250 MSPS acquisition board

The ALPHA250 is a programmable board built around a Zynq 7020 SoC. It features a 100 MHz RF front end with 14-bit ADCs and 16-bit DACs, at 250 MSPS. The RF channels are clocked by a dual PLL, ultra-low jitter clock generator. It includes a 4-channel 24-bit ADC and a 4-channel 16-bit DAC. The board comes with a comprehensive, open source, FPGA / Linux reference design.

Specifications

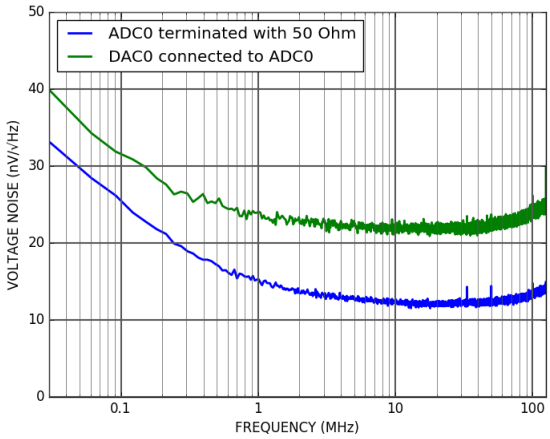
	ALPHA250	**ALPHA250-4**
Programmable logic, processor and memory		
System On Chip	Zynq 7020 XC7Z020-2CLG400I	Zynq 7020 XC7Z020-2CLG400I
Memory	512 MB of DDR3L SDRAM	512 MB of DDR3L SDRAM
Processor	ARM dual-core CPU (Cortex-A9)	ARM dual-core CPU (Cortex-A9)
100 MHz low-noise RF front-ends		
RF ADC	2 channels, 14-bit, 250 Msps, DC coupled	4 channels, 14-bit, 250 Msps, DC coupled
RF DAC	2 channels, 16-bit, 250 Msps, DC coupled	
Input to output latency	90 ns	
Input / Output	1 Vpp, 50 Ω	1 Vpp, 50 Ω
Ultra-low jitter clock for RF ADC, DAC and FPGA		
Clock generator	Dual loop PLL, 100-fs RMS jitter (12 kHz to 20 MHz)	Dual loop PLL, 100-fs RMS jitter (12 kHz to 20 MHz)
On-board VCXO	160 dBc / Hz @ 10 kHz	160 dBc / Hz @ 10 kHz
Reference clock inputs	FPGA, external clock or internal crystal oscillator	FPGA, external clock or internal crystal oscillator
On-board TCXO	10 MHz, 280 ppb	10 MHz, 280 ppb
Precision analog monitoring and control		
Precision ADC	4 channels, 24-bit	4 channels, 24-bit
Precision DAC	4 channels, 16-bit	4 channels, 16-bit

Voltage reference	2.5 V, low-drift (3 ppm/°C)	2.5 V, low-drift (3 ppm/°C)
Temperature sensor	±0.2 °C accuracy	±0.2 °C accuracy
Other		
Connectivity	10/100/1000 Ethernet, USB 2.0, USB-UART	10/100/1000 Ethernet, USB 2.0, USB-UART
General purpose I/O	3V3 16 FPGA I/Os, 8 user LEDs	1V8 16 FPGA I/Os, 8 user LEDs
Operating temperature	-10 °C to 60 °C	-10 °C to 60 °C
Outside dimensions	113 mm x 108 mm x 27 mm	113 mm x 108 mm x 27 mm
Weight	123 g	123 g
Software		
OS	Ubuntu 16.04	Ubuntu 16.04
Reference designs	FFT Analyzer, ADC / DAC with BRAMs, ADC / DAC with DMA, Phase noise analyzer, Loopback	FFT Analyzer, ADC with BRAMs

