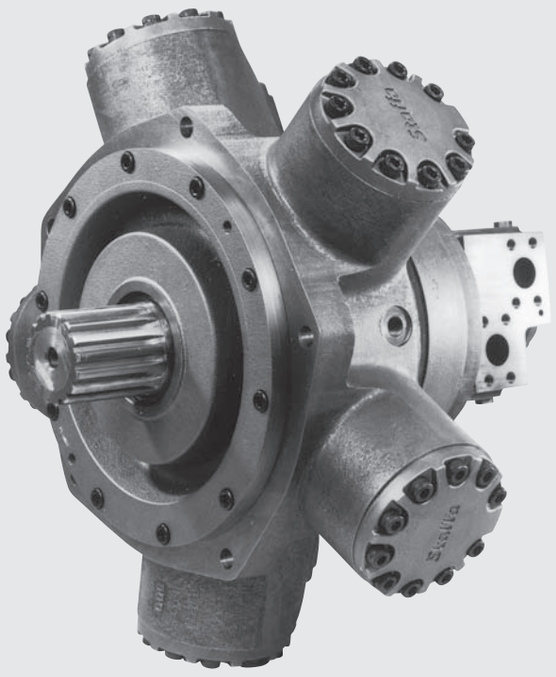
Kawasaki

HMC 200

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 HMC030 of 492 cm^3 (30 in^3) to the HMC325 of 5330 cm^3 (325 in^3) 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.

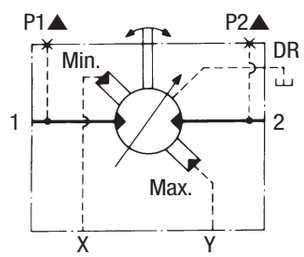
The HMC200 is one of 7 frame sizes and is capable of developing torques up to 12 800 Nm (9440 lbf ft) with a continuous output power of 174 kW (233 hp).

The Kawasaki “Staffa” range also includes fixed displacement motors.

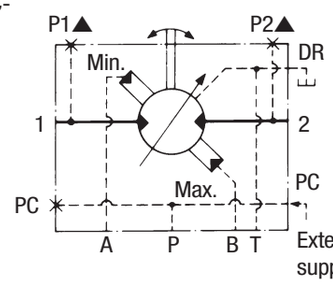
2. FUNCTIONAL SYMBOLS

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

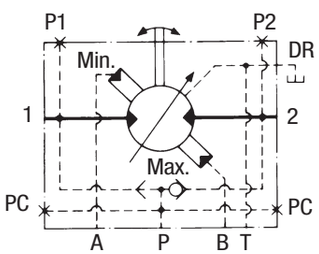
-F(M)*-X-
-SO*-X-



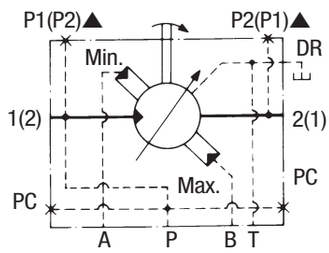
-F(M)*-C-
-SO*-C-



-F(M)*-CS-



-F(M)*-C1 (-F(M)*-C2- in brackets)
-SO*-C1 (-SO*-C2- in brackets)



▲ *-F(M)*-models only*

3. MODEL CODE

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

(F)-HM(*)C200-**-***-***-***-**-(T*)-30-(PL**)**

1 2 3 4 5 6 7 8 9 10

1 FLUID TYPE
- Blank = Petroleum oil
- F3 = Phosphate ester (HFD fluid)
- F11 = Water-based fluids (HFA, HFB & 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, 20 splines to BS 3550
- Q* = Female, 34 splines to BS 3550
- Z* = Cylindrical shaft to DIN 5480 (W85 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
100 to 180 in^3 in 10 in^3 steps, and 188 in^3

5 LOW DISPLACEMENT CODE
05, and 10 to 140 in^3 in 10 in^3 steps

6 MAIN PORT CONNECTIONS
Models with 3" distributor valve
- SO3 = 6-bolt (UNF) flange (Staffa original valve housing)
- F3 = SAE 1 1/4" 4-bolt (UNC) flanges
- FM3 = SAE 1 1/4" 4-bolt (metric) flanges

