WOODWARD

Product Specification **03464**
(Revision B, 11/2022)

VariStroke-GI

Single-Acting Electro-hydraulic Actuator with Optional Trip Function

Applications

The VariStroke-GI is a family of linear electro-hydraulic actuators that are designed to provide the linear actuation force to operate steam turbine control valves, valve racks, and Trip & Throttle Valves (T&TV). This single-acting actuator family 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.

As a product family, users can customize their order to ensure their actuator has the correct bore, length, configuration, shaft threads, and return spring force to meet their specific application.

Single-acting actuators utilize an internal or external return spring to force the output shaft and connected valve to a safe closed position upon a shutdown event. They have several advantages over double-acting actuators, including fail-safe action and not requiring the use of expensive accumulators.

Optionally, users can order VariStroke-GI actuators with or without an integrated fast-acting dump valve. This dump valve is designed to quickly drain oil. Depending on the application, these dump valves can be driven directly from the VariStroke-GI servo or from the turbine shutdown system.

Available Models	Typical Applications
• Single acting integrated power cylinder • Single acting remote power cylinder	• Steam Turbine Control Valves
• Single acting integrated power cylinder with simplex dump valve • Single acting remote power cylinder with simplex dump valve*	• Steam Turbine Control Valves requiring fast slew rates • Steam Turbine (T&TV) Valves requiring fast slew rates
• Single acting integrated power cylinder with dump valve ports* • Single acting remote power cylinder with dump valve ports*	• Steam Turbine Control Valves requiring fast slew rates • Steam Turbine (T&TV) Valves requiring dual or triple redundant dump valves

The VariStroke-GI actuator's robust design (corrosion resistant materials, single moving rotary valve, 50 lbs. chip shear force, and self-cleaning port design) make it ideal for challenging applications where dirty or contaminated oil may be present.

The VariStroke-GI also has redundant features which make it ideal for critical steam turbine applications where turbine up-time and availability are essential. This linear actuator can be configured to accept simplex or dual-redundant position demand inputs, and then select the correct input to follow. This linear actuator's dual-redundant 4–20 mA demand inputs and dual-redundant magnetostrictive linear displacement transducer (MLDT) shaft position sensors allow it to continue to operate even with demand input or feedback sensor failures, ensuring extended run-times between forced outages.

- **Applications**
  - Steam Turbine Control Valves
  - Steam Turbine Trip & Throttle Valves
- **Available with and without dump valves**
- **Fast slew rates/times**
- **Dirt-tolerant design**
- **Variable/ configurable shaft stroke lengths**
- **Precise position control**
- **Side-load tolerant**
- **Integrated driver**
  - Two 4–20 mA demand inputs
  - Included valve flow linearization table
- **Redundant MLDT position sensors**
- **Configurable/ electric valve rack seat cushion**
- **Includes partial stroke test function (when used on TTVs)**
- **Models available for hazardous locations**

*Planned for future release

In turbine retrofit applications, the VariStroke-GI is designed to directly replace both existing antiquated servo systems and power cylinders. 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.

In T&TV applications, the VariStroke-GI can be used to replace old problematic hand valve operated actuators which can stick, break, or be difficult to accurately adjust during turbine starts. The VariStroke-GI can be configured to accept manual reset, raise/lower, and partial stroke test commands. Both an analog 4-20mA signal as well as discrete min & max indication output signals make it easy for operators or the plant DCS to verify T&TV position and health. Turbine owners have expressed that related T&TV hand-wheel to hydraulic VariStroke-GI actuation benefits operator safety, turbine availability, and plant atomization.

