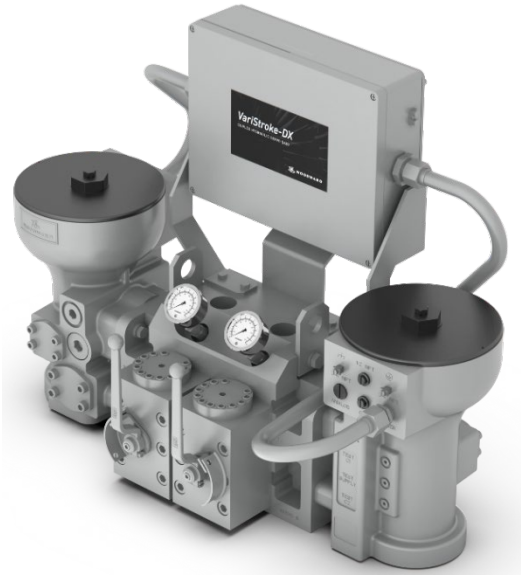
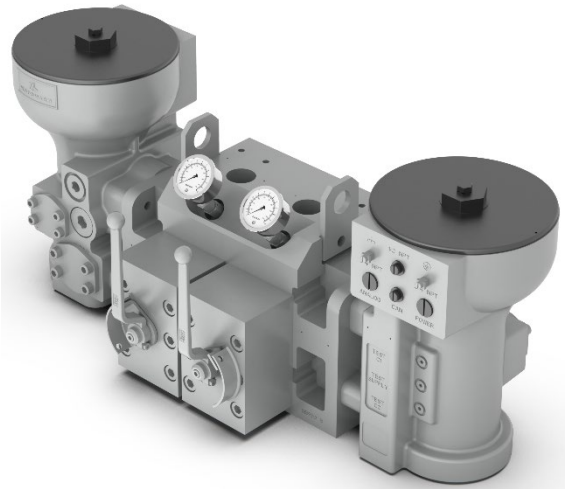
WOODWARD

Product Manual 35132
(Revision D, 6/2025)
Original Instructions





VariStroke-DX
Duplex Hydraulic Servo Skid

Installation and Operation Manual

Released

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.

Woodward Industrial Support: Get Help

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

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.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. The latest version of most publications is available on the Woodward website.

Woodward Industrial Support: Get Help

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.

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Manual 35132

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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.

⚠WARNING

Lockout/Tagout (LOTO)

Ensure that personnel are fully trained on LOTO procedures prior to attempting to replace or service VS-DX on a "live" running prime mover. All safety protective systems (overspeed, over temperature, overpressure, etc.), as well as personal protective equipment (PPE), should be checked prior to beginning work to prevent personal injury, loss of life, or property damage.

WARNING

External Fire Protection

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.

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 because these 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.

Regulatory Compliance

Product Compliance Code: Product certifications are dictated by the product model number, and traceable per the product serial number. For information on which hazardous locations any VariStroke is rated for, refer to the Model Number and Model Number information.

Varistroke Model Number Information

Varistroke Product Line	Valve Size	Configuration	Action		Bore	Stroke		Rod End	Fail-Safe Direction	**Compliance**		Specials
V	XX	X	X	–	XX	XX	–	X	X	X	–	XX

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	North American Div 1 & 2, ATEX/IECEx Zone 1 & 2, TIIS
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	North American Div 1 & 2, ATEX/IECEx Zone 1 & 2, KCS MARK KOREA
C	North American Div 2, ATEX/IECEx Zone 2, KCS MARK KOREA

European Compliance for CE Marking:
These listings are limited only to those units bearing the CE Marking. Review the Compliance Code table for more information.

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 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 2: II 3 G Ex nA IIC T4 Gc

Other European 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 non-electrical portion of the ATEX Directive 2014/34/EU due to 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 the making available on the market of pressure equipment.

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.

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 2: Ex nA IIC T4 Gc

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

CSA: 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.

Field wiring must be suitable for at least 90 °C.

Maximum hydraulic fluid temperature shall not exceed 70°C (158ºF).

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 an ignition-capable level of electrostatic charge. 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. In addition, only clean the equipment with a damp cloth.

⚠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.

Substitution of components may impair suitability for Class I, Division 2 or Zone 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.

Safety Symbols


Direct current


Alternating current


Both alternating and direct current


Caution, risk of electrical shock


Caution, refer to accompanying documents


Protective earth terminal


Frame or chassis terminal

Chapter 1.
General Information

Table 1-1. Definitions and Abbreviations

VS-DX: VariStroke-DX Duplex Hydraulic Servo Skid

VS-GI: VariStroke-GI Servo

DCS: Distributed Control System

In Control: The unit actually controlling the position of the actuation system

Not In Control: The unit acting as the backup to the In Control unit

Master / Slave: The servo designated as the Slave has yielded control to the other servo (Master) by link between the two VS-GI's. The Servo designated as the Master will take control during VS-DX startup.

CMRR: Common Mode Rejection Ratio

VHPC: VariStroke Hydraulic Power Cylinder

Table 1-2. Woodward Reference Literature

Manual 25071: Oils for Hydraulic Controls

Manual 25075: Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls

Manual 26455: Woodward Energy Segment Customer Publications: Cross-Reference by Application Revision Status & Distribution Restrictions

Manual 35119: VariStroke-GI (VS-GI) Electro-Hydraulic Actuator Manual

CMM-03013: Component Maintenance Manual, Bronze Level, VariStroke-DX (VS-DX)

Manual 35148: Customer Service Tool Manual

Manual 35163: VariStroke Power Cylinder Manual

Manual 82715: Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, & Modules

Table 1-3. List of Available VariStroke-DX Skids

Part Number	Description
8918-164	VariStroke-DX Skid, Fail Extend, Junction Box Version
8918-165	VariStroke-DX Skid, Fail Extend, Without Junction Box Version
8918-166	VariStroke-DX Skid, Fail Retract, Junction Box Version
8918-167	VariStroke-DX Skid, Fail Retract, Without Junction Box Version

System Description

The VariStroke-DX (dual-transfer) skid is a dual redundant hydraulic servo system which allows on-line servo repairs and replacement. The system described in this manual consists of a skid-mounted arrangement of two VS-GI servos operating through a transfer valve assembly as shown in Figure 1-1. The VariStroke-GI is a family of linear electrohydraulic actuators that are designed to provide the linear actuation force to operate steam turbine control valves, valve racks, and trip & throttle valves. This single-acting actuator family is intended for use on mechanical drive or generator-drive steam turbines, and uses a low-pressure hydraulic oil source (typically turbine lube oil) to provide its output shaft force. Refer to VariStroke-GI Product Specification 03464 for more information. The VariStroke-DX skid is designed to be used in combination with Woodward's single-acting VariStroke Hydraulic Power Cylinders (VHPC). Refer to VHPC Product Specification 03465 for size and ordering information.

The combined VariStroke-DX and VHPC system is specifically designed for use on critical steam turbine applications where system uptime is essential. The utilized VariStroke-GI servos' superb accuracy and resolution make it ideal for steam turbine valve control. As a result of this servo's integrated redundancy when used within the VariStroke-DX skid, these servos can be repaired or replaced while the turbine is on-line operating normally, which ensures a high level of system reliability and availability. The VS-DX Duplex Hydraulic Servo Skid precisely controls steam turbine actuation system position proportional to the (4 to 20) mA input current signal.

VS-DX Dual Transfer Skid can be used in additional applications not described in this manual. Contact Woodward for more information and guidance.

IMPORTANT

See Table 1-2 for additional manuals and reference materials that are critical to installing, operating, and maintaining VariStroke-DX. Documents are available on www.woodward.com.

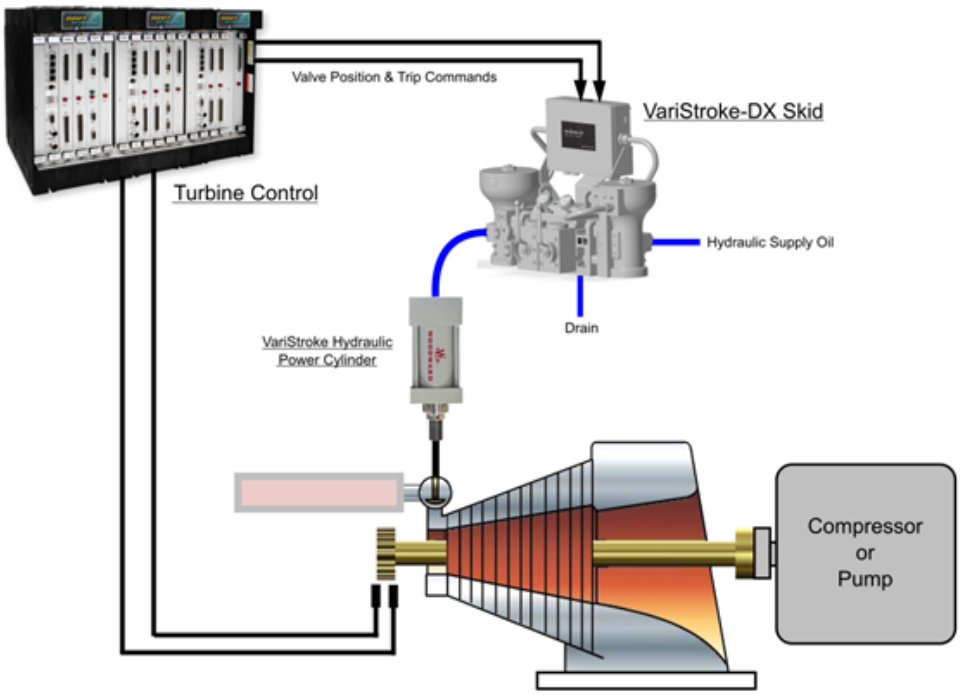

Figure 1-1. Basic VS-DX Application and Configuration

Designed as a stand-alone skid, VS-DX features servo-to-servo communication, and automatic failover logic is included within each servo. During a failure event, this forces an automatic control transfer to the healthy servo with no external control logic or interface required. Optionally, users can use a local switch or control driven relay connected to the skid to routinely select and switch servo functions as the master and as the slave.

The VS-DX uses a specially designed fast-switching high signal select valve to ensure minimal control switchover time and minimal system control pressure disturbance. During normal operation, the In Control servo will control the position of the connected VariStroke Hydraulic Power Cylinder (VHPC), while the Not In Control servo is held in a standby mode with its pressure output port connected to the skid's output drain line. In this state, if the In Control servo or its input demand signal fails, the servo's output is stepped to a failsafe zero pressure level. The Not In Control servo is switched to an In Control state and begins trying to control the VHPC. The skid's specially designed high signal select valve is then hydraulically forced to connect the now healthy and In Control servo to the VHPC hydraulic pressure line.

Design Characteristics

The skid assembly has been designed to offer maximum reliability, especially for critical steam turbine applications. Features include:

- Ease of installation
- Minimum hydraulic connections, reducing the potential for oil leakage
- Compact design
- Rapid control switchover (transfer) time
- Two manually operated isolation valves, which allow each VS-GI to be fully calibrated and checked before switching it to on-line service
- Dirt tolerant servos and shuttle valve
- Online diagnostics and automatic switchover logic
- Online replacement capability to safely and reliably disable, remove or replace either one of the VS-GI's without the need to stop the turbine or control system.

Construction

The VS-DX is an integrated assembly of two Woodward VariStroke-GI servos (VS-GI servos), both connected to a single manifold with all interconnect piping, gauges, and wiring included and factory tested.

The two VS-GI servos are mounted to an anodized aluminum manifold containing the transfer valve, manual isolation valves, pressure gauges, needle valves, and shuttle valve subassembly, as well as electrical junction box. Optionally, the skid may be supplied without a junction box or intercommunication wiring. The VS-DX skid provides a mounting interface on the bottom surface via four threaded holes (see Figures 3-1 through Figure 3-8).

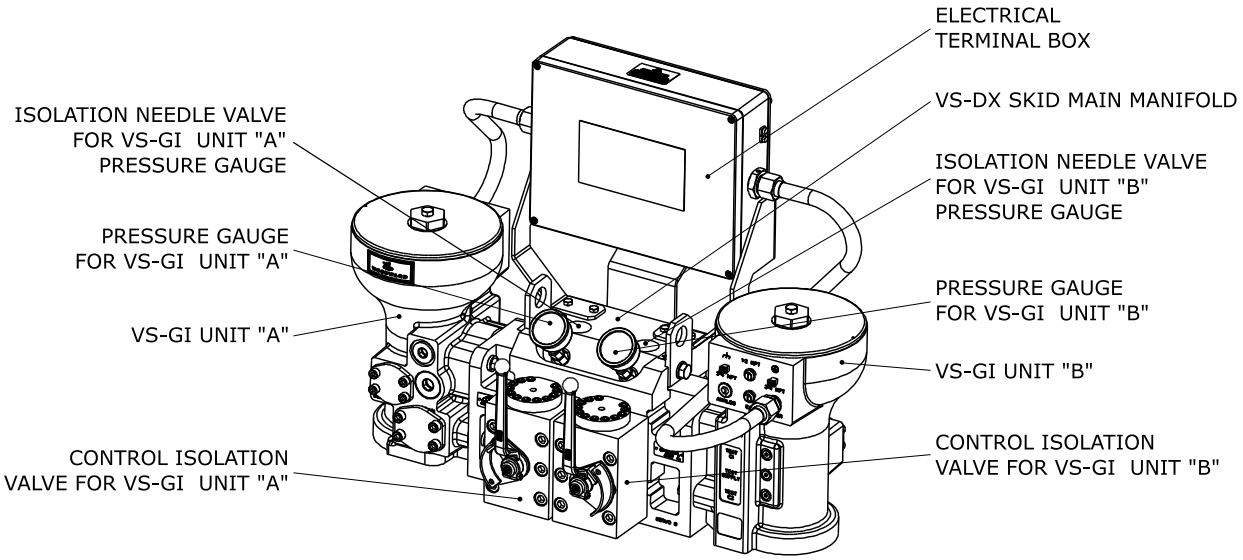

Figure 1-2. VS-DX Main Components (Junction Box Version)

The complete assembly is designed for use in a hazardous environment; see the Regulatory Compliance specifications for more details.

Integrated oil pressure gauges allow the user to visually verify which VS-GI servo is in control and verify the VS-DX output oil header pressure level. The VS-GI discrete output status can also be used to provide verification of operation or shutdown via status lamps and/or the plant DCS to assist with system health monitoring.

All hydraulic ports on each VS-GI servo and the aluminum manifold are marked as SUPPLY, DRAIN, or CONTROL for ease of connection. See Figures 3-1 through Figure 3-11 and the Installation Chapter for detailed information on use of the hydraulic ports.

