Σ-Integration Analog to Digital Converter

Idea, Implementation and Results

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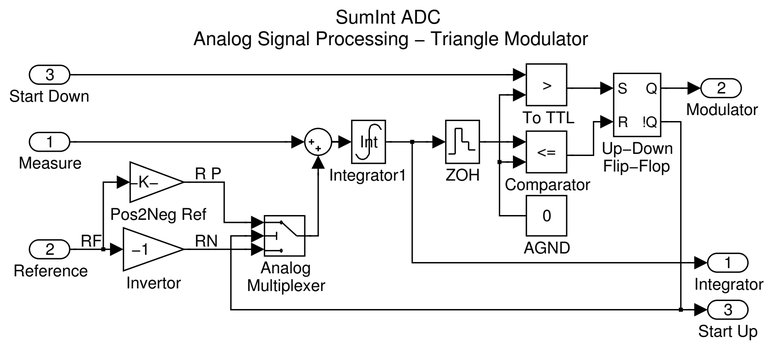
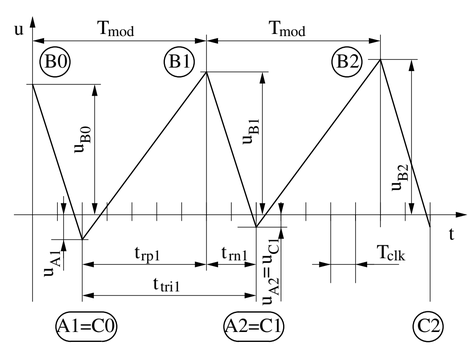
Design of Σ-Integration-ADC

The design combines and preserves the best features of double integration and sigma-delta converters. The resolution is proportional to the digital filter window length thanks to integral character of the primary conversion.



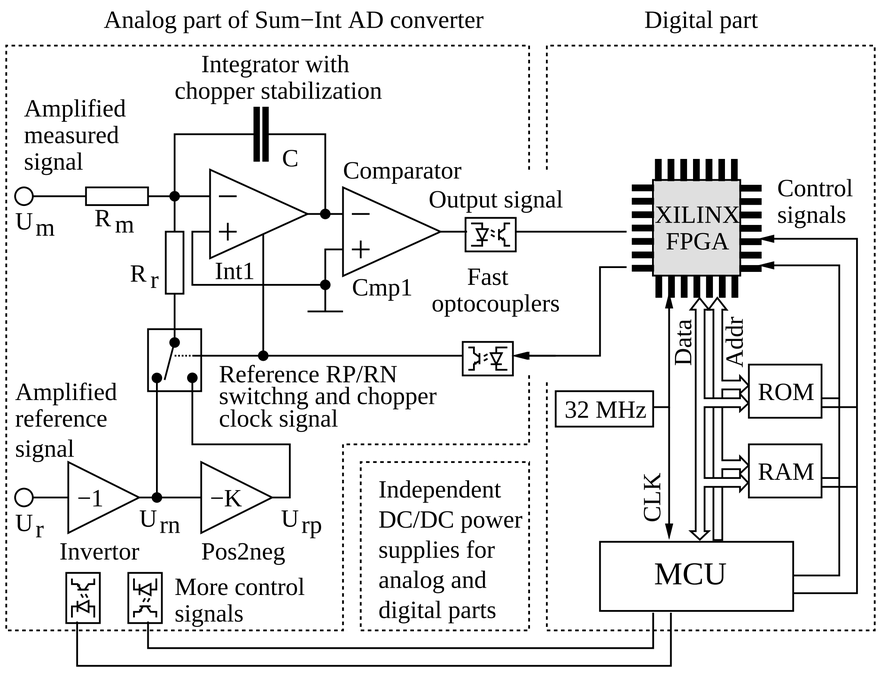


The fundamental component of the design is unique Σ-∫ modulator which requires relatively low frequency of reference polarity switching and continuously integrates the input measured signal. The switching to the negative reference occurs at precise time points with selected period T_{mod}. The switching to positive slope occurs when fast clock (T_{clk}) synchronized comparator output indicates zero–crossing. This arrangement results in non–constant duration of single triangle conversions. The average value of the single triangle conversion duration inclines to T_{mod}.
The average voltage of the measured input over one triangle duration is equivalent to next formula.

$$\overline{u_{m\,i}} = -\frac{u_{rp}t_{rp\,i} + u_{rn}t_{rn\,i}}{t_{rp\,i} + t_{rn\,i}} + \frac{\Delta u_{AC\,i}}{t_{rp\,i} + t_{rn\,i}}$$

