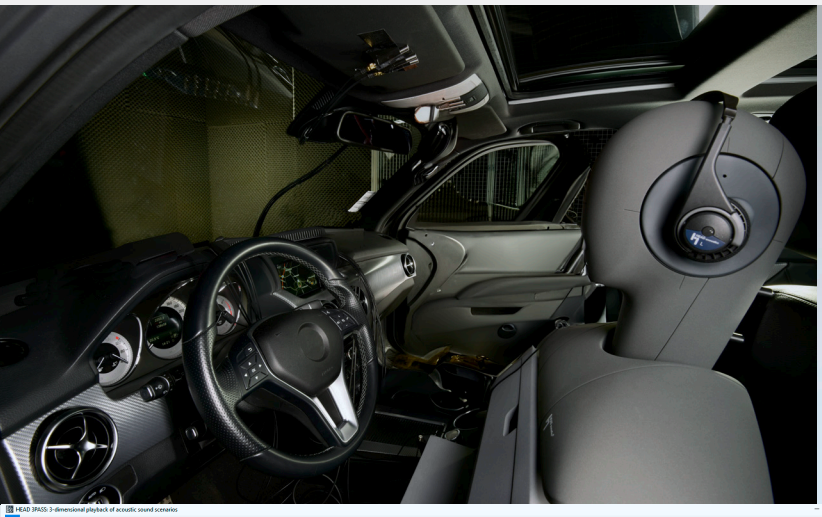
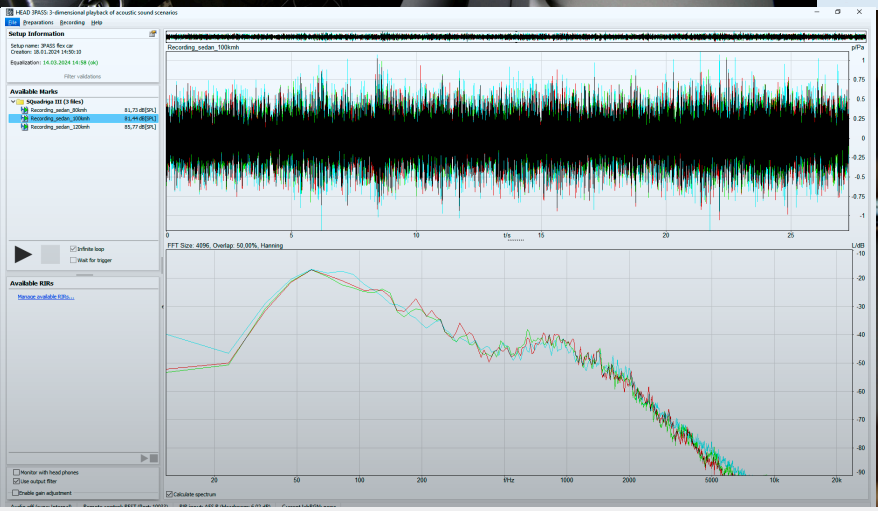
HEAD acoustics

APPLICATION NOTE





3PASS *flex*

3PASS *flex* in cars

Application Note

3PASS *flex* in cars

Revision 1

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1 Introduction

The software 3PASS *flex* enables to simulate background noise precisely in vehicle cabins in terms of level, frequency, as well as spatial, and temporal distribution in the area of the device under test. Equalization of the whole system is conducted fully-automated and digitally.

The application note guides through the entire procedure from recording customized background noises for individual vehicles via equalizing the system to playing back the recorded background noises.

The provided instructions are suitable for preparing measurements with background noise transmission according to various international standards:

- Recommendation ITU-T P.1100 – Narrowband hands-free communication in motor vehicles
- Recommendation ITU-T P.1110 – Wideband hands-free communication in motor vehicles
- Recommendation ITU-T P.1120 – Super-wideband and fullband stereo hands-free communication in motor vehicles
- Recommendation ITU-T P.1140 – Speech communication requirements for emergency calls originating from vehicles
- Recommendation ITU-T P.1150 – In-car communication audio specification

3PASS *flex* operates according to the technical specification ETSI TS 103 224, chapter 7. Please refer to the technical specification for detailed requirements for using the technology and further information.

2 Requirements

2.1 Software

- 3PASS *flex*

2.2 Hardware

2.2.1 HEAD acoustics hardware

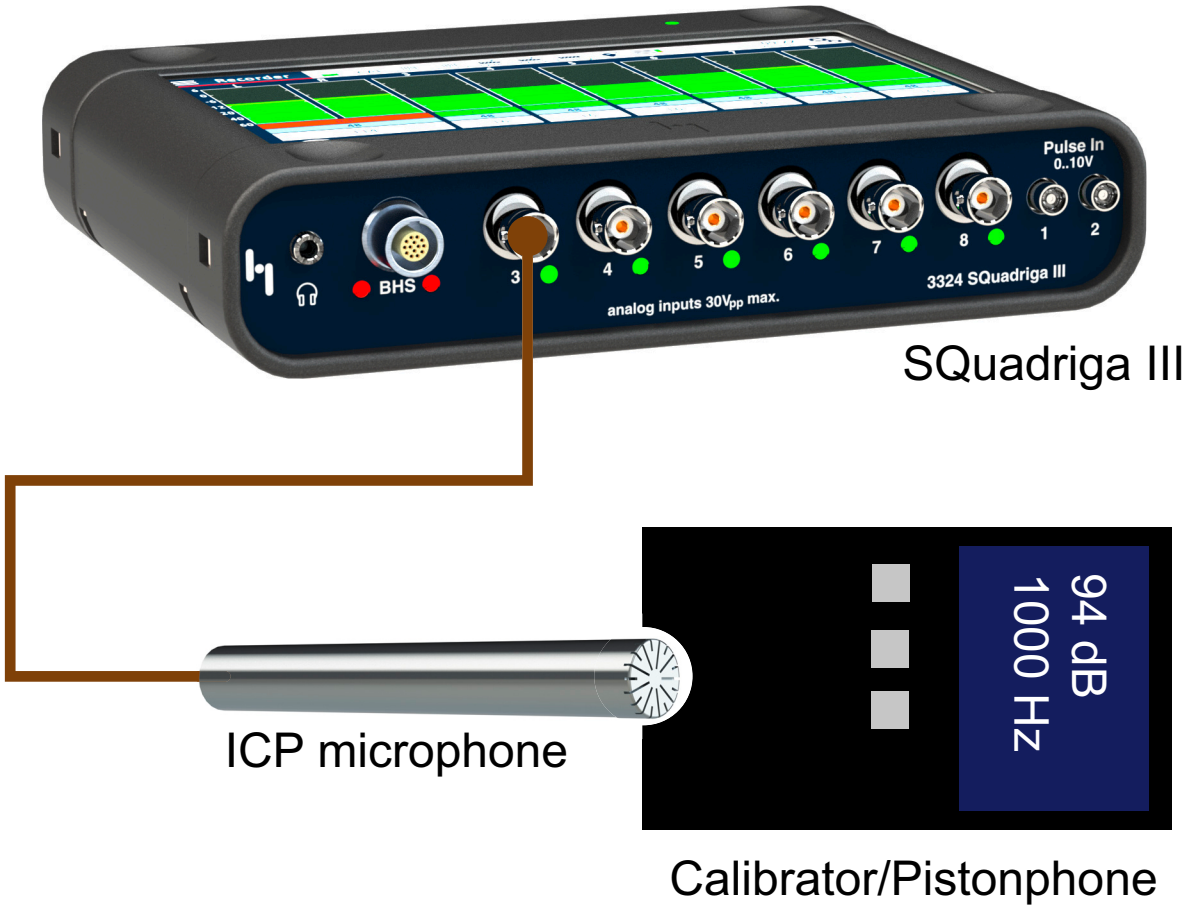
- *lab*BGN, hardware platform for background noise simulation
- SQuadriga III with accessories
  - Controller mode package SQ3 TP 05
  - BHS II, binaural Headset
  - CLL X.10, HEAD*link* cable, 10 m
  - *lab*MA-a, active mounting adapter for mechanical connection
  - *lab*MA-p, passive mounting adapter for mechanical connection
  - RC X.1, remote control
  - RC X.2, radio module for RC X.1
- HSM V
- One of the following HEAD measurement systems:
  - HMS II.3, HEAD measurement system, basic version with right ear simulator, 3.3 pinna, and artificial mouth
    - ► HIS L, HEAD impedance simulator, left
  - HMS II.3 LN, HEAD measurement system, low-noise version with right ear simulator, 3.3 pinna, and artificial mouth
    - ► HIS L LN, HEAD impedance simulator, left, low-noise version
  - HMS II.3 LN HEC, HEAD measurement system, low-noise version with human-like ear canal simulator right and artificial mouth
    - ► HIS L LN HEC, HEAD impedance simulator, left, low noise, human-like ear canal version
  - HMS II.6, HEAD measurement system, free-field microphones (left and right) and artificial mouth
  - HMS II.7, HEAD measurement system, free-field ICP® microphones (left and right) and artificial mouth

2.2.2 Third party hardware

- ICP cardioid microphone
- Four large loudspeakers according to ETSI TS 103 224, chapter 7.1
- Subwoofer according to ETSI TS 103 224, chapter 7.1
- Amplifiers for loudspeakers (and subwoofer)
- Calibrator/Pistonphone

