How To ...

Handheld Solution for Installed Sound

Exel Acoustic Set
Installed Sound Solution

TalkBox Acoustic Generator

This document provides a practical guide on how to use NTi Audio instruments for commissioning and servicing Installed Sound environments and Evacuation Systems.

What you Need:

Exel Acoustic Set with

- XL2 Analyzer
- M4260 Measurement Microphone
- Minirator MR-PRO
- ASD Cable
- Cable Test Plug
- Mains Power Adapters
- Exel System Case

TalkBox Acoustic Generator

What to Do:

NTi Audio instruments can be used for the following tests:

- Cable Test
- Measure THD+N
- 100V Impedance Test
- Polarity Test
- RTA Analysis
- Set up Delay Speakers
- Noise Curves
- Reverberation Time RT60
- Speech Intelligibility STIPA

How to Test Cables

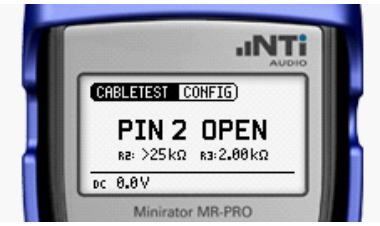
To find any defect in a balanced XLR cable, also when the cable has already been installed in the ceiling, wall or floor.

Connect the Cable Test Adaptor to male side of the cable.

Connect the MR-PRO to the female side of the cable.

On the MR-PRO, select CABLETEST from the main menu.

A clear message is shown if the cable is OK



A broken wire in the cable is detected.

A fault that connects two of the wires in the cable, such as PIN 1 and PIN 2, is detected.

For tips on finding faults, see Appendix A

How To Measure THD+N

A component in your system may add an unacceptable level of harmonics, distortion and/or noise to the signal chain, either because the component is not installed or grounded correctly, the gains are too low or too high, or the component is faulty or simply inferior quality. You can measure this with the THD+N function of the XL2.

Connect the MR-PRO to a line input of your system.

Connect the XL2 to a line output from your system.

On the MR-PRO, select GENERATOR from the main menu, click on WAV and select SINE, set the LVL to 0.00 dBu and the frequency (f) to 1.000 kHz.

On the XL2, select RMS/THD+N from the main menu, set the Filter to Z-WEIGHTING (to measure a flat response across all frequencies), set the units of LVLRMS to dBu, and the units of THDN to %.

The 2-3 indicator shows if the line is balanced.

The LVLRMS value indicates how much the level of the original signal has gained or lost: 0.0 dBu represents no gain or loss.

The FREQ value indicates the principle frequency detected by the XL2. In this example 1.00000 kHz.

The THDN value is a ratio and represents how much of the signal received by the XL2 is NOT this 1 kHz Sine wave. In other words, the **T**otal sum of any **H**armonics, **D**istortions and **N**oise (**THDN**) added by the component under test, expressed as a proportion of the original signal. The THDN unit is shown as a percentage. e.g. 0.0031% means that only 0.0031% of the signal being received by the XL2 is THD+N.

Thus 100% - 0.0031% = 99.9969% of the signal being received by the XL2 is the original 1 kHz Sine wave.

How To Measure THD+N (continued)

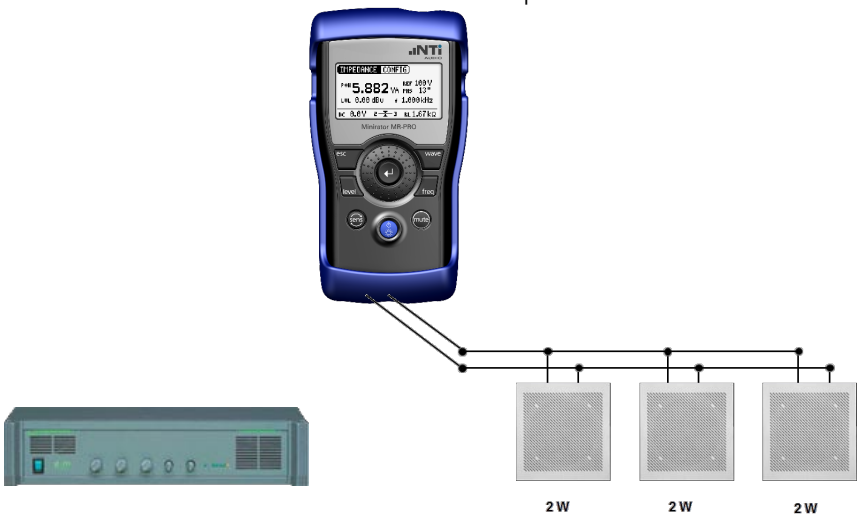
The THDN unit can also be shown in dB with every negative 6 dB meaning that the THDN is a factor of 2 less than the original signal.

