Procedures to Qualify PD Measuring Instruments to use in the Insulation Condition of Cable Systems

Fernando **GARNACHO** LCOE-FFII, HVTC-Universidad Politécnica de Madrid, Spain, FGarnacho@lcoe.etsii.upm.es
Abderrahim **KHAMLICHI**, LCOE-FFII, High Voltage Technological Center, Spain, ak@lcoe.etsii.upm.es,
Ángel **RAMÍREZ**, LCOE-FFII, High Voltage Technological Center, Spain, ARamirez@lcoe.etsii.upm.es
Jorge **ROVIRA** LCOE-FFII, High Voltage Technological Center, Spain, JRovira@lcoe.etsii.upm.es
Fernando **ÁLVAREZ**, Universidad Politécnica de Madrid, Spain, fernando.alvarez@upm.es
Eduardo **ARCONES**, Universidad Politécnica de Madrid, Spain, eduardo.arcones@upm.es

ABSTRACT

Insulation condition of equipment and materials installed in HVAC and HVDC grids is evaluated using online PD measurements by means of PD analysers operating in the HF range (< 30 MHz). To achieve homogenous and comparable results during on line measurements, calibration of PD quantities and characterization of built in diagnostic tools of PD analysers according to standardized procedures are needed. This paper presents procedures to qualify PD measuring instruments used for insulation condition.

KEYWORDS

Partial Discharges, Characterization of PD instruments, Type discharges, HFCT sensor, Electrical noise, Electrical insulation diagnosis.

INTRODUCTION

Nowadays, on line Partial Discharge measurement is one of the most important diagnosis methods [1] and [2] for predictive maintenance of the high voltage cable systems.

Different no conventional PD electromagnetic methods operating on the high frequency range (up to 30 MHz) are used, however, few technical requirements are defined for this kind of PD instruments [3]. For this reason, a European Project in the Metrologic Research Programme (EMPIR) was approved in 2016 to develop a procedure to qualify the capabilities of PD instruments working in HF range in order to check their performances [4].

The proposed qualification method consists in generating trains of reference PD pulses from controlled test cells in a specific voltage range. The controlled PD pulses from different test cells are saved and later they can be mixed with different types of noises (modulated noise, communication PLC noise, random noise, electronic noise, etc.) in order to check the sensitivity in PD detection under representative noise operation conditions.

Different types of representative discharges can be simultaneously generated: cavity defect, surface defect, corona effect and floating potential discharges to analyse the PD instrument capability to discriminate them.

In addition, the test configuration allows analysing the capacity of the PD measuring instrument to discriminate where a PD source is located when it is close to two different high voltage elements.

This paper presents the portable testing setup developed to be used to determine transfer function of HFCT sensors, the scale factor k_q (pC/mV) for specific PD pulse waveforms, the ability to discriminate different PD sources, the capability to the location of a PD source by polarity recognition.

HFCT SENSOR CHARACTERIZATION

High frequency sensors are commonly used for the PD measurements in high voltage grids. It is interesting to determine the transfer impedance of the HFCT sensors expressed in Ω (mV/mA), as well as the phase shift introduced by the HFCT sensor expressed in electric grades. In this way, the amplitude of the signal and the distortion of the current pulse measured by the PD instrument can be estimated. A testing setup has been developed, consisting of a variable frequency generator, a shielded cylindrical compartment, in which the HFCT sensor is placed and connected to a digital oscilloscope through a coaxial cable of 50 Ω. The measurement of the injected current signal, I_{in}, is transformed into a voltage signal, V_{in}, by circulating the current through the load impedance (Z_{load}) of 50 Ω arranged on the oscilloscope terminals (Channel 1). The oscilloscope is used in high input impedance mode, 1 MΩ, so that a voltage V_{in} proportional to the injected current I_{in} (V_{in} = 50 I_{in}) is measured. The output signal of HFCT, V_{out}, is sent to the Channel 2 of the oscilloscope.

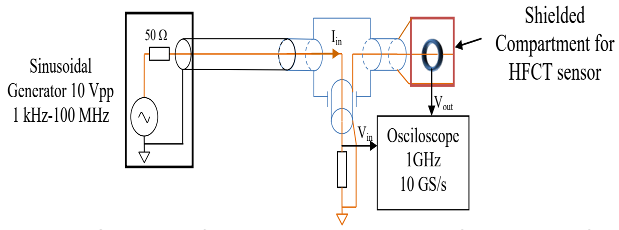

Fig. 1: Circuit of the measuring configuration for determining transfer impedance of an HFCT.

The frequency generator generates sinusoidal waves of frequencies ranging from 0.1 kHz to 100 MHz and the oscilloscope with a bandwidth of 1 GHz, 10 Giga-S/s collects the signals generated by scanning the frequency range. For each discrete point in frequency in which the transfer impedance of the HFCT sensor is measured a sufficiently large number of readings are performed, in order to reduce the random noise component.