HEAD acoustics

APPLICATION NOTE

ACQUA

Measurements and Analyses with ACOPT 41 – Speech-Based Distortion Measure According to ETSI TS 104 063

Application Note

Measurements and Analyses with ACOPT 41 – Speech-Based Distortion Measure According to ETSI TS 104 063

Revision 1

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1 Introduction

1.1 ACOPT 41 – Speech-Based Distortion Measure

Nowadays, state-of-art-terminals apply signal processing and transmission codecs which lead to implausible measurement results if using artificial test signals. Therefore, the method from ETSI TS 104 063 requires real-speech signals.

ACQUA Option 41 (ACOPT 41) adds the speech-based distortion measure calculation model to ACQUA. Speech-based distortion measure is a test according to ETSI TS 104 063 (2025-07) for identifying distortions in speech signals. It applies for testing speech communication terminals by using speech signals, and complements previous tests that included artificial test signals (e.g. sine tones, noise bursts, sweep signals).

1.2 Applications

ACOPT 41 applies to speech communication terminals, such as:

- Smartphones
- Voice over IP telephones
- Headsets
- Speakerphones
- Conference phones
- In-vehicle hands-free terminals

1.3 Abstract

This application note presents the necessary equipment and instructions to conduct measurement and the analysis with ACOPT 41. There are lists of necessary equipment and exemplary measurement configurations for different applications in chapter 2. Chapter 3 includes instructions on how to perform the measurement and the analysis with ACQUA and ACQUAlyzer. The last chapter shows the presentation of the analysis and its relation to ETSI TS 104 063.

2 Requirements and Measurement Configurations

2.1 Hardware Requirements

2.1.1 General

- *lab*CORE (Code 7700)
- *core*BEQ (Code 7740)
- One artificial head from the HMS II Series:
  - HMS II.3 (Code 1703)
    ► HIS L (Code 1701), for binaural application
  - HMS II.3 LN (Code 1703.1)
    ► HIS L LN (Code 1701.1), for binaural application
  - HMS II.3 LN HEC (Code 1703.2)
    ► HIS L LN HEC (Code 1701.2), for binaural application
  - HMS II.3 LN HEC ViBridge (Code 1703.3)

2.1.2 Device Under Test: Handset

- One of the following handset positioners:
  - HHP IV (Code 1406)
  - HHP III.2 (Code 1430)
  - HHP III.1 (Code 1403)
- *core*IP (Code 7770)
- *core*IP-AMR (Code 7772) for handsets using AMR codec
- *core*IP-EVS (Code 7773) for handsets using EVS codec

2.1.3 Device Under Test: Hands-Free

USB connection
- Included in *lab*CORE (Code 7700)

Bluetooth® Classic connection:
- *core*BT2 (7782)

Bluetooth® LE Audio connection:
- *core*BT2LE-EVO (Code 7800)
- *core*BT2LE-Unicast (Code 7789)

2.1.4 Device Under Test: Headset

Analog (TRRS) connection
- HIB I

Bluetooth® Classic connection:
- *core*BT2 (7782)

Bluetooth® LE Audio connection:
- *core*BT2LE-EVO (Code 7800)
- *core*BT2LE-Unicast (Code 7789)

2.2 Software Requirements

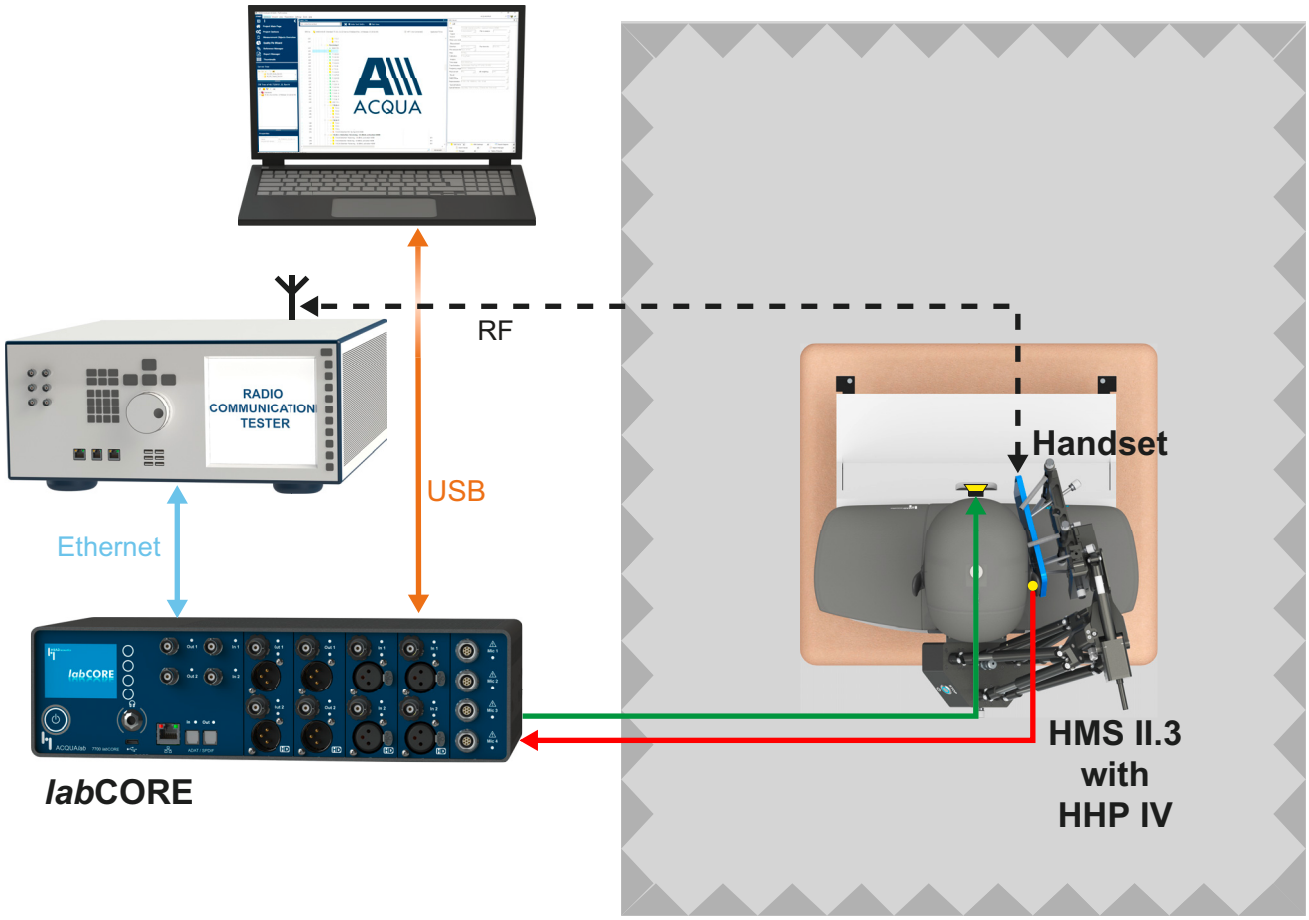
- ACQUA (Code 6810)
- ACOPT 41 (Code 6874)

