



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

HMC 325

**Staffa Fixed Displacement
Hydraulic Motor**



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1. GENERAL DESCRIPTION

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

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

The range of HMC motors extends from the HMC010 of 202 cm³ (12.3 in³) to the HMC325 of 5330 cm³ (325 in³) displacement.

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

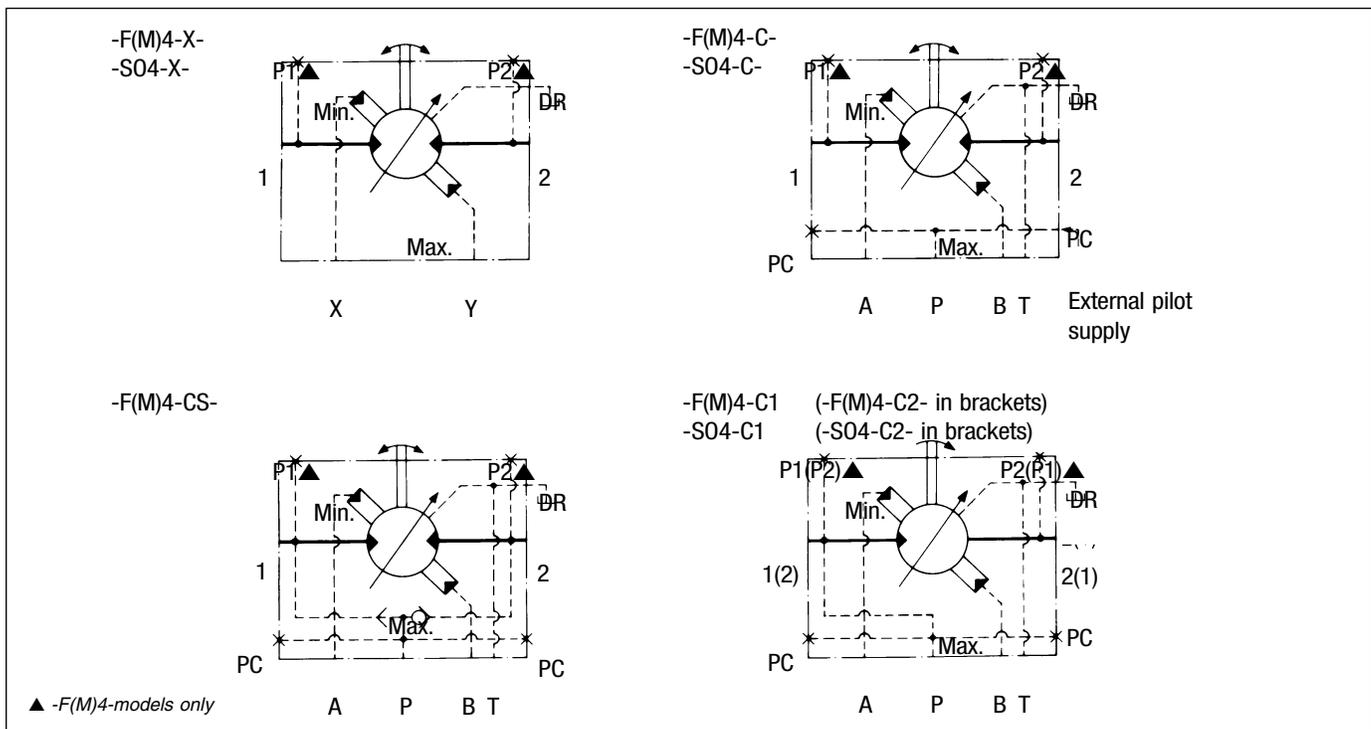
Other mounting options are available on request to match many of the competitor interfaces.

The HMC325 is one of 8 frame sizes and is capable of developing torques up to 22 000 Nm (16 200 lbf ft) with a continuous output power of 140 kW (188 hp).

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

2. FUNCTIONAL SYMBOLS

All model types with variants in model code positions **6** & **7**.