Ordering Numbers

Table 1-4. Ordering Number Table

ITEM #	DESCRIPTION
8918-164	Varistroke-DX, J-Box, Fail Extend, Zone 2
8918-165	Varistroke-DX, No J-Box, Fail Extend, Zone 1
8918-166	Varistroke-DX, J-Box, Fail Retract, Zone 2
8918-167	Varistroke-DX, No J-Box, Fail Retract, Zone 1

Chapter 2.
System Specifications

Table 2-1. Environmental Specifications

Ambient Temperature:	Without junction box: –40 to +85°C (-40 to + 185ºF) With junction box: –30 to +85°C (-22 to + 185ºF)
Vibration:	US MIL-STD 810F, M514.5A, Cat. 4 (0.015 G²/Hz, 10 to 500 Hz, 1.04 Grms)
Shock:	US MIL-STD-810C method 516.2, procedure 1 (10 G Peak, 11 ms duration, saw tooth)
Ingress Protection: (IEC 60529 and IEC 60079)	IP66

Table 2-2. Physical Specifications

With Junction Box	
Height x Width x Depth:	Approx. (725.7 x 968.2 x 632.0) mm / (30.0 x 40.00 x 29.00) inch
Weight:	Approx. 161 kg (353 lb) without oil
Mounting:	4x .625-11 UNF threaded holes (see Figure 1-5)
Without Junction Box	
Height x Width x Depth:	Approx. (725.7 x 968.2 x 632.0) mm / (17.20 x 40.00 x 16.50) inch
Weight:	Approx. 143 kg (315 lb) without oil
Mounting:	4x .625-11 UNF threaded holes (see Figure 3-3)

Table 2-3. Electrical Specifications

With Junction Box	
Terminal block wire size:	Power and internal ground: (0.14 to 6) mm² / (26 to 10) AWG stranded wire Communication signals: (0.2 to 4) mm² / (24 to 12) AWG stranded wire
Conduit Entries:	4 x 3/4 NPT conduit hubs
External PE Ground:	6 mm² / 10 AWG (recommended)
Without Junction Box (to each VS-GI servo)	
Terminal block wire size:	Power and internal ground: Communication signals:
Conduit Entries:	2 x 3/4 NPT 2 x 1/2 NPT
External PE Ground:	4 mm² / 8 AWG (recommended)
Common Specifications	
Supply Voltage	(18 to 32) V (dc), 24 V (dc) nominal
Hold-up time:	7 ms @ 2 A (dc) LAT current
Current Consumption:	2.3 A (MAX) at steady state @ 24 V 10 A transient (100 ms maximum)
Demand Signals #1, 2:	(4 to 20) mA into 200 Ω. >70 dB CMRR. Common Mode Voltage Range ±50 V (dc), Accuracy 0.1% of full scale @ 25 °C
Cylinder Position	(4 to 20) mA into 235 Ω. >70 dB CMRR
Feedback Signals #1, 2:	Common Mode Voltage Range ±50 V (dc), Accuracy 0.1% of full scale @ 25 °C
Analog Output Signal	(4 to 20) mA. Maximum external load: 500 Ω Accuracy ±0.5 % of full scale @ 25 °C
Discrete Output Signal	Configurable for NO or NC, 0.5 A at 24 V (dc), max. 32 V (dc) 0.5 A inductive at 28 V (dc) 0.2 Henry **Note:** Outputs 1 and 2 are required for master/slave and redundant link communication. See Discrete Output section and wiring diagrams for details.
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

Table 2-4. Cylinder Position Sensor Requirements

Output Signal:	Analog: 4–20 mA
Input Voltage:	15 V (dc) (power provided by VariStroke)
Linearity:	±0.04% full stroke
Current Drain:	<100 mA
Sensor Length:	≤ 2 times the cylinder stroke length
Update Rate:	≤ 1 ms
Sensor Cable Length Limit:	10 m (32.8 feet) maximum between sensor and VariStroke

IMPORTANT

Cylinder position update rates that are slower than 1 ms could result in excessive limit cycle, wear, and poor position accuracy.

Woodward does NOT recommend using a combination of LVDTs and Signal Conditioners. This combination will typically result in unacceptable delays in the position sensor update rate.

Woodward recommends that the installer consider Magnetostrictive position sensors and/or DCDTs (Direct Current Differential Transformers).

Table 2-5. Hydraulic Specifications

Oil Temperature:	+15 to +70°C (+59 to 158ºF) continuous
Oil Viscosity:	10 to 55 centistokes
Hydraulic Supply Ports:	1.25 SAE J518 Code 61 Flange (x2) (on Servo “A”& “B”)
Hydraulic Drain Ports:	1.5 SAE J518 Code 61 Flange (x2) (on Servo “A”& “B”) 1.0 SAE J518 Code 61 Flange (on VS-DX Skid manifold)

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

Maximum Input/Supply Pressure:	34.5 barg (500 psig)
Minimum Input/Supply Pressure (above drain line pressure):	3.45 barg (50 psig)
Tank Pressure:	Drain pressure must not exceed 10% of supply pressure or 3.4 bar (50 psig), whichever is less, under any condition.
Recommended Fluid:	Mineral or synthetic based oils may be used. Woodward oil recommendations per manual 25071.
Oil Cleanliness:	ISO 4406:99 code 20/18/16 max fluid cleanliness or better is recommended for optimum reliability.

IMPORTANT

Proper design considerations for supply and drain pressure requirements are imperative to achieve peak performance on VariStroke-DX, specifically:

- **Maintain drain pressure level as low as possible. Minimum input/supply pressure requirements must be met relative to the drain pressure.**
- **Inlet supply pressure should not be allowed to decrease by more than 10% of nominal value during slew/step.**
- **Set hydraulic system pressure regulator to 110% or less of normal operating pressure to prevent over-pressure.**

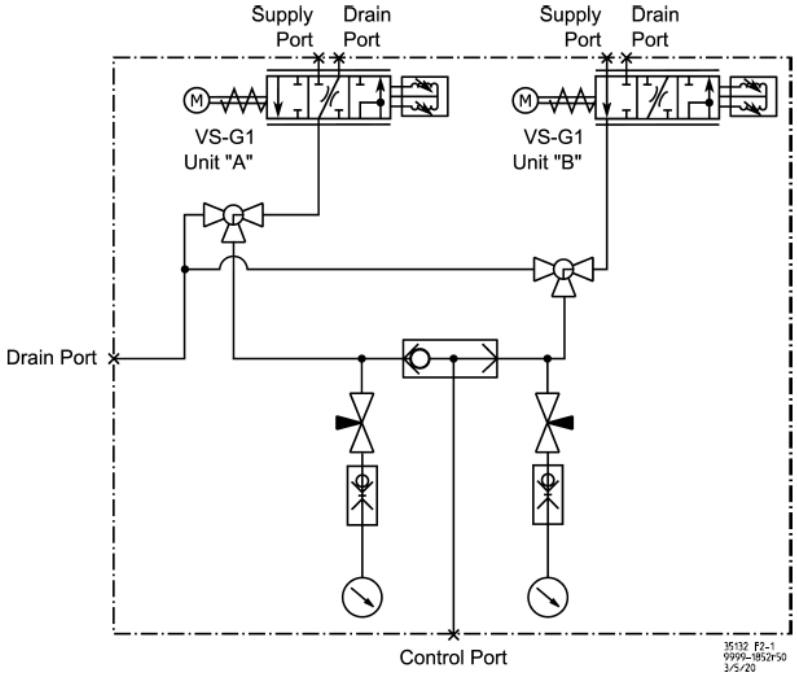

Figure 2-1. VariStroke-DX, Hydraulic Schematic

Chapter 3.
Installation

General Warnings and Installation Drawings

⚠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.

⚠CAUTION
Hearing Protection

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

IMPORTANT

See Table 1-2 for additional manuals and reference materials that are critical to installing, operating, and maintaining VariStroke-DX. These are available on www.woodward.com

