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DATA SHEET

*lab*CORE (Code 7700)

ACQUA*lab* modular multi-channel hardware platform for voice and audio quality testing

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Overview

*lab*CORE is a modular multi-channel hardware platform of the ACQUA*lab* generation by HEAD acoustics. Its wide choice of high-performance analog and digital interfaces as well as its versatility and future-proof technology make labCORE the state-of-the-art all-in-one solution for testing voice and audio quality precisely and efficiently.

Measuring digital and analog telecommunication and audio devices as well as transmission systems, analyzing headsets or headphones, binaural equalization, setups with two artificial head measurement systems, VoIP reference gateway: *lab*CORE is versatile and provides everything in one device – depending on the selected configuration and optional extensions.

Description

*lab*CORE is a high-precision measurement hardware platform. It provides multiple channels, a wide variety of analog and digital inputs and outputs, high processing power and high-performance interfaces. *lab*CORE is an all-in-one solution for measuring the voice and audio quality of a wide range of devices.

*lab*CORE is used in conjunction with the communication quality analysis system ACQUA. Connected to a computer via USB (Plug & Play), it is configured and controlled by ACQUA. Combinations with other HEAD acoustics hardware platforms and software applications are possible.

*lab*CORE settings are controlled via the intuitive ACQUA settings. They can be stored and assigned to selectable measurement sequences.

*lab*CORE can be used for system optimization and development as well as quality control and benchmark testing. It addresses all industries where voice and audio quality of telecommunication and audio devices as well as transmission systems play a decisive role.

The compact body of *lab*CORE requires a height of only two rack units (or more depending on hardware extensions), width and depth fit into a standard 19-inch rack.

For demanding audio analysis with highest possible signal quality and to extend its scope of functions, *lab*CORE can be equipped with up to 10 additional hardware boards.

The boards can be combined in numerous variants to customize *lab*CORE for every possible use-case (respecting physical limitations). *lab*CORE also is expandable with software extensions depending on applications and measurement purposes.

Key Features

- High-precision measurement technology
- High-performance digital & analog inputs and outputs
- Modular concept with a wide choice of additional interfaces:
  - Up to 10 optional hardware extension boards
  - Various software extensions
- Multiple channels
- Versatile, individual tailoring to specific measurement tasks
- Future-proof – new technologies & interfaces can be implemented
- Fast, easy configuration and control via ACQUA
- Silent operation

Applications

- Measurements of telecommunication equipment such as mobile phones, (in-vehicle) hands-free and conference devices
- Headphone and headset testing
- Measurements of high-quality audio equipment
- Testing transmission systems for instance networks and routers
- Evaluating voice and audio quality of IoT devices (e.g. smart speakers)
- Research and development (R&D)
- Conformance tests
- Quality control

General requirements

One of the following **HEAD acoustics software applications**.

- **Full utilization:**
  - **ACQUA (Code 6810)**, Advanced Communication Quality Analysis, Version 4.2.210 or later
  - **RC-*lab*CORE (Code 6984)**, Remote configuration software for *lab*CORE, Version 1.1.100 or later
  - **VoCAS (Code 6984)**, Voice control analysis system,Version 1.2.200 or later
- **Partial utilization:**
  - **HAE-car (Code 6970)**, Background noise simulation system with semi-automated equalization for car cabins, Version 3.2.130 or later
  - **HAE-BGN (Code 6971)**, Background noise simulation system with semi-automated equalization for labs, Version 3.2.130 or later
  - **3PASS *flex* (Code 6995)**, Advanced background noise simulation system with automated equalization - flex version, Version 2.1.400 or later

Options

- ***lab*PWR I.2 (Code 3712),** HEAD*lab* power box, for power supply during mobile use (max. 100 W)
- **RMB IV.3 2RU (Code 9852.2),** 19″ Rack Mount Bracket (2 rack units) for *lab*CORE (2 pcs.)

Delivery items

- ***lab*CORE (Code 7700),** ACQUA*lab* modular multi-channel hardware platform
- **Power supply adapter,** 24 V DC, 150 W, LEMO 4-pin
- **PCC I.9x (Code 997x),** Power cable (to local specification)
- **CDM V (Code 1637),** Cable D-Sub 15-pin ↔ 2 x XLR (AES/EBU in/out) + 2 x BNC (pulse in/out)
- **CUSB II.5 (Code 5478-1.5),** USB 2.0 cable, with ferrite, USB-B ↔ USB-A, 1.5 m
- **CUU II (Code 6094)**, USB 2.0 adapter, USB-C ↔ USB-A
- **HCC-labCORE (Code 1644),** Carrying case for *lab*CORE
- **Manual** (Hardcopy)

Basic Equipment (Front)

LCD display & soft buttons

- LCD color display showing:
  - Button 1: Current settings
  - Button 2: In/output levels
  - Button 3: For future use
  - Button 4: Firmware info

Headphone output

- 6.3 mm headphone jack
- For monitoring or measuring purposes

IN 1/2 & OUT 1/2

- 2 × analog inputs with switchable ground connection
- 2 × analog outputs
- BNC connectors

USB host

- USB Type C-connector
- For measurements of USB devices, e.g. USB headsets
- Adapter CUU II for devices with USB-A connector is supplied

Ethernet

- RJ45 connector
- Connects to: IP-based communication devices, radio tester etc.

ADAT/SPDIF²

- 1 × ADAT input
- 1 × ADAT output
- TOSLINK optical connectors

Basic Equipment (Back)

Digital Audio

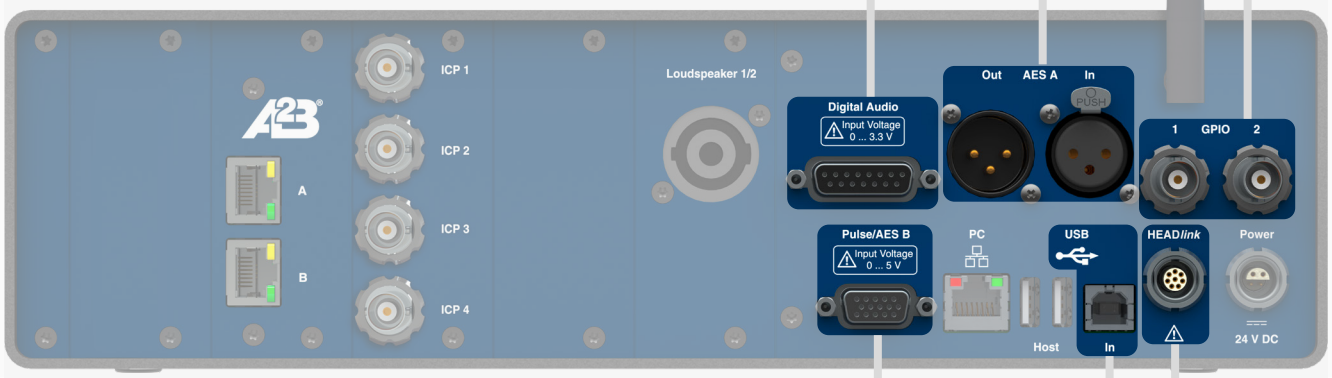
- Audio: 1 × input, 1 × output
- Supports up to 8 audio channels
- Supports I²S Inter-IC
- Pulse/trigger: 2 × in-/output
- Two-row 15-pin D-Sub DA-15

AES A In/Out

- 1 × AES input (XLR female)
- 1 × AES output (XLR male)
- For digital audio signal exchange with other hardware

GPIO 1/2

- 2 × pulse/trigger in-/output
- BNC connectors



Pulse/AES B

- Pulse/trigger: 1 × input, 1 × output
- AES: 1 × input, 1 × output, for digital audio signal exchange with other hardware
- High density 15-pin D-Sub DE-15
- Cable CDM V with all connectors is supplied

USB In[3]

- USB Type-B connector
- For main connection to computer
- Connection cable CUSB II.5 is supplied

HEAD*link*

- 8-pin LEMO for direct connection to HEAD acoustics equipment, e.g.
  - MSA I & MSA I-V1
  - MSA II

Optional Extensions – Hardware Boards (Front)[4]

*core*OUT-A2[5] — Code 7750

- 2 × high-precision low-noise analog outputs
- Each output with
  - 1 × BNC connector (unbalanced)
  - 1 × XLR connector (balanced)

*core*IN-Mic4[5] — Code 7730

- 4 × high-precision low-noise microphone inputs
- 7-pin LEMO connectors
- All inputs support TEDS
- Switchable 200 V polarization voltage

*core*IN-A2[5] — Code 7760

- 2 × high-precision low-noise analog inputs
- Each input with
  - 1 × BNC connector (unbalanced)
  - 1 × XLR connector (balanced)

The five extension slots at the front are designated for the most common extension boards *core*OUT-A2 and *core*IN-Mic4. A total of two *core*IN-A2, two *core*OUT-A2 and one *core*IN-Mic4 can be installed, providing twelve high-precision low-noise analog channels for arbitrary precision measurements: four inputs, for outputs and four microphone inputs.

