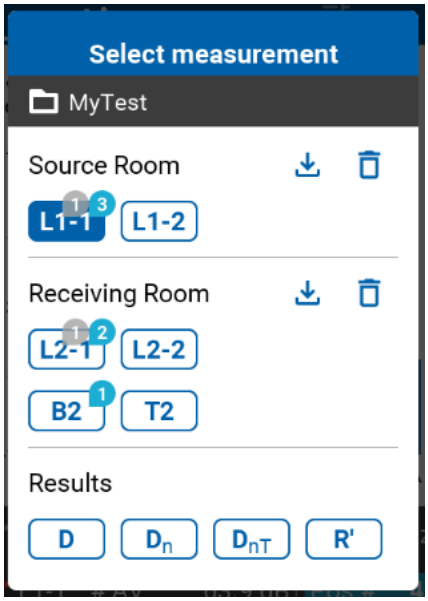


At the "**Select measurement**" page, you may choose the next measurement to be conducted, as well as view the results.

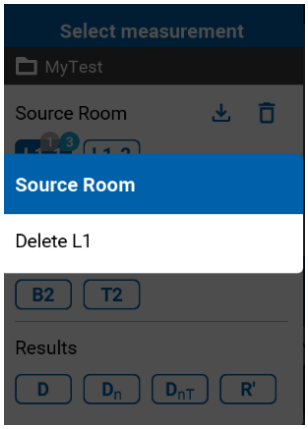
- Transmitting room: L1-x = position of noise source in the transmitting room (number of available positions depends on the afore-mentioned Setting off);
- Receiving Room:
  - L2-x = measuring position in the receiving room (number of available positions depends on the above-mentioned setting off);
  - B2 = Background sound level in the receiving room;
  - T2 = Reverberation time in the receiving room.
- Results: D, Dn, DnT or R';

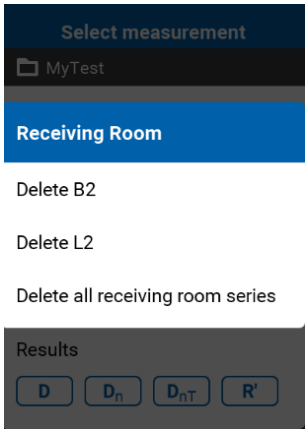


NOTE: During a measurement series, you can check the number of individual measurements taken in the transmitting or receiving room at different sound source positions on the "Select measurement" page.



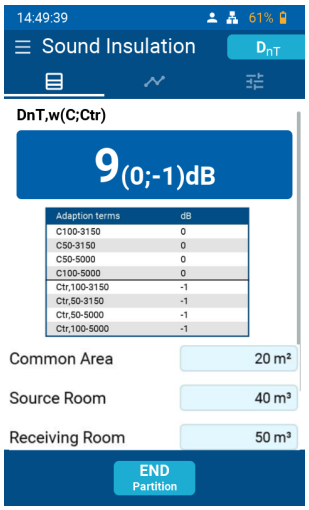
It is possible to exclude individual measurements from the averaging process. This can be done either directly after a faulty measurement or in post-processing.





Active and excluded measurements are clearly indicated in the overview. This ensures that an overview is always maintained.

After tapping on the Result, you can provide the dimensions of the room (e.g., common area (m²), source room (m³), and receiving room (m³)).



2.2.7 Perform sound insulation measurement

The measurement process involves placing the noise source in sending room and measuring parameters in both the sending and receiving rooms. For this purpose, the XL3 Acoustic Analyzer shows on the display, or the sound level spectrum in the sending or receiving room, i.e.:

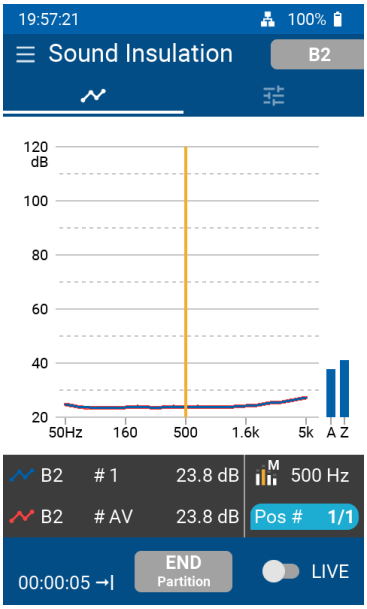
- L1: Level in the sending room;
- L2: Level in the receiving room;

- B2: Background level in the receiving room;
- T2: Reverberation time in the reception room.

2.2.7.1 Background Noise Measurement in the Receiving Room

All measurements can be carried out in the desired order without influencing the final result; however, it is recommended to start with the background level in the receiving room. This initial measurement helps the user understand the appropriate sound level at which the sound source should be set to ensure a good signal-to-noise ratio.

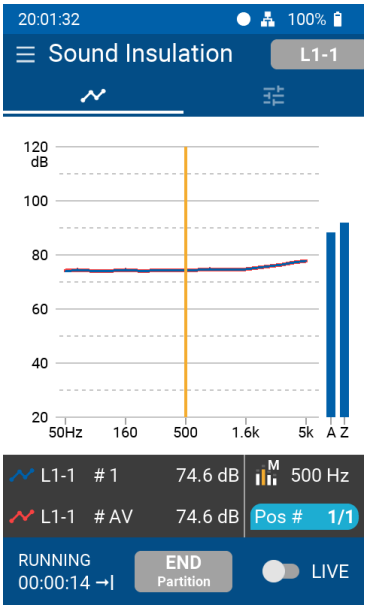
To measure the background sound level B2 in the receiving room (i.e., with the noise source turned off). To do this, select B2 on the "**Select measurement**" page and press the START button.



2.2.7.2 Sound Level Measurement in the Sending Room

Switch on the sound source (e.g. dodecahedron loudspeaker DS3) and move to the desired measurement position. Then, press the START key to initiate the first measurement and wait until it is completed. Move to the next measurement position and press the START key again to start the second (or third, etc.) sound level measurement in the receiving room.

Once you have taken enough individual measurements for L1-1, press the STOP key.



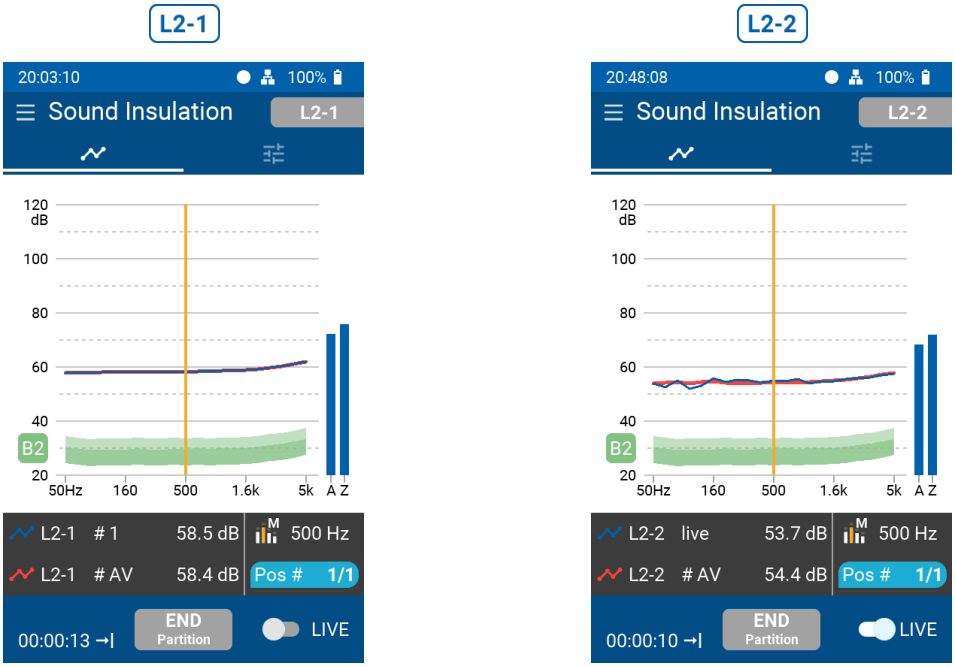
2.2.7.3 Sound Level Measurement in the Receiving Room

Proceed to the L2 receiving room and choose L2-1 located on the "**Select measurement**" page. Activate the sound source (which is still placed at position #1 in the transmitting room) and press the START button to initiate the initial sound level measurement in the receiving room.

Proceed with conducting the remaining measurements in the receiving room for the data set L2-1 and then press the STOP button.

Select L2-2 on the "**Select measurement**" page and position the noise source in the transmitter room at position #2.

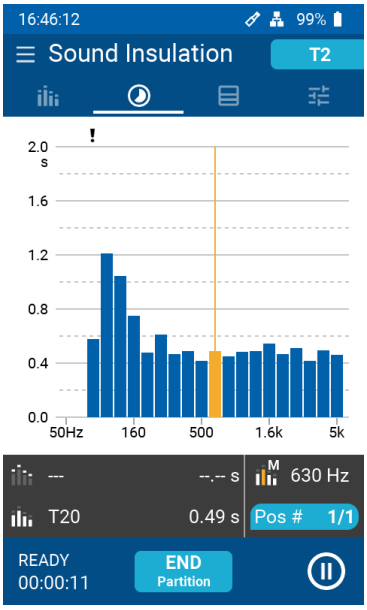
Repeat the aforementioned measurements in both the transmit and receive rooms for noise source position #2. Repeat this process until all L1-x and L2-x measurements for different noise source positions in the sending room are completed.



2.2.7.4 Reverberation Time Measurement in the Receiving Room

Now position the dodecahedron loudspeaker in the receiving room to determine the reverberation time T2. Choose T2 on the "**Select measurement**" page. Press the START button to commence the reverberation time measurement and toggle the speaker On and Off multiple times. Then press the STOP button.

Conclude the measurement series by first pressing the STOP button and then tapping END Partition.

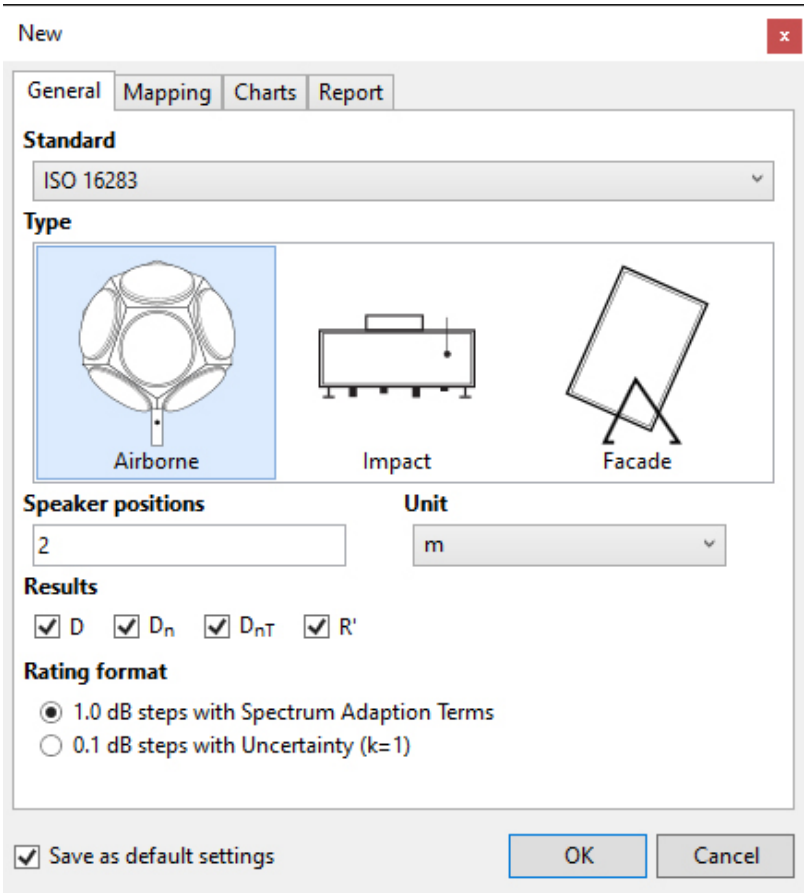


You can now review the measurement results D, Dn, DnT, or R' individually by pressing the corresponding button under "**Results**".

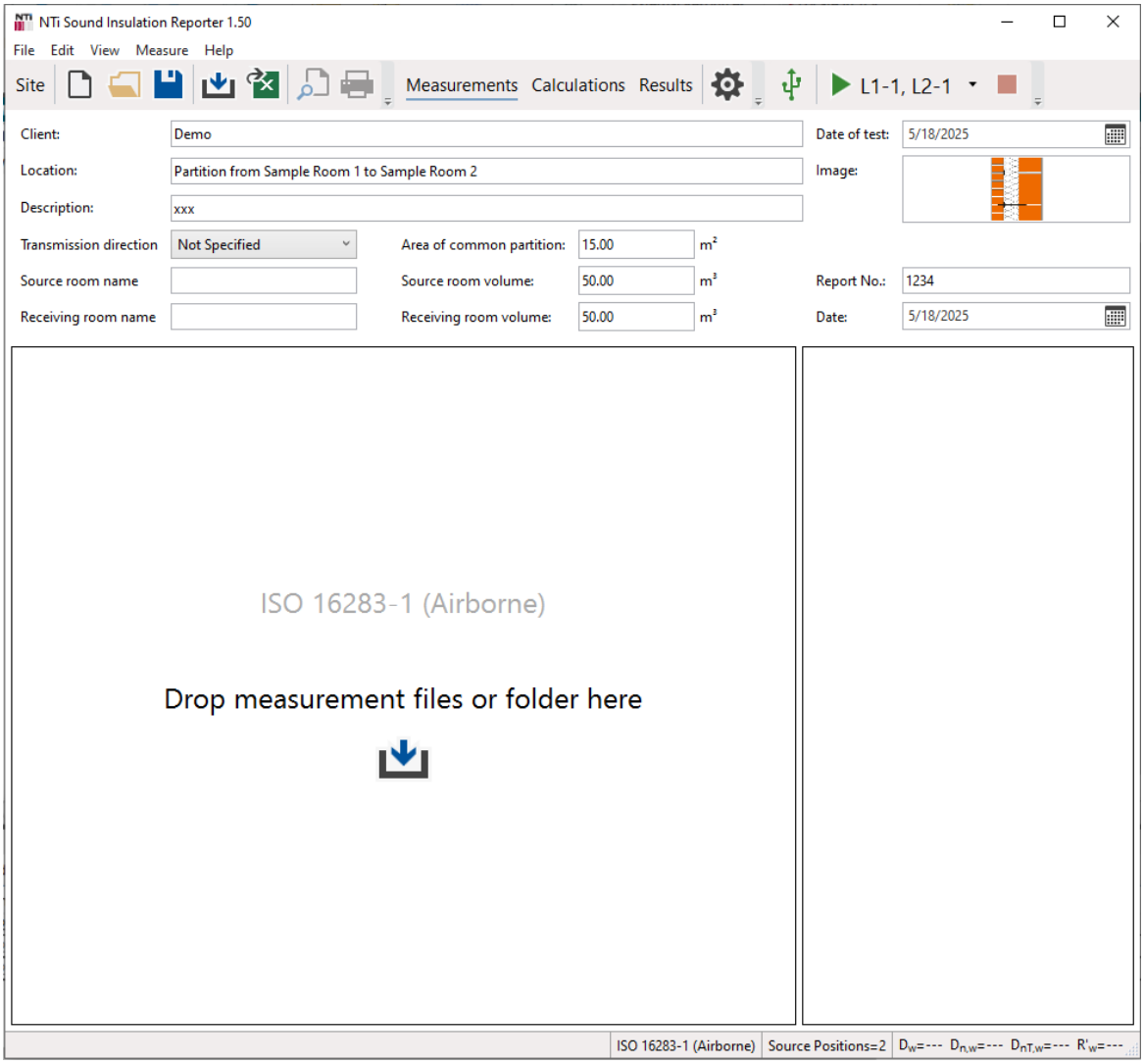
2.2.8 Data Import

The XL3 Acoustic Analyzer measurement data may be imported into the software by drag and drop. The minimum requirement for a successful data import is an XL3 with firmware V1.46 or higher and activated Sound Insulation Option. The Sound Insulation Reporter software verifies the available option online during the data import. Any recorded data with A- or C-weighting is automatically corrected to Z-weighting (=no weighting).

- Start the Sound Insulation Reporter software;
- Click on **File** -> **New**;



- Select your requested **Standard**;
- Select **Airborne**, **Impact** or **Facade Sound Insulation**;
- Select the number of **Speaker positions** used;
- Select **Unit;**
- Define the required **Results;**
- Select the preferred **Rating Format**. Choose either Dw(C;Ctr) = 41 (-1;-3) dB or Dw = 40.5 dB +/- 0.9 dB;
- Confirm with **OK**.



The measurement view with the message "Drop measurement files or folder here" is displayed.

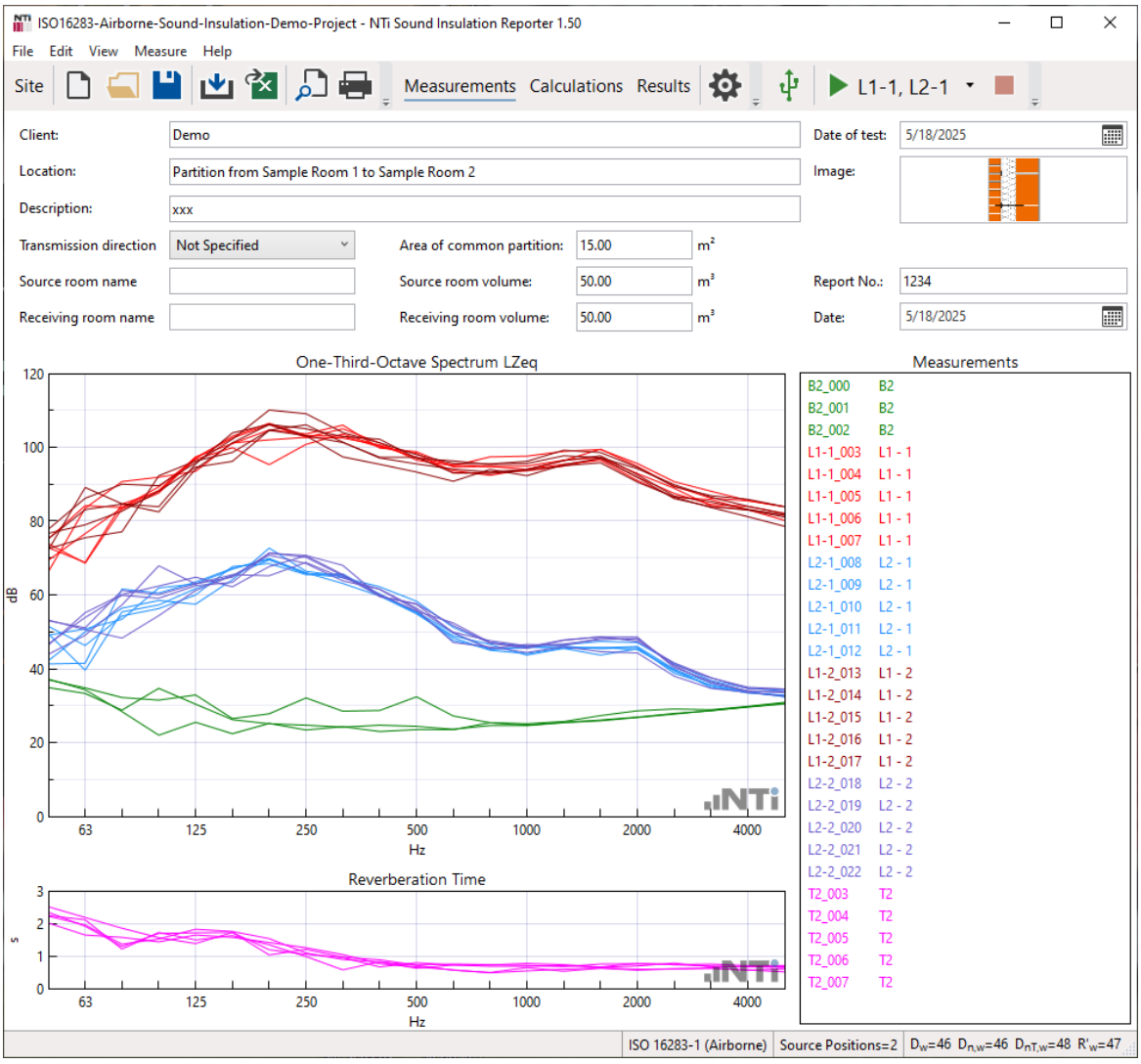
Kindly ensure, prior the data import, that the partition folder contains all required measurement data (*.txt) and *,xl3si system files of each recorded measurement.

- **Site View**:
  - Drag and drop the complete partition folder from the XL3 Acoustic Analyzer memory card into the field **Drop measurement files or folder here**. The partition folder should include the noise spectrum data, the reverberation time data and the *,xl3si system files.

- **New Partition**:
  - Drag and drop the supported files directly into the **Drop measurement files or folder here** field.

    > The supported files for drag and drop in New Partition are .xl3 and .zip;

  - You can also click on **Import** in the main window and select the partition folder. Confirm the selection;
  - Alternatively, click on **File -> Import** and select the folder or single/multiple data files. Confirm the selection.



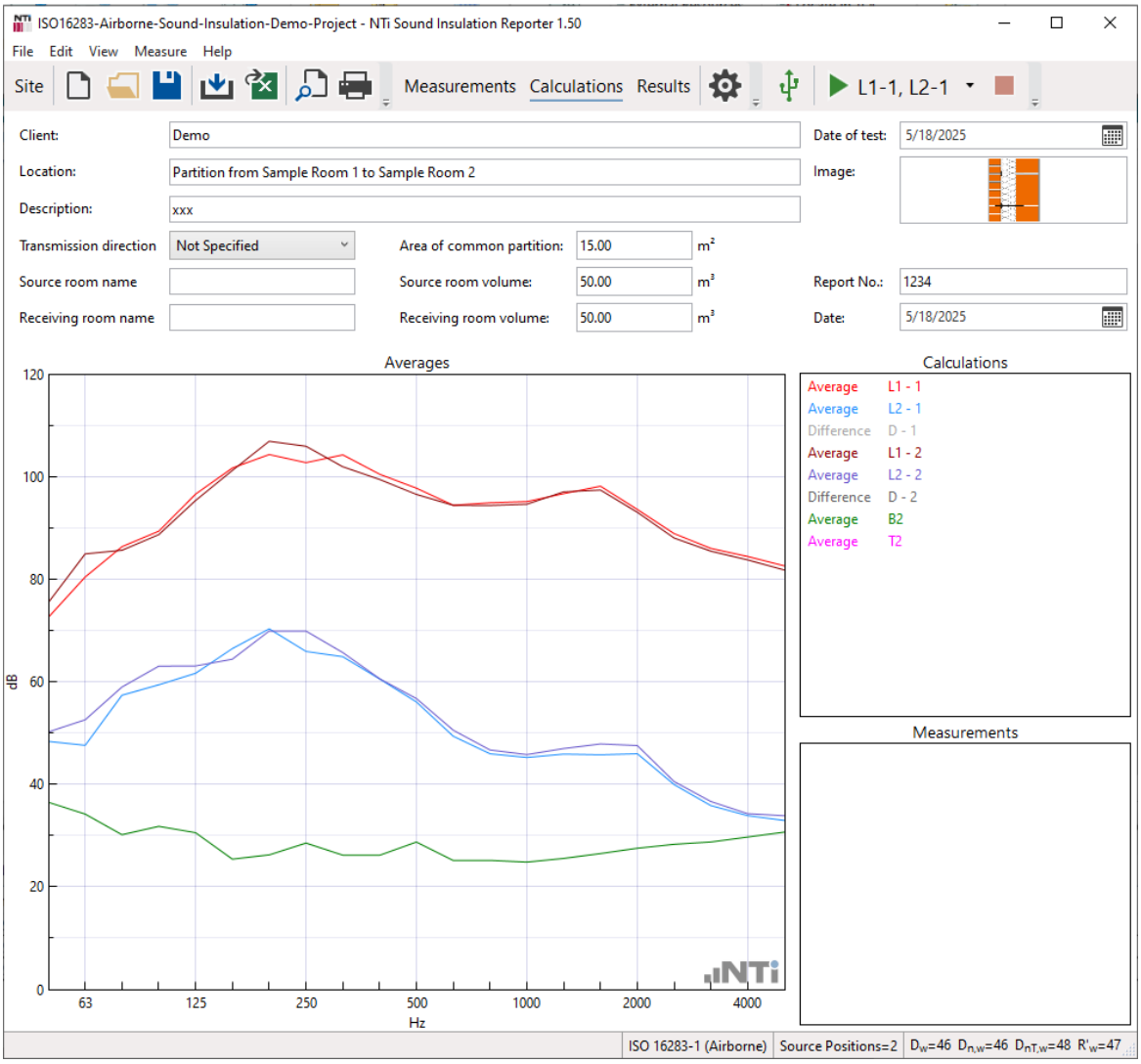
> The measurement data is imported.

All measurement data with mapping information in the file name are assigned automatically by the software, e.g, "L1-1_SLM_001_RTA_3rd_Report.txt" is assigned to L1-1 (=speaker position 1 in the sending room). Alternatively, the mapping may be assigned manually to sending room or receiving room and the individual speaker positions:

- Select the measurement with the mouse;
- Click on the right mouse button;
- Select **Assign To**;
- Assign the measurement;
- Verify the measurement data and delete any false readings from the **Measurements** list on the right.

2.2.9 Measurement Report

- Select **View -> Calculations** in the menu;
- Verify the individual averaged results.

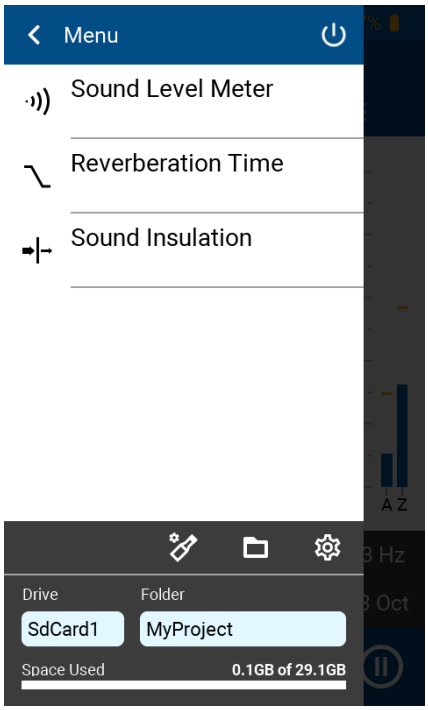


- Select the **View -> Results**,

The sound insulation data and chart are displayed.

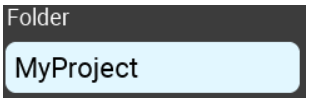
2.3 Manual Measurement with XL3 Acoustic Analyzer

2.3.1 Preparing your XL3 Acoustic Analyzer for Manual Measurements

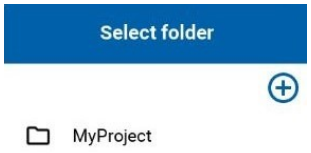


- **Access System Settings**: Tap the Menu Icon and go to System Settings ;
- **Set Save Option**: In General , set "**Save**" to "**manually**";

- **Create or Select Folder**: Tap "Folder" to create a new folder or choose an existing one.



  - To create a new folder, tap the option for creating.

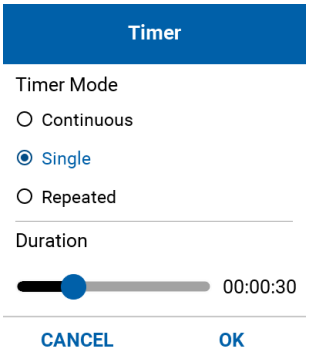


2.3.2 Perform Noise Spectrum Measurements

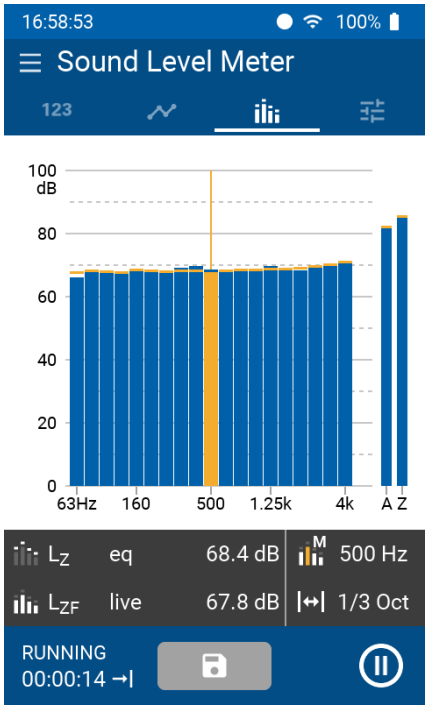
- **Choose Sound Level Meter:** To activate the sound level meter mode, tap the Menu Icon in the upper left corner and then tap "**Sound Level Meter**";
- **Check Logging Settings:** In the Settings menu , go to Report & Logging and make sure the Logging Interval is set to "**off**";
- **Select Spectral Display:** Choose the Spectral Display option.

- **Set Frequency Weighting:** Make sure "**Z**" frequency weighting is selected.

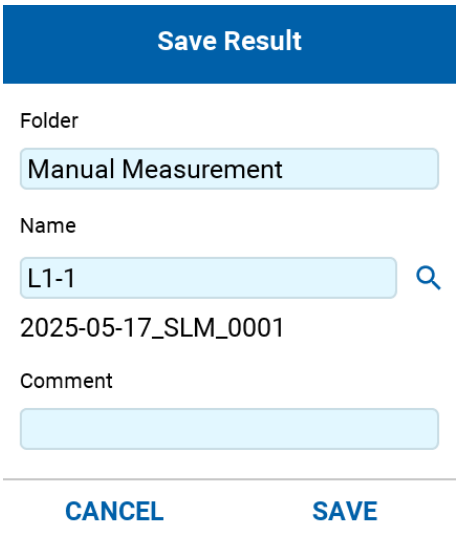
  Set Timer: Choose the Timer Mode option as "**Single**" and set the duration you want, like 30 seconds.



  - To access Timer mode, before starting a measurement, you must tap the "**READY**" icon.



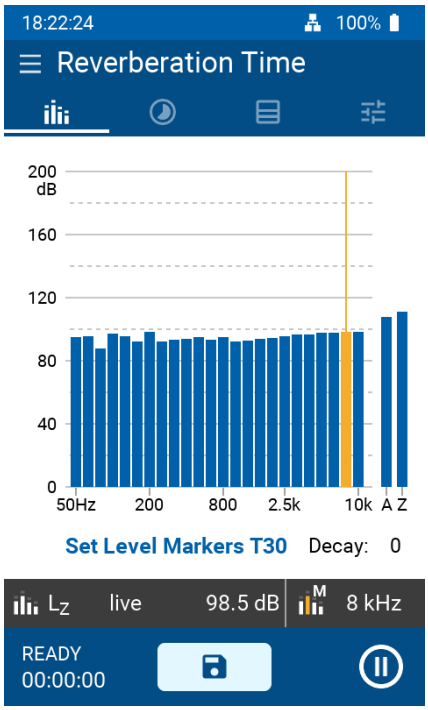
- **Start the Measurement**;
- **Save the Measurement:** After the measurement, save the file by tapping on  .
  - You can use names like L1-1, L1-2, L2-1, L2-2, B2.



2.3.3 Perform Reverberation Time Measurements

- **Choose Reverberation Time**: To activate the Reverberation Time mode, tap the Menu Icon in the upper left corner, then select "Reverberation Time".

> For Reverberation Time measurements using a 1/3 octave filter, the Sound Insulation Option or the Reverberation Time Option is required. Without these options, you can only perform octave measurements, which limits the standards available in the Sound Insulation Reporter.

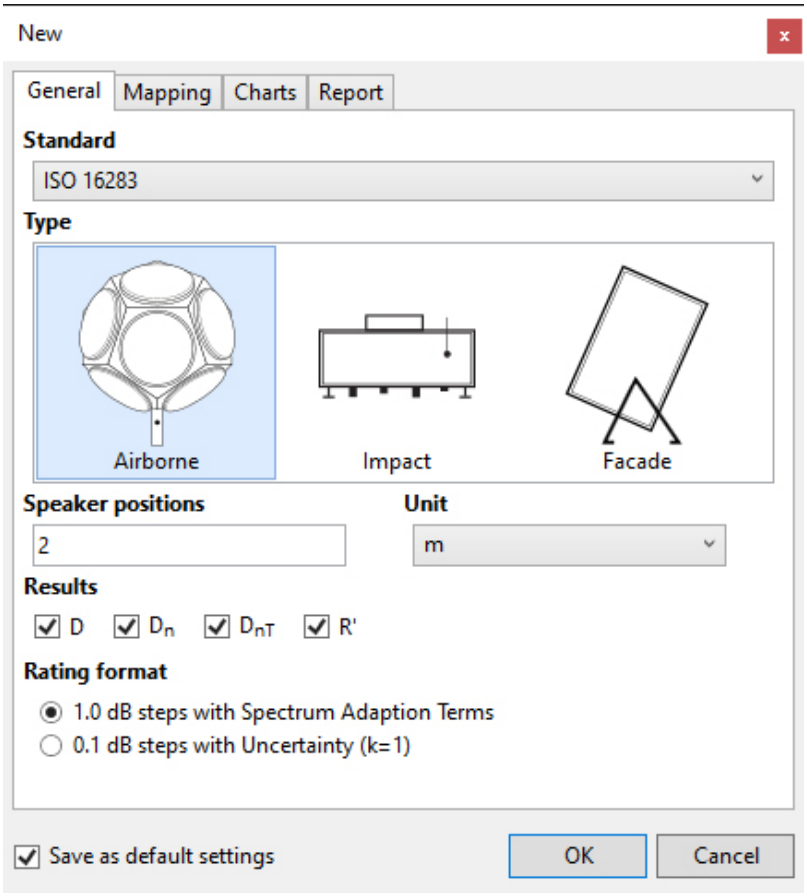


- **Start the Measurement**;
- **Stop the Measurement**;
- **Save the Measurement**: After the measurement, save the file by tapping on .
  - **Suggestion**: Use the name T2.

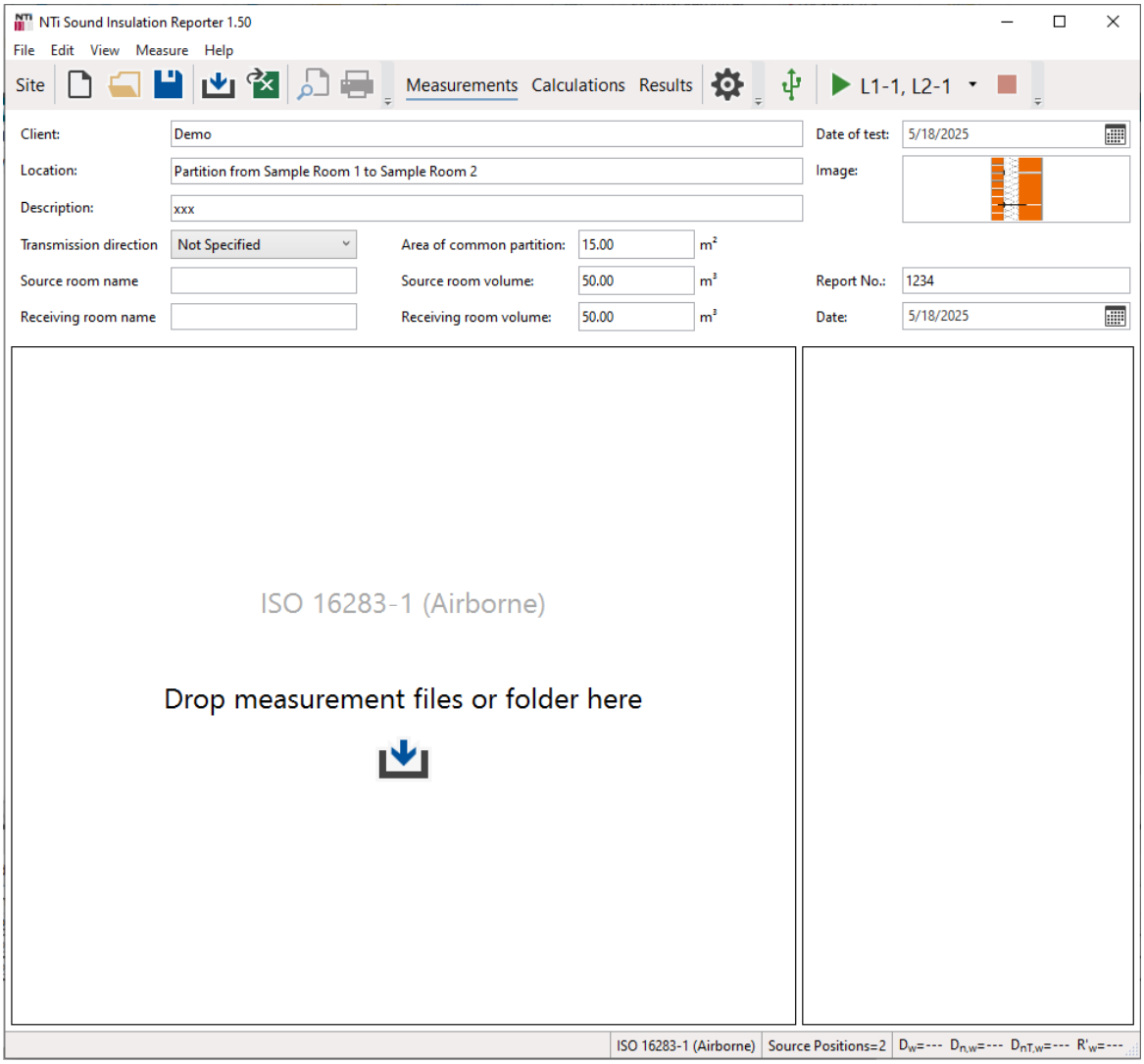
2.3.4 Data Import

The XL2 Acoustic Analyzer measurement data may be imported into the software by drag and drop. The minimum requirement for a successful data import is an XL2 with firmware V4.03 or higher and activated Sound Insulation Option. Instruments using an older firmware may benefit from the online activation of the option without installation on the device. The Sound Insulation Reporter software verifies the available option online during the data import. Any recorded data with A- or C-weighting is automatically corrected to Z-weighting (=no weighting).

- Start the Sound Insulation Reporter software;
- Click on **File** -> **New**;



- Select your requested **Standard**;
- Select **Airborne**, **Impact** or **Facade Sound Insulation**;
- Select the number of **Speaker positions** used;
- Select **Unit;**
- Define the required **Results;**
- Select the preferred **Rating Format**. Choose either Dw(C;Ctr) = 41 (-1;-3) dB or Dw = 40.5 dB +/- 0.9 dB;
- Confirm with **OK**.



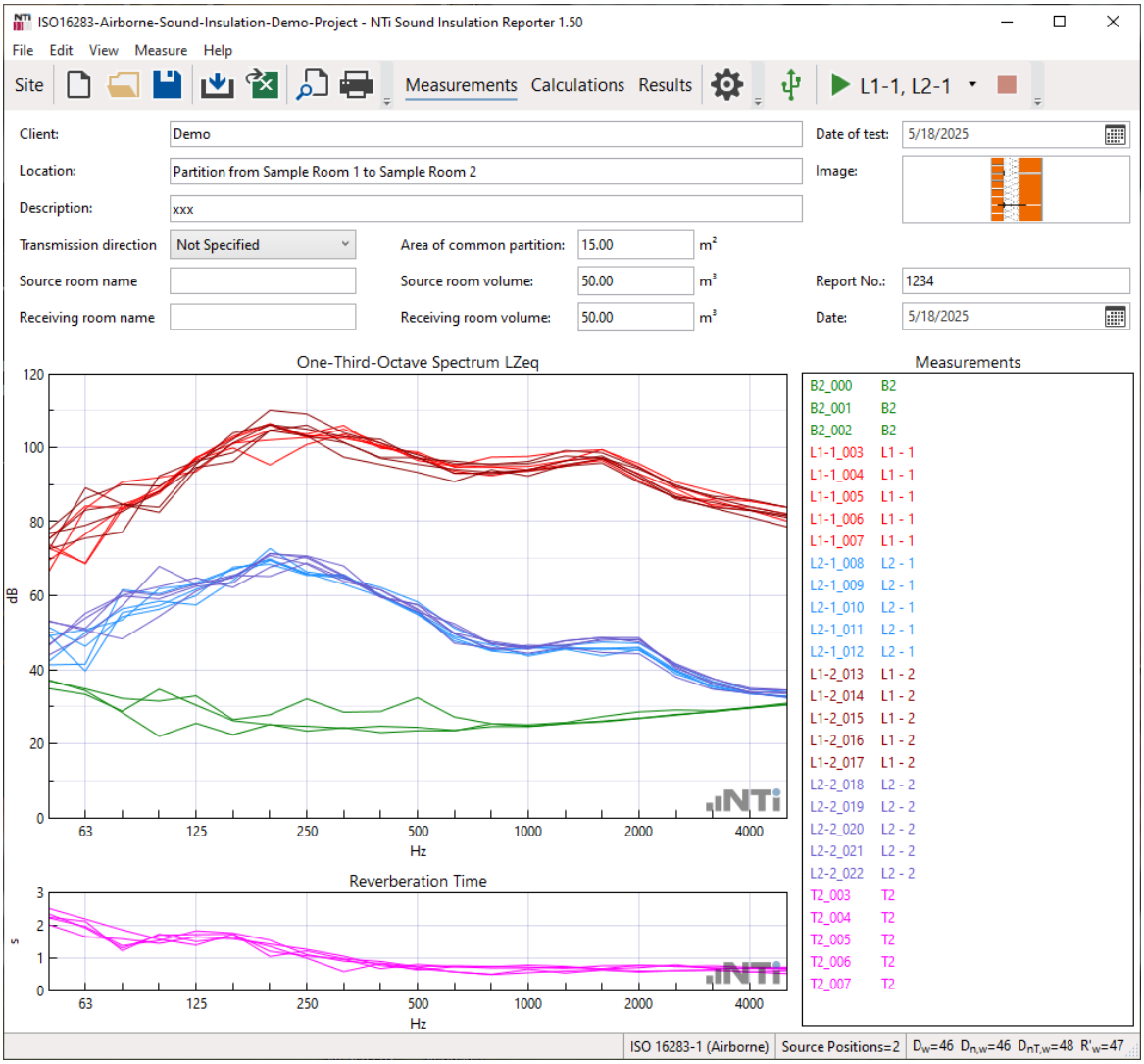
The measurement view with the message "Drop measurement files or folder here" is displayed.

Kindly ensure, prior the data import, that the partition folder contains all required measurement data (*.txt) and *,xl2 system files of each recorded measurement.

- Drag and drop the complete partition folder from the XL2 Acoustic Analyzer memory card into the field **Drop measurement files or folder here**. The partition folder should include the noise spectrum data, the reverberation time data and the *,xl2 system files.

Sound Insulation Reporter offers further possibilities to import measurement data:

- Select all *.xl2 files in the partition folder with all measurement data. Drag and drop the data into the **Drop measurement files or folder here** field;
- Click on **Import** in the main window and select the partition folder. Confirm the selection;
- Click on **File -> Import** and select the folder, single or multiple data files. Confirm the selection.



