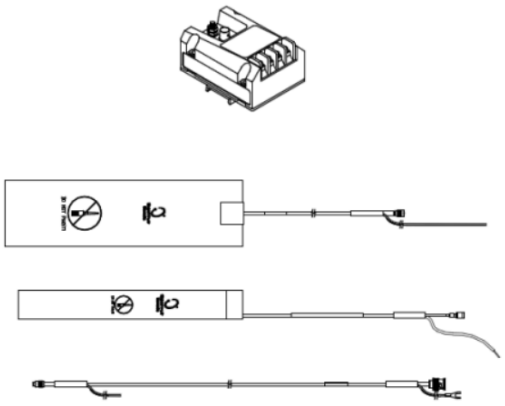
4000 Air Gap Sensor System

Datasheet

Cordant™

167885 Rev. P



Description

Bently Nevada's Air Gap monitoring system provides monitoring and diagnostic capability for all new and existing hydro generators and motor/generators. Air gap monitoring is fully integrated with the Bently Nevada™ 3500/System 1 platform and utilizes the 3500/46M Hydro Monitor. The 4000 Series air gap sensor system is available in 20 mm and 50 mm ranges for optimal resolution across a wide range of measurement requirements.

Criticality

Air gap is a measure of the distance between rotor and stator in a hydroelectric generator. Monitoring of air gap is critically important because both the stator and the rotor on large hydroelectric machines can be quite flexible and their shape and location are affected by operating centrifugal, thermal, and magnetic forces. Off-center or out-of-round conditions will at least reduce operating efficiency and, in more severe cases, can lead to damage from magnetically induced heating or a rotor-to-stator rub.

Measuring Air Gap

Air gap monitoring utilizes multiple specially designed capacitive proximity probes that are mounted on the inner bore of the generator stator in one or more planes. Measurements are made from the stator bore to each rotor pole as the rotor turns. Minimum air gap dimension and location along with rotor shape are directly measured during unit operation. Stator shape is calculated utilizing the multiple air gap probes. The air gap monitoring system provides operations and maintenance personnel with early warning of

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impending problems with shape and concentricity of the generator rotor and stator.

Typical Benefits

Air gap dimensions along with rotor and stator shape cannot be effectively measured with the generator out of service because of the combined effects of centrifugal, thermal, and magnetic forces. Early detection of air gap anomalies will facilitate condition-based maintenance by allowing the user time to plan for repairs before scheduled outages. Long term trending of gap and shapes can be correlated with operating conditions and used in operational and rehabilitation planning. Knowing the rotor and stator shapes and minimum air gap dimensions will provide the operator with the information needed to remove a machine from service before serious damage like that from a rotor stator rub occurs.

Air Gap Probe and Extension Cable

The 4000 series Air Gap probe is designed for maximum survivability in the harshest hydro generator environment. It can continually operate and maintain its accuracy in temperatures up to +125°C (+257°F). The probe can also continually operate and maintain its accuracy in the 1.5 Tesla magnetic field often experienced between the rotor pole and the stator. ClickLoc connectors come standard on both the probe and extension cable to prevent loosening of the connectors.

Proximitor Sensor

The 4000 series Air Gap Proximitor Sensor is based upon our best selling 3300 XL Proximitor Sensor technology. The Proximitor Sensor uses a DIN rail connection to ease installation and to minimize the number of cumbersome screws required when working around the hydro generator. The grounding stud on the Proximitor Sensor features a safety thread in order to ensure the locking nut does not inadvertently fall off during the installation of the ground wire on the extension cable.

Specifications

Unless otherwise noted, these specifications are for a 4000 Series Air Gap Proximitor Sensor, extension cable, and probe between 0°C and +50°C (+32°F to +122°F), with a +24 Vdc power supply, and a 10 kΩ load.

Electrical

Proximitor Sensor Input	Accepts one non-contacting 4000 Series Capacitive Probe and Extension Cable
Power	Requires +23.25 Vdc to +24.75 Vdc at 85 mA maximum consumption
Supply Sensitivity	Less than 2 mV change in output voltage per volt change in input voltage
Output Resistance	50 Ω ± 5%
Extension Cable Capacitance	75.5 pF/m (23.0 pF/ft) typical
Field Wiring	0.2 to 1.5 mm^2 (16 to 24 AWG) Recommend using two-conductor shielded cable. Recommended maximum length of 305 metres (1000 feet) between the 4000 Series Proximitor Sensor and the monitor

