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A/D Converter Definition Of Terms

ANALOG INPUT BANDWIDTH is a measure of the frequency at which the reconstructed output fundamental drops 3 dB below its low frequency value for a full scale input. The test is performed with f_{IN} equal to 100 kHz plus integer multiples of f_{CLK}. The input frequency at which the output is −3 dB relative to the low frequency input signal is the full power bandwidth.

APERTURE JITTER is the variation in aperture delay from sample to sample. Aperture jitter shows up as input noise.

APERTURE DELAY See Sampling Delay.

BOTTOM OFFSET is the difference between the input voltage that just causes the output code to transition to the first code and the negative reference voltage. Bottom Offset is defined as $E_{OB} = V_{ZT} - V_{RB}$, where V_{ZT} is the first code transition input voltage and V_{RB} is the lower reference voltage. Note that this is different from the normal Zero Scale Error.

CONVERSION LATENCY See PIPELINE DELAY.

CONVERSION TIME is the time required for a complete measurement by an analog-to-digital converter. Since the Conversion Time does not include acquisition time, multiplexer set up time, or other elements of a complete conversion cycle, the conversion time may be less than the Throughput Time.

DC COMMON-MODE ERROR is a specification which applies to ADCs with differential inputs. It is the change in the output code that occurs when the analog voltages on the two inputs are changed by an equal amount. It is usually expressed in LSBs.

DIFFERENTIAL GAIN ERROR is the percentage difference between the output amplitudes of a given amplitude small signal, high frequency sine wave input at two different dc input levels.

DIFFERENTIAL NON-LINEARITY (DNL) is the measure of the maximum deviation from the ideal step size of 1 LSB. DNL is commonly measured at the rated clock frequency with a ramp input.

DIFFERENTIAL PHASE ERROR is the difference in the output phase of a reconstructed small signal sine wave at two different dc input levels.

DYNAMIC SPECIFICATIONS of an ADC are those pertaining to an AC input signal. These include S/N ratio, SNR, SINAD, S/(N+D), ENOB, THD, IMD, FPBW, and SSBW.

EFFECTIVE NUMBER OF BITS (ENOB, or EFFECTIVE BITS) is another method of specifying Signal-to-Noise and Distortion Ratio, or SINAD. ENOB is defined as (SINAD - 1.76)/6.02 and says that the converter is equivalent to a perfect ADC of this (ENOB) number of bits.

FULL POWER BANDWIDTH is the frequency at which the reconstructed output fundamental drops 3 dB below its low frequency value for a full scale input. The test is performed with f_{IN} equal to 100 kHz plus integer multiples of f_{CLK}. The input frequency at which the output is −3 dB relative to the low frequency input signal is the full power bandwidth.

FULL SCALE (FS) INPUT RANGE of the ADC is the input range of voltages over which the ADC will digitize that input. For $V_{REF^+} = 3.5V$ and $V_{REF^-} = 1.5V$, $FS = (V_{REF^+}) - (V_{REF^-}) = 2.0V$.

FULL SCALE ERROR is a measure of how far the last code transition is from the ideal 1½ LSB below V_{REF^+} and is defined as:

$$V_{max} + 1.5\ LSB - V_{REF^+}$$

where V_{max} is the voltage at which the transition to the max code occurs.

FULL SCALE STEP RESPONSE is defined as the time required after V_{IN} goes from V_{REF^-} to V_{REF^+}, or V_{REF^+} to V_{REF^-}, and settles sufficiently for the converter to recover and make a conversion with its rated accuracy.

GAIN ERROR (FULL SCALE ERROR) is the difference between the input voltage just causing a transition to positive full scale and V_{REF} - 1.5 LSB.

GAIN TEMPERATURE COEFFICIENT (FULL SCALE TEMPERATURE COEFFICIENT) is the change in gain error divided by change in temperature. Usually expressed in parts per million per degree Celsius (ppm/°C).

INTEGRAL NON-LINEARITY (INL) is a measure of the deviation of each individual code from a line drawn from zero scale or negative full scale (½ LSB below the first code transition) through positive full scale (½ LSB above the last code transition). The deviation of any given code from this straight line is measured from the center of that code value. The end point test method is used. INL is commonly measured at rated clock frequency with a ramp input.