For tips on finding faults, see Appendix A

How to Test 100V Systems (includes 25, 35, 50, 70, 100, 140 and 200V systems)

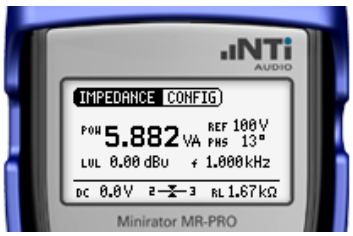
Speakers in 100V systems are joined in parallel and often cover extensive floor areas. Using the MR-PRO Impedance test you can periodically determine that all speakers are connected correctly.

Connect the MR-PRO to the speakers.



100V Amplifier **NOTE: Disconnect all amplifiers.**

On the MR-PRO, select IMPEDANCE from the main menu, click on IMP/POW and select POW, set REF to the reference voltage of your system, set the LVL to 0.00 dBu and the frequency (f) to 1.000 kHz.

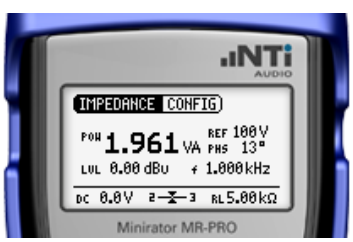


For future reference, make a note of which speakers are connected and how they are connected.

Also note all the values on the MR-PRO screen.

In future, you can repeat the setup as above to verify that all speakers are still connected correctly.

Indicates that only 2 out of the 3 speakers are connected.



Indicates that only 1 out of the 3 speakers are connected.

How to Test Polarity

It is good practice for speakers of the same type to be connected with the same polarity.

Connect the MR-PRO to a line input of your system.

Place the XL2 in front of each speaker.

On the MR-PRO, select GENERATOR from the main menu, click on WAV and select POLARITY.

Adjust the gain of your system and the MR-PRO until the polarity signal can be heard at a decent level.

On the XL2, select Polarity from the main menu, and select 123 from the second menu.

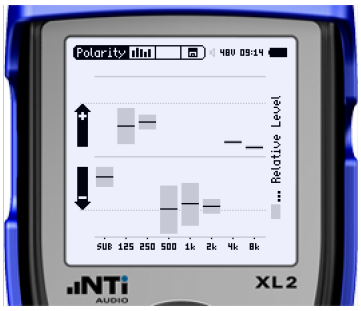
Place the microphone pointing to the middle of the speaker, at a distance from the speaker approximately equal to the diameter of the speaker itself.

The overall polarity of the speaker is shown.

How to Test Polarity (continued)

This overall polarity result obtained may vary between speakers even if the speakers are wired the same. This is due to reflections from the speaker ports and/or nearby surfaces and/or the non-exact placement of the microphone. Further, speakers in multi-speaker cabinets often have mixed polarities by design. We therefore look at the polarity in more detail by examining 8 octave bands.

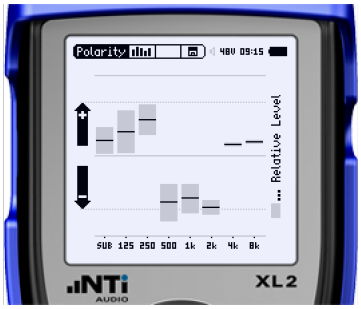
On the XL2, select from the second menu.



