CLASSIFICATION AND PRINCIPLES OF CURRENT CONVERTERS STRUCTURE

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Abstract. *The article discusses the principles of constructing a new ferromagnetic current converter with an adjustable range in transformer and galvanomagnetic modes and their classification. It is described how to determine the methods for measuring current transducers, as well as the differences between the non-contact method and the contact method. It has been determined that current transducers used in traction power control systems must have advanced measurement functions, adjustable range, linear ramping function, high sensitivity and accuracy, and proportional characteristics even under severe operating conditions. A comparative analysis of the main characteristics of existing current measuring converters showed that transformer and galvanomagnetic measuring converters better meet the requirements of traction power supply control systems.*
Keywords: *potentiometric current measurement transducer, adjustable range, non-contact measurement, α - sensor, conventional measurement, ferromagnetic core with multiple windings, magnetic circuit, parametric structure circuit, dynamic response, operator method, switching current, switching voltage.*

The Russian Federation, Germany, Japan, France, USA, China, Great Britain and other leading European countries, as well as Uzbekistan, are considered leaders in the creation and production of ferromagnetic current sensors (FMCS), patents for inventions over the past century and constructions presented in the published scientific and technical literature by professor Zaripov M.F. as a result of the analysis on the methodology “determination of generalized methods for improving the basic characteristics of measurement modifiers and their application” developed by, 57 generalized methods were identified [1]. Of these, 38 FMCS’s are dedicated to improving magnetic systems and 19 to the Hall element (HE) in them [7].

Only the work devoted to the systematization of generalized methods and their analysis, dedicated to the improvement of magnetic systems of FMCS. Therefore, we will also have to limit ourselves to quoting the identified generalized methods for improving magnetic systems in this article and pay attention to the analysis of generalized methods that are related to improving the characteristics of HE used in FMCS next. The generalized methods identified in this can be classified into the following three categories: constructive; technological; use of new materials [1].

Current measurement methods are divided into the following two large groups (Figure 1) [2]: 1) Potentiometric, thermal and electrochemical current measurement sensor (CMS) based contact method; 2) contactless method.

Measurement of currents in a non-contact manner is divided into electromagnetic and remote in turn.

Potentiometric substituents are based on measuring the voltage drop generated by the current being measured in the resistive, inductive, and capacitive elements for which the resistivity is known, whose physical principle (principle)lies in Om’s law.

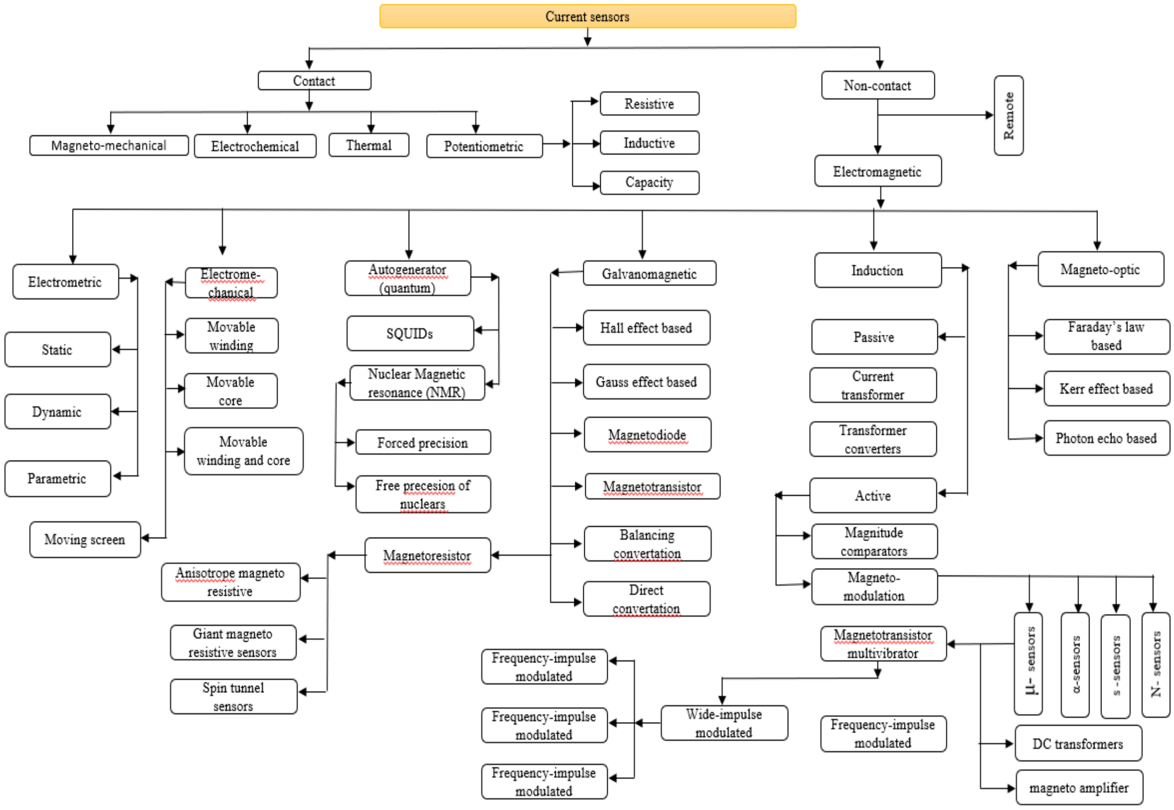

Figure 1. Classification of current sensors

Based on determining the amount of heat separating from the resistive element when a current being measured at a certain time interval passes through the resistive element, whose physical basis lies in the Joule-Lens law.