INTERMODULATION DISTORTION (IMD) is the creation of additional spectral components as a result of two sinusoidal frequencies being applied to the ADC input at the same time. It is defined as the ratio of the power in the intermodulation products to the total power in the original frequencies. IMD is usually expressed in dB.

MISSING CODES are those output codes that are skipped or will never appear at the ADC outputs. These codes cannot be reached by any input value.

MSB (MOST SIGNIFICANT BIT) is the bit that has the largest value or weight. Its value is on half of full scale.

OFFSET ERROR is the difference between the ideal LSB transition to the actual transition point.

OUTPUT DELAY is the time delay after the edge of the input clock before the data update is present at the output pins.

OUTPUT HOLD TIME is the length of time that the output data is valid after the edge of the input clock.

OVERRANGE RECOVERY TIME is the time required after V_{IN} goes from AGND to V_{REF^+} or V_{IN} goes from V_A to V_{REF^-} for the converter to recover and make a conversion with its rated accuracy.

PIPELINE DELAY (LATENCY) is the number of clock cycles between initiation of conversion and when that data is presented to the output driver stage. Data for any given sample is available the Pipeline Delay plus the Output Delay after

that sample is taken. New data is available at every clock cycle, but the data lags the conversion by the Pipeline Delay plus the Output Delay.

PSRR (POWER SUPPLY REJECTION RATIO) is the ratio of the change in dc power supply voltage to the resulting change in Full Scale Error, expressed in dB.

QUANTIZATION ERROR is the error inherent in all A/D conversions. Since even an 'ideal' converter has finite resolution, any analog voltage that falls beween two adjacent output codes will result in an output code that is inaccurate by up to ½ LSB.

RATIOMETRIC OPERATION uses the same reference voltage that is used for the ADC to drive the signal source such that the ratio of the output of that signal source to the reference is a constant. When the driving voltage for that source is also used as the voltage reference for the ADC, the ADC output code is a function of the ratio of the signal source output to the reference voltage and, for a limited reference voltage range, is independent of the value of that reference voltage.

RESOLUTION is the smallest analog increment corresponding to a 1 LSB converter code change. For converters, resolution is normally expressed in bits, where the number of digital codes is equal to 2^n. As an example, a 12-bit converter maps the analog signal into 2^{12} = 4096 digital codes.

SAMPLING (APERTURE) DELAY is the time after the edge of the clock to when the input signal is acquired or held for conversion.

SIGNAL TO NOISE RATIO (SNR) is the ratio, expressed in dB, of the rms value of the input signal at the output to the rms value of the sum of all other spectral components below one-half the sampling frequency, not including harmonics or dc.

SIGNAL TO NOISE PLUS DISTORTION (S/(N+D) or SINAD) is the ratio, expressed in dB, of the rms value of the input signal at the output to the rms value of all of the other spectral components below half the clock frequency, including harmonics but excluding dc.

SPURIOUS FREE DYNAMIC RANGE (SFDR) is the difference, expressed in dB, between the rms values of the input signal at the output and the peak spurious signal. where a spurious signal is any signal present in the output spectrum that is not present at the input.

STATIC SPECIFICATIONS are the specifications of an ADC pertaining to a DC signal input. These include gain error, offset error, and differential and integral linearity errors.

THROUGHPUT RATE is the maximun continuous conversion rate of the ADC.

THROUGHPUT TIME is the inverse of the Throughput Rate.

TOP OFFSET is the difference between the positive reference voltage and the input voltage that just causes the output code to transition to full scale and is defined as $E_{OT} = V_{FT} - V_{REF+}$ where V_{FT} is the full scale transition input voltage. Note that this is different from the normal Full Scale Error.

TOTAL HARMONIC DISTORTION (THD) is the ratio, expressed in dB or dBc, of the rms total of the first six harmonic components to the RMS value of the input signal at the output.

TOTAL UNADJUSTED ERROR (TUE) is the maximum deviation of the voltage corresponding to the center of a digital code's associated input voltage span from the ideal case. Total unadjusted error includes offset error, Gain error, and differential and integral nonlinearity errors.

ZERO SCALE OFFSET ERROR is the difference between the ideal input voltage (½ LSB) and the actual input voltage that just causes a transition from an output code of zero to an output code of one.

ZERO ERROR is the difference between the ideal input voltage (½ LSB) and the actual input voltage that just causes a transition from an output code of zero to an output code of one.

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