



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

HMC 030

**Staffa Dual 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.

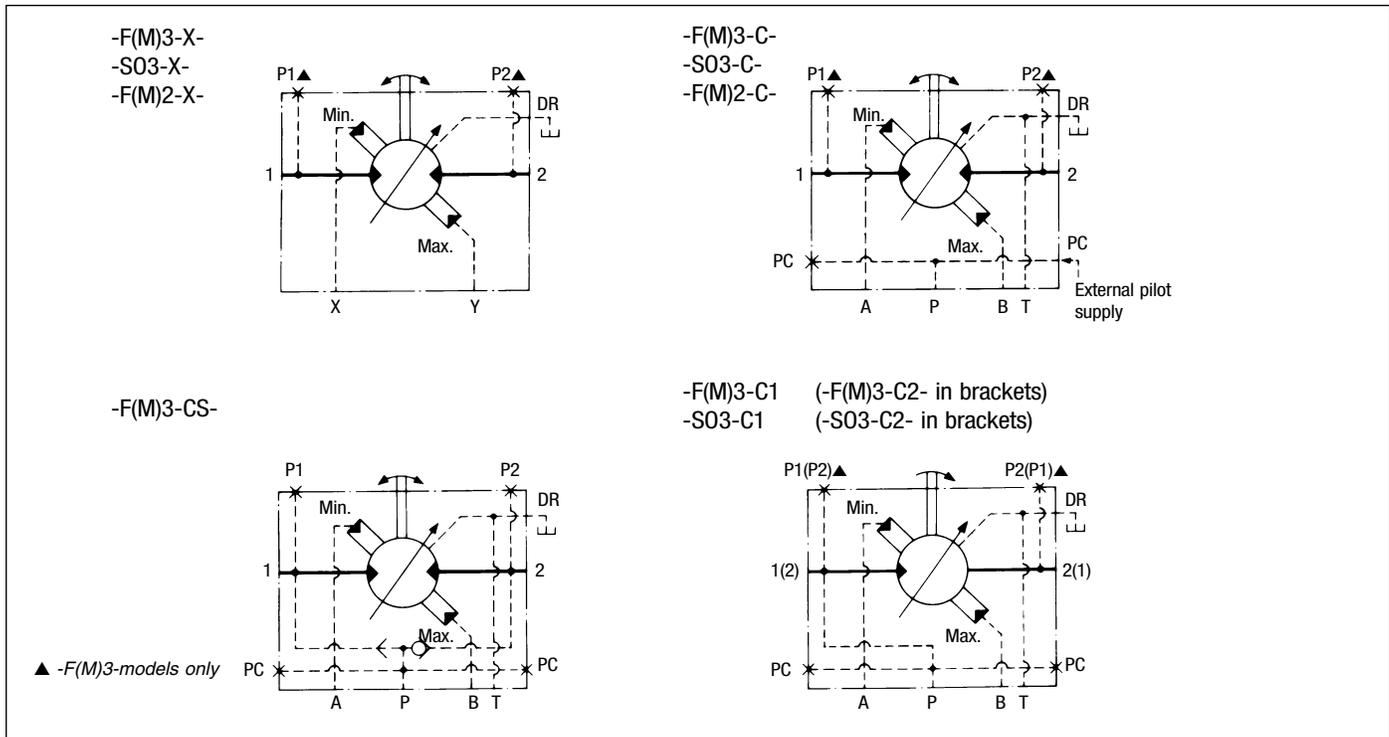
Other mounting options are available on request to match many of the competitor interfaces.

The HMC030 is one of 8 frame sizes and is capable of developing torques up to 1720 Nm (1270 lbf ft) with a continuous output power of 60 kW (80 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(*)C030-**-**.*-***.*-*(T*)-30-(PL**)**

1

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1 FLUID TYPE

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

2 MODEL TYPE

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

3 SHAFT TYPE

P* = Cylindrical shaft with
parallel key
S* = Cylindrical, 17 splines to
BS 3550
Z* = Cylindrical shaft to DIN
5480 (W55 x 3 x 7h)