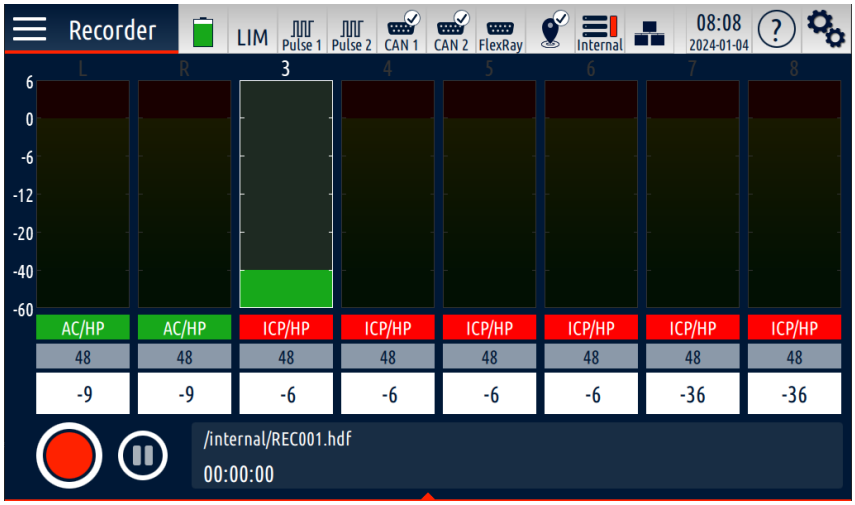
2.3 ICP microphone calibration with SQuadriga III

2.3.1 Connection

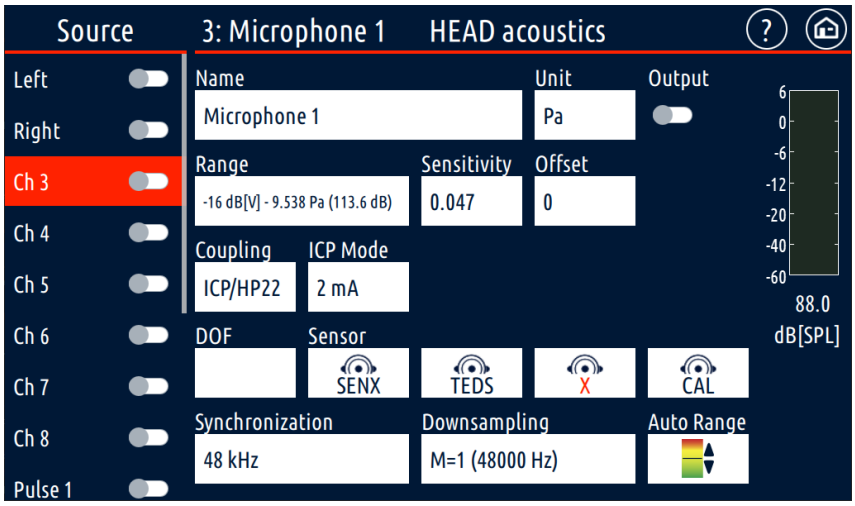


2.3.2 Calibration procedure

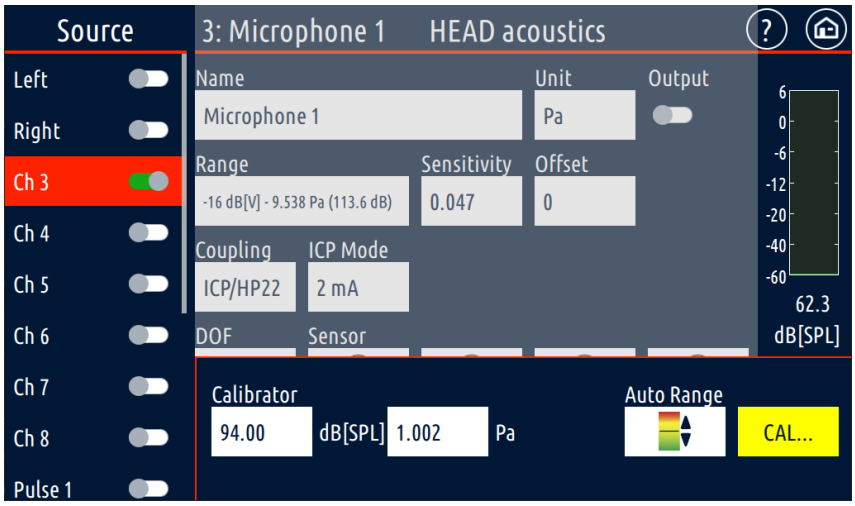
1. Interconnect SQuadriga III with the ICP microphone according to chapter 2.3.1.
2. Attach the calibrator/pistonphone to the ICP microphone.
3. Start SQuadriga III.
4. Select the desired channel for calibration.



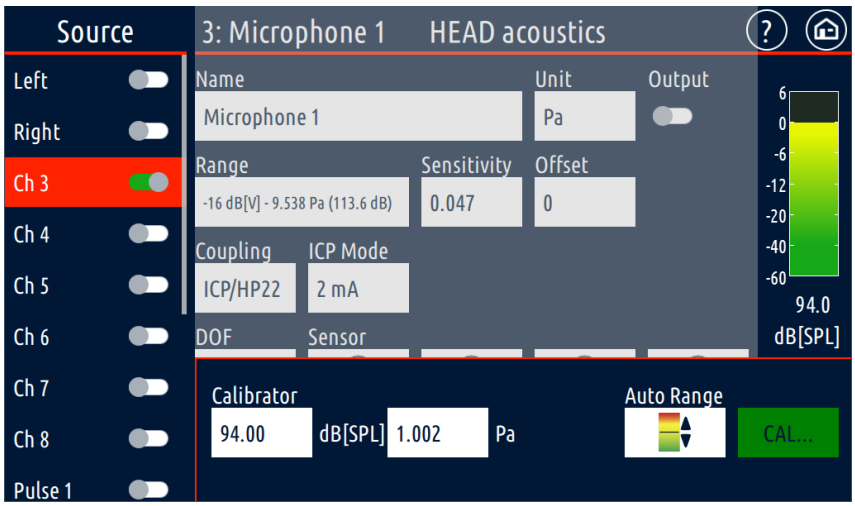
5. Activate the connected channel with the appropriate slider.
6. Set unit to **Pa** (Pascal).
7. Select **TEDS**, if available. Alternatively, set the microphone properties manually:
   - Set **Range** according to the microphone properties.
   - Set **Sensitivity** according to the microphone properties.
   - Set **Coupling** according to the microphone properties.
   - Set **ICP mode** according to the microphone properties.
8. Select **CAL**.



9. Select the **Calibrator** field and enter the output level of the calibrator/ pistonphone in **dB[SPL]** or **Pa**. The values are interdependent.

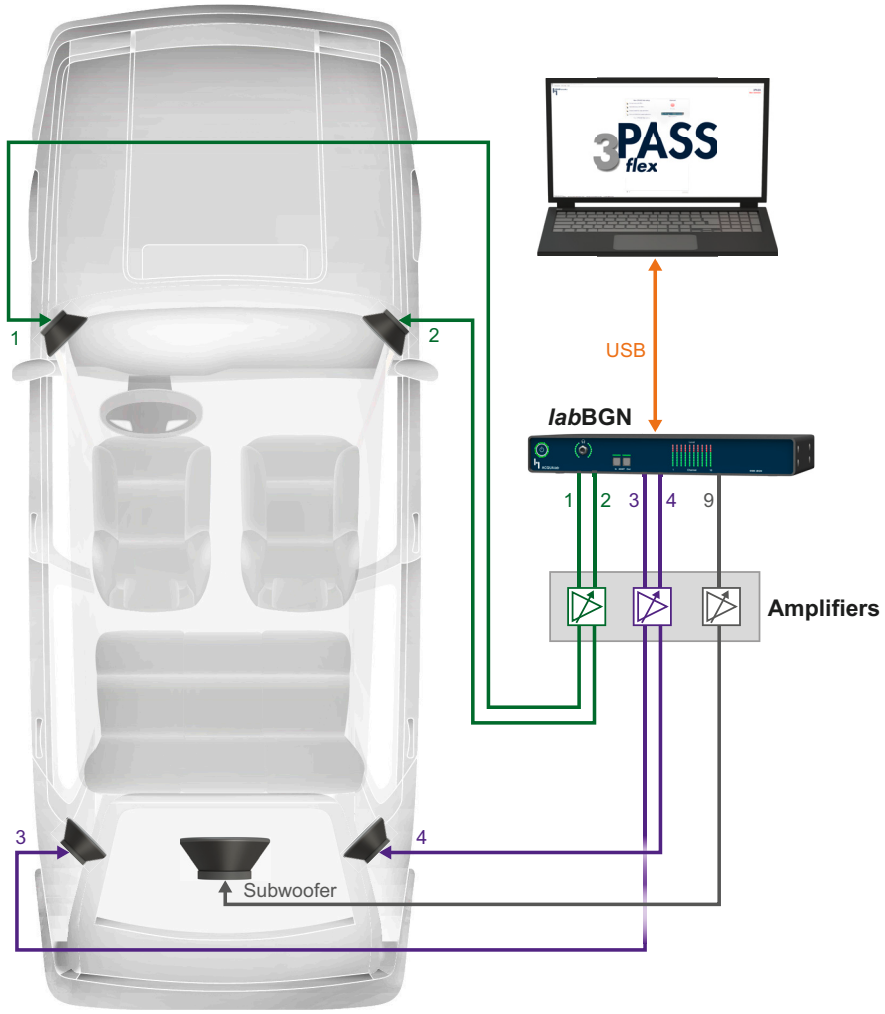


10. Start the signal at the calibrator/ pistonphone.
11. Select **CAL...** .to start the calibration.
12. The calibration has been successful if the **CAL...** button indicates green.



