<table>
<thead>
<tr>
<th>Photo</th>
<th>Type</th>
<th>Series</th>
<th>Description</th>
<th>Main Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Piston Pumps" /></td>
<td>Piston Pumps</td>
<td>PVS</td>
<td>Variable Volume Piston Pump</td>
<td>0.49 - 2.76in³/rev, 3000psi</td>
</tr>
<tr>
<td><img src="image2.png" alt="Piston Pumps" /></td>
<td>Piston Pumps</td>
<td>PZS</td>
<td>Variable Volume Piston Pump</td>
<td>4.27 - 6.10in³/rev, 4085psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.93 - 13.42in³/rev, 3642psi</td>
</tr>
<tr>
<td><img src="image3.png" alt="Vane Pumps" /></td>
<td>Vane Pumps</td>
<td>VDR</td>
<td>Variable Volume Vane Pump</td>
<td>7.9gpm, 2000psi</td>
</tr>
<tr>
<td><img src="image4.png" alt="Vane Pumps" /></td>
<td>Vane Pumps</td>
<td>VDC</td>
<td>High-Pressure Type Variable Volume Vane Pump</td>
<td>7.9 - 31.7gpm, 2000psi</td>
</tr>
<tr>
<td><img src="image5.png" alt="Vane Pumps" /></td>
<td>Vane Pumps</td>
<td>VDS</td>
<td>Small Variable Volume Vane Pump</td>
<td>0.5in³/rev, 4.0gpm, 1000psi</td>
</tr>
<tr>
<td><img src="image6.png" alt="Uni-Pumps" /></td>
<td>Uni-Pumps</td>
<td>UVN</td>
<td>Variable Volume Vane Pump</td>
<td>7.6gpm, 1160psi</td>
</tr>
</tbody>
</table>
PVS Series Variable Volume Piston Pumps

- Design No. 30 is applied on PVS-0B to make the pump more compact and lighter, and reduce noise.
- Production of PVS-3B has been discontinued. Use PZS-3B.
- Pressure adjustment 3 type has been added to PVS-1B-22 and PVS-2B-45. (Design No. 20 is applied only on PVS-2B-45.)

Features

Energy-saving Type with Drastically Reduced Loss

A NACHI-proprietary semi-circular barrel swash plate that receives pressure on its surface ensures a stable discharge volume at all times. This eliminates excess discharge volume, and enables the effective use of power corresponding to the load cycle. This "energy-saving type" conserves energy, reduces power loss, and helps to reduce hydraulic costs.

Silent Type That Demonstrates Its Power Quietly

Proprietary low-noise mechanisms are incorporated on the shoe, swash plate, valve plate, and other locations to ensure silent operation. In particular, a semi-circular barrel swash plate stabilizes operation characteristics to ensure silent operation.
Specifications

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Volume cm/rev (in/rev)</th>
<th>Discharge volume at no-load l/min (gpm)</th>
<th>Pressure adjustment range MPa (PSI)</th>
<th>Allowable peak pressure MPa (PSI)</th>
<th>Revolution speed min⁻¹</th>
<th>Weight Lb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1000 min⁻¹</td>
<td>1200 min⁻¹</td>
<td>1500 min⁻¹</td>
<td>1800 min⁻¹</td>
<td>Min.</td>
</tr>
<tr>
<td>PVS-08-8°</td>
<td>8.0 (0.49)</td>
<td>8.0</td>
<td>9.6</td>
<td>12.0</td>
<td>14.4</td>
<td>2~</td>
</tr>
<tr>
<td>PVS-16°</td>
<td>16.5 (1.01)</td>
<td>16.5</td>
<td>19.8</td>
<td>24.7</td>
<td>29.7</td>
<td>2~</td>
</tr>
<tr>
<td>PVS-22°</td>
<td>22.0 (1.34)</td>
<td>22.0</td>
<td>26.4</td>
<td>33.0</td>
<td>39.6</td>
<td>2~</td>
</tr>
<tr>
<td>PVS-2B-35°</td>
<td>35.0 (2.14)</td>
<td>35.0</td>
<td>42.0</td>
<td>52.5</td>
<td>63.0</td>
<td>2~</td>
</tr>
<tr>
<td>PVS-2B-45°</td>
<td>45.0 (2.76)</td>
<td>45.0</td>
<td>54.0</td>
<td>67.5</td>
<td>81.0</td>
<td>2~</td>
</tr>
</tbody>
</table>

Note: 1. The standard direction of rotation is clockwise when viewed from the shaft end. Consult your agent separately for a counterclockwise direction of rotation.

Handling

Cautions during Pump Installation and Piping

1. Use flexible couplings for connecting the pump shaft to the drive shaft, and prevent a radial or thrust load from being applied on the pump shaft.
2. For centering of the pump shaft, limit the eccentricity between the drive shaft and hydraulic pump shaft to 0.05 mm, and keep the angle error within 1°.
3. Set the clamping length of couplings and hydraulic pump shafts so that it is within at least 2/3 or more of the coupling width.
4. Use a sufficiently rigid pump mounting base.
5. Set the pressure on the pump suction side to -0.03 MPa or more (suction port flow velocity within 2 m/sec).
6. Raise part of the drain piping to above the topmost part of the pump body, and insert the return section of the drain piping into the hydraulic operating fluid. Also, observe the values in the following table to limit the drain back pressure to 0.1 MPa.

<table>
<thead>
<tr>
<th>Item</th>
<th>Model No.</th>
<th>PVS-08</th>
<th>PVS-1B</th>
<th>PVS-2B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe joint size</td>
<td>5/8” or more</td>
<td>1/2” or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe I.D</td>
<td>ø7.6 mm dia or more</td>
<td>ø12 mm dia or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe length</td>
<td>1m or less</td>
<td>1m or less</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Management of Hydraulic Operating Fluid

1. Use good-quality hydraulic operating fluid, and use within a kinematic viscosity range of 20 to 200 mm²/sec during operation. Use an R&O type and wear-resistant type of IS-OGV32 to 68 or equivalent.
2. The optimum kinematic viscosity during operation is 20 to 50 mm²/sec.
3. The operating temperature range is 5 to 60°C. When the oil temperature at startup is 5°C or less, warm up the hydraulic pump by low-pressure, low-operation speed operation until the oil temperature reaches 5°C.
4. Provide a suction strainer with a filtering grade of about 100µm (150 mesh). Be sure to provide a return line filter of grade 20µm or less on the return line to the tank. (When the hydraulic pump is used at a high pressure of 14 MPa or more, we recommend providing a filter of 10µm or less.)
5. Manage the hydraulic operating fluid so that contamination is maintained at class NAS10 or lower.
6. Use hydraulic operating fluid within an operating ambient temperature of 0 to 60°C.

Cautions at Startup

1. Before you start pump operation, fill the pump body with clean hydraulic operating fluid via the lubrication port.
2. An unload is required when the motor is started under condition λ=3. Consult your agent regarding the circuit.
3. Make sure that the pump operates in the direction of rotation the same as that indicated by the arrow on the pump body.
4. Air entering the pump or pipes may cause noise or vibration. At startup, set the pump discharge side to a noload state, and operate the pump in the inching mode to release any air in the pump or pipes.
5. Provide an air bleed valve in circuits where it is difficult to release air at startup.

How to Set Pressure and Discharge Volume

The default pump discharge volume is set to "maximum" and default discharge pressure is set to "minimum". Change the discharge volume and discharge pressure settings according to your particular operating conditions.

Pressure adjustment

Turning the pressure adjusting screw CW increases the pressure.

Discharge volume adjustment

Turning the flow rate adjusting screw CW decreases the discharge volume.

Note: For details regarding the relationship between flow rate adjustment l/min and pump capacity q, see the tables provided in the installation dimension drawings for each of the pumps.

Firmy tighten the lock nuts after you have finished adjustments.
PVS series variable volume piston pump

**Explanation of model No**

- **PVS** – 1 B – 16 N 2 – (**) – 13
  - Design code 30: PVS-0B
  - 12: PVS-1B, PVS-2B (Rc piping)
  - 13: PVS-1B, PVS-2B (SAE piping)
  - 20: PVS-2B-45N3
  - No code: Rc for piping and metric for others
  - E: SAE for piping and metric for others
  - Aux. symbol:
  - Z: Side port type
  - Axial port type
  - Control Type:
  - Pressure compensating range [See Note]
  - Max. volume cc/rev 8, 16, 22, 35, 45 (in³/rev 0.5, 1.0, 1.3, 2.1, 2.8)
  - Mounting B: flange mounting
  - A: Foot mounting
  - Pump size: 0, 1, 2

**Variable control mechanism**
- Standard type:
  - N*: Pressure compensation type (manual mode)
- Option type:
  - P*: Pressure compensation type (remote control mode)
  - N*Q*: 2-pressure, 2-flow rate control
  - R*A*: Solenoid cutoff control
  - W*A*: 2-pressure control
  - RQ*A*: 2-pressure, 2-flow rate control w/ solenoid cutoff
  - C*A*: 2-cutoff control

**Discharge pressure**
- P2: 3-14MPa
- R2: 3-14MPa
- C2: 3-14MPa

**Discharge volume**
- N2: 3-14MPa
- W2: 3-14MPa
- RQ2: 3-14MPa

**Solenoid specifications**
- A0: SA-G01
- A1: SS-G01
- A2: 100V 50/60Hz
- A3: 200V 50/60Hz
- A4: DC12V
- A5: DC24V
- A6: AC115V 60Hz

**Note**
- Variable control mechanism
- N*: Pressure compensation type (manual mode)
- P*: Pressure compensation type (remote control mode)
- N*Q*: 2-pressure, 2-flow rate control
- R*A*: Solenoid cutoff control
- W*A*: 2-pressure control
- RQ*A*: 2-pressure, 2-flow rate control w/ solenoid cutoff
- C*A*: 2-cutoff control

- Pressure adjustment range:
  - 0: 2 ~ 3.5MPa (286 ~ 500psi)
  - 1: 2 ~ 7MPa (286 ~ 1000psi)
  - 2: 2 ~ 14MPa (286 ~ 2000psi)
  - 3: 3 ~ 21MPa (429 ~ 3000psi)
- Applicable to solenoid specifications A, S
- A0: SA-G01
- A1: SS-G01
- A2: 100V 50/60Hz
- A3: 200V 50/60Hz
- A4: DC12V
- A5: DC24V
- A6: AC115V 60Hz

**Examples**

Example 1:
- N*: Pressure compensation type (manual mode)
- PVS-1B-16N2

Example 2:
- P*: Pressure compensation type (remote control mode)
- PVS-1B-16P2

Example 3:
- N*Q*: 2-pressure, 2-flow rate control
- PVS-1B-16N2Q1

Example 4:
- R*: Solenoid cutoff control
- PVS-1B-16R2S2

Example 5:
- W*: 2-pressure control
- SS-G01

Example 6:
- RQ*: 2-pressure, 2-flow rate control w/ solenoid cutoff
- PVS-1B-16RQS2S1

Example 7:
- C*: 2-cutoff control
- SS-G01

- NQ, RS, WS, RQS and CS types are not available for the PVS-0B-8, and the NQ, RQS and CS types are not available for the PVS-1B-16Z and PVS-2B-35Z.
# Variable Control Mechanisms

