MULTICHANNEL PULSE HEIGHT ANALYSER USING FPGA FOR DATA ACQUISITION

Fernandes Newton*1, Vishram Ghadigaonkar*2, Chanin D’souza*3.

Department of Electronics and Telecommunication, Mumbai University
Xavier Institute of Engineering, Mumbai, India
1 Newton.fernandes.inc@gmail.com
2 vishramghadigaonkar177@gmail.com
3 d39souzachanin@yahoo.com

Abstract- This document gives the description of a multichannel pulse height analyser which is implemented using FPGA technology for high speed data acquisition and analysis. Multichannel analysers (MCA) are used globally in various laboratories in the application of nuclear spectroscopy. The most common use of a MCA is to plot the energy spectrum or to find the decay rate of the radio material under test. In the following context we have described the designing of an open source multichannel pulse height analyzer which uses a high speed ADC for data acquisition and displays the output on a graphical user interface designed using labVIEW in a computer.

Keywords: high speed ADC, FPGA, labVIEW.

I. INTRODUCTION

Multichannel analyzers have been around for quite a long time but over the past few decades they have undergone a gradual makeover from the traditional bulk units which were difficult to transport to the PCI bus card layout which included the entire architecture on a single PCI layout PCB which easily fits in the PCI slot of the computer. The data received from the MCA is then analyzed using a data acquisition software in a PC. One of the major problems associated with these is that they are very expensive and also there are a very few manufacturers which manufacture them. The MCA can work in different modes which include the pulse height analysis mode, pulse width analysis, counting rate etc. Taking into account all these factors and problems associated with it, we identified our problem statement that we build a multichannel pulse height analyzer which is simple in its design and constructions, yet accurate but more importantly making it an open source platform and cost effective.

II. DESCRIPTION OF PHA

The working model of the multichannel pulse height analyzer (PHA) is as follows. The radioactive material under test is placed in front of a silicon or germanium detector. As the material radiates the detectors pick up the radiations and produce an output charge whose peak value is directly proportional to the amplitude of the radiation. The output charge given is then given to a wave shaper which shapes the impulse pulse to a Gaussian pulse which makes it easier for pulse processing. This gaussian pulse is then given to the input of a peak detector circuit which detects the peak amplitude of the pulse. On detecting the peak amplitude the circuit triggers the ADC which in turn samples the peak amplitude. The ADC has a sampling rate of 105Msps and works at 100Mhz clock which is derived from the FPGA clock. The FPGA receives the digitized output from the ADC which is in a 2’s complement form and stores this value in a FIFO register which is implemented inside the FPGA and which is controlled by appropriate state machines besides the FPGA also contains the communication module programmed into it to communicate with the PC. The output from the FPGA is then received by the data acquisition software which is designed in labVIEW and it plots the histogram of the channels vs counts or in other words the energy spectrum of the material under test another major advantage which is offered is that if the peak detector is not required then the output from the wave shaper can be directly given to the input of the ADC thus allowing researchers to implement and evaluate the performance of different signal processing algorithms inside the FPGA or in the front end.

![Diagram of the overall system](image.png)

Fig.1 Block diagram of the overall system

III. TECHNICAL ASPECTS
The peak detector used is a traditional circuit which makes use of an op amp, diode and capacitor, as the input increases the capacitor charges to the peak value while the diode prevents the discharge of the capacitor when the value falls. The ADC used is a parallel type ADC which accepts a differential analog input and clock input for this reason the analog input is first given to a differential amplifier or a RF transformers any of which can be selected they convert the single ended input to differential output, also they set the desired dynamic range which is needed for the operation of the ADC. The design of the ADC board is such that we can select whether we want to use the differential amplifier or the RF transformer as the input source for the ADC. Spartan 6 FPGA was selected for this project as it has a high operating frequency of 100Mhz, its ability to interface with different modules and also the amount of dsp slices it contains if signal processing is to be used.

IV. EASE OF CONTROL

The GUI is designed using LabVIEW a software which is used for designing data acquisition systems. The controls of the analyzer are quiet simple which includes a basic start and stop button, a threshold level setter, peak and valleys counter and a graph which plots the histogram of the channels vs counts where the number of channels correspond to each of the peak value detected while the counts gives us the number of times each peak is repeated. All the modules are synchronized with respect to the clock frequency.

V. APPLICATIONS

The following are the applications of the multichannel analyzer

5.1) To study the decay rate of the material under observation.
5.2) To find the energy spectrum of material.
5.3) To detect whether it is a x ray or gamma ray plot.
The applications will vary from user to user depending upon the type of research carried out also various IP cores which will be created.

VI. ACKNOWLEDGMENT

We would like to thank our project guides and professors for their continued support and guidance they provided us with.

VII. REFERENCES