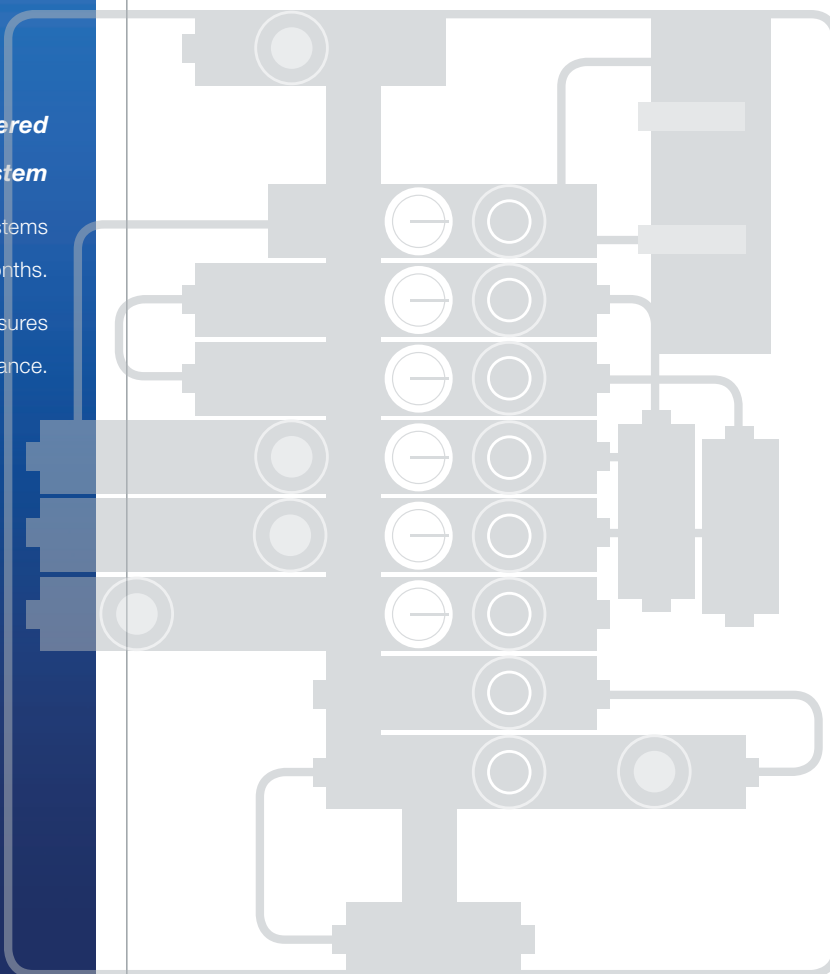


# Calibration and Switching Module

## Application Guide

### **A Swagelok® Pre-Engineered Subsystem**

- Pre-engineered subsystems available in weeks, not months.
- Field-tested design ensures optimum system performance.



- Is a highly configurable unit built with Swagelok modular platform component (MPC) products
- Performs final conditioning of sample before analysis
- Selects from up to 10 sample and 2 calibration streams using the Swagelok stream selector system (SSV series)



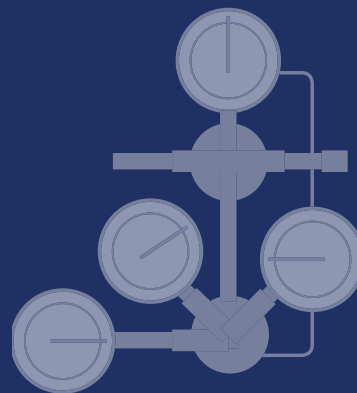
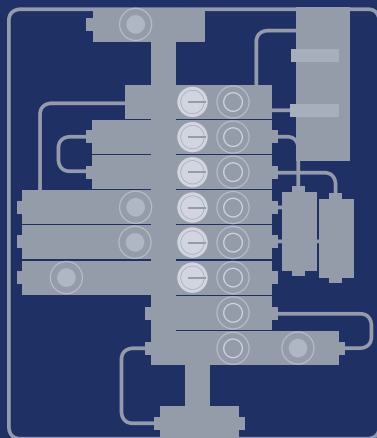
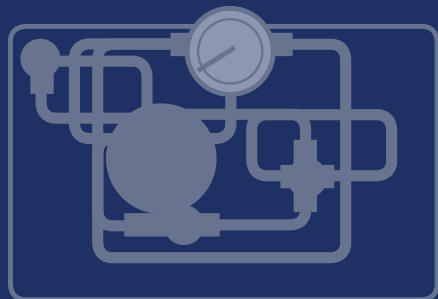
Swagelok®

## Swagelok Pre-Engineered Subsystems

*Swagelok now offers a series of predesigned and preassembled subsystems for use in all types of plants and facilities where fluids are being processed. Use Swagelok pre-engineered subsystems to create fully documented fluid sampling and control systems and bring consistency to your operations. Easy to install and operate, these subsystems offer the high quality and support you expect from Swagelok.*

## Contents

<i>Why Use a Calibration and Switching Module? . . . . .</i>	<i>3</i>
<i>Key Features . . . . .</i>	<i>4</i>
<i>Inlet Assembly Configurations . . . . .</i>	<i>6</i>
<i>Outlet Assembly Configurations . . . . .</i>	<i>10</i>
<i>Options . . . . .</i>	<i>15</i>
<i>Configuring a Calibration and Switching Module . . . . .</i>	<i>17</i>
<i>Where to Install a Calibration and Switching Module . . . . .</i>	<i>18</i>
<i>Materials of Construction . . . . .</i>	<i>19</i>
<i>Pressure-Temperature Ratings . . . . .</i>	<i>20</i>
<i>Testing . . . . .</i>	<i>21</i>
<i>Cleaning and Packaging . . . . .</i>	<i>21</i>
<i>Flow Data . . . . .</i>	<i>21</i>
<i>Dimensions . . . . .</i>	<i>28</i>
<i>Ordering Information . . . . .</i>	<i>30</i>
<i>Regulatory Compliance . . . . .</i>	<i>31</i>



# The Swagelok Calibration and Switching Module (CSM)

## Why Use a Calibration and Switching Module?

To ensure proper function of an online analyzer and to protect the equipment for maximum uptime, all process samples must be conditioned to meet an analyzer's requirements. Conditioning includes verifying that a sample is being inserted into the analyzer at the appropriate pressure, temperature, flow, and filtration level.

### Pressure

Supplying the sample fluid at the appropriate pressure is important in both gas and liquid systems. For gas samples, lower pressure will keep the sample away from its dew point and create safer work conditions. In addition, many injection-style analyzers, such as a chromatograph, depend on constant pressure to ensure a constant injection volume. Liquid systems should maintain a higher pressure to keep a sample away from its bubble point.

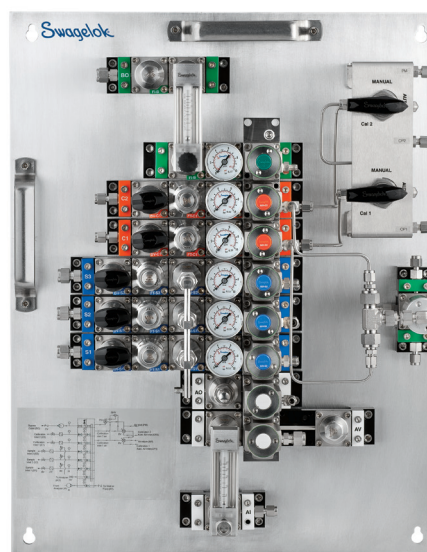
### Temperature

A conditioning system must control sample temperature. Gases at higher temperature will be less likely to reach their dew point or result in water condensation in the sample system. Liquids should be maintained at a temperature low enough to avoid bubbling, but warm enough to prevent freezing.

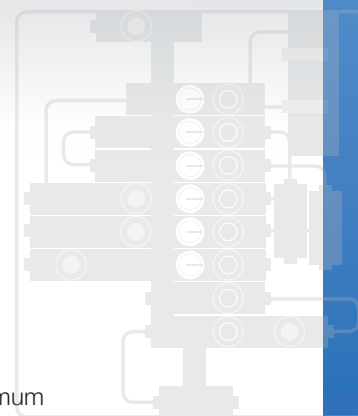
### Flow

The flow rates set at the sample conditioning system dictate the response time of the entire sample system. A typical analyzer flow rate is far too low to result in an acceptable response to the analyzer. Therefore, bypasses are designed into the sample system at various points.

A popular bypass design is a fast loop system, which supplies the analyzer shelter with high flow rates through the transport system. The majority of the fast loop flow returns to the process line, with a lower-flow analyzer line feeding the downstream conditioning system. Alternatively, bypasses can be included in the conditioning system to speed up the flow to the analyzer shelter.



**Typical Swagelok Calibration and Switching Module (CSM)**



## Filtration Level

A common issue with analyzers is clogging due to particulates or mixed phases. An important feature in most conditioning systems is the guard filter that will act as the final shield from particles getting into the analyzer.

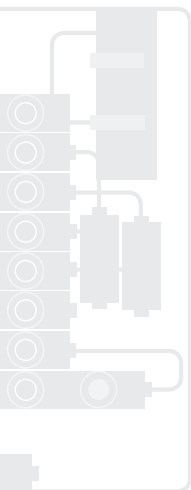
The amount of conditioning performed in the upstream portion of the sample system, as well as the requirements of the analyzer, will determine the amount of conditioning needed in the calibration and switching module.

Component selection and conditioning system design are critical to ensuring that the sample does not become contaminated or change in any way during conditioning; any change to the sample would lead to a misrepresentation of the fluid in the process line. Properly designed conditioning systems include the components that are required to prepare the sample for analysis but do not introduce excessive dead space or contamination points.

Samples are commonly contaminated because of poorly designed or poorly installed stream selection. An ideal stream selector uses double block-and-bleed valve configurations to switch sample lines without allowing any mixing or leaking from unselected inlets; any old internal samples are vented to a bleed line. In addition, the outlet dead space is flushed through the remainder of the sample system to the analyzer by flowing the new sample around a purge loop.

A stream selector should also include the inlets from any calibration fluids for the analyzer. These fluids can contaminate a sample line in the same manner and should be treated as a separate sample stream to the analyzer.

A stream selector unit should be installed as close to the analyzer as possible. Everything downstream of the stream selector will be exposed to all samples and calibration at different times, so minimizing the number of components downstream of the stream selector helps keep the full system clean and easier to maintain. Therefore, the majority of sample conditioning functions should be done upstream of the stream selector, where sample purity is less a concern.



## Key Features

The CSM is built on the Swagelok MPC platform, utilizing the Swagelok stream selector valve (SSV) product, which allows the user to select the configuration required for the specific system. The standard model described here accepts up to ten process and two calibration fluids, either all liquid or all gas.