## Standard type

<table>
<thead>
<tr>
<th>Symbol</th>
<th>External View</th>
<th>Characteristics</th>
<th>Hydraulic Circuit</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td><img src="image1" alt="Flow rate adjusting screw" /></td>
<td><img src="image2" alt="Discharge volume" /></td>
<td><img src="image3" alt="Discharge port" /></td>
<td>Pressure compensation type (manual system) When the discharge pressure reaches the preset volume set by the pressure compensator, the discharge volume is automatically reduced to hold the pressure at the set pressure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image4" alt="Discharge pressure" /></td>
<td><img src="image5" alt="Suction port" /></td>
<td><img src="image6" alt="Drain port" /></td>
</tr>
</tbody>
</table>

## Option type

<table>
<thead>
<tr>
<th>Symbol</th>
<th>External View</th>
<th>Characteristics</th>
<th>Hydraulic Circuit</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td><img src="image7" alt="Flow rate adjusting screw" /></td>
<td><img src="image8" alt="Discharge volume" /></td>
<td><img src="image9" alt="Discharge port" /></td>
<td>Pressure compensation type (remote control mode) This mode demonstrates the same characteristics as the manual mode. The discharge pressure can be adjusted by external pilot pressure. The discharge volume can be adjusted manually. Note 2)</td>
</tr>
<tr>
<td>NQ</td>
<td><img src="image10" alt="Flow rate adjusting screw" /></td>
<td><img src="image11" alt="Discharge volume" /></td>
<td><img src="image12" alt="Suction port" /></td>
<td><img src="image13" alt="Drain port" /></td>
</tr>
<tr>
<td>RS (RA)</td>
<td><img src="image14" alt="Flow rate adjusting screw" /></td>
<td><img src="image15" alt="Discharge volume" /></td>
<td><img src="image16" alt="Suction port" /></td>
<td><img src="image17" alt="Drain port" /></td>
</tr>
<tr>
<td>WS (WA)</td>
<td><img src="image18" alt="Flow rate adjusting screw" /></td>
<td><img src="image19" alt="Discharge volume" /></td>
<td><img src="image20" alt="Suction port" /></td>
<td><img src="image21" alt="Drain port" /></td>
</tr>
<tr>
<td>ROS (RQA)</td>
<td><img src="image22" alt="Flow rate adjusting screw" /></td>
<td><img src="image23" alt="Discharge volume" /></td>
<td><img src="image24" alt="Suction port" /></td>
<td><img src="image25" alt="Drain port" /></td>
</tr>
<tr>
<td>CS (CA)</td>
<td><img src="image26" alt="Flow rate adjusting screw" /></td>
<td><img src="image27" alt="Discharge volume" /></td>
<td><img src="image28" alt="Suction port" /></td>
<td><img src="image29" alt="Drain port" /></td>
</tr>
</tbody>
</table>

Note 1) Many other variable control mechanism are also available in addition to those in the above table. Please consult your agent for details.

Note 2) We recommend ZR-T02-"5895" as the remote control valve. For details, consult your agent. Prevent the pipe volume up to the remote control valve from falling below 150cm³.
Pressure Compensation Type

PVS-08-8N*-E30

Manual mode: standard type

Typical characteristics at hydraulic operating fluid kinematic viscosity of 32 mm²/s

List of Sealing Parts

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Part Name</th>
<th>Qty</th>
<th>Size</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Packing</td>
<td>1</td>
<td>PS46-10000</td>
<td>Bond</td>
</tr>
<tr>
<td>23</td>
<td>Oil seal</td>
<td>1</td>
<td>TCV-25451</td>
<td>N.O.K</td>
</tr>
<tr>
<td>27</td>
<td>O-ring</td>
<td>1</td>
<td>1B-P9</td>
<td>JIS B 2401</td>
</tr>
</tbody>
</table>

Parts marked by an asterisk (*) are not available on the market. Consult your agent.

Relationship between flow rate adjustment length (l) and pump capacity (q)

Set a flow rate adjustment length within the above range. Oil will leak if the pump is operated below the adjustment range lower limit.

Performance Curves

Efficiency Curves

Pressure-Flow Curves

Input Power Curves

Noise Level

Measured at 1m behind pump
Installation Dimension Drawing

PVS-1B-16N*-E13 (Side Port Type)

PVS-1B-16N*-Z13 (Axial Port Type)

Cross-sectional Drawing

The relation between flow adjusting length (r) and pump displacement (q)

List of Sealing Parts

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Part Name</th>
<th>Qty</th>
<th>Size</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Gasket</td>
<td>1</td>
<td>P546-10000</td>
<td>Nihon Tsubakuro</td>
</tr>
<tr>
<td>24</td>
<td>Oil seal</td>
<td>1</td>
<td>TCN-254511</td>
<td>N.O.K</td>
</tr>
<tr>
<td>28</td>
<td>O-ring</td>
<td>1</td>
<td>18-G55</td>
<td>JIS B 2401</td>
</tr>
<tr>
<td>29</td>
<td>O-ring</td>
<td>1</td>
<td>18-P9</td>
<td>JIS B 2401</td>
</tr>
<tr>
<td>30</td>
<td>O-ring</td>
<td>1</td>
<td>18-P14</td>
<td>JIS B 2401</td>
</tr>
</tbody>
</table>

Parts marked by an asterisk (*) are not available on the market.
Consult your agent.
Performance Curves

**Typical characteristics at hydraulic operating fluid kinematic viscosity of 32 mm²/s**

**PVS-1B-16N*(Z)-E13**  
Oil ISO VG 32  
Oil temp. 50°C (122°F)

**Efficiency Curves**

**Pressure-Flow Curves**

**Input Power Curves**

---

**Performance Curves**

**Typical characteristics at hydraulic operating fluid kinematic viscosity of 32 mm²/s**

**PVS-1B-22N*(Z)-E13**  
Oil ISO VG 32  
Oil temp. 50°C (122°F)

**Efficiency Curves**

**Pressure-Flow Curves**

**Input Power Curves**
Installation Dimension Drawing

PVS-2B-35V*-E13 (Side Port Type)

Cross-sectional Drawing

PVS-2B-35V*-E13 (Axial Port Type)

List of Sealing Parts

List of Sealing Parts

Parts marked by an asterisk "*" are not available on the market. Consult your agent.
Performance Curves

PVS-2B-35N*(Z)-E13

Typical characteristics at hydraulic operating fluid kinematic viscosity of 32 mm²/s

Oil ISO VG 32 Oil temp. 50°C (122°F)

Performance Curves

PVS-2B-45N*(Z)-E13, E20

Typical characteristics at hydraulic operating fluid kinematic viscosity of 32 mm²/s

Oil ISO VG 32 Oil temp. 50°C (122°F)
## Response Performance

### Test Circuit

Piping volume 400 cm³

### Pressure MPa

Legend:

- SOL ON
- SOL OFF
- Q (MAX)
- Q (0)

| Model No. | Response Time (s) | Surge Pressure (MPa) | Pressure compensate
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( b_1 )</td>
<td>( b_2 )</td>
<td>( P_s )</td>
</tr>
<tr>
<td>PVS-0B-8</td>
<td>0.03 ~ 0.04</td>
<td>0.04 ~ 0.06</td>
<td>2 ~ 4 (20.4 ~ 40.8)</td>
</tr>
<tr>
<td>PVS-1B-16</td>
<td>0.05 ~ 0.06</td>
<td>0.07 ~ 0.08</td>
<td>4 ~ 7 (40.8 ~ 71.4)</td>
</tr>
<tr>
<td>PVS-1B-22</td>
<td>0.05 ~ 0.06</td>
<td>0.07 ~ 0.08</td>
<td>5 ~ 8 (51.2 ~ 81.6)</td>
</tr>
<tr>
<td>PVS-2B-35</td>
<td>0.05 ~ 0.06</td>
<td>0.05 ~ 0.07</td>
<td>6 ~ 9 (61.2 ~ 91.8)</td>
</tr>
<tr>
<td>PVS-2B-45</td>
<td>0.05 ~ 0.06</td>
<td>0.05 ~ 0.07</td>
<td>6 ~ 9 (61.2 ~ 91.8)</td>
</tr>
</tbody>
</table>

Response performance changes according to pipe volume and size. Use an anti-surging valve to prevent surge voltage.

## Pressure Compensator

### List of Sealing Parts

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Part Name</th>
<th>Qty</th>
<th>Size</th>
<th>For diam 18, 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>O-ring</td>
<td>1</td>
<td>1B-P14</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>O-ring</td>
<td>3</td>
<td>1B-P6</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>O-ring</td>
<td>1</td>
<td>1B-P16</td>
<td></td>
</tr>
</tbody>
</table>

Note: O-ring 1A/B** refers to JIS B2401-1A/B.
**Pressure Compensation Type**

Remote control mode

Explaination of model No.: **PVS - 0 B - 8 P* - E30**

- **Design No.**
  - E30: PVS-0*, E13: PVS-1*, E20: PVS-2* - 4SP3 only
- **Pressure adjustment range**
  - 0: 2 - 3.5MPa (286-500psi)
  - 1: 2 - 7MPa (286-1000psi)
  - 2: 3 - 14MPa (429-2000psi)
  - 3: 3 - 21MPa (429-3000psi)
- **Max. pump capacity (cm³/rev)**
  - Nominal 8, 16, 22, 35, 45 (in³/rev 0.5, 1.0, 1.3, 2.1, 2.8)
- **Pump size**: 0, 1, 2

**P-Q Characteristics**

Set by remote control V

Discharge pressure P MPa

**Flow rate adjusting length**

**Flow rate adjusting screw**

**Pilot port**

**Drain port**

**Discharge port**

**Suction port**

**Lubrication port**

**Installation Dimension Drawing**

**PVS-0B-8P* - E30**

**PVS-1B-16P* - E13**

**PVS-2B-35P* - E13, E20**

**P-11**
2-pressure, 2-flow Rate Control Type

Explanation of model No.: PVS – 1 B – 16 N 3 Q 1 – E13

Design No. E13: PVS-1*, PVS-2*
E20: PVS-2*-45N3Q*

Pressure adjustment range
N*: High-pressure adjustment range, P2
Q*: Low-pressure adjustment range, P1
0: 2- 3.5MPa (286-500psi)
1: 2- 7MPa (286-1000psi)
2: 3-14MPa (429-2000psi)
3: 3-21MPa (429-3000psi)

NQ: 2-pressure, 2-flow rate control
Max. pump capacity (cm³/rev)
Nominal 16, 22, 35, 45 (in³/rev 1.0, 1.3, 2.1, 2.8)
Pump size 1, 2

Installation Dimension Drawing

PVS-1B-16 N*Q*-E13

P-VS-2B-35 N*Q*-E13, E20

P-Q Characteristics

Pump Model No. | q₁ Adjustment Range (in³/rev) | Default q₁ (Setting in³/rev)
--- | --- | ---
PVS-1B-16 | 0 ~ 0.6 | 0.20
PVS-1B-22 | 0 ~ 0.8 | 0.26
PVS-2B-35 | 0 ~ 1.1 | 0.42
PVS-2B-45 | 0 ~ 1.4 | 0.54

Note 1) The setting range of maximum pump capacity q₁ varies according to the setting of q₂.
Note 2) Overall efficiency at a low flow rate is worse than at the maximum flow rate. Pay attention to this when selecting the motor capacity for the drive.
Solenoid Cutoff Control Type

Explanation of model No.: **PVS – 1 B – 16 R 2 S 1 – E13**

- Solenoid power supply: 1: AC110-115V
  - 2: AC220-230V
  - 3: DC12V
  - 4: DC24V

