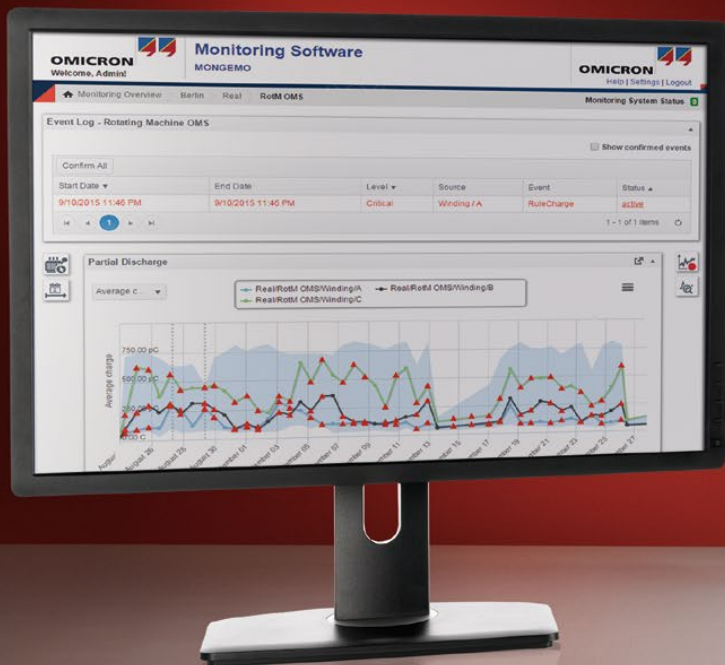


# MONGEMO

Permanent on-line partial discharge monitoring system for power generators and electrical motors



# Continuous monitoring for extending the life of your machines



Turbo generators



Hydro generators



Electrical motors

## Knowing the condition of stator insulation is vital

Statistics for rotating electrical machines show that a major source of failure is linked to defects in stator insulation.

Aging of the stator winding insulation can occur both in the slot and end-winding areas. If the insulation condition is not monitored regularly, an inadequate assessment can lead to improper maintenance. In worst cases it can also lead to dielectric failure and costly downtime.

## Early detection of partial discharges can prevent machine failure

A majority of defects can be detected early through the permanent monitoring of partial discharges (PD). PD occurs in the stator insulation system of generators and motors, where local electric field stress exceeds the local electrical strength.

The insulation materials typically used for rotating machines are resistant to a certain level of PD. However, an increase in PD activity over time can indicate insulation degradation caused by operational stress and aging processes.

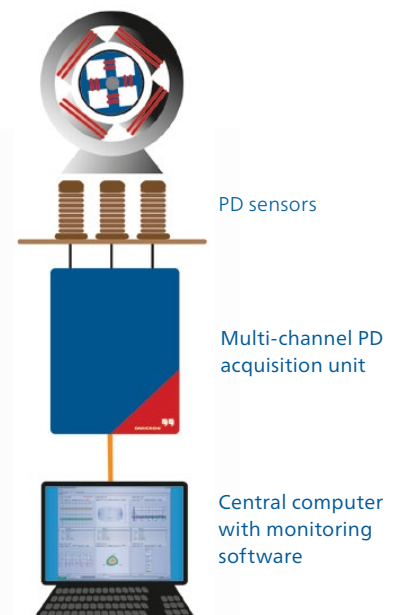
Such a rise in PD activity can be an indication of insulation defects that could lead to serious damage and failure in rotating machines. On-line PD monitoring is therefore a very effective and well-established technique used to continuously assess the condition of a stator winding insulation system.

## Monitoring data helps you to optimize planning

The actionable monitoring data helps you to optimize asset management, maintenance strategy and investment planning. Failures can be avoided through the timely implementation of maintenance and repair measures to ensure a longer service life.

## Modular, expandable design

The MONGEMO monitoring system can be implemented at any point of time during the service life of your rotating machines. Its modular design allows the system to be easily customized and expanded to match your exact monitoring requirements – whether for single or multiple machines.



## MONGEMO at a glance

### Continuous PD detection in rotating machines

Our MONGEMO permanent on-line PD monitoring system combines advanced hardware and software for complete condition assessment of stator insulation in:

- > Turbo generators
- > Hydro generators
- > Electrical motors

### Complete on-line assessments

MONGEMO continuously records PD activity and reliably indicates the state of stator insulation while your machines are on-line during normal operating conditions.

Multi-channel PD data acquisition is performed synchronously. This enables complete data collection for more comprehensive evaluation of individual PD sources.

### Effective noise suppression and source separation

You can easily select the center frequency and the bandwidth of the PD measurement to reach an optimal signal-to-noise ratio, even in noisy on-site conditions.