The main function of the CSM is to condition and select process streams, or to select a calibration stream for analysis. At a minimum, each system must have two inlets—two process stream inlets, or one process stream inlet and a calibration stream inlet. The system selects a fluid for analysis in response to a pneumatic pressure signal from an external source, typically the analyzer. The signal opens one of the SSV double block-and-bleed valve modules corresponding to the stream containing the fluid to be analyzed. The Swagelok CSM offers several additional advantages, including:

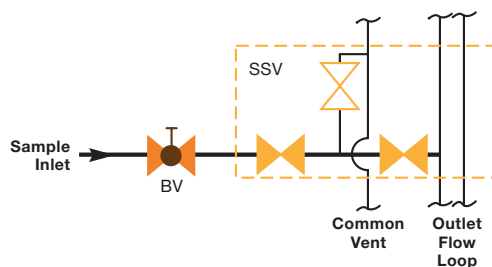
- A variety of sample conditioning configurations available to meet application requirements.
- A manual calibration option that allows the operator to calibrate the analyzer at any time.
- Color-coded stream identification—process stream inlets will always be blue, calibration streams orange, bypass green, and outlet white.
- An integrated flow loop design to ensure consistent delivery times to the analyzer across all streams and eliminate any deadlegs or chance for cross-stream contamination.
- A vented air gap that prevents the hazardous possibility of pneumatic air mixing with system fluid under pressure.
- A modular design that allows easy maintenance. Individual components can be removed from the assembly by loosening four screws accessible from the top of the panel. There is no risk of accidentally disassembling the whole unit or of upsetting other fluid connections.
- A bypass option that allows high flow—and subsequent reduced sample time delay—to the CSM.

## Inlet Assembly Configurations

The CSM can be built with up to six different inlet assembly options to adjust and monitor sample fluid condition.

### Valve Inlet Assembly (VIA)

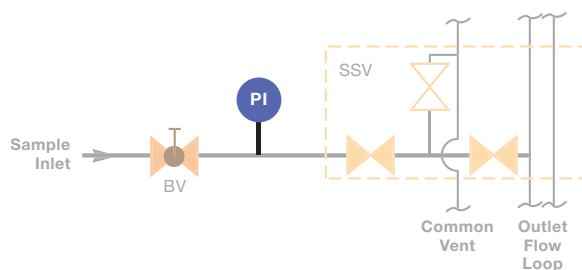
The VIA configuration is the simplest inlet, containing only a sample isolation valve ahead of the SSV series. This configuration should be chosen when the sample is clean and not at excessive pressure for the analyzer.



- The VIA configuration is the simplest inlet assembly with manual shutoff capability.
- This configuration consists of a Swagelok 42T series manual shutoff ball valve (BV) and SSV series.
- The SSV series allows double-block-and-bleed stream selection with other samples or calibration fluids.

### Gauge Inlet Assembly (GIA)

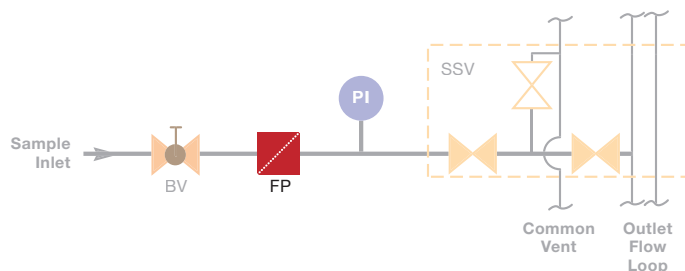
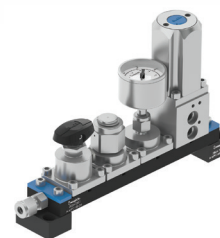
The GIA configuration adds an inlet pressure gauge to the VIA configuration. This system works well with a Swagelok fast loop module if pressure monitoring is needed downstream of the fast loop.



- For pressure monitoring within the CSM, the GIA configuration adds a Swagelok M model pressure gauge (PI) to the VIA configuration.
- The 40 mm (1 1/2 in.) gauge dial is mounted to the modular platform through a Swagelok tube adapter, enabling easy dial positioning.
- Three pressure range options meet various application requirements.

## Filter Inlet Assembly (FIA)

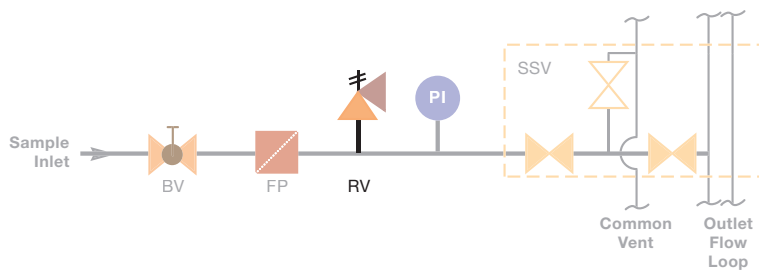
The FIA configuration adds a small filter to the GIA configuration for added analyzer protection. The FIA configuration helps protect the SSV series from an occasional solid particle in an otherwise clean sample fluid. If the sample contains a heavy particulate load, an additional filter upstream of the CSM should be used. All calibration stream inlets come standard with this assembly.



- The FIA configuration is the standard inlet configuration for all calibration streams.
- The FIA configuration adds a Swagelok TF series filter (FP) to the GIA configuration for final particulate removal prior to the analyzer
- The minimal volume filter enhances analyzer response time.
- Quick-change elements are available in 0.5, 2, and 7  $\mu\text{m}$  pore sizes.

## Relief Valve Inlet Assembly (RIA)

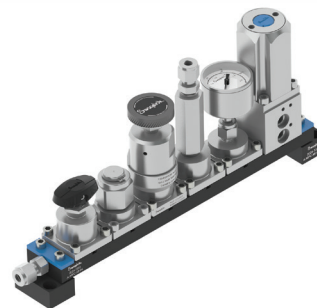
This configuration adds a proportional pressure relief valve to the FIA configuration and helps protect the analyzer if an upstream regulator fails.



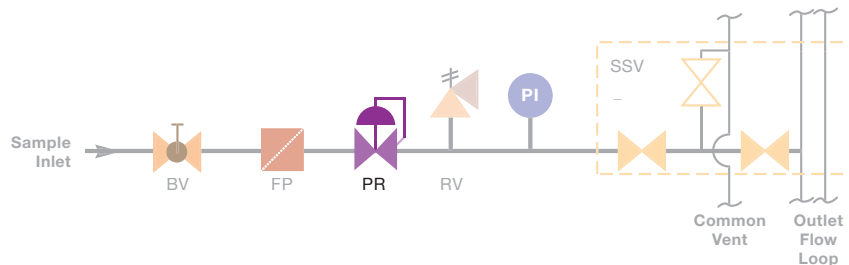
- To protect the sample system from pressure surges, the RIA configuration adds a Swagelok KVV series adjustable relief valve (RV) ahead of the gauge in the FIA configuration.
- The relief valves from multiple inlet assemblies are joined to offer a single connection to vent.
- The relief valve pressure control range is based on selected pressure gauge dial range.

## Pressure Regulator Inlet Assembly (PIA)

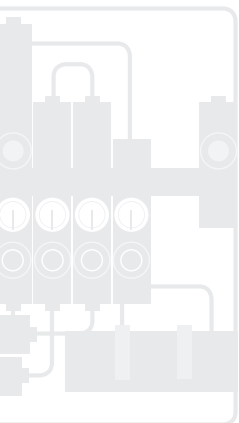
The PIA configuration adds an inlet pressure regulator to the RIA configuration and is a good choice for systems with a fast loop. It allows for pressure equalization of multiple streams before they are switched. For gas samples, 1/8 in. (3 mm) outside diameter connecting tubing is recommended, and the high-pressure lines to the PIA configuration should be as short as possible.



If a pressure-reducing field station, such as the Swagelok field station module, is being used to reduce the pressure of a gas sample at the process tap, it could eliminate the need for a PIA configuration.



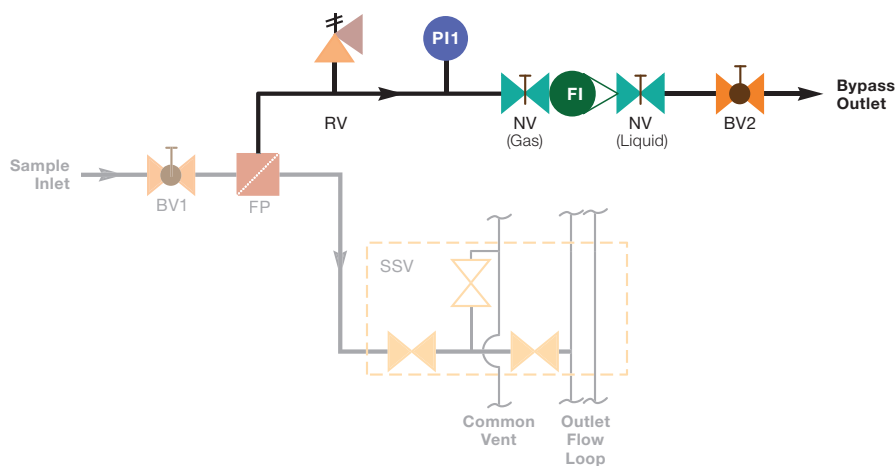
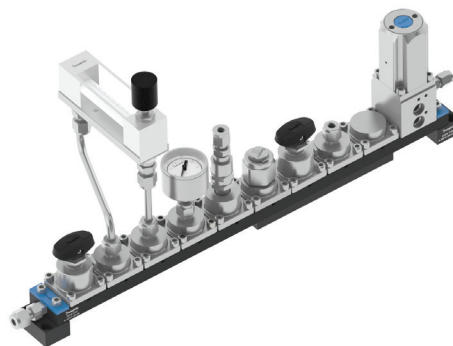
- For localized pressure control within the CSM, the PIA configuration adds a Swagelok KCP series pressure regulator (PR) ahead of the relief valve.
- The regulator pressure control range is based on selected pressure gauge dial range.





## Flow Loop Inlet Assembly (LIA)

The LIA configuration offers constant flow up to the SSV series, which virtually eliminates dead flow and results in minimum time delay. This configuration requires a return connection to the process. This configuration includes an adjustable flowmeter and bypass filter.