- Solenoid specifications: A: SA-G01
  - S: SS-G01

Pressure adjustment range:
- 0: 2-3.5MPa (286-500psi)
- 1: 7MPa (790psi)
- 2: 3-14MPa (429-2000psi)
- 3: 3-21MPa (429-3000psi)

- **R** – Solenoid cutoff control

Max. pump capacity (cm³/rev)
Nominal 16, 22, 35, 45 (in³/rev 1.0, 1.3, 2.1, 2.8)

Installation Dimension Drawing

PVS-1B-16R*A*-E13

- Pressure adjusting screw (at solenoid ON)
- Drain port
- Flow rate adjusting screw

PVS-2B-35R*A*-E13, E20

- Pressure adjusting screw (at solenoid ON)
- Lock nut
- Flow rate adjusting screw

- The coil surface temperature increases if this pump is kept continuously energized.
  - Do not touch the surface of the coil directly with your hands.
2-pressure Control Type

Explanation of model No.: PVS – 1 B – 16 W 2 S 1 – E13

- Solenoid power supply:
  1: AC110-115V
  2: AC220-230V
  3: DC12V
  4: DC24V

- Solenoid specifications:
  A: SA-G01
  S: SS-G01

Pressure adjustment range:
- 0: 2-3.5MPa (286-500psi)
- 1: 2-7MPa (286-1000psi)
- 2: 3-14MPa (429-2000psi)
- 3: 3-21MPa (429-3000psi)

W: 2-pressure control

Max. pump capacity (cm³/rev)
Nominal 16, 22, 35, 45 (in³/rev 1.0, 1.3, 2.1, 2.8)
Pump size 1, 2

Installation Dimension Drawing

PVS-1B-16W*A*-E13

- Flow rate adjusting screw
- Pressure adjusting screw (at solenoid OFF)
- Drain port

Pressure adjustment range
- 0: 2-3.5MPa (286-500psi)
- 1: 2-7MPa (286-1000psi)
- 2: 3-14MPa (429-2000psi)
- 3: 3-21MPa (429-3000psi)

PVS-2B-35W*A*-E13, E20

- Flow rate adjusting screw
- Pressure adjusting screw (at solenoid ON)
- Drain port

Pressure adjustment range
- 0: 2-3.5MPa (286-500psi)
- 1: 2-7MPa (286-1000psi)
- 2: 3-14MPa (429-2000psi)
- 3: 3-21MPa (429-3000psi)

The coil surface temperature increases if this pump is kept continuously energized.
Do not touch the surface of the coil directly with your hands.
2-pressure, 2-flow rate Control Type w/ Solenoid Cutoff

Explanation of model No.: PVS - 1 B - 16 RQ 2 S 1 - E13

- **Solenoid power supply**: 1: AC110-115V
  2: AC220-230V
  3: DC12V
  4: DC24V

- **Solenoid specifications**
  - A: SA-G01
  - S: SS-G01

- **Pressure adjustment range**
  - 0: 2-3.5MPa (28-500psi)
  - 1: 3-7MPa (429-1000psi)
  - 2: 3-14MPa (429-2000psi)
  - 3: 3-21MPa (429-3000psi)

- **RQ**: 2-pressure, 2-flow rate control w/ solenoid cutoff

- **Max. pump capacity (cm³/rev)**
  - Nominal 16, 22, 35, 45 (in³/rev 1.0, 1.3, 2.1, 2.8)

Installation Dimension Drawing

PVS-1B-16 RQ A-S E13

- **2-pressure, 2-flow rate Control Type w/ Solenoid Cutoff**

- **Pressures adjustment range**
  - 0: 2-3.5MPa {286-500psi}
  - 1: 3-7MPa {286-1000psi}
  - 2: 3-14MPa {429-2000psi}
  - 3: 3-21MPa {429-3000psi}

- **Max. pump capacity (cm³/rev)**
  - Nominal 16, 22, 35, 45 (in³/rev 1.0, 1.3, 2.1, 2.8)

The coil surface temperature increases if this pump is kept continuously energized.
Do not touch the surface of the coil directly with your hands.
2-cutoff Control Type

Explanation of model No.: **PVS - 1 B - 16 RQ 2 S 1 - E13**

- **Solenoid power supply:**
  1: AC110-115V
  2: AC220-230V
  3: DC12V
  4: DC24V

- **Solenoid specifications:**
  A: SA-G01
  S: SS-G01

- **Pressure adjustment range:**
  0: 2-3.5MPa (286-500psi)
  1: 2-7MPa (286-1000psi)
  2: 3-14MPa (429-2000psi)
  3: 3-21MPa (429-3000psi)

- **RQ**: 2-pressure, 2-flow rate control w/ solenoid cutoff

- **Max. pump capacity** (cm³/rev)
  Nominal 16, 22, 35, 45 (in³/rev 1.0, 1.3, 2.1, 2.8)

- **Pump size**: 1, 2

**Installation Dimension Drawing**

**PVS-1B.16C-A*-E13**

**PVS-2B.35C-A*-E13(E20)**

- **Discharge pressure** P MPa
- **Discharge capacity** q cm³/rev

**P-Q Characteristics**

- **Discharge pressure P MPa**
  - SOL "ON"
  - SOL "OFF"

*The coil surface temperature increases if this pump is kept continuously energized. Do not touch the surface of the coil directly with your hands.*
Foot Mounting Kit

SAE 2 BOLT MOUNTING

<table>
<thead>
<tr>
<th>Foot mounting kit model</th>
<th>Applicable pump model</th>
<th>Name of part</th>
<th>Dimension mm (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Screw Qty. Washer Qty</td>
<td>A</td>
</tr>
<tr>
<td>IHM-2-10</td>
<td>PVS-1B-8 PVS-1B-16, 22</td>
<td>TB-10 x 30 2 WIP-10 2</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(5.00)</td>
</tr>
<tr>
<td>IHM-4-10</td>
<td>PVS-2B-35, 45</td>
<td>TB-12 x 30 2 WIP-12 2</td>
<td>220.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(8.69)</td>
</tr>
</tbody>
</table>

Flange kit

For PVS-1B, 2B

<table>
<thead>
<tr>
<th>Applicable pump model</th>
<th>PVS-1B-16, 22</th>
<th>PVS-2B-35, 45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flange kit model</td>
<td>IN port</td>
<td>OUT port</td>
</tr>
<tr>
<td>A</td>
<td>70(2.76)</td>
<td>65(2.56)</td>
</tr>
<tr>
<td>B</td>
<td>56(2.20)</td>
<td>52(2.05)</td>
</tr>
<tr>
<td>C</td>
<td>52(2.06)</td>
<td>47(1.87)</td>
</tr>
<tr>
<td>D</td>
<td>26(1.03)</td>
<td>22(0.87)</td>
</tr>
<tr>
<td>T</td>
<td>240(9.44)</td>
<td>240(9.44)</td>
</tr>
<tr>
<td>Ød₁</td>
<td>110(4.33)</td>
<td>110(4.33)</td>
</tr>
<tr>
<td>Ød₂</td>
<td>28(1.10)</td>
<td>22(0.87)</td>
</tr>
<tr>
<td>X</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>Screw</td>
<td>TH-10 x 40</td>
<td>TH-10 x 40</td>
</tr>
<tr>
<td>Washer</td>
<td>WS-B-10</td>
<td>WS-B-10</td>
</tr>
<tr>
<td>Weight kg (lbs.)</td>
<td>0.6(0.32)</td>
<td>0.5(0.23)</td>
</tr>
</tbody>
</table>
To improve reliability, design Nos. 17 and 31 were adopted due to remodeling of the grease injection system connecting section.

**Uni-pump Specifications**

Explanation of model No.

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Motor Output kW</th>
<th>Discharge Pressure MPa</th>
<th>Discharge Volume Q cm³/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPV-0A</td>
<td>0.75 - 3.75</td>
<td>20 - 40</td>
<td>0.75 - 10</td>
</tr>
<tr>
<td>UPV-1A</td>
<td>5.5 - 7.5</td>
<td>20 - 80</td>
<td>15 - 30</td>
</tr>
<tr>
<td>UPV-2A</td>
<td>8.0 - 12</td>
<td>20 - 40</td>
<td>20 - 40</td>
</tr>
</tbody>
</table>

Motor selection curves

- **How to select the motor**
  The lower side of the output curves for each of the motors shown above indicates the operating range under rated output for that motor.
1. A class E totally enclosed fan-cooled type is used as the reference motor.
2. 200 V/220 V, 60 Hz and 200 V, 50 Hz are used as the reference motor voltages.
3. Viewed from the pump side, the suction port on the left side and the discharge port on the right side are used as the reference port locations.
4. Broken lines indicate instances for the A terminal. Broken lines pass through to the other side of the pump along its center.

Note: A terminal measurements are in parentheses ( ).
## Motor Specifications

<table>
<thead>
<tr>
<th>Output kW (HP)</th>
<th>A</th>
<th>IL</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>S=T</th>
<th>KD</th>
<th>KL</th>
<th>O</th>
<th>Frame No.</th>
<th>Weight kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75 (1.0)</td>
<td>4.88</td>
<td>4.23</td>
<td>80</td>
<td>6.30</td>
<td>2.46</td>
<td>1.97</td>
<td>0.39</td>
<td>6.30</td>
<td>-</td>
<td>1.34</td>
<td>9.11</td>
<td>6.10</td>
<td>5.31</td>
<td>0.39-0.98</td>
<td>0.87</td>
<td>4.96</td>
<td>0.83</td>
<td>80M</td>
<td>12</td>
</tr>
<tr>
<td>1.5 (2.0)</td>
<td>5.61</td>
<td>4.67</td>
<td>90</td>
<td>7.01</td>
<td>2.76</td>
<td>2.46</td>
<td>0.39</td>
<td>7.05</td>
<td>-</td>
<td>1.38</td>
<td>10.28</td>
<td>6.69</td>
<td>6.10</td>
<td>0.39-0.98</td>
<td>0.87</td>
<td>5.35</td>
<td>5.35</td>
<td>90L</td>
<td>16</td>
</tr>
<tr>
<td>2.2 (3.0)</td>
<td>6.32</td>
<td>5.35</td>
<td>100</td>
<td>7.68</td>
<td>3.14</td>
<td>2.76</td>
<td>0.51</td>
<td>7.78</td>
<td>-</td>
<td>1.77</td>
<td>11.67</td>
<td>7.68</td>
<td>6.89</td>
<td>0.47-0.98</td>
<td>0.87</td>
<td>5.91</td>
<td>1.79</td>
<td>100L</td>
<td>20</td>
</tr>
<tr>
<td>5.5 (7.5)</td>
<td>6.73</td>
<td>5.65</td>
<td>112</td>
<td>8.62</td>
<td>3.74</td>
<td>2.76</td>
<td>0.55</td>
<td>8.72</td>
<td>-</td>
<td>1.77</td>
<td>12.38</td>
<td>8.82</td>
<td>6.89</td>
<td>0.47-0.98</td>
<td>0.87</td>
<td>6.34</td>
<td>2.09</td>
<td>112L</td>
<td>29</td>
</tr>
<tr>
<td>7.5 (10.0)</td>
<td>8.54</td>
<td>6.44</td>
<td>132</td>
<td>10.87</td>
<td>4.25</td>
<td>2.76</td>
<td>0.63</td>
<td>10.63</td>
<td>12.26</td>
<td>1.97</td>
<td>14.98</td>
<td>9.84</td>
<td>6.89</td>
<td>0.47-0.98</td>
<td>0.134</td>
<td>8.54</td>
<td>1.32</td>
<td>132S</td>
<td>48</td>
</tr>
</tbody>
</table>

*Unit = inch*
**Features**

1. High pressure and high efficiency. These pumps are available in high pressure ranges (up to 28 MPa) with a high operational efficiency.
2. Low noise and low pulsation. These pumps have been developed for low noise and low pulsation operation using the semi-cylindrical swash plate and an increased number of pistons (from 9 to 11 units).
3. High reliability and long service life. Optimum pressure balance provided by the spherical valve plate and the use of copper alloy bushings on the piston sliding surface of the cylinder barrel ensure stable operation for a wider operational range.
4. Applicable for multiple-pump layout. In addition to a single pump layout, PZS Series pumps are applicable for double-pump layout for combination with an IP pump (constant discharge pump) for wider range of applications. Additionally, an adapter kit is available to make a double pump with other pumps (ex. PVS-1B, VDC-1B).

