Axial Piston Motors

Technical Information
General Description

Series 40 motors can be applied together or combined with other products in a system to transfer and control hydraulic power.

Series 40 motors utilize parallel axial piston / slipper design in conjunction with a fixed or tiltable swashplate. There are M25, M35, M44, M46 fixed motor units and M35, M44, M46 variable motor units.

The M35 and M44 variable motors feature a trunnion style swashplate and direct displacement control. The M46 variable motors utilize a cradle swashplate design and a two-position hydraulic servo control.

The M46 variable motor is available in a cartridge flange version, which is designed to be compatible with CW and CT compact planetary gearboxes. This combination provides a short final drive length for applications with space limitations.

- Series 40 - Advanced Technology Today
- 4 Sizes of Fixed Displacement Motors
- 3 Sizes of Variable Displacement Motors
- High Performance at Low Cost
- Efficient Axial Piston Design
- Complete Family of Control Systems
- Proven Reliability and Performance
- Optimum Product Configurations
- Compact, Lightweight
- Worldwide Sales and Service
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Axial Piston Motors

Series 40 Motor Features

M25 Fixed Motor (MF)
- Cylinder Block
- Piston
- Output Shaft
- Lip Seal
- Bearing

M35 Variable Motor (MV)
- Cylinder Block
- Piston
- Swashplate
- Roller Bearing
- Cylinder

M35 Fixed Motor (MF)
- Cylinder Block
- Piston
- Output Shaft
- Lip Seal
- Bearing

M46 Variable Motor (MV) (SAE Flange)
- Cylinder Block
- Piston
- Servo Piston
- Output Shaft
- Bearing
- Lip Seal

M46 Fixed Motor (MF)
- Cylinder Block
- Piston
- Output Shaft
- Lip Seal
- Bearing

M46 Variable Motor (MV) (Cartridge Flange)
- Cylinder Block
- Piston
- Output Shaft
- Lip Seal
- Bearing
System Circuit Description

A Series 40-M35 fixed motor (right) is shown in a hydraulic circuit with a Series 40-M46 variable pump. The white half of the circuit includes pump features. A suction filtration configuration is shown. Pressure regulation valves are included on the pump. A loop flushing module is included on the motor. Note the position of the reservoir and heat exchanger.

Motor Circuit Description

A Series 40 - M46 variable motor circuit schematic is shown above. The system ports “A” and “B” hook up to the high pressure work lines. The motor receives pressurized fluid in its inlet port and discharges de-energized fluid through the outlet port. Either port can act as inlet or outlet; flow can be bidirectional. System port pressure can be gauged through ports M1 and M2. The motor has two case drains (L1 and L2). The motor may or may not include loop flushing. Loop flushing provides additional cooling and filtration capacity.
Axial Piston Motors Series 40

Technical Specification

General Specification

Specifications for Series 40 motors are listed on these two pages. For definitions of the various specifications, see the related pages in this publication. Not all hardware options are available for all configurations; consult the Series 40 Motor Model Code Supplement or Price Book for more information.

<table>
<thead>
<tr>
<th>General Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Type</td>
</tr>
<tr>
<td>Direction of Rotation</td>
</tr>
<tr>
<td>Installation Position</td>
</tr>
<tr>
<td>Filtration Configuration</td>
</tr>
<tr>
<td>Other System Requirements</td>
</tr>
</tbody>
</table>

Specific Data

<table>
<thead>
<tr>
<th>Specific Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame Size</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Motor Configuration</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Displacement</td>
</tr>
<tr>
<td>cm³/rev</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>44</td>
</tr>
<tr>
<td>46</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>kg</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>21</td>
</tr>
<tr>
<td>Mass moment of inertia</td>
</tr>
<tr>
<td>of the internal rotation parts</td>
</tr>
<tr>
<td>kgm²</td>
</tr>
<tr>
<td>0.0017</td>
</tr>
<tr>
<td>0.0029</td>
</tr>
<tr>
<td>0.0028</td>
</tr>
<tr>
<td>0.0046</td>
</tr>
<tr>
<td>Two (2) bolt flange, size B (SAE J744)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Cartridge flange</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Port connection</td>
</tr>
<tr>
<td>SAE straight thread</td>
</tr>
<tr>
<td>O-ring boss</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Output shaft options</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Control options</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Loop flushing</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Displacement limiters</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Speed sensors</td>
</tr>
</tbody>
</table>

= Option
- = not available
Axial Piston Motors Series 40

System Parameters

<table>
<thead>
<tr>
<th>Speed Limits</th>
<th>min⁻¹ • rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frame Size</strong></td>
<td><strong>M25 MF</strong></td>
</tr>
<tr>
<td>Rated speed at max. disp.</td>
<td>4000</td>
</tr>
<tr>
<td>Maxim. speed at max. disp.</td>
<td>5000</td>
</tr>
<tr>
<td>Rated speed at min. disp.</td>
<td>-</td>
</tr>
</tbody>
</table>

Case Pressure

<table>
<thead>
<tr>
<th>Continuous pressure</th>
<th>MPa</th>
<th>bar</th>
<th>psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.17</td>
<td>1.7</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum pressure</th>
<th>MPa</th>
<th>bar</th>
<th>psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.52</td>
<td>5.2</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

System Pressure Range

<table>
<thead>
<tr>
<th>Rated pressure</th>
<th>MPa</th>
<th>bar</th>
<th>psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>210</td>
<td>3000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum pressure</th>
<th>MPa</th>
<th>bar</th>
<th>psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>345</td>
<td>5000</td>
<td></td>
</tr>
</tbody>
</table>

Fluid and Filtration Specifications

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>°C</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent (cold start)</td>
<td>-40</td>
<td>-40</td>
</tr>
<tr>
<td>Continuous</td>
<td>82</td>
<td>180</td>
</tr>
<tr>
<td>Intermittent</td>
<td>104</td>
<td>220</td>
</tr>
</tbody>
</table>

Viscosity

<table>
<thead>
<tr>
<th>Viscosity</th>
<th>mm²/s</th>
<th>[SUS]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>7</td>
<td>49</td>
</tr>
<tr>
<td>Recommended operating range</td>
<td>12-60</td>
<td>[70-278]</td>
</tr>
<tr>
<td>Maximum</td>
<td>1600</td>
<td>[7500]</td>
</tr>
</tbody>
</table>

Cleanliness Level and βₙ-Ratio

<table>
<thead>
<tr>
<th>Required fluid cleanliness level</th>
<th>ISO 4406 Class 18/13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended βₙ-ratio for suction filtration</td>
<td>β₂₅₄₅ = 75 (β₁₀₀ ≥ 2)</td>
</tr>
<tr>
<td>Recommended βₙ-ratio for charge pressure filtration</td>
<td>β₁₃₂₀ = 75 (β₁₀₀ ≥ 10)</td>
</tr>
<tr>
<td>Recommended inlet screen size for charge pressure filtration</td>
<td>100 μm-125 μm</td>
</tr>
</tbody>
</table>
**Model Code**

The model code is a modular description of a specific product and its options. To create a model code to include the specific options desired, see the Series 40 Motor Model Code Supplement or the Series 40 Price Book.

