System for Spectral Investigation of Signals

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Abstract – The idea for realization of the concrete laboratory exercise is to help the students with investigation of the spectrum of basic types of signals. This is according to discipline "Signal and systems". The goal is to build hardware and software for DSP and personal computer.

***Keywords* – Signal and systems, Spectral analysis, Digital signal processing.**

I. INTRODUCTION

A software for spectral analysis for basic types of signals is build as well as hardware part for signal acquisition.The concept for this project is shown in figure 1.

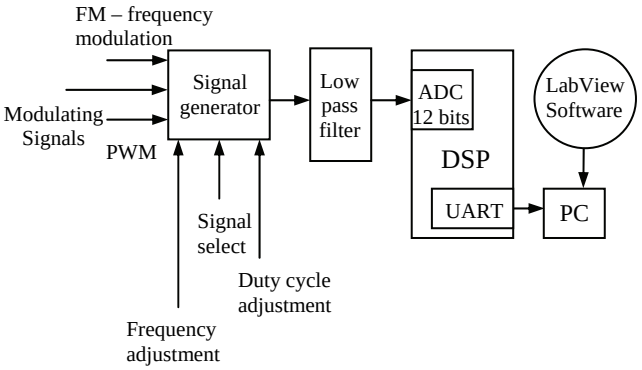

Fig. 1

The purpose of the signal generator is to provide the signal generator for further analysis. Some of the signal parameters can be adjusted or can be driven from additional generators in terms to achieve Frequency Modulation (FM) or Pulse Width modulation (PWM). The active Low-pass filter is implemented in order to make bandwidth limitation, before digitalization in 12-bit Analog to Digital Converter (ADC), which is built –in Digital Signal Processing (DSP). The Universal Asynchronous Receiver Transmitter (UART) realizes the communication with the PC.

II. FORMULATION OF THE PROBLEM

The purpose of the laboratory model is to make the student to become familiar with the spectral characteristics of basic types of signals, discussed in the "Signals and Systems" discipline.

III. HARDWARE PART DISCRIPTION

MAX038 is high frequency, precision, functional generator which can generate exact, sawtooth, triangle, sinusoidal and square signals. This can be done by minimal set of external components. The type of the signal can be chosen by setting of appropriate logic levels of the inputs A0 and A1(figure 2) Duty cycle can be changed from 15% to 85% .

Sinusoidal, square or triangle signals can be set with appropriate code of two TTL pins. The low impedance output of the generator is possible to be loaded up to $\pm 20mA$ current. This chip is applicable for Precision Functional Generators (PFG); Voltage Controlled Oscillators (VCO); Frequency Modulators (FM); Pulse Modulators (PM) and Frequency Synthesizer.

Schematic diagram is shown in figure 2.

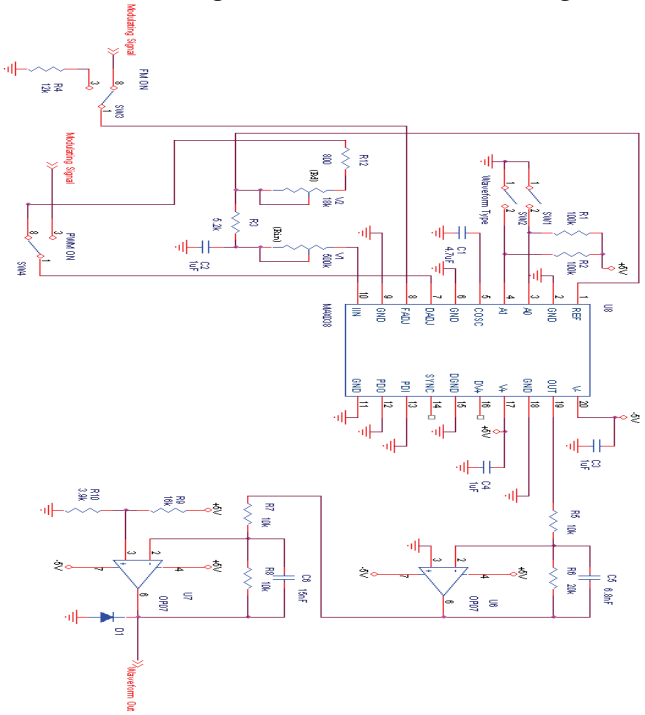

Fig.2

IV. DESCRIPTION OF THE WORK OF THE DIGITAL PART OF THE SCHEME

Figure 3 shows the schematic diagram for the part responsible for sending the digital signal into PC.

