SIL-3 Speed Sensors

for Turbine Applications

Applications

These speed sensors are designed for use in SIL-3, SIL-2, or SIL-1 (safety integrity level) rated turbine or engine 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.

As these variable reluctance (VR) speed sensors do not utilize active components, they have a very low failure rate, 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 MPUs (magnetic pickups) 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 sensor are a good choice in these systems because they are Type A devices (passive), take up less of the safety allocation, and have a lower PFD values than active speed sensors.

- Variable reluctance speed sensors
- No active components
- Rated for use in SIL-3 safety systems
- Low PFD & PFH values
- Low failure rates
- Compatible with Woodward ProTech® & MicroNet logic solvers
- Available with:
  - Imperial or metric threads
  - Different thread lengths
- Temperature Range = –40 °C to +150 °C

Description

These 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 imperial or metric threads and different thread lengths (determined by part number).

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 TÜV SÜD Product Service GmbH to be used in SIL-2 and SIL-3 applications according to IEC 61508. TÜV'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 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.

Generic Sensor Safety Parameters:

Diagnostic Coverage	94.0%
SFF	94.0%
Element Type	Type A
MTTR	72 h
Lifetime	10 years
Systematic Capability	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 any 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".

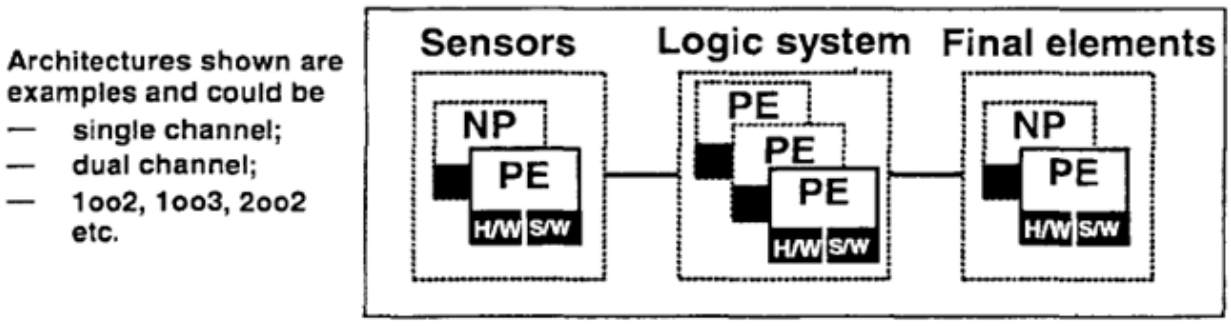

Figure 1. Basic Safety System Diagram

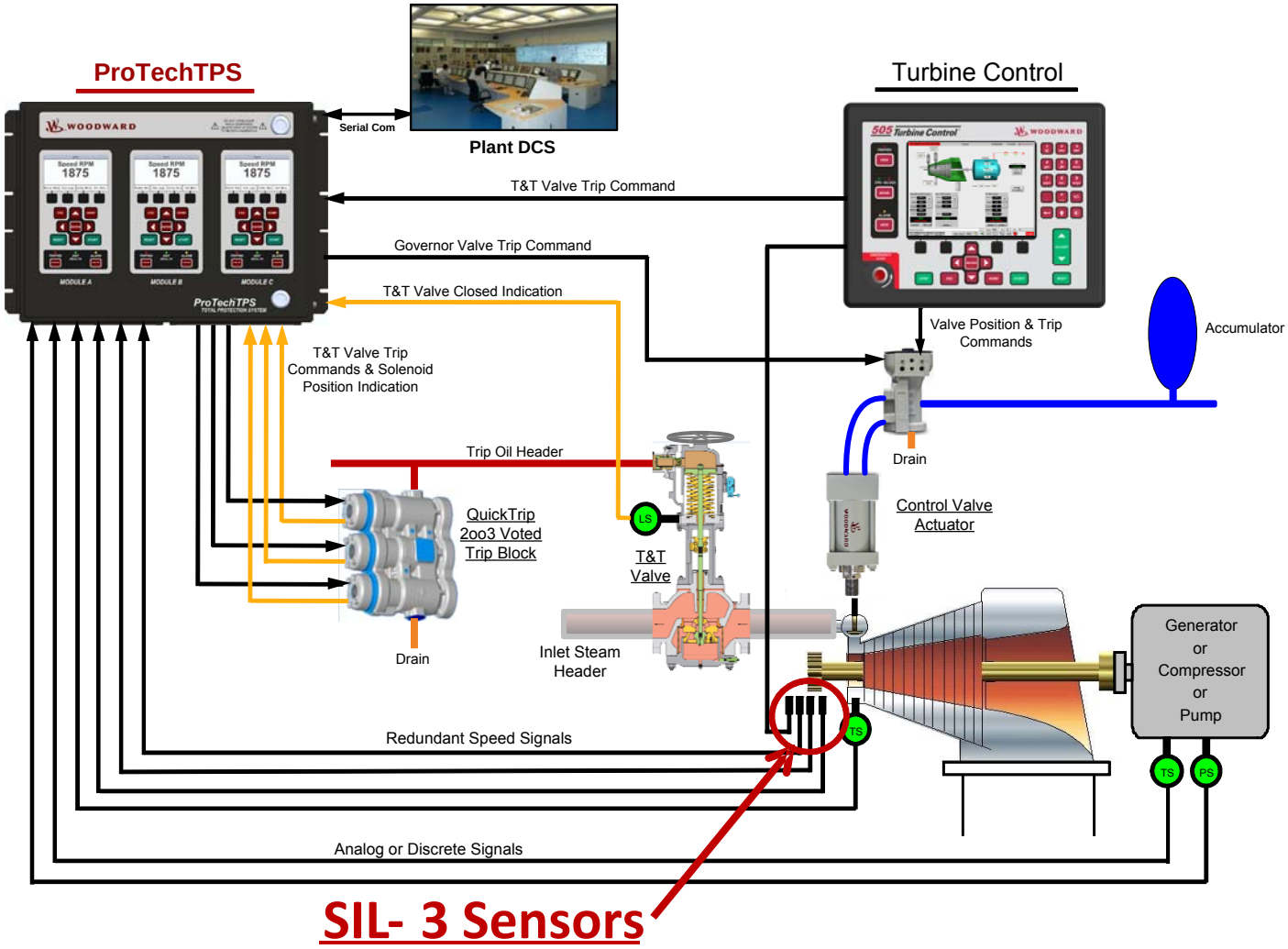

