Staffa

Contents

*** Each section will have a contents page for that specific section as this is a combined document.**

Radial Piston Motors

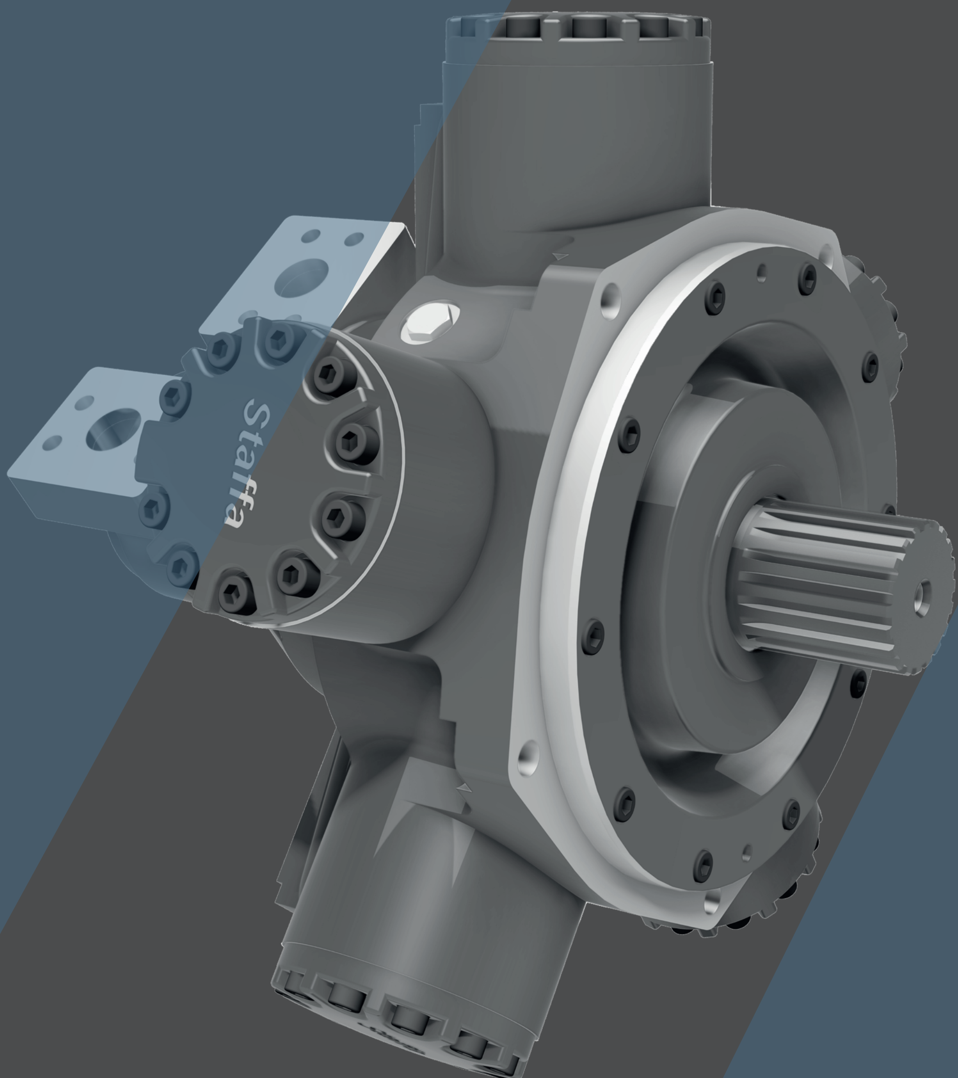
Kawasaki
Powering your potential

Precision Machinery Company

Fixed Displacement Radial Piston

Staffa Motor

HMB Series



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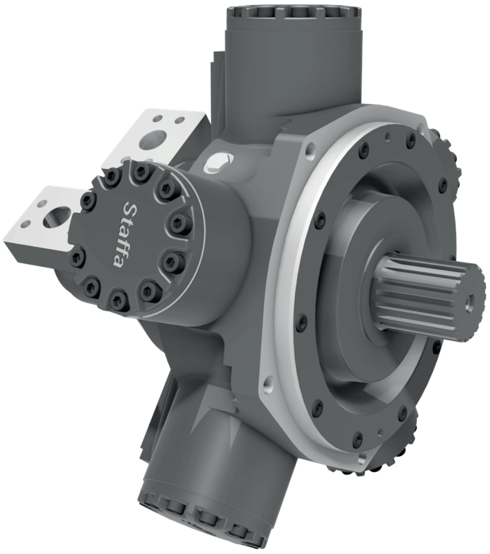
HMB Series

Fixed Displacement Radial Piston Hydraulic Motor



General Descriptions

The Kawasaki "Staffa" range of high torque low speed fixed displacement radial piston hydraulic motors consists of 13 frame sizes ranging from the HMB010 to HMB500. Capacity ranges from 188 to 8,000 cc/rev.

The rugged, well proven design incorporates high efficiency, combined with good breakout torque and smooth running capability.

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

The Kawasaki "Staffa" range also includes dual and triple displacement motors. To obtain details of these product ranges please refer to datasheet M-2002/03.17 and M-2005/12.17

Features

Rugged, reliable, proven design

Unique hydrostatic balancing provides minimum wear and extended life

High volumetric and mechanical efficiency

Capacities range from 50 to 8,000 cc/rev

Large variety of shaft and porting options

Output torque up to 25,250 Nm

Wide range of mounting interfaces available

Alternative displacements also available

HMB Series

Specifications

Motor Type	Geometric displacement (cc/rev)	Average actual running torque (Nm/bar)	Max. continuous speed (rpm)	Max. continuous output (kW)	Max. continuous pressure (bar)	Max. intermittent pressure (bar)
HMB010	188	2.79	500	25	207	241
HMB030	442	6.56	450	42	207	241
HMB030 (FM3)	492	7.31	450	52	207	241
HMB045	740	10.95	400	60	250	293
HMB060	983	14.5	300	80	250	293
HMB080	1,344	19.9	300	100	250	293
HMB100	1,639	24.3	250	110	250	293
HMB125 / **HMHDB125**	2,050	30.66	220	100	250	293
HMB150 / **HMHDB150**	2,470	36.95	220	115	250	293
HMB150 (FM3)	2,470	36.95	168	115	250	293
HMB200 / **HMHDB200**	3,087	46.07	175	130	250	293
HMB200 (FM3)	3,087	46.07	135	130	250	293
HMB270 / **HMHDB270**	4,310	63.79	125	140	250	293
HMB325 / **HMHDB325**	5,310	79.4	100	140	250	293
HMHDB400	6,800	101	120	190	250	293
HMB500	8,000	114	100	170	190	227

Other non standard displacements are possible - check with KPM UK for details.

1 Ordering Code

1-1 Model Coding

F11/HM*B 060 / S3 V/ FM3/Tj/ */ P*****

Fluid Type

Blank	Mineral oil
F3	Phosphate ester (HFD fluid)
F11	Water based fluids (HFA, HFB & HFC)
Alternative fluids contact Kawasaki	

Model Type

HMB	Standard
HMHDB	Heavy duty

** For B400 frame size, only Heavy Duty (HMHDB) is available.*

Motor Frame Size

See options page 4

Shaft Type

See shaft type options in installation drawings

Shaft Orientation

Blank	Horizontal and vertically down
V	Vertically Up

Main Port Connections

See Port Connection options in installation drawings.

Special Features

P*****	Special features (see page 6)
PL***	Non-catalogued features, (*****) = number assigned by Kawasaki as required

Design Series Number

Current series for HMB motors

Tacho Encoder Drive

Blank	None
Tj*	Square wave output with directional signal*
Tk	Combines Tj with the T401 instrument to give a 4 to 20 mA output proportional to speed. Directional signal and speed relay output.

See page 39
** Not available for B010 frame size.*

1-1 Model Coding

Special Features Suffix

/P * * * * *

Shaft Seal Enhancements

A	High pressure shaft seal
B	Improved shaft seal life
C	High pressure shaft seal & improved shaft seal life
0	None

See pages 25 & 26 for details

External Protection

A	Anti-pooling bolt heads
B	Marine-specification primer paint
C	Anti-pooling bolt heads & Marine-specification primer paint
0	None

See pages 28 & 36 for details

Installation Features

A	Drain port adaptor x 1
B	Drain port adaptor x 2
C	Φ21 mm mounting holes
D	Φ22 mm mounting holes
E	Φ21 mm mounting holes & Drain port adaptor x 1
F	Φ21 mm mounting holes & Drain port adaptor x 2
G	Φ22 mm mounting holes & Drain port adaptor x 1
H	Φ22 mm mounting holes & Drain port adaptor x 2
0	None

See pages 34 & 35 for details

Performance Enhancements

A	Increased starting torque
B	Increased power rating
C	Increased starting torque & increased power rating
0	None

See pages 30 & 37-8 for details

Valve Enhancements

A	Improved cavitation resistance
B	Anti-clockwise
C	Thermal shock resistance
D	Improved caviation resistance & anti-clockwise
E	Improved cavitation resistance & thermal shock resistance
F	Anti-clockwise & thermal shock resistance
G	Improved cavitation resistance & anti-clockwise & thermal shock resistance
0	None

See pages 27, 31 & 32 for details

2 Technical Information

2-1 Performance Data

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

This pressure is allowable on the following basis:

a) Up to 50rpm 15% duty for periods up to 5 minutes maximum.
b) Over 50 rpm 2% duty for periods up to 30 seconds maximum.

Static pressure to DNV rules 405 bar (except HMB010 and HMB030 motors).

Limits for fire resistant fluids

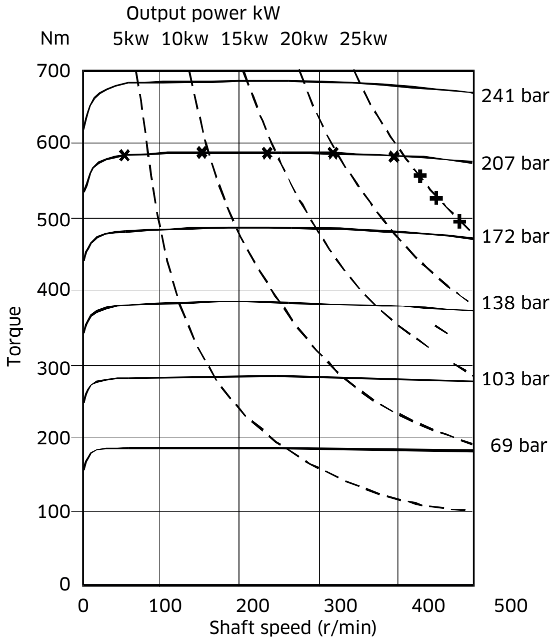
Fluid Type	Continuous Pressure (bar)	Intermittent Pressure (bar)	Max Speed (rpm)	Model Type
HFA 5/95 oil-in-water emulsion	130	138	50% of limits of mineral oil	All models
HFB 60/40 water-in-oil emulsion	138	172	As for mineral oil	All models
HFC water glycol	103	138	50% of limits of mineral oil	All models
HFD phosphate ester	207	241	As for mineral oil	HMB010
	207	293	As for mineral oil	HMB030
	250	293	As for mineral oil	HMB045 to HMHDBB400 inc.
	190	227	As for mineral oil	HMB500

2-1 Performance Data (cont)

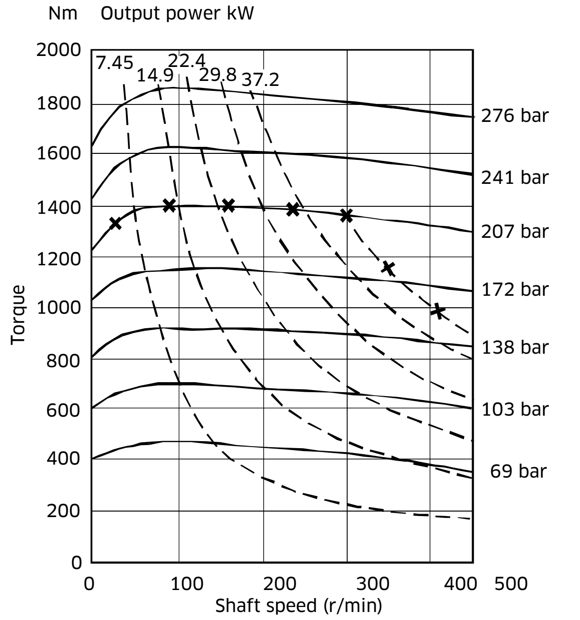
Output Torque Curves

These 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 Mineral 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.

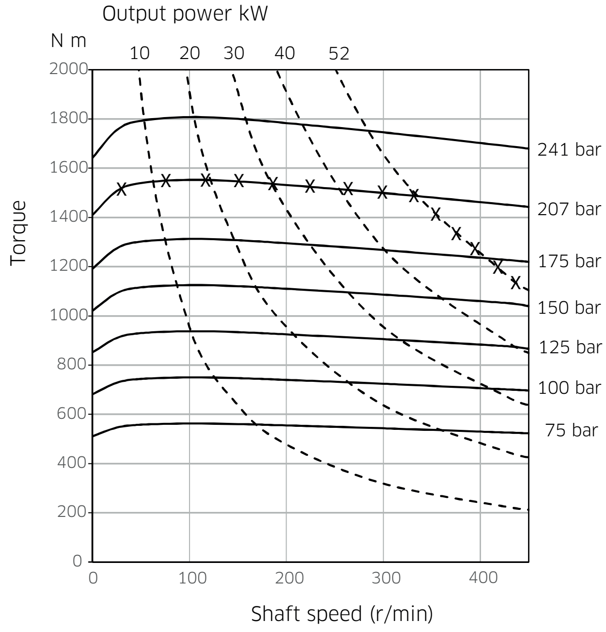
HMB010



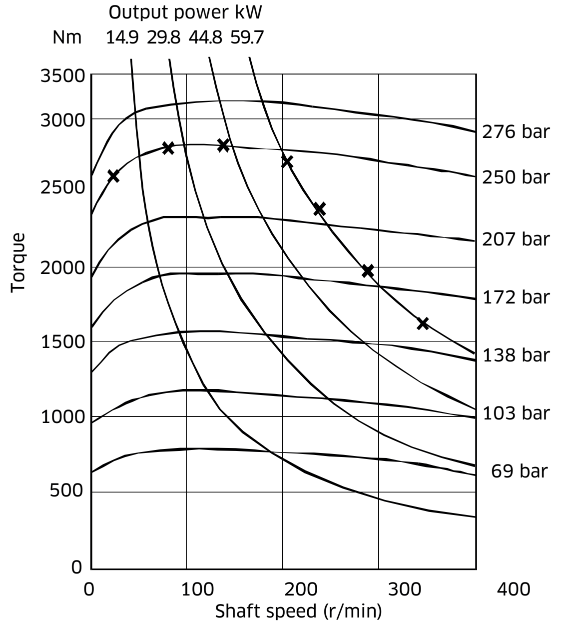
HMB030



HMB030
2-piece



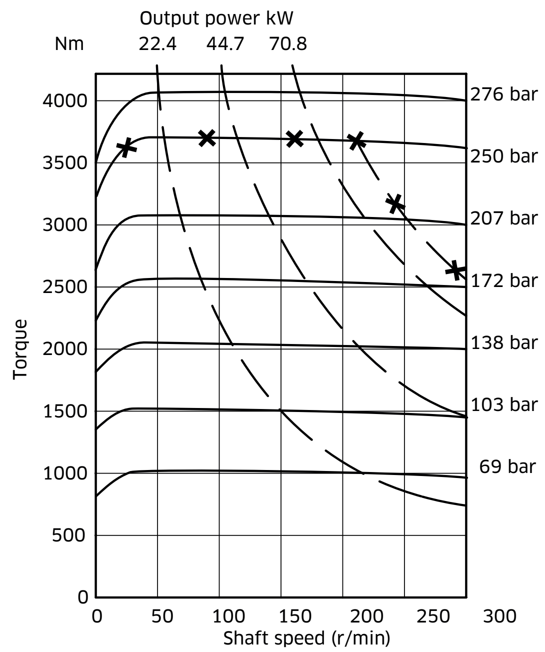
HMB045



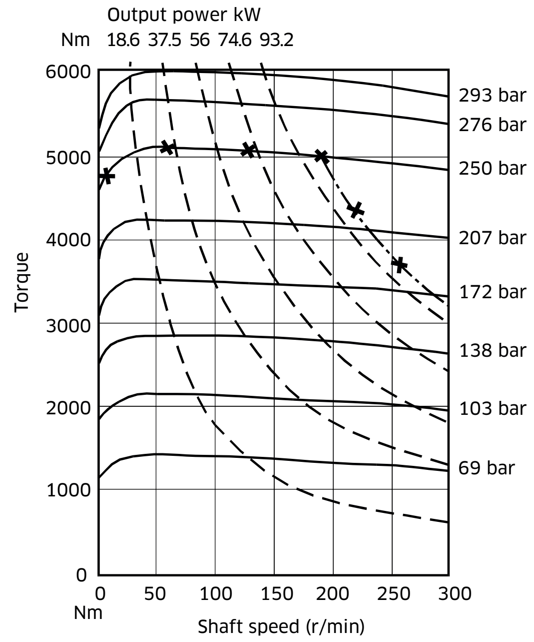
2-1 Performance Data (cont)

Output Torque Curves (cont)

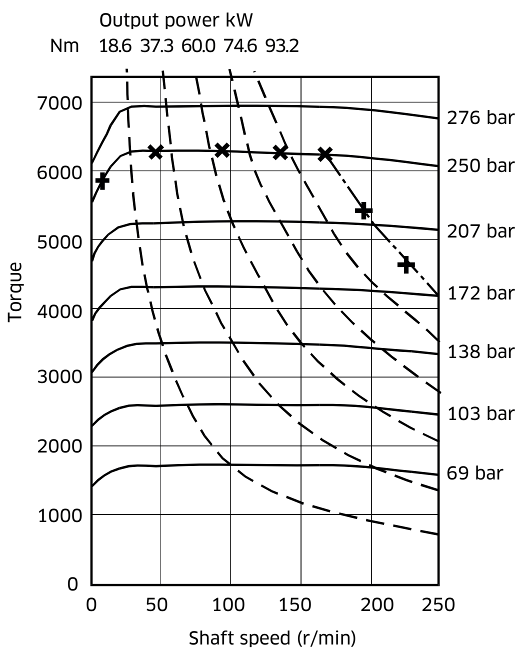
HMB060



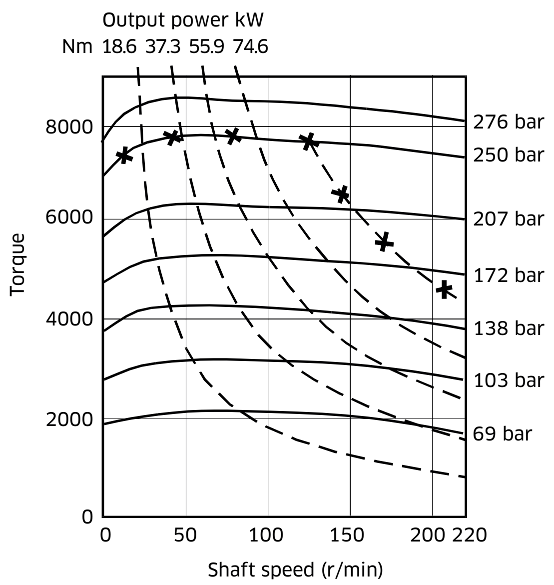
HMB080



HMB100



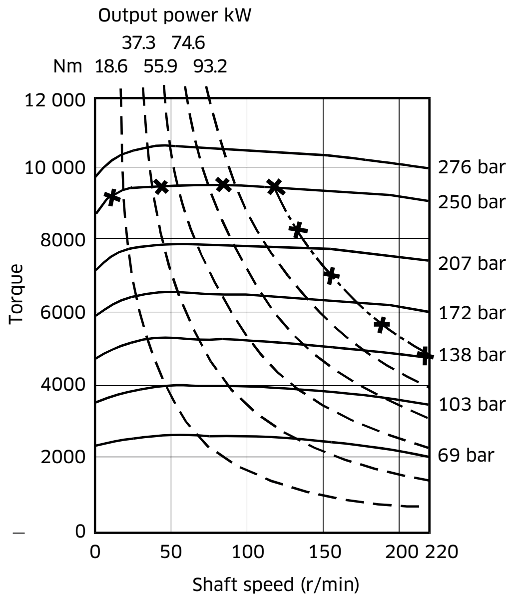
HM(HD)B125



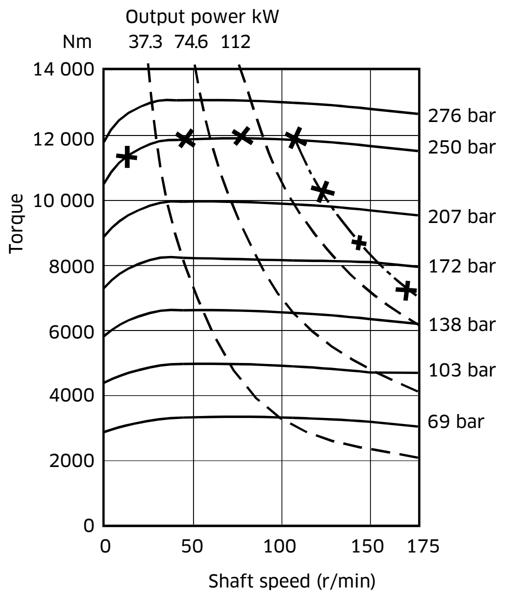
2-1 Performance Data (cont)

Output Torque Curves (cont)

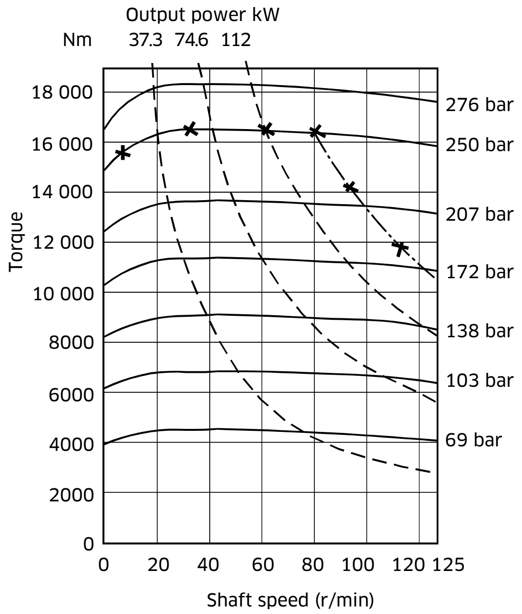
HM(HD)B150



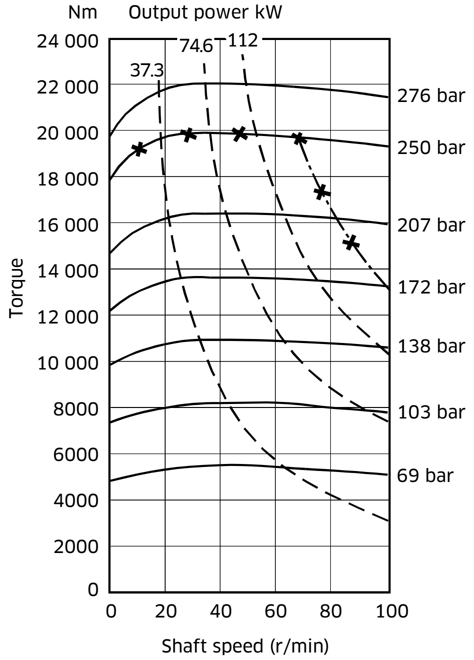
HM(HD)B200



HM(HD)B270



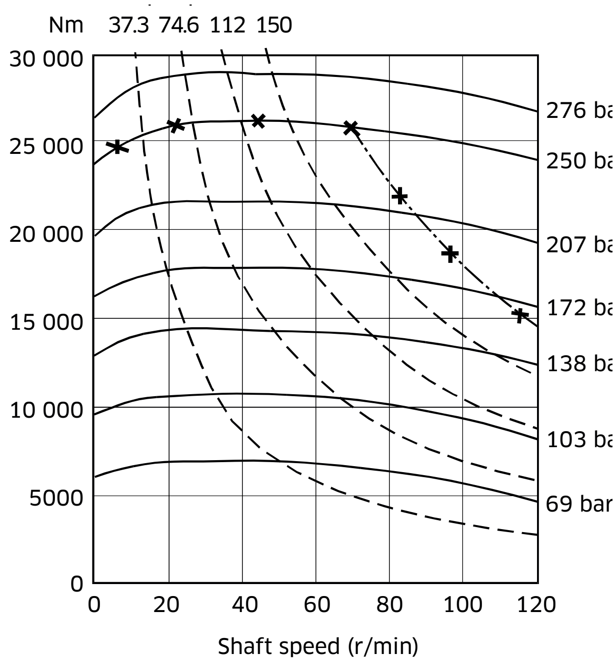
HM(HD)B325



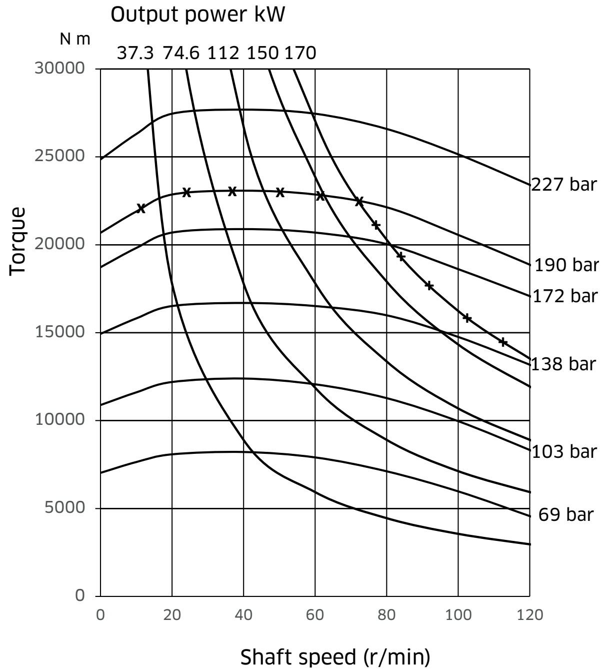
2-1 Performance Data (cont)

Output Torque Curves (cont)

HMHDB400



HMB500



2-2 Volumetric Efficiency Data

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
HMB	cc/rev	K_1	K_2	K_3	K_4
HMB010	188	1.34	534.05	7.31	0.51
HMB030	442	1.04	57.67	2.47	0.59
2-piece HMB030	492	1.04	57.67	2.47	0.59
HMB045	740	1.92	43.36	2.71	1.76
HMB060	983	1.72	29.91	2.35	1.88
HMB080	1,344	1.71	21.62	1.84	1.84
HMB100	1,639	1.83	17.74	1.41	1.88
HM(HD)B125	2,050	2.06	11.45	1.24	1.35
HM(HD)B150	2,470	1.62	9.98	1.00	1.39
HM(HD)B200	3,080	2.53	14.99	0.78	1.39
HM(HD)B270	4,310	3.17	21.16	0.68	1.80
HM(HD)B325	5,310	3.14	18.21	0.55	1.80
HMHDB400	6,800	4.06	10.18	0.53	2.35
HMB500	8,000	9.247	78.247	1.739	5.797

Fluid Viscosity	Viscosity Factor
cSt	Kv
20	1.58
25	1.44
30	1.30
40	1.10
50	1.00
60	0.88

Qt (total leakage) = $[K_1 + n/K_2] \times \Delta P \times Kv \times 0.005$ l/min
Creep speed = $K_3 \times \Delta P \times Kv \times 0.005$ rpm
Crankcase leakage = $K_4 \times \Delta P \times Kv \times 0.005$ l/min
ΔP = differential pressure bar
n = speed rpm

The motor volumetric efficiency can be calculated as follows:

$$\text{Volumetric efficiency (\%)} = \left[\frac{\text{(speed x disp.)}}{\text{(speed x disp.) + Qt}}\right] \times 100$$

Example:
HMB200 motor with displacement of 3.080 l/rev.
Speed 60 rpm
Differential pressure 200 bar
Fluid viscosity 50 cSt

Total leakage = $(K_1 + n/K_2) \times \Delta P \times Kv \times 0.005$ l/min
= (2.53+60/14.99) x 200 x 1 x 0.005
= 6.53 l/min

$$\text{Volumetric efficiency} = \left[\frac{(60 \times 3.080)}{(60 \times 3.080) + 6.53}\right] \times 100$$

= 96.5%

2-3 Shaft Power Calculation

Example (see page 4)

Firstly, to find the maximum differential pressure ΔP at rated speed:

Select the rated shaft power (W) for the motor from the performance data table (page 4).
This is presented in kilowatts so must be converted to watts (x1000).

Then also take the Actual Average running torque in N.m/bar (T_o) and the rated shaft speed in rpm (n).

$$W = \frac{T_o \cdot \Delta P \cdot 2\pi \cdot n}{60}$$

Or to find maximum ΔP then use:

$$\Delta P = \frac{60 \cdot W}{2\pi \cdot T_o \cdot n}$$

HMB270 Example:

Rated shaft power, W (W):	140,000
Average actual running torque, T_o (Nm/bar):	63.79
Rated shaft speed, n (rpm):	125

$$\Delta P = \frac{60 \times 140{,}000}{2\pi \times 63.79 \times 125}$$

ΔP= 167 bar (max.)

Secondly, to find the maximum speed at rated pressure (using the same information as before):

$$n = \frac{60 \cdot W}{2\pi \cdot T_o \cdot \Delta P}$$

Rated pressure (bar):	250

$$n = \frac{60 \times 140{,}000}{2\pi \times 63.79 \times 250}$$

n = 83 rpm (max.)

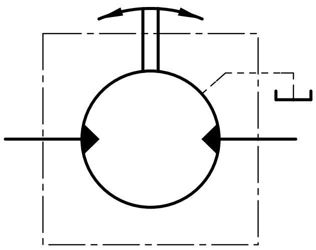
In summary, operating the motor within its shaft power limit, at rated speed, would give a maximum pressure of 167 bar, and operating the motor at rated pressure, would give a maximum speed of 83 rpm.

Notes

1) The maximum calculated speed is based on a rated inlet pressure of 250 bar.
2) The maximum shaft power is only allowable if the motor drain temperature remains below 80°C.
3) The maximum calculated differential pressure assumes that the low pressure motor port is less than 30 bar.

2-4 Functional Symbols

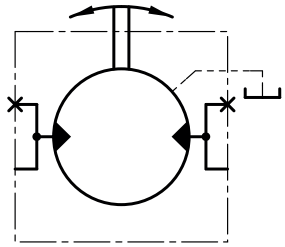
HMB010-
HMB030 (Monobloc)



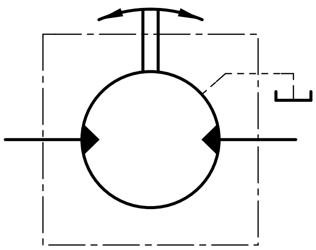
-F(M)3-; F(M)4-; SM3

HMB030*/045*(TPB)
HMB060/080
HMB100/125
HMB150/200

*F(M)3 ONLY

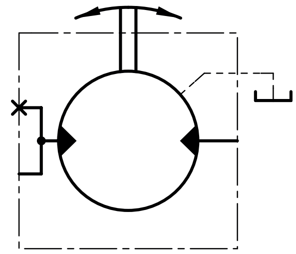


HMB045-**
(Monobloc)

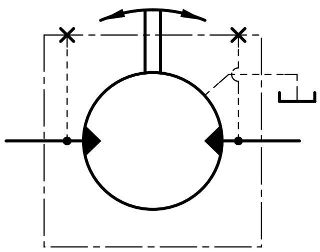


HMHDB400-**-
HMB500

Removable plug



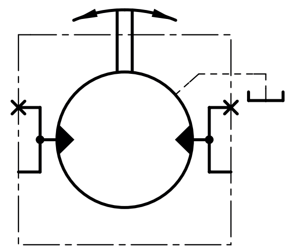
HMB045-**D-
(Monobloc)



HMHDB400-**-
HMB500

S045

Dual ports



2-5 Stress Limits

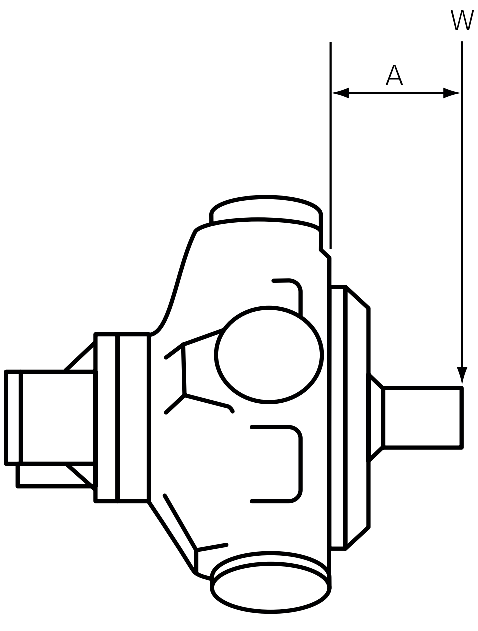
When applying large external radial loads, consideration should also be given to motor bearing lives (see page 16).

Motor Frame Size	Shaft Types	Maximum External Radial Bending Moment [Nm]
HMB010	P, S	1,550
HMB030	P, S & Z	2,400
HMB045	P, S & Z	3,240
HM060, 080 & 100	P, S, Z & T	5,500
HMB125, 150 & 200	P1, S3, S4, Z3, & T	6,600
HMHDB125, 150, 200	S5, Z5 & P2	12,750
HMB270 & 325	P1, S3, Z3 & T	7,500
HMHDB270 & 325	P2, S5 & Z5	15,900
HMHDB400	P, S & Z	16,200
HMB500	P, S & Z	16,200

Example:

Determine the maximum radial shaft load of a HMB080 motor:

Radial load offset, A = 100 mm
Maximum radial load, W = 5,500 (see table)/100
= 55 kN (5,607 kg)



A = Distance from mounting face to load centre (mm)

W = Side load (N)

[Note}
The offset distance A is assumed to be greater than 50 mm.
Contact KPM UK if this is not the case.

2-6 Bearing Life Notes

Consideration should be given to the required motor bearing life in terms of baring service life. The factors that will determine bearing life include:

1) Duty cycle - time spent on and off load

2) Speed

3) Differential pressure

4) Fluid viscosity

5) External radial shaft load

6) External axial shaft load

[NOTE]
A heavy duty HM(HD)B motor can be ordered to further improve bearing life.
Consult KPM UK if you need a detailed bearing life calculation.

2-7 Circuit and Application Notes

Starting torque

The starting torques shown on the graphs on pages 8 to 11 are average and will vary with system parameters.

Low Speed Operations

Minimum operating speeds are determined by the hydraulic system and load conditions (load inertia, drive elasticity, etc.) Recommended minimum speeds are shown below:

Model Type	rpm
HMB010	20
HMB030	5
HMB045	6
HMB060/080/100	3
HM(HD)B/125/150/200	3
HM(HD)B270/325	2
HMHDB400/HMB500	2

High Back Pressure

When both inlet and outlet ports are pressurised continuously, the lower port pressure must not exceed 70 bar at any time.
Note: High back pressure reduces 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) from the operating formula Boost Formula $P = 1 + \frac{N^2 \times V^2}{K} + C$

Where P is in bar, N = motor speed (rpm), V = motor displacement (cc/rev), C = Crankcase pressure (bar) and K=a constant from the table below:

Motor	Porting	Constant (K)
HMB010	Standard	8.0×10^8
HMB030	Standard - Monobloc	3.7×10^9
	F(M)3 SM3	7.5×10^9
HMB045	Standard - Monobloc	1.3×10^{10}
	F(M)3 SM3	1.6×10^{10}
HMB060, HMB080 & HMB100	F(M)3 SM3	1.8×10^{10}
HM(HD)B125, HM(HD)B150 & HM(HD)B200	FM(3) SM3	4.0×10^{10}
	FM(4)	8.0×10^{10}
HM(HD)B270 & HM(HD)B325	FM(4)	7.2×10^{10}
HMHDB400 & HMB500	S045	7.2×10^{10}

2-7 Circuit and Application Notes (cont)

The flow rate of oil needed for the make-up system can be estimated from the crankcase leakage data (see page 12 for calculation method). Allowances should be made for other system losses and also for “fair wear and tear” during the life of the motor, pump and system components.

Cooling Flow

Operating within the continuous rating does not require any additional cooling.

For operating conditions above “continuous”, up to the “intermittent” rating, 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 KPM UK about such applications.

Motorcase pressure

With the standard shaft seal fitted, the motor casing pressure should not exceed 3.5 bar.

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 for casing pressures of:
9 bar for HMB010
10 bar for all remaining frame sizes.

3) Check installation dimensions for maximum crankcase drain fitting depth.

CAUTION

For trouble free operation the motor's crankcase pressure must always be lower than both of the motor port pressures:

$P_{case} < P_{in}$ and $P_{case} < P_{out}$

Hydraulic Fluids

Dependent on motor (see model code fluid type - page 5) suitable fluids include:

a) Antiwear hydraulic oils

b) Phosphate ester (HFD fluids)

c) Water glycols (HFC fluids)

d) 60/40% water-in-oil emulsions (HFB fluids)

e) 5/95% oil-in-water emulsions (HFA fluids)

Reduce pressure and speed limits, as per table on page 23.

Viscosity limits when using any fluid except oil-in-water (5/95) emulsions are:

Max. off load:	**2,000 cSt** (9270 SUS)
Max. on load:	**150 cSt** (695 SUS)
Optimum:	**50 cSt** (232 SUS)
Minimum:	**25 cSt** (119 SUS)

Temperature limits

Ambient min.	-30°C (-22°F)
Ambient max.	+70°C (158°F)

Max. operating temperature range.

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

Note: To obtain optimum services life from both fluid and hydraulic systems components, a fluid operating temperature of 40°C is recommended.

2-7 Circuit and Application Notes (cont)

Mineral oil recommendations

The fluid should be a good hydraulic grade, non-detergent Mineral Oil. It should contain anti-oxidant, antifoam and demulsifying additives. It must contain antiwear or EP additives. Automatic transmission fluids and motor oils are not recommended.

Biodegradable Fluid Recommendations

Well-designed environmentally acceptable lubricants (EALs) may be used with Staffa motors. The EAL must be designed for use in hydraulic systems and have a synthetic ester base. Additives should be as listed for mineral oils, above. The performance of EALs with hydraulic systems vary widely and so checks for seal compatibility, copper alloy compatibility, oxidation resistance and lubrication properties should be carried out before selecting an EAL. For help with EALs please contact KPMUK.

Filtration

Full flow filtration (open circuit), or full boost flow filtration (close circuit) to ensure system cleanliness to ISO4406/1986 code 18/14 or cleaner.

Noise levels

The airborne noise level is less than 66.7 dB(A) DIN & dB(A) NFPA through 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.

Polar moment of intertia and mass table

Motor Frame Size	Polar Moment of Intertia (kg.m^2) (Typical data)	Mass (kg) (Approx. all models)
HMB010	0.0076	40
HMB030	0.0150	73
HMB045	0.0470	120
HMB060	0.0500	144
HMB080	0.0600	144
HMB100	0.0760	144
HMB125	0.2200	217
HMB150	0.2500	265
HMB200	0.2700	265
HMB270	0.4900	420
HMB325	0.5000	429
HMHDB400 - S04	0.5400	481
HMHDB400 - S05	0.5400	510
HMB500	0.5400	510

2-8 Motor Operation at Low Temperature

When operating the motor at low temperature consideration should be given to the fluid viscosity. The maximum fluid viscosity before the shaft should be turned is 2,000 cSt. The maximum fluid viscosity before load is applied to the motor shaft is 150 cSt.

If low ambient temperature conditions exist, then a crankcase flushing flow of at least 5 I/min should be applied to the motor during periods when the motor is not in use.

The shaft seal temperature limits for both medium and high pressure applications are shown in the table below.

	Non-operating temperature limits	Minimum operating temperature
Standard pressure shaft seal	below minus 40°C and above 100°C	minus 30°C
High pressure shaft seal	below minus 30°C and above 120°C	minus 15°C

All seals are very brittle below minus 40°C and are likely to break very easily and due to their sluggish response may not provide a 100% leak free condition.

It should be noted that the maximum continuous operating temperature within the motor crankcase is plus 80°C.

2-9 Freewheeling Notes

All Staffa motors can be used in freewheeling applications.

In all circumstances it is essential that the motor is unloaded (“A” and “B” ports connected together) and that the circuit is boosted.

The required boost pressure is dependent on both the speed and displacement conditions.

It should be noted that for “HMB” series motors, to achieve freewheel, large flows will have to re-circulate around the motor.

This will require a large recirculating valve and consideration of circuit cooling as the motor will be generating a braking torque.

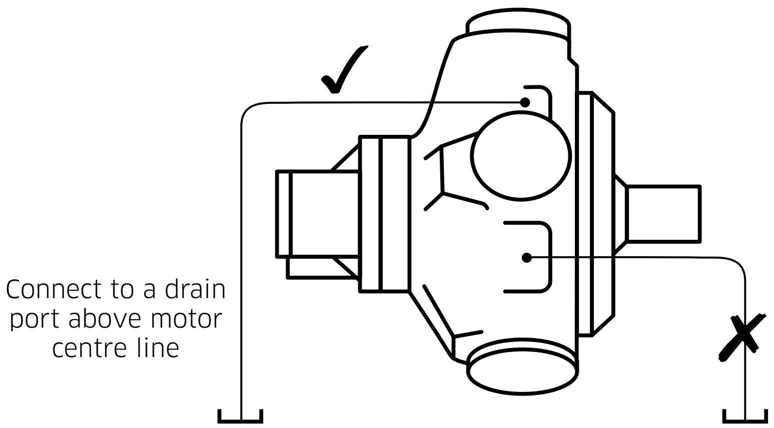
It is for these reasons that “HMC”, “HPC” or "HMF" series motors are the preferred option for freewheeling applications.

See catalogues M-2002/03.17, M-2003/03.17 and M-2005/12.17 for details.

2-10 Crankcase Drain Connections

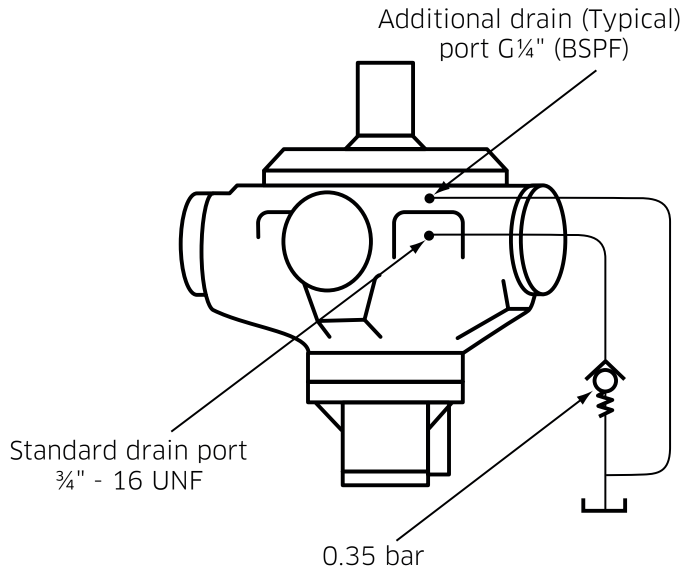
Motor axis - horizontal

The recommended minimum pipe size for drain line lengths up to approx. 5m is 12.0 mm (½") bore. Longer drain lines should have their bore size increased to keep the crankcase pressure within limits.



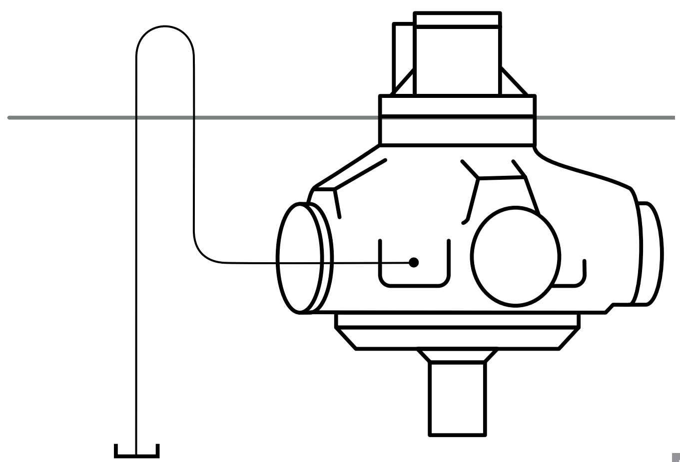
Motor axis - vertical shaft up

Specify "V" within the model code for extra drain port, G¼" (BSPF). Connect this port into the main drain line downstream of a 0.35 bar check valve to ensure good bearing lubrication. The piping arrangement must not allow syphoning from the motorcase. (refer to installation drawing for details).



Motor axis - vertical shaft down

The piping, from any drain port, must be taken above the level of the motorcase to ensure good bearing lubrication. The arrangement must not allow syphoning from the motorcase.



2-11 Installation Data

Spigot

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

The diametrical clearance between the motor spigot and the mounting must not exceed 0.15 mm. 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 bolts is as follows:

M12	97 +/- 7Nm
M14	160 +/- 21Nm
M18	312 +/- 14 Nm
M20	407 +/- 14 Nm
M24	690 +/- 27 Nm
½" UNF	97 +/- 7 Nm
⅝“ UNF	265 +/- 14 Nm
¾“ UNF	393 +/- 14 Nm
1"	810 +/- 27 Nm

Shaft coupling:

Where the motor is solidly coupled to a shaft having independent bearings the shaft must be aligned to within 0.13 mm TIR.

End of Motor Life

The motor unit, hydraulic fluid and packaging must be disposed of carefully to avoid pollution to the environment. The motor unit must be completely empty upon disposal, it must be disposed of according to national regulations and you must also follow safety information for disposal of the hydraulic fluid.

All individual parts of the motor unit must be recycled. Separate the motor unit parts according to: cast parts, steel, aluminium, non-ferrous metal, electronic waste, plastic, and seals.

2-12 Special Features

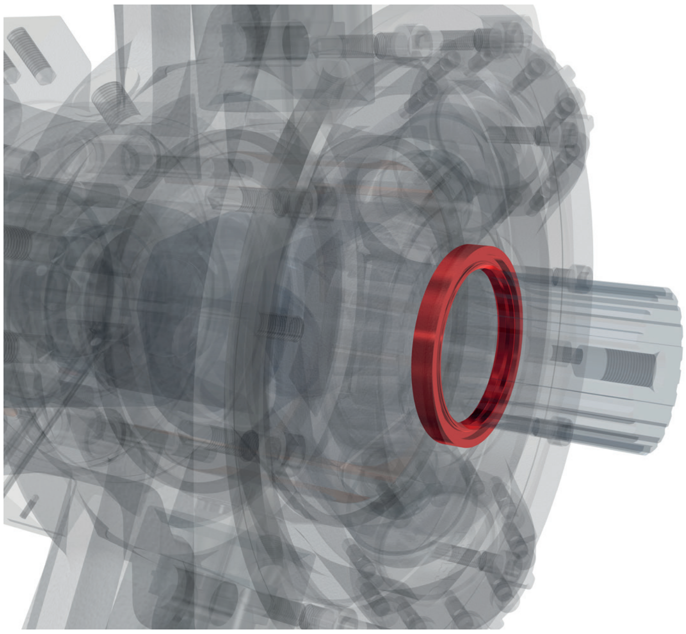
Feature	Page	HMB 010	HMB 030	HMB 030 -F(M)3 HMB 030 -SM3	HMB 045	HMB 045 - F(M)3 HMB 045 - SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/ 200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
High Pressure Shaft Seal	9	○	●	●	●	●	●	●	●	●	●	●	●	●
Improved Shaft Seal Life	10	●	●	●	●	●	●	●	●	●	●	●	●	●
Improved Cavitation Resistance	11	○	○	●	○	●	●	●	●	●	●	●	●	●
Anti-pooling Bolt Heads	12	●	●	●	●	●	●	●	●	●	●	●	●	●
Increased Starting Torque	13	●	●	●	●	●	●	●	●	●	●	●	●	○
Anti-clock-wise Rotation	15	●	●	●	●	●	●	●	●	●	●	●	●	●
Thermal Shock Resistance	16	○	○	●	○	●	●	●	●	●	●	●	●	○
Drain Port Adaptor - ½" BSPP	18	●	●	●	●	●	●	●	●	●	●	●	●	●
Φ21mm Mounting Holes	19	○	○	○	○	○	●	●	●	●	●	●	●	●
Φ22mm Mounting Holes	19	○	○	○	○	○	●	●	●	●	●	●	●	●
Marine-specification Primer Paint	20	●	●	●	●	●	●	●	●	●	●	●	●	●
Increased Power Rating	21	○	○	○	○	○	○	○	●	●	●	●	●	○

● Available
○ Not available

If a motor is to be ordered with any special features listed, please contact Kawasaki.

2-12 Special Features (cont)

High Pressure Shaft Seal



Description:

> 10 bar rated

> Recommended for cold climates

> Rugged aluminium construction

Technical Information

Where crankcase pressure will be higher than 3.5 bar, the high pressure shaft seal should be selected.

Case pressure	≤ 10 bar
Non-operating temperature limits	Below -30°C and above 120°C
Minimum operating temperature	-15°C
Maximum operating temperature	80°C
Minimum viscosity	2,000 cSt
Maximum viscosity	150 cSt

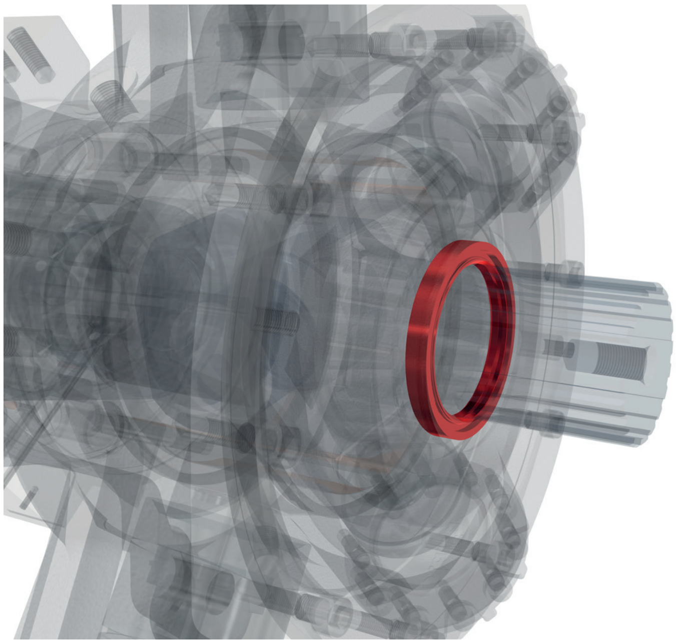
Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
●	●	●	●	●	●	●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

Improved Shaft Seal Life



Description:

> **Stainless steel sleeve prevents corrosion**

> **Improved wear resistance**

> **Recommended for corrosive environments**

Technical Information

A well-established method of increasing rotary seal life in corrosive environments is to fit a thin-walled, stainless steel sleeve to the rotating shaft to provide a corrosion-resistant, wear-resistant counterface surface for the seal to run against. All HMB motors can be fitted with such sleeves upon request.

Sleeve material	A304/301 Stainless Steel
Sleeve surface finish	R_a 0.25 to 0.5 µm (10 to 20 µin)

Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
●	●	●	●	●	●	●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

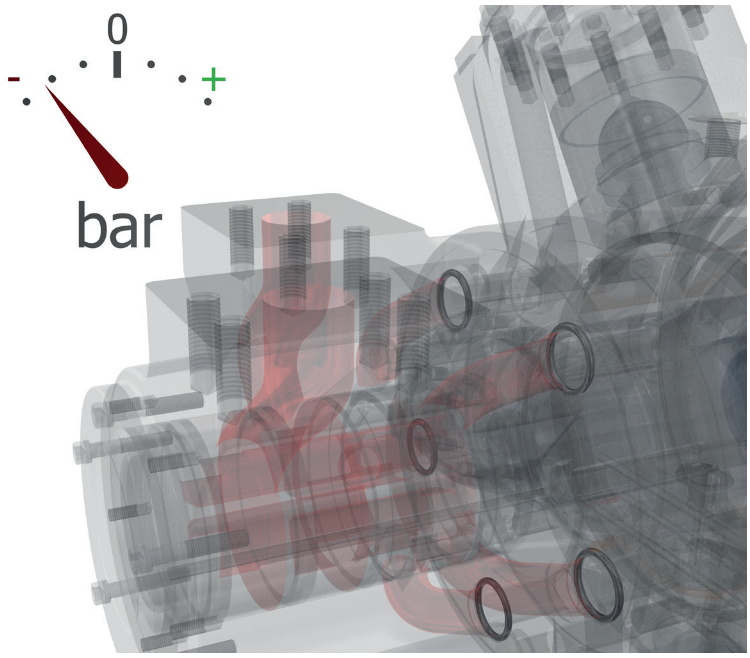
2-12 Special Features (cont)

Improved Cavitation Resistance

Description:

> Recommended for overrunning applications

> Protects against seal damage for short periods of operation in vacuum inlet conditions.