Linear Range	
20 mm System	18.3 mm (720 mils). Linear range begins at approximately 2 mm (80 mils) from the face of the probe and is from 2 to 20.3 mm (80 to 800 mils) (approximately +1 to +10 Vdc)
50 mm System	45.7 mm (1800 mils). Linear range begins at approximately 5.1 mm (200 mils) from the face of the probe and is from 5.1 to 50.8 mm (200 to 2000 mils) (approximately +1 to +10 Vdc)
Average Scale Factor (ASF)	
20 mm System	0.50 V/mm (12.5 mV/mil), nominal
50 mm System	0.20 V/mm (5.0 mV/mil), nominal
Deviation from a Straight Line	
20 mm System	Less than ±1.02 mm (±40 mils) with system between 0°C and +50°C (+32°F and +122°F)
50 mm System	Less than ±2.54 mm (±100 mils) with system between 0°C and +50°C (+32°F and +122°F)
Frequency Response	0 to 2.0 kHz: +0, -3 dB typical with up to 305 metres (1000 feet) of field wiring

Mechanical

Probe Material	FR4 type material
20 mm Sensor Lead Material	50 Ω triaxial, fluoroethylene propylene (FEP) cable
50 mm Sensor Lead Material	75 Ω triaxial, fluoroethylene propylene (FEP) cable
Extension Cable Material	75 Ω triaxial, fluoroethylene propylene (FEP) cable
Proximitor Sensor Material	Aluminum

Tensile Strength (maximum rated)	20 mm probe: 89 N (20 lbf) at both probe lead to probe and probe lead to extension cable connector 50 mm probe: 312 N (70 lbf) at probe lead to probe, 89 N (20 lbf) at probe lead to extension cable connector
Connector Material	Gold-plated brass and gold-plated beryllium copper

Connector-to-Connector Torque	
Recommended Torque	Finger tight
Maximum Torque	0.565 N•m (5 lbf•in)
Minimum Bend Radius	25.4 mm (1.0 in)
System Mass (typical)	
20 mm Probe	Approximately 54 g (0.1 lbs)
50 mm Probe	Approximately 140 g (0.3 lbs)
Extension Cable	Approximately 320 g (0.7 lbs)
Proximitor Sensor	Approximately 380 g (0.8 lbs)

Environmental Limits

Probe Temperature Range	
Operating Temperature	0°C to +125°C (+32°F to +257°F)
Storage Temperature	-35°C to +125°C (-31°F to +257°F)

Extension Cable Temperature Range	
Operating Temperature	0°C to +125°C (+32°F to +257°F)
Storage Temperature	-35°C to +125°C (-31°F to+257°F)
Proximitor Sensor Temperature Range	
Operating Temperature	0°C to +70°C (+32°F to +158°F)
Storage Temperature	-35°C to +85°C (-31°F to +185°F)
Relative Humidity	Less than a 5% change in average scale factor when tested in 93% humidity in accordance with IEC standard 60068-2-78 for up to 56 days.

Compliance and Certifications

FCC

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

RoHS

RoHS Directive 2011/65/EU

EMC

EMC Directive 2014/30/EU

Ordering Information

For the detailed listing of country and product-specific approvals, refer to the *Approvals Quick Reference Guide (108M1756)*.

For additional technical documentation, please log in to bntechsupport.com and access the Bently Nevada Media Library.

4000 Series Air Gap Probes

400102 Air Gap 50 mm Probe

400202 Air Gap 20 mm Probe

Product Number–AA	
A: Cable Length Option	
01	Standard, 18 inches

Includes:

- Air gap probe with integral cable and connector
- Teflon conduit, 12.7 mm (1/2 inch) diameter, 457 mm (18 inch) long
- Loop strap clamp and 1/4-20 bolt
- Adhesive applicator
- Two (2) fiberglass spacers (for 50 mm air gap probes only)

A 30 cc tube of silicone adhesive is no longer provided with each probe, as it is no longer available with a long enough shelf life. A large 305 cc tube is available to purchase separately with a minimum 3-month shelf life that is suitable to install up to 10 Air Gap probes. If a longer shelf life is needed we recommend that this tube be purchased directly from a distributor.