Speaker 1

The polarity spectrum shows individual phase information for different frequency bands. The position of the center of each band indicates the polarity of the band while the length of the band represents how much energy is being received in that band.

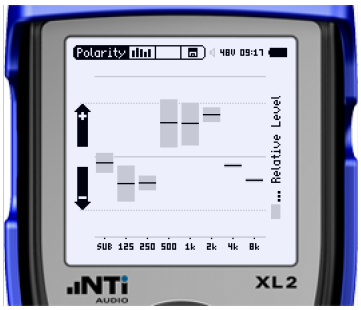
For Speaker 1, as most energy is in the lower half of the screen, the overall polarity shown on the 123 screen is negative.



Speaker 2

For Speaker 2, as most energy is in the upper half of the screen, the overall polarity shown on the 123 screen is positive.

However, as the pattern of the frequency bands are similar (in so much as inverting the pattern over the center horizontal line would create a pattern that was less similar), we can conclude that **Speakers 1 and 2 have the same polarity**.



Speaker 3

For Speaker 3, as most energy is in the upper half of the screen, the overall polarity shown on the 123 screen is positive.

However, as the pattern of the frequency bands is similar when inverted, we can conclude that **Speaker 3 has a different polarity to both Speakers 1 and 2**.

How to Measure an RTA Spectrum

The XL2 provides an RTA (Real Time Analyzer) with which you can measure the audio and acoustic response of your system and the acoustic response of the room.

For example, you can compare the response of the direct sound of speakers that are the same brand and model to verify faults.

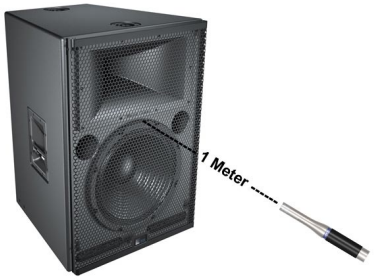
Connect the MR-PRO to a line input of your system.

Place the XL2 in front of each speaker.

On the MR-PRO, select GENERATOR from the main menu, click on WAV and select PNOISE, click on MOD and select CONT.

Adjust the gain of your system and the MR-PRO until the Pink Noise signal can be heard at a decent level.

On the XL2, select SLMETER/RTA from the main menu, and select from the second menu. Choose LZS with Capt and Live . Set resolution to 1/3rd Octave .



Position the microphone so that it mainly picks up the direct sound from the speaker (for example, at one meter). In two-way systems, the microphone should have the same distance from the tweeter and woofer. Use the same relative position for measuring each speaker.

How to Measure an RTA Spectrum (continued)

Select the  and Capture the live RTA 

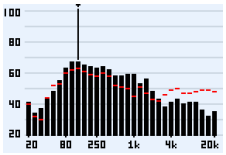
.

Place the microphone at the next speaker.

The differences in the response of the two speakers is shown across the whole frequency spectrum.

Speaker 1 is represented by the dashed line

Speaker 2 is represented by the bars



The result indicates that the tweeter is blown or disconnected on Speaker 2.

How to Setup Delay Speakers

Delay speakers improve the sound quality and speech intelligibility in large venues. If set up correctly the delay speakers should not influence the perceived direction of sound.

Connect the MR-PRO to a line input of your system.

Measure with the XL2 Voice Note microphone.

On the MR-PRO, select GENERATOR from the main menu, click on WAV and select DELAY.

Adjust the gain of your system and the MR-PRO until the Delay signal can be heard at a decent level.

On the XL2, select Delay Time from the main menu.

Connect the MR-PRO directly to the XL2 to synchronize the clocks of the two devices.

The XL2 displays the message “Sychronizing” and the message “Measure“ when the XL2 is ready to measure.

You now have 5 minutes to measure until a new clock sychronization is required.

Connect the MR-PRO again to a line input of your system.

Play the MR-PRO signal through the front speaker only, and STORE the result on the XL2.