Cavitation can occur due to many different factors. Although it is not possible to make the HMB motor resistant to cavitation, certain features can be added to improve the motor's resistance to short periods of lost port pressure.

In applications where the HMB motor can be driven (like a pump) a risk arises that insufficient fluid will be provided to maintain a positive pressure at both main ports of the motor causing cavitation. The results of extended running at these conditions can be catastrophic to the motor's function.

The improved cavitation resistance feature should be considered where:

- Overrunning conditions may occur (load driving the motor)
- Loss of main port pressure while motor is rotating

Note:
This feature comes as standard on monobloc HMB motors (HMB010, HMB030, HMB045).

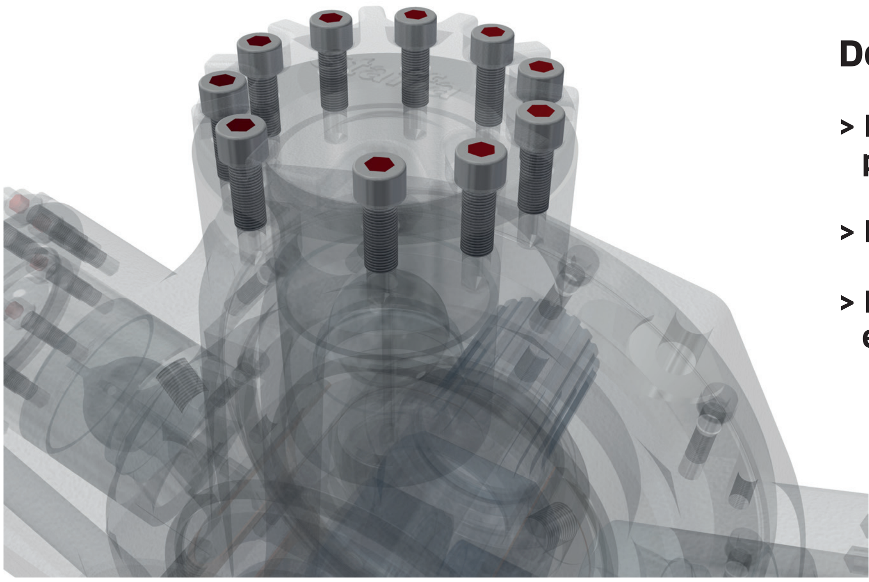
Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
○	○	○	○	●	●	●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

Anti-pooling Bolt Heads



Description:

> **Removes potential for water pooling**

> **Improved corrosion resistance**

> **Recommended for marine environments**

Technical Information

In many marine applications, water pooling in socket head cap screw heads presents a significant corrosion risk. Corroded cap screws can make service and repair of affected units impossible.

To significantly reduce the risk of water damage through pooling, HMB motors can be supplied with silicone filler in all the bolt heads.

Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
●	●	●	●	●	●	●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

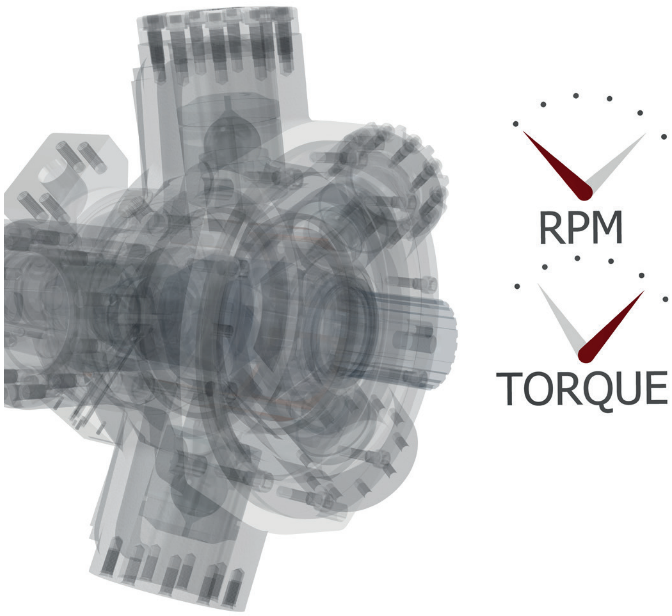
Increased Starting Torque

Description:

> **Optimised for high break-out torque**

> **Recommended for low speed operation**

> **Improved service life for low speed applications**

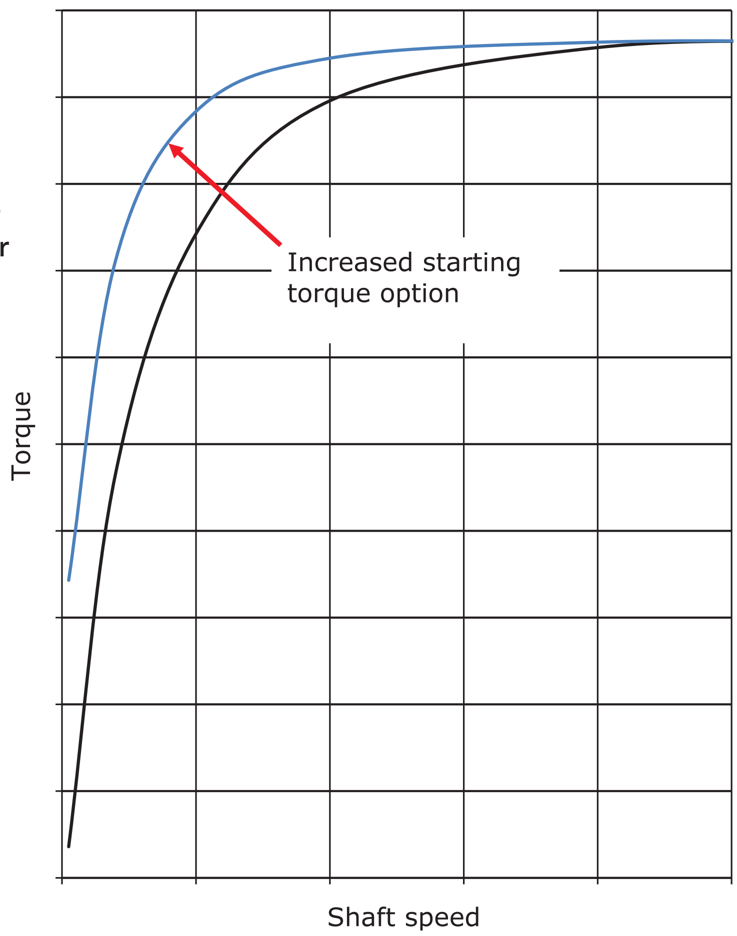


Technical Information

If an application demands the drive motor be run at speeds of less than 10 rpm for most of the duty cycle, or involves frequent start/stop or forward/reverse operation, the Staffa HMB motor range has it covered.

By optimising the HMB motor's design for low speeds, it is possible to increase the break out torque and low speed mechanical efficiency performance.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.



2-12 Special Features (cont)

Increased Starting Torque (cont)

Volumetric Performance

In order to achieve increased torque at low speeds the volumetric characteristics of the motor performance are changed.

When calculating leakage and volumetric efficiency use the constants shown here in place of those given for the standard motor on page 29.

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HMB010	188	8.80	534.05	47.05	7.98
HMB030	442	8.51	57.67	19.37	8.06
2-piece HMB030	492	8.51	57.67	19.37	8.06
HMB045	740	3.93	43.36	12.80	9.23
HMB060	983	9.19	29.91	9.95	9.35
HMB080	1,344	9.18	21.62	7.39	9.31
HMB100	1,639	9.30	17.74	5.47	9.35
HM(HD)B125	2,050	9.53	11.45	4.88	8.82
HM(HD)B150	2,470	9.09	9.98	4.02	8.86
HM(HD)B200	3,080	10.00	14.99	3.20	8.86
HM(HD)B270	4,310	13.63	21.16	3.11	12.26
HM(HD)B325	5,310	13.60	18.21	2.52	12.26
HMHDB400	6,800	19.00	10.18	2.73	17.29

Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
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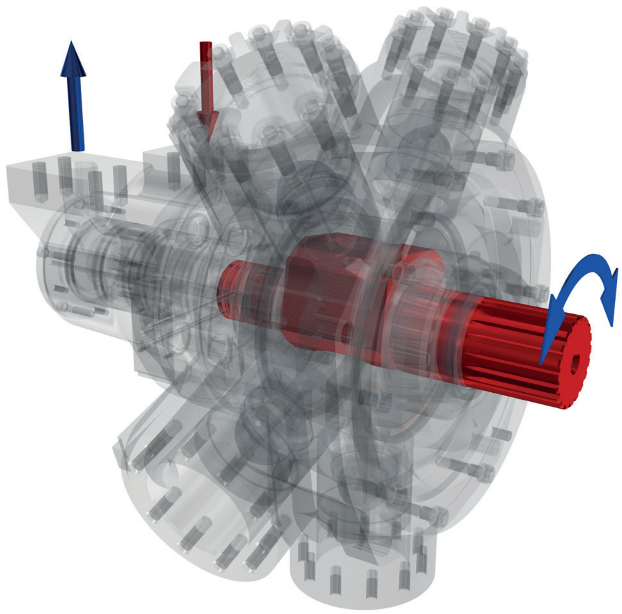
Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

Anti-Clockwise Rotation



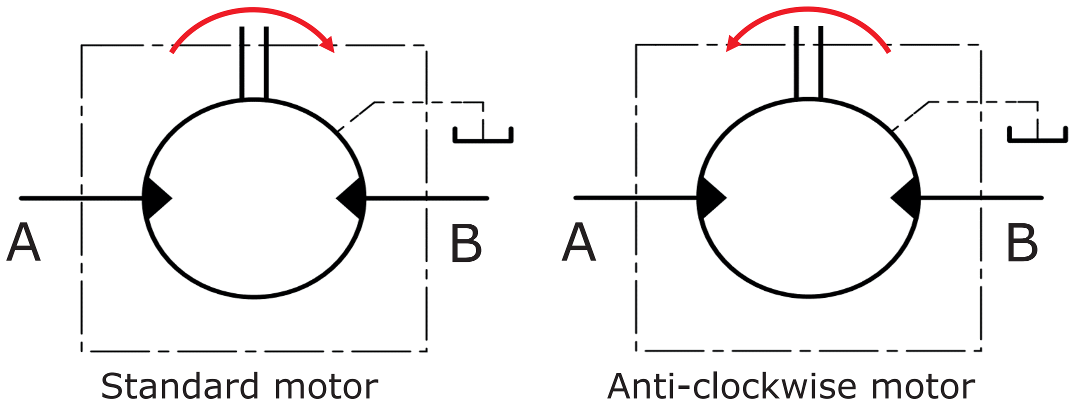
Description:

> Reduce installation complexity

> Standardise equipment designs

Technical Information

All HMB motors can be specified with an anti-clockwise rotation valve configuration. All performance and volumetric characteristics remain unchanged.



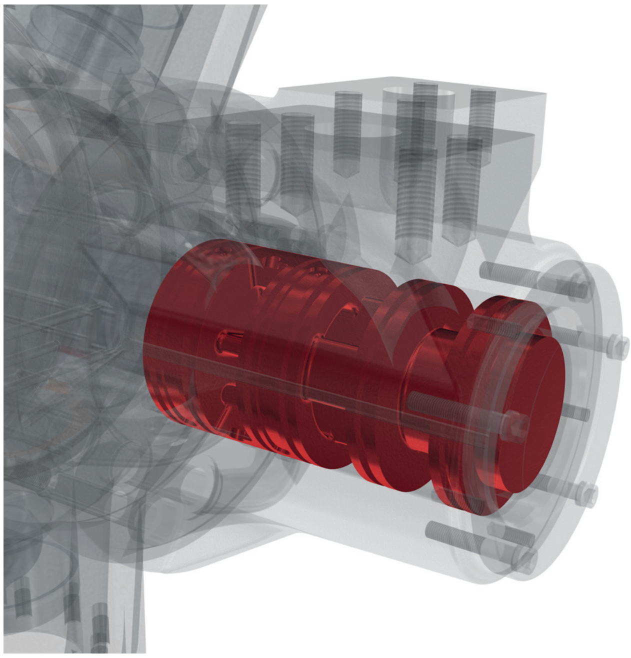
Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
●	●	●	●	●	●	●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

Thermal Shock Resistance



Description:

> Recommended for cold climates

> Optimised for start-up in freezing temperatures

> Engineered for total peace of mind

Technical Information

Starting up a cold system with warm hydraulic fluid is a known cause of heavy wear and potential seizure of hydraulic machinery. To minimise this potential risk, the HMB motor can be configured to combat thermal shocks to give complete peace of mind when operating in very cold climates.

Volumetric Performance

In order to provide thermal shock resistance the volumetric characteristics of the motor performance are changed. When calculating leakage and volumetric efficiency use the constants shown on the next page in place of those given for the standard motor on page 29.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.

Note:
When operating at low temperature, consideration must be given to the guidance notes in Section 2-8 Motor Operation at Low Temperature (see page 20).

2-12 Special Features (cont)

Thermal Shock Resistance (cont)

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HMB060	983	3.72	29.91	4.39	1.88
HMB080	1,344	3.71	21.62	3.32	1.84
HMB100	1,839	3.83	17.74	2.50	1.88
HM(HD)B125	2,050	4.41	11.45	2.21	1.35
HM(HD)B150	2,470	3.97	9.98	1.81	1.39
HM(HD)B200	3,080	4.88	14.99	1.43	1.39
HM(HD)B270	4,310	5.52	21.16	1.23	1.80
HM(HD)B325	5,310	5.49	18.21	0.99	1.80
HMHDB400	6,800	6.41	10.18	0.88	2.35

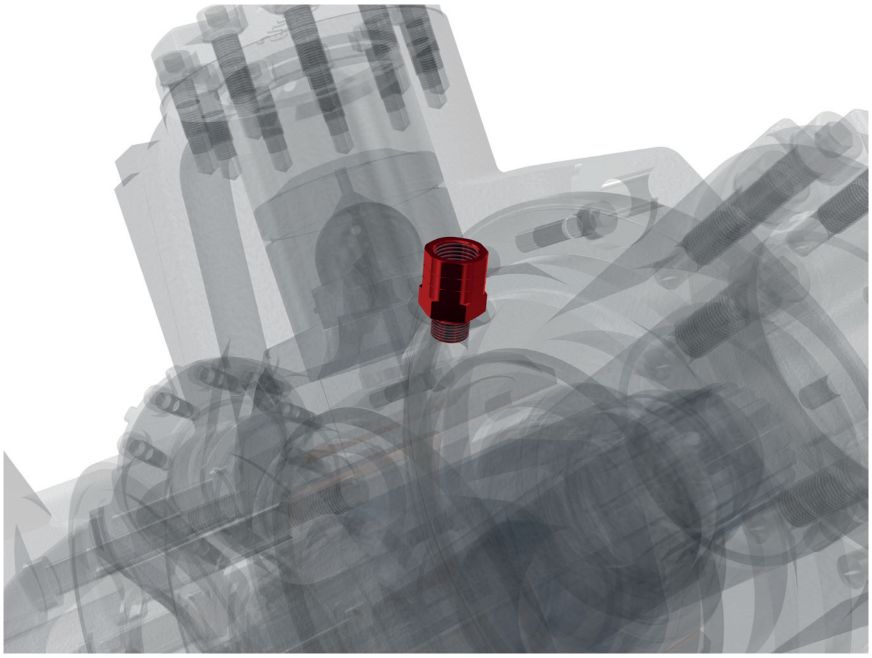
Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
○	○	○	○	●	●	●	●	●	●	●	●	○

Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

Drain Port Adaptors



Description:

> Improves manufacturing logistics

> Motor supplied ready for connection to ½" BSPP male fitting

Technical Information

Motor Type	Adaptor Supplied
HMB010	⅜" BSP to ½" BSPP
HMB030	⅜" BSP to ½" BSPP
HMB045	⅜" BSP to ½" BSPP
HMB045-F(M)3/SM3	¾" UNF 2B to ½" BSPP
HMB060	¾" UNF 2B to ½" BSPP
HMB080	¾" UNF 2B to ½" BSPP
HMB100	¾" UNF 2B to ½" BSPP

Motor Type	Adaptor Supplied
HM(HD)B125	¾" UNF 2B to ½" BSPP
HM(HD)B150	¾" UNF 2B to ½" BSPP
HM(HD)B200	¾" UNF 2B to ½" BSPP
HM(HD)B270	¾" UNF 2B to ½" BSPP
HM(HD)B325	¾" UNF 2B to ½" BSPP
HMHDB400	¾" UNF 2B to ½" BSPP
HMB500	¾" UNF 2B to ½" BSPP

One or two drain adaptors can be supplied.

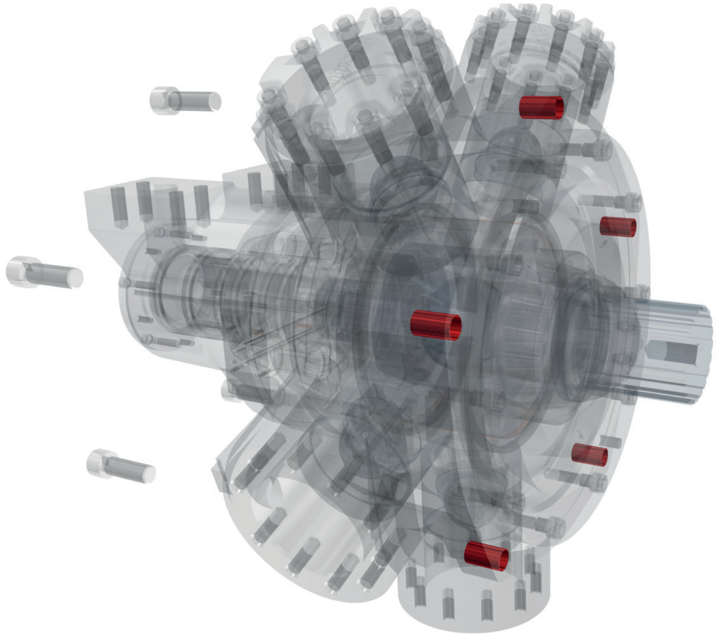
Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
●	●	●	●	●	●	●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

Mounting Hole Diameter



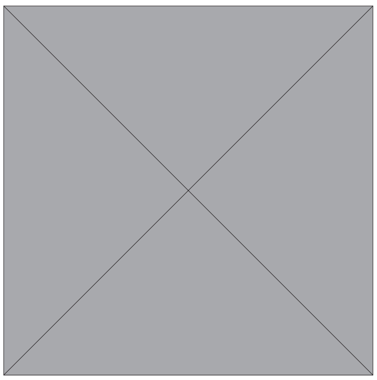
Description:

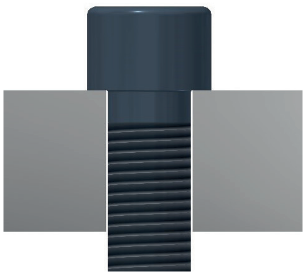
> Matching mounting holes to bolts

> Φ21mm and Φ22mm options available

Technical Information

In different markets, different bolt standards are adopted which may not be best suited to the standard Φ20 mm mounting hole diameter on the HMB motors. To give a correct fit and optimum installation, Φ21 mm or Φ22 mm holes can be selected on larger frame sizes.





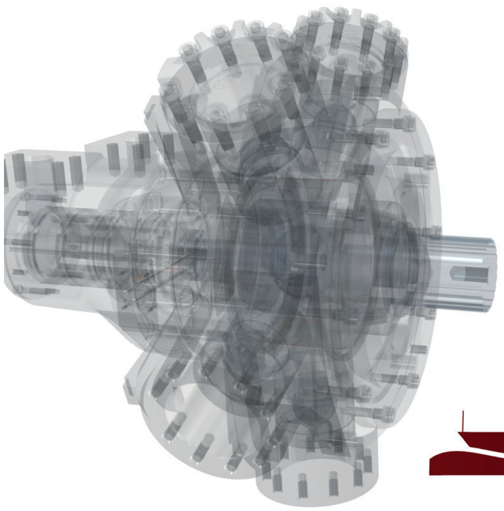
Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
○	○	○	○	○	●	●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

Marine Specification Primer Paint



Description:

- > Improves corrosion and water resistance of the finishing system
- > Excellent adhesion strength
- > Recommended for marine applications

Technical Information

Colour	Red oxide
Type	Single pack epoxy etching primer
Standard	BS 3900 part A 8
Dry film thickness	> 12 µm

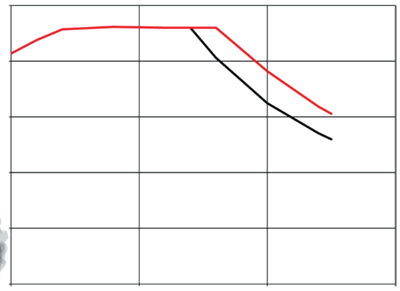
Applicable to:

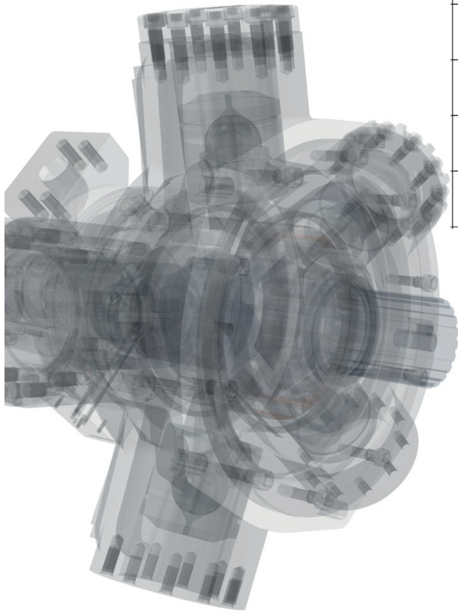
HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
●	●	●	●	●	●	●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

High Power





Description:

> Enhanced power performance

> Improved efficiency

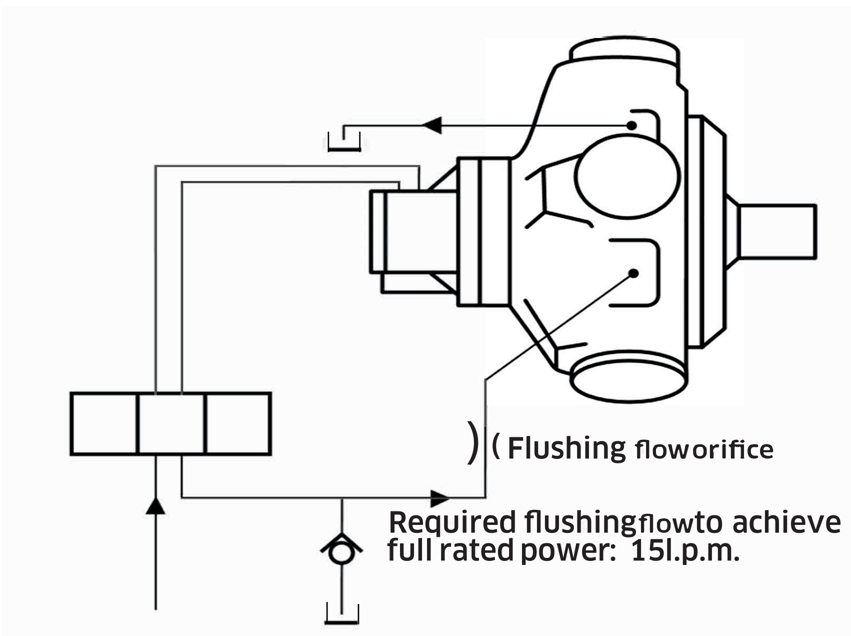
> Improved back pressure rating of 100 bar

Technical Information

The high power option for the HMB motors combines special low-friction components and a crankcase flushing flow to achieve increased shaft power limits. All other performance parameters are unchanged.

Crankcase Flushing

In order to achieve the maximum shaft power, a crankcase flushing flow of 15 l/min should be directed through the crankcase. To improve the cooling effect of the flushing flow the distance between the inlet and outlet drain port connections should be maximised.



2-12 Special Features (cont)

High Power (cont)

Check valve pressure (bar)*	Orifice diameter (mm)
3	4.4
4	4.1
5	3.9
6	3.7
7	3.6
8	3.5
9	3.4
10	3.3

*This assumes that the crankcase pressure is zero. If not, then the check valve pressure will need to be increased to maintain the pressure drop across the orifice.

Note:
If, due to crankcase flushing flow, the crankcase pressure continuously exceeds 3.5 bar, then the motor build should include a high pressure shaft seal.

Performance Data (crankcase flushing required):

Motor Type	Max. continuous output (kW)	Average actual running torque (Nm/bar)
HM(HD)B125	150	30.8
HM(HD)B150	160	37.3
HM(HD)B200	190	46.6
HM(HD)B270	210	64.1
HM(HD)B325	210	80.4
HMHDB400	280	101.4

Applicable to:

HMB 010	HMB 030	HMB 030 -F(M)3/ SM3	HMB 045	HMB 045 -F(M)3/ SM3	HMB 060/ 080	HMB 100	HM(HD)B 125	HM(HD)B 150/200	HM(HD)B 270	HM(HD)B 325	HMHDB 400	HMB 500
○	○	○	○	○	○	○	●	●	●	●	●	○

Please contact Kawasaki to order this feature.

2-12 Special Features (cont)

Tj speed sensor with Tk readout option

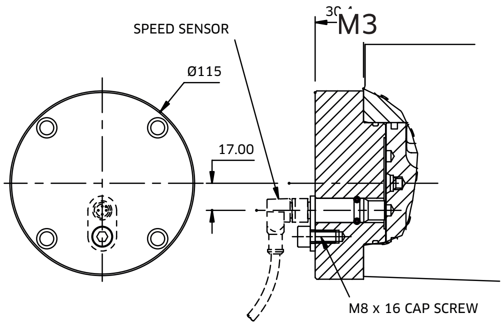
Tj Speed Sensor Technical Specification

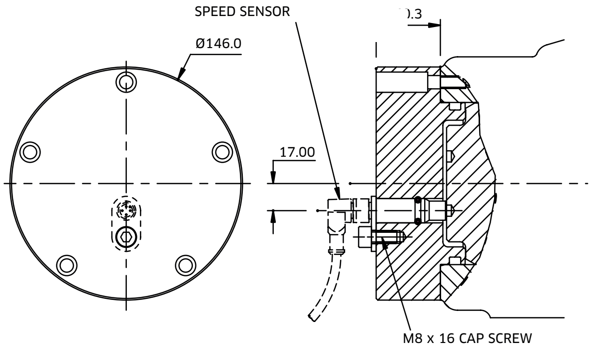
The Tj speed sensor is a hall effect dual channel speed probe that can provide feedback of both speed and direction.

Signal Outputs:	Square wave plus directional signal
Power Supply:	8 to 32 V @ 40 mA
Protection class:	IP68
Output frequency:	16 pulses/revolution

Installation Details

TO SUIT: F3/FM3/SO3 'Tj' TO SUIT: F4/FM4/SO4



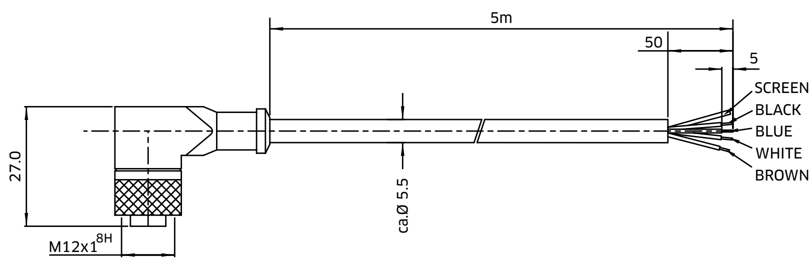


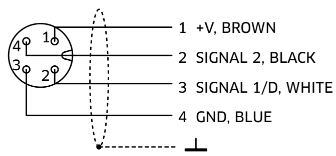
Tk Output Module

The Tk option consists of the Tj speed sensor together with the optional T401 output module.

The addition of the T401 module provides a software configured single channel tachometer and relay with a 0/4-20 mA analogue current output.

The software and calibration cable is also provided.



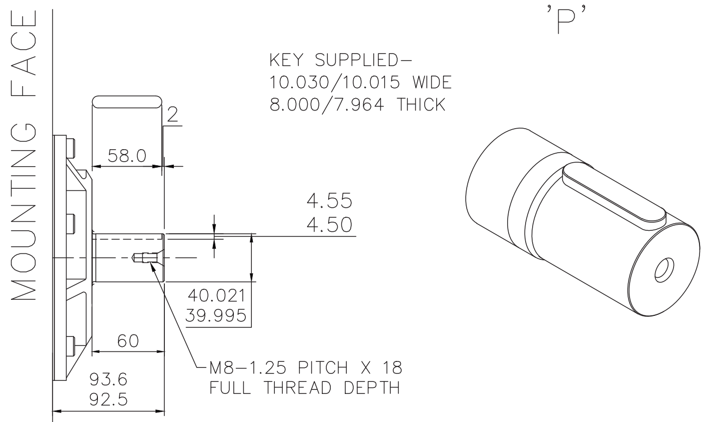


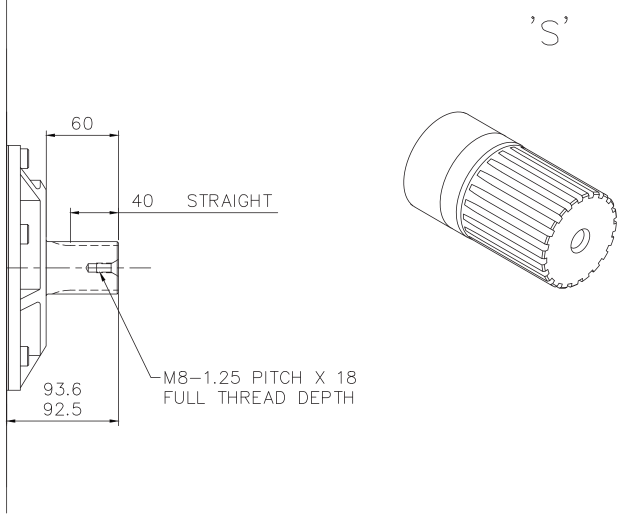
*** Cannot be fitted to HMB010**

3 Dimensions

3-1 HMB010

'P' & 'S' Shafts





SPLINE DATA

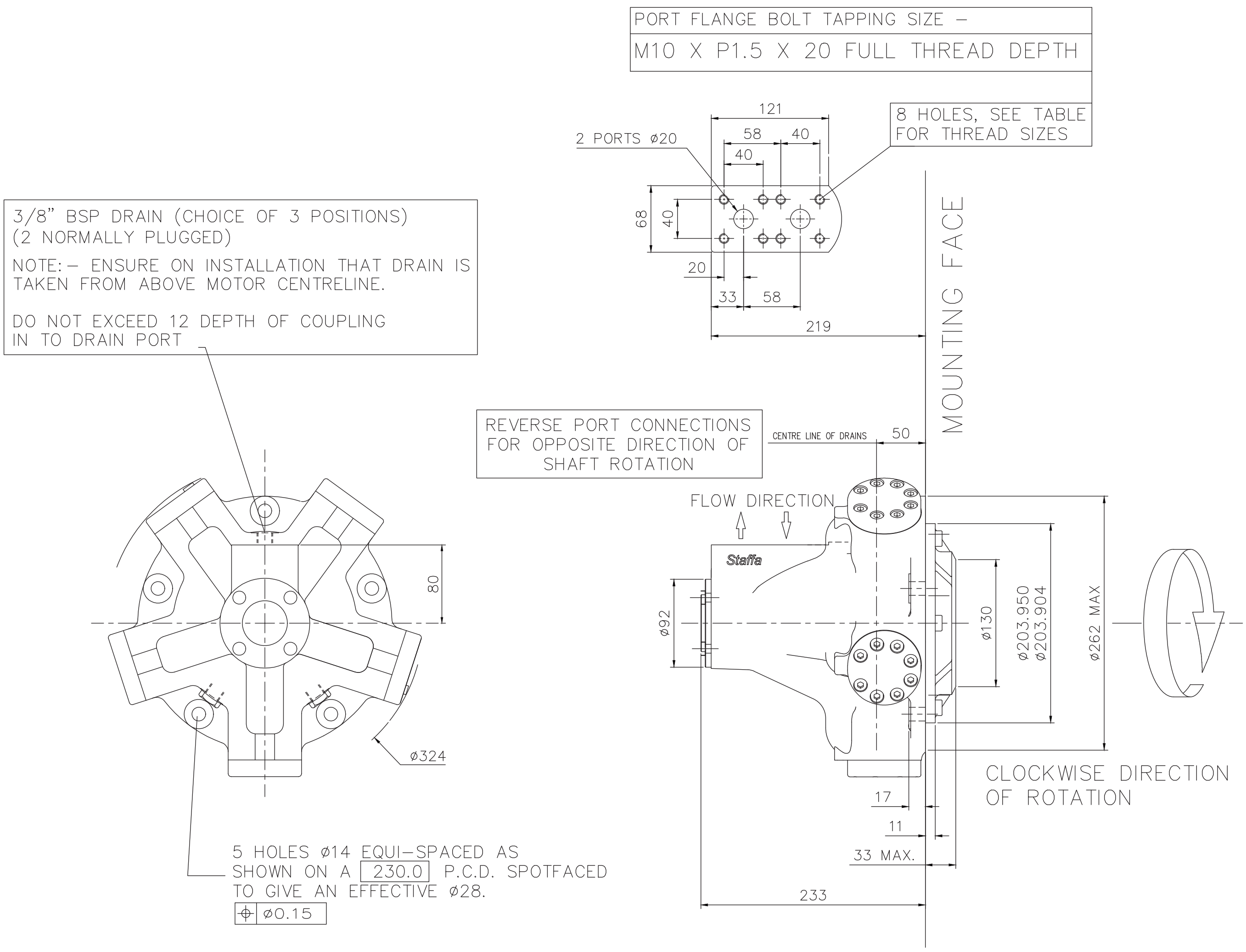
'S'

TO BS 3550 (ANSI B92.1 CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

PRESSURE ANGLE	30°
NUMBER OF TEETH	13
PITCH	8/16
MAJOR DIAMETER	43.71/43.59
FORM DIAMETER	38.136
MINOR DIAMETER	37.36/36.91
PIN DIAMETER	6.096
DIAMETER OVER PINS	50.104/50.152

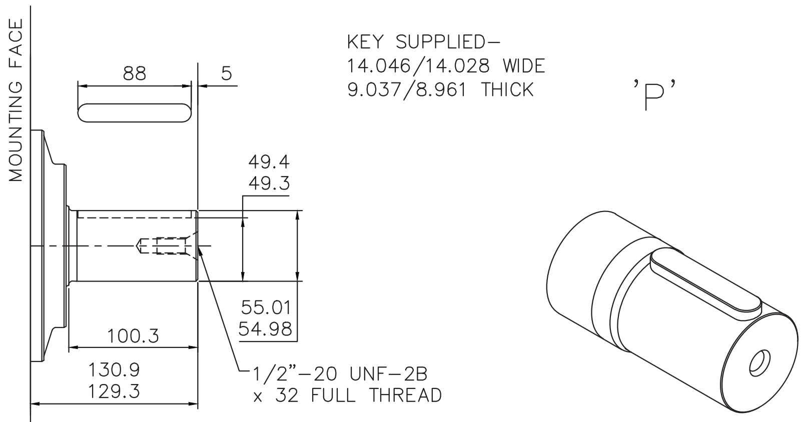
3-1 HMB010 (cont)

Installation



3-2 HMB030

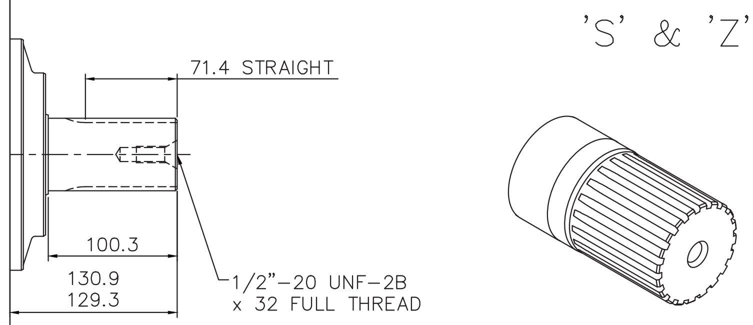
Monobloc - ‘P’, ‘S’ and ‘Z’ Shafts



SPLINE DATA

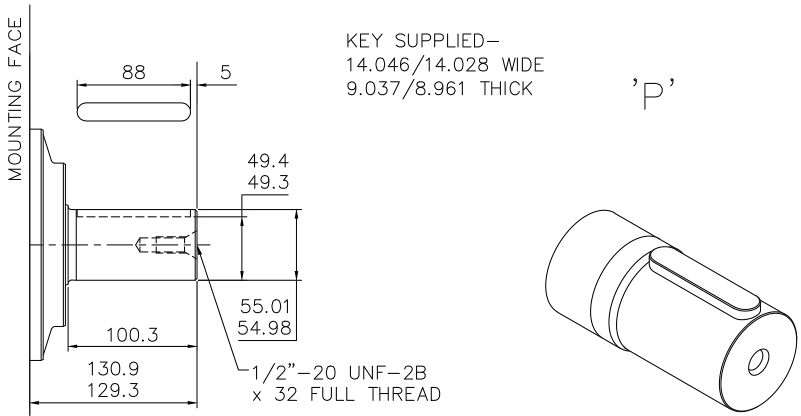
'S'	
TO BS 3550 (ANSI B92.1 CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	17
PITCH	8/16
MAJOR DIAMETER	56.41/56.28
FORM DIAMETER	50.703
MINOR DIAMETER	50.07/49.60
PIN DIAMETER	6.096
DIAMETER OVER PINS	62.985/62.931

'Z'
DIN 5480, W55 X 3 X 17 X 7h



3-3 HMB030 (cont)

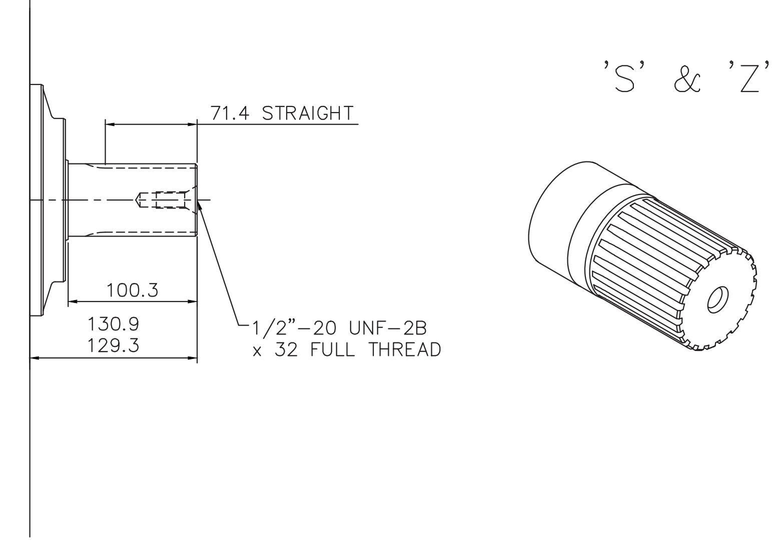
2 Piece - ‘P’, ‘S’ and ‘Z’ Shafts



SPLINE DATA

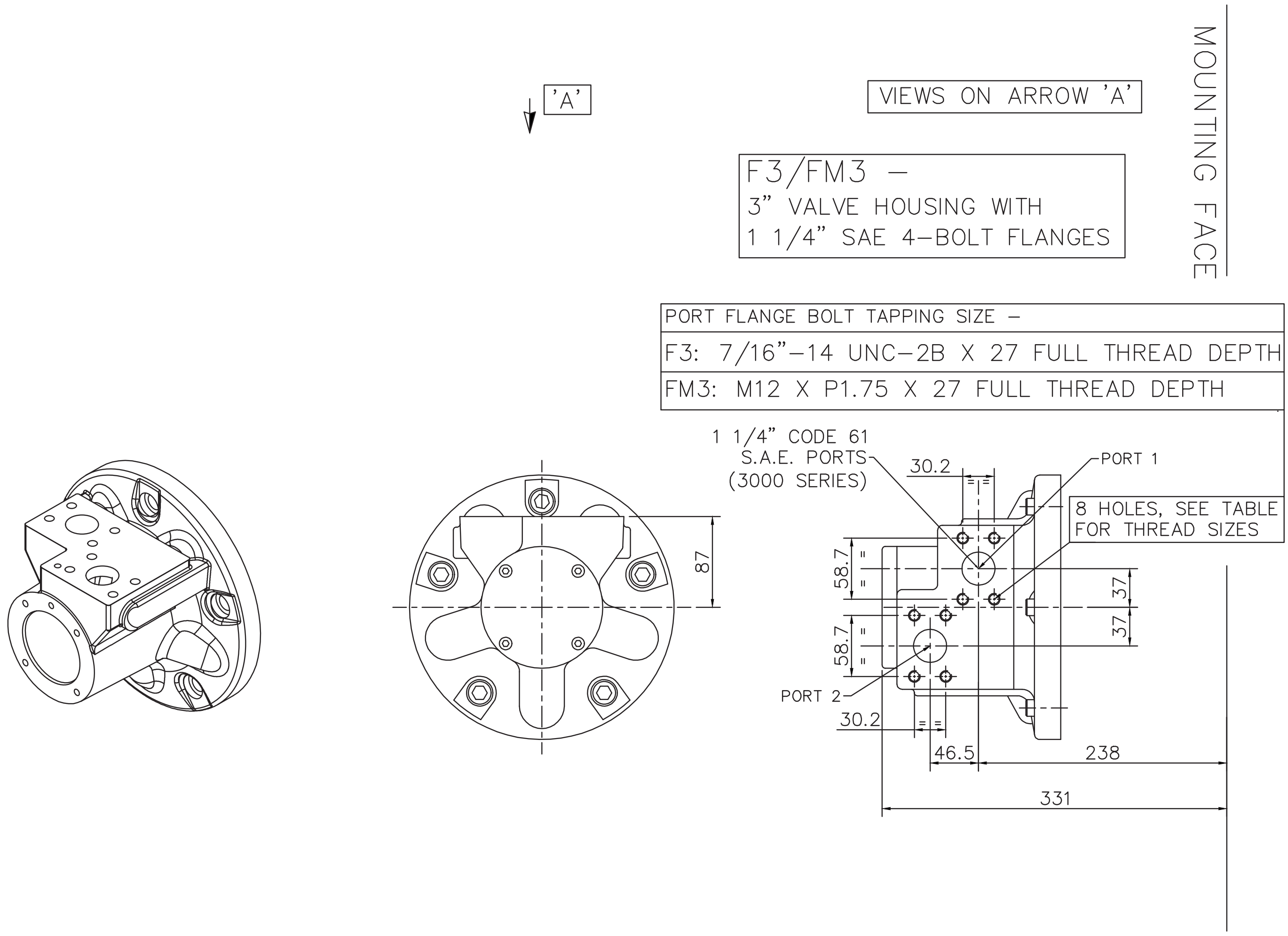
'S'	
TO BS 3550 (ANSI B92.1 CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	17
PITCH	8/16
MAJOR DIAMETER	56.41/56.28
FORM DIAMETER	50.703
MINOR DIAMETER	50.07/49.60
PIN DIAMETER	6.096
DIAMETER OVER PINS	62.985/62.931

'Z'
DIN 5480, W55 X 3 X 17 X 7h



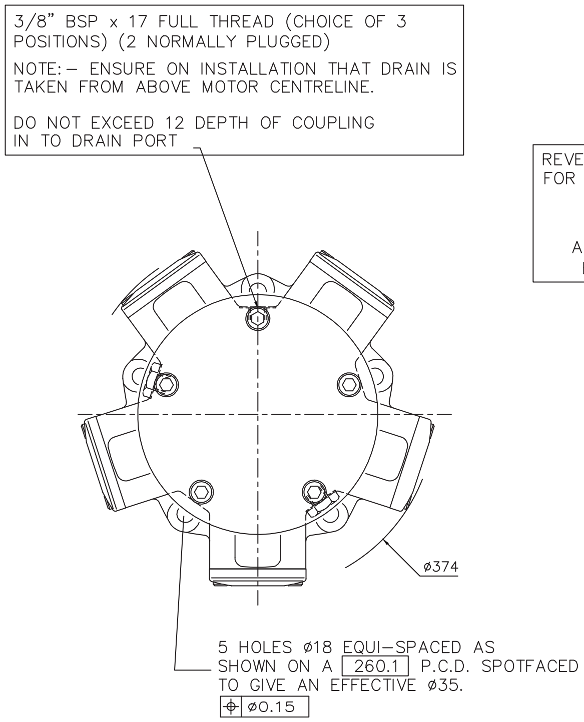
3-2 HMB030 (cont)

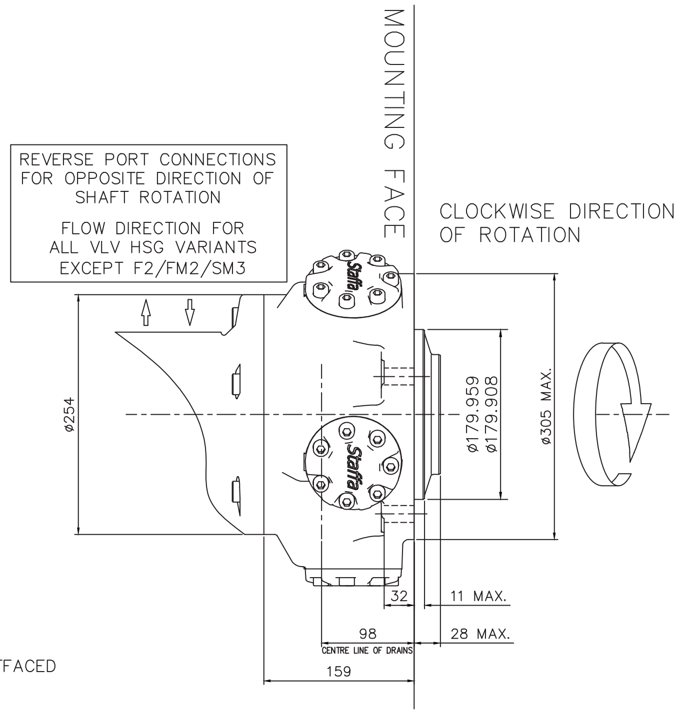
2 Piece - ‘F3’ & ‘FM3’ Valve Housings



3-2 HMB030 (cont)

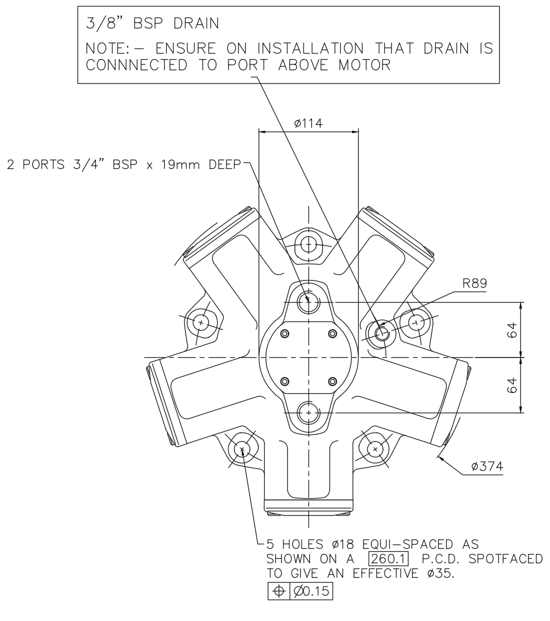
2 Piece - Installation

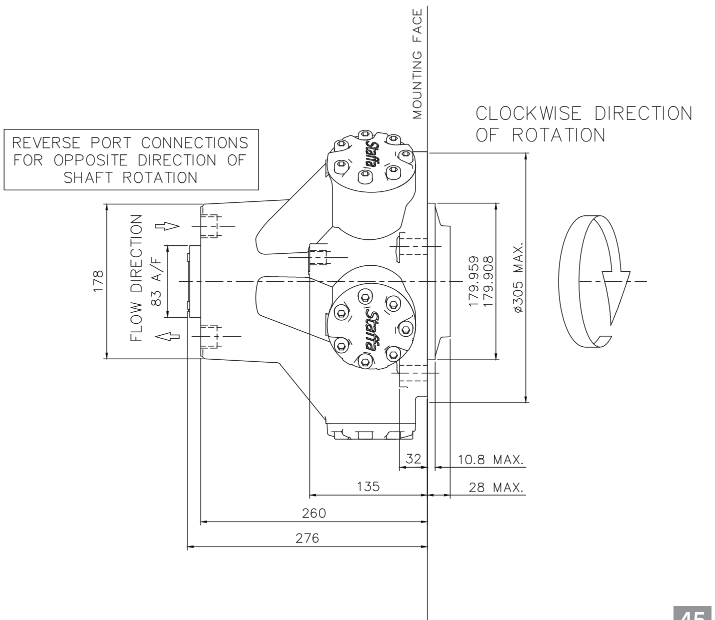




Monobloc - Rear Port Installation

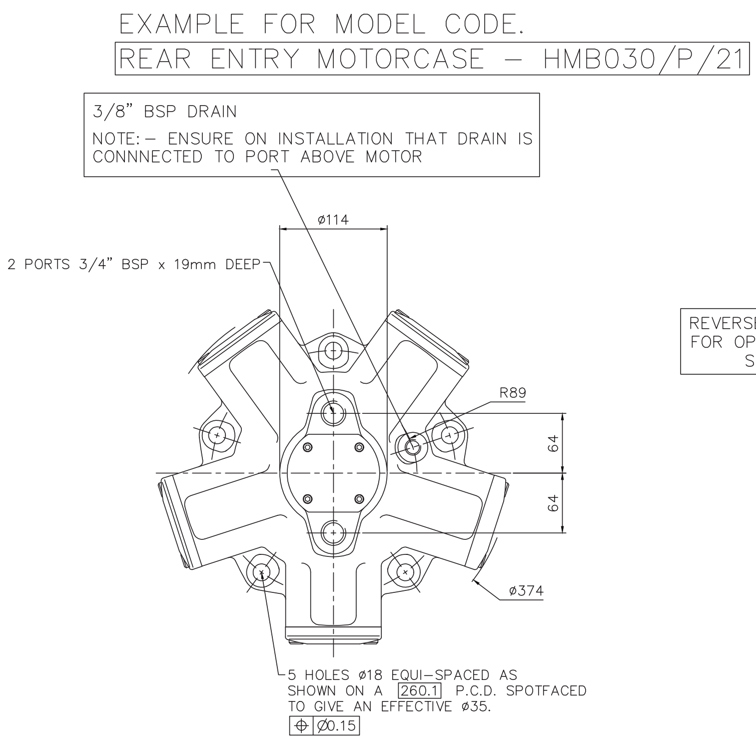
EXAMPLE FOR MODEL CODE.
REAR ENTRY MOTORCASE – HMB030/P/21

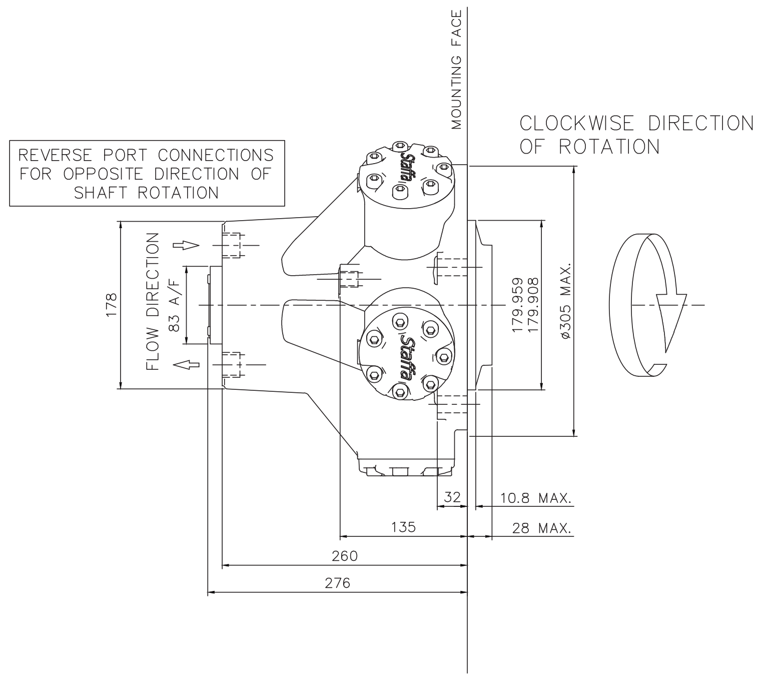




3-2 HMB030 (cont)

