The Truth About 12 Bit Analogue to Digital Convertors

The Voltech PM3000A is *still* the only device on the market to be awarded certification of measurement accuracy complaint with IEC1000-3-2/3.

That hasn't stopped a competitor from suggesting that the Voltech PM3000A does not have the resolution to meet the needs of the standard to which it tests. In fact, the competitor claims that the necessary resolution is impossible with a 12 bit A/D as used by the PM3000A.

The competitors argument is based wholly on the assumption that the rms resolution of an a.c. waveform can be derived from the THD + Noise specification of the A/D converter used, measured in dB from the following equation:

$20 \log 2^{n}$ dB - where n is the number of bits for the A/D

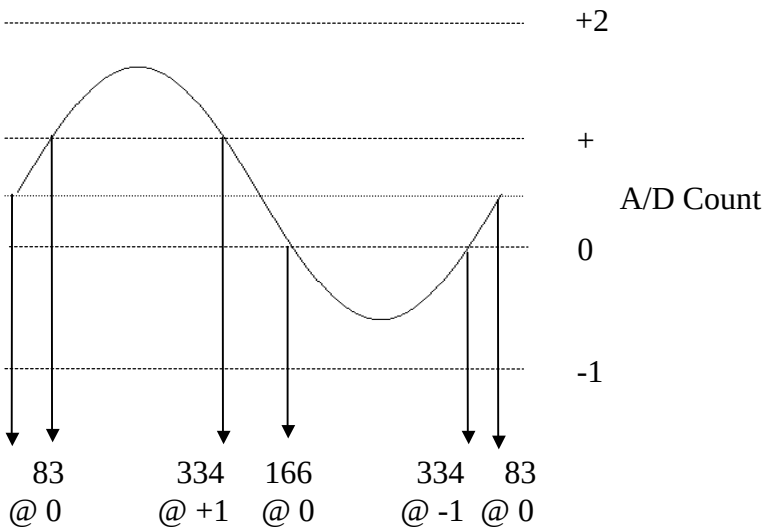
This is actually a rather complicated way of saying that the resolution of a single sample from an A/D is 2 raised to the power of the number of bits.

Using this assumption, it is stated that a 12 bit system can "barely resolve 0.1% (of an rms value) let alone measure it with any accuracy". Is this true?

For the purpose of illustration, let us first consider a 2 bit A/D. On the basis of our competitors theory, this would limit us to a minimum of 25% resolution.

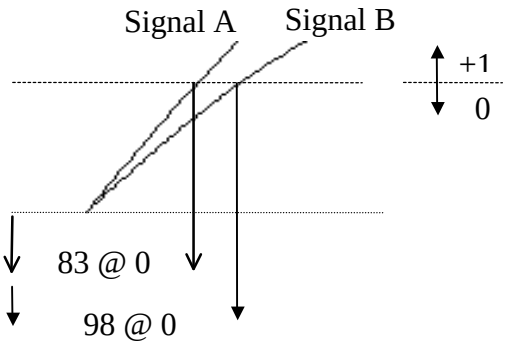
The ability of an A/D converter to resolve a change in an a.c. signal is not simply the quantisation level. By definition, an a.c. signal includes a time domain which permits ratiometric analysis of many samples over a period of time. Illustrated below is a single cycle sine wave that has been digitised by a 2 bit A/D converter. From this, the number of points within each digital level can be derived.

2 bit A/D with 1000 samples over one cycle



Number of samples @ count

It should be clear from this diagram that changes within the apparent resolution of the quantisation level can easily be detected by the corresponding change in samples per count. The following diagram illustrates this.



Number of samples @ count.

Using this technique, the example 2 bit A/D is able to resolve changes in rms voltage of 0.1%. This is 250 times greater resolution than our competitor claims is possible.

Our competitor claims that a 12 bit converter cannot resolve changes smaller than 0.025%.

The following tables show resolution available from a 12 bit converter.

RMS Input	12 Bit Normalised Output
0.70710678	0.70710678
0.70717749	0.70717679
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0.01%	**0.0099%**
0.70710678	0.70710678
0.70711385	0.70711527
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0.001%	**0.0012%**

There is only one conclusion: the Voltech PM3000A offers a resolution far in excess of that claimed to be impossible. The competition has clearly got the resolution issue badly wrong - and, incidentally, has also failed to understand some of the fundamental principles dictated by the standard!”

