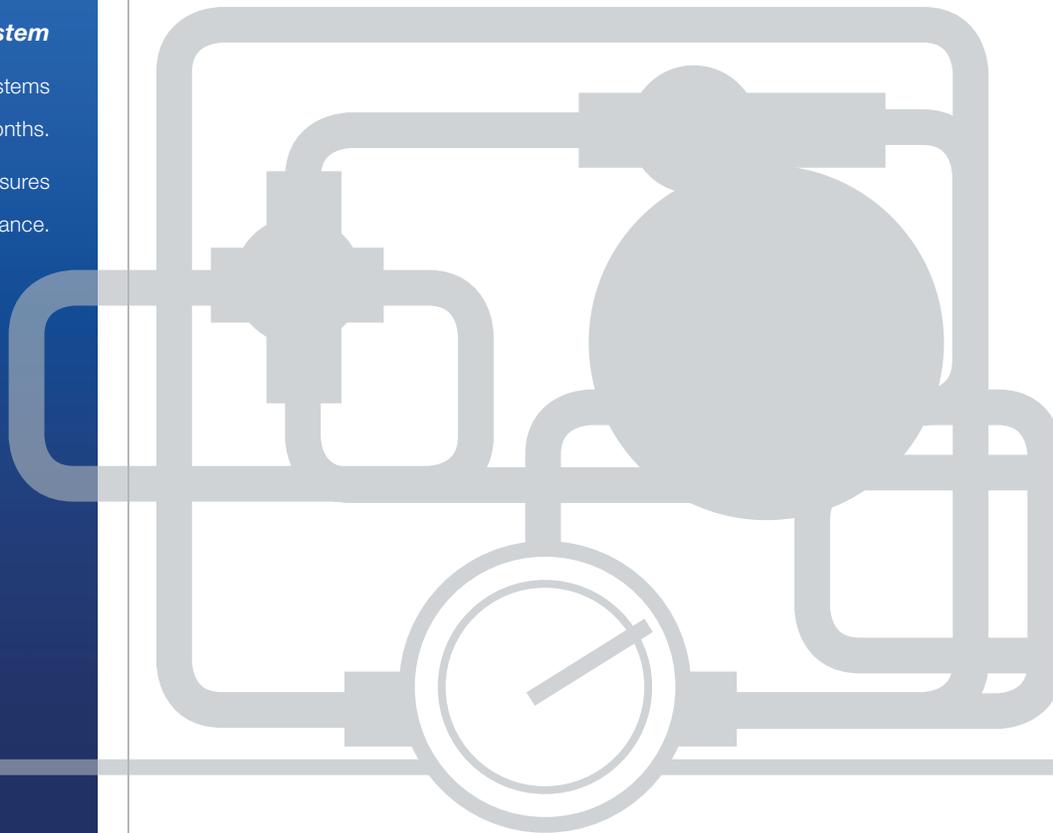


Fast Loop Module

Application Guide

**A Swagelok® Pre-Engineered
Subsystem**

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



- Designed for handling long transport lines from tap to analyzer
- Minimum pressure drop for fastest response time
- Interlocking handles help prevent incorrect sequence of operation

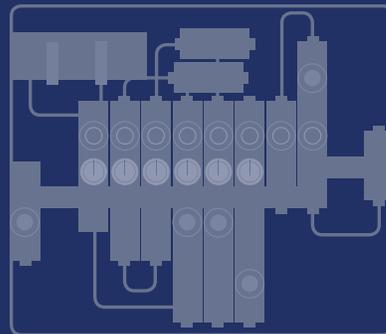
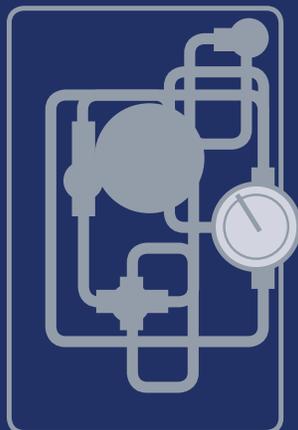
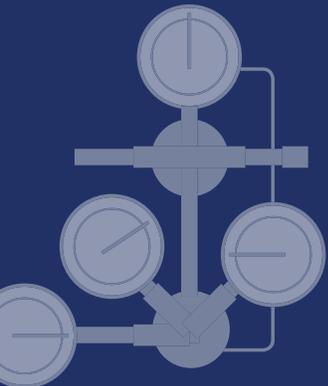
Swagelok®

Swagelok Pre-Engineered Subsystems

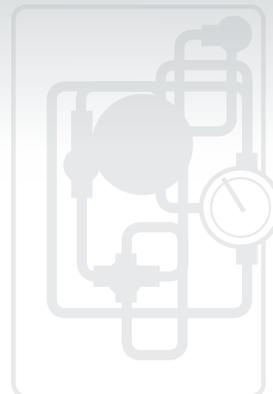
Swagelok now offers a series of predesigned and preassembled subsystems for use in all types of plants and facilities where fluids are being processed. Use Swagelok pre-engineered subsystems to create fully documented fluid sampling and control systems and bring consistency to your operations. Easy to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

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The Swagelok Fast Loop Module (FLM)

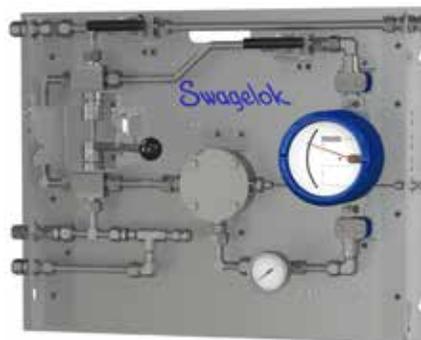


Why Use a Fast Loop Module?