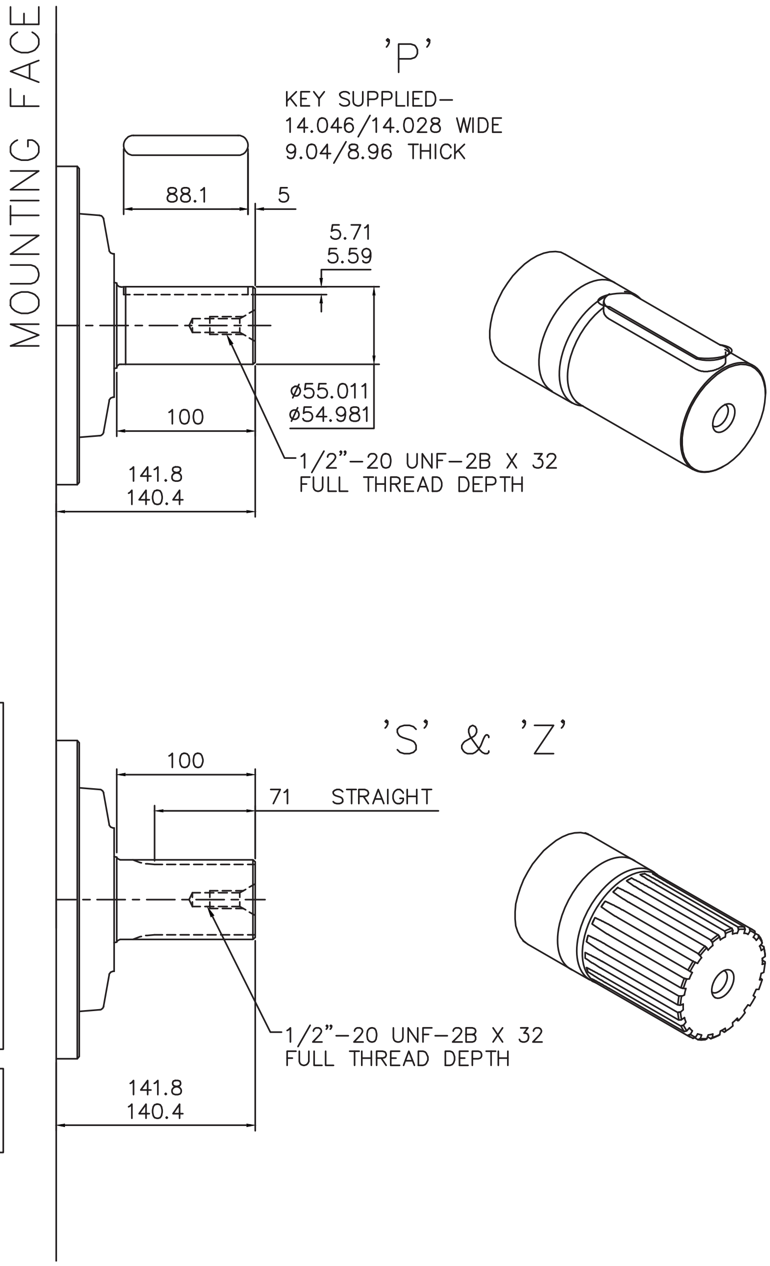
Monobloc - Side Port Installation





3-3 HMB045

Monobloc - 'P', 'S' & 'Z' Shafts



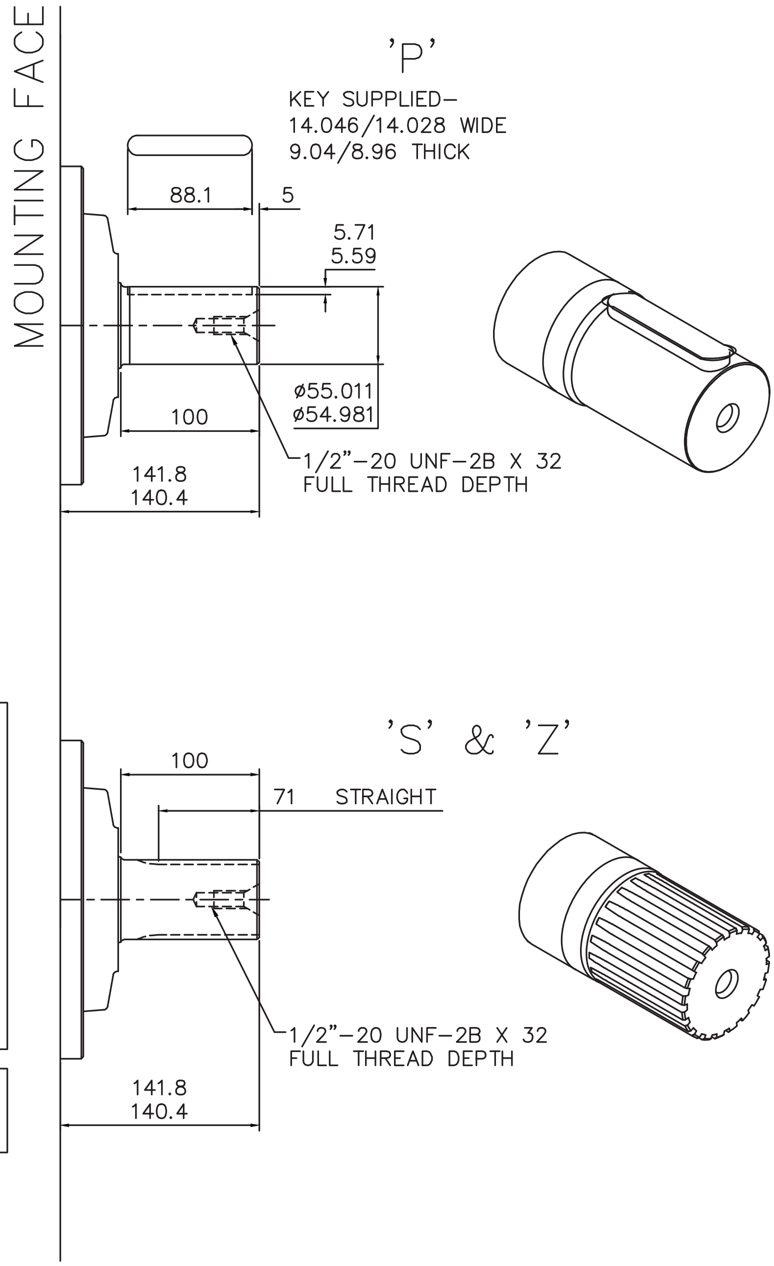
SPLINE DATA

'S'	
TO BS 3550 (ANSI B92.1 CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	17
PITCH	8/16
MAJOR DIAMETER	56.41/56.29
FORM DIAMETER	50.703
MINOR DIAMETER	50.06/49.60
PIN DIAMETER	6.096
DIAMETER OVER PINS	62.984/62.931

'Z'
DIN 5480 W55 x 3 x 17 x 7h

3-3 HMB045 (cont)

2 Piece - 'P', 'S' & 'Z' Shafts



SPLINE DATA

'S'

TO BS 3550 (ANSI B92.1 CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

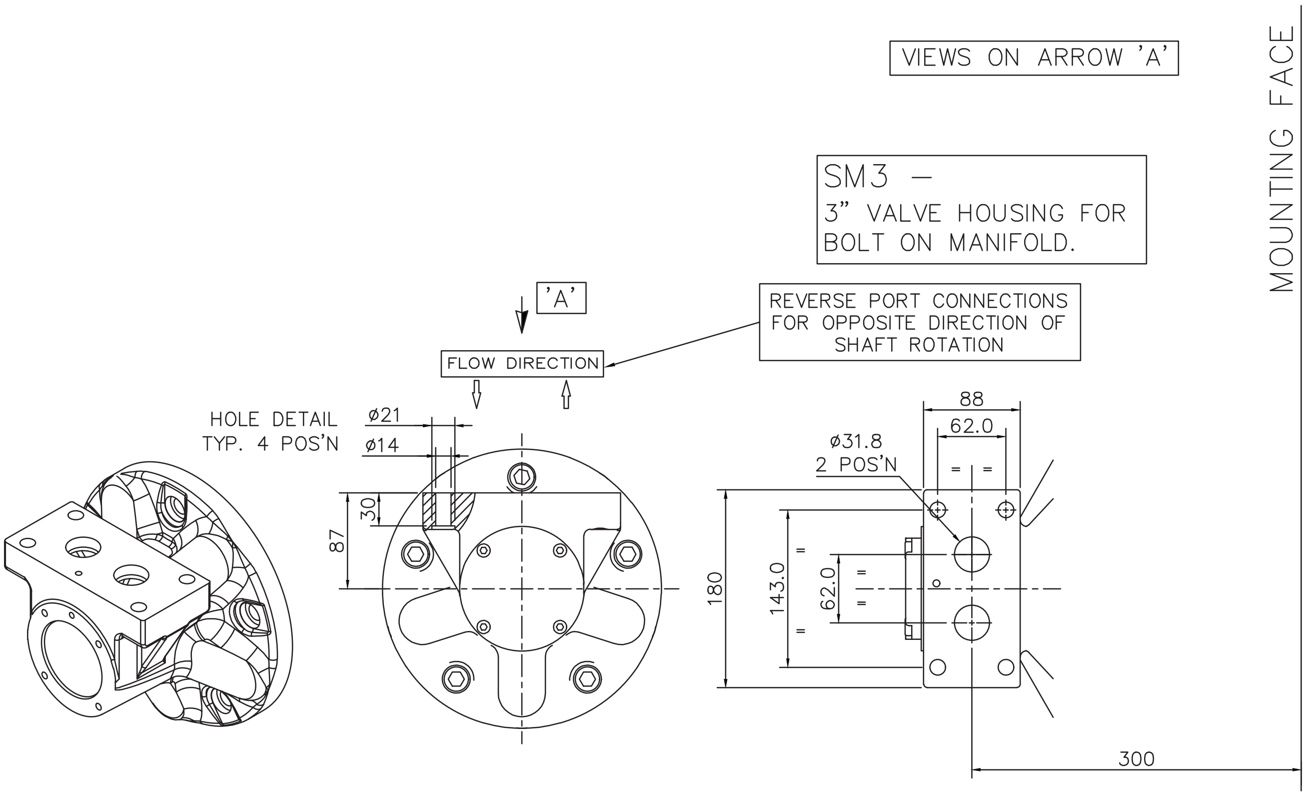
PRESSURE ANGLE	30°
NUMBER OF TEETH	17
PITCH	8/16
MAJOR DIAMETER	56.41/56.29
FORM DIAMETER	50.703
MINOR DIAMETER	50.06/49.60
PIN DIAMETER	6.096
DIAMETER OVER PINS	62.984/62.931

'Z'

DIN 5480 W55 x 3 x 17 x 7h

3-3 HMB045 (cont)

2 Piece -'SM3' Valve Housing



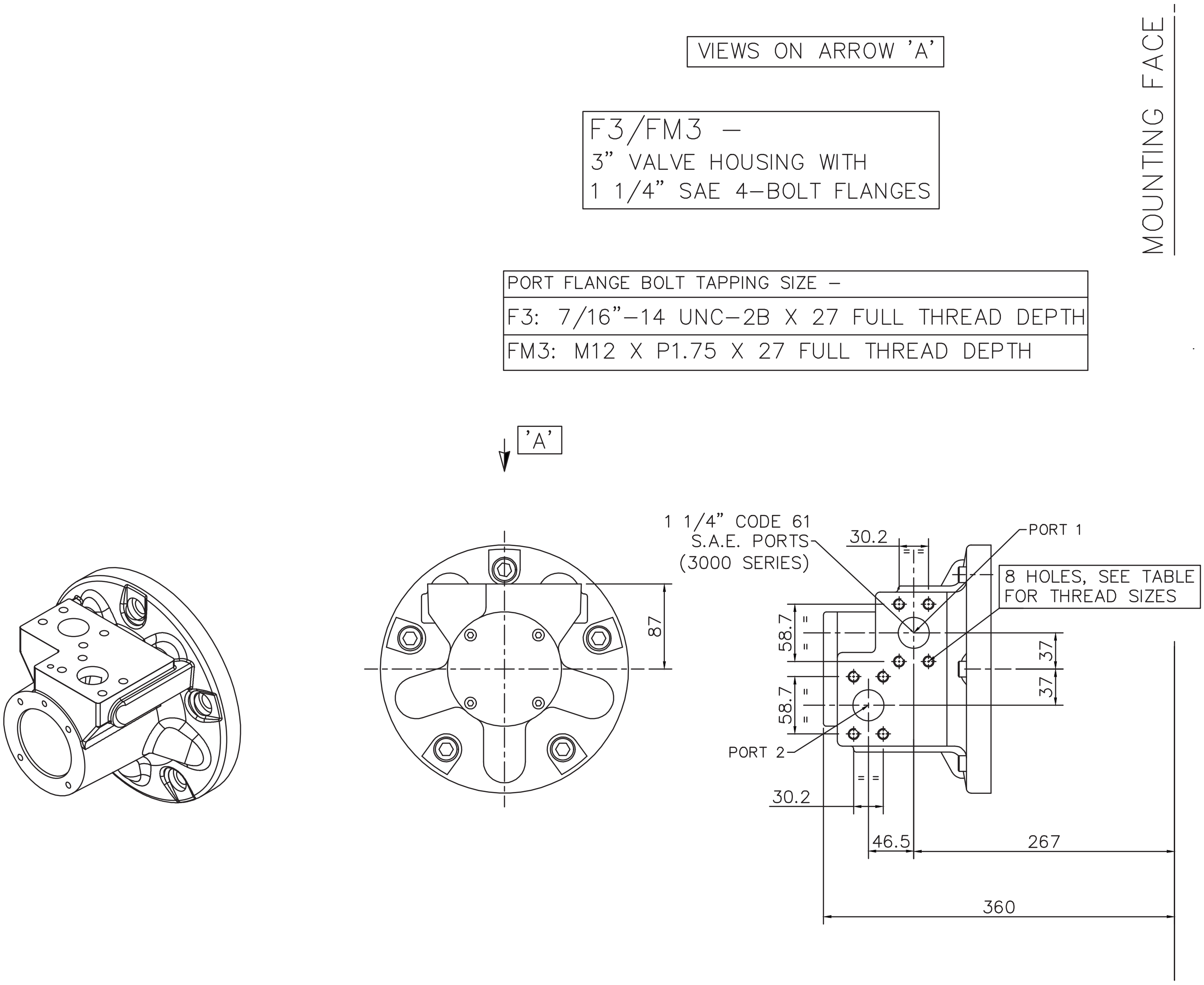
3-3 HMB045 (cont)

2 Piece - 'F3' & 'FM3' Valve Housings

VIEWS ON ARROW 'A'

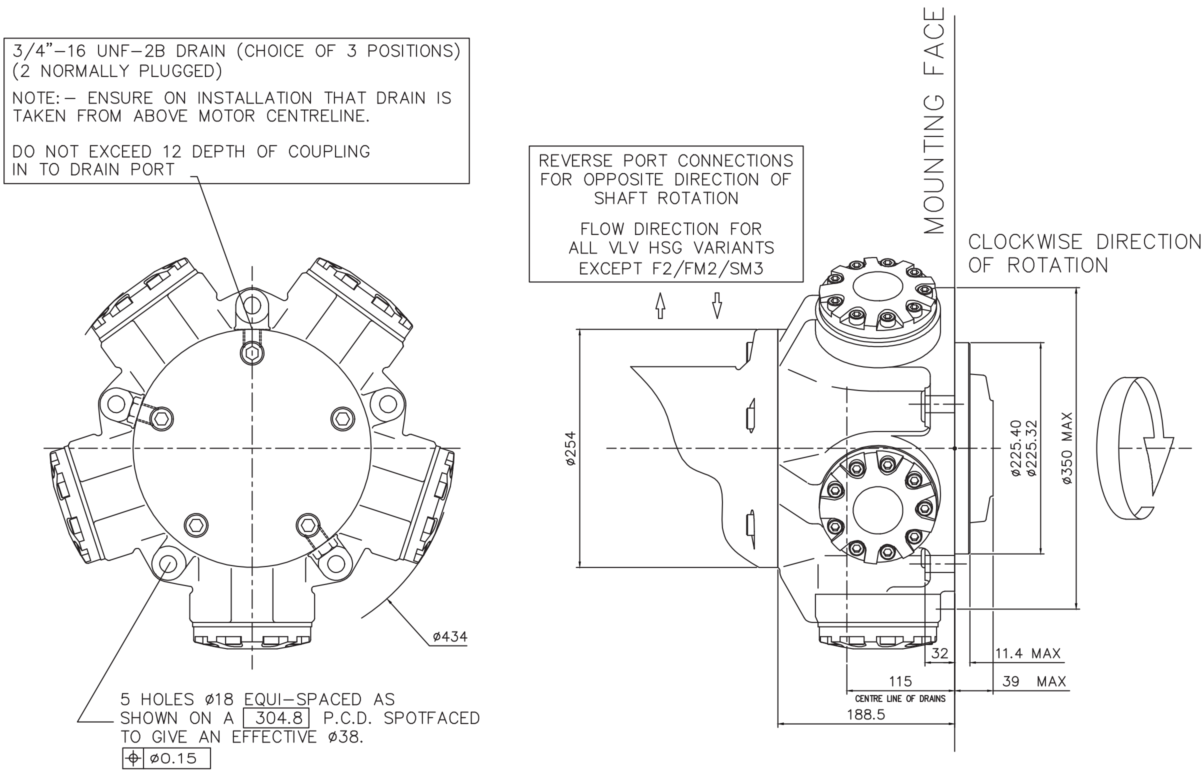
F3/FM3 –
3" VALVE HOUSING WITH
1 1/4" SAE 4–BOLT FLANGES

PORT FLANGE BOLT TAPPING SIZE –
F3: 7/16"–14 UNC–2B X 27 FULL THREAD DEPTH
FM3: M12 X P1.75 X 27 FULL THREAD DEPTH

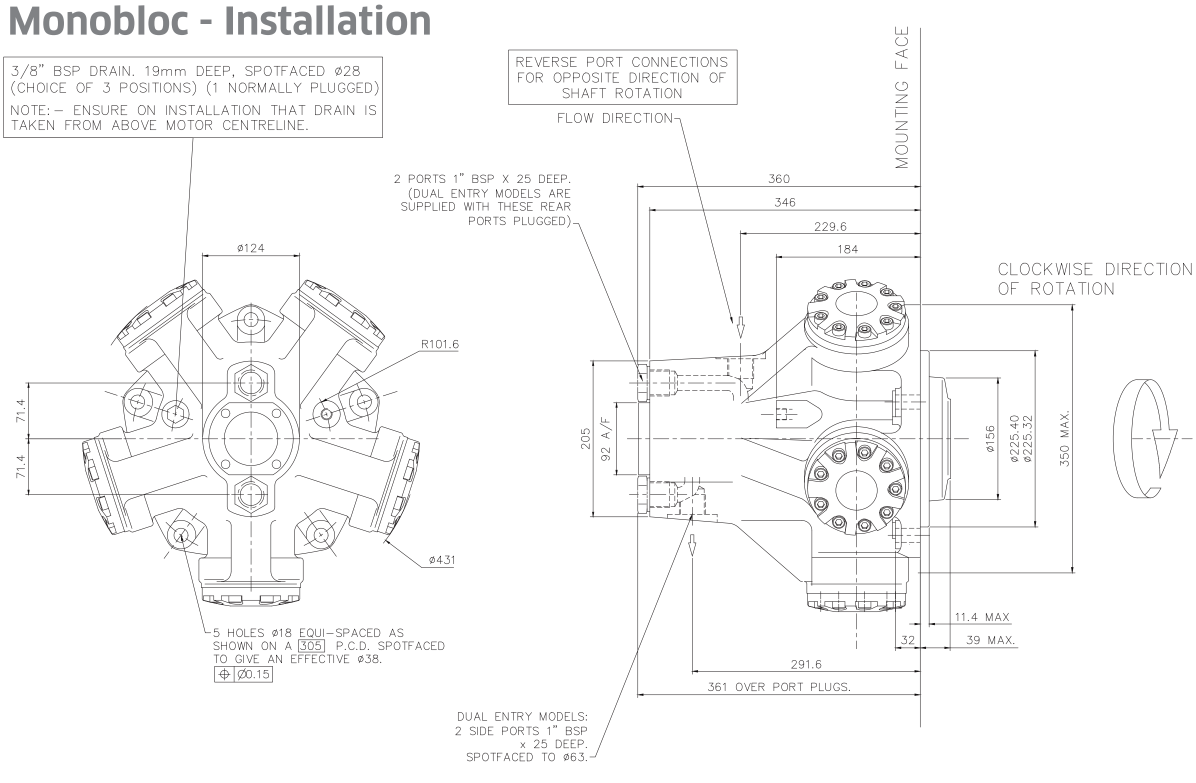


3-3 HMB045 (cont)

2 Piece - Installation

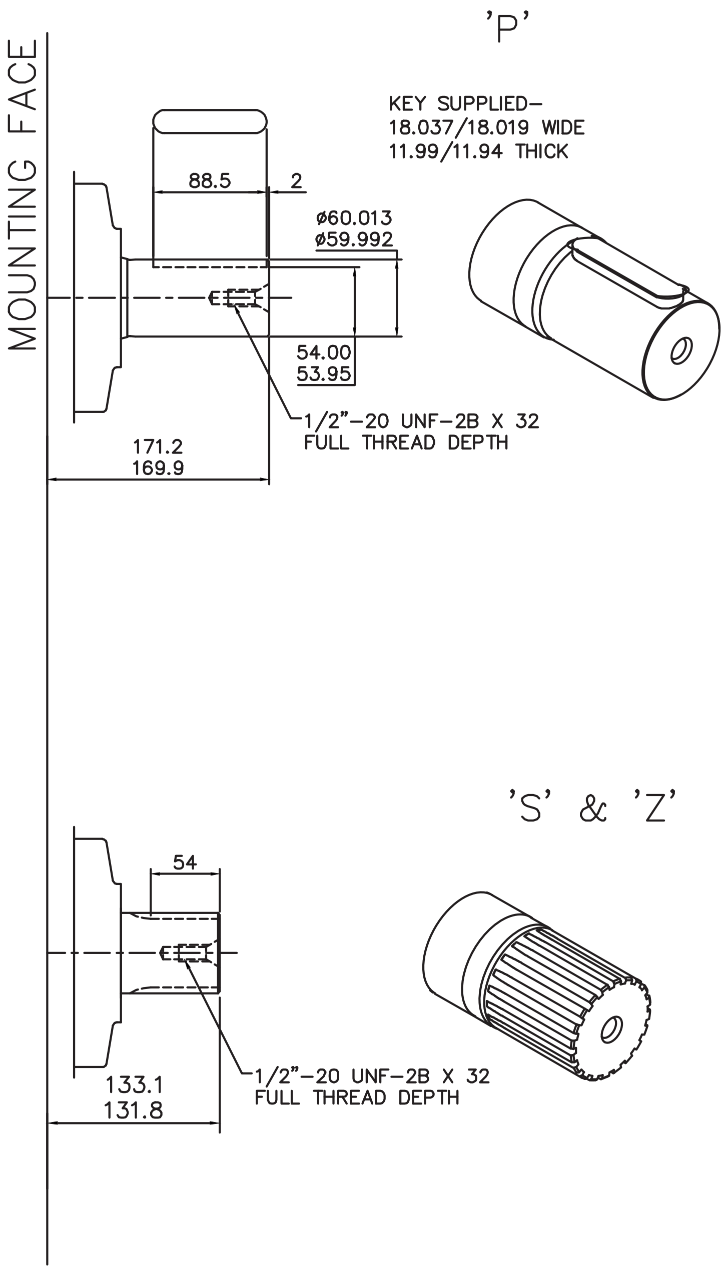


Monobloc - Installation



3-4 HMB060/080

'P', 'S' & 'Z' Shafts



SPLINE DATA

'S'

TO BS 3550 (ANSI B92.1 CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

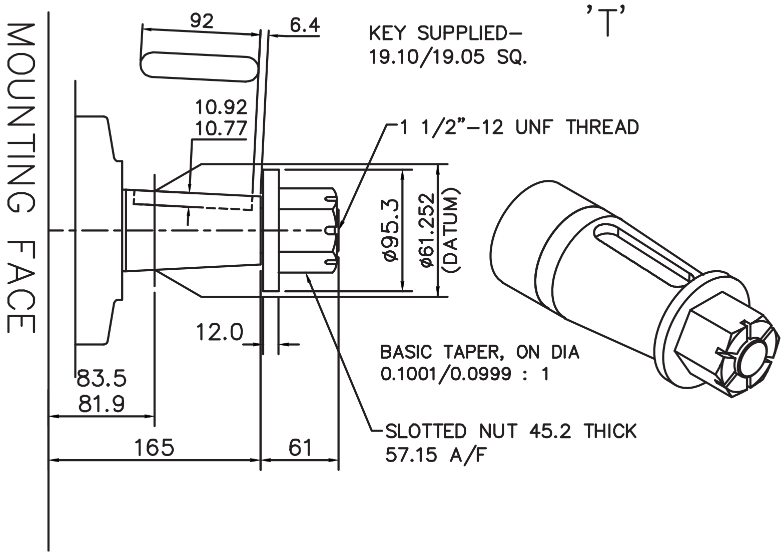
PRESSURE ANGLE	30°
NUMBER OF TEETH	14
PITCH	6/12
MAJOR DIAMETER	62.553/62.425
FORM DIAMETER	55.052
MINOR DIAMETER	54.084/53.525
PIN DIAMETER	8.128
DIAMETER OVER PINS	71.593/71.544

'Z'

DIN 5480 W70 x 3 x 30 x 22 x 7h

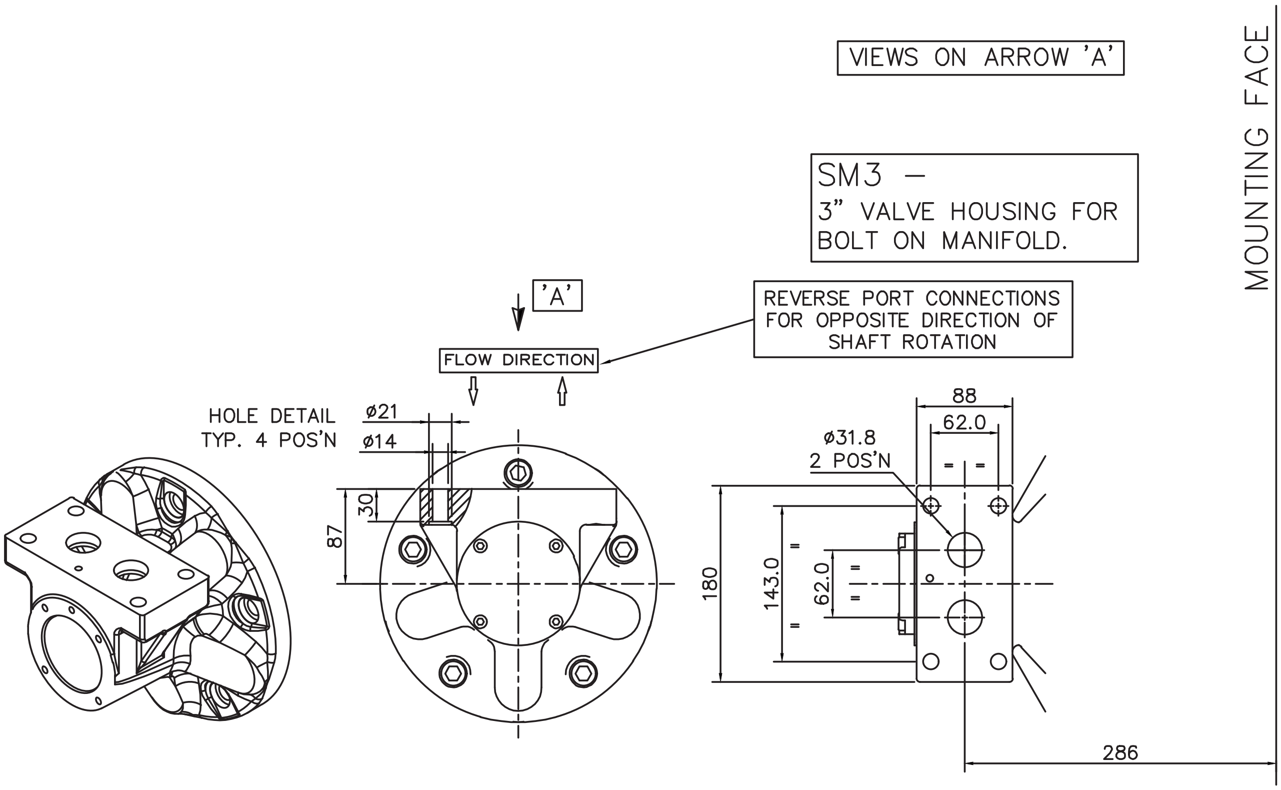
3-4 HMB060/080 (cont)

'T' Shaft



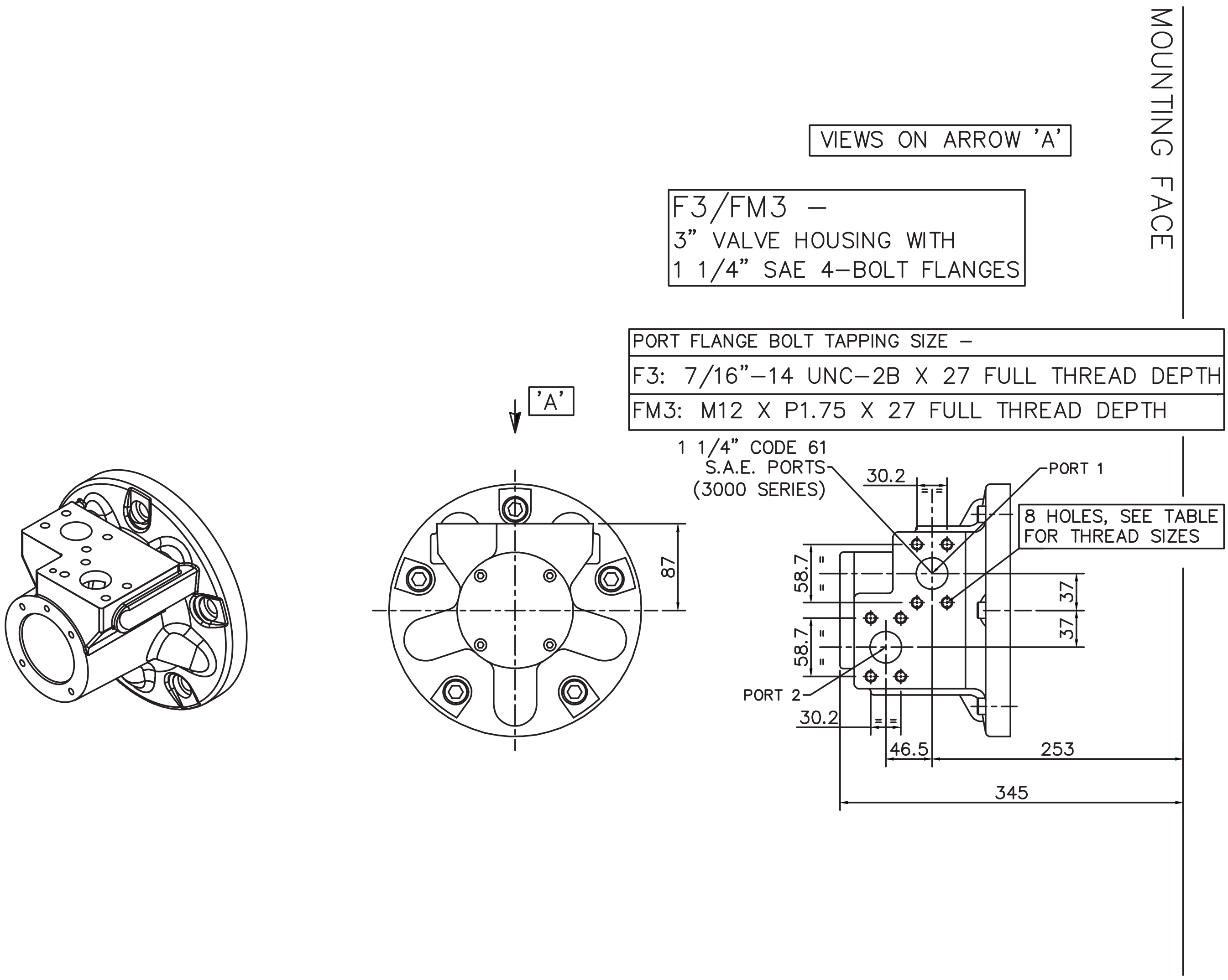
3-4 HMB060/080 (cont)

'SM3' Valve Housing



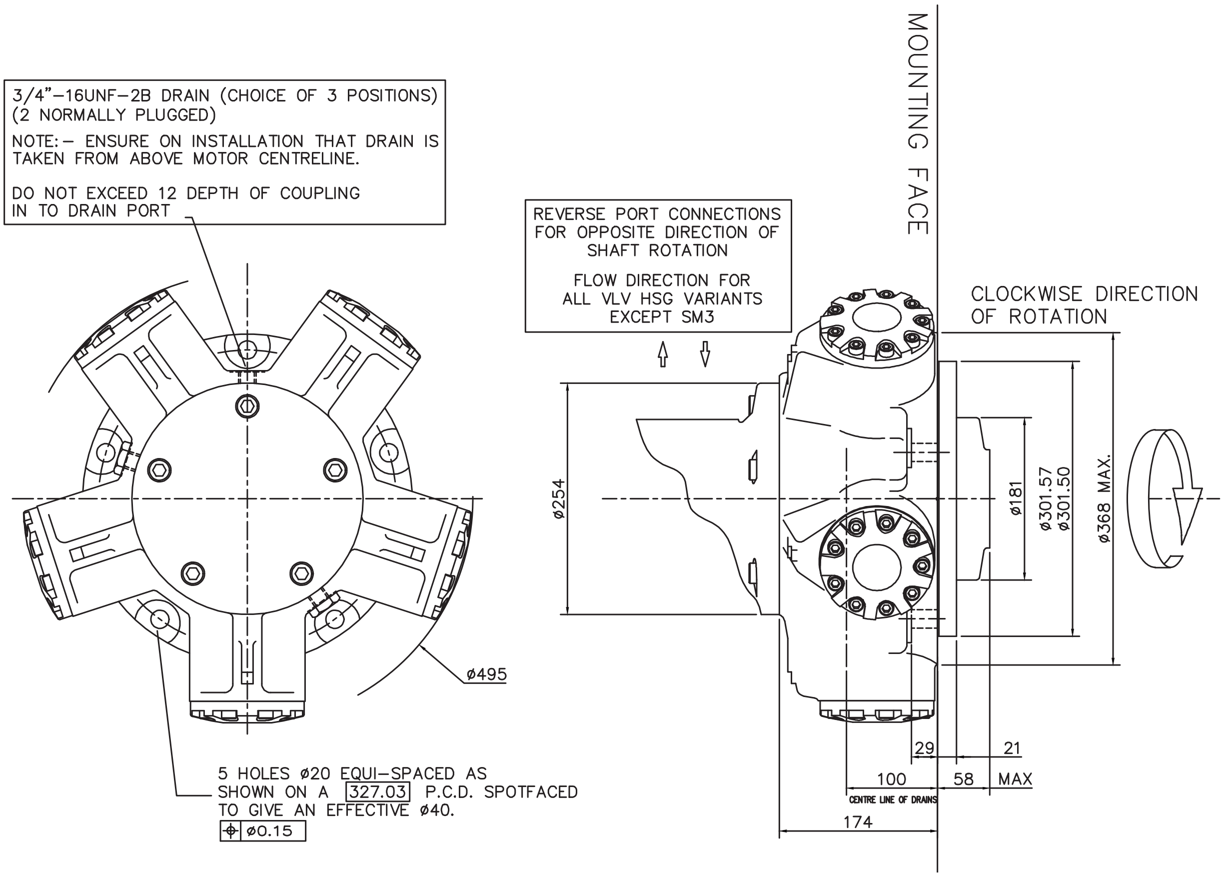
3-4 HMB060/080 (cont)

'F3' & 'FM3' Valve Housings



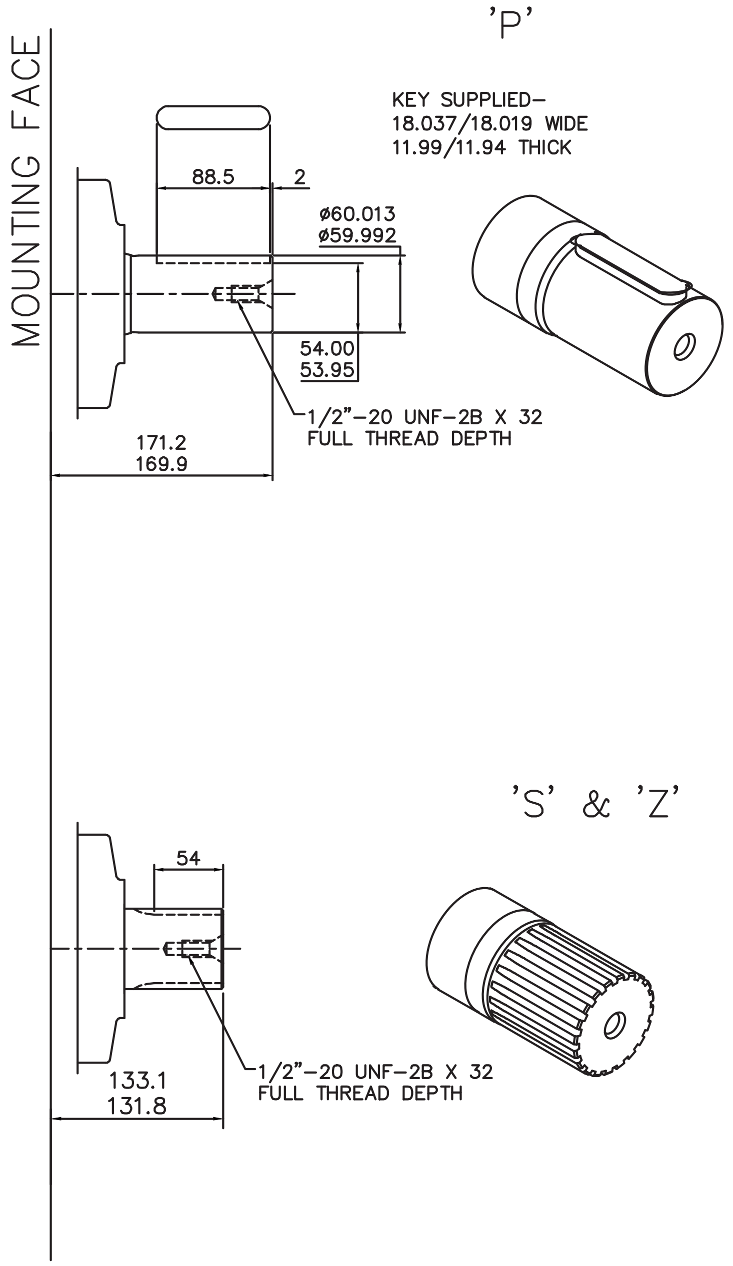
3-4 HMB060/080 (cont)

Installation



3-5 HMB100

'P', 'S' & 'Z' Shafts



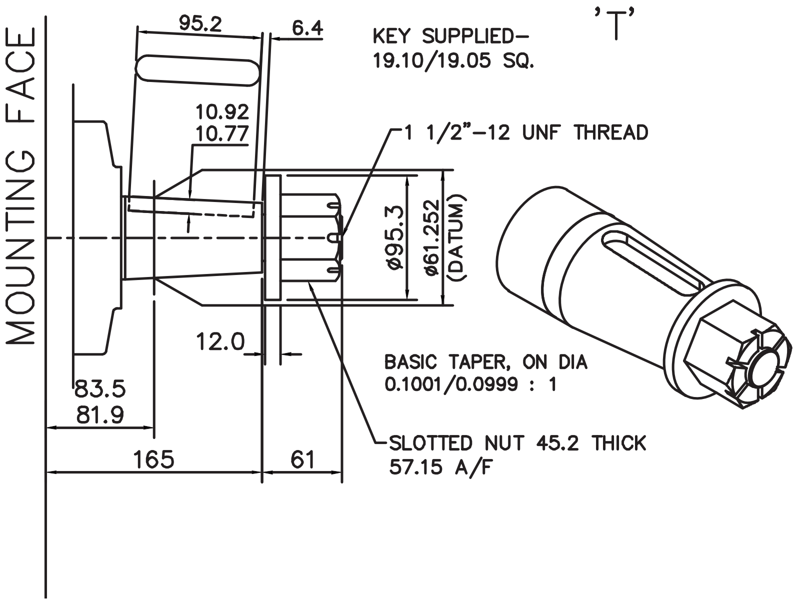
SPLINE DATA

'S'	
TO BS 3550 (ANSI B92.1 CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	14
PITCH	6/12
MAJOR DIAMETER	62.553/62.425
FORM DIAMETER	55.052
MINOR DIAMETER	54.084/53.525
PIN DIAMETER	8.128
DIAMETER OVER PINS	71.593/71.544

'Z'
DIN 5480 W70 x 3 x 30 x 22 x 7h

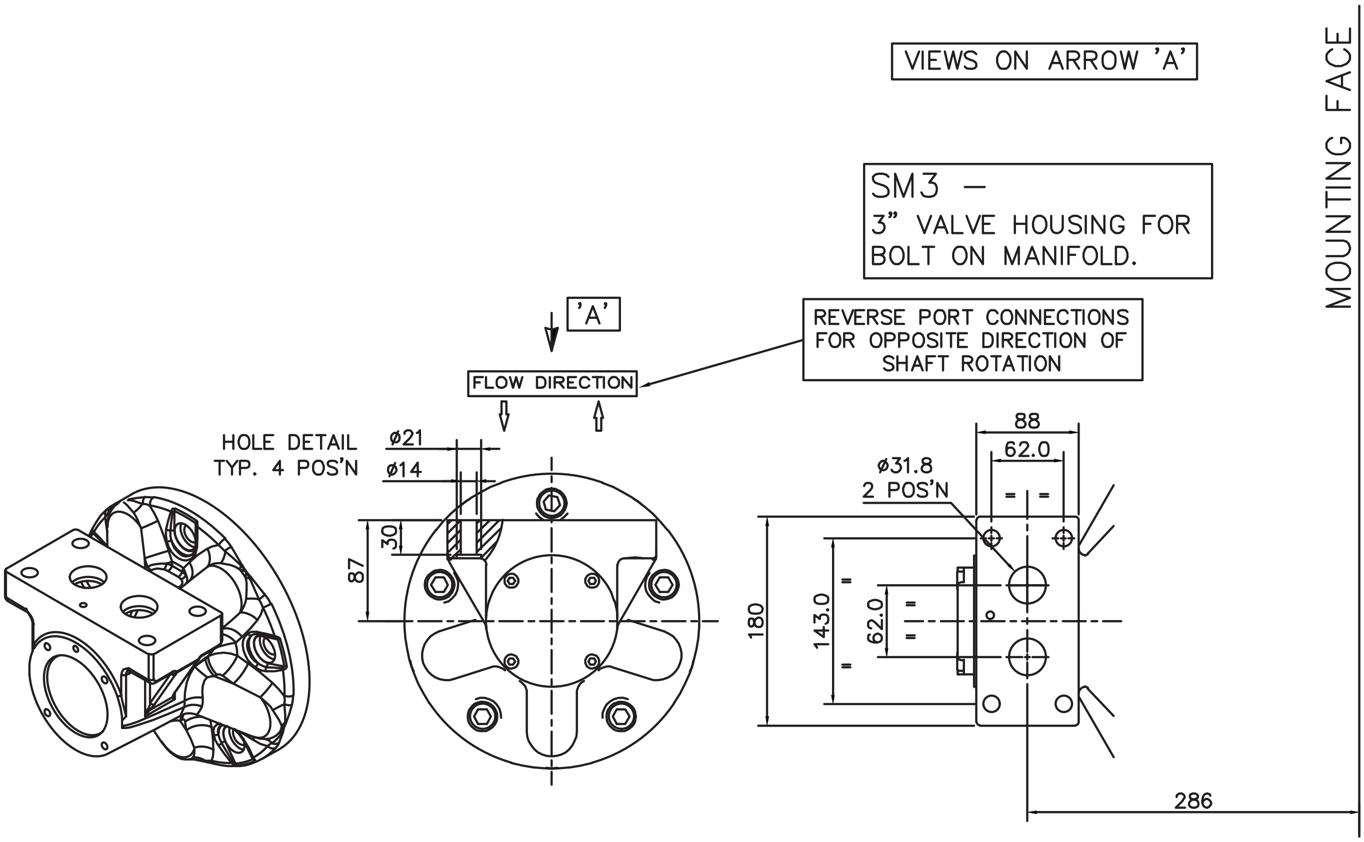
3-5 HMB100 (cont)

'T' Shaft



3-5 HMB100 (cont)

'SM3' Valve Housing



3-5 HMB100 (cont)

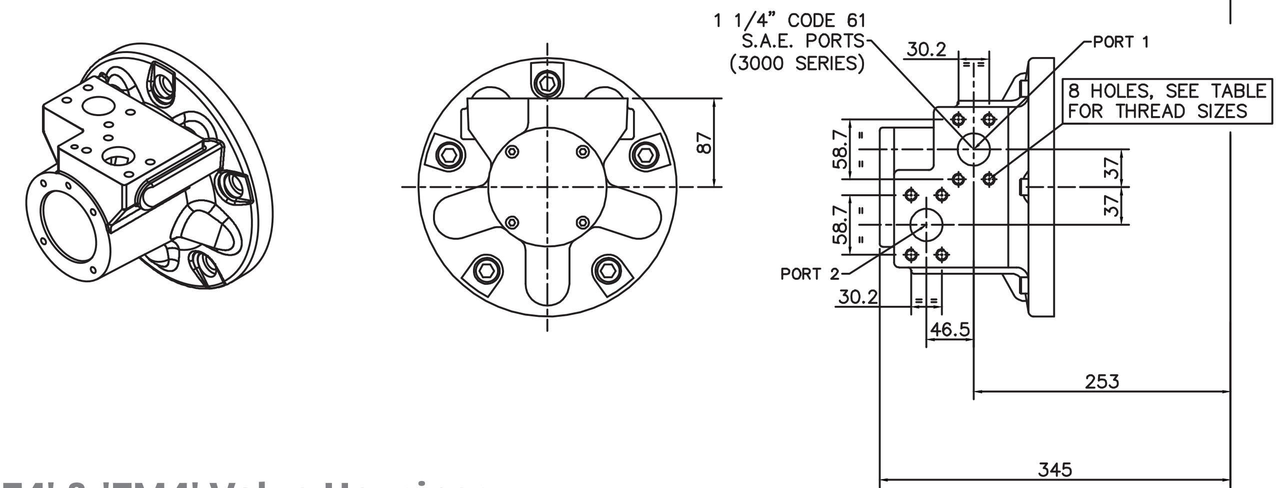
'F3' & 'FM3' Valve Housings

MOUNTING FACE

VIEWS ON ARROW 'A'

F3/FM3 –
3" VALVE HOUSING WITH
1 1/4" SAE 4–BOLT FLANGES

PORT FLANGE BOLT TAPPING SIZE –
F3: 7/16"–14 UNC–2B X 27 FULL THREAD DEPTH
FM3: M12 X P1.75 X 27 FULL THREAD DEPTH

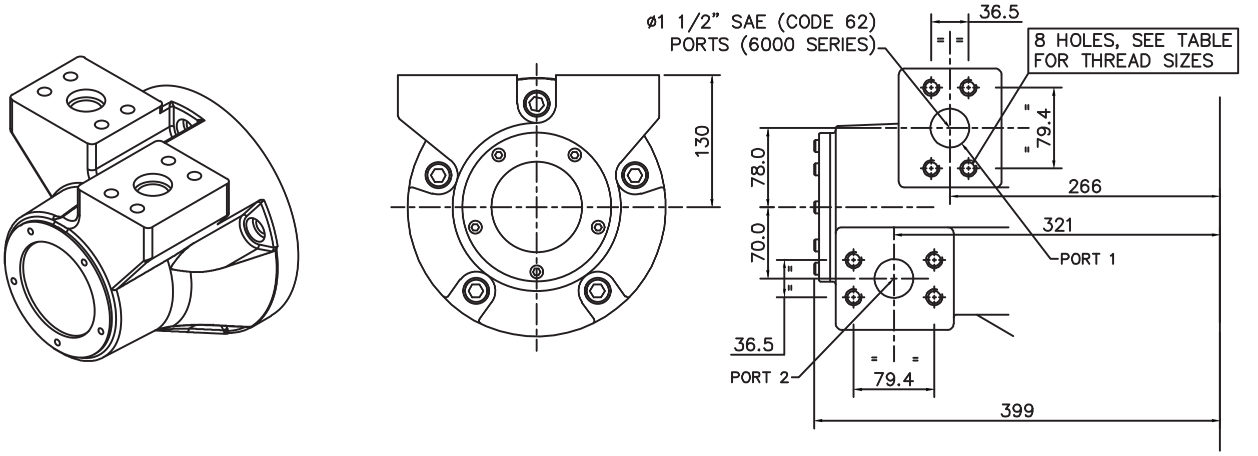


'F4' & 'FM4' Valve Housings

MOUNTING FACE

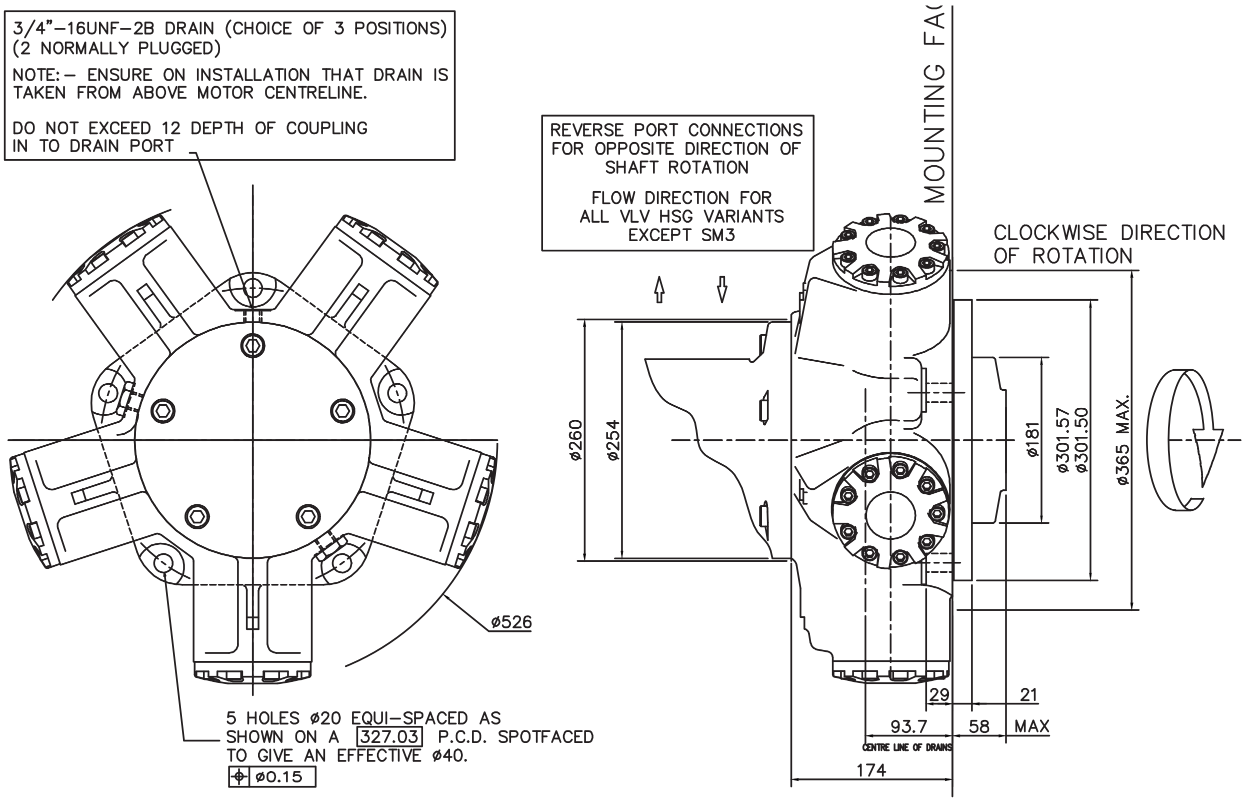
F4/FM4 –
4" VALVE HOUSING WITH
1 1/2" SAE 4–BOLT FLANGES

PORT FLANGE BOLT TAPPING SIZE –
F4: 5/8"–11 UNC–2B X 35 FULL THREAD DEPTH
FM4: M16 X P2 X 35 FULL THREAD DEPTH



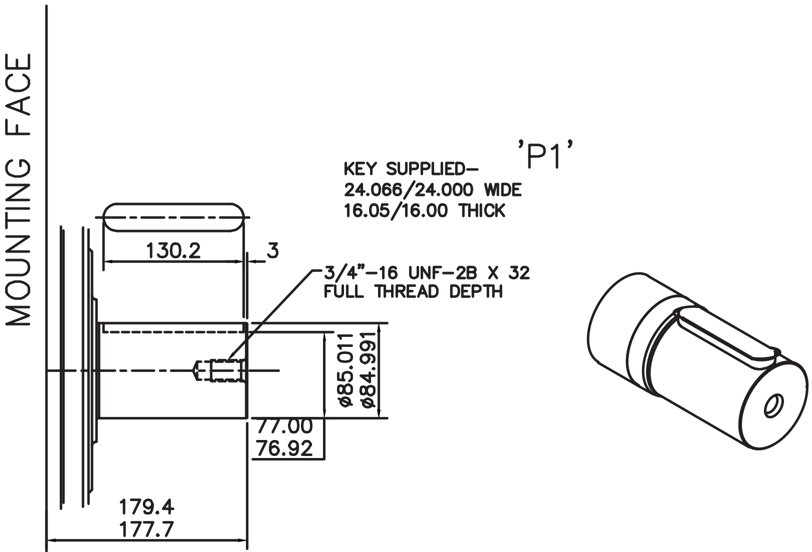
3-5 HMB100 (cont)