3. MODEL CODE

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

(F)-HM(*)C325-**-***.***.***.***.***-(T*)-30-(PL**)**

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1 FLUID TYPE

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

ISO 4401 size O3 mounting face/bi-directional shaft rotation:
C = No shuttle valve
CS■ = With shuttle valve

2 MODEL TYPE

Blank = Standard ("HMC")
M = To NCB (UK) specification 463/1981 ("HMMC")

ISO 4401 size O3 mounting face/uni-directional shaft rotation (viewed on shaft end):
C1 = Control pressure from main port 1 (shaft rotation clockwise with flow into port 1)
C2 = Control pressure from main port 2 (shaft rotation counter-clockwise with flow into port 2)

3 SHAFT TYPE

P* = Cylindrical shaft with 2 parallel keys
S* = Cylindrical, 20 splines to BS 3550
Q* = Cylindrical, internal splines to DIN 5480 (W75 x 3 x 24 x 9H)
Z* = Cylindrical shaft to DIN 5480 (W90 x 4 x 21 x 7h)

■ Not available with "S04" type main port connections **6**

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

8 TACHO/ENCODER DRIVE

T = Staffa original tacho drive
T1 = Suitable for Hohner 3000 series encoders. (Encoder to be ordered separately)

Omit if not required.

4 HIGH DISPLACEMENT CODE

325, 310 or 300 in³

5 LOW DISPLACEMENT CODE

80, 95, and 100 to 220 in³
in 20 in³ steps

9 DESIGN NUMBER, 30 SERIES

Subject to change. Installation and performance details remain unaltered for design numbers 30 to 39 inclusive.

6 MAIN PORT CONNECTIONS

S04 = 6-bolt (UNF) flange: 4" valve (Staffa original valve housing)
F4 = SAE 1 1/2" 4-bolt (UNC, code 62) flanges: 4" valve
FM4 = SAE 1 1/2" 4-bolt (metric, code 62) flanges: 4" valve

10 SPECIAL FEATURES

PL** = non-catalogued features, e.g.:
High pressure shaft seals
Alternative port connections
Stainless steel shaft sleeves
Alternative encoder and tacho drives
Motor valve housing orientation
Shaft variants
Special paint

7 DISPLACEMENT CONTROL PORTS (AND SHUTTLE VALVE)

Threaded ports/bi-directional shaft rotation:
X = X and Y ports G¹/₄" (BSPF to ISO 228/1)

** Number assigned as required to specific customer build.

4. PERFORMANCE DATA

Performance data is valid for Staffa HMC325 motors fully run in and operating with petroleum oil. Leakage values are at fluid viscosity of 50 cSt (232 SUS).

MOTOR SELECTION

Use table 1 to select appropriate displacements for each application. Refer to table 2 for pressure and speed limits when using fire-resistant fluids.

TABLE 1

Displacement code* (Model code positions 4 & 5)		325	310	300	220	200	180	160	140	120	100	95	80◆
Displacement volume/r	cm ³	5326	5080	4916	3605	3277	2950	2622	2294	1966	1639	1557	1311
	in ³	325	310	300	220	200	180	160	140	120	100	95	80
Average actual running torque	Nm/bar	80,4	76,9	74,3	53,9	49,0	43,6	38,3	33,2	27,9	22,4	20,9	17,1
	lbf ft/psi	4.09	3.91	3.78	2.74	2.49	2.22	1.95	1.69	1.42	1.14	1.06	0.87
Max. continuous speed	r/min	100	105	110	150	165	185	200	240	270	325	350	350
Max. continuous output	kW	140	140	140	119	111	103	95	86	77	66	63	54
	hp	188	188	188	160	149	138	127	115	103	88	84	72
Max. intermittent output	kW	180	180	180	167	160	152	143	132	120	107	104	95
	hp	241	241	241	224	214	204	192	177	161	144	140	127
Max. continuous pressure	bar	250	250	250	250	250	250	250	250	250	250	250	250
	psi	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626
Max. intermittent pressure	bar	275	275	275	275	275	275	275	275	275	275	275	275
	psi	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000

* Intermediate displacements in increments of 10 in³ are available to order.

◆ Not available with high displacement codes greater than "310".

TABLE 2

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 (3626)	275 (4000)	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 as specified for each displacement code.