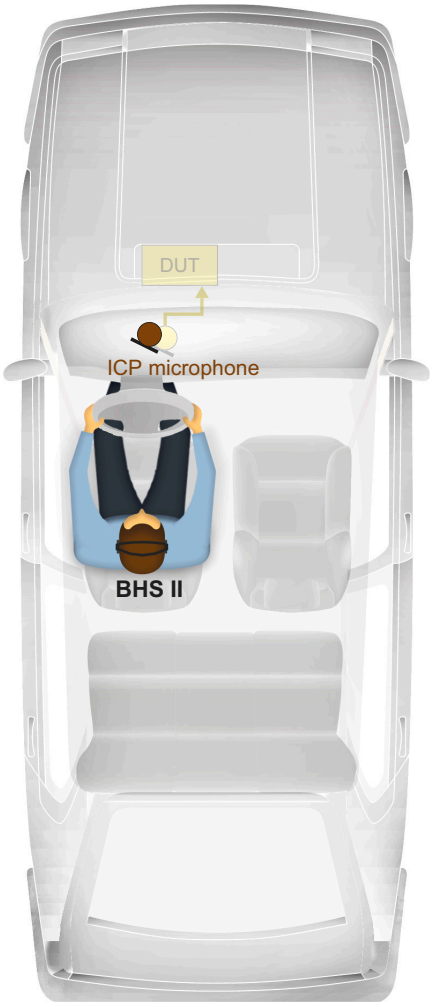
3 Configurations

3.1 Loudspeaker arrangement



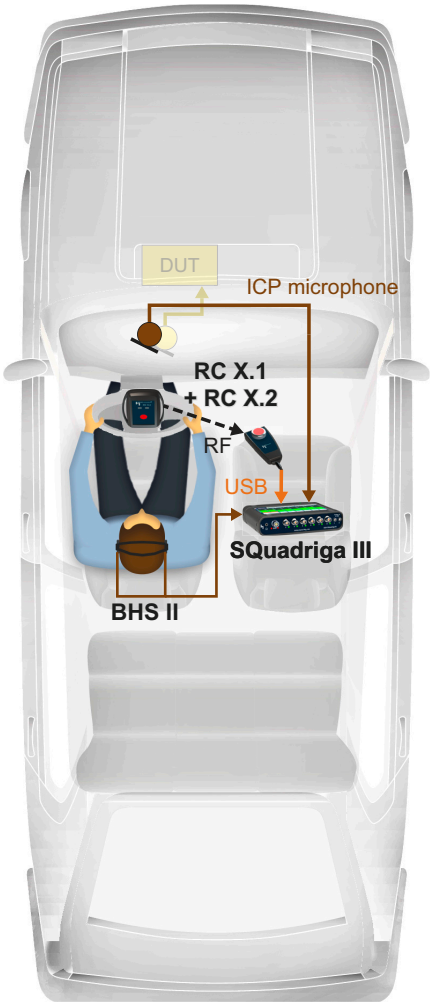
- The loudspeaker configuration shall comply with ETSI TS 103 224, chapter 7.6.1, and ETSI ES 202 396-1, chapter 7.
- Position two loudspeakers in the front left/right of the car, either on the instrument panel or at the bottom in the footwell.
- Position two loudspeakers in the rear left/right of the car at the c-pillar on the backrest of the back seat or the rear shelf.
- Position the subwoofer in the trunk of the car.
- Connect *lab*BGN to 3PASS *flex* PC via USB cable.
- Connect *lab*BGN to the amplifiers via CDX III (breakout cable).
- Connect the loudspeakers to the amplifiers.
- Connect the subwoofer to *lab*BGN.

3.2 Microphone positioning (exemplary)



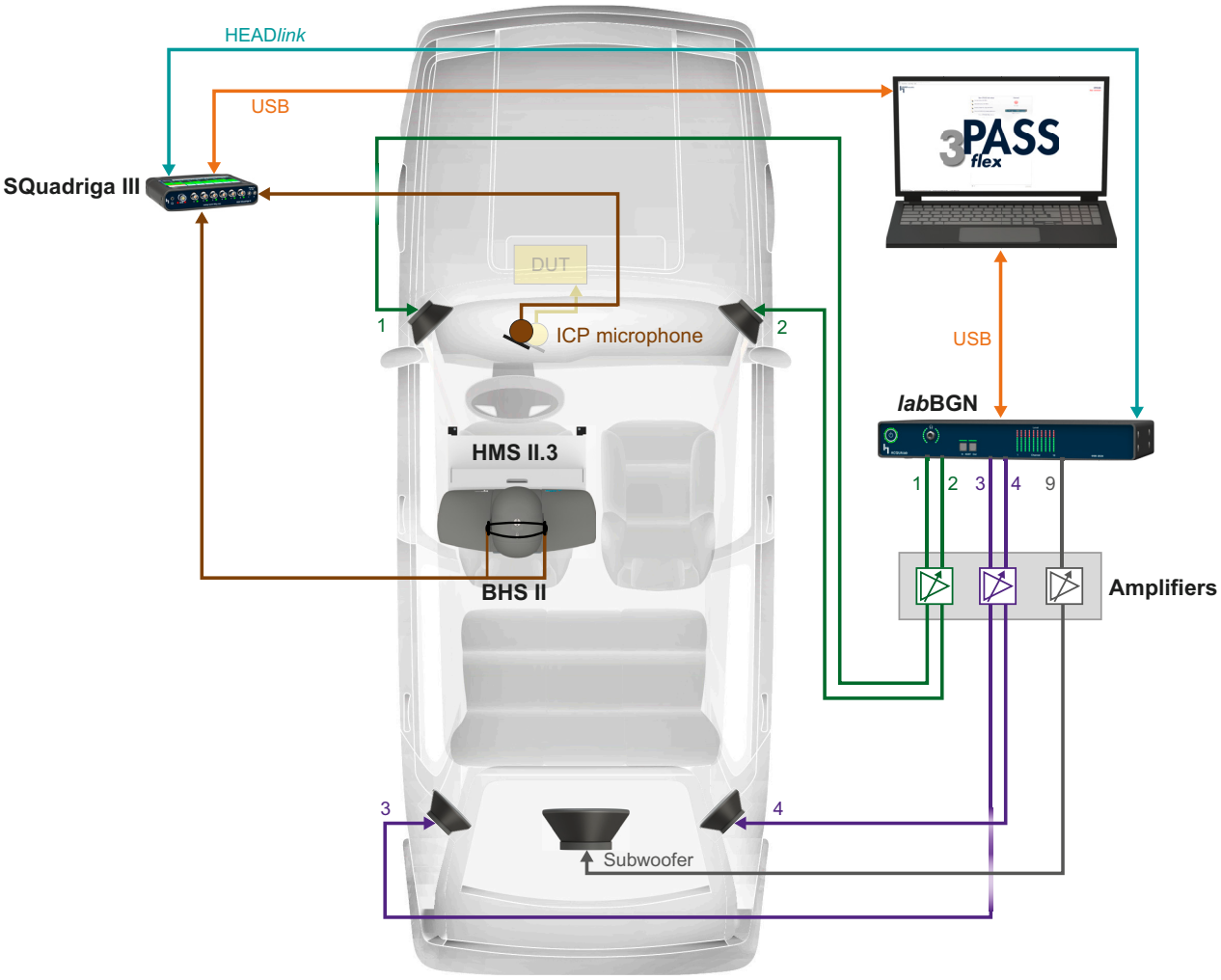
- The microphone positioning shall comply with ETSI TS 103 224, chapter 7.6.2.
- Position the ICP microphone as close as possible to the microphone of the device under test.
- BHS II is positioned on the driver‘s head.

3.3 Recording configuration (exemplary)



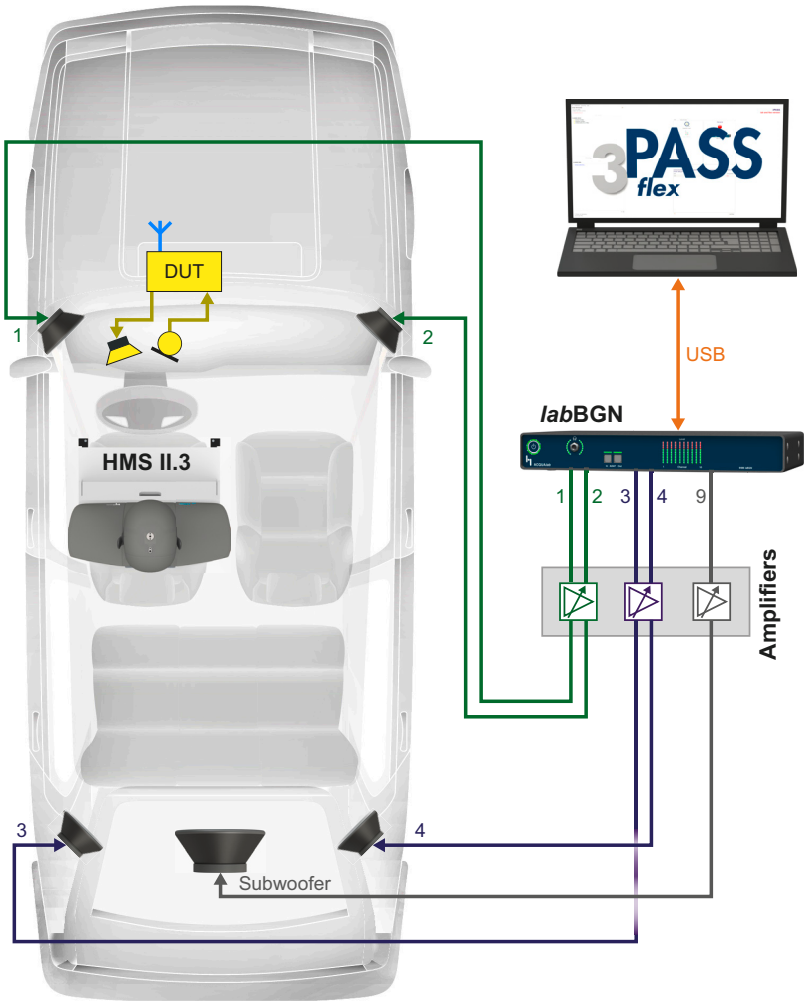
- Connect the ICP microphone to SQuadriga III via BNC cable.
- Connect BHS II to SQuadriga III.
- Connect RC X.1 to SQuadriga III via USB.
- Pair RC X.1 and RC X.2.