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

4 HIGH DISPLACEMENT CODE

15 to 30 in³, in 3 in³ steps

5 LOW DISPLACEMENT CODE

21 to 03 in³, in 3 in³ steps

6 MAIN PORT CONNECTIONS

Models with 2¹/₄" distributor valve◆
F2 = SAE 1" 4-bolt (UNC) flange
FM2 = SAE 1" 4-bolt (metric)
flange

Models with 3" distributor valve
S03 = 6-bolt (UNF) flange (Staffa
original valve housing)
F3 = SAE 1¹/₄" 4-bolt (UNC)
flange
FM3 = SAE 1¹/₄" 4-bolt (metric)
flange

◆ Gives minimum overall length of HMC030
motor

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)

ISO 4401 size 03 mounting face/bi-
directional shaft rotation:

C = No shuttle valve

CS■ = With shuttle valve

ISO 4401 size 03 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)

■ Not available with "S03" and "F(M)2"
type main port connections **6**

▲ Not available with "F(M)2" type main port
connections **6**

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.

9 DESIGN NUMBER, 30 SERIES

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

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

** Number assigned as required to specific
customer build.

4. PERFORMANCE DATA

Performance data is valid for Staffa HMC030 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)		30	27	24	21	18	15	12	09	06	03
Displacement volume/r	cm ³	492	442	393	344	295	246	197	147	98	49
	in ³	30	27	24	21	18	15	12	9	6	3
Average actual running torque	Nm/bar	6,86	6,08	5,30	4,59	3,88	3,20	2,51	1,83	1,15	0,44
	lbf ft/psi	0.349	0.309	0.269	0.233	0.197	0.163	0.128	0.093	0.058	0.022
Max. continuous speed	r/min	450	500	525	550	575	600	600	600	600	1000
Max. continuous output	kW	60	60	55	49	42	35	27	20	10	0
	hp	80	80	74	66	56	47	37	27	13	0
Max. intermittent output	kW	66	66	61	55	48	41	32	24	13	0
	hp	88	88	82	74	64	55	43	32	17	0
Max. continuous pressure	bar	207	207	207	207	207	207	207	207	207	17◆
	psi	3000	3000	3000	3000	3000	3000	3000	3000	3000	250◆
Max. intermittent pressure	bar	241	241	241	241	241	241	241	241	241	17◆
	psi	3500	3500	3500	3500	3500	3500	3500	3500	3500	250◆

* Intermediate displacements are made available to special order.

◆ See "Small displacements" page 7 for information about higher pressure applications.

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	207 (3000)	241 (3500)	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

