Dual Displacement Radial Piston
High Power Staffa Motor

HPC Series
CONTENTS

Specifications and Features 3

1. Ordering Code
   1-1. Model Coding 4 - 5
   1-2. Shaft Options 6
   1-3. Main Port Connection Options 7
   1-4. Special Features 8 - 20

2. Technical Information
   2-1. Performance Data 21 - 26
   2-2. Volumetric Efficiency Data 27
   2-3. Shaft Power Calculations 28
   2-4. Functional Symbols 29
   2-5. Shaft Stress Limits 30
   2-6. Bearing Life Notes 31
   2-7. Circuit and Application Notes 32 - 34
   2-8. Crankcase Flushing Flow 35
   2-9. Motor Operation at Low Temperatures 36
   2-10. Crankcase Drain Connections 37
   2-11. Freewheeling Notes 38
   2-12. Installation Data 39

3. Dimensions
   3-1. HPC080 Installation 40 - 45
   3-2. HPC125 Installation 46 - 51
   3-3. HPC200 Installation 52 - 57
   3-4. HPC270 Installation 58 - 62
   3-5. HPC325 Installation 63 - 67
   3-8. Speed Sensing Options 68
HPC Series

Dual Displacement Radial Piston Hydraulic Motor

General Descriptions

The enhanced version of the standard C series motor includes special low friction components combined with crankcase flushing flow to achieve increased shaft power.

The range of HP motors extends from the HPC080 of 1,600 cc/rev to the HPC325 of 5326 cc/rev. There are 5 frame sizes in this product range for performance details see table below:

Kawasaki “Staffa” high torque, low speed radial piston motors use hydrostatic balancing techniques to achieve high efficiency, combined with good breakout torque and smooth running capability.

The HPC series dual displacement models have two pre-set displacements which can be chosen from a wide range to suit specific application requirements. The displacements are hydraulically selected by a directional control valve which can be remote mounted or directly on the motor. Motor displacement can be changed with ease when the motor is running.

These motors are also available in a continuously variable version using either hydro-mechanical or electro-hydraulic control methods.

Other mounting options are available on request to match many of the competitor interfaces variable version using either hydro-mechanical or electro-hydraulic control methods.

Features

Enhanced power performance
Increased speed
Improved starting and running efficiency
Increased back pressure capability
Speed sensing options
High torques at low speed
Smooth running
Wide range of displacements to suit specific applications
Displacement changes with ease when the motor is running
Various mounting options

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Max. Torque @275 bar (Nm)</th>
<th>Continuous shaft power with flushing (kW)</th>
<th>Continuous shaft power without flushing (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC080</td>
<td>6,630</td>
<td>165</td>
<td>138</td>
</tr>
<tr>
<td>HPC125</td>
<td>8,470</td>
<td>202</td>
<td>135</td>
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<td>HPC200</td>
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<td>HPC270</td>
<td>19,280</td>
<td>278</td>
<td>189</td>
</tr>
<tr>
<td>HPC325</td>
<td>22,440</td>
<td>278</td>
<td>189</td>
</tr>
</tbody>
</table>
### 1-1 Model Coding

**F11/HPC270/S3 V/250/100/FM3/CS/TJ/ */ P*****

**Fluid Type**
- Blank: Mineral oil
- F3: Phosphate ester (HFD fluid)
- F11: Water based fluids (HFA, HFB & HFC)
- Alternative fluids contact Kawasaki

**Motor Frame Size**
- 080
- 200
- 325
- 125
- 270

**Shaft Type**
- Vertically Up

**High Displacement Code**
- ### See displacement code details on pages 21 to 26

**Low Displacement Code**
- ### See displacement code details on pages 21 to 26

**Special Features**
- P*****: See options on page 5.
- PL***: Non-catalogued features (* * *) = number assigned by Kawasaki as required

**Design Series Number**
- Current series for HPC motors

**Tacho Encoder Drive**
- Blank: None
- Tj: Square wave output with directional signal
- Tk: Combines Tj with the T401 instrument to give a 4 to 20 mA output proportional to speed. Directional signal and speed relay output.

**Displacement Control Ports**
- Threaded ports/ bi-directional shaft rotation
- X: X and Y ports G¼” (BSPF to ISO 228/1)
- ISO 4401 size 03 mounting face/ bi-directional shaft rotation
- C: No shuttle
- CS: With shuttle
- ISO4401 size 03 mounting face/uni-directional shaft rotation (viewed on shaft end).

**Main Port Connections**
- See Port Connection details on page 7
# 1-1 Model Coding

## Special Features Suffix

/ P  *  *  *  *  *

### Shaft Seal Enhancements

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>High pressure shaft seal</td>
</tr>
<tr>
<td>B</td>
<td>Improved shaft seal life</td>
</tr>
<tr>
<td>C</td>
<td>High pressure shaft seal &amp; improved shaft seal life</td>
</tr>
<tr>
<td>O</td>
<td>None</td>
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</tbody>
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### External Protection

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>Anti-pooling bolt heads</td>
</tr>
<tr>
<td>B</td>
<td>Marine-specification primer paint</td>
</tr>
<tr>
<td>C</td>
<td>Anti-pooling bolt heads &amp; Marine-specification primer paint</td>
</tr>
<tr>
<td>O</td>
<td>None</td>
</tr>
</tbody>
</table>

### Installation Features

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<th>Description</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>Drain port adaptor x 1</td>
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<tr>
<td>B</td>
<td>Drain port adaptor x 2</td>
</tr>
<tr>
<td>C</td>
<td>Φ21 mm mounting holes</td>
</tr>
<tr>
<td>D</td>
<td>Φ22 mm mounting holes</td>
</tr>
<tr>
<td>E</td>
<td>Φ21 mm mounting holes &amp; Drain port adaptor x 1</td>
</tr>
<tr>
<td>F</td>
<td>Φ21 mm mounting holes &amp; Drain port adaptor x 2</td>
</tr>
<tr>
<td>G</td>
<td>Φ22 mm mounting holes &amp; Drain port adaptor x 1</td>
</tr>
<tr>
<td>H</td>
<td>Φ22 mm mounting holes &amp; Drain port adaptor x 2</td>
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<tr>
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<td>None</td>
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</table>

### Valve Enhancements

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<th>Description</th>
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</thead>
<tbody>
<tr>
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<td>Improved cavitation resistance</td>
</tr>
<tr>
<td>B</td>
<td>Anti-clockwise</td>
</tr>
<tr>
<td>C</td>
<td>Thermal shock resistance</td>
</tr>
<tr>
<td>D</td>
<td>Improved cavitation resistance &amp; anti-clockwise</td>
</tr>
<tr>
<td>E</td>
<td>Improved cavitation resistance &amp; thermal shock resistance</td>
</tr>
<tr>
<td>F</td>
<td>Anti-clockwise &amp; thermal shock resistance</td>
</tr>
<tr>
<td>G</td>
<td>Improved cavitation resistance &amp; anti-clockwise &amp; thermal shock resistance</td>
</tr>
<tr>
<td>O</td>
<td>None</td>
</tr>
</tbody>
</table>

### Performance Enhancements

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</thead>
<tbody>
<tr>
<td>A</td>
<td>Increased starting torque</td>
</tr>
<tr>
<td>O</td>
<td>None</td>
</tr>
</tbody>
</table>
1-2 Shaft Options

Product type

**HPC080**
P = Parallel keyed 60mm diameter shaft
S = Splined shaft 14 teeth BS3550
Z = Splined shaft DIN5480 (W70x3x22x7h)
T = Long taper keyed shaft - 95.2 key slot

**HPC125 & HPC200**
P1 = Parallel keyed 85mm diameter shaft
S3 = Splined shaft 20 teeth BS3550
S4 = Splined shaft 16 teeth BS3550
Z3 = Splined shaft DIN5480 (W85x3x27x7h)
T = Long taper keyed shaft - 133.4 key slot

**HPC270 & HPC325**
P1 = Parallel keyed 85mm diameter shaft
S3 = Splined shaft 20 teeth BS3550
Z4 = Splined shaft DIN5480 (W90x4x21x7h)
T = Long taper keyed shaft - 133.4 key slot

Note:
For installations where the shaft is vertically upwards specify “V” after the shaft type designator so as to ensure that an additional high level drain port is provided within the front cover of the motor.
1-3 Main Port Connections

Product type

HPC080
F3 = 1¼" SAE 4-bolt flange
FM3 = 1¼" SAE 4-bolt flange
F4 = SAE 1½" 4-bolt UNC flanges
FM4 = SAE 1½" 4-bolt metric flanges

HPC125
F3 = 3000 series SAE 4-bolt flange
FM3 = SAE 1½" 4-bolt UNC flanges
F4 = SAE 1½" 4-bolt UNC flanges
FM4 = SAE 1½" 4-bolt metric flanges

HPC200
F3 = 1¼" SAE 61 4-bolt flange
FM3 = 1¼" SAE 61 4-bolt flange
F4 = SAE 1½" 4-bolt UNC flanges
FM4 = SAE 1½" 4-bolt metric flanges

HPC270
F4 = 1½" SAE code 62 4-bolt flange
FM4 = 1½" SAE code 62 4-bolt flange

HPC325
F4 = 1½" SAE code 62 4-bolt flange
FM4 = 1½" SAE code 62 4-bolt flange

See pages 40 to 67 for full dimensional details
# 1-4 Special Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Page</th>
<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Pressure Shaft Seal</td>
<td>9</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Improved Shaft Seal Life</td>
<td>10</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Improved Cavitation Resistance</td>
<td>11</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Anti-pooling Bolt Heads</td>
<td>12</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Increased Starting Torque</td>
<td>13</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Anti-clockwise Rotation</td>
<td>15</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Thermal Shock Resistance</td>
<td>16</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Drain Port Adaptor - ½&quot; BSPP</td>
<td>18</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>21mm Mounting Holes</td>
<td>19</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>22mm Mounting Holes</td>
<td>19</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Marine-specification Primer Paint</td>
<td>20</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

- ● Available
- ○ Not available

If a motor is to be ordered with any special features listed, please contact Kawasaki.
1-4 Special Features

High Pressure Shaft Seal

Description:
> 10 bar rated
> Recommended for cold climates
> Rugged steel and PTFE construction

Technical Information

Where crankcase pressure will be higher than 3.5 bar, the high pressure shaft seal should be selected.

