

PROTECTING YOUR ASSETS

HIGH-PERFORMANCE SAFETY SYSTEMS
FOR TURBINES AND COMPRESSORS

Simple | Reliable | Safe | Precise | Proven

TURBOMACHINERY CONTROL EXPERTS
Turbines | Compressors | Safety | Actuation

 **WOODWARD**

IEC61508 SIL-3 CERTIFIED SYSTEMS



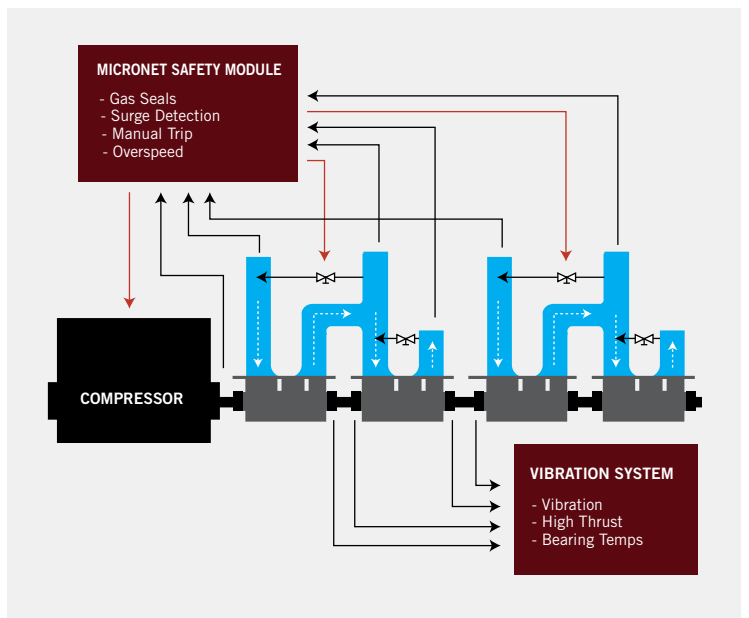
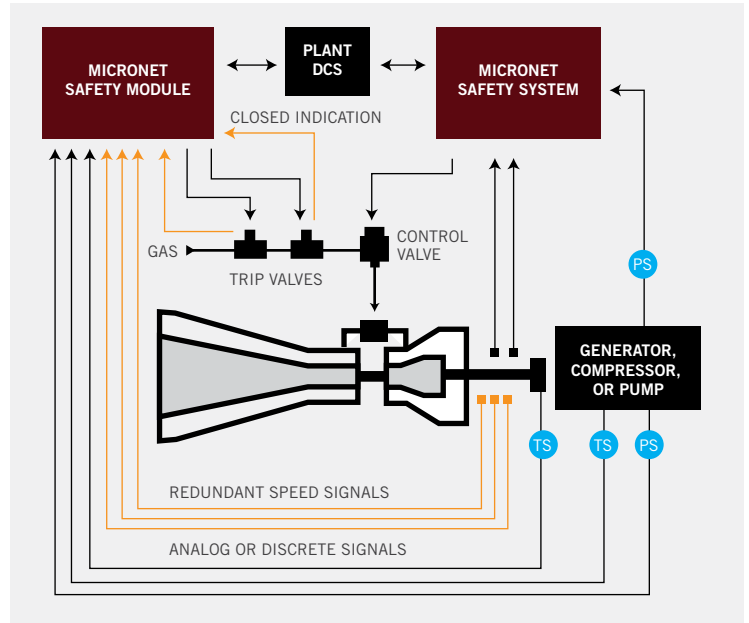
MICRONET-PLUS & TMR APPLICATIONS

In accordance with IEC 61508, TÜV Rheinland has approved Woodward's MicroNet platform to be integrated into SIL-3 based safety systems. The MicroNet platform can now be integrated as a safety PLC to create an IEC 61508 SIL-3 safety certified system. Both the MicroNet-Plus and MicroNet-TMR platforms have been assessed by TÜV for use as a safety control platform in a complete SIL-3 safety system (MPUs, controller, trip solenoids, trip valves, wiring, etc.).

The MicroNet controller platform is a state-of-the-art digital control platform designed to reliably control and protect steam turbines, gas turbines, and compressor trains used in system-critical applications where the chance of a safety issue or large economic losses may be possible.

The MicroNet Plus' dual redundant and the MicroNet TMR's 2-out-of-3 voted architecture ensures that correct decisions are made, correct responses are performed, and the prime mover continues to safely operate no matter the single point failure. The MicroNet TMR's superior architecture and diagnostic coverage combine to create a system with more than 99.99% availability and 99.999% reliability.