MONGEMO also employs advanced noise suppression and fully automated PD cluster separation techniques. These enable you to quickly distinguish multiple PD sources and external noise from each other for convenient evaluation.

### Centralized data processing and analysis

The collected PD data is stored on a central monitoring computer. The MONGEMO system database is scalable to handle large amounts of PD data over time. The system's convenient web interface allows you to access this data remotely for single or multiple machines.

### Software for PD monitoring and analysis

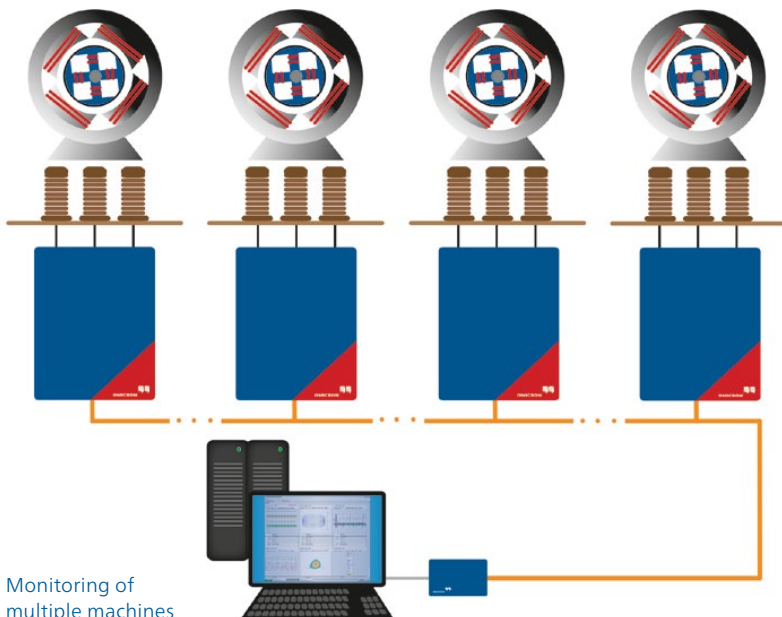
MONGEMO includes two software packages for PD monitoring and analysis.

With the *monitoring software* you can configure the system, set warning and alarm thresholds and view PD data. You can also use it to record real-time data streams for in-depth post analysis. Collected PD data is shown in a trend chart for each phase.

In addition, the *OMS system software* provides you with tools for expert PD analysis and is used for more in-depth evaluation of the recorded raw PD data.

### Expert advice and support

Our dedicated team of high-voltage engineers provides you with complete guidance and support. This includes on-site consultations to evaluate your monitoring needs; customized system design, installation and training; as well as support in data evaluation and reporting.



## Your benefits

- > Customized system approach to match specific monitoring requirements
- > Synchronous, four-channel PD data acquisition for complete PD assessment
- > Advanced noise suppression and fully automated PD cluster separation for convenient evaluation
- > Recording of raw PD data at selected intervals for in-depth post analysis
- > Seamless integration with third-party monitoring devices and SCADA systems

[www.omicronenergy.com/mongemo](http://www.omicronenergy.com/mongemo)

# One system for complete on-line PD monitoring

## MONGEMO system overview

The complete MONGEMO partial discharge (PD) monitoring system for rotating machines includes a variety of PD sensors (coupling capacitors), an acquisition unit for PD data recording and a central computer with monitoring and analysis software.

