

Sepehr Hydraulic Asia



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

# HM(HD)B 200

**Staffa Fixed Displacement  
Hydraulic Motor**



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## 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<sup>3</sup>/r (5.76 to 415 in<sup>3</sup>/r) capacity. The rugged, well-proven design incorporates hydrostatic balancing techniques to achieve high efficiency, combined with good breakout torque and smooth running capability.

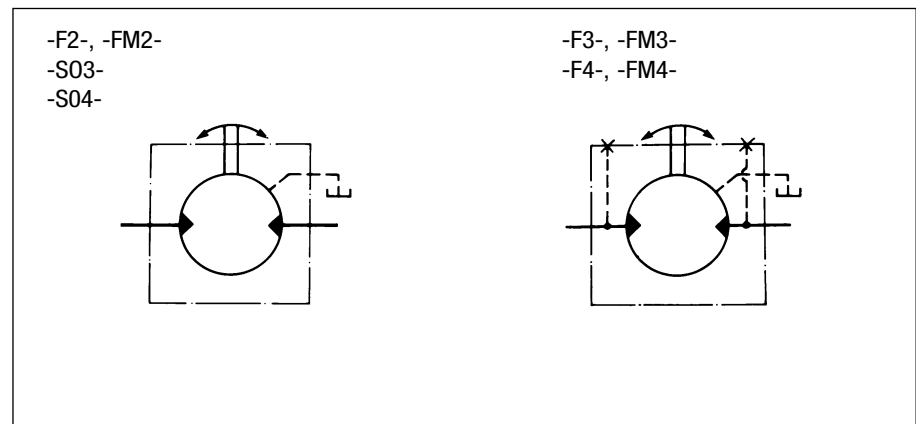
This motor is available with standard or with heavy duty shaft bearings, model types HMB200 and HMHDB200 respectively. Various features and options are available including, on request, mountings to match competitor interfaces.

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 **4**



### 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\*\*)**

**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 ("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 dia). *Hollow shafts are available only with type "SO4" main port connection.*

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

\* 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 2 1/4" distributor valve◆

- F2◆ = SAE 1", 4-bolt (UNC) flanges
- FM2◆ = SAE 1", 4-bolt (metric) flanges

Models with 3" distributor valve◆

- F3◆ = SAE 1 1/4", 4-bolt (UNC) flanges
- FM3◆ = SAE 1 1/4", 4-bolt (metric) flanges
- SO3◆ = 6-bolt (UNF) flange (Staffa original valve housing)

Models with 4" distributor valve

- F4 = SAE 1 1/2", 4-bolt (UNC) flanges
- FM4 = SAE 1 1/2", 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 HMHDB200 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

		Port connection type, model code <b>4</b>		
		F4, FM4, S04	F3, FM3, S03	F2, FM2
Geometric displacement▲	cm <sup>3</sup> /r (in <sup>3</sup> /r)	3080 (188)	3080 (188)	3080 (188)
Average actual running torque	Nm/bar (lbf ft/psi)	46,07 (2.343)	46,07 (2.343)	46,07 (2.343)
Max. continuous◆ speed	r/min	175	135▼	65▼
Max. continuous◆ output	kW (hp)	130 (174)	130 (174)	75 (100)
Max. continuous◆ pressure	bar (psi)	250 (3625)	250 (3625)	250 (3625)
Max. intermittent◆ pressure	bar (psi)	293 (4250)	293 (4250)	293 (4250)

▲ Other displacements can be made available to special order

▼ Recommended limit to avoid excessive pressure losses

◆ See "Rating Definitions", this page

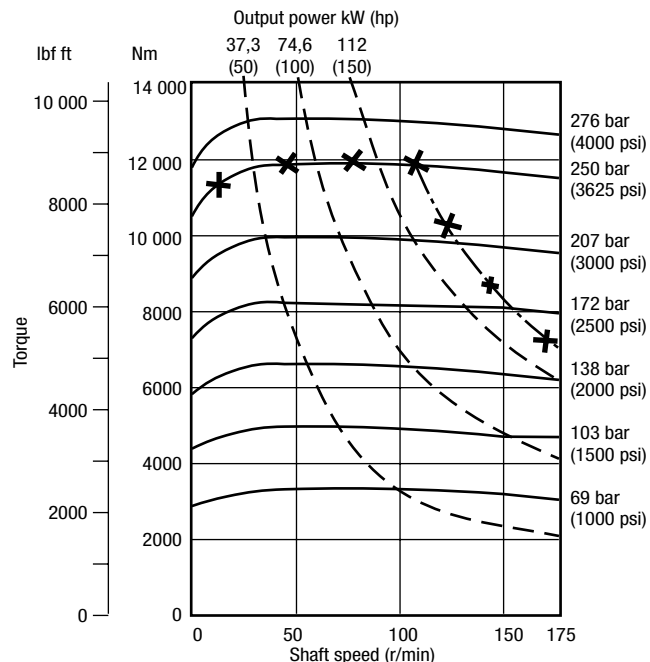
### Limits for Fire Resistant Fluids

Fluid type	Pressure, bar (psi)		Max. speed r/min
	Continuous	Intermittent	
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

