

# 2301E-ST

## Steam Turbine Control for Small Generator Applications



### Applications

The 2301E-ST is a steam turbine control and its internal algorithms are designed for to start/stop, control and protect a small steam turbine driving a generator, pump, or compressor. This control's field/user configurability allows it to be easily configured for and applied in a diverse range of applications. The 2301E-ST's integrated generator power sensor and load-sharing capabilities also make it ideal for small turbine generator sets where a cost-effective control solution is essential.

The 2301E-ST controller includes the following basic turbine control and protection functions:

- Turbine speed control
- Start valve ramp (0 to 100%)
- Manual start, Semi-automatic start, Automatic start option
- Shutdown logic
- Alarm logic
- Overspeed protection
- Platform diagnostics and watchdog protection
- Self powered actuator option
- Woodward Control Assistant service tool communications

Alternatively, the following functions can be configured, depending on application requirements (I/O limitations may prohibit selecting all listed functions at once):

- Critical speed avoidance band logic
- Process control
- Remote speed/load setpoint
- Droop/Isochronous generator control
- KW/Actuator droop
- Two speed sensor inputs (required to meet standard API-611 requirements)
- Generator load sharing (with soft load/unload transfer)
- Generator synchronizer input (SPM-A or SPM-D)
- Generator power sensing input (PTs and CTs)
- Optional operator monitoring panel (downloadable from Woodward website)
- Serial Modbus<sup>®</sup> \*communications

An integral serial RS-422 communications port allows users to interface with the 2301E-ST through industry-standard Modbus protocol.

\* Modbus is a trademark of Schneider Automation Inc.

- Single-valve small steam turbine applications
- API-611 compliant
  - Accepts two speed sensors
- Process control capability
- Load sharing and speed control capability
- KW or speed droop
- Isochronous control capability
- Soft load transfer
- Remote setpoint
- Critical speed avoidance
- PC configurable with Service Tool
- Designed for turbines operating at 90–32,000rpm
- Actuator current range of 4–20 mA or 20–200 mA
- 2301A/D replacement
- Modbus<sup>®</sup> serial
- Optional Hazardous Location models

## Description

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The Woodward 2301E-ST is a microprocessor-based control with integral application software designed for single-valve steam turbine applications. This control is packaged in a ruggedized sheet-metal chassis and consists of a single printed circuit board. Depending on the desired mounting location, both Ordinary-Location and Class-1 Div-2 Hazardous-Location rated models are available. Depending on the desired mounting location, the following two models are available: (1) Ordinary Location rated model, (2) Hazardous Location Class I, Division 2 rated model. Refer to product manual 26694 for a list of model numbers and related product details.

This control is designed to perform the core control and protection functions of a small steam turbine package. The application software is field configurable, allowing it to be configured and modified to meet site-specific requirements. Modbus communications also allow it to easily interface with a package PLC (programmable logic controller) or plant DCS (distributed control system).

The 2301E-ST control is configured and serviced (dynamic adjustments made) via a computer connected to the control's RS-232 communications port. These configuration and dynamic settings are set, changed, tuned, and saved via a computer using Woodward's user-friendly Control Assistant software program. This Windows<sup>®</sup> based software program allows users to easily set and adjust all application-based parameters, plus upload and download configurations to and from the control.

The 2301E-ST hardware includes the following inputs and outputs:

- (1) 24Vdc input power source
- (2) MPU speed sensors
- (1) Actuator driver
- (2) Configurable analog inputs
- (1) Configurable analog output
- (8) Discrete contact inputs
- (4) Discrete "relay driver" outputs
- (1) Load sharing circuit
- (1) Load sensor (3 PT inputs, 3 CT inputs)

## Control Features

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### Turbine Start-up/Shutdown

The 2301E-ST provides configurable turbine start-up scheduling via special valve ramp logic. On start-up, the turbine accelerates according to the valve ramp schedule until the speed control loop takes control of the turbine. The valve ramp can also be used to shut down the turbine.

### Isochronous/Droop Operation

When configured for generator drive applications, the 2301E-ST can operate in either an isochronous or droop load mode. In the "Isochronous" mode, the 2301E-ST controls plant/unit frequency control by maintaining turbine speed. In the "Droop" mode the 2301E-ST controls generator load. If the generator is connected to the utility bus while in droop mode, the unit speed will be determined entirely by the bus frequency. If the generator is disconnected from the utility bus, the unit speed will "droop" as the load increases.

