

# VariStroke-II

## Electro-hydraulic Actuator

### Applications

The VariStroke-II is a linear electro-hydraulic actuator that is designed to provide the linear actuation force to operate steam turbine control valves or valve racks. This integrated actuator is intended for use on mechanical-drive or generator-drive steam turbines, and uses a low-pressure hydraulic oil source (typically turbine lube oil) to provide its output shaft force.

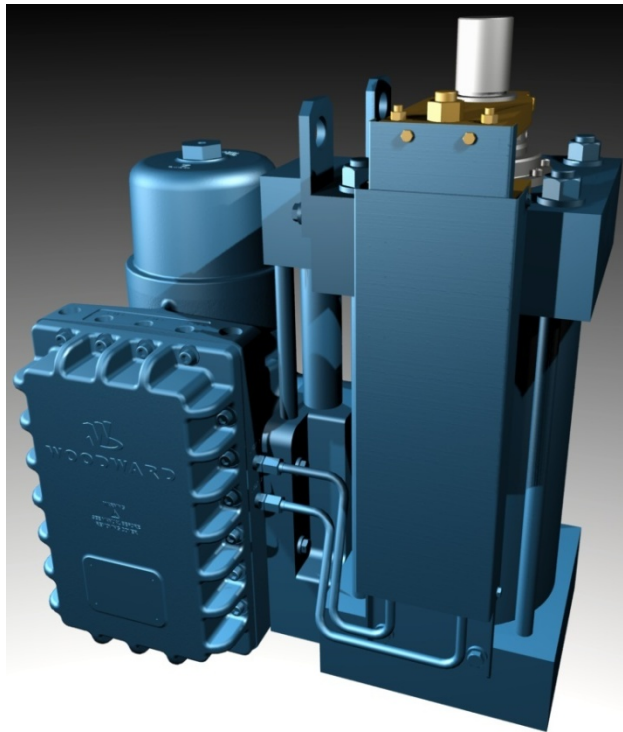
The VariStroke-II's superb accuracy and resolution make it ideal for steam turbine valve control and related turbine speed and load control. The VariStroke-II electronics module accepts either a 4–20 mA or CANopen network-based position demand signals to position a steam control valve. Precise and stable steam valve control directly relates to improved steam turbine speed and load control and reduced system mechanical wear. The actuator's fast 254 mm/s (10 inch/s) slew rate allows applied generator or compressor drive turbines to quickly respond to loss-of-load or emergency shutdown events.

The VariStroke-II's redundant features make it ideal for critical steam turbine applications, where turbine up-time and availability are essential. This linear actuator's dual-redundant demand inputs (via redundant CANopen ports) and dual-redundant LVDT shaft position sensors allow on-line system repair, ensuring extend run-times between forced outages. Since not all steam turbines are created equal, the VariStroke product line was created with the versatility and modularity to be applied on many different turbine sizes and designs. Depending on the turbine application's requirements, users can order an actuator with the required force, stroke, action (double or single), fail-safe direction, hazardous location rating, and type (integrated actuators, remote cylinder actuator kits, or servo only).

The VariStroke-II actuator's robust design (large working area piston, corrosion-resistant materials, single moving rotary valve, and self-cleaning port design) makes it ideal for challenging applications where dirty or contaminated oil may be present.

Optionally, two redundant turbine controllers can be connected to a single VariStroke-II actuator in a redundant master/slave fashion to allow the turbine to continue to operate if either turbine control fails, or if on-line changes are desired.

In turbine retrofit applications, the VariStroke-II can be used to directly replace the existing servo system. This saves costly repairs to existing and aging servos, eliminates the difficulty of obtaining spare parts for obsolete equipment, and reduces calibration time and difficulty.



- Dirt-tolerant design
  - Two moving parts
  - 105 lb chip shear force
  - Self-cleaning valve design
- Variable / configurable shaft stroke lengths
- Fast slew rates/times
  - Up to 10 inches/second (254 mm/s)
- Precise position control
- Side-load tolerant
  - Shaft bearings
  - Triple seal technology
- Integrated driver
  - 4–20 mA or CANopen
  - Included valve flow linearization table
- Redundant CANopen network communications
- Redundant LVDT position sensors
- Certified for Hazardous Locations

## Description

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The VariStroke-II is a linear electro-hydraulic actuator that utilizes a double-acting or single-acting power cylinder (part number dependent) with integrated electronic driver module, servo valve, and LVDT-based position feedback sensors to precisely control steam turbine valves. The actuator's driver module accepts one 4–20 mA, one CANopen, or dual-redundant CANopen demand signal and compares it to the sensed actuator shaft position to accurately control output shaft position.