**Specifications**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Pump Capacity in3/rev (Adjustment Range)</th>
<th>Rated Pressure MPa (psi)</th>
<th>Maximum Working Pressure MPa (psi)</th>
<th>Pressure Adjustment Range MPa (psi)</th>
<th>Revolution Speed min⁻¹</th>
<th>Weight kg</th>
<th>Fixed Discharge Pump (Note 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PZS-3B*-70*1-E4481A  3-E4481A  4-E10</td>
<td>4.27 (2.74 to 4.27)</td>
<td>21 (3000)</td>
<td>28 (4085)</td>
<td>2 to 7 (291 to 1000) 2 to 21 (291 to 3000) 2 to 28 (291 to 4085)</td>
<td>500</td>
<td>1800</td>
<td>37</td>
</tr>
<tr>
<td>PZS-4B*-100*1-E4481A  3-E4481A  4-E10</td>
<td>6.10 (2.44 to 6.10)</td>
<td>21 (3000)</td>
<td>28 (4085)</td>
<td>2 to 7 (291 to 1000) 2 to 21 (291 to 3000) 2 to 28 (291 to 4085)</td>
<td>500</td>
<td>1800</td>
<td>58</td>
</tr>
<tr>
<td>PZS-5B*-130*1-E10  3  4</td>
<td>7.93 (3.11 to 7.93)</td>
<td>21 (3000)</td>
<td>25 (3642)</td>
<td>2 to 7 (291 to 1000) 2 to 21 (291 to 3000) 2 to 25 (291 to 3642)</td>
<td>500</td>
<td>1800</td>
<td>86</td>
</tr>
<tr>
<td>PZS-6B*-180*1-E10  3  4</td>
<td>10.98 (6.16 to 10.98)</td>
<td>21 (3000)</td>
<td>25 (3642)</td>
<td>2 to 7 (291 to 1000) 2 to 21 (291 to 3000) 2 to 25 (291 to 3642)</td>
<td>500</td>
<td>1800</td>
<td>123</td>
</tr>
<tr>
<td>PZS-6B*-220*1-E10  3  4</td>
<td>13.42 (7.56 to 13.42)</td>
<td>21 (3000)</td>
<td>25 (3642)</td>
<td>2 to 7 (291 to 1000) 2 to 21 (291 to 3000) 2 to 25 (291 to 3642)</td>
<td>500</td>
<td>1500</td>
<td>126</td>
</tr>
</tbody>
</table>

**Notes**
1. Fixed discharge pump can be configured by combining with an IP pump.
2. Pump capacity adjustment ranges are for control codes N, R, and W. For information about control code NO, see page P-26.
3. The standard direction of rotation is clockwise when viewed from the shaft end. Contact your agent for information about counterclockwise rotation.
4. A keyed straight shaft is standard. Contact your agent for information about spline shafts.

**Handling**
- Use flexible couplings for connecting the pump shaft to the drive shaft, and prevent radial or thrust load from being applied to the pump shaft.
- Eccentricity between the drive shaft and pump shaft should be no greater than 0.05mm, with an eccentric angle error of 1° or less.
- Keep the clamping length of couplings and pump shafts at least 2/3 the length of the coupling width.
- Use a sufficiently rigid pump mounting base.
- Set pump suction side pressure to 0.03 MPa or more (suction port flow velocity less than 2 m/sec).
- Raise part of the drain piping so it is above the topmost part of the pump body, and insert the return section of the drain piping into the hydraulic operating fluid. Also, observe the values in the following table in order to limit the drain back pressure to 0.1 MPa.
- Use of rubber hose is recommended in order to minimize noise and vibration.

**Management of Hydraulic Operating Fluid**
- Use only good-quality hydraulic operating fluid with a kinematic viscosity during operation within the range of 20 to 200 mm²/sec. Normally, you should use an R&O type and wear-resistant type of ISO VG32 to 68 or equivalent. The optimum kinematic viscosity during operation is 20 to 50 mm²/sec.
- The operating temperature range is 5 to 60°C. When the oil temperature at startup is 5°C or less, run the pump at low pressure and low speed until the oil temperature reaches 5°C.
- Provide a suction strainer with a filtering grade of about 100μ (150 mesh).

(Continued on following page)
Manage hydraulic operating fluid so contamination is maintained at class NAS10 or lower.

Use hydraulic operating fluid when the operating ambient temperature is in the range of 0 to 60°C.

**Startup Precautions**

1. Before starting the pump, fill the pump body with clean hydraulic operating fluid through the lubrication port.
2. An unload circuit is required when the motor is started under condition x–A. Contact your agent about the unload circuit.
3. Check to make sure that the rotation direction of the pump is the same as the rotation direction indicated by the arrow on the pump body.
4. Air entering the pump or pipes can cause noise or vibration. At startup, set the pump discharge side to a no-load state, and operate the pump in the inching mode to remove any air that might be in the pump or pipes.
5. Equip an air bleed valve in circuits where it is difficult to release air before startup.

**Configuring Pressure and Discharge Rate Settings**
The factory default pump discharge rate setting is the setting's maximum value, while the default discharge pressure is the settings minimum value. Change the discharge rate and discharge pressure settings in accordance with your particular operating conditions.

**Pressure Adjustment**
Rotating the pressure adjusting screw clockwise increases pressure.

**Discharge Volume Adjustment**
Rotating the flow rate adjusting screw clockwise decreases the discharge rate.

**Understanding Model Numbers**

**Standard type**
Pressure compensation (N)

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Oil Amount cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>PZS-3B</td>
<td>1000</td>
</tr>
<tr>
<td>PZS-4B</td>
<td>1800</td>
</tr>
<tr>
<td>PZS-5B</td>
<td>2200</td>
</tr>
<tr>
<td>PZS-6B</td>
<td>3000</td>
</tr>
</tbody>
</table>

**Option type**
2-Pressure, 2-Flow Rate Control Type (NQ)

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Oil Amount cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>PZS-4B</td>
<td>1000</td>
</tr>
<tr>
<td>PZS-5B</td>
<td>1800</td>
</tr>
<tr>
<td>PZS-6B</td>
<td>2200</td>
</tr>
<tr>
<td>PZS-4B</td>
<td>3000</td>
</tr>
</tbody>
</table>

**Variable Control Mechanisms**

- **N**: Pressure compensation control
- **E10**: for others

**Design number**
- E4481A for N1 or N3 PZS 3/4B
- E10 for others

**Pressure adjustment range**
1. 2 to 7 MPa (291 to 1000 psi)
2. 2 to 21 MPa (291 to 3000 psi)
3. 2 to 28 MPa (291 to 4085 psi)

**Note:** PZS-5B/6B maximum operating pressure: 25 MPa (3642 psi)

**P-Q characteristics**

**Pump capacity (cm³/rev)**
- 4.27, 6.10, 7.93, 10.98, 13.42

**Mounting method**
- B: Flange type mounting
- A: Foot type mounting

**Variable Control Mechanisms**

- **NQ**: 2-pressure, 2-flow rate control
- **Pump capacity (in³/rev)**
  - 4.27, 6.10, 7.93

**Mounting method**
- B: Flange type mounting
- A: Foot type mounting

**Discharge pressure (MPa)**
- 2 to 7
- 2 to 21
- 2 to 28

**Note:** Securely tighten the lock nut after making adjustments.
Installation Dimension Drawings

Pressure Compensation Type
Installing a remote control relieve valve to the pilot port provides remote control of pressure compensation.
PZS-3B-70N*-E10, E4481A

Solenoid Cutoff Control Type (RS)

PZS-4B-100R*E10

- Design number
- Solenoid power supply
  1: AC100V
  2: AC200V
  3: DC12V
  4: DC24V
- Pressure adjustment range
  1: 2 to 7MPa (291 to 1000psi)
  2: 2 to 21MPa (291 to 3000psi)
  3: 2 to 28MPa (291 to 4085psi)
- Note: PZS-5B/6B maximum operating pressure: 25MPa (3642psi)
- Variable Control Mechanisms
  RS: Solenoid cutoff control
- Pump capacity (in/rev)
  4.27, 6.10, 7.93, 10.98, 13.42
- Mounting method
  B: Flange type mounting
  A: Foot type mounting
- Pump size
  3, 4, 5, 6

2-Pressure Control System (WS)

PZS-4B-100W*E10

- Design number
- Solenoid power supply
  1: AC100V
  2: AC200V
  3: DC12V
  4: DC24V
- Pressure adjustment range
  1: 2 to 7MPa (291 to 1000psi)
  2: 2 to 21MPa (291 to 3000psi)
  3: 2 to 28MPa (291 to 4085psi)
- Note: PZS-5B/6B maximum operating pressure: 25MPa (3642psi)
- Variable Control Mechanisms
  WS: 2-pressure control type
- Pump capacity (in/rev)
  4.27, 6.10, 7.93, 10.98, 13.42
- Mounting method
  B: Flange type mounting
  A: Foot type mounting
- Pump size
  3, 4, 5, 6

P-Q characteristics

Discharge pressure MPa

* SOL"OFF*  SOL"ON"

Discharge port

Suction port  Drain port

Pump capacity

P-Q characteristics

Discharge pressure MPa

* SOL"OFF*  SOL"ON"

Discharge port

Suction port  Drain port
Use a flow adjustment length that is within the range noted in the above chart. Using a length that is outside the lower limit adjustment range can lead to oil leaks.
2-Pressure, 2-Flow Rate Control Type
PZS-3B-70N*Q*-10

PZS-4B-100N*Q*-10

PZS-5B-130N*Q*-10

Pump Volume Adjustable Range

<table>
<thead>
<tr>
<th>Pump Model No.</th>
<th>Volume Adjustment Range cm³/rev</th>
<th>Factory Default qL Setting (cm³/rev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PZS-3B-70N<em>Q</em>-10</td>
<td>5 to 70</td>
<td>5 to 40</td>
</tr>
<tr>
<td>PZS-4B-100N<em>Q</em>-10</td>
<td>16 to 100</td>
<td>7 to 60</td>
</tr>
<tr>
<td>PZS-5B-130N<em>Q</em>-10</td>
<td>17 to 130</td>
<td>8 to 70</td>
</tr>
</tbody>
</table>

Note 1: The setting range for pump maximum capacity qH depends on the qL setting.

Note 2: Overall efficiency at a low flow rate is worse than at the maximum flow rate. Keep this in mind when deciding on the drive motor capacity.