● INTERMITTENT RATING

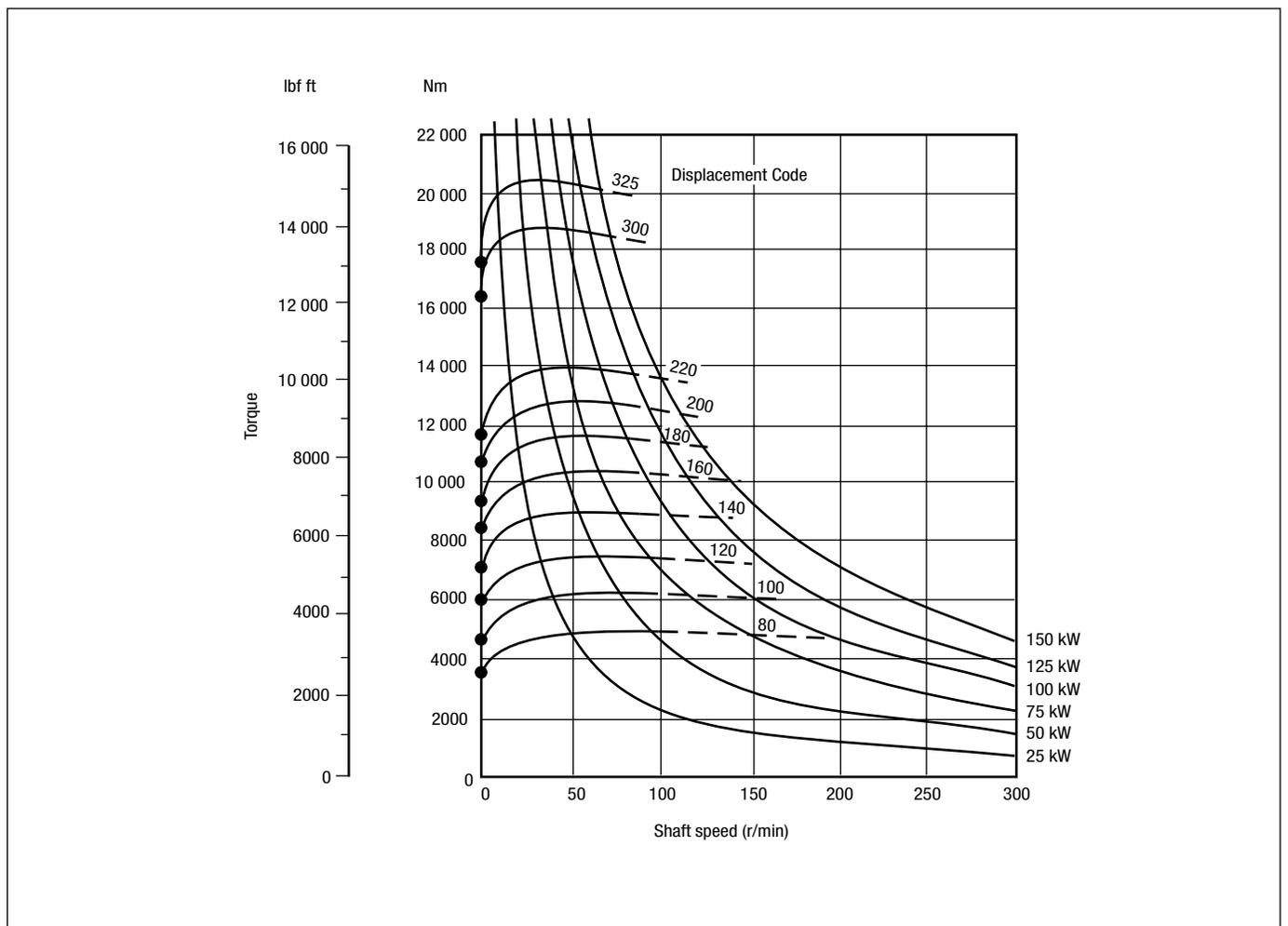
Operation within the intermittent power rating (up to the maximum continuous speed) is permitted on a 15% duty basis, for periods up to 5 minutes maximum.

● INTERMITTENT MAX. PRESSURE

Up to 275 bar (4000 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.

