FUNCTION GENERATOR OF PROGRAMMABLE WAVEFORMS WITH VERY LONG PERIOD CONTROLLED BY THE INPUT SIGNAL

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Abstract

The paper deals with design of slow generator of periodic waveforms the shape of which can be changed. The generator with the period adjustable by control signal could provide wide application.

Keywords:

generator, programmable waveform, converter, frequency range, period, control signal

1. Introduction

The generator is primarily determined to form various periodic courses that should control the mechanical devices simulating various responses, vibrations and changes of parameters. It could be utilized e.g. in medical or other areas.

To reach the most wide range of its utilization we regarded that beside its reliability and precision it has to be easily realizable with the lowest possible price, it could be portable or unit-built so that some of its features could be changed.

2. Block Scheme of Generator

Brief description of function-scheme is given in Fig. 1.

The input voltage u_1 is led to the converter u/f and from there to bistable trigger circuit. The pulses of frequency f are counted in a counter CT and after the maximum has been reached it is set to zero. The output signals from counter CT represent addresses for programmed changable memory M yielding the data necessary for converter D/A from which the required periodical course of u is gained.

Let us consider e.g. 8-bit D/A converter. The memory has 8 outputs and 8 inputs. Binary counter counts on 8 figures. To form one output period u_2 2^8 pulses from bistable trigger circuit are needed.

If we use (u/f) converter, which will be dealt later, the range of frequencies is from 0,1 Hz to 10 kHz, then output periodical course u_2 has the highest frequency $f_{max} = 20$ Hz, ($T_{min} = 50{,}0$ ms) and the lowest frequency $f_{min} = 9{,}8\ 10^{-4}$ Hz ($T_{max} = 17{,}1$ minutes). One period of waveform is composed from 2^8 values that must not be sufficient at some applications.

The more precise results we have achieved using 12 bit D/A converter and corresponding circuit. This has enabled reaching the further shifting to the lower frequency of period u_2.

In this case $f_{max} = 1{,}2$ Hz ($T_{min} = 0{,}83$ s) and $f_{min} = 1{,}22\ 10^{-4}$ Hz ($T_{max} = 2{,}27$ hod.). The number of discrete values of the period of u_2 is 2^{12}

If we want to form e.g. output waveform u_2 in the shape of 10 damped waves then 102 discrete values appropriate to one quarter period cause 1% inaccuracy.

The high precision can be reached by use of 16 bit circuits or by connection with two 8-bit branches according to Fig.2.

Let us consider $(D/A)_1$ and $(D/A)_2$ 8-bit converters. From $(D/A)_1$ come out 2^8 voltage levels. To each of them the further 2^8 values are added so we get 2^{16} values of u_2. In our case of periodic oscillation waveform about 1600,0 values for one quarter period are gained and the inaccuracy is less than 0,06 %.

Minimal period $T_{min} \doteq 13{,}1$ s ($f_{max} \doteq 0{,}076$ Hz) and $T_{max} \doteq 15$ days.

To achieve the greater universality of the device we used converter $(u/f)_2$ at the input u_1. The connection is described later and it enables the changes of input frequency in four decades in the range from cca 10 Hz to 200 kHz.

In this case period of input voltage u_1 $T_{min} \doteq 0{,}3277$ s ($f_{max} \doteq 3{,}05$ Hz) and $T_{max} \doteq 55$ min ($f_{min} \doteq 3{,}05\ 10^{-4}$ Hz.

Connection diagrams according to Fig. 1 and Fig. 2 are not drawn because they can be easily formed in agreement with catalogues of details, except for converter u/f represented in the first case by integrated circuit LM

13700A, eventually LM 11700A produced by the firm National Semiconductors. This converter enables frequency changes from 0,1 Hz to 10 kHz caused by control voltage u from 1 V to 10 V with linearity higher than 0,1 %.

