HEAD acoustics

APPLICATION NOTE

About this document

Content

The following text gives an insight into the Dual ADC technology and its advantages in data acquisition. The first chapter contains brief explanations of the terms used. The second chapter uses the artificial head measurement system HMS V as an example to show the practical benefits of the Dual ADC technology.

Target group

This application note primarily addresses (potential) users of the artificial head measurement system HMS V. In addition, the information provided is also of interest for the use of the HEAD*lab* modules *lab*HSU and *lab*V6HD, since these devices also use the Dual ADC technology in the HD measurement range.

Questions?

Do you have any questions? We look forward to receiving your feedback!
For questions on the content of this document: Imke.Hauswirth@head-acoustics.com
For general technical questions: SVP-Support@head-acoustics.com

Dual-ADC (Analog Digital Converter) – practical benefits

1. Dynamic range, ADC, and Dual ADC

Dynamic range

Dynamic range represents the range in which a signal can vary. At the low end, the dynamic range is limited by the noise floor. Signals with a lower amplitude level are masked by the system's noise floor. At the top the dynamic range is limited by the maximum level. An overload situation occurs if the amplitude level of a signal exceeds this limit. There is no standardized calculation method for determining the dynamic range of a measurement system, for example. The determined dynamic range depends on the analysis bandwidth used. Thus, when specifying the dynamic range, the analysis bandwidth should always be specified, too. The term dynamic range is sometimes erroneously used as a synonym for signal-to-noise ratio.

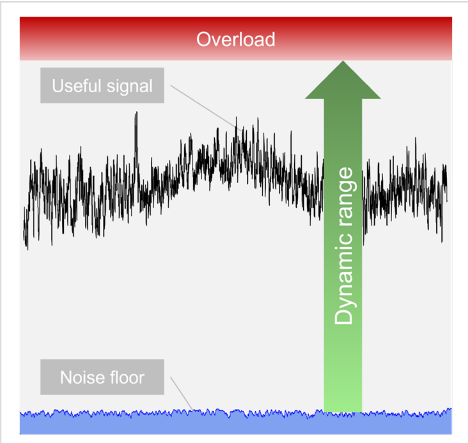

Figure 1: Dynamic range (schematic)

Signal-to-noise ratio

The signal-to-noise ratio is a measure for the technical quality of a useful signal superimposed on an unwanted noise signal. It is defined as the ratio of the average power of the useful signal to the average noise power. In order to reliably extract information from a signal, the useful signal must be clearly distinguishable from the interfering noise signal, thus the signal-to-noise ratio must be sufficiently large.

ADC

The abbreviation ADC stands for Analog Digital Converter. An ADC is used to convert an analog input signal into a digital data stream for further processing. Such conversion, or digitization, is necessary to digitally store the signal and to analyze and modify it using signal processing methods. ADCs are used, for example, in measurement systems in order convert the analog input signals of the sensors into a digital data stream for further processing.

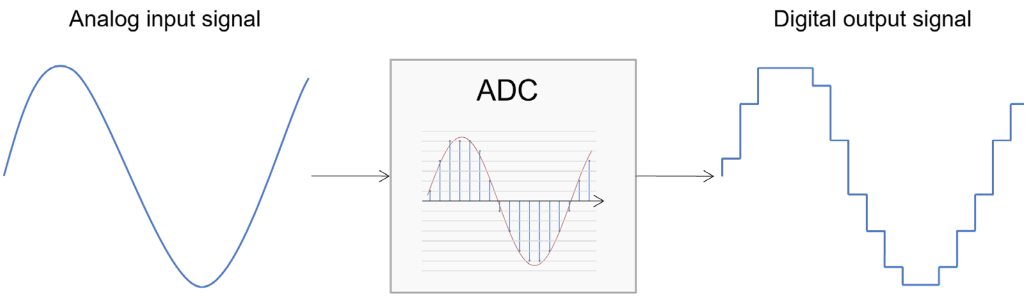

Figure 2: Analog Digital Conversion

Normally, one ADC with different measurement ranges for noises of different levels is used per input channel of a measurement system. This ensures a good level control of the recording.

Dual ADC

When applying the Dual ADC technology, two ADCs are combined for each input channel. One of these two ADCs is set to low gain, the other to high gain. The signal is routed to both ADCs and digitized. A subsequent circuit compares the resulting signals in real time and selects the signal with the better signal-to-noise ratio. The corresponding signals are then combined into a continuous data stream. In this way, the dynamic range of the measurement can be significantly increased in comparison to systems using only one ADC.

Application advantages

The benefit for users is a significant reduction in workload: signals with very high and very low levels can be recorded with only one measurement range.

This can save users setup time since selecting a suitable measurement range and possibly having to switch the measurement range prior to each measurement becomes obsolete. In addition, the risk of overloading a recording is reduced, making unusable measurements virtually non-existent.

Figure 3: HMS V

HEAD acoustics uses the Dual ADC technology with the artificial head measurement system HMS V as well as with the HEAD*lab* modules *lab*HSU and *lab*V6HD when selecting HD measurement range.