<table>
<thead>
<tr>
<th>Case pressure</th>
<th>≤ 10 bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-operating temperature limits</td>
<td>Below -30°C and above 120°C</td>
</tr>
<tr>
<td>Minimum operating temperature</td>
<td>-15°C</td>
</tr>
<tr>
<td>Maximum operating temperature</td>
<td>80°C</td>
</tr>
<tr>
<td>Minimum viscosity</td>
<td>2,000 cSt</td>
</tr>
<tr>
<td>Maximum viscosity</td>
<td>150 cSt</td>
</tr>
</tbody>
</table>

Applicable to:

<table>
<thead>
<tr>
<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
1-4 Special Features

- Improved Shaft Seal Life

**Description:**

- Stainless steel sleeve prevents corrosion
- Improved wear resistance
- Recommended for corrosive environments

**Technical Information**

A well-established method of increasing rotary seal life in corrosive environments is to fit a thin-walled, stainless steel sleeve to the rotating shaft to provide a corrosion-resistant, wear-resistant counterface surface for the seal to run against. All HPC motors can be fitted with such sleeves upon request.

<table>
<thead>
<tr>
<th>Sleeve material</th>
<th>A304/301 Stainless Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeve surface finish</td>
<td>$R_s$ 0.25 to 0.5 μm (10 to 20 μin)</td>
</tr>
</tbody>
</table>

**Applicable to:**

<table>
<thead>
<tr>
<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
1-4 Special Features

Improved Cavitation Resistance

Description:

> Recommended for overrunning applications
> Protects against seal damage for short periods of operation in vacuum inlet conditions.

Cavitation can occur due to many different factors. Although it is not possible to make the HMC motor resistant to cavitation, certain features can be added to improve the motor’s resistance to short periods of lost port pressure.

In applications where the HPC motor can be driven (like a pump) a risk arises that insufficient fluid will be provided to maintain a positive pressure at both main ports of the motor causing cavitation. The results of extended running at these conditions can be catastrophic to the motor’s function.

The improved cavitation resistance feature should be considered where:

- Overrunning conditions may occur (load driving the motor)
- Loss of main port pressure while motor is rotating

Applicable to:

<table>
<thead>
<tr>
<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
1-4 Special Features

Anti-pooling Bolt Heads

Description:

- Removes potential for water pooling
- Improved corrosion resistance
- Recommended for marine environments

Technical Information

In many marine applications, water pooling in socket head cap screw heads presents a significant corrosion risk. Corroded cap screws can make service and repair of affected units impossible.

To significantly reduce the risk of water damage through pooling, HPC motors can be supplied with silicone filler in all the bolt heads.

Applicable to:

<table>
<thead>
<tr>
<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
1-4 Special Features

一个重要特征

### Increased Starting Torque

**Description:**

- Optimised for high break-out torque
- Recommended for low speed operation
- Improved service life for low speed applications

**Technical Information**

如果一个应用要求驱动电机在大多数循环中以小于10 rpm的速度运行，或者涉及到频繁的启动/停止或正转/反转操作，Staffa HMC电机系列就涵盖了这一点。

通过优化HPC电机的低速设计，可以提高启动扭矩和低速机械效率性能。

所有在第2-1节性能数据中给出的数字在选择此功能时仍然有效。

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.
1-4 Special Features

Increased Starting Torque (cont)

Volumetric Performance

In order to achieve increased torque at low speeds the volumetric characteristics of the motor performance are changed.

When calculating leakage and volumetric efficiency use the constants shown here in place of those given for the standard motor on page 27.

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Geometric Displacement</th>
<th>Zero Speed Constant</th>
<th>Speed Constant</th>
<th>Creep Speed Constant</th>
<th>Crankcase Leakage Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC080</td>
<td>1,344</td>
<td>16.26</td>
<td>45.70</td>
<td>9.65</td>
<td>14.66</td>
</tr>
<tr>
<td>HPC125</td>
<td>2,048</td>
<td>12.86</td>
<td>38.50</td>
<td>4.55</td>
<td>11.01</td>
</tr>
<tr>
<td>HPC200</td>
<td>3,087</td>
<td>12.86</td>
<td>38.50</td>
<td>3.02</td>
<td>11.01</td>
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<tr>
<td>HPC270</td>
<td>4,588</td>
<td>13.26</td>
<td>37.30</td>
<td>2.41</td>
<td>12.76</td>
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<tr>
<td>HPC325</td>
<td>5,326</td>
<td>13.26</td>
<td>40.00</td>
<td>2.08</td>
<td>12.76</td>
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</table>

Applicable to:

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<th>HPC125</th>
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<th>HPC325</th>
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<tbody>
<tr>
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<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
1-4 Special Features

Anti-Clockwise Rotation

Description:

> Reduce installation complexity
> Standardise equipment designs

Technical Information

All HPC motors can be specified with an anti-clockwise rotation valve configuration. All performance and volumetric characteristics remain unchanged.

Applicable to:

<table>
<thead>
<tr>
<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
1-4 Special Features

◆ Thermal Shock Resistance

Description:

> Recommended for cold climates
> Optimised for start-up in freezing temperatures
> Engineered for total peace of mind

Technical Information

Starting up a cold system with warm hydraulic fluid is a known cause of heavy wear and potential seizure of hydraulic machinery. To minimise this potential risk, the HPC motor can be configured to combat thermal shocks to give complete peace of mind when operating in very cold climates.

Volumetric Performance

In order to provide thermal shock resistance the volumetric characteristics of the motor performance are changed. When calculating leakage and volumetric efficiency use the constants shown on the next page in place of those given for the standard motor on page 27.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.

Note:
When operating at low temperature, consideration must be given to the guidance notes in Section 2-9 Motor Operation at Low Temperature (see page 36).
### 1-4 Special Features

#### Thermal Shock Resistance (cont)

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Geometric Displacement</th>
<th>Zero Speed Constant</th>
<th>Speed Constant</th>
<th>Creep Speed Constant</th>
<th>Crankcase Leakage Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC080</td>
<td>1,344</td>
<td>11.10</td>
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<td>6.99</td>
<td>7.90</td>
</tr>
<tr>
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<td>2,048</td>
<td>7.70</td>
<td>38.50</td>
<td>3.78</td>
<td>4.25</td>
</tr>
<tr>
<td>HPC200</td>
<td>3,087</td>
<td>7.98</td>
<td>38.50</td>
<td>2.61</td>
<td>4.25</td>
</tr>
<tr>
<td>HPC270</td>
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<td>8.38</td>
<td>37.30</td>
<td>1.91</td>
<td>6.00</td>
</tr>
<tr>
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<td>5,326</td>
<td>8.38</td>
<td>40.00</td>
<td>1.65</td>
<td>6.00</td>
</tr>
</tbody>
</table>

#### Applicable to:

<table>
<thead>
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<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
<tr>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
1-4 Special Features

Drain Port Adaptors

Description:

> Improves manufacturing logistics

> Motor supplied ready for connection to 1½" BSPP male fitting

Technical Information

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Adaptor Supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMC030</td>
<td>¾&quot; UNF 2B to ½&quot; BSPP</td>
</tr>
<tr>
<td>HMC045</td>
<td>¾&quot; UNF 2B to ½&quot; BSPP</td>
</tr>
<tr>
<td>HMC080</td>
<td>¾&quot; UNF 2B to ½&quot; BSPP</td>
</tr>
<tr>
<td>HM(HD)C125</td>
<td>¾&quot; UNF 2B to ½&quot; BSPP</td>
</tr>
<tr>
<td>HM(HD)C200</td>
<td>¾&quot; UNF 2B to ½&quot; BSPP</td>
</tr>
<tr>
<td>HM(HD)C270</td>
<td>¾&quot; UNF 2B to ½&quot; BSPP</td>
</tr>
<tr>
<td>HM(HD)C325</td>
<td>¾&quot; UNF 2B to ½&quot; BSPP</td>
</tr>
</tbody>
</table>

One or two drain adaptors can be supplied.

Applicable to:

<table>
<thead>
<tr>
<th></th>
<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
1-4 Special Features

Mounting Hole Diameter

Description:

> Matching mounting holes to bolts
> Ф21mm and Ф22mm options available

Technical Information

In different markets, different bolt standards are adopted which may not be best suited to the standard Ф20 mm mounting hole diameter on the HMC motors. To give a correct fit and optimum installation, Ф21 mm or Ф22 mm holes can be selected.

Applicable to:

<table>
<thead>
<tr>
<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
<tr>
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<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
1-4 Special Features

Marine Specification Primer Paint

Description:

- Improves corrosion and water resistance of the finishing system
- Excellent adhesion strength
- Recommended for marine applications

Technical Information

<table>
<thead>
<tr>
<th>Colour</th>
<th>Red oxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Single pack epoxy etching primer</td>
</tr>
<tr>
<td>Standard</td>
<td>BS 3900 part A 8</td>
</tr>
<tr>
<td>Dry film thickness</td>
<td>&gt; 12 μm</td>
</tr>
</tbody>
</table>

Applicable to:

<table>
<thead>
<tr>
<th>HPC080</th>
<th>HPC125</th>
<th>HPC200</th>
<th>HPC270</th>
<th>HPC325</th>
</tr>
</thead>
<tbody>
<tr>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
</tbody>
</table>

Please contact Kawasaki to order this feature.
2-1 Performance Data

Performance data is valid for the range of HPC motors when fully run-in and operating with mineral oil.

The appropriate motor displacements can be selected using performance data shown on pages 22 to 26. Refer to the table on this page for pressures and speed limits when using fire-resistant fluids.

Rating definitions

Continuous rating

For continuous duty the motor must be operating within each of the maximum values for speed, pressure and power.

Intermittent rating

Intermittent max pressure: 275 bar.

This pressure is allowable on the following basis:

a) Up to 50 rpm 15% duty for periods up to 5 minutes maximum.
b) Over 50 rpm 2% duty for periods up to 30 seconds maximum.

Static pressure to DNV rules 380 bar.

