AC VOLTAGE AND CURRENT TRANSDUCERS

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REZUMAT. Autorii prezintă în această lucrare două traductoare statice de tensiune-curent alternativ. Traductoarele prezentate se caracterizează prin precizie şi sensibilitate ridicate, timp de răspuns scăzut, caracteristică de ieşire de tip „releu" şi ieşire digitală.

Cuvinte cheie: tensiune alternativă, curent alternativ, traductor.

ABSTRACT. The authors present in this paper two static transducers for sensing the instantaneous values of AC voltage and apparent current, respectively. These transducers emphasize with their high precision and sensitivity and very small self-time response. The operation of the transducers with a "relay"-type characteristic and the logic output signals permit the transducers' utilization in all data processing logic systems.

Keywords: AC voltage, apparent current, transducer.

1. INTRODUCTION

The continuous qualitative and quantitative development of industrial production impose to electrical drives more and more complex requirements under technical and economical aspects. These requirements lead to the increasing of electrical drive installations' complexity. Thus, these installations can be achieved only on the basis of a perfect knowledge of operating conditions and the possibility offered in different situations.

In order to solve any electrical drive problem, it must be started from the specific features of mechanical load and the afferent systems [1], [2]. The ignorance of these features leads, almost without any exceptions, to an inadequate design of electric drives which cannot satisfy the requirements imposed by modern industry.

An efficient electrical drive system requires also the presence of high performance transducers which offer the possibility of real-time measuring of important quantities from the system. The main electrical quantities are: voltage, current, input power and, only for ac drive systems, the power factor [1], [2]. For all these quantities exist measuring methods and well-controlled instruments with high degree of precision. Some difficulties appear only when it must be done higher precision measurements of a short-time transient state. In this situation, classical instruments give unsatisfactory results and are not useful, especially where the system must take some decisions as result of one parameter's variation [3], [5].

It also must be reminded here the requirements of an economical design concerning the investment and the optimization of power parameters, because the electrical drives represent the biggest power consumer in both national and world economy [2].

On the basis of the above considerations, the authors present in this paper two static transducers for sensing the instantaneous values of AC voltage and apparent current, respectively.

2. AC VOLTAGE TRANSDUCER

For any electrical drive system it can be defined two main groups of quantities: electrical and physical-mechanical quantities. Concerning the electrical quantities, a special attention was given to the precise measuring of short-time variations of these quantities.

In DC electrical drives, the measurements can be performed with satisfactory results using classical instruments. On the contrary, in AC drives do not exist well-controlled instruments for measuring the instantaneous value of voltages and currents [6], [7].

The transducer which can be described in this paper is dedicated to instantaneous prescribed value for AC voltage. The electrical schematic which emphasizes the operation principle is shown in Fig. 1 and its waveforms are shown in Fig. 2.

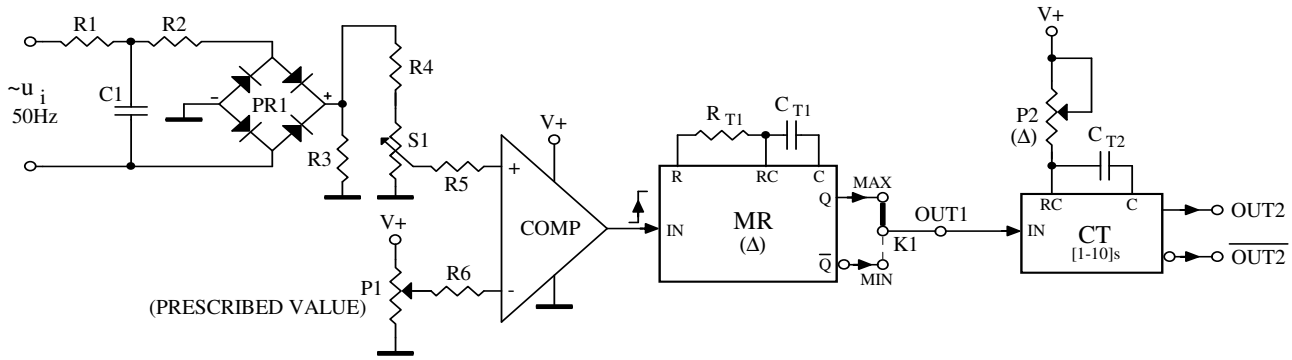

Fig. 1 The electrical schematic of the AC voltage transducer.