Fast loop modules are designed to handle high flows in sample transport lines to reduce time delays for online analyzer systems. Located at the analyzer shelter and offering a bypass, the Swagelok fast loop module (FLM) can isolate the sample system and introduce a purge gas for system cleaning. The FLM extracts a sample through a filter while using the high flow rate of the bypass to keep the filter element clean.

Get a Faster Response

The distance between a sample tap and an analyzer can make it difficult to obtain a useful analytical measurement. Sample transport lines are commonly more than 100 feet (30 meters) of tubing or pipe and require high purge volumes to ensure a fresh sample reaches the analyzer. Ideally, the flow from the sample tap to the analyzer shelter should take one minute or less.



Typical Swagelok Fast Loop Module (FLM)

Depending on the tubing or pipe size of the transport lines, as well as the actual transport distance, this flow rate could be as high as 90 std ft³/h (2548 std L/h). See **Flow Data**, page 14, for guidelines on sample transport volume.

Minimize Sample Waste

A Swagelok FLM also minimizes the amount of extracted sample that is sent to flare or disposal. A bypass filter specially designed for fast loop systems enables the FLM to provide high flow rates. The filter bypasses much of the sample flow and returns it to the process line through a secondary transport line. To generate high flow rates through this bypass loop, the return point must be at a lower pressure than the extraction point.

To further reduce sample waste, many Swagelok FLM configurations offer a sample return line from the analyzer (configurations 2, 3, and 4). This option eliminates sending any continuous flow from an online analyzer to flare or disposal.

Key Features

Designed to optimize online analyzer performance, Swagelok pre-engineered subsystems are fully tested for component performance, system integrity, and fluid flow prior to shipment. A complete pre-engineered subsystem can be configured and ordered using a single ordering number, so order and delivery is simple and fast. All Swagelok pre-engineered subsystems are backed by the Swagelok Limited Lifetime Warranty and supported by Swagelok sales and service representatives.

Interlocking Handles

The Swagelok FLM includes two ball valves that switch flow to a bypass to isolate the sample system and analyzer during maintenance. These bypass valves maintain flow through the fast loop to keep the sample fresh at the bypass point. An innovative interlocking handle system allows for simultaneous actuation of the valves, while allowing for packing adjustments within an individual valve body. In some configurations, the drain and purge valves are locked into the bypass valves to eliminate the possibility of opening the drain or purge lines while the system is in sample mode. All handles can be locked into position to eliminate the possibility of accidental actuation.

Easy Maintenance

Designed to enable easy access to any component without disturbing other components in the system, the Swagelok FLM uses welded assemblies to reduce potential leak points and zero-clearance fittings in straight run tubing sections.

Virtually Eliminates Water Hammer

Closing a valve in a high-flow liquid line causes extreme pressure spikes, referred to as water hammer, which can damage system components. The Swagelok FLM eliminates the possibility of water hammer by making full shutoff impossible. The bypass valves actuate simultaneously to eliminate the possibility of actuating only one of the valves. The three-way valve design allows flow to switch gradually from sample mode to bypass mode, instead of temporarily shutting off during actuation.

Configurations

The FLM base configuration is the framework for all FLM subsystems. The other FLM configurations offer additional features to address specific system requirements.

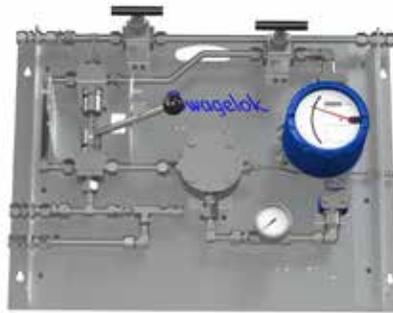


1. FLM Base Model, Bypass Only

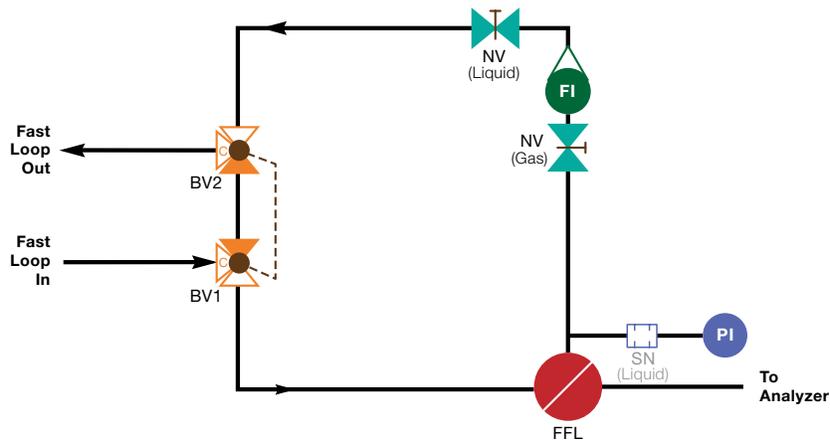
Because it is important to maintain flow through the fast loop system even when the analyzer is not in service, all FLM subsystems feature dual interlocked ball valves (BV1 and BV2) that enable the fast loop to be bypassed when the analyzer is not in service. This key feature maintains flow through the fast loop system and improves overall system performance once the analyzer is back online.

These bypass valves have been designed to include an interlocking handle, which provides simultaneous switching to bypass mode. Further, these valves are specially designed to ensure the bypass opens before the sampling line closes, which eliminates the possibility of water hammer and pressure surges during switching.