3.4 Equalization configuration



- The equalization of 3PASS *flex* complies with ETSI TS 103 224, chapter 7.6.3.
- Position and connect loudspeakers and subwoofer according to chapter 3.1.
- Position the microphones according to chapter 3.2.
- Connect the ICP microphone to SQuadriga III via BNC cable.
- Connect BHS II to SQuadriga III.
- Connect SQuadriga III to the 3PASS *flex* PC via USB cable.
- Connect *lab*BGN to the 3PASS *flex* PC via USB cable.
- Connect SQuadriga III to *lab*BGN via HEAD*link* cable.

3.5 Playback configuration



- Position and connect loudspeakers and subwoofer according to chapter 3.1
- Connect *lab*BGN to 3PASS *flex* PC via USB cable.

4 Recording

4.1 Positioning of microphones

4.1.1 ICP microphones

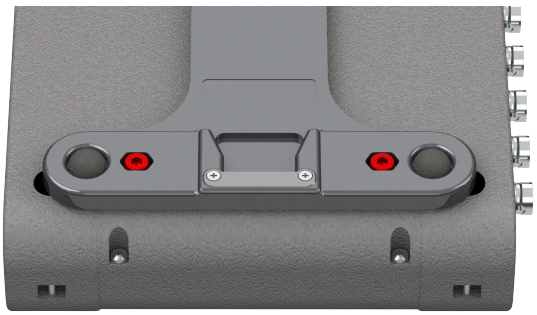
Position the ICP microphone as close as possible to the car‘s hands-free microphones which shall be applied for the measurements. Typical spots of the car‘s microphones are at the rear view mirror or at the ceiling above the driver/passenger. Refer to chapter 3.2.

4.1.2 BHS II

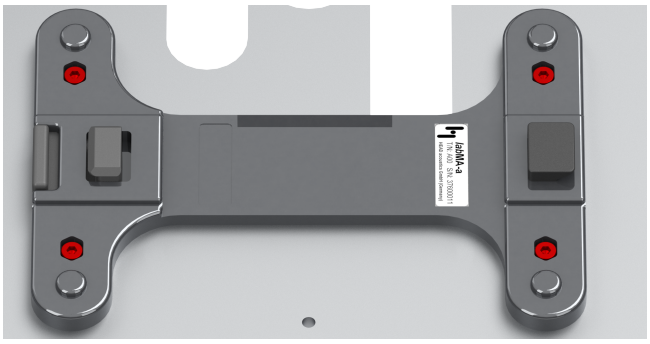
The driver wears BHS II during the recording because the signal at the right ear is considered during equalization.

4.2 Positioning of SQuadriga III on passenger seat

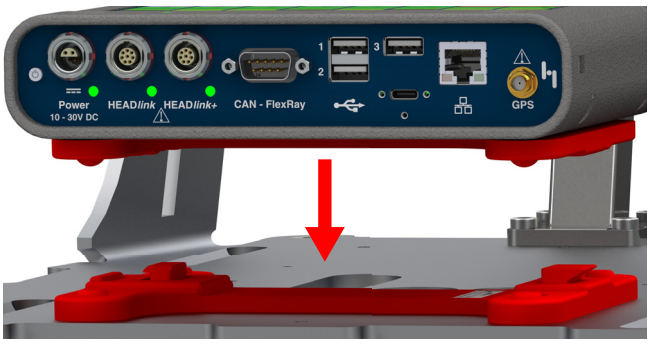
1. Position HSM V on the passenger seat and fix it according to the HSM V manual.
2. Attach *lab*MA-p to the bottom of SQuadriga III with two hex screws M4×8.



3. Attach *lab*MA-a to the bottom plate of HSM V with four hex screws M4×8.



4. Attach *lab*MA-p including SQuadriga III to *lab*MA-a on HSM V.



5. Final position.

4.3 Cabling

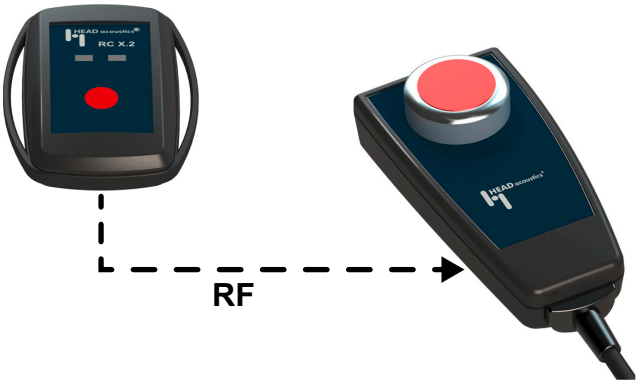
Refer to chapter 3.3. Make sure to fix and conduct all cables within the driver cabin that they do not obstruct the driver and driving security is guaranteed.

4.4 Remote control

Accessories for remote control of SQuadriga III ensure safe driving without distraction.

1. Connect RC X.1 to SQuadriga III via USB.

2. Pair RC X.1 and RC X.2.



3. Attach RC X.2 to the steering wheel of the car.

4.5 Recording procedure

4.5.1 Recording length

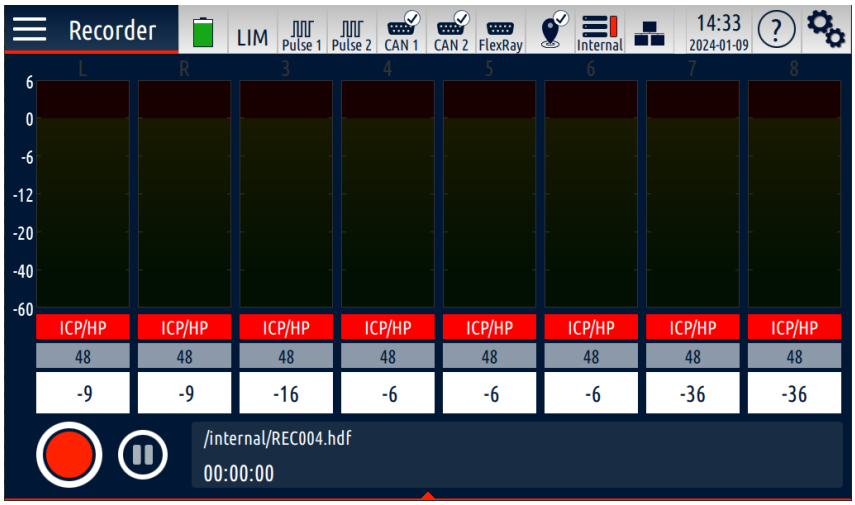
A length between 30 seconds and 60 seconds is usually sufficient for standardized measurements.

4.5.2 Start/stop recording

1. Reach the target speed in the desired driving conditions. Maintain speed during the recording. Activate cruise control, if available.
2. Press the record button ● on RC X.2 to start recording.
3. Record the desired time range.
4. Press the record button ● on RC X.2 to stop recording.

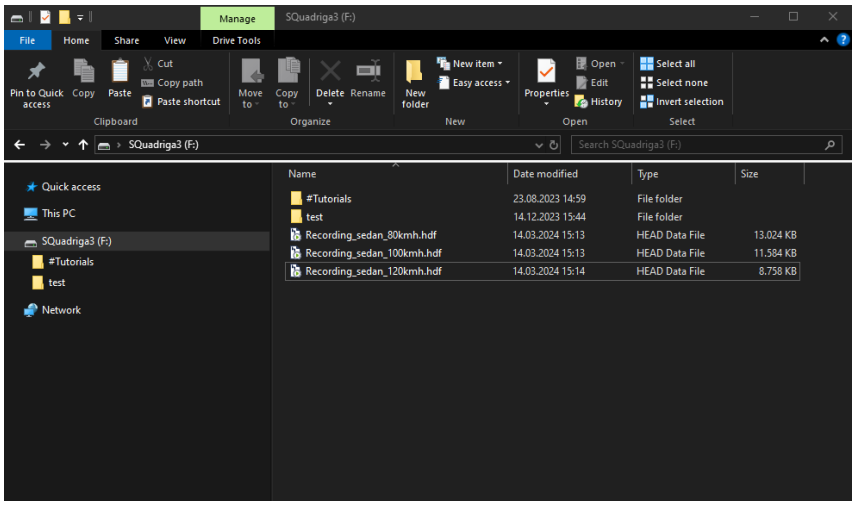
4.6 Import recording to 3PASS *flex*

5. Start the 3PASS *flex* PC.
6. Start 3PASS *flex*.
7. Connect SQuadriga III to the 3PASS *flex* PC via USB.
8. Start SQuadriga III.
9. Select ⚙.

