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How to Analyze Partial Discharge

There are several well-known approaches of partial discharge (PD) analysis. The most common ones are:

- The use of Phase-Resolved Partial Discharge (PRPD), with the PD charge over the phase angle
- The PD trend over time
- The PD charge dependency of the high voltage (Q(U))
- Statistical TDR (sTDR) for localization, where the travelling times in a cable are used to determine the PD position

The reliable methods 3PARD and 3CFRD introduced by OMICRON for PD analysis are based on either time synchronous measurements with three MPD measurement channels or multi-band measurements with one MPD measurement channel for single-phase applications. Both methods help you to discriminate PD sources from noise and simplify measurement analysis in environments with heavy interference.

The Phase-Resolved Partial Discharge (PRPD) diagram is a well-known tool that provides the possibility to analyze the faults with respect to the phase of the applied voltage. Additional information can be obtained by taking into account the position of the PD pulses in reference to the phase of the voltage.

Changes in the PD behavior over time may indicate changes to the PD fault. Some international standards limit the allowed rise of charge during a test to a certain limit.

Figure 1

Phase-Resolved Partial Discharge (PRPD) diagram of an instrument transformer with void superposed with discharges of a sharp edge in the HV setup (corona needle)

Charge and applied voltage vs. time
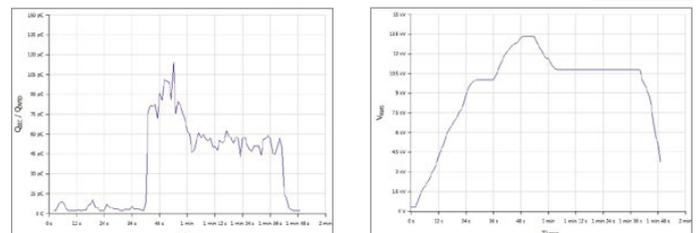
Figure 2

PD repetition rate and RIV value vs. time

Different PD or test related values over the test time
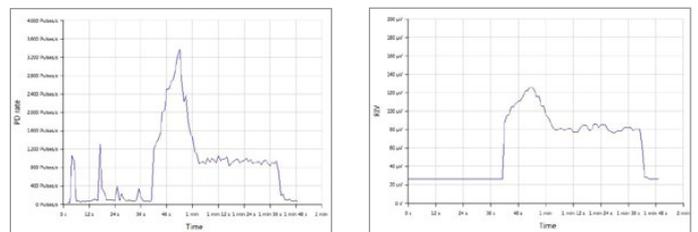
Q(U) will generate a graph that shows the relationship between test voltage level and PD charge magnitude. The relation and behavior of the inception and extinction can help to understand the cause of the PD source. Furthermore, the extinction voltage level is often a very important acceptance criteria for routine tests and should be higher than the voltage used. Figure 3 shows examples of real PD measurements.

For fault localization on power cables, OMICRON supports two methods. These include the Time Domain Reflectometry (TDR) and the Statistical TDR (sTDR). Signal propagation along a medium-voltage/high-voltage cable system can be very complex. Therefore, analyzing the test results is one of the main challenges. TDR is a very well-known tool for fault localization. An example is shown in Figure 5 where the sTDR as also used.
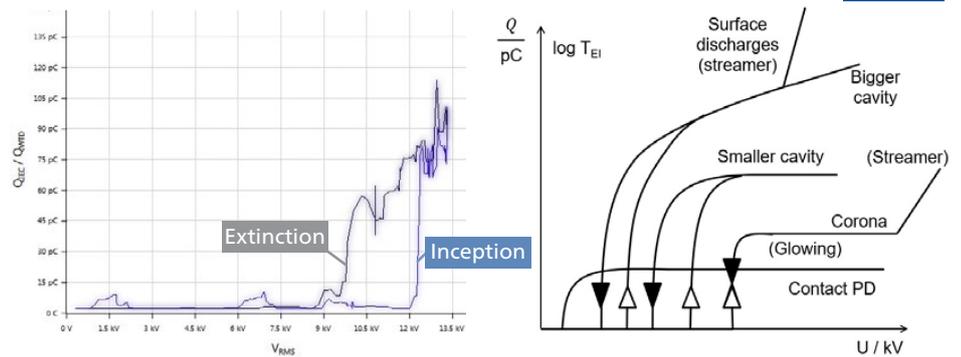
Test voltage run up to 13.5kV and back to identify inception and extinction voltage which can help to identify cause of PD.