Installation



3-6 HM(HD)B125

HMB125 - 'P1', 'S3' & 'Z3' Shafts

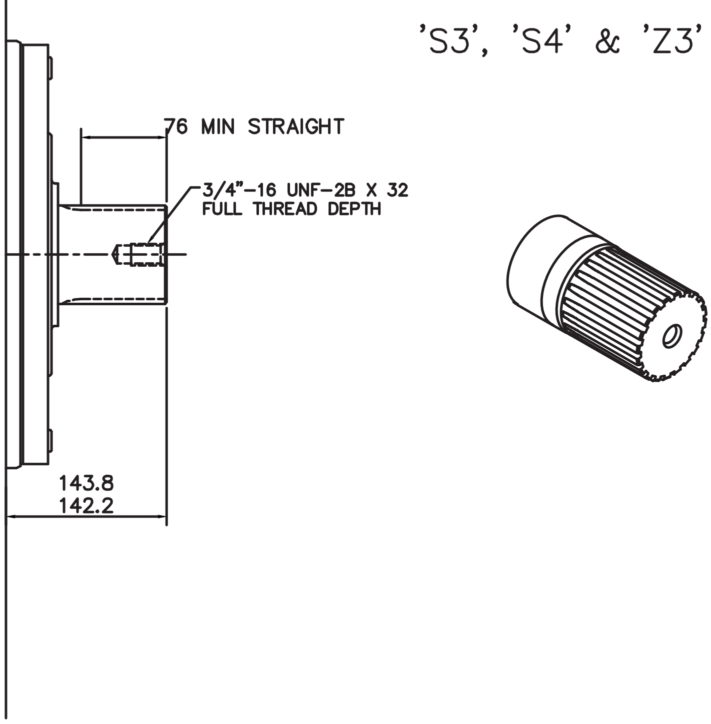


SPLINE DATA

'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

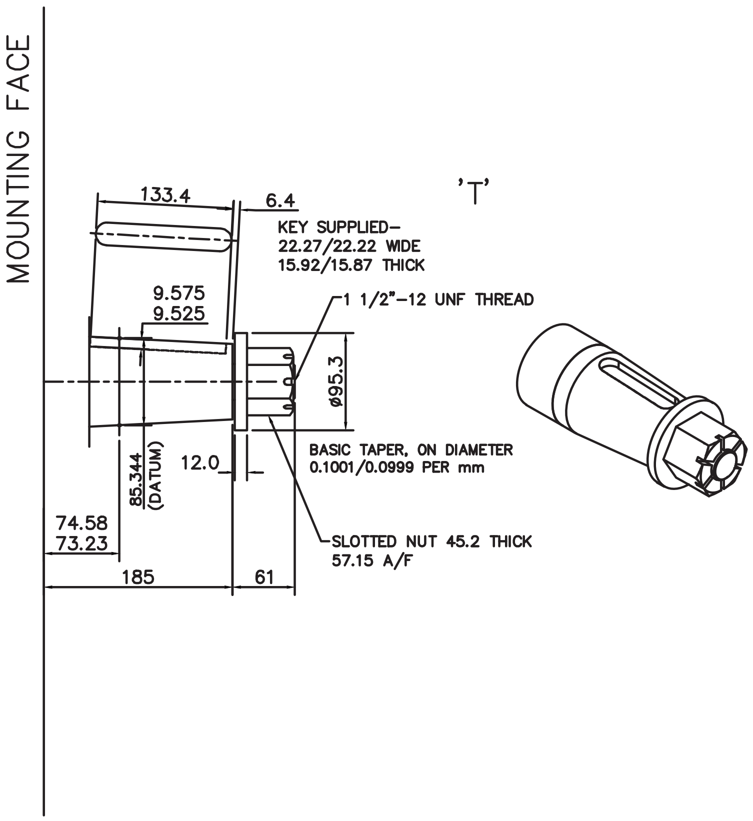
'S4'	
PRESSURE ANGLE	20°
NUMBER OF TEETH	16
PITCH	5/10
MAJOR DIAMETER	86.360/86.233
FORM DIAMETER	76.124
MINOR DIAMETER	74.93/72.39
PIN DIAMETER	8.636
DIAMETER OVER PINS	92.710/92.581

'Z3'
DIN 5480 W85 x 3 x 27 x 7h



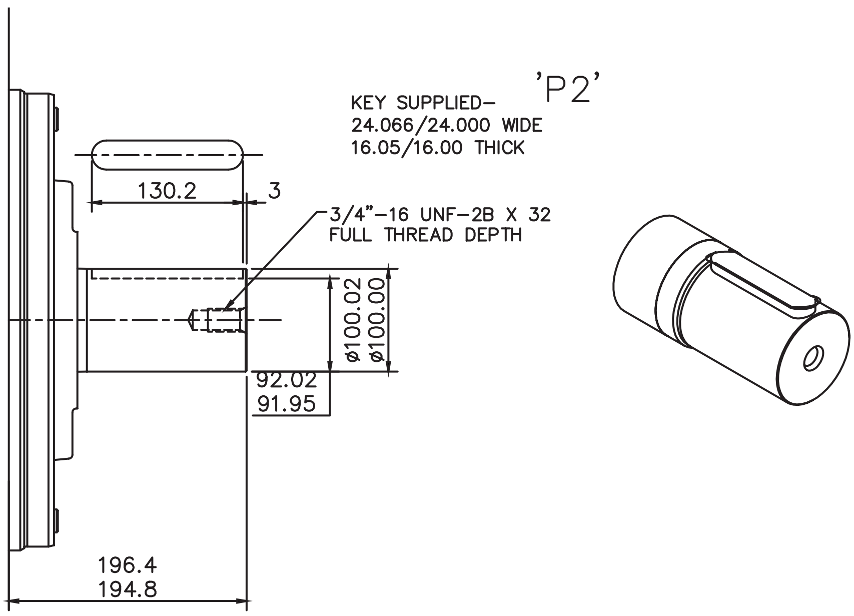
3-6 HM(HD)B125 (cont)

HMB125 - 'T' Shaft



3-6 HM(HD)B125 (cont)

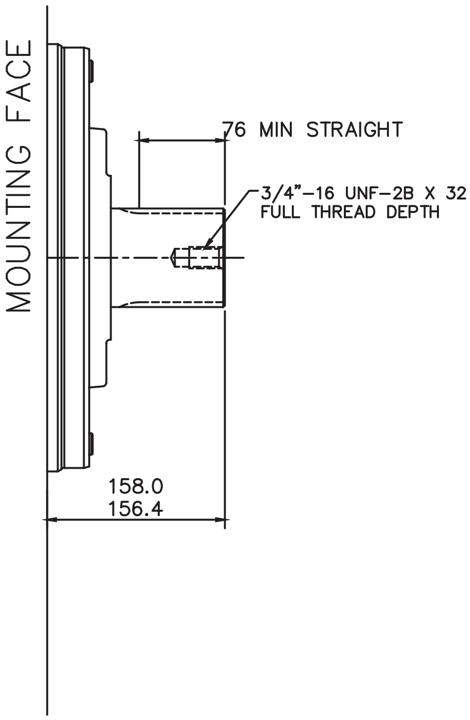
HMHDB125 - 'P2' Shafts

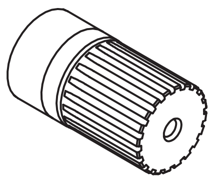


3-6 HM(HD)B125 (cont)

HMHDB125 - 'S5' & 'Z5' Shafts

'S5' & 'Z5'





SPLINE DATA

'S5'

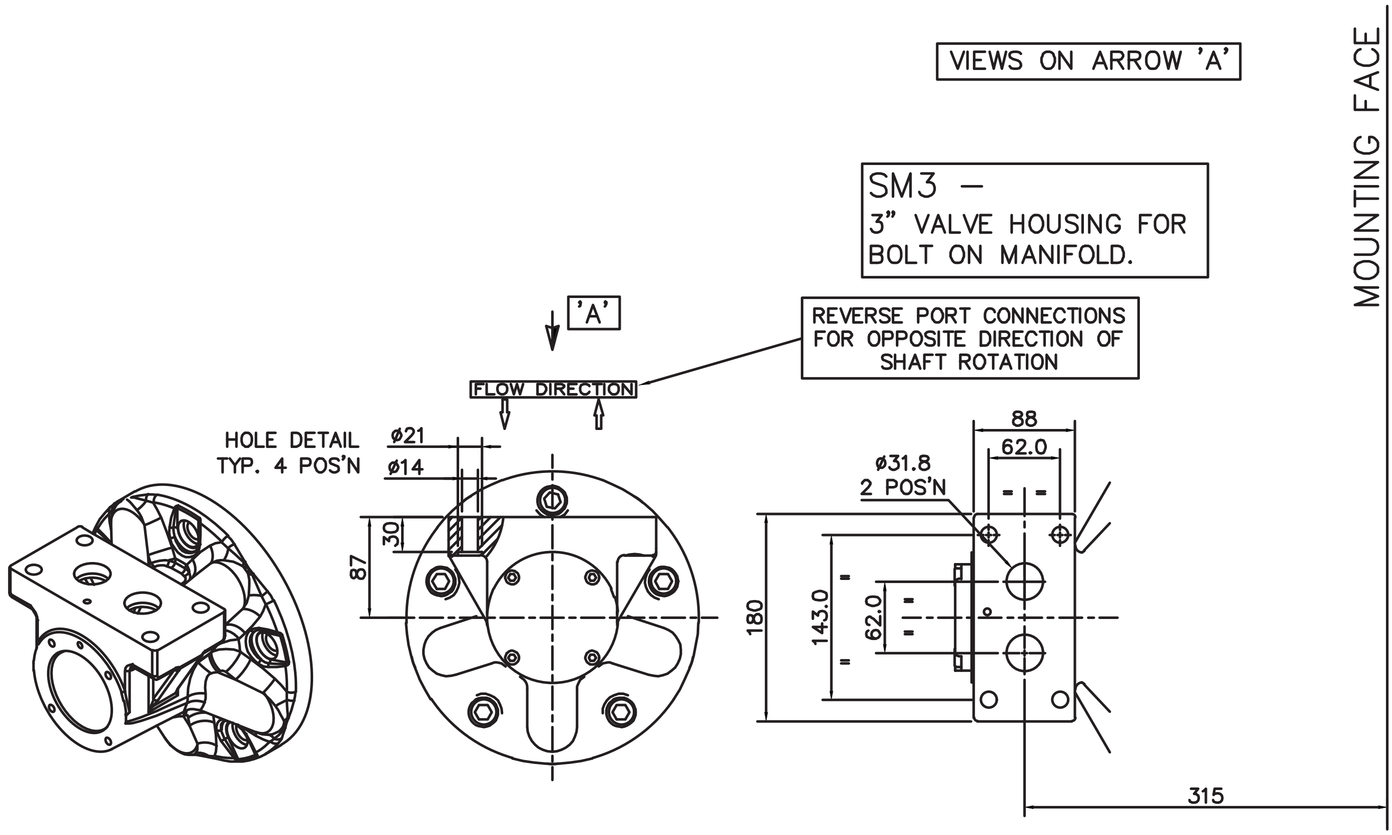
PRESSURE ANGLE	20°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.652/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.626
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

'Z5'

DIN 5480 W100 x 4 x 24 x 7h

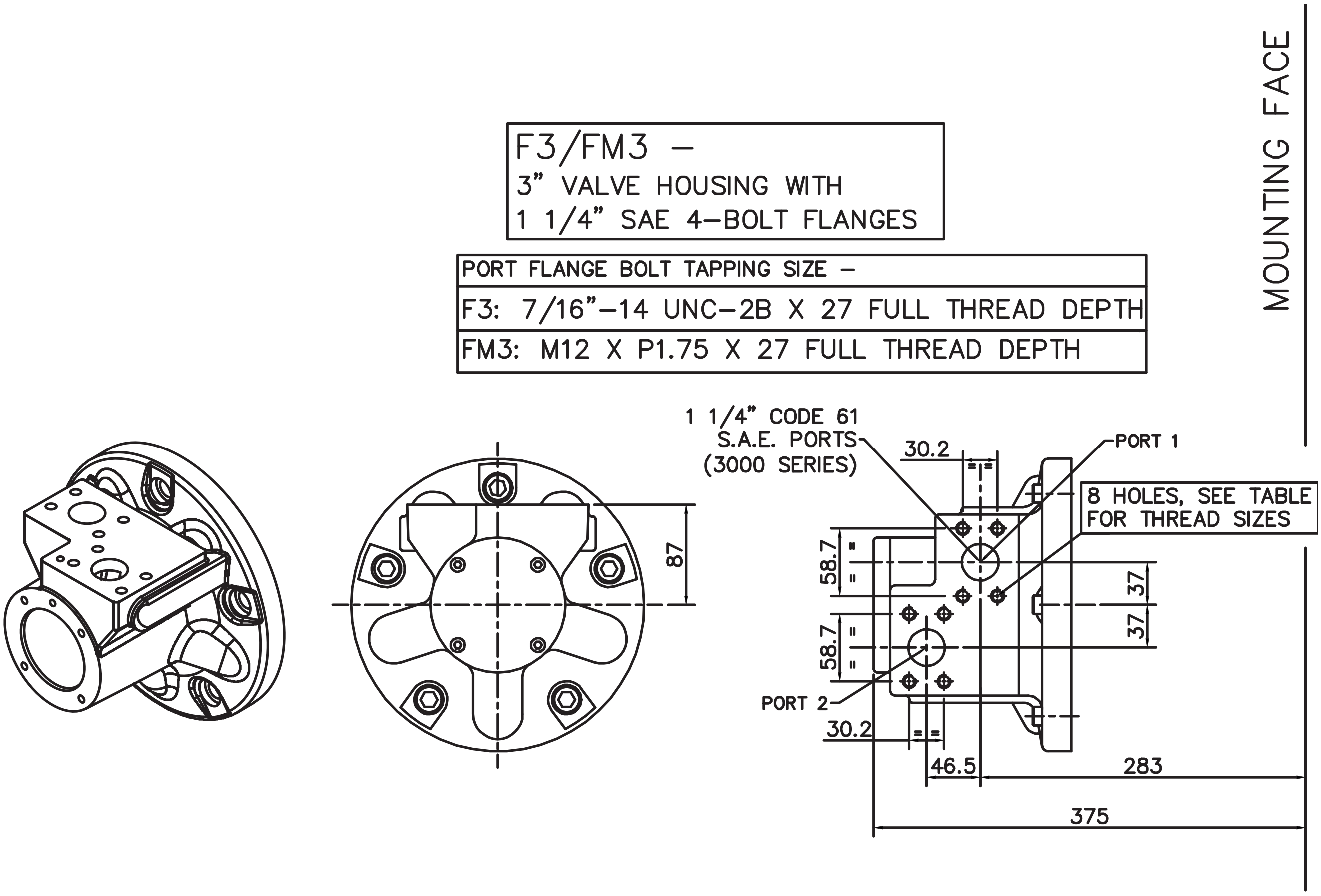
3-6 HM(HD)B125 (cont)

'SM3' Valve Housing



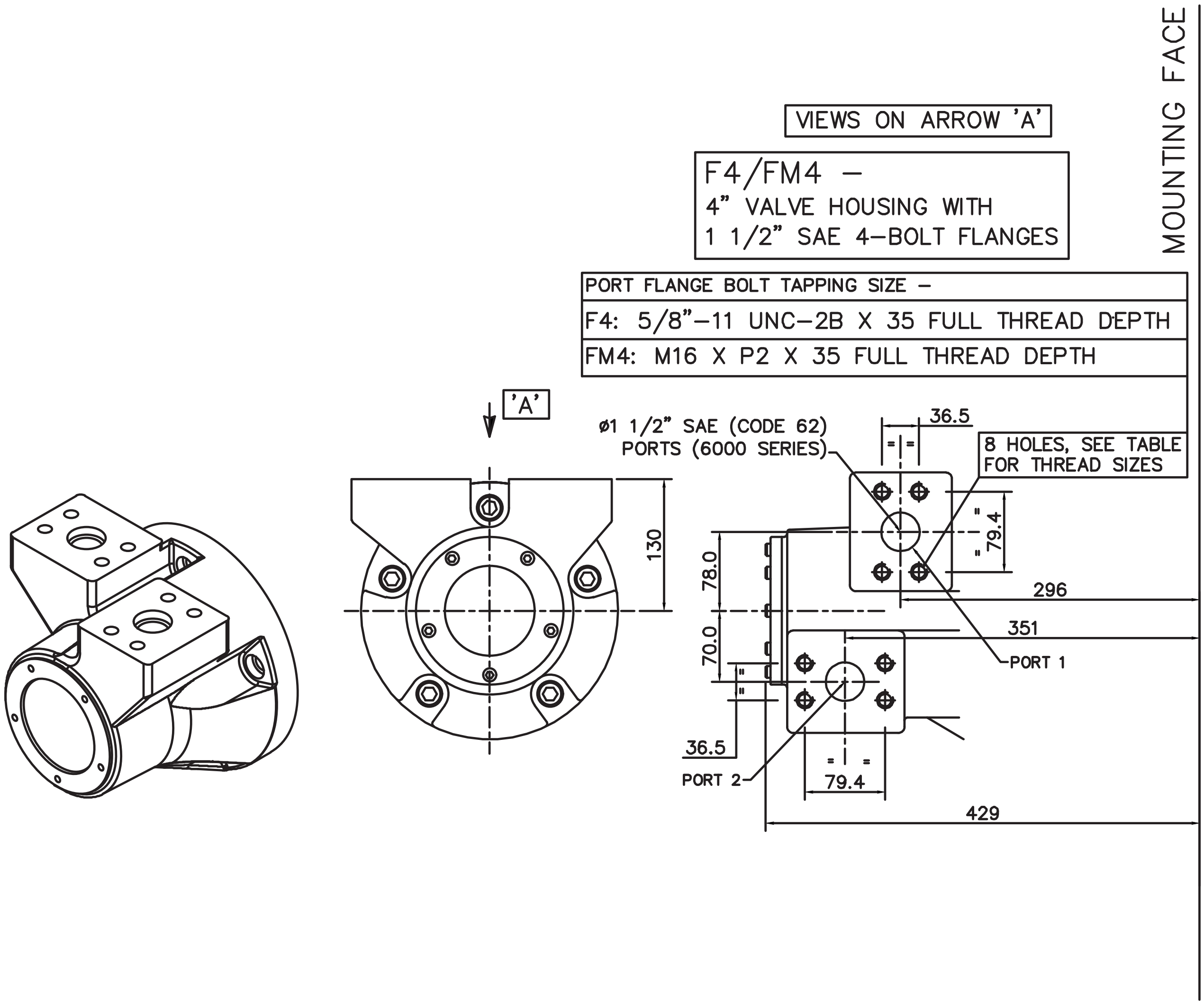
3-6 HM(HD)B125 (cont)

'F3' & 'FM3' Valve Housings



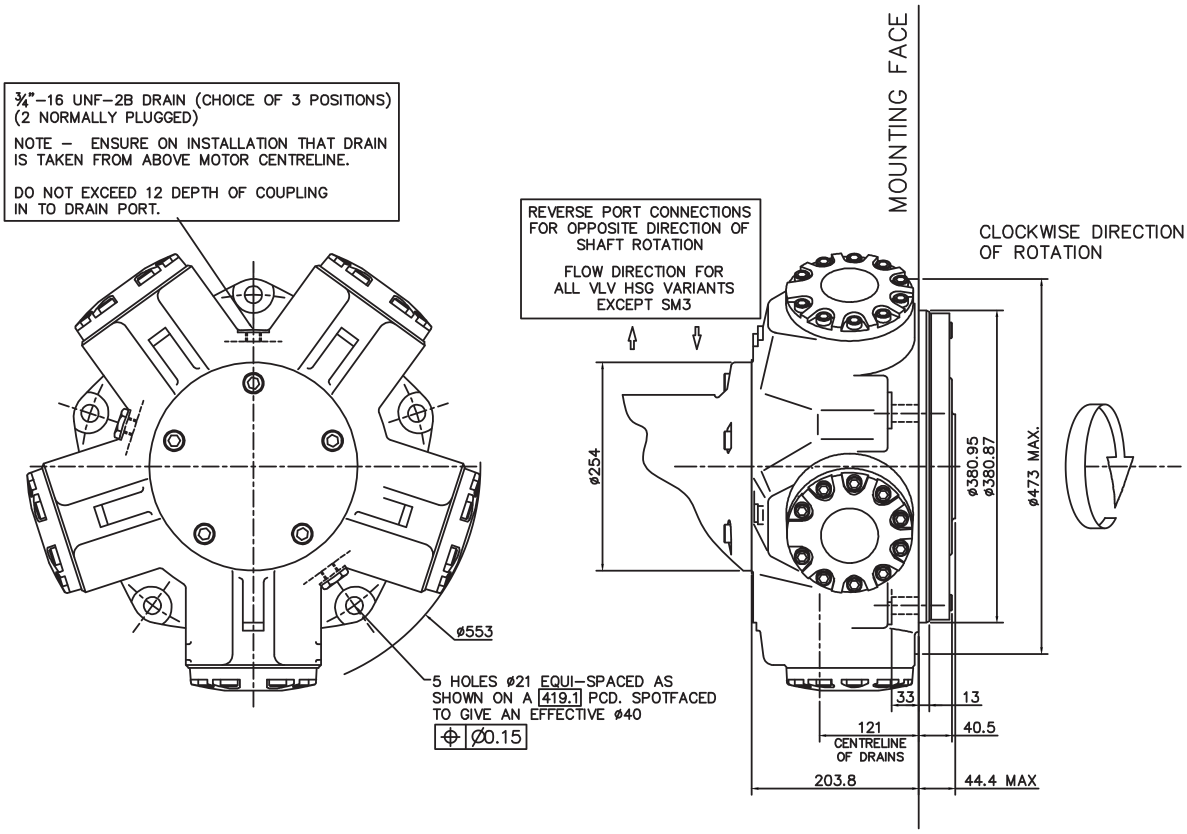
3-6 HM(HD)B125 (cont)

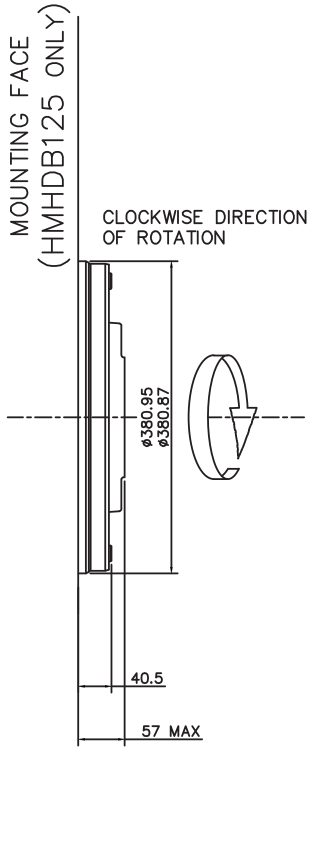
'F4' & 'FM4' Valve Housings



3-6 HM(HD)B125 (cont)

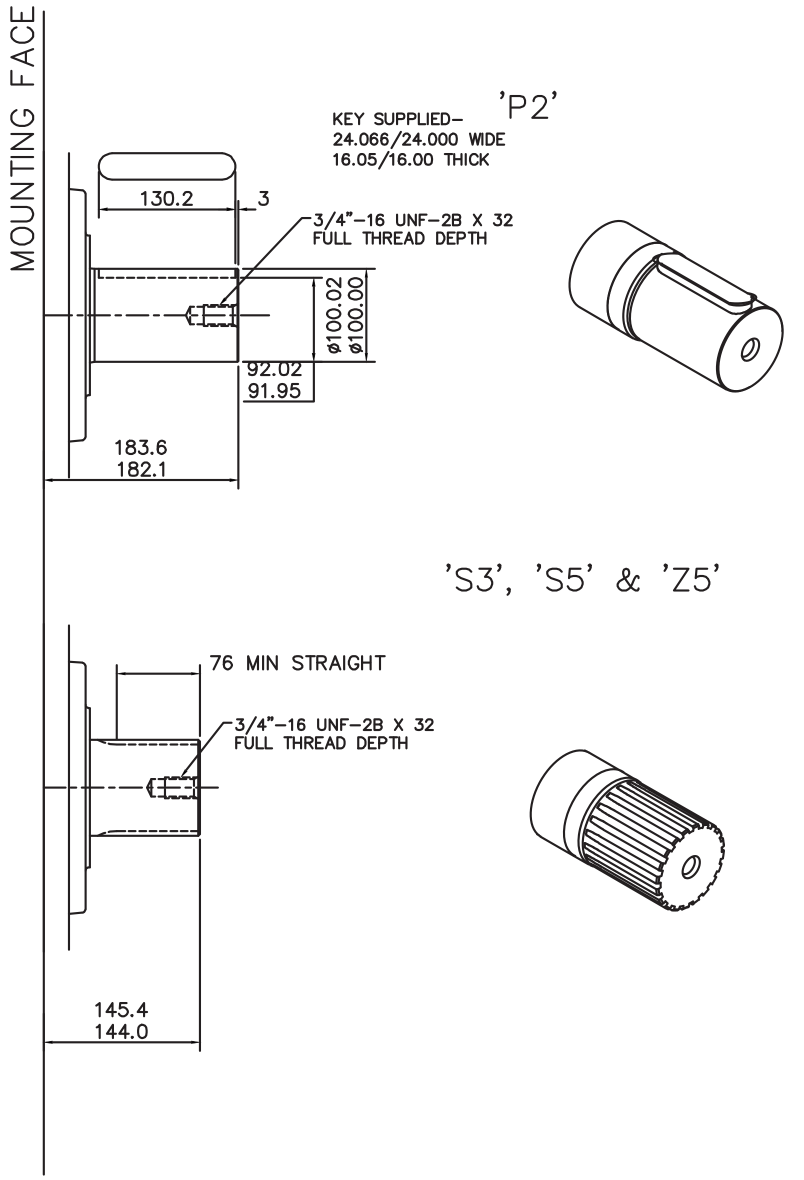
Installation





3-7 HM(HD)B150/200

HMB150/200 - 'P1', 'S3', 'S4' & 'Z3' Shafts



SPLINE DATA

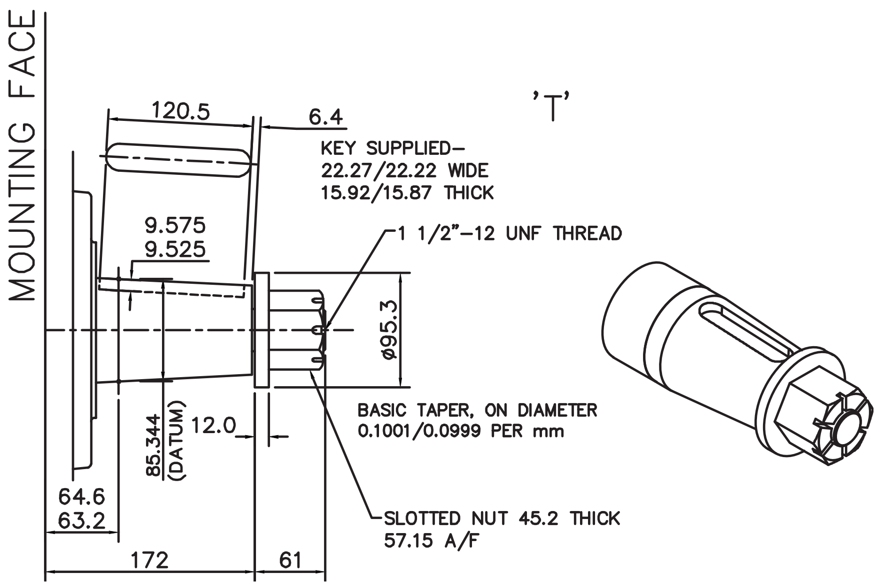
'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'S5'	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.652/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.626
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

'Z5'
DIN 5480 W100 x 4 x 24 x 7h

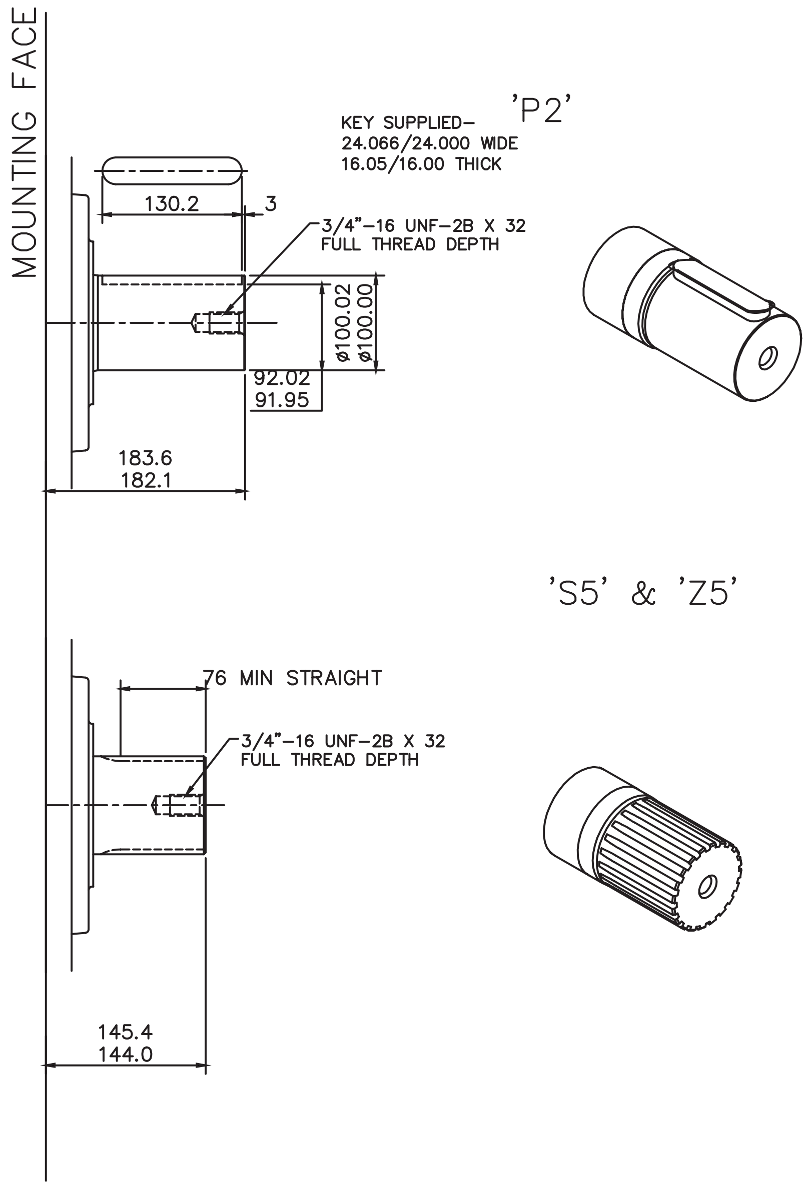
3-7 HM(HD)B150/200 (cont)

HMB150/200 - 'T' Shaft



3-7 HM(HD)B150/200 (cont)

HMHDB150/200 - 'P2', 'S5' & 'Z5' Shafts



SPLINE DATA

'S5'

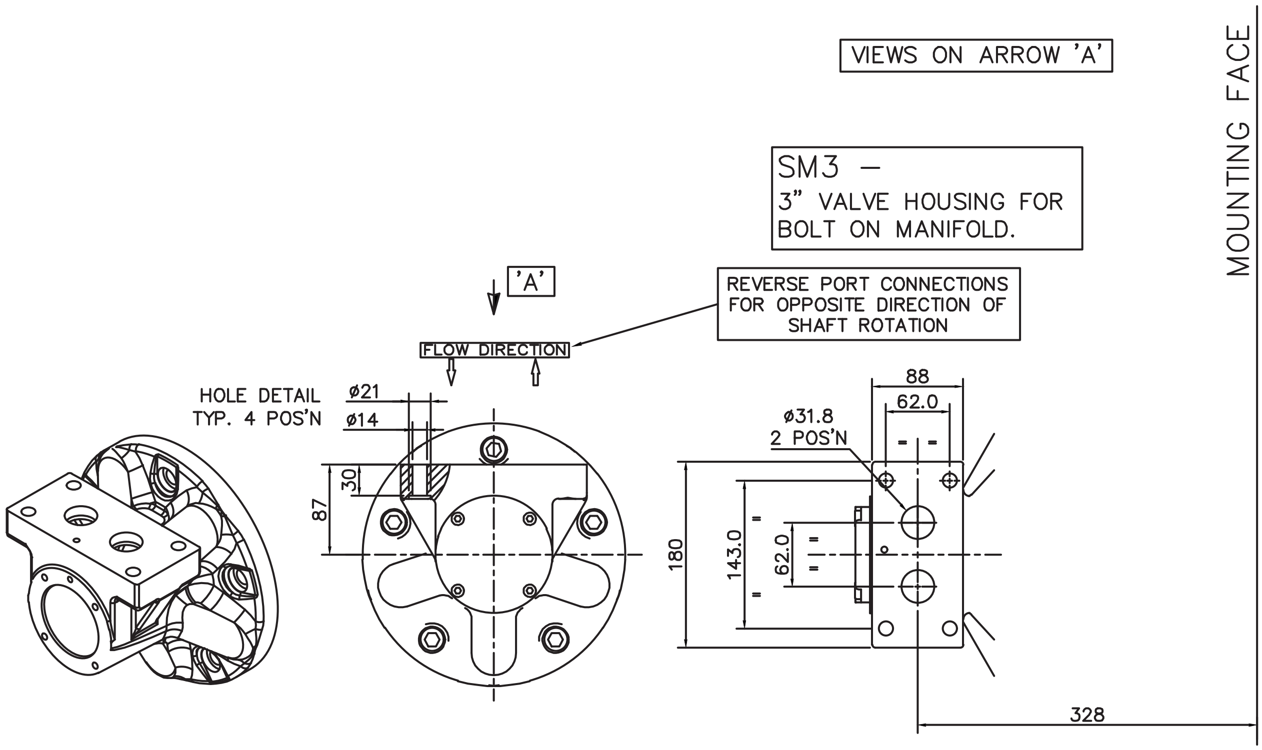
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.652/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.626
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

'Z5'

DIN 5480 W100 x 4 x 24 x 7h

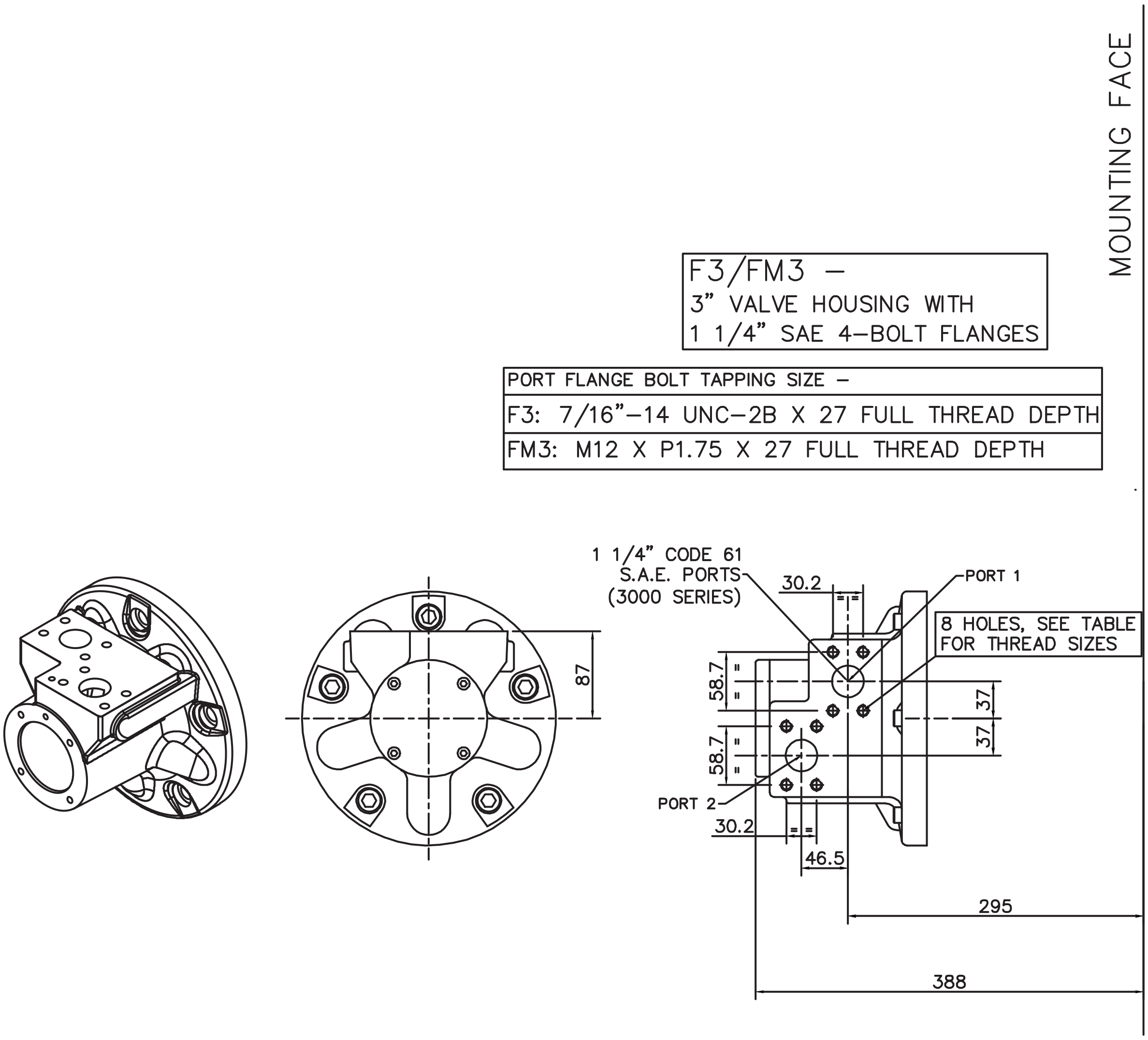
3-7 HM(HD)B150/200 (cont)

'SM3' Valve Housing



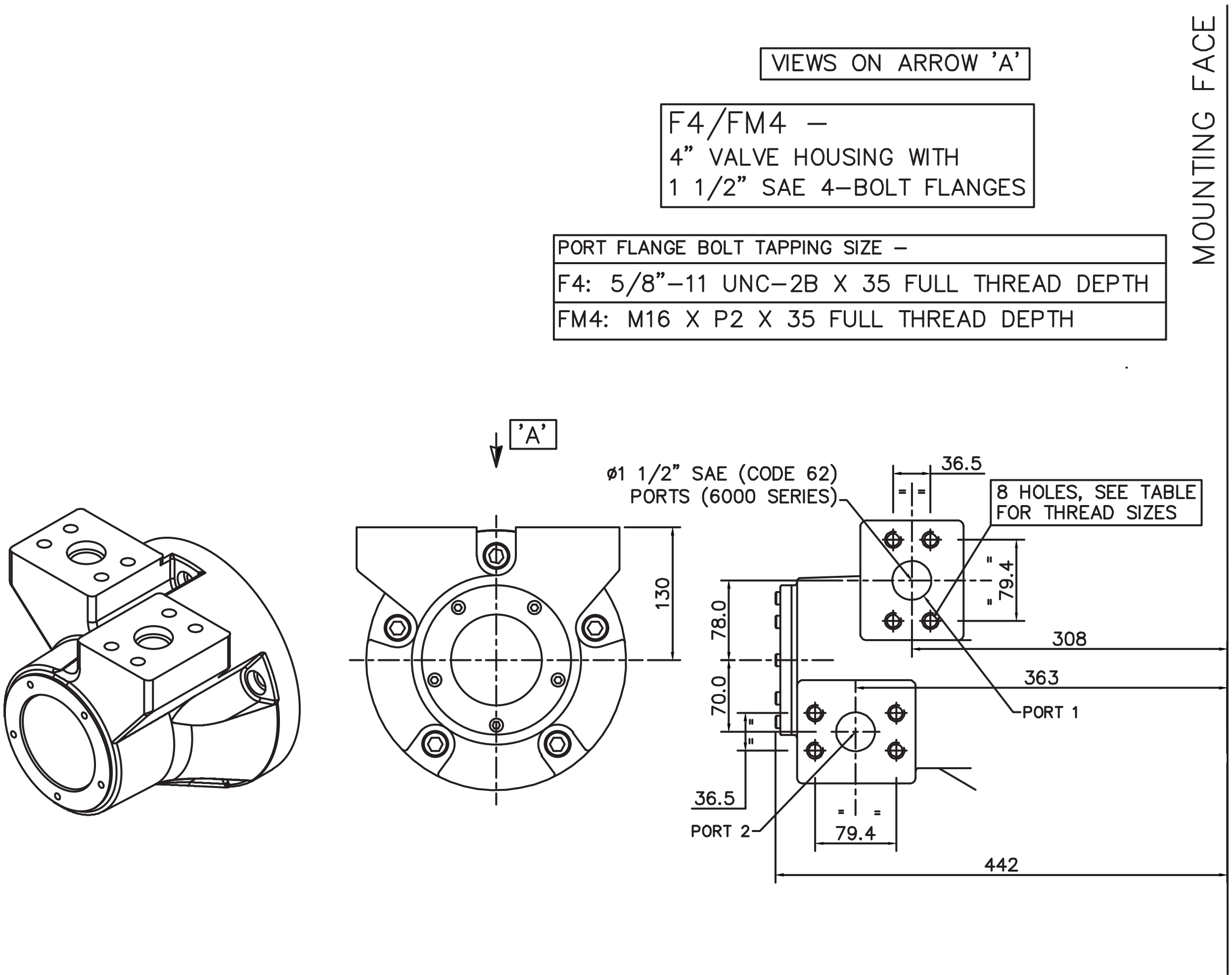
3-7 HM(HD)B150/200 (cont)

'F3' & 'FM3' Valve Housings



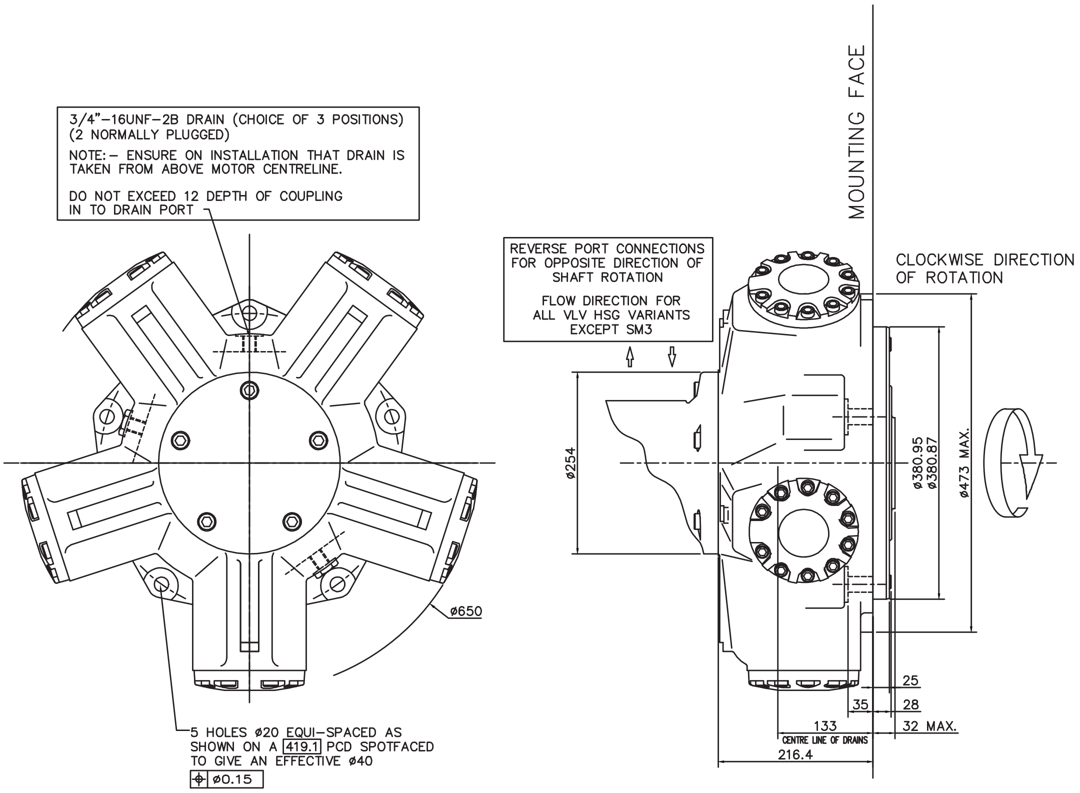
3-7 HM(HD)B150/200 (cont)

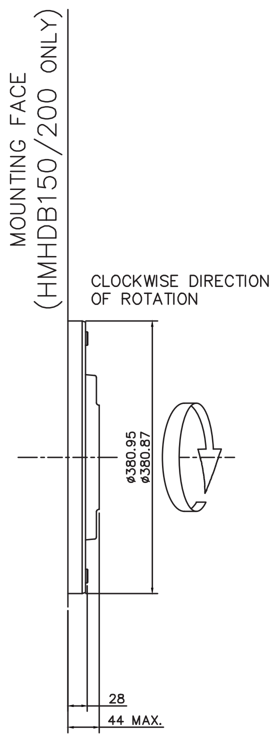
'F4' & 'FM4' Valve Housings



3-7 HM(HD)B150/200 (cont)

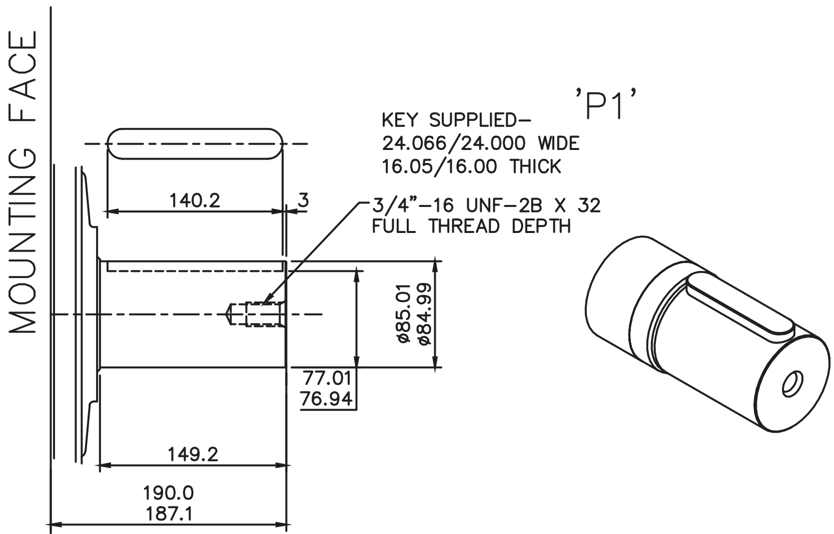
Installation





3-8 HM(HD)B270

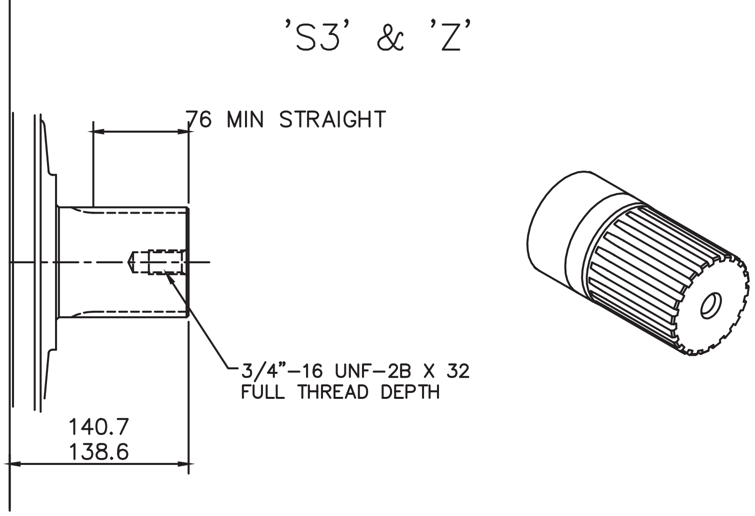
HMB270 - 'P1', 'S3' & 'Z' Shafts



SPLINE DATA

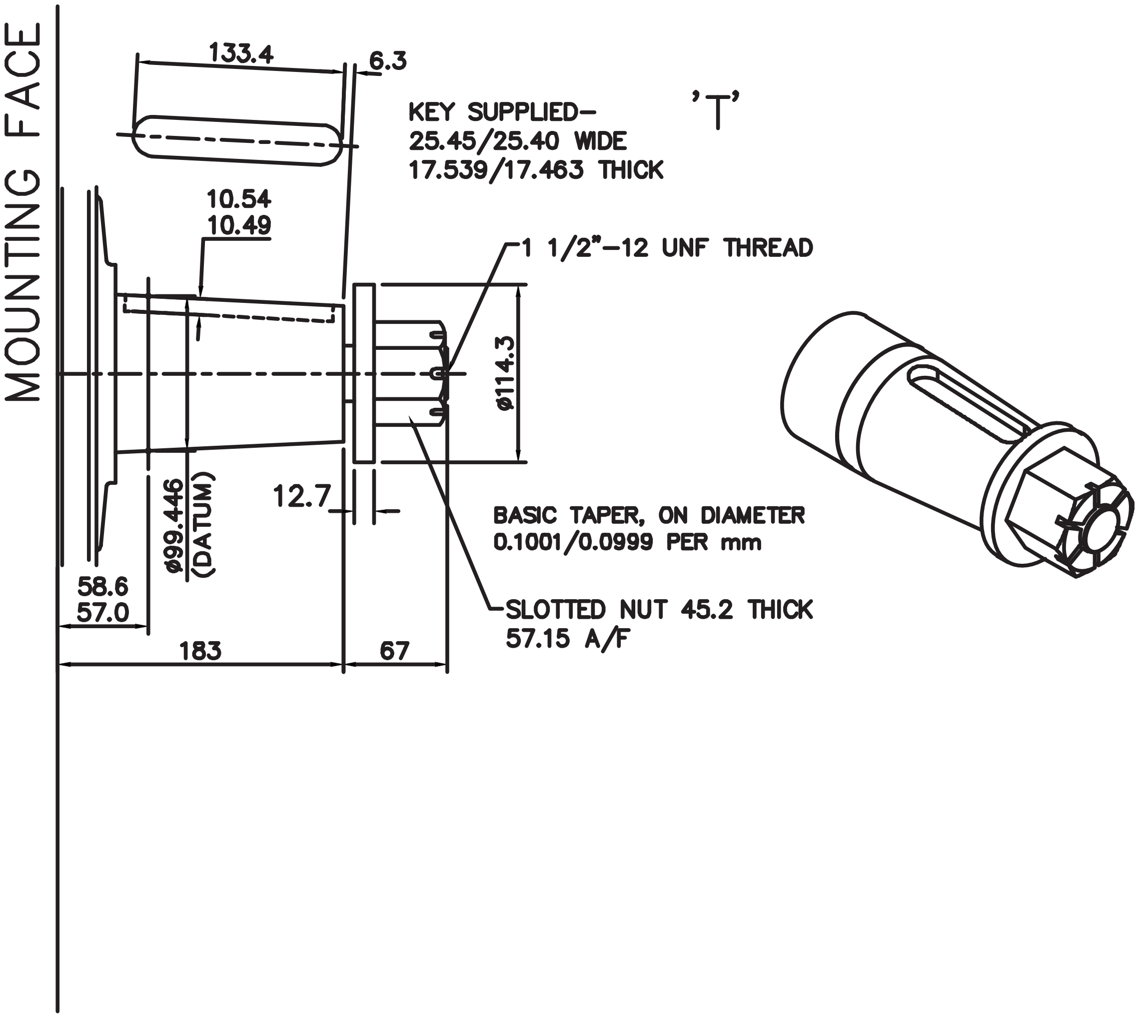
'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z'
DIN 5480 W100 x 4 x 24 x 7h