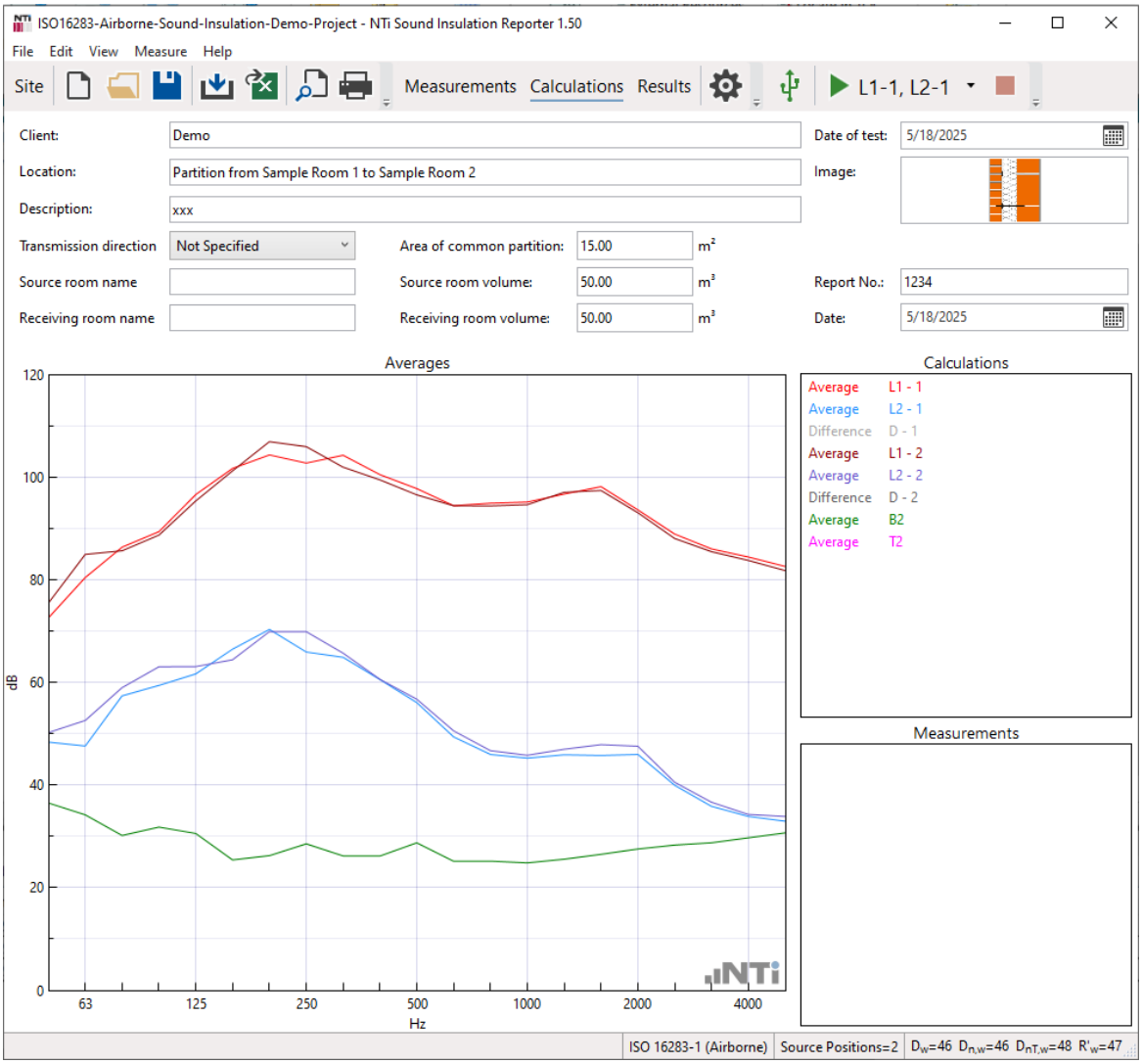
The measurement data is imported.

All measurement data with mapping information in the file name are assigned automatically by the software, e.g, "L1-1_SLM_001_RTA_3rd_Report.txt" is assigned to L1-1 (=speaker position 1 in the sending room). Alternatively, the mapping may be assigned manually to sending room or receiving room and the individual speaker positions:

- Select the measurement with the mouse;
- Click on the right mouse button;
- Select **Assign To**;
- Assign the measurement;
- Verify the measurement data and delete any false readings from the **Measurements** list on the right.

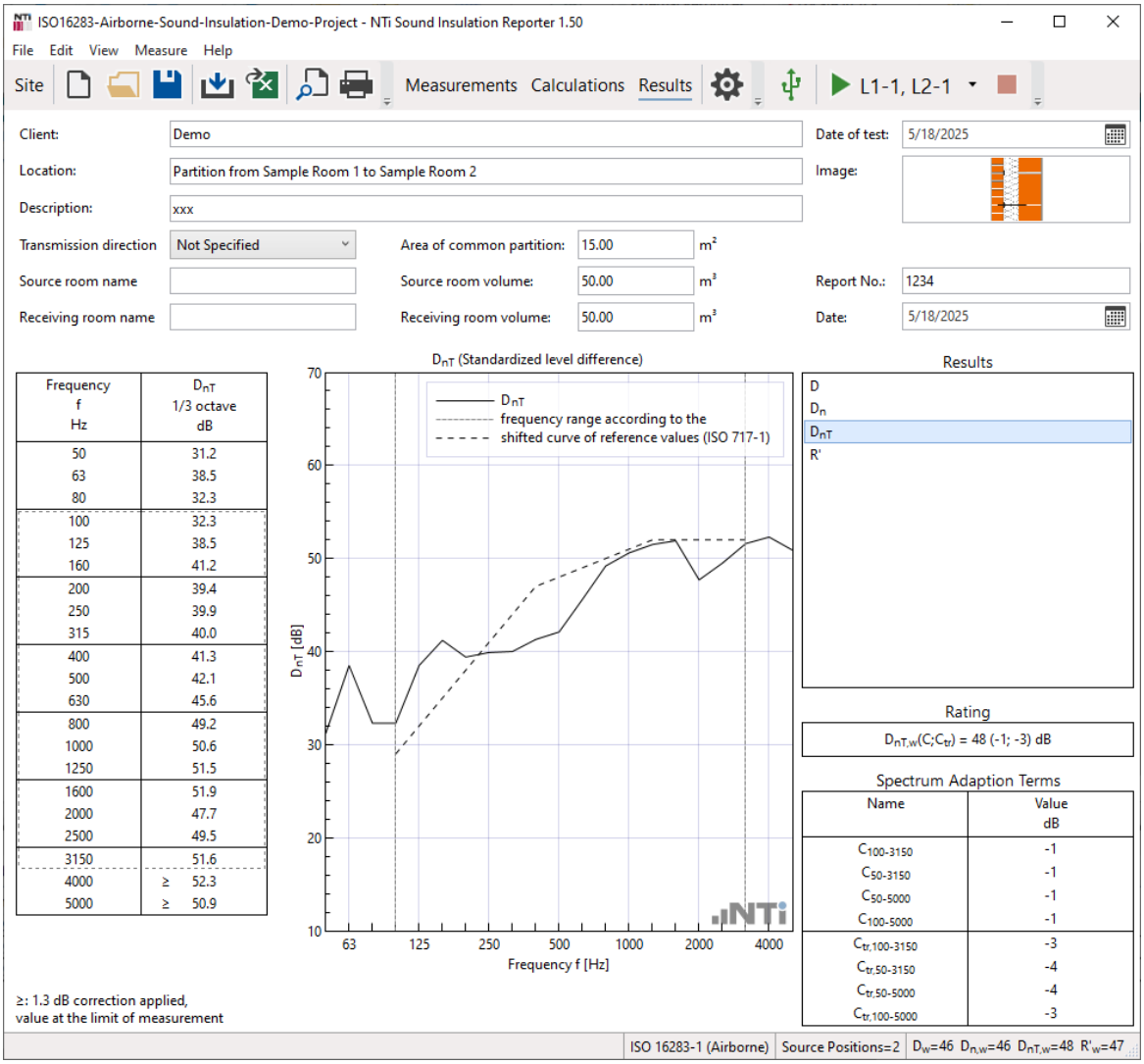
2.3.5 Measurement Report

- Select **View -> Calculations** in the menu;
- Verify the individual averaged results.



- Select the **View -> Results**,

The sound insulation data and chart are displayed.



- Complete the header data with information about client, object, description, partition area and room volumes;
- Print the sound insulation report.

Congratulations, your report is completed!

3 Manual Measurement with XL2 Acoustic Analyzer

3.1 Measurement Configurations

Sound insulation measurements may be performed in various configurations.

3.1.1 Sequential Measurement of Sending- and Receiving Room

The Dodecahedron Speaker Set provides the test signal at continuous sound pressure level for long time; e.g. 1 hour. This supports precise sound insulation readings at measuring the sending and receiving room sequentially. These are the recommended configurations:

Manual Sequential Measurement

Measurements are performed by one person. All measurement data is loaded into Sound Insulation Reporter software after completed measurement with XL2 Acoustic Analyzer.

- 1x Dodecahedron Speaker Set;
- 1x XL2 Acoustic Analyzer;
- 1x M2230 Measurement Microphone;
- 1x Extended Acoustic Pack;
- 1x Sound Insulation Option;
- 1x ASD Cable 5m (alternatively 10m or 20m);
- 1x Mains Power Adapter XL2 Acoustic Analyzer;
- 1x Exel System Case;
- 1x Windows Computer, Laptop or Tablet (to analyze data in Sound Insulation Reporter after completed measurements).

3.1.2 Simultaneous Measurement in Sending- and Receiving Room

The simultaneous measurement configuration reduces the measurement uncertainty; the noise level is measured in both rooms at the same time. These are the recommended configurations:

Manual Simultaneous Measurement

Measurements are performed by two persons - one in each room. All measurement data is loaded into Sound Insulation Reporter software after completed measurement.

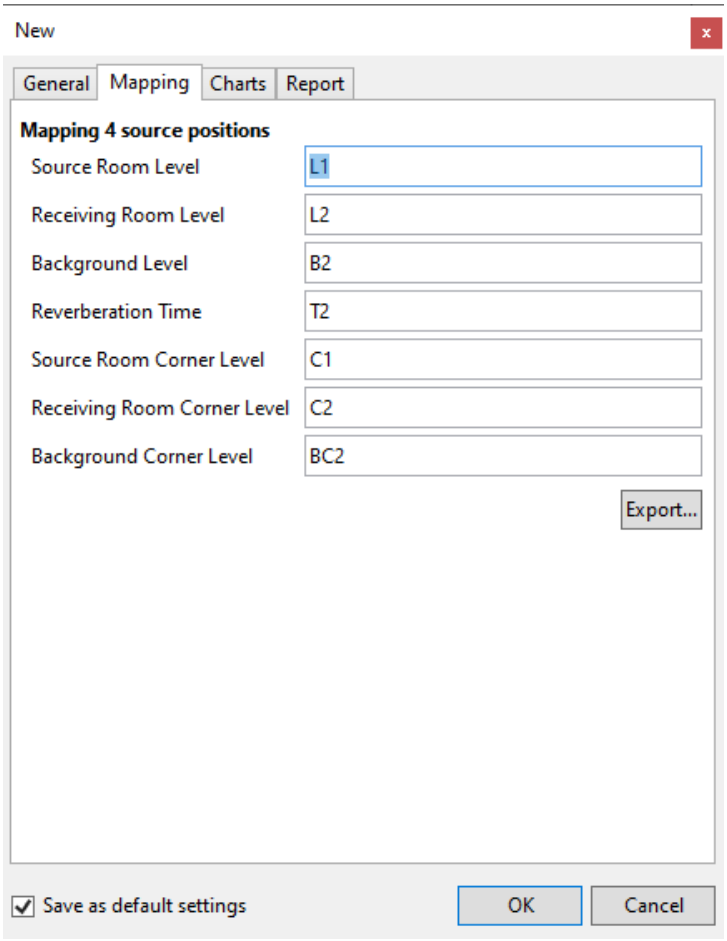
- 1x Dodecahedron Speaker Set;
- 2x XL2 Acoustic Analyzer;
- 2x M2230 Measurement Microphone;
- 2x Extended Acoustic Pack;
- 2x Sound Insulation Option;
- 2x ASD Cable 5m (alternatively 10m or 20m);
- 2x Mains Power Adapter XL2 Acoustic Analyzer;
- 2x Exel System Case;
- 1x Windows Computer, Laptop or Tablet (to analyze data in Sound Insulation Reporter after completed measurements).

3.2 Manual Measurement with XL2 Acoustic Analyzer

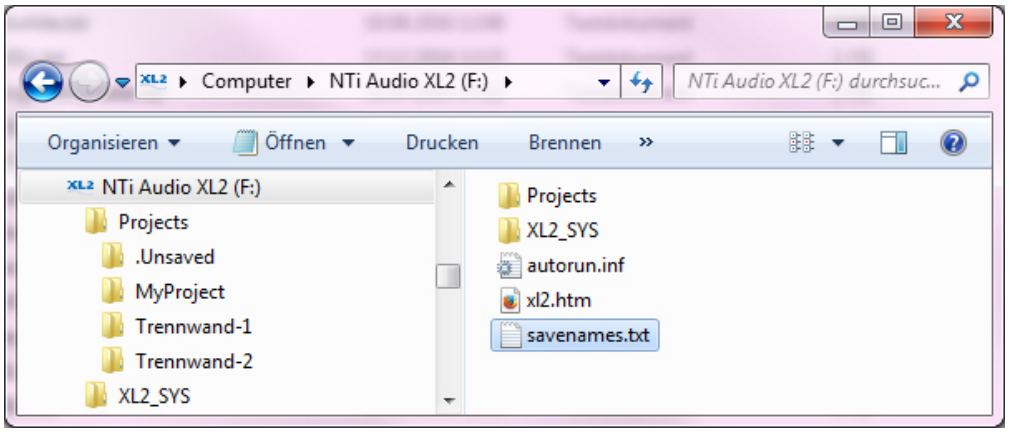
3.2.1 Mapping File for XL2 Acoustic Analyzer

The measurement task onsite is made up of a several separate measurements. The XL2 Acoustic Analyzer may assign each of these measurements with a dedicated mapping, e.g. “L1-1” for the readings taken in the sending room with speaker position 1. This feature supports automated post-processing and reporting in the Sound Insulation Reporter software.

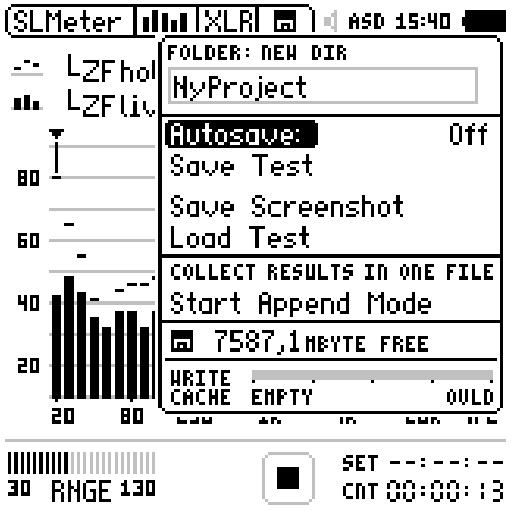
- Load the text file “savenames.txt” with the user defined mapping, such as “L1-1”, “L1-2”,..., into the root directory of the XL2 Acoustic Analyzer. The text file “savenames.txt” may be generated by the Sound Insulation Reporter software:
  - Click on **Settings**;
  - Select the tab **Mapping**;
  - Click **Export**,



- Load the txt-file “savenames.txt” with the various mappings onto the root directory of the XL2 Acoustic Analyzer,



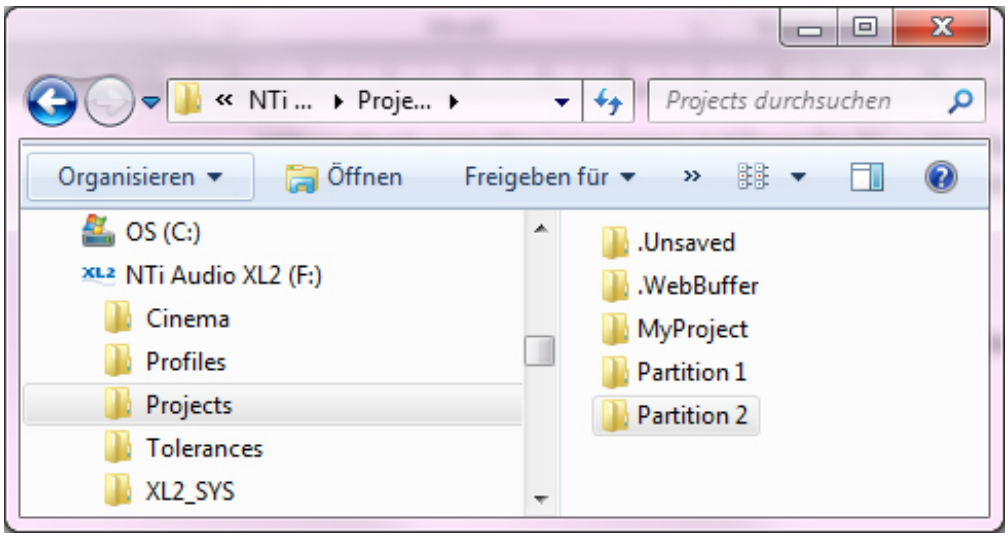
- Next select “Autosave: Off” in the XL2 Acoustic Analyzer memory menu. This allows you to store each individual measurement with the desired mapping. The XL2 Acoustic Analyzer then uses the same mapping for subsequent measurements by default.



3.2.2 Set XL2 Acoustic Analyzer Memory Structure for Multiple Partitions

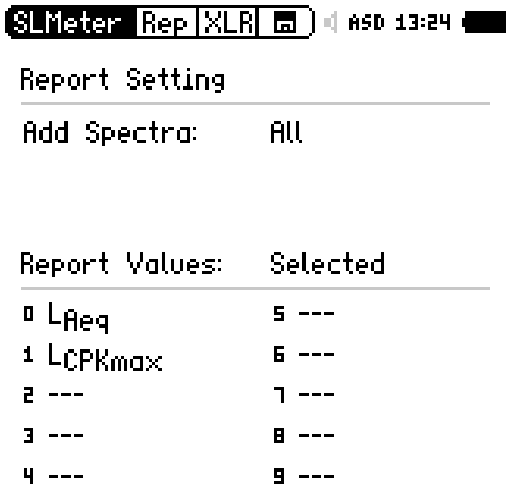
In applications with multiple partitions, it is recommended to use a separate memory folder on the XL2 Acoustic Analyzer for each partition. All measurements belonging to a single partition are then stored in the same folder on the XL2 Acoustic Analyzer memory card. Measurements belonging to multiple partitions can be later copied into the individual partition folders on the computer. Each partition will be an individual project later on in the Sound Insulation Reporter software.

- Connect the XL2 Acoustic Analyzer to the computer and select “Mass Storage”;
- Open the folder “Projects”;
- Generate new subfolders for each partition, e.g. Partition 1, Partition 2, PartitionRoom 1-2, ...



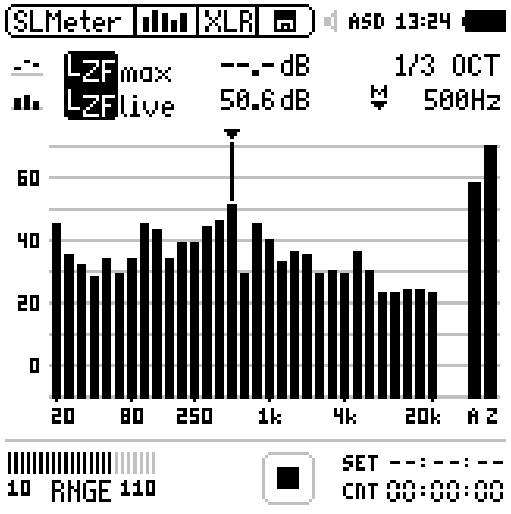
3.2.3 Instrument Settings

- A dedicated profile for Sound Insulation Testing is available for download here. This includes all required instrument settings for successful measurements. Importing the profile into your Sound Level Meter is described in the XL2-Manual; search for “Import MyProfile from PC”;
- Alternatively, you can configure the XL2 Acoustic Analyzer manually. Set the reporting to **Add Spectra: All**. No specific settings for the broadband report levels are required (**Report Values**) - these levels are not required for sound insulation testing.

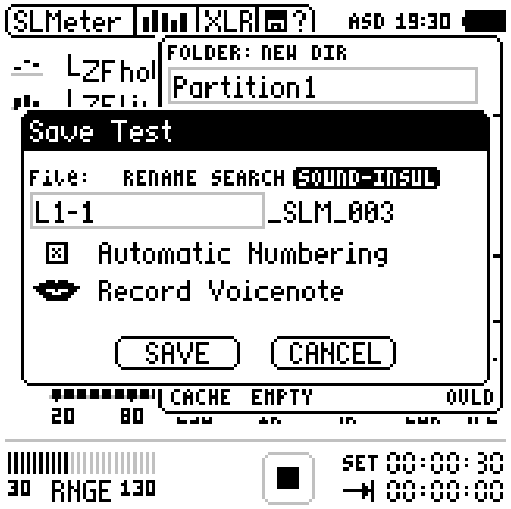


3.2.4 Perform Noise Spectrum Measurements

- Select the SLMeter measurement function on the XL2 Acoustic Analyzer;
- Select the RTA screen and 1/3 octave resolution measurements;
- Ensure the frequency weighting "Z" is selected (= no weighting);
- Start the measurement (hint: best use the single timer setting);
- Stop the measurement after 15 seconds;



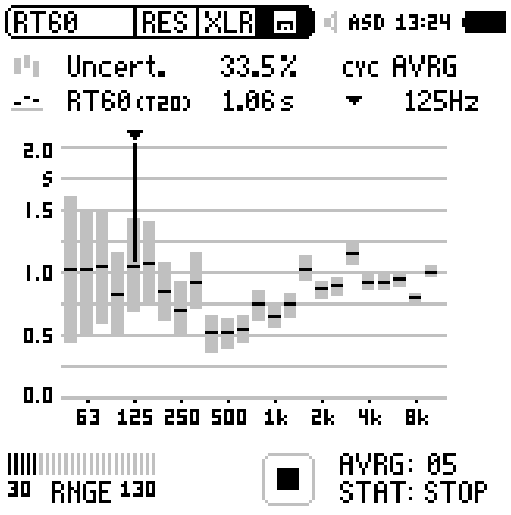
- Open the memory menu and select “Save Test”;
- The XL2 Acoustic Analyzer displays the Save Test pop-up; select “Sound-Insul” at the right end of the first line;



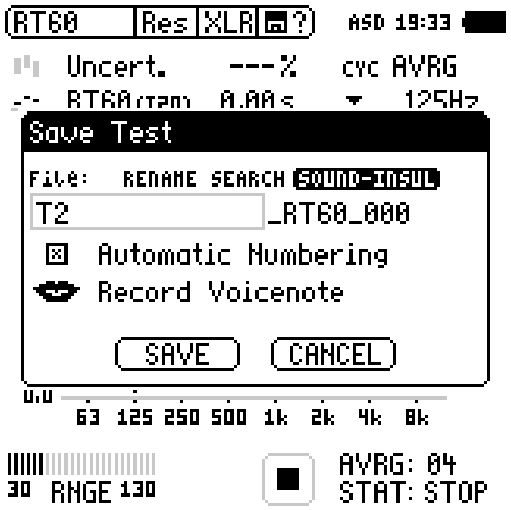
- Select the applicable mapping;
- Confirm your selection with the enter key and save the measurement. The XL2 Acoustic Analyzer saves the measurement data with a file name such as “L1-1_SLM_003_RTA_3rd_Report.txt”;
- Continue with the further measurements "L1-2..., etc.” in the same manner.

3.2.5 Perform Reverberation Time Measurements

- Select the RT60 measurement function on the XL2 Acoustic Analyzer;
- Select 1/3 octave resolution (requires the optional Extended Acoustic Pack pre-installed in the XL2 Acoustic Analyzer);
- Start the measurement;
- Stop the measurement;



- Open the memory menu and select “Save Test”;
- The XL2 Acoustic Analyzer displays the Save Test pop-up; select “Sound-Insul” at the right end of the first line;

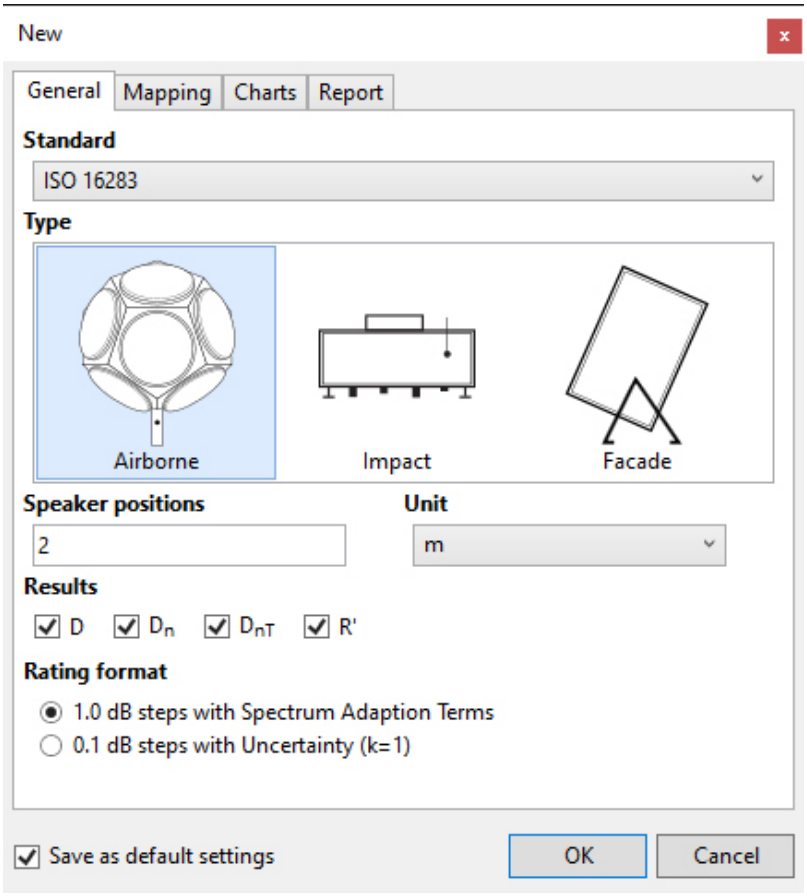


- Select the applicable mapping;
- Confirm your selection with the enter key and save the measurement. The XL2 Acoustic Analyzer saves the measurement data with a file name such as “T2_RT60_000_ Report.txt”;
- Continue with the further measurements in the same manner.

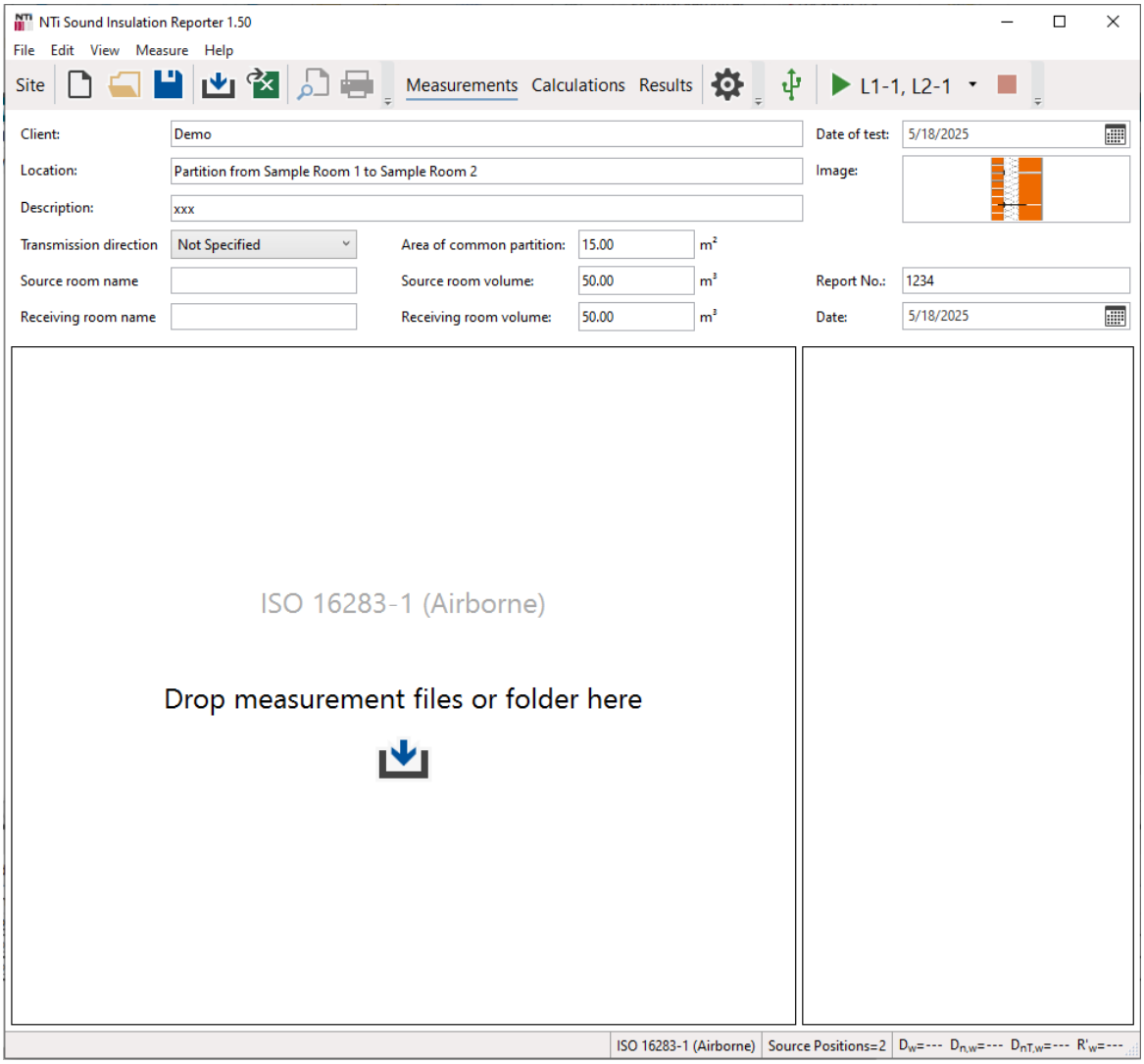
3.2.6 Data Import

The XL3 Acoustic Analyzer measurement data may be imported into the software by drag and drop. The minimum requirement for a successful data import is an XL3 with firmware V1.46 or higher and activated Sound Insulation Option. The Sound Insulation Reporter software verifies the available option online during the data import. Any recorded data with A- or C-weighting is automatically corrected to Z-weighting (=no weighting).

- Start the Sound Insulation Reporter software;
- Click on **File** -> **New**;



- Select your requested **Standard**;
- Select **Airborne**, **Impact** or **Facade Sound Insulation**;
- Select the number of **Speaker positions** used;
- Select **Unit;**
- Define the required **Results;**
- Select the preferred **Rating Format**. Choose either Dw(C;Ctr) = 41 (-1;-3) dB or Dw = 40.5 dB +/- 0.9 dB;
- Confirm with **OK**.



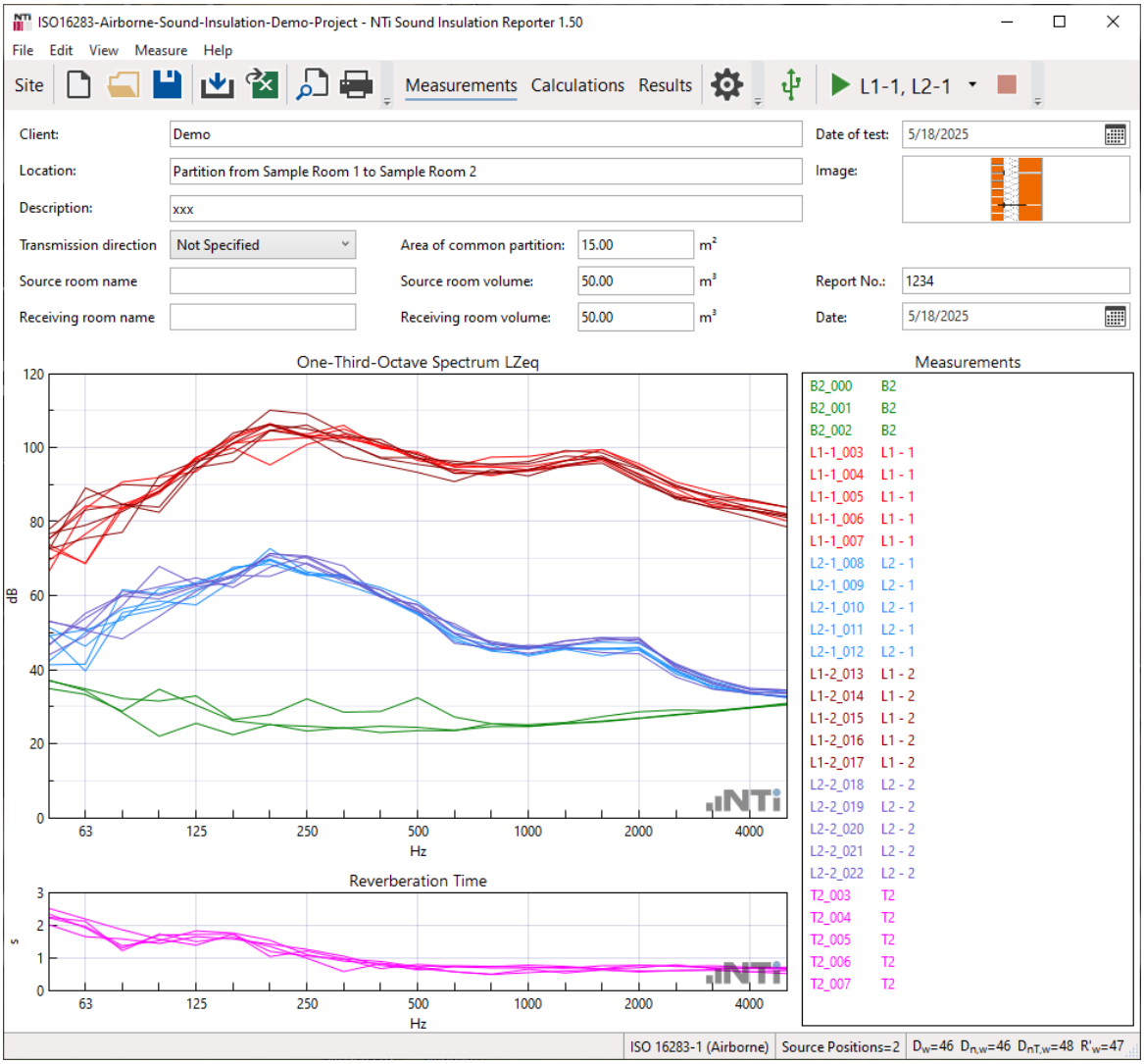
The measurement view with the message "Drop measurement files or folder here" is displayed.

Kindly ensure, prior the data import, that the partition folder contains all required measurement data (*.txt) and *,xl2 system files of each recorded measurement.

- Drag and drop the complete partition folder from the XL2 Acoustic Analyzer memory card into the field **Drop measurement files or folder here**. The partition folder should include the noise spectrum data, the reverberation time data and the *,xl2 system files.

Sound Insulation Reporter offers further possibilities to import measurement data:

- Select all *.xl2 files in the partition folder with all measurement data. Drag and drop the data into the **Drop measurement files or folder here** field;
- Click on **Import** in the main window and select the partition folder. Confirm the selection;
- Click on **File -> Import** and select the folder, single or multiple data files. Confirm the selection.



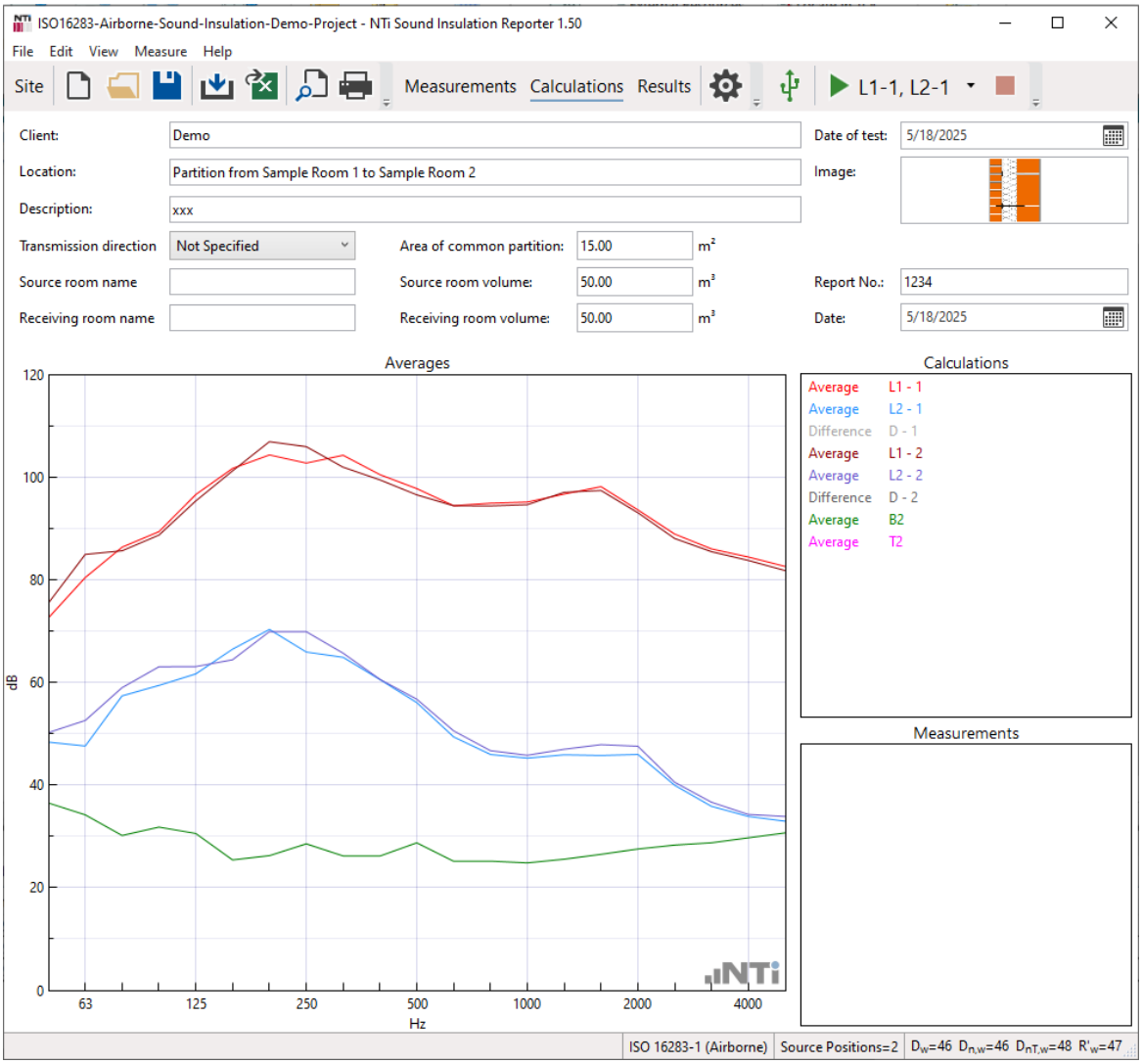
The measurement data is imported.

All measurement data with mapping information in the file name are assigned automatically by the software, e.g, "L1-1_SLM_001_RTA_3rd_Report.txt" is assigned to L1-1 (=speaker position 1 in the sending room). Alternatively, the mapping may be assigned manually to sending room or receiving room and the individual speaker positions:

- Select the measurement with the mouse;
- Click on the right mouse button;
- Select **Assign To**;
- Assign the measurement;
- Verify the measurement data and delete any false readings from the **Measurements** list on the right.

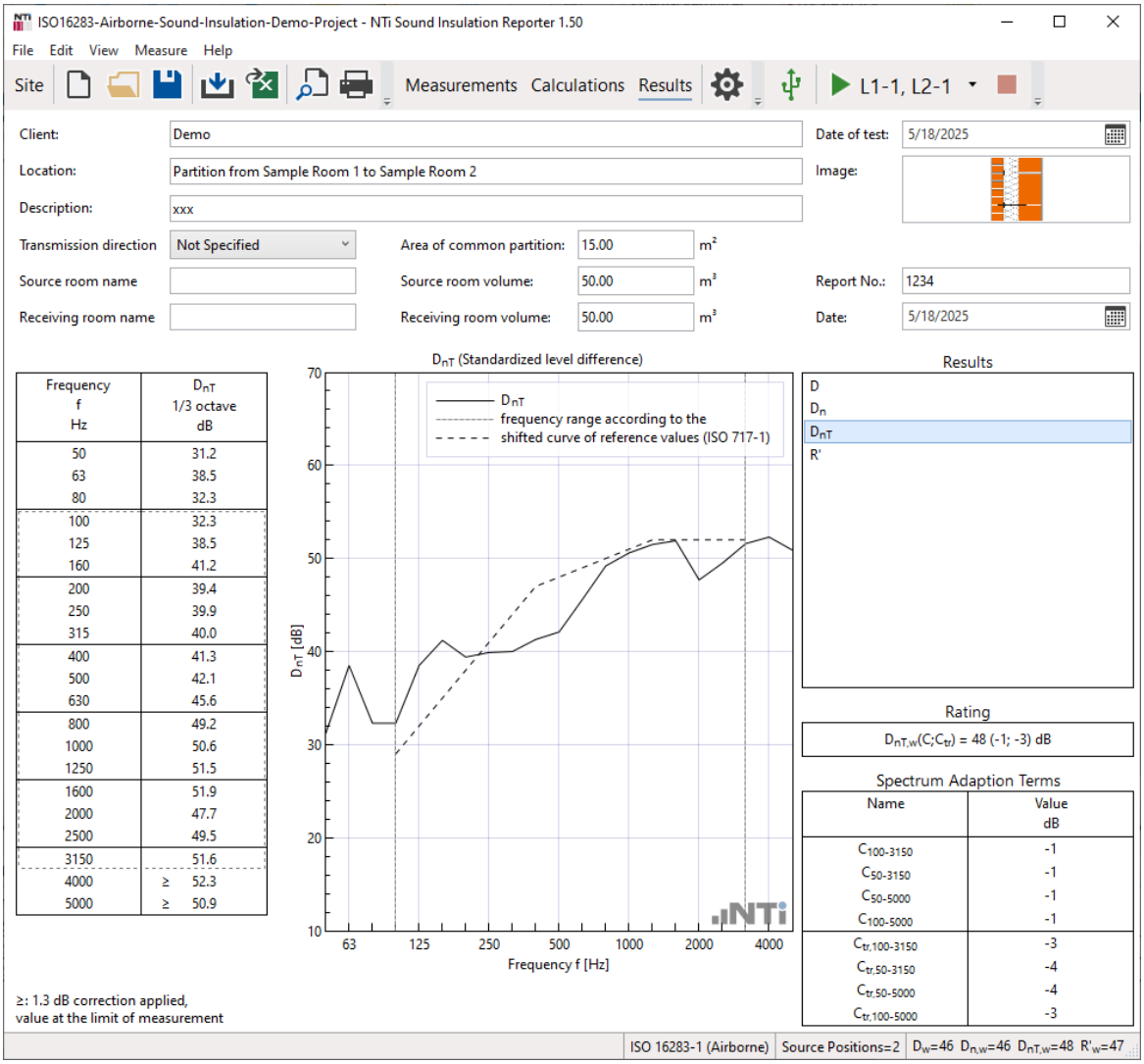
3.2.7 Measurement Report

- Select **View -> Calculations** in the menu;
- Verify the individual averaged results.