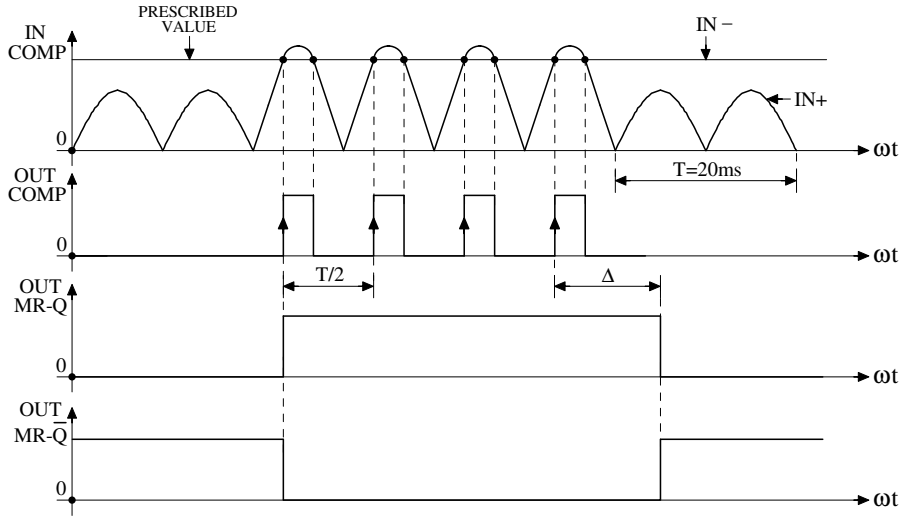

Fig. 2 Waveforms of the AC voltage transducer.

The input ac voltage u_i is full-wave rectified and applied to the non-inverting input of comparator COMP. At the inverting-input of comparator is applied a positive voltage which represents the prescribed value of input voltage.

The comparator output controls the monostable circuit *MR*, which has the time-delay *Δ* greater than half of AC voltage period *T* [3]:

$$\Delta \cong 2.48 \cdot R_{T1} \cdot C_{T1} \qquad (1)$$

The output *Q* of monostable circuit represents the output of AC voltage transducer in its over-voltage relay version (MAX). The negative $\overline{Q}$ output represents the output of transducer in its under-voltage relay version (MIN). Thus, the transducer operates as a relay, providing at the output both logical levels *"0"* and *"1"*, depending on the necessities.

At the same time, the transducer contains a timing circuit *CT* which permits the achievement of time-lag delays up to 10 seconds.

3. AC CURRENT TRANSDUCER

The AC current transducer senses the prescribed instantaneous value of an AC current. This transducer operates with a relay-type characteristic and provides CMOS levels at its output.

The AC current transducer was achieved using the same electrical schematic shown in Fig. 1. The difference consists in the fact that input is connected to a load resistor for a current-transformer especially designed for this transducer. This current transformer has a primary rated current of 5A and, consequently, it can be coupled with the secondary winding of an ordinary current transformer.

4. EXPERIMENTAL RESULTS

The static AC voltage and current transducers were designed to operate at 50Hz frequency. These transducers have a high degree of accuracy (0,1 ÷ 0,2)

and a small self-time response (a statistical average value of 0,015 seconds).

The electrical schematic of a three-phased over - current - MAX [under - current - MIN] relay is shown in Fig. 3.