The actuator's output shaft position is controlled by a digital controller with an internal rotary servo valve that ports supply oil to and from its power cylinder piston. This actuator's advanced digital controller architecture allows it to perform very stable position control during normal operating conditions, and also respond in milliseconds to desired valve step changes during system or plant transients. As a means of protecting the turbine, an internal valve-return spring forces the actuator to a desired failsafe position upon any external or internal failures (electrical input power failure, position sensor failure, processor failure, etc.).

The VariStroke-II actuator is a product family with different models available for purchase depending on the force, stroke, and redundancy required. This actuator is available with standard bore diameters, standard stroke ranges, and with single-acting (spring return) or double-acting (pressure return) operation. The VariStroke's unique "variable stroke" capability also allows users to customize/set the actuator's exact stroke length in the field to meet their required application.

The VariStroke-II is factory and/or field configurable via a computer-based service tool. The actuator's PCI Service Tool uses a simple user-friendly format to allow users to easily configure, calibrate, and adjust all internal functions and response settings. The VariStroke-II also includes a 4–20 mA output channel to indicate output shaft (control valve) position, and unit alarm and shutdown relay outputs for use as unit health and status indications.

The total installed cost for this fully integrated actuator is low because it has been completely assembled and tested at the factory. This greatly reduces OEM and end-user fabrication time, testing time, and site assembly time.

## Features

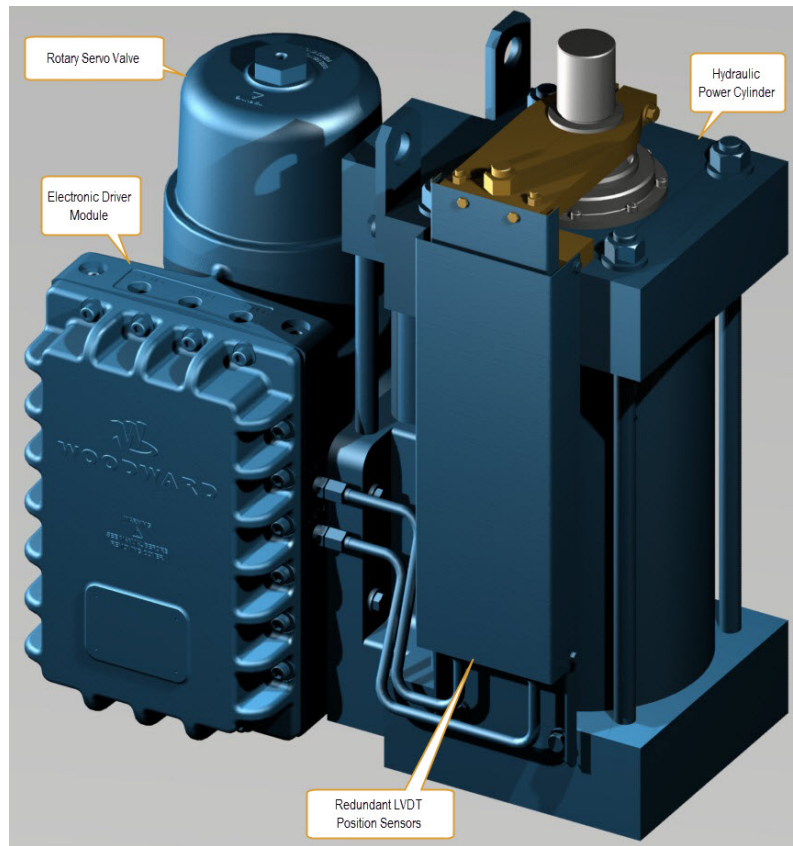
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**Digital Network Communications**—The VariStroke-II actuator can be configured to accept one or two (dual-redundant) CANopen networks from the turbine control system, greatly simplifying system wiring, installation, and troubleshooting. This control-to-actuator digital network can be used to accurately send a position demand signal as well as access actual position, alarm, trip, and health information.

**Valve Rack Linearization**—Since flow-through single and staged inlet steam valves tend to be non-linear throughout their flow range, turbine controls are typically de-tuned to compensate for instability or sluggish control points throughout this range. As a way of allowing turbine control optimization, the VariStroke-II includes an 11-point linearization table to allow turbine OEMs or users to compensate for poor valve linearization by digitally linearizing the control-to-valve flow relationship.