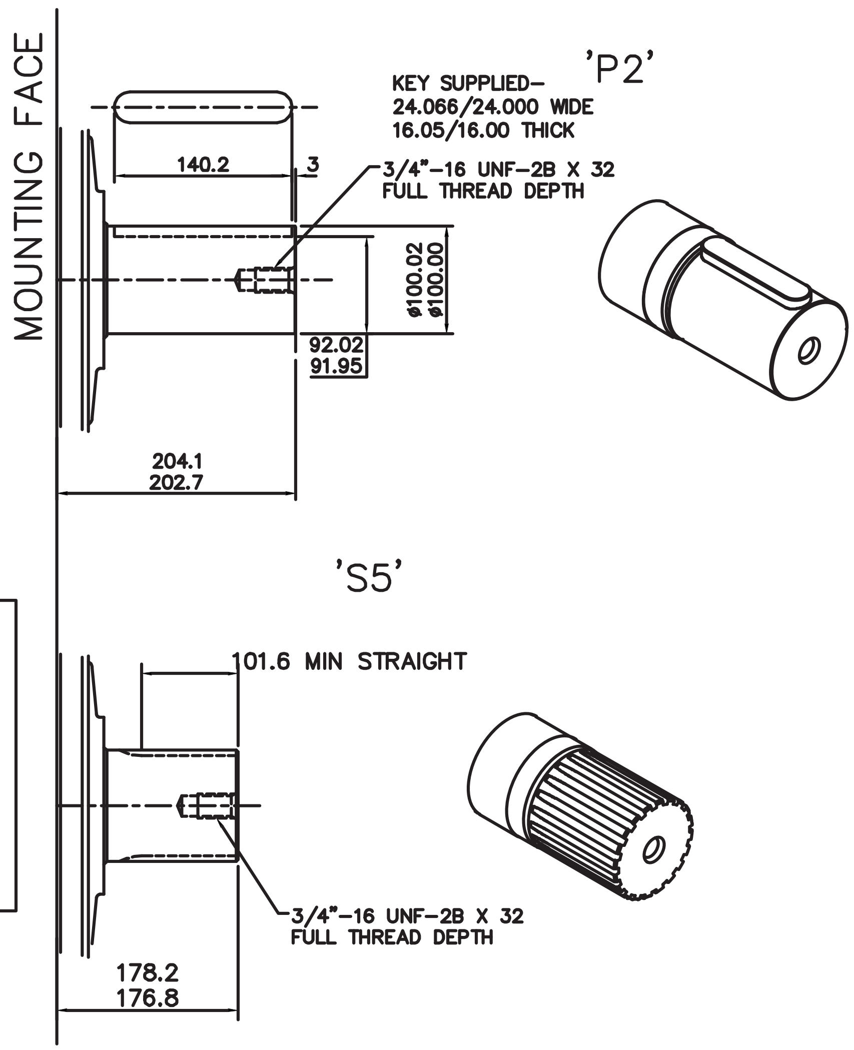
3-8 HM(HD)B270 (cont)

HMB270 - 'T' Shaft



3-8 HM(HD)B270 (cont)

HMHDB270 - 'P2' & 'S5' Shafts

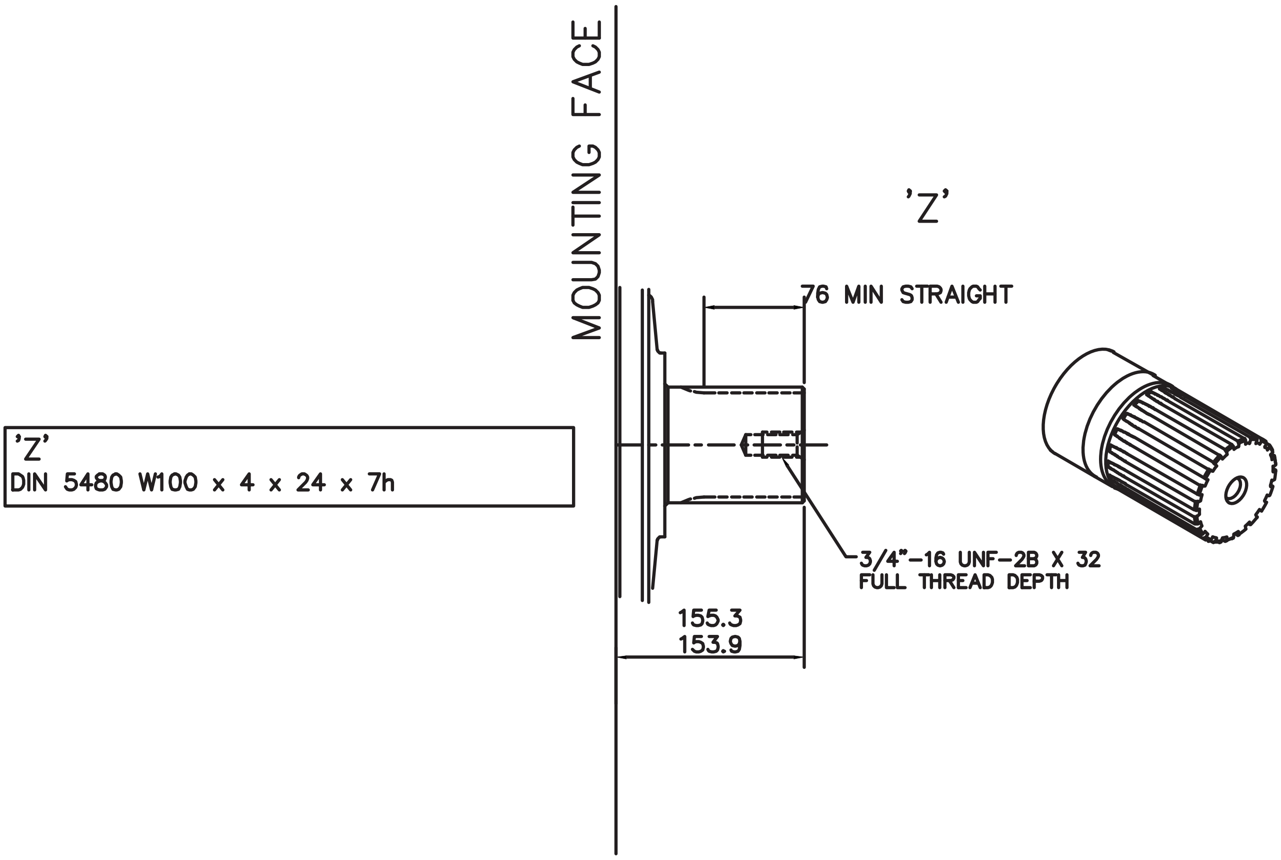


SPLINE DATA

'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.653/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.625
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

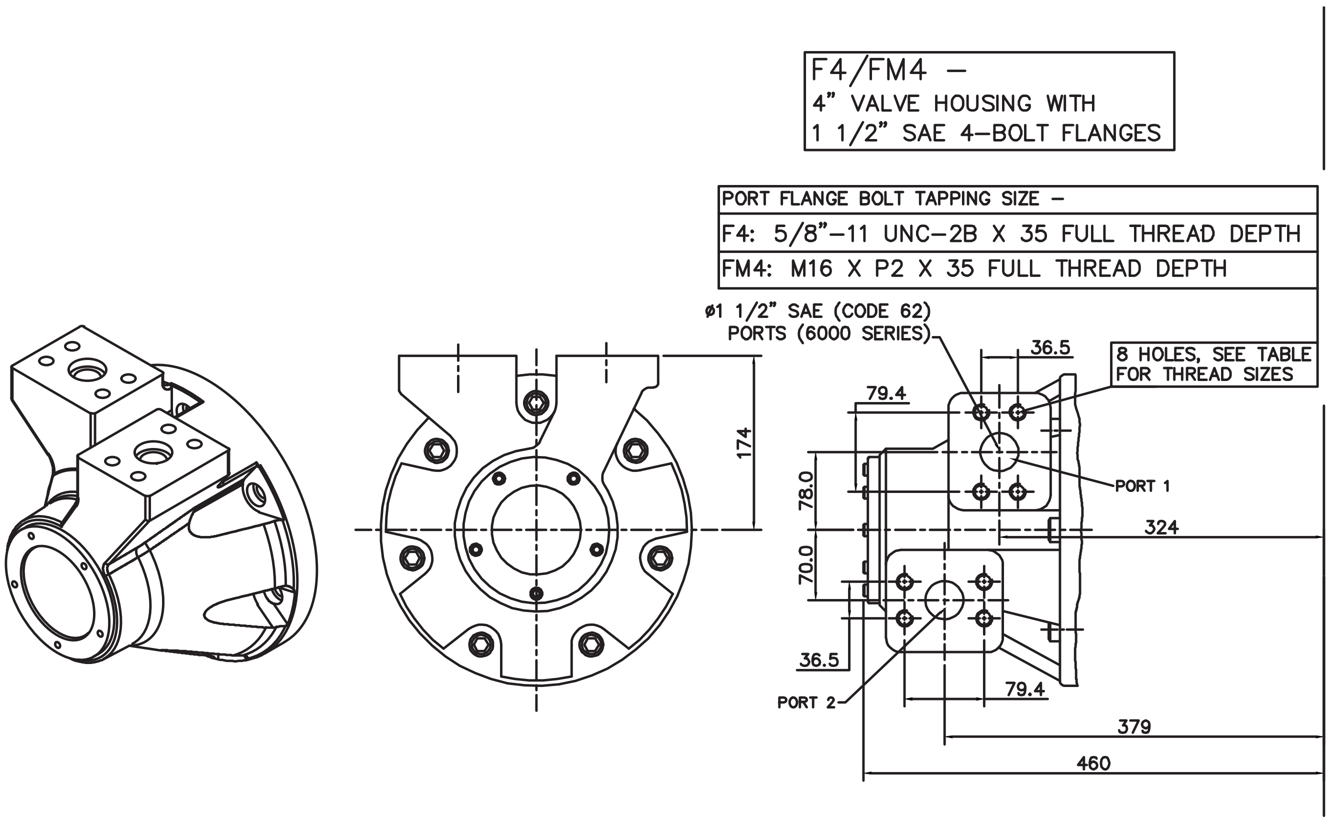
3-8 HM(HD)B270 (cont)

HMHDB270 - 'Z' Shaft



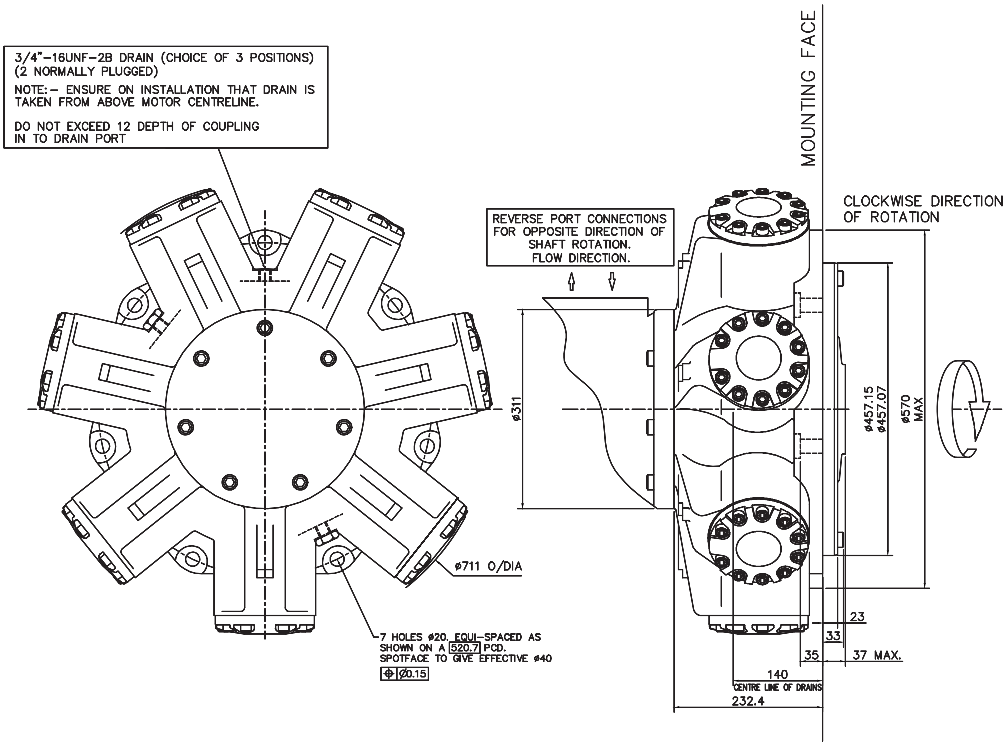
3-8 HM(HD)B270 (cont)

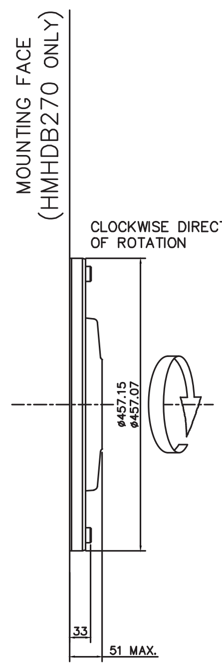
'F4' & 'FM4' Valve Housings



3-8 HM(HD)B270 (cont)

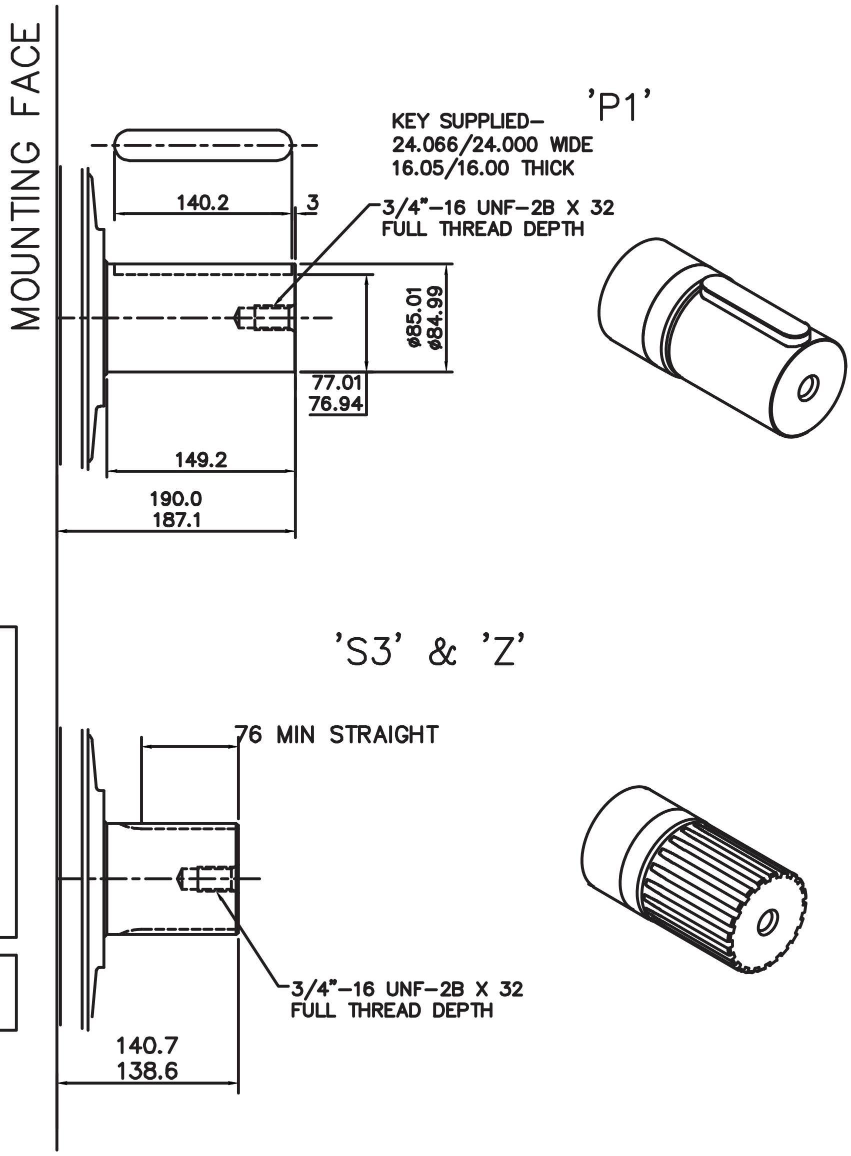
Installation





3-9 HM(HD)B325

HMB325 - 'P1', 'S3' & 'Z' Shafts



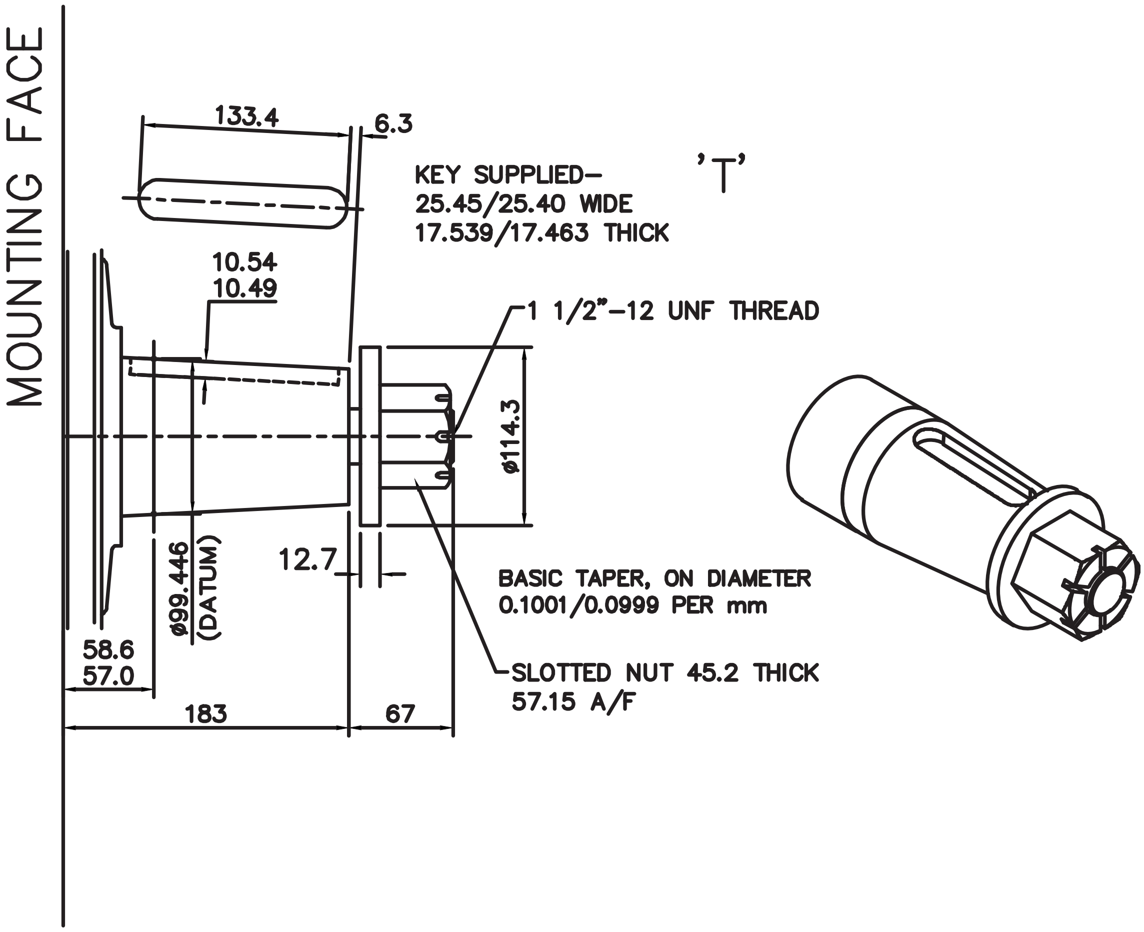
SPLINE DATA

'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z'
DIN 5480 W100 x 4 x 24 x 7h

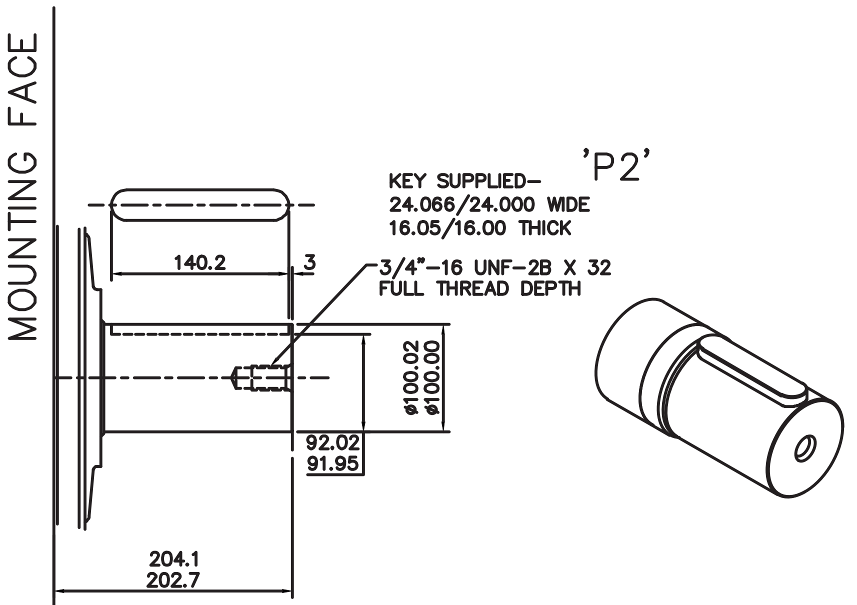
3-9 HM(HD)B325 (cont)

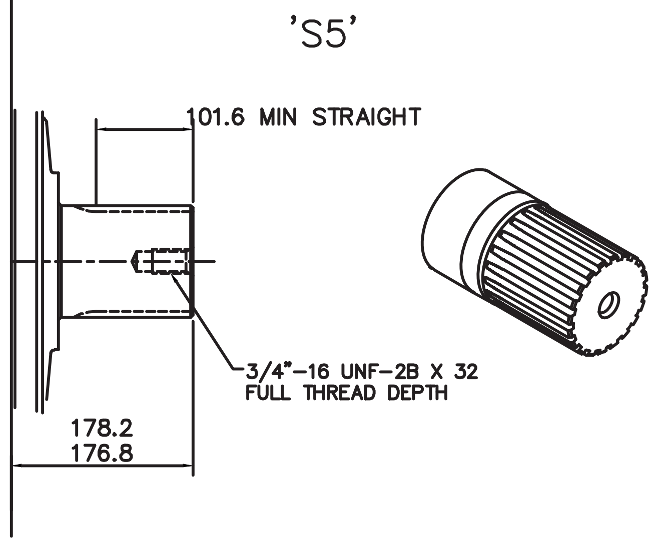
HMB325 - 'T' Shaft



3-9 HM(HD)B325 (cont)

HMHDB325 - 'P2' & 'S5' Shafts



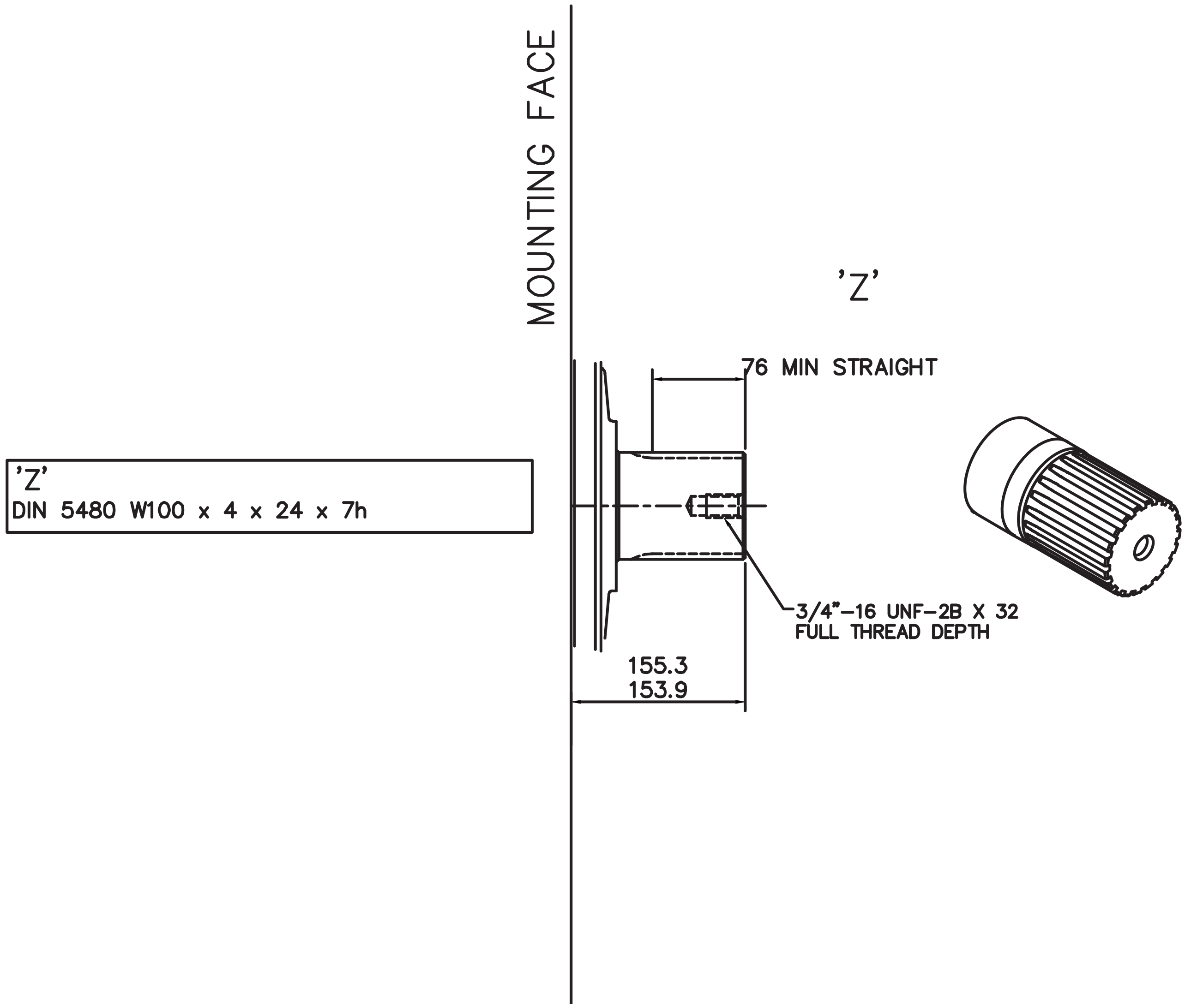


SPLINE DATA

'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.653/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.625
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

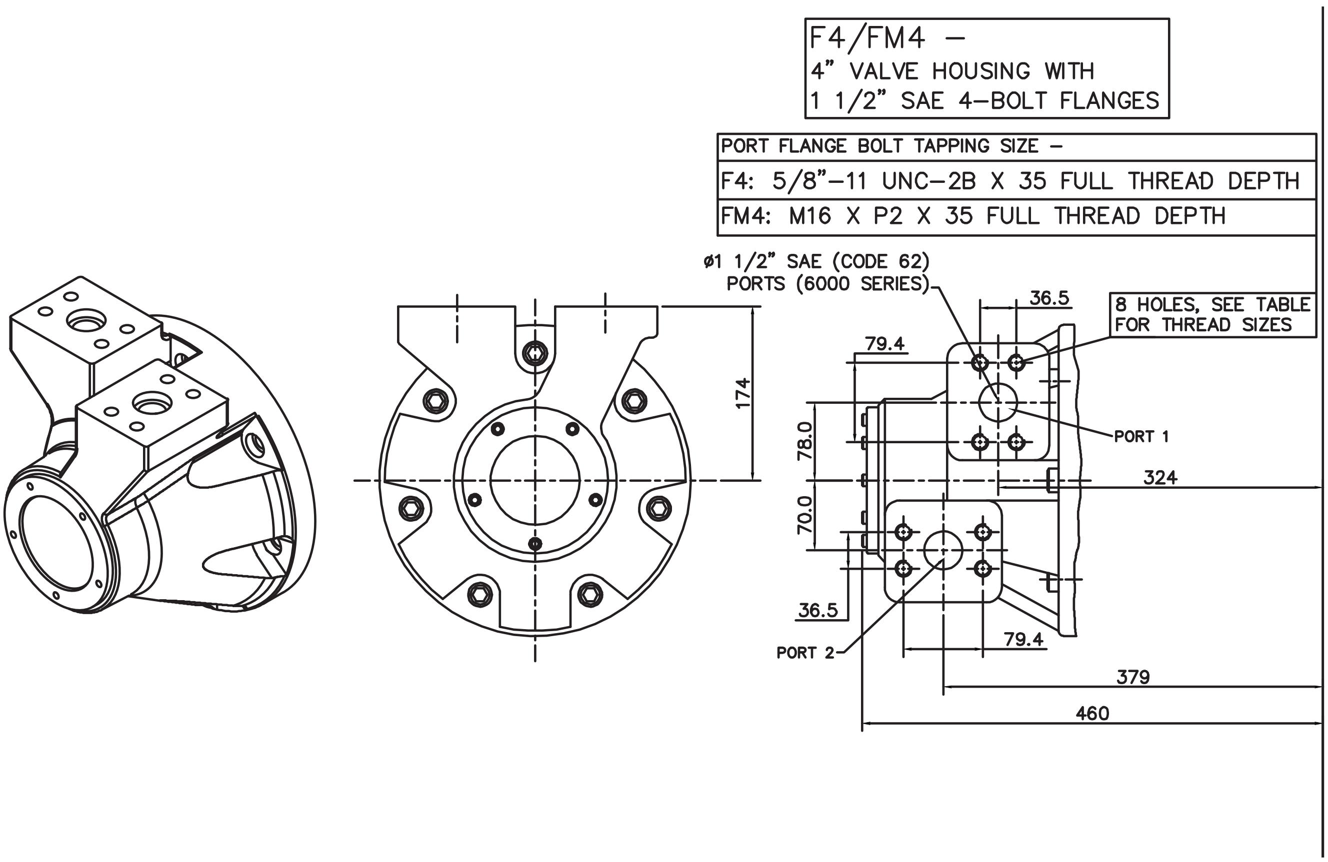
3-9 HM(HD)B325 (cont)

HMHDB325 - 'Z' Shaft



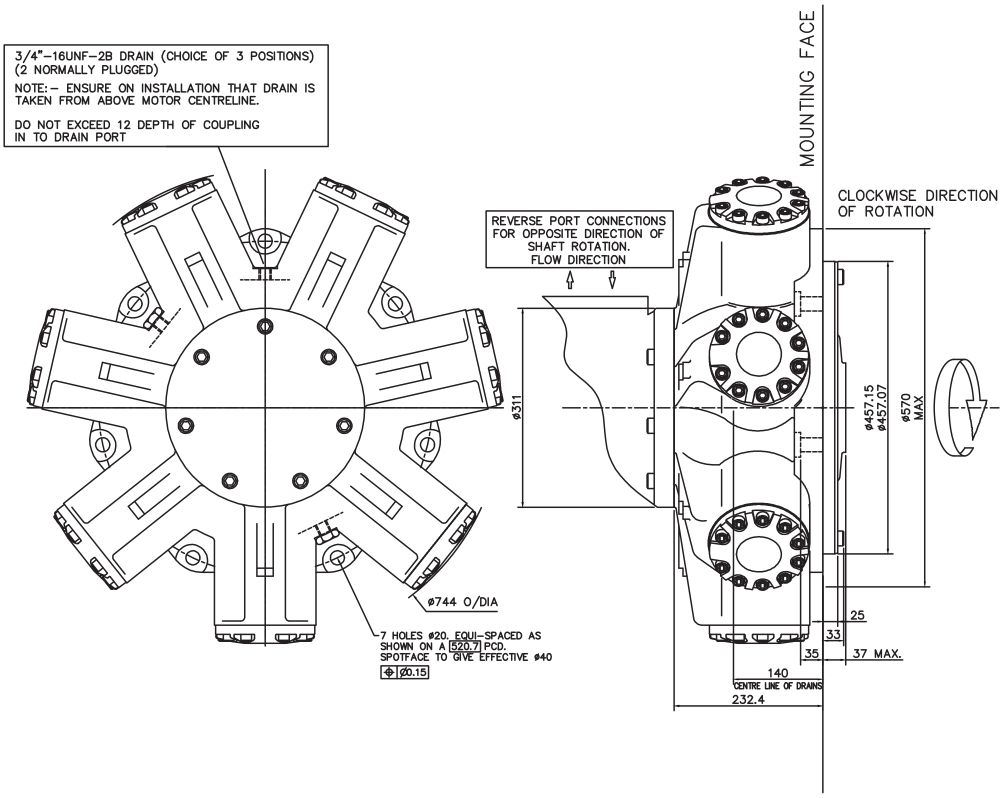
3-9 HM(HD)B325 (cont)

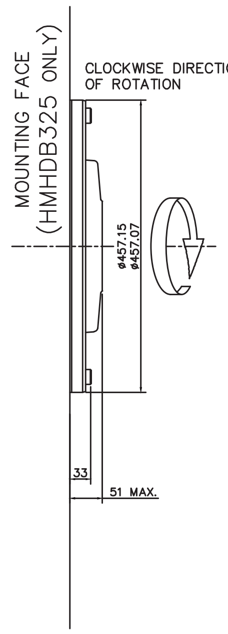
'F4' & 'FM4' Valve Housings



3-9 HM(HD)B325 (cont)

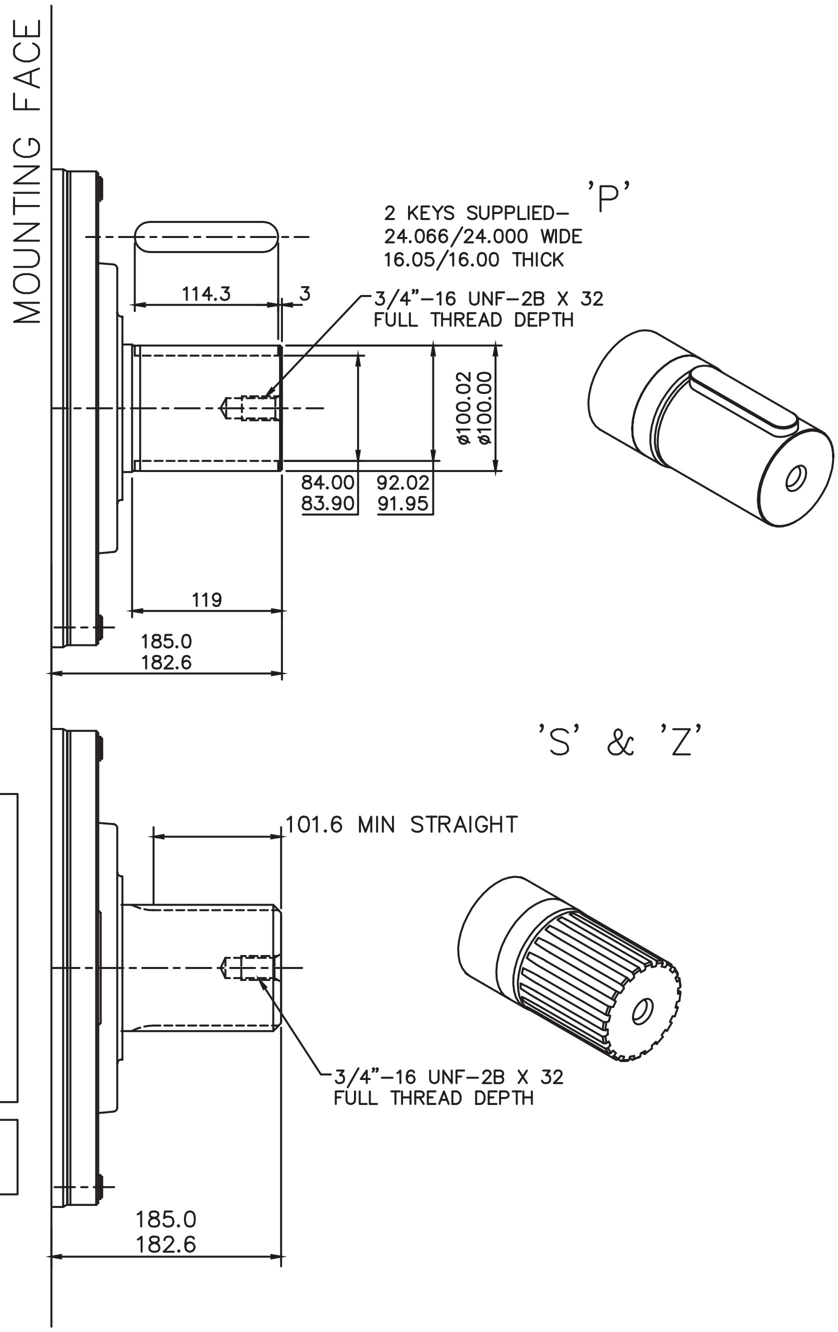
Installation





3-10 HMHDB400

'P', 'S' & 'Z' Shafts



SPLINE DATA

'S'

TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

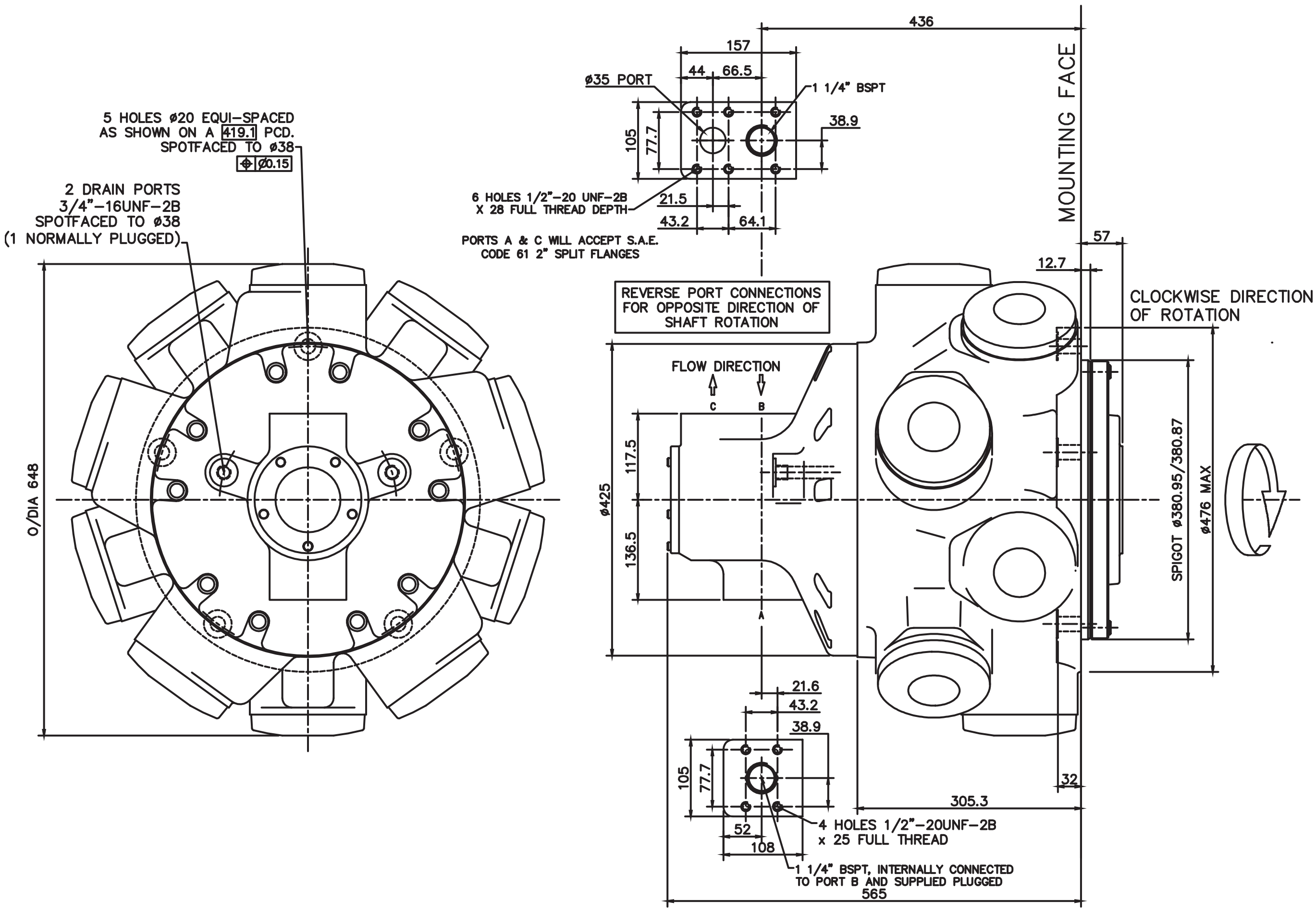
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.653/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.625
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

'Z'

DIN 5480 W100 x 4 x 24 x 7h

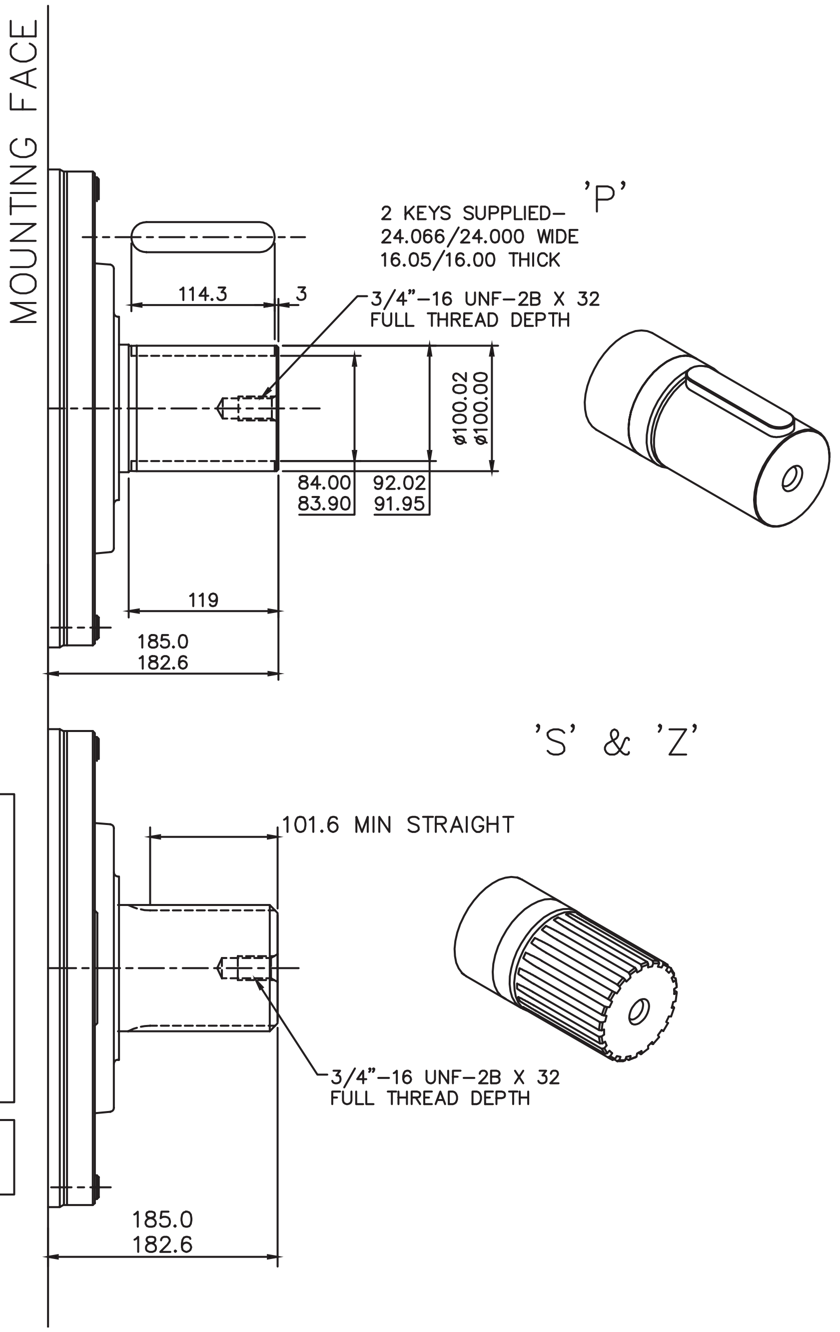
3-10 HMHDB400 (cont)

Installation



3-11 HMB500

'P', 'S' & 'Z' Shafts



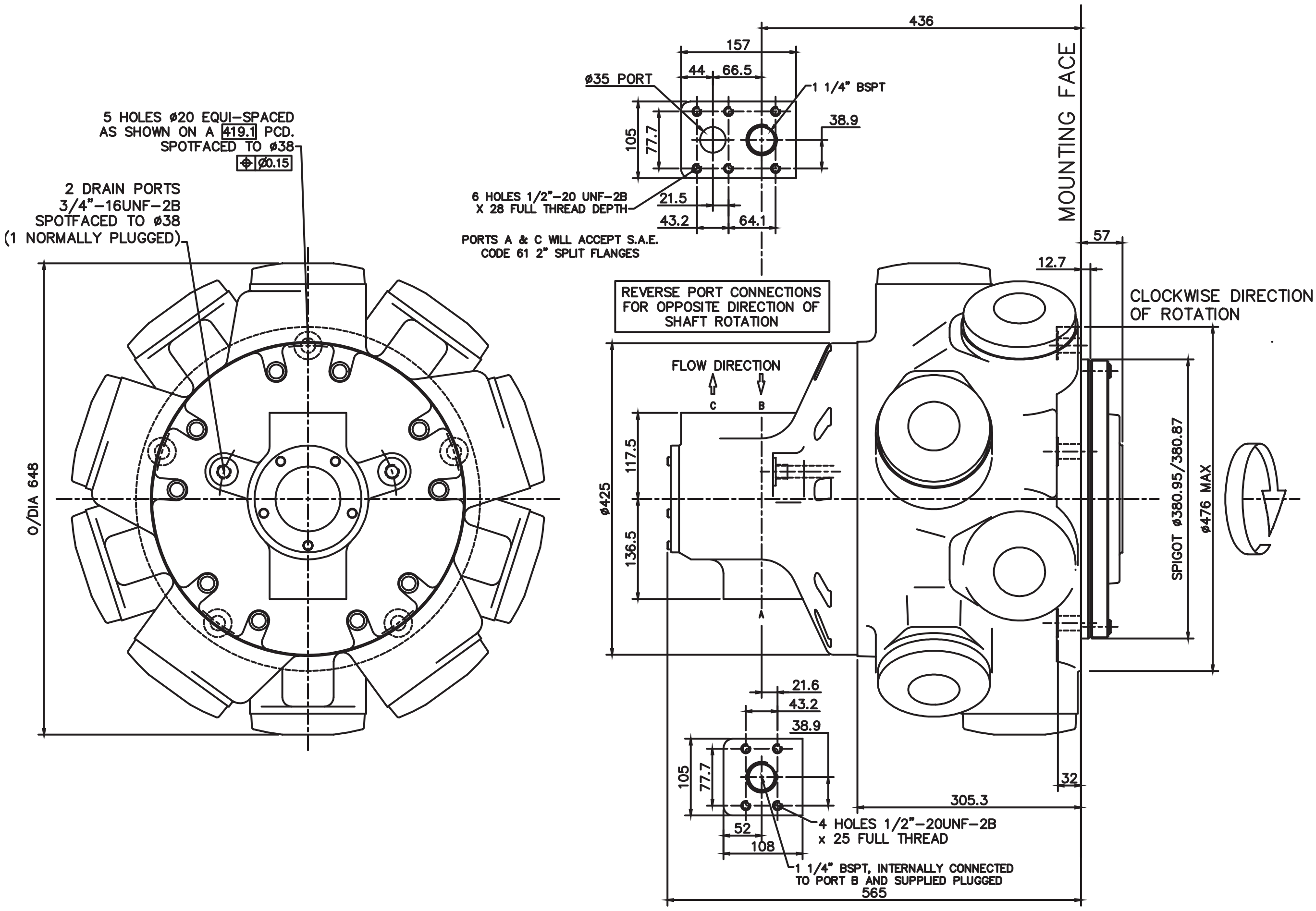
SPLINE DATA

'S'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.653/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.625
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

'Z'
DIN 5480 W100 x 4 x 24 x 7h

3-11 HMB500 (cont)

Installation



NOTES

Conversion Table

Pressure	
bar	PSI
1	14.5
Flow	
l/min	gal/min
1	0.264 US
1	0.219 UK
Length	
mm	inch
25.4	1
Torque	
Nm	lbf ft
1	1.737
Power	
kW	hp
1	1.341
Mass	
kg	lb
1	2.2

NOTES

NOTES

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Tel: +82-55-286-5551
Website: www.flutek.co.kr

The specified data is for product description purposes only and may not be deemed to be guaranteed unless expressly confirmed in the contract.

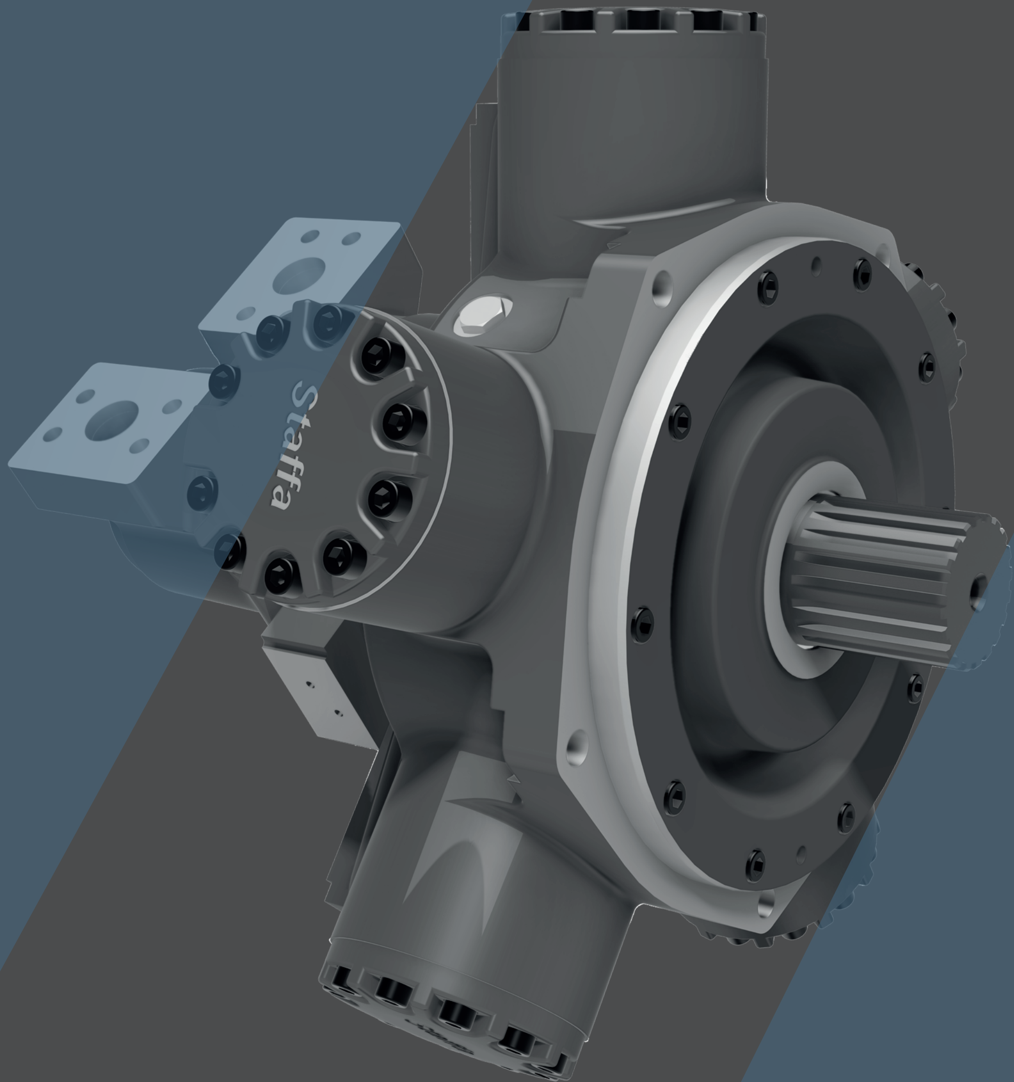
Data sheet: M-10.18

Kawasaki
Powering your potential

Precision Machinery Company

Dual Displacement Radial Piston Staffa Motor

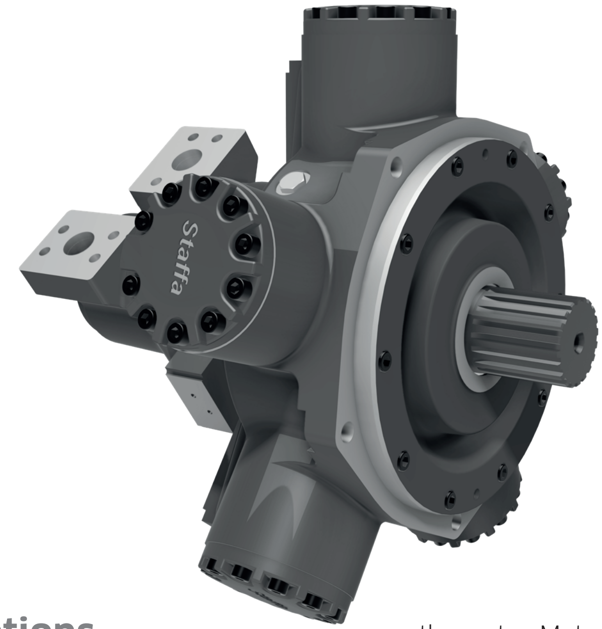
HMC Series



CONTENTS

HMC Series

Dual Displacement Radial Piston Hydraulic Motor



General Descriptions

The range of dual displacement motors extends from the HMC030 in 492 cc/rev to the HMC325 in 5,326 cc/rev.