### 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.



### 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

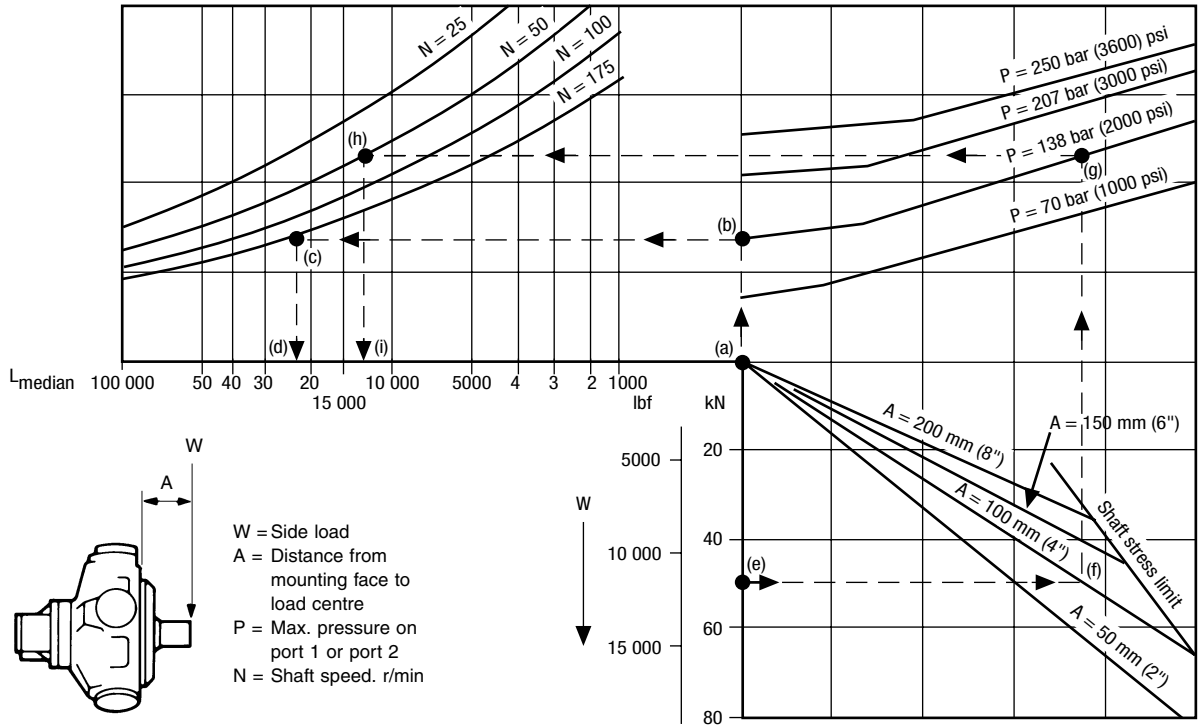
Up to 293 bar (4250 psi) is allowable on the following basis:

- Up to 50 r/min: 15% duty for periods up to 5 minutes maximum.
- Over 50 r/min: 2% duty for periods up to 30 seconds maximum.

**BEARING LIFE**

**For HMB200 models**

(See next page for HMHDB200, heavy duty models)



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.

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.

**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

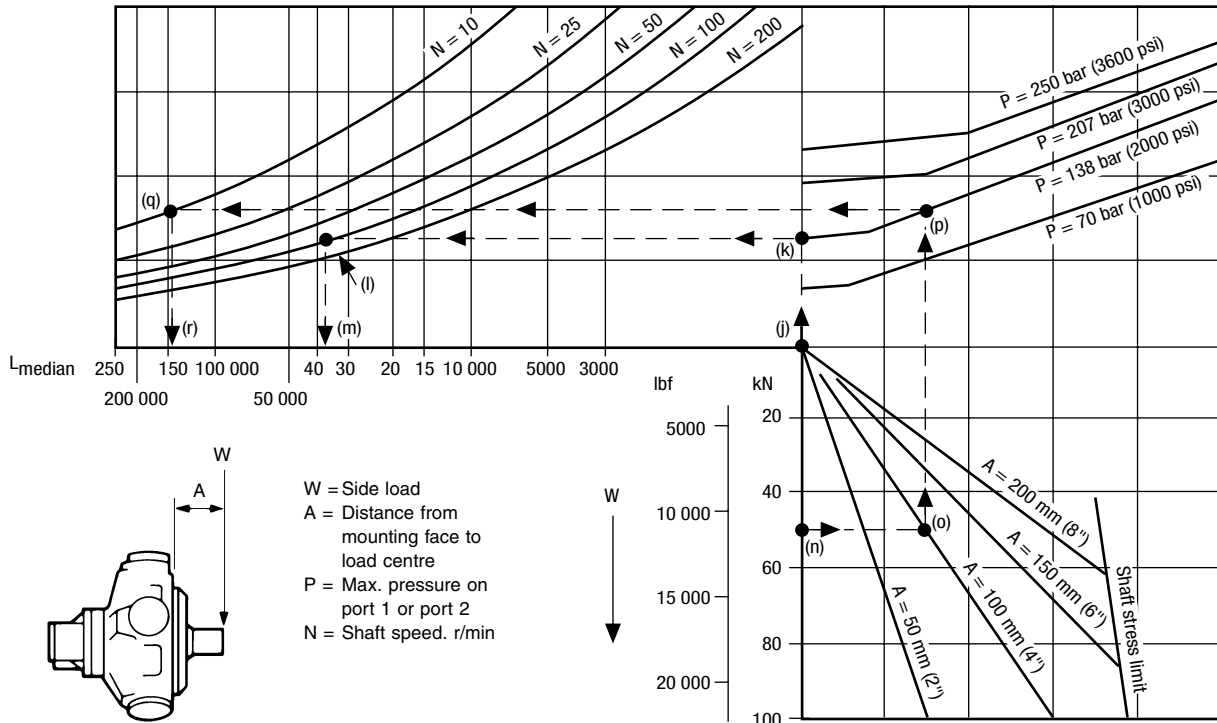
Example 2 (follow chain dotted line):