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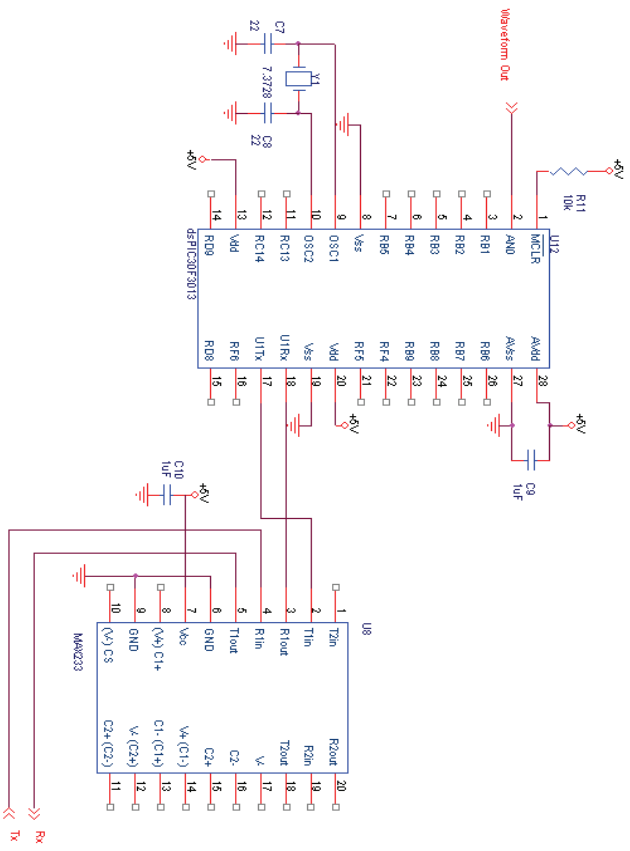

Fig.3.

This part consist DSP and level shifter for RS-232 standard. This DSP as well as ALU, RAM memory, Program memory has a lot of peripherals. In this case the built-in ADC is implemented. It can achieve 12-bit resolution. The type is SAR (succetive approximation register). This type of ADC is relatively fast but the limitation is the resolution (up to 13 and 14 bits). Only one analogue input is used (AN0) .

The DSP system clock is 7372800Hz. It is multiplied by 8 according to used PLL. The real system clock is FOSC*PLL/4. The sampling frequency is chosen to be 8kHz so the overload number in the Timer3 is given by (FCY/SAMPLING_RATE) + 1. Timer3 is responsible for exact discretization .

The other used peripheral module is UART which is used to communicate with the PC. The concrete DSP makes signal processing in terms of decimation by factor 4. This is necessary to reduce the sampling rate as well as to use a relatively simple analogue filter with low order.

The decimation is always along with digital filtration. In this case the digital filter is FIR (Finite Impulse Response) type. This is because FIR has linear phase response and because it is always stable. Higher order of the filter makes long setting time. In our case the number of tabs is 128. The filter is build using Qedesign software.

The window functions is rectangular and the cut-off frequency is 995Hz. According to its Magnitude response is achieved attenuation of 75dB in stop band. The signal processing is in 1.15 format (fixed point).

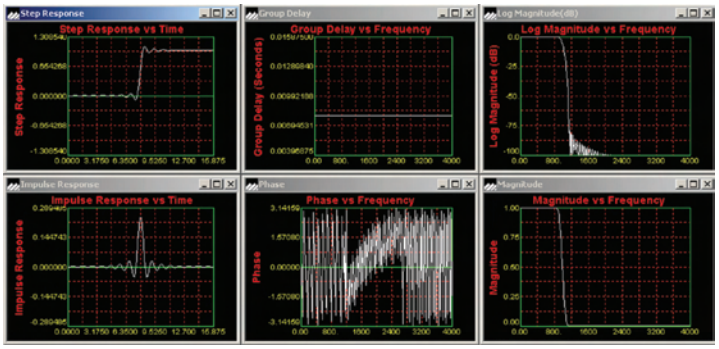

Fig.4.

V. EXPERIMENTAL RESULTS

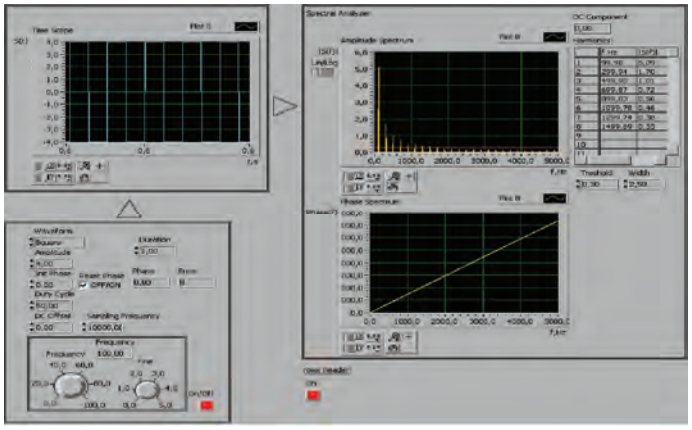

Fig.5.

Figure 5 shows the amplitude and phase spectrum of rectangular pulses. This spectrum is calculated previously and the results are exactly matching.

CONCLUSIONS

A working laboratory model Spectral analysis was described in this paper. The future work will be concentrated in terms to achieve real time spectral analysis of signals with higher bandwidth and to improve throughput of the communication interface using USB instead RS 232 standard.

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