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Research on the Calibration Methods for Ultra-high Frequency Partial Discharge Detector

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Abstract

The performance of UHF partial discharge detector is important for the timely detection and diagnosis of insulation faults. However, the performance calibration method of UHF partial discharge detector under laboratory conditions is not yet fully mature. In this paper, on the basis of the related literature, a specific experimental research of the UHF partial discharge detector based on the gigahertz transverse electromagnetic wave (GTEM) cell about the effective height, amplitude linearity, detection sensitivity, dynamic scope was carried out. The validity of this method is verified by comparing the test equipment of three different manufacturers.

Keywords: ultra high frequency(UHF)；partial discharge(PD)；calibration；effective height；GTEM cell

1. Introduction

In recent years, gas insulated switchgear (GIS) has been widely used in power system because of its small space, excellent electrical performance, strong adaptability to the environment and low maintenance workload. In order to ensure the safety and reliable operation of GIS, a variety of GIS partial discharge detection methods have been put forward by domestic and foreign scientific research institutions and scholars. Among them, ultra high frequency (UHF) has become a major partial discharge detection method for GIS equipment and other high voltage electrical

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equipment with its strong anti-interference ability, high sensitivity, easy identification of defect type and location of discharge source [1-6]. However, the quality of UHF testing equipment in the market is uneven and the consistency is poor, which can cause false alarm, leakage alarm and other issues. To this end, it is necessary to research calibration test methods of the ultra high frequency partial discharge detector, thus, the performance and quality of the detector to effectively evaluate.

At present, the calibration test methods of ultra high frequency partial discharge detector under laboratory conditions is not fully mature. In the literature [7], the electric field intensity and the amplitude linearity of the UHF partial discharge detector are researched from the perspective of the traceability. In the literature [8-11], the effective height, sensitivity, amplitude and frequency response of UHF partial discharge detector were analyzed from different angles based on the GTEM cell. Based on the relevant literature, this paper selects the effective height, amplitude linearity, detection sensitivity and dynamic scope these key indicators to research.

2. UHF partial discharge detector calibration platform

In this paper, the performance of UHF sensors was tested using the gigahertz transverse electromagnetic wave (GTEM) cell. The calibration platform of UHF partial discharge detector consists of standard pulse signal source, GTEM cell, monopole standard probe, high-speed digital oscilloscope, monitoring and control computer, monitoring and analysis software and various cable accessories, as shown in Fig.1. The pulse voltage signal is input to the GTEM cell by the standard pulse signal source, and the electric field is formed in the GTEM cell. In order to minimize the impact of the measured sensor on the GTEM internal field, take the top of the window approach, the measured sensor and the reference sensor placed about 1/3 close to the terminal which the field uniform distribution at this location[9].

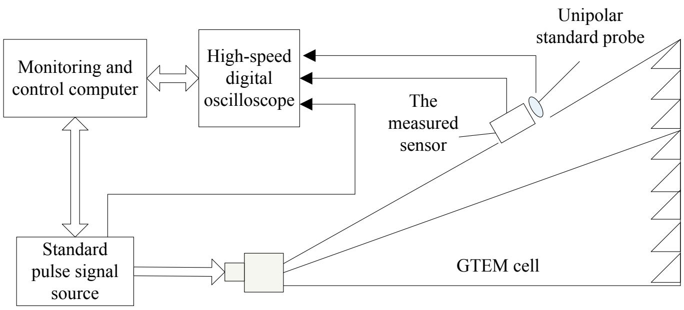

Fig. 1. The schematic diagram of UHF detection system

3. The calibration methods and test analysis

3.1. The effective height test

Set $E_i(t)$ as the electric field at the measured sensor location in the GTEM cell, and $u(t)$ as the voltage signal output by the sensor. According to the relationship between the incident electric field and the output voltage, the transfer function of the sensor can be expressed as:

$$H(f)=\frac{U(f)}{E(f)} \tag{1}$$

In the formula, $U(f)$ is the FFT transformation of the output voltage $u(t)$, $E(t)$ is the FFT transformation of the electric field $E_i(t)$. The unit of $H(f)$ is mm, which is called the effective height of the frequency domain. The