2.3 Speech Signals

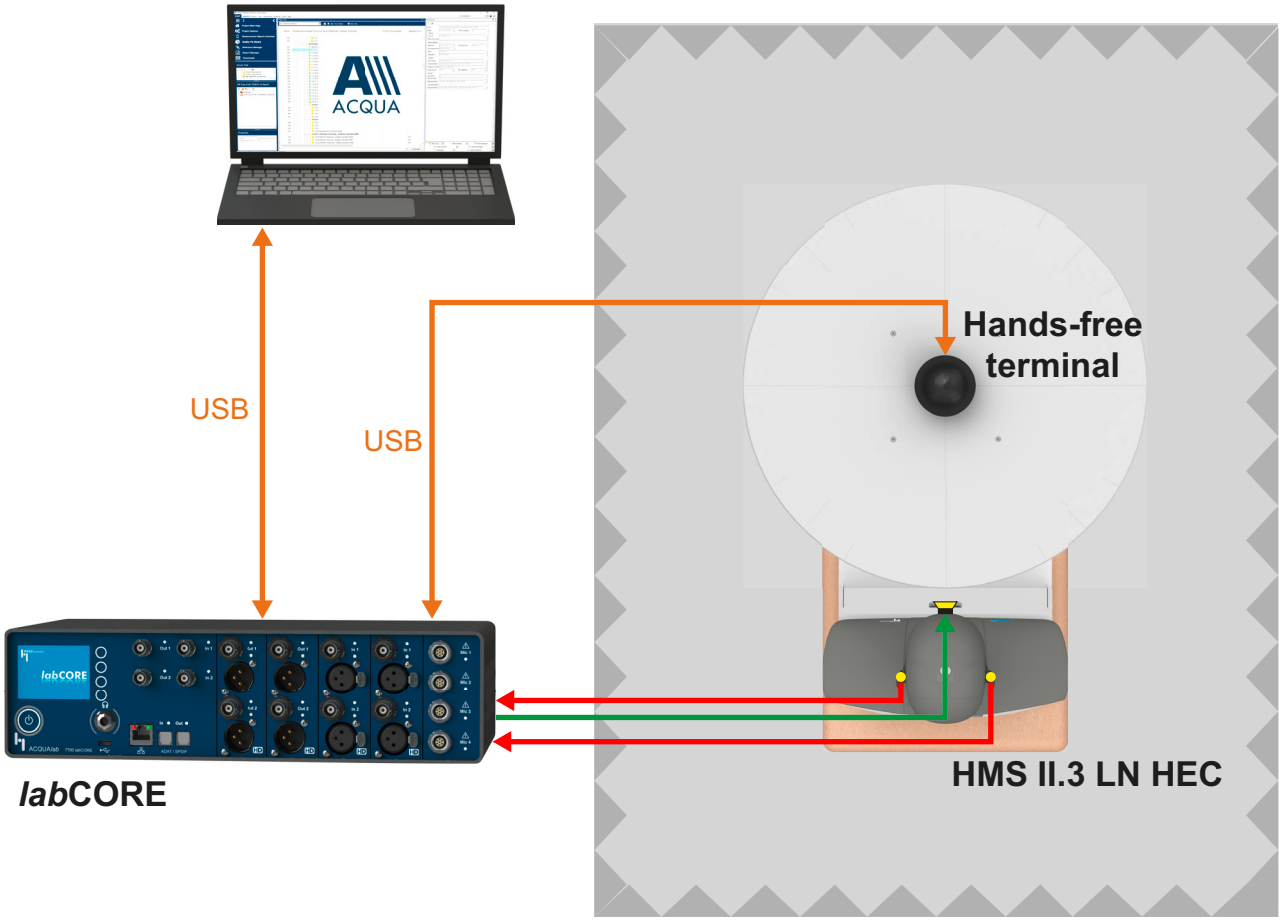
ETSI TS 104 063 [1] recommends speech signals from Recommendation ITU-T P.501 [2], Clauses 7.3, 7.4 , and Annexes C and D. These speech signals are available as download on the website of ITU-T → https://handle.itu.int/11.1002/2000/5080.

2.4 Measurement Configurations

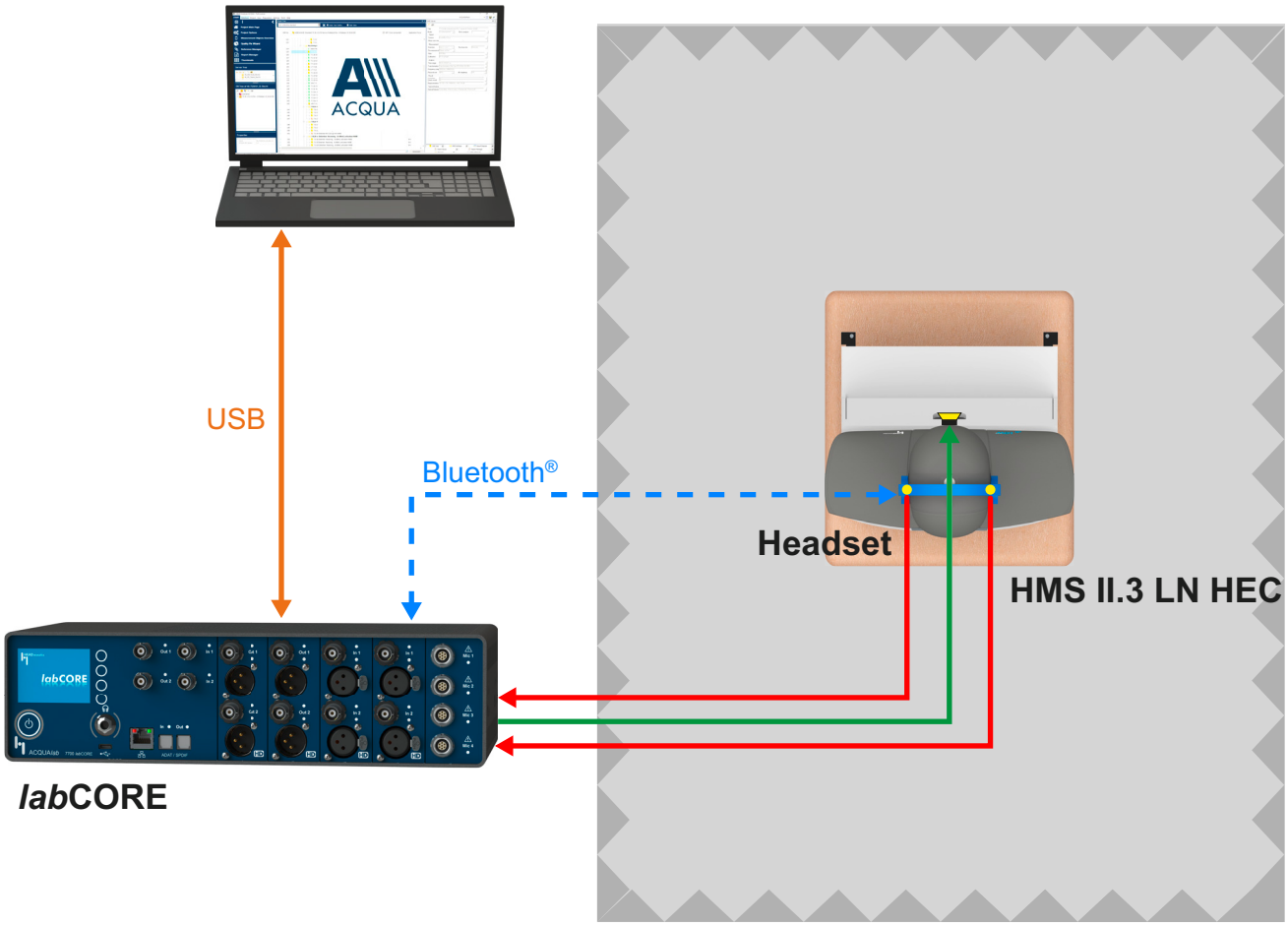
2.4.1 Handset Measurements (exemplary)



2.4.2 Hands-Free Measurements (exemplary)



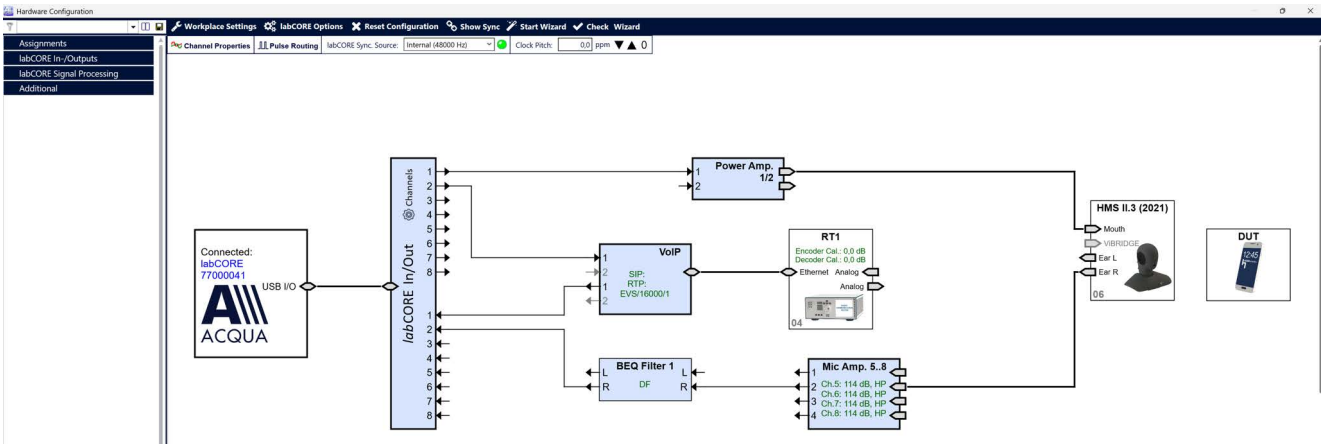
2.4.3 Headset Measurements (exemplary)