Optional Extensions – Hardware (Internal)

The hardware extensions *core*BT and *core*BUS for *lab*CORE are internal modules not visible from the outside. Only the external antenna of the Bluetooth® module *core*BT is visible (see image). *core*BUS, the fundamental component for any extension board, remains fully concealed.

*core*BT — Code 7780

- Hardware extension for Bluetooth® wireless connectivity
- Transforms *lab*CORE into a universal Bluetooth® reference access point
- External antenna for good signal reception
- Suitable for acoustic & electric measurements of Bluetooth® voice & audio devices:
  - mobile phones
  - hands-free devices
  - headsets
  - loudspeakers
  - headphones
  - other devices

*core*BUS — Code 7710

- I/O bus mainboard for *lab*CORE
- Serves as internal interface between basic unit's mainboard and optional hardware extension boards
- Is a requirement for any hardware extension board

Optional Extensions – Hardware Boards (Back)[4]

coreA2B[5] Code 7790

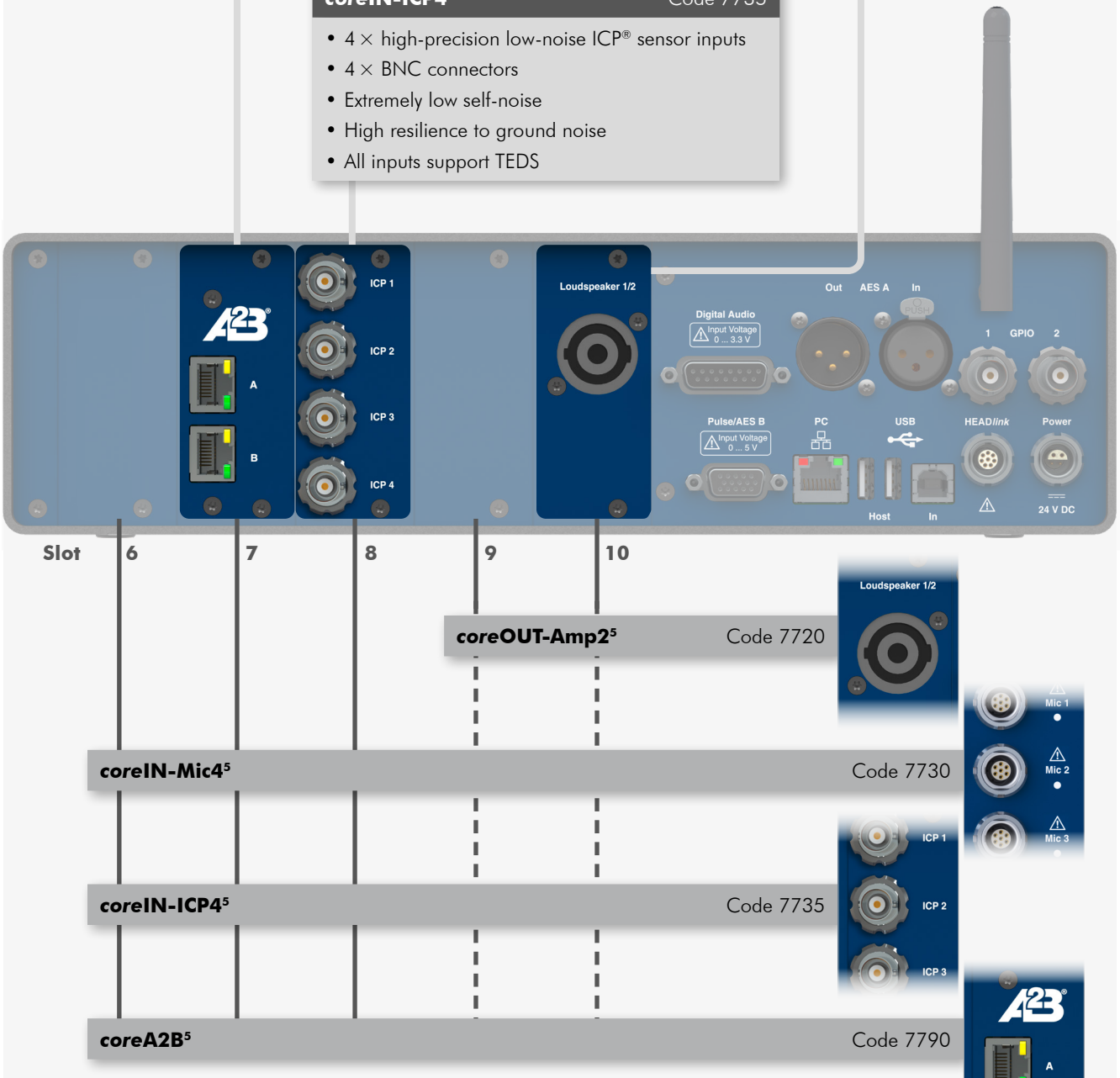
- Connects to the Automotive Audio Bus A²B®
- Can insert & receive audio and configuration data
- 4 selectable modes:
  - Master of the bus
  - Slave node on the bus
  - Bus monitor (passive sniffing)
  - Proxy (full bus control)
- Can serve as an A²B® evaluation board

coreOUT-Amp2[5] Code 7720

- Provides 2 × amplified outputs
- Powers artificial mouths or small loudspeakers
- Efficient class-D technology with low heat dissipation
- 20 Watt RMS output per channel
- 4-pin Speakon socket

coreIN-ICP4[5] Code 7735

- 4 × high-precision low-noise ICP® sensor inputs
- 4 × BNC connectors
- Extremely low self-noise
- High resilience to ground noise
- All inputs support TEDS



The slots at the back have separated slot covers, allowing a wide variety of different *lab*CORE configurations. *core*IN-Mic4, *core*IN-ICP4 and *core*A2B can be installed arbitrarily in any of the rear slots, preferably slot 6, 7 and 8. The slots 9 and 10 are internally prepared for the high power requirements of *core*OUT-Amp2, which is why they should be left available this board if amplified outputs are desired.

Please also see the individual data sheet of each extension for more information.

Optional Extensions – Software

*lab*CORE also supports extension with additional software components. Like the hardware extensions, they add functionality and capability to *lab*CORE, allowing to tailor the hardware platform to various use-cases. The optional software extensions can be divided into two groups: main components and add-ons for the respective components.

Main Components

Binaural Equalization

coreBEQ Code 7740

- Binaural equalization for HEAD acoustics artificial heads[5]
- Can be used on one *lab*CORE unit
- Includes determination of equalization filters for one customer-selected artificial head

Bluetooth

Note: the main component for Bluetooth wireless functionality is the optional hardware extension *core*BT (Code 7780).

