

Iris Power GuardII™

Condition Based Monitoring for Turbogenerators

Integrating technologies for stator and rotor related health assessment



WHY USE CONDITION BASED MONITORING

- **Extend Life of the Asset:** Condition based maintenance detects the onset of problems and repairs can be carried out before major damage occurs, thus extending the life of an asset.
- **Maximize Time between Outages:** Using Condition based maintenance, equipment is removed from service less frequently (it is only done if condition of machine is deteriorated) as compared to the other maintenance schemes.
- **Lower Repair Costs:** Repair costs in detecting problems at an early stage are often only 1% of the cost incurred if failure occurs during normal operation of an asset .
- **Predict Catastrophic Failures:** Maximize revenue from the generator by reducing risk of catastrophic asset failures and schedule maintenance activities to minimize outage cost.
- **Reduce Risk of Damage during Outage:** During disassembly, outage and assembly there is always a risk that inadvertent damage will be done to one of the machine's components.
- According to US Department of Energy (EERE)*, independent surveys suggest the following industrial average savings from initiation of a functional predictive maintenance:
 - Reduction in Maintenance cost : 25% to 30%
 - Reduction of Breakdowns: 70% to 75%
 - Reduction in downtime: 35% to 45%
 - Return on Investment: 10 times



*Source; US Department of Energy
(Website: <http://www1.eere.energy.gov>)

IRIS POWER GuardII for Turbogenerators

Qualitrol-Iris Power specializes in providing measurement technology to detect various parameters which can be used for trending and assessing the stator and rotor condition in a turbine generator. Iris Power GuardII is a continuous online monitor that allows user customization and has the ability to combine multiple technologies in the same box. This gives the end user the option of including the most critical monitoring technologies needed by the asset. Iris Power GuardII has the capability to measure and detect one or more of the following, in a single box:

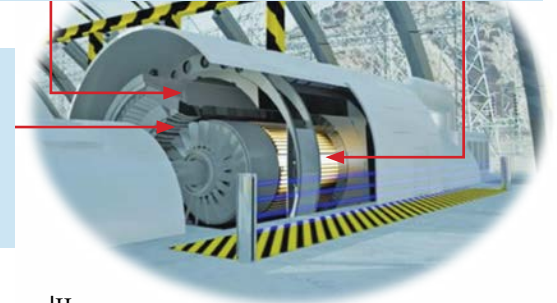
- Partial Discharge (PD) in stator winding insulation,
- Rotor magnetic flux,
- Stator endwinding vibration

Iris Power GuardII is a continuous on-line monitor that has the ability to monitor multiple issues in turbogenerators. The GuardII system has a flexible, modular design that can incorporate a variety of technologies and sensor inputs to meet your rotating machine needs based on the most common failure processes for your specific asset. For example, one of the most common failures in turbogenerators is the stator winding insulation. Thus, one of the major components of the GuardII system can be Partial Discharge (PD) monitoring. GuardII not only monitors PD using Iris Power sensors, including stator slot couplers (SSCs) and epoxy-mica capacitors (EMCs), but also uses condition-based data collection triggers and alert notifications, so that if the PD levels change then the maintenance personnel can receive notification that certain failure processes are within their machine. Another common failure process, the development of shorted turns, occurs with 2- or

Iris Power GuardII system can continuously monitor the stator windings for Partial Discharge activity and acquires PD data automatically, solving the problem of performing PD data collection under changing load and temperature conditions. Alerts are based on Iris Power's extensive database.

The Iris Power GuardII technology can directly measure the level and trend in vibration from the stator endwindings. The fiber optic accelerometers are impervious to the high magnetic and electric fields in the stator endwinding.