Swagelok offers FLM subsystems in two tubing sizes: the 1/4 in. size is used mainly for gas samples, and the 1/2 in. size is usually best for liquid samples. The fast loop circuit monitors and controls flow through the use of an armored flowmeter (FI) and a needle valve (NV) for flow adjustment. This needle valve will be located downstream of the flowmeter for liquid systems but is moved upstream of the flowmeter in gas systems. A pressure gauge is included on the bypass side of the fast loop filter to eliminate the effect of a gauge's deadleg. As further protection, the fast loop pressure gauge on liquid systems has a sintered snubber (SN) in the gauge inlet line to dampen its response to pressure pulses.



**1/2 in. Liquid System with
Optional Grab Sample and Relief
Outlets Shown**



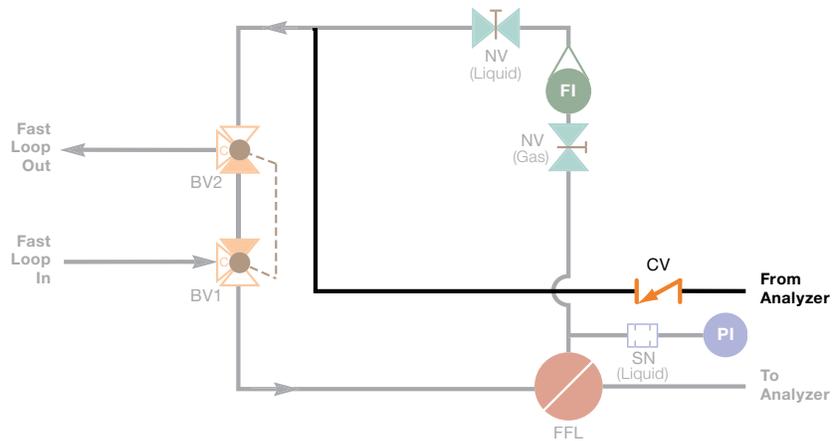
- The base model configuration is suitable for gas or liquid samples.
- The high-flow armored flowmeter (FI) and needle valve (NV) provide flow indication and adjustment.
- A high-efficiency, vortex-style filter (FFL) is cleaned by loop flow velocity.
- Inlet and outlet valves (BV1 and BV2) have integral handles for simultaneous switching to bypass.
- A special flow pattern in the inlet/outlet valves eliminates water hammer during actuation.
- Inlet pressure indication with or without liquid damping (PI) is placed on the bypass side of the filter to eliminate effects of gauge dead space.

2. Return from Analyzer to Process

In this configuration, analyzed sample flow is returned to the FLM from the analyzer and returned to the process. This return line includes a check valve (CV) to prevent backflow to the analyzer. Note: The analyzer will work at full return pressure, which might not be appropriate for a gas sample.



1/2 in. Liquid System with Optional Grab Sample and Relief Outlets Shown

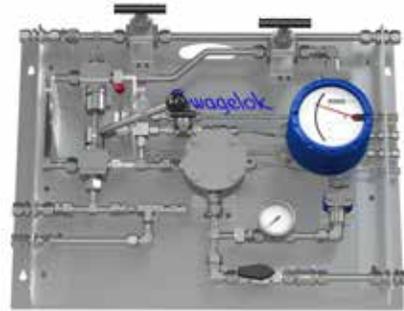


- This configuration includes all of the advantages of the base model and adds a return line from the analyzer to return the fluid to process.
- The sample is returned downstream of flow control (NV) to minimize pressure differential.
- A check valve (CV) prevents backflow to analyzer.

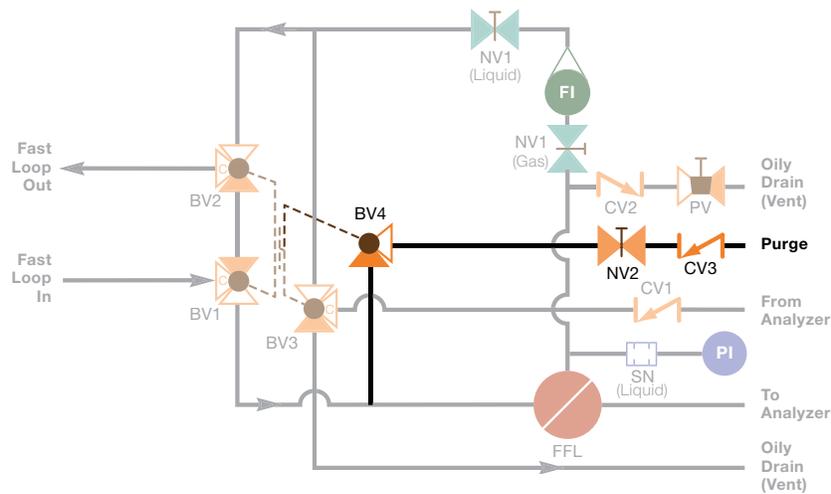
4. Gas or Liquid Purge, Manual Drain

This configuration uses an inert gas or solvent to purge the process fluid from the flowmeter (FI) and filter (FFL) housing and is useful when a filter element needs to be changed or cleaned.

When used in conjunction with the return from analyzer line configuration, the purge configuration allows users to flush the remainder of the analytical sample system downstream of the FLM. The purge valve (BV4) is mechanically linked to the drain valve (BV3) so that both valves can be actuated simultaneously. It is also interlocked with the bypass valves (BV1 and BV2) to eliminate any chance of actuating the purge and drain valves unless these two valves are switched to bypass mode. Downstream of the filter an additional connection to drain is included to ensure full system purging. This drain line includes a manual valve (PV) and check valve (CV2) to prevent backflow from the drain or vent.



