MachineGuard

Doble Lemke

TOGETHER WE POWER THE WORLD®

PD MONITORING SYSTEM

A Complete Partial Discharge Monitoring System for Rotating Machines

The Doble Lemke MachineGuard is a complete monitoring system for assessing the condition of rotating machines. By monitoring the in-service partial discharge (PD), the insulation's performance can be reliability assessed over time, and corrective action can be taken before a failure occurs.

True to form, the Doble Lemke MachineGuard Monitoring System provides the all the tools necessary to install a permanent online monitoring system for just one machine, or is scalable for a multi-unit site. Doble supplements our system by providing the support for installation, commissioning and analysis. You're never alone with Doble. The system can be adapted for usage with any high voltage rotating machine such as turbo generators, hydro generators and high voltage motors.

Features

Highly Sensitive PD Detection
By using low frequency coupling capacitors, the entire length of the stator coil can be sensed. High frequency coupling capacitors do not provide the depth necessary to reliably assess the condition of a machine's entire coil.

Advanced Analysis Tools
Using internationally recognized algorithms approved by IEEE and IEC, the best possible diagnosis for fault conditions can be realized. These tools include Phi-Q-N, Phi-Q and Phi-N displays. Alarming setpoints can be setup from the beginning and modified over time as the machine's normal operating conditions are learned.

Scalable
The PD Evaluation Server can act as the central hub to one or several PD-Guards. Each PD-Guard has its own unique IP address to identify it on the network.

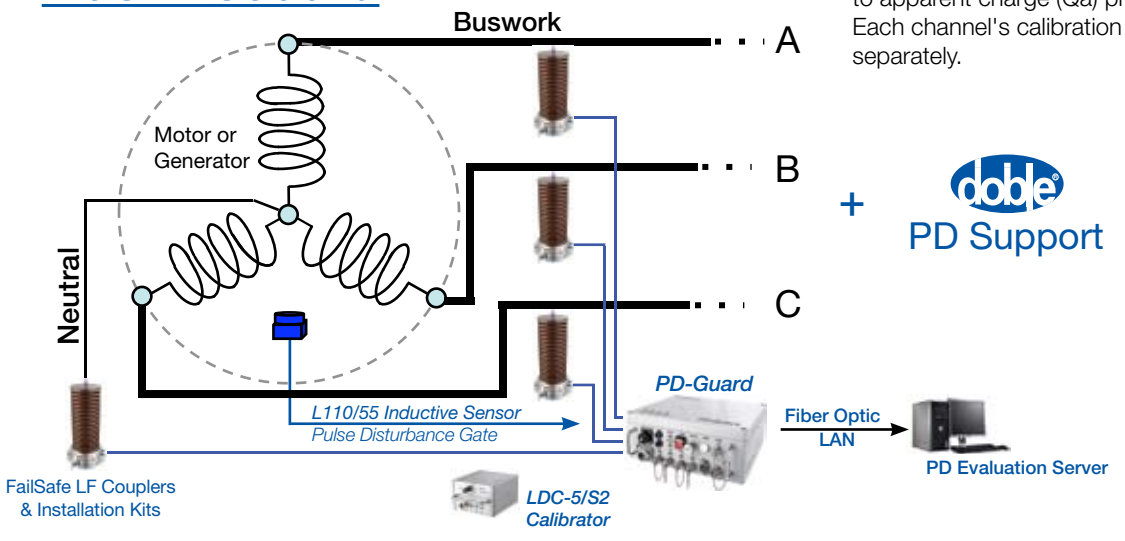
Rugged and Reliable
Central to MachineGuard is the rugged PD-Guard monitoring unit that makes physical connection to the sensing points. This system complies with IP65 industry standards and can survive the harshest environments to include direct spray.

Condition Based Maintenance
Given its online diagnostic capabilities and ability to set alarms, the system can provide advanced notification of impending failure. Better decisions can be made earlier.

Interference Rejection
Nothing is more problematic than the interference caused by on-site noise, exciters and external interference. By using a gating sensor antenna, unwanted exciter noise is removed from the signal before evaluation.

Automatic Calibration
Included is an LDC/S2 Calibrator. In accordance with international standards, all PD measurements must be calibrated to apparent charge (Qa) prior to evaluation. Each channel's calibration data is stored separately.

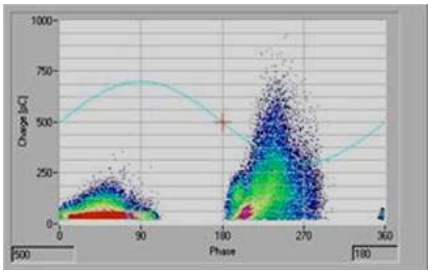
MachineGuard



+ PD Support

Why use the Doble MachineGuard Monitoring System?

