Performance Check of UHF PD Sensor

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I. Research Background

The purpose of this test is to measure the characteristics of UHF sensors, which monitor the transformer's partial discharge so that the results of the UHF frequency band can be consistent and reliable to determine the aging condition of the transformer.

II. Research Contents

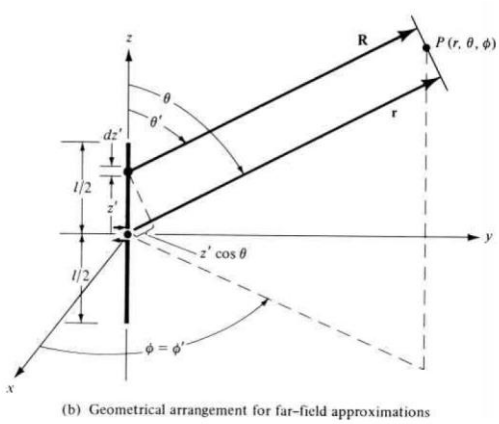
The partial discharge time of high-voltage equipment is about nano second[1] level, and the corresponding electromagnetic wave frequency is about 300 MHz~3 GHz in the frequency band. The UHF sensor is used to receive electromagnetic partial discharge signals from the transformer; the strength and frequency of the signal are related to the characteristics of the UHF sensor. The smaller S_{11} sensor is better for the impedance match of the sensor, and it can reflect less electromagnetic signal. However, S_{11} is affected by the surroundings, so measuring S_{11} independently does not mean the test results are the same in the transformer. The effective antenna height of the sensor is to place the sensor in a GTEM Cell, make the standard antenna the emission source and sensor as the receiver, and convert the test result to the effective antenna height based on S_{21}; the larger S_{21} means it can reflect less electromagnetic signal. However, the result of effective antenna height is under a specific environment; it does not mean the test results are the same in the transformer.

III. Research Results

The measurement environment check

(a) Ideal measurements for S_{11} or VSWR should be carried out in an anechoic chamber, except for laboratory-level precision, it can place the sensor in the far field and be seen that there is no electromagnetic signal interference in the same frequency band and environmental reflections can be ignored[2]. Therefore, testing in an anechoic chamber is not required. The sensor can be placed on a stable non-metallic fixture or work platform with Styrofoam, and then whether the measurement results changed can be checked with moving objects (metal object would be better) around the sensor. If there is no significant change in S_{11} or VSWR, it means that external environmental variables will not interfere S_{11} or VSWR, and the measurement can be carried out.

(b) Measurement with GTEM Cell, it is not affected by the outside since GTEM Cell is closed environment. Measurement environment check is not required[3].

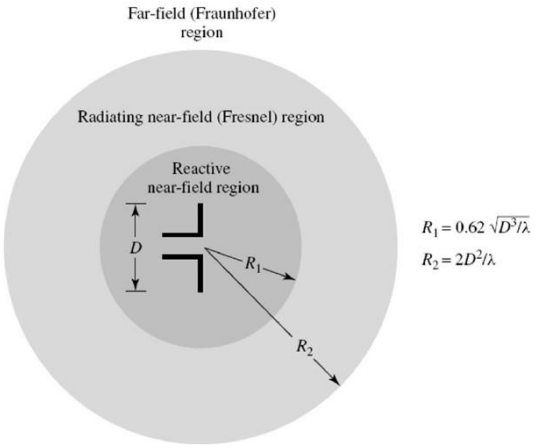


(b) Geometrical arrangement for far-field approximations

Figure 4.5 Finite dipole geometry and far-field approximations.

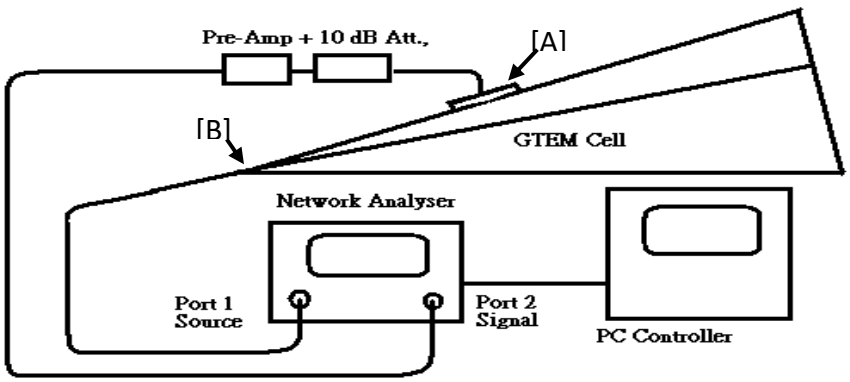
Source: [2]

Figure 1. Far field schematic diagram



Source: [2]

Figure 2. Region of field



Source: [3]

Figure. 3 GTEM Cell schematic diagram

IV. References

[1] Li T, Rong M, Zheng C and Wang X, “Development simulation and experiment study on UHF Partial Discharge Sensor in GIS,” IEEE Trans. on Dielectrics and Electrical Insulation, no.4, vol. 19, pp. 1421-1430, Aug. 2012.

[2] Antenna Theory Analysis and Design Fourth Edition by Constantine A. Balanis. - 4. Linear Wire Antennas

[3] C.-L Fan, W. Liang, M.-H. Chung, and M. Judd, “Comparison of UHF partial discharge sensor calibration system,” *XVII International Symp. on High Voltage Engineering*, Hannover, Germany, Aug. 2011, pp. 1-6.