IP capability

coreIP Code 7770

- Transforms *lab*CORE into a reference gateway for voice quality and audio measurements of IP-based systems & devices (e.g. VoIP & VoLTE telephones)
- Contains integrated VoIP SIP-client and RTP
- Supports many common voice codecs, more sophisticated codecs available as add-on extensions

Add-ons[6]

Binaural Equalization

coreBEQ-Add[7] Code 7741

- Add-on for coreBEQ
- Determination of equalization filters for one additional customer-selected artificial head

Bluetooth

coreBT-EXT Code 7781

- Add-on for *core*BT (see hardware extensions)
- Adds wideband capability for hands-free profiles (mSBC codec) and the Qualcomm® aptX™ audio codec for A2DP profiles

IP capability

coreIP-IMP Code 7771

- Add-on for *core*IP to delay or discard specific RTP packets
- Simulates network conditions like jitter, delay and packet loss
- Reproducible conditions even with active Discontinued Transmission (DTX)/Silence Compression

coreIP-AMR[8] Code 7772

- Add-on for *core*IP for transmission with AMR codec
- Combined software/hardware extension
- Provides the codecs
  - AMR-NB & WB (G.722.2)
  - GSM Enhanced Full Rate

coreIP-EVS Code 7773

- Add-on for *core*IP for transmission with EVS codec
- Supports all bandwidths from narrowband to fullband with all bit-rates and modes (incl. AMR-WB interoperable mode)

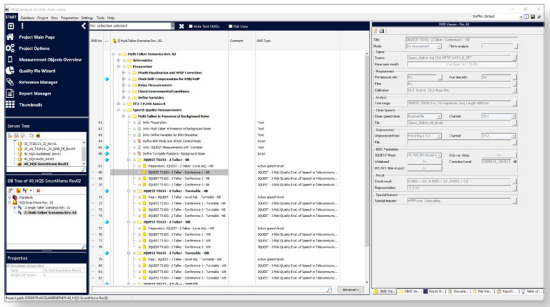
coreIP-OPUS Code 7774

- Add-on for *core*IP for transmission with OPUS codec

Main Software Applications[9]

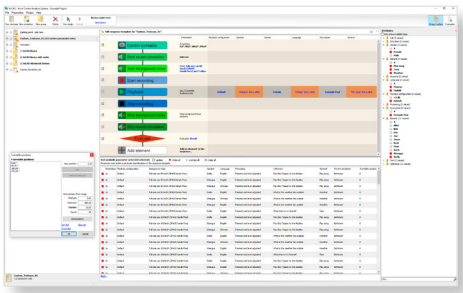
ACQUA

ACQUA (Advanced Communication QUality Analysis) is the main software to fully utilize *lab*CORE with all its functionality. It is a voice and audio quality test and measurement software developed by HEAD acoustics. ACQUA includes a multi-channel signal generator and analyzer. Predefined (but modifiable) measurement descriptors gather results in a database structure. A variety of ACQUA OPTions (ACOPTs) allows individual tailoring of the software to specific fields of application; from the evaluation of frequency responses to psychoacoustic models and voice quality analysis systems.



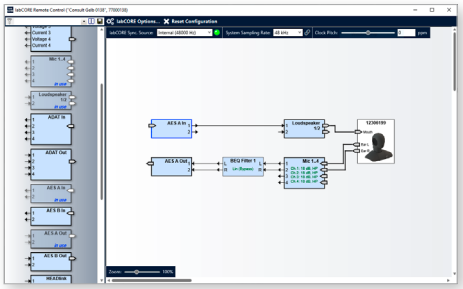
VoCAS

VoCAS is an automated Voice Control Analysis System for testing and optimization of systems and devices with automatic speech recognition (ASR). *lab*CORE serves as the pivotal hardware interface, connecting to the artificial mouth and ears of the HMS system conducting a conversation with the ASR device and triggering background noise simulation.



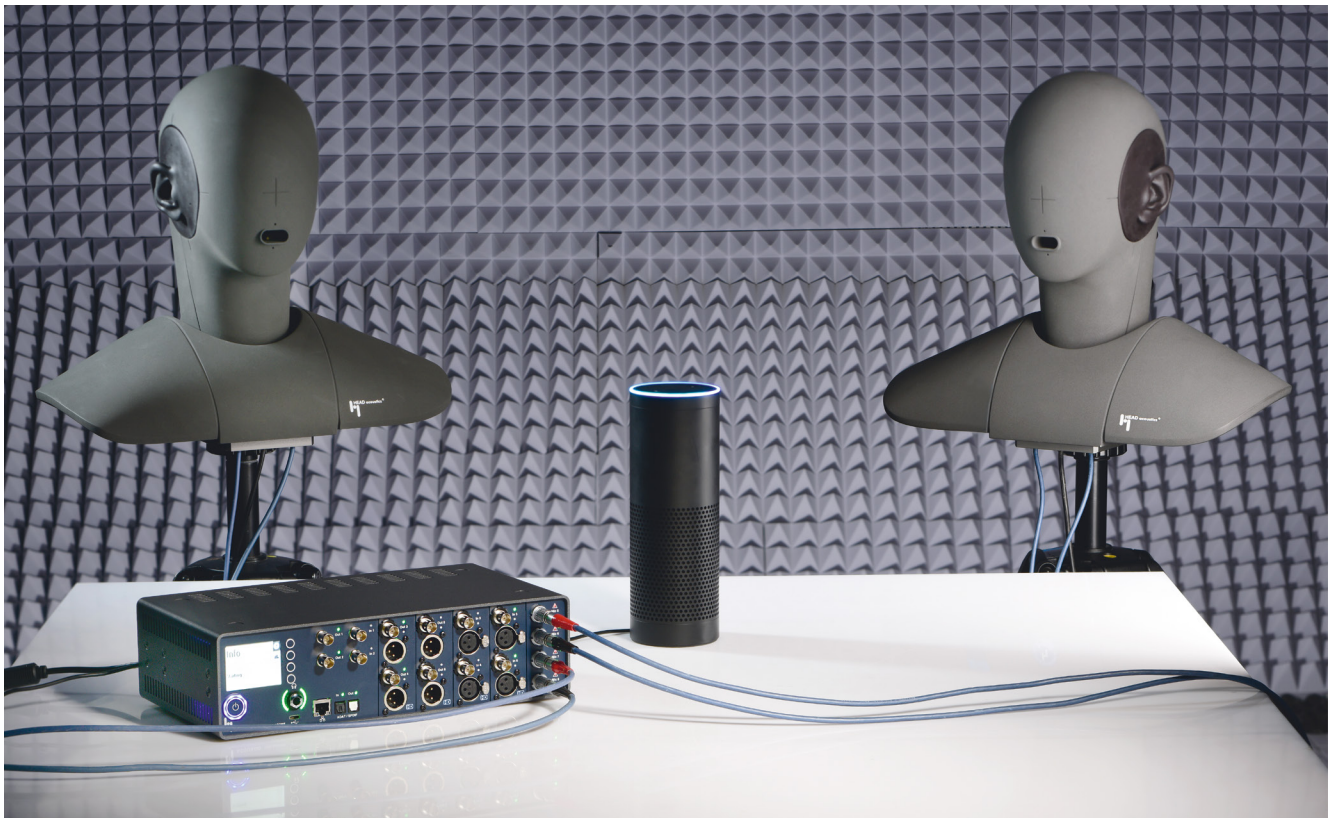
RC-*lab*CORE

RC-*lab*CORE is a software tool for remote configuration of *lab*CORE. Its interface is similar to the hardware configuration window in ACQUA (see next pages).RC-*lab*CORE allows to re-configure connections and hardware settings for *lab*CORE, but it does not include any of the analysis and signal generation capabilities of ACQUA. Also, it does not allow to hand over signals to other software products.



Data sheets

Please also see the individual data sheet of ACQUA, VoCAS and other software applications for more information.



*lab*CORE in ACQUA – Hardware configuration

*lab*CORE interlinks with ACQUA to set up and configure the platform's various in- and outputs. Setup is performed in the hardware configuration window in ACQUA shown below.

Hardware and software elements such as basic equipment and extension boards, software extensions and processing steps are presented as individual block elements. Every block has type-specific inputs and/or outputs.

The blocks can be 'dragged-and-dropped' from the tray on the left side of the hardware configuration window onto the desktop area. Blocks can be arranged arbitrarily on a designated desktop area in the same window. Connections between blocks are established simply by 'left clicking + dragging' a connection from one in-/output to another. When blocks are rearranged on the desktop, established connections will be preserved.

