MEASURING PARTIAL DISCHARGES WITH ENHANCED NOISE REDUCTION BY USE OF MULTI-BAND PD BANDPASS FILTERS

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ABSTRACT

3CFRD is a pulse-shape-analysis, capable of detecting different types of pulses, as PD and noise. The diagram shows clusters for each type of pulses, which can be re-transformated to a familiar PRPD pattern in real-time during the PD measurement. The 3CFRD method helps to suppress disturbances, in order to reach a demanded sensitivity for the PD measurement. The filtered signals can be used for further post-processing, as PD location or pulse-sequence-analysis (PSA). The method was successfully demonstrated with calibrator pulses, artificial PD pulse and cable PD at different cable manufacturers and HV test labs.

KEYWORDS

Partial Discharge, PD, cable, cable length, noise suppression, multi-band PD measurement, 3CFRD, 3-band, pulse-shape analysis

INTRODUCTION

Partial discharge (PD) measurements [1] are part of various dielectric test procedures, as type test or even routine test on XLPE power cables. While doing PD measurements in a well shielded HV test lab, the ambient noise level is sufficient low to guaranty a high sensitivity in order to detect PD reliable in a range below 2.5 pC or even 1 pC. With more and more PD measurements being done close to heavy machinery in a heavily disturbed factory environment, a minimum ambient noise level of < 2.5 pC cannot be achieved that easily. Besides classical gating methods, additional advanced filter techniques have to be used to suppress different types of noise, as sinusoidal noise as well as pulse-type noise with stochastic appearance in time. As a powerful tool to eliminate pulse-type noise of any time-behavior, a pulse-shape analysis (also described in [2]) can be performed. It can be assumed, that PD pulses and noise pulses do have different wave-shapes in time-domain. As modern PD analysis systems typically work in frequency-domain, differences in time-domain are firstly transformed into frequency-domain, which is easily possible by fast FFT algorithms. As frequency-domain and time-domain can be equivalently used to describe a signal, also the frequency spectrum can be used to detect differences in the wave-shape. These differences allow to distinguish between signal (PD) and noise and therefore, to reject the noise. In contrast to existing commercial PD systems with non-satisfactorily performance due to the use of the full frequency spectrum to analyze differences, a very fast method was developed using only three characteristic points in the frequency spectrum, ensuring real-time behavior of the PD system which is mandatorily needed to perform PD measurements. The reduced information of three single points in spectrum is equivalent to the full spectrum in most of the cases.

PULSE CLUSTERING BY 3CFRD

In order to suppress noise, a powerful method to cluster different pulse types (as PD pulses and noise pulses) is the 3 Center Frequency Ratio Diagram (3CFRD). To create such a diagram, the digitized PD current pulse (s. fig. 1) is firstly transformated to the frequency domain by FFT (s. fig. 2). Then three digital bandpass filters with three independent center frequencies (***3CF*** RD – 3 Center Frequency) determine 3 different charge values by quasi-integration of the signal (s. fig. 3). The ratio of these 3 charge values is then finally plotted as vectors into a flat diagram, with 3 axes of 120° phase shift (s. fig. 4). Every axis represents one of the 3 bandpass filters. As a third dimension, the diagram color indicates the repetition rate of the different pulse types. Stable pulses, as partial discharges, often form red well bounded clusters.

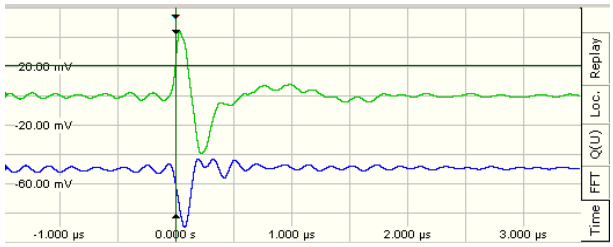

Fig. 1: Two different pulses in time-domain

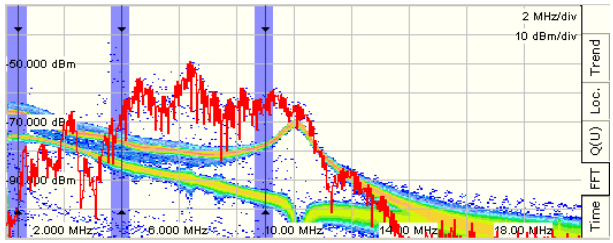

Fig. 2: Three different pulses in frequency domain

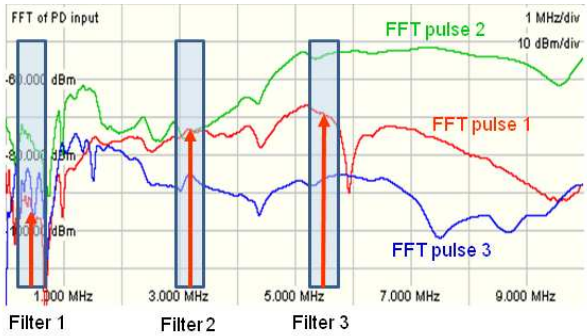

Fig. 3: 3-band PD bandpass filter