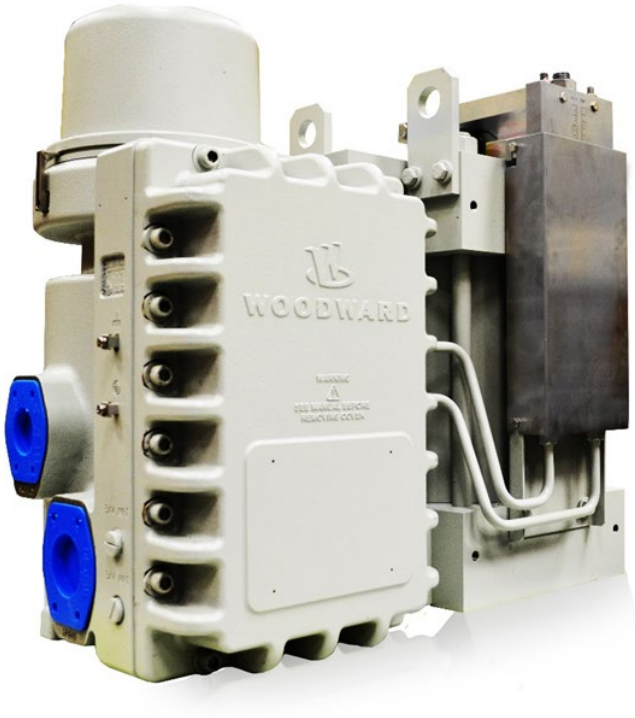
WOODWARD

Product Manual 26740
(Revision G, 1/2025)
Original Instructions



VariStroke-II (VS-II) Electro-Hydraulic Actuator

Installation and Operation Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. The latest version of most publications is available on the Woodward website.

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Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

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Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

If your publication is not on the Woodward website, please contact your customer service representative to get the latest copy.

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Warnings and Notices

Important Definitions



This is the safety alert symbol used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
- **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
- **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
- **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

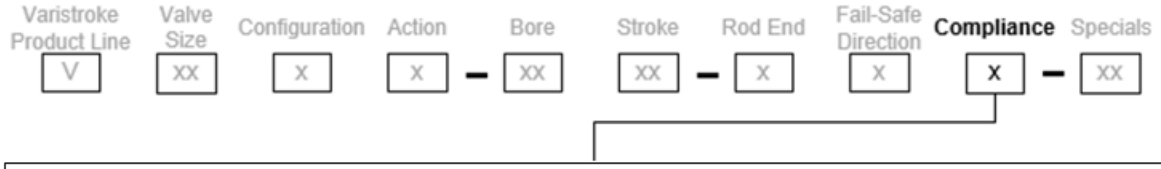
1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible since they do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. After removing the old PCB from the control cabinet, immediately place it in the antistatic protective bag.

IMPORTANT

External wiring connections for reverse-acting controls are identical to those for direct-acting controls.

Regulatory Compliance

VariStroke Model Number Information



Code	Description
0	CE marked for ordinary locations
1	North American Div 1 & 2, ATEX/IECEx Zone 1 & 2
2	North American Div 2, ATEX/IECEx Zone 2
3	North American Div 1 & 2, ATEX/IECEx Zone 1 & 2, EAC
4	North American Div 2, ATEX/IECEx Zone 2, EAC
5	(Reserved for Future Use)
6	(Reserved for Future Use)
7	(Reserved for Future Use)
8	(Reserved for Future Use)
9	North American Div 1 & 2, ATEX/IECEx Zone 1 & 2, CCOE
A	North American Div 2, ATEX/IECEx Zone 2, CCOE
B	(Reserved for Future Use)
C	(Reserved for Future Use)

European Compliance for CE Marking
These listings are limited only to those units bearing the CE Marking

EMC Directive: Declared to Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC).

ATEX – Potentially Explosive Atmospheres Directive: Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres.
Zone 1: II 2 G Ex db IIB T4 Gb, Sira 14ATEX1028X
Zone 2: II 3 G Ex nA IIC T4 Gc
Note: ATEX EU-Type Certificate is limited to Category 2 (Zone 1). See Declaration of Conformity for clarification.

Other European and International Compliance
Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking:

ATEX Directive: Exempt from the ATEX Directive 2014/34/EU as non-electrical equipment bearing no potential ignition sources per EN ISO 80079-36:2016 for Zone 1 installation.

Machinery Directive: Compliant as partly completed machinery with Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on machinery.

Pressure Equipment Directive: Compliant as “SEP” per Article 4.3 to Pressure Equipment

Directive 2014/68/EU on the harmonisation of the laws of the Member States relating to making pressure equipment available on the market.

RoHS Directive: Restriction of Hazardous Substances 2011/65/EU:
Woodward turbomachinery systems products are intended exclusively for sale and use only as a part of Large Scale Fixed Installations per the meaning of Art.2.4(e) of directive 2011/65/EU. This fulfills the requirements stated in Art.2.4(c) and as such the product is excluded from the scope of RoHS2.

EAC Customs Union
These listings are limited only to those units with labels, marking, and manuals in Russian language to comply with their certificates and declaration.

EAC Customs Union (Marked): Certified to Technical Regulation CU 012/2011 for use in potentially explosive atmospheres per Certificate RU C-US.МЮ62.B04436
Zone 1: 1Ex d IIB T4 Gb X
Zone 2: 2Ex nA IIC T4 Gc X

Other International Compliance
These listings are limited only to those units bearing the appropriate marking. Review the Compliance Code table for more information.

IECEx: Certified for use in explosive atmospheres per Certificate:
IECEx CSA 13.0041X
Zone 1: Ex db IIB T4 Gb
Zone 2: Ex nA IIC T4 Gc

CCOE (PESO) India: Certified for explosive atmospheres under Petroleum Rules 2002. Zone 1 and Zone 2 per the IECEx certificate above.

North America Compliance
These listings are limited only to those units bearing the appropriate marking. Review the Compliance Code table for more information.

CSA: Certified for Class I, Div.1 Groups C, D T4 or Class I, Div. 2 Groups A, B, C, D T4. For Use in Canada and the United States. Certificate 2669905.

Special Conditions for Safe Use:
Wiring must be in accordance with North American, European, or other international wiring methods as applicable, and in accordance with the authority having jurisdiction.

A conduit seal must be installed within 457 mm (18 inches) of the conduit entry when the product is used in Zone 1 or Class I, Division 1 hazardous locations. Conduit barriers are not required for Zone 2 or Class I, Division 2 installation.

Field wiring must be suitable for at least +85 °C and 10 °C above the maximum fluid and ambient temperatures. The maximum hydraulic oil temperature is 70 °C continuous.

The flameproof joints are not intended to be repaired. Contact Woodward for information on the dimensions of the flameproof joints, if needed. Return to Woodward for repair and maintenance.

Connect external safety ground terminal to earth ground.

Compliance with the Machinery Directive 2006/42/EC noise measurement and mitigation requirements is the responsibility of the manufacturer of the machinery into which this product is incorporated.

Under certain extreme circumstances, the non-metallic parts incorporated in the enclosure of this equipment may generate a level of electrostatic charge capable of ignition. Therefore, do not install the equipment in a location where the external conditions are conducive to the build-up of electrostatic charge on such surfaces. Proper grounding when used in a fixed installation mitigates this risk. In addition, only clean the equipment with a damp cloth.

For VS-II installed in a Zone 2 area:

- Transient protection for the VS-II is to be provided externally by the end user. The transient protection device is to be set at a level not exceeding 140% of the peak rated voltage (150 Vdc).
- The installation of VS-II shall only be within a Pollution Degree 2 environment as defined in IEC 606641.

⚠WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuits are live unless area is known to be non-hazardous.
Substitution of components may impair suitability for Class I, Division 1/2 or Zone 1/2 applications.

⚠AVERTISSEMENT

Risque d'explosion -- Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous situez bien dans une zone non explosive.
La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division 2 ou Zone 2.

⚠WARNING

The external ground lugs shown on the installation drawing must be properly connected to ensure equipotential bonding. This will reduce the risk of electrostatic discharge in an explosive atmosphere.

Safety Symbols


Direct current


Alternating current


Both alternating and direct current


Caution, risk of electrical shock


Caution, refer to accompanying documents


Protective conductor terminal


Frame or chassis terminal

Chapter 1.
General Information

Introduction

The VariStroke-II is a linear electro-hydraulic actuator that utilizes a double-acting power cylinder with integrated electronic driver module, servo valve, and redundant LVDT (Linear Variable Differential Transformer) position feedback sensors to precisely control steam turbine valves. The actuator's driver module accepts one 4–20 mA position demand 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 combined with an integrated rotary servo valve that ports supply oil to and from its power cylinder. The actuator digital controller architecture allows it to perform stable position control during normal conditions, and also respond quickly to desired valve step changes during system or plant transients. As a means of protecting the turbine, an internal servo valve return spring forces the actuator to a failsafe position upon any internal unit failure (electrical input power failure, position sensor failure, processor failure, etc.).

The VariStroke-II actuator is part of a product family with many different models available for purchase depending on the force, stroke, and redundancy needs. This actuator is available with standard bore diameters and standard stroke ranges. The VariStroke-II's unique "variable stroke" capability also allows users to customize/set the actuator's exact stroke length in the field to meet their requirement.

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 position, and unit alarm and shutdown relay outputs for use as unit health and status indications.

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

The VariStroke-II Actuator offers the following benefits to the user in comparison to other electro-hydraulic actuators:

Dirt Tolerance

The VariStroke-II 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. Also 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-II actuator is designed to operate reliably within such challenging applications. Its corrosion-resistant materials, single moving rotary valve, 610 N (137 lbf) of chip shear force, and self-cleaning port design allow it to operate in such applications without experiencing undesirable sticking or dragging.

Silt Buster

A patented self-cleaning feature that flushes silt and debris from the servo valve. At the interval and amplitude selected by the user, this function provides a very rapid motion of the servo valve spool, allowing any silt to be flushed to the drain passage. This motion is followed immediately by a step of equal amplitude in the opposite direction. The opposing symmetry of the impulse results in no net change in fluid volume to the hydraulic power cylinder, and thus does not interrupt the control of the turbine. This unique feature provides a high degree of stability, reliability, and silt resistance.

Valve Rack Linearization (not currently available)

Because steam flow through single and staged inlet steam valves tends to be non-linear throughout their flow range, turbine controls must be de-tuned to compensate for instability or sluggish control points throughout this range. As a way of allowing turbine control optimization without detuning, 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 triple-seal technology on its output shaft to solve this typical application problem.

VS-II Integrated, Remote Servo Valve Kit, and Remote Servo Valve Construction

The VariStroke-II Integrated actuator is made up of the following major components (Figure 1-1a):

1. Hydraulic Power Cylinder
2. Rotary Servo Valve
3. Feedback Sensors: Redundant LVDTs (Linear Variable Differential Transformer) – for hydraulic power cylinder position controlling
4. Integrated electronic driver module (PCB)

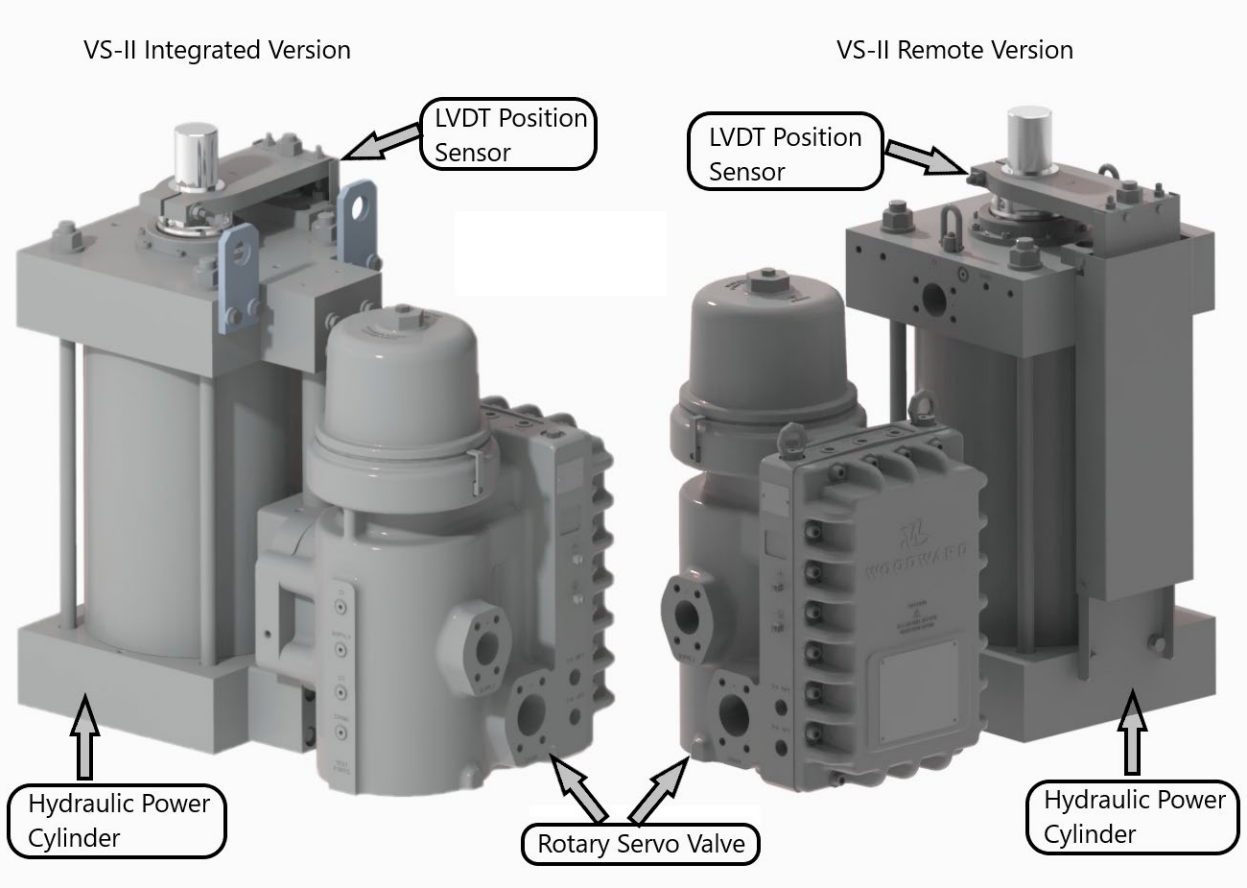


Figure 1-1a. Integrated Actuator Option VariStroke-II Key Features

The VariStroke-II Remote Servo Valve Kit option (Figure 1-1b) contains the same primary components as integrated version. This kit allows the Hydraulic Power Cylinder to be mounted separately from the servo in applications where space is constrained and user supplied hydraulic lines are used to connect the servo and cylinder.

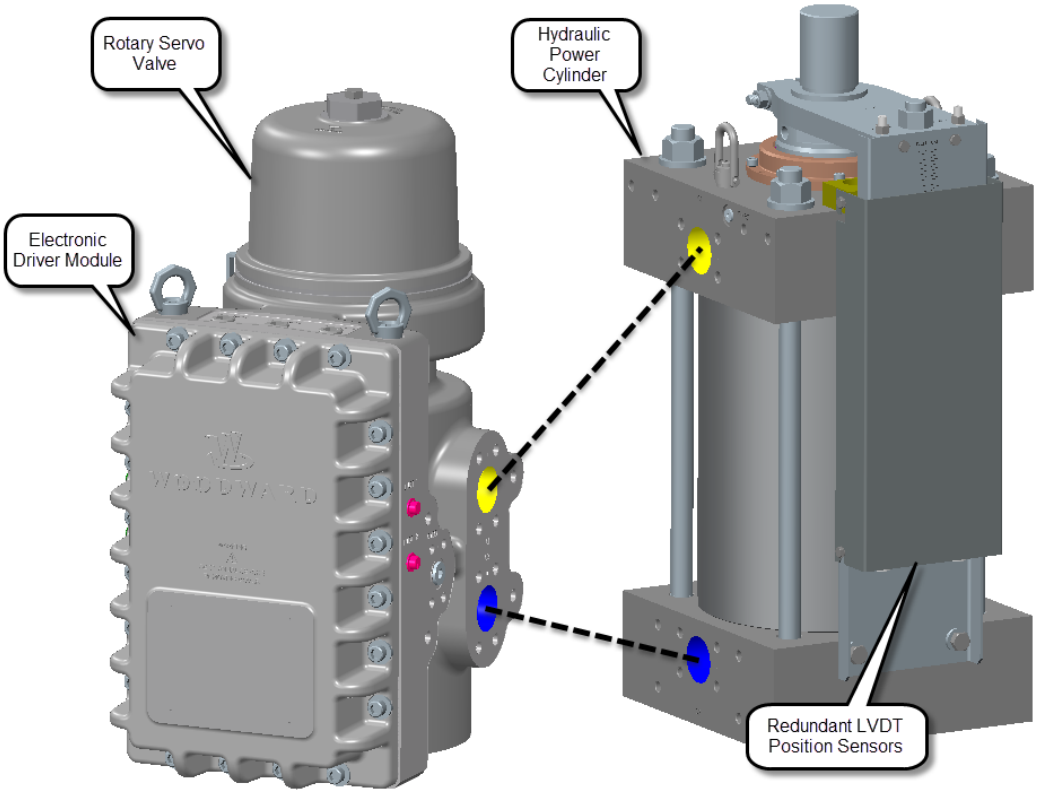


Figure 1-1b. Remote Servo Kit Option VariStroke-II Key Features

The VariStroke-II Remote Servo Valve only (Figure 1-1c) contains just the Servo Valve. The Remote Servo option allows the servo valve to be mounted in a location away from the Hydraulic Power Cylinder in applications where space is constrained. A customer supplied Hydraulic Power Cylinder, with Woodward approved LVDT's, can be used with this Servo Valve only option. Customer supplied hydraulic lines are used to connect the servo and cylinder.

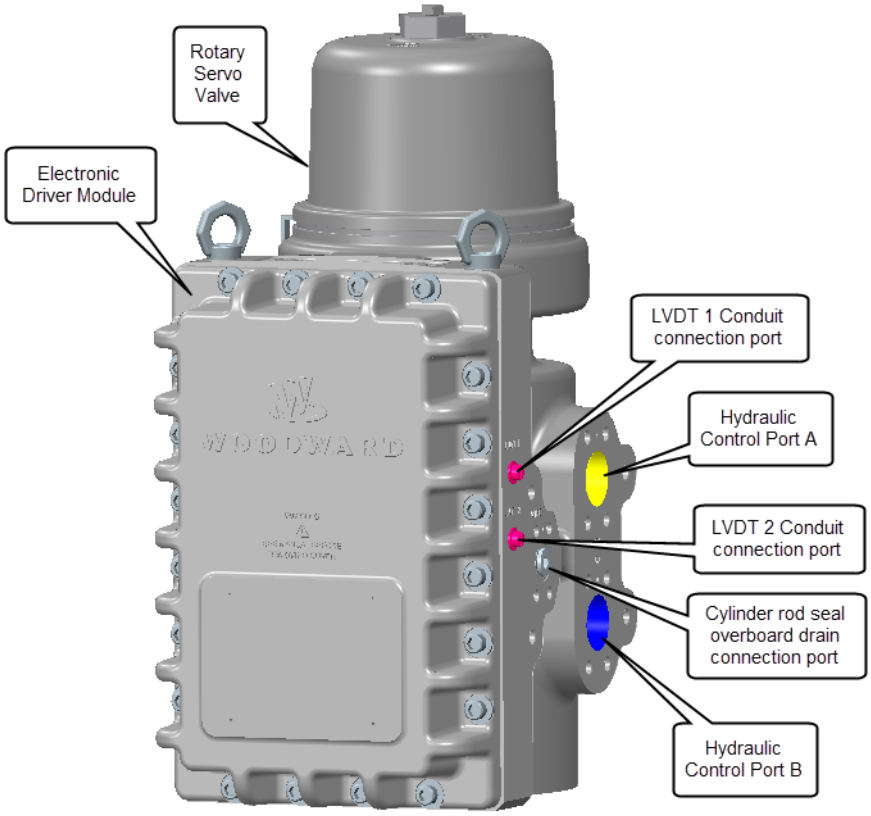


Figure 1-1c. Servo Valve Option VariStroke-II Key Features

Hydraulic Power Cylinder

The simple and robust design of VS-II hydraulic cylinder is capable of consistent performance for extended periods in challenging environments. The hydraulic cylinder is designed to operate with a wide range of hydraulic pressures and with high oil contamination. The actuation stroke range is electronically controlled and can be adjusted precisely using PC service tool, allowing the actuator to be set up to operate at user configured stroke lengths.

The hydraulic Power Cylinder is designed to be field replaceable (in turbine shutdown condition).

The VariStroke-II Remote Servo Valve can be connected to any hydraulic cylinder, however; proper operation requires that the VariStroke-II Stability Equation be satisfied (see Chapter 2, Stability Specifications). In order to control cylinder position, the Cylinder must be equipped with a Woodward LVDT position feedback sensor(s). The position sensor(s) must meet the specifications listed in Chapter 2.

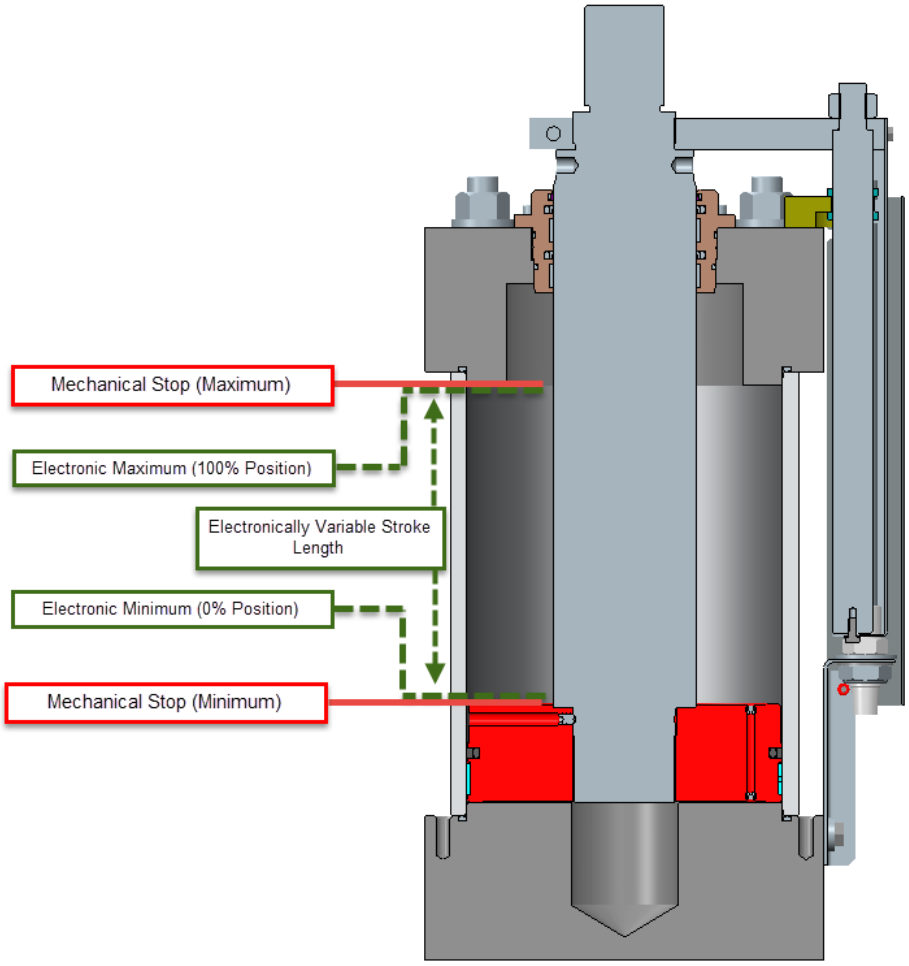


Figure 1-2. Hydraulic Power Cylinder Stroke Adjustment Options

Rotary Servo Valve

The hydraulic valve has four ports: Supply, two Control Ports, and Drain/Tank. With the hydraulic valve in its middle position, all ports are blocked. As the valve rotates, the supply is connected to a control port while simultaneously connecting the drain to the other control port. The combined action of the servo position controller and cylinder position controller modulate the power cylinder position as necessary to match the input demand.

A unique function included in in the control software, called “Silt Buster”, is a periodic, symmetrically opposed impulse which flushes silt and debris from the servo valve without causing undue wear. At the interval and amplitude selected by the user, this function provides a very rapid motion of the servo valve spool allowing any silt to be flushed to the drain passage. This motion is followed immediately by a step of equal amplitude in the opposite direction. The opposing symmetry of the impulse results in no net change in fluid volume to the hydraulic power cylinder, and thus does not interrupt the control of the turbine. This unique function provides a higher degree of stability, reliability, and silt resistance.

If the unit detects any diagnostic shutdown condition, or if the detected diagnostic condition prevents reliable control, or if a loss of power occurs, the servo valve return spring forces the servo valve to connect the appropriate control ports to drain causing the power cylinder to move to the fail-safe position.

Servo Valve Actuator

The VS-II uses a rotary Limited Angle Torque (LAT) actuator. The permanent magnet rotor is directly coupled to the servo valve. The position of the rotor is measured by a resolver. The H-bridge drive is regulated by the microprocessor to precisely control the servo valve position and maintain the cylinder position demand.

Electronic Driver Module

The VS-II uses Woodward’s state-of-the-art VariStroke II as the driver for the servo valve actuator control and for cylinder positon control. The VariStroke II is packaged inside the servo valve enclosure. The VariStroke II accepts either an analog (4-20 mA) or CAN position demand signal and uses +125 Vdc input power supply. Redundant power supply terminals are included. The actuator calibration and configuration can be performed using PC based service tool.

Cylinder Position Control

The cylinder position controller function of the VariStroke II adjusts the hydraulic power cylinder position to match the feedback signal to the position demand signal.

Both the servo valve position controller and cylinder position controller are monitored by the VariStroke II to ensure accurate tracking.

The position controller regulates a Pulse Width Modulated (PWM) drive signal to the servo valve actuator. The drive current to the actuator is regulated, transiently allowing up to 40 Amps to be provided to move the actuator at its maximum speed. A steady state current limit reduces the current to 20 amps after a few seconds to protect the actuator and electronics.

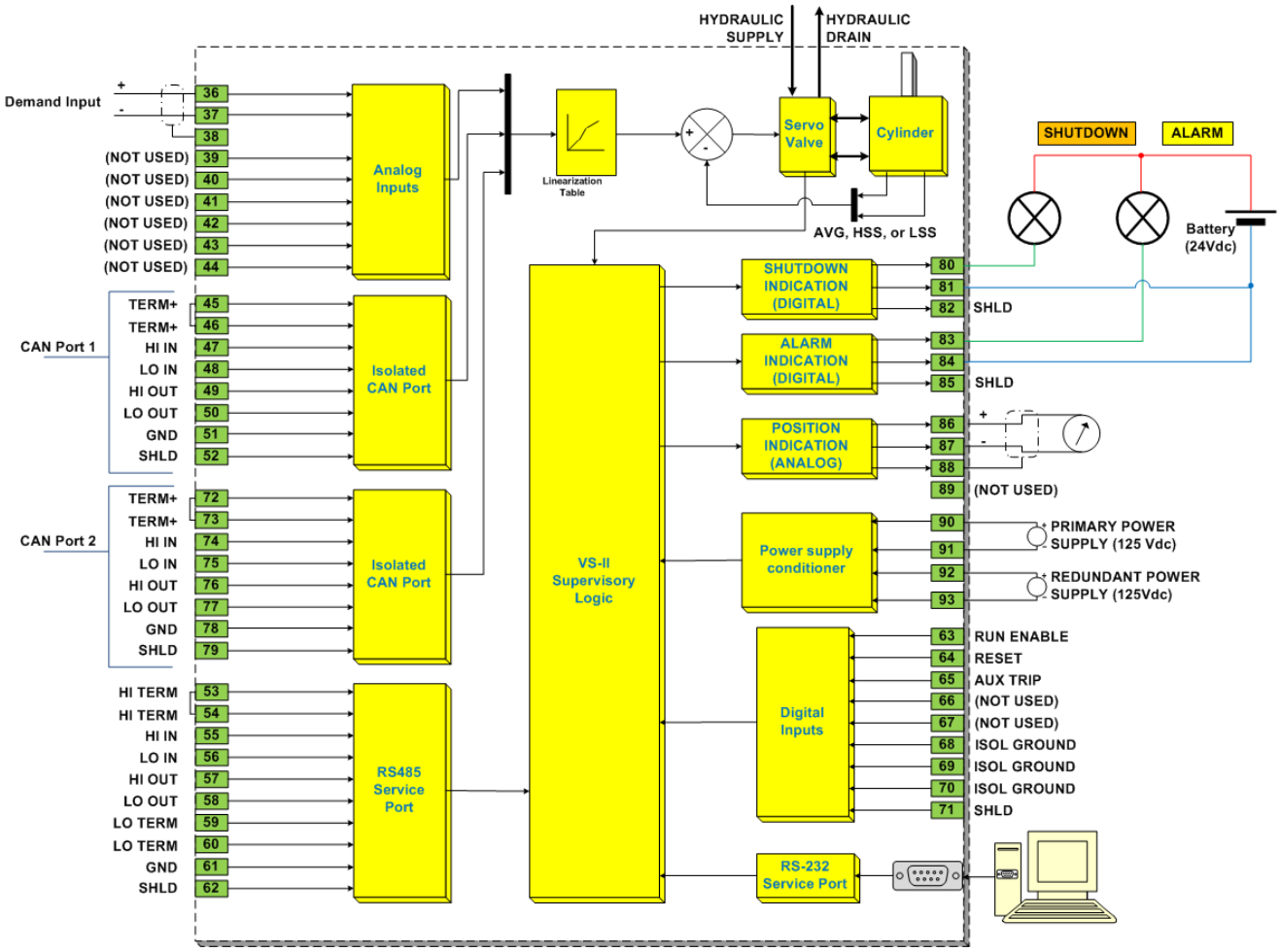


Figure 1-3. Application Example

Ordering Information

The actuator must be sized to meet the application needs by matching an appropriately sized servo valve to the hydraulic cylinder. It can be further customized by choosing from the option table below (Figure 1-4).

Note: There are some limitations to combining certain servo valve-to-hydraulic-cylinder sizes. Please consult Woodward for sizing recommendation and availability.

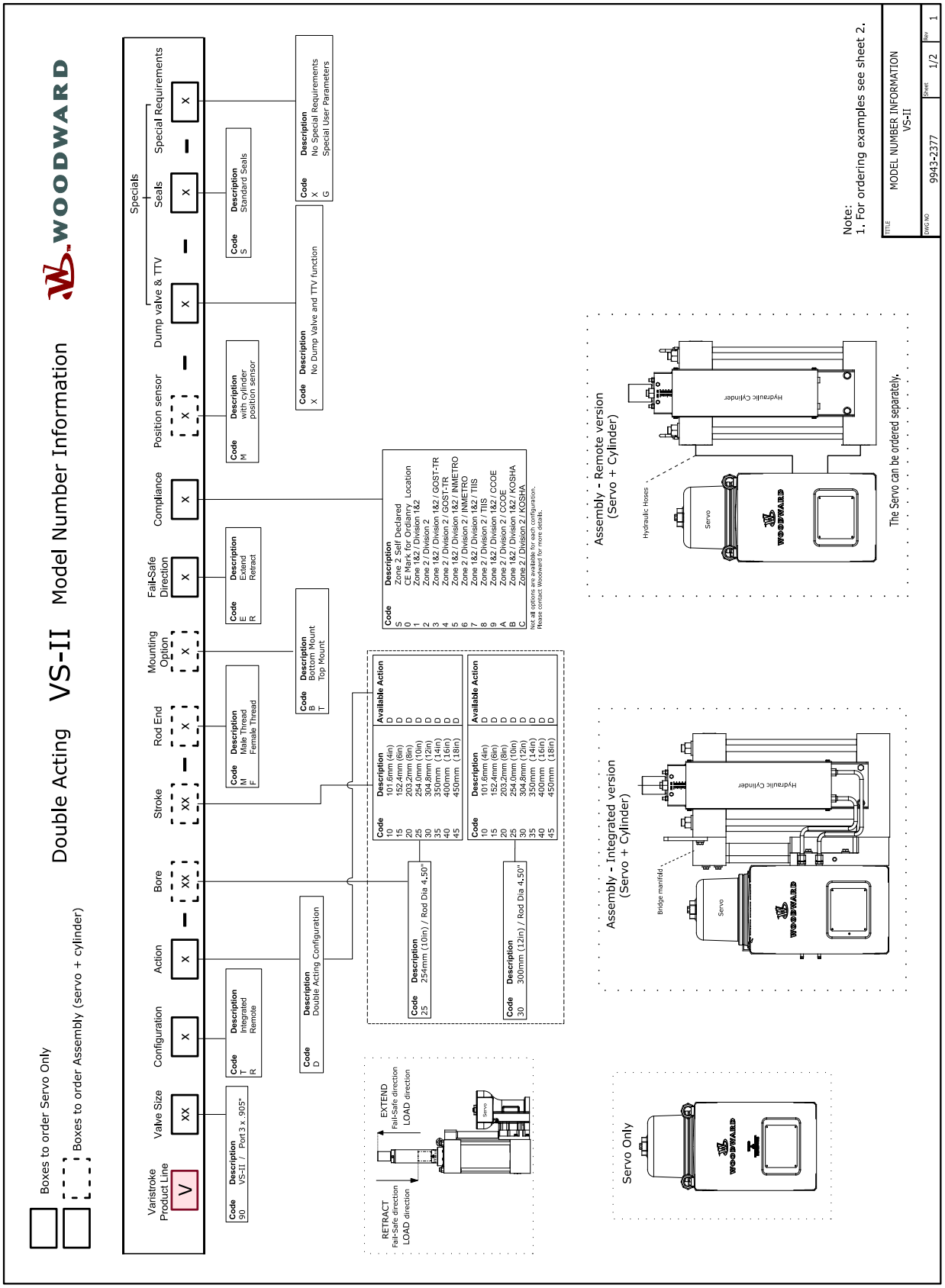


Figure 1-4. Nomenclature and Ordering Number Encoder (page 1)

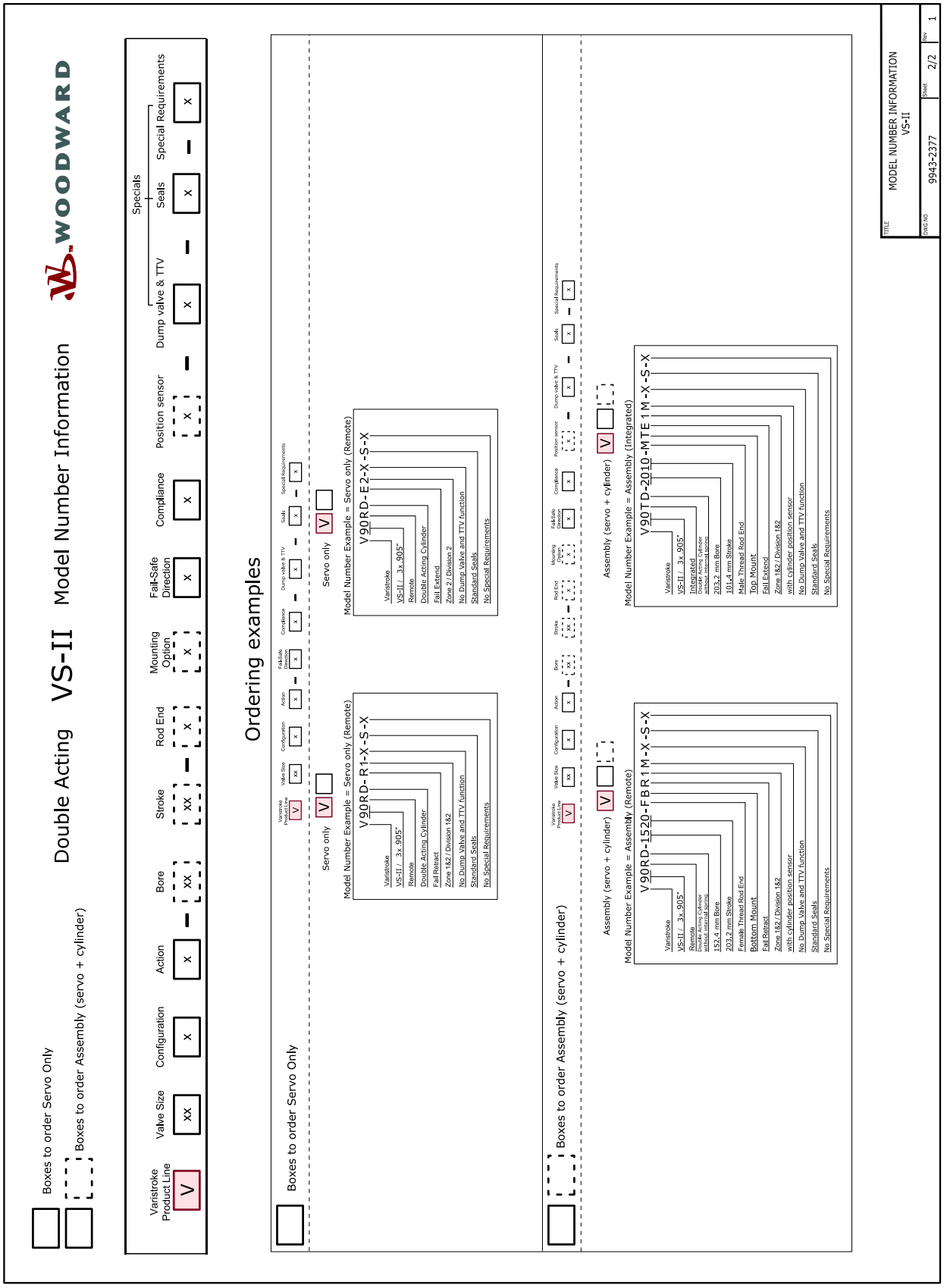


Figure 1-5. Nomenclature and Ordering Number Encoder (page 2)

Chapter 2.
Specifications

Physical and Performance Specifications

Table 2-1a. Physical and Performance Specifications

Bore Diameter (OD)	Rod Diameter (ID)
203.2 mm (8 inches)	88.9 mm (3.5 inches)
254.0 mm (10 inches)	114.3 mm (4.5 inches)
304.8 mm (12 inches)	114.3 mm (4.5 inches)
Stall Force (extending):	
Extend Stall force can be obtained from following equation:	
$\text{Extend Stall} = \frac{\pi\ OD^2}{4} p$ [in² • psi = lbf] or [mm² • MPa = N]	
Stall Force (retracting):	
Retract Stall force can be obtained from following equation:	
$\text{Retract Stall} = \frac{\pi\ (OD^2 - ID^2)}{4} p$ [in² • psi = lbf] or [mm² • MPa = N]	
Extending Slew Rate:	Configurable
Retracting Slew Rate:	Configurable

Note: Slew Rates for Remote Servo Applications may be 10–15% slower due to pressure drop on servo to cylinder piping.

IMPORTANT

It is highly recommended that inlet supply pressure not decrease by more than 10% of nominal value during slew/step.

Table 2-1b. Physical and Performance Specifications (Continued)

Position Accuracy:	±1% of full stroke
Position Repeatability:	±0.5% of full stroke
LVDT Temperature Drift:	0.04% /°C
Failsafe Operation:	Internal return spring on servo valve spool force the Hydraulic Power Cylinder to extend or retract (part number depended) in case of electrical signal loss.

⚠WARNING

Make sure that the VS-II hydraulic connections are installed correctly. Equipment damage is possible if the hydraulic connections are attached incorrectly (backwards). Reversed hydraulic connects will cause the actuator to operate backwards, making the fail-safe position opposite of where the user expects it to be.

Environmental Specifications

Table 2-2. Environmental Specifications

Ambient Temperature:	–40 to +85 °C / –40 to +185 °F
Vibration Resistance:	MIL-STD 810F, M514.5A, Cat. 4 (0.015 G²/Hz, 1.04 Grms)
Shock Resistance:	US MIL-STD-810C method 516.2, procedure 1 (10 G Peak, 11 ms duration, saw tooth)
Corrosion resistance:	Two part epoxy paint coating. Designed for outdoor conditions
Ingress Protection (IEC 60529, IEC 60079-0):	IP66

Electrical Specifications

Table 2-3. Electrical Specifications

Input Power Supply:	90 to 150 Vdc (125 Vdc Nominal)
Current Consumption:	2 A Continuous 10 A Transient (200 ms maximum)
Demand Signal:	4 to 20 mA into 400 k□. >70 dB CMRR. Common Mode Voltage Range ±100 V , Accuracy 0.1% of full scale @ 25 °C
Analog Output Signal:	4 to 20 mA. Maximum load: 500Ω. Accuracy 0.5% of full scale @ 25 °C
Discrete Output Signal:	Configurable NO or NC 0.5 A at 24 V (dc), max 32 V (dc) 0.5 A inductive at 28 (dc) 0.2 henry
Discrete Input Signal:	Contact current 3.8 mA (typ.) @ input closed Max input voltage 32 V (dc), High signal threshold > 7 V; Low signal Threshold < 3 V
Cylinder Feedback Device:	2x LVDT (Linear Variable Differential Transformer) Excitation: 3.0 VRMS at 5000 Hz
Connections:	Power: Removable terminal block for 8 mm² or 8 AWG I/O: Removable terminal block for 0.5 to 1 mm² or 20 -16 AWG
Electrical Conduit Ports:	Analog/Discrete I/O:4 x 0.750”-14 NPT Power: 2x 0.750”-14 NPT LVDT Conduit: 2x .500”-14 NPT 2 X Ground

Cylinder Position Sensor (LVDT) Requirements (Remote Servo Only)

Table 2-4. Cylinder Position Sensor (LVDT) Requirements (Remote Servo Only)

Type:	Six wire, difference/sum, Woodward supplied
Excitation:	3.0 VRMS at 5000 Hz
Sum voltage:	Va + Vb = 1.2 VRMS
Output Voltage Ratio:	(Va-Vb)/(Va+Vb) = ±0.5 VRMS
Linearity:	±0.5% Full Stroke
Sensor Stroke Length (SSL):	1x Cylinder Mechanical Stroke Length ≤ SSL ≤ 1.5x Cylinder Mechanical Stroke Length. Both LVDTs must be of equal length in redundant applications
Sensor Cable Length Limit:	10 m (33 feet) maximum between sensor and VariStroke-II. Shielded, <5nF lumped capacitance

Hydraulic Specifications

Table 2-5a. Hydraulic Specifications

Fluid Type:	Petroleum-based or synthetic turbine and hydraulic fluids; fire resistant turbine and hydraulic fluids such as Fyrquel EHC
Fluid Pressure (p):	Part Number dependent. Maximum operating pressure can be found on the product nameplate. The minimum recommended operating pressure of all VariStroke products is 80 psi (5.51 bar)

IMPORTANT **It is recommended to set hydraulic system pressure regulator to 110% or less of normal operating pressure to prevent over-pressure.**

Table 2-5b. Hydraulic Specifications (Continued)

Proof Pressure:	750 psig (51.71 bar)
Burst Pressure:	1250 psig (86.16 bar)
Fluid Temperature:	15 to 70 °C / 59 to 158 °F continuous
Fluid Cleanliness level:	ISO 4406 code 20/18/16 or cleaner
Output Cylinder Action:	Double
Hydraulic Connections:	Supply Port: 51mm (2”) ISO/DIS6162, DIN20066, JIS8363 flange (SAE J518 Code 61 except for metric bolt size) Drain Port: 64mm (2.5”) ISO/DIS6162, DIN20066, JIS8363 flange (SAE J518 Code 61 except for metric bolt size) Control ports C1 and C2: 51mm (2”) ISO/DIS6162, DIN20066, JIS8363 flange (SAE J518 Code 61 except for metric bolt size) Actuator and Servo OVBD: 32mm (1.25”) ISO/DIS6162, DIN20066, JIS8363 flange (SAE J518 Code 61 except for metric bolt size) or -10 SAE J1926
Supply Fluid Flow:	Refer to the following figures for maximum transient and steady state flow rate requirements.

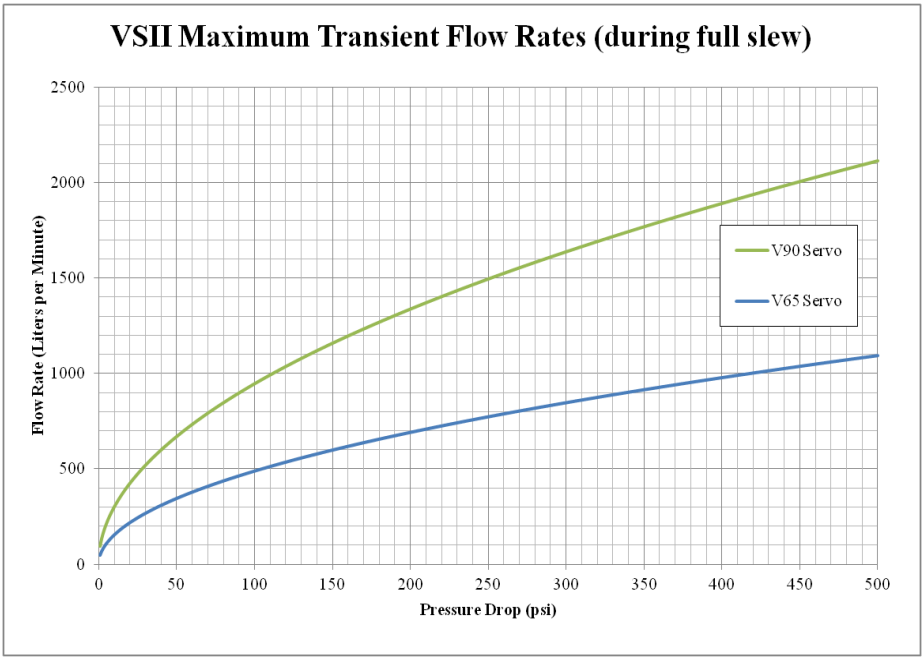


Figure 2-1. Maximum Transient Flow Rates

IMPORTANT

The figure above shows the estimated hydraulic flow necessary to maintain optimum performance of the VS-II. If the flow supplied to the actuator is lower than what is specified, the actuator will continue to operate, but at reduced performance.

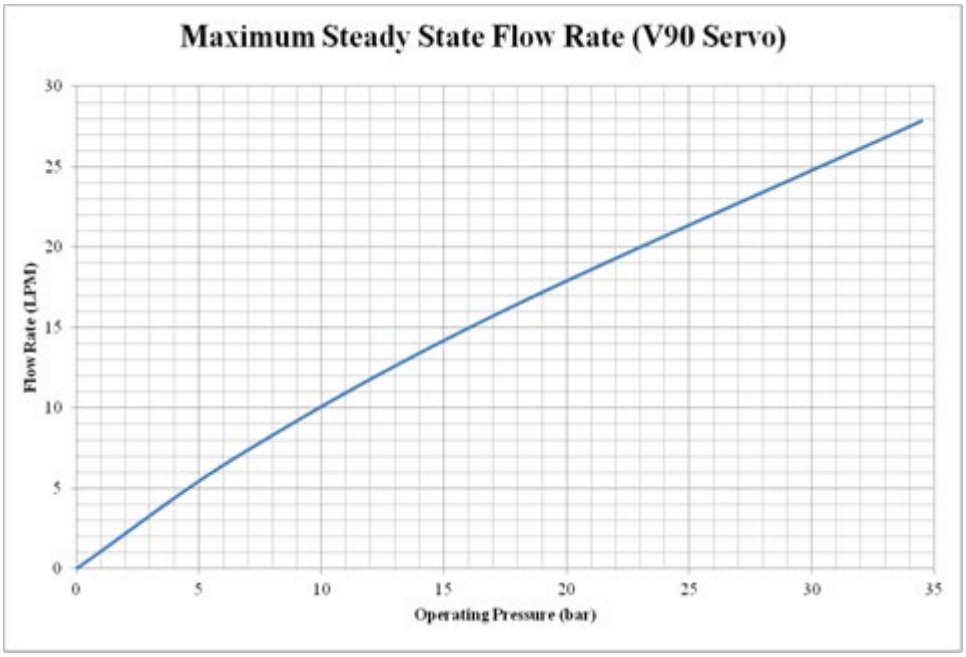


Figure 2-2. Maximum Steady State Flow Rate

IMPORTANT

The figure above shows the estimated hydraulic flow necessary during steady state operation for the V90 servo valve. All other VS-II servo valve models will consume less fluid during steady state operation.

Performance Index

Before purchasing or installing a VS-II actuator, the user should verify that actuator configuration under consideration will have the desired performance at nominal operating oil supply pressure. As shown in the relationship below, the performance of the VS-II is dependent on servo valve size, oil supply pressure, and the used cylinder volume. If the relationship below is satisfied, the actuator will operate smoothly, with minimal limit cycle. If the relationship is not satisfied, a Performance Index Warning light will be illuminated on the Basic Setup Information screen in the Configuration & Calibration settings. The warning light is also seen on the Calibration Manual Stroke screen.

IMPORTANT

If the relationship below is NOT satisfied, the actuator performance will be less than optimal, resulting in possible excessive limit cycle, accelerated wear, and/or unacceptable step response overshoot. The actuator electronics will also output an alarm to provide notification that a "not recommended" configuration is being used, resulting in less than optimal, and possibly unacceptable, performance.

$$PI_{Constant} * \frac{\sqrt{P_{supply}}}{\left(\frac{\pi * D_{cyl}^2}{4} * L_{stroke}\right)} \leq 1$$

Where:

P_{supply} = Supply Pressure in BAR

D_{cyl} = Cylinder Diameter in Centimeters

L_{stroke} = Stroke Length in Centimeters

Note: This is the used maximum stop position. It may or may not equal the Cylinder Length.

$PI_{Constant}$ = Performance Index (Listed in Table Below)

Table 2-6. Servo Valve Size and PI Constant

Servo Valve Size	$PI_{Constant}$
V90	2460

* Servo valve size is currently unavailable and is scheduled for future release.
** Value for $PI_{Constant}$ is estimated.

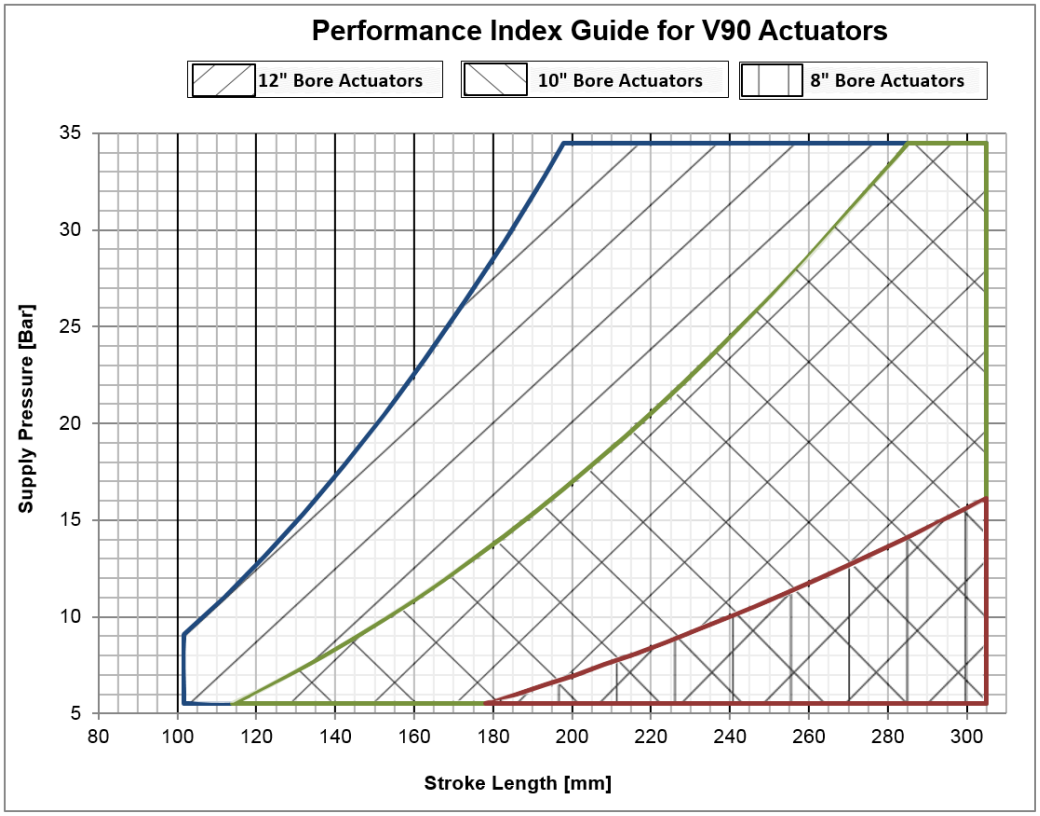


Figure 2-3. Performance Index Guide for V90 Actuators

Diagrams

VS-II Integrated Hydraulic Schematic

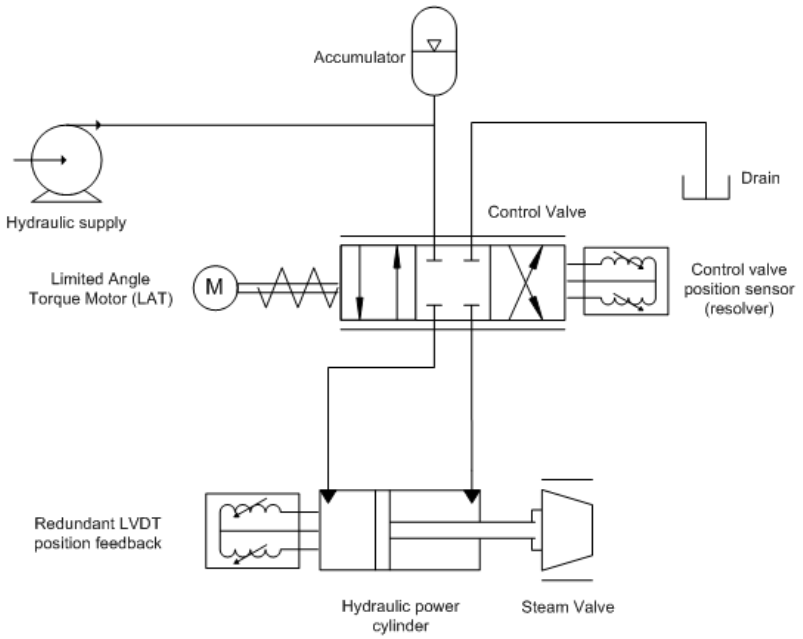


Figure 2-4. VS-II Integrated Hydraulic Schematic

VS-II Remote Servo Hydraulic Schematic

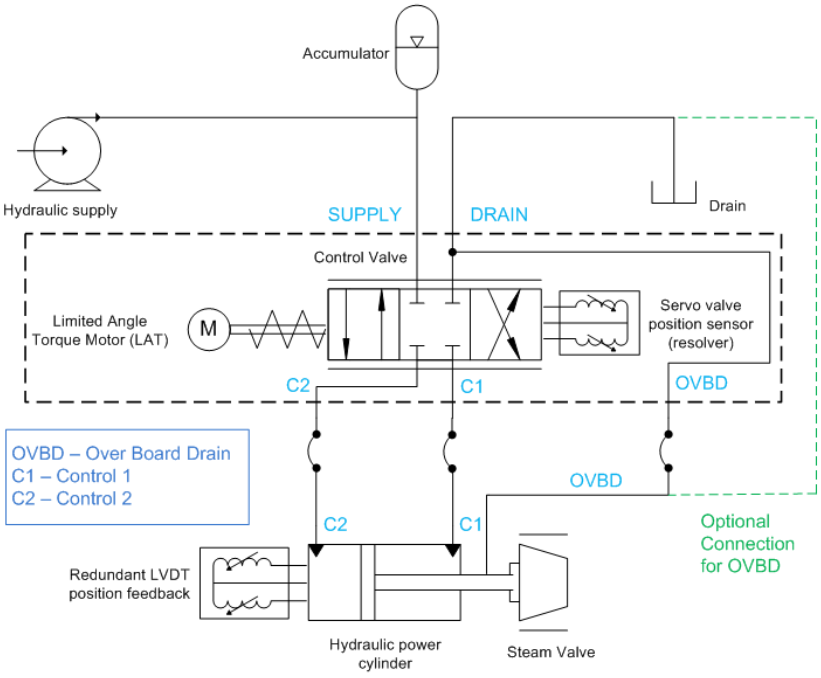


Figure 2-5. VS-II Remote Servo Hydraulic Schematic

VS-II Servo Only Hydraulic Schematic

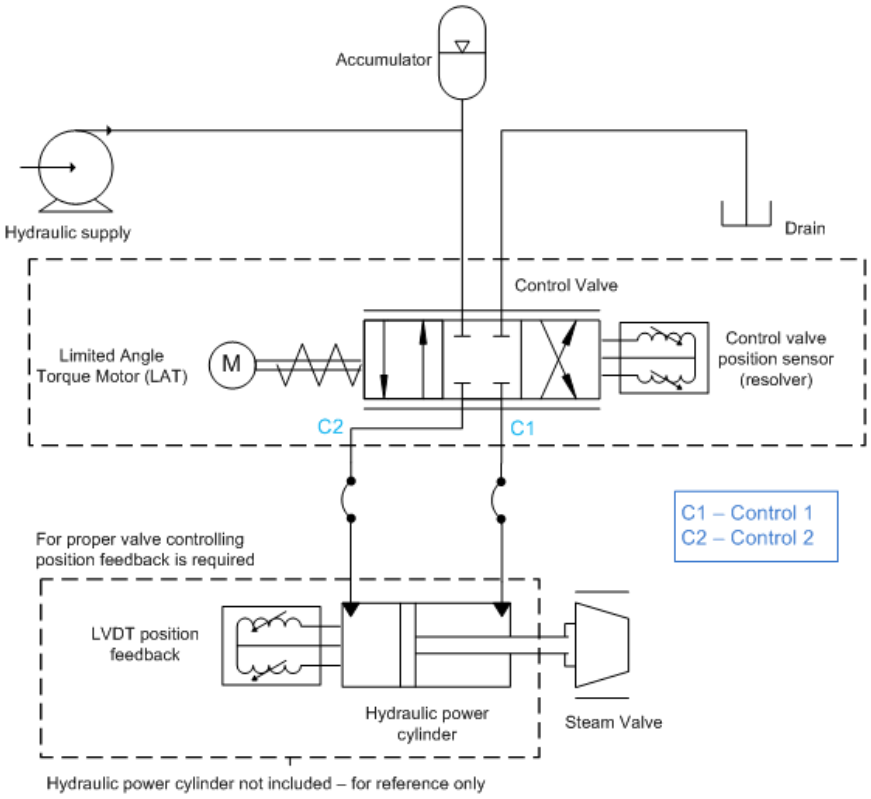


Figure 2-6. VS-II Servo Only Hydraulic Schematic

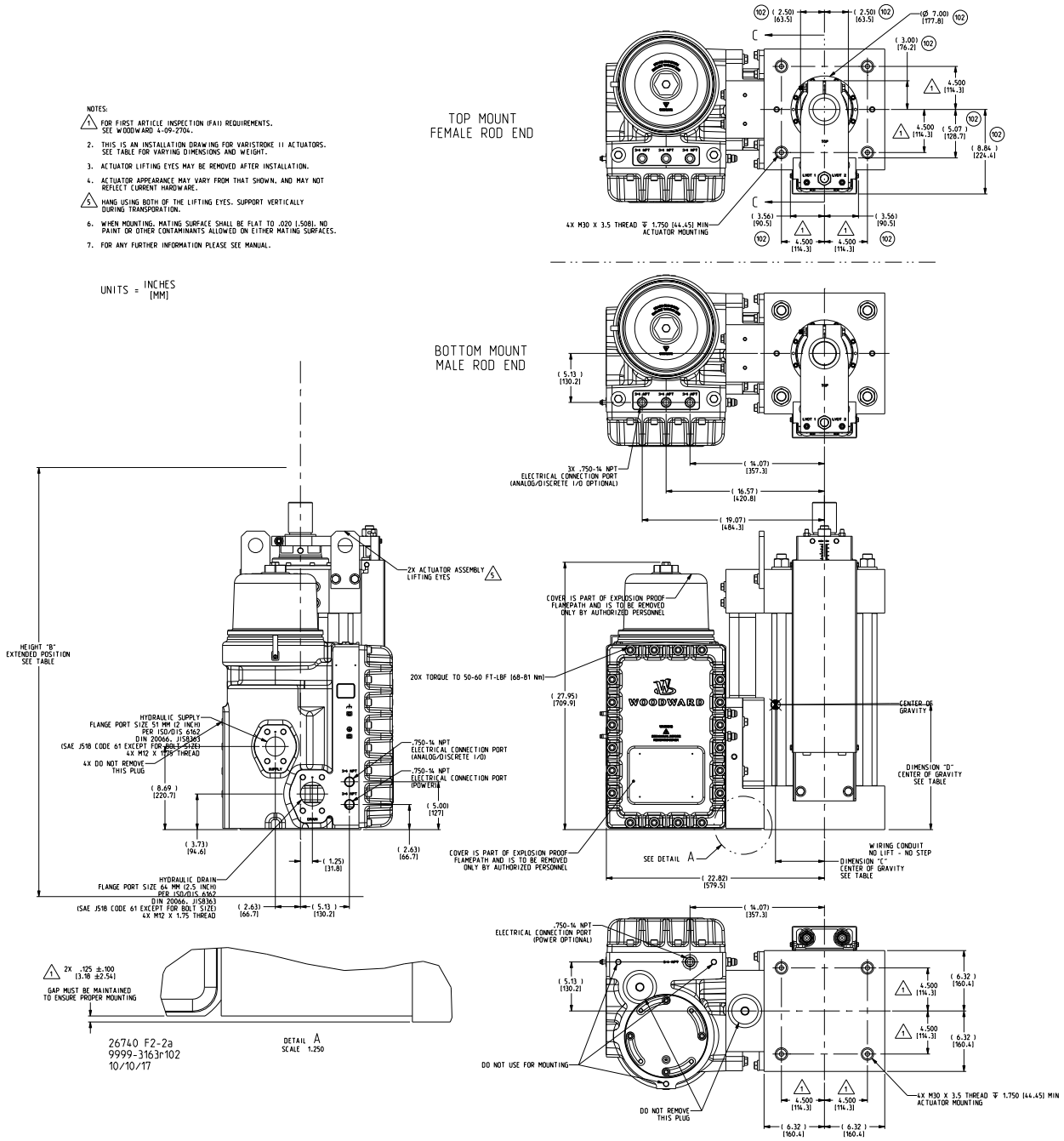


Figure 2-7. Typical VS-II Integrated with 10-inch (254 mm) Bore

TABLE										
MODEL NUMBER	MAX STROKE INCHES [MM]	ROD END TYPE	MOUNTING TYPE	FAILSAFE DIRECTION	HEIGHT "A" INCHES [MM]	HEIGHT "B" INCHES [MM]	DIMENSION "C" INCHES [MM]	DIMENSION "D" INCHES [MM]	DIMENSION "E" INCHES [MM]	APPROXIMATE WEIGHT LBS [kg]
V90TD-2520-MBE	8 [203.2]	MALE	BOTTOM	EXTEND	24.85 [631.2]	(32.85) [834.4]	(5.45) [138.4]	(11.02) [280.0]	(.09) [2.3]	981 [445.0]
V90TD-2520-MBR				RETRACT						
V90TD-2520-MTE			TOP	EXTEND						
V90TD-2520-MTR				RETRACT						
V90TD-2520-FBE		FEMALE	BOTTOM	EXTEND			(5.50) [139.7]	(10.87) [276.1]	(.09) [2.3]	972 [440.9]
V90TD-2520-FBR				RETRACT						
V90TD-2520-FTE			TOP	EXTEND						
V90TD-2520-FTR				RETRACT						
V90TD-2525-MBE	10 [254.0]	MALE	BOTTOM	EXTEND	26.85 [682.0]	(36.85) [936.0]	(5.34) [135.6]	(11.70) [297.2]	(.10) [2.5]	1003 [455.0]
V90TD-2525-MBR				RETRACT						
V90TD-2525-MTE			TOP	EXTEND						
V90TD-2525-MTR				RETRACT						
V90TD-2525-FBE		FEMALE	BOTTOM	EXTEND			(5.39) [136.9]	(11.55) [293.4]	(.10) [2.5]	994 [450.9]
V90TD-2525-FBR				RETRACT						
V90TD-2525-FTE			TOP	EXTEND						
V90TD-2525-FTR				RETRACT						
V90TD-2530-MBE	12 [304.8]	MALE	BOTTOM	EXTEND	28.85 [732.8]	(40.85) [1037.6]	(5.23) [132.8]	(12.38) [314.5]	(.11) [2.8]	1025 [465.0]
V90TD-2530-MBR				RETRACT						
V90TD-2530-MTE			TOP	EXTEND						
V90TD-2530-MTR				RETRACT						
V90TD-2530-FBE		FEMALE	BOTTOM	EXTEND			(5.28) [134.1]	(12.23) [310.6]	(.11) [2.8]	1016 [460.9]
V90TD-2530-FBR				RETRACT						
V90TD-2530-FTE			TOP	EXTEND						
V90TD-2530-FTR				RETRACT						
V90TD-2535-MBE	14 [355.6]	MALE	BOTTOM	EXTEND	30.85 [783.6]	(44.85) [1139.2]	(5.12) [130.0]	(13.06) [331.7]	(.11) [2.8]	1047 [475.0]
V90TD-2535-MBR				RETRACT						
V90TD-2535-MTE			TOP	EXTEND						
V90TD-2535-MTR				RETRACT						
V90TD-2535-FBE		FEMALE	BOTTOM	EXTEND			(5.17) [131.3]	(12.91) [327.9]	(.11) [2.8]	1038 [470.9]
V90TD-2535-FBR				RETRACT						
V90TD-2535-FTE			TOP	EXTEND						
V90TD-2535-FTR				RETRACT						
V90TD-2540-MBE	16 [406.4]	MALE	BOTTOM	EXTEND	32.85 [834.4]	(48.85) [1240.8]	(5.01) [127.3]	(13.74) [349.0]	(.12) [3.0]	1069 [485.0]
V90TD-2540-MBR				RETRACT						
V90TD-2540-MTE			TOP	EXTEND						
V90TD-2540-MTR				RETRACT						
V90TD-2540-FBE		FEMALE	BOTTOM	EXTEND			(5.06) [128.5]	(13.59) [345.2]	(.12) [3.0]	1060 [480.9]
V90TD-2540-FBR				RETRACT						
V90TD-2540-FTE			TOP	EXTEND						
V90TD-2540-FTR				RETRACT						
V90TD-2545-MBE	18 [457.2]	MALE	BOTTOM	EXTEND	34.85 [885.2]	(52.85) [1342.4]	(4.90) [124.5]	(14.42) [366.3]	(.12) [3.0]	1091 [495.0]
V90TD-2545-MBR				RETRACT						
V90TD-2545-MTE			TOP	EXTEND						
V90TD-2545-MTR				RETRACT						
V90TD-2545-FBE		FEMALE	BOTTOM	EXTEND			(4.95) [125.7]	(14.27) [362.5]	(.12) [3.0]	1082 [490.9]
V90TD-2545-FBR				RETRACT						
V90TD-2545-FTE			TOP	EXTEND						
V90TD-2545-FTR				RETRACT						