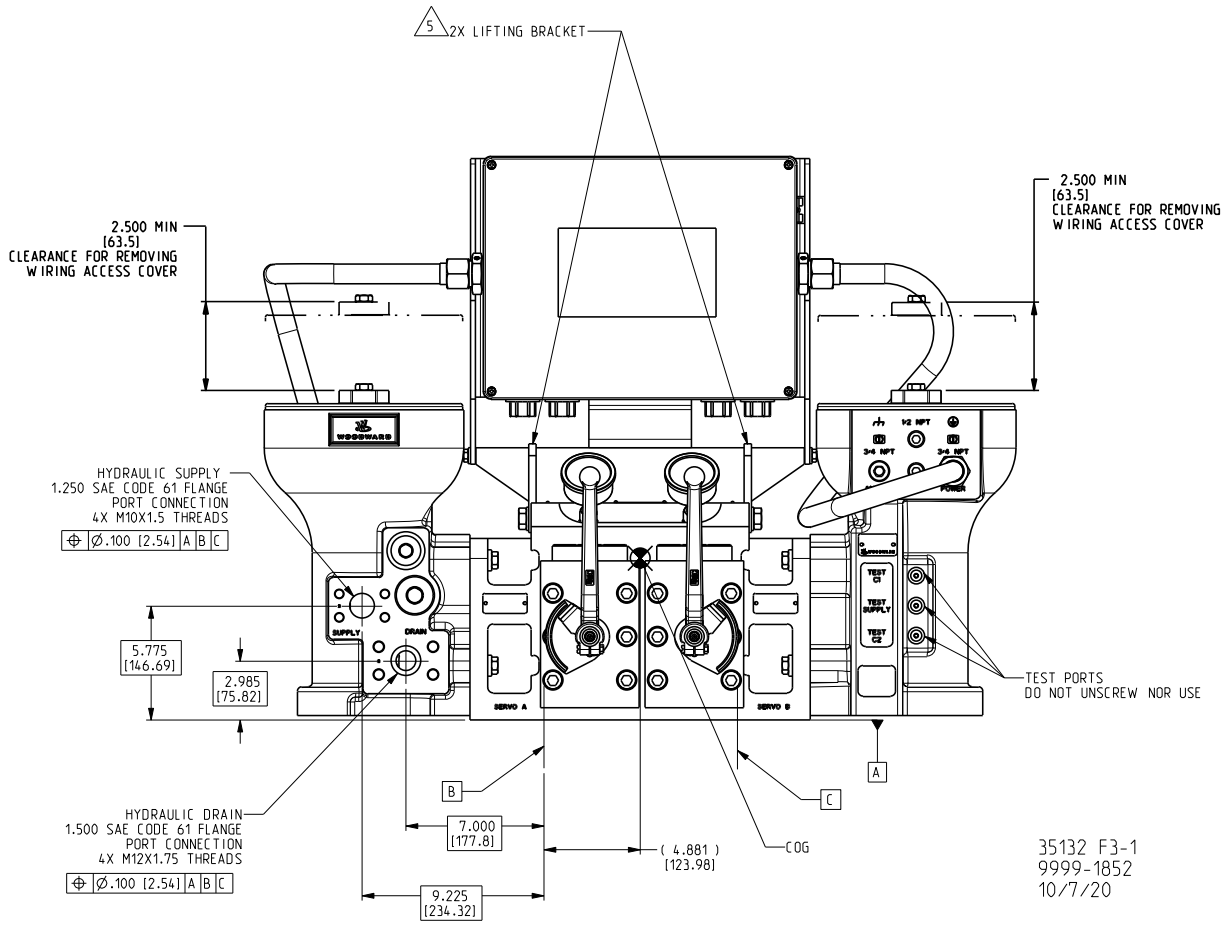

Figure 3-1. VariStroke-DX, Junction Box Version, Front View

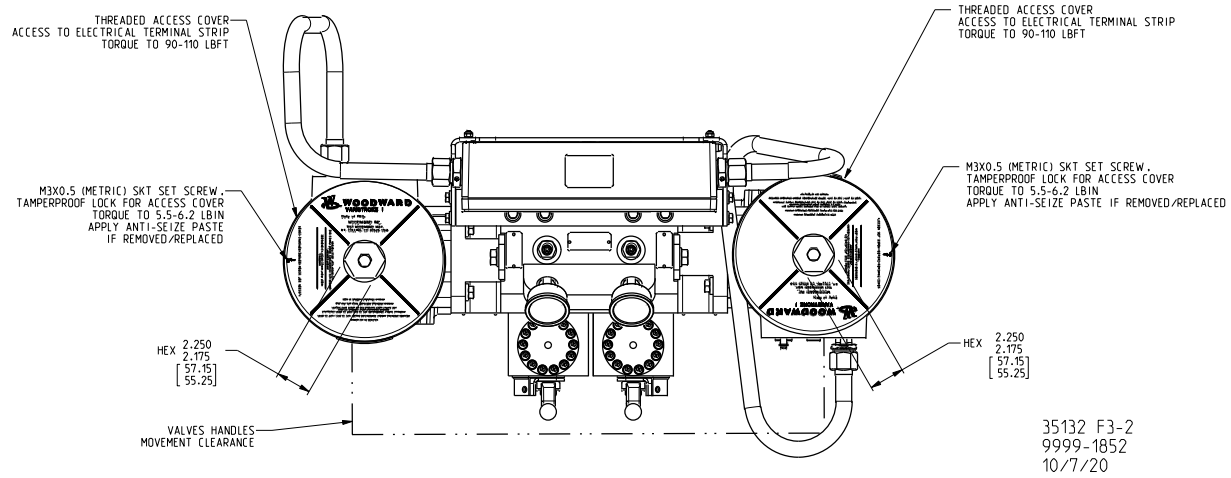

Figure 3-2. VariStroke-DX, Junction Box Version, Top View

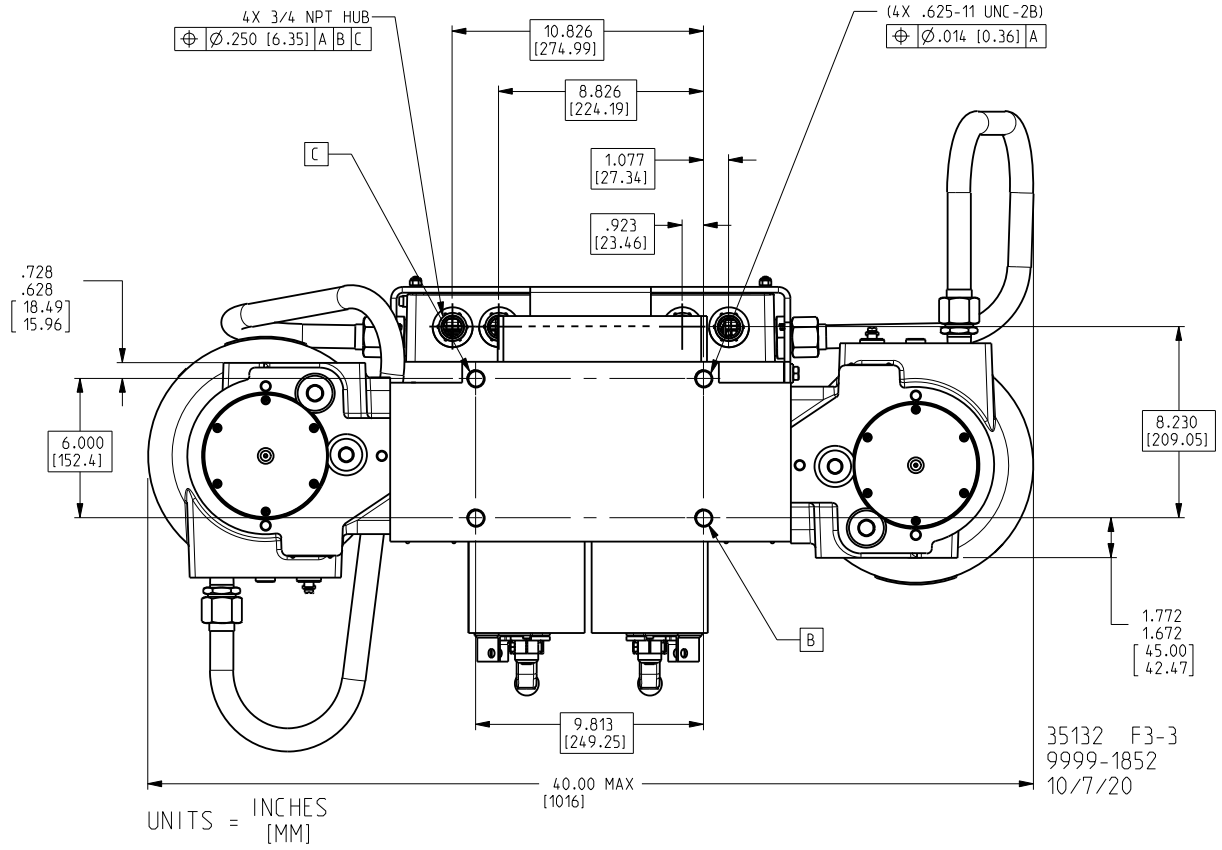

Figure 3-3. VariStroke-DX, Junction Box Version, Bottom View

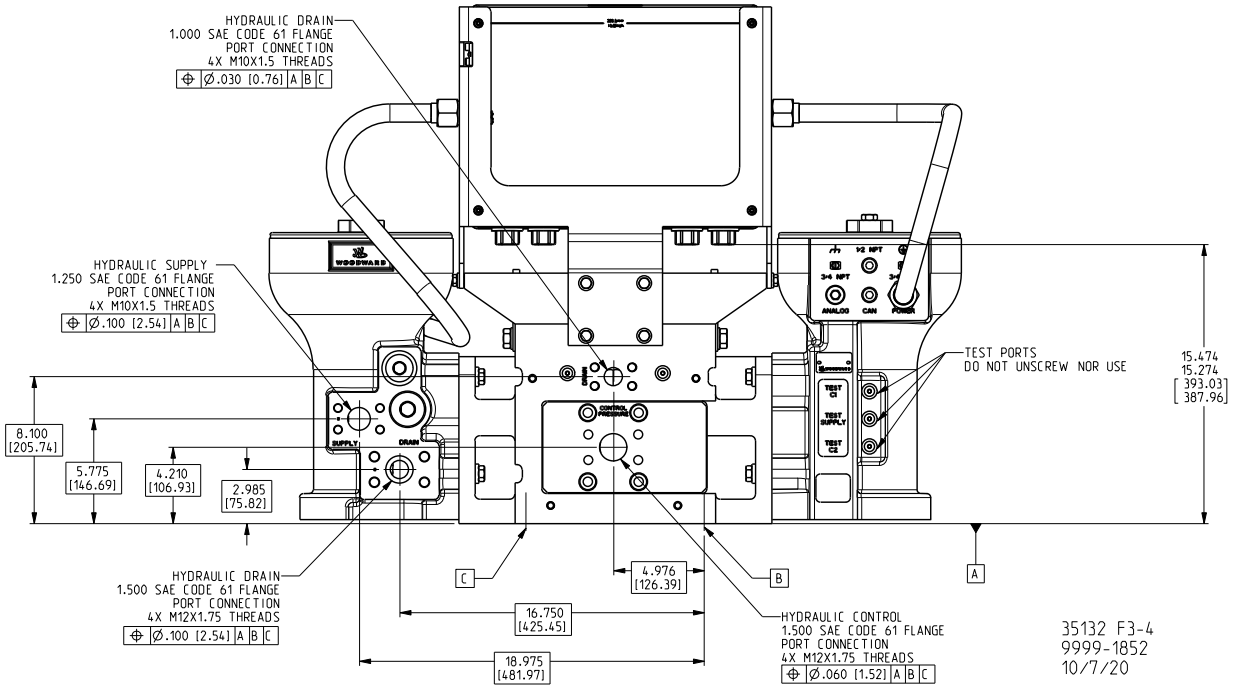

Figure 3-4. VariStroke-DX, Junction Box Version, Back View

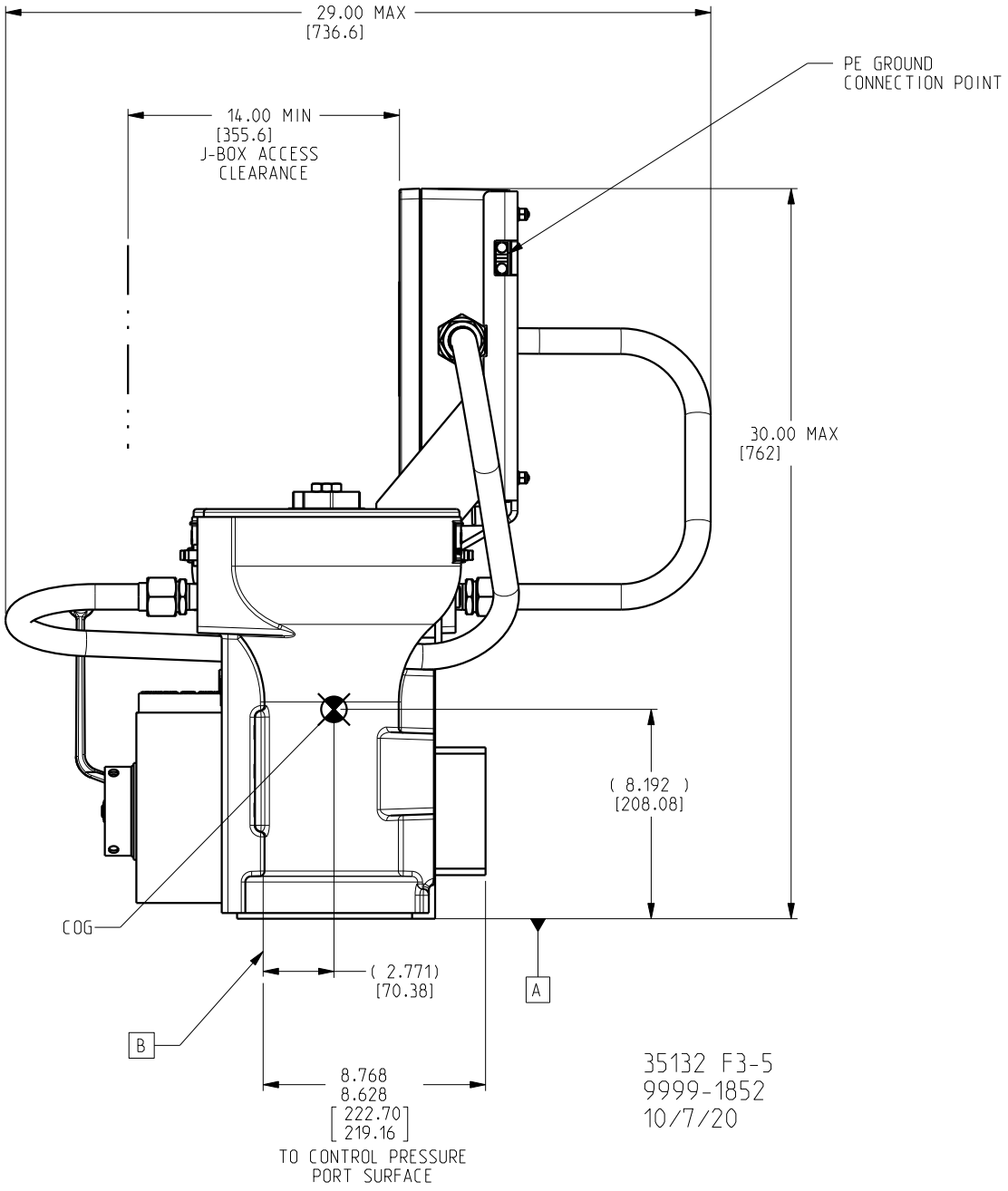

Figure 3-5. VariStroke-DX, Junction Box Version, Side View

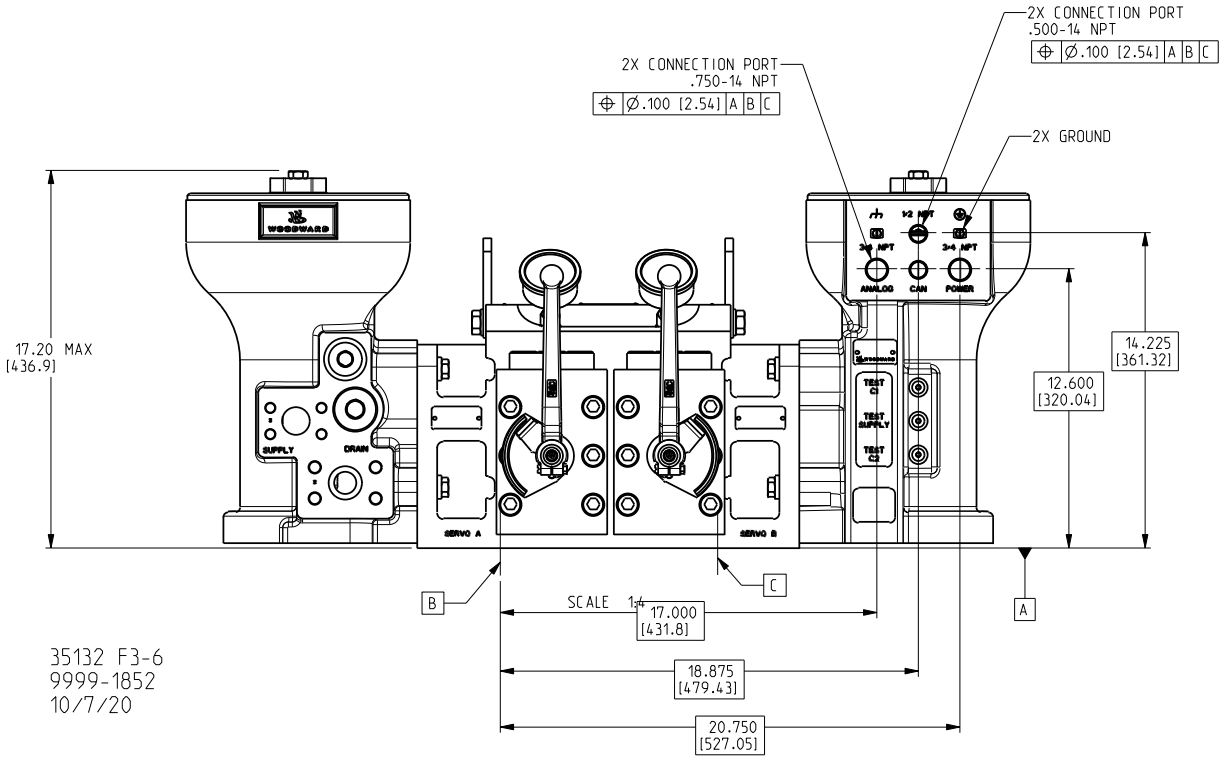

Figure 3-6. VariStroke-DX, Without Junction Box Version, Front View

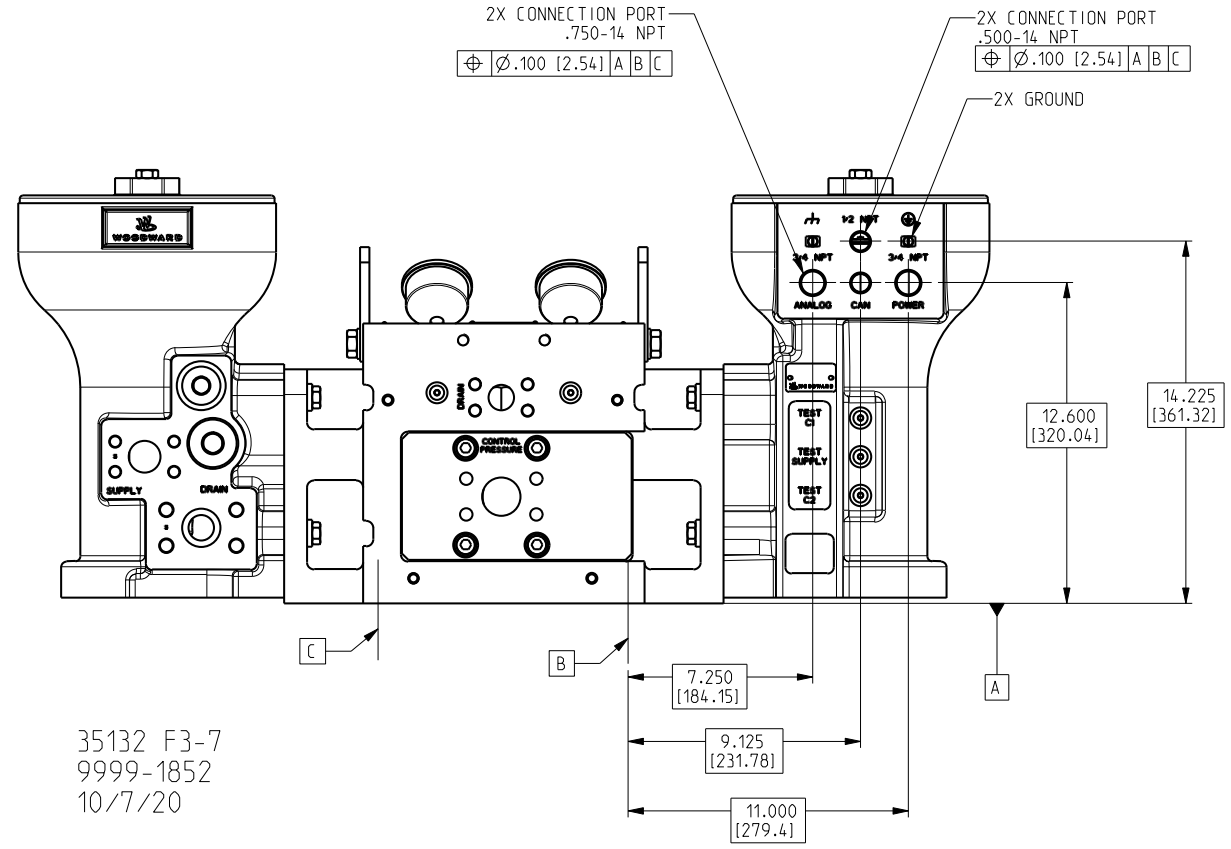

Figure 3-7. VariStroke-DX, Without Junction Box Version, Rear View

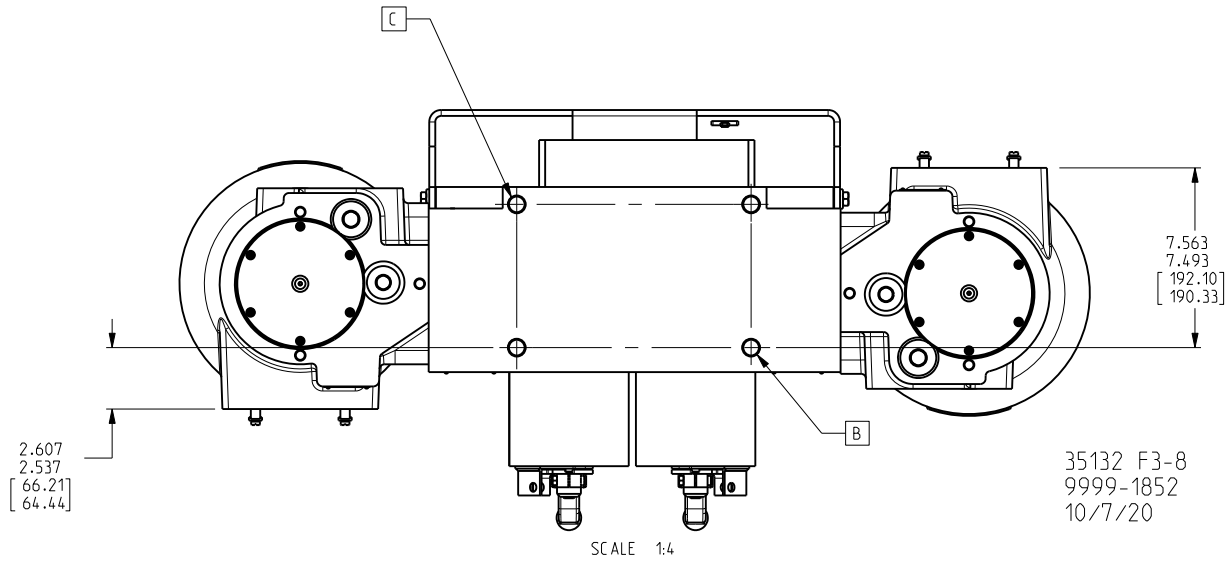

Figure 3-8. VariStroke-DX, Without Junction Box Version, Bottom View

Unpacking and Lifting Instructions

The VS-DX Duplex Hydraulic Servo Skid assembly is carefully packaged at the factory to protect it from damage during shipping. However, careless handling may result in damage to the unit. If any damage to the VS-DX is discovered, notify both the shipping agent and Woodward. When unpacking the VS-DX, do not remove the hydraulic shipping covers until you are ready to connect the servo to hydraulic lines.

⚠WARNING

Lifting Hazard

VS-DX weighs approximately 353 lb (160 kg) and poses a significant safety risk to personnel if handled incorrectly. Carefully review Figures 3-1 through 3-8 and System Information in Chapter 1 for lifting locations and center of gravity before moving the VS-DX. Use only the provided lifting brackets (Figure 3-9) with properly rated lifting equipment. Attach individual straps to each lifting bracket to reduce bracket side loading. Do not lift or handle the VS-DX by the junction box or conduit tubing.