4000 Series Air Gap Proximitor Sensor

400100 Air Gap 50 mm Proximitor Sensor

400200 Air Gap 20 mm Proximitor Sensor

Product Number-AAA-BB	
A: Cable Length Option	
100	10.0 meters (33 feet) system length
B: Linear Range Option	
02	20 mm (0.8 inches)

4000 Series Extension Cable

400130 Air Gap 50 mm Extension Cable

400230 Air Gap 20 mm Extension Cable

Product Number-AAA	
A: Cable Length Option	
100	10.0 meters (33 feet) system length

Accessories

167684	Air Gap Transducer System Operation User Guide
02200627	+24 Vdc Power Supply. Typically 2 sensor systems will be powered by 1 power supply in each Proximitor Housing. The power supply is capable of running 4 sensor systems.

330181	3300 XL Proximitor Housing. Suggested configuration is 330181-01-00-01-00-00; a housing with DIN mount hardware, no conduit fitting, standard 2.34 mm (0.092 in) gland plate thickness, no terminal blocks, and no approvals. Typically 2 sensor systems and 1 power supply will be located in each housing. The housing is capable of holding 1 power supply and 4 Proximitor Sensors.
02173006	Bulk cable (specify length in feet) 1.0 mm^2 (18 AWG), 2-conductor, twisted, shielded cable used for the PROX OUT signal on the Air Gap Proximitor Sensor terminal strip.
168448-01	Air Gap Verification Kit.
173873	7-inch PEEK cable ties suitable for hydro generator environments, bag of 50
179M8417	305 cc silicone adhesive cartridge (3-month minimum shelf life). Suitable for installation of up to 10 Air Gap probes. If a longer shelf life is needed, we recommend that this tube be purchased directly from a distributor (DOWSIL™ 3165 Fast Tack RTV Adhesive Sealant, 305 mL Cartridge).

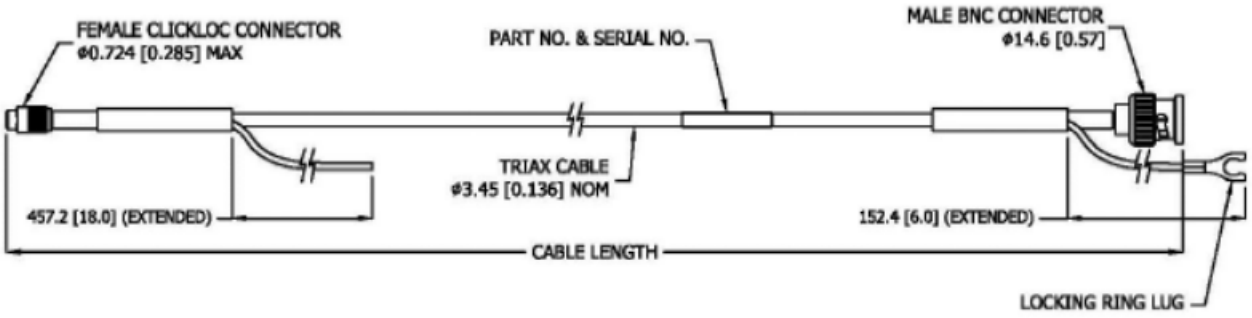


Figure 12: Air Gap 20 mm or 50 mm Extension Cable

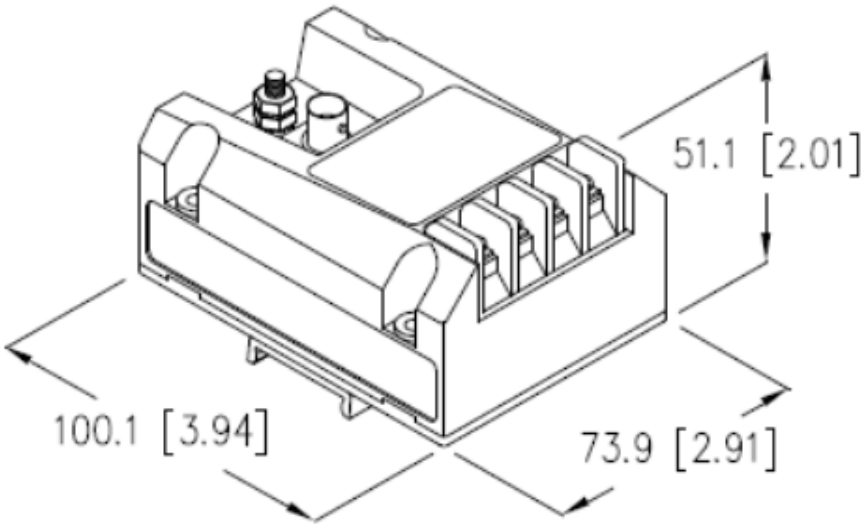


Figure 13: Air Gap 20 mm or 50 mm Proximitor Sensor