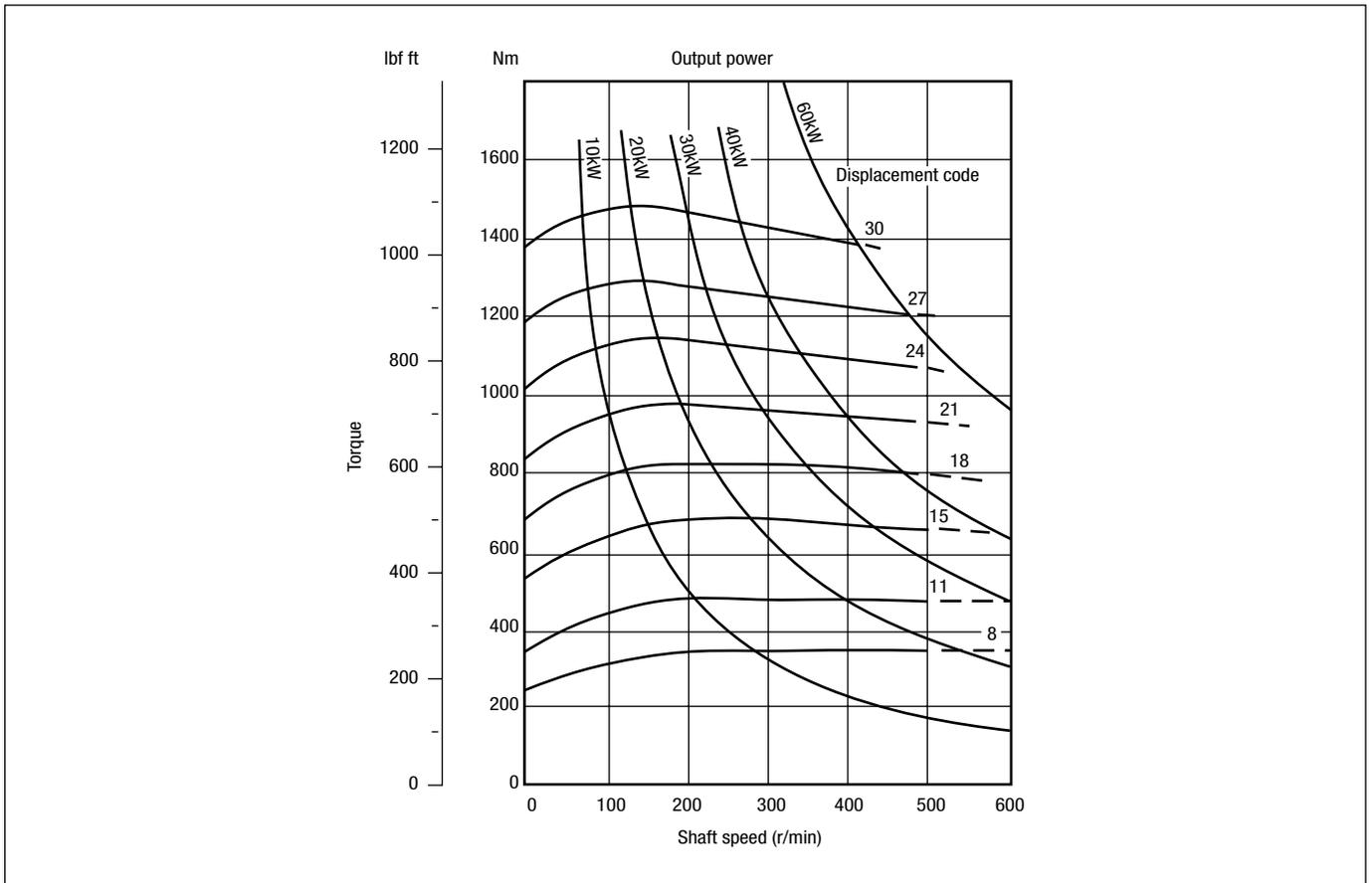
Operation within the intermittent power rating (up to the maximum continuous speed) is permitted on a 15% duty basis, for periods up to 5 minutes maximum.

● INTERMITTENT MAX. PRESSURE

Up to 241 bar (3500 psi) is allowable on the following basis:

- Up to 100 r/min: 15% duty for periods up to 5 minutes maximum.
- Over 100 r/min: 2% duty for periods up to 30 seconds maximum.

