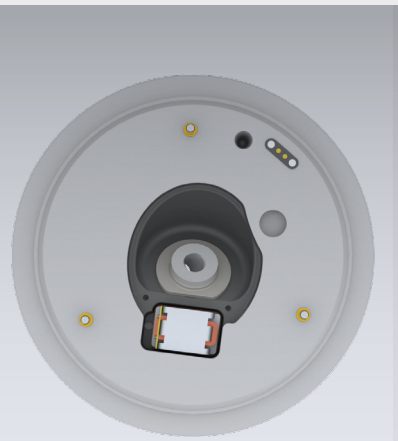
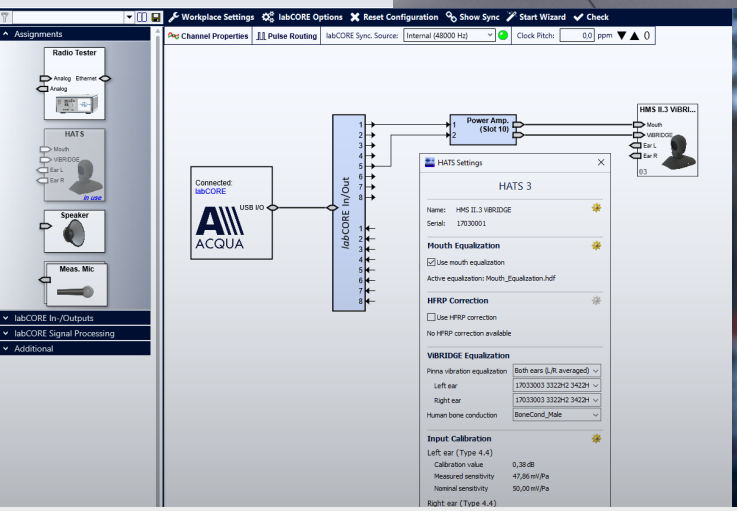
HEAD acoustics

APPLICATION GUIDE





ViBRIDGE

ViBRIDGE Application in ACQUA

Application Guide

ViBRIDGE Application in ACQUA

Revision 2

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1 Introduction

1.1 Brief Description

Headset manufacturers increasingly consider noise-free bone conduction signals to improve speech transmission in their in-ear headsets. Especially in noise-filled environments, the voice of the near-end talker can be separated better from ambient noise or concurrent talkers if in-ear headsets utilize bone conduction. The consideration of bone conduction is the basis for optimally suppressing noise and thus improving speech quality.

HEAD acoustics provides the complete all-in-one solution for testing, optimizing, and validating headsets with voice pick up sensors. The application requires the HMS II.3 ViBRIDGE artificial head connected to the *lab*CORE hardware platform. Furthermore, the ACQUA software application provides control and data acquisition for HMS II.3 ViBRIDGE and *lab*CORE.

This document presents equipment and procedure for using the ViBRIDGE technology with HMS II.3 ViBRIDGE, ACQUA, and *lab*CORE.

1.2 ViBRIDGE Fundamentals

1.2.1 Human Structure-Borne Measurement

Before starting any simulation, understanding human structure-borne voice transmission is key. This requires a reliable and repeatable test setup for assessing the human structure-borne sound close to the ear canal, which is the location where in-ear headsets typically have structure-borne sensors. For this purpose, a sensor was implemented in an in-ear headset mock-up (Fig. 1). The test setup for assessing air-borne sound and structure-borne sound of a person‘s voice is shown in Fig. 2. The subject‘s head is fixed, a measurement microphone is placed at the Mouth Reference Point (MRP), and the mock-up, including the structure-borne sensor, is placed in the subject‘s ear.

Fig. 1: Mock-up used to assess bone-conducted voice signal in the ear canal of human subjects

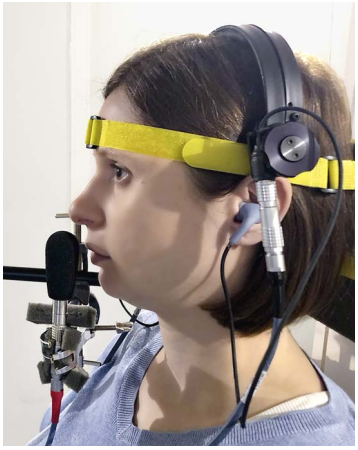


Fig. 2: Setup for measuring human airborne and structure-borne transmitted voice

The measurements were conducted with 11 female and 24 male subjects. Fig. 3 shows the individual structure-borne signal compared to the acoustic signal at the mouth reference point (MRP). Fig. 4 shows the average of these signals for female and male talkers. The difference between female and male voices lies mainly in the frequency range below 300 Hz, where the female voices generally do not provide any signal energy due to the higher fundamental of female voices. Consequently, the average male spectrum is the preferred target spectrum for structure-borne signal simulation.

