Acta Physica Hungarica 59 (1—2), pp. 139—142 (1986)

MICROPROCESSOR BASED RADIATION MONITOR WITH EXTENDED POSSIBILITIES

V.R. DRNDAREVIĆ, A.B.MILIĆ, A.M. KOTUROVIĆ
"Boris Kidrič" Institute of Nuclear Sciences
11001 Beograd, Yugoslavia

This paper presents the realized microprocessor based instrument. Convenient facilities of interest for radiation monitoring are acquired by incorporated adequate software. The main requirements fulfilled by software are defined by the task of the radiation monitor i.e. obtaining dose rate or count rate of pulses from detector. The choice of a convenient algorithm for count rate is discussed. There are other values that may be of interest in application of radiation monitor such as: error of shown result, tendency of dose rate change, the warning signal of approaching the alarm level, as well as the signal of reaching the alarm level. Maximal and/or minimal value of measured dose rate is also useful to be registered. Inclusion of all these possibilities in the software support of the instrument is discussed and the accepted solution is described.

Introduction

The microprocessor has become, in present day instrumentation, an integral component of all instruments and measurement systems with complex demands as well as in the domain of direct data processing, their registration, representing and transmitting from the system. It is possible to increase the possibilities and to improve the characteristics of the instruments by the use of a simple configuration based on the microprocessor. These characteristics are mainly determined by the built in program. The possibility of simple improvement and change of this program represent a particular convenience.

The basic function of the radiation monitor is the measurement of exposition dose rate. This measurement, with certain correction, could be deduced from the measurement of the count rate of random pulses from the detector. The result based on one cycle of measurement, commonly used with a simple digital ratemeter, does not give a result either of satisfactory accuracy or acceptable response time. This problem could be overcome by performing a set of measurements and including proper calculations. In this work a convenient algorithm is used for the calculation of count rate which is based on a set of results of successive measurements. Besides the count rate, i.e. the dose rate, the realised monitor may provide information on: error of displayed result, tendency of dose rate change, the warning signal of approaching alarm level as well as the signal of reaching the alarm level, maximum and minimum value of measured dose rate and eventually the absorbed dose.

Monitor structure

Since the number of pulses, N_{ic}, in the defined measuring period, T_{ic}, is the basis for rate estimation, the instrument structure must provide these fundamental data. The system on the whole must have the capability: to accept these data in order to carry out the program of data treatment giving the rate estimation, to memorize and display the results, to accept the instructions given through the keybord and to control the complete structure behavior.

The listed requirements suggest the monitor structure presented in Fig.1. This structure is realised by the Motorola 6800 microprocessor components.

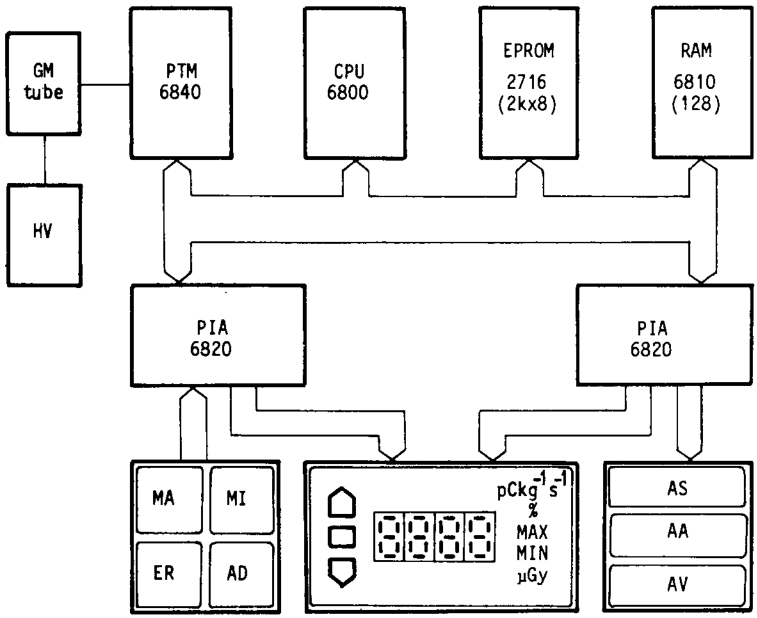

Fig.1. Block diagram of the monitor

The number of random pulses from GM tube, N_{ic}, is registered in one of the three available 16-bite counters of programmable timer module PTM. The other two counters are used for the time measurement, T_{ic}. Calculation with obtained data is done according to the postulated algorithm. The program, placed in 2k byte EPROM, coordinates the whole operation of the monitor. The intermediate results are stored in the RAM, of 128 byte capacity.

Besides the main result in appropriate units, minimum (MI) and maximum (MA) values, error of measurement (ER) and absorbed dose (AD) can also be displayed numerically. The tendency of dose rate change is displayed continually by three LEDs, giving information about the increasing value by a red light, and if decreasing by a green one. In case of no significant change a yellow light appears. The exceeding of alarm level is indicated audio (AA) and visually (AV). Warning about the measured value soon approaching the alarm level is indicated only visually by a flash light (AS).

Communication with the keybord as well as neccessary indication is realized with peripheral interface adapters PIA.

Software

Pulse rate mean value, i.e. estimated dose rate R_{en}, is obtained by a convenient algorithm with floating mean value of k successive measuring results, N_{ic} and T_{ic}. In this way the accuracy is good, and a short response time is maintained. The accepted "damped step" algorithm, given in detail by [1] and [2], may be generally described by the following relations:

$$A)\ R_{en} = \frac{(k-n)N_{1c} + \sum_{1}^{n} N_{ic}}{(k-n)T_{1c} + \sum_{1}^{n} T_{ic}}, \quad \text{for} \quad n \le k \qquad (1)$$

$$B)\ R_{en} = \frac{\sum_{n-k+1}^{n} N_{ic}}{\sum_{n-k+1}^{n} T_{ic}}, \quad \text{for} \quad n > k \qquad (2)$$

C) When $|R_{pn} - R_{e,n-1}| > \theta$, $\theta = F(\sigma)$, take (3)
$n=1$, and go back to step A, where
$R_{pn} = N_{nc}/T_{nc}$, and σ is the
standard deviation.

In our case we have k=8, and $T_{ic} = c^t$.

For small step changes of the measured parameter, this algorithm provides the linear change of obtained results. In the case of sufficiently great change, relation (3) will be satisfied and the result immediately becomes a real high value, although less accurate. In the steps that follow, if the new level is stable enough, the averaging will take place, and the accuracy of results will be increased.

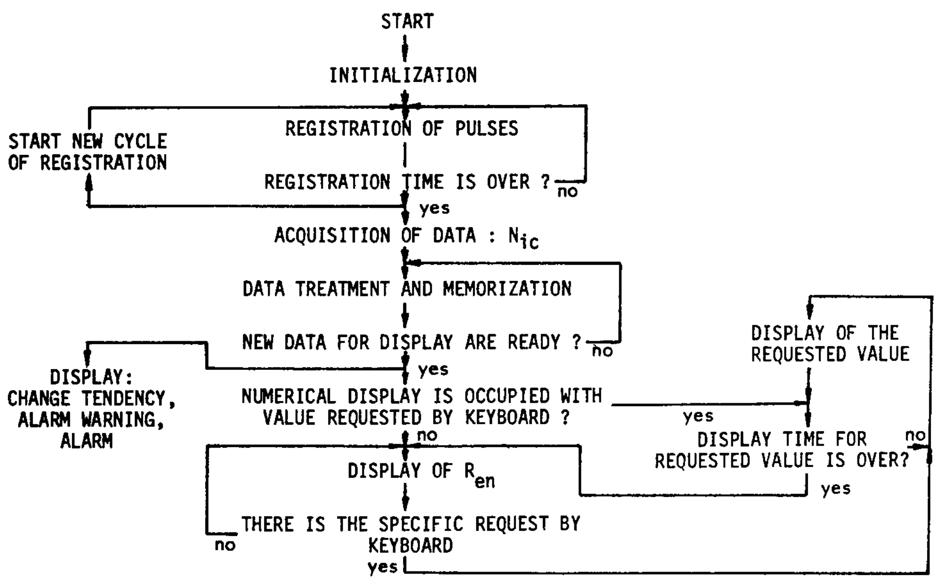

Fig.2. Simplified functional flow diagram of the monitor

The simplified functional flow diagram of the presented instrument defined in fact by the incorporated software, is shown in Fig.2. As it may be seen, the date treatment provides information on a) tendency of measured value change, b) the approaching of alarm level, and c) the reaching of alarm level in addition to the dose rate.

On request by keyboard, the accuracy of displayed dose rate as numerical value may be obtained, as well as minimum and maximum measured values of dose rate and the absorbed dose from the moment when the instrument is switched on.

The limited space does not permit us to discuss in more detail interesting problems of algorithms for the estimation of dose rate change, and for the prediction of approaching the alarm level. Of course, there are other interesting questions in the software that might be disccussed, such as the possibility to use the variable measuring time, T_{ic}, the consequences of such an approach, etc. It seems that this is beyond the scope of this paper.

The software incorporated in the presented instrument, although relatively simple, has proved to be convenient for portable radiation monitors.

Conclusion

In this paper the solution of the microprocessor based radiation monitor with extended possibilities is shown. The use of microprocessor permits convenient data treatement. In this way the useful additional functions might be included by the relatively simple software. The instrument provides the most interesting data for monitoring purposes. Besides the dose rate, it continuously gives information on the tendency of the measured value change, the possible approaching of alarm level, and the reaching of the alarm level. On request by keyboard, it is possible to obtain the accuracy of the displayed dose rate as a numerical value, as well as the minimum and maximum measured values of dose rate, and the value of the absorbed dose from the moment when the instrument is switched on.

Although with many possibilities, the instrument is easy to handle; what is of great importance is that the monitor is meant to be portable.

References

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