



### C.8.2.5.

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

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#### **Résumé**

Les caractéristiques des capteurs de couplage de direction de décharges partielles aux câbles PR de haute tension sont discutés. Un nouveau capteur a été développé, qui combine les avantages des capteurs de couplage de direction et des capteurs inductifs, comme par exemple une très haute sensibilité aussi sur les sites avec des bruits électromagnétiques forts, une distinction entre des décharges partielles internes et des bruits électromagnétiques externes et la possibilité de trouver le lieu des décharges partielles avec une précision de quelques cm.

#### **Abstract**

The theoretical and practical properties of directional coupler PD sensors are discussed and a new special design of a directional coupler is presented which combines the advantages of directional coupler PD sensors and inductive sensors, like very high sensitivity also on-site under noisy conditions, high reliability in the differentiation of internal PD and external noise as well as the possibility of the exact location (within cm) of the PD fault.

## 1 Introduction

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 the 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 [1,2].

In addition to a very high sensitivity a reliable discrimination of 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, which is used to determine the origin of PD.

However, the directional coupler measurement technique requires the evaluation of 4

broadband signals at each accessory, which makes this technique very complex. Therefore additional investigations were done in order to achieve a similar reliability in discrimination of PD from accessories and external noise, but with reduced demands on bandwidth, complexity etc. This can be achieved by a special design of the directional coupler, which will be explained in the following paragraphs.

## 2 Directional coupler properties

Directional couplers are used in many RF applications. They couple energy to different output ports depending on the incident pulse travelling direction. The ability of distinguishing signals by their travelling direction is determined by the directivity of the directional coupler. The amount of energy which is coupled to the output ports is described by the coupling attenuation.