THE GATED AMPLIFIER - DISCRIMINATOR FOR MEASUREMENT OF TEMPORARY PARAMETERS OF ELECTRONIC SCHEMES

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In practical experimental production both application of digital chips and other electronic circuits, it happens it is necessary to make their selection and classification on temporary parameters. The application of usual analog-to-digital converters for this is not possible, as the speech goes about time of switching and delay about nanoseconds, and sometimes fraction of nanoseconds. While selection rate in analog-to-digital converters makes in the best case some megahertz. Or else, time between selections for the analog-digital converter represents microseconds, at the best hundreds of nanoseconds.

The idea of the offered measurement method consist in using the fact, that the test impulses, applied to chip are repeated periodically. Due to this, in each period of test impulses it is possible to make one comparison of the output signal from tested scheme with a reference voltage. Thus, the measurement of parameters will have averaged character.

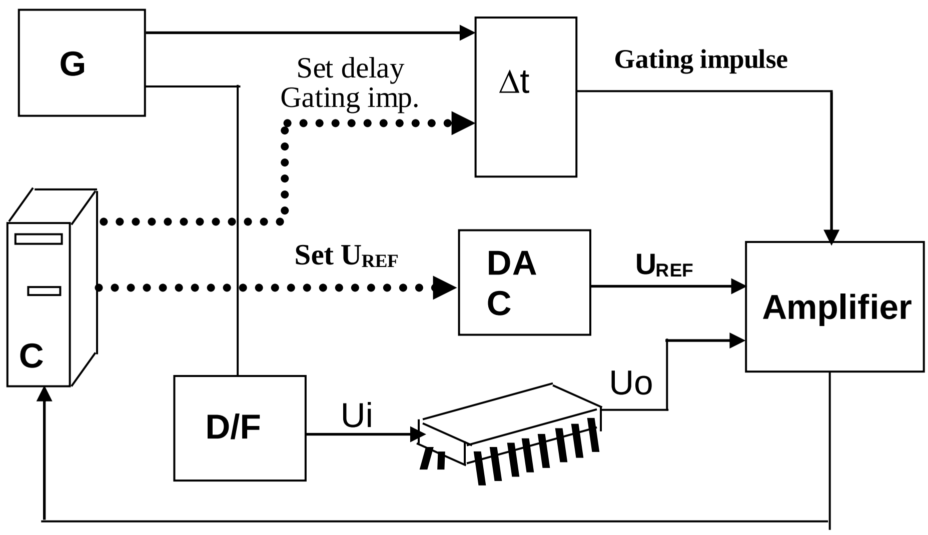

Fig. 1. The flowchart of temporary parameters

The flowchart of measurement of temporary parameters of chips is represented on fig. 2. The quartz oscillator *G* generate a pulse sequence, which through a frequency divider *D/F* is applied to the input of tested chip. The same impulses simultaneously act on a controlled unit of delay Δ*t* for creation gating impulse, which acts on one of inputs of the amplifier - discriminator, and determines the comparison moment of the measured signal with a reference voltage.

The signal from the chip output is applied to one input of the measuring amplifier - discriminator. On the second input of the amplifier the voltage U_{REF} is applied. The comparison of voltages arriving on the amplifier inputs occurs in the moment, when arrive to amplifier the gating impulse front. Thus, the amplifier works as a comparator of instantaneous voltages values given on inputs.

As temporary parameters are accepted the following values (fig. 2):

- the time of switching from zero in unity t_1, time of switching from unity in zero t_2, which are measured between values from 0,1 up to 0,9 from amplitude value;

- the times of signal propagation at switching from unity in a zero and from zero in unity t_3 and t_4.

