

505CC-2

Steam Turbine and Compressor Control



Applications

The 505CC-2 digital controller is designed to control compressors, steam turbines, or steam turbine compressor sets. The 505CC-2's algorithms are designed for application on single valve or single extraction steam turbines, and or one- or two-loop compressor sets. This control's configurability allows it to control motor-driven compressors or turbine-driven compressor sets. This controller uses OEM-qualified control and protection logic, ensuring that turbine and compressor sets are controlled and protected per the OEM's specification. Control strategies for straight-through, iso-cooled, double flow, single sidestream, and back-to-back compressor scenarios are also fully configurable to meet specific site requirements.

The 505CC-2 includes the following PID (Proportional/Integral/ Derivative) closed loop and non-PID open loop functions:

Turbine

- Speed PID Control (with Dual Dynamics)
- Extraction/Admission PID Control
- Ratio & Limiter
- HP & LP Valve Limiters
- Manual/Semi-Auto/Automatic Start Sequence
- Overspeed Test
- Critical Speed Avoidance
- Alarm & Shutdown Logic

Compressor

- Anti-Surge PID Control
- Rate PID Control
- Boost (open-loop backup line response)
- Surge Recovery
- Surge Minimum Position
- Start, Purge, Stop, Shutdown, & Zero Speed Sequencing Positions
- Alarm & Shutdown Logic

Alternatively, the following functions can be configured, depending on the application requirements:

Turbine

- Inlet Pressure PID Control
- Exhaust Pressure PID Control
- Cascade PID Control

Compressor

- Performance Control (Compressor Suction or Discharge Pressure, Flow, or external 4–20 mA signal)

- Integrated control
 - ✓ One- or two-valve steam turbine
 - ✓ One- or two-loop compressor
 - ✓ Superior performance
- Field-proven anti-surge algorithms
- Based on popular 505 Steam Turbine Control
 - ✓ Field-configurable
 - ✓ Change dynamics while online
 - ✓ View turbine and compressor parameters
- Includes user-friendly configuration program
- Optional 381 mm (15") HMI
- OEM Qualified Decoupling Algorithms
- API 612 Compliant

Description

The 505CC-2 digital controller is designed to control and protect steam turbines and or compressors. This controller can be factory- or field-configured to control a steam turbine only, a compressor only, or the complete turbine compressor set. The 505CC-2's turbine control algorithm is patterned after the popular Woodward 505 and 505E controls, and can be configured to control single valve or single extraction steam turbines. When configured as a compressor anti-surge control only, the 505CC-2 can be programmed to control and protect a one- or two-loop compressor set being driven by a motor or steam turbine.

The 505CC-2's control hardware consists of a ruggedized hardware platform designed for control room or skid mount locations. All unit CPU and I/O modules are housed in a compact bulkhead-mounted hardware package, minimizing space and wiring requirements.

Compressor and turbine OEM-qualified algorithms are used within this controller to ensure optimum system performance and protection. The qualified compressor anti-surge algorithm compensates for changing gas/process conditions, ensuring proper operating point calculations and protection limits.

A user-friendly Configuration and Commissioning Tool (CCT) software program gives users a window into the controller to configure, service and operate the unit. This CCT program is provided with each controller on a CD, which can be loaded onto a site computer connected to the 505CC-2. Optionally a 381 mm (15") touchscreen Human Machine Interface (HMI) is available which can also be used as the unit engineering workstation and/or operator control panel. This Ethernet based HMI uses graphical displays to show the entire turbine compressor island, and includes data logging and performance trending screens to give the user a complete picture of the system.

In addition to the HMI/CCT's Ethernet communications, two serial Modbus® * ports are included for remote connection to a plant DCS or other intelligent systems.

* Modbus is a trademark of Schneider Automation Inc.

Key benefits include:

- Fewer plant controllers are required because the turbine & compressor controllers are integrated into one product
- Users can standardize on one controller throughout their plant(s) because the product's configurability allows it to be applied on steam turbines, motor driven compressors, and steam-turbine-driven compressors
- Easy-to-use field-configurable platform allows site personnel to safely and easily make program changes and operate the unit
- Field-proven product with many users, which greatly increases product dependability
- Complies with API-612 standard for petroleum, chemical, and gas processing plants

Configurability

The 505CC-2 inputs and outputs (I/O) are arranged into pre-defined and configurable groups. The pre-defined I/O is fixed based on its usefulness for nearly all applications. The configurable I/O is selected based on the specific needs of each application.

INPUT SIGNALS:

Discrete Inputs (24)

Eight discrete inputs are assigned pre-determined functions and sixteen are configurable.