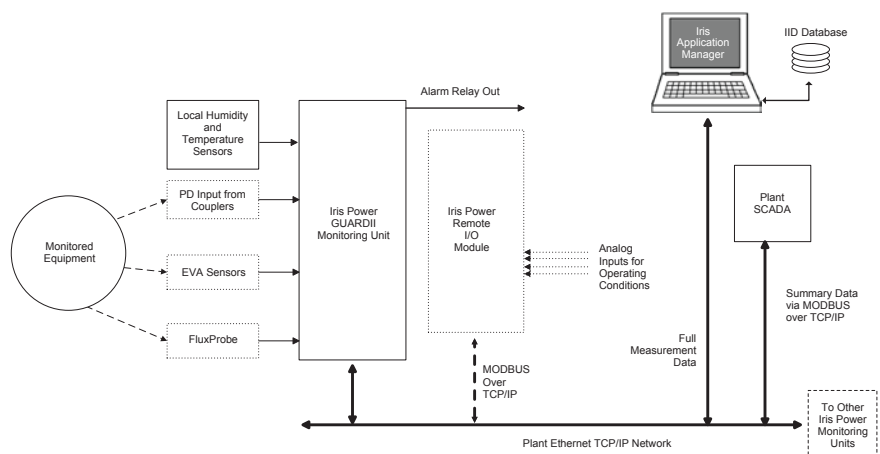
Iris Power GuardII can continuously monitor on-line rotor magnetic flux and can be used to detect and alarm the presence of shorted rotor winding turns in 2 or 4 pole rotors. This system collects and analyzes flux data from any flux probe in real time, providing the coil location and severity of any shorted turns.



4-pole rotors. For that, the GuardII system includes the ability to monitor the Rotor Flux, and by using sophisticated algorithms it can provide warning of shorted turns within the rotor winding. Also an issue with turbogenerators is stator endwinding vibration. The endwinding vibration is controlled under normal circumstances but with stresses such as thermal expansion or machine aging, the endwindings can loosen and can lead to cracking of coil bar insulation.

All these parameters are controlled and monitored by the Iris Application Manager™ (IAM) software. The IAM is a single platform to configure, download, and view data so that one would

only need to learn a single software application. It can be used across several assets regardless of the type of asset. IAM can be used for turbogenerators and motors – each configured specifically for your needs both today and for expansion in the future. The archived data can be downloaded locally over a USB port or remotely over a TCP/IP network communication. Ethernet connectivity allows personnel in distant offices to define or change data trigger conditions and alert levels, as well as to download results remotely for analysis using external viewing software created uniquely for each technology.