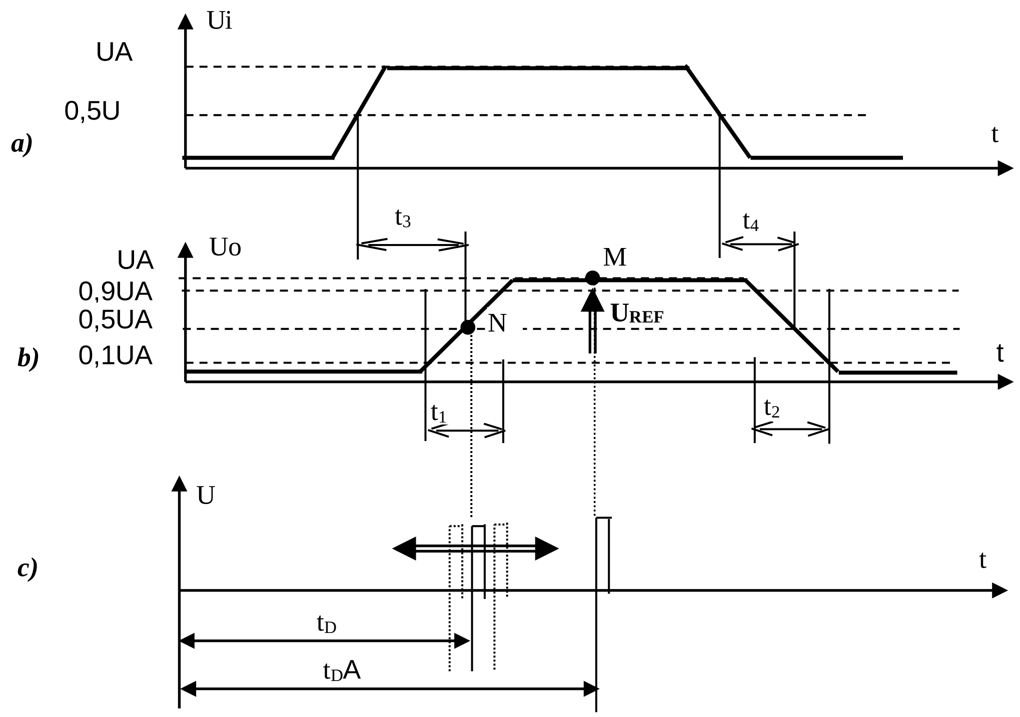

Fig. 2. Temporary parameters of chips. *a*) signal given on chip input;
b) signal obtained from the chip output;
c) the positions of gating impulse during the process of measurements.

The procedure of measurement can be described as follows. In the beginning, the time of the gating t_{DA} (fig. 2.), is installed as the amplitude value of impulse obtained from a chip can be measured. At the same value t_{DA}, reference voltage U_{REF} varies so long as U_{REF} became equal to amplitude value of impulse U_{AO} (point *M*). In this moment the amplifier-discriminator changes its status on an output, the information is transmitted to the computer *C*. Outgoing from the obtained value U_{AO}, the computer determines the necessary value of reference voltage U_{REF}, for the following stage of measurement, for example $0{,}5U_{AO}$. This voltage represents the value of vertical coordinate of a point *N*. At this voltage the delay circuit changes time of delay t_D. The measurement is ended, when the amplifier changes its status on output. In this moment temporary coordinate of a point *N*, that is, the measured parameter of a chip is determined.