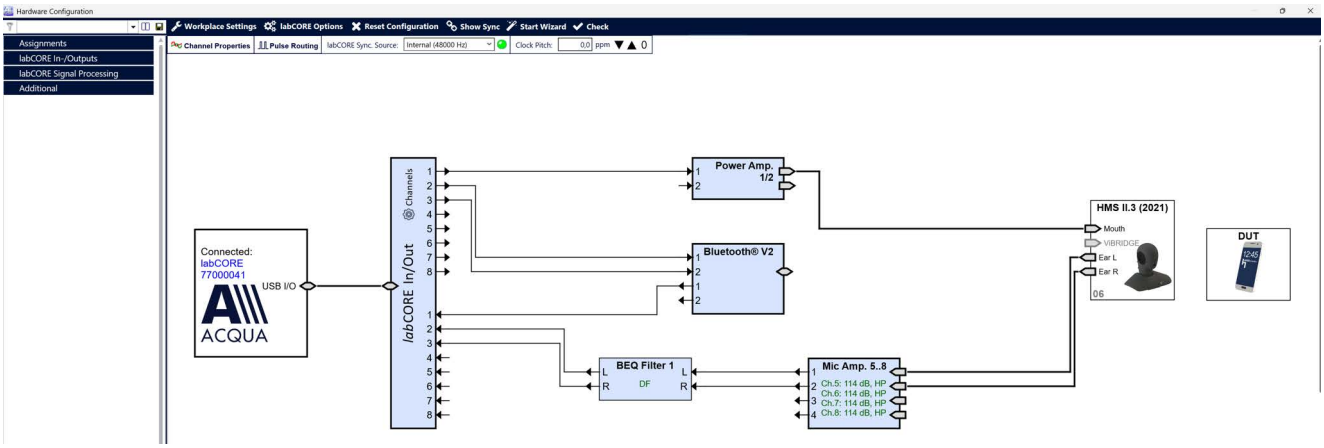
3 Measurements

3.1 Hardware Configurations

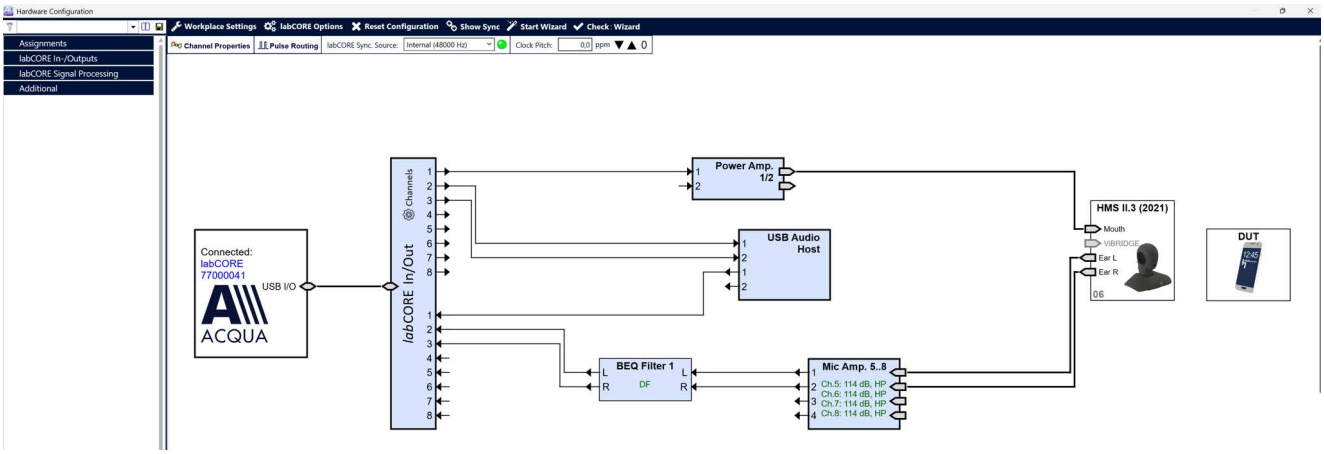
3.1.1 Handset Connection (exemplary)



3.1.2 Bluetooth Connection (exemplary)



3.1.3 USB Connection (exemplary)

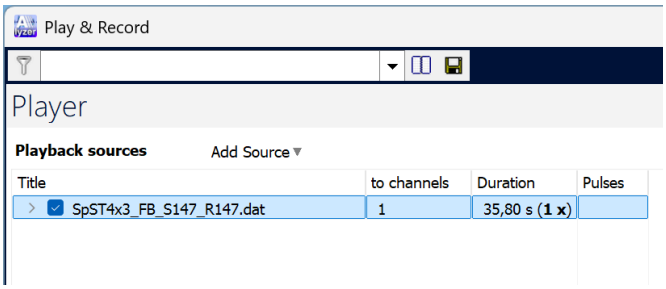


3.2 Measurement with ACQUAlyzer

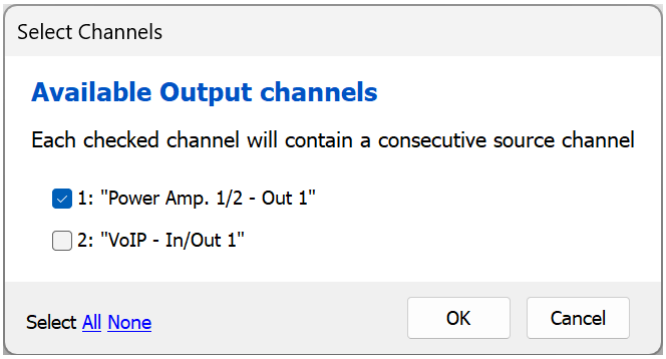
1. Connect and start the equipment of the desired measurement configuration. Refer to chapter 2.4 on page 8 for exemplary measurement configurations.
2. Start ACQUA.
3. Press **F5** or select **Hardware Configuration** on the start screen.
4. Set up the appropriate hardware configuration according to the interface to the device under test.

3.2.1 Recording Audio for Analysis

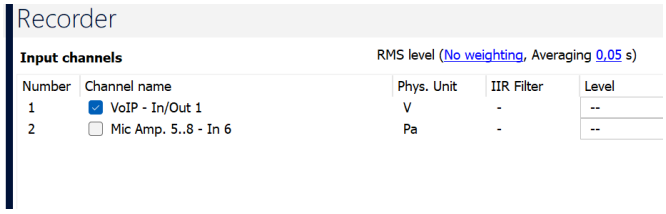
1. Open ACQUAlyzer.
2. Select **Audio** → **Play / Record**.
3. **Playback sources**: Select **Add source...** → **Add files...**
4. Browse for the directory and select the desired fullband source signal. Refer to chapter 2.3 on page 8 for appropriate signals.



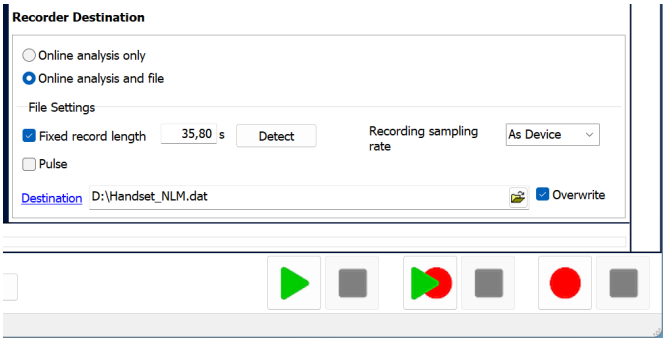
5. Select the column **to channels** for assigning the channel for playing back the source signal.



6. **Input channels**: Enable the input/recording channel(s).

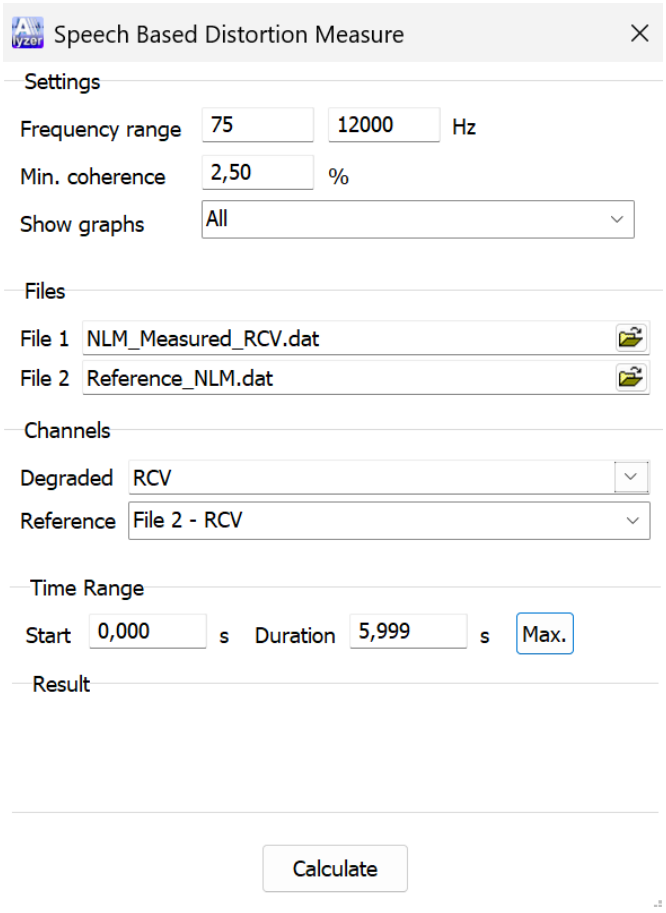


7. **Recorder Destination:**
   - Enable **Online analysis and file**.
   - Enable **Fixed record length** and select **Detect**.
   - Determine the desired **Destination** for the recording.
8. Select the **Play & Record** button to start the playback and the recording.
9. Wait until the recording is over.
10. Close **Play & Record**.