2. Dual ADC with HMS V

Measurement ranges with HMS V

Various measurement ranges are available for recordings to be carried out with the digital artificial head measurement system HMS V. By selecting a suitable measurement range, the user ensures that the useful signal is clearly above the noise floor and that the evaluation of the recording provides meaningful results. With the HMS V, the user can choose between the settings 84 dB, 94 dB, …, 144 dB, depending on whether high or low-level sounds are to be recorded. In addition, the HD measurement range with Dual ADC technology can be used.

Comparison of the measurement range

Figure 4 shows the dynamic ranges for the *84 dB*, *HD* and *144 dB* settings with ID equalization The diagrams each contain the following graphs:

- Red curve: Shows the maximum level of a sinusoidal tone with its corresponding frequency that can be recorded using ID equalization.
- Green curve: Shows the hearing threshold for the diffuse sound field according to ISO 389-7, thus the sound pressure level of noise with third-octave bandwidth that can just be perceived by a person with normal hearing in a diffuse sound field with binaural playback.
- Blue curve: Shows a typical spectrum of a measurement at rest recorded with HMS V using ID equalization. It thus represents the system's noise floor. A third-octave level analysis was used to calculate the spectrum (row: B, spectral weighting: none, filter order: 6th order). Using another analysis or analysis parameters would result in a correspondingly higher or lower graph.

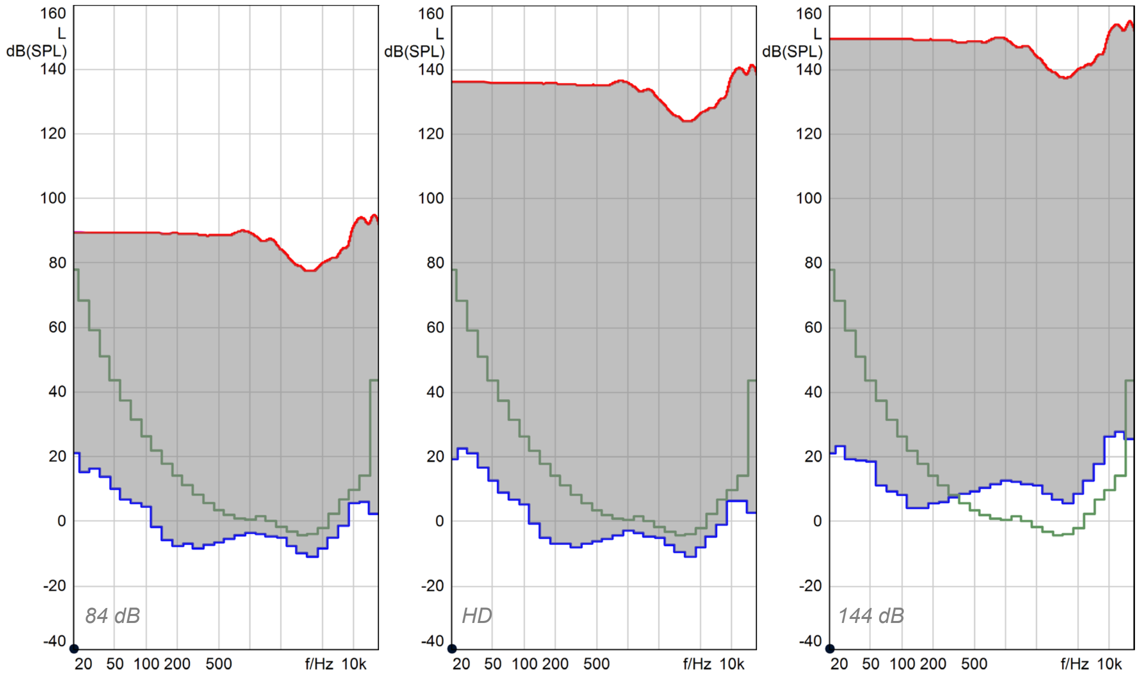

Figure 4: Dynamic ranges of the HMS V (typ.) for three different measurement ranges: 84 dB (left), HD (middle), 144dB (right), each with ID recording equalization

The distance between the blue and the red curves illustrates the range available for the measured signal. For lower measurement ranges, the course of the blue curve (i.e. the noise floor) is significantly influenced by the microphone properties. As these properties do not change for the different measurement ranges, the difference of the blue curves in the left and the middle diagram is very small. The signal-to-noise ratio obtained for these measurement ranges is even good for very quiet sounds close to the human hearing threshold (represented by the green curve). For higher measurement ranges, the influence of the electronics is decisive. The noise floor of the electronics increases for the higher measurement ranges, which is why the blue curve in the right-hand diagram is slightly higher and exceeds the hearing threshold at mid-range and high frequencies. The red curve, which indicates the maximum permissible level, continues to rise from the left to the right diagram according to the selected measurement range.

Overall, the HD measurement range has a larger dynamic range than the other measurement ranges. The noise floor is on par with the most sensitive measurement range and the maximum permissible level is very high. Only using the highest measurement range allows even higher levels to be recorded. The HD measurement range can thus be used for the widest variety of levels. If necessary, the dynamic range can be adjusted by manually selecting the 144dB measurement range for recording very loud signals.