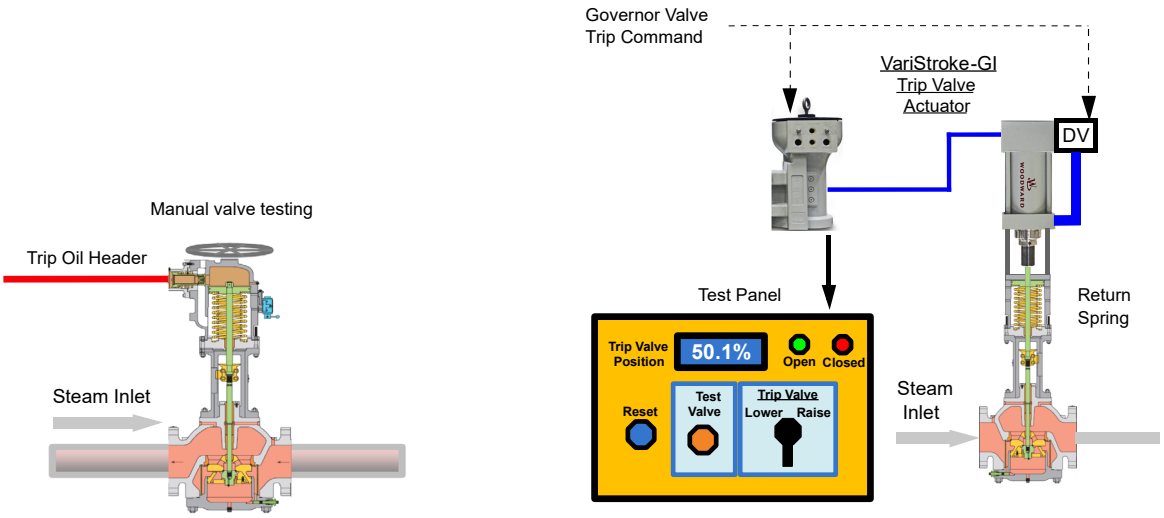


Figure 1. Example T&TV Hand-Wheel to Hydraulic Actuator Conversion

Description

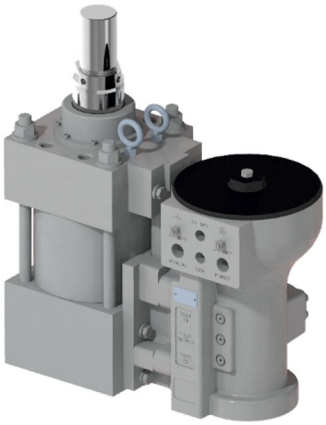
The VariStroke-GI is a linear electro-hydraulic actuator that utilizes a power cylinder with a fail-safe return spring (internal and or external) to force the actuator and connected valve closed during normal operation as well as during a turbine shutdown event. This actuator's integrated electronic driver module, servo valve, and position feedback sensors (MLDTs) function together to precisely control steam turbine control and trip valves.

The VariStroke-GI's special digital controller architecture allows it to perform very stable position control during normal conditions and to 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 failsafe position to safely close turbine control valves upon any internal unit failure (electrical input power failure, position sensor failure, processor failure, etc.).

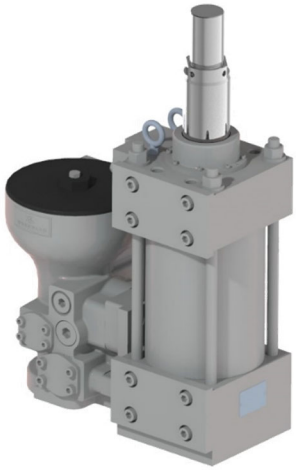
The VariStroke-GI actuator is a product family with different models available for purchase depending on the force, stroke, and redundancy required. This actuator is available with standard bore diameters, standard stroke ranges, and with double acting (pressure return) or double-acting spring assist (pressure and spring return) operation. The VariStroke's unique "variable stroke" capability also allows users to customize/set the actuator's exact stroke length (no less than 50% of mechanical stroke) in the field to meet their required application. The VariStroke-GI is factory and/or field configurable via a computer-based service tool.

Designed to interface directly with turbine controllers and plant DCSs, the VariStroke-GI also includes a 4–20 mA output channel to indicate output shaft position, and uses isolated relay outputs to indicate, alarm, shutdown, conditions and minimum and maximum shaft position. The total installed cost for this fully integrated actuator is low because complete assembly and extensive testing is performed at the factory. This greatly reduces OEM and end-user fabrication time, testing time, and site assembly time.