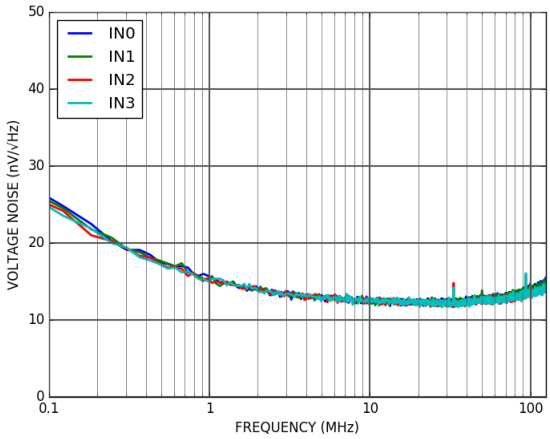
Characterization

Noise floor

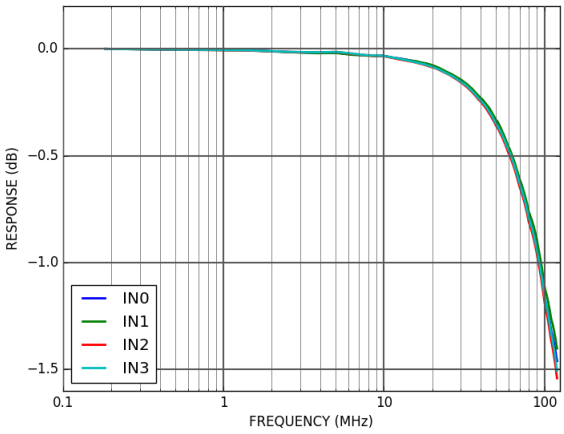
The RF ADC and DAC noise floors were characterized with this script available on GitHub. The input referred voltage noise density of the ADC is about 13 nV/√Hz. DAC voltage noise density is about 23 nV/√Hz (19 nV/√Hz after subtraction of the ADC noise floor).



Below is the representation of the noise floor for the 4 ADC version (ALPHA250-4) inputs (50 ohm terminated):



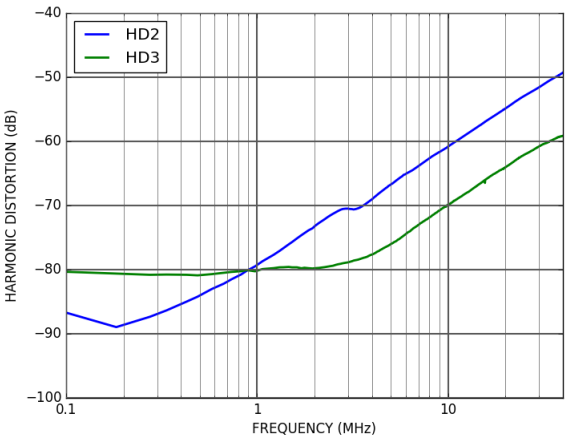
ADC front end frequency response



Frequency response of the ALPHA250-4 analog front ends

Distortion

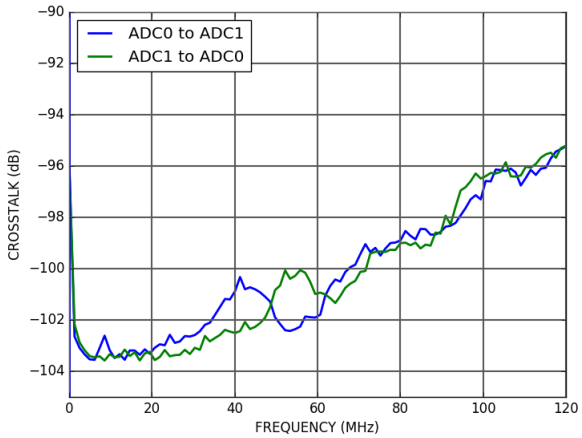
A 1 Vpp sine wave between 100 kHz and 40 MHz was sent by DAC0 and measured by ADC0 (see script). The figure below shows the amplitude of the second and third harmonic, relative to the fundamental frequency:



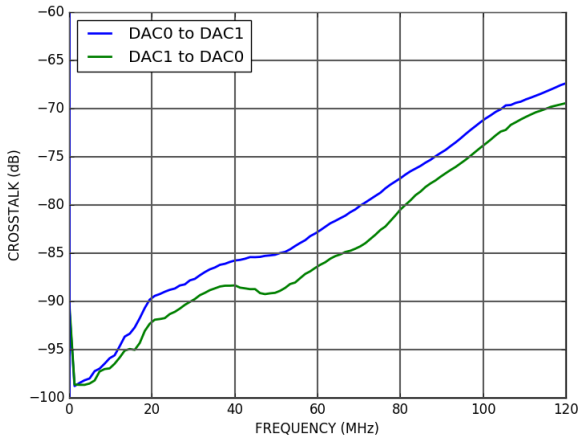
Distortion performance is limited by the DAC. ADC distortion (HD2 and HD3) stays under -80 dB up to 40 MHz.

Crosstalk

The crosstalk between the 2 ADC channels was characterized with the following script. The crosstalk is under -95 dB up to 120 MHz.

