

Vickers®

Servo Valves



SM4-10/12/15 Servovalves

Flows to 57 l/min (15 USgpm) — Pressures to 210 bar (3000 psi)



Introduction

Vickers SM4-10/12/15 servovalves can provide system closed loop control with exact positional accuracy, repeatable velocity profiles, and predictable force or torque regulation.

Typical applications include plastic injection molding and blow molding systems, test and simulation equipment, die casting machines, hydraulic press brakes, animation and entertainment equipment, oil exploration vehicles, and lumber machinery.

The three models in this size of the high performance SM4 series offer a wide range of rated flows from 3,8 to 57 l/min (1.0 to 15 USgpm) at Δp of 70 bar (1000 psi).

The SM4 is a two-stage, modular design, flow control valve which can be

manifold or subplate mounted. A symmetrical, dual coil, quad air gap torque motor is integrally mounted to the first stage nozzle flapper pilot valve with six screws. The second stage utilizes a four-way sliding spool and sleeve arrangement with a mechanical null adjust. Spool position is fed back to the first stage by means of a cantilever spring. An integral 35 micron (absolute) filter protects against contamination of the pilot stage.

An SM4 servovalve, used with a hydraulic cylinder, position transducer, and appropriate electronics, can provide infinite cylinder position control to within 0,025 mm (0.001 in) or better (depending on component selection, length of stroke, and load characteristics).

When applied with servo hydraulic motors, tachometers, and appropriate electronics, the SM4 provides infinite proportional flow control for real-time velocity/acceleration profiles that can be closed loop error corrected to within one-tenth of a revolution per minute. With appropriate pressure transducers or load cells, cylinders, and electronics in force control applications, the SM4 offers exact load pressure/force control and excellent system stability with pressure and load to $\pm 1\%$ full scale.

The field-proven design of the SM4-10/12/15 servovalves, combined with Vickers precision manufacturing techniques, provides you with the optimum in system control.

Features and Benefits

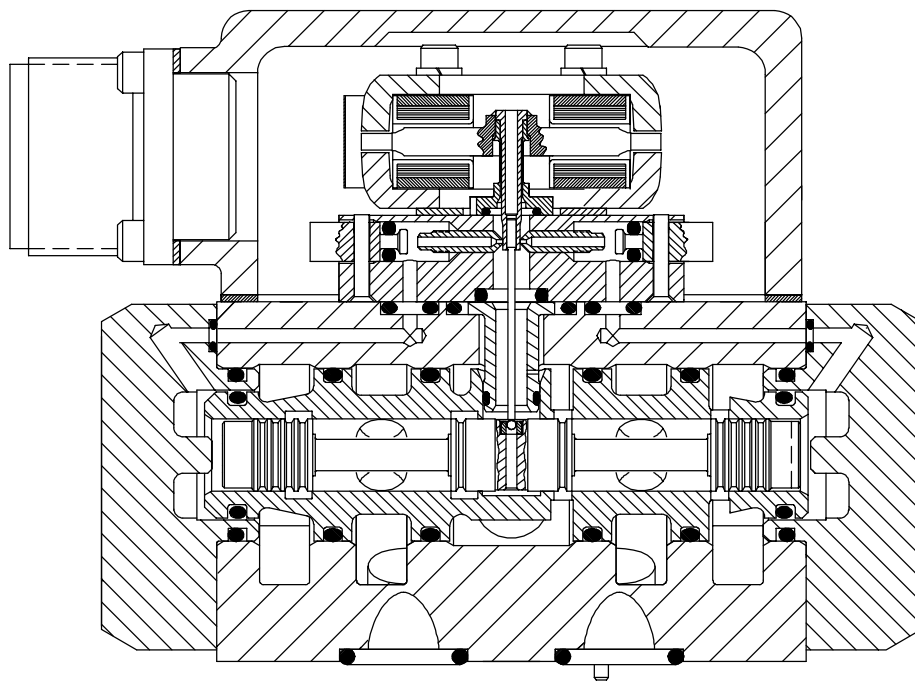
- The wide range of SM4 flow capabilities allows selection of the valve size best suited for an application.
- The high strength aluminum alloy of the second stage valve body means lighter weight with rugged durability.
- The symmetrical, dual-coil, quad air gap, dry torque motor in Vickers servovalves, with its extremely fast response to input signals, can produce highly accurate control profiles.
- Higher frequency response — available on request — provides enhanced system bandwidth for critical performance requirements.
- An integral 35 micron (absolute) filter provides extra first stage contamination protection.
- The spool and sleeve are hardened stainless steel to minimize wear and erosion. The O-ring mounted sleeve eliminates spool binding and ensures smooth operation.
- Customized spool lap and sleeve porting are available to provide the specific flow control required for special applications.
- The SM4's symmetrical design provides inherently dependable metering of control flow with minimum null shifts. The result is more consistent machine operation.
- Viton* seals are standard.
- The flexibility of standardized port circles, mounting patterns, and adapter manifolds makes Vickers servovalves a cost-effective choice for replacing existing servovalves and enhancing existing systems.
- The SM4 features a simple interface to an available dual filter module that provides extra protection against pilot contamination.
- Flushing valves are available that can greatly reduce initial system contamination levels prior to SM4 installation.

* Viton is a registered trademark of the DuPont Co.

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**Cross Section of Typical
SM4-15 Servovalve**



Operating Data

Flow and Leakage

All data is typical, based on actual tests at 70 bar (1000 psi) Δp , 30 cST (141 SUS), and 49°C (120°F).

Model Series	Maximum Rated Flow $\pm 10\%$ l/min (USgpm)	Maximum Total Null Leakage l/min (USgpm)	Maximum Pilot Flow at 70 bar (1000 psi) Δp l/min (USgpm)
SM4-10	38 (10)	1,4 (0.37)	0,35 (0.09)
SM4-12	45 (12)		
SM4-15	57 (15)	2,0 (0.53)	

Performance

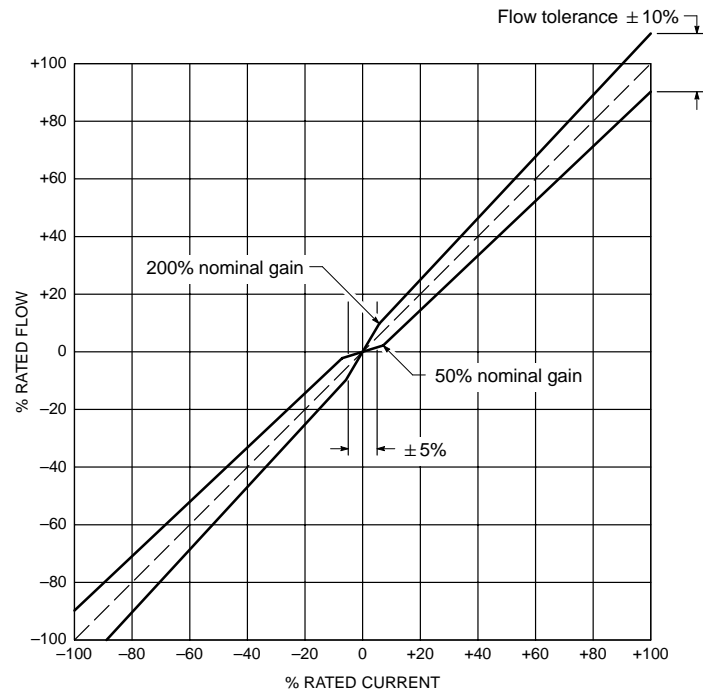
Maximum Supply Pressure bar (psi)	210 (3000)
Minimum Supply Pressure bar (psi)	14 (200)
Proof Pressure % maximum supply pressure	At Supply Port: 150 At Return Port: 100
Burst Pressure, Return Port Open % maximum supply pressure	250
Maximum Operating Temperature °C (°F)	135 (275)
Hysteresis Around Null % of rated current	≤ 3
Symmetry Error % of rated current	<10
Linearity Error % of rated current	<10
Threshold % of rated current	≤ 0.5

Ruggedness Test Results

Vibration Test 5 Hz to 2000 Hz along each axis	No damage to components
Shock Test Up to 150g along all axes	No damage to components
Endurance Test To ISO 6404	No degradation in performance

Flow Gain

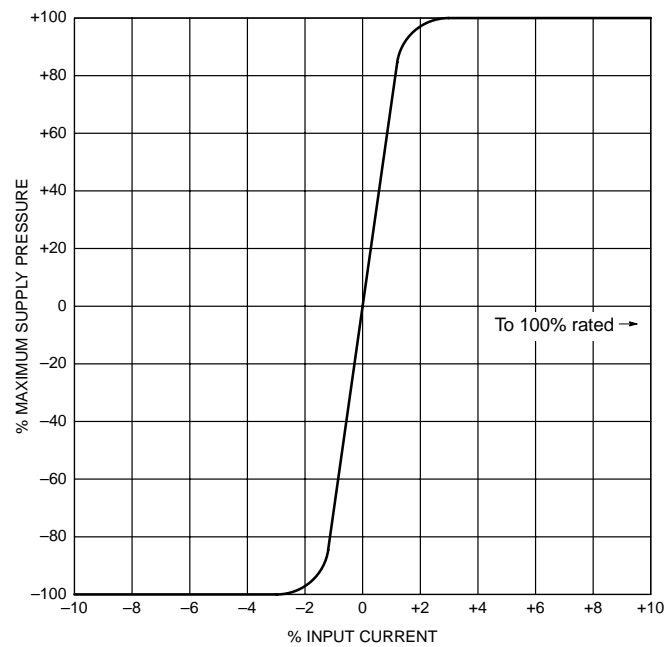
Normal region for standard models shown with typical no-load flow gain tolerances excluding hysteresis.



Pressure Gain

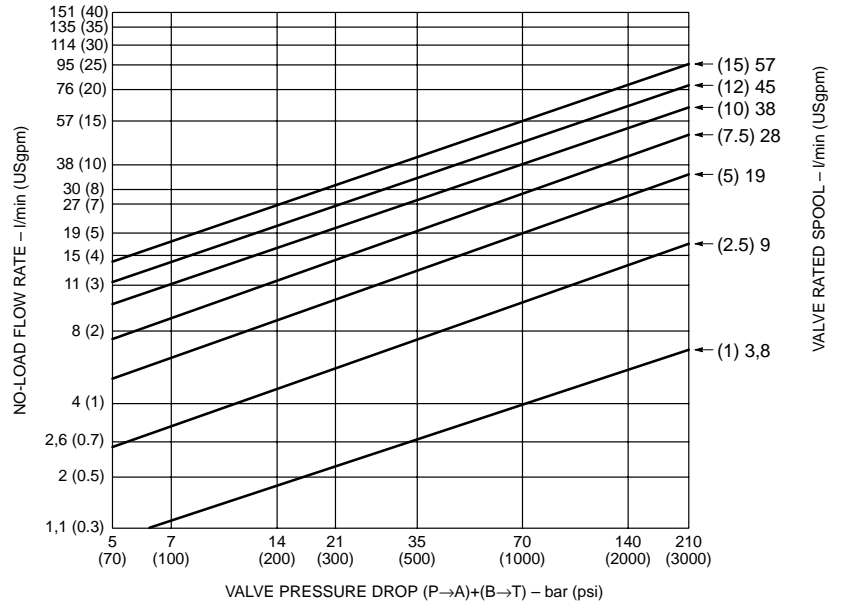
Change in load pressure drop with input current shown with no valve flow and closed control ports.

Pressure gain in the null region is >30% of supply pressure per 1% of rated current.



Change in Rated Flow

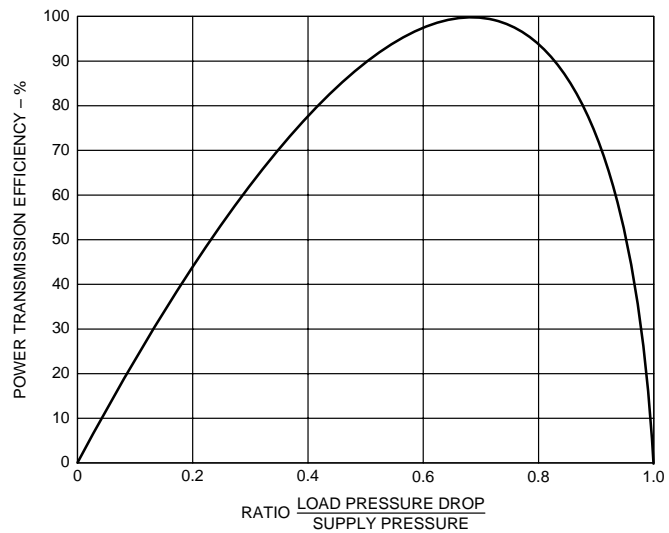
Rated flows at valve pressure drops from 5 bar (70 psi) to 210 bar (3000 psi) for seven of the available spools.



Power Transmission Efficiency

Maximum power envelope expressed as a percentage with T port pressure equal to 0 bar.

Power transferred to the load is optimum when valve pressure drop is one third of supply pressure. Load pressure drop should be limited to $\frac{2}{3}$ of supply pressure so the flow gain of the servovalve remains high enough to maintain control of the load. Overall hydraulic efficiency must be considered when sizing system heat exchangers.



Coil Resistance

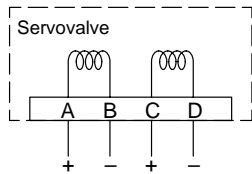
Select coil resistance and connections for compatible interface to servo electronics. **Recommended coil resistance is shown in bold print.**

	Nominal Resistance Per Coil at 21°C (70°F) Ohms	Rated Current mA	
		Single, Parallel, or Differential Connection	Series Connection
Standard coil resistance selection	20	200	100
	30	100	50
	80	40	20
	200	20	10
Optional coil resistance selection	80	50	25
	140	40	20
	200	15	7.5
	300	30	15
	1000	10	5
	1500	8	4

Electrical Polarity for Control Flow Out of B Port

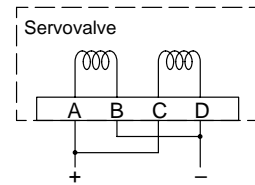
Single:

A+, B-
or
C+, D-



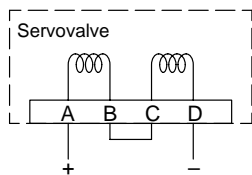
Parallel:

A+, C+
B-, D-
Connect A and C
Connect B and D



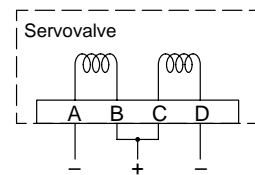
Series:

A+, D-
Connect B and C



Differential:

A-, D-
B+, C+
Connect B and C
BC-, current BA>CD
BC+, current CD>BA



Performance Curves

Frequency Response

Frequency response is defined as the relationship of no-load control flow to input current with a sinusoidal current sweep at constant amplitude over a range of frequencies. It is expressed in frequency (Hz), amplitude ratio (dB), and phase angle (degrees).

Vickers SM4 torque motors are magnetically stabilized for reliable servovalve performance at operating pressures from 14 to 210 bar (200 to 3000 psi).

As shown in the sample curve (below left), standard comparison points for servovalve frequency response are those frequencies at which -3 dB amplitude ratio and 90° phase angle occur.

Calculating Frequency Response at System Pressure

P_S = System pressure

P_M = maximum supply pressure of valve: 210 bar (3000 psi) for SM4-10/12/15

f_{PM} = Frequency (at 90° phase angle) at maximum supply pressure (P_M)

f_{PS} = Frequency (at 90° phase angle) at system pressure (P_S)

1. Calculate the ratio of system pressure to maximum supply pressure:

$$\frac{P_S}{P_M}$$

2. Use the result of step 1 and the curve below to estimate

$$\frac{f_{PS}}{f_{PM}}$$

3. Use the applicable frequency response curve from the following pages to estimate f_{PM} (the maximum supply pressure frequency response at 90° phase angle) for the desired valve rated flow.

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

Example: An SM4-15 valve with a flow of 38 l/min (10 USgpm) is to be used at 165 bar (2400 psi).

1. Calculate the ratio of system pressure to maximum supply pressure:

$$\frac{P_S}{P_M} = \frac{2400 \text{ psi}}{3000 \text{ psi}} = 0.8$$

2. Use the result of step 1 and the curve below right to estimate

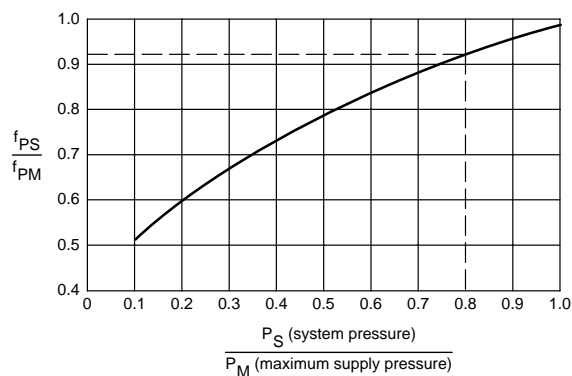
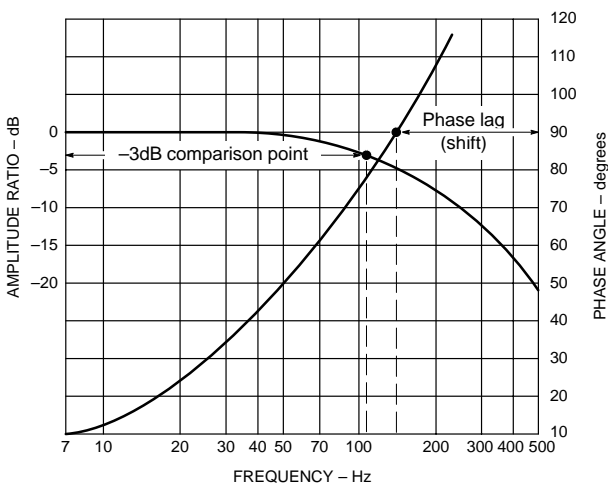
$$\frac{f_{PS}}{f_{PM}} = 0.93$$

3. Use the frequency response curve from page 8 to estimate f_{PM} .

$$f_{PM} = 95 \text{ Hz}$$

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

$$f_{PS} = 0.93 \times 95 \text{ Hz} = 88 \text{ Hz}$$

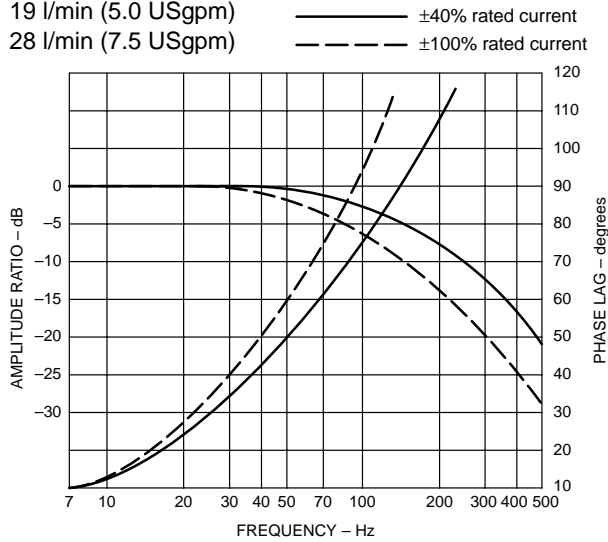


Typical Frequency Response Curves

At 210 bar (3000 psi)

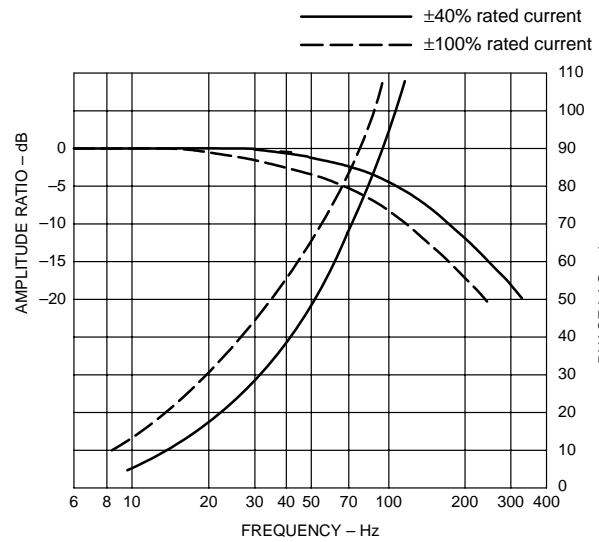
SM4-10/12/15

3,8 l/min (1.0 USgpm)
 9 l/min (2.5 USgpm)
 19 l/min (5.0 USgpm)
 28 l/min (7.5 USgpm)



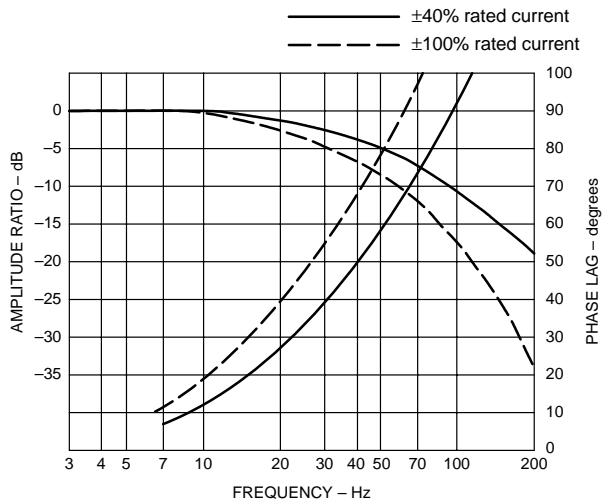
SM4-10/12/15

38 l/min (10 USgpm)



SM4-15

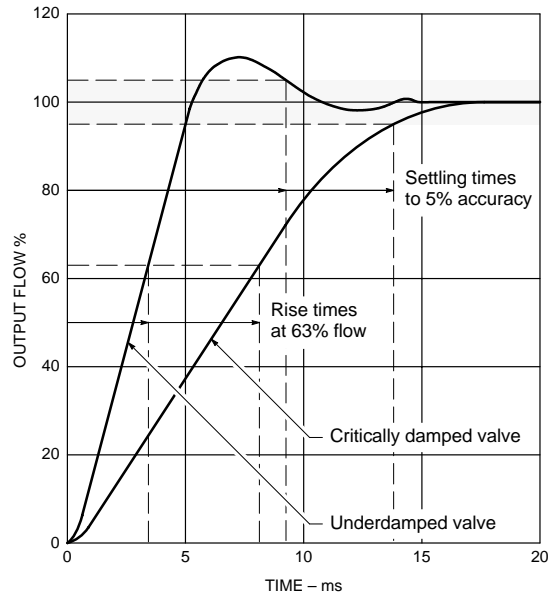
47 l/min (12.5 USgpm)
 57 l/min (15 USgpm)



Step Response

Step response is defined as the typical rise time needed to achieve a given percentage of control flow output. Settling time is the time needed for transient flow fluctuations to diminish to within a given accuracy range. Both are expressed in milliseconds (ms).

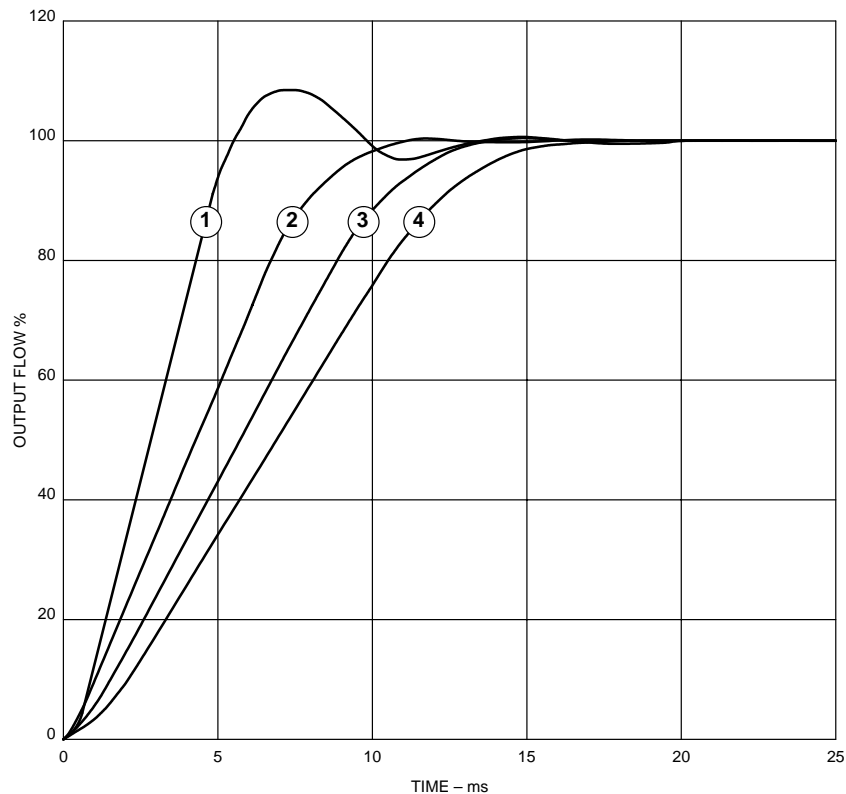
The example at right shows the step response curves for a critically damped valve and an underdamped valve. Rise times are illustrated for 63% of control flow output, and settling times are shown at $100 \pm 5\%$ of control flow output.



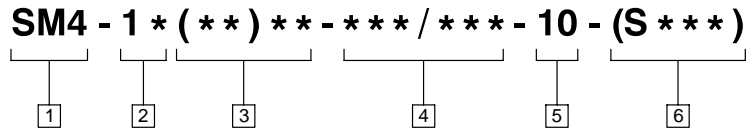
Typical Step Response Curves for Standard Models

SM4-10/12/15 shown at 210 bar (3000 psi).

- ① 1.0, 2.5, 5.0, and 7.5 USgpm
- ③ 12 USgpm (12 and 15 size valves only)
- ② 10 USgpm
- ④ 15 USgpm (15 size valves only)



Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

2 Valve size (mechanical interface)

- 10 – 15,9 mm (0.625 in) port circle
- 12 – 19,8 mm (0.780 in) port circle
- 15 – 23,8 mm (0.937 in) port circle

3 Flow rating

At 70 bar (1000 psi) Δp P→A→B→T.
Other flows available on request.

Code	USgpm	l/min
(1) 3,8	1.0	3,8
(2.5) 9	2.5	9
(5) 19	5.0	19
(7.5) 28	7.5	28
(10) 38	10.0	38
(12) 45*	12.0	45
(12.5) 47**	12.5	47
(15) 57**	15.0	57

* – 12 and 15 size valves only
** – 15 size valves only

4 Coil resistance/rated current

Ohms/mA at 21°C (70°F). Other coils available on request.

Code	Ohms	mA
20/200	20	200
30/100	30	100
80/40	80	40
80/50	80	50
140/40	140	40
200/15	200	15
200/20	200	20
300/30	300	30
1000/10	1000	10
1500/8	1500	8

5 Design number

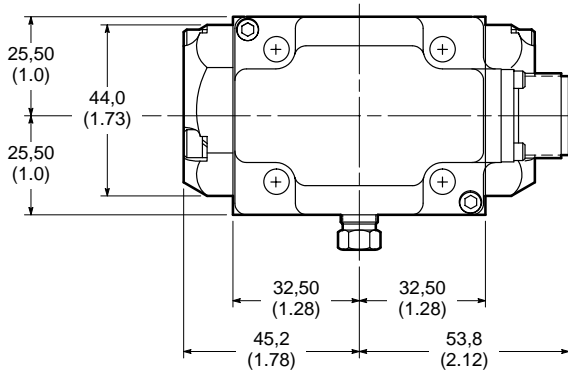
Subject to change. Installation dimensions same for designs 10 through 19.

6 Special features suffix

- S81 – Intrinsically safe valve. Contact your Vickers representative for details.
- S*** – Vickers assigns a unique suffix to denote a particular group of special features. Contact your Vickers representative for details.
- Blank – Standard valve

Installation Dimensions

millimeters (inches)



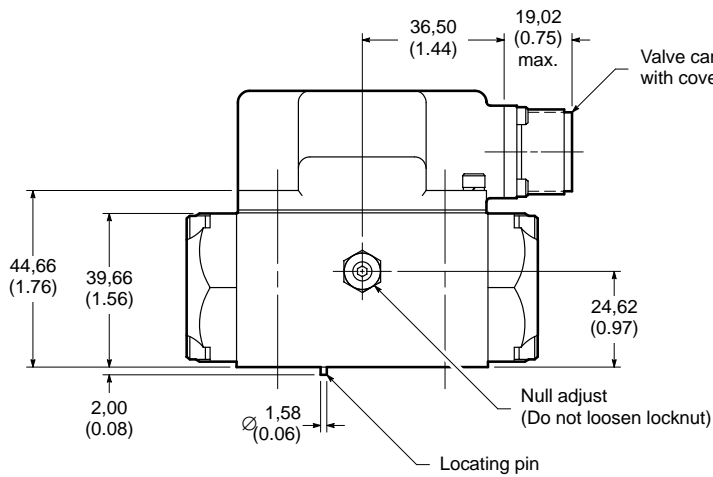
Electrical connector mates with MS-3106-14S-2S (4 pin). Plus signal to A or C causes flow out of port B.

NOTES

Torque mounting screws to 12 to 14 Nm (108 to 120 lb.in.).

Valve mounting surface requires 32 microinch finish flat within 0,025 (0.001).

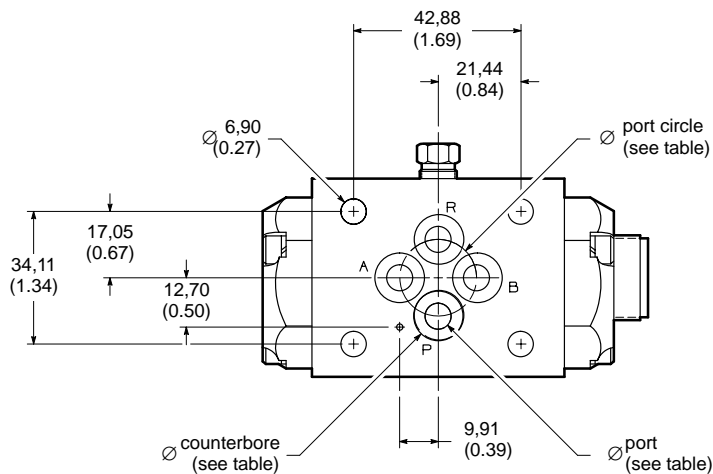
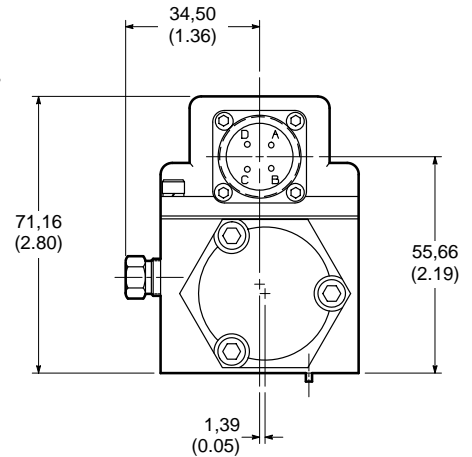
Viton port O-rings provided. SM4-10 O-rings (AS568-010): 1,78 (0.70) cross section and 6,07 (0.239) inner diameter. SM4-12 and SM4-15 O-rings (AS568-013): 1,78 (0.70) cross section and 10,82 (0.426) inner diameter. Replacement O-rings available in seal kits 920318 (SM4-10), 915850 (SM4-12), and 920319 (SM4-15) only.



Valve can be ordered with cover rotated 180°

Null adjust (Do not loosen locknut)

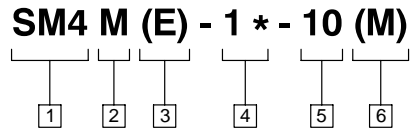
Locating pin



Valve Size	Port Circle Diameter	Port Diameter	Counterbore Diameter
10	15,88 (0.625)	4,85 (0.191)	9,58 (0.377)
12	19,80 (0.780)	6,60 (0.260)	12,74 (0.501)
15	23,80 (0.937)	7,92 (0.312)	14,30 (0.563)

SM4M(E) Mounting Subplates

Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

3 Port connection locations

Blank – Rear ports
E – Side ports

5 Design number

Subject to change. installation dimensions same for designs 10 through 19.

2 Accessory designation

M – Mounting subplate. Maximum supply pressure of 210 bar (3000 psi).

4 Standard SM4 valve size

10 – SM4-10
12 – SM4-12
15 – SM4-15

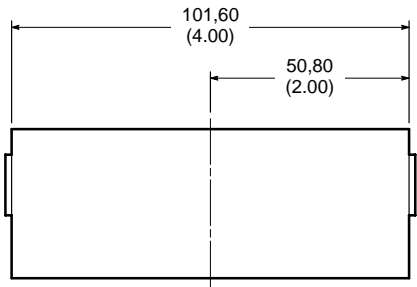
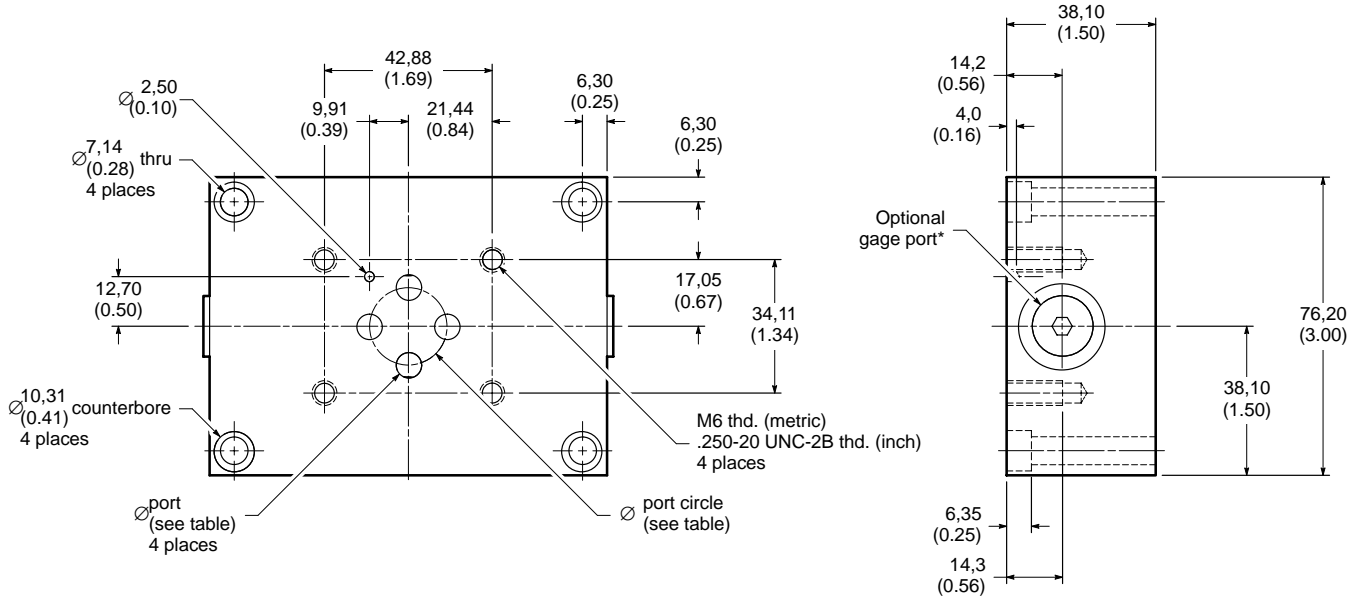
6 Metric suffix

M – Metric version to NG (ISO) standards
Blank – Omit if not required

Installation Dimensions

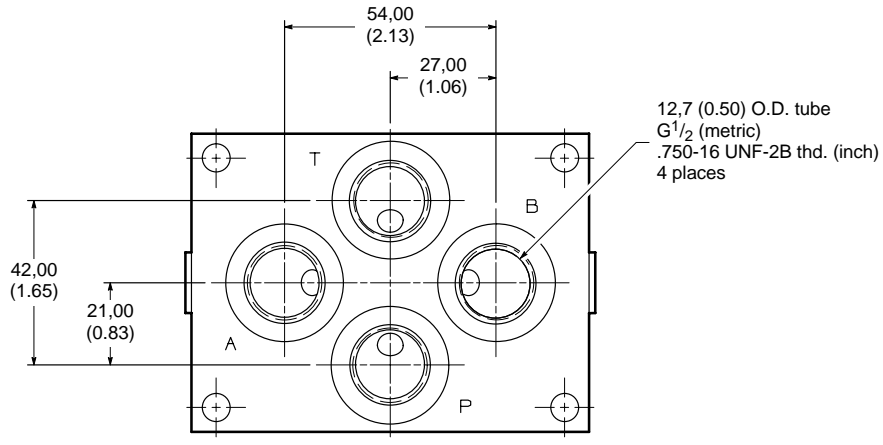
millimeters (inches)

SM4M-10-10(M), SM4M-12-10(M), and SM4M-15-10(M)

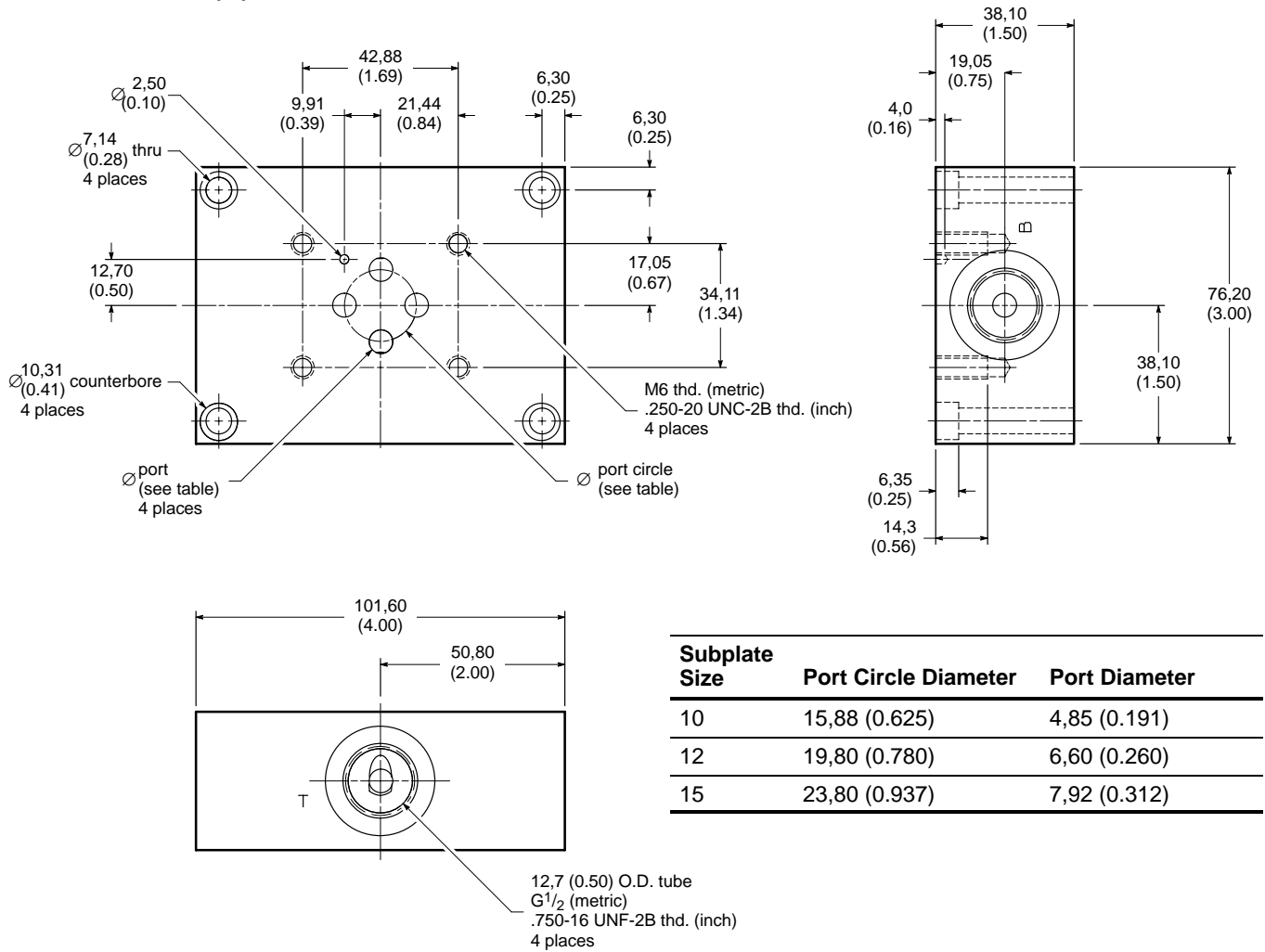


* - 6,35 (0.25) O.D. tube
G¹/₄ (metric)
.4375-20 UNF-2B thd. (inch)
2 places

Subplate Size	Port Circle Diameter	Port Diameter
10	15,88 (0.625)	4,85 (0.191)
12	19,80 (0.780)	6,60 (0.260)
15	23,80 (0.937)	7,92 (0.312)

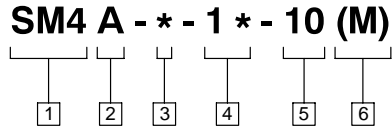


**SM4ME-10-10(M),
SM4ME-12-10(M),
and SM4ME-15-10(M)**



SM4A Adapter Manifolds

Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

3 Interface

3 – ISO 4401-03 (for SM4-10/12/15)
5 – ISO 4401-05 (for SM4-15)

5 Design number

Subject to change. Installation dimensions same for designs 10 through 19.

2 Accessory designation

A – Adapter manifold. Maximum supply pressure of 210 bar (3000 psi).