In this example, the distance from the XL2 to the front speaker is 80.0 meters, and sound takes 231.9 ms to travel that distance through air with a temperature of 25°C

How to Setup Delay Speakers (continued)

Play the MR-PRO signal through the delay speaker only.

In this example, the distance from the XL2 to the delay speaker is 11.0 meters, and sound takes 31.9 ms to travel that distance through air with a temperature of 25°C

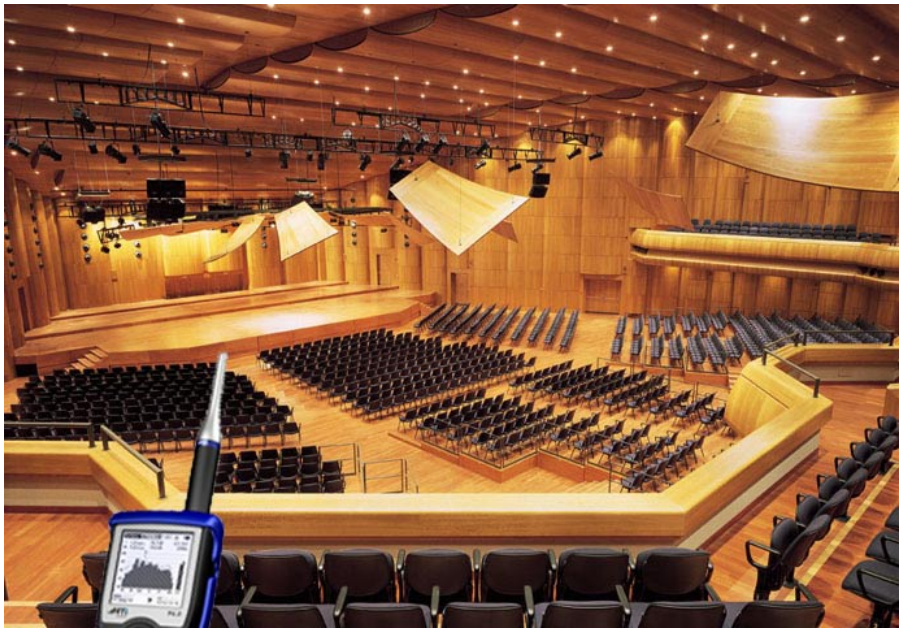
The difference between the two speakers is 231.9 - 31.9 = 200.0 ms.

Adjust your system by adding a delay to the delay speaker of 15 ms more than the difference shown. (200 + 15 = 215 ms)

Why do we need delay speakers? - see Appendix B

How to Measure Noise Curves

Noise Criterion (US) and Noise Rating Curves (Europe) define the limits of octave band spectra for background noise that meet the design requirements of your installation.

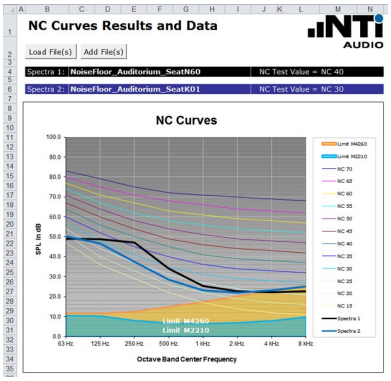


Measure with the XL2
in a 6 to 12 meter grid.

Ensure that the room is quiet.

On the XL2, select profile "NoiseCurves". *

Press the Play button and save each 10-second measurement result.



Copy the saved files to your PC via USB, and load them into the Noise Curves Excel Application Tool ** to create your report.

* http://my.nti-audio.com/support/xl2/download/Profiles/NoiseCurves.prfs

**http://www.nti-audio.com/Portals/0/data/en/NTi-Audio-AppNote-Noise-Curves.zip

How to Measure Reverberation Time RT60

Reverberation affects the sound quality and speech intelligibility in a room.

Connect the MR-PRO to a line input of your system.

Measure with the XL2 in a 6 to 12 meter grid.