Figure 2. Basic Application Diagram

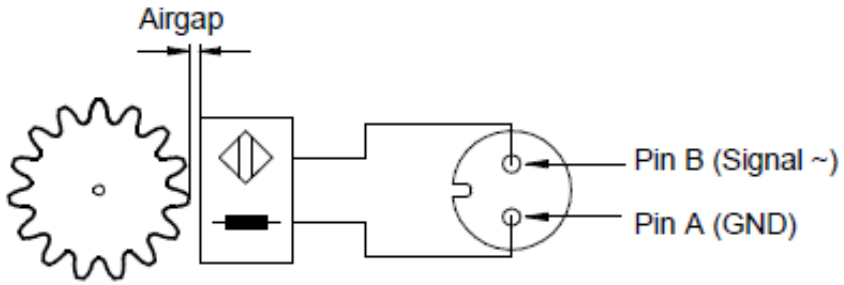

Figure 3. Schematic Diagram

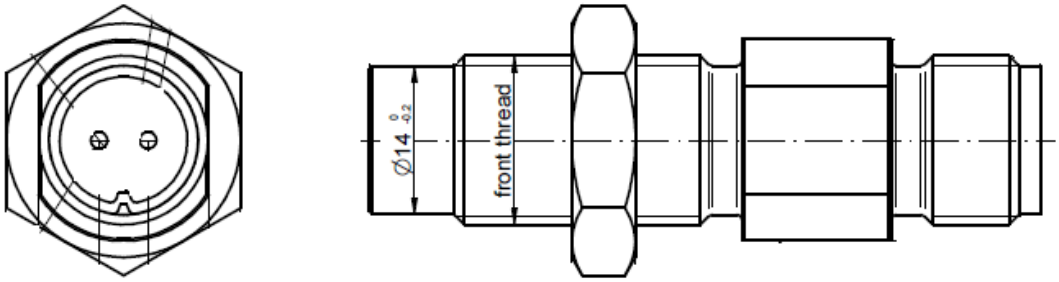

Figure 4. Outline Diagram

Specifications

Physical

Temperature & Humidity
Operating temperature range of entire sensor: –40 °C to +150 °C
Storage temperature range of entire sensor: –40 °C to +150 °C
Relative humidity in ambient atmosphere: 95% maximum

Vibration & Shock Immunity
These sensors have been validated for the following environmental conditions:
Sine sweep: ±0.35 mm in the range 5 to 57 Hz, 5G in the range of 57 to 2000 Hz, 1 oct/min, 10 cycles according to IEC 60068-2-6
Noise: 0.0125 g²/Hz in the range of 5 to 2000 Hz, 30 min/axis according to IEC 60068-2-64, 50 g for 11 ms, half sine wave, 3 shocks + and – for 3 axes, 18 shocks total according to IEC 60068-2-27

EMC
These sensors have been validated for the following EMC conditions. Tests have been performed with increased requirements for safety products with either a longer test time or a greater number of test impulses (according to IEC 61326-3-1).

Electrostatic discharge according to IEC 61000-4-2 and IEC 61326-3-1:
- Up to ±8 kV air discharge
- Up to ±6 kV contact discharge

Electrical fast transients/bursts according to IEC 61000-4-4 and IEC 61326-3-1 direct coupling:
- Up to ±2 kV peak, 5/50 ns, 5 kHz, 75 ms

Surges according to IEC 61000-4-5 and IEC 61326-3-1:
- ±2 kV 1.2/50 µs (line to ground)
- ±1 kV 1.2/50 µs (line to line)

Woodward Part Number	Thread Length (mm)	Thread Length (Inches)	Thread Type	Compatible Connector
1680-2028	35	1.4	5/8" 18 UNF 2A	1630-755
1680-2024	63.5	2.5	5/8" 18 UNF 2A	1630-755
1680-2030	101.6	4	5/8" 18 UNF 2A	1630-755
1680-2029	77	3	M16 x 1.5	1630-755

Figure 5. Sensor Order Information

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