위상 비동기 패턴 기반 PD 진단 방법

PD Diagnosis Method based on Non-phase Synchronized Patterns

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Abstract This paper dealt with partial discharge (PD) diagnosis method based on non-phase synchronized PD patterns extracted from the ultra-high frequency (UHF) signal, for the purpose of condition monitoring of the gas insulated switchgears (GIS) installed in the railway substation. 82 cases of representative PD data, which were acquired from 6 types of PD defects and 4 types of noises, were collected from the field monitoring. The defects included protrusion, floating, free particle, transformer fault, as well as void and crack in the insulator, and four types of noises were external interference, external corona, sensor connector fault, and mobile. PD parameters related to phase and frequency spectrums were analyzed using the decision tree method. From the result, 77 cases were accurately classified, and the proposed classification method had an accuracy of 94%.

Keywords **:** Partial discharge, Non-phase synchronized PD pattern, UHF signal

초 록 본 논문에서는 철도 변전소에 설치된 가스절연개폐장치의 상태진단을 목적으로 위상 비동기 PD 패턴를 이용한 PD 진단 방법에 대해 연구하였다. UHF 센서를 사용하여 6종의 결함 및 4종의 노이즈로부터 대표적인 부분방전 데이터 82개를 수집하였다. 결함은 돌출물, 부유입자, 자유입자, 변압기 결함, 스페이서 내부 공극과 크랙, 노이즈는 외부 잡음, 외부 코로나, 센서 접촉불량, 휴대폰이었다. Decision Tree 방법을 이용하여 위상 스과 주파수 스펙트럼으로 PD 파라미터를 분석하였다. 결과로부터, 본 논문에 제안된 PD 진단 방법은 82개 중 77개의 데이터를 구분하여 94%의 정확도를 가지는 것을 확인하였다.

주요어 : 부분방전, 위상 비동기 PD 패턴, UHF 신호

1. Introduction

The partial discharge (PD) has achieved its significant application in the field of condition monitoring of power facilities [1,2]. Compared with various PD detection methods, the ultra-high frequency (UHF) method is regarded as the best implement for on-line diagnosis of the gas-insulated switchgears (GIS). The phase and frequency spectrums acquired from the accumulation of the UHF signal is widely used for PD evaluation and defects classification [3,4]. From the field experience, however, it is not easy to synchronize the UHF signal with the applied voltage that measured by the potential transformer, resulting

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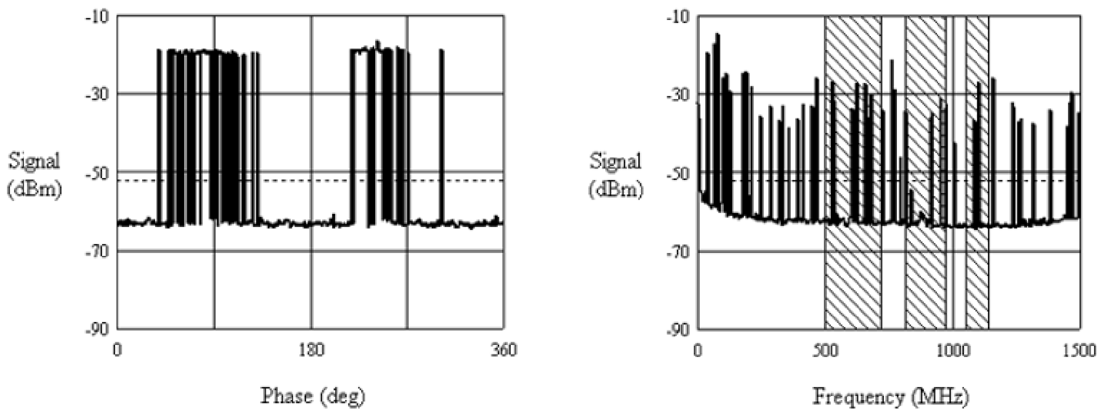
in the inaccurate identification of defect type. Therefore, a PD classification method based on non-phase synchronized PD patterns was proposed in this paper.

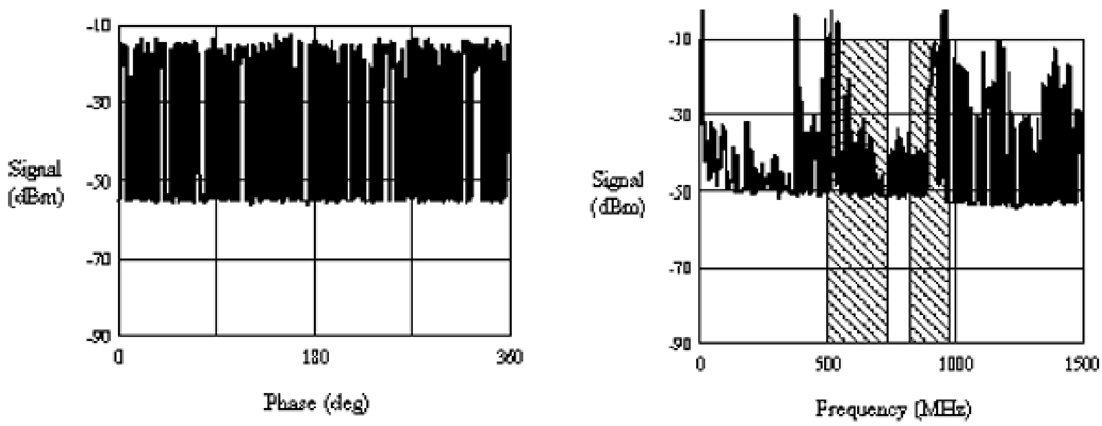
2. Data Analysis and Results

An UHF sensor with a bandwidth of 0.3 MHz ~ 1.5 MHz was used to acquire the phase spectrum and the frequency spectrum from 6 types of defects and 4 types of noises [5]. The defects were protrusion, floating, free particle, transformer fault, void and crack in the insulator, and the noises included external interference, external corona, sensor connector fault, and mobile [6]. Fig. 1 and Fig. 2 illustrate the data examples of floating and sensor connection fault, respectively. Totally 82 cases of such data were collected. The non-phase synchronized parameters related with phase and frequency spectrum shown in Table 1 were extracted from the collected data. After trial and error tests based on the decision tree method, five parameters were selected, which can accurately classify 77 cases of data. The five parameters were group number and



(a) Phase spectrum (b) Frequency spectrum

Fig. 1 Floating defect



(a) Phase spectrum (b) Frequency spectrum

Fig. 2 Sensor connection fault

normalized shape of phase spectrum, as well as the range number, range of peak value, and density levels of frequency spectrum.

Table 1 Non-phase synchronized parameters

Characteristics	phase spectrum	Frequency spectrum
Parameter	Peak value Group number Peak difference between two groups Full phase distribution or not Distribution of each group Density level Normalized shape	Range number Maximum value Range of peak values Peak difference between ranges Density level

3. Conclusions

In this paper, the non-phase synchronized parameters were extracted from the UHF signal to classify the type of PD. As a result, by using the group number and normalized shape of phase spectrum, as well as the range number, range of peak value, and density levels of frequency spectrum, 77 of 82 cases of collected were classified correctly. Therefore, the proposed method had an accuracy of 94%, which is expected to apply for on-site condition monitoring of GIS.

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