3.2.2 Calculation

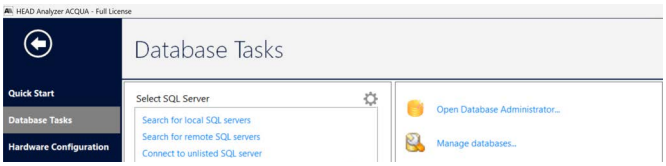
1. Open ACQUAlyzer.
2. Select **Calculation → Speech Based Distortion Measure**.
3. Specify the **Settings**:
   - **Frequency range**:
     Specify the minimum and maximum frequency for determining the range for analysis. Refer to ETSI TS 106 063 [1], Table 1.
   - **Min. coherence**:
     Specify the minimum coherence threshold (usually 2.5%). Refer to ETSI TS 106 063 [1], Clause 5.4.
   - **Show graphs**
     Select the desired graphical presentations of the results.
     ► All
     ► Estimated frequency response
     ► Spectral components
4. **Files**
   Set the file paths of the (degraded) recorded channel and the file containing the reference channel.
5. **Channels**
   - **Degraded**:
     Select the channel including the degraded audio data.
   - **Reference**:
     Select the channel including the reference audio data.
6. **Time Range**
   - **Start**:
     Determine the start time for the range of analysis.
   - **Duration**:
     Determine the duration time of the analysis.
   - **Max.**
     Set Start to 0 and Duration to the maximum duration.
7. Select **Calculate** to start the calculation.
8. Go to chapter 4.1 on page 21 for information on the result presentation.



3.3 Measurement with ACQUA Demo Database

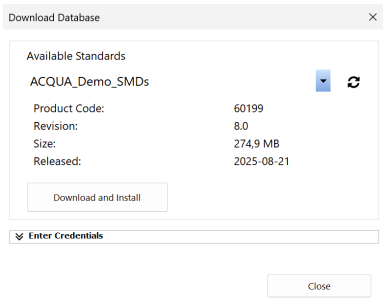
3.3.1 Preparations

1. Start ACQUA.
2. Select **Database Tasks**.
3. Select **Open Database Administrator...**.

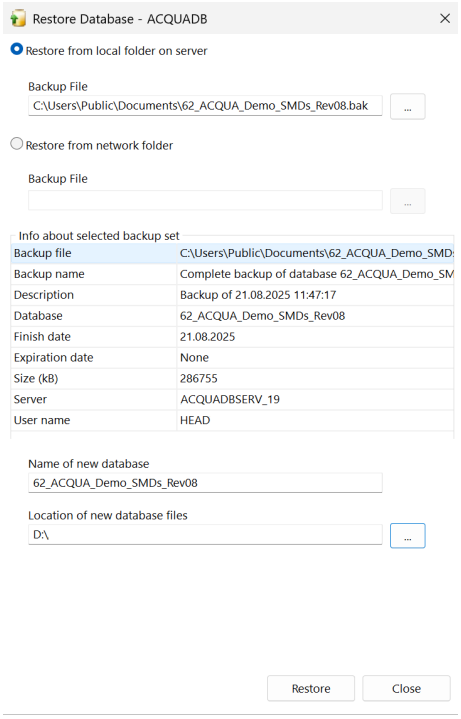


4. Select **Download Database...**.

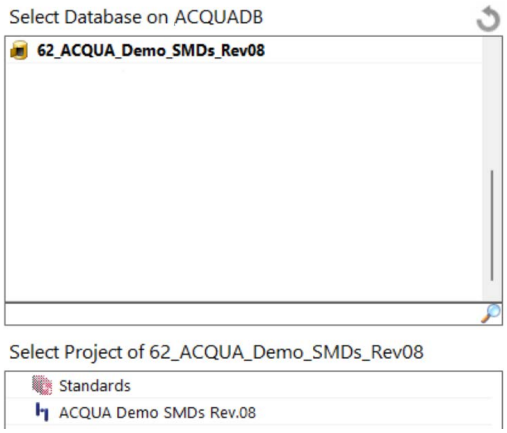
5. Select **ACQUA_Demo_SMDs** from the drop-down list.
6. Select **Download and Install**.



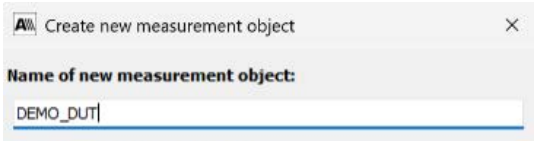
7. Enter a name for the database at **Name of new database** (optional).
8. Select **...** at **Location of new database** file to specify the directory for the database.
9. Select **Restore**.



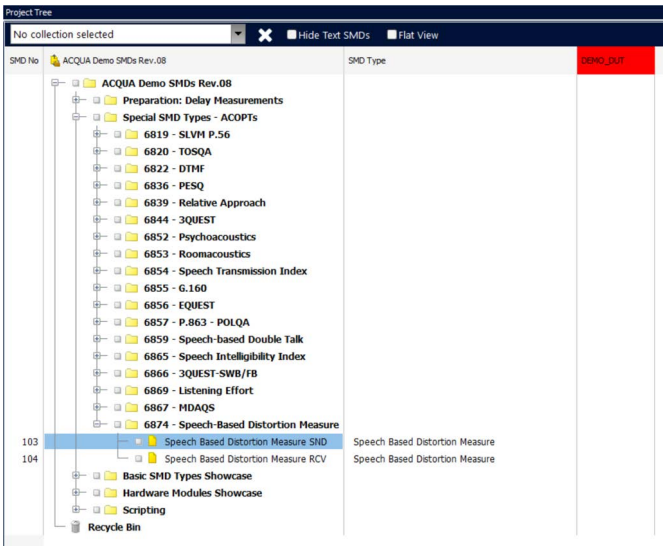
10. Double-click on the database.
11. Double-click on the ACQUA project **ACQUA Demo SMDs Rev.08**.



12. Select **Project → New Measurement Object**.
13. Enter the desired name for the measurement object.
14. Select **OK**.

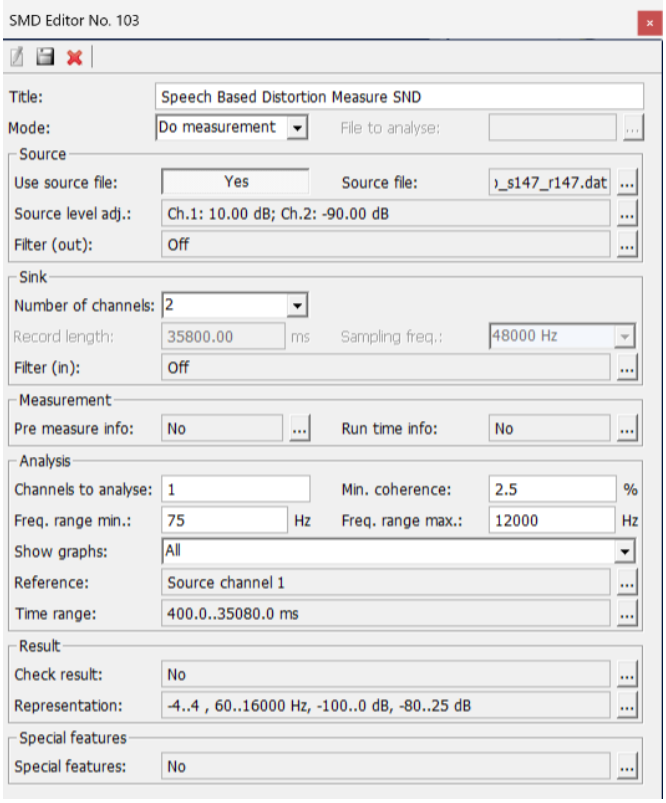


15. The measurement object is immediately active in the project tree.



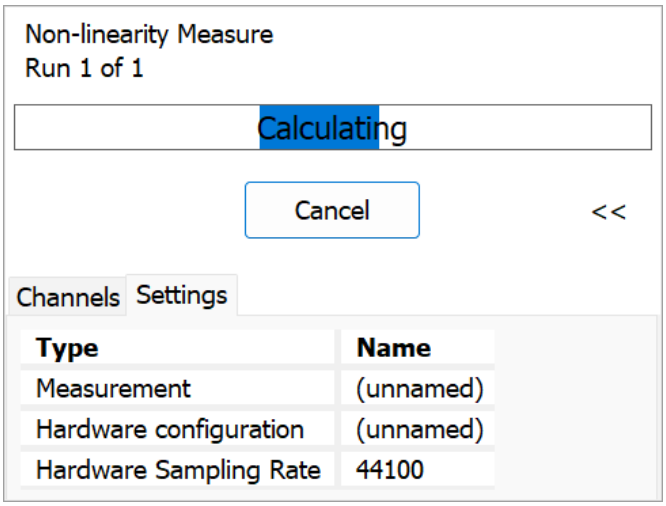
3.3.2 Measurement in Sending Direction

1. Check if all parameters are set appropriately:
   - The prepared SMD already contains an appropriate source file (fullband real speech file).
   - All parameters are already set for the measurement.
   - Make sure that the **Number of channels** value in the **Sink** section correlates with the highest value in **Channels to analyze** from the **Analysis** section.
   - The parameters in the **Analysis** section may be set as desired (except **Channels to analyze**).



