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Analysis of PD source locations in mixed insulated cable circuits

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Abstract: Mixed insulated cable circuits, consisting of different types of insulation (e.g. PILC and XLPE) may result in misinterpretation of the PD source location analysis for diagnostic purposes. The propagation velocities of PD signals may differ for the various cable parts of different types, resulting in dislocations using the standard location technique, up to several percent of the total cable length.
The background theory of the dislocation is described, together with the errors that may occur. Furthermore, the correct location analysis for PD diagnostics of mixed insulated cables is represented, clarified by practical examples to show the differences in the PD location results.

Keywords: partial discharges, PD location, mixed insulated cable circuits

Résumé: L'utilisation de liaisons électriques mixtes constituées de câbles ayant différents types d'évolutions (PI, PRC) peut être à l'origine d'une difficulté d'interprétation de la localisation d'une source de DP dans le cas d'un diagnostic.
Les vitesses de propagation des signaux de DP varient en effet en fonction des caractéristiques des différents composants avec comme conséquence des écarts sur la localisation des défauts pouvant atteindre quelques % de la longueur totale du câble.
La théorie fondamentale de localisation est décrite ainsi que les 4 erreurs associées.
L'étude de la localisation de DP dans le cas d'une liaison mixte est présentée et étayée par des exemples pratiques mettant en évidence les écarts des résultats.

Mots clés: les décharges partielles, la location de PD, les circuits de câbles isolés mélangés

1. Introduction

The detection and localisation of partial discharges (PD) for condition assessment of power cables are used in diagnostic tools all over the world. The location of the PD sources along the cable length can be analysed by PD pulse analysis in the time domain, using fast digitisers in the PD detectors [2,3]. In [1], a PD location technique was already published for insulated power cables under laboratory conditions. The localisation of PD along a power cable length was originally developed and used by cable manufacturers. Cable manufacturers used the PD detection and localisation under laboratory conditions, for insulation quality checks on cable drums at the end of the production line.

If a defect is active in a power cable system, the occurring PD will result in two PD pulses, which will travel away from the source in opposite directions towards both cable ends. The detector is connected to one of the cable ends, while the other cable end is open (disconnected). This means that a full reflection of the PD pulses occurs at this side of the cable sample, see figure 1.

Furthermore, at the detection side, a (almost full) reflection of the arriving PD occurs as $Z_{detector} >> Z_{cable}$. As a result, the PD pulses will travel back and forward through the cable circuit until they are

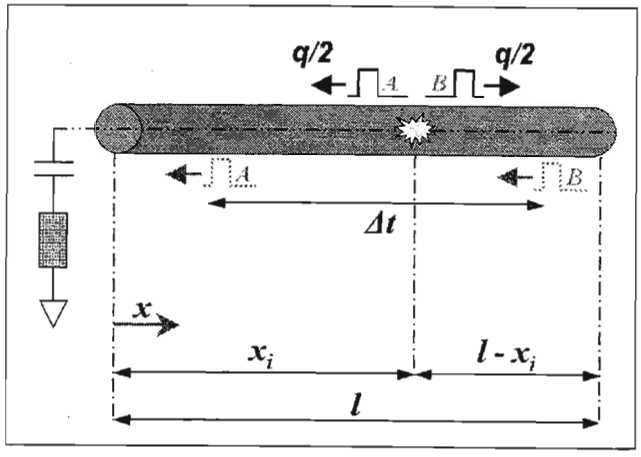

Figure 1: Schematic view of the principle for localisation of partial discharges in power cables [1]. From the time difference between the PD pulses, the location x_i can be determined according to (1).