KFKI
31/1969

A NOVEL MEASURING UNIT WITH INTEGRATED CIRCUITS FOR TIME DISTRIBUTION MEASUREMENTS IN REACTOR PHYSICS

I. Pálmai and B. Hubert

HUNGARIAN ACADEMY OF SCIENCES
CENTRAL RESEARCH INSTITUTE FOR PHYSICS

BUDAPEST

Printed in the Central Research Institute for Physics, Budapest Hungary

Kiadja a KFKI Könyvtár- Kiadói Osztálya. O.v.: Dr. Farkas Istvánné
Szakmai lektor: Szlávik Ferenc. Nyelvi lektor: Kovács Jenőné
Példányszám: 65 Munkaszám: 4780 Budapest, 1969. október 28.
Készült a KFKI házi sokszorositójában. F.v.: Gyenes Imre.

A NOVEL MEASURING UNIT WITH INTEGRATED CIRCUITS FOR TIME DISTRIBUTION MEASUREMENTS IN REACTOR PHYSICS

I. Pálmai, B. Hubert
Central Research Institute for Phyiscs, Budapest

Investigations in reactor physics often require measurements involving time analysis. These measurements of essentially similar character may, however, significantly differ in the criteria of evaluation, the number of parameters to be measured, or the covered range of values. This problem can be successfully tackled by using the TIME DISTRIBUTION MEASURING UNIT of the NTA 512 type basic multichannel analyzer. This unit contains a logic system developed by making use of the integrated circuit elements of the most frequently occurring time distribution measurements, enabling thus the analyzer to perform the following typical measurements in reactor physics.

1. <u>Time Analysis</u>

The start signal delivered to its independent input triggers the channel selection without delay /Fig. 1/. The effect signals arriving to another input are added to the content of the currently selected channel.

The measurement covers by means of the detector located at a given point of the reactor the decay of the neutron pulse injected into the core. The parameters of the decay curve permit the evaluation of important quantities /e.g. reactivity/ [2].

Number of channels	128; 256; or 512
Channel width	20 μsec...100 sec, variable in steps of 1 - 2 - 5

2. Rossi - α - type Measurement

The measurement is similar to 1 /Time analysis/ but only one of the inputs, that of the effect signals, is used. The cycle of channel selection is triggered by the first effect pulse /Fig.2/. The next start signal for channel selection is again the effect pulse which arrives immediately on termination of the last channel interval and so on.

The measurement permits the statistical investigation of the internal dynamics govering the decay of fission chains in subcritical reactor. The information obtainable from this measurement is of the same nature as that obtainable from the pulsed /type 1./ measurement [3]. The advantage of type 2 is that it can be performed without the use of a pulsed neutron source.

Number of channels	128; 256; or 512
Channel width	20 μsec...100 sec, variable in steps of 1 - 2 - 5

3. Rod-drop-type Measurement

The measurement proceeds like 1. /Time analysis/ but the time axis is divided into non-uniform subintervals /Fig. 3/.

The 1 ÷ 64 channel width is τ_1 ;
The 65 ÷ 256 channel width is τ_2 ;
The 257 ÷ 512 channel width is τ_3 .

The values of τ_1, τ_2, τ_3 can be set independently of one another 1-2-4 or 8 times the chosen "channel width". The measurement permits to observe the transient effect due to the absorber rod dropped into the reactor.

The pulse generated at the separate output of the first 64 channels can be utilized for automatically inducing the perturbation

Number of channels	512
Channel width	20 μsec...100 sec.

In the above specified three modes of operation the basic unit of the NTA-512 type analyzer processes the input signals arriving from the measuring unit in normal MULTISCALER mode of operation. The channel width can be set by switch on the front panel of the "Automatic and Timer Unit". The pulses counted in each channel are stored on termination of the selected time interval. During the dead time due to storage no effect signals are accepted by the analyser. The dead time starts on termination of the selected channel interval and its maximum duration is 15 μsec. The value of the dead time has to be subtracted from the nominal value of the channel width.

4. Multidetector Mode

The effect signals delivered simultaneously from four detectors to four independent inputs are registered in the corresponding channel of the analyzer memory divided into four equal subgroups /Fig. 4/. The analyzer operates in this case like four independent parallel operaing multiscalers. The effect signals are counted by the four independent counters located in the measuring unit. The output pulses from the counters are stored parallel and successively in the four subgroups of the memory.

The analyzer operates in MULTISCALER mode.

The maximum dead time due to storage is 50 μsec which has to be subtracted from the switch selectable nominal channel width, like in measurement 2.