Models with 4" distributor valve ▼
- SO4 = 6-bolt (UNF) flange (Staffa original valve housing)
- F4 = SAE 1 1/2" 4-bolt (UNC) flanges
- FM4 = SAE 1 1/2" 4-bolt (metric) flanges

▼ *4" valve permits increased continuous speed ratings, see "Max. continuous speed" in table 1, next page. See also increased installation dimensions with 4" valve.*

7 DISPLACEMENT CONTROL PORTS (AND SHUTTLE VALVE)
Threaded ports/bi-directional shaft rotation:
- X = X and Y ports G 1/4" (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 "SO* " 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 HMC200 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)		188	180	170	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	05/00
Displacement	cm^3	3080	2950	2790	2620	2460	2290	2130	1970	1800	1640	1470	1310	1150	980	820	670	490	330	160	82/00
volume/r	in^3	188	180	170	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	05/00
Average actual	Nm/bar	46,6	44,0	41,7	39,1	36,6	34,0	31,3	28,7	26,3	23,6	21,0	18,3	15,7	12,8	10,6	8,1	5,9	3,1	0,6	0
running torque	lbf ft/psi	2.37	2.24	2.12	1.99	1.86	1.73	1.59	1.46	1.34	1.20	1.07	0.93	0.80	0.65	0.54	0.41	0.30	0.16	0.03	0
Max. continuous speed																					
with 3" valve■	r/min	125	130	140	150	160	170	180	195	210	235	260	295	340	390	440	540	600	600	600	1000
with 4" valve■	r/min	175	180	190	200	215	230	250	270	295	320	350	350	350	350	350	350	350	350	350	1000
Max. continuous	kW	174	174	174	165	156	148	139	131	122	114	105	98	88	81	72	62	48	25	5	0
output	hp	233	233	233	221	209	198	186	176	164	153	141	131	118	109	97	83	64	34	7	0
Max. intermittent	kW	195	195	195	185	175	166	156	147	137	128	118	110	99	91	81	70	54	33	6	0
output	hp	261	261	261	248	235	223	209	197	184	175	158	148	133	122	109	94	72	45	8	0
Max. continuous	bar	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	17◆
pressure	psi	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	3626	250◆
Max. intermittent	bar	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	17◆
pressure	psi	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	250◆

* *Intermediate displacements are made available to special order.*
■ *See model code position* **6**
◆ *See "Small Displacements" page 7 for information about higher pressure applications.*

TABLE 2

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 (3626)	275 (4000)	As for petroleum oil

