Flux Trac™

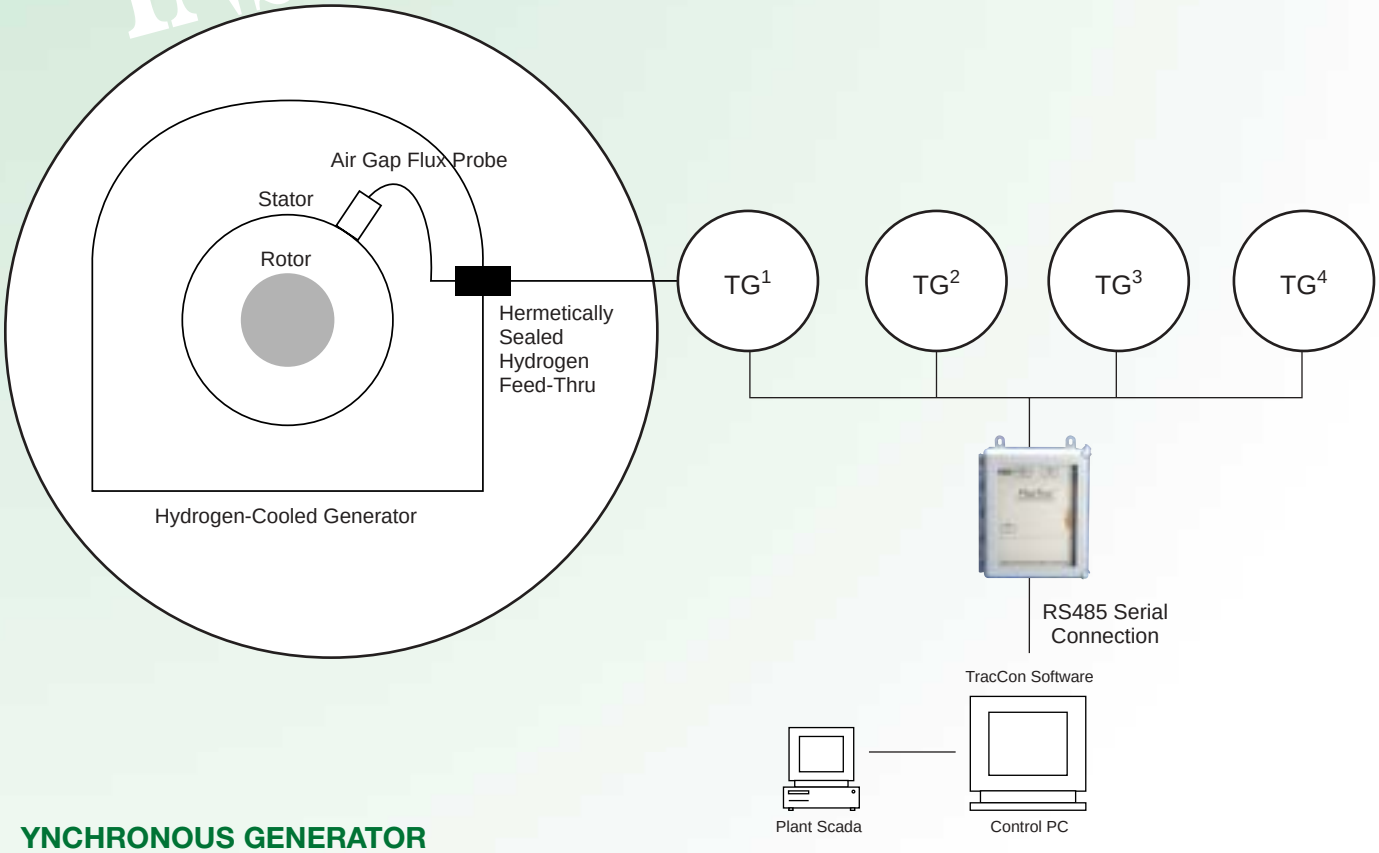
INSTRUMENTS

IRIS POWER ENGINEERING

FluxTrac™

Continuous Monitor for Turbo Generator Rotor Winding Condition.

FluxTrac™



YNCHRONOUS GENERATOR ROTOR WINDINGS

In synchronous generators, insulation is required on the rotor to isolate the various rotor-winding turns and coils from each other, and to isolate the winding from the rotor body and end-rings. This rotor insulation must withstand severe electrical, mechanical, thermal, and environmental stresses. Insulation failure can result from many factors, including thermally or mechanically induced turn-to-turn movement and fretting of the rotor windings, end blocking failure, metallic contamination, and overheating or overvoltage transients. Any of the above conditions can result in a failure of the insulation, and an electrical connection between turns, coils, or the winding and ground.

