5009FT Fault-Tolerant Control

Description

The 5009FT is a standard-off-the-shelf steam turbine control for use on industrial steam turbines used in critical compressor or generator drive applications. This controller is comprised of Woodward's field-proven MicroNet TMR® hardware platform and standard steam turbine software algorithms, and is designed for use in standard OEM turbine packages or by system integrators in turbine upgrade projects.

The 5009FT's fault-tolerant design allows it to operate with any single point of failure without shutting down the turbine, and its TMR (triple modular redundant) design and hot-swap module capability, allows users to easily make system repairs while the turbine set is online and operating normally.

This control's special PID-to-PID logic allows stable control during normal turbine operation and bumpless control mode transfers during plant upsets, minimizing process over- or undershoot conditions. The 5009FT controller senses turbine speed via passive or active speed probes and controls the steam turbine through actuators connected to the turbine inlet steam valves.

This field programmable controller allows users to easily make system configuration changes without the need of an OEM expert. System configuration, calibration, and dynamic tuning changes are made via an integrated engineering workstation. This station also functions as a limited operator control panel, allowing operators to start/stop the turbine, enable/disable all control modes, and view/reset system alarms. Multiple password security levels are available to provide different plant personnel with access to the different levels of the 5009FT's configurations/ adjustments depending on site requirements.

The 5009FT can be purchased separately as a kit or mounted in a free-standing cabinet with an integral engineering workstation, and ready for field termination. The 5009FT can be configured to operate as a stand-alone unit or in conjunction with a plant's Distributed Control System, depending upon the site's requirement.

Optionally (part number dependent), the 5009FT can be purchased with Woodward's integrated compressor control algorithms for compressor sets with 1 or 2 loops (1 or 2 re-cycle valves). This option includes additional I/O modules and Woodward's OEM-qualified 1-& 2-loop compressor control algorithms

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- IEC61508 SIL-3 Certified (Requires MSM)
- Triple modular redundant
- API612 Compliant
- Field-proven controller
- On-line configurable
- On-line repairable
- Integrated engineering workstation
- First-out problem indication
- Fault-tolerant power supplies
- Ethernet communications
- Time-stamped alarms & faults
- Integrated overspeed protection
- Integrated compressor control (optional)
- One millisecond time-stamping

Applications

The 5009FT is designed to control industrial steam turbines of all sizes and types in system-critical applications requiring maximum reliability and availability. This steam turbine controller includes specifically designed algorithms and logic to start, stop, control, and protect industrial steam turbines or turbo-expanders, driving compressors, generators, or pumps.

Designed for today's plant standardization practices, the 5009FT control system's versatile program can be configured to control single valve, or single extraction, or single admission, or single extraction/ admission steam turbines. The 5009FT control's unique PID structure makes it ideal for petrochemical or power generation applications where it is required to control steam plant parameters like compressor speed, generator frequency, turbine load, turbine inlet or exhaust header pressures, or tie-line power.

The 5009FT control's TMR (triple modular redundant) architecture, TMR CPU and I/O modules, on-line configuration, and on-line repair capability make it ideal for use in safety or economically critical applications. This control's fault tolerant design allows it to accept redundant inputs sensors, drive redundant actuators, and interface with redundant operator interface stations, making it capable of extending redundancy throughout the entire turbine package.

For applications requiring multiple human-machine-interfaces (HMIs), users can optionally purchase Woodward's 5009FT OpView™ HMI. This OpView HMI, is comprised of a 17" (43 cm) touchscreen computer panel and purpose-built HMI software program, and has been designed and tested with the 5009FT controller ensuring full compatibility.

For IEC61508 SIL-3 based applications, a safety certified MicroNet Safety Module (MSM) is required as part of the 5009FT MicroNet TMR based system. The MSM functions as the system's SIL-3 logic solver, and its fast (12 millisecond) response time and integrated overspeed and acceleration detection/protection functionality make it ideal for applications on critical turbines. For more information on the MicroNet Safety Module, refer to Woodward product spec 03375.

Triplex Architecture Advantages

- 2-out-of-3 voting provides accurate signal selection, ensuring that bad input signals are not used.
- 2-out-of-3 voting increases system fault coverage close to 100%, which provides an availability of 99.998%.
- CPU failures are accurately detected, and related calculations removed, without affecting system safety.
- Output relay failures can be detected and repaired with the turbine set operating on-line.