Fig. 3: Individual structure-borne signals compared to the average signals at the subjects' mouths

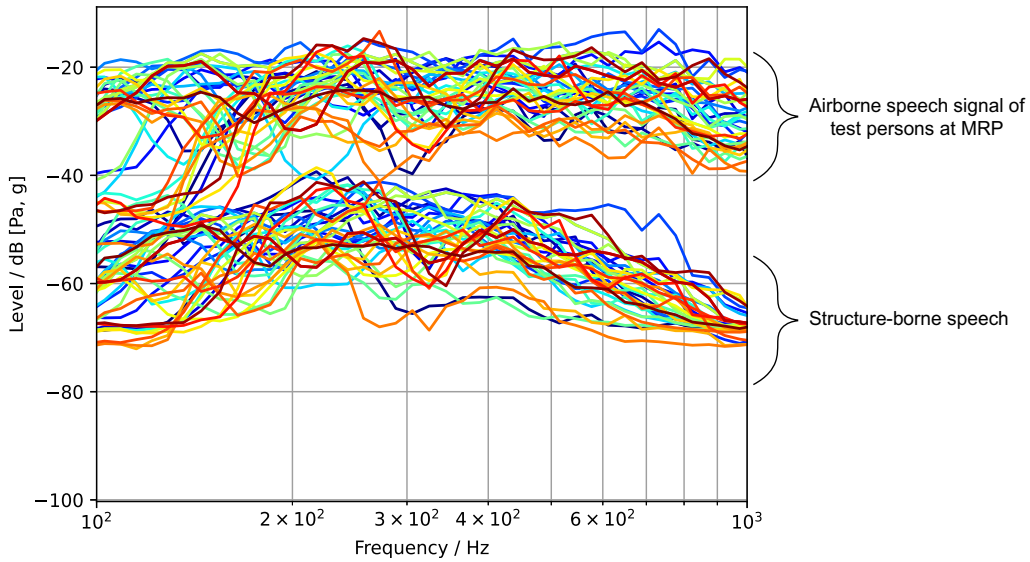
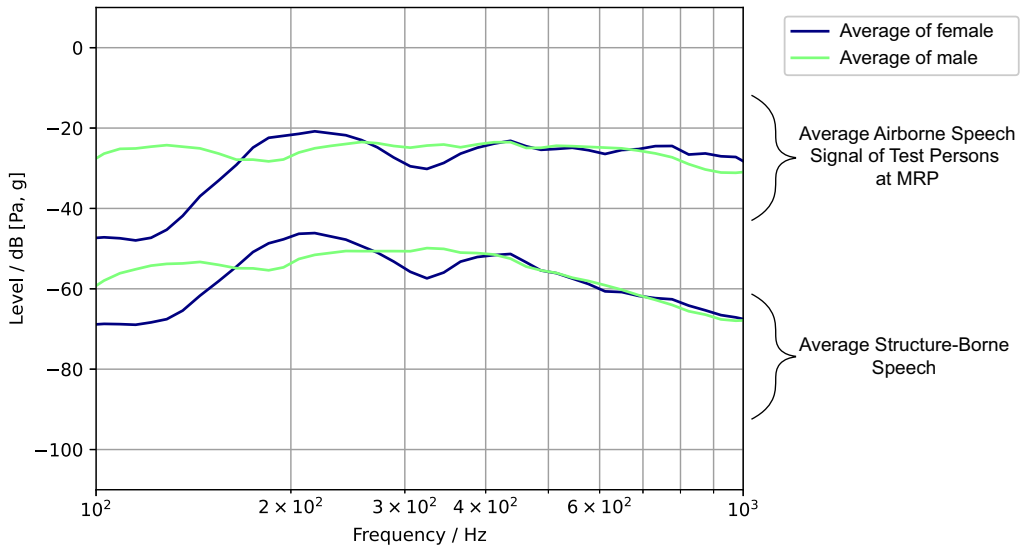


Fig. 4: Average structure-borne signal compared to the average signal at the mouth



1.2.2 Structure-Borne Sound Simulation at the Artificial Ear of HMS II.3 ViBRIDGE

When simulating structure-borne signals at the ear canal of a HATS, it is essential to avoid any airborne sound generation by the shaker initiating the structure-borne sound in the artificial ear canal. The principle of the simultaneous generation of airborne and structure-borne sound is shown in Fig. 5.