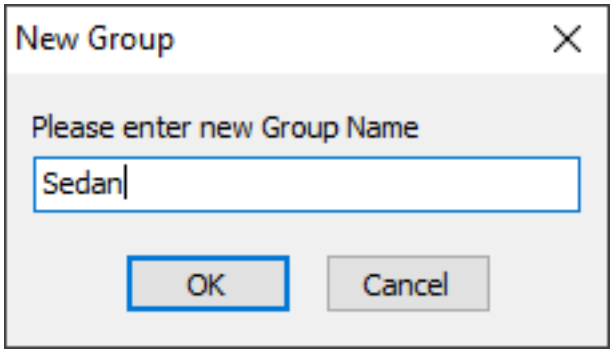


10. Select **Connect to PC as mass storage device**.

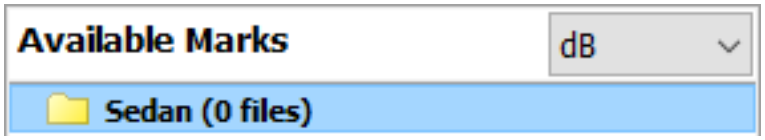
11. Go to 3PASS *flex* PC.
12. Open file explorer.
13. Select **This PC**.
14. Select **SQuadriga3**.
15. Copy desired recordings to a customized directory.



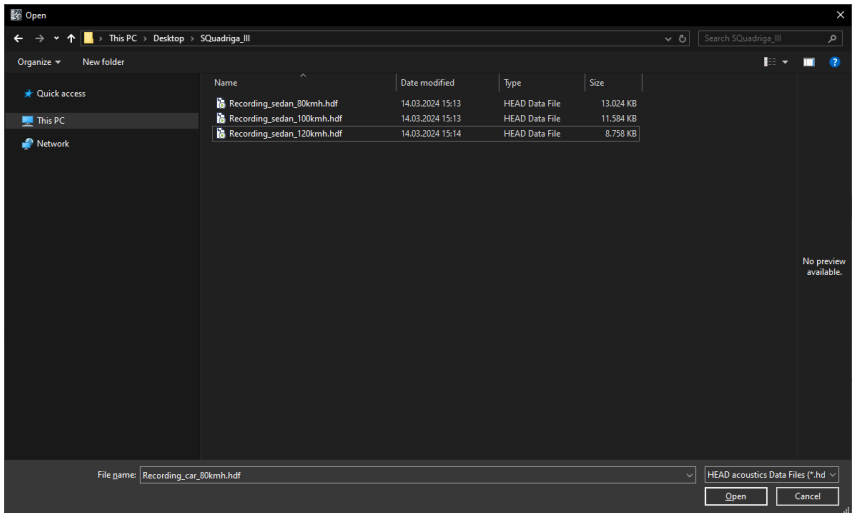
16. Open 3PASS *flex*.
17. Select **File** > **New Mark Group**.
18. Enter a name for the group.
19. Select **OK**.



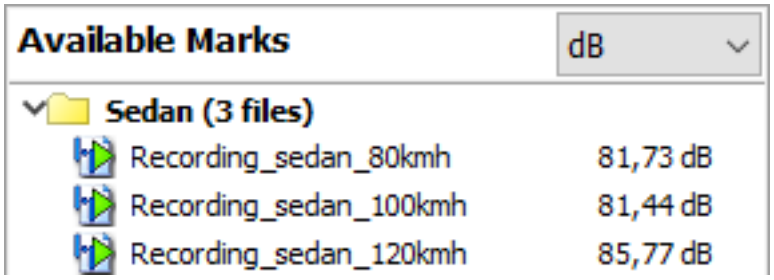
20. Select and highlight the group in **Available Marks**.



21. Select **File** > **Add sourcefiles...** .
22. Browse for the desired directory.
23. Highlight desired files and select **Open**.



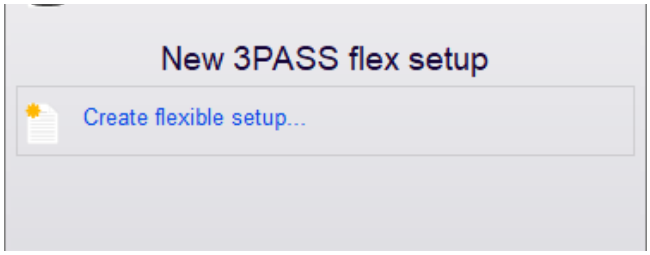
24. The files are available in the group under **Available Marks**.



5 3PASS *flex* setup

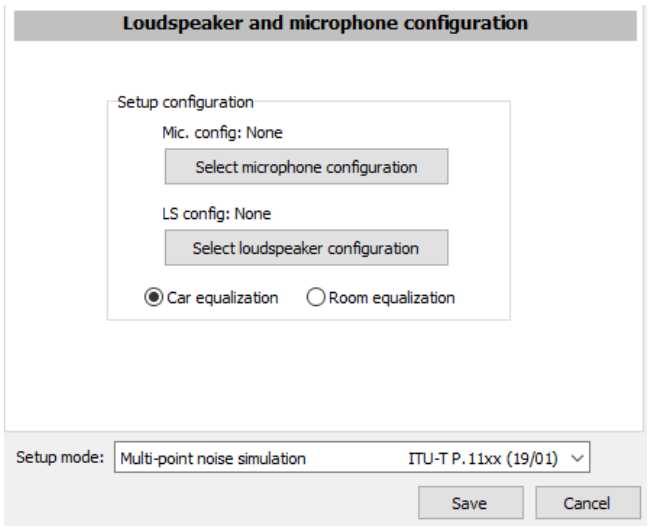
5.1 Setup creation

1. Connect the equipment according to chapter 3.4.
2. Make sure all microphones are calibrated.
3. Select **Create flexible setup**.



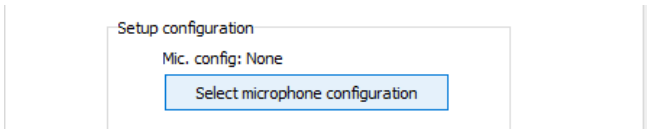
4. Enter a name for the setup.
5. Add comments (optional).
6. Specify microphone configuration. Refer to chapter 5.2.
7. Specify loudspeaker configuration. Refer to chapter 5.3.

8. Select **Car equalization**.
9. Select **Multi-point noise simulation** as **Setup mode**.
10. Select **Save**.

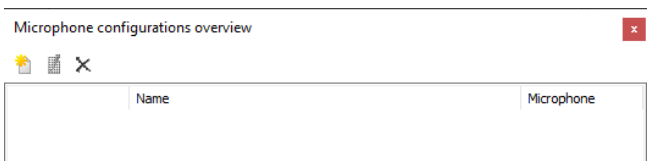


5.2 Microphone configuration

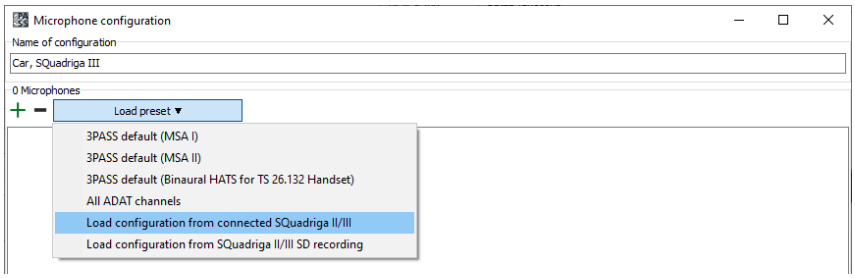
1. Select **Select microphone configuration**.



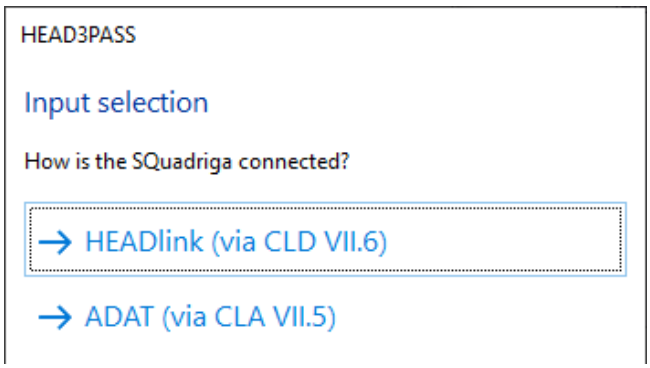
2. Select to create a new microphone configuration.



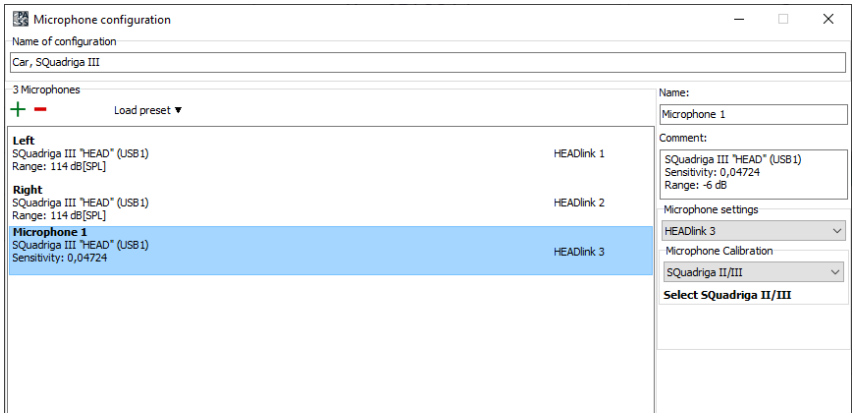
3. Select **Load preset**.
4. Select **Load configuration from connected SQuadriga II/III**.