- Emergency Shutdown
- Reset
- Raise Speed
- Lower Speed
- Open Anti-Surge Valve No. 1
- Close Anti-Surge Valve No. 1
- Open Anti-Surge Valve No. 2
- Close Anti-Surge Valve No. 2
- Configurable Discrete Inputs (16)

Speed Signals (2)

Two pre-defined inputs are available for MPUs or proximity probes.

- Speed Input No. 1
- Speed Input No. 2

Analog Inputs (21)

Eleven analog inputs are assigned pre-determined functions, and ten are configurable.

- Ext/Adm/Inlet/Exhaust Steam Pressure (4–20 mA)
- Compressor Flow Signal No. 1 (4–20 mA)
- Compressor Suction Pressure Signal No. 1 (4–20 mA)
- Compressor Discharge Pressure Signal No. 1 (4–20 mA)

- Compressor Suction Temperature Signal No. 1 (4–20 mA)
- Compressor Discharge Temperature Signal No. 1 (4–20 mA)
- Compressor Flow Signal No. 2 (4–20 mA)
- Compressor Suction Pressure Signal No. 2 (4–20 mA)
- Compressor Discharge Pressure Signal No. 2 (4–20 mA)
- Compressor Suction Temperature Signal No. 2 (4–20 mA)
- Compressor Discharge Temperature Signal No. 2 (4–20 mA)
- Configurable Analog Inputs (10) (4–20 mA)

OUTPUT SIGNALS:

Discrete Outputs (12)

Two discrete outputs are assigned pre-defined functions and ten are configurable.

- Turbine/Compressor Shutdown
- Turbine/Compressor Alarm
- Configurable Discrete Outputs (10)

Actuator Drivers (4)

Four pre-defined actuator driver outputs are assigned.

- HP Actuator (4–20 mA or 20–200 mA)
- LP Actuator (4–20 mA or 20–200 mA)
- Anti-surge Valve No. 1 (4–20 mA)
- Anti-surge Valve No. 2 (4–20 mA)

Analog Outputs (4)

All analog outputs are configurable.

- Configurable Analog Outputs (4) (4–20 mA)

Control Functions

Turbine Start-up/Shutdown

The 505CC-2 provides three selectable start-up modes—Manual, Semi-Auto, and Automatic. In manual mode, the turbine is started by an operator manually cracking the trip and throttle valve, until the 505CC-2 takes control of turbine speed at the programmed level. In the semi-automatic mode, the turbine is started by an operator manually raising/ positioning the 505CC-2's valve demand signal, until the 505CC-2 takes control of turbine speed at the programmed level. In full automatic mode, the 505CC-2 automatically ramps the steam control valve open at a user-defined rate until the 505CC-2 takes control of turbine speed at the programmed level. Two shutdown sequence routines (emergency & controlled) are operator selectable for turbine shutdown situations.

Speed Control

The integrated speed controller receives turbine speed signals from one or two magnetic pickups or proximity probes. The Speed PID compares the speed value against a speed reference setpoint to determine the correct turbine valve(s) position demand.

Extraction/Admission Control

The Extr/Adm Control receives an extraction/admission pressure or flow signal. This signal is compared to a reference setpoint to generate a second turbine valve position demand. Since an extraction/admission turbine has two control valves, the valve position demands from the speed control and the extraction/admission control are fed through Ratio/Limiter software algorithm to establish the correct HP and LP valve positions.

Performance Control

A variety of process control options is available. By using the unit's cascade controller, a user can configure control of compressor suction or discharge pressure, flow, or any other process variable. The performance control compares a signal proportional to the controlled variable to a reference setpoint. Depending on the configuration that is selected, either the speed setpoint or the load demand signal will be modified to accomplish the desired control.

Overspeed Test

The overspeed test function allows an operator to increase the speed reference setpoint above its rated maximum so that the electrical or mechanical overspeed protection systems can be tested. This includes the control's internal overspeed protection logic as well as any external protective devices. Testing can be performed through connected HMIs or from the external contact inputs.

Anti-Surge Control (Closed Loop)

An anti-surge PID receives pressure and flow signals (and temperature, depending on configuration) from the suction and discharge lines on the process compressor. These values are compared to the surge map for the specific compressor. When the computed control limit is exceeded, the output signal will cause the anti-surge valve to open so that the compressor flow is increased and surge is avoided. If the system upset is severe, a second rate-control PID is invoked to more quickly move the valve demand.

