**C8.2.5.**

## Inductive directional couplers as new sensors for PD detection and localization on high voltage XLPE cable accessories

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Sensitive partial discharge (PD) detection is a very important test to ensure the reliability of high voltage (HV) and extremely high voltage (EHV) cable systems with extruded polymeric insulation. However, the conventional PD detection method with decoupling of PD pulses at the cable end is not suitable for long cable lengths because of its limited sensitivity due to the strong high frequency attenuation of high voltage cables. Therefore it is necessary to detect PD close to their possible source, e.g. at joints or terminations, which are mounted on-site.

In addition to a very high sensitivity a reliable discrimination between internal PD and external noise is highly important. These requirements can be fulfilled by directional coupler sensors (DCS), since the DCS enable a very high sensitivity also under noisy on-site conditions and have the ability to distinguish between pulse travelling directions by coupling them to different output ports: Signals travelling in one direction show up at one output port, while almost no signal is coupled to the other output of the coupler. This works in either direction. Using 2 directional couplers at a joint the origin of PD can be exactly determined.

However, the directional coupler measurement technique requires the evaluation of 4 broadband signals at each accessory, which makes this technique complex. Besides, the directional coupler sensor needs to be adjusted to the properties of the high voltage cable.

Therefore theoretical investigations of the directional coupling principle were done in order to achieve a similar reliability in discrimination of PD from accessories and external noise, but with reduced demands on complexity, bandwidth etc. It was found that this can be achieved by a specially designed directional coupler, which uses only the magnetic field component of PD and is therefore called inductive directional coupler.

The working principle of inductive directional couplers is similar to that of the directional couplers. However, while the directional coupler needs an exact adjustment of the relation of capacitive to inductive coupling, which depends on the properties of the high voltage cable, the inductive directional coupler uses only the magnetic field component of PD. Thus there aren't any adjustments to the properties of the high voltage cable necessary. This is a big advantage and qualifies the sensor for standard use in accessories.

The inductive directional coupler provides a different polarity of the output signal depending on the pulse travelling direction. Inductive directional couplers have just one output, the second output known from the directional coupler can be omitted since it contains only redundant information. Two sensors are required for a reliable discrimination of PD from the joint and external noise. Signals from the joint have equal polarity, while external noise has different polarity.

The evaluation of the output signals of inductive directional couplers is done by a new developed measurement device, which evaluates the origin of the measured signals (e.g. joint or external origin) and visualizes the measurement results.

The high frequency and high voltage tests of the sensor and the measurement device in the laboratory showed promising results to apply this technique also on-site.