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

# BEARING LIFE

## For HMHDB200 (heavy duty) models

(See previous page for HMB200, standard models)



### HMHDB200

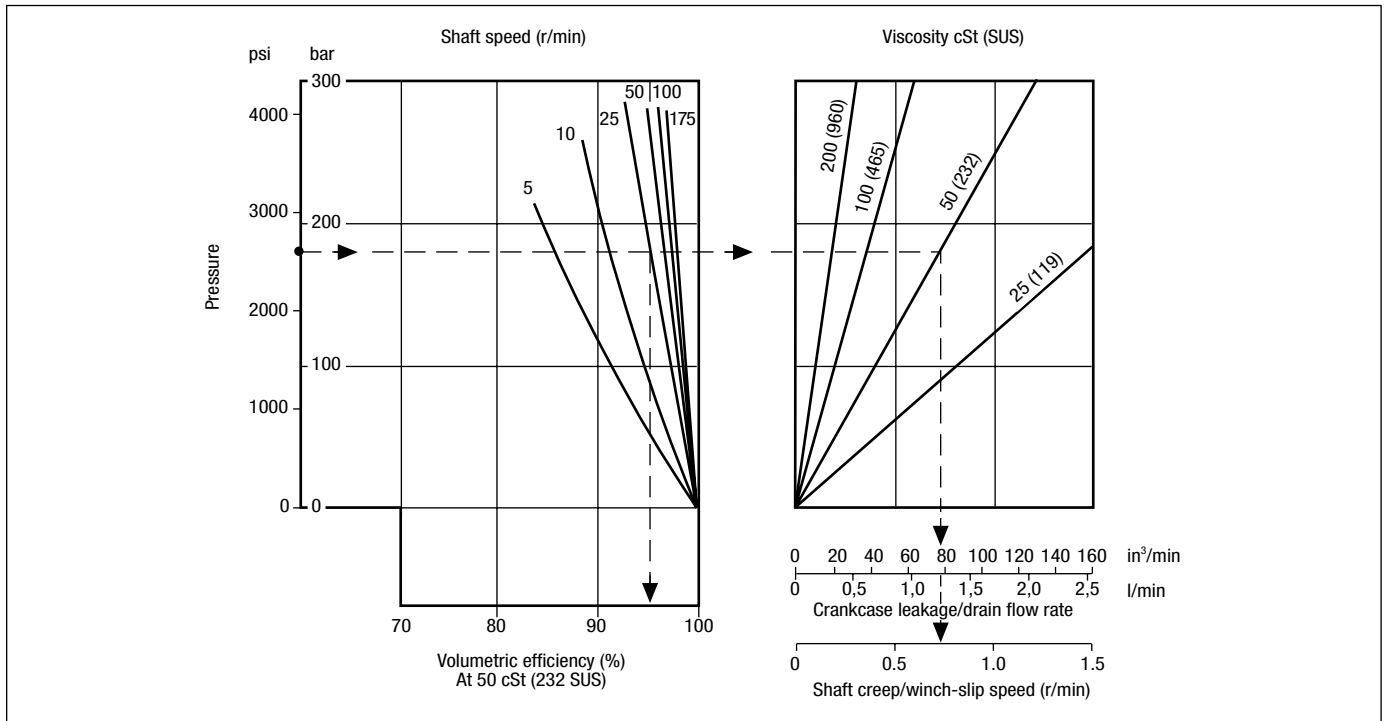
Example 1 (follow chain dotted line):

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

## 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 ..... 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 (76 in<sup>3</sup>/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 <sub>bar</sub> = 440 D <sub>psi</sub> = 30
F3, FM3, S03	D <sub>bar</sub> = 3500 D <sub>psi</sub> = 241
F4, FM4 S04	D <sub>bar</sub> = 15 000 D <sub>psi</sub> = 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 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: 0,27 kg m<sup>2</sup> (920 lb in<sup>2</sup>)

## 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

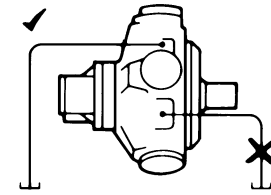
The recommended torque wrench settings for the mounting bolts are:  
M20 bolts.....407±14Nm (300±10 lbf ft)  
3/4" bolts.....393±14Nm (290±10 lbf ft)

#### ● 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.

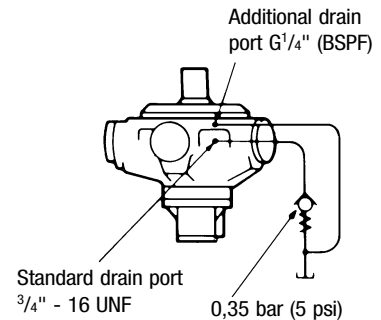
## CRANKCASE DRAIN

Motor axis horizontal



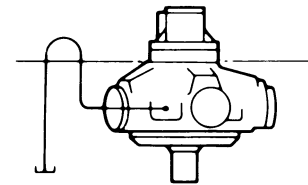
The crankcase drain must be taken from a position above the horizontal centre line of the motor.

