505DE Digital Control
for Double Automatic Extraction / Admission Steam Turbines

- Integrated control
- Double automatic extraction / admission steam turbines
- Based on popular 505E single extraction steam turbine control
- Field-configurable
- Change dynamics while online
- View turbine parameters
- Optional 38 cm (15”) HMI
- Two RS-232 serial Modbus® communication ports
- API 612 Compliant

DESCRIPTION

The 505DE is a microprocessor-based control with integral application software that is designed to control double automatic extraction/admission steam turbines in generator applications. The turbine control architecture is patterned after the popular 505E Single Extraction/Admission Steam Turbine Control. Like the 505E, the 505DE uses configurable software for maximum field flexibility.

The control hardware consists of Woodward’s rugged MicroNet™ platform with five rack-mounted modules (1–power supply, 1–CPU, 3–I/O modules). The main processor, and serial and Ethernet ports are located on the CPU module. The three I/O modules contain the I/O required for double extraction turbine control. The power supply module(s) is provided to power the entire control assembly, including associated field transducers. The control can be provided with one (simplex) or two (redundant) power supplies, depending on site requirements. Typically, the 505DE is mounted in an enclosure rated for the site-specific environmental conditions.

The 505DE control is field configurable. A menu-driven software program installed on any Windows based computer or laptop is used to configure, service, and optionally operate the control/turbine. This program is used to configure the control to the specific application, and to perform system-tuning adjustments on-line if necessary. The control can be configured to operate as a stand-alone unit or in conjunction with a plant’s Distributed Control System.

An optional 38 cm (15”) Human Machine Interface (HMI) is available as an upgrade to the basic system. In addition to functioning as the operator control of the turbine unit, the HMI provides full graphics of the turbine/generator island. Data logging and trending of key system parameters are provided. Normally, the HMI is connected to the control via Ethernet. Two additional serial ports are available for connection to a plant DCS or other intelligent systems.

The 505DE complies fully with the requirements of API 612 for installation in petroleum and chemical plants.

APPLICATIONS

Applications for the 505DE include paper mill and process plants that utilize double automatic extraction or admission steam turbine technology. The control can be configured in the field for a wide variety of application scenarios—including both condensing and non-condensing turbine types. In addition to controlling the basic process requirements, the unit can be used to control generator load. Generator synchronizing and load sharing can be accomplished with the 505DE and external devices such as an SPM-D digital synchronizer and KW power sensor.

CONTROL FUNCTIONS

Turbine Start-up/Shutdown

The 505DE provides three selectable start-up modes: Manual, Semi-Auto, and Automatic. In **Manual** mode, the turbine is started by manually cracking the trip and throttle valve. The 505DE will take control once the speed reaches the control setpoint (min governor). In **Semi-Auto** mode, the 505DE controls the starting steam flow, while the operator uses the HMI or discrete raise/lower contact inputs to manually control turbine speed. In **Automatic** mode, the 505DE ramps open the control valve, then controls turbine speed at user-defined rates and idle setpoints until the turbine speed reaches min governor speed setting. A controlled turbine shutdown routine is also available for non-emergency-based shutdown conditions.

Speed Control

The speed control receives turbine speed information 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 position demands. The speed PID output is sent to a ratio/limiting function to properly apportion its influence on the HP, IP, and LP valve positions.

Extraction/Admission Control

The extraction/admission control consists of two separate PID controls that receive IP and LP pressure signals respectively. These signals are compared to pressure reference setpoints, and appropriate PID output values are generated. These outputs are also sent to the ratio/limiting function to properly apportion their influence on the three control valves.

Ratio/Limiting

The control's ratio/limiting algorithm receives demand signals from the speed/load, HP extraction, and LP extraction PID controllers, then based on the entered turbine performance map calculates respective HP, IP, and LP valve positions to effectively de-couple the effects of each controlled parameter on the other. Four decoupling modes also allow the control to be configured match the specific application's requirements.

Process Control

Many process control options are available. By using the cascade PID feature, the user can configure inlet pressure control, exhaust pressure control, or any other related process control action. The cascade PID compares the selected process input to the process reference to generate an output that is used to control the primary speed setpoint. The inlet or exhaust pressure reference value can be set remotely via a 4–20 mA, discrete raise/lower Modbus command inputs.

