

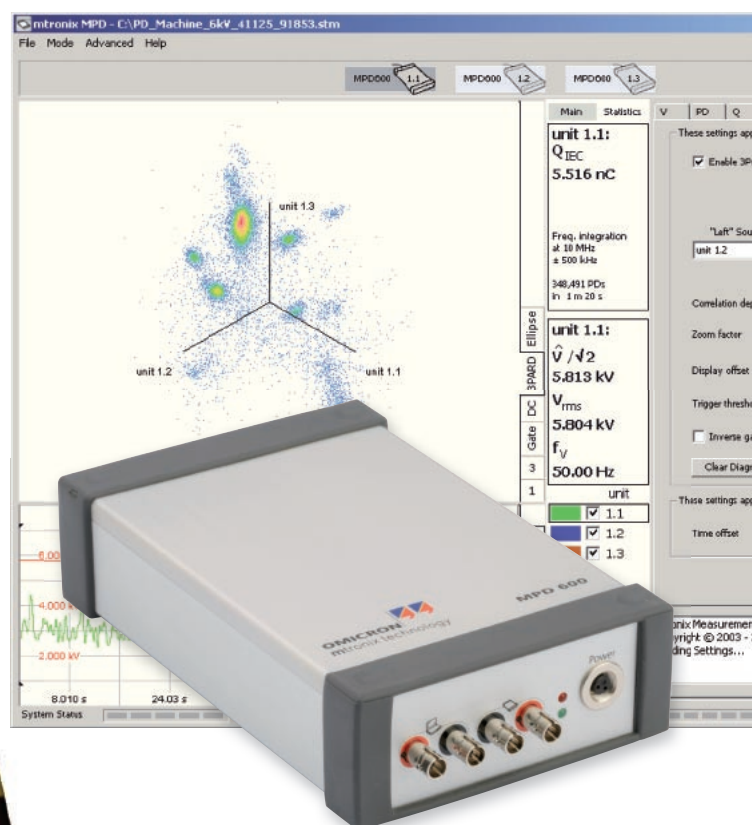


OMICRON
mtronix technology

MPD 600

PARTIAL DISCHARGE ANALYSIS SYSTEM

Synchronous Multi-channel
Optically isolated
Fully digital PD analysis system



Partial Discharge Analysis

The MPD 600 Partial Discharge Analysis System is a high-end, high-precision, modular acquisition and analysis toolkit for detecting, recording, and analyzing partial discharge events in many applications.

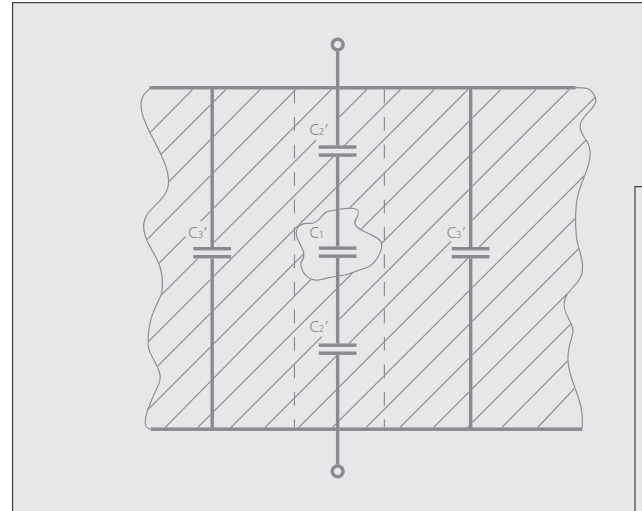
Partial Discharges = weak points in insulation systems

Partial discharge (PD) phenomena, as defined by IEC 60270, are localized dielectric breakdowns of a small portion of a solid or liquid electrical insulation system under high voltage stress.

The detection and monitoring of partial discharge is of vital importance because PD phenomena often precede an insulation breakdown of high voltage equipment, leading to cost-intensive outages and repairs.

In the field of electrical power systems manufacturers, as well as utility operators, constantly strive to improve their quality processes in order to protect their most valuable assets: generators, motors, transformers, switchgear and cable systems. Instrumentation for the accurate detection and evaluation of PD is an integral part of these processes and is also prescribed by a number of international standards.

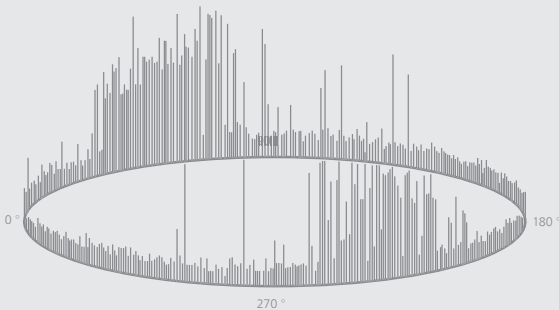
Measuring PD during routine or preventive maintenance with the OMICRON MPD 600 provides full compliance with the relevant standards IEC 60044, IEC 60076, IEC 60270 and IEC 60885 for power systems.



Rising to the Challenge: The OMICRON Solution

The challenge of PD analysis is the detection and evaluation of minute discharges in the range of pico-coulombs (pC) while dealing with test voltages of up to several hundred kilovolts. This is often complicated by severe external interference, or "noise", from nearby equipment caused by corona or other *radio frequency* (RF) sources.

The MPD 600 incorporates a range of leading-edge technologies in order to provide accurate, reliable and reproducible measurements – even under the most demanding circumstances.



Your benefits:

- PD detection in full conformity with IEC 60270
- Excellent noise immunity
- Easily transportable acquisition units allow testing at different locations
- Exceptional graphical display of all relevant PD information
- Safe operation due to the full galvanic isolation of the PD acquisition units

A Fully Digital System

Its versatility and robustness makes the MPD 600 the ideal system for both laboratory and on-site measurement of partial discharge in power system equipment.

The System

The MPD 600 system consists of an acquisition unit, a fiber optic USB-controller and its innovative software to make PD measurements in full accordance with international standards. High-resolution digital processing technology delivers exceptional measurement accuracy.

Field-Proven Technology

Field-tested in some of the world's largest PD measuring projects and used by major cable, transformer and rotating machine manufacturers the system has fully proved its reliability. Hundreds of units are in operation world-wide in industrial and utility applications.