**Name Plate (Fixed Motor)**

```
SAUER SUNDSTRAND
Ames, Iowa, U.S.A. Neumünster, Germany
```

**Identification Number**

```
Model Code
Model No. Ident Nr
4250000 A – 97 – 05 – 12345
```

```
Serial No. Fabr Nr
Made in U.S.A.
```

**Place of Manufacture**

```
Ames, Iowa, U.S.A.
```

**Name Plate (Variable Motor)**

```
SAUER SUNDSTRAND
Ames, Iowa, U.S.A. Neumünster, Germany
MMV-035-D-A-A-D-R-R-NNN
```

**Identification Number**

```
Model Code
Model No. Ident Nr
4354025 A – 97 – 05 – 12345
```

```
Serial No. Fabr Nr
Made in U.S.A.
```

**Place of Manufacture**

```
Ames, Iowa, U.S.A.
```

**Model Code Modules**

```
Frame Product
C D E F G T
025 C A E G A C
```

**Description**

- **Product**: Fixed Displacement Pump
- **Type**: Displacement
- **C**: Seal Group
- **D**: Output Shaft / Through Shaft Configuration
- **E**: End Cap Configuration
- **F**: Cylinder Block Group
- **G**: Housing Type
- **T**: Special Hardware Features

```
Frame Product
C D E F G T
035 D A A D R R
```

**Description**

- **Product**: Variable Displacement Pump
- **Type**: Displacement
- **C**: Seal Group
- **D**: Output Shaft / Through Shaft Configuration
- **E**: Minimum Swashplate Angle
- **F**: Control Features
- **G**: End Cap Configuration
- **T**: Special Hardware Features
**Hydraulic Equations for Motor Selection**

The motor size required for a specific application can be calculated using the equations below.

**Metric System**

<table>
<thead>
<tr>
<th>Based on MPa</th>
<th>Based on bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input flow (Q_e) = (\frac{V_g \cdot n}{1000 \cdot \eta_v}) l/min</td>
<td>Input flow (Q_e) = (\frac{V_g \cdot n}{1000 \cdot \eta_v}) l/min</td>
</tr>
<tr>
<td>Output torque (M_e) = (\frac{V_g \cdot \Delta p \cdot \eta_{mh}}{2 \cdot \pi}) Nm</td>
<td>Output torque (M_e) = (\frac{V_g \cdot \Delta p \cdot \eta_{mh}}{2 \cdot \pi}) Nm</td>
</tr>
<tr>
<td>Output power (P_e) = (\frac{M_e \cdot n}{955} = \frac{Q_e \cdot \Delta p \cdot \eta_t}{60}) kW</td>
<td>Output power (P_e) = (\frac{M_e \cdot n}{955} = \frac{Q_e \cdot \Delta p \cdot \eta_t}{60}) kW</td>
</tr>
<tr>
<td>Speed (n) = (\frac{Q_e \cdot 1000 \cdot \eta_v}{V_g}) min^{-1}</td>
<td>Speed (n) = (\frac{Q_e \cdot 1000 \cdot \eta_v}{V_g}) min^{-1}</td>
</tr>
<tr>
<td>(V_g) = Motor displacement per rev. (\text{cm}^3)</td>
<td>(V_g) = Motor displacement per rev. (\text{cm}^3)</td>
</tr>
<tr>
<td>(\Delta p) = (P_{HD} - P_{ND}) MPa</td>
<td>(\Delta p) = (P_{HD} - P_{ND}) bar</td>
</tr>
<tr>
<td>(\eta_v) = Motor volumetric efficiency</td>
<td>(\eta_v) = Motor volumetric efficiency</td>
</tr>
<tr>
<td>(\eta_{mh}) = Motor mechanical-hydraulic (Torque) efficiency</td>
<td>(\eta_{mh}) = Motor mechanical-hydraulic (Torque) efficiency</td>
</tr>
<tr>
<td>(\eta_t) = Motor overall efficiency</td>
<td>(\eta_t) = Motor overall efficiency</td>
</tr>
<tr>
<td>(p_{HD}) = High pressure MPa</td>
<td>(p_{HD}) = High pressure bar</td>
</tr>
<tr>
<td>(p_{ND}) = Low pressure MPa</td>
<td>(p_{ND}) = Low pressure bar</td>
</tr>
</tbody>
</table>

**Inch System**

<table>
<thead>
<tr>
<th>Based on US gal/min</th>
<th>Based on rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input flow (Q_e) = (\frac{V_g \cdot n}{231 \cdot \eta_v}) US gal/min</td>
<td>Input flow (Q_e) = (\frac{V_g \cdot n}{231 \cdot \eta_v}) US gal/min</td>
</tr>
<tr>
<td>Output torque (M_e) = (\frac{V_g \cdot \Delta p \cdot \eta_{mh}}{2 \cdot \pi}) lbf-in</td>
<td>Output torque (M_e) = (\frac{V_g \cdot \Delta p \cdot \eta_{mh}}{2 \cdot \pi}) lbf-in</td>
</tr>
<tr>
<td>Output power (P_e) = (\frac{V_g \cdot n \cdot \Delta p \cdot \eta_t}{396000}) hp</td>
<td>Output power (P_e) = (\frac{V_g \cdot n \cdot \Delta p \cdot \eta_t}{396000}) hp</td>
</tr>
<tr>
<td>Speed (n) = (\frac{Q_e \cdot 231 \cdot \eta_v}{V_g}) rpm</td>
<td>Speed (n) = (\frac{Q_e \cdot 231 \cdot \eta_v}{V_g}) rpm</td>
</tr>
<tr>
<td>(V_g) = Motor displacement per rev. (\text{in}^3)</td>
<td>(V_g) = Motor displacement per rev. (\text{in}^3)</td>
</tr>
<tr>
<td>(\Delta p) = (P_{HD} - P_{ND}) psid</td>
<td>(\Delta p) = (P_{HD} - P_{ND}) psid</td>
</tr>
<tr>
<td>(\eta_v) = Motor volumetric efficiency</td>
<td>(\eta_v) = Motor volumetric efficiency</td>
</tr>
<tr>
<td>(\eta_{mh}) = Motor mechanical-hydraulic (Torque) efficiency</td>
<td>(\eta_{mh}) = Motor mechanical-hydraulic (Torque) efficiency</td>
</tr>
<tr>
<td>(\eta_t) = Motor overall efficiency</td>
<td>(\eta_t) = Motor overall efficiency</td>
</tr>
<tr>
<td>(p_{HD}) = High pressure psid</td>
<td>(p_{HD}) = High pressure psid</td>
</tr>
<tr>
<td>(p_{ND}) = Low pressure psid</td>
<td>(p_{ND}) = Low pressure psid</td>
</tr>
</tbody>
</table>
Axial Piston Motors Series 40

System Parameters

Case Pressure

Under normal operating conditions, case pressure must not exceed the rated pressure. Momentary case pressure exceeding this rating is acceptable under cold start conditions, but still must stay below the maximum pressure rating. The minimum pressure provides proper lubrication at high speeds. Operation with case pressure in excess of these limits may result in external leakage due to damage to seals, gaskets, and/or housings.