In the physical principle of the method of non-contact measurement of currents, four physical phenomena lie. The first is the full Vine law – Maxwell's first equation, in which a ferromagnetic describes the contact of a current being measured in a non-axial state with the magnetic field it generated around it. In this case, the magnetomotive force (MMF) is integrated using a measuring tube arranged uniformly distributed along the berk contour around the current being measured, and each winding of the measuring tube is equivalent to measuring the strength of the magnetic field at the point where that coil is located. Therefore, it can be obtained that the total number of measurement points around the current being measured is equal to the number of wraps in a single layer of the measuring tube.

If a ferromagnetic berk magnetic conductor is obtained with a high relative magnetic absorption as a berk contour around the current being measured and the same length of the contour as well as its transverse cross section, then the induction of the magnetic field will be at almost the same value along the contour. In this case it would be sufficient to measure the induction value of a single-valued bond with the current being measured at a single point of the berk contour since the current passing through the tire is non-excitable, the surface of the cross section is the same, and the current density in the tire is the same value [4].

The second physical principle of non – contact measurement of currents is based on the law of electromagnetic induction-Maxwell's second equation, in which an electromotive force (EMF) is generated in a measuring tube inserted into the magnetic field around the AC being measured. Therefore, CMS working on this physical principle are called induction.

Induction Toos are divided into active and passive types. Passive toads are divided into current transformer (CT) and transformer modifiers. Passive nets are only used to measure alternating currents. At the expense of external energy in active cells, the parameters of Electrical and magnetic circuits are modulated, and although they are theoretically recommended for the measurement of fixed and variable currents, they are mainly used for the measurement of fixed currents [4]. Depending on the type of parameter being modulated, the active cells are divided into α- , S-, N -, and μ - sensors.

An example of α-sensors is a frame rotating in a magnetic field, an outline fastened to pezocrystalline facets to S-sensors, a ferromagnetic rotor rotating relative to a ferromagnetic stator to N - sensors, and μ - sensors is a device where the relative magnetic absorbency of a magnetic conductor is modulated using an external magnetic field [5].

The third physical principle of non – contact measurement of currents is based on Ampère's law-the force of interaction of the current being measured with an auxiliary magnetic field or ferromagnetic mass, and electromechanical toads are built on this physical principle.

The fourth physical principle of non-contact measurement of currents is based on Maxwell's third equation, which uses the connection between the electric induction vector and the charge density. Electric Toos are built on this physical principle.

For the practical use of the above physical principles of non-contact measurement of currents, elements that are sensitive to the induction of the magnetic field generated by the current being measured and that are called “magnetism” are used [6, 13]. These Toos use three elementary modifiers in the sequence” current-magnetic voltage-magnetic flux (magnetic induction)-generalized parameter [7].

The thermal and electrochemical circuits, which are listed in the classification of their existing toos and belong to the contact measurement method, are not used in automatic control systems due to the complexity of their constructive circuits and the magnitude of the measurement error [8].

The method of non-contact measurement of currents is divided into the following two groups: 1) Traditional CMS; 2) remote CMS. In traditional CMS, the magnesium element is placed with or directly close to the tire on which the measured current is passing. In the case of remote Toos, the non-magnetic element is set at a certain electrical isolation distance depending on the amount of voltage in it from the tire through which the measured current passes, for example, at a tire voltage of 35 kV this distance is 0.6 m, at 110 kV it is 1.0 m, and at 220 kV it is 1.8 m. In remote CMS, the amount of output signal is very small, and it is very difficult to distinguish it from interference signals caused by magnetic fields on side tires and currents in three-phase lines, and therefore the measurement error will be 5% and even greater [6]. Due to this drawback, remote CMS are not used in electrotechnical devices, including automatic control systems (with the exception of high-voltage electrotechnical and electroenergetic devices relay protection system).

The 24 variations of current measurement sensors, synthesized using the Energy-Information method of physical structure principles based on galvanomagnetic and transformer effects, were found to have the highest sensitivity when measuring constant current, A galvanomagnetic modifier based on the giant magnetoresistive effect, and a transformer modifier assorted to the electromagnetic induction effect when measuring alternating current.

Thus, some of the other types of CMS listed in the classification are less common, while some are used in automatic control system of relatively wider traction power grid devices.

Adjusting the measurement limits in transformer FMCS is mainly done by adjusting the number of loops wraps, or by generating oppositely directed magnetomotive forces (MMF)in the primary loop of loops and adjusting their values. Both of these methods involve separation of the primary loop from the source or contact adjustment (as switching occurs). This, naturally, leads to certain inconveniences in production conditions. In order to expand the field of application of FMCS, it is proposed to use FMCS's, in which the ring-shaped element, capable of reducing the value of its threshold of sensitivity, is electrically insulated from each other and made in the form of two ring elements with mutual reflection, at opposite ends of which air intervals are envisaged.

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