Limits for fire resistant fluids

<table>
<thead>
<tr>
<th>Fluid Type</th>
<th>Continuous Pressure (bar)</th>
<th>Intermittent Pressure (bar)</th>
<th>Max Speed (rpm)</th>
<th>Model Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFA 5/95 oil-in-water emulsion</td>
<td>130</td>
<td>138</td>
<td>50% of limits of mineral oil</td>
<td>All models</td>
</tr>
<tr>
<td>HFB 60/40 water-in-oil emulsion</td>
<td>138</td>
<td>172</td>
<td>As for mineral oil</td>
<td>All models</td>
</tr>
<tr>
<td>HFC water glycol</td>
<td>103</td>
<td>138</td>
<td>50% of limits of mineral oil</td>
<td>All models</td>
</tr>
<tr>
<td>HFD phosphate ester</td>
<td>250</td>
<td>293</td>
<td>As for mineral oil</td>
<td>All models</td>
</tr>
</tbody>
</table>
### 2-1 Performance Data (cont)

#### HPC080 Motor (crankcase flushing required)

<table>
<thead>
<tr>
<th>Displacement Code</th>
<th>97.6</th>
<th>90</th>
<th>85</th>
<th>80</th>
<th>75</th>
<th>70</th>
<th>65</th>
<th>60</th>
<th>55</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>cc/rev</td>
<td>1.600</td>
<td>1.475</td>
<td>1.393</td>
<td>1.311</td>
<td>1.229</td>
<td>1.147</td>
<td>1.065</td>
<td>0.983</td>
<td>0.901</td>
</tr>
<tr>
<td>Average actual running torque</td>
<td>Nm/bar</td>
<td>24.1</td>
<td>22.2</td>
<td>20.9</td>
<td>19.7</td>
<td>18.4</td>
<td>17.1</td>
<td>15.9</td>
<td>14.6</td>
<td>13.2</td>
</tr>
<tr>
<td>Average actual mechanical efficiency</td>
<td>%</td>
<td>94.5</td>
<td>94.5</td>
<td>94.3</td>
<td>94.2</td>
<td>94.0</td>
<td>93.8</td>
<td>93.5</td>
<td>93.0</td>
<td>92.2</td>
</tr>
<tr>
<td>Average actual starting torque</td>
<td>Nm/bar</td>
<td>22.0</td>
<td>20.1</td>
<td>18.8</td>
<td>17.6</td>
<td>16.3</td>
<td>15.1</td>
<td>13.9</td>
<td>12.6</td>
<td>11.2</td>
</tr>
<tr>
<td>Average actual starting efficiency</td>
<td>%</td>
<td>86.2</td>
<td>85.7</td>
<td>84.9</td>
<td>84.1</td>
<td>83.4</td>
<td>82.6</td>
<td>81.5</td>
<td>80.1</td>
<td>78.2</td>
</tr>
<tr>
<td>Max continuous speed (F3/FM3)</td>
<td>rpm</td>
<td>270</td>
<td>300</td>
<td>320</td>
<td>340</td>
<td>365</td>
<td>390</td>
<td>420</td>
<td>450</td>
<td>475</td>
</tr>
<tr>
<td>Max continuous speed (F4/FM4)</td>
<td>rpm</td>
<td>365</td>
<td>400</td>
<td>415</td>
<td>430</td>
<td>445</td>
<td>460</td>
<td>475</td>
<td>490</td>
<td>500</td>
</tr>
<tr>
<td>Max continuous power (F3/FM3)</td>
<td>kW</td>
<td>165</td>
<td>157</td>
<td>152</td>
<td>147</td>
<td>145</td>
<td>140</td>
<td>134</td>
<td>131</td>
<td>125</td>
</tr>
<tr>
<td>Max continuous power (F4/FM4)</td>
<td>kW</td>
<td>165</td>
<td>157</td>
<td>152</td>
<td>147</td>
<td>145</td>
<td>140</td>
<td>134</td>
<td>131</td>
<td>125</td>
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<tr>
<td>Max continuous pressure</td>
<td>bar</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Max intermittent pressure</td>
<td>bar</td>
<td>275</td>
<td>275</td>
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<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
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</table>

<table>
<thead>
<tr>
<th>Displacement Code</th>
<th>45</th>
<th>40</th>
<th>35</th>
<th>30</th>
<th>25</th>
<th>20</th>
<th>15</th>
<th>10</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>cc/rev</td>
<td>737</td>
<td>655</td>
<td>574</td>
<td>492</td>
<td>410</td>
<td>328</td>
<td>246</td>
<td>164</td>
</tr>
<tr>
<td>Average actual running torque</td>
<td>Nm/bar</td>
<td>10.6</td>
<td>9.3</td>
<td>8.0</td>
<td>6.6</td>
<td>5.3</td>
<td>4.1</td>
<td>2.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Average actual mechanical efficiency</td>
<td>%</td>
<td>90.4</td>
<td>89.1</td>
<td>87.2</td>
<td>84.8</td>
<td>81.8</td>
<td>77.7</td>
<td>71.0</td>
<td>60.2</td>
</tr>
<tr>
<td>Average actual starting torque</td>
<td>Nm/bar</td>
<td>8.5</td>
<td>7.2</td>
<td>5.9</td>
<td>4.5</td>
<td>3.3</td>
<td>2.0</td>
<td>0.7</td>
<td>/</td>
</tr>
<tr>
<td>Average actual starting efficiency</td>
<td>%</td>
<td>72.6</td>
<td>68.7</td>
<td>63.8</td>
<td>57.9</td>
<td>50.8</td>
<td>38.0</td>
<td>17.5</td>
<td>/</td>
</tr>
<tr>
<td>Max continuous speed (F3/FM3)</td>
<td>rpm</td>
<td>550</td>
<td>600</td>
<td>615</td>
<td>630</td>
<td>630</td>
<td>630</td>
<td>630</td>
<td>1,500</td>
</tr>
<tr>
<td>Max continuous speed (F4/FM4)</td>
<td>rpm</td>
<td>530</td>
<td>545</td>
<td>560</td>
<td>575</td>
<td>585</td>
<td>600</td>
<td>615</td>
<td>630</td>
</tr>
<tr>
<td>Max continuous power (F3/FM3)</td>
<td>kW</td>
<td>113</td>
<td>105</td>
<td>90</td>
<td>73</td>
<td>59</td>
<td>43</td>
<td>30</td>
<td>14</td>
</tr>
<tr>
<td>Max continuous power (F4/FM4)</td>
<td>kW</td>
<td>113</td>
<td>105</td>
<td>90</td>
<td>73</td>
<td>59</td>
<td>43</td>
<td>30</td>
<td>14</td>
</tr>
<tr>
<td>Max continuous pressure</td>
<td>bar</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>17</td>
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<tr>
<td>Max intermittent pressure</td>
<td>bar</td>
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<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>17</td>
</tr>
</tbody>
</table>

Data shown is at 207 bar. Intermediate displacements can be made available to special order.

* See page 32: small displacements. ** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.
## 2-1 Performance Data (cont)

### HPC125 Motor *(crankcase flushing required)*

<table>
<thead>
<tr>
<th>Displacement Code</th>
<th>125</th>
<th>120</th>
<th>110</th>
<th>100</th>
<th>90</th>
<th>80</th>
<th>70</th>
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<tbody>
<tr>
<td>Displacement</td>
<td>cc/rev</td>
<td>2.048</td>
<td>1.966</td>
<td>1.639</td>
<td>1.475</td>
<td>1.311</td>
<td>1.147</td>
</tr>
<tr>
<td>Average actual running torque</td>
<td>Nm/bar</td>
<td>30.8</td>
<td>29.5</td>
<td>27.1</td>
<td>24.5</td>
<td>21.8</td>
<td>19.1</td>
</tr>
<tr>
<td>Average actual mechanical efficiency</td>
<td>%</td>
<td>94.5</td>
<td>94.4</td>
<td>94.3</td>
<td>94.0</td>
<td>93.0</td>
<td>91.7</td>
</tr>
<tr>
<td>Average actual starting torque</td>
<td>Nm/bar</td>
<td>26.4</td>
<td>25.0</td>
<td>22.5</td>
<td>20.0</td>
<td>17.4</td>
<td>14.7</td>
</tr>
<tr>
<td>Average actual starting efficiency</td>
<td>%</td>
<td>810</td>
<td>80.1</td>
<td>78.4</td>
<td>76.6</td>
<td>74.2</td>
<td>70.6</td>
</tr>
<tr>
<td>Max continuous speed (F3/FM3)</td>
<td>rpm</td>
<td>215</td>
<td>225</td>
<td>240</td>
<td>270</td>
<td>300</td>
<td>340</td>
</tr>
<tr>
<td>Max continuous speed (F4/FM4)</td>
<td>rpm</td>
<td>300</td>
<td>310</td>
<td>340</td>
<td>365</td>
<td>400</td>
<td>430</td>
</tr>
<tr>
<td>Max continuous power (F3/FM3)</td>
<td>kW</td>
<td>173</td>
<td>173</td>
<td>171</td>
<td>170</td>
<td>157</td>
<td>147</td>
</tr>
<tr>
<td>Max continuous power (F4/FM4)</td>
<td>kW</td>
<td>202</td>
<td>196</td>
<td>183</td>
<td>171</td>
<td>157</td>
<td>147</td>
</tr>
<tr>
<td>Max continuous pressure</td>
<td>bar</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Max intermittent pressure</td>
<td>bar</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
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<table>
<thead>
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<th>50</th>
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<th>30</th>
<th>20</th>
<th>10</th>
<th>00</th>
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</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>cc/rev</td>
<td>983</td>
<td>819</td>
<td>655</td>
<td>492</td>
<td>328</td>
<td>164</td>
</tr>
<tr>
<td>Average actual running torque</td>
<td>Nm/bar</td>
<td>13.8</td>
<td>11.3</td>
<td>8.8</td>
<td>6.4</td>
<td>4.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Average actual mechanical efficiency</td>
<td>%</td>
<td>88.5</td>
<td>86.5</td>
<td>84.3</td>
<td>81.6</td>
<td>78.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Average actual starting torque</td>
<td>Nm/bar</td>
<td>9.1</td>
<td>6.3</td>
<td>3.2</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Average actual starting efficiency</td>
<td>%</td>
<td>58.1</td>
<td>48.3</td>
<td>30.6</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Max continuous speed (F3/FM3)</td>
<td>rpm</td>
<td>450</td>
<td>500</td>
<td>600</td>
<td>630</td>
<td>630</td>
<td>630</td>
</tr>
<tr>
<td>Max continuous speed (F4/FM4)</td>
<td>rpm</td>
<td>490</td>
<td>515</td>
<td>545</td>
<td>575</td>
<td>600</td>
<td>630</td>
</tr>
<tr>
<td>Max continuous power (F3/FM3)</td>
<td>kW</td>
<td>101</td>
<td>86</td>
<td>65</td>
<td>48</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>Max continuous power (F4/FM4)</td>
<td>kW</td>
<td>101</td>
<td>86</td>
<td>65</td>
<td>48</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>Max continuous pressure</td>
<td>bar</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Max intermittent pressure</td>
<td>bar</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
</tr>
</tbody>
</table>

