TechTalk

Sensors for MV switchgear monitor

Compiled by John Sherriff | June 2020 | Rev 1

The scope

Measurement and analysis techniques are possible with a combination of sensors and processing tools to accurately assess the condition of MV switchgear components during in-service conditions. To improve the sensitivity of PD measurements, different techniques/methods have been developed for both laboratory and on-site applications. All these methods can be divided into conventional and so-called unconventional PD measurement methods.

Conventional PD measurements

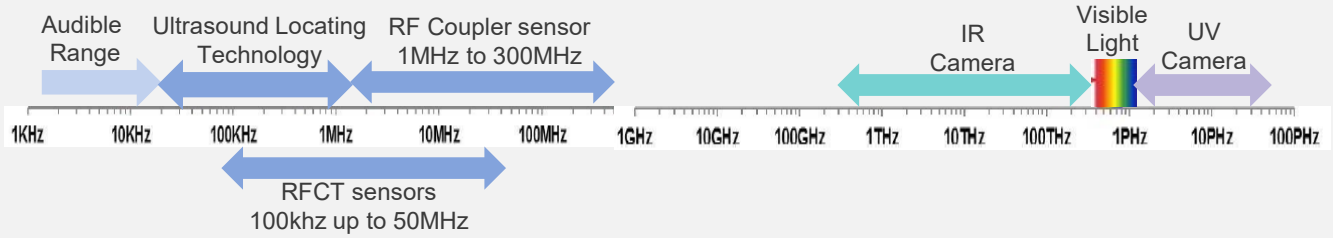
The conventional PD measuring systems (IEC 60270) that are successfully used in the controlled factory or laboratory environment are not always applicable for on-site and whilst assets are in-service, hence unconventional PD detection and measurement methods are utilised.

Unconventional PD measuring

Unconventional PD measuring methods and systems can detect the PD signals identifying different physical characteristics and properties of the PD. In general, electrical methods are based on the measurements of electrical signals in the radio frequencies (RF) ranges e.g. high frequency (HF), very high frequency (VHF) and ultra high frequency (UHF). Partial discharge signals are detected in these bands, and can be used for In-Time monitoring technologies, coupled to trending and alarms. The interference signals must be identified during alarm setting to eliminate false alarms due to higher levels being detected.

Frequency Ranges

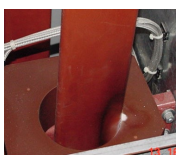
In the detection of PD pulses by electrical methods, two techniques are mainly distinguished: those that apply the conventional method based on the standard IEC 60270, in which PD pulses are measured in a frequency range below 1 MHz, and those that implement non-conventional methods based on the technical specification IEC 62478, in which measurements are performed in the high-frequency (HF) (3–30 MHz), very-high-frequency (VHF) (30–300 MHz), and UHF (300 MHz–3 GHz) ranges



Typical Partial Discharge Defects

Contact Discharges

Air Gap PD



Surface Tracking

Surface Tracking

Termination Discharges

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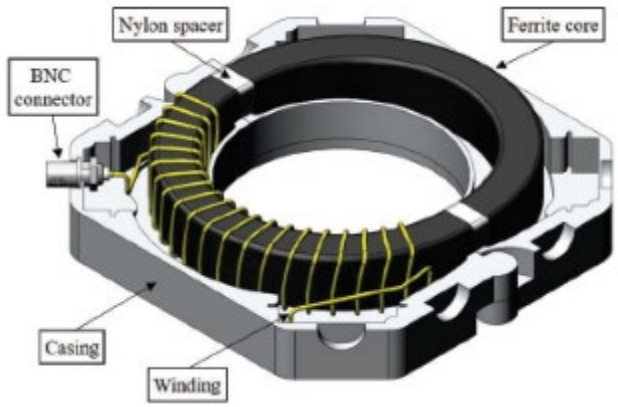
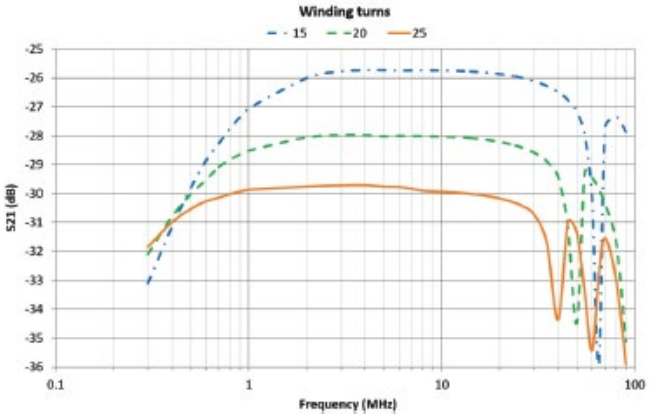
Partial discharge sensors for switchgear monitor

RFCT sensors

The number of turns is one of the parameters that greatly affects the performance of the sensor. The response of the RFCT changes as the number of winding turns varies as shown in the graph below. Sensitivity increases as the number of turns decreases.