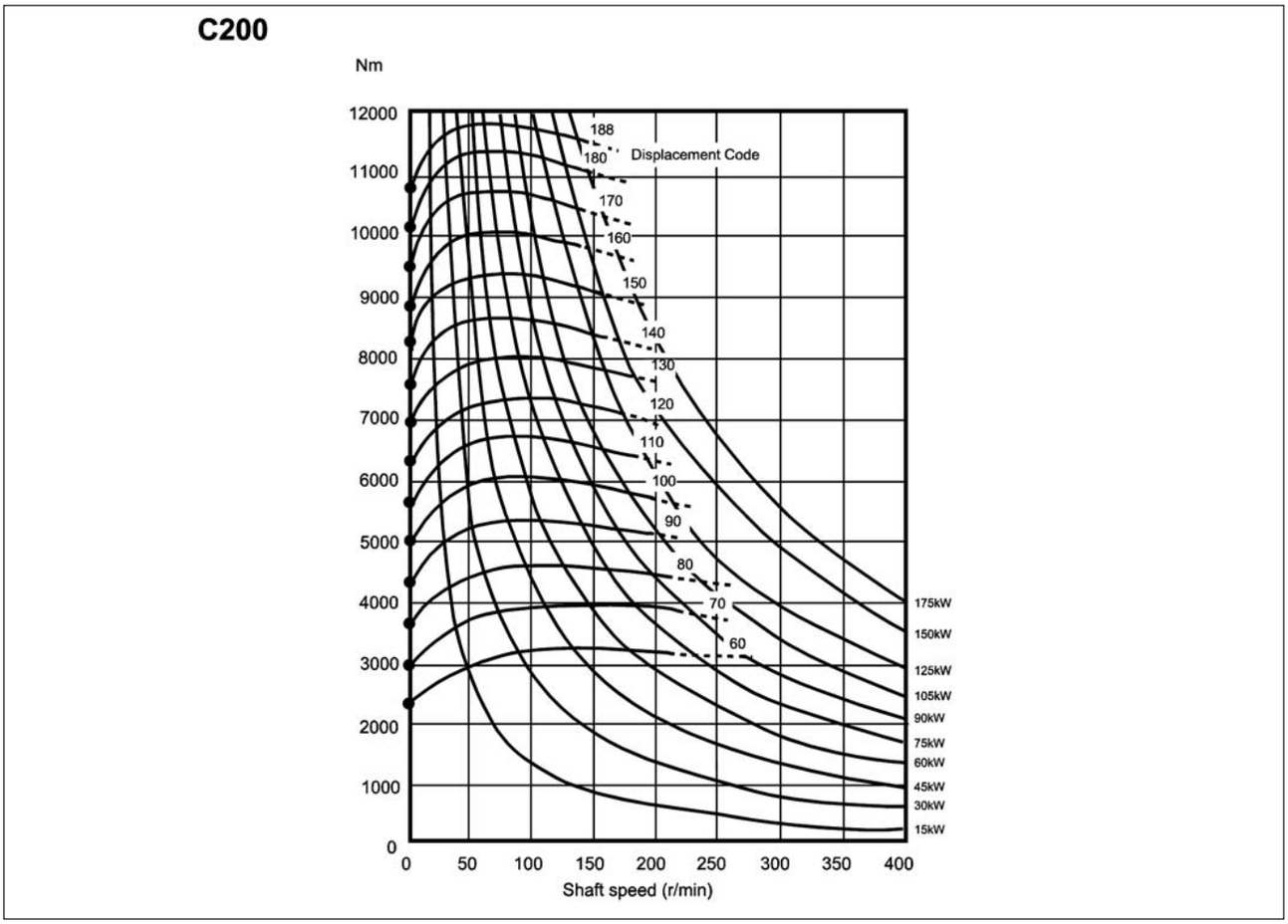
RATING DEFINITIONS

● 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:
(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



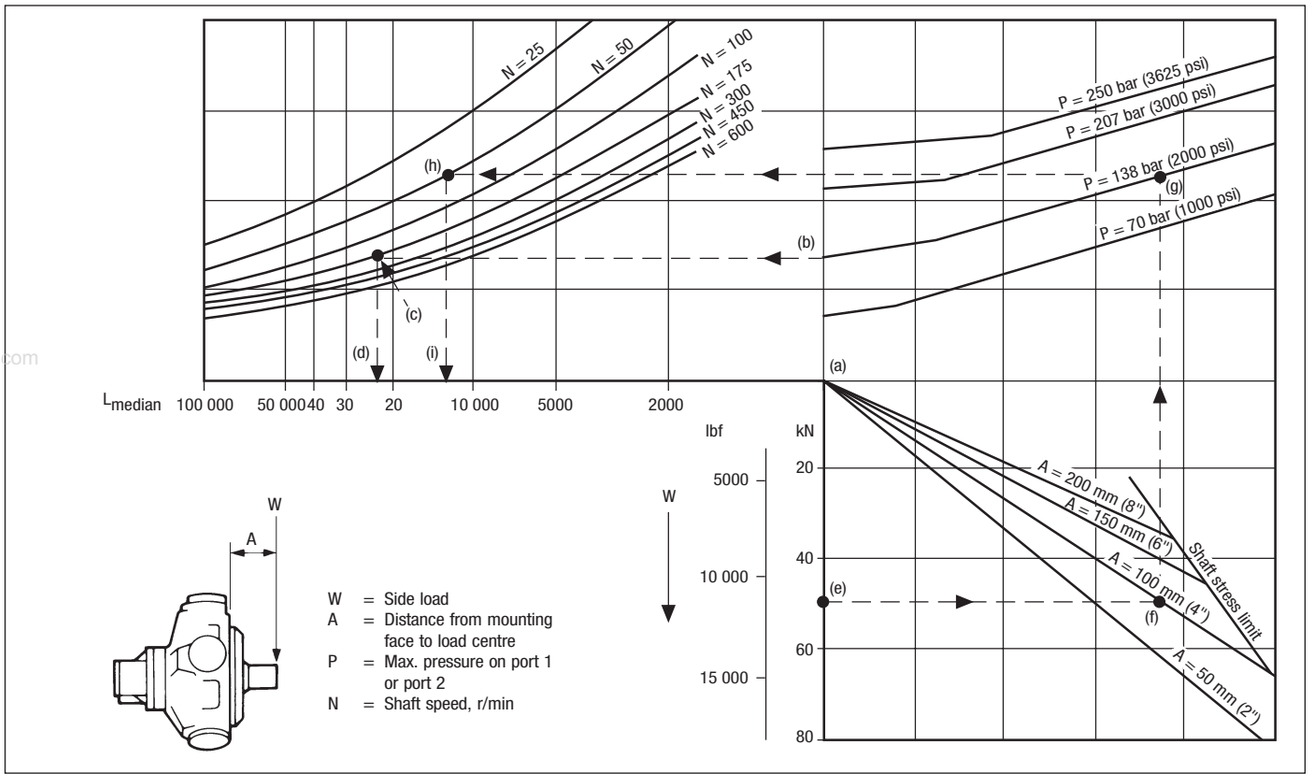
The torque curves indicate, for each displacement, the maximum output torque of the motor with an inlet pressure of 250 bar (3626 psi) and zero output pressure. High return line pressures will reduce the torque for any given pressure differential.