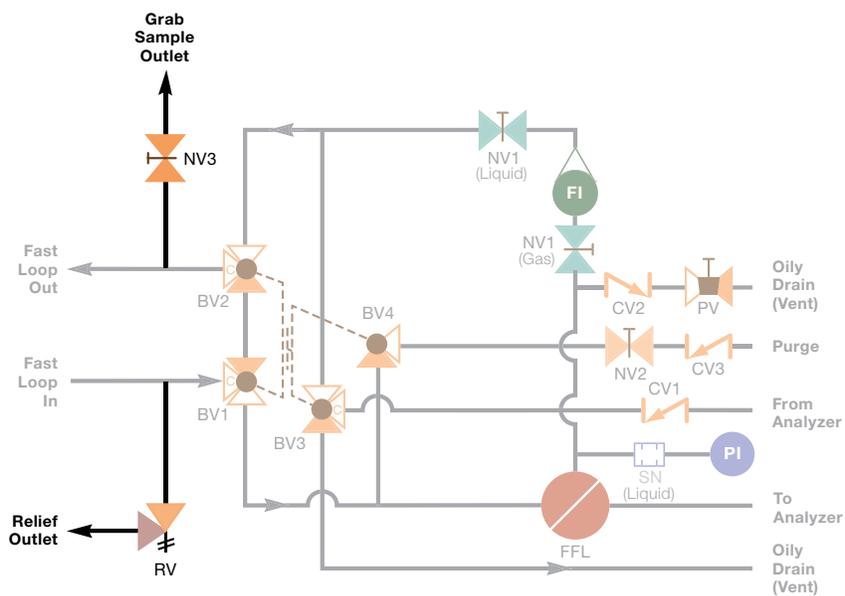
**1/2 in. Liquid System with
Optional Grab Sample and Relief
Outlets Shown**



- This configuration allows for purge inlet through an additional interlocked valve that can only be actuated when in bypass mode.
- A purge connection allows a positive pressure purge fluid to flush the entire system to the drain, for most effective system drainage.
- The purge valve (BV4) is connected to the drain valve (BV3) to ensure simultaneous action.

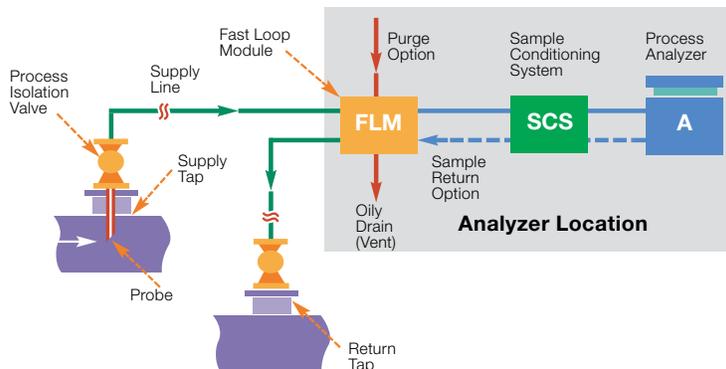
Options

An optional grab sample outlet and a relief outlet are available with all FLM configurations.



- Located downstream of the bypass valves, the sample outlet with a rotary shutoff valve (NV3) allows for sample collection even when the FLM is in bypass mode for maintenance.
- An optional pressure relief valve (RV) protects the gauge and flowmeter from excessive pressure.

Where to Install a Fast Loop Module



The schematic above illustrates an FLM installed in an analytical system. A fast loop needs two process taps: one for sample supply and one for sample return. To avoid the cost of a sample pump and improve sampling system reliability, select a return point location that has lower pressure than the supply tap. Choose process tap locations that are as close to the analyzer as possible.

If the sample contains a condensable gas, heat the fast loop lines and the FLM above the dew point temperature of the sample at process pressure. A liquid sample will need to be heated only if it is necessary to keep from freezing.

How to Select a Fast Loop Module

Tubing Size

Swagelok offers the FLM in two tubing sizes. The 1/2 in. system, which uses 1/2 in. tubing and fittings, offers less flow resistance (higher C_v) and, therefore, is more suitable for liquid samples. The 1/4 in. version is intended mainly for gases.

End Connections

All systems include a 1/8 in. (3 mm) connection to the analyzer line and a 1/4 in. (6 mm) connection to the purge drain. Half-inch systems include 1/2 in. (12 mm) fast loop and drain connections. Quarter-inch systems include 1/4 in. (6 mm) fast loop and drain connections.

Pressure Gauge

The pressure gauge is available with 63 or 100 mm (2 1/2 or 4 in.) dial, control ranges from 0 to 150 bar (0 to 2175 psi), and with or without damping.

Flowmeter

The standard flowmeters for liquid samples are calibrated for water flow. The standard flowmeters for gas samples are calibrated for air at 20°C and 1 bar (absolute).

Filter Element

Choose a filter size based on the filtration needed from the element. Pore sizes from 2 to 50 μm are available.

For more information about installation, operation, and maintenance of Swagelok FLM subsystems, see the *Fast Loop Module User's Manual*, MS-13-219.

Materials of Construction

All wetted metal components are 316 stainless steel.

