SmartVO™ High-Performance Control Valves

Models: VO-100L, VO-100M, VO-100H, VO-100HP, VO-101

Instruction Manual

IM-VO, Revision: V6
August 2016

SIERRA®

GLOBAL SUPPORT LOCATIONS: WE ARE HERE TO HELP!

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IMPORTANT CUSTOMER NOTICE- OXYGEN SERVICE

Sierra Instruments, Inc. is not liable for any damage or personal injury, whatsoever, resulting from the use of Sierra Instruments SmartVO valves for oxygen gas. You are responsible for determining if this SmartVO valve is appropriate for your oxygen application. You are responsible for cleaning the SmartVO valve to the degree required for your oxygen flow application.

TRADEMARKS

SmartVO™ is a trademark of Sierra Instruments, Inc. Other product and company names listed in this manual are trademarks or trade names of their respective manufacturers.

Important Customer Notice

Thank you for choosing the SmartVO™ line of electromagnetic control valves. This manual contains important information about your control valve. Before installing and operating, please read this manual carefully and follow its instructions.

- ✓ Sierra has verified the conformity between the contents in this manual and the hardware described. However, errors may still exist. We regularly review the materials covered in this manual and correct errors with revisions. Any suggestions for improvement will be appreciated.
- ✓ Go to www.sierrainstruments.com/products/downloads.html for a most current electronic version of this manual.
- ✓ We reserve the right to change the content of this manual without prior notification.
- ✓ If you have any questions or problems regarding this manual, please contact Sierra's Customer Service

Customer Service Department:
Toll Free: 800-866-0200 Phone: +831-373-0200 Fax: 831-373-4402
Email: service@sierrainstruments.com

WARNINGS IN THIS MANUAL

Warning, attention, and note statements are used throughout this book to draw your attention to important information.

WARNING

"Warning" statement appears with information that is important to protect people and equipment from damage. Pay very close attention to all warnings that apply to your application. Failure to comply with these instructions may damage the meter and personal injury.

ATTENTION

"Attention" statements in this manual indicate that failure to comply with stated instructions may result in damage to the meter or faulty operation of the flow meter.

NOTE

"Note" indicates that ignoring the relevant requirements or precautions may result in flow meter damage or malfunction.

Table of Contents

Definitions Used in This Manual

SmartVO™ – Sierra's new line of high-performance gas flow control valves. The VO stands for "Valve Only".

Electromagnetic Control Valve – All SmartVO valves are electromagnetic meaning they are comprised of a solenoid coil that creates a magnetic field when electrical current is passed through it.

Purge – The controller is supplied with the ability to open the valve far beyond the full scale position to allow them to be cleaned. This is usually accomplished by blowing clean, dry nitrogen through the instrument. When the valve is opened to this cleaning position, 24 VDC control signal, it is said to be in the Purge mode.

Oscillation – Unstable flow control.

Leak-by – Leakage at a zero control signal.

Finger-tight – This is when a bolt /screw is tightened with your fingers.

Full Scale – This is the highest flow that an instrument will meter within its specified accuracy. It is often possible for an instrument to measure a flow beyond its full scale value, but the accuracy of this measurement may be outside of published specifications.

1. Introduction

1.1. Introduction

Sierra's SmartVO™ control valves offer a robust and field-proven direct-acting electromagnetic proportional control valve technology to compensate for a wide variety of temperature and pressure variations in the gas stream. You can even locally adjust response characteristics for multiple applications or system pressure design changes.

Sierra has manufactured gas flow control valves since the 1980's as part of our mass flow controller product line—so SmartVO is field proven. In the case of our SmartVO, the customer already has flow or pressure metering in place and just needs a means of precision control.

The proven SmartVO valve technology offers precision control for on/off partial flow control over a wide range of flow rates from 0 to 50 sccm up to 1000 slpm and pressures up to 5000 psig (345 barg) with our ValFlex™ high-pressure control valve. It provides fast-response to control signal changes and operates over a wide pressure differential range.

The proprietary frictionless-hovering direct-acting control valve is comprised of a solenoid coil that creates a magnetic field with electrical current designed for use in closed loop flow or pressure control systems.

For precision you can rely on, Sierra's SmartVO is the optimal choice to automate your process.

1.2. Using This Manual

This manual is organized into five chapters with one appendix:

- **Chapter 1** includes the introduction and theory of operation.
- **Chapter 2** provides installation and wiring instructions.
- **Chapter 3** describes valve operation.
- **Chapter 4** covers maintenance.
- **Chapter 5** provides troubleshooting advice.
- **Appendix A** contains product specifications and dimensional drawings.

1.3. Receipt of Your Instrument

When receiving the instrument, carefully check the outside packing carton for damage that may have incurred during shipment. If the carton is damaged, notify the local carrier and submit a report to the factory or distributor. Remove the packing slip and check that all ordered components are present and match your specifications (as ordered). Make sure any spare parts or accessories are not discarded with the packing material. Do not return any equipment to the factory without first contacting one of Sierra's Technical Support Centers.

2. Installation Overview

2.1. Before You Begin Installation

Before installing the valve, verify the following:

1. Make sure the installation site meets the specific operating parameters that were ordered on your SmartVO product. Each valve is factory configured for a specific gas and flow range, pressure differential, temperature range and mounting position.

2. Do not locate the valve in areas subject to sudden temperature changes, moisture, or near equipment radiating significant amounts of heat. Make sure to allow adequate space for cable connectors and wiring.

3. Make sure the location meets the minimum number of recommended pipe diameters upstream and downstream of any NPT or ½ inch process connection. A minimum of two inches is always recommended.

4. If the gas contains any particulate matter, install an in-line filter prior to the valve. Please contact your local Sierra distributor.

5. If the valve is mounted in any position other than horizontal and it was not designed specifically for that position, contact Sierra's Customer Service Department for instructions.

6. Use a properly sized pressure regulator and verify the valve only orifice size is the smallest in the system. There can be no restrictions (such as valves, tubing or piping internal diameters, reducers, etc.) upstream or downstream of the valve only that are less than the valve only orifice size.

7. Confirm that the SmartVO O-ring and valve seat material is compatible with the gas to be measured.

2.2. Quick Installation Guide

Safety

1. Install an appropriate in-line filter upstream, if the gas contains any particulate matter or condensed moisture.

2. Mount with a horizontal gas flow. This orientation is preferable unless the factory design was specifically performed for a vertical flow at the time of purchase. Consult your sales order documentation. Note: Horizontal flow is assumed unless vertical flow upward or downward is specified at the time of your order.

3. Wire the instrument. Connect lead tinned stripped wires to the power supply.

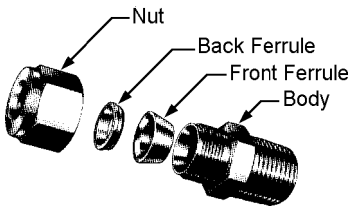
4. Apply the gas listed on the label to the inlet at the recommended inlet pressure. Apply power instantaneously; no warm-up period required.

	**ATTENTION!** Do not leave a control signal applied to the valve when no gas is available to the inlet fitting. This could cause damage, performance issues, and valve overheating.

2.3. Installing the Valve

Follow the installation instructions below that are applicable to your valve's process connection. Before use, all plumbing should be checked carefully for leaks and the valve purged with dry nitrogen. Make sure that the tubing is free from burrs or rims caused by cutting.

