High Current Measurement using Piezo-Electric Transducer

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Abstract— The accurate & reliable measurement of the system parameter is very essential for safe & stable operation of an electric power system. In particular measurement of current & voltage .In past decade, attention on electrical sensor for measurement of high current was quit low, this sensor will replace existing measuring instrument of electrical power system. Research efforts are in progress since many years for viable alternatives to instrument transformers, focusing mainly on reduction of cost, improvement in safety reasons & accuracy of measurement. Convent ally measurement of current by CT, Shunt, hall & iron –cored transformer like CT. In this paper a new approach is introduces for measuring high current by using principle of piezoelectric .This method can use for any rating of current.

Key words: Current Sensor, High-Current, Lead Zirconate Titanate Pb (Zr,Ti)O3 Disc, Piezoelectirc

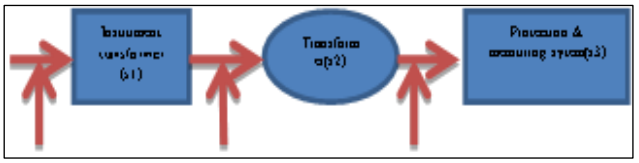
I. INTRODUCTION

In the measuring, counting, control and protection (relaying) field of power supply, it is well known the need of monitoring the electrical potential and current in the conductors of the transmission lines and the conductors connected to substation power transformers. These measurements are transmitted to a central station for the control of the entire power system to assist the dispatch operator and other bulk network functions depending on the so called Power Control Centre.[1]

The instrument transformer technology has changed following the evolution in the protection and metering systems. Until 1975 basic technologies used in high voltage measurements were the electromagnetic (for voltage and current measurement) and the capacitive (for voltage measurement). During the 80's, evolutions were regarding to the reduction of dimensions, increase of reliability, security and accuracy by means of selection of new materials, and construction techniques, e.g. new solid dielectric materials for the housing and new magnetic materials for the cores. However, the theoretical aspects continued being the same. Since the end of 80's, the trend in the requirements of the protection and control systems allowed the research of novel sensors for measuring high voltage and currents. An example of this evolution is the electro-optical instrument transformer which opens the door to a new concept in the systems for monitoring a bulk electric delivery system. Systems for the monitoring and the management of electricity networks are composed basically of four sub-systems (Figure 1.1)

1) S1 - Instrument transformer for measuring currents and voltages.
2) S2 - System for transmitting the signals from instrument transformers to protection and control systems.
3) S3 - Protection and measuring systems.
4) S4 - Software for protection and control system.

Instrument transformers, as the name suggests, are used with measuring and protective equipment in order to monitor electrical parameters such as current and voltage or to use these parameters to activate protection schemes.



High current Low current Software system

Fig. 1.1: four sub system for the monitoring and the management of network

They are thus used with ammeters, voltmeters, energy meters, power factor meters, watt meters, etc., for the measurement of current and voltage, and with protective relays for tripping circuit breakers in the event of faults.[2][3]

II. RELATED WORK

The technology evolution in the protection and control systems (S3) has changed the requirements of the instrument transformers (S1) and the communication of the information (S2). To investigate the requirements of the instrument transformers a good knowledge of the protection systems must be achieved. Table 1.1 shows a classification of the protection systems in accordance with the basic technology. Fuses are the oldest and simplest protection devices. Their operation is based on sacrificing a little element of the system to keep the rest out of danger. Fuses are connected directly to a line which need to be protected from a short-circuit current and their response depends on the calibre and fusion curve chosen.[5] When the fuse actuates the service stops and it does not start again until it is replaced. Because of its simplest operating principle, fuses are the most reliable protection system. This is because they are already a essential device in the protection field. The Direct Electromagnetic Relays were the next devices introduced for protecting. They could continue in service after actuating and also they allowed one to adjust some of the response characteristics. Their operation was based on the force generated for a coil driving directly for the current of the circuit to be protected, to open the spring of a disconnection mechanism. The limitation of this devices were establish for the magnitude of the voltage or current where were applied. Precisely, the name of direct indicated the directed connection of the relays to the voltage or current to be measured.[8] "Modern Transducers for Measuring High current in power system.''