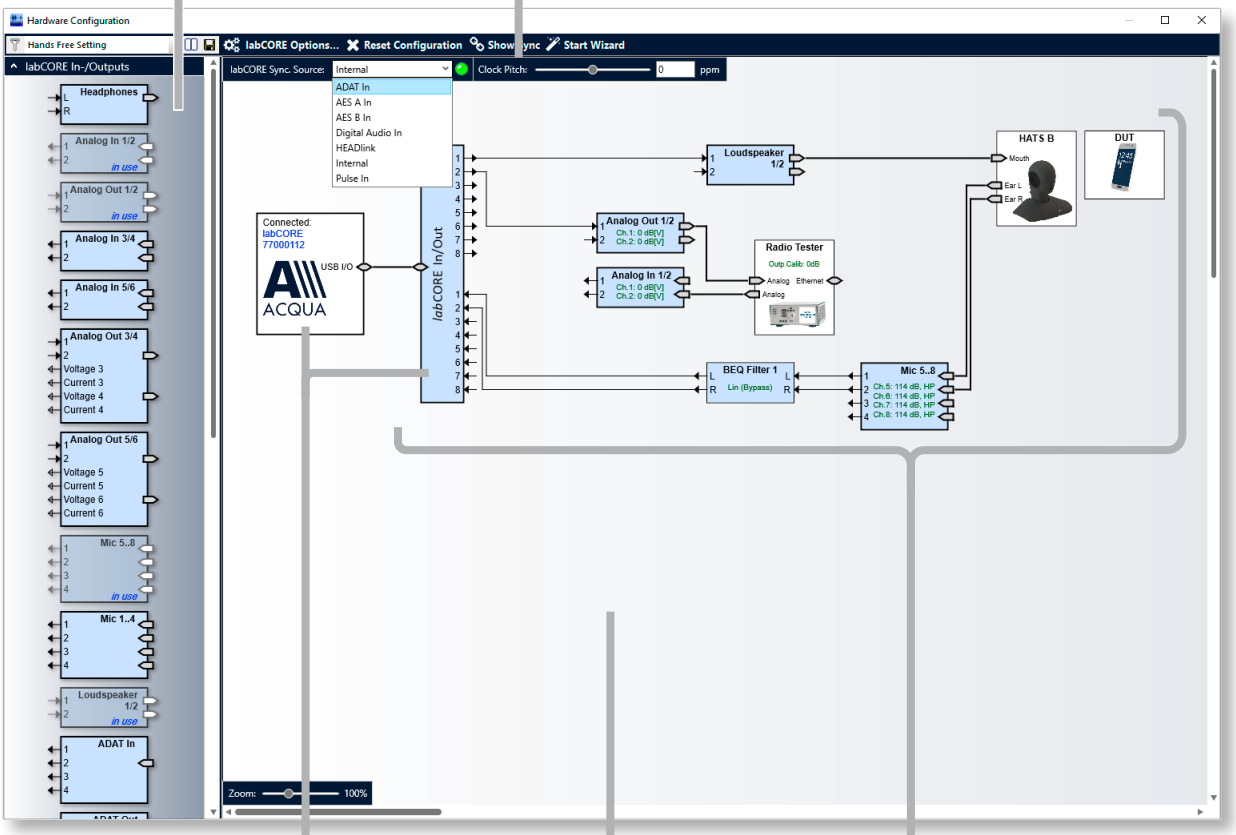
A finished setup is a graphic visualization of the internal interconnections as well as the use of *lab*CORE's in- and outputs. Setups can be stored and assigned to user-selected measurement sequences. This allows unattended measurements with different hardware configurations if changes to the actual hardware and its wiring are not necessary.

Block tray

- Holds all available blocks
- Easy 'dragging & dropping' of blocks onto the desktop
- Blocks in use are grayed out
- Division into groups for better overview

Menu bar

- Allows quick access to most relevant settings:
  - *lab*CORE options
  - Full setup reset
  - Start setup wizard
  - Synchronization source selection
  - Synchronization overview
  - Clock drift compensation for external synchronization sources



ACQUA & *lab*CORE

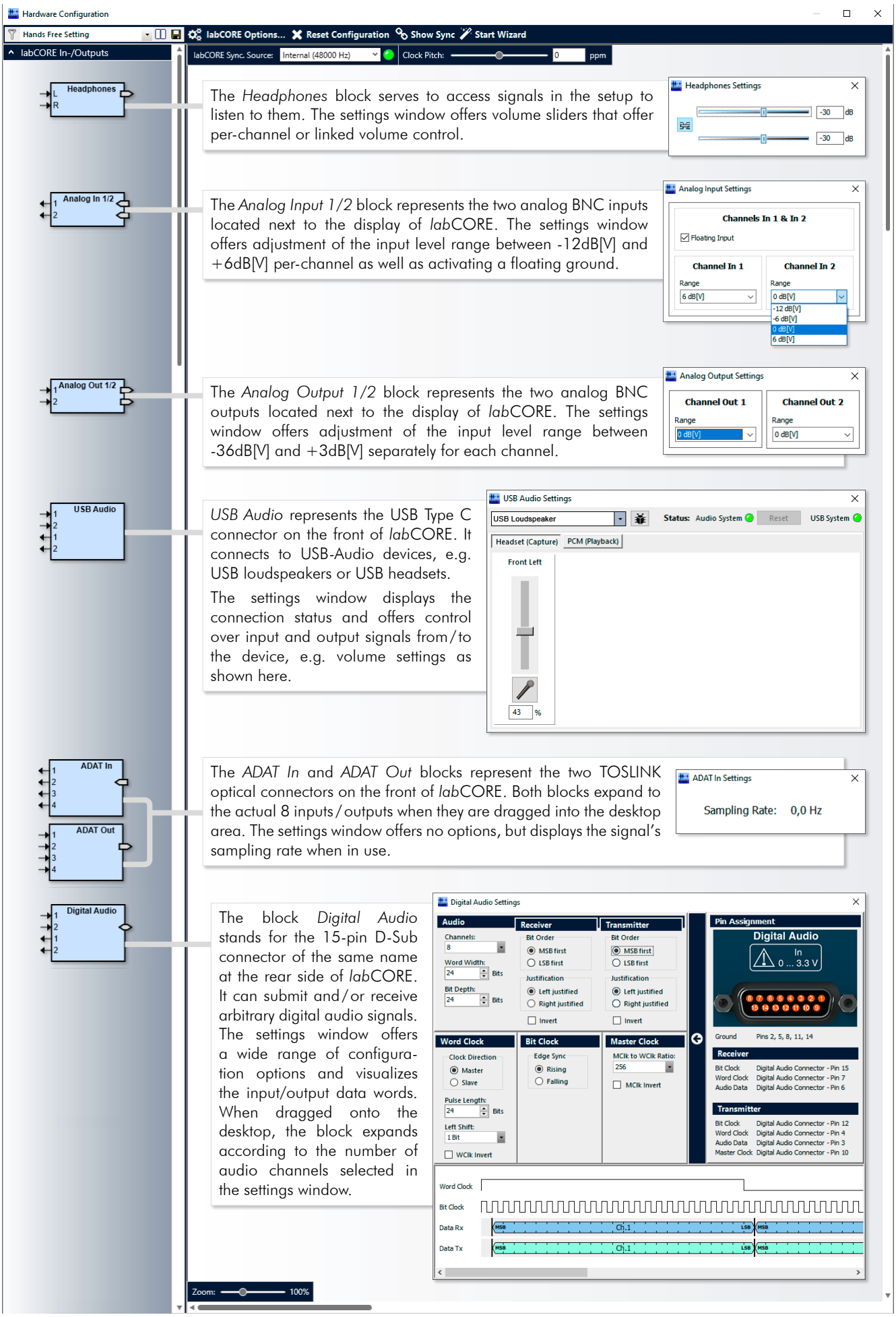
- Represent the hardware interface (*lab*CORE) of the setup and the interlinked software side (ACQUA)
- *lab*CORE block automatically appears when the device is connected and ready

Desktop area

- Area to build arbitrary setups by 'dragging & dropping' blocks from the block tray onto it and connecting them
- Blocks can be arranged and repositioned as desired

Measurement setup (example)

- Blocks are connected with each other through easy 'left click & drag' action
- What-you-see-is-what-you-get approach allows easy creation and modification of measurement setups



The *Headphones* block serves to access signals in the setup to listen to them. The settings window offers volume sliders that offer per-channel or linked volume control.