*Data shown is at 250 bar. Intermediate displacements can be made available to special order.*

*See page 32: small displacements.*  **A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*
2-1 Performance Data (cont)

**HPC200 Motor** (crankcase flushing required)

<table>
<thead>
<tr>
<th>Displacement Code</th>
<th>188</th>
<th>180</th>
<th>170</th>
<th>160</th>
<th>150</th>
<th>140</th>
<th>130</th>
<th>120</th>
<th>110</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement cc/rev</td>
<td>3,067</td>
<td>2,950</td>
<td>2,790</td>
<td>2,620</td>
<td>2,460</td>
<td>2,290</td>
<td>2,130</td>
<td>1,970</td>
<td>1,800</td>
<td>1,639</td>
</tr>
<tr>
<td>Average actual running torque Nm/bar</td>
<td>47.2</td>
<td>45.2</td>
<td>42.6</td>
<td>40.0</td>
<td>37.3</td>
<td>34.7</td>
<td>32.0</td>
<td>29.4</td>
<td>26.7</td>
<td>24.1</td>
</tr>
<tr>
<td>Average actual mechanical efficiency %</td>
<td>96.3</td>
<td>96.2</td>
<td>96.0</td>
<td>95.8</td>
<td>95.4</td>
<td>95.0</td>
<td>94.5</td>
<td>94.0</td>
<td>93.2</td>
<td>92.5</td>
</tr>
<tr>
<td>Average actual starting torque Nm/bar</td>
<td>42.6</td>
<td>40.6</td>
<td>38.0</td>
<td>35.5</td>
<td>33.0</td>
<td>30.6</td>
<td>28.0</td>
<td>25.5</td>
<td>22.9</td>
<td>20.2</td>
</tr>
<tr>
<td>Average actual starting efficiency %</td>
<td>87.0</td>
<td>86.4</td>
<td>85.7</td>
<td>85.1</td>
<td>84.5</td>
<td>83.8</td>
<td>82.8</td>
<td>81.5</td>
<td>79.8</td>
<td>77.5</td>
</tr>
<tr>
<td>Max continuous speed (F3/FM3) rpm</td>
<td>175</td>
<td>180</td>
<td>190</td>
<td>195</td>
<td>200</td>
<td>205</td>
<td>210</td>
<td>225</td>
<td>240</td>
<td>270</td>
</tr>
<tr>
<td>Max continuous speed (F4/FM4) rpm</td>
<td>230</td>
<td>235</td>
<td>240</td>
<td>245</td>
<td>250</td>
<td>265</td>
<td>285</td>
<td>310</td>
<td>340</td>
<td>365</td>
</tr>
<tr>
<td>Max continuous power kW</td>
<td>216</td>
<td>213</td>
<td>212</td>
<td>204</td>
<td>195</td>
<td>186</td>
<td>176</td>
<td>173</td>
<td>171</td>
<td>170</td>
</tr>
<tr>
<td>Max intermittent power kW</td>
<td>261</td>
<td>261</td>
<td>261</td>
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<td>234</td>
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<td>196</td>
<td>183</td>
<td>171</td>
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<tr>
<td>Max continuous pressure bar</td>
<td>250</td>
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<td>250</td>
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</tr>
<tr>
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<table>
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<tr>
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<th>60</th>
<th>50</th>
<th>40</th>
<th>30</th>
<th>20</th>
<th>10</th>
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<tbody>
<tr>
<td>Displacement cc/rev</td>
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<td>1,311</td>
<td>1,150</td>
<td>983</td>
<td>820</td>
<td>655</td>
<td>492</td>
<td>328</td>
<td>164</td>
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</tr>
<tr>
<td>Average actual running torque Nm/bar</td>
<td>21.5</td>
<td>18.9</td>
<td>16.3</td>
<td>13.8</td>
<td>11.3</td>
<td>8.8</td>
<td>6.4</td>
<td>4.2</td>
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</tr>
<tr>
<td>Average actual mechanical efficiency %</td>
<td>91.5</td>
<td>90.5</td>
<td>89.4</td>
<td>88.0</td>
<td>86.3</td>
<td>84.5</td>
<td>82.4</td>
<td>80.0</td>
<td>40.0</td>
<td>0</td>
</tr>
<tr>
<td>Average actual starting torque Nm/bar</td>
<td>17.5</td>
<td>14.8</td>
<td>12.0</td>
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<td>6.0</td>
<td>3.4</td>
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<td>/</td>
<td>/</td>
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</tr>
<tr>
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<td>/</td>
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</tr>
<tr>
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<td>340</td>
<td>390</td>
<td>450</td>
<td>500</td>
<td>600</td>
<td>630</td>
<td>630</td>
<td>630</td>
<td>1,500</td>
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<tr>
<td>Max continuous speed (F4/FM4) rpm</td>
<td>400</td>
<td>430</td>
<td>460</td>
<td>485</td>
<td>515</td>
<td>545</td>
<td>575</td>
<td>600</td>
<td>630</td>
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<tr>
<td>Max continuous power kW</td>
<td>157</td>
<td>147</td>
<td>123</td>
<td>101</td>
<td>86</td>
<td>65</td>
<td>48</td>
<td>30</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Max intermittent power kW</td>
<td>157</td>
<td>147</td>
<td>123</td>
<td>101</td>
<td>86</td>
<td>65</td>
<td>48</td>
<td>30</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Max continuous pressure bar</td>
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<td>250</td>
<td></td>
</tr>
<tr>
<td>Max intermittent pressure bar</td>
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<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td></td>
</tr>
</tbody>
</table>

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

* See page 32: small displacements. ** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.
2-1 Performance Data (cont)

HPC270 Motor (crankcase flushing required)

<table>
<thead>
<tr>
<th>Displacement Code</th>
<th>280</th>
<th>250</th>
<th>220</th>
<th>200</th>
<th>180</th>
<th>160</th>
<th>140</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>cc/rev</td>
<td>4,588</td>
<td>4,097</td>
<td>3,605</td>
<td>3,277</td>
<td>2,950</td>
<td>2,622</td>
<td>2,294</td>
</tr>
<tr>
<td>Average actual running torque</td>
<td>Nm/bar</td>
<td>70.1</td>
<td>62.3</td>
<td>54.5</td>
<td>49.3</td>
<td>44.3</td>
<td>39.0</td>
<td>33.8</td>
</tr>
<tr>
<td>Average actual mechanical efficiency</td>
<td>%</td>
<td>96.0</td>
<td>95.6</td>
<td>95.2</td>
<td>94.6</td>
<td>94.3</td>
<td>93.5</td>
<td>92.5</td>
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<tr>
<td>Average actual starting torque</td>
<td>Nm/bar</td>
<td>64.0</td>
<td>56.6</td>
<td>48.9</td>
<td>43.6</td>
<td>38.4</td>
<td>33.2</td>
<td>28.3</td>
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<tr>
<td>Average actual starting efficiency</td>
<td>%</td>
<td>87.6</td>
<td>86.9</td>
<td>85.2</td>
<td>83.7</td>
<td>81.8</td>
<td>79.7</td>
<td>77.5</td>
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<tr>
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<td>rpm</td>
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<td>160</td>
<td>170</td>
<td>175</td>
<td>210</td>
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<td>275</td>
</tr>
<tr>
<td>Max continuous power</td>
<td>kW</td>
<td>278</td>
<td>261</td>
<td>241</td>
<td>225</td>
<td>208</td>
<td>192</td>
<td>174</td>
</tr>
<tr>
<td>Max continuous pressure</td>
<td>bar</td>
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<td>Max intermittent pressure</td>
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<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
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</table>

<table>
<thead>
<tr>
<th>Displacement Code</th>
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<th>80</th>
<th>60</th>
<th>40</th>
<th>30</th>
<th>20</th>
<th>00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>cc/rev</td>
<td>1,639</td>
<td>1,311</td>
<td>983</td>
<td>655</td>
<td>492</td>
<td>328</td>
</tr>
<tr>
<td>Average actual running torque</td>
<td>Nm/bar</td>
<td>23.5</td>
<td>18.4</td>
<td>13.4</td>
<td>8.6</td>
<td>6.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Average actual mechanical efficiency</td>
<td>%</td>
<td>90.0</td>
<td>88.0</td>
<td>85.5</td>
<td>82.0</td>
<td>80.0</td>
<td>76.0</td>
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<tr>
<td>Average actual starting torque</td>
<td>Nm/bar</td>
<td>19.0</td>
<td>14.7</td>
<td>9.1</td>
<td>4.3</td>
<td>1.9</td>
<td>/</td>
</tr>
<tr>
<td>Average actual starting efficiency</td>
<td>%</td>
<td>72.6</td>
<td>70.2</td>
<td>57.8</td>
<td>40.7</td>
<td>23.5</td>
<td>/</td>
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<tr>
<td>Max continuous speed</td>
<td>rpm</td>
<td>375</td>
<td>430</td>
<td>460</td>
<td>490</td>
<td>515</td>
<td>545</td>
</tr>
<tr>
<td>Max continuous power</td>
<td>kW</td>
<td>133</td>
<td>109</td>
<td>85</td>
<td>56</td>
<td>39</td>
<td>21</td>
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<td>Max continuous pressure</td>
<td>bar</td>
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<td>250</td>
<td>250</td>
<td>250</td>
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<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
</tr>
</tbody>
</table>

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

* See page 32: small displacements.

** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.
2-1 Performance Data (cont)

**HPC325 Motor** (crankcase flushing required)

<table>
<thead>
<tr>
<th>Displacement Code</th>
<th>325</th>
<th>310</th>
<th>300</th>
<th>220</th>
<th>200</th>
<th>180</th>
<th>160</th>
<th>140</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>cc/rev</td>
<td>5,326</td>
<td>5,080</td>
<td>4,916</td>
<td>3,605</td>
<td>3,277</td>
<td>2,950</td>
<td>2,622</td>
</tr>
<tr>
<td>Average actual running torque</td>
<td>Nm/bar</td>
<td>81.6</td>
<td>77.8</td>
<td>75.2</td>
<td>54.5</td>
<td>49.3</td>
<td>44.1</td>
<td>38.8</td>
</tr>
<tr>
<td>Average actual mechanical efficiency</td>
<td>%</td>
<td>96.3</td>
<td>96.2</td>
<td>96.1</td>
<td>95.0</td>
<td>94.6</td>
<td>94.0</td>
<td>93.1</td>
</tr>
<tr>
<td>Average actual starting torque</td>
<td>Nm/bar</td>
<td>74.5</td>
<td>71.1</td>
<td>68.7</td>
<td>49.0</td>
<td>43.9</td>
<td>38.8</td>
<td>33.8</td>
</tr>
<tr>
<td>Average actual starting efficiency</td>
<td>%</td>
<td>87.9</td>
<td>87.9</td>
<td>87.8</td>
<td>85.4</td>
<td>84.2</td>
<td>82.8</td>
<td>81.0</td>
</tr>
<tr>
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<td>rpm</td>
<td>130</td>
<td>135</td>
<td>140</td>
<td>170</td>
<td>190</td>
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<tr>
<td>Max continuous power</td>
<td>kW</td>
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<td>278</td>
<td>278</td>
<td>241</td>
<td>225</td>
<td>208</td>
<td>192</td>
</tr>
<tr>
<td>Max continuous pressure</td>
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<td>250</td>
</tr>
<tr>
<td>Max intermittent pressure</td>
<td>bar</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
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<table>
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<th>60</th>
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<tbody>
<tr>
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<td>1,639</td>
<td>1,557</td>
<td>1,311</td>
<td>983</td>
<td>655</td>
<td>492</td>
</tr>
<tr>
<td>Average actual running torque</td>
<td>Nm/bar</td>
<td>28.5</td>
<td>23.3</td>
<td>22.0</td>
<td>18.2</td>
<td>13.2</td>
<td>8.5</td>
<td>6.3</td>
</tr>
<tr>
<td>Average actual mechanical efficiency</td>
<td>%</td>
<td>91.0</td>
<td>89.2</td>
<td>88.8</td>
<td>87.2</td>
<td>84.6</td>
<td>81.6</td>
<td>80.0</td>
</tr>
<tr>
<td>Average actual starting torque</td>
<td>Nm/bar</td>
<td>24.0</td>
<td>19.3</td>
<td>18.1</td>
<td>14.8</td>
<td>9.0</td>
<td>4.2</td>
<td>1.9</td>
</tr>
<tr>
<td>Average actual starting efficiency</td>
<td>%</td>
<td>76.5</td>
<td>73.8</td>
<td>73.0</td>
<td>70.7</td>
<td>57.8</td>
<td>40.7</td>
<td>23.5</td>
</tr>
<tr>
<td>Max continuous speed</td>
<td>rpm</td>
<td>330</td>
<td>370</td>
<td>405</td>
<td>440</td>
<td>460</td>
<td>495</td>
<td>515</td>
</tr>
<tr>
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<td>kW</td>
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<td>127</td>
<td>110</td>
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<td>48</td>
<td>39</td>
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<tr>
<td>Max continuous pressure</td>
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<td>250</td>
</tr>
<tr>
<td>Max intermittent pressure</td>
<td>bar</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>275</td>
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</tr>
</tbody>
</table>

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

* See page 32: small displacements.

** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.
2-2 Volumetric Efficiency Data

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Geometric Displacement</th>
<th>Zero Speed Constant</th>
<th>Speed Constant</th>
<th>Creep Speed Constant</th>
<th>Crankcase Leakage Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC</td>
<td>cc/rev</td>
<td>K₁</td>
<td>K₂</td>
<td>K₃</td>
<td>K₄</td>
</tr>
<tr>
<td>HPC080</td>
<td>1.639</td>
<td>9.5</td>
<td>45.7</td>
<td>5.8</td>
<td>7.9</td>
</tr>
<tr>
<td>HPC125</td>
<td>2.048</td>
<td>6.1</td>
<td>38.5</td>
<td>3</td>
<td>4.25</td>
</tr>
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<td>HPC200</td>
<td>3.087</td>
<td>6.1</td>
<td>38.5</td>
<td>2</td>
<td>4.25</td>
</tr>
<tr>
<td>HPC270</td>
<td>4.310</td>
<td>6.5</td>
<td>37.3</td>
<td>1.5</td>
<td>6</td>
</tr>
<tr>
<td>HPC325</td>
<td>5.210</td>
<td>6.8</td>
<td>40</td>
<td>1.3</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fluid Viscosity</th>
<th>Viscosity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>cSt</td>
<td>Kv</td>
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<tr>
<td>20</td>
<td>1.58</td>
</tr>
<tr>
<td>25</td>
<td>1.44</td>
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<td>30</td>
<td>1.30</td>
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<tr>
<td>40</td>
<td>1.10</td>
</tr>
<tr>
<td>50</td>
<td>1.00</td>
</tr>
<tr>
<td>60</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Qt (total leakage) = \([K₁ + n/K₂] \times \Delta P \times Kv \times 0.005\) l/min
Creep speed = \(K₃ \times \Delta P \times Kv \times 0.005\) rpm
Crankcase leakage = \(K₄ \times \Delta P \times Kv \times 0.005\) l/min
\(\Delta P\) = differential pressure bar
n = speed rpm

The motor volumetric efficiency can be calculated as follows:

\[
\text{Volumetric efficiency (\%)} = \left(\frac{(\text{speed} \times \text{disp.})}{(\text{speed} \times \text{disp.}) + Qt}\right) \times 100
\]

Example:
HPC200 motor with displacement of 3.087 l/rev.
Speed 60 rpm
Differential pressure 200 bar
Fluid viscosity 50 cSt

Total leakage = \((K₁ + n/K₂) \times \Delta P \times Kv \times 0.005\) l/min
= \((6.1 + 60/38.5) \times 200 \times 1 \times 0.005\)
= 7.7 l/min

Volumetric efficiency = \(\left(\frac{60 \times 3.087}{60 \times 3.087 + 7.7}\right) \times 100\)
= 96%
2-3 Shaft Power Calculation

Example

Firstly, to find the maximum differential pressure $\Delta P$ at rated speed:

Select the rated shaft power ($W$) for the motor from the performance data table (page 24). This is presented in kilowatts so must be converted to watts ($x1000$).

Then also take the Actual Average running torque in N.m/bar ($T_o$) and the rated shaft speed in rpm ($n$).

\[
W = \frac{T_o \cdot \Delta P \cdot 2\pi \cdot n}{60}
\]

Or to find maximum $\Delta P$ then use:

\[
\Delta P = \frac{60 \cdot W}{2\pi \cdot T_o \cdot n}
\]

HPC270 example - with a displacement code of 140:

Rated shaft power ($W$): 174,000
Average actual running torque (Nm/bar): 28.3
Rated shaft speed (rpm): 275

\[
\Delta P = \frac{60 \times 189,000}{2\pi \times 69.4 \times 150}
\]

$\Delta P= 213$ bar (max.)

Secondly, to find the maximum speed at rated pressure:

\[
n = \frac{60 \cdot W}{2\pi \cdot T_o \cdot \Delta P}
\]

Rated shaft power ($W$): 174,000
Average actual running torque (Nm/bar): 28.3
Rated pressure (bar): 250

\[
n = \frac{60 \times 174,000}{2\pi \times 28.3 \times 250}
\]

$n=235$ rpm (max.)

In summary, operating the motor within its shaft power limit, at rated speed, would give a maximum pressure of 213 bar, and operating the motor at rated pressure, would give a maximum speed of 235 rpm.

Notes

1) The maximum calculated speed is based on a rated inlet pressure of 250 bar.
2) The maximum shaft power is only allowable if the motor drain temperature remains below 80°C.
3) The maximum calculated differential pressure assumes that the low pressure motor port is less than 30 bar.
2-4 Functional Symbols

**Example model code:**

HPC***/P/***/**/FM3/X/...

- **X** - external pilot supply to 'X' and 'Y' ports

---

**Example model code:**

HPC***/P/***/**/FM3/C/...

- **C** - single external supply to PC port

---

**Example model code:**

HPC***/P/***/**/FM3/CS/...

- **CS** - internally shuttled pilot supply

---

**Example model code:**

HPC***/P/***/**/FM3/C1/...

- **C1** - internal pilot supply from port 1 for clockwise rotation only

---

There is a single port (PC) in the 'C' spacer.

Pressure ports in FM3 & FM4 valve housings can be called up as special features when required.
2-5 Stress Limits

When applying large external radial loads, consideration should also be given to motor bearing lives (see page 33).

<table>
<thead>
<tr>
<th>Motor Frame Size</th>
<th>Maximum External Radial Bending Moment [kNm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC080</td>
<td>4,500</td>
</tr>
<tr>
<td>HPC125</td>
<td>6,500</td>
</tr>
<tr>
<td>HPC200</td>
<td>6,750</td>
</tr>
<tr>
<td>HPHDC200</td>
<td>12,200</td>
</tr>
<tr>
<td>HPC270</td>
<td>8,250</td>
</tr>
<tr>
<td>HPHDC270</td>
<td>16,000</td>
</tr>
<tr>
<td>HMC325</td>
<td>8,250</td>
</tr>
</tbody>
</table>

Example:

Determine the maximum radial shaft load of a HPC080 motor:

Radial load offset, $A$  = 100 mm
Maximum radial load, $W$  = 4,500 (see table)/100

= 45kN (4,587 kg)

$A$ = Distance from mounting face to load centre (mm)

$W$ = Side load (N)

[Note]
The offset distance $A$ is assumed to be greater than 50 mm. Contact KPM UK if this is not the case.
2-6 Bearing Life Notes

Consideration should be given to the required motor bearing life in terms of baring service life. The factors that will determine bearing life include:

1) Duty cycle - time spent on and off load
2) Speed
3) Differential pressure
4) Fluid viscosity
5) External radial shaft load
6) External axial shaft load
2-7 Circuit and Application Notes

⚠️ Limits for fire resistant fluids

To select either displacement, a pressure at least equal to 67% of the motor inlet/outlet pressure (whichever is higher) is required. In most applications the motor inlet pressure will be used. If the inlet/outlet pressure is below 3.5 bar, a minimum control pressure of 3.5 bar is required. In the event of loss of control pressure the motor will shift to its highest displacement.