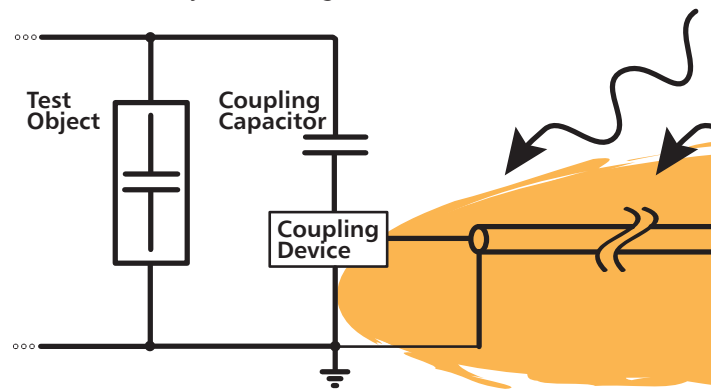
No Practical Limits – up to 960 Channels

The system can be easily expanded to include up to 960 channels, to perform truly parallel and synchronous multi-channel PD measurements. Thus the measuring system provides true plug-and-play functionality. Each channel may be situated up to 2 km/1.2 miles from the adjacent unit.

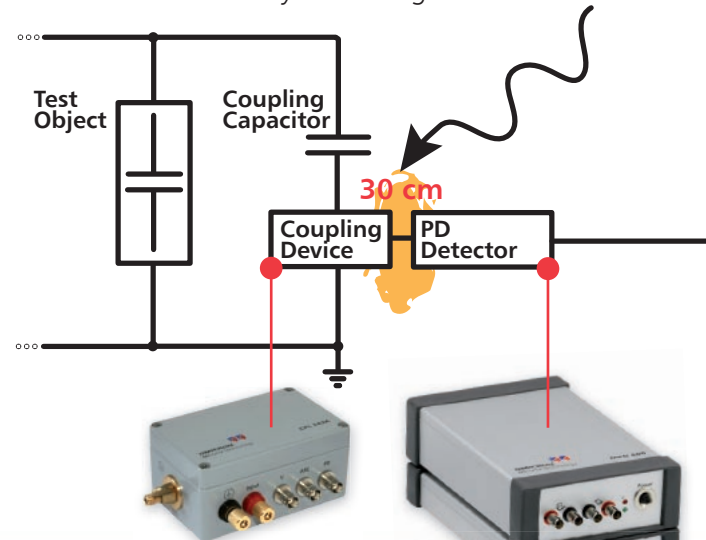
Battery Powered Acquisition Units

Due to the very low power consumption, an uninterrupted battery operation time of more than 8 hours can be guaranteed. During battery operation no noise from the mains power supply can enter the measuring circuit. The measurement unit can be operated at high voltage potential (for ungrounded measurements).

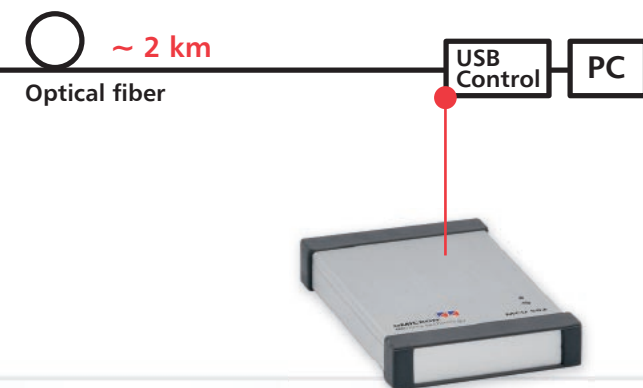
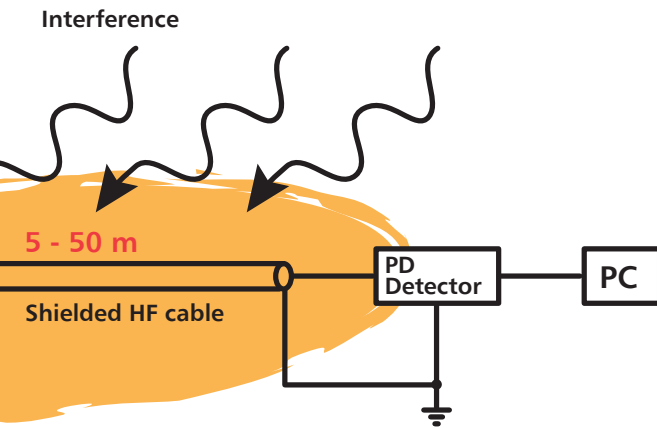
Traditional PD system configuration



OMICRON mtronix PD system configuration



**Approved compliance
to
IEC 60270:2000-12**



Optical Isolation

The unique high-speed fiber-optic network technology guarantees complete galvanic isolation between the individual acquisition units and the PC controller. The elimination of ground loops reduces interference and enables the system to have higher sensitivity (better signal-to-noise-ratio).

Fiber-optic connections are well proven in industrial environments where electrical or radio frequency (e.g. WLAN) connections are unreliable because of frequent disturbances from machines or electrical discharges (e.g. PD). Fiber optic connections may also be very long (up to 2 km/1.2 miles) without degrading the instrument's performance.

Another convincing advantage of the fiber-optic network, in comparison to conventional copper wired systems, is the complete synchronicity of all the connected acquisition units down to the range of nanoseconds. Due to an automatic propagation delay compensation over the length of all network segments, a continuous, uninterrupted acquisition of time-critical PD events and the related test-voltage signal is ensured.

Your benefits:

- Experience of hundreds of units in operation worldwide
- Ability to extend for testing large systems
- No noise from mains due to battery operation
- Optical fiber connections significantly reduce base noise level
- Full synchronicity of coupled PD detectors, leading to extensive analysis possibilities
- Extremely high measurement accuracy and sample rate



Active Noise Suppression

A major problem to overcome when making PD measurements, is interference from electrical noise, which may render the detection and location of PD signals difficult, or even impossible. The elimination of this interference is therefore critical for successful PD detection. The MPD offers several methods for passive and active noise suppression.

Advanced Fully Digital Filtering

In the MPD 600 the classical analog filter has been replaced by a mathematical algorithm. Therefore, no aging effects or drift over time and temperature occurs and the MPD 600 offers an exceptionally high degree of reproducibility to perform reliable, calibrated and traceable PD quality control.

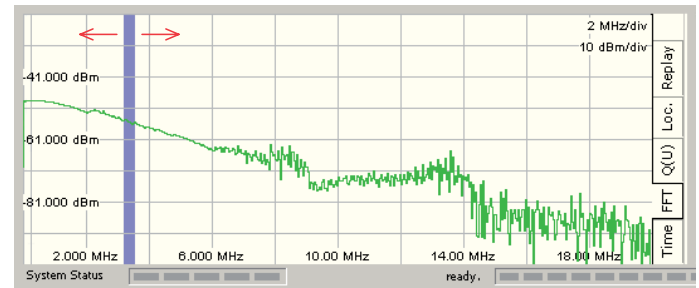
Due to the innovative use of freely selectable bandwidths and filtering, the MPD 600 can be flexibly adjusted to the appropriate pass-band (frequency spectrum range), especially under changing on-site conditions to achieve the maximum measuring sensitivity. These highly flexible filtering options guarantee superior reliability and repeatability of all measured values and result in an outstanding signal-to-noise ratio compared to measuring systems with fixed filtering frequencies.