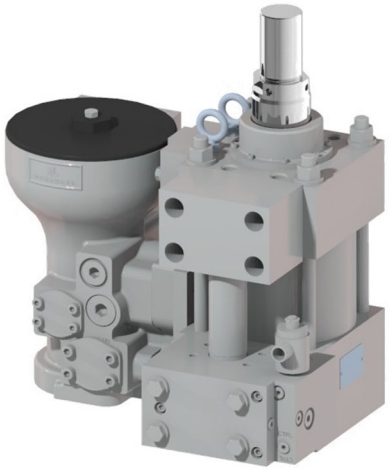
Depending on the application, the VariStroke-GI actuator can be ordered in a variety of configurations. Refer to Figure 2 below to understand the available configurations.



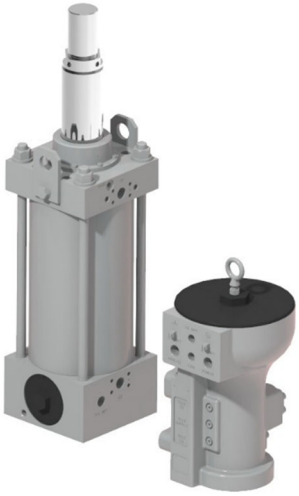
Single Acting Model



Single Acting Model with Dump Valve Ports



Single Acting Model with Dump Valve



Single Acting Model with Remote Cylinder

Figure 2. Available VariStroke-GI Models

Features

Fast Acting Dump Valve — Users can order VariStroke-GI actuators with integrated fast-acting dump valves. When ordered in this configuration, a simplex fast acting dump valve is mounted to the failsafe end of the power cylinder, and depending on the application, it can be driven directly from the VariStroke-GI servo or from the turbine shutdown system. Depending on the model, users can order dump valves to be mounted on the right or left side of the power cylinder.

Fast Acting Dump Valve Ports — Optionally, users can order VariStroke-GI actuators with dump valve ports only. When ordered in this configuration, the VariStroke-GI power cylinder includes ports with removable blanking plates allowing the user to install and or connect their own dump valve assembly.
Note: This configuration allows users of more critical applications to easily connect dual or triple redundant trip block assemblies.

Dirt Tolerance — The VariStroke-GI actuator is specifically designed for steam turbine applications where turbine lube oil is also used to power the hydraulic turbine control valve actuator(s). Steam turbine applications can be extremely challenging for hydraulic control valve actuators as dirt, metal shavings, water, and other contaminants (Babbitt, ammonia, etc.) are common in such oil systems. Additionally, due to the high temperatures at which steam turbines operate, turbine oil breakdown is common, resulting in the creation of a sludge-type substance and the

varnishing of internal system components. However, the VariStroke-GI actuator is designed to operate reliably within such challenging applications. Its corrosion-resistant materials, single moving rotary valve, 50 lbs. of chip shear force, and self-cleaning port design allow it to operate in such applications without experiencing undesirable sticking or dragging.

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-GI actuator incorporates a high-force precision bearing and special seal technology on its output shaft to solve this typical application problem.

T&TV – Trip and Throttle Valve — The VariStroke-GI may be used in T&TV applications. The unit can be configured using the PC Service Tool to accept raise/lower commands from the discrete inputs and single or dual analog inputs for the position setpoint. The valve opening and closing rates and partial stroke test values are also configurable.

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-GI 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.