⚠️ Starting torque

Refer to performance data, (see pages 7 to 13).

⚠️ Low speed operation

The minimum operating speed is determined by load inertia, drive elasticity, motor displacement and system internal leakage. If the application speed is below 3 rpm, then consult KPM UK.

If possible, always start the motor in high displacement.

⚠️ Small displacements

The pressures given in the tables on pages 22 to 28 for displacement code “00” are based on 1,000 rpm output shaft speed. This pressure can be increased for shaft speeds less than 1,000 rpm; consult KPM UK for details. Speeds greater than 1,000 rpm may be applied but only after the machine duty cycle has been considered in conjunction with KPM UK. A zero swept volume displacement (for freewheeling requirements) is available on request, consult KPM UK.

⚠️ High back pressure

When both inlet and outlet ports are pressurised continuously, the lower pressure port must not exceed 70 bar at any time. Note that high back pressure reduces the effective torque output of the motor.

⚠️ Boost pressure

When operating as a motor the outlet pressure should equal or exceed the crankcase pressure. If pumping occurs (i.e. overrunning loads) then a positive pressure, “P”, is required at the motor ports. Calculate “P” (bar) from the operating formula Boost Formula

\[ P = \frac{1 + N^2 \times V^2 + C}{K} \]

Where P is in bar, N = motor speed (rpm), V = motor displacement (cc/rev), C = Crankcase pressure (bar) and K=a constant from the table below:

<table>
<thead>
<tr>
<th>Motor</th>
<th>Porting</th>
<th>Constant (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC080</td>
<td>F(M)3</td>
<td>1.6 \times 10^9</td>
</tr>
<tr>
<td></td>
<td>F(M)4</td>
<td>3.3 \times 10^9</td>
</tr>
<tr>
<td>HPC125</td>
<td>F(M)3</td>
<td>1.6 \times 10^9</td>
</tr>
<tr>
<td></td>
<td>F(M)4</td>
<td>3.3 \times 10^9</td>
</tr>
<tr>
<td>HPC200</td>
<td>F(M)3</td>
<td>1.6 \times 10^9</td>
</tr>
<tr>
<td></td>
<td>F(M)4</td>
<td>3.3 \times 10^9</td>
</tr>
<tr>
<td>HPC270</td>
<td>F(M)4</td>
<td>4.0 \times 10^9</td>
</tr>
<tr>
<td>HPC325</td>
<td>F(M)4</td>
<td>4.0 \times 10^9</td>
</tr>
</tbody>
</table>
2-7 Circuit and Application Notes (cont)

The flow rate of oil for the make-up system can be estimated from the crankcase leakage data (see page 29) plus an allowance for changing displacement:

<table>
<thead>
<tr>
<th>Model</th>
<th>Change Time</th>
<th>Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC080</td>
<td>0.25 sec</td>
<td>32 l/min</td>
</tr>
<tr>
<td>HPC125</td>
<td>0.5 sec</td>
<td>15 l/min</td>
</tr>
<tr>
<td>HPC200</td>
<td>0.5 sec</td>
<td>15 l/min</td>
</tr>
<tr>
<td>HPC270</td>
<td>1 sec</td>
<td>24 l/min</td>
</tr>
<tr>
<td>HPC325</td>
<td>1 sec</td>
<td>20 l/min</td>
</tr>
</tbody>
</table>

Allowances should be made for other systems losses and also for "fair wear and tear" during the life of the motor, pump and system components.

Motorcase pressure

The motorcase pressure should not continuously exceed 3.5 bar with a standard shaft seal fitted. On installations with long drain lines a relief valve is recommended to prevent over-pressurising the seal.

Notes

1) The motorcase pressure at all times must not exceed either the motor inlet or outlet pressure.

2) High pressure shaft seals are available to special order for casing pressures of: 10 bar continuous and 15 bar intermittent.

3) Check installation dimensions (pages 27 to 67) for maximum crankcase drain fitting depth.

Hydraulic Fluids

Dependent on motor (see model code fluid type - page 4) suitable fluids include:

- a) Antiwear hydraulic oils
- b) Phosphate ester (HFD fluids)
- c) Water glycols (HFC fluids)
- d) 60/40% water-in-oil emulsions (HFB fluids)
- e) 5/95% oil-in-water emulsions (HFA fluids)

Reduce pressure and speed limits, as per table on page 21.

Viscosity limits when using any fluid except oil-in-water (5/95) emulsions are:

- Max. off load: 2,000 cSt (9270 SUS)
- Max. on load: 150 cSt (695 SUS)
- Optimum: 50 cSt (232 SUS)
- Minimum: 25 cSt (119 SUS)

Mineral oil recommendations

The fluid should be a good hydraulic grade, non-detergent Mineral Oil. It should contain anti-oxidant, antifoam and demulsifying additives. It must contain antiwear or EP additives. Automatic transmission fluids and motor oils are not recommended.

Biodegradable Fluid Recommendations

Well-designed environmentally acceptable lubricants (EALs) may be used with Staffa motors. The EAL must be designed for use in hydraulic systems and have a synthetic ester base. Additives should be as listed for mineral oils, above. The performance of EALs with hydraulic systems vary widely and so checks for seal compatibility, copper alloy compatibility, oxidation resistance and lubrication properties should be carried out before selecting an EAL. For help with EALs please contact KPMUK.
2-7 Circuit and Application Notes (cont)

Temperature limits

Ambient min. -30°C (-22°F)
Ambient max. +70°C (158°F)
Max. operating temperature range.

Mineral oil Water containing
Min -20°C (-4°F) +10°C (50°F)
Max. +80°C (175°F) +54°C (130°F)

Note: To obtain optimum services life from both fluid and hydraulic systems components, a fluid operating temperature of 40°C is recommended.

Filtration

Full flow filtration (open circuit), or full boost flow filtration (close circuit) to ensure system cleanliness to ISO4406/1986 code 18/14 or cleaner.

Noise levels

The airborne noise level is less than 66.7 dB(A) DIN & dB(A) NFPA through the “continuous” operating envelope. Where noise is a critical factor, installation resonances can be reduced by isolating the motor by elastomeric means from the structure and the return line installation. Potential return line resonances originating from liquid borne noise can be further attenuated by providing a return line back pressure of 2 to 5 bar.

Polar moment of inertia and mass table

<table>
<thead>
<tr>
<th>Motor Frame Size</th>
<th>Displacement code</th>
<th>Polar Moment of Inertia (kg.m^2) (Typical data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC080</td>
<td>90</td>
<td>0.0520</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>0.0440</td>
</tr>
<tr>
<td>HPC125</td>
<td>125</td>
<td>0.2000</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>0.1400</td>
</tr>
<tr>
<td>HPC200</td>
<td>188</td>
<td>0.2300</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>0.1800</td>
</tr>
<tr>
<td>HPC270</td>
<td>280</td>
<td>0.4900</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>0.4700</td>
</tr>
<tr>
<td>HPC325</td>
<td>325</td>
<td>0.5000</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>0.4700</td>
</tr>
</tbody>
</table>

Mass

HPC080 Approx. all models 172 kg.
HPC125 Approx. all models 235 kg.
HPC200 Approx. all models 282 kg.
HPC270 Approx. all models 450 kg.
HPC325 Approx. all models 460 kg.
2-8 Crankcase Flushing Flow

In order to achieve the maximum shaft power, a crankcase flushing flow of 15 l/min should be directed through the motorcase. To improve the cooling effect of flushing flow, the distance between the inlet and outlet drain port connections should be maximised. If a flushing flow is not used, please consult KPM UK to verify performance parameters.

![Diagram of Crankcase Flushing Flow]

<table>
<thead>
<tr>
<th>Check valve pressure (bar) *</th>
<th>Orifice diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4.4</td>
</tr>
<tr>
<td>4</td>
<td>4.1</td>
</tr>
<tr>
<td>5</td>
<td>3.9</td>
</tr>
<tr>
<td>6</td>
<td>3.7</td>
</tr>
<tr>
<td>7</td>
<td>3.6</td>
</tr>
<tr>
<td>8</td>
<td>3.5</td>
</tr>
<tr>
<td>9</td>
<td>3.4</td>
</tr>
<tr>
<td>10</td>
<td>3.3</td>
</tr>
</tbody>
</table>

* This assumes that the crankcase pressure is zero, if not then the check valve pressure will need to be increased to maintain the pressure drop across the orifice.

[Note]

If due to crankcase flushing flow, the crankcase pressure continuously exceeds 3.5 bar, then the motor build should include a high pressure shaft seal.
2-9 Motor Operation at Low Temperature

When operating the motor at low temperature consideration should be given to the fluid viscosity. The maximum fluid viscosity before the shaft should be turned is 2,000 cSt. The maximum fluid viscosity before load is applied to the motor shaft is 150 cSt.

If low ambient temperature conditions exist, then a crankcase flushing flow of at least 5 l/min should be applied to the motor during periods when the motor is not in use.

The shaft seal temperature limits for both medium and high pressure applications are shown in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Non-operating temperature limits</th>
<th>Minimum operating temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard pressure shaft seal</td>
<td>below minus 40°C and above 100°C</td>
<td>minus 30°C</td>
</tr>
<tr>
<td>High pressure shaft seal</td>
<td>below minus 30°C and above 120°C</td>
<td>minus 15°C</td>
</tr>
</tbody>
</table>

All seals are very brittle below minus 40°C and are likely to break very easily and due to their sluggish response may not provide a 100% leak free condition.

It should be noted that the maximum continuous operating temperature within the motor crankcase is plus 80°C.
2-10 Crankcase Drain Connections

Motor axis - horizontal

The recommended minimum pipe size for drain line lengths up to approx. 5m is 12.0 mm (½") bore. Longer drain lines should have their bore size increased to keep the crankcase pressure within limits.

Motor axis - vertical shaft up

Specify "V" within the model code for extra drain port, G¼" (BSPF). Connect this port into the main drain line downstream of a 0.35 bar check valve to ensure good bearing lubrication. The piping arrangement must not allow syphoning from the motorcase. (refer to installation drawing for details).