There are seven frame sizes as shown in the table below:

Motor Type	Max. Torque @275 bar (Nm)	Continuous shaft power (kW)
HMC030	1,655**	60
HMC045	2,930	99
HMC080	6,560	138
HMC125	8,220	135
HMC200	12,820	174
HMC270	19,090	189
HMC325	22,110	189

*** torque calculated at 241 bar*

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 mounted or directly on the motor. Motor displacement can be changed with ease when the motor is running.

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.

Features

High torque at low speed

Smooth running

Wide range of displacements to suit specific applications

Displacement changes with ease when the motor is running

Electro-hydraulic or hydro-mechanical control methods available

Speed sensing options

1 Ordering Code

1-1 Model Coding

F11/HMC270 / S3 V/250/100/FM4/CS/Tj/ * / P*****

Fluid Type

Blank	Mineral oil
F3	Phosphate ester (HFD fluid)
F11	Water based fluids (HFA, HFB & HFC)
Alternative fluids contact Kawasaki	

Motor Frame Size

030	125	270
045	200	325
080		

Shaft Type

See shaft type option list on Page 6

Shaft Orientation

Blank	Standard Orientation
V	Vertically Up

High Displacement Code

###	See displacement code details on pages 21 to 28

Low Displacement Code

###	See displacement code details on pages 21 to 28

Special Features

P*****	See options on page 5.
PL***	Non-catalogued features, (*****) = number assigned by Kawasaki as required

Design Series Number

Current series for HMC motors

Tacho Encoder Drive

Blank	None
Tj	Square wave output with directional signal
Tk	Combines Tj with the T401 instrument to give a 4 to 20 mA output proportional to speed. Directional signal and speed relay output.

Displacement Control Ports

Threaded ports/ bi directional shaft rotation	
X	X and Y ports G¼˝ (BSPF to ISO 228/1)

ISO 4401 size 03 mounting face / bi-directional shaft rotation	
C	No shuttle
CS	With shuttle

ISO4401 size 03 mount with Additional Regulation	
CP18	Constant Pressure Regulator set to 180 bar
CHP18	Constant Pressure Regulator set to 180 bar with override valve attached
See pages 25 for further details Please state CP valve setting when placing order and note that maximum setting is 220 bar (ie CP22)	

Main Port Connections

See Port Connection details on page 7

1-1 Model Coding

Special Features Suffix

/ P * * * * *

Shaft Seal Enhancements

A	High pressure shaft seal
B	Improved shaft seal life
C	High pressure shaft seal & improved shaft seal life
0	None

External Protection

A	Anti-pooling bolt heads
B	Marine-specification primer paint
C	Anti-pooling bolt heads & Marine-specification primer paint
0	None

Installation Features

A	Drain port adaptor x 1
B	Drain port adaptor x 2
C	Φ21 mm mounting holes
D	Φ22 mm mounting holes
E	Φ21 mm mounting holes & Drain port adaptor x 1
F	Φ21 mm mounting holes & Drain port adaptor x 2
G	Φ22 mm mounting holes & Drain port adaptor x 1
H	Φ22 mm mounting holes & Drain port adaptor x 2
0	None

Performance Enhancements

A	Increased starting torque
0	None

Valve Enhancements

A	Improved cavitation resistance
B	Anti-clockwise
C	Thermal shock resistance
D	Improved caviation resistance & anti-clockwise
E	Improved cavitation resistance & thermal shock resistance
F	Anti-clockwise & thermal shock resistance
G	Improved cavitation resistance & anti-clockwise & thermal shock resistance
0	None

1-2 Shaft Options

Product type

HMC030

P	=	Parallel keyed 55mm diameter shaft
S	=	Splined shaft 17 teeth BS3550
Z	=	Splined shaft DIN5480 (W55x3x17x7h)
Z2	=	Splined shaft DIN5480 (W60x3x18x7h)

HMC045

P	=	Parallel keyed 55mm diameter shaft
S	=	Splined shaft 17 teeth BS3550
Z	=	Splined shaft DIN5480 (W55x3x17x7h)
Z2	=	Splined shaft DIN5480 (W60x3x18x7h)

HMC080

P	=	Parallel keyed 60mm diameter shaft
S	=	Splined shaft 14 teeth BS3550
Z	=	Splined shaft DIN5480 (W70x3x22x7h)
T	=	Long taper keyed shaft - 95.2 key slot

HMC125 & HMC200

P1	=	Parallel keyed 85mm diameter shaft
S3	=	Splined shaft 20 teeth BS3550
S4	=	Splined shaft 16 teeth BS3550
Z3	=	Splined shaft DIN5480 (W85x3x27x7h)
T	=	Long taper keyed shaft - 133.4 key slot

HMC270 & HMC325

P1	=	Parallel keyed 85mm diameter shaft
S3	=	Splined shaft 20 teeth BS3550
Z4	=	Splined shaft DIN5480 (W90x4x21x7h)
T	=	Long taper keyed shaft - 133.4 key slot

Note:
For installations where the shaft is vertically upwards specify “V” after the shaft type designator so as to ensure that an additional high level drain port is provided within the front cover of the motor.

1-3 Main Port Connections

Product type

HMC030	=	As per HMC045
HMC045		
SM3	=	1¼” symmetrical ports with through-holes for manifold connection
F3	=	1¼" SAE 4-bolt flange
FM3	=	1¼" SAE 4-bolt flange
HMC080		
SM3	=	1¼” symmetrical ports with through-holes for manifold connection
F3	=	1¼" SAE 4-bolt flange
FM3	=	1¼" SAE 4-bolt flange
F4	=	SAE 1½" 4-bolt UNC flanges
FM4	=	SAE 4-bolt metric flanges
HMC125		
SM3	=	1¼” symmetrical ports with through-holes for manifold connection
F3	=	1¼" SAE 4-bolt flange
FM3	=	1¼" SAE 4-bolt flange
F4	=	SAE 1½" 4-bolt UNC flanges
FM4	=	SAE 4-bolt metric flanges
HMC200		
SM3	=	1¼” symmetrical ports with through-holes for manifold connection
F3	=	1¼" SAE 4-bolt flange
FM3	=	1¼" SAE 4-bolt flange
F4	=	SAE 1½" 4-bolt UNC flanges
FM4	=	SAE 4-bolt metric flanges
HMC270		
F4	=	1½" SAE code 62 4-bolt flange
FM4	=	1½" SAE code 62 4-bolt flange
HMC325		
F4	=	1½" SAE code 62 4-bolt flange
FM4	=	1½" SAE code 62 4-bolt flange

See pages 42 to 80 for full dimensionsal details

1-4 Special Features

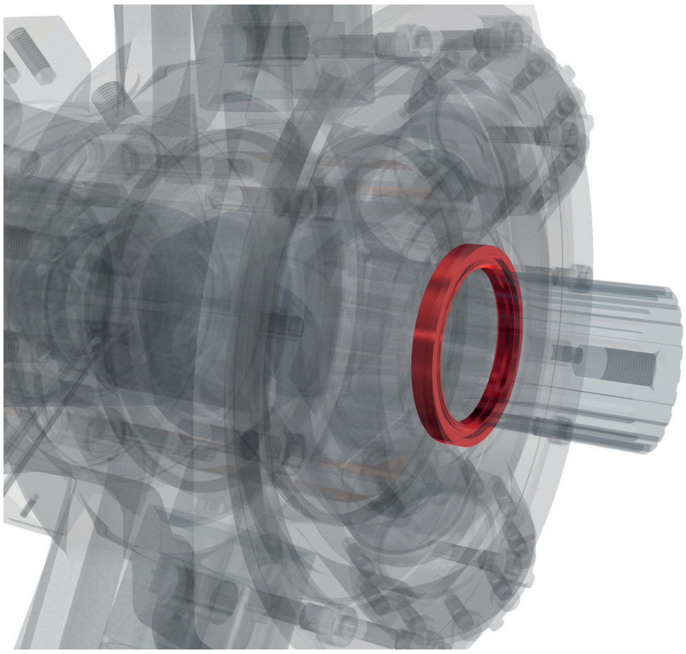
Feature	Page	HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
High Pressure Shaft Seal	9	●	●	●	●	●	●	●
Improved Shaft Seal Life	10	●	●	●	●	●	●	●
Improved Cavitation Resistance	11	●	●	●	●	●	●	●
Anti-pooling Bolt Heads	12	●	●	●	●	●	●	●
Increased Starting Torque	13	●	●	●	●	●	●	●
Anti-clockwise Rotation	15	●	●	●	●	●	●	●
Thermal Shock Resistance	16	●	●	●	●	●	●	●
Drain Port Adaptor - ½" BSPP	18	●	●	●	●	●	●	●
Φ21mm Mounting Holes	19	○	○	●	●	●	●	●
Φ22mm Mounting Holes	19	○	○	●	●	●	●	●
Marine-specification Primer Paint	20	●	●	●	●	●	●	●

● Available
○ Not available

If a motor is to be ordered with any special features listed, please contact Kawasaki.

1-4 Special Features

High Pressure Shaft Seal



Description:

> 10 bar rated

> Recommended for cold climates

> Rugged steel and PTFE construction

Technical Information

Where crankcase pressure will be higher than 3.5 bar, the high pressure shaft seal should be selected.

Case pressure	≤ 10 bar
Non-operating temperature limits	Below -30°C and above 120°C
Minimum operating temperature	-15°C
Maximum operating temperature	80°C
Minimum viscosity	2,000 cSt
Maximum viscosity	150 cSt

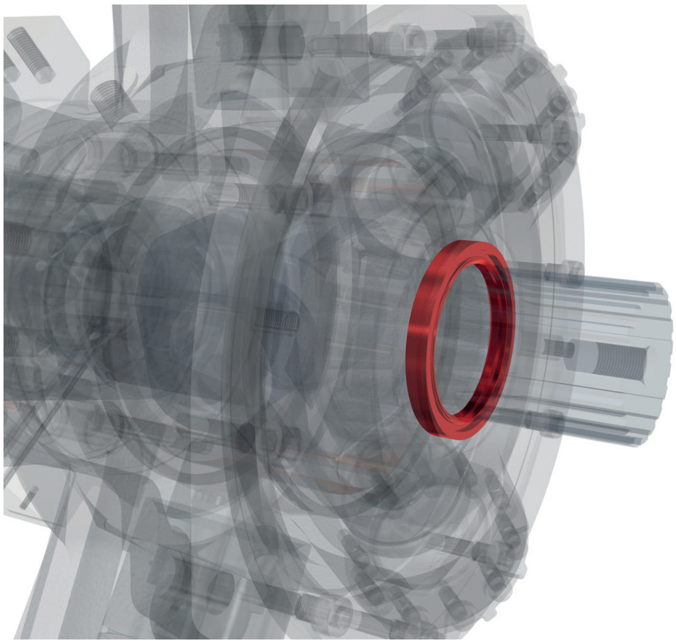
Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Improved Shaft Seal Life



Description:

- **> Stainless steel sleeve prevents corrosion**
- **> Improved wear resistance**
- **> Recommended for corrosive environments**

Technical Information

A well-established method of increasing rotary seal life in corrosive environments is to fit a thin-walled, stainless steel sleeve to the rotating shaft to provide a corrosion-resistant, wear-resistant counterface surface for the seal to run against. All HMC motors can be fitted with such sleeves upon request.

Sleeve material	A304/301 Stainless Steel
Sleeve surface finish	R_a 0.25 to 0.5 µm (10 to 20 µin)

Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

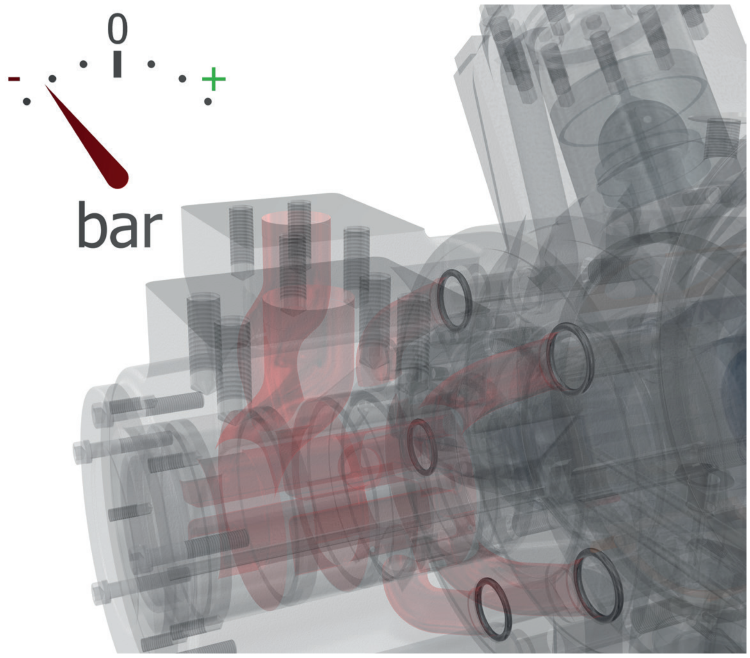
1-4 Special Features

Improved Cavitation Resistance

Description:

> Recommended for overunning applications

> Protects against seal damage for short periods of operation in vacuum inlet conditions.



Cavitation can occur due to many different factors. Although it is not possible to make the HMC motor resistant to cavitation, certain features can be added to improve the motor's resistance to short periods of lost port pressure.

In applications where the HMC motor can be driven (like a pump) a risk arises that insufficient fluid will be provided to maintain a positive pressure at both main ports of the motor causing cavitation. The results of extended running at these conditions can be catastrophic to the motor's function.

The improved cavitation resistance feature should be considered where:

- Overrunning conditions may occur (load driving the motor)
- Loss of main port pressure while motor is rotating

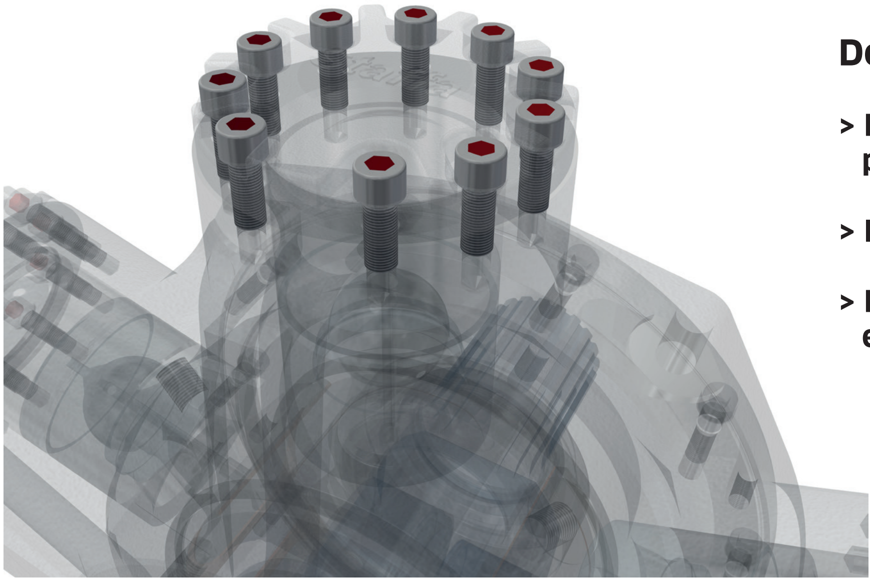
Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Anti-pooling Bolt Heads



Description:

- **> Removes potential for water pooling**
- **> Improved corrosion resistance**
- **> Recommended for marine environments**

Technical Information

In many marine applications, water pooling in socket head cap screw heads presents a significant corrosion risk. Corroded cap screws can make service and repair of affected units impossible.

To significantly reduce the risk of water damage through pooling, HMC motors can be supplied with silicone filler in all the bolt heads.

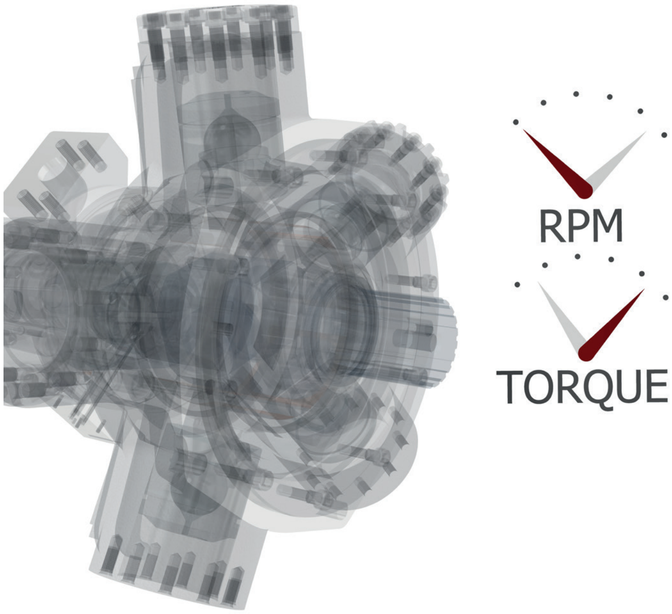
Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Increased Starting Torque



Description:

> **Optimised for high break-out torque**

> **Recommended for low speed operation**

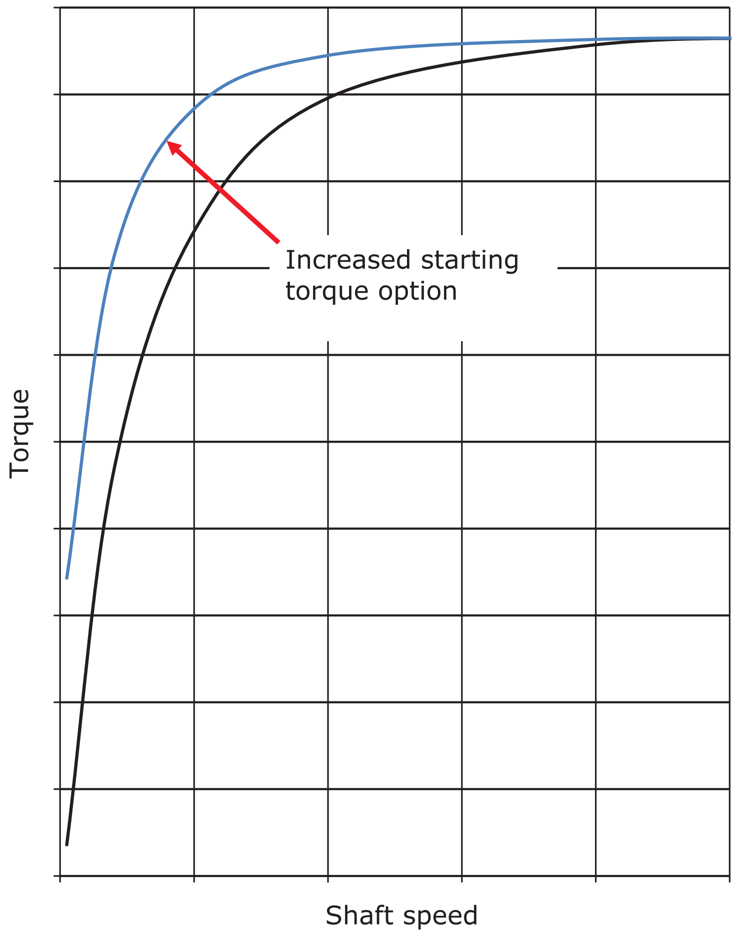
> **Improved service life for low speed applications**

Technical Information

If an application demands the drive motor be run at speeds of less than 10 rpm for most of the duty cycle, or involves frequent start/stop or forward/reverse operation, the Staffa HMC motor range has it covered.

By optimising the HMC motor's design for low speeds, it is possible to increase the break out torque and low speed mechanical efficiency performance.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.



1-4 Special Features

Increased Starting Torque (cont)

Volumetric Performance

In order to achieve increased torque at low speeds the volumetric characteristics of the motor performance are changed.

When calculating leakage and volumetric efficiency use the constants shown here in place of those given for the standard motor on page 29.

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HMC030	492	11.66	*	17.42	10.26
HMC045	737	13.36	47.80	12.26	10.76
HMC080	1,639	16.26	45.70	9.65	14.66
HMC125	2,048	12.86	38.50	4.55	11.01
HMC200	3,087	12.86	38.50	3.02	11.01
HMC270	4,588	13.26	37.30	2.41	12.76
HMC325	5,326	13.26	40.00	2.08	12.76

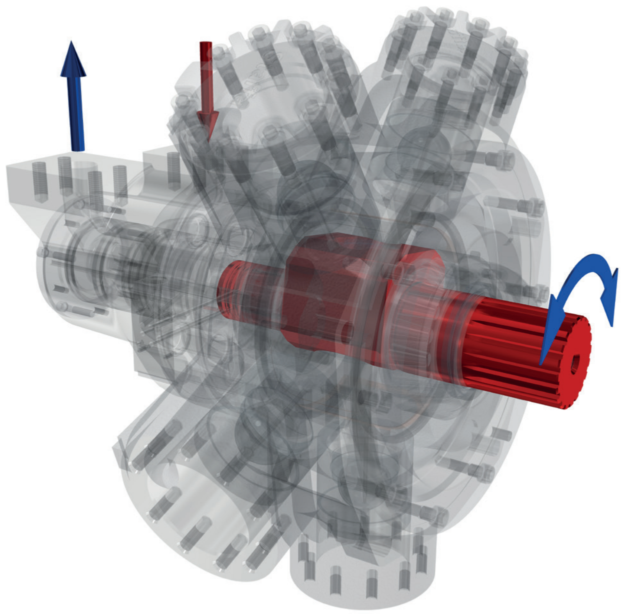
Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Anti-Clockwise Rotation



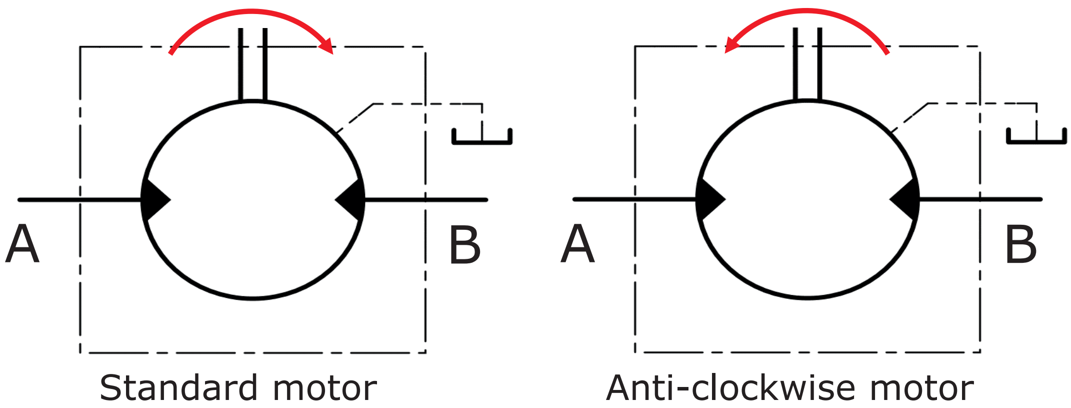
Description:

> Reduce installation complexity

> Standardise equipment designs

Technical Information

All HMC motors can be specified with an anti-clockwise rotation valve configuration. All performance and volumetric characteristics remain unchanged.



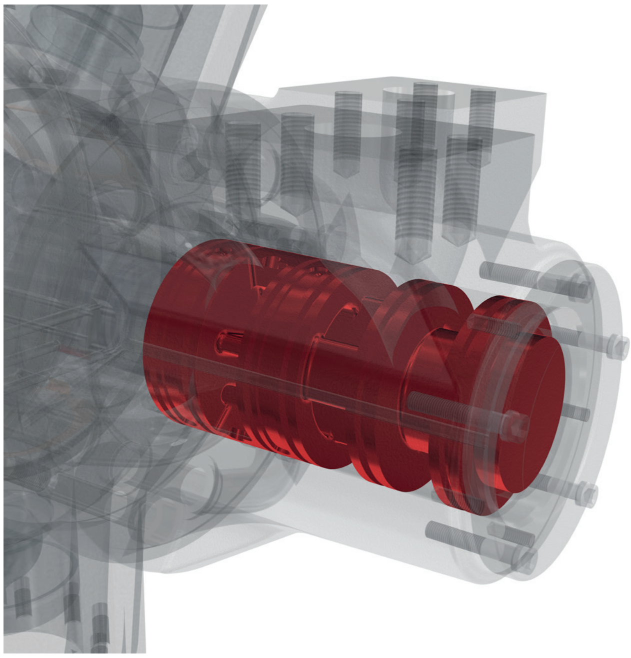
Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Thermal Shock Resistance



Description:

> Recommended for cold climates

> Optimised for start-up in freezing temperatures

> Engineered for total peace of mind

Technical Information

Starting up a cold system with warm hydraulic fluid is a known cause of heavy wear and potential seizure of hydraulic machinery. To minimise this potential risk, the HMC motor can be configured to combat thermal shocks to give complete peace of mind when operating in very cold climates.

Volumetric Performance

In order to provide thermal shock resistance the volumetric characteristics of the motor performance are changed. When calculating leakage and volumetric efficiency use the constants shown on the next page in place of those given for the standard motor on page 29.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.

Note:
When operating at low temperature, consideration must be given to the guidance notes in Section 2-8 Motor Operation at Low Temperature (see page 37).

1-4 Special Features

Thermal Shock Resistance (cont)

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HMC080	1,639	11.10	45.70	6.99	7.90
HMC125	2,048	7.70	38.50	3.78	4.25
HMC200	3,087	7.98	38.50	2.61	4.25
HMC270	4,588	8.38	37.30	1.91	6.00
HMC325	5,326	8.38	40.00	1.65	6.00

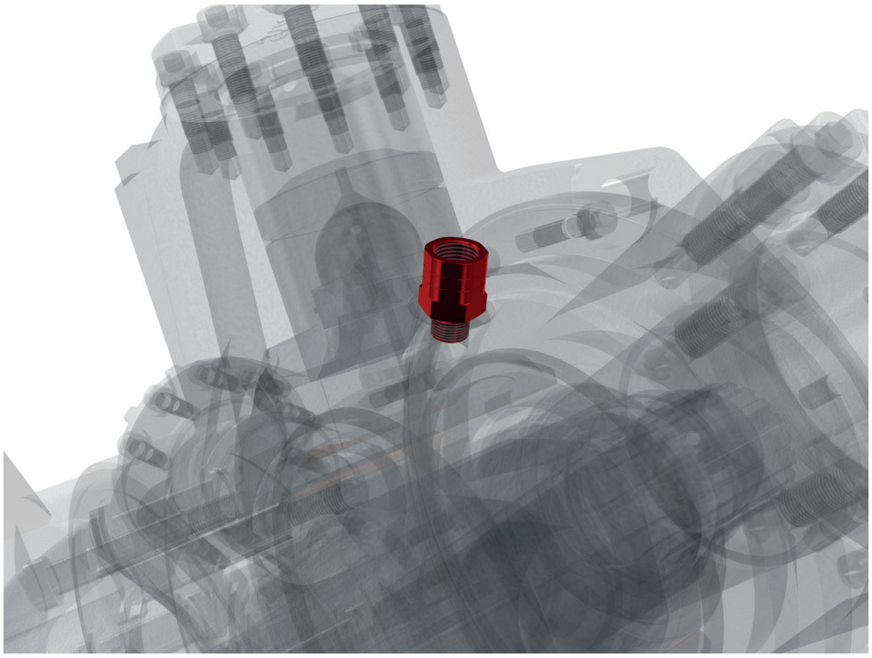
Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Drain Port Adaptors



Description:

> **Improves manufacturing logistics**

> **Motor supplied ready for connection to 1½" BSPP male fitting**

Technical Information

Motor Type	Adaptor Supplied
HMC030	¾" UNF 2B to ½" BSPP
HMC045	¾" UNF 2B to ½" BSPP
HMC080	¾" UNF 2B to ½" BSPP
HM(HD)C125	¾" UNF 2B to ½" BSPP
HM(HD)C200	¾" UNF 2B to ½" BSPP
HM(HD)C270	¾" UNF 2B to ½" BSPP
HM(HD)C325	¾" UNF 2B to ½" BSPP

One or two drain adaptors can be supplied.

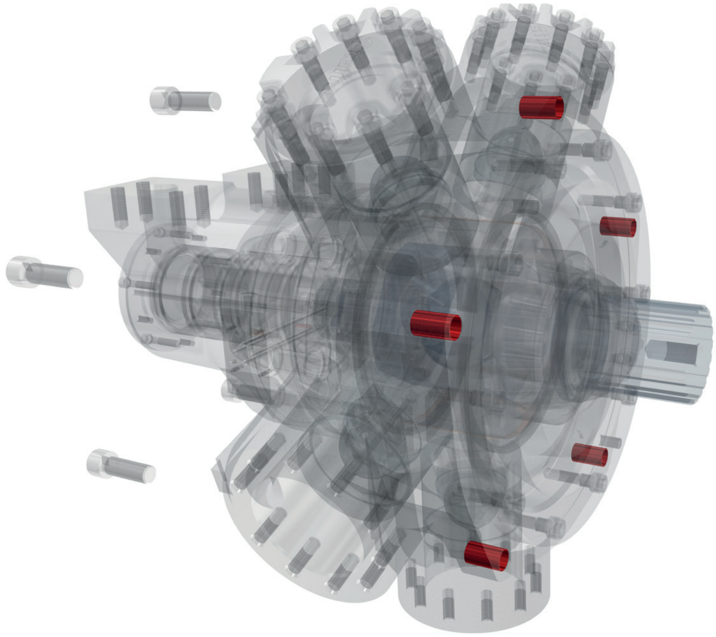
Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Mounting Hole Diameter

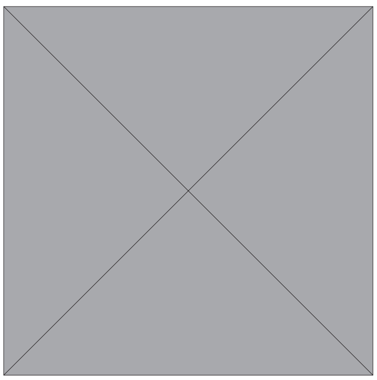


Description:

- > **Matching mounting holes to bolts**
- > **Φ21mm and Φ22mm options available**

Technical Information

In different markets, different bolt standards are adopted which may not be best suited to the standard Φ20 mm mounting hole diameter on the HMC motors. To give a correct fit and optimum installation, Φ21 mm or Φ22 mm holes can be selected on larger frame sizes.



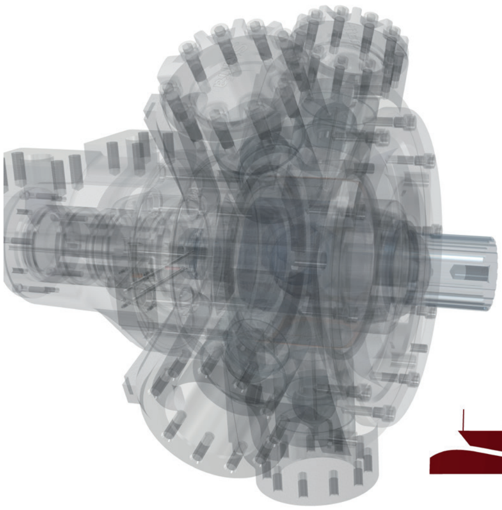
Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
○	○	●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Marine Specification Primer Paint



Description:

> **Improves corrosion and water resistance of the finishing system**

> **Excellent adhesion strength**

> **Recommended for marine applications**

Technical Information

Colour	Red oxide
Type	Single pack epoxy etching primer
Standard	BS 3900 part A 8
Dry film thickness	> 12 μm

Applicable to:

HMC030	HMC045	HMC080	HMC125	HMC200	HMC270	HMC325
●	●	●	●	●	●	●

Please contact Kawasaki to order this feature.

2-1 Performance Data

Performance data is valid for the range of HMC motors when fully run-in and operating with mineral oil.

The appropriate motor displacements can be selected using performance data shown on pages 22 to 28. Refer to the table on this page for pressures and speed limits when using fire-resistant fluids.

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

Intermittent max pressure: 275 bar.

This pressure is allowable on the following basis:

a) Up to 50 rpm 15% duty for periods up to 5 minutes maximum.
b) Over 50 rpm 2% duty for periods up to 30 seconds maximum.

Static pressure to DNV rules 380 bar.

Intermittent power rating

This is permitted on a 15% duty basis for periods upto 5 minutes maximum.

Limits for fire resistant fluids

Fluid Type	Continuous Pressure (bar)	Intermittent Pressure (bar)	Max Speed (rpm)	Model Type
HFA 5/95 oil-in-water emulsion	130	138	50% of limits of mineral oil	All models
HFB 60/40 water-in-oil emulsion	138	172	As for mineral oil	All models
HFC water glycol	103	138	50% of limits of mineral oil	All models
HFD phosphate ester	250	293	As for mineral oil	All models

2-1 Performance Data (cont)

HMC030 Motor (see page 30 for power calculation limits)

Displacement Code		30	27	24	21	18	15
Displacement	cc/rev	492	442	393	344	295	246
Average actual running torque	Nm/bar	6.86	6.08	5.3	4.59	3.88	3.2
Average actual mechanical efficiency	%	87.6	86.4	84.7	83.8	82.6	81.7
Average actual starting efficiency	%	82.8	81.4	79.6	77.1	73.9	69.3
Max continuous speed	rpm	450	500	525	550	575	600
Max continuous power	kW	60	60	55	49	42	35
Max intermittent power	kW	66	66	61	55	48	41
Max continuous pressure	bar	207	207	207	207	207	207
Max intermittent pressure	bar	241	241	241	241	241	241

Displacement Code		12	09	06	03	00	00
Displacement	cc/rev	197	147	98	49	0	0
Average actual running torque	Nm/bar	2.51	1.83	1.15	0.44	0	0
Average actual mechanical efficiency	%	80.1	78.2	73.7	56.4	0	0
Average actual starting efficiency	%	62.6	51.6	29.1	/	/	/
Max continuous speed	rpm	600	600	600	600	1,000	1,500**
Max continuous power	kW	27	20	10	0	0	0
Max intermittent power	kW	32	24	13	0	0	0
Max continuous pressure	bar	207	207	207	17*	17*	17*
Max intermittent pressure	bar	241	241	241	17*	17*	17*

Data shown is at 207 bar. Intermediate displacements can be made available to special order.

** See page 34: small displacements.*

*** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HMC045 Motor (see page 30 for power calculation limits)

Displacement Code		45	40	35	30	25	20
Displacement	cc/rev	737	655	573	492	410	328
Average actual running torque	Nm/bar	10.63	9.4	8.04	6.88	5.68	4.4
Average actual mechanical efficiency	%	90.6	90.2	88.2	87.9	87.0	84.3
Average actual starting efficiency	%	84.5	83.0	81.1	78.4	74.9	69.5
Max continuous speed	rpm	450	550	600	600	600	600
Max continuous power	kW	99	89	79	67	54	42
Max intermittent power	kW	119	107	95	80	65	50
Max continuous pressure	bar	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275

Displacement Code		15	10	5	00	00
Displacement	cc/rev	246	163	81	0	0
Average actual running torque	Nm/bar	3.2	1.55	0	0	0
Average actual mechanical efficiency	%	81.7	59.7	0	0	0
Average actual starting efficiency	%	60.6	43.0	/	/	/
Max continuous speed	rpm	600	600	1,000	1,000	1,500**
Max continuous power	kW	30	15	0	0	0
Max intermittent power	kW	36	18	0	0	0
Max continuous pressure	bar	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 34: small displacements.*

*** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HMC080 Motor (see page 30 for power calculation limits)

Displacement Code		97.6	90	85	80	75	70	65	60	55	50
Displacement	cc/rev	1,600	1,475	1,393	1,311	1,229	1,147	1,065	983	901	819
Average actual running torque	Nm/bar	23.9	22	20.75	19.5	18.25	17.02	15.78	14.55	13.2	12
Average actual mechanical efficiency	%	93.9	93.7	93.6	93.5	93.3	93.2	93.1	93.0	92.1	92.1
Average actual starting efficiency	%	87.1	86.0	85.2	84.3	83.3	80.8	80.8	79.2	77.4	75.1
Max continuous speed (S03/F3/FM3)	rpm	270	300	320	340	365	390	420	450	475	500
Max continuous speed (S04/F4/FM4)	rpm	365	400	415	430	445	460	475	490	500	515
Max continuous power	kW	138	138	134	129	127	123	118	115	110	105
Max intermittent power	kW	170	170	165	159	156	151	145	142	135	129
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275	275

Displacement Code		45	40	35	30	25	20	15	10	5	00	00
Displacement	cc/rev	737	655	574	492	410	328	246	164	82	0	0
Average actual running torque	Nm/bar	10.6	9.24	7.87	6.48	5.31	3.93	2.56	1.57	0	0	0
Average actual mechanical efficiency	%	90.4	88.6	86.1	82.8	81.4	75.3	65.4	60.2	0	0	0
Average actual starting efficiency	%	72.4	69.0	64.4	58.6	50.3	38.0	17.5	/	/	/	/
Max continuous speed (S03/F3/FM3)	rpm	550	600	615	630	630	630	630	630	1,000	1,000	1,500**
Max continuous speed (S04/F4/FM4)	rpm	530	545	560	575	585	600	615	630	1,000	1,000	1,500**
Max continuous power	kW	99	92	79	64	52	38	26	12	0	0	0
Max intermittent power	kW	122	113	97	79	64	47	32	15	0	0	0
Max continuous pressure	bar	250	250	250	250	250	250	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 34: small displacements.*

*** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HMC125 Motor (see page 30 for power calculation limits)

Displacement Code		125	120	110	100	90	80	70	60
Displacement	cc/rev	2,048	1,966	1,802	1,639	1,475	1,311	1,147	983
Average actual running torque	Nm/bar	29.9	28.7	26.3	23.6	21	18.3	15.7	12.8
Average actual mechanical efficiency	%	91.7	91.7	90.5	90.5	89.5	87.7	86.0	81.8
Average actual starting efficiency	%	80.2	79.2	74.3	74.3	71.1	67.0	61.8	54.9
Max continuous speed (S03/F3/FM3)	rpm	215	225	270	270	300	340	390	450
Max continuous speed (S04/F4/FM4)	rpm	300	310	340	365	400	430	460	490
Max continuous power	kW	135	131	122	114	105	98	88	81
Max intermittent power	kW	152	147	137	128	118	110	99	91
Max continuous pressure	bar	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275

Displacement Code		50	40	30	20	10	5	00	00
Displacement	cc/rev	819	655	492	328	164	82	0	0
Average actual running torque	Nm/bar	10.6	8.1	5.9	3.8	0.6	0	0	0
Average actual mechanical efficiency	%	81.3	77.7	75.3	72.8	23.0	0	0	0
Average actual starting efficiency	%	45.2	30.6	/	/	/	/	/	/
Max continuous speed (S03/F3/FM3)	rpm	500	600	630	630	630	1,000	1,000	1,500**
Max continuous speed (S04/F4/FM4)	rpm	515	545	575	600	630	1,000	1,000	1,500**
Max continuous power	kW	72	62	48	24	4	0	0	0
Max intermittent power	kW	81	70	54	33	6	0	0	0
Max continuous pressure	bar	250	250	250	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	275	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 34: small displacements.*

*** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HMC200 Motor (see page 30 for power calculation limits)

Displacement Code		188	180	170	160	150	140	130	120	110	100	90
Displacement	cc/rev	3,087	2,950	2,790	2,620	2,460	2,290	2,130	1,970	1,800	1,639	1,475
Average actual running torque	Nm/bar	46.6	44	39.1	39.1	36.6	34	31.3	28.7	26.3	23.6	21
Average actual mechanical efficiency	%	94.8	93.7	93.9	93.8	93.5	93.3	92.3	91.5	91.8	90.5	89.5
Average actual starting efficiency	%	85.4	84.9	83.9	83.1	81.8	80.7	79.1	77.2	75.4	72.8	69.8
Max continuous speed (S03/F3/FM3)	rpm	175	180	190	195	200	205	210	225	240	270	300
Max continuous speed (S04/F4/FM4)	rpm	230	235	240	245	250	265	285	310	340	365	400
Max continuous power	kW	174	174	174	165	156	148	139	131	122	114	105
Max intermittent power	kW	195	195	195	185	175	166	156	147	137	128	118
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275	275	275

Displacement Code		80	70	60	50	40	30	20	10	5	00	00
Displacement	cc/rev	1,311	1,150	983	820	655	492	328	164	82	0	0
Average actual running torque	Nm/bar	18.3	15.7	12.8	10.6	8.1	5.9	3.8	0.6	0	0	0
Average actual mechanical efficiency	%	87.7	85.8	81.8	81.2	77.7	75.3	72.8	23.0	0	0	0
Average actual starting efficiency	%	66.1	61.1	54.8	45.7	32.1	/	/	/	/	/	/
Max continuous speed (S03/F3/FM3)	rpm	340	390	450	500	600	630	630	630	1,000	1,000	1,500**
Max continuous speed (S04/F4/FM4)	rpm	430	460	485	515	545	575	600	630	1,000	1,000	1,500**
Max continuous power	kW	98	88	81	72	62	48	25	5	0	0	0
Max intermittent power	kW	110	99	91	81	70	54	33	6	0	0	0
Max continuous pressure	bar	250	250	250	250	250	250	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 34: small displacements.*

*** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HMC270 Motor (see page 30 for power calculation limits)

Displacement Code		280	250	220	200	180	160	140	120	100
Displacement	cc/rev	4,588	4,097	3,605	3,277	2,950	2,622	2,294	1,966	1,639
Average actual running torque	Nm/bar	69.4	61.9	53.9	49	43.6	38.3	33.2	27.9	22.4
Average actual mechanical efficiency	%	95.0	94.9	93.9	94.0	92.9	91.8	90.9	89.2	85.9
Average actual starting efficiency	%	84.7	83.8	82.7	81.8	80.6	79.2	77.3	74.9	71.5
Max continuous speed	rpm	150	160	170	175	210	230	275	310	375
Max continuous power	kW	189	176	161	150	139	128	116	104	89
Max intermittent power	kW	213	198	181	169	156	144	132	120	107
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275

Displacement Code		80	60	40	30	20	10	00	00
Displacement	cc/rev	1,311	983	655	492	328	164	0	0
Average actual running torque	Nm/bar	17.1	12.2	7.9	5.15	2.4	0	0	0
Average actual mechanical efficiency	%	82.0	78.0	75.8	65.8	46.0	0	0	0
Average actual starting efficiency	%	66.3	57.8	40.7	23.5	/	/	/	/
Max continuous speed	rpm	430	460	490	515	545	1,000	1,000	1,500**
Max continuous power	kW	73	57	38	26	14	0	0	0
Max intermittent power	kW	95	80	55	38	20	0	0	0
Max continuous pressure	bar	250	250	250	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	275	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 34: small displacements.*

*** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HMC325 Motor (see page 30 for power calculation limits)

Displacement Code		325	310	300	280	250	220	200	180	160	140	120
Displacement	cc/rev	5,326	5,080	4,916	4,588	4,097	3,605	3,277	2,950	2,622	2,294	1,966
Average actual running torque	Nm/bar	80.4	76.6	74.1	69.1	61.6	53.9	49	43.6	38.3	33.2	27.9
Average actual mechanical efficiency	%	94.8	94.7	94.7	94.6	94.5	93.9	94.0	92.9	91.8	90.9	89.2
Average actual starting efficiency	%	85.7	85.4	85.2	84.7	83.8	82.7	81.8	80.6	79.2	77.3	74.9
Max continuous speed	rpm	130	135	140	150	160	170	190	215	230	275	330
Max continuous power	kW	189	189	189	189	176	161	150	139	128	116	104
Max intermittent power	kW	213	213	213	213	198	181	169	156	144	132	120
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275	275	275

Displacement Code		100	95	80	60	40	30	20	10	00	00
Displacement	cc/rev	1,639	1,557	1,311	983	655	492	328	164	0	0
Average actual running torque	Nm/bar	22.4	20.9	17.1	12.2	7.9	5.15	2.4	0	0	0
Average actual mechanical efficiency	%	85.9	84.3	82.0	78.0	75.8	65.8	46.0	0	0	0
Average actual starting efficiency	%	71.5	70.4	66.3	57.8	40.7	23.5	/	/	/	/
Max continuous speed	rpm	370	405	440	460	495	515	545	1,000	1,000	1,500**
Max continuous power	kW	89	85	73	57	38	26	14	0	0	0
Max intermittent power	kW	107	101	95	80	55	38	20	0	0	0
Max continuous pressure	bar	250	250	250	250	250	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	275	275	275	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 34: small displacements.*

*** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-2 Volumetric Efficiency Data

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
HMC	**cc/rev**	**K_1**	**K_2**	**K_3**	**K_4**
HMC030	492	4.90	*	10.00	3.50
HMC045	737	6.60	47.80	8.50	4.00
HMC080	1,639	9.50	45.70	5.80	7.90
HMC125	2,048	6.10	38.50	3.00	4.25
HMC200	3,087	6.10	38.50	2.00	4.20
HMC270	4,588	6.50	37.30	1.50	6.00
HMC325	5,326	6.50	40.00	1.30	6.00

Fluid Viscosity	Viscosity Factor
cSt	**Kv**
20	1.58
25	1.44
30	1.30
40	1.10
50	1.00
60	0.88

Qt (total leakage) $= [K_1 + n/K_2] \times \Delta P \times Kv \times 0.005$ l/min

Creep speed $= K_3 \times \Delta P \times Kv \times 0.005$ rpm

Crankcase leakage $= K_4 \times \Delta P \times Kv \times 0.005$ l/min

ΔP = differential pressure bar

n = speed rpm

The motor volumetric efficiency can be calculated as follows:

$$\text{Volumetric efficiency (\%)} = \left[\frac{(\text{speed x disp.})}{(\text{speed x disp.}) + Qt}\right] \times 100$$

Example:

HMC200 motor with displacement of 3.087 l/rev.

Speed 60 rpm

Differential pressure 200 bar

Fluid viscosity 50 cSt

Total leakage $= (K_1 + n/K_2) \times \Delta P \times Kv \times 0.005$ l/min

$= (6.1+60/38.5) \times 200 \times 1 \times 0.005$

$= 7.7$ l/min

$$\text{Volumetric efficiency} = \left[\frac{(60 \times 3.087)}{(60 \times 3.087) + 7.7}\right] \times 100$$

= 96%

2-3 Shaft Power Calculation

Example

Firstly, to find the maximum differential pressure ΔP at rated speed:

Select the rated shaft power (W) for the motor from the performance data table (page 24).
This is presented in kilowatts so must be converted to watts (x1000).

Then also take the Actual Average running torque in N.m/bar (T_o) and the rated shaft speed in rpm (n).

$$W = \frac{T_o \cdot \Delta P \cdot 2\pi \cdot n}{60}$$

Or to find maximum ΔP then use:

$$\Delta P = \frac{60 \cdot W}{2\pi \cdot T_o \cdot n}$$

HMC270 Example - with a displacement code of 280:

Rated shaft power (W):	189,000
Average actual running torque (Nm/bar):	69.4
Rated shaft speed (rpm):	150

$$\Delta P = \frac{60 \times 189{,}000}{2\pi \times 69.4 \times 150}$$

ΔP= 174 bar (max.)

Secondly, to find the maximum speed at rated pressure (using the same information as before):

$$n = \frac{60 \cdot W}{2\pi \cdot T_o \cdot \Delta P}$$

Rated pressure (bar):	250

$$n = \frac{60 \times 189{,}000}{2\pi \times 69.4 \times 250}$$

n = 104 rpm (max.)

In summary, operating the motor within its shaft power limit, at rated speed, would give a maximum pressure of 174 bar, and operating the motor at rated pressure, would give a maximum speed of 104 rpm.

Notes

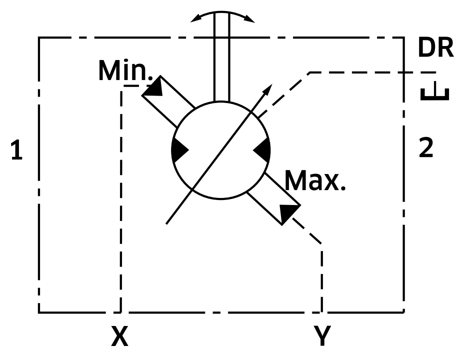
1) The maximum calculated speed is based on a rated inlet pressure of 250 bar.
2) The maximum shaft power is only allowable if the motor drain temperature remains below 80°C.
3) The maximum calculated differential pressure assumes that the low pressure motor port is less than 30 bar.

2-4 Functional Symbols

Example model code:

HMC*/P/***/**/FM3/X/...**

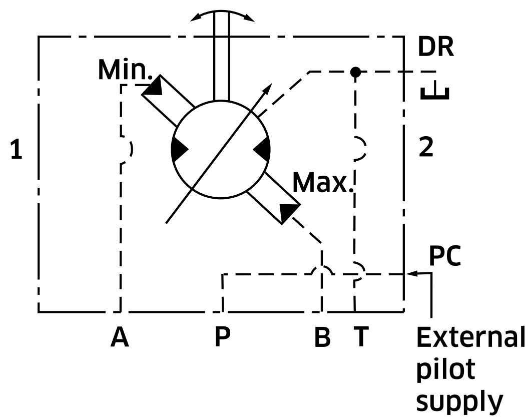
X - external pilot supply to 'X' and 'Y' ports



Example model code:

HMC*/P/***/**/FM3/C/...**

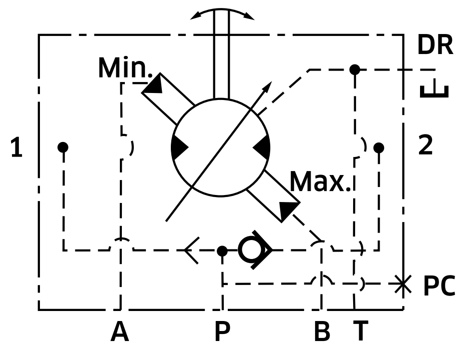
C - single external supply to PC port



Example model code:

HMC*/P/***/**/FM3/CS/...**

CS - internally shuttled pilot supply



There is a single port (PC) in the 'C' spacer.

Pressure ports in FM3 & FM4 valve housings can be called up as special features when required.

2-5 Stress Limits

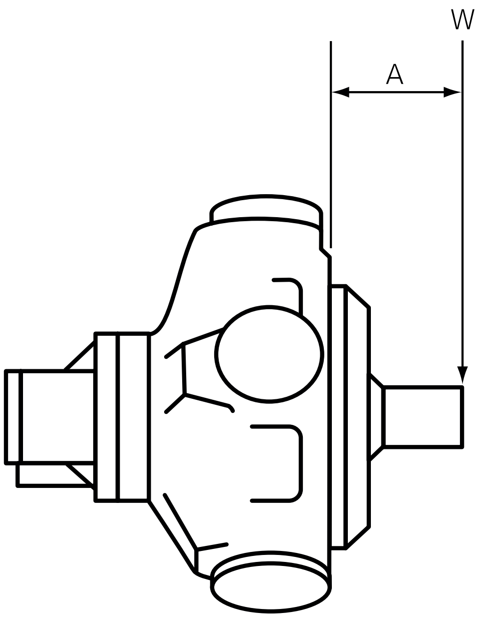
When applying large external radial loads, consideration should also be given to motor bearing lives (see page 33).

Motor Frame Size	Maximum External Radial Bending Moment [Nm]
HMC030	2,600
HMC045	3,300
HMC080	4,500
HMC125	6,500
HMC200	6,750
HMC270	8,250
HMC325	8,250

Example:

Determine the maximum radial shaft load of a HMC080 motor:

Radial load offset, A	= 100 mm
Maximum radial load, W	= 4,500 (see table)/100
	= 45kN (4,587 kg)



A = Distance from mounting face to load centre (mm)

W = Side load (N)

[Note}
The offset distance A is assumed to be greater than 50 mm.
Contact KPM UK if this is not the case.

2-6 Bearing Life Notes

Consideration should be given to the required motor bearing life in terms of baring service life. The factors that will determine bearing life include:

1) Duty cycle - time spent on and off load

2) Speed

3) Differential pressure

4) Fluid viscosity

5) External radial shaft load

6) External axial shaft load

2-7 Circuit and Application Notes

Limits for fire resistant fluids

To select either displacement, a pressure at least equal to 67% of the motor inlet/outlet pressure (whichever is higher) is required. In most applications the motor inlet pressure will be used. If the inlet/outlet pressure is below 3.5 bar, a minimum control pressure of 3.5 bar is required. In the event of loss of control pressure the motor will shift to its highest displacement.

Starting torque

Refer to performance data, (see pages 7 to 13).

Low speed operation

The minimum operating speed is determined by load inertia, drive elasticity, motor displacement and system internal leakage. If the application speed is below 3 rpm, then consult KPM UK.

If possible, always start the motor in high displacement.

Small displacements

The pressures given in the tables on pages 22 to 28 for displacement code “00” are based on 1,000 rpm output shaft speed. This pressure can be increased for shaft speeds less than 1,000 rpm; consult KPM UK for details. Speeds greater than 1,000 rpm may be applied but only after the machine duty cycle has been considered in conjunction with KPM UK. A zero swept volume displacement (for freewheeling requirements) is available on request, consult KPM UK.