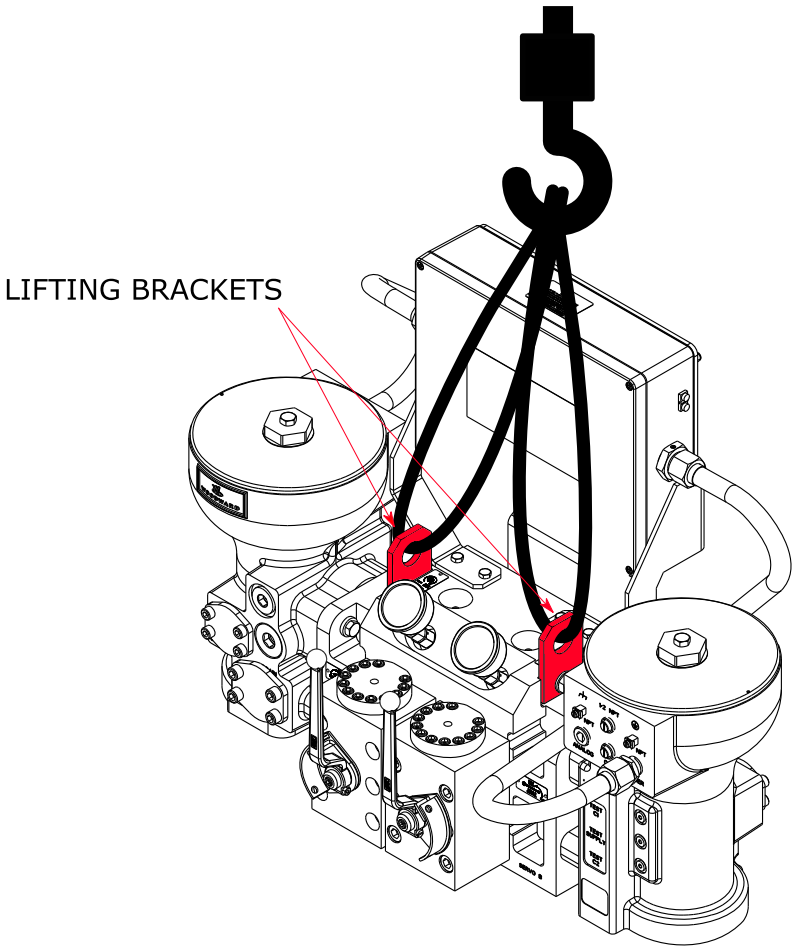

Figure 3-9. VS-DX Lifting Bracket Locations

Mounting Instructions

The VS-DX assembly is designed to be attached to a horizontal structure via the four threaded holes on the bottom of the aluminum manifold (See Figures 3-1 through Figure 3-8). The VS-DX should be mounted as close as possible to the controlled system (hydraulic power actuator) to minimize the hydraulic control line length and oil volume to achieve optimum system response.

Avoid mounting the VS-DX near heat sources and provide adequate ventilation. Review the restrictions stated in the Specifications Chapter before selecting a mounting location.

Mount the VS-DX using four 0.625-11 UNF size screws UNF Class 8.8 minimum. Bolts thread engagement are a minimum 0.7 inch, maximum 1 inch (bolts not delivered with unit). The typical tightening torque is 67 ± 7 Nm (50 ±5 LBFT) assuming mounting base material Yield Strength minimum at level 662 MPa / 96 ksi. See Figure 3-3 for bolts pattern.

The intended mounting location should allow enough space to remove the VS-GI servo top covers for access to the commissioning service ports, terminal blocks, and to see the status LEDs on the printed circuit board inside each VS-GI.

IMPORTANT **When installing the VS-DX, pay attention to clearances required to remove and replace component parts such as the redundant VS-GI servo in the event of a failure.**

Hydraulic Connections

There are two hydraulic ports on the back side of the VS-DX manifold marked DRAIN for the drain oil port and CONTROL for the control oil connection to actuation system. Additionally, on each VS-GI servo unit, there are two hydraulic ports marked SUPPLY for the supply oil port and DRAIN for the drain oil port. See Table 3-1 for port size and bolt size recommendations.

Table 3-1. VS-DX Hydraulic Ports Details

VS-DX SAE J518 Code 61 Ports

Description	Port Size (inch)	Bolt Size
VS-GI Servo Supply Port	1.25	4x M10 x 1.50
VS-GI Servo Drain Port	1.50	4x M12 x 1.75
VS-DX Skid Control Port	1.50	4x M12 x 1.75
VS-DX Skid Drain Port	1.00	4x M10 x 1.50

Prior to connecting the hydraulic lines to the skid, ALL hydraulic lines should be thoroughly flushed to prevent contamination from entering the VS-DX.

A high capacity, serviceable filter is recommended upstream of the VS-DX supply ports (see recommended hydraulic cleanliness in Hydraulic Specification section). Verify the flow direction of all the hydraulic connections attached to the VS-DX skid manifold.

The pump capacity must be large enough to supply the required slew rate of the attached servo system with some margin. If the supply pressure to the servos sags during a transient, this will impact the stability and overall performance of the system.

IMPORTANT

Ensure the pressure head created by the siphon on the drain line is within the allowable limits stated in the Specifications Chapter, or performance will be negatively affected

A siphon is required on the VS-GI servo drain line to avoid draining of hydraulic oil and air entrapment, which may result in unstable operation of the control system. The required minimum siphon height is shown in Figures 3-10 and 3-11. A siphon is not required on the skid manifold drain line.

Woodward highly recommends the user install isolation valves on system process piping on each of the VS-GI servo supply and drain lines for ease of VS-GI servo replacement. See Figure 3-11.

IMPORTANT

Install isolation valves on the supply and drain line close to VS-DX. It will prevent hydraulic oil return from line during VS-GI servo replacement.

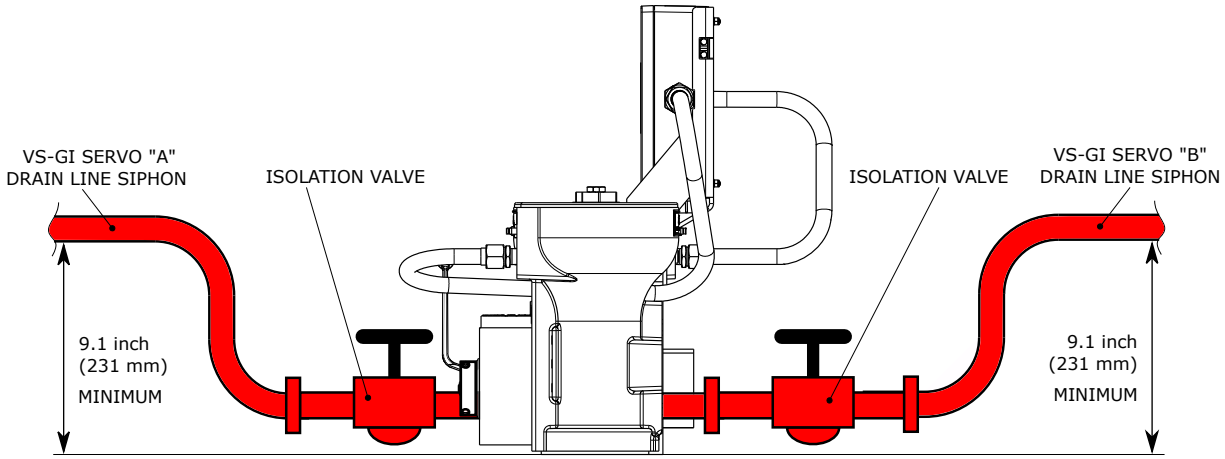

Figure 3-10. VS-GI Servos Siphons

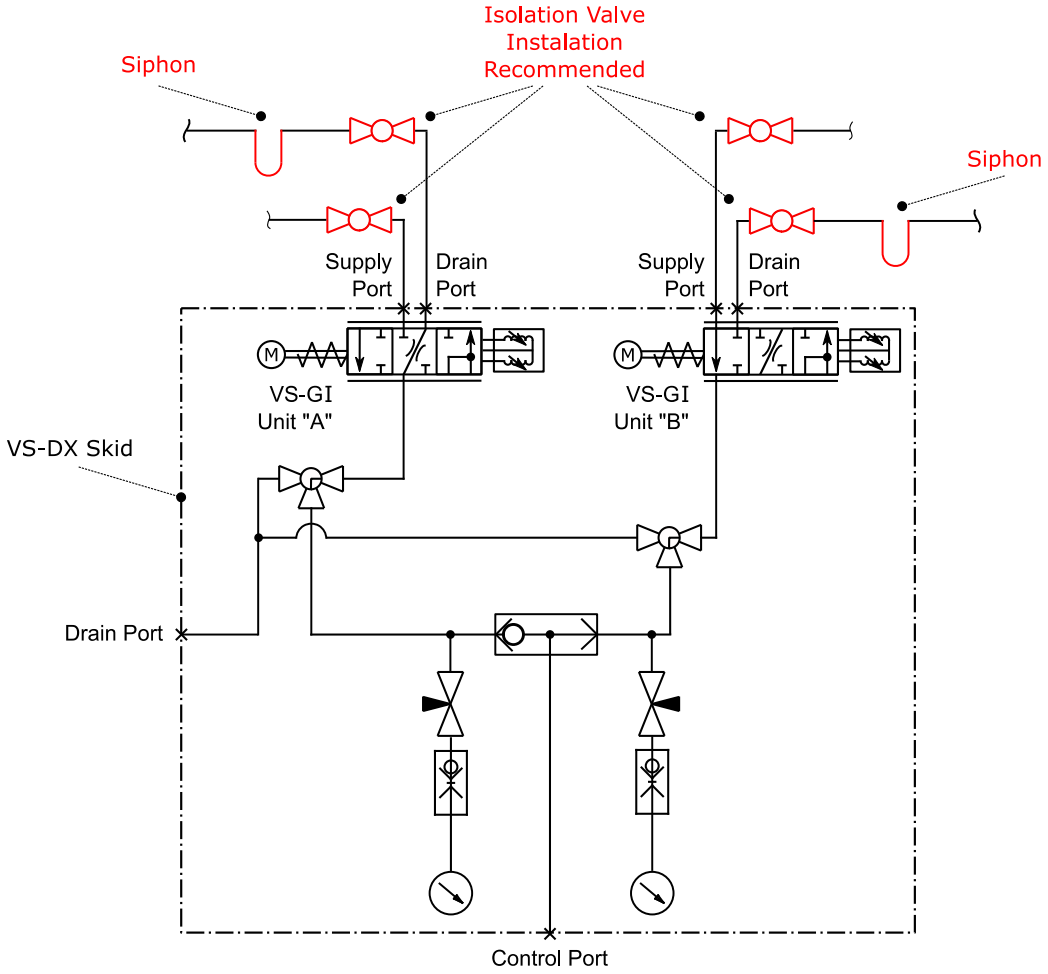

Figure 3-11. Process Piping – Siphons and Isolation Valves

Electrical Connections

⚠WARNING

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Review all applicable Special Conditions of Safe Use listed in the Regulatory Compliance chapter.

⚠WARNING

Protect Critical Enclosure Joints

Take care not to damage the junction box or VS-GI servo cover sealing surfaces or threads during removal or installation. Damage to these joints may compromise the ingress or explosion protection ratings of the product. Prior to replacing the cover(s), inspect the seal and mating faces on each part. Clean the surfaces with rubbing alcohol if necessary.
Proper torque is critical for the function of these joints. Review Figure 3-12 for details.

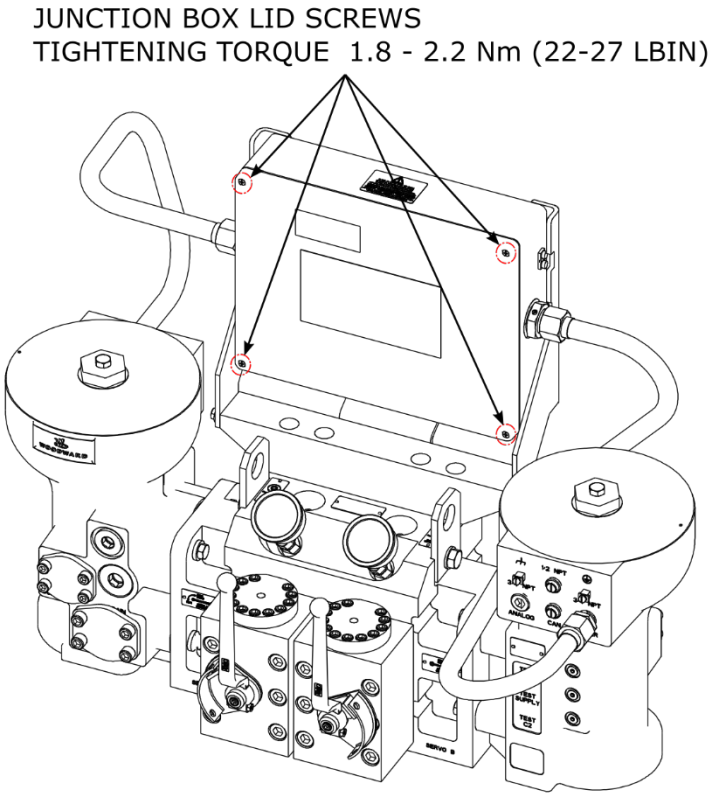

Figure 3-12. Junction Box Lid Screws Tightening Torque

Apply local procedures, codes, and directives for installing electrical/electronic equipment and, where applicable, for installing devices in hazardous environments.

VS-DX models are available with and without an electrical junction box. This manual will primarily address electrical considerations for the version with a junction box, with references to the VS-GI manual 35119 for models without a junction box.

The VS-DX version with junction box features an electrical terminal box with four (4) 3/4 NPT conduit hub entry points for the customer wiring.

Wiring Requirements:

- Individually shielded twisted pair cable
- Use screened cable for all analog signals, and avoid routing power supply wires and signal wires within the same conduit and entry hub
- Wire Gauge Range: (0.14 to 6) mm² / (26 to 10) AWG

Make all electrical, signal, and grounding connections in accordance with Figures 3-13 through Figure 3-19.

The wiring for the VS-DX skid is shown in Figures 3-14, 3-15, and 3-16. The required minimum wiring for proper operation is as follows:

- Supply power (18 to 32) VDC, 24 VDC nominal for each converter
- Analog setpoint (4 to 20) mA into 200 Ω. 70 dB CMRR. Common Mode Voltage Range: ±50 VDC for each servo
- Master designation discrete input + & - for each servo
- Redundant link input and output for each servo (factory provided on junction box version)
- Power cylinder position feedback

IMPORTANT

During operation, the setpoint signals to both servos must be nearly identical to avoid unexpected actuator position disturbance after control switchover between VariStroke-DX skid servos.

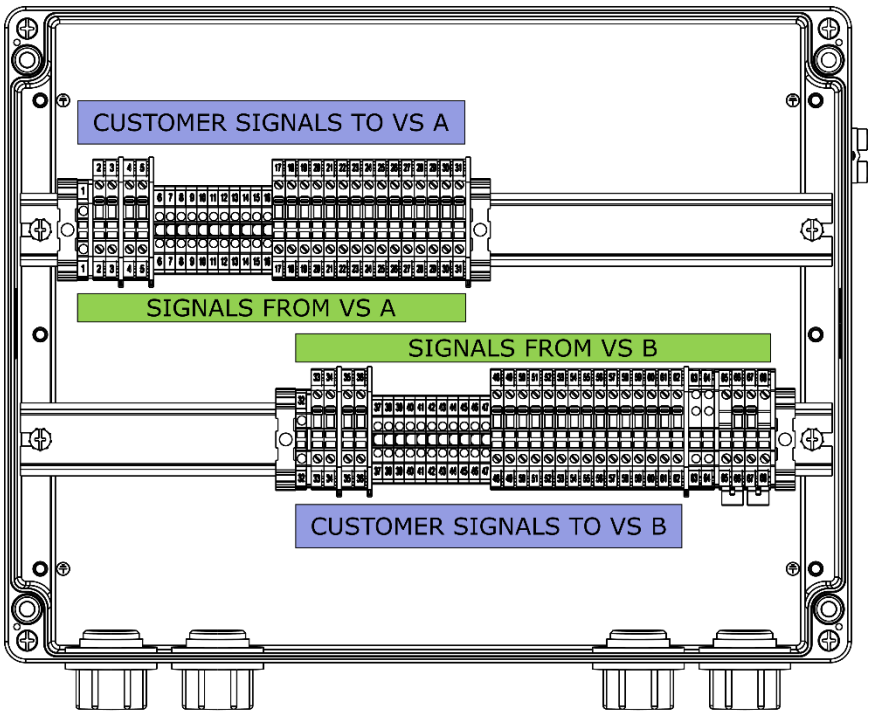

Figure 3-13. VariStroke-DX, Junction Box Version, Main Terminal Box, Wiring Points Access