- Select the **View -> Results**,

The sound insulation data and chart are displayed.



- Complete the header data with information about client, object, description, partition area and room volumes;
- Print the sound insulation report.

Congratulations, your report is completed!

3.3 Automated Measurement (remote controlled)

The Sound Insulation Reporter software facilitates remote sound insulation measurements using compatible Acoustic Analyzers. Both the XL3 Acoustic Analyzer and XL2 Acoustic Analyzer offer options for remote measurement, but they differ in their connectivity requirements.

- **XL3 Acoustic Analyzer**: can be connected to the same Wi-Fi network as the computer running the Sound Insulation Reporter. This allows the software to automatically detect the XL3 Acoustic Analyzer units, enabling users to initiate measurements remotely. While wireless measurement is an option, it is not the only method available; users can also connect via USB-C cable.
- **XL2 Acoustic Analyzer**: in contrast, the XL2 Acoustic Analyzer analyzers require the activation of the remote measurement option and must be connected via a USB cable to perform remote measurements using the Sound Insulation Reporter.

For example, one XL3 Acoustic Analyzer can be positioned in the source room while another XL3 Acoustic Analyzer is in the receiving room to measure airborne sound insulation. The communication between the analyzers and the software is primarily wireless for XL3 Acoustic Analyzer units, providing flexibility in measurement setups.

3.3.1 Simultaneous Measurement in Sending and Receiving Room

The simultaneous measurement configuration reduces the measurement uncertainty; the noise level is measured in both rooms at the same time. These are the recommended configurations:

Automated Simultaneous Measurement

Configuration is remotely controlled by one person.

- 1x Dodecahedron Speaker Set;
- 2x Acoustic Analyzers (XL3 Acoustic Analyzer or XL2 Acoustic Analyzer);
- 2x M2230 Measurement Microphone;
- With XL3 Acoustic Analyzer:
  - 2x Sound Insulation Option.
- With XL2 Acoustic Analyzer:
  - 2x Extended Acoustic Pack;
  - 2x Sound Insulation Option;
  - 2x Remote Measurement Option;
- 2x ASD Cable 5m (alternatively 10m or 20m);
- 2x Mains Power Adapter (optional);
- 2x Exel System Case (optional);
- 1x Windows Computer, Laptop or Tablet (to start/stop measurements live in Sound Insulation Reporter);
- Using XL3 Acoustic Analyzer:
  - 1x Wi-Fi Access Point (Hotspot).
- Using XL2 Acoustic Analyzer:
  - 1x Wi-Fi Access Point (generating Wi-Fi network, e.g. SILEX SX-ND-4350 WAN) or USB Device Server (using existing Wi-Fi network); available at your preferred supplier.

3.3.2 Sequential Measurement of Sending and Receiving Room

The Dodecahedron Speaker Set provides the test signal at continuous sound pressure level for long time; e.g. 1 hour. This supports precise sound insulation readings at measuring the sending and receiving room sequentially. These are the recommended configurations:

Automated Sequential Measurement

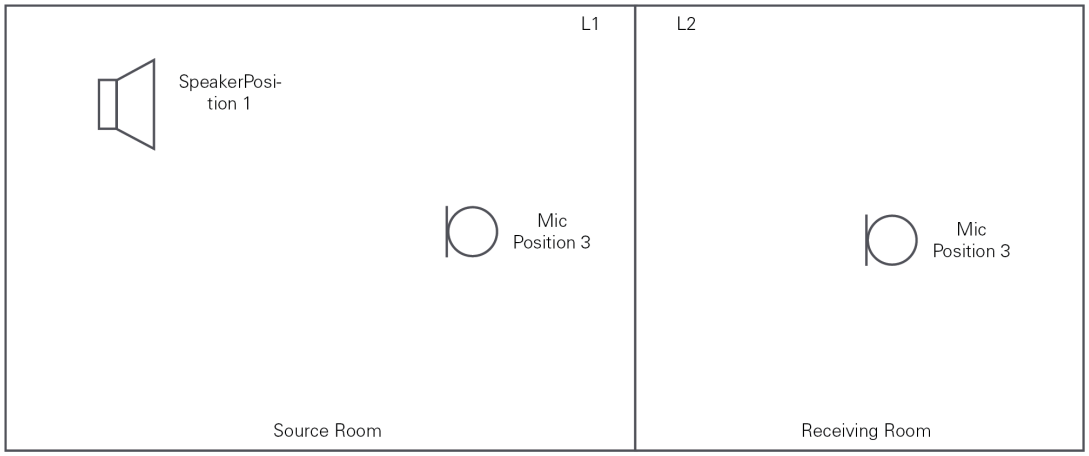
Configuration is remotely controlled by one person:

- 1x Dodecahedron Speaker Set;
- 1x Acoustic Analyzer (XL3 Acoustic Analyzer or XL2 Acoustic Analyzer);
- 1x M2230 Measurement Microphone;
- With XL3 Acoustic Analyzer:
  - 1x Sound Insulation Option;
- With XL2 Acoustic Analyzer:
  - 1x Extended Acoustic Pack;
  - 1x Sound Insulation Option;
  - 1x Remote Measurement Option;
- 1x ASD Cable 5m (alternatively 10m or 20m);
- 1x Mains Power Adapter (XL3 Acoustic Analyzer or XL2 Acoustic Analyzer) (optional);
- 1x Exel System Case (optional);
- 1x Windows Computer, Laptop or Tablet (to start/stop measurements live in Sound Insulation Reporter);
- 1x Wi-Fi Access Point (generating Wi-Fi network, e.g. SILEX SX-ND-4350 WAN) or USB Device Server (using existing Wi-Fi network); available at your preferred supplier.

3.3.3 Configuration

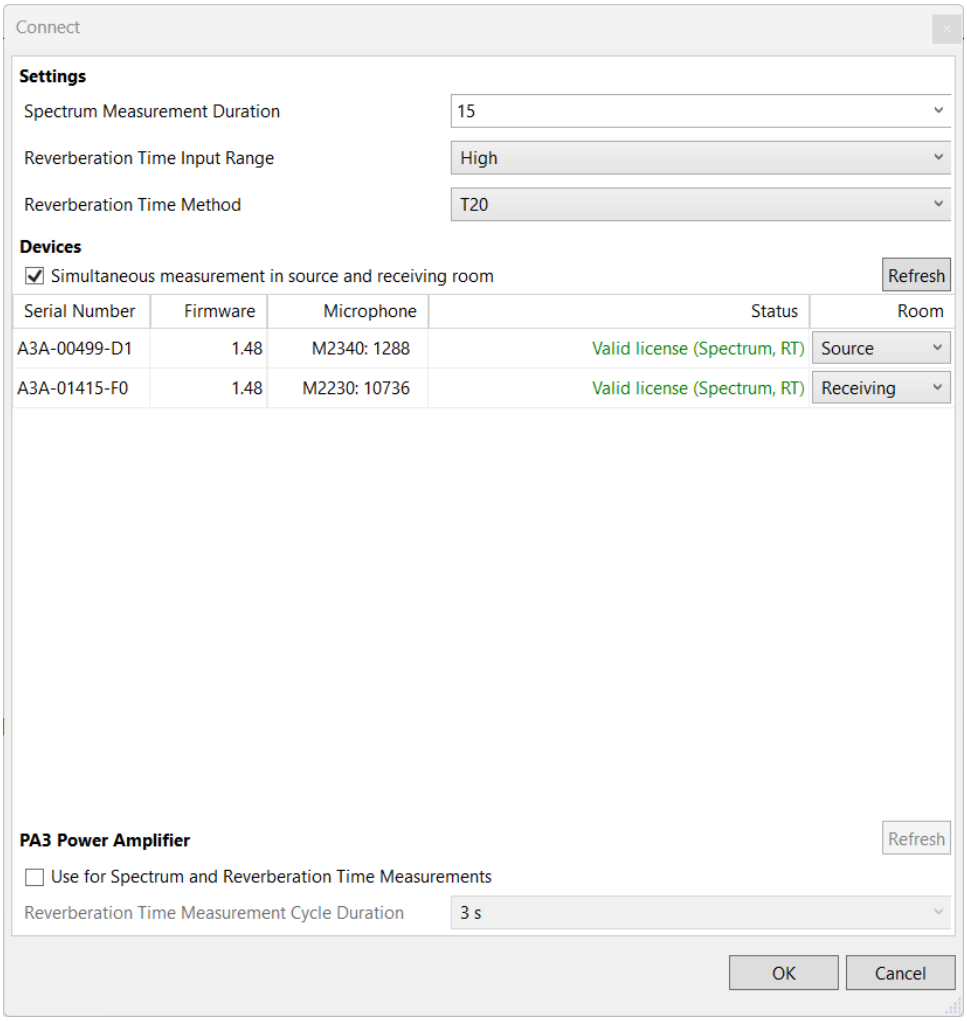
3.3.3.1 Speaker and Microphone Configuration

The sound spectra in the source room and the receiving room are measured simultaneously by individual XL2 Acoustic Analyzer. The Sound Insulation Reporter Software controls the instruments and visualizes the live measurement data.



3.3.3.2 Measuring with XL3 Acoustic Analyzer

To perform the measurement using wireless connectivity with the XL3 Acoustic Analyzer, you need to set up the hotspot/access point to which you will connect your Sound Level Meter (SLM) and the PC that will control the unit. After that, the Sound Insulation Reporter will detect your XL3 Acoustic Analyzer in the window:

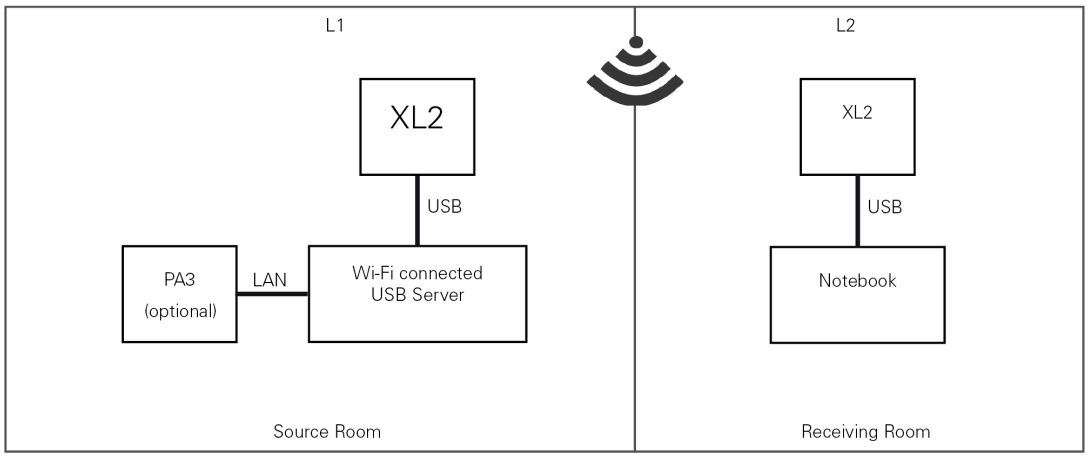


After completing the settings on the Connect page, press **OK**. You can then define the type of measurement and the room where the device is positioned. Then press ▶ to perform the measurement remotely.

3.3.3.3 Measuring with XL2 Acoustic Analyzer

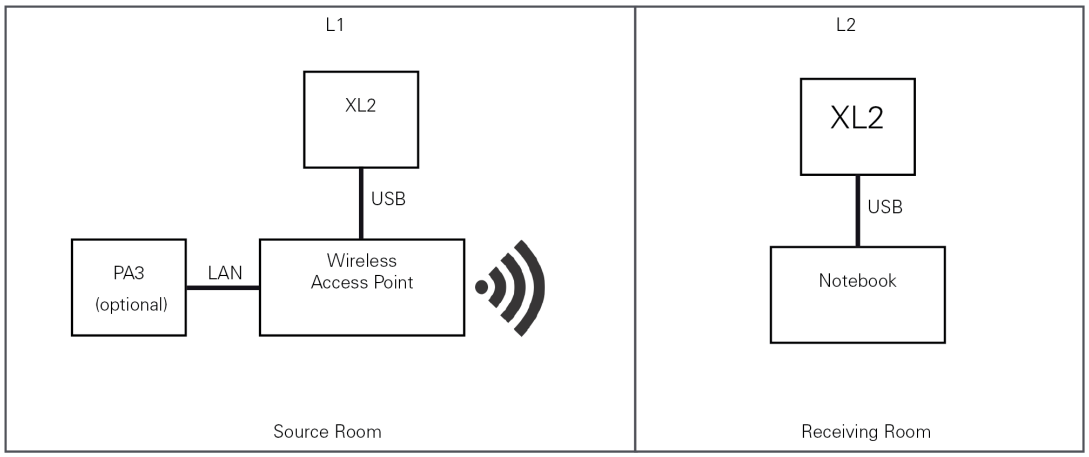
3.3.3.3.1 Case A) Instrument Configuration "External Wi-Fi network available"

If a Wi-Fi network is already available at the measurement location, you may connect the XL2 Acoustic Analyzer (and optionally the PA3 power amplifier) in the source room to the controller PC (notebook) in the receiving room by using a Wi-Fi connected USB Server.



3.3.3.3.2 Case B) Instrument Configuration "Local Wi-Fi network"

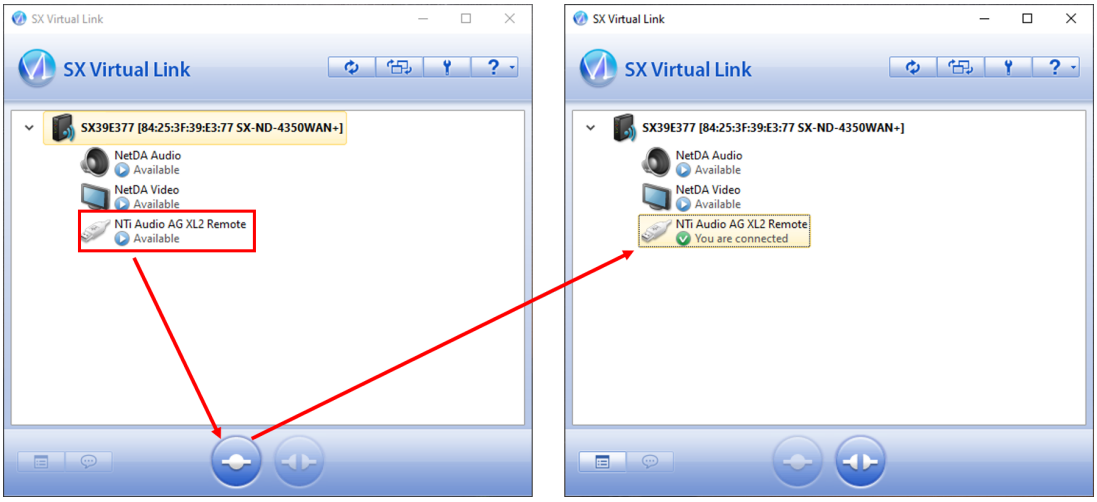
If no external Wi-Fi network is available, you may establish your own local Wi-Fi network by using a portable Wireless Access Point. This device connects the XL2 Acoustic Analyzer (and optionally the PA3 power amplifier) in the source room to the controller PC (notebook) in the receiving room.



3.3.3.3.3 Recommended setup procedure for Wireless Access Point "SILEX SX-ND-4350 WAN"

1. Download and install the “SX Virtual Link" software;
2. Connect the SILEX Wireless Access Point to AC mains;

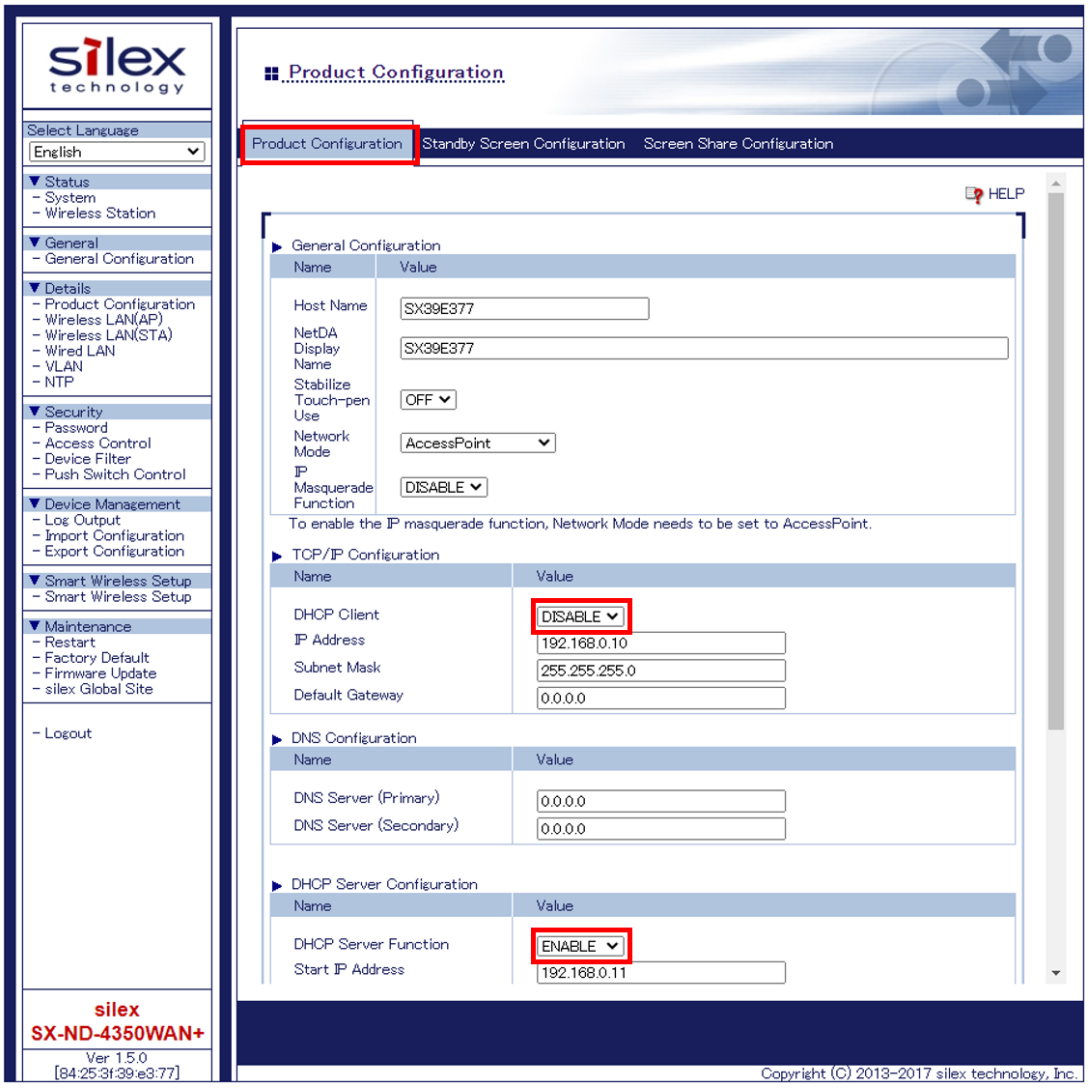
3. Connect the XL2 Acoustic Analyzer via a USB cable to the SILEX Wireless Access Point, and optionally also the PA3 via an Ethernet cable;
4. Switch ON the XL2 Acoustic Analyzer, select the “COM port” mode and wait, until the LED on the SILEX Wireless Access Point starts flashing;
5. Run the SILEX SX Virtual Link software on the controller PC (notebook);
6. In the control panel of the SILEX SX Virtual Link software, click on “NTi Audio AG XL2 Remote’ then on the “Connect” button.



7. Right click on "NTi Audio AG XL2 Remote” to open the "Remote Properties” panel; therein, click on “Device Server Properties”.

8. Press the Enter key to log in (no password required);
9. Adjust the settings as shown on the next page.

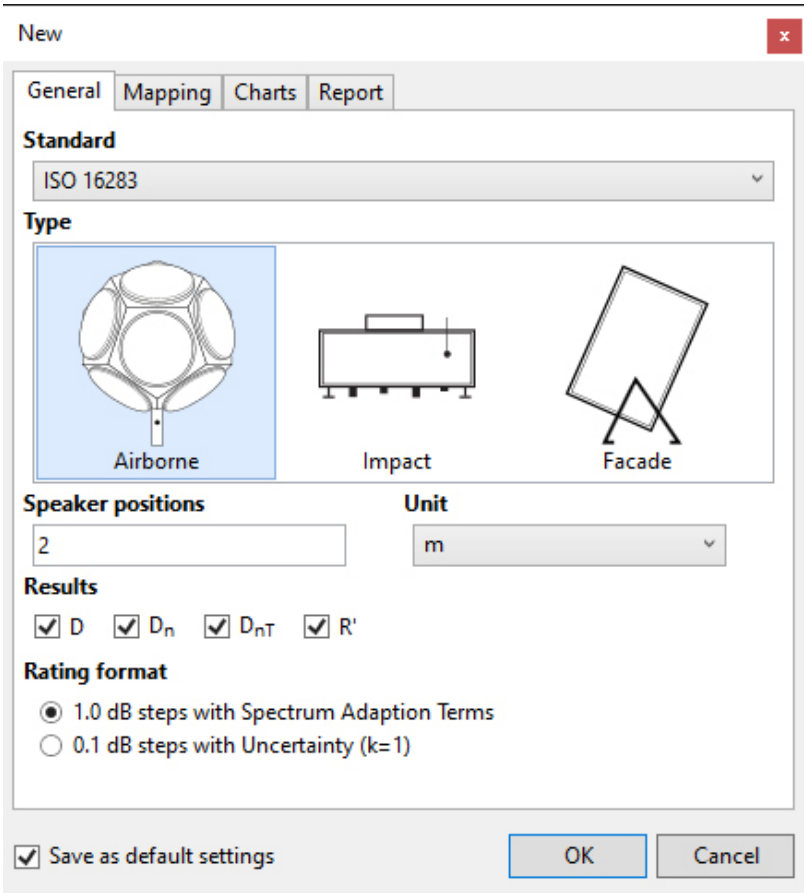
3.3.3.3.4 Product Configuration for Wireless Access Point type "SILEX SX-ND-4350 WAN"



1. Select the menu “Product Configuration";
2. Make sure that the DHCP Client is switched to “DISABLE” and the DHCP Server Function to “ENABLE”;
3. Click on “Submit” to confirm the settings;
4. Toggle to the SIR software and verify, whether the XL2 Acoustic Analyzer instruments are connected properly.

3.3.4 Selecting Standard and Type of Sound Insulation

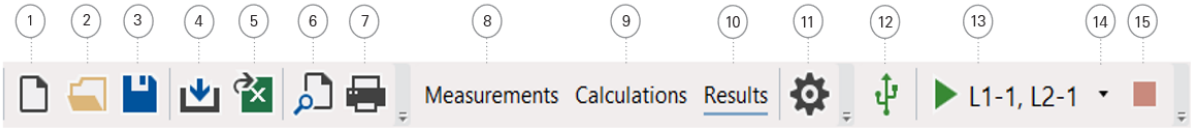
- Start the Sound Insulation Reporter software;
- Click on **File -> New**,



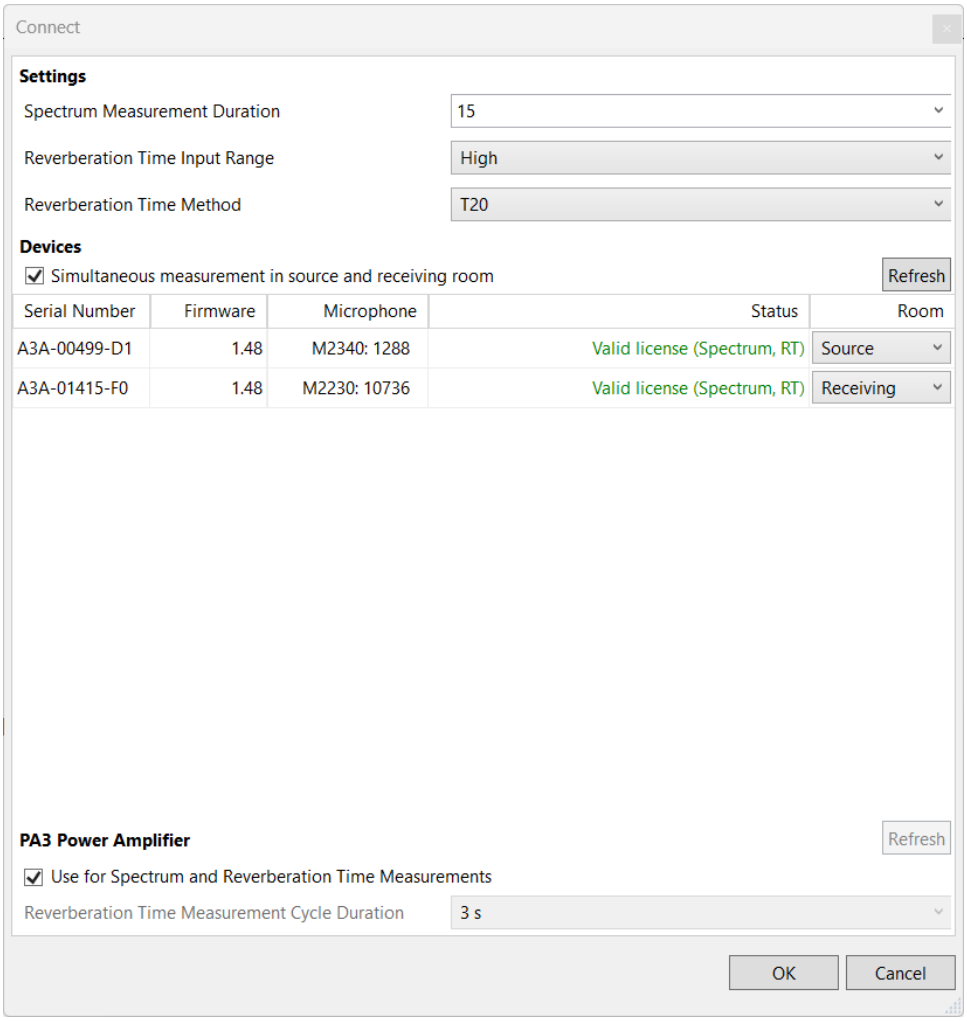
- Select your requested **Standard**;
- Select **Airborne**, **Impact** or **Facade** Sound Insulation;
- Select the number of **Speaker positions** used;
- Select **Unit**;
- Define the required **Results**;
- Select the preferred **Rating Format**, Choose either Dw(C;Ctr) = 41 (1-3) dB or Dw = 40.5 dB +/-0.9 dB;
- Confirm with **OK**.

3.3.5 Preparing the Measurement

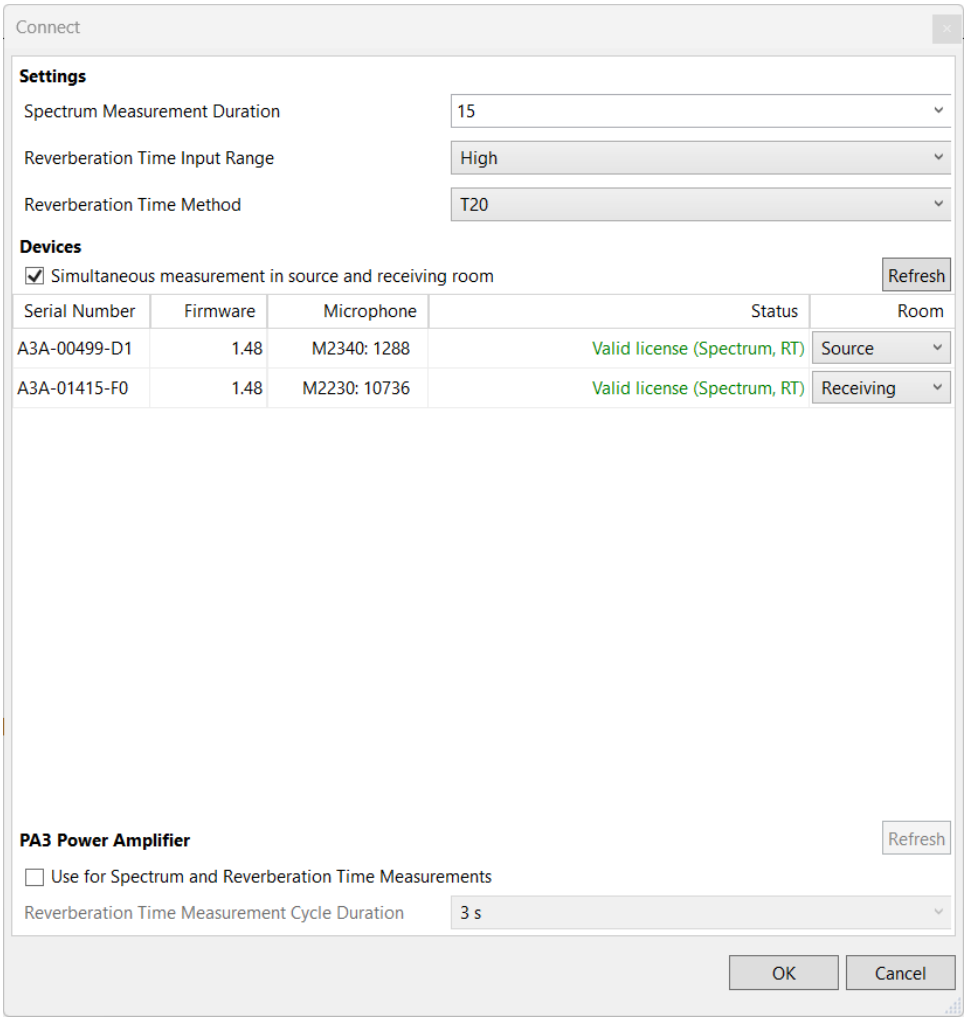
- Click on **Connect...** (12) in the toolbar.



- The Sound Insulation Reporter software detects all available XL3 Acoustic Analyzer and XL2 Acoustic Analyzer(connected in the COM-port mode);
- Verify the connected Acoustic Analyzer.
- For XL3 Acoustic Analyzer, the status will validate if a valid license is applied for the Sound Insulation Option or if the Sound Insulation Reporter 365 is enabled. Please ensure that you have an active internet connection while using the XL3;
- For XL2 Acoustic Analyzer, the status will validate if a valid license is applied for the Extended Acoustic Pack, Remote Measurement Option, and Sound Insulation Option, or if the Sound Insulation Reporter 365 is enabled.

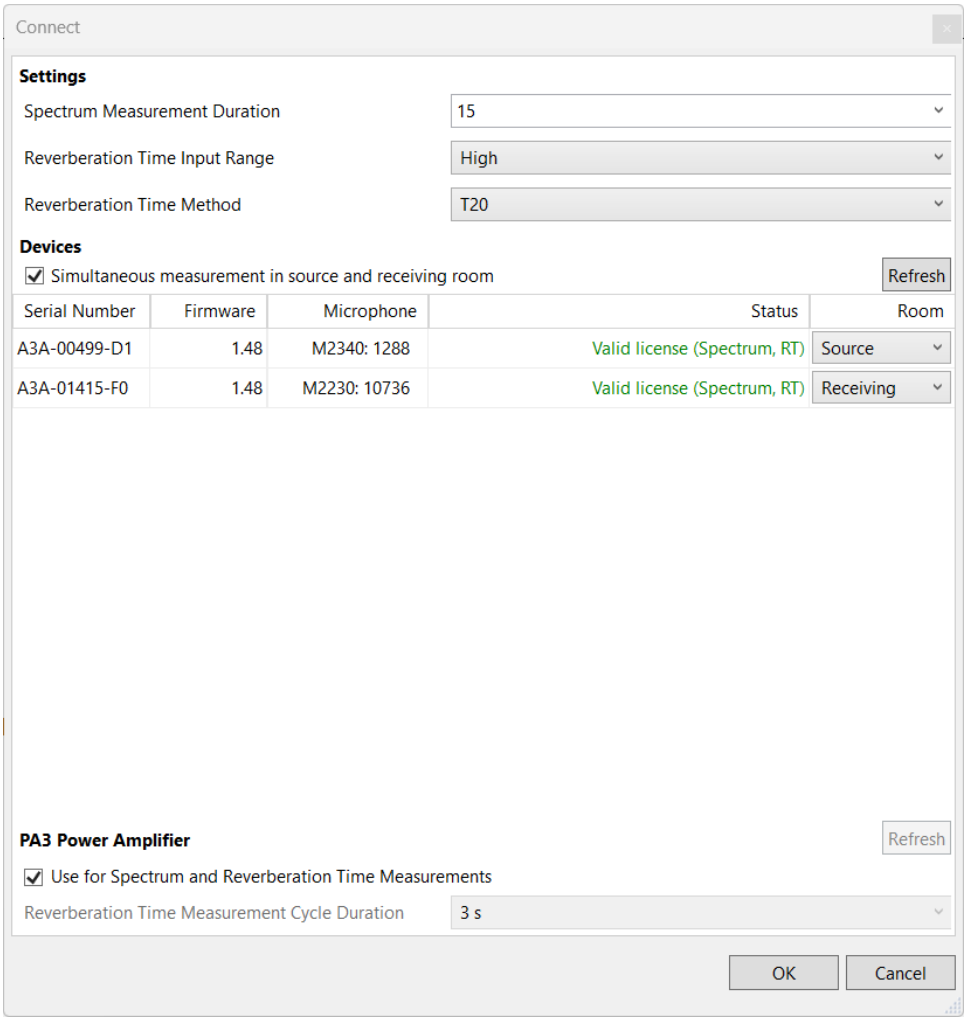


- Tick **Simultaneous measurement in source and receiving room** as applicable. This selection is dedicated for parallel measurements in source and receiving room with one or more instruments, Assign at least one device to the source room and another one to the receiving room. This is applicable for airborne or facade sound insulation measurements.



- The **PA3 Power Amplifier** for the Dodecahedron Speaker DS3 may also be remotely controlled. For this purpose, you may connect the PAS using a LAN cable to the:
  - LAN network for a fixed permanent installation;
  - Wi-Fi access point for an onsite temporarily installation.
- Select **Use for Spectrum and Reverberation Time measurements**;
- Click on **Refresh**;

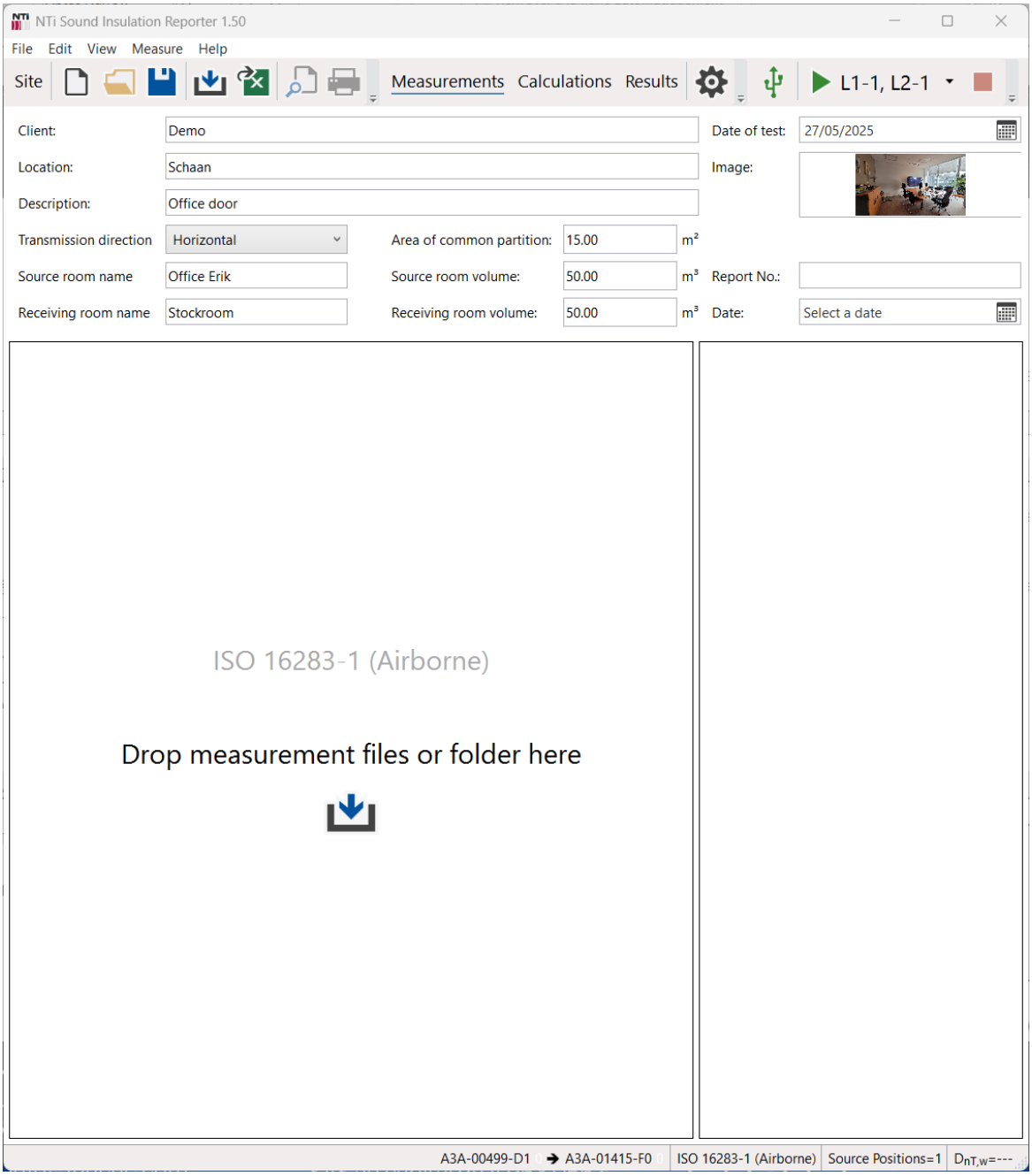
The IP number of the connected PA3 Power Amplifier is displayed (**Connected to xx.xxx.x.xx**)



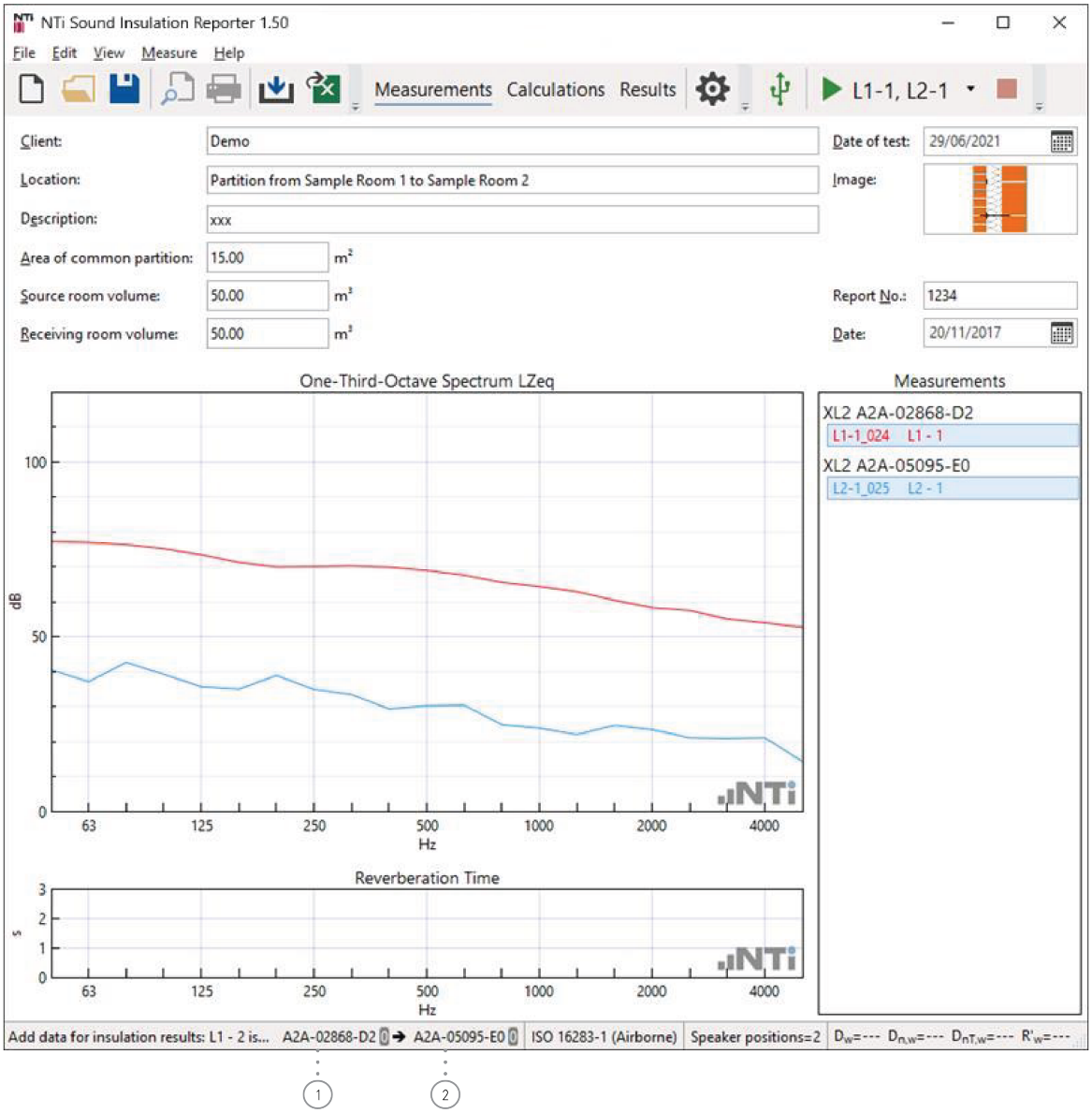
- Verify the firewall settings on the connected computer; the access to the displayed IP address has to be enabled. In case of the message **A critical error occurred** is shown at the start of your next measurement, then disable the firewall for evaluation shortly;
- Confirm your settings with **OK**.

3.3.6 Sound Spectrum Measurement

- Select the measurement in the drop-down menu, e.g. **L1-1**, **L2-1** for simultaneous measurement of sending and receiving room at speaker position 1,



- Press **Start** in the toolbar;



The remote measurement is started, The actual levels are visualized in the software.

1 **Sending Room**

Serial number of the Acoustic Analyzer assigned to sending room and measurement timer.