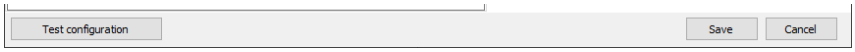
5. Select the present connection between SQuadriga III and *lab*BGN (in the presented configuration: HEAD*link*).



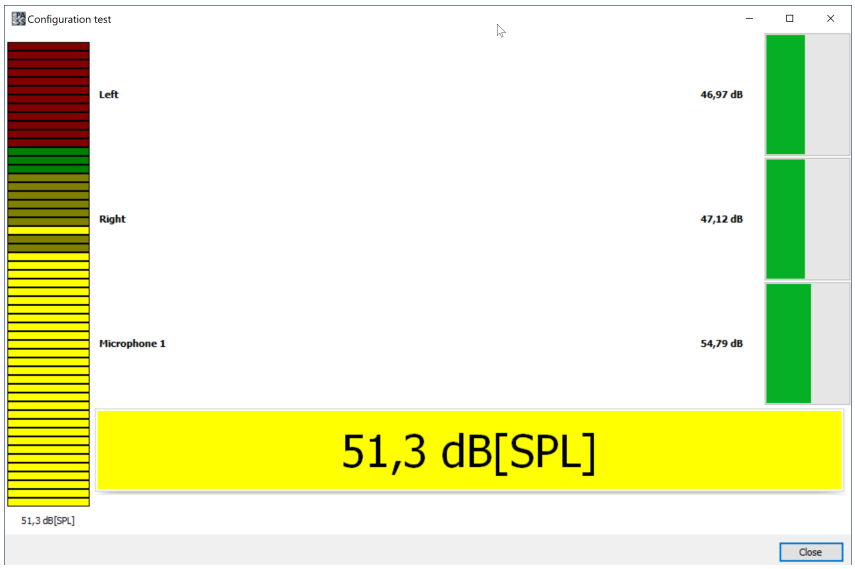
6. Enter a name for the microphone configuration.
7. Select each microphone to check its settings.



8. Select **Test configuration** to check the current input level of each microphone.



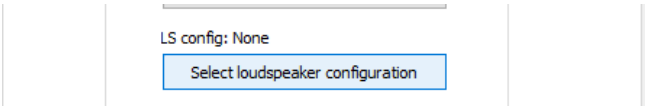
9. Check if each microphone receives and transmits an appropriate signal.
10. Select **Close**.



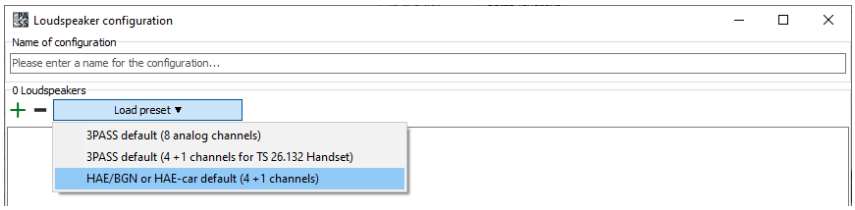
11. Select **Save**.

5.3 Loudspeaker configuration

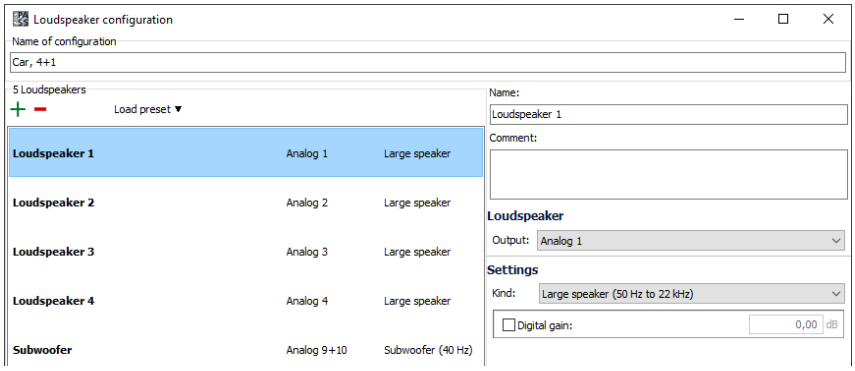
1. Select **Select loudspeaker configuration**.



2. Select **Load preset**.
3. Select **HAE/BGN or HAE-car default (4+1 channels)**.

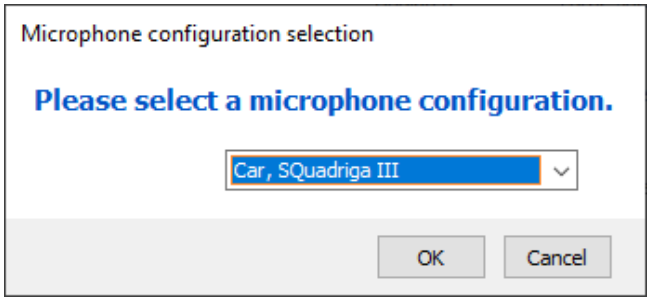


4. Enter a name for the loudspeaker configuration.
5. Select each loudspeaker/ subwoofer and set **Kind** according to its technical specification.

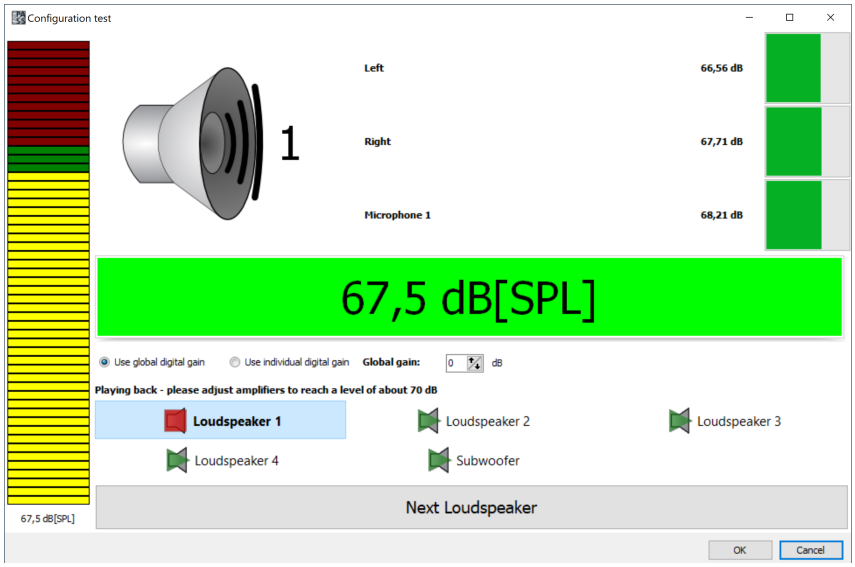


6. Select **Test configuration** to check the current output level of each loudspeaker.

7. Select the microphone configuration from chapter 5.2.
8. Select **OK**.



9. Start playback for each loudspeaker and adjust its volume with the amplifiere to reach a level of approximately 70 dB[SPL].



10. Select **Save**.

6 Equalization

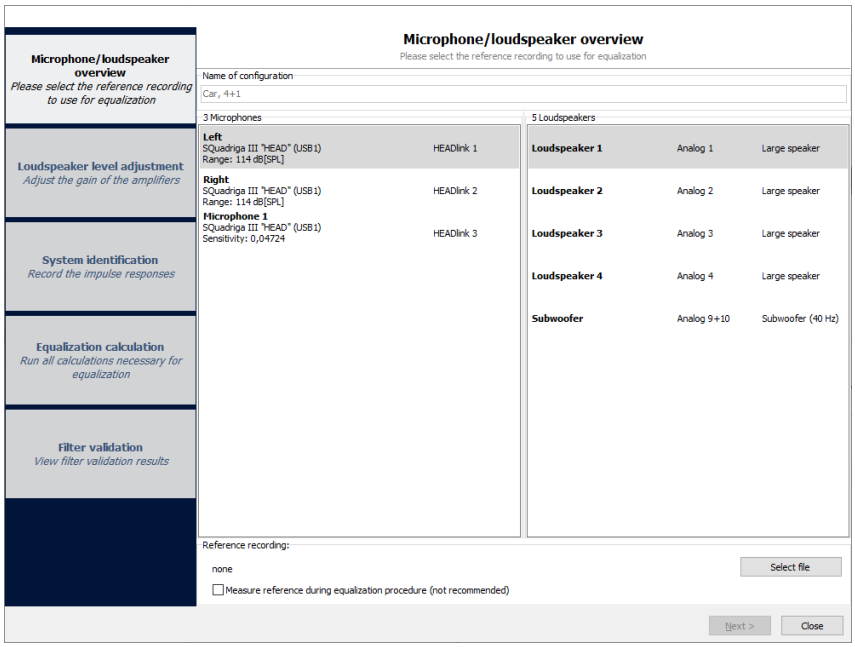
6.1 General

Equalize a 3PASS *flex* setup to acquire proper measurement results later on. The latest equalization of a 3PASS *flex* setup is valid. Previous equalization data will be overwritten.

