PD Measurements on Power Transformers

Partial discharge (PD) can damage insulation materials in power transformer bushings and windings. This can lead to insulation breakdown and costly outages. PD is observed in power transformer bushings and windings if the insulation material between different voltage potentials is aged, contaminated or faulty.

PD measurement is a reliable and non-destructive method used to diagnose the condition of a power transformer insulation system. It is performed during factory acceptance, on-site commissioning and routine maintenance testing to detect critical defects and assess risks.

When measuring and analysing PD activity in power transformers, the particular tests and test set-ups are determined by the type of transformer and to which standard the measurements are performed. Depending on the type of bushings used, the PD analysis system is connected either to the capacitive tap of the bushings or to an external coupling capacitor. This allows electrical PD measurements on the transformer.

PD is measured either in pC (according to the IEC 60270 standard) or in µV (according some NEMA or CISPR standards mentioned in IEEE standards). Advanced noise suppression techniques are commonly deployed in high-interference environments to minimize irrelevant data.

There are different methods for measuring PD on power transformers. Depending on their rated voltage level and construction type, some transformer bushings are equipped with measuring taps. Figure 1 shows how the bushing taps can be used to connect the coupling device (e.g. OMICRON CPL) and PD measuring system (e.g. OMICRON MPD 800 or MONTESTO 200) to the transformer.

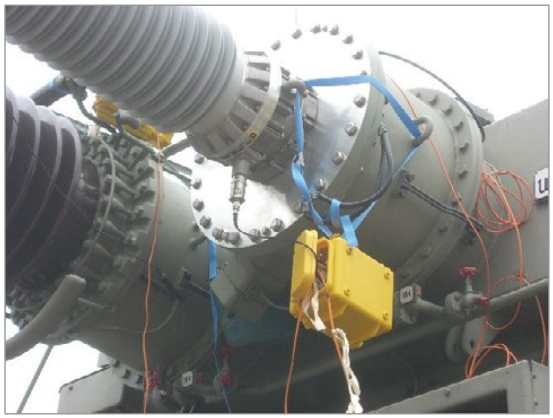


Figure 1

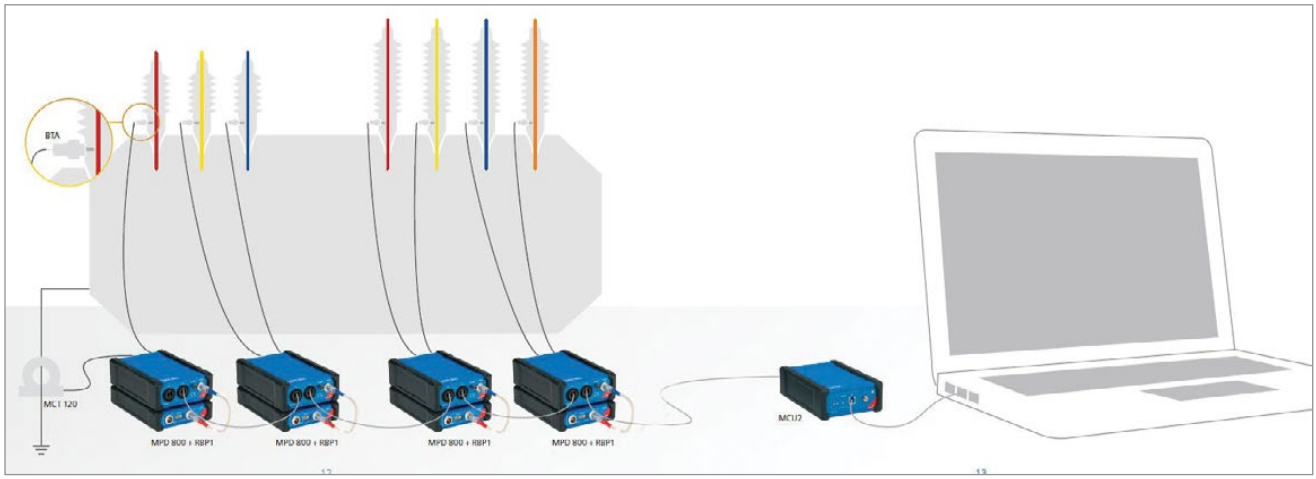
Measurement with MPD 600 in protection case on an HV bushing with measurement taps.

