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Sensitive PD detection on high voltage XLPE cable lines using field coupling sensors

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Sensitive PD measurements on high voltage and extremely high voltage cable lengths and accessories are of increasing interest. They are used for development, type and routine tests in laboratories as well as for on-site tests, e.g. after installation.

The benefit of a PD measurement depends very much on the achievable sensitivity which is often limited by noisy on-site conditions. An additional difficulty is the strong, frequency dependent attenuation of PD pulses propagating through the high voltage cable. Thus the conventional PD measurement with decoupling of the pulses at the cable ends is often not suitable for long cable length.

However, since the high voltage cable lengths are carefully tested by the manufacturer, it is acceptable for on-site testing to measure PD exclusively at the accessories. The PD measurement using sensors directly at the accessories provides a higher sensitivity than the conventional PD measurement, since the PD can be detected close to their origin. However, a sensitivity of pC on site, which is often wanted or sometimes even demanded by the customer, is difficult to achieve using simple capacitive or inductive sensors.

A significant improvement could be achieved by directional coupler sensors, which provide an unequivocal and reliable discrimination of PD from the joint and external noise from left or right of the accessory. Besides, the origin of the PD can be exactly located with an accuracy of some cm. The high sensitivity of pC could be achieved also on-site under heavy noisy conditions as well as in unscreened laboratories. This is an important advantage of directional coupler sensors compared to other sensors, like e.g. simple capacitive or inductive sensors.

On the other hand it is not always necessary to use the most powerful sensor technology. In some cases it is possible to partly compensate missing features of the sensor technology by advanced PD measurement and evaluation systems, e.g. a new developed fully digital PD measurement system which provides a very sensitive, synchronous PD measurement on multiple locations. In this case simple field sensors can be used and nevertheless a localization of PD is possible within some meters accuracy by the evaluation of the synchronous measurement data.

The paper will discuss in detail the properties (like sensitivity, noise rejection, operating frequency range, etc.) and the related individual advantages and drawbacks of capacitive, inductive and directional coupler sensors as well as methods and new techniques for evaluation of the measured PD signals. Several examples of on-site and laboratory applications are presented.