For IEC61508 SIL-3 based applications, a safety certified MicroNet Safety Module (MSM) is required as part of the MicroNet system. The MSM functions as the system's SIL-3 logic solver, and its fast (10 millisecond) response time and integrated overspeed and acceleration detection/protection functionality make it ideal for applications on critical high-speed rotating motors, compressor, turbines, or engines. For more information on the MicroNet Safety Module, refer to Woodward product spec 03375.



* **MicroNet Kitted Safety System**
TÜV Rheinland REF#: 968/EZ 929.00/13

* **ProTech GII, TPS and MSM Safety System**
TÜV Rheinland REF#: 968/EZ 307.01/10

HIGH-PERFORMANCE SOLUTIONS

DURING THE BLINK OF AN EYE

Woodward turbine safety systems precisely and reliably scan rotor speed and other key turbine operating parameters over 40 times per second. Low rotor inertias of smaller steam turbines pose controlling problems for general-purpose PLCs (programmable logic controllers). However, the deterministic behavior and fast scan rates of Woodward safety logic solvers were designed in collaboration with turbine manufacturers to ensure the fast response times required to shut down large, medium, and small turbines, quickly and safely.

DECADES OF EXPERIENCE IN EVERY SAFETY MODULE

Sensing turbine speed for the purpose of very quickly and accurately sensing a turbine overspeed condition is a challenge for any safety PLC or overspeed detection device. Issues like tooth-to-tooth variances in the speed gear, rotor run-out, the number and size of gear teeth variances, speed-gear tooth profile differences, and induced electrical noise from other plant sources challenge even the best speed sensing circuit.

Woodward uses its 140+ years of turbine control and speed sensing experience to create speed sensing circuits that quickly sense turbine speed changes and accurately filter out all of the related variances and signal noise to accurately sense the turbine rotor's true speed.

SAFETY SYSTEMS MATCHED TO YOUR APPLICATION

From the simplex to the triple-modular-redundant, Woodward has the safety system to meet your asset protection requirements.



* ProTech®-SX

SIL-2

Turbomachinery Safety Logic Solver

- 2 redundant speed inputs
- 7 analog/discrete inputs
- Overspeed and over acceleration protection
- Custom programming
- Trip valve response monitor



* ProTech®-GII

SIL-3

Steam or Gas Turbine Overspeed Device

- Accepts 3, 2, or 1 speed inputs
- Overspeed and over-acceleration protection
- Field configurable
- 2-o-o-3 voted or independent output models



* ProTech®TPS
* MicroNet® Safety Module

SIL-3

Turbomachinery Logic Solver

- Accepts 3, 2, or 1 speed inputs
- 30 analog/discrete inputs
- 15 relay outputs
- 2-o-o-3 voted or independent output models
- Overspeed and over-acceleration protection
- Custom programming
- Trip valve response monitor
- 1 millisecond time synchronization (MicroNet)



* MicroNet®Plus
* MicroNet® Safety Module

SIL-3

Turbomachinery Logic Solver

- Accepts 3, 2, or 1 speed inputs
- 100+ analog/discrete inputs
- 100+ relay outputs
- 2-o-o-3 voted or independent output models
- Overspeed and over-acceleration protection
- Custom programming
- Trip valve response monitor
- 1 millisecond time synchronization

PROTECTION BEYOND OVERSPEED

Although overspeed protection is a key function of any turbomachinery safety system, advancements in computing technology allow Woodward safety systems to detect and even anticipate many different types of unsafe operating conditions and safely shut down the turbine, avoiding costly catastrophic failures and people being hurt or killed. Leveraging high-end processors and field proven algorithms, Woodward's line of turbine safety systems can function as the logic solver for all related safety instrumented functions (SIFs).

Safety instrumented functions include:

- ➔ Turbine overspeed
- ➔ Turbine over-acceleration
- ➔ Anti-surge control failure (compressor only)
- ➔ Lost lube/control oil
- ➔ Enclosure fire
- ➔ Combustor flame-out (gas turbine only)
- ➔ Turbine control failure
- ➔ Lost gland seal steam
- ➔ Stuck/slow shutdown valve



DIAGNOSTIC COVERAGE WITH QUICKTRIP BLOCK ASSEMBLIES

Equipment safety standards require a high level of diagnostic coverage to verify the operational integrity of a safety system. One method of assuring that this coverage meets the required safety integrity level for the respective safety instrumented function is to routinely test and verify operation of different components within the safety system.