<table>
<thead>
<tr>
<th>Case Pressure</th>
<th>MPa</th>
<th>bar</th>
<th>psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous pressure</td>
<td>0.17</td>
<td>1.7</td>
<td>25</td>
</tr>
<tr>
<td>Maximum pressure</td>
<td>0.52</td>
<td>5.2</td>
<td>75</td>
</tr>
</tbody>
</table>

Speed Limits

Rated Speed is the speed limit recommended at full power condition and is the highest value at which normal life can be expected.

Maximum Speed is the highest operating speed permitted and cannot be exceeded without reduction in the life of the product or risking immediate failure and loss of driveline power (which may create a safety hazard). In the range between rated and maximum speed please contact your SAUER-SUNDSTRAND representative.

System Pressure

System pressure is the differential pressure between system ports referenced to case pressure. It is a dominant operating variable affecting hydraulic unit life. High pressure, which results from high load, reduces expected life in a manner similar to many mechanical assemblies such as engines and gear boxes. There are load-to-life relationships for the rotating group and for the shaft bearings.

Rated pressure is the average, regularly occurring operating pressure that should yield satisfactory product life. Maximum pressure is the highest intermittent pressure allowed, and is the relief valve setting. It is determined by the maximum machine load demand. For most systems, the load should move at this pressure. Maximum pressure is assumed to occur a small percentage of operating time, usually less than 2% of the total. Both the continuous and maximum pressure limits must be satisfied to achieve the expected life.

<table>
<thead>
<tr>
<th>System Pressure Range</th>
<th>MPa</th>
<th>bar</th>
<th>psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated pressure</td>
<td>21</td>
<td>210</td>
<td>3 000</td>
</tr>
<tr>
<td>Maximum pressure</td>
<td>34.5</td>
<td>345</td>
<td>5 000</td>
</tr>
</tbody>
</table>

WARNING

The loss of hydrostatic drive line power in any mode of operation (e.g., forward, reverse, or “neutral” mode) may cause the loss of hydrostatic braking capacity. A braking system, redundant to the hydrostatic transmission must, therefore, be provided which is adequate to stop and hold the system should the condition develop.

WARNING

The loss of hydrostatic drive line power in any mode of operation (e.g., forward, reverse, or “neutral” mode) may cause the loss of hydrostatic braking capacity. A braking system, redundant to the hydrostatic transmission must, therefore, be provided which is adequate to stop and hold the system should the condition develop.

All pressure limits are differential pressures (referenced to charge pressure) and assume normal charge pressure and no externally applied shaft loads.
Axial Piston Motors

Series 40

Fluid Specifications

Hydraulic Fluid

Ratings and data are based on operating with hydraulic fluids containing oxidation, rust and foam inhibitors. These fluids must possess good thermal and hydrolytic stability to prevent wear, erosion and corrosion of the internal components.

Fire resistant fluids are also suitable at modified operating conditions. Please see SAUER-SUNDSTRAND publication 697581 or BLN-9887 for more information. Refer to publication ATI-9101E for information relating to biodegradable fluids.

It is not permissible to mix hydraulic fluids. For more information contact your SAUER-SUNDSTRAND representative.

Suitable Hydraulic Fluids:
- Hydraulic fluids per DIN 51 524, part 2 (HLP)
- Hydraulic fluids per DIN 51 524, part 3 (HVLP)
- API CD, CE and CF engine fluids per SAE J183
- M2C33F or G automatic transmission fluids (ATF)
- Dexron II (ATF), which meets the Allison C3- and Caterpillar TO-2 test
- Agricultural multi purpose oil (STOU)
- Premium turbine oils

Temperature and Viscosity

Temperature and viscosity requirements must be concurrently satisfied. The data shown in the tables assume petroleum-based fluids, are used.

The high temperature limits apply at the hottest point in the transmission, which is normally the motor case drain. The system should generally be run at or below the rated temperature. The maximum temperature is based on material properties and should never be exceeded.

Cold oil will generally not affect the durability of the transmission components, but it may affect the ability to flow oil and transmit power; therefore temperatures should remain 16°C (30°F) above the pour point of the hydraulic fluid. The minimum temperature relates to the physical properties of component materials.

For maximum unit efficiency and bearing life the fluid viscosity should remain in the recommended operating range. The minimum viscosity should be encountered only during brief occasions of maximum ambient temperature and severe duty cycle operation. The maximum viscosity should be encountered only at cold start.

Heat exchangers should be sized to keep the fluid within these limits. Testing to verify that these temperature limits are not exceeded is recommended.

Temperature Range

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>°C</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent (cold start)</td>
<td>-40</td>
<td>-40</td>
</tr>
<tr>
<td>Continuous</td>
<td>82</td>
<td>180</td>
</tr>
<tr>
<td>Intermittent</td>
<td>104</td>
<td>220</td>
</tr>
</tbody>
</table>

Viscosity

<table>
<thead>
<tr>
<th>Viscosity</th>
<th></th>
<th>mm²/s [SUS]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td></td>
<td>7 [49]</td>
</tr>
<tr>
<td>Recommended</td>
<td></td>
<td>12-60 [70-278]</td>
</tr>
<tr>
<td>operating range</td>
<td></td>
<td>1 600 [7 500]</td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td>intermittent, cold start</td>
</tr>
</tbody>
</table>

T002 055E
T002 010E
To prevent premature wear, it is imperative that only clean fluid enter the hydrostatic transmission circuit. A filter capable of controlling the fluid cleanliness to ISO 4406 Class 18/13 (SAE J1165) or better under normal operating conditions is recommended.

The filter may be located either on the inlet (suction filtration) or discharge (charge pressure filtration) side of the charge pump. The selected filtration system must maintain a cleanliness level of 18/13 per ISO 4406.

The selection of a filter depends on a number of factors including the contaminant ingestion rate, the generation of contaminants in the system, the required fluid cleanliness, and the desired maintenance interval. Filters are selected to meet the above requirements using rating parameters of efficiency and capacity.

