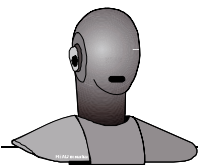


# ACQUA

## Calibration of External Devices with Analog Interfaces



**HEAD acoustics**  
**Application Note**



This Application Note is a copyrighted work by HEAD acoustics GmbH.

The information and artwork in this Application Note are the property of HEAD acoustics GmbH and shall not be reproduced or copied or used in whole or in part without written permission.

Copyright 2006 by HEAD acoustics GmbH.  
All Rights Reserved.

AACHENHEAD<sup>®</sup> is a registered trademark.

HEAD acoustics<sup>®</sup> is a registered trademark.





The diagram illustrates the CMU 200 system architecture, which is used for speech processing and evaluation. It consists of several interconnected components:

- ACQUA (Acoustic Quality Control Unit):** A yellow block on the left that interfaces with the MFE via USB.
- MFE (Multi-Frequency Encoder):** A grey block that receives input from the ACQUA and outputs to the CMU 200. It has two channels, Ch1 and Ch2, each with an OUT and IN port.
- CMU 200 (Communication Modem Unit):** A light blue block containing:
  - Encoder/Decoder:** Two red blocks for processing the speech signal.
  - 1kHz Sine Wave:** A signal source for testing.
  - Switches:** A central switch that routes the signal between the encoder and decoder.
  - HF/NF (High/Low Frequency) Filters:** Two grey blocks for filtering the signal.
- Mobile (Mobile Phone):** An orange block that receives the signal from the CMU 200 and outputs to the speaker. It contains a Decoder, Encoder, and HF/NF filters.
- Speaker:** A grey block on the right that outputs the final speech signal.

**CMU 200 Settings:**

- 1: Decoder Cal.
- 2: Encoder Cal.
- 3: Handset Low

The diagram shows the flow of the signal from the ACQUA through the MFE, CMU 200, and Mobile phone to the speaker. The signal is split into two channels, Ch1 and Ch2, which are processed by the CMU 200 and then the Mobile phone. The speaker outputs the final speech signal.

### Sending direction (D/A converter)

During the measurement of digital terminals in sending direction (an artificial mouth “talks” to the terminal device microphone) a D/A converter is required in many cases which reconverts the digital signal produced by the terminal under test into an electrical signal. In order to get a reference for the electrical signals to the digital network level, a calibration has to be carried out on channel 1 of the measurement system. For this purpose a new electrical calibration value is defined in ACQUA (Fig. 2) and a calibration signal with approx. 1 kHz (sine wave) is generated digitally on the network side. Some devices have a built-in generator (e.g. CMU 200 “Decoder Cal”, see Fig. 1), others require an external digital signal source (e.g. AETHRA).

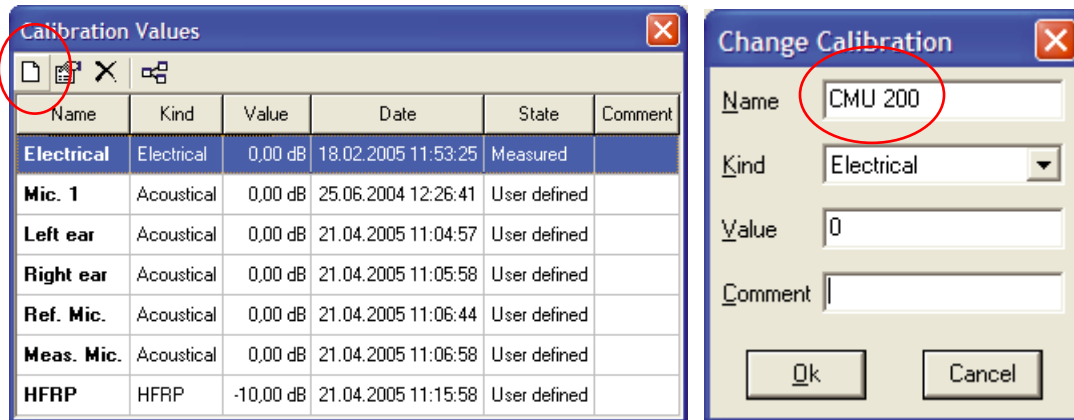
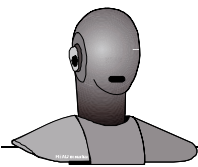


Fig. 2

Via the ACQUA menu command “Settings/Calibration Values” please create a new calibration by clicking on the corresponding icon.