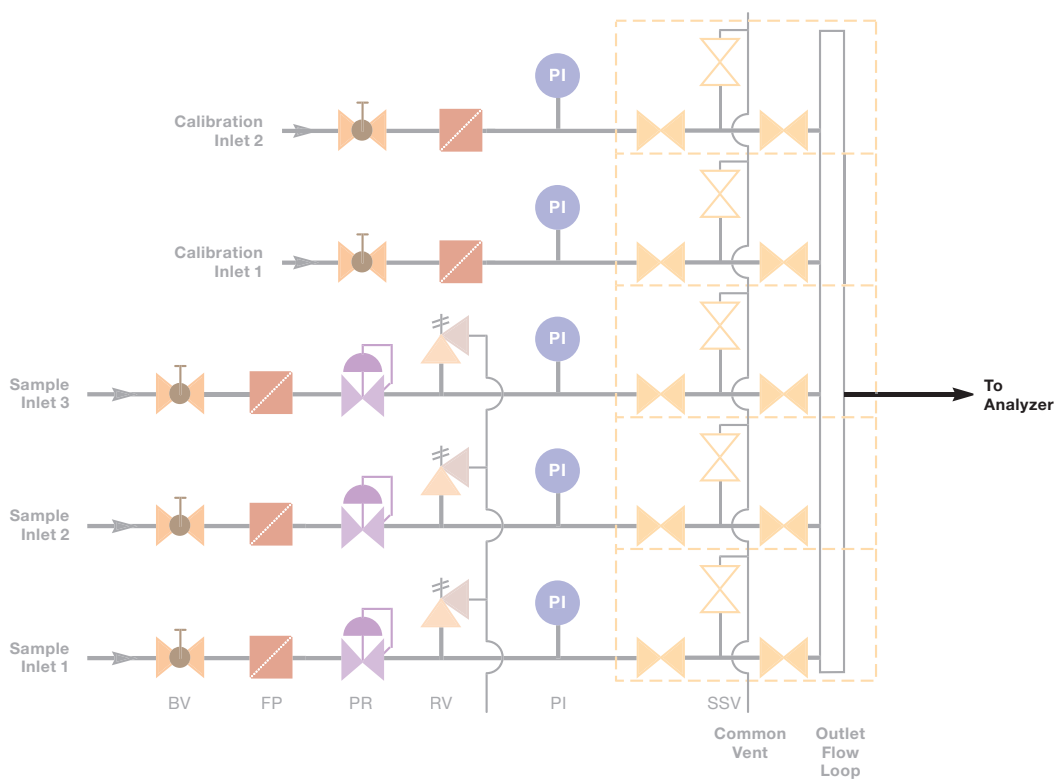


- The LIA configuration offers the most conditioning for a sample inlet.
- The bypass filter (FP) enables flow to continue through the flow loop while the SSV series is closed, resulting in a timely, fresh sample.
- The bypass line includes a Swagelok G1 or M1 series flowmeter (FI) for bypass flow control.
- The flow pattern is similar to a modular fast loop for optimal analyzer response.

## Outlet Assembly Configurations

### No Flow Control

In cases where flow control and measurement are not needed—or will be performed outside of the CSM—the system can be designed with an outlet fitting.

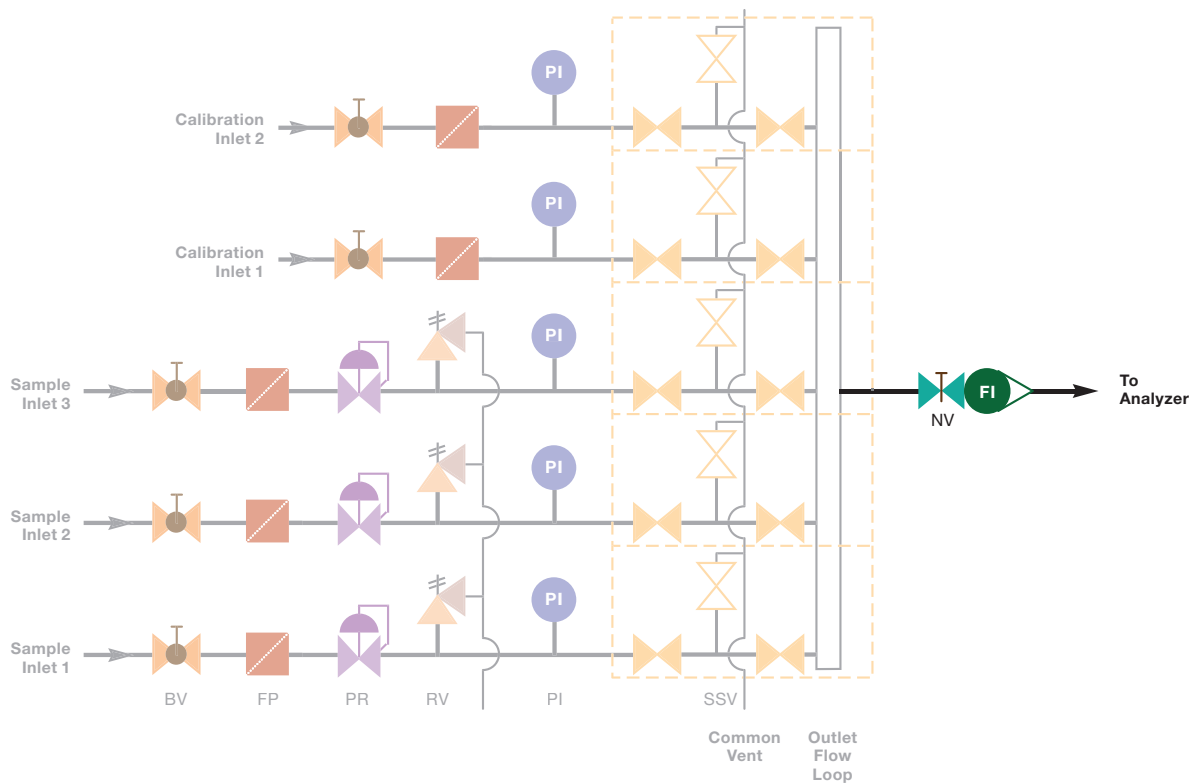


**Shown with 3 PIA Streams and 2 FIA Calibration Streams**



## Upstream Flowmeter

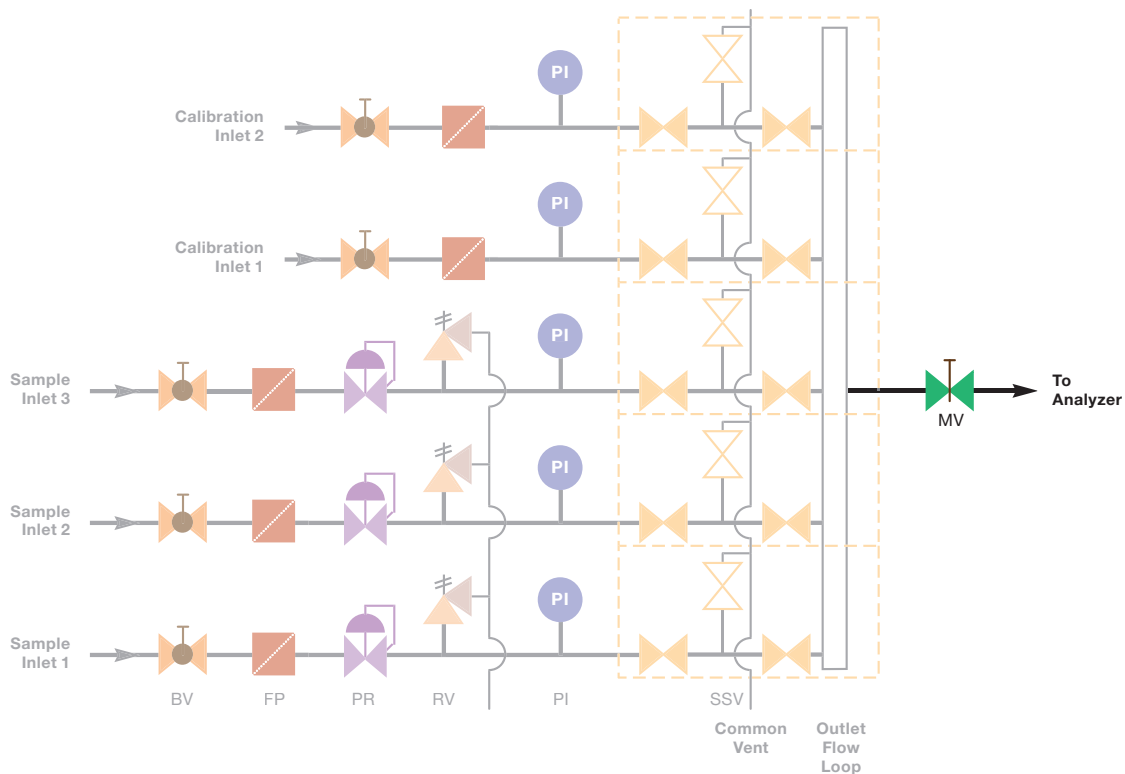
The upstream flowmeter outlet uses a glass or metal tube flowmeter (FI) with integral needle valve (NV) to control and measure flow at the SSV series outlet. This configuration is typical in gas analysis because the analyzer usually operates at lower pressures.



**Shown with 3 PIA Streams and 2 FIA Calibration Streams**

## Upstream Metering Valve

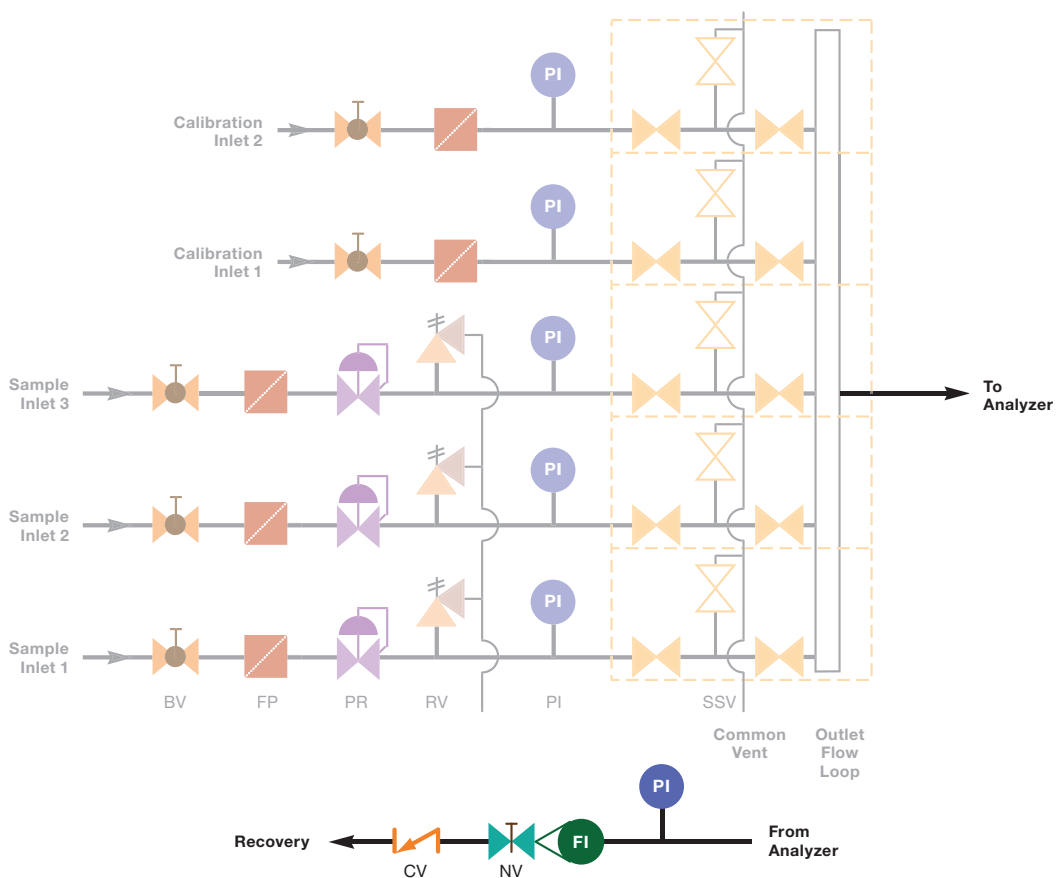
The upstream metering valve outlet consists of an M series metering valve (MV) for flow control ahead of the analyzer. The valve is placed on the MPC modular footprint at the SSV series outlet. In this configuration, the system does not include flow measurement functionality.



