Influence of Low Power Voltage Transformers (LPVT) on the Results of VLF Diagnostic Tests on Medium Voltage Cables

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ABSTRACT

Low-power voltage transformers (LPVT) are promising alternatives to conventional voltage transformers and are increasingly installed in medium voltage underground cable systems. Besides standard operation conditions, commissioning testing of new lines, or testing for maintenance and condition monitoring purposes on existing lines has to be considered for the use of low-power voltage transformers. This paper illustrates an experimental investigation on the potential impact of LPVTs on results of VLF cable testing and diagnostic measurements. The study is based on results of partial discharge and dissipation factor measurements performed on different LPVT technologies. The paper also features a field case study.

KEYWORDS

Partial discharge testing, PD capturing, dissipation factor measurement, tan delta, condition based maintenance, VLF , low power voltage transformers

INTRODUCTION

The integration of power plants for the generation of renewable energy at all voltage levels of power systems and the increasing number of relatively large electrical consumers are accompanied by major challenges for the transmission and distribution systems due to bidirectional power flow, dynamic behaviour of generation and consumption, increased amount of transmitted energy and further reasons. The challenges create the need for new regulative and protective concepts in future smart grids. These concepts again require an increased amount of information on network parameter at different points within distribution systems. To enable the collection of data on a large scale, suitable sensors and measuring systems are required to provide high performance without compromising the operation of the system. Such sensors need also to be easy to be implemented and cost effective.

Low power voltage transformers

Due to the availability of “intelligent electronic devices” (IED) which can use low power signal to offer monitoring, measurement and protection, “low-power voltage transformers” (LPVT) are increasingly used in medium voltage distribution systems [4, 5]. Passive low-power voltage transformers, currently available in the market, are using voltage divider principles to provide a low power voltage signal proportional to the high voltage to be measured, that means, unlike traditional instrument transformers, there is no need for a ferromagnetic core, this provides advantages regarding linearity, frequency characteristics, weight, space requirements, reliability, maintenance and cost.

Possible access points for measuring devices in medium voltage distribution systems dominated by cable lines are primary and secondary substations to which the cables are connected. Sensors can be located inside a substation, in transition components or in cable accessories installed on power cables. Screened separable connectors for connecting power cables to compact switchgear are easily accessible components for integrating voltage measurement systems (**Fig.1**).

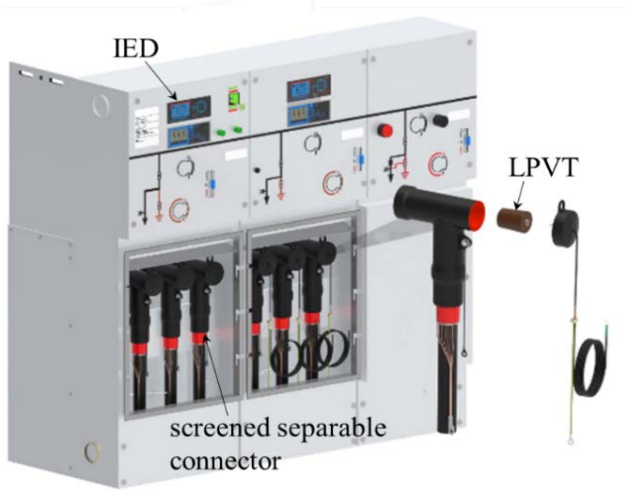

Fig.1: Example of a medium voltage switchgear equipped with screened separable connectors, LPVTs and IEDs

LPVTs based on a capacitive, resistive or a mixed divider principle (**Fig.2**) integrated in epoxy resin components have been established in the market over the last few years [5]. Most resistive dividers in fact are resistive-capacitive dividers, since stray capacitances have to be taken into account. Typical divider ratios of primary voltage to secondary voltage U_1/U_2 are e.g. 6,154/1 or 10,000/1. LPVTs are available for measurement and protective purposes in different accuracy classes, e.g. 0.2 or 0.5, which correlates to their defined limits for ratio and phase error under different test conditions specified in IEC 61869-1, IEC 61869-6 and IEC 61869-11 [1,2, 3].

Very low frequency (vlf) testing in distribution networks

Network operators are increasingly faced with challenges to deliver power with high availability and reliability at the lowest possible costs, combined with new challenges that are briefly described above.