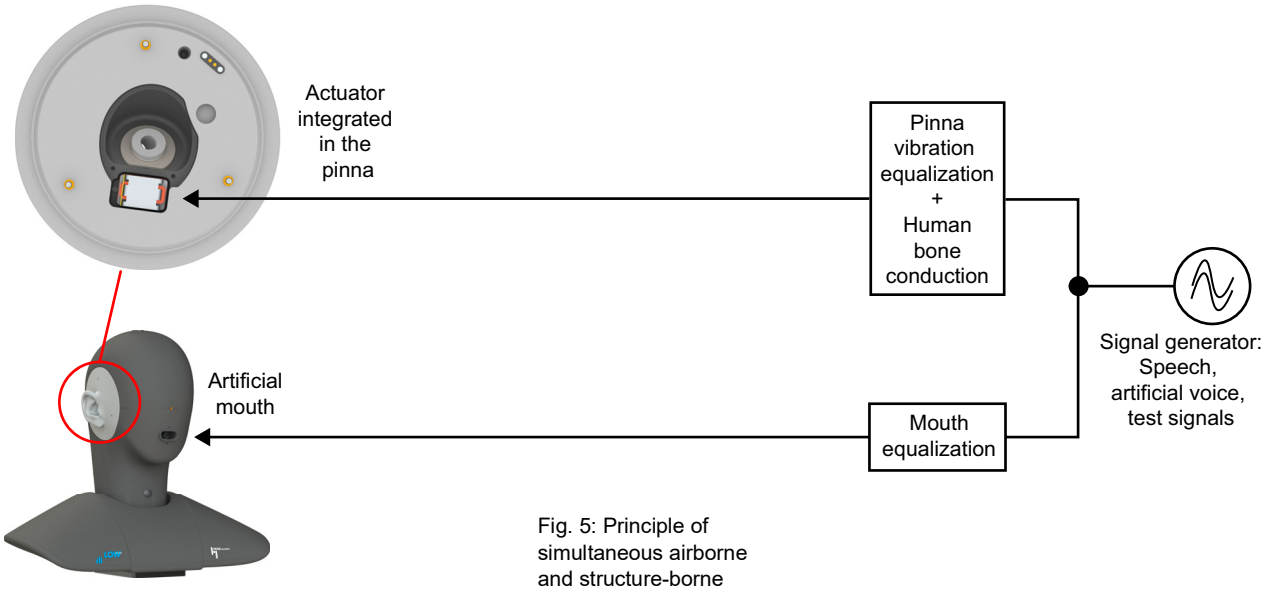
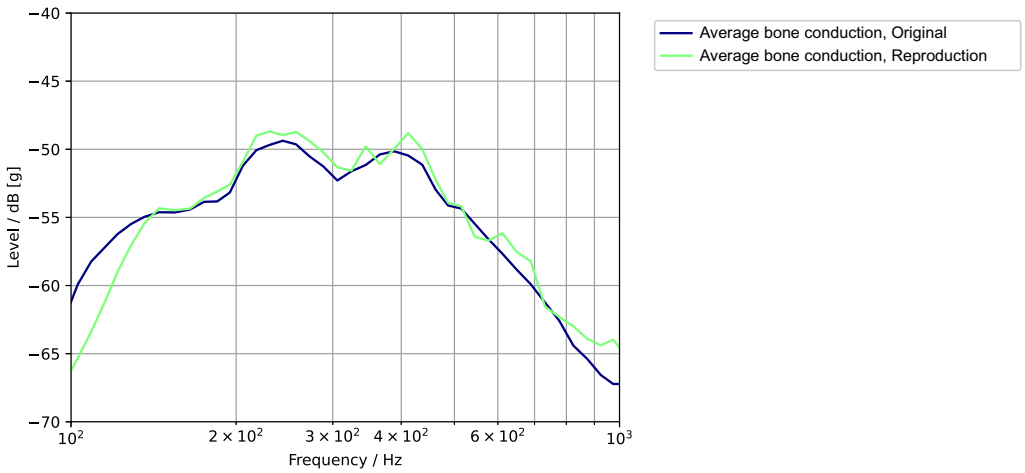


Fig. 5: Principle of simultaneous airborne and structure-borne simulation at HMS II.3 ViBRIDGE

The human bone conduction describes the transmission path in the human bone from the mouth to the ear canal. The pinna vibration equalization is the equalization of the mechanical system actuator included in the ViBRIDGE pinna and works as follows. The generated signal is equalized so that the target spectrum of the speech signal shown in Fig. 4 is met. The same in-ear sensor (cf. Fig.1) used in the tests with humans is positioned in the ear canal of the ViBRIDGE pinna of HMS II.3 ViBRIDGE and verifies this convergence. The equalization process is identical to the equalization of the artificial mouth, resulting in a virtually flat frequency response, so any test signal is reproduced with the correct structure-borne level at the ear canal. The equalization leads to spectral accuracy in equalization, as shown in Fig. 6.

Fig. 6: Original (blue, average human signal) and simulated (green, measured at HATS) structure-borne signals after equalization



2 Requirements

2.1 Preconditions

2.1.1 ACQUA

Since ACQUA version 6.1.100 and labCORE Firmware 3.8.20, ViBRIDGE is fully supported and can be used as described in this document.

2.1.2 ViBRIDGE Filter Files

ViBRIDGE filter files (*.veq) are provided by HEAD acoustics. They include ViBRIDGE equalization filters for each ViBRIDGE pinna purchased by the customer.

HEAD acoustics also provides filter files (*.veq) containing filters for the average human bone conduction (male and female). They are used as target spectrum for measurements with ViBRIDGE.

Previous ViBRIDGE equalization filters in HEAD data format (*.hdf) which have been delivered until the end of June 2024 are obsolete and not compatible with ACQUA 6.1.100.

2.1.3 HQS-ViBRIDGE

Please use revision 02 or newer of the HEAD quality standard HQS-ViBRIDGE.

Revision 01 of HQS-ViBRIDGE is outdated and applies the ViBRIDGE filters via single measurement descriptors (SMD). Therefore, Revision 01 of the database is not compatible with ACQUA 6.1.100 and the instructions in this document.

2.2 Equipment

2.2.1 General

The listed equipment is necessary for operating ViBRIDGE appropriately. Further equipment may be necessary for including a device under test in the configuration. The instructions in this document require basic knowledge about operating the ACQUA software.

