ALTERA ANALYSES OF IONIZATION MEASUREMENTS

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Altera UP2 board is used for the signal processing of a simple ionizing radiation detector. At the output of these detectors a pulse train is obtained whose average value is proportional with the dose rate from the radiation sources. Due to the stochastically nature of the radiation, obtaining correct result during measuring asks for complex deeds and analyses. The detector is excited with different radiation intensity, and with Altera UP2 an analyses is made in different circumstances. The results obtained with Altera board are compared with a professional measuring device containing a complex detector.

Keywords: dose rate, stochastic process, altera experimental board

1. INTRODUCTION

Measurements in radiation field are the only solution for controlling the environment where the measuring device is practically used to compensate the disability of our senses. Besides controlling the environment, today's use of ionizing radiation in industry, medicine and for scientific purposes, asks for defining maximum allowed dose rates which living matter can absorb without any consequences. Important parameters of ionizing radiation could be detected with different types of detectors. One of the most important values in dosimetry, which could be measured with more simpler types od detectors, is dose rate D':

$$\left[D^{'}\right]_M = \frac{[D]_M}{[t]_M} = \frac{J/kg}{s} = \frac{Gy}{s}$$

There are different ways of measurement. One of the simpliest and in the same time cheapest solution is with pulse detectors which when are in a radiation field pulses are obtained at their outputs. The average value of the pulse numbers from the detector in a determined time interval is a measure for the dose rate from the radiation source.

Having in mind the stohastical nature of the measuring phenomenon, meters that have fixed measuring time interval will have fluctuation of the final results. More correct result is obtained when the measuring interval is longer. From the other side, the measuring interval should be limitted. In the case of fast changes of the dose rate in the measuring interval a completly uncorrect result will be obtained.

In this paper Altera board is used for experimental verification of optimal measurement interval. The pulses from a conventional detector are an input in the Altera board, where results are processed for different given measurment intervals.

The Altera UP2 is stand-alone experimental board design to meet the needs of constructors in a laboratory environment. It is based on FLEX 10K and MAX7000 device which provide a superior platform for implementing digital logic design using industry standard development tools to a programmable logic devices (PLDs).

The EPF10K70 device is based on SRAM technology and has 3,744 logic elements and nine embedded array blocks. Each logic element consists of a four-input look-up table, a programmable flip-flop and dedicated signal paths for carry and cascade functions. Each embedded array block provides 2,048 bits of memory, which can be used to create RAM, ROM or FIFO functions, and also can implement logic functions such as multipliers, micro controllers, state machines and DSP functions.

The EPM7128S device is based on erasable programmable read-only memory (EEPROM) elements. The device consist 128 macro cells, and each macro cell has a programmable AND/OR array with independently programmable clock.

2. ALTERA EXPERIMENTAL BOARD AS A PRACTICE DOSE RATE MEASURING DEVICE

Figure 1 shows the detector unit near a radiation source, Altera experimental board and an oscilloscope with which the input pulses are controlled. A measuring time is chosen and it is shown on one of the displays. The measurement result is read out on the other display.

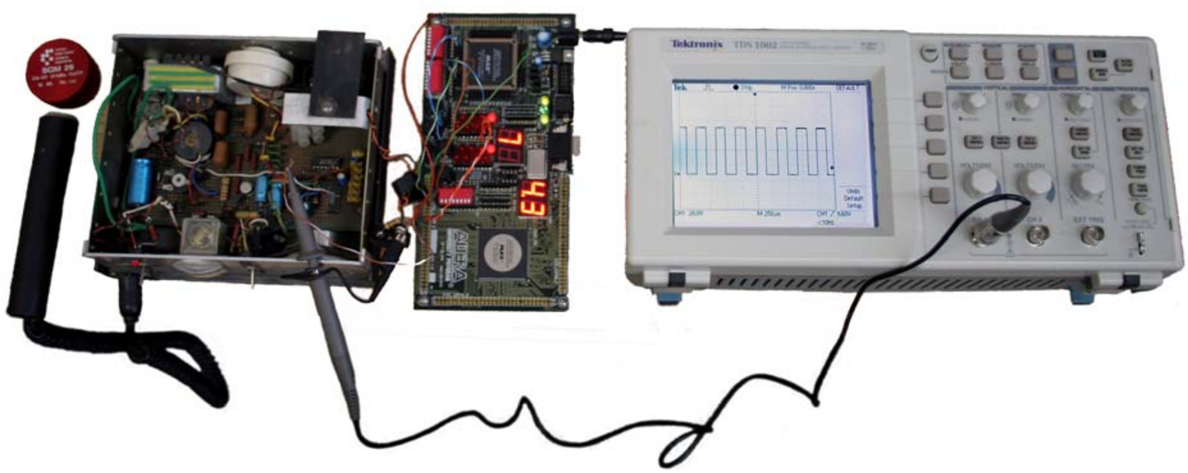

Fig. 1 Altera experimental configuration

A block diagram of a dose rate measuring device is shown on the fig. 2. It contains two basic parts: the detector unit and the Altera experimental board. The block between the detector unit and the Altera board is a circuit for forming the pulses from the detector unit. TTL compatible pulses are input pulses in the Altera board.

The main part of the detector unit is the radiation sensor ZP 1400 PH built in basic measurement circuits of PHILIPS D8686A and D8685A[5].

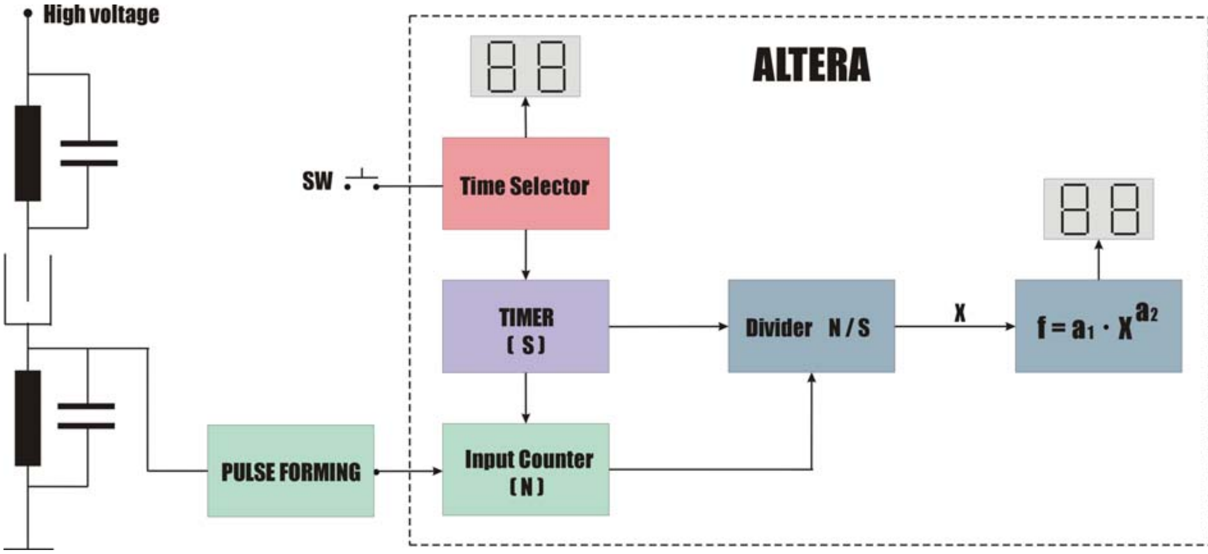

Fig. 2 Block diagram of a dose rate measuring device

The Altera experimental board is the second digital part of the dose rate-measuring device. For realization of the project both EPM7128S and EPF10K70 programable logic devices are used where algorithms for counting and calculating are being implemented. On the global block diagram of the digital parts implemented to the Altera experimental board are shown. Altera uses the output pulses from the detector unit as the input information for the digital logic. Generally the digital logic works as a two states state machine to which we can adjoin two measuring periods:

- Counting period (Tcount); Calculating period (Tcalc) (fig.3)

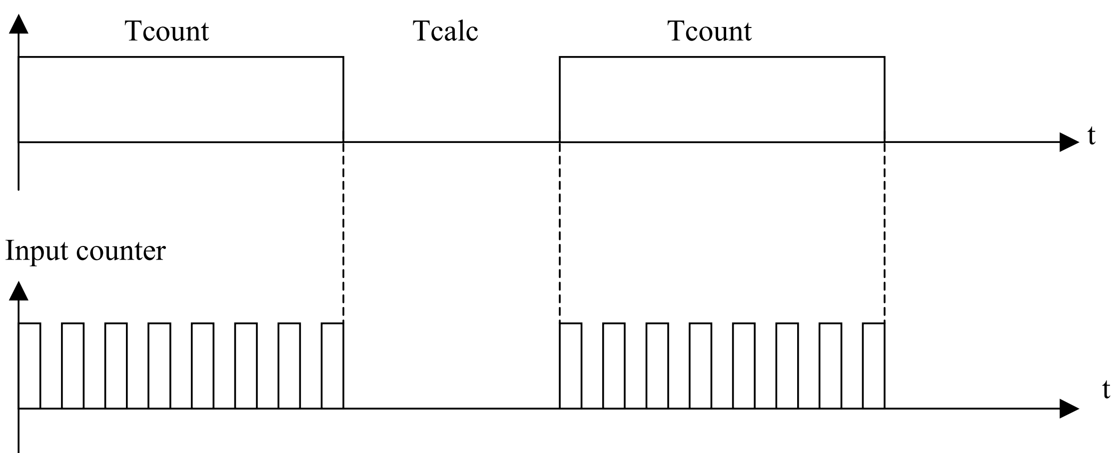

Fig. 3 Timing diagram

- The block "TIME SELECTOR" is used for choosing the measuring time in the period from 1 to 15 seconds by simple pressing the SW (switch) button. The state of the "TIME SELECTOR" is shown on the onboard two segment digital display.
- "TIMER" is a block used for measuring the time of the chosen period and also takes part for synchronization between counting (Tcount) and calculating (Tcalc) period. For measuring the time period the onboard crystal oscillator with frequency of 25.175 MHz is used.
- The block "INPUT COUNTER" is used for counting the input pulses obtained from detector unit in the appropriate counting (Tcount) period.
- The "DIVIDER" represents a digital circuit for dividing the input data. The input data for this block are the counted pulses from the "INPUT COUNTER" and the time measured by the "TIMER" expressed in seconds.
- The last block is used for implementing a function for calculating the dose rate of ionizing radiation and showing the results on the digital display.

The input data for this block are the data obtained from the "DIVIDER" and two coefficients a1 and a2, which are experimentally determined by performing the measurements with different types of radiation sources. Due to the nonlinear law between the pulses obtained from the detector unit and the momentary value of the absorbing ionizing radiation, we use a table with correction of the results where the segments are calculated, considering maximum possible error of 5%.

The detector ZP 1400 PH is assigned for β and γ radiation between 10^{-3} to 10^{2} mGy/h. Its typical characteristic is shown on the fig. 4.

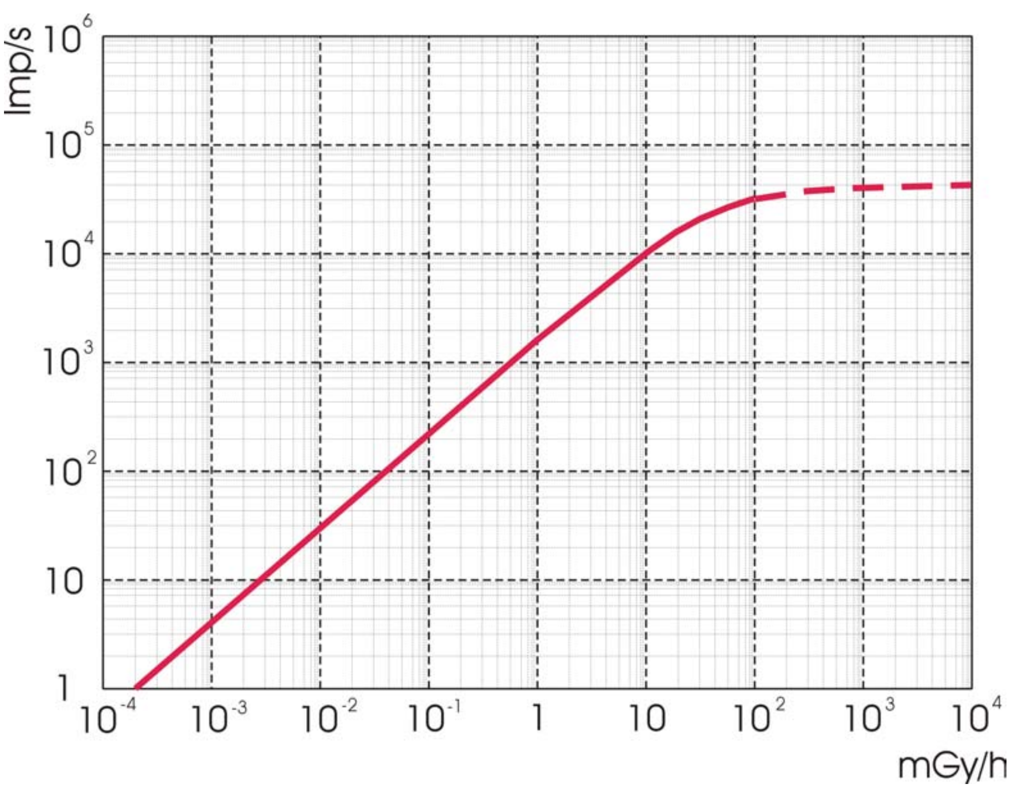

Fig. 4 Typical characteristic of ZP1400PH detector

3. RESULTS

The measurements are made for time period changed from 1 to 15 seconds for 5 independent cases. The results are compared with professional measuring device SGM29 equipped with detector type NE105, scintillator 25x25 mm and photomultiplicator EMI 9734A. The measurements were made with a source of ionizing radiation ^{137}Cs (37KBq).

The results are shown on fig. 5, i. e. in table 1.

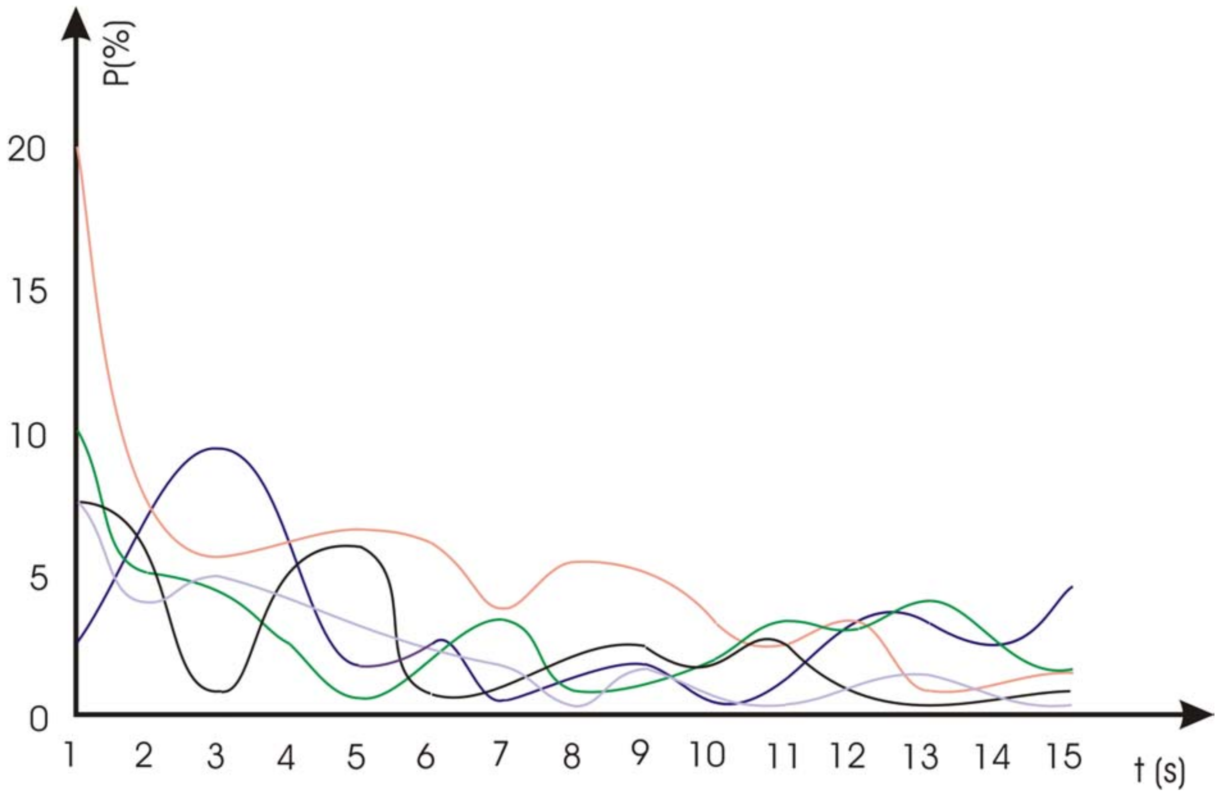

Fig. 5 Obtained results for five different measurement intervals

Table 1

P(%)		Time (s)														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1	-2,50	-7,50	-9,17	-6,88	-2,00	-2,50	0,36	0,94	1,39	-0,25	0,91	3,13	3,08	2,50	4,67
	2	20,00	7,50	5,83	6,25	6,50	6,25	3,93	5,31	5,00	3,75	2,50	3,33	1,92	1,07	1,67
	3	10,00	5,00	-4,17	-2,50	-0,50	2,08	3,24	0,94	1,11	2,00	3,18	2,92	3,65	2,50	1,67
	4	-7,50	-6,25	-1,67	5,00	6,50	1,67	1,43	1,56	2,50	2,00	2,50	0,63	0,19	-0,36	-0,83
	5	-7,50	-3,75	5,00	3,75	3,00	-2,50	-2,14	0,31	-2,22	-1,00	-0,23	1,46	1,73	0,54	0,17

The results obtained with Altera board for different measurement time are compared with the results obtained with SGM 29.

4. CONCLUSION

From the analysis of the results, it can be seen that standard deviation of dose rate measurements decreases with increases of the measuring period. But, on the other side, the time interval should be short enough to satisfy some security conditions for early warning, and in the same time, long enough to maintain the relative accuracy.

This project can serve for further more complicated experiments for measuring dose rate of ionizing radiation by using Altera experimental board.

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5. REFERENCE

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