CONNECTIONS CHART

CABLE WOODWARD P/N	TERMINAL NO	CONDUCTOR WIRE COLOUR	WIRE SIZE (AWG)	SIGNAL	
5450-2161	1	GREEN/YELLOW	16	VARISTROKE-GI UNIT "A" GROUNDING	VARISTROKE-GI "A" POWER
	2	RED	16	VARISTROKE-GI UNIT "A" 24 VDC 1 POWER +	
	3	BLACK	16	VARISTROKE-GI UNIT "A" 24 VDC 1 POWER -	
	4	BROWN	16	VARISTROKE-GI UNIT "A" 24 VDC 2 POWER +	
	5	BLUE	16	VARISTROKE-GI UNIT "A" 24 VDC 2 POWER -	
	6	VIOLET	22	VARISTROKE-GI UNIT "A" ANALOG IN 1 PWR -	VARISTROKE-GI "A" ANALOG INPUTS
	7	BLUE	22	VARISTROKE-GI UNIT "A" ANALOG IN 1 SIG -	
	8	BROWN	22	VARISTROKE-GI UNIT "A" ANALOG IN 1 SIG +	
	9	ORANGE	22	VARISTROKE-GI UNIT "A" ANALOG IN 1 PWR +	
	10	PINK	22	VARISTROKE-GI UNIT "A" ANALOG IN 2 PWR -	
	11	GRAY	22	VARISTROKE-GI UNIT "A" ANALOG IN 2 SIG -	
	12	TAN	22	VARISTROKE-GI UNIT "A" ANALOG IN 2 SIG +	
	13	RED/GREEN	22	VARISTROKE-GI UNIT "A" ANALOG IN 2 PWR +	
	14	WHITE/GRAY	22	VARISTROKE-GI UNIT "A" DISCRETE IN RUN ENABLE IN	VARISTROKE-GI "A" DISCRETE INPUTS
	15	WHITE/VIOLET	22	VARISTROKE-GI UNIT "A" DISCRETE IN RESET	
	16	WHITE/BLACK/GREEN	22	VARISTROKE-GI UNIT "A" DISCRETE IN MASTER UNIT DESIG	
	17	SHIELD		VARISTROKE-GI UNIT "A" ANALOG IN 1 DEMAND SHLD	VARISTROKE-GI "A" ANALOG INPUTS
	18	BLACK	22	VARISTROKE-GI UNIT "A" ANALOG IN 1 DEMAND -	
	19	RED	22	VARISTROKE-GI UNIT "A" ANALOG IN 1 DEMAND +	
	20	SHIELD		VARISTROKE-GI UNIT "A" ANALOG IN 2 DEMAND SHLD	
	21	BLACK	22	VARISTROKE-GI UNIT "A" ANALOG IN 2 DEMAND -	
	22	WHITE	22	VARISTROKE-GI UNIT "A" ANALOG IN 2 DEMAND +	
	23	RED/YELLOW	22	VARISTROKE-GI UNIT "A" DISCRETE OUT ALARM -	VARISTROKE-GI "A" DISCRETE OUTPUTS
	24	RED/BLACK	22	VARISTROKE-GI UNIT "A" DISCRETE OUT ALARM +	
	25	WHITE/BLACK	22	VARISTROKE-GI UNIT "A" DISCRETE OUT SHUTDOWN -	
	26	WHITE/RED	22	VARISTROKE-GI UNIT "A" DISCRETE OUT SHUTDOWN +	
	27	WHITE/BLUE	22	VARISTROKE-GI UNIT "A" DISCRETE OUT IN CONTROL -	
	28	WHITE/BROWN	22	VARISTROKE-GI UNIT "A" DISCRETE OUT IN CONTROL +	
	29	SHIELD		VARISTROKE-GI UNIT "A" ANALOG OUT SHLD	VARISTROKE-GI "A" ANALOG OUTPUTS
	30	GREEN	22	VARISTROKE-GI UNIT "A" ANALOG OUT -	
	31	BLACK	22	VARISTROKE-GI UNIT "A" ANALOG OUT +	
5450-2162	32	GREEN/YELLOW	16	VARISTROKE-GI UNIT "B" GROUNDING	VARISTROKE-GI "B" POWER
	33	RED	16	VARISTROKE-GI UNIT "B" 24 VDC 1 POWER +	
	34	BLACK	16	VARISTROKE-GI UNIT "B" 24 VDC 1 POWER -	
	35	BROWN	16	VARISTROKE-GI UNIT "B" 24 VDC 2 POWER +	
	36	BLUE	16	VARISTROKE-GI UNIT "B" 24 VDC 2 POWER -	
	37	VIOLET	22	VARISTROKE-GI UNIT "B" ANALOG IN 1 PWR -	VARISTROKE-GI "B" ANALOG INPUTS
	38	BLUE	22	VARISTROKE-GI UNIT "B" ANALOG IN 1 SIG -	
	39	BROWN	22	VARISTROKE-GI UNIT "B" ANALOG IN 1 SIG +	
	40	ORANGE	22	VARISTROKE-GI UNIT "B" ANALOG IN 1 PWR +	
	41	PINK	22	VARISTROKE-GI UNIT "B" ANALOG IN 2 PWR -	
	42	GRAY	22	VARISTROKE-GI UNIT "B" ANALOG IN 2 SIG -	
	43	TAN	22	VARISTROKE-GI UNIT "B" ANALOG IN 2 SIG +	
	44	RED/GREEN	22	VARISTROKE-GI UNIT "B" ANALOG IN 2 PWR +	
	45	WHITE/GRAY	22	VARISTROKE-GI UNIT "B" DISCRETE IN RUN ENABLE IN	VARISTROKE-GI "B" DISCRETE IN
	46	WHITE/VIOLET	22	VARISTROKE-GI UNIT "B" DISCRETE IN RESET	
	47	WHITE/BLACK/GREEN	22	VARISTROKE-GI UNIT "B" DISCRETE IN MASTER UNIT DESIG	
	48	SHIELD		VARISTROKE-GI UNIT "B" ANALOG IN 1 DEMAND SHLD	VARISTROKE-GI "B" ANALOG IN
	49	BLACK	22	VARISTROKE-GI UNIT "B" ANALOG IN 1 DEMAND -	
	50	RED	22	VARISTROKE-GI UNIT "B" ANALOG IN 1 DEMAND +	
	51	SHIELD		VARISTROKE-GI UNIT "B" ANALOG IN 2 DEMAND SHLD	
	52	BLACK	22	VARISTROKE-GI UNIT "B" ANALOG IN 2 DEMAND -	
	53	WHITE	22	VARISTROKE-GI UNIT "B" ANALOG IN 2 DEMAND +	
	54	RED/YELLOW	22	VARISTROKE-GI UNIT "B" DISCRETE OUT ALARM -	VARISTROKE-GI "B" DISCRETE IN
	55	RED/BLACK	22	VARISTROKE-GI UNIT "B" DISCRETE OUT ALARM +	
	56	WHITE/BLACK	22	VARISTROKE-GI UNIT "B" DISCRETE OUT SHUTDOWN -	
	57	WHITE/RED	22	VARISTROKE-GI UNIT "B" DISCRETE OUT SHUTDOWN +	
	58	WHITE/BLUE	22	VARISTROKE-GI UNIT "B" DISCRETE OUT IN CONTROL -	
	59	WHITE/BROWN	22	VARISTROKE-GI UNIT "B" DISCRETE OUT IN CONTROL +	
	60	SHIELD		VARISTROKE-GI UNIT "B" ANALOG OUT SHLD	VARISTROKE-GI "B" ANALOG OUT
	61	GREEN	22	VARISTROKE-GI UNIT "B" ANALOG OUT -	
	62	BLACK	22	VARISTROKE-GI UNIT "B" ANALOG OUT +	
5450-2161	63	WHITE/ORANGE	22	VARISTROKE-GI UNIT "A" DISCRETE IN DIGITAL GND	VARISTROKE-GI "A"/ "B" REDUNDANT SIGNALS
5450-2162		WHITE/GREEN	22	VARISTROKE-GI UNIT "B" DISCRETE OUT RENDUNDANT LINK OUT-	
5450-2161	64	WHITE/GREEN	22	VARISTROKE-GI UNIT "A" DISCRETE OUT RENDUNDANT LINK OUT-	
5450-2162		WHITE/ORANGE	22	VARISTROKE-GI UNIT "B" DISCRETE IN DIGITAL GND	
5450-2161	65	WHITE/BLACK/RED	22	VARISTROKE-GI UNIT "A" DISCRETE IN REDUNDANT LINK IN	
5450-2162	66	WHITE/YELLOW	22	VARISTROKE-GI UNIT "B" DISCRETE OUT REDUNDANT LINK OUT+	
5450-2161	67	WHITE/YELLOW	22	VARISTROKE-GI UNIT "A" DISCRETE OUT REDUNDANT LINK OUT+	
5450-2162	68	WHITE/BLACK/RED	22	VARISTROKE-GI UNIT "B" DISCRETE IN REDUNDANT LINK IN	

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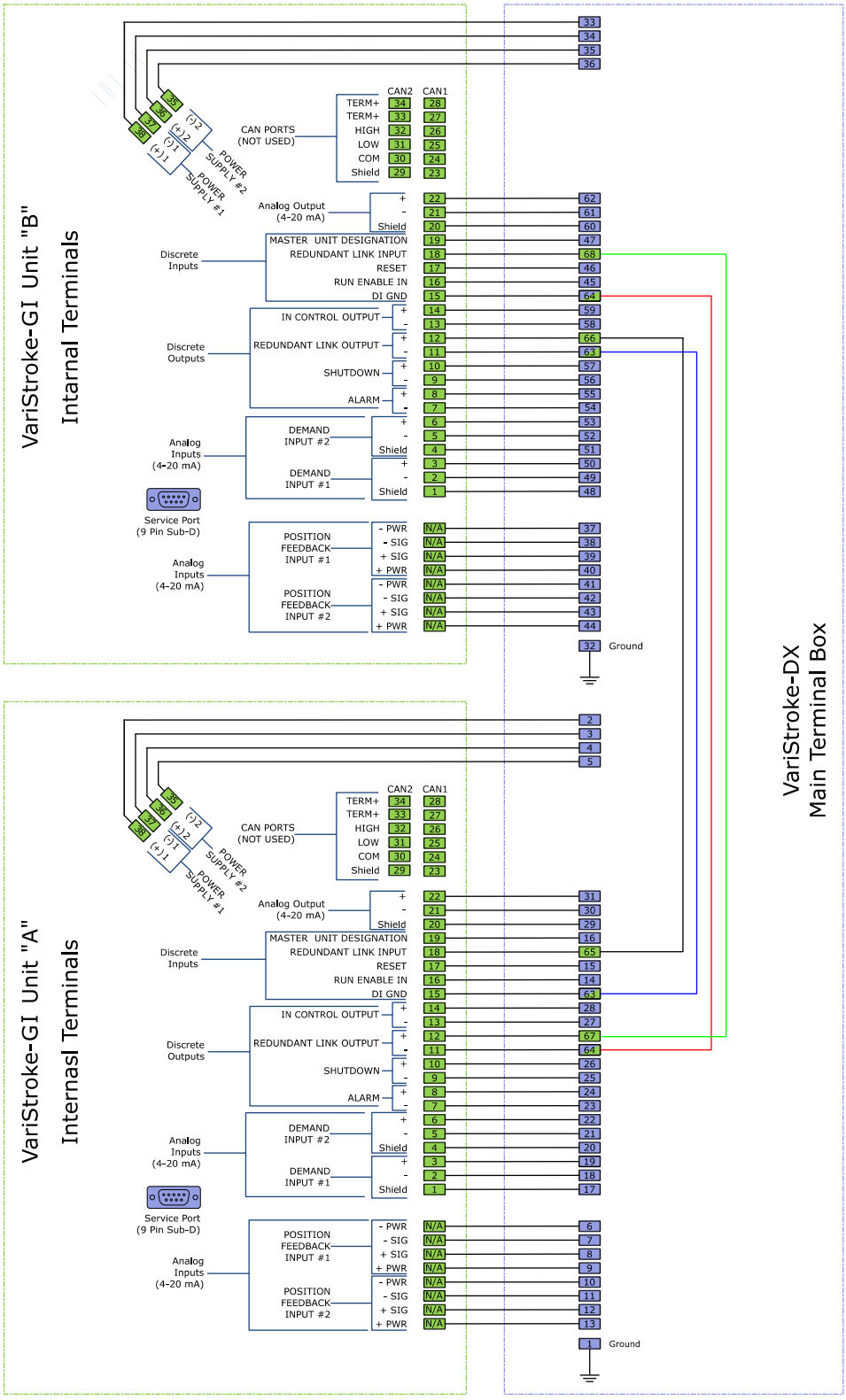
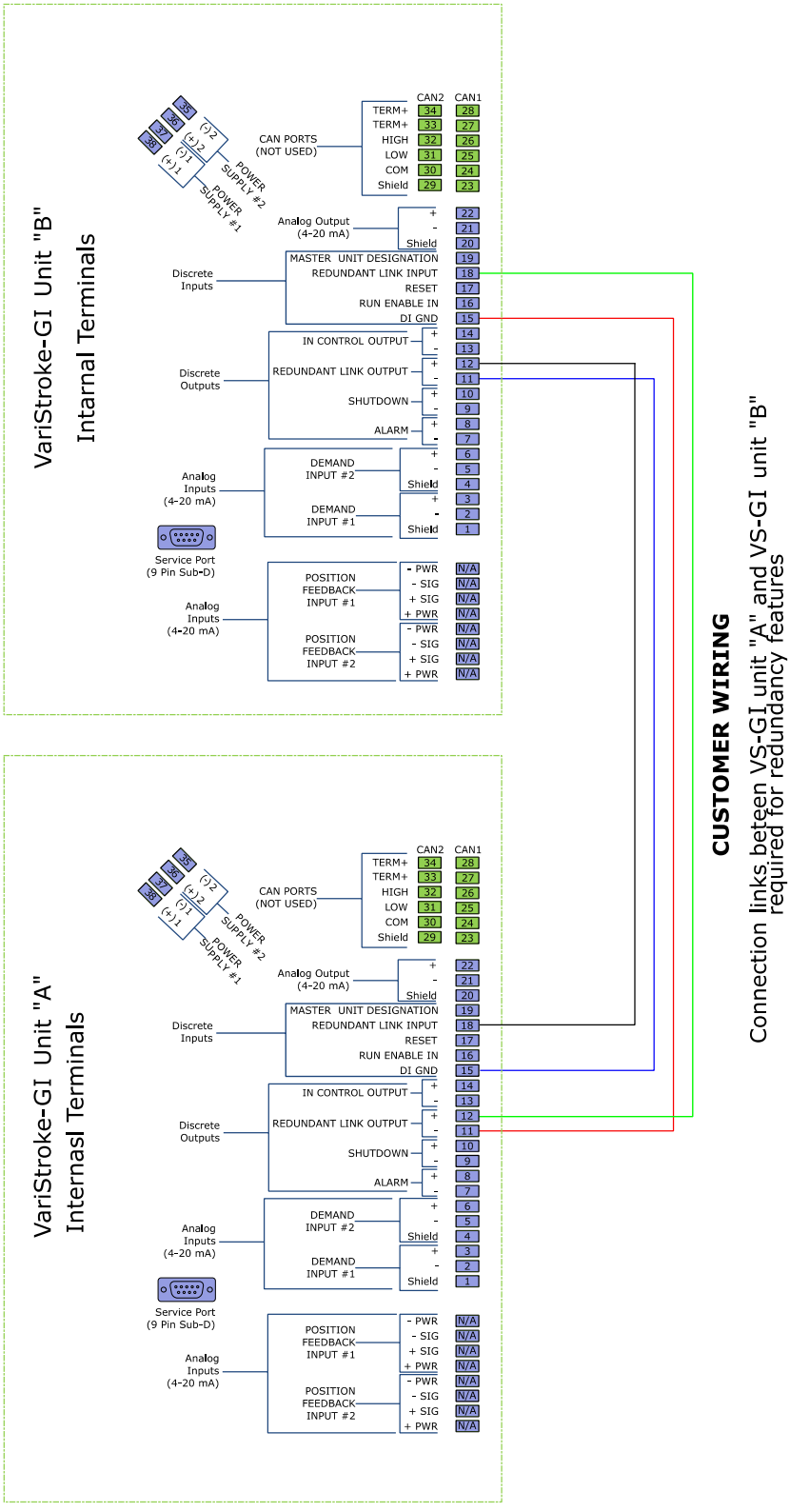
Figure 3-14. VariStroke-DX, Junction Box Version, Main Terminal Block Connections Chart



Terminal color codes:

- Customer accessible terminal
- VS-DX internal terminal - no accesible for customer

Figure 3-15. VariStroke-DX, Junction Box Version, Wiring Diagram



Terminal color codes:

- Customer accessible terminal
- VS-DX internal terminal - no accesible for customer

Figure 3-16. VariStroke-DX, VariStroke-DX, Without Junction Box Version, Wiring Diagram

Shielded Wiring

Use shielded cable for all analog signals and the RS-232 service port. Terminate shields as shown in the following sections. Avoid routing power supply wires and signal wires within the same conduit unless properly shielded. When bundling the field wiring inside the servo, separate the unshielded power and discrete inputs/outputs from the shielded analog signals and RS-232.