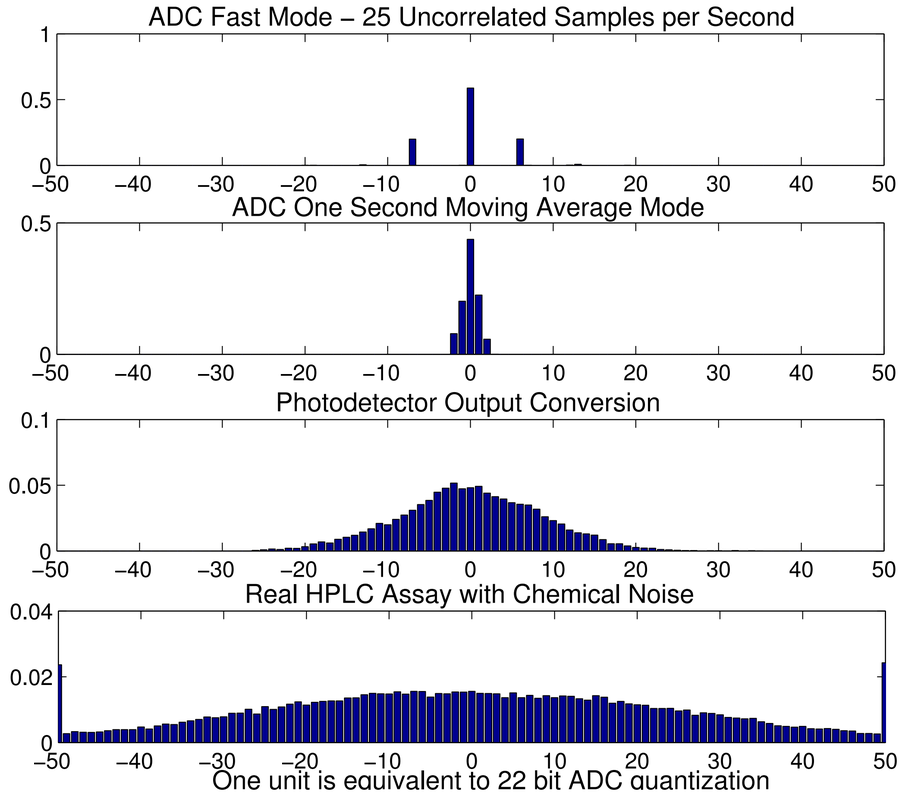
The second member represents bounded conversion uncertainty. The final ADC n modulation cycles conversion resolution obtained from the precious analysis is

$$log_2\left((n-1)\,\frac{T_{mod}}{2T_{clk}}\right)$$

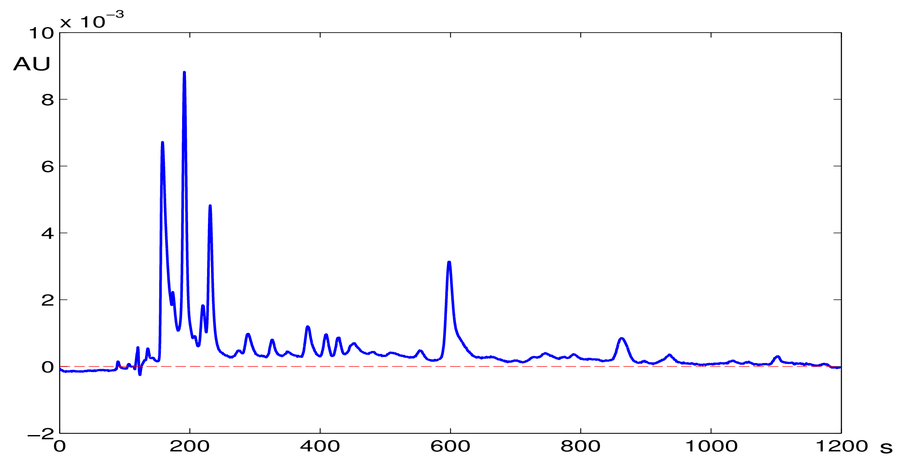


Measured Results

The presented results has been obtained on **XILINX** FPGA ADC implementation of converter used in **LCD5000** spectrophotometers.



The fast mode is equivalent to 25 Hz 19-bit conversion, that is why the histogram is characterized by isolated values of output codes for DC input signal. When moving filtering length is set to one second theoretical resolution increases to 24-bits that is more than demonstrated 22-bit resolution, but the theoretical single code distribution is widened by noise. The AD converter contributes many times lower noise than used photodetector or even HPLC assay chemical background.



The last picture presents real HPLC assay of Oligo-Nucleotides measured by the developed ADC.

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The designed instrument is serially produced by INGOS s.r.o. `http://www.ingos.cz`