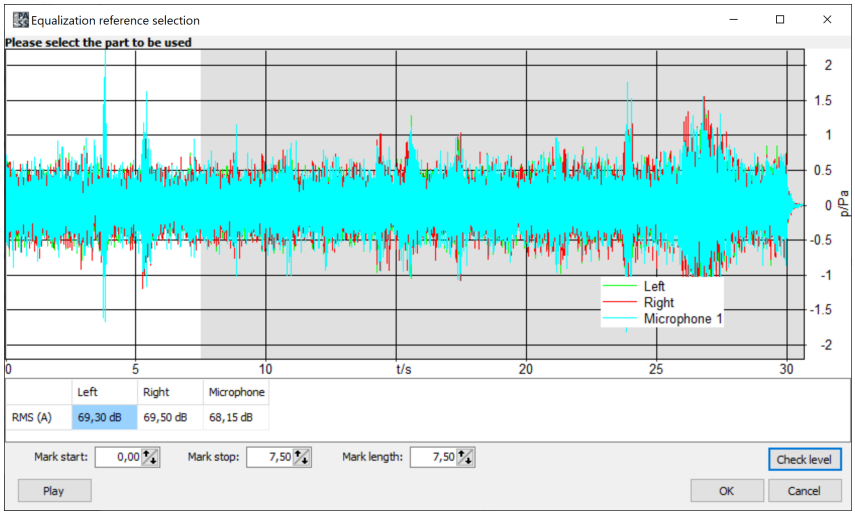
Recording a reference audio file (5 to 10 seconds long, average level 65 dB_{SPL}) with the selected setup is a requirement before starting the equalization. It is recommended to apply the recording from chapter 4 as reference file.

6.2 Equalization procedure

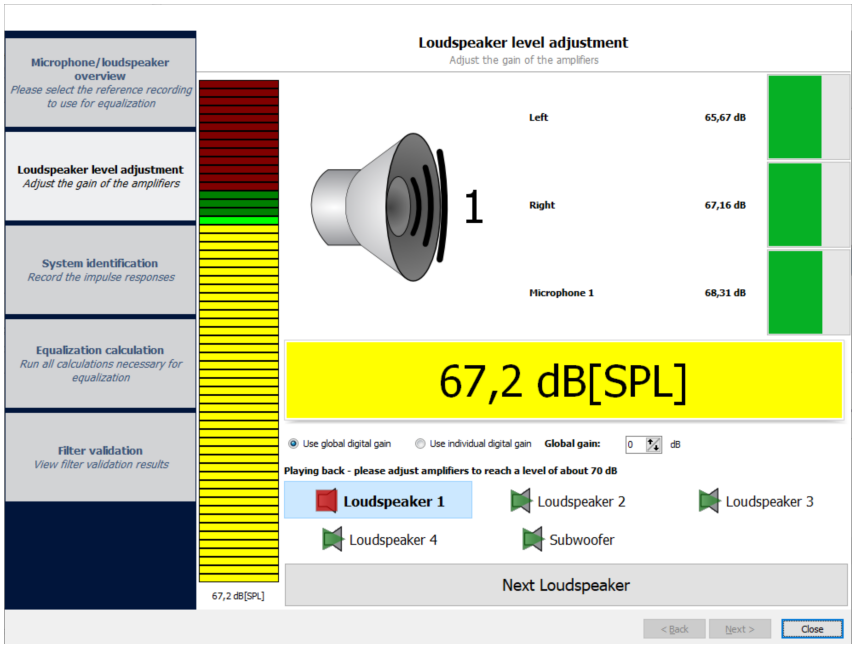
1. Connect the equipment according to chapter 3.4.
2. Select **Preparations** in the menu bar.
3. Select **Equalization wizard**.
4. Select **Select file**.



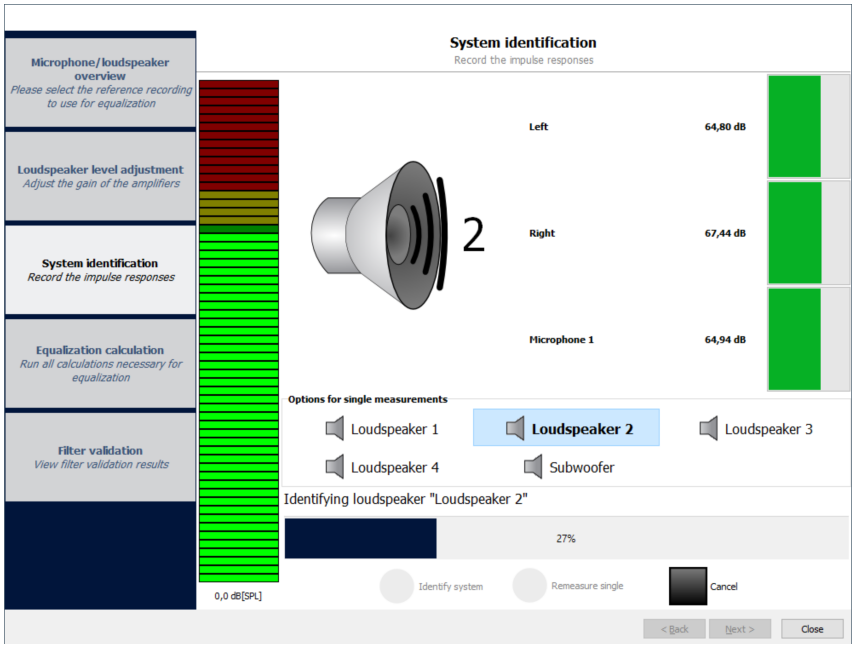
5. Browse for the recording audio file. The file shall have been recorded with the currently enabled 3PASS *flex* setup.
6. Mark a 5-10 seconds interval from the audio file's waveform as reference for the equalization.
7. Select **Check level** to confirm an average level of at least 65 dB_{SPL}(A) in the marked area for all channels.
   If the average level does not comply, mark another area or apply another recording.
8. Confirm with **OK**.
9. Select **Next**.



10. Select Loudspeaker 1.
11. Adjust the loudspeaker volume at the amplifier to reach a level of approximately 70 dB[SPL].
12. Select **Next Loudspeaker**.
13. Repeat step 11 for all loudspeakers and the subwoofer.
14. Select **Next**.

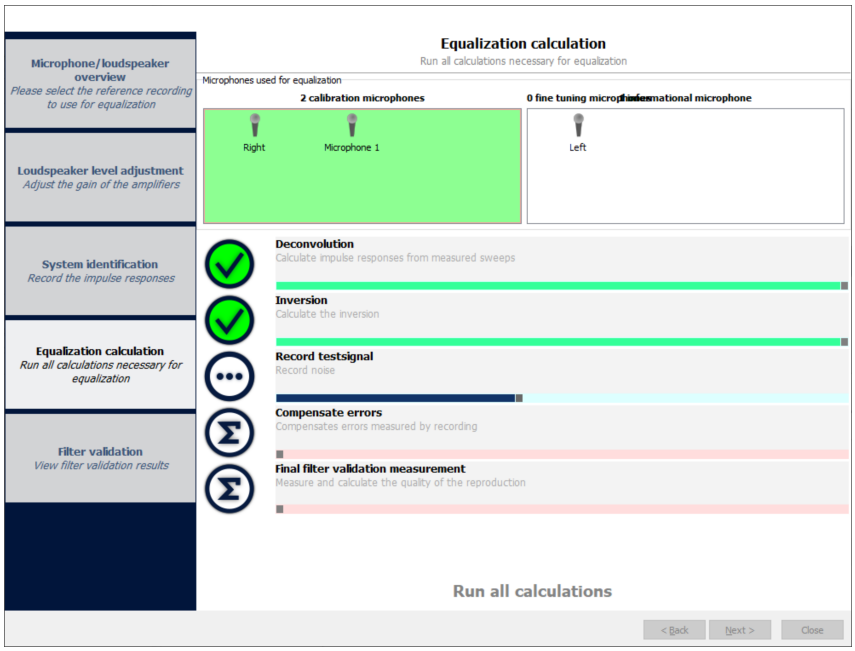


15. Select **Identify system** to start recording impulse responses. 3PASS *flex* plays back sweeps with the loudspeakers.
    Make sure that there is absolute silence during the impulse response recordings. Any disturbance will influence the recordings and eventually the equalization.
16. Select **Next**.



17. Categorize microphones into calibration or informational microphones via drag and drop. Apply the ICP microphone and the right BHS II microphone as **calibration microphones**. Apply the left BHS II microphone as **informational microphone**.

    The recorded data of the selected calibration microphones will be considered for the equalization calculations. Informational microphones are only informative. Their data has no influence on the equalization results.



18. Select **Run all calculations**.
    Make sure that there is absolute silence during calculation steps
    - Record test signal
    - Final filter validation measurement

    Any disturbance will influence the recordings and eventually the equalization.

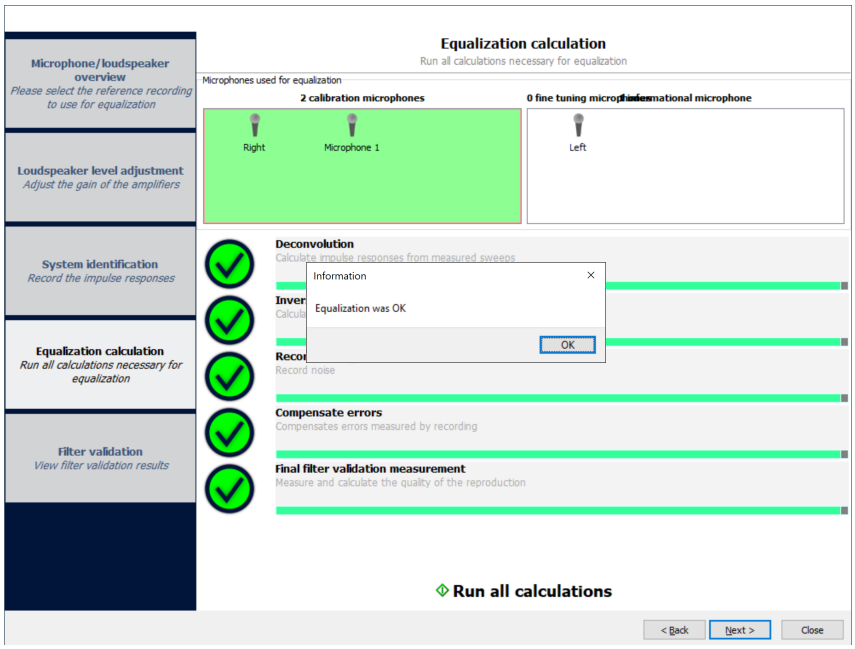
Calculation not started yet.