Wiring

The cable insulation of all wiring must have a temperature rating of at least 90C.

When preparing cables for VS-DX with junction box:

1. Strip the cable insulation/jacket (not the wire insulation) to expose 12 cm of the conductors. Strip the wire insulation 5 mm from each conductor. Mark the wires according to their designation.

2. Remove the top access cover from junction box. Pass the wires through the appropriate conduit hub and sealing device (not provided) and attach to the terminal blocks in accordance with the wiring diagrams (see Figures 3-4 and 3-5). Tighten the terminal block flange screws to 0.5 ±0.1 Nm (4.4 ±0.9 LBIN). Reinstall the junction box cover and tighten screws firmly.

3. Install the PE ground and EMC ground straps to the lugs provided. Tighten to 5.1 Nm (45 LBIN).

Input Power

The VS-DX requires an electrical power source capable of a supplying the necessary output voltage and current at full transient conditions. For each VS-GI servo, the electrical power supply should be able to provide 3.1 A at 18 VDC continuously, with a peak of 10 A maximum transient. Refer to Table 3-2 for recommended fuse ratings and circuit breakers.

Use a separate electrical power source and switch for each VS-GI servo. To supply power use terminal blocks:

- 2, 3, or/and 4, 5 (when using redundant supply source) for servo VS-GI “A”
- 33, 34 or/and 35, 36 (when using redundant supply source) for servo VS-GI “B”

NOTICE

Each VS-GI servo should be powered from separate power sources with a switch at the power source in order to safely service the unit.

Table 3-2. Recommended Fuse Ratings or Circuit Breakers.

Component	Input Voltage	Maximum Transient Input Current	Maximum Power	Maximum Slow Blow Fuse / C.B. Rating
VS-I servo “A”	(18 to 32) VDC, 24 VDC nominal	10 A	340 W (100 ms)	20% above steady state current
VS-I servo “B”	(18 to 32) VDC, 24 VDC nominal	10 A	340 W (100 ms)	20% above steady state current

For more information on input power requirements, see Woodward manual 35119 for the VS-GI servo.

Discrete Inputs

Each VS-GI has four discrete inputs. External power is not necessary for these inputs as the isolation is provided internally. The discrete inputs have an internal pull-up resistor and are inverted at the processor, such that an open circuit is the passive low state. The high state is achieved when the input is pulled low by an external contact to the isolated ground terminal provided. There are four inputs and one ground terminal.

Only one (DI GND) is provided, so it is necessary to share the one ground if more than one input is used.

Master Designation Input (Discrete Input 4) determines if the VS-GI is the master or slave in a redundant configuration. Woodward recommends using two Digital Outputs from the DCS for commanding master/slave towards each VariStroke. The DCS must always give simultaneously opposite signals to each VariStroke servo.

⚠WARNING

Master/Slave

Do not command "be slave" signal to both VariStrokes. It will make the system inoperable - neither VariStroke will be controlling Cylinder position.

Do not command "be master" signal to both VariStrokes. It can cause performance decrease and can cause unstable unit operation.

Redundant Link Input (Discrete Input 3) is dedicated to a redundant pair configuration. The two VS-GI's communicate which servo is in control via a pulse train on these discrete lines. Redundant Link Input must be wired to Redundant Link Output (Discrete Output 1) of the other servo. This wiring is provided from the factory, but must remain in place for the switching performance to operate as designed.

⚠WARNING

Never disconnect the redundancy link between VS-GIs when BOTH servos are powered. This will cause redundancy logic not to work properly as master-standby configuration and both servos (VS-GIs) would simultaneously operate InControl state (control process). It can cause performance decrease and can cause unstable servo operation.

Discrete Outputs

Discrete Output 1, is dedicated to the pulse train output for use in redundant configurations. It cannot be configured by the user.

Discrete Output 2 for VS-DX skid is configured as "In Operation" annunciation. It cannot be configured by the user.

Unit Grounding

The junction box must be grounded using the designated PE ground connection point. PE ground connection point is located on the sidewall of the junction box. Use the required wire type (typically green/yellow, 3 to 6 mm² / 12 to 10 AWG) as necessary to meet the installation safety ground requirements. Torque the ground lug to 5.1 Nm (45 LBIN).

NOTICE

Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagrams.

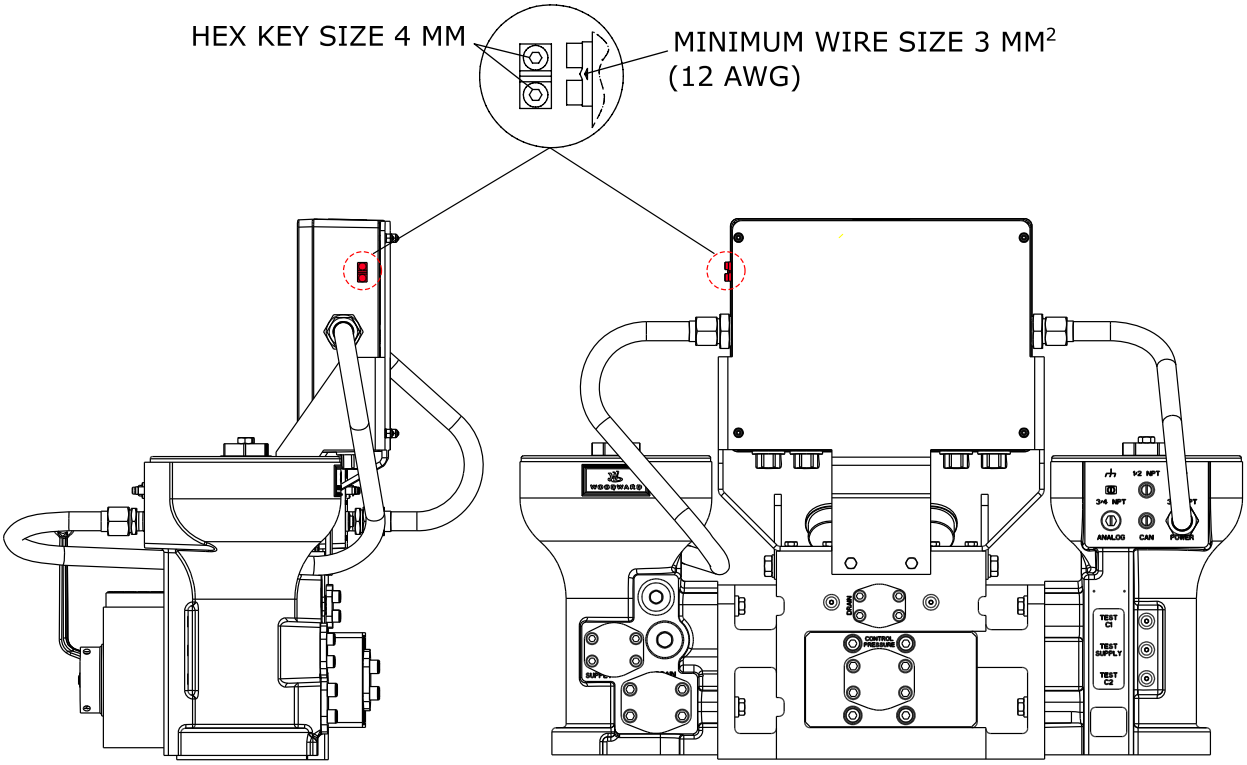


Figure 3-17. VS-DX PE Ground Connection, Junction Box Version

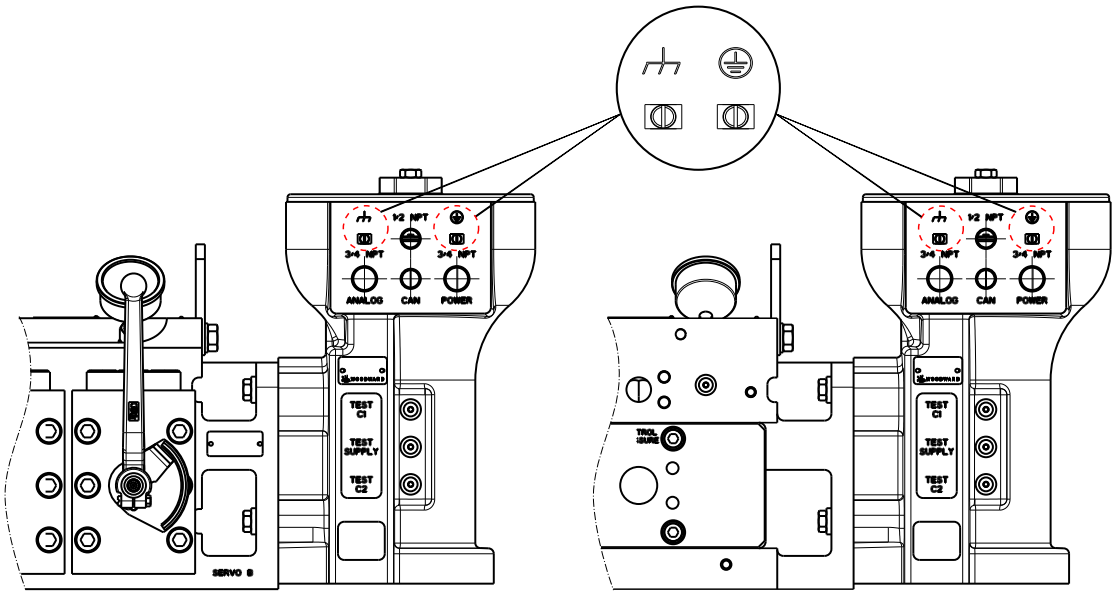


Figure 3-18. VS-DX PE / Chassis Ground Connection
Without Junction Box Version (On Both VS-GI Servos)

Power Cylinder Electrical Connection with VS-DX

Connect leads from the power cylinder (e.g. Woodward VHPC) according to the wire diagram shown in Figure 3-9. For more details using Woodward VHPC, refer to manual **35163**.

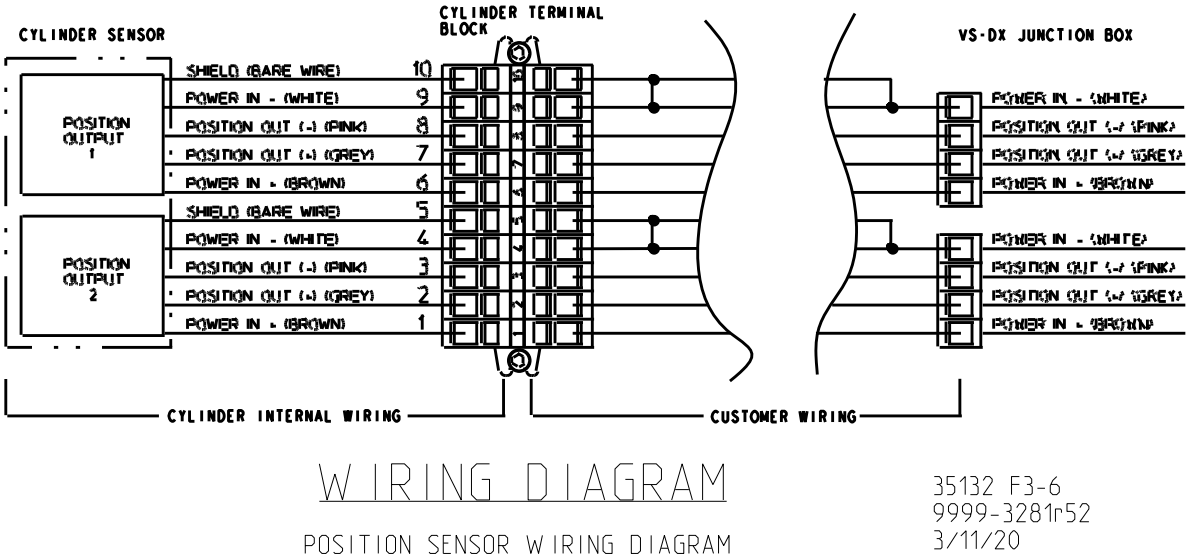


Figure 3-19. Cylinder Position Sensor Connection Scheme
(Woodward VHPC Shown)

WARNING

RISK OF SHOCK AND DECREASED EMC PERFORMANCE

All bare shield wires of the field wiring cable must be isolated from the Power Cylinder chassis, or any conduit used. Woodward recommends using suitably rated heat shrink tubing on the shield wire when connecting at the terminal block, as well as tubing over the length of the customer cable. Failure to isolate the shield wire results in a connection of BAT- to the cylinder chassis.

An electrical short of the bare shield wire to chassis could lead to:

- **Decreased EMC performance and read-out accuracy.**
- **A hazardous accessible voltage on the external cylinder chassis which could result in electric shock. The severity of this shock risk is dependent upon each installation, configurations of servo battery supply and grounding, and the bonding provided by installation of the power cylinder.**

Chapter 4.
Operation

⚠WARNING

Only trained personnel should be allowed to work on this device during operation. An improperly calibrated control could cause an overspeed or other damage to the prime mover. To prevent possible serious injury from an overspeeding prime mover, read and follow this entire procedure before starting the prime mover.

⚠WARNING

Automatic process control should not be activated until the commissioning procedure and calibration process for both servos is complete. Incorrect operation or improper tuning could cause erratic operation when the system is operated automatically by the turbine control system.

⚠WARNING

Overspeed / Overpressure

Never close the drain line when supply pressure is present on the VS-GI servo, otherwise the control output pressure can increase suddenly and cannot be controlled by the input setpoint. This could cause the turbine to overspeed. The supply pressure isolation valve and the control pressure isolation valve should always be closed prior to closing the drain line.

⚠WARNING

The "*Master/Slave*" indication shows only which servo is designated for primary operation from the control system. Because it is possible for the slave to be in control, the user must confirm which servo is controlling the skid output via the external gauges and the "In Control" discrete output status.

IMPORTANT

Carefully review Woodward Manual 35148 (VS-I Customer Service Tool User Manual) before commissioning the VariStroke-DX or connecting to the VariStroke communication port.

IMPORTANT

Best practice is to keep settings files saved from each VariStroke in Plant. Files shall be saved and stored after each successful/finalized configuration change or calibration performed. This is to have settings backup in case of unit replacement or further configuration modifications causing improper behavior.

⚠WARNING

Sudden Movement

Stay clear of the actuator output shaft and all equipment that may be actuated by the Discrete or Analog Output, as sudden movement can occur at any time during initial operation and calibration.

Special consideration should be used in the following scenarios:

- **The VS-DX can be controlled remotely, therefor follow all LOTO (LockOut/TagOut) procedures prior to connecting to internal servo RS-232 communication ports.**
- **All outputs are capable of changing states in Run Mode. Any outputs connected to the VS-DX can suddenly move with this change of state. Use caution when using this feature.**
- **Clearing diagnostics may change the state of device outputs.**
- **Entering manual modes and/or changing modes may change the state of device outputs.**
- **VS-GI servo will be switch to the shutdown condition when control signal is set or drop below 2 mA.**

Failure to anticipate sudden movement can lead to property damage, personal injury, or death.

IMPORTANT

Operation with Contaminated Oil

When VS-DX is expected to operate with contaminated oil, Woodward recommends the following best practices:

- **Switch control periodically between VS-GI servos to help flush sediment buildup from the VS-DX skid.**
- **Configure the SiltBuster function on both VS-GI servos so the servos perform a periodic self-cleaning activity to release buildup of contamination, if any (see manual 35148 for more details).**
- **Connect discrete output that signals for internal faults (Shutdown, Alarm) to the turbine control system. This will ensure that both servos are functioning at the time of Master/Slave switchover.**

VS-DX Configuration and Calibration

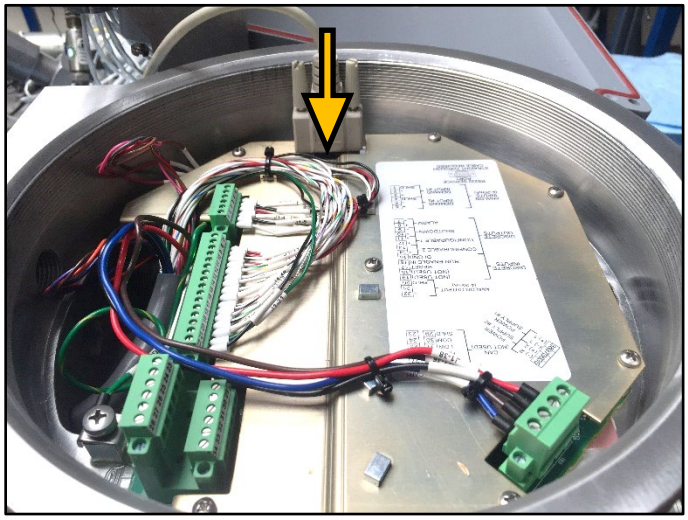
When commissioning the VS-DX skid, each VS-GI servo (Servo “A” and Servo “B”) must be configured and calibrated separately using the VS-I Customer Service Tool (see Woodward manual 35148).