The measurement permits to observe simultaneously with the phenomenon followed up by the measurement of type 1 also its spatial distribution.

Number of channels	4 x 128 /64/
Channel width	100 μsec...100 sec.

5. Feynman-type Measurement

The signals delivered to the effect input drive the channel selector unit of the analyzer by passing through a gating circuit of variable gate width. The address register of the analyzer is stepped by the effect signals arriving within the gate interval. If "n" effect signals have arrived in this interval the content of the "n+1"-th channel increases by a unit value on its termination.

During the measurement the analyzer operates in "ANALYSIS" mode. Between individual measurements /gate intervals/ the measuring unit does not accept effect signals. The dead time between gate pulses is maximum 15 μsec. The width of the gate pulse is switch selectable on the front panel of the Automatic and Timer Unit. The effective width of the gate pulse is equal to the nominal value set by the switch.

The standard deviation and average value of the number of counts can be evaluated from the measured data. The fit of the curve for the relative value of the two quantities versus gate width to the theoretical predictions permits to evaluate parameters similar to those covered by the Rossi- α - type measurement.

Gate width	variable from 20 μsec...100 sec in steps of 1 - 2 - 5.

The simplified block diagram of the "Time Distribution Measuring Unit" and its connection to the NTA 512 Analyzer is to be seen in Fig. 6. In the Time Analysis and Rod-drop type measurements the registration of the address series is started by the input signal to connector St; while in the Rossi - α -type measurement by the input pulse to connector "GENERAL" In these three modes of operation the input pulse series to GENERAL are counted successively by the arithmetic register of the analyzer. In the are counted successively by the arithmetic register of the analyzer. In the Rod-drop type measurement the channel width is determined by the switch position selected on the front pannel and the dividing clock signal. In Multidetector mode the parallel output pulses of the registers R1 - R4 are taken across a gate system /K/ successively to the parallel input of the arithmetic register by means of a control unit /BV/ which selects always the appropriate memory subgroup of the analyzer. The four types of measurements mentioned above proceed in Multiscaler mode of operation, that is each channel is selected successively according to the time interval set by switches. Simultaneously with the selection of a new channel the information collected by the arithmetic register in the preceding interval is added to the content of the preceding channel. In the Feynman-type measurement the analyzer operates in "ANALYSIS" mode. The channel number in this case is determined by the number of input pulses to the GENERAL connector during the switch presettable time interval and counted serially into the address register. On termination of the preset time interval a unit value is added to the content of the corresponding channel.

Lettering in Fig. 6

R_1-R_4	16 bit registers	F	Amplifier
K	Gate system	SV	Start control
BV	Selection Control	SzV	Counting control.

In the measuring unit the integrated circuit elements have been chosen from the SN74 series of the TTL system manufactured by TEXAS /USA/. In the test runs the electrical and mechanical properties of the elements proved to be satisfactory.

References

[1] G. Robert Keepin, Physics of nuclear kinetics, Addson-Wesley 1965.

[2] Z. Gyimesi, J. Valkó, Investigation of the dynamic properties of the critical assembly ZR-4. V.-th Conference on Physics and Technique of Research Reactors. Warsawa, December 16-21, 1968.

[3] E. Buttler, P. Liewers and Z. Szatmáry, Comparison of Rossi-Alpha and Correlation Function Measurements. Zfk-153. V.-th Conference on Physics and Technique of Research Reactors. Warsawa, December 16-21, 1968.

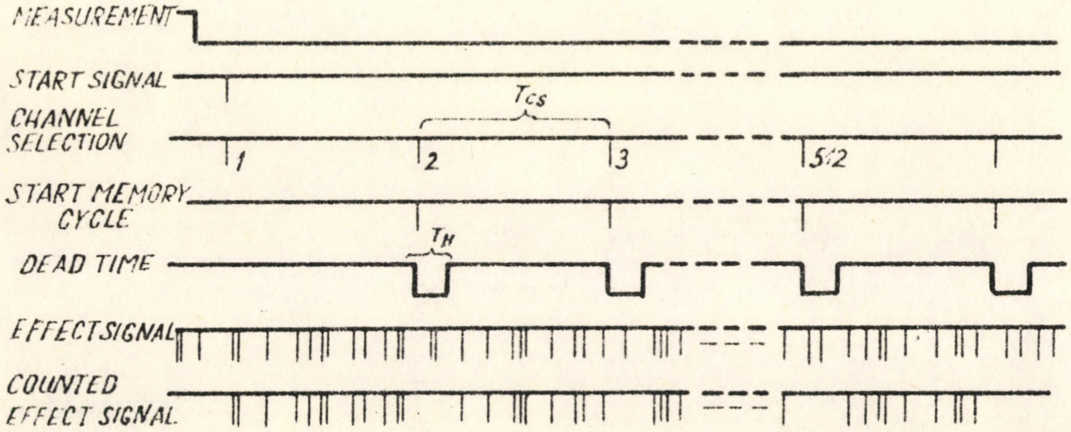

Fig. 1.

