DATA CONVERTER REFERENCE

Theoretical Noise Floor (-dBFS)

FFT Points	12-Bit	14-Bit	16-Bit
1024	101	113	125
2048	104	116	128
4096	107	119	131
8192	110	122	134
16384	113	125	137
32768	116	128	140
SNR (dB)	**74.0**	**86.0**	**98.1**

Binary Data Types

Scale	Offset Binary	Twos Comp
+FS - 1 LSB	1111...1111	0111...1111
+3/4 FS	1110...0000	0110...0000
+1/2 FS	1100...0000	0100...0000
+1/4 FS	1010...0000	0010...0000
+0	1000...0000	0000...0000
-0	----...----	----...----
-1/4 FS	0110...0000	1110...0000
-1/2 FS	0100...0000	1100...0000
-3/4 FS	0010...0000	1010...0000
-FS + 1 LSB	0000...0001	1000...0001
-FS	0000...0000	1000...0000

Conversion Factors

Number. of Bits (n)	States 2n	LSB Weight ppm	Resolution %	Dynamic Range (dB)
4	16	62,500	6.25	24
5	32	31,250	3.125	30
6	64	15,625	1.563	36
7	128	7,813	.781	42
8	256	3,906	0.391	48
9	512	1,953	0.195	54
10	1,024	977	0.0977	60
11	2,048	488	0.0488	66
12	4,096	244	0.0244	72
13	8,192	122	0.0122	78
14	16,384	61	0.0061	84
15	32,768	31	0.00305	90
16	65,536	15	0.00153	96
17	131,072	8	0.00076	102
18	262,144	4	0.00038	108
19	524,288	2	0.00019	114
20	1,048,576	1	0.00010	120
21	2,097,152	0.48	0.00005	126
22	4,194,304	0.24	0.00002	132
23	8,388,608	0.12	0.00001	138
24	16,777,216	0.06	0.000005	144

Data Converter Equations

RMS signal $= \frac{A}{\sqrt{2}} = \frac{FSR/2}{\sqrt{2}}$ where FSR = Full Scale (Input) Range of Sampling A/D converter

RMS noise $= \frac{q}{\sqrt{12}}$ where q = LSB

$$SNR = \frac{\text{RMS signal}}{\text{RMS noise}}$$

Signal to Noise Ratio (SNR)

SNR (dB) = 6.02n + 1.76 n= number of bits

$= 20 \log \left(2^{(n-1)} \sqrt{6} \right)$

Total Harmonic Distortion (THD) - the ratio of the RMS sum of the first five harmonic components to the RMS value of the fundamental input signal.

$$THD\ (-dB) = 20 \log \sqrt{\left[10^{\left(\frac{2nd\ HAR}{20}\right)}\right]^2 + \left[10^{\left(\frac{3rd\ HAR}{20}\right)}\right]^2 + \ldots}$$ *HAR (-dB)

Signal to Noise Ratio + Distortion (SINAD) - the ratio of the measured RMS signal to the RMS sum of all other spectral components below the Nyquist frequency (fs/2), excluding DC.

$$SINAD\ (+dB) = -20 \log \sqrt{10^{-\frac{(SNR\ without\ dist.)}{10}} + 10^{+\frac{(THD)}{10}}}$$

Effective Number of Bits (ENOB) - the converter's effective resolution (in bits) specified for a given input frequency (MHz) and a sampling clock rate (MSPS).

$$ENOB = \frac{(SNR + Distortion) - 1.76 + 20 \log \left(\frac{Full\ scale\ amplitude}{Actual\ input\ amplitude} \right)}{6.02}$$

Spurious Free Dynamic Range (SFDR) - the ratio of the fundamental RMS amplitude to the RMS amplitude of the next largest spectral component in the spectrum below fs/2, where fs is the sampling frequency.

Theoretical Noise Floor Assumptions: Coherent sampling and no windowing

Noise Floor (-dBFS) = 6.02n + 1.76 + 10 log $\left(\frac{N}{2}\right)$ where n = number of bits and N = Number of FFT Points