Kawasaki Motors Corp., U.S.A.
Precision Machinery Division

HMHDB 400

Staffa Fixed Displacement Hydraulic Motor

CONTENTS

1. GENERAL DESCRIPTION

The HMHDB400 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.

Various features and options are available including, on request, mountings to match competitor interfaces.

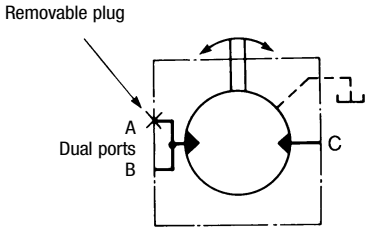
The HMHDB400 is capable of torque outputs up to 29 800 Nm (21 980 lbf ft) and speeds to 120 r/min with a continuous output of up to 190 kW (256 hp).

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

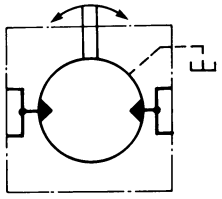
2. FUNCTIONAL SYMBOLS

Model types with variants in model code position **4**

HMHDB400-**-30
(No symbol in model code position **4**)



HMHDB400-**-S045-30
Dual ports



3. MODEL CODE

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

(F)-HM(*)HDB400-*(V)-(****)-(**)3*-(PL**)**

1 **2** **3** **4** **5** **6** **7**

1 FLUID TYPE

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

2 MODEL TYPE

Blank = Standard ("HMHDB")
M = To NCB (UK) specification 463/1981 ("HMMHDB")

3 SHAFT TYPE

P* = Cylindrical shaft with two keys
S* = Cylindrical, 23 splines to BS 3550
Z* = Cylindrical to DIN 5480 (W100 x 4 x 24 x 7h)
Q* = Female, 31 splines to BS 3550
X* = Tapered, keyed shaft

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

4 MAIN PORT CONNECTIONS

Blank = Combined 6-bolt flange and 4-bolt SAE connections:
Ports "B" and "C" 6-bolt (UNF) flange
Ports "A" and "C" SAE 2" 4-bolt (UNF) flanges
S045 = 2 x 6-bolt (UNF) flanges (2 inlet and 2 outlet ports available)

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.

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 HMHDB400 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

Geometric displacement▲	6800 cm^3/r (415 in^3/r)
Average actual running torque	101 Nm/bar (5.15 lbf ft/psi)
Max. continuous◆ speed	120 r/min
Max. continuous◆ output	190 kW (256 hp)
Max. continuous◆ pressure	250 bar (3625 psi)
Max. intermittent◆ pressure bar	293 bar (4250 psi)

▲ *Other displacements are available to special order*

◆ *See "Rating Definitions", this page*

LIMITS FOR FIRE RESISTANT FLUIDS

Fluid type	Pressure, bar (psi) Continuous	Intermittent	Max. speed r/min
HFA, 5/95% oil-in-water emulsion	103 (1500)	138 (2000)	50% of limits for petroleum oil
HFB, 60/40% water-in-oil emulsion	138 (2000)	172 (2500)	As for petroleum oil
HFC, water glycol	103 (1500)	138 (2000)	50% of limits for petroleum oil
HFD, phosphate ester	250 (3625)	293 (4250)	As for petroleum oil