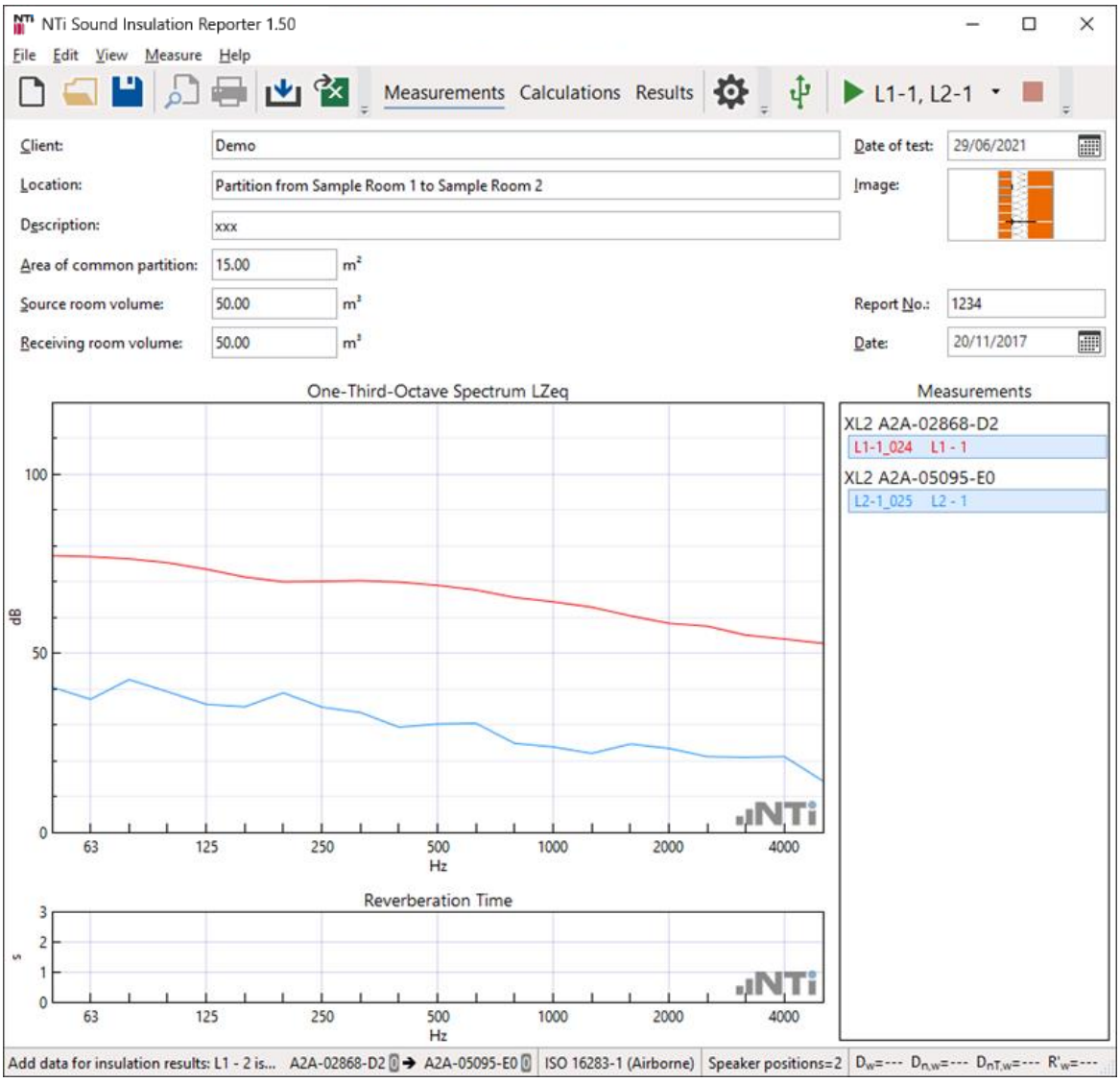
2 **Receiving Room**

Serial number of the Acoustic Analyzer assigned to receiving room and measurement timer.

- The measurement stops automatically after the preset measurement duration;
- Move the microphone position and continue with the next measurement;
- Follow the same procedure for the second speaker position and the background noise recording.

3.3.7 Reverberation Time Measurement

- Select **T2** for the reverberation time measurement in the toolbar.



- Press Start in the toolbar;
- Activate the dodecahedron speaker with pink noise or the impulse sound source;

> The XL2 Acoustic Analyzer measures the reverberation time. The averaged test result is visualized in the software.

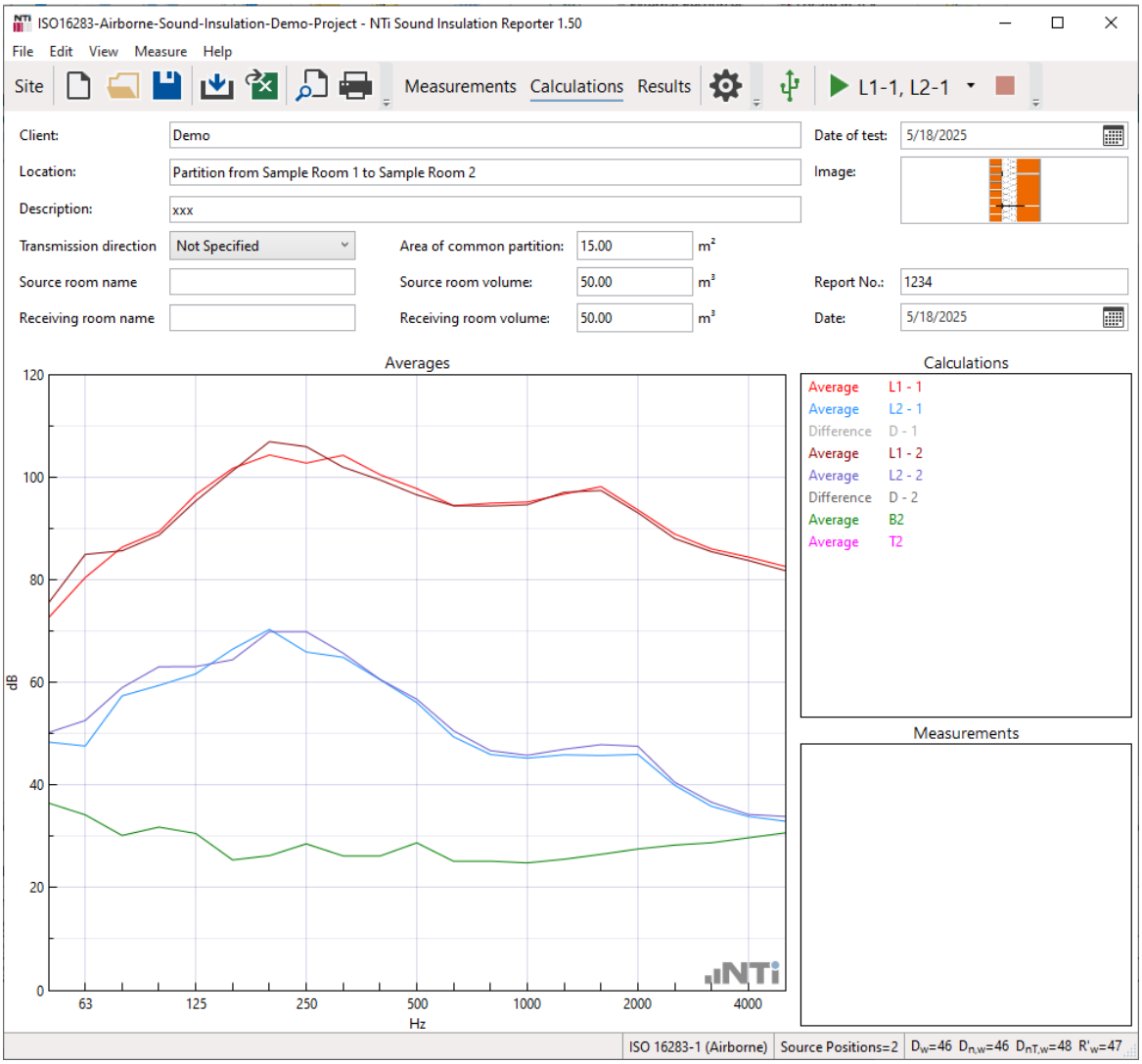
- Press Stop in the toolbar;

> The reverberation time measurement is completed.

- Move the microphone position and continue with the next measurement;
- Verify the measurement data and delete any false readings from the **Measurements** list on the right.

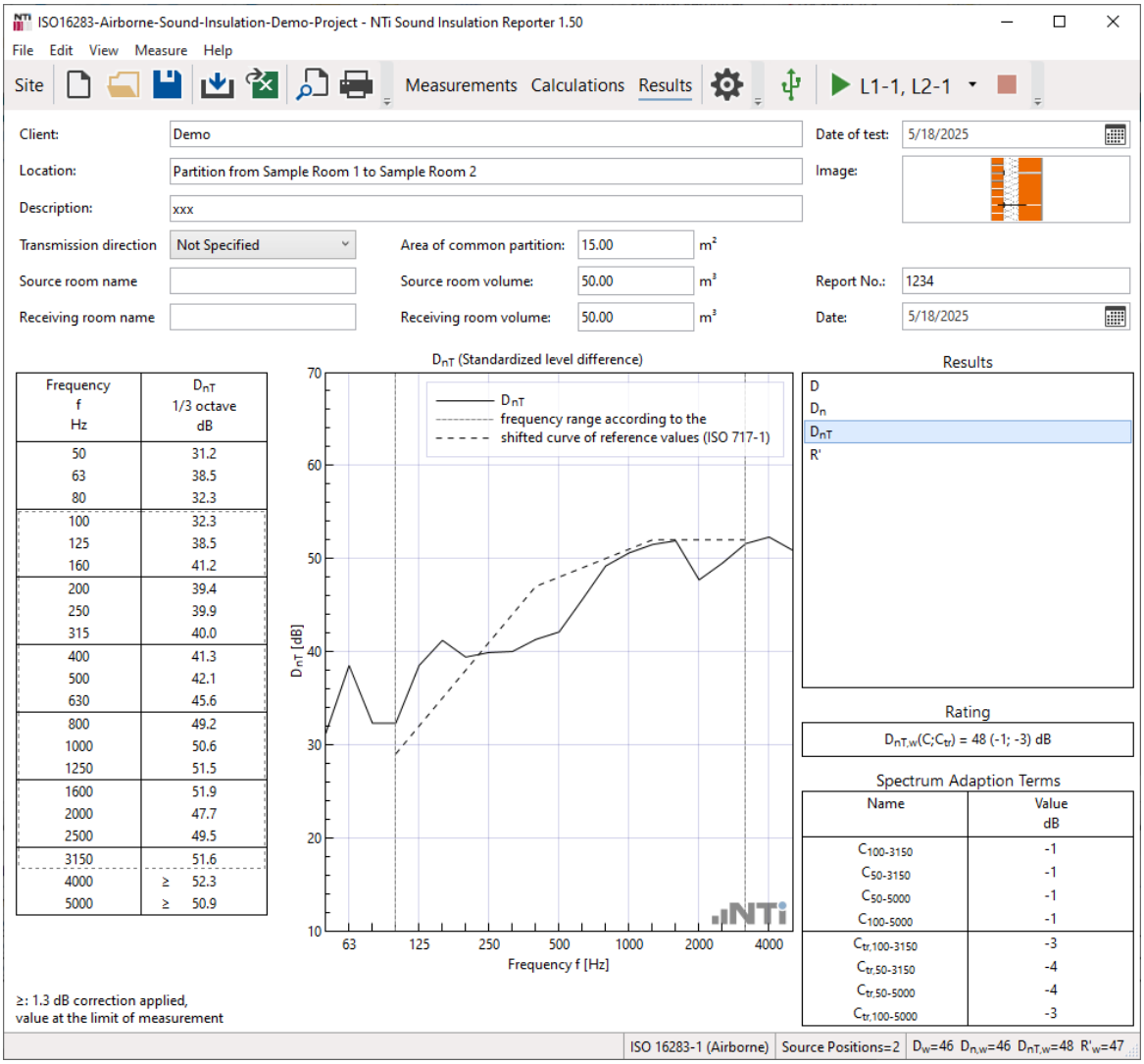
3.3.8 Measurement Report

- Select **View -> Calculations** in the menu.
- Verify the individual averaged results.



- Select the **View -> Results**.

The sound insulation data and chart are displayed.



- Complete the header data with information about client, object, description, partition area and room volumes;
- Print the sound insulation report.

Congratulations, your report is completed!

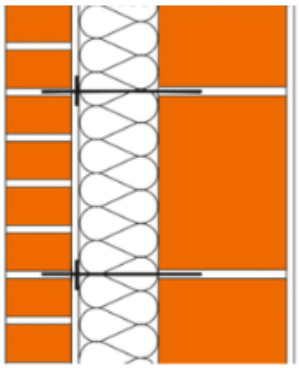
4 Sound Insulation Report

The software generates automated reports in accordance with the supported standards. Print the reports for the selected results.

Standardized level difference in accordance with ISO 16283-1
Field measurements of airborne sound insulation between rooms

Client: Demo
Location: Partition from Sample Room 1 to Sample Room 2
xxx

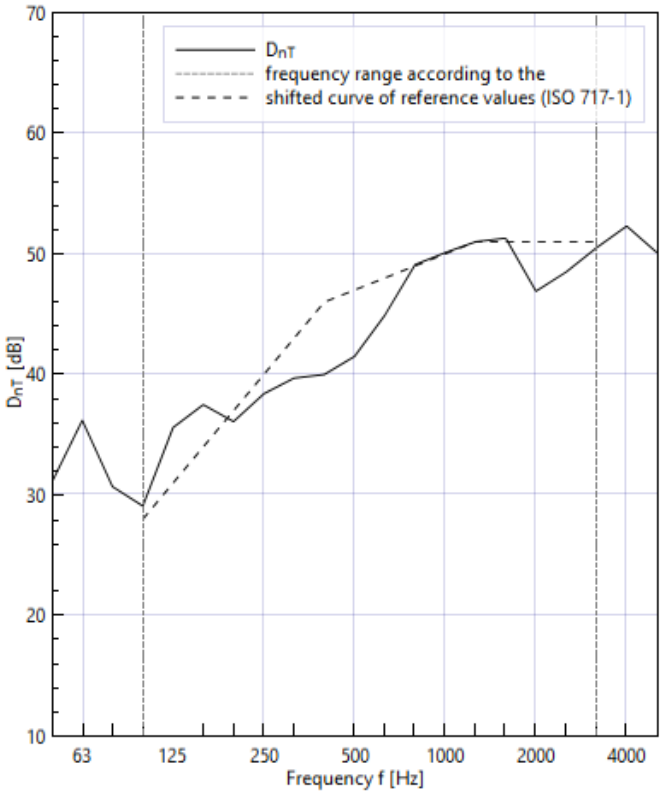
Date of test: 15/03/2016



XL2 Sound Level Meter: A2A-05850-E0 (M4260: 3285)
Area of common partition: 15.00 m²
Source room volume: 50.00 m³
Receiving room volume: 50.00 m³

Frequency f Hz	D_{nT} 1/3 octave dB
50	31.1
63	36.2
80	30.7
100	29.1
125	35.6
160	37.5
200	36.1
250	38.4
315	39.7
400	40.0
500	41.5
630	44.9
800	49.1
1000	50.1
1250	51.0
1600	51.3
2000	46.9
2500	48.5
3150	50.5
4000	≥ 52.3
5000	≥ 50.1

≥: 1.3 dB correction applied,
value at the limit of measurement



Rating in accordance with ISO 717-1:

$D_{nT,w}(C;C_{tr})$ = 47 (-1; -4) dB

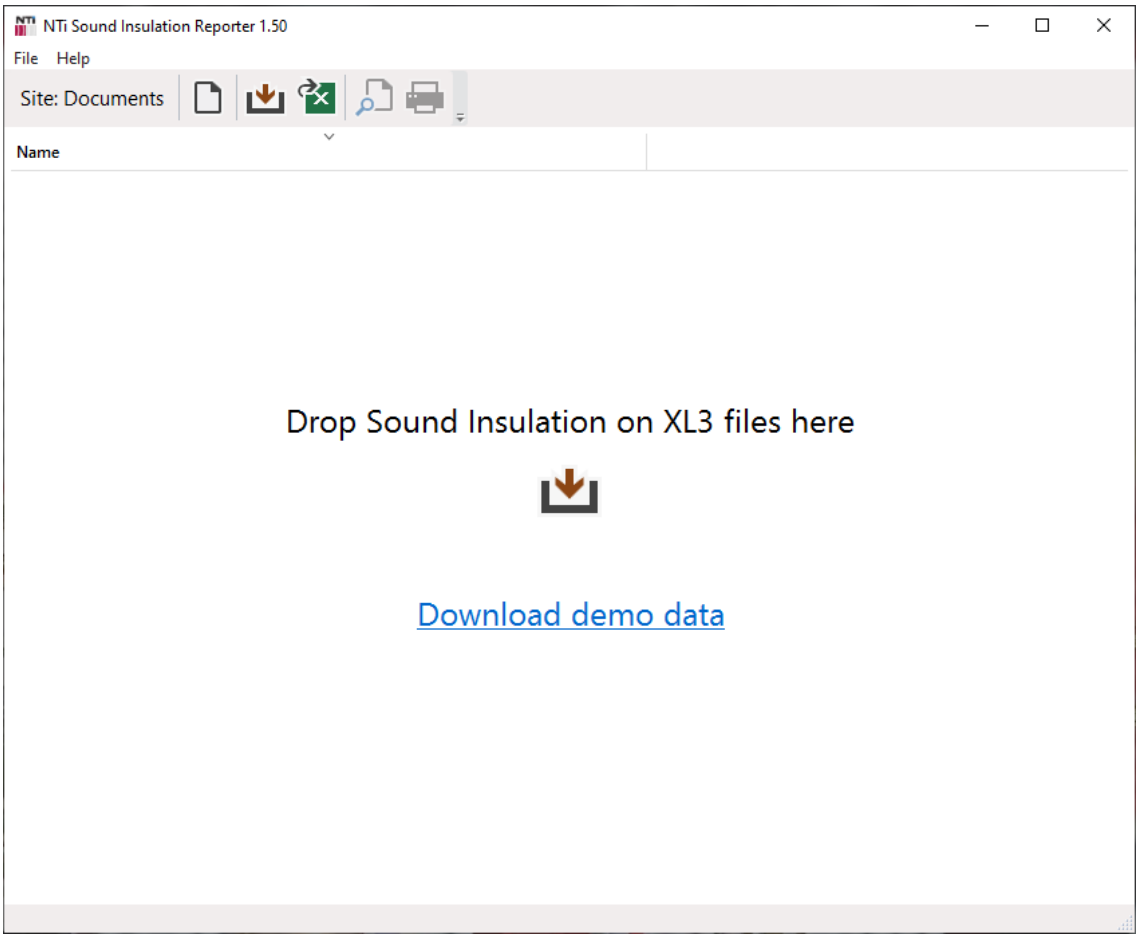
$C_{50\text{-}3150}$ = -1 dB; $C_{50\text{-}5000}$ = -1 dB; $C_{100\text{-}5000}$ = -1 dB
$C_{tr,50\text{-}3150}$ = -5 dB; $C_{tr,50\text{-}5000}$ = -5 dB; $C_{tr,100\text{-}5000}$ = -4 dB

Evaluation based on field measurement using results obtained by an engineering method.

Report No.: 1234 Name: Building Acoustic Inc.
Date: 20/11/2017 Signature:

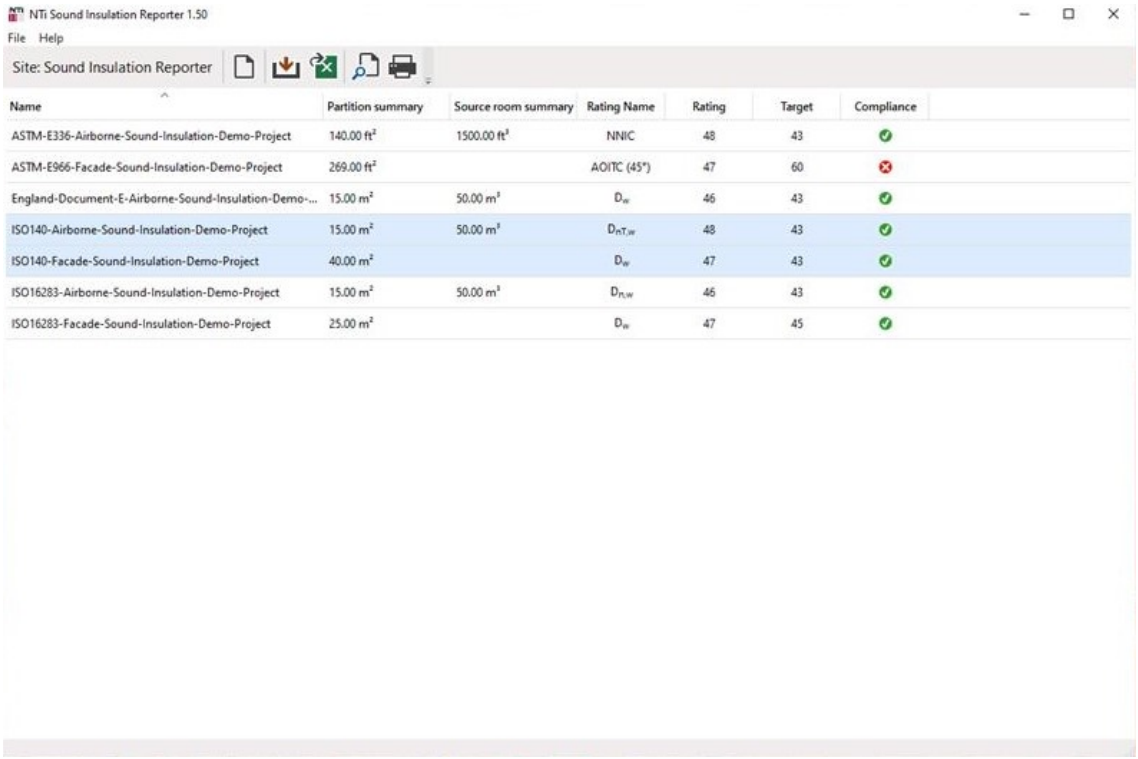
4.1 Site View

Site View mode is a powerful workspace where you can display and edit all measured partitions at once. The side view mode also displays rating, target and compliance. These features were added in the Version 1.50 of the Sound Insulation Reporter. The following video provides a detailed explanation of the Site View feature: New features in Sound Insulation Reporter 1.50.

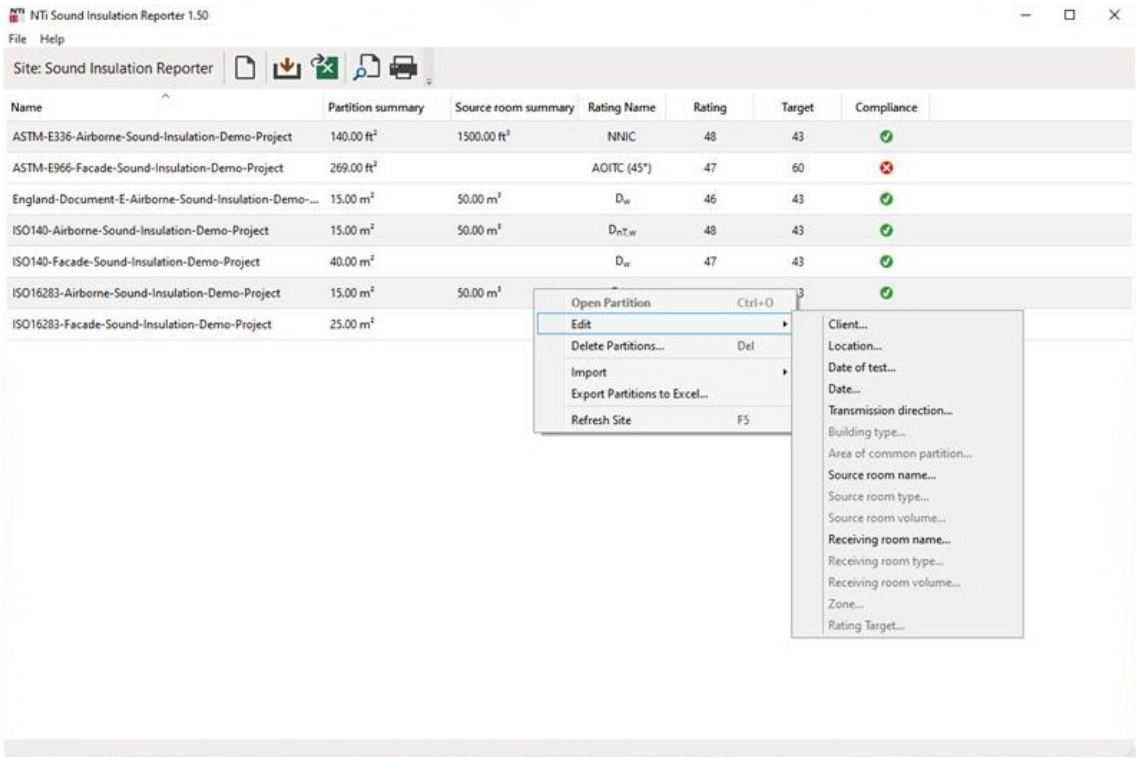


In the Site View mode you can import your data that has been measured using XL3 Sound Insulation Option, so it will be displayed at least where you can edit specific information about your measurements. If you prefer the legacy workflow you can, just click to New Partitions button to import your measurements and continue working as before.

The Site View mode offers several features that enhance the efficiency of managing sound insulation measurements. One of the key functionalities is batch editing, which allows users to edit multiple parameters across various partitions simultaneously. This includes the ability to modify details such as the source room and receiving room names, as well as the volume or area of the common partition.



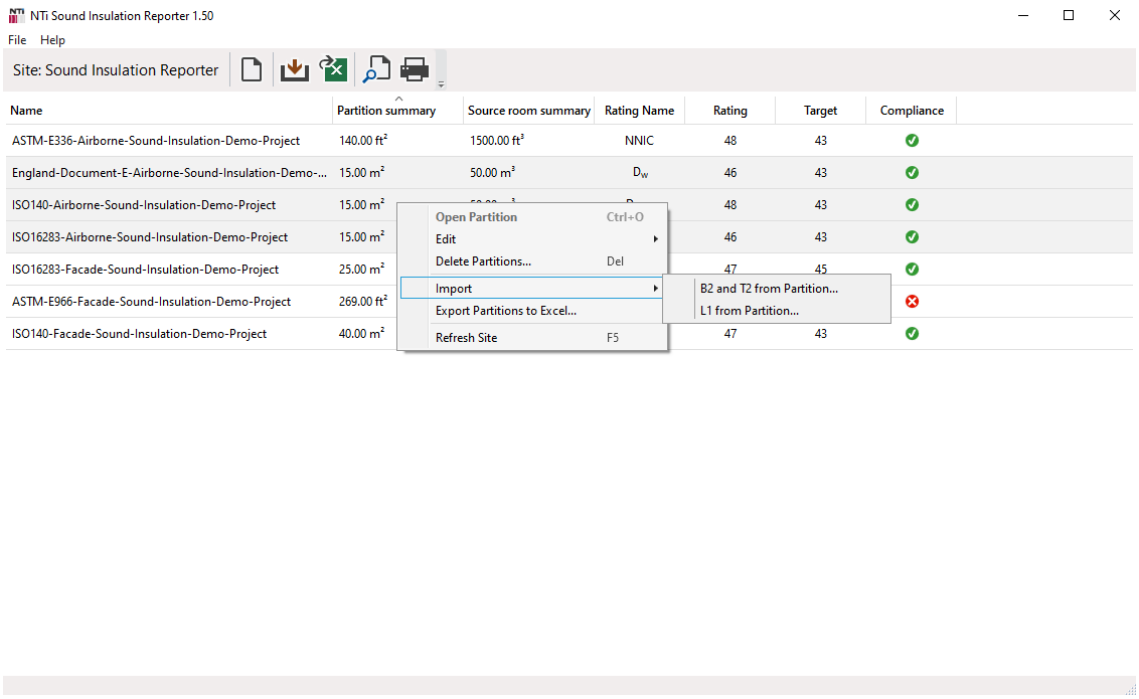
Additionally, the Site View mode incorporates features for rating, target, and compliance assessment. Users can quickly determine whether their results meet the necessary criteria through intuitive pass and fail indicators, streamlining the evaluation process.



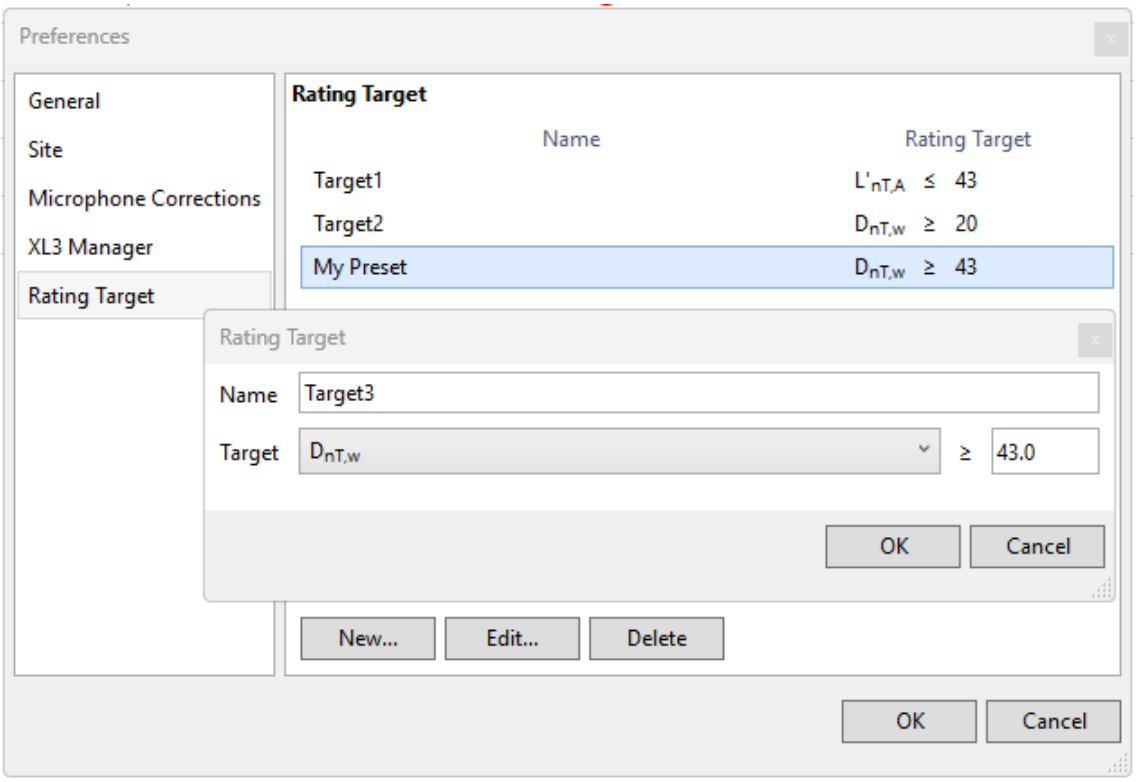
Another significant feature is report preview  , which enables users to generate comprehensive reports for all partitions directly from the side view. This functionality simplifies documentation and analysis, making it easier to track and present results.

For data management, the Site View mode allows for data export , enabling users to select specific partitions and export them into Excel files for further analysis. This capability ensures that data can be easily manipulated and shared as needed.

Moreover, users can import B2 and T2 results from other measurements, provided they relate to the same receiving rooms. This functionality promotes data consistency and saves time when working across multiple tests, enhancing overall workflow efficiency.



The Site View mode also supports the addition of custom targets. Users can define manual targets alongside predefined standards, allowing for easy customization and quick access to target presets whenever required. Furthermore, it is possible to set manual targets for individual tests or select multiple tests in the side view mode to apply a target to all selected tests, providing flexibility in managing measurement criteria.


Preferences
General
Site
Microphone Corrections
XL3 Manager
Rating Target
Rating Target
Name
Rating Target
Target1
L'nT,A ≤ 43
Target2
DnT,w ≥ 20
My Preset
DnT,w ≥ 43
Rating Target
Name
Target3
Target
DnT,w
≥
43.0
OK
Cancel
New...
Edit...
Delete
OK
Cancel

File	**Change Site...**	Allows you to switch to a different site, enabling you to manage and organize measurements across various projects.
	Refresh Site	Updates the current site view to reflect any recent changes or new data, ensuring that you are working with the most current information.
	New Partitions...	Initiates the import process for new measurements, allowing you to add partitions to your current project while maintaining the legacy workflow.
	Open Partition	Enables you to access and edit specific partitions within the current site, providing detailed information and options for modification.
	Delete Partitions...	Allows you to remove selected partitions from the site view, streamlining your project by eliminating unnecessary data.
	Import Sound Insulation on XL3	Select the Sound Insulation file (.xl3si) generated during measurements conducted in Sound Insulation Option on the XL3. This file contains all predefined information regarding the measurements, as well as details about the rooms or partitions specified in the XL3 Acoustic Analyzer.
	Export to Excel...	Export all measurement data and results into MS Excel.

Preferences...

General

The Sound Insulation Reporter software is available in Chinese, English and German language. Additionally, the reporting is offered in the languages Czech and Italian. The default setting use the language of the operating system installed on your computer. Select the language as follows:

- Select **File** in the menu;
- Select **Preferences...**;
- Select the language. Changing the language will require a restart of the software;
- Confirm the settings with **OK**.

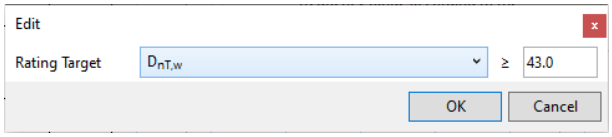
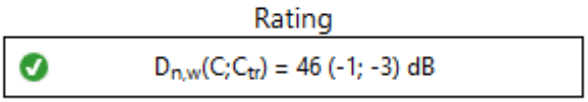
The software closes and restarts with the selected language.

Site

This option allows you to configure the site columns displayed in the Site View. You can customize the visibility of the following columns:

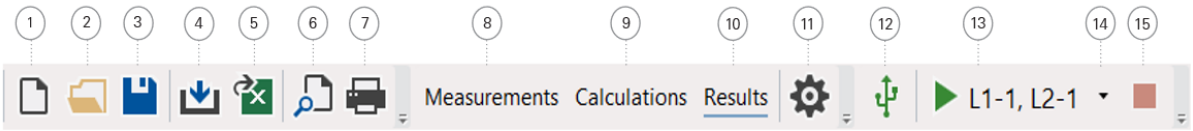
- **Column Name:** The identifier for each column.
- **Name:** The name of the site or project.
- **Standard:** The applicable standards for sound insulation measurements.
- **Type:** The type of measurement or partition.
- **Client:** The name of the client associated with the project.
- **Location:** The geographical location of the site.
- **Date of Test:** The date when the measurements were conducted.
- **Date:** The date of data entry or modification.
- **Partition Summary:** A brief overview of the measured partitions.
- **Transmission Direction:** The direction of sound transmission between rooms.
- **Building Type:** The classification of the building (e.g., residential, commercial).
- **Area of Common Partition:** The area of shared partitions between rooms.

	• Enter any applicable frequency response correction for the used measurement microphones here with type and serial number. The unit is [dB]. This correction is automatically applied at the import of any data recorded with this microphone or any remote measurements performed. Sound Insulation Reportercalculates (measurement result + correction) for each frequency band and presents the result in the chart. The data set requires to list the same type and serial number in the header data in order to detect the microphone type and serial number.
	• Note: the correction is not applied on any existing projects.
	
	XL3 Manager
	
	The XL3 Manager allows you to manage your XL3 devices efficiently. Within this section, you can perform the following actions:
	
	• **New...:**Create a new entry for an XL3 device. You will need to fill in the following fields:
	  • **Serial Number:** Enter the unique serial number of the XL3 device.
	  • **Password:** Provide the password associated with the device.
	• **Edit...:**Modify the details of an existing XL3 device entry.
	• **Delete...:**Remove an existing XL3 device entry from the list.
	
	If automatic discovery of the XL3 device is not available, you can manually enter the IP address. The following field is provided for this purpose:
	
	• **IP Address:** Enter the IP address of the XL3 device.
	  • Additionally, there is a Test IP option that allows you to verify the connectivity to the specified IP address.
	
	Rating Target
	
	Configure the Rating Target or select a predefined Rating Target from the list (Preferences > Rating Target) to assess the compliance of your measurement against established expectations.

		 The outcome will be presented as a Pass/Fail result in the Compliance column.  Pass according to Rating result and its Target Fail according to Rating result and its Target
	Exit	Close the software.
Help	**Online Help**	Link to download the user manual in PDF form.
	Check for Updates...	Checks for available updates of the Sound Insulation Reporter software.
	Download Demo Data...	This option allows you to download sample measurement data for demonstration purposes. This demo data can be used to familiarize yourself with the features and functionalities of the Sound Insulation Reporter without the need for actual measurements.
	About	List's version and copyright details of the software.

4.2 Main Menu

4.2.1 Toolbar



1	**New Project** A project contains the measurement data of one partition. The airborne or impact sound insulation of a new project is calculated in accordance with the selected standard. • Select the number of **Speaker positions** used for the measurements with the XL2 Acoustic Analyzer or ; • Select **Unit**; • Select the **Results** required; • Select the preferred **Rating Format** for the standards BB93, DIN4109, ISO 16283, ISO 10140 and SIA 181. By default is the single number rating provided in 1.0 dB steps in all standards, e.g, Dw(C;Ctr) = 41 (-1;-3) dB, Alternatively, the standards BB93, DIN4109, ISO 16283, ISO 10140 and SIA 181 may show the single number rating in 0.1 dB steps with measurement uncertainty, e.g, 40,5 dB +/- 0.9 dB; • Confirm the settings with **OK**.
2	**Open Project File** • Select an existing project file *.xlba.
3	**Save Project File** • Save the actual sound insulation data as project file *.xlba.
4	**Import** • Select the folder containing the original XL2 Acoustic Analyzer or XL3 Acoustic Analyzer measurement data *.txt, *.xl2 and *.xl3sifiles and confirm with "Select folder". All measurement files within the selected folder are imported into the software. Any recorded data with A- or C-weighting is automatically corrected to Z-weighting (=no weighting).
5	**Export to Excel** • Exports all measurement data and results into MS Excel.
6	**Print Preview** • The sound insulation reports for the selected results are displayed.
7	**Print** • The sound insulation reports for the selected results are printed.
8	**Measurement View** • The original XL2 Acoustic Analyzer or XL3 Acoustic Analyzer measurements data is visualized in the frequency range from 50 Hz to 5 kHz. By default, all measurement data, as well as the speaker position for the sound insulation calculation, are automatically assigned to the corresponding sending or receiving room. Alternatively, the data can be assigned manually.

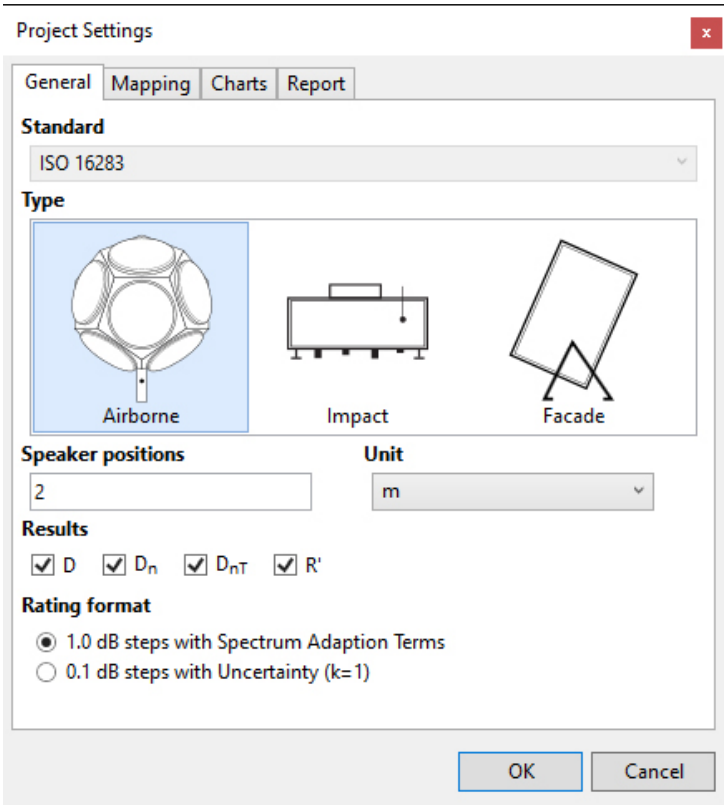
9	**Calculation View**
	• Displays the average of the:
	  • sending room level for each speaker position;
	  • receiving room level for each speaker position;
	  • background noise level;
	  • reverberation time.

10	**Results View**
	• Displays the following sound insulation results based on the selected result type:
	  • table from 50 Hz - 5 kHz;
	  • standardized chart from 50 Hz - 5 kHz;
	  • single number sound insulation rating;
	  • rating corrections Cxx.

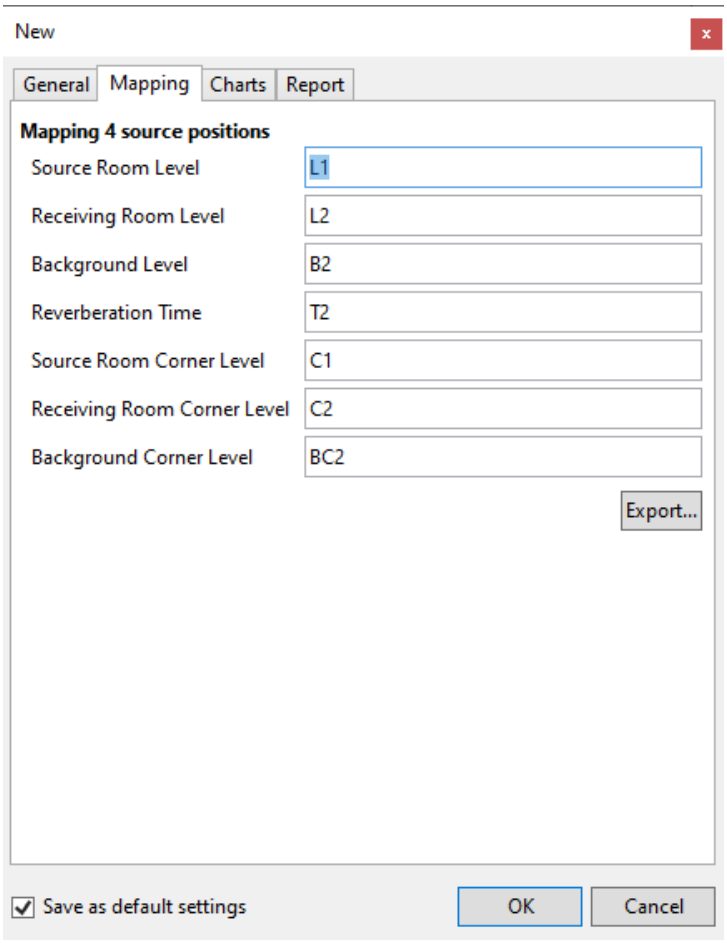
(11) **Settings**

General

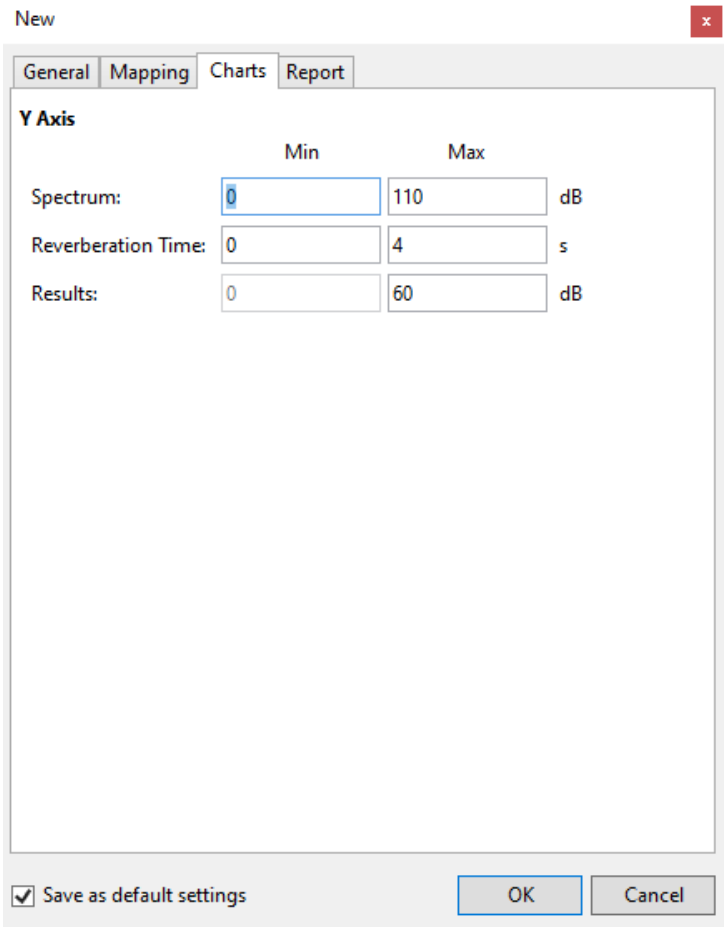
- Select the number of **Speaker positions** used for the measurements;
- Select **Unit**;
- Select the **Results** required.