OUTPUT TORQUES



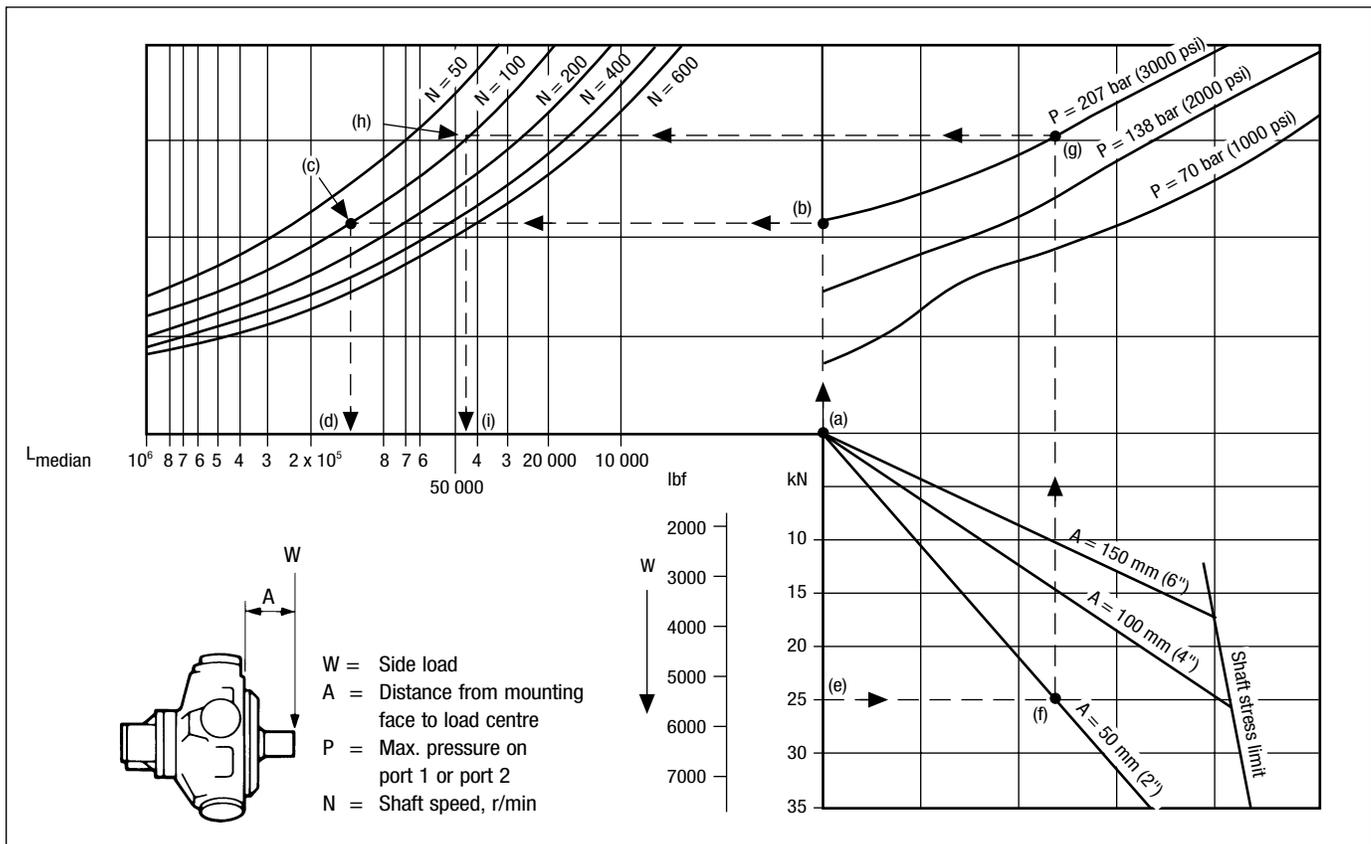
The torque curves indicate, for each displacement, the maximum output torque of the motor with an inlet pressure of 207 bar (3000 psi) and zero output pressure. High return line pressures will reduce the torque for any given pressure differential.

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. Pressure175 bar (2500 psi)
2. Displacement code15 (in³/r)
3. Speed300 r/min

To obtain:

4. Volumetric efficiency94.8%
5. Crankcase leakage3,0 l/min
(180 in³/min)
6. Shaft creep speed17 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.