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

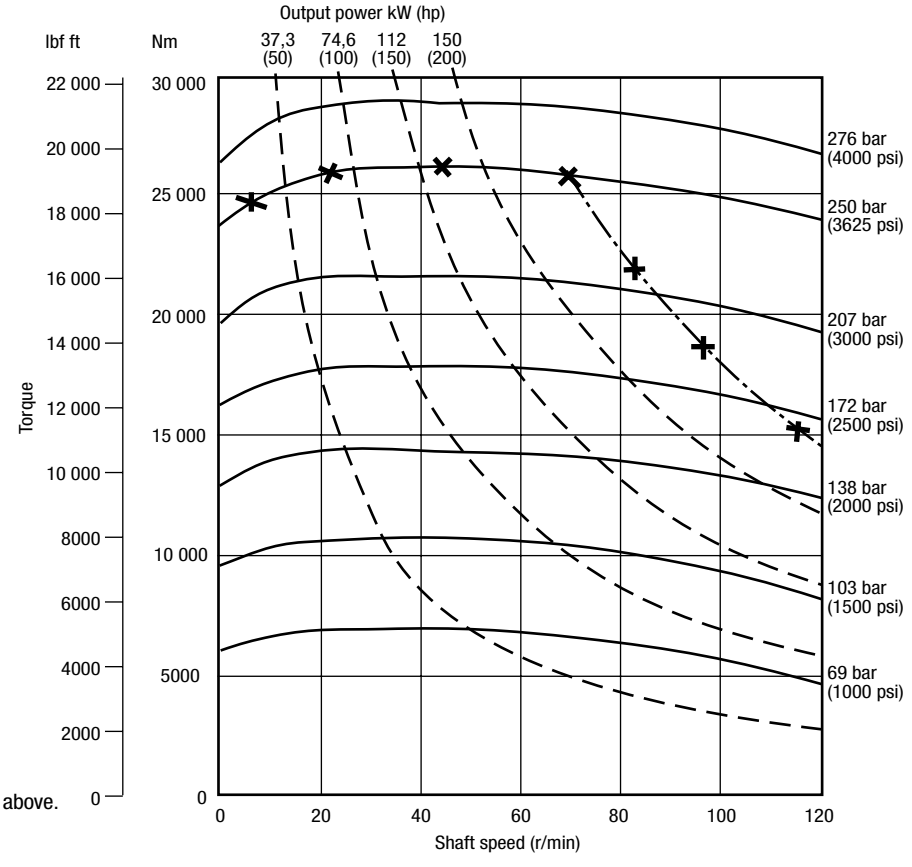
Up to 293 bar (4250 psi) is allowable on the following basis:

(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.

