Optical System for Underground Cable Maintenance, Mixed Lines Fault Discrimination and Underground Cable Fault Location

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ABSTRACT

The use of optical current transformers for measuring currents connected with conventional communications fibers opens up unconventional possibilities for the operation of underground cables. A system on a 115kv cable with distances of 12km has been developed and implemented. The cable's nominal currents together with the screen currents at the grounding points have been measured, and this represents a paradigm shift in the management of buried cables, providing maintenance, discrimination and fault location.

KEYWORDS

OCT Optical Current Transformer.

SM Single Mode fiber optic.

INTRODUCTION

The underground cable installations are a reality that for various reasons begins to impose.

The strong social rejection of the overhead installations, the weather non-dependence of the underground facilities, their own security and their capacity to reach the urban centers, make these facilities an element of greater interest within the transport network of any TSO.

The presence of electric mobility in the cities is going to suppose a strong increase in the mesh needs and as result, a strong increase of this type of facilities is expected.

Despite their clear advantages, they have certain drawbacks. They tend to be unassisted systems or with very precarious maintenance, precisely because of their buried condition. They also present problems in lines of a mixed nature, for the discrimination of where the fault lies, due to the disparity of the characteristic impedance of both lines (aerial and underground). Finally, in case of fault, it is difficult to discern the point of failure, and consequently the times of replacement of the installation.

Currently, alternatives are still being searched to monitor and operate this type of facility in a safe manner. So Cigre has several working groups, in which the remote sensing is a constant.

As an alternative we suggest improving the information available about the installation with both: the nominal currents of the cable and the currents of the screens. Conventional current measurement systems require power supply systems and, of course, are not considered passive and therefore maintenance-free.

Optical current transformers, developed with optical fiber, do allow this type of measurement, module and phase, (remote and passive) and the deployed system shows that this approach is feasible. Also, with the contribution of these magnitudes has been resolved in a complete and compact way all the needs of this type of facilities, which would be the Maintenance of the facility and the Discrimination and the Location of the fault.

OPTICAL CURRENT TRANSFORMER (OCT).

The use of fiber optic systems has dramatically increased in the last ten years. Deployment of fiber optics within the field of communication have allowed for features that until now were considered exclusively academic level.

Optical fibers allow direct measurements of magnitudes relevant to underground power cables, such as current (Faraday effect), temperature and strain measurements (Rayleigh, Raman or Brillouin scattering).

Development of the parts making up a guided optical system, including light sources, amplifiers, polarizers, mirrors, and passive parts, has greatly improved, especially when working within the usual communications window of 1310 nm and 1550 nm.

Some existing fiber optic current measurement solutions based on initial patents, do not allow for the connection of optical transformers and interrogators using standard single-mode fibers of type G652 or G657, as they require polarization-maintaining (PM) [2] fibers for the connection. However, at this time, measurement schemes that do not require the PM method have been developed, such that the connection link can be deployed using standard single-mode fibers for the communication [1].

In this way, it is possible to connect interrogators located in a substation with OCTs, using the single-mode optical communication fibers already installed alongside cables. The passive OCTs do not require any power supply, and they are free from maintenance.

The distance between interrogator and OCT is not the limiting factor, which instead is defined by the following conditions:

- Number of OCTs used per fiber, normally 3, 6 or more.
- Structure of the OCT measurement scheme (Faraday, Sagnac or other effects)
- Emission power; it is feasible to work with