Stand-alone valves are supplied with compression, VCO, VCR, or NPT process connections. To ensure a successful installation, inlet and outlet tubing should be in a clean state prior to plumbing the SmartVO into the system. **The shipping caps covering the inlet/outlet fittings should not be removed until immediately prior to installation.**



2.3.1 Compression Fittings

1. Position the valve with the flow direction arrow pointing downstream in the direction of the flow.
2. Verify the position of the front and back ferrule as shown at right. Insert the tubing into the fitting. Make sure that the tubing rests firmly on the shoulder of the fitting and that the nut is finger-tight. Scribe the nut at the six o'clock position.
3. While holding the fitting body steady with a backup wrench, tighten the nut 1 and 1/4 turns, watching the scribe mark make one complete revolution and continue to the nine o'clock position. For 1/16 inch, 1/8 inch and 3/16 inch (2, 3 and 4 mm) sizes tighten only 3/4 turn from finger-tight. **Do not over-tighten!**
4. Check the system's entire flow path thoroughly for leaks. **Do not use liquid leak detectors**. Instead, monitor pressure decay. Exposing the instrument to leak detector fluid may cause damage.

2.3.2 VCO Fittings

1. Position the valve with the flow direction arrow pointing downstream in the direction of flow.
2. Tighten the nut finger-tight, and then 1/4 of a turn tighter with a wrench. **Do not over-tighten!**
3. Check the system's entire flow path thoroughly for leaks. **Do not use liquid leak detectors**. Instead, monitor pressure decay. Exposing the instrument to leak detector fluid may cause damage.

2.3.3 VCR Fittings

1. Position the instrument with the flow direction arrow pointing the direction of flow.
2. Install new gaskets that are compatible with the gas to be used.
3. Tighten the nut finger-tight, and then 1/8 of a turn tighter with a wrench. **Do not over-tighten!**
4. Check the system's entire flow path thoroughly for leaks. **Do not use liquid leak detectors!** Instead, monitor pressure decay. Exposing the instrument to leak detector fluid may cause damage.

2.3.4 NPT Fittings All Types

1. Install a section of straight pipe at least five pipe diameters in length upstream of the valve.
2. Position the valve with the flow direction arrow pointing downstream in the direction of flow.
3. Apply high quality Teflon tape to the male NPT fitting. Alternatively, use a high quality paste pipe thread sealant suitable for the application and gas, and apply this compound to the inlet and outlet male fittings following the manufacturer's recommendations. Avoid getting the tape or thread sealant in your process plumbing.
4. Tighten each fitting until leak tight. **Do not over-tighten!**
5. Check the system's entire flow path thoroughly for leaks. **Do not use liquid leak detectors!** Instead, monitor pressure decay. Exposing the instrument to leak detector fluid may cause damage.

2.3.5 Wiring the Valve

The valve operates on a 0-24 VDC control signal. Polarity is unimportant.

3. Operation

3.1. Electromagnetic Control Valve Operation

After your instrument is installed and the system has undergone a complete leak check as discussed in detail in Chapter 2, follow these steps:

1. Apply power; no warm up needed
2. Turn on the gas supply
3. Adjust the SmartVO to the desired flow.

WARNING!
During operation the valve can become hot.

ATTENTION!
Never leave the valve with no gas supply and a control signal applied. The valve will open to its command position and eventually overheat causing possible damage.

3.2. Valve Purge Operation

The purge function opens the valve completely (recommended 120% of the calibrated full scale value, but can be much more and can be dangerous) for the purpose of quickly flushing unwanted gas from the flow path. When the valve is opened for purging, it allows flows far in excess of the rated full scale of the controller.

NOTE
Purge mode allows far more gas to flow through the valve! Before using valve purge operation, insure proper downstream capacity and ventilation.

IMPORTANT NOTES ABOUT PURGING

Purging Non-Reactive Gases:

Purge your SmartVO with clean, dry nitrogen for a minimum of 2 hours.

Purging Reactive Gases:

One of the following methods may be used:

- Cycle purge. This is done by alternately evacuating and purging the instrument for 2 to 4 hours with clean, dry nitrogen.
- Purge the instrument with clean, dry nitrogen for 18 to 24 hours.
- Evacuate the instrument for 18 to 24 hours.

IMPORTANT SAFETY NOTES ABOUT PURGING

	**WARNING!** **When toxic or corrosive gases are used, purge unit thoroughly with inert dry gas before disconnecting from the gas line to prevent personnel from being injured when coming in contact with the instrument.**

	**WARNING!** **If an instrument used with a toxic or corrosive gas is returned to the factory, a Material Safety Data Sheet (MSDS) must be enclosed & attached to the outside of the box to alert Sierra personnel of the potential hazard. Also, make sure the inlet & outlet are securely sealed.**

4. Maintenance

Valves essentially require no scheduled maintenance other than periodic flow path cleaning if the gas is dirty. If an in-line filter is used, the filtering element should be periodically replaced or ultrasonically cleaned. Included in this chapter are general instructions for:

- Flow Path Maintenance
- Valve Maintenance
- Valve Adjustment

NOTE
It is important that this valve be maintained only by qualified personnel.

4.1. Flow Path Maintenance

The valve flow path is either aluminum or 316L stainless steel (wetted magnetic parts of the solenoid valve are 416 stainless steel) with Viton® , Buna, Neoprene®, Kalrez®, PFA Teflon®, or Polyamide® seals as options, depending on the gas used. The flow path should be periodically inspected and cleaned as required.

WARNING!
Always fully neutralize any toxic gas trapped inside the transducer before removing from the gas line

NOTE
When toxic or corrosive gases are used, purge unit thoroughly with inert dry gas before disconnecting from the gas line. A SmartVO used with toxic or corrosive gas must NOT be returned to the factory. Contact technical support for details.

4.2. Valve Maintenance

Electromagnetic control valves may require spring-tension adjustments for various reasons (See Section 4.3 Valve Adjust Procedure). No maintenance is required under normal operating conditions other than an occasional cleaning. Use of certain corrosive gases may require frequent replacement of the valve plug and O-rings. This indicates a need for a different elastomer.

WARNING!
Do not attempt any valve adjustments while the meter is “online” with any dangerous gas.

4.2.1. Electromagnetic Valves Low/Medium Flow

Low and medium flow use the same valve design; high flow models use a larger version. Cleaning can often be accomplished by opening the valve using the purge function and flushing in both directions.

Alternatively, the valve may be manually opened by turning the adjustment screw fully counterclockwise.

4.2.2 Electromagnetic Valves High Flow

The high flow electromagnetic valve is similar in design to the low/medium flow valve. As with the low/medium flow valve, cleaning can often be accomplished by opening the valve using the purge function and flushing in both directions. Alternatively, the valve may be manually opened by loosening the 3/8 inch lock nut on top of the valve and turning the adjustment screw fully counterclockwise.

NOTE
If your unit is experiencing performance issues please contact factory. If the valve has been damaged, does not function properly anymore or you simply want to have the valve cleaned, repaired, and re-set-up contact the factory for return shipping instructions.

5. Troubleshooting

5.1. Troubleshooting Procedures

This section is provided to help locate the cause of a SmartVO failure. It is not intended to be an all-inclusive repair manual. In the case of major repairs, the unit should be returned to the factory for service. See below, returning equipment to the factory, for shipping instructions.

When you suspect that the SmartVO is not operating correctly, there are a few simple checks that can be made before dismantling the unit:

1. Make certain that there are no leaks in the line.
2. Check that all cables are connected and in good working condition.
3. Verify that the control signal is properly connected to the valve, is stable, and has an adequate power rating.
4. Check the control signal over the entire flow range.
5. Check for adequate pressure differential across the valve.

After verifying the factor above, follow the troubleshooting procedures outlined on the next page.

5.2. Electromagnetic Control Valves

Problem	Possible Cause	Solution
No or reduced flow	In-line filter clogged	Clean or replace filter
	Gas leak	Find & correct leaks
	Valve not adjusted properly	Adjust valve
Valve does not respond to control signal or oscillates	Low or no gas pressure	Set correct gas pressure
	Faulty cable or connector	Correct or replace
	Faulty control signal	Correct control signal
	Valve not adjusted properly	Adjust valve

WARNING!
Always remove power before disassembling the SmartVO.