Limiter Control

A Limiter PID feature is available to allow inlet pressure or generator load limiting. The PID compares the selected variable to a limit reference to generate an output that is low-signal-selected with the main speed/load PID control. This action has the effect of overriding the speed/load demand until the operating conditions cause the selected variable to fall below its limit value.

Critical Speed Avoidance

The 505DE includes three user-selectable critical speed bands. During start-up, the turbine speed is rapidly ramped through the 'criticals' so as to minimize machine vibrations.

Overspeed Test

The overspeed test capability allows the operator to increase the speed reference beyond its rated maximum so that the electrical and mechanical overspeed protection systems can be tested. This includes the temporary override of the 505DE's internal overspeed protection logic. Testing can be performed from the optional HMI or external contact inputs.

Ladder Logic Kit

The 505DE can also be purchased with an internal ladder logic kit that includes the ladder logic software program and a discrete I/O module (48 inputs and 24 outputs). This kit allows a standard-formatted ladder logic program of site-specific logic to run inside the 505DE and have access to internal parameters, alarm buses, and analog and discrete I/O.

Communications

An Ethernet port on the 505DE provides an interface to the optional 38 cm (15") HMI. In addition, two RS-232 serial Modbus® * ports are available for connection to customer plant level control and DCS.

* Modbus is a trademark of Modicon, Inc.

CONFIGURABILITY

The 505DE includes configurable and non-configurable capabilities. Non-configurable functions are those that are always required no matter what the site-specific machine architecture is. These non-configurable functions include:

- Speed PID Control
- P1 Extraction/Admission Control
- P2 Extraction/Admission Control
- Ratio/Limiters
- HP, IP, and LP Valve Limiters
- Critical Speed Avoidance
- Start-up Slow Roll
- Alarm and Shutdown Logic
- Serial and Ethernet Modbus Communications

Depending on the application, the following configurable functions are provided and can be selected through a configuration menu:

- Inlet Pressure Control
- Exhaust Pressure Control
- Process Control
- Bootstrap Starts, Casing Temp Based Starts
- KW Limiting
- Inlet Pressure Limiting
- Other Process Parameter Limiting/Control
- Remote Speed/Ext/Adm Setting (4–20 mA)
- Overspeed Testing
- Isochronous Load Sharing
- Synchronizing
- 4–20 mA Readouts
- Relay Indication Outputs

In order to support the control flexibility, the inputs and outputs (I/O) are also defined as either pre-defined or application configurable. The pre-defined I/O is fixed based on its usefulness for nearly all applications. The configurable I/O is selected only if needed for the application at hand.

Input Signals

Discrete Inputs (28)
All discrete inputs are pre-defined:
- Configurable Shutdown and Alarm signals
- Setpoint Raise/Lower signals
- PID Enable/Disable commands
- Breaker position indications signals

Speed Signals (2)
Two pre-defined inputs are provided for MPUs (100–24 950 Hz) or proximity probes (0.5–24 950 Hz):
- Speed Input No. 1
- Speed Input No. 2

Analog Inputs (16)
All analog inputs are pre-defined 4–20 mA inputs:
- HP and LP Extraction header pressures, and remote setpoint signals
- Inlet and Exhaust header pressures, and remote setpoint signals
- Generator Load and Synchronizer/Loadshare input signals
- Configurable Casing Temperature signals (4)
- Configurable Monitor Analog Input signals (5)