HMC030

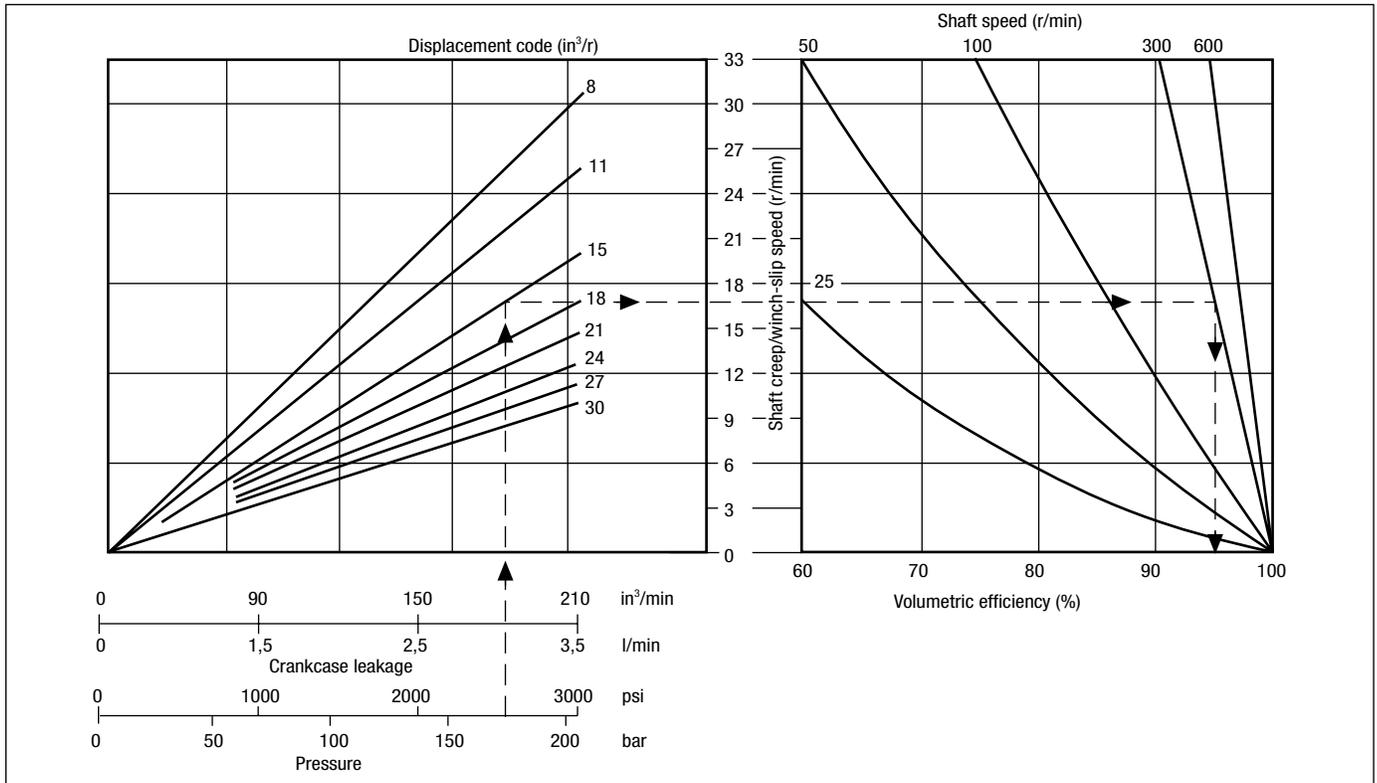
Example 1 (follow chain dotted line):

Side load (W)	a) 0
System pressure (P)	b) 207 bar (3000 psi)
Speed (N)	c) 100 r/min
Median bearing life	d) 136 000 hrs
L10 bearing rating = median x 0.2	27 200 hrs

Example 2 (follow chain dotted line):

Side load (W)	e) 25 kN (5620 lbf)
Load offset (A) from motor mounting face	f) 50 mm (2.0 in)
System pressure (P)	g) 207 bar (3000 psi)
Speed (N)	h) 100 r/min
Median bearing life	i) 45 500 hrs
L10 bearing rating = median x 0.2	9100 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. For motors with low displacement below 12 in³ and starting under load it is recommended to select high displacement for start-up.

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.

SMALL DISPLACEMENTS

(3 in³ and below)

The pressures given in the table on page 4 for displacement code "03" (and below) are based on 1000 r/min output shaft speed. These pressures can be increased for shaft speeds less than 1000 r/min; consult Kawasaki for details.

In addition to 3 in³, a zero swept volume displacement (for free wheeling requirements) is available on request, subject to Kawasaki approving the application.

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:

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

Where:

C = crankcase pressure, bar

D = see table

N = speed, r/min

V = displacement, cm³/r

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

Where:

C = crankcase pressure, psi

D = see table

N = speed, r/min

V = displacement, cm³/r

Port connection type	D value
F3 FM3, S03	D _{bar} = 7.5 x 10 ⁹ D _{bar} = 2.0 x 10 ⁶
F2, FM2	D _{bar} = 3,7 x 10 ⁹ D _{bar} = 9.5 x 10 ⁵

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 0,2 sec requires 11 l/min (2.0 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 holes, 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 load2000 cSt (9270 SUS)
Max. on load150 cSt (695 SUS)
Optimum50 cSt (232 SUS)
Minimum25 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 to 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
30	0,012	40
15	0,0094	32

11. MASS

Approx. all models: 100 kg (220 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

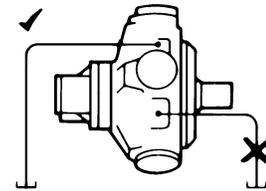
The recommended torque wrench setting for the M18 bolts is: 312±7Nm (230±5 lbf ft)

● 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.