**Side Load Capability**—A common problem with turbine actuators is oil leaking from their output shaft due to connection to valve rack linkages which have an arc-type of motion. This motion results in side loading of the actuator shaft, and after long periods may result in shaft-seal wear and resultant oil leakage. Designed for a continuous side load of up to 10% of actuator output, the VariStroke-II actuator incorporates a high-force precision bearing and special seal technology on its output shaft to solve this typical application problem.

**Soft Stop Capability**—Turbine valve seat life is always a concern among turbine OEMs and owners. To assist with extending the life of turbine control valves (or valve racks) and their valve seats, the VariStroke-II actuator includes a "Soft Stop" feature which allows users to optionally configure a point above the valve seat (mechanical stop) to slow the valve's rate of travel, thus softening how hard the valve rack strikes its valve seat (minimum mechanical stop) and lengthening the life of both the valve and the valve seat.



**Figure 1. VariStroke-II Key Features**

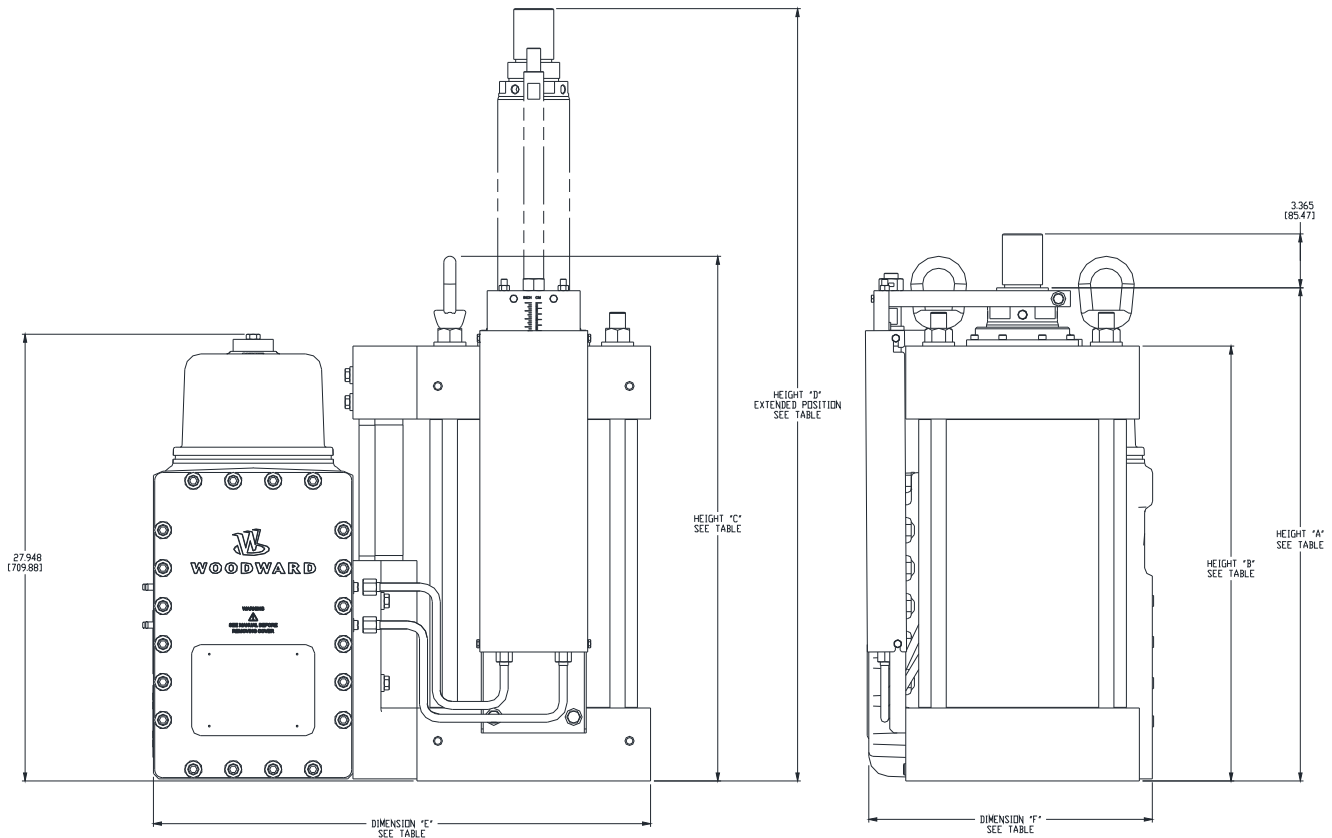


TABLE							
STROKE [INCH]	HEIGHT "A" ±.005 INCHES (MM)	HEIGHT "B" INCHES (MM)	HEIGHT "C" INCHES (MM)	HEIGHT "D" INCHES (MM)	DIMENSION "E" INCHES (MM)	DIMENSION "F" INCHES (MM)	APPROXIMATE WEIGHT LBS (kg)
8	24.85 (631.2)	21.20 (538.4)	27.82 (681.2)	42.31 (1074.6)	31.13 (790.7)	17.75 (450.8)	1164 (527.9)
10	26.85 (681.9)	23.20 (589.2)	29.82 (732.0)	44.31 (1125.4)	31.13 (790.7)	17.75 (450.8)	1188 (538.6)
12	28.85 (732.7)	25.20 (640.0)	30.82 (782.8)	46.31 (1176.2)	31.13 (790.7)	17.75 (450.8)	1211 (549.3)
14	30.85 (783.5)	27.20 (690.8)	32.82 (833.6)	48.31 (1227.0)	31.13 (790.7)	17.75 (450.8)	1235 (560.6)
16	32.85 (834.3)	29.20 (741.6)	34.82 (884.4)	50.31 (1277.8)	31.13 (790.7)	17.75 (450.8)	1258 (570.6)
18	34.85 (885.1)	31.20 (792.4)	36.82 (935.2)	52.31 (1328.6)	31.13 (790.7)	17.75 (450.8)	1282 (581.5)

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**Figure 2. VariStroke-II Outline Drawing**

## Specifications

### Performance

Linearity:	±1.0% of full range
Repeatability:	±0.5% of full range
Temperature Drift:	0.04%/°C
Failsafe Operation:	Internal return spring on servo valve
Open Slew Rate:	> 200 mm per second (8 inches/s)
Close/Trip Slew Rate:	254 mm per second (10 inches/s)
Configuration:	Computer based Service Tool (RS-232 communications port)