Filter efficiency may be measured with a Beta ratio \( \beta_x \). For simple suction-filtered closed circuit transmissions and open circuit transmissions with return line filtration, a filter with a \( \beta_x \)-ratio within the range of \( \beta_{35-45} = 75 \) (\( \beta_{30} \geq 2 \)) or better has been found to be satisfactory. For some open circuit systems, and closed circuits with cylinders being supplied from the same reservoir, a considerably higher filter efficiency is recommended. This also applies to systems with gears or clutches using a common reservoir. For these systems, a filter within the range of \( \beta_{15-20} = 75 \) (\( \beta_{10} \geq 10 \)) or better is typically required.

Since each system is unique, the filtration requirement for that system will be unique and must be determined by test in each case. It is essential that monitoring of prototypes and evaluation of components and performance throughout the test program be the final criteria for judging the adequacy of the filtration system. See publication BLN-9887 or 697581 and ATI-E9201 for more information.

### Cleanliness Level and \( \beta_x \)-Ratio

<table>
<thead>
<tr>
<th>Cleanliness Level</th>
<th>( \beta_x )-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required fluid cleanliness level</td>
<td>ISO 4406 Class 18/13</td>
</tr>
<tr>
<td>Recommended ( \beta_x )-ratio for suction filtration</td>
<td>( \beta_{35-45} = 75 ) (( \beta_{30} \geq 2 ))</td>
</tr>
<tr>
<td>Recommended ( \beta_x )-ratio for charge pressure filtration</td>
<td>( \beta_{15-20} = 75 ) (( \beta_{10} \geq 10 ))</td>
</tr>
<tr>
<td>Recommended inlet screen size for charge pressure filtration</td>
<td>100 ( \mu \text{m} )-125 ( \mu \text{m} )</td>
</tr>
</tbody>
</table>

\( \beta_x \)-Ratio is a measure of filter efficiency defined by ISO 4572. It is defined as the ratio of the number of particles greater than a given diameter ("\( \times \" in \( \mu \text{m} \)) upstream of the filter to the number of these particles downstream of the filter.
System Requirements

Axial Piston Motors

Series 40

Independent Braking System

**WARNING**
The loss of hydrostatic drive line power in any mode of operation (e.g., forward, reverse, or “neutral” mode) may cause the loss of hydrostatic braking capacity. A braking system, redundant to the hydrostatic transmission must, therefore, be provided which is adequate to stop and hold the system should the condition develop. 

Reservoir

The function of the reservoir is to remove air and to provide make up fluid for volume changes associated with fluid expansion or contraction, possible cylinder flow, and minor leakage.

The reservoir should be designed to accommodate maximum volume changes during all system operating modes and to promote deaeration of the fluid as it passes through the tank.

A suggested minimum reservoir volume equal to 1/2 charge pump flow/min. This allows 30 seconds fluid dwell for removing entrained air at the maximum return flow.

This is usually adequate to allow for a closed reservoir (no breather) in most applications. The reservoir outlet to the charge pump inlet should be above the bottom of the reservoir to take advantage of gravity separation and prevent large foreign particles from entering the charge inlet line.

The reservoir inlet (fluid return) should be positioned so that the flow to the reservoir is discharged below the normal fluid level, and also directed into the interior of the reservoir for maximum dwell and efficient deaeration.

Overpressure Protection

Series 40 motors (as well as other system components) have pressure limitations. Relief valves or pressure limiters should be present in the high pressure circuit to protect components from excessive pressures.

Series 40 pumps are available with a range of high pressure relief valve settings. Refer to publication BLN-9989 for more information.

**WARNING**
High pressure relief valves are intended for transient overpressure protection and are not intended for continuous pressure control. Operation over relief valves for extended periods of time may result in severe heat build up. High flows over relief valves may result in pressure levels exceeding the nominal valve setting and potential damage to system components.

Bypass Valves

In some applications it is desirable to bypass fluid around the variable displacement pump allowing, for example, a vehicle to be moved short distances at low speeds without running the prime mover. This is accomplished by a manually operated bypass valve. When open, this valve connects both sides of the pump/motor circuit and allows the motor to turn. This valve must be fully closed for normal operation.

Bypass valves are available in Series 40 pumps. Refer to publication BLN-9989 for more information.

**WARNING**
Bypass valves are intended for moving a machine or vehicle for very short distances at very slow speeds. They are NOT intended as “tow” valves.
Loop Flushing Valve

Series 40 motors may incorporate an integral loop flushing valve. Installations that require additional fluid to be removed from the main hydraulic circuit because of fluid cooling requirements, or circuits requiring the removal of excessive contamination, will benefit from loop flushing. A loop flushing valve will remove heat and contaminants from the main loop at a rate faster than otherwise possible. (Contact your Sauer-Sundstrand representative for production availability on specific frame size motors.)

Series 40 motors equipped with an integral loop flushing valve include a loop flushing relief valve and may include an orifice with the valve. The flushing flow will be a function of the relative settings of the motor charge relief, the pump charge relief valve, and the orifice size (if present). The motor relief must be set to a pressure less than or equal to the pump relief to provide loop flushing.

Loop flushing flows of 3.8 to 7.6 l/min (1 to 2 gpm) are adequate for most applications. Contact your Sauer-Sundstrand representative for assistance.

### Loop Flushing Specs

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Flow Rate</td>
<td>3.8 - 7.6 l/min. (1-2 gpm)</td>
</tr>
<tr>
<td>Relief Setting</td>
<td>1.4 - 2.5 MPa [14 - 25 bar] (200 - 355 psi)</td>
</tr>
<tr>
<td>Orifice Size</td>
<td>non or 1.4 mm (0.055 in)</td>
</tr>
</tbody>
</table>

**WARNING**

Incorrect charge pressure settings may result in the inability to build required system pressure and/or inadequate loop flushing flows. Correct charge pressure must be maintained under all conditions of operation to maintain pump control performance.
M35, M44, and M46 variable motors have **minimum displacement limiters**. These can be adjusted by loosening the sealing lock nut, adjusting displacement by rotating the screw with a wrench, then locking the adjuster by torquing the sealing lock nut.

Minimum unit displacement is obtained with the adjuster screw at its maximum extension from the end cap or displacement control piston cover. All motors are shipped with the limiter set for minimum motor displacement.

The M35 and M44 MV minimum displacement limiter is located in the end cap.

The M46 MV minimum displacement limiter is located in the displacement control piston cavity. The length and configuration of this limiter will depend upon the control option installed in the motor.

M46 MV units may have an optional mechanical **maximum displacement limiter** located in the displacement control piston cover. The maximum displacement limit can be adjusted by loosening the sealing lock nut, adjusting displacement by rotating the screw with a screwdriver, then locking the adjuster by torquing the sealing lock nut.

Maximum unit displacement is obtained with the adjuster screw standing at its maximum height out of the displacement control piston cover. All motors are shipped with the limiter set for maximum motor displacement.