However, there are limitations in noisy situations with multiple reflections. The sTDR is more robust in noisy environments and can visualize the multiple reflection points in a histogram. Figure 4 shows the first arrived trigger impulse (green) and further relaxions (red, orange, dark green). Every pair of trigger impulse and further impulse lead to a point in the sTDR. This leads to precise and sensitive result.
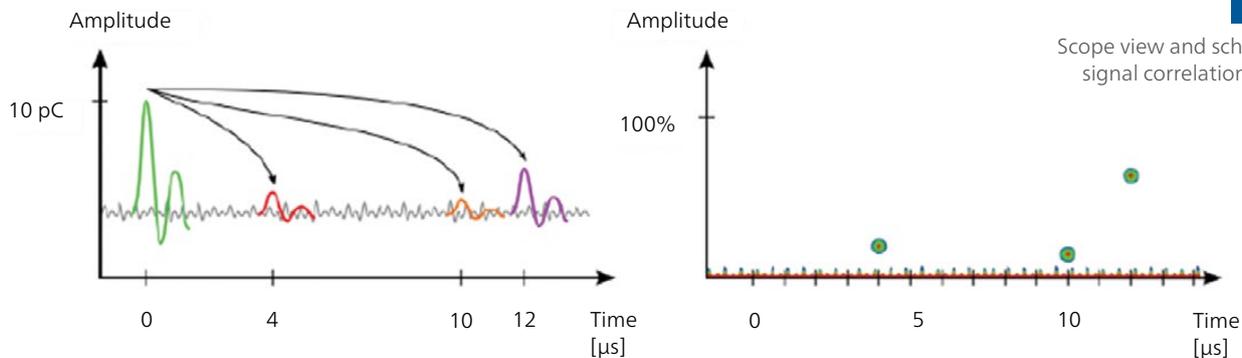
Figure 4

Scope view and schematic of signal correlation for sTDR

In Figure 5, the TDR and the sTDR show a reflection after 9.54µs. The location of the PD source can be calculated by knowing the velocity for the signal (about 161m/µs) and the total cable length, respectively the reflection points of the cable (2782 m).
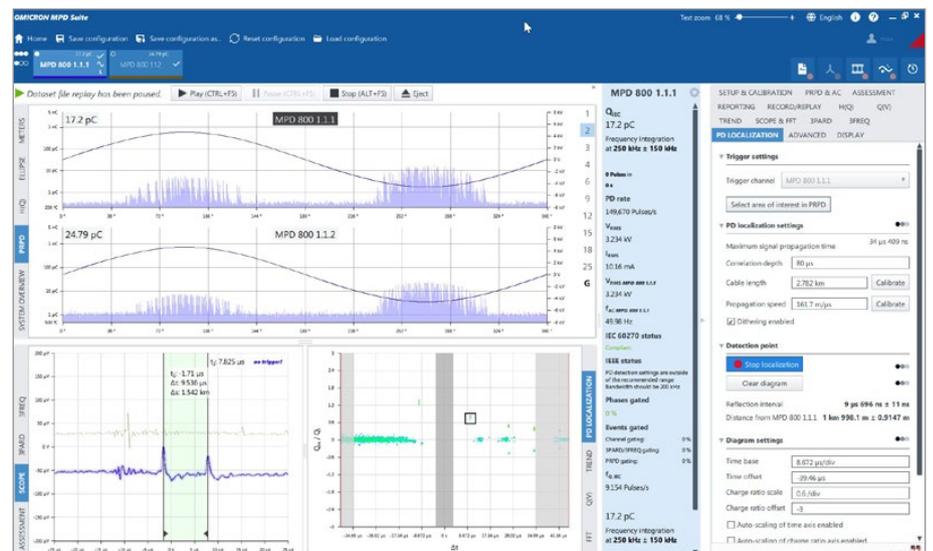
Figure 5

TDR and sTDR used in the MPD Software Suite for localization PD source (at 2011 m from point measurement) in a 2782m cable

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