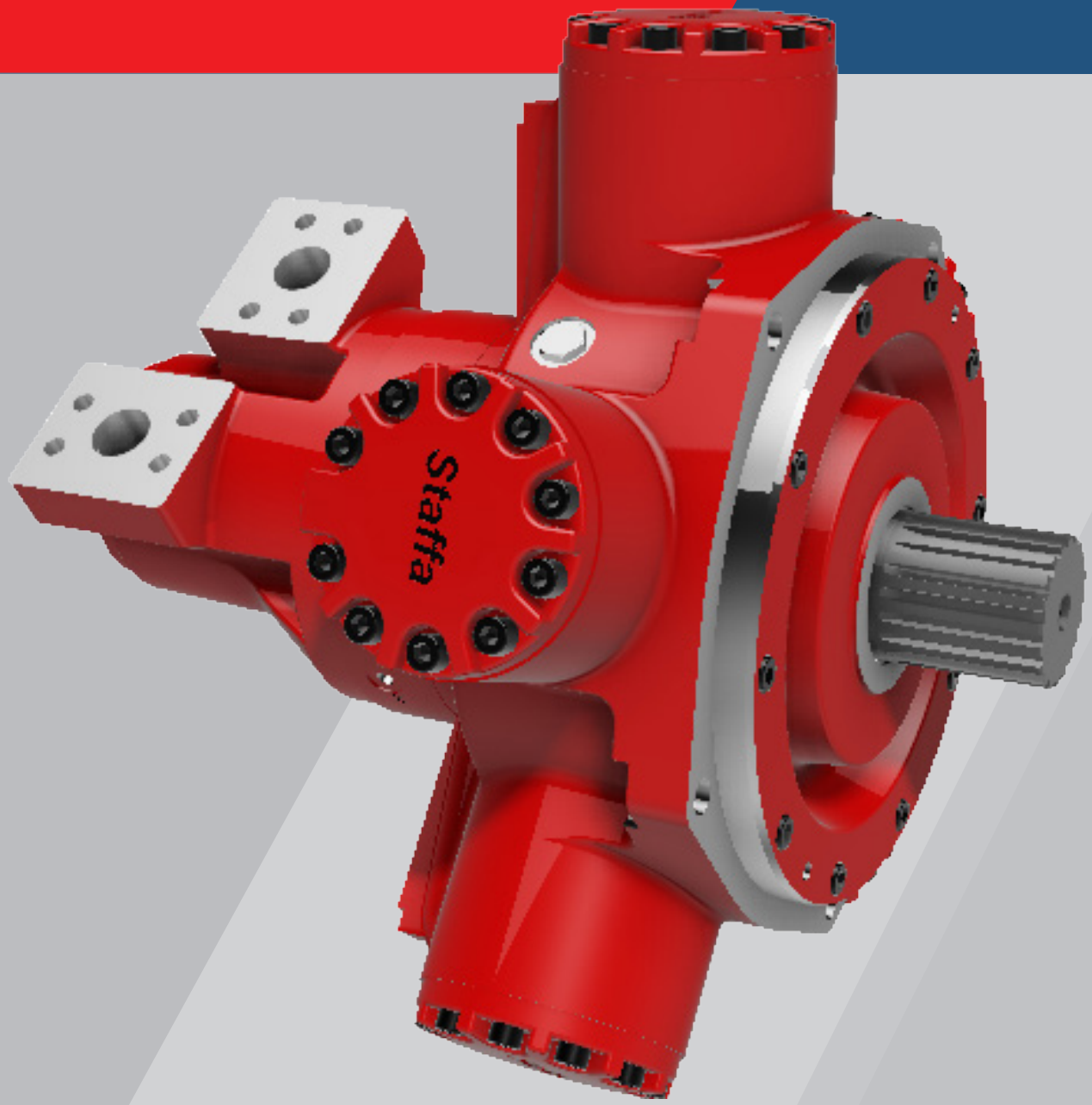
Kawasaki
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Precision Machinery Company

# Three-Speed Radial Piston Staffa Motor

# HMF Series



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# HMF Series

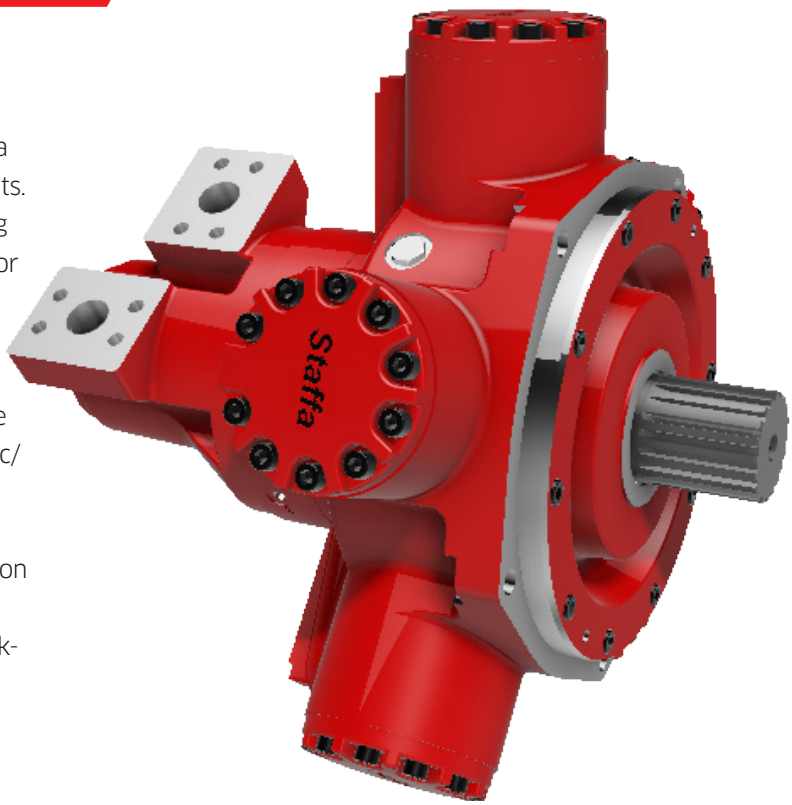
## Three-Speed Staffa Motor

### ■ General Descriptions

The HMF series three-speed models have three pre-set displacements which can be chosen from a wide range to suit specific application requirements. The displacements are hydraulically selected using remotely mounted directional control valves. Motor displacement can be changed with ease while the motor is running.

The range of three speed motors extends from the HMF100 in 1,600cc/rev to the HMF325 in 5,326cc/rev.

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




### ■ Features

- **3 displacement modes**
- **Freewheel options available**
- **High torque at low speed**
- **Smooth running**
- **Wide range of displacements to suit specific applications**
- **Displacement changes with ease when the motor is running**
- **Speed sensing options**

| | Displacement (cc/rev) | Ideal Specific Torque (N m/bar) | Mechanical Efficiency (%) | Operating Pressure (bar) | Peak Pressure (bar) | Power Rating (kW) | Speed Rating (rpm) | Freewheel Speed (rpm) |
|---|---|---|---|---|---|---|---|---|
| HMF100 | 1,600 | 25.5 | 93.9 | 300 | 405 | 165 | 600 | 1500 |
| HMF200 | 3,087 | 49.1 | 94.8 | 300 | 405 | 195 | 600 | 1500 |
| HMF270 | 4,588 | 73.0 | 95.0 | 300 | 405 | 213 | 600 | 1500 |
| HMF325 | 5,326 | 84.8 | 94.8 | 300 | 405 | 213 | 600 | 1500 |

**For detailed performance figures see Section 2-1*

# 1 Ordering Code

## 1-1 Model Coding

F11/HMF270 / S3 V/280/140/00/FM4/X/Tj/**/P*****

### Fluid Type

| (refer to Section 2-1 for performance data) | |
|---|---|
| Blank | Mineral oil |
| F3 | Phosphate ester (HFD fluid) |
| F11 | Water based fluids (HFA, HFB & HFC) |
| Alternative fluids contact Kawasaki | |

### Model Type

| | |
|---|---|
| HM | Standard |
| HMHD | Heavy duty |

### Motor Frame Size

| | |
|---|---|
| F100 | F270 |
| F200 | F325 |

### Shaft Type

| See shaft type option list on Section 1-2 |
|---|

### Shaft Orientation

| | |
|---|---|
| Blank | Standard orientation |
| V | Vertically Up (extra drain) |

### High Displacement Code

| | |
|---|---|
| ### | See displacement code details on Section 2-1 |

### Medium Displacement Code

| | |
|---|---|
| ### | See displacement code details on Section 2-1 |

### Low Displacement Code

| | |
|---|---|
| ### | See displacement code details on Section 2-1 |

### Main Port Connections

| | |
|---|---|
| ### | See port connection details on Section 1-3 |

### Displacement Control Ports

| Threaded ports | |
|---|---|
| X | X, Y and Z ports G 1/4" (BSPF to ISO 228/1) |

### 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. |

### Design Series Number

| | |
|---|---|
| ** | Current series for HMF motors |

### Special Features

| | |
|---|---|
| P***** | Special features (see options in Section 2-13) |
| PL*** | Non-catalogued features, (***) = number assigned by Kawasaki as required. |

# 1-1 Model Coding

## Special Features Suffix

/ P * * * * *

### Shaft Seal Enhancements

| | |
|---|---|
| A | High pressure shaft seal |
| B | Improved shaft seal life |
| C | High pressure shaft seal & improved shaft seal life |
| 0 | None |

See Section 2-12 for details

### External Protection

| | |
|---|---|
| B | Marine-specification primer paint |
| D | Unpainted |
| E | Marine Specification Cylinder Heads |
| F | Marine spec Cylinder Heads + Marine specification paint HP20 |
| G | Marine spec Cylinder Heads + Carboline grey paint |
| 0 | None |

See Section 2-12 for details

### Installation Features

| | |
|---|---|
| A | Drain port adaptor x 1 |
| B | Drain port adaptor x 2 |
| C | Φ21 mm mounting holes |
| D | Φ22 mm mounting holes |
| E | Φ21 mm mounting holes & Drain port adaptor x 1 |
| F | Φ21 mm mounting holes & Drain port adaptor x 2 |
| G | Φ22 mm mounting holes & Drain port adaptor x 1 |
| H | Φ22 mm mounting holes & Drain port adaptor x 2 |
| 0 | None |

See Section 2-11 for details

### Performance Enhancements

| | |
|---|---|
| A | Increased starting torque |
| 0 | None |

See Section 2-12 for details

### Valve Enhancements

| | |
|---|---|
| A | Improved cavitation resistance |
| B | Anti-clockwise |
| C | Thermal shock resistance |
| D | Improved caviation resistance & anti-clockwise |
| E | Improved cavitation resistance & thermal shock resistance |
| F | Anti-clockwise & thermal shock resistance |
| G | Improved cavitation resistance & anti-clockwise & thermal shock resistance |
| 0 | None |

See Section 2-12 for details

# 1-2 Shaft Options

## Product type

### HMF100

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

### HMF200

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

### HMHDF200

| | | |
|---|---|---|
| P2 | = | Parallel keyed 100mm diameter shaft |
| S5 | = | Splined shaft 23 teeth BS3550 |
| Z5 | = | Splined shaft DIN5480 (W100x4x24x7h) |

### HMF270

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

### HMHDF270

| | | |
|---|---|---|
| P2 | = | Parallel keyed 100mm diameter shaft |
| S5 | = | Splined shaft 23 teeth BS3550 |
| Z | = | Splined shaft DIN5480 (W100x4x24x7h) |

### HMF325

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

### HMHDF325

| | | |
|---|---|---|
| P2 | = | Parallel keyed 100mm diameter shaft |
| S5 | = | Splined shaft 23 teeth BS3550 |
| Z | = | Splined shaft DIN5480 (W100x4x24x7h) |

**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

### HMF100

| | | |
|---|---|---|
| SM3 | = | 1¼" symmetrical ports with through-holes for manifold connection |
| F3 | = | 1¼" SAE code 62 4-bolt flange |
| FM3 | = | 1 ¼" SAE code 62 4-bolt flange |
| F4 | = | 1½ SAE code 62 4-bolt UNC flange |
| FM4 | = | 1½" SAE code 62 4-bolt metric flange |

### HM(HD)F200

| | | |
|---|---|---|
| SM3 | = | 1¼" symmetrical ports with through-holes for manifold connection |
| F3 | = | 1¼" SAE code 61 4-bolt UNC flange |
| FM3 | = | 1¼" SAE code 61 4-bolt metric flange |
| F4 | = | 1½" SAE code 62 4-bolt UNC flange |
| FM4 | = | 1½" SAE code 62 4-bolt metric flange |

### HM(HD)F270

| | | |
|---|---|---|
| F4 | = | 1½" SAE code 62 4-bolt UNC flange |
| FM4 | = | 1½" SAE code 62 4-bolt metric flange |

### HM(HD)F325

| | | |
|---|---|---|
| F4 | = | 1½" SAE code 62 4-bolt UNC flange |
| FM4 | = | 1½" SAE code 62 4-bolt metric flange |

See Section 3 for full dimensional details

# 2 Technical Information

## 2-1 Performance Data

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

The appropriate motor displacements can be selected using performance data shown in Section 2-1. Refer to the table on this page for pressures and speed limits when using fire-resistant fluids.

### Limits for fire-resistant fluids

| Fluid Type | Continuous Pressure (bar) | Intermittent Pressure (bar) | Max Speed (rpm) | Model Type |
|---|---|---|---|---|
| HFA 5/95 oil-in-water emulsion | 103 | 138 | 50% of limits of mineral oil | All models |
| HFB 60/40 water-in-oil emulsion | 138 | 172 | As for mineral oil | All models |
| HFC water glycol | 103 | 138 | 50% of limits of mineral oil | All models |
| HFD phosphate ester | 250 | 275 | As for mineral oil | All models |

Specify make and type of fluid on your order if other than mineral oil.

### Rating definitions

#### Continuous rating

The motor must be operated within each of the maximum values for speed, pressure and power.

#### Intermittent pressure rating

Intermittent max pressure: 300bar.

This pressure is allowable on the following basis:

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

#### Static Pressure

Static pressure to DNV rules 405bar (DNV-GL-RU-Ship Part 4.).

#### Intermittent power rating

This is permitted on a 15% duty basis for periods up to 5 minutes maximum.

# 2-1 Performance Data (cont)

## Available displacements

When selecting displacement modes on the HMF motors, there is an important rule that must be followed: due to physical constraints there is a minimum achievable difference between the medium and low displacement modes which varies across the frame sizes as shown in the table below:

| Motor Type | Minimum allowable difference between medium and low displacements | |
|---|---|---|
| | cc/rev | $in^3$/rev |
| HMF100 | 655 | 40 |
| HMF200 | 1,230 | 75 |
| HMF270 | 1,720 | 105 |
| HMF325 | 1,720 | 105 |

Minimum allowable medium displacement = low displacement + table value

**Examples:**

For HMF270 with 280 $in^3$/rev. (4,588 cc/rev.) maximum displacement and 00 $in^3$/rev. minimum displacement, the medium displacement must be above 105 $in^3$/rev. (1,720 cc/rev).

Minimum allowable medium displacement = 0 + 105 = 105 $in^3$/rev (1,720 cc/rev)

For HMF200 with 188 $in^3$/rev. (3,087 cc/rev.) maximum displacement and 40 $in^3$/rev. (655 cc/rev.) minimum displacement, the medium displacement must be above 115 $in^3$/rev. (1,885 cc/rev).

Minimum allowable medium displacement = 40 + 75 = 115 $in^3$/rev (1,885 cc/rev)

# 2-1 Performance Data (cont)

## HMF100 Motor (see section 2-13 for power calculation limits)

| Displacement Code | | 97.6 | 90 | 85 | 80 | 75 | 70 | 65 | 60 | 55 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | cc/rev | 1,600 | 1,475 | 1,393 | 1,311 | 1,229 | 1,147 | 1,065 | 983 | 901 | 819 |
| Average actual running torque | Nm/bar | 23.90 | 22.00 | 20.75 | 19.50 | 18.25 | 17.02 | 15.78 | 14.55 | 13.20 | 12.00 |
| Average actual mechanical efficiency | % | 93.9 | 93.7 | 93.6 | 93.5 | 93.3 | 93.2 | 93.1 | 93.0 | 92.6 | 92.1 |
| Average actual starting efficiency | % | 87.1 | 86.0 | 85.2 | 84.3 | 83.3 | 82.1 | 80.8 | 79.2 | 77.4 | 75.1 |
| Max continuous speed (SM3/F3/FM3) | rpm | 270 | 300 | 320 | 340 | 365 | 390 | 420 | 450 | 475 | 500 |
| Max continuous speed (F4/FM4) | rpm | 365 | 400 | 415 | 430 | 445 | 460 | 475 | 490 | 500 | 515 |
| Max continuous power | kW | 138 | 138 | 134 | 129 | 127 | 123 | 118 | 115 | 110 | 105 |
| Max intermittent power | kW | 170 | 170 | 165 | 159 | 156 | 151 | 145 | 142 | 135 | 129 |
| Max continuous pressure | bar | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| Max intermittent pressure | bar | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 |

| Displacement Code | | 45 | 40 | 35 | 30 | 25 | 20 | 15 | 10 | 5 | 00 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | cc/rev | 737 | 655 | 574 | 492 | 410 | 328 | 246 | 164 | 82 | 0 | 0 |
| Average actual running torque | Nm/bar | 10.60 | 9.24 | 7.87 | 6.48 | 5.31 | 3.93 | 2.56 | 1.57 | 0 | 0 | 0 |
| Average actual mechanical efficiency | % | 90.4 | 88.6 | 86.1 | 82.8 | 81.4 | 75.3 | 65.4 | 60.2 | 0 | 0 | 0 |
| Average actual starting efficiency | % | 72.4 | 69.0 | 64.4 | 58.6 | 50.3 | 38.0 | 17.5 | / | / | / | / |
| Max continuous speed (SM3/F3/FM3) | rpm | 550 | 600 | 615 | 630 | 630 | 630 | 630 | 630 | 1,000 | 1,000 | 1,500** |
| Max continuous speed (F4/FM4) | rpm | 530 | 545 | 560 | 575 | 585 | 600 | 615 | 630 | 1,000 | 1,000 | 1,500** |
| Max continuous power | kW | 99 | 92 | 79 | 64 | 52 | 38 | 26 | 12 | 0 | 0 | 0 |
| Max intermittent power | kW | 122 | 113 | 97 | 79 | 64 | 47 | 32 | 15 | 0 | 0 | 0 |
| Max continuous pressure | bar | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 17* | 17* | 17* |
| Max intermittent pressure | bar | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 17* | 17* | 17* |