4 Standard SM4 valve size

10 – SM4-10
12 – SM4-12
15 – SM4-15

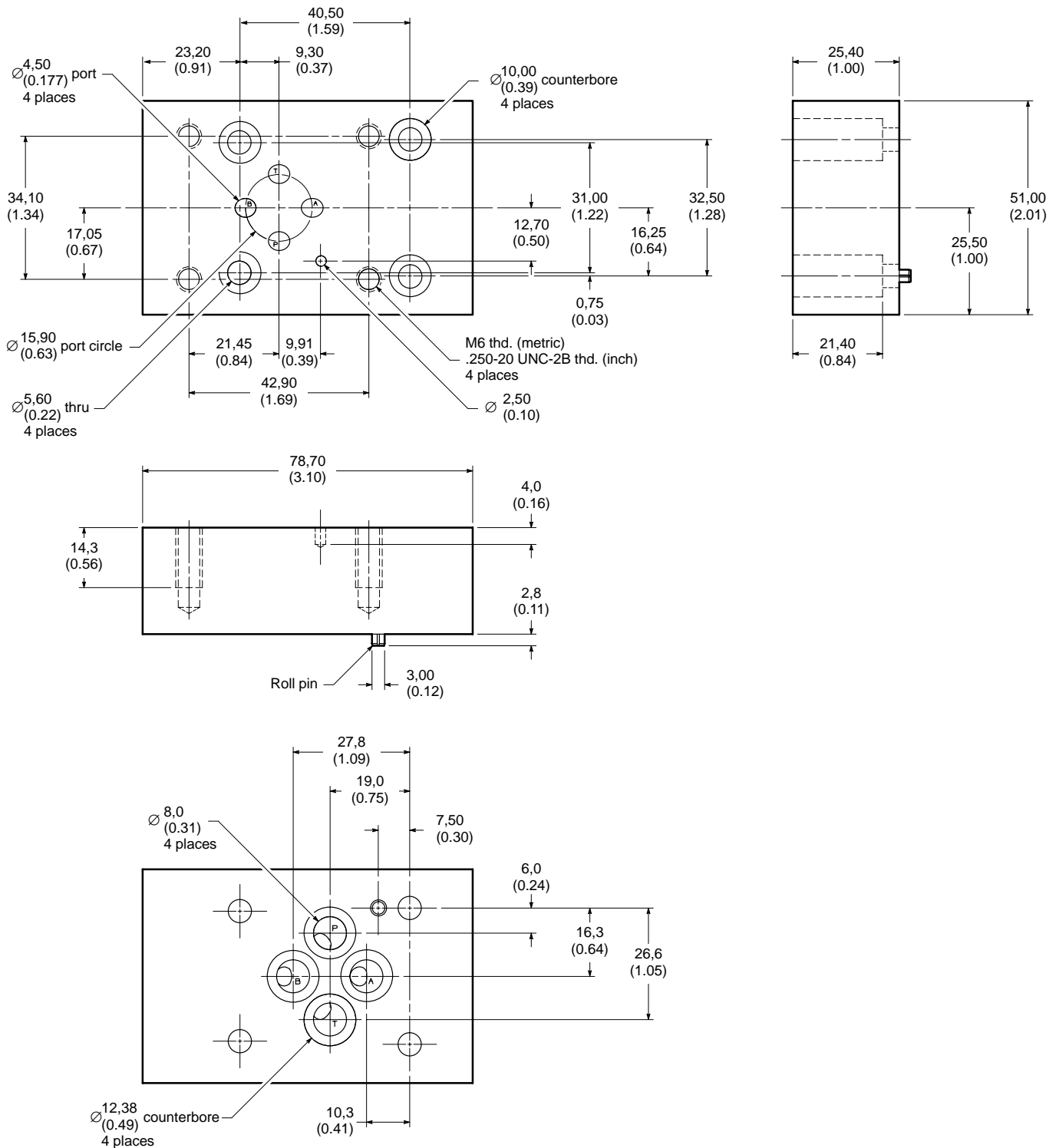
6 Metric suffix

M – Metric version to NG (ISO) standards
Blank – Omit if not required

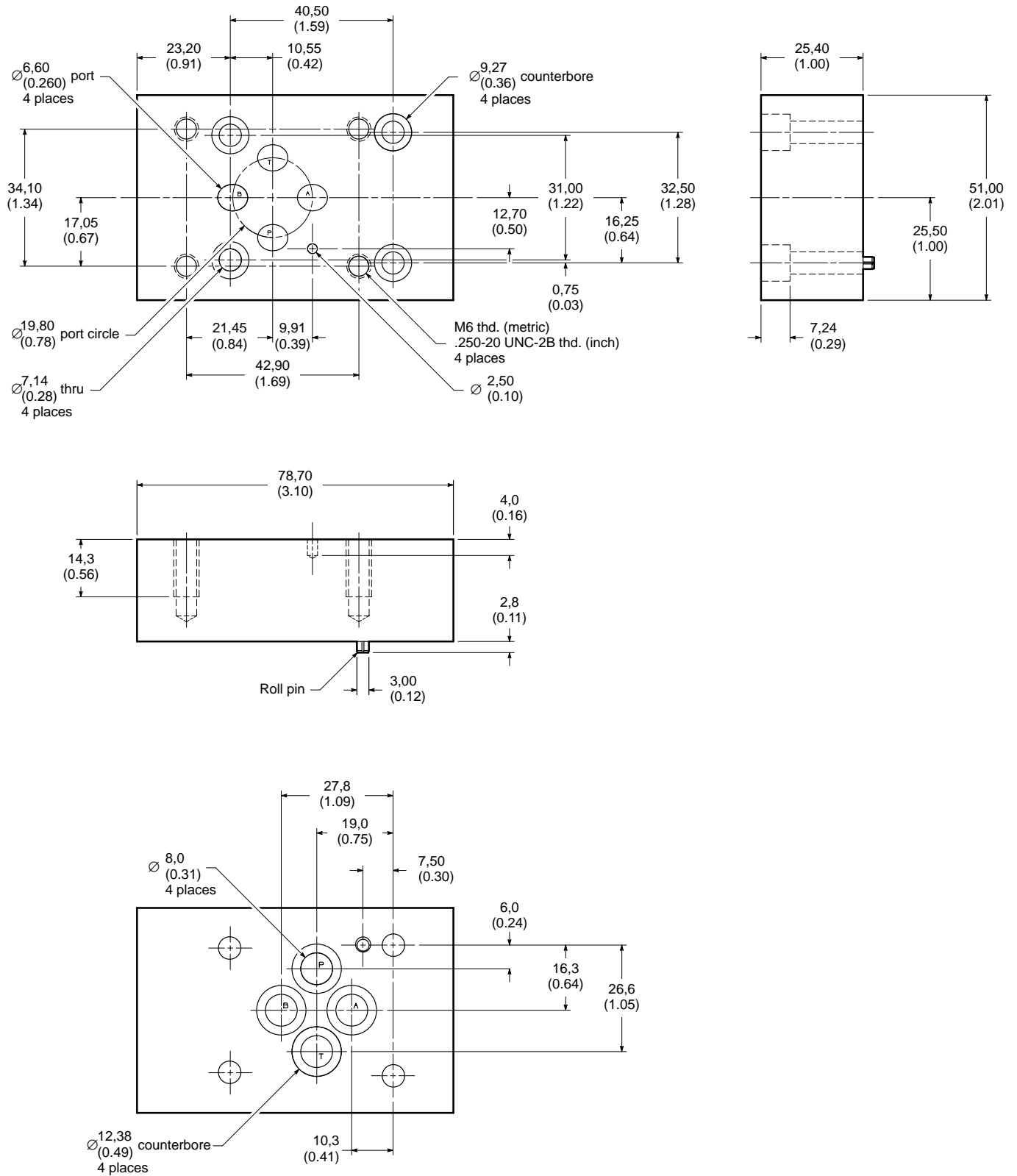
Installation Dimensions

millimeters (inches)

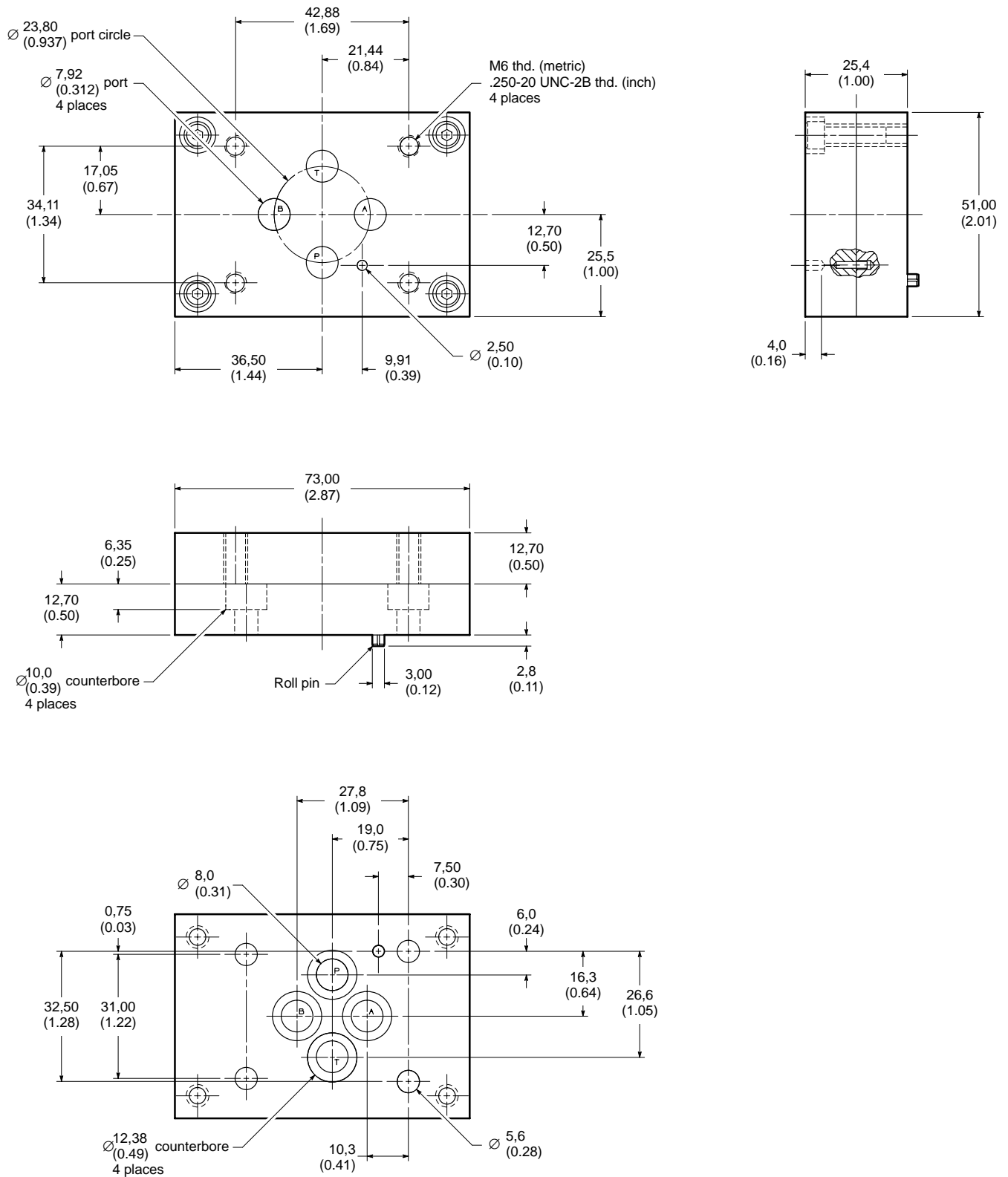
SM4A-3-10-10(M)



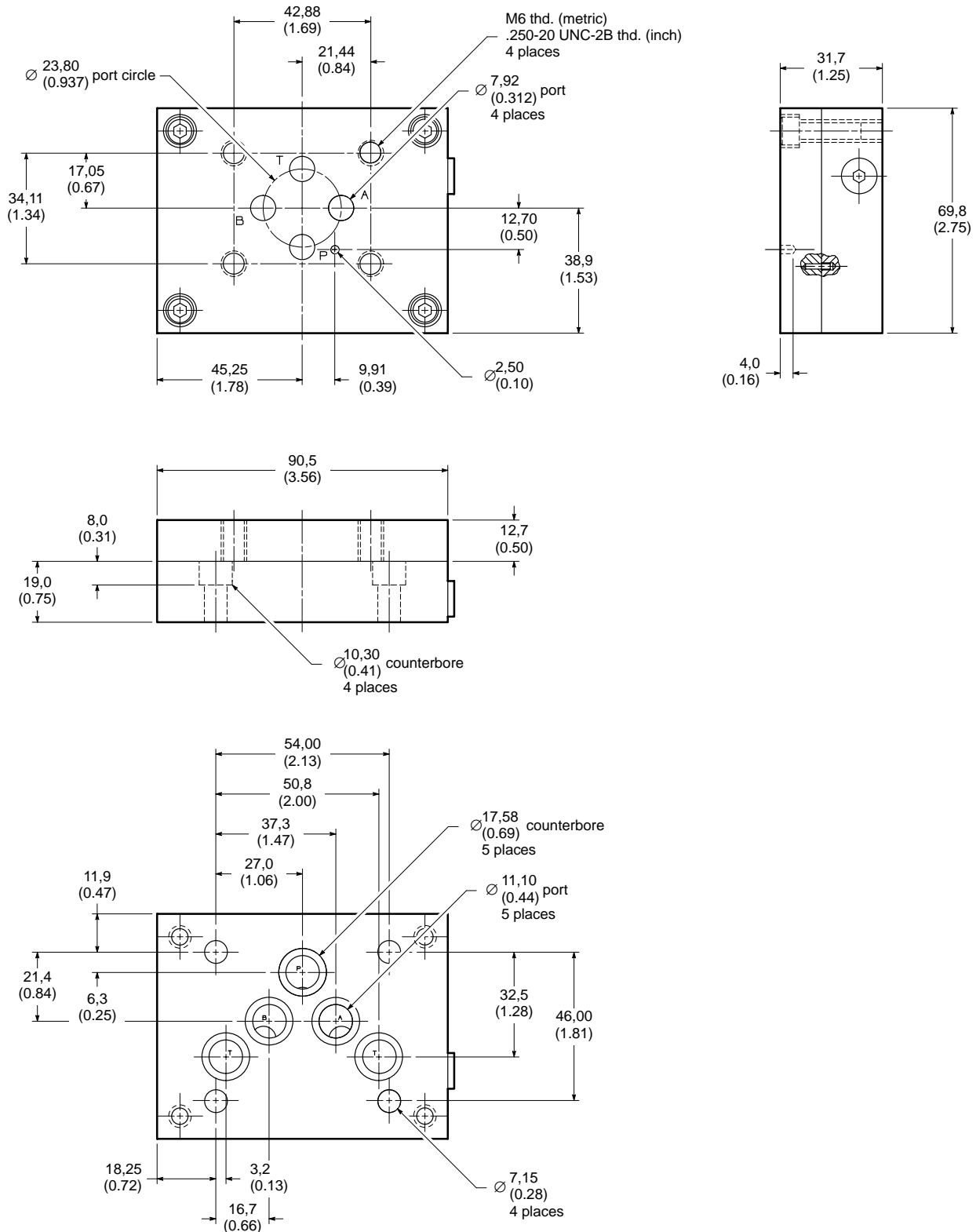
SM4A-3-12-10(M)



SM4A-3-15-10(M)



SM4A-5-15-10(M)



Weights

The following table lists approximate dry weights for SM4-10/12/15 servovalves and related accessories.

Description	Model Code	Weight kg (lbs.)
Servovalve	SM4-10/12/15	0,68 (1.5)
Mounting subplate	SM4M(E)-10/12/15-10(M)	0,73 (1.6)
Adapter manifold	SM4A-3-10/12/15-10(M)	0,240 (0.53)
	SM4A-5-15-10(M)	0,499 (1.10)
Flushing valve	SM4FV-10/12/15-10	0,15 (0.32)

Additional Accessories

Description	Model Code
Adapter manifold, SM4-15 to 0.875 port circle (inch)	SM4A-15-M76-10
Adapter manifold, SM4-15 to 0.875 port circle (metric)	SM4A-15-M76-10M
Adapter manifold (SM4-15 to 0.875 port circle) mounting bolt kit (inch) $5/16-18 \times 1\frac{1}{2}$ "	BK688701
Adapter manifold (SM4-15 to 0.875 port circle) mounting bolt kit (metric) M8 x 35mm	BK689630M
Adapter manifold (SM4A-3-10 or SM4A-3-15) mounting bolt kit (inch) $10-24 \times 1\frac{1}{2}$ "	BK855984
Adapter manifold (SM4A-3-10 or SM4A-3-15) mounting bolt kit (metric) M5 x 12mm	BK855985M
Adapter manifold (SM4A-5-15) mounting bolt kit (inch) $1/4-20 \times 3/4$ "	BK855986
Adapter manifold (SM4A-5-15) mounting bolt kit (metric) M6 x 20mm	BK855987M
Cable clamp (MS3057-6)	126058
Cable connector (MS3106-14S-2S)	242123
Flushing valve mounting bolt kit (inch) $1/4-20 \times 1$ "	BK866686
Flushing valve mounting bolt kit (metric) M6 x 25mm	BK689629M
Seal kit (SM4-10)	920318
Seal kit (SM4-12)	915850
Seal kit (SM4-15)	920319
Subplate mounting bolt kit (inch) $1/4-20 \times 1\frac{1}{2}$ "	BK855992
Subplate mounting bolt kit (metric) M6 x 40mm	BK855993M
Valve mounting bolt kit (inch) $1/4-20 \times 2\frac{1}{4}$ "	BK866685
Valve mounting bolt kit (metric) M6 x 60mm	BK689623M

Servo Electronics

See application brochure 656 for the complete Vickers line of amplifiers, power supplies, and function modules.

Application Data

Fluid Cleanliness

Proper fluid condition is essential for long and satisfactory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials, and additives for protection against wear of components, elevated viscosity and inclusion of air.

Essential information on the correct methods for treating hydraulic fluid is included in Vickers publication 561 "Vickers Guide to Systemic Contamination Control," available from your local Vickers distributor or by contacting Vickers, Incorporated. Recommendations on filtration and the

selection of products to control fluid condition are included in 561.

Recommended cleanliness levels, using petroleum oil under common conditions, are based on the highest fluid pressure levels in the system and are coded in the chart below. Fluids other than petroleum, severe service cycles, or temperature extremes are cause for adjustment of these cleanliness codes. See Vickers publication 561 for exact details.

Vickers products, as any components, will operate with apparent satisfaction in fluids with higher cleanliness codes than those described. Other manufacturers

will often recommend levels above those specified. Experience has shown, however, that life of any hydraulic component is shortened in fluids with higher cleanliness codes than those listed below. These codes have been proven to provide a long, trouble-free service life for the products shown, regardless of the manufacturer.

NOTE

Vickers will extend, by one year, the standard warranty on all Vickers products used in a system protected by Vickers filters (and elements) applied in a manner consistent with the principles presented in Vickers publication 561.

Product	System Pressure Level bar (psi)		
	<70 (<2000)	70–207 (2000–3000)	207+ (3000+)
Vane pumps, fixed	20/18/15	19/17/14	18/16/13
Vane pumps, variable	18/16/14	17/15/13	
Piston pumps, fixed	19/17/15	18/16/14	17/15/13
Piston pumps, variable	18/16/14	17/15/13	16/14/12
Directional valves	20/18/15	20/18/15	19/17/14
Proportional valves	17/15/12	17/15/12	15/13/11
Servo valves	16/14/11	16/14/11	15/13/10
Pressure/Flow controls	19/17/14	19/17/14	19/17/14
Cylinders	20/18/15	20/18/15	20/18/15
Vane motors	20/18/15	19/17/14	18/16/13
Axial piston motors	19/17/14	18/16/13	17/15/12
Radial piston motors	20/18/14	19/17/13	18/16/13

Eaton Hydraulics

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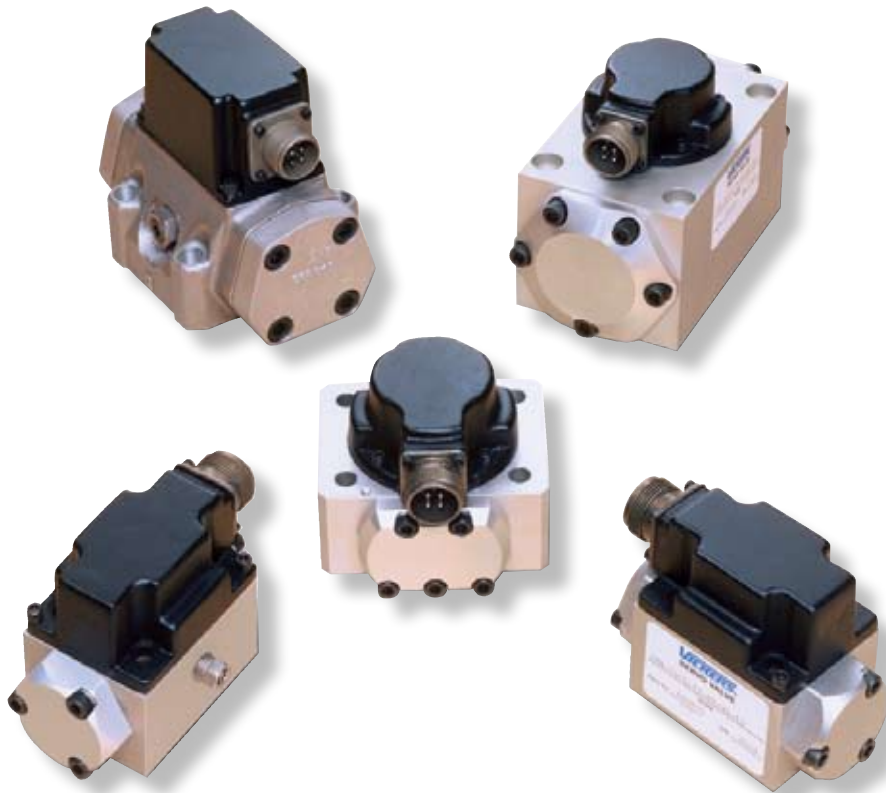


Vickers®

SM4-20 Servo Valves
Catalog

Flows to
76 l/min
(20 USgpm) –

Pressures
to 210 bar
(3000 psi)



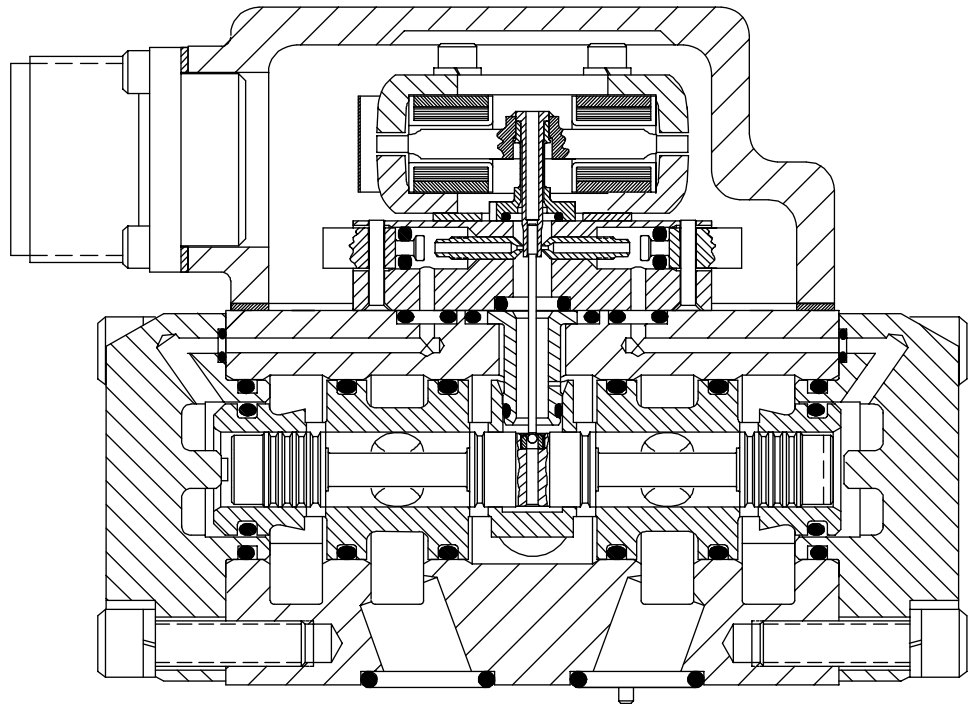
EATON

Powering Business Worldwide

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Cross Section of
Typical SM4-20
Servovalve



Introduction

Eaton Vickers® SM4-20 servo valves can provide system closed loop control with exact positional accuracy, repeatable velocity profiles, and predictable force or torque regulation.

Typical applications include plastic injection molding and blow molding systems, test and simulation equipment, die casting machines, hydraulic press brakes, animation and entertainment equipment, oil exploration vehicles, and lumber machinery.

This model of the high performance SM4 series offers a wide range of rated flows from 3,8 to 76 l/min (1.0 to 20 US-gpm) at Δp of 70 bar (1000 psi).

The SM4 is a two-stage, modular design, flow control valve which can be manifold or subplate mounted. The

symmetrical, dual coil, quad air gap torque motor is integrally mounted to the first stage nozzle flapper pilot valve with six screws. The second stage utilizes a four-way sliding spool and sleeve arrangement with a mechanical null adjust. Spool position is fed back to the first stage by means of a cantilever spring. An integral 35 micron (absolute) filter reduces sensitivity to contamination of the first stage.

An SM4 servo valve, when used with a hydraulic cylinder, position transducer, and appropriate electronics, can provide infinite cylinder position control to within 0,025 mm (0.001 in) or better, depending on the components selected, length of stroke, and load characteristics.

When applied with servo hydraulic motors using tachometer feedback and appropriate electronics, the SM4 provides infinite proportional flow control for real-time velocity/acceleration profiles. The resulting closed loop system can be error corrected to within one-tenth of a revolution per minute. With appropriate pressure transducers or load cells in force control applications, the SM4 makes possible exact load pressure/force control. In addition, excellent system stability with pressure and load to $\pm 1\%$ full scale can be achieved.

The field-proven design of the SM4-20 servo valve, combined with Eaton Vickers® precision manufacturing techniques, provides you with the optimum in system control.

Features and Benefits

- The wide range of SM4-20 flow capabilities allows selection of the valve size best suited for an application.
- The high strength aluminum alloy of the second stage valve body means lighter weight with rugged durability.
- The symmetrical, dual-coil, quad air gap, dry torque motor, with its extremely fast response to input signals, results in highly accurate control profiles.
- Higher frequency response is available on request to provide enhanced system bandwidth for critical performance requirements.
- An integral 35 micron (absolute) filter provides extra first stage contamination protection.
- The spool and sleeve are hardened stainless steel to minimize wear and erosion. The O-ring mounted sleeve eliminates spool binding and ensures smooth operation.
- Customized spool lap and sleeve porting are available to provide the specific flow control required for special applications.
- The SM4's symmetrical design provides inherently dependable metering of control flow with minimum null shifts. The result is more consistent machine operation.
- DuPont Viton® seals are standard.
- The flexibility of a standardized port circle and mounting pattern, with available adapter manifolds, makes Vickers SM4-20 servo valves a cost-effective choice for replacing existing servo valves and enhancing system performance.
- The SM4-20 features a simple interface to an available dual filter module that provides extra protection against pilot stage contamination.
- Flushing valves are available that can greatly reduce initial system contamination levels prior to SM4 installation.

Operating Data

Flow and Leakage

All data is typical, based on actual tests at 70 bar (1000 psi) Δp , 30 cST (141 SUS), and 49°C (120°F).

MODEL SERIES	MAXIMUM RATED FLOW $\pm 10\%$	MAXIMUM TOTAL NULL LEAKAGE	MAXIMUM PILOT FLOW AT 70 BAR (1000 PSI) ΔP
	l/min (USgpm)	l/min (USgpm)	l/min (USgpm)
SM4-20	76 (20)	2,0 (0.52)	0,35 (0.092)

PERFORMANCE

Maximum Supply Pressure		
bar (psi)	SM4-20:	210 (3000)*
Minimum Supply Pressure		
bar (psi)		14 (200)
Proof Pressure		At Supply Port: 150
% maximum supply pressure		At Return Port: 100
Burst Pressure, Return Port Open		
% maximum supply pressure		250
Maximum Operating Temperature		
°C (°F)		135 (275)
Hysteresis Around Null		
% of rated current		≤ 3
Symmetry Error		
% of rated current		<10
Linearity Error		
% of rated current		<10
Threshold		
% of rated current		≤ 0.5

* SM4-20 (-50 design) features maximum supply pressure of 350 bar (5000 psi). See publication 662 for details.

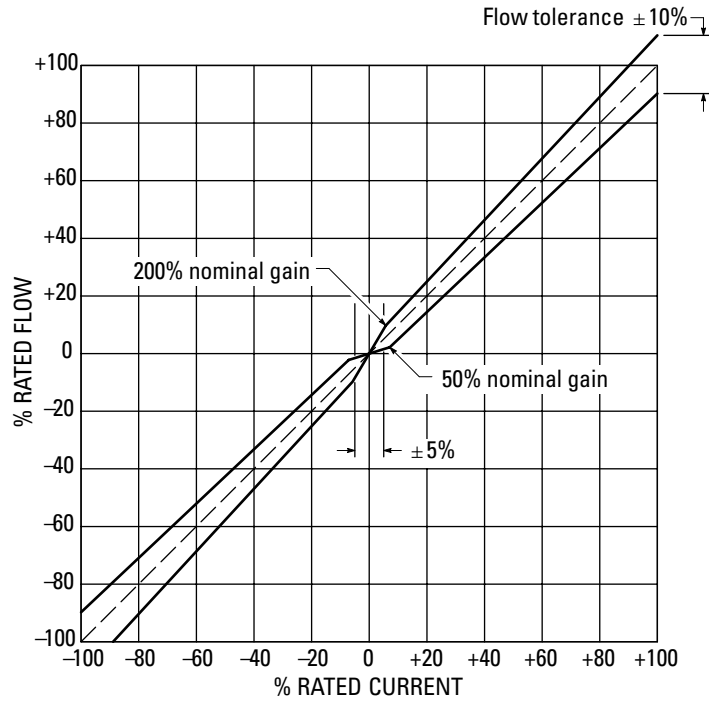
RUGGEDNESS TEST RESULTS

Vibration Test	
5 Hz to 2000 Hz along each axis	No damage to components
Shock Test	
Up to 150g along all axes	No damage to components
Endurance Test	
To ISO 6404	No degradation in performance

Operating Data

Flow Gain

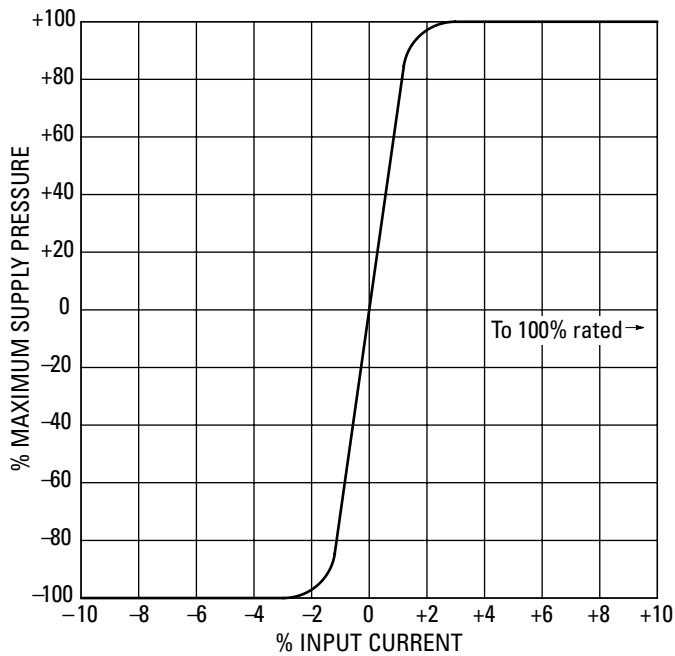
Normal region for standard models shown with typical no-load flow gain tolerances excluding hysteresis.



Pressure Gain

Change in load pressure drop with input current shown with no valve flow and closed control ports.

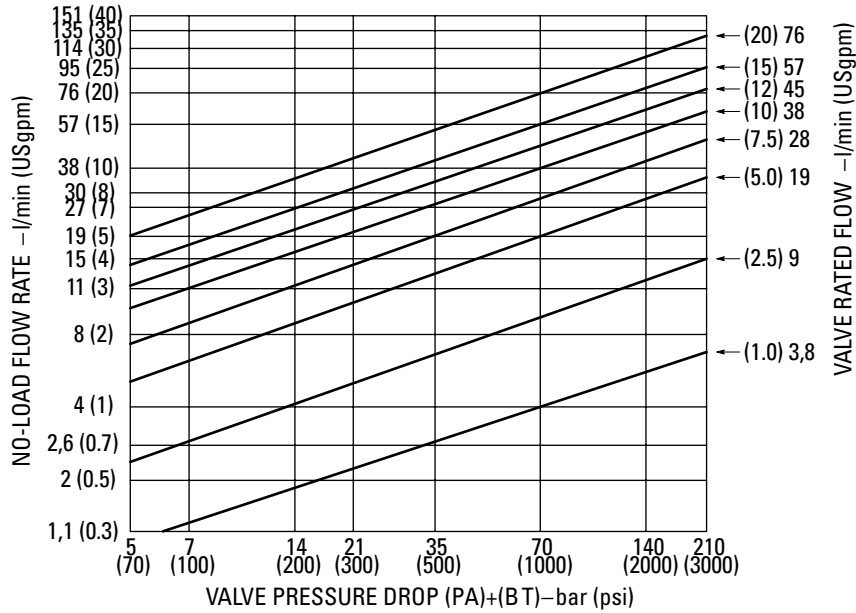
Pressure gain in the null region is >30% of supply pressure per 1% of rated current.



Operating Data

Change in Rated Flow

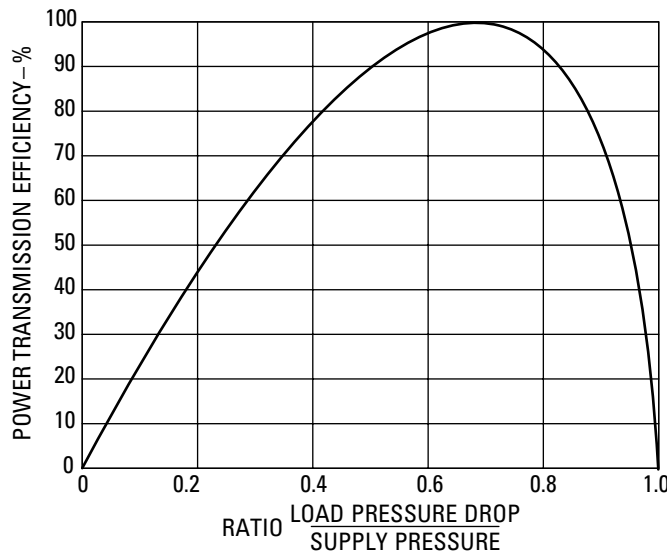
Rated flows at valve pressure drops from 5 bar (70 psi) to 210 bar (3000 psi) for eight of the available spools.



Power Transmission Efficiency

Maximum power envelope expressed as a percentage with T port pressure equal to 0 bar.

Power transferred to the load is optimum when valve pressure drop is one third of supply pressure. Load pressure drop should be limited to 2/3 of supply pressure so the flow gain of the servovalve remains high enough to maintain control of the load. Overall hydraulic efficiency must be considered when sizing system heat exchangers.



Operating Data

Coil Resistance

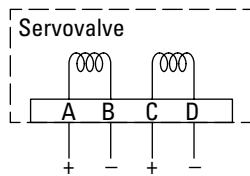
Select coil resistance and connections for compatible interface to servo electronics. Recommended coil resistance is shown in bold print.

	Nominal Resistance Per Coil at 21°C (70°F) Ohms	Rated Current mA	
		Single, Parallel, or Differential Connection	Series Connection
Standard coil resistance selection	20	200	100
	30	100	50
	80	40	20
	200	20	10
Optional coil resistance selection	80	50	25
	140	40	20
	200	15	7.5
	300	30	15
	1000	10	5
	1500	8	4

Electrical Polarity for Control Flow Out of B Port

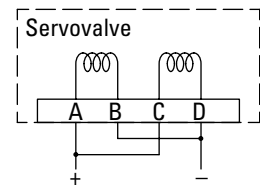
Single:

A+, B-
or
C+, D-



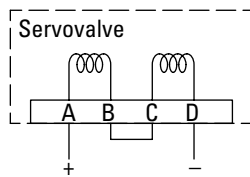
Parallel:

A+, C+
B-, D-
Connect A and C
Connect B and D



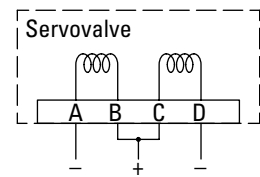
Series:

A+, D-
Connect B and C



Differential:

A-, D-
B+, C+
Connect B and C
BC-, current BA > CD
BC+, current CD > BA



Performance Curves

Frequency Response

Frequency response is defined as the relationship of no-load control flow to input current with a sinusoidal current sweep at constant amplitude over a range of frequencies. It is expressed in frequency (Hz), amplitude ratio (dB), and phase angle (degrees).

As shown in the sample curve (below left), standard comparison points for servo-valve frequency response are those frequencies at which -3 dB amplitude ratio and 90° phase angle occur.

Eaton Vickers® SM4 torque motors are magnetically stabilized for reliable servo valve performance at operating pressures from 14 to 210 bar (200 to 3000 psi).

Calculating Frequency Response at System Pressure

P_S = System pressure

P_M = Maximum supply pressure of valve: 210 bar (3000 psi) for SM4-20 (-10 design)

f_{PM} = Frequency (at 90° phase angle) at maximum supply pressure (P_M)

f_{PS} = Frequency (at 90° phase angle) at system pressure (P_S)

1. Calculate the ratio of system pressure to maximum supply pressure:

$$\frac{P_S}{P_M}$$

2. Use the result of step 1 and the curve below to estimate

$$\frac{f_{PS}}{f_{PM}}$$

3. Use the applicable frequency response curve from page 7 to estimate f_{PM} (the maximum supply pressure frequency response at 90° phase angle) for the desired valve rated flow.

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

Example: A standard performance SM4-20 valve with a flow of 38 l/min (10 USgpm) is to be used at 165 bar (2400 psi).