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.

	HMC200
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) 22 000 hrs
L10 bearing rating = median x 0.2	4400 hrs
Example 2 (follow chain dotted line):	
Side load (W)	e) 50 kN (11 240 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

● 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

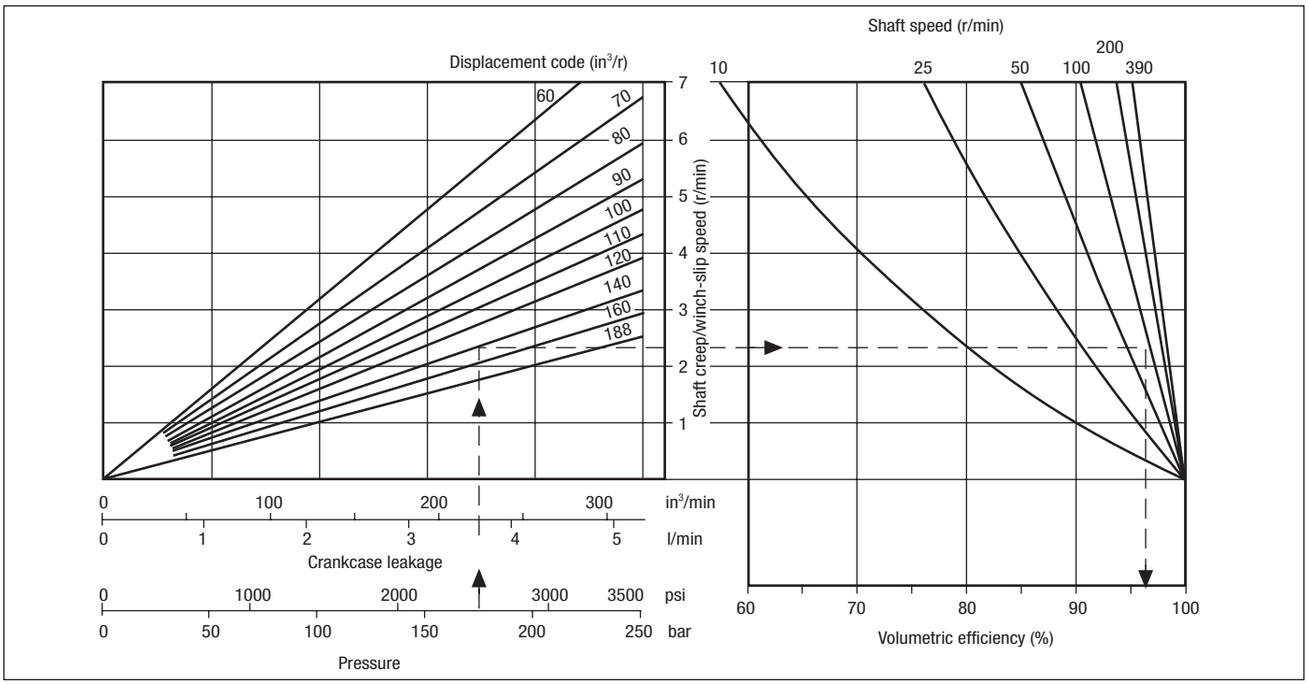
The nomograph on page 7 enables the average volumetric efficiency, crankcase (drain) leakage and "winch slip"/shaft creep speed to be estimated.