Powerful Gating Methodology

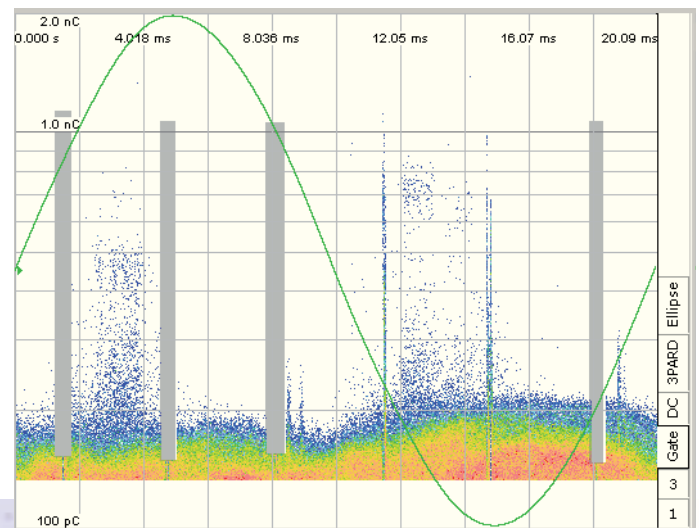
An unlimited number of Phase/Amplitude Gates allows the suppression of signals with a certain amplitude and fixed phase position (e.g. converter pulses, drives, irrelevant PD).

To eliminate the effect of disturbances (e.g. corona) from the measurement results, an optional external unit can be used for the Unit (Antenna) Gating. All pulses which are identified simultaneously by this unit and the PD measuring station, must result from disturbances because the external gating unit cannot see actual PD pulses from the equipment under test.

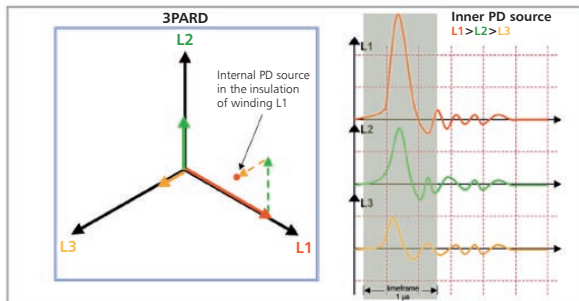
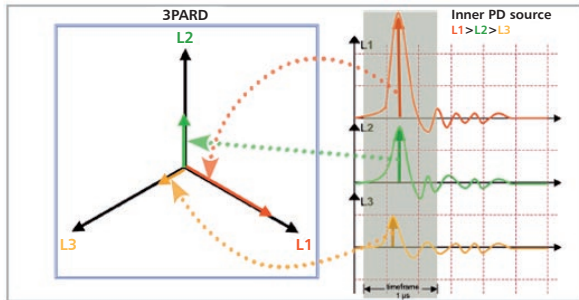
Non-stationary pulses which are not fixed in phase ("moving" vs. phase) – e.g. interference from drives, motor-generator test sets and temporary interference – can be suppressed by the unique *Dynamic Noise Gating* (DyNG) in which the amplitude-phase window follows the disturbance pulses dynamically.



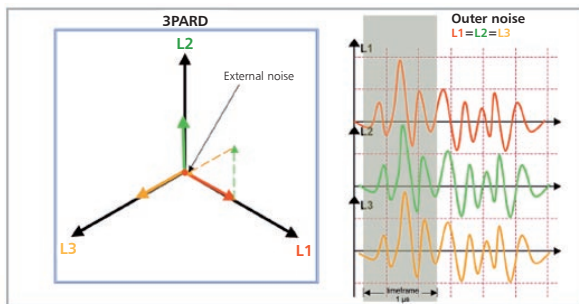
Flexibly adjusted to the appropriate frequency spectrum range



Gated disturbance pulses



Inner PD source is clearly identified



Outer noise generates a cluster at zero-point

Some noise can look very similar to PD. With the increasing use of power electronic components, these pulses can be ever-present in factory environments. PD fault recognition usually requires a great deal of experience and knowledge to differentiate between different fault patterns in phase resolved diagrams. There is also a challenge to distinguish several PD sources from each other and from superimposed disturbance pulses or crosstalk.

Advanced Noise Separation Tools

The 3PAR (3-Phase Amplitude Relation Diagram) helps to differentiate various PD sources from each other, as well as from PD-like disturbances, which increases the ease of PD source recognition. Through measuring three phases simultaneously, the combined results can be displayed in a single diagram called the 3PAR. This allows noise to be clearly separated from real PD within the test object. In some cases, this may save considerable expense by dispensing with the need for a Faraday cage.

The 3CFRD (3 Center Frequency Relation Diagram) characterizes PD sources by their frequency signature. Even for a single phase or a single PD decoupling position, pulse-triples can be acquired by using three different PD filter settings. The signal output from three filters with different center frequencies or bandwidths, allows a pulse-waveform-analysis.

Your benefits:

- Unrivalled opportunity to adapt the measurement settings to the on-site conditions with a freely selectable center frequency
- Outstanding SNR (signal to noise ratio) due to variable bandwidth filters
- Easy suppression of phase-fixed noise signals by an unlimited number of gates
- Ability to separate inner and outer PD with an external gating unit
- Dynamic noise gating enables the removal of unwanted cyclical, non-phase relational pulses
- Easy-to-use 3PAR, 3CFRD functionality separates noise from inner PD

Powerful Software

The innovative software solution provides multiple user interface options: Basic, Cable and Expert Mode – these modes provide tailor-made solutions for different user needs.

BASIC Mode – Results at the "click" of a mouse

- Highly responsive real-time display (> 20 frames/sec)
- Fully configurable and highly responsive real-time oscilloscope views, for the voltage and PD inputs
- Flexible PD event visualization, including the phase resolved histogram view, ellipse and real-time view
- Reproduction of a classical analog feel

In Basic Mode, most parameters and settings are automatically determined by the software, so the user can focus on performing the PD measurement.

