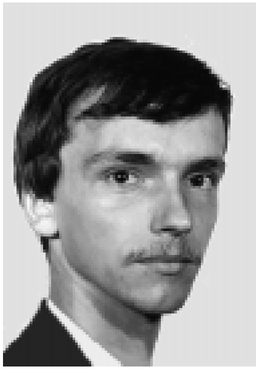
Sound quality can be measured

Karl Otto Bäder

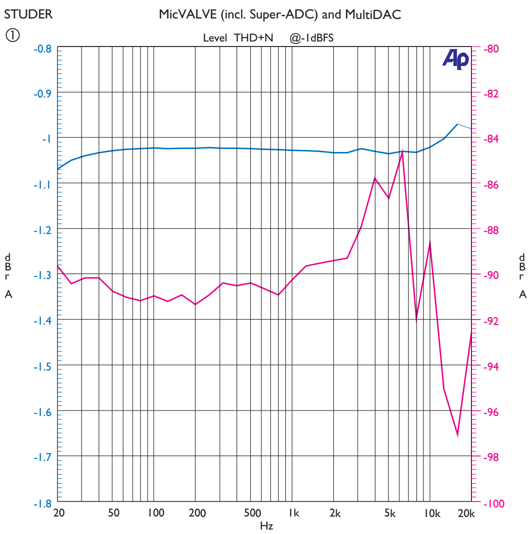


Silvio Gehri

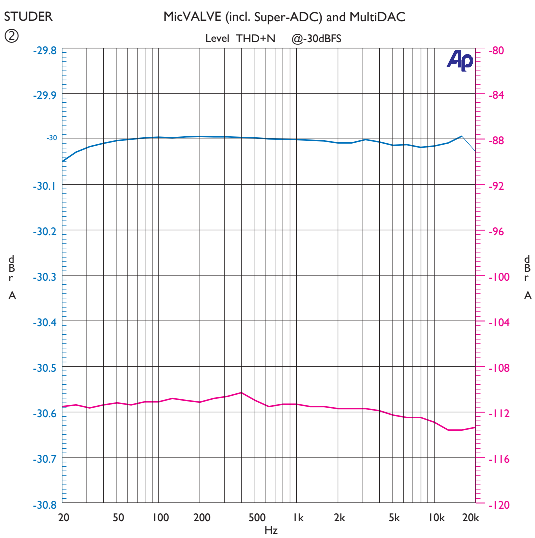
Behind the “excellent sound” of the STUDER equipment there are, of course, technical reasons. The corresponding parameters are measurable and can be weighted. The following report gives some examples of the quality control procedures to which our equipment is subjected.

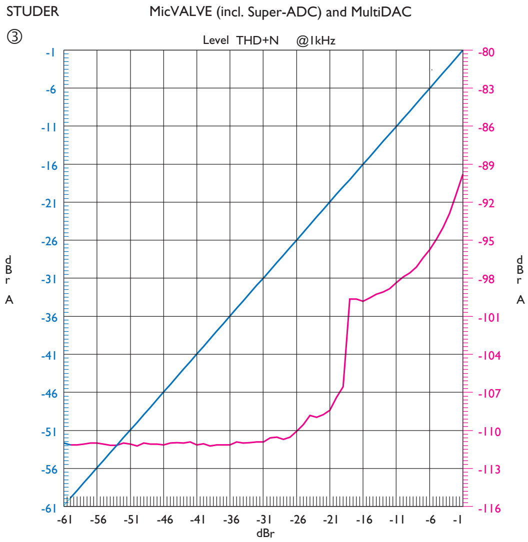
Converter

Although the introduction of the sigma-delta converters resulted in a significant improvement over previous designs, the conversion of analog signals to the digital level and vice versa is still a potential weak spot in the observed system.

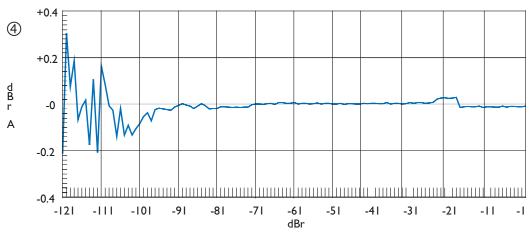


The measurements show the results of a chain of STUDER equipment of the D19 family connected in series, that is, the MicVALVE with 22-bit A/D conversion and the MultiDAC with 23-bit D/A conversion. This chain covers not only the complete conversion and reconversion in the measurement path, but also all other components of the equipment (including input and output transformers) and therefore corresponds to the situation encountered in practice.



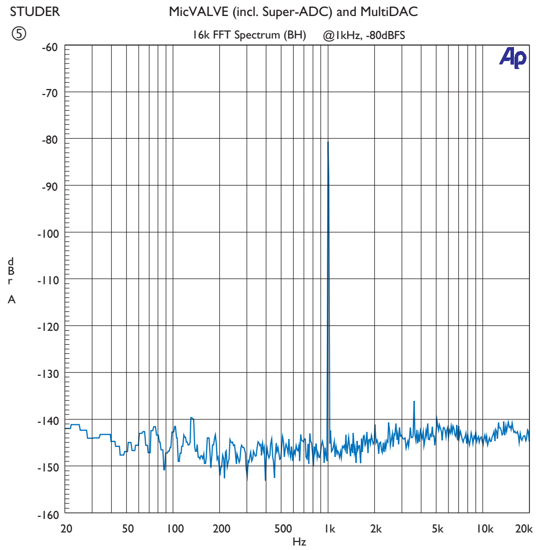


Measurement 1 shows the frequency response (left-hand ordinate) as well as the THD+N (right-hand ordinate) at a level 1 dB below full scale. In the THD+N measurement the stimulus is filtered out. Striking is that despite the transformers the harmonic distortion does not increase at lower frequencies. Even at approx. 6 kHz the harmonic distortion is still less than 0.01 %. As shown in measurement 2 this distortion is caused by an analog circuit (same measurement with a stimulus of -30 dB). Here the distortion components are no longer recognizable, the THD+N value consists purely of noise.