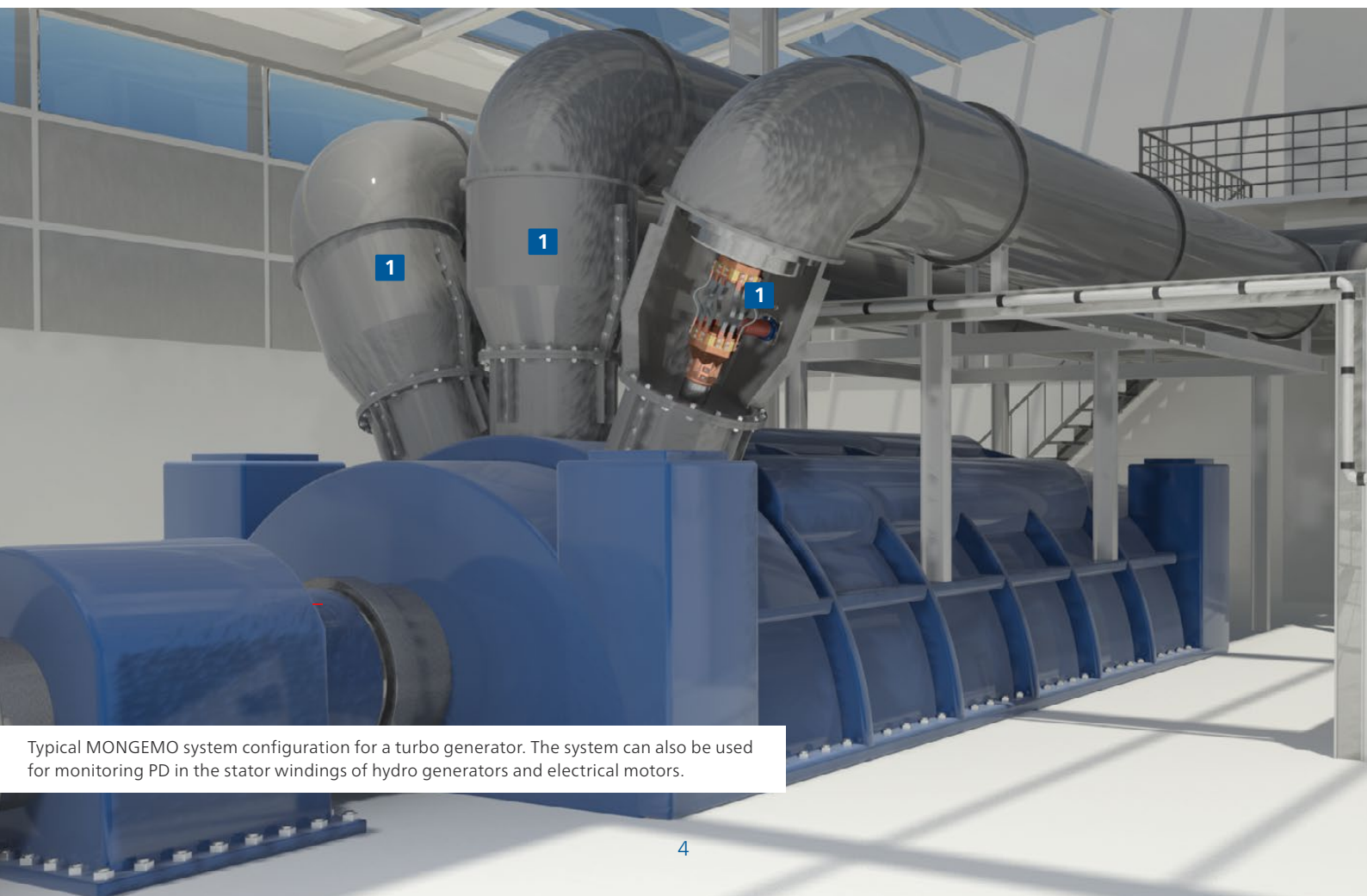
## Customized to meet your requirements

We design, install and set up the MONGEMO monitoring system according to your requirements for a wide variety of hydro and turbo generators and electrical motors. Multiple PD data acquisition units can be used with the same monitoring computer and software.

## 1 Coupling capacitors



- > Especially designed for detecting PD signals on generators and motors with up to 24 kV rated voltage
- > Capacitive sensors from 80pF to 2.2nF (up to 10nF with external quadripole) are supported
- > Detect PD in the frequency range according to the international standards IEC 60034-27-1, IEC 60034-27-2 and IEEE 1434
- > Strong mechanical robustness allows installation in both horizontal and vertical positions
- > Connected to the OMS 841 data acquisition unit via screened tri-axial cables in order to minimize the impact of external interference



Typical MONGEMO system configuration for a turbo generator. The system can also be used for monitoring PD in the stator windings of hydro generators and electrical motors.

## 2 Protective enclosure



- > Protects data acquisition unit from dust and moisture
- > Lockable door to prevent unauthorized access
- > Input ports for connections from coupling capacitors
- > Ports for fiber optic cable connection to central monitoring computer or SCADA system

## 3 OMS 841 acquisition unit



- > 4-channel, simultaneous acquisition of PD data from all three phases and an additional monitoring point
- > Adjustable PD band pass filter bandwidths up to 5 MHz
- > Synchronous PD signal processing with advanced source separation
- > External 12 V lead-acid battery bridges temporary power outages (optional)

## 4 Fiber optic connectivity

- > Connects each acquisition unit to the central computer
- > Provides uninterrupted data transmission over long distances
- > Robust against electromagnetic interferences
- > Ensures personal safety with complete galvanic isolation

## 5 Central computer and monitoring software

- > Ensures expandable, long-term data storage and retrieval with a state-of-the-art database system
- > Manages monitoring parameters and defined thresholds for warning and alarm levels
- > Trend visualization and raw PD data recording for in-depth post analysis
- > Performs data post-processing to provide useful information about insulation state
- > Customizable integration of third-party sensors and SCADA systems



# Software for complete PD monitoring and analysis

## Actionable data for reliable assessment

MONGEMO includes two software packages for partial discharge (PD) monitoring and analysis.

The *monitoring software* allows you to configure the system for remote monitoring of single or multiple machines via the central computer.