Example (follow chain dotted line):
Given:
1. Pressure .....175 bar (2500 psi)
2. Displacement code.....140 (in^3/r)
3. Speed .....100 r/min

To obtain:
4. Volumetric efficiency 96.5%
5. Crankcase leakage .....3,7 l/min (230 in^3/min)
6. Shaft creep speed .....2.4 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.

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 4 are average and will vary with system parameters. For motors with low displacement below 50 in^3 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

(5 in^3 and below)
The pressures given in the table on page 4 for displacement code "05" (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 5 in^3, 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:

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

Where:
C = crankcase pressure, bar
D = see table
N = speed, r/min
V = displacement, cm^3/r

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

Where:
C = crankcase pressure, psi
D = see table
N = speed, r/min
V = displacement, in^3/r

Port connection type	D value
F3, FM3, SO3	$D_{bar} = 1{,}6 \times 10^{10}$ $D_{psi} = 4.1 \times 10^6$
F4, FM4, SO4	$D_{bar} = 3{,}3 \times 10^{10}$ $D_{psi} = 8.4 \times 10^6$

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 15 l/min (4.0 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 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 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 m²	lb in²
188	0,23	800
75	0,18	600

11. MASS

Approx. all models: 282 kg (600 lb)

12. INSTALLATION DATA

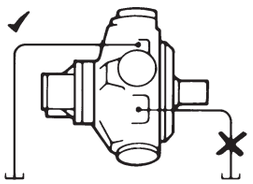
General
● Spigot
The motor should be located by the mounting spigot on a flat, robust surface using correctly sized bolts. The diametral clearance between the motor spigot and the mounting must not exceed 0,15 mm (0.006"). If the application incurs shock loading, frequent reversing or high speed running, 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" UNF .....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.

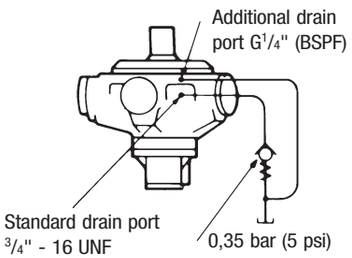
CRANKCASE DRAIN

Motor axis horizontal



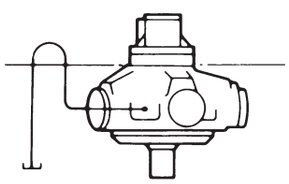
The crankcase drain must be taken from a position above the horizontal centre line of the motor.

