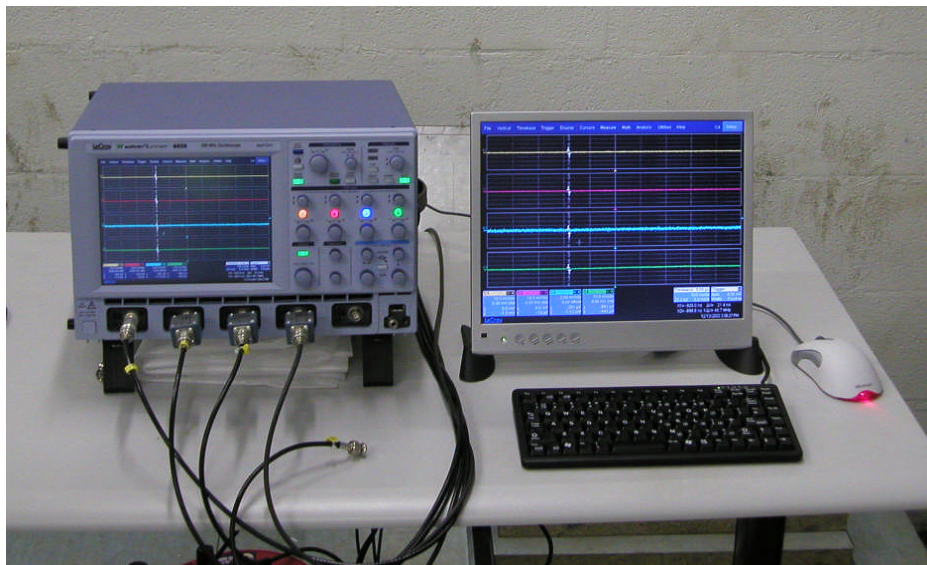


M&B Systems Power Test Equipment

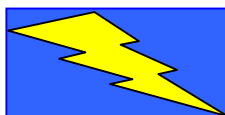
M&B Systems Partial Discharge Monitoring Equipment

Partial Discharge Analysis can be used as a viable preventative maintenance tool for medium or high voltage plant. The technique can be applied to switchgear, motors, generators, cables and transformers. Planned periodical testing using these techniques helps identify problem areas in electrical plant prior to major failure. Analysis of this data using the PD Gold Event Recogniser long shot software helps provide operators with corrective maintenance actions.

PD Detection Systems Type HVS 2000 PDD/T for on- line and off –line partial discharge testing

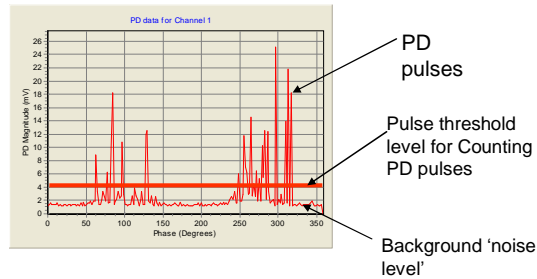


Advanced Technology for Industry



Desired measurements of simple partial discharge (PD) detector

- Whole periods captured synchronously
- Threshold level for number of pulses per cycle
- Noise waveforms can be used for 'gating' external pulsed interference
- Period divided up into slots, and peak detected for each slot
- This is the way the PDGOLD software works using a digitizer front end in peak detector mode i.e.



