

Operational amplifiers are d.c. voltage amplifiers with a high amplification whose input circuit is constructed as a differential amplifier. A disturbing effect is exerted, in cases where an operational amplifier is used as an a.c. voltage amplifier, by a d.c. voltage superimposed on the a.c. voltage input signal, also termed d.c. offset, since there is thereby produced at the output a shift in potential which in certain applications, e.g. with a d.c. connection of a plurality of operational amplifiers, may be undesirable. It is known for said shifts in potential to be eliminated by capacitance coupling, or in the case of a known constant d.c. offset by the application of balancing voltages.

There is known from the printed patent specification EP-A-0 087 501 a trigger circuit which derives from a frequency mixture exhibiting high and low frequencies the components of the highest frequencies and converts them into square-wave pulses. A circuit is proposed which comprises a peak voltage detector consisting of a first operational amplifier with an antiparallel circuit of two diodes in the feedback loop, the first input of said diodes forming the input of the trigger circuit and the second input being connected via a capacitor to a fixed potential. There is connected to the peak voltage detector a comparator, which contains a second operational amplifier whose first input is connected to the output of the first operational amplifier and whose second input is connected to the first input of the first operational amplifier.

The aim of the invention is to set forth a circuit in which there is derived from an input a.c. voltage of known amplitude with an unknown d.c. offset a square-wave voltage, by means of the d.c. connection of two operational amplifiers.

This aim is achieved according to the invention by the features given in claim 1. Developments of the invention are characterised in the sub-claims.

By the application of the circuit according to patent claim 1 it is ensured for the first operational amplifier producing the a.c. voltage amplification that there is set immediately on the attainment of the first a.c. voltage maximum or minimum a d.c. voltage amplification of $v = 1$. This is achieved by the use in the feedback loop of two antiparallel connected diodes, by means of which a capacitor located in the low point of the a.c. voltage feedback is immediately charged, independently of the size of the feedback resistors, i.e. without a time constant, onto the potential of the unknown d.c. offset present at the input. Since the d.c. offset at the output of the amplifier coincides in value with the d.c. offset at the input, it is possible to relate the inputs of the second operational amplifier operating as a comparator directly to said potential. From a comparison of the amplified a.c. voltage at the output of the first operational amplifier with the input voltage there may be generated a square-wave signal with no, or only slight, constant d.c. offset, since the d.c. component is roughly of equal size at the two inputs of the comparator.

The size of the superimposed amplified a.c. voltage at the output of the first operational amplifier is determined by the values of the resistors forming the feedback. It is smaller than the forward voltage of e.g. ± 0.7 Volt of the antiparallel connected diodes, so that no limiting action by the diodes may take place. The d.c. voltage A arising at the output of the first operational amplifier is governed by the equation $A = UC \pm UF$, where UC is the voltage at the capacitor and UF the forward voltage of the diodes.

The circuit is particularly suitable for the conversion of small a.c. voltages into square-wave voltages, there being superimposed on the a.c. voltage with known constant maximum amplitude occurring at the input of the first operational amplifier an external d.c. offset voltage of unknown value. Said constellation exists e.g. if it is desired to use magnetic field-dependent sensors, such as are supplied e.g. by the company Sony, to determine the commutating moment in the case of a d.c. motor with a rotor comprising of magnetic poles. Such d.c. motors are used e.g. as capstan motors in magnetic tape wheels.

A detailed exemplifying explanation of the invention will be given below with reference to a figure.

- Fig. 1 shows in a circuit diagram the conversion of a sinusoidal a.c. voltage with d.c. offset into a square-wave voltage, said a.c. voltage having been generated in magnetic field-dependent sensors.
- Fig. 2 shows curves plotted at various points of the circuit according to Fig. 1.
- Fig. 3 shows transient and decay phenomena in the circuit constructed according to Fig. 1.

Fig. 1 shows in a circuit diagram the conversion of a sinusoidal a.c. voltage with d.c. offset into a rectangular voltage, said a.c. voltage having been generated in magnetic field-dependent sensors. In the magnetic field-dependent sensors S1 and S2, which are connected in series between +UB and reference potential (earth), there is generated by a rotor R bearing a pair of magnetic poles N, S on the rotation of said rotor a sinusoidal a.c. voltage, which is affected by a d.c. voltage offset at the junction point E of the two sensors. The size of the offset results from the d.c. resistors of the sensors and the applied voltage +UB. The offset-affected a.c. voltage present at the junction point E is on the one hand fed to the operational amplifier OP1 working as an amplifier at its non-inverting input, and to the operational amplifier OP2 working as a comparator at its inverting input. The a.c. voltage amplification in OP1 is set by a feedback circuit formed as a voltage divider, which is formed from a high-value resistor R1 between output A and inverting input, as well as by a series circuit of resistor R2 with an earthed capacitor C1, said series circuit being connected at the inverting input.