CAUTION
Only qualified personnel should perform maintenance and troubleshooting procedures.

5.3. Technical Support

If you encounter any problem with your instrument, review the configuration information for each step of the installation, operation, and set up procedures as explained in this manual. Verify that your settings and adjustments are consistent with factory recommendations. Refer to Chapter 5: Troubleshooting for specific information and recommendations.

If the problem persists after following the troubleshooting procedures outlined in Chapter 5, contact any of the following Technical Support Centers. It may also help to call your Sierra Sales Agent, who is also well trained in the operation of the product.

IMPORTANT: When contacting Technical Support, make sure you have included the following information*:*

- The flow range, serial number, Sierra order number and model number (all marked on the instrument data label).
- The problem you are encountering and any corrective action taken.
- Application information (gas, pressure, temperature, pipe and fitting configuration).

Customer Service and Support Information:

Email Technical Support: service@sierrainstruments.com
Email Sales: sales@sierrainstruments.com

Factory USA
Toll Free: 800-866-0200
Phone: 831-373-0200
Fax: 831-373-4402
Email: service@sierrainstruments.com

European Sales & Service Center:
Phone: +31 72 5071400
Fax: +31 72 5071401
Email: service@sierra-instruments.nl

Asia Sales & Service Center:
PHONE: + 8221 5879 8521
FAX: +8621 5879 8586
EMAIL: www.sierra-asia.com

5.4. Returning Equipment to the Factory

Factory Calibration—All Models

Sierra Instruments maintains a fully-equipped calibration laboratory. All measuring and test equipment used in the calibration of Sierra transducers are traceable to NIST Standards. Sierra is ISO-9001 registered and conforms (but is not certified) to the requirements of ISO-17025.

Instructions for Returning Your Instrument for Service

The following information will help you return your instrument to the Sierra Instruments' Factory Service Center and will ensure that your order is processed promptly. Prices may vary depending on the flow range, type of gas and operating pressure of your unit. To request a rough estimate of the pricing, contact your local Sierra Instruments distributor or contact one of our offices directly. A detailed quote will be provided following a full evaluation of your instrument. Our expedite fees are: 5 day turnaround 25%, 3 day turnaround 50%, and 2 day turnaround 100%.

Please follow these easy steps to return your instrument for factory service:

1. Obtain a Return Materials Authorization (RMA) number from the Sierra Instruments website at http://www.sierrainstruments.com/rma/login.php. You may also obtain this from the factory by calling (800) 866 0200 between 8:00 a.m. and 5:00 p.m. PST Monday through Friday or via e-mail by contacting service@sierrainstruments.com.

2. If you require service beyond calibration, but do not know which service(s) will be required, describe the symptoms as accurately as possible on the RMA form.

3. Pack your instrument carefully. Use the original packaging and foam or bubble wrap (packing peanuts NOT recommended) and include a copy of the RMA form (complete with Sierra supplied RMA number) with the unit(s).

4. Ship the unit(s) to the following address:

   Sierra Instruments, Inc.
   Attention: Factory Service Center
   5 Harris Court, Building L
   Monterey, CA 93940 USA
   RE: RMA# (your number)

5.5. Warranty Policy

Limited Warranty Policy- Register Online

All Sierra products are warranted to be free from defects in material and workmanship and will be repaired or replaced at no charge to Buyer, provided return or rejection of product is made within a reasonable period but no longer than one (1) year for calibration and non-calibration defects, from date of delivery. To assure warranty service, customers must register their products online on Sierra's website. Online registration of all of your Sierra products is required for our warranty process. Register now at www.sierrainstruments.com/register. Learn more about Sierra's warranty policy at www.sierrainstruments.com/warranty.

Appendix A: Product Specifications

OPERATION SPECIFICATIONS

Models, Flow Rates, Input Power, & Coil Resistance
The SmartVO requires a valve control circuit and power supply. Supply your own control circuit, or we offer a complete dual solenoid valve control package and power supply. See p. 3 for more information.

VO-100L Economical Low Flow
Maximum flow rate to 50 slpm
Input power: 24 VDC +/- 10%; at 264 mA
Coil resistance: 100 Ohms (nominal at room temperature)

VO-100M Medium Flow
Maximum flow rate to 300 slpm
Input power: 24 VDC +/- 10%; at 629 mA
Coil resistance: 42 Ohms (nominal at room temperature)

VO-100H High Flow
Maximum flow rate to 1000 slpm
Input power: 24 VDC +/- 10%; at 1056 mA
Coil resistance: 25 Ohms (nominal at room temperature)

VO-100HP High Pressure
Maximum flow rate to 20 slpm
Input power: 24 VDC +/- 10%; at 629 mA
Coil resistance: 42 Ohms (nominal at room temperature)

VO-101 Ultra Low Flow
Maximum flow rate to 50 sccm
Input power: 24 VDC +/- 10%; at 264 mA
Coil resistance: 100 Ohms (nominal at room temperature)

Gases (All Versions)
All clean gases including corrosives and toxics; specify when ordering

Control Range (All Versions)
2% to 100%, control signal dependent

Turndown (All Versions)
50:1

Operating Temperature (All Versions)
32°F to 122°F (0°C to 50°C)

Leak Integrity (All Versions)
5 X 10^{-9} atm cc/sec of helium or better

Power Requirements
All configurations require 24 VDC +/- 10%.
Provide your own power supply or we offer a power supply with fly leads, 12.5 Amps, 110–230 VDC. CE Approved.

Response Time
Immediate

Warranty
1-year factory warranty

PRESSURE SPECIFICATIONS

Gas Pressure Rating
Wide operating pressure 0 psig to 5000 psig (0 barg to 345 barg)

Gas Pressure for SmartVO Versions
VO-100L-AL: 145 psig (10 barg), rated burst pressure to 225 psig (15 barg)
VO-100L-SS: 500 psig (34.5 barg), rated burst pressure to 750 psig (51.7 barg)
VO-100M-SS: 500 psig (34.5 barg), rated burst pressure to 750 psig (51.7 barg)
VO-100H-SS: 500 psig (34.5 barg), rated burst pressure to 750 psig (51.7 barg)
VO-100HP-SS: 5000 psig (345 barg), rated burst pressure to 7500 psig (517 barg)
VO-101-SS: 500 psig (34.5 barg), rated burst pressure to 750 psig (51.7 barg)

Minimum Differential Pressure Requirement
(Note: Tested with N_2 at 70°F (21.1°C) and outlet at ambient pressure)

Minimum Differential Pressure Requirement VO-100L, VO-100M & VO-100H				
Flow Rate (slpm)	Pressure Drop in PSI (mbar)			
	Low Flow 1/4-inch fittings 0 - 50 slpm	Low Flow 3/8-inch fittings 10 - 50 slpm	Medium Flow 3/8 or 1/2-inch fittings 20 - 300 slpm	High Flow Small Bore 1/2 or 3/4-inch fittings 100 - 1000 slpm
0.02	1 (69)	N/A	N/A	N/A
0.2	1.5 (103.4)	N/A	N/A	N/A
1	1.88 (129.6)	N/A	N/A	N/A
5	4.7 (324.1)	N/A	N/A	N/A
10	6 (413.7)*	4.75 (327.5)	N/A	N/A
20	12 (827.4)*	8.25 (568.8)	1 (69)	N/A
30	15 (1034.2)*	11.75 (810.1)	1.2 (82.7)	N/A
40	30 (2068.4)*	15.25 (1051.5)	1.6 (110.3)	N/A
50	50 (3447.4)*	18.75 (1292.8)	2 (137.9)	N/A
100	N/A	N/A	5 (344.7)*	0.30 (20.7)
150	N/A	N/A	10 (689.5)*	0.67 (46.2)
200	N/A	N/A	15 (1034.2)*	1.13 (77.9)
250	N/A	N/A	20 (1379)*	1.67 (115.1)
300	N/A	N/A	25 (1723.7)*	2.34 (161.3)
350	N/A	N/A	N/A	3.05 (210.3)
400	N/A	N/A	N/A	3.82 (263)
450	N/A	N/A	N/A	4.61 (317.9)
500	N/A	N/A	N/A	5.45 (375.8)
750	N/A	N/A	N/A	9.14 (630.2)
1000	N/A	N/A	N/A	13.82 (952.9)