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

**See Section 2-8: small displacements.*

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

# 2-1 Performance Data (cont)

## HMF200 Motor (see section 2-13 for power calculation limits)

| Displacement Code | | 188 | 180 | 170 | 160 | 150 | 140 | 130 | 120 | 110 | 100 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | cc/rev | 3,087 | 2,950 | 2,790 | 2,620 | 2,460 | 2,290 | 2,130 | 1,970 | 1,800 | 1,639 | 1,475 |
| Average actual running torque | Nm/bar | 46.6 | 44.0 | 41.7 | 39.1 | 36.6 | 34.0 | 31.3 | 28.7 | 26.3 | 23.6 | 21.0 |
| Average actual mechanical efficiency | % | 94.8 | 93.7 | 93.9 | 93.8 | 93.5 | 93.3 | 92.3 | 91.5 | 91.8 | 90.5 | 89.5 |
| Average actual starting efficiency | % | 85.4 | 84.9 | 83.9 | 83.1 | 81.8 | 80.7 | 79.1 | 77.2 | 75.4 | 72.8 | 69.8 |
| Max continuous speed (SM3/F3/FM3) | rpm | 175 | 180 | 190 | 195 | 200 | 205 | 210 | 225 | 240 | 270 | 300 |
| Max continuous speed (F4/FM4) | rpm | 230 | 235 | 240 | 245 | 250 | 265 | 285 | 310 | 340 | 365 | 400 |
| Max continuous power | kW | 174 | 174 | 174 | 165 | 156 | 148 | 139 | 131 | 122 | 114 | 105 |
| Max intermittent power | kW | 195 | 195 | 195 | 185 | 175 | 166 | 156 | 147 | 137 | 128 | 118 |
| Max continuous pressure | bar | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| Max intermittent pressure | bar | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 275 |

| Displacement Code | | 80 | 70 | 60 | 50 | 40 | 30 | 20 | 10 | 5 | 00 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | cc/rev | 1,311 | 1,150 | 983 | 820 | 655 | 492 | 328 | 164 | 82 | 0 | 0 |
| Average actual running torque | Nm/bar | 18.3 | 15.7 | 12.8 | 10.6 | 8.1 | 5.9 | 3.8 | 0.6 | 0 | 0 | 0 |
| Average actual mechanical efficiency | % | 87.7 | 85.8 | 81.8 | 81.2 | 77.7 | 75.3 | 72.8 | 23.0 | 0 | 0 | 0 |
| Average actual starting efficiency | % | 66.1 | 61.1 | 54.8 | 45.7 | 32.1 | / | / | / | / | / | / |
| Max continuous speed (SM3/F3/FM3) | rpm | 340 | 390 | 450 | 500 | 600 | 630 | 630 | 630 | 1,000 | 1,000 | 1,500** |
| Max continuous speed (F4/FM4) | rpm | 430 | 460 | 485 | 515 | 545 | 575 | 600 | 630 | 1,000 | 1,000 | 1,500** |
| Max continuous power | kW | 98 | 88 | 81 | 72 | 62 | 48 | 25 | 5 | 0 | 0 | 0 |
| Max intermittent power | kW | 110 | 99 | 91 | 81 | 70 | 54 | 33 | 6 | 0 | 0 | 0 |
| Max continuous pressure | bar | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 17* | 17* | 17* |
| Max intermittent pressure | bar | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 17* | 17* | 17* |

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

**See Section 2-8: small displacements.*

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

# 2-1 Performance Data (cont)

## HMF270 Motor (see section 2-13 for power calculation limits)

| Displacement Code | | 280 | 250 | 220 | 200 | 180 | 160 | 140 | 120 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | cc/rev | 4,588 | 4,097 | 3,605 | 3,277 | 2,950 | 2,622 | 2,294 | 1,966 | 1,639 |
| Average actual running torque | Nm/bar | 69.4 | 61.9 | 53.9 | 49.0 | 43.6 | 38.3 | 33.2 | 27.9 | 22.4 |
| Average actual mechanical efficiency | % | 95.0 | 94.9 | 93.9 | 94.0 | 92.9 | 91.8 | 90.9 | 89.2 | 85.9 |
| Average actual starting efficiency | % | 84.7 | 83.8 | 82.7 | 81.8 | 80.6 | 79.2 | 77.3 | 74.9 | 71.5 |
| Max continuous speed | rpm | 150 | 160 | 170 | 175 | 210 | 230 | 275 | 310 | 375 |
| Max continuous power | kW | 189 | 176 | 161 | 150 | 139 | 128 | 116 | 104 | 89 |
| Max intermittent power | kW | 213 | 198 | 181 | 169 | 156 | 144 | 132 | 120 | 107 |
| Max continuous pressure | bar | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| Max intermittent pressure | bar | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 |

| Displacement Code | | 80 | 60 | 40 | 30 | 20 | 10 | 00 | 00 |
|---|---|---|---|---|---|---|---|---|---|
| Displacement | cc/rev | 1,311 | 983 | 655 | 492 | 328 | 164 | 0 | 0 |
| Average actual running torque | Nm/bar | 17.1 | 12.2 | 7.9 | 5.2 | 2.4 | 0 | 0 | 0 |
| Average actual mechanical efficiency | % | 82.0 | 78.0 | 75.8 | 65.8 | 46.0 | 0 | 0 | 0 |
| Average actual starting efficiency | % | 66.3 | 57.8 | 40.7 | 23.5 | / | / | / | / |
| Max continuous speed | rpm | 430 | 460 | 490 | 515 | 545 | 1,000 | 1,000 | 1,500** |
| Max continuous power | kW | 73 | 57 | 38 | 26 | 14 | 0 | 0 | 0 |
| Max intermittent power | kW | 95 | 80 | 55 | 38 | 20 | 0 | 0 | 0 |
| Max continuous pressure | bar | 250 | 250 | 250 | 250 | 250 | 17* | 17* | 17* |
| Max intermittent pressure | bar | 300 | 300 | 300 | 300 | 300 | 17* | 17* | 17* |

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

**See Section 2-8: small displacements.*

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

# 2-1 Performance Data (cont)

## HMF325 Motor (see section 2-13 for power calculation limits)

| Displacement Code | | 325 | 310 | 300 | 280 | 250 | 220 | 200 | 180 | 160 | 140 | 120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | cc/rev | 5,326 | 5,080 | 4,916 | 4,588 | 4,097 | 3,605 | 3,277 | 2,950 | 2,622 | 2,294 | 1,966 |
| Average actual running torque | Nm/bar | 80.4 | 76.6 | 74.1 | 69.1 | 61.6 | 53.9 | 49.0 | 43.6 | 38.3 | 33.2 | 27.9 |
| Average actual mechanical efficiency | % | 94.8 | 94.7 | 94.7 | 94.6 | 94.5 | 93.9 | 94.0 | 92.9 | 91.8 | 90.9 | 89.2 |
| Average actual starting efficiency | % | 85.7 | 85.4 | 85.2 | 84.7 | 83.8 | 82.7 | 81.8 | 80.6 | 79.2 | 77.3 | 74.9 |
| Max continuous speed | rpm | 130 | 135 | 140 | 150 | 160 | 170 | 190 | 215 | 230 | 275 | 330 |
| Max continuous power | kW | 189 | 189 | 189 | 189 | 176 | 161 | 150 | 139 | 128 | 116 | 104 |
| Max intermittent power | kW | 213 | 213 | 213 | 213 | 198 | 181 | 169 | 156 | 144 | 132 | 120 |
| Max continuous pressure | bar | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| Max intermittent pressure | bar | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 |

| Displacement Code | | 100 | 95 | 80 | 60 | 40 | 30 | 20 | 10 | 00 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | cc/rev | 1,639 | 1,557 | 1,311 | 983 | 655 | 492 | 328 | 164 | 0 | 0 |
| Average actual running torque | Nm/bar | 22.4 | 20.9 | 17.1 | 12.2 | 7.9 | 5.2 | 2.4 | 0 | 0 | 0 |
| Average actual mechanical efficiency | % | 85.9 | 84.3 | 82.0 | 78.0 | 75.8 | 65.8 | 46.0 | 0 | 0 | 0 |
| Average actual starting efficiency | % | 71.5 | 70.4 | 66.3 | 57.8 | 40.7 | 23.5 | / | / | / | / |
| Max continuous speed | rpm | 370 | 405 | 440 | 460 | 495 | 515 | 545 | 1,000 | 1,000 | 1,500** |
| Max continuous power | kW | 89 | 85 | 73 | 57 | 38 | 26 | 14 | 0 | 0 | 0 |
| Max intermittent power | kW | 107 | 101 | 95 | 80 | 55 | 38 | 20 | 0 | 0 | 0 |
| Max continuous pressure | bar | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 17* | 17* | 17* |
| Max intermittent pressure | bar | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 17* | 17* | 17* |

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

**See Section 2-8: small displacements.*

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

# 2-2 Volumetric Effciency Data

| Motor Type | Geometric Displacement | Zero Speed Constant | Speed Constant | Creep Speed Constant | Crankcase Leakage Constant |
|---|---|---|---|---|---|
| HMF | cc/rev | $K_1$ | $K_2$ | $K_3$ | $K_4$ |
| HMF100 | 1,600 | 9.50 | 45.70 | 5.80 | 7.90 |
| HMF200 | 3,080 | 6.10 | 38.50 | 2.00 | 4.25 |
| HMF270 | 4,310 | 6.50 | 37.30 | 1.50 | 6.00 |
| HMF325 | 5,310 | 6.80 | 40.00 | 1.30 | 6.00 |

| Fluid Viscosity | Viscosity Factor |
|---|---|
| cSt | Kv |
| 20 | 1.58 |
| 25 | 1.44 |
| 30 | 1.30 |
| 40 | 1.10 |
| 50 | 1.00 |
| 60 | 0.88 |

**Qt (total leakage)** = $[K_1 + n/K_2] \times \Delta P \times K_V \times 0.005$ l/min

**Creep speed** = $K_3 \times \Delta P \times K_V \times 0.005$ rpm

**Crankcase leakage** = $K_4 \times \Delta P \times K_V \times 0.005$ l/min

**ΔP** = 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:**

HMF200 motor with displacement of 3.087 l/rev.

**Speed** 60 rpm

**Differential pressure** 200 bar

**Fluid viscosity** 50 cSt

**Total leakage** = $(K_1 + n/K_2) \times \Delta P \times K_V \times 0.005$ l/min

= $(6.1+60/38.5) \times 200 \times 1 \times 0.005$

= 7.7 l/min

**Volume efficiency**

$$= \left[\frac{(60 \times 3.087)}{(60 \times 3.087) + 7.7}\right] \times 100$$

= 96%

# 2-3 Displacement Change Sequence

## Displacement Sequence Rule

Due to the physical construction of the HMF motor series, all HMF motors must adhere to the following rule when changing the displacement mode of the motor. Failure to do so could result in damage to the motor and the invalidating of the warranty.

**RULE: HMF series motors can only be moved to low or medium displacement modes from a starting position of high displacement mode.**

The control system governing the displacement change mechanism must not allow the machine operator to contravene this rule.

## Displacement Sequence Description

For most applications the HMF motor will start up in the high displacement mode. As with HMC and HPC motors, this is achieved by supplying pilot pressure to the 'Y' port only.

To change to the low displacement mode, pilot pressure is switched to the 'X' port only. As such, switching between the high and low displacement modes of an HMF series motor is the same as for an HMC or HPC series motor.

In order to select the medium displacement mode, the motor must first be returned to the high displacement mode, as stated by the rule above. Then, with pilot pressure maintained on the 'Y' port, pilot pressure is applied to the 'Z' port. After a short delay (see timing chart below) the pilot pressure is switched from the 'Y' port to the 'X' port to leave pilot pressure being supplied to both 'X' and 'Z' ports. The motor is now in medium displacement mode. When the medium displacement mode has been fully engaged, the pilot pressure to the 'Z' port may be switched off or maintained without any effect on the motor's displacement mode.

To return to the high displacement mode, from either medium or low displacement mode, pilot pressure is applied to the 'Y' port only.

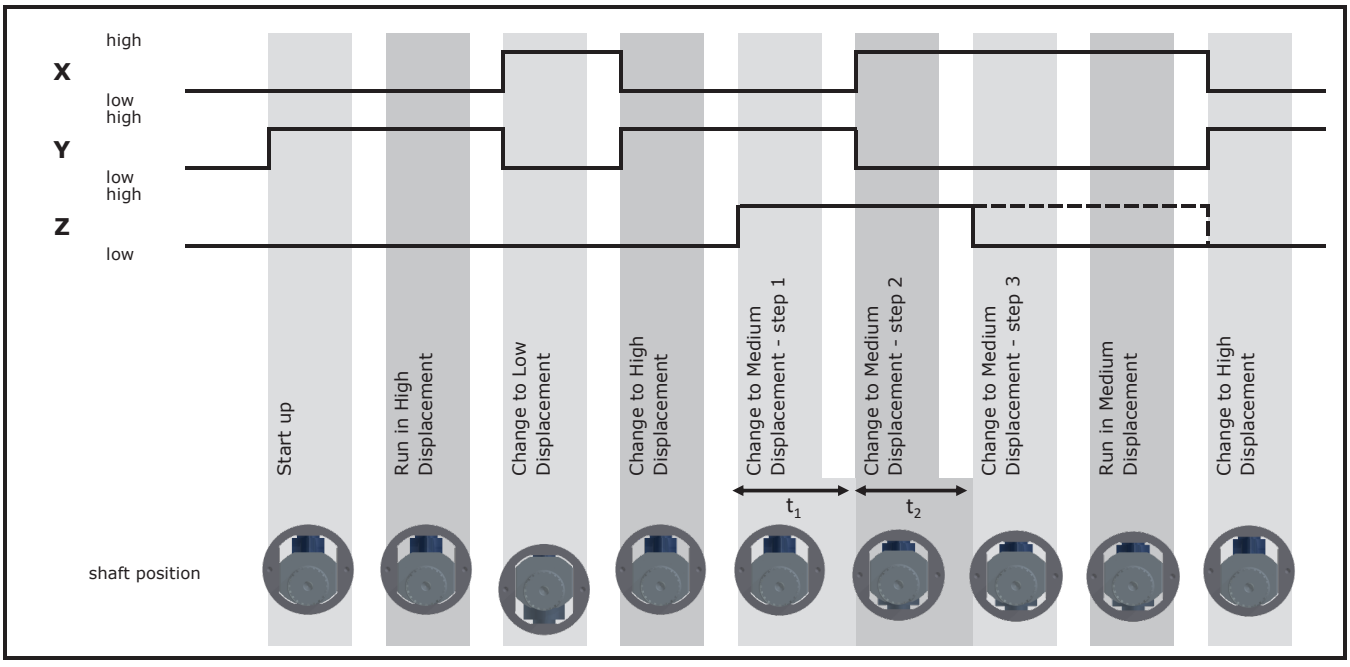
There now follow three representations of the same displacement change sequence just described: high to low, back to high, then to medium, and, finally, back to high. Firstly, a table showing the sequence in which the 'X', 'Y' and 'Z' ports are pressurised at each stage. Secondly, a timing chart showing when the pilot pressure can be switched between 'X', 'Y' and 'Z' ports. And thirdly, a schematic showing a possible control circuit with a valve firing chart.

# 2-3 Displacement Change Sequence (cont)

## Displacement Sequence Control Table

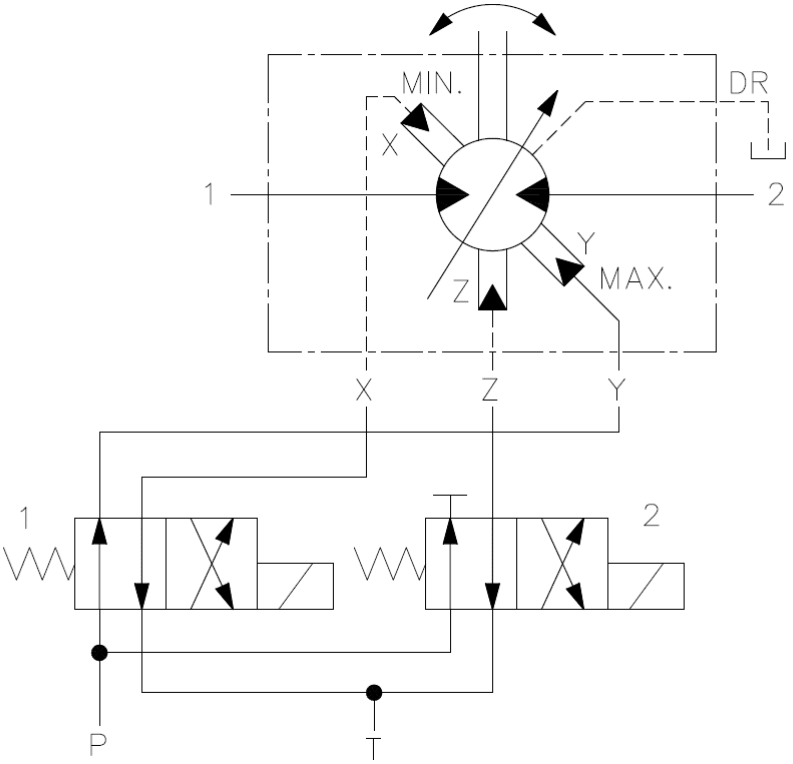
| Sequence | Pressure to | Displacement |
|---|---|---|
| 1 | Y | High |
| 2 | X | Low |
| 3 | Y | High |
| 4 | Y&Z | High |
| 5 | X&Z | Medium |
| 6 | X | Medium |
| 7 | Y | High |

## Displacement Sequence Control Timing



# 2-3 Displacement Change Sequence (cont)

## Displacement Sequence Control Schematic




| Displacement | Valve 1 Solenoid | Valve 2 Solenoid |
|---|---|---|
| High | OFF | OFF |
| Low | ON | OFF |
| High | OFF | OFF |
| Medium | OFF<br>ON<br>ON | ON<br>ON<br>(OFF) |
| High | OFF | OFF |

# 2-4 Shaft Power Calculation

## Example:

**Firstly, to find the maximum differential pressure ΔP at rated speed:**

Select the rated shaft power (W) for the motor from the performance data table (see Section 2-1). 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 ΔP then use:

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

**HMF270 Example** - with a displacement code of 280:

| | |
|---|---|
| Rated shaft power (W): | 189,000 |
| Average actual running torque (Nm/bar): | 69.4 |
| Rated shaft speed (rpm): | 150 |

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

**ΔP = 174 bar (max.)**

**Secondly, to find the maximum speed at rated pressure:(using the same information as before):**

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

Rated pressure (bar): 250

$$n = \frac{60 \times 189{,}000}{2\pi \times 69.4 \times 250}$$

**n = 104 rpm (max.)**

In summary, operating the motor within its shaft power limit, at rated speed, would give a maximum pressure of 174 bar, and operating the motor at rated pressure, would give a maximum speed of 104rpm.

**NOTES:**

**1)** The maximum calculated speed is based on a rated inlet pressure of 250bar.

**2)** The maximum shaft power is only allowable if the motor drain temperature remains below 80°C.

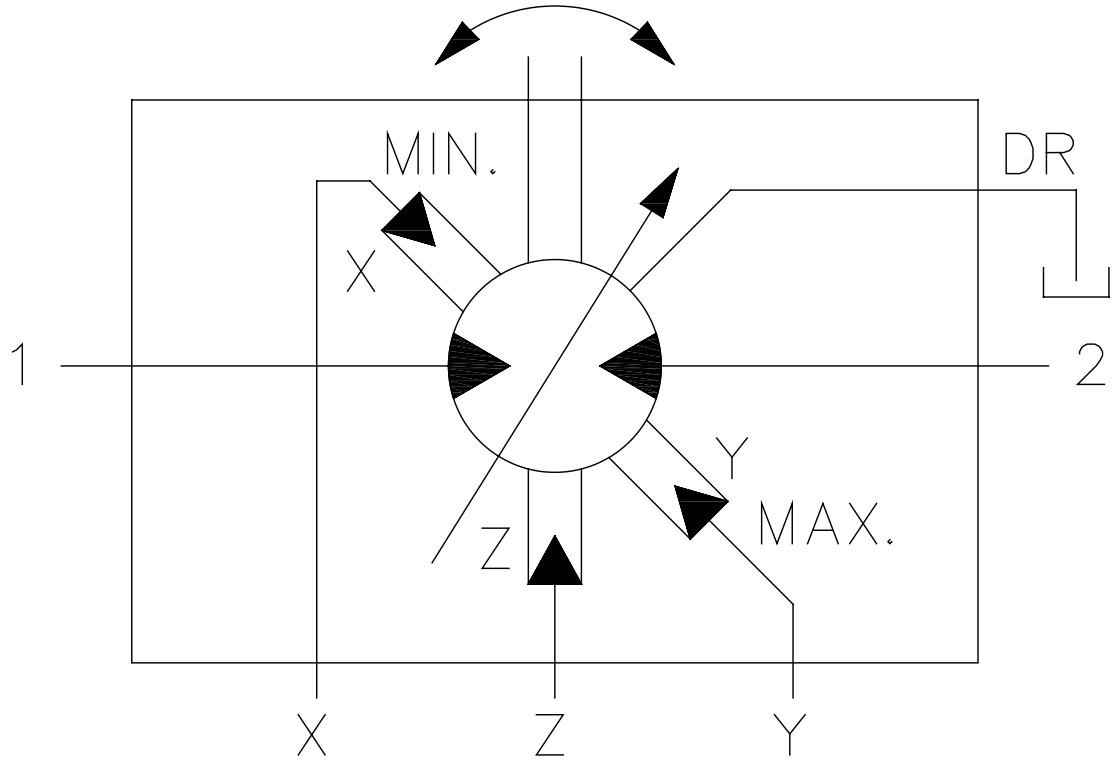
**3)** The maximum calculated differential pressure assumes that the low pressure motor port is less than 30bar.