Axis vertical, shaft up



An additional G<sup>1</sup>/<sub>4</sub>" (BSPF) drain port is provided 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, see above diagram.

Axis vertical, shaft down



Use any drain position. The drain line should be run above the level of the uppermost bearing; if there is risk of syphoning then a syphon breaker should be fitted.

## START-UP

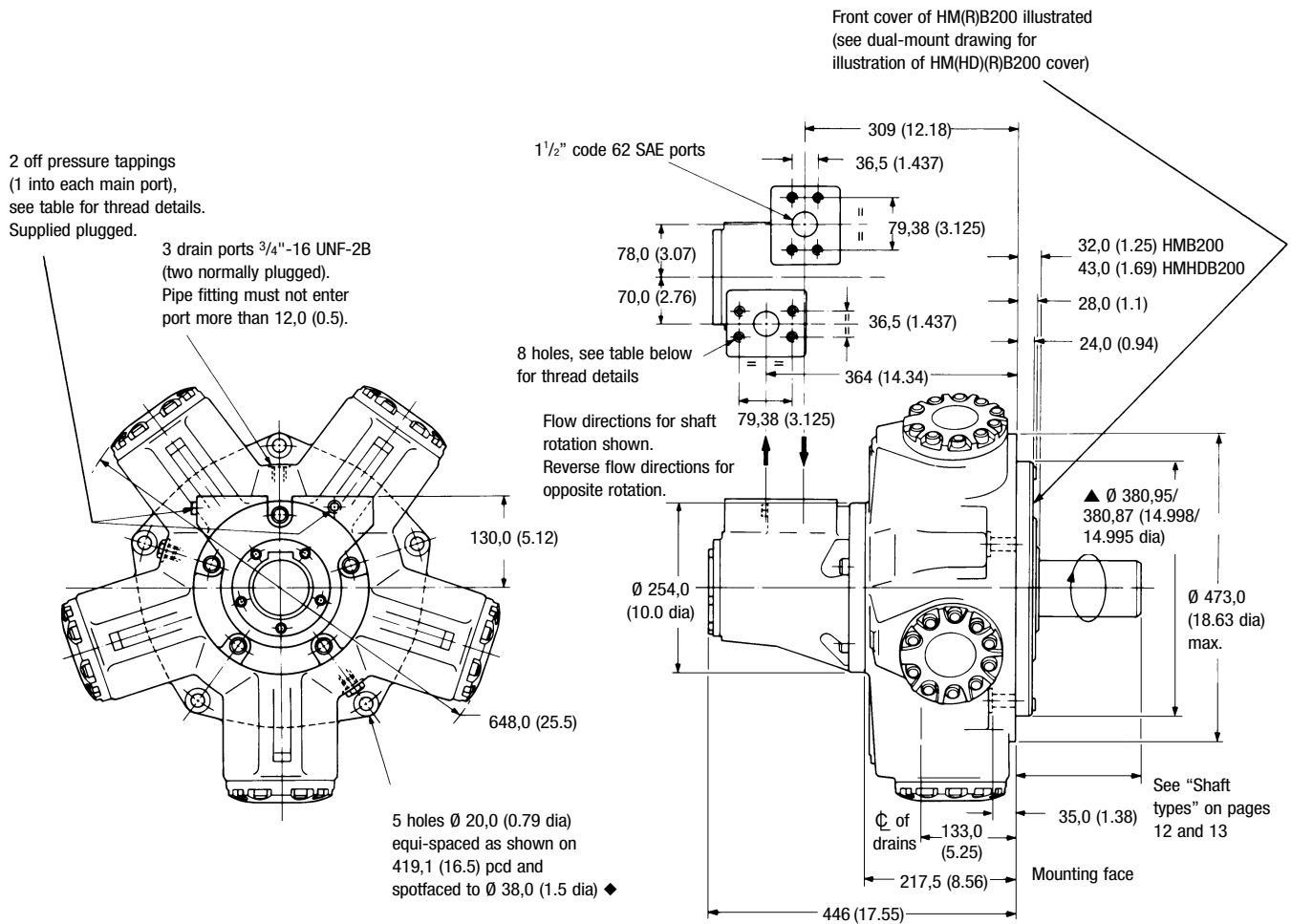
Fill the crankcase with system fluid. Where practical, a short period (30 minutes) of “running in” should be carried out.



# 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 "S04", "F3", "FM3" and "S03" port connection.  
See drawing of dual-mount model for details of types "F2" and "FM2" port connection.