1. Calculate the ratio of system pressure to maximum supply pressure:

$$\frac{P_S}{P_M} = \frac{2400 \text{ psi}}{3000 \text{ psi}} = 0.8$$

2. Use the result of step 1 and the curve below right to estimate

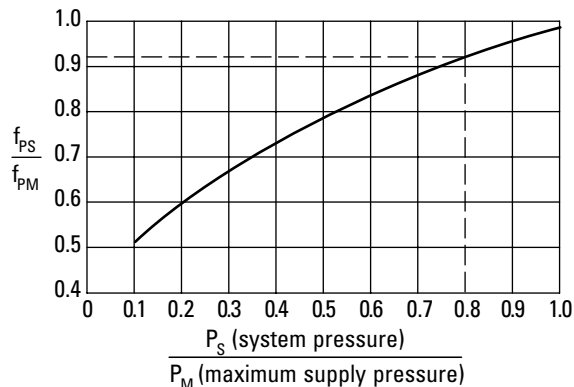
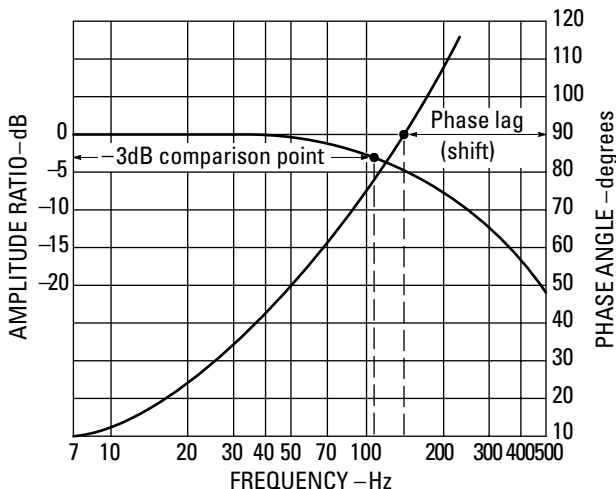
$$\frac{f_{PS}}{f_{PM}} = 0.92$$

3. Use the frequency response curve from page 7 to estimate f_{PM} .

$$f_{PM} = 100 \text{ Hz}$$

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

$$f_{PS} = 0.92 \times 100 \text{ Hz} = 92 \text{ Hz}$$



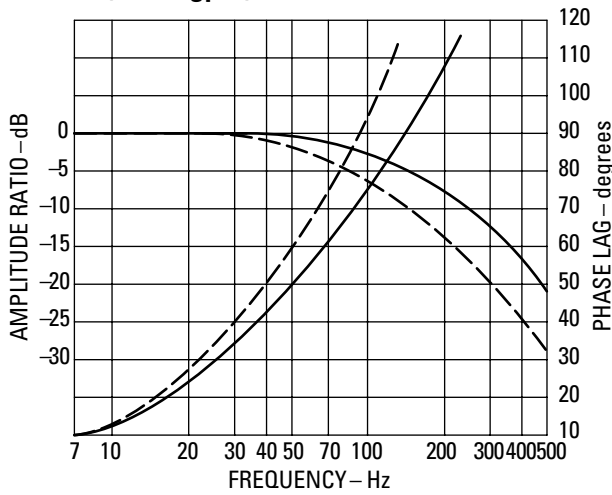
Performance Curves

Typical Frequency Response Curves

SM4-20 (-10 design) shown at 210 bar (3000 psi)

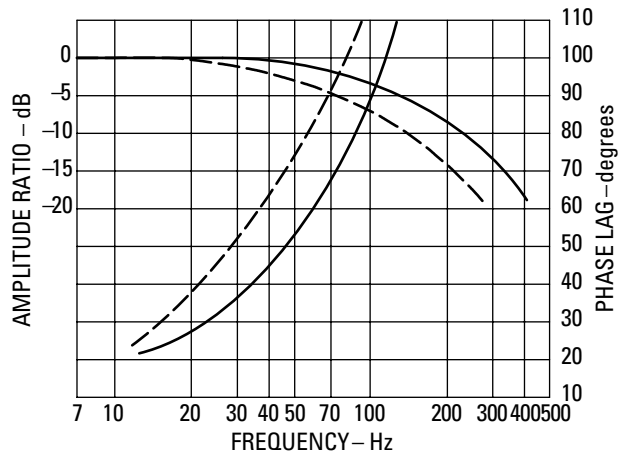
3,8 l/min (1.0 USgpm)
9 l/min (2.5 USgpm)
19 l/min (5.0 USgpm)
28 l/min (7.5 USgpm)

— ±40% rated current
 - - - ±100% rated current



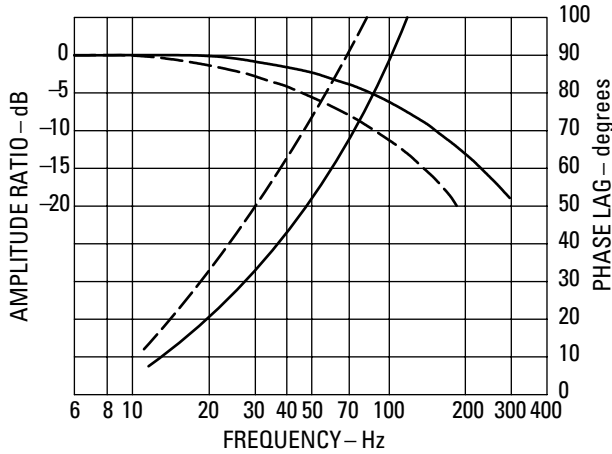
38 l/min (10 USgpm)

— ±40% rated current
 - - - ±100% rated current



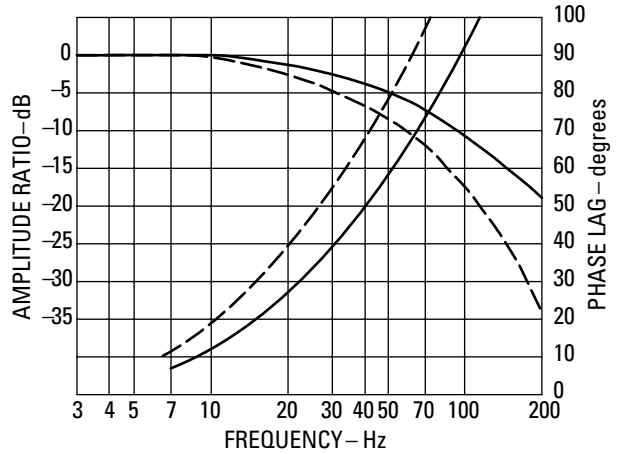
47 l/min (12.5 USgpm)

— ±40% rated current
 - - - ±100% rated current



57 l/min (15 USgpm)
76 l/min (20 USgpm)

— ±40% rated current
 - - - ±100% rated current

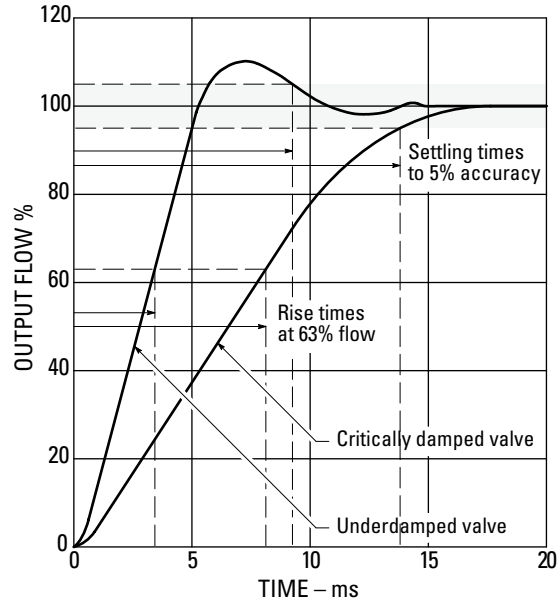


Performance Curves

Step Response

Step response is defined as the typical rise time needed to achieve a given percentage of control flow output. Settling time is the time needed for transient flow fluctuations to diminish to within a given accuracy range. Both are expressed in milliseconds (ms).

The example at right shows the step response curves for a critically damped valve and an underdamped valve. Rise times are illustrated for 63% of control flow output, and settling times are shown at $100 \pm 5\%$ of control flow output.

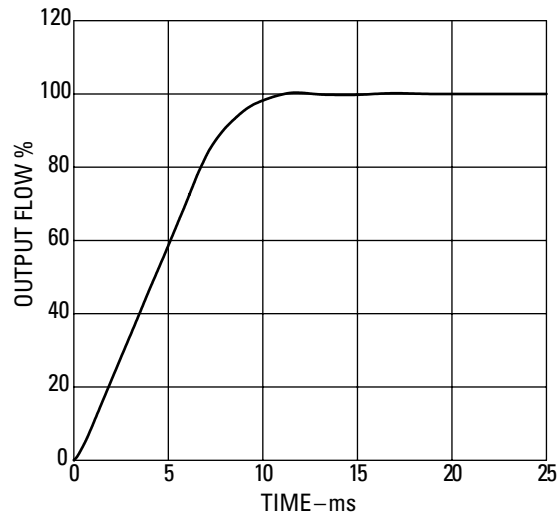
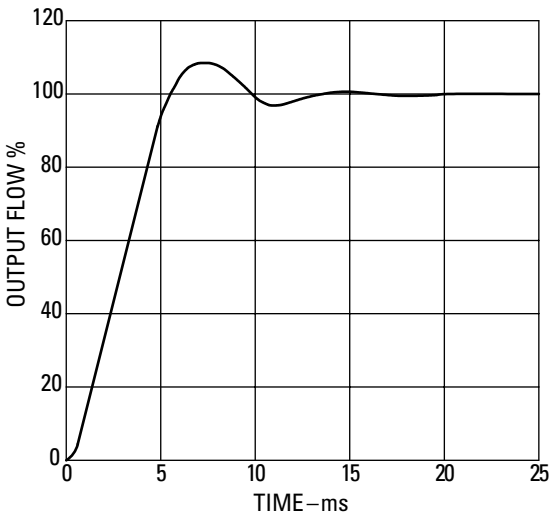


Typical Step Response Curves for Standard Models

SM4-20 shown at 210 bar (3000 psi)

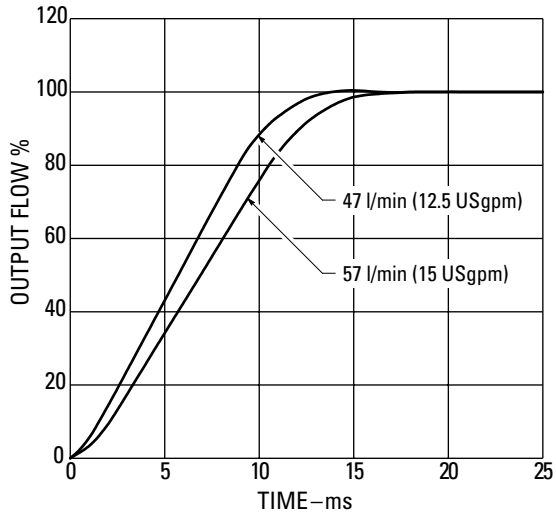
- 3,8 l/min (1.0 USgpm)
- 9 l/min (2.5 USgpm)
- 19 l/min (5.0 USgpm)
- 28 l/min (7.5 USgpm)

38 l/min (10 USgpm)

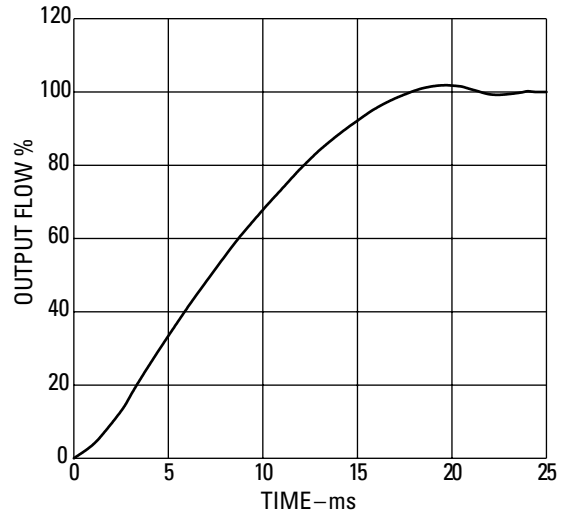


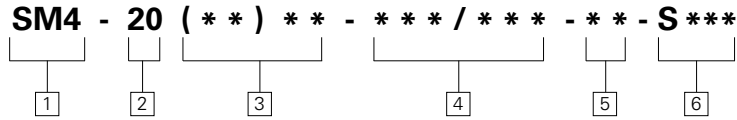
Performance Curves

**47 l/min (12.5 USgpm)
57 l/min (15 USgpm)**



76 l/min (20 USgpm)





1 Series Designation

SM4 – Servo valve, high performance, four-way

2 Valve Size

20 – 22,2 mm (0.875 in) port circle

3 Flow Rating

At 70 bar (1000 psi) Δp
P → A → B → T.
Other flows available on request.

Code	USgpm	l/min
(1) 3,8	1.0	3,8
(2.5) 9	2.5	9
(5) 19	5.0	19
(7.5) 28	7.5	28
(10) 38	10.0	38
(12) 45	12.0	45
(12.5) 47	12.5	47
(15) 57	15.0	57
(20) 76	20.0	76

4 Coil resistance/rated current

Ohms/mA at 21°C (70°F).
Other coils available on request.

Code	Ohms	mA
20/200	20	200
30/100	30	100
80/40	80	40
80/50	80	50
140/40	140	40
200/15	200	15
200/20	200	20
300/30	300	30
1000/10	1000	10
1500/8	1500	8

5 Design Number

Subject to change. Installation dimensions same for designs 10 through 19.

6 Special Features Suffix

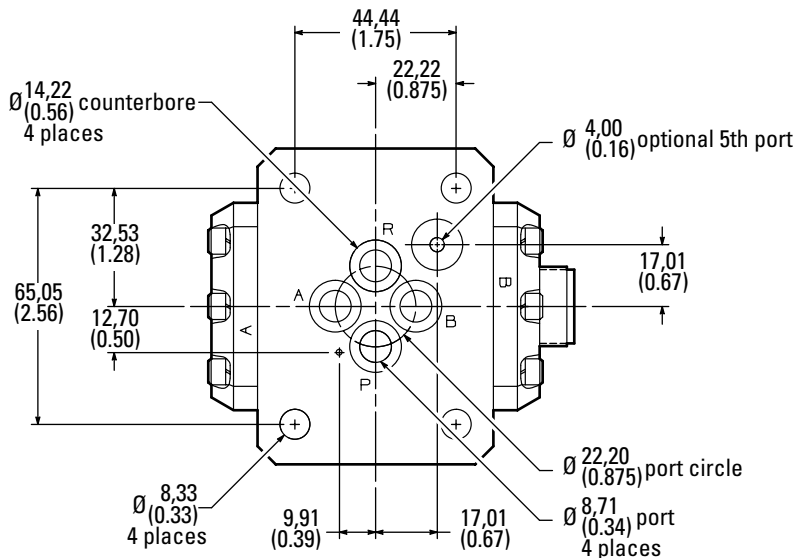
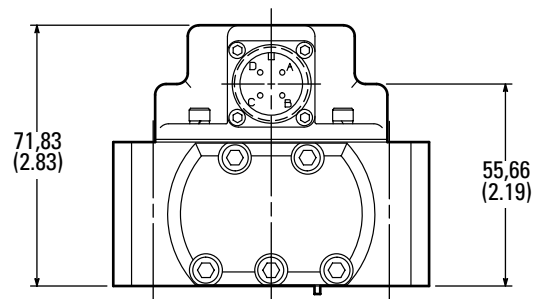
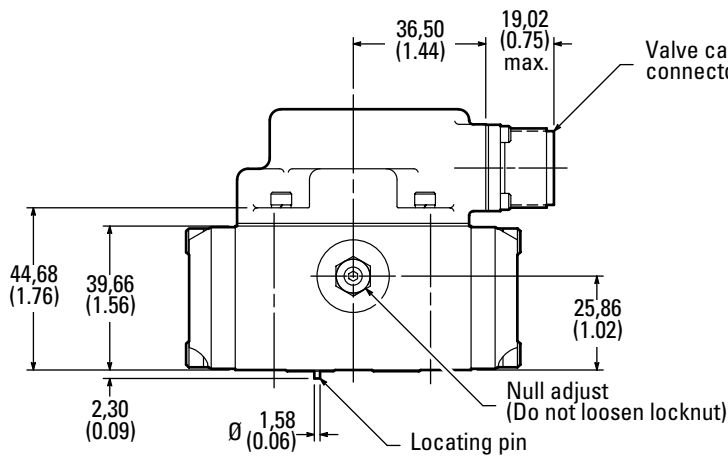
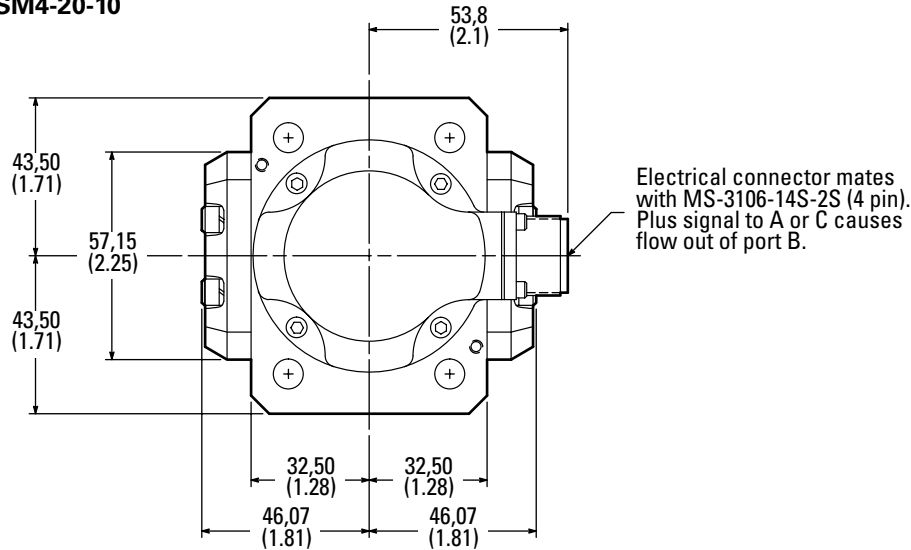
S81 – Intrinsically safe valve. Contact your Vickers representative for details.

S*** – Vickers assigns a unique suffix to denote a particular group of special features. Contact your Vickers representative for details.

Blank – Standard valve

Installation Dimensions

SM4-20-10



NOTES

Torque mounting screws to 14 to 15 Nm (120 to 130 lb.in.).

Valve mounting surface requires 32 microinch finish flat within 0,025 (0.001).

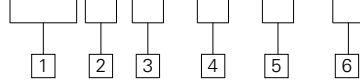
Viton® port O-rings (AS568-013) provided: 1,78 (0.070) cross section and 10,82 (0.426) inner diameter. Replacement O-rings available in seal kit 920320 only.

Dimensions in inches (mm)

Model Code

SM4M(E) Mounting Subplates

SM4 M (E) - 20 - 10 - (M)



1 Series Designation

SM4 – Servo valve, high performance, four-way

2 Accessory Designation

M – Mounting subplate. Maximum supply pressure of 210 bar (3000 psi).

3 Port Connection Locations

Blank – Rear ports
E – Side ports

4 Standard SM4 Valve Size

20 – SM4-20 or SP4-25

5 Design Number

Subject to change. Installation dimensions same for designs 10 through 19.

-10 design indicates 210 bar (3000 psi) maximum supply pressure.

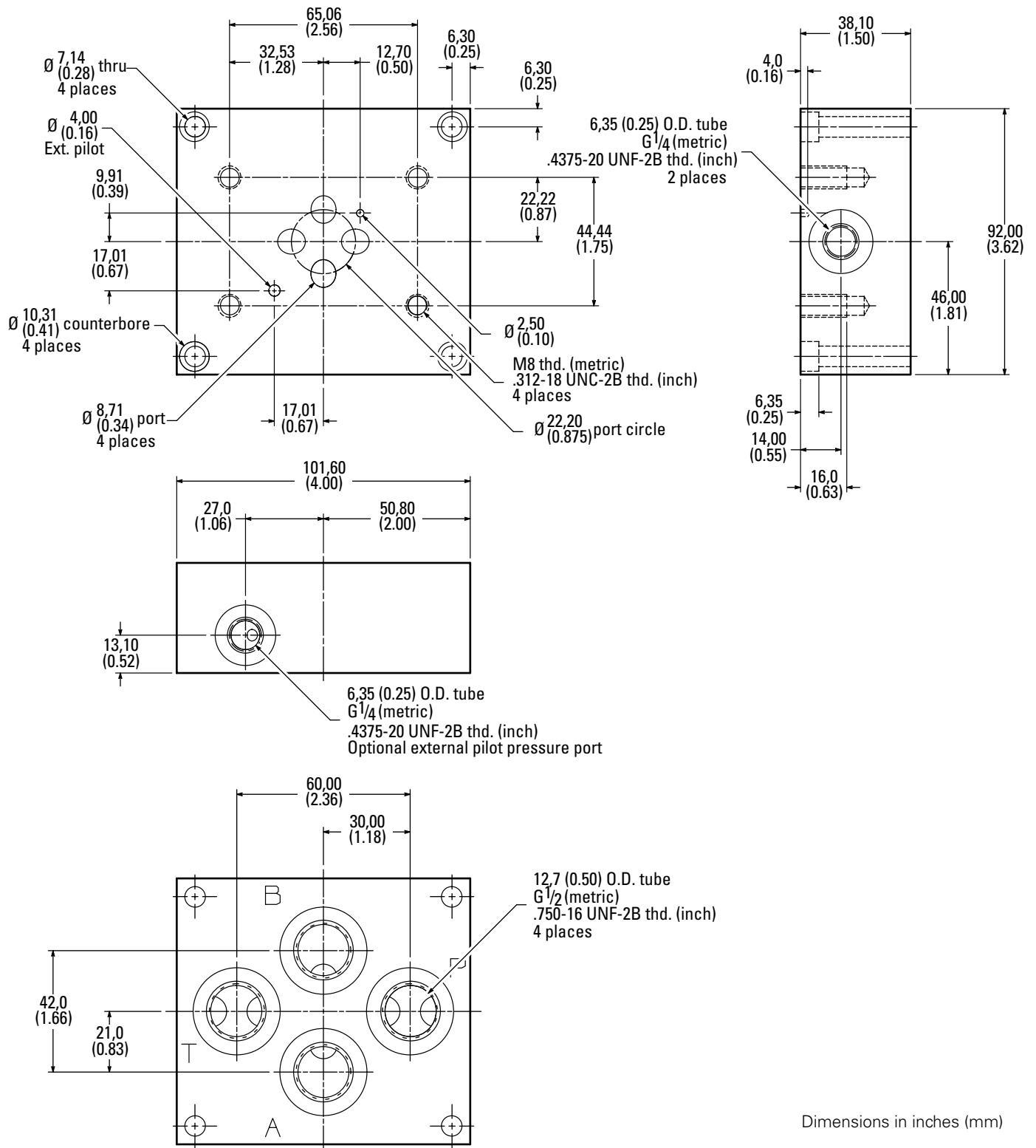
6 Metric Suffix

M – Metric version to NG (ISO) standards

Blank – Omit if not required

Installation Dimensions

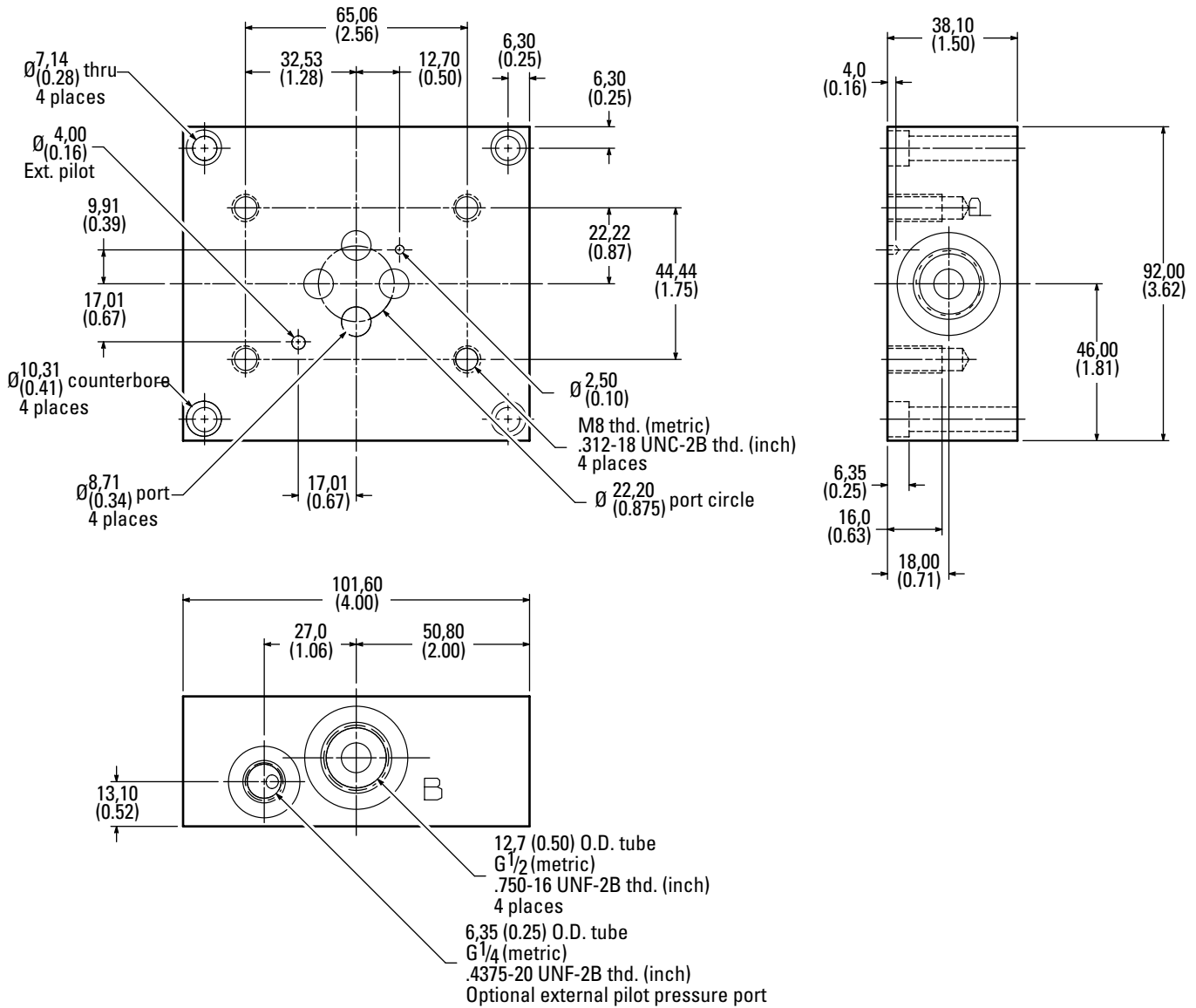
SM4M-20-10(M)



Dimensions in inches (mm)

Installation Dimensions

SM4ME-20-10(M)

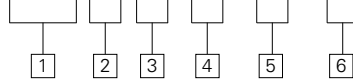


Dimensions in inches (mm)

Model Code

SM4A Adapter Manifolds

SM4 A - 5 - 20 - 10 - (M)



1 Series Designation

SM4 – Servovalve, high performance, four-way

2 Accessory Designation

A – Adapter manifold. Maximum supply pressure of 210 bar (3000 psi).

3 Interface

5 – ISO 4401-05

4 Standard SM4 Valve Size

20 – SM4-20 or SP4-25

5 Design Number

Subject to change. Installation dimensions same for designs 10 through 19.

-10 design indicates 210 bar (3000 psi) maximum supply pressure.

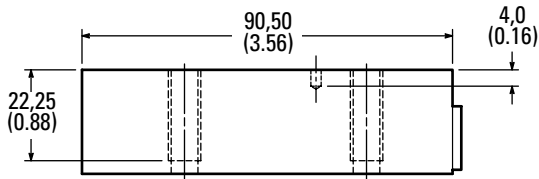
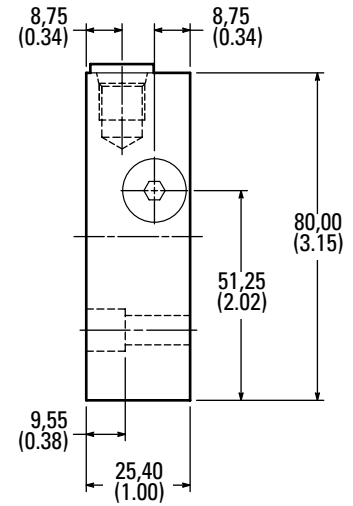
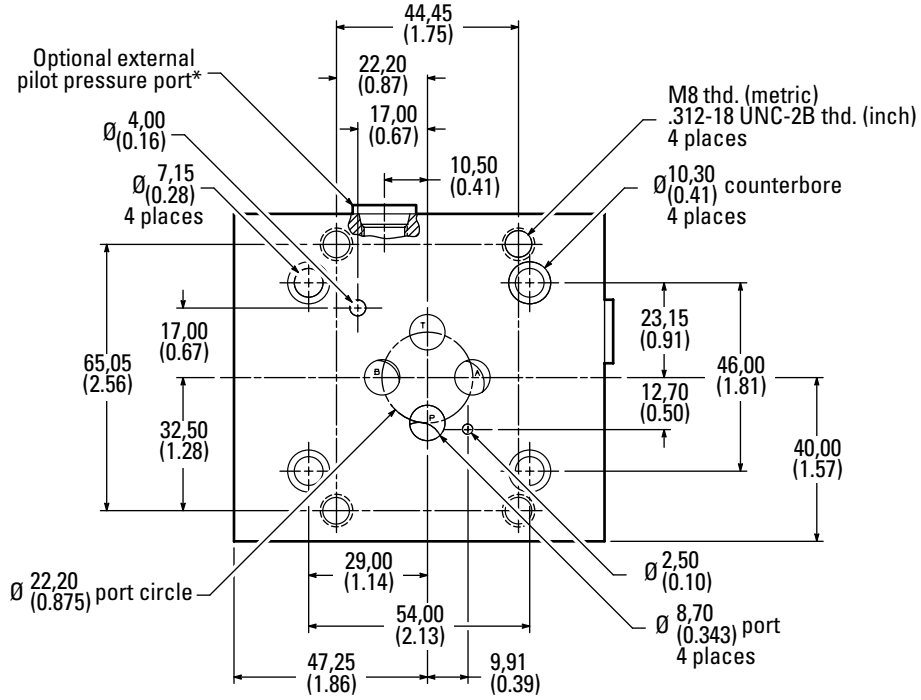
6 Metric Suffix

M – Metric version to NG (ISO) standards

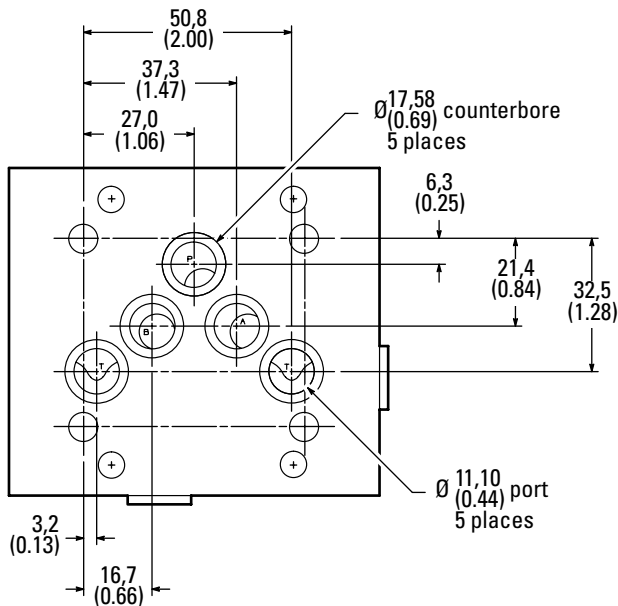
Blank – Omit if not required

Installation Dimensions

SM4A-5-20-10(M)



* - 6,35 (0.25) O.D. tube
 G 1/4 (metric)
 .4375-20 UNF-2B thd. (inch)

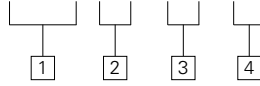


Dimensions in inches (mm)

Model Code

SM4FV Flushing Valves

SM4 FV - 20 - 10



1 Series Designation

SM4 – Servovalve, high performance, four-way

2 Accessory Designation

FV – Flushing valve. Maximum flushing pressure of 35 bar (500 psi).

4 Design Number

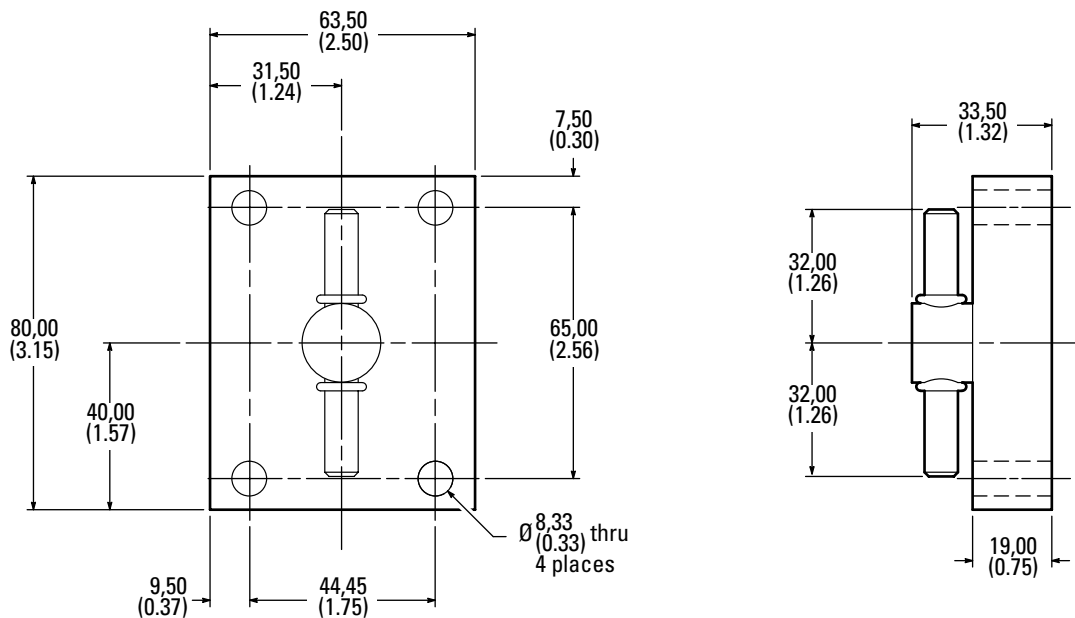
Subject to change. Installation dimensions same for designs 10 through 19.

3 Standard SM4 Valve Size

20 – SM4-20 or SP4-25

Installation Dimensions

SM4FV-20-10

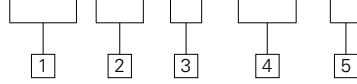


Dimensions in inches (mm)

Model Code

SM4FM Filter Modules

SM4 FM - 20 - (CB) - **



1 Series Designation

SM4 – Servovalve, high performance, four-way

2 Accessory Designation

FM – Filter module. Maximum supply pressure of 210 bar (3000 psi).

3 Standard SM4 Valve Size

20 – SM4-20 or SP4-25

4 Crossport bleed designation

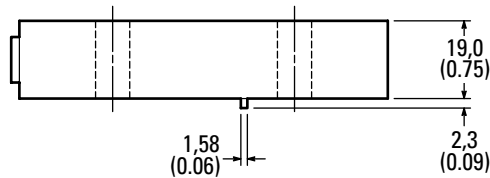
CB – Includes crossport bleed feature

Blank – Omit if not required

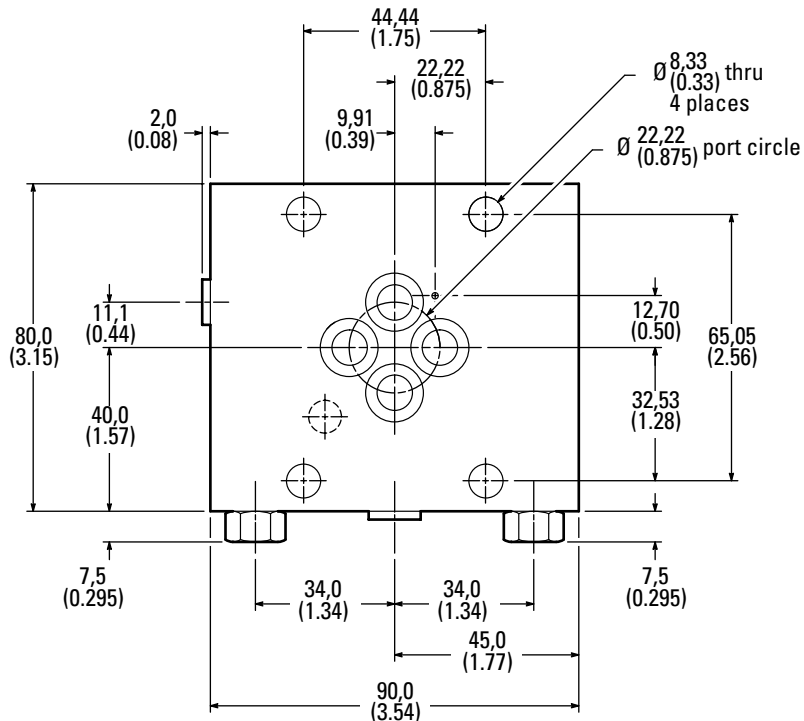
5 Design Number

Subject to change. Installation dimensions same for designs 10 through 19.

Installation Dimensions



SM4FM-20-10



Dimensions in inches (mm)

Weights

The following table lists approximate dry weights for SM4 servo valves and related accessories.

DESCRIPTION	MODEL CODE	WEIGHT
		kg (lbs.)
Servovalve	SM4-20	1,05 (2.3)
Mounting subplate	SM4M(E)-20-10(M)	0,91 (2.0)
Adapter manifold	SM4A-5-20-10(M)	0,439 (0.97)
Flushing valve	SM4FV-20-10(M)	0,27 (0.58)
Filter module	SM4FM-20-(CB)-10	0,73 (1.6) est.

Additional Accessories

SM4-20 (-10 DESIGN) ACCESSORIES	MODEL CODE
Adapter manifold mounting bolt kit (inch) 1/4–20 x 1"	BK866686
Adapter manifold mounting bolt kit (metric) M6 x 25mm	BK689629M
Cable clamp (MS3057-6)	126058
Cable connector (MS3106-14S-2S)	242123
Connector kit 926467	
Cross-port bleed module mounting bolt kit (inch) 5/16–18 x 23/4"	BK855421
Filter kit	926469
Filter module kit	886819
Filter module mounting bolt kit (inch) 5/16–18 x 23/4"	BK855421
Filter module mounting bolt kit (metric) M8 x 70mm	BK689624M
Filter module with cross-port bleed mounting bolt kit (inch) 5/16–18 x 31/4"	BK927736
Flushing valve mounting bolt kit (inch) 5/16–18 x 11/4"	BK688701
Flushing valve mounting bolt kit (metric) M8 x 35mm	BK689630M
Seal kit (SM4-20)	920320
Subplate mounting bolt kit (inch) 1/4–20 x 11/2"	BK855992
Subplate mounting bolt kit (metric) M6 x 40mm	BK855993M
Valve mounting bolt kit (inch) 5/16–18 x 2"	BK866687
Valve mounting bolt kit (metric) M8 x 50mm	BK866690M

Servo Electronics

See application brochure 656 for the complete Eaton Vickers® line of amplifiers, power supplies, and function modules.

Application Data

Fluid Cleanliness

Proper fluid condition is essential for long and satisfactory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials, and additives for protection against wear of components, elevated viscosity and inclusion of air.

Essential information on the correct methods for treating hydraulic fluid is included in Eaton publication 561 "Vickers Guide to Systemic Contamination Control," available from your local Eaton distributor. Recommendations on filtration and the selection of products to control fluid condition are included in 561.

Recommended cleanliness levels, using petroleum oil under common conditions, are based on the highest fluid pressure levels in the system and are coded in the

chart below. Fluids other than petroleum, severe service cycles, or temperature extremes are cause for adjustment of these cleanliness codes. See Eaton publication 561 for exact details.

Eaton products, as any components, will operate with apparent satisfaction in fluids with higher cleanliness codes than those described. Other manufacturers will often recommend levels above those specified. Experience has shown, however, that life of any hydraulic component is shortened in fluids with higher cleanliness codes than those listed below. These codes have been proven to provide a long, trouble-free service life for the products shown, regardless of the manufacturer.

NOTE

Eaton will extend, by one year, the standard warranty on all Eaton products used in a system protected by Eaton filters (and elements) applied in a manner consistent with the principles presented in Eaton publication 561.

PRODUCT	SYSTEM PRESSURE LEVEL BAR (PSI)		
	<70 (<2000)	70–207 (2000–3000)	207+ (3000+)
Vane pumps, fixed	20/18/15	19/17/14	18/16/13
Vane pumps, variable	18/16/14	17/15/13	
Piston pumps, fixed	19/17/15	18/16/14	17/15/13
Piston pumps, variable	18/16/14	17/15/13	16/14/12
Directional valves	20/18/15	20/18/15	19/17/14
Proportional valves	17/15/12	17/15/12	15/13/11
Servo valves	16/14/11	16/14/11	15/13/10
Pressure/Flow controls	19/17/14	19/17/14	19/17/14
Cylinders	20/18/15	20/18/15	20/18/15
Vane motors	20/18/15	19/17/14	18/16/13
Axial piston motors	19/17/14	18/16/13	17/15/12

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Powering Business Worldwide

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Printed in USA
Document No. V-VLPO-MC009-E
September 2008

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Vickers®

Servo Valves



SM4-20 (-50 Design) Servovalves

Flows to 76 l/min (20 USgpm) — Pressures to 350 bar (5000 psi)



Introduction

Vickers SM4-20 (-50 design) servovalves can provide system closed loop control with exact positional accuracy, repeatable velocity profiles, and predictable force or torque regulation. Typical applications include automatic gage control (AGC), roll bend/roll balance systems, plastic injection molding systems, test and simulation equipment, and hydraulic press brakes.

The high performance SM4-20 (-50 design) offers a wide range of rated flows from 3,8 to 76 l/min (1.0 to 20 USgpm) at Δp of 70 bar (1000 psi). The -50 design valve is designed for a maximum supply pressure of 350 bar (5000 psi).

The SM4-20 (-50 design) is a two-stage, modular design, flow control valve which can be manifold or subplate mounted.

The first stage consists of a symmetrical torque motor with dual coils and quad air gaps, flapper-nozzle pilot, and a centering feedback spring. An integral 35 micron absolute filter reduces sensitivity to contamination of the first stage.

The second stage utilizes a four-way sliding spool and sleeve arrangement with a mechanical null adjust. Spool position is fed back to the first stage by means of a cantilever spring.

An SM4-20 (-50 design) servovalve — when used with a hydraulic cylinder, position transducer, and appropriate electronics — can provide infinite cylinder position control to within 0,025 mm (0.001 in) or better, depending on components selected, length of stroke, and load characteristics.

When applied with servo hydraulic motors using tachometers and appropriate electronics, the SM4 provides infinite proportional flow control for realtime velocity/acceleration profiles. The resulting closed loop system can be error corrected to within one-tenth of a revolution per minute. With appropriate pressure transducers or load cells in force control applications, the SM4-20 (-50 design) makes possible exact load pressure/force control. In addition, excellent system stability with pressure and load to $\pm 1\%$ full scale can be achieved.

The field-proven design of the SM4-20 (-50 design) servovalve, combined with Vickers precision manufacturing techniques, provides you with the optimum in system control.