# 2-5 Functional Symbols

## Example model code:

**HMF***/P/***/**/**/FM3/X/...**

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



# 2-6 Stress Limits

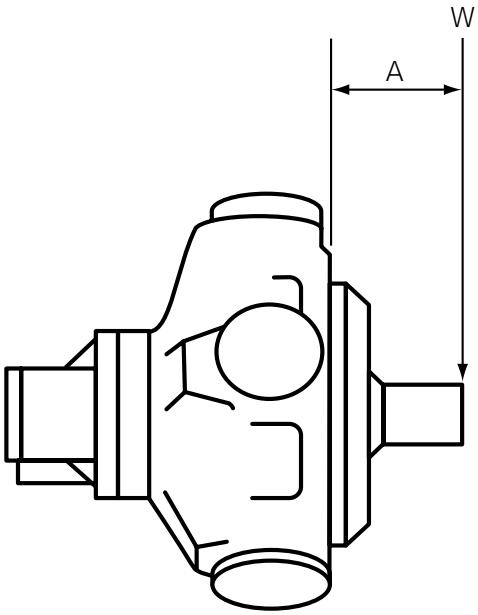
When applying large external radial loads, consideration should also be given to motor bearing lives (see Section 2-7).

| Motor Frame Size | Maximum External Radial Bending Moment [kNm] |
|---|---|
| HMF100 | 4,500 |
| HMF200 | 6,750 |
| HMHDF200 | 12,750 |
| HMF270/ HMF325 | 8,250 |
| HMHDF270/ HMHDF325 | 15,900 |

**Example:**

Determine the maximum radial shaft load of a HMF motor:

Radial load offset, A = 100mm
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 50mm. Contact Kawasaki if this is not the case.

# 2-7 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**

# 2-8 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 3.5bar, a minimum control pressure of 3.5bar is required. In the event of loss of control pressure the motor will shift to its highest displacement.

## Starting torque

Refer to performance data, (refer to Section 2.1).

## 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 3rpm, then consult Kawasaki.
If possible, always start the motor in high displacement.

## Small displacements

The pressures given in the table in Section 2 for displacement code “00” are based on 1,000rpm output shaft speed. This pressure can be increased for shaft speeds less than 1,000rpm; consult Kawasaki for details. Speeds greater than 1,000 rpm may be applied but only after the machine duty cycle has been considered in conjunction with Kawasaki. A zero swept volume displacement (for freewheeling requirements) is available on request, consult Kawasaki.

## High back pressure

When both inlet and outlet ports are pressurised continuously, the lower pressure port must not exceed **70bar** 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 boost formula:

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

N = motor speed (rpm), V = motor displacement (cc/rev), C=crankcase pressure (bar).

| Motor Frame Size | Porting | Constant (K) |
|---|---|---|
| HMF100 | SM3 | $1.6 \times 10^{16}$ |
| | F(M)3 | $1.6 \times 10^{10}$ |
| | F(M)4 | $3.3 \times 10^{10}$ |
| HM(HD)F200 | SM3 | $1.6 \times 10^{10}$ |
| | F(M)3 | $1.6 \times 10^{10}$ |
| | F(M)4 | $3.3 \times 10^{10}$ |
| HM(HD)F270 & HM(HD)F325 | F(M)4 | $4.0 \times 10^{10}$ |

# 2-8 Circuit and Application Notes (cont)

The flow rate of oil for the make-up system can be estimated from the crankcase leakage data (see Section 2-2) plus an allowance for changing displacement:

e.g.

| | |
|---|---|
| **HMF100** | To change high to low in 0.25 sec requires 32 l/min |
| **HM(HD)F200** | To change high to low in 0.5 sec requires 15 l/min |
| **HM(HD)F270** | To change high to low in 1 sec requires 24 l/min |
| **HM(HD)F325** | To change high to low in 1 sec requires 20 l/min |

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 3.5bar 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: 10bar continuous and 15bar intermittent.

**3)** Check installation dimensions (Section 3) for maximum crankcase drain fitting depth.

## Motorcase pressure

Dependent on motor (see model code fluid type - Section 1-1) 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 in Section 2-1.

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

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

# 2-8 Circuit and Application Notes (cont)

## Temperature limits

**Ambient min.** -30°C
**Ambient max.** +70°C

| Max. operating temperature range. | **Mineral oil** | **Water containing** |
|---|---|---|
| **Min** | -20°C | +10°C |
| **Max. *** | +80°C | +54°C |

* To obtain optimum services life from both fluid and hydraulic systems components, 65°C normally is the maximum temperature expected for water-containing fluids.

## Filtration

Full flow filtration (open circuit), or full boost flow filtration (close circuit) to ensure system cleanliness to ISO4406 code 22/18/13 or cleaner.

## Noise levels

The airborne noise level is less than 66.7dBA (DIN) 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 resonance originating from liquid borne noise can be further attenuated by providing a return line back pressure of 2 to 5bar.

## Polar moment of intertia and mass table

**Typical data**

| Motor Frame Size | Displacement code | Polar Moment of Intertia (kg m2) (Typical) | Mass (kg) (Approx. all models) |
|---|---|---|---|
| HMF100 | 90 | 0.0520 | 172 |
| | 45 | 0.0440 | |
| HMF200 | 188 | 0.2300 | 282 |
| | 75 | 0.1800 | |
| HMF270 | 280 | 0.4900 | 450 |
| | 100 | 0.4700 | |
| HMF325 | 325 | 0.5000 | 460 |
| | 100 | 0.4700 | |

## Mass

HMF100 Approx. all models 172kg.
HM(HD)F200 Approx. all models 282kg.
HM(HD)F270 Approx. all models 450kg.
HM(HD)F325 Approx. all models 460kg.

# 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 2,000cSt. The maximum fluid viscosity before load is applied to the motor shaft is 150cSt.

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.

| | Non-operating temperature limits | Minimum operating temperature |
|---|---|---|
| Standard pressure shaft seal | below minus 40°C and above 100°C | minus 30°C |
| High pressure shaft seal | below minus 30°C and above 120°C | minus 15°C |

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.

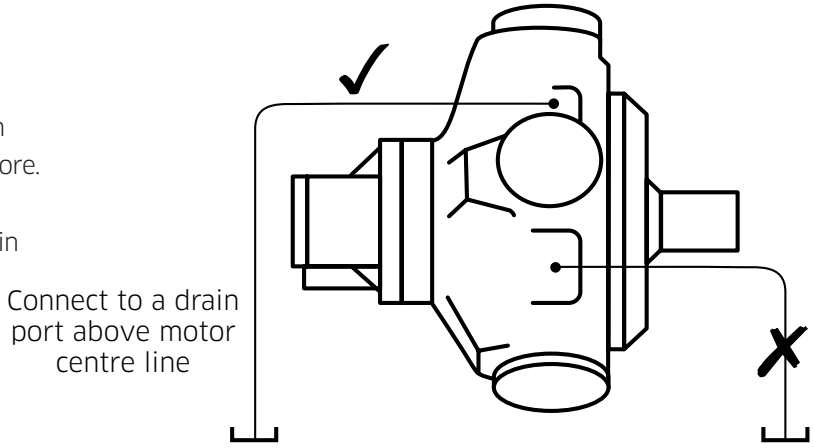
It should be noted that the maximum continuous operating temperature within the motor crankcase is plus 80°C.

It is recommended that the motor is operated by observing the rule for viscosity and the minimum operating temperature.

# 2-10 Crankcase Drain Connections

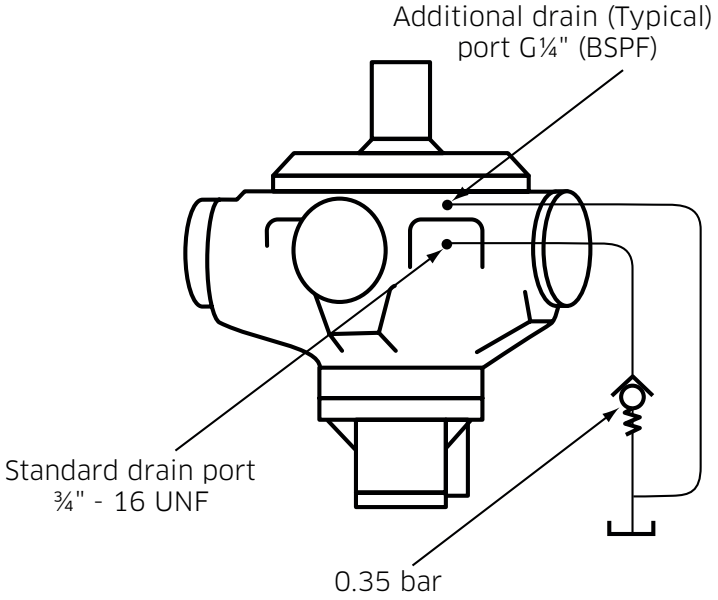
## Motor axis - horizontal

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



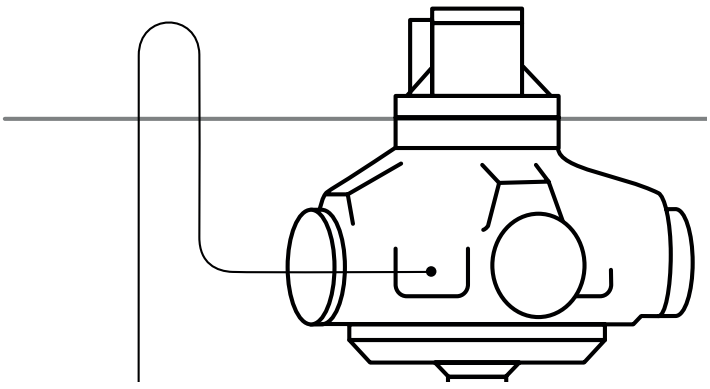

## Motor axis - vertical shaft up

Specify "V" within the model code for extra drain port, G¼" (BSPF). Connect this port into the main drain line downstream of a 0.35bar 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 in Section 2-4).

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" and "F" 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 Section 2-1).

## 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 3.5bar 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 in Section 2-8 Boost Pressure. The maximum motor and control pressure at 1,000rpm is 17bar 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 1,000rpm.

For speeds above this up to 1,500rpm 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 0.15mm. 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:

| | |
|---|---|
| **M12** | 97 +/- 7Nm |
| **M14** | 160 +/- 21Nm |
| **M18** | 312 +/- 14 Nm |
| **M20** | 407 +/- 14 Nm |
| **M24** | 690 +/- 27 Nm |
| **½" UNF** | 97 +/- 7 Nm |
| **⅝" UNF** | 265 +/- 14 Nm |
| **¾" UNF** | 393 +/- 14 Nm |
| **1"** | 810 +/- 27 Nm |

### Shaft coupling

Where the motor is solidly coupled to a shaft having independent bearings the shaft must be aligned to within 0.13mm 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. 5m is 12.0mm 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 0.35bar 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 Kawasaki.

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.

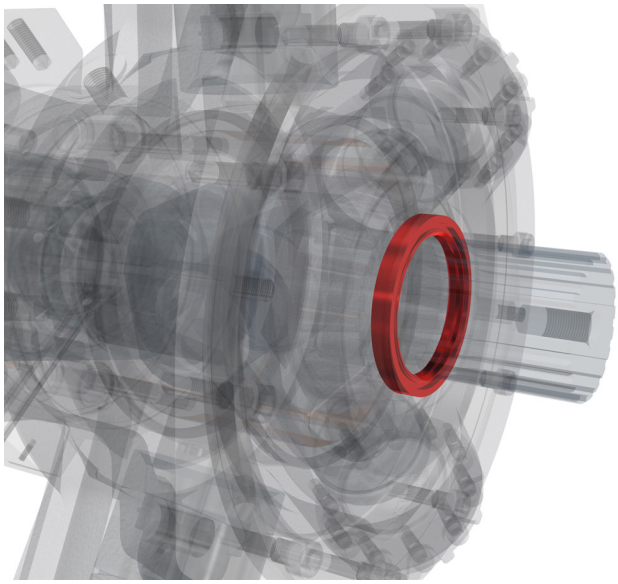
## Start - up

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.

# 2-13 Special Features

The HMF motor can be ordered with special features which can improve the motor's performance for different applications.

## High Pressure Shaft Seal



### Description:

**> 10bar rated**

**> Recommended for cold climates**

**> Rugged aluminium construction**

### Technical Information

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

| | |
|---|---|
| Case pressure | ≤ 10bar |
| Non-operating temperature limits | Below -30°C and above 120°C |
| Minimum operating temperature | -15°C |
| Maximum operating temperature | 80°C |
| Minimum viscosity | 2,000cSt |
| Maximum viscosity | 150cSt |

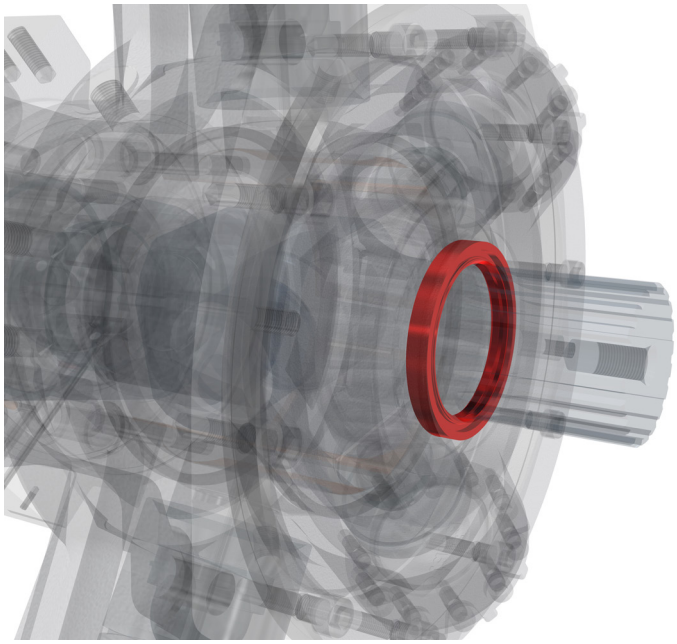
### Applicable to:

| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

# 2-13 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 HMF motors can be fitted with such sleeves upon request.

| | |
|---|---|
| Sleeve material | A304 Stainless Steel |
| Sleeve surface finish | $R_a$ 0.25 to 0.5µm (10 to 20µin) |

### Applicable to:

| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

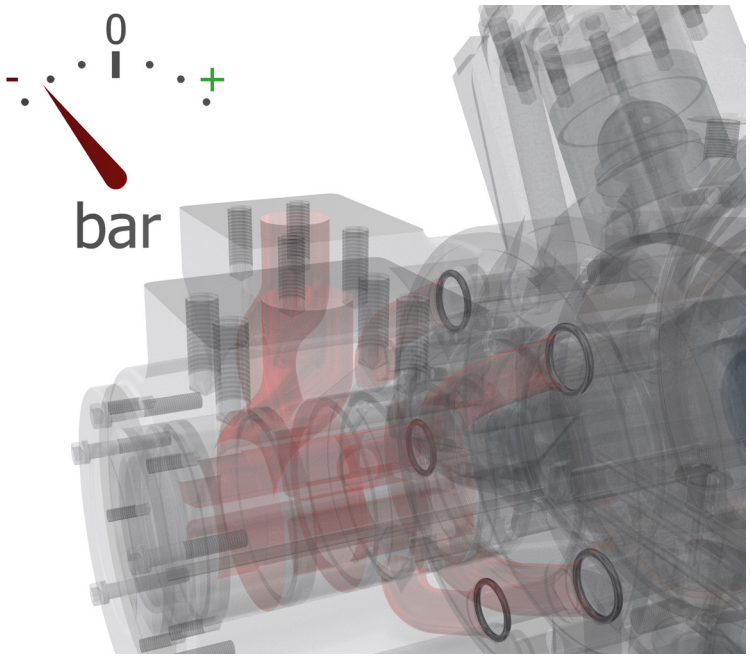
# 2-13 Special Features

## Improved Cavitation Resistance

### Description:

> **Recommended for overunning 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 HMF 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 HMF 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

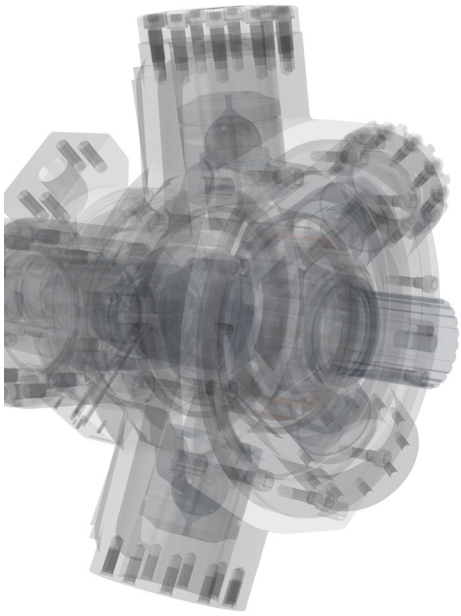
### Applicable to:

| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

# 2-13 Special Features

## Increased Starting Torque






### Description:

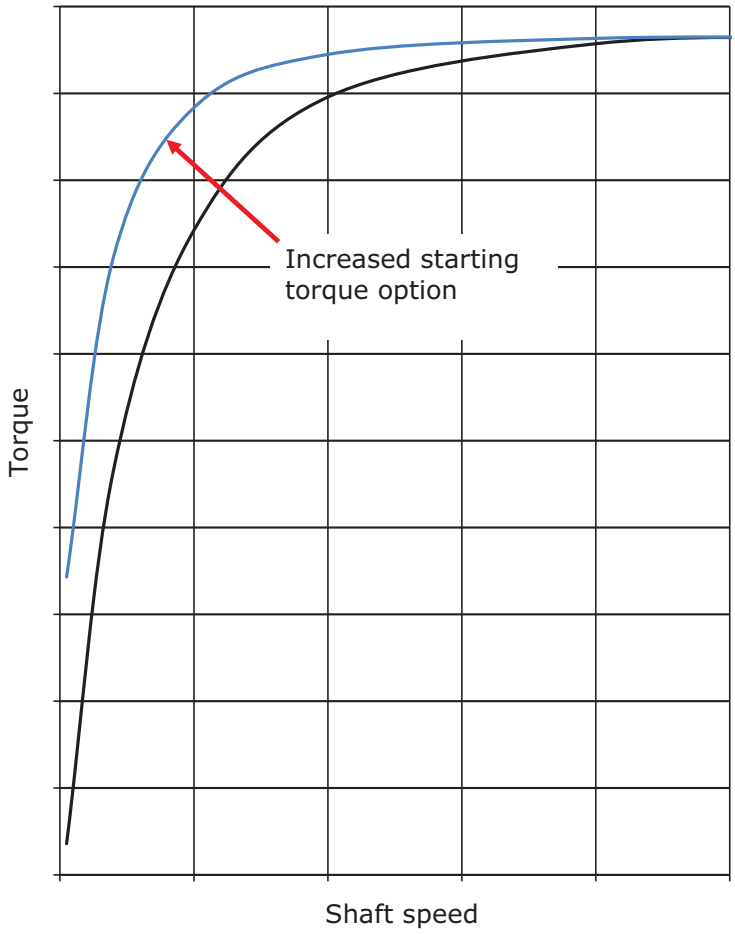
- **Optimised for high break-out torque**
- **Recommended for low speed operation**
- **Improved service life for low speed applications**

### Technical Information

**If an application demands the drive motor be run at speeds of less than 10rpm for most of the duty cycle, or involves frequent start/stop or forward/ reverse operation, the Staffa HMF motor range has it covered.**

By optimising the HMF motor's design for low speeds, it is possible to increase the break out torque and low speed mechanical efficiency performance.