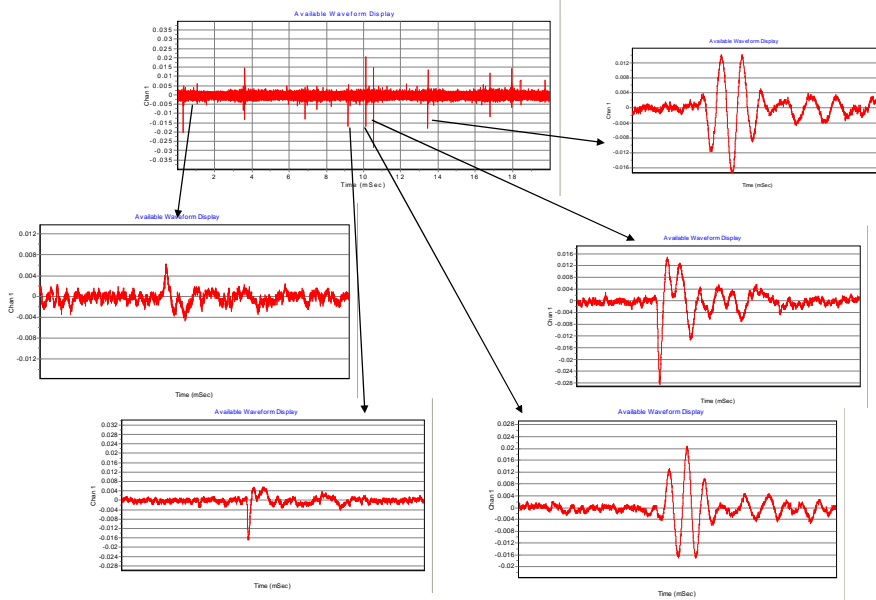
System performance

- As PD pulses comprise only a small fraction of the power cycle, the event recogniser can boast signal/noise ratio of nearly 5 times better than conventional PD detectors on average, and in some cases this can be up to 50 times for some types of data
- Discrimination of PD and noise is carried out using adaptive algorithms, and does not require any external hardware. However, noise gating is still a standard option for PDGOLD using a second channel as the noise source.
- Sensors can include aerial types (TEV probes), high frequency current transformers (HFCT's), ultrasonic sensors (no event recognition is available for ultrasound), or direct HV capacitive coupling.
- System is designed as a spot testing package. However, test times can collect data up to PC memory size, which can be several days if required..

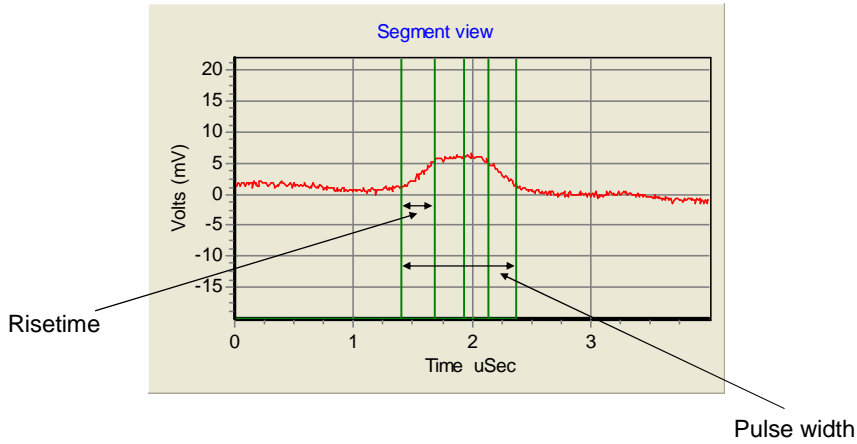
Main ideas of combining event recognition with PDGOLD data

- Whole period waveforms captured at a single shot
- PDGOLD data extracted as normal
- Waveform data cannot be saved as too much data is involved (5 – 8MBytes/period/channel)
- Save event ‘Segments’ of PD waveforms for later analysis
- Event recognisers can distinguish between noise from test object and local equipment PD
- RF noise reduction can be used as standard

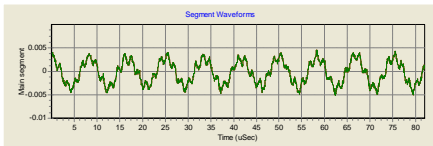
Varying waveforms from a single period



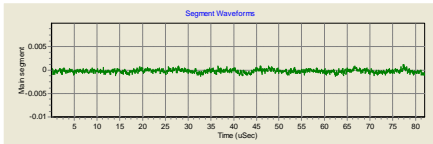
PD pulse cursors from special data adaptive algorithms



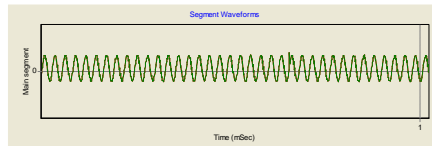
RF noise reduction using single frequency spectral subtraction



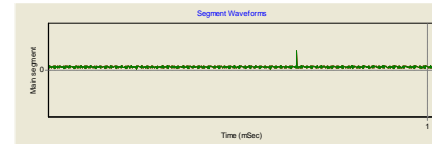
RF noise subtraction



Reduction of 6.6 in the standard deviation of the waveforms. Plotted on the same vertical scale