2.2.2 Hardware Requirements

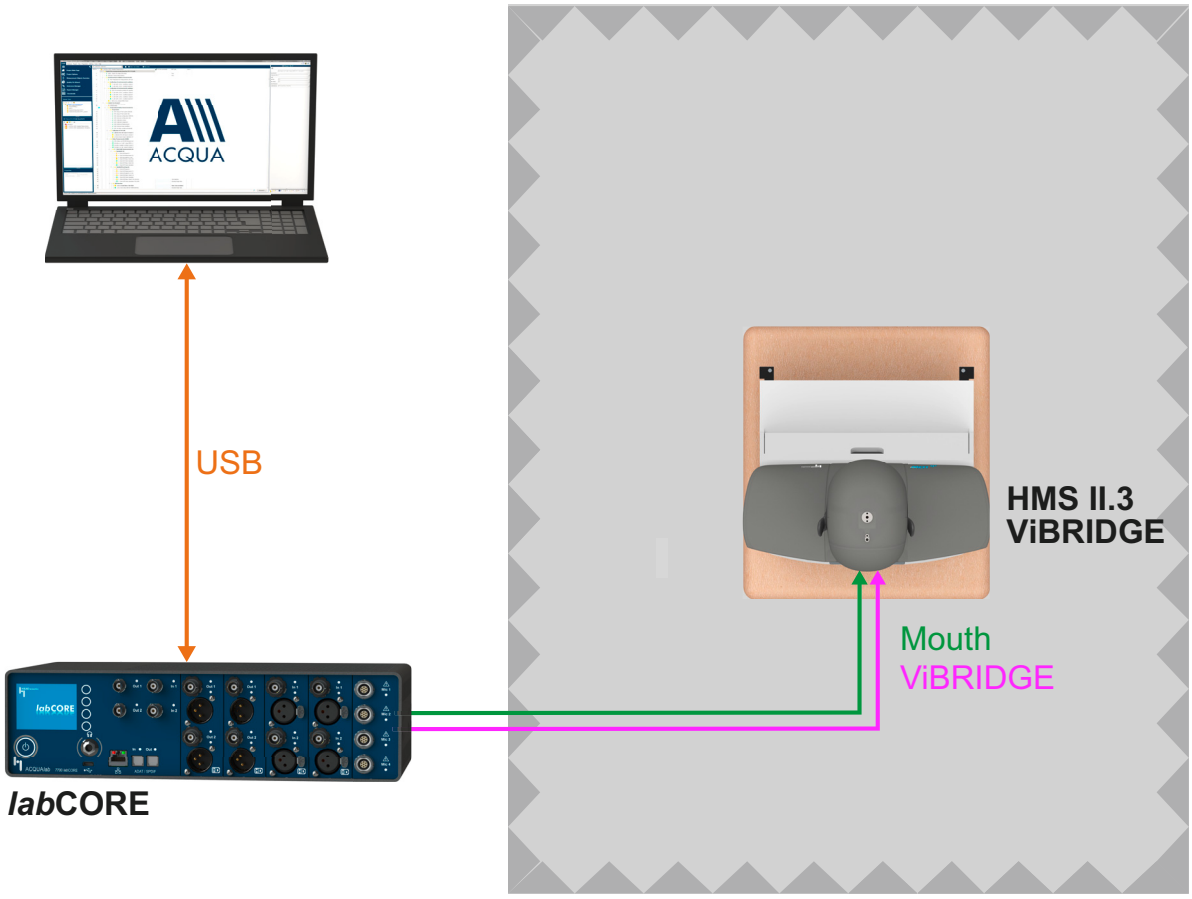
- *lab*CORE with firmware version 3.8.20 (at least)
- *core*BUS
- *core*OUT-Amp2
- HMS II.3 ViBRIDGE

2.2.3 Software Requirements

- ACQUA version 6.1.100 (at least)
- ViBRIDGE equalization filter file (*.veq)
  - ViBRIDGE equalization filters for left pinna, right pinna, or average
  - Filter files for the average human bone conduction (male and female)

2.3 Preparations

2.3.1 Connections



- Connect HMS II.3 ViBRIDGE to *core*OUT-Amp2 with cable CSS V.3.
- Connect *lab*CORE to ACQUA PC with cable CUSB II.5.

2.3.2 Mouth Equalization for HMS II.3 ViBRIDGE

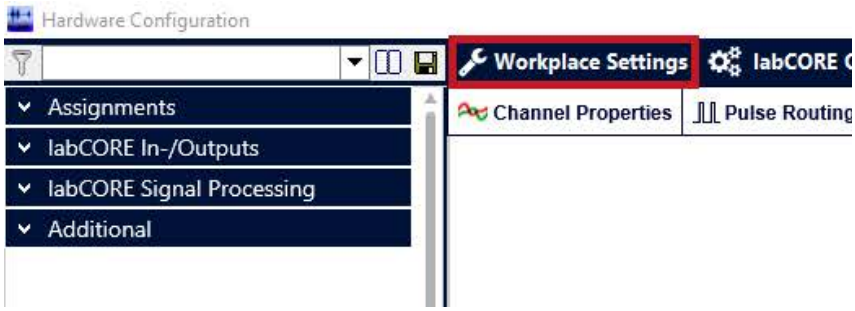
Applying the mouth loudspeaker of HMS II.3 ViBRIDGE requires an appropriate equalization of the loudspeaker. Refer to HMS II Series manual or ACQUA Online Help for instructions to execute the mouth equalization.

3 Set Up and Activate ViBRIDGE in ACQUA

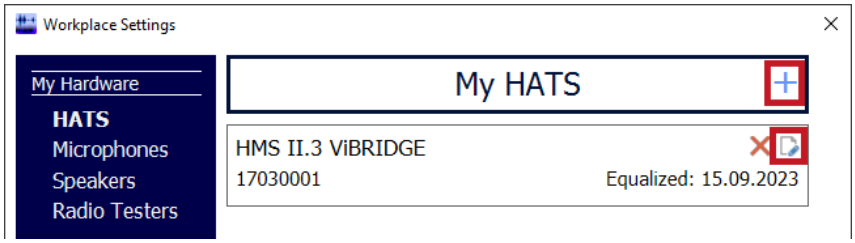
3.1 Manage ViBRIDGE Filters

3.1.1 General Steps

1. Connect the hardware according to chapter 2.3.1.
2. Start ACQUA.
3. Select **Settings > Hardware Configuration** (alternatively press F5 on the keyboard).
4. Select the **Workplace settings**.