Enter a name (e.g. “CMU 200”), select “Kind: Electrical” and click on “OK” (you do not have to enter a value, because this will be determined during the calibration measurement).

### Determining the reference value:

The level of the calibration signal is given in dBm0 in most cases. As ACQUA displays the results in dB[1Vrms], the level must be converted from dBm0 to dB[1Vrms]. If the level is given in digital FullScale, it has to be converted to dBm0 first.

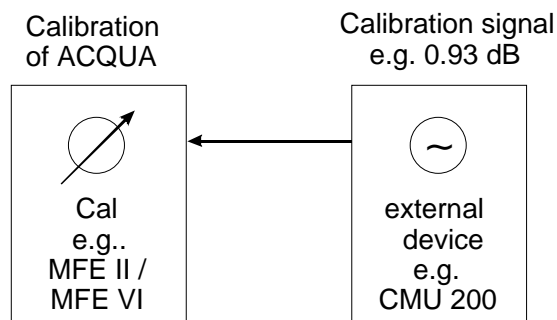


Fig. 3: Block diagram illustrating the principle of the calibration measurement

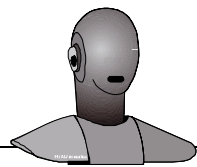
Formula:

$$0 \text{ dB[FullScale]} = + 3.14 \text{ dBm0}$$

(all narrow-band digital networks using A-Law encoding, e.g. GSM network)

$$0 \text{ dBm0} = - 2.21 \text{ dB[1Vrms]}$$

$$0 \text{ dB[FullScale]} = + 3.14 \text{ dBm0} - 2.21 \text{ dB[1Vrms]} = + 0.93 \text{ dB[1Vrms]}$$



**Input Calibration (Electrical)**

Calibration Kind	Input Calibration
Name	Calibration Kind
Reference Value	<b>Acoustical:</b> Calibrate your microphone using pistonphone or calibrator
Input	<b>Electrical:</b> Click this to calibrate an input using a signal generator
Meas. Parameters	
Start	

☐ Acoustical  
☒ Electrical

< Back   Next >   Close

**Fig. 4**

Please start the calibration procedure via the ACQUA menu command "Preparation/Input Calibration" and select "Electrical" as calibration kind. Click on "Next" to continue.

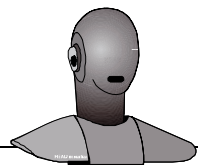
**Input Calibration (CMU 200)**

Calibration Kind	Input Calibration
Name	Name
Reference Value	Select the name of an existing calibration or enter a new one
Input	Double-Click a name to edit a calibration
Meas. Parameters	New
Start	Electrical CMU 200

< Back   Next >   Close

**Fig. 5**

Select the calibration name you created previously and click on "Next" to continue.



The screenshot shows the 'Input Calibration (CMU 200)' dialog box with the 'Reference Value' tab selected. The left sidebar contains buttons for 'Calibration Kind', 'Name', 'Reference Value' (which is highlighted), 'Input', 'Meas. Parameters', and 'Start'. The main area has the title 'Input Calibration' and subtitle 'Reference Value'. Below this is the instruction 'Enter the output level of your signal generator'. At the bottom, there is a text input field containing '0,93', a unit dropdown menu currently showing 'dB[V]' with a dropdown list open showing 'dB[V]', 'dBm0', and 'V', and buttons for '< Back', 'Close', and an unlabeled button.

**Fig. 6**

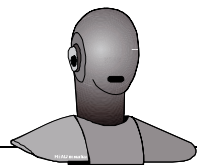
Since ACQUA version 2.2.100 the conversion between db [V], dBm0 and V is calculated automatically. Enter the output level of your signal generator in the corresponding field (please look it up in the manual of the manufacturer).