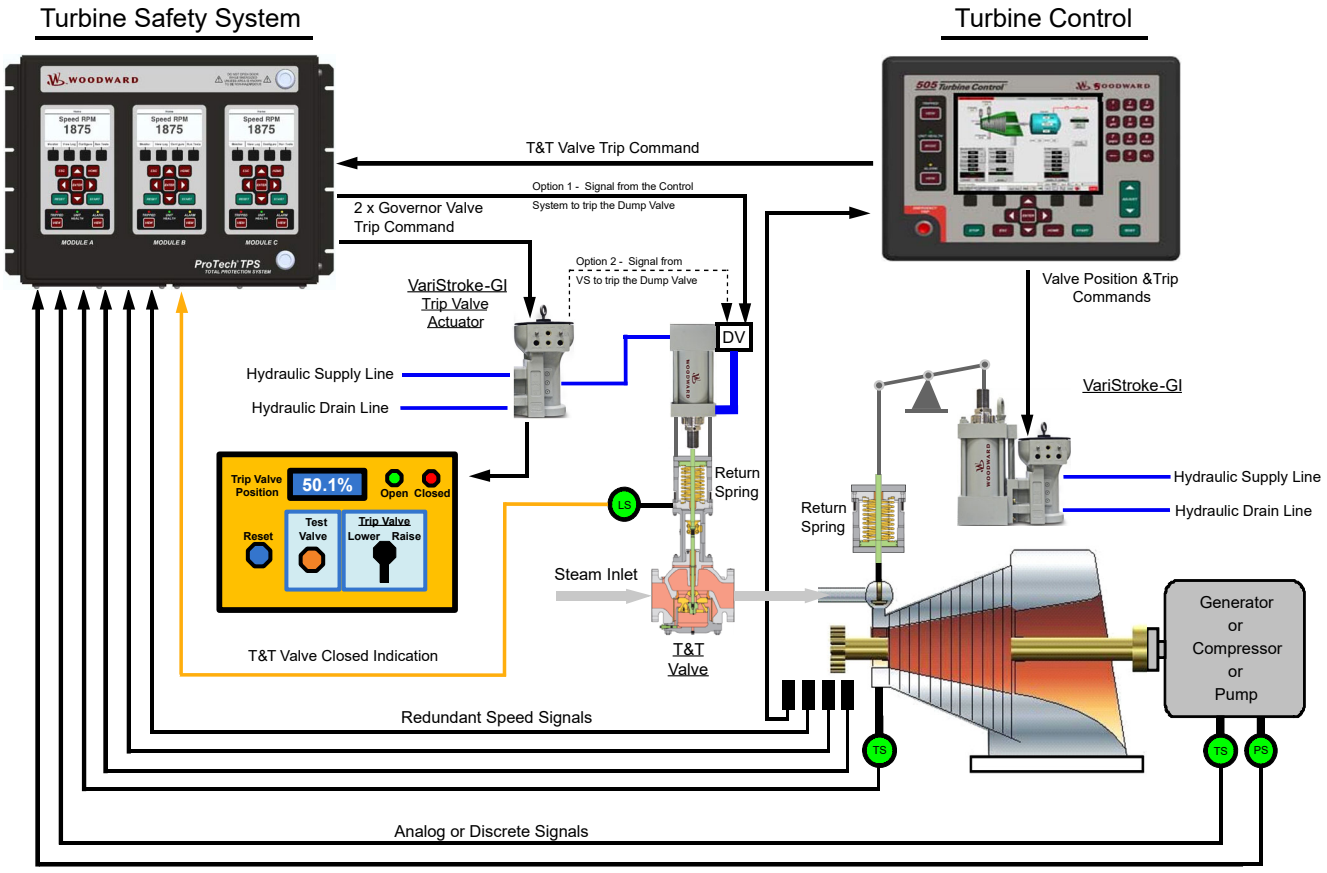


Figure 3. Typical VariStroke-GI Applications

Specifications

Performance

Position Accuracy:	±2% of full range
Position Repeatability:	±1% of full range
Temperature Drift:	0.04%/°C
Failsafe Operation:	Internal return spring on servo valve
Open Slew Rate:	Configurable
Slew Rate:	Up to 1140 mm/s (without dump valve)
Configuration:	Computer-based Service Tool (RS-232 communications port) Linearization table allows valve rack flow linearization

Physical

Available Model Stroke Range:	50.8-76.2-101.6-152.4-203.2-254-304.8 mm / 2-3-4-6-8-10-12 inches Determined by model number (cylinder bore size & direction dependent)
Max Stall Force:	Retract direction = 2300—14 200 kgf @ 34.5 bar / 5080—31 300 lbs @ 500 psig Extend direction = 2850—17 800 kgf @ 34.5 bar / 6280—39 200 lbs @ 500 psig
Cylinder Dimensions:	Determined by model number; available bore sizes 101.4-127-152.4-203.2-254 mm (4-5-6-8-10 inches)
Cylinder Types:	Single-acting (can be ordered with & without internal return spring)
Failsafe Direction:	Extend or Retract (determined by model number)
Actuator Dimensions:	Determined by configuration
Weight:	Determined by model number
Mounting:	Any attitude (bolt patterns & sizes are determined by model number)