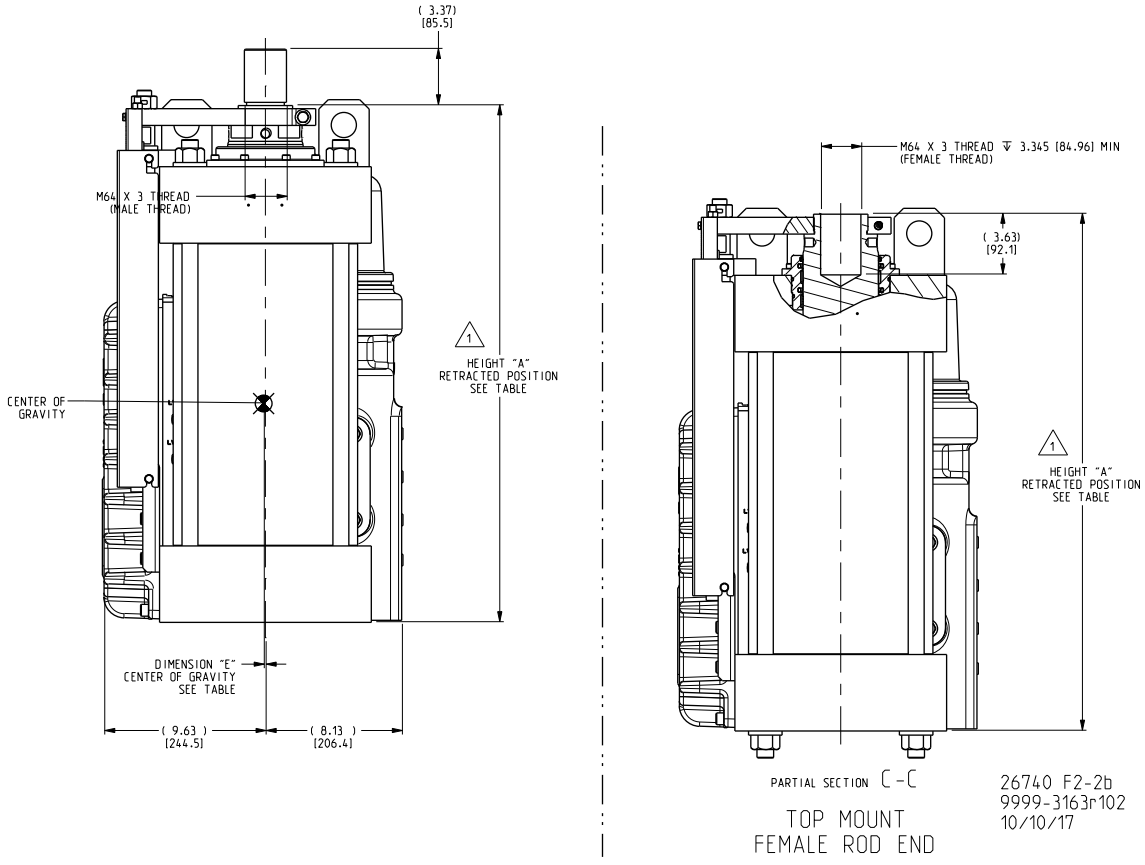


Figure 2-8. Typical VS-II Integrated with 10-inch (254 mm) Bore

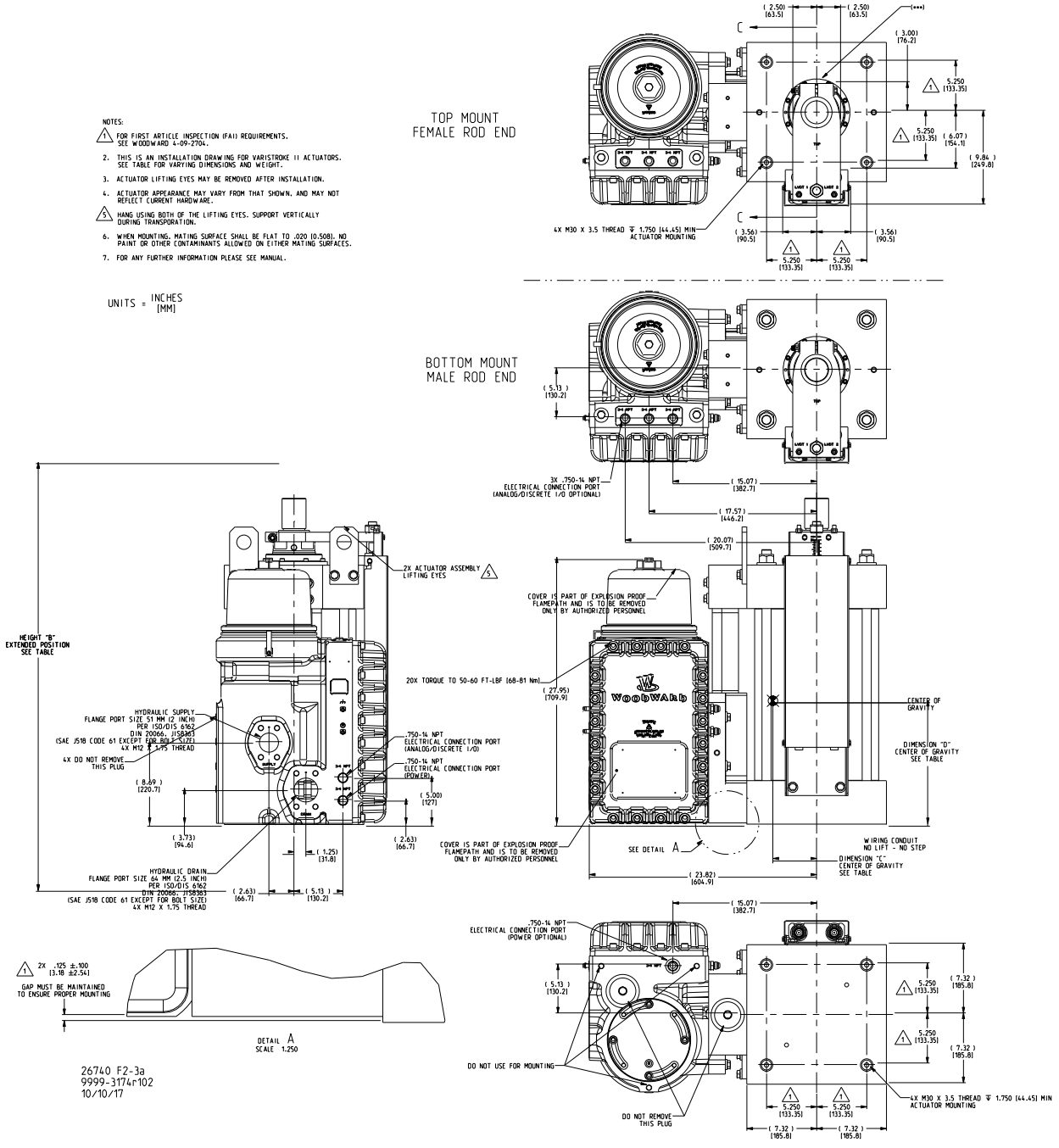


Figure 2-9. Typical VS-II Integrated with 12-inch (305 mm) Bore

TABLE											
	MODEL NUMBER	MAX STROKE INCHES [MM]	ROD END TYPE	MOUNTING TYPE	FAILSAFE DIRECTION	HEIGHT "A" INCHES [MM]	HEIGHT "B" INCHES [MM]	DIMENSION "C" INCHES [MM]	DIMENSION "D" INCHES [MM]	DIMENSION "E" INCHES [MM]	APPROXIMATE WEIGHT LBS [kg]
	9907-1263	8 [203.2]	MALE	BOTTOM	EXTEND	24.85 [631.2]	(32.85) [834.4]	(4.90) [124.5]	(10.87) [276.1]	(.09) [2.3]	1168 [529.8]
(102)	9907-1784				RETRACT						
	9907-1780			TOP	EXTEND						
	V90TD-3020-MTR				RETRACT						
	V90TD-3020-FBE		FEMALE	BOTTOM	EXTEND			(4.94) [125.5]	(10.72) [272.3]	(.09) [2.3]	1158 [525.3]
	V90TD-3020-FBR				RETRACT						
	V90TD-3020-FTE			TOP	EXTEND						
	V90TD-3020-FTR				RETRACT						
	9907-1499	10 [254.0]	MALE	BOTTOM	EXTEND	26.85 [682.0]	(36.85) [936.0]	(4.81) [122.2]	(11.55) [293.4]	(.10) [2.5]	1191 [540.2]
	V90TD-3025-MBR				RETRACT						
	V90TD-3025-MTE			TOP	EXTEND						
	V90TD-3025-MTR				RETRACT						
(102)	9907-1547		FEMALE	BOTTOM	EXTEND			(4.85) [123.2]	(11.40) [289.6]	(.10) [2.5]	1181 [535.7]
	V90TD-3025-FBR				RETRACT						
	V90TD-3025-FTE			TOP	EXTEND						
	V90TD-3025-FTR				RETRACT						
(102)	9907-1283	12 [304.8]	MALE	BOTTOM	EXTEND	28.85 [732.8]	(40.85) [1037.6]	(4.72) [119.9]	(12.23) [310.6]	(.11) [2.8]	1215 [551.1]
	V90TD-3030-MBR				RETRACT						
	V90TD-3030-MTE			TOP	EXTEND						
	V90TD-3030-MTR				RETRACT						
	V90TD-3030-FBE		FEMALE	BOTTOM	EXTEND			(4.76) [120.9]	(12.08) [306.8]	(.11) [2.8]	1205 [546.6]
	V90TD-3030-FBR				RETRACT						
	V90TD-3030-FTE			TOP	EXTEND						
	V90TD-3030-FTR				RETRACT						
(102)	9907-1537	14 [355.6]	MALE	BOTTOM	EXTEND	30.85 [783.6]	(44.85) [1139.2]	(4.63) [117.6]	(12.91) [327.9]	(.11) [2.8]	1238 [561.5]
	V90TD-3035-MBR				RETRACT						
	V90TD-3035-MTE			TOP	EXTEND						
	V90TD-3035-MTR				RETRACT						
	V90TD-3035-FBE		FEMALE	BOTTOM	EXTEND			(4.67) [118.6]	(12.76) [324.1]	(.11) [2.8]	1228 [557.0]
	V90TD-3035-FBR				RETRACT						
	V90TD-3035-FTE			TOP	EXTEND						
	V90TD-3035-FTR				RETRACT						
	V90TD-3040-MBE	16 [406.4]	MALE	BOTTOM	EXTEND	32.85 [834.4]	(48.85) [1240.8]	(4.54) [115.3]	(13.59) [345.2]	(.12) [3.0]	1261 [572.0]
	V90TD-3040-MBR				RETRACT						
	V90TD-3040-MTE			TOP	EXTEND						
	V90TD-3040-MTR				RETRACT						
	V90TD-3040-FBE		FEMALE	BOTTOM	EXTEND			(4.58) [116.3]	(13.44) [341.4]	(.12) [3.0]	1251 [567.4]
	V90TD-3040-FBR				RETRACT						
	V90TD-3040-FTE			TOP	EXTEND						
	V90TD-3040-FTR				RETRACT						
	V90TD-3045-MBE	18 [457.2]	MALE	BOTTOM	EXTEND	34.85 [885.2]	(52.85) [1342.4]	(4.45) [113.0]	(14.27) [362.5]	(.12) [3.0]	1285 [582.9]
	V90TD-3045-MBR				RETRACT						
	V90TD-3045-MTE			TOP	EXTEND						
	V90TD-3045-MTR				RETRACT						
	V90TD-3045-FBE		FEMALE	BOTTOM	EXTEND			(4.49) [114.0]	(14.12) [358.6]	(.12) [3.0]	1275 [578.3]
	V90TD-3045-FBR				RETRACT						
	V90TD-3045-FTE			TOP	EXTEND						
	V90TD-3045-FTR				RETRACT						

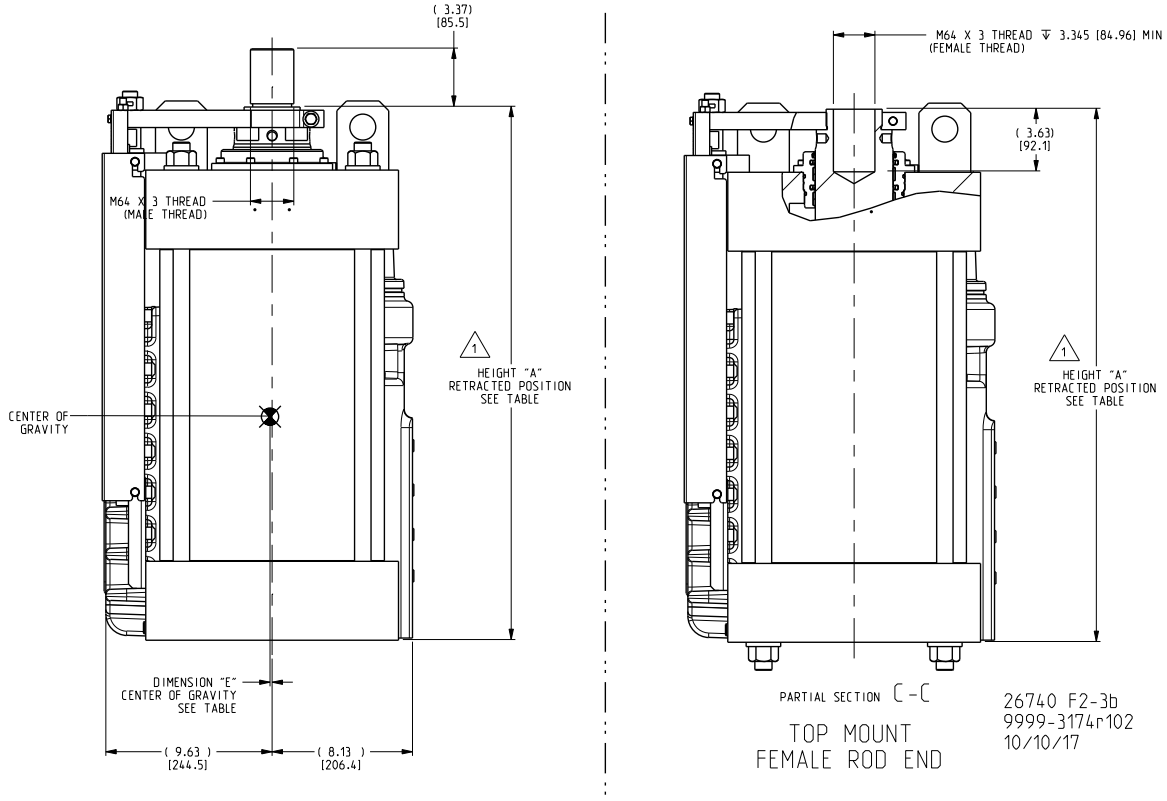


Figure 2-10. Typical VS-II Integrated with 12-inch (305 mm) Bore

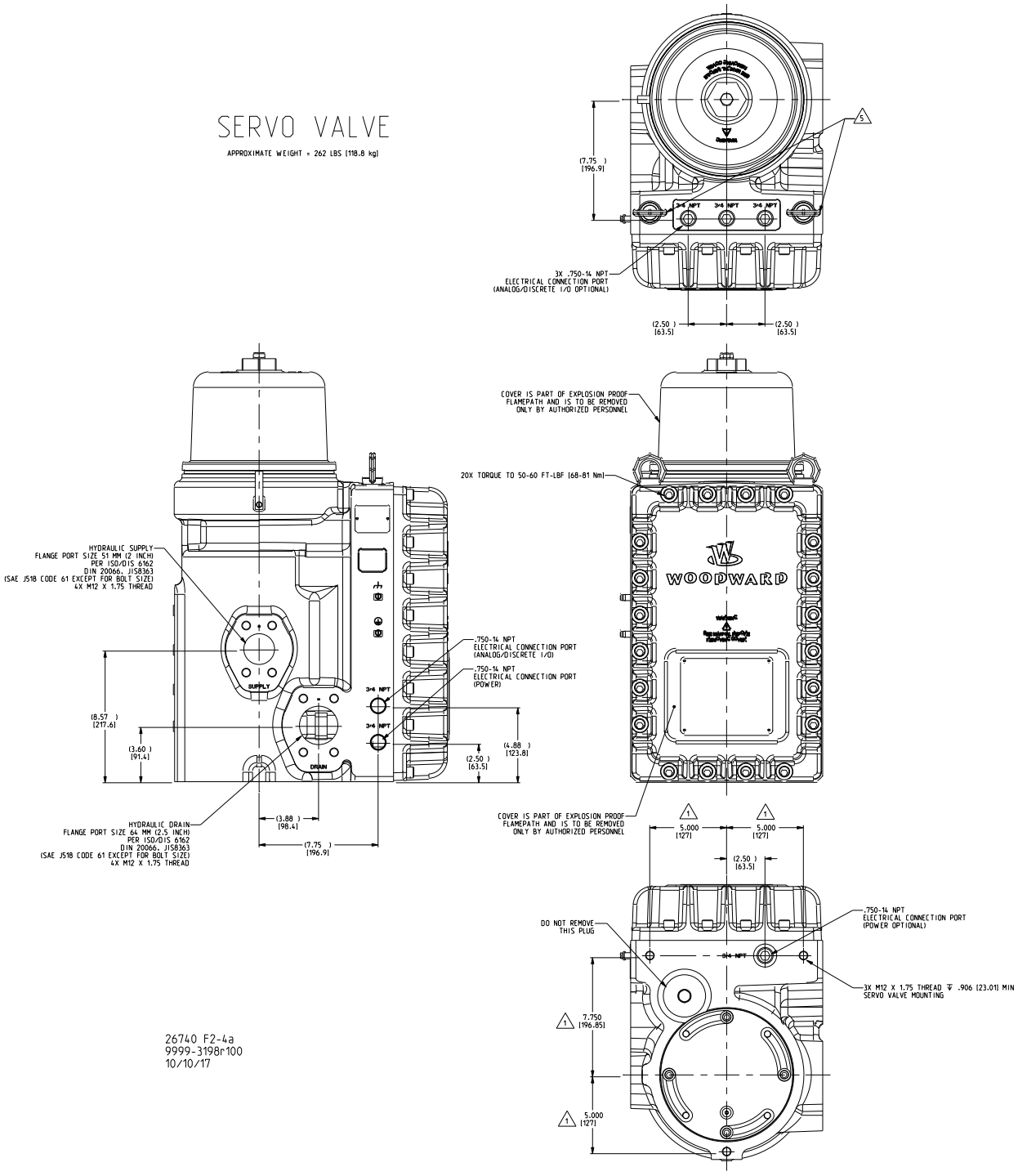


Figure 2-11. Typical VS-II Remote Kit with 10-inch (254 mm) Bore

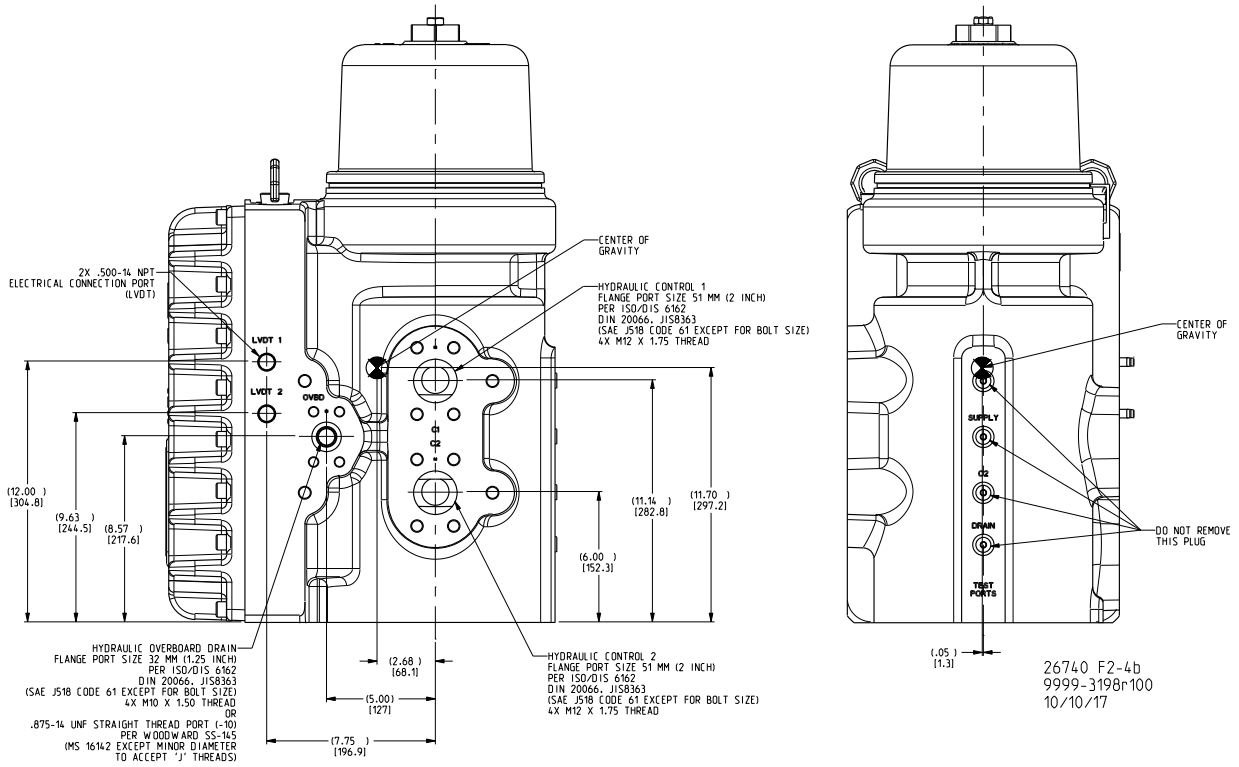


Figure 2-12. Typical VS-II Remote Kit with 10-inch (254 mm) Bore (Continued)

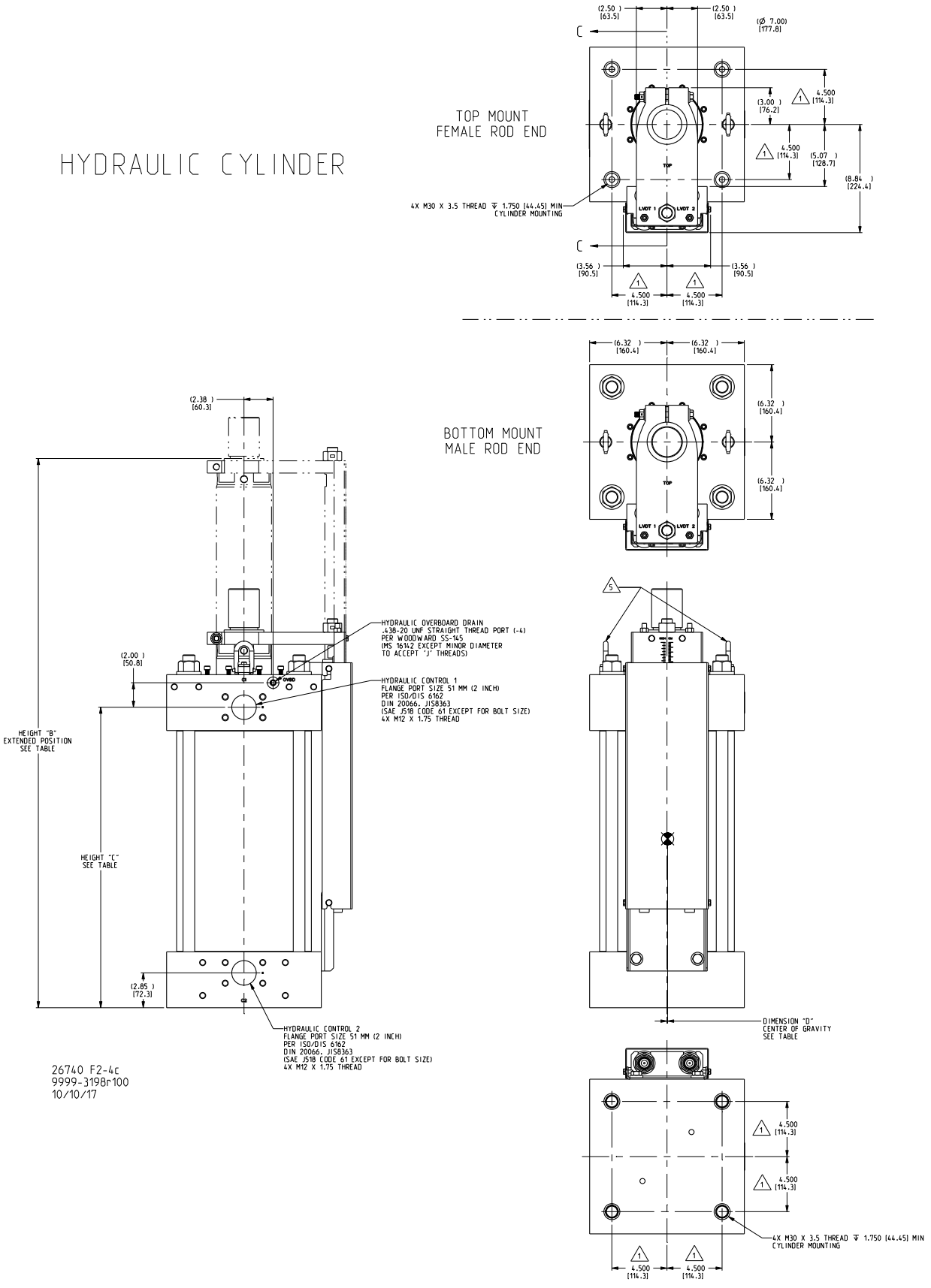


Figure 2-13. Typical VS-II Hydraulic Cylinder for Remote Kit with 10-inch (254 mm) Bore

TABLE									
MAX STROKE INCHES [MM]	ROD END TYPE	MOUNTING TYPE	HEIGHT "A" INCHES [MM]	HEIGHT "B" INCHES [MM]	HEIGHT "C" INCHES [MM]	DIMENSION "D" INCHES [MM]	DIMENSION "E" INCHES [MM]	DIMENSION "F" INCHES [MM]	APPROXIMATE WEIGHT LBS [kg]
8 [203.2]	MALE	BOTTOM	24.85 [631.2]	(32.85) [834.4]	(18.54) [470.9]	(.06) [1.5]	(10.92) [277.4]	(.19) [4.8]	593 [269.0]
		TOP							
	FEMALE	BOTTOM				(.06) [1.5]	(10.70) [271.8]	(.19) [4.8]	583 [264.4]
		TOP							
10 [254.0]	MALE	BOTTOM	26.85 [682.0]	(36.85) [936.0]	(20.54) [521.7]	(.06) [1.5]	(11.88) [301.8]	(.20) [5.1]	614 [278.5]
		TOP							
	FEMALE	BOTTOM				(.06) [1.5]	(11.64) [295.7]	(.20) [5.1]	604 [274.0]
		TOP							
12 [304.8]	MALE	BOTTOM	28.85 [732.8]	(40.85) [1037.6]	(22.54) [572.5]	(.06) [1.5]	(12.83) [325.9]	(.20) [5.1]	635 [288.0]
		TOP							
	FEMALE	BOTTOM				(.06) [1.5]	(12.59) [319.8]	(.20) [5.1]	625 [283.5]
		TOP							
14 [355.6]	MALE	BOTTOM	30.85 [783.6]	(44.85) [1139.2]	(24.54) [623.3]	(.05) [1.3]	(13.79) [350.3]	(.21) [5.3]	656 [297.6]
		TOP							
	FEMALE	BOTTOM				(.05) [1.3]	(13.54) [343.9]	(.21) [5.3]	646 [293.0]
		TOP							
16 [406.4]	MALE	BOTTOM	32.85 [834.4]	(48.85) [1240.8]	(26.54) [674.1]	(.05) [1.3]	(14.76) [374.9]	(.22) [5.6]	677 [307.1]
		TOP							
	FEMALE	BOTTOM				(.05) [1.3]	(14.50) [368.3]	(.22) [5.6]	667 [302.5]
		TOP							
18 [457.2]	MALE	BOTTOM	34.85 [885.2]	(52.85) [1342.4]	(28.54) [724.9]	(.05) [1.3]	(15.72) [399.3]	(.22) [5.6]	698 [316.6]
		TOP							
	FEMALE	BOTTOM				(.05) [1.3]	(15.46) [392.7]	(.22) [5.6]	688 [312.1]
		TOP							

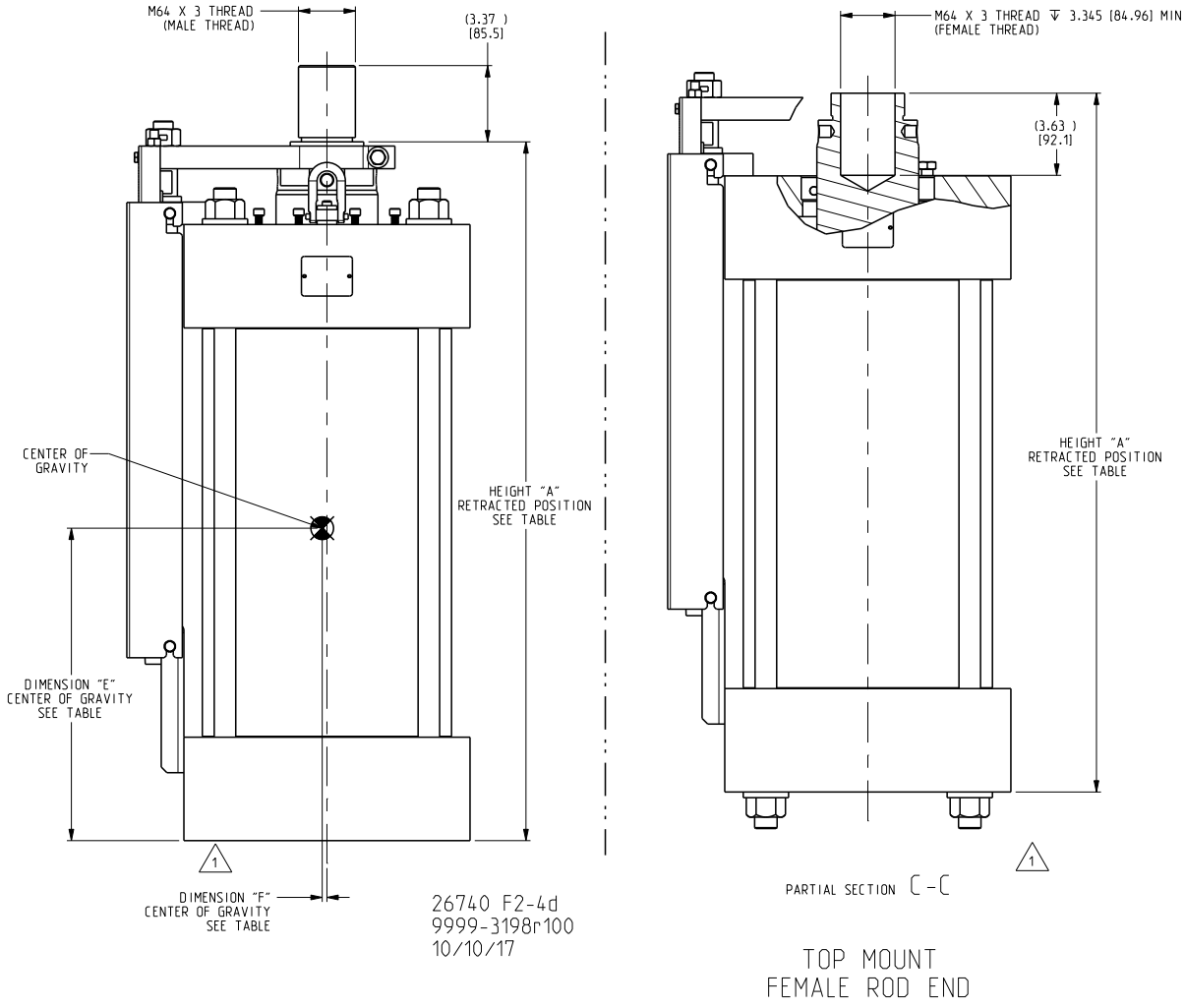


Figure 2-14. Typical VS-II Hydraulic Cylinder for Remote Kit with 10-inch (254 mm) Bore (continued)

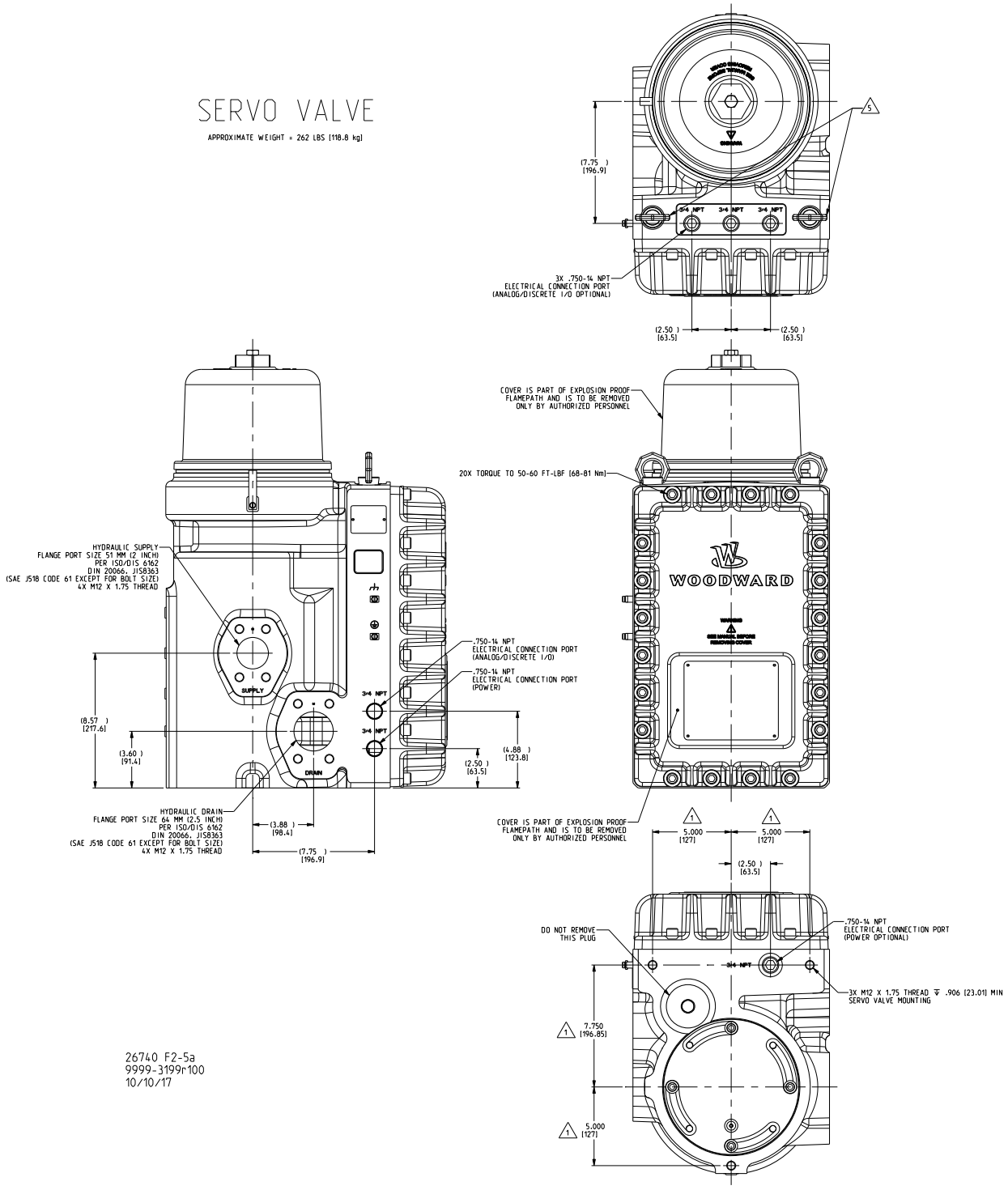


Figure 2-15. Typical VS-II Remote Kit with 12-inch (305 mm) Bore

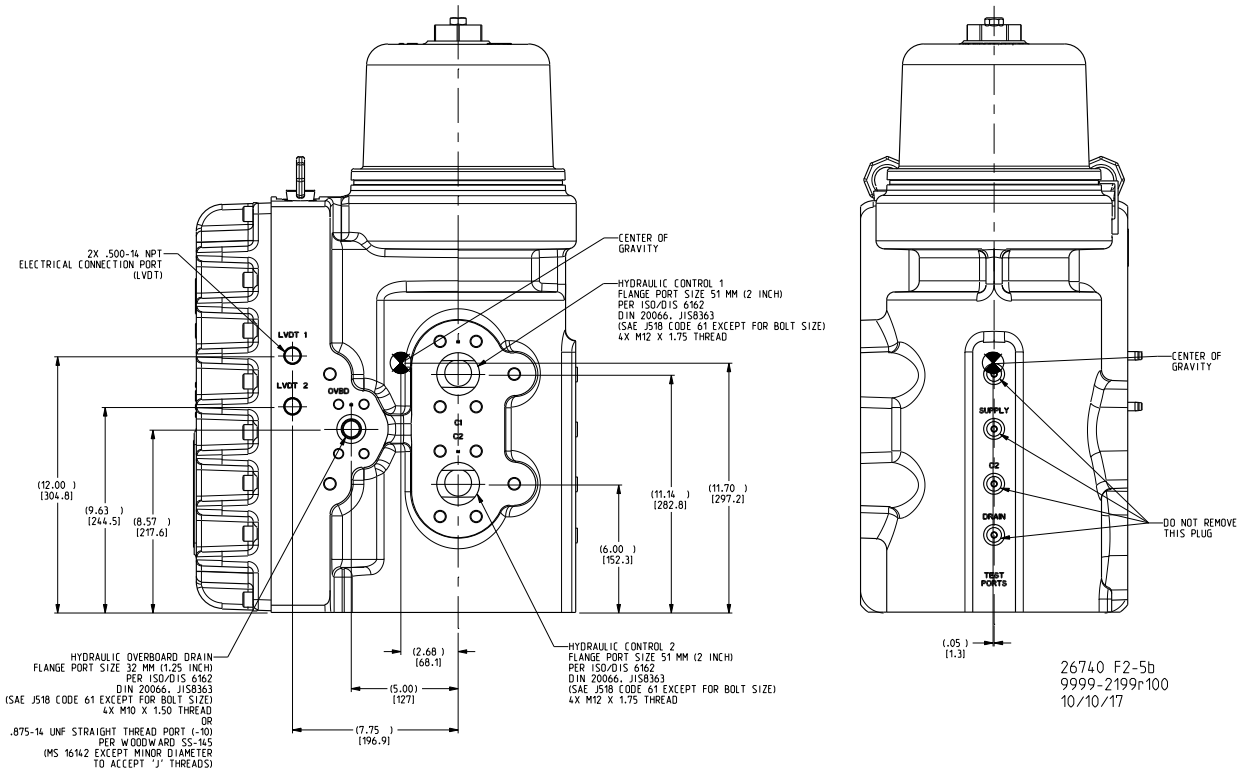


Figure 2-16. Typical VS-II Remote Kit with 12-inch (305 mm) Bore (continued)

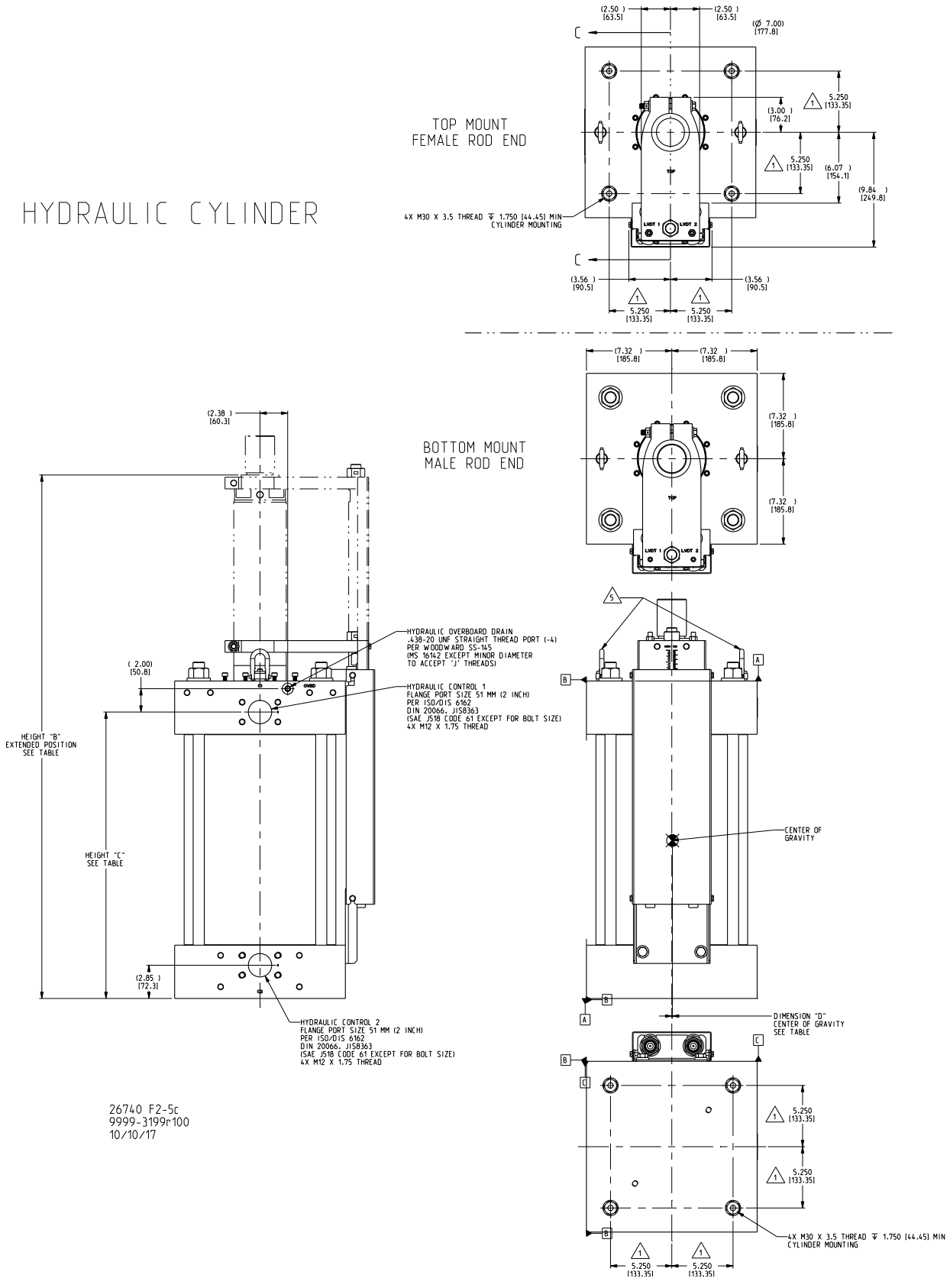


Figure 2-17. Typical VS-II Hydraulic Cylinder for Remote Kit with 12-inch (305 mm) Bore

TABLE									
MAX STROKE INCHES [MM]	ROD END TYPE	MOUNTING TYPE	HEIGHT "A" INCHES [MM]	HEIGHT "B" INCHES [MM]	HEIGHT "C" INCHES [MM]	DIMENSION "D" INCHES [MM]	DIMENSION "E" INCHES [MM]	DIMENSION "F" INCHES [MM]	APPROXIMATE WEIGHT LBS [kg]
8 [203.2]	MALE	BOTTOM	24.85 [631.2]	(32.85) [834.4]	(18.54) [470.9]	(.06) [1.5]	(10.71) [272.0]	(.17) [4.3]	779 [353.3]
		TOP							
	FEMALE	BOTTOM				(.06) [1.5]	(10.54) [267.7]	(.17) [4.3]	769 [348.8]
		TOP							
10 [254.0]	MALE	BOTTOM	26.85 [682.0]	(36.85) [936.0]	(20.54) [521.7]	(.06) [1.5]	(11.65) [295.9]	(.18) [4.6]	802 [363.8]
		TOP							
	FEMALE	BOTTOM				(.06) [1.5]	(11.47) [291.3]	(.18) [4.6]	792 [359.2]
		TOP							
12 [304.8]	MALE	BOTTOM	28.85 [732.8]	(40.85) [1037.6]	(22.54) [572.5]	(.06) [1.5]	(12.59) [319.8]	(.18) [4.6]	825 [374.2]
		TOP							
	FEMALE	BOTTOM				(.06) [1.5]	(12.40) [315.0]	(.18) [4.6]	815 [369.7]
		TOP							
14 [355.6]	MALE	BOTTOM	30.85 [783.6]	(44.85) [1139.2]	(24.54) [623.3]	(.06) [1.5]	(13.54) [343.9]	(.19) [4.8]	847 [384.2]
		TOP							
	FEMALE	BOTTOM				(.06) [1.5]	(13.34) [338.8]	(.19) [4.8]	837 [379.7]
		TOP							
16 [406.4]	MALE	BOTTOM	32.85 [834.4]	(48.85) [1240.8]	(26.54) [674.1]	(.06) [1.5]	(14.48) [367.8]	(.19) [4.8]	870 [394.6]
		TOP							
	FEMALE	BOTTOM				(.06) [1.5]	(14.28) [362.7]	(.19) [4.8]	860 [390.1]
		TOP							
18 [457.2]	MALE	BOTTOM	34.85 [885.2]	(52.85) [1342.4]	(28.54) [724.9]	(.05) [1.3]	(15.43) [391.9]	(.20) [5.1]	893 [405.1]
		TOP							
	FEMALE	BOTTOM				(.05) [1.3]	(15.22) [386.6]	(.20) [5.1]	883 [400.5]
		TOP							

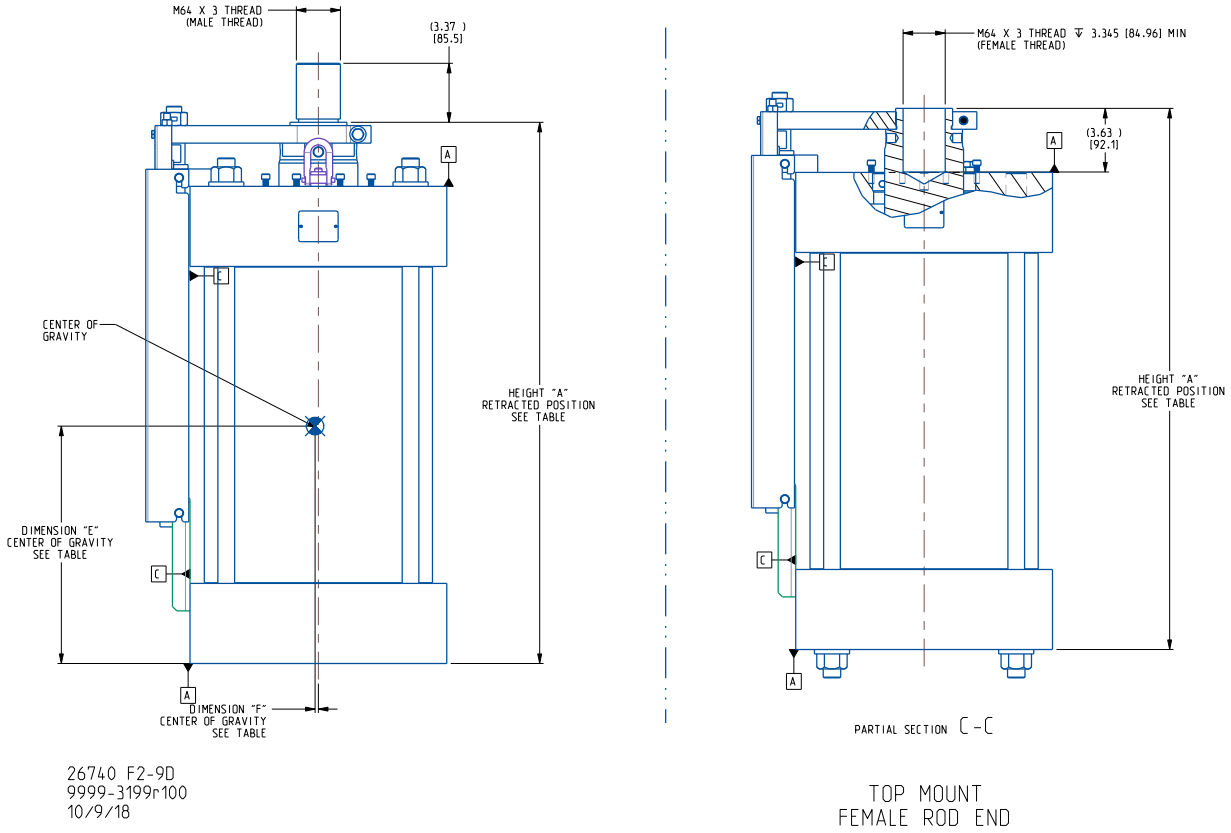


Figure 2-18. Typical VS-II Hydraulic Cylinder for Remote Kit with 12-inch (305 mm) Bore (continued)

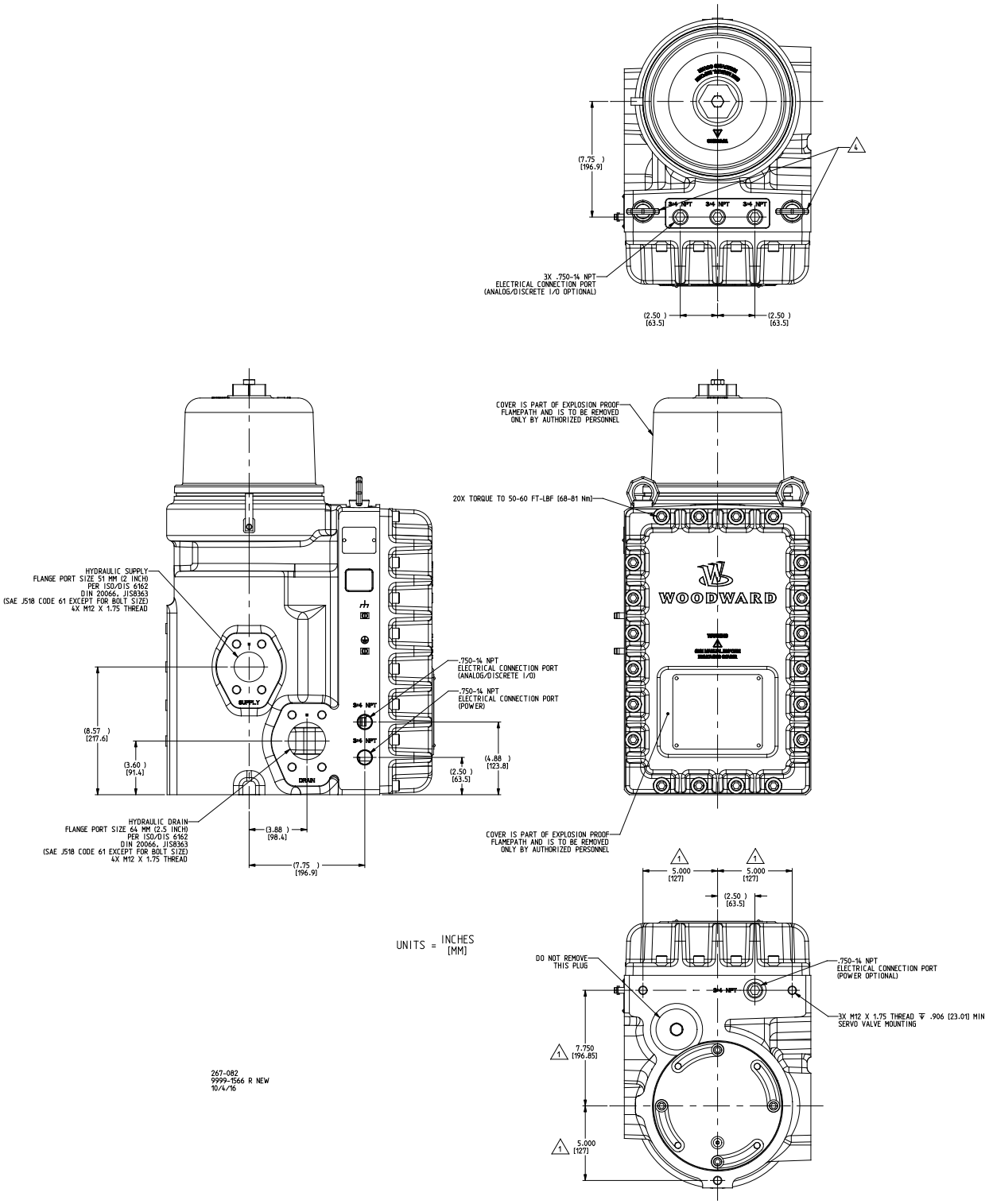


Figure 2-19. Typical VS-II Servo Valve for Remote Mounting

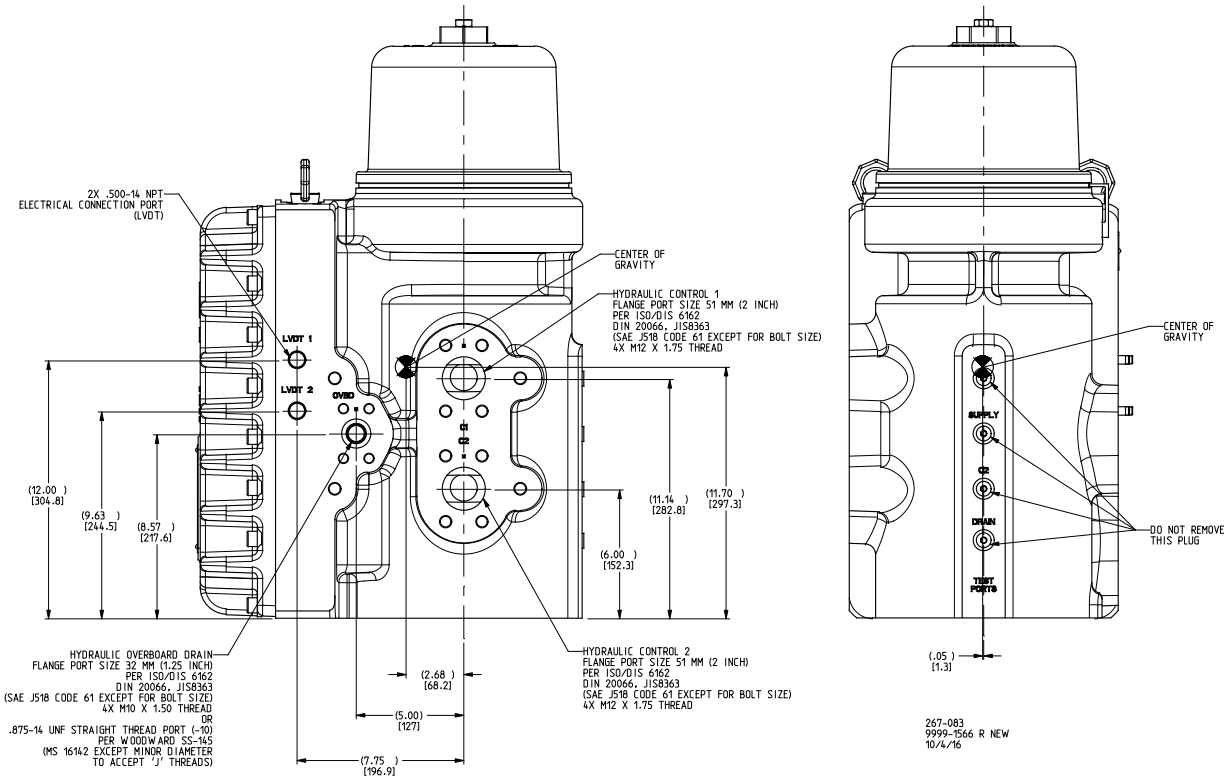


Figure 2-20. Typical VS-II Servo Valve for Remote Mounting

NOTES

1. These general reference outline drawings apply to Woodward VS-II only. Consult Woodward for the most current outline drawing.

2. Installation Orientation. Orientation vertical approximately as shown See elsewhere in this manual for other installation recommendations.

3. Service Manual Replacement Parts
   - Servo Valve – Consult Woodward for part number
   - Hydraulic Power Cylinder – Consult Woodward for part number
   - Manual – Consult Woodward for part number
   - LVDT – Consult Woodward for part number
   - Seals Kit(s) – Refer to Chapter 8 for additional details
   - Electronics module– Consult Woodward for part number

Chapter 3.
Installation

Receiving Instructions

The VS-II is carefully packed at the factory to protect it from damage during shipping; however, careless handling during shipment can result in damage. If any damage to the VS-II is discovered, immediately notify both the shipping agent and Woodward.

Unpacking Instructions

Carefully unpack the VS-II and remove it from the shipping container. Do not remove the hydraulic, electric blanking covers and hydraulic power cylinder's output threaded shaft mesh until you are ready to mount the unit.

⚠WARNING

External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

⚠WARNING

Take care not to damage the electronics cover's seal, the cover surface, the threads, or the VS-II housing mating surface while removing or replacing the cover.

⚠WARNING

For Division 1/Zone 1 products: Proper torque on all joints is very important to ensure that the unit is sealed properly.

⚠CAUTION

Due to typical noise levels in engine and turbine environments, hearing protection should be worn when working on or around the VS-II.

⚠CAUTION

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

⚠CAUTION

For lifting and transportation use lifting straps fitted through both lifting lugs provided with the product. Support vertical position of the VS-II during transportation.

Installation Instructions

General

See the outline drawings (Figures 2-2, 2-3, 2-4, 2-5, and 2-6) and Specifications for:

- Outline dimensions
- Hydraulic connections and fitting sizes
- Electrical connections
- Weight of the VS-II

A vertical actuator position is generally preferred to conserve floor space as well as ease of making electrical and hydraulic connections, however; the VS-II can be mounted in any attitude.

Allow space for removal of the front cover for access to the terminal blocks and to see the status LEDs on the printed circuit board.

If the VS-II actuator is to be installed in close proximity to uninsulated/unshielded steam valves or piping, radiation heat shields should be installed between the actuator and these hot surfaces.

NOTICE

Do not mount the Integrated VariStroke-II actuator or the Remote servo valve directly to any surface with a temperature greater than 85° C. Doing so may cause the electronic control to overheat and shut down.

The hydraulic power cylinder, when using a remote servo valve, may be mounted in areas with ambient temperatures up to 120 ° C.

The VS-II Integrated Actuator is designed to be fully supported by the Hydraulic Power Cylinder Mating Surface. For the Remote Servo Kit and Servo only configurations, the Hydraulic Power Cylinder and the Servo are each mounted separately as defined below. The individual VS-II actuator and Servo valve bolt patterns, bolts, and bolting torque recommendations are in presented in Table 3-1 and Figures 3-1a through 3-1e.

