<table>
<thead>
<tr>
<th></th>
<th>Flows to</th>
<th>Pressures to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vickers®</td>
<td>76 l/min</td>
<td>210 bar</td>
</tr>
<tr>
<td>SM4-20 Servo Valves</td>
<td>(20 USgpm)</td>
<td>(3000 psi)</td>
</tr>
</tbody>
</table>

**Catalog**

*Image of Vickers® SM4-20 Servo Valves*

---

**Eaton**

*Powering Business Worldwide*
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</table>

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 ±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) $\Delta p$, 30 cST (141 SUS), and 49°C (120°F).

<table>
<thead>
<tr>
<th>MODEL SERIES</th>
<th>MAXIMUM RATED FLOW ±10%</th>
<th>MAXIMUM TOTAL NULL LEAKAGE</th>
<th>MAXIMUM PILOT FLOW AT 70 BAR (1000 PSI) $\Delta p$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>l/min (USgpm)</td>
<td>l/min (USgpm)</td>
<td>l/min (USgpm)</td>
</tr>
<tr>
<td>SM4-20</td>
<td>76 (20)</td>
<td>2.0 (0.52)</td>
<td>0.35 (0.092)</td>
</tr>
</tbody>
</table>

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 $\leq$ 3

Symmetry Error
% of rated current $< 10$

Linearity Error
% of rated current $< 10$

Threshold
% of rated current $\leq 0.5$

* 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
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 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.

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

Electrical Polarity for Control Flow Out of B Port

**Single:**
A+, B−
orC+, 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
**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**

\[ P_S = \text{System pressure} \]
\[ P_M = \text{Maximum supply pressure of valve: 210 bar (3000 psi) for SM4-20 (-10 design)} \]
\[ f_{PM} = \text{Frequency (at 90° phase angle) at maximum supply pressure (P_M)} \]
\[ f_{PS} = \text{Frequency (at 90° phase angle) at system pressure (P_S)} \]
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
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).
\[ f_{PS} = 0.92 \times 100 \text{ Hz} = 92 \text{ Hz} \]
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)**

38 l/min (10 USgpm)

47 l/min (12.5 USgpm)

57 l/min (15 USgpm)

76 l/min (20 USgpm)
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±5% of control flow output.

Typical Step Response Curves for Standard Models

SM4-20 shown at 210 bar
(3000 psi)

38 l/min (10 USgpm)

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)
Performance Curves

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

OUTPUT FLOW %

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

**76 l/min (20 USgpm)**

OUTPUT FLOW %
Model Code

__Series Designation__
SM4 – Servovalve, high performance, four-way

__Valve Size__
20 – 22.2 mm (0.875 in) port circle

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

<table>
<thead>
<tr>
<th>Code</th>
<th>USgpm</th>
<th>l/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) 3.8</td>
<td>1.0</td>
<td>3.8</td>
</tr>
<tr>
<td>(2.5) 9</td>
<td>2.5</td>
<td>9</td>
</tr>
<tr>
<td>(5) 19</td>
<td>5.0</td>
<td>19</td>
</tr>
<tr>
<td>(7.5) 28</td>
<td>7.5</td>
<td>28</td>
</tr>
<tr>
<td>(10) 38</td>
<td>10.0</td>
<td>38</td>
</tr>
<tr>
<td>(12) 45</td>
<td>12.0</td>
<td>45</td>
</tr>
<tr>
<td>(12.5) 47</td>
<td>12.5</td>
<td>47</td>
</tr>
<tr>
<td>(15) 57</td>
<td>15.0</td>
<td>57</td>
</tr>
<tr>
<td>(20) 76</td>
<td>20.0</td>
<td>76</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Ohms</th>
<th>mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/200</td>
<td>20</td>
<td>200</td>
</tr>
<tr>
<td>30/100</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>80/40</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>80/50</td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>140/40</td>
<td>140</td>
<td>40</td>
</tr>
<tr>
<td>200/15</td>
<td>200</td>
<td>15</td>
</tr>
<tr>
<td>200/20</td>
<td>200</td>
<td>20</td>
</tr>
<tr>
<td>300/30</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>1000/10</td>
<td>1000</td>
<td>10</td>
</tr>
<tr>
<td>1500/8</td>
<td>1500</td>
<td>8</td>
</tr>
</tbody>
</table>

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

Valve can be ordered with connector positioned over any port.