*Larger fittings recommended for these flow rates as 1/4–inch fittings reduce overall performance: high pressure version (flow is limited to 20 slpm)

PRESSURE SPECIFICATIONS (CONTINUED)

Minimum Differential Pressure Requirement VO-100HP	
Pressure Drop in PSI (mbar)	
Flow Rate (slpm)	1/4-inch fittings
0.1	5 (344.7)
1	7.5 (517.1)
6	4.75 (327.5)
10	30 (2068.4)
12	8.25 (568.8)
15	11.75 (810.1)
20	60 (4136.9)

Minimum Differential Pressure Requirement for VO-101
30 psi (2040 mbar) optimum
1 psi (68 mbar) minimum at 70°F (21.1°C) with outlet at ambient pressure

PHYSICAL SPECIFICATIONS

Valve Type
Proprietary electromagnetic proportional control with a solenoid coil that creates a magnetic field with electrical current

Flow Body Materials
Aluminum, 316L and 416 stainless steel

Elastomers
Viton®, Buna, Neoprene®, Kalrez®

Valve Seats
Viton®, Buna, Neoprene®, Kalrez®, PFA Teflon®, and ValFlex™

Weight

VO-100L-AL	.76 lbs (1.67 kg)
VO-100L-SS	1.17 lbs (2.57 kg)
VO-100M-SS	3.3 lbs (7.26 kg)
VO-100H-SS	8 lbs (17.6 kg)
VO-100HP-SS	1.8 lbs (3.96 kg)
VO-101-SS	1.17 lbs (2.57 kg)

Electrical Connections
Fly leads, stripped & tinned, spades

Enclosure
NEMA 4X enclosure for valve control circuit

Approvals
CE approved

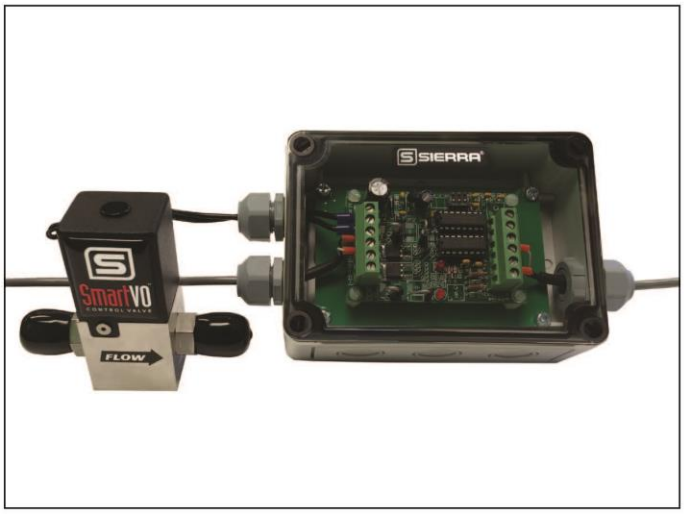
VALVE CONTROL CIRCUITS

Supply your own control circuit or we offer a complete dual solenoid valve control (see options below) with 24 VDC +/- 10% power supply.
Learn more at sierrainstruments.com/smartvo/control-circuit

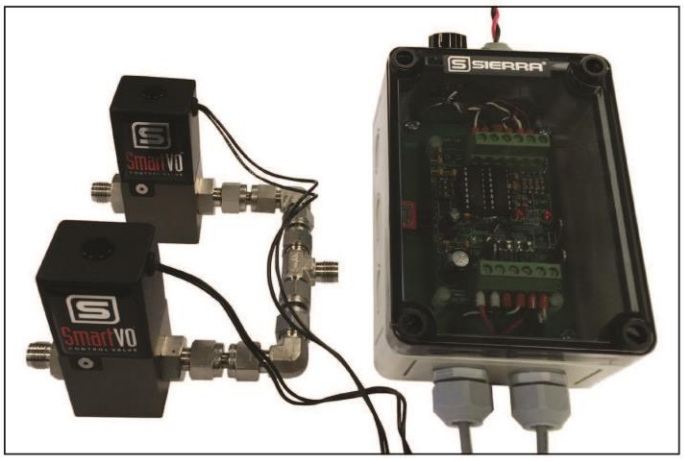
Model Code	Description
VC-2	Dual solenoid valve controller with 0–5 VDC external setpoint control signal.
VC-2P	Dual solenoid valve controller with 0–5 VDC onboard potentiometer setpoint control signal.
VC-2C	Dual solenoid valve controller with 4–20 mA setpoint control signal.

VALVE CONTROL CONFIGURATIONS

VO-100L-SS with Valve Control Circuit in enclosure, cord grips, and Sierra power supply



Two VO-100L-AL with Valve Control Circuit in enclosure with potentiometer, and Sierra power supply



One VO-100L and one VO-100M with 6-pin connection, Valve Control Circuit in enclosure, and Sierra power supply

