20 BIT EQUIPMENT FOR 16 BIT WORK?

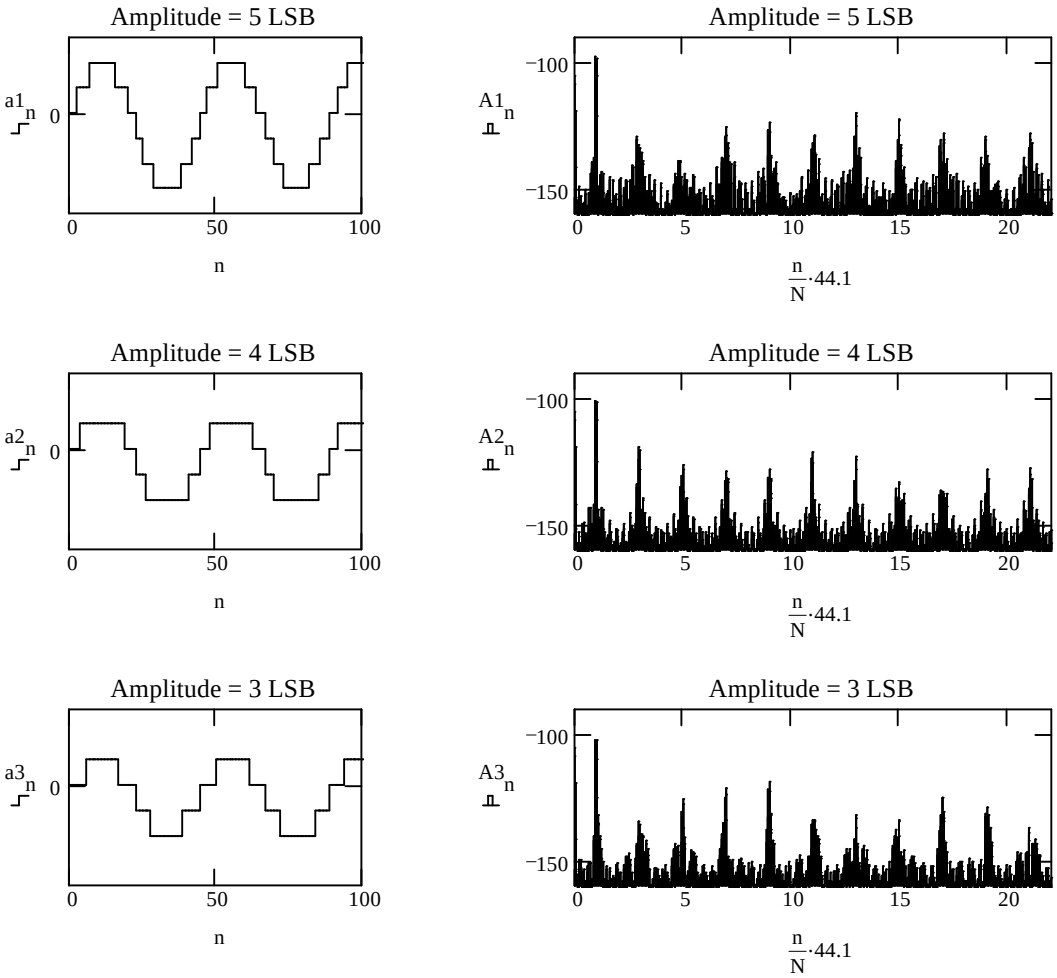
by Dan Lavry, Lavry Engineering

The reasons for using 20 bit equipment for producing a 16 bit outcome requires some understanding of the problems associated with the 16 bit standard. This article review these problems and their solutions. The experianced reader will realize that most A/D conversion equipment falls way short of yielding the performance required for dither and/or noise shaping. The practical requirements for small signal linearity and noise floor are around 120dB A/D noise floor and 20 bits of small signal linearity. Similarly, 16 bits D/A converters need to have 20 bit small signal linearity for proper reconstruction of dithered and/or noise shaping signals.

Undithered signal with amplitudes above one LSB (least significant digit):

Digital quantization without dither causes harmonic distortions and noise. The nature of the distortion content and the distribution of noise over the frequency range are highly dependent on the signal content, (amplitude and frequency) and on DC offset (small changes in circuit component values and tiny variations in air pressure on the microphone membrane).

In the following plots we show a 1KHz pure tone at 3 amplitudes (peak to peak values). a1, a2 and a3 show sample value vs. time for 16 bit quantization. A1, A2 and A3 show the corresponding frequency plots. Note that the harmonic distortion structure changes with signal amplitude. Zero DC offset causes odd harmonics.



In the following plots we repeat the previously shown signals but with a slight DC offset. The DC added is only 1/4 LSB (such small DC change can occur in real life situations within a few seconds). Signals b1, b2 and b3 show sample values vs. time and B1, B2 and B3 show the corresponding frequency plots. Note that the distortion structure include even harmonics due to the added DC offset.