Motor axis - vertical shaft down

The piping, from any drain port, must be taken above the level of the motorcase to ensure good bearing lubrication. The arrangement must not allow syphoning from the motorcase.
2-11 Freewheeling Notes

All Staffa motors can be used in freewheeling applications. In all circumstances it is essential that the motor is unloaded ("A" and "B" ports connected together) and that the circuit is boosted. The required boost pressure is dependent on both the speed and displacement conditions of the motor determined by the maximum overrunning load condition (see boost pressure calculation method on page 32).

It should be noted that for "B" motors large flows will re-circulate around the motor. This will require a large recirculating valve and consideration of circuit cooling as the motor will be generating a braking torque. It is for these reasons that "C" series motors are the preferred option for freewheeling applications. It is normal to select displacement codes 00, 05 or 10.

Selecting the lowest zero displacement option (00) will allow the motor shaft to be rotated at high speed without pumping fluid and with a minimum boost and drive torque requirement. Consideration must also be given when freewheeling that the load does not drive the motor above its rated freewheeling speed condition. (see pages 22 to 26).

Displacement selection

Under all operating conditions the control pressure port should be at least 67% of the motor inlet/outlet pressure whichever is the higher.

A minimum control pressure at the low displacement selection port of 3.5 bar is necessary to ensure that the motor remains in its minimum displacement condition. A separate pressure supply may be necessary to ensure this condition is always maintained. It should be noted that with the loss of control pressure, the motor will shift to its high displacement condition, which could result in damage to the motor.

Boost requirement

The minimum required boost pressure as noted above can be ascertained utilising the calculation method shown on page 19. The maximum motor and control pressure at 100 rpm is 17 bar and must not be exceeded since higher pressures will increase motor losses at the conrod slipper interface and valve assembly and thereby will significantly increase the motor operating temperature.

The boost flow required should be sufficient to make-up circuit leakage loss and provide cooling for recirculating flow pressure drop.

Crankcase cooling

A crankcase flushing flow of up to 15 l/min can be used to control and reduce the temperature rise of the motor during the freewheel operation.

This should not be necessary for speeds below 1,000 rpm.

For speeds above this up to 1,500 rpm then crankcase flushing flow must be used.
2-12 Installation Data

General

Spigot
The motor should be located by the mounting spigot on a flat, robust surface using correctly sized bolts. The diametrical clearance between the motor spigot and the mounting must not exceed 0.15 mm. If the application incurs shock loading, frequent reversing or high speed running, then high tensile bolts should be used, including one fitted bolt.

Bolt Torque
The recommended torque wrench setting for bolts is as follows:

<table>
<thead>
<tr>
<th>Thread Type</th>
<th>Torque Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>M18</td>
<td>312 +/- 7 Nm</td>
</tr>
<tr>
<td>⅝” UNF</td>
<td>265 +/- 14 Nm</td>
</tr>
<tr>
<td>M20</td>
<td>407 +/- 14 Nm</td>
</tr>
<tr>
<td>¾” UNF</td>
<td>393 +/- 14 Nm</td>
</tr>
</tbody>
</table>

Shaft coupling:
Where the motor is solidly coupled to a shaft having independent bearings the shaft must be aligned to within 0.13 mm TIR.

Motor axis - horizontal
The crankcase drain must be taken from a position above the horizontal centre line of the motor, (refer to installation drawing for details).

Motor axis - vertical shaft up
The recommended minimum pipe size for drain line lengths up to approx. 5 m is 12.0 mm as an internal diameter. If using longer drain lines, then increase the pipe internal bore diameter to keep the motorcase pressure within specified limits.

Specify “V” in the model code for extra drain port, G¼” (BSPF). Connect this port into main drain line downstream of a 0.35 bar check valve.

Motor axis - vertical shaft down
Piping (from any drain port) must be taken above level of motorcase.

Bearing lubrication - piping
The installation arrangement must not allow syphoning from the motorcase. Where this arrangement is not practical, please consult KPM UK.

Any of the drain port positions can be used, but the drain line should be run above the level of the uppermost bearing and if there is risk of syphoning then a syphon breaker should be fitted.

Start - up
Fill the crankcase with system fluid. Where practical, a short period (30 minutes) of “running in” should be carried out with the motor unloaded and set to its high displacement.
3 Dimensions

Conversion Table

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>bar</td>
<td>Nm</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>14.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow</th>
<th>Power</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>l/min</td>
<td>kW</td>
<td>kg</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0.264</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>25.4</td>
</tr>
<tr>
<td>inch</td>
<td>1</td>
</tr>
</tbody>
</table>

3-1 HPC080

◆ 'P', 'S' & 'Z' Shafts

SPLINE DATA

'S'
- TO BS 3550 (ANSI B92.1 CLASS 5)
- FLAT ROOT SIDE FIT, CLASS 1
- PRESSURE ANGLE 30º
- NUMBER OF TEETH 14
- PITCH 6/12
- MAJOR DIAMETER 62.553/62.425
- FORM DIAMETER 55.052
- MINOR DIAMETER 54.084/53.525
- PIN DIAMETER 8.128
- DIAMETER OVER PINS 71.593/71.544

'Z'
- DIN 5480 W70 x 3 x 30 x 22 x 7h
3-1 HPC080 (cont)

'T' Shaft
3-1 HPC080 (cont)

'F3' & 'FM3' Valve Housings
3-1 HPC080 (cont)

- 'F4' & 'FM4' Valve Housings

![Diagram of F4/FM4 Valve Housings]

**PORT FLANGE BOLT TAPPING SIZE**

- **F4:** 5/8"-11 UNC-2B x 35 Full Thread Depth
- **FM4:** M16 x P2 x 35 Full Thread Depth

**B HOLES, SEE TABLE FOR THREAD SIZES**

**PORT 1**
- 316
- 371

**PORT 2**
- 36.5
- 79.4

**Port Flange Dimensions:**
- 316
- 371

**Dimensions:**
- 130
- 70.0
- 78.0
- 450
3-1 HPC080 (cont)

**'C', 'CS' & 'X' C Spacers**

Displacement Selection (via remotely located valve):
- High displacement: P to A; X to T
- Low displacement: P to C; Y to T

Displacement selector valve is not supplied with motor; specify & order separately.

Mounting Interface for Directional Control Valve to ISO 4401 Size 03/ANSI B1.7M Size D03

Connection to P port:
- 0.25" (BSPP) x 15 full thread deep; supplied plugged.

4 holes M6 x 12 deep for orientation pin.

CS Type Shuttle on F3 & FM3 assemblies only

CS Type Shuttle Endcap on F4 & FM4 assemblies only
3-1 HPC080 (cont)

Installation

3/4"-16UNF-2B DRAIN (CHOICE OF 3 POSITIONS)
(2 NORMALLY PLUGGED)

NOTE: ENSURE ON INSTALLATION THAT DRAIN IS TAKEN FROM ABOVE MOTOR CENTRELINE.
DO NOT EXCEED 12 DEPTH OF COUPLING IN TO DRAIN PORT

5 HOLES #20 EQUI-SPACED AS SHOWN ON A 327.03 P.C.D. SPOTFACED TO GIVE AN EFFECTIVE #40.

FLOW DIRECTION FOR ALL VLV HSG VARIANTS EXCEPT F2/FM2/SM3

REVERSE PORT CONNECTIONS FOR OPPOSITE DIRECTION OF SHAFT ROTATION

MOUNTING FACE

CLOCKWISE DIRECTION OF ROTATION

SEE C-SPACERS
3-2 HPC125

◆ 'P1', 'S3' & 'Z3' Shafts

SPLINE DATA

'S'
- TO BS 3550 (ANSI B92.1, CLASS 5)
- FLAT ROOT SIDE FIT, CLASS 1
- PRESSURE ANGLE 30°
- NUMBER OF TEETH 20
- PITCH 6/12
- MAJOR DIAMETER 87.953/87.825
- FORM DIAMETER 80.264
- MINOR DIAMETER 79.485/78.925
- PIN DIAMETER 8.128
- DIAMETER OVER PINS 97.084/97.030

'S3' & 'Z3'
- 3/4"-16 UNF-2B X 32 FULL THREAD DEPTH
- 76 MIN STRAIGHT

'Z'
- DIN 5480 W85 x 3 x 27 x 7h
3-2 HPC125 (cont)

'T' Shaft

KEY SUPPLIED—
22.27/22.22 MDE
15.92/15.87 THICK

BASIC TAPER, ON DIAMETER
0.1001/0.0999 PER mm
3-2 HPC125 (cont)

• 'F3' & 'FM3' Valve Housings

F3/FM3 —
3" VALVE HOUSING WITH
1 1/4" SAE 4-BOLT FLANGES

PORT FLANGE BOLT TAPPING SIZE —
F3: 7/16"-14 UNC-2B X 27 FULL THREAD DEPTH
FM3: M12 X P1.75 X 27 FULL THREAD DEPTH

1 1/4" CODE 61
S.A.E. PORTS—
(3000 SERIES)
3-2 HPC125 (cont)

-'F4' & 'FM4' Valve Housings
3-2 HPC125 (cont)

'C', 'CS' & 'X' C Spacers

**DISPLACEMENT SELECTION**
- 
- HIGH DISPLACEMENT: P to T; X to T
- LOW DISPLACEMENT: P to X; Y to T

*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR; SPECIFY & ORDER SEPARATELY*

**MOUNTING INTERFACE FOR DIRECTIONAL CONTROL**
- VALVE TO ISO 4401 SIZE O3/ANSI B133.74 SIZE D3
- *DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR; SPECIFY & ORDER SEPARATELY*

**CONNECTION TO P PORT**
- G/A (NPTF) X 15
- FULL THREAD DEPTH, SUPPLIED PLUGGED

**DETAIL SCALE 1:1**
- **4 HOLE**
- M5 X 12 DEEP
- **HOLE FOR ORIENTATION PIN**

**CS TYPE SHUTTLE ON F3 & FM3 ASSEMBLIES ONLY**

**CS TYPE SHUTTLE ENDCAP ON F4 & FM4 ASSEMBLIES ONLY**
3-2 HPC125 (cont)

Installation

NOTE - ENSURE ON INSTALLATION THAT DRAIN IS TAKEN FROM ABOVE MOTOR CENTRELINE.
DO NOT EXCEED 12 DEPTH OF COUPLING IN TO DRAIN PORT.