The *Analog Input 1/2* block represents the two analog BNC inputs located next to the display of *lab*CORE. The settings window offers adjustment of the input level range between -12dB[V] and +6dB[V] per-channel as well as activating a floating ground.

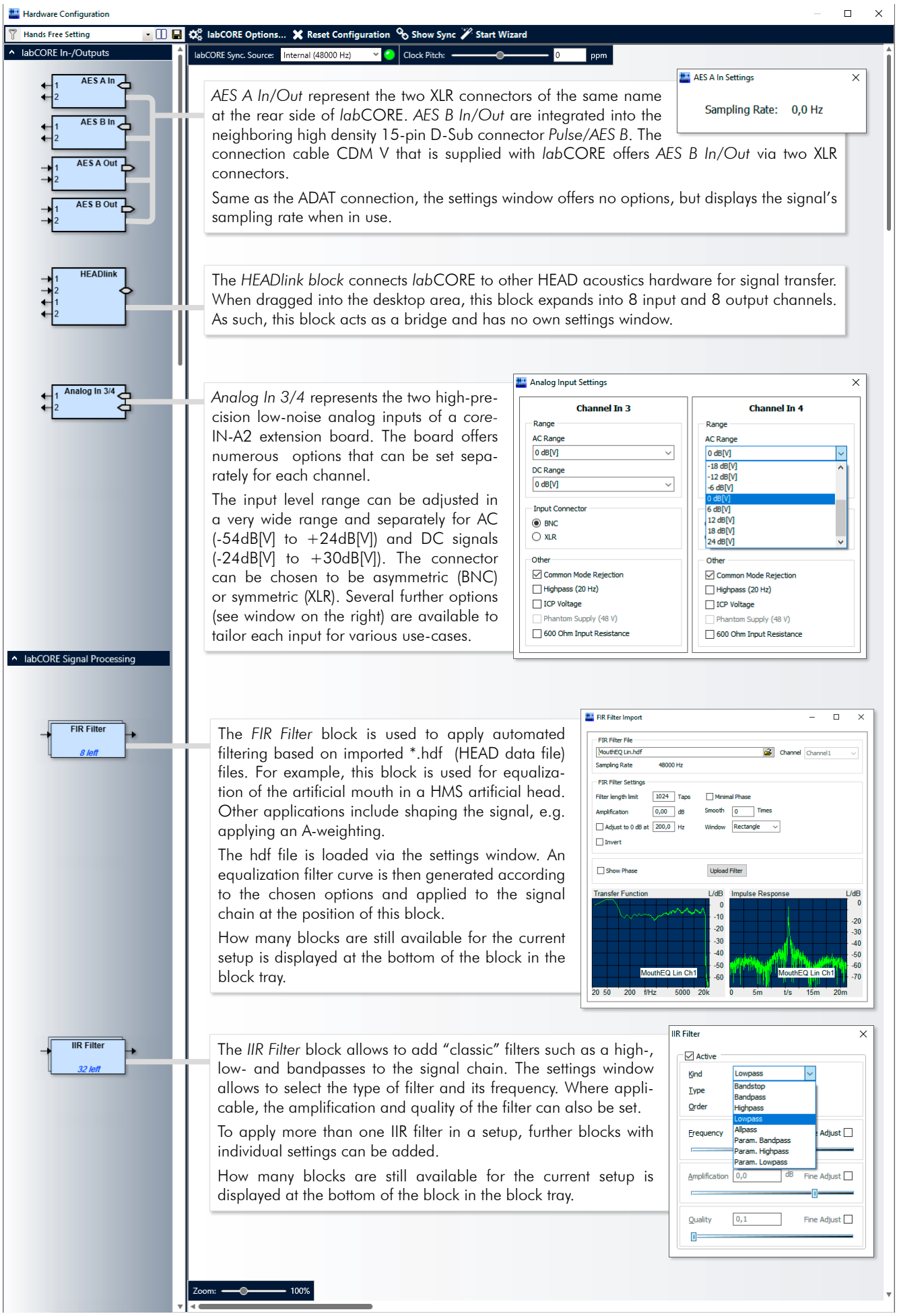
The *Analog Output 1/2* block represents the two analog BNC outputs located next to the display of *lab*CORE. The settings window offers adjustment of the input level range between -36dB[V] and +3dB[V] separately for each channel.

USB Audio represents the USB Type C connector on the front of *lab*CORE. It connects to USB-Audio devices, e.g. USB loudspeakers or USB headsets.

The settings window displays the connection status and offers control over input and output signals from/to the device, e.g. volume settings as shown here.

The *ADAT In* and *ADAT Out* blocks represent the two TOSLINK optical connectors on the front of *lab*CORE. Both blocks expand to the actual 8 inputs/outputs when they are dragged into the desktop area. The settings window offers no options, but displays the signal's sampling rate when in use.

The block *Digital Audio* stands for the 15-pin D-Sub connector of the same name at the rear side of *lab*CORE. It can submit and/or receive arbitrary digital audio signals. The settings window offers a wide range of configuration options and visualizes the input/output data words. When dragged onto the desktop, the block expands according to the number of audio channels selected in the settings window.



AES A In/Out represent the two XLR connectors of the same name at the rear side of *lab*CORE. *AES B In/Out* are integrated into the neighboring high density 15-pin D-Sub connector *Pulse/AES B*. The connection cable CDM V that is supplied with *lab*CORE offers *AES B In/Out* via two XLR connectors.

Same as the ADAT connection, the settings window offers no options, but displays the signal's sampling rate when in use.

The *HEADlink block* connects *lab*CORE to other HEAD acoustics hardware for signal transfer. When dragged into the desktop area, this block expands into 8 input and 8 output channels. As such, this block acts as a bridge and has no own settings window.

Analog In 3/4 represents the two high-precision low-noise analog inputs of a *core*-IN-A2 extension board. The board offers numerous options that can be set separately for each channel.

The input level range can be adjusted in a very wide range and separately for AC (-54dB[V] to +24dB[V]) and DC signals (-24dB[V] to +30dB[V]). The connector can be chosen to be asymmetric (BNC) or symmetric (XLR). Several further options (see window on the right) are available to tailor each input for various use-cases.

The *FIR Filter* block is used to apply automated filtering based on imported *.hdf (HEAD data file) files. For example, this block is used for equalization of the artificial mouth in a HMS artificial head. Other applications include shaping the signal, e.g. applying an A-weighting.