By means of said feedback circuit known in itself the d.c. voltage component present at the output A is also fed back to the

inverting input of OP1. On application of the operating voltage, capacitor C1 is charged in accordance with the circuit-wise formed time constant ($R1, R2, C1$), so that only after a period of time predetermined by the time constant is a state reached in which the d.c. voltage building up at output A corresponds with respect to its size to the d.c.-offset voltage present at input E, i.e. only after a plurality of oscillations of the a.c. voltage generated in the sensors S1, S2 is a state reached in which the d.c. amplification $v = 1$ applies. In order to shorten substantially said undesirable start-up operation, the junction point C of C1 with R2 is connected via two antiparallel connected diodes D1, D2 to the output A. Capacitor C1 is thereby immediately on the attainment of a first maximum of the a.c. voltage charged via the internal resistor of a conductive diode onto the d.c. offset voltage, so that the a.c. voltage fed via decoupling resistor R4 to the comparator OP2 at its non-inverting input exhibits immediately after turn-on a d.c. offset which corresponds in its size to the d.c. offset fed at the inverting input.

In Fig. 1 there is shown a resistor R3 in series with the antiparallel connected diodes D1, D2. Said resistor has a value which is kept sufficiently low that the time constant for the charging operation of C1 is not affected to a significant extent. It is also possible to dispense with said resistor. Resistor R5 between output of OP2 and the latter's non-inverting input serves for linearization purposes, it has no significance for the effect of the circuit.

At the output D of comparator OP2 there arises immediately after the turn-on the square-wave voltage converted out of the input a.c. voltage, said square-wave voltage being able, due to inaccuracies in the circuit, to be affected by a slight but constant d.c. offset. By the fixing of the value for capacitor C1 the last state of said rectangular voltage may be stored for a particular period, so that with intermittent operation a motor commutation, e.g. for a capstan motor, controlled by the square-wave voltage may be continued with the correct commutating phase. The use of magneto-resistance elements makes it possible, even when the motor is stationary, to determine statically the assignment of the pairs of magnetic poles to the coils to be commutated.

Fig. 2 shows curves plotted at various points of the circuit according to Fig. 1. In Fig. 2a it is seen that all the curves are affected with a d.c. offset voltage. Curve E shows the input a.c. voltage at point E, curve A the output a.c. voltage at the output A of the first operational amplifier OP1 and curve B the voltage plot at the junction point of the diodes D1, D2 with R3. Fig. 2b shows in curve D the output signal from comparator OP2. A slight d.c. offset, the value of which is not however constant, may arise due to incompletely symmetrical construction of the circuit and is without significance for the further processing of the signal.

Fig. 3 shows transient and decay phenomena in the circuit constructed according to Fig. 1. After the turn-on the voltage

in curve C, i.e. the voltage at capacitor C1, on attainment of the first maximum of the output voltage A with positive or, as shown on the left, with negative amplitude is set in the time T1 to the d.c. offset value, i.e. from the attainment of the first maximum of voltage A onwards said voltage is constant. In the case of a turn-off operation in the time T2 the voltage C settles down at a value which is assigned to the last amplitude value of the input a.c. voltage E, whereby over a protracted period due to the charging of capacitor C1 said value, i.e. also the position of the magnetic poles in their assignment to the sensors, is stored for subsequent control operations.

The following components were used in a constructed circuit:

S1, S2 = Magneto-resistance element DM-106 B, SONY
 R1 = 470K, R2 = 33K, R3 = 0.1K, R4 = 22K, R5 = 270K
 C1 = 47 μ F, D1, D2 = 1N4148.

Claims

1. Circuit for converting a sinusoidal a.c. voltage superimposed with a d.c. voltage - d.c.-offset - into a square-wave voltage, with two operational amplifiers, in which the d.c.-offset-affected sinusoidal a.c. voltage (E) is fed to the first operational amplifier (OP1), configured as an amplifier, to the non-inverting input and to the second operational amplifier (OP2), configured as a comparator, directly to the inverting input, and the output (A) of the first operational amplifier (OP1) is d.c. connected to the non-inverting input of the second operational amplifier (OP2), with a feedback network for adjusting the gain in the first operational amplifier (OP1), characterised in that the feedback network is formed by a first resistor (R1) between output (A) and the inverting input of the first operational amplifier (OP1), a circuit connected to the inverting input and consisting of a second resistor (R2) in series with a capacitor (C1) connected to reference potential (earth), and by two antiparallel connected diodes (D1, D2) connected at the junction point (C) of the second resistor (R2) with the capacitor (C1), said diodes (D1, D2) being connected to the output (A).
2. Circuit according to claim 1, characterised in that the a.c. voltage gain in the first operational amplifier (OP1) is by selection of the voltage divider resistors (R1, R2) adjusted in such a way that the a.c. voltage amplitude at its output (A) is approximately equal to or less than the sum of the forward voltages of the diodes (D1, D2).

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3. Circuit according to claim 1, characterised in that the a.c. voltage is generated by means of rotating pairs of magnetic poles in sensors (S1, S2) detecting static magnetic fields, the a.c. voltage generated exhibiting a constant maximum amplitude which is smaller in value than the d.c.-offset voltage.
4. Circuit according to claim 3, characterised in that at the output of the second operational amplifier (OP2) a square-wave voltage arises whose last state is maintained, even if the movement of the magnetic poles ceases, for the period of time which results from the time constant of capacitor (C1) with the connected resistors.



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