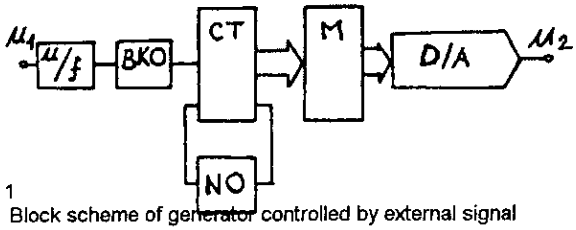

Fig. 1
Block scheme of generator controlled by external signal
u/f - voltage-to-frequency converter
BKO - bistable trigger circuit
CT - counter
NO - zero setting circuit
M - memory
D/A - digital-to-analog converter

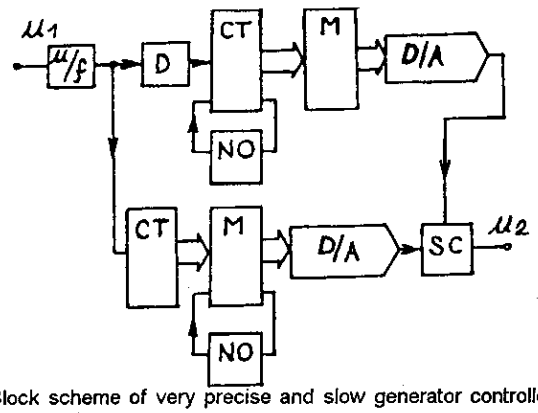

Fig. 2
Block scheme of very precise and slow generator controlled by external signal
u/f - voltage-to-frequency converter
D - frequency divider
CT - counters
NO - zero setting circuits
M - memories
D/A - digital-to-analog converters
SC - summary circuit

The second converter u/f (it can replace the first one and vice versa yielding the changes of generator parameters) was composed from two integrated circuits of the firm KTE and this scheme with informative values is given in Fig. 3.

Details used in schemes in Figs. 1 and 2 were bistable trigger circuits - MH 7493, D-counters MH 7493, CT- 2x MH 7493, EPROM - MH 82716, accumulator MHB 8282, C/A - MDA C08C, MACO1, MAC156.

In Fig. 4 there is a function generator that we have composed of two integrated circuits LM 13700 or LM 13700 A, LM 11700 A developed by the firm National Semiconductors. They consist of their own operational amplifiers and current generators controlled by the input control voltage. The frequency range is wider than 4 decades from 20 Hz. The scheme of the operational amplifiers with current generators was taken from the catalogue of the firm given above.

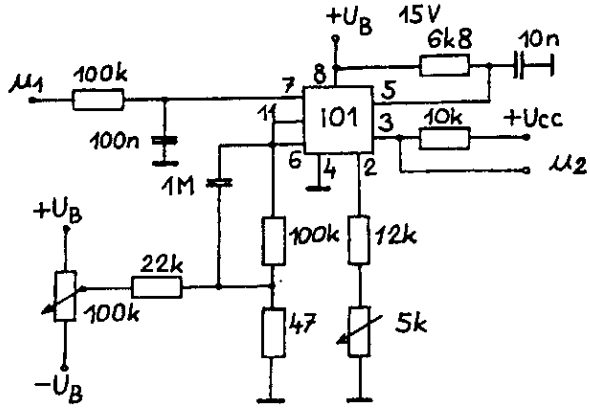

Fig. 3
Voltage-to-frequency converter u/f - LM 231 produced by the firm National Semiconductors

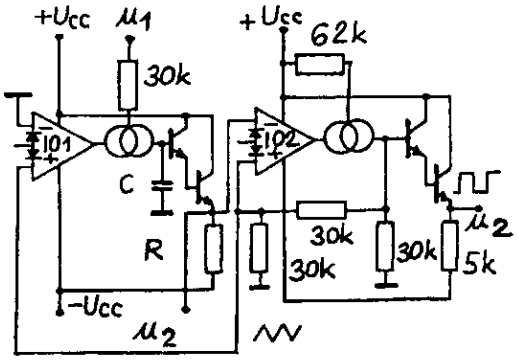

Fig. 4
Analog-to-digital converter composed of two integrated circuits LM 13700 or LM 13700 A, LM 117 A

3. Conclusions

The article deals briefly with the design of programmable waveforms generator, parameters of which could be changed yielding the considerable accuracy of required waveform, especially long-lasting and by control signal adjustable period that could provide wide application.

The further details concerning converters $(A/f)_1$, and $(A/f)_2$ enabling this period control can be found in catalogues of given firms [1], [2]. In cases where there is no necessity to control the frequency by control signal it is possible to disconnect these circuits and replace them by precise pulse generators.

4. References

[1] Catalogue of the firm National Semiconductors, 1994

[2] Catalogue of the firm KTE, 1994