Generator End Winding Vibration Sensors

for Online Condition Monitoring

Increase the life expectancy of your turbine generator

Continuous online monitoring of a variety of generator parameters can greatly increase the life expectancy and economic performance of your turbine generator. In particular, generator component vibration is a major concern, and your need for reliable and accurate data is of prime importance.

Because the stator winding overhang region is particularly susceptible to vibration induced by electromagnetic forcing (occurring at twice the synchronous frequency), mechanical forcing and thermal effects, the end winding can suffer from significant levels of vibration. Long-term exposure to high levels of vibration can loosen the end winding support system, translating to failures due to insulation cracking, partial discharge, cooling leaks, and even short-circuit conditions.

Through online monitoring of vibration amplitudes, you can lessen or prevent forced outages related to such failures. Early detection of abnormalities allows for timely and planned intervention that helps increase your plant generation availability.

Problems associated with stator end winding vibrations are the primary cause of generator forced outages. And, because the end winding region of the generator is an electrically hostile and potentially explosive environment with very high voltages and electromagnetic disturbances present, conventional instrumentation is unsuitable.

Fortunately, GE has significant experience in the installation of bespoke high-voltage (HV) protected accelerometers and fiber-optic accelerometers. We test both sensor types to help ensure that they will safely withstand the electrical forces present in the end winding region, even under fault conditions. And, we make sure that the sensor's accelerometer type and frame penetrations are tailored to suit your specific installation requirements, with options available for both air- and hydrogen-cooled machines.

A full sensor installation—typically consisting of either six or 12 measurement positions—can be completed within a standard planned outage.

Our technicians and engineers draw on more than 40 years of end winding accelerometer design and installation experience and more than 200 machine installations. Notably, sensors taken from machines after more than 30 years of service have been removed from protective casings, recalibrated, and found to have suffered no performance degradation.

Customer benefits

- **Better overall efficiency** due to reduced machine downtime
- **Improved safety** through reductions in machine failure risk
- **Lower capital costs** resulting from extended machine service life
- **Lower machine repair costs** as problems are identified before they cause serious damage
- **Reduced risks of forced outages** with enhanced predictive maintenance capability through the continuous monitoring of machine health data

fact sheet

HV protected accelerometers

To provide reliable and accurate signals—even under extreme conditions—GE carefully selects accelerometers from a range of trusted manufacturers. Tested to withstand more than twice the line voltage of the stator, the piezoelectric accelerometers are hermetically sealed from the high-voltage environment using epoxy glass casings. Based on your specific application, select either charge mode or voltage mode output to provide uniaxial or triaxial measurements.

To help maintain high signal quality, GE selected an ultra-low noise accelerometer signal cable that is protected and electrically isolated from HV areas of the stator winding by a sheath of silicone tubing, which is itself tested to withstand voltages higher than 50 kV.

Our installations are carried out by highly experienced generator technicians and engineers to help ensure uncompromised electrical and mechanical integrity of the structure.

Technical specifications

Piezoelectric Sensors (Charge Mode)

- **Long-term stability** at generator operating temperatures
- **Low transverse sensitivity** for accurate phase reference and low interference
- **High-frequency response** to help capture all relevant harmonic frequencies
- **Excellent frequency linearity** for high accuracy over the measured frequency range
- **Low magnetic sensitivity** for significantly lower risk of induced noise
- **Proven long-term reliability** with a deliverable lifespan that is in line with generator winding life expectancy

ICP/IEPE Sensors (Voltage Mode)

- **On-board electronics** for high output/weight ratio
- **Low impedance** allowing the use of long, inexpensive cables
- **High-frequency response** to capture all relevant harmonic frequencies
- **Low magnetic sensitivity** allowing significantly lower risk of induced noise
- **Excellent frequency linearity** for high accuracy over the measured frequency range


HV Protected Accelerometer

Customer benefits

- **Excellent flexibility** through a choice of sensor design types available to suit your measurement requirements, machine type, location, and budget
- **Accurate measurements**—in all degrees of freedom—facilitated through uniaxial, biaxial and triaxial sensor designs
- **Safe operation** in HV environments achieved through rigorous sensor testing
- **Proven reliability** based on hundreds of units in operation around the world
- **Fast installation** achieved with low capital cost piezoelectric sensors that typically can be delivered for short-notice installation during forced outages

Fiber-optic accelerometers

Due to their non-metallic construction, fiber-optic accelerometers are immune to electromagnetic interference. An excellent choice for use in high-risk electrical areas, these units provide substantial insulation between the sensor and instrumentation for significantly less risk to personnel or equipment.