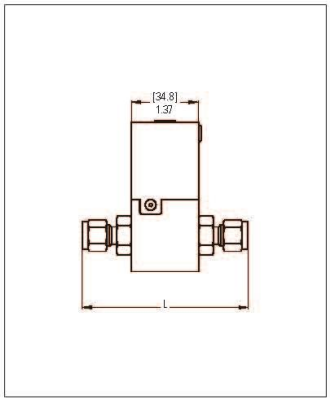
Valve Control Circuit in enclosure

SMARTVO VALVES

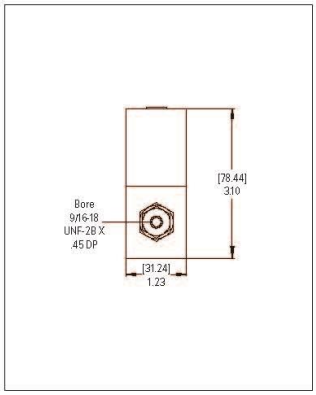
VO-100L-SS Version

VO-100HP

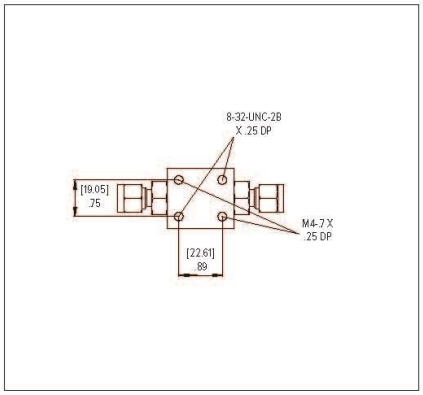
VO-100L & VO-101 Front View



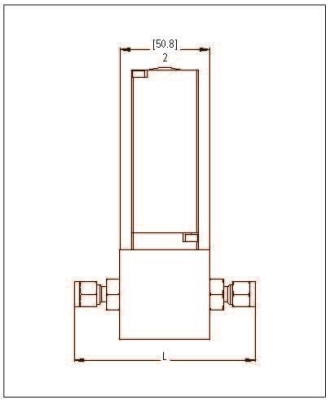
VO-100L & VO-101 Side View



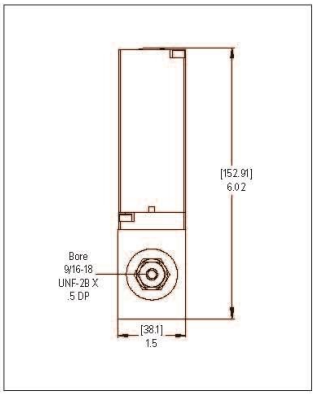
VO-100L & VO-101 Bottom View



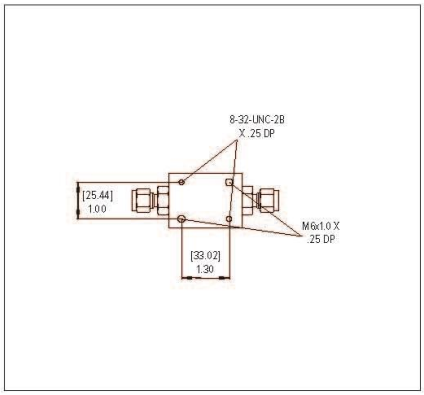
VO-100M Front View



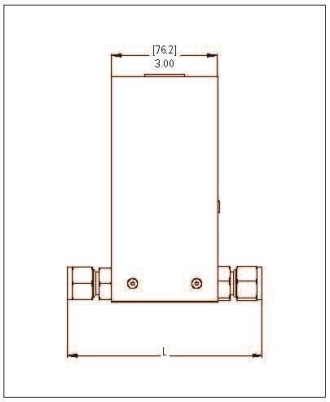
VO-100M Side View



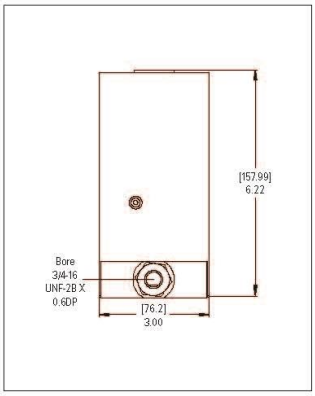
VO-100M Bottom View



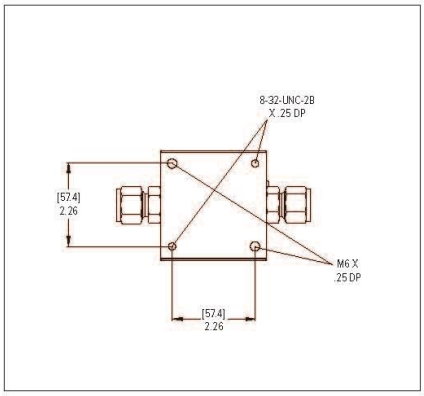
VO-100H Front View



VO-100H Side View



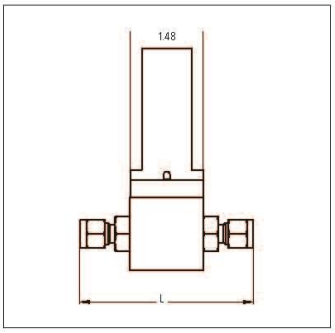
VO-100H Bottom View



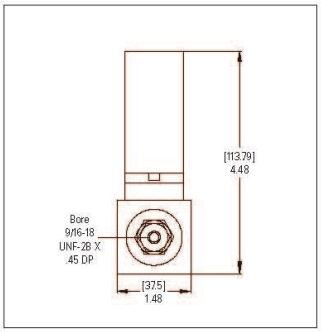
All dimensions are in inches with [mm] in brackets. Certified drawings are available upon request.

DIMENSIONAL DRAWINGS (CONTINUED)

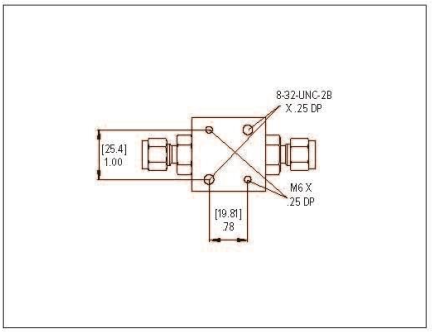
VO-100HP Front



VO-100HP Side View



VO-100HP Bottom View

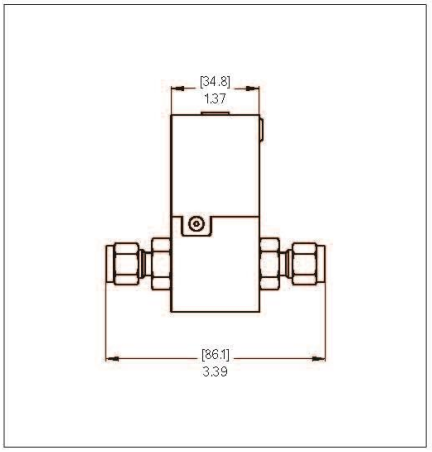


All dimensions are in inches with [mm] in brackets. Certified drawings are available upon request.

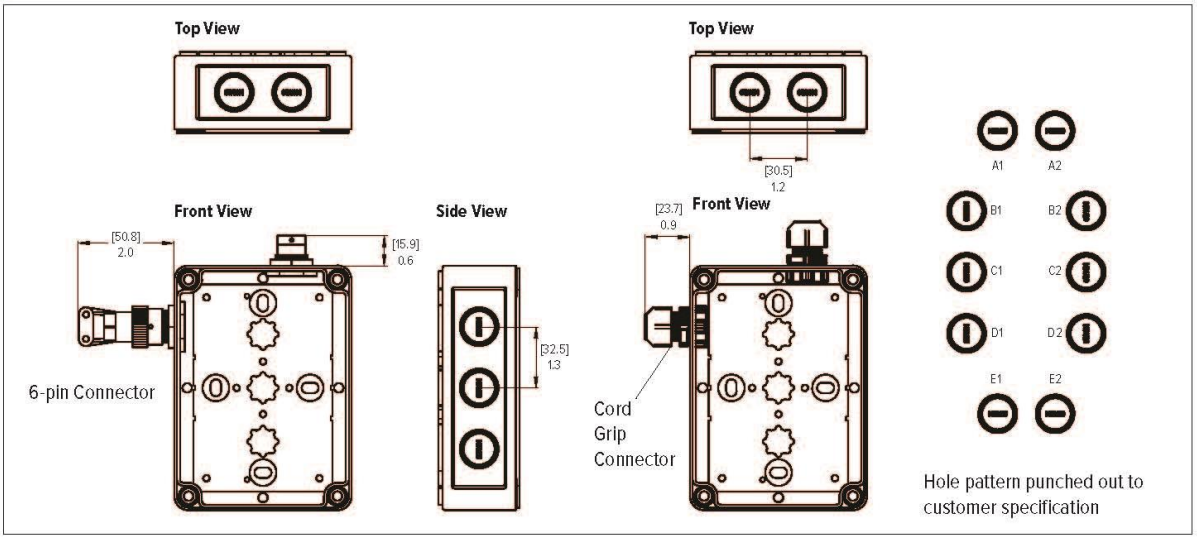
Dimension L Length with Fittings in Inches (mm)					
Fittings	VO-101	VO-100L	VO-100M	VO-100H	VO-100HP
No Fittings	1.37 (34.8)	1.37 (34.8)	2 (50.8)	3 (76.2)	1.48 (37.59)
1/8-inch compression	3.21 (82)	3.21 (82)	N/A	N/A	3.32 (84)
1/4-inch compression	3.39 (86)	3.39 (86)	N/A	N/A	3.5 (89)
3/8-inch compression	3.51 (89)	3.51 (89)	4.14 (105)	N/A	3.62 (92)
1/2-inch compression	N/A	N/A	4.3 (109)	5.3 (135)	N/A
1/4-inch VCO	2.93 (74)	2.93 (74)	N/A	N/A	3.04 (77)
1/2-inch VCO	3.37 (86)	3.37 (86)	4 (102)	N/A	3.48 (88)
3/4-inch VCO	4.7 (119)	4.7 (119)	5.33 (135)	N/A	4.81 (122)
1/4-inch VCR	3.25 (83)	3.25 (83)	N/A	N/A	3.36 (85)
1/2-inch VCR	3.55 (90)	3.55 (90)	4.18 (106)	5.18 (132)	3.66 (93)
6 mm compression	3.41 (87)	3.41 (87)	N/A	N/A	3.52 (89)
10 mm compression	N/A	N/A	4.2 (107)	5.2 (132)	N/A
12 mm compression	N/A	N/A	4.38 (111)	5.38 (137)	N/A
1/4-inch FNPT	3.22 (82)	3.22 (82)	3.85 (98)	N/A	3.33 (85)