Table 3-1. VS-II Product Installation Interface

VariStroke-II Cylinder Bore Size [mm] (in) (Fig. 3-1a,b,c,d)	Dim. "A" [mm](in)	Dim. "B" [mm](in)	Thread "C"	Min Thread Depth [mm] (in)	Min. Bolt Grade	Bolting Torque [N•m] (lbf-ft)	Bolt Tolerance Class
[254] (10)	[228.6] (9)	[228.6] (9)	M30x3.5	[44] (1.75)	8.8	[490–600] (360-440)	6 g
[305] (12)	[266.7] (10.5)	[266.7] (10.5)	M30x3.5	[44] (1.75)	8.8	[490–600] (360-440)	6 g

VariStroke-II Remote Servo valve (Fig. 3-1e)	Dim. 'A' [mm](in)	Dim. 'B' [mm](in)	Dim. 'C' [mm](in)	Thread "D"	Min Thread Depth [mm] (in)	Min. Bolt Grade	Bolting Torque [N•m] (lbf-ft)	Bolt Tolerance Class
V90	[127](5)	[197] (7.75)	[127](5)	M12x1.75	[23] (.90)	8.8	[54–68] (40-50)	6 g

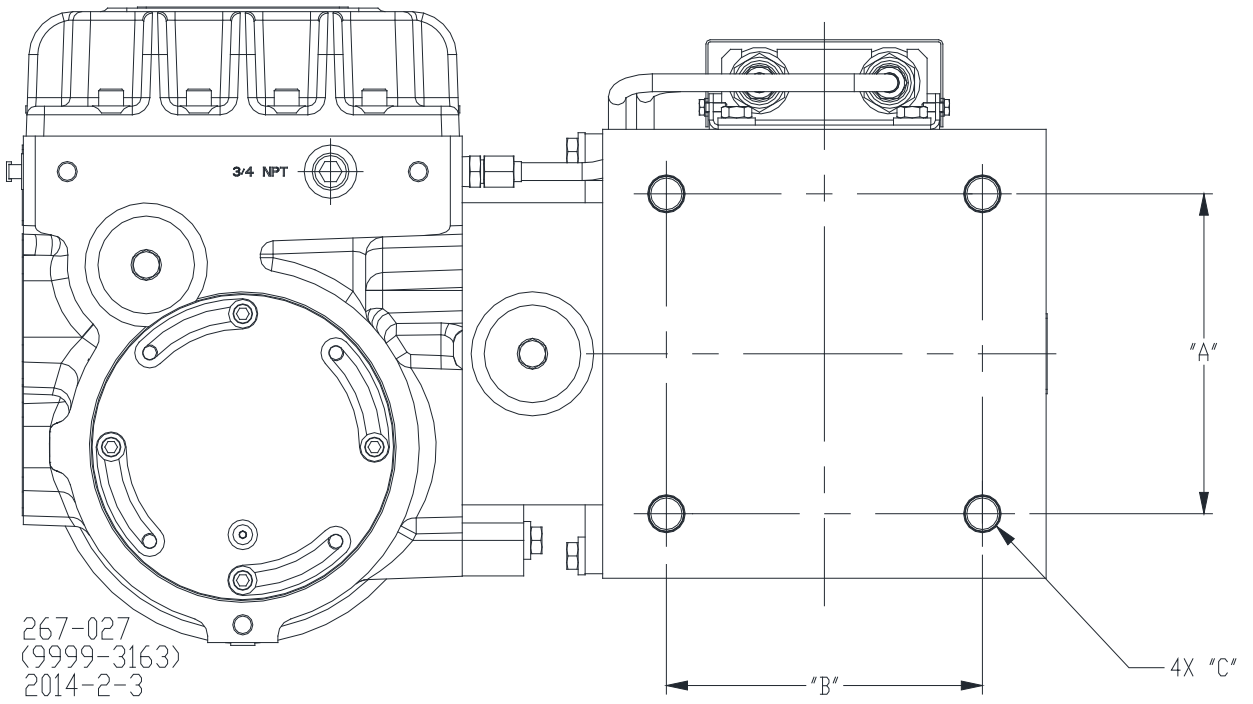


Figure 3-1a. VS-II Actuator Bottom Mount. Product Installation Interface; Mounting Bolt Pattern

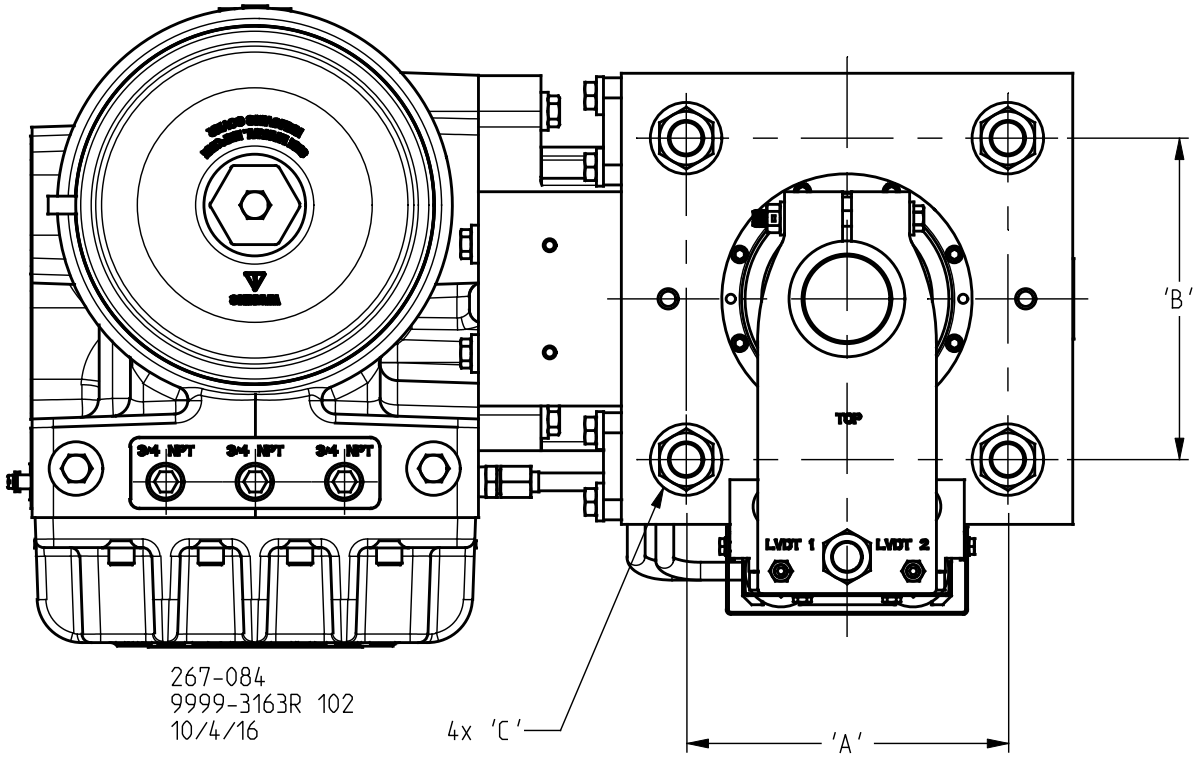


Figure 3-1b. VS-II Actuator Top Mount. Product Installation Interface; Mounting Bolt Pattern

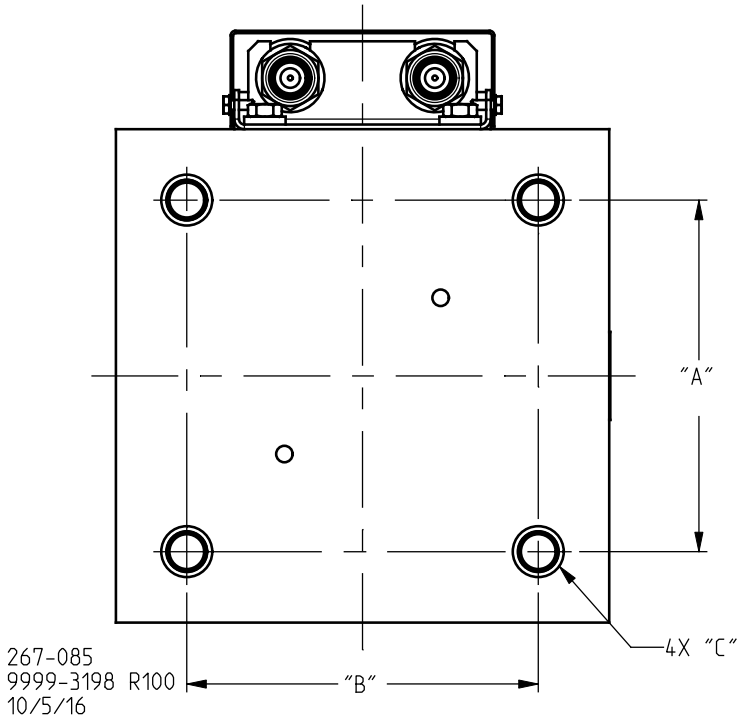


Figure 3-1c. VS-II Remote Cylinder Bottom Mount. Product Installation Interface; Mounting Bolt Pattern

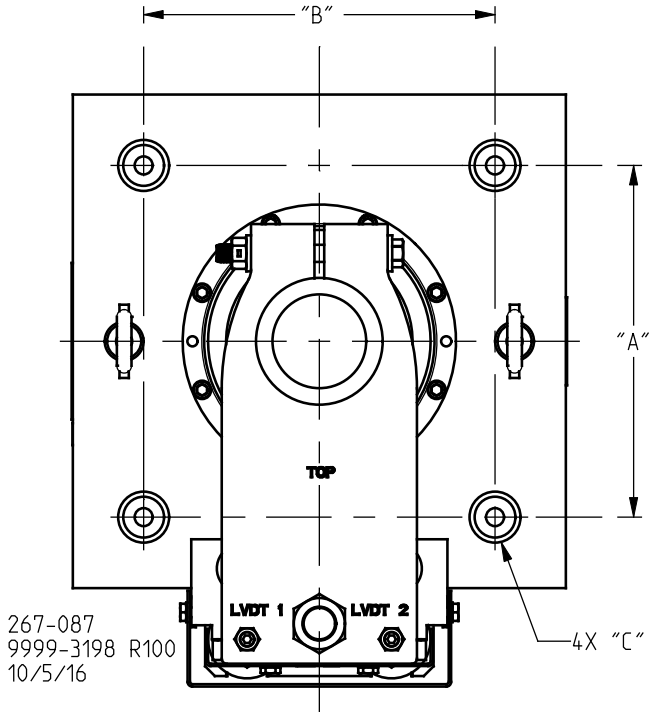


Figure 3-1d. VS-II Remote Cylinder Top Mount. Product Installation Interface; Mounting Bolt Pattern

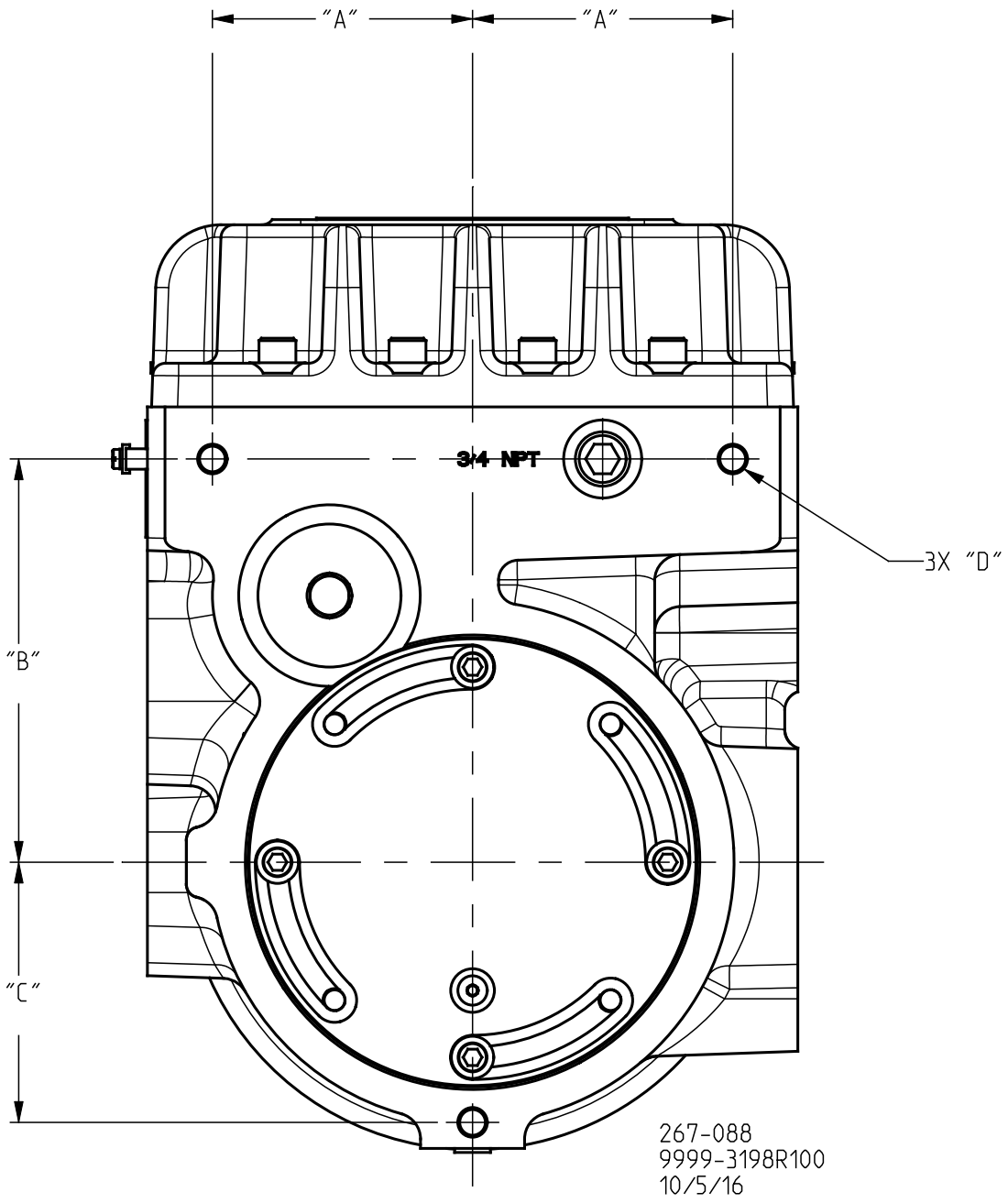


Figure 3-1e. VS-II Remote Servo Bottom Mount. Product Installation Interface; Mounting Bolt Pattern

NOTICE

Minimum Bolt Grade, Bolting Torque and Thread Engagement Recommendation is valid for low carbon steel mounting surface to which product is bolted. For different configuration please consult Woodward for torque and bolts grade recommendations.

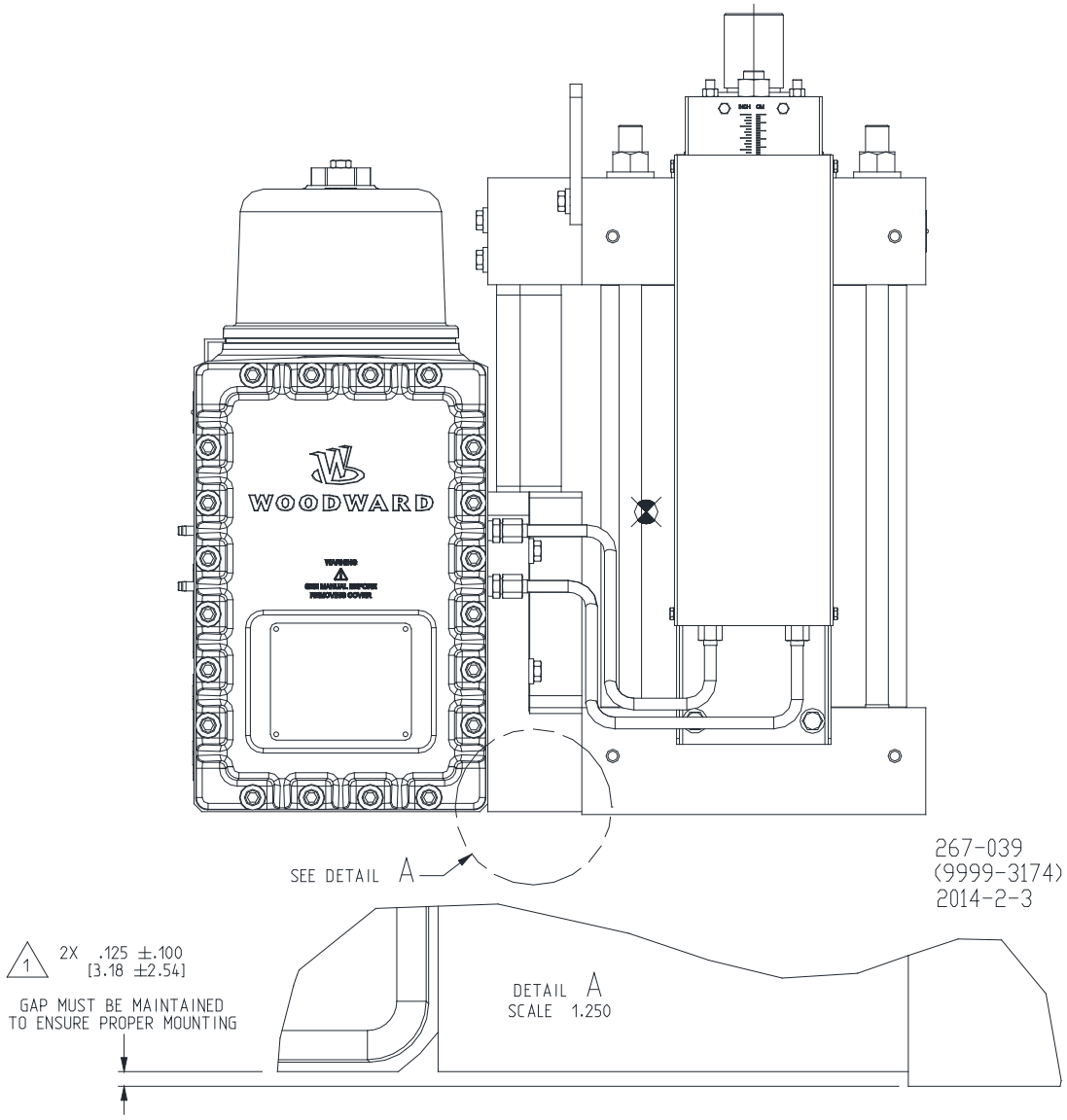


Figure 3-2. Mounting Gap

WARNING

The VS-II Actuator is designed for support by the Hydraulic Power Cylinder Mating Surfaces, either top or bottom mount. Additional supports are neither needed nor recommended.

The servo valve part of the Integrated Actuator is not designed to support any load from the actuator (cylinder). The installation must maintain the minimum required gap between servo valve and the actuator mounting surface to prevent any loads being transmitted to the servo valve. For reference see outline drawings (Figures 2-2 and 2-3).

Mounting deviations from that recommended by Woodward might cause assembly damage, improper performance or operator injury risk.

Improper mounting may be considered as a violation of warranty conditions.

⚠WARNING

To prevent damage to the actuator from excessive side loading, the maximum allowable linkage misalignment from the actuator output shaft (rod) is 5°.

⚠WARNING

Make sure that the linkages and couplings connecting the VS-II output shaft to the turbine are appropriately sized and are able to withstand the stall force and dynamic loads.

⚠WARNING

VS-II actuator lifting is allowed ONLY by using two provided lifting eyes on the hydraulic power cylinder. The VS-II Servo valve lifting is allowed ONLY by using two provided lifting eyes on the servo valve. Support the VS-II in the vertical position during transportation.

⚠WARNING

Make sure that the crane, cables, straps, and all other lifting equipment used for VS-II lifting are able to support the VS-II weight. See outline drawings for VS-II weights.

Hydraulic Connections

For the VS-II Integrated Actuator or Servo valve there are two hydraulic connections that must be made to each actuator: supply and drain. For Remote Servo valve installations, additional hydraulic connections must be made between the servo valve and the hydraulic power cylinder.

Hydraulic Connections:

- Supply Port: 51mm (2”) ISO/DIS6162, DIN20066, JIS8363 flange (SAE J518 Code 61 except for metric bolt size)
- Drain Port: 64mm (2.5”) ISO/DIS6162, DIN20066, JIS8363 flange (SAE J518 Code 61 except for metric bolt size)
- Control ports C1 and C2: 51mm (2”) ISO/DIS6162, DIN20066, JIS8363 flange (SAE J518 Code 61 except for metric bolt size)
- Actuator and Servo Overboard Drain (OVBD): 32mm (1.25”) ISO/DIS6162, DIN20066, JIS8363 flange (SAE J518 Code 61 except for metric bolt size) or -10 SAE J1926

  Note: SAE J518, JIS B 8363, ISO/DIS 6162 AND DIN 20066 are interchangeable, except for bolt sizes. VS-II uses metric bolt sizes.

Hydraulic connection tightening torques:

- Hydraulic Supply & Drain:
  4x M12x1.75 Screws Torque to (72 – 88) Nm, (53 - 65 lbf-ft)
- Hydraulic Control Ports:
  4x M12x1.75 Screws Torque to (72 – 88) Nm, (53 - 65 lbf-ft)
- Overboard Drain Ports:
  4x M10x1.5 Screws Torque to (45 - 55) Nm, (27 - 40 lbf-ft)

⚠CAUTION

Before installing the VS-II, all hydraulic lines must be thoroughly flushed to remove all contamination.

Make provisions for proper filtration of the hydraulic fluid that will supply the actuator. The system filtration should be designed to assure a supply of hydraulic oil with a target cleanliness level of ISO 4406 code 20/18/16 or cleaner.

The tubing connected to the actuator must be constructed to eliminate any transfer of vibration or other forces to the actuator.

The hydraulic supply to the actuator is to be 51 mm (2 inch) tubing, or larger, capable of supplying 681 L/min (180 US gal/min) at 34.47 bar / 500 psig.

The hydraulic drain should be 63.5 mm (2.5 inch) tubing, or larger, and must not restrict the flow of fluid from the actuator. The drain pressure must not exceed 10% of supply pressure or 3.5 bar (50 psig), whichever is less, under any condition.
Pipe diameters to both the Supply and Drain connections should be maximized, within reason, to ensure that flow losses and restrictions are minimized. For the same reason, pipe lengths should be kept to a minimum.

IMPORTANT

It is highly recommended that inlet supply pressure at the actuator inlet not be allowed to decrease by more than 10% of nominal value during slew/step.

The hydraulic supply capacity should be large enough to supply the required slew rate of the attached servo system (See Hydraulic Supply Specifications). Significant reductions in dynamic performance, slew speed, and load capacity will be caused when the VS-II does not receive the required flow and pressure.

> **Note:** It is strongly recommended that a high volume hydraulic accumulator be positioned on the supply line *as close to the VariStroke-II actuator as possible* in order to maintain supply pressure and flow.

The supply pressure at the actuator inlet should remain within 10% of the set operating pressure during a full slew. See Figure 3-3 below.

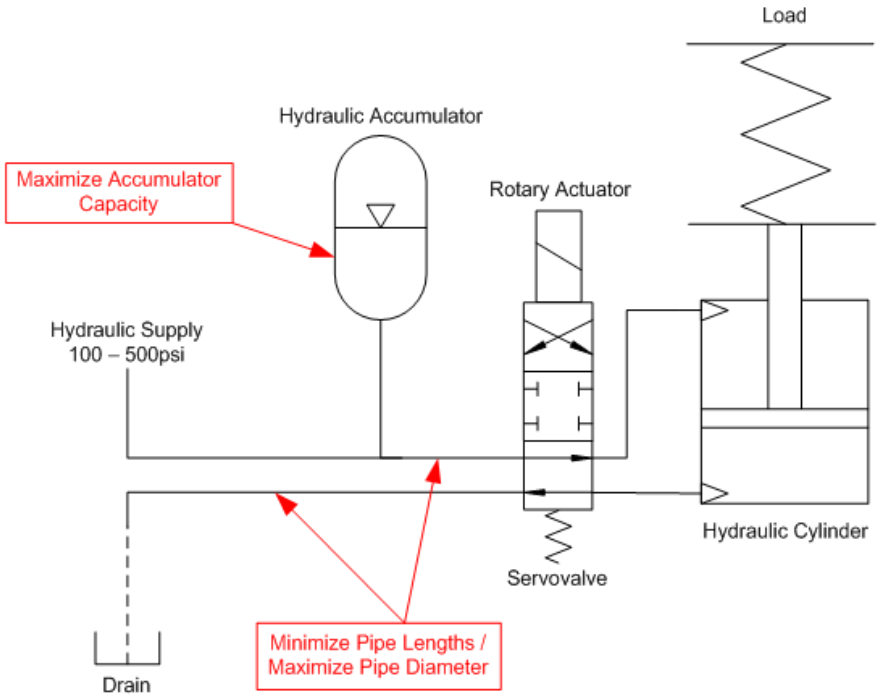


Figure 3-3. Suggested Configuration

WARNING

Do not remove any test port connection plugs when hydraulic supply pressure is applied. All required hydraulic connections must be made before hydraulic pressure is applied. Hydraulic test ports provided for use by authorized service personnel only.

Electrical Connections

An overall electrical wiring diagram is shown in Figure 3-4. Detailed wiring requirements for these connections will follow in the remainder of the Electrical Connections section. The RS-232 connection is covered in Chapter 5 (Installing and Running the PC Service Tool).

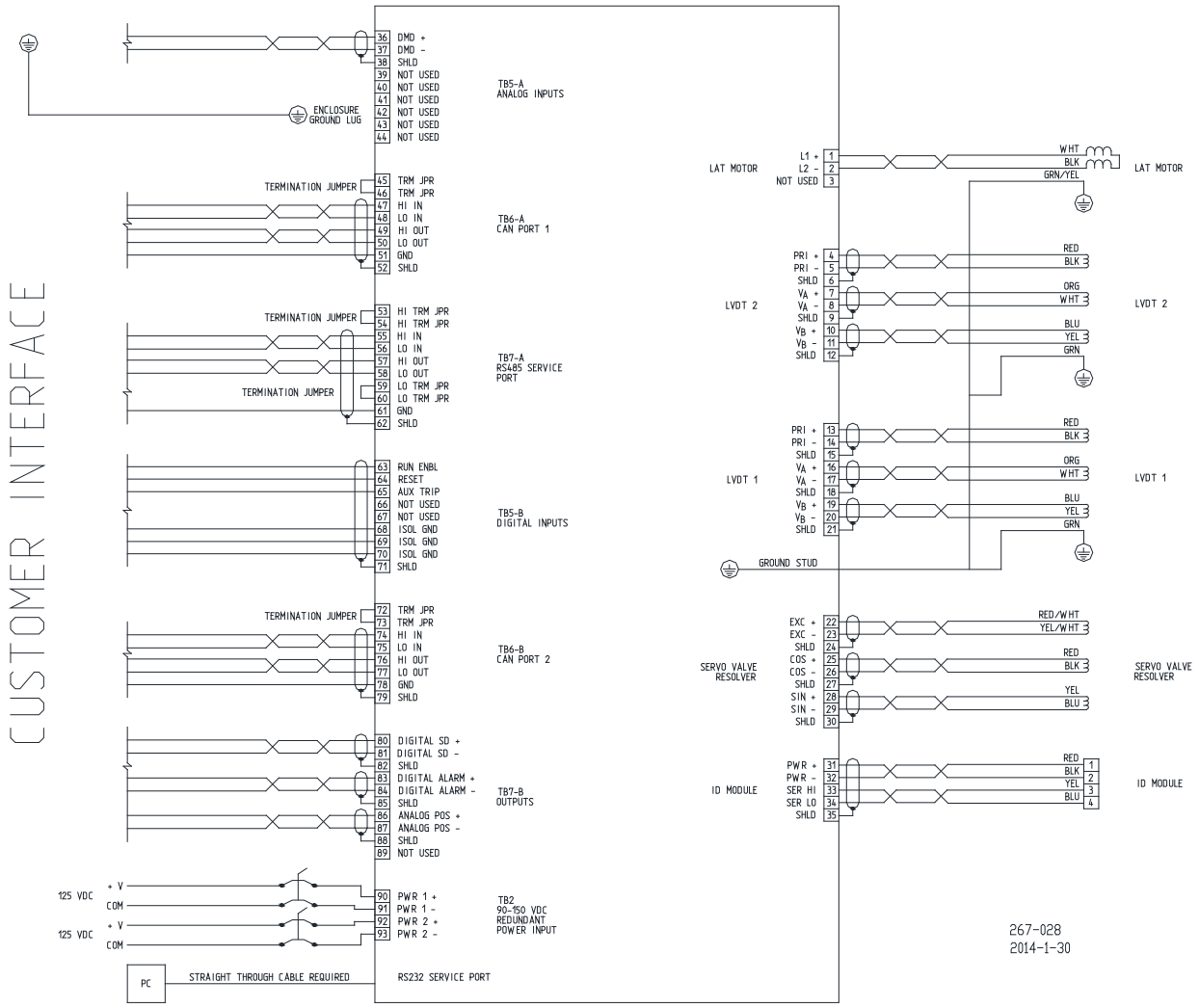


Figure 3-4. Electrical Wiring Diagram

Chapter 4.
Electrical I/O

Electrical Connection Ports

A total of six 0.750-14 NPT electrical connection ports are provided for Electrical I/O conduits or cable glands. See Outline drawings 2-2 through 2-6 for locations. The Power Supply port should be used only for power supply cables. Low-level signal cables must be separated from the power cables. Wiring must be per applicable Regulatory Compliance requirements.

Power Supply Inputs

The VS-II is designed with redundant power supply inputs through internal diode isolation power capability. The redundant power supply input option is ideal for users to use two separate power supplies at the same time. If one of the inputs is lost, drops low, or experiences temporary power loss, the other power input will take over without being affected by the first input. The user is provided with four terminals (each terminal is sized for 8 AWG wire), two pairs each of positive and negative, in order to allow the redundant power supply connections.

Power Supply Requirement

The VS-II requires dc input voltage within the range of 90 to 150VDC and wiring sized appropriately to provide the nominal voltage at the VS-II input terminals (during transients) to operate within specification. We recommend that the user provide appropriate power and fusing as shown in Table 4-1 in order to safely operate the VS-II.

Table 4-1. VS-II Power Requirements

Nominal Voltage	Description	Values
125 Vdc	**Input Voltage Range**	90 Vdc to 150 Vdc
	Steady State Current	2 A continuous
	Transient Current	10 A transient for 200 ms depending on the stroke of the output shaft
	Fuse	15 A, 250 V Slow Blow (time delay—minimum I^2t rating of 1200 A^2s)
	Circuit Breaker	20 A, 250 V minimum

For installations with 110/220VAC power distribution, Woodward has identified and tested the following AC/DC power supply, two of which are required for nominal operation. Since the VS-II accepts redundant power inputs, the user can optionally use two additional of the converters (four total) for redundancy.

Acopian Power Supply

Acopian Power Supply Part Number: W110LT650D2P (quantity 2 or 4 depending on redundancy).
Additional information is available on the Acopian website: http://www.acopian.com

Accessory mounting kits are available from Acopian. Here is a list applicable in a VSII application.

- Wall mount: NP6
- Vertical DIN Rail mount: WL35DIN
- Horizontal DIN Rail mount: WLH35DIN

Specifications:

- AC Input: 90 – 265VAC, 49 - 420Hz, single phase
- DC Output (per supply): 110VDC, 6.5A

This power supply model number is configured for parallel operation and has a feature to adjust fan speed based on temperature. Since the VS-II can draw current pulse from the power supply, two of the Acopian units are required in parallel to provide the necessary power to the VS-II.

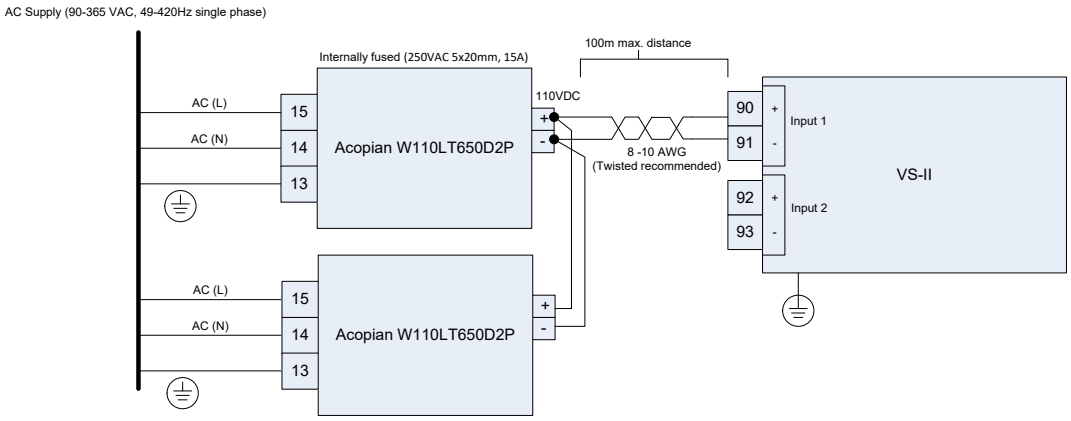


Figure 4-1. Simplex Power Supply Input

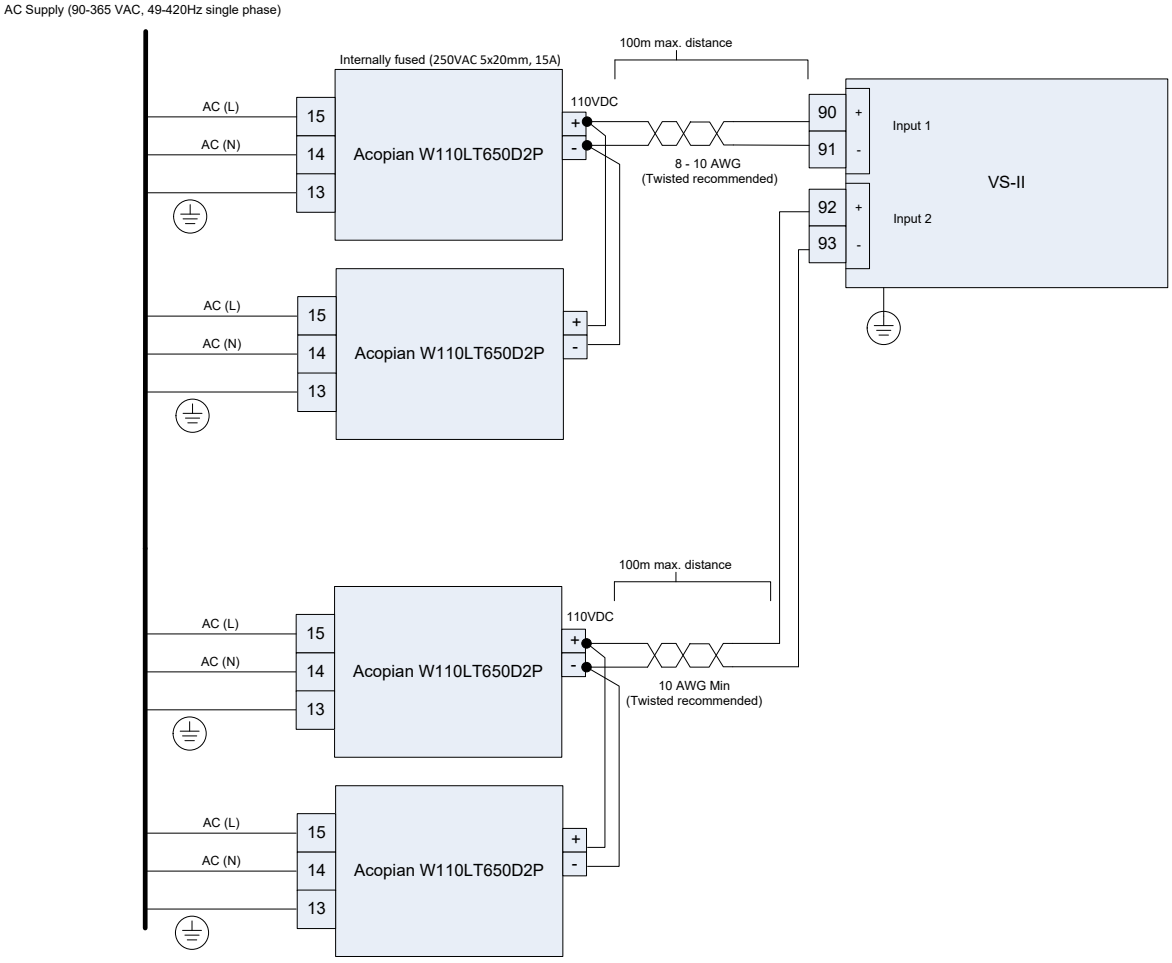


Figure 4-2. Redundant Power Supply Input

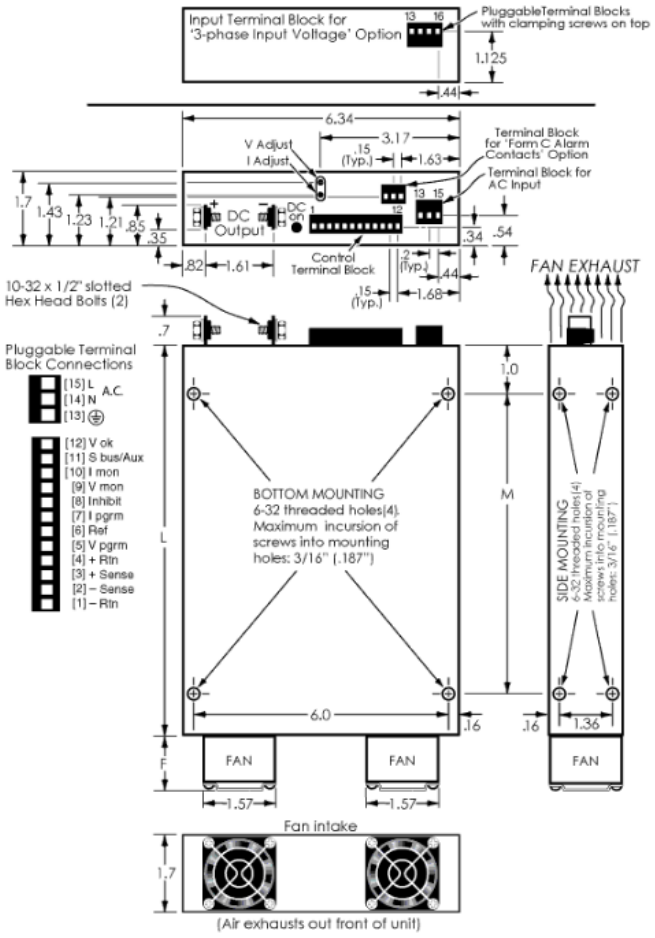


Figure 4-3. Acopian W110LT650D2P Outline Drawing

Table 4-2. Acopian W110LT650D2P Dimensions

Case Size	L	M	F	Approx. Weight
WL9	9.9	6.5	1.3	4 lb. 13 oz.

NOTICE

Overcurrent protection devices recommended in this manual are intended to provide protection against faults which result in increased current flow, and therefore, increased heating and the probability of the start and spread of fire.

Power Wiring

The VS-II is not equipped with an input power switch. Proper input power wiring to the VS-II is crucial to its operation; therefore, we recommend that a safety input power switch be provided for installation and servicing. Do not use a fuse as a switch. A circuit breaker meeting the power supply requirement may be used for this purpose. It is important that proper wiring be applied during system installation to avoid an unwanted power trip or ground loop. Figure 4-1 illustrates the right and wrong ways to wire the power cable to the VS-II.

The VS-II is provided with power terminals that are suitable for the selected supplied line voltage application. Positive and negative pins are designated for each input power entry that are sized for 8 AWG wire. This allows for redundancy in the power supply input. If one of the inputs is lost, or drops low, then the other input will take over the operation without being affected by the first input or dealing with any temporary loss of operation. The two inputs of the connector are independent from each other through internal diode isolation. Ideally, these redundant inputs would be used with two separate power supplies, but can be tied together for operation with a single supply and redundant wiring (Figure 4-2). For increased reliability, Woodward recommends that you always takes advantage of the dual 8 AWG wiring configuration for your power supply requirements.

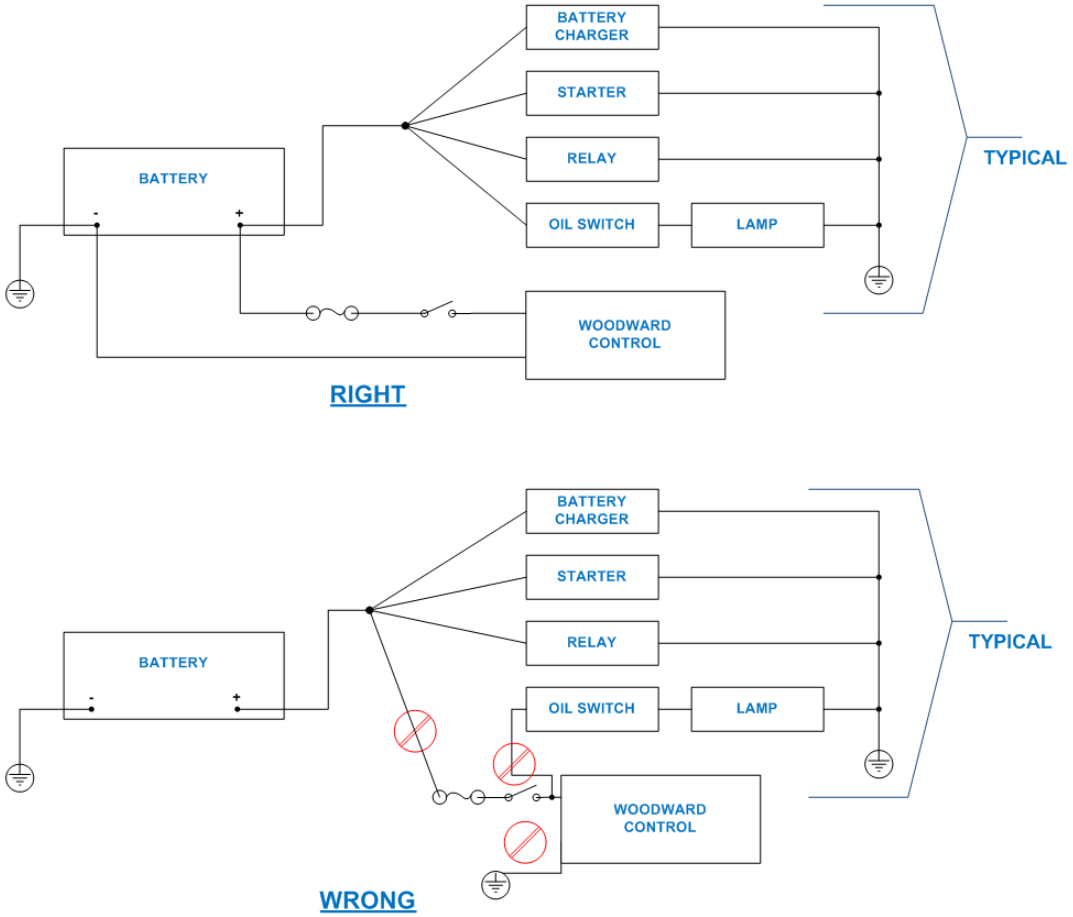


Figure 4-4. Power Wiring Recommendation

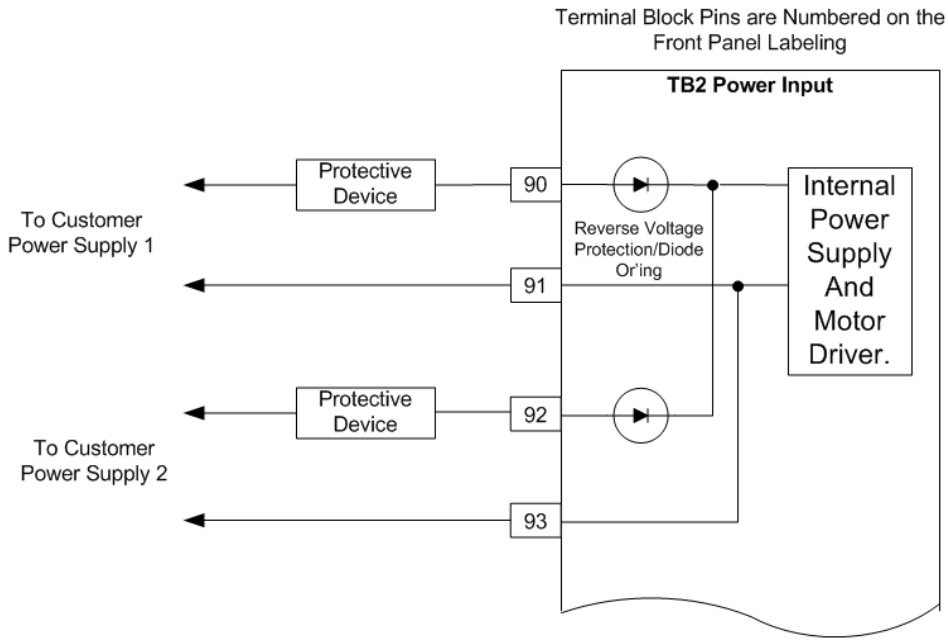


Figure 4-5. Input Power Interface Diagram

Power Input Cable Requirements

Cable selection and sizing are very important to avoid power loss during driver operation. **The power supply input at the VS-II driver's input terminals must always provide the required nominal voltage for the driver, especially under transient conditions.**

The input power wire must comply with local code requirements and be of sufficient size such that the power supply voltage minus the voltage loss in the two lead wires to the VS-II driver does not drop below the driver input minimum voltage requirement.

American Wire Gauge Voltage Drop

A standard wire gauge voltage drop at maximum ambient temperature is provided in Table 4-2 to assist the cable selection.

Table 4-3. Voltage Drop Using American Wire Gauge (AWG)

Wire Gauge (AWG)	Voltage Drop per Meter @ 10 A Round-Trip (V)	Voltage Drop Per Foot @ 10 A Round-Trip (V)
8	0.05	0.016
10	0.083	0.025
12	0.131	0.040

A guideline for allowable voltage drop is to size wire for <5% of the nominal voltage under maximum transient conditions. Maximum transient current can be found in Table 4-1.

Voltage Drop Calculation Using American Wire Gauge

Example: A 10 AWG wires will drop 0.025 V/ft at 10 A at maximum ambient temperature. Using 100 feet between the VS-II driver and the power supply would provide a voltage drop of 100 x 0.025 = 2.5 V. It is very important to ensure the voltage at the driver's input terminal is within the product power input specification in order to achieve the maximum performance.

Wire Area Voltage Drop

A standard wire area voltage drop at maximum ambient temperature is provided in Table 4-3 to assist the cable selection.

Table 4-4. Voltage Drop Using Wire Area (mm²)

Wire Gauge (mm²)	Voltage Drop Per Meter @ 10 A Round-Trip (V)	Voltage Drop Per Foot @ 10 A Round-Trip (V)
10	0.043	0.013
6	0.072	0.022
4	0.108	0.033

Example: 6 mm² wires will drop 0.072 V/m at 10 A. Using 50 meters between the VariStroke II driver and the power supply would provide a voltage drop of 50 x 0.072 = 3.6 V.

NOTICE

The voltage at the VS-II input power terminal block must always stay within the input voltage specification in order for the VS-II to operate correctly. There is no cable length limitation to the input power of the VS-II as long as the voltage at the VS-II power input terminal is within the VS-II voltage range specification.

Unit Grounding

The unit housing must be grounded using the designated EMC ground connection point and PE ground connection points circled in Figure 4-3, top and bottom, respectively.

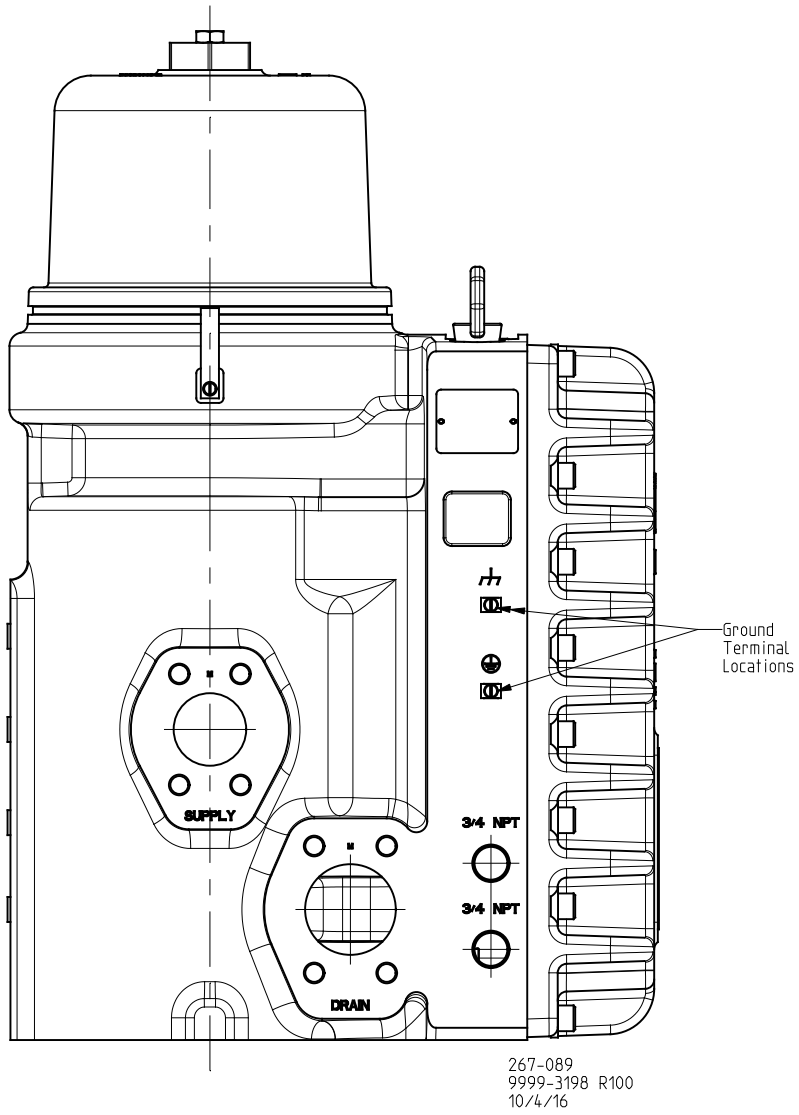


Figure 4-6. Grounding terminal locations

For the PE connection, use required type (typically green/yellow, 2.5 mm² / 12 AWG) as necessary to meet the installation safety ground requirements. For the EMC ground connection, use a short, low-impedance strap or cable (typically > 3 mm² / 12 AWG and < 46 cm / 18 inches in length). Torque the ground lugs to 5.1 N·m (3.8 lb-in).

IMPORTANT **In cases where the EMC ground configuration also meets installation safety ground requirements, no additional PE ground is required.**

LVDT Feedback

There is a 5 kHz excitation signal that is sent out to the LVDT's primary coil from the driver, and secondary coil voltages (V_A & V_B) are sent back. These signals are then translated through a resolver to digital (RDC) algorithm, and from the output of that block the processor calculates the hydraulic power cylinder position. This information is then fed into the control model at the appropriate intervals. VS-II features redundant LVDTs that are used to monitor the hydraulic power cylinder's linear position.

The LVDT's are pre-wired in the Integrated VS-II actuators and no LVDT wiring by the installer is required.

For Remote Servo kits and Servo Only installations: The LVDT feedback should be appropriately wired and shielded according to instructions in this manual and the length of the wires should be limited to 10 m and the lumped capacitance should be limited to 5 nF (Figures 4-4 & 4-5).

LVDT Requirements:

Table 4-5. LVDT Requirements

Type:	Six wire, difference/sum, Woodward supplied
Excitation:	3.0 VRMS at 5000 Hz
Sum Voltage:	Va + Vb = 1.2 VRMS
Output Voltage Ratio:	(Va - Vb)/(Va + Vb) = ±0.5 VRMS
Linearity:	±0.5% Full Stroke
Sensor Stroke Length (SSL):	1x Cylinder Mechanical Stroke Length ≤ SSL ≤ 1.5x Cylinder Mechanical Stroke Length. Both LVDTs must be of equal length in redundant applications
Sensor Cable Length Limit:	10 m (33 feet) maximum between sensor and VariStroke-II. Shielded, <5nF lumped capacitance

LVDT Signal Requirement:

Primary (Generated from VS-II)
- Frequency: 5 kHz
- Voltage: Controlled by VS-II

V_A and V_B (Signal returned from the position sensor).
- Max Voltage: ±1.5 V.

LVDT Wiring Requirements:

- Shielding: Per drawing below
- The maximum capacitance of the shielded twisted pair resolver cables should be less than a total of 5 nF (not including internal capacitance) in order to meet positioning accuracy and performance specifications
- Maximum Run Length: 10 m
- Wire Gauge Range: 16–20 AWG
- Keep this and all other low level signal cables separated from motor cables and input power cables to avoid unnecessary coupling (noise) between them.

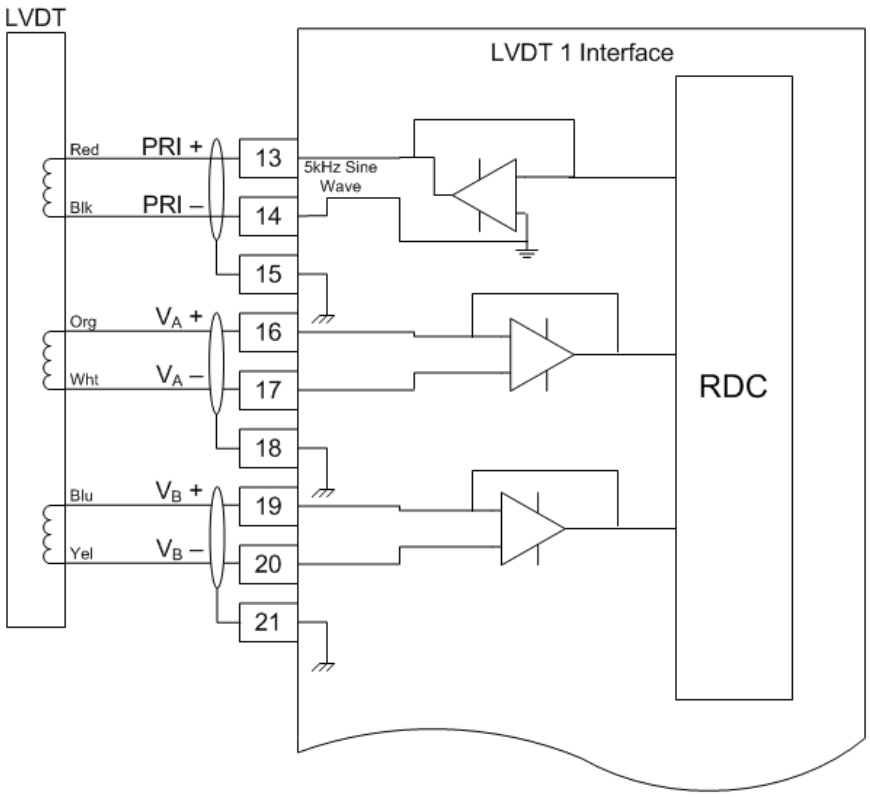


Figure 4-7. LVDT 1 Interface Diagram

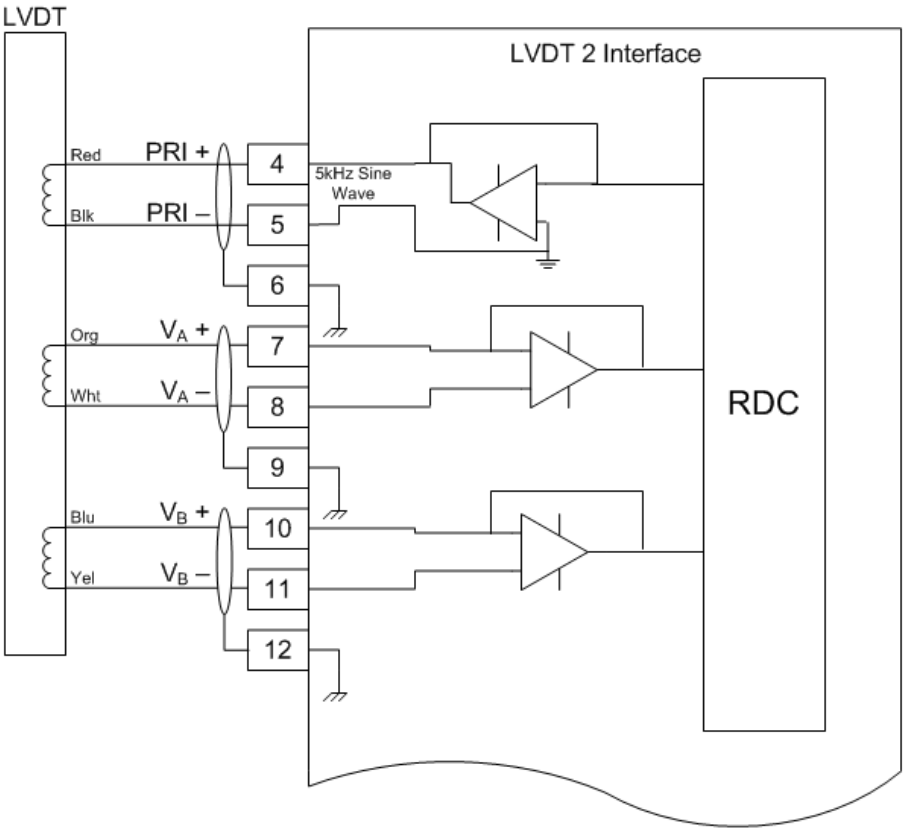


Figure 4-8. LVDT 2 Interface Diagram

RS-232 Service Port

The RS-232 port (Figure 4-6) should only be used during the VS-II Configuration with the Service Tool. See Chapter 5 for the detailed description of the configuration for this positioner. All normal operation command and monitoring should be done through the Ethernet, CAN, or other command and feedback type depending on the positioner configuration. It is recommended that an RS-232 isolator be applied when using the serial port in order to avoid any possible communication issues. The reason for this is that the port is not isolated, and we would like to avoid any potential ground loops or unnecessary EMI noise coupling related to PC connections and typical industrial environments. The RS-232 port requires a straight-through cable.

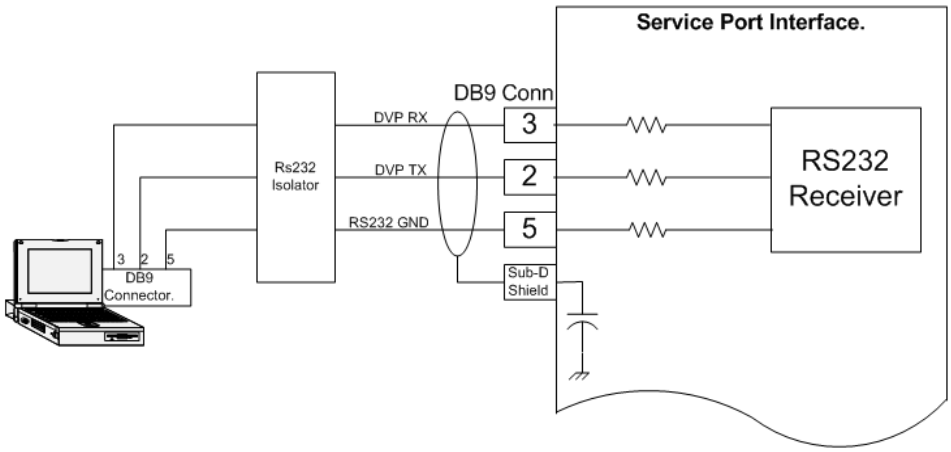


Figure 4-9. RS-232 Interface Diagram

RS-232 Communication Specification:

- Data Rate: fixed baud rate at 38.4 kbps
- Isolation: 1500 Vac from input power

Wiring Requirements:

- External RS-232 Isolator is Recommended (Phoenix Contact PSM-ME-RS-232/RS-232-P, Woodward P/N 1784-635)
- Straight-through cable type
- Keep this and all other low level signal cables separated from motor cables and input power cables to avoid unnecessary coupling (noise) between them.

Analog Input

The analog input for the VS-II is a 4–20 mA configuration used as the position command (demand) input.

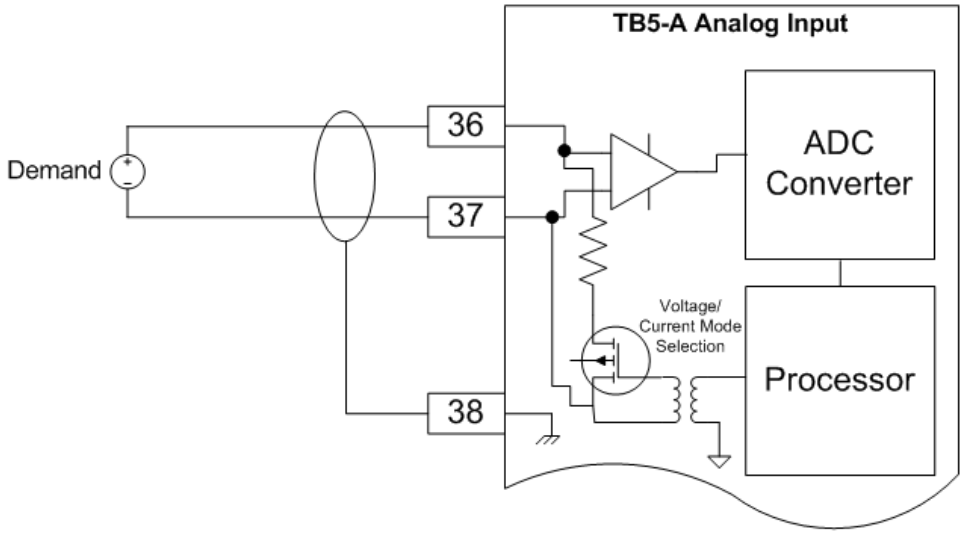


Figure 4-10. Analog Input Interface Diagram

Analog Input Specification:

- Analog 4–20 mA: Range is 2 to 22 mA
- Max. temperature Drift: 200 ppm/°C
- Calibrated Accuracy: 0.1% of FS
- Common Mode Voltage: ±100 V
- Common Mode Rejection Ratio: –70 dB @ 500 Hz
- Isolation: 400 kΩ from each terminal to Digital Common
  1500 Vac from Input Power

Wiring Requirements:

- Individually shielded twisted pair cable
- Keep this and all other low level signal cables separated from motor cables and input power cables to avoid unnecessary coupling (noise) between them.
- Maximum Run Length: 100 m
- Wire Gauge Range: 16–20 AWG (0.5 to 1.3 mm³)

Analog Output

The analog output of the VS-II is in the form of a 4–20 mA output and can drive load resistances up to 500Ω. This output is configured to report actual hydraulic power cylinder position. This output is designed for monitoring and diagnostic purposes only, and is not meant for any type of closed loop feedback.

