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High Voltage Partial Discharge

Deployment of Distributed On-Line Partial Discharge Monitoring Devices On medium Voltage Electricity Networks

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Summary

- Wide-Area Distribution Network Partial Discharge Monitoring Solution
- Includes PD monitoring at both primary and secondary switchgear (RMU,s)
- Uses Portable, Remote-Access PD Monitor Units moved around the network

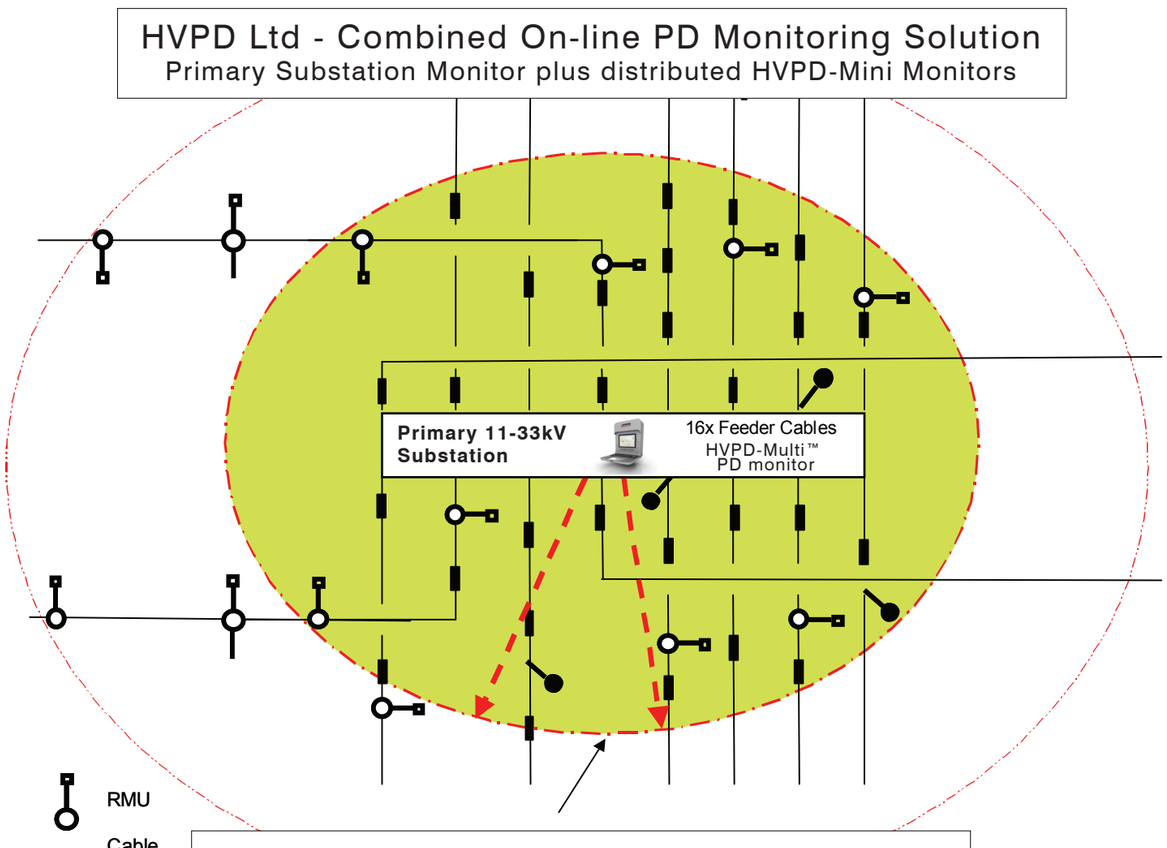
Objectives

To develop a complete, wide-area medium voltage (mv) network on-line Partial Discharge (PD) monitoring solution.

Using portable PD monitoring devices are installed at both primary and secondary substations (RMU,s).

The distributed monitoring devices at secondary substations assists in testing longer circuits (>2.5km in length) which cannot be solely monitored at primary substations, due to the effects of PD signal attenuation on the cables.

Precedence-based data capture with 2x HFCT sensors is used at the secondary substations (RMU,s) to determine on which circuit the PD is on and which direction the PD activity is coming from.



Secondary Switchgear & RMU Monitors

Further extension of PD monitoring into the network, beyond the 'reach, of any PD monitors installed at primary substations is achieved by using portable, secondary PD monitors situated at Ring Main Units and other secondary switchgear.
This combined, wide-area network monitoring solution is shown opposite. With the combined use of PD monitors at both primary and secondary switchgear, cables of lengths of up to 5 km and four RMUs/switches can be monitored.
PD testing at the RMU,s sites must capture data synchronously on both sides of the RMU so that the origin of the PD activity can be located using 'Precedence Detection' techniques.