Features and Benefits

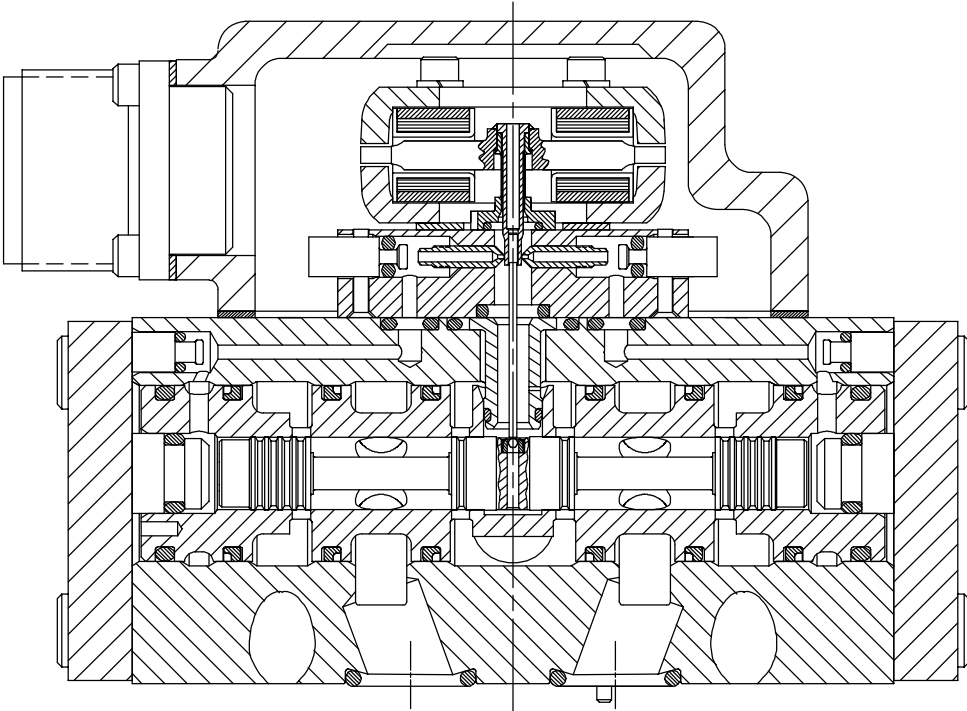
- The SM4-20 (-50 design) features a special stainless steel body and end caps for operating pressures up to 350 bar (5000psi).
- An integral filter for extra first stage contamination protection greatly reduces the likelihood of hard-over failures.
- Higher frequency response is available on request. This provides enhanced system bandwidth for critical performance requirements.
- The wide range of SM4-20 (-50 design) flow capabilities allow selection of the valve size best suited for an application.
- Jeweled orifices greatly extend the life of the valve.
- The balanced dual-coil, twin air gap, sealed torque motor in Vickers servovalves with its extremely fast response to input signals results in highly accurate control profiles.
- The exclusive jeweled feedback ball receiver virtually eliminates the wear that can lead to loss of control across null in other servovalves.
- Viton* seals are standard.
- The interchangeability made possible by standardized valve port circles, mounting patterns, and adapter manifolds makes Vickers servovalves the perfect choice for cost effective enhancement of existing systems.
- The SM4-20 (-50 design) can be interfaced to an available dual filter module to provide extra protection against pilot stage contamination.
- Customized spool lap and sleeve porting are available to provide the specific flow control required for special applications.
- The spool and sleeve are made of hardened steel and mounted with O-rings to minimize material erosion and eliminate spool binding, thus ensuring smooth operation.
- The SM4-20 (-50 design) is available with an optional pilot pressure port that provides either additional first stage filtration or the use of external pilot pressure for freedom from supply pressure fluctuations.
- Flushing valves are available to reduce initial system contamination levels prior to SM4 installation.

* Viton is a registered trademark of the DuPont Co.

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Cross Section of Typical SM4-20 (-50 Design) Servovalve



Operating Data

Flow and Leakage

All data is typical, based on actual tests at 70 bar (1000 psi) Δp , 30 cST (141 SUS), and 49°C (120°F).

Model Series	Maximum Rated Flow $\pm 10\%$ l/min (USgpm)	Maximum Total Null Leakage l/min (USgpm)	Maximum Pilot Flow at 70 bar (1000 psi) Δp l/min (USgpm)
SM4-20 (-50 design)	76 (20)	2,00 (0.52)	0,35 (0.092)

Performance

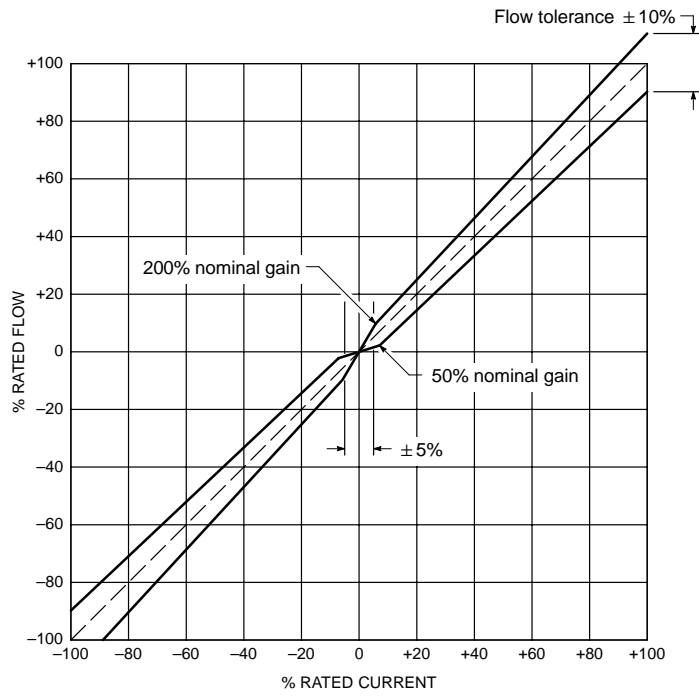
Maximum Supply Pressure bar (psi)	350 (5000)
Minimum Supply Pressure bar (psi)	14 (200)
Proof Pressure % maximum supply pressure	At Supply Port: 150 At Return Port: 100
Burst Pressure, Return Port Open % maximum supply pressure	250
Maximum Operating Temperature °C (°F)	135 (275)
Hysteresis Around Null % of rated current	≤ 3
Symmetry Error % of rated current	< 10
Linearity Error % of rated current	< 10
Threshold % of rated current	≤ 0.5

Ruggedness Test Results

Vibration Test 5 Hz to 2000 Hz along each axis	No damage to components
Shock Test Up to 150g along all axes	No damage to components
Endurance Test To ISO 6404	No degradation in performance

Flow Gain

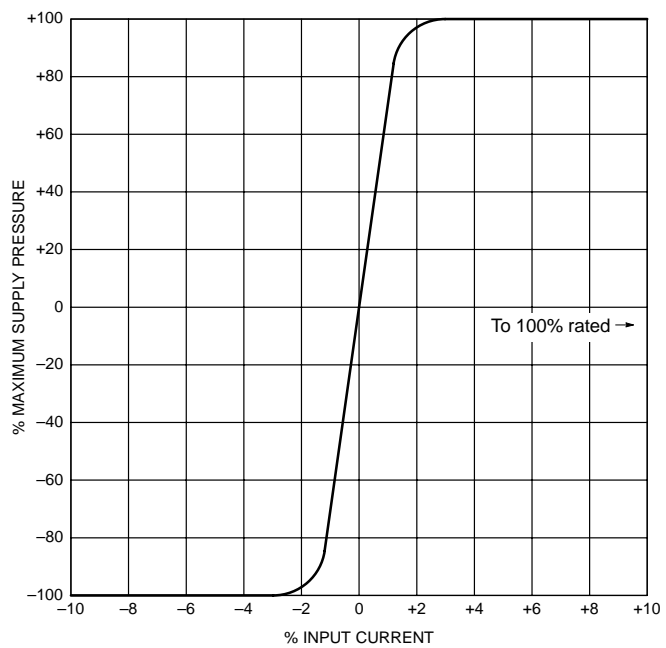
Normal region for standard models shown with typical no-load flow gain tolerances excluding hysteresis.



Pressure Gain

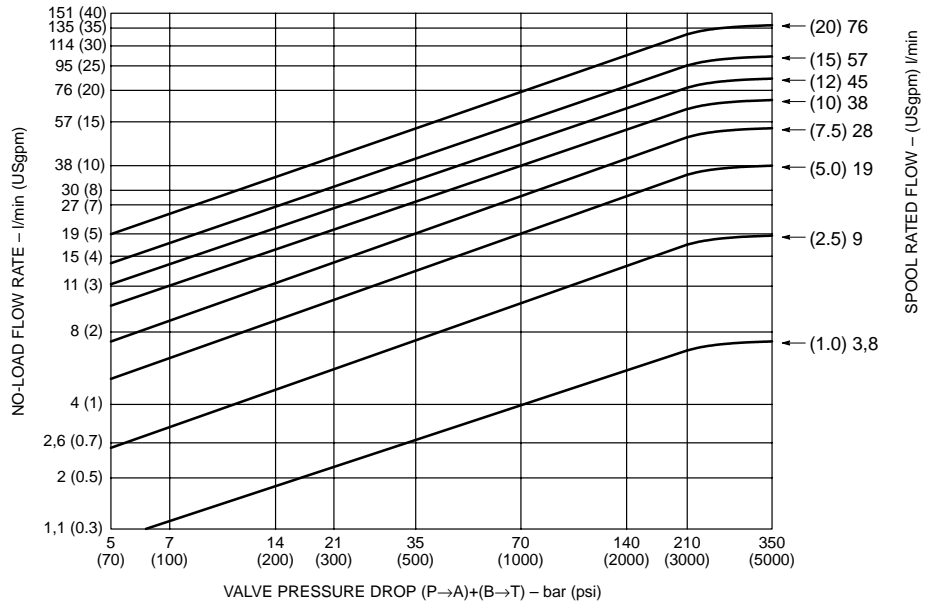
Change in load pressure drop with input current shown with no valve flow and closed control ports.

Pressure gain in the null region is $>30\%$ of supply pressure per 1% of rated current.



Change in Rated Flow

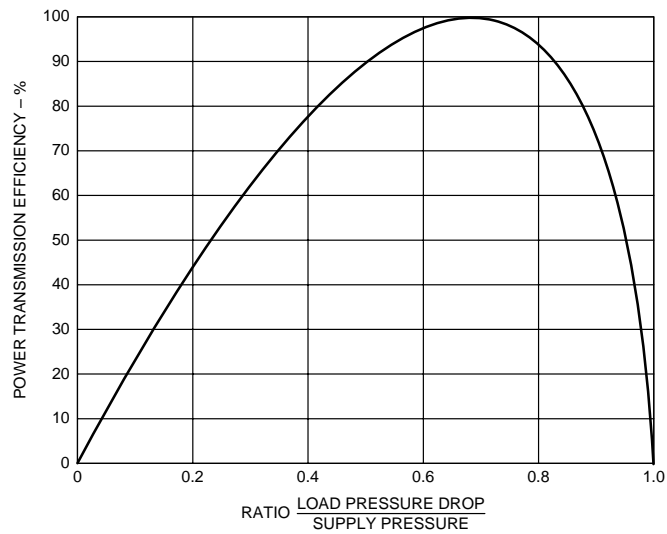
Rated flows at valve pressure drops from 5 bar (70 psi) to 350 bar (5000 psi) for eight of the available spools.



Power Transmission Efficiency

Maximum power envelope expressed as a percentage with T port pressure equal to 0 bar.

Power transferred to the load is optimum when valve pressure drop is one third of supply pressure. Load pressure drop should be limited to $\frac{2}{3}$ of supply pressure so the flow gain of the servovalve remains high enough to maintain control of the load. Overall hydraulic efficiency must be considered when sizing system heat exchangers.



Coil Resistance

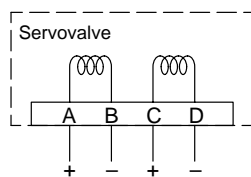
Select coil resistance and connections for compatible interface to servo electronics. **Recommended coil resistance is shown in bold print.**

	Nominal Resistance Per Coil at 21°C (70°F) Ohms	Rated Current mA	
		Single, Parallel, or Differential Connection	Series Connection
Standard coil resistance selection	20	200	100
	30	100	50
	80	40	20
	200	20	10
Optional coil resistance selection	80	50	25
	140	40	20
	200	15	7.5
	300	30	15
	1000	10	5
	1500	8	4

Electrical Polarity for Control Flow Out of B Port

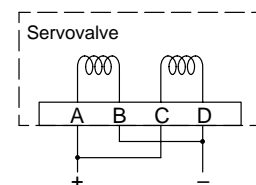
Single:

A+, B-
or
C+, D-



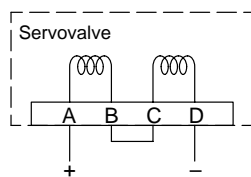
Parallel:

A+, C+
B-, D-
Connect A and C
Connect B and D



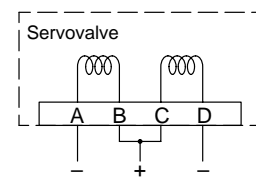
Series:

A+, D-
Connect B and C



Differential:

A-, D-
B+, C+
Connect B and C
BC-, current BA>CD
BC+, current CD>BA



Performance Curves

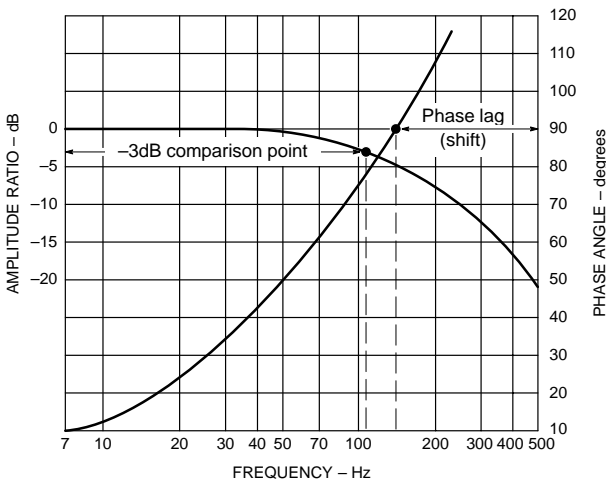
Frequency Response

Frequency response is defined as the relationship of no-load control flow to input current with a sinusoidal current sweep at constant amplitude over a range of frequencies. It is expressed in frequency (Hz), amplitude ratio (dB), and phase angle (degrees).

Vickers SM4 torque motors are magnetically stabilized for reliable servovalve performance at operating pressures from 14 to 350 bar (200 to 5000 psi).

As shown in the sample curve (below left), the standard comparison point is -3 dB amplitude ratio, and 90° phase angle is a measure of the servovalve bandwidth.

Frequency response is lower for increased valve flow rates because of changes in internal design, such as spool and sleeve diameters, flapper nozzle assembly, and feedback spring rates.



Calculating Frequency Response at System Pressure

P_S = System pressure

P_M = Reference pressure of valve:
210 bar (3000 psi) for SM4-20 (-50 design)

f_{PM} = Frequency (at 90° phase angle) at reference pressure (P_M)

f_{PS} = Frequency (at 90° phase angle) at system pressure (P_S)

1. Calculate the ratio of system pressure to reference pressure:

$$\frac{P_S}{P_M}$$

2. Use the result of step 1 and the curve below to estimate

$$\frac{f_{PS}}{f_{PM}}$$

3. Use the applicable frequency response curve from the following pages to estimate f_{PM} (the reference pressure frequency response at 90° phase angle) for the desired valve rated flow.

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

Example: An SM4-20-50 valve with a flow of 38 l/min (10 USgpm) is to be used at 275 bar (4000 psi).

1. Calculate the ratio of system pressure to reference pressure:

$$\frac{P_S}{P_M} = \frac{4000 \text{ psi}}{3000 \text{ psi}} = 1.33$$

2. Use the result of step 1 and the curve below right to estimate

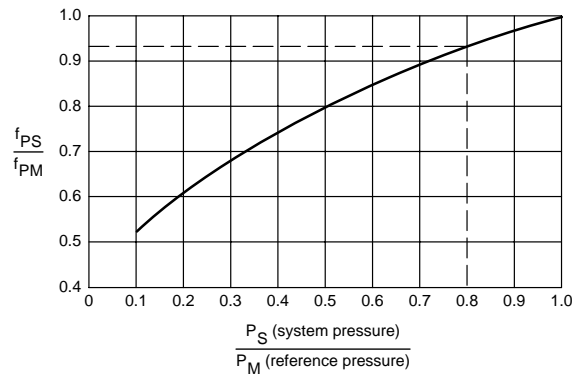
$$\frac{f_{PS}}{f_{PM}} = 1.1$$

3. Use the frequency response curve from page 7 to estimate f_{PM} .

$$f_{PM} = 120 \text{ Hz}$$

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

$$f_{PS} = 1.1 \times 120 \text{ Hz} = 135 \text{ Hz}$$



Typical Frequency Response Curves for Standard Models

SM4-20 (-50 design) shown at 210 bar (3000 psi) reference pressure

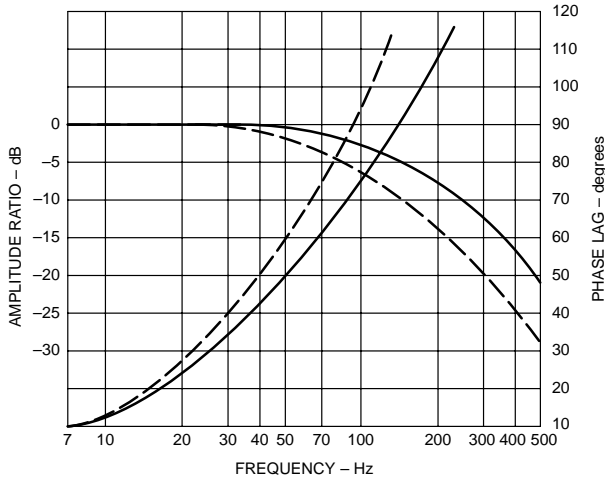
3,8 l/min (1.0 USgpm)

9 l/min (2.5 USgpm)

19 l/min (5.0 USgpm)

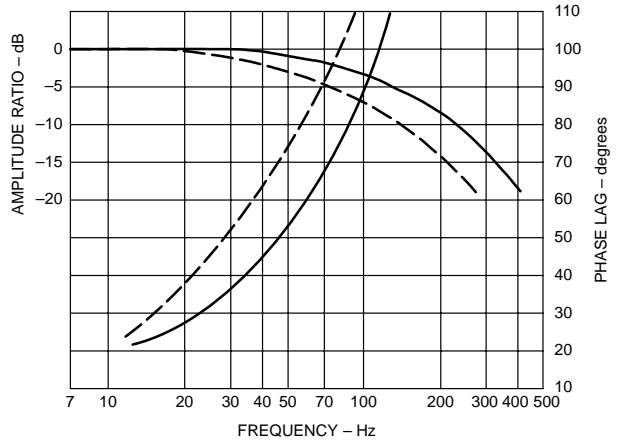
28 l/min (7.5 USgpm)

— $\pm 40\%$ rated current
 - - - $\pm 100\%$ rated current



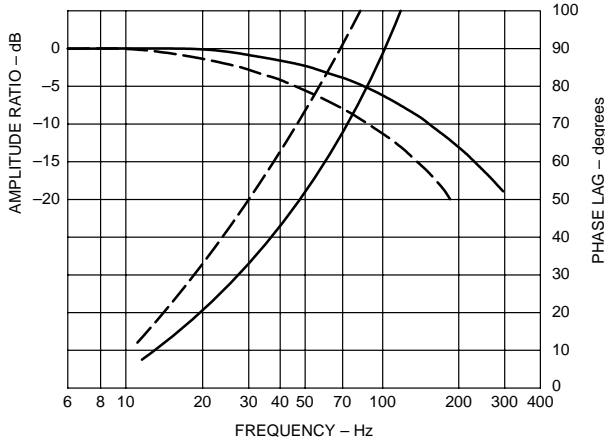
38 l/min (10 USgpm)

— $\pm 40\%$ rated current
 - - - $\pm 100\%$ rated current



47 l/min (12.5 USgpm)

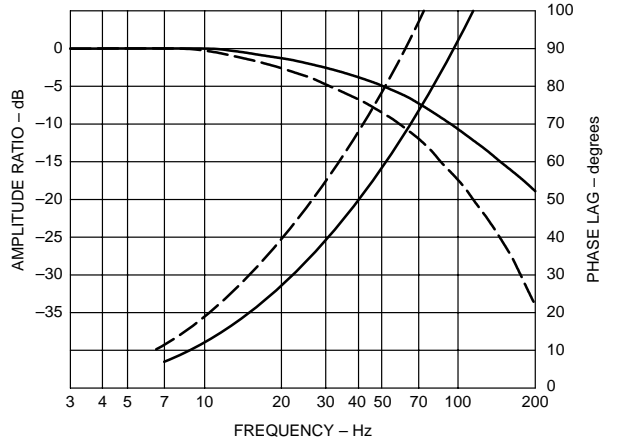
— $\pm 40\%$ rated current
 - - - $\pm 100\%$ rated current



57 l/min (15 USgpm)

76 l/min (20 USgpm)

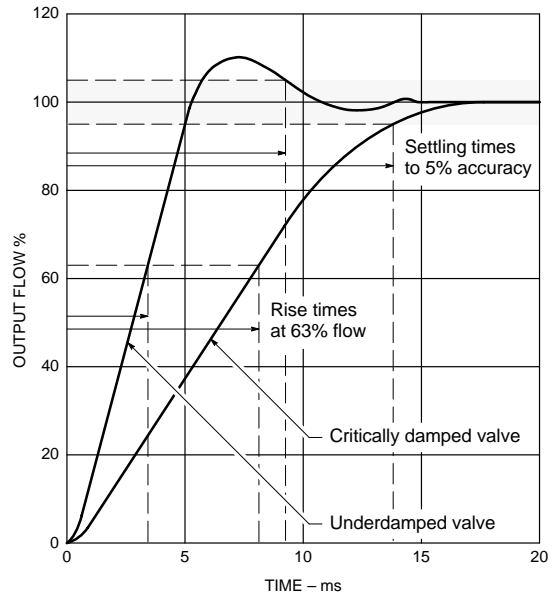
— $\pm 40\%$ rated current
 - - - $\pm 100\%$ rated current



Step Response

Step response is defined as the typical rise time needed to achieve a given percentage of control flow output. Settling time is the time needed for transient flow fluctuations to diminish to within a given accuracy range. Both are expressed in milliseconds (ms).

The example shows the step response curves for a critically damped valve and an underdamped valve. Rise times are illustrated for 63% of control flow output, and settling times are shown at $100 \pm 5\%$ of control flow output.

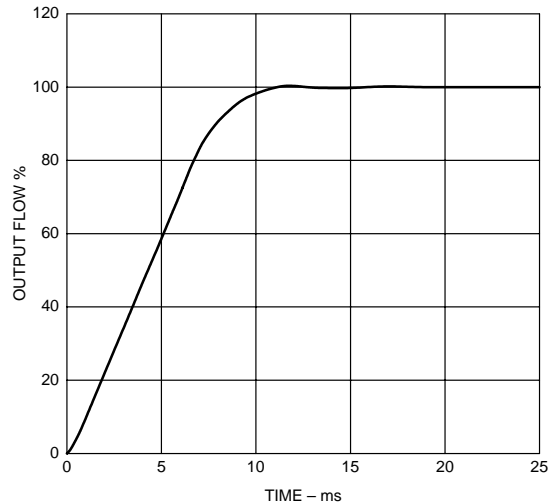
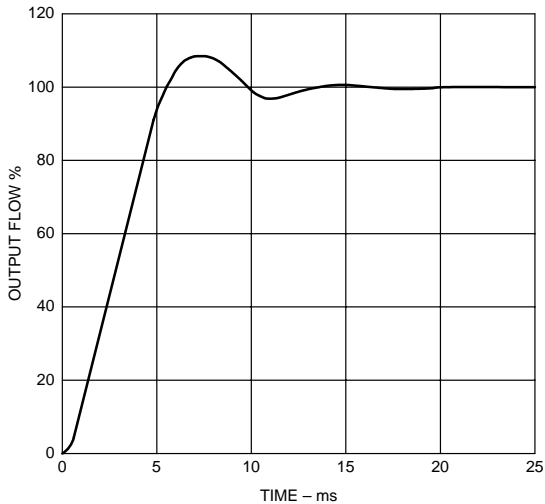


Typical Step Response Curves for Standard Models

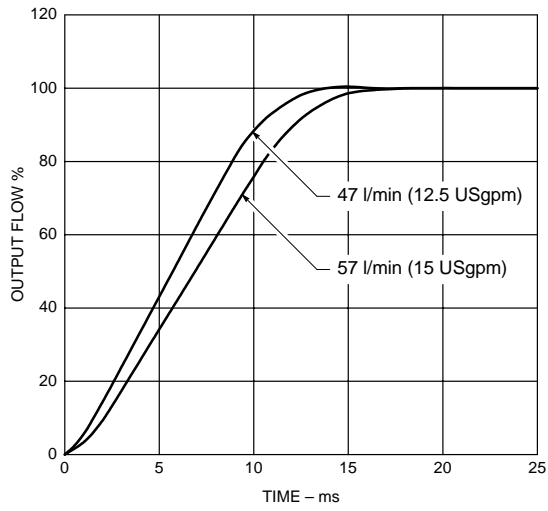
SM4-20 shown at 210 bar (3000 psi) reference pressure

3,8 l/min (1.0 USgpm)
 9 l/min (2.5 USgpm)
 19 l/min (5.0 USgpm)
 28 l/min (7.5 USgpm)

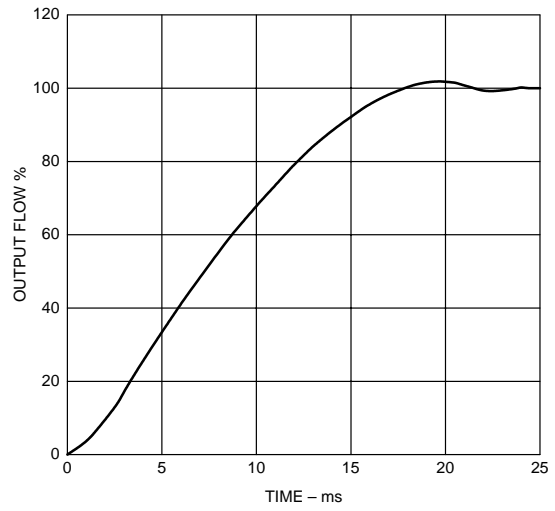
38 l/min (10 USgpm)



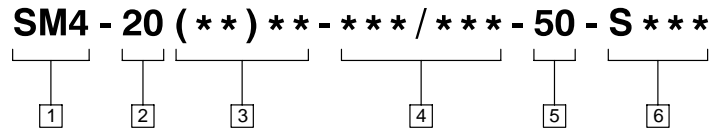
47 l/min (12.5 USgpm)
57 l/min (15 USgpm)



76 l/min (20 USgpm)



Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

2 Valve size

20 – 22,2 mm (0.875 in) port circle

3 Flow rating

At 70 bar (1000 psi) Δp P→A→B→T.
Other flows available on request.

Code	USgpm	l/min
(1) 3,8	1.0	3,8
(2.5) 9	2.5	9
(5) 19	5.0	19
(7.5) 28	7.5	28
(10) 38	10.0	38
(12) 45	12.0	45
(12.5) 47	12.5	47
(15) 57	15.0	57
(20) 76	20.0	76

4 Coil resistance/rated current

Ohms/mA at 21°C (70°F). Other coils available on request.

Code	Ohms	mA
20/200	20	200
30/100	30	100
80/40	80	40
80/50	80	50
140/40	140	40
200/15	200	15
200/20	200	20
300/30	300	30
1000/10	1000	10
1500/8	1500	8

5 Design number

Subject to change. Installation dimensions same for designs 50 through 59.

-50 design indicates 350 bar (5000 psi) maximum supply pressure.

6 Special features suffix

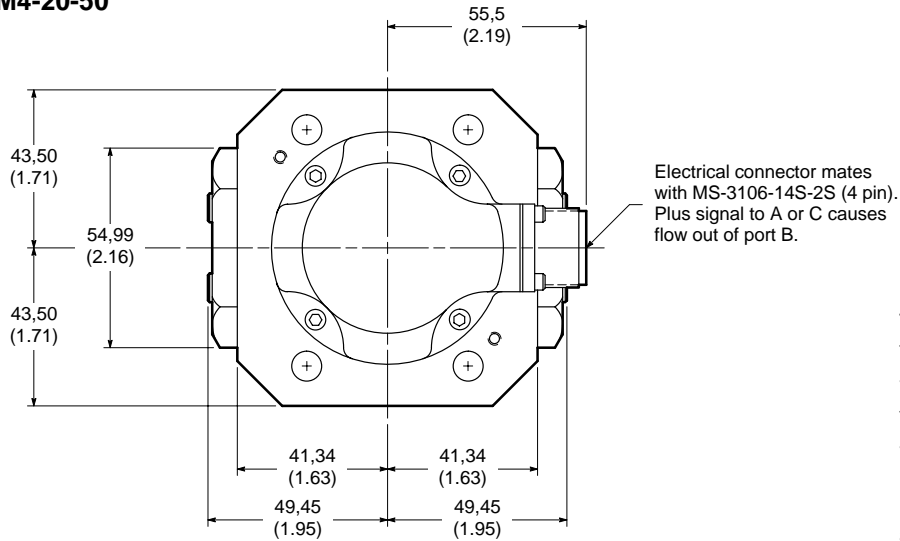
S*** – Vickers assigns a unique suffix to denote a particular group of customized features. Contact your Vickers representative for details.

Blank – Standard valve

Installation Dimensions

millimeters (inches)

SM4-20-50

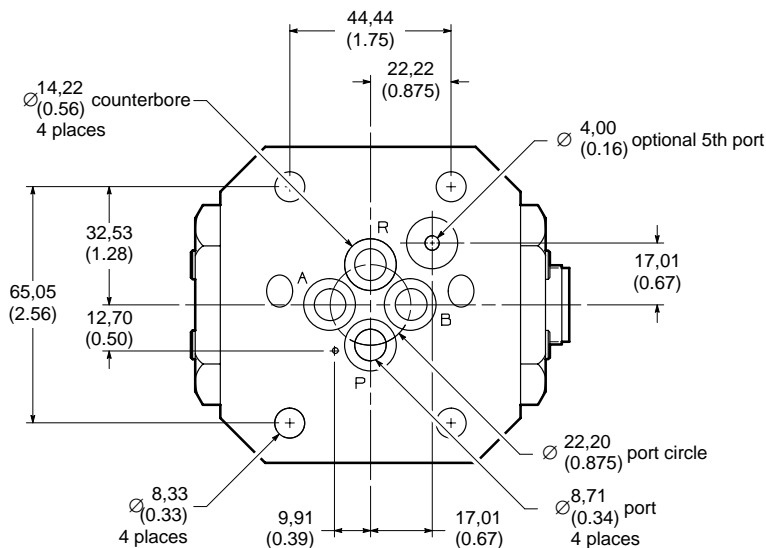
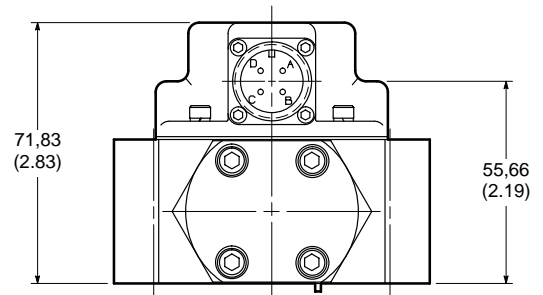
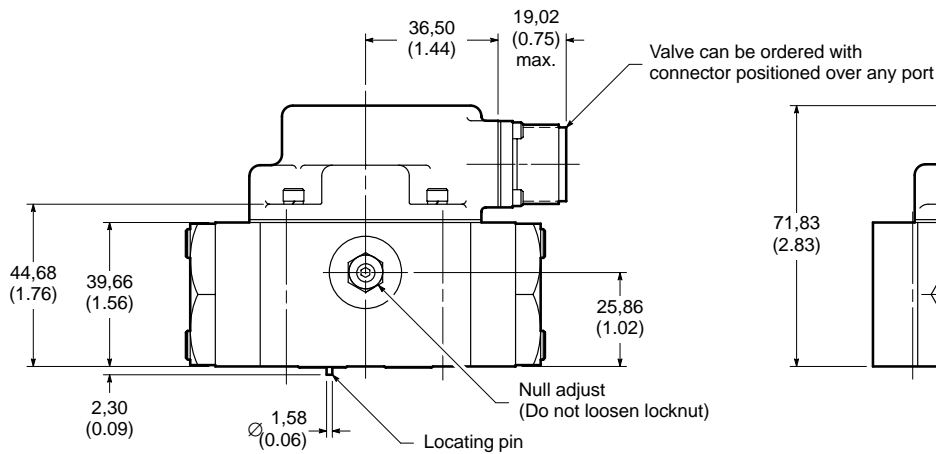


NOTES

Torque mounting screws to 14 to 15 Nm (120 to 130 lb.in.).

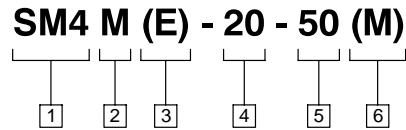
Valve mounting surface requires 32 microinch finish flat within 0,025 (0.001).

Viton port O-rings (AS568-013) provided: 1,78 (0.070) cross section and 10,82 (0.426) inner diameter. Replacement O-rings available in seal kit 920320 only.



SM4M(E) Mounting Subplates

Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

3 Port connection locations

Blank – Rear ports
E – Side ports

5 Design number

Subject to change. Installation dimensions same for designs 50 through 59.

2 Accessory designation

M – Mounting subplate. Maximum supply pressure of 350 bar (5000 psi).

4 Standard SM4 valve size

20 – SM4-20

-50 design indicates 350 bar (5000 psi) maximum supply pressure.

6 Metric suffix

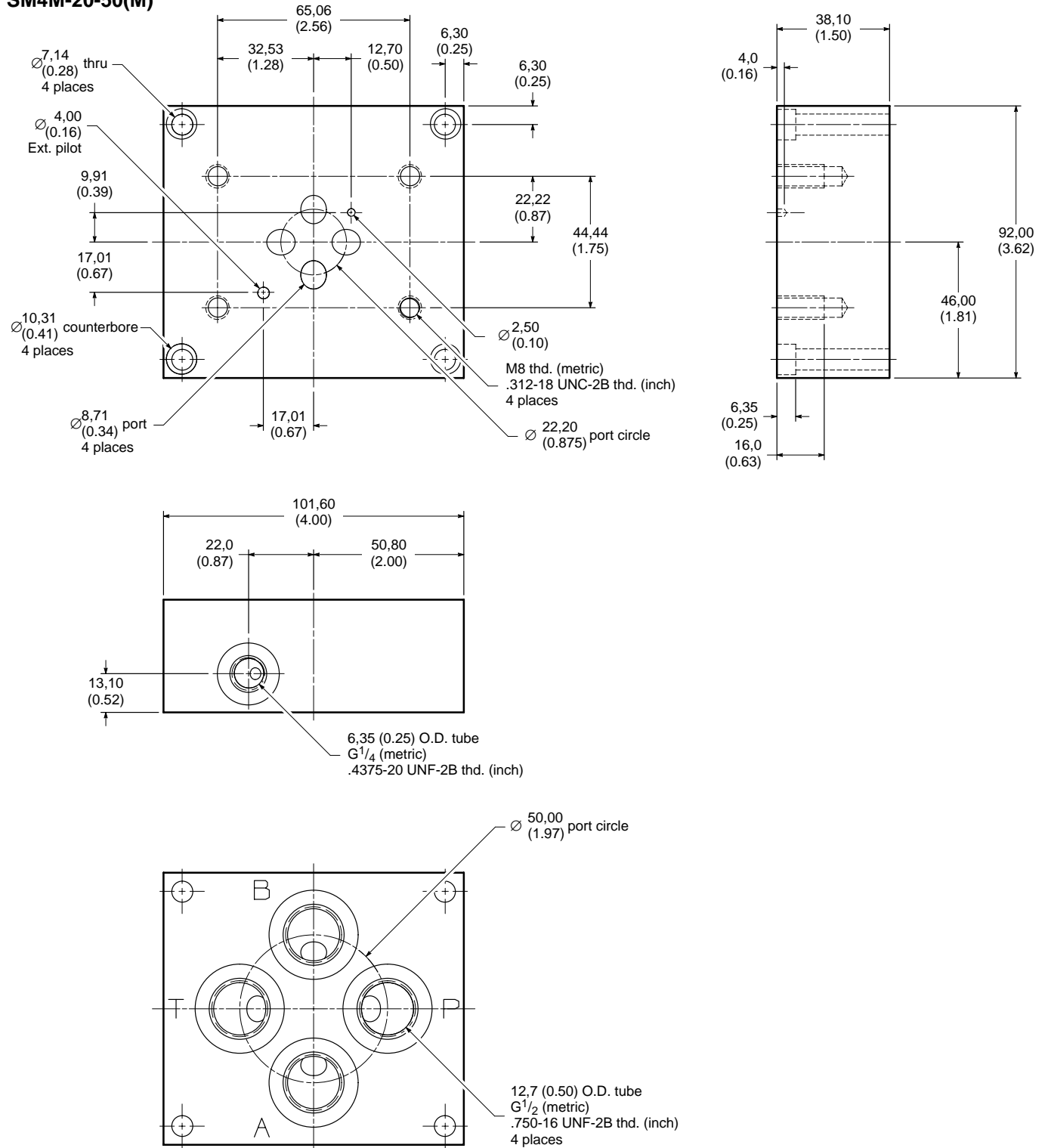
M – Metric version to NG (ISO) standards
Blank – Omit if not required

SM4M(E) Mounting Subplates

Installation Dimensions

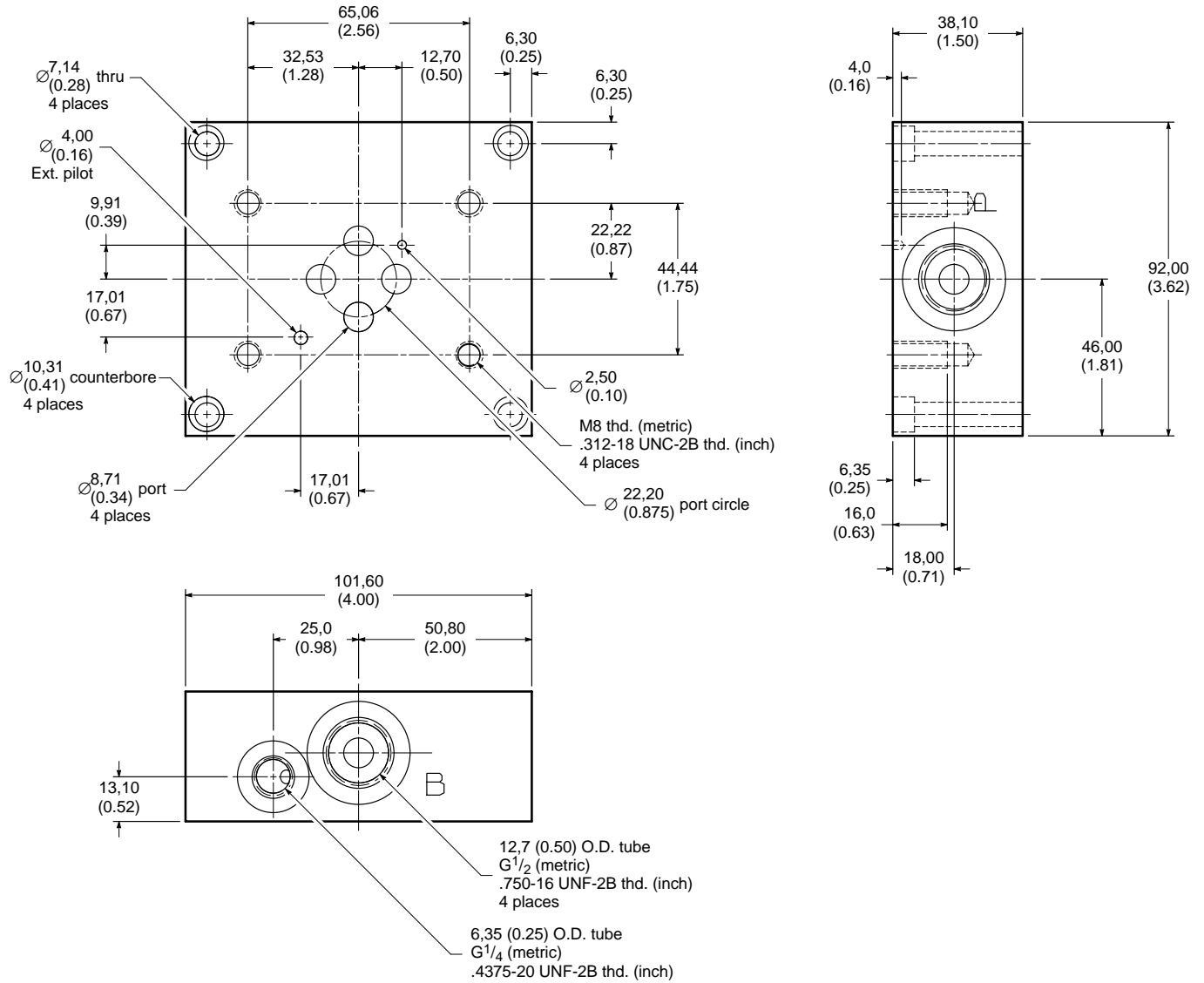
millimeters (inches)

SM4M-20-50(M)



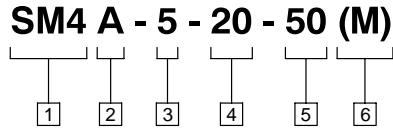
millimeters (inches)

SM4ME-20-50(M)



SM4A Adapter Manifolds

Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

2 Accessory designation

A – Adapter manifold. Maximum supply pressure of 350 bar (5000 psi).

3 Interface

5 – ISO 4401-05

4 Standard SM4 valve size

20 – SM4-20

5 Design number

Subject to change. Installation dimensions same for designs 50 through 59.

-50 design indicates 350 bar (5000 psi) maximum supply pressure.