Different RFCT sensors supplied by Martec

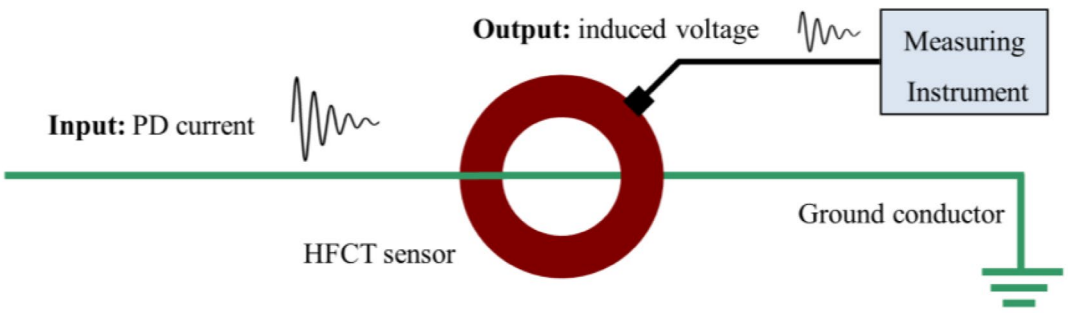
Dynamic Rating Sensor

TECHIMP Sensor

HVPD Sensor

RFCT with earth strap

This sensor consists of an induction coil with a ferromagnetic core that is suitable for the measurement of transient signals as PD pulses. For this application, the sensor can be modelled as a system in which the input is the current of the PD pulses flowing through it and the output is the induced voltage measured over the input impedance of the measuring instruments (usually 50 Ω)



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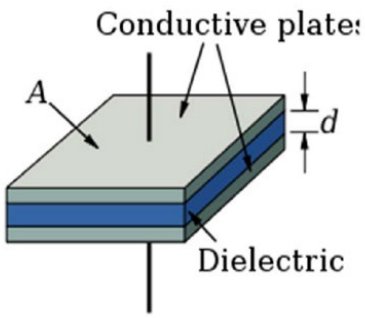
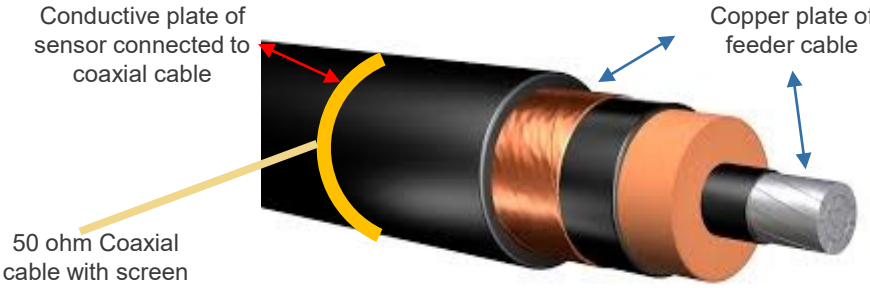
Partial discharge sensors for switchgear monitor

Coupler sensors

The permanent coupler sensor is a passive, non-galvanic sensor used for on-line measurement of partial discharge (PD) pulses. The sensor is engineered to capture PD pulses with a wide frequency range. (1 MHz to 300 MHz)

The design as illustration below, is a capacitive sensor with one side of the sensor being an insulated copper plate that couples to the shield portion of the feeder cable. This can be fit around the termination earth strap that is at zero potential.





$$Z_c = \frac{1}{2\pi jfC}$$

where :

Z_c is the capacitive impedance of the sensor or its opposition to a current wh en voltage in applied.

j is a complex number equivalent to i

f is the frequency of the applied voltage (Hz)

C is the capacitanc e of the sensor (F).

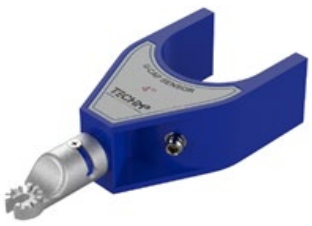
From the above equation, as the frequency (f) of the applied voltage increases, the capacitive impedance of the sensor decreases. Placing the sensor over the cable insulation is nearly equivalent to a galvanic connection to the copper screen and conductor.

Note:- Galvanic isolation (connection) is used where two or more electric circuits must communicate, but their grounds may be at different potentials.

Different Coupler sensors

Martec Coupler Sensor

TECHIMP Coupler Sensor



TECHIMP Open end Coupler Sensor