Primary Substation PD Monitoring

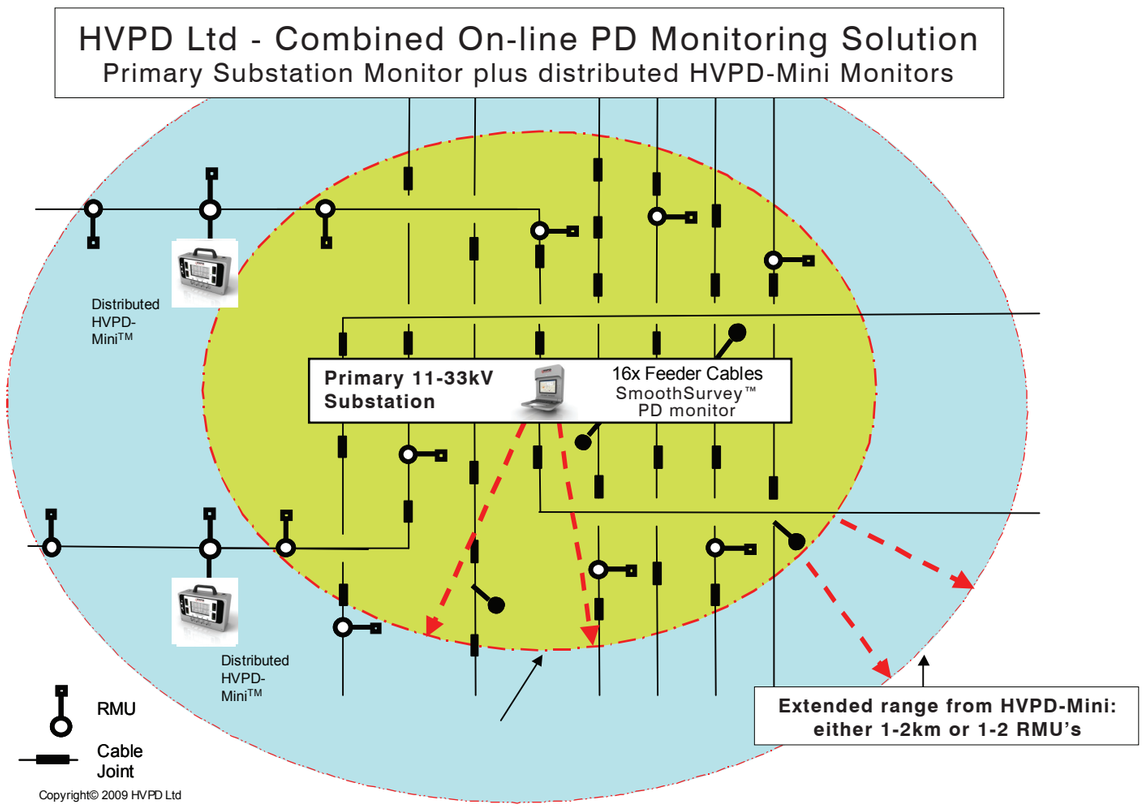
In 2009, EDF Energy have over 1,000 11kV cable feeders being monitored using the web-enabled, remote-access PD monitors.

A portable, 16-channel primary substation monitor technology has been developed which can be moved around large, utility distribution networks to carry out short-term PD monitoring.

Multiplexers are utilised to allow multiple (up to 16x) mv cable feeders to be tested with one portable monitoring device.

Remote-access communications using internet connections of Ethernet/LAN, HSDPA or GSM (3G mobile phone)

The effective range of the PD monitor is up to 1.5-2.5km or 2-3x switches (RMU,s), depending on the cable insulation type.