EXAMPLE OF DIMENSIONS WITH FITTINGS

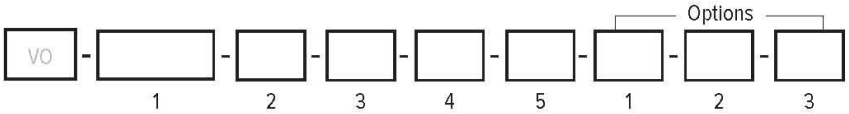
Example: VO-100L with 1/4-inch compression adds 2.02 inches to footprint, so overall dimension is 2.02 + 1.37 = 3.39 inches.



VALVE CONTROL CIRCUIT ENCLOSURE — DIMENSIONS



ORDERING



Instructions: To order a SmartVO, please fill in each feature number block by selecting the codes from the corresponding features below.
Note: All SLPM flow ranges also available in NLPM

Parent Model Number	
VO	SmartVO™ High-Performance Gas Flow Control Valves Standard configuration includes: flow body constructed of aluminum or 316L and 416 stainless steel; Viton® (standard) elastomers and valve seats; electrical connectors come stripped and tinned; requires 24 VDC input power; CE approved.

Note: This is a valve only. The valve requires a valve control circuit and a power supply. The end user may supply or a control PCA may be purchased from Sierra. See Options 1 and 2 below.

Feature 1: Flow Body	
100L-AL	VO-100L Economical Low Flow: Aluminum construction; flow up to 50 slpm; operating temperature 122°F (50°C); pressure up to 145 psig (10 barg); requires a 12-30 VDC power supply and a valve positioner
100L-SS	VO-100L Economical Low Flow: Stainless steel construction; flow up to 50 slpm; operating temperature 122°F (50°C); pressure up to 500 psig (34.5 barg), requires a 12-30 VDC power supply and a valve positioner
100M-SS	VO-100M Medium Flow: Stainless steel construction; flow up to 300 slpm; operating temperature 122°F (50°C); pressure up to 500 psig (34.5 barg); requires a 12-30 VDC power supply and a valve positioner
100H-SS	VO-100H High Flow: Stainless steel construction; flow up to 1000 slpm; operating temperature 122°F (50°C); pressure up to 500 psig (34.5 barg); requires a 12-30 VDC power supply and a valve positioner
100HP-SS	VO-100HP High Pressure: Stainless steel construction; flow up to 20 slpm; operating temperature 122°F (50°C); pressure up to 5000 psig (345 barg) burst tested to 7500 psig (517 barg), requires a 12-30 VDC power supply and a valve positioner
101-SS	VO-101 Ultra Low Flow: Stainless steel construction; flow up to 50 sccm; operating temperature 122°F (50°C); pressure up to 500 psig (34.5 barg); requires a 12-30 VDC power supply and a valve positioner

Feature 2: Fittings	
0	No fittings (customer to supply)
1	1/8-inch compression. For low flow bodies (maximum 5 slpm)
2	1/4-inch compression. For low and medium flow bodies (maximum 50 slpm)
3	3/8-inch compression. For low, medium and high flow bodies (maximum 300 slpm)
4	1/2-inch compression. For medium and high flow bodies
5	1/4-inch VCO. For low and medium flow bodies (maximum 50 slpm)
6	1/2-inch VCO. For low and medium flow bodies
7	3/4-inch VCO. For high flow bodies (maximum 300 slpm)
8	1/4-inch VCR. For low and medium flow bodies (maximum 50 slpm)
9	1/2-inch VCR. For low, medium and high flow bodies
10	6 mm compression. For low and medium flow bodies (maximum 50 slpm)
11	10 mm compression. For medium and high flow bodies
12	12 mm compression. For medium and high flow bodies
13	1/4-inch FNPT adapter bushing. For low and medium flow bodies

Feature 3: Elastomers	
OV1	Viton® for low, medium and high flow bodies
OB1	Buna for low, medium and high flow bodies
ON1	Neoprene® for low and medium flow bodies
ON2	Neoprene® for high flow bodies
OK1	Kalrez® for low flow bodies
OK2	Kalrez® for medium flow bodies
OK4	Kalrez® for high flow bodies

Feature 4: Valve Seat	
SV1	Viton® (standard)
SB1	Buna
SN1	Neoprene® or equivalent
SK1	Kalrez® or equivalent for low or medium flow bodies
SK2	Kalrez® or equivalent for high flow bodies
ST1	PFA Teflon® or equivalent (Note: No bubble tight shutoff. Up to 1% FS leak-by)
VX1	ValFlex™ inert, carbon-reinforced Polyamide for HP model only (Note: No bubble tight shutoff. Up to 1% FS leak-by); ValFlex™ required for CO2 above 50% concentration or 250 psi

Feature 5: Electrical Connectors	
ST	Stripped and tinned
HS	Horizontal spade
SS	Slotted spade

Option 1: Valve Control Circuits	
VC-2	Dual solenoid valve controller with 0-5 VDC external setpoint control signal.
VC-2P	Dual solenoid valve controller with 0-5 VDC onboard potentiometer setpoint control signal.
VC-2C	Dual solenoid valve controller with 4-20 mA setpoint control signal.

Option 2: Power Supplies	
100- T10F ( )	Low, Medium and High Flow SmartVO. 24 VDC power supply. Supplied with fly leads, 1.25 Amps, 110-230 VAC, CE approved. Specify plug preference in parentheses: (US) for USA plug, (EU) for Euro plug, (UK) for Great Britain plug. Note while VC2 will control two valves, T10F can supply power to two L, M flows but only one 100H

Option 3: Enclosure	
ENCL ( )	NEMA 4X enclosure for valve controller PCA. Specify cord grip or 6 pin in parentheses ( ). Use ADS to specify desired hole pattern.

*Disclaimer: Dependent on availability of stock.

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VO C 5/16

Appendix B: Valve Control Circuits & Power Supply

SmartVO™ Valve Control Circuits & Power Supply

Quick Start Guide

The same control valve used in every SmartTrak MFC, the appropriately named SmartVO™ "VO for Valve-Only" offers a robust and field-proven, direct-acting electromagnetic proportional control valve technology to perform over a wide variety of temperature and pressure variations in the gas stream. You can even locally adjust response characteristics for multiple applications or system pressure design changes. The SmartVO™ requires a valve control circuit and power supply. For flexibility, the end user can supply their own control circuit and power or they have the option to order this control/power package from Sierra.

Sierra's Valve Control Package Includes:

- Valve Control Circuit (PCA with NEMA 4X enclosure): Dual solenoid valve controller with either 0-5 VDC, 4-20 mA setpoint control or a 0-5 VDC potentiometer setpoint control (see figure 2a).
- Power Supply: 24 VDC +/- 10%

See Options 1, 2, and 3 on page 5 of this document for more information.