OUTPUT TORQUES



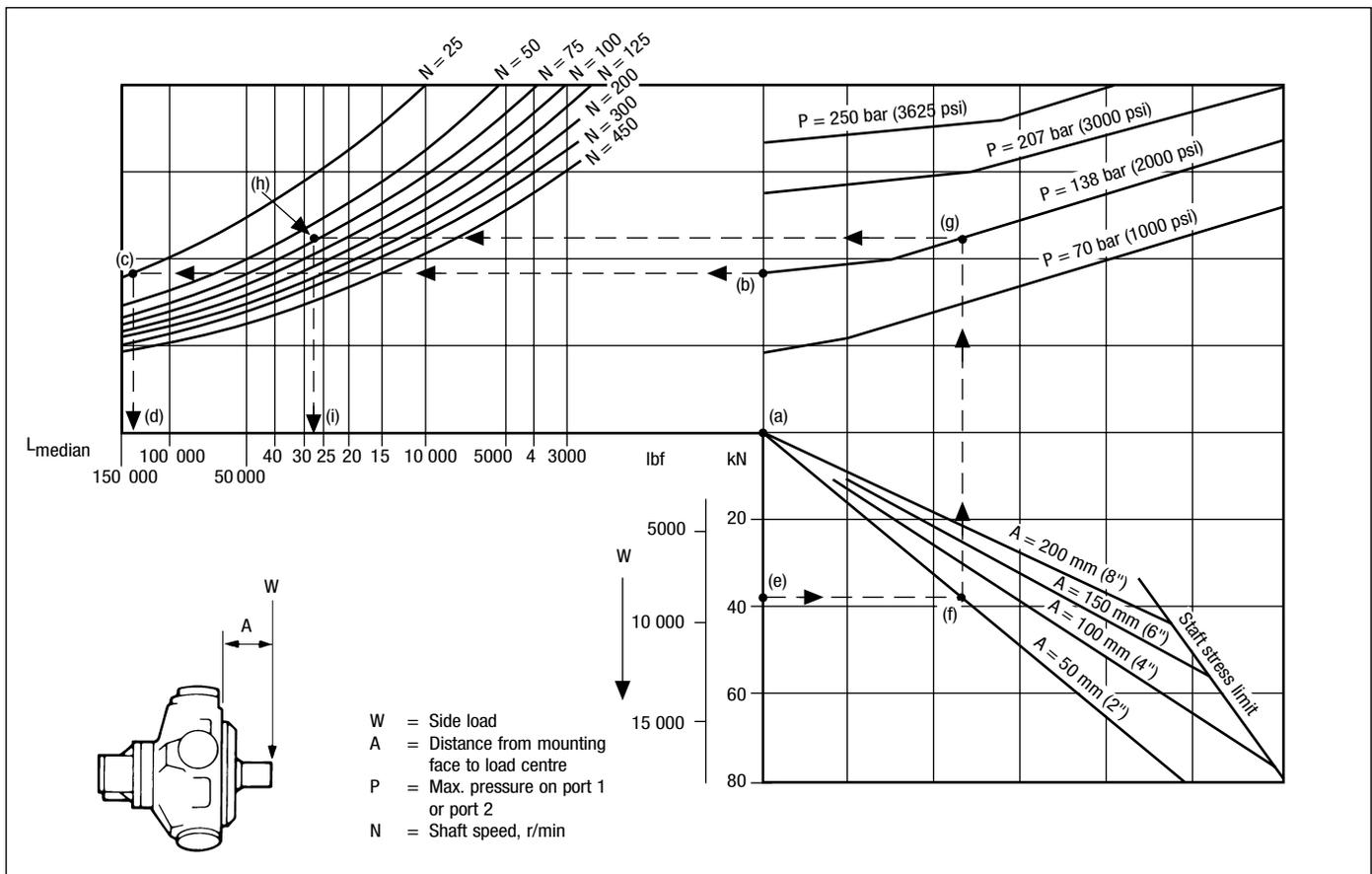
The torque curves indicate, for each displacement, the maximum output torque of the motor with an inlet pressure of 250 bar (3626 psi) and zero output pressure. High return line pressure will reduce the torque for any given pressure differential.

