Question: "Is there any difference between ADC and DAC linearity?"

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A test program is developed for linearity tests of both ADC and DAC devices. Is there any difference in ADC and DAC linearity testing? Can I use the same calculation algorithm for both of ADC and DAC linearity tests?

Answer from Don Blair:

The definitions of the End-point linearity error of ADCs and DACs by industry standard JEDEC are as follows:

> ADC: The difference between the actual analog value at the transition between any two adjacent steps and its ideal value after offset error and gain error have been adjusted to zero
>
> DAC: The difference between the actual step value and the nominal step value after offset error and gain error have been adjusted to zero

In the case of a DAC, the "step value" is the analog output from the DAC. When the DAC is tested, the measured values of the analog output voltage of each digital input are used for the calculation of non-linearity.

In the case of an ADC, the "analog value at the transition" can not be measured directly. You can measure the analog value at the threshold of two adjacent output codes. The "analog value at the transition" is the middle of the each code. In the IEEE Standard, this "analog value at the transition" is called as "code transition level (T[k])". The definition of the "code transition level" is defined by IEEE as follows:

> code transition level (T[k]): The value of the converter-input parameter at the transition point between two given adjacent code bins. The transition point is defined as the input value that causes 50% of the output codes to be greater than or equal to the upper code of the transition, and 50% to be less than the upper code of the transition. The transition level T [k] lies between code bin k_1 and code bin k.

Actually, the "analog value at the transition" or "code transition level (T[k])" is calculated as the middle value of the measured thresholds of adjacent output codes. For example, if we assume that the analog value at threshold of code 0xA0 and 0xA1 is 1.1V and the analog value at threshold of code 0xA1 and 0xA2 is 1.102V, the "analog value at the transition" of 0xA1 is (1.1 + 1.102)/2 = 1.101V.

The "analog value at the transition" of code 0x00 is assumed as the analog value 0.5 x "average LSB size" smaller than the analog value at threshold at code 0x00 and 0x01.

After calculating all of the "analog values at the transition", you can use the same calculation program code for DAC.

Reference: "IEEE Standard for Terminology and Test Methods for Analog-to-Digital Converters"; IEEE Std 1241-2000
"JEDEC STANDARD Terms, Definitions, and Letter Symbols for Microelectronic Devices"; JESD99B
"DSP Based Testing" by Hideo Okawara, 2001.