The large scope view shows the high-voltage curve(s) of the connected acquisition units, as well as the phase resolved histogram of the currently selected unit

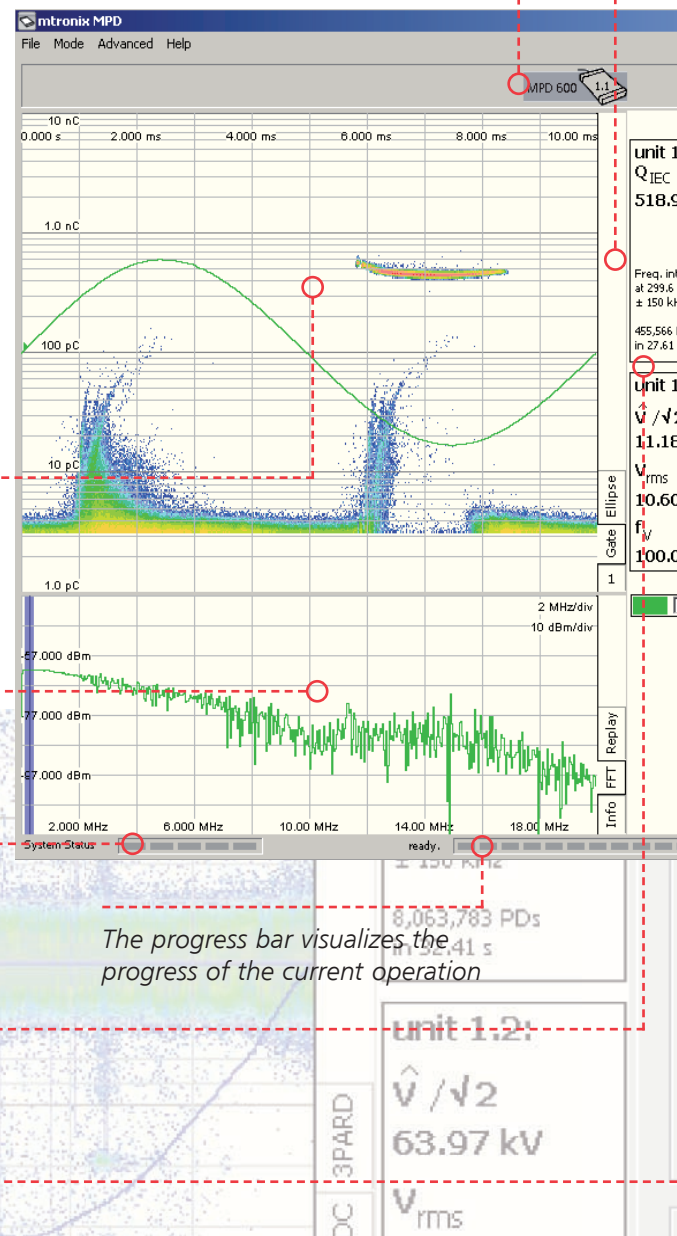
The small scope view can be configured to show different sets of data: the spectrum of the input signal at the PD input (DC through 20 MHz), the time signal, trend curves for a variety of measurement quantities and a replay log

The status bar shows the initialization status of the software by means of 5 indicators

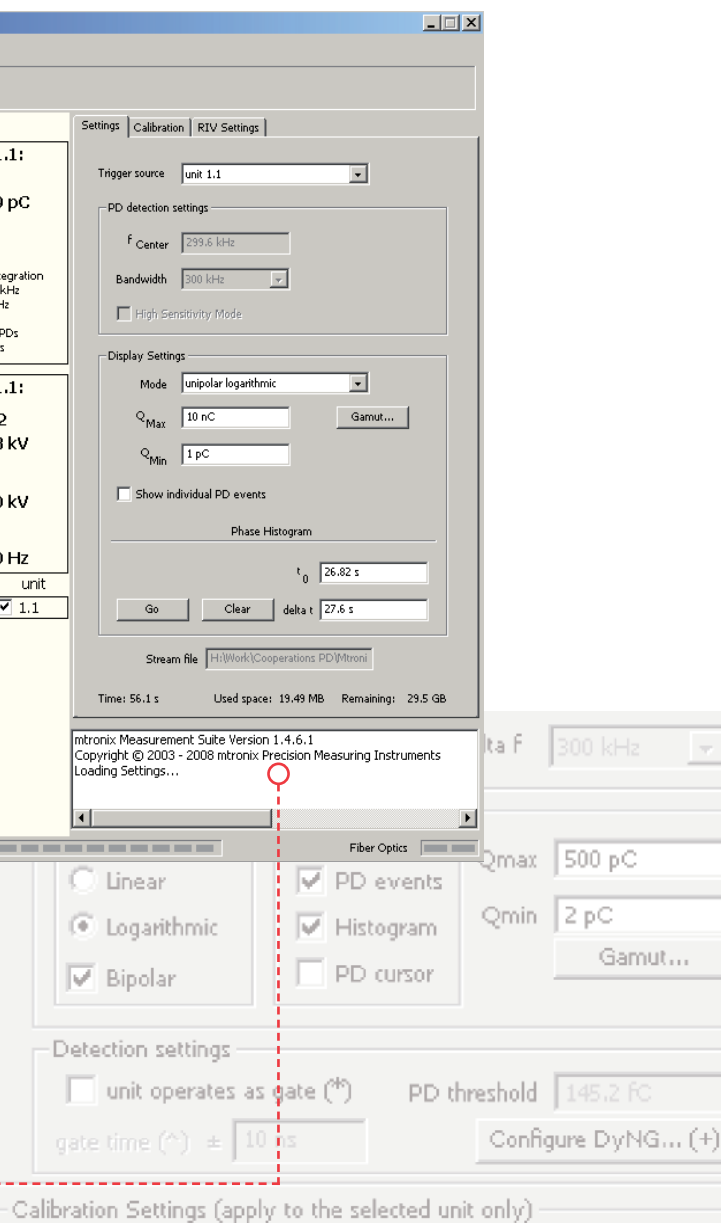
The measured quantities display shows the current values for quantities conforming with IEC 60270 such as: charge level, high voltage, frequency, etc.

The log area displays status and warning messages in a form easily readable by the user

The acquisition unit display indicates which units have been detected



The display is subdivided in the large scope view, the small scope view, and the measured quantities display



EXPERT Mode – Making Everything Possible

The MPD 600 Expert Mode allows the user to manually control every aspect of the PD detection and analysis process and provides access to advanced visualization options.

Expert Mode features:

- 3PARD – 3-Phase Amplitude Relation Diagram
- 3CFRD – 3 Center Frequency Relation Diagram
- Control of advanced noise suppression by Dynamic Noise Gating
- Hardware gating
- Full oscilloscope style functionality for PD input signals
- Q(U) diagram
- Control of RIV measurement
- PD detection and analysis for DC applications
- Long-term trending of all relevant PD related data for monitoring purposes
- Statistical PD fault location
- Statistical PD event evaluation (e.g. Q_{IEC} average)

Your benefits:

- Tailor-made user interfaces
- Multiple display options for PD events to fit the user requirements
- Full overview of all relevant data such as: PD level according to IEC 60270, test voltage, system status etc.
- Intuitive oscilloscope style view with full functionality
- Support of *Radio Interference Voltage* (RIV) and DC measurements



Post Processing of Real-time Data

The comprehensive recording and reporting capabilities of the MPD's software provides a quick and concise overview of complex test runs. The system records and stores every detail of a test, regardless of whether the test took hours, days or even months to complete.