### KW Droop Operation

If KW droop is configured, the control uses the output from its integral power sensor to sense and control unit load. The control's power sensor output can be monitored via serial communications or through the control's analog readout. If required, any of the control's four relay outputs can be configured as a power level switch to drive auxiliary devices or indicators.

### Isochronous Load Sharing

The 2301E-ST includes an analog load sharing network input, which is compatible with Woodward's 2301A line of controls. The control's soft load/unload transfer function can also be configured to rate limit unit loading and unloading.

### DSL-2, SPM-A or SPM-D Compatible Input

Optionally one of the 2301E-ST's analog inputs can be configured to accept a bi-polar signal from Woodward's DSL-2 (Digital Synchronizer and Load Control) or Woodward's SPM-A or SPM-D synchronizers.

## Critical Speed Avoidance

The 2301E-ST can be configured to provide one speed band/range to be avoided for turbine protection. Within the set critical speed avoidance band the turbine speed setpoint will rapidly ramp through the critical speed range at the set rate.

## Remote Speed/Load Setpoint

Optionally, one of the control's two analog inputs can be configured to remotely control the control's speed/load setpoint. The maximum rate at which the speed/load setpoint can be changed by the remote input is configurable by the user. The remote speed/load setpoint can be enabled and disabled from a contact input or via Modbus communications.

## Process Control

A process PID control function can be configured to receive an analog process input signal, compare this signal to a setpoint and vary the turbine speed or load to maintain the desired process operating point. The process setpoint is adjustable by raise/lower contact inputs, via Modbus communications or a configurable remote 4–20 mA setpoint signal.

## Communications

The 2301E-ST's RS-232 port is used to interface with Windows-based PC program "Control Assistant" installed and used on a computer connected to this port. The Control Assistant software program is downloadable from Woodward's software web page and is used to set and adjust all application-based parameters, plus upload and download configuration setting files to and from the control.

The 2301E-ST's RS-422 port communicates via an industry standard Modbus protocol and can be used to monitor all turbine-specific parameters as well as control the unit (start, stop, etc.) as the application requires. Optionally, a software-based operator monitoring tool can be downloaded from Woodward's software web page, installed on a computer, and used to monitor all sensed turbine parameters (speed, load, inputs outputs, alarms, shutdown events, etc.)

## Specifications

PHYSICAL	
<b>Dimensions Ordinary Location Model</b>	387.85 x 158.50 x 50.8 mm (15.25 x 7.1 x 2 inches)
<b>Dimensions Hazardous Location Model</b>	390.5 x 254 x 66 mm (15.375 x 10 x 2.6 inches)
<b>Weight</b>	1.75 kg / 3.86 lb
<b>Mounting</b>	Any attitude (bolt patterns & sizes are determined by model number)
ENVIRONMENTAL	
<b>Operating Temperature Range</b>	–40 to +70 °C (–40 to +158 °F)
<b>Storage Temperature Range</b>	–40 to +105 °C (–40 to +221 °F)
<b>Shock</b>	US MIL-STD 810C, Method 516.2
ELECTRICAL	
<b>Input Power Source</b>	18–36 Vdc @ 0.43 Amps steady state, 7 A peak (100 ms)
<b>Power Consumption</b>	< 20 W nominal
<b>Speed Input Signals</b>	100–24,950 Hz, (90–32,000 rpm) @ 1.7–35 Vac
<b>PT Input Signals</b>	90–240 Vac (3 phase)
<b>CT Input Signals</b>	0–7.2 amps (3 phase)
<b>Synchronizer Input Signal</b>	+2.5Vdc (DSL-C-II, SPM-A or SPM-D)
<b>Actuator Output Signal</b>	4–20 mA or 0–200mA
<b>Analog Input Signals</b>	4–20 mA
<b>Discrete Input Signals</b>	3 mA @ 24 Vdc
<b>Discrete Input Signals</b>	4–20 mA
<b>Discrete Output Signals</b>	Solid state relay driver powered by external +24 Vdc source, max current 200 mA
<b>Service Tool Port (J1)</b>	RS-232 communications to Woodward Control Assistant / Service Tool
<b>Communication Port (J2)</b>	RS-422, 9-pin connector, 9600 to 115 200 baud, full duplex





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