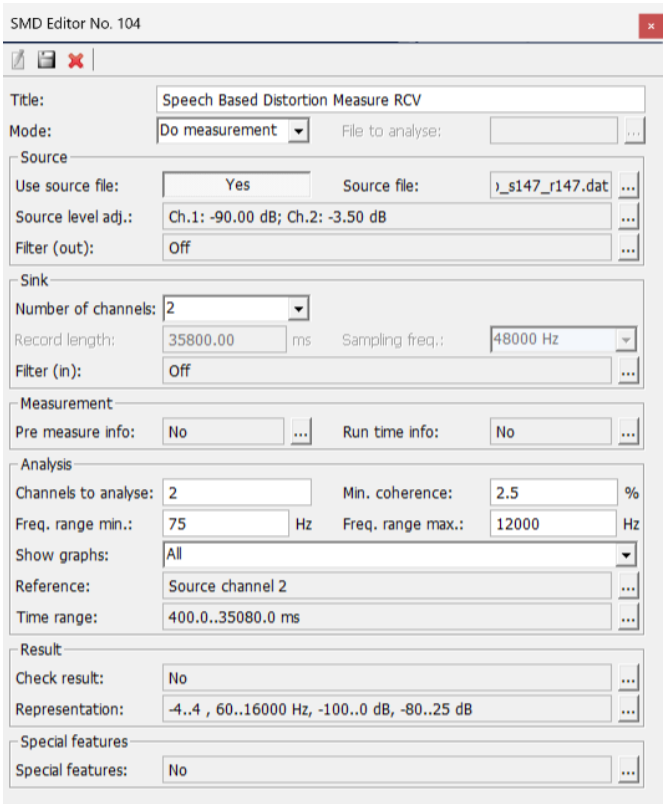
2. Right-click on the SMD and select **Start this Measurement**.

3. The measurement/calculation runs.
4. Go to chapter 4.2 on page 22 for information on the result presentation.



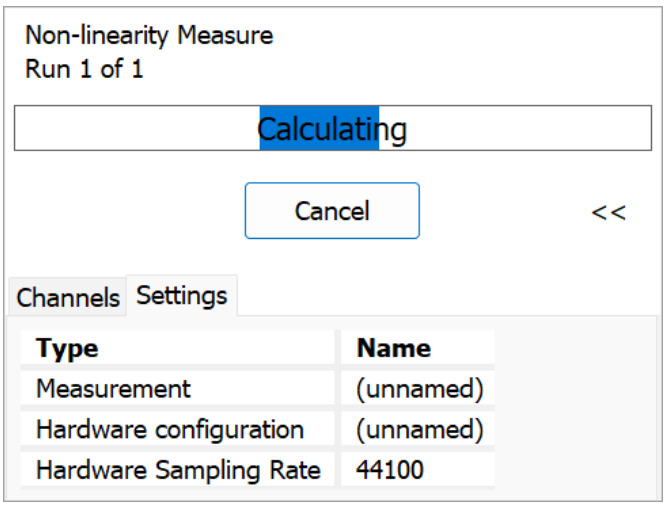
3.3.3 Measurement in Receiving Direction

1. Check if all parameters are set appropriately:
   - The prepared SMD already contains an appropriate source file (fullband real speech file).
   - All parameters are already set for the measurement.
   - Make sure that the **Number of channels** value in the **Sink** section correlates with the highest value in **Channels to analyze** from the **Analysis** section.
   - The parameters in the **Analysis** section may be set as desired (except **Channels to analyze**).



2. Right-click on the SMD and select Start this Measurement.

3. The measurement/calculation runs.
4. Go to chapter 4.2 on page 22 for information on the result presentation.

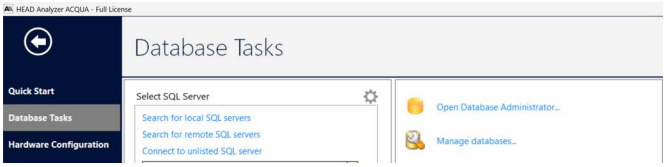


3.4 Measurement with Customized ACQUA Database

3.4.1 Preparations

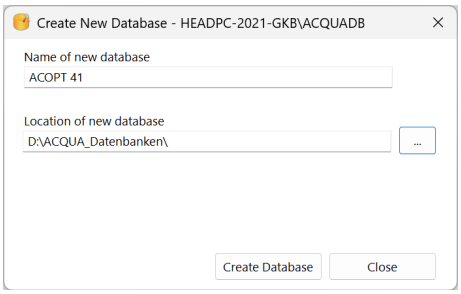
Refer to chapter 2.3 on page 8 for appropriate source signals.

1. Start ACQUA.
2. Select **Database Tasks**.
3. Select **Open Database Administrator...**.

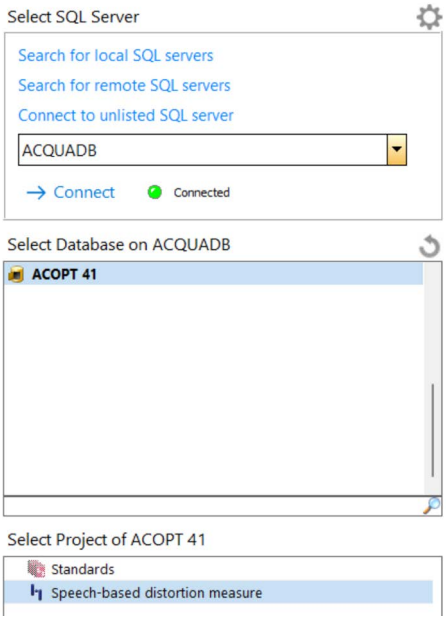


4. Select **Create New Database...**.

5. Enter the desired name for the database.
6. Select **...** to specify the location of the new database.
7. Select **Create Database**.
8. Close **Database Administrator**.



9. **Select SQL Server**
   Select the SQL server from the drop-down list and select **Connect**.
10. **Select Database**
    Double-click on the database
11. **Select Project**
    Double click on the project.

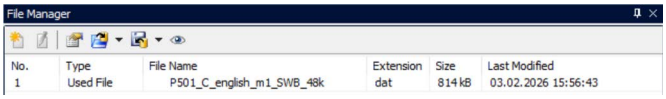


12. Right-click into the project tree window.
13. Select **New** → **SMD**.

14. Select **Project** → **New Measurement Object**.
15. Enter the desired name for the measurement object.
16. Select **OK**.

17. The measurement object is immediately active in the project tree.

18. Select **View** → **File Manager**.
19. Select **Import Files**.
20. Select **to HEAD Data Format**.
21. Select the desired file.



3.4.2 Measurement

Right click on the SMD and select Edit.

- Enter a title (optional)
- Select Mode → Do Measurement.

Source

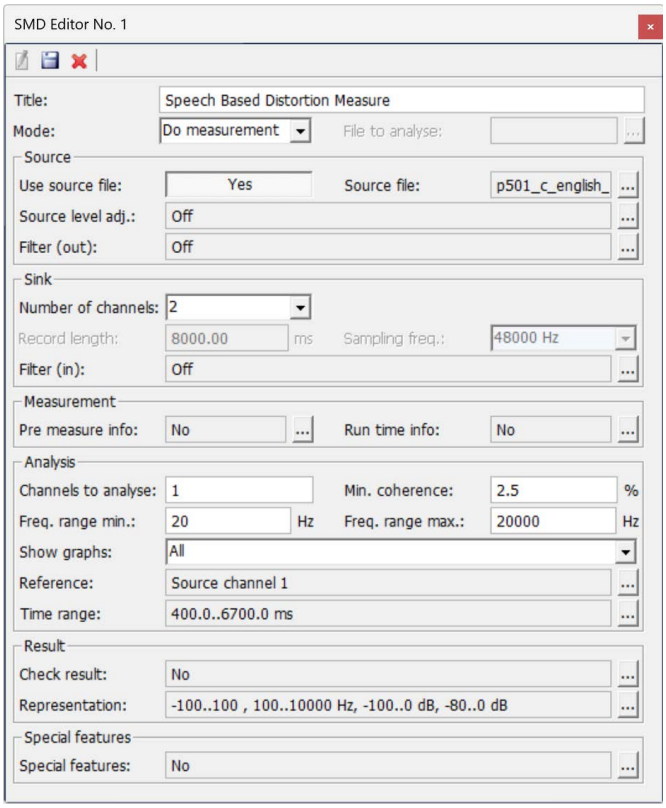
- Enable **Yes** → **Use source file**.
- Select **Source file** → **...** to allocate the desired file from the File Manager of the database.
- (Optional) **Select Source level adj.** → **...** to adjust the level of the source file.

