# FEEDING THE URAL-2 ELECTRONIC DIGITAL COMPUTER WITH INFORMATION OBTAINED BY MEANS OF V. M. ANAN'EV'S MULTI-INPUT ANALYZER AND RECORDED ON ONE MAGNETIC TAPE TRACK

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It was pointed out in the book of V. A. Kozhevnikov and R. M. Meshcherskii [1] that for a number of reasons "there is a definite gap between the development of the latest methods of obtaining and analyzing scientific information based on the use of electronic computers and the practical mass use of these methods in physiological experiments." This is explained, in particular, by the lack of special equipment for recording and storing a large volume of primary information obtained when investigating living objects.

If we take into account the specific nature of feeding information into electronic computers, we can divide the systems for recording experimental data into two categories.

In one of them the information is recorded in a form convenient for direct input into the electronic computer, which is achieved by using punched cards, punch tape, and magnetic tape with a multitrack recording in binary code. While having definite virtues these systems are rather complex, expensive, and frequently have unsatisfactory operational qualities – all this is a serious obstacle to their wide use in medical and biological investigations.

More promising are the devices of the second group in which the forms of recording information that are standard for electronic computers are not used but those which are more convenient for experimenters. Magnetic information carriers, primarily magnetic tape, are used in the most widespread systems of recording and storing experimental data pertaining to this category. The methods of recording can be different. Most frequently used are the methods of frequency or pulse modulation which, as of late, are being replaced by the method of binary code recording [1-3]. The instruments of this group require additional information converters for its input into the electronic computer. However, the development of such converters at, for example, individual computer centers makes it possible for many research laboratories to use computer techniques.

In certain cases even some change in the logic of the computer operations is expedient to ensure successful input of information.

On the basis of the Ural-2 electronic digital computer we developed a method of feeding information recorded by the multi-input analyzer of V. M. Anan'ev (see preceding article) on one track of a magnetic tape.

The main virtue of Anan'ev's analyzer is the possibility of simultaneous analyses of many electrograms which is achieved by the sequential recording of all signals. Recording of information on one track of a magnetic tape in a binary form provides sufficient simplicity and reliability of the entire device. The codes of the number and the control signals are separated by a tag selector, which is a necessary link in the method of V. N. Anan'ev. This selector is installed directly in the computer room. The time relationships for the impulses fed to the Ural-2 from this selector are shown in Fig. 1.

The commutation time $T_k$ is selected depending upon the frequency of the input signals. Thus, when analyzing an EEG, $T_k = 0.01$ sec. When $T_k$ = const the number of input signals n can vary from 1 to $n_{max}$ depending upon the purposes of the experiment; $n_{max}$ can be determined from the relationship

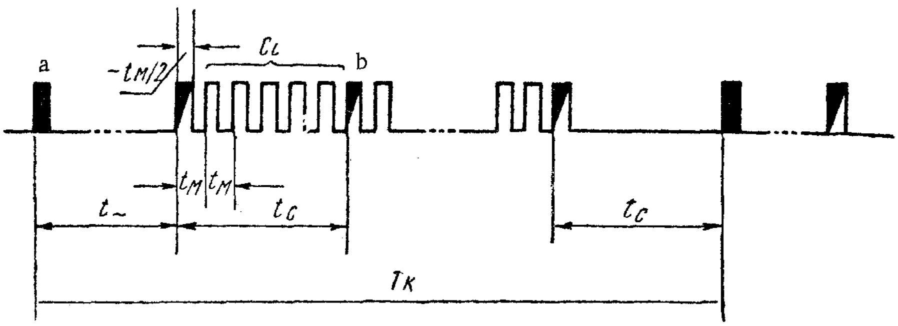


Fig. 1. Diagram of input pulses. a) Cycle tag; b) signal tag; $C_i$) digit order tags; $T_k$) signal commutation time; $t_m$) minimal interval between adjacent tags ($50 \div 60$ μsec); $t_c$) interval between adjacent numbers ($300 \div 350$ μsec); $t_\sim$) interval between cycle tag and first tag of number (400 μsec $+ (t_k - tc)$.

$$n_{\max} = \frac{T_k - t_\sim}{t_c} - 1 . \tag{1}$$

If $T_k = 0.01$ sec, $t_\sim \simeq t_e, \simeq 350$ μsec, then $n_{\max} \sim 26$ signals, which is sufficient for a wide range of problems.

The maximal number of analyzed signals can be increased by a greater density of the recording, by increasing the tape drive speed, and by changing the commutation time $T_k$.

When $n < n_{\max}$, $t_\sim$ changes within wide limits and as a result the repitition rate of the signal tag can vary from 2.8 to 0.1 kc. The amount of entering information can be estimated by the formula:

$$N = \frac{n+1}{T_k} \cdot t_e, \tag{2}$$

where $t_e$ is the time of the experiment. For the program detection of each cycle of n numbers, recording of zero at the start of each cycle is provided. Therefore n + 1 is used in Eq. (2). When $t_e = 30$ sec and $T_k = 0.01$ sec, $N \simeq 80{,}000$ numbers. With an increase in the number of recorded signals and time of the experiment the quantity of information consists of hundreds of thousands of numbers. The considerable volume and characteristics of recording the information create certain difficulties when feeding it to the electronic digital computer.