Perform the following steps to access the RS-232 service port on the VS-GI servo:

1. Loosen the set screw from the VariStroke servo cover (1.5mm socket hex). Do not remove the set screw.

2. Loosen the VariStroke servo cover using a large adjustable wrench (2 1/4 in hex, counterclockwise direction).

3. Connect the communication cable to the VariStroke communication port.



To perform VS servo calibration please follow procedure steps according to Woodward manual 35148 *VS-GI Customer Service Tool User Manual*.

Once calibration is complete, several master/slave control transfers should be completed between both VS-GI's with a common demand position signal of 12 mA to ensure that the output of both VS-GI's responds correctly to a switching demand but also damps quickly and is stable after transfer.

Re-install the servo covers and set screws with the torque/recommendation listed below:

-Servo cover tightening torque: 90 to 110 LBFT

-Servo cover set screw thread into the cover until the end of the screw is flush with the top surface of the cover

To aid with calibration, pressure gages are provided on the skid assembly (see Figure 4-1). These gages indicate which servo is in control. If necessary, each pressure gauge could be isolated using dedicated manual isolation valve.

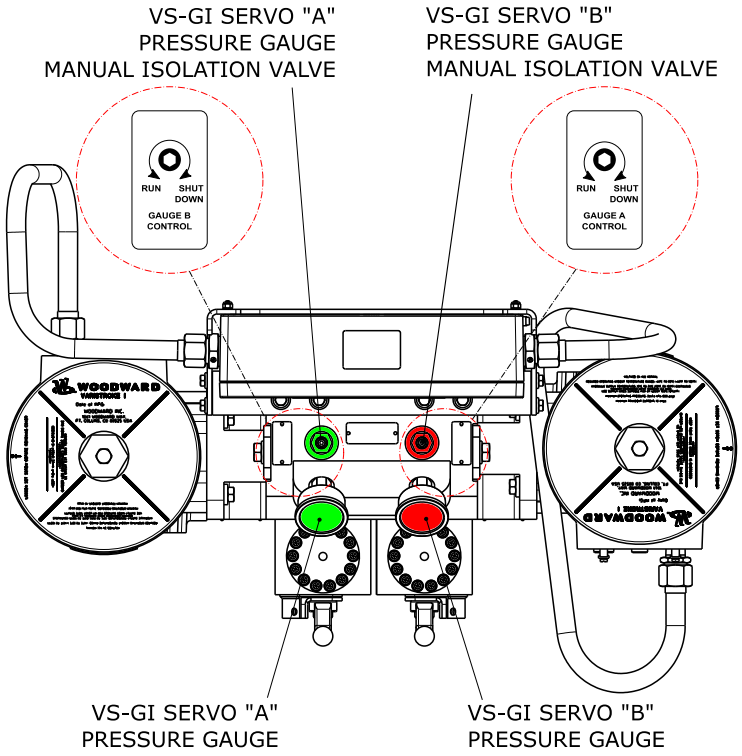


Figure 4-1. VS-DX Skid Pressure Gauges and the Location of its Isolation Valves

VS-DX Commissioning Procedure

The following procedure should be performed in the order as stated while commissioning the VS-DX skid:

1. Review all warnings in this chapter and the installation chapter prior to beginning work.
2. Shut down and tag out the turbine or controlled process according to site operating procedures.
3. Install the VS-DX skid in according to instructions in Chapter 3.
4. Make all necessary hydraulic and electric connections.
5. Close and tag out the VS-DX skid control isolation valves (of servo A and servo B). See Figure 4-3 for RUN/SHUT DOWN orientations.

Varistroke "A"
1. Servo valve
2. Pressure gauge isolation valve
3. Pressure gauge
4. Control port isolation valve

Varistroke "B"
5. Servo valve
6. Pressure gauge isolation valve
7. Pressure gauge
8. Control port isolation valve

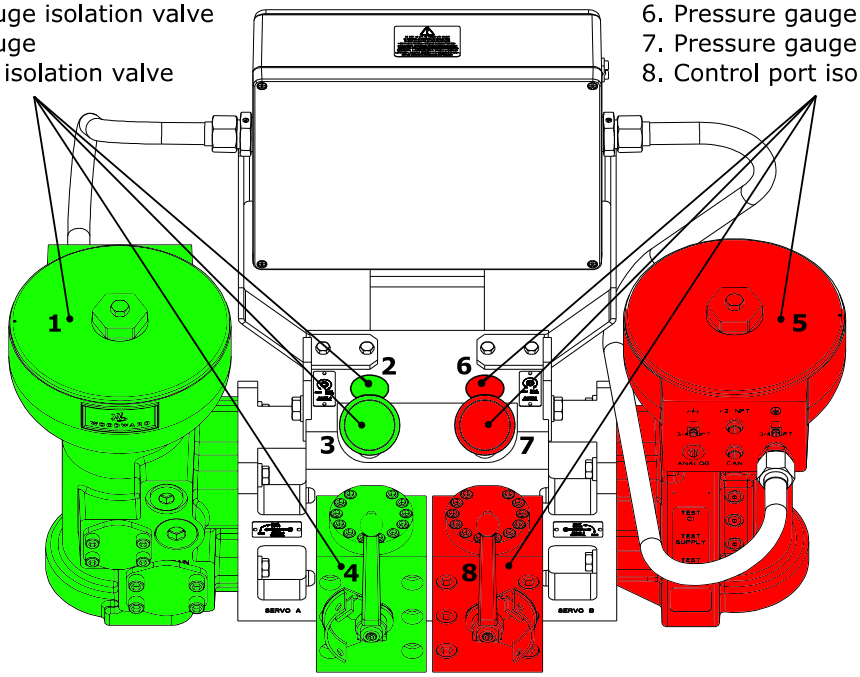


Figure 4-2. VS-DX Servo A and B Components

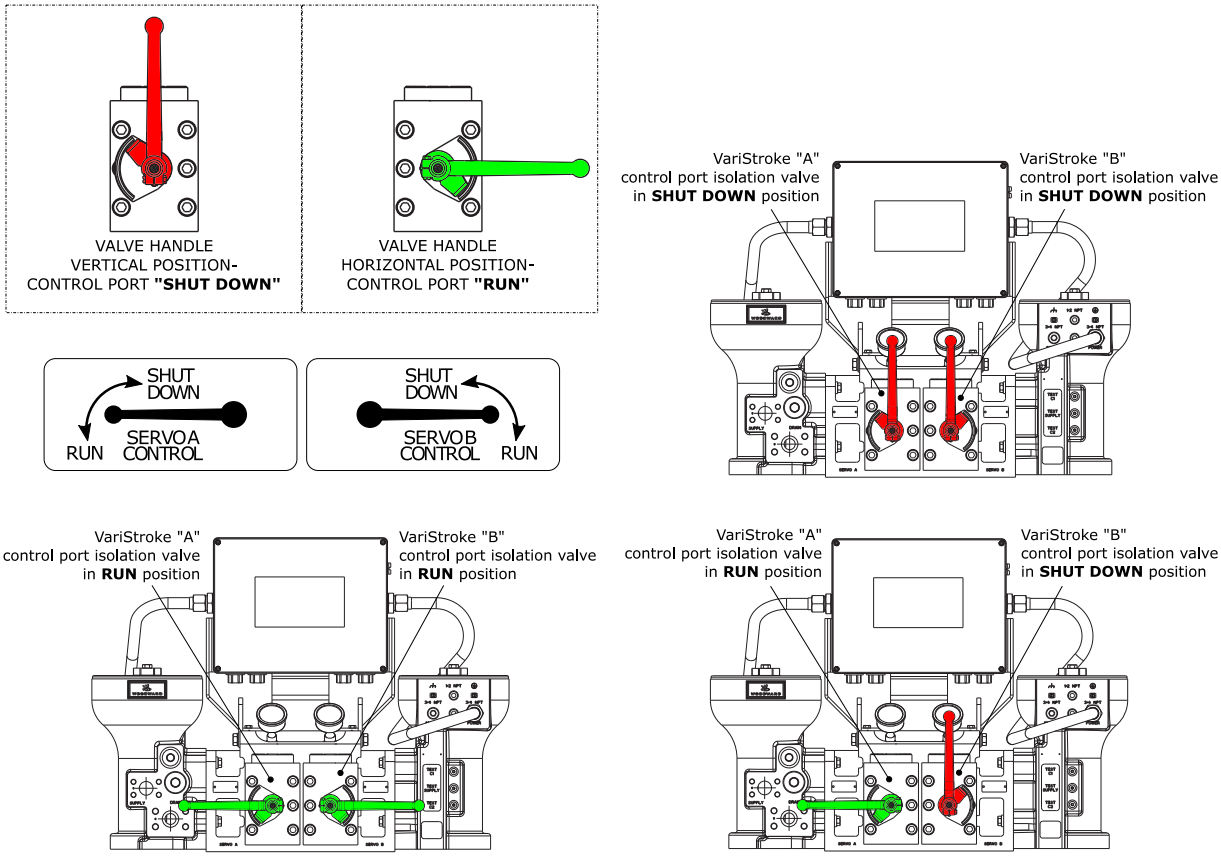


Figure 4-3. VS-DX Isolation Valves Positions

6. Slowly open the drain isolation valves (not provided) on process lines connected to VS-DX skid (to both VS-GI servos).
7. Slowly open supply isolation valves (not provided) on process lines connected to VS-DX skid (to both VS-GI servos).

WARNING

Make sure that proper control isolation valve is closed, locked out, and tagged, and turbine or control process is in a shutdown condition during the VS-GI installation or VS-DX skid maintenance.

WARNING

Make sure that VS-DX skid and VS-GI servos drain port are opened before supply valves opening.

8. Slowly increase supply pressure to VS-DX skid.
9. Inspect all hydraulic connections to ensure there are no leaks.
10. Switch on power supply 24 VDC to the VS-GI servo “A”.
11. Use the internal RS-232 port to communicate with VS-GI servo “A” (see Chapter 3 for access instructions).
12. Switch Master Designation to servo “A” (see Chapter 3 for electrical connections).
13. Confirm using the Customer Service Tool that VS-GI servo “A” is in control mode.

Use the Customer Service Tool to configure VS-GI servo “A” (see Woodward Manual 35148 for instructions):

a. Adjust the Minimum and Maximum Demand In signal (4...20 mA input)
b. Input signals required for VS-GI servo operation
c. Discrete inputs and outputs of the VS-GI servo
d. Adjust the supply pressure variable to match the system pressure level provided to the VS-DX skid

14. Slowly open VS-GI servo "A" Control Isolation Valve (lever in horizontal position).
15. Inspect all hydraulic connections to ensure there are no leaks.
16. Flush the entire control system to release all trapped air. Repeat this flushing procedure until stable servo operation is achieved (stable controlled actuator position).
17. Using the Customer Service Tool, complete the power cylinder calibration procedure (see Woodward Manual 35148 for instructions).
18. Store (download) the settings file of the configured servo VS-GI servo “A” for future use.
19. Slowly close the control isolation valve for VS-GI servo "A" (lever in vertical position position).
20. Switch on the power supply 24 VDC to VS-GI servo “B”.
21. Use the internal RS-232 port to communicate with VS-GI servo “B” (see Chapter 3 for access instructions).
22. Switch Master Designation to servo “B” (see Chapter 3 for electrical connections).
23. Confirm in the Customer Service Tool that VS-GI servo “B” is in control mode.
24. Use the Customer Service Tool to configure VS-GI servo “B” (see Woodward Manual 35148 for instructions):
    a. Adjust the Minimum and Maximum Demand In signal (4...20 mA input),
    b. Input signals required for VS-GI servo operation,
    c. Discrete inputs and outputs of the VS-GI servo,
    d. Adjust the supply pressure variable to match the system pressure level provided to the VS-DX skid,
25. Slowly open VS-GI servo “B” Control Isolation Valve (lever in horizontal position).
26. Inspect all hydraulic connections to ensure there are no leaks.
27. Flush the entire control system to release all trapped air. Repeat flushing procedure until stable servo operation is achieved (stable controlled actuator position).
28. Using the Customer Service Tool, complete the power cylinder calibration procedure (see Woodward Manual 35148 for instructions).
29. Store (download) the settings file from of the configured servo VS-GI servo “B” for future use.
30. Slowly open the control isolation valve for VS-GI servo “A” (now both isolation valves on VS-DX are open).

31. Inspect all hydraulic connections to ensure there are no leaks.
32. Perform several Master Designation transfers between both VS-GI servos with a demand signal of 12 mA to ensure that the control transfer is performing correctly and that the output is stable after transfers.
33. Repeat switching performance at high, mid, and low demand signal levels.
34. Power down the VS-GI servo currently In control mode, verify if the second servo takes control.
35. Repower the first VS-GI servo, verify servo resumes control.
36. Set second servo In control mode
37. Power down the second VS-GI servo, confirm that the first servo takes control.
38. Repower the second VS-GI servo, verify it resumes control.

To confirm which servo is actually in control of the VS-DX skid output pressure, the servo in control status should be verified by checking all of these items:

- The status of discrete output 2
- The status indication in the service tool
- The pressure indicated on the gauges

Disabling One of the VS-GI Servovalves

If a VS-GI servo fails or needs to be disabled, it can be locked out of the system using the control isolation valve. To ensure there is no electrical transient created on the servo in control, the user must power down the failed servo and isolate all its electrical connections inside VS-DX skid electrical terminal box using dedicated knife disconnect type terminals:

- VariStroke servo “A” terminals: 2, 3, 4, 5, 17, 18,19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31.

- VariStroke servo “B” terminals: 33, 34, 35, 36, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62.

To terminate the servo in the VS-DX skid without an electrical junction box, power down the respective servo and isolate below signals connected to servo:

Power Supply #1 : Respective terminals inside servo # 37, 38
Power Supply #2 : Respective terminals inside servo # 35, 36
Demand Input #1 : Respective terminals inside servo # 1, 2, 3
Demand Input #2 : Respective terminals inside servo # 4, 5, 6
Alarm: Respective terminals inside servo # 8, 7
Shutdown: respective terminals inside servo # 10, 9
In Control Output: Respective terminals inside servo # 13, 14
Analog Output: Respective terminals inside servo # 20, 21, 22

For a complete procedure on VS-GI servo replacement, see Woodward Component Maintenance Manual CMM-03013.

VS-DX Performance

The VS-DX skid has been characterized to optimize transfer time and pressure stabilization during servo to servo control switchover, whether this is commanded or automatic in a fault event. A special shuttle valve design provides “bumpless position” switchover between VS-GI servos which minimizes the disturbance on the power actuator or other control system position. Additionally, the advanced shuttle valve design provides high dirt tolerance and a leak tight construction.

Figures 4-6 and 4-7 show typical transfer performance of the VS-DX skid.