Turn-to-turn shorts are probably the most common rotor insulation failure mode. Such shorts will result in:

- higher electrical loss and decreased generator power and efficiency
- potential for thermal unbalance and mechanical vibrations which are field current dependent
- magnetic unbalance and mechanical vibrations of the rotor
- higher rotor temperatures due to higher field currents
- overheating due to turn shorts that can eventually lead to a rotor ground fault with the potential for a second catastrophic rotor ground

On-line detection of turn failures is critical in ensuring the integrity of rotor insulation in operating machines, and for assessing the quality of rotor repairs. On-line flux monitoring is a proven technology for detecting and tracking such failures, and providing early warning of developing rotor insulation degradation.

FluxTrac MONITOR

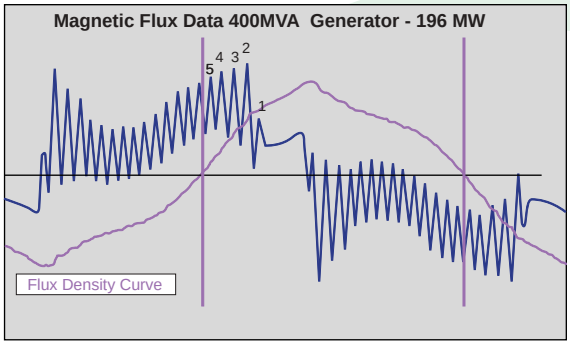
FluxTrac™ is a field-hardened, permanently-connected monitor for making rotor magnetic flux measurements using existing flux probes. Up to four generators can be connected to the monitor. Traditionally, such measurements have been achieved utilizing portable instrumentation. With the advent of cost-effective modern electronics, the rotor flux test lends itself to automated data collection via a permanently-connected ***FluxTrac*** instrument. For your convenience, the data can be collected remotely from the user's office via our Windows-based TracCon™ software,

eliminating the need for a costly and time consuming site visit each time flux measurements are required. ***FluxTrac*** is ideal in today's environment of reduced maintenance and testing staff. In automated plants where load data is locally available, integrating ***FluxTrac*** with your machine monitoring systems will eliminate testing time, and guarantee the collection of accurate, and trendable results. The ***FluxTrac*** monitor measures the magnetic flux in the vicinity of the rotor surface in synchronous machines to determine if turn-to-turn shorts have occurred in the rotor winding. This test has been widely applied in large turbine generators, and has found more a limited application in critical synchronous motors and hydrogenerators. Flux measurements are the most powerful means of monitoring the condition of rotor windings on-line, and are a proven tool used to provide information on the integrity of the rotor winding inter-turn insulation. This information is critical in planning maintenance, explaining abnormal vibrations, and verifying new and rewound rotor integrity.

THEORY OF FLUX MONITORING

In addition to producing the main radial magnetic flux that crosses from the rotor to the stator, a round rotor produces a local field around each slot in the rotor. This leakage flux results from the coils in the rotor winding and is related to the total ampere-turns in each slot. Any change in the total current within a slot, due to shorted turns, produces a change in the leakage flux, associated with the affected slot. To measure this leakage flux, a sensor or "flux probe" is permanently installed on the stator. During machine operation, the flux from each slot will induce a current in this flux probe, as the rotor moves by it. The voltage signal can be measured via a suitable oscilloscope, or a dedicated recording instrument.

Each peak of the resulting voltage waveform represents the leakage flux around one rotor slot. An inter-turn short in a coil reduces the peaks associated with the two slots containing the faulted coil. The recorded waveform data is analyzed to locate anomalies in the voltage waveforms, indicative of shorted turns. This can be attained by comparing matching slots on opposite rotor poles, or by trending the signal for a given slot over time.



To maximize the sensitivity to shorted turns in all rotor slots, the signals from the flux probe must be measured under different load conditions, ranging from no load to full load. At a zero crossing of the total air-gap flux (which is a function of the excitation flux and armature reaction flux, thus being dependent on the generator's load points), the sensitivity to the leakage flux is the highest. Thus, flux readings are recorded at various load points depending on the number of slot pairs in a pole. With the waveforms being digitally recorded at each load step, specialized software can determine the number of shorted turns in each slot, and can identify the slots with the shorts.

