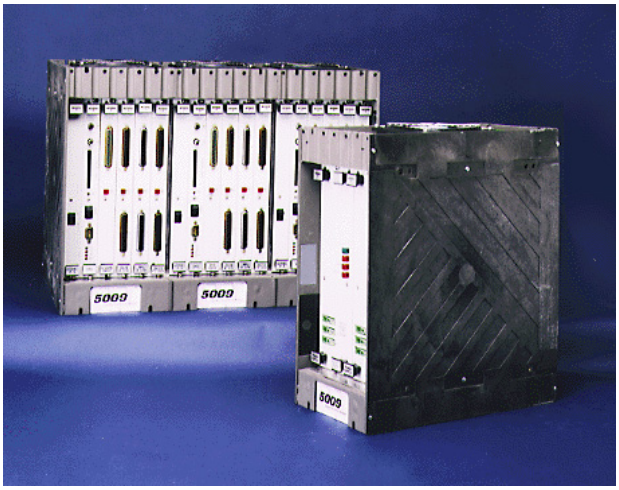
5009

Fault-Tolerant Control

Applications



The 5009 fault-tolerant control is designed to provide highly reliable control on critical steam turbine applications. It can be configured to control condensing, back pressure, and single automatic extraction/ admission turbines. The 5009 control features fully triple redundant CPU and I/O (TMR) to meet the reliability needs of the industrial turbine control market. The 5009 is field programmable and uses Windows menu-driven software to guide site engineers through configuring the control to a specific generator or mechanical drive application. The 5009 can be purchased separately or mounted in a free-standing cabinet with an integral HMI ready for field termination. The 5009 can be configured to operate as a stand-alone unit or in conjunction with a plant's Distributed Control System.

Optional 5009-C Model
The 5009-C controller is designed for compressor drive applications only and includes the following capabilities:

- Extraction or non-extraction unit control
- Includes inlet header & speed control de-coupling mode
- Proportional or integrating servo position control (includes LVDT/ RVDT excitation)
- Boiler/extraction pressure variation compensation
- Dual servo position loop control (pilot position + cylinder position)

NOTE: Generator management and load control functionality are not included with this model.

Fault-Tolerant Design

Woodward's 5009 digital control uses a 32-bit microprocessor to control industrial steam turbines, small utility turbo-generators, or turboexpanders. The 5009 consists of three isolated kernel sections. Each section includes its own power supply, CPU, and I/O modules.

The kernel sections individually monitor all input data, perform all application calculations, and generate all output values and responses. The responses are then assessed within the 2-out-of-3 voting logic. With this configuration, any fault or number of faults associated with a kernel can be tolerated without affecting system operation.

The triplex architecture provides following advantages:

- 2-out-of-3 voting provides superior fault detection of all I/O, hardware, and control algorithms.
- Reliability is vastly improved by extending fault coverage close to 100%, which provides an availability of 99.998% with a MTTR of 4 hours.
- The OEM is offered greater flexibility for implementing a variety of fault-tolerant configurations.
- Kernel faults can be isolated without loss of I/O redundancy.

The 5009 also performs as a First-Out indicator for system shutdowns, thus reducing troubleshooting time. Multiple external system shutdowns (10) can be brought into the 5009 to allow it to shut down the system safely, latch-in the cause of the shutdown, and time-stamp the event to a 1-millisecond resolution.

- No single point of failure
- Full TMR design (triple modular redundancy)
- Fault-tolerant power supplies
- Fault-tolerant relays (latent fault detection)
- Field-configurable standard software
- Windows compatible
- Microsoft Dynamic Data Exchange (DDE)
- Real time multitasking operating system
- Time-stamped I/O (not available with 5009-C)
- CE Marked
- UL/cUL Listed Class I, Division 2 (FT relay module and OpView™ monitor are UL/cUL Listed for Ordinary Locations)

The 5009 includes two power supplies, each of which powers the control from a separate power source. Inside each power supply are three independent power converters, one for each CPU/IO section. Because the CPUs have separate, dedicated power supplies and power busses, any single fault in the power system affects at most one CPU. The triple redundant power architecture provides maximum protection against hardware failures.