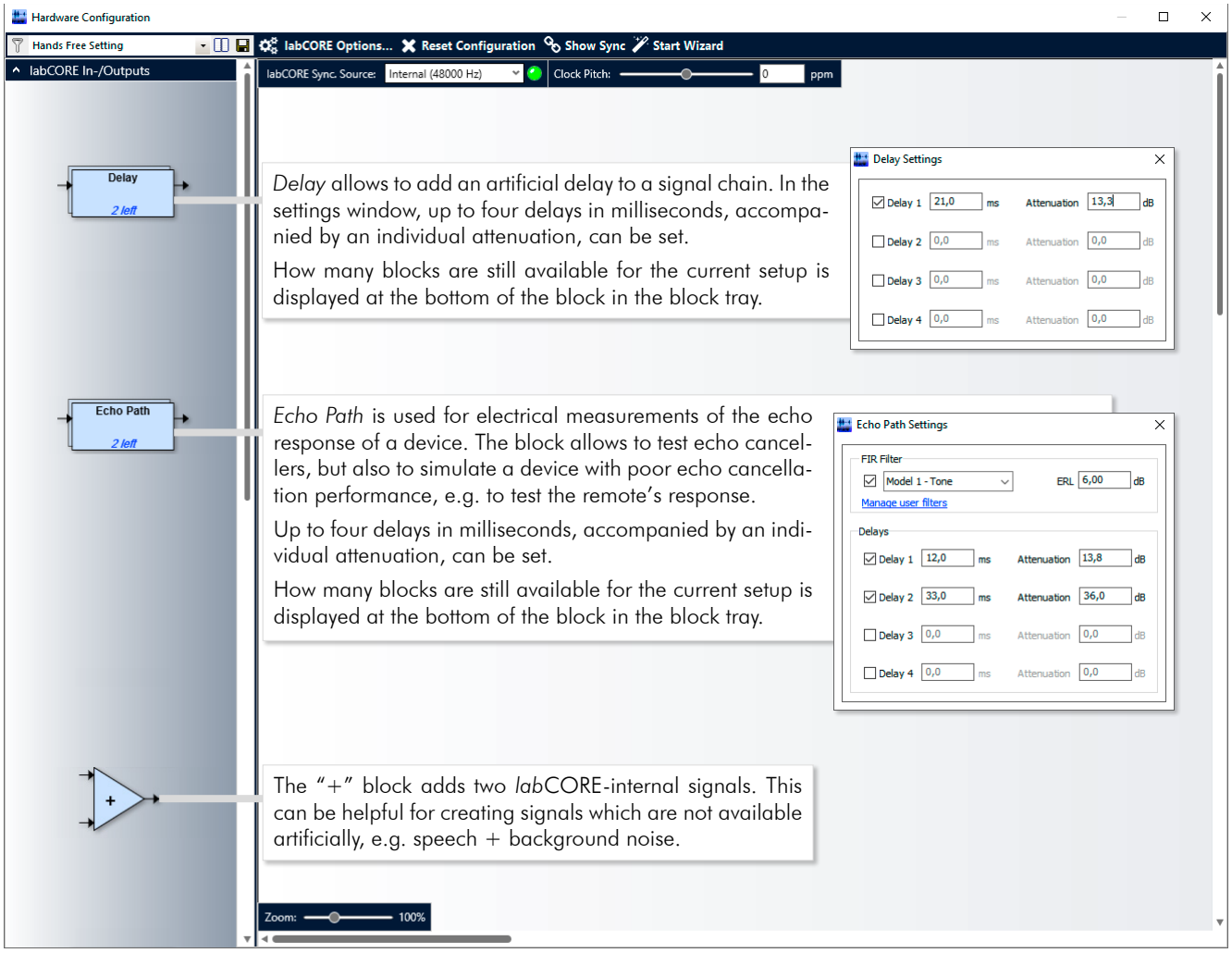
The hdf file is loaded via the settings window. An equalization filter curve is then generated according to the chosen options and applied to the signal chain at the position of this block.

How many blocks are still available for the current setup is displayed at the bottom of the block in the block tray.

The *IIR Filter* block allows to add "classic" filters such as a high-, low- and bandpasses to the signal chain. The settings window allows to select the type of filter and its frequency. Where applicable, the amplification and quality of the filter can also be set.

To apply more than one IIR filter in a setup, further blocks with individual settings can be added.

How many blocks are still available for the current setup is displayed at the bottom of the block in the block tray.

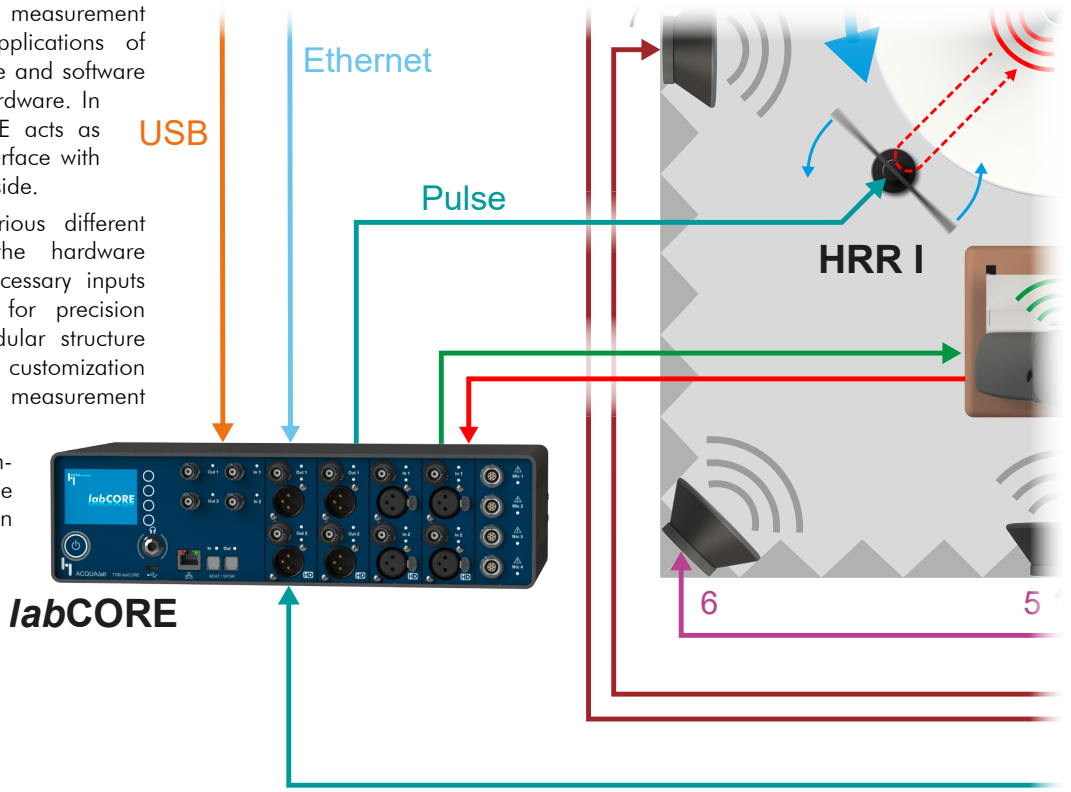


*lab*CORE application examples

The following two measurement setups show typical applications of HEAD acoustics hardware and software as well as third party hardware. In both examples, *lab*CORE acts as the central hardware interface with ACQUA on the software side.

The involvement of various different components requires the hardware platform to offer all necessary inputs and outputs adequate for precision measurements. The modular structure of *lab*CORE enables customization precisely tailored to the measurement scenario.

Additionally, the functionality of *lab*CORE can be extended at any time when new use cases arise.



Configuration example 1: Mobile phone in test room

This exemplary test scenario depicts testing of a mobile phone according to 3GPP TS 26.131/132. This test setup requires the following connections with *lab*CORE:

- A radio tester generates an RF network for the device under test. *lab*CORE connects to the radio tester either via 'Ethernet' (front) or the analog 'OUT 1/2' (front) to send and receive measurement signals.
- Data exchange with the ACQUA PC is handled though a USB-B connection via 'USB In' (rear).
- The artificial mouth and ear of HMS II.3-33/-LN are connected to *lab*CORE through the optional extension boards *core*IN-Mic4 and *core*OUT-Amp2. The boards provide high-precision microphone inputs for the artificial ear as well as amplified outputs for the loudspeakers of the artificial mouth.
- The pulses to trigger background noise playback through 3PASS *lab* are generated by *lab*CORE as well. They are sent to *lab*BGN to synchronize playback with measurements to ensure full repeatability. The connection used for this is 'Pulse/AES B' (rear).

In this application, *lab*CORE is equipped with the following extensions:

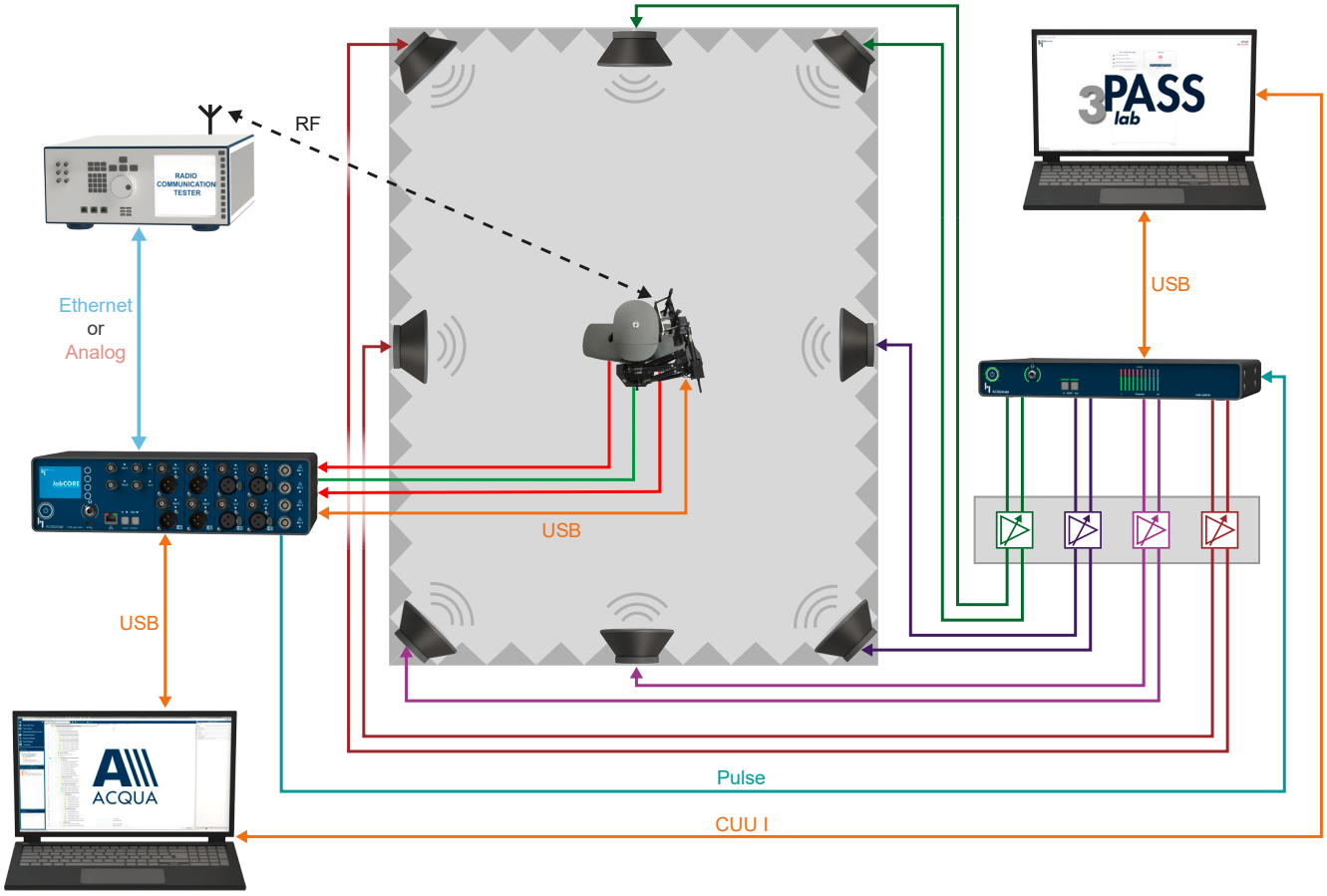
Hardware

- coreBUS (Code 7710)
- coreOUT-Amp2 (Code 7720)
- coreIN-Mic4 (Code 7730)
- coreIP-AMR (Code 7772)

Software

- coreBEQ (Code 7740)
- coreIP (Code 7770)
- coreIP-IMP (Code 7771)

For further details, please refer to the data sheet of the corresponding HEAD acoustics measurement standard TS 26 131-32 (Code 6777).



Configuration example 2: Bluetooth connection to a vehicle's head unit

This second exemplary test scenario shows a measurement setup for an in-vehicle hands-free communication system. The vehicle's head unit has Bluetooth functionality, therefore labCORE connects via *core*BT. This test setup requires the following connections with *lab*CORE:

- *lab*CORE is equipped with the optional extension *core*BT to connect to the device under test (DUT) via Bluetooth.
- Data exchange with the ACQUA PC is handled though a USB-B connection via 'USB In' (rear).
- The artificial mouth and ear of HMS II.3-33/-LN are connected to *lab*CORE through the optional extension boards *core*IN-Mic4 and *core*OUT-Amp2. The boards provide high-precision microphone inputs for the artificial ear as well as amplified outputs for the loudspeakers of the artificial mouth.
- The pulses to trigger background noise playback through 3PASS *flex* are generated by *lab*CORE as well. They are sent to *lab*BGN to synchronize playback with measurements to ensure full repeatability. The connection used for this is 'Pulse/AES B' (rear).

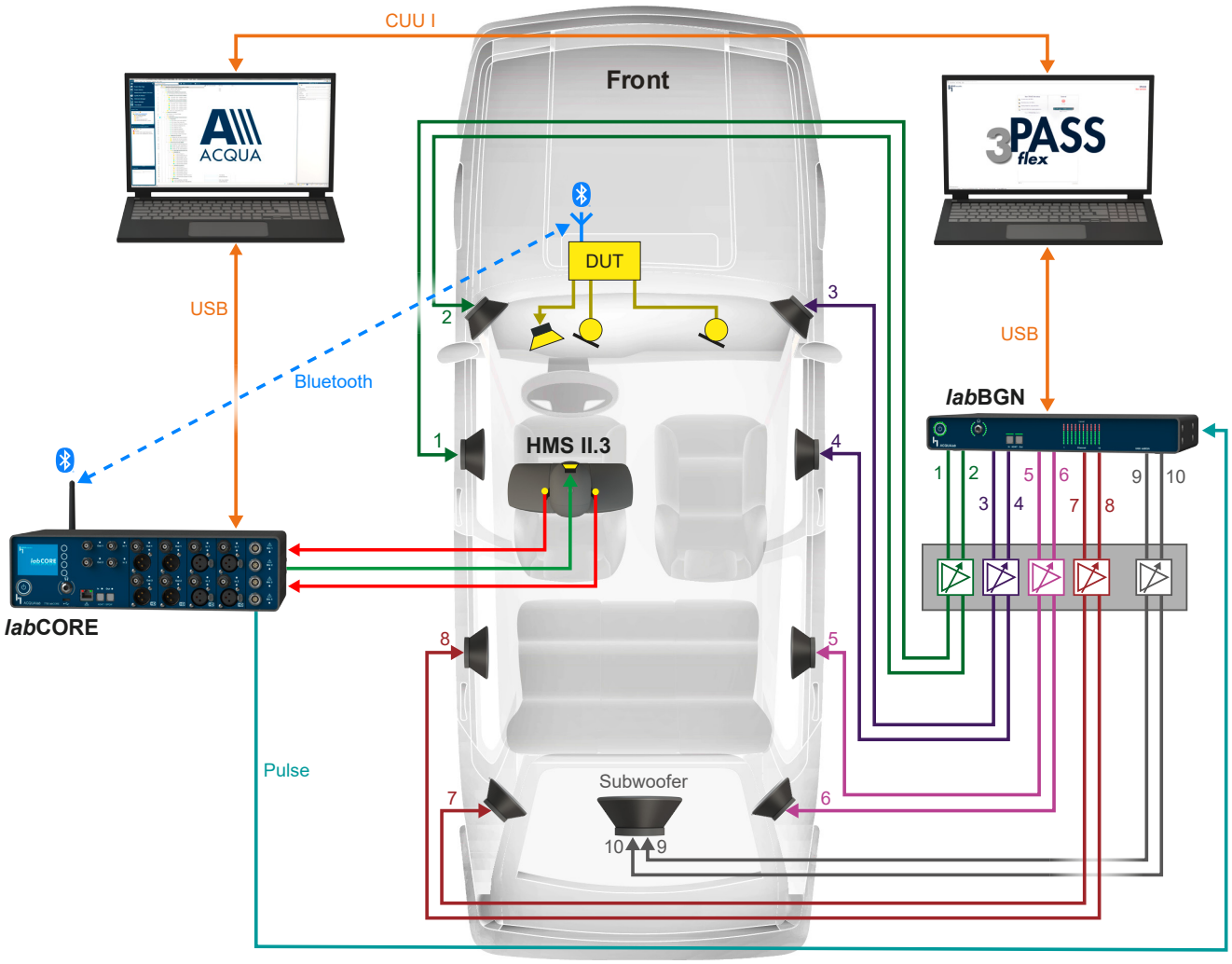
In this application, *lab*CORE is equipped with the following extensions:

Hardware

- coreBUS (Code 7710)
- coreOUT-Amp2 (Code 7720)
- coreIN-Mic4 (Code 7730)
- coreBT (Code 7780)

Software

- coreBEQ (Code 7740)



