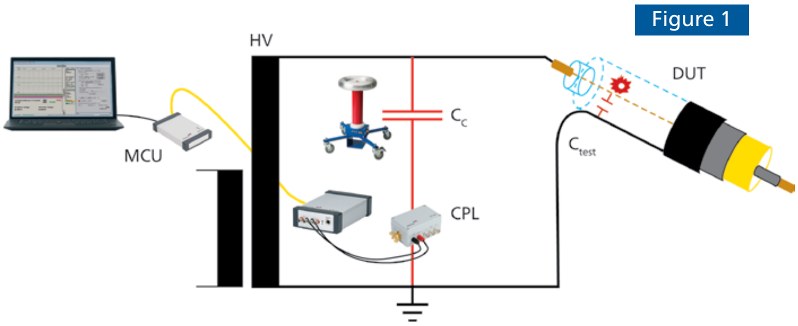
Partial Discharge Measurement Coupling Methods

Coupling Capacitors

A coupling capacitor (C_c) is a very common coupling method when performing a PD measurement as described in the IEC 60270 standard. When a partial discharge event occurs, the coupling capacitor provides the devices under test (DUT) with a displacement current, which is measurable at the coupling devices (CPL). Such an approach provides additional information about the test voltage, which is needed for a phase-related partial discharge (PRPD) measurement.

Figure 1

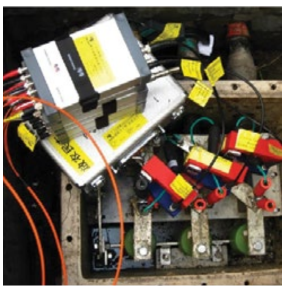


Typical PD measurement setup according to IEC 60270

OMICRON offers standard coupling capacitors from 12 kV up to 100 kV. When using a coupling capacitor without an integrated measuring impedance, the low side of the coupling capacitor has to be connected to the input of the CPL measuring impedance (basic test setup with measurement on ground potential).

Connect the PD output of the CPL measuring impedance to the PD input of the MPD data acquisition unit, and do the same for the testing voltage. The CPL impedance box and MPD acquisition unit can be placed on various positions, such as on HV potential or within the test object path due to the fiber optic approach. Therefore, different setups have their benefits.

Figure 2



Example of using an HFCT in a cross bonding box

Example of HFCT grounding cable at a power transformer

High-Frequency Current Transformers

PD causes electromagnetic signals. Inductive sensors pick up the magnetic part of the electric signal by the same principle as a "real" transformer. High-Frequency Current Transformers, or HFCTs, are often used if a ground/earth connection is available. Therefore the HFCT is placed around these connections and transfers the high-frequency impulse to a secondary winding. The main benefit of using HFCTs is the possibility to measure PD pulses not at high-voltage potential but at grounding connections without opening them.

If more than one grounding wire is used, it should be considered to extend the length of one of these wires to feed both grounding wires through the HFCT. Otherwise, the HFCT will measure only parts of the high-frequency signals. The percentage of the signals measured is defined by the high-frequency impedance of the wires.

Bushing Taps – for PD measurements on power transformers

There are several advantages when tapped bushings are available:

- NO external coupling capacitor is required
- Less background noise in the measuring system
- The coupling device is directly connected to the measuring tap
- On-line measurements are possible in case of permanent installed measuring units

Nevertheless, the installation of the measuring set up must be done when the transformer is disconnected.

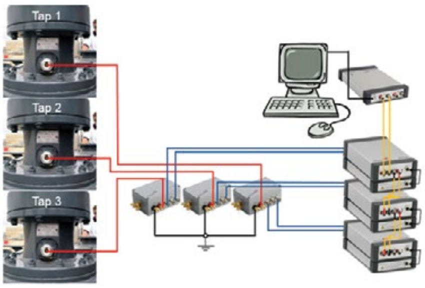


Figure 3

PD measurement set up at 3-phase bushing taps

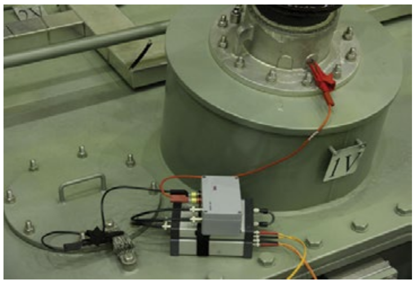
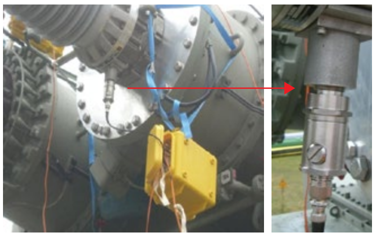


Figure 4

Connection example to bushing taps of power transformer

Figure 5

Bushing adapter



Example of using bushing tap adapters

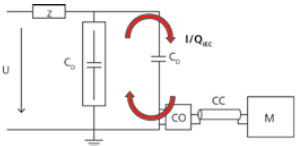
There are several connectors available depending on the bushing tap structure. It is recommended to consider proper adapter solutions, because of the damages that can occur as a result of accidental disconnections.

Ultra-High Frequency PD measurements

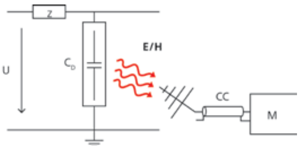
The frequency range of a UHF measurement is 300 MHz to 3GHz and the range typically used is from 200 MHz to 1.5 GHz, depending on device under test. For the past 25 years, this method has been used in Gas-Insulated Switchgear (GIS) and is now also applied to other electrical assets, such as power transformers.

The PD discharge process can be very fast and is consequently measurable in the UHF range. Especially in the high frequency range, interferences are often not broadband and can often be avoided through adapting the center frequency. This unconventional UHF measuring method can be used for commissioning tests as well as on-site and for online diagnostics.

Figure 6



IEC compliant PD measurement



UHF PD measurement

A brief description of the two methods (IEC and UHF) is provided in Figure 7. Until now there is no standard procedure to calibrate UHF measurements.

Figure 7

	IEC measurement	**UHF measurement**
Dispersion	Compensation current	Electromagnetic field
Coupling	Discrete capacitor	Antenna
Frequency	kHz - some MHz	100-2000 MHz
Calibration	Small setups, low frequencies	Magnitude and damping depends on position of defects