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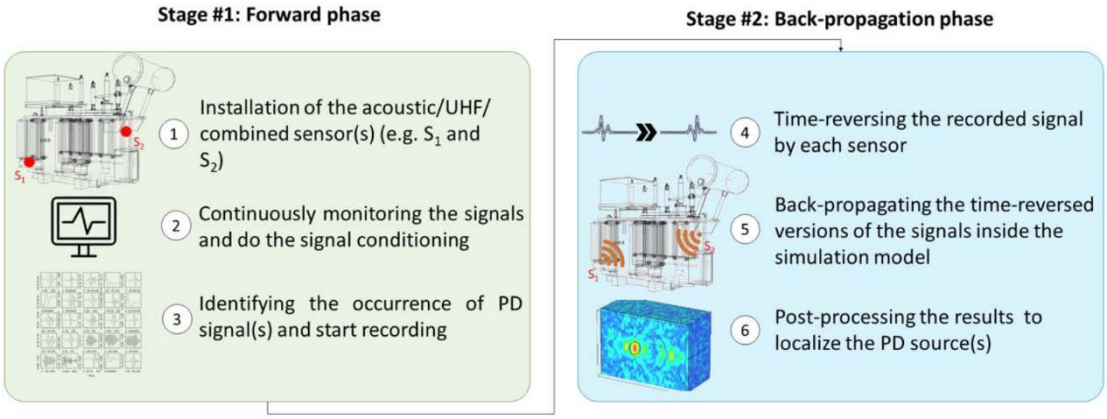
Licensing Opportunity

TTO – Technology Transfer Office

Partial Discharge Localization Using Time Reversal

Application to Power Transformers & Gas-Insulated Substations



Ref. Nr

6.2047

Keywords

Time reversal; partial discharge; localization; dielectric insulation; diagnostic; on-line monitoring

Intellectual Property

PCT/IB2020/061271

Publications

Sensors 2020, 20(5), 1419

IEEE Transactions on Dielectrics and Electrical Insulation 2020, 27(6), 2203

Date

16/01/2021

Description

Partial Discharges (PD) are partial electrical breakdowns taking place in dielectric insulation. If not detected, PD may lead to the breakdown of the insulation system and cause severe damage to the power equipment. PD detection techniques make use of either acoustic or electro-magnetic measurements. State of the art 3D localization methods are based on the time difference of arrival of signals. These methods require precise determination of the onset time of the arriving signals, at least 4 synchronized sensors and are highly sensitive to noise.

To reduce the number of sensors and increase the sensitivity to weak PD, the invention aims at using for the first time the Time Reversal (TR) method to locate the PD sources.

- The signals from a single or from multiple PD are continuously monitored by one or multiple acoustic or electromagnetic sensors and processed as needed.
- The recorded signals are time reversed and back propagated into the acoustic and electromagnetic numerical model of the power equipment.
- 3D localization is obtained by calculating the maximum electric/acoustic field criterion.

Proof of Concept results obtained on a power transformer mockup with Signal to Noise Ratio (SNR) of 10 dB revealed the capability of the TR method to locate PD in 3D with only one sensor. The PD source locations were estimated with an error of less than 8 mm, lower than 1 tenth of the wavelength at the upper cutoff frequency of the signal (PD frequency bandwidth 0.3 to 3 GHz).

Supported by the EPFL Enable grant, investigations are ongoing to further assess the TR method performance on a real power transformer.

Advantages

- Detection and localization of multiple PD sources with only one acoustic and/or one UHF sensor.
- The TR method is not affected by the signal onset times nor by the need to have a clean propagation path between the PD sources and the sensors.
- The TR method is insensitive to the length and polarization of the PD, and robust against noise.
- Cost reduction of the measurement apparatus.
- Simplification of the measurement apparatus.
- Minimum maintenance of the measurement apparatus for PD sources on line monitoring.

Applications

- Power equipment and apparatuses such as power transformers, GIS, electric motors, super capacitors.
- Power modules of Electric Vehicles (EV), EV motors.
- The method is suitable for Factory Tests (FAT) and Site Acceptance Tests (SAT) during the commissioning phases.
- On-line diagnostic tools to monitor power equipment, provide localization and severity of single or multiple incipient defects, estimate remaining life expectancy, optimize availability and minimize outages.