RF noise subtraction

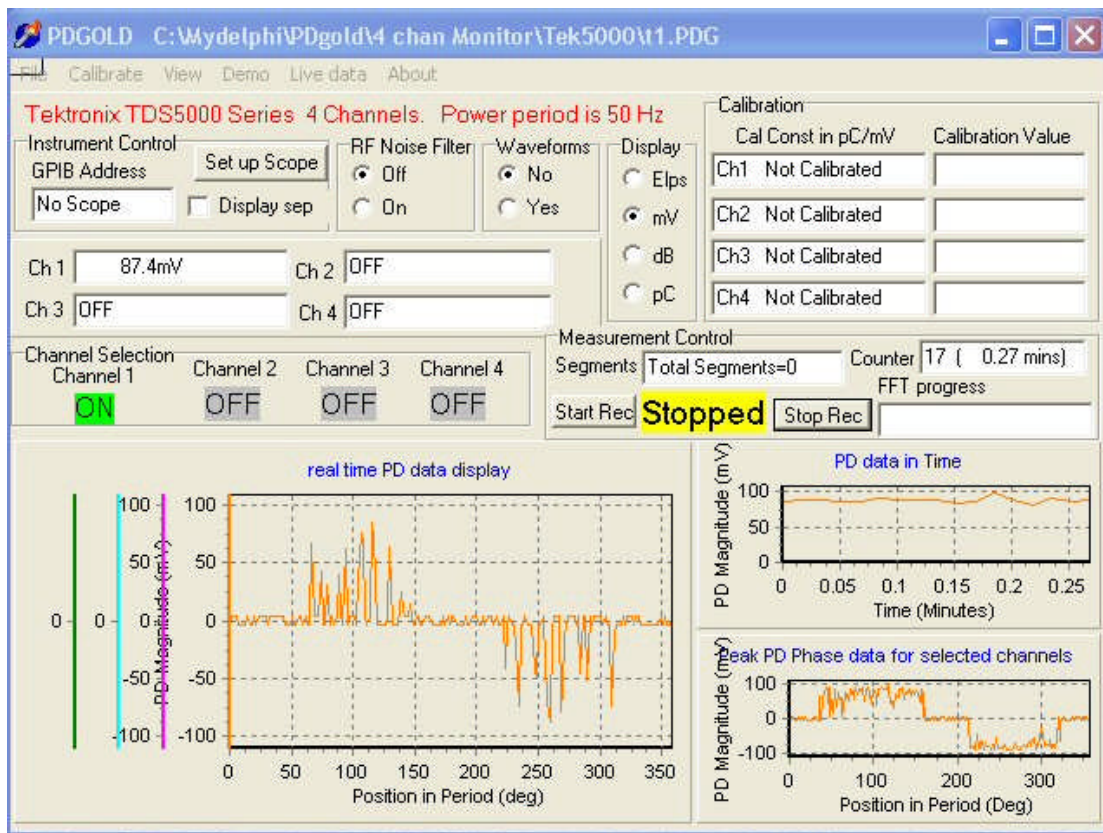


Reduction of just under 10 in the standard deviation of the waveforms. Plotted on the same vertical scale

System packages and options

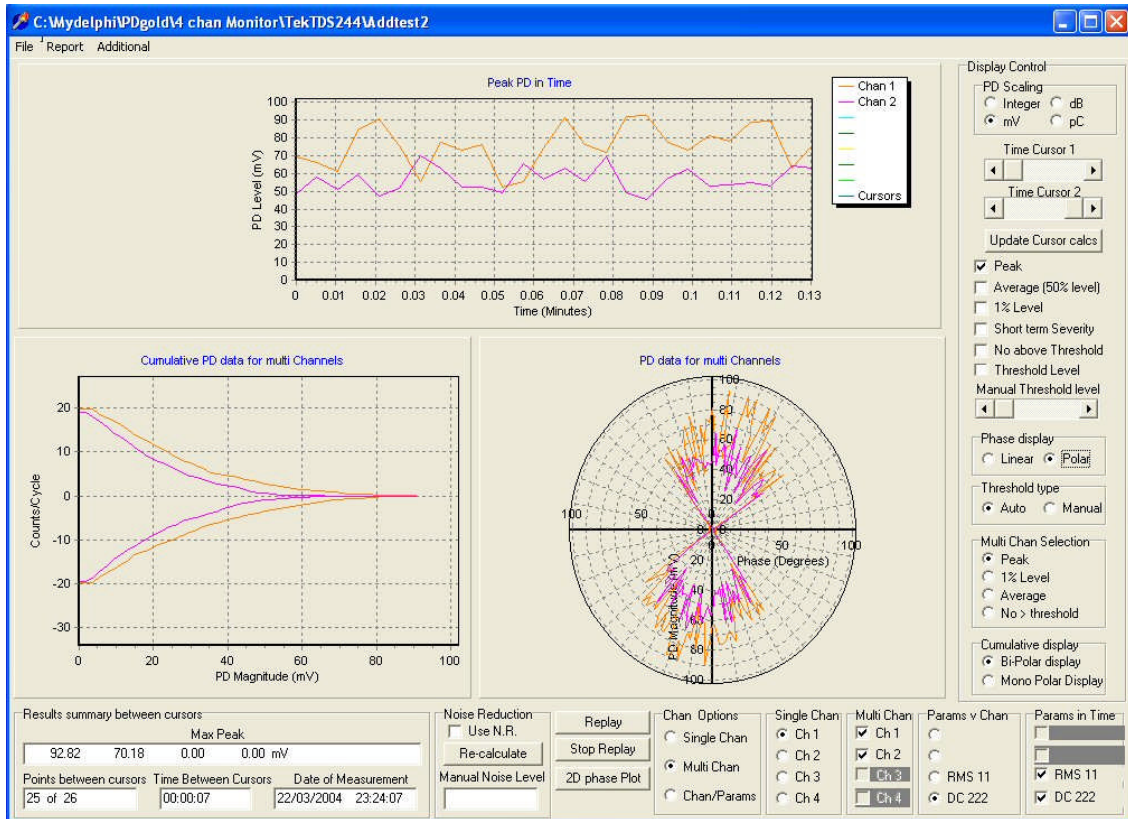
- **PDGOLD software comes as standard, with the following options:-**
 - Event recogniser software for on-line PD measurements
 - Event recogniser includes the cable PD parameters software for simple on-line location, pC size estimate, and correction for distance travelled
 - Rotating machines option for 3-phase on-line testing of higher voltage motors and generators. PD mapping (uses cursors to draw a 'map' of cable PD events)