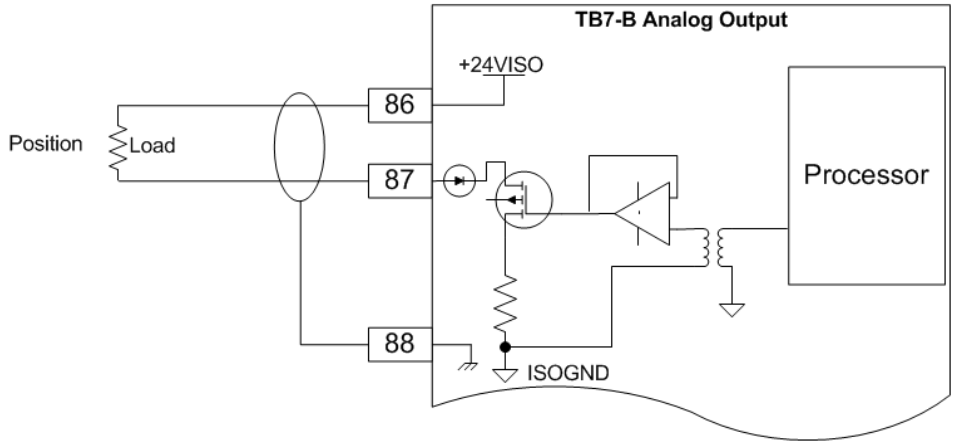


Figure 4-11. Analog Output Interface Diagram

Analog Output Specification:

- Calibrated Accuracy: 0.5% of full range
- Output Range: 4 to 20 mA
- Load Range: 0 Ω up to 500 Ω
- Maximum Temperature Drift: 300 ppm/°C
- Isolation: 500 Vac from Digital Common, 1500 Vac from Input Power

Wiring Requirements:

- Individually shielded twisted pair cable
- Keep this and all other low level signal cables separated from motor cables and input power cables to avoid unnecessary coupling (noise) between them.
- Maximum Run Length: 100 m
- Wire Gauge Range: 16–20 AWG (0.5 to 1.3 mm³)
- Shielding: per drawing above

Discrete Inputs

The VS-II has five discrete inputs. Terminals 63, 64, and 65 are configured for Run Enable, Reset, and Auxiliary Trip at the factory, while terminals 66 and 67 are not used as a default as shown in Figure 4-9. See Chapters 5 and 6 to learn more about configuration of the input and how to make changes if necessary.

The two states that the inputs expect are tied to the isolated ground terminals 68, 69, and 70 provided or to the +18 V isolated input to the control. There are five inputs and only three ground terminals provided, so it may be necessary to use one ground for multiple inputs. This is understood and allowable. Through the software, the user can configure these inputs as active high (open) or active low (ground) depending on the wiring preference. We recommend that the discrete inputs be configured as active low in order to protect against broken wires. A broken wire will look like an open input, which will be the inactive state. This is especially important in the case of a shutdown input. External power is not necessary for these inputs as the isolation is provided internally.

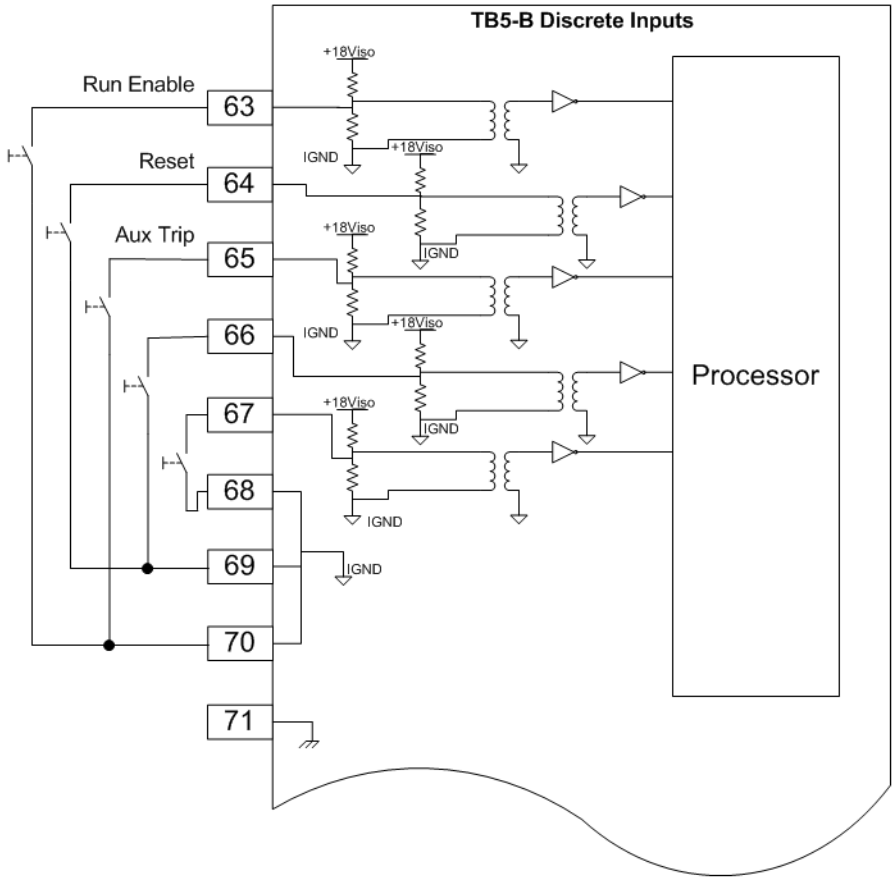


Figure 4-12. Discrete Input Interface Diagram

Discrete Input Specification

- Trip Points:
  - If the input voltage is less than 3 V the input is guaranteed to detect a low state (input voltage<3 V = LO).
  - If the input voltage is greater than 7 V the input is guaranteed to detect a high state (input voltage >7 V = HI).
  - The open state will look like a high state to the controller, and, therefore the two states of the input are open or tied to ground.
  - The hysteresis between the low trip point and the high trip point will be greater than 1 V.
- Contact Types; The inputs will accept either:
  - A dry contact from each terminal to ground or
  - An open drain/collector switch to ground
- Isolation: 500 Vac from Digital Common, 1500 Vac from Input Power

Wiring Requirements:

- Keep this and all other low-level signal cables separated from motor cables and input power cables to avoid unnecessary coupling (noise) between them.
- Maximum Run Length: 100 m
- Wire Gauge Range: 16–20 AWG

Discrete Outputs

There are two Discrete Outputs on the VS-II. Either output can be configured to react to any or all the Alarms/Shutdowns in the positioner. The outputs can also be configured as active on or active off. See Chapters 5 and 6 to learn more about configuration of the input and how to make changes if necessary. The outputs can be used as high side or low side drivers depending on user preference. We recommend, however, that the output be used as a high side driver as shown in the diagram below. This configuration will make some common wiring faults to ground more detectable.

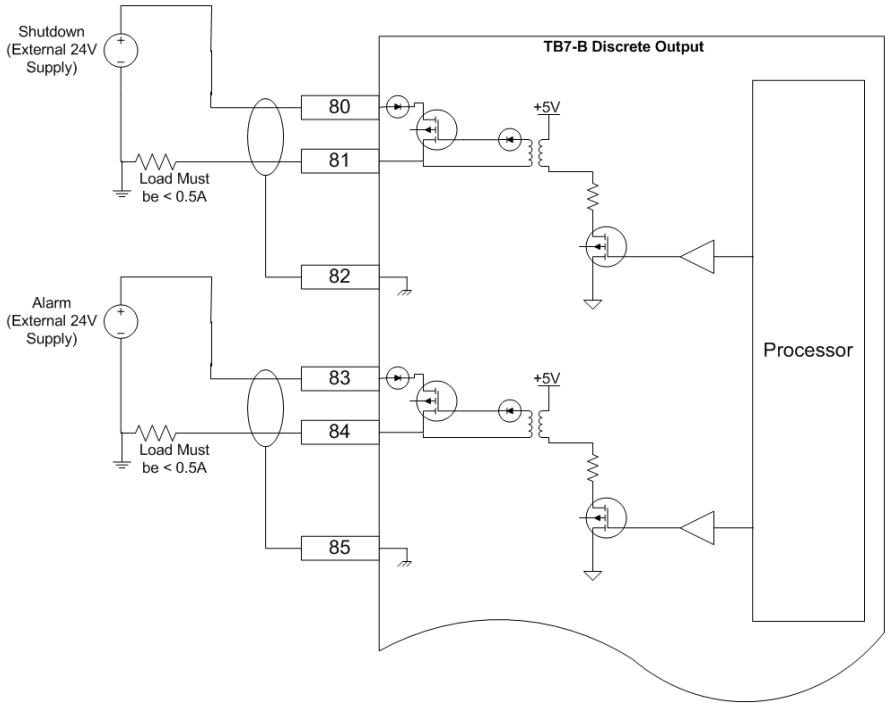


Figure 4-13. Discrete Output Interface Diagram

Discrete Output Specification:

- External Power Supply Voltage Range: 18–32 V
- Maximum Load Current: 500 mA
- Protection:
  - The outputs are short circuit protected
  - The outputs are recoverable after short circuit is removed
- Response Time: Less than 2 ms
- On-state Saturation Voltage: less than 1 V @ 500 mA
- Off-state Leakage Current: less than 10 µA @ 32 V
- Hardware Configuration Options: The outputs can be configured as high-side or low-side drivers, but we recommend that they be used as high side drivers if possible.
- Isolation: 500 Vac from Digital Common, 1500 Vac from Input Power

Wiring Requirements:

- Individually shielded twisted pair cable
- Keep this and all other low level signal cables separated from motor cables and input power cables to avoid unnecessary coupling (noise) between them.
- Maximum Run Length: 100 m
- Wire Gauge Range: 16-20 AWG (0.5 to 1.3 mm^3)
- Shielding: per drawing above

CAN Communication Ports 1 and 2

The VS-II device may be controlled via CAN communication. There are two possible modes: CANopen single with or without analog backup, CANopen dual, and CANopen Virtual.

1. The CANopen single with or without backup: This mode uses CAN port 1 for communication. Optionally it is possible to configure (by CAN communication) the analog input as a backup signal. By default, the analog input is a backup signal. (See analog input section for how to interface and setup an analog input.)

2. CANopen Dual: This mode uses CAN port 1 and CAN port 2. If the two ports are working correctly, information received from CAN port 1 is used. If communication by CAN port 1 is not possible any more (detected by communication time out), CAN port 2 is used for communication.

3. CANopen Virtual: This mode is used when two VS-II units are linked together. This mode is currently not supported by the software/firmware in VS-II

The CAN communication baud rate can be selected using the Service Tool. The possible options are:

- 125 kbps
- 250 kbps
- 500 kbps

Per CiA DS-102 Standard, the following are the recommended maximum cable lengths. Differences in the baud rate and the cable length affect the number of units that can be put onto a network.

Table 4-6. Recommended Maximum Cable Lengths per CiA DS-102 Standard

Baud Rate	Cable Length	Number of VS-II on link
500 Kbps	100 m	15
250 Kbps	250 m	7
125 Kbps	500 m	3

IMPORTANT

The use of controlled impedance (120 ohm) cable is recommended for proper CANbus operation. See ISO 11898 series standards for further information.

⚠WARNING

For communication wiring, use wires with a temperature rating of at least 5 °C above surrounding ambient. All other functions use wires with a temperature rating of at least 10 °C above surrounding ambient.

NOTICE

Discharge to chassis prior to connecting or disconnecting CAN connector.

If CAN port 1 is used, see Figure 4-11 of the CAN port interface. See the Analog Input section above for the analog interface diagram.

Pins 45 and 46 are the termination jumper. Connecting these two pins with a short wire on the connector will enable an internal 120 Ω resistor between CAN high and CAN low wire. This may help with the termination.

⚠WARNING

If internal termination is used, disconnecting the terminal block will result in communication disruption of all CAN devices on the network, not just the VS-II. If this is not desired, do not use the internal termination—use external termination.

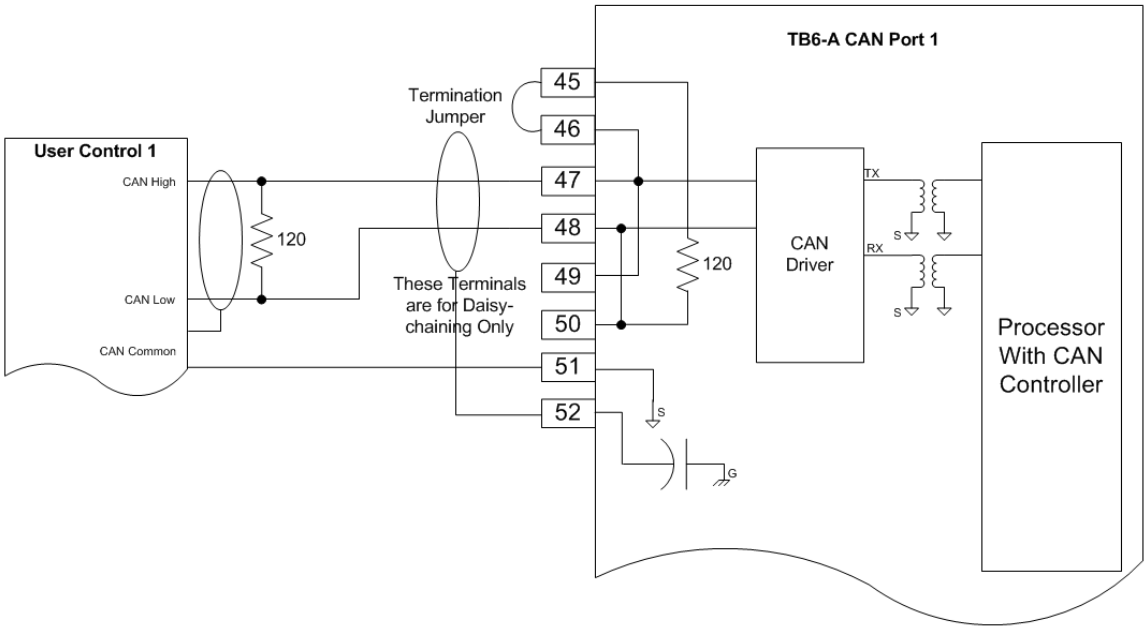


Figure 4-14. CAN Port 1

Pins 47 and 48 are the CAN High and CAN low wires typically found on a CAN system.

Pins 49 and 50 are two additional CAN high and CAN low pins. These can be used to daisy chain the CANbus to the next device, without the need for a junction box.

WARNING

If the daisy chain is used, disconnecting the connector will disconnect the complete CANbus. Other devices communicating on the CANbus will not be able to communicate any more. If this is not desired, do not daisy chain the VS-II.

Pin 51 is the CAN ground. The VS-II side of the CAN link is galvanically isolated from the VS-II, ground, and system common. Therefore, there is a need to connect the isolated ground to the ground of the user control.

Pin 52 is the ground of the VS-II. This pin is also used to terminate the wiring shield.

NOTICE

Discharge to chassis prior to connecting or disconnecting CAN connector.

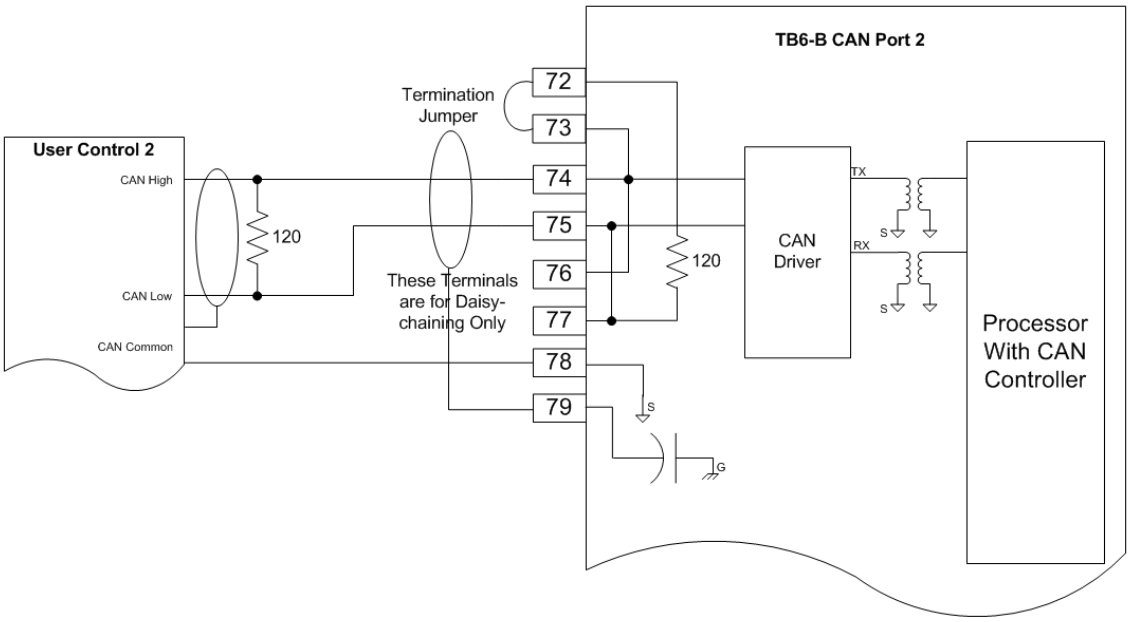


Figure 4-15. CAN Port 2

If you are using dual can communication mode, there are two identical communication ports. Port 1 and port 2 are wired identically. For description, see port 1.

Table 4-7. CAN Port Pin Function

Pin Number	Function
45	CAN 1 Termination jumper
46	CAN 1 Termination jumper
47	CAN 1 High in
48	CAN 1 Low in
49	CAN 1 High out
50	CAN 1 Low out
51	CAN 1 ISO GND
52	CAN 1 Shield
72	CAN 2 Termination jumper
73	CAN 2 Termination jumper
74	CAN 2 High in
75	CAN 2 Low in
76	CAN 2 High out
77	CAN 2 Low out
78	CAN 2 ISO GND
79	CAN 2 Shield

See Chapter 6 for more information on CANopen communications.

RS-485 Communication Port

The VS-II provides an isolated RS-485 communication port (Figure 4-13). This port can be used for a long-distance connection to the control system to utilize the Service Tool.

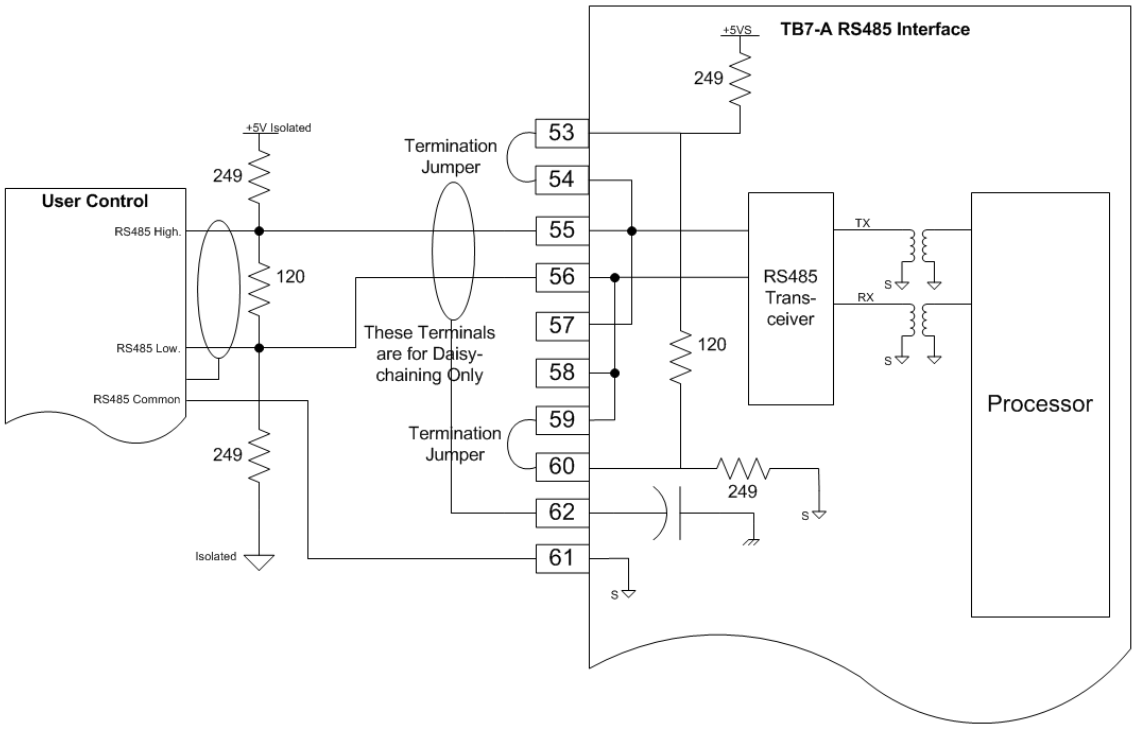


Figure 4-16. RS-485 Interface Diagram

RS-485 Port Specification (Service Port)

- Baud Rate: Fixed at 38.4 kbps
- Isolation: 500 Vac from Digital Common, 1500 Vac from input power

Wiring Requirements:

- Individually shielded twisted pair cable
- Keep this and all other low level signal cables separated from motor cables and input power cables to avoid unnecessary coupling (noise) between them.
- Maximum Run Length: 100 m
- Wire Gauge Range: 16–20 AWG
- Shielding: per drawing above

General Wiring Information

The VS-II has 6x 0.750-14 NPT wiring entries. It is important to use different wiring entries for low-signal cables and input power cables to avoid unnecessary coupling (noise) between them. It is recommended to use either the entry at the bottom or lower left (when facing the servo valve front access cover) for input power cables.

When wiring using cable and cable glands, the gland fitting (not included with VS-II actuator) must meet the same hazardous locations criteria as the VS-II. Follow all manufacturer installation recommendations and special conditions for safe use that are supplied with the cable gland. The cable insulation must have a temperature rating of at least 85 °C and 10 °C above the maximum ambient and fluid temperature.

⚠WARNING

Use of appropriately certified cable glands or sealing device is required for all entries to the flameproof enclosure to maintain the method of protection.

Strip the cable insulation (not the wire insulation) to expose 12 cm of the conductors. Strip the wire insulation 5 mm from each conductor. Mark wires according to their designation and install connectors, if required.

Remove the front access cover. Pass the wires through the cable gland (not provided) or conduit fitting and attach to the printed circuit board terminal blocks in accordance with their wiring diagram. Snap the terminal blocks into the header terminal blocks on the PCB. Tighten the terminal block flange screws to 0.5 N•m (4.4 lb-in).

Install the PE ground and EMC ground straps to the lugs provided. Tighten to 5.1 N•m (45 lb-in).

⚠WARNING

For Class I, Division 1 products: Conduit seals must be installed within 46 cm (18 inches) of the conduit entry when the VS-II is used in Class I, Division 1 hazardous locations.

Tighten the cable gland fitting per manufacturer's instructions or pour the conduit seal to provide strain relief for the cable and to seal the interface between the wiring cable and the VS-II.

Chapter 5.
Service Tool Installation

The VS-II includes a software-based Programming and Configuration tool (PCT) that can be loaded onto a computer and used to:

- Change maximum stop position and cylinder size settings.
- Calibrate the final cylinder.
- Configure the inputs and outputs
- View diagnostic flags

⚠WARNING **An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.**

System Requirements

The minimum system requirements for the Service Tool software are:

- Microsoft Windows® 7, Vista SP1 or later, XP SP3 (32 & 64-bit); Support of XP ended on 2014 April 8
- Microsoft .NET Framework ver. 4.0 & Hot Fix KB2592573
- 1 GHz Pentium® CPU
- 512 MB of RAM
- Minimum of 800 by 600 pixel screen with 256 colors
- Recommended screen resolution of 1024 X768 or higher
- 9 pin-D Serial Port (RS232)
- Woodward ToolKit Software

Setup

The PC Service Tool or Programming and Configuration Tool is a software application which runs on Windows-based PC or laptop. It requires a physical RS-232 connection between the computer and the VS-II. The physical connection can be made by connecting to the VS-II at the Service Port (RS-232). The electronics enclosure cover must be removed to access this port on the electronic control board. Remove the twenty (20) M12 screws that are around the perimeter of the cover and carefully remove the cover. Take care to not lose the O-ring seal or damage the mating surfaces of the cover and the servo valve body.

> **Note:** When replacing the electronics enclosure cover, ensure that the O-ring seal is completely seated in the O-ring groove and that the mating surfaces are clean, install the cover and M12 screws, and torque the M12 screws to 68-81 Nm (50–60 ft-lbf).

Use a straight-through serial cable (not null modem). For newer PCs or laptops with USB ports, a USB-to-serial converter is required. An approved converter can be obtained from Woodward P/N 8928-1151.

Woodward offers a serial cable as a kit that can be ordered. The part number for this kit is 8928-7323, which contains a 10-foot long (3 m) DB9-F to DB9-M straight-through cable.

> **Note:** this cable has two nuts on the screws on the female end that need to be removed prior installing this end.

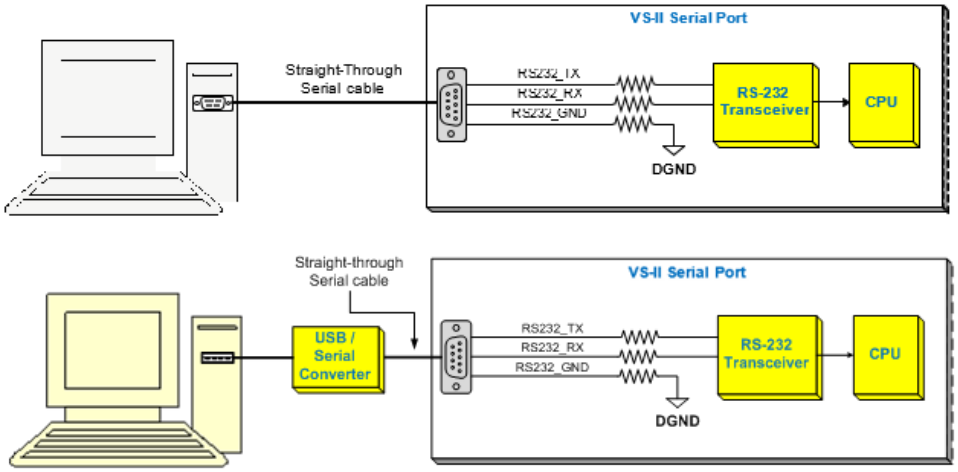


Figure 5-1. Service Port Connections

WARNING

Do not to damage the O-ring cover seal, the cover surface, or the VS-II servo valve surface while removing or replacing the cover. Damage to sealing surfaces may result in moisture ingress, fire, or explosion. Clean the surface with rubbing alcohol if necessary. Inspect the cover joint surfaces to ensure that they are not damaged or contaminated.

Installing the VariStroke-II Service Tool

Use the following installation procedure to install the VariStroke-II Service Tool (Programming and Configuration Tool).

Locate/obtain VS-II Service Tool Installation CD provided with each VS-II. (Alternatively, the VS-II Service Tool Installation file can be downloaded from Woodward's website [**www.woodward.com/software**]). Search for VariStroke II.

To run the installation program follow the installation instructions (shown below).

1. Double click on the install file 9927-2325_xxx.exe. (Note: xxx is a placeholder for the revision of the install package i.e. 9927-2325_NEW.exe. or 9927-2325_A.exe are examples of Rev NEW and Rev A versions.). If the following screen appears, this means there is a new version of ToolKit which needs to be installed on the PC.

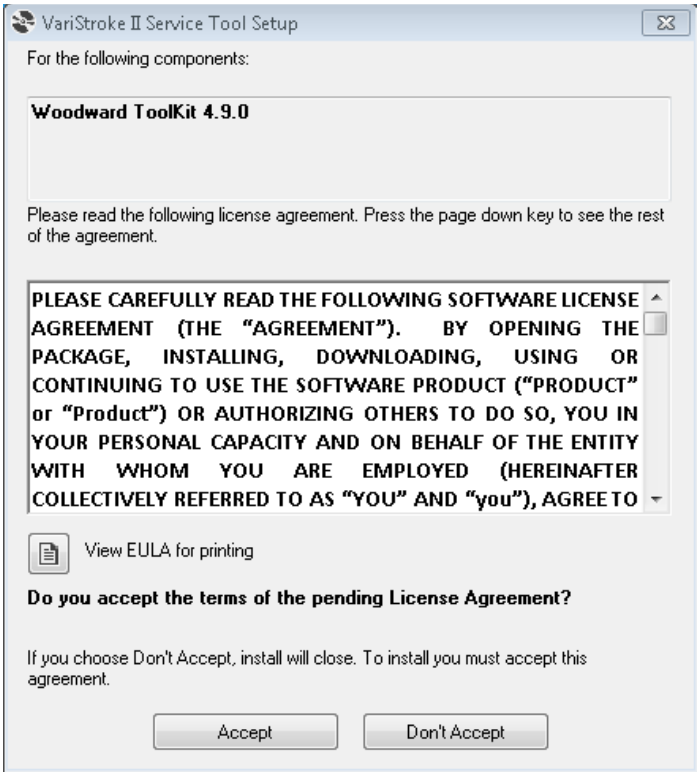


Figure 5-2. ToolKit License Agreement

2. The Tool launches and the Welcome screen is displayed. Click on “Next”.

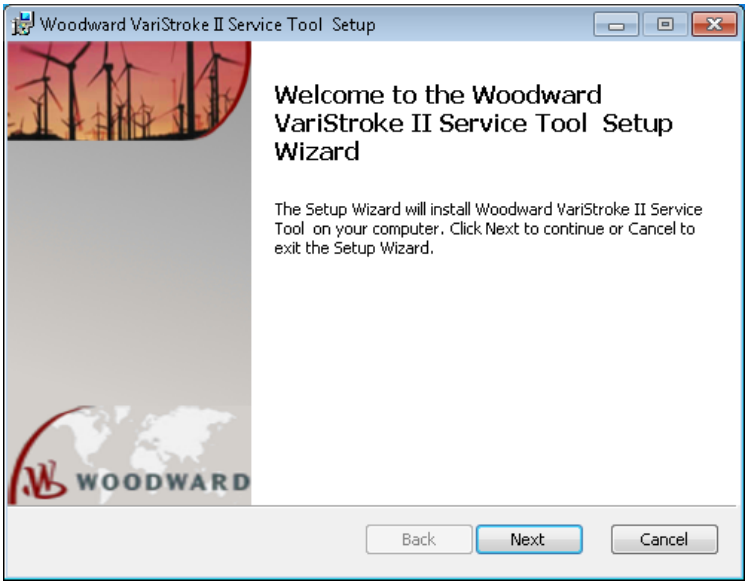


Figure 5-3. VariStroke II Installation Wizard Welcome Screen

3. The EULA screen appears. Accept the terms of the License Agreement by checking the checkbox, then click “Next” to continue.

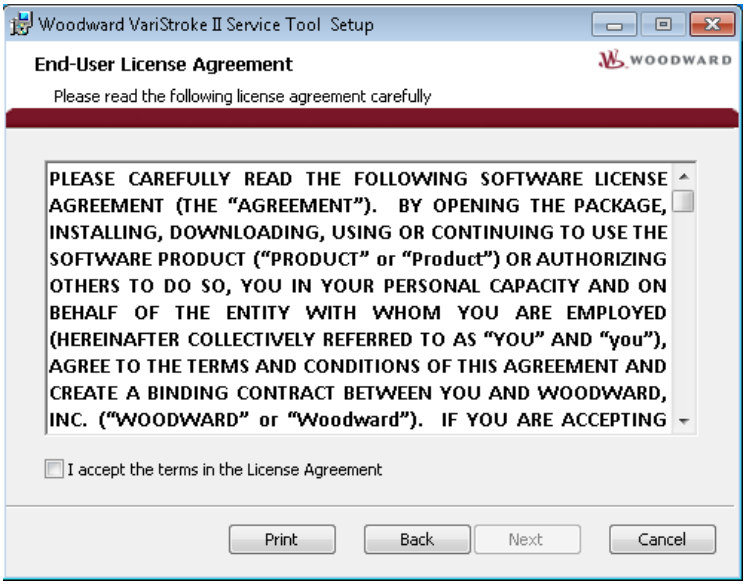


Figure 5-4. Installation End-User License Agreement

4. The Install page appears. “Create shortcut for this program on the desktop” is set as the default. Uncheck this box if you do not want a Service Tool icon on your desktop. Click on “Install”.

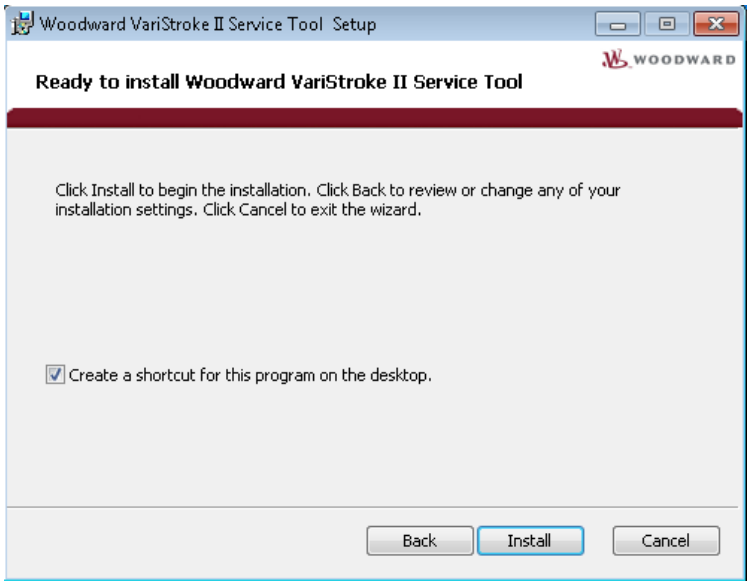


Figure 5-5. Installation Install Page

5. The Installation of the Service tool will proceed.

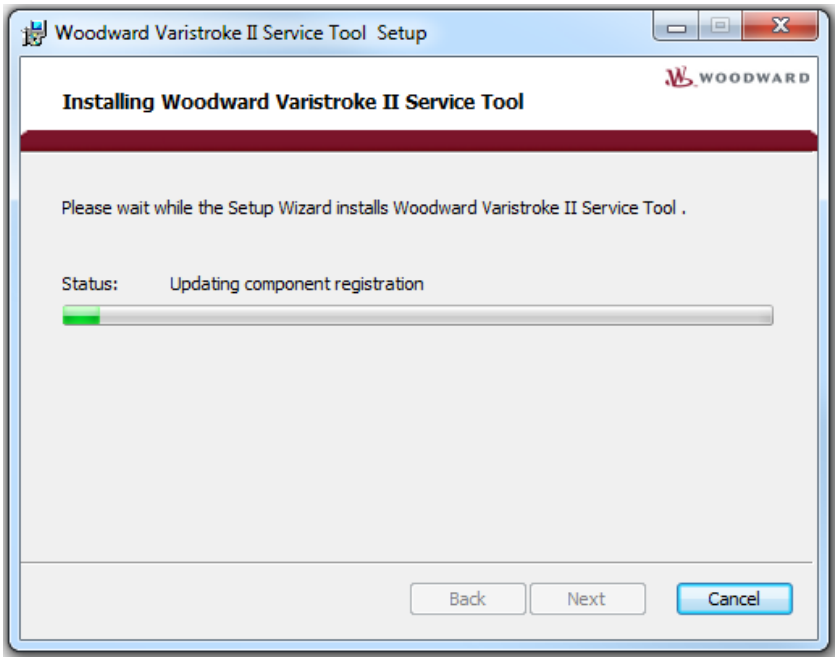


Figure 5-6. Service Tool Installation in Progress

6. When the installation is finished, the Installation Complete screen will appear. The “Launch when setup exits” box in the lower left is unchecked by default. You do not want to launch the Service tool until the VS-II has been connected to the computer through a serial cable. At launch the Service tool detects which COM port is connected to the VS-II.

NOTICE

If you launch the service tool application before you connect the serial cable between the computer and the VS-II the service tool will not detect the new serial connection. To detect the connection you will have to exit and re-launch the service tool.

7. When you click on “Finish” you will exit the installation wizard.

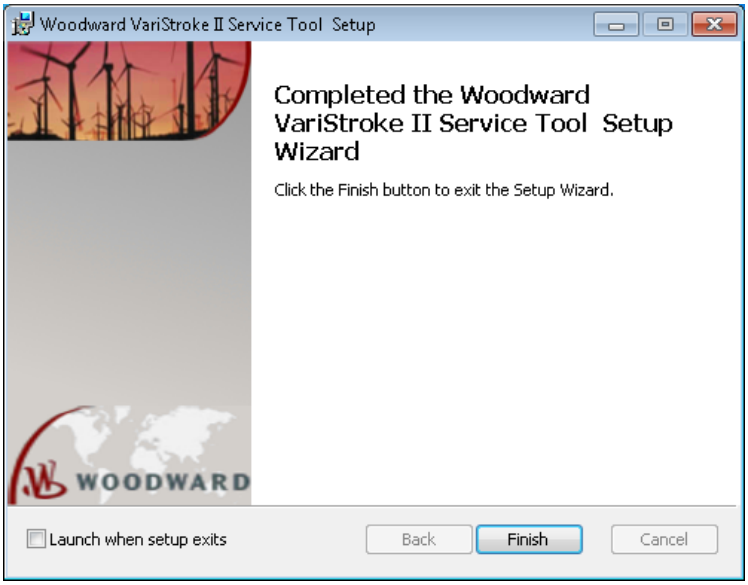


Figure 5-7. Service Tool Installation Complete

Getting Started with the VS-II Service Tool

The VS-II Service Tool communicates with the VS-II via RS-232 connection. The PC (personal computer), running the VS-II Service Tool is connected to the VS-II using a 9-pin straight-through serial cable. Connect the serial cable to the RS-232 Service Port on the back side of the VS-II and an unused RS-232 serial port (COM port) on the PC side.

Refer to the appropriate VS-II Outline drawing for the exact location of the VS-II Service port (marked RS232 SERVICE PORT). Also, refer to the section RS-232 Service Port section in Chapter 2 for the technical specifications of the RS-232 Service Port.

IMPORTANT

The serial cable used to connect the VS-II to the PC running the VS-II Service Tool has to be set up as straight-through configuration. Do NOT use a serial cable with Null-Modem configuration to connect the VS-II to the PC!

General Installation Check before Applying Power to the VS-II

1. Verify the power source is set to within the input operating voltage range. Always make sure that the power at the driver is within the input power range to ensure the operation of the VS-II.
2. Verify all VS-II cable connections are properly installed, including EMC ground and PE ground, and I/O cable shield grounding termination. See Chapter 4.
3. In the case of using Analog input as demand source, verify that the input command is between 4 to 20 mA.

IMPORTANT

Check all wiring from point to point, all connections, and terminations to ensure having proper installation before applying power to the VS-II.

IMPORTANT

Verify that hydraulic supply pressure is not present at the VS-II before applying power to the VS-II or unexpected motion of the output shaft may occur.

⚠WARNING

Failure to follow general installation check prior to applying the power to the driver could damage the turbine due to overspeed conditions if the actuator shuts down in the wrong direction.

Connecting and Disconnecting the VS-II Service Tool

1. After the VS-II and the PC have been connected via the serial cable and power is applied to the VS-II, the VS-II Service Tool can be started from the Windows Start menu or a shortcut on the Desktop (if applicable). The service tool will launch and the next screen you will see will be the Home Screen of the VS-II service Tool.

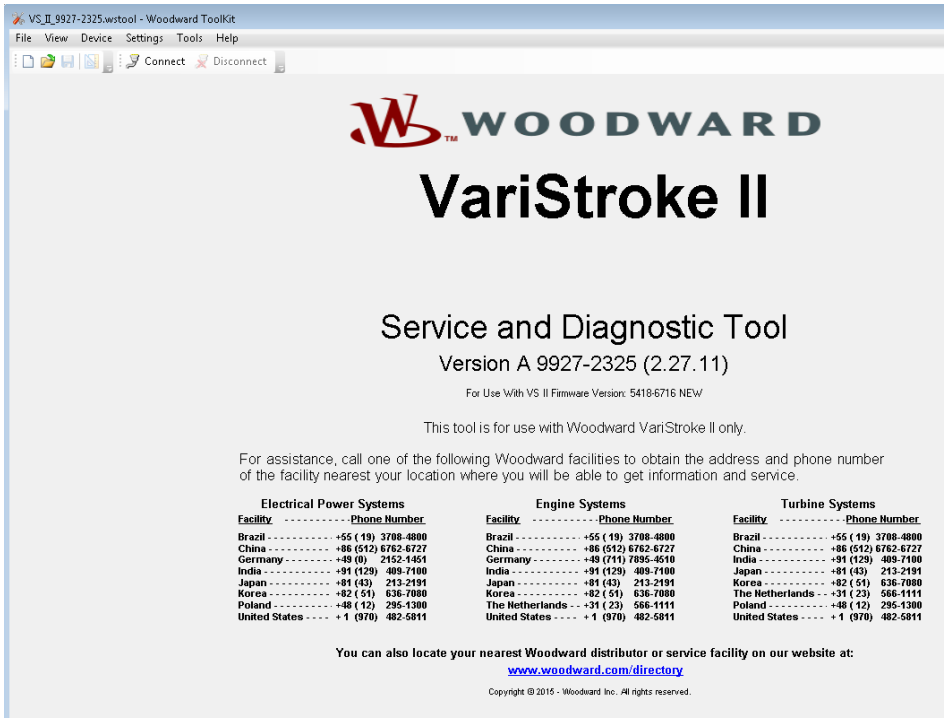


Figure 5-8. Home Screen

2. Connection to the VS-II is made by clicking the connect button on the tool bar.

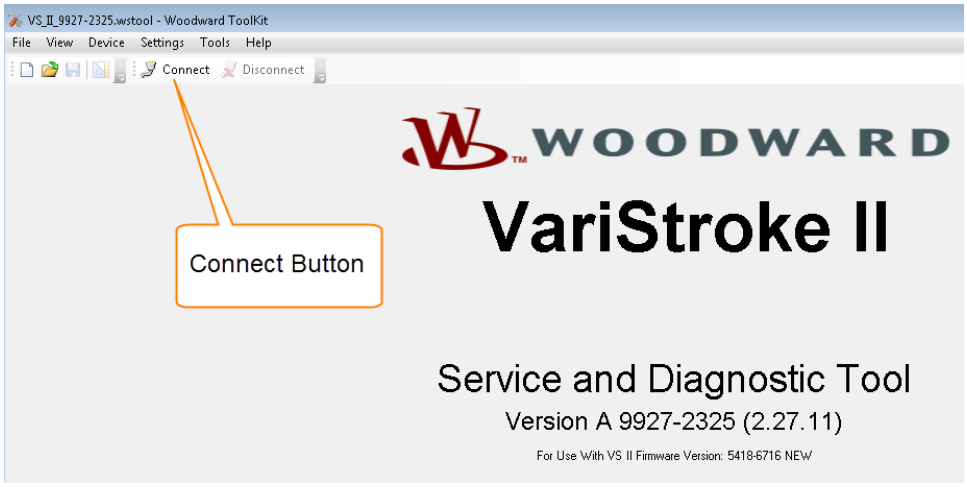


Figure 5-9. Service Tool Connection Button

You will then see the following screen in Figure 5-10.



Figure 5-10. Service Tool Communications Port Selection

Select the network connection that the serial cable is connected to. Select your available network and then set “Baud Rate” to “AutoDetection”. Press the “Connect” button. The Service Tool will connect to the VS-II within a few seconds. When it does, the “Connect” button in the ribbon will be grayed-out and the “Disconnect” button will be activated. The Service tool is now connected and communicating with the VS-II and you can calibrate, configure and control the VS-II through the service tool.

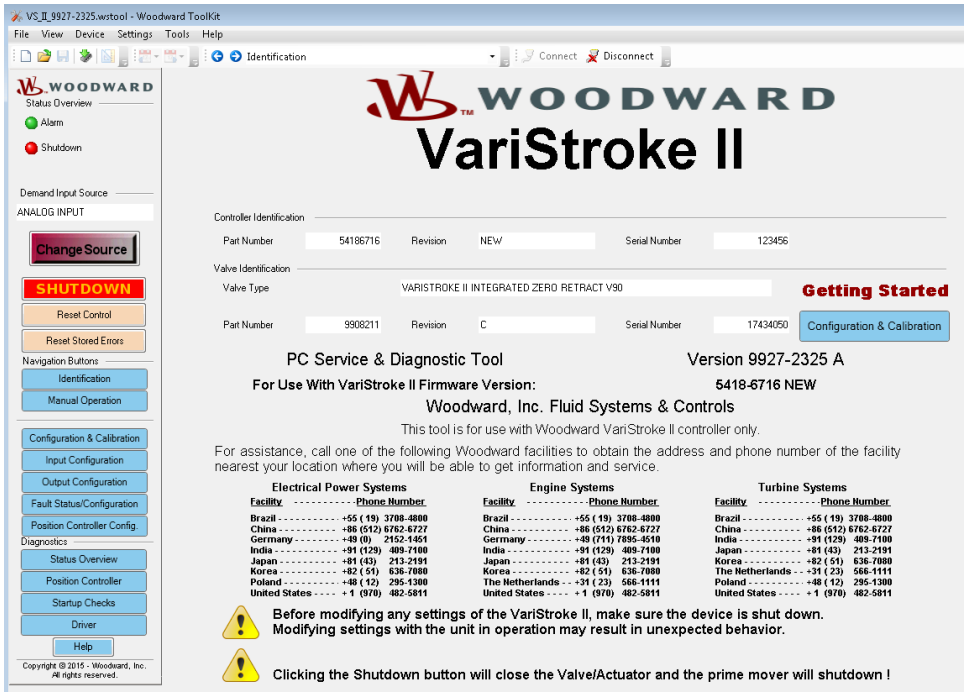


Figure 5-11. Service Tool Main Screen

If the Service Tool does not establish a successful connection to the VS-II after approximately 30 seconds, or the VS-II Service Tool annunciates that it cannot find the correct SID file, refer to the next section “Connection Troubleshooting” for further information.

When you want to end your session and disconnect the Service Tool from the VS-II press the “Disconnect” button. The Service tool will cease communication with the VS-II, the “Disconnect” button will be grayed-out and the “Connect” button will be activated. The service tool is now ready to communicate with the VS-II the next time you press the “Connect” button.

Connection Troubleshooting

Service Tool Does Not Connect to VS-II

If the communication has not been established after approximately 30 seconds, disconnect the Service Tool from the VS-II by either selecting the disconnect button or using ‘Device’ and ‘Disconnect’ from the main tool bar.

Check the serial connection between the VS-II and the PC and make sure the straight-through serial cable is connected correctly on the PC and VS-II side. Verify that the serial cable is securely connected to the *selected* communication port on the VS-II and the PC. Also, check that the power supply is connected and turned on.

Service Tool Cannot Find the Correct SID File

The communication between the VS-II Service Tool and the VS-II is based on the Service Interface Definition (SID) file that defines the communication variable mapping. If the SID file is missing, communication between the VS-II Service Tool and the VS-II is not possible. The SID file is included in the Service Tool software installation package and is installed to directory chosen during the Service Tool install.

A dialog box similar to the following appears upon trying to connect if the Service Tool cannot find the correct SID file to communicate with the VS-II.

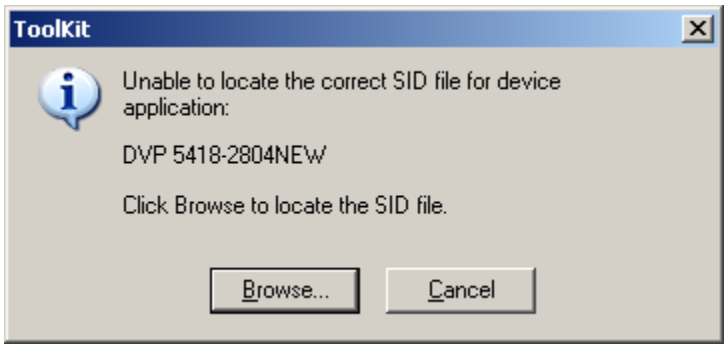


Figure 5-12. Service Tool Unable to Locate SID File

If this occurs, select the browse button and choose the 'C:\Program Files\Woodward\Toolkit Definitions' folder (default setting) or any custom folder for SID files selected during the installation process of the Service Tool.

To change the settings for default folders for SID files, select 'Options' from the 'Tools' menu on the main tool bar.

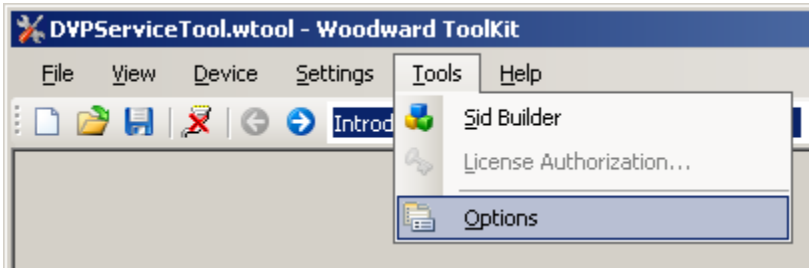


Figure 5-13. Service Tool Update Default Folder for SID Files

Highlight the SID files option and the select 'Modify'. Using the browser, choose the folder where the SID file is located. When finished select 'OK'.

Chapter 6.
Configuration, Calibration, and Monitoring

The VS-II Service Tool is organized in to a series of pages that allow the VS-II to be set up for proper operation. The following section will outline the various pages and their functions.

WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown system to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown system must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown system may also be needed for safety, as appropriate.

WARNING

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

Service Tool Sidebar

The sidebar shown below is present on every Service Tool page. Included in this sidebar are operational status indicators and information, as well as “Shortcuts” for changing Demand Input Source or navigating to commonly accessed Service Tool pages.

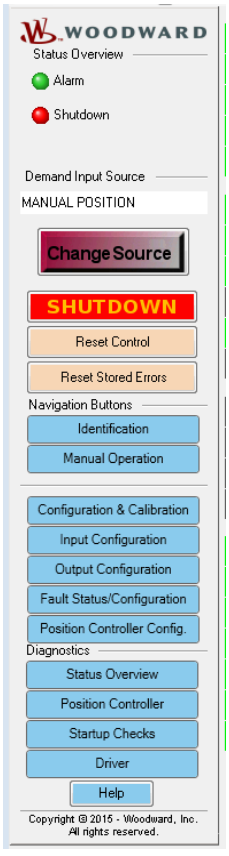


Figure 6-1. Service Tool Summary Faults and Control Buttons

Alarm LED:

When this LED indicator is illuminated yellow, the unit has detected an operating condition, which is outside of recommended operating parameters, but the VS-II is still operating. The cause of alarm conditions should be determined and corrected to prevent damage to the turbine, VS-II, or other auxiliary equipment. Refer to Chapter 7 for a list of Alarm conditions.

Shutdown LED:
When this LED indicator is illuminated red, a shutdown condition has been invoked. This state may have occurred because the analog inputs are not in the 4–20 mA range, or the Run Enable discrete input is selected and not on, or the Shutdown button has been pressed. After checking that the analog demands and the Run Enable are OK, refer to Chapter 7 for a list of Shutdown conditions if the problem persists.

Demand Input Source:
This shows the currently selected actuator position demand source. Possible options are: Analog Input, CAN OPEN digital input, and Manual Position.

Change Source:
This button pops up a screen that allows the Demand Input source to be selected. Possible options are: Analog Input, CAN OPEN digital input, and Manual Position. Analog Input and CAN OPEN digital input are for demand signals from an external control and Manual Position is used for manual positioning from within the Service Tool.

Shutdown button:
This button can be used to invoke a shutdown condition and move the actuator to the minimum position.

⚠WARNING

The SHUTDOWN button will move the VS-II to 0% position. This will potentially shut down the Prime Mover (Turbine)!

Reset Control
This button will reset the control from a shutdown condition, provided the cause of the shutdown has been cleared. Identified causes of shutdown conditions can be found on the Fault Status/Configuration page. All diagnostic flags will be cleared if the diagnostic condition is no longer present.

⚠WARNING

The Reset button will reset the VS-II if diagnostic condition(s) are no longer present. The valve/actuator system will become active! Ensure system is tagged out or ready to operate before issuing the Reset command. Stay clear of any moving parts WHEN resetting the control.

Reset Stored Errors
Operational errors are stored in non-volatile memory until cleared by pressing this button. This button will reset the stored faults, on screens that indicate stored faults, if the diagnostic condition(s) are cleared. Only pressing the Reset Stored Errors button resets the stored flag, a power cycle will not clear these flags. Stored faults will not affect the operation of the VS-II.

Navigation Buttons
Pressing these buttons will navigate you to the most commonly used pages of the VS-II Service Tool. Pages can also be accessed by using the dropdown menu at the top of the Toolkit Window.

Diagnostics Buttons
Pressing these buttons will navigate you to the pages with operational values that could be useful for diagnostics and troubleshooting.

Identification Page

This page will display system information about the VS-II Actuator/servo that is currently connected to the PC Service Tool.

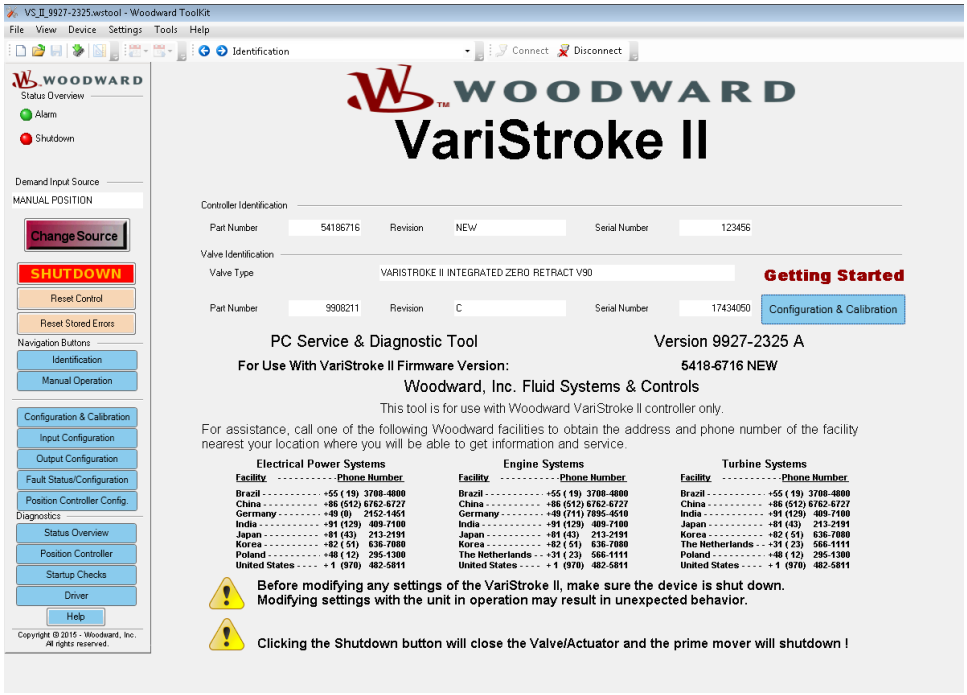


Figure 6-2. System Information Page

Controller Identification
(Driver P/N, S/N, Revision)**:** These fields display the Electronic Driver Part Number (B_P/N), Serial Number (B_S/N), and Revision Number. This information is entered automatically by the VS-II software.

Valve Identification (Actuator P/N, Revision, S/N)**:** These fields display the Actuator Assembly Part Number (P/N), Revision Number, and Serial Number (S/N). This information is entered automatically by the VS-II software.

PC Service & Diagnostic Tool Version: This field displays the Version of Firmware installed. This information is entered automatically by the VS-II software.

Firmware Version: This field displays the firmware part number and version of the software programmed into the VS-II driver. This information is entered automatically by the VS-II software.

Status Overview Page

This page monitors the VS-II core operational values.

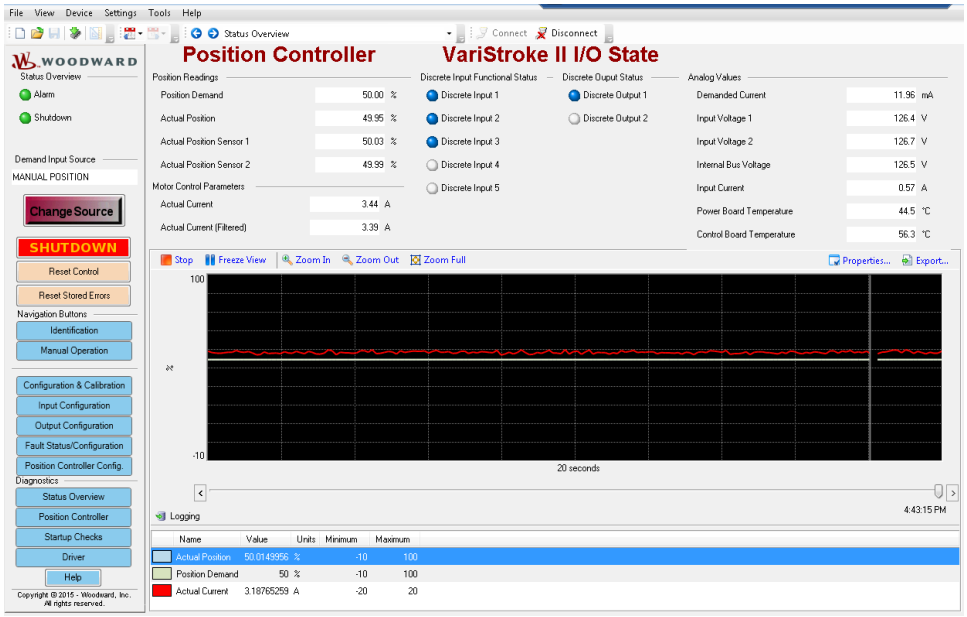


Figure 6-3. Status Overview Page

Position readings:
Position demand is the position command in % of full (100%) calibrated stroke.

Actual position is the actuator hydraulic cylinder position in % of full (100%) calibrated stroke. It is the average of the two cylinder position sensor readings.

Actual positions sensor 1 and 2 are the hydraulic cylinder position readings in % of full (100%) calibrated stroke from each of the two LVDT position sensors.

Motor Control Parameters:
Actual current is the instantaneous current going to the Servo valve control motor.

Actual current (filtered) is the average current going to the Servo valve control motor. The instantaneous current is constantly changing and the average gives a better assessment of control current.

Discrete Input and Discrete Output Status: The status of the discrete inputs and outputs is shown in Figure 6-3 and will annunciate when active. The discrete input and output behavior is user configurable on the Input and Output configuration pages.

Analog Values:
Demanded Current is the current on the analog terminals
Input Voltage 1 is the voltage at the supply terminals 1.
Input Voltage 2 is the voltage at the supply terminals 2.
Internal Bus Voltage is the voltage on the VS-II internal power Bus.
Input Current is the current into the VS-II.
Power Board Temperature is the temperature measured on the power board of the VS-II.
Control Board Temperature is the temperature measured on the control board of the VS-II.

Trending Plot/ Graph:
This graph will display the current demanded position, the actual measured feedback position of the final cylinder, and the servo valve motor current with respect to time. The “Start” button in the upper left hand corner of the graph starts the trending process. Pressing the Stop button freezes the currently displayed values. Pressing the Start button again erases the last traces and restarts the trending process. Pressing the Properties button opens the Trending Properties window. From this window trend screen properties such as time span and sample rate can be changed.

The Export feature will export data collected during the trending process for further analysis in a spreadsheet.

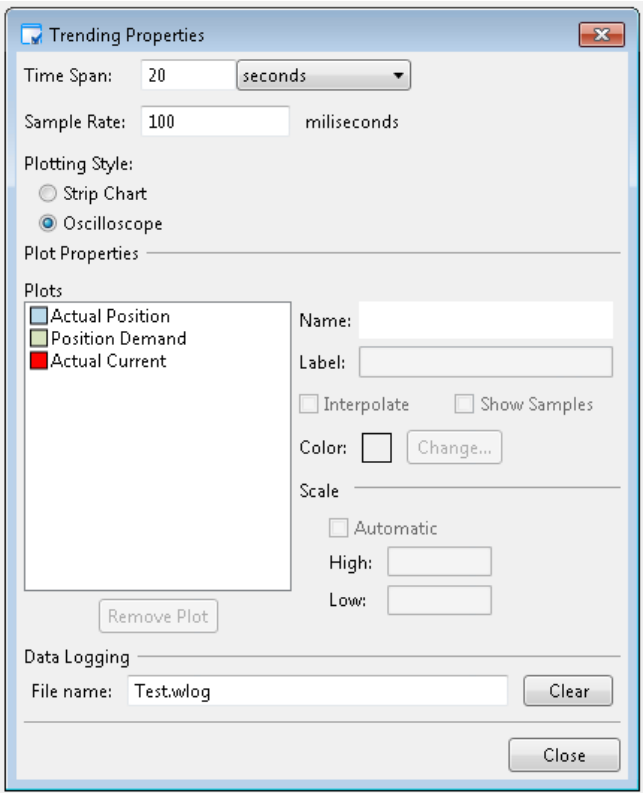


Figure 6-4. Trending Properties Page

Configuration and Calibration Page

The Configuration and Calibration page can be used to set the VS-II operating pressure and cylinder diameter to the desired value and to start the calibration process. The “wizards” will guide you through the actuator configuration and calibration. The “wizards” will remember where you are in the process and will return you to where you left off if you navigate to a different page to view or set something else.

⚠WARNING

To prevent personal injury or death and damage to equipment, the controlled prime mover must not be allowed to run or operate during any of the following procedures. The main steam valve or main fuel control must be turned off to prevent operation of the controlled system.

NOTICE

To enable the Configuration and Calibration functions of the VS-II must be shutdown by any of the following methods. Press the Shutdown button when in any of the three demand input source selections, or when in analog or CAN demand input source, set the RUN ENABLE line low, and/or put your analog input demand(s) below 2 mA (suggest 0 mA).

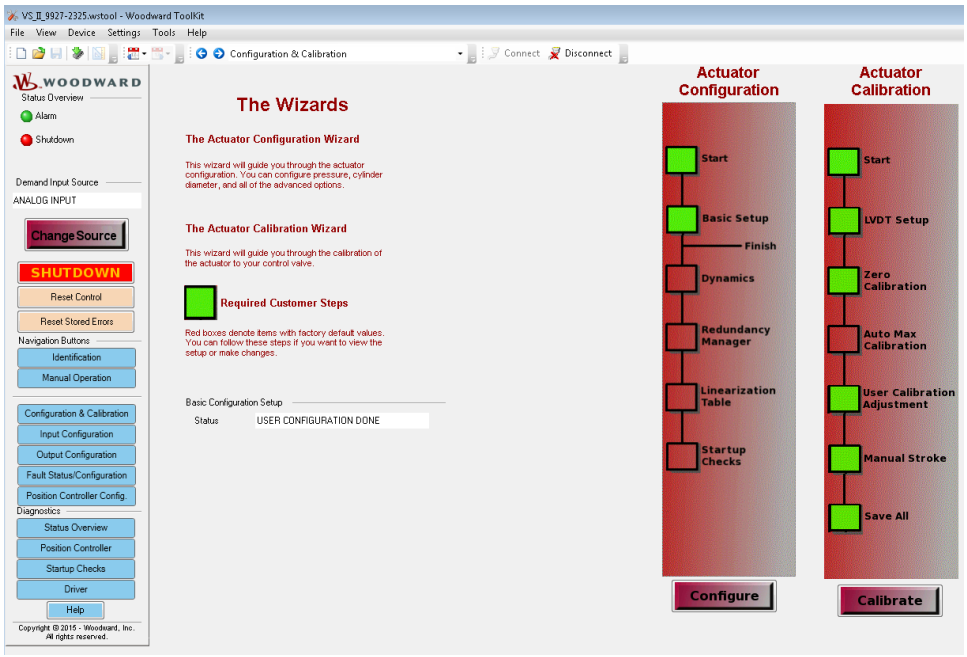


Figure 6-5. Configuration and Calibration Page

Actuator Configuration

Press the Configure button to begin the actuator configuration wizard. The following screen will appear, which gives detailed instructions for navigation using the wizard.