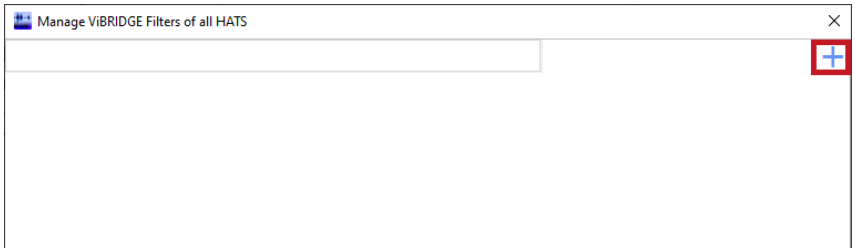


5. Select **Assignments** > **HATS**.
6. Select **+** to add a new HATS (only if the desired HATS has not been added already).
7. Select to edit the **HATS Settings** of the desired HMS II.3 ViBRIDGE.



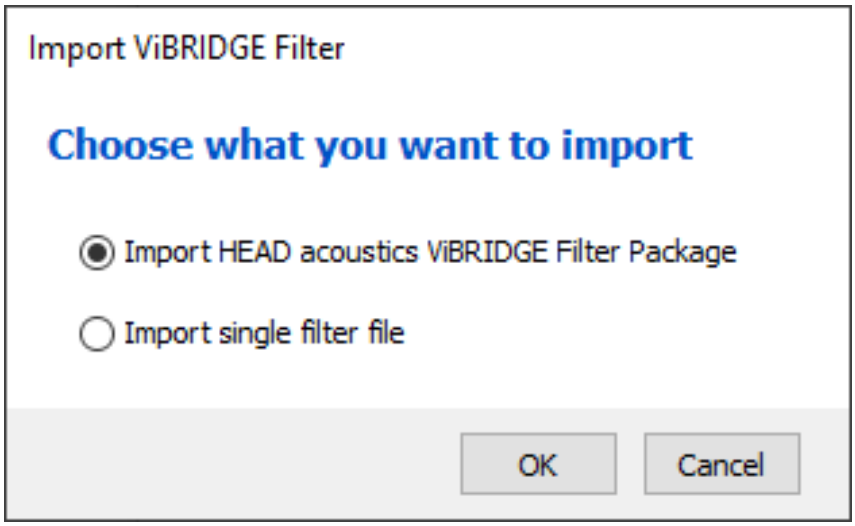
8. Select **Manage ViBRIDGE filters**. The link is only available if the **HATS settings** assign ear simulator HIS LN HEC and pinna type 4.4 to the desired HMS II.3 ViBRIDGE.

9. Select **+** to add
   - a ViBRIDGE filter package (*.veq), refer to chapter 3.1.2.
   - a customized filter, refer to chapter 3.1.3.1.
   - Alternatively: Create and add a customized filter via ACQUA database, refer to chapter 3.1.3.

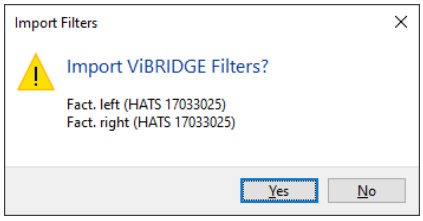


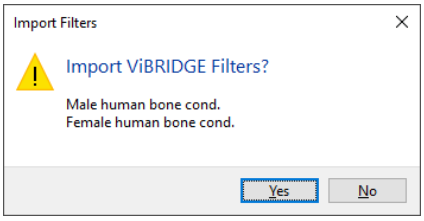
3.1.2 Import HEAD acoustics ViBRIDGE Filter Package

1. Select **Import HEAD acoustics ViBRIDGE Filter Package**.
2. Select **OK**.
3. Browse for the directory of the filter file (*.veq) and open it.



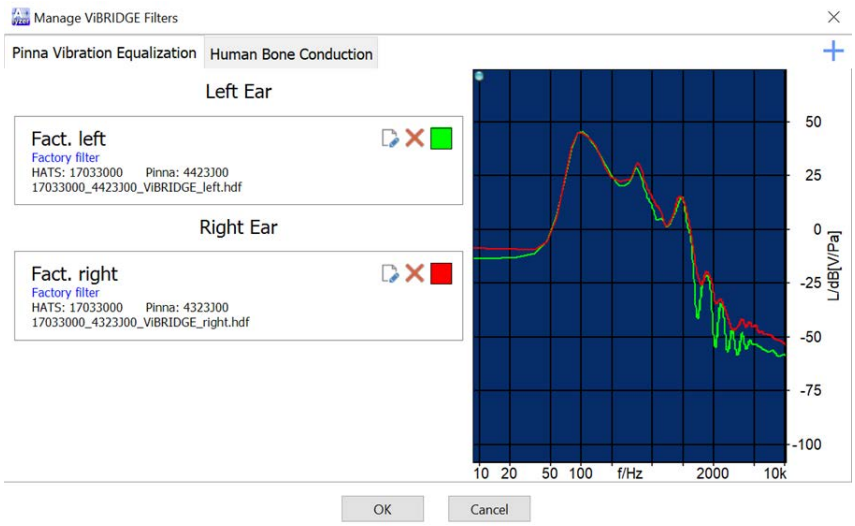
4. Confirm the import of the filters by selecting **Yes**.