The screenshot shows the 'Input Calibration (CMU 200)' dialog box with the 'Input' tab selected. The left sidebar is the same as in Fig. 6, with 'Input' now highlighted. The main area has the title 'Input Calibration' and subtitle 'Input'. Below this is the instruction 'Select the input where your sensor is connected'. A warning message reads: 'Frontend manual Your current hardware settings will not be changed'. There are two sections: '-Channel' with radio buttons for 'Channel 1 (Default)' (selected) and 'Channel 2', and '-Input' with a dropdown menu showing 'Default'. At the bottom are buttons for '< Back', 'Next >', and 'Close'.

**Fig. 7**

Select the settings as shown above and click on "Next" to continue.





**Input Calibration (CMU 200)**

Calibration Kind	Input Calibration
Name	Measurement Parameters
Reference Value	<b>Duration</b> Length of the measurement
Input	<b>Generate Signal</b> Generate output signal with selected frequency and level during calibration
<b>Meas. Parameters</b>	
Start	Duration <input type="text" value="1000"/> ms
	—Sampling Rate
	<input type="radio"/> 44.1 kHz <input checked="" type="radio"/> 48 kHz
	—Generate Signal
	<input type="checkbox"/> Channel 1 <input type="text" value="1020"/> Hz
	<input type="checkbox"/> Channel 2 <input type="text" value="0,0"/> dB

< Back   Next >   Close

**Fig. 8**

Select the settings as shown above and click on “Next” to continue.

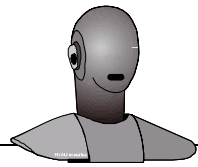
**Input Calibration (CMU 200)**

Calibration Kind	Input Calibration
Name	Start
Reference Value	Prev. calibration: <b>0,00 dB</b> 24.04.2006 11:48:00 New calibration: Not done
Input	Name CMU 200
Meas. Parameters	Kind Electrical
<b>Start</b>	Ref. value 0,93 dB[V]
	Channel Channel 1
	Input Default
	Comment

< Back   Start   Close

**Fig. 9**

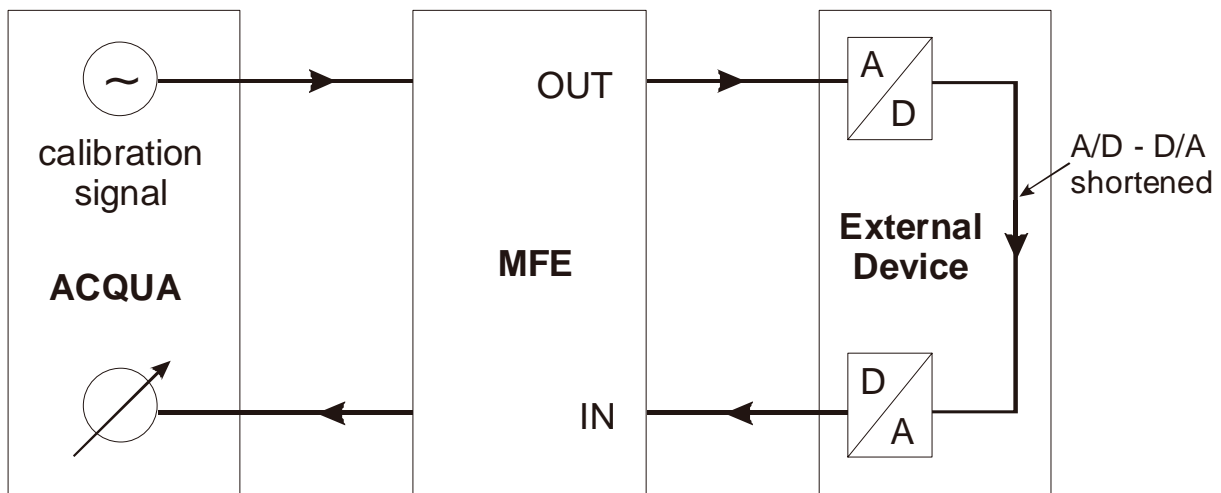
Click on “Start” to start the calibration measurement. The measured calibration value will be displayed at the top of the window next to the label “New calibration”.



### Receiving direction (A/D converter)

In receiving direction the measurement signal is electrically fed into the A/D converter of the external device by ACQUA. The measurement system again operates with voltage values with the reference 1 V<sub>rms</sub>. The measurement signals should have an input level defined in dBm<sub>0</sub> at the digital input of the terminal in the network.