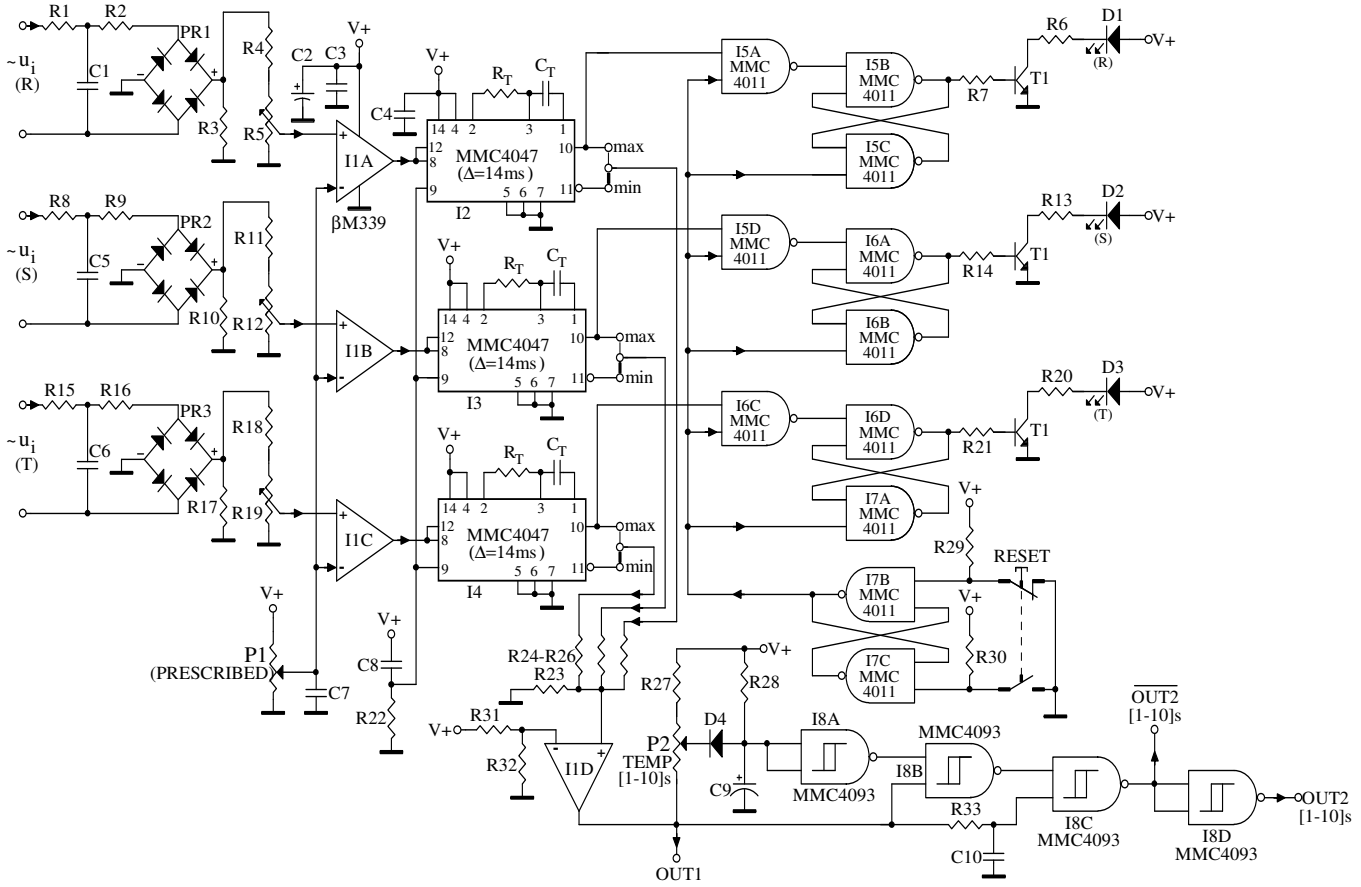

Fig. 3 The electrical schematic of a three-phased voltage (current) relay.

The monostable circuits from the schematic have a timing constant of 14 ms, due to the variations of main frequency in the range of (45÷50)Hz. Owing to its non-time delayed (OUT1) and time delayed (OUT2 and inverted $\overline{\text{OUT2}}$) outputs, the schematic is able to satisfy the requirements imposed by practice. This relay operates in an electronic protection installation for medium voltage substations (BEP) [4].

On a special stand achieved in Electrical Drives Laboratory from Electrical Engineering Faculty of Iaşi, it was experimented a starting method of wound-rotor induction motor using the motor's stator current [5]. The utilization of an AC apparent current relay is recommended for high power induction motors, because the reactive stator current doesn't strongly influence the value of apparent starting current.

5. CONCLUSIONS

The AC voltage and current transducers presented in this paper emphasize with their high precision and sensitivity (degree of precision 0,1 ÷ 0,2) and very small self-time response (a statistical average time of 0,015 seconds). Practically and theoretically, their time constant cannot be further decreased, at least for the electrical drives supplied from the main frequency of 50 Hz.

The missing of moving parts and the utilization of semiconductor devices (CMOS integrated circuits) offer a high reliability which leads to a practically unlimited service period. The operation of the transducers with a relay-type characteristic (mono-phased or three-phased, over or under-voltage or current) and the logic output signals (time-delayed or non-time-delayed) permit the transducers' utilization in all data processing logic systems.

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