Discharge pulses travel through the winding via the inductive, capacitive and resistive impedance network. IEC 60270 defines a measurement frequency range f_1: 30 -100 kHz and f_2: 500 kHz. In this range, the dominant propagation path is by standing waves, and relatively little signal power is lost by attenuation. However, traveling waves are not propagated above a maximum frequency Fmax, where L and K are the series inductance and capacitance respectively.



$$Fmax = \frac{1}{\sqrt{(L*K)}}$$

For most large generators and motors, this works out to be a few megahertz. Above this, the coupling is capacitive through the series and shunt capacitances. Here the high value of the latter ensures that attenuation is high. Early on-line PD monitoring systems detected at several tens of megahertz. This avoided high levels of interference, but resulted in only a very small part of the winding nearest to the HV connection being monitored for partial discharge. More modern systems, like the PD-Guard, can operate below 1MHz because they use more sophisticated signal processing and noise suppression.

Modern signal processing also allows pulse phase resolution analysis, and this is invaluable in identifying the type and source of partial discharge. This makes the visual inspection much easier.

The general materials used in stator windings are tolerant to PD. Normally, these levels of PD exist throughout the machine's life. However, significant increases in PD will follow if the bars or coils become loose in the core, the resin binder deteriorates, stress relief systems fails, or the end windings become cracked or contaminated. The onset and progress of deterioration can be evaluated via trend analysis and interpretation of the phase resolved “Partial Discharge Pattern”. Maintenance can then be scheduled more accurately and avoid costly business failures.

The cost of business interruption can be between 20 and 50 times greater than the cost of the rotating machine itself. It is critical that the onset of deterioration be identified so remedial action be can be taken before a failure occurs. The MachineGuard monitoring system performs the test without disruption and is an effective tool for implementing a condition based maintenance program.

Real-time measurements and signal processing allows detection of defects in the complete windings. Being on-line, the measurements allow assessment under the operating conditions of changing load, temperature and stress distribution. Signal processing and evaluation tools allow identification of the type of problem and whether the problem is in the slot of end-winding. A complete system allows analysis on site with a stepped alarm feature, and web-based interrogation by Doble experts. We recommend that the result be reviewed by Doble quarterly regardless of whether an alarm has been received.

Turn-key System

Commissioning and Calibration

Doble provides all the tools, sensors, cables and software. We can even provide computer based servers if not already available. Our staff will commission, calibrate and verify proper operation. Of course, we will train staff on how to operate and maintain. After the system is in service, Doble will assist in the analysis and tuning of the system alarms. We can also provide yearly training for your test crew.

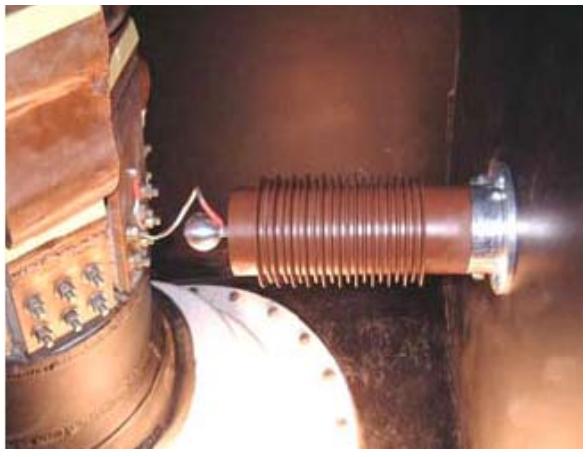
If necessary, Doble can arrange for the installation and required conduit and mounting hardware for enclosures and computer systems.

PD Monitoring System installed on the busbar of a turbo generator

MachineGuard Architecture

A typical MachineGuard monitoring system consists of:

- 4 FaileSafe LF Capacitors (PDDC-24 or PDDC-12) with associated ground and sensing cables. Motors will only require 3 as they may not have an accessible neutral.
- 1 PD-Guard Partial Discharge Monitor
- 1 Fiber-optic Link
- 1 License for the PD Evaluation Server and associated PD-Guard Analysis Software
- 4 Coupler installation kits
- 1 External Calibrator LDC-5/S2



Typical Problems Identified!

Slot Discharge
Where bar looseness has led to vibration on the core, destroying the screen coating.

Vibration Sparking
Where all or part of the screen coating is isolated from ground as the bar vibrates. It then discharges to ground.

Void Formation
Where the epoxy debonds through thermal ageing.

End Winding Discharge
Where the stress relief has degraded or there is conducting contamination.

The “Complete Package”

We don’t deliver parts, we deliver the whole package. MachineGuard is composed of a suite of products that are optimized for deep winding fault identification and diagnosis without compromising the reliability of the rotating machine. Key components and services included in the Doble MachineGuard are:

Doble PD Support

You’re never alone with Doble. Doble provides site commissioning, training and diagnostic services through our established Doble Client Service Engineering group. This group of over 35 client service support engineers in 7 countries worldwide are available 24/7 to provide assistance when you need it.