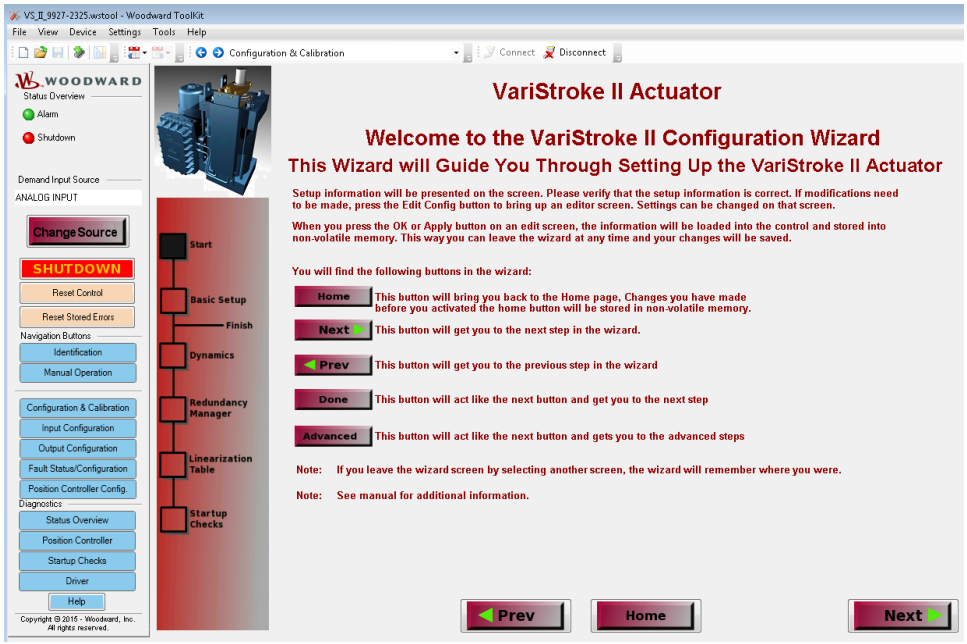


Figure 6-6. Detailed Wizard Navigation Instructions

To begin the actuator configuration, press “Next” and the following screen will appear:

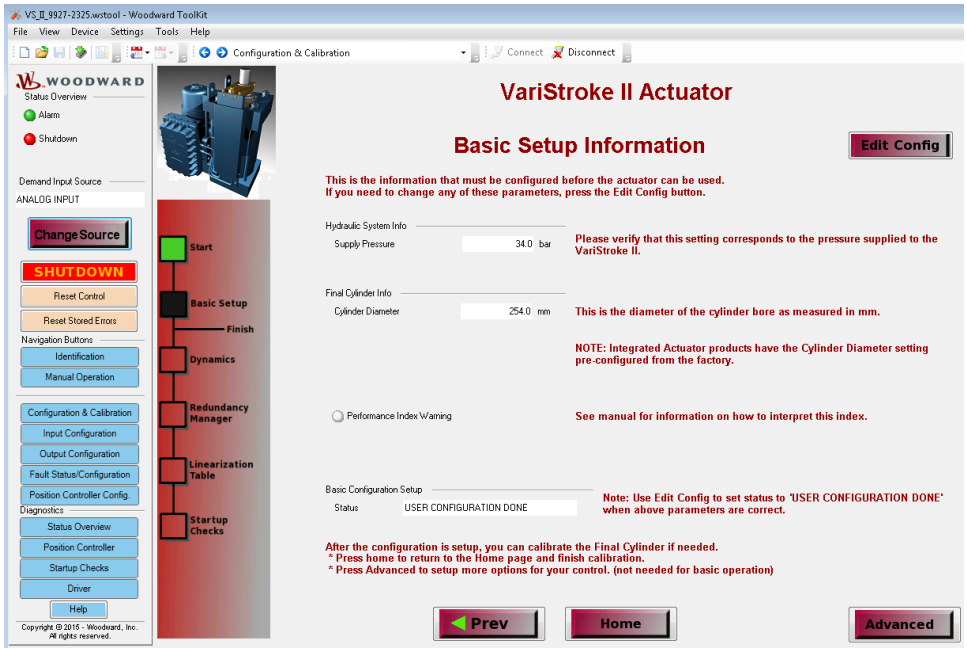


Figure 6-7. VS-II Current Settings

This page displays the operational settings stored in the VS-II. If the Supply pressure or the Final Cylinder (hydraulic power cylinder) diameter is incorrect, or the status is “USER CONFIGURATION NOT DONE”, press the Edit Config button in the upper right corner of the screen to edit them. The VS-II will not respond to position demand input until this setup is completed and confirmed by setting the status to “USER CONFIGURATION DONE”.

If the Performance Index Warning is on, the hydraulic pressure may be too high for optimum performance with this cylinder diameter. See the “Performance Index” section in Chapter 2 for more detailed information.

When the “Edit Config” button is pushed, the following screen will appear:

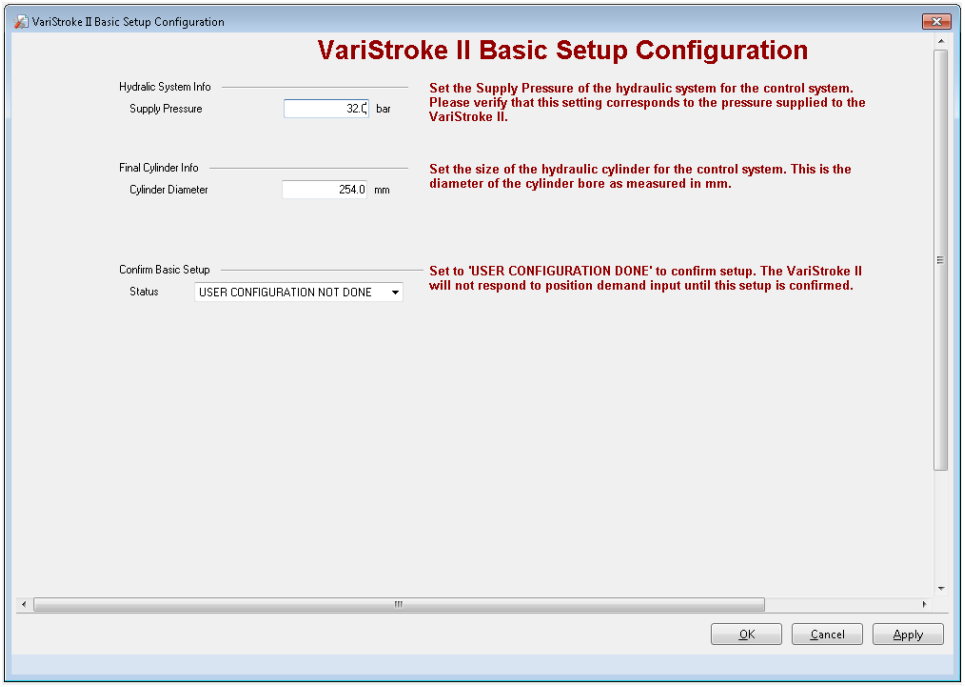


Figure 6-8. VS-II Configuration Editing Screen

The valid range of supply pressures is between 3.5 and 34.4 bar. After setting the correct supply pressure and cylinder diameter, **make sure that “Confirm Basic Setup” is set to “USER CONFIGURATION DONE”** to confirm setup. The VS-II will not respond to position demand input until this setup is confirmed. Click “OK” when done and the wizard will save the values and return to the previous page. “Apply” will also save the values, but you must press the “Cancel” button to return to the previous page (the newly saved values will not be canceled). The “Cancel” button will only cancel *unsaved* values and return you to the previous page.

NOTICE

Failure to input the correct Supply Pressure can result in unstable actuator performance. Ensure that this setting is correct and that the system pressure regulators and accumulators do not allow more than a ±10% variation in Supply Pressure.

NOTICE

Stability: Certain combinations of Supply Pressure and Cylinder Volume can cause the actuator to operate at reduced performance. See the “Performance Index” section in Chapter 2 for more detailed information.

Press “Home” to return to the Home Page and start Calibration.

The “Advanced” button is used to access the more advanced Configuration Options. These are pre-configured from the factory and normally do not need to be changed.

The Advanced Setup includes the following:

- Control Bandwidth
- Slew Rate limit
- Slow Zone
- Position Sensor Redundancy
- Servo Valve Startup Spring Check
- Final Cylinder LVDT Position Sensor Startup Check

When the “Advanced” button is pushed, the following screen will appear:

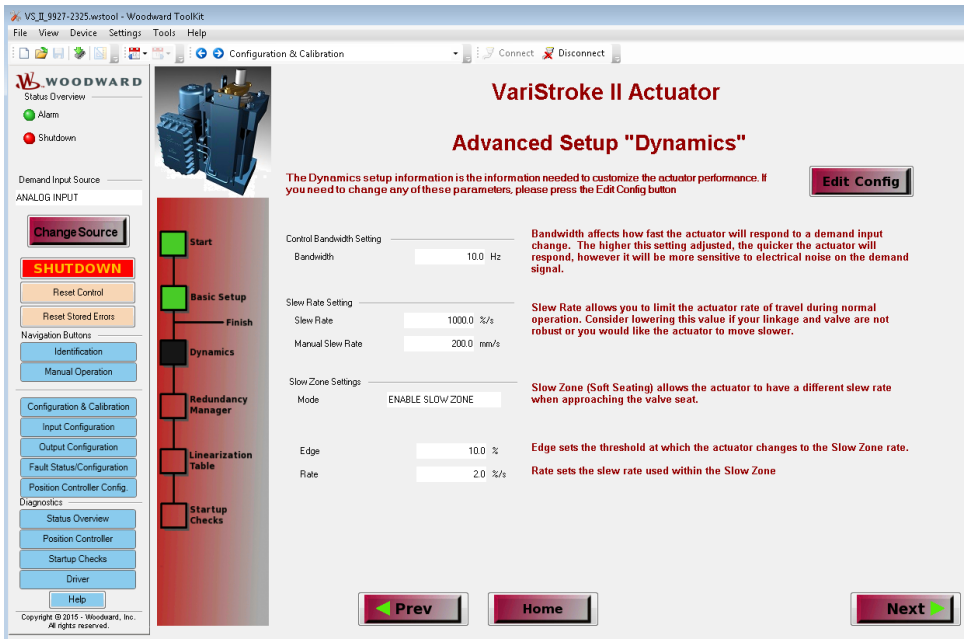


Figure 6-9. VS-II Advanced Setup “Dynamics”

Press the “Edit Config” button in the upper right corner of the screen to edit any of the values shown on this screen or press “Next” to go to the next page to edit settings not shown on this screen. Continue to press “Next” until the settings you want to access are shown, then press “Edit Config”

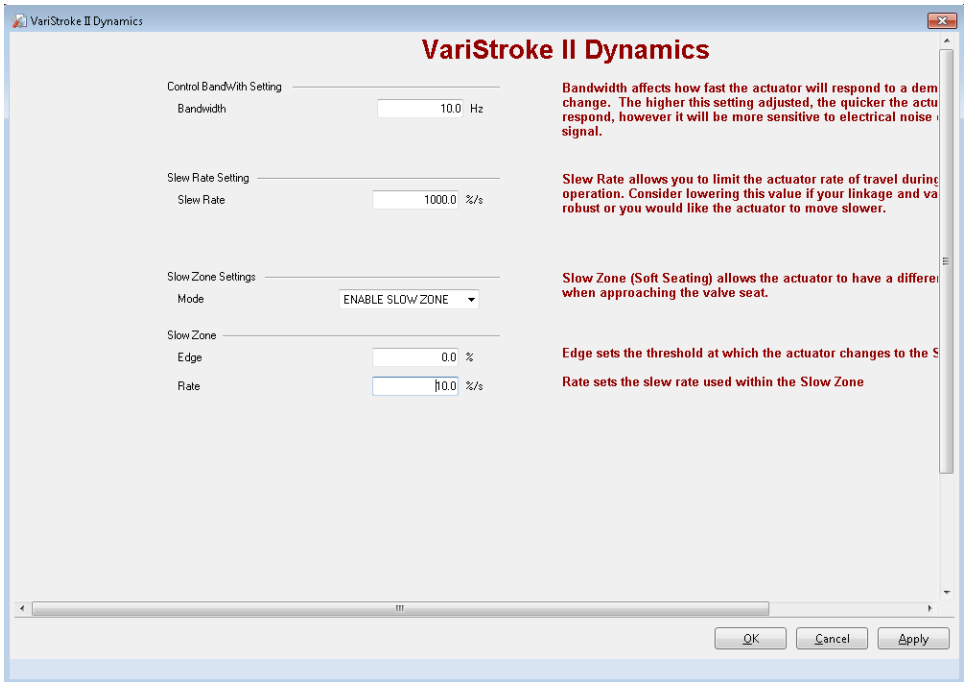


Figure 6-10. “Edit Config” for Dynamics settings:

Control Bandwidth:
Bandwidth affects how fast the actuator will respond to a position demand change. The higher this setting is set, the quicker the actuator will respond. However, it will be more sensitive to electrical noise on the signal. Valid settings are between 0.5 and 10 Hz. The default setting is 5 Hz and this is recommended for most applications. Consider utilizing analog output to monitor actuator position if service tool usage is not an option to verify the bandwidth setting is correct. If too high it could cause limit cycle which would lead to premature product wear, or if too low, reduced performance or outer loop instability.

Slew Rate Setting:
This setting allows a maximum *limit* to be set on the actuator rate of travel in percentage of full travel/second. Valid values are between one and 1000 %/second. The higher values, such as 1000 %/second, do not necessarily mean the actuator will move at that rate, but would be the maximum rate allowed by the control if supply pressure was high enough/load low enough to achieve this rate. The rate limit should be set to a lower value if a high rate is undesirable for the operation of the turbine.

Slow Zone Setting:
This can be thought of as Soft Seating, similar to a hydraulic cushion except that it is electronically controlled by the VS-II control and servo valve. This function can be used to limit the steam valve seating velocity in order to lengthen the life of the valve.

NOTICE

The Slow Zone feature will not function in some shutdown conditions. Loss of cylinder position feedback, loss of electrical power, or an internal electronics fault will result in loss of the Soft Seating functionality.

Slow Zone “Edge” adjustment sets the position at which the actuator slew rate limit will switch from the Operation Slew Rate Limit to the Slow Zone Rate.

Slow Zone “Rate” is the slew rate, in %/second, of the actuator in the Slow Zone. This adjustment sets the slew rate limit of the actuator when the position is below the Slow Zone Edge value. *Note: This only limits rate of travel in the direction toward 0%.* Valid values are zero to 50% for the Edge, and one to 51%/second for Rate.

NOTICE

Incorrect Slew Rate Limits and Soft Seating adjustments can result in high seating velocities that may damage equipment.

⚠WARNING

Configuration of the Slow Zone settings and Slew Rate Limits can result in excessively slow closing speeds.

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

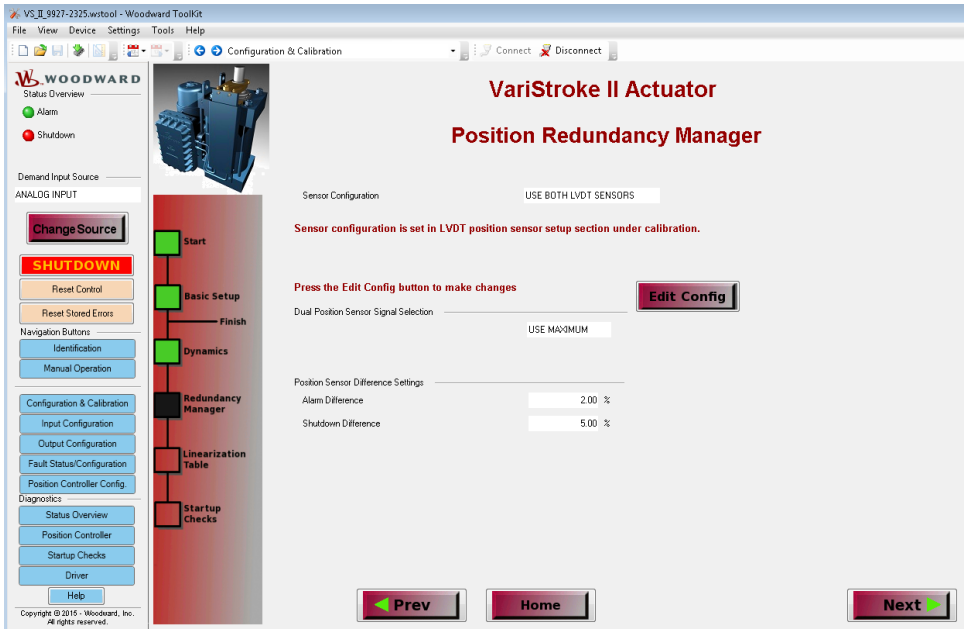


Figure 6-11. Position Redundancy Manager Page:

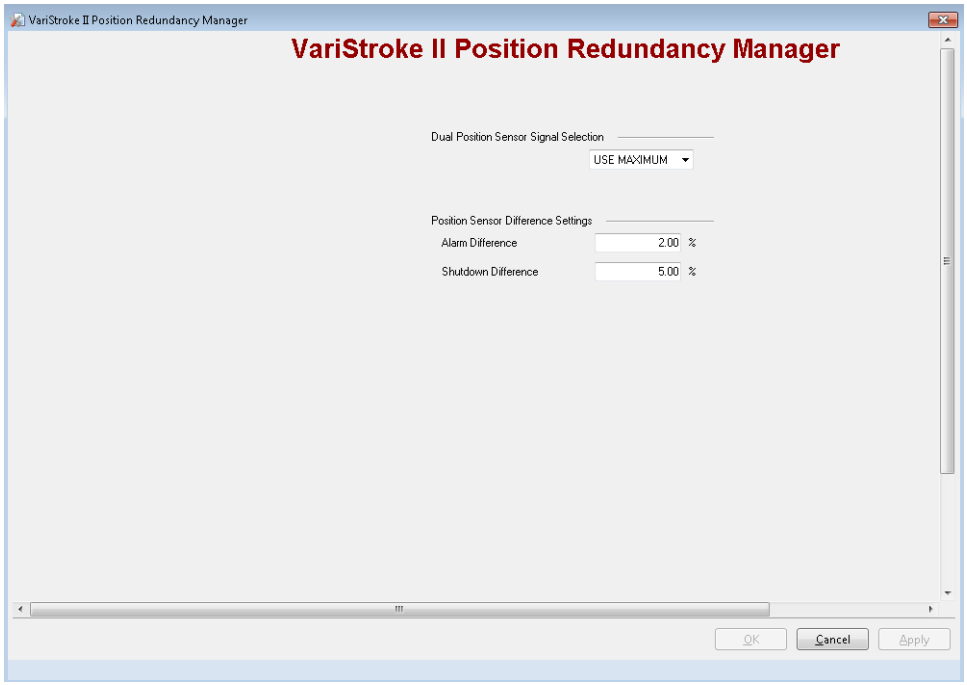


Figure 6-12. Edit Configuration for Position Redundancy Manager

Dual Position Sensor Signal Selection:
Since the redundant LVDT sensor outputs will be slightly different due to sensor calibration variation, how the LVDT sensor outputs are used by the control needs to be defined. “Use Maximum’ uses the LVDT signal that is highest, “Use Minimum” uses the LVDT signal that is lowest, and “Use Average” uses the average of both LVDT signals. In addition to defining which sensor(s) is used during normal operation, “Selection” will affect which direction a momentary “bump” in actuator position will be if there is a failure of one or the other sensor. For example, if set to “Use Minimum” and the sensor reading minimum fails, the control will switch to the sensor reading maximum, which will in turn affect a momentary “bump” of the actuator position toward minimum.

Position Sensor (LVDT) Difference Settings:
“Alarm difference” is the threshold level that a cylinder position sensor error alarm will be annunciated. “Shutdown difference” is the threshold level at which a shutdown will be initiated.

Linearization Table Page:

Note: The Linearization Table is not implemented for VariStroke II Service Tool 9927-2325.

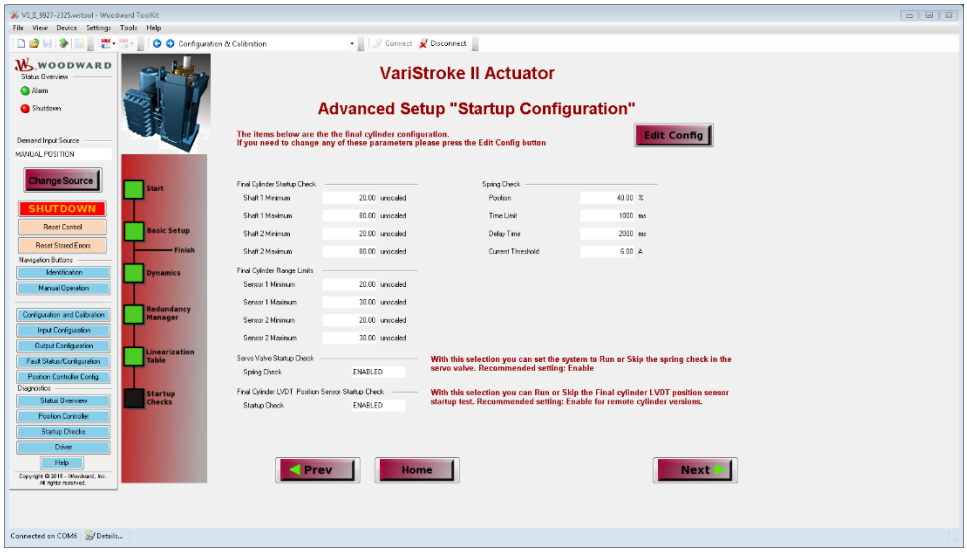


Figure 6-13. Startup Configuration Page

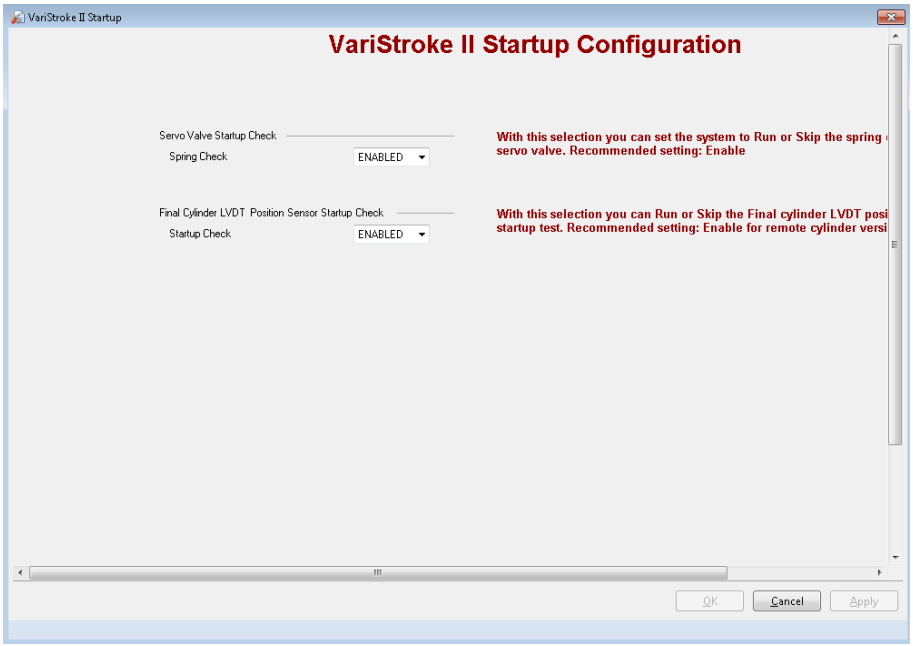


Figure 6-14. Edit Configuration for Startup Configuration

Servo Valve Startup Check: Spring Check:
Upon startup and reset commands, the VS-II performs a brief test to ensure that the servo valve return spring is functioning properly. This is performed before moving the actuator away from the fail-safe position and will not move the actuator. It is recommended that this check be “Enabled”.

Final Cylinder LVDT Position Sensor Startup Check:
This test is performed anytime the control is initializing the servo valve control for operation and checks both LVDT position sensors for proper function. It is recommended that this check be “Enabled”.

Actuator Calibration

The VariStroke-II Actuator has an electronically variable stroke length to match the stroke of the valve it is attached to, adjustable anywhere between 50 and 100% of the mechanical stroke of the hydraulic power cylinder. To calibrate the actuator to the valve stroke, the first step of the Calibration is to verify that the correct LVDT sensitivity is entered. After that, there is an Auto Zero function, where the control strokes the actuator to find the “zero” position of the valve stroke. Next, the maximum valve position is found, which can be done either automatically or manually. Finally, the VS-II can be manually stroked to verify the stroke settings.

Press the **“Calibrate”** button to begin the actuator calibration wizard. The following screen will appear, which gives detailed instructions for navigation using the wizard. The VS-II must be in shutdown mode to use the calibration wizard.

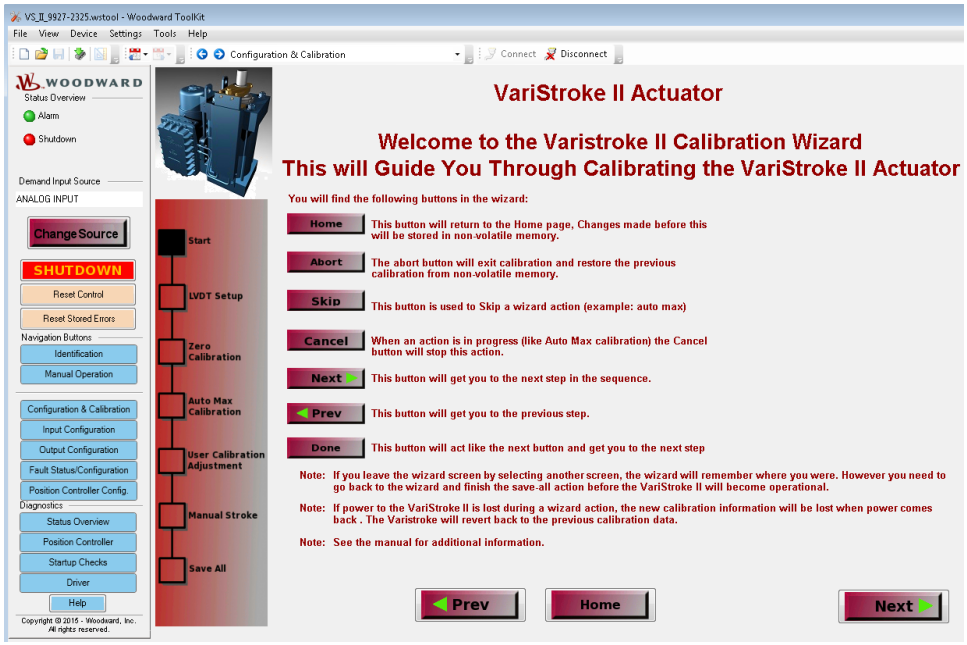


Figure 6-15. VariStroke II Actuator Calibration Wizard

Press “Next” to enter the **Calibration Mode**.

> **Note:** the VariStroke II **must be Shutdown to enter Calibration Mode**. To do this, press the ‘Shutdown” button when in any of the three selectable demand input source selections, or when in analog or CAN demand input source, set the RUN ENABLE line low, and/or put the analog input demand(s) below 2 mA (suggest 0 mA).

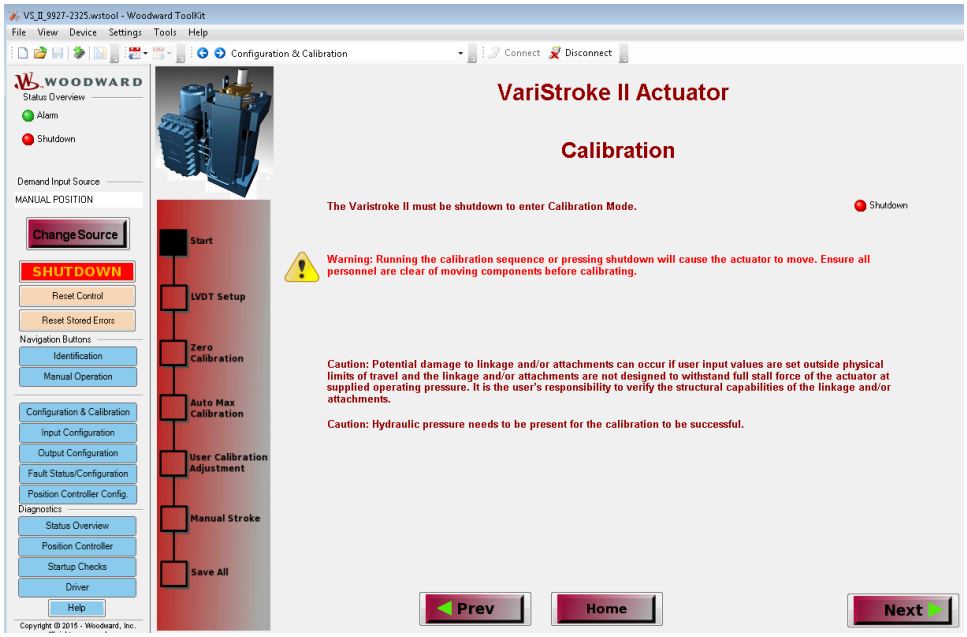


Figure 6-16. VariStroke II Calibration Mode

Press “Next”:

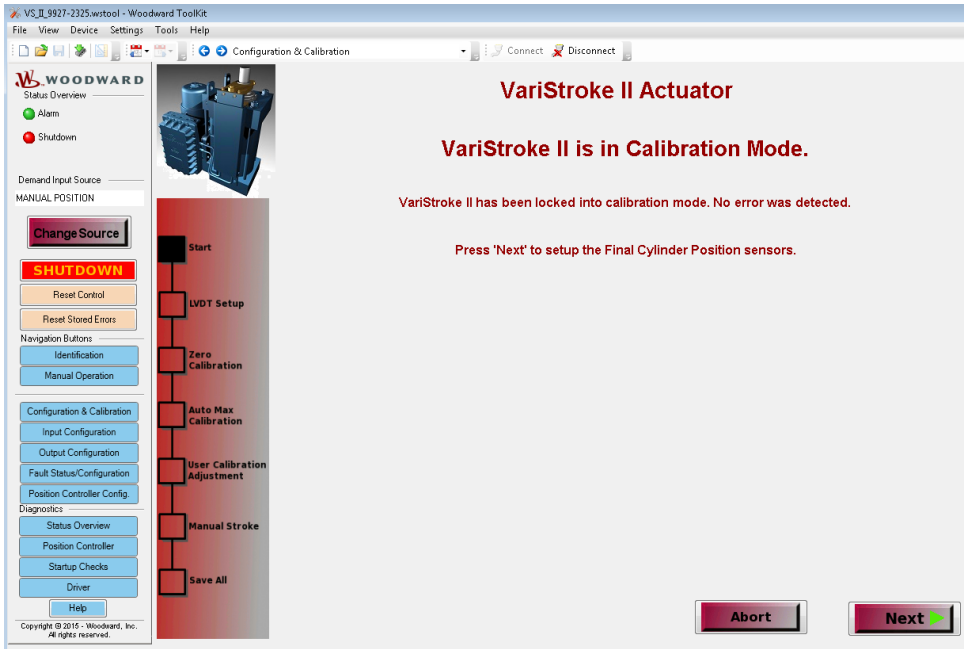


Figure 6-17. Confirmation that VariStroke II has been locked in Calibration Mode

Press “Next” to **set up the LVDT’s**:

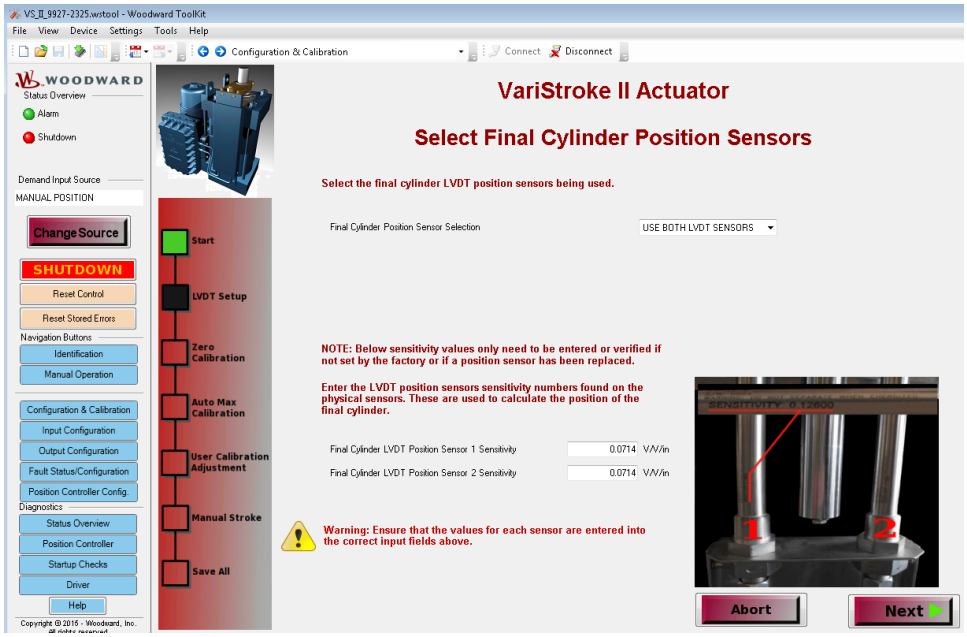


Figure 6-18. Cylinder Position Sensor Final Selection

On this page, nothing needs to be done if a complete Woodward integrated or remote VS-II was purchased. If a non-Woodward power cylinder is used, or if an LVDT is replaced, enter the LVDT Sensitivity values here.

If only one LVDT is used, or if one is damaged, the sensor that is to be used by the VS-II control can also be selected on this page.

Press “Next” **to begin Calibration of the actuator** and the following screen appears:

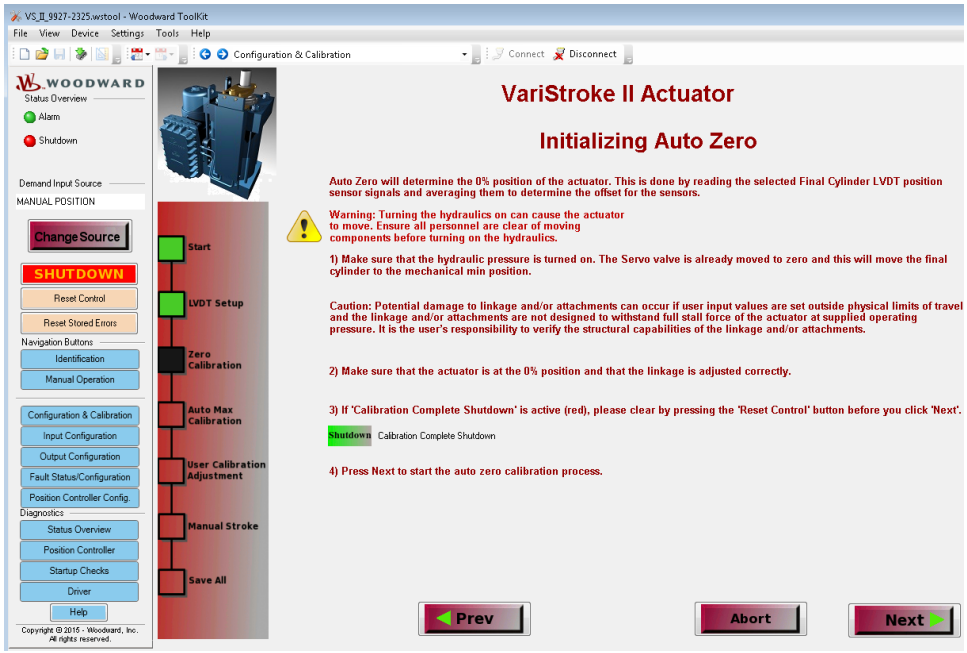


Figure 6-19. Initializing Auto Zero Page

⚠CAUTION

Potential damage to linkage and/or attachments can occur if the linkage and/or attachments are not designed to withstand the full stall force of the actuator at the supplied operating pressure. It is the installer's responsibility to verify the structural capabilities of the linkage and/or attachments. IF the linkage and/or attachments CANNOT WITHSTAND THE FULL STALL FORCE of the actuator DO NOT USE "Auto Zero" or "AutoMaxCal" with the linkage connected to the actuator. Instead, "Auto Zero" and "ManualCal" must be used with the linkage *disconnected* to set the desired stroke length and offsets.

⚠WARNING

Turning on the hydraulic supply can cause the actuator to move. Ensure all personnel are clear of moving components before turning on the hydraulics and/or initiating the calibration sequence.

Before beginning calibration the VS-II must have power and hydraulic pressure supplied to the unit.

If the Calibration Complete Shutdown indicator on the screen is red, press the "Reset Control" button before pressing "Next".

Auto Zero
Press "Next" to start the Auto Zero process. Pressing this button will open the VS-II servo valve, causing the actuator to move toward the minimum/fail-safe position. Once a physical stop is contacted, the VS-II will capture this as the mechanical minimum position.

⚠WARNING

The actuator may move rapidly toward the minimum position, depending on initial position and hydraulic supply pressure.

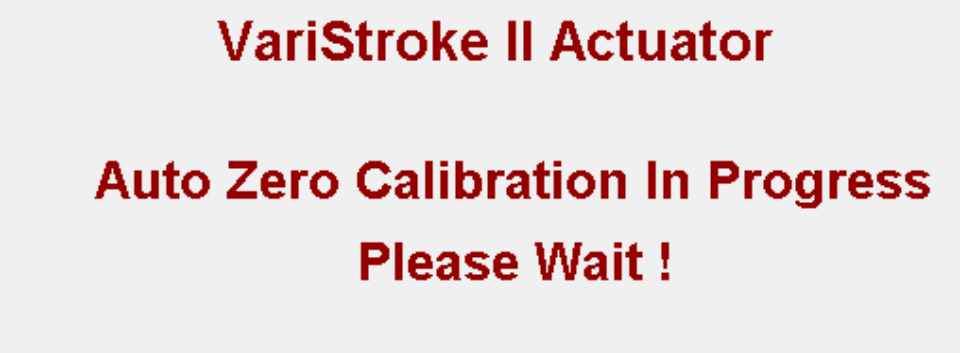


Figure 6-20. Auto Zero Automatic Calibration Process Warning.

When Auto Zero is complete, the following screen will appear:

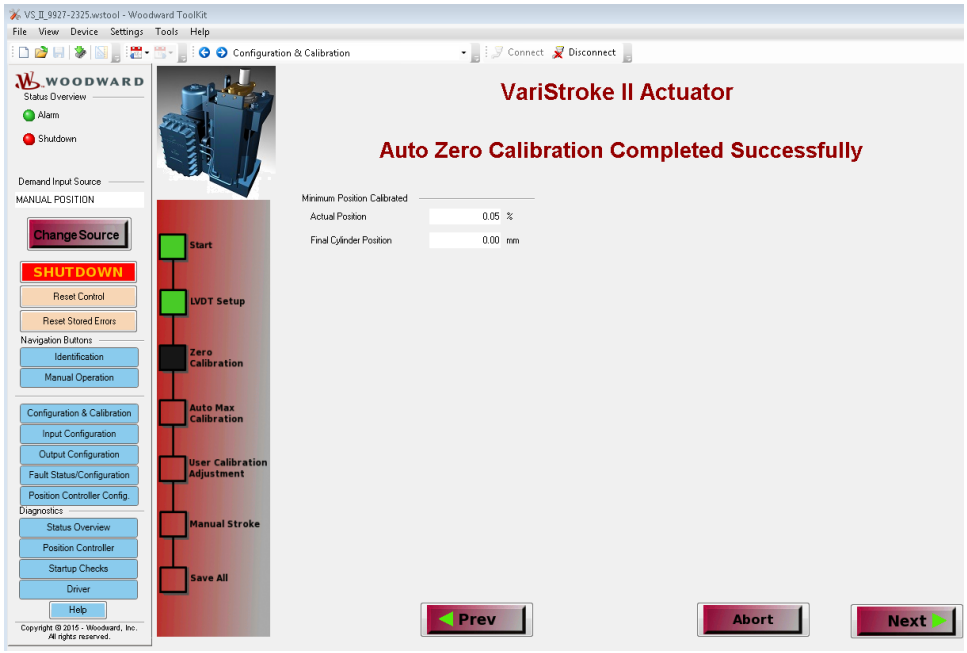


Figure 6-21. Successful Completion of Auto Zero Calibration

Press “Next” to access the Max Calibration selection screen. On this screen there will be a choice of either **ManualCal** or **AutoMaxCal**. AutoMaxCal will move the actuator from 0% until it either reaches (stalls out against) the maximum end of the valve/linkage travel or the end of the mechanical stroke of the VS-II actuator.

AutoMaxCal

⚠CAUTION

Potential damage to linkage and/or attachments can occur if the linkage and/or attachments are not designed to withstand the full stall force of the actuator at the supplied operating pressure. It is the installer’s responsibility to verify the structural capabilities of the linkage and/or attachments. IF the linkage and/or attachments CANNOT WITHSTAND THE FULL STALL FORCE of the actuator DO NOT USE “Auto Zero” or “AutoMaxCal” with the linkage connected to the actuator. Instead, “Auto Zero” and “ManualCal” must be used with the linkage *disconnected* to set the desired stroke length and offsets.

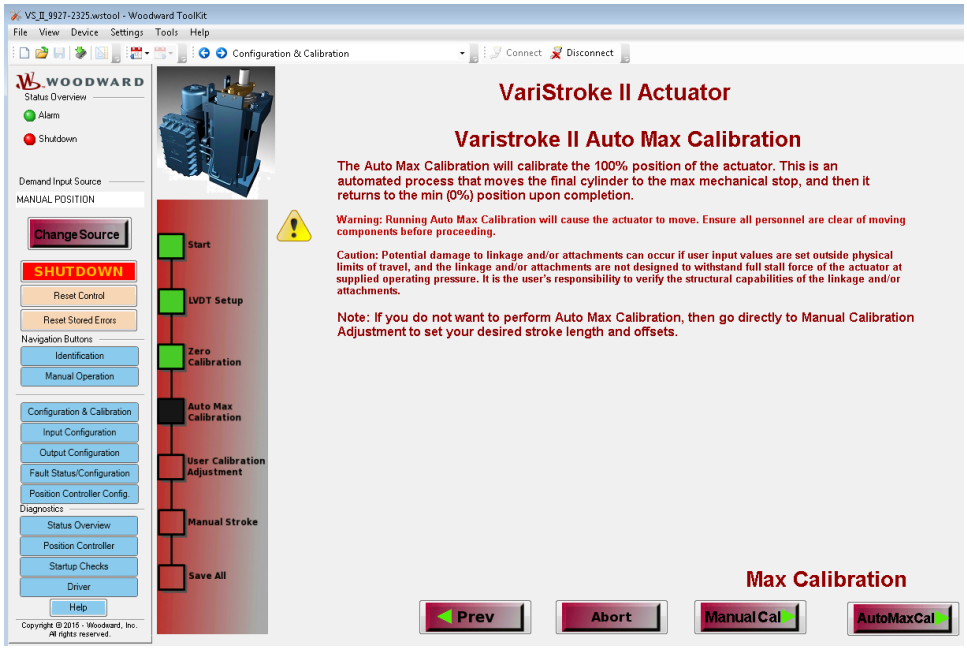


Figure 6-22. Auto Max Calibration Page

Press “AutoMaxCal” to start the automatic process that automatically finds the maximum mechanical stroke limit or press “ManualCal” to manually set the maximum stroke limit (see Manual Calibration section below).

After pressing “AutoMaxCal”, the VS-II servo valve will slightly open to slowly move the actuator toward the maximum position. Once a physical stop is contacted, the VS-II will capture this as the mechanical maximum position. The actuator will then slowly return to the minimum positon.

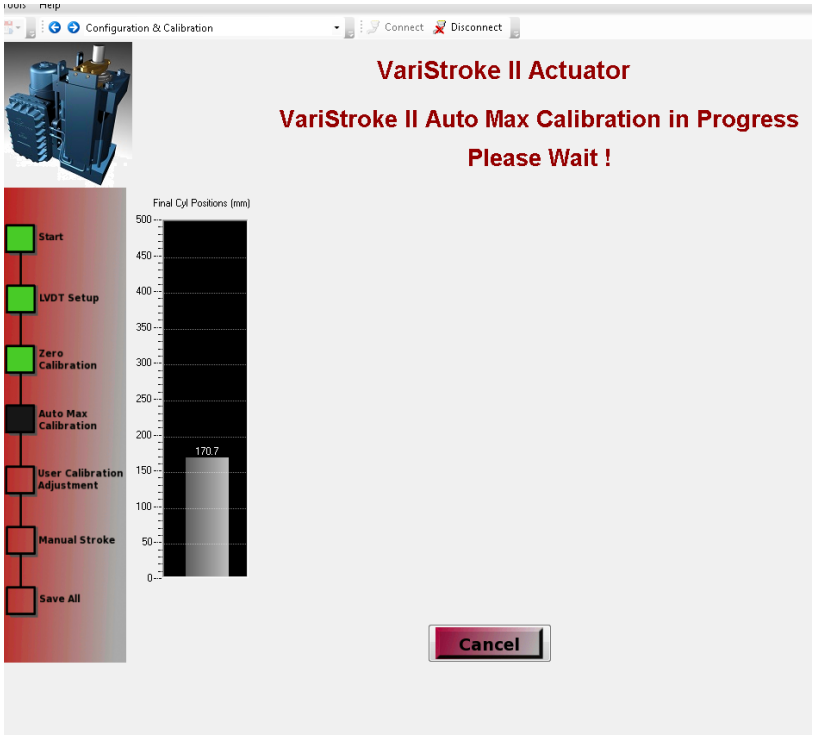


Figure 6-23. Auto Max Calibration in Progress Page

Followed by the Auto Calibration Routine Complete page.

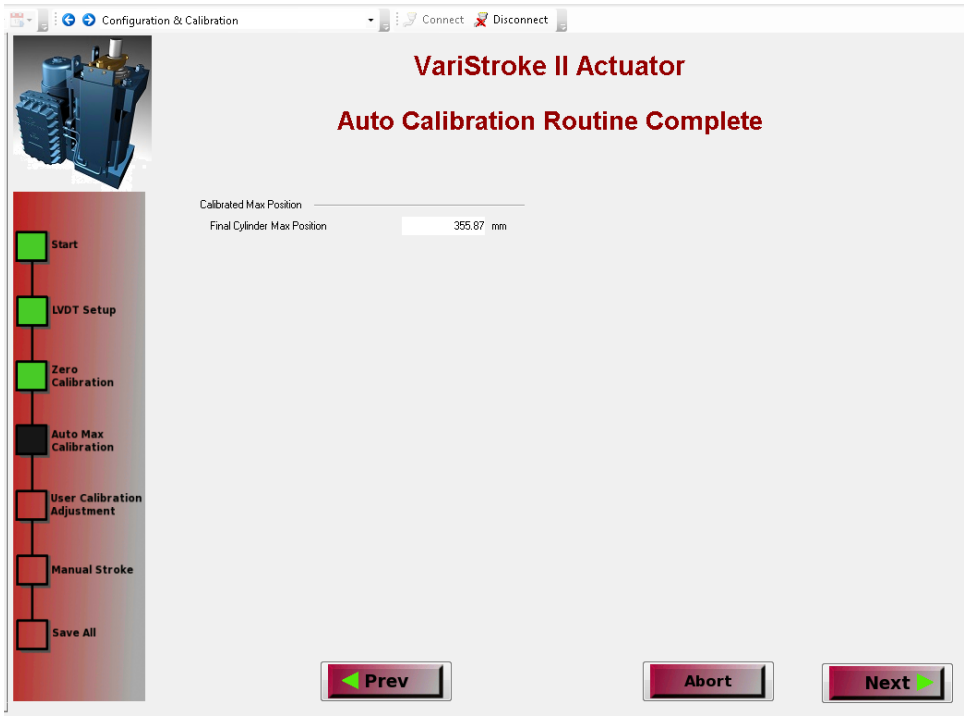


Figure 6-24. Auto Calibration Routine Complete Page

Press “Next” to go to the next screen, Manual Calibration, which is the same screen that would have been reached by pressing **“ManualCal”** earlier in this section.

Manual Calibration

Manual Calibration can be used to set both the minimum (0 %) and maximum (100%) final cylinder positions or to modify the positions from the automatic calibration positions.

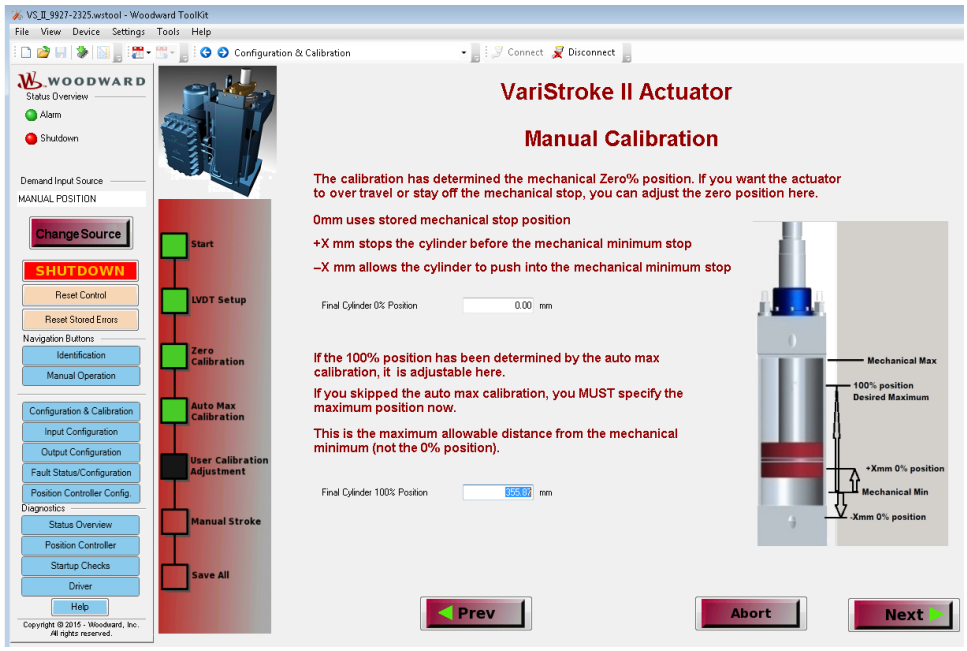


Figure 6-25. VS-II Manual Calibration Page

Zero percent actuator position (corresponding to 0% position demand) can be offset from the mechanical end of travel stop found by the “Auto Zero” function. For example, if the linkage was adjusted such that the final cylinder was offset 3mm above its minimum travel position when the steam valve was in the closed position (before the Auto Zero function was run), then inputting -3mm (or any value less than “0”) into the Final Cylinder 0% Position box will cause the VS-II to apply closing force to the valve/linkage when 0% position (4 mA) is demanded. This feature can be used to assure that the steam valve continues to fully close if there is a thermal expansion dimensional change or steam valve wear.

If the **AutoMaxCal was not used, then the Maximum Position must be specified now.** This position is specified in millimeters and is the maximum allowed travel distance from the mechanical travel minimum position found during the Auto Zero function, not the 0% position if you are using a 0% position offset.

Manual Stroke (calibration mode)
It is recommended that the VS-II actuator be manually stroked from minimum to maximum position to verify correct operation and that the steam valve fully opens and closes with current settings. Additionally, for installations where the linkage was disconnected for calibration because it could not withstand the full stall force of the actuator, it is extremely important to verify that the actuator travel matches the steam valve so that the linkage is not damaged when it is reconnected.

WARNING

The Manual Stroke mode will cause the actuator to move. Ensure all personnel are clear of moving components before entering manual stroke mode.

Press “Next”, then “Manual Stroke” to advance to the Manual stroke page.

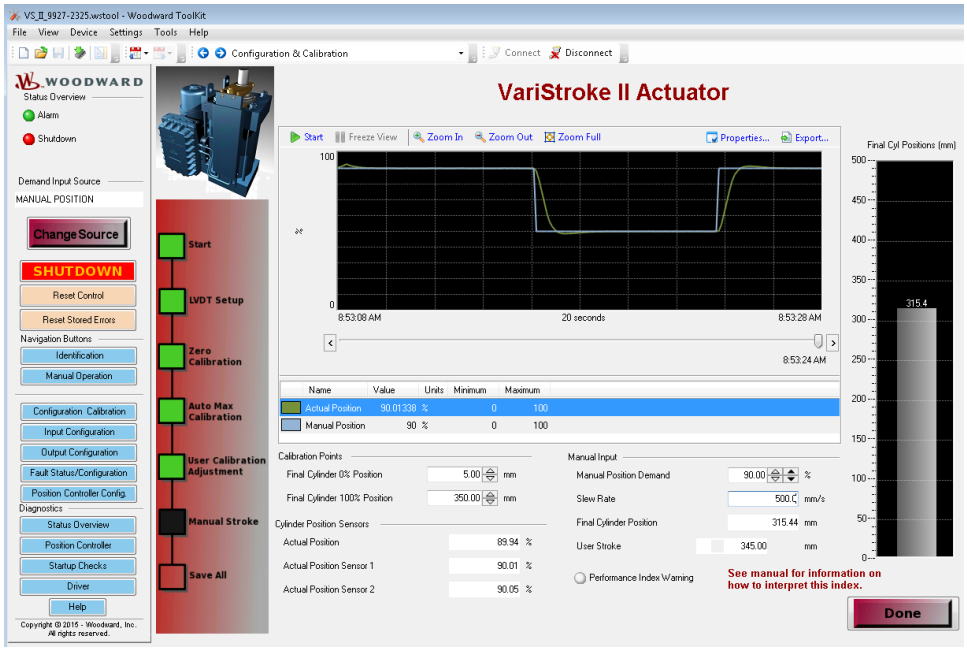


Figure 6-26. Manual Stroke Page

The manual stoke page contains a trending chart, Final Cylinder Position (mm) bar meter, Calibration Point setting, Manual Position demand input, and Slew Rate input.
Actuator movement can be monitored and viewed using this trend chart. To do so, press “Start” at the top left corner of the trend chart. The properties of the chart can be changed using properties button. The data can be exported using the Export button. Real time actuator position is also seen in the bar meter on the right side of the screen.

⚠WARNING

Improper linkage adjustment or calibration could result in the steam valve not fully closing at the 0% position. Use the manual stroking function to verify that the VS-II can fully close the steam control valve. Visually verify that the actuator travel direction matches the demand signal and that the opening and closing directions are correct.

The Calibration of the actuator can be changed by inputting new values into the 0% and 100% calibration boxes. This will overwrite the values from the Auto Cal and Manual Cal process. The settings can be verified or tested by inputting the values directly into the Manual Position demand box and selecting Enter. Alternatively, the up and down arrows can be used to change the demanded position, in 1% or 10% of the displayed value steps. The rate at which the actuator slews can be set by inputting the desired rate into the Slew Rate box.

Note: This only affects the slew rate for Manual Operation.

For normal operation, the slew rate limit that is used was set during the configuration process done earlier.

Cylinder Position Sensors, Final Cylinder Position, User Stroke, and Performance Warning are informational only and cannot be adjusted.

If the Performance Index Warning light is illuminated it means that the Configuration (Servo valve size, operating pressure, cylinder displacement) may not provide optimal performance. Overshoot and limit cycle may be unacceptable. See the Performance Index section in Chapter 2 for more information.

When complete, press “Done”

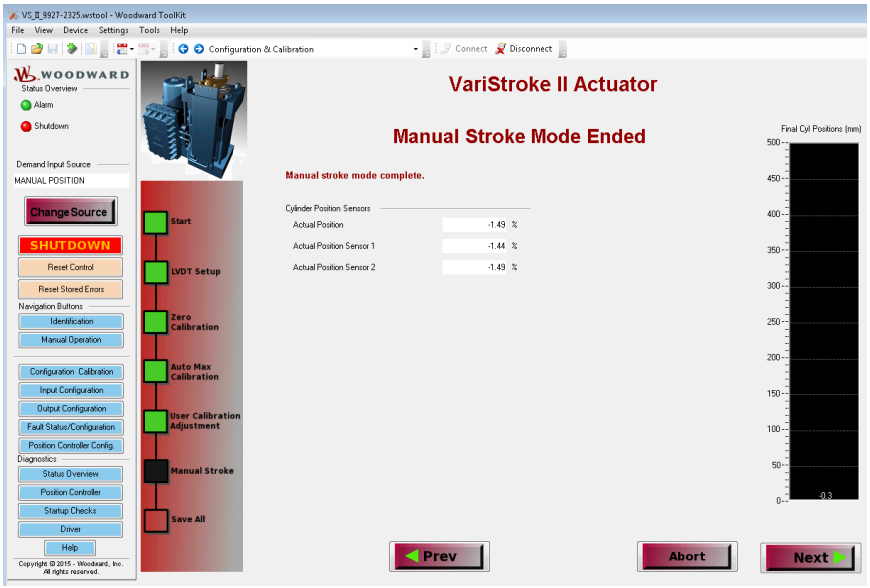


Figure 6-27. Manual Stroke Mode Complete Page

Press “Next” to continue, or “Abort” to exit without saving.

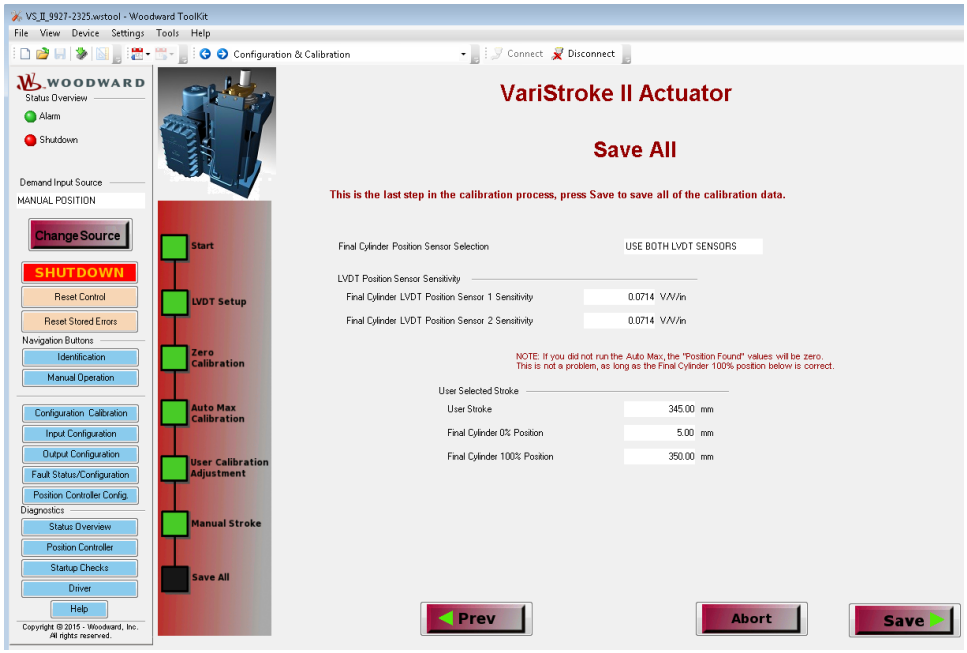


Figure 6-28. Save or Abort Configuration Changes Page

If satisfied with the Calibration settings displayed, press “Save”, or “Abort” to exit without saving.

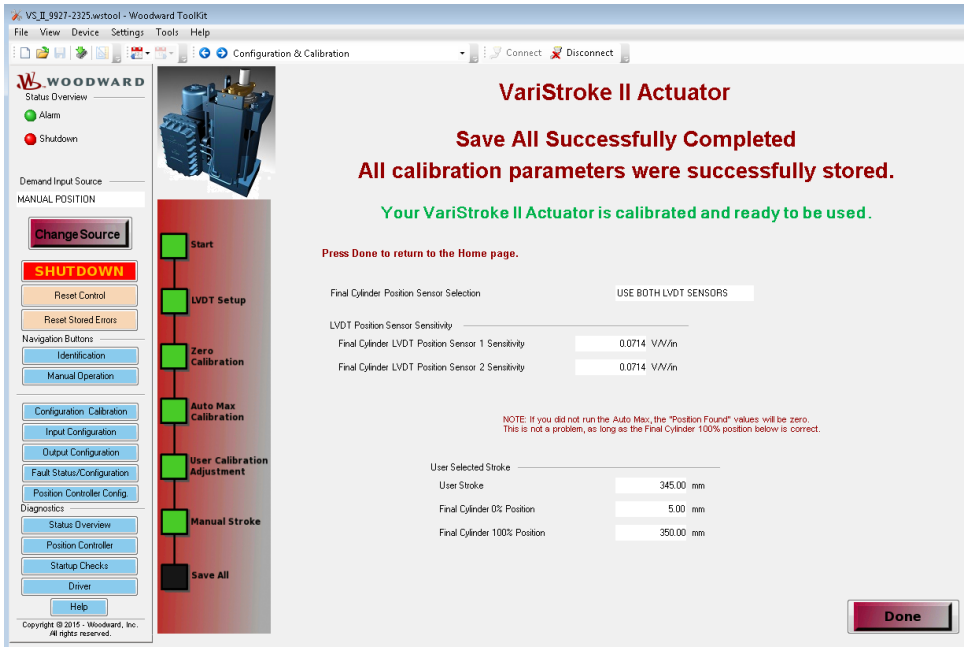


Figure 6-29. Calibration Parameters Successfully Saved Page

Press “Done” to return to the home page. A “Calibration Complete Shutdown” is issued upon completion of Calibration. This flag can be viewed on the “Fault Status/Configuration” page. This will need to be cleared before the VS-II can begin normal operation by pressing “Reset Control”.

Manual Operation Page

This page is different from the Manual Operation page that is within the Configuration Calibration Wizard. No changes can be done to the configuration from this page, unlike within the wizard.

WARNING

Do not allow the controlled steam turbine to run or operate during any of the following procedures, preventing personal injury or death and damage to equipment. Turn off the main steam valve to prevent operation of the controlled system.

Once the Manual Operation button is pressed, the following screen will be displayed below the trend chart. Actuator movement can be monitored and viewed using this trend chart. To do so, press “Start” at the top left corner of the trend chart. To change the cylinder position, change the Position Request value (see below). Demand Input Source must be set to “Manual Position” and the control must be in operational mode, not shutdown, for manual operation to work. Press “Change Source” to select Manual Position, and press Reset Control to exit Shutdown mode.