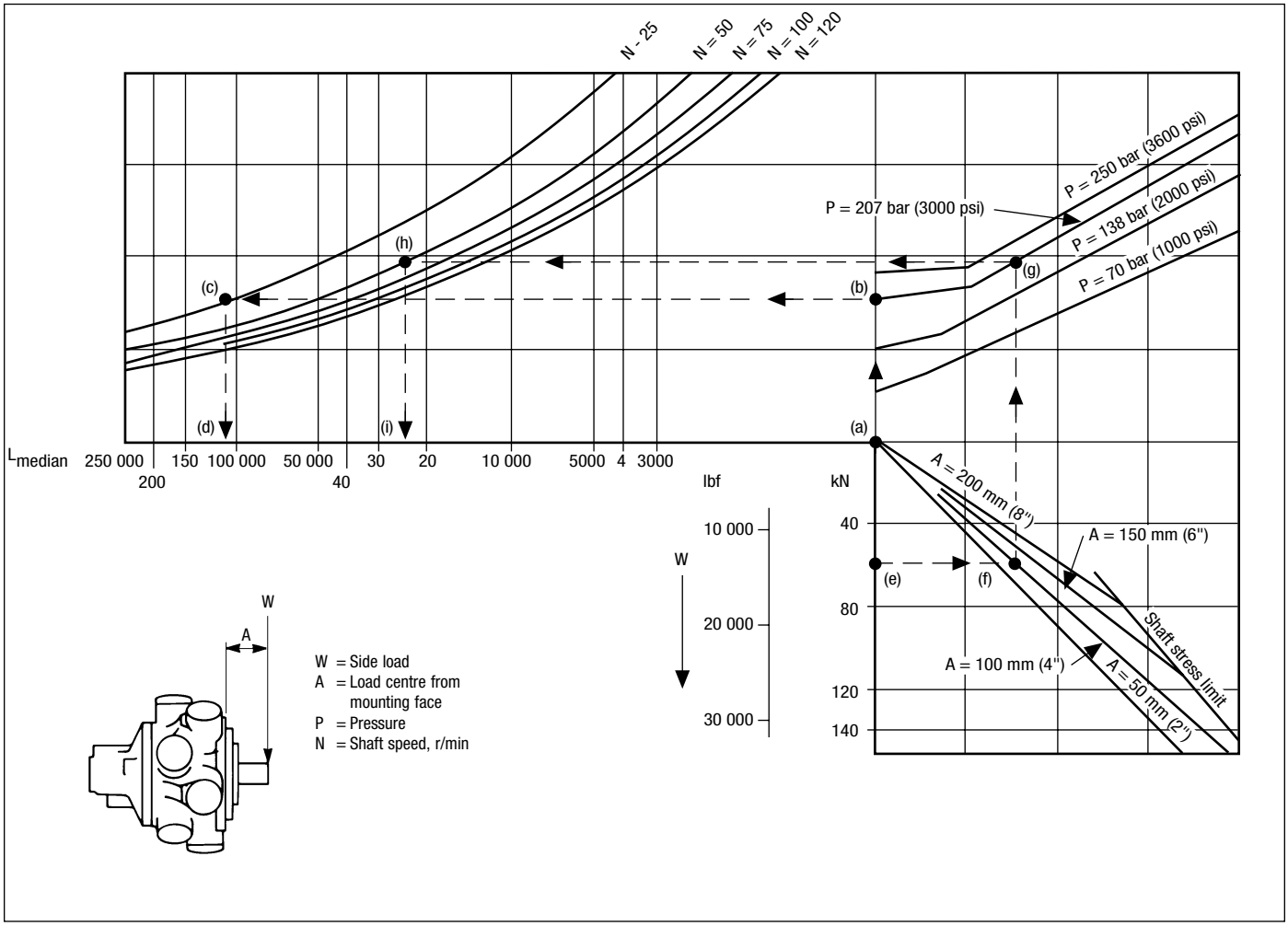
OUTPUT TORQUES

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.



–x–x–x– Upper limit of continuous rating envelope, see "Rating definitions" above.

BEARING LIFE



The nomograph allows 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.*

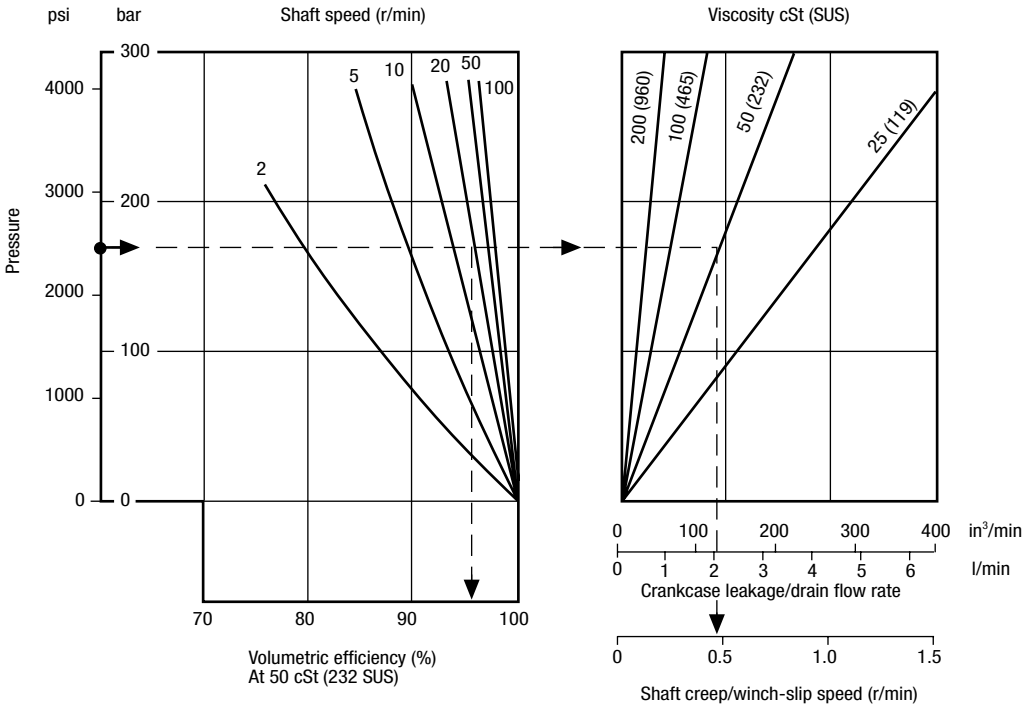
	HMHDB400
Example 1 (follow chain dotted line):	
Side load (W)	a) 0
System pressure (P)	b) 207 bar (3000 psi)
Speed (N)	c) 25 r/min
Median bearing life	d) 110 000 hrs
L10 bearing rating = median x 0.2	22 000 hrs
Example 2 (follow chain dotted line):	
Side load (W)	e) 60 kN (13 500 lbf)
Load offset (A) from motor mounting face	f) 100 mm (4.0 in)
System pressure (P)	g) 207 bar (3000 psi)
Speed (N)	h) 50 r/min
Median bearing life	i) 22 000 hrs
L10 bearing rating = median x 0.2	4400 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.