The solid line portion of each curve indicates the levels of maximum torque and speed that are permitted on a "continuous" basis.

The dotted portion of each curve indicates the levels of torque and speed at which the motor can operate at an "intermittent" rating.

The starting torques shown on the graph are average and will vary with crankshaft angle.

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.

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 the shaft. Infrequent loading above these limits may be permitted; consult Kawasaki.

VOLUMETRIC EFFICIENCY

The nomograph on page 7 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 150 bar (2175 psi)
2. Displacement code..... 160 (in³/r)
3. Speed 50 r/min

To obtain:

4. Volumetric efficiency 95.7%
5. Crankcase leakage 3,2 l/min (195 in³/min)
6. Shaft creep speed 1.8 r/min

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

HMC325

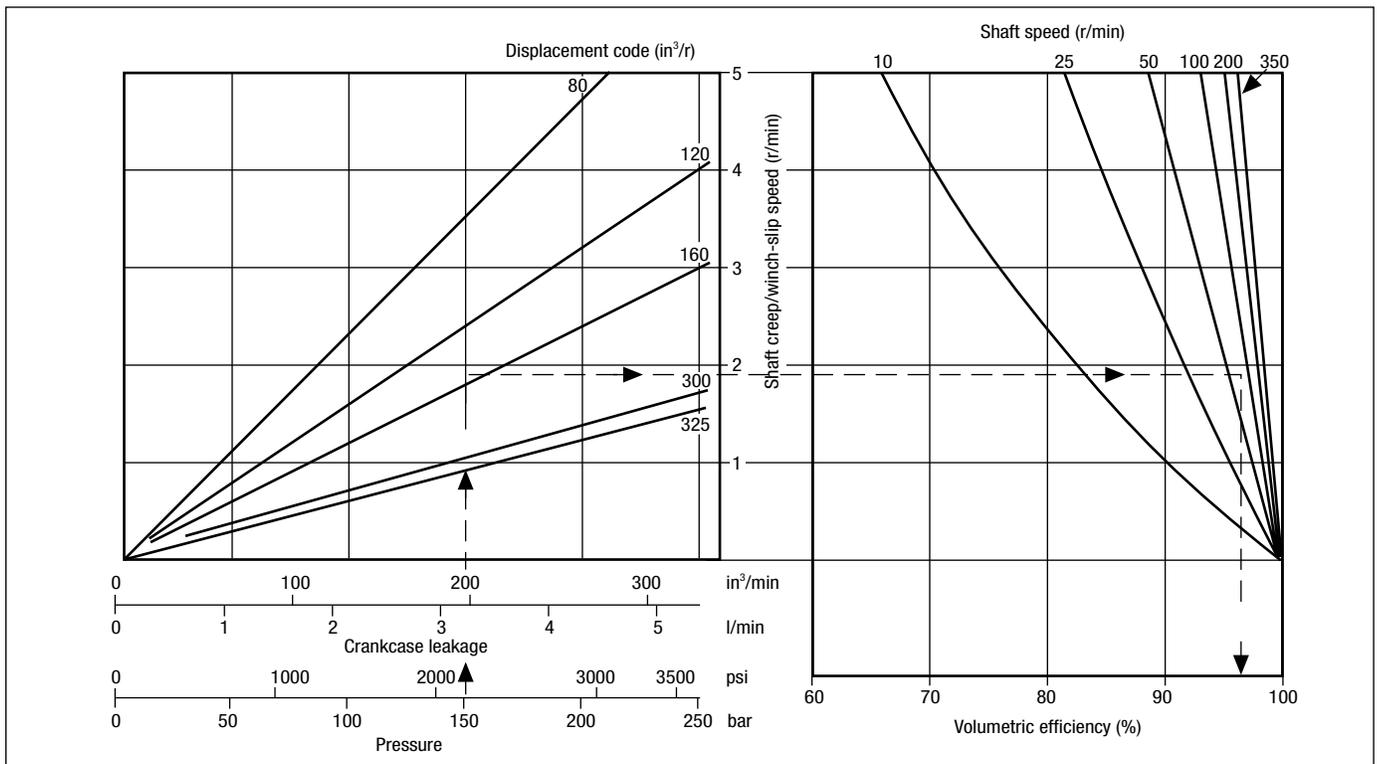
Example 1 (follow chain dotted line):