5. The filters are categorized in two types. They can be viewed on different tabs:
   - Pinna vibration equalization includes the available filters for the left and the right ear.
   - Human bone conduction includes the filters for the human bone conduction (male/female).

   The filters can be viewed in the diagram, renamed, or deleted from the list.
6. Select **OK** to complete the import procedure and save the filters.



3.1.3 Customized ViBRIDGE Equalization Filters

Custom filters may be used, too. There is an ACQUA database for creating and importing ViBRIDGE equalization filters. Furthermore, existent ViBRIDGE equalization filters can be imported manually.

3.1.3.1 ViBRIDGE Equalization Database

In addition to the factory filters created during production with a reference sensor, the ViBRIDGE equalization database includes measurements, calculations, and instructions for creating a ViBRIDGE pinnae equalization filter via a custom DUT sensor. The ViBRIDGE pinnae equalization filter can be exported directly from the database to the appropriate HATS in the **Workplace Settings**.

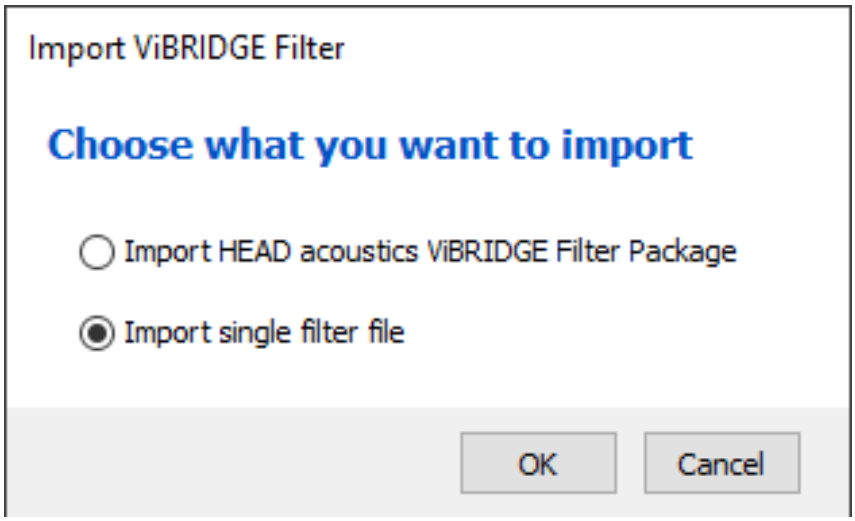
The database is available as download (access to HEAD acoustics Customer Area required) and has to be applied in ACQUA.

Download ViBRIDGE Equalization Database

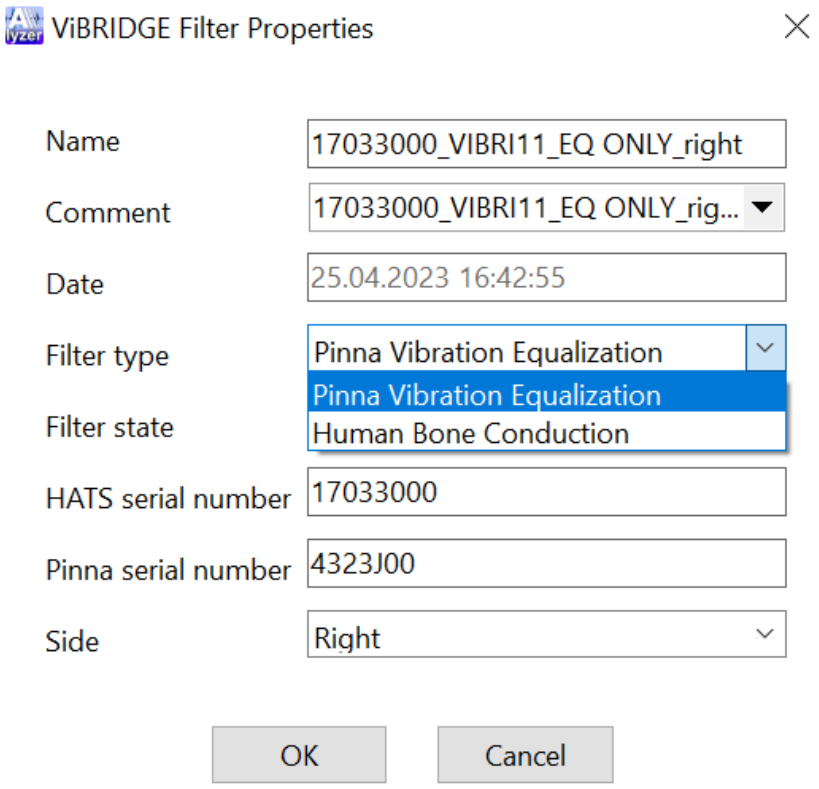
3.1.3.2 Import single filter file

This chapter provides information on importing ViBRIDGE equalization filter files manually.

1. Select **Import single filter file**.
2. Select **OK**.
3. Browse for the directory of the filter file (*.hdf) and open it.