P-Q characteristics
PZS Pump 2-Pressure 2-Flow Rate Control Flow Rate Adjustment Graph

- Be sure to adjust the low flow rate first, and then adjust the maximum flow rate.
- Remember that the maximum flow rate adjustment range (lower limit) changes in accordance with the low flow rate adjustment. The maximum flow rate adjustment lower limit is equivalent to the low flow rate adjustment length (L1) plus 11mm.
- Pump efficiency at a low flow rate is worse than at the maximum flow rate. Keep this in mind when deciding on the drive motor capacity.
Using the installed solenoid valve so it is continuously conducting current can cause the coil surface to become hot. Do not touch the surface of the coil directly with your hands.
Solenoid Cutoff Control Type
PZS-3B-70R*S*-10

Using the installed solenoid valve so it is continuously conducting current can cause the coil surface to become hot.
Do not touch the surface of the coil directly with your hands.
Performance Curves

PZS-3B-70N*-10

Typical Characteristics at a Hydraulic Operating Fluid Kinematic Viscosity of 46 mm²/s

PZS-4B-100N*-10

Typical Characteristics at a Hydraulic Operating Fluid Kinematic Viscosity of 46 mm²/s
PZS-6B-220N*-10

Typical Characteristics at a Hydraulic Operating Fluid Kinematic Viscosity of 46 mm²/s

Cross-sectional Drawing

PZS-3B-70N*-E4481, E10
PZS-4B-100N*-E4481, E10
PZS-6B-**N*-E10

List of Sealing Parts

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Part Name</th>
<th>Product Number</th>
<th>Remarks</th>
</tr>
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<tbody>
<tr>
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<td>18-G105</td>
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<td>O-ring 18-P21</td>
<td>18-P21</td>
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Note 1: Contact your agent about this type of O-ring.
### Pressure Compensator

<table>
<thead>
<tr>
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<th>Part Name</th>
<th>Part No.</th>
<th>Part Name</th>
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<td>Spring guide</td>
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<td>Spring</td>
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**PZS-5B**

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<td>JIS B 2407</td>
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*Parts marked by an asterisk * are not available on the market. Consult your agent.*
### List of Sealing Parts

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Name</th>
<th>Part Number</th>
<th>Q'ty</th>
<th>Remarks</th>
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<td>PZS-5B</td>
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### Foot Mounting Installation Measurement Chart

**IHM-55-10**

<table>
<thead>
<tr>
<th>Flange Part No.</th>
<th>Bolt</th>
<th>Washer</th>
<th>O-ring</th>
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<tbody>
<tr>
<td>TH-16x40</td>
<td>WP-16</td>
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<td>1B-G50</td>
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<tr>
<td>TH-20x50</td>
<td>WP-20</td>
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<td>1B-G50</td>
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<td>TH-20x50</td>
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### Screw In Type

<table>
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<tr>
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<th>Applicable Pump Flange Part No.</th>
<th>Flange Part No.</th>
<th>Bolt</th>
<th>Washer</th>
<th>O-ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>PJF-10300T</td>
<td>PZS-3B</td>
<td>H03J-100120</td>
<td>4</td>
<td>WS-B-12</td>
<td>1B-G50</td>
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<tr>
<td>PJF-10400T</td>
<td>PZS-4B</td>
<td>H03J-100160</td>
<td>4</td>
<td>WS-B-12</td>
<td>1B-G60</td>
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<tr>
<td>PJF-10500T</td>
<td>PZS-5B</td>
<td>H03J-100200</td>
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<td>1B-G75</td>
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<tr>
<td>PJF-10600T</td>
<td>PZS-6B</td>
<td>H03J-100240</td>
<td>4</td>
<td>WS-B-12</td>
<td>1B-G85</td>
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### Welded Type

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<tr>
<th>Welded Type Flange Kit model No.</th>
<th>Applicable Pump Flange Part No.</th>
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<td>PZS-4B</td>
<td>H03J-200160</td>
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<td>1B-G60</td>
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<td>1B-G75</td>
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<td>H03J-200240</td>
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<td>1B-G85</td>
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### Piping Flange Kit

**Foot Mounting Kit**

**PZM-*10**

**Foot Mounting Kit Model No.**

<table>
<thead>
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<th>Model No.</th>
<th>Measurements (in)</th>
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<tbody>
<tr>
<td>PZM-3-10</td>
<td>A: 11.63 B: 13.15 C: 6.00</td>
</tr>
<tr>
<td>PZM-4-10</td>
<td>A: 11.42 B: 13.15 C: 6.30</td>
</tr>
<tr>
<td>IHM-55-10</td>
<td>A: 13.00 B: 14.57 C: 7.87</td>
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**Foot Mounting Kit Weight (kg)**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>S</th>
<th>T</th>
<th>U</th>
<th>V</th>
<th>(S)</th>
<th>Td</th>
<th>ad</th>
<th>ad</th>
<th>ad</th>
<th>kg</th>
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</thead>
<tbody>
<tr>
<td>PZM-3-10</td>
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<td>0.98</td>
<td>5.64</td>
<td>1020</td>
<td>-</td>
<td>1.75</td>
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<td>1.38</td>
<td>0.71</td>
<td>3.39</td>
<td>13.5</td>
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<tr>
<td>PZM-4-10</td>
<td>2.44</td>
<td>1.10</td>
<td>6.36</td>
<td>1020</td>
<td>-</td>
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<td>2.44</td>
<td>6.00</td>
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<td>0.71</td>
<td>6.00</td>
<td>18.0</td>
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<td>IHM-55-10</td>
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**Note:** The IHM-55-10 (J) dimension (2.76) is the value for the PZS-5B. This dimension becomes 2.28 in the case of the PZS-6B.

**The IHM-55-10 (I) dimension (1.57) is the value for the PZS-5B. This dimension becomes 1.10 in the case of the PZS-6B.**
Features

1. High efficiency operation with minimal power loss
   All the performance of the original new VDR series mechanisms combines with precision machining for a pump that minimizes power loss, especially at full cut-off.

2. Quiet operation
   Journal bearings with a proven record on IP pumps plus new suction and discharge port configurations reduce operating noise and deliver quiet operation with minimal vibration, even in the high-pressure range.

3. Compact and simple design, easy operation
   Compact and quiet, VDS Series variable vane pumps are economical and easy to handle. A simple design allows use in a wide range of hydraulic systems.

4. Precise characteristics, prompt response
   Prompt response at both ON-OFF and OFF-ON ensures instantaneous, stable, high-precision operation.

5. Solidly built for high efficiency and long life
   VDS Series pumps are built to last, with a design that incorporates years of NACHI experience and know-how. Specially selected materials and skilled workmanship provide outstanding durability along with stable, high-efficiency operation.

Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Delivery (l/min (gpm) at No-Load)</th>
<th>Pressure Adjust Range kgf/cm² (psi)</th>
<th>Drive Speed (rpm)</th>
<th>Max. Setting Pressure kgf/cm² (psi)</th>
<th>Weight kgf (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot Mounting</td>
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<tr>
<td>VDS-OB-1A1-E11</td>
<td>1800rpm</td>
<td>10-20</td>
<td>800</td>
<td>20</td>
<td>70</td>
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<td>VDS-OB-1A2-E11</td>
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<td>30-70</td>
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<td>70</td>
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<tr>
<td>Flange Mounting</td>
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<tr>
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<td>VDS-OB-1A3-E11</td>
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<td></td>
</tr>
</tbody>
</table>

- Flow Rate Setting = Maximum Flow Rate
- Pressure Setting = Pressure shown in table below

However: Q = q × n × 10⁻³
Q: No-load Discharge Rate (l/min)
q: Capacity (cm³/rev)
N: Revolution Speed (min⁻¹)

Flow Adjustment Rotation Angle (°) and Pump Capacity (cc)

The values indicated above are at maximum pump discharge volume with the flow volume adjusting screw at the 0° position. The broken line shows the flow volume adjustment range lower limit value.

Handling

1. The direction of rotation for this pump is clockwise (rightward) when viewed from the shaft side.
2. Drain piping must be direct piping up to a point that is below the tank fluid level, and back pressure due to pipe resistance should not exceed 0.03 MPa.
3. When adjusting pressure, pressure is increased by clockwise (rightward) rotation of the adjusting screw and decreased by counterclockwise (leftward) rotation.
4. When adjusting the flow rate, the flow rate is decreased by clockwise (rightward) rotation of the adjusting screw and increased by counterclockwise (leftward) rotation. The graph on the right provides general guidelines for the relationship between the rotation angle of the flow rate adjusting screw and the no-load discharge rate.
5. Factory Default P-Q Settings (Standard Model)
   - Flow Rate Setting = Maximum flow rate for model as indicated in the catalog
   - Pressure Setting = Pressure shown in table below

<table>
<thead>
<tr>
<th>Factory Default Pressure Settings MPa (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: 2.0 (286)</td>
</tr>
<tr>
<td>2: 3.5 (500)</td>
</tr>
<tr>
<td>3: 7.0 (1000)</td>
</tr>
</tbody>
</table>

Trust Screw

The thrust screw is precision adjusted at the factory during assembly. Never touch the thrust screw.

Initial Operation

Before operating the pump for the first time, put the pump discharge side into the no-load state and then repeatedly start and stop the motor to bleed all air from inside the pump and the suction piping. After confirming that the pump is discharging oil, continue the no-load operation for at least 10 minutes to discharge all the air from the circuit.

For the hydraulic operating fluid, use an R&O type and wear-resistant type of ISO VG32 to 68 or equivalent (viscosity index of at least 90). Use hydraulic operating fluid that provides kinematic viscosity during operation in the range of 20 to 150 mm²/s.

The operating temperature range is 15 to 60°C. When the oil temperature at startup is 15°C or less, perform a warm-up operation at low pressure until the oil temperature reaches 15°C. Use the pump in an area where the temperature is within the range of 0 to 60°C.

(Continued on following page)
Suction pressure is -0.03 to +0.03 MPa (-4.3 to +4.3 psi), and the suction port flow rate should be no greater than 2 m/sec.

Avoid pulley, gear, and other drive systems that impart a radial or thrust load on the end of the pump shaft. Mount the pump so its pump shaft is oriented horizontally.

Provide a suction strainer with a filtering grade of about 100 μm (150 mesh). For the return line to the tank, use a 25 μm line filter.

Manage hydraulic operating fluid so contamination is maintained at class NAS10 or lower. Take care to avoid contamination with water or other foreign matter, and watch for discoloration. Whitish fluid indicates that air has contaminated the fluid, and brownish fluid indicates the fluid is dirty.

Contact your agent about using water- and glycol-based hydraulic operating fluids.

At startup, repeat the inching operation (start-stop) to bleed air from the pump and pipes.

Equip an air bleed valve in circuits where it is difficult to bleed air before startup.

To ensure proper lubrication of the pump's rubbing surfaces, supply oil to the interior of the pump before starting operation.

When centering the pump shaft, eccentricity with the motor shaft should be no greater than 0.05 mm. The angle error should be no greater than 1°.