PD data is processed and displayed in either real-time or historical views. You are provided with warnings and alarms of increased PD activity well before failures occur.

The *OMS system software* is also included for in-depth post-analysis of the raw PD data.

## 1 Getting started

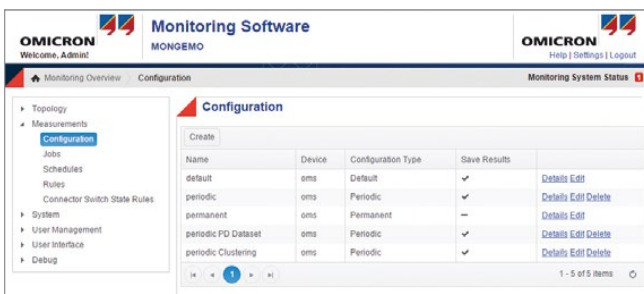
### Monitoring software dashboard



Select desired activity, including:

- > Setup system configuration or make changes
- > View current monitoring session in real time (see **2**)
- > View and analyze monitoring trend data (see **2**)

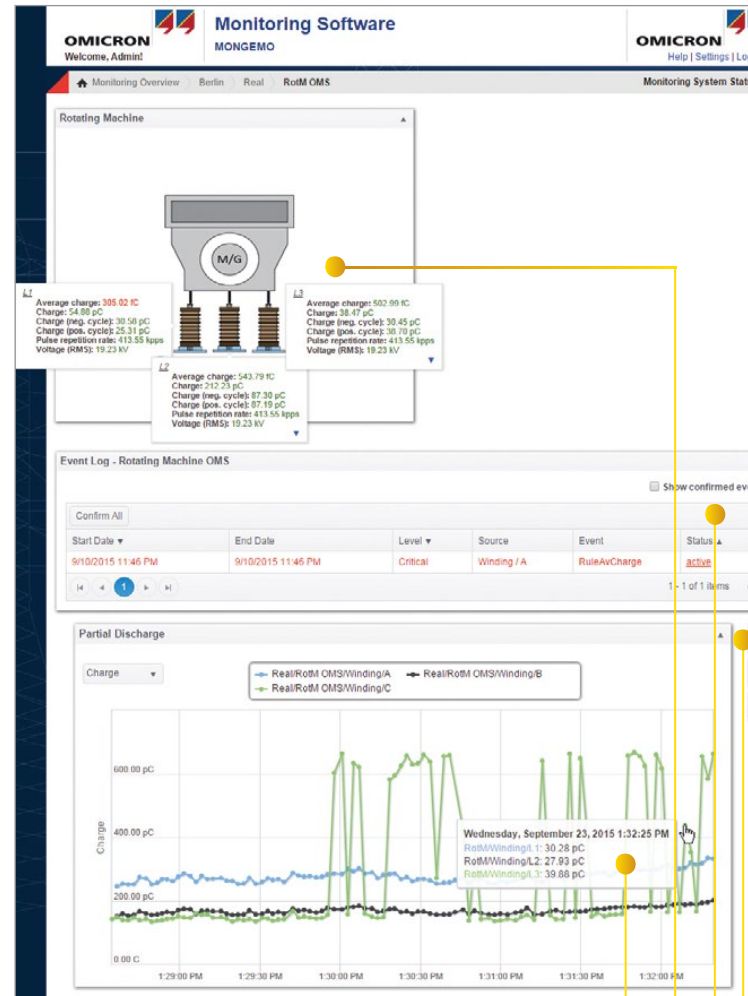
### System configuration and control



- > Configuration of all monitoring-related parameters
- > Define threshold settings for alarm notifications
- > Define recording of PD data sets

## 2 View PD data

### Real-time PD data



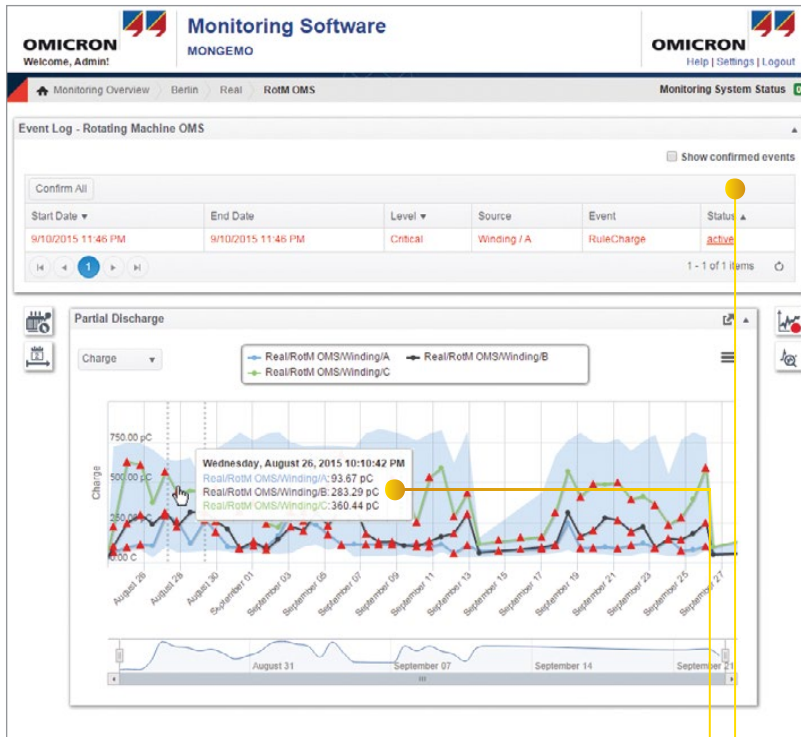
- > Scroll over data points to view date, time and PD values for each phase
- > View actual PD values and alarm status
- > Event log shows triggered alarms for selected assets