Linearization table allows valve rack flow linearization.

### Physical

Stroke Lengths:	(determined by model number) = 50–457 mm (2–18 inches) (102, 203, 305, 457 mm) (4, 8, 12, 18 inches) Stroke lengths can be set between 50% to 100% of maximum
Max Stall Force:	(model number dependent) 450–18 000 kg max @ 35 bar (1000–40 000 lb @ 500 psi) Retract direction = (bore area – rod area) x (supply pressure) Extend direction = (bore area) x (supply pressure)
Cylinder Dimensions:	(determined by model number) See out line drawings below. Available bore sizes (102, 152, 254, 305 mm) (4, 6, 10, 12 inches)
Cylinder Type:	Double Acting (model number dependent) [future single acting models planned]
Failsafe Direction:	Extend or Retract (model number dependent)
Visual:	Included stroke gauge
Actuator Dimensions:	Determined by configuration
Weight:	Determined by model number
Mounting:	Any attitude (bolt patterns & sizes are determined by model number)

### Environmental

Ambient Temperature Range:	–20 to +85 °C (–4 to +185 °F)
Operating Oil Temperature Range:	–20 to +80 °C (–4 to +185 °F)
Shock:	US MIL-STD-810C method 516.2, procedure 1 (10 G Peak, 11 ms duration, saw tooth waveform)
Vibration:	US MIL-STD 810F, M514.5A, Cat. 4(0.015 G <sup>2</sup> /Hz, 10–500 Hz, 1.04 Grms)
Ingress Protection:	IP66 per EN 60529

### Electrical

Input Supply:	90–150 Vdc (1 A steady state, 3 A peak for 200 ms)
Optional available external power supply:	90–132 Vac or 180–264 Vac @ 47–440 Hz
Analog Input Signals:	Isolated 4–20 mA
Analog Output Signal:	4–20 mA
Discrete Input:	Isolated with internal wetting voltage (Run/Enable function)
Discrete Outputs:	Relay Drivers = 500 Ω max @ 18–32 Vdc (Alarm & Trip Functions)
Network Comms:	2 CANopen Dual Redundant ports
Service Tool Port:	DB-9 RS-232 Port

### Hydraulic

Supply Pressure Range:	5.5 to 35 bar (80 to 500 psi)
Recommended Oil Cleanliness:	ISO 20/16 Class (40 μm nominal)
Fluid Ports:	SAE J518 Code 61
Steady State Oil Consumption- Max:	30 L/min (7.9 US gal/min)

### PENDING Regulatory Compliance

European Compliance for CE Marking:

EMC Directive:	2004/108/EC
ATEX Directive:	94/9/EC Zone 2, Category 3, Group II G Ex nA II T3; and LCIE 08 ATEX 6123 Zone 1, Category 2, Group II G Ex d IIB T3 and LCIE 08 ATEX 6124 Zone 2, Category 3, Group II G Ex nA IIC T3

Other European/International Compliance:

(Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking.)

