IRIS POWER

TGA-B

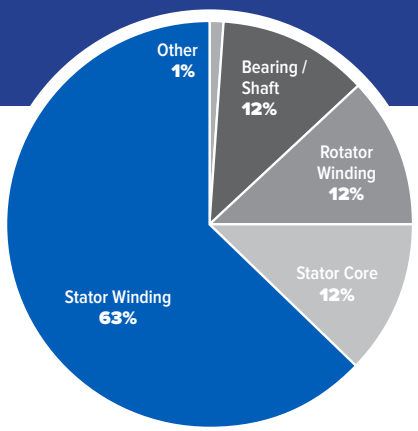
Periodic Online Partial Discharge Monitoring Instrument for Turbine Generators and Motors

IRIS POWER
A QUALITROL Company

> We have not found another test method that produces as much decision support data for generator stator maintenance planning based on actual in-service insulation condition... Analysts were able to recommend the needed corrective maintenance before the maintenance outages began.

Partial Discharge Is A Leading Symptom Of Failures On Generator Stator Windings

Insulation problems are one of the principal causes of forced outages for generators, motors switchgear and dry type transformers which result in considerable damage and lost revenues. Periodic online monitoring of partial discharge provides a cost effective and proven technique to minimize the risk of unexpected failures.



FAILURE MECHANISMS FOR GENERATORS

Allianz insurance, Survey 1996-1999
VDE Colloquium, June 28, 2001

Global Acceptance Of Online Partial Discharge Monitoring

Partial discharges in degrading high voltage stator windings give rise to small voltage pulses which travel through the stator winding. The magnitude and number of these pulses depends on the degree of insulation deterioration. As the magnitude and number of partial discharge voltage pulses increase, the rate of electrical insulation deterioration is also increasing.

Partial Discharge monitoring has won worldwide acceptance across utilities, major industrial companies and manufacturers. Iris Power has provided products for partial discharge monitoring on over 16,000 assets globally in addition to partial discharge monitoring being recommended in industry standards such as IEEE Standard 1434-2014 and IEC TS 60034-27-2:2012.

Avoid In Service Failures With Early Detection Of Failure Mechanisms

Partial Discharge monitoring has become an important tool for condition based maintenance on generators by identifying risks of failure caused by abrasion of insulation, loose stator windings, thermal degradation of insulation and manufacturing defects.

Iris Power online partial discharge monitoring instruments have accurately identified problems on many hundreds of generators with hundreds of case studies and dozens of published papers by Iris Power customers that confirm Iris Power partial discharge monitoring instruments can help:

- Prioritize assets needing immediate maintenance
- Identify and repair damage at an earlier stage
- Avoid in-service failures
- Reduce outage frequency when results are good
- Obtain information regarding the type and location of maintenance required prior to outages
- Reduce overall cost of maintenance

Development Of Iris Power Partial Discharge Monitoring

The development of Iris Power partial discharge testing instruments in 1990's was funded by the North American utility industry (CEA and EPRI) to provide machine owners a method of detecting stator insulation problems and obtaining adequate data to make maintenance decisions independent of equipment manufacturers.

The TGA-B was designed specifically for monitoring partial discharges under normal electrical, mechanical and thermal machine operating stresses without interference from external noise such as power system corona, output bus arcing or other common electrical disturbances. There are now over 65,000 Iris Power partial discharge Epoxy Mica Capacitive Sensors installed across thousands of motors, generators and metal glad switchgear globally that are monitored by Iris Power portable and continuous instruments.

Epoxy Mica Capacitors Installed On Generator BUS

Epoxy Mica Capacitors (80pF)

Sensor Installation and Configuration

Iris Power Epoxy Mica Capacitors (EMCs) are 80pF capacitors that are used to block high voltage output from the generator since impedance is inversely proportional to frequency. The 60 Hz or 50 Hz power frequency is filtered with >30 MΩ impedance while the high frequency partial discharge pulses up to 250 MHz easily pass through the EMC with only 10's Ω impedance. This allows us to see small partial discharge pulses of under 100 mV on rotating machines rated over 3.3kV.