VOLUMETRIC EFFICIENCY



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 ..... 170 bar (2500 psi)
2. Speed .....20 r/min
3. Viscosity .....50 cSt (232 SUS)

To obtain:
4. Volumetric efficiency 96%
5. Crankcase leakage .....2 l/min
(121 in^3/min)
6. Shaft creep speed .....0.45 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 2 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:

$$P\ (bar) = 1 + \frac{N^2}{D_{bar}} + C\ bar$$

$$P\ (psi) = 14.5 + \frac{N^2}{D_{psi}} + C\ psi$$

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

Port connection type	D value
No symbol at model code **4**	$D_{bar} = 1300$ $D_{psi} = 90$
SO45	$D_{bar} = 1560$ $D_{psi} = 107$

The flow rate of oil needed for the make-up system can be estimated from the crankcase leakage figure (see Volumetric Efficiency graph on page 6). 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 over-pressurizing 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

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

* *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: 0,54 kg m^2 (1840 lb in^2)

11. MASS

HMHDB400 with 4" valve .....481 kg (1060 lb)
HMHDB400 with 4 1/2" valve.....510 kg (1124 lb)

12. INSTALLATION DATA

GENERAL

● Spigot

The motor should be located by the mounting spigot on a flat, robust surface using correctly sized bolts. The diametral clearance between the motor spigot 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

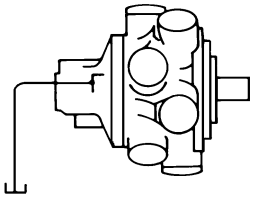
The recommended torque wrench settings for the mounting bolts are:
M20 bolts .....407±14Nm (300±10 lbf ft)
3/4" bolts.....393±14Nm (290±10 lbf ft)

● 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.

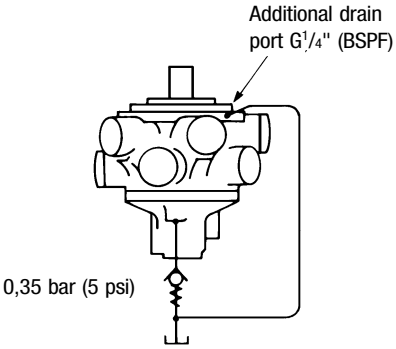
CRANKCASE DRAIN

Motor axis horizontal



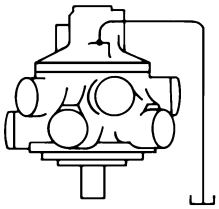
The drain line should be taken from the highest drain port position to ensure lubrication of the shaft bearings.

Axis vertical, shaft up



An additional G1/4" (BSPF) drain port is provided in the mounting flange when the "V" (shaft vertically upwards) designator is given after the shaft type letter in position **3** of the model code. This additional drain should be connected into the main motor casing drain line downstream of a 0,35 bar (5 psi) check valve to ensure lubrication of the upper bearing.

Axis vertical, shaft down



Use either drain port. There are no special requirements for the drain line with this type of installation.