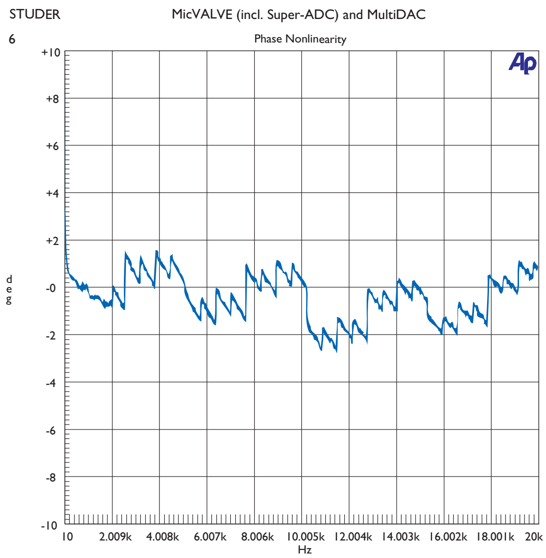


Whereas the two first measurements were conducted with a sliding frequency but fixed level, measurement 3 shows a recording with a fixed frequency (1 kHz) but rising level. The left-hand ordinate again relates to the level, the right-hand ordinate to the THD+N value. At lower levels there is a constant background noise of approx. 111 - 112 dB below full scale which increases only at higher levels.

Of major interest is measurement 4 that investigates the non-linearity errors of the converters. The measurement was conducted with a bandpass. Throughout the investigated spectrum the maximum deviation remained below 0.2 dB where the values below approx. 105 dB are caused by inaccuracies of the measurement system.

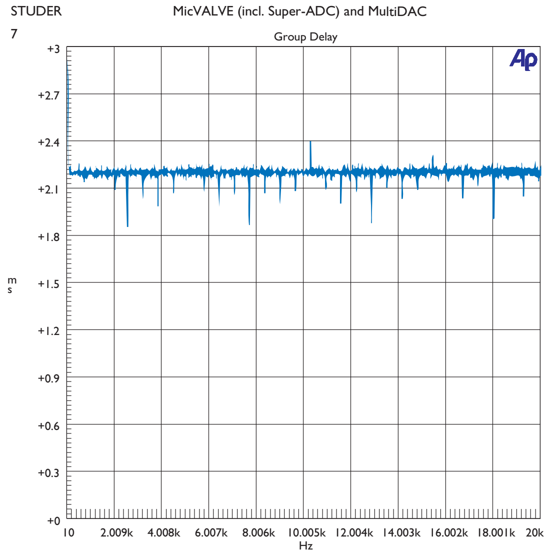


Measurement 5 illustrates an FFT analysis of the noise and distortion spectrum with a measurement tone of 1 kHz at -80 dB. At 16 k FFT points and using a Blackmann/Harris window a constant bin of 2.7 Hz over the measurement range is observed. As this value remains constant the noise does no longer increase with the root of f as it would be typical for white noise.

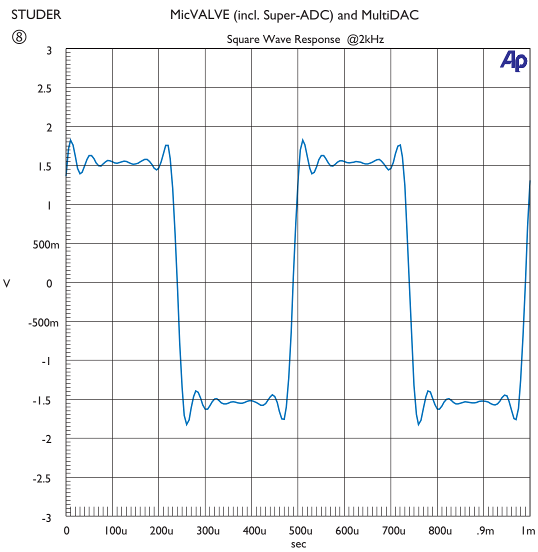


The measurement shows that hardly any harmonic components occur; only at 2 kHz can a very small value be detected. Also discrete low frequency components in the noise cannot be detected.

Measurement 6 is a very tricky measurement because for measuring the non-linearity of the phase the basic delay of the measurement path must be compensated. In the measurement system (SYSTEM ONE from Audio Precision) very high phase values occur before the compensation. Due to these high values the system must change over to floating point mode. The continuous mode switching results in the uniform staircase of the measurement. Accurate qualitative statements on the characteristics of the test object cannot be made; certain is only that they are significantly better than those of the measuring equipment.



The group delay error was computed from measurement 6 and depicted in fig. 7. It also shows the superposition of the effects from the test object and the measuring equipment. It is apparent, however, that the threshold of 0.4 ms referred to in the literature (Blauert/Schlichthärle) is never exceeded. In the tested STUDER equipment no group delay effects are noticeable; only at extremely low frequencies (below 50 Hz) can a rise be observed.



In view of these excellent results in the phase error measurement it comes as no surprise that also the square-wave behavior is very good. Measurement 8 shows a highly symmetric pattern of the overshoots with a 2 kHz signal.