### Port tappings

Model code	Tapping size for flange bolts	Gauge tappings
F4	5/8"-11 UNC-2B x 35,0 (1.38) full thread depth	9/16"-18 UNF-2B, SAE J475
FM4	M16 x P2.0 x 35,0 (1.38) full thread depth	G1/4" (BSPF)

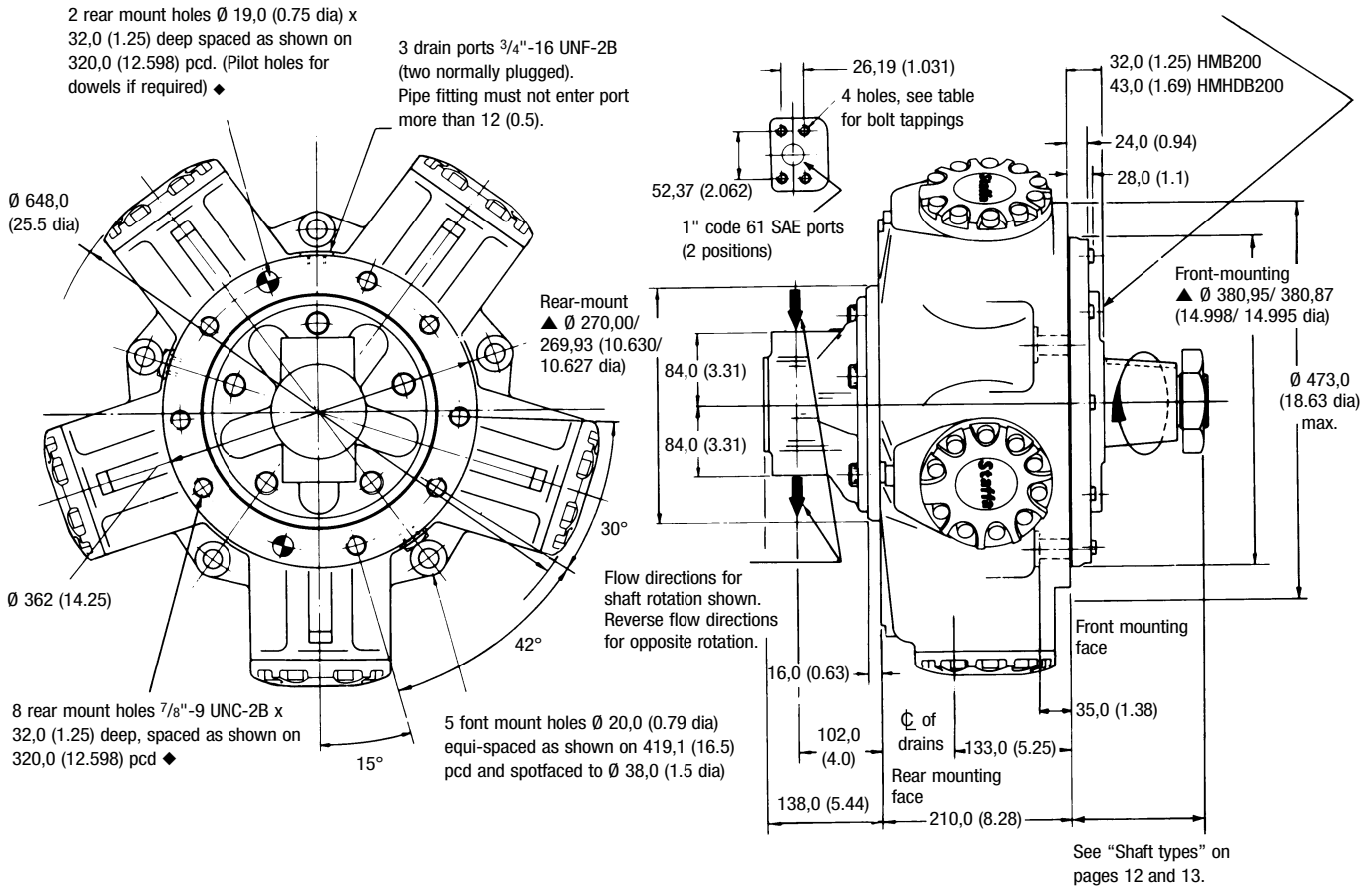
♦ Ø 0,15 (0.006)

▲ Mounting location diameter

**DUAL-MOUNT MODELS**  
**HMRB200 AND HMHDB200 MOTORS WITH TYPES "F2" AND**  
**"FM2" (1" SAE) PORT CONNECTION**

See additional views for shaft types and for types "F3", "FM3"  
 "S04" and "S03" port connection.