### Recording raw PD data sets

MONGEMO records raw PD data sets based on a defined time schedule – either in real time, periodically or when a PD parameter exceeds a pre-set threshold.

The raw PD data can be analyzed in depth with the expert PD analysis software provided. We can also assist you with PD data evaluation upon request. (See **3**)

## Historical PD data



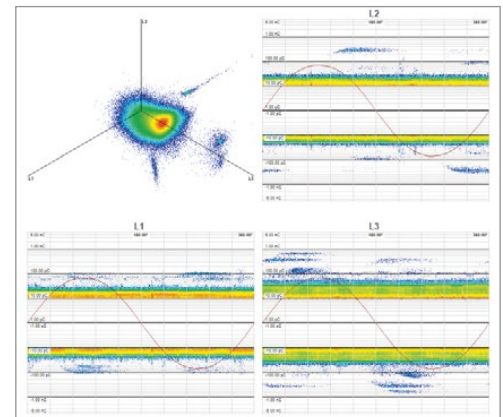
- > See PD trend charts for each phase/channel
- > Scroll over data points to view date, time and PD values
- > Event log shows corresponding warnings and alarms for all monitored assets
- > Zoom into any part of a historical diagram to see more detail
- > Trend data can be easily exported to a .csv data file

## Pop-up windows show PD diagrams

By clicking on each point of the historical PD trend diagram, a pop-up window will open with different types of PD diagrams to choose from:

- > 3PARD and PRPD
- > Automated clustering results
- > Pulse distribution
- > PD data sets

These enable you to quickly evaluate the PD data. All charts and diagrams can be printed and saved in various formats.



3PARD and PRPD pop-up window

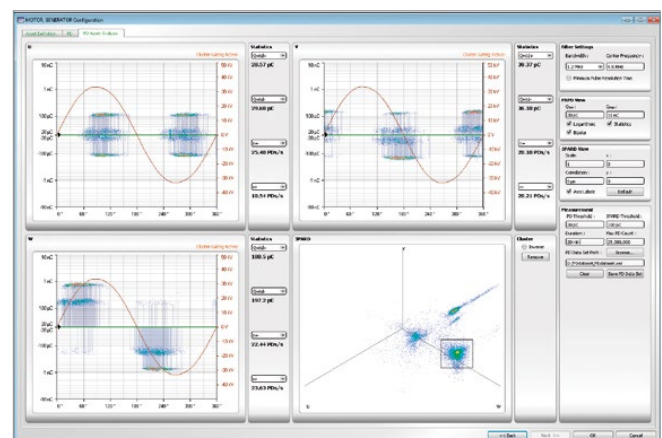
## 3 Expert PD analysis

### When in-depth investigation is required

Detailed PD diagnosis can be done using the *OMS system software*. This advanced software allows you to apply various filters to see more detail of the PD activity.

### PD data evaluation support from OMICRON

We can also provide you with an in-depth analysis of collected PD data as well as condition reporting for your monitored machines. These optional monitoring services are available upon request.



