Contribution to localization of a fault on a long extruded submarine cable by LV Time Domain Reflectrometry

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The localization of an electric fault on a submarine cable can be done using LV reflectometer. The implementation of this technique requires to take into account the propagation velocity of the signal, which was generally considered as constant.

However, through the literature, uncertainty affecting the knowledge of the propagation velocity of the signal, for example between 140 and 160 m/µs for a lapped cable, is likely to introduce notable uncertainties into the localization of a fault on a long cable.

The precise localization of an electric fault on a long submarine cable by Time Domain Reflectrometry is affected by the attenuation of the signal and especially by its deformation during its propagation. This deformation affects the head of signal, and, in particular the identification of the foot of the considered signal which determines the distance separating the echo-meter from the fault. In fact, the effective foot of the reflected signal, such as it appears to the operator, and the theoretical foot of the reflected signal, such as it results from its deformation, are distinct. This distinction is at the origin of uncertainty affecting the velocity measurement of propagation of a signal on a submarine cable.

To correctly interpret the propagation of the signal between its emission and its reception after having been considered on the fault, we theoretically reconstituted it starting from the parameters of line **R, L, C** and **G**, which vary according to the frequency. The parameters **R** and **L** can be theoretically given, whereas the parameters C and G require to know the variations of **ε** and tg δ with the frequency. These variations can become important in high frequency on synthetic insulations for example due to the presence of the semiconductor screens or other reasons.

These parameters being defined, the answer to an impulse can be calculated by summation on the frequencies varying, in theory, from 0 ad infinitum. One however limits the spectrum to a frequency F = 1/t, T being the front time of the impulse. Having a limited summation, the wave of return is numerically calculated, thus making it possible to distinguish its effective foot such as it appears to the operator, from his theoretical foot.

This analysis leads to theoretically distinguishing, for a particular distance traversed by a signal in a cable, the effective foot and the theoretical foot. This distinction, which increases with the distance covered by the signal, physically originates in the loss and the attenuation of its components to more high frequency. In other words, the “apparent” speed of the signal decreases with the distance over which the signal travels.

The application of this analysis can be considered on a long submarine cable with synthetic insulation.