Low-cost multi-channel analyzer based on implementation of multi-rate interpolating algorithm

M. S. Farias[1], F. Lacerda[1], M. A. A. Pinheiro[3], C. M. Salgado[2], P. V. R. Carvalho[1]
E-mail: msantana@ien.gov.br, flacerda@ien.gov.br, otero@ien.gov.br, paulov@ien.gov.br

[1]*SEINS, IEN;* [2]*DIRAD, IEN;* [3]*IRD*

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Most of applications on nuclear experiments require measurements using an analog-to-digital converter (ADC). In the case of the Multi-Channel Analyzer (MCA), the aim is to implement a digital version of the analog chain with a good pulse height analysis. However, the higher the desired accuracy and sample frequency, the higher the data acquisition system cost. This report shows the application of multi-rate techniques to increase the resolution of measurements with lower cost digital data acquisition systems [1]. In such a way, an acquisition system with a low time resolution can have its resolution increased up to 16 times (L16) in the time. This allows a pulse height assessment to be performed using a more adequate acquisition rate for the generation of a sample gamma ray energy histogram. To increase the resolution, we used the expander sampling rate to subdivide the interval of original sampling inserting null samples, that, after adjusted by filtering, receive coherent values. The action of the filter on the sequence in the time domain is an operation known as convolution. The filter is designed to give a coherent value to the null samples inserted by the expander, without changing the original samples of the input sequence. The multi-rate technique to increase the sampling rate F to F' value, by an integer factor L (that is, F' = FL), consists of inserting L-1 null samples between each pair of samples of the original sequence whose rate we want to modify, and a low pass filter h(m) for the interpolation of the values of output, as shown at the block diagram notation in Figure 1.

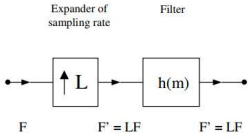

Figure 1. Block diagram notation of interpolation by a factor of L.

A low-cost National Instruments acquisition board (USB-6009) was used as the ADC to the MCA. This board has a maximum sampling rate of 48 kS/s and a 14-bit resolution. The signal interpolation and processing of the data are performed by software. To diminish the execution time of the software developed, all the data acquisition received from the hardware are kept in memory. We also developed a DLL (Dynamic-link library) optimized for the L16 interpolation. With L16 interpolation the sampling rate was increased to 768 kS/s. Figure 2 shows the design of the developed MCA, based on NaI(Tl) detector. The entire data presentation, the results presentation, and the signals processing, as well as the storage of the results, was developed in Labview.

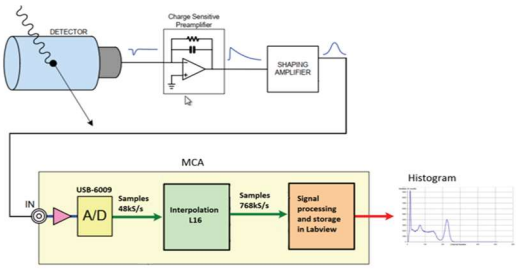

Figure 2. MCA developed.

With the sampling rate increased by the L16 interpolation, the energy histogram is obtained with the presence of the photopic, as shown in the figure 3. The developed software also performs pulse counting through a single-channel analyzer (SCA).

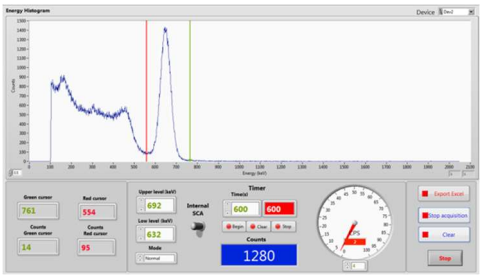

Figure 3. Software developed.

References

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