Power Requirements

All SmartVO control valves are designed to run on 24 VDC +/- 10%. We offer the 100-T10F, a 24 VDC power supply which can be used for all models. The T10F can power two VO-100L, VO-100M, VO-100HP, or VO-101, but will only power one VO-100H. Figure 1 shows the maximum flow, current and coil resistance at this flow. Note: The maximum output of the T10F is 1.5A (1500 mA). This is why it can only power one VO-100H.

Power Requirements			
	Max flow (slpm)	Current at Max Flow (mA)	Coil Resistance (Ω)
VO-100L	50	264	100
VO-100M	300	629	42
VO-100H	1000	1056	25
VO-100HP	20	629	42
VO-101	0.05	264	100

Figure 1. Maximum flow, current and coil resistance

Valve Control Requirements

A setpoint signal is required to position the valve. This is typically a 0-5 VDC or 4-20 mA analog signal.
Others may be 0-10 or 1-5 VDC, 0-20 mA or RS-232 signals. A valve control circuit is used to convert this setpoint signal into (typically) a pulse-width modulated (PWM) valve control signal. This varies the voltage across the coil to adjust the valve position based on the setpoint signal.

In many cases, the end user will have drive control circuits, especially if the SmartVO is used in an OEM application, where the setpoint is an analog signal from another instrument like a flowmeter, pressure sensor, or temperature sensor.

1

Dual Solenoid Valve Controller Options (Model Code VC-2 & VC-2C)

Sierra offers the VC-2 dual pulse-width modulated (PWM) solenoid valve controller. The VC-2 PWM valve controller allows you to independently control the power of one or two proportional solenoid valves, up to 5 amps. Use of PWM and low on-resistance transistors allows for high efficiency control with minimal power loss. Selectable PWM frequencies allow for optimal control for your particular valve (See Figure 2b).

Valve Control Circuit Options

If you do require a valve control circuit, we offer three versions:

1. Dual solenoid valve controller with 0-5 VDC external setpoint control signal (Model Code: VC-2)
2. Dual solenoid valve controller with 0-5 VDC onboard potentiometer setpoint control signal (Model Code: VC-2P)
3. Dual solenoid valve controller with 4-20 mA setpoint control signal (Model Code: VC-2C)

Figure 2a. NEMA 4X Enclosure for Control Circuit.

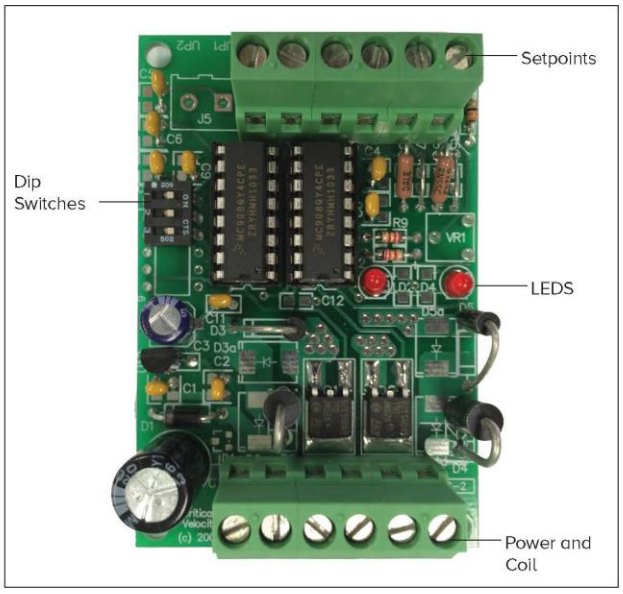

Figure 2b. Dual Solenoid Valve Control Options VC-2 and VC-2C

Setting Up Your Valve Control PCA (Option VC-2 or VC-2C)

Setting up the VC-2, VC-2P or VC-2C consists of four steps:

1. Wire power to the VC-2, VC-2P, or VC-2C.
2. Wire the PWM signal output to the valve coil.
3. Wire a setpoint to the VC-2, VC-2P, or VC-2C.
4. Set the dip switches for the proper PWM frequency.

Step 1: Wire power supply to the VC-2, VC-2P or VC-2C (See Figure 3)

Setting up the VC-2, VC-2P or VC-2C consists of four steps:

- Check power supply is not live.
- Connect power supply (+) to V+ and power supply return (-) to GND.

Step 2: Wire PWM signal output to the valve coil (See Figure 3)

- Connect valve coil wires to O1+, O1-.
- If you have two valves, then the second valve would be connected to O2+, O2-. These connections are directionless with the Smart VO.

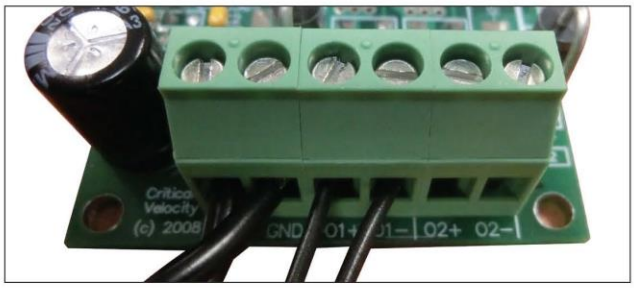

Figure 3. Power Supply and Valve Coil Terminals

Step 3: Wire a setpoint to the VC-2 (Figure 4 and 5 for schematics)

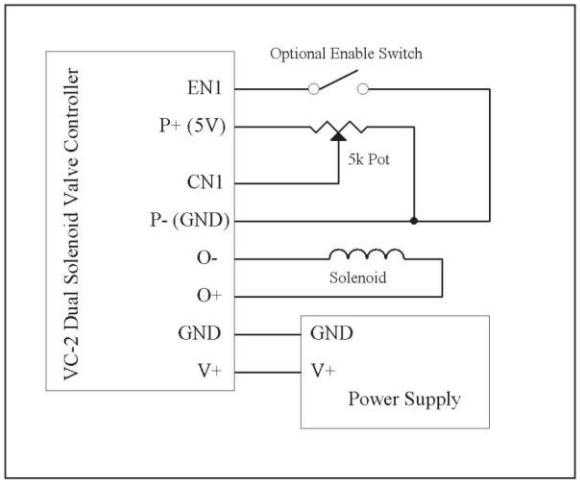

Figure 4. Setpoint Signal Wiring

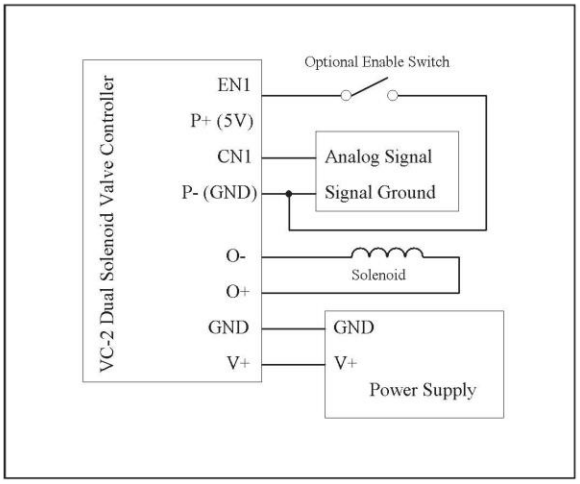

Figure 5. Potentiometer Connections

- Connect external setpoint to CN1+ and P-. The same is true for both 0-5 VDC (VC-2) and 4-20mA (VC-2C) in this configuration (See Figure 4).
- Alternative setpoint signal control for VC-2P only is to connect a potentiometer high to P+ (5 VDC signal), potentiometer low to P-, and the wiper to CN1. This will attenuate a 5 VDC signal to some fraction between 0-5 VDC. It is recommended the potentiometer used is between 1 and 30 kOhm, with 10 kOhm being the nominal value (See Figure 5).
- If you are using two valves: setpoint signal to CN1 will NOT control second valve (O2+/O2-). To use the same setpoint signal for both valves: jump signal from CN1 to CN2 (See Figure 6).
- To use independent setpoint signal for each: Connect separate setpoint signal to CN2 and P-. This can also be done with a potentiometer wiper to CN2 and P+/P- per note above (See Figure 7).
- Note if using a Sierra supplied T10F only ONE high flow valve can be powered