Based on the logic of the operations the Ural-2 can be continuously fed a quantity of numbers not exceeding the volume of the internal store, i.e., 4096 20-digit numbers. When reading in, from the magnetic recorder, information exceeding the indicated value, partial losses of information connected with stopping of the recorder are inevitable. Furthermore, temporary distortions of experimental data, which are undesirable for subsequent analysis, arise. It turned out that this difficulty can be avoided by writing the numerical mass directly into the magnetic tape store (MTS), by-passing the internal store. A simplified block diagram of the magnetic recorder input of the Ural-2 is shown in Fig. 2.

The codes of the numbers are fed to the receiving register RR, and the cycle tag and the signal tag to the control unit CU forming the line series for the MTS and controlling blocking of the RR. In addition to introducing additional connecting units between the tag selector and the MTS, it is necessary to change the logic of operations 54 and 53 controlling the magnetic tape – internal store group write-in.

The operation of recording the numbers in the MTS has the following form:

| | | |
|---|---|---|
| 54 | $a_0$ | 0 |
| K | m | 0 |
| 00 | $a_n$ | 0 |

Here $a_0$ is the start address of the ferrite core store (FS); $a_n$ is the end address of the FS; m is the number of the magnetic tape zone of the machine. A new quantity, multiplicity (K), is introduced which makes it possible to record in one zone of the MTS continuously $N = 4096 \cdot K$ 20-digit numbers. If $K = 2^6 = 64$, $N \simeq 262{,}000$ numbers.

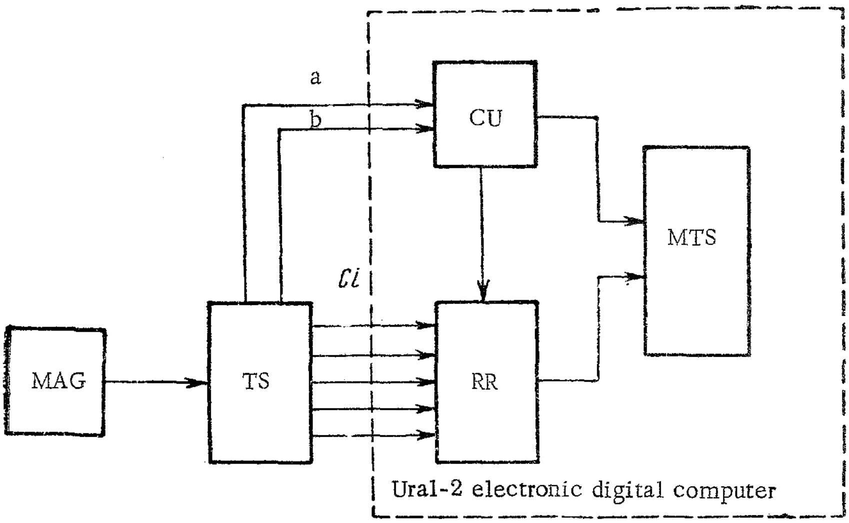


Fig. 2. Enlarged block diagram of magnetic recorder input of the Ural-2 electronic digital computer. MAG) MAG-59 magnetic recorder; TS) tag selector of V. M. Anan'ev; RR) receiving register; CU) control unit; MTS) magnetic tape store.

Write-in from the magnetic recorders is accomplished only when K = 0. In this case we introduce the limitation $a_0 = 0$ which is not essential for the program but simplifies the logic of the operation. When K = 0 the operation performs the usual functions. Control of group write-in of information when the operation is changed is accomplished by the shift counter of the arithmetic unit connected by additional circuits with the operation register, cycle counter, and units of the MTS. The value of K is determined by the total amount of numbers recorded during the experiment $t_e$. The results of the experiment as a whole are written into one zone of the MTS also during time $t_e$.

Then upon writing in the MTS-FS the appropriate part of the mass for subsequent analysis is selected by means of the variable K. In this case, for the numbers represented by the five-digit binary code, just as in V. M. Anan'ev's analyzer, there is a fourfold consolidation of the information. By means of a program, standard for n signals, the recorded material is preliminarily analyzed, the quality of the input is estimated, and the numbers are sorted by channels by means of the magnetic drum (MD). The thus processed experimental material can be written in a consolidated form convenient for further calculations on the wide magnetic tape of the computer.

Upon reprocessing or analysis of the material by a new algorithm the input need not be done from the tag selector. For debugging and routine test runs of new units there is a special operating procedure in which signals from the tag selector are completely imitated. A magnetic tape store operating under check conditions is used as the imitator.

A shortcoming of the described input system is the low utilization factor (about 20%) of the magnetic tape of the electronic computer which is determined by the method of recording the initial information and by the difference in the travel rates of the recorder tape (76 cm/sec) and the tape in the MTS (150 cm/sec). However, as a result of subsequent consolidation of the numerical mass this shortcoming becomes unimportant.

This system of continuous input into the computer of an appreciable volume of information amounting to hundreds of thousands of numbers from a one-track magnetic recorder and tag selector is reasonably simple and can be used by any group operating the Ural-2 electronic digital computer.

## SUMMARY

A method is described for a continuous feeding into a "Ural-2" electronic computer of information recorded on one magnetic tape track and containing more than 1 million bits. Used in combination with V. M. Anan'ev's multi-input analyzer and marking selector the present method enables complete automation of electrogram processing.

## LITERATURE CITED


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