High back pressure

When both inlet and outlet ports are pressurised continuously, the lower pressure port must not exceed **70 bar** at any time. Note that high back pressure reduces 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) from the operating formula Boost Formula

$$P = 1 + \frac{N^2 \times V^2}{K} + C$$

Where P is in bar, N = motor speed (rpm), V = motor displacement (cc/rev), C = Crankcase pressure (bar) and K=a constant from the table below:

Motor	Porting	Constant (K)
HMC030	F(M)3 & SM3	7.5×10^9
HMC045	F(M)3 & SM3	1.6×10^{10}
HMC080	F(M)3 & SM3	1.6×10^{10}
	F(M)4	3.3×10^{10}
HMC125 & HMC200	F(M)3 & SM3	1.6×10^{10}
	F(M)4	3.3×10^{10}
HMC270 & HMC325	F(M)4	4.0×10^{10}

2-7 Circuit and Application Notes (cont)

The flow rate of oil for the make-up system can be estimated from the crankcase leakage data (see page 29) plus an allowance for changing displacement:

e.g.

HMC030	To change high to low in 0.2 sec requires 11 l/min
HMC045	To change high to low in 0.25 sec requires 15 l/min
HMC080	To change high to low in 0.25 sec requires 32 l/min
HMC125	To change high to low in 0.5 sec requires 15 l/min
HMC200	To change high to low in 0.5 sec requires 15 l/min
HMC270	To change high to low in 1 sec requires 24 l/min
HMC325	To change high to low in 1 sec requires 20 l/min

Allowances should be made for other systems losses and also for “fair wear and tear” during the life of the motor, pump and system components.

Motorcase pressure

The motorcase pressure should not continuously exceed 3.5 bar with a standard shaft seal fitted. On installations with long drain lines a relief valve is recommended to prevent over-pressurising the seal.

Notes

1) The motorcase 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: 10 bar continuous and 15 bar intermittent.

3) Check installation dimensions (pages 27 to 67) for maximum crankcase drain fitting depth.

Hydraulic Fluids

Dependent on motor (see model code fluid type - page 3) suitable fluids include:

a) Antiwear hydraulic oils

b) Phosphate ester (HFD fluids)

c) Water glycols (HFC fluids)

d) 60/40% water-in-oil emulsions (HFB fluids)

e) 5/95% oil-in-water emulsions (HFA fluids)

Reduce pressure and speed limits, as per table on page 21.

Viscosity limits when using any fluid except oil-in-water (5/95) emulsions are:

Max. off load:	**2,000 cSt** (9270 SUS)
Max. on load:	**150 cSt** (695 SUS)
Optimum:	**50 cSt** (232 SUS)
Minimum:	**25 cSt** (119 SUS)

Mineral oil recommendations

The fluid should be a good hydraulic grade, non-detergent Mineral Oil. It should contain anti-oxidant, antifoam and demulsifying additives. It must contain antiwear or EP additives. Automatic transmission fluids and motor oils are not recommended.

Biodegradable Fluid Recommendations

Well-designed environmentally acceptable lubricants (EALs) may be used with Staffa motors. The EAL must be designed for use in hydraulic systems and have a synthetic ester base. Additives should be as listed for mineral oils, above. The performance of EALs with hydraulic systems vary widely and so checks for seal compatibility, copper alloy compatibility, oxidation resistance and lubrication properties should be carried out before selecting an EAL. For help with EALs please contact KPMUK.

2-7 Circuit and Application Notes (cont)

Temperature limits

Ambient min. -30°C (-22°F)
Ambient max. +70°C (158°F)
Max. operating temperature range.

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

Note: To obtain optimum services life from both fluid and hydraulic systems components, a fluid operating temperature of 40°C is recommended.

Filtration

Full flow filtration (open circuit), or full boost flow filtration (close circuit) to ensure system cleanliness to ISO4406/1986 code 18/14 or cleaner.

Noise levels

The airborne noise level is less than 66.7 dB(A) DIN & dB(A) NFPA through 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.

Polar moment of intertia and mass table

Motor Frame Size	Displacement code	Polar Moment of Intertia (kg.m²) (Typical data)	Mass (kg) (Approx. all models)
HMC030	30	0.0120	100
	15	0.0094	
HMC045	45	0.0440	150
	30	0.0410	
HMC080	90	0.0520	172
	45	0.0440	
HMC125	125	0.2000	235
	50	0.1400	
HMC200	188	0.2300	282
	75	0.1800	
HMC270	280	0.4900	450
	100	0.4700	
HMC325	325	0.5000	460
	100	0.4700	

2-8 Motor Operation at Low Temperature

When operating the motor at low temperature consideration should be given to the fluid viscosity. The maximum fluid viscosity before the shaft should be turned is 2,000 cSt. The maximum fluid viscosity before load is applied to the motor shaft is 150 cSt.

If low ambient temperature conditions exist, then a crankcase flushing flow of at least 5 l/min should be applied to the motor during periods when the motor is not in use.

The shaft seal temperature limits for both medium and high pressure applications are shown in the table below.

	Non-operating temperature limits	Minimum operating temperature
Standard pressure shaft seal	below minus 40°C and above 100°C	minus 30°C
High pressure shaft seal	below minus 30°C and above 120°C	minus 15°C

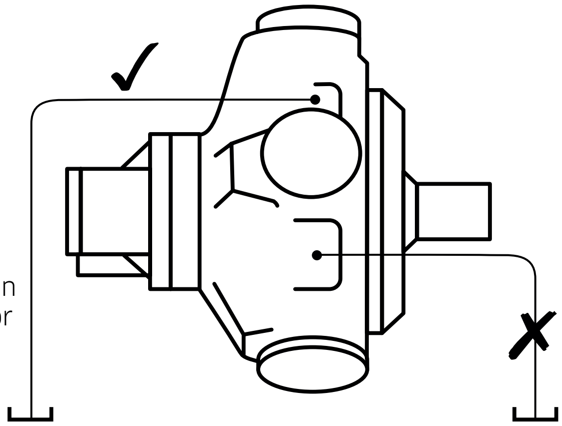
All seals are very brittle below minus 40°C and are likely to break very easily and due to their sluggish response may not provide a 100% leak free condition.

It should be noted that the maximum continuous operating temperature within the motor crankcase is plus 80°C.

2-9 Crankcase Drain Connections

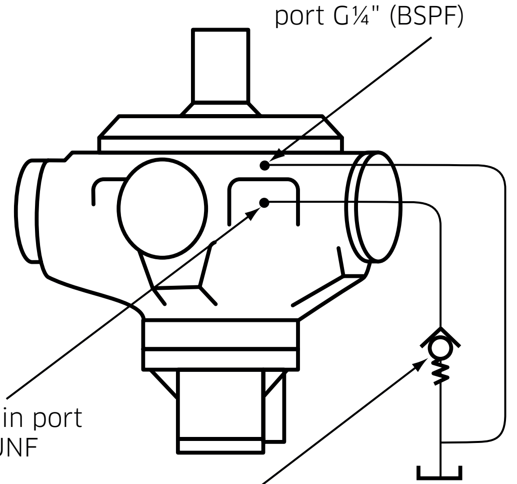
Motor axis - horizontal

The recommended minimum pipe size for drain line lengths up to approx. 5m is 12.0 mm (½") bore. Longer drain lines should have their bore size increased to keep the crankcase pressure within limits.



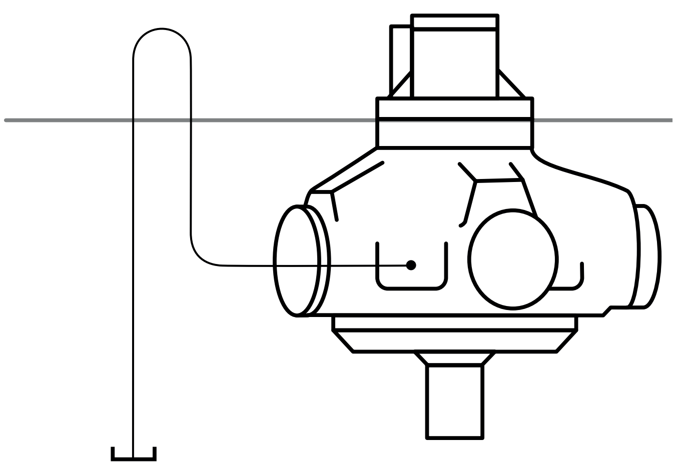
Motor axis - vertical shaft up

Specify "V" within the model code for extra drain port, G¼" (BSPF). Connect this port into the main drain line downstream of a 0.35 bar check valve to ensure good bearing lubrication. The piping arrangement must not allow syphoning from the motorcase. (refer to installation drawing for details).



Motor axis - vertical shaft down

The piping, from any drain port, must be taken above the level of the motorcase to ensure good bearing lubrication. The arrangement must not allow syphoning from the motorcase.



2-10 Freewheeling Notes

All Staffa motors can be used in freewheeling applications. In all circumstances it is essential that the motor is unloaded ("A" and "B" ports connected together) and that the circuit is boosted. The required boost pressure is dependent on both the speed and displacement conditions of the motor determined by the maximum overrunning load condition (see boost pressure calculation method on page 19)

It should be noted that for "B" motors large flows will re-circulate around the motor. This will require a large recirculating valve and consideration of circuit cooling as the motor will be generating a braking torque. It is for these reasons that "C" series motors are the preferred option for freewheeling applications. It is normal to select displacement codes 00, 05 or 10.

Selecting the lowest zero displacement option (00) will allow the motor shaft to be rotated at high speed without pumping fluid and with a minimum boost and drive torque requirement. Consideration must also be given when freewheeling that the load does not drive the motor above its rated freewheeling speed condition. (see pages 22 to 28).

Displacement selection

Under all operating conditions the control pressure port should be at least 67% of the motor inlet/outlet pressure whichever is the higher.

A minimum control pressure at the low displacement selection port of 3.5 bar is necessary to ensure that the motor remains in its minimum displacement condition. A separate pressure supply may be necessary to ensure this condition is always maintained. It should be noted that with the loss of control pressure, the motor will shift to its high displacement condition, which could result in damage to the motor.

Boost requirement

The minimum required boost pressure as noted above can be ascertained utilising the calculation method shown on page 19. The maximum motor and control pressure at 100 rpm is 17 bar and must not be exceeded since higher pressures will increase motor losses at the conrod slipper interface and valve assembly and thereby will significantly increase the motor operating temperature.

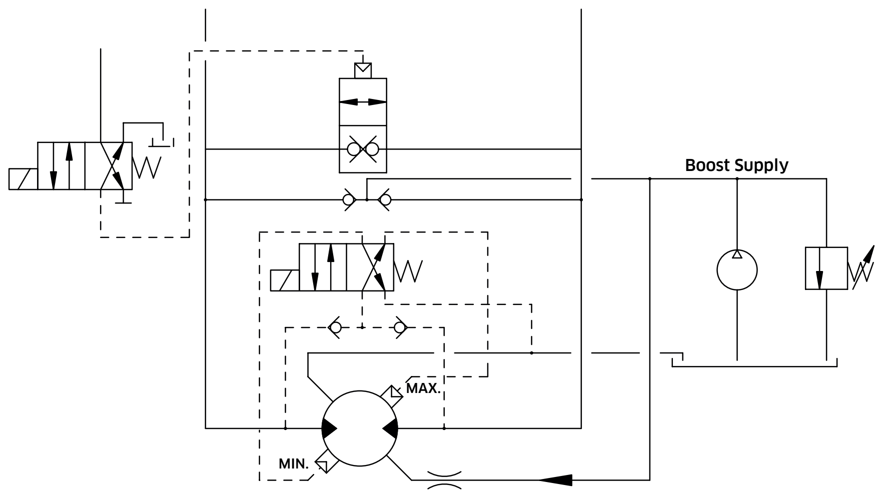
The boost flow required should be sufficient to make-up circuit leakage loss and provide cooling for recirculating flow pressure drop.

Crankcase cooling

A crankcase flushing flow of up to 15 l/min can be used to control and reduce the temperature rise of the motor during the freewheel operation.

This should not be necessary for speeds below 1,000 rpm.

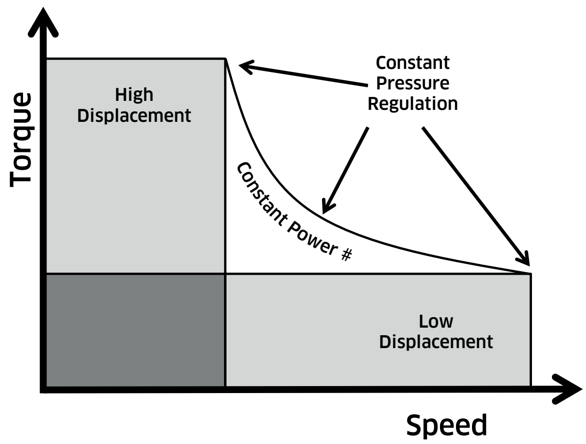
For speeds above this up to 1,500 rpm then crankcase flushing flow must be used.



2-11 Constant Pressure Regulator (CP)

Introduction

The constant pressure regulator control has been developed for the HMC dual displacement motor series. Whereas the standard dual displacement motor operates only at either maximum or minimum displacement, the constant pressure regulator continually adjusts the motor displacement within the selected displacement range so as to keep the hydraulic inlet pressure constant. In order to provide an infinite smooth and controllable displacement change an enhanced low friction crankshaft assembly with anti-scuffing features is utilised.



Assumes Constant Input Flow to the Motor

Description

A constant pressure regulated motor incorporates a pressure sensing control (CP in model code) which senses and responds to variations in motor inlet pressure. Changes in inlet pressure from a chosen, preset value cause the control to direct oil to the relevant displacement piston chamber within the crankshaft, thereby altering displacement so as to maintain the inlet motor pressure constant.

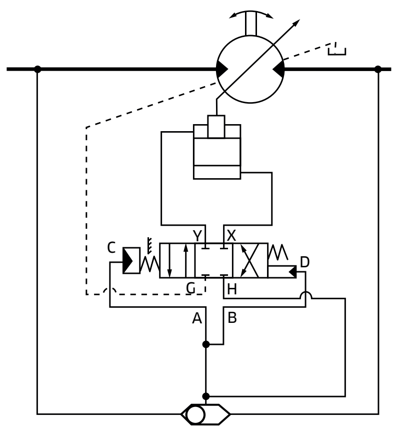
The factory preset pressure of this valve is matched to the specific power requirements of the application.

An optional ISO4401, size 3 overide valve (CHP in the model code) can be incorporated which enables high and low displacements to be selected individually).

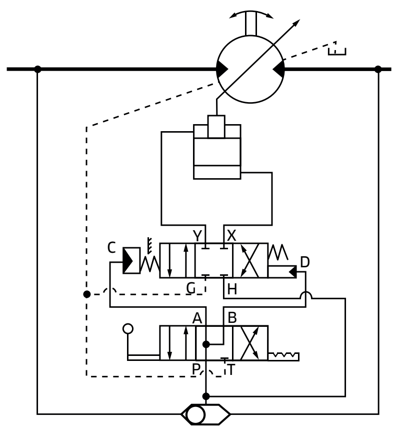
It should be noted that for inlet pressures below 7 bar, independent of the preset pressure setting, the motor will stay in its fail safe high displacement condition. An increasing pressure thereafter will instantaneously force the motor to its low displacement condition after which the constant pressure regulation will commence.

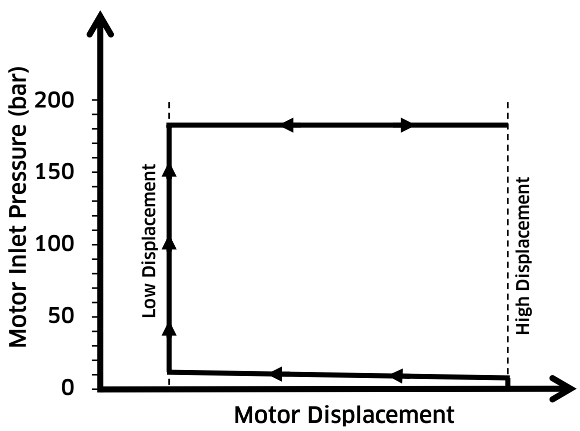
Consult KPM UK for further details.

CP Valving



CHP Valving





2-12 Installation Data

General

Spigot

The motor should be located by the mounting spigot on a flat, robust surface using correctly sized bolts.
The diametrical clearance between the motor spigot and the mounting must not exceed 0.15 mm. 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 bolts is as follows:

M18	312 +/_ 7 Nm
⅝" UNF	265 +/_ 14 Nm
M20	407 +/_ 14 Nm
¾" UNF	393 +/_ 14 Nm

Shaft coupling:

Where the motor is solidly coupled to a shaft having independent bearings the shaft must be aligned to within 0.13 mm TIR.

Motor axis - horizontal

The crankcase drain must be taken from a position above the horizontal centre line of the motor, (refer to installation drawing for details).

Motor axis - vertical shaft up

The recommended minimum pipe size for drain line lengths up to approx. 5 m is 12.0 mm as an internal diameter. If using longer drain lines, then increase the pipe internal bore diameter to keep the motorcase pressure within specified limits.

Specify "V" in the model code for extra drain port, G¼" (BSPF). Connect this port into main drain line downstream of a 0.35 bar check valve.

Motor axis - vertical shaft down

Piping (from any drain port) must be taken above level of motorcase.

Bearing lubrication - piping

The installation arrangement must not allow syphoning from the motorcase. Where this arrangement is not practical, please consult KPM UK.

Any of the drain port positions can be used, but the drain line should be run above the level of the uppermost bearing and 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 unloaded and set to its high displacement.

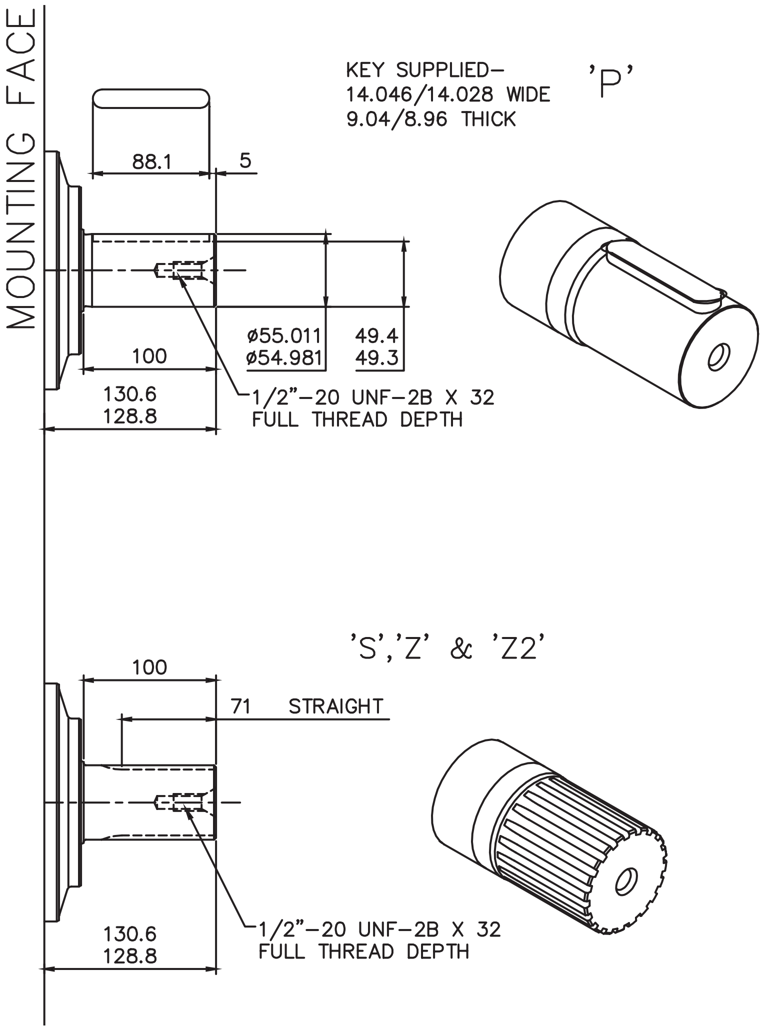
Conversion Table

Pressure	
bar	PSI
1	14.5
Flow	
l/min	gal/min
1	0.264 US
1	0.219 UK
Length	
mm	inch
25.4	1

Torque	
Nm	lbf ft
1	1.737
Power	
kW	hp
1	1.341
Mass	
kg	lb
1	2.2

3-1 HMC030

'P', 'S', 'Z' & 'Z2' Shafts



SPLINE DATA

'S'
TO BS 3550 (ANSI B92.1 CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

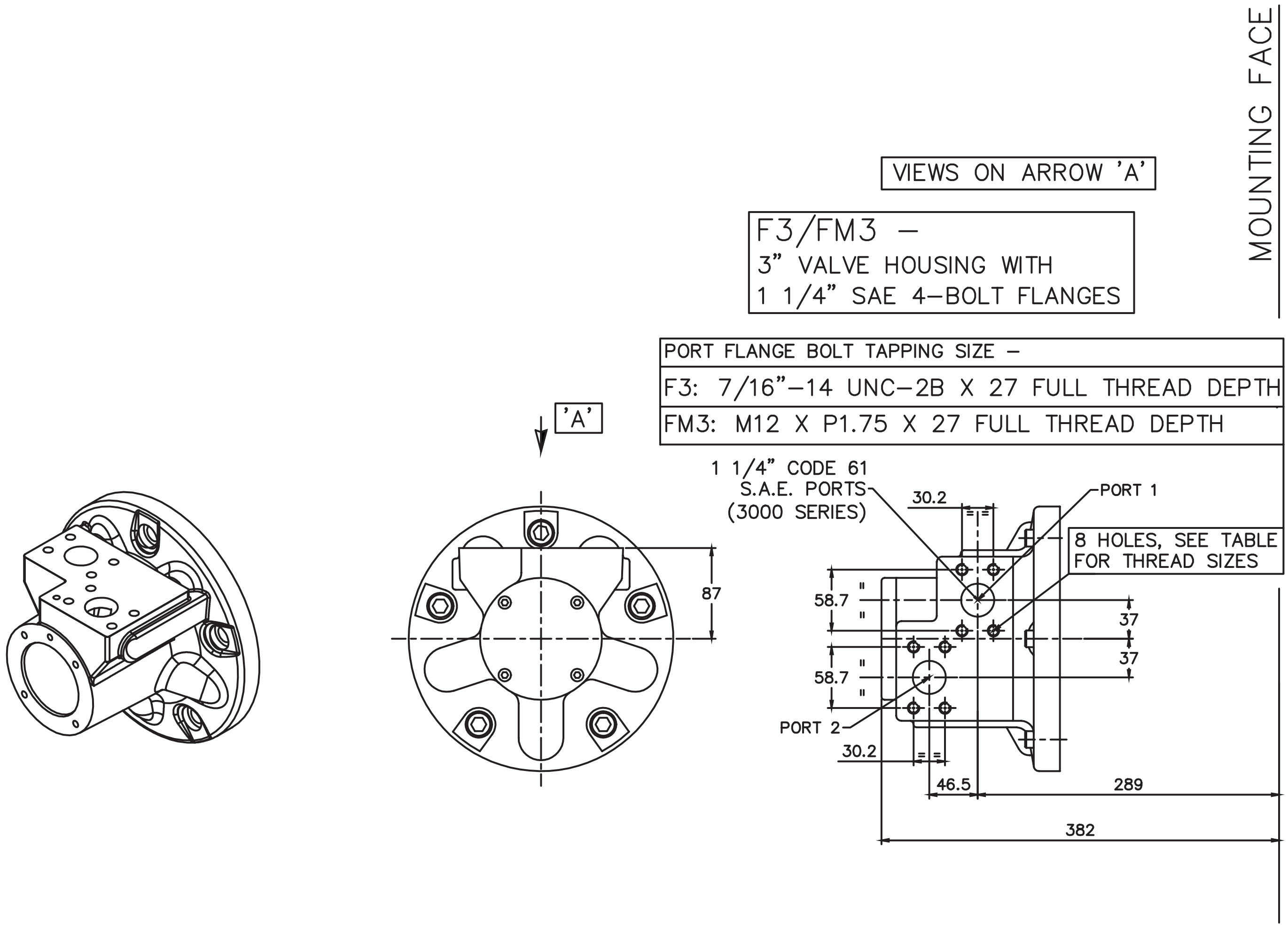
PRESSURE ANGLE	30°
NUMBER OF TEETH	17
PITCH	8/16
MAJOR DIAMETER	56.41/56.29
FORM DIAMETER	50.70
MINOR DIAMETER	50.06/49.60
PIN DIAMETER	6.096
DIAMETER OVER PINS	62.984/62.931

'Z'
DIN 5480 W55 x 3 x 17 x 7h

'Z2'
DIN 5480 W60 x 3 x 18 x 7h

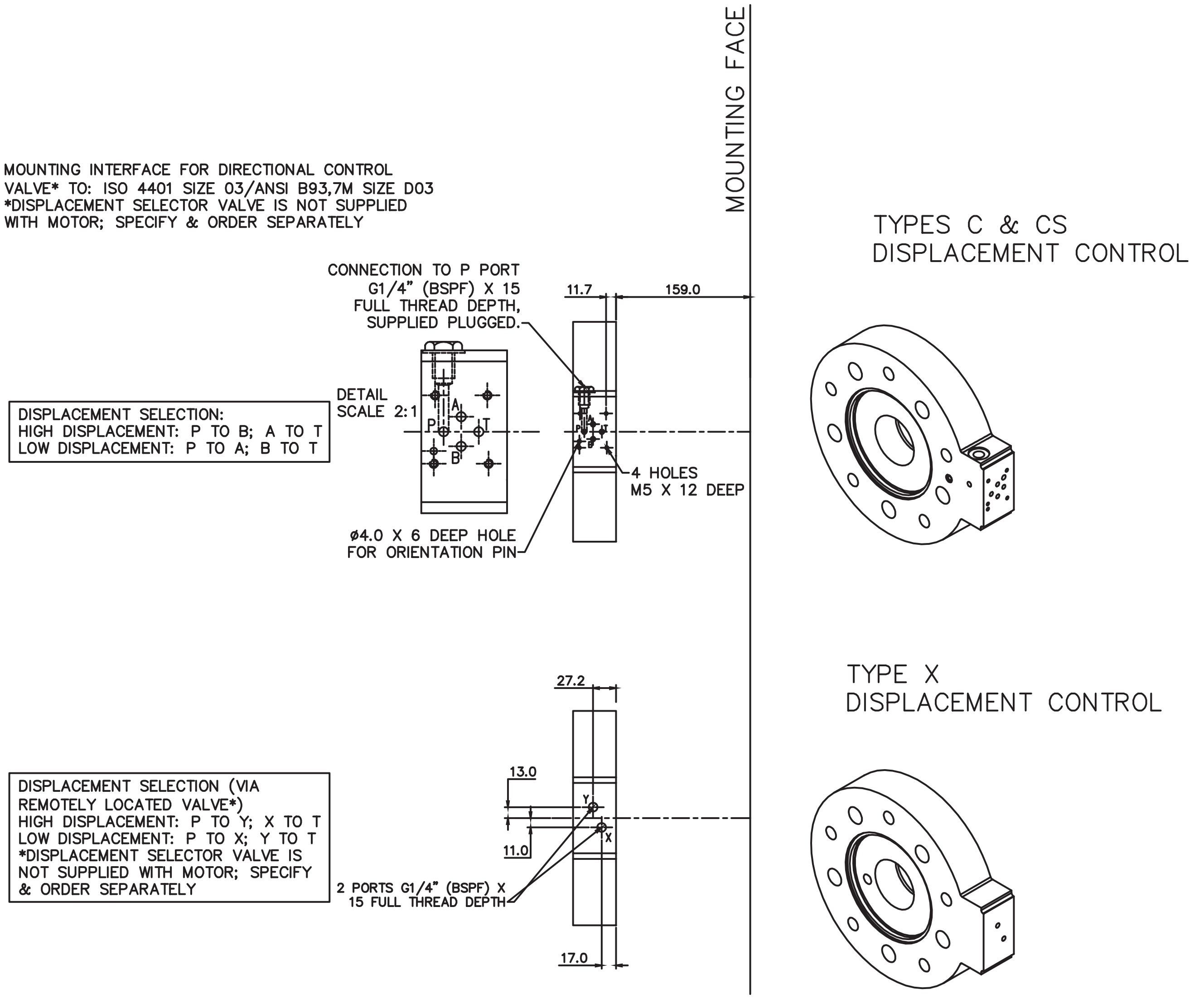
3-1 HMC030 (cont)

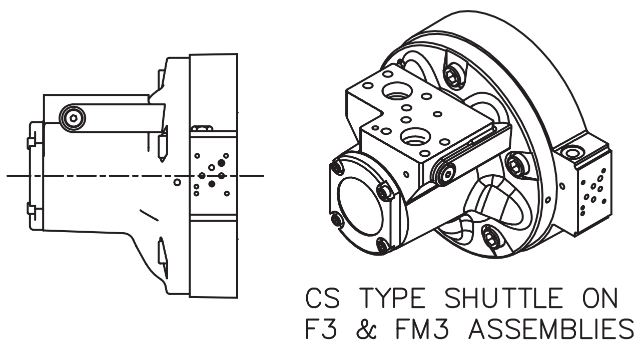
'F3' & 'FM3' Valve Housings



3-1 HMC030 (cont)

'C', 'CS' & 'X' C Spacers

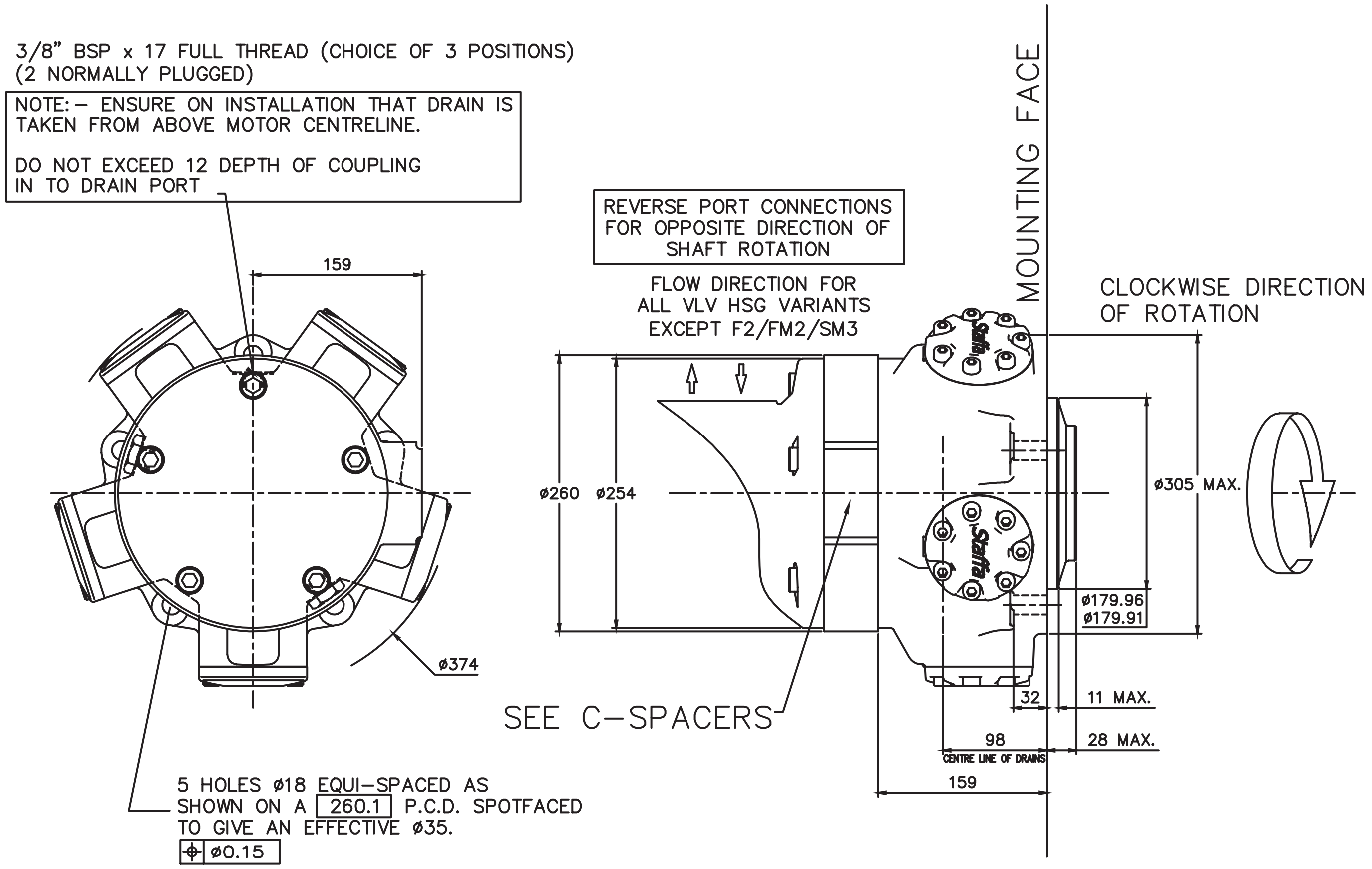




CS TYPE SHUTTLE ON F3 & FM3 ASSEMBLIES ONLY

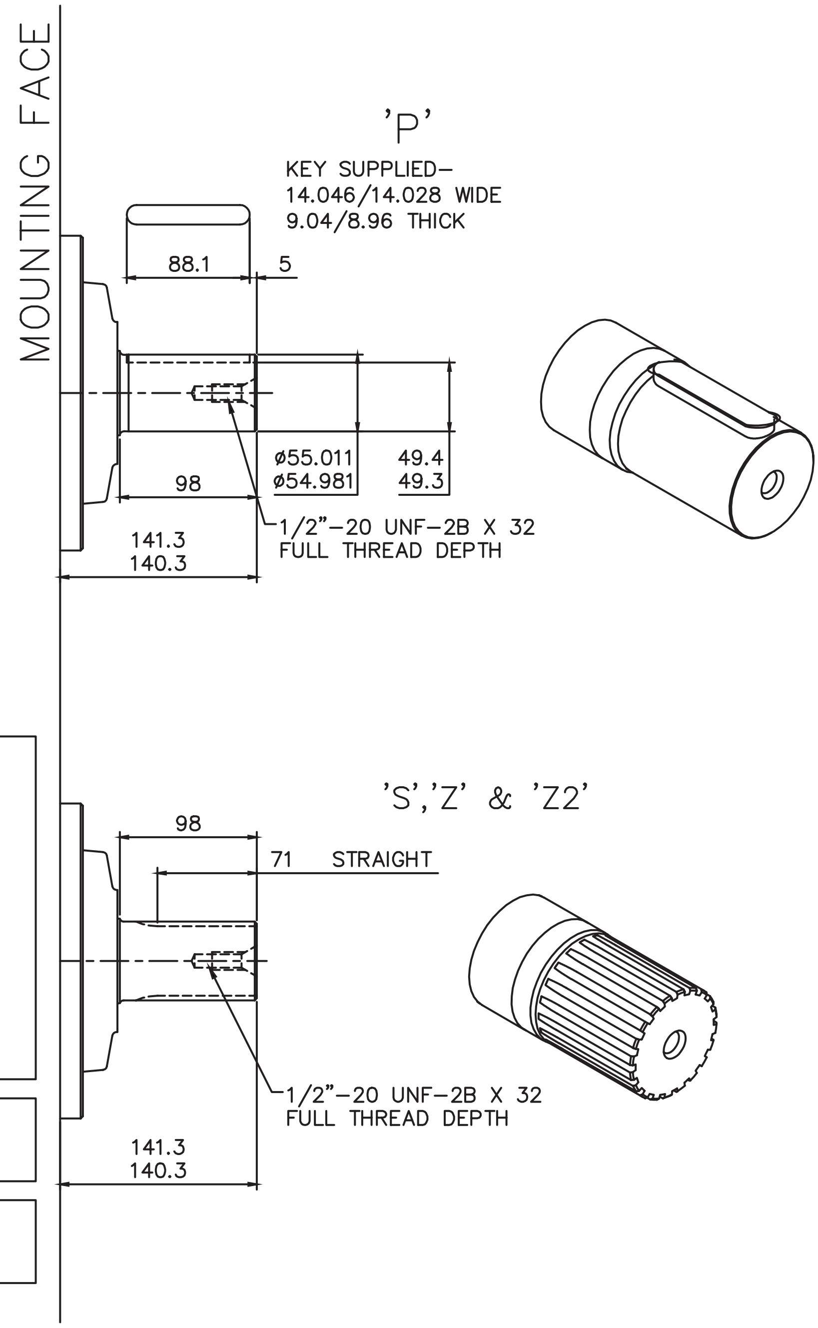
3-1 HMC030 (cont)

Installation



3-2 HMC045

'P', 'S', 'Z' & 'Z2' Shafts



SPLINE DATA

'S'

TO BS 3550 (ANSI B92.1 CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

PRESSURE ANGLE	30°
NUMBER OF TEETH	17
PITCH	8/16
MAJOR DIAMETER	56.41/56.29
FORM DIAMETER	50.70
MINOR DIAMETER	50.06/49.60
PIN DIAMETER	6.096
DIAMETER OVER PINS	62.984/62.931

'Z'

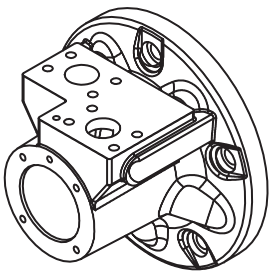
DIN 5480 W55 x 3 x 17 x 7h

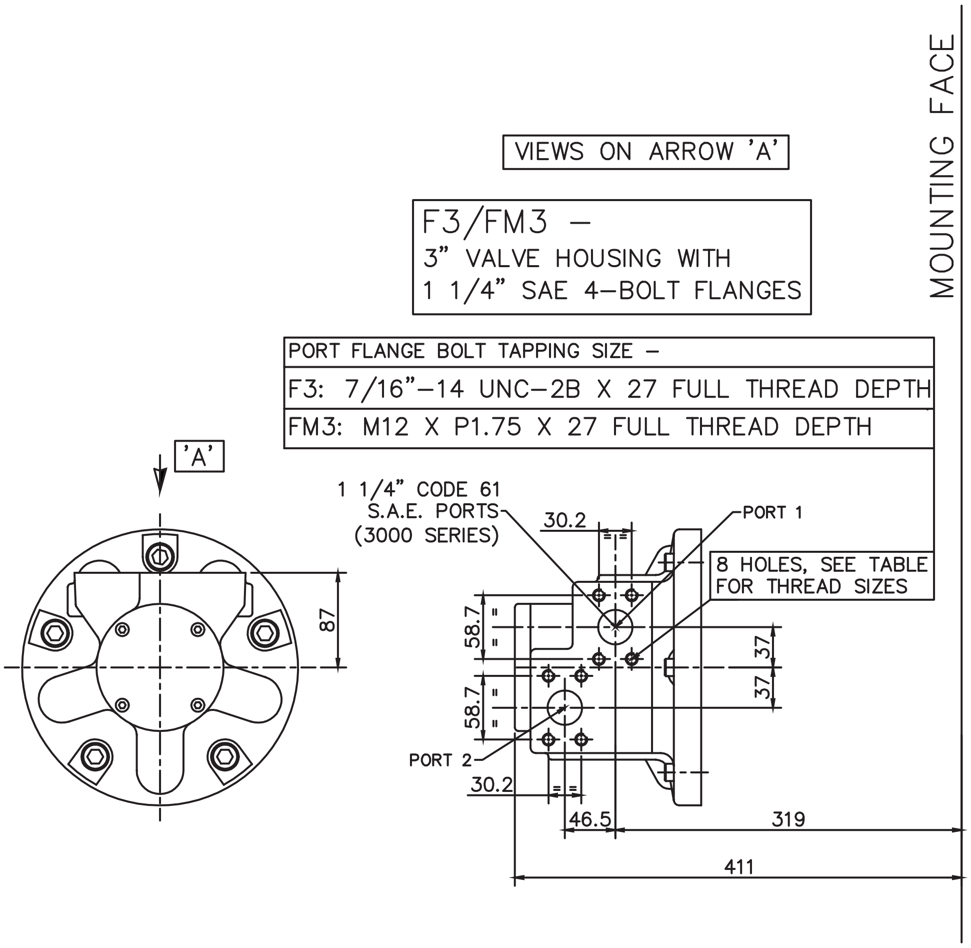
'Z2'

DIN 5480 W60 x 3 x 18 x 7h

3-2 HMC045 (cont)

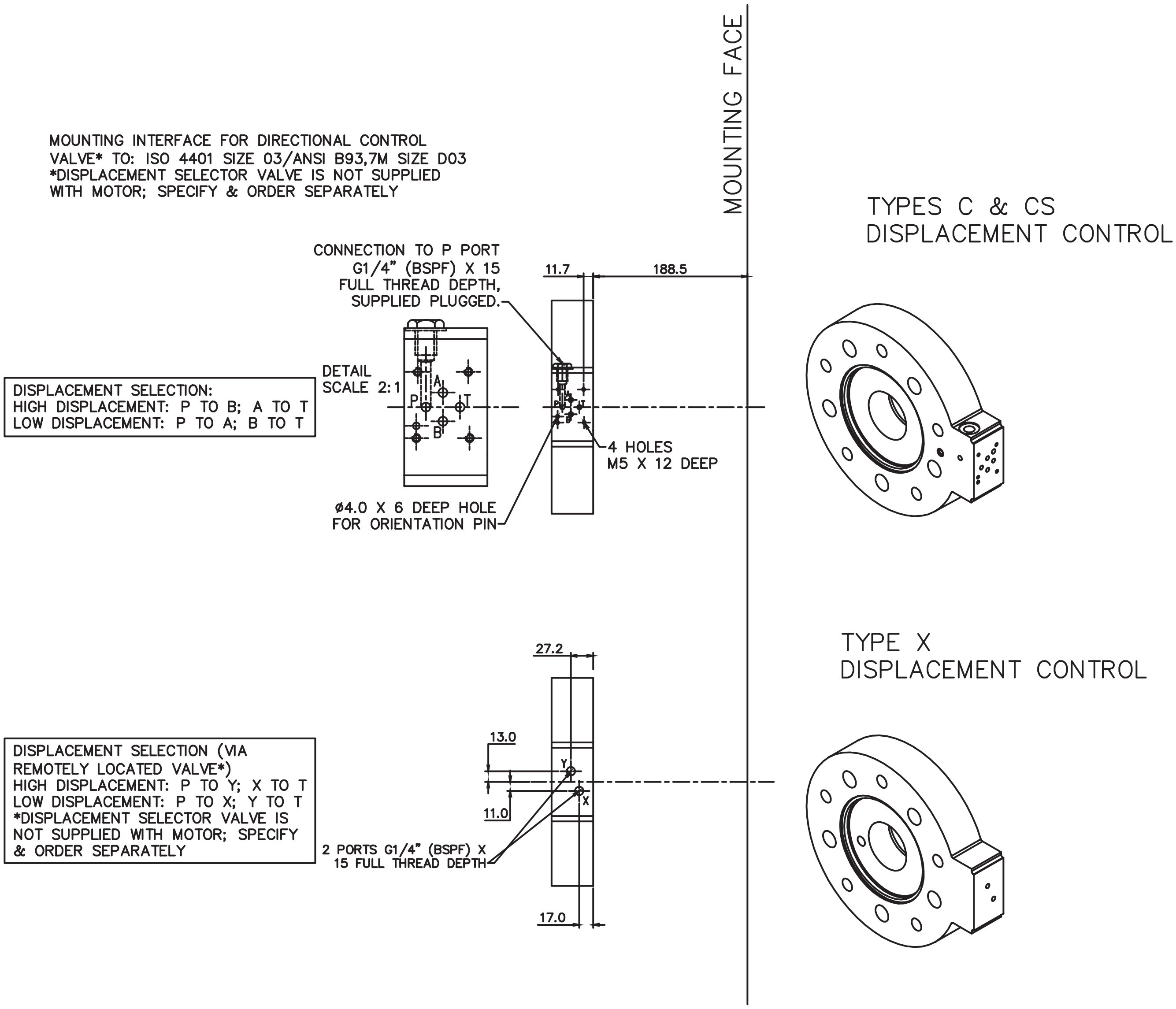
'F3' & 'FM3' Valve Housings

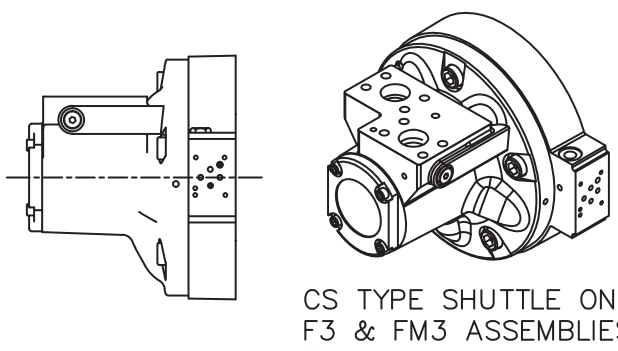




3-2 HMC045 (cont)

'C', 'CS' & 'X' C Spacers

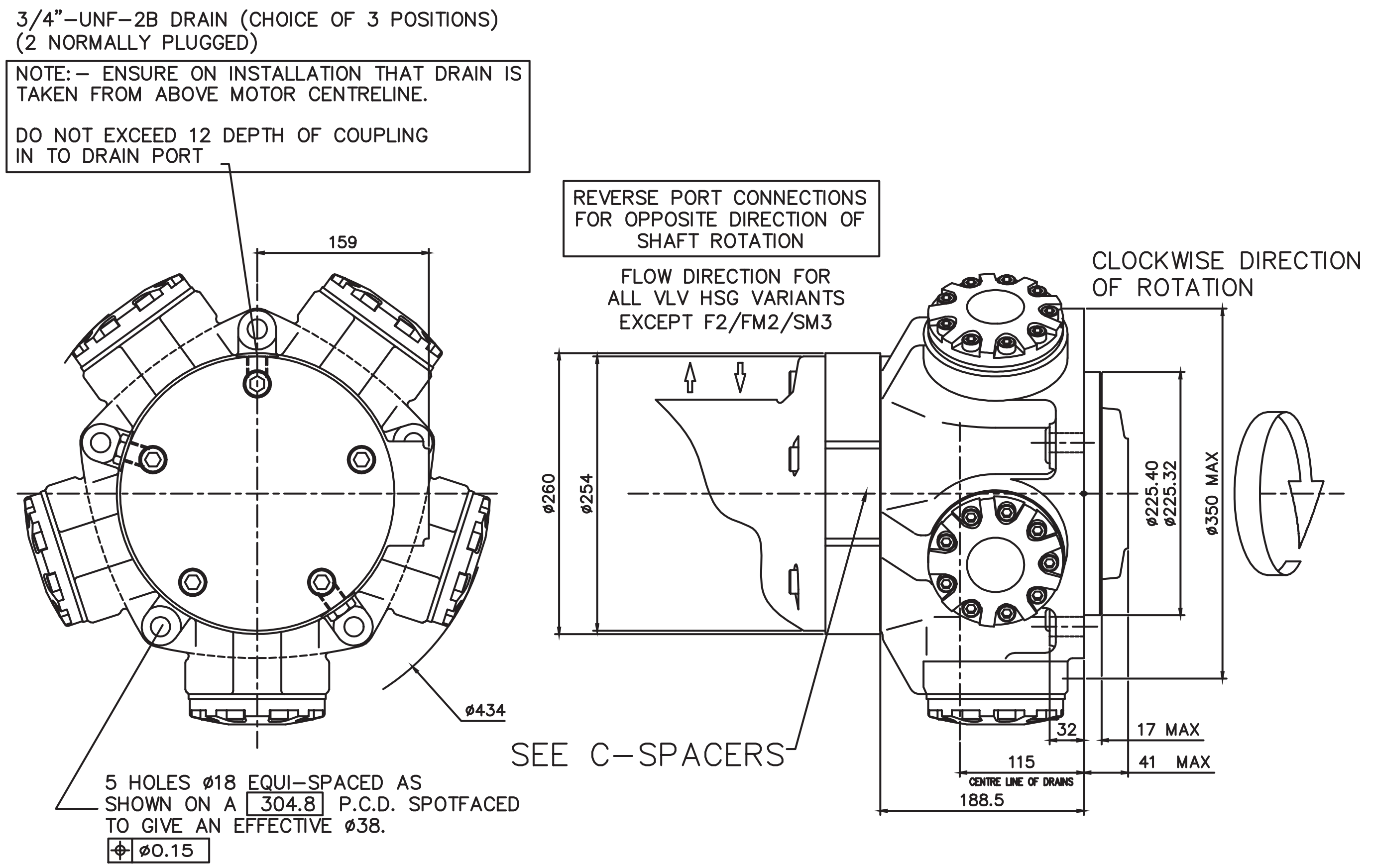




CS TYPE SHUTTLE ON F3 & FM3 ASSEMBLIES ONLY

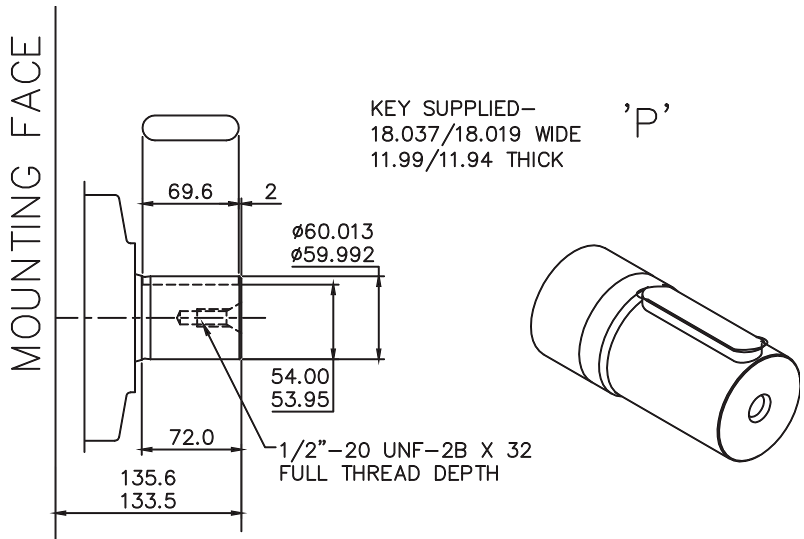
3-2 HMC045 (cont)

Installation



3-3 HMC080

'P', 'S' & 'Z' Shafts



SPLINE DATA

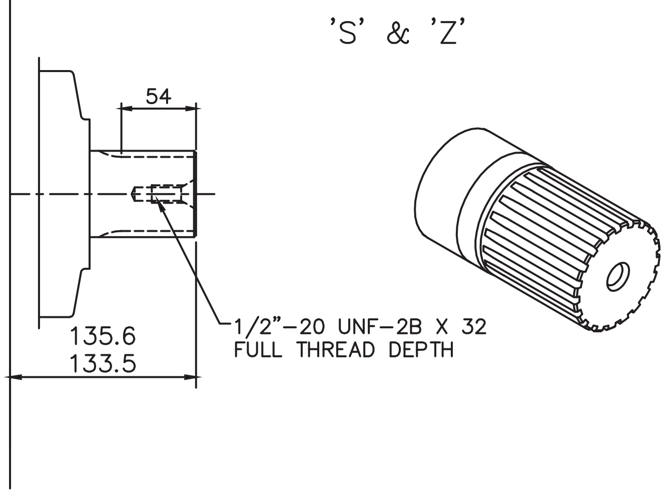
'S'

TO BS 3550 (ANSI B92.1 CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

PRESSURE ANGLE	30°
NUMBER OF TEETH	14
PITCH	6/12
MAJOR DIAMETER	62.553/62.425
FORM DIAMETER	55.052
MINOR DIAMETER	54.084/53.525
PIN DIAMETER	8.128
DIAMETER OVER PINS	71.593/71.544

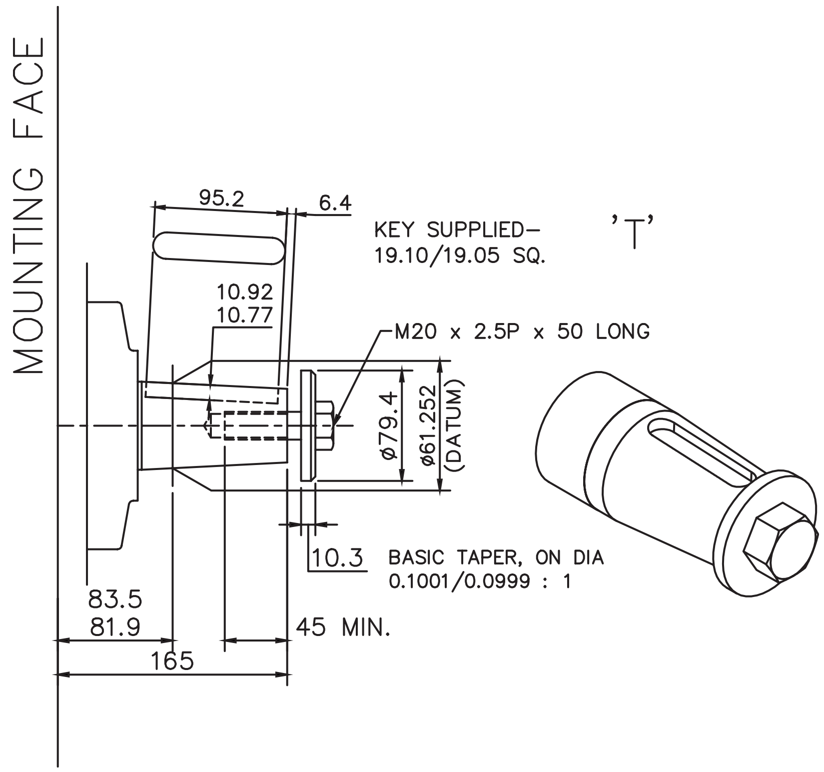
'Z'

