

SIL-3 Hazloc Speed Sensors

for Turbine Applications

Applications

SIL-3 Hazloc speed sensors are identical to Woodward's existing ATEX/NA Zone 1/Div 1 MPU probes except they are also certified for use in up to SIL-3 (Safety Integrity Level) rated safety systems. When applied with a SIL-rated logic solver and final element, users can easily create an overspeed safety instrumented function (SIF), which meets the required safety integrity level for the specific application.



These variable reluctance (VR) speed sensors utilize passive components which results in very low failure rates, making them ideal for use in safety systems requiring long system life and low probability of failure on demand (PFD) values.

Rotating machinery requires speed sensing for rotor control, monitoring, and safety. Speed sensing is accomplished using a variety of technologies. Variable-reluctance-based magnetic pickup units (MPUs) are commonly selected because of their simplicity, reliability, and low cost. MPUs are passive probes in the sense that there are no active signal conditioning electronics in the probe. VR (passive) sensors also do not require an external supply, simplifying the overall system and increasing system reliability values.

MPUs produce a voltage output when ferrous material passes through the magnetic field at the end of the pickup (pole piece). Since most turbines and engines have large gears made of ferrous material (usually iron or steel), magnetic pickups can usually be installed without adding attachments to a gear or shaft. Non-ferrous materials, such as aluminum, brass, and some stainless steels, will not excite a magnetic speed sensor.

To simplify application and installation concerns, these sensors have been validated to be directly compatible with Woodward's ProTech® and MicroNet™ safety logic solvers when used in SIL-3 or SIL-2 certified safety systems, including:

- ProTech-GII—Overspeed Detection System (SIL-3 certified)
- ProTech-SX—Simplex Safety Logic Solver (SIL-2 certified)
- ProTech-TPS—Safety Logic Solver including Overspeed Detection (SIL-3 certified)
- MSM—MicroNet Safety Logic Solver (SIL-3 certified)

For industrial applications, it is recommended that standard API670 be referenced, as it includes application guidelines for speed sensors applied on rotating machinery, including steam turbines, gas turbines, turbo expanders, and variable-frequency drives. Compliance to functional safety standard IEC61508 is increasingly required in new and retrofit systems. Safety-certified passive speed sensors are a valid choice in these systems because they are Type A devices (passive), take up less of the safety allocation, and have lower PFD values than active speed sensors.

- Variable reluctance speed sensors
- No active components
- Rated for use in **SIL-1, 2, or 3** safety systems
- Rated for Div 1 and Zone 1 hazardous locations
- Low PFD & PFH values
- Low failure rates
- Compatible with Woodward ProTech® & MicroNet logic solvers
- Available with:
 - .625x18 and .750-20 threads
 - Thread length options
- Temperature Range = -65 °C to +100 °C

Description

SIL-3 Hazloc speed sensors are single-channel, variable-reluctance speed sensors consisting of a single inductive coil and a permanent magnet. A ferrous gear tooth passing the sensor pole piece changes the magnetic field strength, inducing an AC voltage. The frequency of the output signal is proportional to the velocity of the gear tooth passing the sensor's pole piece. The amplitude of the signal depends on the following:

- Angular speed
- Air gap between sensor face (pole piece) and target (gear tooth)
- Target (gear tooth) geometry
- Target (gear tooth) ferrous material properties
- Load impedance of the electrical circuit used to sense output signal

Depending on the application, these sensors can be ordered with different thread sizes and thread lengths (determined by part number). They are threaded for conduit fittings and have flying leads, allowing for easy adaptation in Zone 1/Div 1 and Zone 2/Div 2 classified environments.

Sensed minimum and maximum frequency is dependent on the application (toothed gear, air gap, overspeed detection system (ODS), trigger level, etc.). VR sensors are not designed to measure low frequencies. The sensor's voltage level is low at lower frequencies, which results in a signal voltage level that may be too low to be detected by some overspeed detection systems. Depending on the ODS, it is usually possible to measure frequencies up to about 40 kHz.

Functional Safety

These sensors are certified by CSA to be used in SIL-1, SIL-2, and SIL-3 applications according to IEC 61508. CSA's SIL certificate and corresponding report can be provided by Woodward upon request. The sensors are designed to be integrated into a safety-related system or subsystem. Voting between individual sensors is required in accordance with IEC 61508 for SIL2/SIL3 and ISO 13849-1 CAT 3 PL e. Impedance measurement to detect open circuit and channel trips shall be realized in accordance to IEC 61508 SIL2/SIL3 and ISO 13849-1 CAT 3 PL e.