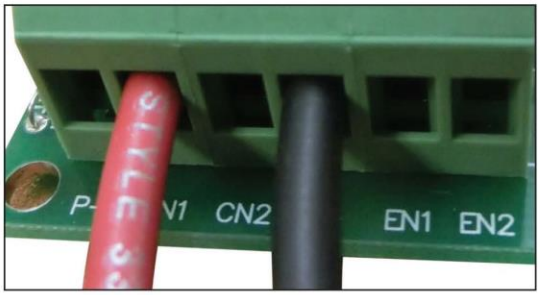

Figure 6. Setpoint Signal

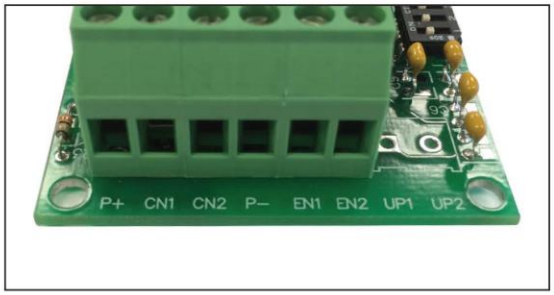

Figure 7. Setpoint Terminal Board

- UP1 and UP2 are not used
- EN1 and EN2 are output enabled and not generally used. The output is enabled by default and is internally pulled up. Bringing the EN pin low immediately brings the PWM output to 0%. Allowing the pin to return to high re-enables the PWM output at the previous duty cycle.

Operational Notes

- The on-board LED's will flash slowly during normal operation. The LED will flash quickly when an error is detected.
- For the valve control circuit VC-2 (0-5 VDC): There is a built-in dead-band that sets the duty cycle to: 0% for any voltage level < 0.10 V. 100% for any voltage level > 4.90 V.
- For the valve control circuit VC-2C: (4-20 mA control): A current between 4 and 20 mA applied to CN1 (CN2) and the P- pins will produce a varying pulse width from 0 – 100% at the output. Any current less than 4 mA will produce no output and indicates a disconnected or failed signal wire. The LED will flash quickly when the controller detects less than 4 mA.

Step 4: Set up dip switches

- The dip switches are used to set up the PWM frequency to the valve coil (See Figure 7). Sierra has done extensive testing and recommends the settings below (See Figure 8). If the VC-2 is purchased as a package with SmartVO and application conditions are provided, Sierra will set up the optimal frequency for the application at the factory. In general, 1.5 Hz is recommended.

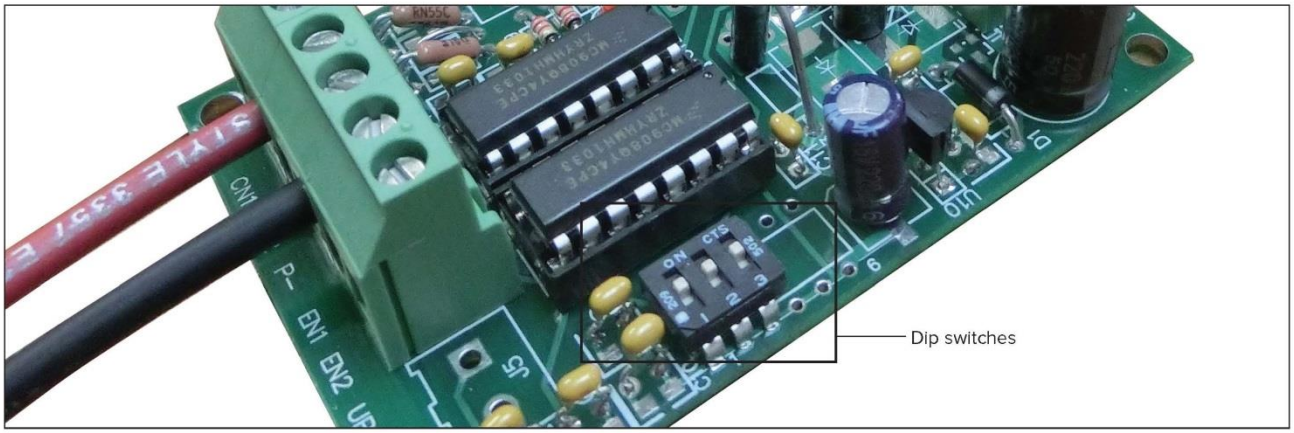

Figure 8. Location of Dip Switches

Recommended Dip Switch Settings			
Frequency	Switch 1	Switch 2	Switch 3
200 Hz	OFF	OFF	ON
400 Hz	OFF	ON	OFF
800 Hz	OFF	ON	ON
1.5 kHz	ON	OFF	OFF
3 kHz	ON	OFF	ON
6 kHz	ON	ON	OFF
12 kHz	ON	ON	ON
24 kHz	OFF	OFF	OFF

Figure 9. Dip Switch Settings

You are now ready to use the valve control circuit to control the SmartVO. Turn on the power and control the valve with the external set-point or potentiometer.

Notes:

- The full VC-2 dual PWM solenoid valve controller from Critical Velocity Enterprises is available here.
- A fuse appropriately rated for the load device is required to ensure safe operation.
- This controller is not reverse-polarity protected. Ensure that it is wired correctly before applying power. Always turn off the power supply before making any changes to the wiring.
- Ground wire pair as well as the Out+ and Out- wire pair.
- Ensure that the controller has adequate air flow for proper cooling. If operating for extended periods of time in high temperature environments, a cooling fan may be necessary.
- Use the shortest possible wiring between the load and controller, and between the controller and the power source. Ensure that the cables carrying the load current are adequately sized. Inadequate power supply filtering or other causes leading to a high impedance path to the power supply will result in higher losses in the filter capacitor and wiring, and may damage the load and/or controller.
- Coil noise or coil whine is a phenomenon of electromagnetic coils like those used in the SmartVO. These coils have a certain resonant frequency when coupled with the rest of the electric circuit, as well as a resonance at which it will tend to physically vibrate. This can be objectionable. Sierra has selected the PWM frequency that minimizes coil noise while maintaining best performance, but this can also be field adjusted as required by selecting the desired frequency using the DIP switches.

Ordering the Power Supply and Valve Control Circuit

To order the valve control circuit option and power supply, reference the price list Option: 1 Valve Control PCA and Option 2: Power Supplies. See the order information below.

Option 1: Valve Control PCA	
VC-2	Dual solenoid valve controller with 0-5 VDC external setpoint control signal.
VC-2P	Dual solenoid valve controller with 0-5 VDC onboard potentiometer setpoint control signal.
VC-2C	Dual solenoid valve controller with 4-20 mA setpoint control signal.

Option 2: Power Supplies	
100- T10F ( )	Low, Medium and high flow SmartVO. 24 VDC power supply. Supplied with fly leads, 1.25 Amps, 110-230 VAC, CE approved. Specify plug preference in parentheses: (US) for USA plug, (EU) for Euro plug, (UK) for Great Britain plug. Note while VC-2 will control two valves, T10F can supply power to two VO-100L, VO-100M flows but only one VO-100H

Option 3: Enclosure	
ENCL ( )	NEMA 4X enclosure for valve controller PCA. Specify cord grip or 6 pin in parentheses ( ). Use ADS to specify desired hole pattern.