---

### Understanding Model Numbers

**VDS - O *- 1 A *- E11**

- **Design number**
- **Pressure adjustment range**
  - 1: 1 to 2 MPa (146 to 292 psi)
  - 2: 1.5 to 3.5 MPa (218 to 500 psi)
  - 3: 3 to 7 MPa (437 to 1000 psi)
- **Flow rate characteristics A: Constant discharge rate type**
- **Ring size**
  - 1: 4.0 gpm (1800 min⁻¹ no load)
- **Mounting method**
  - A: Foot type mounting  B: Flange type mounting
- **Pump size:** 0
- **Pump Type:** VDS Series Compact Variable Vane Pump

---

### Installation Dimension Drawings

**VDS-0A-1A-*-E11**

Foot Mounting Type: mm (inch)

- **Pressure adjusting screw**
  - 99.5 (3.92)
  - 59.5 (2.34)
- **Flow rate adjusting screw**
  - 96 (3.78)
  - 118.5 (4.67)

---

Note) Foot Mounting Kit: IHM-2-10
VDS-0B-1A-*-E11
Flange Mounting

Performance Curves
Typical characteristics at hydraulic operating fluid kinematic viscosity of 32 mm²/s

Power Loss Curve – At Full Cutoff

Noise Characteristics
Cross-sectional Drawing

VDS-0B-1A*-E11

List of Sealing Parts

Seal Kit: VBAS-200B00
Applicable Pump Model: VDS-0A/B-1A*-E11

<table>
<thead>
<tr>
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<th>Part Name</th>
<th>Part Number</th>
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<tr>
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<td>O-ring</td>
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<td>1</td>
</tr>
</tbody>
</table>

Note: 1. Oil seals are manufactured by Nippon Oil Seal Industry Co. Ltd. (NOK).
2. O-ring 1A/B** refers to JIS B2401-1A.

Part No. | Part Name    | Part No. | Part Name
---------|--------------|----------|--------------
1        | Body         | 16       | Key
2        | Cover (A)    | 17       | Nut
3        | Cover (B)    | 18       | O-ring
4        | Shaft        | 19       | O-ring
5        | Cam ring     | 20       | O-ring
6        | Vane         | 21       | O-ring
7        | Plate (S)    | 22       | O-ring
8        | Plate (H)    | 23       | Screw
9        | Thrust screw | 24       | Bearing
10       | Screw        | 25       | Screw
11       | Piston       | 26       | Screw
12       | Holder       | 27       | Oil seal
13       | Spring       | 28       | Snap ring
14       | Nut          | 29       | Pin
15       | Cap          | 30       | Nameplate
VDR 22 Design Series Variable Volume Vane Pump

Features

1. **Stable, highly efficient operation up to 14 MPa**
   A biased piston that minimizes ring vibration and leak-free pressure balance construction enables highly efficient high-pressure operation, and very stable performance up to 14 MPa.

2. **High-precision instantaneous response**
   Response has been improved by a special bias piston mechanism. Prompt response at both ON-OFF and OFF-ON ensures instantaneous, stable, high-precision operation.

3. **Silent operation, even in the high pressure range**
   Quiet journal bearings, a bias piston that allows a 3-point support system, and new suction and discharge port shapes all contribute to minimize operation noise. Silent, vibration-free operation is ensured, even in the high pressure range.

4. **Reduced power loss**
   A combination of NACHI original mechanical innovations and precision machining create a pump that minimizes power loss, especially at full cutoff.

5. **Solid construction stands up to harsh operating conditions**
   The tough and rugged construction of this pump is made possible by a long history of quality pump designs. This, in combination with specially selected materials and skilled workmanship, provides outstanding durability.

Specifications

<table>
<thead>
<tr>
<th>Model type</th>
<th>Delivery at no load /min (gpm)</th>
<th>Pressure adjusting range kgf/cm² (psi)</th>
<th>Drive speed rpm</th>
<th>Max. setting pressure kgf/cm² (psi)</th>
<th>Weight kg (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Foot Mounting</td>
<td>1800 r.p.m.</td>
<td>1500 r.p.m.</td>
<td>1200 r.p.m.</td>
<td>Max.</td>
</tr>
<tr>
<td>VDR-1A-1A2-*22</td>
<td>VDR-1A-1A2-*22</td>
<td>VDR-1B-1A2-*22</td>
<td>30 (7.9)</td>
<td>25 (6.6)</td>
<td>20 (5.3)</td>
</tr>
<tr>
<td>VDR-1A-1A3-*22</td>
<td>VDR-1A-1A3-*22</td>
<td>VDR-1B-1A3-*22</td>
<td>VDR-1A-1A4-*22</td>
<td>VDR-1B-1A4-*22</td>
<td>VDR-1A-1A5-*22</td>
</tr>
</tbody>
</table>

**Handling**

1. **Rotation Direction**
   The direction of rotation is always clockwise (rightward) when viewed from the shaft side.

2. **Drain**
   Drain piping must be direct piping up to a point that is below the tank fluid level, and back pressure due to pipe resistance should not exceed 0.03 MPa. When using a pump that has drain ports at two locations, use the drain port that is higher after the pump is installed.

3. **Discharge Volume Adjustment**
   The discharge flow rate is decreased by clockwise (rightward) rotation of the discharge rate adjusting screw, and increased by counterclockwise (leftward) rotation. Loosen the lock nut before making adjustments. After adjustment is complete, re-tighten the lock nut. The graph on the right provides general guidelines for the relationship between the rotation angle of the flow rate adjusting screw and the no-load discharge rate.

(Continued on following page)
However: $Q = q \times n \times 10^{-3}$

Q: No-load Discharge Rate $Q$ l/min
q: Volume cm$^3$/rev
N: Revolution Speed min$^{-1}$

The broken line shows the flow volume adjustment range lower limit value.

Note) The values indicated above are at maximum discharge volume with the flow volume adjusting screw at the 0° position.

4 Pressure Adjustment
Pressure is decreased by clockwise (rightward) rotation of the discharge rate adjusting screw, and increased by counterclockwise (leftward) rotation.

Factory Default P-Q Settings (Standard Model)
- Flow Rate Setting = Maximum flow rate for model as indicated in the catalog
- Pressure Setting = Pressure shown in table to the right

Thrust Screw
The thrust screw is precision adjusted at the factory during assembly. Never touch the thrust screw. See callout 2 in the cross-section diagram on page V-9.

Initial Operation
Before operating the pump for the first time, put the pump discharge side into the no-load state and then repeatedly start and stop the motor to bleed all air from inside the pump and the suction piping. After confirming that the pump is discharging oil, continue the no-load operation for at least 10 minutes to discharge all the air from the circuit.

Provide an air bleed valve in circuits where it is difficult to bleed air before startup.

Sub Plate
Use the following table for specification when a sub plate is required.

For detailed dimensions, see pages.

For the hydraulic operating fluid, use type ISO VG32 or equivalent (viscosity index of at least 90) for pressures of 7MPa or lower, and type ISO VG68 or equivalent (viscosity index of at least 90) for pressures greater than 7MP.

The operating temperature range is 15 to 60°C. When the oil temperature at startup is 15°C or less, perform a warm-up operation at low pressure until the oil temperature reaches 15°C. Use the pump in an area where the temperature is within the range of 0 to 60°C.

Suction pressure is -0.03 to +0.03MPa (-0.3 to +0.3kgf/cm$^2$), and the suction port flow rate should be greater than 2m/sec.

Avoid pulley, gear, and other drive systems that impart a radial or thrust load on the end of the pump shaft. Mount the pump so its pump shaft is oriented horizontally.

(Continued on following page)
Provide a suction strainer with a filtering grade of about 100 μm (150 mesh). For the return line to the tank, use a 25μm line filter. Manage hydraulic operating fluid so contamination is maintained at class NAS10 or lower. Take care to avoid contamination with water or other foreign matter, and watch out for discoloration. Whitish fluid indicates that air has contaminated the fluid, and brownish fluid indicates the fluid is dirty. Contact your agent about using water- and glycol-based hydraulic operating fluids. At startup, repeat the inching operation (start-stop) to bleed air from the pump and pipes. Equip an air bleed valve in circuits where it is difficult to bleed air before startup.

Installation Dimension Drawings

VDR-1A-*A*-22

Flow adjusting screw
Pressure adjusting screw

VDR-1B-*A*-22

Drain (1A4, 1A5 type only)
Rc 1/4 (E: NPT 1/4)

To ensure proper lubrication of the pump's rubbing surfaces, supply oil to the interior of the pump before starting operation. When centering the pump shaft, eccentricity with the motor shaft should be no greater than 0.05mm. Use a pump mounting base of sufficient rigidity. The angle error should be no greater than 1°.
Performance Curves

Typical characteristics at hydraulic operating fluid kinematic viscosity of 32 mm²/s

- VDR-1*-1A2-22
- VDR-1*-1A3-22
- VDR-1*-1A4-22
- VDR-1*-1A5-22
- VDR-1*-2A2-22
- VDR-1*-2A3-22

Power Loss Curves at Full-cut off

Noise Level measured at 1m behind pump
Cross-sectional Drawing

VDR-1A-*A*-22

List of Sealing Parts

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Part Name</th>
<th>Part No.</th>
<th>Part Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Packing</td>
<td>25</td>
<td>Pin</td>
</tr>
<tr>
<td>27</td>
<td>Oil seal</td>
<td>26</td>
<td>Spring pin</td>
</tr>
<tr>
<td>29</td>
<td>Backup ring</td>
<td>27</td>
<td>Cover</td>
</tr>
<tr>
<td>30</td>
<td>Backup ring</td>
<td>28</td>
<td>Cover</td>
</tr>
<tr>
<td>31</td>
<td>O-ring</td>
<td>29</td>
<td>Shaft</td>
</tr>
<tr>
<td>32</td>
<td>O-ring</td>
<td>30</td>
<td>Rotor</td>
</tr>
<tr>
<td>33</td>
<td>O-ring</td>
<td>31</td>
<td>Ring</td>
</tr>
<tr>
<td>34</td>
<td>O-ring</td>
<td>32</td>
<td>Vane</td>
</tr>
<tr>
<td>35</td>
<td>O-ring</td>
<td>33</td>
<td>Plate (5)</td>
</tr>
<tr>
<td>36</td>
<td>Plate (H)</td>
<td>34</td>
<td>Plate (H)</td>
</tr>
<tr>
<td>37</td>
<td>Piston</td>
<td>35</td>
<td>Piston</td>
</tr>
<tr>
<td>38</td>
<td>Spring</td>
<td>36</td>
<td>Screw</td>
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<tr>
<td>39</td>
<td>Screw</td>
<td>37</td>
<td>Screw</td>
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<td>Nut</td>
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<td>Nut</td>
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<tr>
<td>41</td>
<td>Piston</td>
<td>39</td>
<td>Plug</td>
</tr>
<tr>
<td>42</td>
<td>Holder</td>
<td>40</td>
<td>O-ring</td>
</tr>
<tr>
<td>43</td>
<td>Adapter</td>
<td>41</td>
<td>O-ring</td>
</tr>
<tr>
<td>44</td>
<td>Packing</td>
<td>42</td>
<td>O-ring</td>
</tr>
<tr>
<td>45</td>
<td>Bearing (5)</td>
<td>43</td>
<td>O-ring</td>
</tr>
<tr>
<td>46</td>
<td>Bearing (H)</td>
<td>44</td>
<td>Screw</td>
</tr>
<tr>
<td>47</td>
<td>Thrust screw</td>
<td>45</td>
<td>Key</td>
</tr>
<tr>
<td>48</td>
<td>Key</td>
<td>46</td>
<td>Nameplate</td>
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<td>49</td>
<td>Cap</td>
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<td>Screw</td>
</tr>
<tr>
<td>50</td>
<td>Pin</td>
<td>48</td>
<td>Pin</td>
</tr>
</tbody>
</table>

Note:
1. Oil seals are manufactured by Nippon Oil Seal Industry Co. Ltd. (NOK).
2. O-ring 1A-** refers to JIS B2401-1A-**.
3. For VDR-1B-**-22, the seal kit number becomes VDBS-101B00, without the 42 and 43 O-rings.