<u>Safety Function:</u>				
<i>To provide a voltage output of frequency proportional to the turbine shaft speed.</i>				
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4		Variable reluctance speed sensors		
Architectural constraints & Type of product A/B		HFT = 0 (1oo1) Type A	HFT = 1 (1oo2) Type A	HFT = 1 (2oo3) Type A
Safe Failure Fraction (SFF)		60%	90%	90%
Random hardware failures: [h ⁻¹]	λ_{DD}	3.81E-08	5.72E-08	5.72E-08
	λ_{DU}	2.54E-08	6.35E-09	6.35E-09
Random hardware failures: [h ⁻¹]	λ_{SD}	0.00E-00	0.00E-00	0.00E-00
	λ_{SU}	0.00E-00	0.00E-00	0.00E-00
Diagnostic coverage (DC)		60%	90%	90%
PFD @ PTI = 8760 Hrs. MTTR = 8 Hrs.		1.13E-04	5.62E-06	5.62E-06
Probability of Dangerous failure (High Demand - PFH) [h ⁻¹]		2.54E-08	1.27E-09	1.27E-09
Hardware safety integrity compliance		Route 1 _H	Route 1 _H	Route 1 _H
Systematic safety integrity compliance		SC3 – See report R80070273B		
Systematic Capability (SC1, SC2, SC3, SC4)		SC3 – See report R80070273B		
Hardware safety integrity achieved		SIL 2	SIL 3	SIL 3

To guarantee conformity to functional safety, the sensors must be used in a redundant architecture of at least two sensors. Depending on the overall safety requirements, several configurations are possible (1oo2, 2oo3, 2oo4, etc.).

The sensors themselves do not have integrated diagnostics. They safely deliver the tooth frequency to the overspeed protection system. The sensors can be used in either “low demand mode” or “high demand / continuous mode”.

Architectures shown are examples and could be

- single channel;
- dual channel;
- 1oo2, 1oo3, 2oo2 etc.