Configuration Label	Component	Manufacturer, Model	Material Grade / ASTM Specification
BV	Ball valve	Swagelok 40G or 40 series	See Swagelok <i>One-Piece Instrumentation Ball Valves—40G Series and 40 Series</i> catalog, MS-02-331
CV	Check valve	Swagelok CH series	See Swagelok <i>Check Valves—C, CA, CH, CP, and CPA Series</i> catalog, MS-01-176
FI	Flow indicator	Swagelok M1 series (1/4 in. systems) or M4 series (1/2 in. systems) variable area flowmeter	See Swagelok <i>Variable Area Flowmeters—G Series and M Series</i> catalog, MS-02-346
FFL	Filter-fast loop	Tornado™ Model 601 or 602 centrifugal filter	See Tornado Model 601 or 602 catalog, www.apluscorporation.com
NV	Needle valve— flowmeter (1/4 in. systems)	Swagelok M1 series integral needle valve	See Swagelok <i>Severe-Service Union Bonnet Needle Valves—N Series and HN Series</i> catalog, MS-01-168
	Needle valve— flowmeter (1/2 in. systems)	Swagelok 12N series	
	Needle valve— optional grab sample outlet	Swagelok 3N or 12N series	
	Needle valve— optional purge outlet	Swagelok 3N series	
PI	Pressure indicator	Swagelok B model pressure gauge	See Swagelok <i>Pressure Gauges, Industrial and Process—PGI Series</i> catalog, MS-02-170
RV	Relief valve	Swagelok R3A series (1/4 in. systems, all seal materials; 1/2 in. systems, perfluorocarbon FFKM seals) or R4 series (1/2 in. systems, fluorocarbon FKM seals)	See Swagelok <i>Proportional Relief Valves—R Series</i> catalog, MS-01-141
SN	Snubber fitting	Swagelok snubber fittings- gauge protectors	See Swagelok <i>Pressure Gauges, Industrial and Process—PGI Series</i> catalog, MS-02-170
PV	Plug valve	Swagelok P4T or P6T series	See Swagelok <i>Plug Valves—P4T and P6T Series</i> catalog, MS-01-59
System Hardware and Optional Components			
—	Face seal fittings, O-ring	Swagelok VCO® fittings	See Swagelok <i>VCO O-Ring Face Seal Fittings</i> catalog, MS-01-28
—	Mounting brackets, mounting plates	Various	304 SS / A240
—	Mounting screws	Various	300 series SS
—	Pipe fittings	Swagelok	See Swagelok <i>Pipe Fittings</i> catalog, MS-01-147
—	Tube fittings	Swagelok	See Swagelok <i>Gaugeable Tube Fittings and Adapter Fittings</i> catalog, MS-01-140
—	Tube supports	Swagelok bolted plastic clamp supports	See Swagelok <i>Tubing Tools and Accessories</i> catalog, MS-01-179
—	Tubing	Swagelok	See Swagelok <i>Stainless Steel Seamless Tubing</i> catalog, MS-01-153-SCS
—	Weld fittings	Swagelok Micro-Fit® fittings	See Swagelok <i>Weld Fittings</i> catalog, MS-01-149



Pressure-Temperature Ratings

Ratings are limited to:

- 212°F (100°C) high temperature limit with silicone-filled gauges.
- 25°F (–4°C) low temperature limit with optional relief valves.

System Size	1/4 in.	1/2 in.
Temperature °F (°C)	Working Pressure psig (bar)	
0 (–17) to 50 (10)	1450 (100)	–
50 (10) to 150 (65)	1450 (100)	1500 (103)
250 (121)	1450 (100)	–
300 (148)	1000 (68.9)	–

Testing

Every Swagelok FLM subsystem is shell tested with nitrogen at 145 psig (10 bar) to a requirement of no detectable leakage with a liquid leak detector.

See individual valve product catalogs for shutoff testing information.

Cleaning and Packaging

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

Flow Data

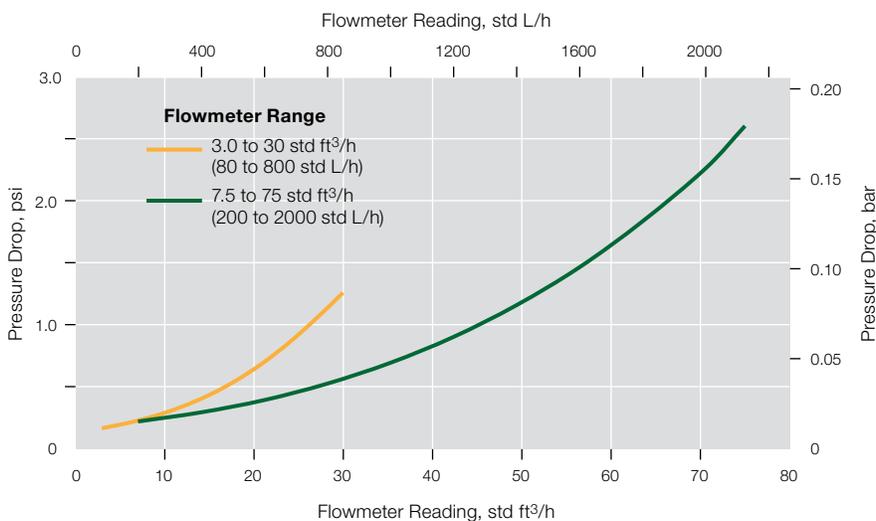
The Swagelok FLM subsystem provides high flow rates to an analyzer shelter for maintaining a one-minute flow time.

Gas Systems

See **Calculating Actual Gas Flow Rate from Flowmeter Reading**, next page, for important information about gas system flow data.