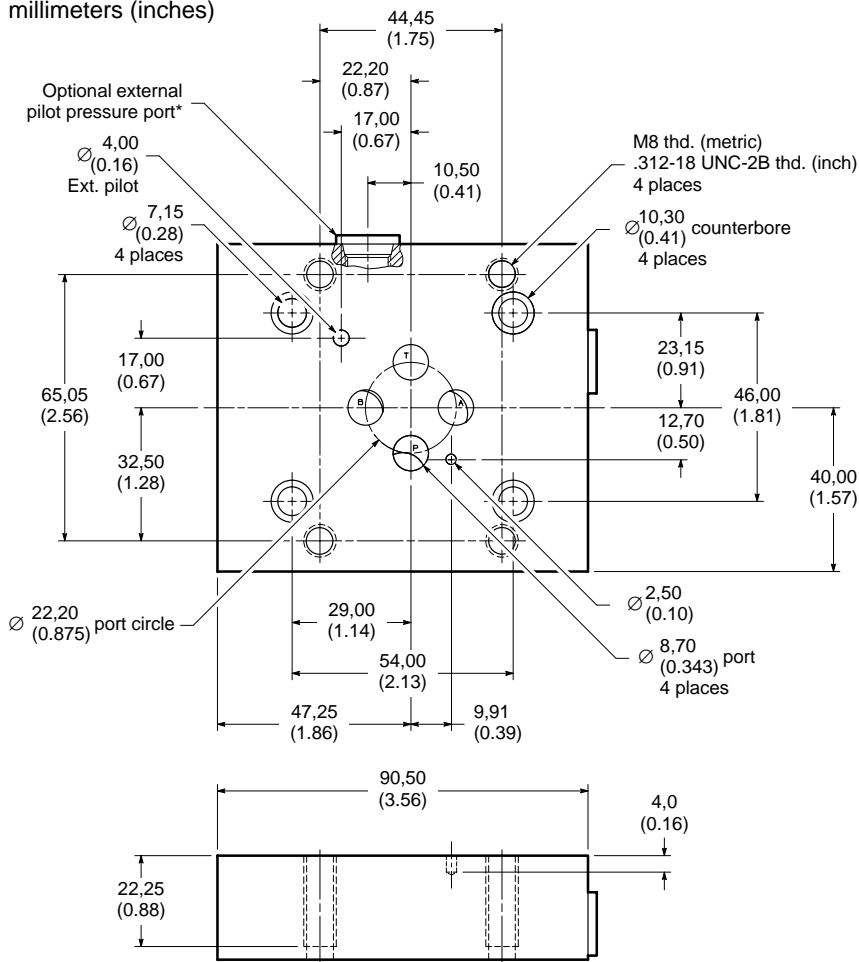
6 Metric suffix

M – Metric version to NG (ISO) standards

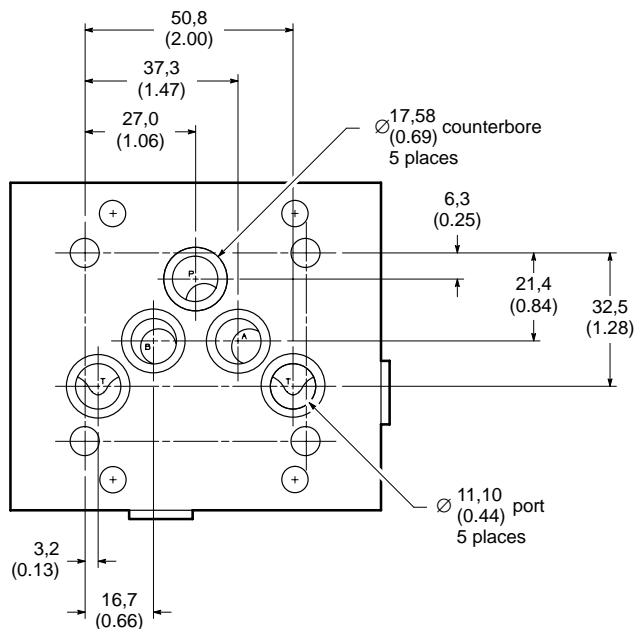
Blank – Omit if not required

Installation Dimensions

millimeters (inches)



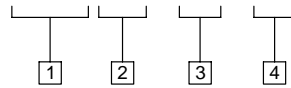
* - 6,35 (0.25) O.D. tube
 G¹/₄ (metric)
 .4375-20 UNF-2B thd. (inch)



SM4FV Flushing Valves

Model Code

SM4 FV - 20 - 10



1 Series designation

SM4 – Servovalve, high performance, four-way

2 Accessory designation

FV– Flushing valve. Maximum flushing pressure of 35 bar (500 psi).

4 Design number

Subject to change. Installation dimensions same for designs 10 through 19.

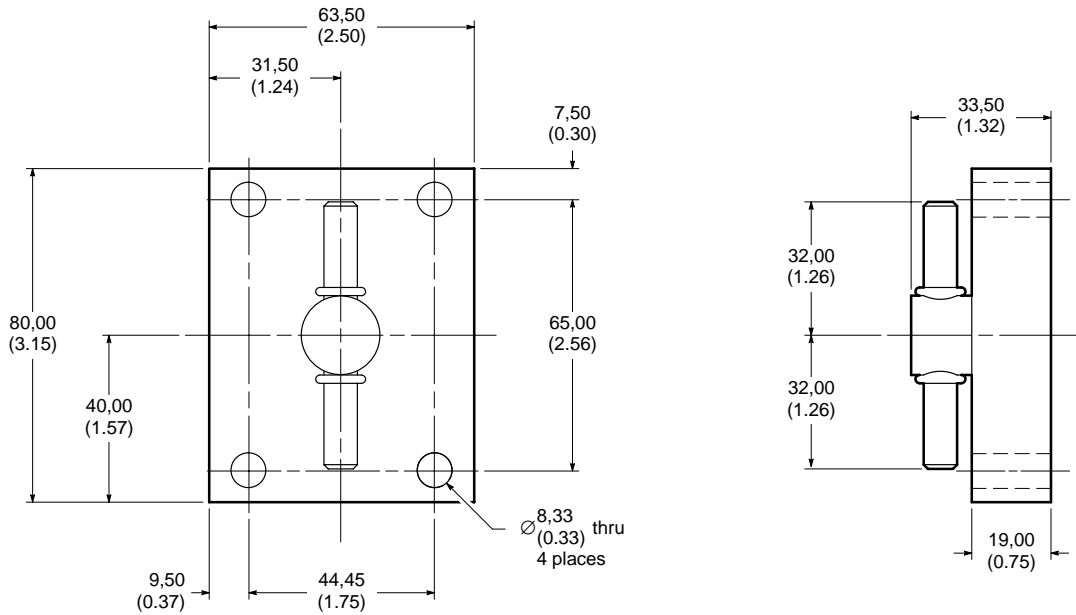
3 Standard SM4 valve size

20 – SM4-20

Installation Dimensions

millimeters (inches)

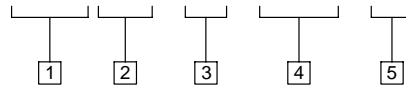
SM4FV-20-10



SM4FM Filter Modules

Model Code

SM4 FM - 20 - (CB) - 50



1 Series designation

SM4 – Servovalve, high performance, four-way

3 Standard SM4 valve size

20 – SM4-20

5 Design number

Subject to change. Installation dimensions same for designs 50 through 59.

2 Accessory designation

FM – Filter module. Maximum supply pressure of 350 bar (5000 psi).

4 Crossport bleed designation

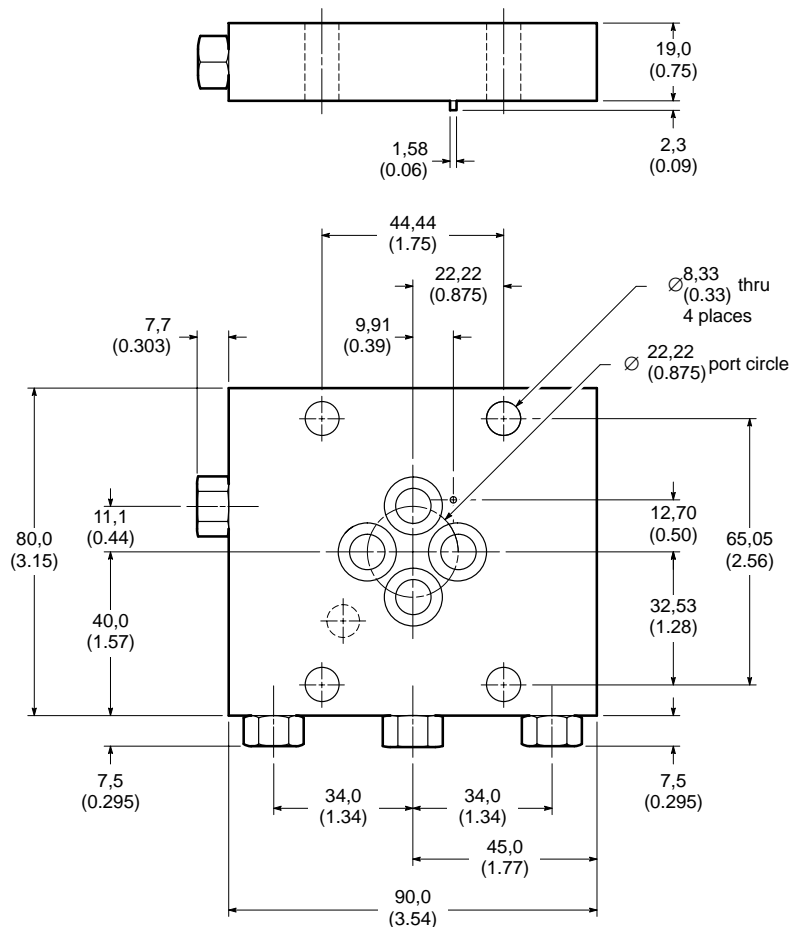
CB – Includes crossport bleed feature
Blank – Omit if not required

-50 design indicates 350 bar (5000 psi) maximum supply pressure.

Installation Dimensions

millimeters (inches)

SM4FM-20-50



Weights

The following table lists approximate dry weights for the SM4-20 (-50 design) and related accessories.

Description	Model Code	Weight kg (lbs.)
Servo valve	SM4-20 (-50 design)	2,1 (4.6)
Mounting subplate	SM4M(E)-20-50(M)	0,91 (2.0)
Adapter manifold	SM4A-5-20-50(M)	0,44 (0.97)
Flushing valve	SM4FV-20-10	0,27 (0.58)
Filter module	SM4FM-20-(CB)-50	0,73 (1.6) est.

Additional Accessories

SM4-20 (-50 design) Accessories	Model Code
Adapter manifold mounting bolt kit (inch) $\frac{1}{4}$ -20 x 1"	BK866686
Adapter manifold mounting bolt kit (metric) M6 x 25mm	BK689629M
Cable clamp (MS3057-6)	126058
Cable connector (MS3106-14S-2S)	242123
Connector kit	926467
Cross-port bleed module mounting bolt kit (inch) $\frac{5}{16}$ -18 x $2\frac{3}{4}$ "	BK855421
Filter kit	926469
Filter module kit	886819
Filter module mounting bolt kit (inch) $\frac{5}{16}$ -18 x $2\frac{3}{4}$ "	BK855421
Filter module mounting bolt kit (metric) M8 x 70mm	BK689624M
Filter module with cross-port bleed mounting bolt kit (inch) $\frac{5}{16}$ -18 x $3\frac{1}{4}$ "	BK927736
Flushing valve mounting bolt kit (inch) $\frac{5}{16}$ -18 x $1\frac{1}{4}$ "	BK688701
Flushing valve mounting bolt kit (metric) M8 x 35mm	BK689630M
Seal kit (SM4-20)	920320
Subplate mounting bolt kit (inch) $\frac{1}{4}$ -20 x $1\frac{1}{2}$ "	BK855992
Subplate mounting bolt kit (metric) M6 x 40mm	BK855993M
Valve mounting bolt kit (inch) $\frac{5}{16}$ -18 x 2"	BK866687
Valve mounting bolt kit (metric) M8 x 50mm	BK866690M

Servo Electronics

See application brochure 656 for the complete Vickers line of amplifiers, power supplies, and function modules.

Application Data

Fluid Cleanliness

Proper fluid condition is essential for long and satisfactory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials, and additives for protection against wear of components, elevated viscosity and inclusion of air.

Essential information on the correct methods for treating hydraulic fluid is included in Vickers publication 561 "Vickers Guide to Systemic Contamination Control," available from your local Vickers distributor or by contacting Vickers, Incorporated. Recommendations on filtration and the

selection of products to control fluid condition are included in 561.

Recommended cleanliness levels, using petroleum oil under common conditions, are based on the highest fluid pressure levels in the system and are coded in the chart below. Fluids other than petroleum, severe service cycles, or temperature extremes are cause for adjustment of these cleanliness codes. See Vickers publication 561 for exact details.

Vickers products, as any components, will operate with apparent satisfaction in fluids with higher cleanliness codes than those described. Other manufacturers

will often recommend levels above those specified. Experience has shown, however, that life of any hydraulic component is shortened in fluids with higher cleanliness codes than those listed below. These codes have been proven to provide a long, trouble-free service life for the products shown, regardless of the manufacturer.

NOTE

Vickers will extend, by one year, the standard warranty on all Vickers products used in a system protected by Vickers filters (and elements) applied in a manner consistent with the principles presented in Vickers publication 561.

Product	System Pressure Level psi		
	<2000	2000–3000	3000+
Vane pumps, fixed	20/18/15	19/17/14	18/16/13
Vane pumps, variable	18/16/14	17/15/13	
Piston pumps, fixed	19/17/15	18/16/14	17/15/13
Piston pumps, variable	18/16/14	17/15/13	16/14/12
Directional valves	20/18/15	20/18/15	19/17/14
Proportional valves	17/15/12	17/15/12	15/13/11
Servo valves	16/14/11	16/14/11	15/13/10
Pressure/Flow controls	19/17/14	19/17/14	19/17/14
Cylinders	20/18/15	20/18/15	20/18/15
Vane motors	20/18/15	19/17/14	18/16/13
Axial piston motors	19/17/14	18/16/13	17/15/12

Eaton Hydraulics

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Telephone: (44) 170-548-6451
Fax: (44) 170-548-7110



Vickers®

Servo Valves



SM4-40 Servovalves

Flows to 151 l/min (40 USgpm) — Pressures to 350 bar (5000 psi)



Released 1/94

Introduction

Vickers SM4-40 servovalves can provide system closed loop control with exact positional accuracy, repeatable velocity profiles, and predictable force or torque regulation.

Typical applications include plastic injection molding and blow molding systems, test and simulation equipment, die casting machines, hydraulic press brakes, animation and entertainment equipment, oil exploration vehicles, and lumber machinery.

Applications of the 350 bar (5000 psi) SM4-40 (-50 design) include automatic gage control (AGC), roll bend/roll balance systems, plastic injection molding systems, test and simulation equipment, and hydraulic press brakes.

This model of the high performance SM4 series offers a wide range of rated

flows from 76 to 151 l/min (20 to 40 USgpm) at Δp of 70 bar (1000 psi).

The SM4 is a two-stage, modular design, flow control valve which can be manifold or subplate mounted. The symmetrical, dual coil, quad air gap torque motor is integrally mounted to the first stage nozzle flapper pilot valve with six screws. The second stage utilizes a four-way sliding spool and sleeve arrangement with a mechanical null adjust. Spool position is fed back to the first stage by means of a cantilever spring. An integral 35 micron (absolute) filter protects against contamination of the first stage.

An SM4 servovalve, used with a hydraulic cylinder, position transducer, and appropriate electronics, can provide infinite cylinder position control to within 0,025 mm (0.001 in) or better (depending

on component selection, length of stroke, and load characteristics).

When applied with servo hydraulic motors, tachometers, and appropriate electronics, the SM4 provides infinite proportional flow control for real-time velocity/acceleration profiles that can be closed loop error corrected to within one-tenth of a revolution per minute. With appropriate pressure transducers or load cells, cylinders, and proper electronics in force control applications, the SM4 offers exact load pressure/force control and excellent system stability with pressure and load to $\pm 1\%$ full scale.

The field-proven design of the SM4-40 servovalve, combined with Vickers precision manufacturing techniques, provides you with the optimum in system control.

Features and Benefits

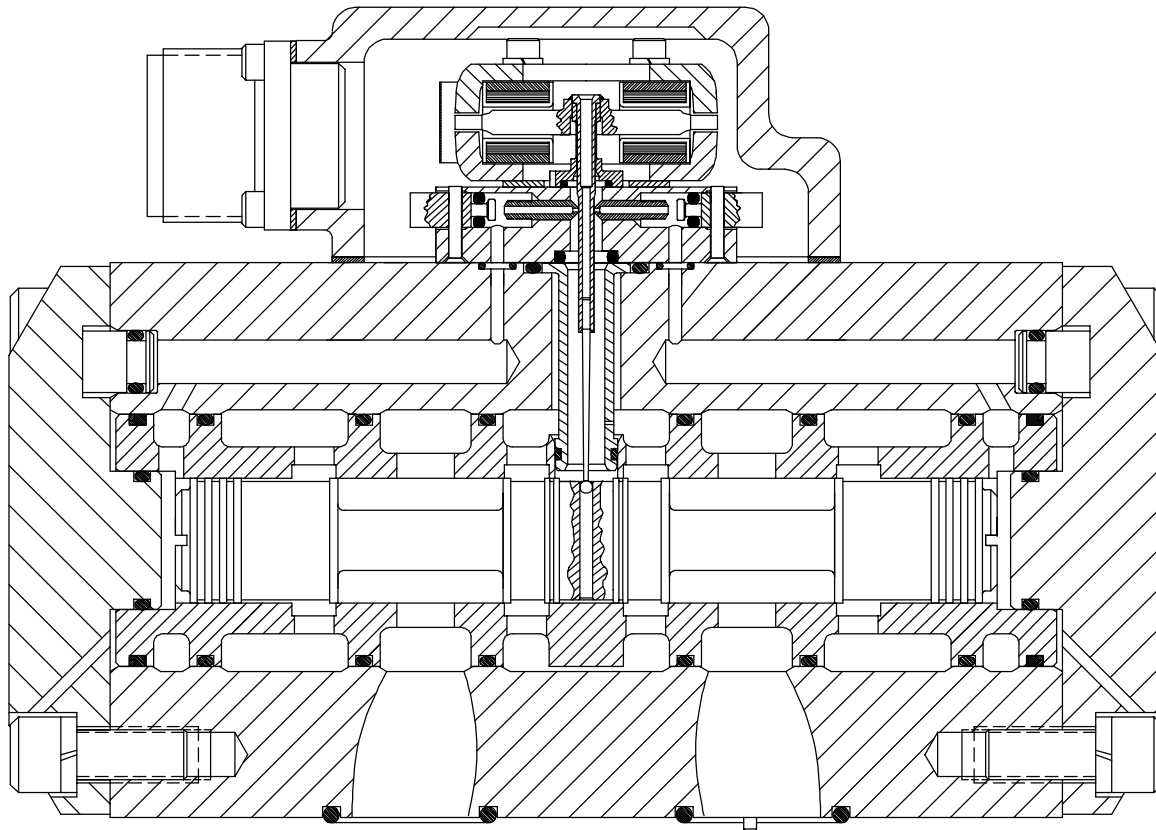
- The wide range of SM4 flow capabilities allows selection of the valve size best suited for an application.
- The SM4-40 (-10 design) has a high strength aluminum alloy second stage valve body for lighter weight with rugged durability.
- The SM4-40 (-50 design) features a special stainless steel body and end caps for operating pressures up to 350 bar (5000 psi).
- The symmetrical, dual-coil, quad air gap, dry torque motor in Vickers servovalves, with its extremely fast response to input signals, can produce highly accurate control profiles.
- Higher frequency response — available on request — provides enhanced system bandwidth for critical performance requirements.
- An integral 35 micron (absolute) filter provides extra first stage contamination protection.
- The spool and sleeve are hardened stainless steel to minimize wear and erosion. The O-ring mounted sleeve eliminates spool binding and ensures smooth operation.
- Customized spool lap and sleeve porting are available to provide the specific flow control required for special applications.
- The SM4's symmetrical design provides inherently dependable metering of control flow with minimum null shifts. The result is more consistent machine operation.
- Viton* seals are standard.
- The flexibility of standardized port circles, mounting patterns, and adapter manifolds makes Vickers servovalves a cost-effective choice for replacing existing servovalves and enhancing existing systems.
- The SM4-40 features a simple interface to an available dual filter module that provides extra protection against pilot contamination.
- Flushing valves are available that can greatly reduce initial system contamination levels prior to SM4 installation.

* Viton is a registered trademark of the DuPont Co.

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**Cross Section of Typical
SM4-40 Servovalve**



Operating Data

Flow and Leakage

All data is typical, based on actual tests at 70 bar (1000 psi) Δp , 30 cST (141 SUS), and 49°C (120°F).

Model Series	Maximum Rated Flow $\pm 10\%$ l/min (USgpm)	Maximum Total Null Leakage l/min (USgpm)	Maximum Pilot Flow at 70 bar (1000 psi) Δp l/min (USgpm)
SM4-40 (-10 design)	151 (40)	3,48 (0.92)	0,9 (0.24)
SM4-40 (-50 design)			

Performance

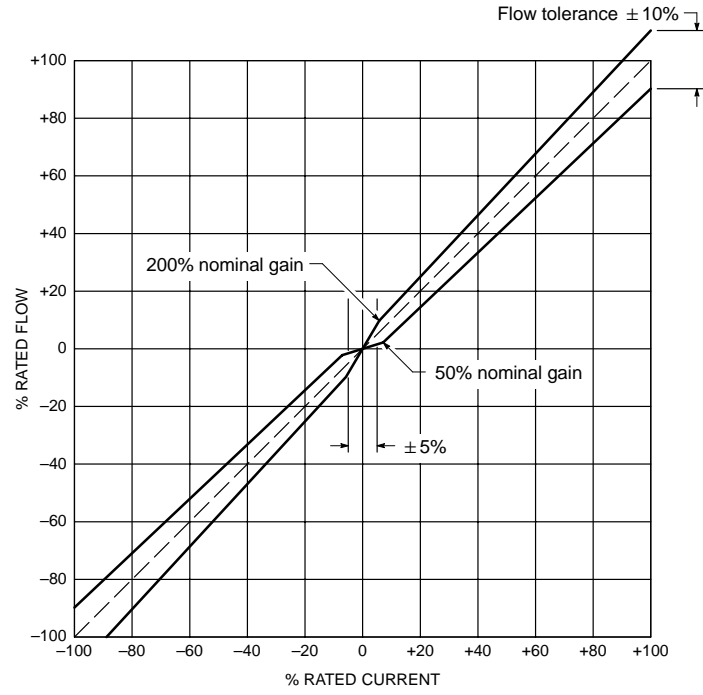
Maximum Supply Pressure bar (psi)	SM4-40 (-10 design): 210 (3000) SM4-40 (-50 design): 350 (5000)
Minimum Supply Pressure bar (psi)	14 (200)
Proof Pressure % maximum supply pressure	At Supply Port: 150 At Return Port: 100
Burst Pressure, Return Port Open % maximum supply pressure	250
Maximum Operating Temperature °C (°F)	135 (275)
Hysteresis Around Null % of rated current	≤ 3
Symmetry Error % of rated current	< 10
Linearity Error % of rated current	< 10
Threshold % of rated current	≤ 0.5

Ruggedness Test Results

Vibration Test 5 Hz to 2000 Hz along each axis	No damage to components
Shock Test Up to 150g along all axes	No damage to components
Endurance Test To ISO 6404	No degradation in performance

Flow Gain

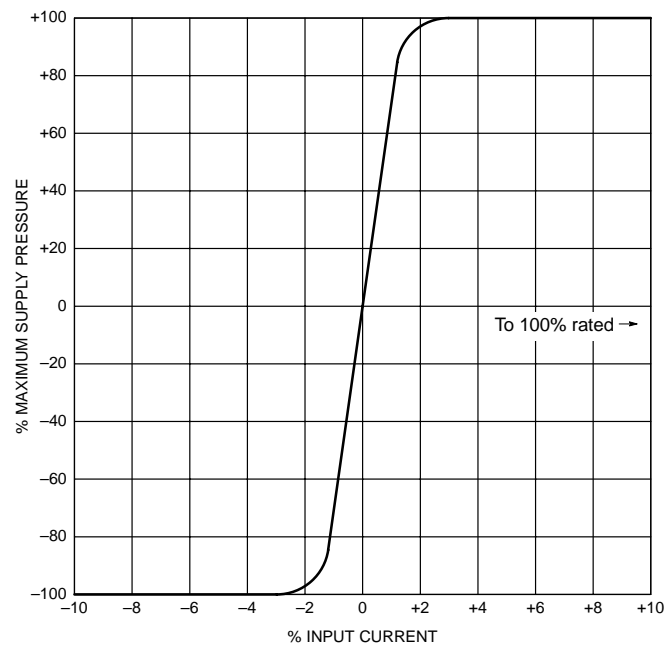
Normal region for standard models shown with typical no-load flow gain tolerances excluding hysteresis.



Pressure Gain

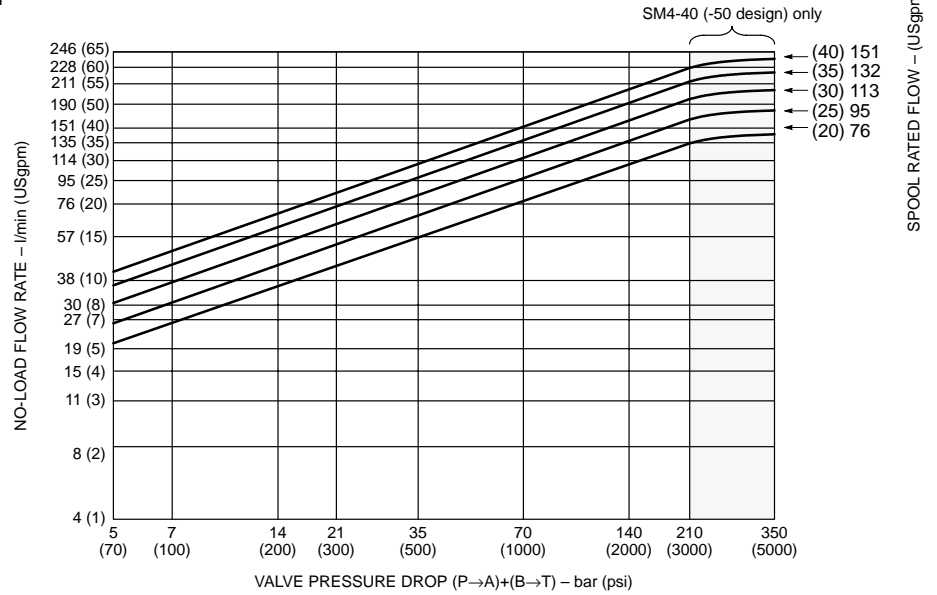
Change in load pressure drop with input current shown with no valve flow and closed control ports.

Pressure gain in the null region is $>30\%$ of supply pressure per 1% of rated current.



Change in Rated Flow

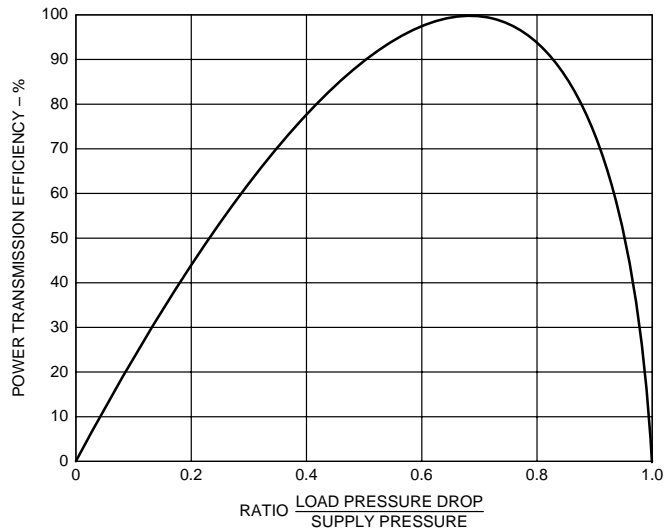
Rated flows at valve pressure drops from 5 bar (70 psi) to 350 bar (5000 psi) for the five available spools.



Power Transmission Efficiency

Maximum power envelope expressed as a percentage with T port pressure equal to 0 bar.

Power transferred to the load is optimum when valve pressure drop is one third of supply pressure. Load pressure drop should be limited to $\frac{2}{3}$ of supply pressure so the flow gain of the servovalve remains high enough to maintain control of the load. Overall hydraulic efficiency must be considered when sizing system heat exchangers.



Coil Resistance

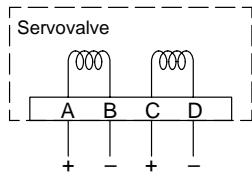
Select coil resistance and connections for compatible interface to servo electronics. **Recommended coil resistance is shown in bold print.**

	Nominal Resistance Per Coil at 21°C (70°F) Ohms	Rated Current mA	
		Single, Parallel, or Differential Connection	Series Connection
Standard coil resistance selection	20	200	100
	30	100	50
	80	40	20
	200	20	10
Optional coil resistance selection	80	50	25
	140	40	20
	200	15	7.5
	300	30	15
	1000	10	5
	1500	8	4

Electrical Polarity for Control Flow Out of B Port

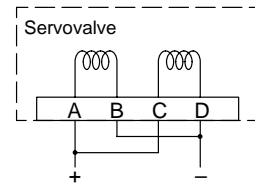
Single:

A+, B-
or
C+, D-



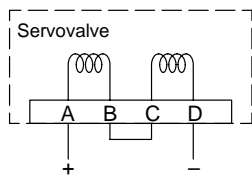
Parallel:

A+, C+
B-, D-
Connect A and C
Connect B and D



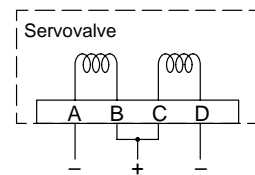
Series:

A+, D-
Connect B and C



Differential:

A-, D-
B+, C+
Connect B and C
BC-, current BA > CD
BC+, current CD > BA



Performance Curves

Frequency Response

Frequency response is defined as the relationship of no-load control flow to input current with a sinusoidal current sweep at constant amplitude over a range of frequencies. It is expressed in frequency (Hz), amplitude ratio (dB), and phase angle (degrees).

As shown in the sample curve (below left), standard comparison points for servovalve frequency response are those frequencies at which -3 dB amplitude ratio and 90° phase angle occur.

Vickers SM4 torque motors are magnetically stabilized for reliable servovalve performance at operating pressures from 14 to 350 bar (200 to 5000 psi).

Calculating Frequency Response at System Pressure

P_S = System pressure
 P_M = Maximum supply pressure of valve: 210 bar (3000 psi) for SM4-40 and 350 bar (5000 psi) for SM4-40 (-50 design)
 f_{PM} = Frequency (at 90° phase angle) at maximum supply pressure (P_M)
 f_{PS} = Frequency (at 90° phase angle) at system pressure (P_S)

1. Calculate the ratio of system pressure to maximum supply pressure:

$$\frac{P_S}{P_M}$$

2. Use the result of step 1 and the curve below to estimate

$$\frac{f_{PS}}{f_{PM}}$$

3. Use the applicable frequency response curve from the following pages to estimate f_{PM} (the maximum supply pressure frequency response at 90° phase angle) for the desired valve.

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

Example: A standard performance SM4-40 (-10 design) valve with a flow of 95 l/min (25 USgpm) is to be used at 165 bar (2400 psi).

1. Calculate the ratio of system pressure to maximum supply pressure:

$$\frac{P_S}{P_M} = \frac{2400 \text{ psi}}{3000 \text{ psi}} = 0.8$$

2. Use the result of step 1 and the curve below right to estimate

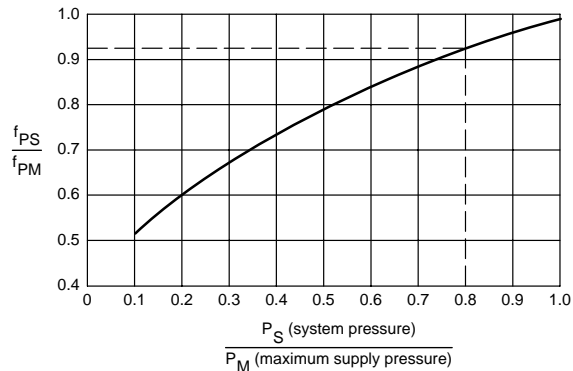
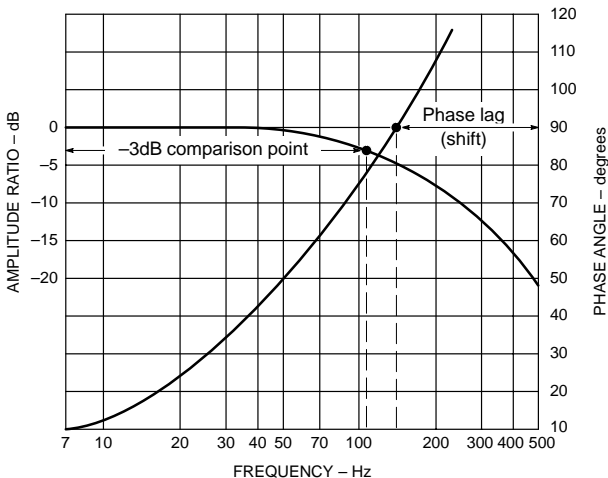
$$\frac{f_{PS}}{f_{PM}} = 0.92$$

3. Use the frequency response curve from page 7 to estimate f_{PM} .

$$f_{PM} = 42 \text{ Hz}$$

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

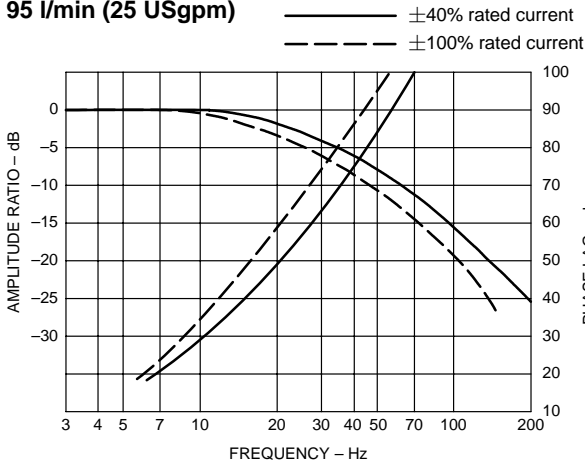
$$f_{PS} = 0.92 \times 42 \text{ Hz} = 39 \text{ Hz}$$



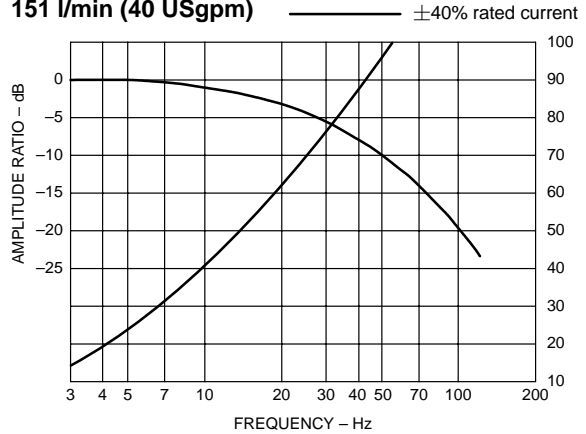
Typical Frequency Response Curves

SM4-40 (-10 and -50 designs) shown at 210 bar (3000 psi)

76 l/min (20 USgpm)
95 l/min (25 USgpm)



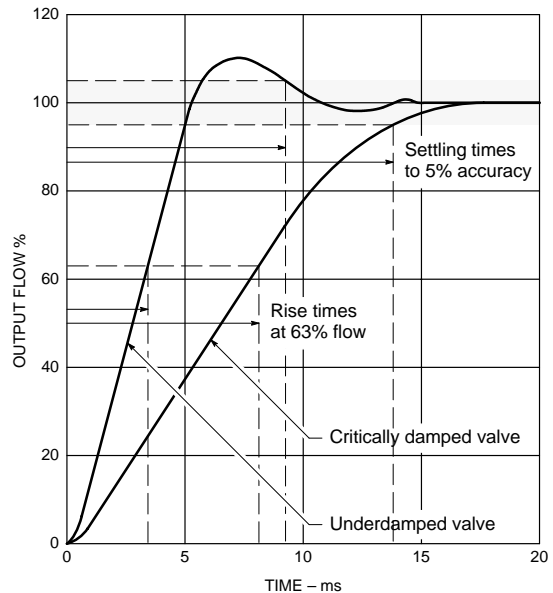
113 l/min (30 USgpm)
132 l/min (35 USgpm)
151 l/min (40 USgpm)



Step Response

Step response is defined as the typical rise time needed to achieve a given percentage of control flow output. Settling time is the time needed for transient flow fluctuations to diminish to within a given accuracy range. Both are expressed in milliseconds (ms).

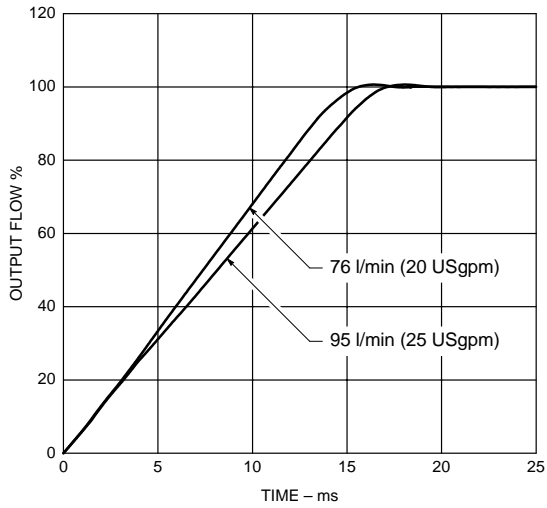
The example at right shows the step response curves for a critically damped valve and an underdamped valve. Rise times are illustrated for 63% of control flow output, and settling times are shown at $100 \pm 5\%$ of control flow output.



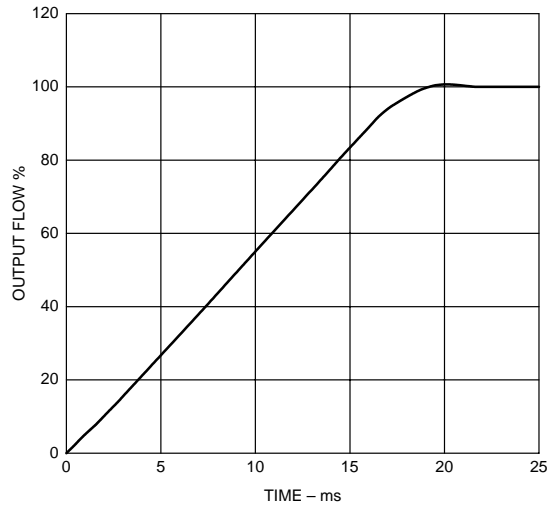
Typical Step Response Curves for Standard Models

SM4-40 (-10 and -50 designs) shown at 210 bar (3000 psi)

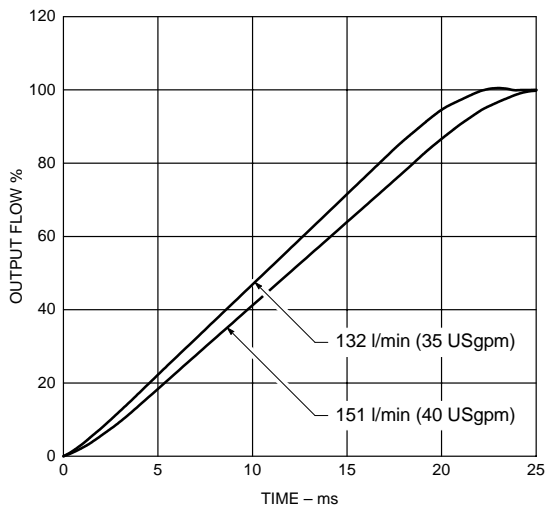
76 l/min (20 USgpm)
95 l/min (25 USgpm)



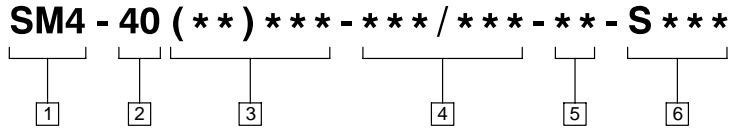
113 l/min (30 USgpm)



132 l/min (35 USgpm)
151 l/min (40 USgpm)



Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

2 Valve size

40 – 44,5 mm (1.75 in) port circle

3 Flow rating

At 70 bar (1000 psi) Δp P→A→B→T.
Other flows available on request.

Code	USgpm	l/min
(20) 76	20.0	76
(25) 95	25.0	95
(30) 113	30.0	113
(35) 132	35.0	132
(40) 151	40.0	151

4 Coil resistance/rated current

Ohms/mA at 21°C (70°F). Other coils available on request.

Code	Ohms	mA
20/200	20	200
30/100	30	100
80/40	80	40
80/50	80	50
140/40	140	40
200/15	200	15
200/20	200	20
300/30	300	30
1000/10	1000	10
1500/8	1500	8

5 Design number

Subject to change. Installation dimensions same for designs 10 through 19 and for designs 50 through 59.