For this purpose the digital send and receive line at the A/D converter are shortened (e.g. CMU 200 Encoder Cal.; cf. Fig. 1, switch position 2) and a level measurement with suitable output level is conducted (e.g. -10 dB[1V<sub>rms</sub>] = -10.93 dB[FullScale (GSM)] = 7.79 dBm<sub>0</sub>). It is important that during this measurement the calibration value is used which was previously determined in sending direction.

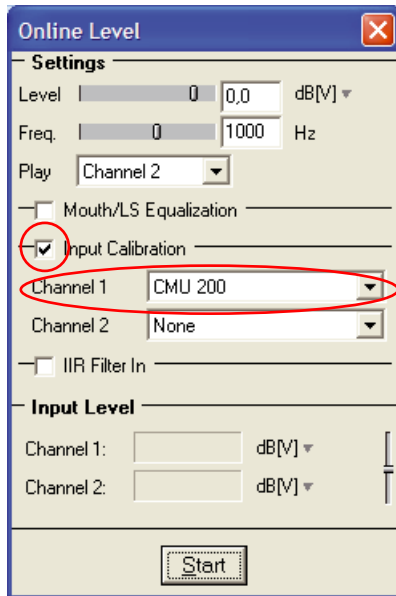
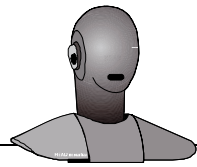


**Fig. 10**

The measurement signal is provided at output II of the front end and measured at input I. The difference between the level of the measured signal and the sent signal corresponds to the required output correction.

If the device is able to connect the A/D converter directly to the D/A interface (e.g. CMU 200) or in case of a non-compressing codec on the digital loop (e.g. G.711), the feature “Online Level” (Fig. 11) evoked via the ACQUAlyzer “Audio” menu can be used in order to determine the level difference. In all other cases a measurement descriptor has to be created for this purpose (cf. ACQUA online help).

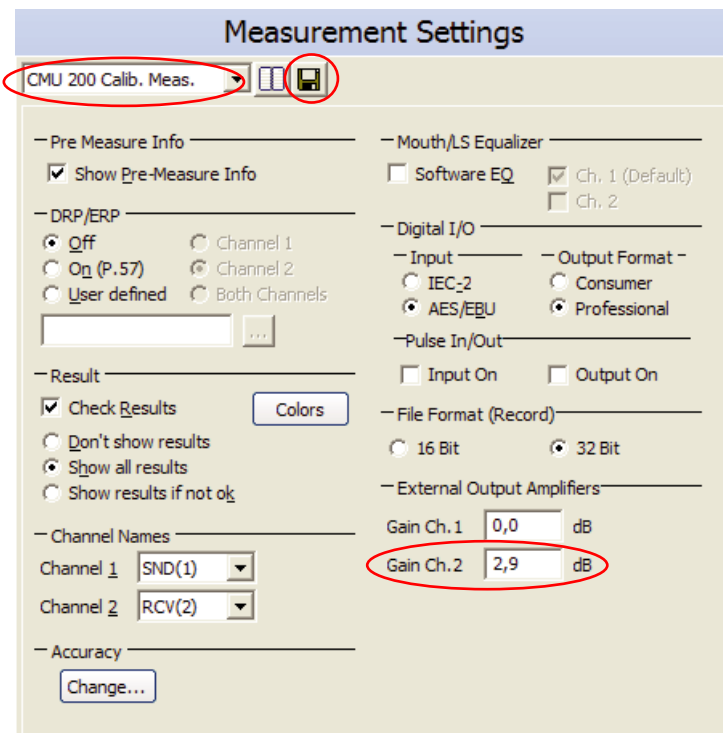




**Fig. 11: Example Online Level for CMU 200**

Activate the checkbox “Input Calibration” and select the previously created calibration for Channel 1. Click on “Start” to determine the level.

The determined level subsequently has to be entered in “Measurement Settings: External Output Amplifiers: Gain Ch.2” (Fig. 12). A positive entry lowers the output level. The setting should be saved under a recognizable name.



**Fig. 12: Example Measurement Settings for CMU 200**