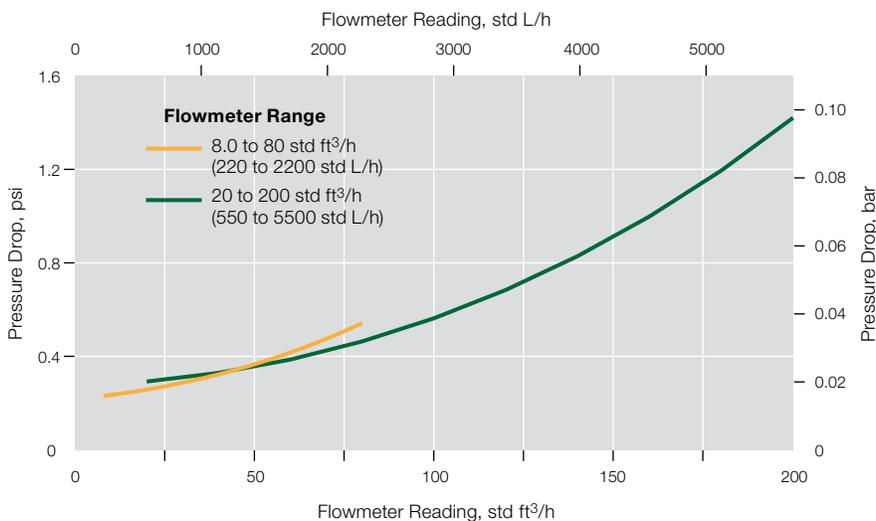
1/4 in. FLM—Nitrogen at 70°F (20°C)

Flowmeter calibrated to 1.013 bar pressure, 20°C temperature, 1.293 kg/m³ fluid density.



1/2 in. FLM—Nitrogen at 70°F (20°C)

Flowmeter calibrated to 1.013 bar pressure, 20°C temperature, 1.293 kg/m³ fluid density.



Flow Data

Calculating Actual Gas Flow Rate from Flowmeter Reading

Standard 1/4 in. and 1/2 in. FLM 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

ρ_{cal} = fluid density of calibrated scale

ρ_{new} = new fluid density

P_{cal} = pressure of calibrated scale

P_{new} = new pressure

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

T_{new} = new temperature, in °C

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

Example:

Scale Calibration	Your Fluid
--------------------------	-------------------

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

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

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

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

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

Example:

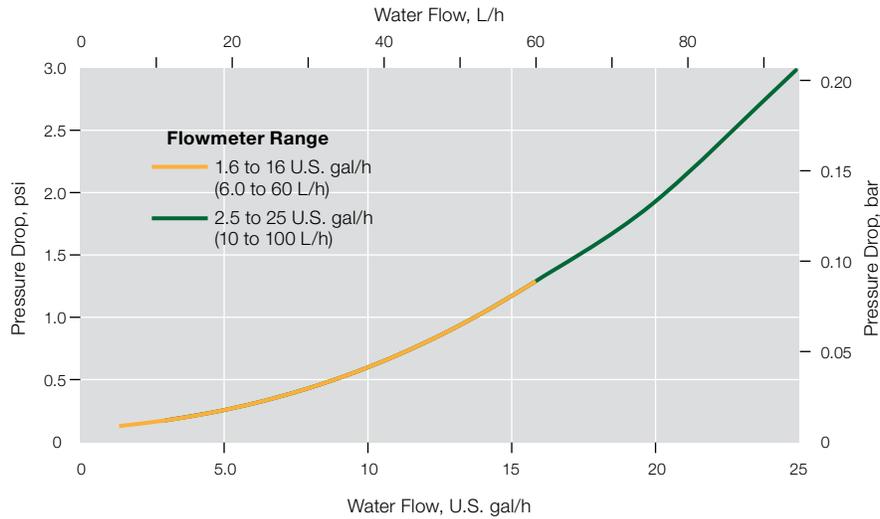
The flowmeter reading is 100 L/h.

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

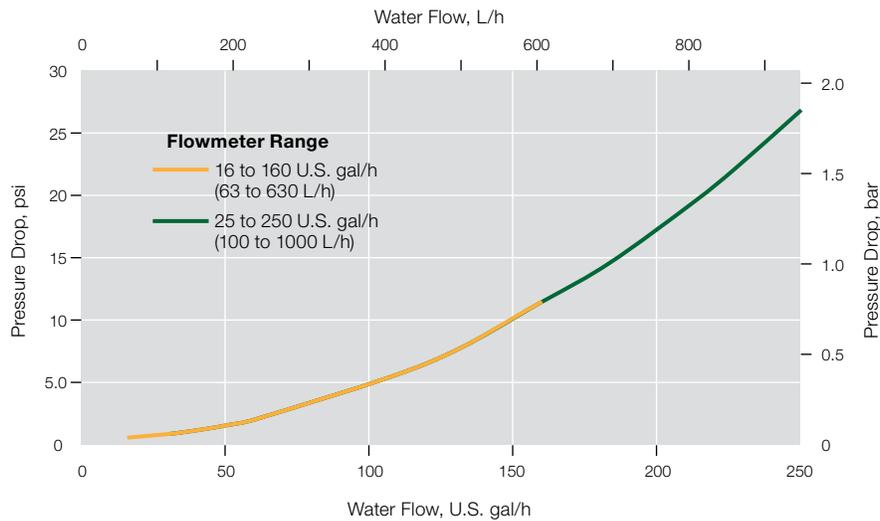
Flow Data

Liquid Systems

1/4 in. FLM—Water at 70°F (20°C)



1/2 in. FLM—Water at 70°F (20°C)