Machinery Directive:	Compliant as a component with 98/37/EC
Pressure Equipment Directive:	Compliant as “SEP” per Article 3.3 to 97/23/EC

North American Compliance:

cUL:	Certified for Class I, Division 1, Groups C and D and Class I, Division 2, Groups A, B, C, and D, T3 at 93 °C Ambient for use in Canada and the United States.
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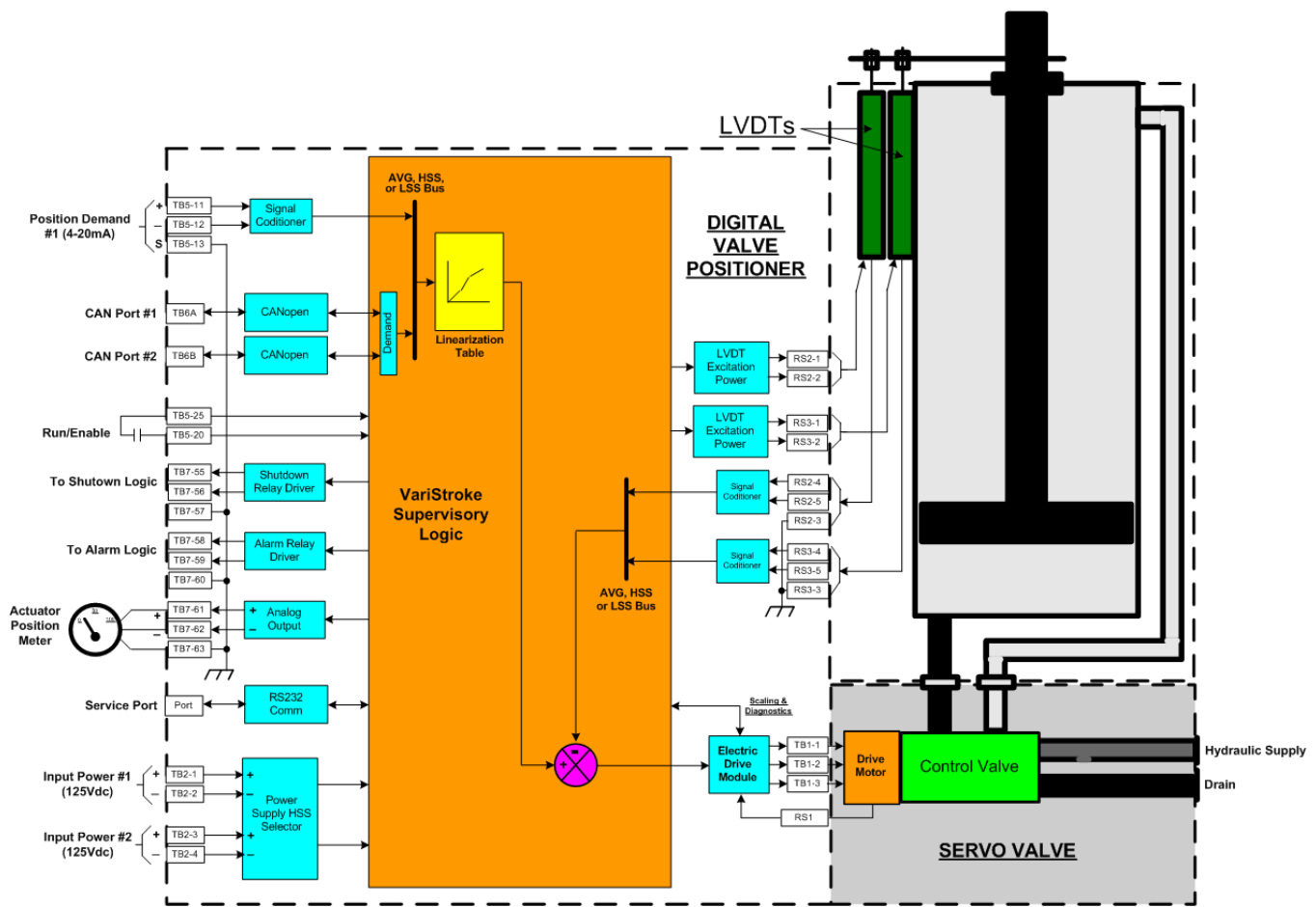


Figure 5. VariStroke-II Interface Schematic



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