Shown with 3 PIA Streams and 2 FIA Calibration Streams

## Downstream Flowmeter

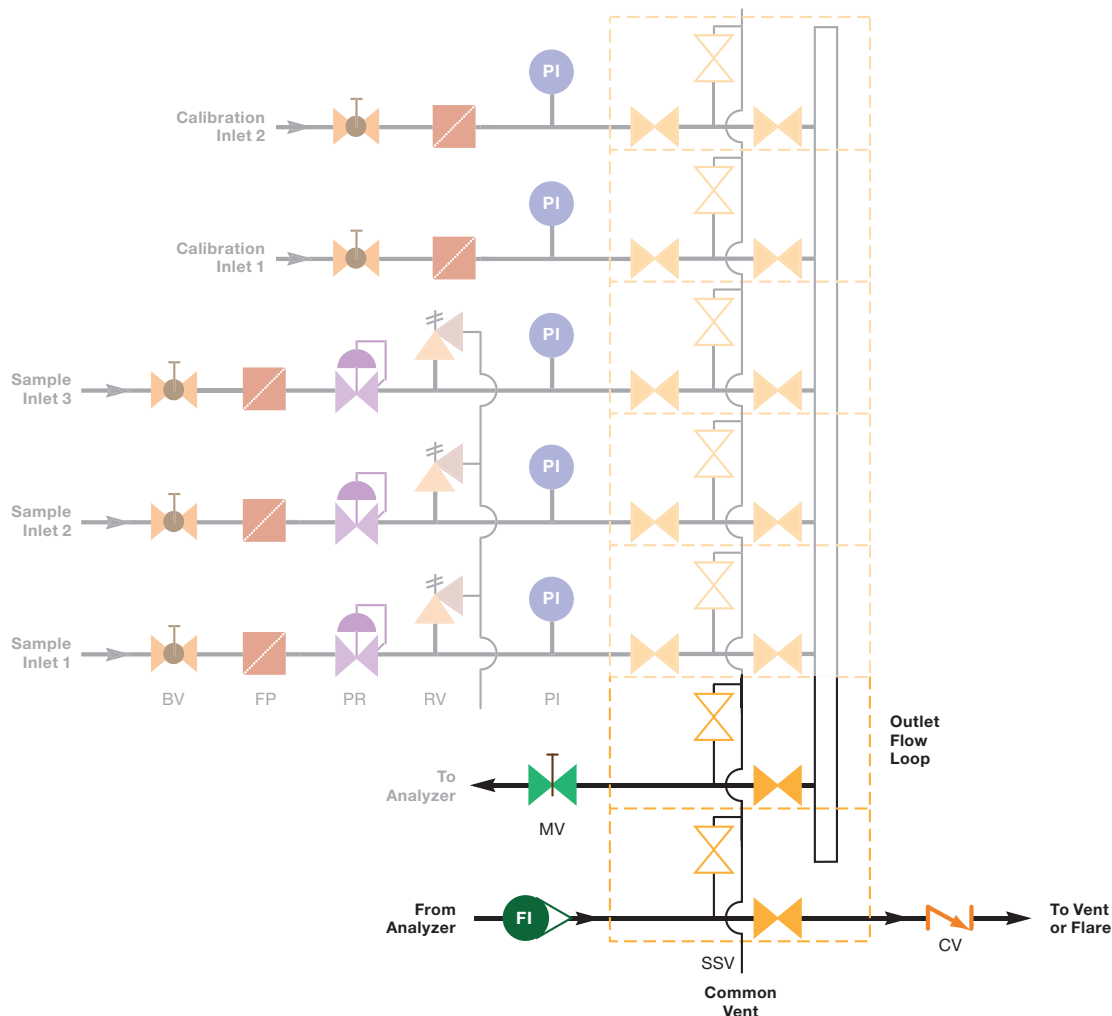
The downstream flowmeter outlet allows for the pressure drop from the flowmeter (FI) needle valve (NV) to be downstream of the analyzer. This configuration, which is typically used in liquid systems, also includes a pressure gauge (PI) to indicate pressure at the analyzer outlet and a check valve (CV) to protect against back flow from the recovery system.



Shown with 3 PIA Streams and 2 FIA Calibration Streams

## Atmospheric Reference Vent (ARV)

The ARV outlet brings a gas sample to atmospheric pressure before injection into a gas chromatograph or similar discontinuous analyzer. This configuration is designed for gas systems where the functionality is not already integrated into the system analyzer. The ARV is connected immediately downstream of the stream-select function and is an integral part of the SSV series. It isolates the analyzer from the CSM and opens the analyzer to atmosphere for pressure reference.



Shown with 3 PIA Streams and 2 FIA Calibration Streams

For additional information, see the Swagelok *Stream Selector System for Process Analyzer Applications* catalog, MS-02-326.

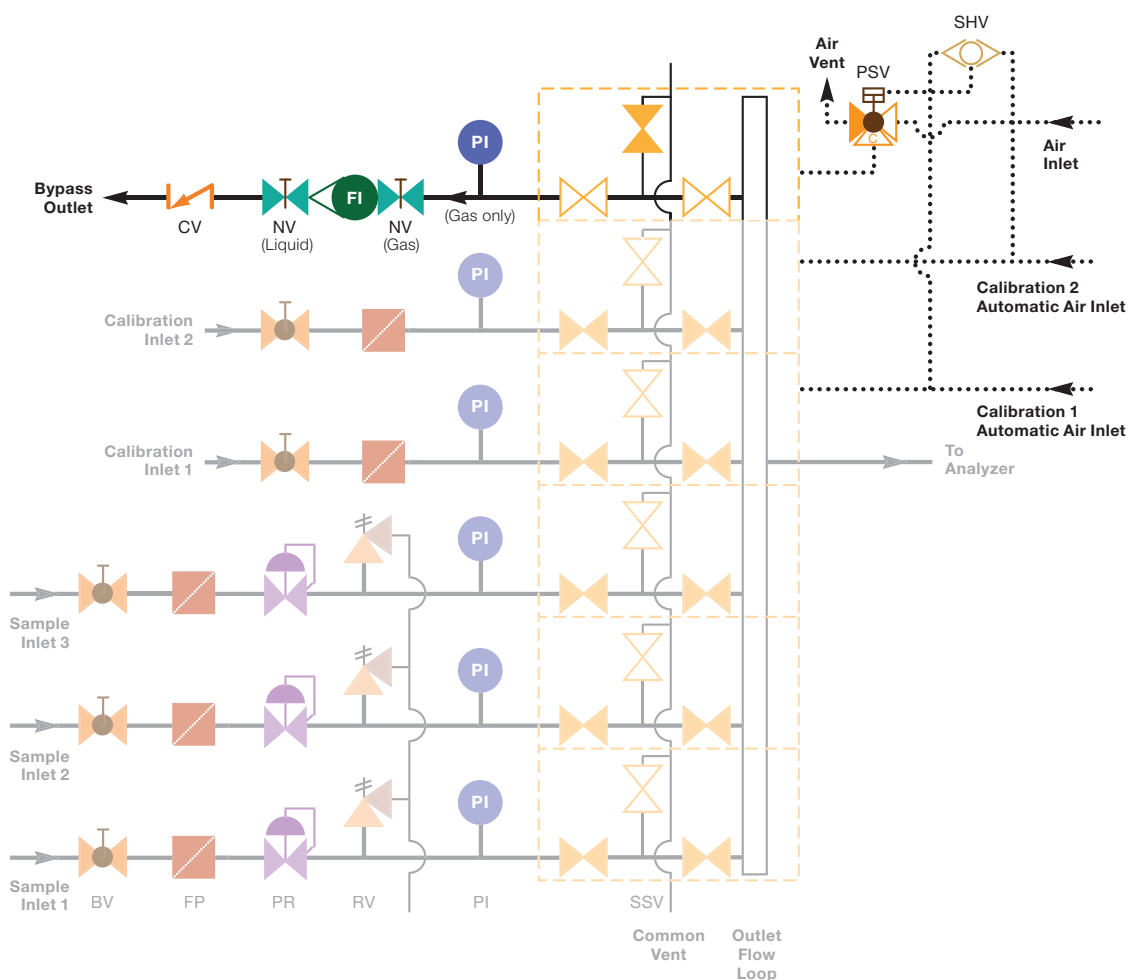
## Options

The calibration and switching module can be built with various options to control flow to the analyzer.

### Bypass

The bypass option increases the flow of each selected process stream, bypassing some of the sample flow to a vent connection for disposal or return connection to the process. Because of the low volume of Swagelok modular components, a bypass flow may not be required for a fast response. This option should be selected if analyzer flow is insufficient to quickly purge the process sample inlet lines.

The bypass option consists of an additional SSV series that is held in the normally open position during standard operation. However, when a calibration stream is selected, the bypass SSV series closes to conserve expensive calibration fluid. A flowmeter is also included.