Axis vertical, shaft up



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

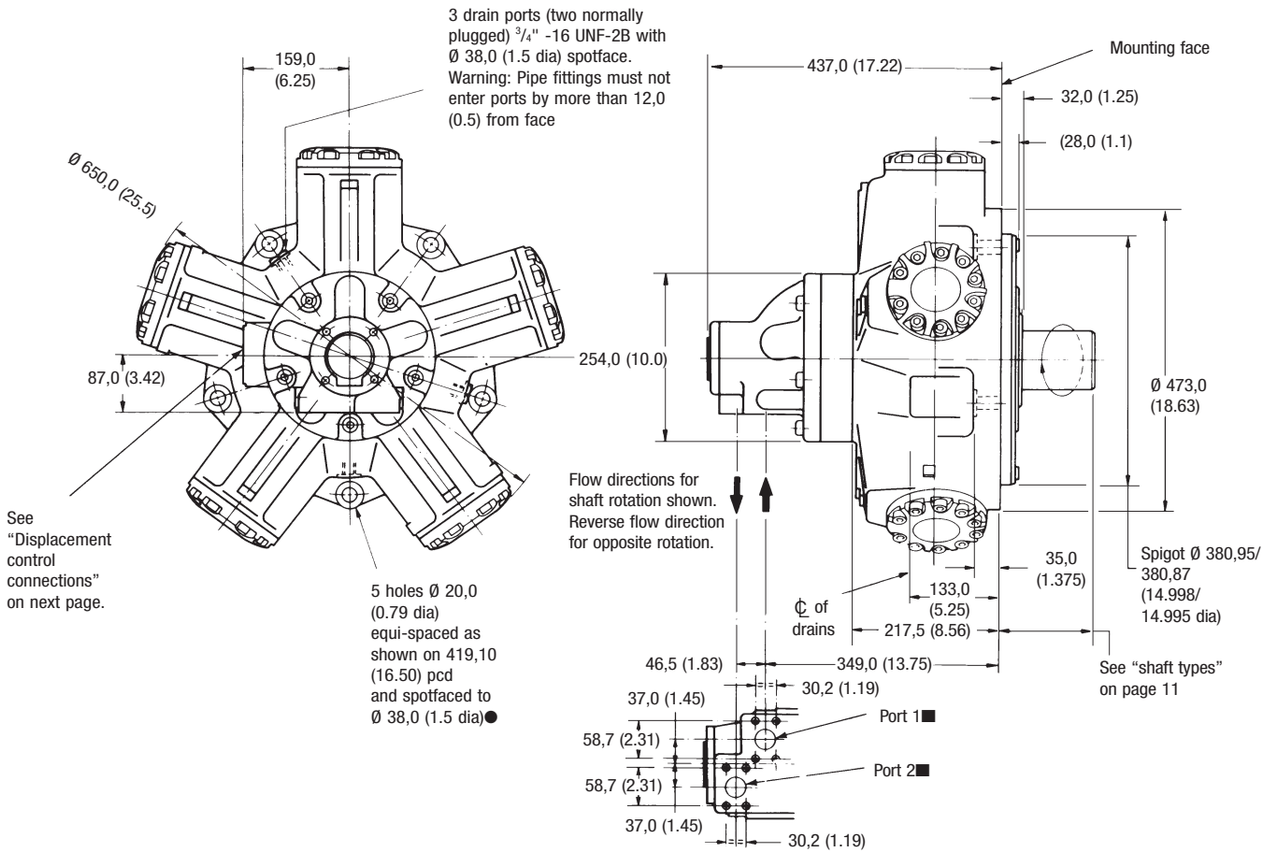
Fill the crankcase with system fluid. Where practical, a short period (30 minutes) of "running in" should be carried out with the motor set to its high displacement (pressure to port Y, or to port B of the size 03 pilot valve).

13. INSTALLATION DIMENSIONS IN MM (INCHES)

HMC200 MOTOR WITH TYPE "F3"/"FM3" ($1^1/_4$" SAE) MAIN PORTS CONNECTION

See additional views for:
Displacement control connections, shaft types, alternative main port connections for 3" valve, and all port connections with 4" valve

3rd angle projection

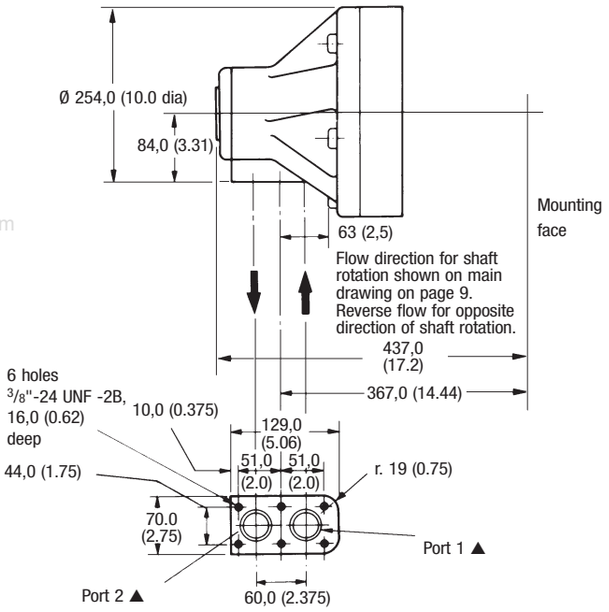


● *Suitable for M20 or 3/4" bolts. Maximum reaming diameter 21,0 (0.83) (for fitted bolt); see "Installation Data".*