Iris Power typically installs two 80pF epoxy mica capacitive couplers per phase on generators. Noise pulses originating outside the machine arrive at the sensor closer to the power system first. Partial discharge pulses originating in the machine winding arrive at the sensor nearest the machine first. This allows the TGA-B to automatically distinguish between noise and winding partial discharge based onpulse arrival time.

Motors with over 30m of cable the switchgear may require only one epoxy mica capacitor per phase. The TGA-B automatically analyzes the pulse shapes to separate distorted pulses originating from the power system from machine partial discharges.

Data Collection Method

- The online partial discharge test takes less than 30 minutes per machine with data collected in a simple, safe and non-destructive manner based on sound principles that are recommended by manufacturers and industry standards such as IEEE Std. 1434-2014 and IEC60034-27-2: 2012.
- The operator connects low voltage coaxial cable from the Iris Power PDA-IV portable instrument to a coupler termination box. The PDA-IV instrument is then connected to a control computer that runs the PDLight Pro and PDView software using a USB or Ethernet cable.
- The test is initiated through the PDLight Pro software which automatically collects the partial discharge data while the machine is running and without any interference to normal operation of the generator.

Termination Box

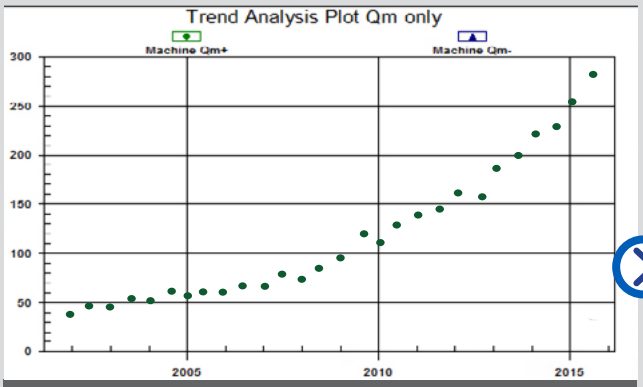
Iris Power TGA-B

Control Computer Installed with PDLitePro & PDView

Data Analysis and Information Outputs

Iris Power is foremost focused on providing a clear, reliable and repeatable result that allows the user to understand the true condition of the motor or generator and to make educated decisions on operations and maintenance. The TGA-B instrument has been designed to automatically collect partial discharge data and output the relevant information needed to provide a decisive means of:

- Identifying Partial Discharge Severity
- Identifying Probable Causes of Winding Deterioration
- Comparing Relative Health Across Machines



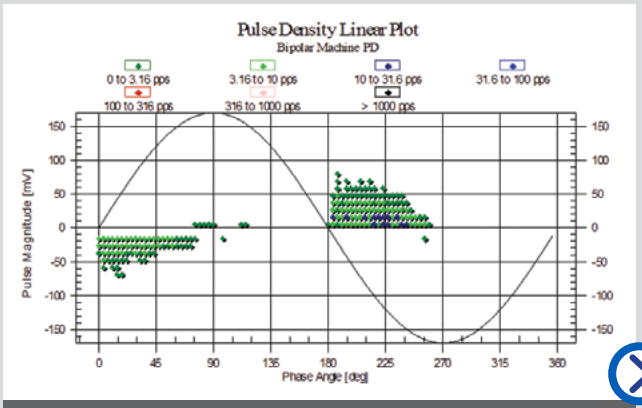
Peak Partial Discharge Magnitude (Qm) Trend Graph Showing Increasing Rate of Partial Discharge Severity

Peak Partial Discharge Magnitude

Peak pulse magnitude (Qm) values are automatically calculated by the PDA-IV instrument and output to help understand the relative health of each asset. The Qm value is defined in IEEE 1434 and IEC 60032-27-2 to allow several means of comparison including the following:

Trending of Qm to show any major change in the rate deterioration of the stator winding insulation.

Comparison of generator condition against similar machines using the freely available Iris Partial Discharge Severity Tables which are composed of over 550,000 test results collected across most makes and sizes of machines.