- 10 to 19 – 210 bar (3000 psi) maximum supply pressure
- 50 to 59 – 350 bar (5000 psi) maximum supply pressure

6 Special features suffix

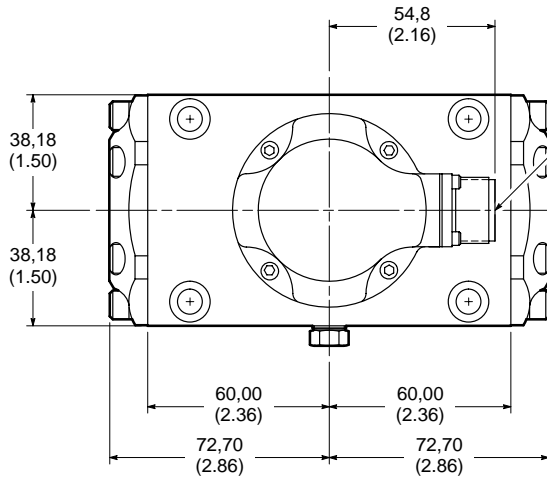
S81 – Intrinsically safe valve (-10 design only). Contact your Vickers representative for details.

S*** – Vickers assigns a unique suffix to denote a particular group of special features. Contact your Vickers representative for details.

Blank – Standard valve

Installation Dimensions

millimeters (inches)



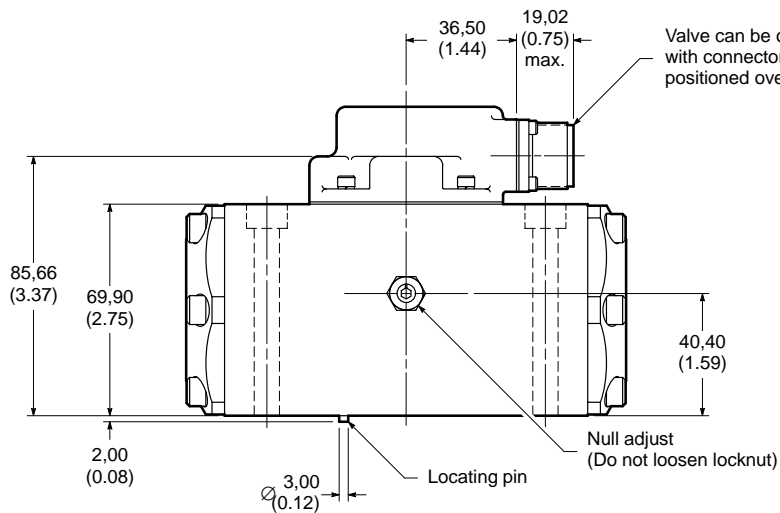
Electrical connector mates with MS-3106-14S-2S (4 pin). Plus signal to A or C causes flow out of port B.

NOTES

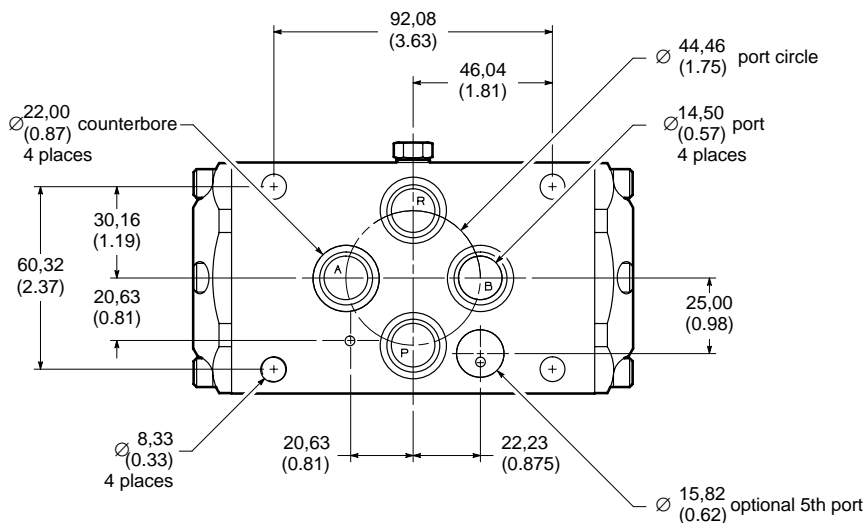
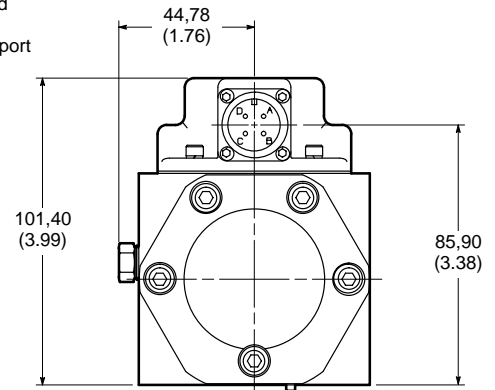
Torque mounting screws to 22 to 27 Nm (190 to 240 lb.in.).

Valve mounting surface requires 63 microinch finish flat within 0,05 (0.002).

Viton port O-rings (AS568-018) provided: 1,78 (0.070) cross section and 18,77 (0.739) inner diameter. Replacement O-rings available in seal kit 920321 only.

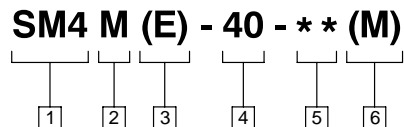


Valve can be ordered with connector positioned over any port



SM4M(E) Mounting Subplates

Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

3 Port connection locations

Blank – Rear ports
E – Side ports

5 Design number

Subject to change. Installation dimensions same for designs 10 through 19 and for designs 50 through 59.

2 Accessory designation

M – Mounting subplate. Maximum supply pressure of 210 bar (3000 psi), except -5* designs with maximum supply pressure of 350 bar (5000 psi).

4 Standard SM4 valve size

40 – SM4-40

10 to 19 – 210 bar (3000 psi) maximum supply pressure
50 to 59 – 350 bar (5000 psi) maximum supply pressure

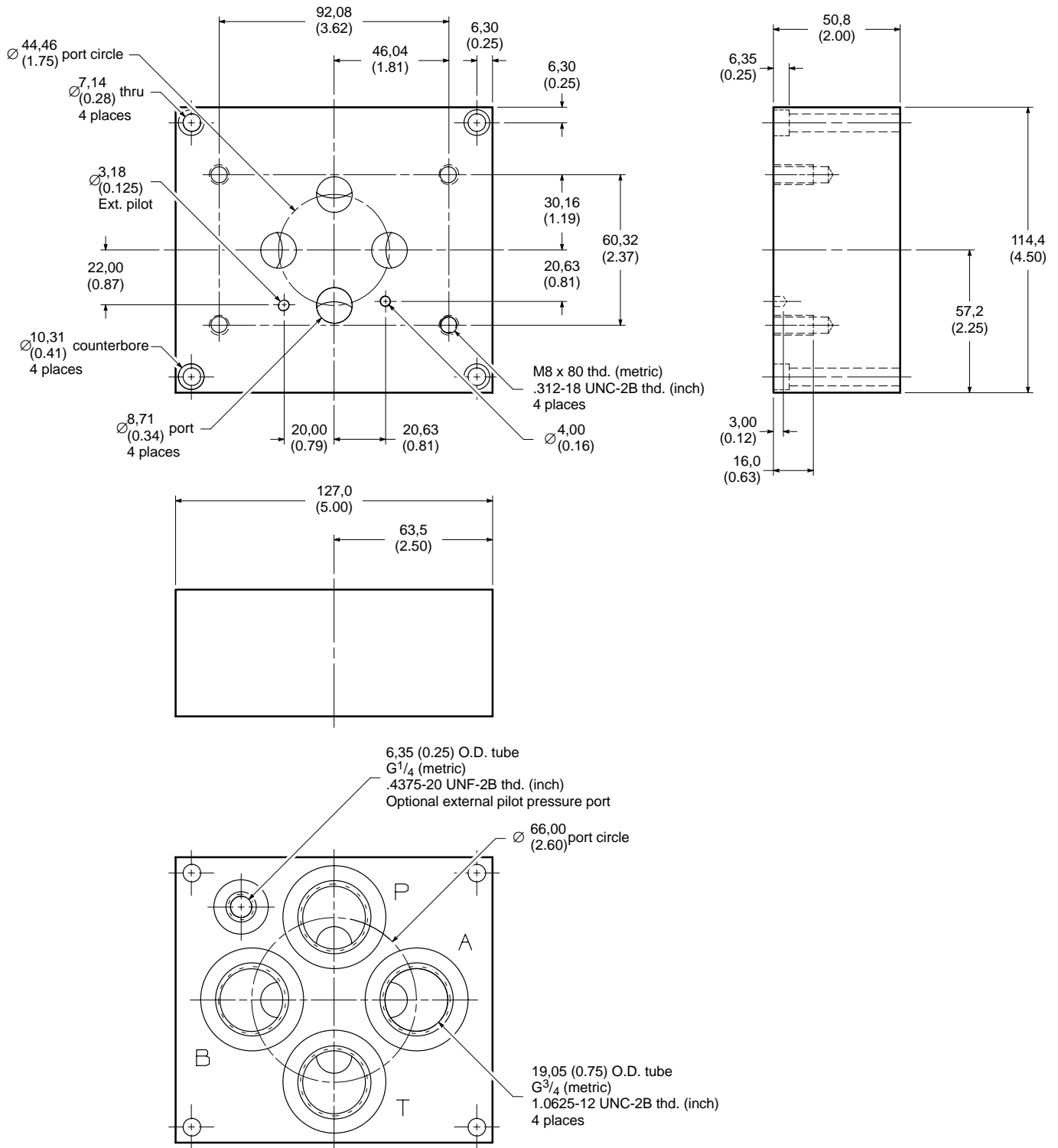
6 Metric suffix

M – Metric version to NG (ISO) standards
Blank – Omit if not required

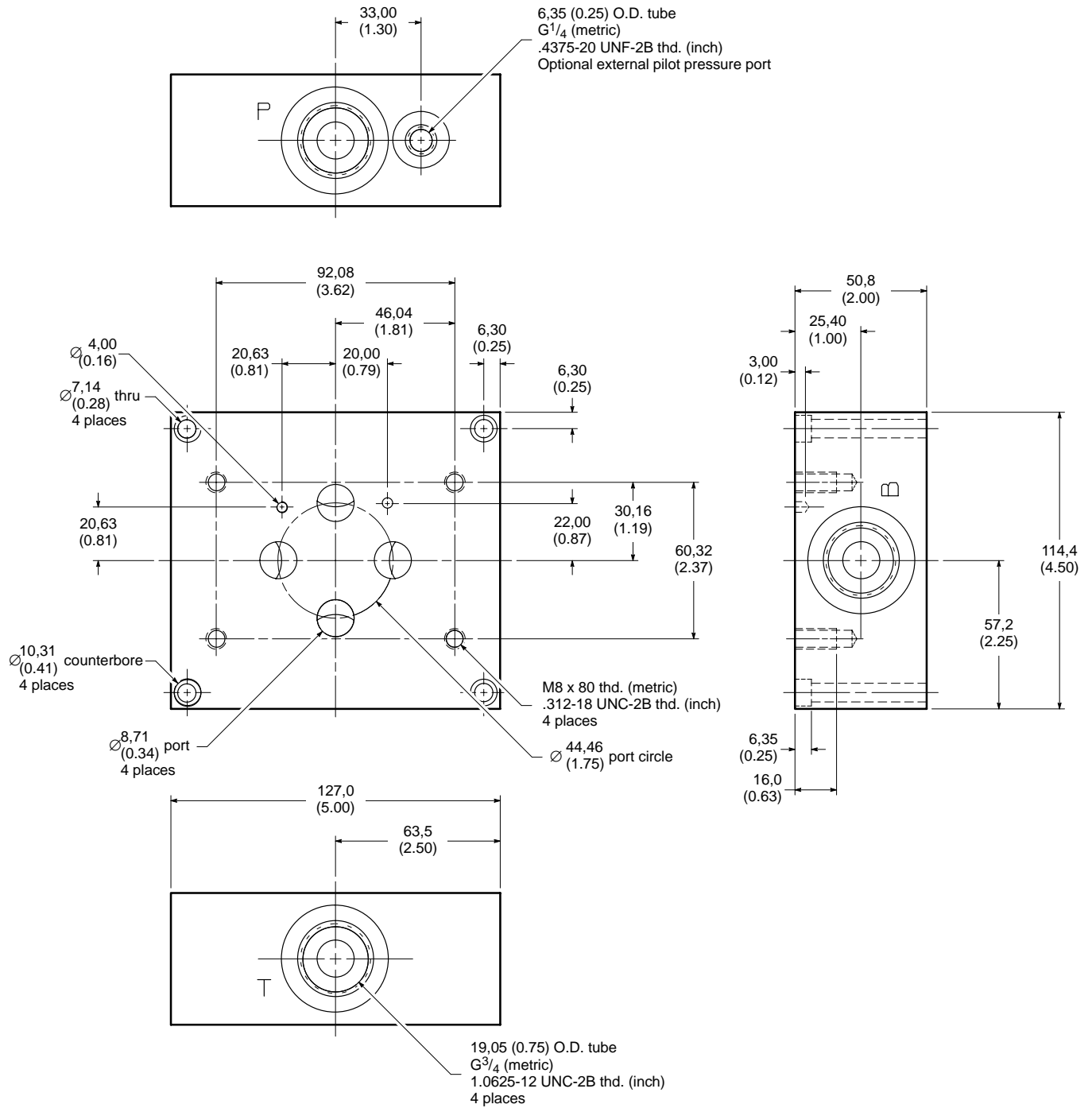
Installation Dimensions

millimeters (inches)

SM4M-40-10/50(M)

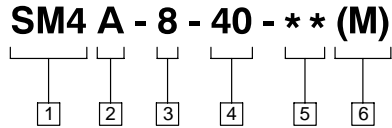


SM4ME-40-10/50(M)



SM4A Adapter Manifolds

Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

2 Accessory designation

A – Adapter manifold. Maximum supply pressure of 210 bar (3000 psi), except -5* designs with maximum supply pressure of 350 bar (5000 psi).

3 Interface

8 – ISO 4401-08

4 Standard SM4 valve size

40 – SM4-40

5 Design number

Subject to change. Installation dimensions same for designs 10 through 19 and for designs 50 through 59.

10 to 19 – 210 bar (3000 psi) maximum supply pressure

50 to 59 – 350 bar (5000 psi) maximum supply pressure

6 Metric suffix

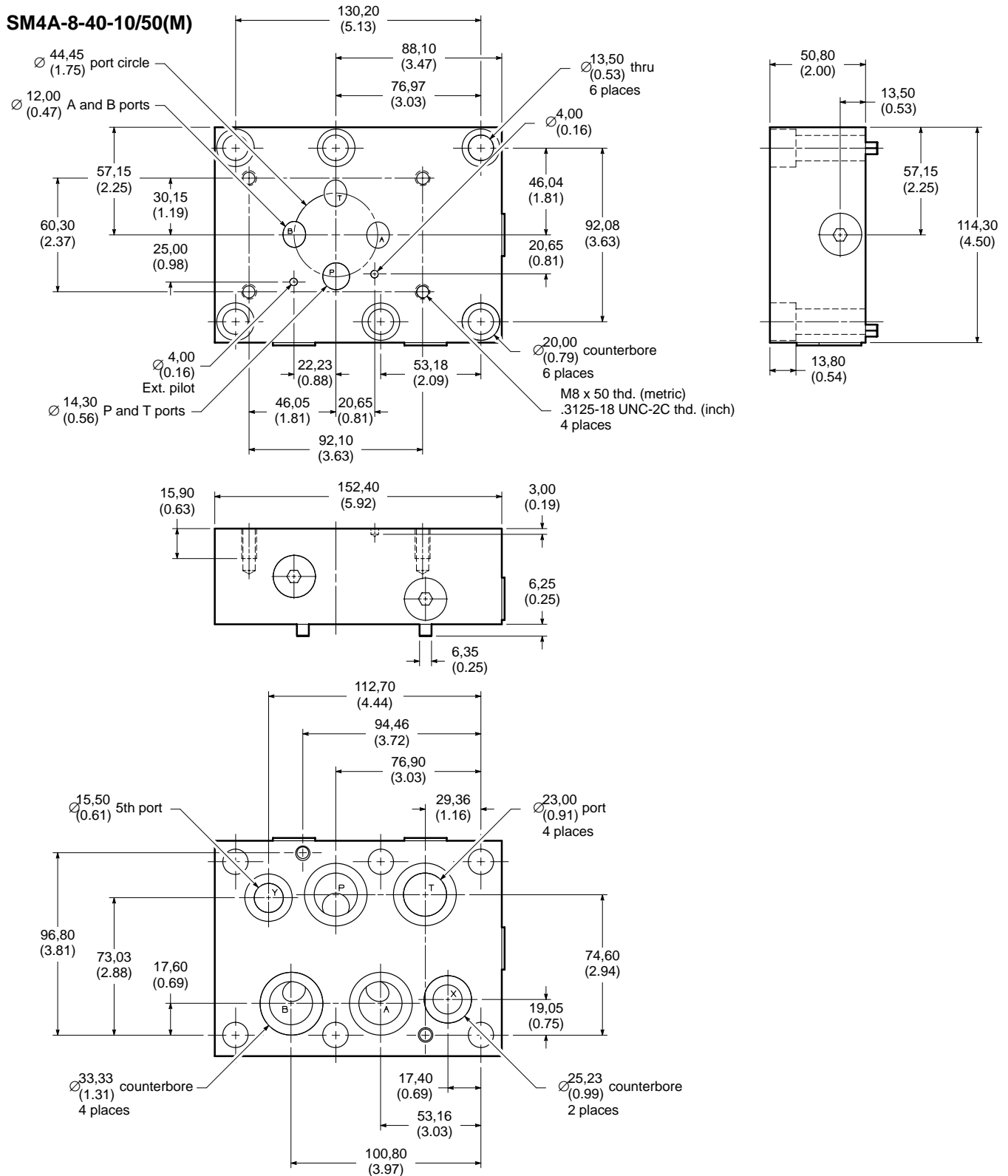
M – Metric version to NG (ISO) standards

Blank – Omit if not required

Installation Dimensions

millimeters (inches)

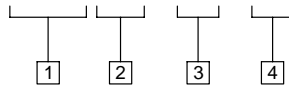
SM4A-8-40-10/50(M)



SM4FV Flushing Valves

Model Code

SM4 FV - 40 - 10



1 Series designation

SM4 – Servovalve, high performance, four-way

2 Accessory designation

FV– Flushing valve. Maximum flushing pressure of 35 bar (500 psi).

4 Design number

Subject to change. Installation dimensions same for designs 10 through 19.

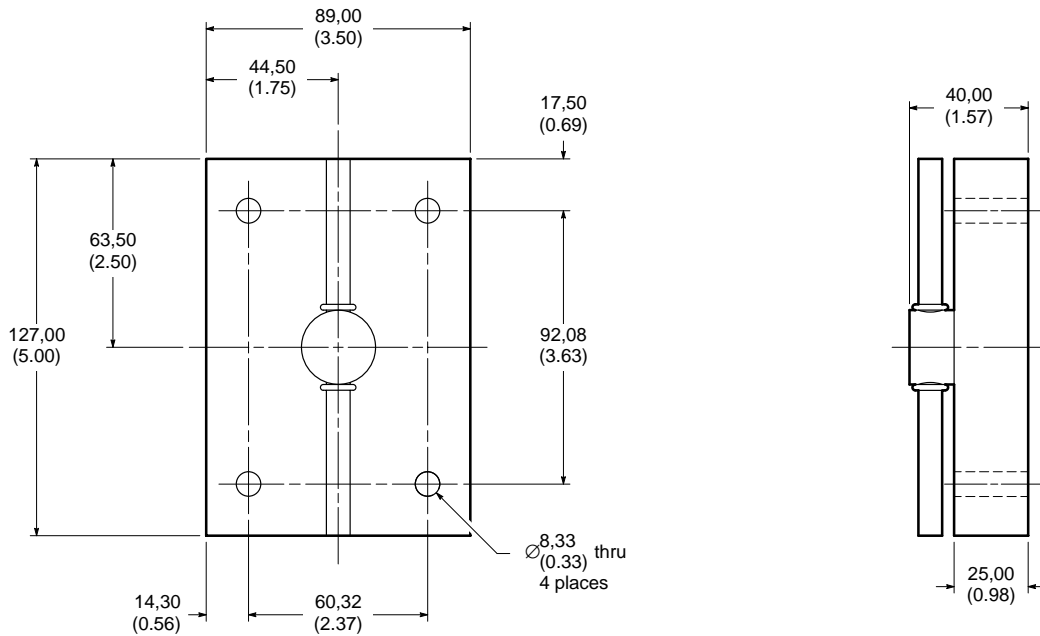
3 Standard SM4 valve size

40 – SM4-40

Installation Dimensions

millimeters (inches)

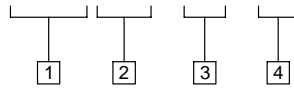
SM4FV-40-10



SM4FM Filter Modules

Model Code

SM4 FM - 40 - * *



1 Series designation

SM4 – Servovalve, high performance, four-way

2 Accessory designation

FM – Filter module. Maximum supply pressure of 210 bar (3000 psi), except -5* designs with maximum supply pressure of 350 bar (5000 psi).

4 Design number

Subject to change. Installation dimensions same for designs 10 through 19 and for designs 50 through 59.

10 to 19 – 210 bar (3000 psi) maximum supply pressure

50 to 59 – 350 bar (5000 psi) maximum supply pressure

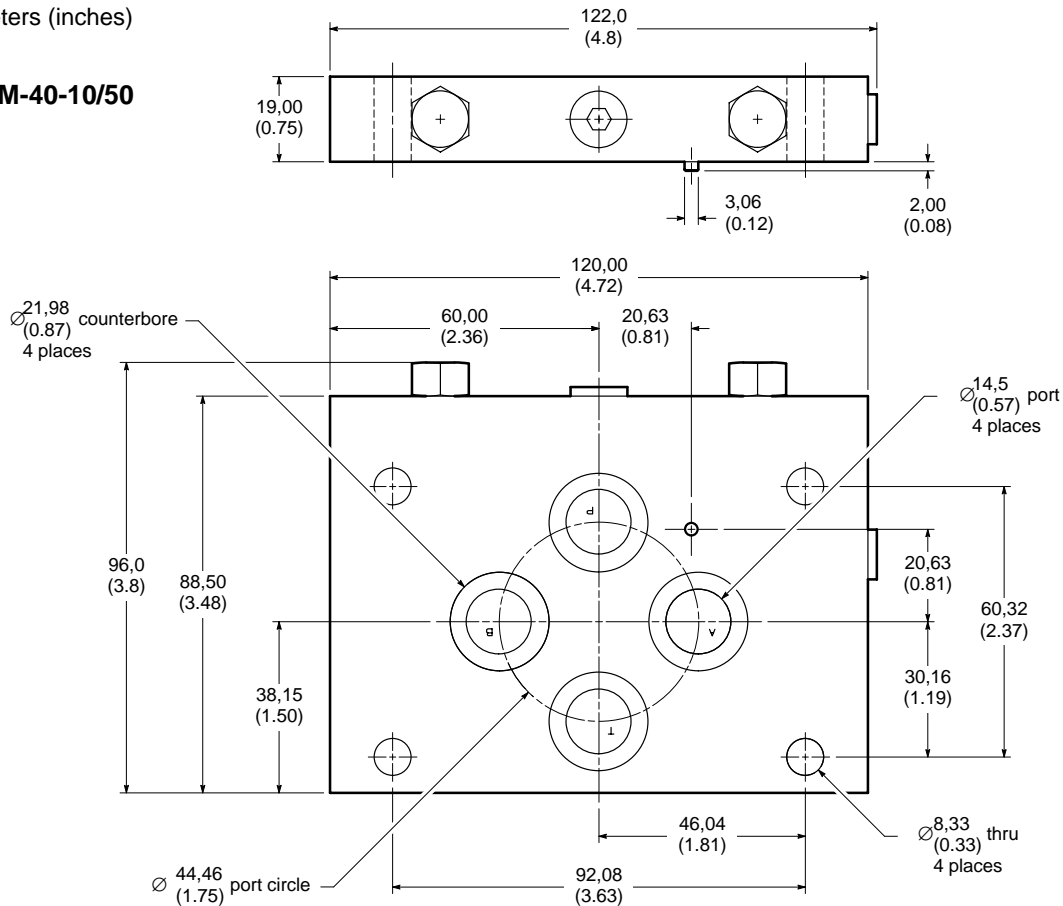
3 Standard SM4 valve size

40 – SM4-40

Installation Dimensions

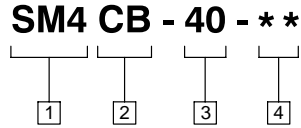
millimeters (inches)

SM4FM-40-10/50



SM4CB Cross Port Bleed Modules

Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way

2 Accessory designation

CB – Cross port bleed module. Includes cross port bleed feature between ports A and B. Maximum supply pressure of 210 bar (3000 psi), except -5* designs with maximum supply pressure of 350 bar (5000 psi).

4 Design number

Subject to change. Installation dimensions same for designs 10 through 19 and for designs 50 through 59.

10 to 19 – 210 bar (3000 psi) maximum supply pressure

50 to 59 – 350 bar (5000 psi) maximum supply pressure

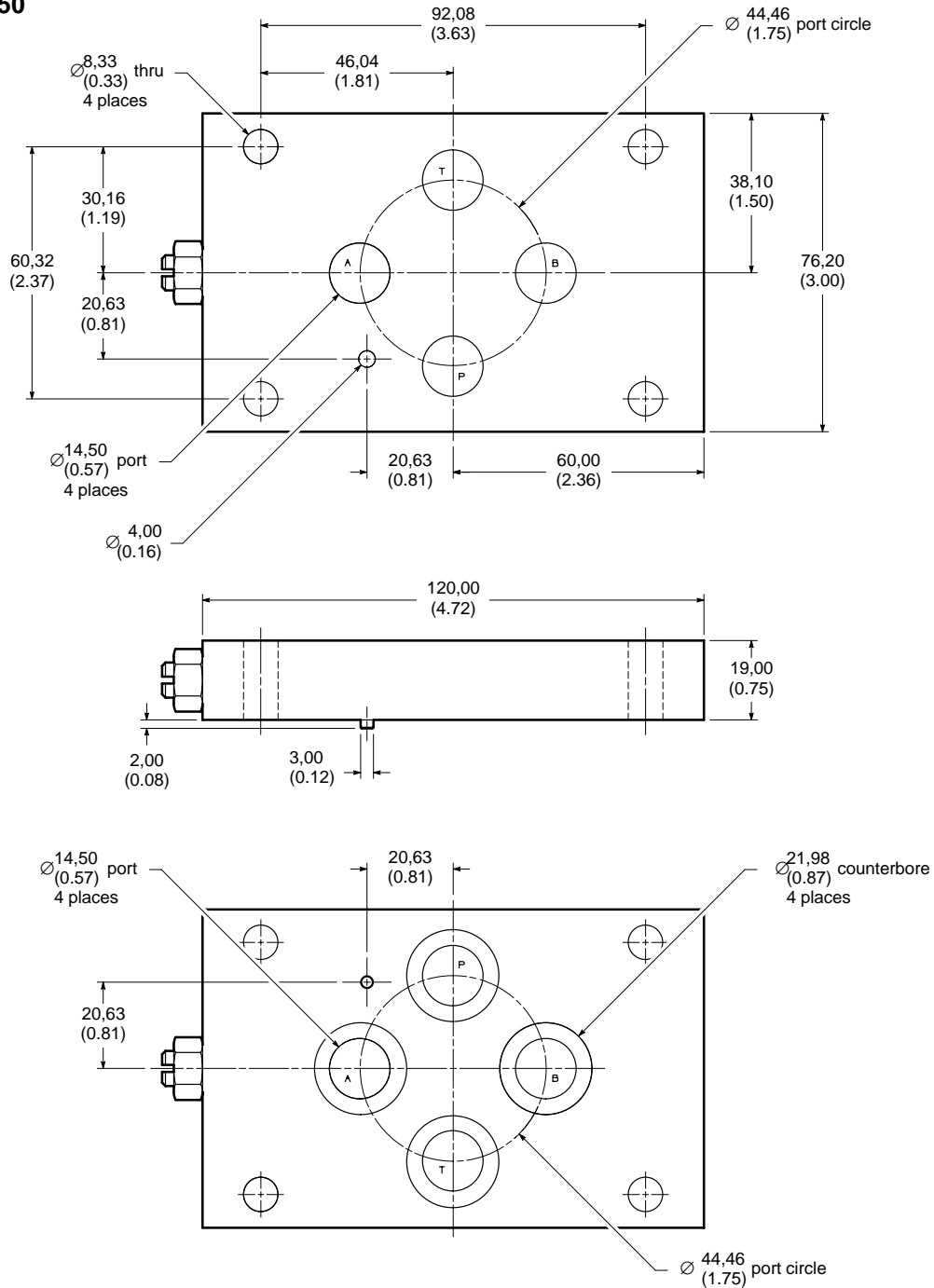
3 Standard SM4 valve size

40 – SM4-40

Installation Dimensions

millimeters (inches)

SM4CB-40-10/50



NOTE

Viton port O-rings (AS568-018) provided:
1,78 (0.070) cross section and 18,77 (0.739)
inner diameter.

13 Weights

The following table lists approximate dry weights for SM4-40 servovalves and related accessories.

Description	Model Code	Weight kg (lbs.)
Servovalve	SM4-40 (-10 design)	2,8 (6.2)
	SM4-40 (-50 design)	5,0 (11.0)
Mounting subplate	SM4M(E)-40-10(M)	1,8 (4.0)
	SM4M(E)-40-50(M)	5,0 (11.0)
Adapter manifold	SM4A-8-40-10(M)	2,013 (4.44)
	SM4A-8-40-50(M)	5,0 (11.0)
Flushing valve	SM4FV-40-10(M)	0,77 (1.70)
Filter module	SM4FM-40-10(M)	1,38 (3.04)
	SM4FM-40-50(M)	1,4 (3.1)
Cross port bleed module	SM4CB-40-10	0,60 (1.32)
	SM4CB-40-50	1,70 (3.74)

14 Additional Accessories

SM4-40 Accessories	Model Code
Valve mounting bolt kit (inch) $\frac{5}{16}$ -18 x 3"	BK866689
Valve mounting bolt kit (metric) M8 x 80mm	BK689628M
Subplate mounting bolt kit (inch) $\frac{1}{4}$ -20 x $2\frac{1}{4}$ "	BK866685
Subplate mounting bolt kit (metric) M6 x 60mm	BK689623M
Adapter manifold mounting bolt kit (inch) $\frac{1}{2}$ -13 x $2\frac{1}{4}$ "	BK855990
Adapter manifold mounting bolt kit (metric) M12 x 60mm	BK855991M
Flushing valve mounting bolt kit (inch) $\frac{5}{16}$ -18 x $1\frac{1}{2}$ "	BK927862
Flushing valve mounting bolt kit (metric) M8 x 40mm	BK927863M
Filter module mounting bolt kit (inch) $\frac{5}{16}$ -18 x $3\frac{3}{4}$ "	BK916140
Filter module mounting bolt kit (metric) M8 x 100mm	BK916141M
Filter kit (valve)	926470
Filter kit (filter module)	916277
Cable connector (MS3106-14S-2S)	242123
Cable clamp (MS3057-6)	126058
Seal kit	920321

Servo Electronics

See application brochure 656 for the complete Vickers line of amplifiers, power supplies, and function modules.

Application Data

Fluid Cleanliness

Proper fluid condition is essential for long and satisfactory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials, and additives for protection against wear of components, elevated viscosity and inclusion of air.

Essential information on the correct methods for treating hydraulic fluid is included in Vickers publication 561 "Vickers Guide to Systemic Contamination Control," available from your local Vickers distributor or by contacting Vickers, Incorporated. Recommendations on filtration and the

selection of products to control fluid condition are included in 561.

Recommended cleanliness levels, using petroleum oil under common conditions, are based on the highest fluid pressure levels in the system and are coded in the chart below. Fluids other than petroleum, severe service cycles, or temperature extremes are cause for adjustment of these cleanliness codes. See Vickers publication 561 for exact details.

Vickers products, as any components, will operate with apparent satisfaction in fluids with higher cleanliness codes than those described. Other manufacturers

will often recommend levels above those specified. Experience has shown, however, that life of any hydraulic component is shortened in fluids with higher cleanliness codes than those listed below. These codes have been proven to provide a long, trouble-free service life for the products shown, regardless of the manufacturer.

NOTE

Vickers will extend, by one year, the standard warranty on all Vickers products used in a system protected by Vickers filters (and elements) applied in a manner consistent with the principles presented in Vickers publication 561.

Product	System Pressure Level psi		
	<2000	2000–3000	3000+
Vane pumps, fixed	20/18/15	19/17/14	18/16/13
Vane pumps, variable	18/16/14	17/15/13	
Piston pumps, fixed	19/17/15	18/16/14	17/15/13
Piston pumps, variable	18/16/14	17/15/13	16/14/12
Directional valves	20/18/15	20/18/15	19/17/14
Proportional valves	17/15/12	17/15/12	15/13/11
Servo valves	16/14/11	16/14/11	15/13/10
Pressure/Flow controls	19/17/14	19/17/14	19/17/14
Cylinders	20/18/15	20/18/15	20/18/15
Vane motors	20/18/15	19/17/14	18/16/13
Axial piston motors	19/17/14	18/16/13	17/15/12

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Telephone: (44) 170-548-6451
Fax: (44) 170-548-7110



Vickers®

Servo Valves



SX4 Servovalves

Flows to 76 l/min (20 USgpm) — Pressures to 350 bar (5000 psi)



Introduction

Vickers SX4 servovalves provide closed loop control with exact positional accuracy, repeatable velocity profiles, and predictable force or torque regulation. Compared to Vickers SM4 servovalves, the SX4 offers extended frequency response and improved stability in closed loop systems.

Typical applications include plastic injection molding and blow molding systems, test and simulation equipment, die casting machines, hydraulic press brakes, animation and entertainment equipment, oil exploration vehicles, and lumber machinery.

The four models in the extended frequency response SX4 series offer a wide range of rated flows from 3,8 to 76 l/min (1.0 to 20 USgpm) at Δp of 70 bar (1000 psi).

The SX4 is a two-stage, modular design, flow control valve which can be manifold or subplate mounted. The symmetrical, dual coil, quad air gap torque motor mounts to the first stage nozzle flapper valve with six screws for better stability in high shock environments. An integral 35 micron absolute filter reduces sensitivity to contamination of the first stage. The second stage utilizes a four-way sliding spool and sleeve arrangement with a mechanical null adjust. Spool position is fed back to the first stage by means of a mechanical spring.

An SX4 servovalve can be used with a hydraulic cylinder, position transducer, and electronics for infinite cylinder position control to within 0,025 mm (0.001 in) or better, depending on component selection, length of stroke,

and load characteristics. When applied with servo hydraulic motors, tachometers, and electronics, the SX4 provides infinite proportional flow control for real-time velocity/acceleration profiles that can be closed loop error corrected to within one-tenth of a revolution per minute. With appropriate pressure transducers or load cells, cylinders, and electronics in force control applications, the SX4 offers exact load pressure/force control and excellent system stability with pressure to $\pm 0,07$ bar (± 1 psi) and load to $\pm 1\%$ full scale.

The field-proven design of the SX4 servovalve, combined with Vickers precision manufacturing techniques, provides you with the optimum in system control.

Features and Benefits

- The extended frequency response of the Vickers SX4 servovalve makes it the best competitive choice across a full range of applications.
- Each size of the extended frequency response SX4 is available in both standard response and high response models. The high response models offers enhanced system bandwidth for critical performance requirements.
- The wide range of SX4 flow capabilities allows selection of the valve size best suited for an application.
- The high strength aluminum alloy of the second stage valve body means lighter weight with rugged durability.
- The SX4-20 is also available with a special stainless steel body and end caps for operating pressures up to 350 bar (5000psi).
- The symmetrical, dual-coil, quad air gap, dry torque motor in Vickers servovalves, with its extremely fast response to input signals, results in highly accurate control profiles.
- The SX4's exclusive jeweled feedback ball receiver virtually eliminates the wear that can lead to loss of control across null in other servovalves.
- An improved null adjust provides smoother, more precise adjustment.
- Jeweled orifices greatly extend the life of the valve.
- An integral 35 micron filter provides extra first stage contamination protection.
- The spool and sleeve are hardened stainless steel to minimize wear and erosion. The sleeve is mounted with O-rings to eliminate spool binding and ensure smooth operation.
- Customized spool lap and sleeve porting are available to provide the specific flow control required for special applications.
- The SX4's symmetrical design provides inherently dependable metering of control flow and minimum null shifts. The result is more consistent machine operation.
- Viton* seals are standard.
- The flexibility of standardized port circles, mounting patterns, and adapter manifolds makes Vickers servovalves a cost effective choice for replacing existing servovalves and enhancing existing systems.
- The SX4-20 is available with an optional pilot pressure port that allows either additional first stage filtration or the use of external pilot pressure for freedom from supply pressure fluctuations.
- The SX4 features a simple interface to an available dual filter module that provides extra protection against system contamination.

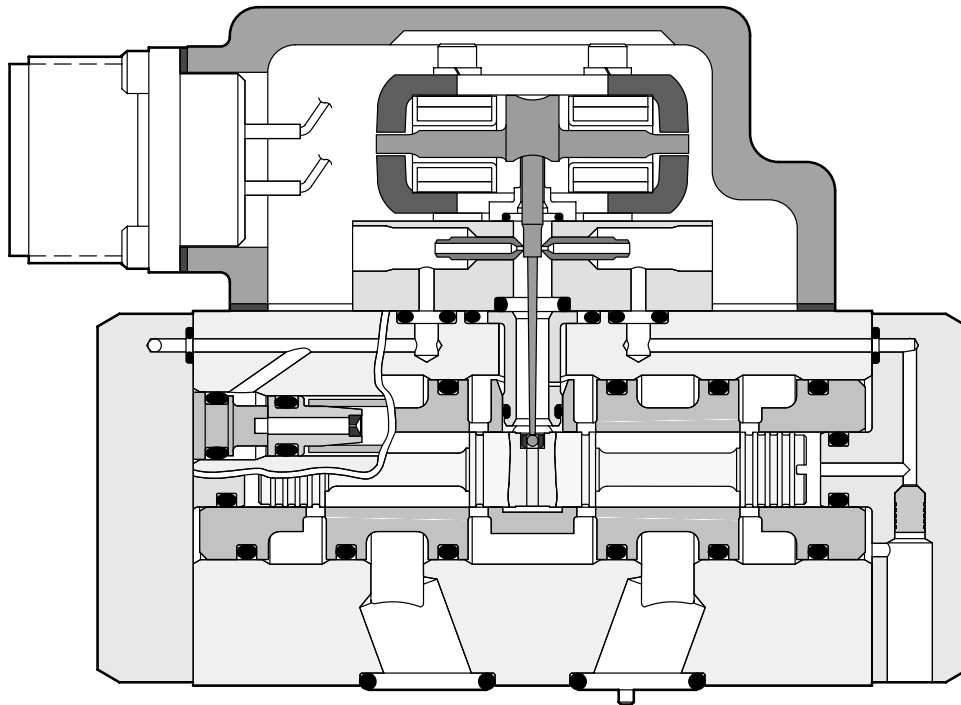
* Viton is a registered trademark of the DuPont Co.

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* – For use with SX4 or SM4 valves

Cross Section of Typical SX4-20 Servo Valve



Operating Data

Flow and Leakage

All data is typical, based on actual tests at 70 bar (1000 psi) Δp , 30 cST (141 SUS), and 49°C (120°F).