Communications

The 5009 control can communicate directly with plant Distributed Control Systems and/or CRT based operator control panels, through two Modbus® * communication ports. These ports support RS-232 communications using ASCII or RTU Modbus transmission protocols.

Communications between the 5009 and a plant DCS can also be performed through hardwired connections. Since all 5009 PID setpoints can be controlled through analog input signals, interface resolution and control is not sacrificed.

*—Modbus is a trademark of Schneider Automation Inc.

Flexibility

The 5009 is field programmable, allowing site engineers to configure the control to their specific application and make future control configuration changes. The 5009 can be field programmed for mechanical drive or generator applications. Over 100 on-line program adjustments are available to allow program refinements while a unit is running. Inputs and outputs are programmable as required by the application or interface.

System Protection

- Integral overspeed protection logic
- First-out indication (individual shutdown inputs)
- Bumpless transfer between control modes if a transducer failure is detected
- Local/remote control priority and selection
- Failsafe shutdown logic
- Password protection security

Control

The following PIDs are available to perform as process controllers or limiters:

- Speed/Load PID (with Dual Dynamics)
- Auxiliary PID (limiter or control)
- Cascade PID
- Extraction and/or Admission PID
- Valve Control PID (part number dependent)

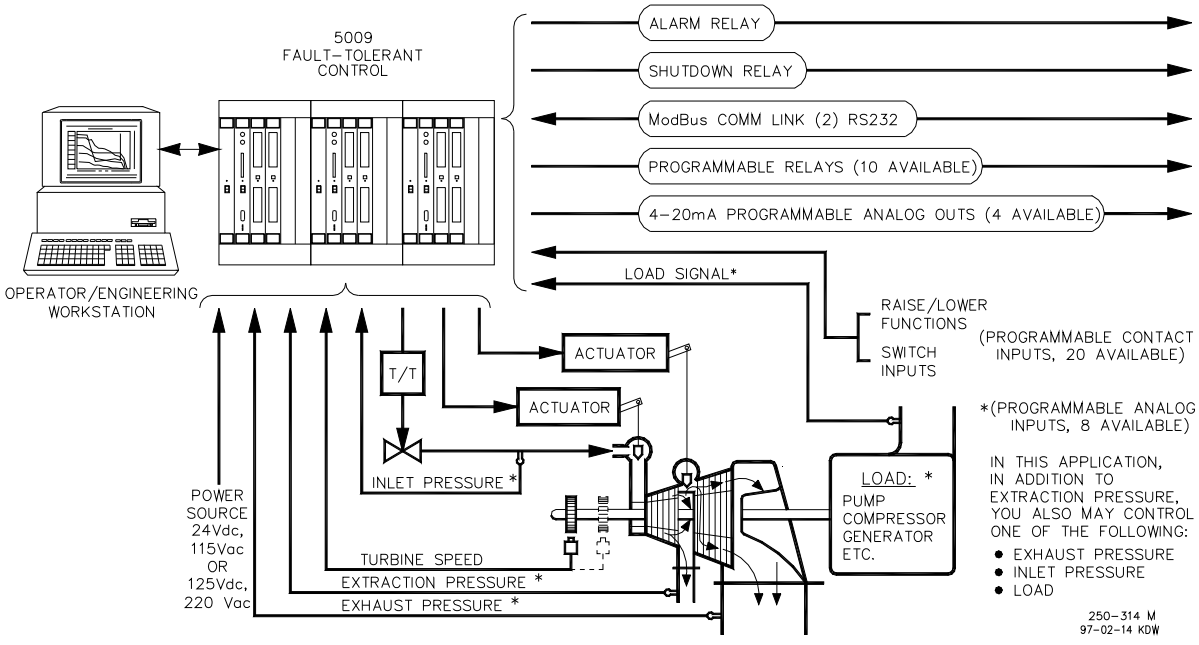
Microsoft DDE Compliance

The 5009 comes with a Windows DDE (Dynamic Data Exchange) server program. When this server is active, Microsoft programs which support DDE (Excel, Word, Access, etc.) can be used to display live data from the 5009 inside their own documents.