Environmental

Operating Temperature Range:	–40 to +85 °C (–40 to +185 °F)
Operating Oil Temperature Range:	+15 to +70 °C (+59 to +158 °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^2/Hz, 10–500 Hz, 1.04 Grms)
Ingress Protection:	IP66 per IEC/EN 60529

Electrical

Input Supply:	18–32 Vdc @ 2.3 A steady state, 10 A peak (100 ms maximum)
Analog Input Signals:	Isolated 4–20 mA (200 Ω input impedance)
Analog Output Signal:	4–20 mA – maximum external load: 500 Ω
Discrete Inputs:	Optically isolated (requires 24 Vdc wetting voltage)
Discrete Outputs Rating:	0.5 A @ 24 Vdc
Service Tool Port:	RS-232 communications

Hydraulic

Supply Pressure Range:	3.45 to 34.5 bar (50 to 500 psig)
Fluid Types:	Mineral or synthetic or Fyrquel EHC-based oils may be used
Recommended Oil Cleanliness:	24 to 40 pm nominal, β_{75} (ISO 4406 code 20/18/16 Class) max
Recommended Viscosity:	20 to 100 centistokes
Fluid Ports:	SAE J518 Code 61
Steady State Oil Consumption Max:	10.8 L/min @ 34.5 bar (2.8 US gal/min @ 500 psig)
Max Flow Rate:	358 L/min @ 5.5 bar / 95 US gal/min @ 80 psig 929 L/min @ 34.5 bar / 245 US gal/min @ 500 psig

Regulatory Compliance

(Listings are limited only to those units bearing the appropriate marking or agency information. See model number compliance code)

European Compliance for CE Marking

EMC Directive:	2014/30/EU
ATEX Directive:	2014/34/EU Zone 1: PENDING Zone 2: II 3 G, Ex nA IIC T4 Gc IP66

Other European Compliance

Machinery Directive:	Compliant as a partly completed machinery per 2006/42/EC
Pressure Equipment Directive:	Compliant as “SEP” per Article 4.3 to 2014/68/EU

International Compliance

IECEx:	Certified for use in hazardous locations per IECEx 13.0041X Zone 1: PENDING Zone 2: II 3 G, Ex nA IIC T4 Gc IP66

North American Compliance

CSA:	For use in Canada and the United States. Class I, Div. 1, Groups C&D T4 and Class I, Div. 2 Groups A,B,C,D T4

See Technical Manual B35119 for additional regulatory compliance information.