III. PROPOSED SYSTEM

The value of transformation ratio actual ratio is not equal to the turn ratio. Also the value is not constant, but depends upon the magnetizing and loss component of the exciting current, the secondary winding load current and its power factor. Also the other due to secondary winding current not being 180 out of phase with the primary winding current.[1 , 2]

A. Error in CT

For high voltage application, porcelain insulators and oil-impregnated materials have been used to provide insulation between the primary bus and the secondary windings. The

insulation structure requires to be designed carefully to avoid electric field stresses which could eventually cause insulation breakdowns.

Another aspect that affects the response under transient conditions is the low frequency response of the conventional. Moreover this aspect become, at present more and more significant due to increase of harmonic level in the network.[8,9]

Although secondary 5A,during a short circuit fault on the power system the current magnitude increases from several times to ten times.

The standard 5A low burden secondary configuration is not compatible with the new technology which uses analog to digital convertors requiring low voltage input at the front end.

For another deficiency to see comparison table.

The advances in the protection and measuring systems have motivated new requirements in the instrument transformers. This evolution has been affected, mainly, due to the characteristics of the secondary transducers. Microprocessor (numeric) and digital technologies convert the measure in information codified by means of a voltage of electronic level (from some mV up to some volts). The classic code in the form of a voltage or current with a certain power is now going to be abandoned. Thus, the new transducers will have to improve their accuracy, safety, electromagnetic interference, stability and frequency and transient response in order to be of the same standard as the protection and measurement system.[7]

Measuring High current in power system.''

IV. PROPOSED SYSTEM

A. Prototype construction

Two types of construction were evaluated, depending if both currents were driven in the same sense or on contrary senses. In the first case, the appeared forces are always in compression, while in the second case the forces will be tensile. Here it is discussed a prototype with compressive forces. This type of device has the advantage in front the tensile type that the decoupling between piezoelectric discs and the conductors does not occur and the mechanical requirements are lower.

B. Prototype with two parallel currents

The prototype, consists of two piezoelectric rings of PZT-5 connected in parallel. The current arrives to the sensor and is divided in an upper and a lower copper electrode. In this way two parallel current appear in both sides of the piezoelectric sensor and so a compressive force. The path of the current is closed in the opposite end. The external electrodes of the sandwich are connected to ground and the middle electrode provides the generated output voltage. Both copper electrodes were constructed to provide a necessary stiffness to the sandwich (quasi-blocking measurement). The sensor was finally fixed together with the electrodes by using a screw passing through the internal hole

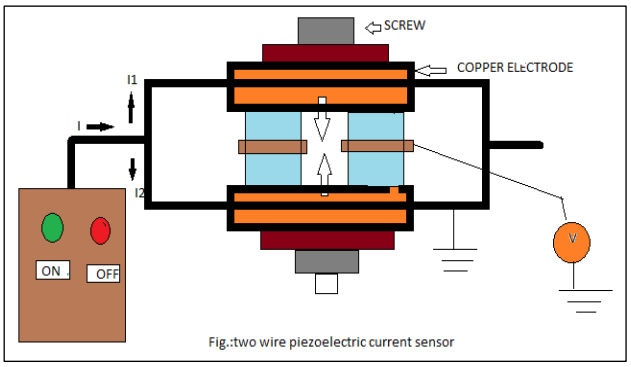


Fig. 2: Two wire Piezoelectric current sensor

V. CONCLUSION

The two-wire piezoelectric transducer is a more reliable alternative for measuring current. It reduces in a 100% the magnetic core use, and so core saturation problem does not exist. The two-wire piezoelectric transducer presented represents only the initial successful step in the research in the field of piezoelectric current transducer. Another important effect to be analyzed corresponds to the effects of the temperature is in the measurements. Ceramic materials are pyroelectric and their stability against the temperature is very low. The effect and behaviour of the sensor for the temperature increase for current flow of the order of 100A or more is very important. A counter measure to this is the use of piezoelectric materials with a good thermal stability.

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