Whether taking PD measurements for routine testing in the lab or commissioning and preventive testing on-site, the measurements are often performed under tight time constraints. More often than not, there is insufficient time to make a detailed analysis of the PD patterns or the changes in PD activity which occur during testing.

Powerful Recording

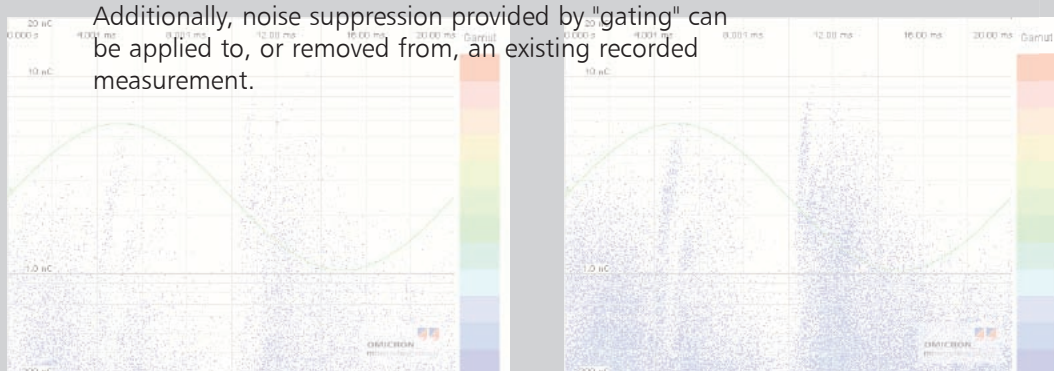
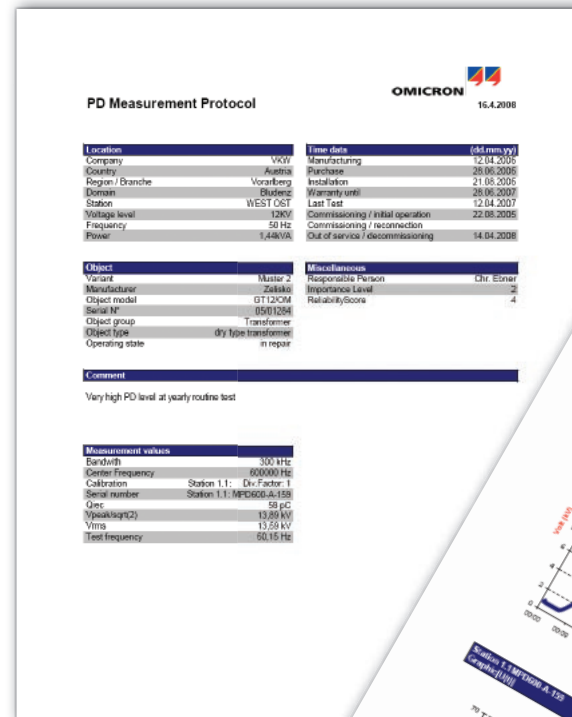
The MPD 600 can record every single PD event during a test to the computer's hard-disk drive. This is done at a rate of more than 1.4 million pulses per second. The test voltage is recorded at more than 20,000 samples per second.

In addition, all relevant system settings are also stored. The growing data pool can be used as reference material or as a knowledge base for the interpretation of future measurement results.

REPLAY Mode – Just like a movie

Replaying the recorded data allows the measurements from the testing on-site to be reviewed and compiled in to a set of comprehensive reports.

In contentious cases, e.g. after an insulation breakdown, forensic analysis can be performed using the recorded data leading up to the event. Additionally, noise suppression provided by "gating" can be applied to, or removed from, an existing recorded measurement.





3PARD Separation

The online 3PARD provides a very reliable method for associating different PD sources within a 3-phase set-up with particular PD fault locations.

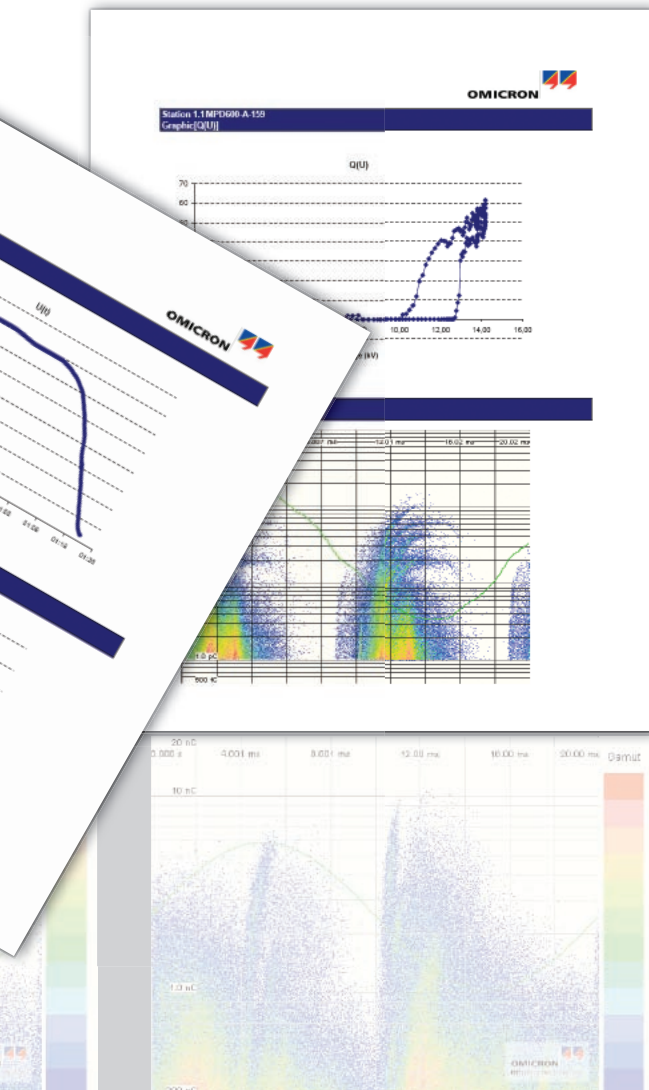
Multiple PD faults can be easily differentiated in this way, by an automatic algorithm. For PD fault classification, the 3PARD clustering method allows the generation of individual phase-resolved PD (PRPD) patterns for classical PD evaluation.