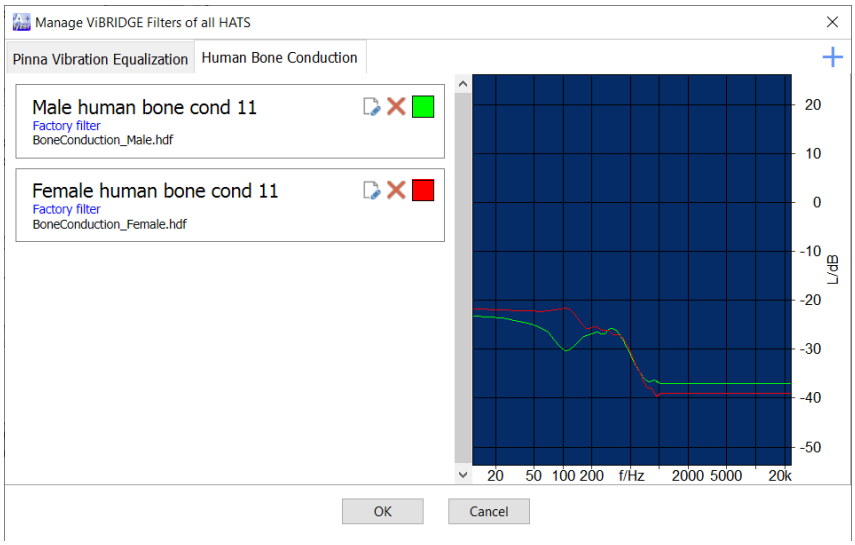
4. Specify properties of the filter.
   - Name
   - Comment (optional)
   - Select the desired filter type
   - Enter the HATS serial number (only for filter type: Pinna vibration equalization)
   - Enter the serial number of the pinna (only for filter type: Pinna vibration equalization)
   - Specify the side of the pinna (only for filter type: Pinna vibration equalization)
5. Select **OK** to confirm the properties.



6. The filters are categorized in two types. They can be viewed in different tabs:
   - Pinna vibration equalization includes the available filters for the left and the right ear.
   - Human bone conduction includes the filters for the human bone conduction (male/female).

   The filters can be viewed in the diagram, renamed, or deleted from the list.

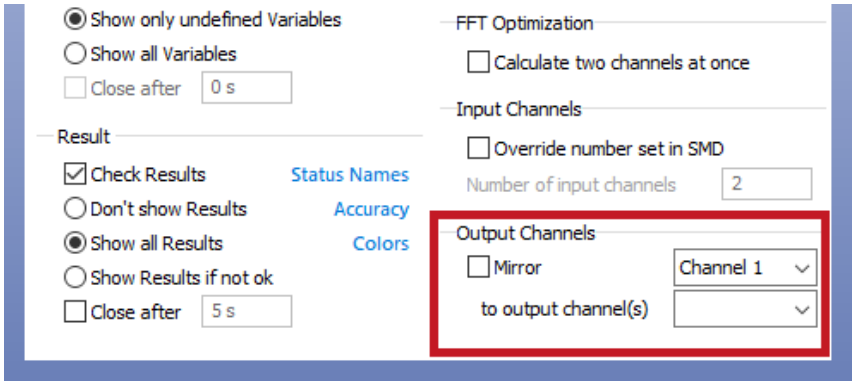
Select **OK** to complete the import procedure and save the filters.



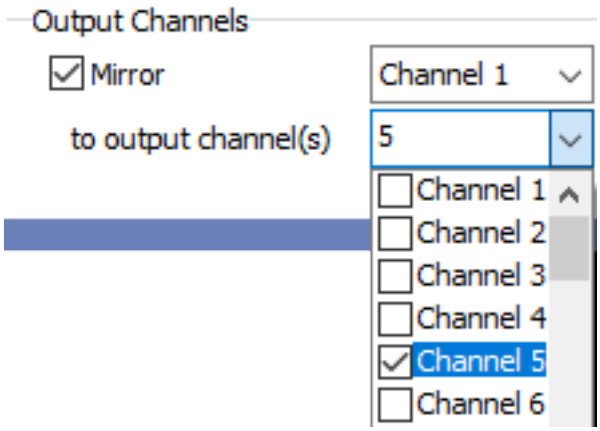
3.2 Measurement Settings

ACQUA can mirror the source signal output channel to another output channel. This function is required for measurements using single channel source files for playback. The used channels in this document may differ from user experience.

1. Select **Settings > Meas./Report Settings** (alternatively press F2 on the keyboard).



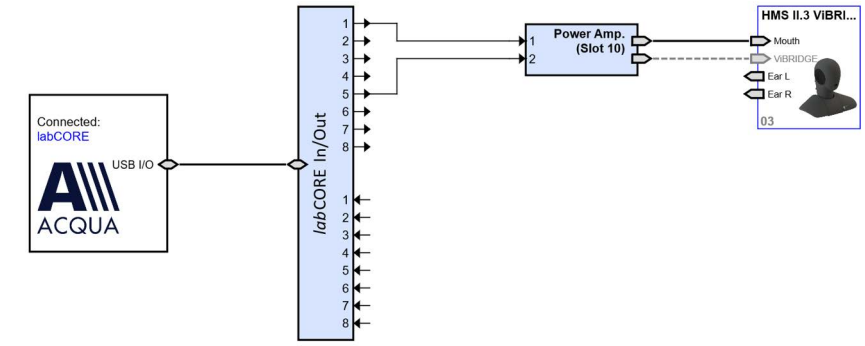
2. Enable **Mirror**.
3. Select the desired source signal output channel in the top drop-down list for mirroring.
4. Enable the desired channel to output the same signal as the mirrored channel in the bottom drop-down list.