Output Signals

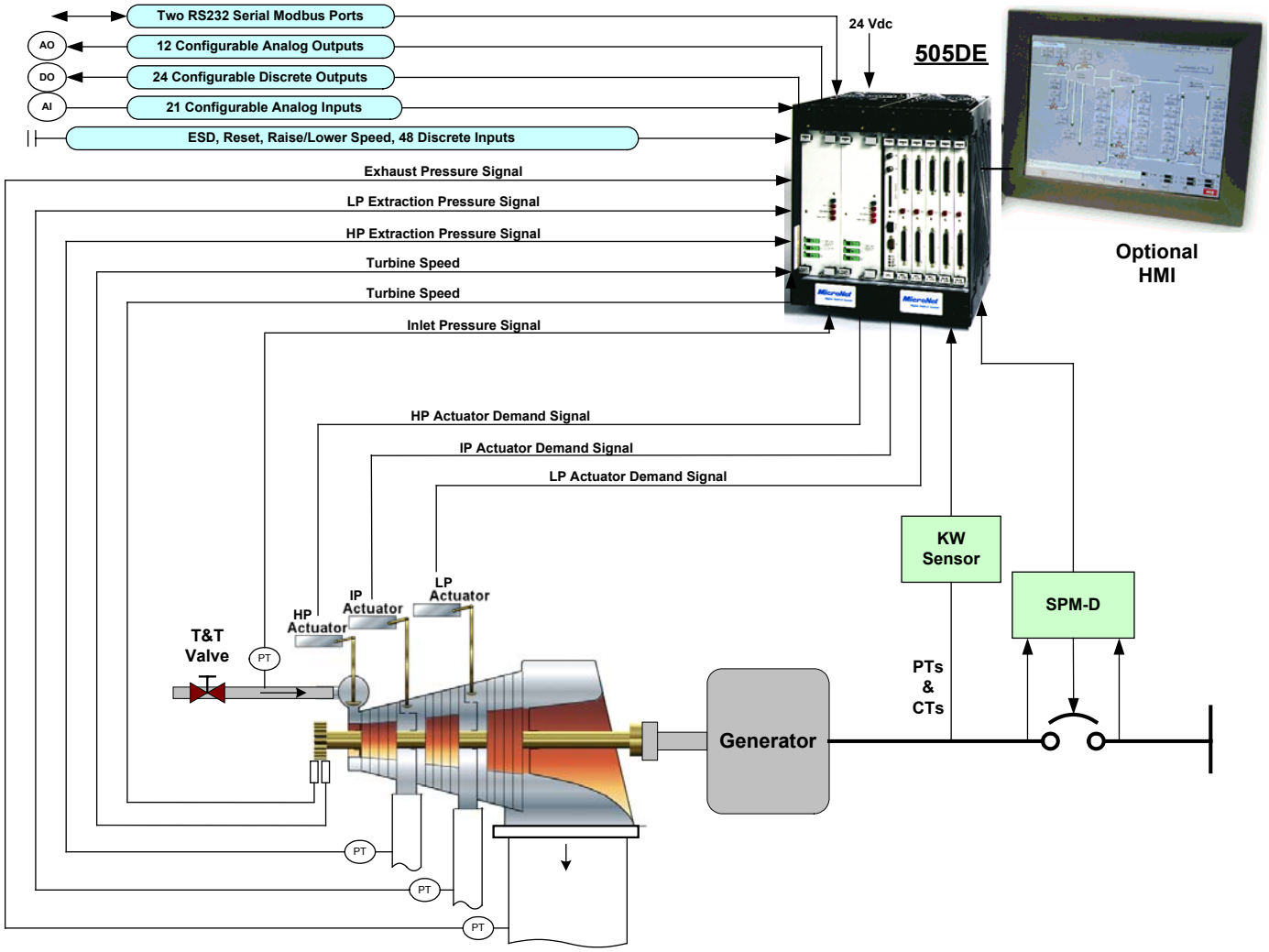
Discrete Output Relays (17)
5 pre-defined (Alarm, Shutdown active, Reset active, Ready to synchronize, Open breaker) and 12 configurables
All discrete outputs are configurable with up to 40 configurable options:
- Shutdown and Alarm relay outputs
- Controlling Mode indication relay outputs
- Speed and Analog Level indication relay outputs

Actuator Driver Outputs (3)
Three actuator output signals are pre-defined:
- HP Actuator (4–20 mA or 20–200 mA)
- IP Actuator (4–20 mA or 20–200 mA)
- LP Actuator (4–20 mA or 20–200 mA)

Analog Outputs (12)
4 pre-defined for valves and 8 configurables
All analog outputs are 4–20 mA signals and are functionally configurable:
- Configurable Analog Outputs (23 config options)

Power Supply (Simplex or Redundant Options)
- AC/DC option (accepts 88–132 Vac/47–63 Hz or 100–150 Vdc)
- HVAC option (accepts 180–264 Vac/47–63 Hz or 200–300 Vdc)