*lab*CORE technical data	
General	
Operation	Remote control via control software
System check	Automatic hardware check during boot up
Power supply	External power supply, 24 V DC ,150 W
Power consumption	max. 20 W (when used without extensions), up to 150 W depending on configuration
Clock accuracy	Calibration accuracy: ± 0.25ppm Temperature stability: ± 1ppm for temperature range 15° C – 35° C, 59° F – 95° F Aging stability: ± 1ppm within first year after calibration, typically lower
Environmental conditions	
Operating temperature range	0° C – 35° C; 32° F – 95° F
Storage temperature range	-20° C – 70° C; -4° F – 158° F
Air humidity	20 % – 80 % (non-condensing environment)
Other	
Overall dimensions (W x H x D)	327 mm x 88 mm x 175 mm
Weight	ca. 1.55 kg
Front Panel	
In 1/2 (analog)	
Connection	2 × BNC
Channels	2
Absolute max. voltage	-5 V...+5 V
Input ranges (dBV)	+ 6, 0, - 6, - 12, - 18, - 24
Input impedance	200 kΩ
Coupling	AC coupled, high-pass filter 1st order, fg=7.05 Hz
Frequency response	48 kHz sampling rate, 60 Hz – 20 kHz : ± 0.05 dB 96 kHz sampling rate, 60 Hz – 40 kHz: ± 0.1 dB
S/N	48 kHz sampling rate, 20 Hz – 20 kHz, +0 dBV range: typical -109 dB 96 kHz sampling rate, 20 Hz – 40 kHz, +0 dBV range: typical -102 dB
THD+N	48 kHz sampling rate, @ 1 kHz, +0 dBV range: typical -101 dB[10] 96 kHz sampling rate, @ 1 kHz, +0 dBV range: typical -101 dB[10]
Crosstalk	@ 1 kHz: < -120 dB
Level accuracy	± 0.1 dB (1 kHz)
A/D resolution	32 bit
A/D sampling rates (kHz)	32, 44.1, 48, 64, 88.2, 96
Out 1/2 (analog)	
Connection	2 × BNC
Channels	2
Output range (dBV)	+6, 0, -6, -12, -18, -24
Output impedance	10 Ω
Coupling	DC coupled
Frequency response	48 kHz sampling rate, 20 Hz – 20 kHz: ± 0.05 dB 96 kHz sampling rate, 20 Hz – 40 kHz: ± 0.3 dB
S/N	48 kHz sampling rate, 20 Hz – 20 kHz, +0 dBV range: typical -111 dB 96 kHz sampling rate, 20 Hz – 40 kHz, +0 dBV range: typical -105 dB
THD+N	48 kHz sampling rate, @ 1 kHz, +0 dBV range: typical -100 dB 96 kHz sampling rate, @ 1 kHz, +0 dBV range: typical -94 dB
Crosstalk	@ 1 kHz: < -120 dB
Level accuracy	± 0.1 dB (1 kHz)
D/A resolution	32 bit
D/A sampling rates (kHz)	32, 44.1, 48, 64, 88.2, 96

*lab*CORE technical data		
Headphones		
Connection		1 × 6.3 mm stereo headphone jack
Channels		2
Output range (dBV)		+6, 0, -6, -12, -18, -24
Output impedance		< 1 Ω
Coupling		DC coupled
Frequency response		48 kHz sampling rate, 20 Hz – 20 kHz: ± 0.05 dB 96 kHz sampling rate, 20 Hz – 40 kHz: ± 0.3 dB
S/N		48 kHz sampling rate, 20 Hz – 20 kHz, +0 dBV range, @ 32 Ω load: typical -103 dB 96 kHz sampling rate, 20 Hz – 20 kHz, +0 dBV range, @ 32 Ω load: typical -97 dB
THD+N		48 kHz sampling rate, @ 1 kHz, 0 dB slider position, @ 32 Ω load: typical -99 dB 96 kHz sampling rate, @ 1 kHz, 0 dB slider position, @ 32 Ω load: typical -93 dB
Crosstalk		@ 1 kHz: < -100 dB
Level accuracy		± 0.1 dB (1 kHz)
A/D resolution		32 bit
A/D sampling rates (kHz)		32, 44.1, 48, 64, 88.2, 96
USB host (front)		
Connection		1 × USB-C 2.0 high-speed
Output current as host		max. 500 mA, 5 V
Ethernet (front)		
Connection		1 × RJ45
Data rate		10/100/1000 Mbit/s
ADAT / SPDIF*		
Connection		2 × TOSLINK (1 × input, 1 × output)
Channels		8 (ADAT @ 48 kHz), 2 (S/PDIF*)
Sampling rates ADAT (kHz)		32, 44.1, 48
Sampling rates S/PDIF* (kHz)		32, 44.1, 48, 64, 88.2, 96
*) S/PDIF will be supported in a future firmware release		
Rear Panel		
Digital Audio		
Connection		1 × Two-row 15-pin D-Sub DA-15
Audio	Channels	1, 2, 4, 8 (selectable)
	Voltage level input	0…3.3 V (low 0…0.8 V, high 2…3.3 V)
	Voltage level output	0…0.4 V (low) / 2.9…3.3 V (high)
Pulse	Channels	2 pulse/trigger (both selectable as input or output)
	Sampling rates (kHz)	32, 44.1, 48, 64, 88.2, 96
	Voltage level input	0…3.3 V (low 0…0.8 V, high 2…3.3 V)
	Voltage level output	0…0.5 V / 3.3 V (Open drain output with 1 kΩ pull-up resistor to 3.3 V)
	Impedance	1 kΩ to +3.3 V (Open drain input/output)
Common signal ground for all connectors of 'Digital Audio', separated from rest of system		
AES A		
Connection		1 × XLR female (input), 1 × XLR male (output)
Channels		2
Sampling rates (kHz)		32, 44.1, 48, 64, 88.2, 96

***lab*CORE technical data**		
GPIO 1/2		
Connection		2 × BNC
Channels		2 pulse/trigger (both selectable as input or output)
Voltage level input		0…3.3 V (low 0…0.8 V, high 2…3.3 V)
Voltage level output		0…0.5 V / 3.3 V (Open drain output with 1 kΩ pull-up resistor to 3.3 V)
Impedance		1 kΩ to +3.3 V (Open drain input/output)
Pulse/AES B		
Connection		High density 15-pin D-Sub DE-15 (connection cable CDM V is supplied)
Pulse	Connection (via CDM V)	2 × BNC
	Channels	2 pulse/trigger (1 × input, 1 × output)
	Voltage level input	0…3.3 V (low 0…0.8 V, high 2…3.3 V)
	Voltage level output	0 / 3.3 V (Open drain output with 1 kΩ pull-up resistor to 3.3 V)
	Impedance	1 kΩ to +3.3 V (Open drain input/output)
AES B	Connection (via CDM V)	1 × XLR female (input), 1 × XLR male (output)
	Channels	2
	Sampling rates (kHz)	32, 44.1, 48, 64, 88.2, 96
Common signal ground for all connectors of 'Pulse/AES B', separated from rest of system		
PC* (Ethernet rear)		
Connection		1 × RJ45
Data rate		10/100/1000 Mbit/s
*) Only for internal use		
USB Host*		
Connection		2 × USB-A 2.0 high-speed
*) Only for internal use or charging/powering USB devices		
USB In		
Connection		1 × USB-B 2.0 high-speed (Cable CUSB II.5 is supplied)
HEAD*link*		
Connection		1 × LEMO 8-pin socket
Power		
Connection		1 × LEMO 4-pin socket, hermaphroditic connector

1) Exemplary configuration with optional accessories. Your configuration may vary.

2) S/PDIF will be supported in a future firmware release.

3) The RJ45 connector 'PC' and USB Type-A connectors 'Host' are only for internal use. The USB Type-A connectors 'Host' can be used for charging/powering USB devices.

4) This illustration shows an exemplary set of hardware extensions.

5) This hardware extension requires the I/O bus mainboard coreBUS (Code 7710).

6) All add-ons require their respective base extension.

7) Equalization for compatible third party artificial heads upon request.

8) Includes an internal hardware module.

9) See 'General Requirements' for other software applications.

10) Both channels used.