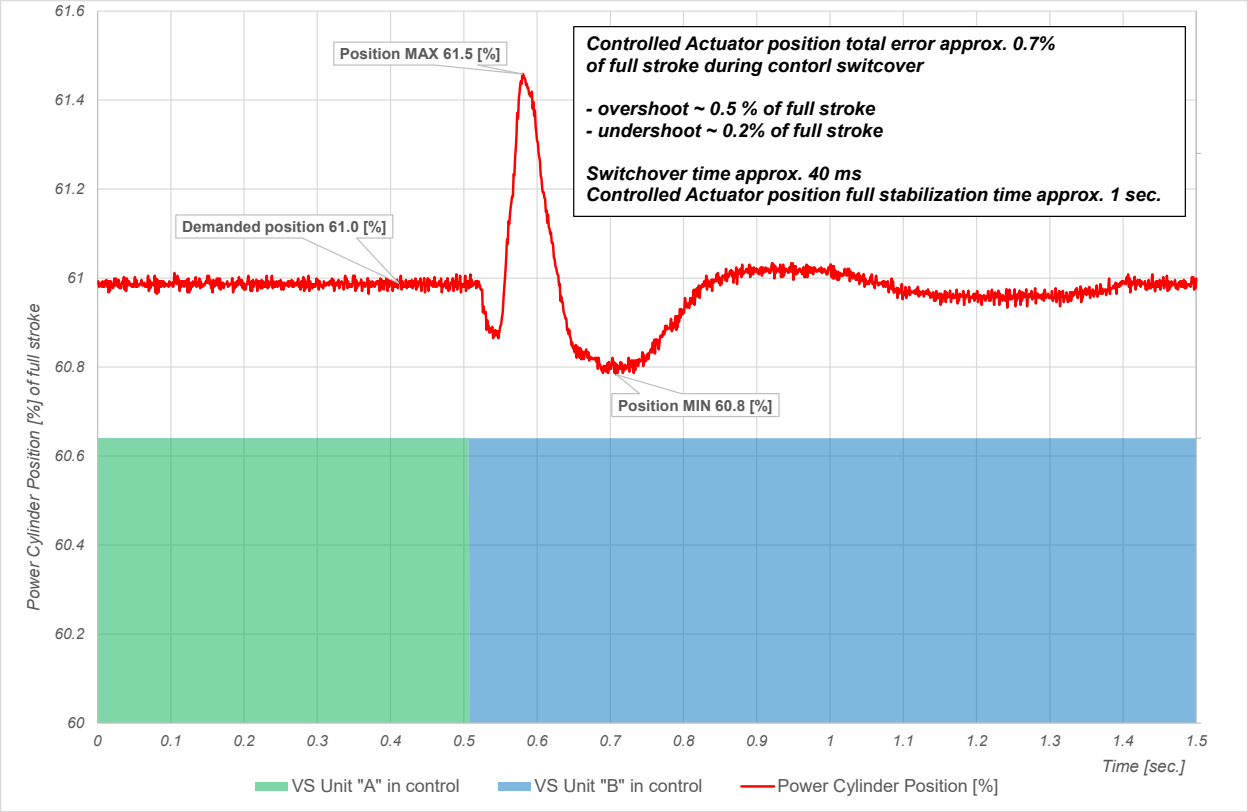


Figure 4-4. VS-DX Servo to Servo Control User Demanded Switchover Action Typical Performance

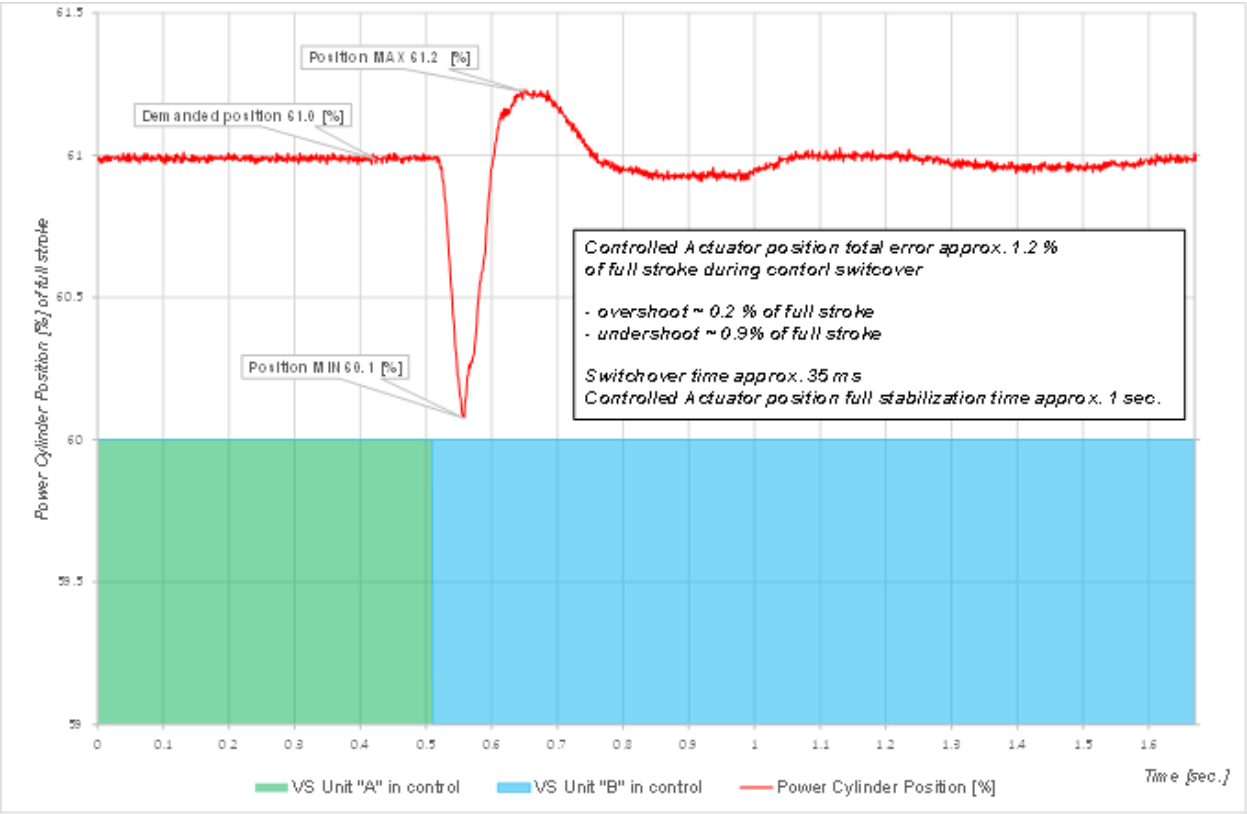


Figure 4-5. VS-DX Servo to Servo Control Switchover Action Typical Performance
(One Servo Shutdown)

VS-DX Skid Trapped Air Bleeding Procedure

NOTICE

Initiate the automatic air bleeding procedure only when the VS-GI servo is hydraulically isolated using the dedicated control isolation valve located on the VS-DX skid. Initiating this procedure without isolation could cause damage to the turbine hardware.

The automatic air bleeding procedure is required after on-line servo replacement (VS-GI firmware functionality is available with the Customer Service Tool. Initiate this procedure only when the servo is not controlling the process and is hydraulically isolated with respective control isolation valve.

See Woodward Component Maintenance Manual CMM-03013 *Bronze Level, VariStroke-DX (VS-DX)* and manual *35148 VS-GI Customer Service Tool User Manual* for details.

VS-DX Skid Configuration

To prepare to operate and configure each individual VS-GI servo, follow Woodward manual 35148 *VS-I Customer Service Tool User Manual.*

Chapter 5.
Repair and Troubleshooting

WARNING

Prior to beginning any work on the VS-DX, review all warnings and related safety content in the Installation and Operation chapters. Instructions provided in this chapter assume the user is already aware of the risks associated.

General

Repairs and servicing of the VS-DX must be performed by Woodward or its authorized service facilities or trained personnel.

Do not remove or alter any of the nameplates as they bear important information which may be necessary to service or repair the servo.

Table 5-1. List of Available Replacement Kits

#	P/N to Order	Description
1	8935-1340	KIT-VS-GI SERVO REPLACEMENT, WITHOUT JUNCTION BOX VERSION, FAIL EXTEND, FOR VS-DX SKID
2	8935-1341	KIT-VS-GI SERVO REPLACEMENT, JUNCTION BOX VERSION, FAIL EXTEND, FOR VS-DX SKID
3	8935-1342	KIT-VS-GI SERVO REPLACEMENT, WITHOUT JUNCTION BOX VERSION, FAIL RETRACT, FOR VS-DX SKID
4	8935-1343	KIT-VS-GI SERVO REPLACEMENT, JUNCTION BOX VERSION, FAIL RETRACT, FOR VS-DX SKID
5	8935-1338	KIT- REPLACEMENT ISOLATION VALVE, RIGHT HAND, FOR VS-DX SKID
6	8935-1339	KIT- REPLACEMENT ISOLATION VALVE, LEFT HAND, FOR VS-DX SKID
7	8935-1344	KIT - PRESSURE GAUGE, FOR VS-DX SKID
8	8935-1336	KIT - SHUTTLE VALVE, FOR VS-DX SKID

For installation instructions of VS-DX replacement kits, see Woodward Component Maintenance Manual CMM-03013.

Troubleshooting

General

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

Troubleshooting Procedure

Table 5-2 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.

⚠WARNING

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.

For troubleshooting see manual 35119 (VS-GI Manual) and 35148 (Customer Service Tool Manual).

Table 5-2. Troubleshooting Data

Symptom	Cause	Recommended Action
No pressure at the control port	No hydraulic supply.	Check hydraulic supply pressure and ensure all lines are connected to the appropriate ports. Open the respective isolation needle valve located on the VS-DX manifold.
	Faulty power, check for green LED.	Check power connections, 24 VDC pins.
	Error condition, check red LED (alarm or shutdown; discrete output is active).	If on, check actuator wire connection.
	Power supply too weak.	Monitor the supply voltage while making a large step. The voltage should not dip or rise significantly. See recommended power requirements in the specification section.
	Power supply is limiting current.	Change limit level to maximum (>= 10 A).
	Bad power supply.	Use Woodward recommended power supply.
	Electronics fault in VS-GI.	Check for electronics fault using Customer Service Tool software.
Pressure control fluctuation	Fluid lines incorrectly installed.	Check fluid connections.
	Contamination within control.	Check the fluid for excessive contamination. Replace or add a system filter ahead of the VS-DX unit supply. Contact Woodward service.
	To high oil flow	Check the oil installation and servo valve for leakage
	Air trapped in VS-DX control path	Perform system flushing if possible.
	No transfer valve switching	Contact Woodward service.

Symptom	Cause	Recommended Action
Slow dynamics	Cold oil (oil viscosity too high).	Wait until normal temperature is reached.
	Connections line tubes too small or too long.	Use bigger and/or shorter tubes.
	Insufficient pump capacity or too low supply pressure	Monitor the supply pressure while performing a maximum position step, the supply pressure should not drop significantly.
	Hydraulic Power Actuator load is too high	If possible, increase supply pressure. Verify power actuator load capability- if required, replace with bigger actuator size.
	Servo(s) dynamic parameters settings is not optimal	Perform VS-GI servo(s) dynamics parameter adjustment.
High frequency oscillation	High friction in servo.	Clean spool/sleeve pair by servo flushing with clean oil.
	High VS-GI internal friction.	Check the fluid for excessive contamination. Replace or add a system filter ahead of the VS-DX supplies. Increase the frequency of the silt buster impulse. Contact Woodward service.
	Dynamic adjustments are not optimal	Reduce gain settings.
Low frequency oscillation	Air trapped in VS-DX control path	Perform system flushing if possible.
	Supply pressure is not stable	Fix it
	Power cylinder load is too high	Reduce load if possible or reconfigure system hardware for higher load capability.
	Demand signal is not stable	Tune demand input filter if Demand signal is affected by noise – (VS Bandwidth settings)
	Both VS-GI units are in control mode	Assign control to one unit only.
	Dynamic adjustments are not optimal.	Adjust Integral Trim settings.
Discrete outputs not working	Incorrect wiring.	Correct wiring.
Analog output (4 to 20 mA) not working	Incorrect wiring.	Correct wiring. Verify analog output settings match control.
Intermittent behavior	Intermittent wiring.	Replace faulty wire(s).
	Damaged insulation.	Replace faulty wire(s).
	Bad contact at connectors.	Re-install all wires.
	Too high ambient or oil temperature.	Lower temperature. See specification.
Internal VS-GI oil leakage	Excessive wear or damage of valve Sleeve seals.	Replace VS-GI and Adjust Control System: - Check for control signal instability. If control signal is highly active reduce dynamic settings at main control. Check wiring for proper shielding or ground loops. Correct these issues until the demand signal is stable. - Check for excessive drain pressure. - Reduce or eliminate dither setting in the VS-GI and/or at the main control.
Large cylinder-position hysteresis	Abnormal high friction.	Adjust control dither in VS-GI Clean or change power cylinder/ power cylinder linkage.
	Excessive input control noise.	Reduce or eliminate dither at turbine control. Check wiring for ground loops. Check for instability, reduce dynamic settings at VS-GI or main control.

Symptom	Cause	Recommended Action
Non-zero pressure when shut down	Drain pressure is too high.	Reduce drain pressure.
No switching between units	No health signal communication between units.	Check wiring between units.
Non-Symmetric Switching performance between units on the same skid.	Contamination.	Check the fluid for excessive contamination. Replace or add a system filter ahead of the VS-DX supply. Contact Woodward service.
	Incorrect settings/calibration	Using the Customer Service Tool, check if both units are set with the same settings. Perform power cylinder calibration procedure.
Pressure gauge(s) lack of indication	Isolation needle valve closed on pressure gauge line.	Open respective isolation needle valve located on VS-DX manifold.
	Pressure gauge failure.	Replace pressure gauge.

VS-GI Servo Replacement Procedure

If a VS-GI servo fails or needs to be disabled, it can be locked out of the system using the control isolation valve. To ensure there is no electrical transient created on the servo in control, it is mandatory to power down the failed servo, isolate all of its electrical connections inside the VS-DX electrical terminal box using dedicated knife disconnect type terminals.

For a complete procedure of the individual VS-I replacement, see Woodward Component Maintenance Manual CMM-03013.
When replacing a failed VS-GI Servo, always follow the following steps in order to ensure there are no interactions with the operating servo:

1. Power down the failed servo.
2. Close and lock-out the respective control isolation valve.
3. Close and lock-out the respective supply isolation valve if necessary (not provided with VS-DX skid)
4. Close and lock-out the respective drain isolation valve if necessary (not provided with VS-DX skid)
5. Ensure the work area around the skid is free from combustible medium before removing covers.
6. Disconnect all knife disconnect type terminals connected with servo to be serviced in VS-DX skid electrical terminal box.

Chapter 6.
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
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
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 7.
Asset Management and Refurbishment Scheduling Period

The following recommendations regarding the Woodward designed and manufactured VS-GI servo are to assist in properly managing the reliability, availability, and “safety of operation” expectations established for turbines. While there are electronic control systems designed to monitor and diagnose the operational performance of these components, control monitoring cannot replace normal preventative maintenance practices. It is important to follow these recommendations in order to avoid unnecessary and unscheduled shutdowns.

This product is designed for continuous operation under the conditions listed in the Specifications Chapter. Periodic service is not required on any components. Recommend performing service during major turnarounds, scheduled every five to eight years depending on the site and application. During major outages, Woodward recommends the VS-GI servo be sent back to Woodward or a Woodward Authorized Service Facility (AISF) for inspection, component servicing and to take advantage of related product software and hardware improvements.

Installations that do not meet “normal” industrial operating conditions may require customized maintenance cycles to maximize reliability, performance, and asset life. Contact your local Woodward representative for a detailed evaluation of your site conditions to determine the right maintenance cycles for your installation.

Woodward’s overhaul services will return the unit to “like new” condition ready for another full operating cycle, lasting until the next planned maintenance outage. Upon reaching the recommended maintenance cycle of the auxiliary component, please contact either the sites turbine OEM service representative, local Woodward Distributor or Woodward Authorized Independent Service Facility to facilitate services. See Chapter 6 for Product Support and Services Options.

Chapter 8.
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.

Revision History

Revision D
- Removed Figure 1-3 “Nomenclature and Ordering Number Encoder” and re-numbered figures
- Added Table 1-4
- Replaced Figure 3-14 Connections Chart

Revision C—
- Replaced Figure 3-14 Connections Chart

Revision B—
- Removed special requirements (Transient Protection and Pollution Degree 2) in Special Conditions section (pg. 6)
- Replaced Declarations

Revision A—
- Revised manual titles in Table 1-2
- Added Table 1-3
- Moved outline drawings from Chapter 1 to Chapter 3
- Added Table 3-1
- Added paragraph above Figure 3-2
- Added Figures 3-2 through 3-4 then renumbered remaining figures
- Added Warning box below Figure 3-4
- Major revision to the third paragraph in Discrete Inputs section on pg. 29
- Revised Discrete Outputs section on pg. 29
- Replaced Figures 3-11 and 3-12
- Edited Signal Word boxes on pg. 36
- Added Important box on pg. 37
- Revised most of the procedure beginning on pg. 38
- Added Figures 4-4 and 4-5
- Added two Important Boxes on pg. 42
- Revised most of the VS-DX Unit Trapped Air Releasing Procedure section on pg. 47
- Revised last sentence on pg. 50
- Major revisions on Table 5-2
- Added VS-DX Servo Replacement Procedure

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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Released

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 35132.

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