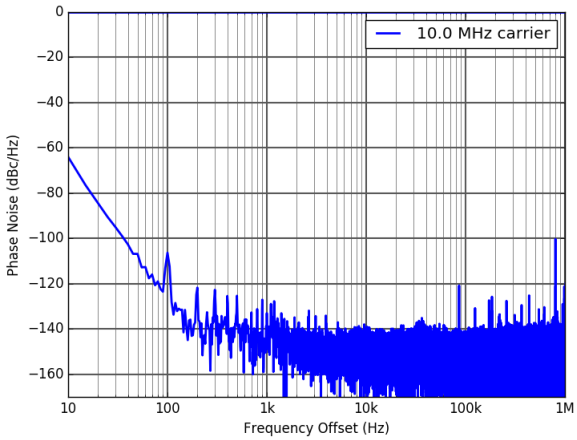


The crosstalk between the two DAC channels is shown below:



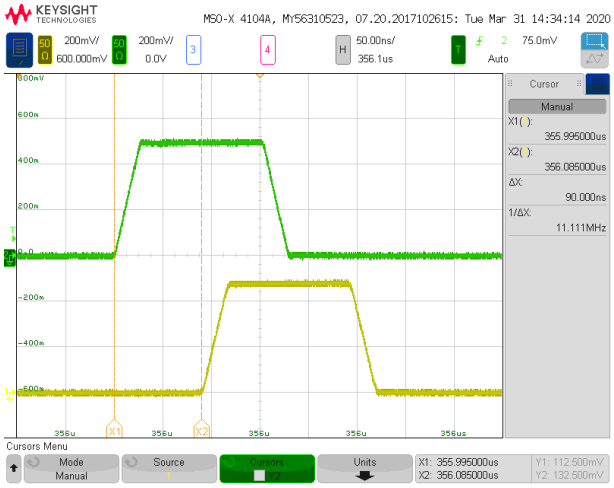
Phase Noise

The phase noise of a 10 MHz OCXO reference clock (from Textronix MCA 3027) against the internal TCXO was measured with the Phase Noise Analyzer reference design:



Input to output latency

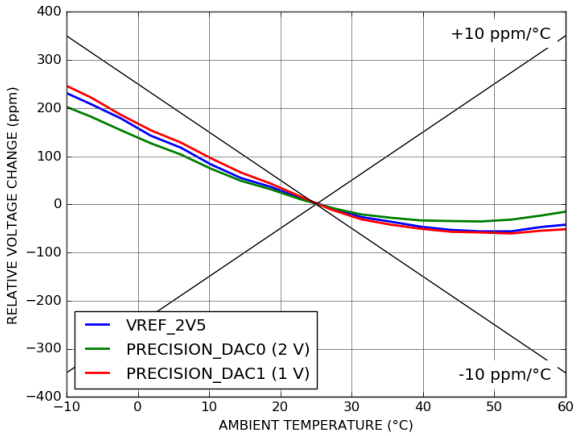
Using the loopback reference design, we observe the delay between a pulse in input (green) and the reproduced pulse at the output (yellow) for the ALPHA250 - 2 ADC, 2 DAC version:



Loopback latency is 90 ns, corresponding to a π/4 phase shift at 1.4 MHz.

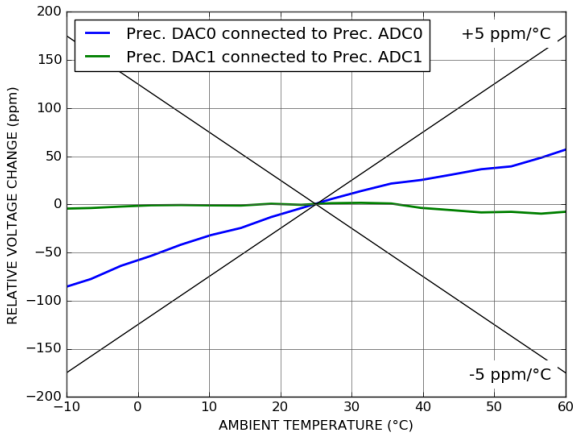
Precision converters

Temperature stability of voltage reference and precision DAC



Temperature stability of precision DAC measured by precision ADC

DAC output voltage is set to 1 V on channels 0 and 1. Precision DAC output is connected to precision ADC input.



Since the voltage references of the precision DAC and the precision ADC are derived from the same voltage reference, the above measurement realizes a **ratiometric measurement** which rejects voltage reference drifts. Note that the 2.5 V reference avalaible on the expansion connector can also be used for ratiometric measurement.

Ordering codes

REFERENCE	ATTRIBUTE
ALPHA250	RF front end 2 ADC, 2 DAC
ALPHA250-4	RF front end 4 ADC
ALPHA250-BP	RF front end 2 ADC, 2 DAC / Mounted baseplate
ALPHA250-4-BP	RF front end 4 ADC / Mounted baseplate