# Reliable and early PD detection in stator windings

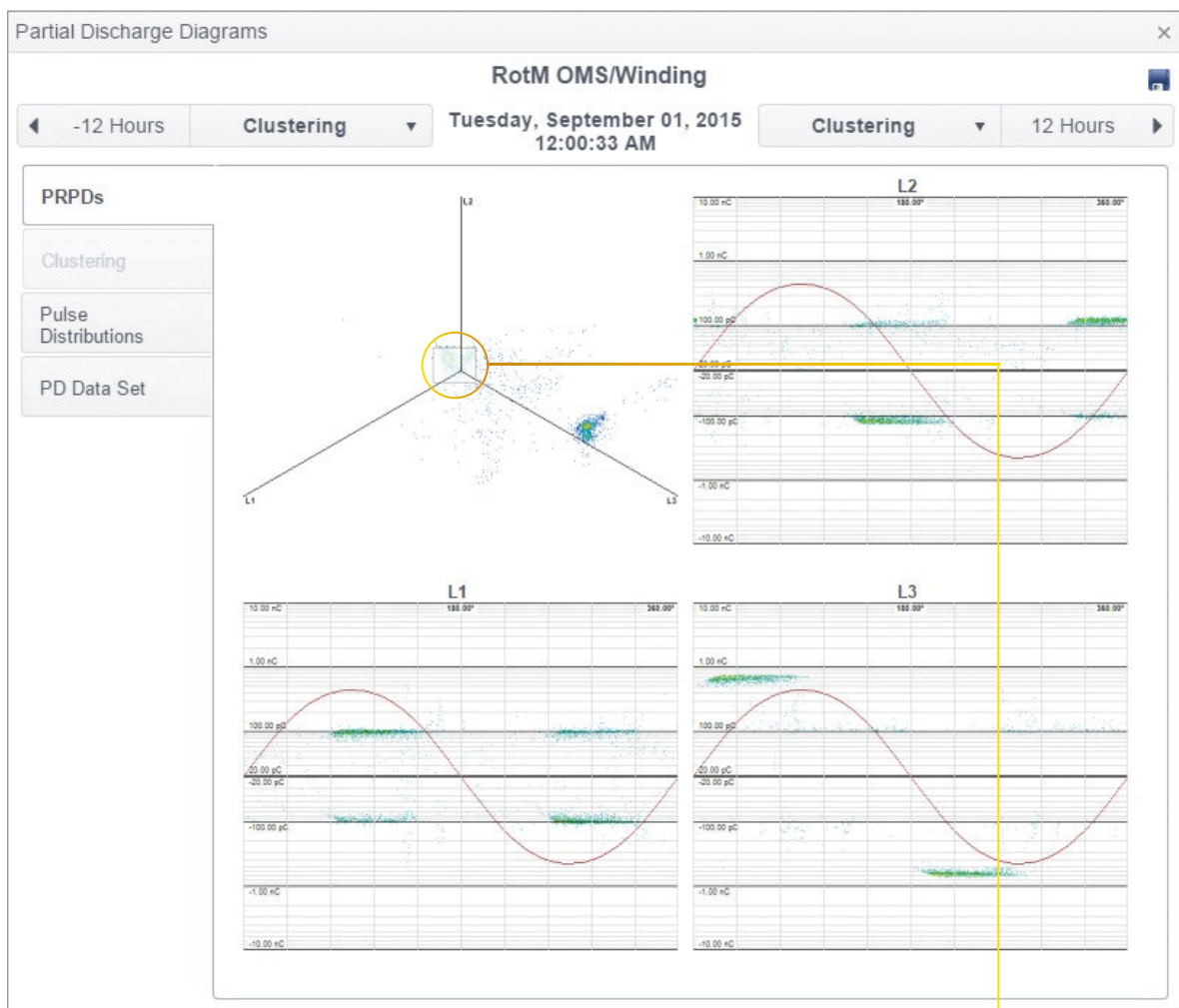
## Effective source separation and evaluation techniques

The key to successful partial discharge (PD) measurement in stator windings is the separation of parallel active PD sources and the distinction between potentially damaging PD, tolerable PD occurrences and external noise inevitably present in industrial surroundings.

In order to separate clusters of multiple PD sources, MONGEMO employs synchronous, multi-channel 3PARD (3-Phase Amplitude Relation Diagram) and automatic cluster separation evaluation techniques.

These advanced technologies are supplemented by the system's recording of raw PD data for in-depth post analysis and are based on our knowledge and many years of experience in PD detection and source separation.