Functionality

5009 control capabilities are:

- Speed/frequency control
- Turbine or generator load control/limiting
- Turbine inlet header pressure control/limiting
- Turbine exhaust header pressure control/limiting
- Plant import/export power control/limiting
- Isochronous load sharing between units (with DSLC™ Digital Synchronizer and Load Control)
- Extraction and/or admission header pressure control
- Any process directly related to unit load



Controlled Extraction Steam Turbine

Features

- Fault-tolerant I/O handling and processing
- Latent fault detection on relay outputs
- Ten time-stamped external alarms and trips
- Discrete input time-stamp with 1 ms resolution
- Analog input time-stamp with 5 ms resolution
- Extensive fault detection and annunciation
- Critical speed avoidance (2 speed bands)
- Auto start sequence (hot & cold starts)
- Three sensors per critical parameter can be configured
- Dual speed/load dynamics
- First-out indication (shutdowns)
- 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 comm links
- Remote analog setpoints for Speed/Load, Auxiliary, cascade, and extraction/admission PIDs
- Windows program for monitoring and adjusting control parameters
- Proportional or integrating Servo Position Control with LVDT/RVDT excitation (part number dependent)

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) (4 dedicated, 20 programmable)
Analog Inputs	8 programmable 4–20 mA inputs

OUTPUTS

Valve/Actuator Drivers	2 single-coil (proportional) or dual-coil actuator outputs (4–20 mA or 20–160 mA), or 2 integrating actuator outputs (±250 mA max.; part number dependent)
Discrete Outputs	12 relay outputs with latent fault detection (2 dedicated, 10 programmable)
Analog Outputs	4 programmable current outputs (4–20 mA)
Servo Positioner	2 LVDT or RVDT or 1–5 V or 4–20 mA inputs (part number dependent)

COMMUNICATION

Serial	2 Modbus (ASCII or RTU) comm ports (RS-232 compatible)
Serial	1 PC port for programming, on-line adjustments, system monitoring and troubleshooting

OPERATING CONDITIONS

Temperature	0 to +55 °C non-enclosed 0 to +45 °C cabinet enclosure 0 to +35 °C cabinet enclosure with OpView™ monitor
Shock	US MIL-STD-810C, Method 516.2-1, Procedure 1B
Vibration	Lloyd's ENV2 test #1

REGULATORY COMPLIANCE

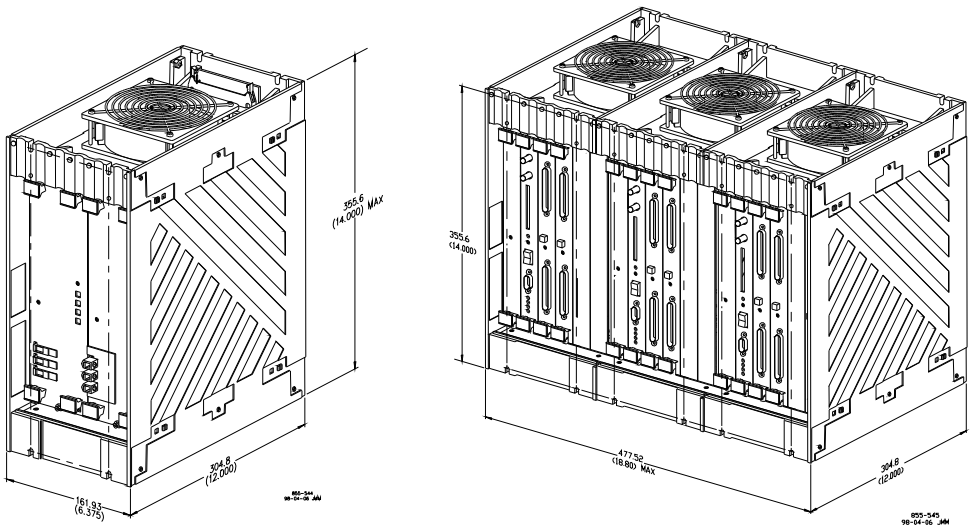
European Compliance for CE Mark:	EMC Directive and Low Voltage Directive
North American Compliance:	UL Listed for Class I, Division 2, Groups A, B, C, D (FT relay module and OpView monitor are UL/cUL Listed for Ordinary Locations)

5009 CHASSIS

Bulkhead or Adaptable to 19" (483 mm) rack mount back panel with 18 slot VME motherboard and chassis

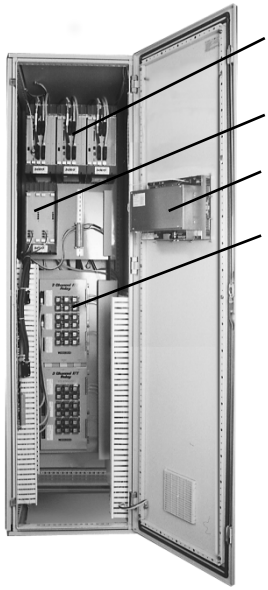
Approximate dimensions:

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 lbs (25 kg) fully loaded



Power Chassis and Control Chassis

5009 Installed in Optional Cabinet



Not shown: optional rolling restart station and 19” rack mount adapter kit

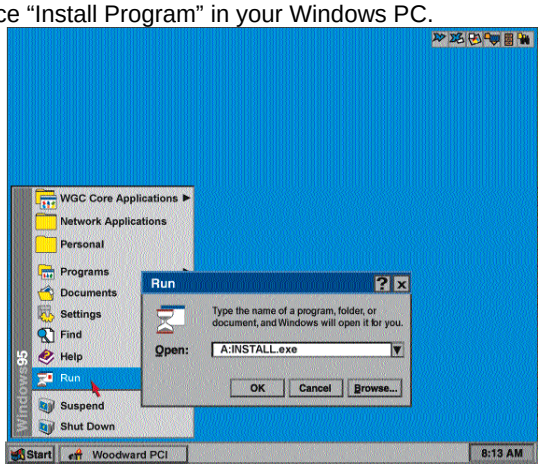
5009 Available Options

(Any or all options may be selected)

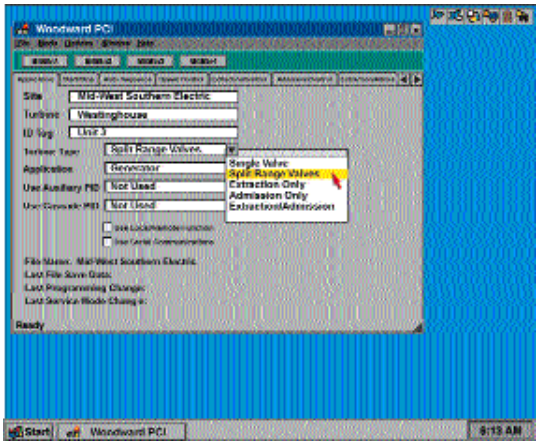
- Standard cabinet (NEMA 12, ~24x87x32”, ~610x2210x813 mm)
- Standard HMI with self-generating graphics
- 19” (~483 mm) rack mount adapter kit

Programming is easy:

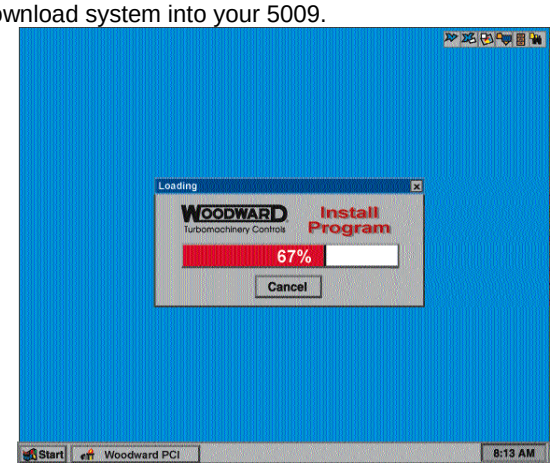
1–Place “Install Program” in your Windows PC.



2–Configure system through user-friendly “Install Program” and drop-down windows.



3–Download system into your 5009.



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Distributors & Service

Woodward has an international network of distributors and service facilities. For your nearest representative, call the Fort Collins plant or see the Worldwide Directory on our website.

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