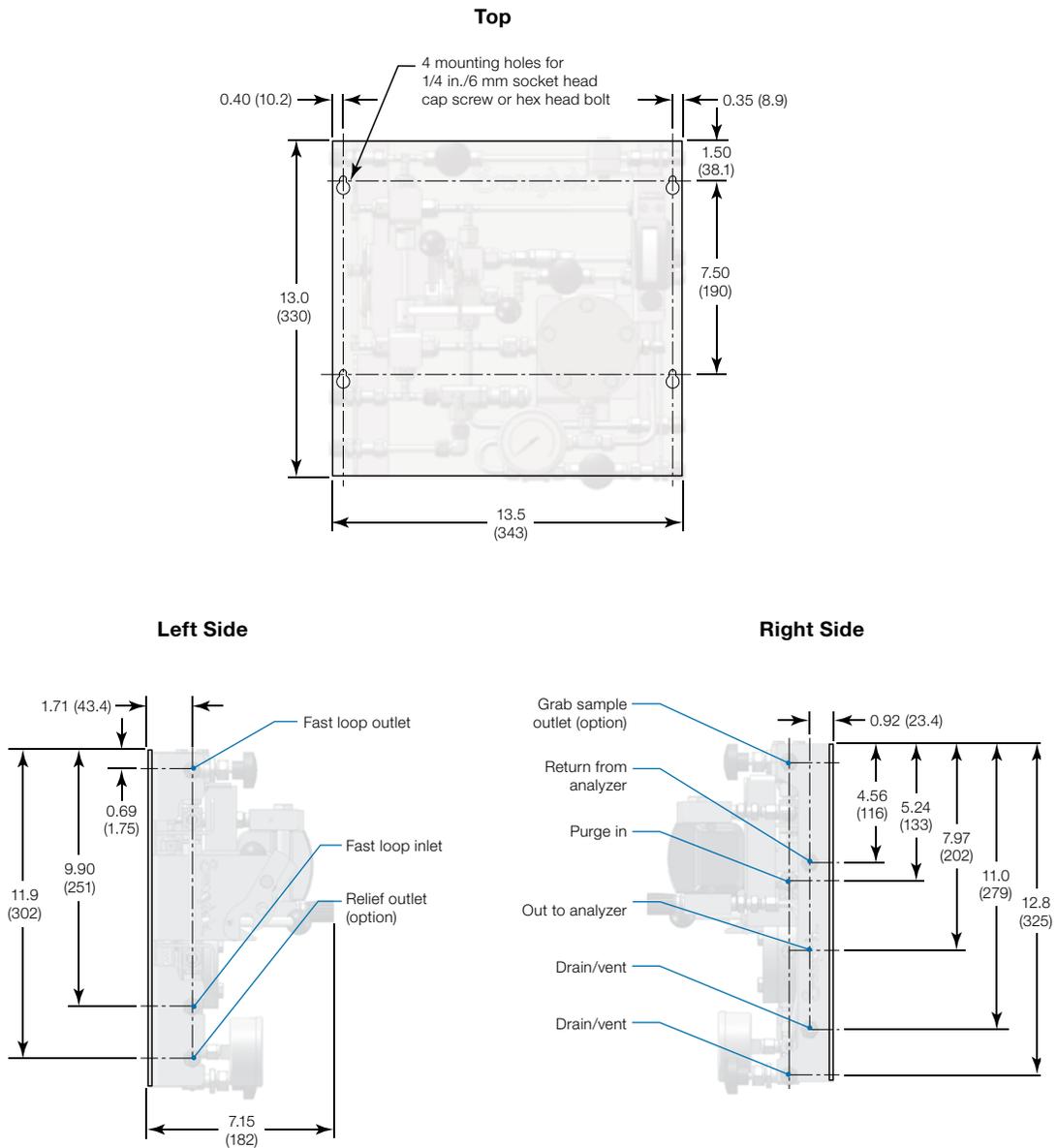
Flowmeter Calibration

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.