■ *Port connection details*

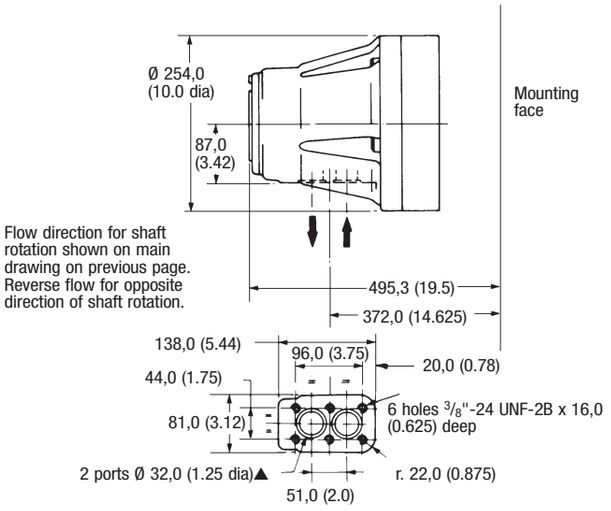
Model code 6	Flange	Bolt tappings
F3	$1^1/_4$" SAE code 61 4-bolt flange	$^7/_{16}$"-14 UNC-2B x 27,0 (1.06) deep
FM3	$1^1/_4$" SAE code 61 4-bolt flange	M12-6H x P1.75 x 27,0 (1.06) deep
S03	Staffa 3" 6-bolt flange, see separate view on next page	

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



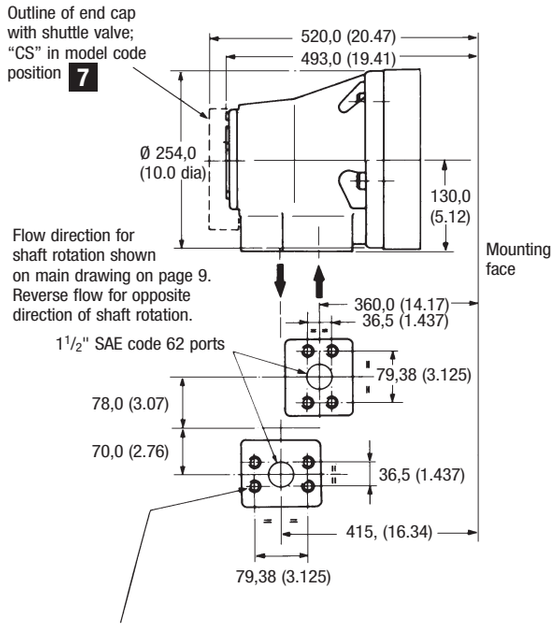
▲ *Ø 28 (1.125 dia), with recess for 31,0 (1.22) i/d x Ø 4 (0.157 dia) section O-ring*

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



▲ *Ø 32 (1.25 dia), with recess for 38.1 (1.50) i/d x Ø 3.53 (0.139 dia) section O-ring*

4" VALVE HOUSING WITH SAE 1 1/2" 4-BOLT FLANGES, "F4" OR "FM4" IN MODEL CODE POSITION 6



Port connection details

Model code 6	Bolt tappings
F4	5/8"-11 UNC-2B x 35,0 (1.38) deep
FM4	M16 x P2,0 x 35,0 (1.38) deep

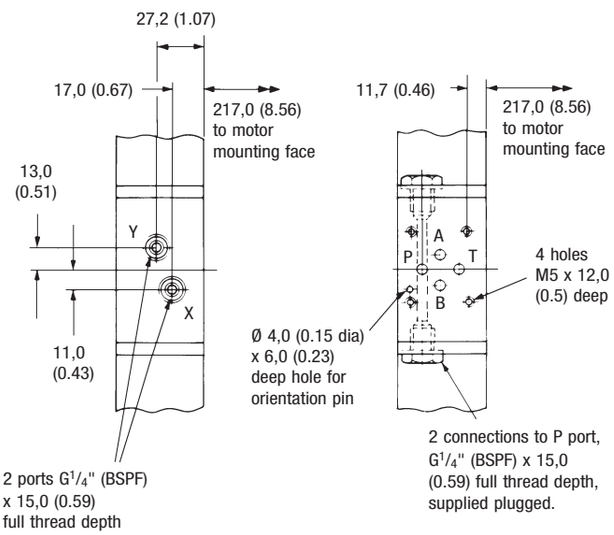
DISPLACEMENT CONTROL CONNECTIONS, MODEL CODE POSITION 7

Type X
G1/4" (BSPF) tapped ports X and Y

Displacement selection (via remotely located valve ◆):
High displacement: P to Y; X to T
Low displacement: P to X; Y to T