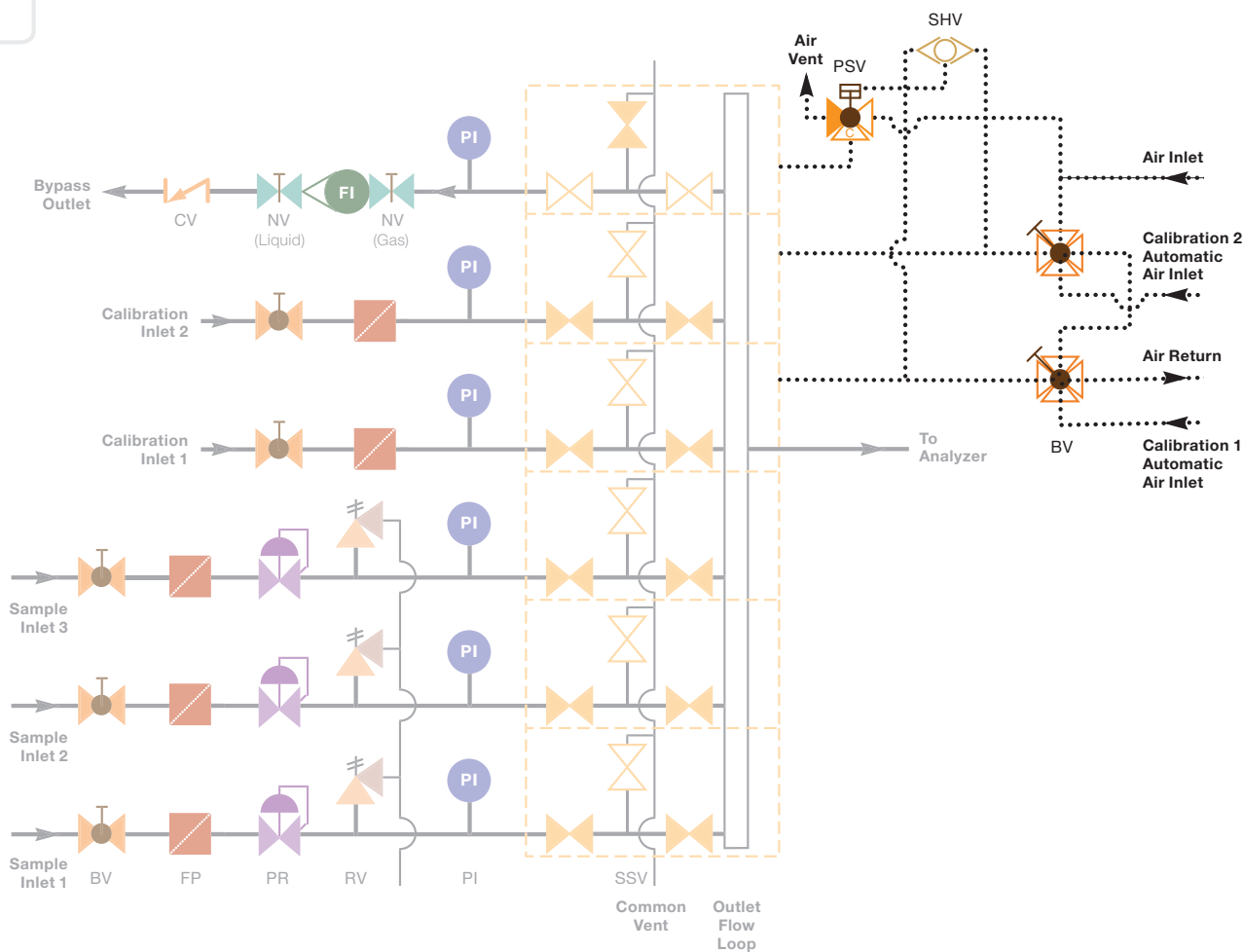


## Manual Calibration Assembly (MCA)

This option enables operators to manually actuate the appropriate valve for calibration. It is an ideal option for systems with analyzers that analyze a single stream but require a zero and a span fluid for calibration.

A CSM can be specified with automatic selection of up to two calibration fluids. The SSV series selects a fluid for analysis in response to a pneumatic-pressure signal from an external source, typically the analyzer. The manual calibration option allows operators to override the pneumatic pressure signal and select the appropriate SSV for calibration.

In order to properly use manual calibration, the operator must be able to interrupt or temporarily prohibit automatic pneumatic signals from reaching the analyzer or chromatograph. Otherwise, these systems could automatically activate during the manual calibration procedure.



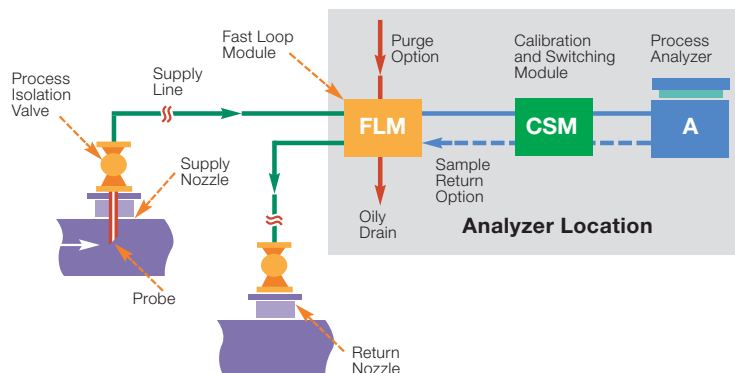


## Configuring a Calibration and Switching Module

As standard options, the CSM can be configured to handle the minimum conditioning of an isolation valve (VIA stream) through full conditioning of pressure regulation and bypass flow (LIA stream). Once the amount of conditioning that is required is determined, a CSM can be configured using the following simple, six-step process.

1. Determine which inlet assembly configuration will provide the conditioning components needed to prepare the sample for the analyzer. (See page 6 for inlet assembly configurations.) This step includes determining the pressure range and filtration pore size as needed.
2. Determine the number of samples. The CSM can be designed to accommodate one sample inlet or up to ten sample inlets. Each sample line will be selected for analysis by a Swagelok SSV series stream selector valve.
3. Determine the number of calibration inlets. The CSM can be designed to include up to two calibration fluids. These calibration lines will include the conditioning components found in the filter inlet assembly (FIA) to ensure the proper cleanliness of the calibration fluid. (See page 7 for the FIA configuration.)
4. Determine outlet assembly configurations. The CSM offers various methods for controlling the stream selection outlet, including an atmospheric reference vent (ARV) for injection-style analyzers, as well as sample flow measurement or control. (See pages 10 through 14 for outlet assembly configurations.)
5. Determine whether sample stream bypass is needed. The Swagelok SSV series can include an additional bypass outlet, which will greatly increase the sample flow rate without increasing flow to the analyzer. (See page 15 for the bypass configuration.)
6. Determine whether manual calibration is needed. Most analyzers are able to switch to a calibration line during operations. However, if this flexibility is not available with your analyzer, switching to a calibration stream may require reprogramming of the solenoid control valves. The CSM allows for manual calibration by overriding the pneumatic signals to the stream selector and opening a calibration line for the analyzer through a manual valve. (See page 16 for the manual calibration configuration.)

## Where to Install a Calibration and Switching Module



The schematic illustrates the Swagelok CSM installed in a typical analytical sample system. Depending on the application, a fast loop module (FLM) can supply the CSM with flow from a bypass fast loop filter for improved response time to the analyzer. The CSM can incorporate additional bypasses that can be returned to the process line—through the fast loop or separately—or sent to a disposal system. The number of inlets will be determined by the number of samples and calibration lines being sent to a single analyzer.

For more information about installation, operation, and maintenance of Swagelok CSM subsystems, see the *Calibration and Switching Module User's Manual*, MS-13-217.

## Materials of Construction

Configuration Label	Component	Manufacturer, Model	Material Grade / ASTM Specification	
			Wetted Components	Nonwetted Components
BV	Ball valve	Swagelok 42T series	See Swagelok <i>Modular Platform Components</i> catalog, MS-02-185	See Swagelok <i>One-Piece Instrumentation Ball Valves—40G and 40 Series</i> catalog, MS-02-331
CV	Check valve	Swagelok CH series		See Swagelok <i>Check Valves</i> catalog, MS-01-176
FI	Flow indicator	Swagelok G1 or M1 series variable area flowmeter	See Swagelok <i>Variable Area Flowmeters</i> catalog, MS-02-346	
FP	Filter-particulate	Swagelok TF series	See Swagelok <i>Modular Platform Components</i> catalog, MS-02-185	See Swagelok <i>Filters</i> catalog, MS-01-92
MV	Metering valve	Swagelok M series		See Swagelok <i>Metering Valves</i> catalog, MS-01-142
NV	Needle valve—flowmeter	Swagelok G1 or M1 series variable area flowmeter integral needle valve	See Swagelok <i>Variable Area Flowmeters</i> catalog, MS-02-346	
PI	Pressure indicator	Swagelok M model pressure gauge	See Swagelok <i>Modular Platform Components</i> catalog, MS-02-185	
PR	Pressure regulator	Swagelok KCP series	See Swagelok <i>Modular Platform Components</i> catalog, MS-02-185	See Swagelok <i>Pressure Regulators</i> catalog, MS-02-230
PSV	Pneumatic switching valve	Swagelok PSV series	See Swagelok <i>Modular Platform Components</i> catalog, MS-02-185	
RV	Relief valve	Swagelok KVV series	See Swagelok <i>Pressure Regulators</i> catalog, MS-02-230	
SHV	Shuttle valve	Swagelok	316 SS, fluorocarbon elastomer	316 SS
SSV	Stream selector valve	Swagelok SSV series	See Swagelok <i>Modular Platform Components</i> catalog, MS-02-185	See Swagelok <i>Stream Selector System</i> catalog, MS-02-326
—	Fittings	Swagelok	316 SS / A276, A479, or A182	
—	Tubing	Swagelok	316 / 316L SS / A213 <sup>①</sup> or A269	
—	Substrate channels, substrate flow components, manifold channels, manifold flow components, seals, mounting blocks, assembly hardware	Swagelok	See Swagelok <i>Modular Platform Components</i> catalog, MS-02-185	
—	Mounting plate	Swagelok	304 SS / ASTM A240	
Manual Calibration Option				
BV	Ball valve	Swagelok 40G and 40 series	See Swagelok <i>One-Piece Instrumentation Ball Valves—40G Series and 40 Series</i> catalog, MS-02-331	
—	Fittings	Swagelok	316 SS / A276, A479, or A182	
—	Mounting bracket	Swagelok	304 SS / A240	
—	Tubing	Swagelok	316 / 316L SS / A213 or A269	

① Nominal wall thickness, not minimum wall thickness.

## Pressure-Temperature Ratings

### Process Components

Temperature, °F (°C)	Working Pressure, psig (bar)
20 (–6)	200 (13.7)
30 (–1)	250 (17.2)
150 (65)	

Pressure ratings are limited to:

- 25 psig (1.7 bar) with pressure gauge option **A** (0 to 2.5 bar [0 to 36 psi])
- 100 psig (6.8 bar) with pressure gauge option **B** (0 to 10 bar [0 to 145 psi])
- 145 psig (9.9 bar) for any CSM subsystem that includes a G1 model flowmeter:
  - Flow loop inlet assembly (page 9)
  - Upstream flowmeter outlet configuration (page 11)
  - Downstream flowmeter outlet configuration (page 13)
  - ARV outlet configuration (page 14)
  - Bypass configuration (page 15).

The M1 model flowmeter does not limit the pressure ratings shown above.