**WARNING**

Care should be taken in adjusting displacement limiters to avoid an undesirable condition of output flow or speed. The sealing lock nut must be retorqued after every adjustment to prevent an unexpected change in output conditions and to prevent external leakage during pump operation.
Speed Sensor Option

An optional speed sensor for direct measurement of speed is available. This sensor may also be used to sense the direction of rotation.

A special magnetic speed pick-up ring is pressed onto the outside diameter of the shaft and a Hall effect sensor is located in the motor housing. The sensor accepts supply voltage and outputs a digital pulse signal in response to the speed of the ring. The output changes its high/low state as the north and south poles of the permanently magnetized speed ring pass by the face of the sensor. The digital signal is generated at frequencies suitable for microprocessor based controls.

The sensor is available with a Packard Weather-Pack 4-pin sealed connector.

Contact your SAUER-SUNDSTRAND representative for more information.

For detailed technical data please see the table.

Connecting pin designation:

- Pin 1 or A: Supply voltage
- Pin 2 or D: Direction of rotation
- Pin 3 or B: Speed signal, digital
- Pin 4 or C: Gnd common

### Technical Data Speed Sensor

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>4.5-15 V&lt;sub&gt;DC&lt;/sub&gt;</td>
</tr>
<tr>
<td>Required current</td>
<td>12 mA at 5 V&lt;sub&gt;DC&lt;/sub&gt;</td>
</tr>
<tr>
<td>(no load)</td>
<td></td>
</tr>
<tr>
<td>Max. current</td>
<td>20 mA at 5 V&lt;sub&gt;DC&lt;/sub&gt;</td>
</tr>
<tr>
<td>Max. frequency</td>
<td>15 kHz</td>
</tr>
<tr>
<td>Voltage “high”</td>
<td>Supply voltage -0.5 V</td>
</tr>
<tr>
<td>Voltage “low”</td>
<td>0.5 VDC max.</td>
</tr>
<tr>
<td>Temperature range</td>
<td>-40 to 110 °C (-40 to 250 °F)</td>
</tr>
</tbody>
</table>

It is not acceptable to energize the 4.5-15 V<sub>DC</sub> speed sensor with 12 V<sub>DC</sub> battery voltage; it must be energized by a regulated power supply. If it is desirable to energize the sensor with battery voltage, contact your Sauer-Danfoss representative for an optional speed sensor.

### Data Magnetic Speed Pick-up Ring

<table>
<thead>
<tr>
<th>Frame Size</th>
<th>M25</th>
<th>M35</th>
<th>M44</th>
<th>M46</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse/Rev</td>
<td>43</td>
<td>46</td>
<td>46</td>
<td>51</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Packard Weather-Pack 4 pin (Supplied Connector)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matting Connector No.: K03379</td>
</tr>
<tr>
<td>Id.-No.: 505341</td>
</tr>
</tbody>
</table>

Cross-Section of Speed Sensor on Cylinder Kit
Shaft Options

Series 40 motors are available with a variety of splined, straight keyed, and tapered shaft ends. Nominal shaft sizes and torque ratings for some available shafts are shown in the accompanying table.

Torque ratings assume no external radial loading. **Continuous (Cont)** torque ratings for splined shafts are based on spline tooth wear, and assume the mating spline has a minimum hardness of Rc 55 and full spline depth with good lubrication.

Maximum torque ratings are based on shaft torsional strength and assume a maximum of 200,000 load reversals.

Contact your Sauer-Sundstrand representative for more information.

### Shaft Availability and Torque Ratings

<table>
<thead>
<tr>
<th>Shaft Options</th>
<th>Frame Size</th>
<th>M25 MF</th>
<th>M35 MF</th>
<th>M35 MF</th>
<th>M44 MF</th>
<th>M46 MF</th>
<th>M35 MV</th>
<th>M44 MV</th>
<th>M46 MV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 tooth, 16/32 pitch</td>
<td>Continuous</td>
<td>Nm</td>
<td>85</td>
<td>750</td>
<td>73</td>
<td>650</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>Nm</td>
<td>140</td>
<td>1,240</td>
<td>226</td>
<td>2,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spline</td>
<td>Continuous</td>
<td>Nm</td>
<td></td>
<td></td>
<td>153</td>
<td>1,350</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 tooth, 16/32 pitch</td>
<td>Maximum</td>
<td>Nm</td>
<td></td>
<td></td>
<td>362</td>
<td>3,200</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

= not available

**NOTE:** Recommended mating splines for splined output shafts should be in accordance with ANSI B92.1 Class 5. Sauer-Sundstrand external splines are modified Class 5 Fillet Root Side Fit. The external spline Major Diameter and Circular Tooth Thickness dimensions are reduced in order to assure a clearance fit with the mating spline.

### Through-Shaft Options

Optional through-shafts are available on Series 40 fixed and variable displacement motors (as noted in the accompanying table). Through-shafts are provided for use in secondary (parking) braking systems. Through-shaft ends are not intended for continuous power transmission.

Contact your Sauer-Sundstrand representative when considering the through-shaft option.

**WARNING**

Exceeding these torque limits could cause shaft breakage, which could result in a loss of breaking function and machine control, and a potential runaway condition.
Bearing Life and External Shaft Loading

Bearing life is a function of speed, pressure and swashplate angle plus any external loads. Other life factors include oil type and viscosity.

In vehicle propulsion drives with no external loads, where the speed, pressure, and swashplate angle are often changing, normal bearing B10 (90% survival) life will exceed the hydraulic unit life.

In non-propel drives, such as conveyors or fan drives, the operating speed and pressure may be nearly constant leading to a distinctive duty cycle compared to that of a propulsion drive. In these types of applications, a bearing life review is recommended.

Series 40 motors are designed with bearings that can accept some incidental external radial and thrust loads. However, any amount of external load will reduce the expected bearing life.

The allowable radial shaft loads are a function of the load position, the load orientation, and the operating pressures of the hydraulic unit. All external shaft loads will have an effect on bearing life. In motor applications where external shaft loads cannot be avoided, the impact on bearing life can be minimized by orienting the load to the 180 degree position.

The recommended maximum radial loads (Re) is based on an external moment (Me) and the distance (L) from the mounting flange to the load, see table at right. The loads in the table reflect a worst case external load orientation (0 degrees), continuously applied working pressure of 140 bar (2000 psi), 20 bar (285 psi) charge pressure, 1800 rpm and a bearing life (B10) of 2000 hours.

The recommended maximum allowable radial load is calculated as:

\[ R_e = \frac{M_e}{L} \]

Thrust loads in either direction should be avoided.

If continuously applied external radial loads exceed the recommended maximum allowable, or thrust loads are known to occur, contact Sauer-Sundstrand for an evaluation of unit bearing life. Optional high capacity bearings are available.