Front cover of HM(HD)RB200  
 illustrated (see front-mount drawing  
 for illustration of HM(R)B200 cover)



Port flange bolt tappings

Model Bolt tappings  
 code **4**

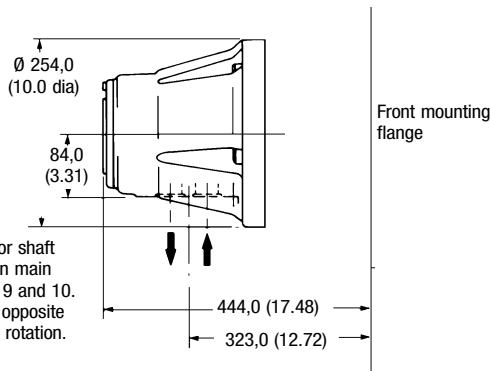
F2  $\frac{3}{8}$ "-16 UNC-2B x 22,0 (0.87) deep

FM2 M10 x P1.5 x 22,0 (0.87) deep

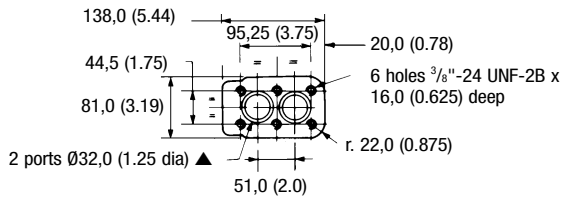
◆  $\varnothing$  0,15 (0.006)

▲ Mounting location diameter

**4" VALVE HOUSING WITH 6-BOLT FLANGE, "S04" IN MODEL CODE POSITION 4.**

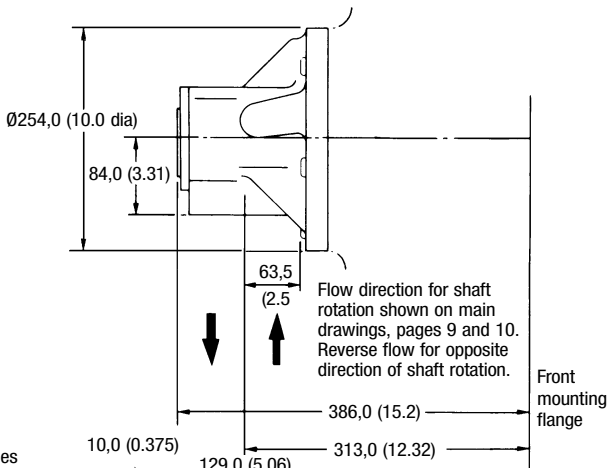


Flow directions for shaft rotation shown on main drawings, pages 9 and 10. Reverse flow for opposite direction of shaft rotation.

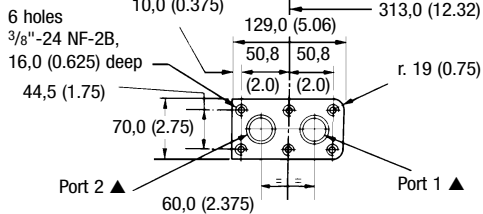


▲  $\varnothing 32,0$  (1.125 dia) with recess for 38,1 (1.5) i/d x  $\varnothing 3,53$  (0.139 dia) section O-ring

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

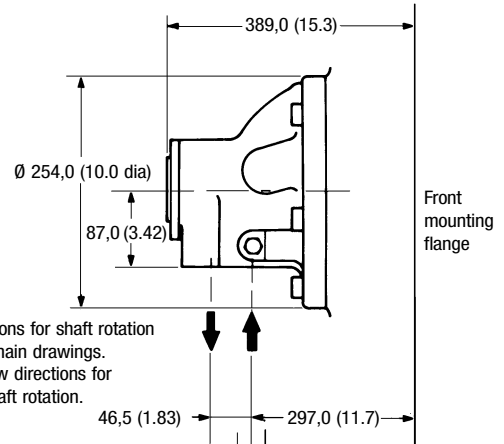


Flow direction for shaft rotation shown on main drawings, pages 9 and 10. Reverse flow for opposite direction of shaft rotation.

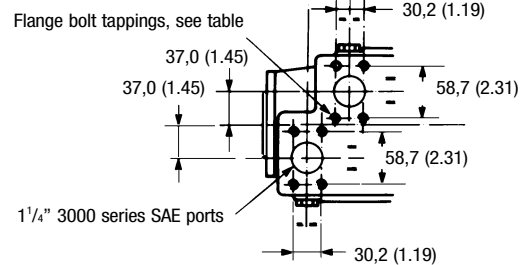


▲  $\varnothing 28$  (1.125 dia) with recess for 31,0 (1.22) i/d x  $\varnothing 4$  (0.57 dia) section O-ring

**3" VALVE HOUSING WITH SAE 1 1/4" 4-BOLT FLANGES, "F3" OR "FM3" IN MODEL CODE POSITION 4.**



Flow directions for shaft rotation shown on main drawings. Reverse flow directions for opposite shaft rotation.



**Flange bolt tappings**

Model code 4	Tapping size for flange bolts	Gauge tappings
F3	7/16"-14 UNC-2B x 27,0 (1.06) full thread depth	9/16"-18 UNF-2B, SAE J475
FM3	M12 x P1.75 x 27,0 (1.06) full thread depth	G1/4" (BSPF)

### SHAFT TYPES "P1" & "HP1", MODEL CODE POSITION 3

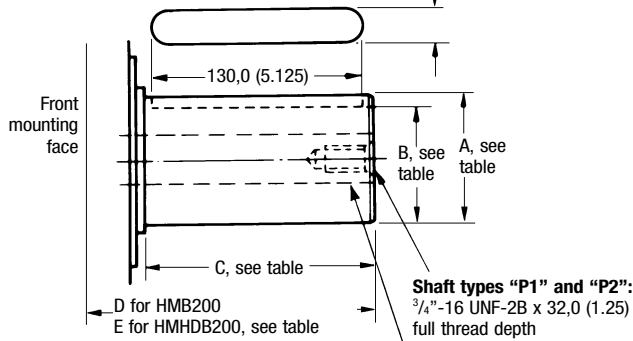
Ø 85,0 (3.35 dia) cylindrical shaft with key, with optional through hole.

