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Partial Discharge Detection Using Low-cost Real-time Software Defined Radio Technology

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Partial discharge (PD) is an electrical discharge that occurs across a compromised part of the dielectric insulation separating two high voltage (HV) conductors. PD typically causes additional damage with time to the dielectric which, if left unaddressed, may ultimately result in catastrophic insulation failure.

The emergence of wireless technology has opened new opportunities in PD monitoring. This paper proposes the use of the Software Defined Radio (SDR) 'Universal Software Radio Peripheral' (USRP) for PD detection.

The study has been conducted using the USRP-SDR transceiver. It has a frequency range of 50 MHz to 2.2 GHz. A block diagram of the USRP-SDR device is shown in Figure 1.

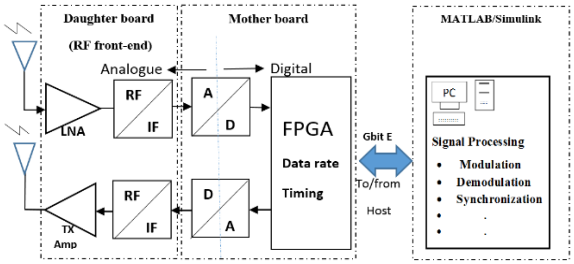

Fig. 1 USRP Block diagram

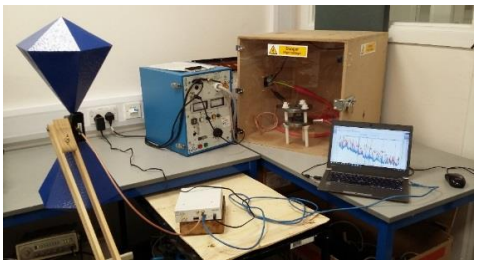

Fig. 2 Experimental setup

Fig. 2 shows the experimental setup. It consists of an HV AC power supply, a PD emulator and a USRP N200 transceiver connected to a laptop via a Giga Ethernet cable. The emulator is contained within a non-conducting box with an interlock that de-energizes the power supply should the door in the box be opened. This is to protect against accidental contact of personnel with the energized device. The radiated PD signal is received via a wideband bi-conical antenna and processed by the USRP. MATLAB post-processing of signal is also applied.

Fig. 3 shows measured spectra using the USRP N200. The upper (red) curve is the spectrum measured when the PD signal is present. The lower (blue) curve is the spectrum measured when the PD signal is absent. The difference in signal level is up to approximately 20 dB within the 50 MHz – 800 MHz frequency band. To validate the USRP SDR results, a portable spectrum analyzer has been employed. Fig. 4 shows the measured spectra in the absence and in the presence of a PD signal. There is a similarity between Figs 3 and 4, although Fig. 3 is noisier. The results obtained using the USRP N200 are sufficiently close to those obtained from the spectrum analyser to suggest it can yield reliable spectral information relating to PD.

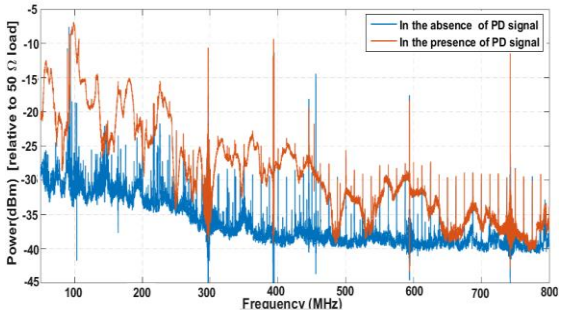

Fig. 3 PD signal measured spectrum using USRP N200

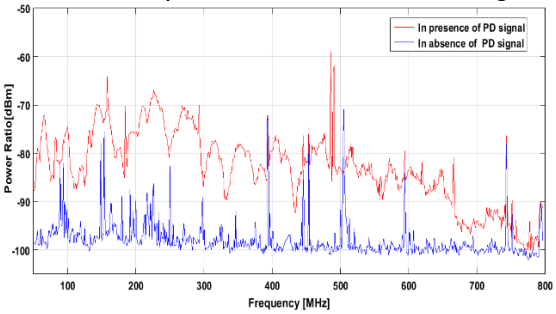

Fig. 4 PD signal measured spectrum using Spectrum analyzer