	Mapping	Sound insulation measurements require the recording of multiple noise spectras in the sending and the receiving rooms. The XL2 Acoustic Analyzer with firmware V4.03 or higher simplifies the data handling of these measurements by recording each data set with a dedicated location mapping, such as “L1-1” for a measurement carried out in the sending room with speaker position 1. Storing the measurement data with this mapping on the XL2 supports the automated data assigning to the corresponding room and speaker position during the data import into the Sound Insulation Reporter software. • Click on **Export**..., this generates the text file savenames.txt; • Load the txt-file "savenames.txt" with the various mappings, like "L1-1", "L1-2"... onto the SD card of the XL2 Acoustic Analyzer; • Copy this file onto the root directory of the XL2 Acoustic Analyzer memory card; • Select the memory menu on the XL2 Acoustic Analyzer and set **Autosave: Off**. Each measurement can be manually stored on the XL2 Acoustic Analyzer with one of the predefined mappings.

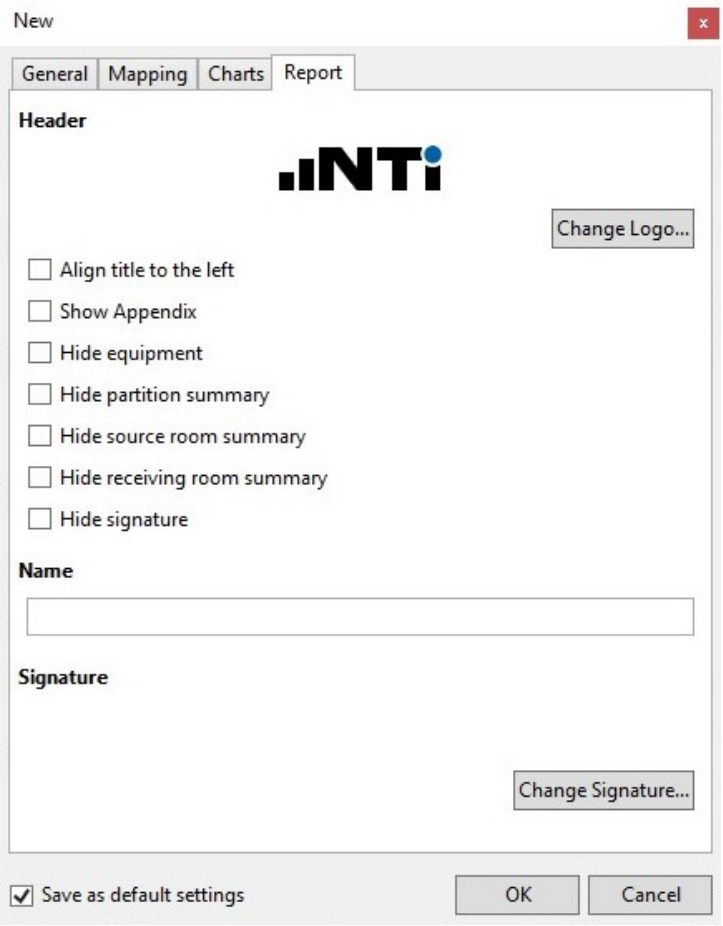

New
General
Mapping
Charts
Report
Mapping 4 source positions
Source Room Level
L1
Receiving Room Level
L2
Background Level
B2
Reverberation Time
T2
Source Room Corner Level
C1
Receiving Room Corner Level
C2
Background Corner Level
BC2
Export...
Save as default settings
OK
Cancel

	Charts	**Spectrum**	Set the Y-axis scaling for measurements and calculations view;
		Reverberation Time	Set the Y-axis scaling for measurements and calculations view;
		Results	Set the Y-axis scaling for the chart in results view. The default sapn is 60 dB.



Report

- Load your company logo for the printed measurement reports;
- **Align title to the left** offers more space for your company logo in the report header;
- **Show Appendix** enables an appendix field in the report header; this allows adding the report with an appendix number to a longer report;
- **Hide equipment** offers more space for the description in the report.



- **Hide area of common partition** is e.g, used in applications without a common partition;
- **Hide source room volume** offers also more space for the description in the report;
- Set the **Name of the test institute**, e.g. your company name;
- Load your **Signature** for the print measurement reports.

The recommended maximum size for the imported picture is

- Logo: 120 x 30 px, 96 dpi

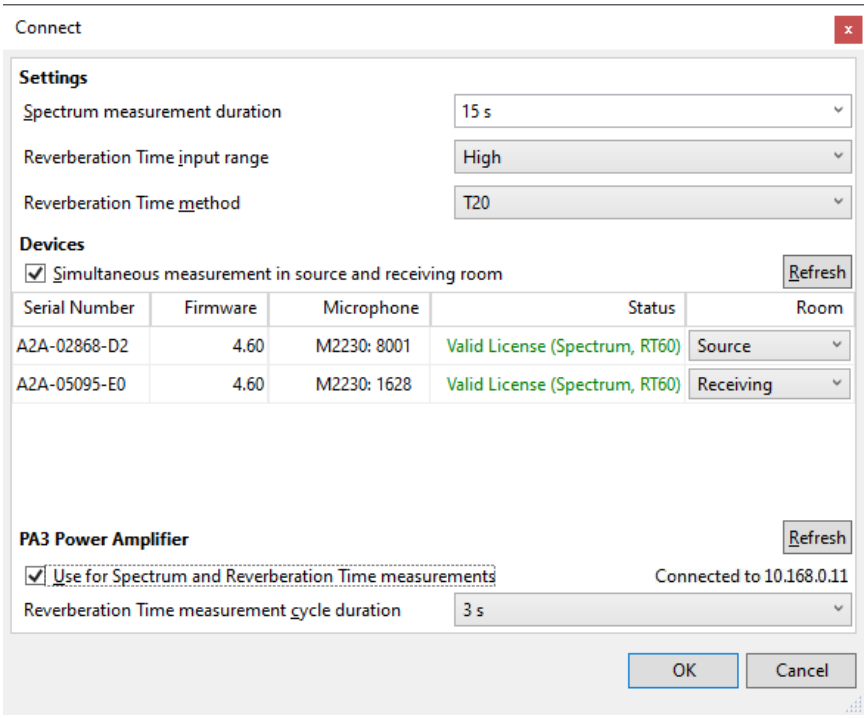
	• Signature: 350 x 70 px, 96 dpi

(12) **Connect**

- Select the **SLM measurement duration** (default = 15 seconds);

  The standard ISO 16283 lists a minimum measurement duration for fixed microphone positions of:

  - 6 seconds for the frequency range 100 Hz - 5000 Hz;
  - 15 seconds for the frequency range 50 Hz - 5000 Hz.
- Select the **Reverberation Time input range** (default = High);
- Select the **Reverberation Time method** (default = T20);
- Click **Refresh** to detect the connected XL2 Acoustic Analyzer or XL3 Acoustic Analyzer



- **Simultaneous measurement in source and receiving room**
  - This selection is dedicated for parallel measurements in source and receiving room with one or more instruments. Assign at least one device to the source room and another one to the receiving room for airborne or facade sound insulation measurements. The Sound Insulation Reporter software may operate multiple instruments at the same time.
- Measuring with one or more instruments in the same room:
  - Do not select **Simultaneous measurement in source and receiving room**;
  - Assign the applicable instruments to **Any**.

	• Microphone:
	  • Arrows next to the serial number indicate, that the assigned microphone correction will be applied. This may be set at **File -> Preferences... -> Microphone Corrections**.
	• The **Status** column list one of the following information:
	  • **Valid Licence**;
	  • **Upgrade required**;
	  • **Unassigned Device** (XL2 Acoustic Analyzer or XL3 Acoustic Analyzer will not be used to measure);
	  • **Not Connected** (the XL2 Acoustic Analyzer or XL3 Acoustic Analyzer was previously connected and assigned to the specified room; if you forgot to connect it, then place it in the assigned room, connect it and click **Refresh**; if you don't want to use this device anymore, the ignore this message).
	PA3 Power Amplifier
	• Tick this setting to remotely control the PA3 power amplifier for the Spectrum and Reverberation Time measurements, which needs to be connected via LAN or Wi-Fi to the network;
	• Set the **Reverberation Time measurement cycle duration** from 1 to 10 seconds.

(13)	**Start Remote Measurement** • Start here the selected measurement. The measurement will automatically stop after the preset measurement duration.

(14)	**Select Measurement**
	• Select one of the following measurements at airborne sound insulation testing:
	  • L1-1, L2-1 (sending & receiving room simultaneously @ speaker position 1);
	  • L1-2, L2-2 (sending & receiving room simultaneously @ speaker position 2);
	  • B2 (background noise);
	  • T2 (reverberation time).

(15)	**Stop Remote Measurement** • Stop here selected measurement prior the automated stop according the preset measurement duration.

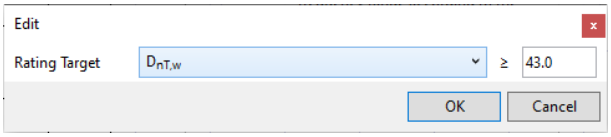
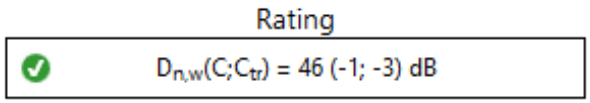
4.3 Menu

The software offers the following menu functionalities:

File	**Site**	Provides a dedicated workspace for displaying all measured partitions. This view enables simultaneous editing of multiple partitions and functions as a repository for storing all measurements associated with a specific project.
	New Partition...	A project contains the measurement data of one partition. The airborne or impact sound insulation of a new project is calculated in accordance with the selected standard: • Select the number of **Speaker positions** used for the measurement with the XL2 Acoustic Analyzer or XL3 Acoustic Analyzer; • Select **Unit**; • Select the **Results** required; • Select the preferred **Rating Format** for the standards BB93, DIN4109, ISO 16283, ISO 10140 and SIA 181. By default is the single number rating provided in 1.0 dB steps in all standards, e.g. Dw(C;Ctr) = 41 (-1;-3) dB. Alternatively, the standards BB93, DIN4109, ISO 16283, ISO 10140 and SIA 181 may show the single number rating in 0.1 dB steps with measurement uncertainty, e.g. 40.5 dB +/- 0.9 dB; • Confirm the settings with **OK**.
	Open Partition...	Select an existing project file *.xlba.
	Save Partition	Save the actual sound insulation data as project file *.xlba.
	Save Partition as...	Save the project with selectable name and path.
	Print Preview	The sound insulation reports for the selected results are displayed.
	Print...	The sound insulation reports for the selected results are printed.

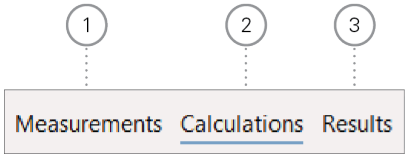
	Import	**Folder...**	Select a folder in order to import all measurement data stored in this folder.
		File...	Select a single measurement data file *.xl2 or *.xl3si.
		Airborne Difference...	Applicable for standard DIN 4109 only. Select an airborne sound insulation project based on DIN 4109.
		Any recorded data with A- or C-weighting is automatically corrected to Z-weighting (=no weighting).	
	Import Sound Insulation on XL3	Select the Sound Insulation file (.xl3si) generated during measurements conducted in Sound Insulation Option on the XL3. This file contains all predefined information regarding the measurements, as well as details about the rooms or partitions specified in the XL3 Acoustic Analyzer.	
	Export to Excel...	Export all measurement data and results into MS Excel.	

	Preferences...	**General** The Sound Insulation Reportersoftware is available in Chinese, English and German language. Additionally, the reporting is offered in the languages Czech and Italian. The default setting use the language of the operating system installed on your computer. Select the language as follows: • Select **File** in the menu; • Select **Preferences...**; • Select the language. Changing the language will require a restart of the software; • Confirm the settings with **OK**. The software closes and restarts with the selected language. **Microphone Corrections** • Enter any applicable frequency response correction for the used measurement microphones here with type and serial number. The unit is [dB]. This correction is automatically applied at the import of any data recorded with this microphone or any remote measurements performed. Sound Insulation Reportercalculates (measurement result + correction) for each frequency band and presents the result in the chart. The data set requires to list the same type and serial number in the header data in order to detect the microphone type and serial number. • Note: the correction is not applied on any existing projects.
	Recent	Select a recently-opened project.
	Exit	Close the software.

Edit	**Cut**	Cut the text from any text box.
	Copy	Copy the data selected in the right-hand **Measurements**, **Calculations** or **Results** box.
	Paste	Paste the copied text into any text box.
	Delete	Delete the data selected in the right-hand selection box in **Measurements**.
	Select All	Select all data in the right-hand **Measurements** box (applicable in Measurements View only).
	Deselect All	Deselect all earlier selected data in the right-hand **Measurements** box (applicable in Measurements View only).
	Rating Target...	Configure the Rating Target or select a predefined Rating Target from the list (Preferences > Rating Target) to assess the compliance of your measurement against established expectations.  The outcome will be presented as a Pass/Fail result in the Compliance column.  Pass according to Rating result and its Target Fail according to Rating result and its Target
View	**Measurements**	Select the Measurements View.
	Calculations	Select the Calculation View.
	Results	Select the Results View.
	Settings	Opens the Project Settings window.
Measure	**Connect...**	Opens the window **Connect**.
	Start	Starts the selected measurement.
	Stop	Stops the select measurement.
	Measurements e.g. L1-1/L2-1	Select the measurement.
Help	**Online Help**	Link to download the user manual in PDF form.
	Check for Updates...	Checks for available updates of the Sound Insulation Reporter software.
	About	List's version and copyright details of the software.

4.4 Analysis and Reporting Views

The Sound Insulation Reportersoftware offers three views for fast data analysis and straightforward reporting in accordance with the standard.



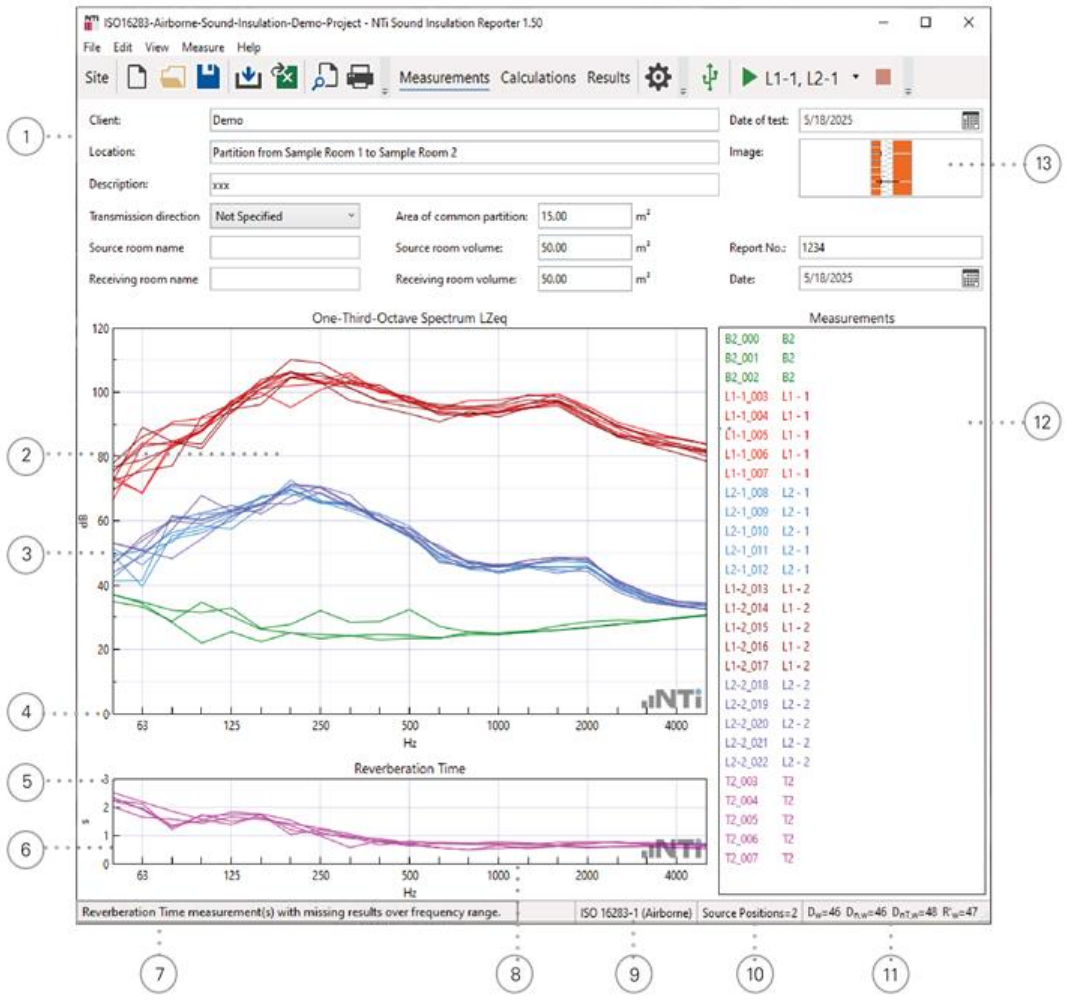
1 **Measurements View**

2 **Calculations View**

3 **Results View**

4.4.1 Measurement View

By default, all measurement data are automatically assigned to the corresponding sending or receiving room, as well as the speaker position for the sound insulation calculation. Alternatively, the date can be assigned manually.

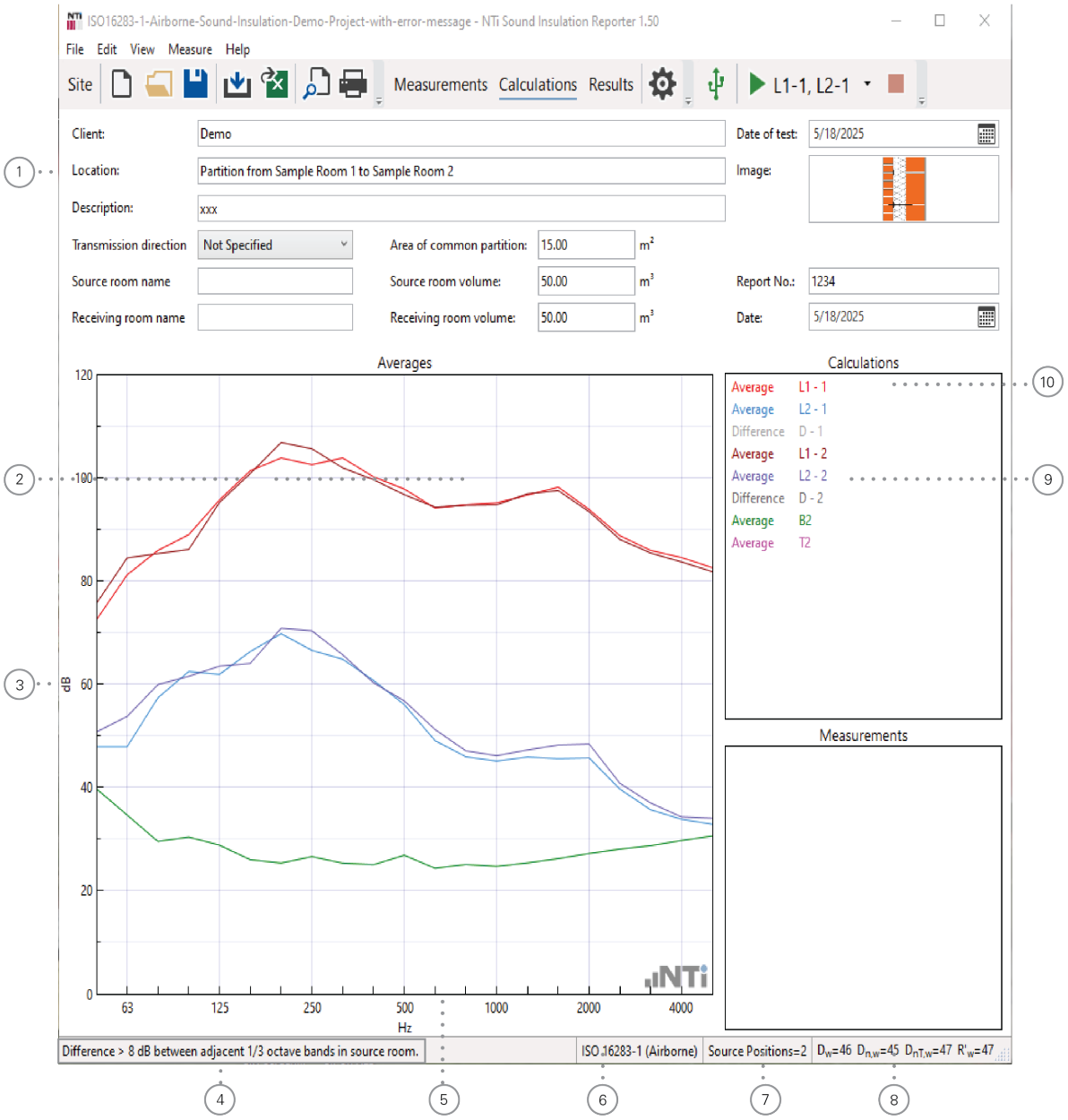


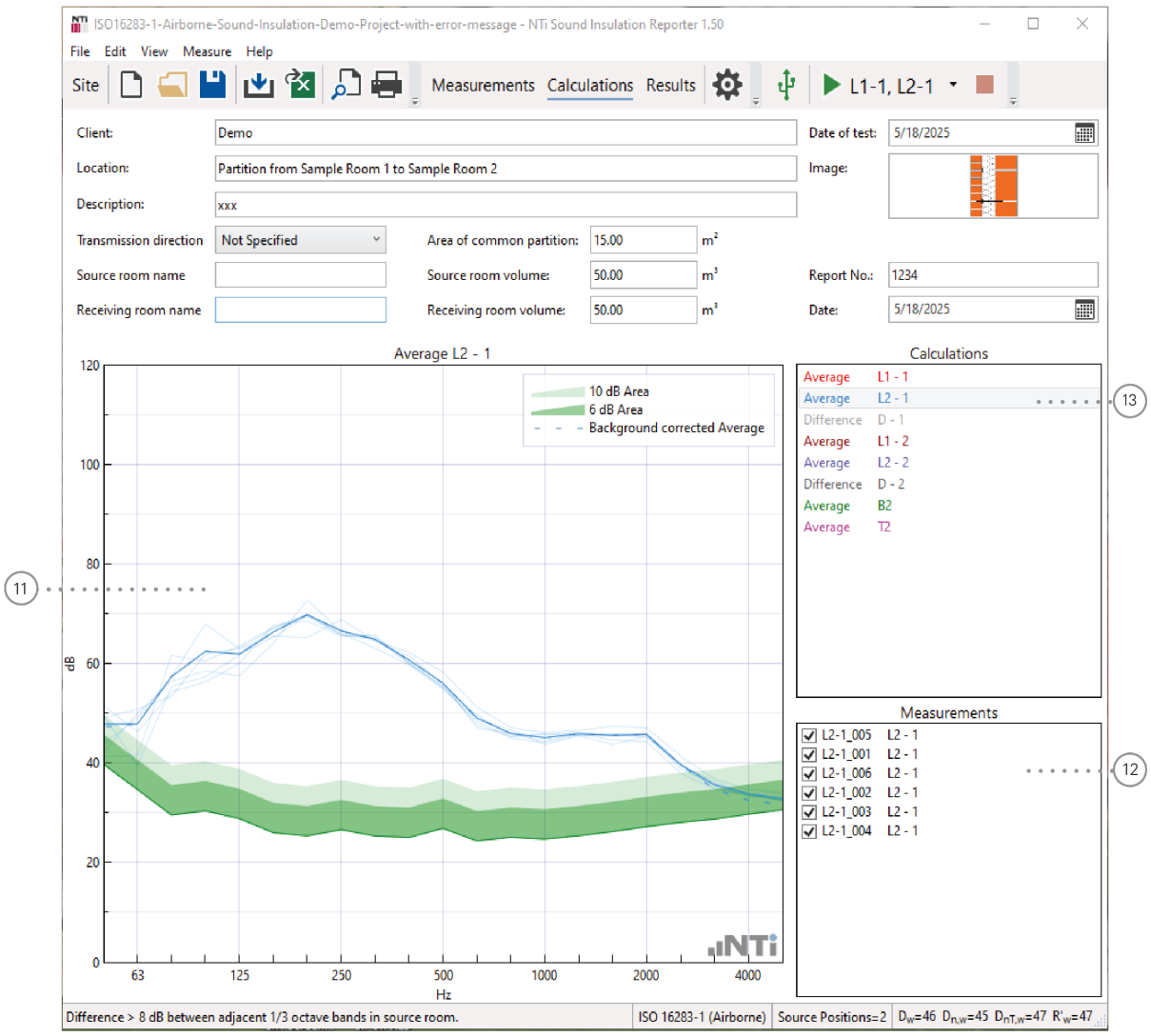
1	**Details** • Header data of the Sound Insulation Reporter. The partition area and volume parameters are used for the sound insulation calculation.
2	**Spectrum Measurements Chart** • The original XL2 Acoustic Analyzer measurement data is visualized in the frequency range from 50 Hz to 5 kHz.
3	**Y-Axis of Spectrum Measurements Chart** • Set the Y-axis in **Settings -> Charts**.
4	**X-Axis of Spectrum Measurements Chart** • The X-axis is fixed to 50 Hz - 5 kHz.
5	**Reverberation Time Measurements Chart** • The original XL2 Acoustic Analyzer measurement data is visualized in the frequency range from 50 Hz to 5 kHz.
6	**Y-Axis of Reverberation Time Measurements Chart** • Set the Y-axis in **Settings -> Charts**.
7	**Guideline Bar** • Additional information about displayed measurement data is listed here.
8	**X-Axis of Reverberation Time Measurements Chart** • The X-axis is fixed to 50 Hz - 5 kHz.
9	**Standard** • Selected standard for the sound insulation calculation and reporting.
10	**Speaker Positions** • Reads the number of set speaker positions.
11	**Single Number Sound Insulation** • Reads the single number results. Select the calculated results in **Settings -> General**.

12	**Measurements List with Mappings**
	• List all the imported XL2 Acoustic Analyzer measurement data files with the automatically-assigned mapping. The mapping may be assigned manually to sending room or receiving room and the individual speaker positions:
	  • Select the measurement with the mouse;
	  • Click on the right mouse button;
	  • Select **Assign To**;
	  • Assign the measurement.

13	**Image**
	• Click into the image field and load a drawing or picture describing the partition. The recommended maximum size is for:
	  • A4 Reporting: 340 x 160 px;
	  • Letter Reporting: 350 x 130 px.

4.4.2 Calculations View





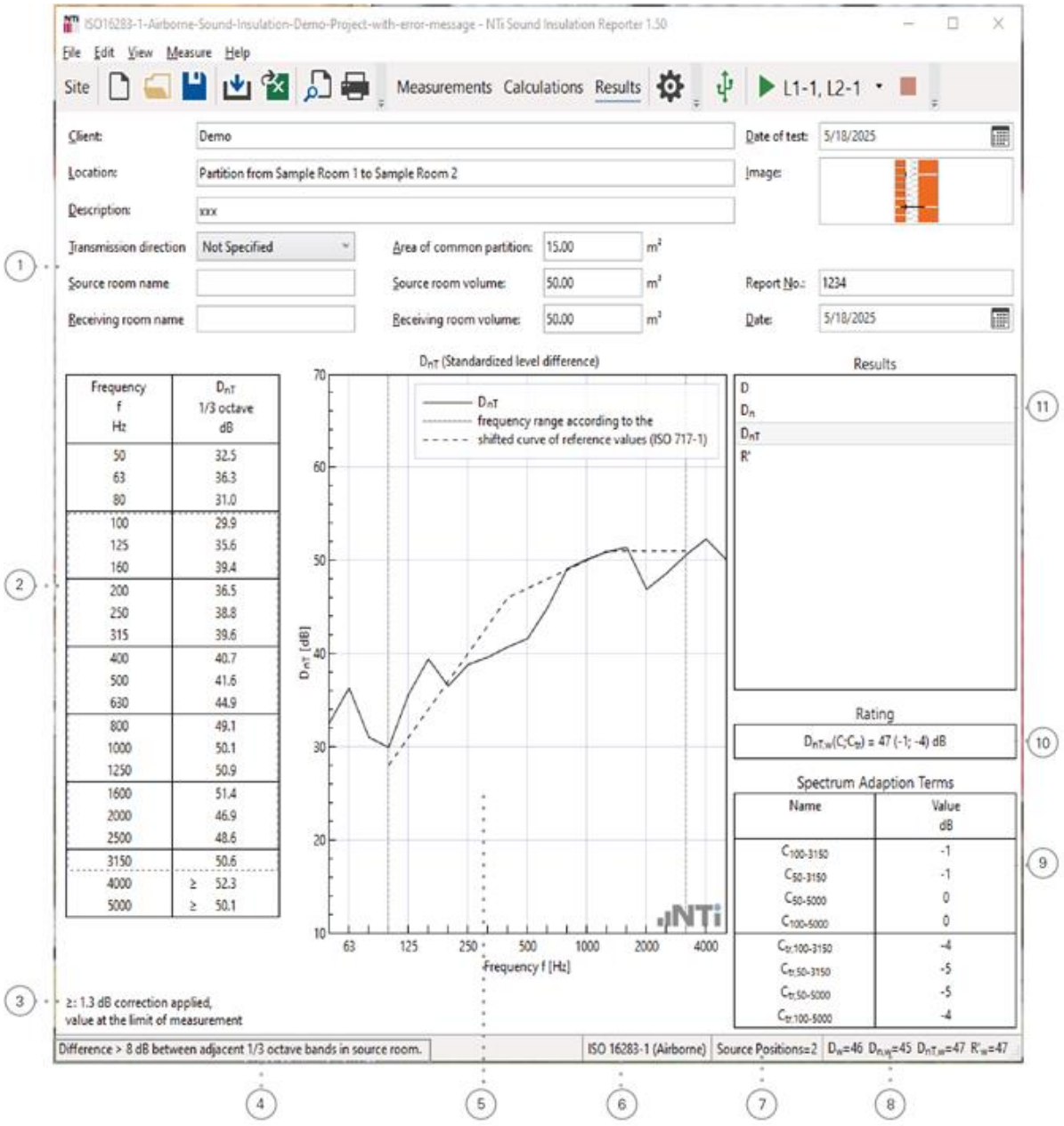
1	**Details** • These data are listed in the header of the Sound Insulation Reporter. The partition area and volume parameters are used for the sound insulation calculation.
2	**Chart** • The averaged measurement data for sending room, receiving room and individual speaker position is visualized in the frequency range from 50 Hz to 5 kHz.
3	**Y-Axis** • Set the Y-axis in **Settings -> Charts**.
4	**Guideline Bar** • Additional information about displayed measurement data is listed here.
5	**X-Axis** • The X-axis is fixed to 50 Hz - 5 kHz.

6	**Standard** • Selected standard for the sound insulation calculation and reporting.
7	**Speaker Positions** • Reads the number of set speaker positions.
8	**Single Number Sound Insulation** • Reads the single number results. Select the calculated results in **Settings -> General**.
9	**Differences** • Select **Difference D-1** and view the averaged sending room, averaged receiving room and the calculated difference for the speaker position 1. Any applicable background noise correction is included by default.
10	**Average** • Averaged data sets for sound insulation calculation • Select e.g. **Average L1-1** for detailed verifications of the measurement data used for the average calculation • Press ESC on the keyboard to return to the default view with all averaged measurements.
11	**Detailed View** • Displays all measurement data and the averaged result for the selected parameter.
12	**Measurement Selection** • Disable any measurement data, which shall not be used for the average calculation.
13	**Selected Average Parameter** • Select the parameter for detailed analysis.

4.4.3 Results View

The results view displays the following sound insulation results based on the selected result type:

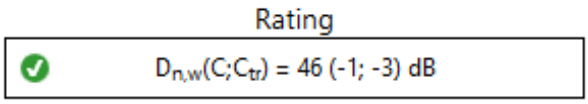
- Table from 50 Hz - 5 kHz;
- Standardized chart from 50 Hz - 5 kHz;
- Single number quantity;
- Spectrum adaptation terms C and Ctr.



1	**Details** • These data are listed in the header of the sound insulation report. The partition area and room volume parameters are used for the sound insulation calculation.
2	**Results** • Sound insulation results in the frequency range from 50 Hz to 5 kHz; • The fixed background noise correction of 1.3 dB is automatically applied in case the receiving room level differs by less than 6 dB from the background noise level, e.g. in accordance with ISO 16283. In case this fixed correction is applied, then the applicable frequency bands are marked by the symbol ≤ or ≥; see 3.

3	**Information about Background Noise Correction** • A fixed background noise correction applied in the table at 2 frequency bands marked by the symbol ≤ or ≥.
4	**Guideline Bar** • Additional information about displayed measurement data is listed here.
5	**Results Chart** • Sound insulation results spectrum with shifted reference curve in the frequency range from 50 Hz to 5 kHz.
6	**Standard** • Selected standard for the sound insulation calculation and reporting.
7	**Speaker Positions** • Reads the number of set speaker positions.
8	**Single Number Sound Insulation** • Reads the single number results. Select the calculated results in **Settings -> General**.

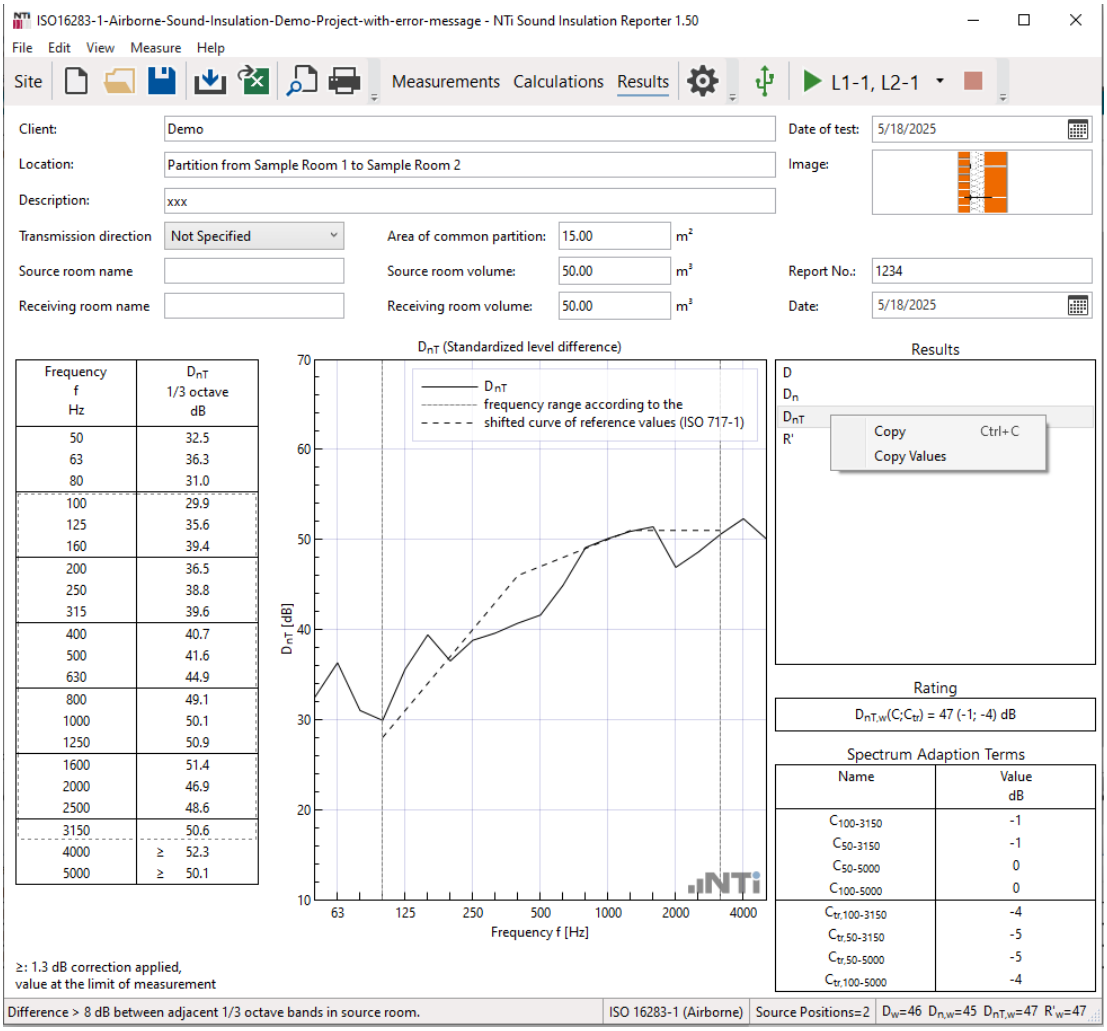
9	**Spectrum Adaption Terms**
	Value, in decibels, to be added to the single-number rating (e.g. R'w) in accordance with ISO standards. These take into account different spectra of noise sources; such as pink noise (C) and road traffic noise (Ctr).
	Application examples:
	• C:
	  • Living Area Noise (talking, music, radio, TV), trains at middle and high speed, highway traffic @ speed > 80 km/h, jets in near distance, factories with mainly middle- and high-frequency noise.
	• Ctr:
	  • traffic noise in cities, trains at low speed, jets in far distance, airplanes, factories with mainly low-frequency noise.

10	**Single Number Quantity** • This is the single number sound insulation result. The single number result equals the level of the shifted reference curve at 500 Hz; • Select the preferred **Rating Format** for the standards BB93, DIN4109, ISO 16283, ISO 10140 and SIA 181. By default is the single number rating provided in 1.0 dB steps in all standards, e.g, DwiC;Ctr) = 41 (-1;-3) dB. Alternatively, the standards BB93, DIN4109, ISO 16283, ISO 10140 and SIA 181 may show the single number rating in 0.1 dB steps with measurement uncertainty, e.g. 40.5 dB +/-0.9 dB. • When you click on Rating, you can add a Rating Target, which will later appear in the Site View to indicate whether the results are in compliance. The outcome will be presented as a Pass/Fail result in the Compliance column.  Pass according to Rating result and its Target Fail according to Rating result and its Target
11	**Result Selector Box** • Select the required sound insulation result here. The available results are preset in **Settings - > General**.

4.5 Export Measurement Data

Click on the "Export to Excel..." button in the menu bar. This exports all measurement data and results into MS Excel. Alternatively, you may export individual data and charts for user defined analysis and reporting as follows:

- Select the required result or data set in the right-hand column and click with the right mouse key,



- Select **Copy** or **Copy values**. **Copy** selects the data with headers - **Copy values** just the data;
- Alternatively press CTRL+C on the computer keyboard;
- Open the application e.g. Microsoft Excel;
- Press CTRL+V on the computer keyboard for the data or Paste Special for the chart.

The selected measurement data is exported.

4.6 Re-Use and Edit Data

This chapter describes how measurement data may be imported from other projects and how reverberation time date may be duplicated and edited.

4.6.1 Add Data from other Projects

Measurement data may be imported from other projects. This allows to re-use the same background noise or reverberation time data of the receiving room for multiple projects; e.g. in case the sound insulation from rooms left, right or on top of the receiving room shall be evaluated. Also, data recorded directly by the Sound Insulation Reporter software by automated measurements may be re-used in this manner.

How to import data from another project?

- Select File -> Import -> Measurements from Project;
- Select your existing Sound Insulation Reporter Project;

All data of the selected project is imported into the existing project.

- You may delete any non-required data;
- Verify the assignment of the imported data.

4.6.2 Edit reverberation time data

Reverberation time data sets may be incomplete, e.g. due to insufficient sound energy in the room in lower frequency bands. The Sound Insulation Reporter software allows to duplicate a reverberation time data sets and edit them for evaluation. The original data set remains available.

How to duplicate and edit reverberation time data?

- Select the Measurement View;
- Click with the right-mouse-button on a reverberation time measurement;
- Select Duplication to Edit...; the Edit Measurement panel opens;
- Edit name and data values;
- Press OK to store your changes;
- Delete the original data set or disable it in the Calculations View from the average calculation.

4.7 Standard ISO 16283

4.7.1 Low Frequency Procedure for Rooms < 25 m3

The following applies:

- First a room volume < 25 m3 has to be entered. Then the measured data may be assigned in accordance with the low frequency procedure;
- The reverberation time of the 63 Hz octave band is calculated based on linear average of measured 50 Hz, 63 Hz and 80 Hz frequency bands.

4.7.2 Measurement of Doors

For the measure the sound insulation of doors the following has to be observed:

- The area of common partition is the area of the free opening in which the door, including its frame, is mounted;
- The apparent sound reduction index of a door measurement is correct in case all the sound is transmitted through the door area;

- A second sound insulation measurement is required in order to check the flanking transmission by fitting the door with additional sound insulation. The measured sound insulation is stored as reference;
- The reference data from the second measurement may be loaded into the project of the door under test by selecting **File -> Import -> Reference R'...**;
- Compare the sound insulation of the door under test and the reference in the **Calculations** view;
- The Results view presents the apparent sound insulation R' including any applicable corrections.

4.8 Standard DIN 4109

4.8.1 Airborne sound transmission correction at impact insulation assessments

The standard DIN 4109 can be selected at the start of a new project. The functionalities and calculations are identical to the standard ISO 16283. Additionally, is the German requirement to perform an airborne sound transmission correction at impact insulation assessments listed in Appendix A of DIN 4109-4:2016.

In case a high airborne sound level is generated by the tapping machine in the sending room, then the measured impact noise level in the receiving room can be influenced by the airborne noise transmission through the partition under investigation. Follow these steps to include the correction for the airborne sound transmission:

- Assess the airborne sound insulation D between the two partitions (create a new project and select the standard DIN 4109);
- Verify the impact sound insulation without any airborne sound correction;
- Measure the sound pressure level of the tapping machine in the sending room and assign the data sets to the sending room **L1** in the software;
- Select in the menu **File -> Import -> Airborne Difference...** and choose the project with the airborne sound insulation D;

The project with the airborne sound insulation D is loaded and the correction applied for the impact sound insulation calculation.

- Evaluate the effect with or without airborne sound transmission correction by deleting the **Airborne Difference D** in the **Measurements** view and import this correction again as required.

4.8.2 Airborne sound transmission testing of doors from apartments to stair cases or corridors

The stair case or corridor is used as sending room. The sending room level is measured by scanning the level in front of the door. This measurement method requires a 3 dB correction to default measurements in the room.