Types C, CS, C1 and C2
Mounting interface for directional control valve ◆ to: ISO 4401 size 03 ANSI/B93. 7M size D03

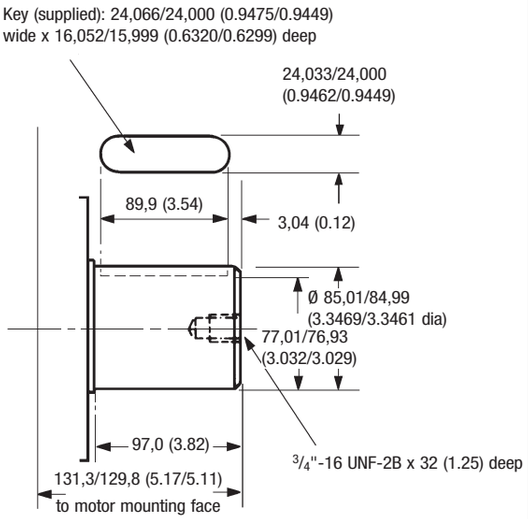
Displacement selection:
High displacement: P to B; A to T
Low displacement: P to A; B to T



◆ *Displacement selector valve is not supplied with the motor; specify and order separately.*

SHAFT TYPE "P", MODEL CODE POSITION 3

Straight shaft with rectangular key

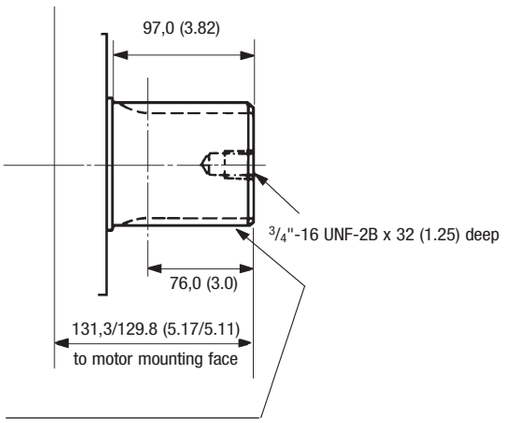


SHAFT TYPE "S", MODEL CODE POSITION 3

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

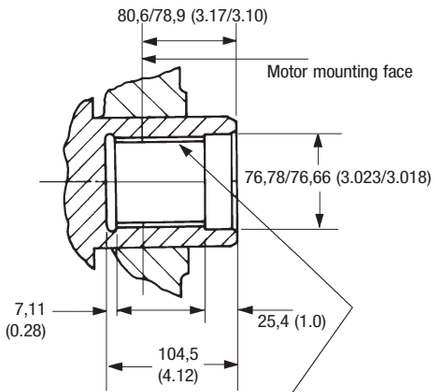
Pressure angle	30°
Number of teeth	20
Pitch	6/12
Major diameter	87,953/87,826 (3.4627/3.4577)
Form diameter	80,264 (3.1600)
Minor diameter	79,484/78,925 (3.1293/3.1073)
Pin diameter	8,128 (0.3200)
Diameter over pins	97,084/97,031 (3.8222/3.8201)

For type Z shaft
DIN 5480, W85 x 3 x 27 x 7h

SHAFT TYPE "Q", MODEL CODE POSITION 3

Female straight shaft with 34 splines to BS 3550

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.*



Spline data

Internal spline to BS 3550-1963
Flat root, side fit, class 1

Pressure angle	30°
Number of teeth	34
Pitch	12/24
Major diameter	74,414/74,018 (2.9297/2.9176)
Minor diameter	69,977/69,850 (2,7550/2.7500)
Pin diameter	3,658 (0.1440)
Pin flatted to	3,556 (0.1400)
Diameter between pins	66,744/66,815 (2.6277/2.6305)

Presented by:

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