Side load (W)	a) 0
System pressure (P)	b) 138 bar (2000 psi)
Speed (N)	c) 25 r/min
Median bearing life	d) 130 000 hrs
L10 bearing rating = median x 0.2	26 000 hrs

Example 2 (follow chain dotted line):

Side load (W)	e) 38 kN (8500 lbf)
Load offset (A) from motor mounting face	f) 50 mm (2.0 in)
System pressure (P)	g) 138 bar (2000 psi)
Speed (N)	h) 75 r/min
Median bearing life	i) 26 500 hrs
L10 bearing rating = median x 0.2	5300 hrs

VOLUMETRIC EFFICIENCY



5. CIRCUIT AND APPLICATION NOTES

DISPLACEMENT SELECTION

To select either displacement, a pressure at least equal to 2/3 of the motor inlet/outlet pressure (whichever is higher) is required. In most applications the motor inlet pressure will be used.

For inlet/outlet pressures below 3,5 bar (50 psi) a minimum control pressure of 3,5 bar (50 psi) is required. In the event of loss of control pressure the motor will shift to its highest displacement.

For rapid reversing applications it is recommended to externally source the control oil supply direct from the system pump (use displacement control type "X" or "C" - *not* "CS", "C1" or "C2" - in model code position **7**).

STARTING TORQUES

The starting torques shown on the graph on page 5 are average and will vary with system parameters.

LOW SPEED OPERATION

(High displacement mode)

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 ports. Calculate "P" (bar/psi) from the appropriate formula:

$$P \text{ (bar)} = 1 + \frac{N^2 \times V^2}{4 \times 10^{10}} + C$$

Where:

C = crankcase pressure, bar

N = speed, r/min

V = displacement, cm³/r

$$P \text{ (psi)} = 14.5 + \frac{N^2 \times V^2}{1 \times 10^7} + C$$

Where:

C = crankcase pressure, psi

N = speed, r/min

V = displacement, in³/r

The flow rate of oil needed for the make-up system can be estimated from the crankcase leakage figure (see Volumetric Efficiency graph above) plus an allowance for changing displacement; e.g. to change high to low in 1 sec requires 20 l/min (5.3 USgpm).

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

Displacement code	kg m ²	lb in ²
325	0,87	3000
100	0,61	2100

11. MASS

Approx. all models: 460 kg (1015 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"). 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

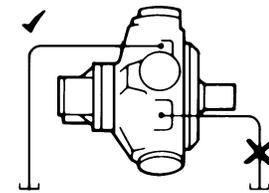
The recommended torque wrench settings for the mounting bolts are:
M20.....407±14 Nm (300±10 lbf ft)
3/4"393±14 Nm (290±10 lbf ft)

● 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") TIR.

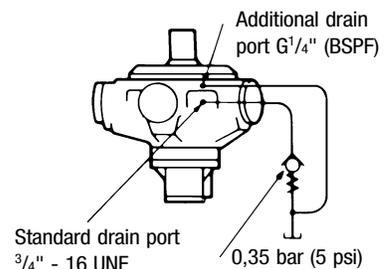
CRANKCASE DRAIN

Motor axis horizontal



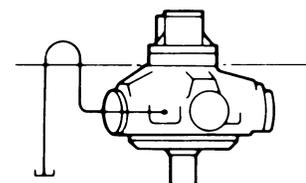
The crankcase drain must be taken from a position above the horizontal centre line of the motor.