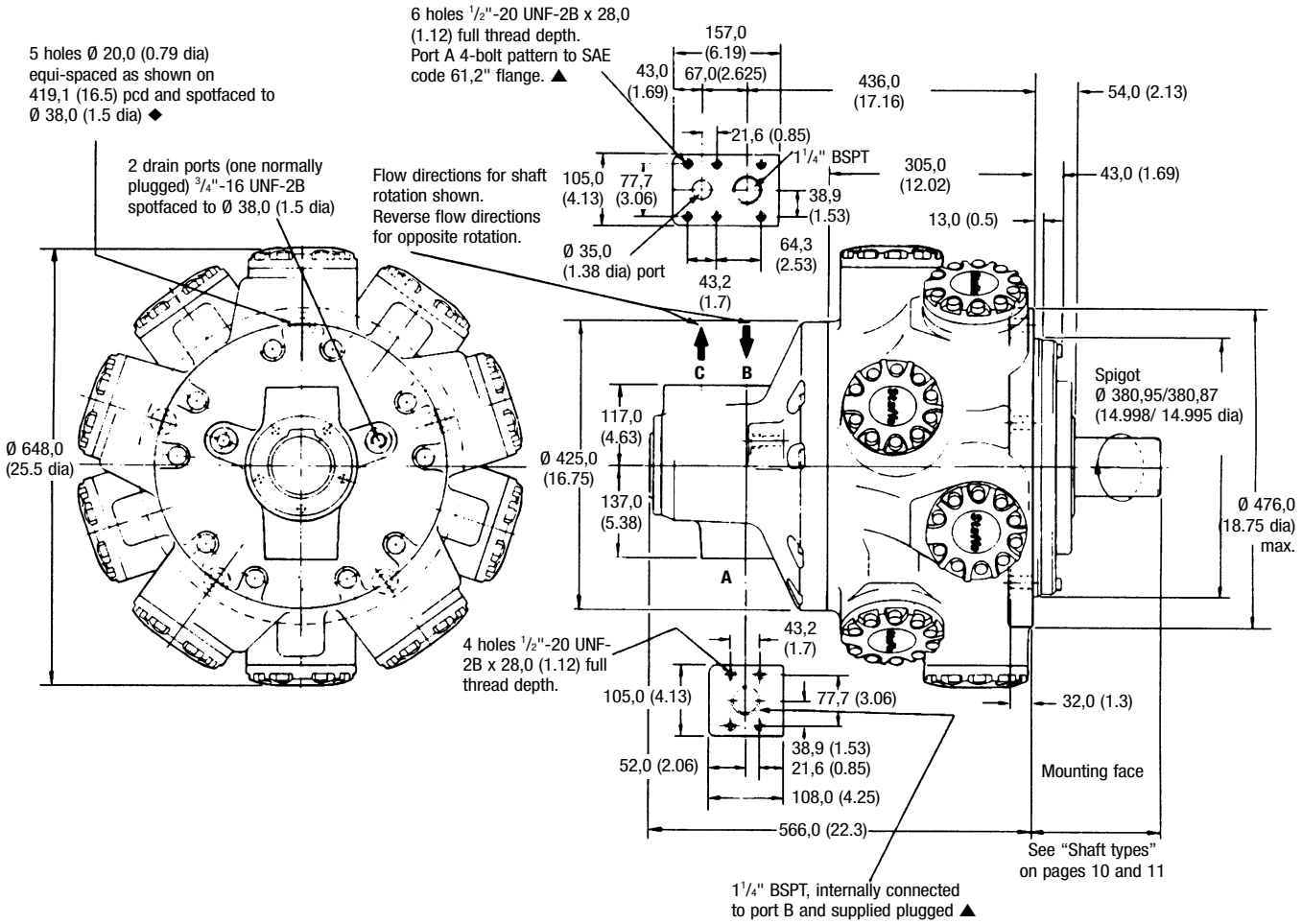
START-UP

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)