Dimensions

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

1/4 in. FLM



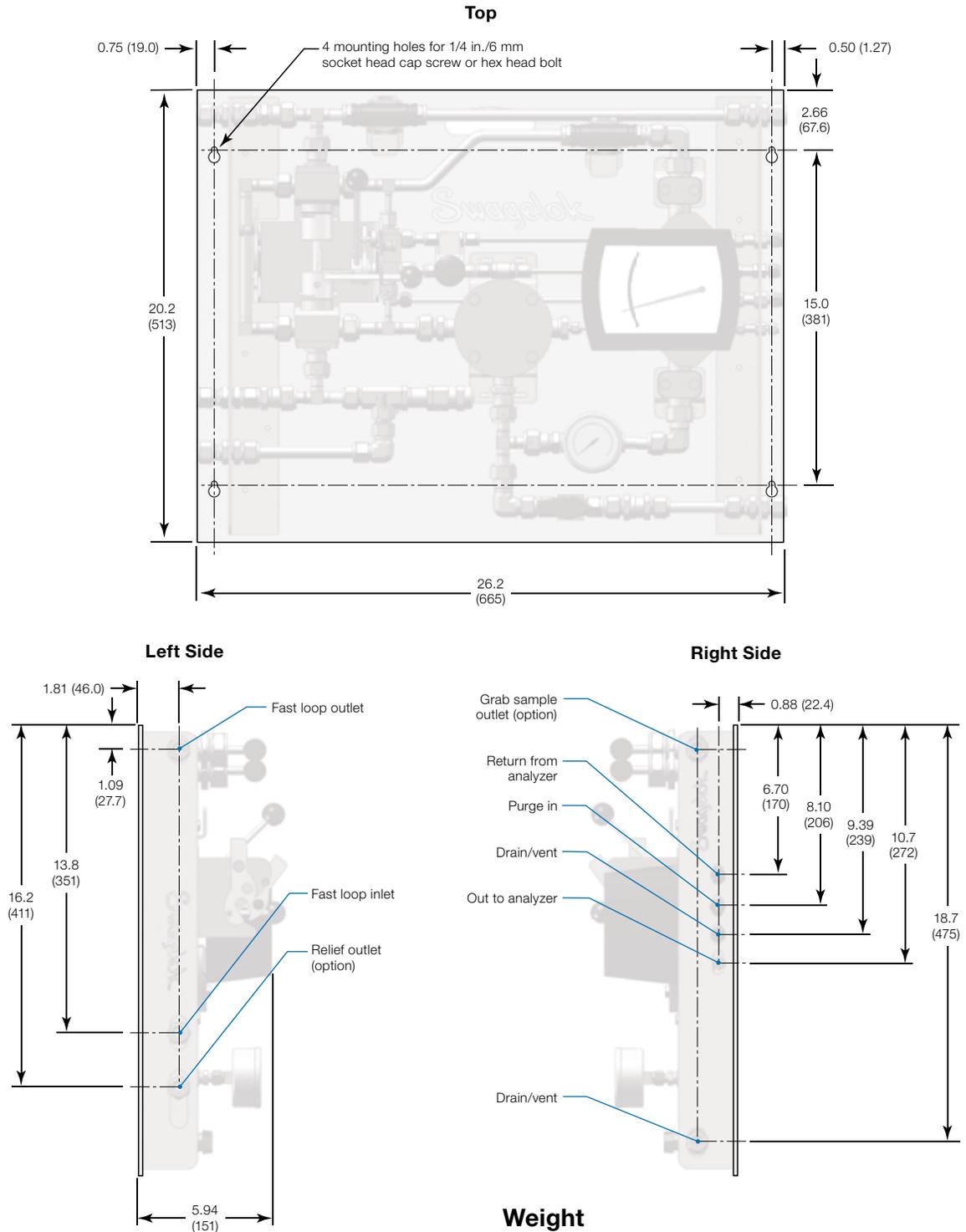
Weight

22 to 27 lb (10.0 to 12.2 kg)

Dimensions

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

1/2 in. FLM



Ordering Information

Build an FLM subsystem ordering number by combining the designators in the sequence shown below.

1
2
3
4
5
6
7
8
9
10

FLM - **G4** - **1** **2** **M** **E** **B** - **A** **1** **S4** **KZ**

1 Fluid, System Size

G4 = Gas, 1/4 in.
G8 = Gas, 1/2 in.
L4 = Liquid, 1/4 in.
L8 = Liquid, 1/2 in.

2 Configuration

1 = Base module, bypass only (page 5)
2 = Return from analyzer to process (page 6)
3 = Return from analyzer switch drain (page 7)
4 = Gas or liquid purge, manual drain (page 8)

3 Pressure Gauge Dial Size, Fill

Swagelok B Model

1 = 63 mm (2 1/2 in.), unfilled
2 = 63 mm (2 1/2 in.), silicone fill
3 = 100 mm (4 in.), unfilled[Ⓢ]
4 = 100 mm (4 in.), silicone fill[Ⓢ]

[Ⓢ] Not recommended for G4 or L4 systems.

4 Pressure Gauge Dial Range

Swagelok B Model (primary scale: bar; secondary scale: psi)

K = 0 to 10 bar (0 to 145 psi)
M = 0 to 25 bar (0 to 362 psi)
P = 0 to 100 bar (0 to 1450 psi)
Q = 0 to 150 bar (0 to 2322 psi)

5 Flowmeter Range

G4 Systems (Swagelok M1 Model)

E = 3.0 to 30 std ft³/h air
G = 7.5 to 75 std ft³/h air
P = 80 to 800 std L/h air
R = 200 to 2000 std L/h air

G8 Systems (Swagelok M4 Model)

D = 8.0 to 80 std ft³/h air
F = 20 to 200 std ft³/h air
N = 220 to 2200 std L/h air
P = 550 to 5500 std L/h air

L4 Systems (Swagelok M1 Model)

F = 1.6 to 16 U.S. gal/h water
H = 2.5 to 25 U.S. gal/h water
Q = 6.0 to 60 L/h water
S = 10 to 100 L/h water

L8 Systems (Swagelok M4 Model)

K = 16 to 160 U.S. gal/h water
M = 25 to 250 U.S. gal/h water
X = 63 to 630 L/h water
Z = 100 to 1000 L/h water

6 Filter Element Pore Size

B = 2 μm
D = 10 μm
F = 25 μm

7 Relief Valve Spring Set Pressure

Swagelok R3A or R4 Series

A = 50 to 350 psig (3.4 to 24.1 bar), pre-set to 130 psig (9.0 bar)
B = 350 to 750 psig (24.1 to 51.7 bar), pre-set to 330 psig (22.8 bar)
C = 750 to 1500 psig (51.7 to 103 bar), pre-set to 1300 psig (89.6 bar)
D = 750 to 1500 psig (51.7 to 103 bar), pre-set to 1500 psig (104 bar)
X = No relief valve

8 Grab Sample Outlet

1 = Grab sample outlet
X = No grab sample outlet

9 End Connections

All connections within the FLM subsystem are fractional; you may choose fractional or metric inlet and outlet connections.

G4 and L4 Systems

S4 = 1/4 in. Swagelok tube fittings
6M = 6 mm Swagelok tube fittings

G8 and L8 Systems

S8 = 1/2 Swagelok tube fittings
12M = 12 mm Swagelok tube fittings
F8 = 1/2 female NPT

10 Seal Material

KZ = Perfluorocarbon FFKM
VI = Fluorocarbon FKM

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.

Caution: Do not mix or interchange Swagelok product components with those of other manufacturers.

Warranty Information

Swagelok products are backed by The Swagelok Limited Lifetime Warranty. For a copy, visit swagelok.com or contact your authorized Swagelok representative.