Comprehensive External Application Interface

The flexible application interface, based on Microsoft® COM, allows the complete transfer of all measured quantities and configuration settings to further analysis and visualization tools such as Microsoft® Excel or MATLAB®.

Customizable Report Generator

The optional Report Generator provides full support for Microsoft® Excel and allows the control and integration of all of the measurement functions of the MPD 600 system into a customized report suitable for immediate printing.



Your benefits:

- Replay of the measurement enables the comprehensive assessment of PD events in the office
- Easy-to-use 3PARD functionality allows the separation of several PD faults
- Microsoft® Excel based report generator allows the creation and printing of customized reports

High-Sensitivity Cable Testing

Factory Testing

In screened test labs. PD measurements on HV components can be performed with the standard PD measuring circuit, using coupling capacitors and measuring impedances. After the calibration process, the MPD 600 will display the value of the apparent charge in accordance with IEC 60270. Graphical tools, such as PRPD pattern visualization, support the PD analysis.

In addition to the charge information, the MPD 600 can locate PD faults in HV cable segments using internal *Time Domain Reflectometry* (TDR) algorithms. By analyzing the time delays of the different PD pulses arising from propagation and reflection, it is possible to determine the PD fault location.

If many PD pulses are taken into account, a statistical evaluation can be accomplished which gives a higher probability for a certain fault location. Accordingly this procedure can deliver fault locations for more than one PD fault on the cable system.

On-site Testing

The PD measurement provides one major criterion for assessing the quality of the cable and its accessories, as well as their assembly on-site. The cables are tested with a sensitive PD measurement during manufacture and so during commissioning the focus is on the quality control of cable accessories, such as joints and terminations.

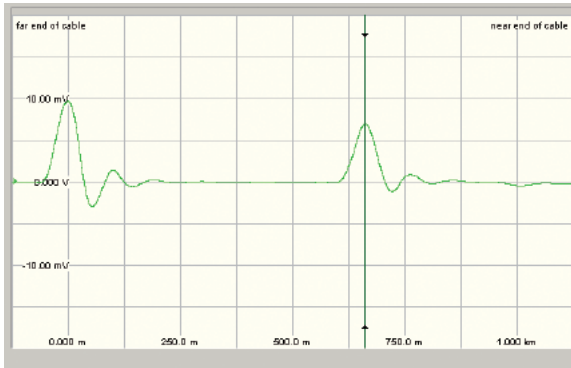
In addition to the classical PD measurement with a coupling capacitor at the cable termination, there are alternative decoupling methods based on PD-field sensors which are becoming more important. These sensors are mounted close to the accessories and hence they have a considerably better measuring sensitivity compared to a measurement taken at the cable end. Examples include capacitive sensors, inductive sensors and *directional coupling sensors* (DCS).



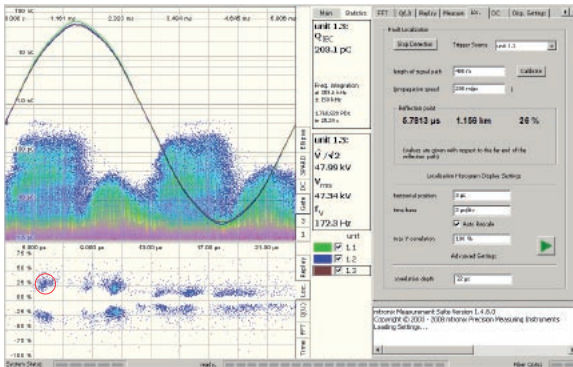
Factory test of a cable drum



Installed cable system



Runtime based fault location



Statistical Time Domain Reflectometry fault location

Fault Location – the CABLE Mode

The Cable Mode is an intuitive three-step interface for factory quality assurance testing of high-voltage cables, as well as for cable fault location.

Unique PD Fault Location Method

PD fault location in cables can be carried out using common single-pulse *Time Domain Reflectometry* (TDR), statistical TDR or the MPD 600-specific dual-end method which can achieve an outstanding accuracy of less than 0.2 % of the overall cable length.

Dual End Method

The Dual End Method, where one MPD 600 is situated at each end of the cable, delivers the highest accuracy levels as it uses the shortest possible signal paths between any PD sources and the measuring system.



Your benefits:

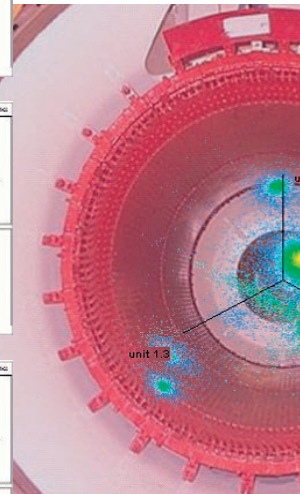
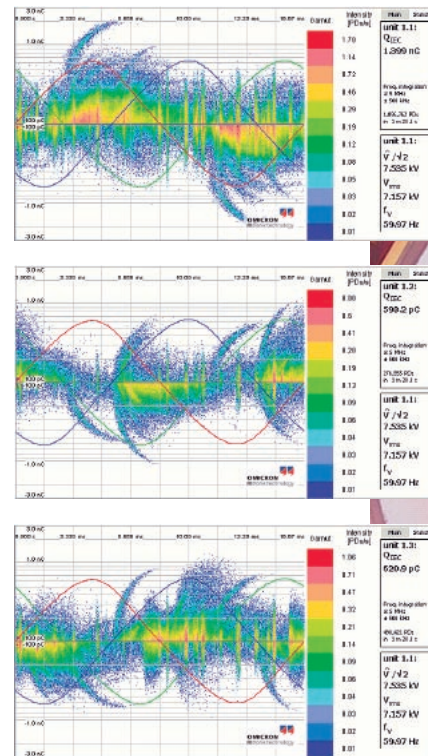
- Measurement results in compliance with IEC 60270:2000
- Sensitivity < 1 pC for high precision measurements under test field conditions
- Accurate PD fault location via statistical PD pulse evaluation
- Time and cost-savings due to true multi-channel measurements on long cables, while providing increased safety and accuracy

Testing of Motors & Generators

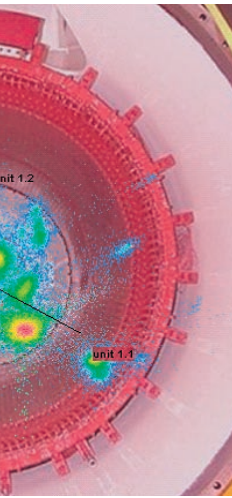
The predictive maintenance of high voltage equipment is being increasingly employed to improve its reliable and economic operation. Partial discharge measurements are, for this reason, increasingly used for on-line and off-line condition assessment of rotating machines used in power generation, industrial drives and traction.