Model Series	Maximum Rated Flow $\pm 10\%$ l/min (USgpm)	Maximum Total Null Leakage l/min (USgpm)	
		Standard Lap and Standard Response	Standard Lap and High Response
SX4-10	38 (10)	0,95 (0.25)	1,21 (0.32)
SX4-12	45 (12)	1,32 (0.35)	1,59 (0.42)
SX4-15	57 (15)	1,32 (0.35)	1,59 (0.42)
SX4-20	76 (20)	1,32 (0.35)	1,59 (0.42)
SX4-V-20	76 (20)	1,32 (0.35)	1,59 (0.42)

Performance

Maximum Supply Pressure bar (psi)	SX4-10/12/15/20: 210 (3000) SX4-V-20: 350 (5000)
Minimum Supply Pressure bar (psi)	14 (200)
Proof Pressure % maximum supply pressure	At Supply Port: 150 At Return Port: 100
Burst Pressure, Return Port Open % maximum supply pressure	250
Maximum Operating Temperature °C (°F)	135 (275)
Hysteresis Around Null % of rated current	<3
Symmetry Error % of rated current	<10
Linearity Error % of rated current	<10
Threshold % of rated current	<0.5
Maximum Pilot Flow at 70 bar (1000 psi) Δp l/min (USgpm)	Standard Response: 0,38 (0.1) High Response: 0,64 (0.17)

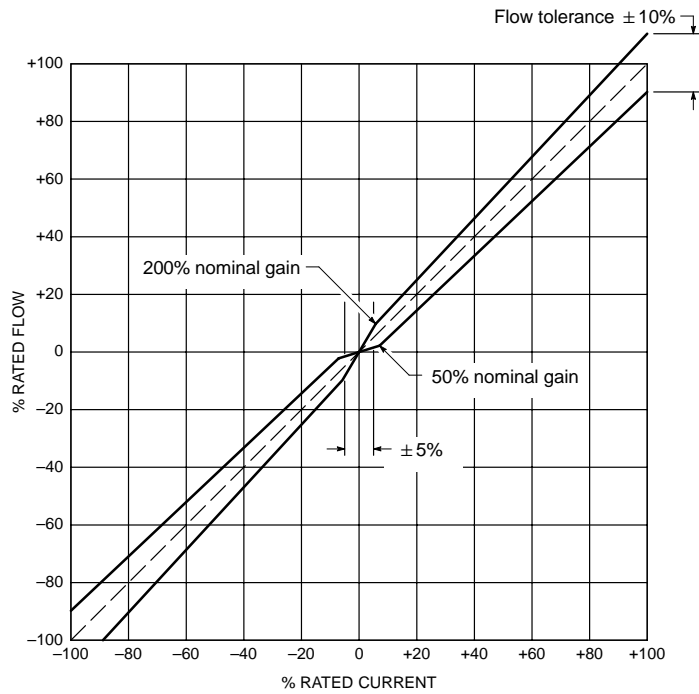
Ruggedness Test Results

Vibration Test 5 Hz to 2000 Hz along each axis	No damage to components
Shock Test Up to 150g along all axes	No damage to components
Endurance Test To ISO 6404	No degradation in performance

Operating Data

Flow Gain

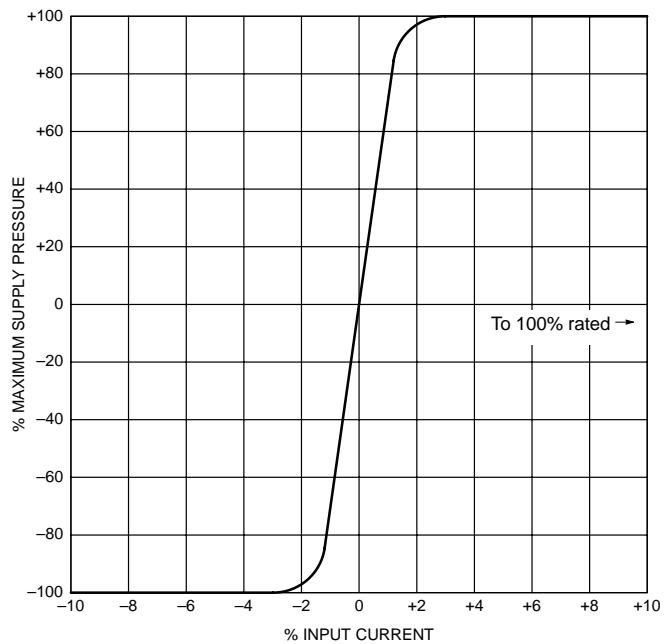
Normal region for standard models shown with typical no-load flow gain tolerances excluding hysteresis.



Pressure Gain

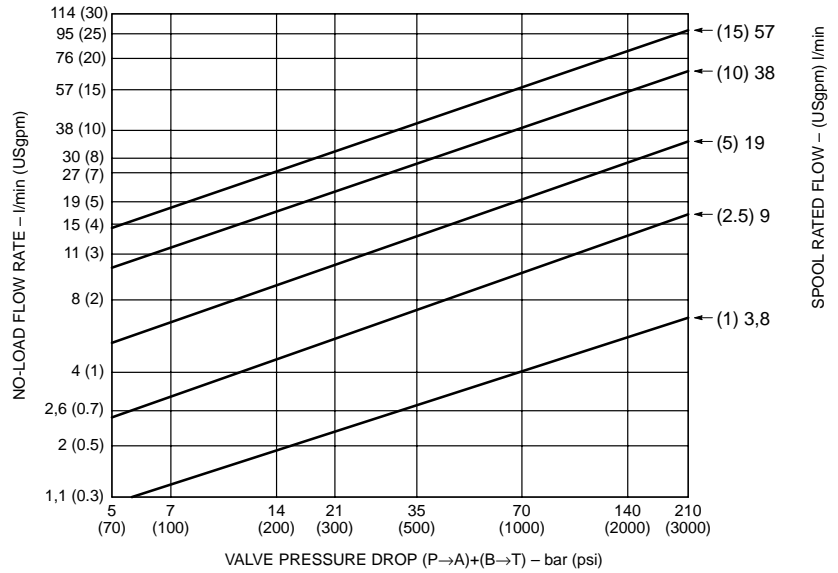
The curve shows change in load pressure drop with input current, with no valve flow and closed control ports.

Pressure gain in the null region is >30% of supply pressure per 1% of rated current.



Operating Data

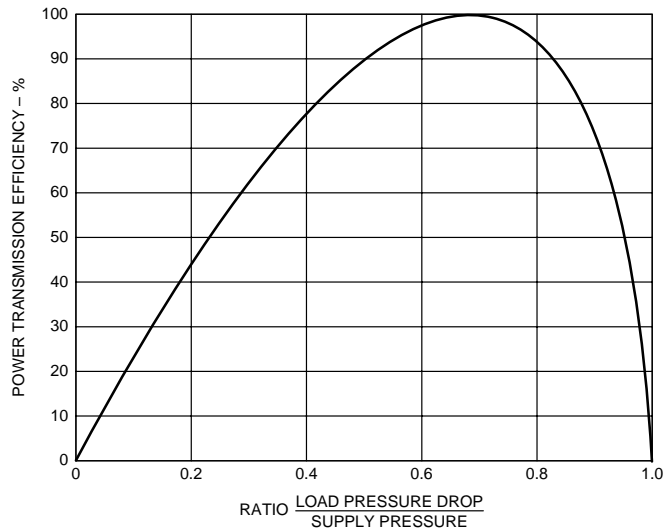
Change in Rated Flow vs. Pressure Drop



Power Transmission Efficiency

The curve shows the maximum power envelope expressed as a percentage with T port pressure equal to 0 bar.

Power transferred to the load is optimum when valve pressure drop is one third of supply pressure. Load pressure drop should be limited to $\frac{2}{3}$ of supply pressure so the flow gain of the servovalve remains high enough to maintain control of the load. Overall hydraulic efficiency must be considered when sizing system heat exchangers.



Operating Data

Coil Resistance

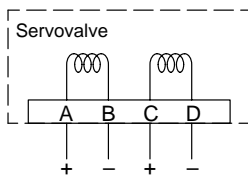
Select coil resistance and connections for compatible interface to servo electronics. **Recommended coil resistance is shown in bold print.**

	Nominal Resistance Per Coil at 21°C (70°F) Ohms	Rated Current mA	
		Single, Parallel, or Differential Connection	Series Connection
Standard response coil resistance selection	20	200	100
	30	100	50
	80	40	20
	80	50	25
	140	40	20
	200	15	7.5
	200	20	10
	300	30	15
	1000	10	5
	1500	8	4
High response coil resistance	80	40	20
	200	20	10

Electrical Polarity for Control Flow Out of B Port

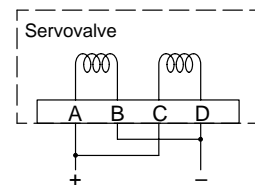
Single:

A+, B-
or
C+, D-



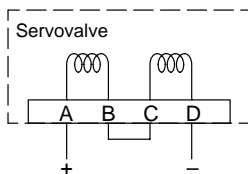
Parallel:

A+, C+
B-, D-
Connect A and C
Connect B and D



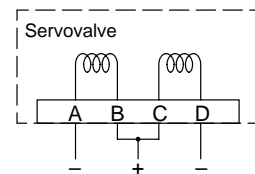
Series:

A+, D-
Connect B and C



Differential:

A-, D-
B+, C+
Connect B and C
BC-, current BA>CD
BC+, current CD>BA



Performance Curves

Frequency Response

Frequency response is defined as the relationship of no-load control flow to input current with a sinusoidal current sweep at constant amplitude over a range of frequencies. It is expressed in frequency (Hz), amplitude ratio (dB), and phase angle (degrees).

As shown in the sample curve (below left), standard comparison points for servovalve frequency response are those frequencies at which -3 dB ratio and 90° phase angle occur.

Vickers SX4 torque motors are magnetically stabilized for reliable servovalve performance at operating pressures from 14 to 350 bar (200 to 5000 psi).

Calculating Frequency Response at System Pressure

P_S = System pressure

P_M = Maximum supply pressure of valve: 210 bar (3000 psi) for SX4-10/12/15/20 and 350 bar (5000 psi) for SX4-V-20

f_{PM} = Frequency (at 90° phase angle) at maximum supply pressure (P_M)

f_{PS} = Frequency (at 90° phase angle) at system pressure (P_S)

1. Calculate the ratio of system pressure to maximum supply pressure:

$$\frac{P_S}{P_M}$$

2. Use the result of step 1 and the curve below to estimate

$$\frac{f_{PS}}{f_{PM}}$$

3. Use the applicable frequency response curve from the following pages to estimate f_{PM} (the maximum supply pressure frequency response at 90° phase angle) for the desired valve.

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

Example: A standard performance SX4-20 valve with a flow of 38 l/min (10 USgpm) is to be used at 165 bar (2400 psi).

1. Calculate the ratio of system pressure to maximum supply pressure:

$$\frac{P_S}{P_M} = \frac{2400 \text{ psi}}{3000 \text{ psi}} = 0.8$$

2. Use the result of step 1 and the curve below right to estimate

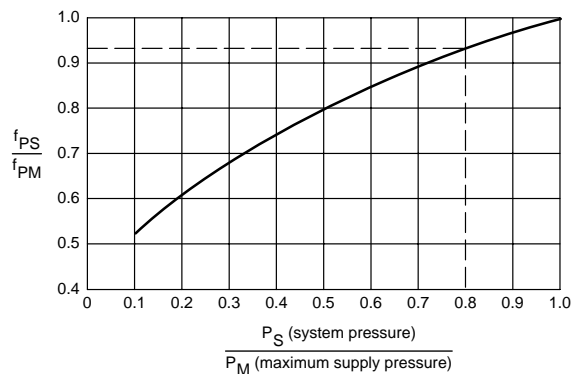
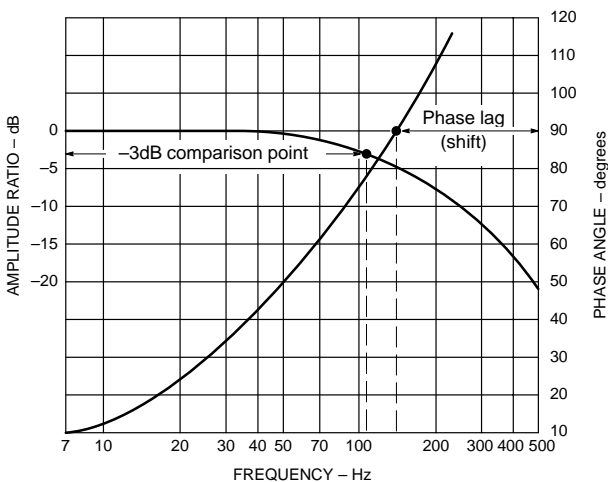
$$\frac{f_{PS}}{f_{PM}} = 0.92$$

3. Use the frequency response curve from page 8 to estimate f_{PM} .

$$f_{PM} = 120 \text{ Hz}$$

4. Multiply the values obtained in steps 2 and 3. The result is f_{PS} (system pressure frequency response at 90° phase angle).

$$f_{PS} = 0.92 \times 120 \text{ Hz} = 110 \text{ Hz}$$

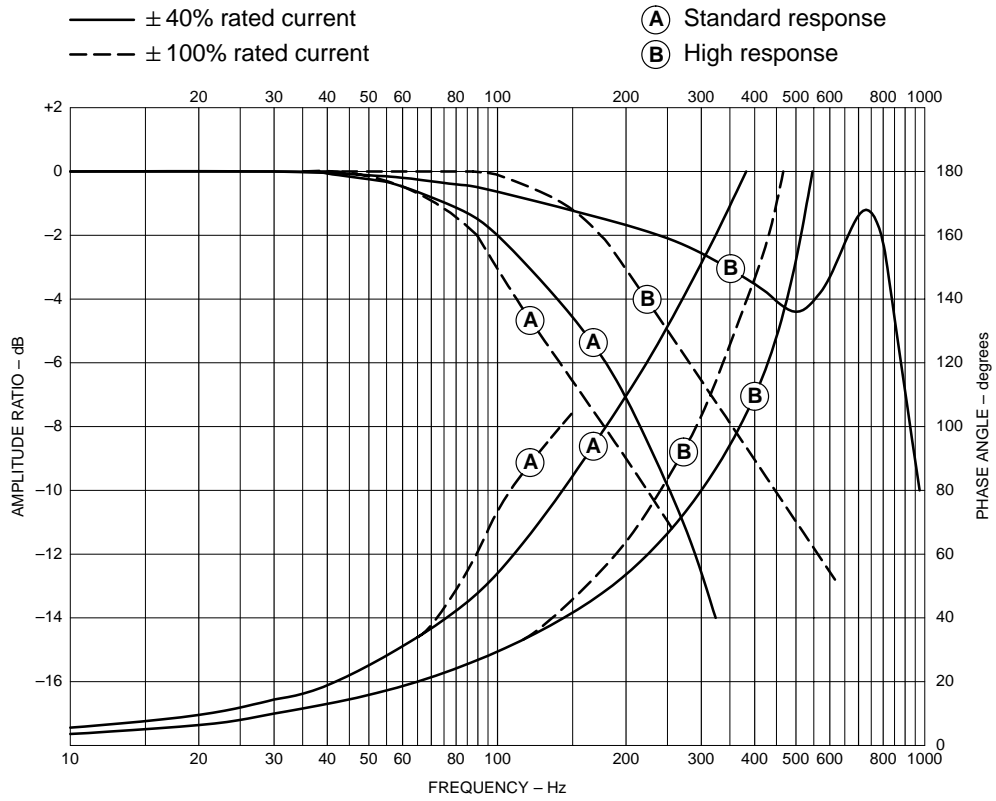


Performance Curves

Typical Frequency Response Curves

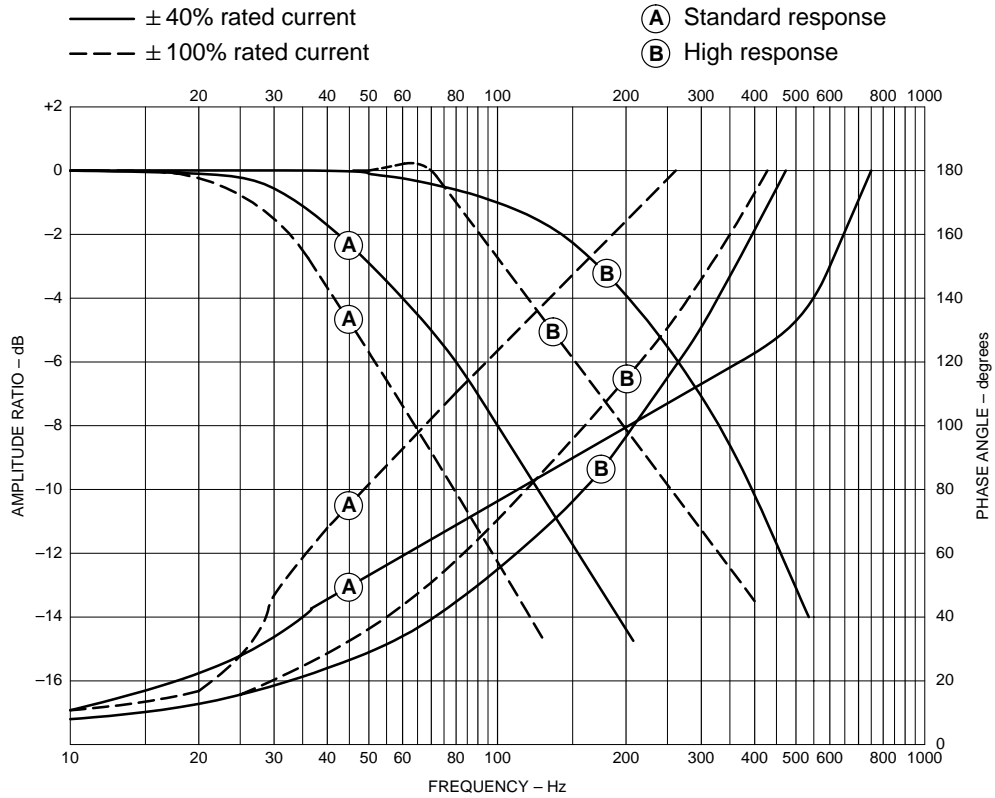
At 210 bar (3000 psi)

1, 2.5, and 5 USgpm servovalves

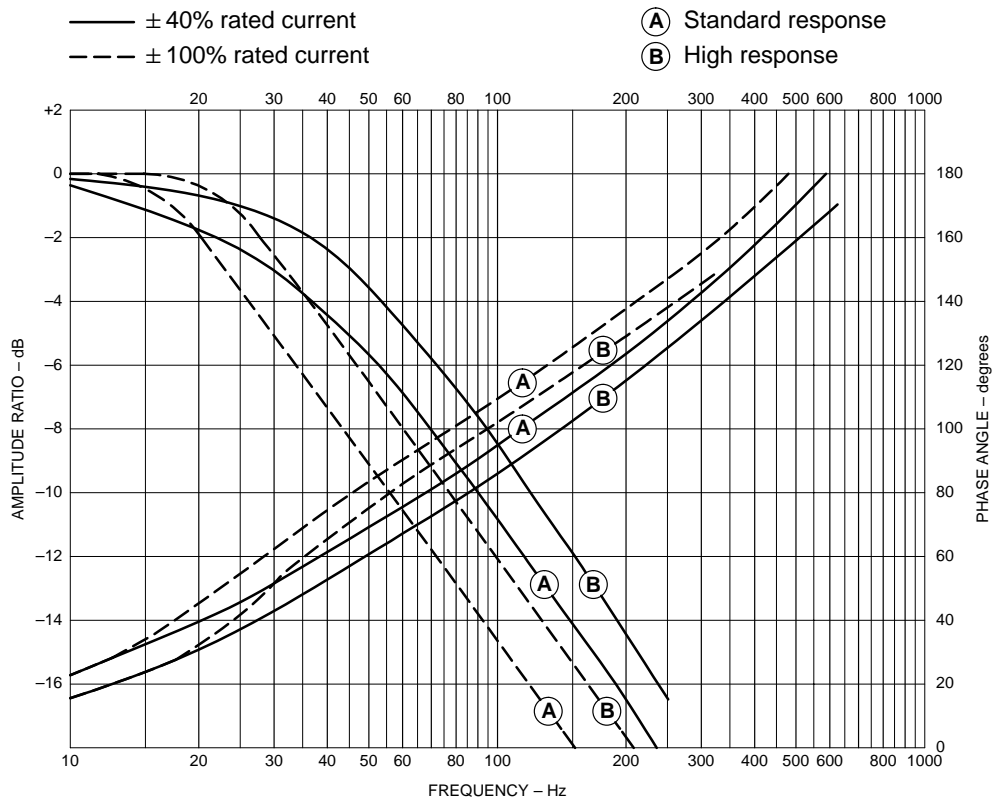


Performance Curves

10 USgpm servovalves



15 and 20 USgpm servovalves

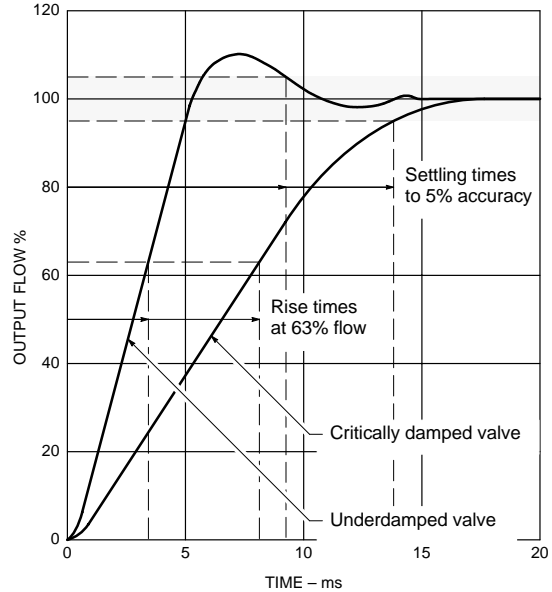


Performance Curves

Step Response

Step response is defined as the typical rise time needed to achieve a given percentage of control flow output. Settling time is the time needed for transient flow fluctuations to diminish to within a given accuracy range. Both are expressed in milliseconds (ms).

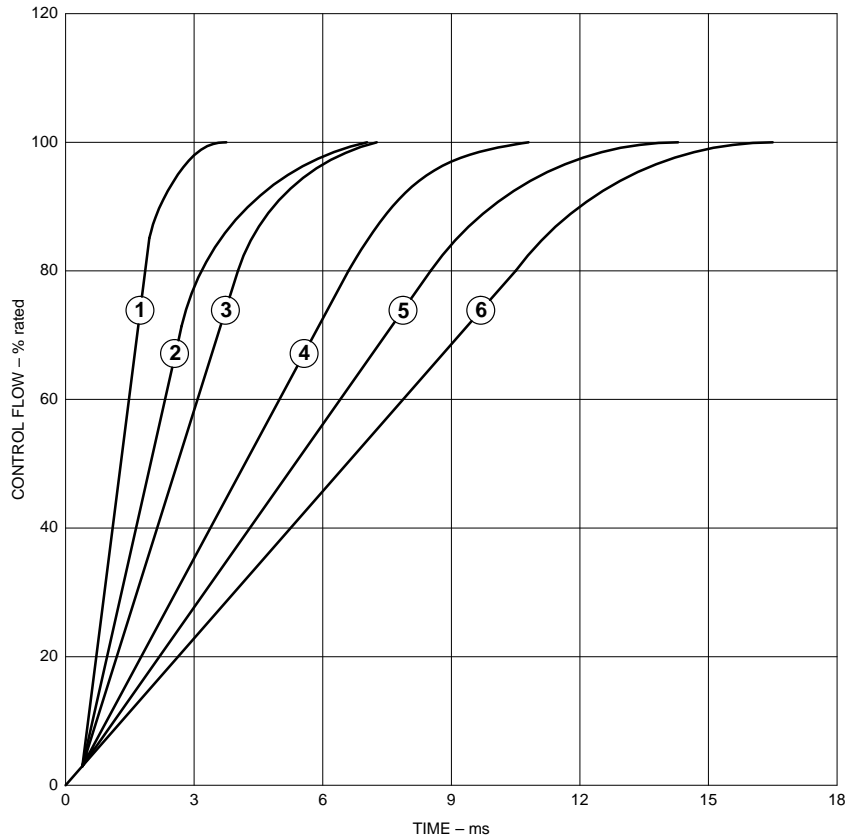
The example at right shows the step response curves for a critically damped valve and an underdamped valve. Rise times are illustrated for 63% of control flow output, and settling times are shown at 95% of control flow output.



Typical Step Response Curves for Standard Models

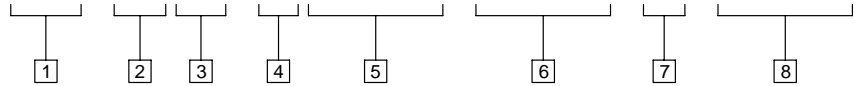
SX4-10/12/15/20 shown at 210 bar (3000 psi).

- ① 1, 2.5, and 5 USgpm high response
- ② 1, 2.5, and 5 USgpm standard response
- ③ 10 USgpm high response
- ④ 10 USgpm standard response
- ⑤ 15 and 20 USgpm high response
- ⑥ 15 and 20 USgpm standard response



Model Code

SX4 - (H) (V) - ** () ** - ***/** - 10 - (S ***)**



1 Series designation

SX4 – Servovalve, extended frequency response, four-way

2 Response

Blank – Standard response
H – High response*

* – High response at flow rates above 38 l/min (10 USgpm) available in SX4-20 valve size only.

3 Pressure rating

Blank – 210 bar (3000 psi)
V – 350 bar (5000 psi)

4 Valve size (mechanical interface)

10 – 15,9 mm (0.625 in) port circle
12 – 19,8 mm (0.780 in) port circle
15 – 23,8 mm (0.937 in) port circle
20 – 22,2 mm (0.875 in) port circle

5 Flow rating

At 70 bar (1000 psi) Δp P→A→B→T.
Other flows available on request.

Code	USgpm	l/min
(1) 3,8	1.0	3,8
(2.5) 9	2.5	9
(5) 19	5.0	19
(10) 38	10.0	38
(15) 57**	15.0	57
(20) 76†	20.0	76

** – 15 and 20 size valves only
† – 20 size valves only

6 Coil resistance/rated current

Ohms/mA at 21°C (70°F). Other coils available on request.

Code	Ohms	mA
20/200	20	200
30/100	30	100
80/40	80	40
80/50	80	50
140/40	140	40
200/15	200	15
200/20	200	20
300/30	300	30
1000/10	1000	10
1500/8	1500	8

7 Design number

Subject to change. Installation dimensions same for designs 10 through 19.

8 Special feature suffix

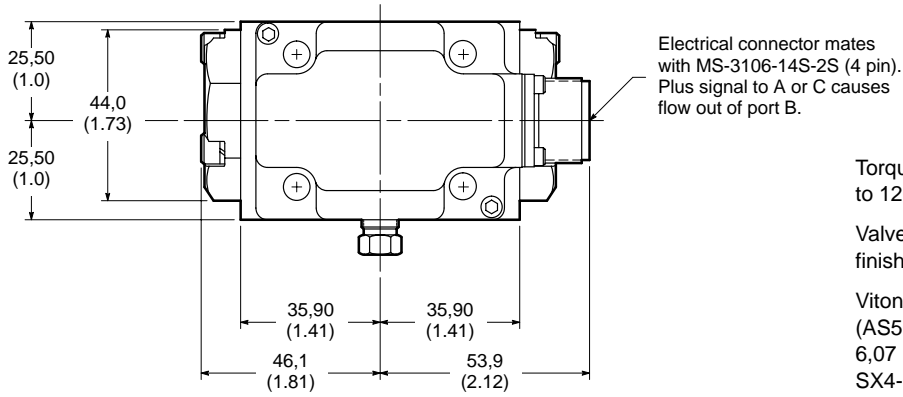
S*** – Vickers assigns a unique suffix to denote a particular group of special features. Contact your Vickers representative for details.

Blank – Standard valve

Installation Dimensions

SX4-10/12/15

millimeters (inches)

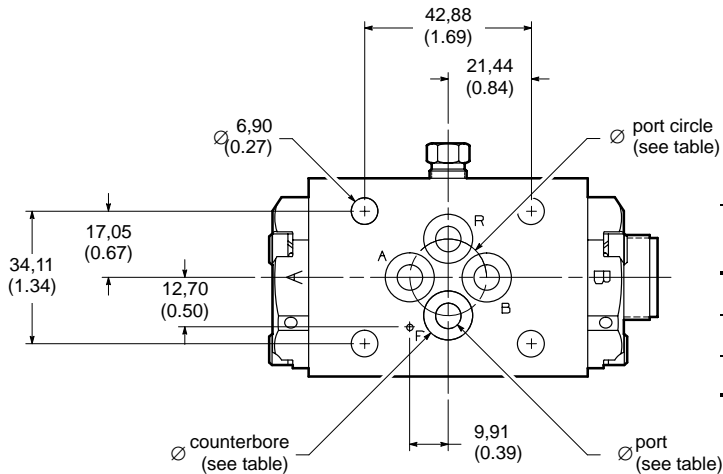
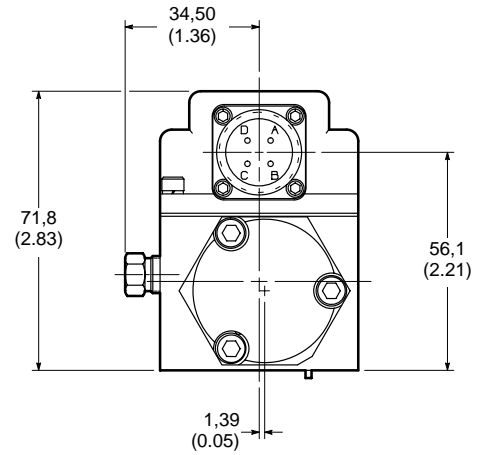
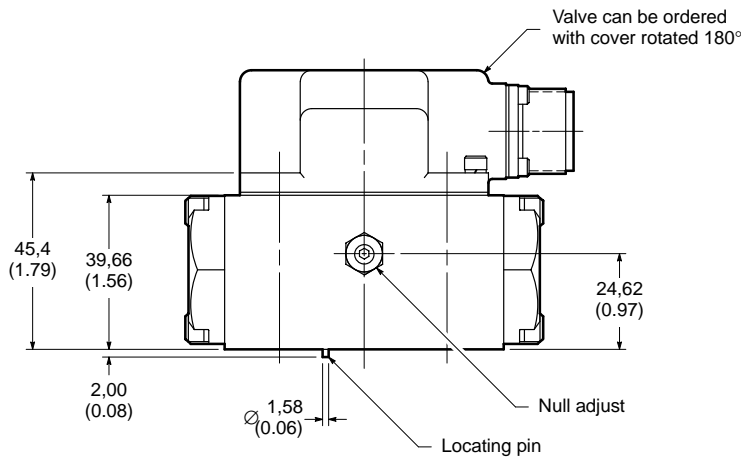


NOTES

Torque mounting screws to 12 to 14 Nm (108 to 120 lb.in.).

Valve mounting surface requires 32 microinch finish flat within 0,025 (0.001).

Viton port O-rings provided. SX4-10 O-rings (AS568-010): 1,78 (0.070) cross section and 6,07 (0.239) inner diameter. SX4-12 and SX4-15 O-rings (AS568-013): 1,78 (0.070) cross section and 10,82 (0.426) inner diameter.



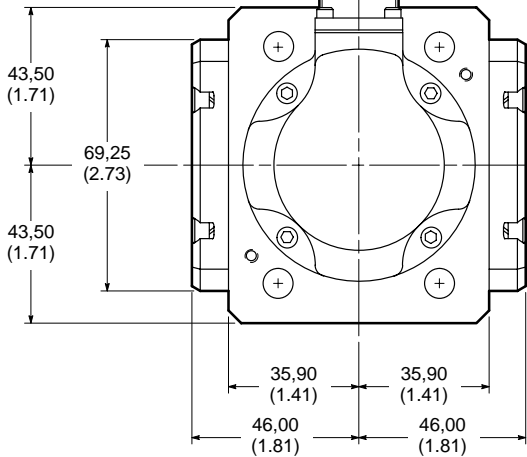
Valve Size	Port Circle Diameter	Port Diameter	Counterbore Diameter
10	15,88 (0.625)	4,85 (0.191)	9,58 (0.377)
12	19,80 (0.780)	6,60 (0.260)	12,74 (0.501)
15	23,80 (0.937)	7,92 (0.312)	14,30 (0.563)

Installation Dimensions

SX4-20

millimeters (inches)

Electrical connector mates with MS-3106-14S-2S (4 pin). Plus signal to A or C causes flow out of port B.

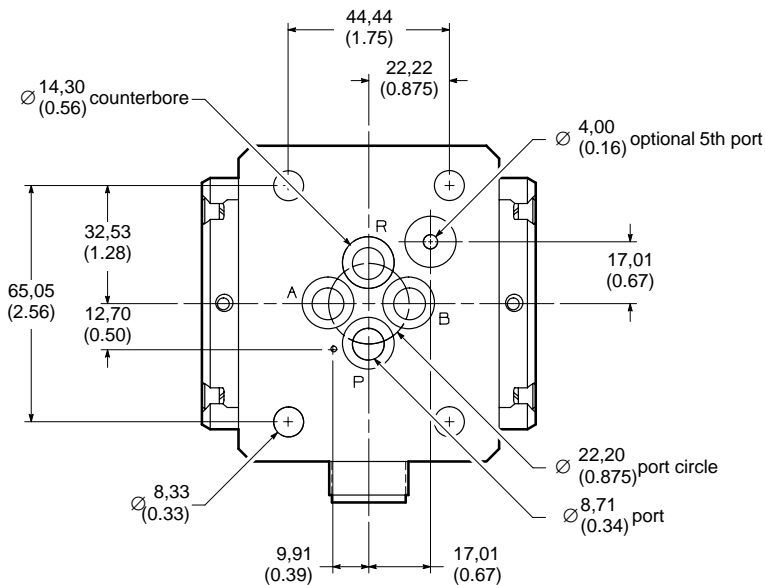
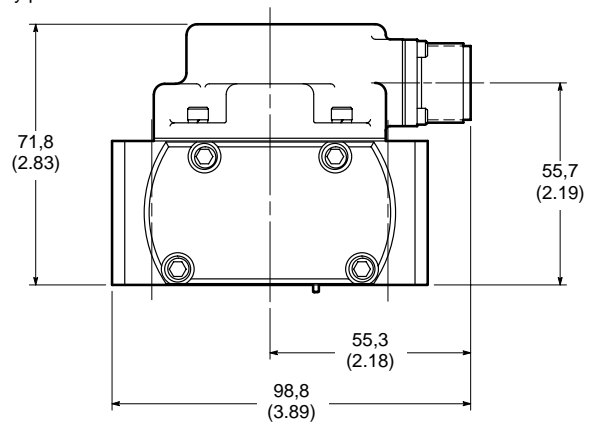
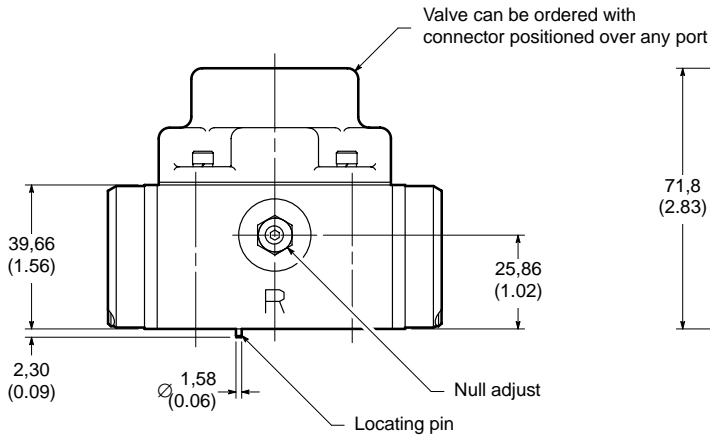


NOTES

Torque mounting screws to 14 to 15 Nm (120 to 130 lb.in.).

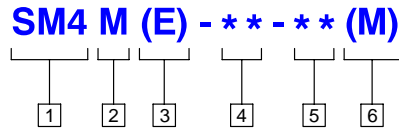
Valve mounting surface requires 32 microinch finish flat within 0,025 (0.001).

Viton port O-rings provided. SX4-20 O-rings (AS568-013): 1,78 (0.070) cross section and 10,82 (0.426) inner diameter.



SM4M(E) Mounting Subplates

Model Code

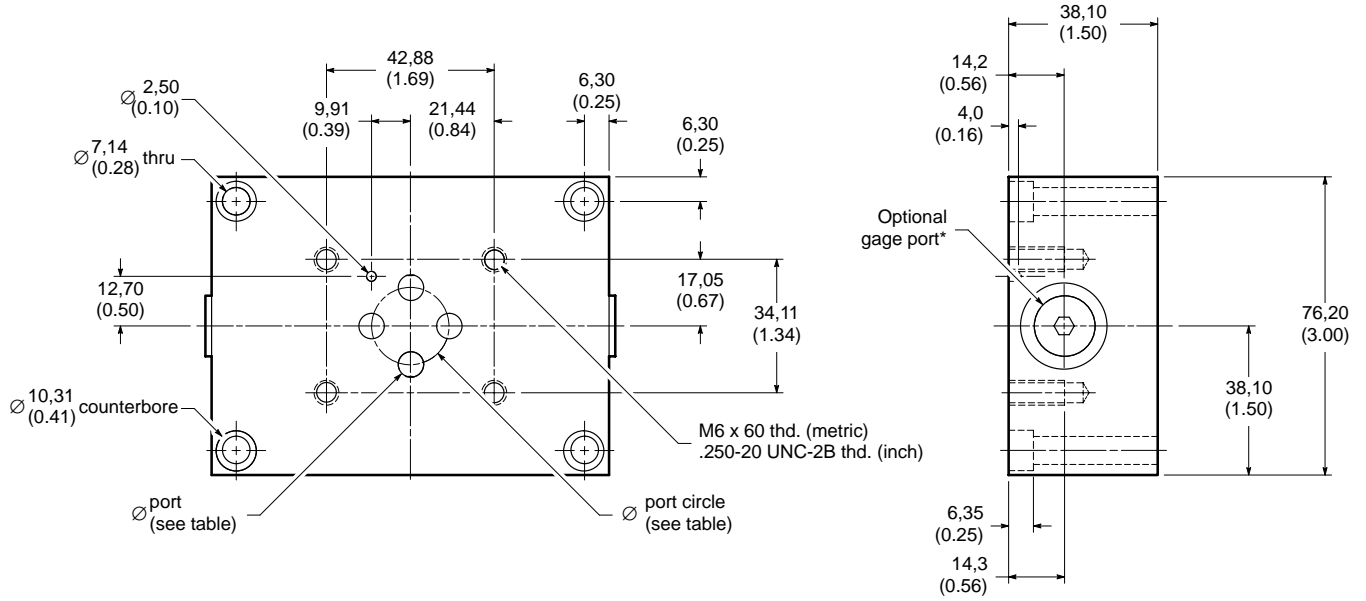


SM4M(E) Mounting Subplates

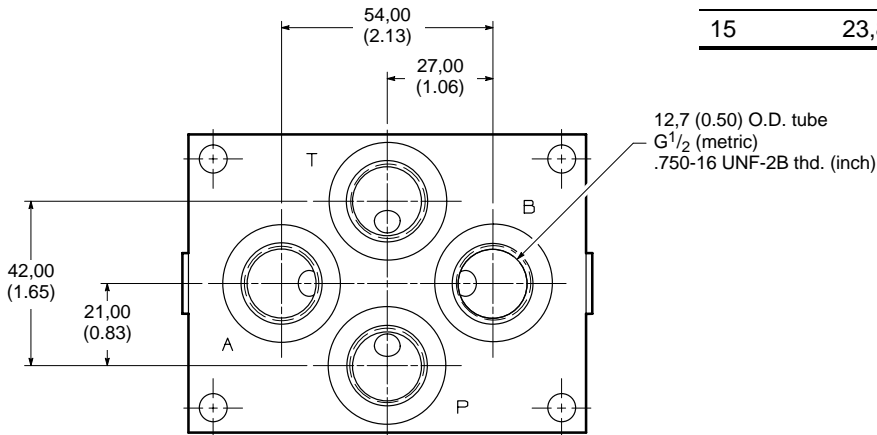
Installation Dimensions

millimeters (inches)

**SM4M-10-10,
SM4M-12-10,
and SM4M-15-10**



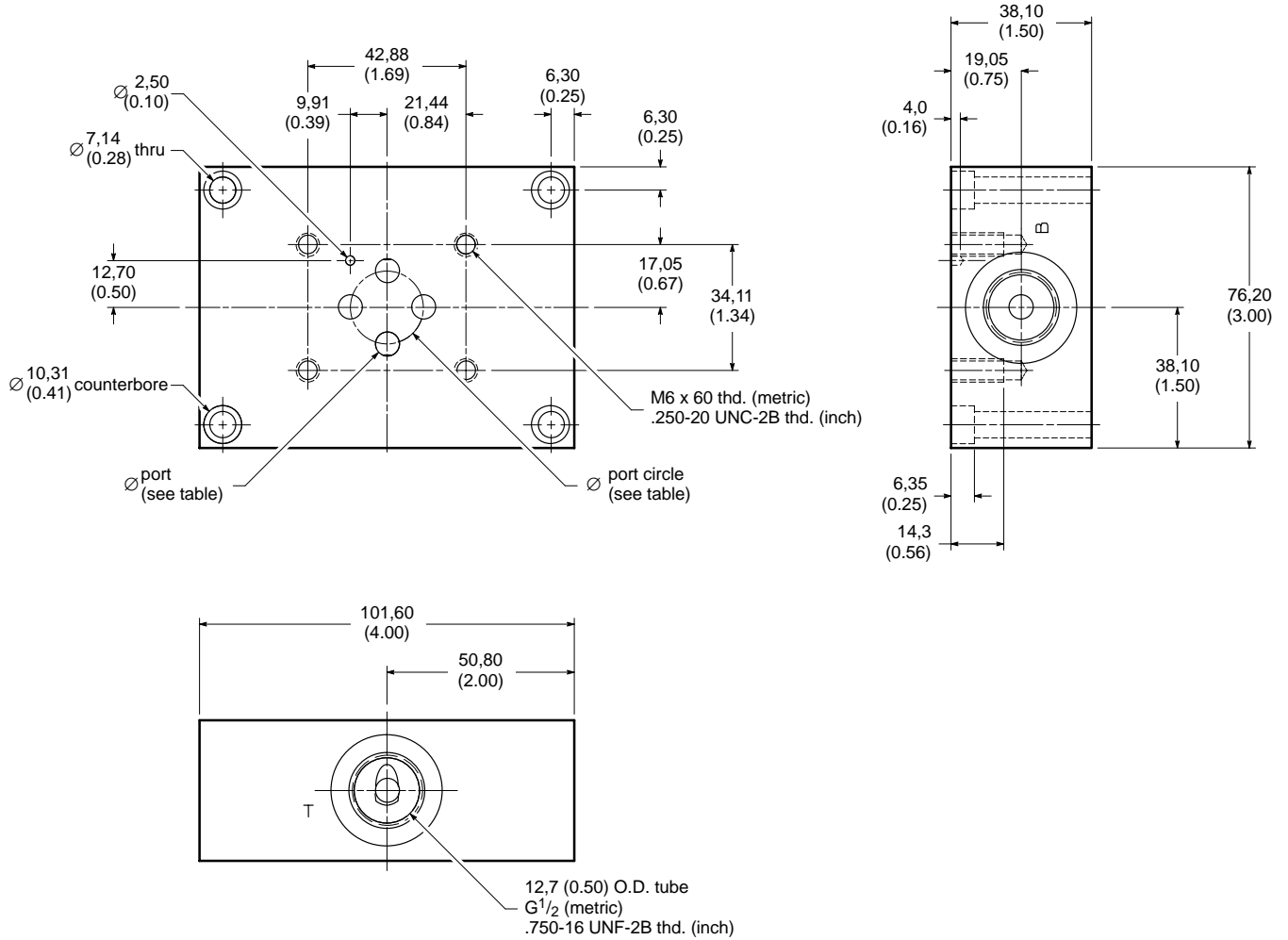
* - 6,35 (0.25) O.D. tube
G¹/₄ (metric)
.4375-20 UNF-2B thd. (inch)