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



# 2-13 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 Section 2-2.

| Motor Type | Geometric Displacement | Zero Speed Constant | Speed Constant | Creep Speed Constant | Crankcase Leakage Constant |
|---|---|---|---|---|---|
| | cc/rev | K1 | K2 | K3 | K4 |
| HMF100 | 1,600 | 16.26 | 45.70 | 9.65 | 14.66 |
| HM(HD)F200 | 3,084 | 12.86 | 38.50 | 3.02 | 11.01 |
| HM(HD)F270 | 4,588 | 13.26 | 37.30 | 2.41 | 12.76 |
| HM(HD)F325 | 5,326 | 13.26 | 40.00 | 2.08 | 12.76 |

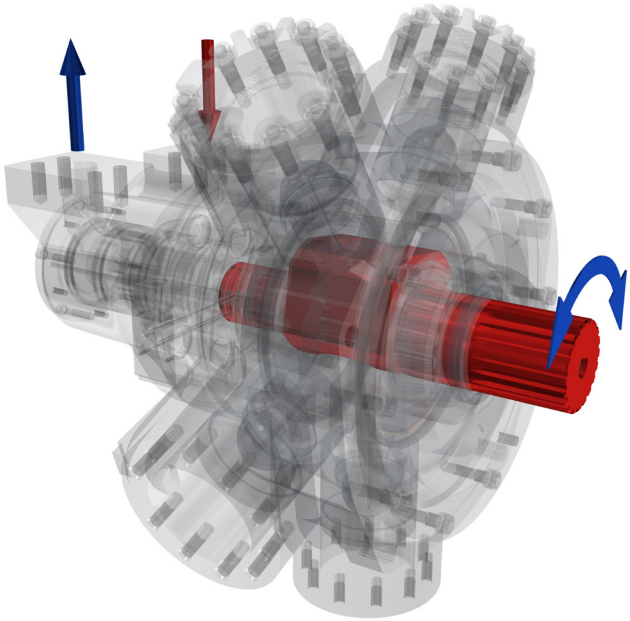
### Applicable to:

| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

# 2-13 Special Features

## Anti-Clockwise Rotation



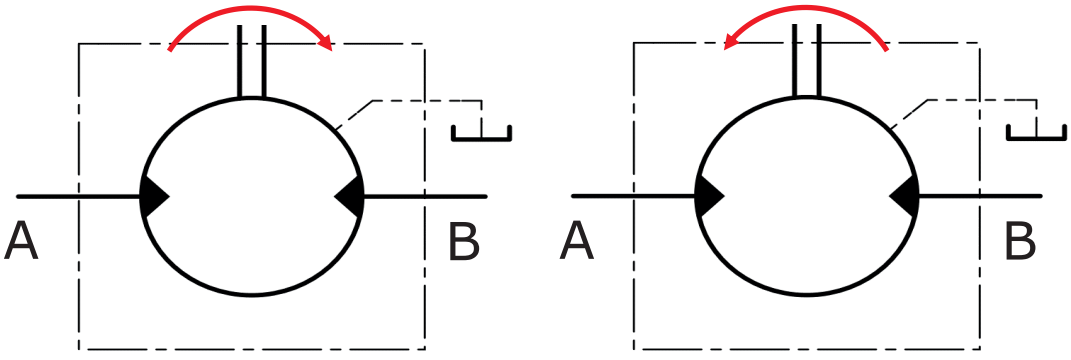
### Description:

> **Reduce installation complexity**

> **Standardise equipment designs**

### Technical Information

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




Standard motor

Anti-clockwise motor

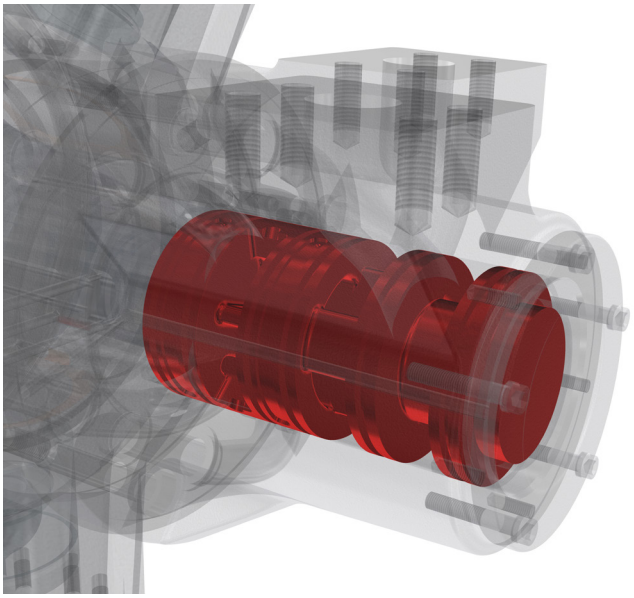
### Applicable to:

| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

# 2-13 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 motor with warm hydraulic fluid is a known cause of heavy wear and potential seizure of hydraulic machinery. To minimise this potential risk, the HMF 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 in Section 2-13 in place of those given for the standard motor in Section 2-1. 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 2-8 Motor Operation at Low Temperature.

| Motor Type | Geometric Displacement | Zero Speed Constant | Speed Constant | Creep Speed Constant | Crankcase Leakage Constant |
|---|---|---|---|---|---|
| | cc/rev | K1 | K2 | K3 | K4 |
| HMF100 | 1,600 | 11.10 | 45.70 | 6.99 | 7.90 |
| HM(HD)F200 | 3,087 | 7.98 | 38.50 | 2.61 | 4.25 |
| HM(HD)F270 | 4,588 | 8.38 | 37.30 | 1.91 | 6.00 |
| HM(HD)F325 | 5,326 | 8.38 | 40.00 | 1.65 | 6.00 |

### Applicable to:

| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

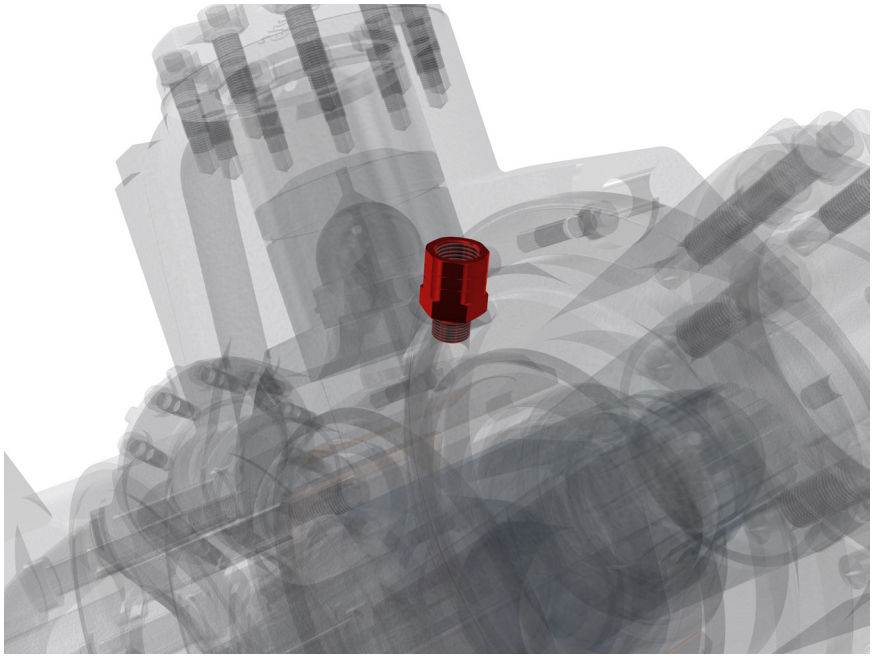
# 2-13 Special Features

## Drain Port Adaptors

### Description:

> Improves manufacturing logistics

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



### Technical Information

| Motor Type | Adaptor Supplied |
|---|---|
| HMF100 | ¾" UNF 2B to ½" BSPP |
| HM(HD)F200 | ¾" UNF 2B to ½" BSPP |
| HM(HD)F270 | ¾" UNF 2B to ½" BSPP |
| HM(HD)F325 | ¾" UNF 2B to ½" BSPP |

One or two drain adaptors can be supplied.

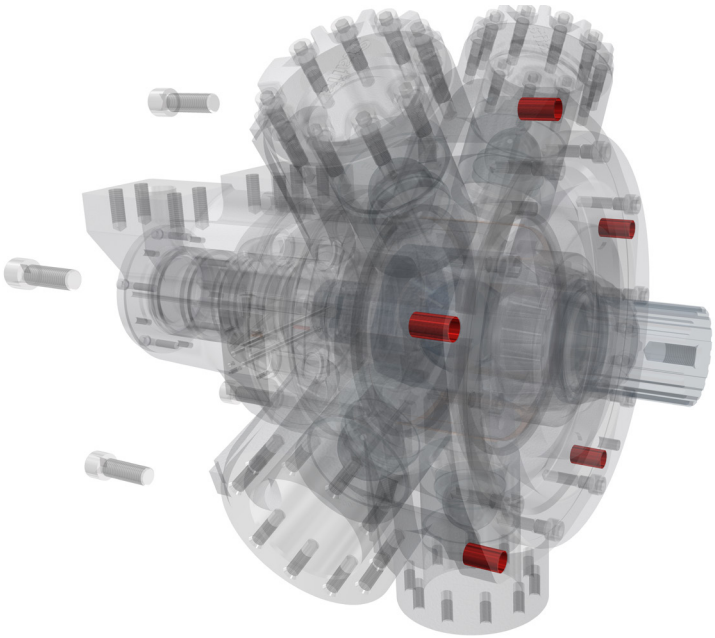
### Applicable to:

| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

# 2-13 Special Features

## Mounting Hole Diameter



### Description:

> Matching mounting holes to bolts

> Φ21mm and Φ22mm options available

### Technical Information

In different markets, different bolt standards are adopted which may not be best suited to the standard Φ20 mm mounting hole diameter on the HMF motors. To give a correct fit and optimum installation, Φ21 mm or Φ22 mm holes can be selected on all frame sizes.





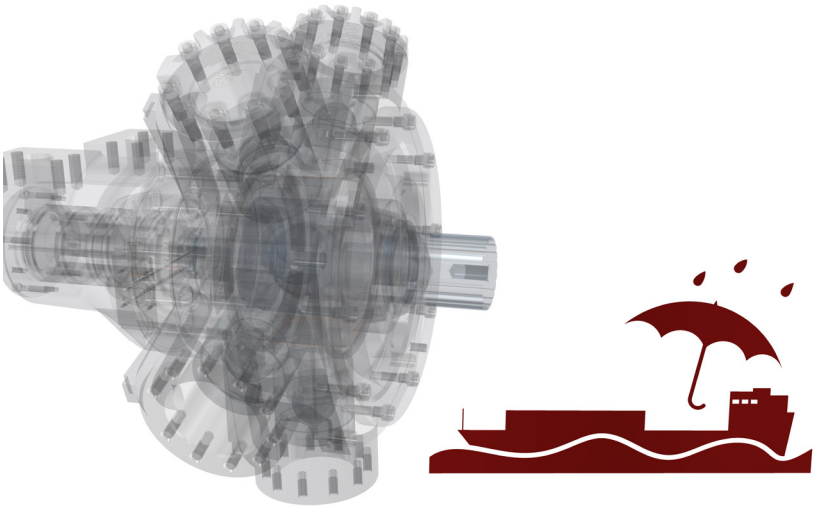
### Applicable to:

| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

# 2-13 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

| | |
|---|---|
| Colour | Red oxide |
| Type | Single pack epoxy etching primer |
| Standard | BS 3900 part A 8 |
| Dry film thickness | > 12µm |

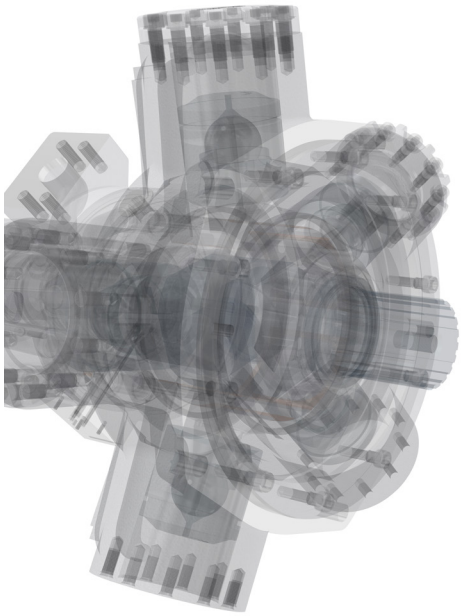
### Applicable to:

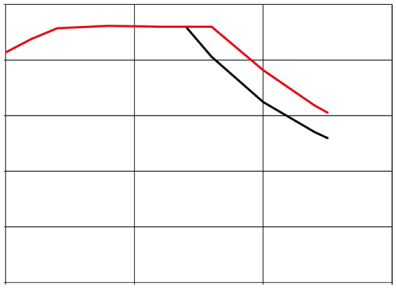
| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

# 2-13 Special Features

## High Power





### Description:

> Enhanced power performance

> Improved efficiency

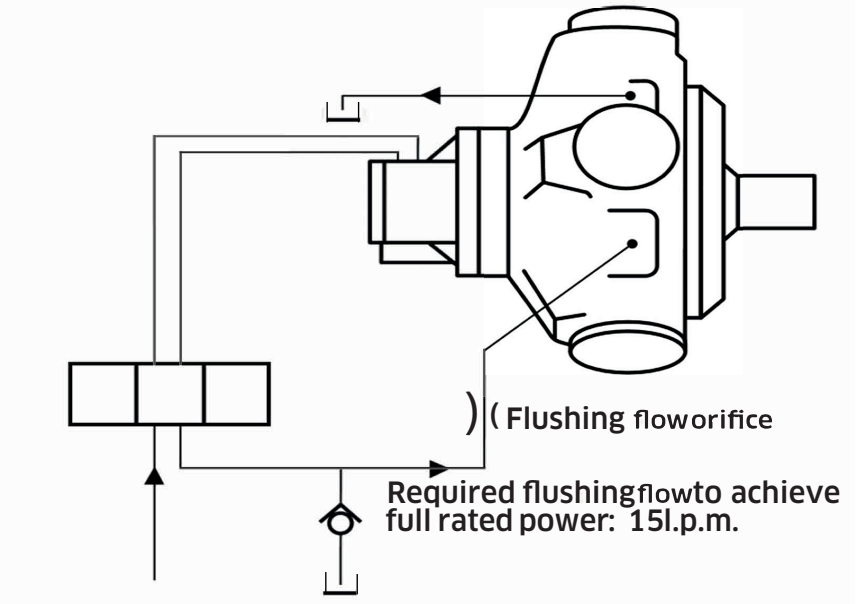
> Improved back pressure rating of 100bar

### Technical Information

The high power option for the HMF motors combines special low-friction components and a crankcase flushing flow to achieve increased shaft power limits. All other performance parameters are unchanged.

### Crankcase Flushing

In order to achieve the maximum shaft power, a crankcase flushing flow of 15 l/min should be directed through the crankcase. To improve the cooling effect of the flushing flow the distance between the inlet and outlet drain port connections should be maximised.



# 2-13 Special Features

## High Power (cont)

| Check valve pressure (bar)* | Orifice diameter (mm) |
|---|---|
| 3 | 4.4 |
| 4 | 4.1 |
| 5 | 3.9 |
| 6 | 3.7 |
| 7 | 3.6 |
| 8 | 3.5 |
| 9 | 3.4 |
| 10 | 3.3 |

*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 3.5bar, then the motor build should include a high pressure shaft seal.

### Performance Data (crankcase flushing required):

| Motor Type | Max. continuous output (kW) | Average actual running torque (Nm/bar) |
|---|---|---|
| HMF100 | 165 | 24.1 |
| HM(HD)F200 FM3/SM3 valve assembly | 216 | 47.2 |
| HM(HD)F200 FM4 valve assembly | 261 | 47.2 |
| HM(HD)F270 | 278 | 70.1 |
| HM(HD)F325 | 278 | 81.6 |

**NOTE:**
The speed limits and pressure limits remain unchanged from the standard motor.

### Applicable to:

| HMF100 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

Please contact Kawasaki to order this feature.

# 2-13 Special Features

## Marine-Style Cylinder Head

### Description:

> **Reduces water entrapment**

> **Improves corrosion resistance**

> **Aids paint coverage**



When top-coat paint solutions are applied to any surface, the coverage can easily become sub-optimal for very complex shapes. As the protection of the Staffa motor's external surfaces is critical in corrosive environments, the marine-style cylinder head, which is geometrically simplified in comparison to the standard design, can be specified for all HMF motors to aid in the optimal application of the top-coat paint solution.

### Technical Information

No installation dimensions or after-market parts are affected when selecting this option as it is completely interchangeable with the standard cylinder head. Existing motors may be upgraded to use these cylinder heads without the need for any other replacement parts.

### Applicable to:

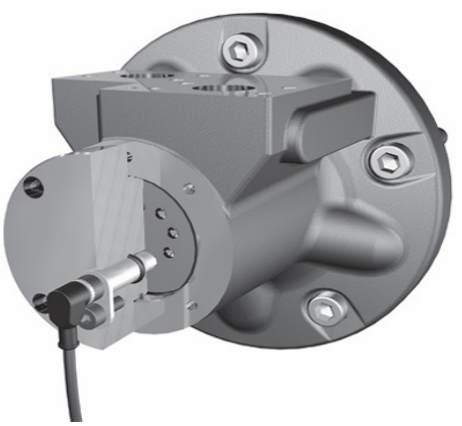
| HMF080 | HM(HD)F200 | HM(HD)F270 | HM(HD)F325 |
|---|---|---|---|
| ● | ● | ● | ● |

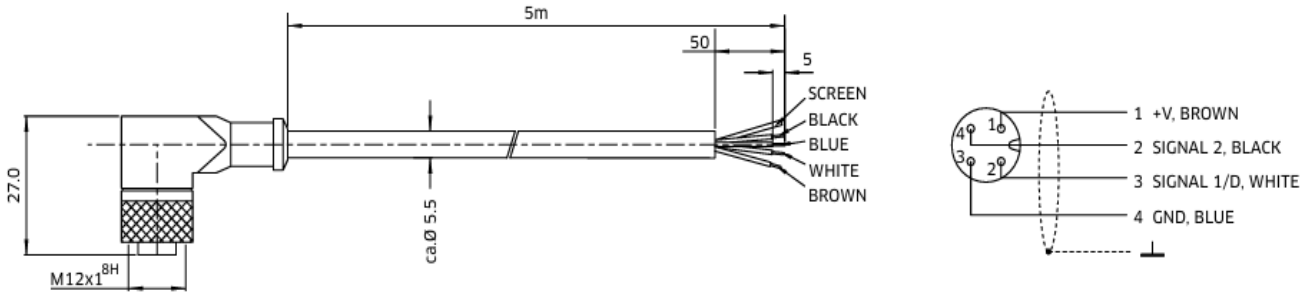
# 2-12 Special Features (cont)

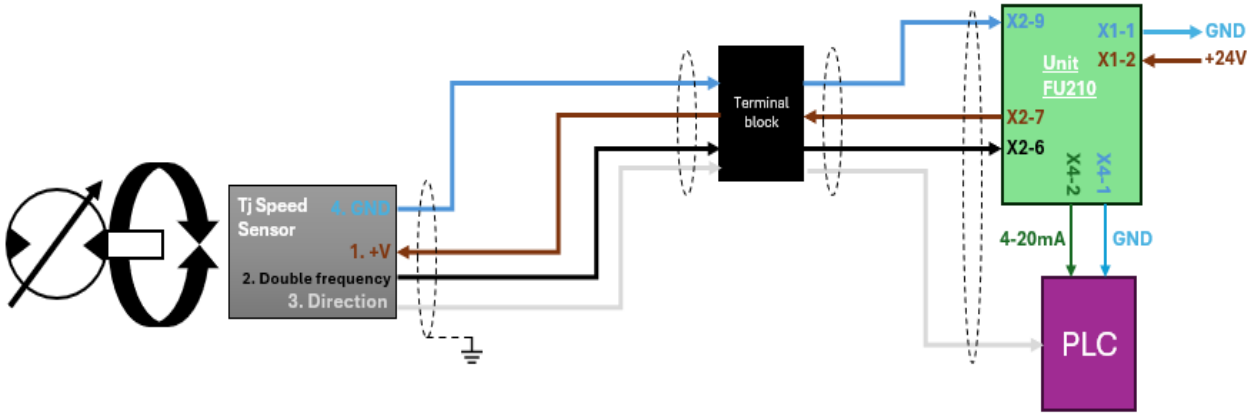
## Tj speed sensor technical specification

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 32V @ 40mA |
| Protection Class: | IP68 |
| Output Frequency: | 16 pulses/revolution |





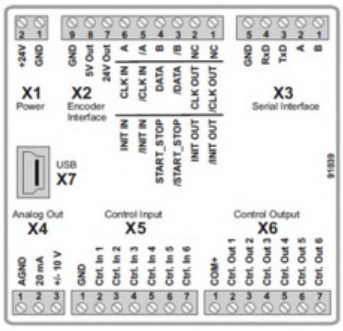
# 2-12 Special Features (cont)

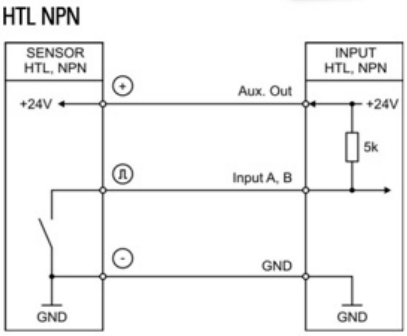
## Ts readout option

The Ts option consists of the Tj speed sensor together with the optional FU210 output module.