Challenges of on-site PD Measurements on Rotating HV Machines

- the presence of electrical interferences, especially in a noisy industrial environment
- the presence of partial discharge is typical in the stator insulation of large high voltage rotating machines and a specified level is considered acceptable
- the need for recognition and separation of multiple PD sources which commonly occur within the stator winding insulation
- the classification of PD sources in order to distinguish between normal and harmful occurrences



The system offers a unique possibility to differentiate multiple PD sources. The standard PD evaluation methods such as, pattern analysis in the time domain, time of flight, pulse sequence analysis, TDR localization etc. can become more useful and reliable even under critical on-site conditions.



- the center frequency and the bandwidth can be freely chosen, which allows the measurement system to have the optimum settings for the device under test and the correct frequency range to ensure that disturbances remain low (i.e. there is a high signal-to-noise ratio)
- 3 different gating options: hardware gating (with an additional measuring channel), dynamic noise gating and adjustable gating windows
- synchronous detection of PD and noise signals on all three stator phase windings and optionally on the neutral of the machine. This allows the measurement of PD impulses generated in the insulation of a particular phase winding and those coupled to the adjacent windings through capacitive and inductive cross-talk
- due to the complex structure of a stator winding, every source of PD impulses within the machine has a unique impulse-to-coupling-parameter ratio. Through 3PARD-visualization every PD source within the machine, as well as external noise appears in clear distinguishable clusters

Subsequently each cluster can be easily separated and analyzed without superimposition effects.

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Multi-Channel Transformer Testing

Power transformers are at the heart of the power system and, as such, are vital for ensuring the security of supply. PD measurements are an important tool for transformer diagnostics, helping to optimize operational availability.

PD measurements can be performed off-line or on-line, depending on the availability of suitable PD signal decoupling options. The MPD 600 enables the user to quickly measure all of the relevant quantities for a reliable PD measurement – no matter whether the transformer is single or three-phase.

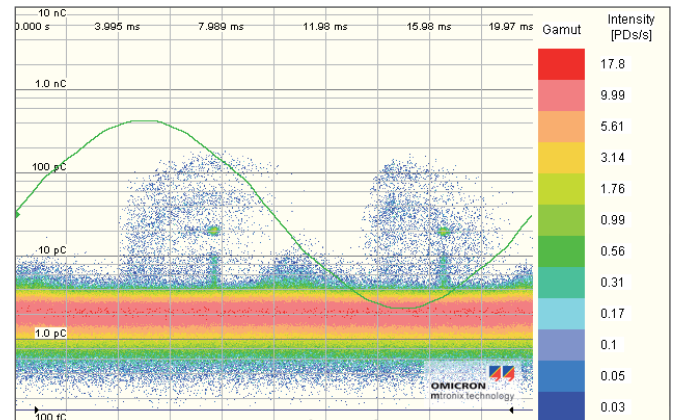
Multi-Channel Measurement

Using the OMICRON synchronous, digital, multi-terminal PD measurement technique, it is possible to decouple PD pulses simultaneously at both the high and low voltage terminals of a power transformer. This technique allows the determination of cross-talk of PD signals between the three phases of the power transformer windings.

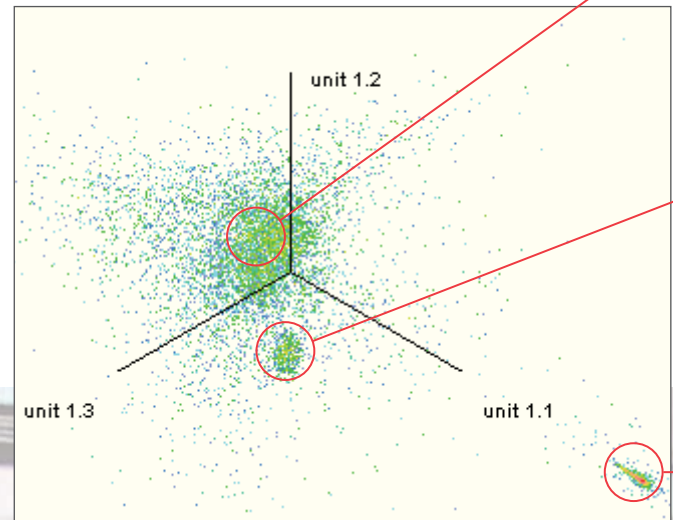
Thus, it is possible to obtain a separate PRPD pattern for each PD source by recalculation of the related 3PARD cluster during the ongoing PD measurement. Hence, the 3PARD is also a convenient evaluation method to decrease the influence of environmental noise during on-site PD measurements.

Using the MPD 600 it is possible to save the detected PD signals of all the connected phases, together with their time stamps and related test voltages to disk.

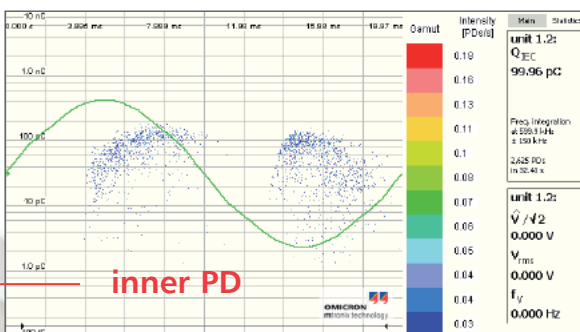
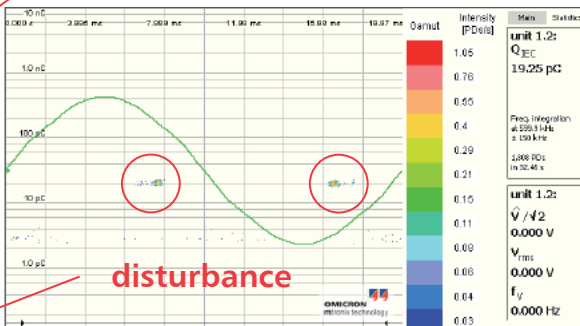
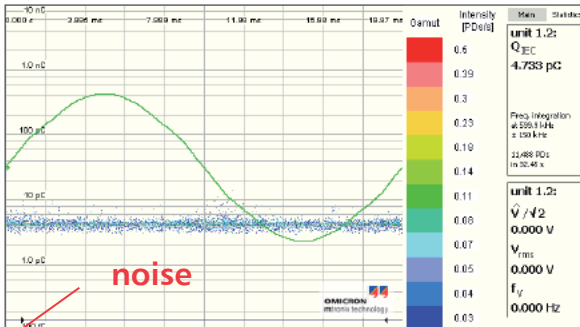
As a result, different PD sources appear in definite, distinguishable frequency clusters. Each of them can then be transferred into an ordinary PRPD phase diagram related to the chosen phase.