As an alternative to performing PD measurements at the measurement tap of the bushing, PD measurements can also be performed with coupling capacitors, as is often the case in high-voltage labs and test bays. While the low-voltage side is used to induce the power, the high-voltage side of the power transformer is connected to the coupling capacitor.

Especially for on-site PD measurements on power transformers, OMICRON currently supports three different possibilities:

1) Using a conventional PD measurement via bushing taps (example shown in Figures 1 and 2)
2) UVS 610 UHF sensor via drain valves (with the MPD 600 system as shown in Figure 4)
3) MCT 120 High-Frequency Current Transformer (HFCT) on the grounding cable from the transformer tank (as shown in Figure 2)

Figure.2



Conventional PD measurement on an HV bushing *without* measurement taps

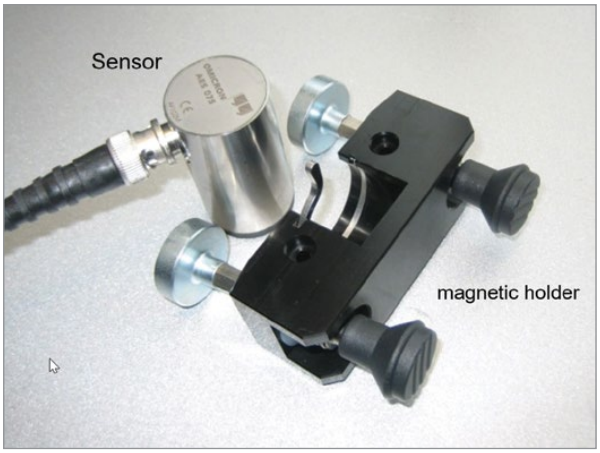
With permanently-installed connections to the bushing tap via BTA, CPL 844 and a terminal box for convenient plug-and-play PD connections, the operator can perform a PD measurement whenever it is needed, even during normal operating conditions without shutting down the power transformer.

Additionally, OMICRON provides users with a solution for the PD localization using AES 075 acoustic sensors on the transformer tank (Figure 3). Acoustic partial discharge measurements are performed with the PDL 650, which records the measured values of multiple acoustic sensors simultaneously. The software then calculates the fault location based on the time difference between the incoming signals.

This principle of localization can be done in a pure acoustic approach or for even more accurate and reliable results, the acoustic PD measurement can be combined with the MPD 800 and even with a UHF measurement together with the MPD 600.

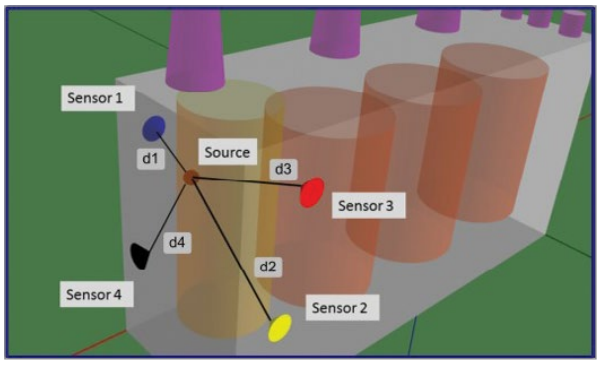
In the latter case, sensors within the transformer walls can be used to receive the high-frequency (UHF) electromagnetic wave that is emitted during PD. A measurement setup is shown in Figure 4.