Tapered output shafts or “clamp-type” couplings are recommended for applications where radial shaft side loads are present.

### External Shaft Moments

<table>
<thead>
<tr>
<th>Frame Size</th>
<th>M25MF</th>
<th>M35MF</th>
<th>M44MF</th>
<th>M46MF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Me (Nm)</td>
<td>29</td>
<td>25</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>255</td>
<td>225</td>
<td>215</td>
<td></td>
</tr>
<tr>
<td>Tin (N</td>
<td>1380</td>
<td>2000</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td></td>
<td>310</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tout (N)</td>
<td>690</td>
<td>1380</td>
<td>1820</td>
<td></td>
</tr>
<tr>
<td></td>
<td>155</td>
<td>310</td>
<td>409</td>
<td></td>
</tr>
</tbody>
</table>

**External Shaft Load Orientation**

- **F_B**: Force of block (applies at center of gravity)
- **L**: Distance from mounting flange to point of load
- **Me**: External shaft moment
- **Re**: Maximum radial side load
- **T_in**: Max. axial shaft load
- **T_out**: Max. axial shaft load

0° Re  
90° Re  
270° Re  
180° Re  
End view of shaft  
Axis of swashplate rotation (MV)  

0° Re  
90° Re  
270° Re  
180° Re  
End view of shaft  
Axis of swashplate rotation (MV)
Hydraulic Unit Life

Hydraulic unit life is defined as the life expectancy of the hydraulic components. Hydraulic unit life is a function of speed and system pressure; however, system pressure is the dominant operating variable affecting hydraulic unit life. High pressure, which results from high load, reduces expected life in a manner similar to many mechanical assemblies such as engines and gear boxes.

It is desirable to have a projected machine duty cycle with percentages of time at various loads and speeds. An appropriate design pressure can be calculated by Sauer-Sundstrand from this information. This method of selecting operating pressure is recommended whenever duty cycle information is available. In the absence of duty cycle data, an estimated design pressure can usually be established based on normal input power and maximum pump displacement.

Efficiency Graphs

The following performance graph provides typical volumetric and overall efficiencies for Series 40 motors. These efficiencies apply for all Series 40 motors at maximum displacement.

Note that all pressure limits are differential pressures (referenced to charge pressure) and assume normal charge pressure.

Series 40 motors will meet satisfactory life expectancy if applied within the parameters specified in this bulletin (see p. 10). For more detailed information on hydraulic unit life see BLN-9884, “Pressure and Speed Limits.”

1 At maximum displacement, assumes fluid viscosity in continuous range (p. 11).
Variable Motor Controls

Direct Displacement Control (DDC)

The Direct Displacement Control can be located on either side of the M35 and M44 variable motors. It provides a simple, positive method of control. Movement of the control shaft causes a proportional swashplate movement, thus varying the motor's displacement from full displacement to minimum displacement.

Some applications (generally vehicle propel) will require a provision for non-linear control input to produce desirable control feel.

- Minimum torque necessary to hold the swash plate per 7 MPa [70 bar] (1 000 psi) of differential system pressure is 11.3 Nm (100 lbf-in).
- Maximum allowable trunnion torque is 79.1 Nm (700 lbf-in)
- Maximum trunnion angle is 16° for M35 and M44.

### Motor Displacement vs Swashplate Rotation

<table>
<thead>
<tr>
<th>Data DDC</th>
<th>100%</th>
<th>79.1</th>
<th>7.91</th>
<th>16°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum torque</td>
<td>Nm</td>
<td>lbf-in</td>
<td>7.91</td>
<td>16°</td>
</tr>
<tr>
<td>Minimum torque to hold per 7 MPa [70 bar] (1 000 psi)</td>
<td>Nm</td>
<td>lbf-in</td>
<td>11.3</td>
<td>100</td>
</tr>
<tr>
<td>Maximum angle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Series 40 - M46 variable displacement motors are equipped with a hydraulically controlled swashplate. The motor is typically spring biased toward maximum displacement. A hydraulic piston is used to shift the swashplate from maximum to minimum displacement. SAE flange motors utilize a single servo piston which can be regulated by a single- or two-line control. Cartridge flange motors utilize a two piston control which is regulated by a single-line control.

With the standard single-line control option, hydraulic pressure is supplied to the “bottom” control port (port X1) to shift the motor to minimum displacement. The opposite end of the displacement control piston is internally drained to the motor case. A minimum pressure of 1.38 MPa [13.8 bar] (200 psi) is required to shift the swashplate. When the control pressure is removed, the bias spring returns the motor to maximum displacement.

A customer supplied 2-position, 3-way control valve is generally used with the single-line control. Hydraulic pressure on the control piston must not exceed 2.76 MPa [27.6 bar] (400 psi).

When the M46 variable motor is utilized in applications where frequent shifting “on-the-go” is encountered as part of the normal duty cycle, the optional two-line control is recommended. Applications with routine shifting from “work” range to “travel” range do not require the two-line control.

Control pressure is ported to port X1 and drained from port X2 to command minimum displacement and ported to port X2 and drained from port X1 to command maximum displacement.

A customer supplied 2-position, 4-way control valve is generally used with the two-line control. Hydraulic pressure on the control piston must not exceed 2.76 MPa [27.6 bar] (400 psi).

The shift rate for either the single- or two-line control can be optimized for the application requirements by orifices in either (or both) the control valve supply and drain lines.

Contact your Sauer-Sundstrand representative for additional information.

### Data HDC

<table>
<thead>
<tr>
<th></th>
<th>Single line control</th>
<th>Two line control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum pressure on control</td>
<td>MPa bar psi</td>
<td>2.76 27.6 400</td>
</tr>
<tr>
<td>Minimum pressure to shift</td>
<td>MPa bar psi</td>
<td>1.38 13.8 200</td>
</tr>
<tr>
<td>Control valve (customer supplied)</td>
<td>2-position/3-way</td>
<td>2-position/4-way</td>
</tr>
</tbody>
</table>

E860200T
M25 MF: Axial Ports, Twin Ports, Loop Flushing, Speed Sensor

<table>
<thead>
<tr>
<th>Motor Shaft Rotation</th>
<th>Flow Direction</th>
<th>Port &quot;A&quot;</th>
<th>Port &quot;B&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clockwise (CW)</td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Counterclockwise (CCW)</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
</tbody>
</table>

**M25 MF Dimensions**

*All SAE straight thread O-Ring ports per SAE J1926. Shaft rotation is determined by viewing motor from output shaft end. Contact your SAUER-SUNDSTRAND representative for specific installation drawings.*
M25 MF: Mounting Flange, Shaft

Axial Piston Motors Series 40

Coupling Must Not Protrude Beyond This Surface

Mounting Flange (Ref)