Functionality

5009FT control functional capabilities:
- Speed/frequency control
- Turbine or generator load control/limiting
- Extraction and/or admission header pressure control
- Compressor control (optional add-on)
  - o 1 or 2 loop
  - o Anti-surge protection
  - o Performance control
- Turbine inlet header pressure control/limiting
- Turbine exhaust header pressure control/limiting
- Plant import/export power control/limiting
- Isochronous load sharing between units (with EGCP-3 controls)
- Any process directly related to unit load
- Proportional or integrating Servo Position Control with LVDT/RVDT excitation (part number dependent)

Features

- Fault-tolerant I/O handling and processing
- Latent fault detection on relay outputs
- Time-stamped alarms and trips
- Discrete input time-stamp with 1 ms resolution
- Analog input time-stamp with 5 ms resolution
- Extensive fault detection and annunciation—including first-out indication
- Critical speed avoidance (3 speed bands)
- Auto start sequence (hot & cold starts)
- Three sensors per critical parameter can be configured
- Dual speed/load dynamics
- Zero speed detection with proximity probe down to 0.5 Hz
- Peak speed indication for overspeed trip
- Automatic hand valve operation (using first stage pressure)
- Independent Modbus® * communication links
- Remote analog setpoints for all PIDs
- CCT (Configuration & Commissioning Tool)—17" (43 cm) touchscreen engineering workstation for configuration, service, and turbine operation.

*—Modbus is a trademark of Schneider Automation Inc.

Control Specifications

Inputs

Power	Redundant power supplies with the following input options: 18–32 Vdc, 100–150 Vdc, 88–132 Vac (47–63 Hz), 180–264 Vac (47–63 Hz), 200–300 Vdc
Speed	4 MPUs (1–30 Vrms) or proximity probes (24 Vdc and 12 Vdc power provided), 0.5 to 25 kHz
Discrete Inputs	24 contact inputs 24 V (CE or UL) or 125 Vdc (UL only) (1 dedicated, 23 programmable)
Analog Inputs	8 programmable 4–20 mA inputs (32 inputs with compressor control option)

Outputs

Valve/Actuator Drivers	2 single-coil (proportional) or 2 dual-coil actuator outputs (4–20 mA or 20–160 mA), Optional—2 integrating ±200 mA max integrating actuator outputs with 2 LVDT or RVDT or 1–5 V or 4–20 mA position feedback inputs
Discrete Outputs	12 relay outputs with latent fault detection (1 dedicated, 11 programmable)
Analog Outputs	4 programmable 4–20 mA outputs (12 outputs with compressor control option)

Communication

Ethernet	6 10/100BaseT Ports (Modbus TCP or UDP & Service Tool communication)
Serial	3 Modbus (ASCII or RTU) communication ports (RS-232, 242, 285 compatible)

Operating Conditions

Temperature	5009FT Cabinet System: 0 - 40° C (32 - 104° F) surrounding air temperature.
	5009FT Components purchase as a kit: 0 - 55° C (32 - 131° F) surrounding air temperature.
Emissions	EN61000-6-4
Immunity	EN61000-6-2

Regulatory Compliance

(Listings are limited only to those units bearing the appropriate Marking or Agency Identification)

European Compliance for CE Marking:	EMC Directive: 2014/30/EU
	Low Voltage Directive: 2014/35/EU
North American Compliance:	CSA Certified for Ordinary Locations in the United States and Canada per CSA Certificate 2291171.

