변압기의 온라인 PD 모니터링을 위한 UHF 기술의 동향

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Trend in UHF Technique for On-Line PD Monitoring of Transformer

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Abstract : A field-oriented UHF system for on-line PD monitoring of transformers is designed, which has been installed inside the oil tank of a 220kV transformer in a substation. This system has successfully captured long intermittent discharge signals that hadn't been detected through conventional techniques, and solved the problem successfully. The results demonstrate that UHF technique has great advantages for on-line PD monitoring of transformers. By adopting the peak detection technique, it becomes easy and effective for the transplantation of the phase-resolved pattern recognition technique from conventional method to UHF method, and then to realize continuous on-line monitoring, source characterization and trending analysis.

Key Words : UHF, PD monitoring, Transformer, Field test

1. Introduction

The studies of UHF partial discharge detection technique mainly concentrate on the following aspects: sensor design, optimization and calibration [1-4], UHF radiation and propagation mechanism, PD source characterization and fault location. In addition, some researchers use UHF method as an anti-interference tool for the conventional technique. Of course, most of the researches are specially developed for GIS, but as a matter of fact, many of the above techniques can be used to transformers. In 1996, Rutgers firstly explored the feasibility of using UHF technique in transformers[2]. After that, many people made deep researches into this project, and good results is obtained both in laboratory and field practices [5]. As for practical use, phase-resolved pattern recognition and trending analysis are the most useful tools for UHF method, just as it is for traditional technique. But because the original UHF signal is very fast, only lasts for the magnitude of nano seconds, it is extremely hard to correlate it with power cycle. At present, people mostly fulfill this function by using the POW mode of the spectrum analyzer, but it's a rather luxury approach and inconvenient at the same time. The peak detection technique is very effective to condition the UHF signal and can accomplish the same function as SA quite easily. This paper adopts the peak detection technique in the field-oriented UHF on-line PD monitoring system of transformers, then the two practical working instances are introduced in detail, the results indicate the effectiveness of the UHF technique and its superiority over conventional methods.

2. Experimentals

The system includes two main parts: the stationary continuous-working equipment that deals with the UHF peak detection signals, and the movable instrument that analyzes the original UHF signals in time domain as well as frequency domain. The stationary equipment is a self-developed industrial PC system, which is made up of a fast DAQ card and real-time analyzing software. While the movable part is a high quality digital oscilloscope that works in "plug and play" mode.

Usually in the practices of UHF, the phase information of the PD is obtained by using a SA that is set to POW mode. When considers the cost factors and the convenience reasons, the SA does not suitable to be used as a component of the stationary equipment, so the peak detection technique is adopted to condition the original UHF signals, which not only maintains the phase and magnitude info, but also lower the requirements for the digital sampling rate greatly. By doing this, the cost of the device is reduced to the maximum extent, and the traditional phase-resolved pattern recognition technique can then be transplanted to the UHF method.

3. Results and Discussion

During the period of monitoring, three intensive signals were captured by the measuring system. The amplitudes of the signals were about 400mV, which were much higher than that of the background noises (see Figure 1). When each signal was captured, the operations of the transformer tap changer could be excluded definitely. The time intervals between two signals were seven hours approximately. The time domain waveform of the signals indicated that they were much likely to be discharges, but it was kept uncertain whether they were generated inside the transformer oil tank or other electrical equipments' operation coupled into the transformer from the power lines.

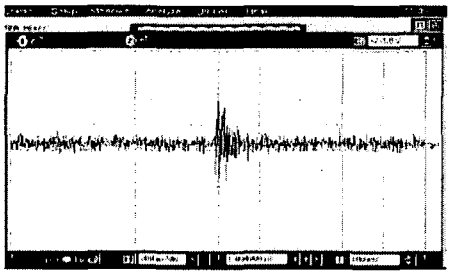

Fig. 1. A typical suspicious discharge signal.

As in the conventional PD test, the procedure is to apply 1.3 times of normal voltage for 30 minutes to each phase one by one. The conventional results are shown in Table 1. It shows that the background of the manhole antenna is about 30mV, while the PD signal is approximately 150mV. Besides, each time the waveform of the signal almost keeps the same, which indicate that it is a monotype discharge. The case of the hand hole antenna is analogous as the manhole antenna, but the signals are much smaller. Because the signals become steady and low in a few minutes, we conclude that it is gas cavity discharge in oil or corona discharges on small conductor burrs which soon be melted down by the PD energy. The results demonstrate that the sensitivity of the UHF system is high enough to detect very small discharges in transformers.

Table 1. Apparent discharges recorded with conventional method.

Apparent charge [pC]	Applied Voltage [V]	Phase		
		R	S	T
Maximum	189	2000	800	1200
Steady	189	100	130	110

4. Conclusion

Peak detection technique makes it easier and cheaper for UHF method to import conventional phase-resolved pattern recognition technique and trending analysis, which makes it more practicable for on-line utilization of UHF technique.

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