4.8.3 Measurement of the airborne sound insulation of external components in the building

The Sound Insulation Reportersoftware calculates the sound reduction index R' according to the angle used by the loudspeaker to the perpendicular of the test object. One of the following measurements methods may be selected:

- Element Loudspeaker method:
  - flush-mounted microphone close to the test surface;
  - the sound reduction index R' is calculated according to DIN 4109-4 (formula B.2):

$$\mathrm{R'd} = \mathrm{L1} - \mathrm{L2} + 10 * \log\left(\mathrm{S}^{\star}\mathrm{T}/(0.16 * \mathrm{V})^{\star}\cos\mathrm{d}\right)$$

- Global Loudspeaker method:
  - microphone mounted 2 m in front of the building;
  - athe sound reduction index R' is calculated according to DIN 4109-4 (formula B.3):

$$\mathrm{R'd} = \mathrm{L'1} - \mathrm{L2} + 10 * \log(\mathrm{S} * \mathrm{T}/\left(0.16 * \mathrm{V}\right) * \cos\mathrm{d}) + 3\ \mathrm{dB}$$

Where:

L1	sound pressure level on the surface of the test object [dB]
L'1	sound pressure level at 2 m in front of the test object [dB]
L2	sound pressure level in the receiving room [dB]
S	area of the test item
T	reverberation time
V	volume of the reception room
δ	angle of the loudspeaker to the vertical perpendicular of the test object

4.9 Standard ISO 10140

ISO 10140 specifies a laboratory method for measuring the:

- airborne sound insulation of building products, such as walls, floors, doors, windows, shutters, façade elements or façades;
- impact sound insulation for floor assemblies.

4.9.1 Flanking Transmission at Airborne Sound Insulation

In laboratories complying with ISO 10140-5, ensure that the sound transmitted by indirect paths is negligible compared with the sound transmitted through the test element. A preliminary test shall be carried out to ensure that sound power transmitted through the surrounding partition is small compared with the sound power transmitted through the test element.

- Select the applicable test arrangement in the **Project Settings**:
  - **Full-size test opening**;
  - **Reduced-size opening (building element)**;
  - **Reduced-size opening (technical element)**.
- Measure the maximum airborne sound insulation of the test stand and store the project data as reference;
- Install the test element and perform the sound insulation test;
- The reference data may be loaded into the project of the test element by selecting **File -> Import -> Reference Level ...**;
- Compare the sound insulation of the test element and the reference in the **Calculations** view;
- The **Results** view presents the apparent sound insulation R' including any applicable corrections.

4.9.2 Floor coverings - Improvement of Impact Sound Insulation

The Sound Insulation Reporter software allows evaluating the weighted reduction in impact sound pressure level ΔL. This is the impact sound insulation improvement of a floor under test compared to a reference floor.

- Measure the impact sound insulation of the reference floor and save the data in a project;
- Open a new impact sound insulation project and activate ΔL as result;
- Measure the impact sound insulation of the floor under test;
- Select **File -> Import -> Reference Level Ln...**;
- Select the reference floor project. Now the reference level Ln is imported and displayed in the measurements view;
- Switch to the results view and select the result ΔL;
- Set the Y-scaling in the Settings-Charts menu as required.

4.10 Standard BB93

Building Bulletin 93 (BB93) explains minimum performance standards for the acoustics of school buildings in the UK. The latest edition is dated February 2015. The sound insulation is measured and reported in accordance with ISO 16283.

For the purpose of the assessment the mid-frequency reverberation time Tmf may be edited in accordance with BB93, which lists the maximum expected reverberation time of the finished and unfurnished room. The Tmf is the is the arithmetic average of the reverberation times in the 500 Hz, 1 kHz and 2 kHz octave bands, or the arithmetic average of the reverberation times in the one-third octave bands from 400 Hz to 2.5 kHz. In practice the difference between the measured and listed Tmf will be small. This is acceptable in the interests of simplicity and ease of measurement.

4.11 England/Wales: Approved Document E (2003)

Approved Document E provides guidance on the resistance to the passage of sound in domestic buildings, in schools and flats. This guidance applies to new buildings, to alterations to pre-existing premises and to buildings being converted to flats in the England and Wales. The latest amendment has been made in 2015.

It specifies to measure the sound insulation in accordance with the standard series ISO 140.

5 Revision-History

5.1 Release V1.47, Oct 2024

- Chinese standard GB/T 19889:2022;
- Remote measurement:
  - Support XL3 Acoustic Analyzer.
- General:
  - Show insulation results after first measurement/speaker position.
- Reporting:
  - Language Lithuanian.

5.2 Release V1.40, Nov 2022

- XL3 Acoustic Analyzer:
  - Import measurement data;
  - Import sound insulation projects (File -> Sound Insulation on XL3 Acoustic Analyzer...).
- General:
  - Import and drag&drop of zip files;
  - Rounding of spectrum adaption terms in accordance with ISO 717.
- Reporting:
  - Language Latvian.

5.3 Release V1.36, Nov 2021

- Dutch standard NEN 5077:2019;
- Swiss standard SIA181:2020;
- Updated ASTM E336 to latest release 2020;
- Façade Sound Insulation:
  - Global and Element Loudspeaker method;
  - Signal sources Road Traffic, Railway Traffic and Aircraft Traffic.
- ISO 16283:
  - Airborne sound insulation of doors;
  - Rating result for impact source "Rubber Ball";
  - Low frequency procedure for rooms < 25 m3 calculates reverberation time as linear average of 50 Hz, 63 Hz and 80 Hz frequency bands.

- ISO 717:
  - Spectrum adaption terms for rating format 0.1 dB calculated according to ISO 717-1:2020.
- ISO 10140:
  - Impact source "Rubber Ball";
  - Include flanking transmission.
- DIN 4109:
  - Calculate Sound Insulation Index R' for "Global" measurement method;
- Remote measurement:
  - Support spectrum measurements without optional Extended Acoustic Pack installed.
- Reporting:
  - Values at the limit of measurement are marked by ≤ or ≥;
  - Languages Dutch, French, Korean, Swedish;
  - Optimized chart and scaling;
  - Increased maximum room volume.

5.4 Release V1.30, Dec 2019

- Enable copy and edit Reverberation Time data;
- Import measurement data from other projects (re-use live measurements for different standards);
- Impact sound pressure level reduction ΔLw for ISO 10140;
- Standard BB93, Acoustic Design of Schools;
- Updated measurement uncertainty according to ISO 12999-1:2014 for DIN 4109, ISO 16283, ISO 10140 and SIA 181;
- Standard DIN 4109:
  - Door scanning method for airborne sound insulation;
  - Simultaneous measurement of send and receive room for impact sound insulation;
  - List frequency bands with airborne noise correction for impact sound insulation measurements;
  - Angle of incidence for façade sound insulation.
- Remote measurement:
  - Extended measurement duration settings for Noise and Reverberation Time;
  - Selectable T20 or T30 reverberation time measurement.

- Reporting:
  - Appendix number in header;
  - More space for long descriptions;
  - Extended configurations for flexible reporting;
  - Languages Italian and Czech;
  - Today button on calendar date.

5.5 Release V1.28

- Sound Insulation in accordance with DIN 4109 including airborne noise correction at impact noise measurement;
- Laboratory measurement of sound insulation of building elements in accordance with ISO 10140;
- Measurement and analysis of impact sound insulation with rubber ball in accordance with ISO 16283-2;
- Flexible range setting for remote measurement of reverberation time;
- Apply frequency response correction data for measurement microphone;
- Automated test signal activation with remotely controlled PA3 Power Amplifier for Dodecahedron Speaker DS3;
- Extended reporting flexibilities, e.g. hide sending room volume.

5.6 Release V1.27

- Export to Excel;
- Sound Insulation in accordance with SIA 181:2006;
- Low-frequency procedure in accordance with ISO 16283;
- Measurement uncertainty listed as single-number results in accordance with ISO 717;
- Remote measurement in the same room with one or multiple instruments;
- Extended reporting flexibilities, e.g. picture added.

5.7 Release V1.26

- Remote measurement in sending and receiving room at the same time;
- Façade Sound Insulation in accordance with ISO 16283-3, ISO 140-5 and ASTM E966;
- Sound Insulation in accordance with GB/T 19889;
- Extended reporting flexibilities.

5.8 Release V1.25

- Remote measurement in sending and receiving room at the same time;
- Façade Sound Insulation in accordance with ISO 16283-3 and ASTM E966;
- Extended reporting flexibilities.

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APPENDIX: Sound Insulation Measurement

This application note describes how to measure sound insulation. This includes airborne and impact sound insulation between two rooms and the airborne sound insulation of façades using sound pressure measurements. All measurements are performed by the XL3 Acoustic Analyzer or XL2 Acoustic Analyzer and documented using the Sound Insulation Reporter software in accordance with the standard series ISO 16283 and ASTM.

The sound insulation is calculated by combining multiple sound pressure level and reverberation time measurements. The measured frequency range is typically from 50 Hz to 5 kHz. The measured airborne sound insulation is frequency-dependent but can be converted into a single number, the sound reduction index, to characterize the acoustic performance.

This application note applies to rooms with a volume between 25 m3 and 250 m3. Special methods apply to smaller rooms.

a. Required instrumentation

The sound level meter shall meet the requirements of a Class 1 instrument in accordance with the IEC 61672-1 standard. The recommended configuration consists of:

XL3 Acoustic Analyzer

- XL3 Acoustic Analyzer or XL3-TA for legally traceable measurements (=XL3 Acoustic Analyzer with Type Approval Option installed);
- Reverberation Time Option or Sound Insulation Option (required for reverberation time measurement in 1/3 octave resolution;
- Sound Insulation Bundle or Sound Insulation Reporter365 (annual subscription service).

XL2 Acoustic Analyzer

- XL2 Acoustic Analyzer or XL2-TA for legally traceable measurements (=XL2 Acoustic Analyzer with Type Approval Option installed);
- Optional Extended Acoustic Pack installed (required for reverberation time measurement in 1/3 octave resolution);
- XL2 Acoustic Analyzer Sound Insulation Option (permanently installed) or Sound Insulation Reporter365 (annual subscription service).

- M2230 Measurement Microphone;
- ASD Cable, 5m;
- NTi Audio Class 1 Sound Calibrator 94 dB;
- Lightweight Microphone Tripod;
- DS3 Dodecahedron Speaker;
- PA3 Power Amplifier;
- Tapping Machine TM3;
- Computer/Tablet with Sound Insulation Reporter software.

a.1 Calibration

At the beginning and at the end of each measurement day, the entire sound pressure level measurement system shall be checked with the NTi Audio Class 1 Sound Calibrator 94 dB. This calibrator meets the class 1 requirements specified in the standard IEC 60942.

Notes:

- The sound pressure level measuring system shall be calibrated at intervals not exceeding two years;
- Wear hearing protection for all measurements.

b. Application Note: Manual Sound Insulation Measurement

c. Airborne Sound Insulation between two Rooms

Measuring the airborne sound insulation between two rooms in a building requires the following measurements:

- Sound pressure level in the sending room;
- Sound pressure level in the receiving room;
- Background noise level in the receiving room;
- Reverberation time in the receiving room.

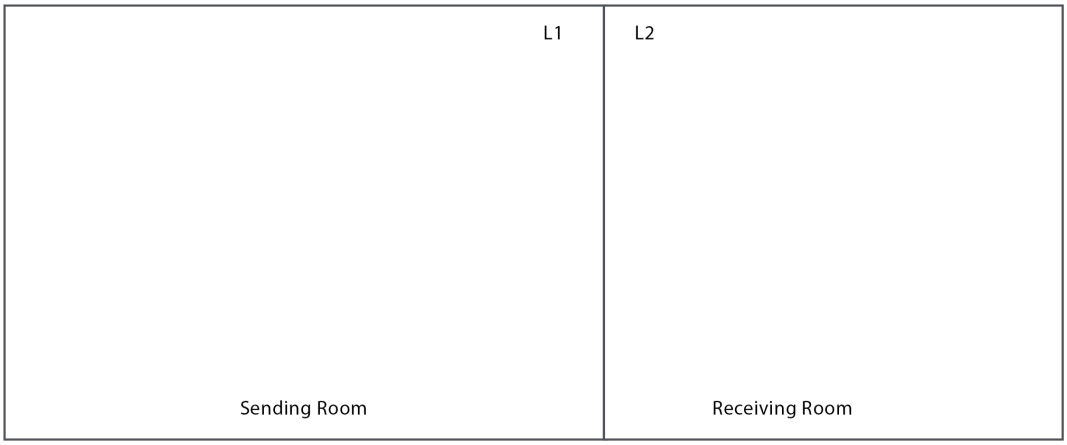
The basic concept of sound insulation measurements is to play a pink noise test signal by the Dodecahedron Speaker DS3 in the sending room. This generates a diffuse sound field in the room. The generated sound is transmitted through the common partition into the receiving room, where also a diffuse sound field throughout the room is assumed.

First the sound pressure level spectrum is measured in the sending room at multiple microphone positions and averaged. The same is repeated for the receiving room - any disturbing background noise is deducted.

The difference indicates the insulation for the first speaker position. The same procedure is repeated for a second speaker position. Additional reverberation time measurements are carried out in the receiving room for corrections - e.g, the receiving room level is higher at very reverberant rooms.

c.1 Room Selection

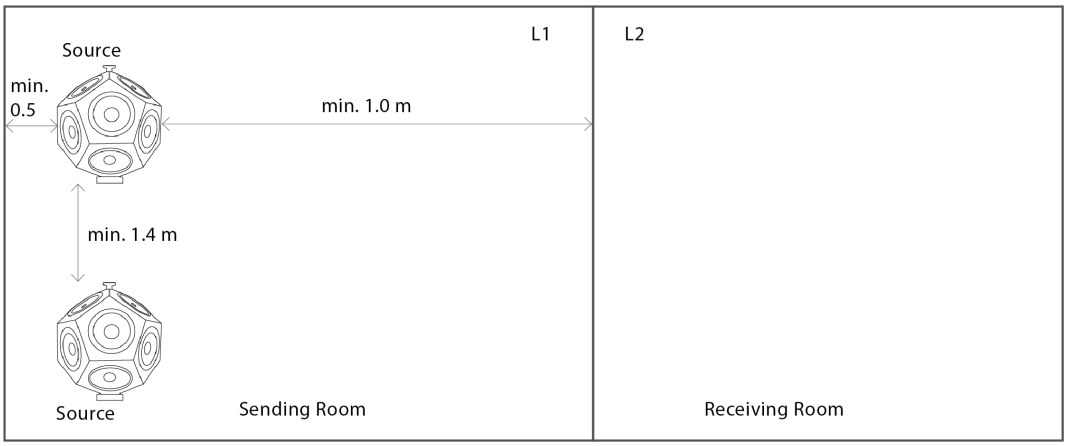
Airborne sound insulation is measured between two rooms. One room is chosen as the sending room and the other one is chosen as the receiving room. In case the volumes of the two rooms differ, then the smaller room shall be used as the receiving room. If one of the rooms is box-shaped and the other has a more complicated geometry, the box-shaped room shall be used as the receiving room.



Selecting Sending Room and Receiving Room

c.1.1 Speaker Position

- Position the Dodecahedron Speaker DS3 in the sending room;
- The measurements have to be carried out with at least two different speaker positions;
- Choose speaker position 1 at least 0.5 m from any room boundary and at least 1.0 m from the separating partition. Position 2 shall be similarly chosen, plus be in a different plane relative to the room boundaries, and with a minimum 1.4 m distance to position 1. In case the separation partition is a floor and the speaker is in the upper room, then the Dodecahedron Speaker DS3 has to be at least 1 m above the floor. The distances are measured from the center of the individual driver unit of the Dodecahedron Speaker DS3 closest to the boundary or other speaker position.



Positions of the test signal source for the sound level measurements

c.1.2 Test Signal Level

- Reduce level settings on PA3 Power Amplifier to minimum;
- Power on PA3 Power Amplifier;
- Select the signal source "EQ Pink" for a flat acoustic response in the source room. Go for "Pink" in case a higher level is required;

- Press "Signal ON" and increase the level unit it is minimum of 6 dB - better 10 dB - higher in the receiving room than the background noise (in each frequency band from 50 Hz to 5000 Hz). In case this is not possible, then the Sound Insulation Reporter software will automatically apply corrections in accordance with the standard.

c.2 Background Noise Level in Receiving Room

c.2.1 Preparation

- It's recommended to vacate the room during the measurement so that any noise generated by the operator will not affect the measurement.

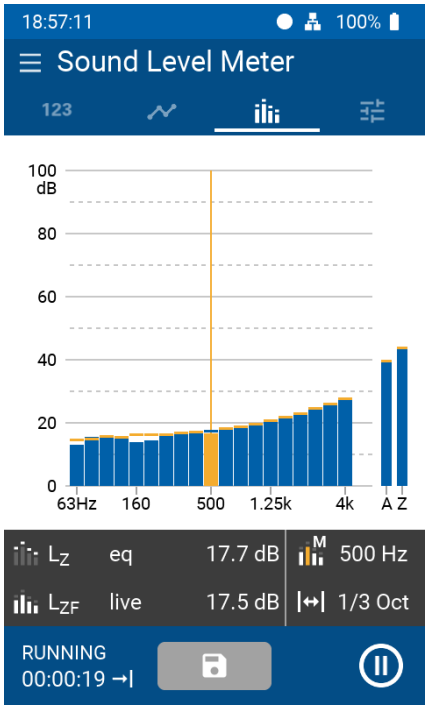
XL2 Acoustic Analyzer

- Select the RTA page in the SLMeter function on the XL2 Acoustic Analyzer;
- Select 1/3 octave measurement resolution;

Background Noise Spectrum in the Receiving Room

XL3 Acoustic Analyzer

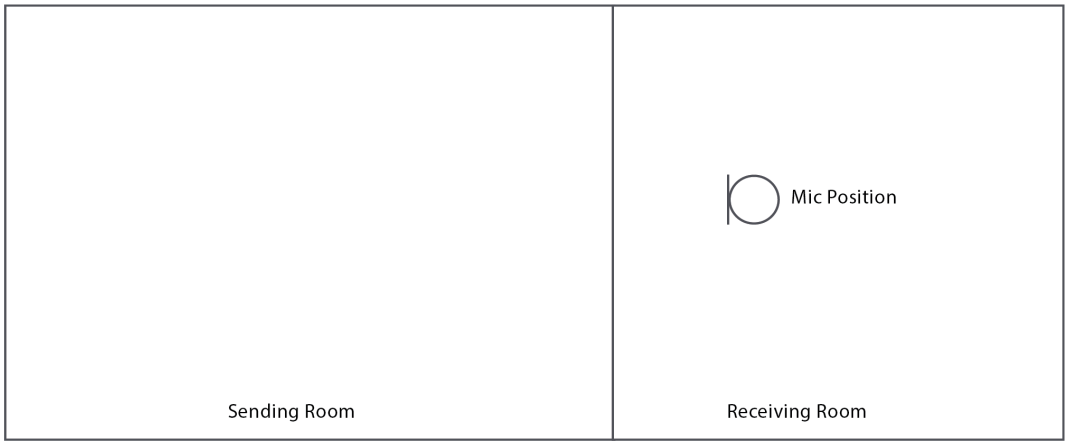
- Select the Sound Level Meter-function on the XL3 Acoustic Analyzer;
- Select 1/3 octave measurement resolution;



Background Noise Spectrum in the Receiving Room

c.2.2 Measurement

- Measure the background noise LZeq in the receiving room for the 15 seconds. In case the background noise is not steady and continuous, then a longer measurement period shall be applied e.g. 30 seconds;
- Store the individual readings on the XL2 Acoustic Analyzer or XL3 Acoustic Analyzer.



Measure the Background Noise Level Lb in the Receiving Room

c.3 Sound Pressure Levels at speaker position 1

c.3.1 Preparation

Define five microphone positions in the sending and receiving room, distributed within the maximum permitted space throughout each room. The positions shall be in a different plane relative to the room boundaries and shall not form a regular grid. For example, mark the positions on the floor with a tape. The following minimum distance apply:

- 0.7 m between microphone positions;
- 0.5 m from any room boundary;
- 1.0 m between any microphone position and the speaker.

It's recommended to vacate the room during the level measurement as the operator introduces additional absorption.

c.3.2 Measurements in Sending Room

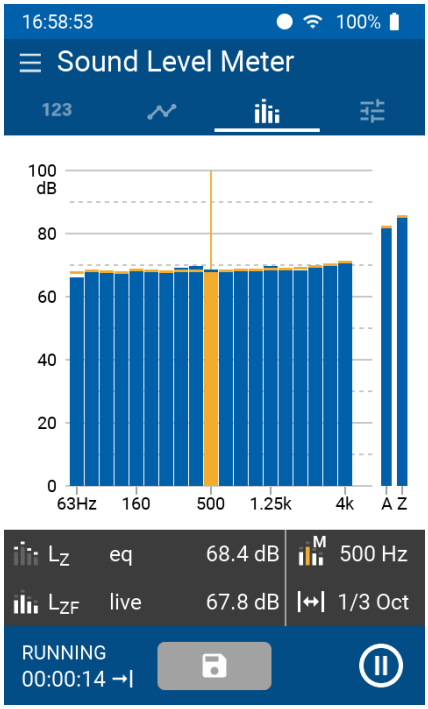
XL2 Acoustic Analyzer

- Measure the sound level spectrum LZeq in the sending room at each position for a measurement period of at least 15 seconds;
- Store the individual readings on the XL2 Acoustic Analyzer.

Noise Spectrum in the Sending Room

XL3 Acoustic Analyzer

- Measure the sound level spectrum LZeq in the sending room at each position for a measurement period of at least 15 seconds;
- Store the individual readings on the XL3 Acoustic Analyzer.



Noise Spectrum in the Sending Room

c.3.3 Measurements in Receiving Room

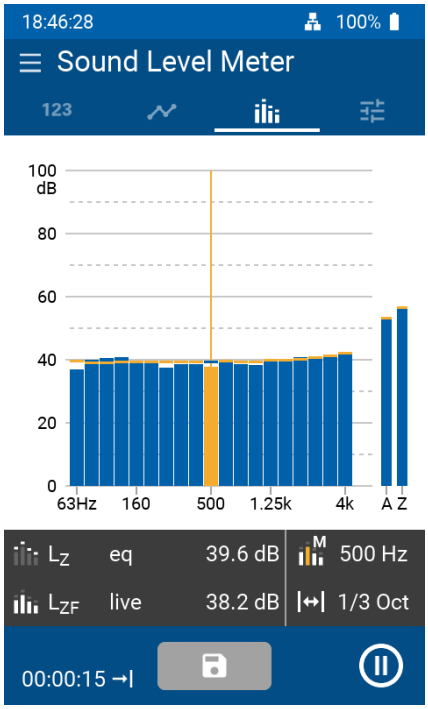
XL2 Acoustic Analyzer

- Measure the sound level spectrum LZeq in the receiving room at each position for a measurement period of at least 15 seconds;
- Store the individual readings on the XL2 Acoustic Analyzer.

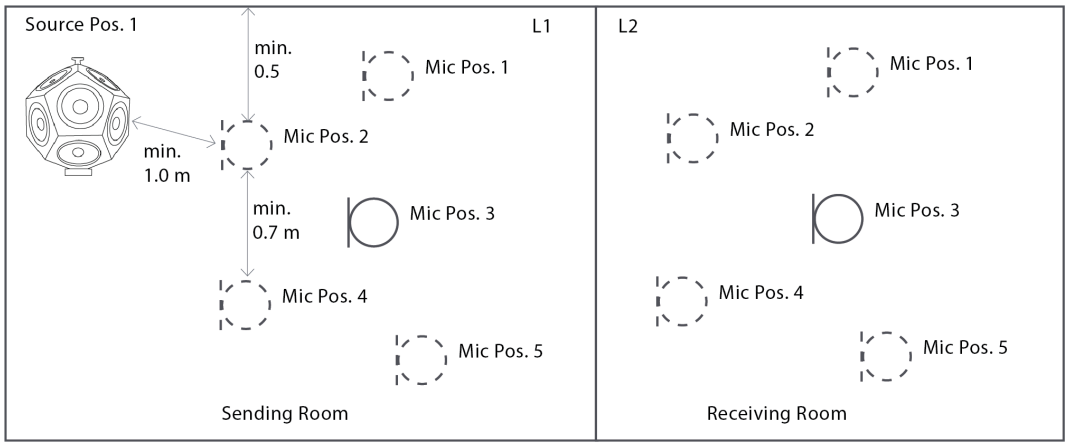
Noise Spectrum in the Receiving Room

XL3 Acoustic Analyzer

- Measure the sound level spectrum LZeq in the receiving room at each position for a measurement period of at least 15 seconds;
- Store the individual readings on the XL3 Acoustic Analyzer.



Noise Spectrum in the Receiving Room



Measure the Sound Levels in the Sending and Receiving Room with the Speaker at Position 1

c.3.4 Sound Pressure Levels at speaker position 2

Move the Dodecahedron Speaker DS3 to source position 2.

c.3.5 Measurements in the Sending Room

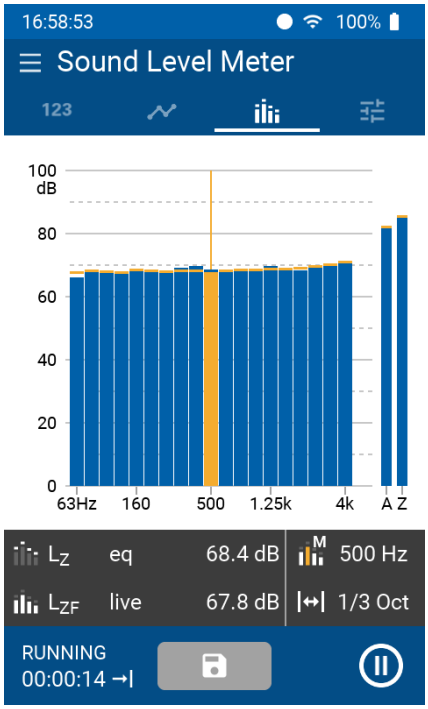
XL2 Acoustic Analyzer

- Measure the sound level spectrum LZeq in the sending room at each position for a measurement period of at least 15 seconds;
- Store the individual readings on the XL2 Acoustic Analyzer.

Noise Spectrum in the Sending Room

XL3 Acoustic Analyzer

- Measure the sound level spectrum LZeq in the sending room at each position for a measurement period of at least 15 seconds;
- Store the individual readings on the XL3 Acoustic Analyzer.



Noise Spectrum in the Sending Room

c.3.6 Measurements in Receiving Room

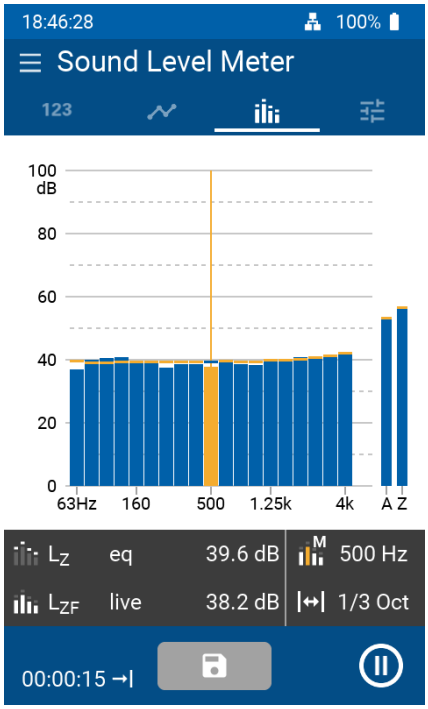
XL2 Acoustic Analyzer

- Measure the sound level spectrum LZeq in the receiving room at each position for a measurement period of at least 15 seconds;
- Store the individual readings on the XL2 Acoustic Analyzer.

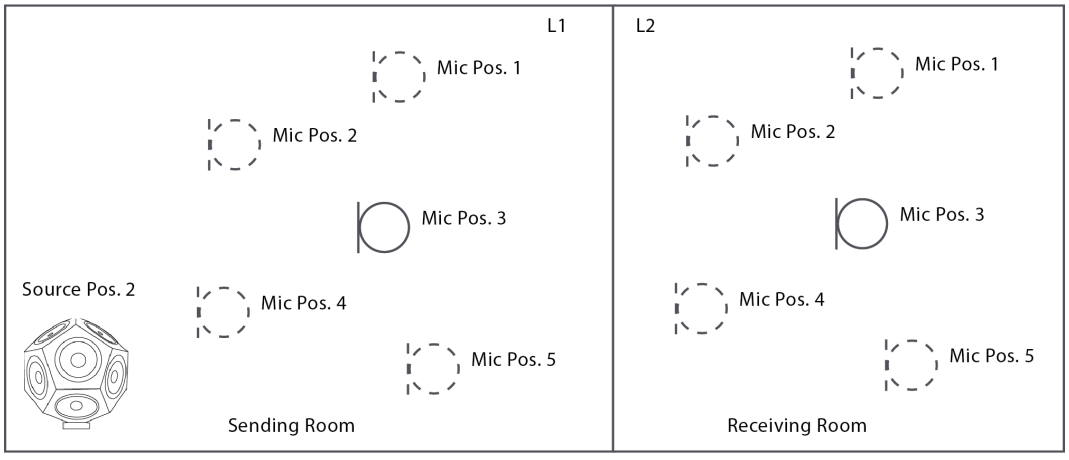
Noise Spectrum in the Receiving Room

XL3 Acoustic Analyzer

- Measure the sound level spectrum LZeq in the receiving room at each position for a measurement period of at least 15 seconds;
- Store the individual readings on the XL3 Acoustic Analyzer.



Noise Spectrum in the Sending Room



Measure the Sound Levels in the Sending and Receiving Room with the Speaker at Position 2

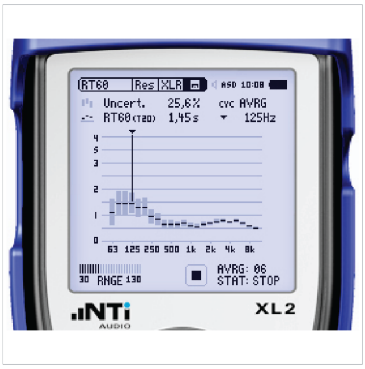
c.4 Reverberation Time in Receiving Room

c.4.1 Preparation

- Move the Dodecahedron Speaker DS3 to the receiving room;
- Select three microphone positions in the receiving room;

XL2 Acoustic Analyzer

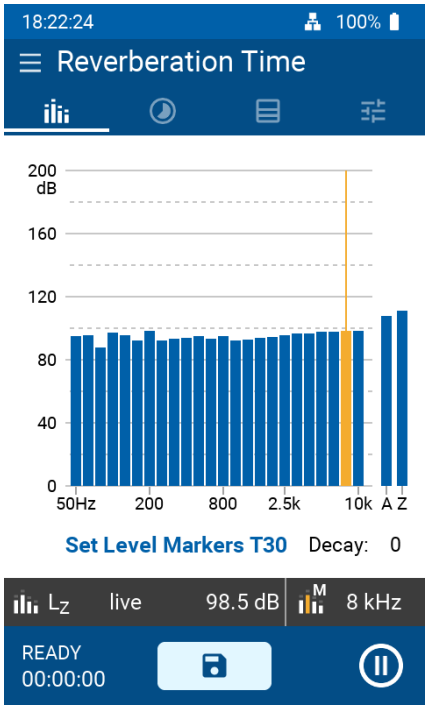
- Select the RT60 measurement function on theXL2 Acoustic Analyzer;
- Select the 1/3 octave resolution on the XL2 Acoustic Analyzer.



Reverberation Time T

XL3 Acoustic Analyzer

- Select the Reverberation Time function on the XL3 Acoustic Analyzer;
- Select the 1/3 octave resolution on the XL3 Acoustic Analyzer.



Reverberation Time T

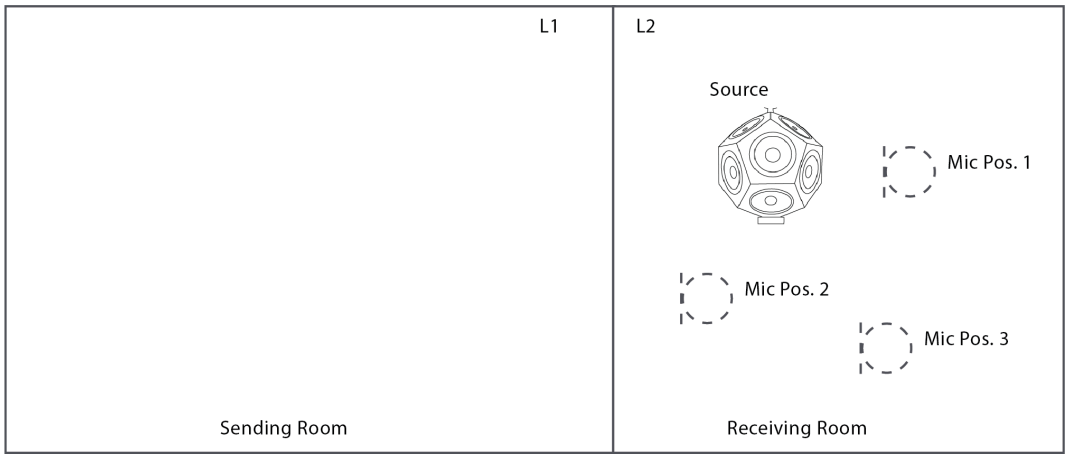
c.4.2 Measurement

XL2 Acoustic Analyzer

- Start the measurement on the XL2 Acoustic Analyzer;
- Start / stop the test signal:
  - Guideline: Set the on/off cycle time for the signal longer than the expected reverberation time.
- Measure at least two decays per position - better three decays;
- Stop the measurement on the XL2 Acoustic Analyzer;
- Store the readings on the XL2 Acoustic Analyzer.

XL3 Acoustic Analyzer

- Start the measurement on the XL3 Acoustic Analyzer;
- Start / stop the test signal:
  - Guideline: Set the on/off cycle time for the signal longer than the expected reverberation time.
- Measure at least two decays per position - better three decays;
- Stop the measurement on the XL3 Acoustic Analyzer;
- Store the readings on the XL3 Acoustic Analyzer.



Measure the Reverberation Time T in the Receiving Room

c.5 Data Analysis and Reporting

Verify and document all readings by using the Sound Insulation Reporter software. This is a PC-Software dedicated for building acoustics professionals. Load all measurement records into the software and generate the sound insulation report. The software calculates the weighted ratings based on the reference curve shifting method in accordance with the ISO 717-1 standard.

Calculation formulas:

- $\mathbf{D = L1 - L2;}$
- $\mathbf{Dn = D - 10\ log(A/10);}$
- $\mathbf{DnT = D + 10\ log(T/0.5);}$

- $R' = D + 10\ \log(S/A)$;
- $A = 0.16^{*}V/T$.

A	Equivalent absorption area of the receiving room [m2]
D	Level difference between the sending and receiving room [dB]
Dn	Normalized level difference [dB] (the level difference D is standardized to the equivalent absorption area of 10 m2 in the receiving room)
DnT	Standardized level difference [dB] (the level difference D is standardized to the 0.5 seconds reference value of the reverberation time in the receiving room)
DnT,w	Weighted standardized level difference (is the value of the reference curve at 500 Hz after shifting the reference curve) [dB]
L1	Sound pressure level in the sending room [dB]
L2	Sound pressure level in the receiving room [dB]
R'	Apparent sound reduction index of field measurement [dB]
R'w	Weighted apparent sound reduction index [dB] (is the value of the reference curve at 500 Hz after shifting the reference curve)
S	Partition area between the sending and receiving room [m2]
T	Reverberation time in the receiving room [s]
V	Volume of the receiving room in [m3]

d. Impact Sound Insulation

Two different source types can be used for the measurement of the impact sound insulation:

- Tapping Machine:
  - used to assess a variety of light, hard impacts such as footsteps from walkers waring hard-heeled footwear or dropped objects.
- Rubber Ball:
  - used to assess heavy, soft impacts such as from walkers in bare feet or children jumping, as well as quantifying absolute values that can be related to human disturbance.

Here the measurement with the Tapping Machine is described.

Measuring the impact sound insulation requires the following measurements:

- Background noise level in the receiving room;
- Sound pressure level in the receiving room;
- Reverberation time in the receiving room.

d.1 Getting Started

d.1.1 Room Selection

Typically, the impact sound insulation is measured between two rooms above each other. The Tapping Machine is positioned in the upper room, the source room. The measurements are performed in the lower room, the receiving room.

d.1.2 Source Position

- Position the Tapping Machine in the sending room;
- The measurements have to be carried out with at least four different source positions. The minimum distance to any wall shall be 0.5 m. In case of floor constructions with beams the tapping machine should be placed in an angel of 45° to the direction of the beams.

d.2 Background Noise Level in Receiving Room

d.2.1 Preparation

- It's recommended to vacate the room during the measurement so that any noise generated by the operator will not affect the measurement.

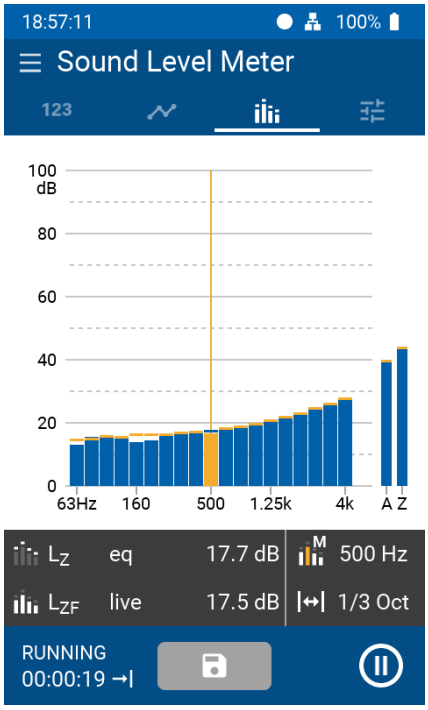
XL2 Acoustic Analyzer

- Select the RTA page in the SLMeter function on the XL2 Acoustic Analyzer;
- Select 1/3 octave measurement resolution;

Background Noise Spectrum in the Receiving Room

XL3 Acoustic Analyzer

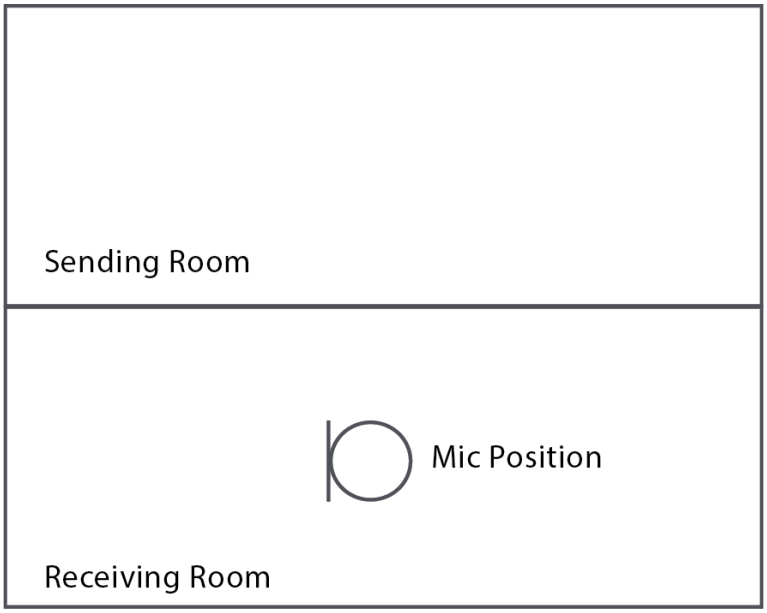
- Select the Sound Level Meter-function on the XL3 Acoustic Analyzer;
- Select 1/3 octave measurement resolution;



Background Noise Spectrum in the Receiving Room

d.2.2 Measurement

- Measure the background noise LZeq in the receiving room for 15 seconds. In case the background noise is not steady and continuous, then a longer measurement period shall be applied, e.g. 30 seconds;
- Store the readings on the XL2 Acoustic Analyzer or XL3 Acoustic Analyzer.



Measure the Background Noise Level Lb in the Receiving Room - Side View

d.3 Sound Pressure Level in Receiving Room

d.3.1 Preparation

The Tapping Machine TM3 shall be placed in at least four different positions randomly distributed on the floor under test. The hammer connecting line should be at 45° to the direction of any applicable beams or ribs in the floor. Each source position shall have a minimum distance of 0.5 m the any room boundary.

Define four microphone positions, distributed within the maximum permitted space throughout the receiving room. Use at least two microphone positions for each source position. The microphone positions shall be in a different plane relative to the room boundaries and shall not form a regular grid.

For example, mark the positions on the floor with a tape. The following minimum distances apply:

- 0.7 m between microphone positions;
- 0.5 m from any room boundary;
- 1.0 m from the partition being excited by the impact source.

It's recommended to vacate the room during the level measurement as the operator introduces additional absorption.

d.3.2 Measurements

- Measure the sound level spectrum LZeq at each microphone position for a measurement period of 15 seconds;

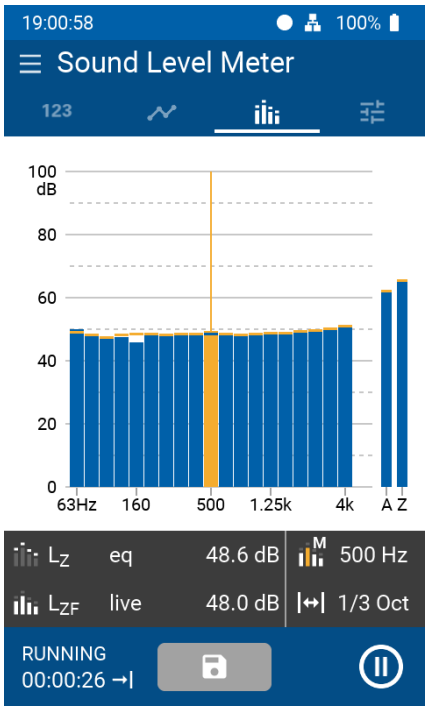
XL2 Acoustic Analyzer

- Store the individual readings in the XL2 Acoustic Analyzer for post calculation of the sound insulation.

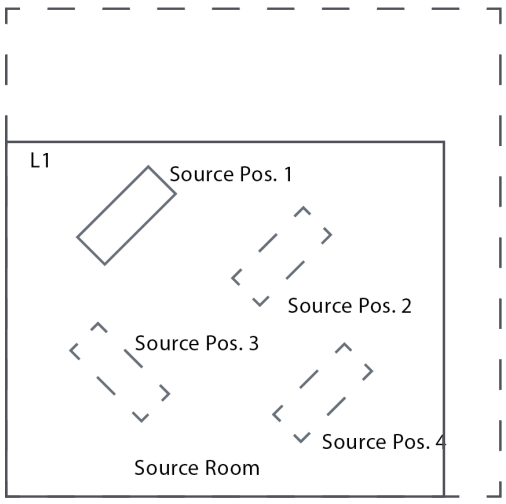
Noise Spectrum in the Receiving Room

XL3 Acoustic Analyzer

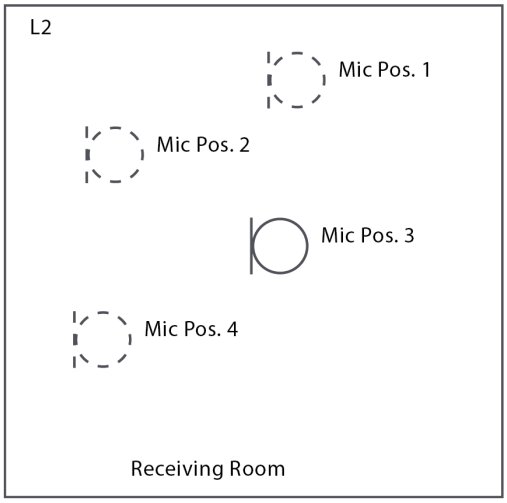
- Store the individual readings in the XL3 Acoustic Analyzer for post calculation of the sound insulation.