20.638 [0.8125] Pitch dia
30 Pressure Angle
13 Teeth, 16/32 Pitch
Fillet Root Side Fit
per ANSI B92.1 Class 5
Also Mates with Flat Root Side Fit

21.717 dia. [0.8550]
18.8 max [0.74]
7.9 [0.31]

SPLINED OUTPUT SHAFT: OPTION E

Mounting Flange (Ref)

2.875 [0.113] dia
0.25 [0.01] min R On Edges

33.32 max [1.312]
16.5 [0.65]
Full Spline
18.8 max [0.74]

3.81 max [0.150]
22.22 Gauge dia [0.875]

6.30 x 22.22 dia Woodruff Key [0.248 x 0.875]
0.25 [0.01] min R On Edges

3.44 [0.135]

2.50 max [0.100]
Tapered
OUTPUT SHAFT: OPTION N

27 [1.06]
33.3 Gauge Dim [1.311]

42.8 [1.68]

Coupling Must Not Protrude Beyond 29.4 max [1.000]

25.4 max [1.000] Nominal Shaft dia

0.755-16 UNF-2A Thd

6.25 x 2.50 [0.248 x 0.099]
0.25 [0.01] min R On Edges

2.875 [0.113] dia

VIEW "X"
(FRONT VIEW)
*All SAE straight thread O-Ring ports per SAE J1926.
Shaft rotation is determined by viewing motor from output shaft end.
Contact your SAUER-SUNDSTRAND representative for specific installation drawings.
**Axial Piston Motors**

**Series 40**

**M35/M44 MF: Mounting Flange, Shafts**

<table>
<thead>
<tr>
<th>Shaft Option</th>
<th>Shaft Length [mm]</th>
<th>Shaft Diameter [mm]</th>
<th>Full Spline &quot;U&quot;</th>
<th>Major Dia. [mm]</th>
<th>Pitch Dia. [mm]</th>
<th>No. Teeth &quot;Z&quot;</th>
<th>Pitch &quot;Z&quot;</th>
<th>Thru Shaft</th>
</tr>
</thead>
</table>

*All SAE straight thread O-Ring ports per SAE J1926.*

Shaft rotation is determined by viewing motor from output shaft end.

Contact your SAUER-SUNDSTRAND representative for specific installation drawings.

---

**VIEW "X"**

(FRONT VIEW)

Approx. Center of Gravity

37.046 [1.461] Case Drain - L1 Both Sides

3.75 [0.148] (2) Places

4.52 [0.178] (2) Places

---

**SPLINED OUTPUT SHAFT (SEE TABLE)**

**TAPERED OUTPUT SHAFT: OPTION N**

**STRAIGHT KEYS: OUTPUT SHAFT: OPTION Y**

---

P100 466E

---

M35/M44 MF Splined Shaft Options
Axial Piston Motors  

Series 40

M35/M44 MV Dimensions

M35/44 MV: Twin Ports, Thru Shaft

<table>
<thead>
<tr>
<th>Motor Shaft Rotation</th>
<th>Flow Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clockwise (CW)</td>
<td>Port &quot;A&quot; In</td>
</tr>
<tr>
<td></td>
<td>Port &quot;B&quot; Out</td>
</tr>
<tr>
<td>Counterclockwise (CCW)</td>
<td>Port &quot;A&quot; Out</td>
</tr>
<tr>
<td></td>
<td>Port &quot;B&quot; In</td>
</tr>
</tbody>
</table>

0.5625-18" System Pressure Gauge Port M2
0.5625-18" System Pressure Gauge Port M1

VIEW "Z" (REAR VIEW)  
TWIN PORTS

LEFT SIDE VIEW

VIEW "W"

P100 468E
*All SAE straight thread O-Ring ports per SAE J1926.
Shaft rotation is determined by viewing motor from output shaft end.
Contact your SAUER-SUNDSTRAND representative for specific installation drawings.
M46 MF Dimensions

M46 MF: Axial Ports, Twin Ports, Loop Flushing, Speed Sensor

Motor Shaft Rotation | Flow Direction
---|---
Clockwise (CW) | Port "A" | Port "B"
Counterclockwise (CCW) | Out | In

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>(in)</th>
<th>(cm)</th>
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<tbody>
<tr>
<td>29.7</td>
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<td>91.4</td>
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<td>39.4</td>
<td>1.55</td>
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<td>3/4</td>
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<tr>
<td>53.3</td>
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<td>7/8</td>
<td>2.50</td>
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</tr>
<tr>
<td>63.5</td>
<td>2.50</td>
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<tr>
<td>188.6</td>
<td>7.42</td>
<td></td>
</tr>
<tr>
<td>140.3</td>
<td>5.52</td>
<td></td>
</tr>
<tr>
<td>202.2</td>
<td>7.96</td>
<td></td>
</tr>
<tr>
<td>173.6</td>
<td>6.84</td>
<td></td>
</tr>
<tr>
<td>85.3</td>
<td>3.36</td>
<td></td>
</tr>
<tr>
<td>162.9</td>
<td>6.42</td>
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<tr>
<td>140.3</td>
<td>5.52</td>
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<tr>
<td>173.6</td>
<td>6.84</td>
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</tr>
<tr>
<td>202.2</td>
<td>7.96</td>
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</tr>
</tbody>
</table>

VIEW "Z" (REAR VIEW) AXIAL PORTS W/ LOOP FLUSHING

VIEW "Z" RADIAL (TWIN) PORTS W/ LOOP FLUSHING

LEFT SIDE VIEW AXIAL PORTS W/ LOOP FLUSHING

LEFT SIDE VIEW RADIAL (TWIN) PORTS W/ LOOP FLUSHING

P100 470E
All SAE straight thread O-Ring ports per SAE J1926. Shaft rotation is determined by viewing motor from output shaft end. Contact your SAUER-SUNDSTRAND representative for specific installation drawings.
Axial Piston Motors
Series 40

M46 MF: Mounting Flange, Shaft, Speed Sensor

### M46 MF Splined Shaft Options

|--------------|-------------------|--------------------|-----------------------------|-------------------|-----------------------|----------------|-------------|-------------|----------|----------|

### Notes

- **SPLINED OUTPUT SHAFT (SEE TABLE)**
  - "P" max
  - "U" Full Spline
  - "T" max dia
  - "V" dia
- **PACKING**
  - "W" Pitch dia
  - 30° Pressure Angle
  - "Y" Teeth, "Z" Pitch
  - Fillet Root Side Fit
  - per ANSI B92.1 Class No. 5
  - Also Mates with Flat Root Side Fit
- **COUPLING MUST NOT PROTRUDE BEYOND THIS SURFACE**
  - Coupling Must Not Protrude Beyond This Surface
  - Coupling Must Not Protrude Beyond This Surface

---

**Packard Weather-Pack**
- 4-Way Conn. (male)
- Mates with Packard Part No. 12015797
- 4-Way Tower (female)
- or Sauer-Sundstrand
- Kit No. K03384

**Pulse Pick-up Option**

**VIEW "X" (FRONT VIEW)**
**Axial Piston Motors**

**Series 40**

**M46 MV (SAE Flange) Dimensions**

**M46 MV (SAE Flange): Side Ports, Loop Flushing**

<table>
<thead>
<tr>
<th>Motor Shaft Direction</th>
<th>Flow Direction</th>
<th>Port &quot;A&quot;</th>
<th>Port &quot;B&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clockwise (CW)</td>
<td>Out</td>
<td>In</td>
<td>In</td>
</tr>
<tr>
<td>Counterclockwise (CCW)</td>
<td>In</td>
<td>Out</td>
<td>Out</td>
</tr>
</tbody>
</table>

*All SAE straight thread O-Ring ports per SAE J1926.*

Shaft rotation is determined by viewing motor from output shaft end.