VDR-1A
VDC-1A

<table>
<thead>
<tr>
<th>Model</th>
<th>Domestic</th>
<th>E Series</th>
<th>Weight (lbf)</th>
<th>h (in)</th>
<th>B (in)</th>
<th>C (in)</th>
<th>Outlet Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MVD-1-115-10</td>
<td>MVD-1-115-E10</td>
<td>3.7 (8.2)</td>
<td>61.1 (2.41)</td>
<td>32</td>
<td>26</td>
<td>3/8</td>
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<tr>
<td>2</td>
<td>MVD-1-115X-E10</td>
<td>MVD-1-115X-E10</td>
<td>(8.4)</td>
<td>(1.24)</td>
<td>(1.26)</td>
<td>(1.02)</td>
<td>1/2</td>
</tr>
<tr>
<td>3</td>
<td>MVD-1-135-10</td>
<td>MVD-1-135-E10</td>
<td>4.9 (10.8)</td>
<td>61.1 (2.9)</td>
<td>40</td>
<td>40</td>
<td>3/8</td>
</tr>
<tr>
<td>4</td>
<td>MVD-1-135X-E10</td>
<td>MVD-1-135X-E10</td>
<td>(10.5)</td>
<td>(1.57)</td>
<td>(1.57)</td>
<td>(1.57)</td>
<td>1/2</td>
</tr>
</tbody>
</table>
Overview

The VDC series high pressure variable volume vane pumps are a new series of pumps. In addition to Nachi's three exclusive mechanisms (pressure control; pressure balance; ring stopper mechanism), a unique and exclusive three-point ring support system which makes maximum utilization of high pressure oil has been adopted to provide stable high pressure and quiet operation. The new series of hydraulic pumps are ideal for applications, such as: machine tools, industrial machinery and vehicles.

Features

1. **High efficiency, high pressure operation**
The unique pressure regulator and pressure balance mechanism, plus the exclusive three-point ring support system has improved performance during high pressure operation. The pump operates with high efficiency and stable performance up to a maximum of 140kgf/cm² (2000 psi).

2. **Low vibration and noise levels**
The new mechanisms reduces vibration and noise levels. Of particular note is the unique and exclusive three-point support system which uses, a regulating piston and a bias piston to eliminate vibration. The mechanism, together with improvements to the shape of the inlet and outlet ports and high performance journal bearings, has reduced the noise level during operation.

3. **Fast response**
The ring stopper mechanism serves to allow swifft response whether in starting, stopping, or with load fluctuations, for high precision operation.

4. **Stable discharge with sharp cut-off characteristics**
A revolutionary pressure compensator type pressure regulation mechanism provides, stable sharp cut-off characteristics. The compensator serves to provide stable and constant volume through our pressure ranges.

5. **High efficiency operation with reduced power loss**
Efficiency has been improved with the new mechanisms and Nachi's high precision machining technology. Power loss has been reduced, especially during dead-heading.

6. **Easy adjusting in maintenance and handling**
Maintenance is easier due to the positioning of the pressure adjusting mechanism and the volume adjusting mechanism on the same side of the pump.
# Specifications

## Single Pump

<table>
<thead>
<tr>
<th>Model type</th>
<th>Flange mounting</th>
<th>Foot mounting</th>
<th>Flow at no load u/min (gpm)</th>
<th>Pressure adjusting range kgf/cm² (psi)</th>
<th>Drive speed rpm</th>
<th>Max setting pressure kgf/cm² (psi)</th>
<th>Weight kgf (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDC-1A1A2=20</td>
<td>VDC-1B1A2...</td>
<td>VDC-1B1A2...</td>
<td>30 (11.5)</td>
<td>15 - 35 (214 - 500)</td>
<td>1800</td>
<td>35 (500)</td>
<td>9.5 (20.9)</td>
</tr>
<tr>
<td>VDC-1A1A3=20</td>
<td>VDC-1B1A3...</td>
<td>VDC-1B1A3...</td>
<td>25 (9.6)</td>
<td>20 - 70 (286 - 1000)</td>
<td>1800</td>
<td>70 (1000)</td>
<td>105 (1500)</td>
</tr>
<tr>
<td>VDC-1A1A4=20</td>
<td>VDC-1B1A4...</td>
<td>VDC-1B1A4...</td>
<td>20 (7.6)</td>
<td>50 - 105 (714 - 1500)</td>
<td>1800</td>
<td>140 (2000)</td>
<td>140 (2000)</td>
</tr>
<tr>
<td>VDC-1A1A5=20</td>
<td>VDC-1B1A5...</td>
<td>VDC-1B1A5...</td>
<td>15 (5.6)</td>
<td>70 - 140 (1000 - 2000)</td>
<td>1800</td>
<td>105 (1500)</td>
<td>140 (2000)</td>
</tr>
</tbody>
</table>

## Double Pump

<table>
<thead>
<tr>
<th>Model type</th>
<th>Head end pump</th>
<th>Shaft end pump</th>
<th>Drive speed rpm</th>
<th>Weight kgf (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>1800</td>
<td>20 (44.1)</td>
</tr>
<tr>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>1500</td>
<td>20 (44.1)</td>
</tr>
<tr>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>1800</td>
<td>35 (77.2)</td>
</tr>
<tr>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>1500</td>
<td>35 (77.2)</td>
</tr>
<tr>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>1800</td>
<td>50 (110.3)</td>
</tr>
<tr>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>VDC-1B1A2A3=20</td>
<td>1500</td>
<td>50 (110.3)</td>
</tr>
</tbody>
</table>
Handling

1. The rotation is clockwise as viewed from the shaft side.

2. Drain piping must be direct and piping up to a point that is below the tank fluid level, and piping should comply with the conditions shown in the table below to ensure that back pressure due to pipe resistance does not exceed 0.1MPa. When using a pump that has drain ports at two locations, use the drain port that is higher after the pump is installed. In the case of a double pump, run separate pipes from both the shaft side and the head side drains directly connect to the tank, so the drain pipe is below the surface of the oil.

Discharge Volume Adjustment

The discharge flow rate is decreased by clockwise (rightward) rotation of the discharge rate adjusting screw, and increased by counterclockwise (leftward) rotation.

Loosen the lock nut before making adjustments. After adjustment is complete, re-tighten the lock nut.

The graph below provides general guidelines for the relationship between the rotation angle of the flow rate adjusting screw and the no-load discharge rate.

However: \[ Q = q \times N \times 10^{-3} \]

\( Q \) : No-load Discharge Rate \( \text{Q} \) \( \text{L/min} \)

\( q \) : Volume \( \text{cm}^3/\text{rev} \)

\( N \) : Revolution Speed \( \text{min}^{-1} \)

Note)

The values indicated above are at maximum pump discharge volume with the flow volume adjusting screw at the 0° position. The broken line shows the flow volume adjustment range lower limit value.

Pressure Adjustment

Pressure is increased by clockwise (rightward) rotation of the discharge rate adjusting screw, and decreased by counterclockwise (leftward) rotation.

Loosen the lock nut before making adjustments. After adjustment is complete, re-tighten the lock nut.

P-Q adjustment at time of shipment from plant

Flow adjustment: Has already been adjusted to maximum flow indicated for the model type in the catalog.

Pressure adjustment: Has already been adjusted to preset pressures given in Table below:

<table>
<thead>
<tr>
<th>Pipe Joint Size</th>
<th>At least ( \frac{1}{4}&quot; )</th>
<th>At least ( \frac{1}{4}&quot; )</th>
<th>At least ( \frac{3}{8}&quot; )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe I.D.</td>
<td>At least ( \phi 7.6 )</td>
<td>At least ( \phi 7.6 )</td>
<td>At least ( \phi 9.6 )</td>
</tr>
<tr>
<td>Pipe Length</td>
<td>1m or less</td>
<td>1m or less</td>
<td>1m or less</td>
</tr>
</tbody>
</table>

Thrust Screw and Stopper

The thrust screw and stopper are precision adjusted at the factory during assembly. Never touch them.

See callouts 15/43 and 15/38 in the VDC-1A and 2A/3A cross-section diagrams on pages V-19 and V-20.

An unload circuit is required when the motor is started under condition \( \lambda - \Delta \). Contact your agent about the unload circuit.

Initial Operation

Before operating the pump for the first time, put the pump discharge side into the no-load state and then repeatedly start and stop the motor to bleed all air from inside the pump and the suction piping. After confirming that the pump is discharging oil, continue the no-load operation for at least 10 minutes to discharge all the air from the circuit. Provide an air bleed valve in circuits where it is difficult to bleed air before startup.

Sub Plate

Use the table below to specify a sub plate type when one is required.

(Continued on following page)
Foot Mounting
For a double pump with VDC-3 foot mounting, the foot mounting kit and pump are sold as a set. When only the mounting feet are required, pump mounting bolts, washers and other parts are sold together as the Foot Mounting Kit.

Hydraulic oil: When the pump is to be used at pressures of less than 70kgf/cm² (1000 psi), use good quality petroleum base hydraulic oil with a rating of 30~50cSt (141 ~232 SUS) (equivalent to ISO VG32) at 40˚C (104˚F). Operation at pressure exceeding 70kgf/cm² (1000 psi), use oil with a rating of 50~70cSt (232 ~324 SUS) (equivalent to ISO VG68) at 40˚C (104˚F).

The operating temperature range is 15 to 60°C. When the oil temperature at startup is 15°C or less, perform a warm-up operation at low pressure until the oil temperature reaches 15°C. Use the pump in an area where the temperature is within the range of 0 to 60°C.

Suction pressure is -0.03 to +0.03MPa (-4.3 to +4.3psi), and the suction port flow rate should be no greater than 2m/sec.

Avoid pulley, gear, and other drive systems that impart a radial or thrust load on the end of the pump shaft. Mount the pump so its pump shaft is oriented horizontally.

Provide a suction strainer with a filtering grade of about 100μm (150 mesh). For the return line to the tank, use a 25μm line filter.

Manage hydraulic operating fluid so contamination is maintained at class NAS10 or lower. Take care to avoid contamination with water and other foreign matter, and watch out for discoloration. Whities fluid indicates that air has contaminated the fluid, and brownish fluid indicates the fluid is dirty.

Contact your agent about using water- and glycol-based hydraulic operating fluids.

At startup, repeat the inching operation (start-stop) to bleed air from the pump and pipes.

Equip an air bleed valve in circuits where it is difficult to bleed air before startup.

To ensure proper lubrication of the pump's rubbing surfaces, supply oil to the interior of the pump before starting operation.

Alignment: Alignment between the pump shaft and the motor shaft should be parallel within 0.05mm (0.002 inch), and within 1° for the angle between the two shafts. Use a pump mounting base of sufficient rigidity.