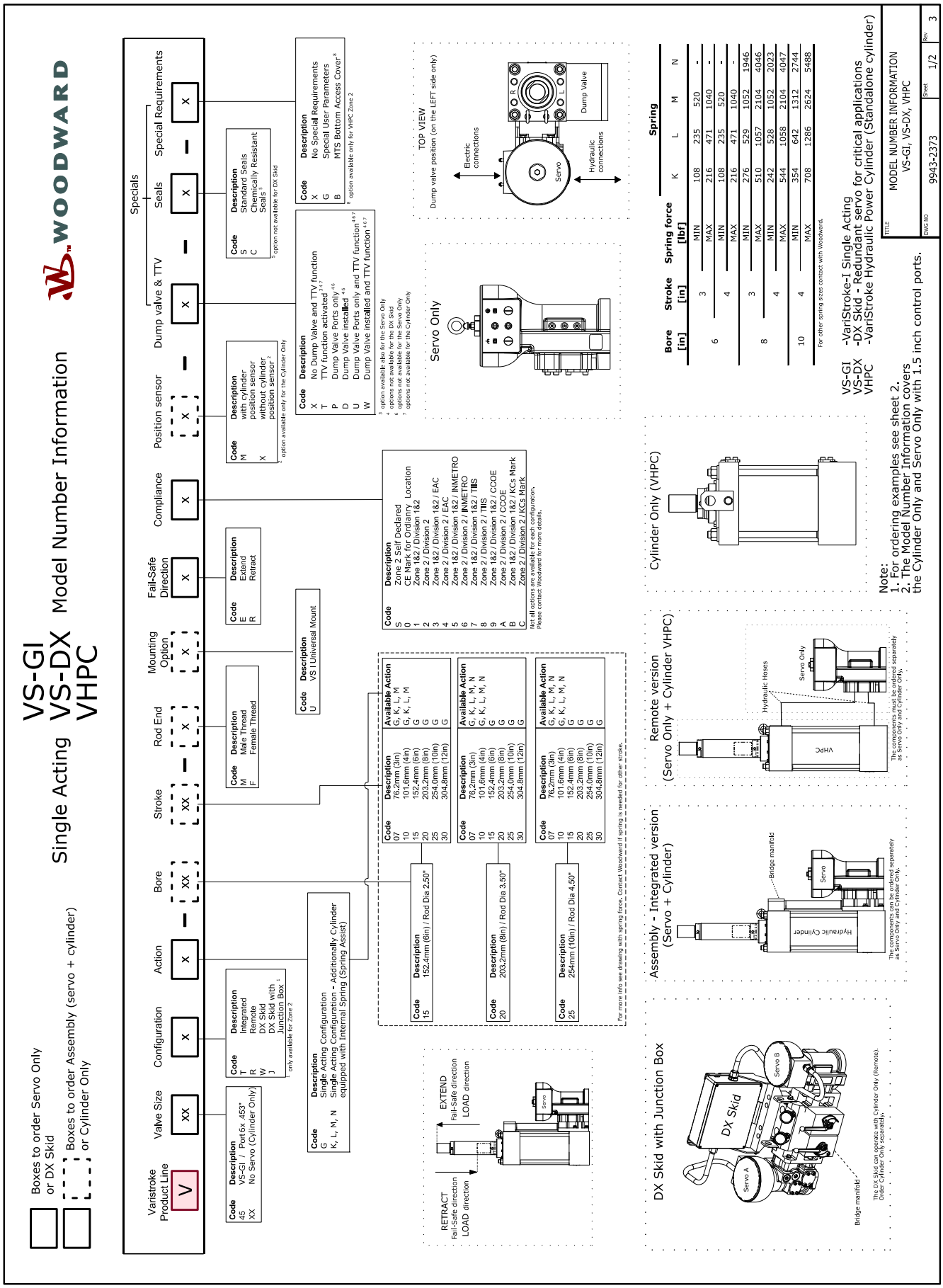


Figure 4. VariStroke GI Available Models / Ordering Number Encoder (page 1)

