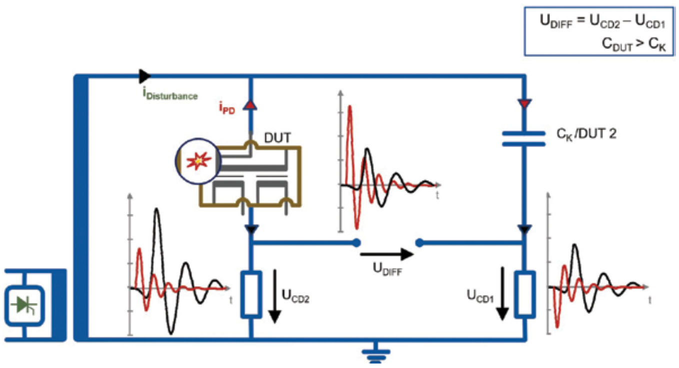
Differential Partial Discharge Measurements

According to the IEC 60270 standard, partial discharge (PD) measurement on high-voltage equipment is a globally established method used for quality assurance. However, as mentioned in our last article, these measurements are challenged in the test field due to interference. A method for reducing interference, which is mentioned in the IEC 60270 standard, is the differential measurement using PD balanced bridges.

For example, the MBB1 together with the MPD PD measurement and analysis system and two CPL1 measurement impedances from OMICRON form a balance bridge measurement system that can effectively reduce noise in the testing environment. Noise suppression can be achieved because of superimposition of the external interference in both measurement branches.

Figure 1



Principle of differential PD measurement (unbalanced)

PD signals and common mode disturbance signals show differences in the polarity in the two branches of a PD measurement circle. If PD is not measured with a single measuring impedance, but rather as a difference signal according to Figure 1, common mode (disturbance) signals (shown in black) will be reduced whereas PD signals (shown in red) will be superimposed constructively. As a consequence, the signal-to-noise-ratio of the measurement will increase. This principle has been used since the early days of PD measurement and is also described in the IEC 60270 standard.

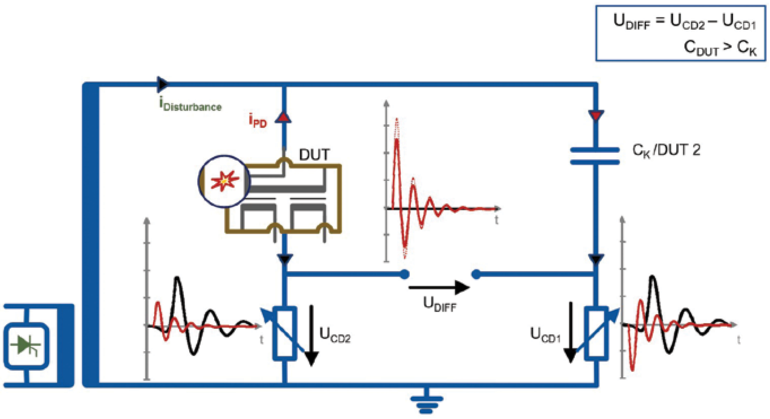
Measurements like this require symmetry in terms of impedance (capacitance, tan δ, inductance) between the Device Under Test (DUT1) and CK/DUT2. As a truly symmetrical bridge-type setup is hardly ever possible under real conditions, the signals have to be balanced to get better noise reduction. This is done in classical measurement bridges by adjusting the measuring impedances (see Figure 2).

In the automatic mode, a calibrator is connected as a common mode source (between HV and GND) and the software calculates the parameterization according to the measured data.

Figure 3 shows a setup with a 6.6 kV voltage transformer (VT) as the test object and a 1 nF coupling capacitor. The DUT has a capacity of 350 pF and a known insulation defect that leads to internal PD above 5 kV. On the top electrode of the test transformer, a wrench was installed to induce corona discharges. The PD signals were decoupled in the ground path of CK (CD1) and DUT (CD2).

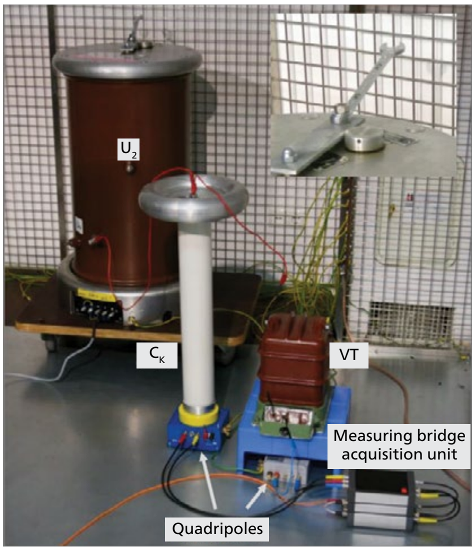
The synchronization voltage was measured on CD1, and the PD signals were measured within a frequency range of 250 kHz ± 150 kHz. During the adjustment and calibration, the weighting ratio was detected to be 1:2.45. To assess the noise suppression, common-mode pulses with a charge of 2 nC were injected after calibration.

Figure 2



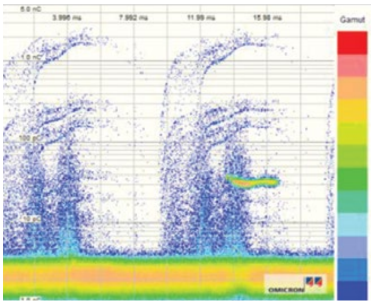
Principle of differential PD measurement (balanced)

Figure 3



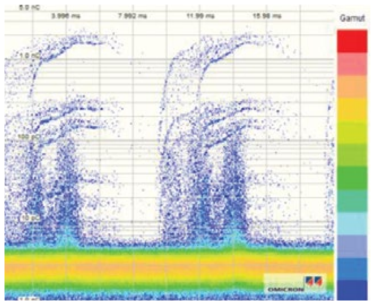
Laboratory setup

Figure 4



PRPD pattern CD1

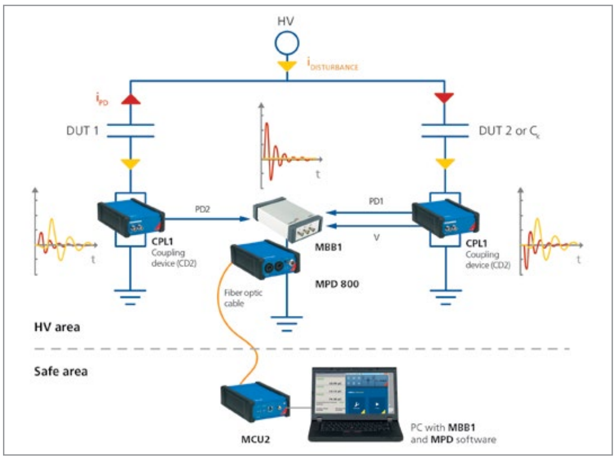
Figure 5



PRPD pattern with balance bridge method

Figure 4 and Figure 5 show the PRPD pattern at a test voltage of 5.5 kV. Both patterns cover a time span of 20 s. The wrench causes strong corona discharges on CD1 and CD2. In the Balance Bridge Mode, the disturbance is reduced and cannot be detected anymore. The insulation defect causes strong internal PD activity with similar PRPD patterns.

Figure 6



Differential PD measurement setup with OMICRON's MBB1 balanced measurement bridge system

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