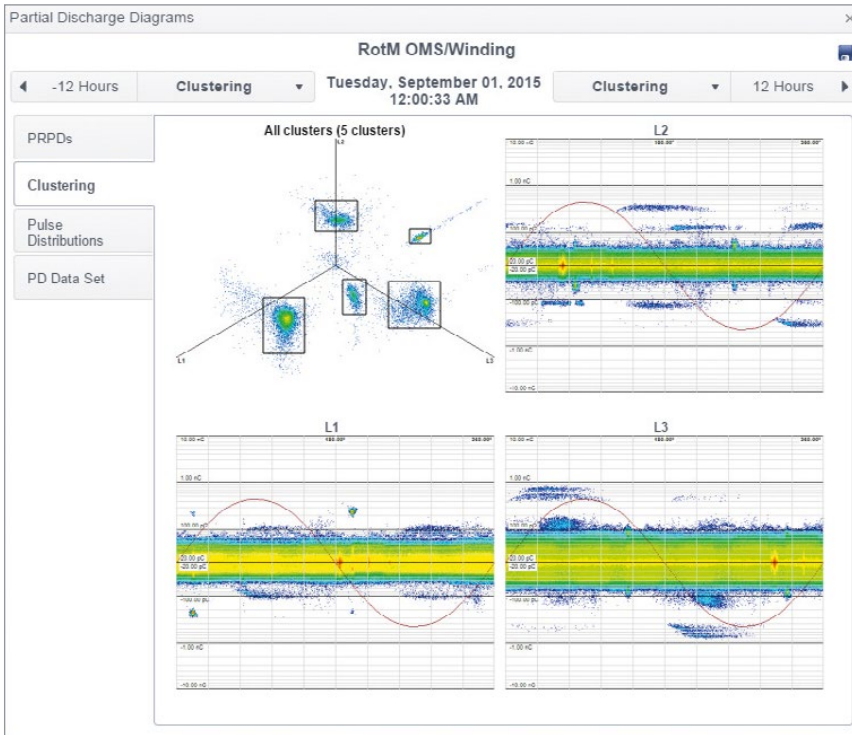
### Noise suppression through 3PARD filter



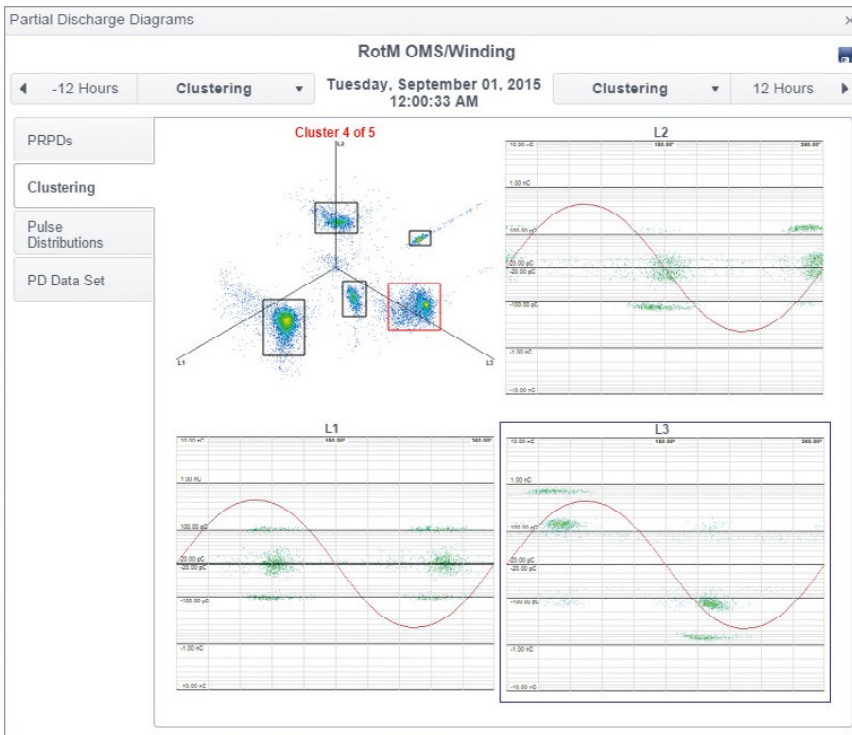
- > 3PARD diagrams and PRPD patterns are saved for each point in the PD trend.
- > 3PARD visualizes the relation among amplitudes of a single PD pulse in one phase and its cross-talk generated signals in the other two phases.
- > In order to initially eliminate interference (similar amplitudes in all three phases) from the measurement results, the corresponding area can be excluded by the semi-transparent box shown in the 3PARD.



## Automated cluster separation



- > A highly efficient hierarchical density-based clustering algorithm is applied for the automatic clustering of heterogeneous 3PARD data.
- > Automated data evaluation and cluster separation are performed regularly, periodically or when triggered by an alarm (violation of pre-set threshold).
- > For each cluster, the MONGEMO monitoring software identifies the phase of signal origin.



- > A user-selected cluster is transformed back to its correlated phase-resolved PD pattern (PRPD).
- > As a result of this separation, single PD sources are shown in the corresponding PRPDs to enable even non PD experts to perform an initial assessment of PD activity and potential risk.
- > The related raw PD data is saved in order to carry out a more in-depth expert analysis at a later point in time.