### SHAFT TYPES "P2" & "HP2", MODEL CODE POSITION 3

Ø 100,0 (3.94 dia) cylindrical shaft with key, with optional through hole.

Key (supplied) 24,066/24,000 (0.9475/0.9449) wide x 16,05/16,0 (0.632/0.630) thick

24,000/24,051 (0.9469/0.9449)

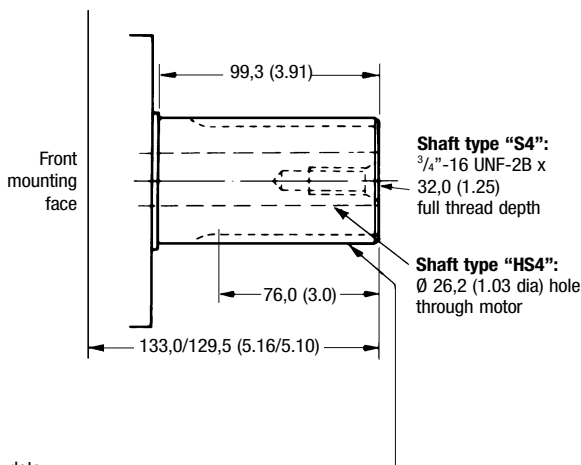


Shaft types "HP1" and "HP2".  
Ø 26,2 (1.03 dia) hole through motor

Dimension ref.	Shaft code: P1, HP1	P2, HP2
A	Ø 85,011/84,991 (3.3469/3.3461 dia)	Ø 100,02/100,00 (3.9378/3.9370 dia)
B	77,01/76,94 (3.032/3.029)	92,02/91,95 (3.623/3.620)
C	138,0 (5.44)	137,0 (5.4)
D	166,6/165,1 (6.56/6.50)	Not applicable
E	178,6/177,0 (7.03/6.97)	184,3/181,3 (7.26/7.14)

### SHAFT TYPES "S4" & "HS4", MODEL CODE POSITION 3

Cylindrical shaft with 16 involute form splines.

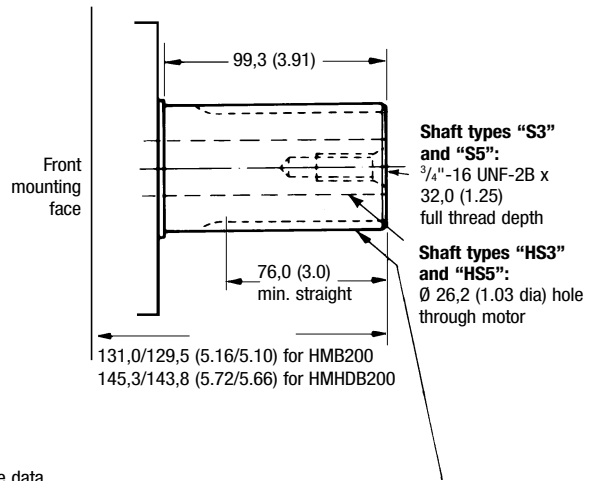


Spline data

For shaft types "S4" and "HS4"	
Involute gear tooth form	
Pressure angle	20°
Number of teeth	16
Pitch	5/10
Major diameter	86,360/86,233 (3.400/3.395)
Form diameter	76,124 (2.997)
Minor diameter	74,93/72,39 (2.95/2.85)
Pin diameter	8,636 (0.3400)
Diameter over pins	92,71/92,581 (3.650/3.645)

### SHAFT TYPES "S3", "HS3", "S5" & "HS5" IN MODEL CODE POSITION 3

Cylindrical shafts with splines to BS 3550-1963, with optional through hole



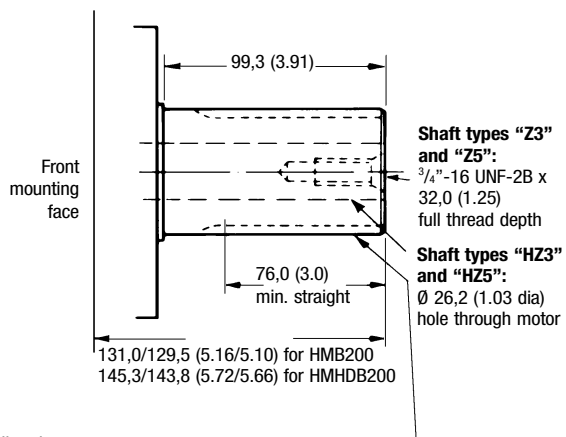
Spline data

To BS 3550 - 1963 & ASA.B5.15-1960  
Flat root side fit, class 1

	Shaft types "S3" and "HS3"	Shaft types "S5" and "HS5"
Pressure angle	30°	30°
Number of teeth	20	23
Pitch	6/12	6/12
Major diameter	87,953/87,825 (3.4627/3.4577)	100,66/100,52 (3.9627/3.9577)
Form diameter	80,264 (3.160)	92,939 (3.6590)
Minor diameter	79,485/78,925 (3.1293/3.1073)	92,185/91,625 (3.6293/3.6073)
Pin diameter	8,128 (0.3200)	8,128 (0.3200)
Diameter over pins	97,084/97,030 (3.8222/3.8201)	109,58/109,51 (4.3140/4.3117)