The addition of the FU210 module provides a software configured single channel tachometer and relay with a /4-20mA analogue current output which comes pre-programmed with the motor.

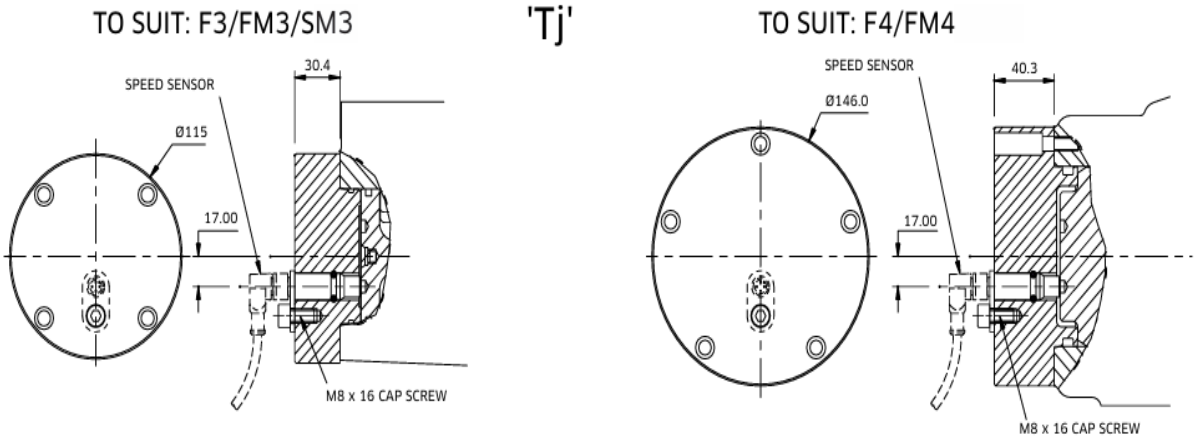
For more in-depth information please contact KPM UK.






## Installation Details



# 3 Dimensions

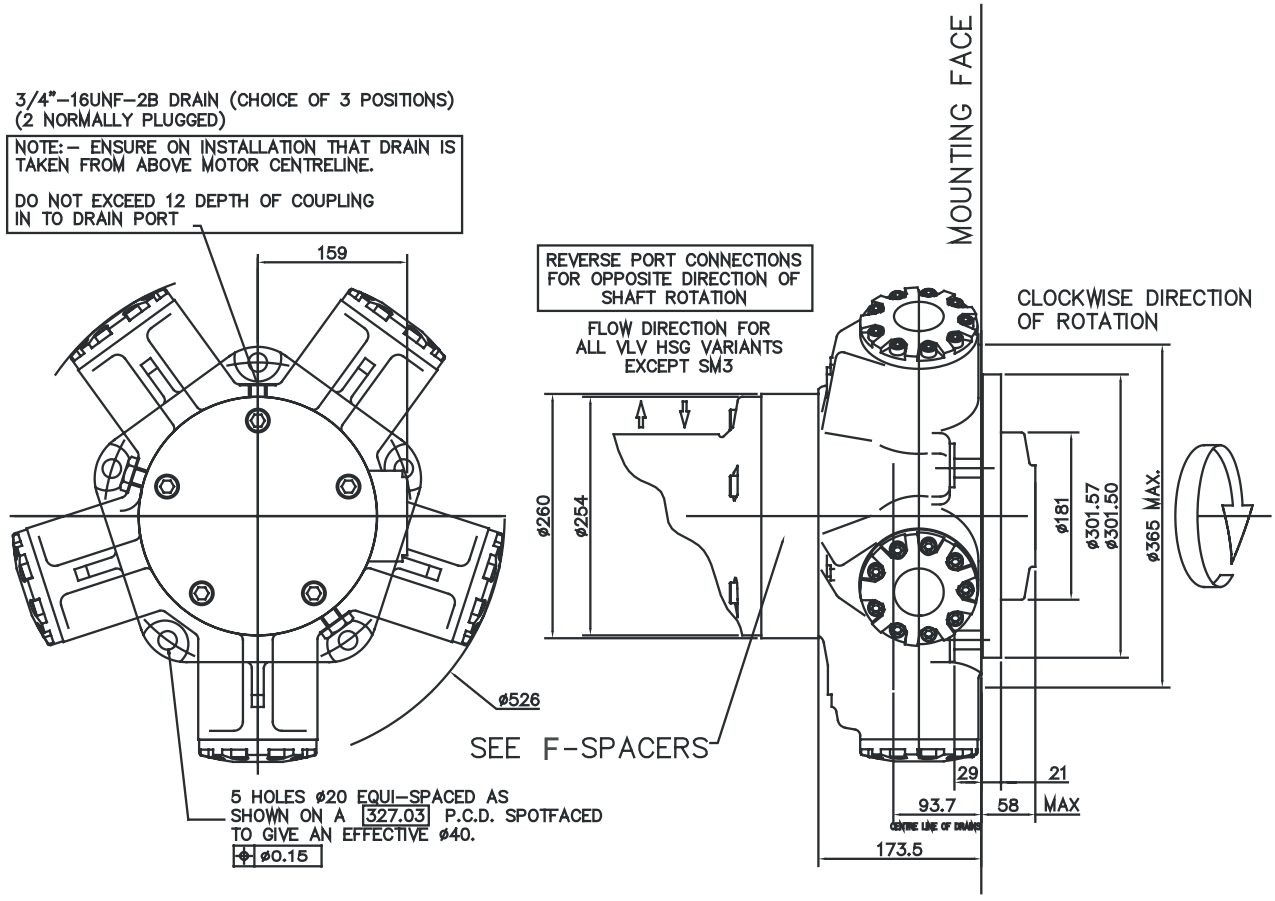
### Conversion Table

| Pressure | |
|---|---|
| bar | PSI |
| 1 | 14.5 |
| **Flow** | |
| l/min | gal/min |
| 1 | 0.264 US |
| 1 | 0.219 UK |
| **Length** | |
| mm | inch |
| 25.4 | 1 |

| Torque | |
|---|---|
| Nm | lbf ft |
| 1 | 0.737 |
| **Power** | |
| kW | hp |
| 1 | 1.341 |
| **Mass** | |
| kg | lb |
| 1 | 2.2 |

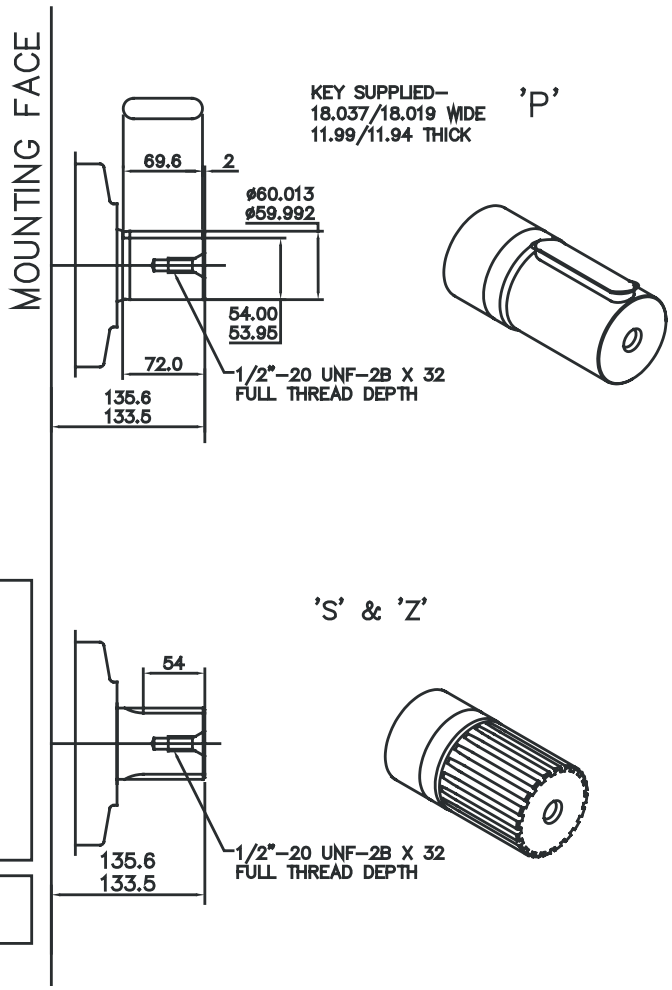
## 3-1 HMF100

### Installation



# 3-1 HMF100 (cont)

## 'P', 'S' and 'Z' Shafts




SPLINE DATA

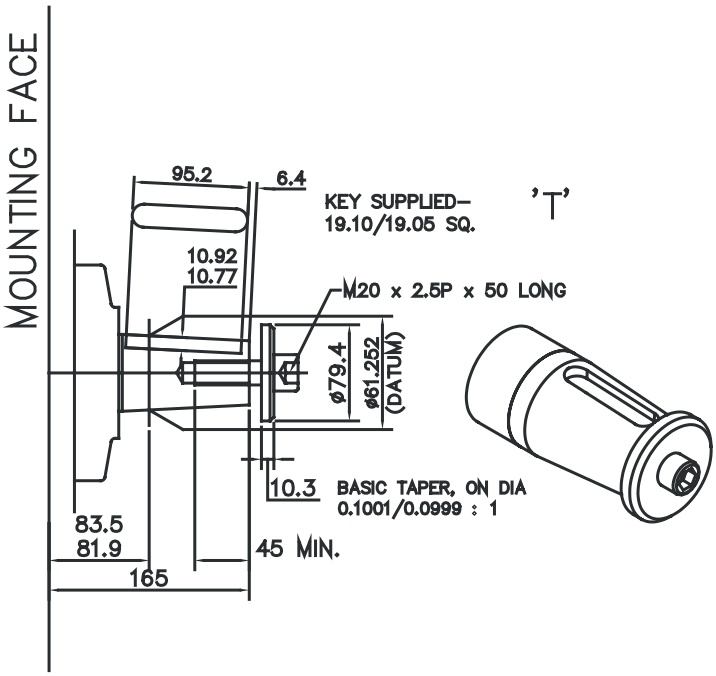
'S'
TO BS 3550 (ANSI B92.1 CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

| | |
|---|---|
| PRESSURE ANGLE | 30° |
| 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

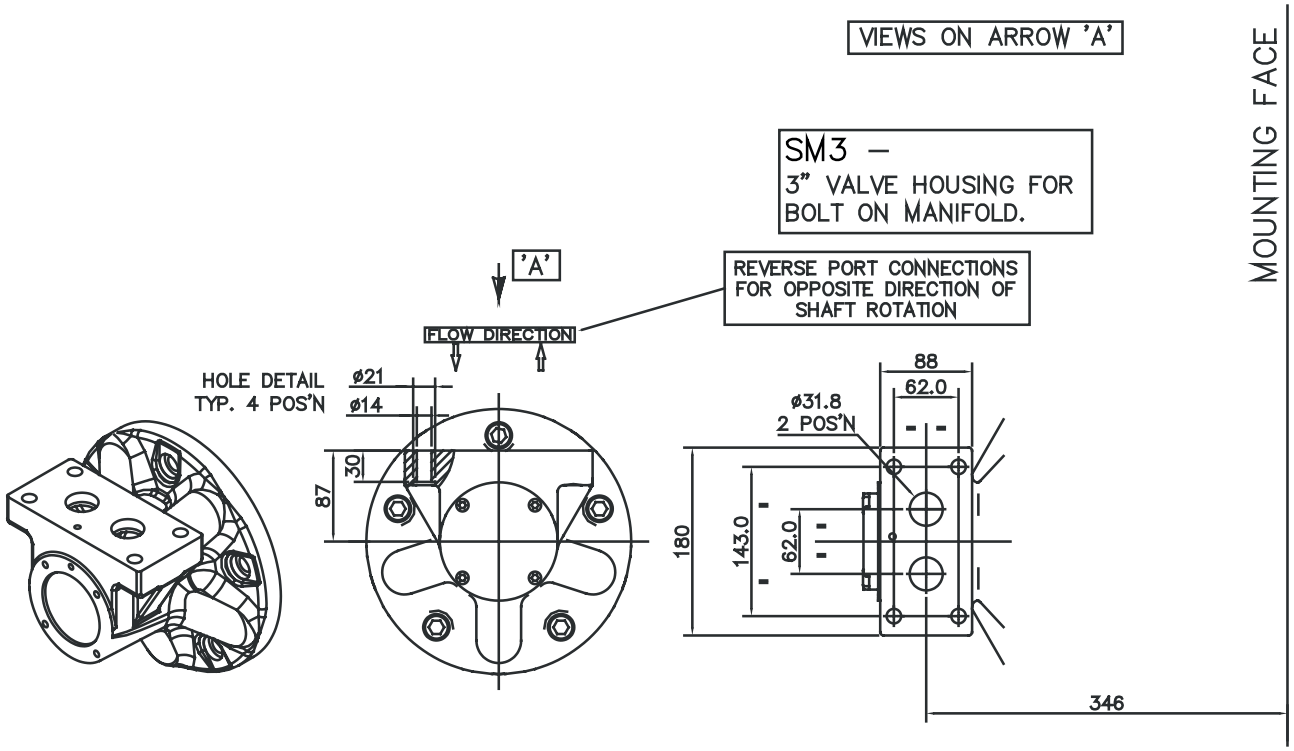
# 3-1 HMF100 (cont)

## 'T' Shaft



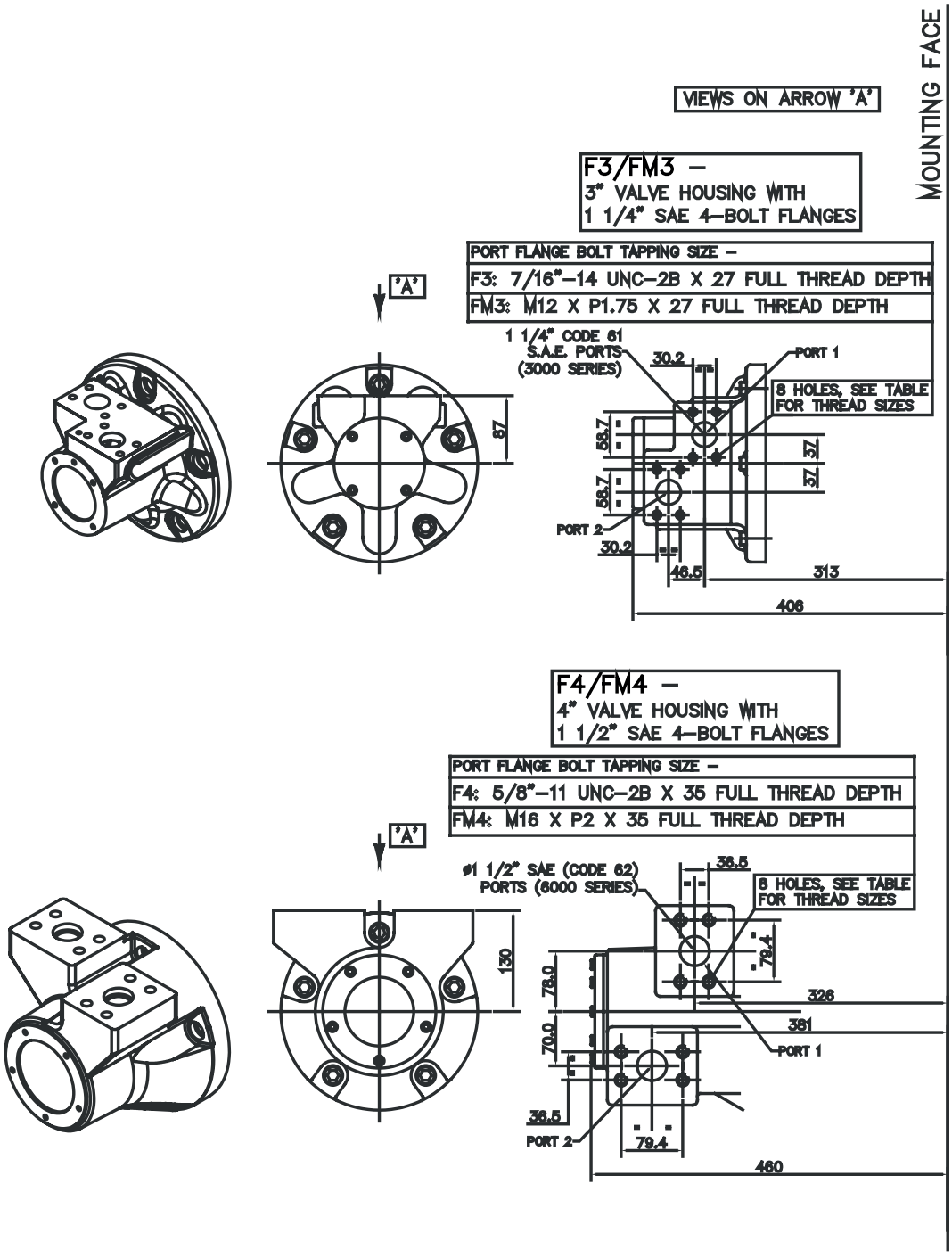
# 3-1 HMF100 (cont)

## 'SM3' Valve Housing



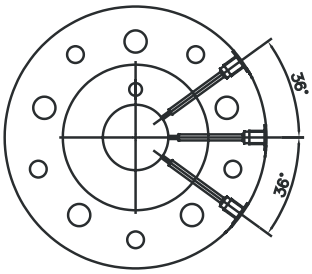
# 3-1 HMF100 (cont)

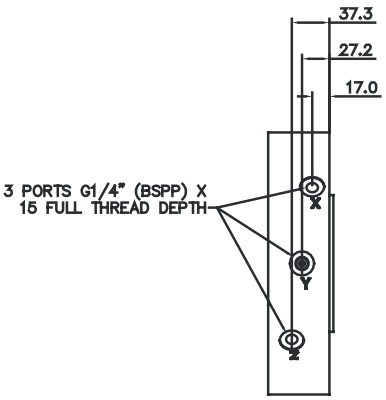
## 'F3', 'FM3', 'F4' & 'FM4' Valve Housings



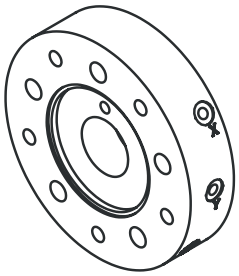
# 3-1 HMF100 (cont)

## 'X' F Spacer



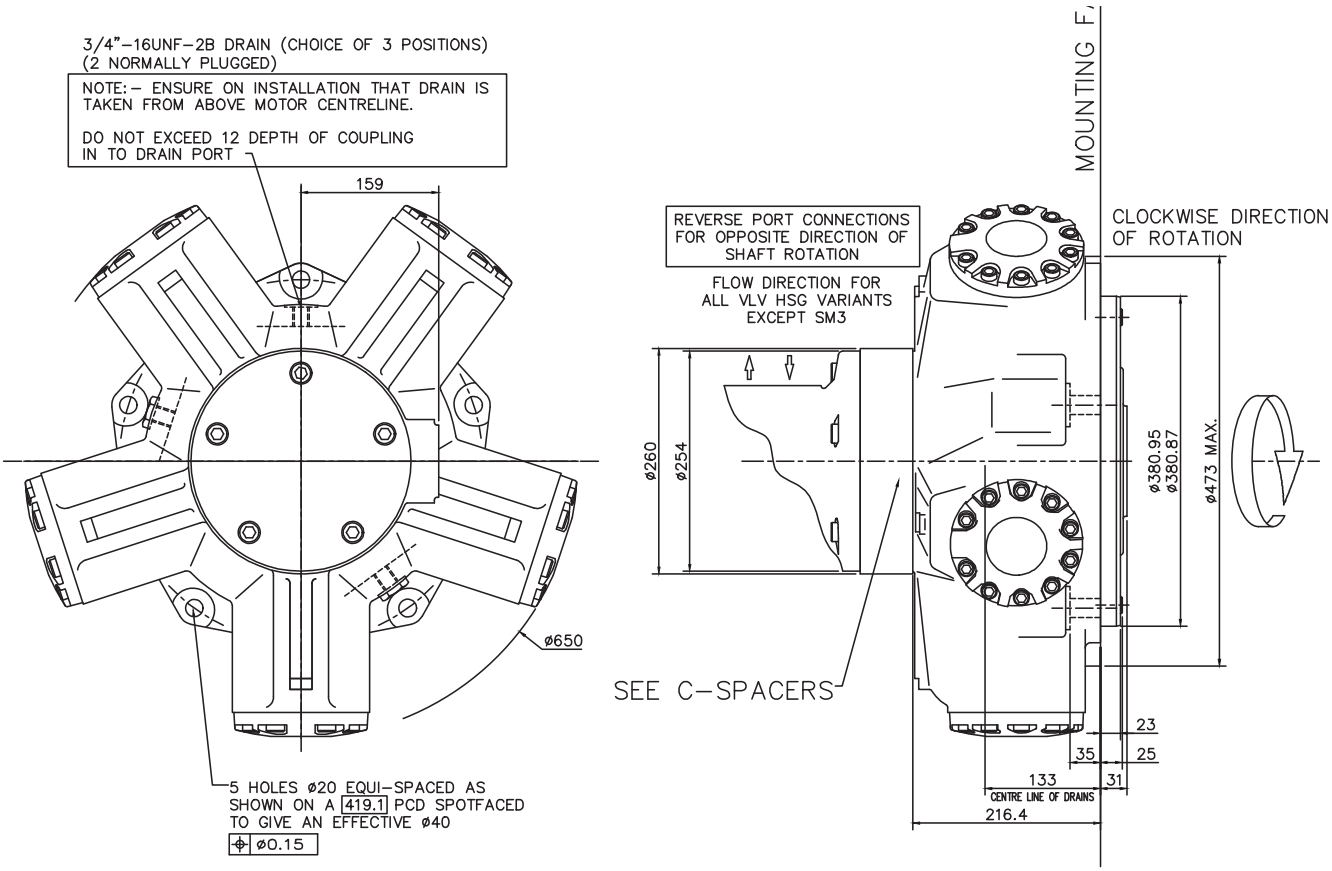

TYPE X
DISPLACEMENT CONTROL



DISPLACEMENT SELECTION (VIA REMOTELY LOCATED VALVE*)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
MID DISPLACEMENT: P TO X AND Z: Y TO T
SEE TIMING CHART.
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR.

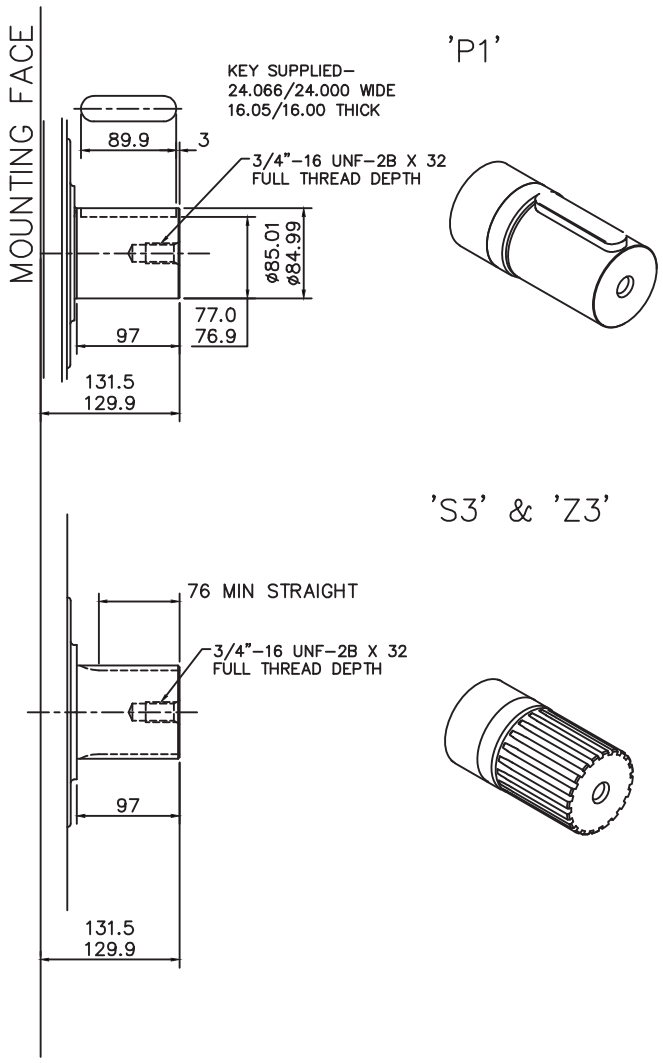
# 3-2 HM(HD)F200

## Installation



# 3-2 HMF200 (cont)

## 'P1', 'S3' and 'Z3' Shafts



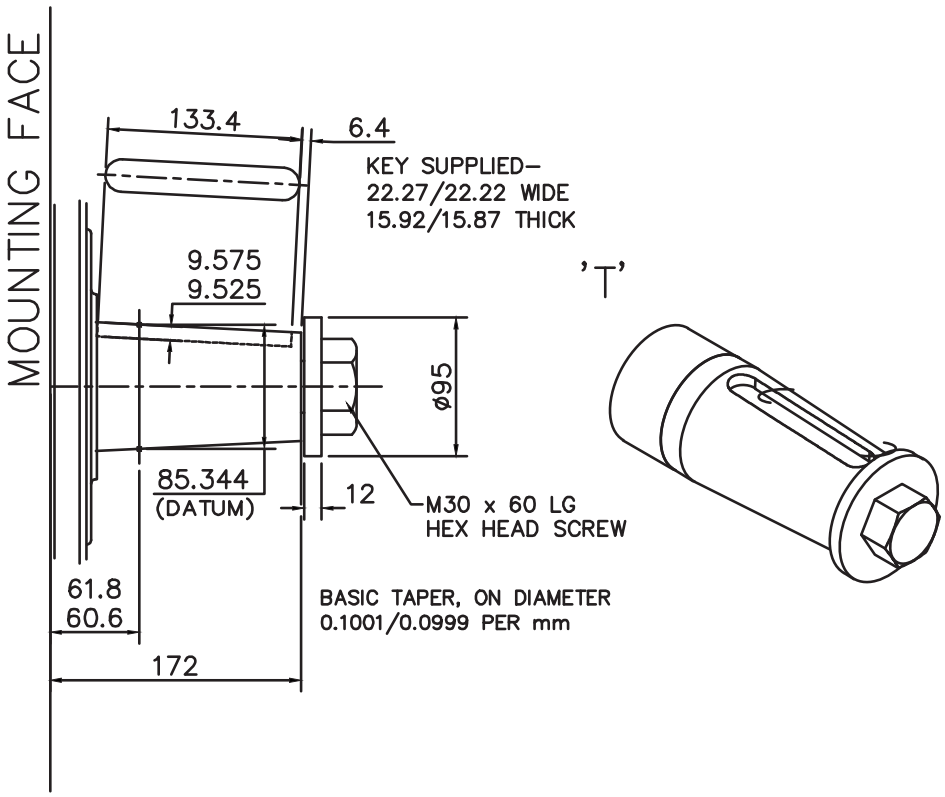

SPLINE DATA

| 'S3' | |
|---|---|
| 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 |

| 'Z3' |
|---|
| DIN 5480 W85 x 3 x 27 x 7h |

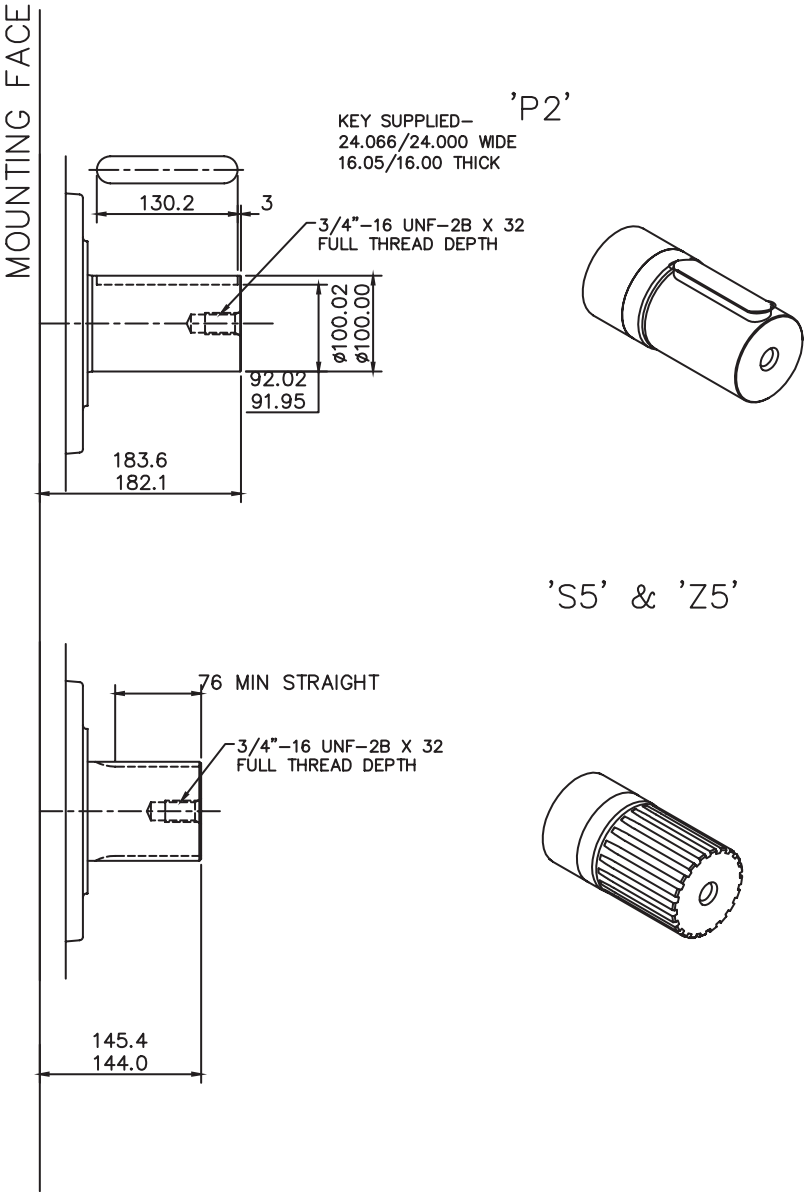
# 3-2 HMF200 (cont)

## 'T' Shaft



# 3-2 HMHDF200 (cont)

## 'P2', 'S5' and 'Z5' Shafts



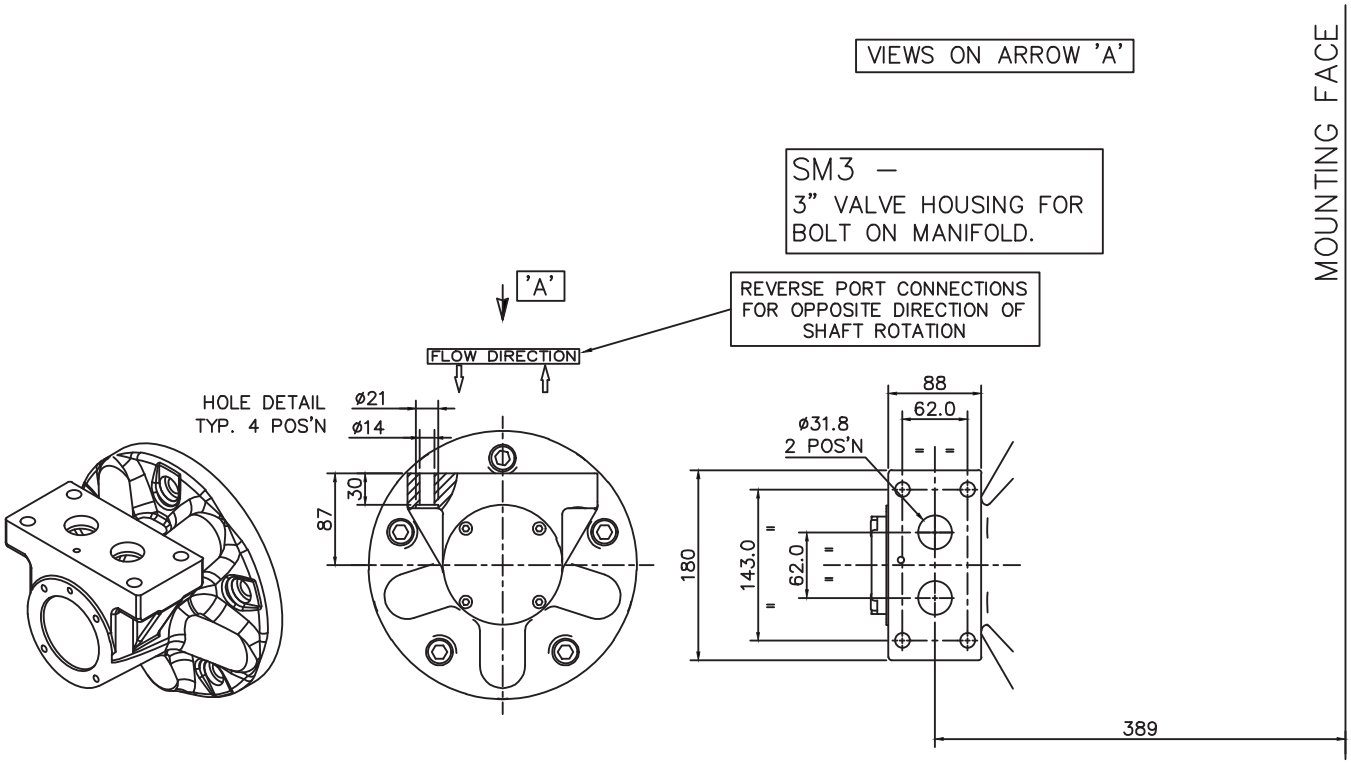

SPLINE DATA

| 'S5' | |
|---|---|
| PRESSURE ANGLE | 30° |
| NUMBER OF TEETH | 23 |
| PITCH | 6/12 |
| MAJOR DIAMETER | 100.652/100.526 |
| FORM DIAMETER | 92.939 |
| MINOR DIAMETER | 92.184/91.626 |
| PIN DIAMETER | 8.128 |
| DIAMETER OVER PINS | 109.573/109.517 |

| 'Z5' |
|---|
| DIN 5480 W100 x 4 x 24 x 7h |

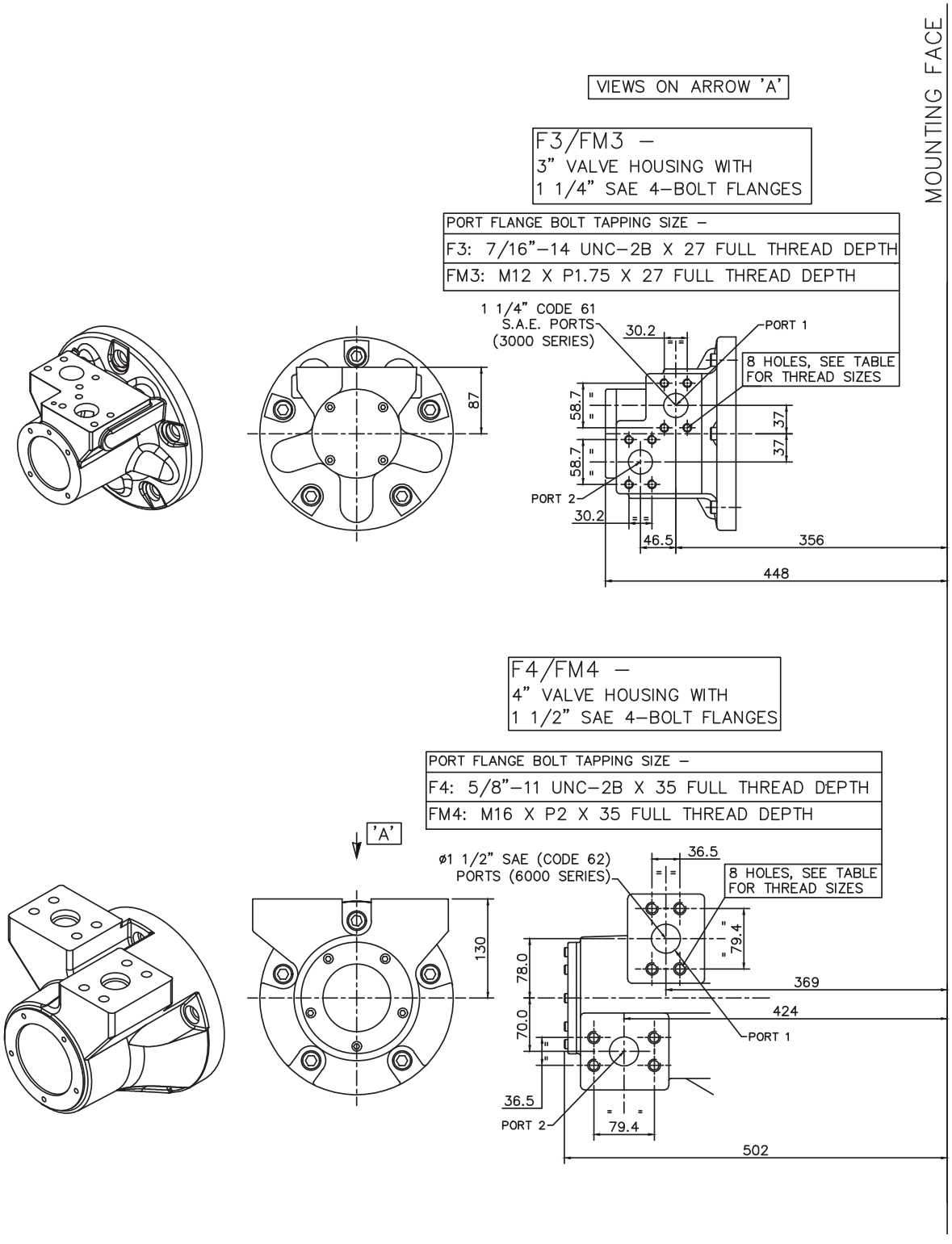
# 3-2 HM(HD)F200 (cont)

## 'SM3' Valve Housing



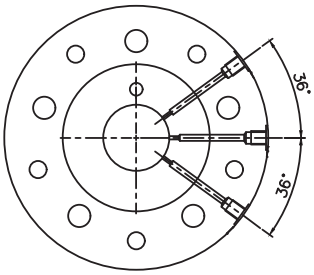
# 3-2 HM(HD)F200 (cont)

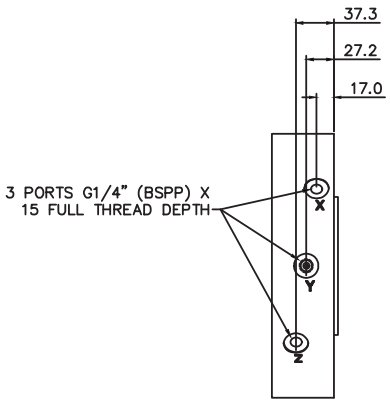
## 'F3', 'FM3', 'F4' & 'FM4' Valve Housings



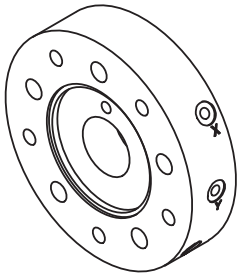
# 3-2 HM(HD)F200 (cont)

## 'X' F Spacer



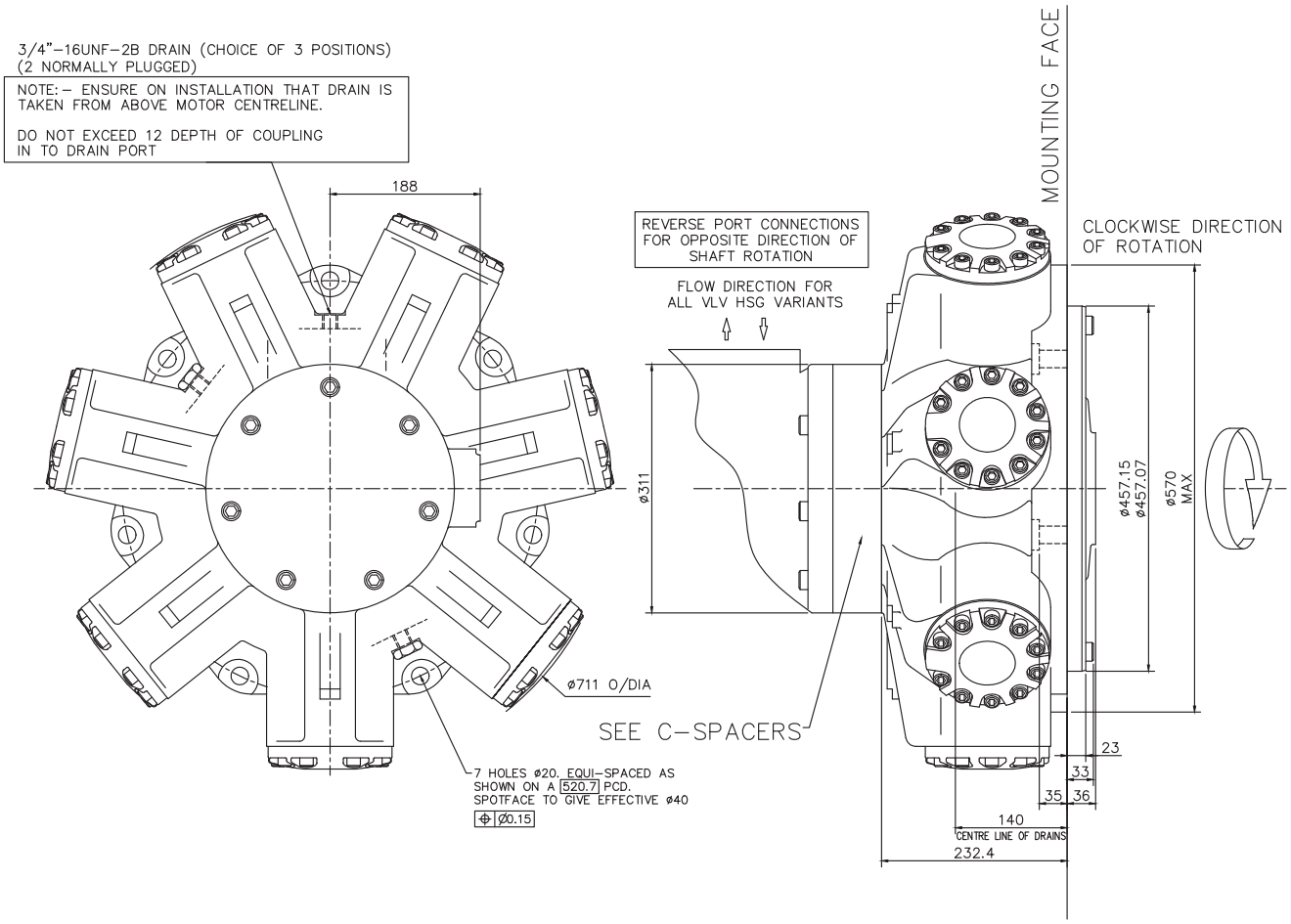

TYPE X
DISPLACEMENT CONTROL




DISPLACEMENT SELECTION (VIA REMOTELY LOCATED VALVE*)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
MID DISPLACEMENT: P TO X AND Z: Y TO T
SEE TIMING CHART.
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR.

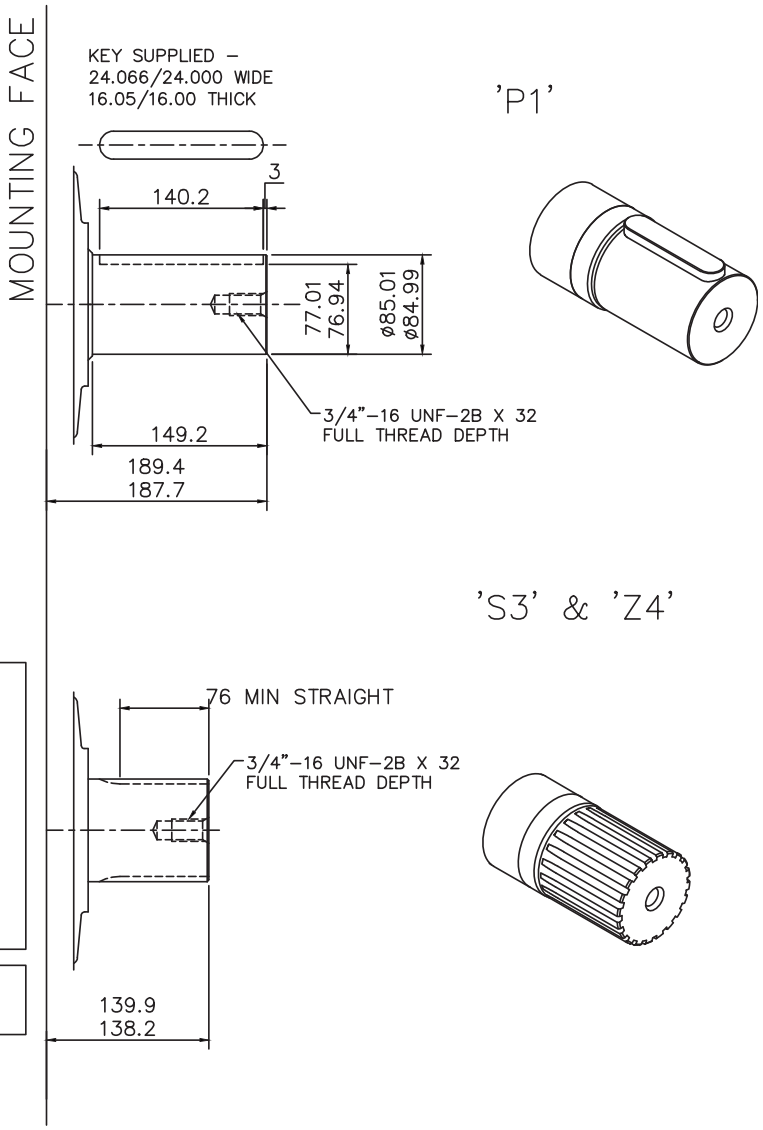
# 3-3 HM(HD)F270

## Installation



# 3-3 HMF270 (cont)

## 'P1', 'S3' and 'Z4' Shafts




SPLINE DATA

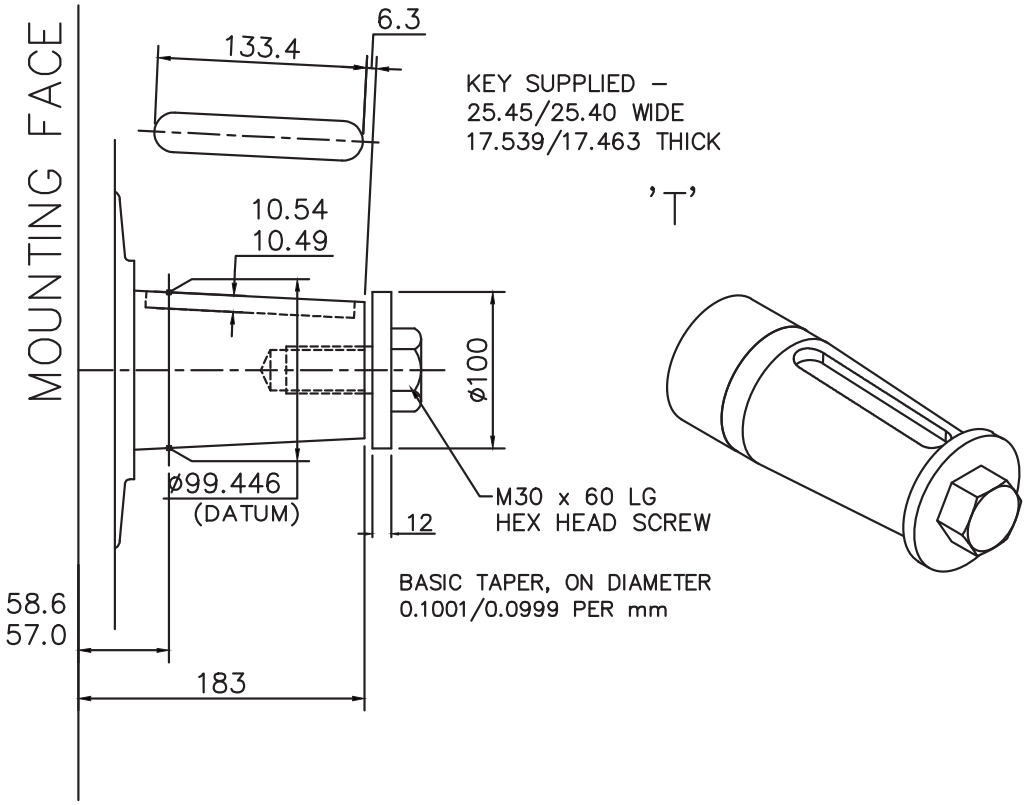
'S3'
TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

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

'Z4'
DIN 5480 W90 x 4 x 21 x 7h

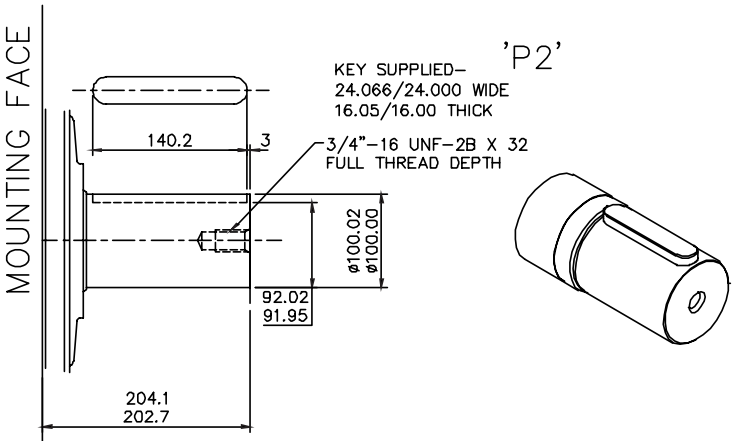
# 3-3 HMF270 (cont)

## 'T' Shaft



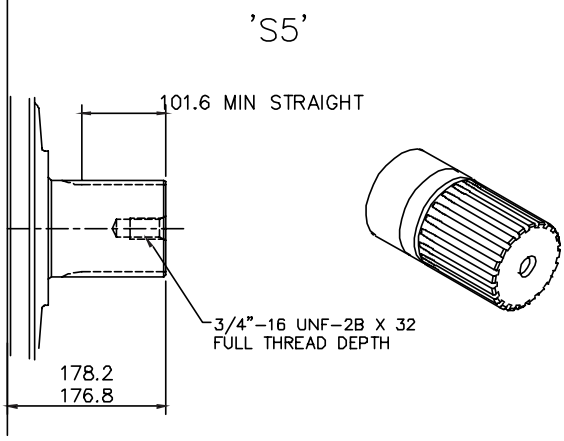
# 3-3 HMHDF270 (cont)

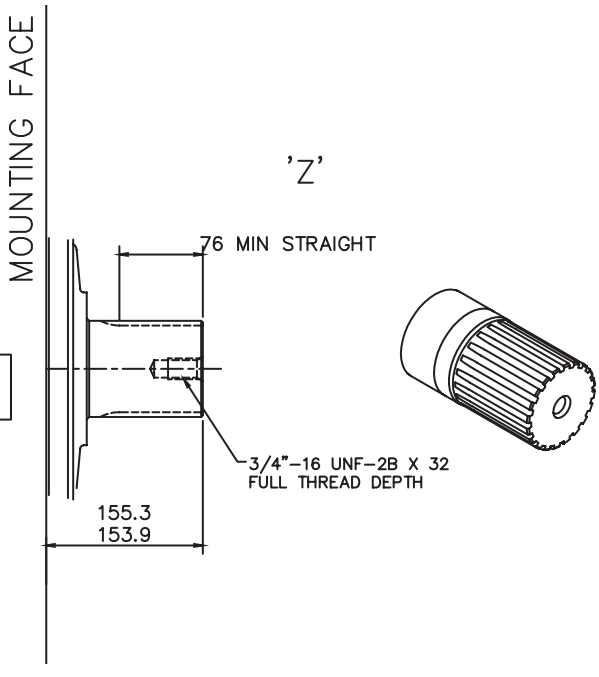
## 'P2', 'S5' and 'Z' Shafts




SPLINE DATA

| 'S5' | |
|---|---|
| TO BS 3550 (ANSI B92.1, CLASS 5) | |
| FLAT ROOT SIDE FIT, CLASS 1 | |
| PRESSURE ANGLE | 30° |
| NUMBER OF TEETH | 23 |
| PITCH | 6/12 |
| MAJOR DIAMETER | 100.653/100.526 |
| FORM DIAMETER | 92.939 |
| MINOR DIAMETER | 92.184/91.625 |
| PIN DIAMETER | 8.128 |
| DIAMETER OVER PINS | 109.573/109.517 |

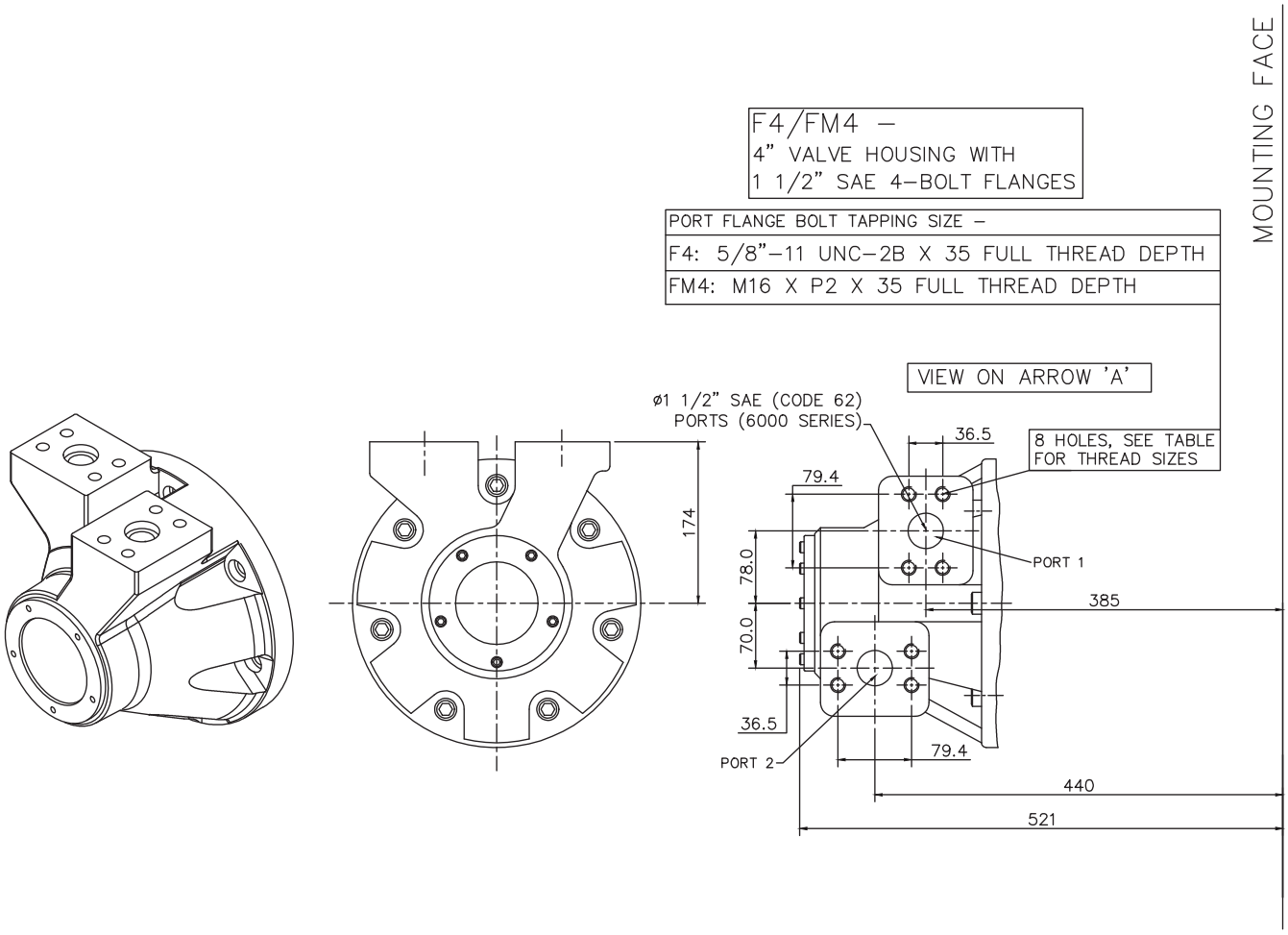



| 'Z' |
|---|
| DIN 5480 W100 x 4 x 24 x 7h |

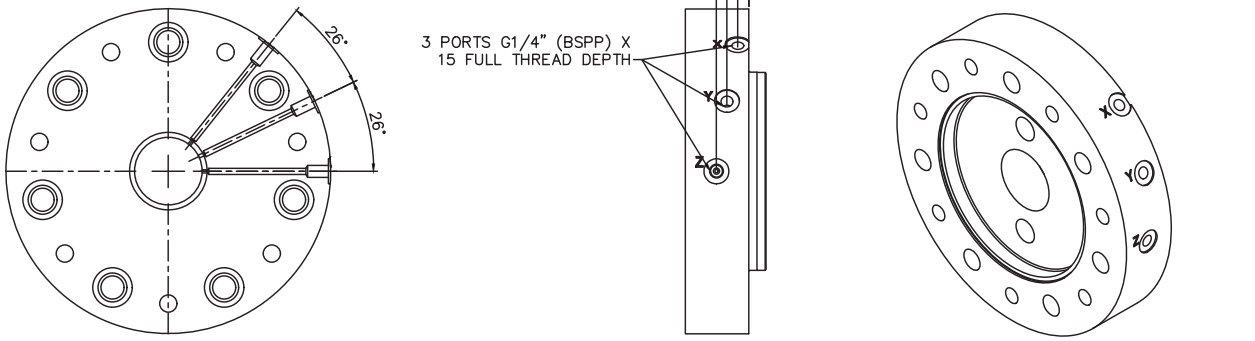
# 3-3 HM(HD)F270 (cont)

## 'F4' & 'FM4' Valve Housings



# 3-3 HM(HD)F270 (cont)

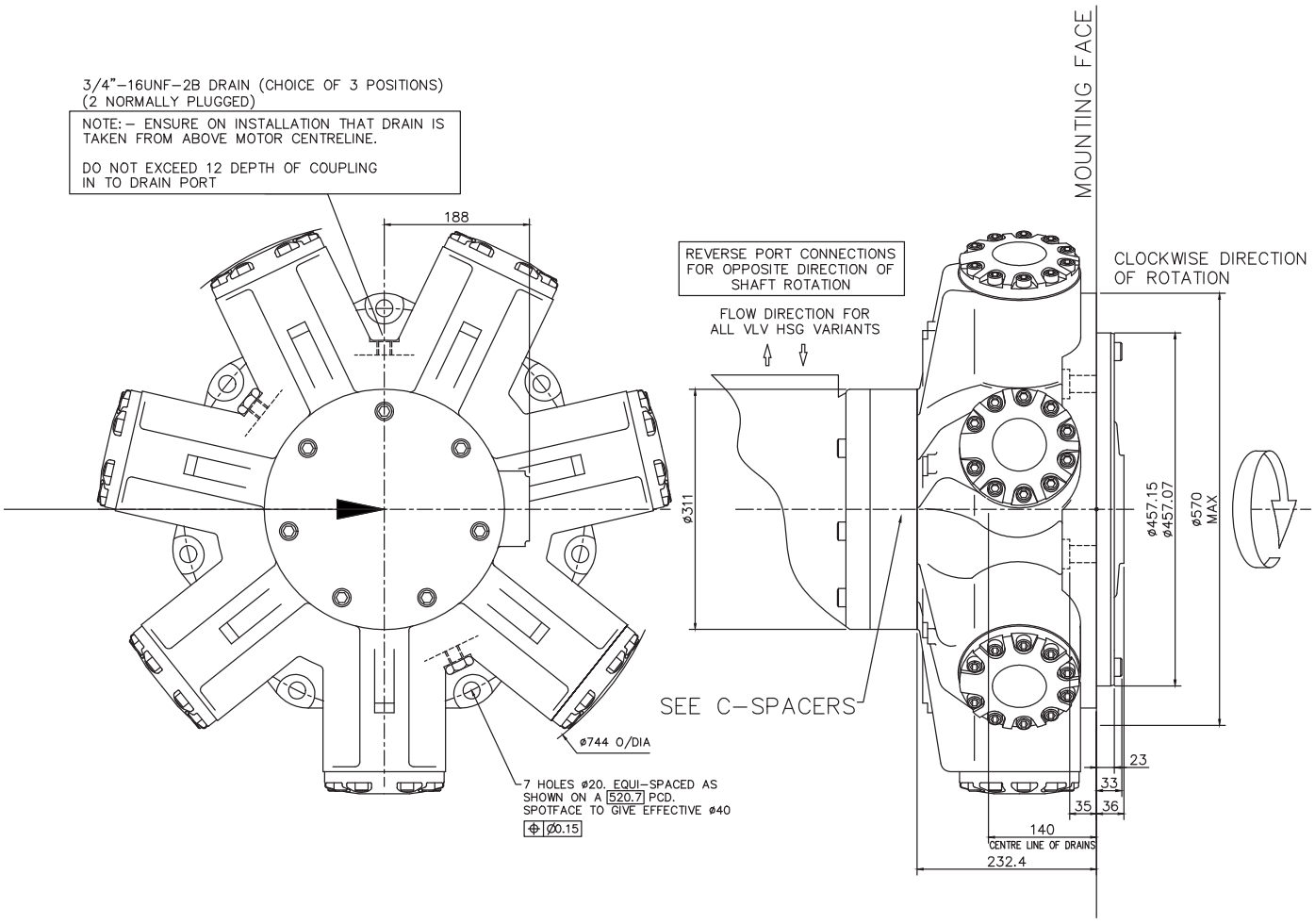
## 'X' F Spacer




DISPLACEMENT SELECTION (VIA REMOTELY LOCATED VALVE*)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
MID DISPLACEMENT: P TO X AND Z: Y TO T
SEE TIMING CHART.
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR.

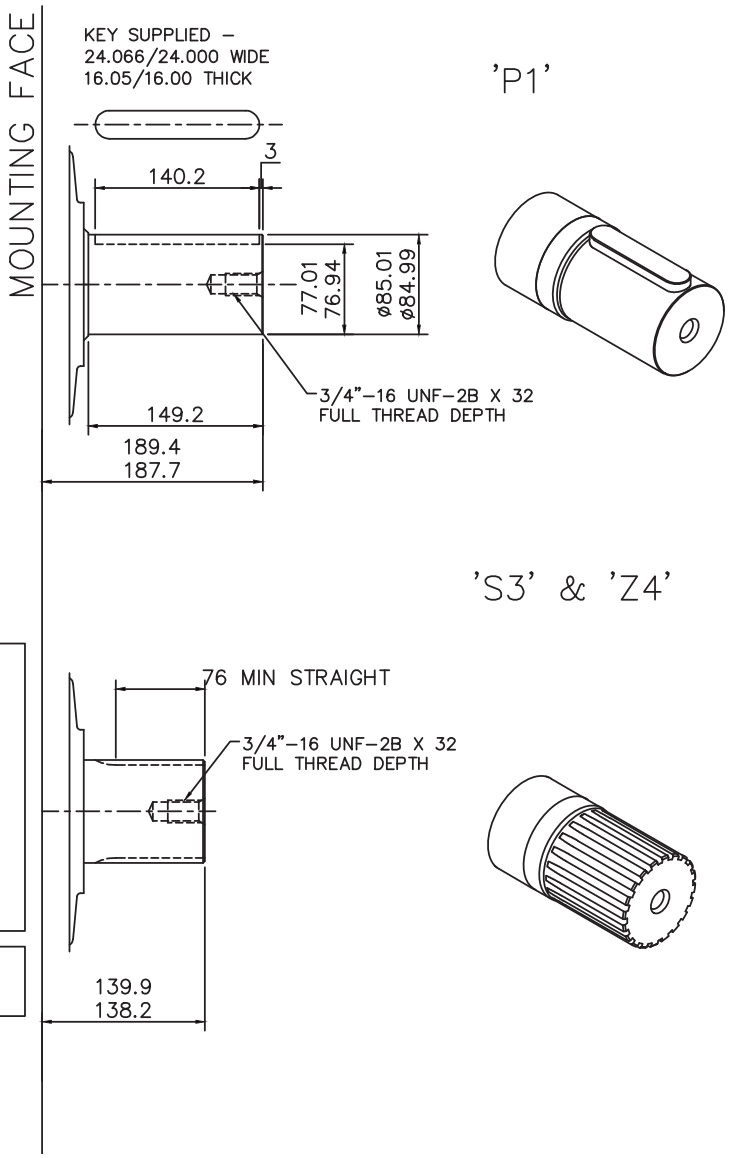
# 3-4 HM(HD)F325

## Installation



# 3-4 HMF325 (cont)

## 'P1', 'S3' and 'Z4' Shafts




SPLINE DATA

'S'

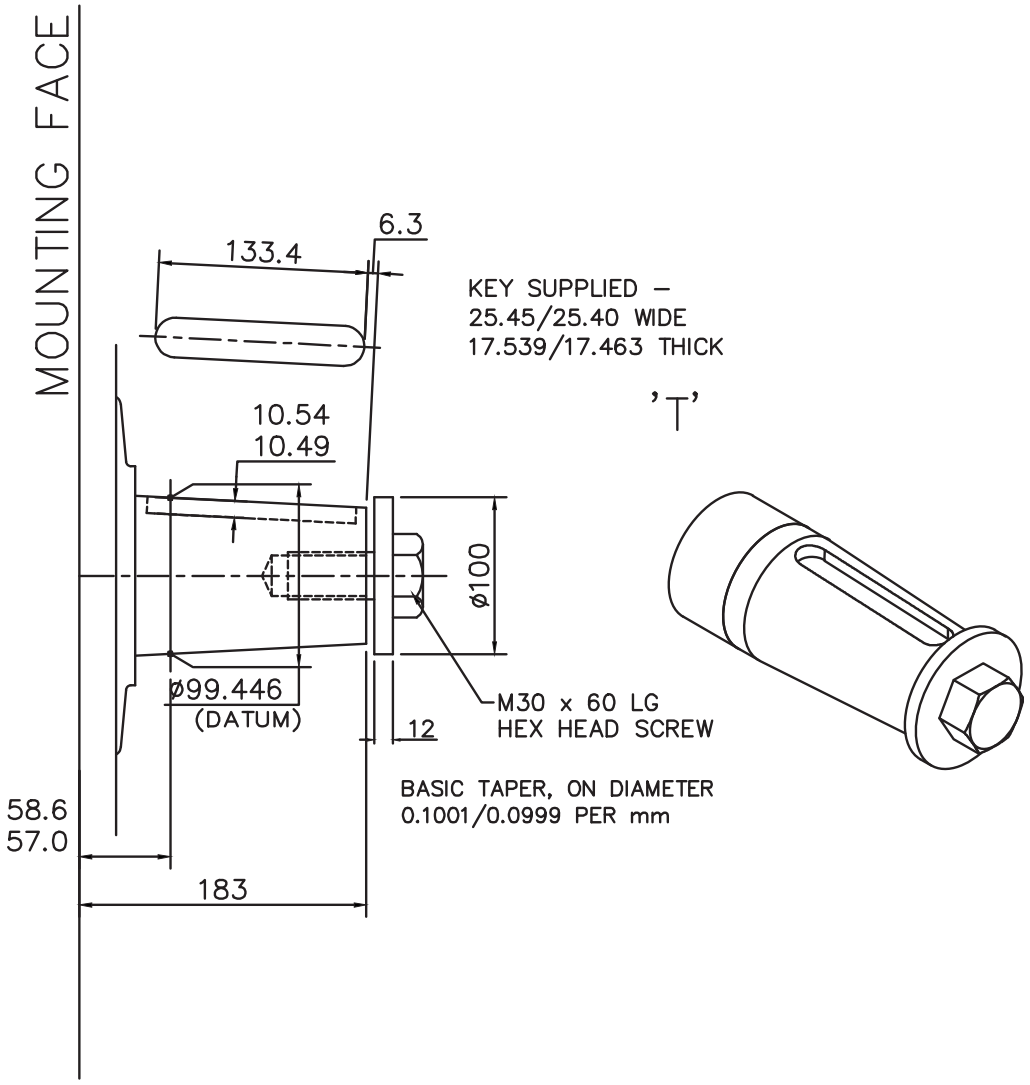
| | |
|---|---|
| TO BS 3550 (ANSI B92.1, CLASS 5) | |
| FLAT ROOT SIDE FIT, CLASS 1 | |
| PRESSURE ANGLE | 30° |
| NUMBER OF TEETH | 20 |
| PITCH | 6/12 |
| MAJOR DIAMETER | 87.953/87.825 |
| FORM DIAMETER | 80.264 |
| MINOR DIAMETER | 79.485/78.925 |
| PIN DIAMETER | 8.128 |
| DIAMETER OVER PINS |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

'Z'

DIN 5480 W90 x 4 x 21 x 7h

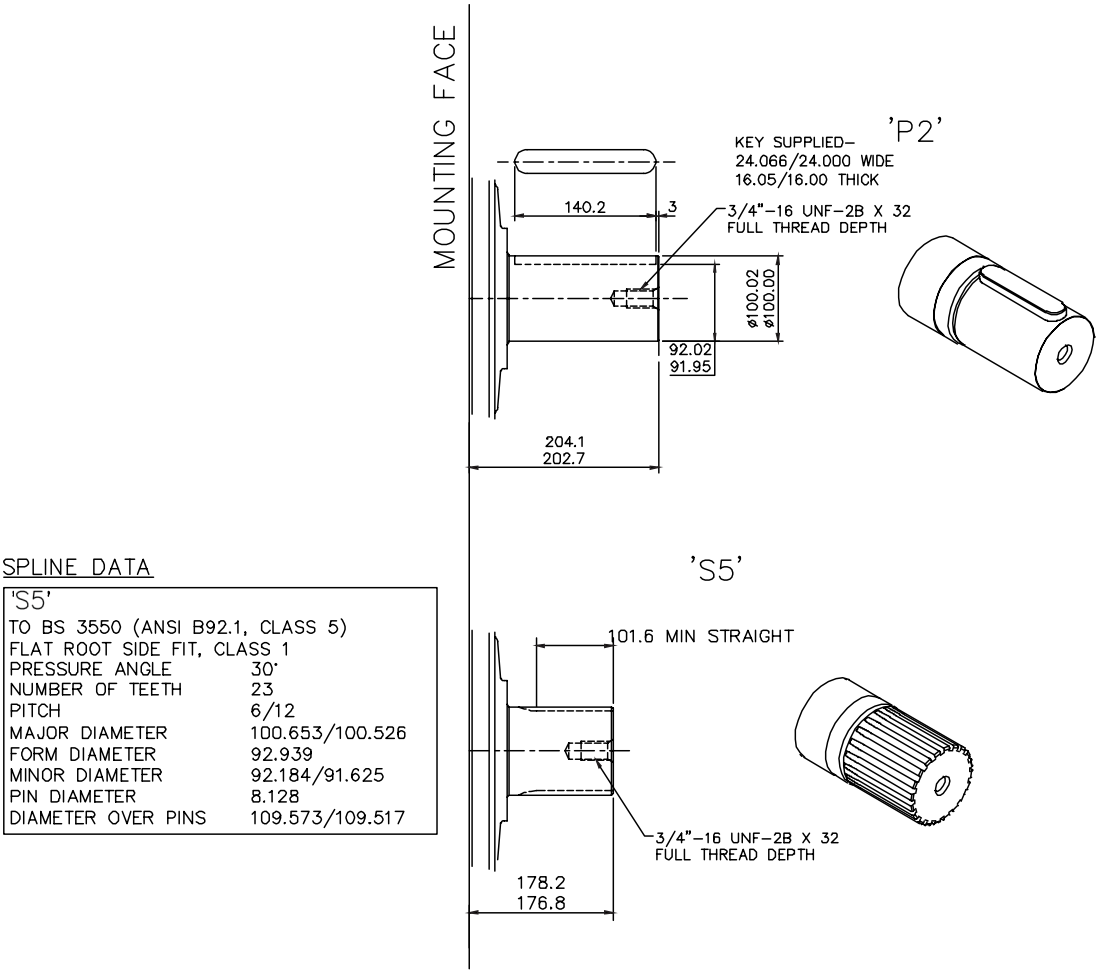
# 3-4 HMF325 (cont)

## 'T' Shaft



# 3-4 HMHDF325 (cont)

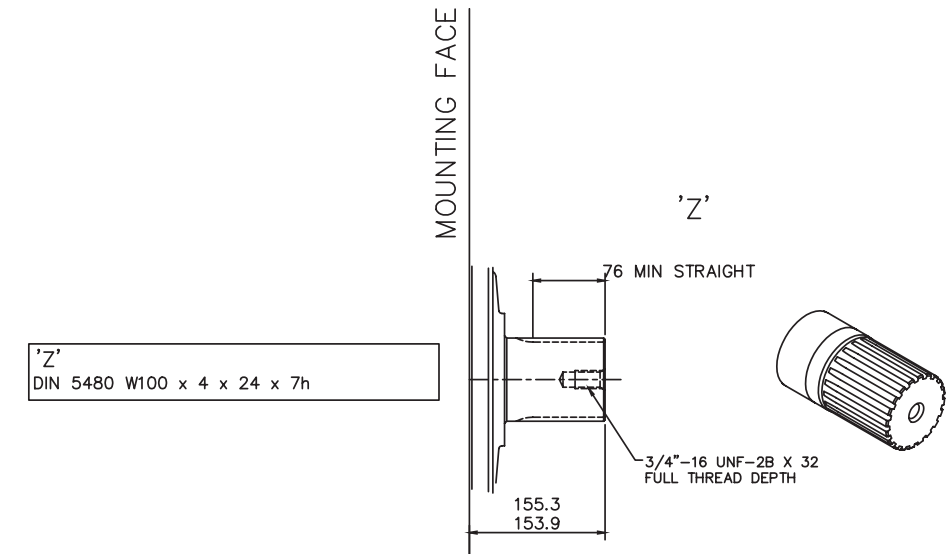
## 'P2', 'S5' and 'Z' Shafts




SPLINE DATA

| 'S5' | |
|---|---|
| TO BS 3550 (ANSI B92.1, CLASS 5) | |
| FLAT ROOT SIDE FIT, CLASS 1 | |
| PRESSURE ANGLE | 30° |
| NUMBER OF TEETH | 23 |
| PITCH | 6/12 |
| MAJOR DIAMETER | 100.653/100.526 |
| FORM DIAMETER | 92.939 |
| MINOR DIAMETER | 92.184/91.625 |
| PIN DIAMETER | 8.128 |
| DIAMETER OVER PINS | 109.573/109.517 |

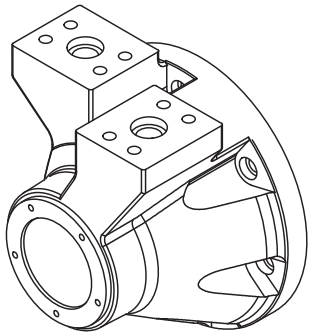


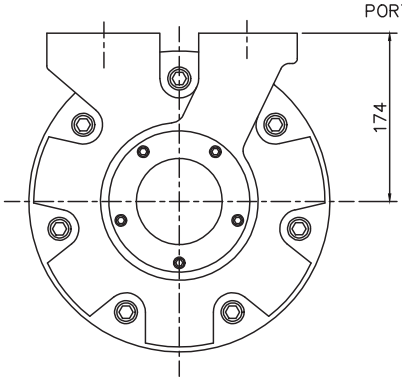




| 'Z' |
|---|
| DIN 5480 W100 x 4 x 24 x 7h |

# 3-4 HM(HD)F325 (cont)

## 'F4' & 'FM4' Valve Housings

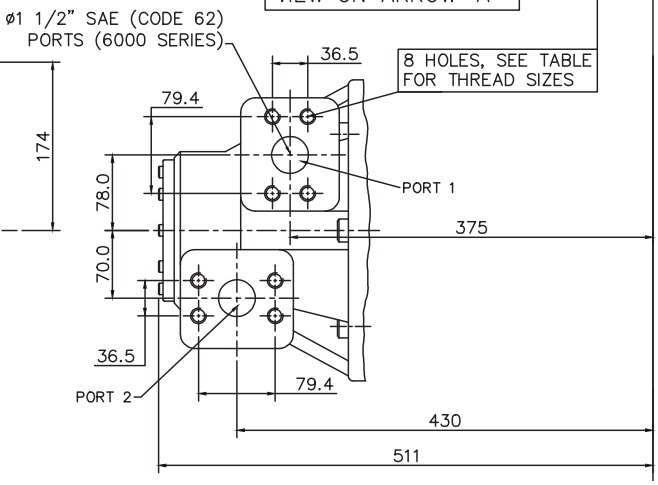





F4/FM4 –
4" VALVE HOUSING WITH
1 1/2" SAE 4–BOLT FLANGES

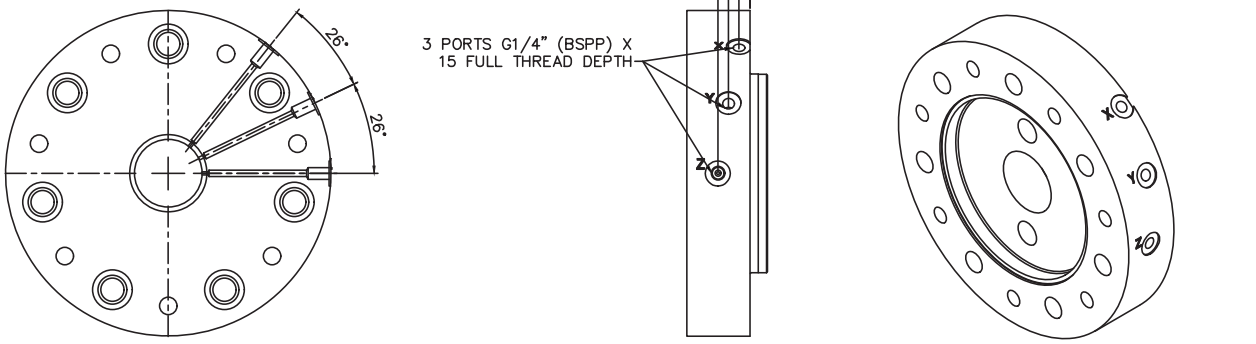
| PORT FLANGE BOLT TAPPING SIZE – |
|---|
| F4: 5/8"–11 UNC–2B X 35 FULL THREAD DEPTH |
| FM4: M16 X P2 X 35 FULL THREAD DEPTH |

VIEW ON ARROW 'A'



# 3-4 HM(HD)F325 (cont)

## 'X' F Spacer




DISPLACEMENT SELECTION (VIA REMOTELY LOCATED VALVE*)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
MID DISPLACEMENT: P TO X AND Z: Y TO T
SEE TIMING CHART.
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR.

# NOTES

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**The specified data is for product description purposes only and may not be deemed to be guaranteed unless expressly confirmed in the contract.**

Data sheet: M-2005/03.17