3PARD



3PARD – reliable separation of different PD sources in clusters during 3-phase measurements



Your benefits:

- Time and cost saving resulting from true multi-channel measurements
- Optimized operational availability due to proven PD measuring technology
- Reduced down-time of the transformer

Technical Data

MPD 600 – Acquisition Unit

Input Voltage

V input: 60 V rms (max), PD input: 10 V rms (max)

Input Frequency Range

V input: 0 Hz – 4.3 kHz, PD input: 0 Hz – 20 MHz

Input Impedance

V input: 1 M Ω , in parallel 1 μ F, PD input: 50 Ω

Dynamic Range

V input: 102 dB, PD input: 132 dB (overall)
70 dB (per input range selection)

Measurement Uncertainty

PD level: $\pm 2\%$ of calibrated PD value
voltage: $\pm 0.05\%$ of calibrated voltage
frequency: ± 1 ppm

Temperature

0 $^{\circ}$ C ... 55 $^{\circ}$ C (operating), -10 $^{\circ}$ C ... 70 $^{\circ}$ C (storage)

Humidity

5 % ~ 100 % non-condensing

Indicators

2 x LED (stand-by/power/operational status, fiber optics data integrity)

Connectors

1 x mtronix fiber optic network (2 x ST connector master/2 x ST connector slave)
2 x BNC: low-frequency voltage input (V), high-frequency partial discharge detection input (PD)

Power Supply

8 – 12 V DC, max. power dissipation: 4 W (stand-by < 10 mW), via ext. power supply (input range 100 – 240 V, 50 – 60 Hz) or Li-Ion battery (11.2 V/4.8 Ah, battery lifetime > 8 h)

Controls

All functions fully remote-controlled

Dimensions

110 x 190 x 44 mm (W x D x H)

MCU 502 – Fiber Optic Bus Controller

Indicators

1 x LED: USB connection/system error

Connectors

1 x USB 2.0 type B
2 x mtronix fiber optical network (4 x ST connector)

Power Supply

USB 2.0 bus-powered

Additional Hardware Features

1 x light-sensitive line trigger, 50/60 Hz

Dimensions

110 mm x 180 mm x 30 mm (W x D x H)

System Data

Minimum PC Requirements

Intel[®] Pentium[®] 4 (≥ 2.5 GHz), Pentium[®] M (≥ 1.5 GHz), Core[™], Core[™] Duo processor; AMD Athlon[™] 64, Turion[™] 64 processor; 1 GB RAM; USB 2.0 compatible; Microsoft[®] Windows[™] XP, Microsoft[®] Windows[™] 2000 Professional, or Microsoft[®] Windows Vista[™] operating system

Fiber Optic Network Features

Duplex multi-mode ST fibers, 50/125 μ m, near-infrared (820 nm)

PD Detection Features

Continuous, uninterrupted acquisition of PD events

Supports frequency domain and time domain integration.

Integration ranges freely selectable:

Time domain: 100 ns ... 8 μ s

Frequency Domain:

center frequency: 0 Hz ... 32 MHz

bandwidths: 9/30/100/300 kHz

1 MHz, or 3 MHz

System noise: < 0.015 pC (frequency domain integration at maximum bandwidth)

Spectrum analyzer system noise: < -120 dBm

Max. double pulse resolution < 200 ns (time domain integration superposition error < 1 %)

Max. pulse frequency: 1.5 MHz per fiber optical network

PD event time resolution: < 2 ns

Certified charge evaluation in compliance with IEC 60270:2000



Ordering Information

VE004110	Single-Channel PD measuring system: - acquisition unit MPD 600 - controller unit MCU 502 - quadripole CPL 542, 0.5A [VEHZ4100] or 2A [VEHZ4101] with 2 BNC cables - basic SW package & user documents - fiber optical cables 20m [VEHK4001] or 50m [VEHK4002] - power supply, charger & Li-Ion battery [VEHZ4105]	VE004200	Charge calibrator CAL 542 set A (0.1 pC - 10 pC)
		VE004210	Charge calibrator CAL 542 set B (1 pC - 100 pC)
		VE004220	Charge calibrator CAL 542 set C (10 pC - 1 nC)
		VE004230	Charge calibrator CAL 542 set D (0.1 nC - 10 nC)
VE004130	Three-Channel PD measuring system (for 3-phase measurements): - 3x acquisition unit MPD 600 - controller unit MCU 502 - 3 x quadripole CPL 542, 0.5A [VEHZ4100] or 2A [VEHZ4101] with 2 BNC cables - basic SW package & user documents - fiber optical cables 20m [VEHK4001] or 50m [VEHK4002] - 3 x power supply, charger & Li-Ion battery [VEHZ4105]	VEDK4100	CALCERT: Calibration and Calibration certificate for "Charge calibrator CAL 542 set A-D" All calibrators need to be sent to OMICRON for recalibration every 2 years
		VEHP0040	Aluminium transport case with wheels for 600 series systems (suitable for up to 4 units plus accessories and basic length fiber optical cables)
		VEHP0041	Outdoor Pelican measuring case (suitable for single channel system VE004110)
VE004120	Hardware gating system: - acquisition unit MPD 600 G - fiber optical cables 20m [VEHK4001] or 50m [VEHK4002] - power supply, charger & Li-Ion battery [VEHZ4105]		
VESM4101	Optional software module ADVANCED - MPD 600 SW ADVANCED, including numerous analysis tools (e.g. 3PAR, RIV, Trending, DC measurements, dynamic noise gating, statistic data evaluation)		
VESM4102	Optional software module CABLE: - MPD 600 SW CABLE, option for semi-automatic fault localization in cables using TDR (Time Domain Reflectometry) - statistical and oscilloscope-based		
VESM4103	Optional software module REPORT: - MPD 600 SW REPORT, optional for automatic test report generation in MS Excel™. Requires MS Excel™ (2000, XP, 2003, VISTA) - MATLAB® compatible data export		

OMICRON is an international company serving the electrical power industry with innovative testing and diagnostic solutions. The application of OMICRON products provides users with the highest level of confidence in the condition assessment of primary and secondary equipment on their systems. Services offered in the area of consulting, commissioning, testing, diagnosis, and training make the product range complete.

Customers in more than 130 countries rely on the company's ability to supply leading edge technology of excellent quality. Broad application knowledge and extraordinary customer support provided by offices in North America, Europe, South and East Asia, and the Middle East, together with a worldwide network of distributors and representatives, make the company a market leader in its sector.

With its policy of pioneering development OMICRON continues to lead the field in creating solutions to meet the needs of 21st century customers.

mtronix, part of the OMICRON group, was founded by a team formerly associated with the Technical University of Berlin. They have considerable experience of research in the field of sophisticated electronic measuring systems and have produced designs which perfectly complement the other products of the group.

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