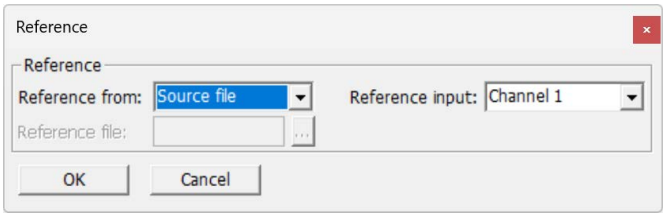
Sink

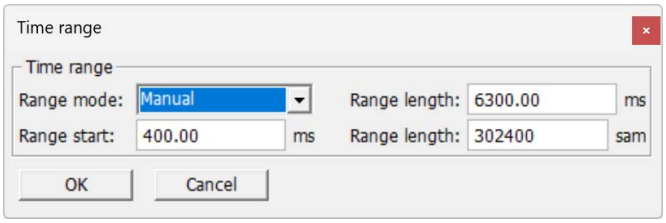
- **Number of channels**:
  Determine the number of channels for recording.
- Make sure that the **Number of channels** value correlates with the highest value in **Channels to analyze** from the **Analysis** section.

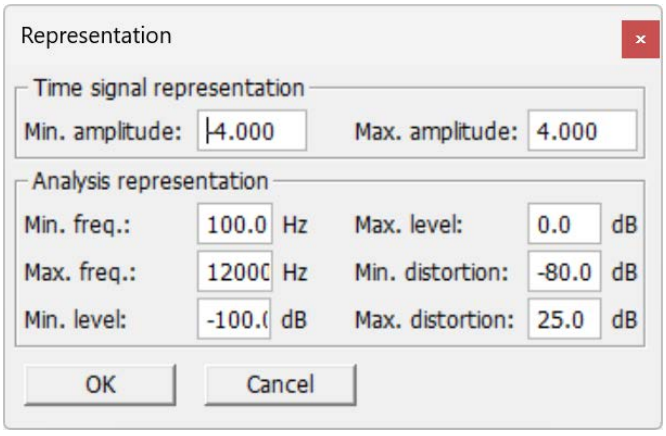
Analysis

- **Channels to analyze**:
  Specify the channel that shall be analyzed.
- **Min. coherence**:
  Specify the minimum coherence threshold (usually 2.5%). Refer to Refer to ETSI TS 106 063 [1], Clause 5.4.
- **Freq. range min./max.**:
  Specify the minimum and maximum frequency for determining the range for analysis. Refer to ETSI TS 106 063 [1], Table 1.
- **Show graphs**:
  Select the desired graphical presentations of the results.
  - All
  - Estimated frequency response
  - Spectral components
- **Reference**:
  Select **Reference** → **...** to specify the reference channel for the analysis.
- **Time range**:
  Select **Time range** → **...** to specify the time range from the recorded signal which shall be analyzed.
- **Representation**:
  Select **Representation** → **...** to specify the axis scaling of the result diagrams.
  - Abscissa: Frequency
  - Ordinate frequency response: Level
  - Ordinate spectral components: Distortion



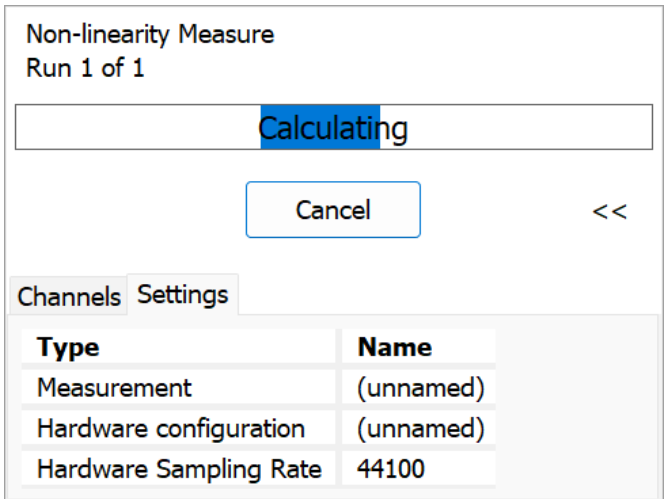






22. Right-click on the SMD and select **Start this Measurement**.

23. The measurement/calculation runs.
24. Go to chapter 4.2 on page 22 for information on the result presentation.



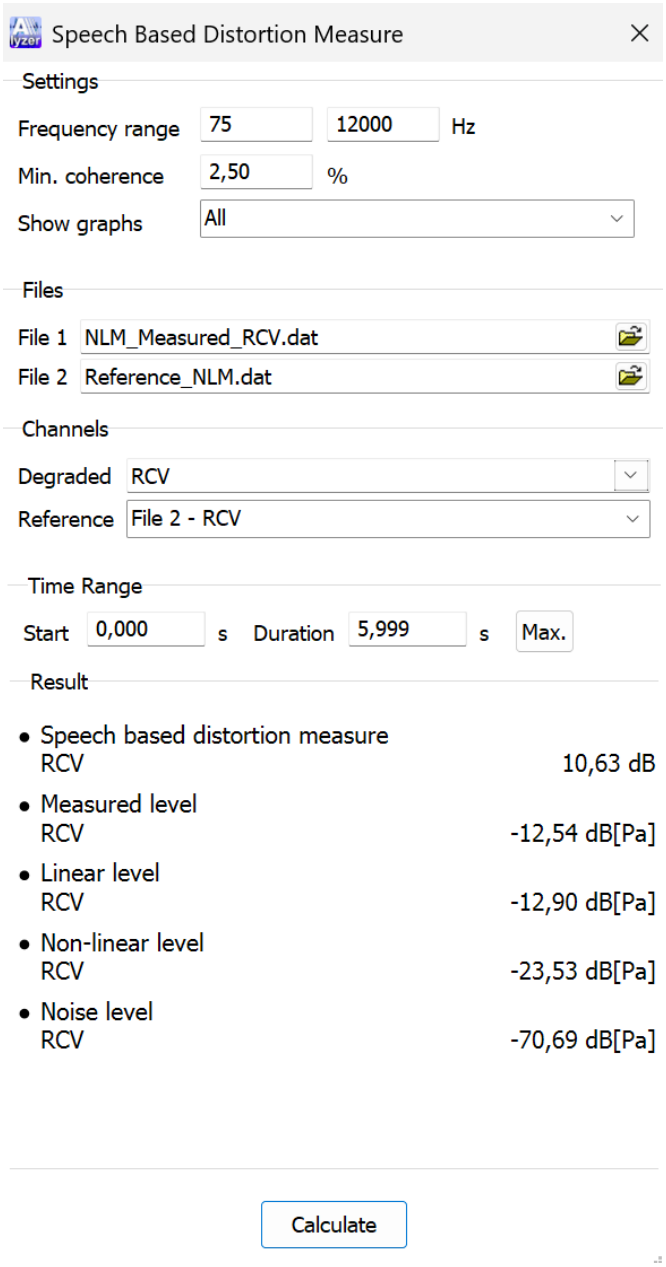
4 Analysis Presentation

4.1 Manual Calculation via ACQUAlyzer

4.1.1 Calculation Window

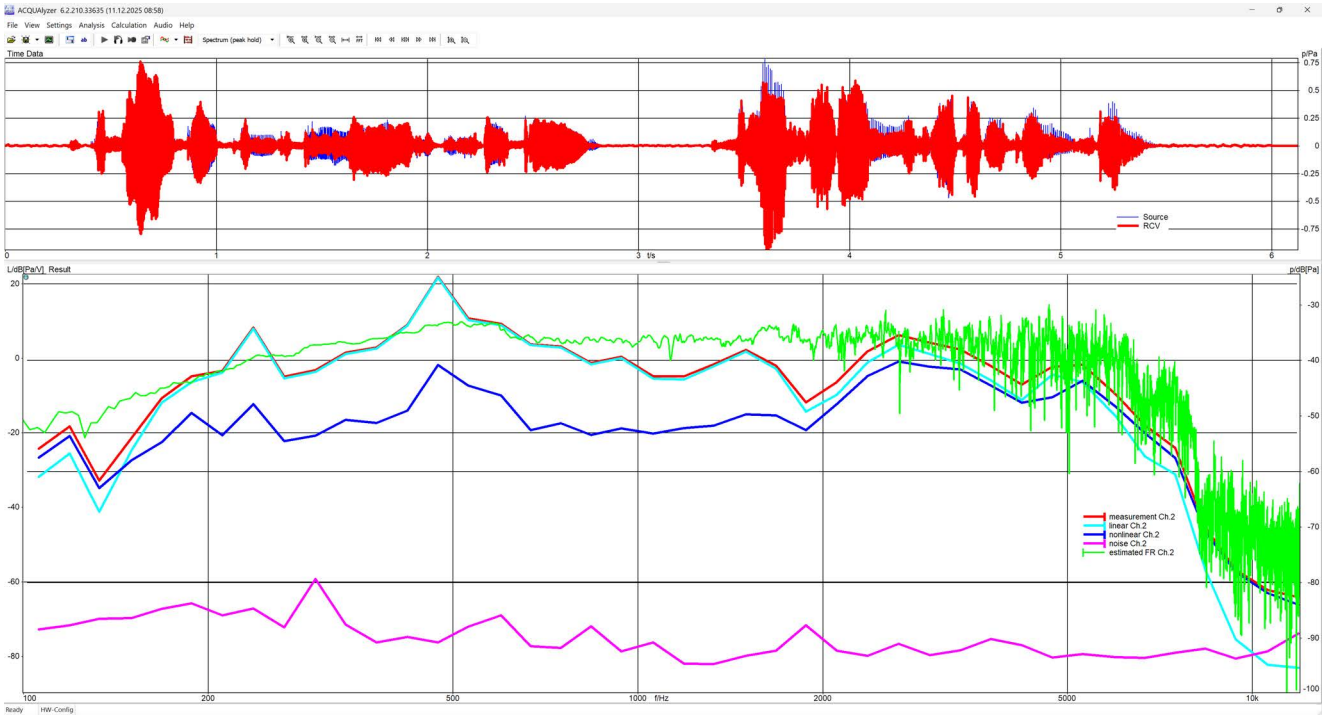
The calculation presents the results at the bottom of the calculation window. The results of five parameters are presented:

- **Speech-based distortion measure**:
  Calculated average of the level non-linearity measure (distortion). Refer to ETSI TS 104 063 [1], Clause 5.8.
- **Measured level**: Average level of the measured signal.
  Refer to ETSI TS 104 063 [1], Clause 5.4.
- **Linear level**: Average level of the linear signal component.
  Refer to ETSI TS 104 063 [1], Clause 5.5.
- **Non-linear level**: Average level of the non-linear signal component.
  Refer to ETSI TS 104 063 [1], Clause 5.7.
- **Noise level**: Average level of the noise component.
  Refer to ETSI TS 104 063 [1], Clause 5.6.



4.1.2 Analysis Window

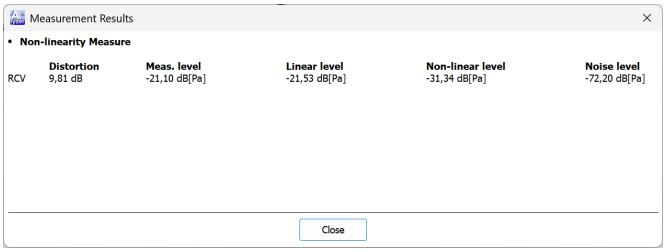
The analysis window of ACQUAlyzer displays the graphs of the calculated parameters automatically after completing the calculation.



4.2 Calculation via SMD

4.2.1 Measurement Results

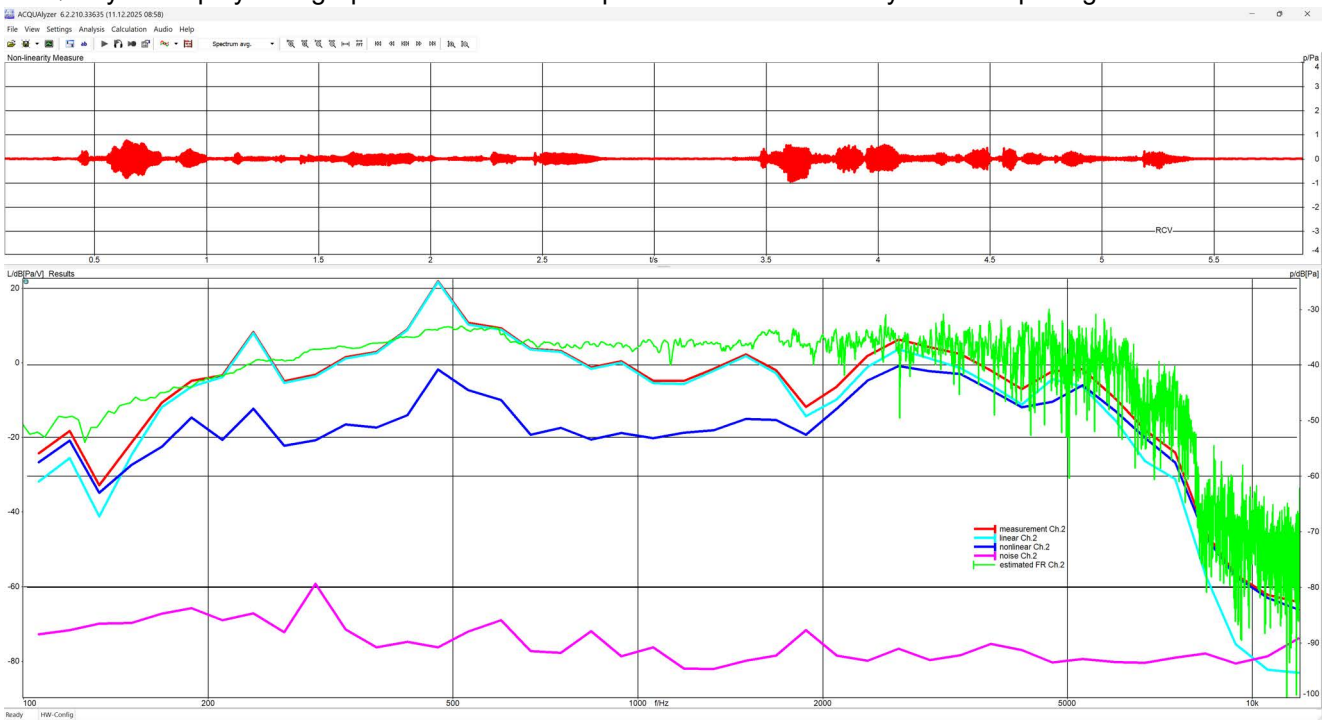
After completing the calculation the result window opens. The results of five parameters are presented:



- Distortion:
  Calculated average level of the non-linearity measure (distortion). Refer to ETSI TS 104 063 [1], Clause 5.8.
- Measured level: Average level of the measured signal.
  Refer to ETSI TS 104 063 [1], Clause 5.4.
- Linear level: Average level of the linear signal component.
  Refer to ETSI TS 104 063 [1], Clause 5.5.
- Non-linear level: Average level of the non-linear signal component.
  Refer to ETSI TS 104 063 [1], Clause 5.7.
- Noise level: Average level of the noise component.
  Refer to ETSI TS 104 063 [1], Clause 5.6.

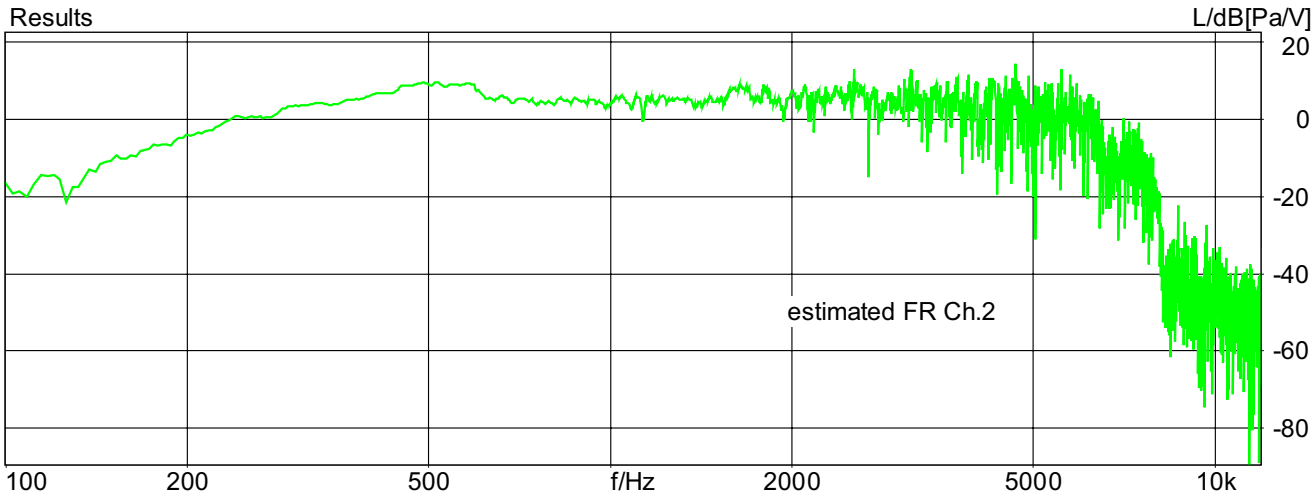
4.2.2 Result Presentation in ACQUAlyzer

The time window (top graph) displays the time signal of the analyzed signal. The analysis window (bottom) of ACQUAlyzer displays the graphs of the calculated parameters automatically after completing the calculation.