Figure.3



Acoustic PD sensor with magnetic holder

Figure.4



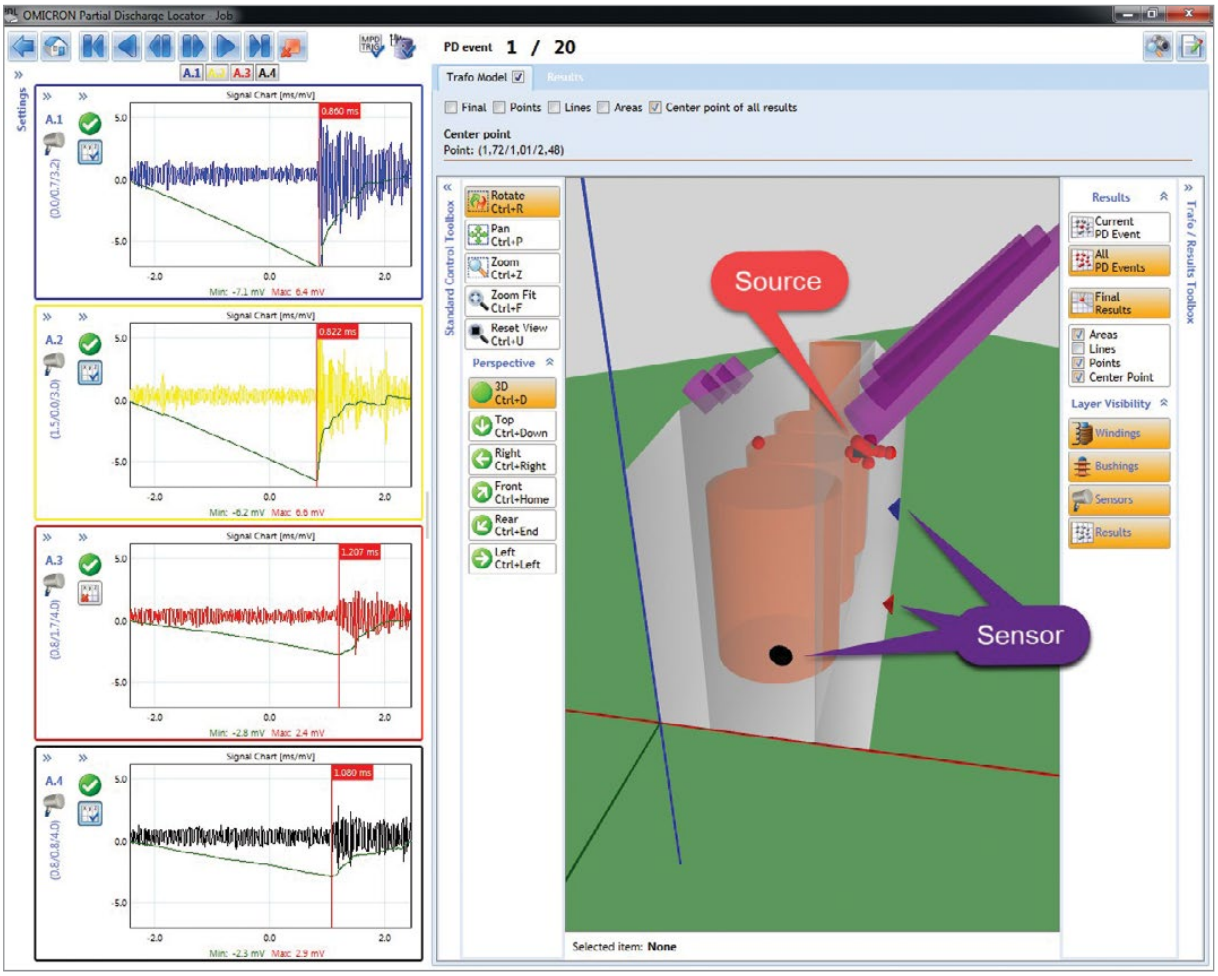
Principle of acoustic PD localization with external sensors

In this way the electrical partial discharge signals trigger the acoustic evaluation, making it easier to locate the PD failure. The measurement acoustic signals are analyzed in the PDL software. The system estimates the time delays and with the sensor position the software can calculated the source location. Power transformer model, sensor and source location are visualized by using a 3D model.

Figure 5

Drain valve sensor for insertion temporary into the transformer for UHF PD measurement

Figure 6



The PDL 650 PD localization system analyses the acoustic signals and estimates the location of the source in a 3D model of the power transformer.