Real-time Monitoring of Power Transformers in EDP Distribuição Substations using New Diagnostic Techniques

The growing need for the reduction of maintenance costs in the electric energy sector has boosted a shift to condition-based maintenance programs of some components, with special emphasis on power transformers due to their critical role in the power system. In this context, this project aims the development of a non-invasive real-time diagnostic system for power transformers of EDP Distribuição.

Main Project Team

Sérgio Cruz	**PS-Co**
André Mendes	PS-Co

Funding Agencies

EDP Distribuição, S.A.	**68,385€**
Start Date	01/03/2013
Ending Date	28/02/2014

Indicators

Conference papers	1
Laboratory prototypes	1

Two Main Publications

J. M. P. Pinto, P. C. Carreira, P. B. V. Vidal, J. V. F. Ferreira, S. M. A. Cruz, E. G. Marques, **Non-intrusive solution for power transformers real time monitoring using an hybrid Park's vector and model-based approach**, International Conference and Exhibition on Electricity Distribution - CIRED 2015, Lyon, France, June, 2015

PROJECT WEBPAGE URL

https://www.it.pt/Projects/Index/1838

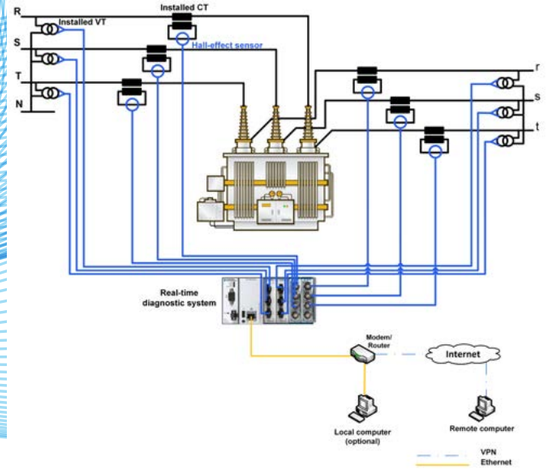

Fig. 1 Architecture of the developed real-time diagnostic system

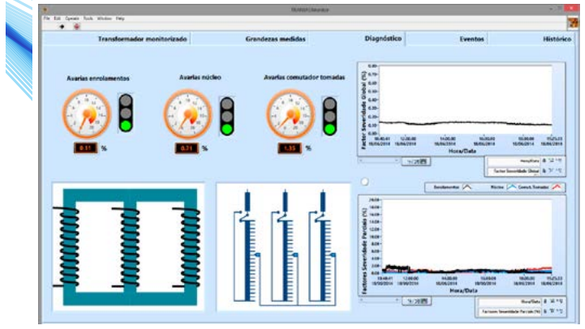

Fig. 2 User interface of the application developed showing the condition of the power transformer

GENERAL MOTIVATION AND OBJECTIVES

Power transformers are the most critical and expensive components in any production, transportation and distribution network. All electric energy produced and consumed by the end-user flows by power transformers. Thus, it is easily recognized that a fault in this equipment may lead to interruptions of the electrical service and has serious direct and indirect costs to the energy system operator.

Traditionally, power transformers are subjected to a periodic maintenance plan, which usually consists in annual inspections to perform a dissolved gas analysis to the oil, physicochemical tests, search for furanic compounds, etc, for screening and detection of anomalies. These tests are expensive, require physical access to the power transformer and are not very reliable. In addition, the transformer may eventual develop an incipient fault between each inspection, later on progressing unnoticed until finally culminating into a more serious and eventually catastrophic fault. This is leading utilities to seek for more advanced diagnostic solutions that may give an early warning about any fault at an incipient stage, thus avoiding an unscheduled shutdown of the power transformer and reducing maintenance costs.

In this context, the main objective of this project is the development and validation in two pilot primary substations of EDP Distribuição, of a new non-invasive automatic diagnostic system, able to detect in real-time the majority of faults that may appear in a power transformer without human intervention.

CHALLENGE

Development of a non-invasive real-time diagnostic system for power transformers based solely on the analysis of electric variables, easily measured with the aid of voltage and current transformers available in the primary substations. The system should be able to detect and discriminate different types of faults in the windings, magnetic core and OLTC of power transformers.

WORK DESCRIPTION AND ACHIEVEMENTS

The tasks carried out and the obtained results can be grouped into three different categories: algorithms, hardware and software.

Algorithms:

- Development and validation, in the laboratory and in the field using two real power transformers, of two diagnostic techniques able to detect and discriminate three different types of transformer faults: (i) inter-turn short-circuits in the windings; (ii) hot spots in the magnetic circuit; (iii) increase of the contact resistance of the OLTC.
- The diagnostic algorithms can be applied to any oil-immersed or dry-type power transformer used in the production, transportation and distribution energy systems as well as in industry

Hardware:

- The architecture of a real-time compact processing platform, based on a real-time processor and FPGA, was designed and validated in the field
- Precision signal conditioning electronics was developed in partnership with a subcontractor for the measurement with high accuracy of the secondary currents of the current transformers located in the substation
- The hardware developed is able to measure with precision the electric variables needed by the diagnostic system: primary and secondary voltages and currents of the monitored power transformers.

Software:

- An application with an intuitive and user-friendly interface was developed, which allows the operator to monitor in real-time the actual condition of each component of the power transformers located in the substation. The software allows to visualize different variables related to the operation of the power transformers and issues a final report about the condition of each power transformer
- The tool developed automatically issues warnings, alerts and operator recommendations in case a fault is detected and some action is required