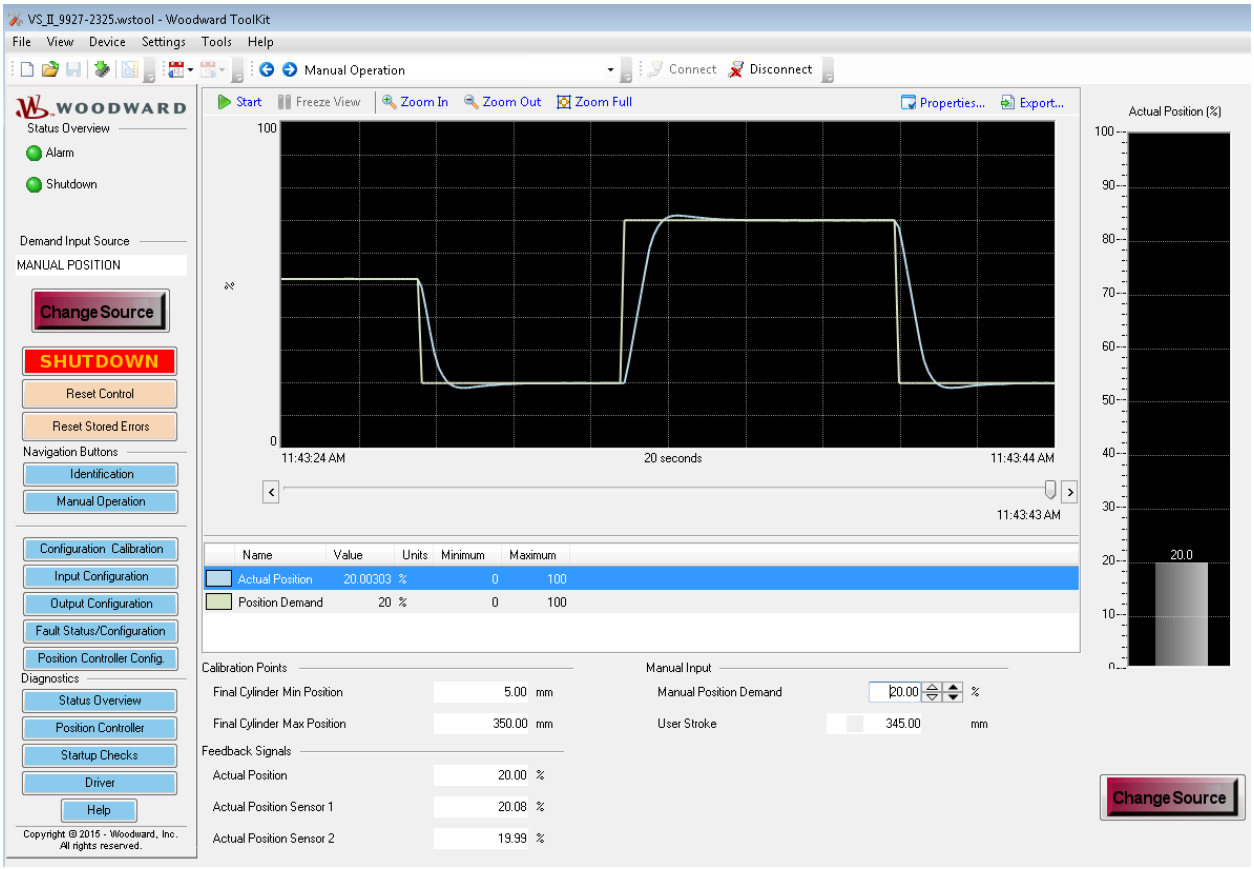


Figure 6-30. Manual Operation Page

Input Configuration Page

The Input Configuration page provides the user with the ability to change the input source and to modify or edit the configuration of the selected source. These will be explained in detail in the following sections.

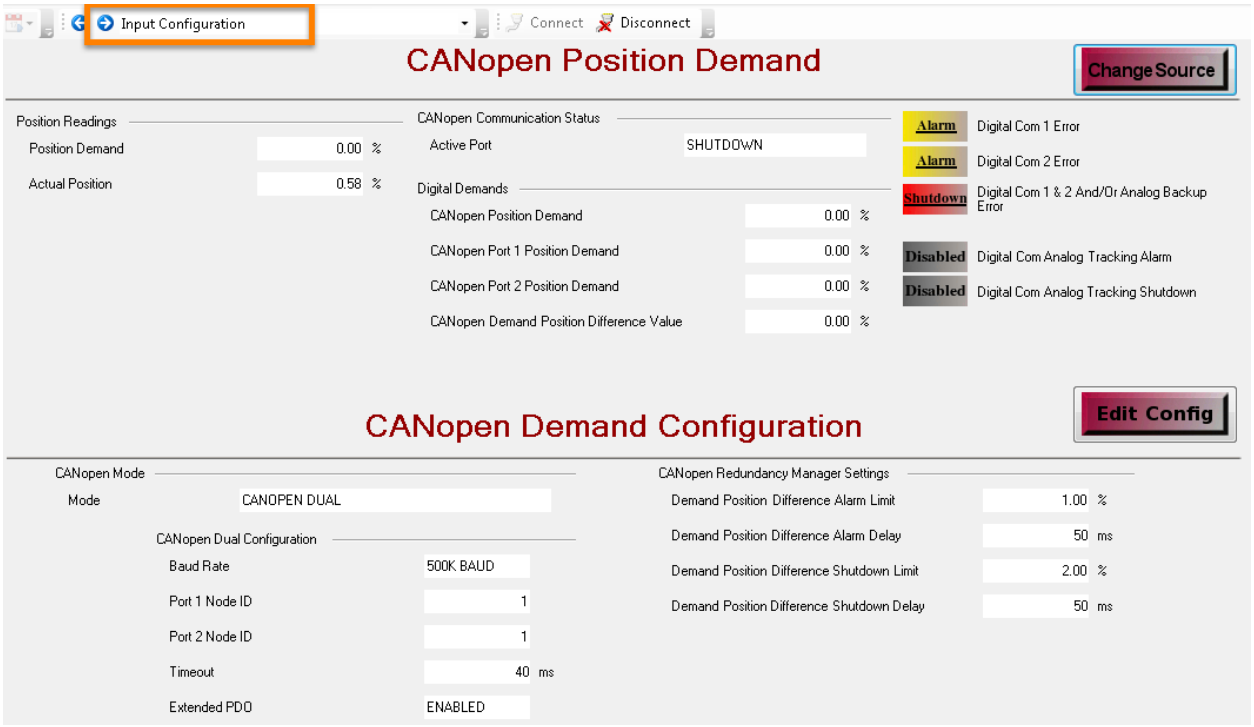


Figure 6-31. Input Configuration Page

Demand Input Selection Demand Input Source

This is accessed by clicking the Change Source button on the upper Right corner of the Input Configuration page. The dropdown menu offers three options for selecting source Manual Position, Analog Input, and CAN Open Digital Input.

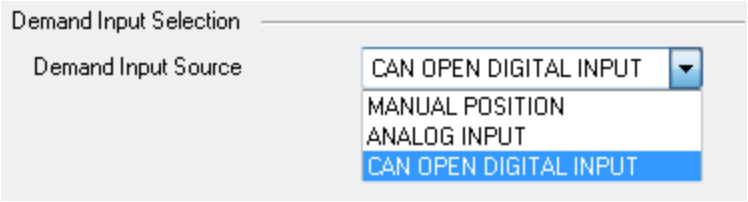


Figure 6-32. Demand Input Source Dropdown Menu

Manual Position Demand

This results from selecting the Manual Position Demand option from the Demand Input Source dropdown menu.



Figure 6-33. Manual Position Demand Input Source Page

Position Readings of Position Demand and Actual Position are displayed in percentages and the blue Manual Operation button when selected navigates you back to the Manual Operation Page.

WARNING **Do not use this unless prime mover is locked off!**

Analog Position Demand Configuration

This results from selecting the Analog Input option from the Demand Input Source dropdown menu. These indicators show the analog input mode and the actual set position in percent of position (%) resulting from the currently active analog input configuration.

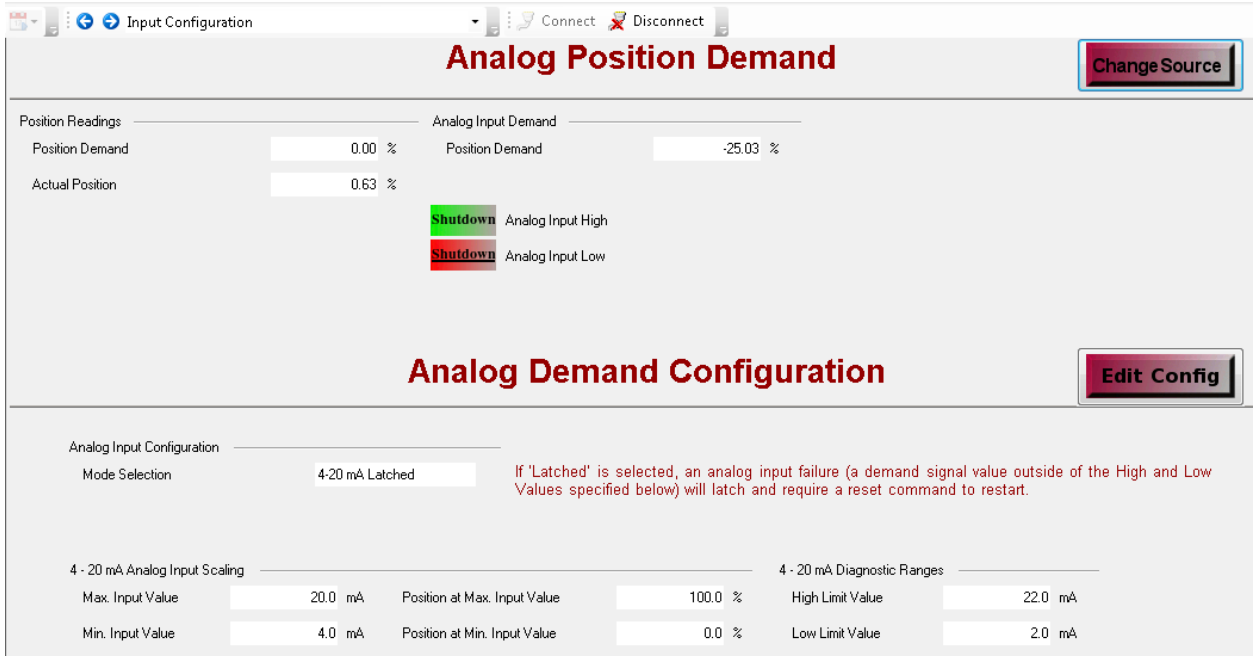


Figure 6-34. Analog Position Demand Input Mode Selection Page

Additionally, the Analog Position Demand section of the image above includes High and Low Input warnings with the indication of function shutdown as operational (green) or inoperable (red).

Analog Demand Configuration

This results from selecting the “Edit Config” button (located in the right-middle of the Analog Position Demand Input Source page). This page provides access to the Mode Selection dropdown menu and the ability to adjust the 4-20 mA Input Scaling and 4-20 mA Diagnostic Ranges settings.

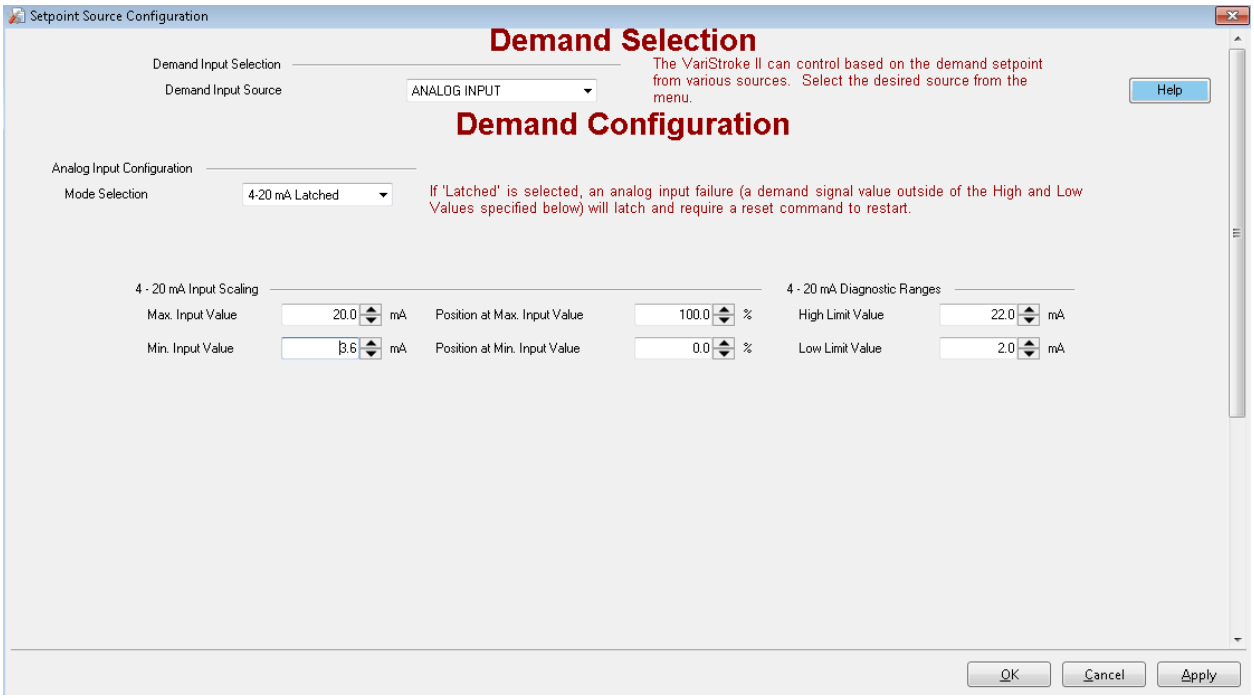


Figure 6-35. Analog Demand Configuration Page

Default values are displayed after the “Edit Config” button is selected. Mode selection is made through the dropdown menu and the other valve configurations are made by toggling the up/down arrow buttons or by writing the desired values in the windows.

CANopen Position Demand Input Source Page

This page is opened after selecting Can Open Digital Input from the source dropdown menu. These indicators indicate the CANopen Mode (Single CANopen with or without Analog Backup, Dual CANopen or CANopen Virtual), the active port, and Set Position value shown in percent position (%). There are also colored indicators showing status and error messages as applicable.

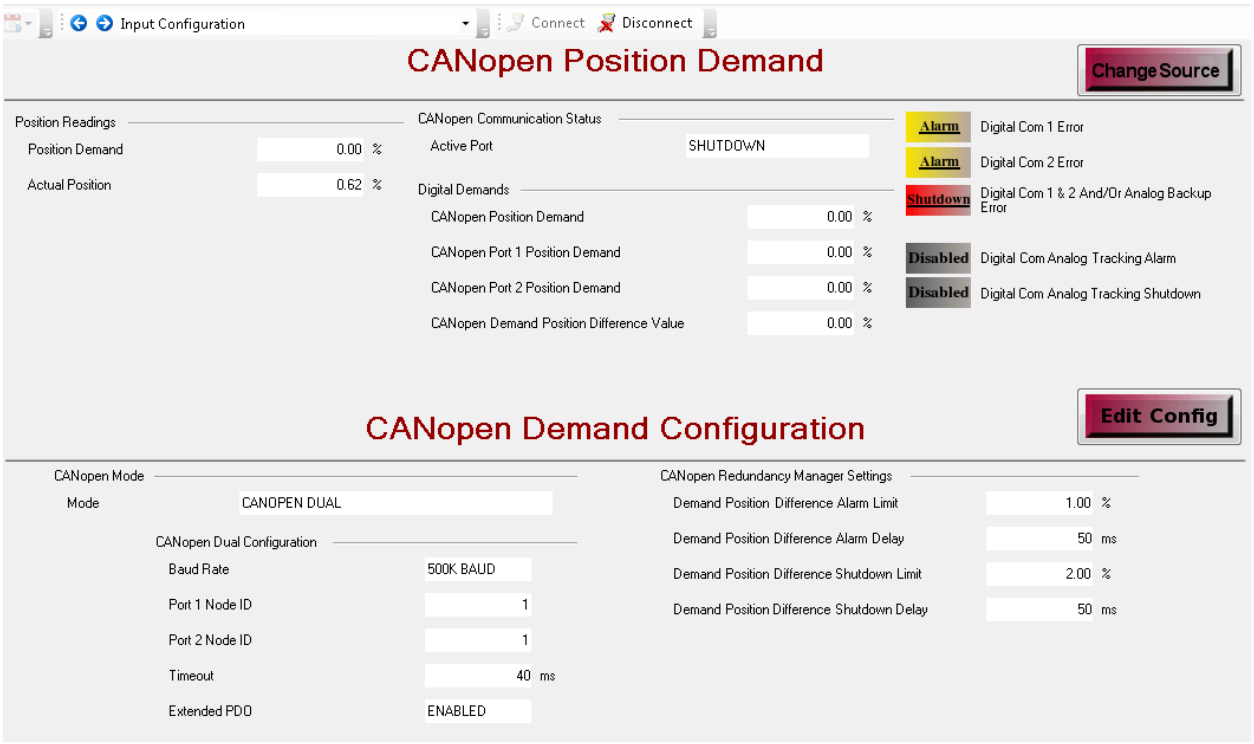


Figure 6-36. CANopen Position Demand Input Source Page

CANopen Dual Demand Configuration Page

CANopen Dual is when both CAN communication ports are to be used simultaneously for redundancy. The Global Settings configuration is explained in the section below. The CANopen Redundancy Manager Configuration while in CANopen Dual mode allows the user to identify which Node ID are applicable for Port 1 and Port 2.

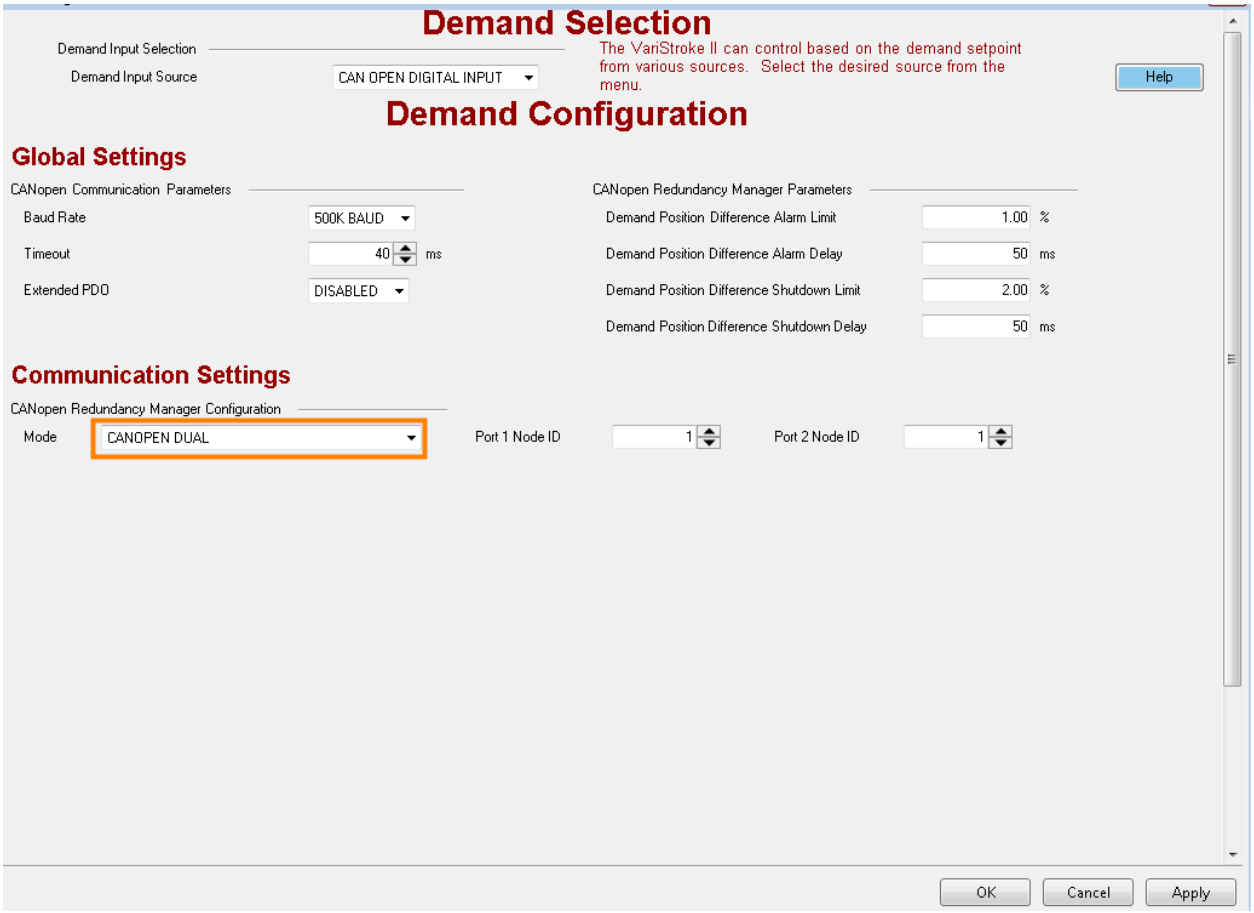


Figure 6-37. CANopen Dual Demand Configuration Page

CANopen Communications Parameters Baud Rate Dropdown Menu

This menu enables the user to select between 125K, 250K, and 500K Baud rate to match the desired equipment settings.



Figure 6-38. CANopen Communications Parameters Baud Rate Dropdown

CANopen Configuration Global Settings Extended PDO Dropdown Menu

This dropdown allows the user to select to enable or disable the Extended PDO. The enabling of extended PDOs means that the user will have access to all of the available PDOs (1 through 8, inclusive). If disabled, then only PDOs 1 through 4, inclusive, are accessible. You also have the ability to adjust the Timeout value either by typing in a specific value or by clicking the up/down arrows which will increase/decrease the timeout interval.

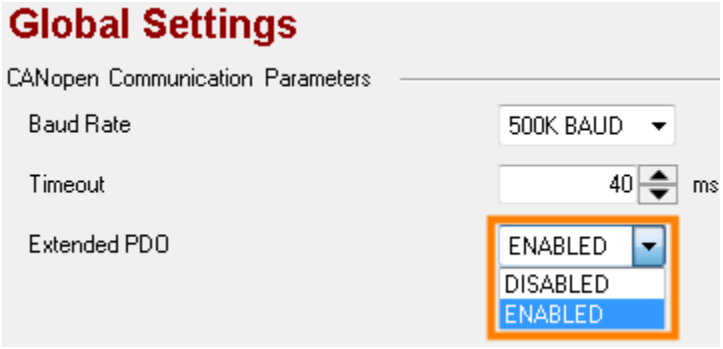


Figure 6-39. CANopen Configuration Global Settings Extended PDO Dropdown

CANopen Single With/Without Analog Backup Configuration Page

Selecting this option from the communications settings adds Analog input options to the digital communications parameters. You have the option to turn off the analog input settings, use the 4-20 milliamp not latched, or 4-20 milliamp Not Latched configuration. For additional information, refer to the Analog Input Settings section above.

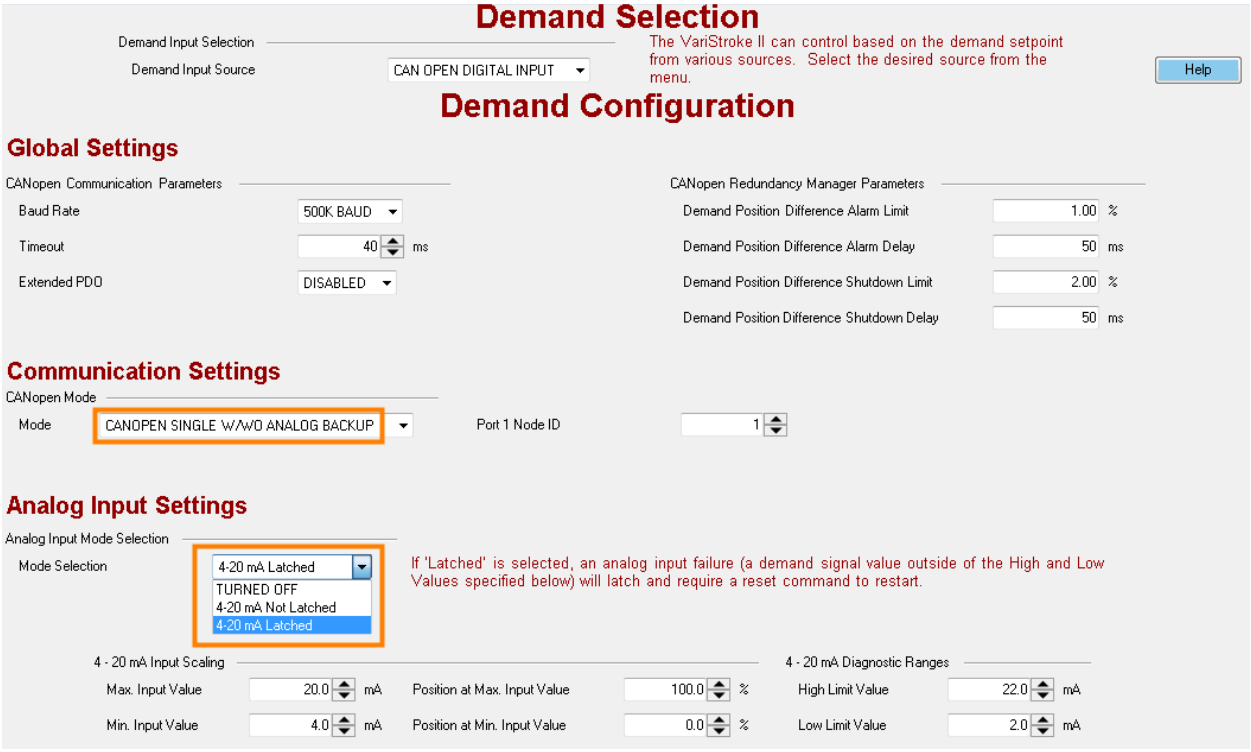


Figure 6-40. CANopen Single W/WO Analog Backup Configuration Page

CANopen Virtual Configuration Page

Note: The CANopen Virtual option is not currently supported by VS-II

Output Configuration Page

The scaling, and diagnostic settings for the analog output are displayed on the Analog Output Configuration page. This has been combined with the Discrete Output Configuration on the same page.

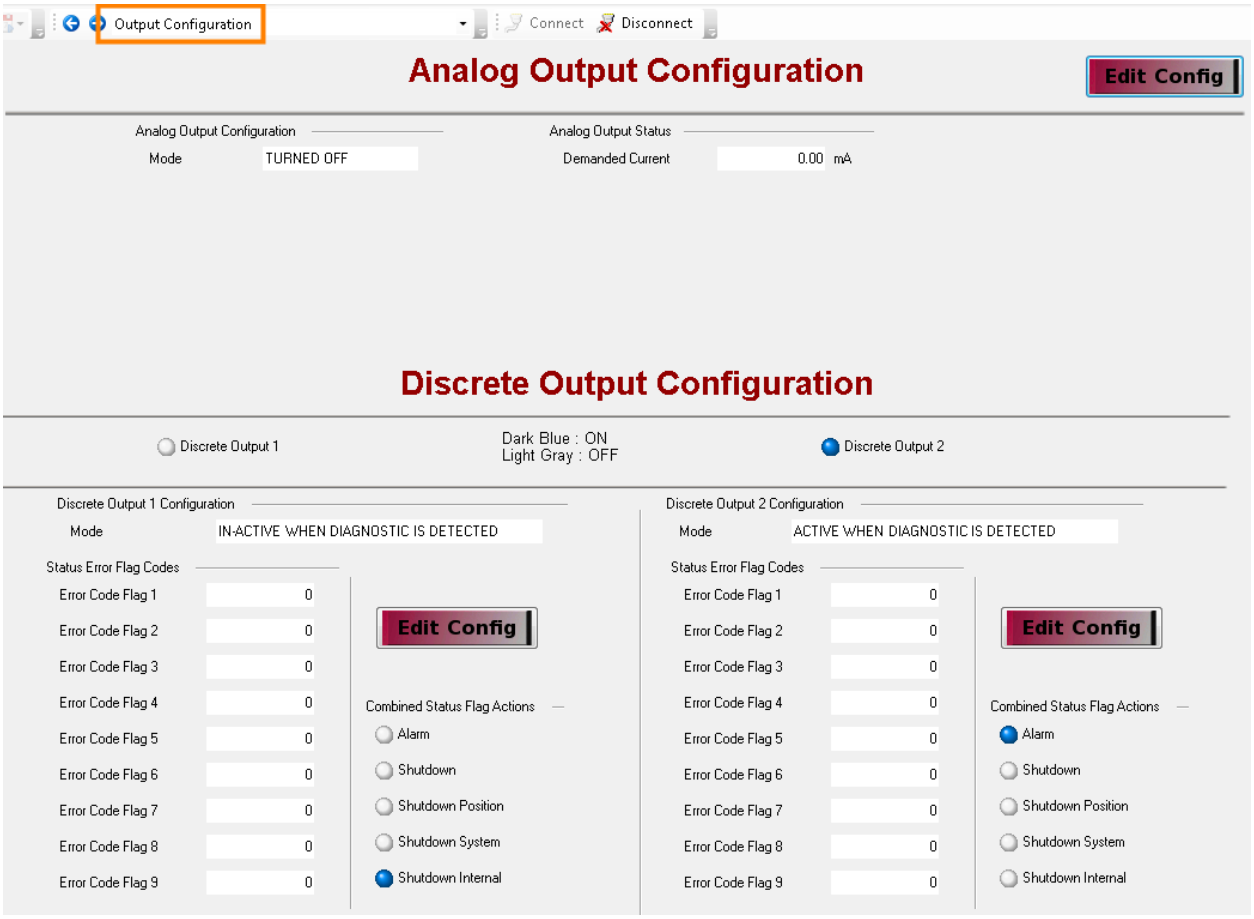


Figure 6-41. Output Configuration Page

Analog Output Mode Selection Dropdown Menu

The VariStroke II control variable represented by the analog output signal is configurable from the Mode Selection pull-down list.
The following options can be selected:

- Turned Off
- Actual Position
- Echo Setpoint
- Motor Current (quadrature current)
- Servo Position

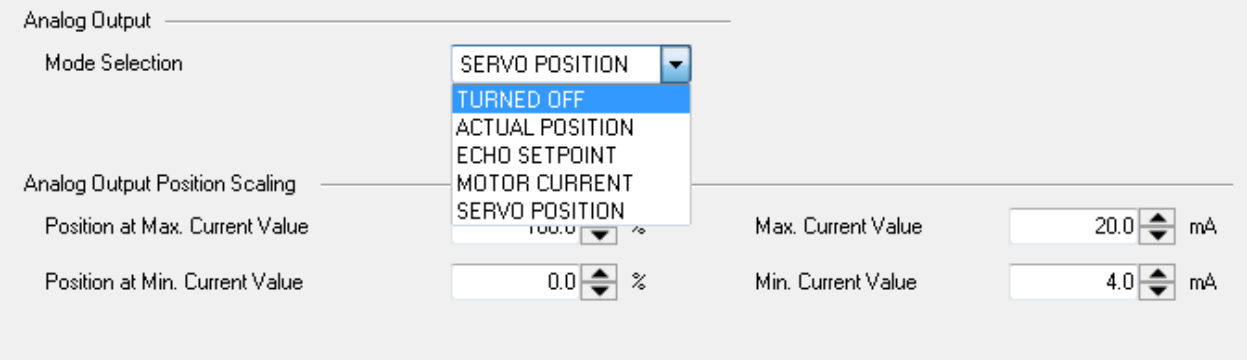


Figure 6-42. Analog Output Mode Selection Dropdown Menu

Analog Output Mode Selection Actual Position

By adjusting the output scaling values, the selected VariStroke II control variable can be can be adjusted to match those observed at the transmitting device.

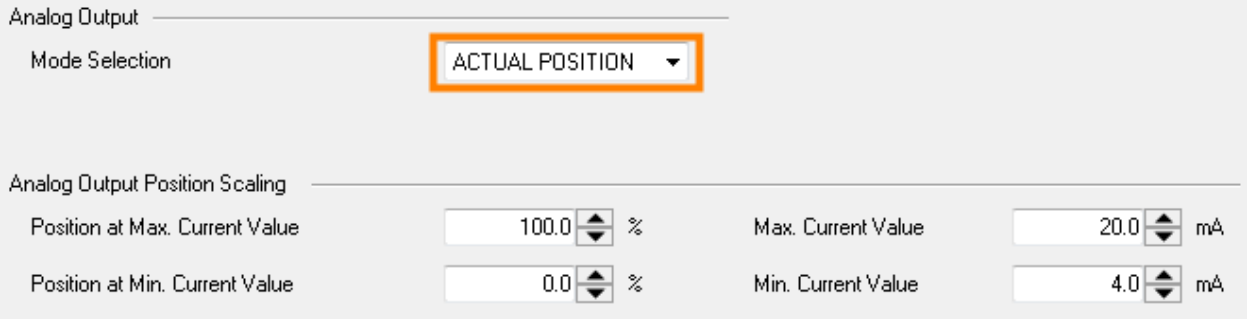


Figure 6-43. Analog Output Mode Selection Actual Position

Actual Position

This page displays the position scaling selections made on the configuration page with real-time incrementing Demand Current value in milliamps and the Actual Position in incrementing percentages.

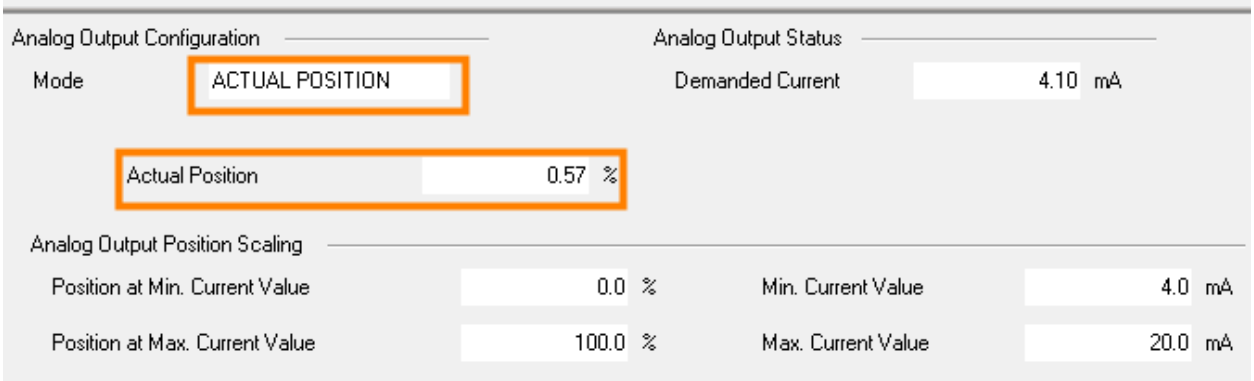


Figure 6-44. Actual Position

Analog Output Mode Selection Echo Setpoint

The ability to adjust the Output Position Scaling values is identical to the Actual Position configuration.

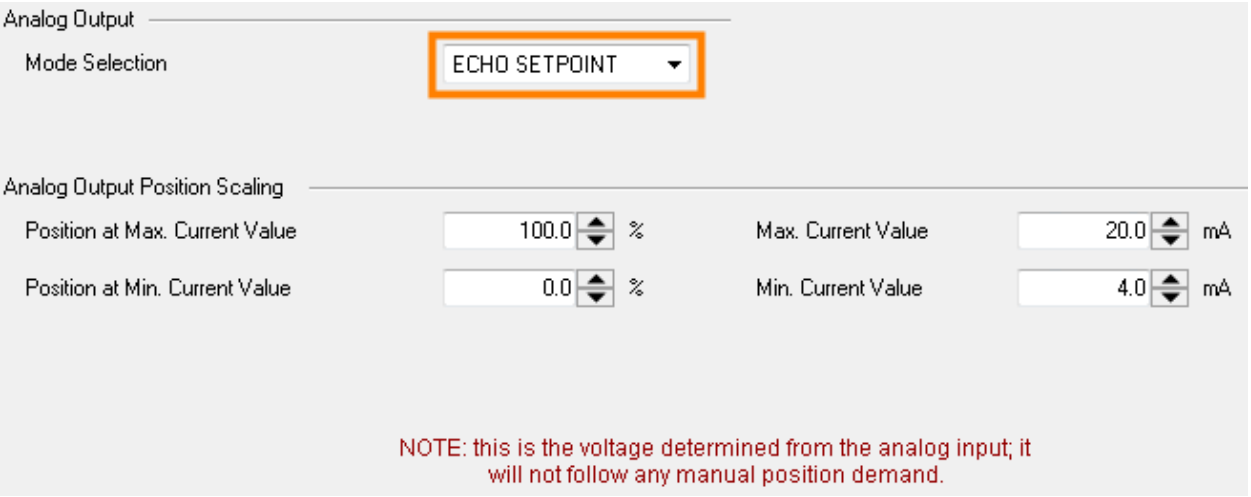


Figure 6-45. Analog Output Mode Selection Echo Setpoint

Echo Setpoint

This display page contains the Output Position Scaling values set on the Configuration page with the Demanded Current fixed at the Echo Setpoint and the real-time incrementing Actual Position values displayed by percentage.

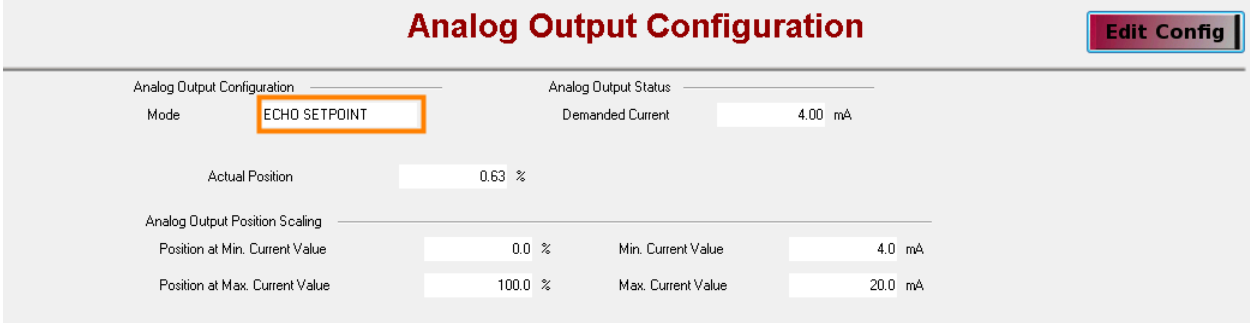


Figure 6-46. Echo Setpoint

Analog Output Mode Selection Motor Current

The Motor Current Configuration page allows the user to adjust the Output Motor Current Scaling values.

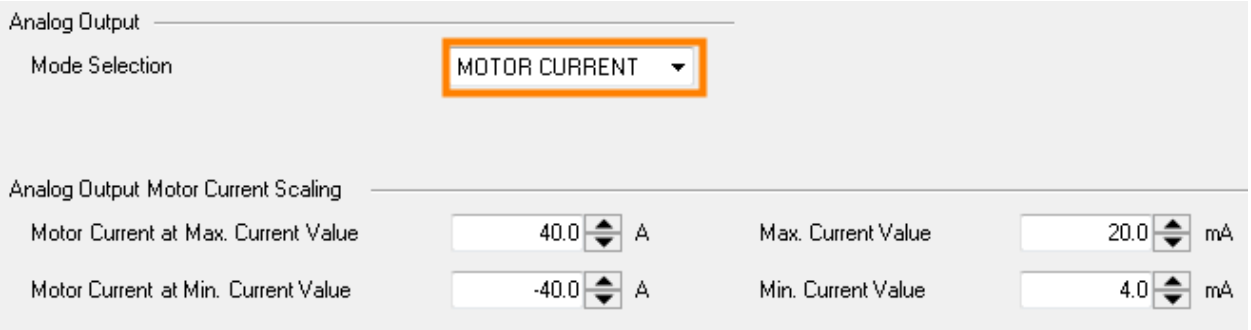


Figure 6-47. Analog Output Mode Selection Motor Current

Motor Current

This page displays the output motor current scaling values set on the previous page and the real-time incrementing Demanded Current in milliamps and the Actual Current in Amps.

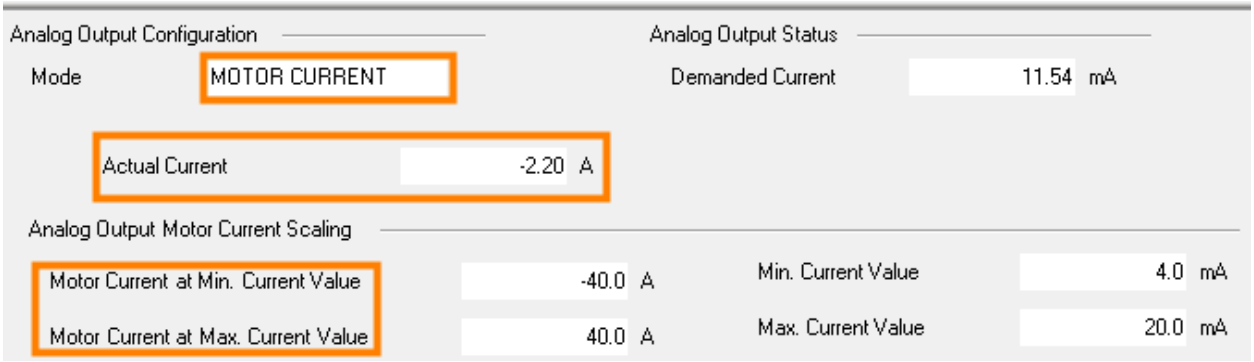


Figure 6-48. Motor Current

Discrete Output Configuration

The Discrete Output Configuration page contains displays and edit configuration options for Discrete Output 1 and Discrete Output 2. The main configuration of the discrete outputs is performed on this page. Each of the discrete outputs is configured in the same manner. Each of the two discrete outputs can be configured to activate (or de-activate) upon detection of any of fault conditions monitored by the VariStroke II.

The image below is how the display looks when both outputs are turned off. The indicators on the first row display blue when the output is enabled or turned on and display gray when the output is turned off. To configure Output 1 or Output 2 click the appropriate red “Edit Config” button.

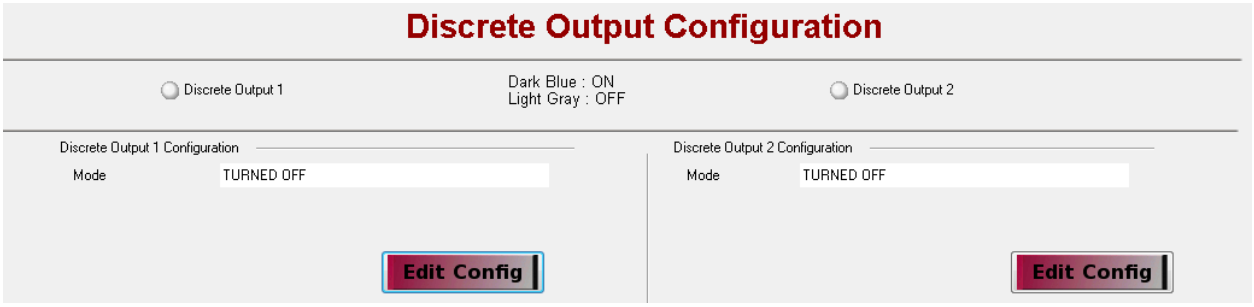


Figure 6-49. Discrete Output Configuration

Discrete Output 1 & 2 Configuration Dropdown Menus

The drop down menus are identical for both the Discrete Output 1 and Discrete Output 2 configuration and offer Turned Off, Speed Switch, Active When Diagnostic is Detected, and In-Active when Diagnostic is Detected as user-selected options. Select the behavior of the discrete output from the dropdown menu.

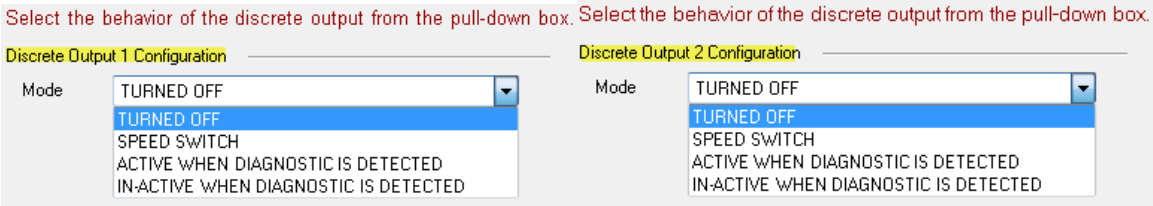


Figure 6-50. Discrete Output 1 & 2 Configuration Dropdown Menus

Discrete Output 1 Active Discrete 2 Speed Switch

Each discrete output may be configured independently of the other. If you select a combined flag, (indicated by column beneath the Edit Config button) typically there is no need to select any individual flags (displayed in figures 6-51 through 6-53 below). In the example in figure 6-51 Output 1 is active mode with a combined flag of Shutdown Internal selected and no individual flags selected. Output 2 mode is set to Speed Switch.

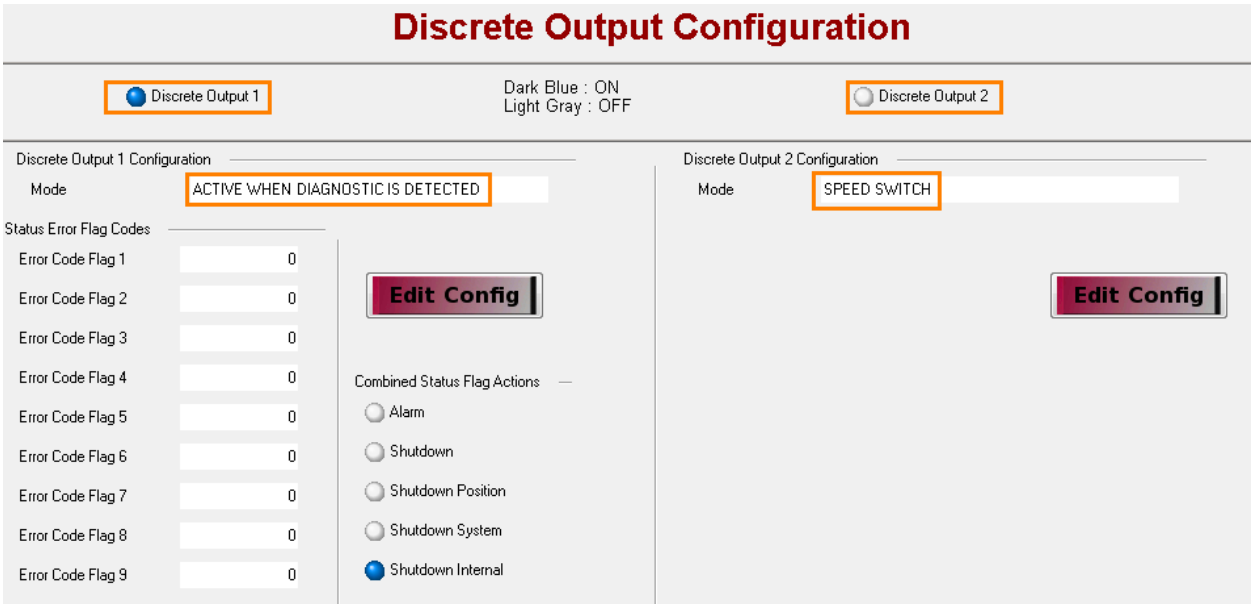


Figure 6-51. Discrete Output 1 Active Discrete 2 Speed Switch

Discrete Output 2 Flag Selection (1-4)

If you do not select a combined flag, using the next button brings you to the page to configure flags 1-4 which are to be used for this output. Select one box from the list below each flag and you will see the selected flags with a check in the box to the left of the individual flag.

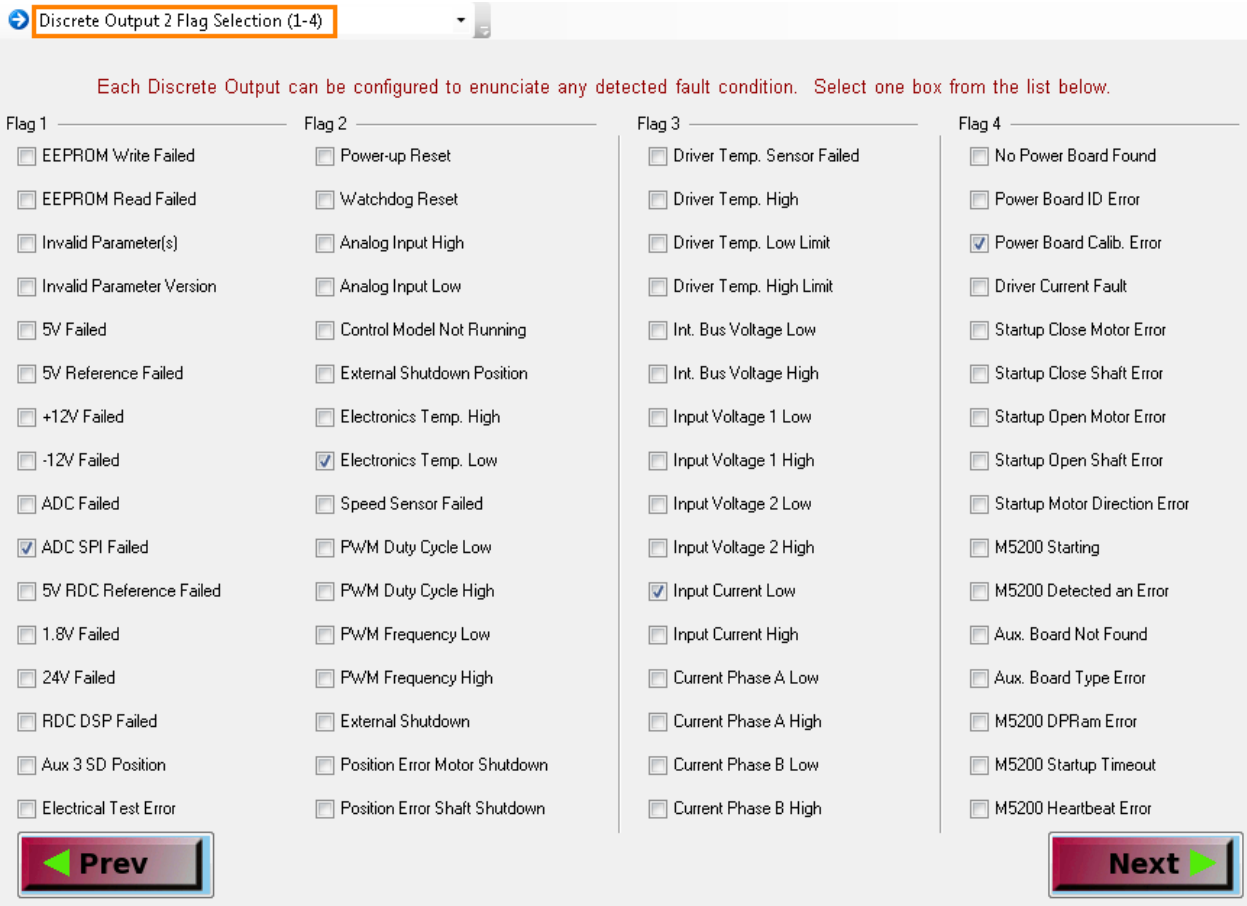


Figure 6-52. Discrete Output 2 Flag Selection (1-4)

Discrete Output 1 Flag Selection (5-8)

The same situation is displayed below showing the options available for flags 5-8. Remember Discrete Output 1 and Discrete Output 2 have identical selections.

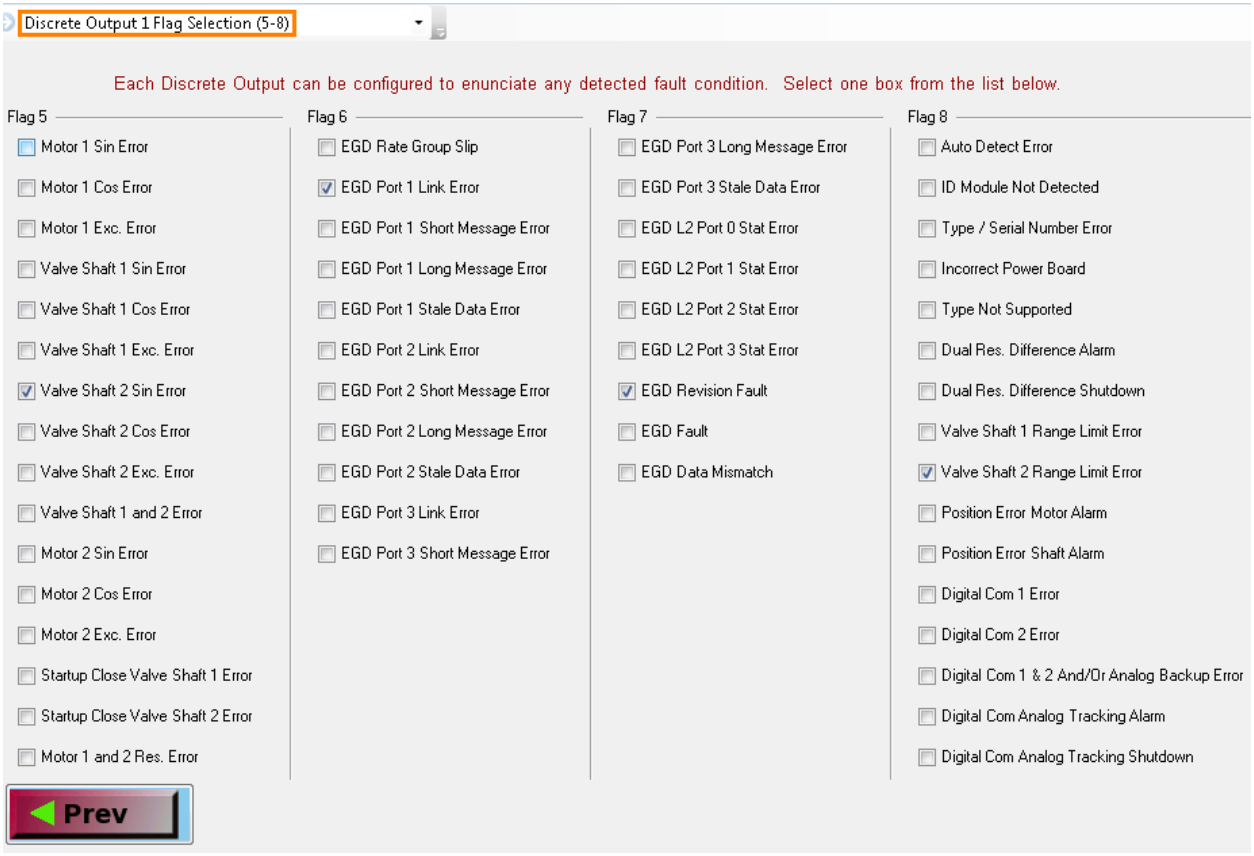


Figure 6-53. Discrete Output 1 Flag Selection (5-8)

Discrete Output 1 Active Flag Selection (5-8) and Discrete Output 2 Active Flag Selection (1-4)

Figure 6-54 shows the results of the previous selections of combined and individual selections. Both Outputs are on and error flags 1-4 (Output 2) and flags 5-8 (Output 2) show the error codes for each error flag selected.

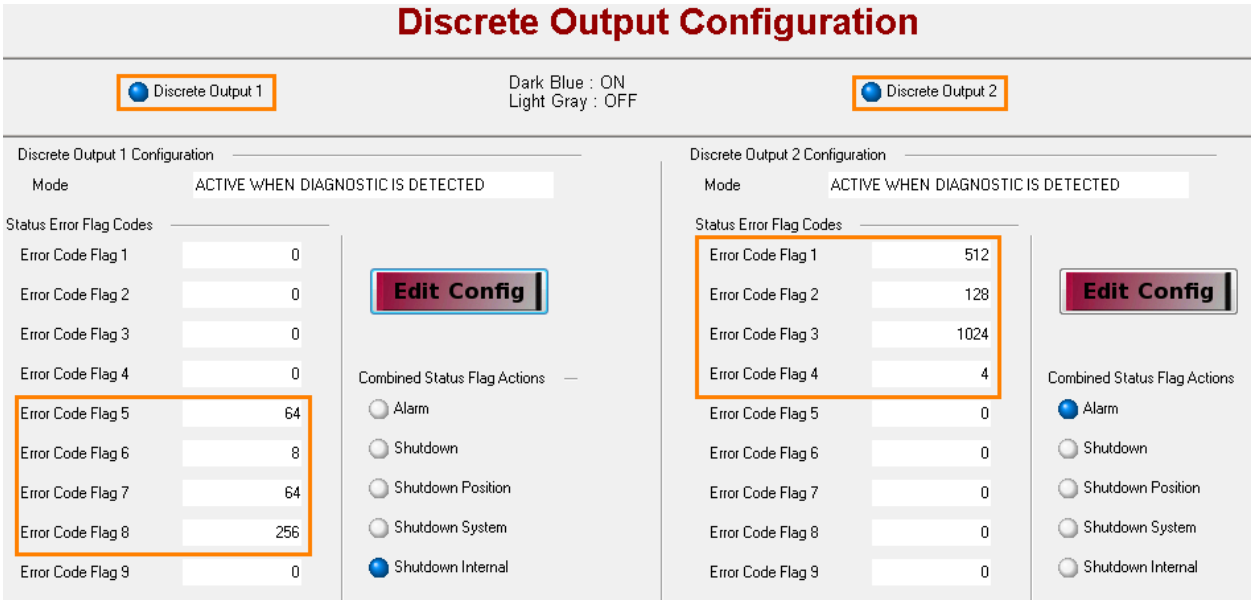


Figure 6-54. Discrete Output 1 Active Flag Sel. (5-8) Discrete Output 2 Active Flag Sel. (1-4)

Fault Status and Configuration Overview

Some of the VariStroke II's process fault and status flags are user-configurable. The configuration of these process fault and status flags is done on the Process Fault and Status Flag Configuration page.

Clicking the Internal VariStroke II Fault Status button redirects the service tool Fault Status and Configuration Overview page to the Fault Status and Configuration Overview Internals page.

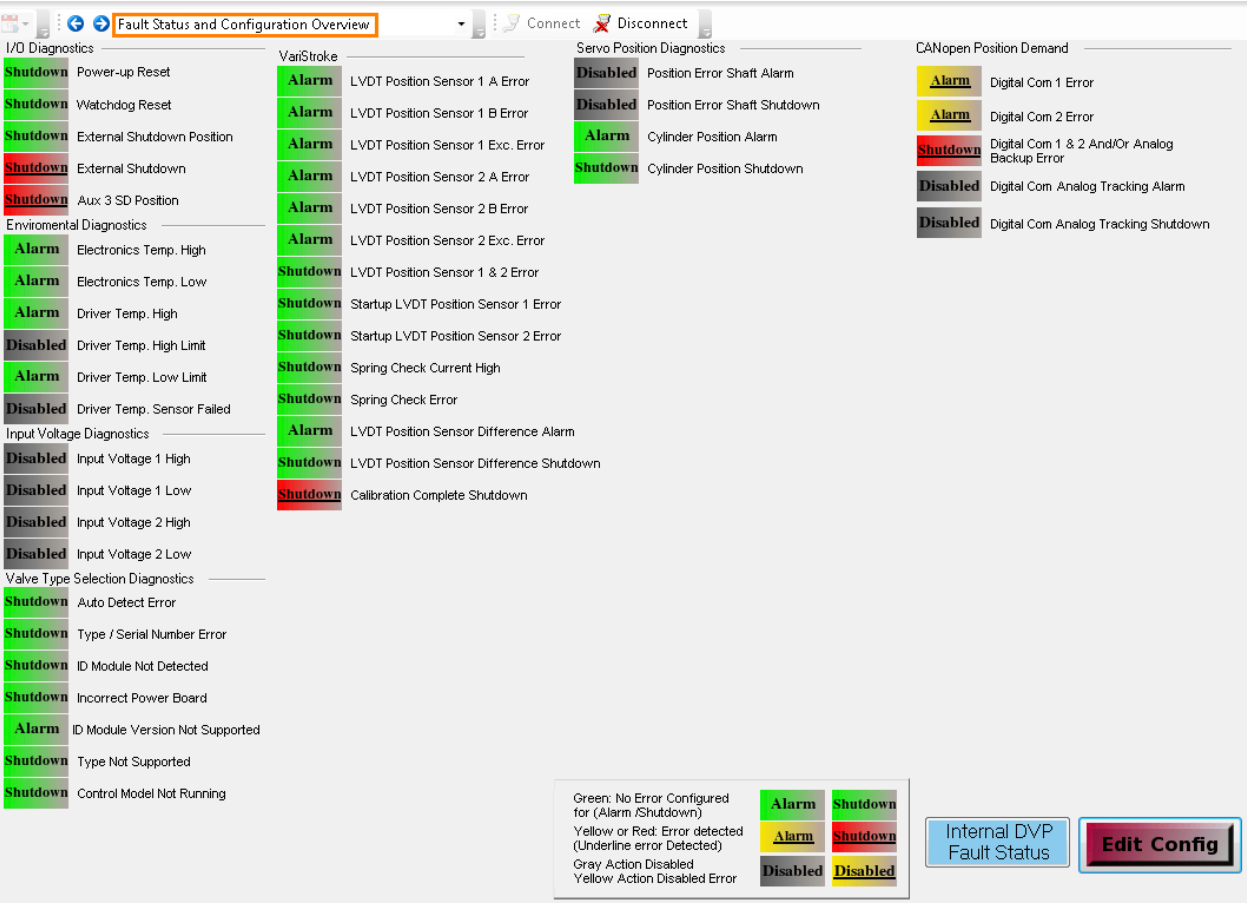


Figure 6-55. Fault Status and Configuration Overview Page

Process Fault and Status Flag Configuration Page

Clicking the “Edit Config” button on the lower/right corner of the page opens the Process Fault and Status Flag Configuration page. All of the Diagnostics shown on this screen are user-configurable, i.e. they can all be either enabled or disabled (using the left button) or configured as Alarm (AL in yellow) or Shutdown (SD in red) (using the right button).

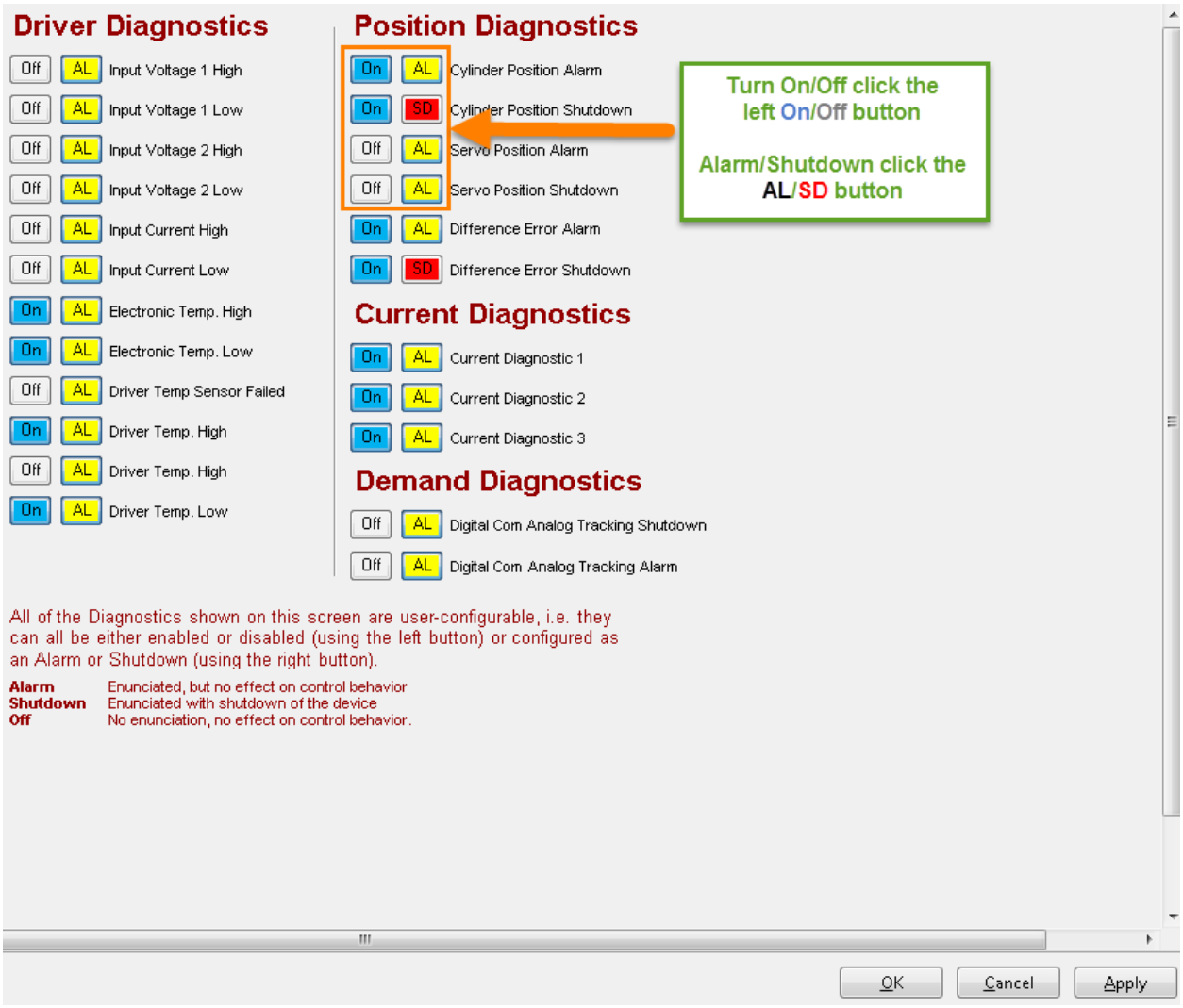


Figure 6-56. Process Fault and Status Flag Configuration Page

Alarm: Enunciated, but no effect on control behavior.
Shutdown: Enunciated with shutdown of the device.
Off: The condition will not show up in an overall Alarm or Shutdown status, but the individual indicator will still show the actual status.