Temperature ratings apply both to system fluid (media) and to ambient surroundings, except for CSM systems that use these process components:

Component	Temperature, °F (°C)
G1 model flowmeter	Media: 23 to 150 (–5 to 65)
	Ambient: 20 to 150 (–6 to 65)
Pressure gauge	Media: 20 to 150 (–6 to 65)
	Ambient: 20 to 140 (–6 to 60)

### Pneumatic Components

With Bypass Option and Calibration Inlets	
Temperature, °F (°C)	Working Pressure, psig (bar)
20 (–6)	45 to 100 (3.2 to 6.8)
30 (–1)	40 to 100 (2.8 to 6.8)
150 (65)	
Without Bypass Option or With Bypass Option and No Calibration Inlets	
20 (–6)	45 to 150 (3.2 to 10.3)
30 (–1)	40 to 150 (2.8 to 10.3)
150 (65)	

## Testing

Every Swagelok CSM subsystem is factory pressure tested at 1000 psig (69 bar) or its maximum rated pressure if less than 1000 psig (69 bar).

## Cleaning and Packaging

All Swagelok CSM subsystems are cleaned in accordance with Swagelok *Standard Cleaning and Packaging (SC-10)*, MS-06-62.

## Flow Data

### CSM Inlet and Outlet Assembly Flow Coefficients

Inlet Assembly Configuration	Flow Coefficient ( $C_v$ )
Filter (FIA) 7 $\mu$ m element 2 $\mu$ m element 0.5 $\mu$ m element	0.041 0.036 0.025
Gauge (GIA)	0.05
Flow loop (LIA) 7 $\mu$ m filter element 2 $\mu$ m filter element 0.5 $\mu$ m filter element	Analyzer stream 0.035 0.030 0.018
Pressure regulator (PIA)	0 to 0.031 (regulator full open)
Relief valve (RIA) 7 $\mu$ m filter element 2 $\mu$ m filter element 0.5 $\mu$ m filter element	0.037 0.032 0.021
Valve (VIA)	0.065

Outlet Assembly Configuration	Flow Coefficient ( $C_v$ )
Upstream flowmeter Gas systems  Liquid systems	0.01 to 0.015 (needle valve open)  0.05 to 0.07 (needle valve open)
Upstream metering valve 3 turns open 5 turns open 7 turns open 10 turns, full open	0.009 0.015 0.022 0.030
Downstream flowmeter	0.02 to 0.03 (needle valve open)
Atmospheric reference vent (ARV) Metering valve 3 turns open Metering valve 5 turns open Metering valve 7 turns open Metering valve 10 turns, full open	0.005 0.007 0.011 0.015
Bypass Gas systems  Liquid systems	0.01 to 0.015 (needle valve open)  0.02 to 0.03 (needle valve open)

### CSM Inlet and Outlet Assembly Flow Graphs

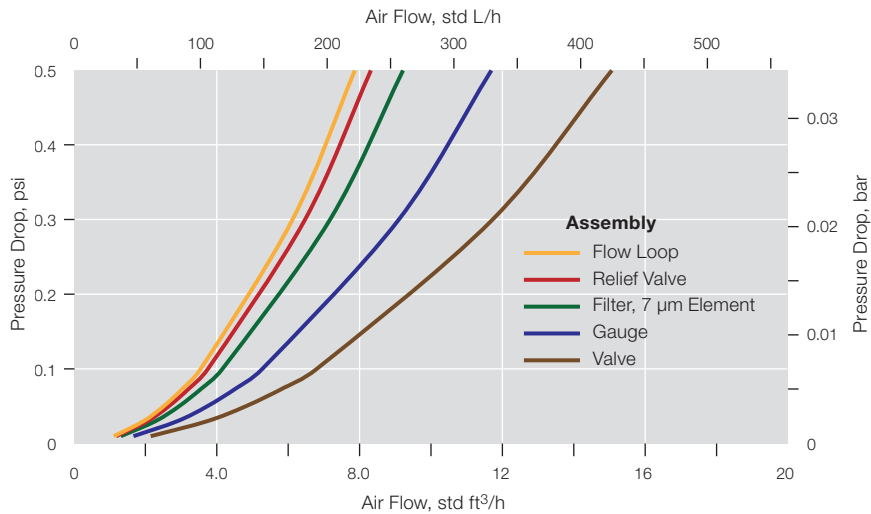
The total CSM subsystem pressure drop is the sum of inlet and outlet assembly pressure drops.

1. Find the graph with your sample inlet assembly in the left column. Determine the pressure drop based on a desired flow rate.
2. Using the same flow rate, determine the pressure drop in the outlet assembly
3. Add the inlet and outlet assembly pressure drops to obtain the CSM subsystem pressure drop.

## Flow Data

### Air Flow

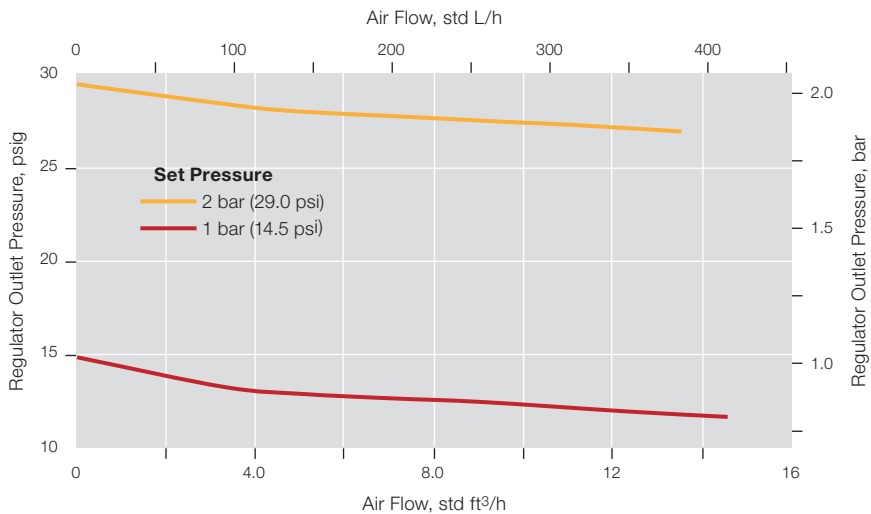
#### Flow Loop, Relief Valve, Filter, Gauge, and Valve Inlet Assemblies



#### Pressure Regulator Inlet Assembly

Regulator Control Range 0 to 50 psig (0 to 3.4 bar);

Pressure Gauge Dial Range 0 to 2.5 bar (0 to 36 psi)

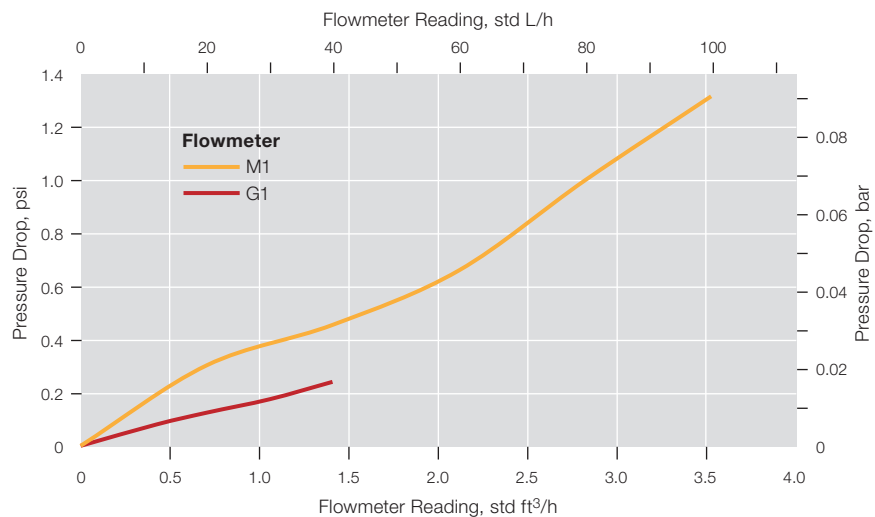


## Flow Data

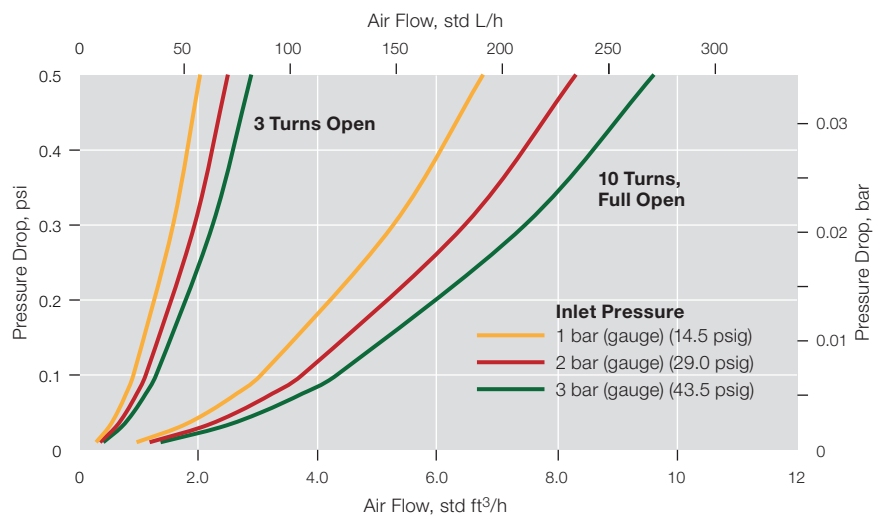
### Air Flow

#### Upstream Flowmeter Outlet Assembly

See **Calculating Actual Gas Flow Rate from Flowmeter Reading**, page 25.