5 HOLE #21 EQUIS-SPACED AS SHOWN ON A 5/16 PCD. SPOTFACED TO GIVE AN EFFECTIVE #40

5/16 UNF-28 DRAIN (CHOICE OF 3 POSITIONS)
(2 NORMALLY PLUGGED)

FLOW DIRECTION FOR ALL VLV HSG VARIANTS EXCEPT F2/FW2/SM3

REVERSE PORT CONNECTIONS FOR OPPOSITE DIRECTION OF SHAFT ROTATION

CLOCKWISE DIRECTION OF ROTATION

MOUNTING FACE
3-3 HPC200

- 'P1', 'S3' & 'Z3' Shafts

### SPLINE DATA

#### 'S'
- TO BS 3550 (ANSI B92.1, CLASS 5)
- FLAT ROOT SIDE FIT, CLASS 1
- PRESSURE ANGLE: 30°
- NUMBER OF TEETH: 20
- PITCH: 6/12
- MAJOR DIAMETER: 87.953/87.825
- FORM DIAMETER: 80.264
- MINOR DIAMETER: 79.485/78.925
- PIN DIAMETER: 8.128
- DIAMETER OVER PINS: 97.084/97.030

#### 'Z'
- DIN 5480 WB5 x 3 x 27 x 7h
3-3 HPC200 (cont)

'T' Shaft

MOUNTING FACE

133.4

6.4

KEY SUPPLIED -
22.27/22.22 MMDE
15.82/15.87 THICK

9.575
9.525

85.344
(DATUM)

12

M30 x 60 LG
HEX HEAD SCREW

61.8
60.6

172

BASIC TAPER, ON DIAMETER
0.1001/0.0999 PER mm
3-3 HPC200 (cont)

❖ 'F3' & 'FM3' Valve Housings

F3/FM3 —
3" VALVE HOUSING WITH
1 1/4" SAE 4—BOLT FLANGES

PORT FLANGE BOLT TAPPING SIZE —
F3: 7/16"—14 UNC—2B X 27 FULL THREAD DEPTH
FM3: M12 X P1.75 X 27 FULL THREAD DEPTH

1 1/4" CODE 61
S.A.E. PORTS
(3000 SERIES)

PORT 1

8 HOLES, SEE TABLE
FOR THREAD SIZES

46.5
438
346
30.2
56.7
56.7
30.2
37
37
50.2

PORT 2
3-3 HPC200 (cont)

■ 'F4' & 'FM4' Valve Housings

**VIEWS ON ARROW 'A'**

**F4/FM4 —**
4" VALVE HOUSING WITH 
1 1/2" SAE 4-BOLT FLANGES

**PORT FLANGE BOLT TAPPING SIZE —**

F4: 5/8"-11 UNC-2B X 35 FULL THREAD DEPTH
FM4: M16 X P2 X 35 FULL THREAD DEPTH

8 HOLES, SEE TABLE FOR THREAD SIZES
3-3 HPC200 (cont)

'C', 'CS' & 'X' C Spacers

**HPC MOTORS**

- **MOUNTING FACE**

  - **TYPE X DISPLACEMENT CONTROL**

    - **DISPLACEMENT SELECTION (via REMOTELY LOCATED VALVE)**
      - HIGH DISPLACEMENT: P TO V, X TO T
      - LOW DISPLACEMENT: P TO A, B TO T
      - *DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR; SPECIFY & ORDER SEPARATELY*

    - **MOUNTING INTERFACE FOR DIRECTIONAL CONTROL**
      - VALVE TO ISO 4401 SIZE 0/43, W4 SIZE 003
      - *DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR; SPECIFY & ORDER SEPARATELY*

    - **CONNECTION TO P PORT**
      - G1/4" (BSPP) x 15 FULL THREAD DEPTH, SUPPLIED PLUGGED

- **TYPES C, CS & C1 DISPLACEMENT CONTROL**

  - **DETAIL SCALE 2:1**
    - #4-40 X 6 DEEP HOLE FOR ORIENTATION PIN
  - **520.0**

- **CS TYPE SHUTTLE ON F3 & FM3 ASSEMBLIES ONLY**

- **CS TYPE SHUTTLE ENDCAP ON F4 & FM4 ASSEMBLIES ONLY**
3-3 HPC200 (cont)

Installation

3/4"-16UNF-2B DRAIN (CHOICE OF 3 POSITIONS)
(2 NORMALLY PLUGGED)

NOTE: -- ENSURE ON INSTALLATION THAT DRAIN IS
TAKEN FROM ABOVE MOTOR CENTRELINES.

DO NOT EXCEED 12 DEPTH OF COUPLING
IN TO DRAIN PORT.

SEE C-SPACERS
3-4 HPC270

◆ 'P1', 'S3' & 'Z4' Shafts

SPLINE DATA

'S'
TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1
PRESSURE ANGLE 30°
NUMBER OF TEETH 20
PITCH 6/12
MAJOR DIAMETER 87.953/87.825
FORM DIAMETER 80.284
MINOR DIAMETER 79.485/78.925
PIN DIAMETER 8.128
DIAMETER OVER PINS 97.084/97.030

'Z'
DIN 5480 W90 x 4 x 21 x 7h
3-4 HPC270 (cont)

'T' Shaft

KEY SUPPLIED -
25.45/25.40 MDE
17.539/17.483 THICK

M30 x 60 LG
HEX HEAD SCREW

BASIC TAPER, ON DIAMETER
0.1001/0.0999 PER mm
3-4 HPC270 (cont)

◆ ‘F4’ & ‘FM4’ Valve Housings

F4/FM4 —
4" VALVE HOUSING WITH
1 1/2" SAE 4-BOLT FLANGES

PORT FLANGE BOLT TAPPING SIZE —
F4: 5/8"-11 UNC-2B X 35 FULL THREAD DEPTH
FM4: M16 X P2 X 35 FULL THREAD DEPTH

Ø1 1/2" SAE (CODE 62)
PORTS (6000 SERIES)

PORT 1
375

PORT 2
36.5

79.4

79.4

36.5

79.4

430

511
3-4 HPC270 (cont)

◆ 'C', 'CS' & 'X' C Spacers

Displacement Selection (Via Remotely Located Valve*)
- High displacement: P to T, X to T
- Low displacement: P to X, Y to T
*Displacement selector valve is not supplied with motor; specify & order separately

Mounting Interface for Directional Control Valve
- DISPLACEMENT SELECTION:
  - High displacement: P to B, A to T
  - Low displacement: P to A, B to T
- CONNECTION TO P PORT:
  - G1/4" (BSPF) x 15
  - FULL THREAD DEPTH
  - Supplied plugged

Types C, CS & C1 Displacement Control

CS Type Shuttle Endcap on F4 & FM4 Assemblies Only
Installation

3/4"-18UNF-2B DRAIN (CHOICE OF 3 POSITIONS)
(2 NORMALLY PLUGGED)

NOTE: ENSURE ON INSTALLATION THAT DRAIN IS TAKEN FROM ABOVE MOTOR CENTRELINE.

DO NOT EXCEED 12 DEPTH OF COUPLING IN TO DRAIN PORT.

REVERSE PORT CONNECTIONS FOR OPPOSITE DIRECTION OF SHAFT ROTATION
FLOW DIRECTION FOR ALL VLV HSG VARIANTS

SEE C-SPACERS

7 HOLES #60, EQUALLY SPACED AS SHOWN ON A BORE POD SPOTFACE TO BE EFFECTIVE #40
3-5 HPC325

- 'P1', 'S3' & 'Z4' Shafts

**SPLINE DATA**

'S'
- TO BS 3550 (ANSI B92.1, CLASS 5)
- FLAT ROOT SIDE FIT, CLASS 1
- PRESSURE ANGLE 30°
- NUMBER OF TEETH 20
- PITCH 6/12
- MAJOR DIAMETER 87.953/87.825
- FORM DIAMETER 80.264
- MINOR DIAMETER 79.485/78.925
- PIN DIAMETER 8.128
- DIAMETER OVER PINS 97.084/97.030

'Z'
- DIN 5480 W90 x 4 x 21 x 7h
3-5 HPC325 (cont)

'T' Shaft

- Key supplied: 25.45/25.40 wide, 17.539/17.463 thick
- M30 x 60 LG hex head screw
- Basic taper, on diameter: 0.1001/0.0999 per mm
3-5 HPC325 (cont)

'F4' & 'FM4' Valve Housings
3-5 HPC325 (cont)

'C', 'CS' & 'X' C Spacers

DISPLACEMENT SELECTION (VA REMOTELY LOCATED VALVE)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR; SPECIFY & ORDER SEPARATELY

CONNECTION TO P PORT
G1/4" (BSPP) X 15 FULL THREAD DEPTH; SUPPLIED PLUGGED

DISPLACEMENT SELECTION:
HIGH DISPLACEMENT: P TO B; A TO T
LOW DISPLACEMENT: P TO A; B TO T

4 HOLES M5 X 12 DEEP
4.0 X 6 DEEP HOLE FOR ORIENTATION PIN

538.0
**3-5 HPC325** (cont)

**Installation**

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3/4"-16UNF-2B DRAIN (CHOICE OF 3 POSITIONS)
(2 NORMALLY PLUGGED)

**NOTE:** ENSURE ON INSTALLATION THAT DRAIN IS
TAKEN FROM ABOVE MOTOR CENTRELINE.
DO NOT EXCEED 12 DEPTH OF COUPLING IN TO DRAIN PORT

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REVERSE PORT CONNECTIONS
FOR OPPOSITE DIRECTION OF
SHAFT ROTATION

FLOW DIRECTION FOR
ALL VLV HSG WARRANTS

SEE C-SPACERS

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MOUNTING FACE

CLOCKWISE DIRECTION
OF ROTATION
3-12 Speed Sensing Options

Tj speed sensor with Tk readout option

Tj Speed Sensor Technical Specification

The Tj speed sensor is a hall effect dual channel speed probe that can provide feedback of both speed and direction.

- Signal Outputs: Square wave plus directional signal
- Power Supply: 8 to 32 V @ 40 mA
- Protection class: IP68
- Output frequency: 16 pulses/revolution

Installation Details

TO SUIT: F3/FM3/SO3

Tj

TO SUIT: F4/FM4/SO4

Tk Output Module

The Tk option consists of the Tj speed sensor together with the optional T401 output module.

The addition of the T401 module provides a software configured single channel tachometer and relay with a 0/4-20 mA analogue current output.

The software and calibration cable is also provided.
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confirmed in the contract.

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