⚠WARNING

Modification of these settings could affect operation and plant diagnostics annunciation! An appropriate review of the settings is recommended PRIOR to making these modifications!

⚠WARNING

Disabling diagnostic flags or changing their function from Shutdown to Alarm could result in a dangerous condition! An appropriate review of the settings is recommended PRIOR to making these modifications!

IMPORTANT

In the case of the analog input, EGD or PWM input diagnostics, if either one of these inputs is not used, the associated diagnostics are automatically disabled. It is not necessary to disable these diagnostics explicitly.

NOTICE

In some cases, if the VariStroke II is operated continuously under conditions where one or more of these diagnostic conditions are detected, some performance degradation or reduction in component life may occur. It is the responsibility of the user to configure these settings to ensure safe operation.

Each process fault or status flag can be configured as either an alarm or shutdown, and can be configured as either active, or disabled. In the presence of detected condition, a diagnostic configured as a shutdown will result with the VariStroke II overriding the setpoint and directing the actuator to the failsafe position (in most cases 0%). If a diagnostic is configured as an alarm, the detected condition will be annunciated on the service tool, and a discrete output if selected, but the VariStroke II will continue to control. A disabled diagnostic, will be annunciated, and will not generate a shutdown condition.

Fault Status and Configuration Overview Internals

This page is display only and no configuration actions may be taken by the operator. Select the blue "Return To Fault Status" button to the Fault Status and Configuration Overview page.

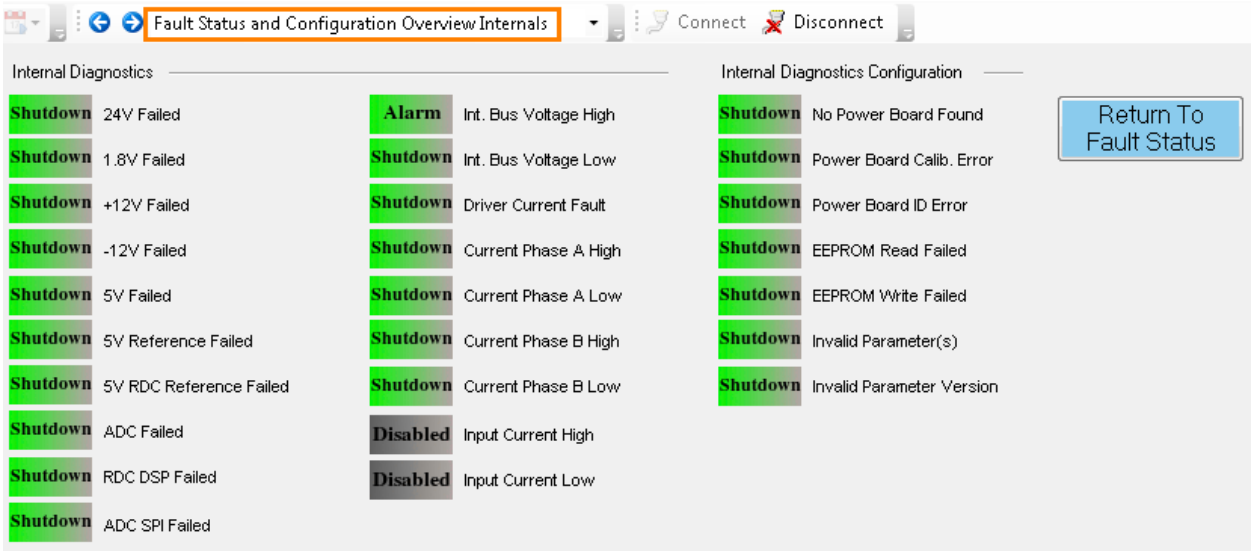


Figure 6-57. Fault Status and Configuration Overview Internals Page

Position Controller Configuration Operation Page

The Position Controller Configuration menu indicates the general overview of the actuator operation. The individual configuration edit options will be described in separate sections below.

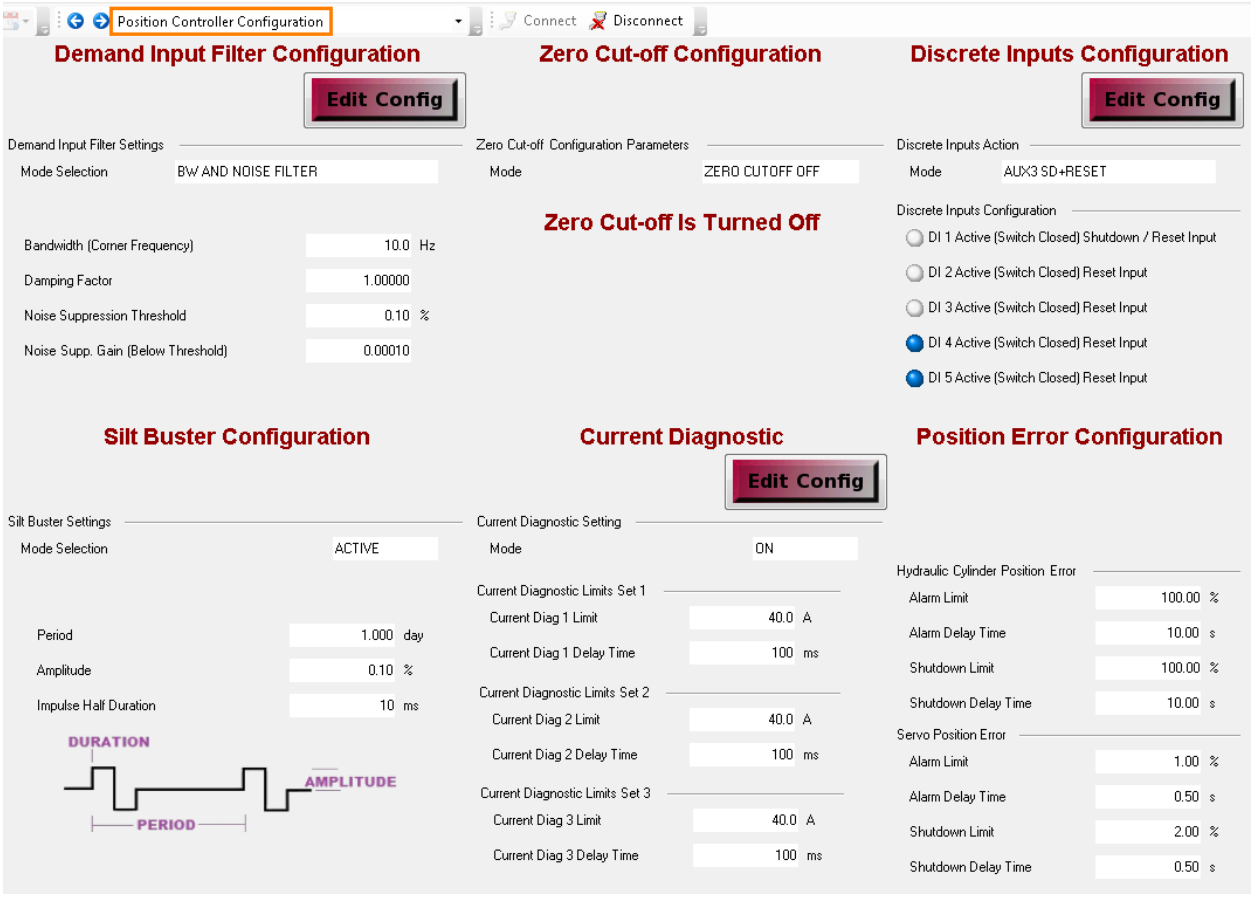


Figure 6-58. Position Controller Configuration

Note: Proceed with caution. Editing the configuration with the VariStroke II in the wrong state of operations may result in errors or damage.

NOTICE

Before modifying any settings of the VariStroke II, make sure the device is shut down. Modifying settings with the unit in operation may result in unexpected behavior!

⚠WARNING

The SHUTDOWN button will move the valve to 0% position. This will potentially shut down the Prime Mover!

IMPORTANT

The setpoint filter is implemented in series with the control model.

Demand Input Filter Configuration

This group contains the settings for the setpoint filter. If the input filter is turned off the setpoint signal is not filtered. The bandwidth filter acts to limit the system response to the specified settings (required by some applications). The noise suppression filter attenuates the amplitude of low amplitude, high frequency noise signals (due to speed pickup anomalies, or transducer noise). The input filter is used to shape the frequency response characteristics of the valve/actuator system for bandwidth, noise and slew rate limiting to certain applications.

Mode Selections:

- Input Filter Off
- Bandwidth Filter
- Noise Filter
- BW and Noise Filter
- Slew Rate Filter
- Slew Rate and BW Filter
- Slew Rate and Noise Filter
- Slew Rate, BW, and Noise Filter

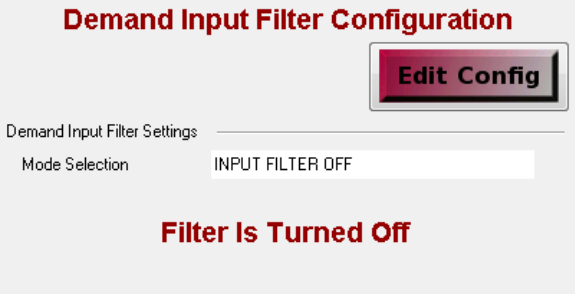


Figure 6-59. Demand Input Filter Configuration

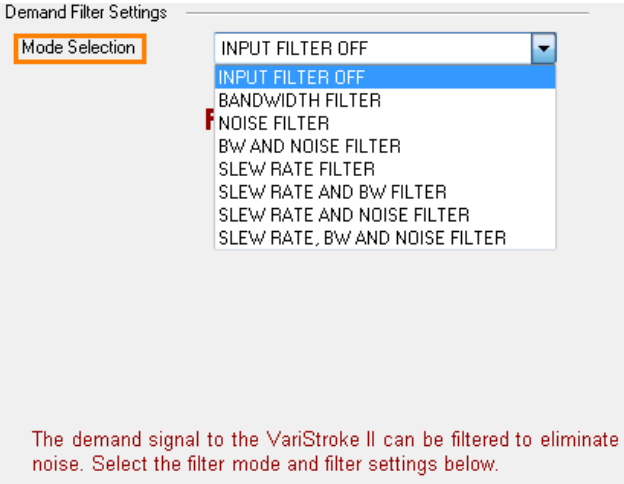


Figure 6-60. Demand Filter Settings Mode Selection

Bandwidth Filter Mode Settings

The active bandwidth frequency and damping factor is displayed when the bandwidth filter is selected. The Bandwidth (Corner Frequency) in Hertz and the Damping Factor may be set by overwriting the values or clicking on the up/down arrows.

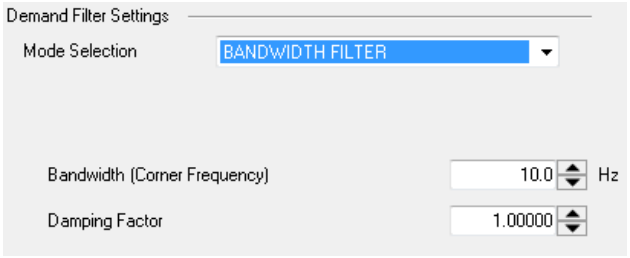


Figure 6-61. Bandwidth Filter Mode Settings

Demand Input Bandwidth Filter Display

After the Demand Filter Settings are selected in Bandwidth Mode, this display is what you may expect to see on the Demand Input Filter Configuration page.

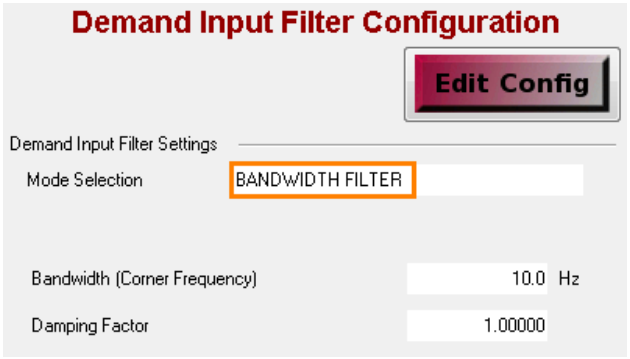


Figure 6-62. Demand Input Bandwidth Filter Display

Noise Filter Mode Settings

When you select the Noise Filter Mode, you may configure the Noise Suppression Threshold and the Noise Suppression Gain (Below Threshold).

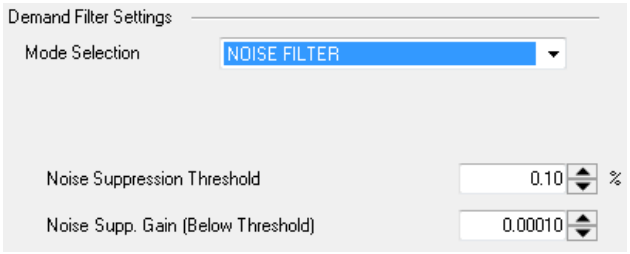


Figure 6-63. Demand Filter Settings Mode Noise Filter

Demand Input Noise Filter Display

The active noise filter setting field is displayed when noise filter is selected.

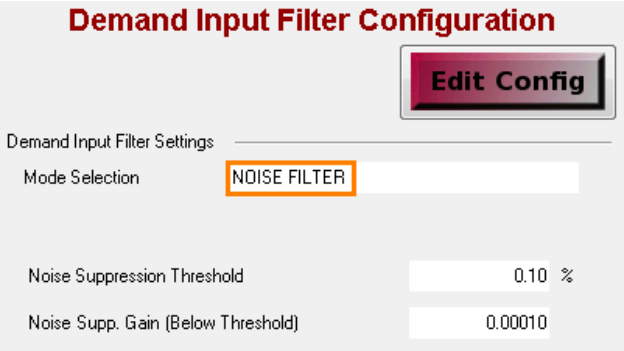


Figure 6-64. Demand Input Noise Filter

Demand Filter Settings Mode Bandwidth and Noise Filter

This page allows the filter to be set for a bandwidth and noise combination function. You may configure the same settings for Bandwidth and Noise filters.

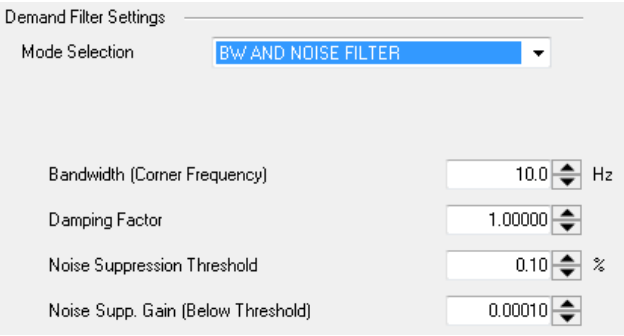


Figure 6-65. Demand Filter Settings Mode Bandwidth and Noise Filter

Demand Input Bandwidth and Noise Filter

This is the resulting display after configuring the Bandwidth and Noise Filter.

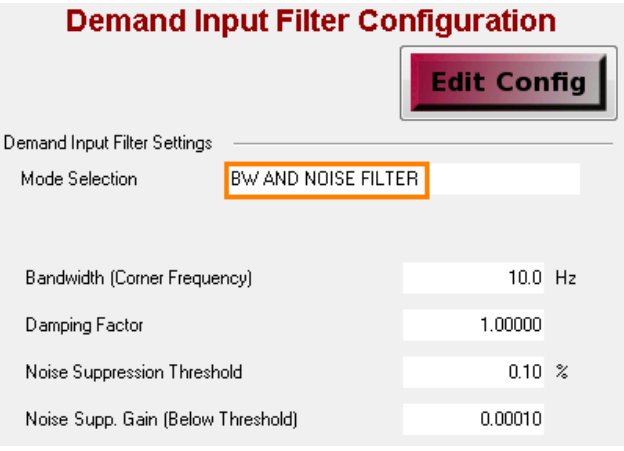


Figure 6-66. Demand Input Bandwidth and Noise Filter

Demand Filter Settings Mode Slew Rate Filter

The filter is displayed in percentage per second and limits the maximum rate of change determined by the user adjusting the filter.

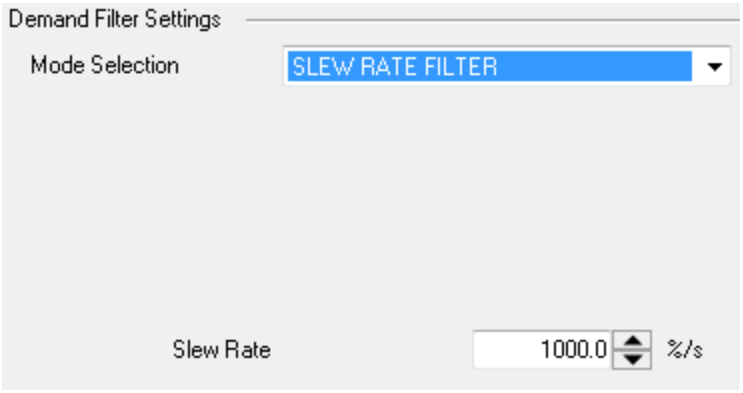


Figure 6-67. Demand Filter Settings Mode Slew Rate Filter

Demand Input Slew Rate Filter

This is the resulting display after configuring the Slew Rate Filter.

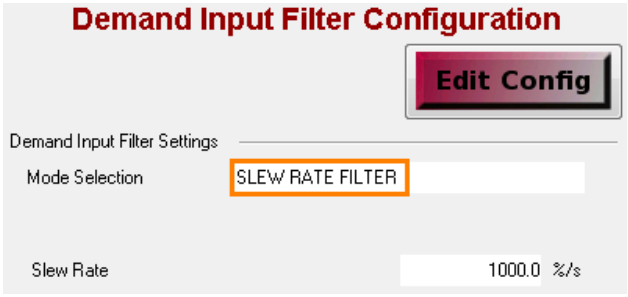


Figure 6-68. Demand Input Slew Rate Filter

Demand Filter Settings Mode Slew Rate and Bandwidth Filter

This page allows the filter to be set for slew rate and bandwidth combination function.

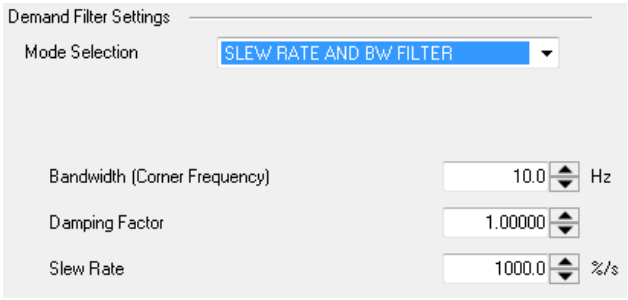


Figure 6-69. Demand Filter Settings Mode Slew Rate and Bandwidth Filter

Demand Input Slew Rate and Bandwidth Filter

This is the resulting display after configuring the Slew Rate and Bandwidth Filter.

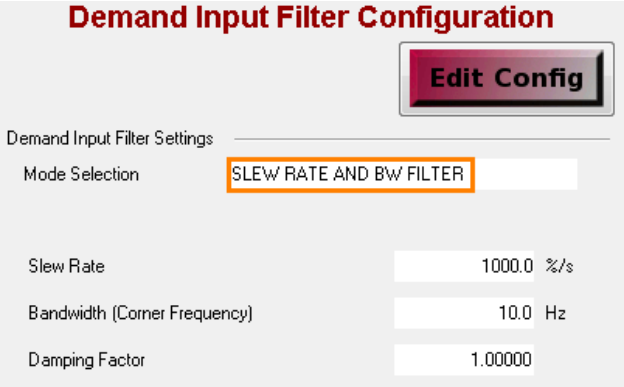


Figure 6-70. Demand Input Slew Rate and Bandwidth Filter

Demand Filter Settings Mode Slew Rate and Noise Filter

This page allows the filter to be set for slew rate and noise combination function.

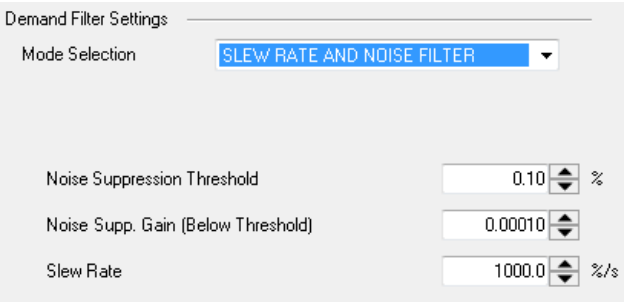


Figure 6-71. Demand Filter Settings Mode Slew Rate and Noise Filter

Demand Input Slew Rate and Noise Filter

This is the resulting display after configuring the Slew Rate and Noise Filter.

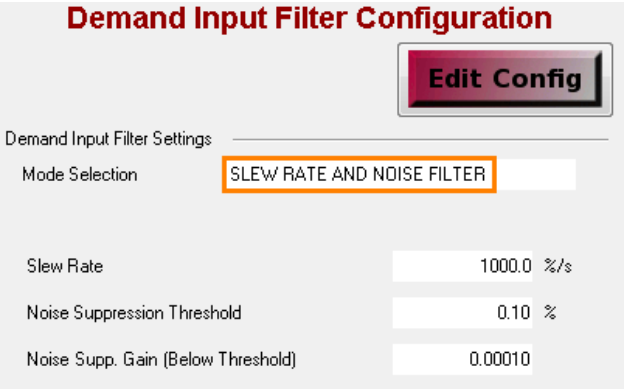


Figure 6-72. Demand Input Slew Rate and Noise Filter

Demand Filter Settings Mode Slew Rate, Bandwidth and Noise Filter

This page allows the filter to be set for slew rate, bandwidth and noise combination function.

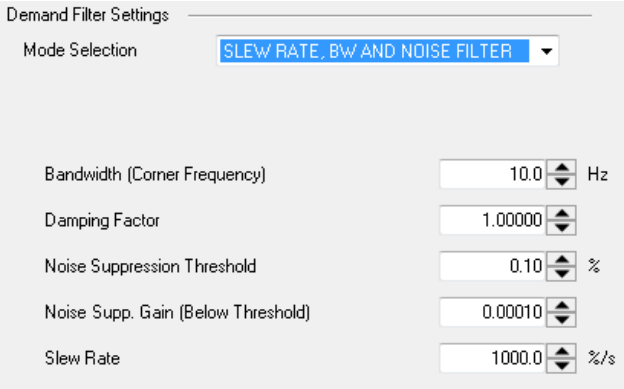


Figure 6-73. Demand Filter Settings Mode Slew Rate, Bandwidth and Noise Filter

Demand Input Slew Rate Bandwidth and Noise Filter

This is the resulting display after configuring the Slew Rate, Bandwidth, and Noise Filter.

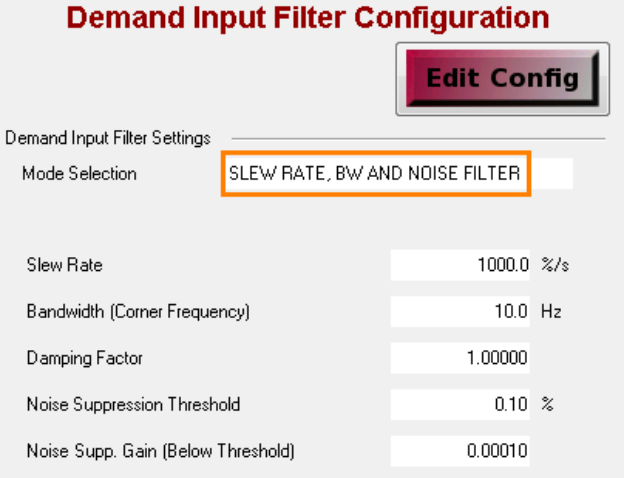


Figure 6-74. Demand Input Slew Rate Bandwidth and Noise Filter

Zero Cut-off Configuration

Currently, this feature is not used in VariStroke II. This is not active and can be disregarded.

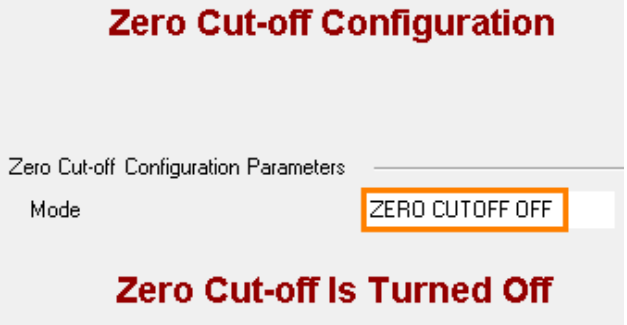


Figure 6-75. Zero Cut-off Configuration

Discrete Inputs Configuration

This tool provides you the ability to select or deselect any combination of five discrete inputs (DI1, DI2, DI3, DI4, and/or DI 5). Each of these options are available with each selection on the dropdown menu except for Turned Off. The remaining options are Shutdown Reset/Reset, AUX3, AUX3 SD+Reset, and Shutdown Reset/Reset Fast. These selections are automated or “Plug and Play” and are described below in detail.

Note: Several special modes can override the availability of these inputs. Specifically, CAN HW ID mode or any valve types using a motor brake can capture one or more of Discrete Inputs.

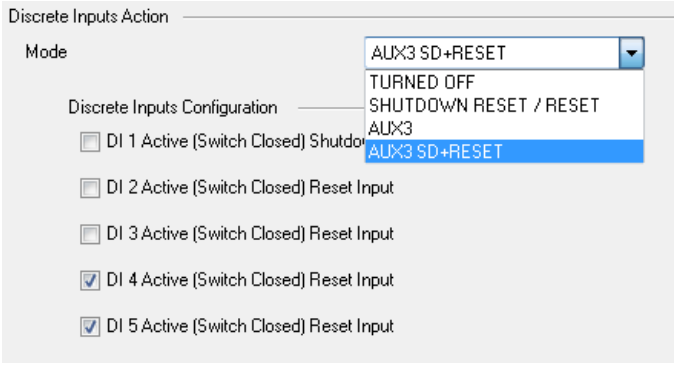


Figure 6-76. Discrete Inputs Configuration

Discrete Inputs Action

The behavior of the discrete input can be selected from the drop-down list on this screen.

- Turned Off
- Shutdown Reset / Reset
- AUX3
- AUX3 SD+Reset

If the Shutdown Reset / Reset mode is selected, the discrete inputs behave as follows:

Table 6-1. Discrete Input

Discrete Input #	Behavior
1	Shutdown / Reset
2	Reset
3	N/A
4	N/A
5	N/A

If Discrete Input 1 is triggered while the VariStroke II is running, a shutdown command will be issued and the VariStroke II will be shut down. If the Discrete Input 1 is triggered while the VariStroke II is shut down, a reset command will be issued and it will be reset to start up and resume its normal operation.

If Discrete Input 2 is triggered while the VariStroke II is running, a reset command will be issued, which does not have any effect on the operation of the VariStroke II. However, if the VariStroke II is shut down the issued reset command will start up the VariStroke II and it will reset the alarm.

Discrete Inputs 3-5 are not used. They have been implemented for future use.

The default behavior of these discrete inputs is that their state is true or positive when the discrete input is active or the input contact is closed. De-selecting the input box will reverse this default behavior. This behavior can be modified individually for each discrete input.

⚠WARNING

Modification of these settings could affect operation of the VariStroke II! An appropriate review of the settings is recommended PRIOR to making these modifications!

⚠WARNING

Modification of these settings could affect operation and plant diagnostics annunciation! An appropriate review of the settings is recommended PRIOR to making these modifications!

Each discrete output can be triggered by any of the process fault and status flags detected within the VariStroke II. To select which diagnostics will trigger the discrete output, select the check box to the left of the desired diagnostic. If more than one diagnostic is selected the discrete output will be triggered if any single condition is detected. This behavior acts as an OR condition.

Shutdown Reset/Reset

An automated response to a signal originating from an outside source that has a 1 second filter. This response will shut down the actuator and reset any error flags that may have been displaying an error.

AUX3

A channel that receives an external input related to an external safety measure being initiated.

AUX3 SD+Reset

A channel that receives an external input related to an external safety measure being initiated which is combined with a shutdown message and a reset message being communicated.

Silt Buster Configuration

This configuration is dependent upon the valve or actuator that is being read by the VariStroke II and the settings are not configurable by the user. This page is a display only and displays servo valve activity which are perturbations (small vibrations) that are introduced into the valve to prevent silt build up. Mode Selection is factory set to Active. The Period is the delay between perturbations and is specified in units of days. Amplitude is displayed in percentages of zero to 100%. Impulse half duration is displayed in milliseconds.

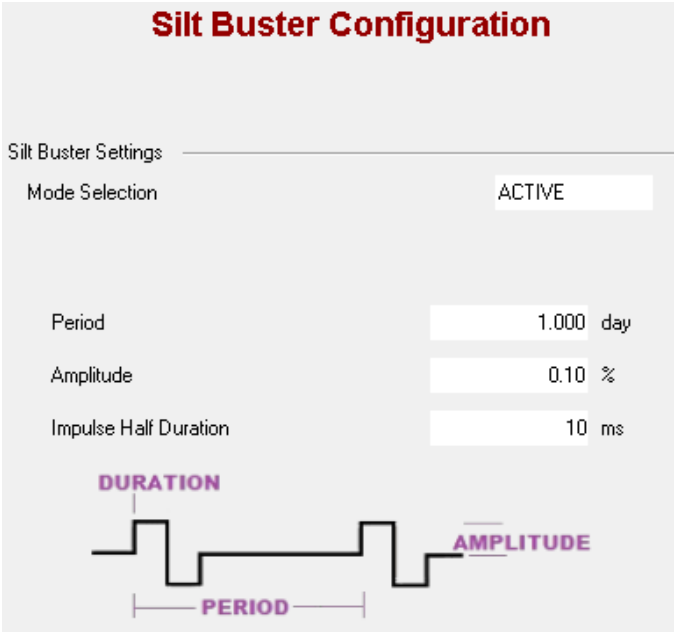


Figure 6-77. Silt Buster Configuration

Current Diagnostic Configuration – Off

With the current diagnostic drop down selected in the “OFF’ position, there are no additional options available.

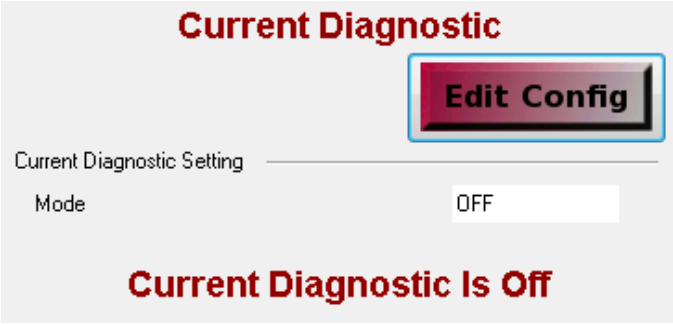


Figure 6-78. Current Diagnostic Off

Current Diagnostic Configuration – On

With the current diagnostic dropdown selected in the ‘ON’ position, the only configuration option is either on or off. Each of the settings available in Current Diagnostic Limit Set 1, 2, and 3 are user configurable.

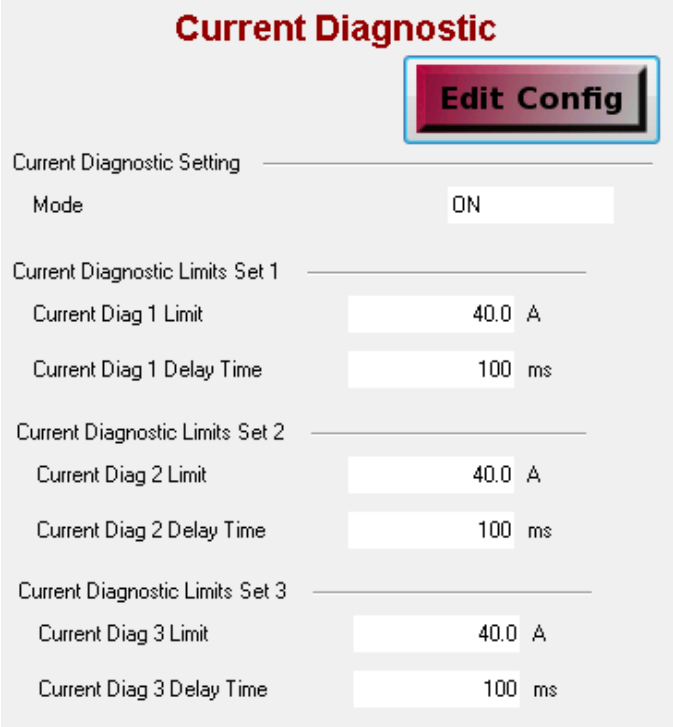


Figure 6-79. Current Diagnostic Configuration – On

Position Error Configuration

This display only functionality has two displays, Hydraulic Cylinder Position Error and Servo Position Error.

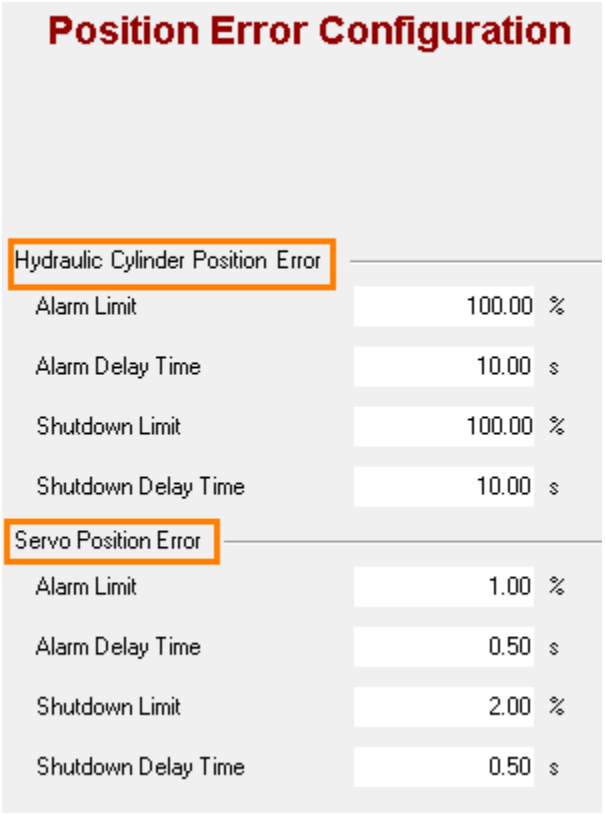


Figure 6-80. Position Error Configuration

Hydraulic Cylinder Error consists of the following:
- Alarm Limit displayed in percent position
- Alarm Delay Time displayed in seconds
- Shutdown Limit displayed in percent position
- Shutdown Delay Time displayed in seconds

Servo Position Error consists of the following:
- Alarm Limit displayed in percent position
- Alarm Delay Time displayed in seconds
- Shutdown Limit displayed in percent position
- Shutdown Delay Time displayed in seconds

Chapter 7. Diagnostics

This chapter includes the pages that are useful for diagnostics. It includes Status Overview, Position Controller, Startup Checks, and Driver pages.

Status Overview Page

The Status Overview page contains the Position Controller (readout only), the VariStroke II Input/Output State (readout only), Analog Values, and the Trend Chart (user configurable). Each of these is described in detail in the sections below.

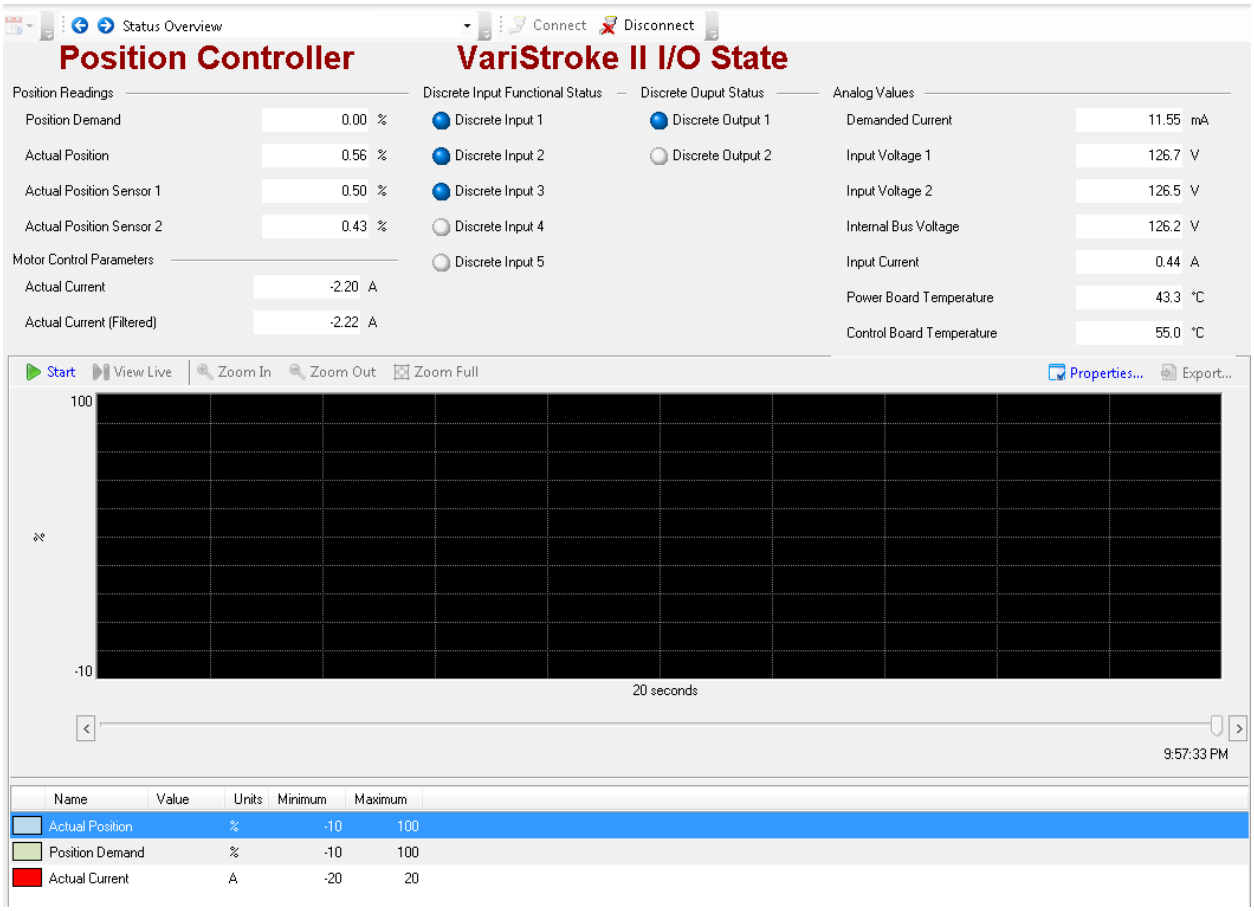


Figure 7-1. Status Overview Page

Position Controller

The Position Controller contains Position Reading and Motor Control Parameter readouts which show the user information necessary to observe the real-time performance of the actuator being controlled by the VariStroke II.

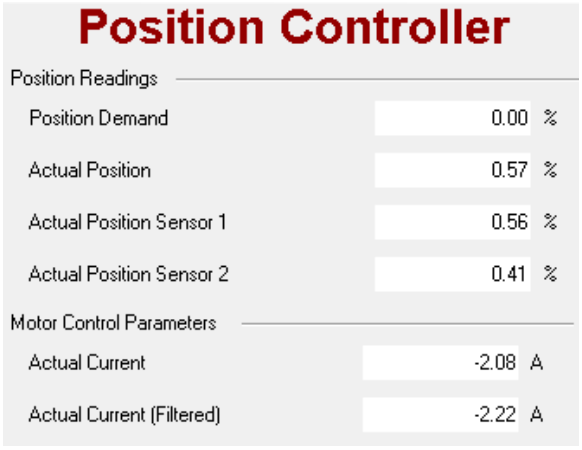


Figure 7-2. Position Controller

VariStroke II Input/Output State and Analog Values

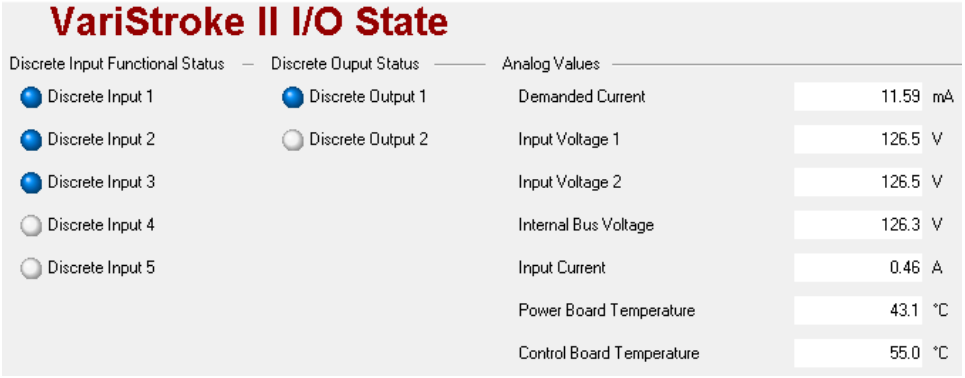


Figure 7-3 VariStroke II Input/Output State and Analog Values

Status Overview Trend Chart

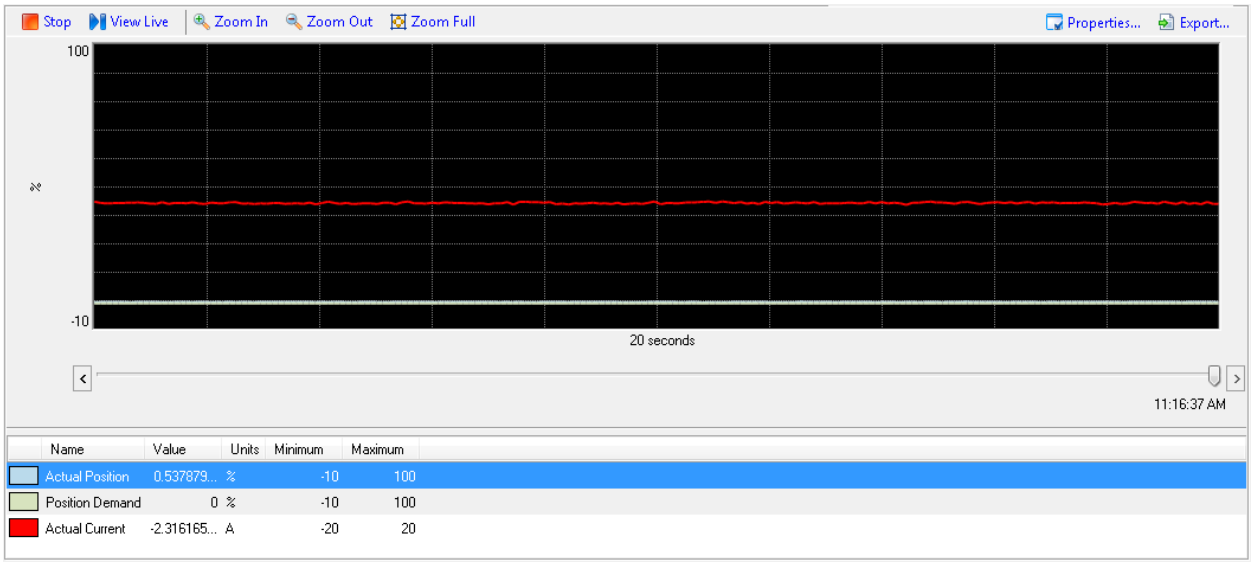


Figure 7-4 Status Overview Trend Chart

Trend Chart Trending Properties Configuration Page

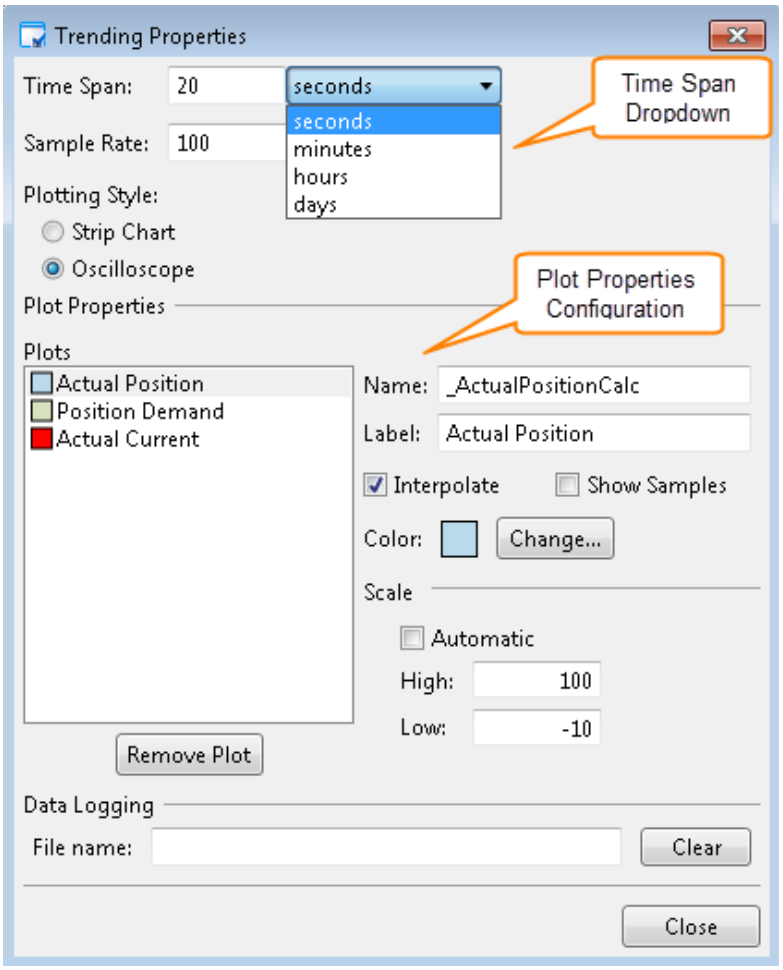


Figure 7-5. Trend Chart Trending Properties Page

Position Controller Page

This page is display only and no configuration actions may be taken by the operator.

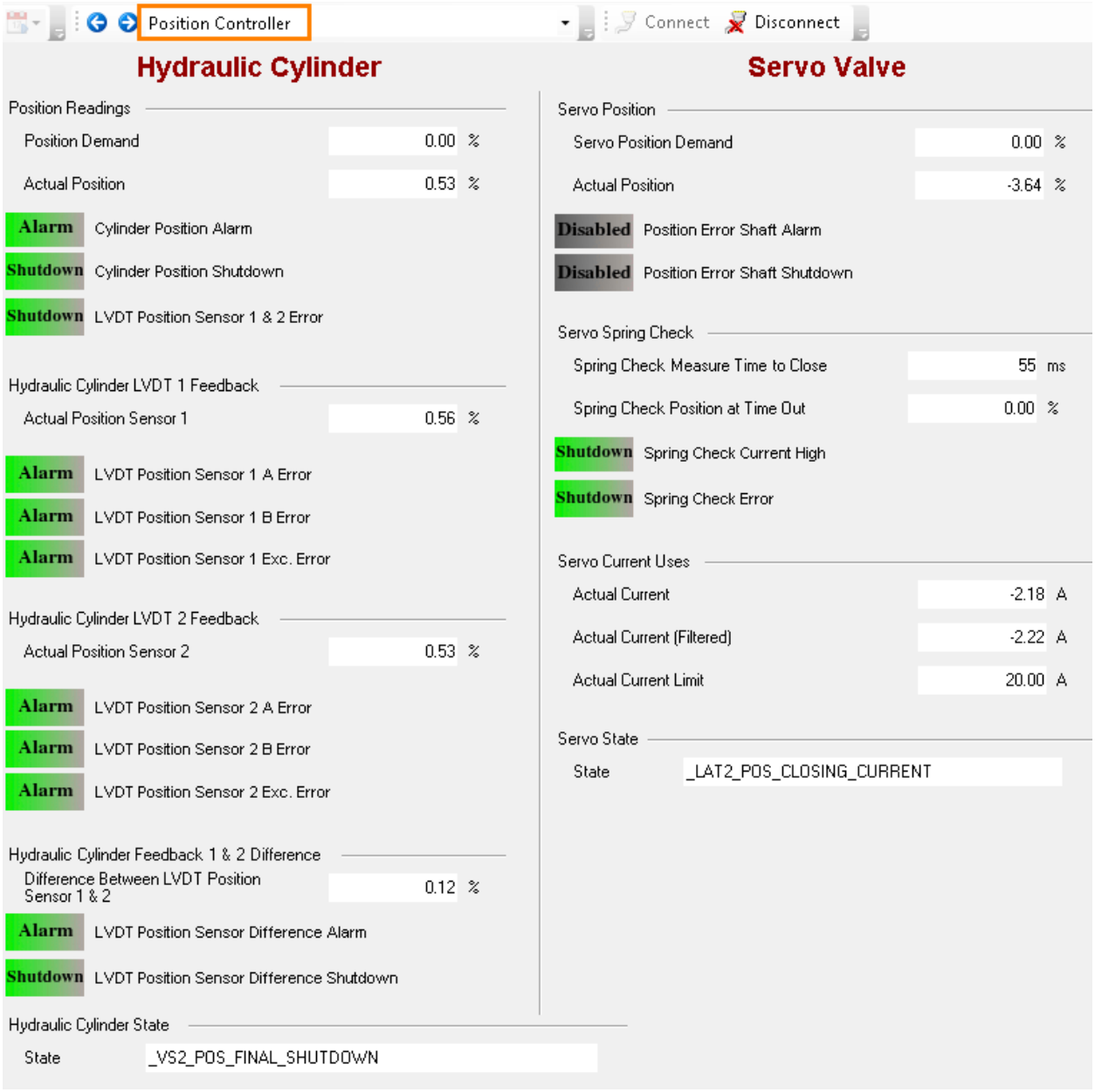


Figure 7-6. Position Controller Page

Hydraulic Cylinder

Hydraulic Cylinder Contains Position Readings, Hydraulic Cylinder LVDT 1 Feedback, Hydraulic Cylinder LVDT 2 Feedback, Hydraulic Cylinder Feedback 1 & 2 Difference, and Hydraulic Cylinder State.

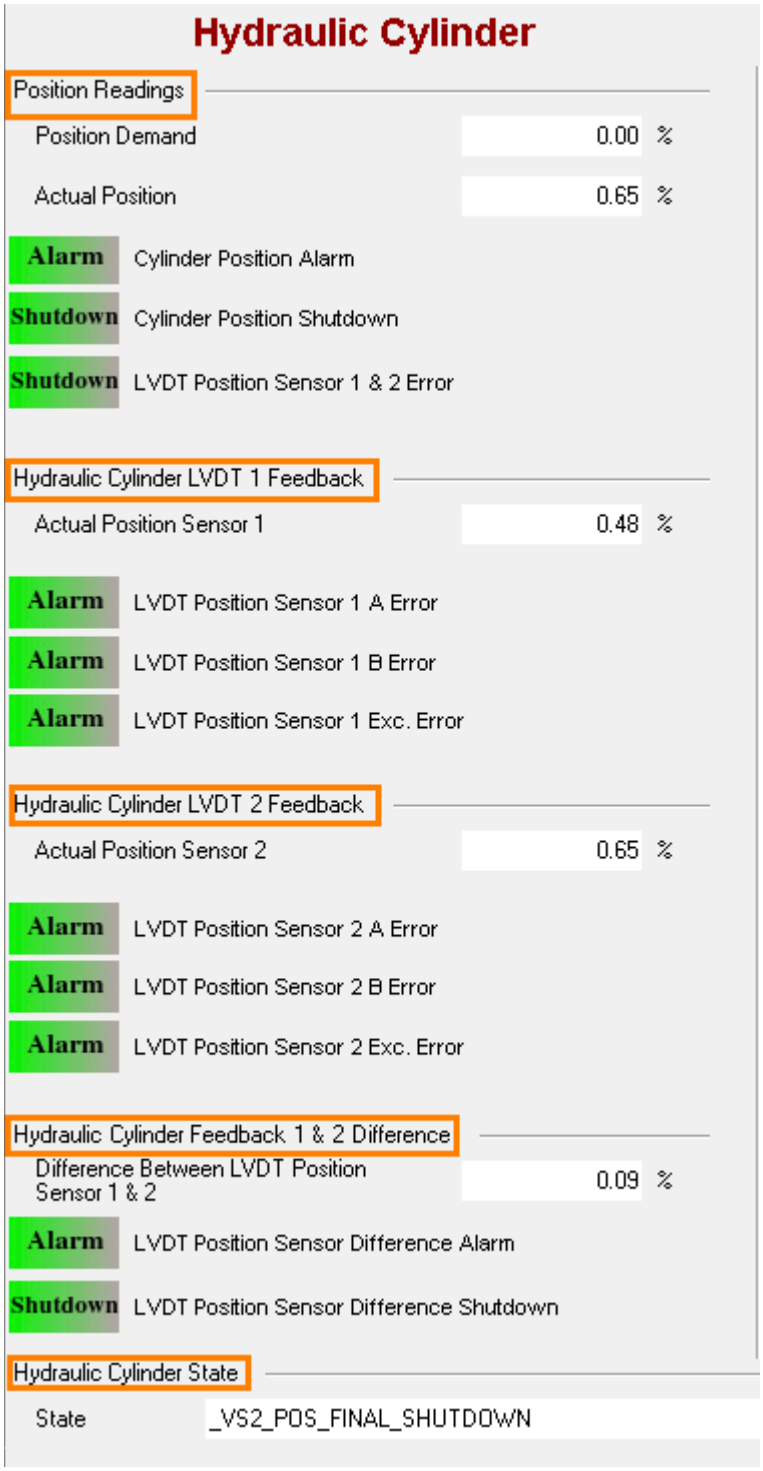


Figure 7-7. Hydraulic Cylinder

Position Readings

- Position Demand is displayed in a value of percentage
- Actual Position is a real-time display in a value of percentage
- Cylinder Position Alarm error flag
- Cylinder Position Shutdown error flag
- LVDT Position Sensor 1&2 error flag

Hydraulic Cylinder LVDT 1 Feedback

- Actual Position Sensor 1 is a real-time display in a value of percentage.
- LVDT Position Sensor 1 A error flag
- LVDT Position Sensor 1 B error flag
- LVDT Position Sensor 1 Excitation error flag

Hydraulic Cylinder LVDT 2 Feedback

- Actual Position Sensor 2 is a real-time display in a value of percentage.
- LVDT Position Sensor 2 A error flag
- LVDT Position Sensor 2 B error flag
- LVDT Position Sensor 2 Excitation error flag

Hydraulic Cylinder Feedback 1 & 2 Difference

- Difference between LVDT Position Sensor 1&2 is a real-time display in a value of percent position.
- LVDT Position Sensor Difference Alarm error flag
- LVDT Position Sensor Difference Shutdown error flag

Hydraulic Cylinder State

The current state of the hydraulic cylinder control algorithm is displayed in the State window.

Servo Valve

This is not user configurable display of the Servo Position, Servo Spring Check, Servo Current Uses, and Servo State.

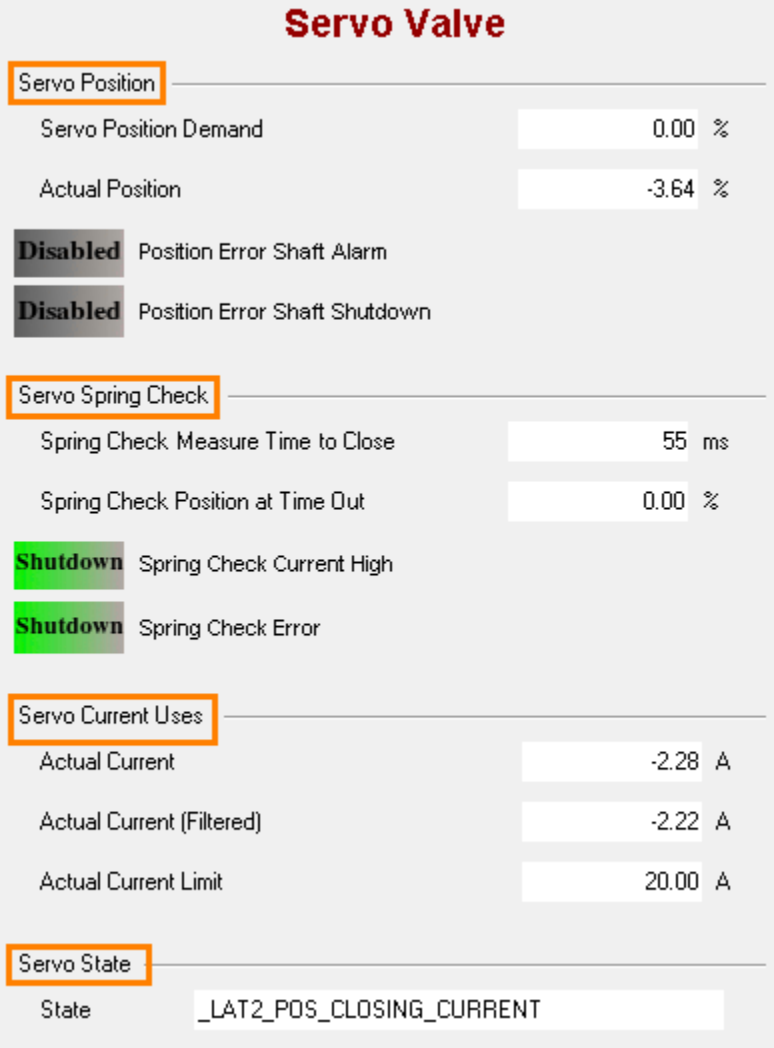


Figure 7-8. Servo Valve

Servo Position

- Servo Position Demand
- Actual Position - real-time display in a value of percentage
- Position Error Shaft Alarm error flag
- Position Error Shaft Shutdown error flag

Servo Spring Check

- Spring Check Measure Time to Close – value displayed in milliseconds
- Spring Check Position at Time Out – value displayed in percentage
- Spring Check Current High error flag
- Spring Check Error flag

Servo Current Uses

- Actual Current - real-time display in a value of amps
- Actual Current (Filtered) - real-time display in a value of amps
- Actual Current Limit - real-time display in a value of amps

Servo State

The current state of the Servo control algorithm is displayed in the State window.

Startup Checks Page

This page is display only and no configuration actions may be taken by the operator. The available fields may change depending on what is applicable for the connected actuator.

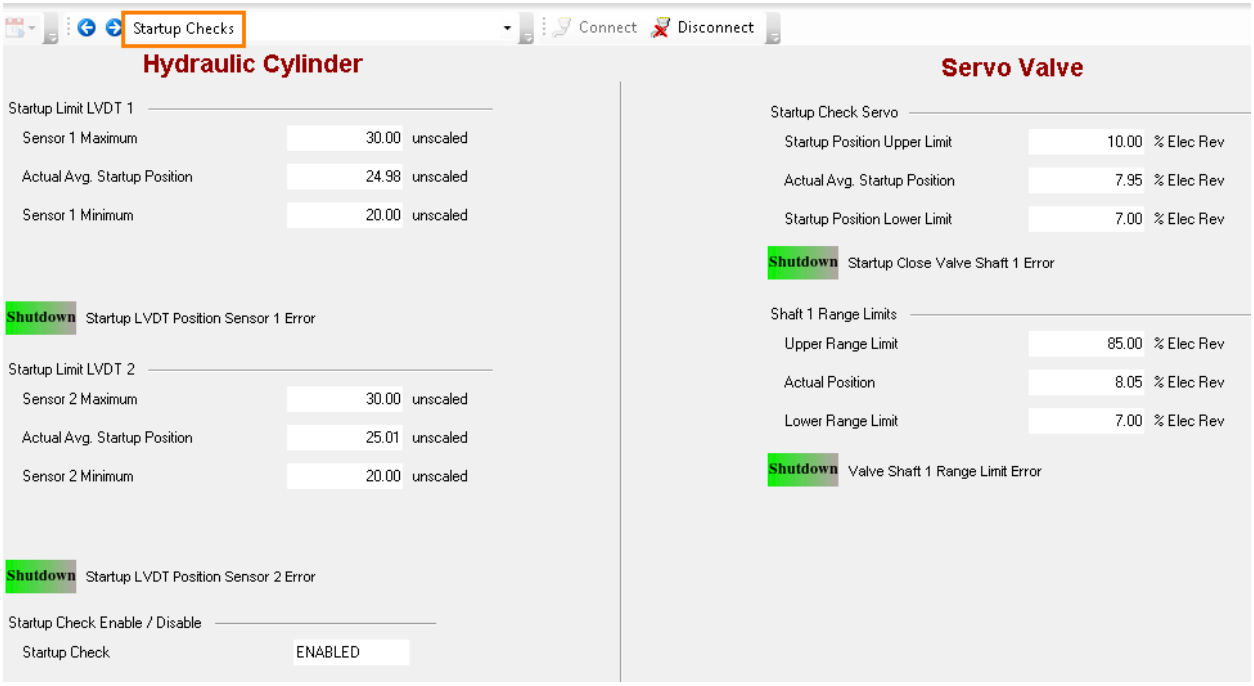


Figure 7-9. Startup Checks

Hydraulic Cylinder

This field is display only and not user configurable. It contains Startup Limit LVDT 1 and LVDT 2 plus a readout if the startup check is enabled or disabled.