Comm Ports
- One Ethernet port (OPC or Modbus)
- Two RS-232 Modbus ports



505DE Functional Block Diagram

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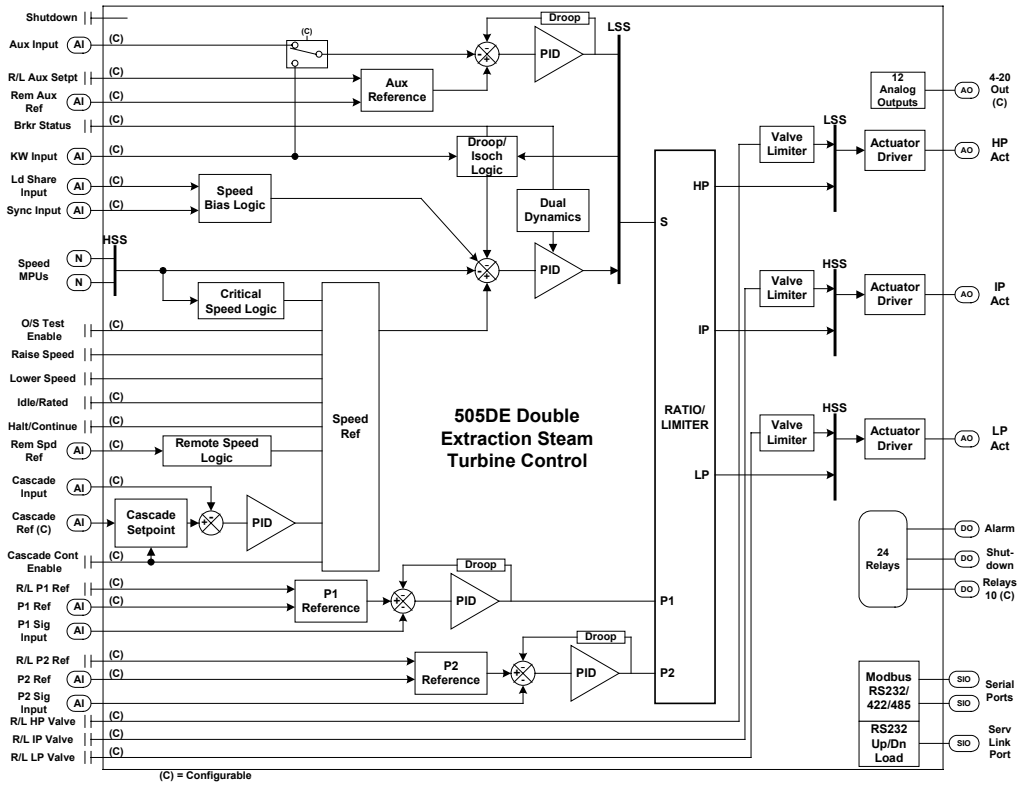
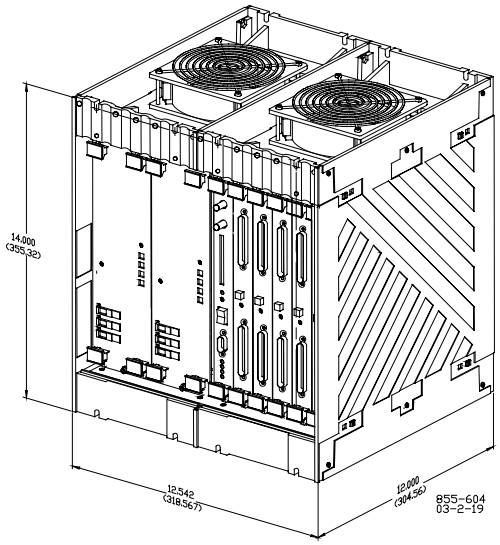


505DE Internal Block Diagram

SPECIFICATIONS

Operating Conditions	
Temperature	0 to 55 °C (32 to 131 °F) ambient air temperature range 0 to 50 °C (32 to 122 °F) for Pentium/NT CPU
Shock	US MIL-STD-810C, method 516.2-1, procedure 1B
Vibration	Lloyd's ENV2 test #1
Emissions	EN55011, Class A, Gr 1
Immunity	EN50082-2 (1995)
Certifications	
	CE, UL/cUL (Class I, Division 2), LR for Cat ENV1 & ENV2, ABS
Chassis	
Dimensions	320 mm wide x 363 mm high x 307 mm deep (12.6" wide x 14.3" high x 12.1" deep)
Approximate Weight	16 kg (35 lb)
Power Supply Input Options	18–36 Vdc, 100–150 Vdc, 88–132 Vac (47–63 Hz), 180–264 Vac (47–63 Hz)



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