Axis vertical, shaft up



An additional G¹/₄" (BSPF) drain port in the front cover 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

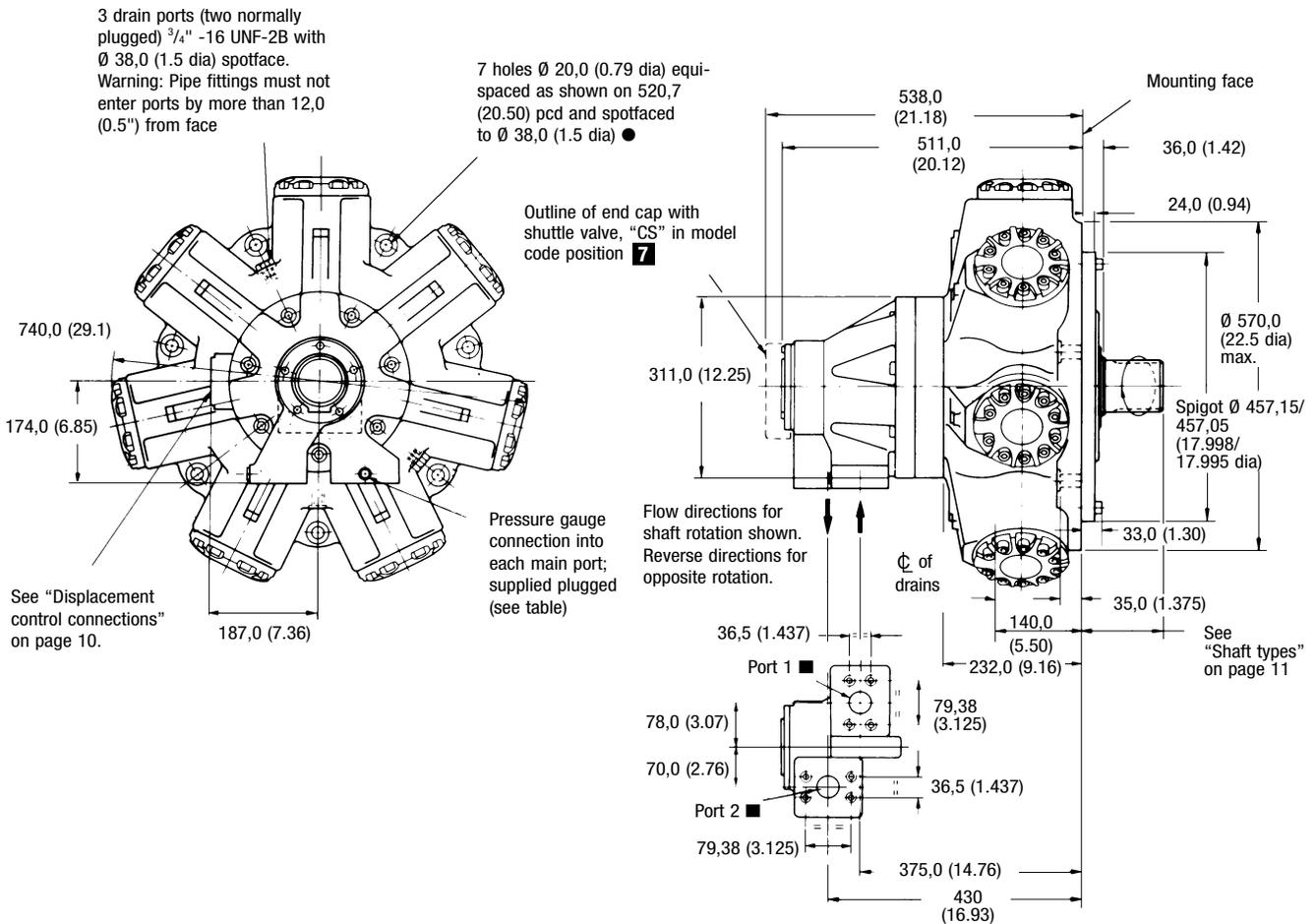
Fill the crankcase with system fluid.
Where practical, a short period (30 minutes) of "running in" should be carried out with the motor set to its high displacement (pressure to port Y, or to port B of the size O3 pilot valve).

13. INSTALLATION DIMENSIONS IN MM (INCHES)

HMC325 MOTOR WITH TYPE "F4"/"FM4" MAIN PORTS CONNECTION

See additional views for:

Displacement control connections, all shaft types and alternative main ports connection



● Suitable for M20 or $\frac{3}{4}$ " bolts. Maximum reaming diameter 21,0 (0.83) (for fitted bolt); see "Installation Data".