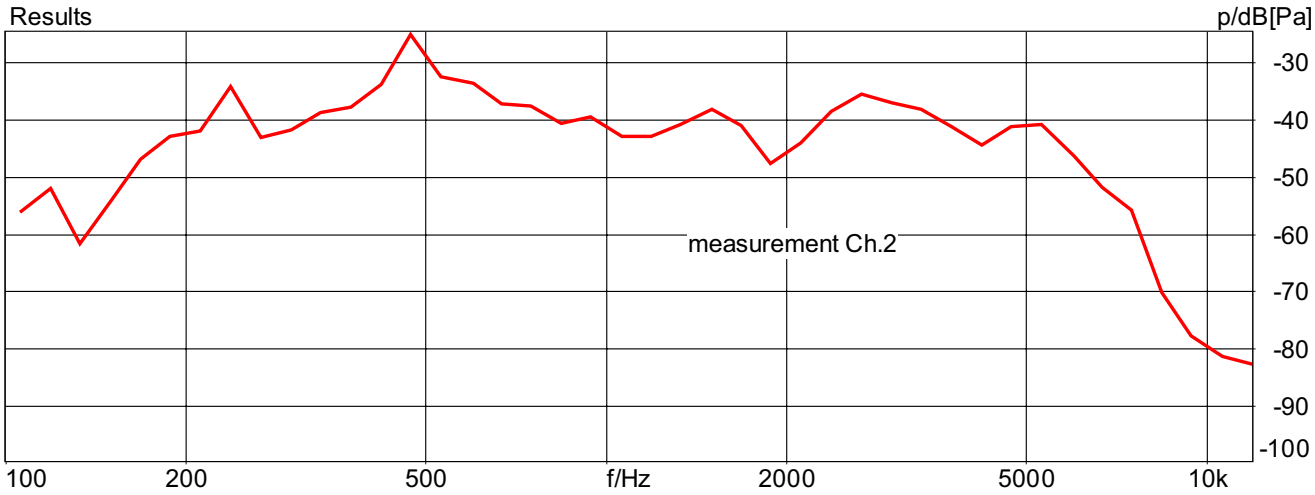
4.3 Result Graphs

4.3.1 Frequency Response



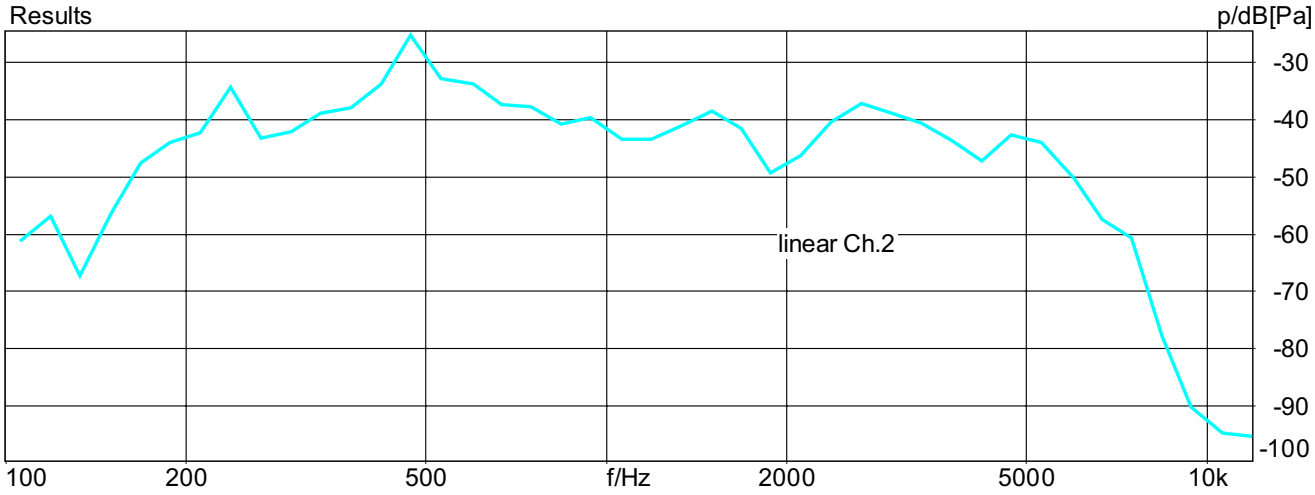
An estimated frequency response of the measured signal. Its purpose is informational.

4.3.2 Measurement



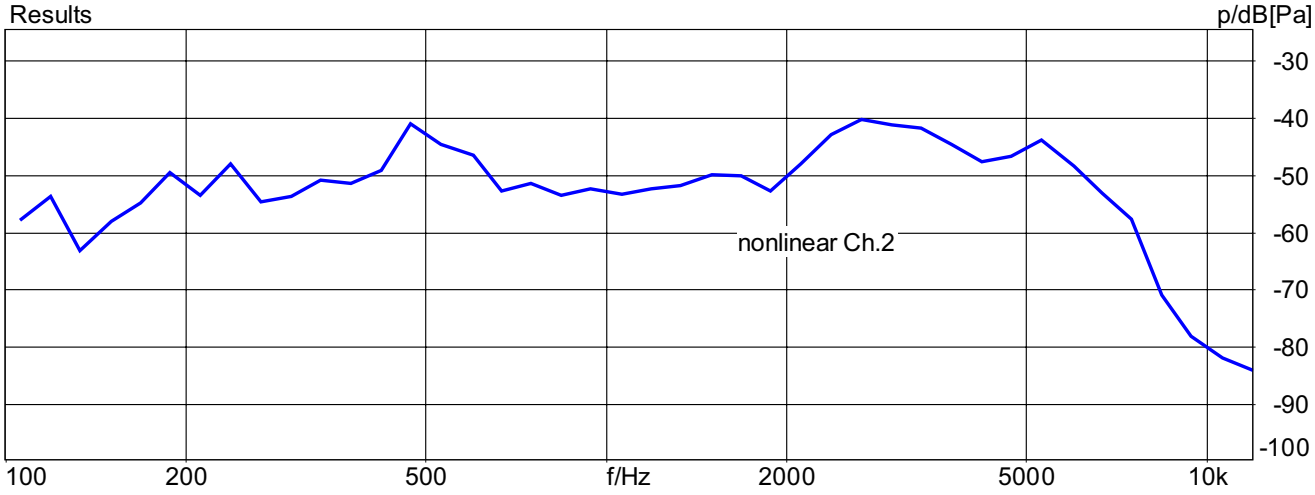
Fast Fourier Transformation (FFT) of the estimated impulse response. The impulse response is estimated from the source signal (reference) and the recorded signal (measured) according to ETSI TS 104 063 [1], Clause 5.4.

4.3.3 Linear



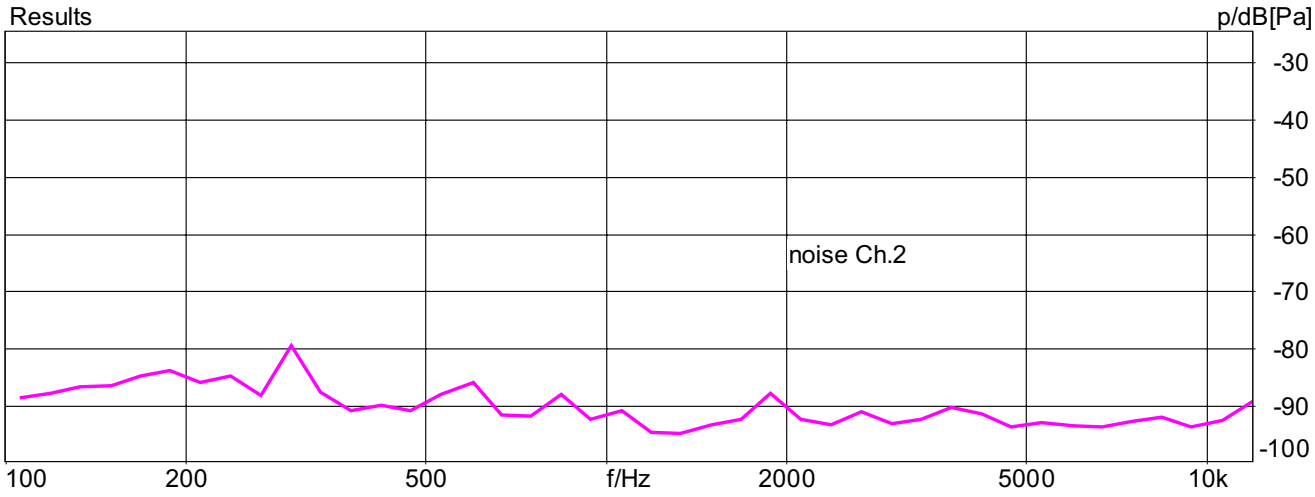
FFT of the calculated linear component according to ETSI 104 063 [1], Clause 5.5.

4.3.4 Non-Linear



FFT of the calculated average non-linear signal component according to ETSI TS 104 063 [1], Clause 5.7.

4.3.5 Noise



FFT of the calculated spectral noise according to ETSI TS 104 063 [1], Clause 5.6.

5 References

[1] ETSI TS 104 063 V1.1.1 (2025-07): “Speech and multimedia Transmission Quality (STQ); A nonlinearity measure for distortion analysis of speech communication terminals”.

[2] Recommendation ITU-T P.501 (2025-04): “Test signals for use in telephony and other speech-based applications”.