

DIBAS ADC test results

Glenn Jones, Jason Ray August 13, 2013

Test method

The ADCs for a single ROACH were connected to a 3-dB splitter and to a signal generator. The 3-dB splitter had significant roll-off above 1 GHz, so the amplitude of the sine wave was increase to compensate for this roll-off. For each test, the FPGA was deprogrammed, then the Valon was set to the desired sampling bandwidth. In all cases, the Valon channel spacing (`chan_spacing`) parameter was set to 2.0 MHz. Then the FPGA was programmed with the indicated boffile. Then 500 ADC snapshots were acquired; each consisting of 16384 8-bit samples from each of the two ADCs. The samples were then written to disk for analysis.

Analysis

The raw ADC samples were sorted to make a histogram of values, which are plotted on a log scale for each measurement. Note that for the $F_s/2=1536.0$ MHz, the two test tone frequencies are small rational multiples of the sampling clock, so the histogram is not fully populated.

For each row of the 500 x 16384 sample array, an FFT was computed, and the squared-magnitude (power) was computed. The mean was taken across the 500 rows to form a 8193 point power spectrum. This power spectrum is plotted in dB relative to the test tone and the top 10 spurious frequencies are noted.

To verify the performance of the ADC, the SINAD and ENOB were calculated as follows. The Signal to Noise and Distortion (SINAD) ratio is defined as:

$$\text{SINAD} = \frac{P_{\text{signal}} + P_{\text{noise}} + P_{\text{distortion}}}{P_{\text{noise}} + P_{\text{distortion}}}$$

In this case, P_{signal} was taken to be the power in the FFT bin containing the test tone.

$P_{\text{noise}}+P_{\text{distortion}}$ is then the power in all other FFT bins except the DC bin. However, in this test, we also did not count the power in the bins at 1/4 of the Nyquist frequency (0, 2048, 4096, 8192) because these bins are dominated by offsets in the four ADC cores that make up each ADC. These offsets can be removed by tuning the ADC control registers, but we have not yet attempted this. The method has been shown to work for this ADC, however.

Finally, we convert the SINAD to dB by taking $10*\log_{10}(\text{SINAD})$. We then compute the Effective Number of Bits (ENOB) as:

$$\text{ENOB} = \frac{\text{SINAD} - 1.76}{6.02}$$

Test summaries

dibasr2-1

Boffile	Fs/2 (valon) MHz	Tone MHz,dBm	ADC0 SINAD dB	ADC0 ENOB bits	ADC1 SINAD dB	ADC1 ENOB bits
adctest2	2048	1900, +14	36.5	5.8	36.2	5.7
adctest2	2048	950, +9	38.5	6.1	39.6	6.3
adctest2_512	1536	1440, +9	38.0	6.0	40.5	6.4
adctest2_512	1536	720, +6	39.5	6.3	41.5	6.6
adctest2_512	512	450, +6	39.0	6.2	41.2	6.5
adctest2_512	512	225, +6	39.7	6.3	42.4	6.7

dibasr2-2

Boffile	Fs/2 (valon) MHz	Tone MHz,dBm	ADC0 SINAD dB	ADC0 ENOB bits	ADC1 SINAD dB	ADC1 ENOB bits
adctest2	2048	1900, +14	37.2	5.9	35.3	5.6
adctest2	2048	950, +9	42.0	6.7	40.0	6.4
adctest2_512	1536	1440, +9	41.6	6.6	41.3	6.6
adctest2_512	1536	720, +6	42.7	6.8	42.4	6.7
adctest2_512	512	450, +6	42.4	6.8	41.9	6.7
adctest2_512	512	225, +6	44.2	7.0	43.3	6.9

dibasr2-3

Boffile	Fs/2 (valon) MHz	Tone MHz,dBm	ADC0 SINAD dB	ADC0 ENOB bits	ADC1 SINAD dB	ADC1 ENOB bits
adctest2	2048	1900, +14	37.5	5.9	37.1	5.9
adctest2	2048	950, +9	40.8	6.5	41.7	6.6
adctest2_512	1536	1440, +9	39.3	6.2	42.1	6.7
adctest2_512	1536	720, +6	40.4	6.4	42.5	6.8
adctest2_512	512	450, +6	41.0	6.5	42.0	6.7
adctest2_512	512	225, +6	42.3	6.7	43.9	7.0

Detailed plots for each test are included in the attached files:

- 2013-08-13-dibasr2-1-plots.pdf
- 2013-08-13-dibasr2-2-plots.pdf
- 2013-08-13-dibasr2-3-plots.pdf