IRIS POWER ON-LINE PRODUCTS

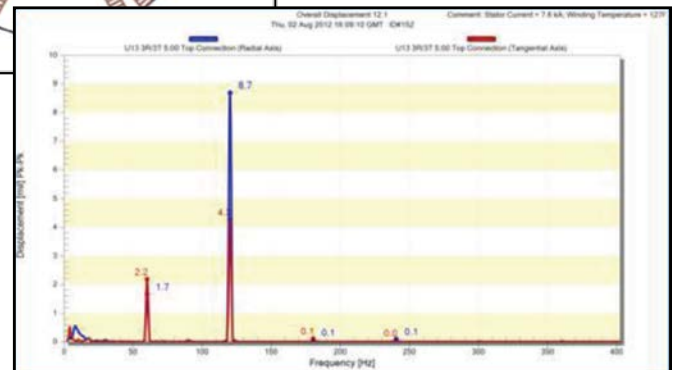
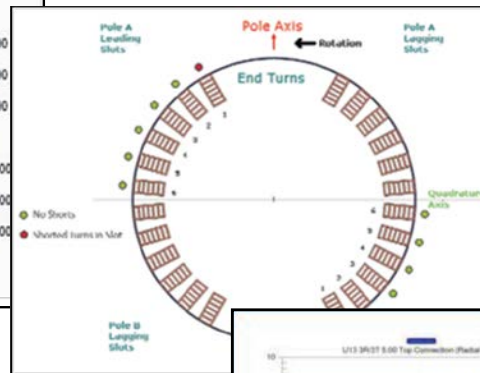
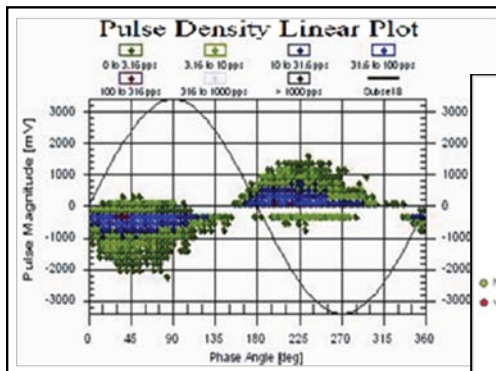
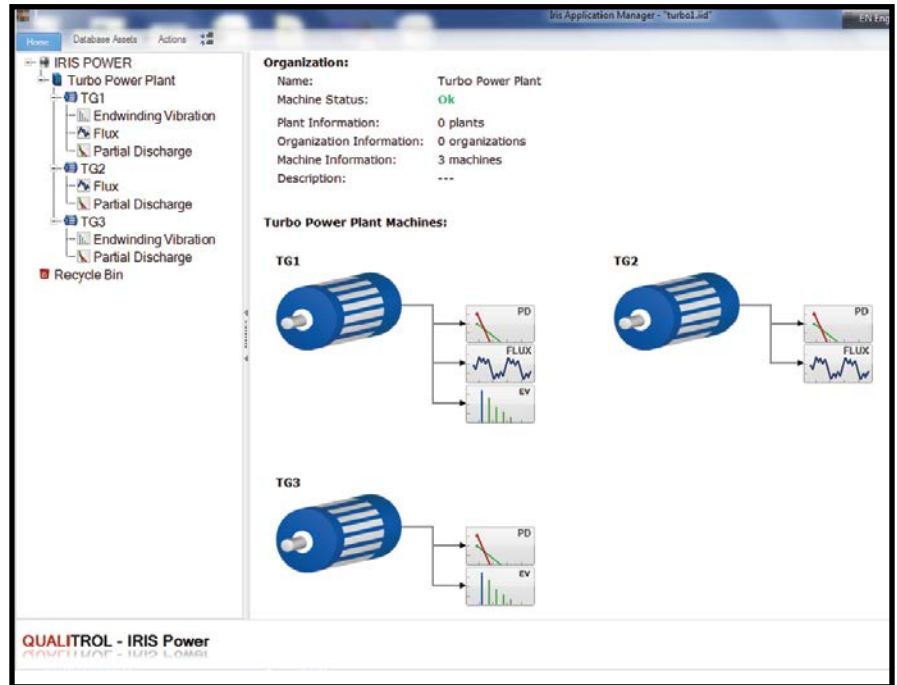
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IRIS APPLICATION MANAGER (IAM)

IAM Dashboard

The Iris Power GuardII includes the IAM software which is a Windows™ based software suite for configuring the PD and/or flux modules, downloading the archived data, and viewing and trending the data collected by the data acquisition unit. Features include:

- Provide at-a-glance status information for every asset in a database.
- Ability to monitor multiple plants, assets and technologies.
- Download data/diagnostics from GuardII and TracII monitors.
- Add/Configure assets, sensors, continuous and portable monitors.
- Ethernet connectivity allows personnel in distant offices to remotely collect and analyze data.



WHY INSTALL A CONTINUOUS CBM SYSTEM?

A User's Perspective:

"After acquiring readings continuously, the acquired PD data began to increase on the winding. Specifically, the data showed that the PD activity was high on all three phases of the unit. The unit was taken off line and inspected. It was found that all six phase barriers were burnt and close to a flash over.

While working on the unit, the winder stated that he felt if the repair was not pointed out then the unit would not last another quarter."

IRIS POWER GuardII for Turbogenerators

BENEFITS OF IRIS POWER GUARDII CONDITION BASED MONITORING SYSTEM

Stator and rotor knowledge leadership:

The user's assessment of stator insulation system condition using on-line PD testing is greatly enhanced by having access to Iris Power's extensive PD database of over 270,000 test results. The collective experience and results of our clients are regularly summarized in statistical tables, available to all users. This data is also used to automatically configure your GuardII PD system alert levels. GuardII employs advanced algorithms to analyze flux data on rotor windings regardless of load changes. This technology accurately detects the presence of shorted turns.

Turnkey solution: Where facilities have existing sensors for PD, flux, and/or endwinding vibration sensors, GuardII monitor installation does not require an outage and the installation effort is limited to providing power to the monitor, configuration, and if desired, running a communication link to a remote Windows computer. Combined with the Iris Application Manager (IAM), one can collect data from multiple rotating machines which can be monitored continuously at a given time. This lowers the burden on plant personnel to collect data.