■ Port connection details

Model code 6	Flange	Bolt tappings	Pressure gauge connections
F4	1 $\frac{1}{2}$ " SAE code 62 4-bolt flange	$\frac{5}{8}$ "-11 UNC-2B x 35,0 (1.38) deep	$\frac{9}{16}$ "-18 UNF-2B, SAE J475
FM4	1 $\frac{1}{2}$ " SAE code 62 4-bolt flange	M16-6H x P2.0 x 35,0 (1.38) deep	G $\frac{1}{4}$ " (BSPF)
S04	Staffa 4" 6-bolt flange, see separate view on page 10.		

SHAFT TYPE "P", MODEL CODE POSITION 3

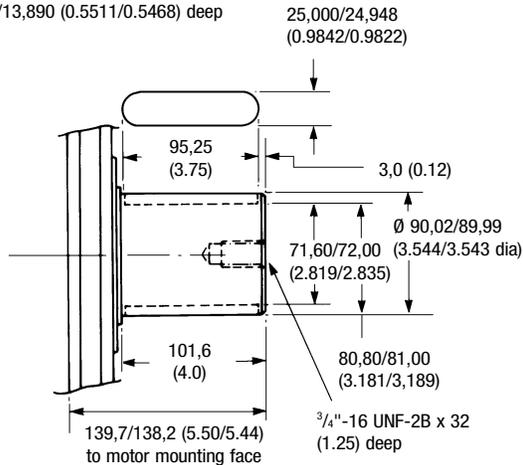
Straight shaft with 2 rectangular keys

Warning: Maximum allowable torque for this shaft is 17 500 Nm (12 930 lbf ft)

2 keys supplied:

25,000/24,948 (0.9842/0.9822) wide

x 14,000/13,890 (0.5511/0.5468) deep

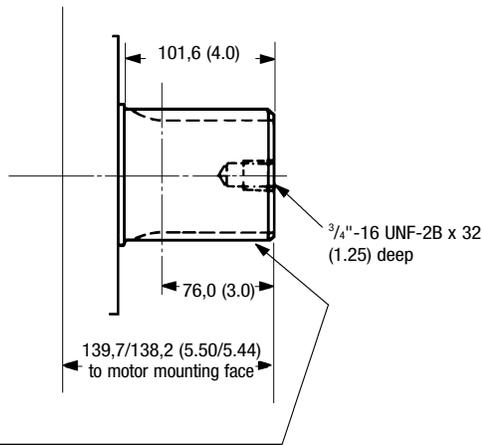


SHAFT TYPE "S", MODEL CODE POSITION 3

Straight shaft with 20 splines to BS 3550

SHAFT TYPE "Z", MODEL CODE POSITION 3

Straight shaft with splines to DIN 5480



Spline data

For type S shaft

To BS 3550/SAE J498c (ANSI B92.1-1970, class 5)

Flat root, side fit, class 1

Pressure angle	30°
Number of teeth	20
Pitch	6/12
Major diameter	87,953/87,826 (3.4627/3.4577)
Form diameter	80,624 (3.1600)
Minor diameter	79,484/78,925 (3.1293/3.1073)
Pin diameter	8,128 (0.3200)
Diameter over pins	97,084/97,031 (3.8222/3.8201)

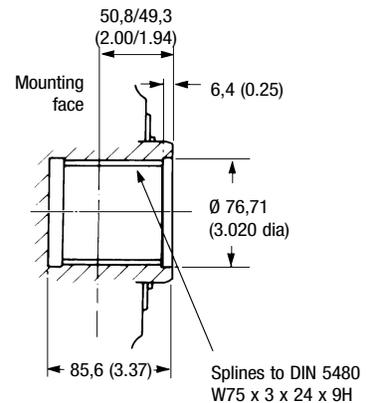
For type Z shaft

DIN 5480, W90 x 4 x 21 x 7h

SHAFT TYPE "Q", MODEL CODE POSITION 3

Cylindrical, internal splines to DIN 5480

Note: The "Q" shaft will transmit the maximum torques given on page 5. However, customers should ensure that their own mating shaft will transmit the torque required in their application.



Presented by:



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