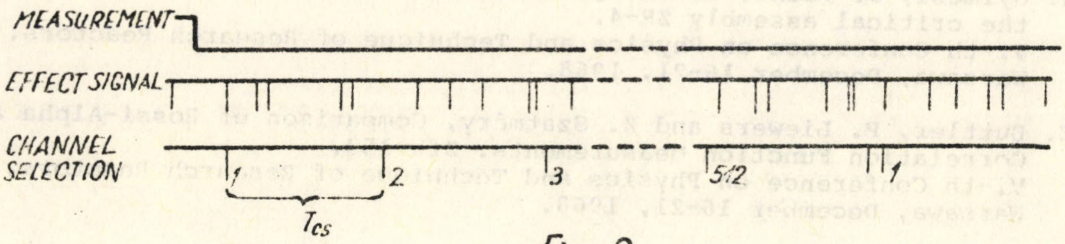

Fig. 2.

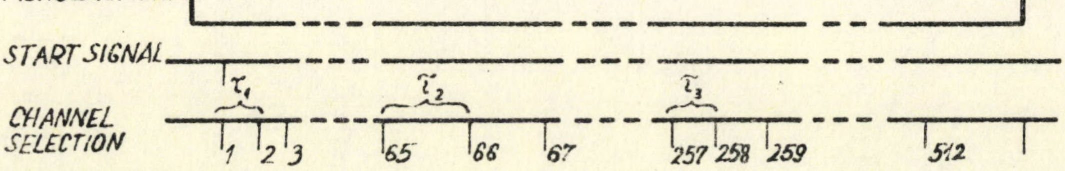

Fig. 3.

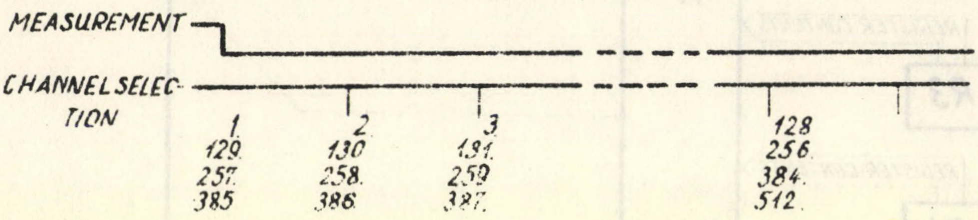
MEASUREMENT
CHANNEL SELECTION
1
129.
257.
385
2.
130
258.
386.
3.
131.
259
387.
128
256.
384.
512.

Fig. 4.

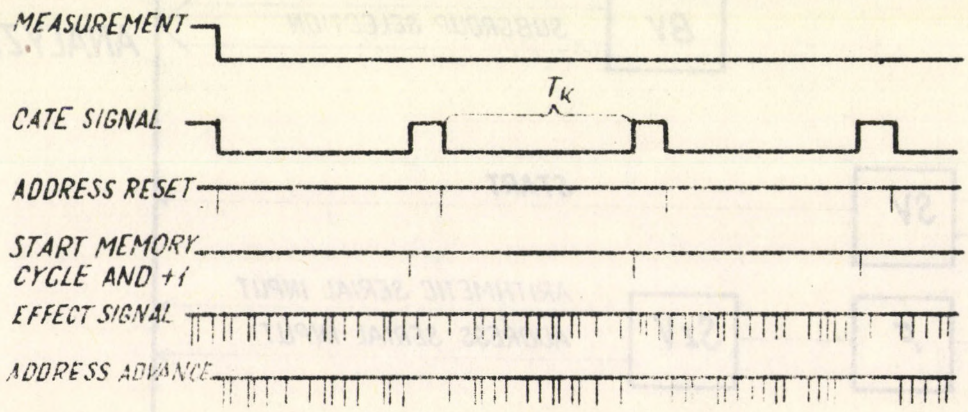
MEASUREMENT
T_K
CATE SIGNAL
ADDRESS RESET
START MEMORY
CYCLE AND +1
EFFECT SIGNAL
ADDRESS ADVANCE

Fig. 5.