Noise Spectrum in the Receiving Room



Tapping Machine Positions in Source Room - Top View



Measure the Sound Levels in the Receiving Room with Tapping Machine at Source Position 1 - Top View

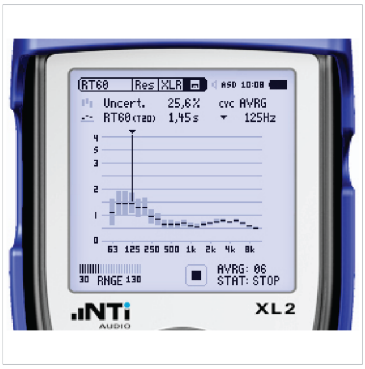
d.4 Reverberation Time in Receiving Room

d.4.1 Preparation

- Move the Dodecahedron Speaker DS3 to the receiving room;
- Select three microphone positions in the receiving room;

XL2 Acoustic Analyzer

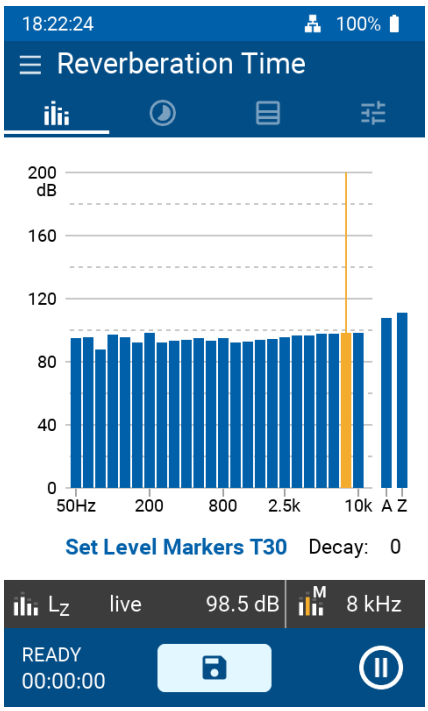
- Select the RT60 measurement function on the XL2 Acoustic Analyzer;
- Select the 1/3 octave resolution on the XL2 Acoustic Analyzer.



Reverberation Time T

XL3 Acoustic Analyzer

- Select the Reverberation Time function on the XL3 Acoustic Analyzer;
- Select the 1/3 octave resolution on the XL3 Acoustic Analyzer.



Reverberation Time T

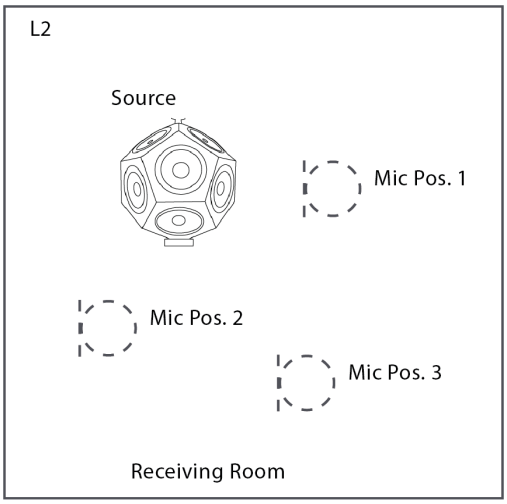
d.4.2 Measurement

XL2 Acoustic Analyzer

- Start the measurement on the XL2 Acoustic Analyzer;
- Start / stop the signal;
  - Guideline: Set the on/off cycle time for the signal longer than the expected reverberation time.
- Measure at least two decays per position - better three decays;
- Stop the measurement on the XL2 Acoustic Analyzer;
- Store the readings on the XL2 Acoustic Analyzer.

XL3 Acoustic Analyzer

- Start the measurement on the XL3 Acoustic Analyzer;
- Start / stop the signal;
  - Guideline: Set the on/off cycle time for the signal longer than the expected reverberation time.
- Measure at least two decays per position - better three decays;
- Stop the measurement on the XL3 Acoustic Analyzer;
- Store the readings on the XL3 Acoustic Analyzer.



Measure the Reverberation Time T in the Receiving Room

d.5 Data Analysis and Reporting

Verify and document all readings by using the Sound Insulation Reporter software. This is a PC-Software dedicated for building acoustics professionals. Load all measurement records into the software and generate the sound insulation report. The software calculates the weighted ratings based on the reference curve shifting method in accordance with the ISO 717-2 standard.

Calculation formulas:

- $L'n = Li + 10\ \log(A/10)$;
- $L'nT = Li - 10 \log(T/0.5)$;

- $A = 0.16^{*}V/T.$

A	Equivalent absorption area of the receiving room [m2]
Li	Impact sound pressure level in the receiving room [dB]
L'n	Normalized sound pressure level [dB]
Ln,w	Weighted normalized sound pressure level [dB] (is the value of the reference curve at 500 Hz after shifting the reference curve)
L'nT	Standardized impact sound pressure level [dB]
L'nT,w	Weighted normalized impact sound pressure level [dB] (is the value of the reference curve at 500 Hz after shifting the reference curve)
T	Reverberation time in the receiving room [s]
V	Volume of the receiving room in [m3]

e. Airborne Sound Insulation of Facades

Two measurement methods are distinguished for the measurement of the airborne sound insulation of façades.

- Element method:
  - For sound insulation measurements of façades elements, e.g. windows;
  - The purpose of the measurement is to obtain sound reduction index results for comparison with laboratory.
- Global method:
  - Provides the real sound level reduction of a façade under test in a given place relative to a position 2 m in front of the façade;
  - Preferred method for sound insulation measurements of whole façades including all flanking paths;
  - The result cannot be compared with that of laboratory measurements.

Here the global measurement method is described.

Measuring the airborne sound insulation of façades requires the following measurments:

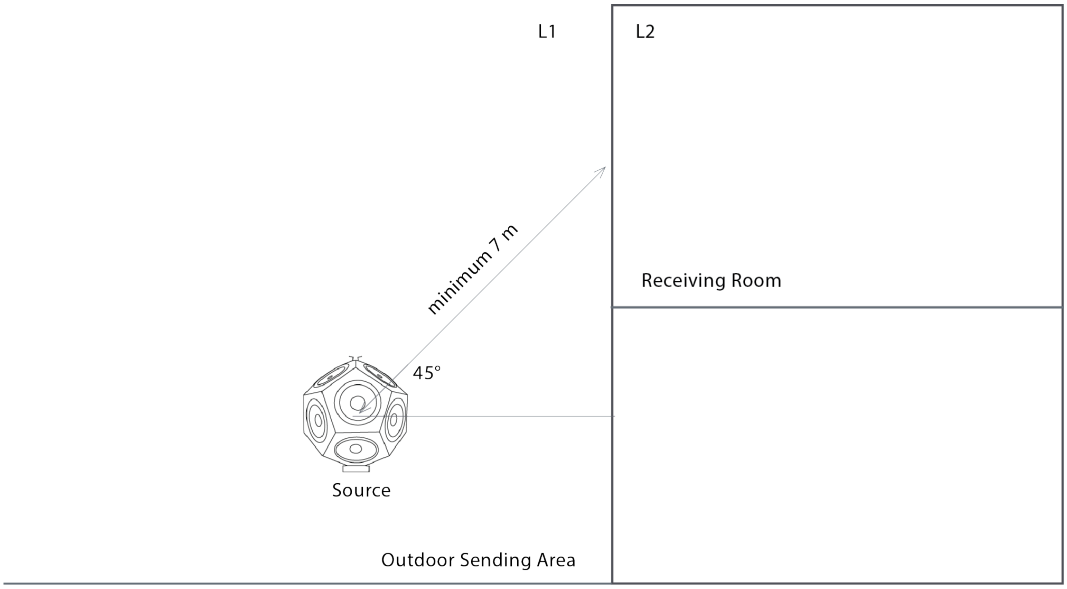
- Background noise level in the receiving room;
- Sound pressure level in front of façade;
- Sound pressure level in the receiving room;
- Reverberation time in the receiving room.

e.1 Getting Started

e.1.1 Speaker Position

- Position the Dodecahedron Speaker DS3 outdoors in front of the façade. The distance D shall be at least 5 m;
- The angle of sound incidence at the facade shall be 45° +/- 5°. The distance from the loudspeaker to the center of the facade under test shall be at least 7 m;
- The sending sound pressure level is measured 2 m in front of the façade;

- The measurements may be carried out at one or multiple speakers positions. Several speaker positions are required at very large rooms or in case the room has two or more outside walls.



e.1.2 Test Signal Level

- Start the pink noise test signal at a low level;
- Increase the level until it is minimum of 6 dB — better 10 dB - higher in the receiving room than the background noise (in each frequency band from 0 Hz to 5000 Hz). In case this is not possible, then the Sound Insulation Reporter software will automatically apply corrections in accordance with the standard.

e.2 Background Noise Level in Receiving Room

e.2.1 Preparation

- It's recommended to vacate the room during the measurement so that any noise generated by the operator will not affect the measurement.

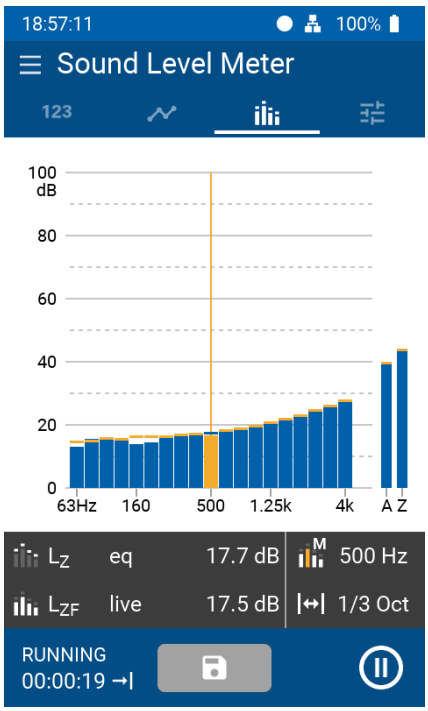
XL2 Acoustic Analyzer

- Select the RTA page in the SLMeter function on the XL2 Acoustic Analyzer;
- Select 1/3 octave measurement resolution;

Background Noise Spectrum in the Receiving Room

XL3 Acoustic Analyzer

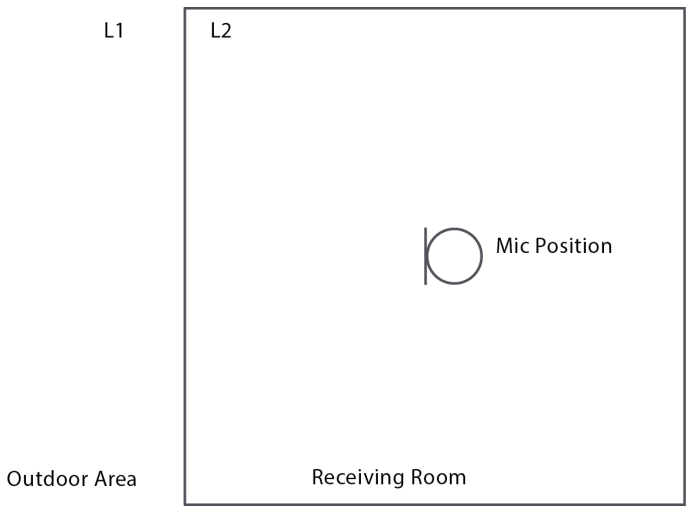
- Select the Sound Level Meter-function on the XL3 Acoustic Analyzer;
- Select 1/3 octave measurement resolution;



Background Noise Spectrum in the Receiving Room

e.2.2 Measurement

- Measure the background noise LZeq in the receiving room for 15 seconds. In case the background noise is not steady and continuous, then a longer measurement period shall be applied, e.g. 30 seconds;
- Store the readings on the XL2 Acoustic Analyzer or XL3 Acoustic Analyzer.



Measure the Background Noise Level Lb in the Receiving Room - Top View

e.3 Outdoor Sound Pressure Level in front of Facade

e.3.1 Preparation

The sending sound pressure level is measured outdoor at 2 m (+/- 0.2m) in front of the facade surface center under test. The height of the microphone is 1.5 m above the receiving room floor.

e.3.2 Measurements

- Measure the sending sound level spectrum LZeq for a measurement period of at least 15 seconds;

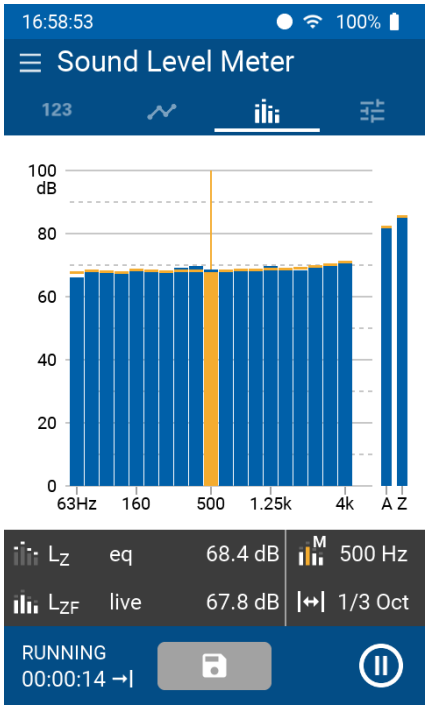
XL2 Acoustic Analyzer

- Store the readings on the XL2 Acoustic Analyzer.

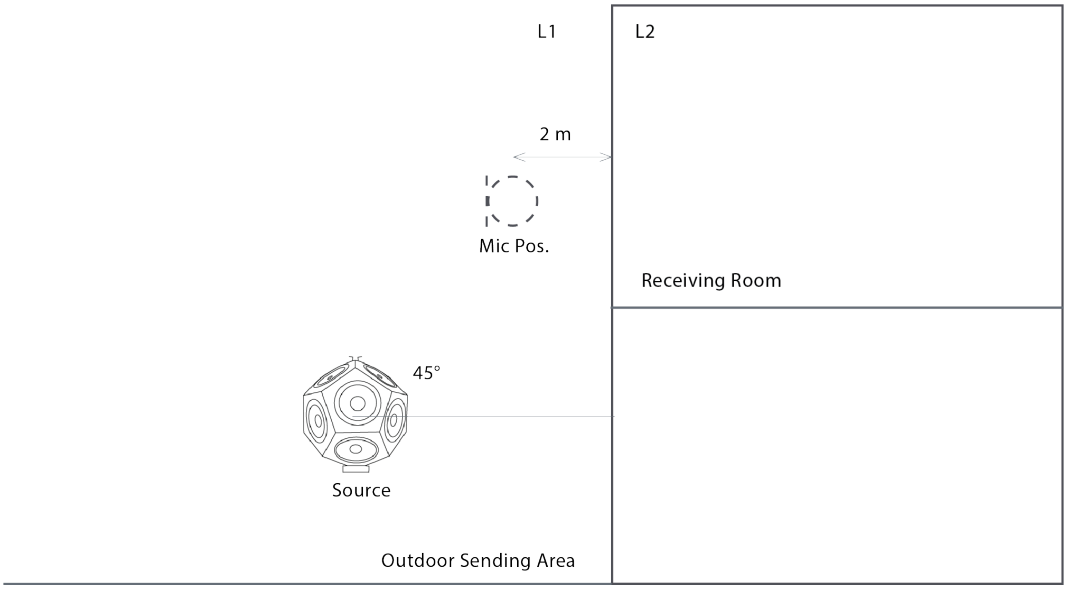
Noise Spectrum in front of Facade

XL3 Acoustic Analyzer

- Store the readings on the XL3 Acoustic Analyzer.



Noise Spectrum in front of the Facade



Measure the Sound Level in the Outdoor Sending Area - Side View

e.4 Sound Pressure Level in Receiving Room

e.4.1 Preparation

Define five microphone positions in the sending and receiving room, distributed within the maximum permitted space throughout each room. The positions shall be in a different plane

relative to the room boundaries and shall not form a regular grid. For example, mark the positions on the floor with a tape. The following minimum distances apply:

- 0.7 m between microphone positions;
- 0.5 m from any room boundary;
- 1.0 m between any microphone position and the speaker.

It's recommended to vacate the room during the level measurement as the operator introduces additional absorption.

e.4.2 Measurements

- Measure the sending and receiving sound level spectrum LZeq at each microphone position for a measurement period of at least 15 seconds;

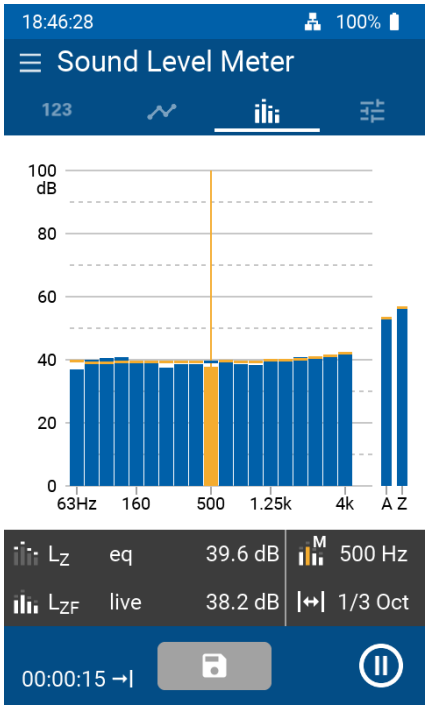
XL2 Acoustic Analyzer

- Store the readings on the XL2 Acoustic Analyzer.

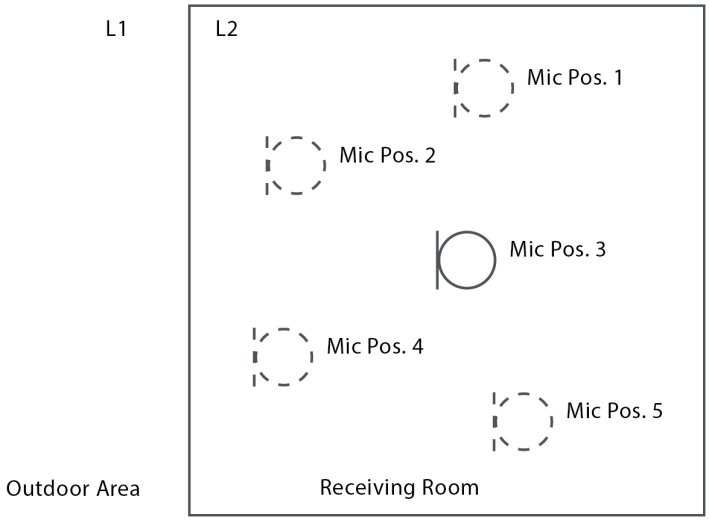
Noise Spectrum in the Receiving Room

XL3 Acoustic Analyzer

- Store the readings on the XL2 Acoustic Analyzer.



Noise Spectrum in the Receiving Room



Measure the Sound Levels in the Receiving Room - Top View

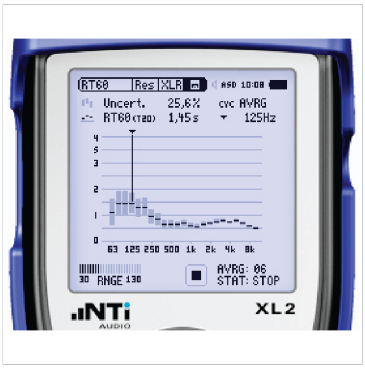
e.5 Reverberation Time in Receiving Room

e.5.1 Preparation

- Move the Dodecahedron Speaker DS3 to the receiving room;
- Select three microphone positions in the receiving room;

XL2 Acoustic Analyzer

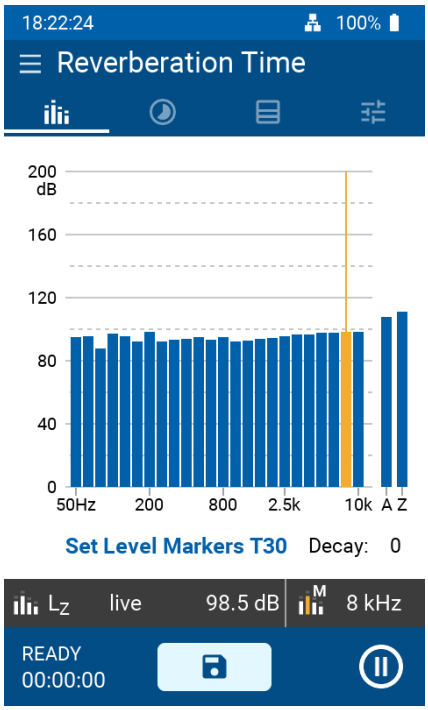
- Select the RT60 measurement function on the XL2 Acoustic Analyzer;
- Select the 1/3 octave resolution on the XL2 Acoustic Analyzer.



Reverberation Time T

XL3 Acoustic Analyzer

- Select the Reverberation Time function on the XL3 Acoustic Analyzer;
- Select the 1/3 octave resolution on the XL3 Acoustic Analyzer.



Reverberation Time T

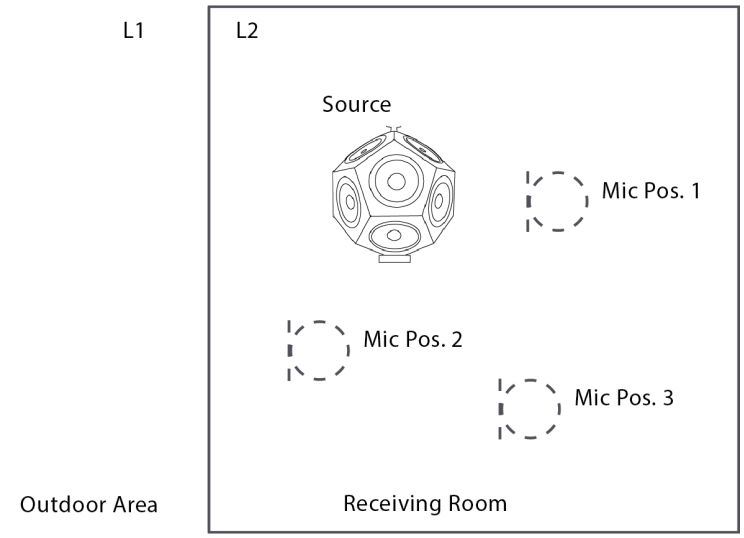
e.5.2 Measurement

XL2 Acoustic Analyzer

- Start the measurement on the XL2 Acoustic Analyzer;
- Start / stop the signal:
  - Guideline: Set the on/off cycle time for the signal longer than the expected reverberation time.
- Measure at least two decays per position - better three decays;
- Stop the measurement on the XL2 Acoustic Analyzer;
- Store the readings on the XL2 Acoustic Analyzer.

XL3 Acoustic Analyzer

- Start the measurement on the XL3 Acoustic Analyzer;
- Start / stop the signal:
  - Guideline: Set the on/off cycle time for the signal longer than the expected reverberation time.
- Measure at least two decays per position - better three decays;
- Stop the measurement on the XL3 Acoustic Analyzer;
- Store the readings on the XL3 Acoustic Analyzer.



Measure the Reverberation Time T - Top View

e.6 Data Analysis and Reporting

Verify and document all readings by using the Sound Insulation Reporter software. This is a PC-Software dedicated for building acoustics professionals. Load all measurement records into the software and generate the sound insulation report. The software calculates the weighted ratings based on the reference curve shifting method in accordance with the ISO 717-1 standard.

Calculation formas:

- $\mathbf{D2m = L1, 2m - L2;}$
- $\mathbf{D2m, n = D2m - 10\log(A/10);}$

- $D2m,nT = D2m + 10\log(T/0.5);$
- $R'45° = D + 10\lg(S/A) - 1.5;$
- $A = 0.16 * V/T.$

A	Equivalent absorption area of the receiving room [m2]
D	Difference between facade level and receiving room level using element method [dB]
D2m	Difference between level 2 m in front of facade and receiving room level [dB]
D2m,n	Normalized level difference [dB] (the level difference D is standardized to the equivalent absorption area of 10 m2 in the receiving room)
D2m,nT	Standardized level difference [dB] (the level difference D is standardized to the 0.5 seconds reference value of the reverberation time in the receiving room)
DnT,w	Weighted standardized level difference (is the value of the reference curve at 500 Hz after shifting the reference curve) [dB]
L1,2m	Sound pressure level measured 2 m in front of facade [dB]
L2	Sound pressure level in the receiving room [dB]
R'45°	Apparent sound reduction index of field measurement using element method [dB]
R'45°,w	Weighted apparent sound reduction index using element method [dB] (is the value of the reference curve at 500 Hz after shifting the reference curve)
S	Partition area between the sending and receiving room m2
T	Reverberation time in the receiving room [s]
V	Volume of the receiving room in [m3]

f. Application Note: Sound Insulation Measurement with XL3 Acoustic Analyzer Sound Insulation Option

g. Airborne Sound Insulation between two Rooms

Measuring the airborne sound insulation between two rooms in a building requires the following measurements:

- Sound pressure level in the sending room;
- Sound pressure level in the receiving room;
- Background noise level in the receiving room;
- Reverberation time in the receiving room.

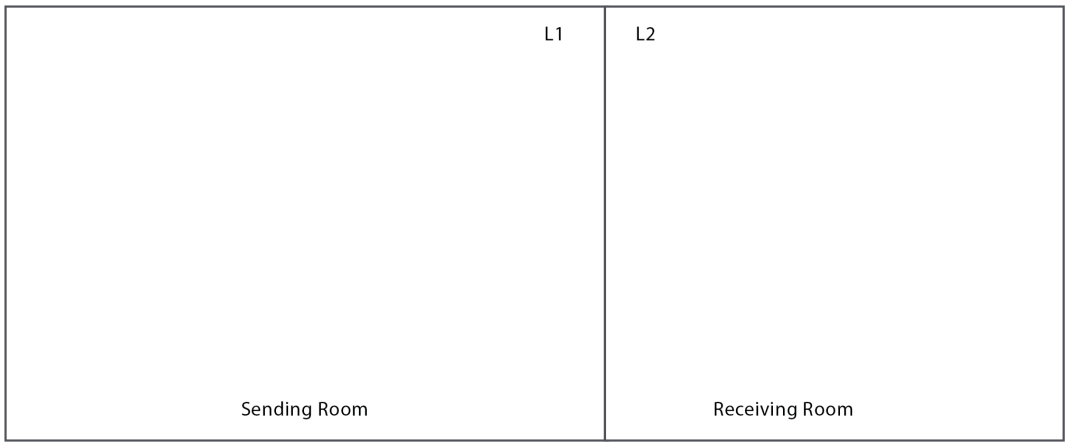
The basic concept of sound insulation measurements is to play a pink noise test signal by the Dodecahedron Speaker DS3 in the sending room. This generates a diffuse sound field in the room. The generated sound is transmitted through the common partition into the receiving room, where also a diffuse sound field throughout the room is assumed.

First the sound pressure level spectrum is measured in the sending room at multiple microphone positions and averaged. The same is repeated for the receiving room - any disturbing background noise is deducted.

The difference indicates the insulation for the first speaker position. The same procedure is repeated for a second speaker position. Additional reverberation time measurements are carried out in the receiving room for corrections - e.g, the receiving room level is higher at very reverberant rooms.

g.1 Room Selection

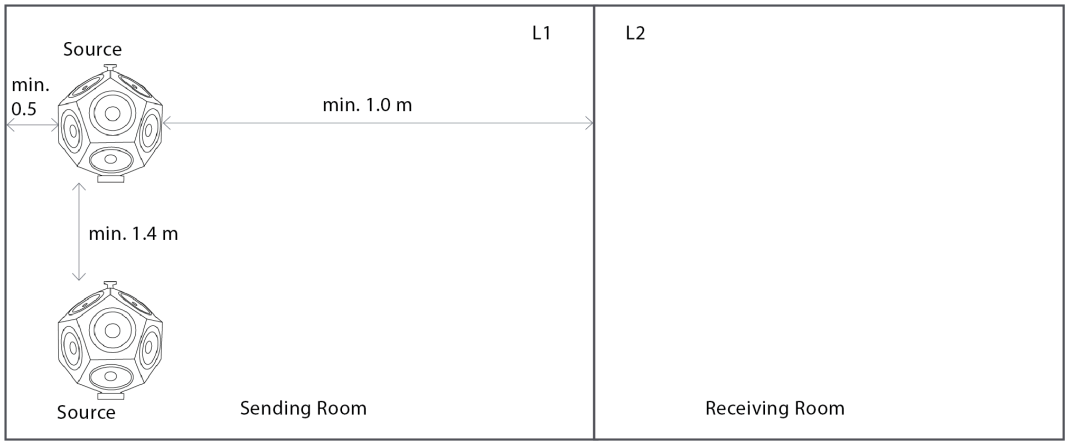
Airborne sound insulation is measured between two rooms. One room is chosen as the sending room and the other one is chosen as the receiving room. In case the volumes of the two rooms differ, then the smaller room shall be used as the receiving room. If one of the rooms is box-shaped and the other has a more complicated geometry, the box-shaped room shall be used as the receiving room.



Selecting Sending Room and Receiving Room

g.1.1 Speaker Position

- Position the Dodecahedron Speaker DS3 in the sending room;
- The measurements have to be carried out with at least two different speaker positions;
- Choose speaker position 1 at least 0.5 m from any room boundary and at least 1.0 m from the separating partition. Position 2 shall be similarly chosen, plus be in a different plane relative to the room boundaries, and with a minimum 1.4 m distance to position 1. In case the separation partition is a floor and the speaker is in the upper room, then the Dodecahedron Speaker DS3 has to be at least 1 m above the floor. The distances are measured from the center of the individual driver unit of the Dodecahedron Speaker DS3 closest to the boundary or other speaker position.



Positions of the test signal source for the sound level measurements

g.1.2 Test Signal Level

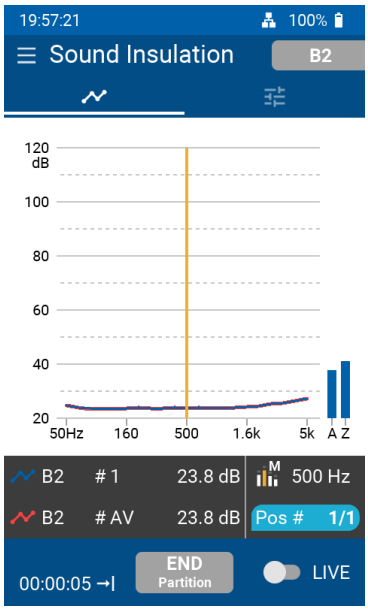
- Reduce level settings on PA3 Power Amplifier to minimum;
- Power on PA3 Power Amplifier;
- Select the signal source "EQ Pink" for a flat acoustic response in the source room. Go for "Pink" in case a higher level is required;
- Press "Signal ON" and increase the level unit it is minimum of 6 dB - better 10 dB - higher in the receiving room than the background noise (in each frequency band from 50 Hz to 5000 Hz). In case this is not possible, then the Sound Insulation Reporter software will automatically apply corrections in accordance with the standard.

g.2 Background Noise Level in Receiving Room

g.2.1 Preparation

- It's recommended to vacate the room during the measurement so that any noise generated by the operator will not affect the measurement.

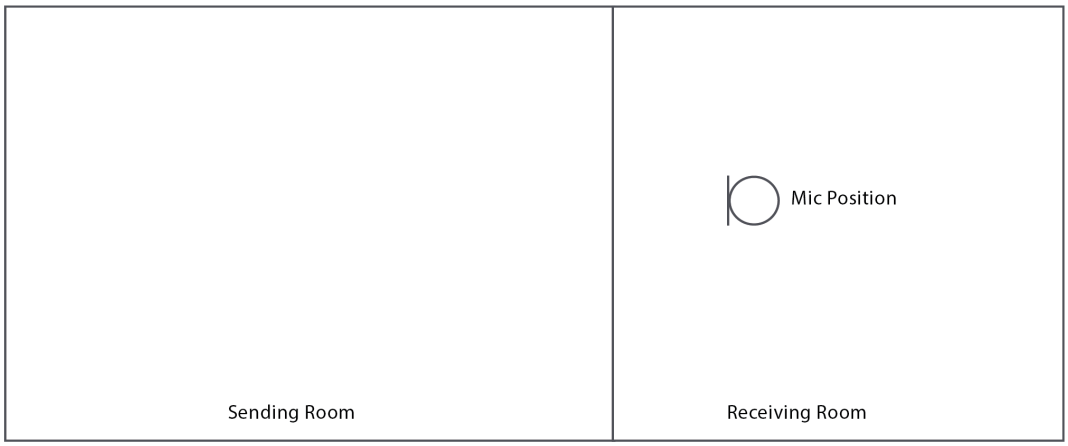
To measure the background sound level in the receiving room, select B2 on the XL3 Acoustic Analyzer "**Select measurement**" page and press the START button.



Background Noise Spectrum in the Receiving Room

g.2.2 Measurement

- Measure the background noise LZeq in the receiving room for the 15 seconds. In case the background noise is not steady and continuous, then a longer measurement period shall be applied e.g. 30 seconds;
- Store the individual readings on the XL3 Acoustic Analyzer.



Measure the Background Noise Level Lb in the Receiving Room

g.3 Sound Pressure Levels at speaker position 1

g.3.1 Preparation

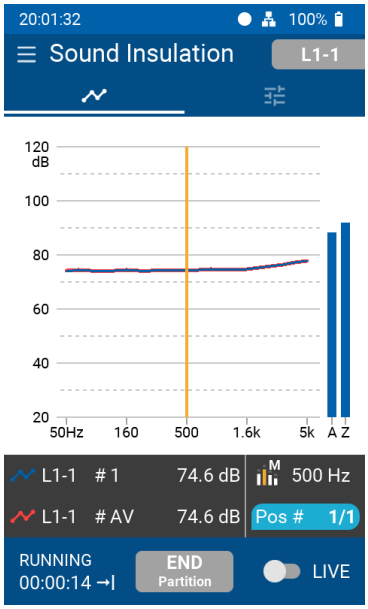
Define five microphone positions in the sending and receiving room, distributed within the maximum permitted space throughout each room. The positions shall be in a different plane relative to the room boundaries and shall not form a regular grid. For example, mark the positions on the floor with a tape. The following minimum distance apply:

- 0.7 m between microphone positions;
- 0.5 m from any room boundary;
- 1.0 m between any microphone position and the speaker.

It's recommended to vacate the room during the level measurement as the operator introduces additional absorption.

g.4 Measurements in Sending Room

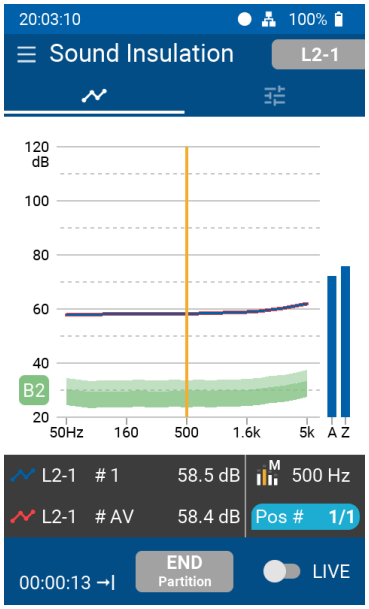
Press the START key to initiate the measurement and wait until it is completed. Once you have taken enough individual measurements for L1-1, press the STOP key on theXL3 Acoustic Analyzer.



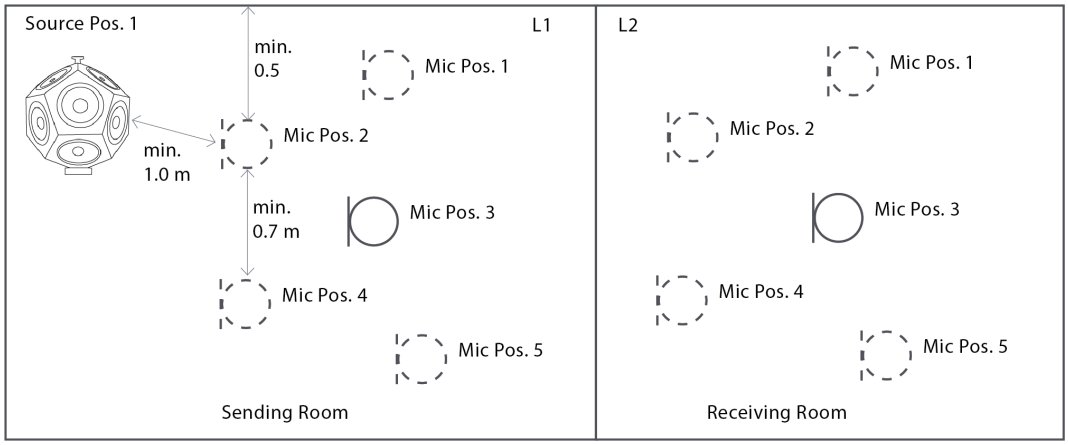
Noise Spectrum in the Sending Room

g.4.1 Measurements in Receiving Room

- Proceed to the L2 receiving room and choose L2-1 located on the "**Select measurement**" page. Activate the sound source (which is still placed at position #1 in the transmitting room) and press the START button to initiate the initial sound level measurement in the receiving room.
- Proceed with conducting the remaining measurements in the receiving room for the data set L2-1 and then press the STOP button.
- Select L2-2 on the "**Select measurement**" page and position the noise source in the transmitter room at position #2.
- Repeat the aforementioned measurements in both the transmit and receive rooms for noise source position #2. Repeat this process until all L1-x and L2-x measurements for different noise source positions in the transmitter room are completed.



Noise Spectrum in the Receiving Room



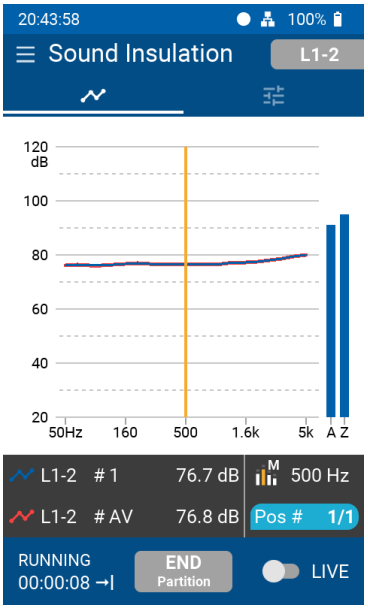
Measure the Sound Levels in the Sending and Receiving Room with the Speaker at Position 1

g.4.2 Sound Pressure Levels at speaker position 2

Move the Dodecahedron Speaker DS3 to source position 2.

g.4.3 Measurements in the Sending Room

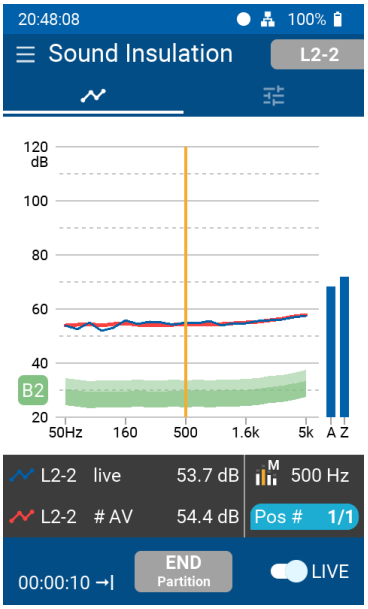
- Press the START key to initiate the first measurement and wait until it is completed. Move to the next measurement position and press the START key again to start the second (or third, etc.) sound level measurement in the receiving room. Once you have taken enough individual measurements for L1-2, press the STOP key on theXL3 Acoustic Analyzer.



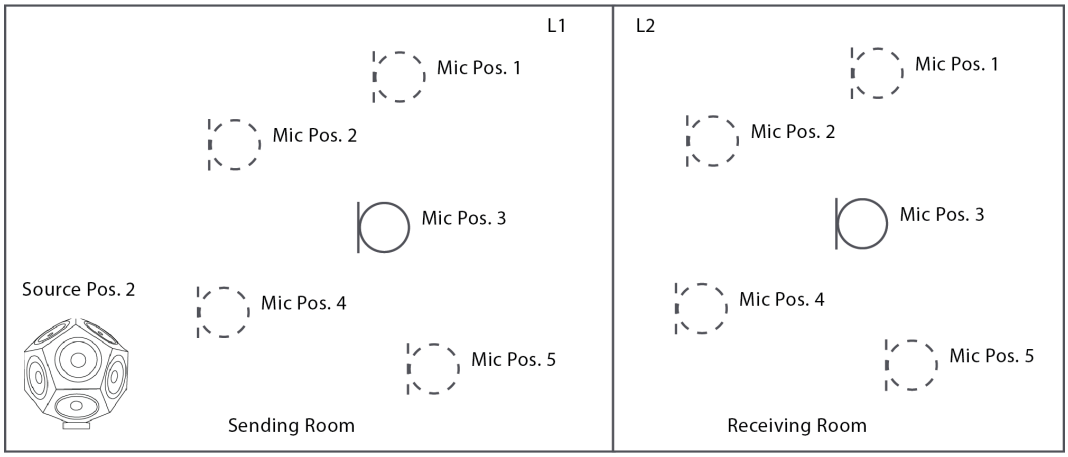
Noise Spectrum in the Sending Room

g.4.4 Measurements in Receiving Room

- Select L2-2 on the "**Select measurement**" page and position the noise source in the transmitter room at position #2.
- Repeat the aforementioned measurements in both the transmit and receive rooms for noise source position #2. Repeat this process until all L1-x and L2-x measurements for different noise source positions in the transmitter room are completed.



Noise Spectrum in the Receiving Room



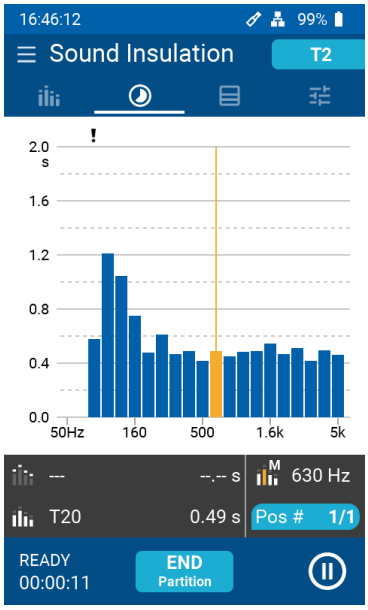
Measure the Sound Levels in the Sending and Receiving Room with the Speaker at Position 2

g.5 Reverberation Time in Receiving Room

g.5.1 Preparation

- Move the Dodecahedron Speaker DS3 to the receiving room;
- Select three microphone positions in the receiving room;

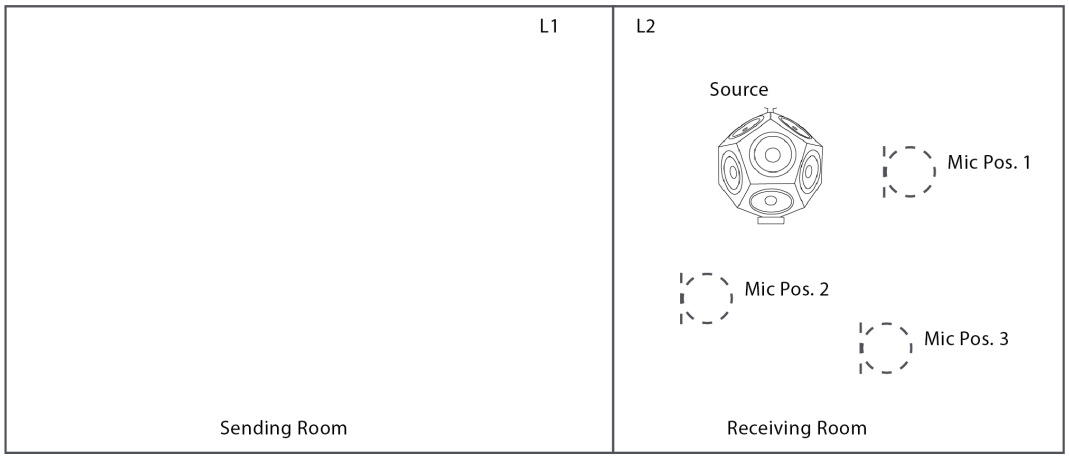
- Choose T2 on theXL3 Acoustic Analyzer "**Select measurement**" page.
- Press the START button to commence the reverberation time measurement and toggle the speaker On and Off multiple times. Then press the START button.