GE supplies and fits uniaxial and biaxial sensors from a number of industry-leading manufacturers. The voltage output is supplied by an optoelectronic converter with inbuilt signal conditioning, and the sensors offer a nominal sensitivity of 100 mV/g, with measurements performed over a 10 to 1,000 Hz frequency range.

The sensor's design and construction includes polymer tubing that embeds the optical fibers of the cable. This configuration reinforces the delicate optical fibers, protecting against damage through impact or abrasion that can occur during outages and routine inspections. Additionally, the optoelectronic and conditioning circuitry is housed in a sealed, feed-through connector integral to the sensor's construction. All sensor designs are ATEx-certified, as necessary.


Accelerometers installed on Phase End Connection

Dual Axis Fibre-Optic Accelerometer & Feedthrough

Technical Data	
Nominal Sensitivity	100 mV/g
Frequency Range	10 to 1,000 Hz
Bias Voltage	6 V DC
Dynamic Range	0-40 g at 100 Hz

Testing and calibration

Before GE ships a high-voltage protected accelerometer, it undergoes a comprehensive test to ensure that it can withstand a voltage of at least twice the generator line-voltage to the assembly for one minute. Additionally, the completed assembly may be subject to partial discharge testing to help ensure that no potentially damaging discharge activity is present at voltages representative of operating conditions.

Following testing, we perform a final calibration of all accelerometers to help ensure accurate and reliable functionality prior to installation. During the calibration, we conduct the following assessments:

- **Accelerometer Frequency Response**: An electro-dynamic vibration table is used to apply a sine sweep between 10 Hz and 1,000 Hz, with sensor output compared to a known reference.
- **Output Linearity:** The sensor is subjected to acceleration levels varying between 0.1 g peak and 5 g peak at a single reference frequency.

Following final testing and calibration, GE supplies an installation report that includes test certifications confirming applied test voltages and calibration curves for all sensors.

Customer benefits

- **Proven sensor quality** achieved through testing and calibration to traceable standards after manufacture and prior to installation
- **Installation excellence** provided by skilled engineers and generator specialists with specific product knowledge
- **Rugged design and secure installation** using proven techniques and materials to withstand the harsh operating environment inside a turbine generator
- **Fast delivery** of permanent installations within short-duration outages

Installation methodology

GE technicians bond the sensors to the measurement surface using high-strength epoxy adhesive, providing both a secure attachment and good transmission of in-service vibrations. Additional security is supplied by one of two methods:

- Wrapping in resin-saturated cloth tape that acts as a high-strength mechanical restraint when cured and later heated
- Mechanical restraint using a glass composite clamp secured with glass screws and saturated felt

Cables are routed to the casing termination point, and the cable is secured to existing anchor points with saturated tape when suitable points are available. When anchor points are not available, the cables are secured by adhering cable bases using high-strength epoxy adhesive, or by drilling and tapping where appropriate and securing with c-shaped clamps held in place with glass screws.

Our technicians carefully consider the cable route to help ensure that adjacent phase groups are given sufficient clearance. Cables are secured to the internal structure at separation distances no greater than 100 mm to reduce tribological-induced noise.

Excess cable is removed where possible or, in the case of fiber-optic installations, secured and coiled neatly at a suitable location, preferably close to the casing feed-through position.

Proven solutions

GE offers a range of availability and performance boosting solutions, covering all cooling technologies, all generator sizes, and all OEMs. Local presence, global expertise and a strong heritage are the basis of our universal portfolio of generator service solutions.

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To find out more about GHM End Winding Vibration Sensors, please contact your local GE representative or visit **gepower.com**.

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