Subplate Size	Port Circle Diameter	Port Diameter
10	15,88 (0.625)	4,85 (0.191)
12	19,80 (0.780)	6,60 (0.260)
15	23,80 (0.937)	7,92 (0.312)

SM4M(E) Mounting Subplates

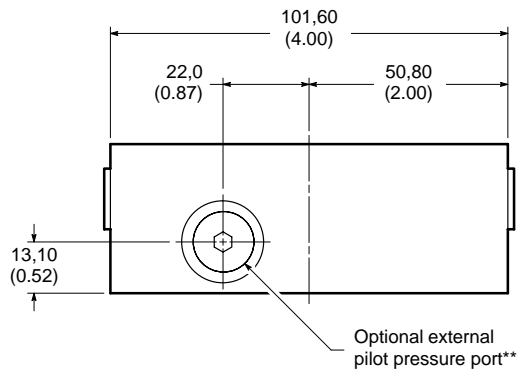
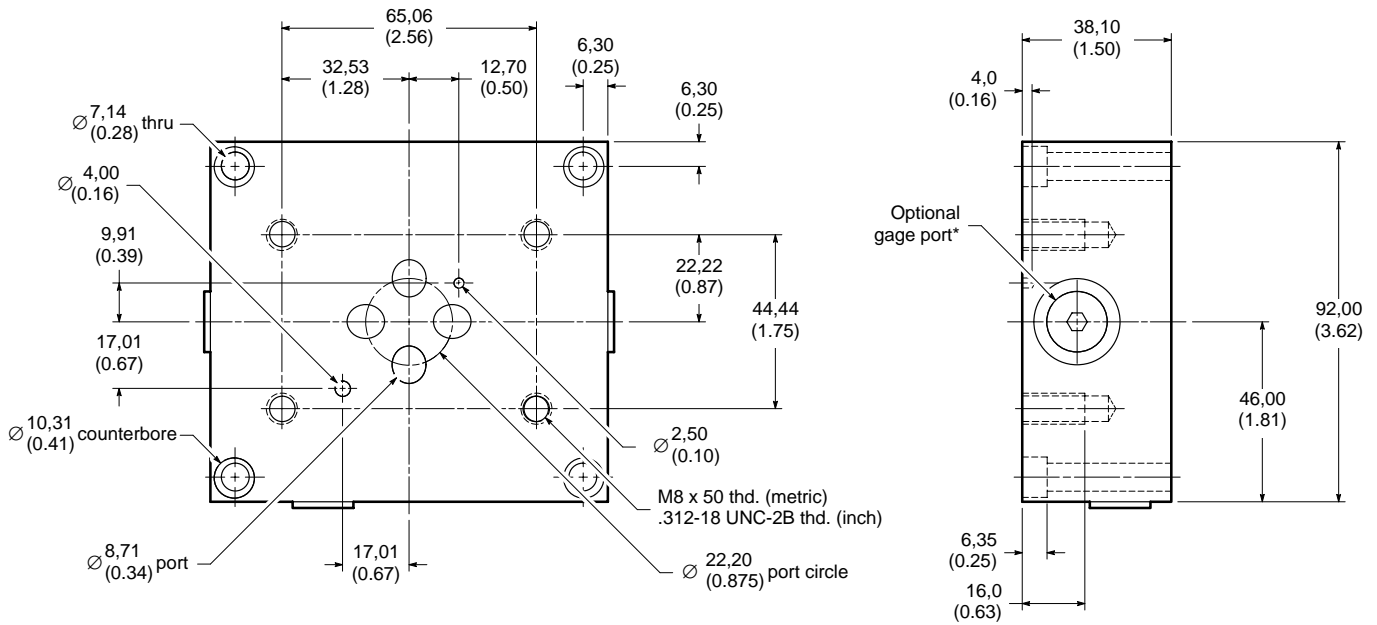
**SM4ME-10-10,
SM4ME-12-10,
and SM4ME-15-10**



Subplate Size	Port Circle Diameter	Port Diameter
10	15,88 (0.625)	4,85 (0.191)
12	19,80 (0.780)	6,60 (0.260)
15	23,80 (0.937)	7,92 (0.312)

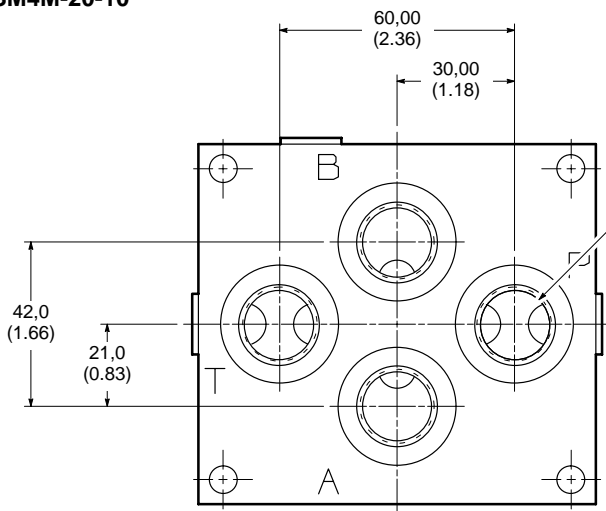
SM4M(E) Mounting Subplates

SM4M-20-10/50



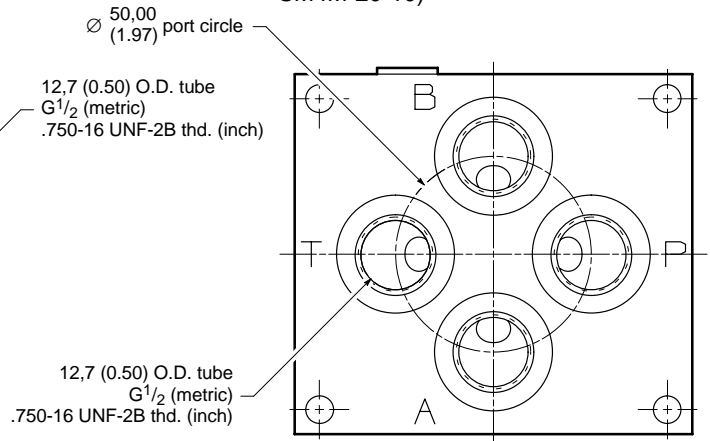
- * - SM4M-20-10 only
6.35 (0.25) O.D. tube
G¹/₄ (metric)
.4375-20 UNF-2B thd. (inch)
- ** - 6.35 (0.25) O.D. tube
G¹/₄ (metric)
.4375-20 UNF-2B thd. (inch)

SM4M-20-10



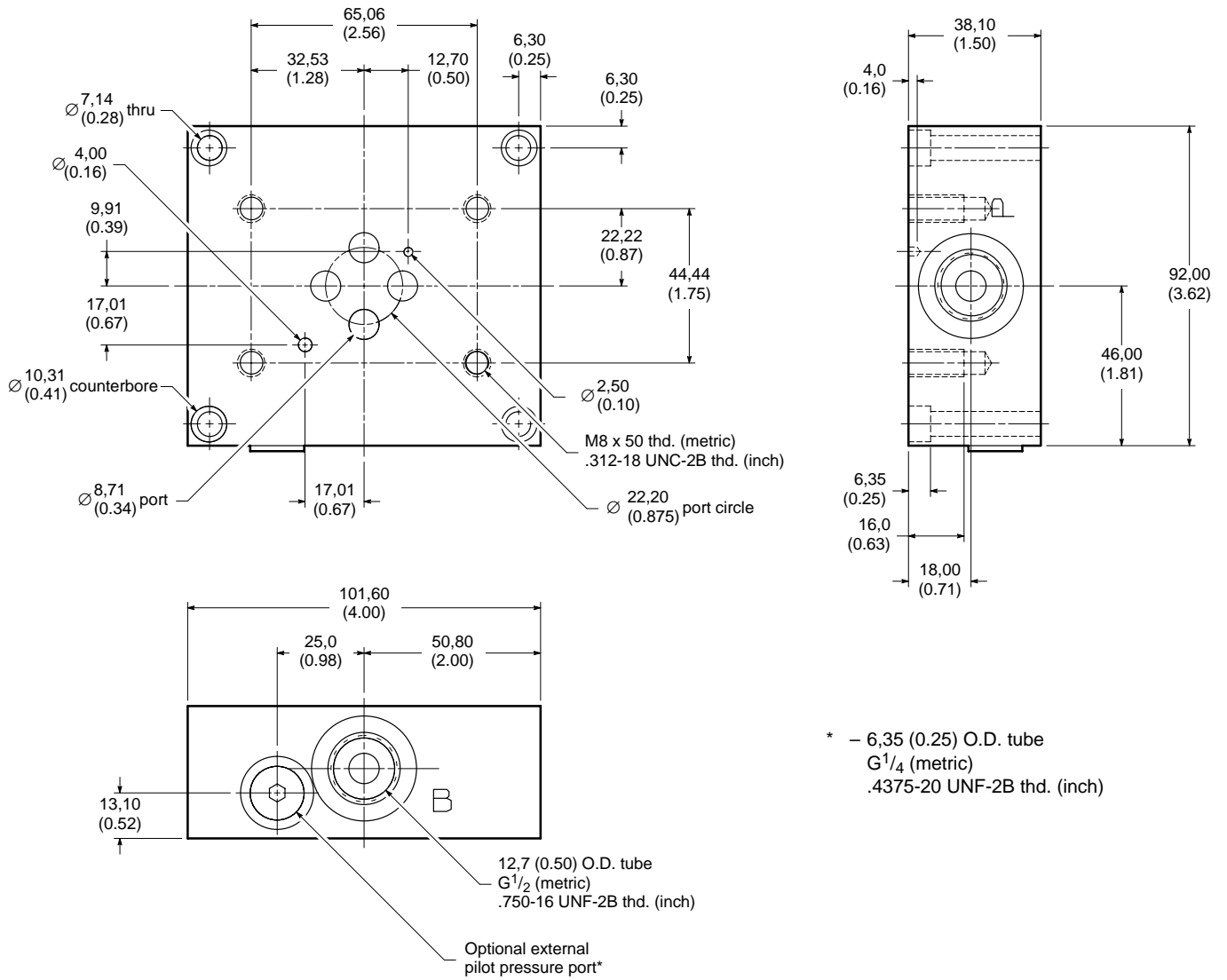
SM4M-20-50

(All other dimensions same as SM4M-20-10)



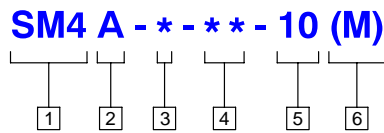
SM4M(E) Mounting Subplates

SM4ME-20-10/50



SM4A Adapter Manifolds

Model Code



1 Series designation

SM4 – Servovalve, high performance, four-way (for use with SX4 or SM4 valves)

3 Interface

- 3 – ISO 4401-03 (for SM4-10/12/15)
- 5 – ISO 4401-05 (for SM4-15/20)

5 Design number

Subject to change. Installation dimensions same for designs 10 through 19.

2 Accessory designation

A – Adapter manifold. Maximum supply pressure of 210 bar (3000 psi).

4 Standard SM4 valve size

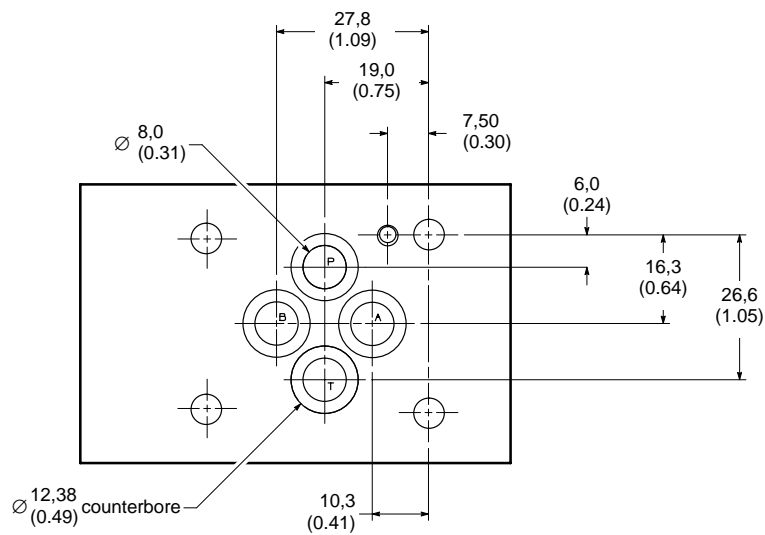
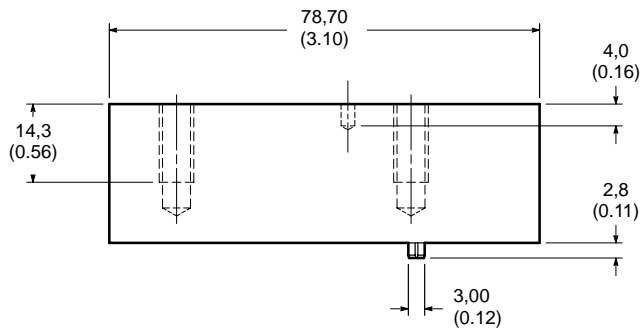
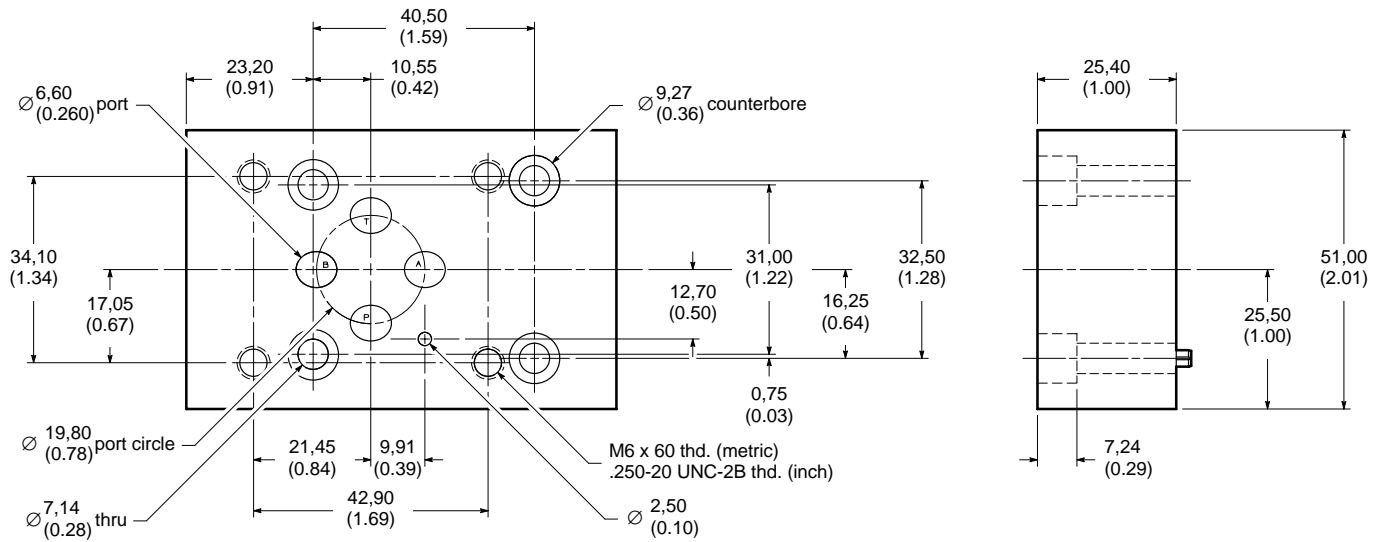
- 10 – SM4-10
- 12 – SM4-12
- 15 – SM4-15
- 20 – SM4-20 or SP4-25

6 Metric suffix

- M – Metric version to NG (ISO) standards
- Blank – Omit if not required

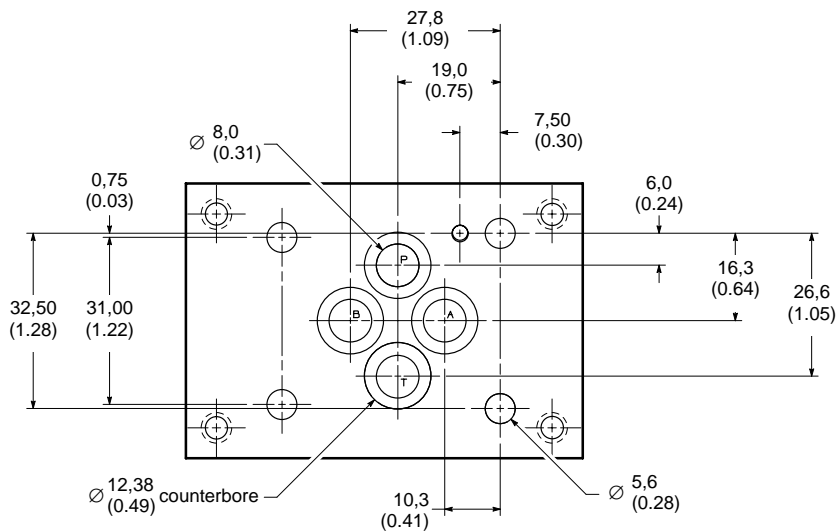
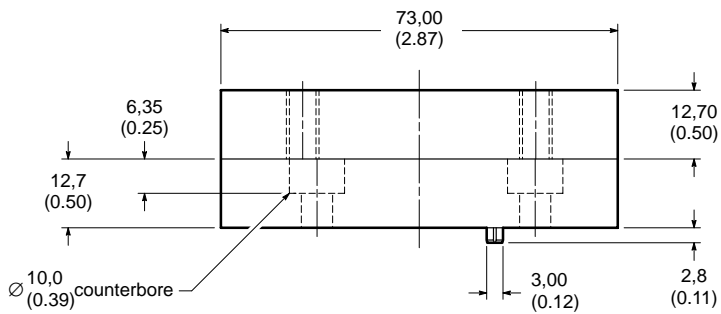
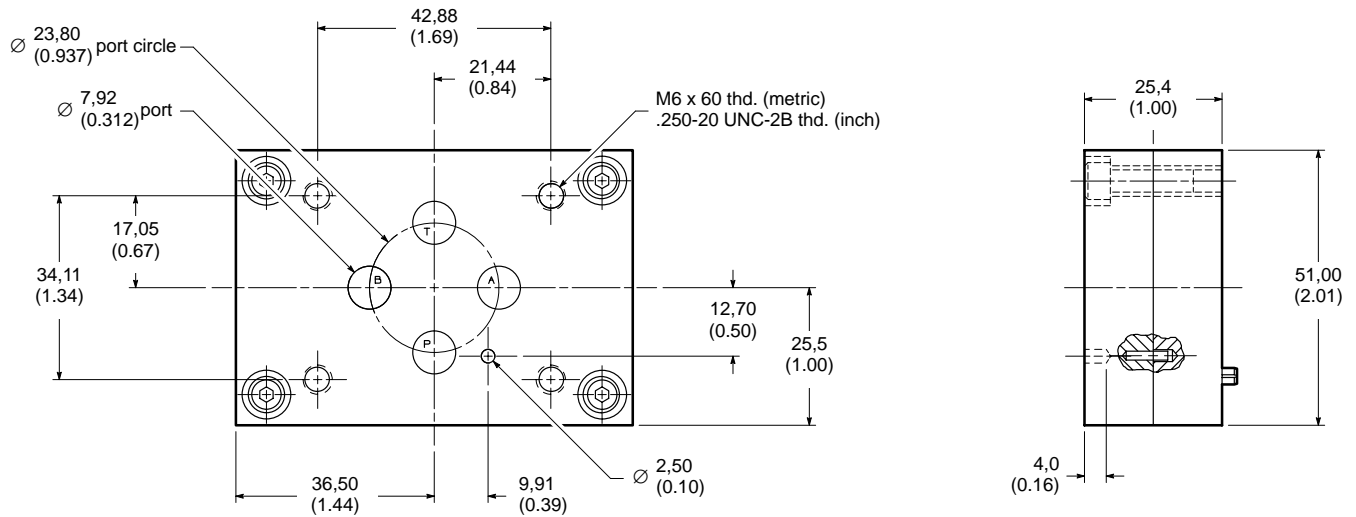
SM4A Adapter Manifolds

SM4A-3-12-10



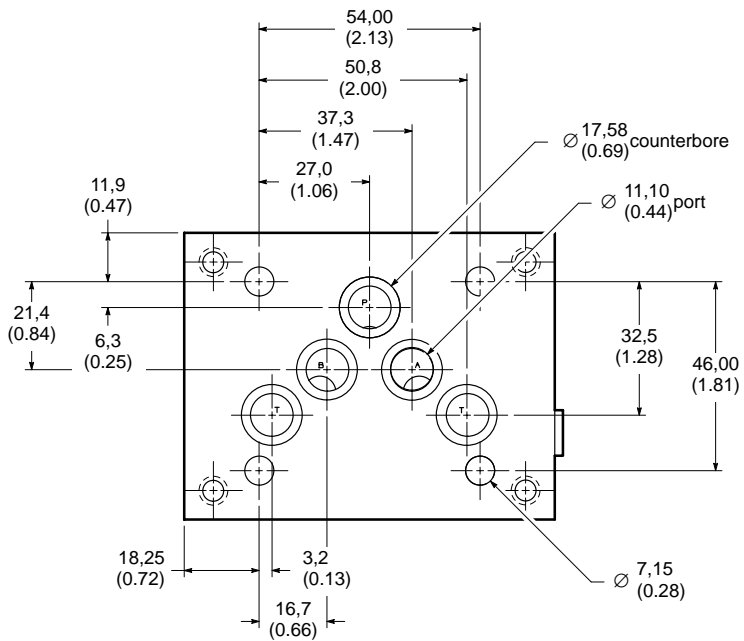
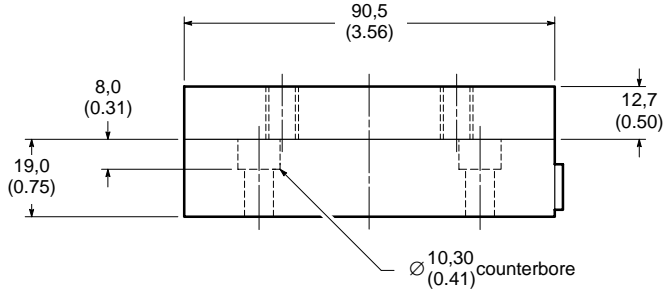
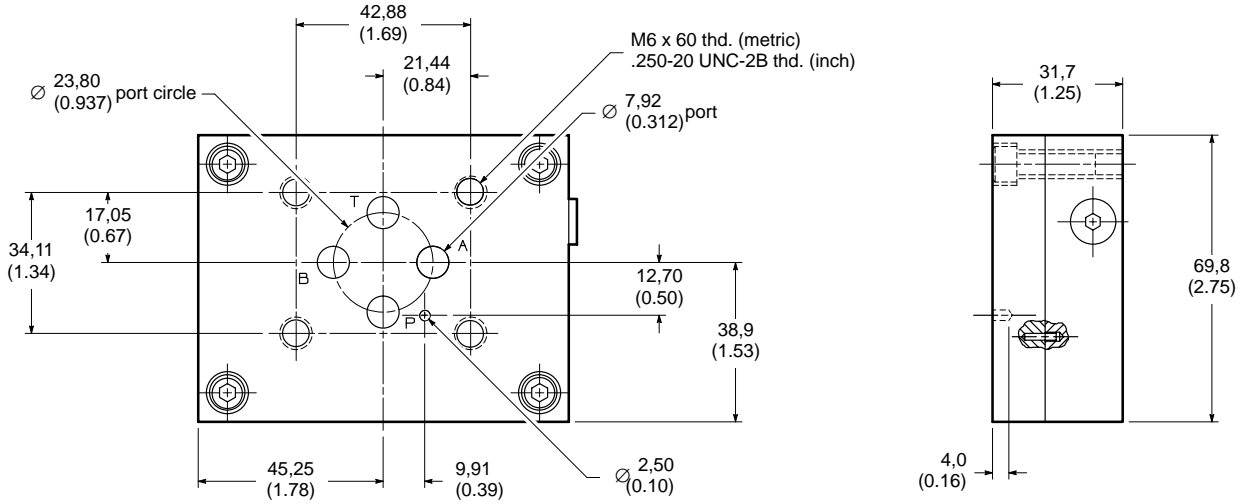
SM4A Adapter Manifolds

SM4A-3-15-10



SM4A Adapter Manifolds

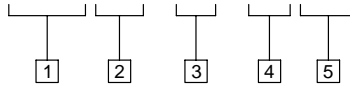
SM4A-5-15-10



SM4FV Flushing Valves

Model Code

SM4 FV - * * - 10 (M)



1 Series designation

SM4 – Servovalve, high performance, four-way (for use with SX4 or SM4 valves)

3 Standard SM4 valve size

10/12/15 – SM4-10
20 – SM4-20 or SP4-25

5 Metric suffix

M – Metric version to NG (ISO) standards
Blank – Omit if not required

2 Accessory designation

FV– Flushing valve. Maximum flushing pressure of 35 bar (500 psi).

4 Design number

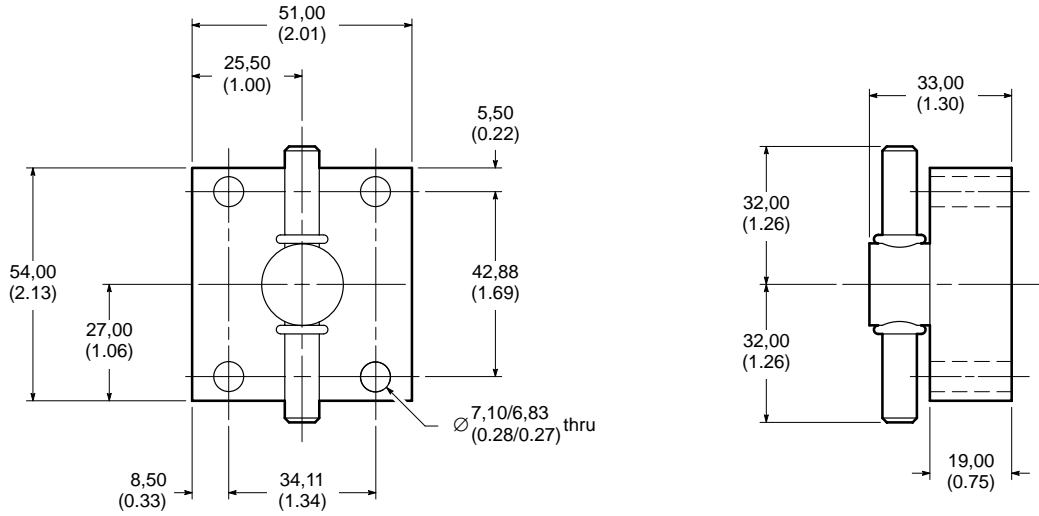
Subject to change. Installation dimensions same for designs 10 through 19.

SM4FV Flushing Valves

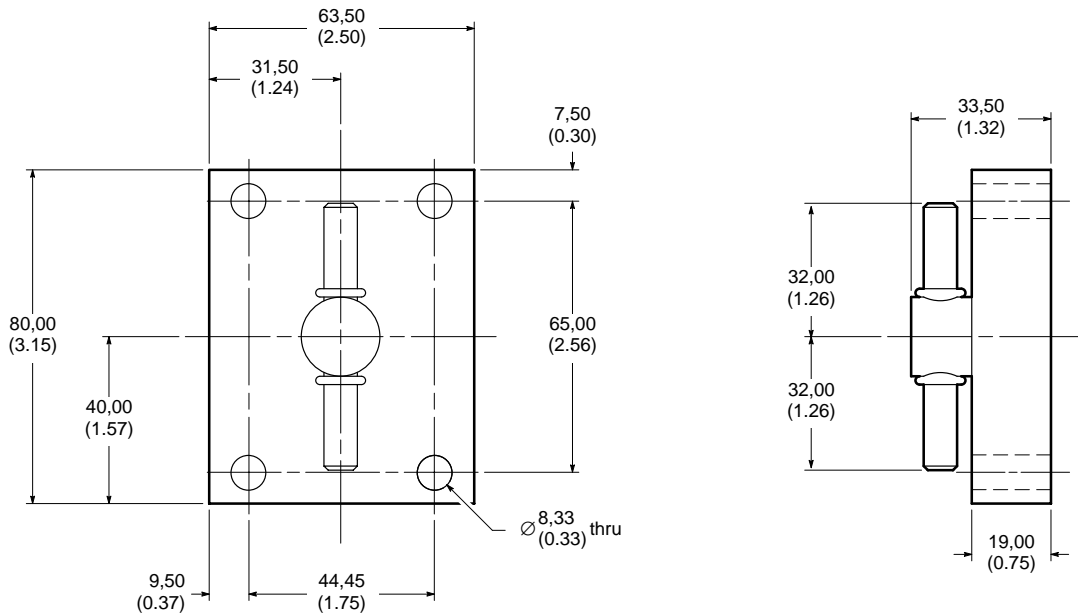
Installation Dimensions

millimeters (inches)

SM4FV-10/12/15-10



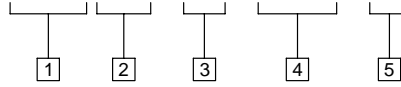
SM4FV-20-10



SM4FM Filter Modules

Model Code

SM4 FM - 20 - (CB) - * *



1 Series designation

SM4 – Servo valve, high performance, four-way (for use with SX4 or SM4 valves)

2 Accessory designation

FM – Filter module. Maximum supply pressure of 210 bar (3000 psi), except -5* designs with maximum supply pressure of 350 bar (5000 psi).

3 Standard SM4 valve size

20 – SM4-20 or SP4-25

4 Crossport bleed designation

CB – Includes crossport bleed feature
Blank – Omit if not required

5 Design number

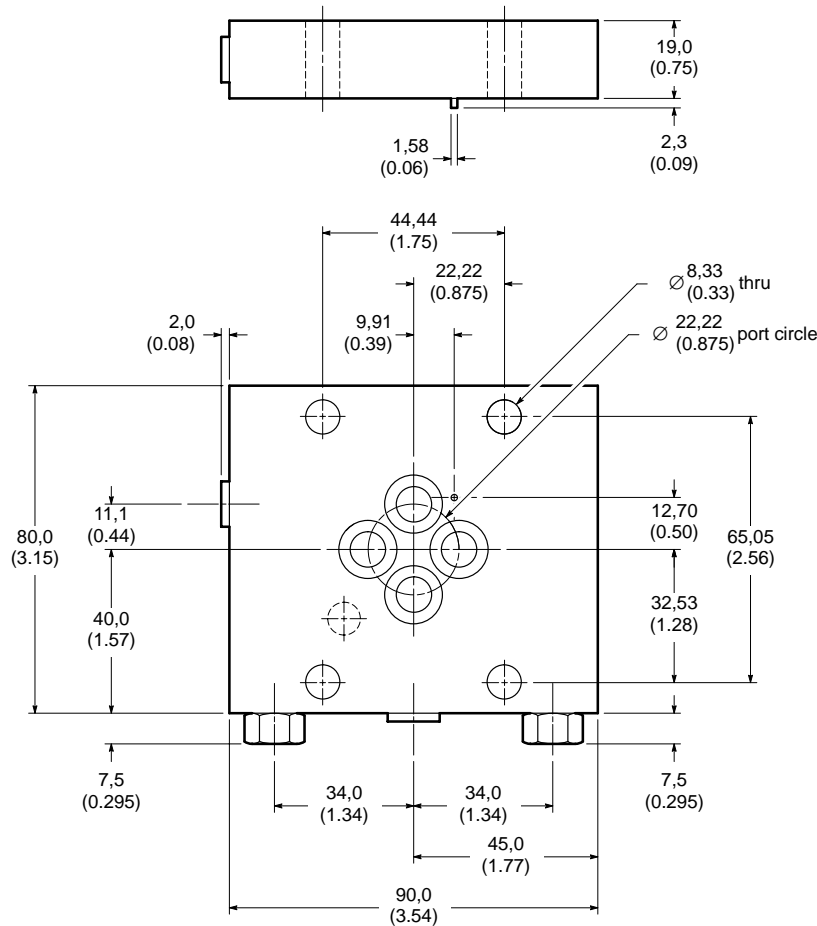
Subject to change. Installation dimensions same for designs 10 through 19.

Installation dimensions also same for designs 50 through 59. Maximum supply pressure of 350 bar (5000 psi).

Installation Dimensions

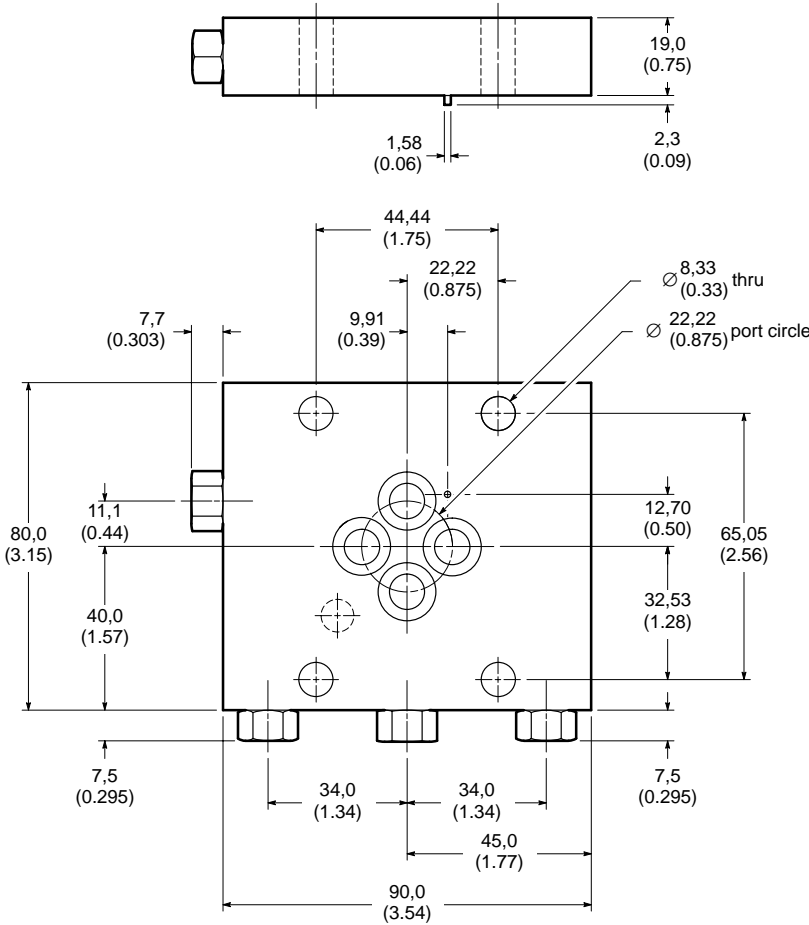
millimeters (inches)

SM4FM-20-10



SM4FM Filter Modules

SM4FM-20-50



Weights

The following table lists approximate dry weights for SX4 servovalves and related accessories.

Description	Model Code	Weight kg (lbs.)
Servovalve	SX4-10/12/15	0,73 (1.6)
	SX4-20	1,04 (2.3)
	SX4-20-V	2,18 (4.8)
Mounting subplate	SM4M(E)-10/12/15-10	0,73 (1.6)
	SM4M(E)-20-10/50	0,91 (2.0)
Adapter manifold	SM4A-3-10/12/15-10(M)	0,240 (0.53)
	SM4A-5-15-10	0,499 (1.10)
	SM4A-5-20-10/50	0,439 (0.97)
Flushing valve	SM4FV-10/12/15-10(M)	0,15 (0.32)
	SM4FV-20-10(M)	0,27 (0.58)
Filter module	SM4FM-20-50	1,04 (2.3)

Additional Accessories

SX4-10/12/15 Accessories	Model Code
Adapter manifold, SX4-15 to 0.875 port circle (inch)	SM4A-15-M76-10
Adapter manifold, SX4-15 to 0.875 port circle (metric)	SM4A-15-M76-10M
Adapter manifold (SX4-15 to 0.875 port circle) mounting bolt kit (inch) $\frac{5}{16}$ -18 x 1 $\frac{1}{2}$ "	BK688701
Adapter manifold (SX4-15 to 0.875 port circle) mounting bolt kit (metric) M8 x 35mm	BK689630
Adapter manifold (SM4A-3-10 or SM4A-3-15) mounting bolt kit (inch) $\frac{1}{4}$ -20 x 1"	BK855984
Adapter manifold (SM4A-3-10 or SM4A-3-15) mounting bolt kit (metric) M5 x 12mm	BK855985M
Adapter manifold (SM4A-5-15) mounting bolt kit (inch) $\frac{1}{4}$ -20 x $\frac{3}{4}$ "	BK855986
Adapter manifold (SM4A-5-15) mounting bolt kit (metric) M6 x 20mm	BK855987M
Cable clamp (MS3057-6)	126058
Cable connector (MS3106-14S-2S)	242123
Connector kit	926467
Filter kit	927826
Flushing valve mounting bolt kit (inch) $\frac{1}{4}$ -20 x 1"	BK866686
Flushing valve mounting bolt kit (metric) M6 x 25mm	BK689629M
Seal kit (SX4-10)	927808
Seal kit (SX4-12)	927809
Seal kit (SX4-15)	927810

SX4-10/12/15 Accessories (continued)	Model Code
Subplate mounting bolt kit (inch) $1/4-20 \times 1\frac{1}{2}$ "	BK855992
Subplate mounting bolt kit (metric) M6 x 40mm	BK855993M
Valve mounting bolt kit (inch) $1/4-20 \times 2\frac{1}{4}$ "	BK866685
Valve mounting bolt kit (metric) M6 x 60mm	BK689623M

SX4-20 Accessories	Model Code
Adapter manifold mounting bolt kit (inch) $1/4-20 \times 1$ "	BK866686
Adapter manifold mounting bolt kit (metric) M6 x 25mm	BK689629M
Cable clamp (MS3057-6)	126058
Cable connector (MS3106-14S-2S)	242123
Connector kit	926467
Cross-port bleed module mounting bolt kit (inch) $5/16-18 \times 2\frac{3}{4}$ "	BK855421
Filter kit (SX4-20 and SX4-H-20)	927774
Filter kit (SX4-V-20 and SX4-HV-20)	927775
Filter module kit (SX4-20 and SX4-H-20)	886819
Filter module mounting bolt kit (inch) $5/16-18 \times 2\frac{3}{4}$ "	BK855421
Filter module mounting bolt kit (metric) M8 x 70mm	BK689624M
Filter module with cross-port bleed mounting bolt kit (inch) $5/16-18 \times 3\frac{1}{4}$ "	BK927736
Flushing valve mounting bolt kit (inch) $5/16-18 \times 1\frac{1}{4}$ "	BK688701
Flushing valve mounting bolt kit (metric) M8 x 35mm	BK689630M
Seal kit (SX4-20)	927776
Seal kit (SX4-H-20)	927777
Subplate mounting bolt kit (inch) $1/4-20 \times 1\frac{1}{2}$ "	BK855992
Subplate mounting bolt kit (metric) M6 x 40mm	BK855993M
Valve mounting bolt kit (inch) $5/16-18 \times 2$ "	BK866687
Valve mounting bolt kit (metric) M8 x 50mm	BK866690M

Servo Electronics

Refer to application brochure 656 for the complete Vickers line of amplifiers, power supplies, and function modules.

Application Data

Fluid Cleanliness

Proper fluid condition is essential for long and satisfactory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials, and additives for protection against wear of components, elevated viscosity and inclusion of air.

Essential information on the correct methods for treating hydraulic fluid is included in Vickers publication 561 "Vickers Guide to Systemic Contamination Control," available from your local Vickers distributor or by

contacting Vickers, Incorporated. Recommendations on filtration and the selection of products to control fluid condition are included in 561.

Recommended cleanliness levels, using petroleum oil under common conditions, are based on the highest fluid pressure levels in the system and are coded in the chart below. Fluids other than petroleum, severe service cycles, or temperature extremes are cause for adjustment of these cleanliness codes. Refer to Vickers publication 561 for exact details.

Vickers products, as any components, will operate with apparent satisfaction in fluids with higher cleanliness codes than those described. Other manufacturers will often recommend levels above those specified. Experience has shown, however, that life of any hydraulic component is shortened in fluids with higher cleanliness codes than those listed below. These codes have been proven to provide a long, trouble-free service life for the products shown, regardless of the manufacturer.

Product	System Pressure Level		
	psi		
	<2000	2000–3000	3000+
Vane pumps, fixed	20/18/15	19/17/14	18/16/13
Vane pumps, variable	18/16/14	17/15/13	
Piston pumps, fixed	19/17/15	18/16/14	17/15/13
Piston pumps, variable	18/16/14	17/15/13	16/14/12
Directional valves	20/18/15	20/18/15	19/17/14
Proportional valves	17/15/12	17/15/12	15/13/11
Servo valves	16/14/11	16/14/11	15/13/10
Pressure/Flow controls	19/17/14	19/17/14	19/17/14
Cylinders	20/18/15	20/18/15	20/18/15
Vane motors	20/18/15	19/17/14	18/16/13
Axial piston motors	19/17/14	18/16/13	17/15/12
Radial piston motors	20/18/14	19/17/13	18/16/13