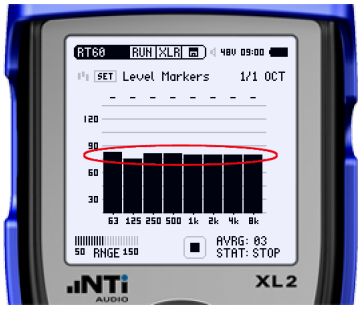
On the MR-PRO, select GENERATOR from the main menu, click on WAV and select PNOISE, click on MOD and select ⎍⎍, click on CYC and select 3/3s.

Adjust the gain of your system and the MR-PRO until the Pink Noise signal can be heard at a decent level.

On the XL2, select RT60 from the main menu, Run from the second menu, and 1/1 OCT resolution.

In a quiet room, click SET.

This records the noise floor and sets the Level Markers 35dB above the noise floor in each frequency band.

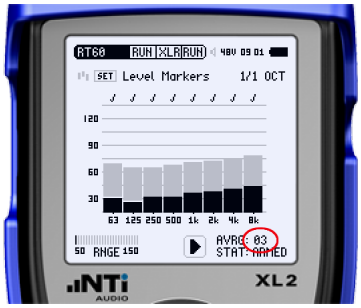


Play the cyclic PNOISE from the MR-PRO through your system. Adjust the gain of your system and your MR-PRO so that there is enough energy to reach the top of the Level markers in as many frequency bands as possible on the XL2.

WARNING: It is advisable to wear hearing protection.

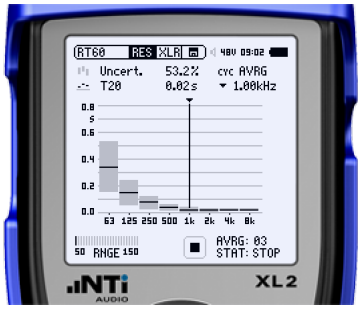
Hint: You may have to increase the bass frequencies on your system. Even so, it is often impossible to create enough energy in the 63Hz frequency band

How to Measure Reverberation Time RT60 (continued)



On the XL2, press the Play button.

The status (STAT) changes to ARMED. Each time a cycle is completed by the MR-PRO, the AVRG value increments. Take at least 3 measurements ensuring that each frequency band displays a tick mark after each measurement cycle (except maybe the 63Hz band).



On the XL2, press the Stop button.

On the MR-PRO, press the mute button.

On the XL2, select Res from the second menu. The RT60 results are shown.

Save the test.

How to Measure Speech Intelligibility STIPA

STIPA (**S**peech **T**ransmission **I**ndex for **P**ublic **A**ddress) quantifies the intelligence of speech in your installed system.

Place the TalkBox at the normal speaking position in front of the microphone.

Measure with the XL2 in a 6 to 12 meter grid.

On the TalkBox, select the STIPA signal (signal number 1).

Adjust the gain of your system until the STIPA signal can be heard at the normal operating level of the system.

On the XL2, select STIPA from the main menu, and Cor from the second menu.

Turn Ambient Noise Correction On.

At a time when the room is full of people and the background noise is at a level you would expect during announcements, click MEASURE to measure the background noise, and/or click EDIT to manually adjust the background noise dB values in each frequency band.

Click SAVE to save the noise file.

On the XL2, select 123 from the second menu.

With the room empty (perhaps at night), play the STIPA signal from the TalkBox (signal 1) through the microphone.

On the XL2, press the Play button.

Remain silent during the next 15 seconds while the STI value is measured.

How to Measure Speech Intelligibility STIPA (continued)

The STI value is shown, including the noise measured earlier.

"Measured" shows the STI value without the noise.

If the STI value measured is close to the limit specified in the design requirements of your installation, on the XL2, select Avr from the second menu.

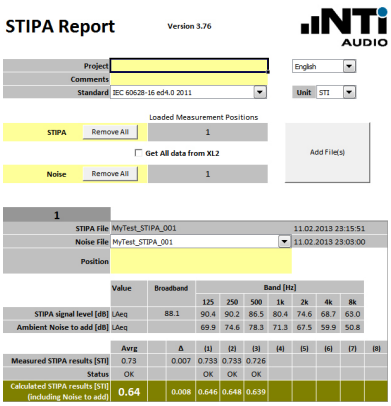
Click ADD CYCLE to measure again from the same measurement position. Repeat for at least 3 cycles.