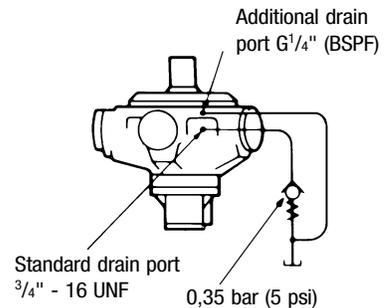
CRANKCASE DRAIN

Motor axis horizontal



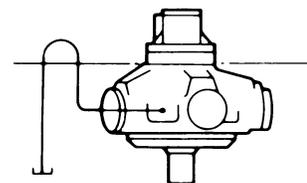
The crankcase drain must be taken from a position above the horizontal centre line of the motor.

Axis vertical, shaft up



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

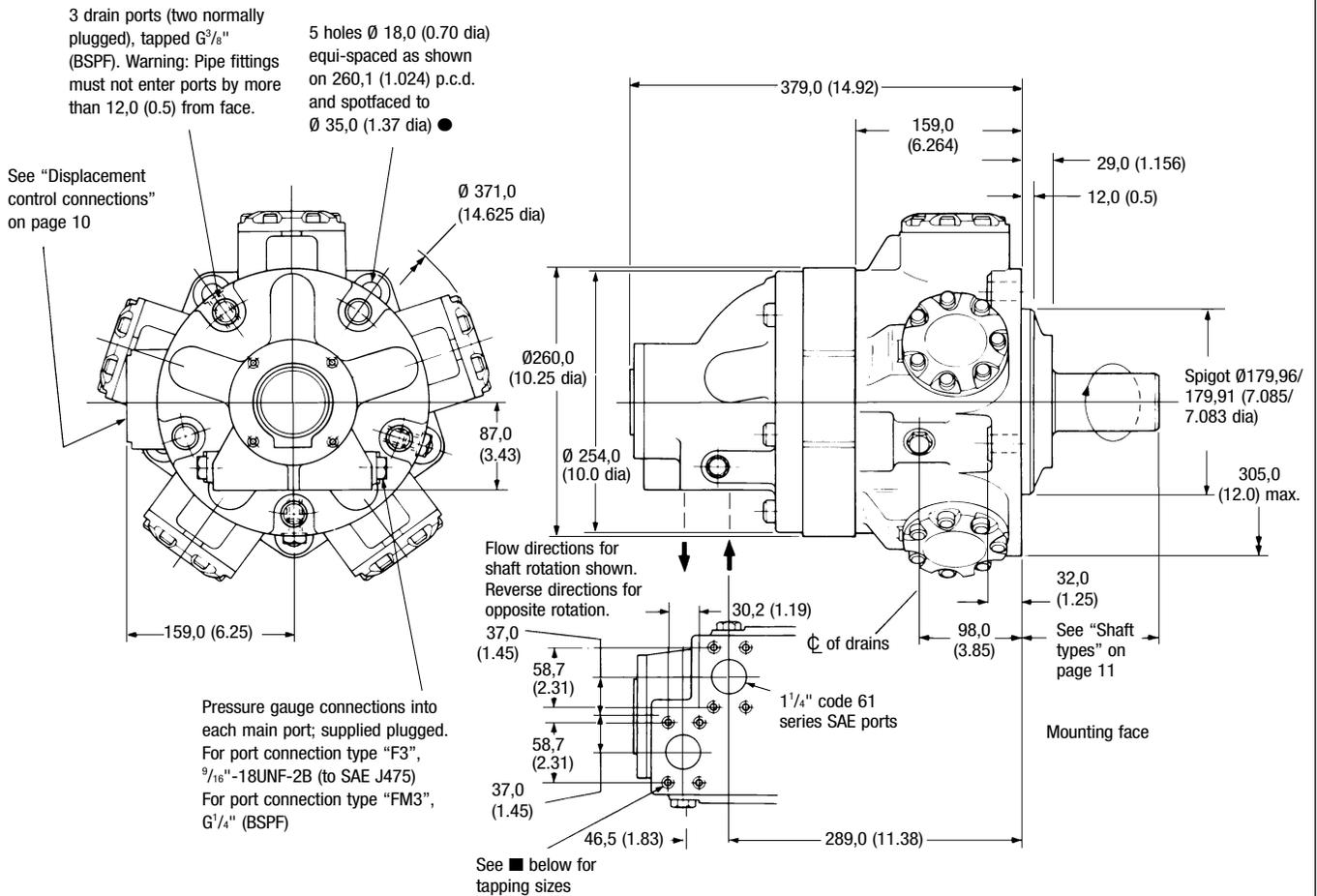
Fill the crankcase with system fluid.
Where practical, a short period (30 minutes) of "running in" should be carried out with the motor set to its high displacement (pressure to port Y, or to port B of the size O3 pilot valve).