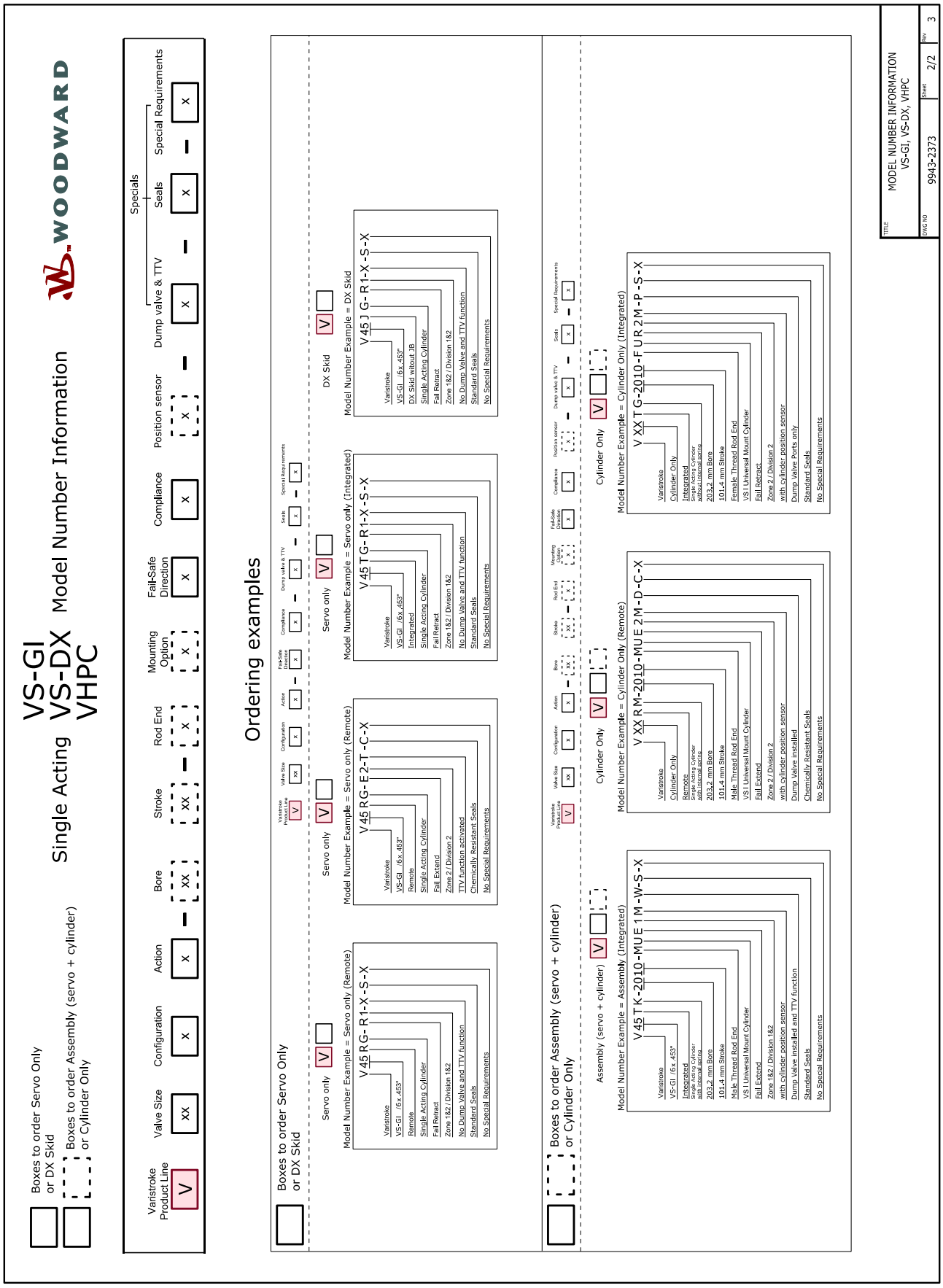


Figure 5. VariStroke GI Available Models / Ordering Number Encoder (page 2)