HMHDB400 MOTORS WITH 6-BOLT (UNF) FLANGE OR SAE 2", 4-BOLT (UNF) FLANGES; NO SYMBOL AT MODEL CODE POSITION 4

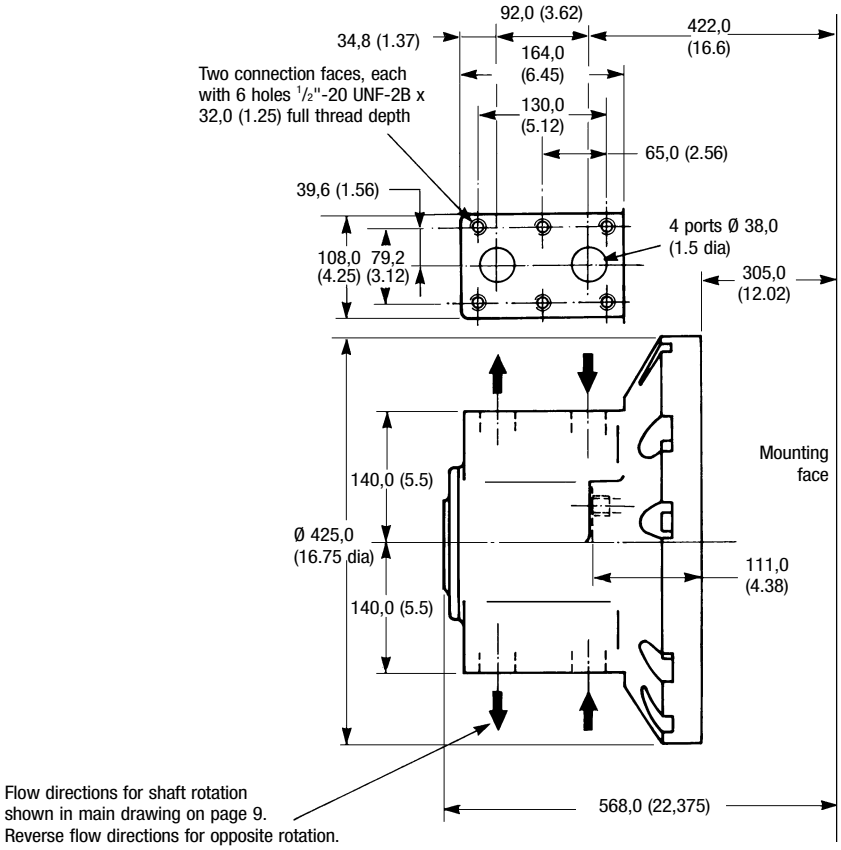
3rd angle projection



▲ *Motor as supplied is ready for 6-bolt connection to be made to ports B and C. For use with 2" SAE flanges at ports A and C, remove plug from port A and plug port B. In some installations piping advantages may be obtained by using both common ports A and B.*

◆ ⌖ Ø 0,15 (0.006)

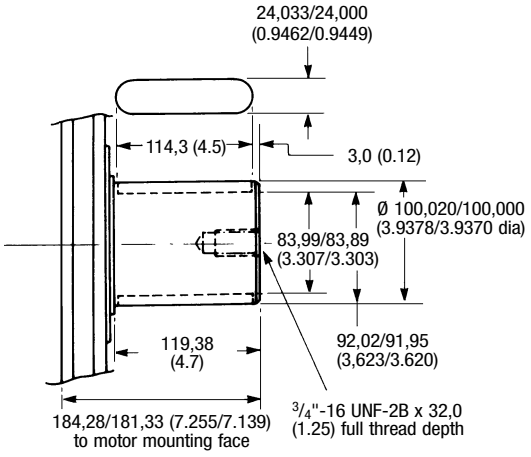
DUAL PORT, 6-BOLT FLANGE CONNECTION, "SO45" IN MODEL CODE POSITION 4



SHAFT TYPE "P", MODEL CODE POSITION 3

Cylindrical shaft with 2 keys

2 keys supplied:
24,067/24,000 (0.9475/0.9449) wide x
16,055/15,999 (0.6320/0.6299) thick

