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Improved diagnosis of MV paper-insulated cables using signal analysis

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Résumé

Afin d'améliorer l'estimation des décharges partielles et d'augmenter le degré d'automatisation des mesures, la recherche suivante est réalisée. D'abord un catalogue de signaux de décharges partielles et du bruit dans des câbles sélectionnés est établie. Puis ce catalogue est utilisé pour l'estimation des signaux de décharges partielles en appliquant un modèle paramétrique ou un modèle non-paramétrique, ce qui mène à une réduction du bruit superposé aux signaux de décharges partielles et ainsi à une détection améliorée des décharges. L'applicabilité de ces méthodes est discutée en relation avec les systèmes mobiles pour l'évaluation de l'état de l'isolation des câbles.

Abstract

With the purpose of improving the PD estimation accuracy and the degree of automation of the measurements, the following study is carried out. Initially, a library of different discharge pulses and actual background noise from a selection of cables is established. This library is then used for the estimation of PD-signals from a parametric model and a non-parametric model leading to reduction of the noise superimposed on the PD-signals and thus to an improved PD-detection. The applicability of these methods is discussed in relation to mobile systems for the assessment of cable insulation condition.

Introduction

For some years, diagnosis of MV cable insulation has been possible with 0.1 Hz partial discharge measurement equipment [1]. These systems measure the magnitude and position of partial discharges (PD) in a power cable. The results form a PD-map of the cable, which is used to point out seeds to future faults in the cable. Apart from measuring the partial discharges, the system is also supplying the cable with 0.1 Hz high voltage. The low frequency has been chosen in order to make the high voltage generator compact, which is necessary for a mobile system. Each cable is measured for approximately 10 minutes, and during that period the discharge pulses are stored by means of a digital storage oscilloscope. The procedure is repeated for each cable phase, and a PD-map is made, in which all discharges are plotted as dots in a (position, magnitude) coordinate system.

This paper is limited to discuss the determination of the position of the discharges. The paper describes two methods that are successfully used in the Danish 0.1 Hz measurement system. The main subject of this paper is a non-linear least squares optimisation method, based on a system model. Furthermore, the more simple cumulative summation method is described, and the two methods are compared.

Positioning PD in MV Cables

Basically, the method of time-domain reflectometry is used to determine the position of the discharge, as seen on Fig. 1. By determining the time between the reception of the primary pulse, and the pulse that has been reflected in the far end of the cable, Δt, it is possible to determine the position:

$$d = L - \frac{\Delta t \cdot v}{2} \qquad (1)$$

- where L is the cable length, and v is the travel velocity in the cable . L and v are constant for all measurements made on a cable. The determination of Δt can be done in many ways; the simplest is to directly

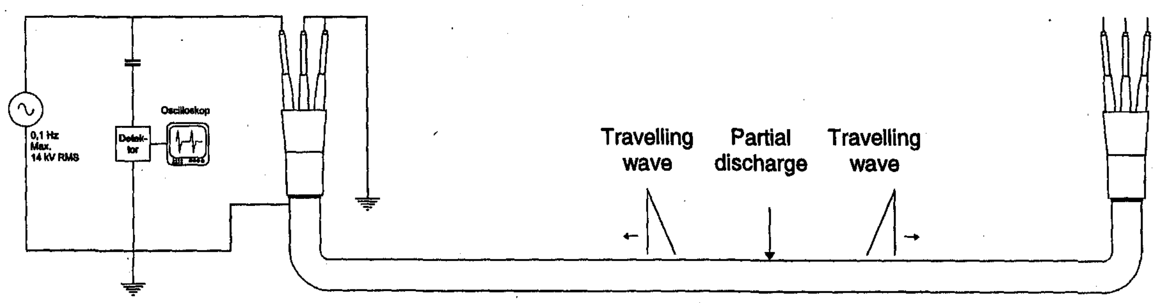

Fig. 1: Principle of positioning