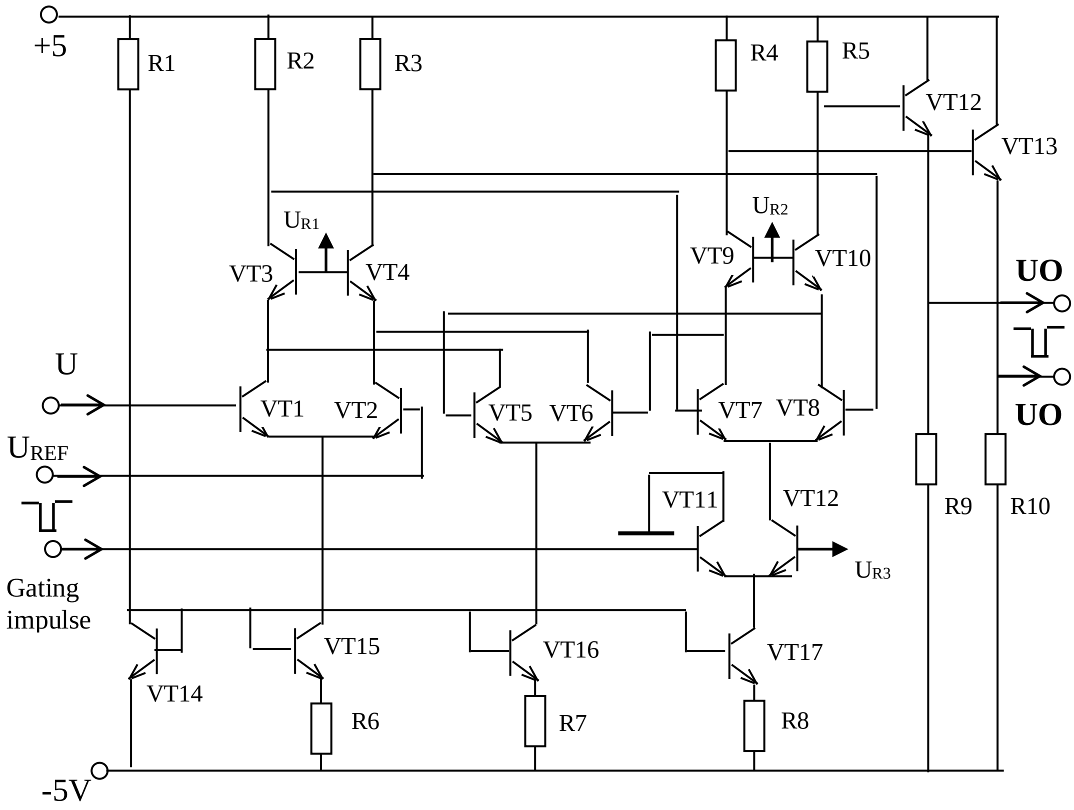

Fig. 3. The scheme of the gating amplifier - discriminator

The scheme of the measuring gating amplifier – discriminator is represented on the fig. 3. It consists from two differential cascades constructed on transistors *VT1*, *VT2* and *VT7*, *VT8* accordingly. A distinctive feature of the presented amplifier is the application as load of the schemes with common base *VT3*, *VT4* and *VT9*, *VT10*. The transistors *VT15*, *VT16* and *VT17* represent sources of current i.e. mirror of currents, *VT14* - is reference transistor. The amplifier is split swept by positive feedback through the differential cascade *VT5*, *VT6*. The current of current generator *VT17*, which supply the second cascade, pass through the current switch *VT11*, *VT12*.

Signal obtained from U_O, is applied to one of inputs of the first differential amplifier i.e. to the base of transistor *VT1*. Simultaneously on the second input of a differential amplifier is applied U_{REF}.

In the initial status to the input “ gating impulse ” is applied the level of logical unity which is higher than U_{R3}, therefore all current of a current generator *VT17* passes through the transistor *VT11*. It means, that the current of power supply of the second differential cascade of the amplifier practically is equal to zero. Therefore, on the output of emitter followers *VT12*, *VT12* there will be a voltage equal to

$$+5\text{-}U_{BE} \approx 4{,}3 \text{ V}.$$

In the moment of measurement to the input "gating impulse" is applied an short negative impulse, which switch the current of generator *VT17* from the transistor *VT11* in the transistor *VT12*. As a result, the second differential cascade became in operating duty. Thus, in the moment of arrival of gating impulse, the scheme works as differential amplifier swept by positive feedback, which strengthens a difference $U_{DIF}=U_{o}\text{-}U_{REF}$. As a result of comparison, during gating impulse one of transistors *VT7* or *VT8* remain enclosed. The second transistor will be opened during the time of gating impulse. The signal will be strengthened by the cascade on transistors *VT9*, *VT10* and will appear on one of outputs of emitter followers *VT12*, *VT13*. On which output the negative impulse will appear, depends from what is higher - Uo or U_{REF}. The comparison of signals occurs during the front of gating impulse, therefore time of measurement appears practically very short and can representing fractions of nanoseconds.

The speed of operation of the amplifier is determined by two parameters: by an amplification factor of the amplifier and its passband. The combination of these two contradictory requirements was possible by using the following factors:

- the application of differential switches of a current, in these schemes at switching does not occur changes of consumed energy, and, therefore, signal should not make path from the scheme up to the power supply;

- usages as load of cascades with common base, which strengthen a signal on voltage and simultaneously have the greatest passband;

- usage of positive feedback.