#### Upstream Metering Valve Outlet Assembly

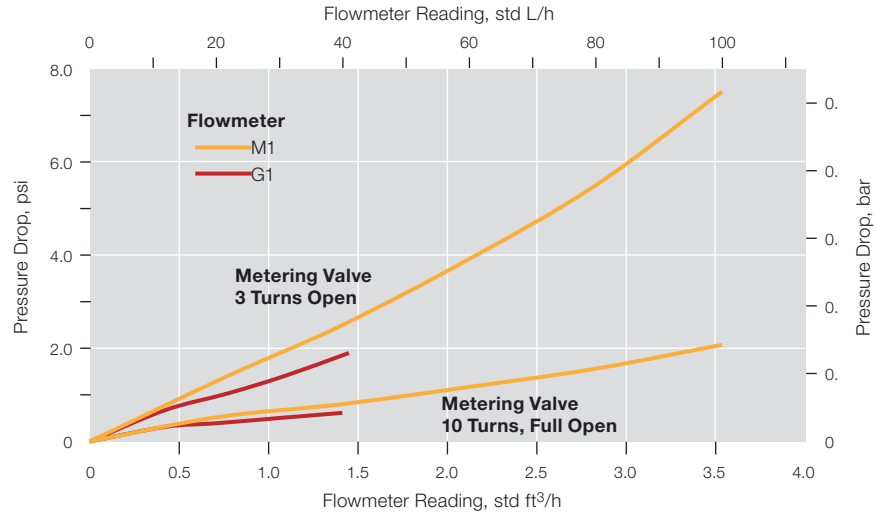


## Flow Data

### Air Flow

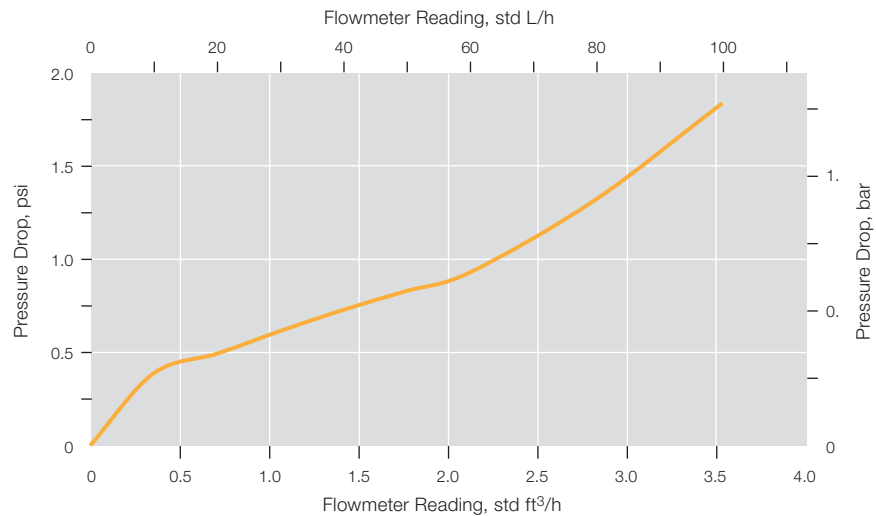
#### Atmospheric Reference Vent Assembly

See **Calculating Actual Gas Flow Rate from Flowmeter Reading**, page 25.



#### Bypass Assembly

See **Calculating Actual Gas Flow Rate from Flowmeter Reading**, page 25.





## Flow Data

### Calculating Actual Gas Flow Rate from Flowmeter Reading

Standard CSM gas subsystems contain flowmeters calibrated at with dry air at typical ambient pressure and temperature (1.013 bar absolute and 20°C). To obtain flow data that reflect your system fluid, pressure, and temperature, you must calculate a conversion factor, then multiply the conversion factor by the flowmeter reading.

Use the equation below to calculate the conversion factor.

$$F = \sqrt{\frac{\rho_{\text{cal}}}{\rho_{\text{new}}}} \times \sqrt{\frac{P_{\text{new}}}{P_{\text{cal}}}} \times \sqrt{\frac{273 + T_{\text{cal}}}{273 + T_{\text{new}}}}$$

where

F = conversion factor

$\rho_{\text{cal}}$  = fluid density of calibrated scale

$\rho_{\text{new}}$  = new fluid density

$P_{\text{cal}}$  = pressure of calibrated scale

$P_{\text{new}}$  = new pressure

$T_{\text{cal}}$  = temperature of calibrated scale, in °C

$T_{\text{new}}$  = new temperature, in °C

For temperatures in °F, replace 273 in the equation with 460.

Example:

<b>Scale Calibration</b>	<b>Your Fluid</b>
--------------------------	-------------------

$\rho_{\text{cal}} = 1.5 \text{ kg/m}^3$	$\rho_{\text{new}} = 1.5 \text{ kg/m}^3$
--	--

$P_{\text{cal}} = 7 \text{ bar}$	$P_{\text{new}} = 10 \text{ bar}$
----------------------------------	-----------------------------------

$T_{\text{cal}} = 30^\circ\text{C}$	$T_{\text{new}} = 60^\circ\text{C}$
-------------------------------------	-------------------------------------

$$F = \sqrt{\frac{1.5}{1.5}} \times \sqrt{\frac{10}{7}} \times \sqrt{\frac{273 + 30}{273 + 60}} = 1.14$$

Multiply 1.14 by the flowmeter reading to determine the actual flow rate.

Example:

The flowmeter reading is 100 L/h.

$$100 \text{ L/h} \times 1.14 = 114 \text{ L/h}$$

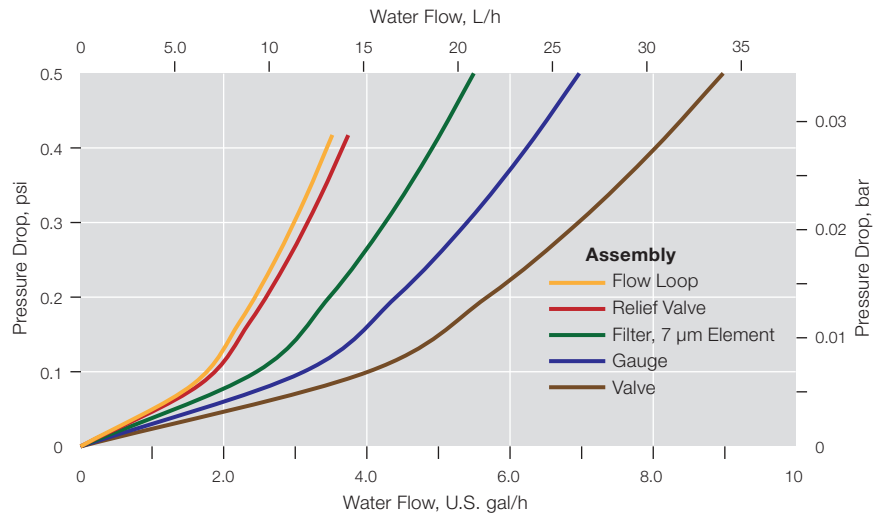
### Flowmeter Calibration

Every Swagelok flowmeter is factory calibrated to its media, flow range, and accuracy class using clean, dry air for air-flow range models and water for water-flow range models. For more information, see the Swagelok *Variable Area Flowmeters* catalog, MS-02-346.