The Doble PD-Guard

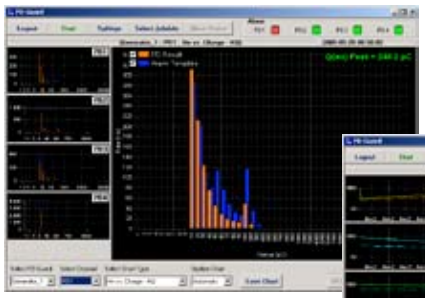
At the heart of MachineGuard is the highly compact, rugged, and light-weight Doble PD-Guard. This provides all inputs necessary to monitor the partial discharge from the three phase machine bus as well as the neutral. The PD-Guard provides input for HF interference gating, thus allowing the system to remove unwanted exciter noise. You only monitor the condition of the machine. The PD-Guard is a ULTRA rugged unit that can withstand the rigors of an industrial environment. It is designed for fully-automatic, continuous, maintenance-free operation and can be easily mounted in any position.

PD Evaluation Server

The PD Evaluation Server can communicate with one or multiple PD-Guard monitors. This makes the system truly scalable and manageable from a single location. The server controls the processing of measurement jobs, generates alarms and performs backups. The server is connected to the PD-Guard using a fiber optic connection, thus minimizing unwanted noise. Data can then be viewed on a remote computer on the network running the analysis software. The analysis software can display historical PD magnitude and peak values in accordance with IEEE and IEC standards. Included analysis and display tools can be used to characterize, diagnose, and setup alarms. The analysis tools include Phi-Q graphs, Phi-Q-N pattern and Q-N alarm templates.

The Doble FailSafe LF Capacitor (PDDC-12 & PDDC-24)

The test equipment should never compromise the safety and reliability of the apparatus under test. The FailSafe LF Capacitor is the industries's only integrated high voltage fused coupling capacitor. If for any reason the capacitor should experience a failure, it is safely removed from the system. In addition, the coupler provides the low frequency response necessary by using a 2 nF capacitor for deep coil sensing. Other system on the market only provide HF couplers that only penetrates the first few coils of the stator.

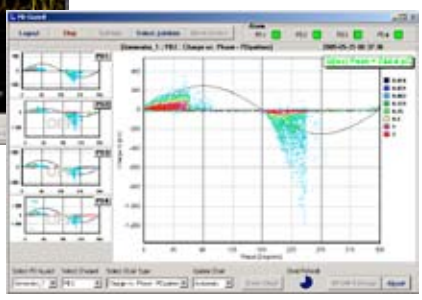


1 NORMAL OPERATION
Auto-Alarming

Hn/s vs. Charge

2 ENQUIRY
Trending

Q (mV)-Trending



3 ENQUIRY
Pattern Analysis

Phase Resolved PD Pattern

Increasing information depth from “Status Quo changed” to “failure patterns”

Key Specifications*

PD-Guard

- Display and transmittion of PD history in real time
- PD magnitude as peak or average value
- PD magnitude weighted to the IEC 60270 characteristic
- PD Current
- Noise rejection
- Frequency and domain signal conditioning
- Easy alarm settings can be configured for each measuring channel separately
- Automatic testing procedures for: testing time, and sequence of activation
- 4 channel monitoring of partial discharged

PD Evaluation Server & PD-Guard Analysis Software

- Measures jobs from all PD-Guard devices
- Generates alarms and performs backups
- Each PD-Guard devices operates as a to client the control software
- Measuring and analysis to include displaying the test voltage
- Automatic calibration – calibration data will be stored for each channel separately
- Display of green/red indicator per phase, per apparatus based on alarm level
- Replay of several PD quantities and derived quantities (Phi-Q, Phi-Q-N pattern, Q-N graph and alarm template)
- Full screen scale for per channel and live PD graphics
- Storage of all pertinent electronic data
- Requires a separate central PC Server for installation

Doble FailSafe LF Coupler (PDDC-12 & PDDC-24)

- PD Decoupling unit with integrated measuring impedance for decoupling of pulses from the measuring circuit
- For generators systems up to 24 kV
- For permanent, reliable system integrity
- Integrated HV fuse -- decoupling unit will become a high resistance in the event of failure
- Only one cable per sensor
  - PD and voltage signals are superimposed

LDC-5/S2 External Calibrator

- External calibration of PD measurement in accordance with IEC 60270
- Battery powered

Doble Support

- Expert PD analysis by a Doble Expert
- Automatic quarterly reports provided by Doble
- Support available 24 hours a day 7 days a week

** Please refer to individual component product brochures for a more complete list of specifications.*

Specifications are subject to change without notice.

Service Package or Lease Options Available

- To install the couplers and terminal box outside the casing
- To install software and set up the system and alarm features
  - It is very important to configure the alarm values and take an initial fingerprint of the monitored generator
- To review and report on a quarterly basis, and respond as required to any alarms
- If leased, Doble will provide any and all replacement components and provide expert review

For more information, contact
PDinfo@doble.com
or visit www.doble.com

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Doble is certified ISO 9001:2000

Doble is an ESCO Technologies Company

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