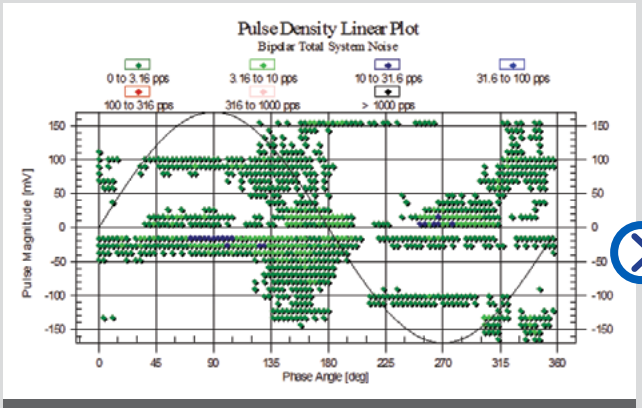


Phase Resolved Partial Discharge Plot showing pulse magnitude (mV) and frequency (pulses per second) by phase angle in the machine

Machine Partial Discharge

Electrical disturbances including partial discharges in the transmission lines (corona) or transformer as well as sparking of overhead cranes or on-site welding can create pulses similar to partial discharges. It is important to be able to understand the difference between power system noise and machine partial discharges to avoid false positive indications, to prevent unnecessary shut-downs and to avoid in-service failures.

The Iris Power TGA-B is designed specifically for Turbine Generators and Motors to ensure machine partial discharges are viewed and analyzed separately from system noises.



Phase Resolved Partial Discharge Plot showing pulse magnitude (mV) and frequency (pulses per second) by phase angle from the system

Separation of System Noise

Installation of two couplers per phase allows the TGA-B instrument to automatically distinguish between power system noise by evaluating pulse shape and the time of arrival of pulses.

Pulses originating outside the generator which arrive to the instrument through sensor closest to the system so can be automatically separated and classified as disturbances.

The pulses that arrive at the machine side sensor are automatically classified as machine partial discharges. Any pulses between the two sensors are automatically classified as pulses on the isolated phase bus.

Product Overview

The Iris Power TGA-B instrument provides the most reliable and accurate portable partial discharge monitoring solution on the market that is designed specifically for motors and generators.

- Advanced noise separation based on pulse shape and time of arrival methods to consistently quantify and isolate partial discharges from system disturbances.
- Test frequency range from 40 MHz to 350MHz while working with 80 pF Epoxy Mica Capacitors (EMCs) and 2 MHz to 350 MHz with 1 - 2 nF capacitive couplers.
- Optional capability for offline partial discharge testing of individual stator bars, coils and windings.
- Ability to operate instrument from 12V battery pack

Partial Discharge Pulse Measurement

Frequency Bandwidth	0.1 MHz - 350 MHz
Phase Windows	100 phase windows per cycle
Pulse Amplitude Range	2 mV - 34,000 mV 10 Sensitivity Range Settings
Data Acquisition Time	5s per magnitude window
Resolution	6ns for EMCs
Ambient Sensors	Ambient Temperature Sensor Ambient Humidity Sensor
Sensor Compatibility	80 pF EMC (6.9kV - 35 kV) - 6 Sensor Inputs

Operating Conditions

Operating Temperature	-15°C to 45°C (5°F to 113°F)
Relative Humidity	Up to 95% non-condensing

Accessories Included

Power Supply Cord	1.8m (6 ft)
Power Supply Adapter	Input: 100–240 VAC, 1.5A, 50–60Hz Output: 12 VDC, 5A
Ethernet Cable	3m (10ft) CAT-5
AC Reference Cable	1.8m (6ft) Shrouded Plug
USB Cable	1.5m (5ft)
Impact Resistant Case	41 cm x 31 cm x 21 cm (WxDxH) 16" x 12" x 8" (WxDxH) 10 kg (22 lbs)

Software & Manual

PDLITEPRO	Included
PDVIEW Standard Edition	Included
PDVIEW Advanced Edition	Optional
User & Installation Manuals	Included

Testing And Certification

Vibration Test	IEC 60068-26
Shock Test	IEC 60068-2-27
Transit Vibration	MIL-STD 810G, Method 514
Electrical	CE, UL

Options

Controlling Computer	Details Available On Request
Sensor Compatibility	Stator Slot Coupler (TGA-SB) Hydro EMC Couplers (TGA-BP)
VFD Motor Operation	20 Hz - 120 Hz Reference Circuit Capacitive Divider
Low Frequency Test	Offline Testing 80pF EMC 25kV or 28 kV 50 kHz- 5 MHz

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