Whereas turn shorts in stator windings can rapidly lead to failure, turn shorts in synchronous rotor windings may not, in themselves, lead to this eventuality. One or more shorted turns can be sustained indefinitely as long as the required excitation is adequate, and the increased level of vibration that shorted turns may produce remains within acceptable limits. If gradual aging is occurring, more and more shorted turns will arise indicating a risk of a rotor ground fault.

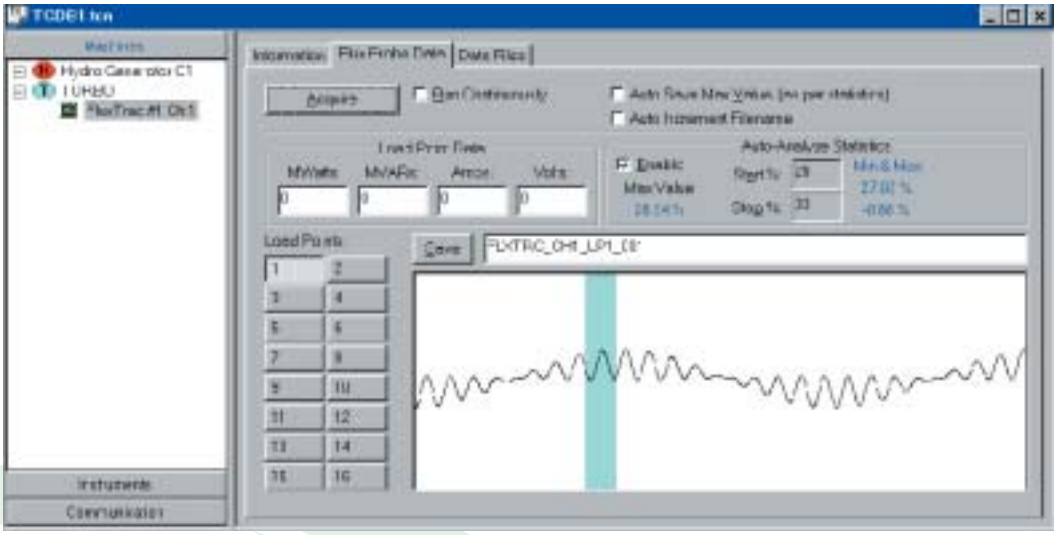
APPLICATION

Measuring air-gap flux requires the permanent installation of a flux probe within the air gap to measure the slot leakage flux. The sensor consists of a large number of turns with a small diameter magnet wire on a bobbin, with the axis of the coil oriented in the radial direction. To improve its sensitivity to the leakage flux, the coil should be located 2-3 cm away from the rotor surface. The flux probe is usually mounted at the turbine end of the stator core, at the 10 o'clock position to minimize the possibility of damage to the coil when the rotor is removed. A hermetically sealed "feed-thru" is required to bring the probe signals out of the machine on hydrogen-cooled generators.

The ***FluxTrac*** instrument can be connected to up to four flux probes, allowing the instrument to record data on up to four generators per plant. Coaxial, shielded cable is used to connect the flux probe outputs to a centrally located ***FluxTrac***. Using the Windows-based TracCon™ software will trigger on-demand recordings on any one of the four inputs. The instrument then transmits this data back to your PC for archiving, analysis and trending. Data can be analyzed utilizing spreadsheet software, or custom analysis packages from many vendors.

FEATURES

- ***FluxTrac*** is a sophisticated, field-hardened microcontroller-based instrument in a NEMA 4X package capable of monitoring up to four flux probes (sequentially).
- The instrument can be calibrated for a broad range of input signal levels allowing it to employ existing wedge mounted probes from any manufacturer.
- The data measured with ***FluxTrac*** is compatible with existing portable instrumentation. The software output is a text file that can be analyzed via a spreadsheet program or directly imported into available third party analysis software.
- The instrument has a wide range of computer connection options, including RS233, RS485 (copper or fiber), or TCP/IP Ethernet via an external Terminal Server. Our TracCon™ data acquisition software can be configured for any of these communication options and can be operated either locally or from a remote location to acquire and store flux data on demand. This remote communications ability emancipates maintenance staff from the necessity of having to travel to the plant, or being available for hard-to-schedule generator run-ups.
- Through custom interfaces to your plant SCADA or control system, the TracCon software can be fully automated to collect flux data at pre-programmed generator load points. This fully automated flux recording is an option which will be available in the near future.



FluxTrac™ *Control - Data Acquisition Screen*

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