### SHAFT TYPES "Z3", "HZ3", "Z5" & "HZ5" IN MODEL CODE POSITION 3

Cylindrical shafts with splines to DIN 5480, with optional through hole



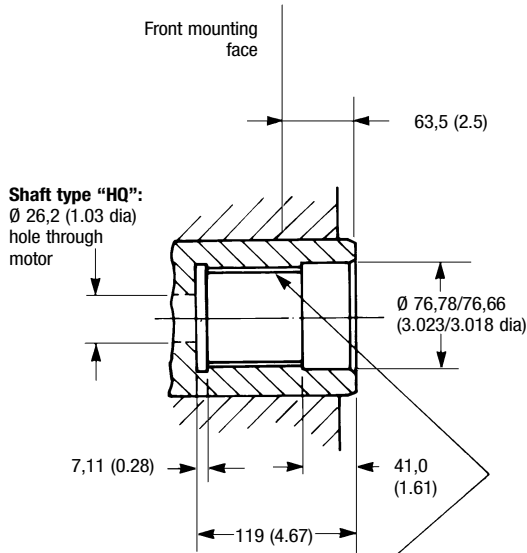
Spline data

Shaft code	Splines to Din 5480
Z3	W85 x 3 x 27 x 7h
HZ3	
Z5	W100 x 4 x 24 x 7h
HZ5	

### SHAFT TYPES "Q" AND "HQ", MODEL CODE POSITION 3

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.



Spline data

To BS 3550-1963 and ASA. B5. 15-1960

Flat root side fit

Pressure angle 30°

Number of teeth 34

Pitch 12/24

Major diameter 74,414/74,084 (2.9297/2.9167)

Minor diameter 69,977/69,850 (2.7750/2.7500)

Pin diameter 3,658 (0.1440)

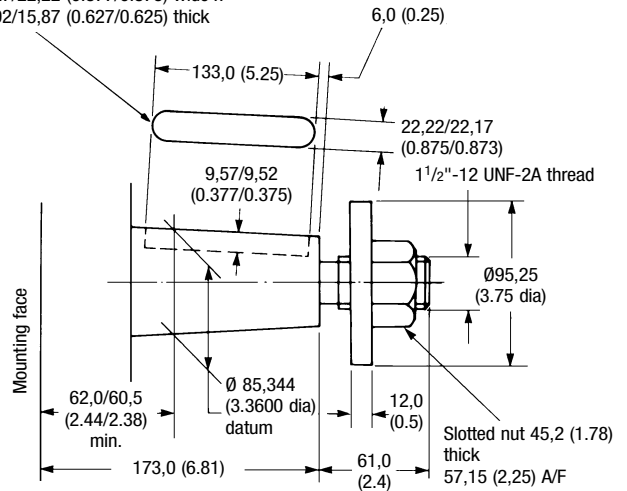
Pin flattened to 3,556 (0.1400)

Diameter between pins 66,744/66,815 (2.6277/2.6305)

### SHAFT TYPE "T", MODEL CODE POSITION 3

Long taper, with key

Key size:  
 22,27/22,22 (0.877/0.875) wide x  
 15,92/15,87 (0.627/0.625) thick



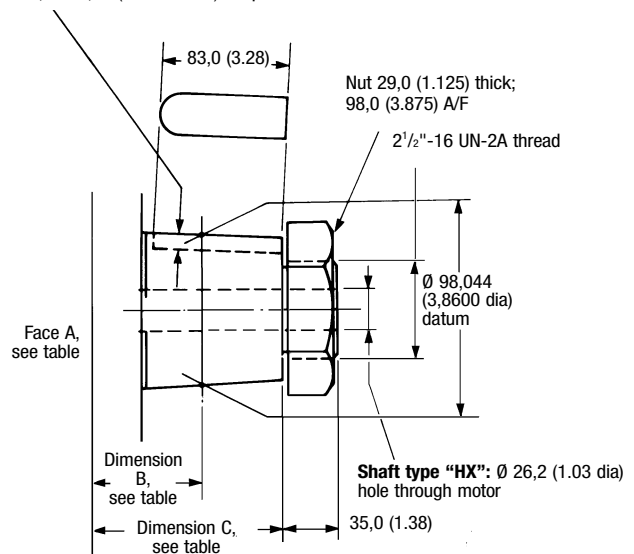
Basic taper, on diameter  
 0,0999/0,1001 per mm  
 (0.0999/0.1001 per in)

### SHAFT TYPES "X" AND "HX", MODEL CODE POSITION 3

Short taper, with key; with optional through hole

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 x  
 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)

For front mount models

Face A = Front mounting face  
 Dimension B = 73,15/71,78 (2.880/2.826)  
 Dimension C = 125,0 (4.92)

For dual mount models

Face A = Rear mounting face  
 Dimension B = 283,18/281,81 (11.149/11.095)  
 Dimension C = 335,0 (13.2)

## NOTES

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Presented by:



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