Contact your SAUER-SUNDSTRAND representative for specific installation drawings.
Axial Piston Motors Series 40

M46 MV (SAE Flange): Axial Ports, Loop Flushing

View "Z" (Rear View)
Axial Ports w/ Loop Flushing

Loop Flushing Relief Valve

7/16 — 20" Gauge Ports M1 and M2

63.5 [2.50]

60.9 [3.00]

89.7 [3.53]

w/o loop flushing

8.4 [0.33]

(2) Places

42.4 [1.67]

(2) Places

71.6 [2.82]

1-1/16 — 12" Port "A"

229.7 [9.04]

Loop Flushing Shuttle Valve

98.3 [3.87]

1-1/16 — 12" Port "B"

28.6 [1.13]

(2) Places

80.9 [3.19]

"Z"

LEFT SIDE VIEW
Axial Ports w/ Loop Flushing

P100 475
All SAE straight thread O-Ring ports per SAE J1926.
Shaft rotation is determined by viewing motor from output shaft end.
Contact your SAUER-SUNDSTRAND representative for specific installation drawings.
M46 MV (SAE Flange): Mounting Flange, Shaft

<table>
<thead>
<tr>
<th>Shaft Option</th>
<th>Shaft Extension [\text{in}]</th>
<th>Max. Coupling ENG Stamp</th>
<th>Shaft Diameter [\text{in}]</th>
<th>Full Spindle Length [\text{in}]</th>
<th>Major Dia. [\text{in}]</th>
<th>Pitch Dia. [\text{in}]</th>
<th>No. Teeth</th>
<th>Pitch [\text{in} ]</th>
<th>Thru Shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>32.94 [1.297]</td>
<td>32 [1.26]</td>
<td>19.1 [0.75]</td>
<td>15.8 [0.62]</td>
<td>21.72 [0.855]</td>
<td>20.638 [0.8125]</td>
<td>13</td>
<td>16/32</td>
<td>—</td>
</tr>
<tr>
<td>B</td>
<td>32.94 [1.297]</td>
<td>32 [1.26]</td>
<td>19.1 [0.75]</td>
<td>15.8 [0.62]</td>
<td>21.72 [0.855]</td>
<td>20.638 [0.8125]</td>
<td>13</td>
<td>16/32</td>
<td>13T</td>
</tr>
<tr>
<td>E</td>
<td>37.72 [1.485]</td>
<td>36.6 [1.44]</td>
<td>28.4 [1.119]</td>
<td>22.86 [0.90]</td>
<td>24.89 [0.980]</td>
<td>23.812 [0.9375]</td>
<td>15</td>
<td>16/32</td>
<td>—</td>
</tr>
<tr>
<td>F</td>
<td>37.72 [1.485]</td>
<td>36.6 [1.44]</td>
<td>28.4 [1.119]</td>
<td>22.86 [0.90]</td>
<td>24.89 [0.980]</td>
<td>23.812 [0.9375]</td>
<td>15</td>
<td>16/32</td>
<td>13T</td>
</tr>
</tbody>
</table>

**OUTPUT SHAFT (SEE TABLE)**

**SPLINED**

**COUPLING MUST NOT PROTRUDE BEYOND THIS SURFACE**

**W** Pitch dia

30° Pressure Angle

“V” Teeth, “Z” Pitch

Flat Root Side Fit

Also Mate with Flat Root Side Fit

**TAPERED**

**OUTPUT SHAFT: OPTION J**

**P100 477E**
*All SAE straight thread O-Ring ports per SAE J1926.
Shaft rotation is determined by viewing motor from output shaft end.
Contact your SAUER-SUNDSTRAND representative for specific installation drawings.
Axial Piston Motors

Series 40

M46 MV (Cartridge Flange) Dimensions

M46 MV (Cartridge Flange): Twin Ports, Loop Flushing, Speed Sensor

<table>
<thead>
<tr>
<th>Motor Shaft Direction</th>
<th>Flow Direction</th>
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<tr>
<td></td>
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</table>

Loop Flushing Relief Valve

VIEW "Z"
(REAR VIEW)
RADIAL (TWIN) PORTS W/ LOOP FLUSHING

NOTE: Units w/ defeated loop flushing have same dimensions

Packard Weather-Pack
4-Way Conn. (Male)
Mates with
Packard Part No 12015797
4-Way Tower (Female)
OR
Sauer-Sundstrand
Kit No. K03384

Speed Sensor Option

VIEW "W"
(BOTTOM VIEW)
RADIAL (TWIN) PORTS W/ LOOP FLUSHING

P100 479-1E
**Axial Piston Motors**

**Series 40**

**M46 MV (Cartridge Flange): Mounting Flange, Shaft**

<table>
<thead>
<tr>
<th>M46 MV (Cartridge) Splined Shaft Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shaft Option</strong></td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>E</td>
</tr>
</tbody>
</table>

**SPLINED OUTPUT SHAFT (SEE TABLE)**

View "X" (Front View)

**Designed to be compatible with CW12, CW18, CT18, CT26, and CT35 Compact Planetary Drives.**

*All SAE straight thread O-Ring ports per SAE J1926.*

Shaft rotation is determined by viewing motor from output shaft end.

Contact your SAUER-SUNDSTRAND representative for specific installation drawings.
S40 Motor Schematics

Series 40 - M25 Fixed Motor Schematic (No Loop Flushing)

Series 40 - M25/M35/M44/M46 Fixed Motor Schematic

Series 40 - M25/M35/M44 Variable Motor Schematic

Series 40 - M46 Variable Motor Schematic
SAUER-SUNDSTRAND is a world leader in the design and manufacture of Hydraulic Power Systems. Research and development resources in both North America and Europe enable SAUER-SUNDSTRAND to offer a wide range of design solutions utilizing hydraulic power system technology.

SAUER-SUNDSTRAND specializes in integrating a full range of system components to provide vehicle designers with the most advanced total-design system.

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