Null adjust (Do not loosen locknut)

Locating pin

Dimensions in inches (mm)

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.
## Model Code

### SM4M(E) Mounting Subplates

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

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Model Code

#### Series Designation

**SM4** – Servo valve, high performance, four-way

#### Accessory Designation

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

#### Port Connection Locations

- **Blank** – Rear ports
- **E** – Side ports

#### Standard SM4 Valve Size

**20** – SM4-20 or SP4-25

#### Design Number

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

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

#### Metric Suffix

- **M** – Metric version to NG (ISO) standards
- **Blank** – Omit if not required
SM4ME-20-10(M)

Installation
Dimensions

Dimensions in inches (mm)
Model Code
SM4A Adapter
Manifolds

Series Designation
SM4 – Servovalve, high performance, four-way

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

Interfave
5 – ISO 4401-05

Standard SM4 Valve Size
20 – SM4-20 or SP4-25

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

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

Metric Suffix
M – Metric version to NG (ISO) standards
Blank – Omit if not required
Model Code
SM4FV Flushing Valves

SM4 FV - 20 - 10

Series Designation
SM4 – Servovalve, high-performance, four-way

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

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

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) - **

Series Designation
SM4 – Servovalve, high performance, four-way

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

Standard SM4 Valve Size
20 – SM4-20 or SP4-25

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

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

Installation Dimensions

SM4FM-20-10

Dimensions in inches (mm)
The following table lists approximate dry weights for SM4 servo valves and related accessories.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>MODEL CODE</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servovalve</td>
<td>SM4-20</td>
<td>1,05 (2.3)</td>
</tr>
<tr>
<td>Mounting subplate</td>
<td>SM4M(E)-20-10(M)</td>
<td>0,91 (2.0)</td>
</tr>
<tr>
<td>Adapter manifold</td>
<td>SM4A-5-20-10(M)</td>
<td>0,439 (0.97)</td>
</tr>
<tr>
<td>Flushing valve</td>
<td>SM4FV-20-10(M)</td>
<td>0,27 (0.58)</td>
</tr>
<tr>
<td>Filter module</td>
<td>SM4FM-20-(CB)-10</td>
<td>0,73 (1.6) est.</td>
</tr>
</tbody>
</table>

Additional Accessories

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

Servo Electronics

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

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>SYSTEM PRESSURE LEVEL</th>
<th>BAR (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vane pumps, fixed</td>
<td>20/18/15</td>
<td>19/17/14</td>
</tr>
<tr>
<td>Vane pumps, variable</td>
<td>18/16/14</td>
<td></td>
</tr>
<tr>
<td>Piston pumps, fixed</td>
<td>19/17/15</td>
<td>18/16/14</td>
</tr>
<tr>
<td>Piston pumps, variable</td>
<td>18/16/14</td>
<td>17/15/13</td>
</tr>
<tr>
<td>Directional valves</td>
<td>20/18/15</td>
<td>20/18/15</td>
</tr>
<tr>
<td>Proportional valves</td>
<td>17/15/12</td>
<td>17/15/12</td>
</tr>
<tr>
<td>Servo valves</td>
<td>16/14/11</td>
<td>16/14/11</td>
</tr>
<tr>
<td>Pressure/Flow controls</td>
<td>19/17/14</td>
<td>19/17/14</td>
</tr>
<tr>
<td>Cylinders</td>
<td>20/18/15</td>
<td>20/18/15</td>
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<tr>
<td>Vane motors</td>
<td>20/18/15</td>
<td>19/17/14</td>
</tr>
<tr>
<td>Axial piston motors</td>
<td>19/17/14</td>
<td>18/16/13</td>
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</table>