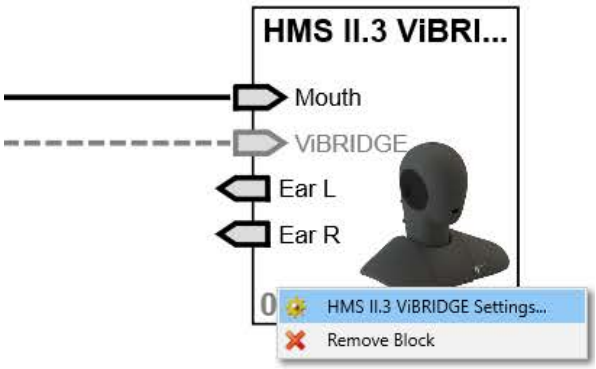


3.3 Set Up Configuration and Activate ViBRIDGE

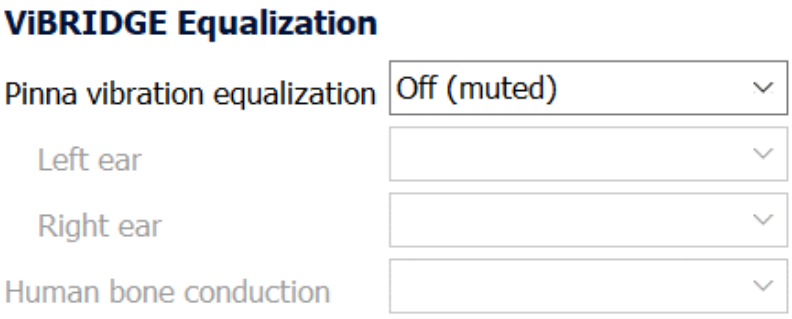
This chapter requires importing appropriate ViBRIDGE filters for operation. Please refer to chapter 3.1.

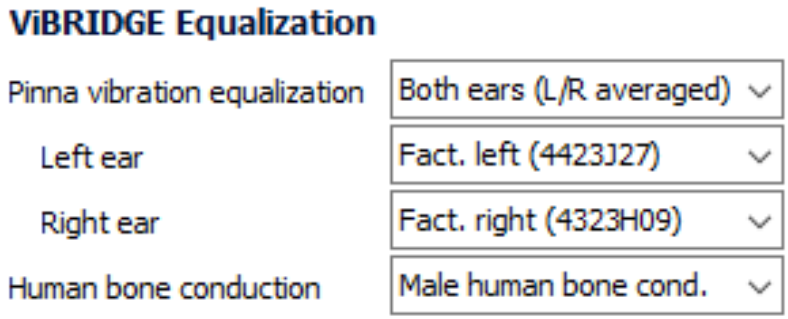
1. Select **Settings > Hardware Configuration** (alternatively press F5 on the keyboard).
2. Connect the **ACQUA** block to the **labCORE In/out** block.
3. Drag and drop the **Power amp.** block (from **labCORE In-/Outputs**) and the desired **HATS** block (from **Assignments**) to the configuration section.
4. Connect the source signal channel to input 1 of the **Power Amp.** block.
5. Connect the mirror channel to input 2 of the **Power Amp.** block.
6. Connect output 1 of the **Power amp.** block to the **Mouth** connection of the **HATS** block.
7. Connect output 2 of the **Power Amp.** block to the **ViBRIDGE** connection of the **HATS** block. The connection string appears dashed.
8. Right click on the **HATS** block.
9. Select **HATS Settings** (⚙).





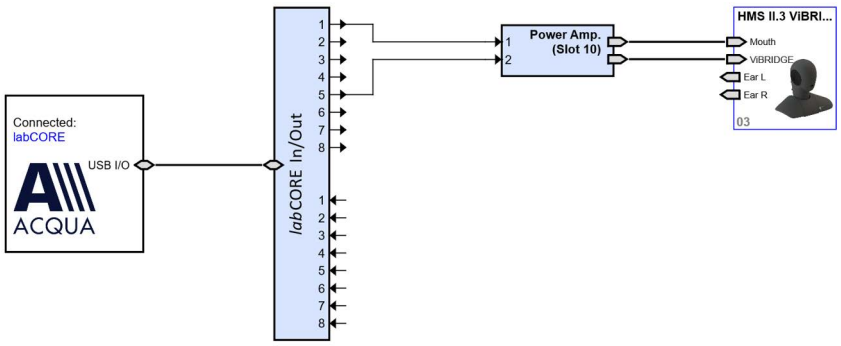
10. Select the desired **Pinna vibration equalization**.
    - **Off (muted)**: ViBRIDGE is idle. Important note: For avoiding playback of unwanted signals at the ViBRIDGE actuator, it is crucial to either keep all ViBRIDGE connections in the hardware configuration or disconnect input 2 from the **Power Amp.** block.
    - **Left ear**: Pinna vibration equalization for the left ear.
    - **Right ear**: Pinna vibration equalization for the right ear.
    - **Both ears (L/R averaged)**: Averaged equalization filter of both filters (left/right pinna vibration equalization). This equalization filter is inferior compared to applying a left/right ear equalization filter for a single pinna.





11. Select the desired equalization filter for the **Left ear** from the drop-down list.
12. Select the desired equalization filter for the **Right ear** from the drop-down list.
13. Select the desired **Human bone conduction** filter (target spectrum) from the drop-down list.

14. Close the **HATS settings**.
15. After assigning the ViBRIDGE equalization appropriately, the connection string of the ViBRIDGE connection appears solid.
    Both signals, **Mouth** and **ViBRIDGE**, are exactly synchronized, but a delay of approximately 42.7 ms (at 48 kHz sampling rate) is added to the playback delay of these channels as a result of the equalization filters. ACQUA automatically applies the same delay to all other active channels in the **Hardware Configuration** for full synchronization.



16. ViBRIDGE is now fully operational.