### Understanding Model Numbers

**Single Pump**

**VDC - 2 A - 1 A 4 - * 20/35**

- **Design code**
  - E20 = VDC-1A, VDC-2A, VDC-3A/B
  - E35 = VDC-1B, VDC-2B
  - 20 = All metric version

- **Pressure adjusting range**
  - 2: 15 ~ 35 kgf/cm² (214 ~ 500 psi)
  - 3: 20 ~ 70 kgf/cm² (286 ~ 1000 psi)
  - 4: 50 ~ 105 kgf/cm² (714 ~ 1500 psi)
  - 5: 70 ~ 140 kgf/cm² (1000 ~ 2000 psi)

- **Pressure volume characteristics**
  - A: Constant volume type

- **Mounting**
  - A: Foot mounting
  - B: Flange mounting

- **Pump size**: 1, 2, 3

VDC series variable volume vane pump

Note: Remote control pressure compensating type is available. Please check with factory.
Double Pump

VDC-1 2 B-1 A 5-2 A 3 - * 20

- Design code
  - E35 = VDC-11B, VDC-12B
  - E20 = VDC-13B
  - 20 = All metric version

- Pressure adjusting range of shaft end pump
  - 3: 20 ~ 70 kgf/cm²  286 ~ 1000 psi
  - 5: 70 ~ 140 kgf/cm²  1000 ~ 2000 psi

- Pressure volume characteristics of shaft end pump
  - A: Constant volume type

- Ring size of shaft end pump: 1, 2

- Pressure adjusting range of head end pump

- Pressure volume characteristics of head end pump

- Ring size of head end pump

- Mounting: B: Flange mounting

- Pump size of shaft end pump: 1, 2, 3

- Pump size of head end pump: 1, 2

VDC series double variable volume vane pump

Installation Dimension Drawings

VDC-1A-*A*-20 mm(inch)
VDC-2A-*A*-20 mm (inch)

VDC-1B-*A*-E35 (SAE-A MOUNT)

VDC-3A-1A-*20 mm (inch)
VDC-2B-*A*-E35  
(SAE-B MOUNT)

VDC-3B-A*-20  mm(inch)  
(SAE-C MOUNT)

VDC-11B-*A*-A*-E35  mm(inch)
**Performance Curves**

Typical characteristics at hydraulic operating fluid kinematic viscosity of 32 mm/s

**Power loss**

<table>
<thead>
<tr>
<th>VDC-1</th>
<th>VDC-2</th>
<th>VDC-3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="VDC-1" /></td>
<td><img src="image2" alt="VDC-2" /></td>
<td><img src="image3" alt="VDC-3" /></td>
</tr>
</tbody>
</table>

**Noise Characteristics**

<table>
<thead>
<tr>
<th>VDC-1</th>
<th>VDC-2</th>
<th>VDC-3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="VDC-1" /></td>
<td><img src="image5" alt="VDC-2" /></td>
<td><img src="image6" alt="VDC-3" /></td>
</tr>
</tbody>
</table>
**Cross-sectional Drawing**

VDC-1A-*A*-E20/35  
VDC-2A-*A*-E20/35  

### Seal Component Table (VDC-1*, VDC-2*)

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Part Name</th>
<th>Part Number</th>
<th>Q'ty</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Oil seal</td>
<td>TCN-224211</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>O-ring</td>
<td>SBS(NOK)</td>
<td>1</td>
</tr>
<tr>
<td>26</td>
<td>O-ring</td>
<td>AS568-034</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>O-ring</td>
<td>AS568-026</td>
<td>1</td>
</tr>
<tr>
<td>28</td>
<td>O-ring</td>
<td>1A-P14</td>
<td>1</td>
</tr>
<tr>
<td>29</td>
<td>O-ring</td>
<td>1A-P22</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>O-ring</td>
<td>1A-P20</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>O-ring</td>
<td>1A-P5</td>
<td>2</td>
</tr>
<tr>
<td>32</td>
<td>O-ring</td>
<td>1A-P6</td>
<td>4</td>
</tr>
<tr>
<td>33</td>
<td>O-ring</td>
<td>1A-P25</td>
<td>1</td>
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<tr>
<td>34</td>
<td>O-ring</td>
<td>1A-P22</td>
<td>1</td>
</tr>
<tr>
<td>35</td>
<td>O-ring</td>
<td>1A-P10A</td>
<td>1</td>
</tr>
<tr>
<td>36</td>
<td>Backup ring</td>
<td>VCB34-10100</td>
<td>1</td>
</tr>
<tr>
<td>37</td>
<td>Backup ring</td>
<td>VCB34-10200</td>
<td>1</td>
</tr>
<tr>
<td>57</td>
<td>O-ring</td>
<td>1A-P14</td>
<td>1</td>
</tr>
<tr>
<td>58</td>
<td>O-ring</td>
<td>1B-P6(Hs90)</td>
<td>3</td>
</tr>
</tbody>
</table>

**Note:** Seal kit = VCBS-101A00 (VDC-1A)  
VCBS-101B00 (VDC-1B)  
VCBS-102A00 (VDC-2A)  
VCBS-102B00 (VDC-2B)
Seal Component Table (VDC-3*)

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Part Name</th>
<th>Part Number</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Oil seal</td>
<td>TCN-335811</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>O-ring</td>
<td>1A-G130</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>O-ring</td>
<td>AS568 (S6H90)</td>
<td>1</td>
</tr>
<tr>
<td>26</td>
<td>O-ring</td>
<td>AS568 (S6H90)</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>O-ring</td>
<td>1A-G40</td>
<td>2</td>
</tr>
<tr>
<td>28</td>
<td>O-ring</td>
<td>1A-P12</td>
<td>1</td>
</tr>
<tr>
<td>29</td>
<td>O-ring</td>
<td>1A-P9</td>
<td>2</td>
</tr>
<tr>
<td>30</td>
<td>O-ring</td>
<td>1A-P7</td>
<td>2</td>
</tr>
<tr>
<td>31</td>
<td>O-ring</td>
<td>1A-P7</td>
<td>2</td>
</tr>
<tr>
<td>32</td>
<td>O-ring</td>
<td>1B-P14</td>
<td>1</td>
</tr>
<tr>
<td>33</td>
<td>Snap ring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Screw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Screw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Screw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Screw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Screw (stopper)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Screw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Plug</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Washer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Nameplate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Pole</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Valve body</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Spool</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Holder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>Plunger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Spring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>Retainer</td>
<td></td>
<td></td>
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<tr>
<td>50</td>
<td>Screw</td>
<td></td>
<td></td>
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<tr>
<td>51</td>
<td>Nut</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>O-ring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>O-ring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Plug</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>Plug</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Screw</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Seal kit = VCBS-103B00
VDC Series
Double Pump

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Part Name</th>
<th>VDC-11A-**-20</th>
<th>VDC-12A-**-20</th>
<th>VDC-22A-**-20</th>
<th>VDC-13A-**-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>O-ring</td>
<td>—</td>
<td>1A-G60</td>
<td>1A-G60</td>
<td>1A-G85</td>
</tr>
<tr>
<td>7</td>
<td>O-ring</td>
<td>1A-G85</td>
<td>1A-G45</td>
<td>1A-G60</td>
<td>1A-G85</td>
</tr>
</tbody>
</table>

Note: Other parts are the same as the single pump.

Note: See the description of the single pump for seal parts that are not included in the list.
UVN Series
Variable Volume Vane Uni-Pump

The New Uni-Pump All-in-One Pump and Motor
Get all of the power and almost none of the noise with our new Uni-Pump integrated variable vane pump and motor. Featuring our original pump and electromotor shaft connection, the Uni-Pump produces limited noise.

This compact, all-in-one type even consumes 40% less energy than standard models. Pump capacities up to 7.6gpm with 1160psi. Low heat generation results in a longer operation life.

Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Vane pump side Delivery gpm at no load</th>
<th>Pressure Adjustment Range psi</th>
<th>Motor side AC230V</th>
<th>Weight lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>UVN-1A-0A2-0.7E-4M-11</td>
<td>1.5kW</td>
<td>3.8</td>
<td>1HPX4p</td>
<td>41.9</td>
</tr>
<tr>
<td>UVN-1A-0A2-1.5E-4M-11</td>
<td>2HPX4p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-0A3-0.7E-4M-11</td>
<td>0.75kW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-0A3-1.5E-4M-11</td>
<td>2HPX4p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-0A4-0.7E-4M-11</td>
<td>3HPX4p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-0A4-1.5E-4M-11</td>
<td>48.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-1A2-1.5E-4M-11</td>
<td>3HPX4p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-1A2-2.2E-4M-11</td>
<td>48.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-1A3-1.5E-4M-11</td>
<td>3HPX4p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-1A3-2.2E-4M-11</td>
<td>48.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-1A4-1.5E-4M-11</td>
<td>3HPX4p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVN-1A-1A4-2.2E-4M-11</td>
<td>48.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Motor Selection Method

The available range in the rated output of each motor is shown below the output curve of each motor in the graph.

(Example)
Find the motor to be used at a pressure of 3.5MPa (507psi) discharge rate of 3.2gpm and frequency of 60Hz.

(Solution)
As illustrated by the broken line in the graph, you are looking for the motor located above the crossing port between the pressure of 3.5MPa (507psi) and discharge rate of 3.2gpm.
### Performance Characteristics

**Power Consumption**

**Noise Characteristics**

**Oil Temperature Characteristics**

#### Conditions

The value in the left-hand drawing represents typical characteristics under the following conditions:
- Oil used: ISO VG32 or its equivalent
- Oil temperature: 104 +/- 41°F
- Measuring distance: 3.3 feet around the unit

**Note:**

The noise characteristics depend on the installation floor base conditions and the presence of the surrounding substance reflecting the sound, and so may be different from the above description in some cases.

---

#### Conditions

The value on the left-hand drawing represents typical characteristics under the following conditions:
- Oil used: ISO VG32 or its equivalent
- Speed: 1800 min⁻¹
- Room temperature: 84°F
- Motor: 0.75–2.2 kW

**Notes:**

1. For 5.0MPa (724ps) of a 2.6 gallon tank. It should be noted that there is a big rise in oil temperature under continuous operation. In this case, we recommend use of a 5.3 gallon tank.
2. Rise of oil temperature depends on the conditions of using an actual machine, and so may be different from the above description in some cases.

---

### Table: Dimensions (Inch)

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>IL</th>
<th>C</th>
<th>KD</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>TXS</th>
<th>R*</th>
<th>KB</th>
<th>O</th>
<th>P</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>UVN-1A*-A*-0.7E-4M-11</td>
<td>0.79</td>
<td>3.54</td>
<td>3.15</td>
<td>6.18</td>
<td>2.46</td>
<td>1.97</td>
<td>0.09</td>
<td>4.72</td>
<td>2.80</td>
<td>9.06</td>
<td>6.10</td>
<td>4.72</td>
<td>0.59X0.39</td>
<td>0.20</td>
<td>4.33</td>
<td>2.56</td>
<td>5.12</td>
<td>3.62</td>
</tr>
<tr>
<td>UVN-1A*-A*-1.5E-4M-11</td>
<td>0.79</td>
<td>3.94</td>
<td>3.54</td>
<td>6.89</td>
<td>2.76</td>
<td>2.46</td>
<td>0.13</td>
<td>5.04</td>
<td>3.07</td>
<td>10.04</td>
<td>6.69</td>
<td>5.91</td>
<td>0.59X0.39</td>
<td>0.20</td>
<td>4.72</td>
<td>2.56</td>
<td>5.12</td>
<td>3.94</td>
</tr>
<tr>
<td>UVN-1A*-A*-2.2E-4M-11</td>
<td>0.79</td>
<td>4.33</td>
<td>3.94</td>
<td>7.68</td>
<td>3.15</td>
<td>2.76</td>
<td>0.13</td>
<td>5.43</td>
<td>3.46</td>
<td>11.22</td>
<td>7.87</td>
<td>6.50</td>
<td>0.67X0.47</td>
<td>0.24</td>
<td>5.28</td>
<td>2.56</td>
<td>5.31</td>
<td>4.33</td>
</tr>
</tbody>
</table>