MICROPROCESSOR BASED DIGITAL RADIATION METER/MONITOR

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INTRODUCTION

Digital radiation meters/monitors,which are essentialy digital ratemeters, have been always very atractive for instrumentation designers since digital instruments have advantages in applications when compared with analogue ones (Ref.1).

The integrated electronics allowed the digital ratemeter to be realized in a convenient size with facilities inherent to digital techniques, but not all of them have been included as yet (Ref.2).

By invention of microprocessor in 1971 these problems have been overcome and it was possible to realize not only fundamental tasks but to offer quite new sollutions (Ref.3.4).

The microprocessor, as a component with defined and fixed structure, performs arithmetic and logic operations by a set of instructions i.e. by a given program. Programing depends on the ability of a programer and offers an unlimited variety of different functions including those of interest for digital ratemeters i.e. radiation monitors.

MICROPROCESSOR BASED INSTRUMENT STRUCTURE

The pulse train from radiation detector and the time interval during which the pulses are registered are sources of information for digital radiation meters. Both information are fed into the separate inputs of digital ratemeter which is an input part of a microprocessor based instrument shown in fig.1. The functioning of a digital ratemeter is determined by the program instructions applied on the microprocessor and thus the instrument becomes digital radiation meter. The single measuring cycle duration is determined by preset numbers of pulses in the two programable comparators: for detector pulses and for clock pulses. It should be noted that the predetermined numbers in the programable comparators are set by the microprocessor. The bus line organization is used in the structure, the general purpose microprocessor is assumed, and the operation is evident from fig.1.

In one measuring cycle the digital ratemeter at the output provides the number of detector pulses $/N_C/$ registered during the measuring time $/T_C/$ as well as the number of registred clock pulses, defining T_C. These elementary data, Nc and Tc, can be a final result for counting rate i.e. dose rate, or may undergo a further treatment to get more accurate results and to deduce different information. Simultaneously microprocessor can provide information on: tendency and/or velocity of changes, maximal or minimal value measured during the past period, the statistical error of results, integral dose; it can also accomplish comparison with predetermined values and so on.

Thus the microprocessor based radiation meter/monitor is potentialy a multifunctional instrument and it should be designed in that way.

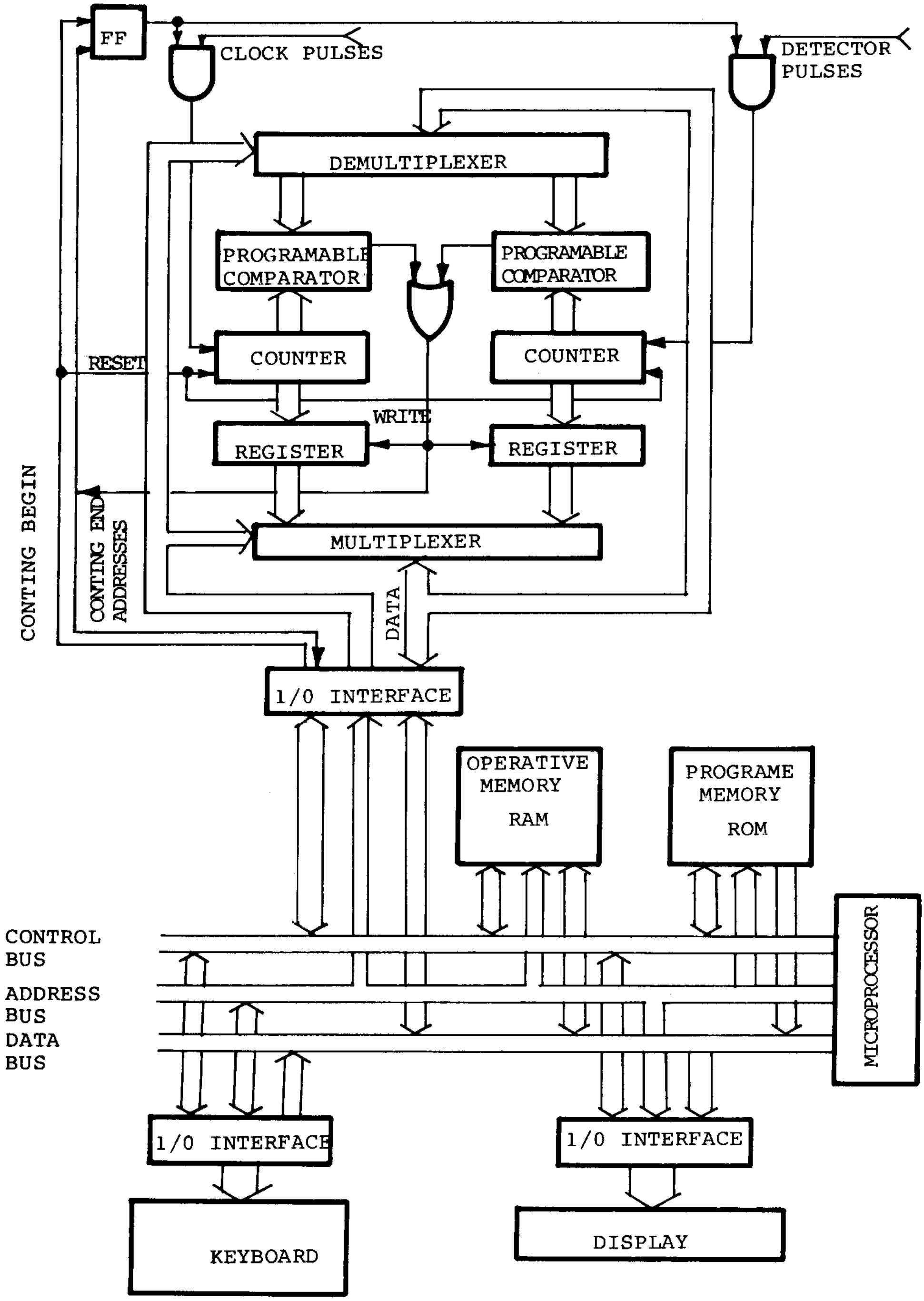
FF
CLOCK PULSES
DETECTOR PULSES
DEMULTIPLEXER
PROGRAMABLE COMPARATOR
PROGRAMABLE COMPARATOR
COUNTER
COUNTER
RESET
WRITE
REGISTER
REGISTER
CONTING BEGIN
CONTING END
ADDRESSES
MULTIPLEXER
DATA
1/0 INTERFACE
OPERATIVE MEMORY RAM
PROGRAME MEMORY ROM
CONTROL BUS
ADDRESS BUS
DATA BUS
MICROPROCESSOR
1/0 INTERFACE
1/0 INTERFACE
KEYBOARD
DISPLAY

Fig.1.

INSTRUMENT SOFTWARE

The main consequence of microprocessor presence in the instrument is that the digital radiation meter/monitor functions are not any more accomplished by the hardware but by a convenient program built in the microprocessor based instrument.

The basic monitoring function - dose rate measurement - can already be obtained by a simple algorithm. A direct imitation of an analogue ratemeter with the diode pump circuit, is inconvenient and unreasonable for a digital ratemeter. Meanwhile it is possible to use a very simple algorithm giving the basic result:

a) - after termination of the measuring cycle calculate the partial result: $R_p = N_c/T_c$;

b) - form the sum S_k of k partial resuls: add the n^{th} partial result and substract the $(n-k)^{th}$ partial results;

c) - devide the sum S_k by k, so find the average rate

$$R = \left(\sum_{n-k+1}^{n} R_p\right)/k$$

d) - return to a).

When all single measuring intervals are equal (T_c = const) this algorithm provides linear change of the result for the step change of measured radiation field.The time to reach the final result and steady state depends on k, as well as the error of a result in the steady state.

Other algorithms for the dose rate can also be formed with different characteristics and conveniences (Ref. 5) and generaly one should find the algorithm which would include microprocessor versatility and offer good quality result.

Using a digital ratemeter in this way only, we have not gained too much from a microprocessor. Microprocessor allows us to extend the algorithm and from the same data to calculate additional quantities, allready mentioned above: the accuracy of dose rate, tendency of change, integral doserate, minimal or maximal value in determined measuring period, etc. All these additional quantities improve the measuring qualities of a radiation meter/monitor and may be usefull in practice.

Besides, one should not forget that different types of corrections can be introduced in the algorithm of data treatement: temperature and presure corrections, detector nonlinear characteristics and dead time losses corrections etc.

To have realy multifunctional instrument and to use fully the microprocessor possibilities the algorithm of data treatment might be complex and based on quite new approaches.

The structure given in fig.1. is very flexible, although not the only possible. There the microprocessor controls completely the structure functions, i.e. it is program controled, what is very convenient. This permits the designer to create extremely sophisticated algorithm for acquisition and treatment of data, in order to develop new better solution and to suit the users.

CONCLUSION

It is evidently justified to introduce a microprocessor in the structure of radiation meters/monitors. Its use offers all facilities and conveniences of digital techniques, which are numerous and may be of interest in health physics instrumentation design practice. In such a way the radiation meter/monitor becomes the multifunctional instrument, with many useful characteristics increasing its qualities and influencing measurement methodology and philosophy.

One can expected that the future radiation meters/monitors will mainly be microprocessor based, and the proposed structure is the one that can be used for this purpose conveniently.

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