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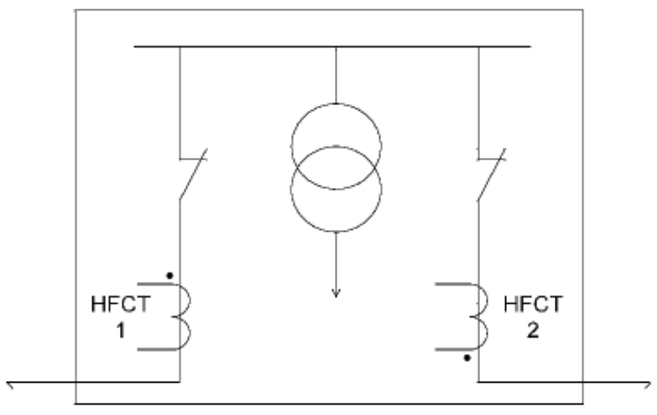
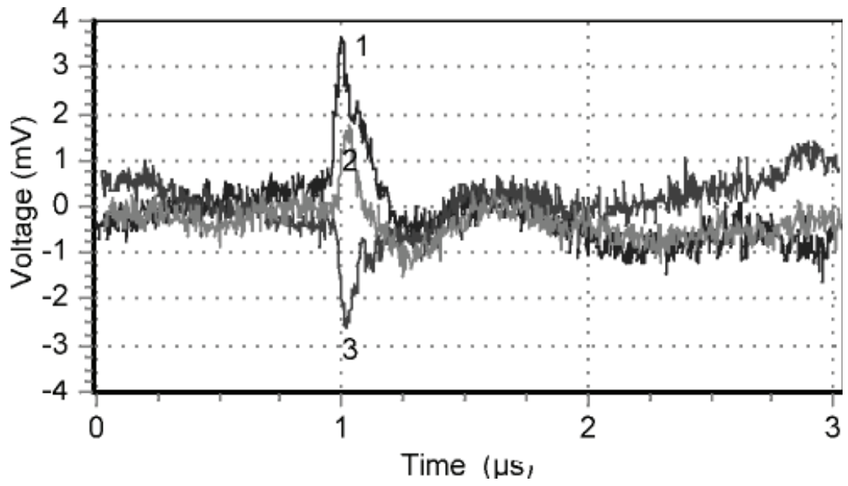
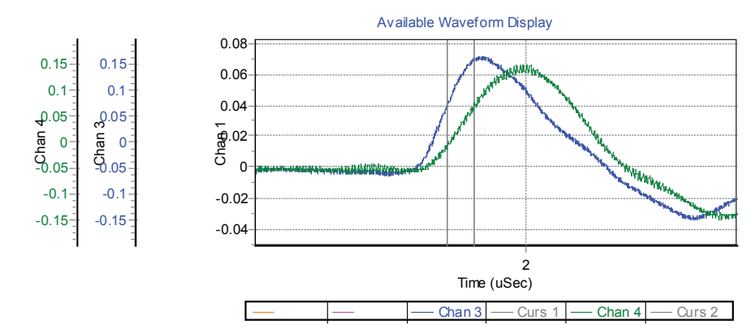


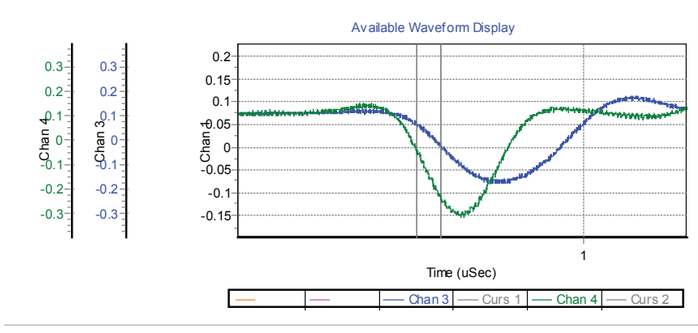
HFCT Connections at RMU - sensors connected with opposite polarity with reference to earth



Pulses across RMU with long transformer cable – 1 - incoming, 2— outgoing, 3- transformer cable



Pulse Delay across RMU of 90 nSec - Blue Pulse First



Pulse Delay across RMU of 60 nSec - Green Pulse First

HFCT's are installed with their windings in the same direction with respect to the flow of PD currents from either feeder (Top left above) so that for a PD on either feeder both sensors will detect pulses with the same polarity. There is a short time delay of between 20-60 nSec on the signals received on the two sensors, depending on the time delay of the signal path through the RMU. The pulse which came first is used to determine the source of the PD through 'Precedence, measurements to enable the RMU PD monitor to 'point, towards the direction of the origin of the PD.

Results & Conclusions

- It is possible to carry out wide-area network PD monitoring using a combination of multiplexed, multi-channel PD monitors at primary substations and synchronous, PD monitors with 'Precedence Detection, at secondary switchgear and Ring Main Units (RMU,s).
- For large utility MV networks, the largest savings in the network running costs are to be made in deferring and/or targeting capital replacement programmes of the cable population.
- Similar studies on industrial customer networks with critical processes show that this is not the case as here the cost of an interruption dominates the capital cost of cable replacement. Such customers have less difficulty in justifying the cost of diagnostic measurements, or complete system monitoring.
- The costs of installing permanent PD monitoring technology to monitor 100% of large utility networks are presently prohibitively high (although this may change in the future).
- The alternative of using portable PD monitors, moved between different substations for a week at a time requires significantly less capital investment than permanent installations and is more appropriate for wide-area public utility networks. It is recommended in this case that a portable monitor solution is used as an alternative to the large-scale installation of permanent PD monitors for large-scale utility networks.
- The new portable PD technologies described in this paper, when incorporated into a structured, condition-based asset management plan such as the 4-phase Asset Management Solution can offer a cost-effective alternative to permanent PD Monitor installations.

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