Minutes of February 15, 2004 TC-10 Meeting in Tucson, Arizona (Rev 03-Apr-2005)

Draft Standard for Terminology and Test Methods for Digital to Analog Converters

Attendance:

Steve Tilden	Texas Instruments
Bill Boyer	Sandia National Laboratories
Bob Graham	Sandia National Laboratories
Sol Max	LTX Corporation
Pasquale Daponte	University of Sannio

A new style manual is available. Everyone present took a copy from Pasquale

The group agreed that any changes to the draft standard should occur only after a reviewer has approved the changes. Unreviewed changes should not be edited into the draft by Pasquale Daponte until the approval is received.

Pasquale Daponte has the right to reject any changes.

There appears to be some ambiguity on the terms "code width" and "code height". The terms should not be used for the DAC standard.

The decision tree for accepting a change to the standard is listed below.

1. Change is proposed, or a new input is provided
2. A reviewer checks it
3. Committee Review & Approval
4. Pasquale enters changes into draft.

PHD student attempts to generate GUM (Uncertainty Analysis). Steve Tilden described TI's procedure for incorporating guard-banding in a scientific way.

Pasquale pointed out that jitter should be with square wave, and he recommended the following changes to some of the definitions:

jitter: The deviation at a specified reference level instant for a specified square-wave output.

bandwidth: The frequency at which the rms of a sinusoidal output signal is attenuated by 3 dB from the level at a specified low frequency.

The following suggestions by Sol Max were accepted

complex image rejection will be deleted

complex modulation will be deleted

Change the following definitions to the wording specified

dynamic offset and gain: The DC value of the analog output and its gain may be specified for certain types of converters while the converter is generating AC waveforms.

full-scale range (FSR): The difference between the most positive and most negative analog outputs of a converter's operating range. Generally FSR includes the virtual codes at the minimum and the maximum outputs. Thus, a -10V to +10V DAC will have FSR equal to 20V.

glitch: A short, undesirable transient in the analog output.

glitch area (GA): The time integral of the analog value of the glitch transient.

glitch energy (GE): The time integral of the electrical power of the glitch transient.

harmonic distortion, second (HD2): will be deleted

harmonic distortion, third (HD3): will be deleted

multiplying DAC: A DAC that allows a signal to be applied to the reference input pin to scale the DAC output.

output propagation delay (t_{PD}): The delay between the 50% point of the clock edge and the time when the DAC output traverses 50% of the output transition. The propagation delay includes the effect of digital pipelines, and analog filtering.

Pass band: Frequency band in which a small sine-wave waveform generated by a DAC is not significantly attenuated.

Pasquale Daponte will provide a reference for the definition of:

peak-to-average ratio (PAR):.

Bob Graham, at the suggestion of Fang, will generate a more accurate definition of

phase noise: Frequency representation of time-based jitter, typically expressed as a noise spectral density at a specific offset frequency from a carrier. .

resolution: Maximum Number of input bits that can be presented to the DAC.

It was requested that the new P181 definitions be added for:

rise time (t_R):

fall time (tF)

The following definitions were recommended

power-supply rejection (PSR): The amount of change in the DAC's output value (often measured at full scale), as the power-supply voltage changes. PSR assumes that the converter's linearity is unaffected by changes in the power-supply voltage.

power-supply sensitivity (PSS): Synonymous with PSR

total harmonic distortion plus noise (THD+N): The ratio of the sum of the RMS values of the non-fundamental frequency components of the output sine wave to the RMS value of the fundamental sine wave. It is typically expressed in decibels. This is similar to THD, but also includes the noise.

In static testing change the note to the following:

NOTE: In case of stacked DAC's, , the user may decide to not test all codes but may opt to test only codes around bit transitions. Alternatively, CD-quality audio DAC's can be tested by measuring THD+N. This parameter directly relates to audible quality and takes less test time.

To measure a DAC's dynamic performance, the test stimulus is a digital signal at the input of the DAC, and the analogue output is measured. Note that this digital signal is usually a quantized version of an ideal waveform. An ideal DAC will produce the exact analogue signal of its input without any deterioration. But a non-ideal DAC will produce a different version of the digital signal, which could be different in amplitude, and which could contain all kinds of distortion and noise.

When a quantized sine-wave is used as the stimulus of a DAC, the output of the converter observed with a spectrum analyzer, contains the initial sine-wave, its harmonics and an aliased signal generated because the DAC is updated at a constant period. The signal or its harmonic will be measured directly if its frequency is below Nyquist. If the location of the harmonics is above the Nyquist frequency, the aliased frequencies will be measured instead. In normal DAC applications the DAC output is low-pass filtered to reduce the spurious frequency content. For DAC testing it is recommended that the low-pass filter not be used, and that all the spurious components be measured directly. The performance of the filtered DAC can be extrapolated from the non-filtered version of the output.

Any instrument used to measure the output of a DAC needs to have better performance than the DAC itself so that the distortion and the noise of the instrument could be ignored in the measurement. In practice, this condition will quickly reach its limits. To overcome this condition, a band-reject or notch filter is usually used to reduce the signal amplitude of the sine-wave, thus, reducing the dynamic range of the signal to be measured. And also, more and more often in practice, a digitizer is used instead of a spectrum analyzer.

Replace all its' with its.

The definitions of Gain and offset will be redefined so that if the output is larger than expected then the Gain is >1. This is assigned to Sol Max

Change 4.6.1 to read:

4.6.1 Signal-to-noise and distortion ratio (SINAD)

The ratio of DAC output sine-wave signal power to the noise and distortion. Unless otherwise specified, it is assumed to be the ratio of root-mean-square (rms) DAC output to rms noise for sine wave output signals. SINAD depends on the amplitude and frequency of the output sine-wave. The amplitude and frequency at which the measurement is made shall be specified. For testing of a DAC, the signal amplitude is usually the output full scale range of the DAC. When expressed in dB, the Signal-to-noise and distortion ratio is the negative of the THD+N result.

The definition of noise in Clause XXX (specify the Clause number) does include distortions due to nonlinearities. The term "Distortion" is included in this definition of a signal-to-noise ratio to make it clear that random noise, fixed-pattern noise, and distortions are included in the measured parameter. SINAD can be determined equivalently from either the time domain or the frequency domain as a consequence of Parseval's Theorem.

All the words "we" are being replaced appropriately.

We will change the revision level on the DAC

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Pasquale will update to new format.