Calculation in progress.

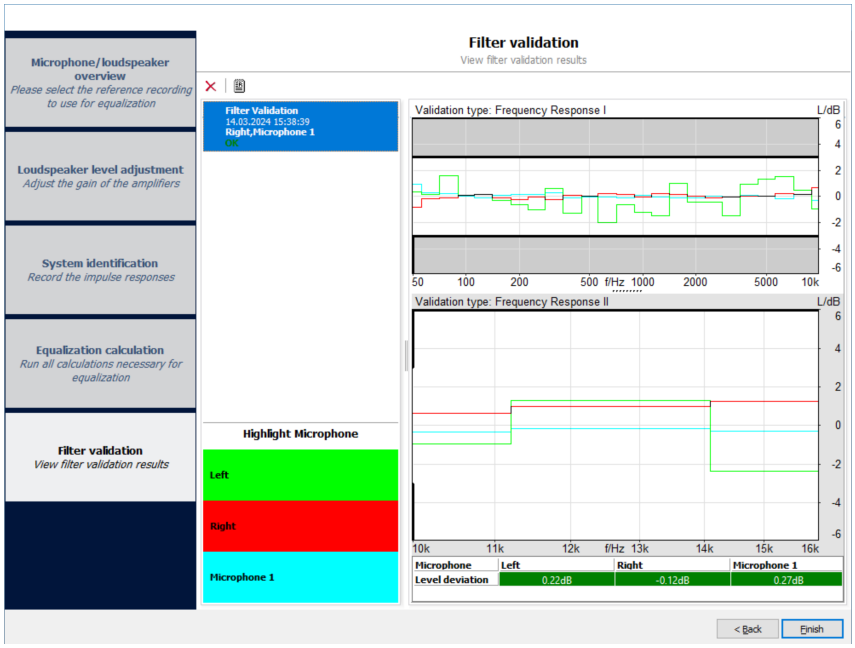
Calculation successful.

Calculation error.

19. 3PASS *flex* announces a successful/failed equalization. If the equalization fails, review filter validation and consider appropriate measures.
20. Confirm with **OK**.
21. Select **Next**.



22. Select **Finish** to complete the equalization.

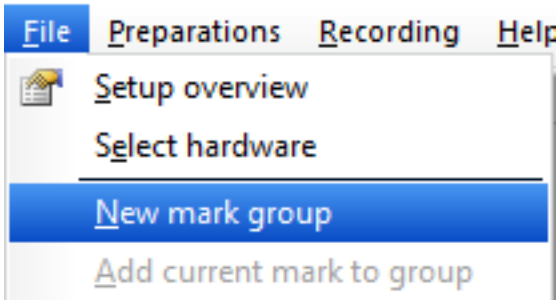


7 Playback via 3PASS *flex*

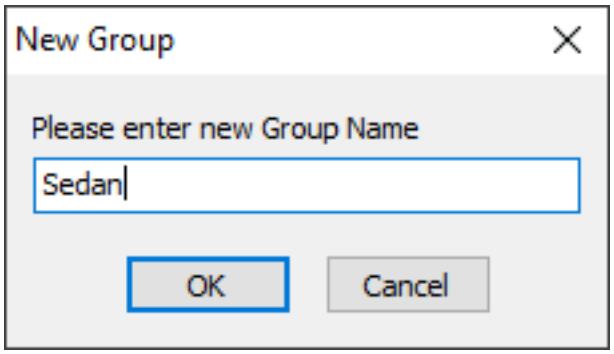
Load equalized setup from chapter 5 and connect the equipment according to chapter 3.5. Use only background noise files for playback which have been recorded with the appropriate and individual microphone arrangement (cf. ETSI TS 103 224, chapter 7.3).

7.1 Import recordings

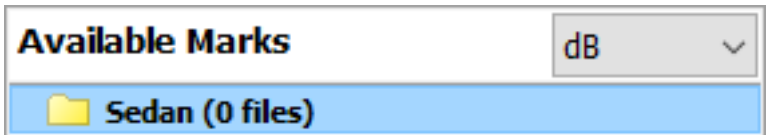
1. Select **File** > **New mark group**.



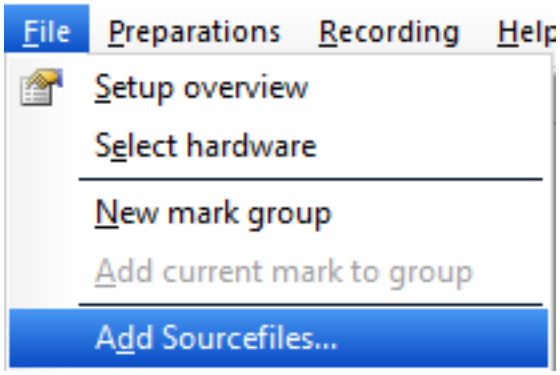
2. Enter a name for the group.
3. Select **OK**.



4. Select the group.

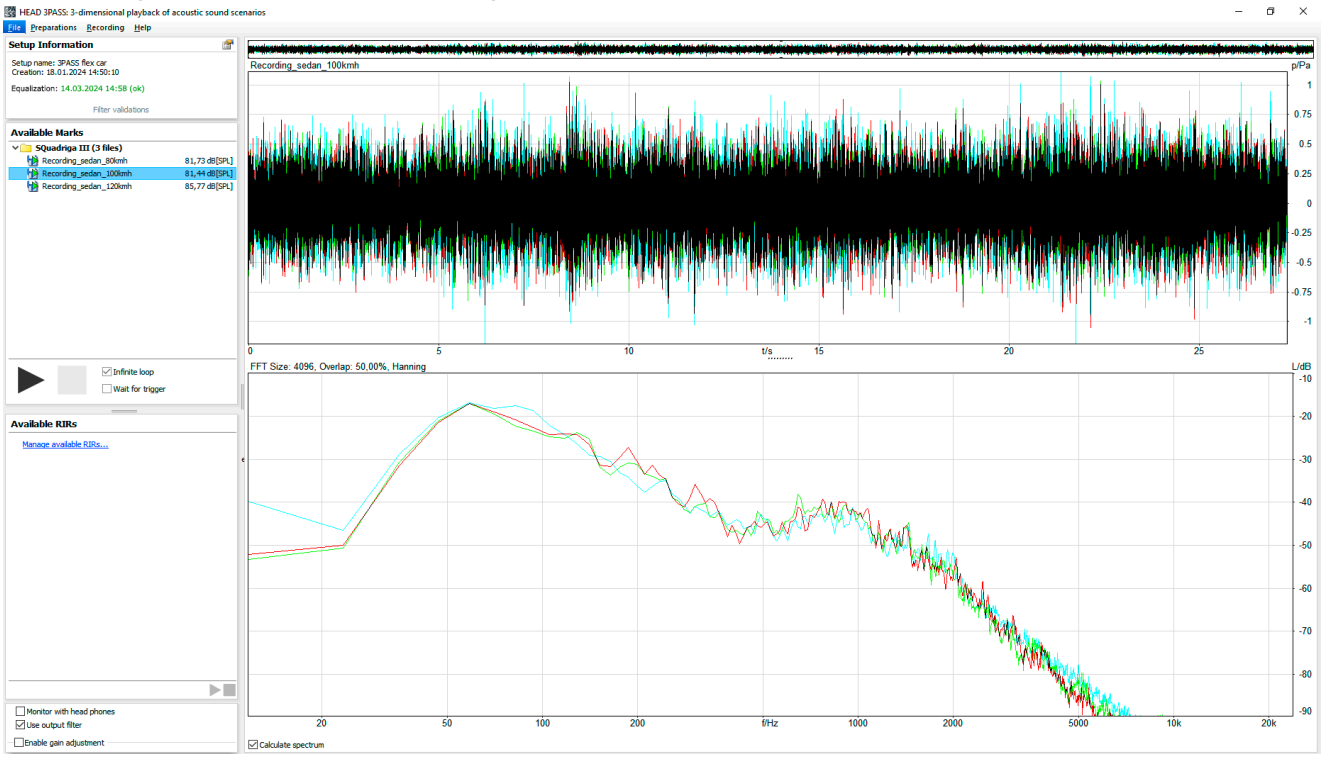


5. Select **File** > **Add Sourcefiles**.
6. Browse for the source files with the file explorer.
7. Select source files.
8. Select **Open**.

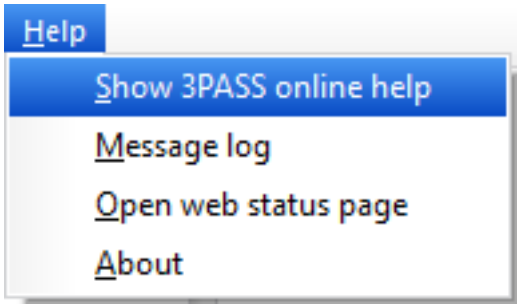


9. The files are available for playback under **Available marks**.

7.2 Play back files manually



1. Select and highlight the desired file in Available marks.
2. Select ▶ to play back the file.

7.3 Play back files via remote control

1. Select **Help** in the menu bar.
2. Select **Show 3PASS Online Help**.
3. Go to **Remote control via ACQUA**.