Reverberation Time T

g.5.2 Measurement

Conclude the measurement series by first pressing the STOP button and then tapping END Partition. You can now review the measurement results D, Dn, DnT, or R' individually by pressing the corresponding button under "**Results**".



Measure the Reverberation Time T in the Receiving Room

g.6 Data Analysis and Reporting

Verify and document all readings by using the Sound Insulation Reporter software. This is a PC-Software dedicated for building acoustics professionals. Load all measurement records into the software and generate the sound insulation report. The software calculates the weighted ratings based on the reference curve shifting method in accordance with the ISO 717-1 standard.

Calculation formulas:

- $D = L1 - L2;$
- $Dn = D - 10\ \log(A/10);$
- $DnT = D + 10\ \log(T/0.5);$
- $R' = D + 10\ \log(S/A);$
- $A = 0.16^{*}V/T.$

A	Equivalent absorption area of the receiving room [m2]
D	Level difference between the sending and receiving room [dB]
Dn	Normalized level difference [dB] (the level difference D is standardized to the equivalent absorption area of 10 m2 in the receiving room)
DnT	Standardized level difference [dB] (the level difference D is standardized to the 0.5 seconds reference value of the reverberation time in the receiving room)
DnT,w	Weighted standardized level difference (is the value of the reference curve at 500 Hz after shifting the reference curve) [dB]
L1	Sound pressure level in the sending room [dB]
L2	Sound pressure level in the receiving room [dB]
R'	Apparent sound reduction index of field measurement [dB]
R'w	Weighted apparent sound reduction index [dB] (is the value of the reference curve at 500 Hz after shifting the reference curve)
S	Partition area between the sending and receiving room [m2]
T	Reverberation time in the receiving room [s]
V	Volume of the receiving room in [m3]

h. Impact Sound Insulation

Two different source types can be used for the measurement of the impact sound insulation:

- Tapping Machine:
  - used to assess a variety of light, hard impacts such as footsteps from walkers waring hard-heeled footwear or dropped objects.
- Rubber Ball:
  - used to assess heavy, soft impacts such as from walkers in bare feet or children jumping, as well as quantifying absolute values that can be related to human disturbance.

Here the measurement with the Tapping Machine is described.

Measuring the impact sound insulation requires the following measurements:

- Background noise level in the receiving room;
- Sound pressure level in the receiving room;
- Reverberation time in the receiving room.

h.1 Getting Started

h.1.1 Room Selection

Typically, the impact sound insulation is measured between two rooms above each other. The Tapping Machine is positioned in the upper room, the source room. The measurements are performed in the lower room, the receiving room.

h.1.2 Source Position

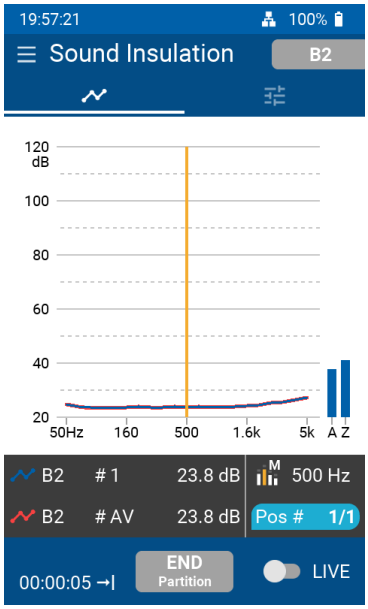
- Position the Tapping Machine in the sending room;
- The measurements have to be carried out with at least four different source positions. The minimum distance to any wall shall be 0.5 m. In case of floor constructions with beams the tapping machine should be placed in an angel of 45° to the direction of the beams.

h.2 Background Noise Level in Receiving Room

h.2.1 Preparation

- It's recommended to vacate the room during the measurement so that any noise generated by the operator will not affect the measurement.

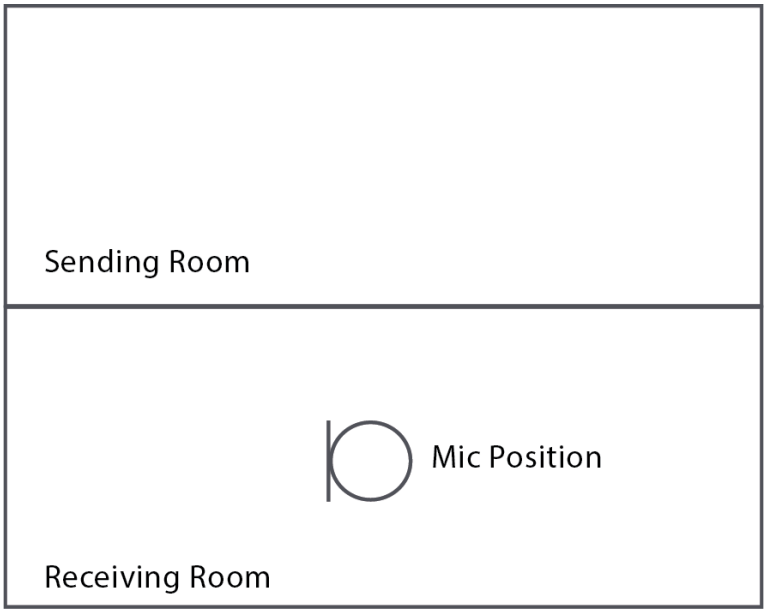
To measure the background sound level in the receiving room, select B2 on the XL3 Acoustic Analyzer "**Select measurement**" page and press the START button.



Background Noise Spectrum in the Receiving Room

h.2.2 Measurement

- Measure the background noise LZeq in the receiving room for 15 seconds. In case the background noise is not steady and continuous, then a longer measurement period shall be applied, e.g. 30 seconds;
- Store the readings on the XL3 Acoustic Analyzer.



Measure the Background Noise Level Lb in the Receiving Room - Side View

h.3 Sound Pressure Level in Receiving Room

h.3.1 Preparation

The Tapping Machine TM3 shall be placed in at least four different positions randomly distributed on the floor under test. The hammer connecting line should be at 45° to the direction of any applicable beams or ribs in the floor. Each source position shall have a minimum distance of 0.5 m the any room boundary.

Define four microphone positions, distributed within the maximum permitted space throughout the receiving room. Use at least two microphone positions for each source position. The microphone positions shall be in a different plane relative to the room boundaries and shall not form a regular grid.

For example, mark the positions on the floor with a tape. The following minimum distances apply:

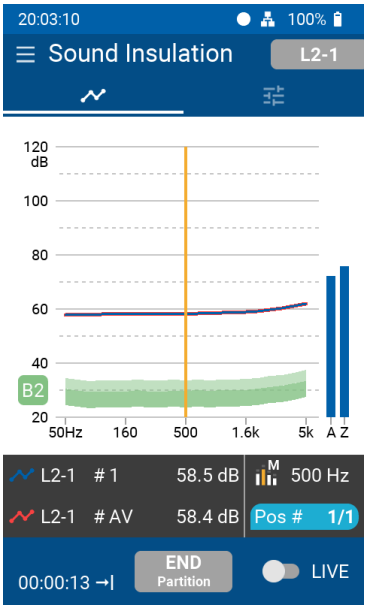
- 0.7 m between microphone positions;
- 0.5 m from any room boundary;
- 1.0 m from the partition being excited by the impact source.

It's recommended to vacate the room during the level measurement as the operator introduces additional absorption.

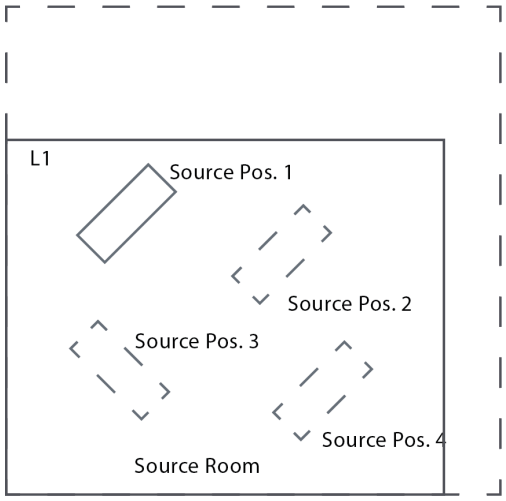
h.3.2 Measurements

- Measure the sound level spectrum LZeq at each microphone position for a measurement period of 15 seconds;

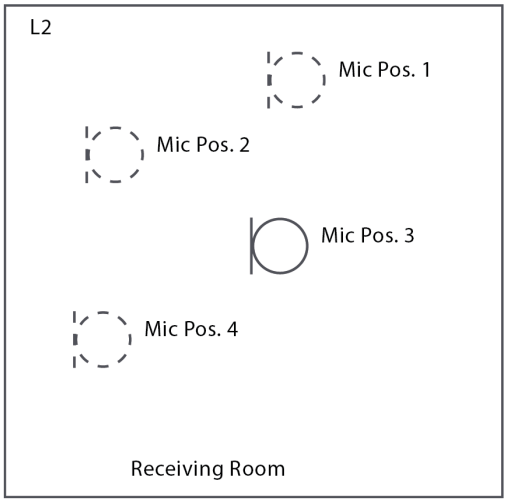
- Proceed to the L2 receiving room and choose L2-1 located on the "**Select measurement**" page. Activate the sound source (which is still placed at position #1 in the transmitting room) and press the START button to initiate the initial sound level measurement in the receiving room.
- Proceed with conducting the remaining measurements in the receiving room for the data set L2-1 and then press the STOP button.
- Select L2-2 on the "**Select measurement**" page and position the noise source in the transmitter room at position #2.
- Repeat the aforementioned measurements in both the transmit and receive rooms for noise source position #2. Repeat this process until all L1-x and L2-x measurements for different noise source positions in the transmitter room are completed.



Noise Spectrum in the Receiving Room



Tapping Machine Positions in Source Room - Top View

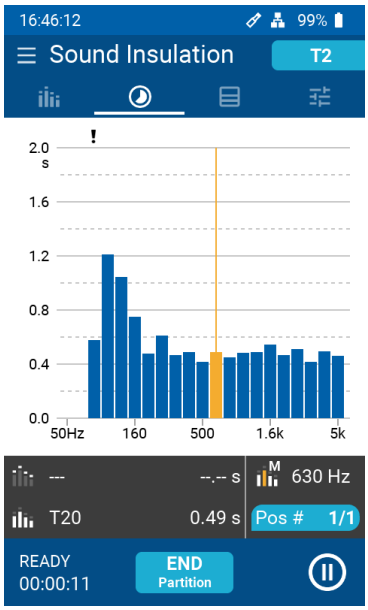


Measure the Sound Levels in the Receiving Room with Tapping Machine at Source Position 1 - Top View

h.4 Reverberation Time in Receiving Room

h.4.1 Preparation

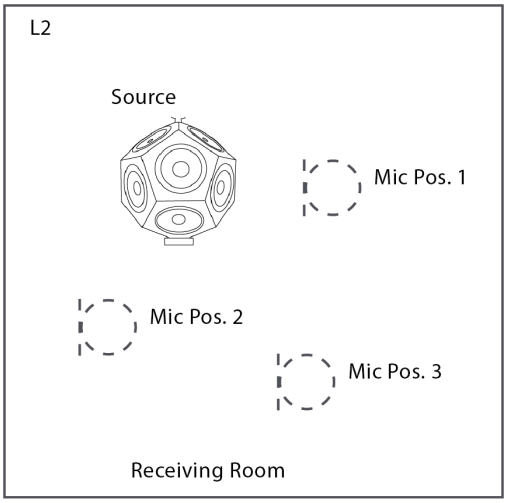
- Move the Dodecahedron Speaker DS3 to the receiving room;
- Select three microphone positions in the receiving room;
  - Choose T2 on theXL3 Acoustic Analyzer "**Select measurement**" page.
  - Press the START button to commence the reverberation time measurement and toggle the speaker On and Off multiple times. Then press the START button.



Reverberation Time T

h.4.2 Measurement

Conclude the measurement series by first pressing the STOP button and then tapping END Partition. You can now review the measurement results L'n and L'nT individually by pressing the corresponding button under "**Results**".



Measure the Reverberation Time T in the Receiving Room

h.5 Data Analysis and Reporting

Verify and document all readings by using the Sound Insulation Reporter software. This is a PC-Software dedicated for building acoustics professionals. Load all measurement records into the software and generate the sound insulation report. The software calculates the weighted ratings based on the reference curve shifting method in accordance with the ISO 717-2 standard.

Calculation formulas:

- $L'n = Li + 10\ \log(A/10);$
- $L'nT = Li - 10\log(T/0.5);$
- $A = 0.16^{*}V/T.$

A	Equivalent absorption area of the receiving room [m2]
Li	Impact sound pressure level in the receiving room [dB]
L'n	Normalized sound pressure level [dB]
Ln,w	Weighted normalized sound pressure level [dB] (is the value of the reference curve at 500 Hz after shifting the reference curve)
L'nT	Standardized impact sound pressure level [dB]
L'nT,w	Weighted normalized impact sound pressure level [dB] (is the value of the reference curve at 500 Hz after shifting the reference curve)
T	Reverberation time in the receiving room [s]
V	Volume of the receiving room in [m3]

i. Airborne Sound Insulation of Facades

Two measurement methods are distinguished for the measurement of the airborne sound insulation of façades.

- Element method:
  - For sound insulation measurements of façades elements, e.g. windows;
  - The purpose of the measurement is to obtain sound reduction index results for comparison with laboratory.
- Global method:
  - Provides the real sound level reduction of a façade under test in a given place relative to a position 2 m in front of the façade;
  - Preferred method for sound insulation measurements of whole façades including all flanking paths;
  - The result cannot be compared with that of laboratory measurements.

Here the global measurement method is described.

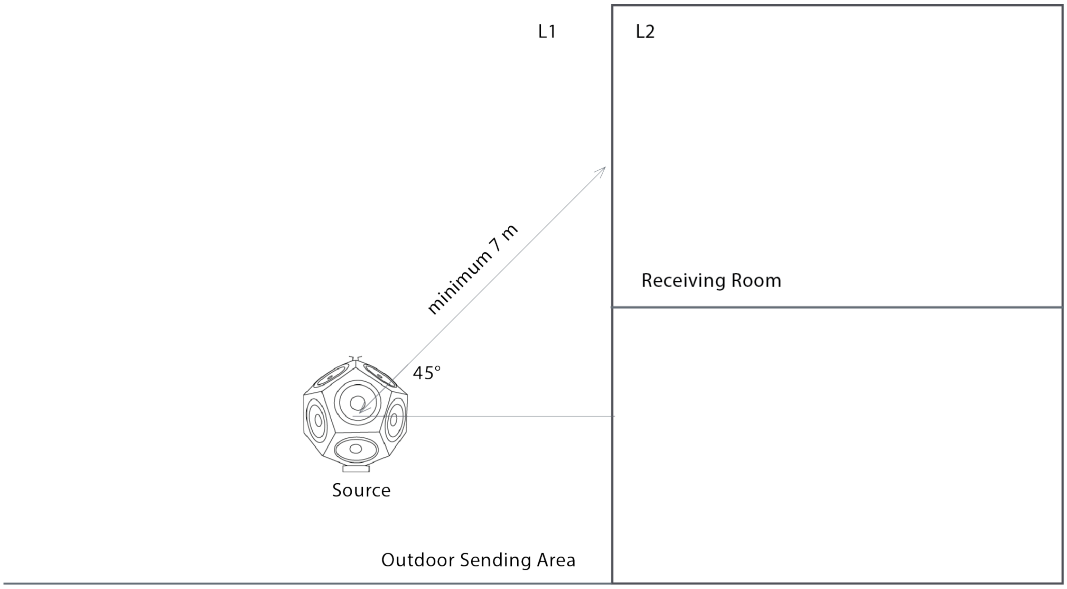
Measuring the airborne sound insulation of façades requires the following measurments:

- Background noise level in the receiving room;
- Sound pressure level in front of façade;
- Sound pressure level in the receiving room;
- Reverberation time in the receiving room.

i.1 Getting Started

i.1.1 Speaker Position

- Position the Dodecahedron Speaker DS3 outdoors in front of the façade. The distance D shall be at least 5 m;
- The angle of sound incidence at the facade shall be 45° +/- 5°. The distance from the loudspeaker to the center of the facade under test shall be at least 7 m;
- The sending sound pressure level is measured 2 m in front of the façade;
- The measurements may be carried out at one or multiple speakers positions. Several speaker positions are required at very large rooms or in case the room has two or more outside walls.



i.1.2 Test Signal Level

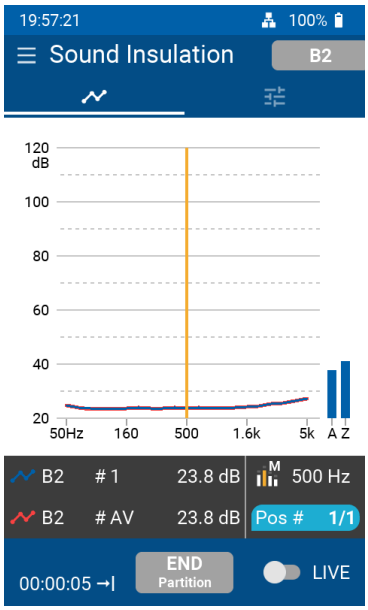
- Start the pink noise test signal at a low level;
- Increase the level until it is minimum of 6 dB — better 10 dB - higher in the receiving room than the background noise (in each frequency band from 0 Hz to 5000 Hz). In case this is not possible, then the Sound Insulation Reporter software will automatically apply corrections in accordance with the standard.

i.2 Background Noise Level in Receiving Room

i.2.1 Preparation

- It's recommended to vacate the room during the measurement so that any noise generated by the operator will not affect the measurement.

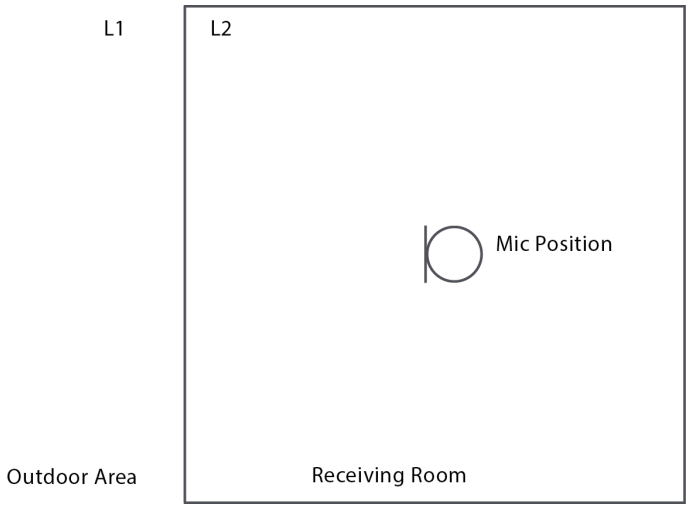
To measure the background sound level in the receiving room, select B2 on the XL3 Acoustic Analyzer "**Select measurement**" page and press the START button.



Background Noise Spectrum in the Receiving Room

i.2.2 Measurement

- Measure the background noise LZeq in the receiving room for 15 seconds. In case the background noise is not steady and continuous, then a longer measurement period shall be applied, e.g. 30 seconds;
- Store the readings on the XL3 Acoustic Analyzer.



Measure the Background Noise Level Lb in the Receiving Room - Top View

i.3 Outdoor Sound Pressure Level in front of Facade

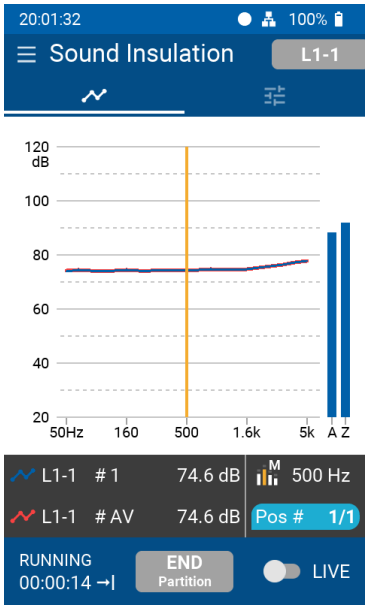
i.3.1 Preparation

The sending sound pressure level is measured outdoor at 2 m (+/- 0.2m) in front of the facade surface center under test. The height of the microphone is 1.5 m above the receiving room floor.

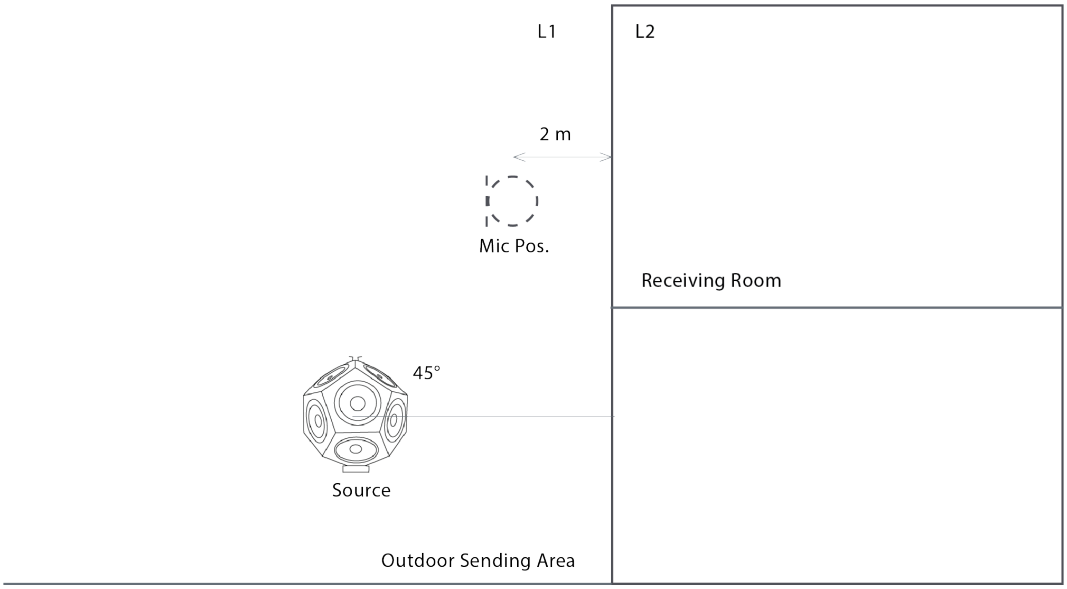
i.3.2 Measurements

- Measure the sending sound level spectrum LZeq for a measurement period of 15 seconds;

Press the START key to initiate the measurement and wait until it is completed. Once you have taken enough individual measurements for L1-1, press the STOP key on theXL3 Acoustic Analyzer.



Noise Spectrum in front of Facade



Measure the Sound Level in the Outdoor Sending Area - Side View

i.4 Sound Pressure Level in Receiving Room

i.4.1 Preparation

Define five microphone positions in the sending and receiving room, distributed within the maximum permitted space throughout each room. The positions shall be in a different plane relative to the room boundaries and shall not form a regular grid. For example, mark the positions on the floor with a tape. The following minimum distances apply:

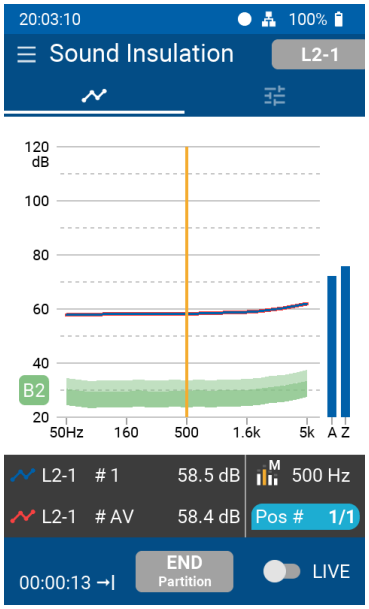
- 0.7 m between microphone positions;
- 0.5 m from any room boundary;
- 1.0 m between any microphone position and the speaker.

It's recommended to vacate the room during the level measurement as the operator introduces additional absorption.

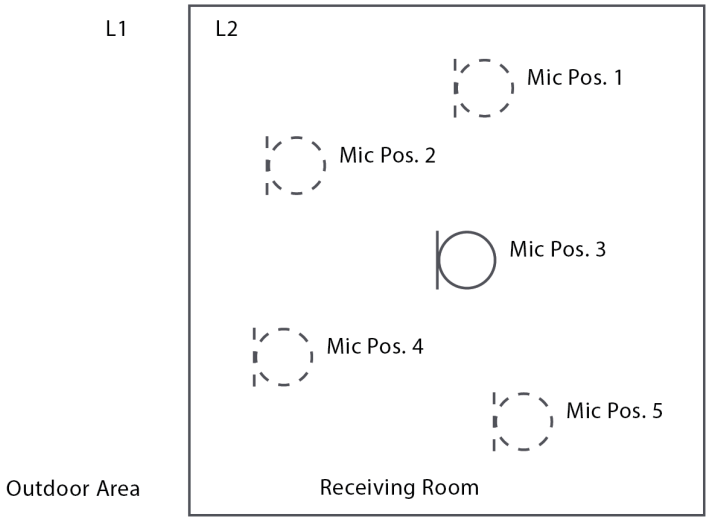
i.4.2 Measurements

- Measure the sending and receiving sound level spectrum LZeq at each microphone position for a measurement period of 15 seconds;

- Proceed to the L2 receiving room and choose L2-1 located on the "**Select measurement**" page. Activate the sound source (which is still placed at position #1 in front of Facade) and press the START button to initiate the initial sound level measurement in the receiving room.
- Proceed with conducting the remaining measurements in the receiving room for the data set L2-1 and then press the STOP button.
- Select L2-2 on the "**Select measurement**" page and position the noise source in front of the Facade at position #2.
- Repeat the aforementioned measurements in both, in front of the Facade and Receive rooms for noise source position #2. Repeat this process until all L1-x and L2-x measurements for different noise source positions in the transmitter room are completed.



Noise Spectrum in the Receiving Room

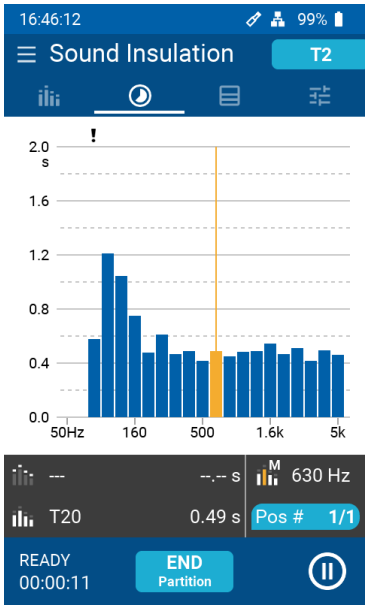


Measure the Sound Levels in the Receiving Room - Top View

i.5 Reverberation Time in Receiving Room

i.5.1 Preparation

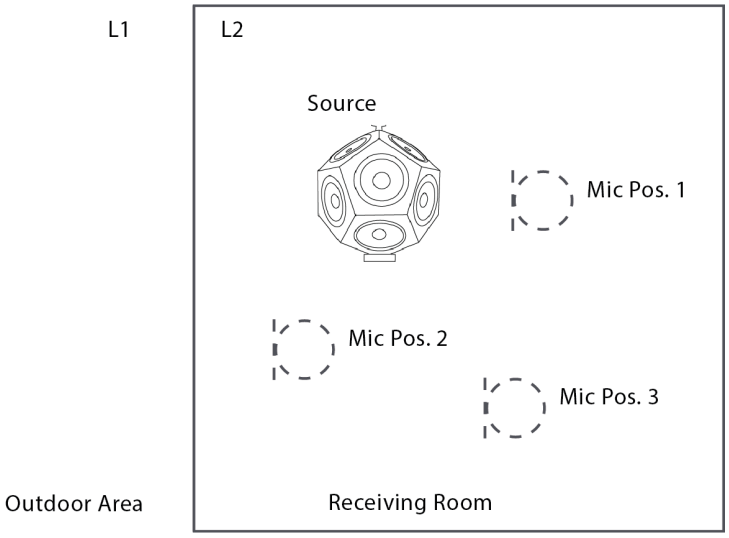
- Move the Dodecahedron Speaker DS3 to the receiving room;
- Select three microphone positions in the receiving room;
  - Choose T2 on theXL3 Acoustic Analyzer "**Select measurement**" page.
  - Press the START button to commence the reverberation time measurement and toggle the speaker On and Off multiple times. Then press the START button.



Reverberation Time T

i.5.2 Measurement

Conclude the measurement series by first pressing the STOP button and then tapping END Partition. You can now review the measurement results D or R'45° individually by pressing the corresponding button under "**Results**".



Measure the Reverberation Time T - Top View

i.6 Data Analysis and Reporting

Verify and document all readings by using the Sound Insulation Reporter software. This is a PC-Software dedicated for building acoustics professionals. Load all measurement records into the software and generate the sound insulation report. The software calculates the weighted ratings based on the reference curve shifting method in accordance with the ISO 717-1 standard.

Calculation formas:

- $D2m = L1,2m - L2;$
- $D2m,n = D2m - 10\log(A/10);$
- $D2m,nT = D2m + 10\log(T/0.5);$
- $R'45° = D + 10\lg(S/A) - 1.5;$
- $A = 0.16 * V/T.$

A	Equivalent absorption area of the receiving room [m2]
D	Difference between facade level and receiving room level using element method [dB]
D2m	Difference between level 2 m in front of facade and receiving room level [dB]
D2m,n	Normalized level difference [dB] (the level difference D is standardized to the equivalent absorption area of 10 m2 in the receiving room)
D2m,nT	Standardized level difference [dB] (the level difference D is standardized to the 0.5 seconds reference value of the reverberation time in the receiving room)
DnT,w	Weighted standardized level difference (is the value of the reference curve at 500 Hz after shifting the reference curve) [dB]
L1,2m	Sound pressure level measured 2 m in front of facade [dB]
L2	Sound pressure level in the receiving room [dB]
R'45°	Apparent sound reduction index of field measurement using element method [dB]
R'45°,w	Weighted apparent sound reduction index using element method [dB] (is the value of the reference curve at 500 Hz after shifting the reference curve)
S	Partition area between the sending and receiving room m2
T	Reverberation time in the receiving room [s]
V	Volume of the receiving room in [m3]

j. Know How

j.1 Diffuse Sound Field

One of the assumptions commonly made in sound insulation measurements is that the sound field in a room can be considered as being diffuse (= the sound energy density is uniform throughout the space). This is not strictly correct because diffuse sound fields don't occur in real box-shaped rooms with stationary surfaces and absorbent boundaries. However, in the field situation there are some rooms in which there are close approximations to a diffuse sound field in the mid and high frequency ranges. In frequency bands lower than

about 400 Hz in general and especially lower than 100 Hz, no diffuse-field conditions in the test room can be expected especially when room volumes of 50 m3 or less are considered.

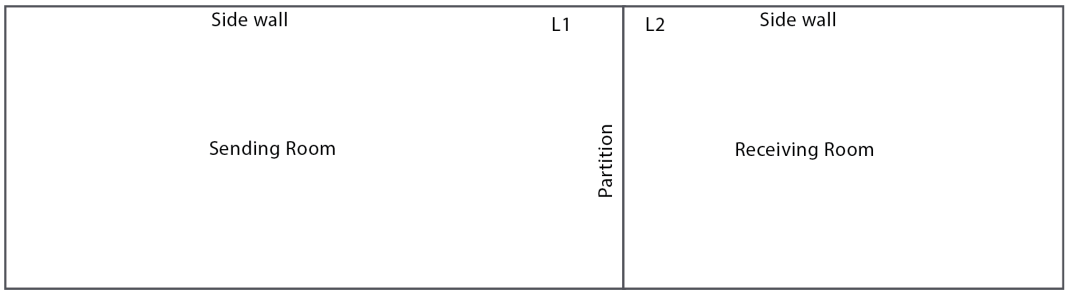
The preceding described measurement procedure allows for measurements to be taken without any knowledge as to whether the sound field can be considered as diffuse or non-diffuse.

j.2 Source Position

For airborne sound insulation measurements in non-diffuse sound fields it is necessary to excite the majority of the modes in the source room. For this reason, loudspeaker positions near the corners are used in boxshaped rooms as well as other shapes of room. Many more modes are excited by the source in a corner position than a central point. In addition, it is necessary to take average measurement from more than one source position. (Sound Insulation by Carl Hopkins, 2007, Elsevier & Revision of international standards by Carl Hopkins, 2015, Elsevier).

j.3 Sound Reduction Index R

The sound insulation capabilities of a particular wall, ceiling, or component can be measured in a laboratory, and a sound reduction index R assigned to it. For such laboratory measurements it's important that the sound transmitted from the sending room into the receiving room not directly through the partition under test (e.g. via the side walls) is at least 15 dB below the sound transmitted directly through the partition.



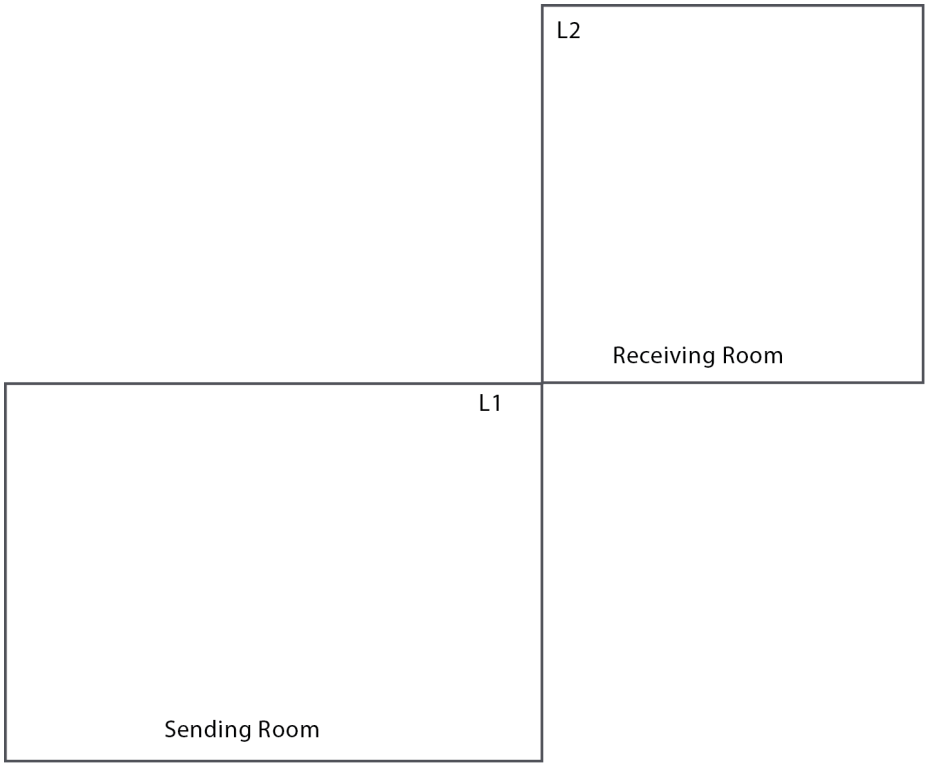
Default room layout

j.4 Apparent Sound Reduction R'

In an actual building (outside of the laboratory), sound may find a way around the main room-separating partition e.g, through a window or an electric wiring channel; the sound level in the receiving room is not just the sound transmitted through the partition itself. Therefore, the so-called Apparent Sound Reduction Index R’ is measured.

j.5 Normalized level difference Dn

The normalized level difference Dn is used for situations where there is no common partition area or where the partition area is not easily determined (e.g. fan opening, ventilation, etc.). The sound pressure level is measured in the sending and receiving room and the difference D calculated. As the level in the receiving room depends on the absorption within the room, the level difference is normalized with the actual absorption area in the receiving room in relation to a reference absorption area of 10 m2. In relation to the sound insulation index R, a normalized level difference Dn of, for example, 40 dB can be seen as a wall area of 10 m2 with R = 40 dB.



Room layout without common partition area

j.6 Standardized level difference DnT

The standardized level difference describes the sound insulation between two rooms. This term is commonly specified in local standards with minimum requirements. The sound pressure level is measured in the sending and receiving room and the difference D calculated. As the level in the receiving room depends on the reverberation time T in the room, the level difference is standardized to the measured reverberation time in the receiving room in relation to a reference reverberation time of 0.5 seconds.

j.7 Related Standards

ISO 16283-1	Acoustics — Field measurement of sound insulation in buildings end of building elements — Part 1: Airborne sound insulation
ISO 16283-2	Acoustics — Field measurement of sound insulation in buildings and of building elements — Part 2: Impact sound insulation
ISO 16283-3	Acoustics — Field measurement of sound insulation in buildings and of building elements — Part 3: Facade sound insulation
ISO 717-1	Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation
ISO 717-2	Acoustics — Rating of sound insulation in buildings and of building elements — Part 2: Impact sound insulation
IEC 61672-1	Electroacoustics — Sound level meters — Part 1: Specifications
IEC 61260-1	Electroacoustics — Octave-band and fractional-octave-band filters — Part 1 Specifications
IEC 60942	Electroacoustics - Sound calibrators
ISO 3382-2	Acoustics — Measurement of room acoustic parameters — Part 2: Reverberation time in ordinary rooms

k. Sound Insulation according ASTM

k.1 Airborne Sound Insulation

ASTM specifies the measurement of airborne sound insulation between two rooms in the standards E336 and E413. Calculation formulas:

- $NR = L1 - L2;$
- $NNR = NR + 10\log(T/0.5);$
- $ATL = NR + 10\log(S/A);$
- $A = 55.26^{*} V/(c * T);$
- $c = 20.047 * SQRT(273.15 + t).$

ATL	Apparent transmission loss [dB]
ASTC	Apparent sound transmission class [dB] (single number rating obtained by applying the classification procedure of Classification E413 to apparent transmission loss data)
A	Sound absorption in the receiving room [m2]
c	Speed of sound [m/s]
L1	Sound pressure level in the sending room [dB]
L2	Sound pressure level in the receiving room [dB]
NR	Noise reduction between the sending and receiving room [dB]
NIC	Noise isolation class [dB] (a single-number rating calculated in accordance with Classification E413 using measured values of noise reduction)
NNR	Normalized noise reduction [dB] (the level difference D is standardized to the 0.5 seconds reference value of the reverberation time in the receiving room)
NNIC	Normalized noise isolation class [dB] (a single-number rating calculated in accordance with Classification E413 using measured values ofnormalized noise reduction)
S	Partition area between the sending and receiving room [m2]
t	Room temperature [°C]
T	Reverberation time in the receiving room [s]
V	Volume of the receiving room in [m3]

k.2 Impact Sound Insulation

ASTM specifies the measurement of impact sound insulation in the standards E1007 and E989. Calculation formulas:

- $ANISPL = ISPL - 10\log(10/A);$
- $RTNISPL = ISPL - 10\log(T/0.5);$
- $A = 55.26 * V/(c * T);$
- $c = 20.047 * SQRT(273.15 + t).$

A	Sound absorption in the receiving room [m2]
AIIC	Apparent impact insulation class [dB] (a single-number rating derived from values of ANISPL in accordance with Classification E989,formerly FIIC for field impact insulation class)
ANISPL	Absorption normalized impact sound pressure level [dB]
c	Speed of sound [m/s]
ISPL	Impact sound pressure level produced in the receiving room by the operation of the standard tapping machine on a floor-ceiling assembly[dB]
ISR	Impact sound rating [dB] (a single-number rating derived from values of ISPL in accordance with Classification E989)
NISR	Normalized impact sound rating [dB] (a single-number rating derived from values of RTNISPL in accordance with Classification E989)
RTNISPL	Reverberation time normalized impact sound pressure level [dB]
t	Room temperature [°C]
T	Reverberation time in the receiving room [s]
V	Volume of the receiving room in [m3]

k.3 Facade Sound Insulation

ASTM specifies the measurement of facade sound insulation in the standards E966 and E1332. Calculation formulas:

- $\mathrm{OINR} = \mathrm{Lfree - Lin;}$
- $\mathrm{OINR} = \mathrm{L2m - Lin - 2\ dB;}$
- $\mathrm{OINR} = \mathrm{Lflush - Lin - 5\ dB}$
- $\mathrm{AOITL} = \mathrm{OINR} + 10\log(\mathrm{S^{*}\cos Q/A}) + 6dB;$
- $\mathrm{A} = 55.26\ \mathrm{*\ V/(c*\ T)};$
- $\mathrm{c} = 20.047\ \mathrm{*\ SQRT\ (273.15 + t)}.$

A	Sound absorption in the receiving room [m2]
AOITC	Apparent outdoor-indoor transmission class [dB] (a single-number rating calculated in accordance with Classification E1332 using measured values of apparent outdoor-indoor transmission loss)
AOITL	Apparent outdoor-indoor transmission loss [dB]
c	Speed of sound [m/s]
L2m	Nearby microphone method - sound pressure level measured 2 m in front of facade [dB]
Lflush	Flush microphone method - sound pressure level measured very close to the facade [dB]
Lfree	Calibrated source method - sound pressure level of the source calibrated in free-field environment at the same distance that the source is to be facade dB]
Lin	Sound pressure level in the receiving room [dB]
OINIC	Outdoor-indoor noise isolation class [dB] (a single-number rating calculated in accordance with Classification E1332 using values of outdoor-indoor noise reduction)

OINR	Outdoor-indoor noise reduction [dB]
S	Partition area between the outdoor area and receiving room [m2]
t	Room temperature [°C]
T	Reverberation time in the receiving room [s]
Θ	Angle of incidence of test sound [°]
V	Volume of the receiving room in [m3]

k.4 Related Standards

ASTM E336	Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
ASTM E413	Classification for Rating Sound Insulation
ASTM E1007	Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures
ASTM E989	Standard Classification for Determination of Single-Number Metrics for Impact Noise
ASTM E966	Standard Guide for Field Measurements of Airborne Sound Attenuation of Building Facades and Facade Elements
ASTM E1332	Standard Classification for Rating Outdoor-Indoor Sound Attenuation
ANSI/ASA S1.4 / Part 1	American National Standard Electroacoustics - Sound Level Meters - Part Specifications (a nationally adopted international standard IEC 61672-1)
ANSI/ASA S1.11 / Part 1	Electroacoustics - Octave-band and Fractional-octave-band Filters -Part 2: Pattern-evaluation Tests (a nationally adopted international standard IEC 61260-1)
ANSI/ASA S1.40	American National Standard Specifications and Verification Procedures for Sound Calibrators
IEC 60942	Electroacoustics - Sound calibrators
ASTM E2235	Standard Test Method for Determination of Decay Rates for Use in Sound Insulation Test Methods