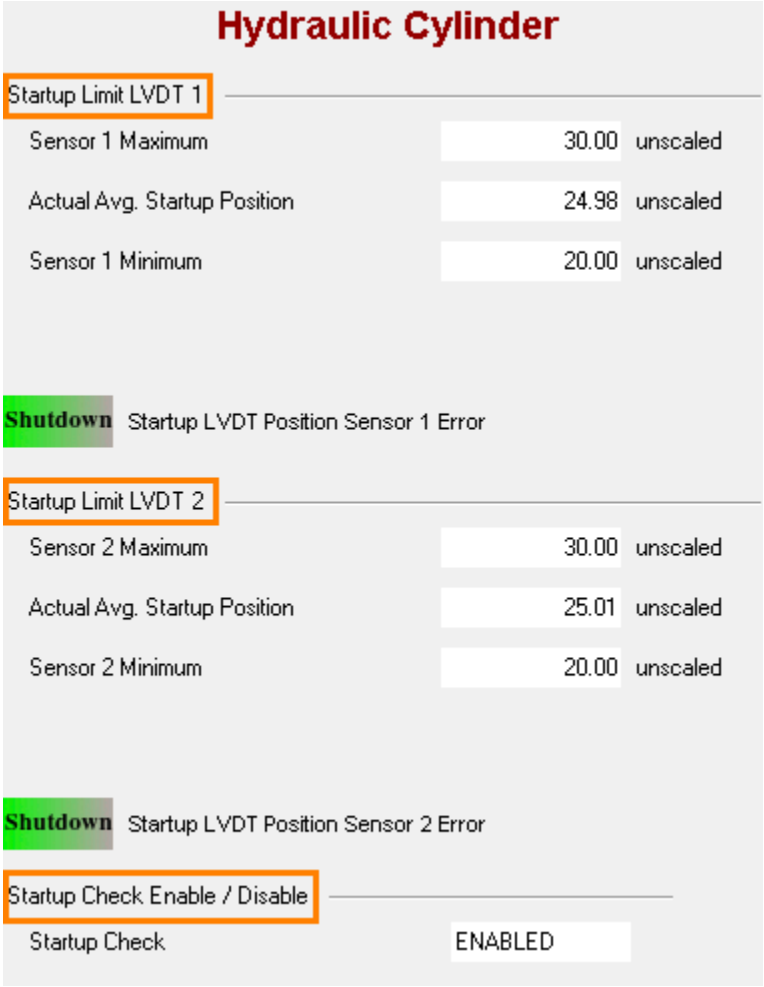


Figure 7-10. Hydraulic Cylinder

Startup Limit LVDT 1

- Sensor 1 Maximum
- Actual Average Startup Position
- Sensor 1 Minimum
- Startup LVDT Position Sensor 1 error flag

Startup Limit LVDT 2

- Sensor 2 Maximum
- Actual Average Startup Position
- Sensor 2 Minimum
- Startup LVDT Position Sensor 2 error flag

Startup Check Enable/Disable

The status of the startup check is displayed in the Startup Check window.

Servo Valve

This field is display only and not user configurable. It contains Startup Check Servo and Shaft 1 Range Limits.



Figure 7-11. Servo Valve

Startup Check Servo

- Startup Position Upper Limit
- Actual Average Startup Position
- Startup Position Lower Limit
- Startup Close Valve Shaft 1 error flag

Shaft 1 Range Limits

- Upper Range Limit
- Actual Position
- Lower Range Limit
- Valve Shaft 1 Range Limit error flag

Driver Page

This page is display only and no configuration actions may be taken by the operator. The available fields may change depending on what is applicable for the connected actuator.

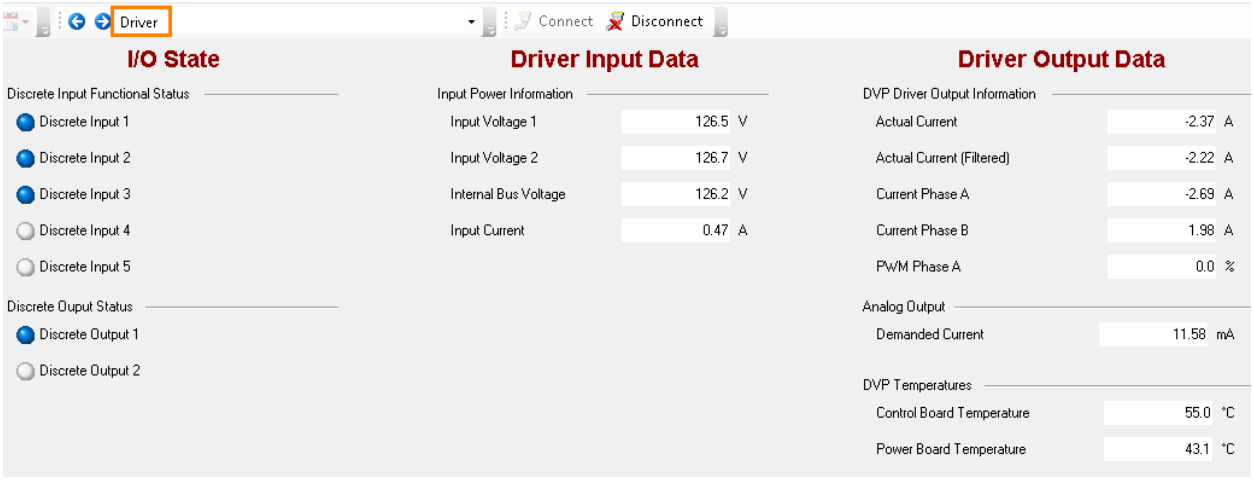


Figure 7-12 Driver Page

Driver Input/Output (I/O) State

This section displays which discrete inputs and output are active (blue) or inactive (gray)

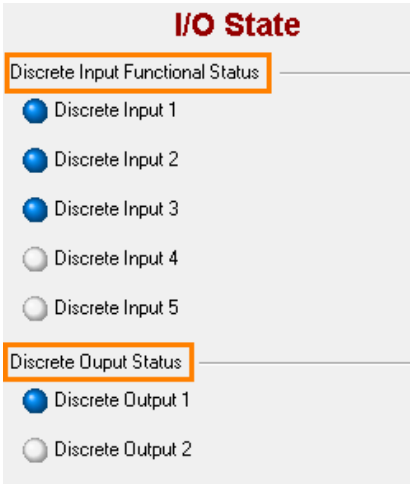


Figure 7-13. Driver Input/Output State

Driver Input Data

This section displays the Input Power Information to include Input Voltages 1 and 2, Internal Bus Voltage, and Input Current (Amps)

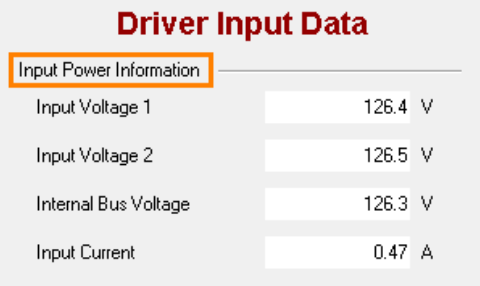


Figure 7-14. Driver Input Data

Driver Output Data

This portion of the Driver page displays VariStroke II Driver Output Information, Analog Output information, and VariStroke II Temperatures information and are described in detail in the sections below the image.

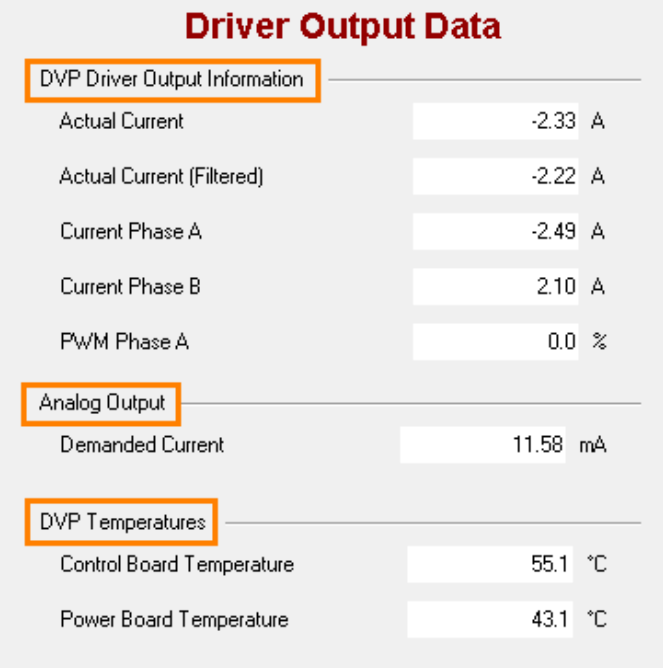


Figure 7-15. Driver Output Data

Driver Output Information

- Actual Current: Displayed in positive or negative value of Amplitude, this represents the instantaneous servo motor current.
- Actual Current (Filtered): Displayed in positive or negative value of Amplitude, this represents, the servo motor current, but with a filter to smooth out the reading. The filtered current reading is intended to be more of a time average of the servo current.
- Current Phase A: Displayed in positive or negative value of Amplitude, this represents the current measured in one of the two sensors in the driver output. It is equal in amplitude (within sensor tolerance) but opposite polarity of the Current Phase B reading.
- Current Phase B: Displayed in positive or negative value of Amplitude, this represents the current measured in one of the two sensors in the driver output. It is equal in amplitude (within sensor tolerance) but opposite polarity of the Current Phase A reading.

- PWM Phase A: Displayed in positive or negative value of Amplitude, this represents the duty cycle setting of the output section and is related to the Actual Current value. It can be used as troubleshooting information if the servo motor is operating correctly.

Analog Output

Demanded Current which is displayed in milliamps and represents the output value selected in the Analog Output Configuration.

Control Board Temperatures

Control Board Temperature which is displayed in degrees Celsius, enables the user to monitor the temperature of the VariStroke II control board and be aware of an over temperature situation or nominal operating temperature. Power Board Temperature is also displayed in degrees Celsius and provides real-time monitoring of the power board temperature.

Resolver and LVDT Diagnostics

The Resolver and LVDT Diagnostics page is a display only page which has Resolver and LVDT Position Sensors Diagnostics including Resolver, LVDT Position Sensor 1, and LVDT Position Sensor 2. Each of these functions will be described in detail below.

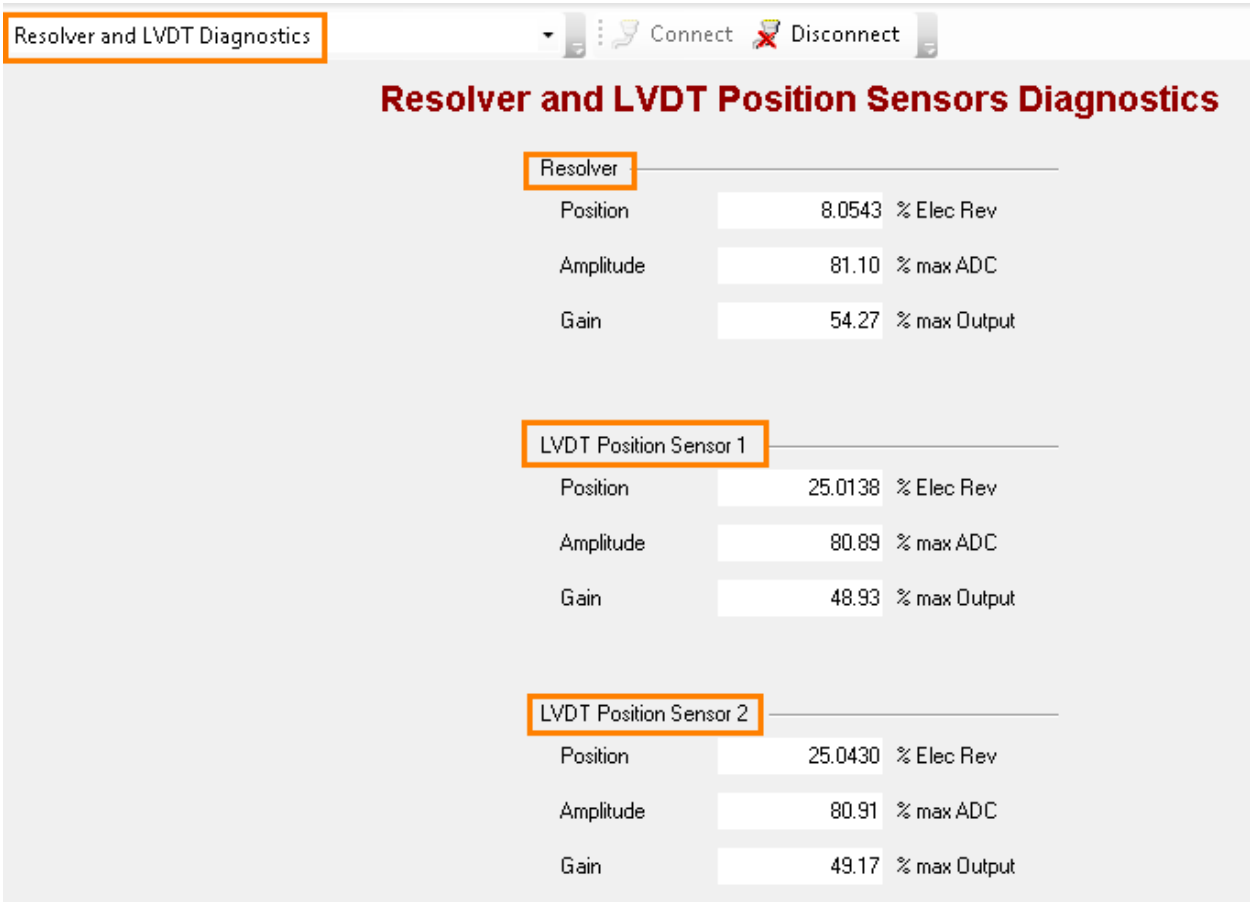


Figure 7-16. Resolver and LVDT Position Sensors Diagnostics

Resolver

This portion of the page displays Position in a value of percentage of Electrical Revolutions, Amplitude in percentage of maximum Analog Digital Converter, and Gain in percentage of maximum output.

LVDT Position Sensor 1

This portion of the page displays Position in a value of percentage of Electrical Revolutions, Amplitude in percentage of maximum Analog Digital Converter, and Gain in percentage of maximum output.

LVDT Position Sensor 2

This portion of the page displays Position in a value of percentage of Electrical Revolutions, Amplitude in percentage of maximum Analog Digital Converter, and Gain in percentage of maximum output.

Chapter 8
Repair and Troubleshooting

WARNING

To prevent possible serious personal injury, or damage to equipment, be sure all electric power, hydraulic pressure, and rod end force have been removed from the actuator before beginning any maintenance or repairs.

WARNING

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the VS-II actuator.

General

The VariStroke-II is warranted to be free from defects in materials and workmanship, when installed and used in the manner for which it was intended, for a period of 36 months from the date of shipment from Woodward.

It is recommended that all repairs and servicing of the VariStroke-II be performed by Woodward or its authorized service facilities.

Use of a cable gland or stopping plug that does not meet the hazardous area certification requirements or thread form or thread size will invalidate the suitability for hazardous locations.

Never remove or alter the nameplate as it bears important information which may be necessary to service or repair the unit.

Hardware Replacement

Woodward recommends the following service spares to be on-site for support services necessary between major overhauls of the actuator. If it is determined that any hardware needs replacement, contact Woodward for instruction manuals, videos and assistance at www.woodward.com. For a complete inspection, overhaul and certification of the unit at the recommended service interval identified by Woodward, please refer to Chapter 8 on service options available for your needs.

The following is a list of service spare kits for on-site support to order when you first install your new unit:

Table 8-1. Service Spare Kit for On-Site Support

Woodward Item Number	Description
9907-1287	V90v-E Hydraulic Servo, Fail Extend
9907-1288	V90V-E Hydraulic Servo, Fail Retract
8923-2020	Manifold Seal Replacement Kit
8923-1325	Shaft Seal Replacement Kit 10 and 12 Inch Bore
8923-2680	LVDT Protection Kit. VSII. 12 Bore, 12 Stroke
8923-2679	LVDT Protection Kit. VSII. 12 Bore, 10 Stroke
8923-2672	LVDT Protection Kit. VSII. 12 Bore, 8 Stroke
8923-2666	LVDT Protection Kit. VSII. 10 Bore, 12 Stroke
8923-2669	LVDT Protection Kit. VSII. 10 Bore, 10 Stroke
8923-2668	LVDT Protection Kit. VSII. 10 Bore, 8 Stroke
1680-1104-10	LVDT, 4 Inch Stroke
1680-1104-15	LVDT, 6 Inch Stroke
1680-1104-20	LVDT, 8 Inch Stroke
1680-1104-25	LVDT, 10 Inch Stroke
1680-1104-30	LVDT, 12 Inch Stroke
1680-1104-35	LVDT, 14 Inch Stroke
1680-1104-40	LVDT, 16 Inch Stroke
1680-1104-45	LVDT, 18 Inch Stroke
8923-2023	LVDT Connector Replacement Kit
8923-2024	DVP Replacement Kit.

Shaft Seal Replacement

Shaft seal replacement kits may be ordered from Woodward for both 10 and 12 inch bore cylinders by item number 8935-1325.

Refer to Figure 8-1 which displays all part numbers in the kit. The location and assembly orientation of the components must be installed as depicted in Figure 8-1.

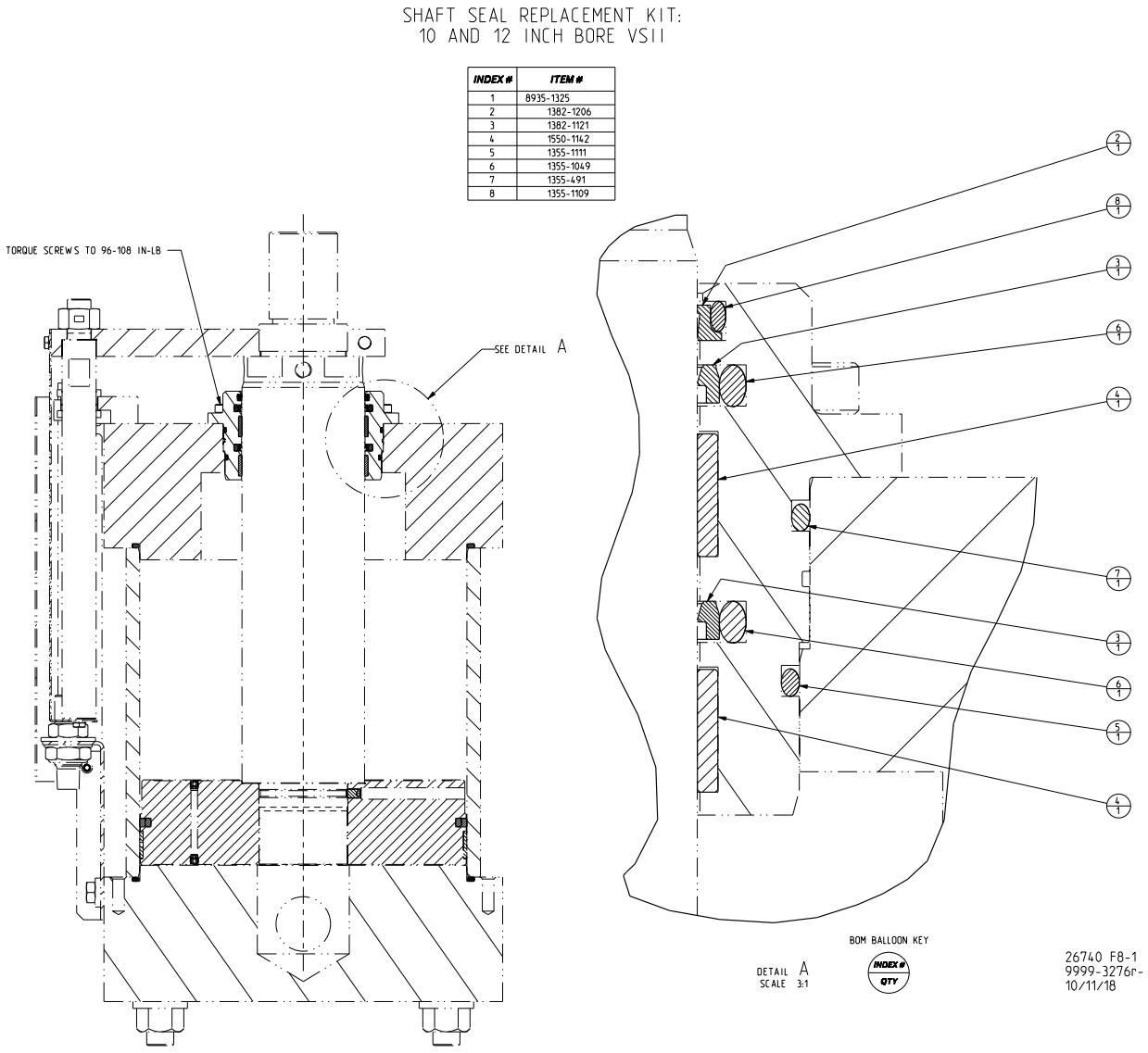


Figure 8-1. Shaft Seal Replacement Kit and Installation

LVDT Protection Kit

Protection Kits may be ordered from Woodward for 10 and 12 inch bore cylinders and for 8, 10 and 12 inch stroke by installation drawing number 9999-1758-11

Refer to figure 8-2 which displays all part numbers in the kit. The location and assembly orientation of the components must be installed as depicted in Figure 8-2

OPTIONS CHART					
SIZE	KIT #1	COVER #6	PLATE #2	SILK SCREEN #5	LENGTH
12 BORE, 12 STROKE	8923-2680	3550-1516-30	3600-2962-2	4349-5265-30	10.185
12 BORE, 10 STROKE	8923-2679	3550-1516-25	3600-2962-2	4349-5265-25	10.185
12 BORE, 8 STROKE	8923-2672	3550-1516-20	3600-2962-2	4349-5265-20	10.185
10 BORE, 12 STROKE	8923-2666	3550-2516-30	3600-2962-1	4349-5265-30	9.185
10 BORE, 10 STROKE	8923-2669	3550-1516-25	3600-2962-1	4349-5265-25	9.185
10 BORE, 8 STROKE	8923-2668	3550-2516-20	3600-2962-1	4349-5265-20	9.185

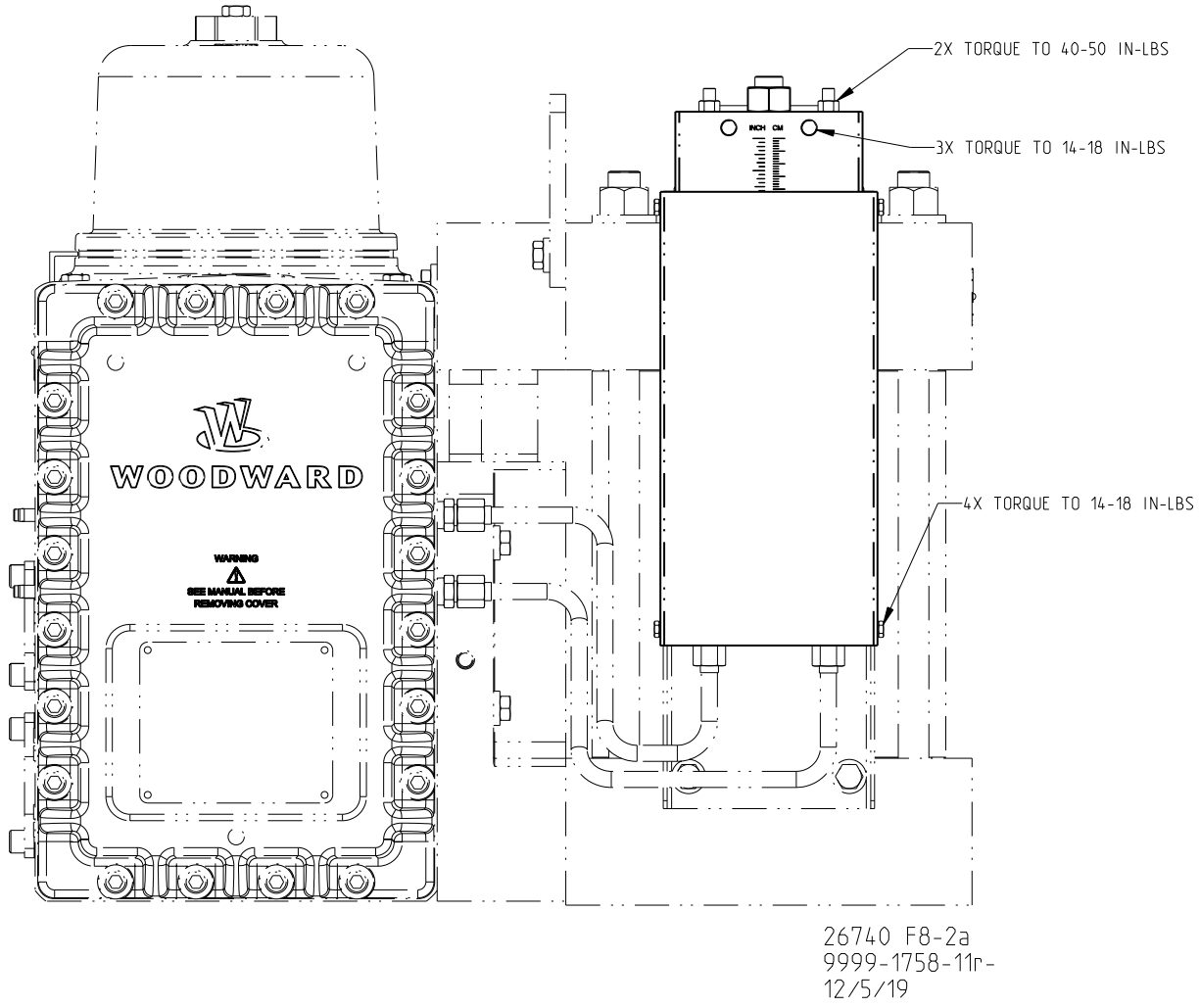
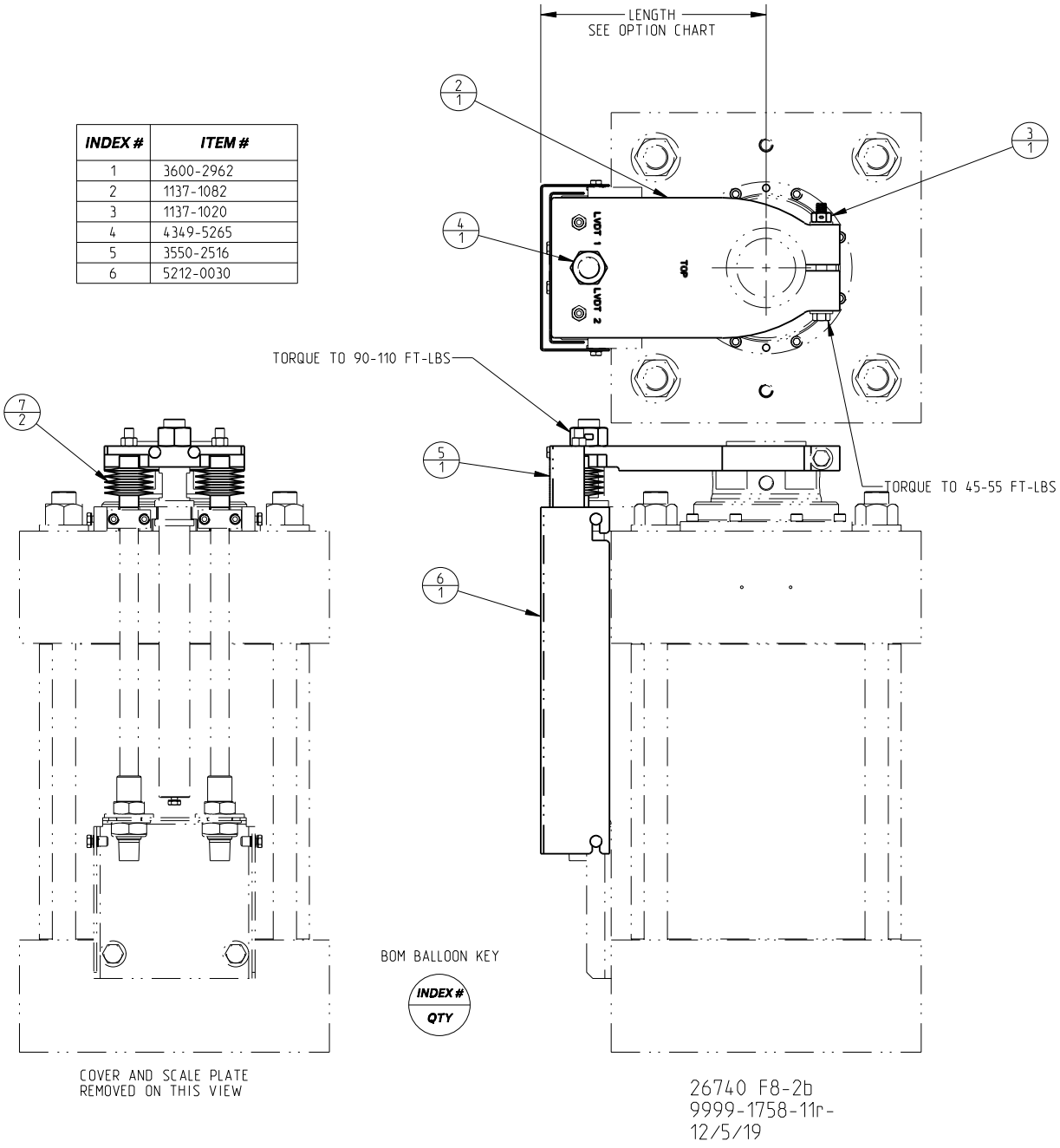


Figure 8-2a. Bellows Protection Kit and Installation



INDEX #	ITEM #
1	3600-2962
2	1137-1082
3	1137-1020
4	4349-5265
5	3550-2516
6	5212-0030

Figure 8-2b. Bellows Protection Kit and Installation (Continued)

Troubleshooting

General

The following troubleshooting guide will help you isolate trouble with the servo valve, hydraulic power cylinder, control circuit board, wiring, and system problems. Troubleshooting beyond this level is recommended ONLY when complete facility control testing is available.

Troubleshooting Procedure

This table is a general guide for isolating system problems. In general, most problems are a result of incorrect wiring or installation practices. Make sure that the system wiring, input/output connections, controls and contacts are correct and in good working order. Complete the checks in order. Each check assumes that the preceding checks have been completed and any problems have been corrected.

The table has been ordered in the sequence of appearance of the diagnostic in the VariStroke-II service tool.

⚠WARNING

Be prepared to make an emergency shutdown of the turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

⚠WARNING

EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

⚠WARNING

ELECTRICAL SHOCK HAZARD—Follow all local plant and safety instructions/precautions before proceeding with Troubleshooting the VS-II Control.

⚠WARNING

The external ground lugs shown on the installation drawing must be properly connected to ensure equipotential bonding. This will reduce the risk of electrostatic discharge in an explosive atmosphere.

Table 8-2. VS-II Troubleshooting Guide – General Faults

Problem	Cause	Remedy
Shutdown Detection: Shutdown command sent by Service Tool, Analog Demand out of range, digital communication protocols (CAN open), Run Enable, or diagnostic.	It is normal for this to occur when a shutdown position has been commanded from an external source. I.E. Service Tool, Digital Communication or Discrete Input. This is also normal when the Analog Demand signal has been turned off or set out of range.	Take away shutdown command and reset VS-II for normal operation. Ensure the VS-II has a valid demand signal (4-20 mA).
	Unexpected command from digital communication.	Take away shutdown command and reset VS-II for normal operation.
	Discrete input (run enable) wiring problem.	Fix wiring problem.
	Run Enable configuration problem.	Ensure the Used / Not Used settings inside the VS-II match the Active/Inactive settings of the controller. Settings can be modified using the Service Tool. If the Run Enable is not used, disable this function using the Service Tool.
	Critical Alarm / Diagnostic triggered a shutdown	Using the Service Tool, view the Alarms / Shutdowns page to determine the fault. Use the remainder of this chapter to determine the cause and solution to the fault.
	Position Sensor Loop Power Output Overloaded (Remote Servo Only)	Ensure position sensor wiring and power supply are connected correctly. See Chapter 3: Cylinder Position Feedback Analog Inputs
Alarm Detection: Alarm or Shutdown has been detected.	Diagnostic triggered an Alarm and/or Shutdown	Using the Service Tool, view the Alarms / Shutdowns page to determine the fault. Use the remainder of this chapter to determine the cause and solution to the fault.
Erratic control	Faulty demand signal/electrical noise on demand signal	Check demand signal connections and wiring for proper shielding. Use cables/conduits that are separated from power wiring
Slow Slew Rates	Loss or reduction in hydraulic supply pressure	Ensure that hydraulic pressure at the servo valve does not drop more than 10% during a full slew. Consider adding a high volume hydraulic accumulator to the supply line adjacent to the VariStroke. See Chapter 2 : Hydraulic Specifications

Table 8-3. I/O Diagnostics

Problem / Alarm	Cause	Remedy
Power-up Reset Detection: CPU reset by a power up event.	It is normal for the Power Up Reset diagnostic to occur upon power up of the VS-II (or after momentary power interruption).	Issue a reset to the VS-II.
	If this occurs while the VS-II is powered, and the diagnostic is triggered during a fast position transient, most likely the power infrastructure is not delivering the power needed.	During transient: Check power supply, terminal voltage at the VS-II during a 0-100% position transient, check wire gauge and length, fuses or other resistive components in the power supply system.
Watchdog Reset Detection: CPU reset without a power up event.	It is normal for this to occur after the software is updated.	Issue a reset to the VariStroke-II.
	A software lockup occurred.	If the cause is not a software update: Contact Woodward Technical Support.
Ext. Shutdown Position Detection: Command sent by Digital communication protocols like: EGD, CANopen.	It is normal for this to occur when a shutdown position has been commanded from an external source, i.e. Service Tool, or Digital Communication.	Take away command and reset VariStroke-II for normal operation.
	Unexpected command from digital communication.	Take away command and reset VariStroke-II for normal operation.
External Shutdown Detection: Command sent by Service Tool or digital communication protocols like: EGD, CANopen or discrete inputs.	It is normal for this to occur when a shutdown position has been commanded from an external source, i.e. Service Tool, Digital Communication or Discrete Input.	Take away command and reset VariStroke-II for normal operation.
	Unexpected command from digital communication.	Take away command and reset VariStroke-II for normal operation.
	Discrete input wiring problem.	Fix wiring problem.
	Discrete input configuration problem.	Ensure the Active/Inactive settings inside the VariStroke-II match the Active/Inactive settings of the controller. Settings can be modified using the Service Tool. If the Discrete Input is not used, disable this function using the Service Tool.
Auxiliary 3 SD Position	Auxiliary 3 Shutdown Position circuit is open. Auxiliary 3 configured incorrectly	Ensure the Aux 3 Active/Inactive settings inside the VS-II match the Active/Inactive settings of the controller. Settings can be modified using the Service Tool in Position Controller Config/ Discrete inputs Config section If the Aux 3 is not used, disable this function using the Service Tool by checking Active (open contact=no shutdown)

Table 8-4. Demand Input Configuration

Problem	Cause	Remedy
Analog Input High Detection: The analog demand input is above the diagnostic threshold. This is a user configurable parameter. Typically 22 mA.	Short in wiring to external voltage.	Check wiring for shorts to positive voltages.
	Control system 4 to 20 mA output has failed high.	Check the current to the analog input to the VS-II. Fix control system.
	Incorrect user configurable parameter in the electronics module for the max input diagnostic.	Verify the 4–20 mA Diagnostic Range: High Limit Value using the VS-II Service Tool.
	VS-II internal electronics failure.	Contact Woodward Technical Support for further assistance.
Analog Input Low Detection: The analog input is below the diagnostic threshold. This is a user configurable parameter. Typically 2 mA.	Wiring is disconnected or loose.	Check terminals and connections.
	Short in wiring to external voltage.	Check wiring for shorts to positive voltages or ground
	Control system 4 to 20 mA output has failed high.	Check the current to the analog input to the VS-II. Fix control system.
	Incorrect user configurable parameter in the electronics module for the max input diagnostic.	Verify the 4–20 mA Diagnostic Range: High Limit Value using the VS-II Service Tool.
	VS-II internal electronics failure.	Contact Woodward Technical Support for further assistance.
Digital Com 1 Error Detection: When you have selected the CANopen communication as the input, and the fast messages (fast data and synch) from the control system to port 1 are received slower than the timeout parameter setup in the CANopen configuration this flag will be set.	The CANopen ID's in the control system and in the DVP are not the same.	Change the DVP or Control system Node ID's and make them the same. Make sure every DVP on the network has a unique Node ID.
	The CANopen baud rate in the control system and the DVP are not the same.	Change the DVP or control system baud rate so they are the same. All nodes on a network need to have the same baud rate.
	Time out time is set too fast for the rate group you are running in the control system.	Confirm that the timeout value is longer than the rate group settings. For example: values used are 10 msec rate group, timeout value 40msec Check if this timeout is acceptable from a prime mover operation and safety.
	CANopen termination resistors incorrect or not installed.	Install or correct the termination resistors, see CANopen installation part of the manual.
	CANopen wiring issue, lost connectors or defective wires.	Measure and/or inspect the cable and cable connections and repair/replace defective cables and cable connections
	CANopen wire type incorrect (too high capacitive values)	Select approved CANopen cables. See installation instruction section of the manual.
	CANopen wire(s) are too long, and/or stub are too long.	Place components closer, or reduce the baud rate. See installation section of the manual. Check that you do not overload the CANopen network if you reduce the baud rate. See CANopen timing section of the manual.

Problem	Cause	Remedy
Digital Com 2 Error Detection: When you have selected the CANopen communication as you input, and the fast messages (fast data and synch) from the control system to port 2 are received slower than the timeout parameter setup in the CANopen configuration this flag will be set.	The CANopen ID's in the control system and in the DVP are not the same.	Change the DVP or Control system Node ID's and make them the same. Make sure every DVP on the network has a unique Node ID.
	The CANopen baud rate in the control system and the DVP are not the same.	Change the DVP or control system baud rate so they are the same. All nodes on a network need to have the same baud rate.
	Time out time is set too fast for the rate group you are running in the control system.	Confirm that the timeout value is longer than the rate group settings. For example: values used are 10 msec rate group, timeout value 40msec Check if this timeout is acceptable from a prime mover operation and safety.
	CANopen termination resistors incorrect or not installed.	Install or correct the termination resistors, see CANopen installation part of the manual.
	CANopen wiring issue, lost connectors or defective wires.	Measure and/or inspect the cable and cable connections and repair/replace defective cables and cable connections
	CANopen wire type incorrect (too high capacitive values)	Select approved CANopen cables. See installation instruction section of the manual.
	CANopen wire(s) are too long, and/or stub are too long.	Place components closer, or reduce the baud rate. See installation section of the manual. Check that you do not overload the CANopen network if you reduce the baud rate. See CANopen timing section of the manual.
Digital Com 1 & 2 And/Or Analog Backup Error Detection: This flag will be set when all communication is lost Com 1 and Com 2 in dual CANopen mode -or- Com 1 and Analog backup in single CANopen with backup.	When this flag is set, you also will have the Digital Com 1 and 2 flag set (if dual CANopen is selected) or the Digital com 1 and Analog high or analog low flag set (if single CANopen with backup)	Follow the Cause's and Remedy's for these flags. These are explained in detail in this table.
Digital Com Analog Tracking Alarm Detection: When the difference between the demanded position on the CANopen port 1 and the analog backup is larger than the difference value parameter for longer than the time value parameter, this flag will be set. In Dual CANopen mode the difference between port1 and port 2 demanded position is calculated.	The analog system has an error that has not resulted in a high or low error flag being set.	Correct the analog system.
	The Control system does not keep the two redundant signals the same. (The values are scaled different or from a different source in the program, or the timing is incorrect.)	Debug and correct control system.
	If the analog backup is used, the analog system accuracy is outside the alarm value set.	Make alarm value bigger if acceptable for this application or make analog system accuracy better.
	Too long of a delay between analog and CANopen when values are set the same.	Determine the delay and if acceptable for the application, correct the difference time delay time in the DVP.

Problem	Cause	Remedy
Digital Com Analog Tracking Shutdown Detection: When the difference between the demanded position on the CANopen port 1 and the analog backup is larger than the difference value parameter for longer than the time value parameter this flag will be set. In Dual CANopen mode we will calculate the difference between port1 and port 2 demanded position.	The analog system has an error that has not resulted in a high or low error flag being set.	Correct the analog system.
	The Control system does not keep the two redundant signals the same. (The values are scaled different or from a different source in you program, or the timing is in correct.)	Debug and correct control system.
	If the analog backup is used, the analog system accuracy is outside the alarm value set.	Make alarm value bigger if acceptable for this application or make analog system accuracy better.
	Too long a delay between analog and CANopen when values are set the same.	Too long a delay between analog and CANopen when values are set the same.

Table 8-5. Environmental Diagnostics

Problem	Cause	Remedy
Electronics Temp. High Detection: The Control Board temperature sensor indicates a temperature above 140° C.	The ambient temperature of the driver is higher than allowed by specification.	Reduce ambient temperature to within specification limits.
	The Temperature sensor is defective.	Contact Woodward Technical Support for further assistance.
Electronics Temp. Low Detection: The Control Board temperature sensor indicates a temperature below –45° C.	The ambient temperature of the driver is lower than allowed by specification.	Increase ambient temperature to within specification limits.
	The Temperature sensor is defective.	Contact Woodward Technical Support for further assistance.
Driver Temp. High Detection: The heat sink temperature is above 115 Degrees C	The ambient temperature of the driver is above specification.	Reduce ambient temperature to within specification limits.
	The Temperature sensor is defective.	Contact Woodward Technical Support for further assistance.
Driver Temp. High Limit Detection: The heat sink temperature is above 130 Degrees C.	The ambient temperature of the driver is far above specification.	Reduce ambient temperature to within specification limits.
		Check if there are other heat sources on the mounting surface heating up the ambient temperature around the VariStroke-II.
		Check if the driver is using more current than normal to position the valve.
Driver Temp. Low Limit Detection: The heat sink temperature is below –45° C.	The ambient temperature of the driver is far above specification. The ambient temperature of the driver is below specification.	Increase ambient temperature to within specification limits.
Driver Temp. Sensor Failed Detection: The temperature sensor is at min or max.	The temperature sensor has failed.	Contact Woodward Technical Support for further assistance.

Table 8-6. Input Voltage Diagnostics

Problem	Cause	Remedy
Input Voltage 1 or 2 High Detection: The measured voltage at Input 1 or 2 is higher than the specification limit**:** 150 VDC	Power supply and/or setting incorrect for application.	Check input voltage and correct voltage to within specification limits.
	Excessive charging voltage and/or battery failure.	
	Power supply has problem regulating the voltage at the input terminals during high current transients.	Determine if the power supply is of the correct type to be used with the VariStroke-II. See power supply section in this manual.
Input Voltage 1 or 2 Low Detection: The measured input voltage on input number 1 is lower than the specification limit**:** 90 VDC	Power is not connected to this input. (Dual inputs are provided for redundancy)	If redundancy is not required, jumper power to both inputs.
	The power supply is not capable of delivering the transient current.	Determine if the power supply is capable of delivering the transient current. See power supply section in this manual.
	The Power supply wiring is incorrectly sized for the required transient current.	Determine if the wiring is according to the manual.
	Excessive resistance in the wiring due to fuses, connectors, etc. that limits the max transient current to the driver.	Determine if there is excessive resistance in the power supply wiring and correct. Contact Woodward Technical support for appropriate procedure to evaluate the power infrastructure.

Table 8-7. Valve Type Selection Diagnostics

Problem	Cause	Remedy
Auto Detect Error Detection: This diagnostic is only enabled when the VariStroke-II has been configured for auto detection. (See Auto detection Section) This diagnostic is set when: The VariStroke-II fails to communicate with the ID module due to write or read problems or the calibration records in the ID module are corrupted (CRC16 failure) The VariStroke-II fails to write the calibration records into the non-volatile memory.	Failure to read the ID module on the valve/actuator system.	See associated diagnostics on the Actuator Type Selection Screen in the Service Tool. If “ID Module Not Detected” is annunciated, check wiring to the ID module.
	ID module calibration record corrupted.	See Fault Status/Configuration Overview Internals Screen in the VariStroke-II Service Tool. If “Invalid Parameter(s)” is annunciated, the calibration records are corrupt in the ID module. Contact Woodward Technical Support for a copy of the correct parameter file. Servo valve Serial Number will need to be provided.
	VariStroke-II non-volatile memory error.	See Fault Status/Configuration Overview Internals screen in the VariStroke-II Service Tool. If “EEPROM Read/Write Failed” or “Invalid Parameter(s)” is annunciated Contact Woodward Technical Support ***IMPORTANT*** **A reset will force the VariStroke-II to retry auto detection of the connected valve.**

Problem	Cause	Remedy
Type / Serial Number Error Detection: If during power up the VariStroke-II detects a valve/actuator system with a different serial number or valve type this diagnostic will be annunciated.	User has connected a different valve to the VariStroke-II.	See the Actuator Type Selection Screen in the Service Tool. Verify the "Type" and "Serial Number" match the valve/actuator system connected to the VariStroke-II.
	User has loaded a parameter set to the VariStroke-II that does not match this valve/actuator system serial number.	Use the auto detection function or down load the actuator specific calibration file into the VariStroke-II for the correct serial number. **⚠WARNING** **Operation of the VariStroke-II with incorrect parameter files can cause personal injury and/or property damage.**
	ID module factory calibration incorrect for this valve type / serial number.	Contact Woodward Technical Support for further assistance.
ID Module Not Detected Detection: During power up, the control model the ID Module cannot be read.	Failure to read the ID module on the valve/actuator system.	See associated diagnostics on the Actuator Type Selection Screen in the Service Tool. If "ID Module Not Detected" is annunciated, check wiring to the ID module.
	ID module calibration record corrupted.	See Process Fault & Status Overview Internals Screen in the VariStroke-II Service Tool. If "Invalid Parameter(s)" is annunciated the calibration records are corrupt in the ID module. Contact Woodward Technical Support for a copy of the correct parameter file. Valve Serial Number will need to be provided.
	The valve does not have an ID module.	Contact Woodward Technical Support for a copy of the correct parameter file. Valve Serial Number will need to be provided. ***NOTICE*** **The correct parameter file must be uploaded into the VariStroke-II. Any reset command via the VariStroke-II Service Tool or any other applicable method (e.g. Discrete Input) will force the driver to use the internally stored parameters. This will allow the VariStroke-II to function without an ID module.** **⚠WARNING** **It is the user's responsibility to make sure the correct parameters are stored in the VariStroke-II! Operation of the VariStroke-II with incorrect parameter files can cause personal injury and/or property damage.**

Problem	Cause	Remedy
Incorrect Power Board Detection: During power up the VariStroke-II checks the ID module to determine the power board needed for the valve/actuator system. If the power board ID required and the power board detected do not match, this diagnostic will be annunciated.	Valve/actuator system does not match the VariStroke-II power board.	Contact Woodward Technical Support to determine the correct VariStroke-II and valve/actuator system for your application.
ID Module Version Not Supported Detection: This diagnostic is annunciated if the actuator type reported by the valve/actuator system in the ID module is not supported by the VariStroke-II software.	VariStroke-II software does not support ID module version.	Update Software. Contact Woodward Technical Support for upgrade to the latest revision of the VariStroke-II software.
Type Not Supported Detection: This diagnostic is annunciated if the actuator type reported by the valve/actuator system in the ID module is not supported by the VariStroke-II software.	VariStroke-II software does not support this actuator type.	Update software. Contact Woodward Technical Support for upgrade to the latest revision of the VariStroke-II software.
Control Model Not Running	This flag is not an actual error, it indicates that the control model has not been started yet.	Wait until the control model is started and this flag will turn off automatically.
		Check other flag(s) to determine why the control model has not started

Table 8-8. VariStroke-II (Feedback) Faults

Problem	Cause	Remedy
LVDT Position Sensor 1 or 2 , (coil)A or B Error Detection: Coil voltage outside of 0.3 to 0.9 VRMS	Feedback sensor wiring fault or failed sensor coil.	Check all connections between the LVDT and the Electronic Control; check for any impediment to motion. Check coil resistance If problem persists, service will be required.
Start-up LVDT Position 1 Error Detection: During manufacturing at the factory, the LVDT is mechanically adjusted for a nominal min stop value of 25.0. During power up and initialization the VariStroke-II verifies that the actuator is located at the min stop. This diagnostic occurs if LVDT Position Sensor 1 is not within range given by the Sensor 1 Minimum and Sensor 1 Maximum values.	Calibration values specific to the valve/actuator serial number are incorrect as stored in the VariStroke-II.	Use the auto detection function (for valves equipped with the ID module) or down load the calibration file (based on serial number and calibration date) for the VariStroke-II.
	The Valve is not closed during the start-up check.	Review the results shown on the Startup Checks Screen. If this occurs intermittently, it may be necessary to check for high operating friction in the steam valve, linkage, or actuator. Contact Woodward for further assistance.
	The wiring to the LVDT is not connected.	Check the LVDT wiring.
	The LVDT setting has moved	Contact Woodward Technical Support for further assistance.

Problem	Cause	Remedy
Start-up LVDT Position 2 Error Detection: During manufacturing at the factory, the LVDT is mechanically adjusted for a nominal min stop value of 25.0. During power up and initialization the VariStroke-II verifies that the actuator is located at the min stop. This diagnostic occurs if LVDT Position Sensor 2 is not within range given by the Sensor 2 Minimum and Sensor 2 Maximum values.	Calibration values specific to the valve/actuator serial number are incorrect as stored in the VariStroke-II.	Use the auto detection function (for valves equipped with the ID module) or down load the calibration file (based on serial number and calibration date) for the VariStroke-II.
	The Valve is not closed during the start-up check.	Review the results shown on the Startup Checks Screen. If this occurs intermittently, it may be necessary to check for high operating friction in the steam valve, linkage, or actuator. Contact Woodward for further assistance.
	The wiring to the LVDT is not connected.	Check the LVDT wiring.
	The LVDT setting has moved	Contact Woodward Technical Support for further assistance.
Spring Check Current High Detection: During the startup spring test the VariStroke-II will check that the current to be below a given threshold at a set position where the startup check is started. This is to make sure that there is no fluid flow through the servo valve that will change the time it takes to close the servo by spring. If the current is not below the threshold this flag will be set.	Oil contamination levels above specification limits causing servo valve sticking.	Ensure oil supply meets specified cleanliness requirements. Replace / filter oil and flush the valve with clean oil. If problem persists, service may be required. Contact Woodward Technical Support for further assistance.
	There is fluid flow through the servo valve	Turn off hydraulic supply and restart VariStroke-II.
Spring Check Failed Detection: During startup check the VariStroke-II controller will open the servo valve (without moving the final cylinder) and then turn off the driver power to the servo. The return spring will close the valve. The time until the valve reaches zero % position is measured. If this time is longer than the set time parameter, this flag will be set and assume the return spring was not capable of closing the servo.	Broken return spring	Service is required. Contact Woodward Technical Support for further assistance.
	Servo valve seizure	Ensure oil supply meets specified cleanliness requirements. Replace / filter oil and flush the valve with clean oil. If problem persists, service may be required. Contact Woodward Technical Support for further assistance.
LVDT Position Sensor Difference Alarm Detection: The difference between the feedback signals of LVDT Position Sensor 1 and LVDT Position Sensor 2 is greater than the set alarm limit value.	Alarm Limits too set too tight	Set alarm range wider. Go to Configure and Calibration, Advanced.
	LVDT not calibrated correctly	Sensors need calibration. Contact Woodward Technical Support for further assistance.
LVDT Position Sensor Difference Shutdown Detection: The difference between the feedback signals of LVDT Position Sensor 1 and LVDT Position Sensor 2 is greater than the set alarm limit value.	Alarm Limits too set too tight	Set alarm range wider. Go to Configure and Calibration, Advanced.
	LVDT not calibrated correctly	Sensors need calibration. Contact Woodward Technical Support for further assistance.

Problem	Cause	Remedy
Calibration Complete Shutdown	It is normal for this to occur at the completion of calibration	Verify that there is a valid demand signal and reset control

Table 8-9. Servo Position Diagnostics

Problem	Cause	Remedy
Position Error Shaft Alarm Detection: The Servo Valve is unable to maintain position within the tracking error fault limits. This will trigger an Alarm **Position Error Shaft Shutdown** Detection: The Servo Valve is unable to position within the tracking error fault limits. This will trigger a Shutdown	Oil contamination levels above specification limits causing servo valve sticking	Ensure oil supply meets specified cleanliness requirements. Replace / filter oil and flush the valve with clean oil. If problem persists, service may be required.
	Excessive Valve Wear	Service is required.
	VS-II electronics failure.	Contact Woodward Technical Support for assistance.
Cylinder Position Alarm Detection: The Power Cylinder is unable to position within the tracking error fault limits. This will trigger an Alarm **Cylinder Position Shutdown** Detection: The Power Cylinder is unable to position within the tracking error fault limits. This will trigger a Shutdown	Sticking/seized Steam Valve and/or linkage friction excessive or binding	Clean steam valve. Clean, lube, align linkage to reduce friction/binding.
	Excessive thermal growth in linkage preventing cylinder from reaching end positions.	Lower the ambient temperature of the VariStroke-II and/or linkage or recalibrate when hot. If this is not possible, consider disabling this diagnostic.
	Contamination in the valve/actuator system.	Ensure oil supply meets cleanliness requirements. Replace / filter oil and flush the valve with clean oil. If problem persists, service may be required.
	Low oil supply pressure supplied to the VariStroke-II	Identify cause of low oil pressure and correct. Ensure that the force required to move the valve and linkage does not exceed 2/3 the stall force of the VariStroke-II at the operating hydraulic pressure.
	Excessive Valve/Actuator Wear	Service is required.
	Faulty / erratic LVDT position sensor feedback	Check all connections to the final cylinder; check for any impediment to motion. If problem persists, service will be required.

Table 8-10. Performance Faults

Problem	Cause	Remedy
Performance Index Warning Detection: The settings for Supply Pressure, Cylinder Diameter, Final Cylinder 0% Position, and Final Cylinder 100% Position do not meet the Performance Index criteria.	Incorrect configuration and calibration settings.	See *Chapter 2: Stability Specifications* for the details of this alarm.
	The VS-II servo valve is too large for the set cylinder volume.	

Table 8-11. Internal Diagnostics

Problem	Cause	Remedy
24 V Failed Detection: Internal +24 V is outside acceptable range of 22.1 V to 30.7 V.	An internal error has occurred in the driver.	Service required.
1.8 V Failed Detection: Internal 1.8 V is outside acceptable range of 1.818 V to 2.142 V.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
+12 V Failed Detection: Internal +12 V is outside acceptable range of 10.6 V to 15.8 V.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
–12 V Failed Detection: Internal –12 V is outside acceptable range of –13.7 V to –8.6 V.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
5 V Failed Detection: Internal 5 V is outside acceptable range of 4.86 V and 6.14 V.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
5 V Reference Failed Detection: Internal 5 V reference is outside acceptable range.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
5 V RDC Ref. Failed Detection: Internal 5 V RDC reference is outside acceptable range.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
ADC Failed Detection: Internal ADC in processor core has stopped running.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
RDC DSP Failed Detection: DSP that runs the Resolver-to-digital converter has stopped running.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
ADC SPI Failed Detection: External ADC in processor core has stopped running.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
Electronics Fault	An internal error has occurred in the driver.	Service required.
Int. Bus Voltage High Detection: The internal bus voltage sensor is at max.	Internal problem with the electronics	Contact Woodward Technical Support for further assistance.
Int. Bus Voltage Low Detection: If the internal bus voltage Sensor is at min	Internal problem with the electronics	Contact Woodward Technical Support for further assistance.

Problem	Cause	Remedy
Driver Current Fault Detection: The Driver fault is detected by monitoring the currents in the driver output stages.	A short exists between phases of the motor or wiring.	Check for phase to phase shorts in the wiring. Check for phase to phase short in the motor.
	A short exists between a phase and the ground (wiring or motor)	Check for phase to ground shorts in the wiring. Check for phase to ground (earth ground, motor housing) short in the motor.
	A short exists between phase and power supply positive (Wiring problem)	Check for phase to power supply positive short in wiring.
	Internal electronics problem. (This is unlikely, the Driver Current Fault is designed to protect the driver from damage)	Contact Woodward Technical Support for further assistance.
Current Phase A High Detection: The phase A current sensor is at max output.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
Current Phase A Low Detection: The phase A current sensor is at min output.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
Current Phase B High Detection: The phase B current sensor is at max output.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
Current Phase B Low Detection: The phase B current sensor is at min output.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
Input Current High Detection: The Input current sensor is at max output.	The Current sense circuit has failed.	Contact Woodward Technical Support for further assistance.
Input Current Low Detection: The Input current sensor is at min output.	The Current sense circuit has failed.	Contact Woodward Technical Support for further assistance.
No Power Board Found Detection: During power up the control board will read the power board. This diagnostic will be set if no Power Board is found.	VariStroke-II internal electronics failure or there is no power board connected.	Contact Woodward Technical Support for further assistance.
Power Board Calib. Error Detection: During power up the calibration record in the control is set to “No Power Board” this diagnostic will be set.	The control board has not been calibrated during electrical production.	Contact Woodward Technical Support for further assistance.
Power Board ID Error Detection: During power up, the Power board ID and the stored ID in the calibration record do not match.	The Power board has been changed to a different type after calibration.	Contact Woodward Technical Support for further assistance.
EEPROM Read Failed Detection:	Internal electronics failure.	Contact Woodward Technical Support for further assistance.

Problem	Cause	Remedy
After multiple retries and data comparison the software is not able to read from the non-volatile memory. **EEPROM Write Failed** Detection: After multiple retries and data comparison the software is not able to write to the non-volatile memory.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
Invalid Parameters(s) Detection: CRC16 check failures on both parameter sections.	If a new embedded program has been loaded the parameters have not been updated.	Refer to the embedded software update procedure to update the parameters. Cycle power to restart the VariStroke-II.
	Internal electronics failure.	Contact Woodward Technical Support for further assistance.
Invalid Parameter Version Detection: Version information not correct in the non-volatile memory.	Internal electronics failure.	Contact Woodward Technical Support for further assistance.

Maintenance

To maximize the life of the VS-II, please refer to the maintenance recommendation in Chapter 9: Asset Management and Refurbishment Scheduling Period

Chapter 9.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.

A current list of Woodward Business Partners is available at:
https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner

Product Service Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (Woodward North American Terms and Conditions of Sale 5-09-0690) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward North American Terms and Conditions of Sale 5-09-0690).

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward North American Terms and Conditions of Sale 5-09-0690) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward North American Terms and Conditions of Sale 5-09-0690). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- Return authorization number
- Name and location where the control is installed
- Name and phone number of contact person
- Complete Woodward part number(s) and serial number(s)
- Description of the problem
- Instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:
- Protective caps on any connectors
- Antistatic protective bags on all electronic modules
- Packing materials that will not damage the surface of the unit
- At least 100 mm (4 inches) of tightly packed, industry-approved packing material
- A packing carton with double walls
- A strong tape around the outside of the carton for increased strength

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:
- The part number(s) (XXXX-XXXX) that is on the enclosure nameplate
- The unit serial number, which is also on the nameplate

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.
- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner**

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at **https://www.woodward.com/support**, which also contains the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name

Site Location

Phone Number

Fax Number

Prime Mover Information

Manufacturer

Turbine Model Number

Type of Fuel (gas, steam, etc.)

Power Output Rating

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Symptoms

Description

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Chapter 10.
Asset Management and Refurbishment Scheduling Period

This product is designed for continuous operation in a typical industrial environment and includes no components that require periodic service. However, to take advantage of related product software and hardware improvements, we recommend that your product be sent back to Woodward or to a Woodward authorized service facility after every five to ten years of continuous service for inspection and component upgrades. Please refer to the above service programs when returning products.

Chapter 11.
Long-Term Storage Requirements

Units that will not be put into service within twelve months should be packaged for long-term storage as described in Woodward manual 25075, *Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls*.

Revision History

Changes in Revision G—
- Removed references to V65 models

Changes in Revision F—
- Revised Regulatory Compliance section
- Revised Special Conditions for Safe Use section
- New Figure 1-1a
- Updated Model Number Information (Figures 1-4 and 1-5) in Chapter 1
- Replaced Declarations

Changes in Revision E—
- Added Kit part numbers to table 8-1
- Added LVDT Protection Kit section to Chapter 8
- Added Figures 8-2a and 8-2b
- Added new DoC

Changes in Revision D—
- Changed reference in Note at bottom of page 40
- Added Shaft Seal Replacement section to Chapter 8
- Deleted two part numbers and added one part number to Table 8-1
- Added Figure 8-1

Changes in Revision C—
- Added System Requirements section to Chapter 5
- New EU Declaration

Changes in Revision B—
- Updated EMC, ATEX, and Pressure Equipment Directives in Regulatory Compliance Section
- Updated DOC/DOI

Changes in Revision A—
- Updated Power Supply Requirements Section in Chapter 4
- Added Figures 4-1, 4-2, and 4-3

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00420-04-EU-02-01
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	Varistroke Electro Hydraulic Actuators: VS-I, VS-II, VS-GI, VS-DX
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC)
Markings in addition to CE marking: (Marking depends on model code. See Product Manual)	(no additional marking for Ordinary Location code 0 models) Ⓔx Category 2 Group II G, Ex db IIB T4 Gb Ⓔx Category 3 Group II G, Ex nA IIC T4 Gc
Applicable Standards:	EN 61000-6-4, 2007/A1:2011: EMC Part 6-4: Generic Standards – Emissions for Industrial Environments EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards – Immunity for Industrial Environments EN IEC 60079-0:2018 - Explosive Atmospheres - Part 0: Equipment – General requirements (A review against EN IEC 60079-0:2018, which is harmonized, shows no significant changes relevant to this equipment so EN 60079-0 :2012/A11 : 2013 continues to represent "State of the Art") EN 60079-1:2014 - Explosive Atmospheres – Part 1 : Equipment protection by flameproof enclosures "d" (A review against EN IEC 60079-1:2014, which is harmonized, shows no significant changes relevant to this equipment so EN 60079-1:2007 continues to represent "State of the Art") EN 60079-15: 2010 - Explosive Atmospheres - Part 15: Equipment protection by type of protection "n"
Third Party Certification: (VS-I, VS-II only)	Zone 1: SIRA 14ATEX1028X CSA Group Netherlands B.V. (NB 2562) Utrechseweg 310, 6812 AR, Arnhem, Netherlands
Conformity Assessment: (VS-I, VS-II only)	Zone 1: ATEX Annex IV - Production Quality Assessment, 01 220 113542 TUV Rheinland Industrie Service GmbH (0035) Am Grauen Stein, D51105 Cologne

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Signature	Annette Lynch
Full Name	**Annette Lynch**
Position	**Engineering Manager**
Place	**Woodward, Fort Collins, CO, USA**
Date	04-Oct-2021

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DECLARATION OF INCORPORATION
Of Partly Completed Machinery
2006/42/EC

File name: 00420-04-EU-MD-02-01
Manufacturer's Name: WOODWARD INC.

Manufacturer's Address: 1041 Woodward Way
Fort Collins, CO 80524 USA

Model Names: Varistroke Electro Hydraulic Actuators: VS-I, VS-II, VS-GI

This product complies, where applicable, with the following Essential Requirements of Annex I: 1.1, 1.2, 1.3, 1.5, 1.6, 1.7

The relevant technical documentation is compiled in accordance with part B of Annex VII. Woodward shall transmit relevant information if required by a reasoned request by the national authorities. The method of transmittal shall be agreed upon by the applicable parties.

The person authorized to compile the technical documentation:

Name: Dominik Kania, Managing Director
Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of this Directive, where appropriate.

The undersigned hereby declares, on behalf of Woodward Inc. of Loveland and Fort Collins, Colorado that the above referenced product is in conformity with Directive 2006/42/EC as partly completed machinery:

MANUFACTURER

Annette Lynch
Signature

Annette Lynch
Full Name

Engineering Manager
Position

Woodward Inc., Fort Collins, CO, USA
Place

March 18, 2022
Date

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We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 26740.

B26740: G

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Phone +1 (970) 482-5811

Email and Website—www.woodward.com

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.