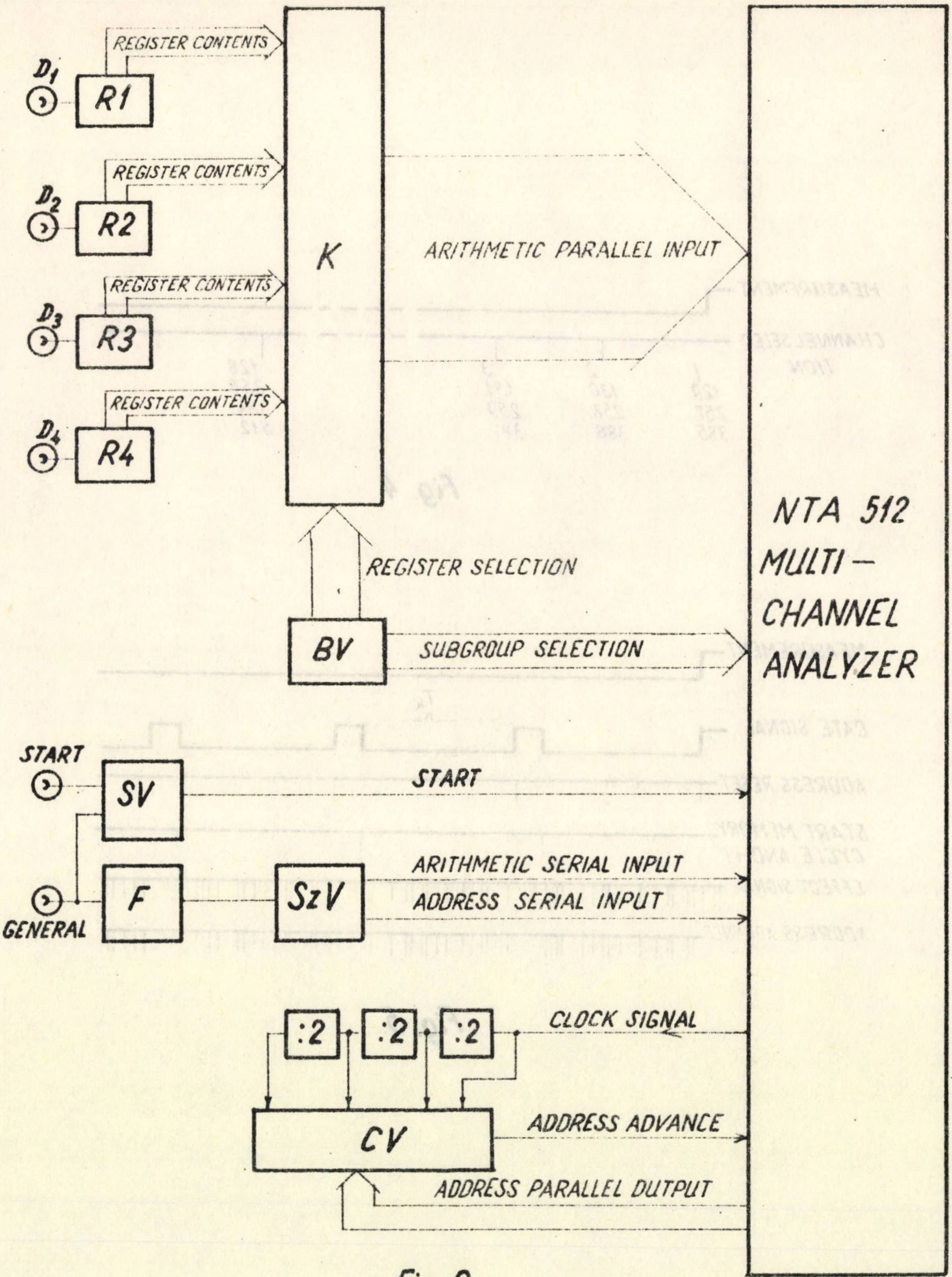
D1
R1
REGISTER CONTENTS
D2
R2
REGISTER CONTENTS
D3
R3
REGISTER CONTENTS
D4
R4
REGISTER CONTENTS
K
ARITHMETIC PARALLEL INPUT
REGISTER SELECTION
BV
SUBGROUP SELECTION
NTA 512 MULTI-CHANNEL ANALYZER
START
SV
START
GENERAL
F
SzV
ARITHMETIC SERIAL INPUT
ADDRESS SERIAL INPUT
:2
:2
:2
CLOCK SIGNAL
CV
ADDRESS ADVANCE
ADDRESS PARALLEL OUTPUT

Fig. 6.