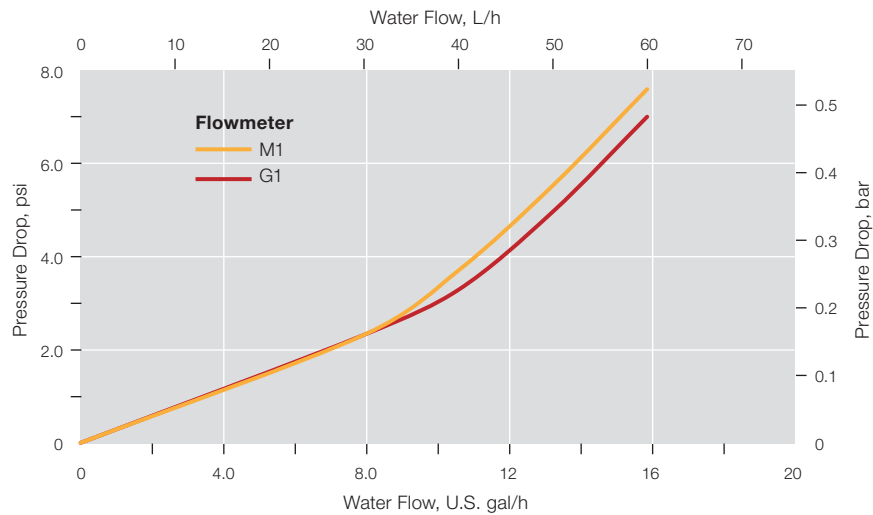
## Flow Data

### Water Flow

#### Flow Loop, Relief Valve, Filter, Gauge, and Valve Inlet Assemblies



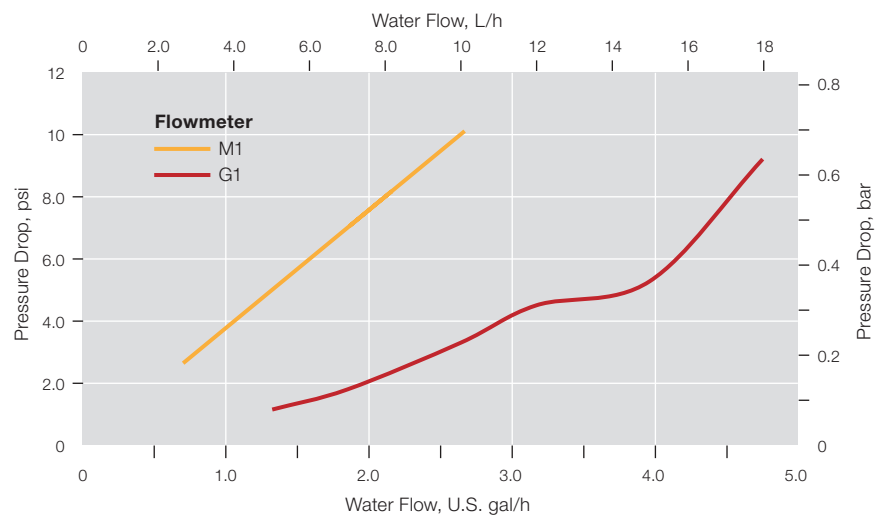
#### Upstream Flowmeter Outlet Assembly



## Flow Data

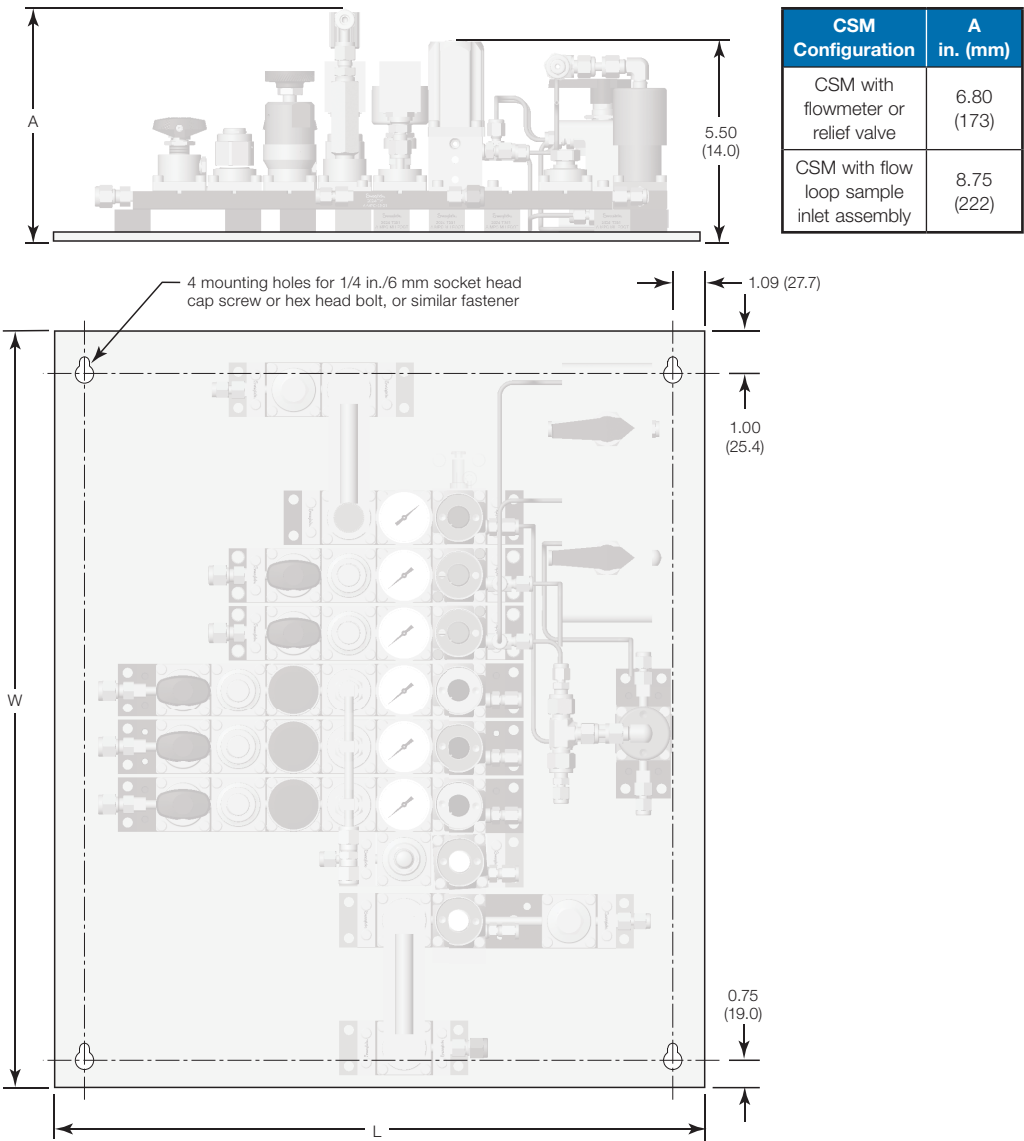
### Water Flow

#### *Downstream Flowmeter and Bypass Assemblies*



Dimensions

Dimensions, in inches (millimeters), are for reference only and are subject to change.



Weight

Plate Dimension W in. (mm)	Plate Dimension L, in. (mm)					
	12.0 (305)	15.0 (381)	18.0 (457)	23.0 (584)	28.0 (711)	34.0 (864)
	CSM Subsystem Weight, lb (kg)					
12.0 (305)	22.0 (10.0)	27.0 (12.2)	30.0 (13.6)	38.0 (17.2)	52.0 (23.6)	56.0 (25.4)
15.0 (381)	28.0 (12.7)	38.0 (17.2)	43.0 (19.5)	59.0 (26.8)	70.0 (31.8)	73.0 (33.1)
18.0 (457)	42.0 (19.1)	47.0 (21.3)	50.0 (22.7)	90.0 (40.8)	98.0 (44.5)	104 (47.2)
23.0 (584)	58.0 (26.3)	64.0 (29.0)	74.0 (33.6)	128 (58.1)	135 (61.2)	146 (66.2)
28.0 (711)	70.0 (31.8)	72.0 (32.7)	78.0 (35.4)	152 (68.9)	162 (73.5)	175 (79.4)
34.0 (864)	—	82.0 (37.2)	112 (50.8)	164 (74.4)	185 (83.9)	200 (90.7)

## Dimensions

Dimensions, in inches (millimeters), are for reference only and are subject to change.

### Plate Dimension L

Inlet Stream Configuration Designator	Dimension L, in. (mm)				
	Bypass Option				
	No	No	Yes	Yes / No	Yes / No
	Manual Calibration				
	No	No	No	Yes	Yes
	Outlet Designator				
	3, X	1, 2, A	All	3, A, X	1, 2
<b>F</b> Filter (FIA)	12.0 (305)	15.0 (381)	15.0 (381)	18.0 (457)	23.0 (584)
<b>G</b> Gauge (GIA)	12.0 (305)	15.0 (381)	15.0 (381)	18.0 (457)	23.0 (584)
<b>L</b> Flow loop (LIA), 1 inlet	23.0 (584)	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)
<b>L</b> Flow loop (LIA), 2 inlets	23.0 (584)	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)
<b>L</b> Flow loop (LIA), 3 or more inlets	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)	34.0 (864)
<b>P</b> Pressure regulator (PIA)	15.0 (381)	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)
<b>R</b> Relief valve (RIA)	15.0 (381)	18.0 (457)	18.0 (457)	18.0 (457)	23.0 (584)
<b>V</b> Valve (VIA)	12.0 (305)	15.0 (381)	15.0 (381)	18.0 (457)	23.0 (584)

### Plate Dimension W

Number of Inlet Streams	Dimension W, in. (mm)						
	Bypass Option						
	No	No	Yes	Yes	Yes	No	Yes
	Manual Calibration						
	Yes / No	Yes / No	No	No	Yes	Yes / No	Yes / No
	Outlet Designator						
	2, X	1	X	1, 2	1, 2, X	3, A	3, A
2	12.0 (305)	15.0 (381)	15.0 (381)	18.0 (457)	18.0 (457)	15.0 (381)	18.0 (457)
3	12.0 (305)	15.0 (381)	15.0 (381)	18.0 (457)	18.0 (457)	18.0 (457)	23.0 (584)
4	15.0 (381)	15.0 (381)	18.0 (457)	18.0 (457)	18.0 (457)	18.0 (457)	23.0 (584)
5	18.0 (457)	18.0 (457)	18.0 (457)	18.0 (457)	23.0 (584)	23.0 (584)	23.0 (584)
6	18.0 (457)	18.0 (457)	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)	28.0 (711)
7	18.0 (457)	18.0 (457)	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)	28.0 (711)
8	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)	28.0 (711)	28.0 (711)
9	23.0 (584)	23.0 (584)	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)
10	23.0 (584)	23.0 (584)	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)
11	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)
12	28.0 (711)	28.0 (711)	34.0 (864)	34.0 (864)	34.0 (864)	34.0 (864)	34.0 (864)

## Ordering Information

Build a CSM subsystem ordering number by combining the designators in the sequence shown below.

1 2 3 4 5 6 7 8 9 10 11  
 CSM - **G** - **2** **P** **1** - **B** **D** **C** - **F** **A** **X** - **M**

### 1 Fluid

**G** = Gas  
**L** = Liquid

### 2 Number of Process Sample Inlets

**1** = 1 inlet  
**2** = 2 inlets  
**3** = 3 inlets  
**4** = 4 inlets  
**5** = 5 inlets  
**6** = 6 inlets  
**7** = 7 inlets  
**8** = 8 inlets  
**9** = 9 inlets  
**0** = 10 inlets

### 3 Inlet Assembly Configuration

**F** = Filter (FIA, page 7)  
**G** = Gauge (GIA, page 6)  
**L** = Flow loop (LIA, page 9)  
**P** = Pressure regulator (PIA, page 8)  
**R** = Relief valve (RIA, page 7)  
**V** = Valve (VIA, page 6)

### 4 Number of Calibration Inlets

**0** = 0 inlets  
**1** = 1 inlet  
**2** = 2 inlets

### 5 Pressure Gauge Dial Range

#### Swagelok B Model

**A** = 0 to 2.5 bar (0 to 36 psi)  
**B** = 0 to 10 bar (0 to 145 psi)  
**C** = 0 to 25 bar (0 to 362 psi)  
**X** = No gauge

### 6 Analyzer/Outlet Flowmeter Range

**X** = No flowmeter (**Outlet Assembly Configuration** designators **2** and **X** only)

#### Swagelok G1 Model

##### Gas Systems

**B** = 0.8 to 8 std L/h  
**D** = 4 to 40 std L/h  
**E** = 6 to 60 std L/h

##### Liquid Systems

**C** = 1.2 to 12 L/h  
**D** = 2.5 to 25 L/h  
**F** = 6 to 60 L/h

#### Swagelok M1 Model

##### Gas Systems

**K** = 5 to 50 std L/h  
**L** = 10 to 100 std L/h

##### Liquid Systems

**M** = 1 to 10 L/h  
**N** = 2.5 to 25 L/h  
**Q** = 6 to 60 L/h

### 7 Filter Element Pore Size

**A** = 0.5  $\mu$ m  
**B** = 2  $\mu$ m  
**C** = 7  $\mu$ m  
**X** = No filter

### 8 Bypass (page 15) or Flow Loop Inlet Flowmeter Range

**X** = No bypass

*Flowmeter selection **required** for inlet assembly configuration **L** and for bypass configuration.*

#### Swagelok G1 Model

##### Gas Systems

**D** = 4 to 40 std L/h  
**F** = 10 to 100 std L/h

##### Liquid Systems

**D** = 2.5 to 25 L/h  
**G** = 10 to 100 L/h

#### Swagelok M1 Model

##### Gas Systems

**K** = 5 to 50 std L/h  
**L** = 10 to 100 std L/h

##### Liquid Systems

**N** = 2.5 to 25 L/h  
**S** = 10 to 100 L/h

### 9 Outlet Assembly Configuration

**1** = Upstream flowmeter (page 11)  
**2** = Upstream metering valve (page 12)  
**3** = Downstream flowmeter (page 13)  
**A** = Atmospheric reference vent (ARV, gas systems *only*, page 14)  
**X** = No flow control (page 10)

### 10 Manual Calibration Assembly (MCA, page 16)

*When MCA option is selected, number of inlets **must** equal number of calibration inlets (designator **4**).*

**1** = 1 calibration inlet  
**2** = 2 calibration inlets  
**X** = No MCA

### 11 Options

*Sample inlet and bypass option assemblies have 1/4 in./6 mm Swagelok tube fitting end connections. Outlet and calibration inlet assemblies have 1/8 in./3 mm Swagelok tube fitting end connections.*

**Omit for fractional end connections (standard).**

**-M** = Metric connections

## Regulatory Compliance

### Europe

- Pressure Equipment Directive (PED) 2014/68/EU
- Atmospheres Explosive Directive (ATEX) 2014/34/EU
- Restriction of Hazardous Substances Directive (RoHS) 2011/65/EU

### Americas

- Hazardous location electrical approval (CSA/UL)
- CRN registered in Canada (individual components of assembly)

Contact your authorized Swagelok representative for specific assembly compliance approvals and certifications available from the manufacturer.

#### Safe Product Selection

**When selecting a product, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.**



#### **WARNING**

**Do not mix/interchange Swagelok products or components not governed by industrial design standards, including Swagelok tube fitting end connections, with those of other manufacturers.**

## Warranty Information

Swagelok products are backed by The Swagelok Limited Lifetime Warranty. For a copy, visit [swagelok.com](https://www.swagelok.com) or contact your authorized Swagelok representative.