Unprecedented customer service and technical support: With trained technical specialists and sales staff, Qualitrol-Iris Power is your single point of contact for all stator and rotor related monitoring solutions and support for turbogenerators and motors. Qualitrol-Iris Power also has world-class machines experts to aid with data interpretation.

Flexible and modular platform: Additional technologies such as Shaft Voltage & Current monitoring are also available and can be integrated with the GuardII monitoring system. GuardII can combine up to 3 technologies based on user needs. These upgrades can be made in the field.

Third party interface: Modbus over Ethernet protocol included for interfacing to third party applications, e.g. to receive from plant systems, machine operating condition data such as active power, reactive power, stator voltage, winding temperature, and hydrogen pressure, and/or bring the summary values to plant systems.

Reliable prediction: GuardII system has undergone unique and rigorously researched methods to overcome the electrical interference (noise) which is typical in most plant environments. This ensures reliable and repeatable PD, flux and endwinding vibration measurements with a low probability of false alarms.

Customer education: The data can be

easily interpreted by a maintenance professional after participating in a training seminar offered by Qualitrol-Iris Power's experienced engineering staff.

Large monitoring range: GuardII can continuously monitor a large range of turbogenerators to diagnose stator and rotor related conditions and increase the life of the assets.

What is Partial Discharge Monitoring?

Partial discharges (PD) are small electrical sparks that occur within the high voltage electrical insulation in stator windings. PD occurs whenever there are small air gaps or voids in or on the surface of the insulation. Over 60 years' experience has shown that as a stator winding deteriorates from winding vibration, operation at high temperatures, or contamination from oil, moisture and other chemicals, the PD activity will increase by a factor of ten or more. Thus, on-line PD monitoring detects the main root causes of stator winding failure. Since PD monitoring can be performed during normal motor or generator operation, and generally gives two or more years of warning of a risk of failure, online PD monitoring has become a very powerful tool for condition-based maintenance. PD is a symptom of abrasion of insulation, loose wedges, thermal degradation, manufacturing defects—all of which could lead to stator winding insulation failure if not detected and repaired early.

What is Stator Endwinding Vibration Monitoring?

Generator stator windings outside of the stator core are referred to as the endwinding (EW). The EW is at high-voltage and requires support against mechanical vibration driven by magnetic and mechanical forces. Machine endwindings are designed so that under normal circumstances these vibrations are controlled enough to prevent significant movement. However, the EW support system can deteriorate due to:

- Looseness of the EW support and tie structure due to mechanical aging and thermal expansion;
- Poor design of the EW due to resonance conditions close to the primary mechanical forces of rotational frequency and twice the AC line frequency;

What is Magnetic Flux Monitoring?

Monitoring rotor flux provides information on the integrity of the rotor winding interturn insulation. This information is critical in planning maintenance, explaining abnormal vibrations and verifying new and rewound rotor integrity. Magnetic flux signals are acquired from a probe permanently mounted on the machine stator.

A shorted turn means the insulation of the winding is deteriorated or burned and hence the current no longer takes the designed path. A turn-to-turn short is the most frequent rotor insulation failure mechanism and can result in:

- Thermal imbalance of the rotor pole and spider leading to increased mechanical vibration
- Magnetic imbalance in the flux resulting in mechanical vibration
- Inability to reach the rated MVA for that machine
- Rotor ground insulation failure

- Abnormal operating events such as short circuits resulting in stress and deflection of components beyond their mechanical limits;
- Relative motion between one component and another which can abrade the high voltage insulation on the coils.

EW vibration can lead to cracking of the coil/bar insulation just outside of the stator slot and, in severe cases, may cause the copper conductors to fatigue crack leading to high arcing currents. Eventually, any of these issues can lead to stator winding ground faults. EW vibration monitoring using fiber optic accelerometers in the EW can warn operators when dangerous vibration levels begin to occur.

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QUALITROL-IRIS POWER HAS BEEN THE WORLD LEADER IN MOTOR AND GENERATOR WINDING DIAGNOSTICS SINCE 1990, PROVIDING A FULL LINE OF ON-LINE AND OFF-LINE TOOLS, AS WELL AS COMMISSIONING AND CONSULTING SERVICES.



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