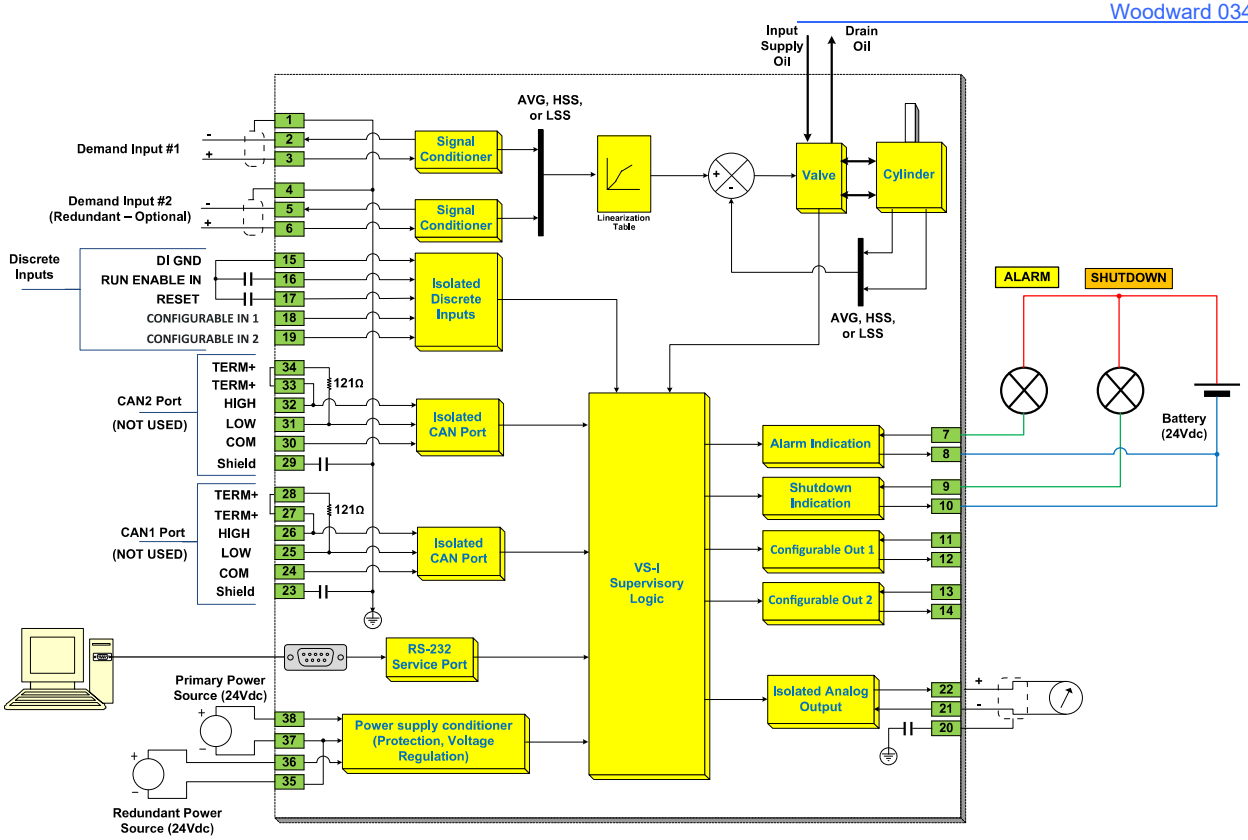


Figure 6. VariStroke-GI Interface

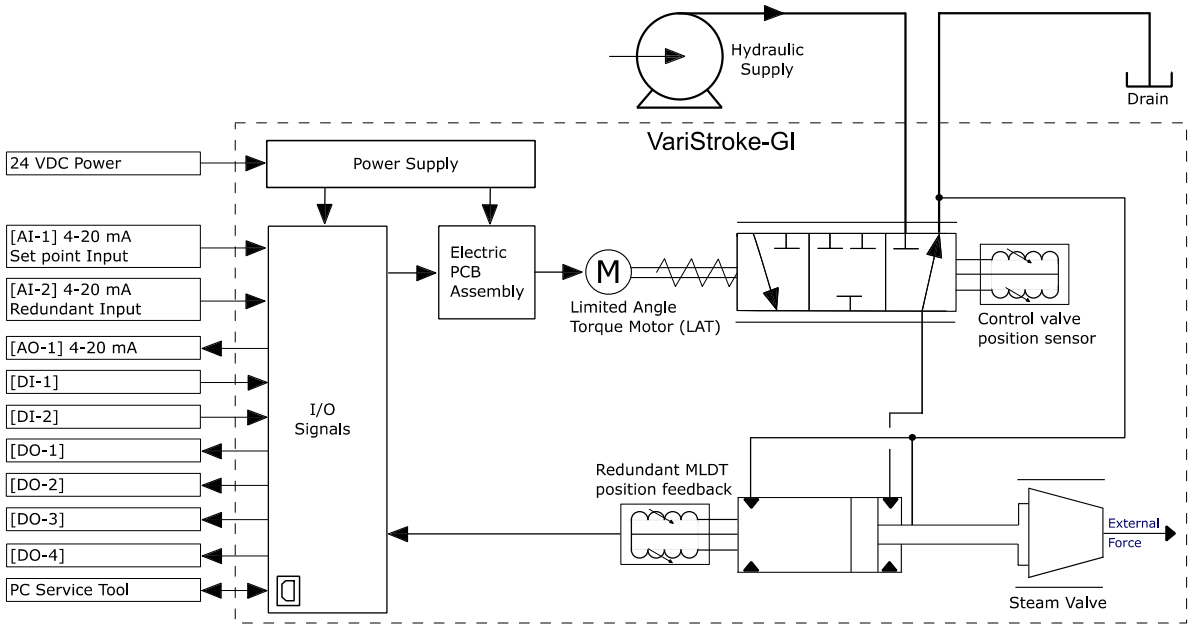


Figure 7. Basic Device Block Diagram

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For more information contact: