HM(HD)B

200

Staffa Fixed Displacement
Hydraulic Motor
1. GENERAL DESCRIPTION

The HM(HD)B200 fixed displacement motor is one of 12 frame sizes in the Kawasaki “Staffa” range of high torque, low speed radial piston motors which extends from 94 to 6800 cm$^3$/r (5.76 to 415 in$^3$/r) capacity. The rugged, well-proven design incorporates hydrostatic balancing techniques to achieve high efficiency, combined with good breakout torque and smooth running capability.

This motor is available with standard or with heavy duty shaft bearings, model types HMB200 and HMHDB200 respectively. Various features and options are available including, on request, mountings to match competitor interfaces.

The HMHDB200 is capable of torque outputs up to 13 500 Nm (9950 lbf ft) and speeds to 175 r/min with a continuous output of up to 130 kW (174 hp).

The Kawasaki “Staffa” range also includes dual and continuously variable displacement motors, plus matching brakes and gearboxes to extend the available torque range.

2. FUNCTIONAL SYMBOLS

All model types with variants in model code position.

-F2-, -FM2-, -S03-, -S04-

-F3-, -FM3-, -F4-, -FM4-
3. MODEL CODE

Features shown in brackets ( ) may be left blank according to requirements. All other features must be specified.

(F**)HM(**)B200-{H}**-{(V)}**-{(**)}-3*-{(PL**)}

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
</table>

1. FLUID TYPE
- Blank = Petroleum oil
- F3 = Phosphate ester (HFD fluid)
- F11 = Water-based fluids (HFA, HFB & HFC)

2. MODEL TYPE
- Blank = Standard (“HMB”)
- M = To NCB (UK) specification 463/1981 (“HMMB”)
- HD = Heavy duty (“HMHDB”)
- R = Dual mount, front or rear (“HMRB”)

3. SHAFT TYPE
Use “H” prefix code as noted to specify “hollow” shafts with through hole Ø 26.2 (1.03 in dia). Hollow shafts are available only with type “SO4” main port connection.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylindrical, keyed shafts</td>
<td></td>
</tr>
<tr>
<td>(H)P1*</td>
<td>Ø 85mm (3.35 in dia)</td>
</tr>
<tr>
<td>(H)P2*</td>
<td>Ø 100mm (3.94 in dia); HMHDB200 only</td>
</tr>
<tr>
<td>Cylindrical, splined shafts</td>
<td></td>
</tr>
<tr>
<td>(H)S3*</td>
<td>20 splines to BS 3550</td>
</tr>
<tr>
<td>(H)S4*</td>
<td>16 splines, 20° involute form</td>
</tr>
<tr>
<td>(H)S5*</td>
<td>23 splines to BS 3550; HMHDB200 only</td>
</tr>
<tr>
<td>(H)Z3*</td>
<td>Splines to DIN 5480 (W85 x 3 x 27 x 7h)</td>
</tr>
<tr>
<td>(H)Z5*</td>
<td>Splines to DIN 5480 (W100 x 4 x 24 x 7h); HMHDB200 only</td>
</tr>
<tr>
<td>(H)Q*</td>
<td>Female, 34 internal splines to BS 3550; HMHDB200 only</td>
</tr>
<tr>
<td>Tapered shafts</td>
<td></td>
</tr>
<tr>
<td>T*</td>
<td>Long taper, keyed shaft</td>
</tr>
<tr>
<td>(H)X*</td>
<td>Short taper, keyed shaft; HMHDB200 only</td>
</tr>
</tbody>
</table>

* For installations where shaft is vertically upwards specify “V” after shaft type letter to ensure that additional high level drain port is provided.

▲ Not normally recommended for use in heavy duty applications.

4. MAIN PORT CONNECTIONS

Models with 2¼” distributor valve
- F2 = SAE 1”, 4-bolt (UNC) flanges
- FM2 = SAE 1”, 4-bolt (metric) flanges

Models with 3” distributor valve
- F3 = SAE 1¼”, 4-bolt (UNC) flanges
- FM3 = SAE 1¼”, 4-bolt (metric) flanges
- SO3 = 6-bolt (UNF) flange (Staffa original valve housing)

- Models with 4” distributor valve
  - F4 = SAE 1½”, 4-bolt (UNC) flanges
  - FM4 = SAE 1½”, 4-bolt (metric) flanges
  - SO4 = 6-bolt (UNF) flange (Staffa original valve housing)

▲ These port options allow reduced installation dimensions but have flow limitations; see “Performance Data” (page 4) for recommended maximum speeds.

▼ Obligatory for hollow shaft motors

5. TACHO/ENCODER DRIVE
- T = Staffa original tacho drive
- T1 = Suitable for Hohner 3000 series encoders. (Encoder to be ordered separately).
Omit if not required and when specifying shaft types “H”.

6. DESIGN NUMBER, 3* SERIES
Subject to change, installation and performance details remain unaltered for design numbers 30 to 39 inclusive.

7. SPECIAL FEATURES
- PL** = non-catalogued features, e.g.:
  - Stainless steel shaft sleeves
  - Alternative encoder and tacho drives
  - Alternative port connections
  - Shaft variants
  - Alternative capacities
  - Special mountings
  - Special paint

** Number assigned as required to specific customer build.
4. PERFORMANCE DATA

Performance data is valid for Staffa HMB200 and HMDB200 motors fully run in and operating with petroleum oil. See separate table for pressure and speed limits when using fire-resistant fluids. Leakage values are at fluid viscosity of 50 cSt (232 SUS).

MOTOR DATA

<table>
<thead>
<tr>
<th>Port connection type, model code</th>
<th>Geometric displacement cm³/r (in³/r)</th>
<th>Average actual running torque Nm/bar (lbf ft/psi)</th>
<th>Max. continuous speed r/min</th>
<th>Max. continuous output kW (hp)</th>
<th>Max. continuous pressure bar (psi)</th>
<th>Max. intermittent pressure bar (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F4, FM4, SO4</td>
<td>3080 (188)</td>
<td>46.07 (2.343)</td>
<td>175</td>
<td>130 (174)</td>
<td>250 (3625)</td>
<td>293 (4250)</td>
</tr>
<tr>
<td>F3, FM3, SO3</td>
<td>3080 (188)</td>
<td>46.07 (2.343)</td>
<td>135</td>
<td>130 (174)</td>
<td>250 (3625)</td>
<td>293 (4250)</td>
</tr>
<tr>
<td>F2, FM2</td>
<td>3080 (188)</td>
<td>46.07 (2.343)</td>
<td>65</td>
<td>75 (100)</td>
<td>250 (3625)</td>
<td>293 (4250)</td>
</tr>
</tbody>
</table>

▲ Other displacements can be made available to special order
▼ Recommended limit to avoid excessive pressure losses
◆ See “Rating Definitions”, this page

Limits for Fire Resistant Fluids

<table>
<thead>
<tr>
<th>Fluid type</th>
<th>Pressure, bar (psi)</th>
<th>Max. speed r/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFA, 5/95% oil-in-water emulsion</td>
<td>103 (1500)</td>
<td>50% of limits for petroleum oil</td>
</tr>
<tr>
<td>HFB, 60/40% water-in-oil emulsion</td>
<td>138 (2000)</td>
<td>As for petroleum oil</td>
</tr>
<tr>
<td>HFC, water glycol</td>
<td>103 (1500)</td>
<td>50% of limits for petroleum oil</td>
</tr>
<tr>
<td>HFD, phosphate ester</td>
<td>250 (3625)</td>
<td>As for petroleum oil</td>
</tr>
</tbody>
</table>

OUTPUT TORQUES

The torque curves indicate the maximum output torque and power of a fully run-in motor for a range of pressures and speeds when operating with zero outlet pressure on petroleum oil of 50 cSt (232 SUS) viscosity. High return line pressures will reduce torque for a given pressure differential.

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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**
Operation within the intermittent power rating (up to the maximum continuous speed) is permitted on a 15% duty basis, for periods up to 5 minutes maximum.

**INTERMITTENT MAX. PRESSURE**
Up to 293 bar (4250 psi) is allowable on the following basis:
(a) Up to 50 r/min: 15% duty for periods up to 5 minutes maximum.
(b) Over 50 r/min: 2% duty for periods up to 30 seconds maximum.
The nomographs on this and the following page allow the median bearing life to be determined for conditions of:
1. No side load and no axial thrust
2. Side load and no axial thrust

To determine L10 life predictions per ISO 281-1-1977 multiply the median figure by 0.2.

**HMB200**

Example 1 (follow chain dotted line):
- Side load (W) a) 0
- System pressure (P) b) 138 bar (2000 psi)
- Speed (N) c) 175 r/min
- Median bearing life d) 23 000 hrs

L10 bearing rating = median x 0.2 4600 hrs

Example 2 (follow chain dotted line):
- Side load (W) e) 50 kN (11 236 lbf)
- Load offset (A) from motor mounting face f) 100 mm (4.0 in)
- System pressure (P) g) 138 bar (2000 psi)
- Speed (N) h) 50 r/min
- Median bearing life i) 12 000 hrs

L10 bearing rating = median x 0.2 2400 hrs

For more precise life prediction, or where axial thrusts are incurred, a computer analysis can be provided by Kawasaki on receipt of machine duty cycle.

**SHAFT STRESS LIMIT**
The shaft stress limit in the nomograph is based on the fatigue rating of shaft types “S” and “P”. Infrequent loading above these limits may be permitted; consult Kawasaki.
BEARING LIFE

For HMHDB200 (heavy duty) models
(See previous page for HMB200, standard models)

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**HMHDB200**

Example 1 (follow chain dotted line):
- Side load (W) \( j \) 0
- System pressure (P) \( k \) 138 bar (2000 psi)
- Speed (N) \( l \) 100 r/min
- Median bearing life \( m \) 36 000 hrs
- L10 bearing rating = median x 0.2 7200 hrs

Example 2 (follow chain dotted line):
- Side load (W) \( n \) 50 kN (11236 lbf)
- Load offset (A) from motor mounting face \( o \) 100 mm (4.0 in)
- System pressure (P) \( p \) 138 bar (2000 psi)
- Speed (N) \( q \) 10 r/min
- Median bearing life \( r \) 150 000 hrs
- L10 bearing rating = median x 0.2 30 000 hrs

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W = Side load
A = Distance from mounting face to load centre
P = Max. pressure on port 1 or port 2
N = Shaft speed, r/min

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**For HMHDB200 (heavy duty) models**
(See previous page for HMB200, standard models)
This nomograph enables the average volumetric efficiency, crankcase (drain) leakage and “winch slip”/shaft creep speed to be estimated.

Example (follow chain dotted line):
Given:
1. Pressure ................. 180 bar (2610 psi)
2. Speed ................................. 25 r/min
3. Viscosity ................ 50 cSt (232 SUS)
To obtain:
4. Volumetric efficiency .............. 95.4%
5. Crankcase leakage ........... 1,25 l/min
6. Shaft creep speed ............. 0.7 r/min

The shaft creep speed occurs when the load attempts to rotate the motor against closed ports as may occur, for example, in winch applications.

5. CIRCUIT AND APPLICATION NOTES

STARTING TORQUES
The starting torques shown on the graph on page 4 are average and will vary with system parameters.

LOW SPEED OPERATION
Minimum operating speeds are determined by load conditions (load inertia, drive elasticity, etc.). For operation at speeds below 3 r/min consult Kawasaki.

HIGH BACK PRESSURE
When both inlet and outlet ports are pressurized continuously, the lower pressure in one port must not exceed 70 bar (1000 psi). Consult Kawasaki on applications beyond this limit. Note that high back pressures reduce 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 inlet ports. Calculate “P” according to port connection type being used, from:

\[ P \text{ (bar)} = 1 + \frac{N^2}{D\text{bar}} + C \text{ bar} \]

\[ P \text{ (psi)} = 14.5 + \frac{N^2}{D\text{psi}} + C \text{ psi} \]

Where:
N = speed, r/min
D = see table
C = crankcase pressure

Port connection type | D value
---|---
F2, FM2 | D\text{bar} = 440
 | D\text{psi} = 30
F3, FM3, S03 | D\text{bar} = 3500
 | D\text{psi} = 241
F4, FM4 S04 | D\text{bar} = 15 000
 | D\text{psi} = 1034

The flow rate of oil needed for the make-up system can be estimated from the crankcase leakage figure (see Volumetric Efficiency graph above). Allowance should be made for other system losses and also for “fair wear and tear” during the life of the motor, pump and other system components.

COOLING FLOW
Operation within the continuous ratings does not require any additional cooling.

For operating conditions above “continuous”, up to the “intermittent” ratings, additional cooling oil may be required. This can be introduced through the spare crankcase drain hole, or in special cases through the valve spool end cap. Consult Kawasaki about such applications.
MOTOR CASING PRESSURE
With the standard shaft seal fitted, the motor casing pressure should not exceed 3.5 bar (50 psi). On installations with long drain lines a relief valve is recommended to prevent overpressurizing the seal.

Notes:
1. The casing 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:
   - Continuous: 10 bar (150 psi)
   - Intermittent: 15 bar (225 psi)
3. Check installation dimensions (page 9) for maximum crankcase drain fitting depth.

6. HYDRAULIC FLUIDS
Dependent on motor (see Model Code position 1) suitable fluids include:
- Antiwear hydraulic oils
- Phosphate esters (HFD fluids)
- Water glycols (HFC fluids)
- 60/40% water-in-oil emulsions (HFB fluids)
- 5/95% oil-in-water emulsions (HFA fluids)

▲ Reduced pressure and speed limits, see page 4.

Viscosity limits when using any fluid except oil-in-water (5/95%) emulsions are:
Max. off load ........... 2000 cSt (9270 SUS)
Max. on load ............. 150 cSt (695 SUS)
Optimum ................... 50 cSt (232 SUS)
Minimum .................. 25 cSt (119 SUS)

PETROLEUM OIL RECOMMENDATIONS
The fluid should be a good hydraulic grade, non-detergent petroleum oil. It should contain anti-oxidant, anti-foam and demulsifying additives. It must contain antiwear or EP additives. Automatic transmission fluids and motor oils are not recommended.

7. TEMPERATURE LIMITS
Ambient min........................ -30°C (-22°F)
Ambient max........................ +70°C (158°F)

Max. operating temperature range

<table>
<thead>
<tr>
<th>Petroleum oil</th>
<th>Water-containing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.</td>
<td>-20°C (-4°F)</td>
</tr>
<tr>
<td>Max.*</td>
<td>+80°C (175°F)</td>
</tr>
</tbody>
</table>

▲ To obtain optimum service life from both fluid and hydraulic system components 65°C (150°F) normally is the maximum temperature except for water-containing fluids.

8. FILTRATION
Full flow filtration (open circuit), or full boost flow filtration (closed circuit) to ensure system cleanliness of ISO 4406/1986 code 18/14 or cleaner.

9. NOISE LEVELS
The airborne noise level is less than 66.7 dB(A) DIN (70 dB(A) NFPA) throughout 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 (30 to 70 psi).

10. POLAR MOMENT OF INERTIA
Typical data: 0.27 kg m² (920 lb in²)

11. MASS
Approx., all models: 265 kg (584 lb)

12. INSTALLATION DATA

GENERAL
- Location diameter
  The motor should be located by the mounting location diameter on a flat, robust surface using correctly sized bolts. The diametral clearance between the location diameter and the mounting must not exceed 0.15 mm (0.006 in). 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 settings for the mounting bolts are:
  - M20 bolts.....407±14Nm (300±10 lbf ft)
  - 3/4" bolts.....393±14Nm (290±10 lbf ft)

- Shaft coupling
  Where the motor is solidly coupled to a shaft having independent bearings the shafts must be aligned to within 0.13 mm (0.005 in) TIR.

CRANKCASE DRAIN
The crankcase drain must be taken from a position above the horizontal centre line of the motor.

START-UP
Fill the crankcase with system fluid. Where practical, a short period (30 minutes) of “running in” should be carried out.
13. INSTALLATION DIMENSIONS IN MM (INCHES)

FRONT-MOUNTING MODELS
HMB200 & HMHDB200 MOTORS WITH TYPE “F4”/“FM4”
(1 1/2” SAE) PORT CONNECTION

See additional views for shaft types and for types “SO4”, “F3”, “FM3” and “SO3” port connection.
See drawing of dual-mount model for details of types “F2” and “FM2” port connection.

2 off pressure tappings
(1 into each main port),
see table for thread details.
Supplied plugged.

3 drain ports 3/4”-16 UNF-2B
(two normally plugged).
Pipe fitting must not enter port more than 12.0 (0.5).

5 holes Ø 20.0 (0.79 dia)
equi-spaced as shown on
419.1 (16.5) pcd and
spotfaced to Ø 38.0 (1.5 dia)

Port tappings

<table>
<thead>
<tr>
<th>Model code</th>
<th>Tapping size for flange bolts</th>
<th>Gauge tappings</th>
</tr>
</thead>
<tbody>
<tr>
<td>F4</td>
<td>5/8”-11 UNC-2B x 35.0 (1.38) full thread depth</td>
<td>5/8”-18 UNF-2B, SAE J475</td>
</tr>
<tr>
<td>FM4</td>
<td>M16 x P2.0 x 35.0 (1.38) full thread depth</td>
<td>G1/4” (BSPF)</td>
</tr>
</tbody>
</table>

* Ø 0.15 (0.006)

▲ Mounting location diameter
DUAL-MOUNT MODELS
HMRB200 AND HMHDRB200 MOTORS WITH TYPES “F2” AND “FM2” (1” SAE) PORT CONNECTION

See additional views for shaft types and for types “F3”, “FM3” “SO4” and “SO3” port connection.

2 rear mount holes Ø 19.0 (0.75 dia) x 32.0 (1.25) deep spaced as shown on 320.0 (12.598) pcd. (Pilot holes for dowels if required)

3 drain ports 3/4"-16 UNF-2B (two normally plugged). Pipe fitting must not enter port more than 12 (0.5).

8 rear mount holes 7/8"-9 UNC-2B x 32.0 (1.25) deep, spaced as shown on 320.0 (12.598) pcd

5 font mount holes Ø 20.0 (0.79 dia) equi-spaced as shown on 419.1 (16.5) pcd and spotfaced to Ø 38.0 (1.5 dia)

Flow directions for shaft rotation shown. Reverse flow directions for opposite rotation.

Port flange bolt tappings

<table>
<thead>
<tr>
<th>Model</th>
<th>Bolt tappings</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2</td>
<td>3/8&quot;-16 UNC-2B x 22.0 (0.87) deep</td>
</tr>
<tr>
<td>FM2</td>
<td>M10 x P1.5 x 22.0 (0.87) deep</td>
</tr>
</tbody>
</table>

Mounting location diameter

Ø 0.15 (0.006)
4" VALVE HOUSING WITH 6-BOLT FLANGE, “S04” IN MODEL CODE POSITION 4.

- Ø 254.0 (10.0 dia)
- 84.0 (3.31)
- 444.0 (17.48)
- 323.0 (12.72)

Flow directions for shaft rotation shown on main drawings, pages 9 and 10. Reverse flow for opposite direction of shaft rotation.

3" VALVE HOUSING WITH 6-BOLT FLANGE, “S03” IN MODEL CODE POSITION 4.

- Ø254,0 (10.0 dia)
- 84.0 (3.31)
- 63.5 (2.5)
- 10.0 (0.375)
- 63.5 (2.5)
- 129.0 (5.06)
- 50.8 (2.0)
- 50.8 (2.0)
- 50.8 (2.0)
- r. 19 (0.75)
- Port 2 ▲
- Port 1 ▲

Flow direction for shaft rotation shown on main drawings, pages 9 and 10. Reverse flow for opposite direction of shaft rotation.

6 holes ¼"-24 NF-2B, 16.0 (0.625) deep

Flange bolt tappings

<table>
<thead>
<tr>
<th>Model code</th>
<th>Tapping size for flange bolts</th>
<th>Gauge tappings</th>
</tr>
</thead>
<tbody>
<tr>
<td>F3</td>
<td>⅞&quot;-14 UNC-2B x 27.0 (1.06)</td>
<td>½&quot;-18 UNF-2B, SAE J475 full thread depth</td>
</tr>
<tr>
<td>FM3</td>
<td>M12 x P1.75 x 27.0 (1.06)</td>
<td>G1¼&quot; (BSPF)</td>
</tr>
</tbody>
</table>
SHAFT TYPES “P1” & “HP1”, MODEL CODE POSITION
Ø 85.0 (3.35 dia) cylindrical shaft with key, with optional through hole.

SHAFT TYPES “P2” & “HP2”, MODEL CODE POSITION
Ø 100.0 (3.94 dia) cylindrical shaft with key, with optional through hole.

Key (supplied) 24.06/24.00 (0.9475/0.9449) wide x 16.05/16.0 (0.632/0.630) thick

SHAFT TYPES “S1” & “HS1”, MODEL CODE POSITION
Ø 85.0 (3.35 dia) cylindrical shaft with key, with optional through hole.

SHAFT TYPES “S2” & “HS2”, MODEL CODE POSITION
Ø 100.0 (3.94 dia) cylindrical shaft with key, with optional through hole.

Key (supplied) 24.06/24.00 (0.9475/0.9449) wide x 16.05/16.0 (0.632/0.630) thick

SHAFT TYPES “S3” & “HS3”, “S5” & “HS5” IN MODEL CODE POSITION
Cylindrical shafts with splines to BS 3550-1963, with optional through hole

SHAFT TYPES “Z3”, “HZ3”, “Z5” & “HZ5” IN MODEL CODE POSITION
Cylindrical shafts with splines to DIN 5480, with optional through hole
SHAFT TYPES “Q” AND “HQ”, MODEL CODE POSITION

Female shaft with 34 splines to BS 3550, with optional through hole.

Note: The “Q” and “HQ” shafts will transmit the maximum torque given on page 4. However, customers should ensure that their own mating shaft will transmit the torque required in their application.
Staffa hydraulic motors are manufactured to the highest quality standards in a Kawasaki ISO 9001 certified facility. Certification No. 891150