PD Software –Main PD display window



For each power cycle the peak value, average value and number of pulses above threshold are displayed. A threshold is automatically calculated to give reasonable answers for the number of pulses per cycle. The algorithm used for this takes the largest 10% of the pulses away from the population, and takes the average of the rest as the level for the threshold. This ensures that all the largest pulses are always included, as well as a large fraction of the rest.

PD Software – Analysis and display window



The purpose of this window is to allow some analysis of the recorded data. The way this is achieved, is to take the recorded data in time, to set some time cursors, and to calculate some statistics from the resulting data.

Two main methods of looking at the data are included. These are multi-channel, and single channel mode. A single parameter is displayed for each channel. These can be peak, 1% level, average or number greater than threshold. The alternative method of viewing the data, is single channel mode, in which a single channel of data is displayed, but a variety of different parameters can be seen simultaneously. Hence using the single and multi-channel approach, all the parameters of all the channels can be displayed, but not all at the same time.

Using RFCT's (Radio frequency current transformers) for detection

The discharge detector is eminently suited to using high frequency current transformers (RFCT's) for the PD detection process.

Capacitor Couplers used for PD detection

Capacitor couplers are used to obtain PD information from large generators, the coupler in the form of an HV capacitor terminated usually with a resistive element to earth is connected directly to the HV conductor of the stator winding. The couplers can be connected either at the manufacturing stage or can be fitted later when the machine is taken out of service. PD signals are obtained from the coupler, this providing a low pass filter for the high frequency PD signals but blocking the HV power frequency voltage. The PD signal is obtained using a small RFCT which is fitted in the earthy end of the coupling capacitor, this provides an isolated signal for use by the Digital PD unit. (For further information refer to M&B Application notes)

PD detection on generators and motors

PD detection in motors and generators can produce PD events from what can be a complex impedance. This type of measurement can produce PD pulses that have very fast oscillations. These oscillations arise from multiple reflections from different parts of the machine windings. In such cases, to measure the magnitudes of these pulses correctly, the full bandwidth is used. Frequencies of oscillations in the PD pulses between 10MHz and 100MHz will produce results of this form.

Very fast pulses and electromagnetic pickup

When using PD signals from Aerial or electromagnetic probe pickups (for switchgear, bushings etc), direct connection to the digitizer is essential. The bandpass amplifier is not suitable for this application. Couplers which are used for this type of measurement are capacitively coupled probes mounted within an insulated housing and fitted with a magnetic face for connecting to metal cladding on HV switchgear. These probes are referred to as **TEV Probes**.

The software can display the data in dB, where the levels are relative to 0dB=1uWatt into 50Ω. This has been the conventional origin for switchgear measurements.



Magnetic Capacitive Coupler, TEV Probes fitted to 33kV Switchgear



Cables tested using high frequency CT's (RFCT) around earth straps

PD Detection and on-line monitoring

Provides an accurate measurement of partial discharge (PD) magnitude and pulse rates in a wide range of applications.

Features of the PD monitor

- PD magnitude over 60dB
- Measures PD pulse rates
- Discrimination of PD and noise is carried out using adaptive algorithms, and does not require any external hardware. However, noise gating is still a Standard option for PDGOLD using a second channel as the noise source.
- Monitoring of both magnitude and pulse rates
- PD phase data within the power cycle as standard
- Real time digital output of results
- Threshold settings for discriminating noise and PD data
- Software for data analysis using PD Gold Windows XP professional based software
- Used with either direct connection or electromagnetic radio pickup

Applications & Uses

- Manufacturing using PD for quality assurance
- Testing high voltage plant for commissioning troubleshooting etc.
- On-line monitoring for high voltage sealing ends and cables
- High voltage sub-station testing for maintenance and asset management.
- High voltage testing for component manufacture
- Pass/fail testing for HV plant commissioning

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