5009FT Chassis
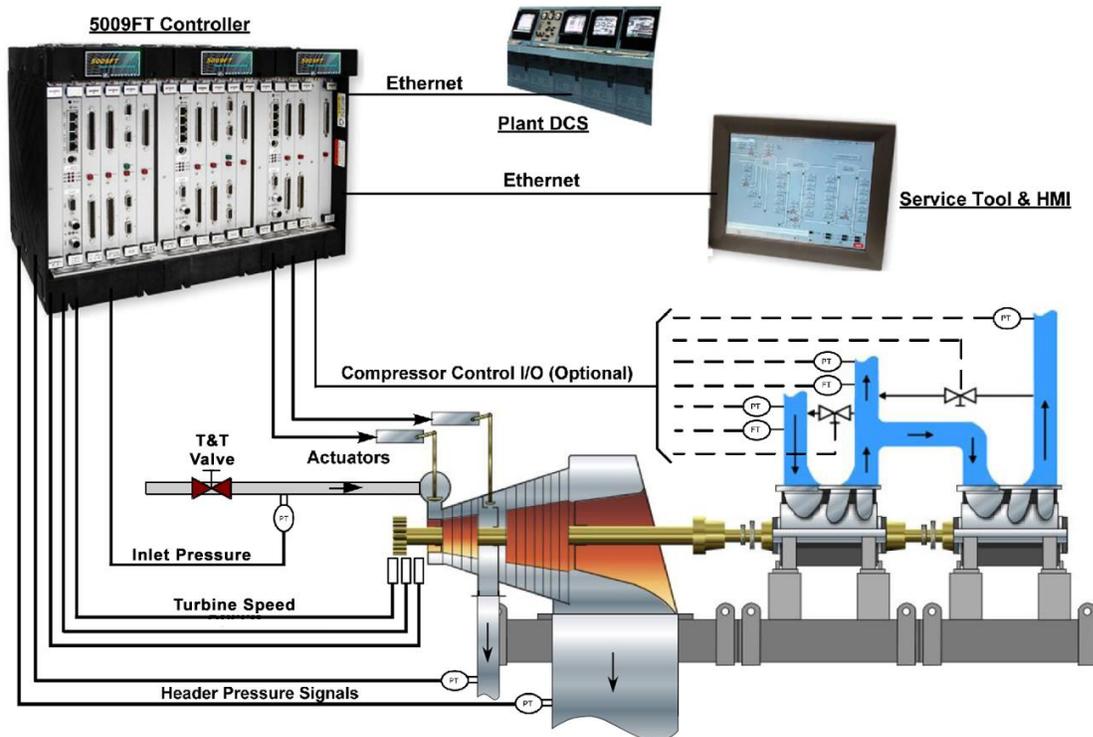
Bulkhead or Adaptable to 19" (483 mm) rack-mount back panel with 18 slot VME motherboard and chassis
Approximate dimensions:

Control Chassis	19" wide x 14" high x 12" deep (483 mm wide x 356 mm high x 305 mm deep)
Power Chassis	7" wide x 14" high x 12" deep (178 mm wide x 356 mm high x 305 mm deep)
Approximate Weight	56 lb (25 kg) fully loaded
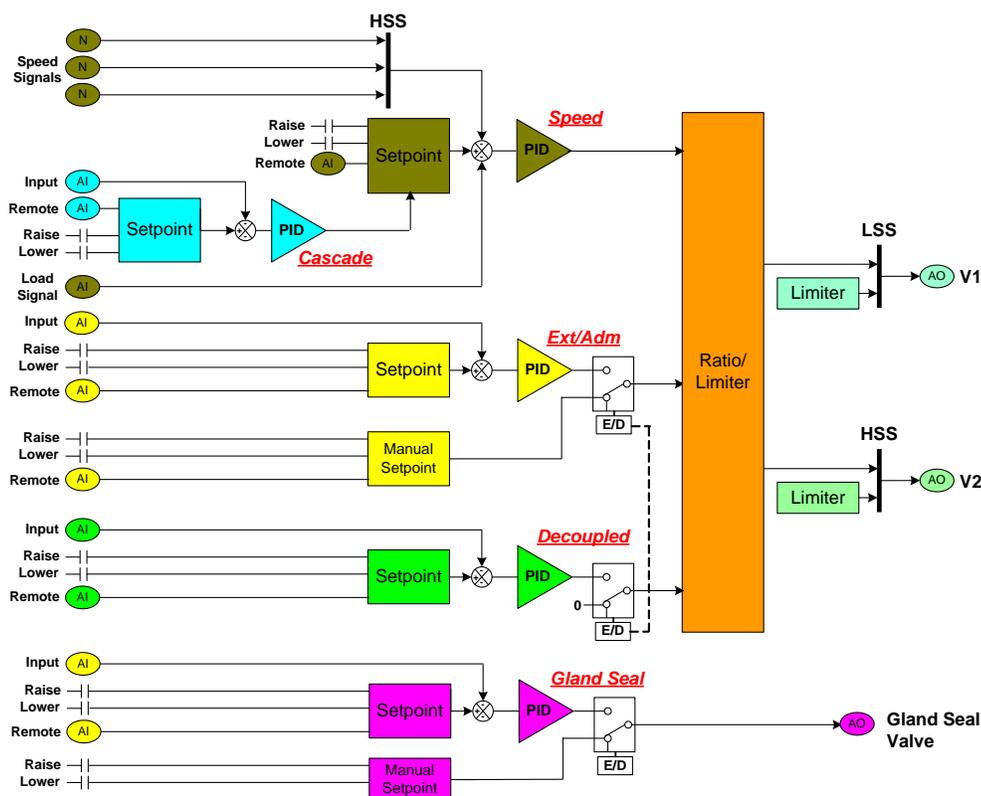
Typical 5009FT Functional Diagram

Typical 5009FT Application Diagram

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