Diagnostic tests can be difficult to perform on safety system components the turbomachinery is operating, without compromising the safety of the machine or reducing the integrity of the safety system. For this reason, in conjunction with steam turbine OEMs, Woodward created its "QuickTrip" trip block assembly.

The QuickTrip trip bloc assembly is designed for use in steam turbine shutdown systems for quick and reliable dumping of the turbine's trip oil header. This integrated trip block assembly is intended for use on mechanical-drive or generator-drive steam turbines that use low-pressure (5-25 bar / 73-363 psi) hydraulic trip oil headers.

The QuickTrip bloc's fault-tolerant design makes it ideal for critical steam turbine applications where turbine up-time and availability are essential. This trip block assembly's 2-out-of-3 voting design provides users with a very high level of system reliability as well as compliance with industry standard API-670.

TRIP VALVE HEALTH MONITORING

The reliability of shutdown components is of critical importance to ensure equipment, plant, and personnel safety and health. Just as important is how fast these shutdown components function in an emergency situation. In situations where a turbine is operating at its full-load position and receiving 100% input energy, it is imperative when immediate loss-of-load conditions occur that the entire shutdown system responds quickly enough to shut off the input energy source and safely shutdown the turbine.

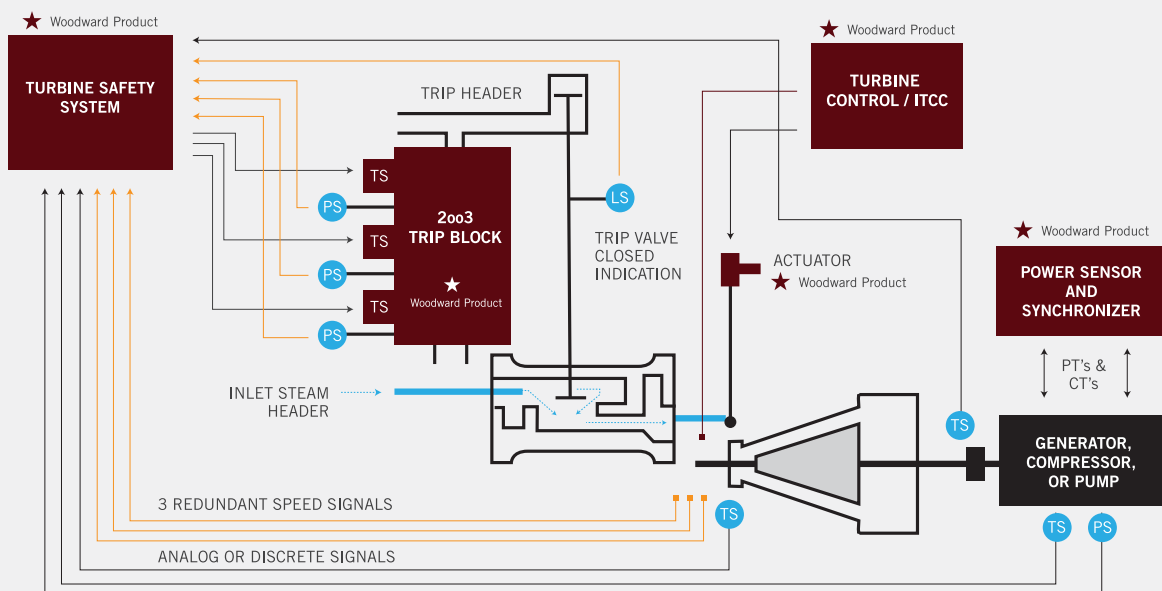
For this reason American Petroleum Institute's standard API670 5th Edition now requires the following in Section #8: "If specified, the machine vendor or responsible party shall verify that the response time of the entire overspeed detection

system including final control elements is fast enough to prevent the prime mover and any of its driven machines from exceeding their maximum allowable speeds."

To enable turbine users and operators to meet this new standard, Woodward's turbine safety systems encompass functions to measure and record the time it takes to sense a shutdown condition (overspeed or other) to the time it takes for the final element (trip valve) to shut off the input energy source. This response-time-based function records the response of the system on a 1 millisecond basis and issues an alarm if any component of the shutdown circuit takes too long to operate, allowing plant personnel to correct the problem before it is too late.



* Throttle Trip Valve



GLOBAL SUPPORT

Woodward's global support network and our turbomachinery OEM partners provide an extensive range of technical and after-sales support services. This global presence allows us to respond quickly to the needs of our customers anywhere in the world. In today's complex control world, customers have come to recognize our people's expertise beyond the control system and depend on our global teams as critical plant support assets.

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CONTENT

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