Save the test to the default MyProject folder.

Move to the next measurement position if required, select 123 from the second menu and start a new measurement.

Creating a STIPA Report

Once all of your positions have been measured, connect your XL2 to your PC via USB. Select "Mass Storage" on your XL2 when prompted.



On the Excel STIPA Reporting Tool, click the "Get All Data from XL2" checkbox.

Your STIPA report will now be generated.

HINT: You can right-click and replace the NTi logo with your own logo

Appendix A

Tips on finding faults

There are several actions you can take before reaching for your test instruments:

- Stay calm - blaming people or equipment will not solve the problem
- Check Stereo - is the problem on one side (fault is probably post-mixer) or both sides (fault is probably pre-mixer) of the stereo image?
- Be methodical - follow each signal path, rather than checking components randomly
- Switch it out - consider changing breakout channel, mixer channel with ones that are known to be working

No Sound

Check the obvious

- are all components switched on?
- is the channel muted on the mixer?
- are all cables in the signal path plugged in correctly?
- does a battery need replacing?
- is the input gain on the mixer too low?

Hum

Very often mains hum is caused by faulty cabling of equipment

- if your earth reference voltage is different from one end of the signal path than the other - plug all components (mixer, processors and PA) into a single electricity mains socket
- if you run an audio cable through a load of coiled mains cable - tidy up your cables
- if you use lighting dimmers on the same supply as your sound system supply

Earth hum can be very difficult to find, especially with very large installed systems. You can determine were the hum is coming from by turning off all equipment apart from your mixing desk and then turning on each piece of equipment one by one.

Appendix B

Why do we need delay speakers?

The Problem

If you can not cover the whole audience area with one speaker system, you can setup additional speakers further into the hall to cover the audience areas that are set away from the stage.

However, the audience sitting close to these additional speakers will SEE the performance in front of them but HEAR the performance coming from the direction of the additional speaker nearest to them.

The result is that the sound experience for these people is not ideal - it is much more desirable to perceive the sound coming from the direction of the band.

The Solution

We can bring the perceived direction of sound back to the front PA while still maintaining enough level to cover the areas that are set away from the stage.

The trick is to add a delay to the additional speakers (thus called "delay speakers") so that the sound from the front PA arrives at the audience closest to a delay speaker 15 ms BEFORE the sound from the delay speaker arrives.

As the first sound arriving is then from the front PA, the perceived direction of the main sound is therefore also from the front PA, while the sound from the delay speaker is perceived as a single reflection of the sound from the front PA, and is not perceived as a secondary auditory event. Thus the sound from the delay speaker has no effect on the perceived direction of the sound, resulting in a rich sound experience.

Further, it is now possible to increase the sound pressure of the delay speaker up to 10 dB higher than the front PA without affecting the perception of sound direction.

Appendix B (continued)

The Haas Effect

Humans perceive direction of sound to be coming from the position from where the first sound arrives.

If a sound from a second source (in this case the delay speakers) arrives within 5 ms after the first source, then this second source also has an influence on the perceived direction of the sound and the listener will perceive the sound to be coming from a position somewhere between the delay speakers and the front PA.

If, on the other hand, a sound from the second source arrives between 5 ms and 35 ms after the first source, then this second source is perceived by the listener as a single reflection of the sound from the front PA and has no influence on the perceived direction of the sound - the overall sound is thus perceived to be coming from the direction of the front PA.

Finally, if a sound from the second source arrives more than 35 ms after the first source, then this second source is perceived by the listener as a separate sound source (an echo) and the listener perceives two separate directions of sound - from the front PA and from the delay speakers.

Therefore, giving the delay speakers between 5 ms and 35 ms (as a rule, set it to 15 ms) of delay allows you to bring more sound level to the back of the room without altering the perception of direction of sound. This somewhat remarkable phenomena is known as the Haas Effect.