Anti-Surge Control (Open Loop)

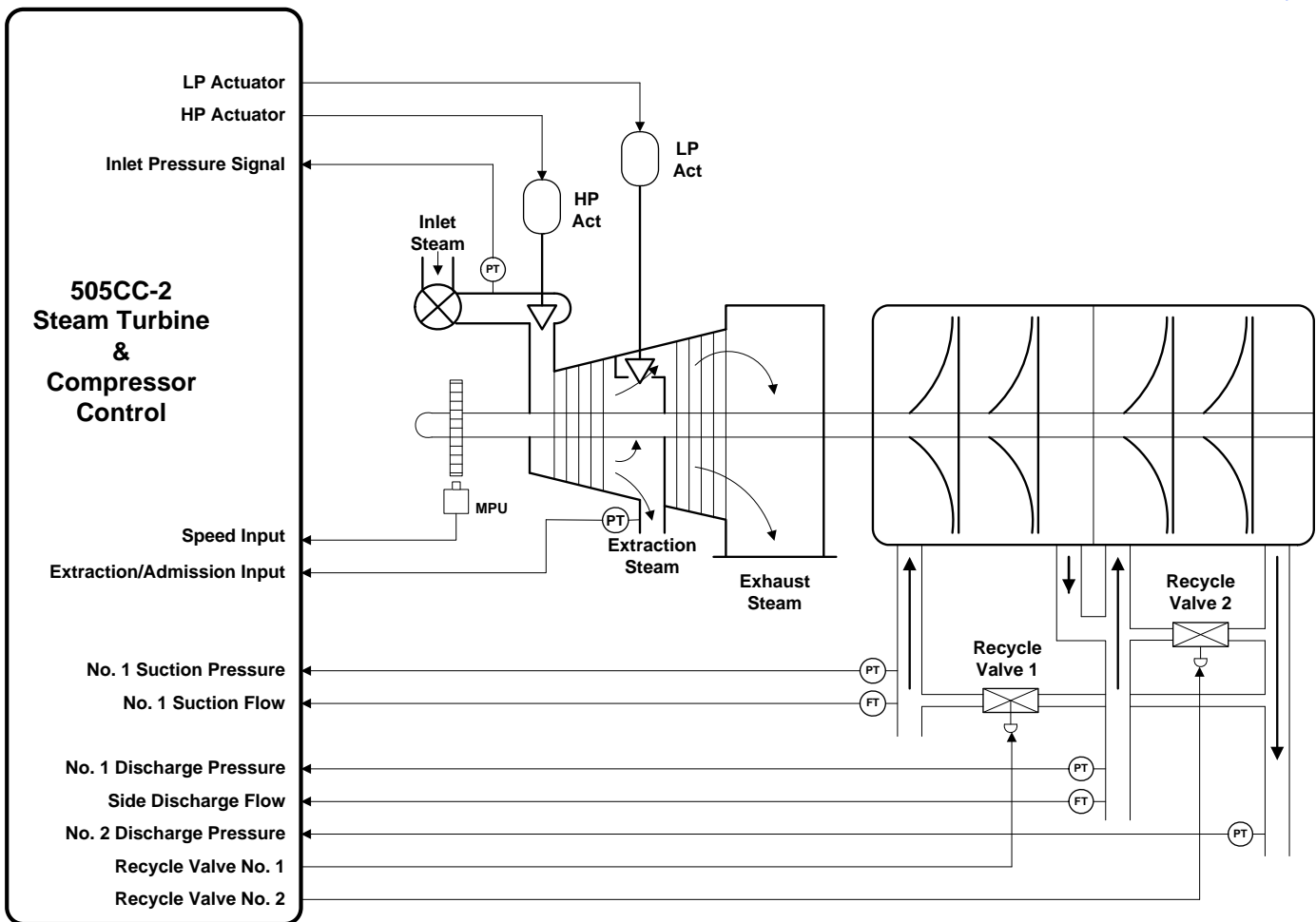
A variety of secondary control actions are available should the primary anti-surge corrections prove inadequate. A Boost routine, which acts after the closed-loop controls but before the surge limit is reached, opens the recycle valve further than what the closed loop PID would normally demand. A Pre-Pack feature is included to compensate for long piping runs that exhibit significant lags. If a surge event occurs in spite of these corrective actions, a Surge Recovery system and a Surge Minimum Position capability take over until the primary anti-surge protection resumes control.

Compressor-based Process Control

Compressor suction pressure and compressor discharge pressure can be limited by modulation of the compressor recycle valve. These functions act in a backup role to help increase the suction pressure or decrease the discharge pressure when the turbine speed is changed. A suction pressure override PID and a discharge pressure override PID take effect when turbine speed alone cannot maintain these process setpoints.