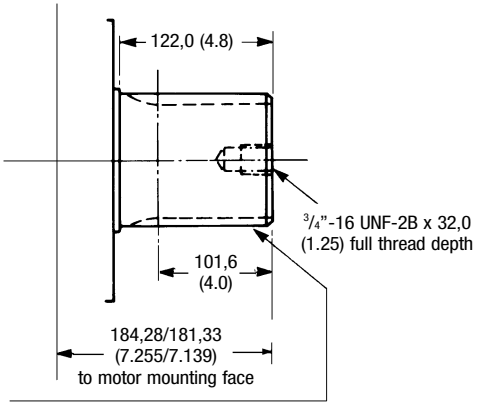


SHAFT TYPE "S", MODEL CODE POSITION 3

Cylindrical shaft with 23 splines to BS 3550-1963

SHAFT TYPE "Z", MODEL CODE POSITION 3

Cylindrical shaft with splines to DIN 5480



Spline data

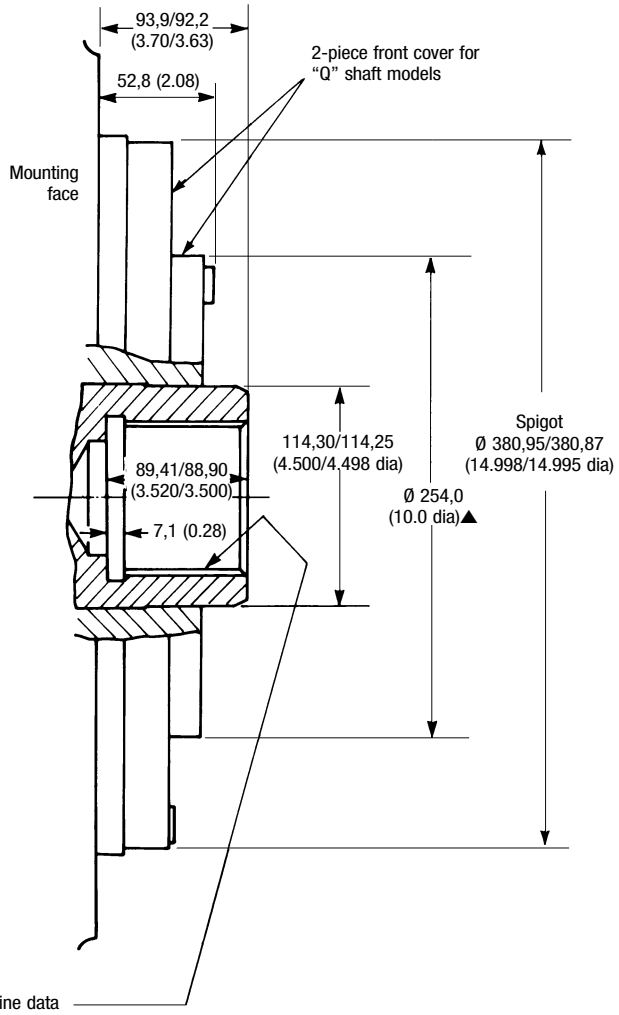
For shaft type "S"	
To BS 3550-1963 & ASA.B5. 15-1960	
Flat root, side fit, class 1	
Pressure angle	30°
Number of teeth	23
Pitch	6/12
Major diameter	100,65/100,52 (3.9627/3.9577)
Form diameter	92,939 (3.6590)
Minor diameter	92,185/91,625 (3.6293/3.6073)
Pin diameter	8,128 (0.3200)
Diameter over pins	109,58/109,52 (4.3140/3.3117)

For shaft type "Z"
DIN 5480, W100 x 4 x 24 x 7h

SHAFT TYPE "Q", MODEL CODE POSITION 3

Female shaft with 31 splines to BS 3550

Note: The "Q" shaft 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.



To BS 3550-1963 & ASA.B5. 15-1960	
Flat root, side fit	
Pressure angle	30°
Number of teeth	31
Pitch	10/20
Pitch diameter	78,740 (3.1000)
Major diameter	81,661/81,280 (3.2150/3.2000)
Form diameter	80,828 (3.1822)
Minor diameter	76,327/76,200 (3.0050/3.000)
Space width:	
Min. effective	3,990 (0.1571)
Max. actual	4,074 (0.1604)

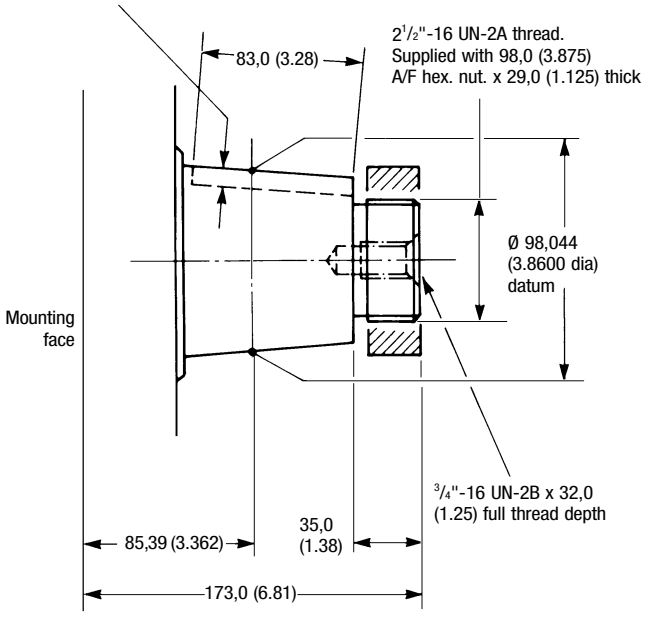
▲ *Use mounting face spigot for motor location.*

SHAFT TYPE "X", MODEL CODE POSITION 3

Taper shaft, with key

Key supplied:
25,48/25,43 (1.003/1.001) wide x
17,539/17,462 (0.6905/0.6875) thick

Keyway size:
25,43/25,40 (1.001/1.000) wide
10,54/10,49 (0.415/0.413) deep



Basic taper on diameter:
0.0999/0.1001 per mm
(0.0999/0.1001 per in)

Presented by:

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Precision Machinery Division

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Staffa hydraulic motors are manufactured to the highest quality standards in a Kawasaki ISO 9001 certified facility. Certification No. 891150