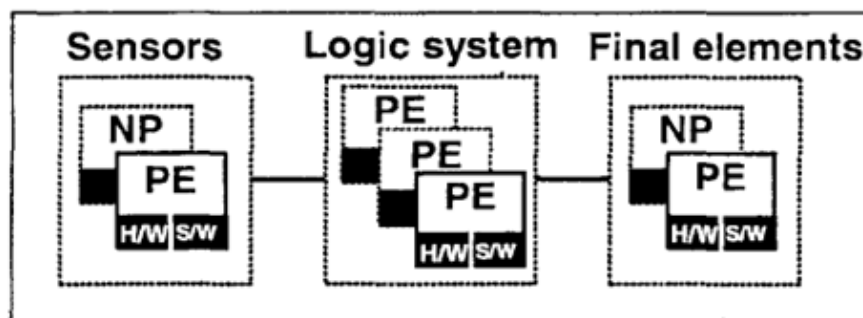


Figure 1: Basic Safety System Diagram

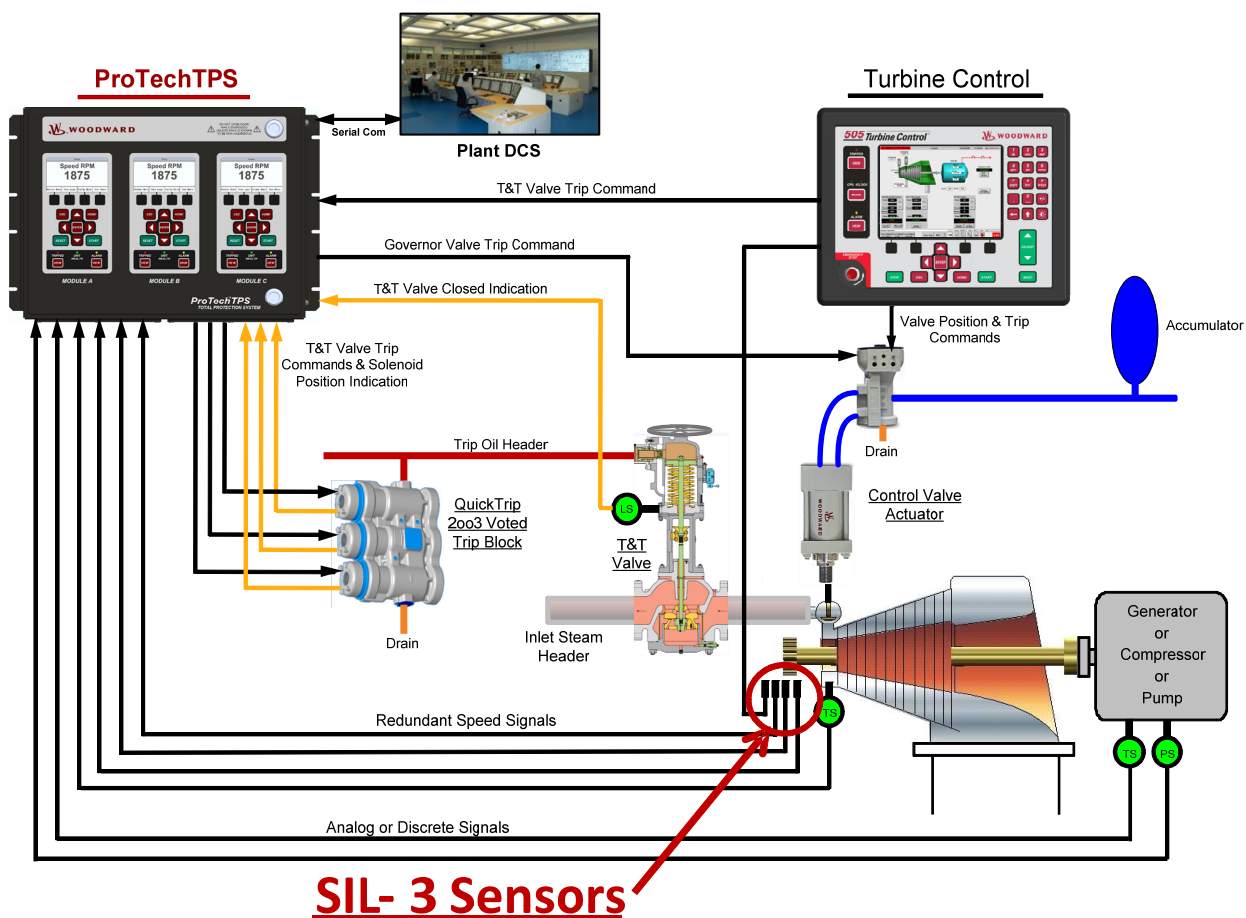


Figure 2: Basic Application Diagram

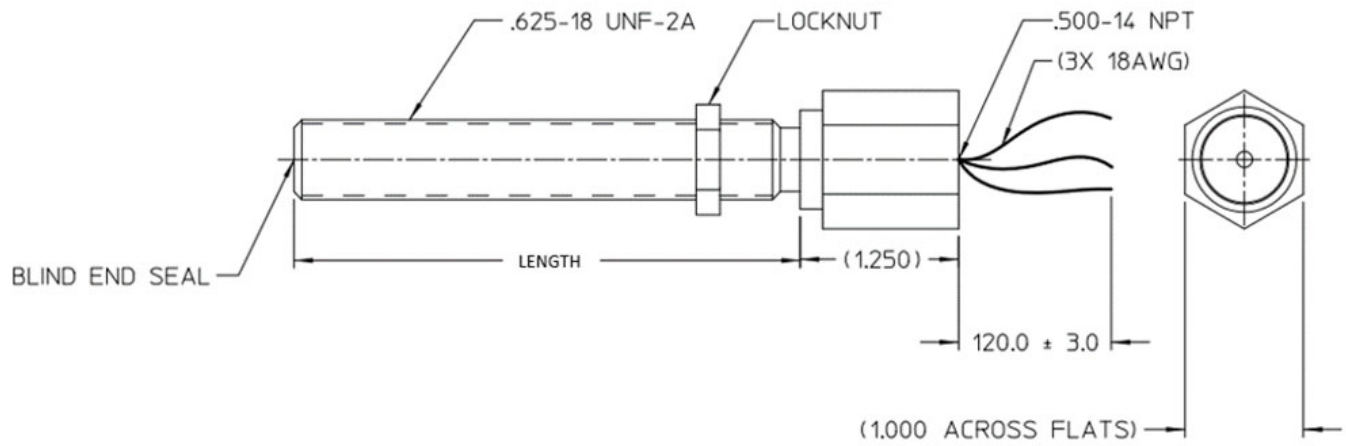


Figure 3: .625-18 Thread Units

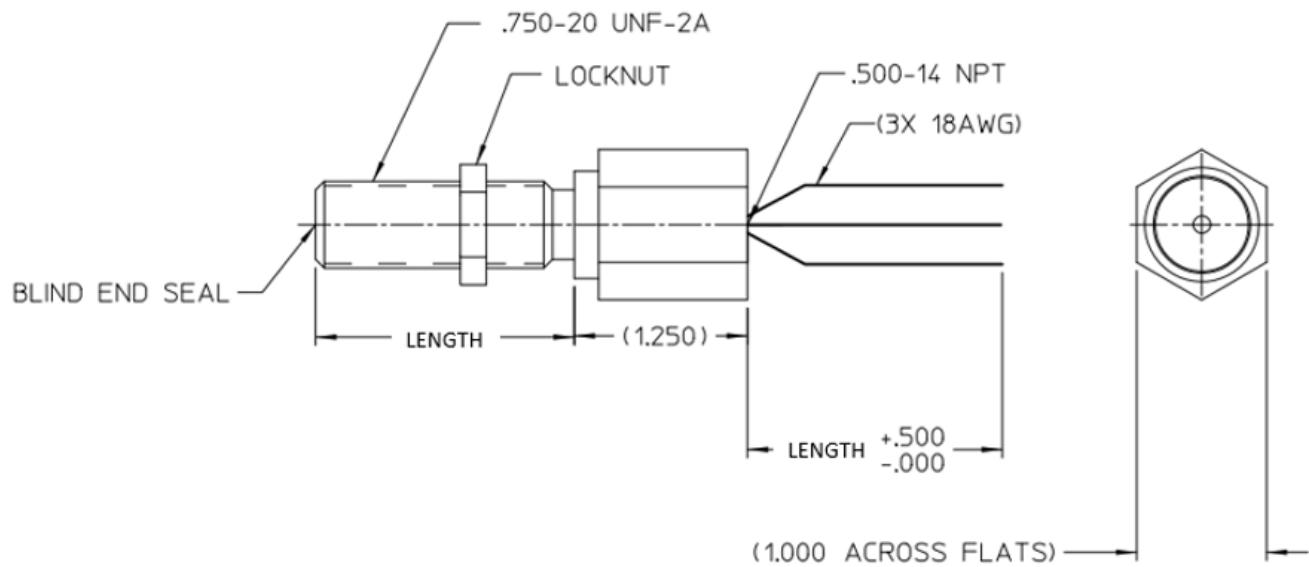


Figure 4: .750-20 Thread Units

Specifications

Temperature & Humidity

- Operating temperature range: –65 °C to +100 °C
- Storage temperature range of entire sensor: –65 °C to +105 °C
- Relative humidity in ambient atmosphere: 100% maximum, protection class IP65

Performance

- Output Voltage: 54V (p-P) minimum with .005" airgap, 8 pitch gear, 1000 ips surface speed, and 100K Ohms load.
- DC Resistance: 180 Ohms +/-10% at 25.6 C.
- Inductance: 60 mH with 6 VRMS at 1 KHz.
- HiPot: 1000V +/-15VRMS Minimum (lead wires to case).

Hazardous Location Listings– Certified and Marked For:

- North American Class 1 Div 1 Groups A, B, C & D
- IECEx, ATEX, and PESO India CCOE:
 - Ex db IIC T4 or 105°C Gb

Functional Safety

- CSA Certified per IEC 61508 for use in SIL-1 to SIL-3 systems.

PART NUMBER	DESCRIPTION
1680-2004.SIL	MAGNETIC, 0.750-20, 1.867 INCH, 10 FT CABLE, 54V, EXPLOSION PROOF, SIL-3
1680-2005.SIL	MAGNETIC, 0.625-18, 4.000 INCH, 10 FT CABLE, 54V, EXPLOSION PROOF, SIL-3
1680-2006.SIL	MAGNETIC, 0.625-18, 2.750 INCH, 10 FT CABLE, 54V, EXPLOSION PROOF, SIL-3
1680-2007.SIL	MAGNETIC, 0.625-18, 6.000 INCH, 10 FT CABLE, 54V, EXPLOSION PROOF, SIL-3
1680-2008.SIL	MAGNETIC, 0.625-18, 1.800 INCH, 10 FT CABLE, 54V, EXPLOSION PROOF, SIL-3
1680-2017.SIL	MAGNETIC, 0.750-20, 1.867 INCH, 27 FT CABLE, 54V, EXPLOSION PROOF, SIL-3

Figure 5: Sensor Ordering Information



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