Communications

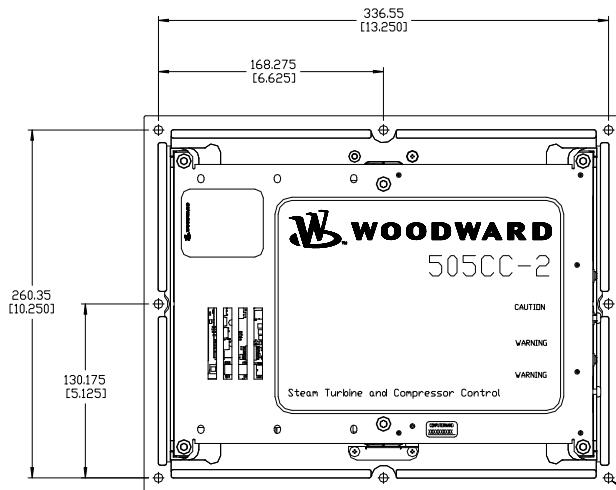
An Ethernet port on the 505CC-2 provides an interface to a site computer or optional 381 mm (15") HMI running the 505CC-2's Configuration and Commissioning Tool (CCT). This device allows the control to be configured to the specific needs of the current application. After configuration, the CCT can be used to tune, monitor, and control the 505CC-2. In addition, two RS-232/-422/-485 communication ports are available for connection to customer plant level control and DCS.



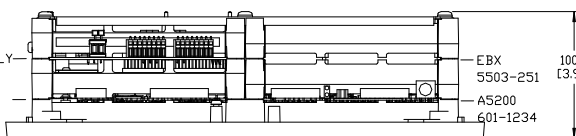
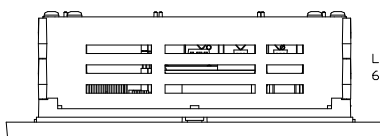
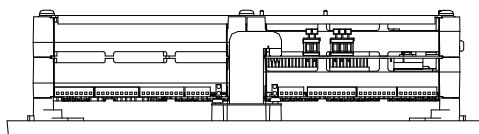
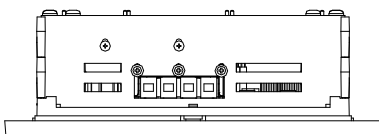
505CC-2 Block Diagram

NOTES:

1. ALLOW A MINIMUM OF 1.00 INCH AIRSPACE AROUND ALL 4 SIDES AND TOP OF ENCLOSURE.
2. STAINLESS STEEL INTERNAL TOOTH LOCK WASHER RECOMMENDED BETWEEN THE MOUNTING FLANGE AND THE MOUNTING SCREW HEADS.
3. DIMENSIONS ARE SHOWN AS: [MM] [INCH]



8X MTG HOLES AS FOLLOWS:
A) #6 FDR #4 SCREWS [2.361]
B) #6.40 FDR 1/4 INCH (#8-32) SCREWS
⌀ 1.4 [0.551] Ⓜ



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505CC-2 Outline Drawing (Do not use for construction)

Specifications

Hardware Manual	26451
Power Supply Rating	18–32 Vdc
Power Consumption	Less than 65 W
Magnetic Pickup	100–24 950 Hz
Proximity Probe	0.5–24 950 Hz
Discrete Inputs	3 mA @ 24 Vdc, impedance 5.2 kΩ nominal
Analog Inputs	4–20 mA
Actuator Outputs	4–20 mA or 20–200 mA
Analog Outputs	4–20 mA
Discrete Outputs	Powered by external +12 or +24 Vdc source, output current 200 mA maximum
Communication Ports	One Ethernet; Modbus YCP, UDP Two RS-232, RS-422, or RS-485

505CC-2 Control

Ambient Operating Temperature Range	–20 to +70 °C
Storage Temperature Range	–40 to +85 °C
Vibration:	Lloyds Test Specification No. 1, 2002, Vibration Test 1 (5–13.2 Hz, ±1 mm; 13.2–100 Hz, ±0.7 g)
Shock:	US MIL-STD-810C, 516.2-2 (30 g, 11 ms, 1/2 sine)
Humidity	95% at +20 to +55 °C

Optional HMI Touchscreen

Ambient Operating Temperature Range	–10 to +55 °C
Shock	10 g peak acceleration (11 ms duration)

Regulatory Compliance

North American:	UL:	UL Listed for Class I, Division 2, Groups A, B, C, & D, T3C at 70 °C surrounding air temperature. For use in Canada and the United states. (UL File E156028)
European Compliance for CE Marking:	EMC Directive:	2004/108/EC
	Low Voltage Directive:	2006/95/EC
	ATEX Directive:	94/9/EC (Zone 2, Cat. 3, Group II G, Ex nA IIC T3 X)
Marine Compliance:	ABS:	ABS Rules 2006 SVR 4-2-1/7.3, 7.5.1, 7.9.3/174-9-7/Table 9
	DNV:	Standard No. 2.4, 2006: Temp. Class B, Hum. Class B, Vib. Class C, and EMC Class A
	LRS:	Test Specification No. 1, 2002: ENV1, ENV2, and ENV3

Optional Regulatory Compliance

North American	HMI	UL Ordinary Locations
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