13. INSTALLATION DIMENSIONS IN MM (INCHES)

HMC030 MOTOR WITH TYPE "F3"/"FM3" (SAE 1 1/4" 4-BOLT FLANGE) MAIN PORTS CONNECTION

See additional views for:

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



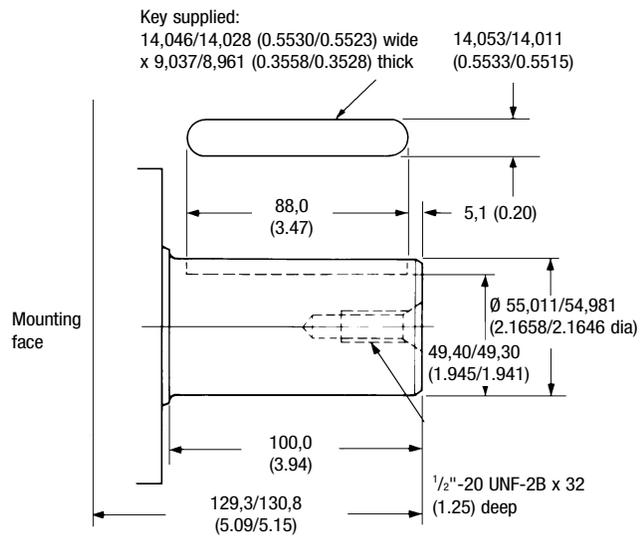
● Suitable for M18 or 5/8" dia bolts. Maximum reaming diameter, one hole, 18,5 (0.728) (for fitted bolt); see "Installation Data".

■ Port connection details.

Model code	Flange	Bolt tappings
F3	1 1/4" SAE 4-bolt flange	7/16"-14 UNC x 27,0 (1.06) deep
FM3	1 1/4" SAE 4-bolt flange	M12 x P1.75 x 27,0 (1.06) deep
S03	Staffa 3" 6-bolt flange, see separate view on page 10.	
F2/FM2	1" SAE 4-bolt flange, see separate view on page 10.	

SHAFT TYPE "P", MODEL CODE POSITION 3

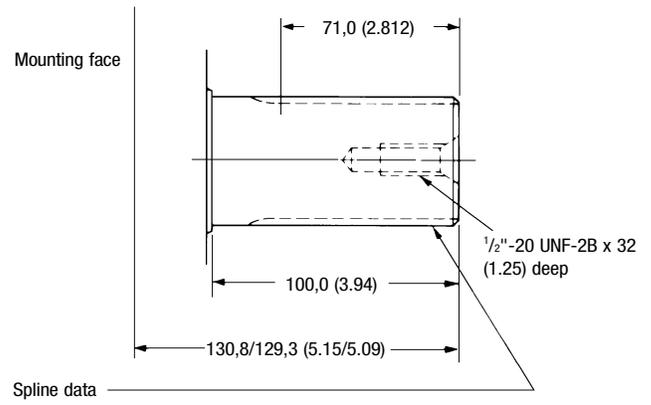
Cylindrical shaft with rectangular key

**SHAFT TYPE "S", MODEL CODE POSITION 3**

Cylindrical shaft with 17 splines to BS 3550

SHAFT TYPE "Z", MODEL CODE POSITION 3

Cylindrical shaft with splines to DIN 5480



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	17
Pitch	8/16
Major diameter	56,41/56,29 (2.221/2.216)
Form diameter	50,703/(1.9962)
Minor diameter	50,06/49,60 (1.971/1.953)
Pin diameter	6,096 (0.2400)
Diameter over pins	62,984/62,931 (2.4797/2.4776)

For type Z shaft
 DIN 5480, W55 x 3 x 17 x 7h

Presented by:



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