# Technical specifications

## Partial discharge measurements

Number of input channels	4
Connector type	BNC
Frequency range	AC: DC ... 16 kHz PD: 16 kHz ... 30 MHz
Sampling rate	AC: 31.25 kS/s PD: 125 MS/s
Peak input levels	AC: 200 mA PD: 80 V
Measurement accuracy	AC: $\pm 0.25\%$ ( $40 \text{ Hz} < f < 70 \text{ Hz}$ ) PD: $\pm 5\%$ ( $f = 300 \text{ kHz}$ , $\Delta f = 150 \text{ kHz}$ )
Maximum double pulse resolution	< 200 ns
PD event time resolution	< 2 ns
PD filter bandwidth	9 kHz ... 5 MHz (10 bandwidth settings)
System noise	< 1 pC ( $f = 400 \text{ kHz}$ , $\Delta f = 300 \text{ kHz}$ , input range $\leq 320 \text{ mV}$ )

## Mechanical data – Enclosure with acquisition unit

Dimensions (W × H × D) (cable glands not mounted)	400 × 500 × 210 mm / 15.7 × 19.7 × 8.3 in.
Weight	~15 kg / 33 lb.

## OMS 841 power supply

24 V DC / 0.5 A

## OMS 841 external power supply

AC (max.)	DC (max.)
110 V AC ... 240 V AC / 50/60 Hz / max. 0.28 A	110 V DC ... 300 V DC / max. 0.12 A

## Fiber optic connection

Medium	Standard: Duplex multi-mode fiber optic cables 50/125 $\mu\text{m}$ (OM3 or better) Optional: Duplex single-mode fiber optic cables 9/125 $\mu\text{m}$ (OS1 or better)
Wavelength	1300 nm
Maximum cable length	4 km (multi-mode), 40 km (single mode)
Connector type	LC



## High-quality support at every stage of your monitoring project

MONGEMO is not only a complete set of hardware and software components. It also includes the dedicated service we provide you. Our monitoring experts are working for you to support you in all stages of your monitoring project.

We provide you with peace of mind while matching the actual needs of your high-voltage equipment over its operational lifetime.

## Environmental requirements

Operating temperature	-30 ... +55 °C / -22 ... +131 °F
Storage temperature	-40 ... +80 °C / -40 ... +176 °F
Humidity	Up to 95 % r.H. (non-condensing)
Maximum altitude	4,000 m / 13,123.4 ft.

## Vibration, shock and protection class

	Standard	Rating
Vibration	EN 60068-2-6	Frequency range: 10 Hz ... 150 Hz  Acceleration: 2 g continuous (20 m/s <sup>2</sup> ), 10 cycles per axis
Shock	EN 60068-2-27	15 g/11 ms, half-sinusoid, per axis
Protection class	EN 60529	IP 50 (OMS 841) IP 65 (OMS enclosure)

## Electromagnetic compatibility

Emission	EN 55011/22, 30 MHz ... 3 GHz FCC Subpart B, 30 MHz ... 1 GHz
Immunity	EN 61000-6-5: MV/HV substations

## Safety requirements

Safety requirements for electrical equipment for measurement, control and laboratory use	EN 61010-1
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## Software requirements

### OMS System Software / Monitoring Software

The minimum system requirements for running the OMS System Software and the Monitoring Software are:

- > Windows 7 (64bit), Windows 8 (64bit) or Windows Server 2012 (64bit)
- > Processor: Intel i5 2.4 GHz or a comparable x64 processor
- > RAM: 4GB
- > USB 2.0 high speed port
- > Screen resolution (minimum): 1024 x 768 pixels

A central computer that meets these software requirements is provided by OMICRON.

## Communication protocols

RS485	ModBus RTU ProfiBus DP
Ethernet/TCP IP	ModBus TCP DNP3 IEC 60870-5-104 IEC 61850 Profinet OPC UA

We start the implementation of your monitoring system by understanding your needs and challenges. With this input, the system can be designed and configured according to your needs. Then our team of specialists installs the system for you on-site.

During the commissioning of the system, its performance and measurement sensitivity are verified. You are then trained on how to use the system and how to take maximum advantage of its features.

Our HV experts are available to help you interpret and analyze the data. We can also provide you regular asset condition reports and recommendations for further action.

## Monitoring project knowledge and expertise you can rely on

- > Evaluation of monitoring requirements
- > Project-specific monitoring system design
- > Integration of monitoring system into existing infrastructure
- > Installation, commissioning and calibration of the monitoring system
- > Monitoring system and data evaluation training
- > Data analysis and interpretation
- > Worldwide customer service & hotline

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

Customers in more than 140 countries rely on the company's ability to supply leading-edge technology of excellent quality. Service centers on all continents provide a broad base of knowledge and extraordinary customer support. All of this together with our strong network of sales partners is what has made our company a market leader in the electrical power industry.

The following publications provide information about additional monitoring solutions from OMICRON:



OMS 605 Portable PD Monitoring System for High-Voltage Assets



MONTRANO Continuous Monitoring System for Power Transformers



Continuous PD Monitoring System for High-Voltage Cable Systems

For more information, additional literature, and detailed contact information of our worldwide offices, please visit our website.