DIN 5480 W70 x 3 x 30 x 22 x 7h



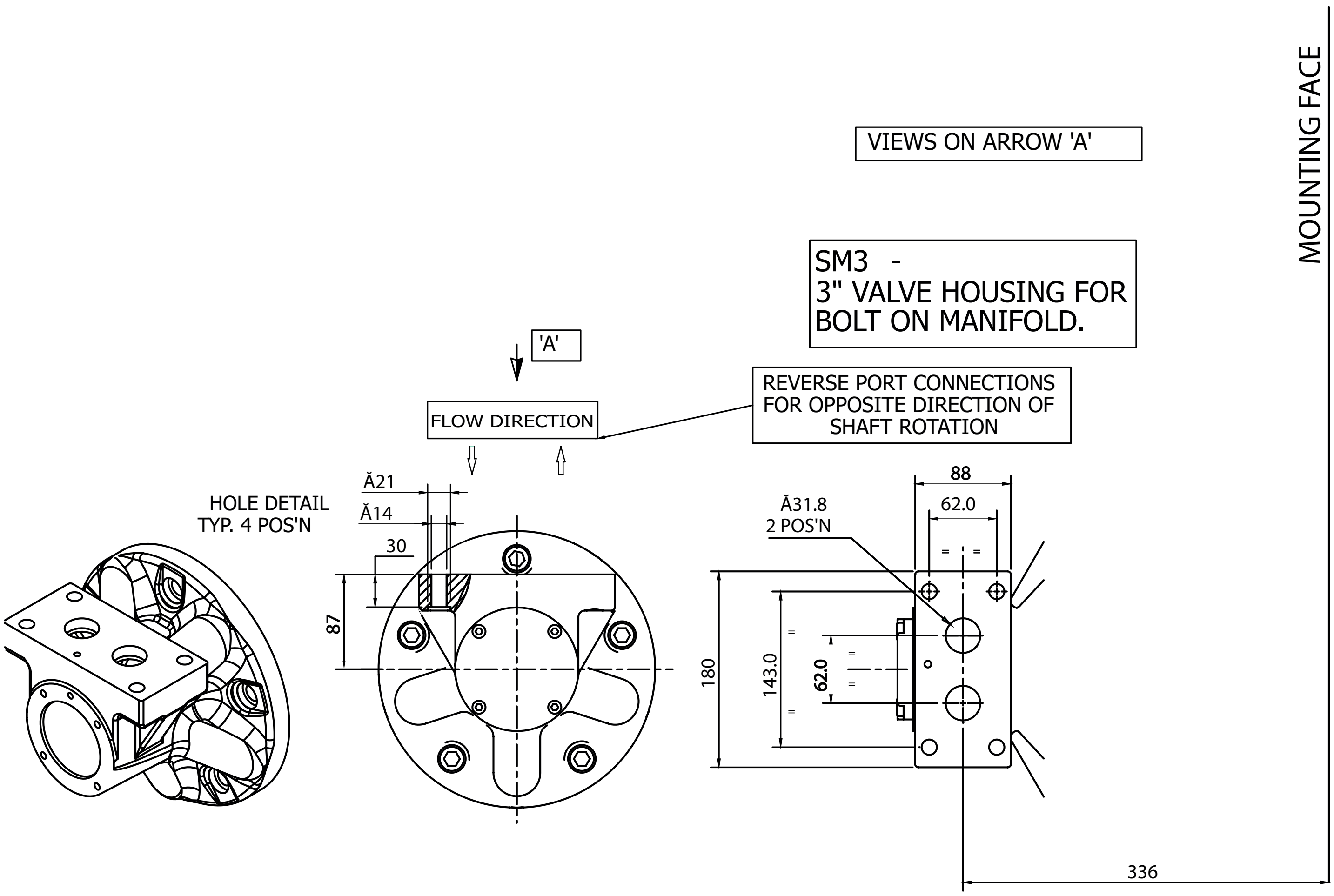
3-3 HMC080 (cont)

'T' Shaft



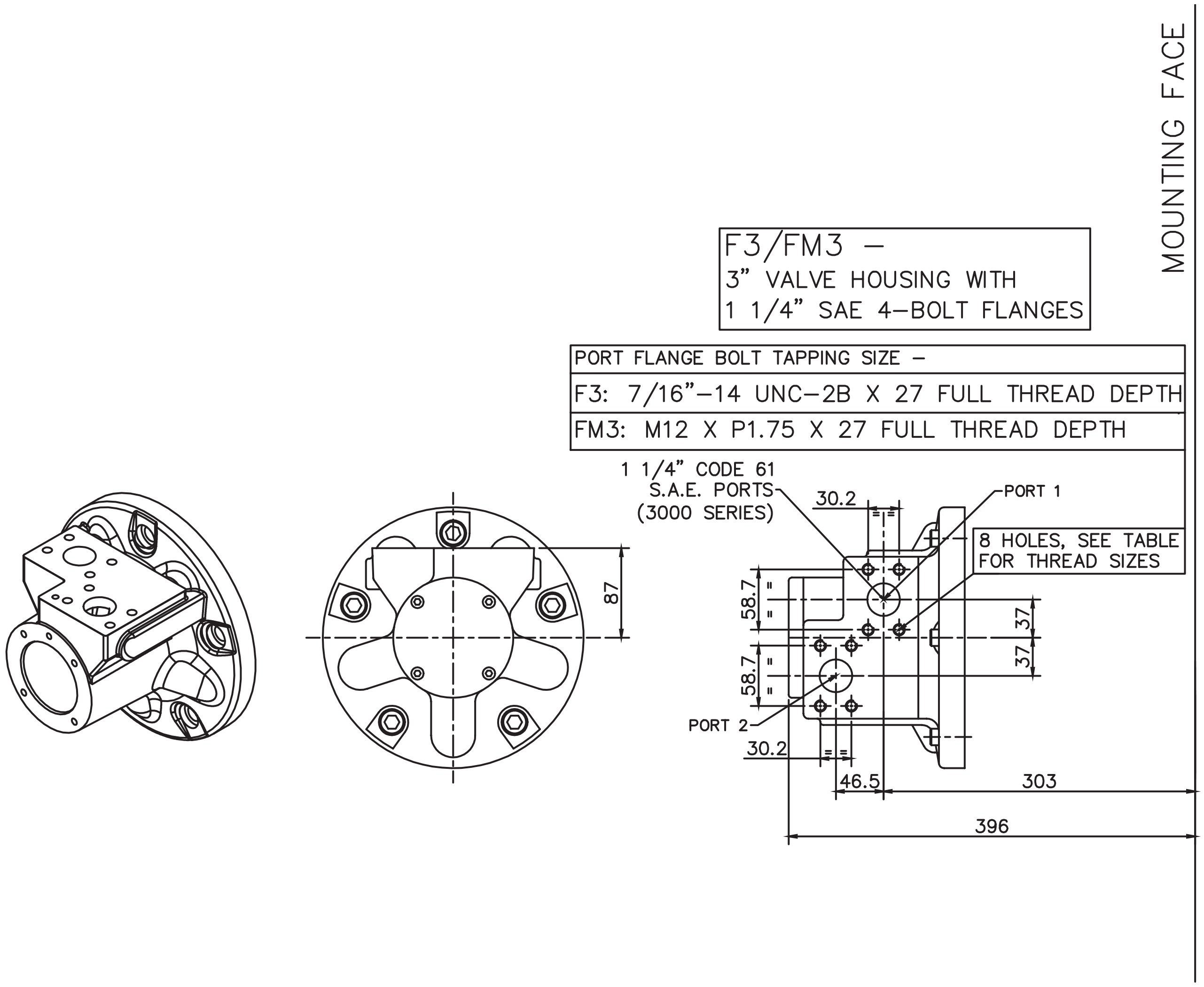
3-3 HMC080 (cont)

'SM3' Valve Housing



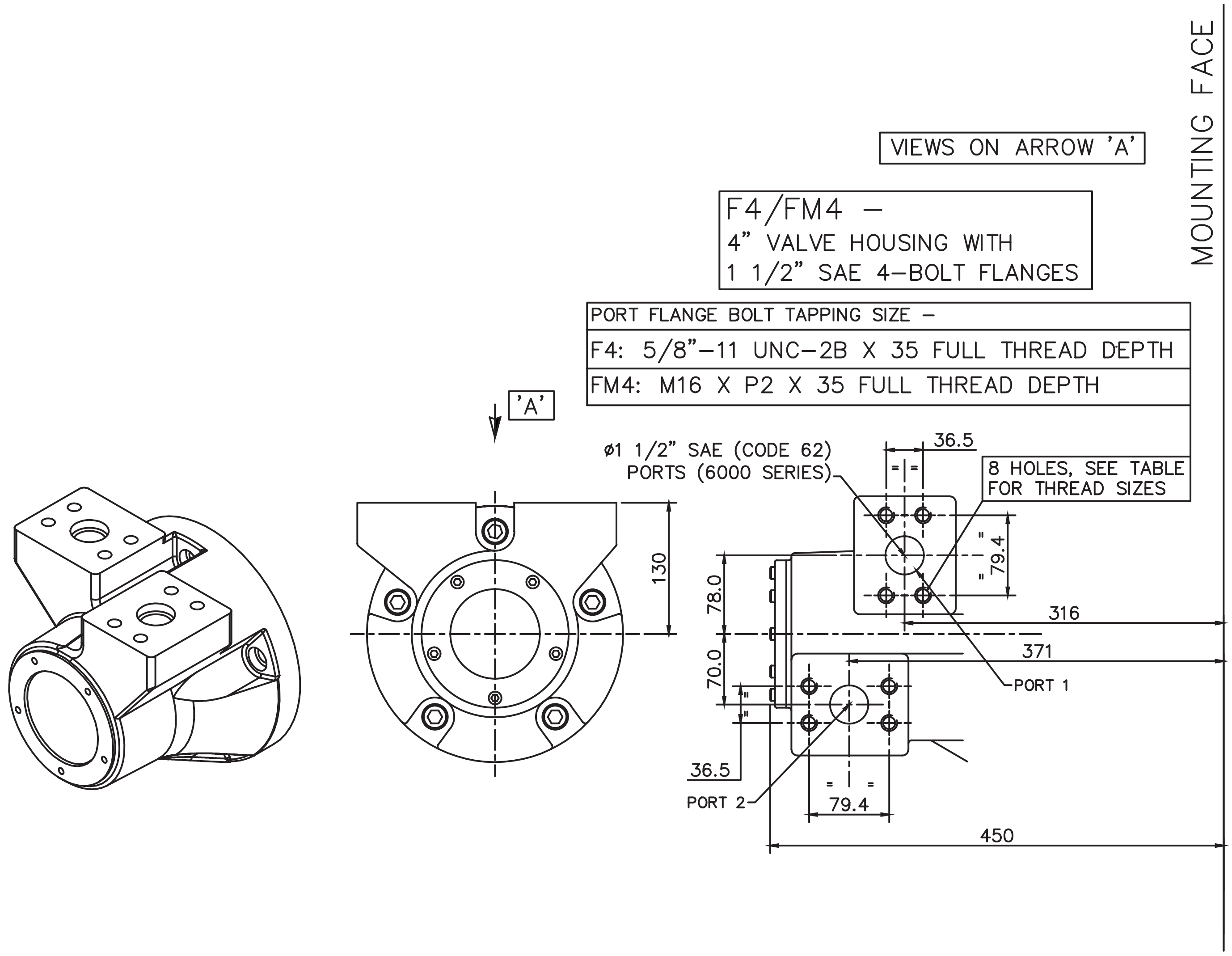
3-3 HMC080 (cont)

'F3' & 'FM3' Valve Housings



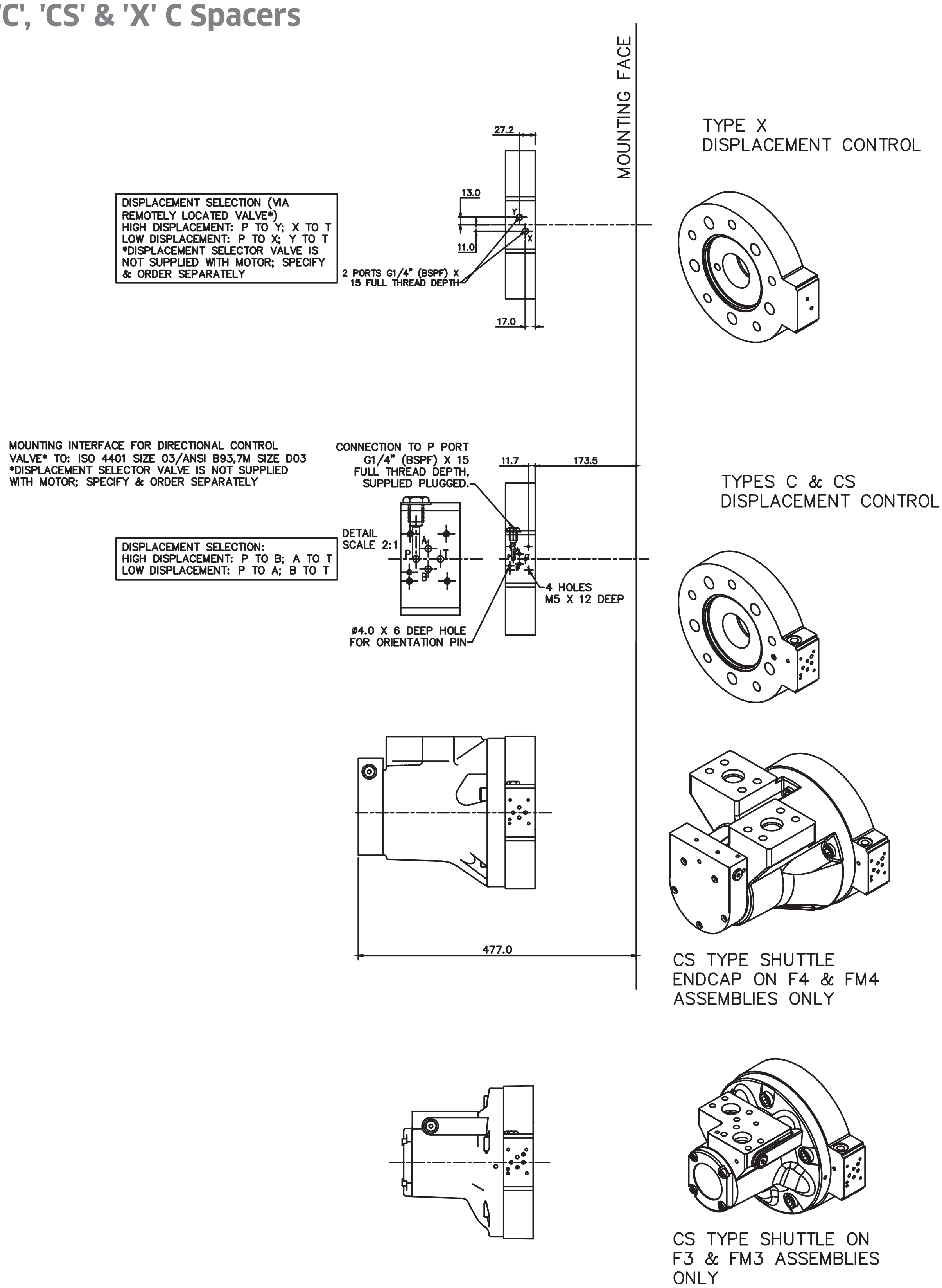
3-3 HMC080 (cont)

'F4' & 'FM4' Valve Housings



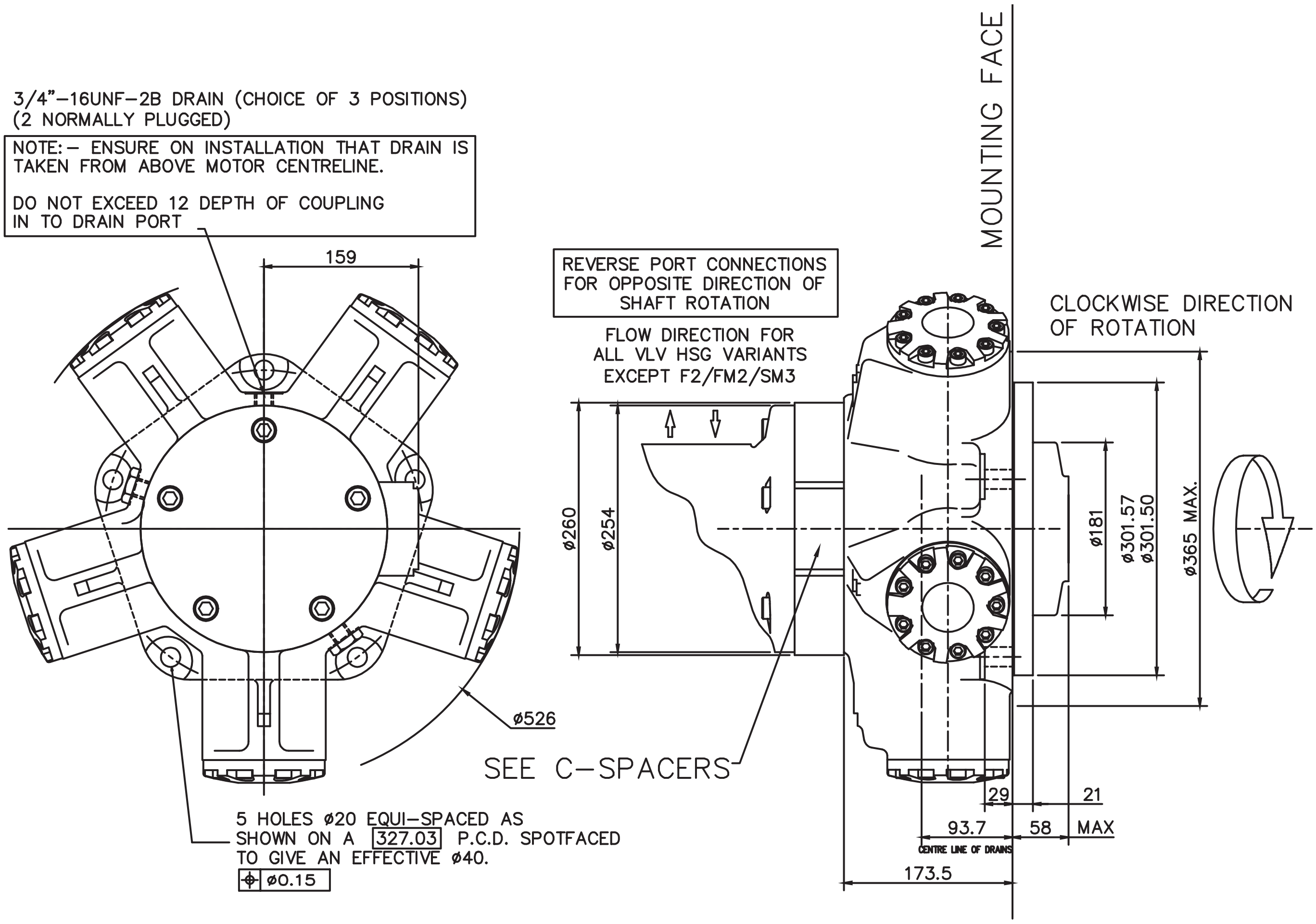
3-3 HMC080 (cont)

'C', 'CS' & 'X' C Spacers



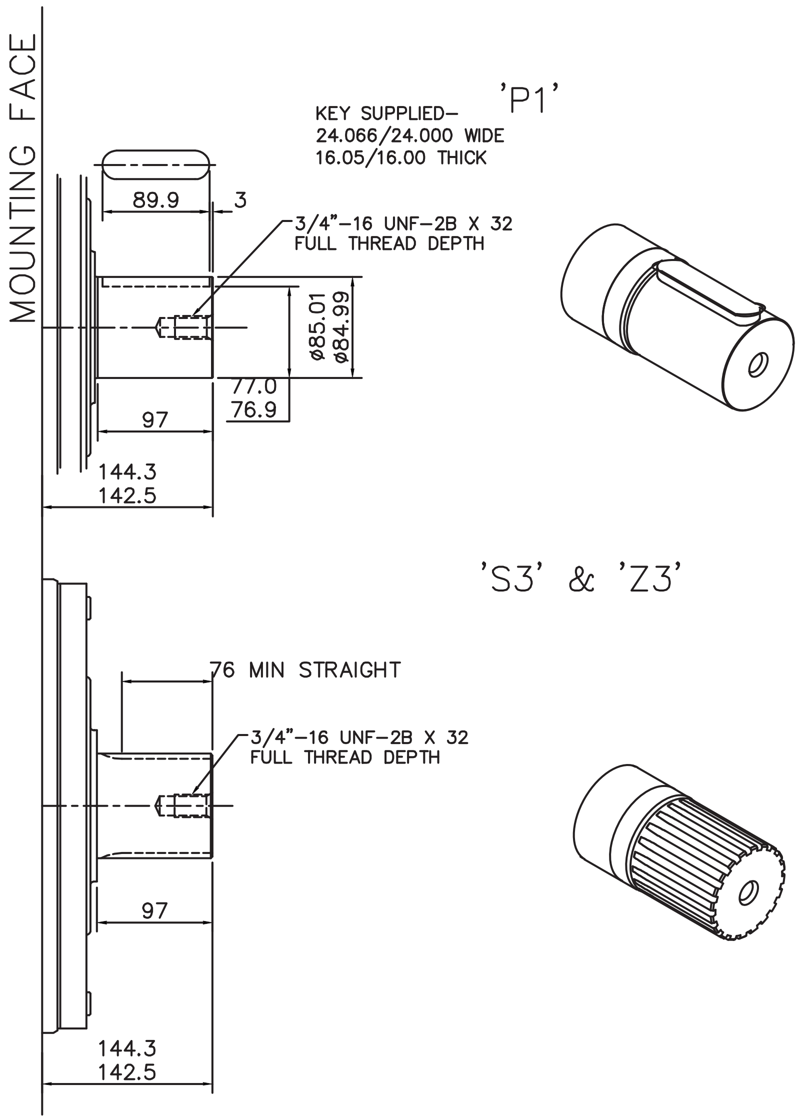
3-3 HMC080 (cont)

Installation



3-4 HMC125

'P1', 'S3' & 'Z3' Shafts



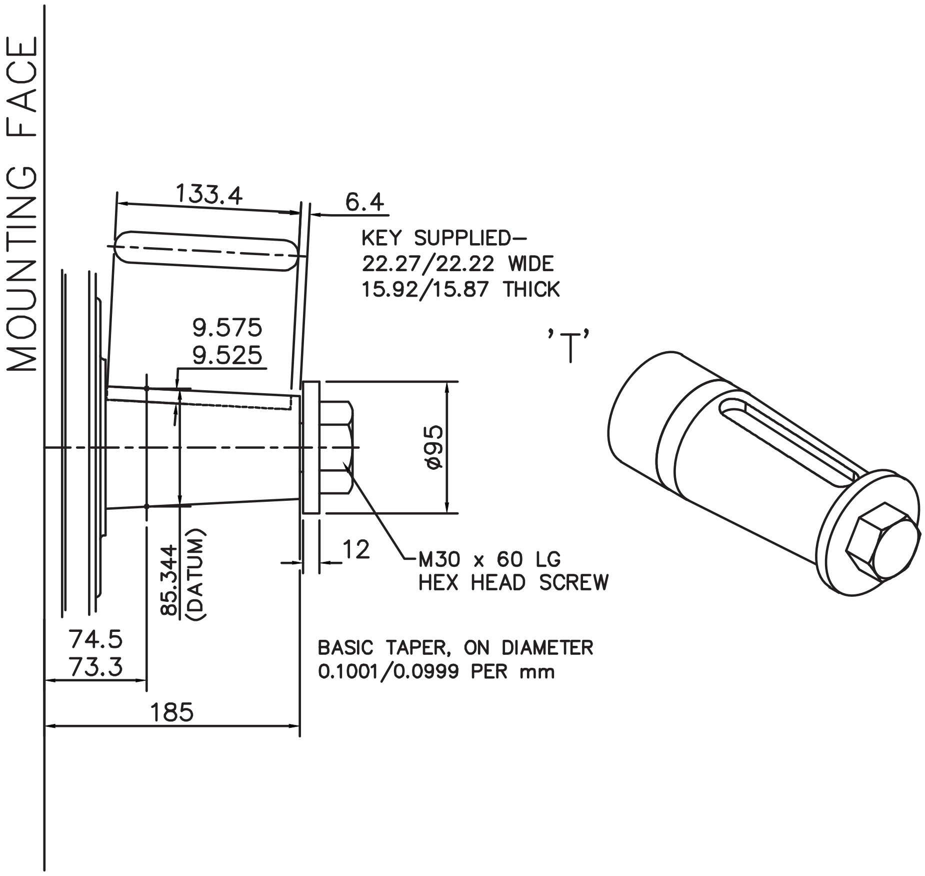
SPLINE DATA

'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z3'
DIN 5480 W85 x 3 x 27 x 7h

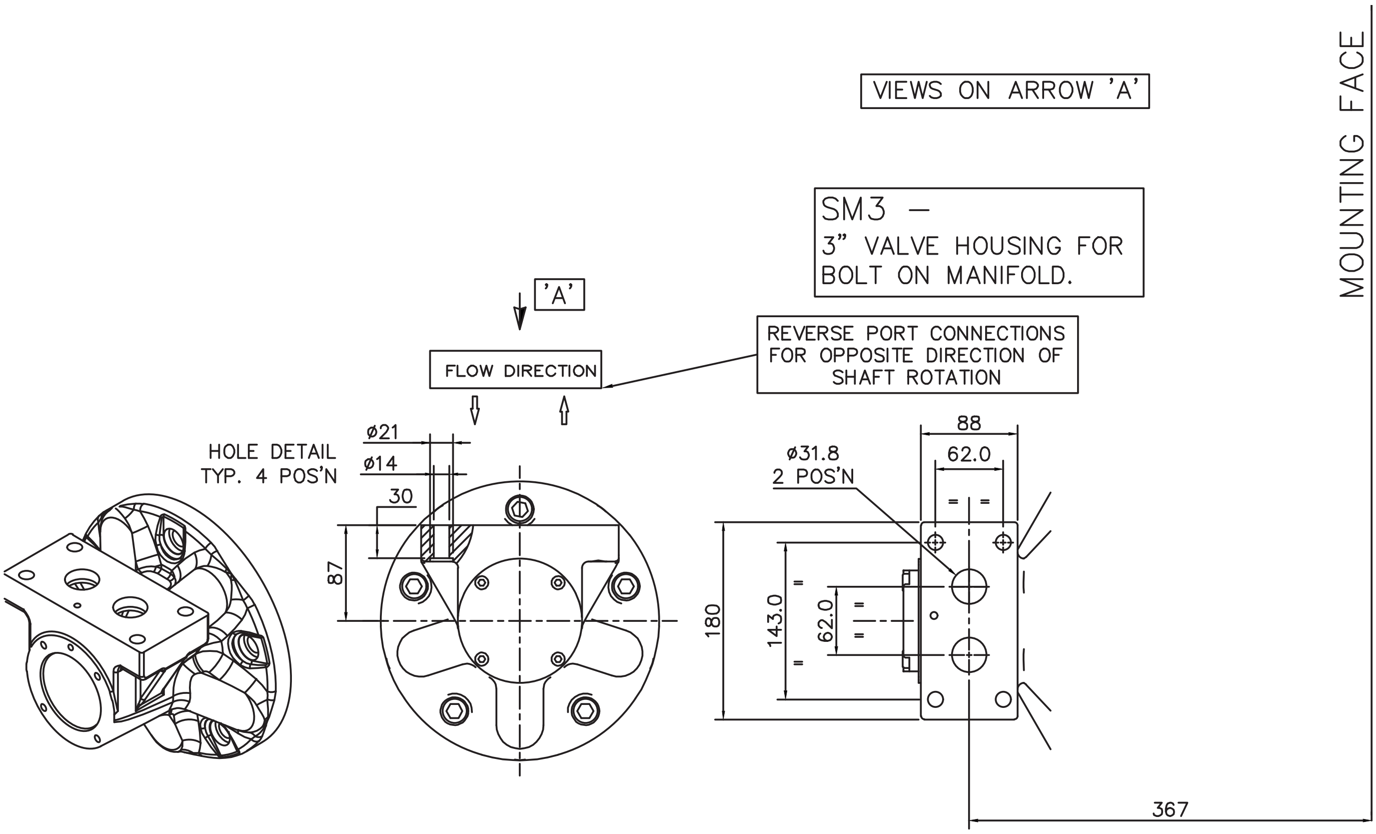
3-4 HMC125 (cont)

'T' Shaft



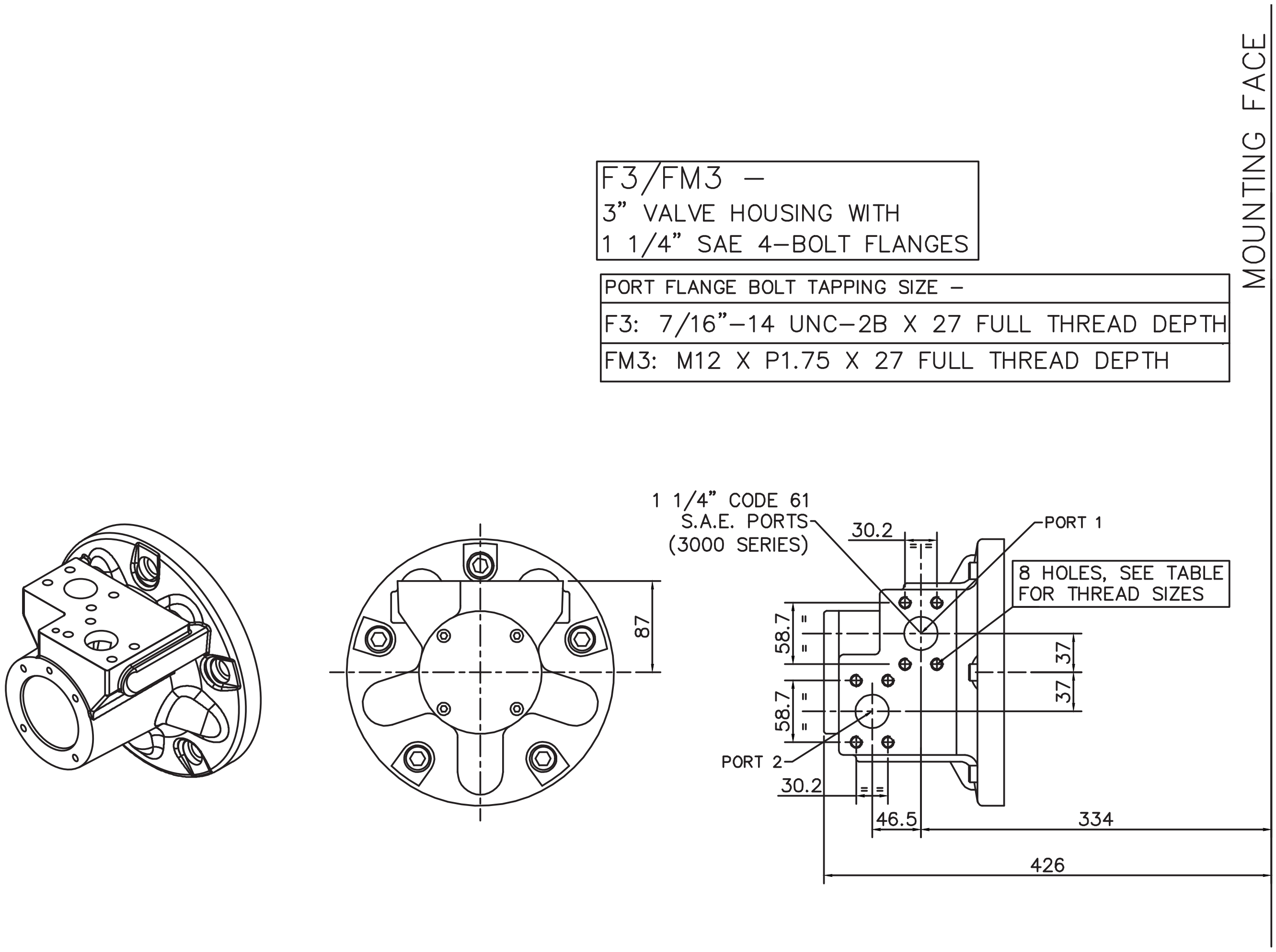
3-4 HMC125 (cont)

'SM3' Valve Housing



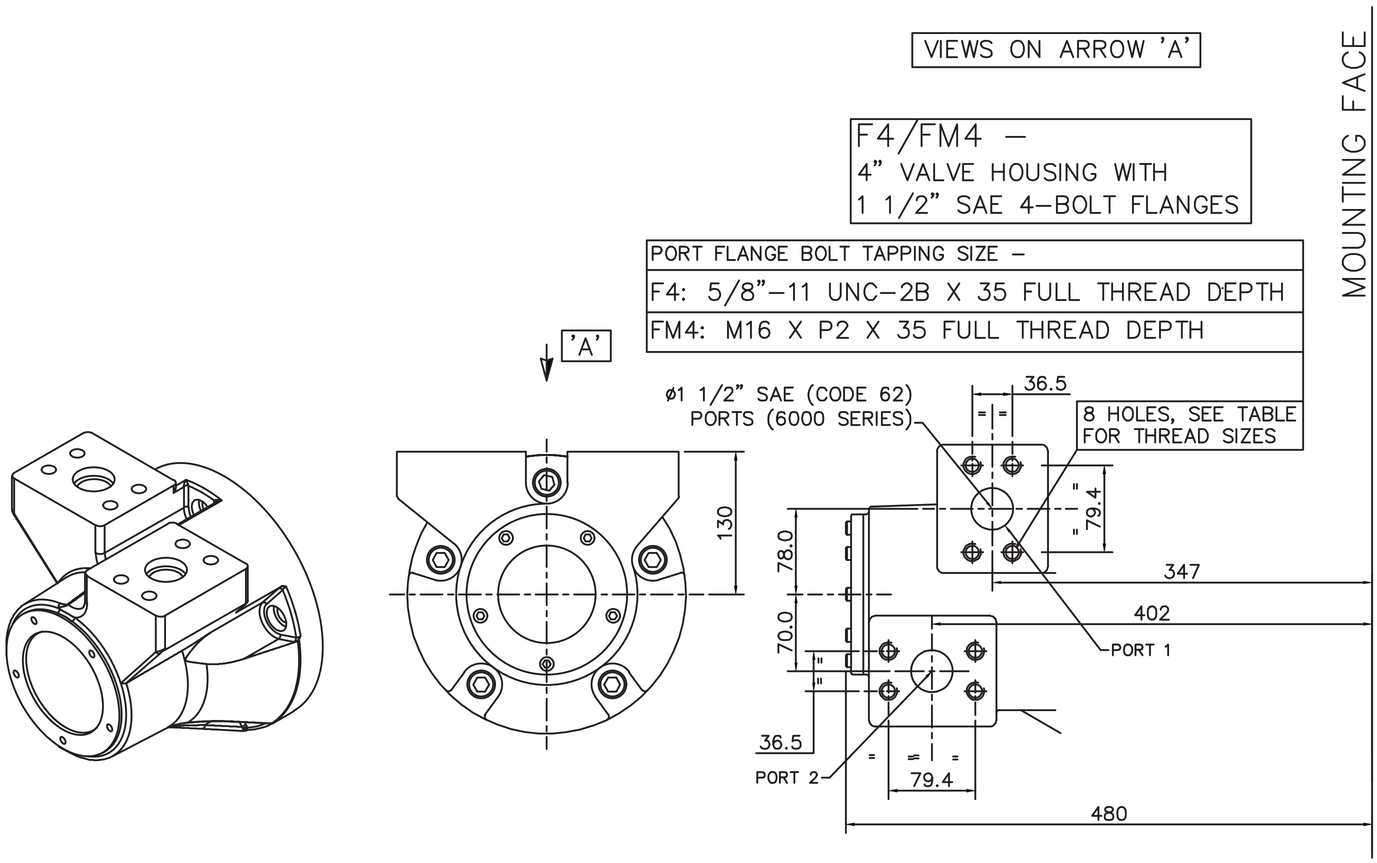
3-4 HMC125 (cont)

'F3' & 'FM3' Valve Housings



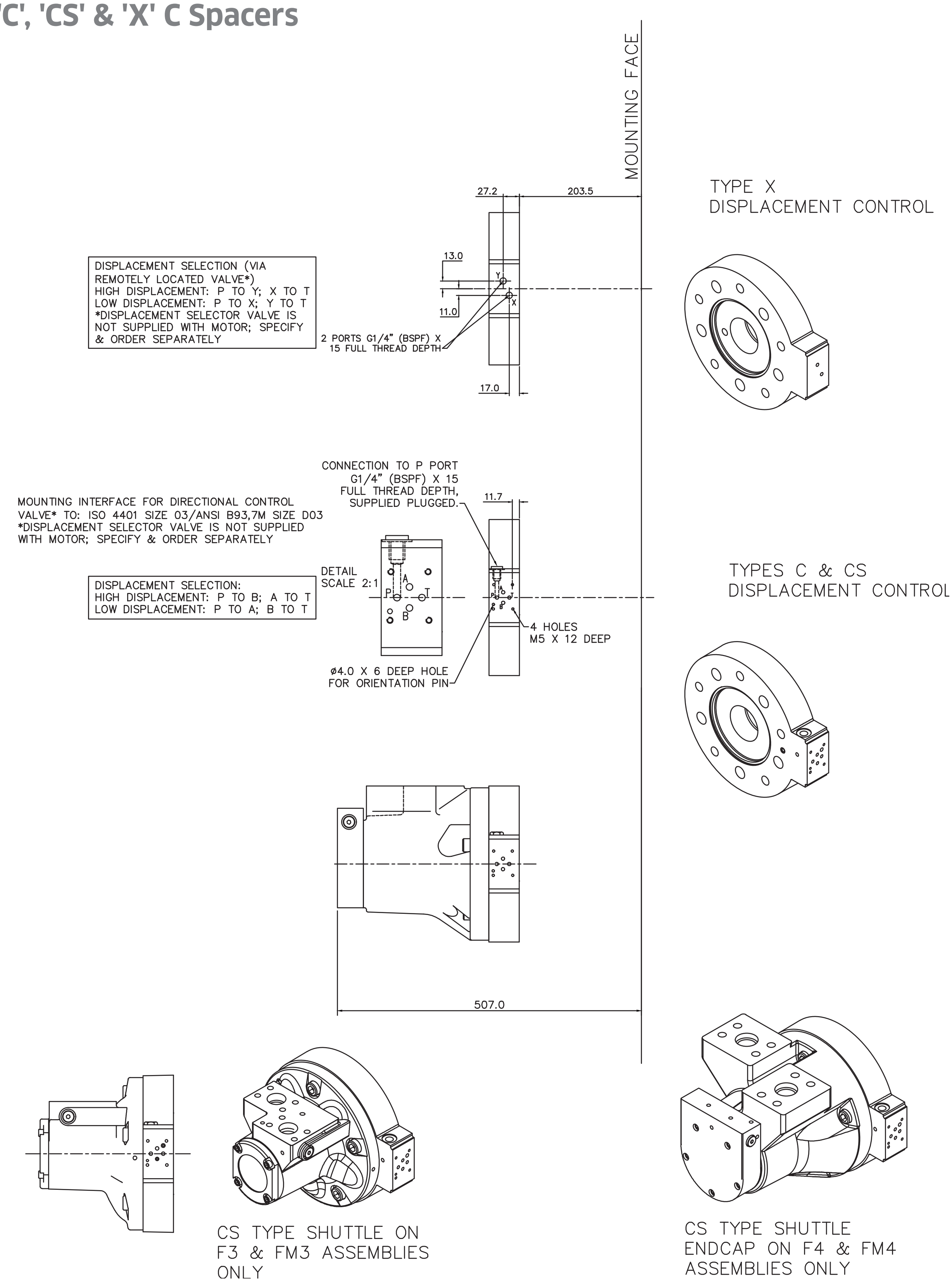
3-4 HMC125 (cont)

‘F4' & 'FM4' Valve Housings



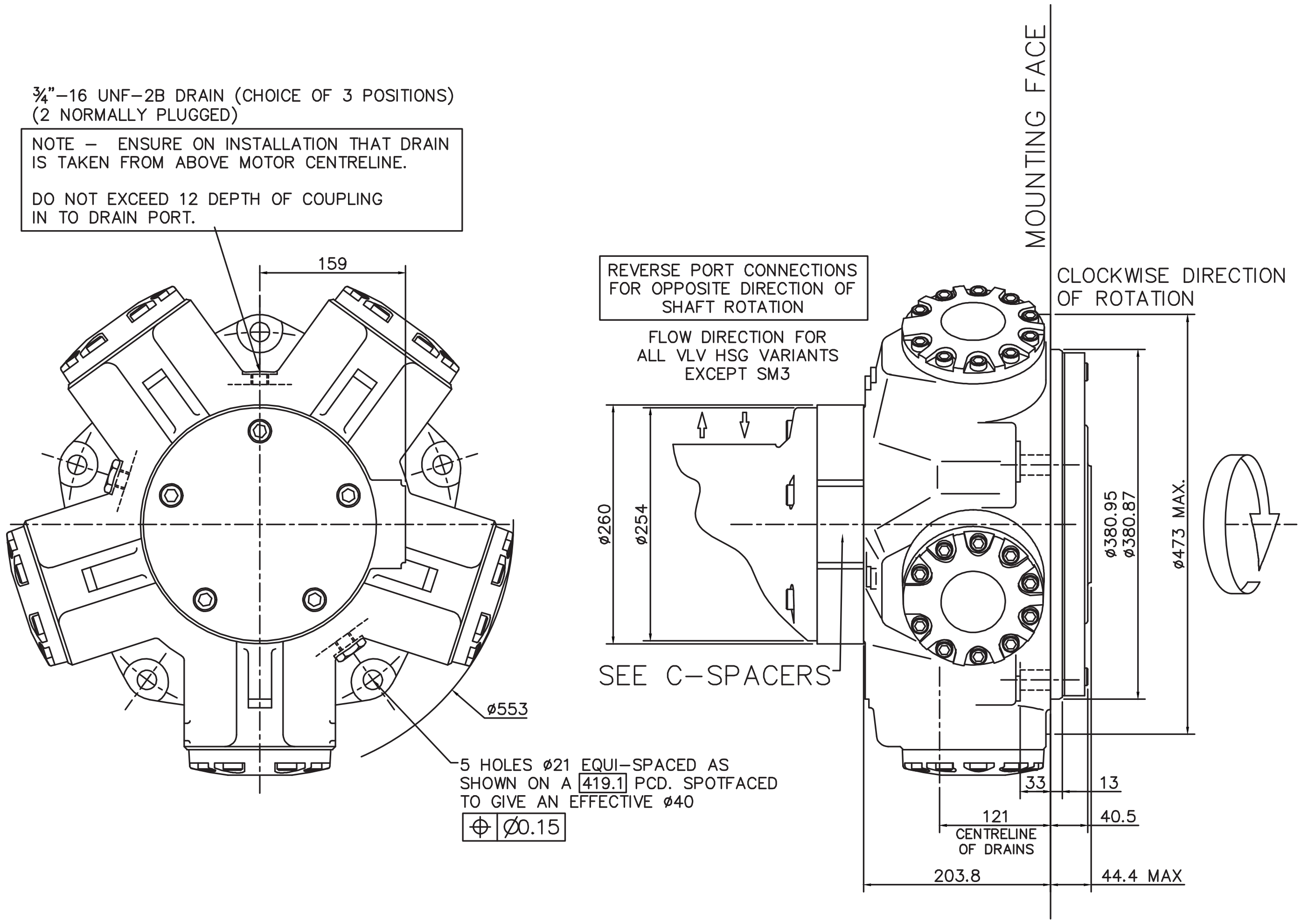
3-4 **HMC125** (cont)

'C', 'CS' & 'X' C Spacers



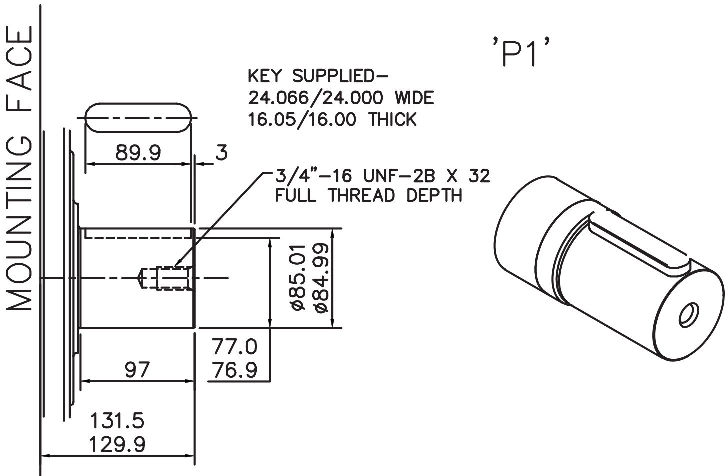
3-4 HMC125 (cont)

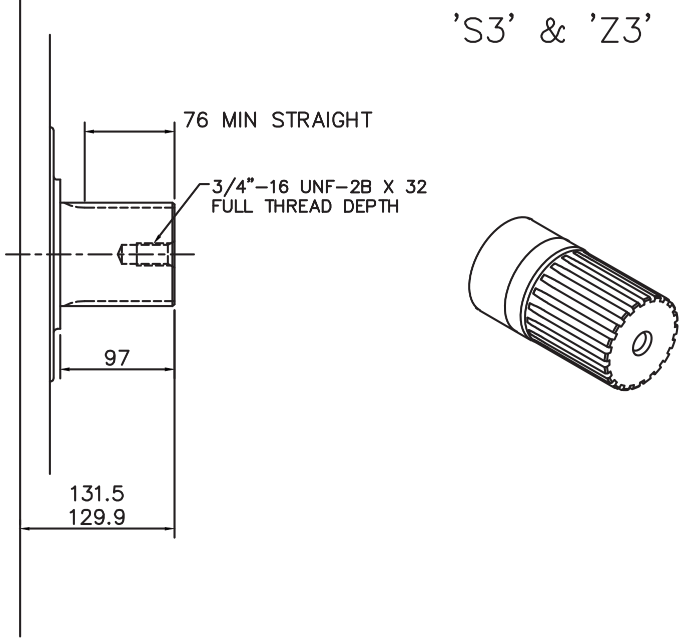
Installation



3-5 HMC200

'P1', 'S3' & 'Z3' Shafts





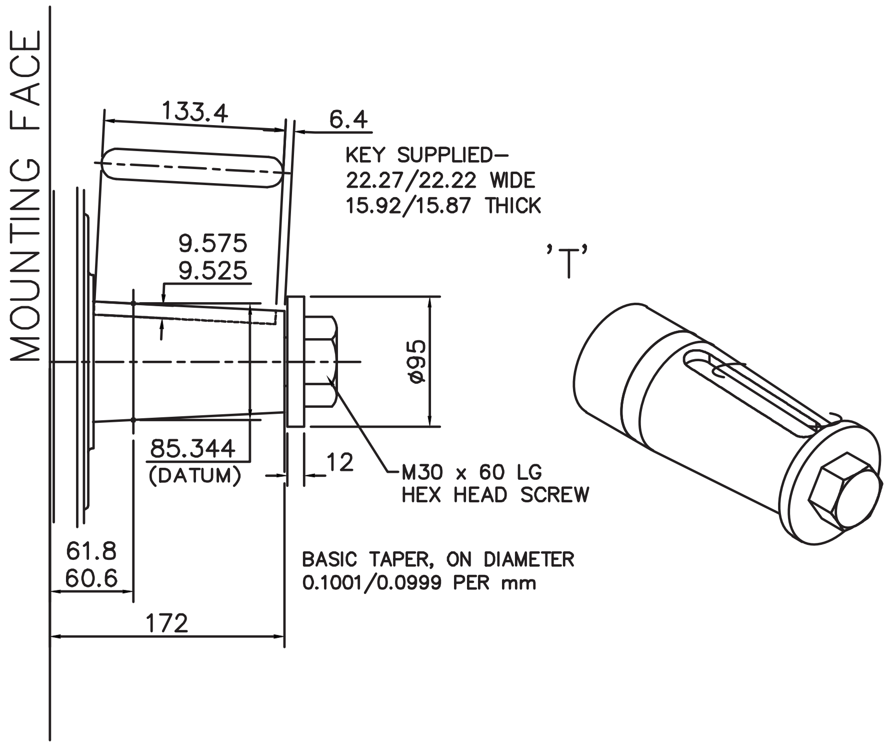
SPLINE DATA

'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z3'
DIN 5480 W85 x 3 x 27 x 7h

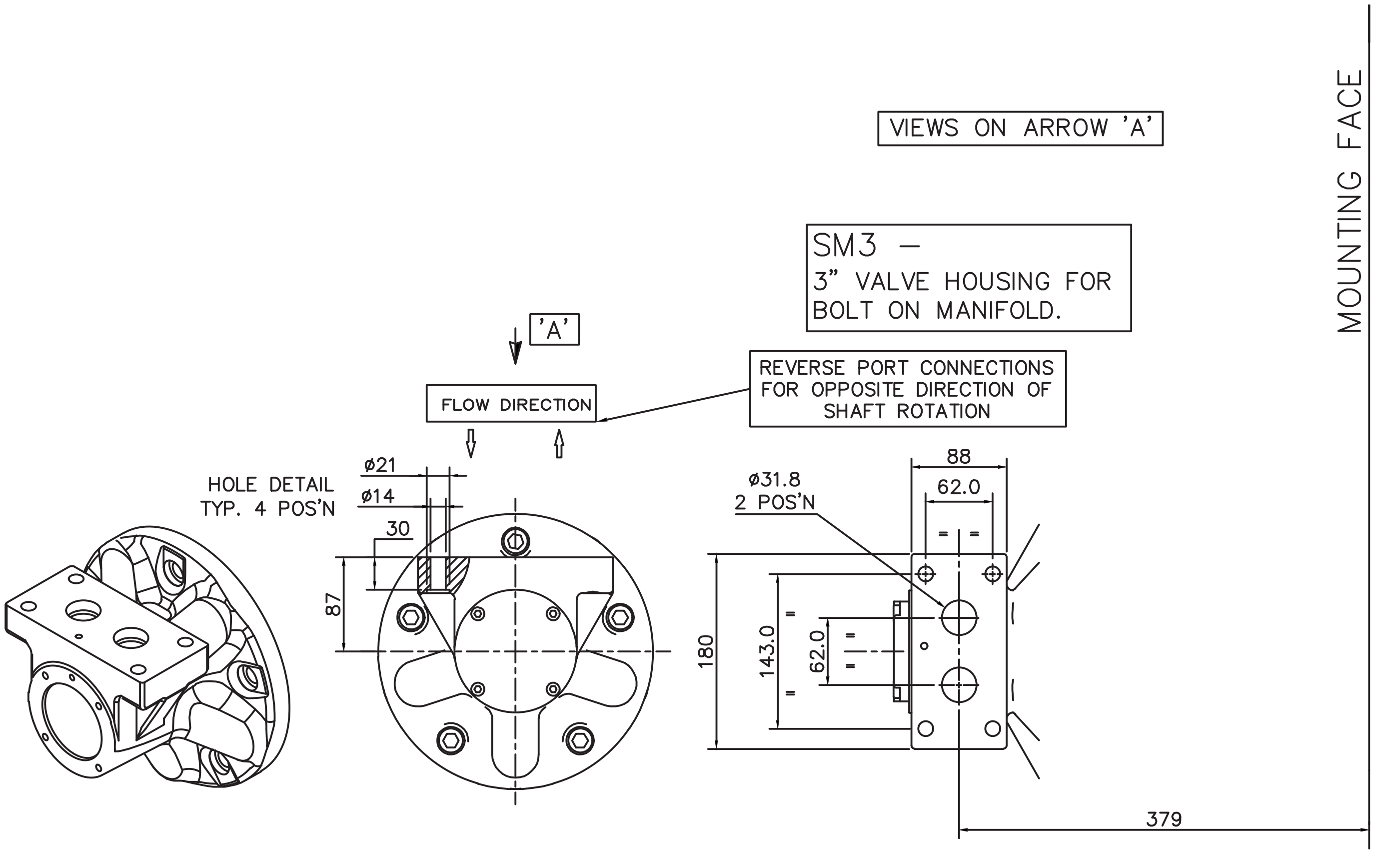
3-5 HMC200 (cont)

'T' Shaft



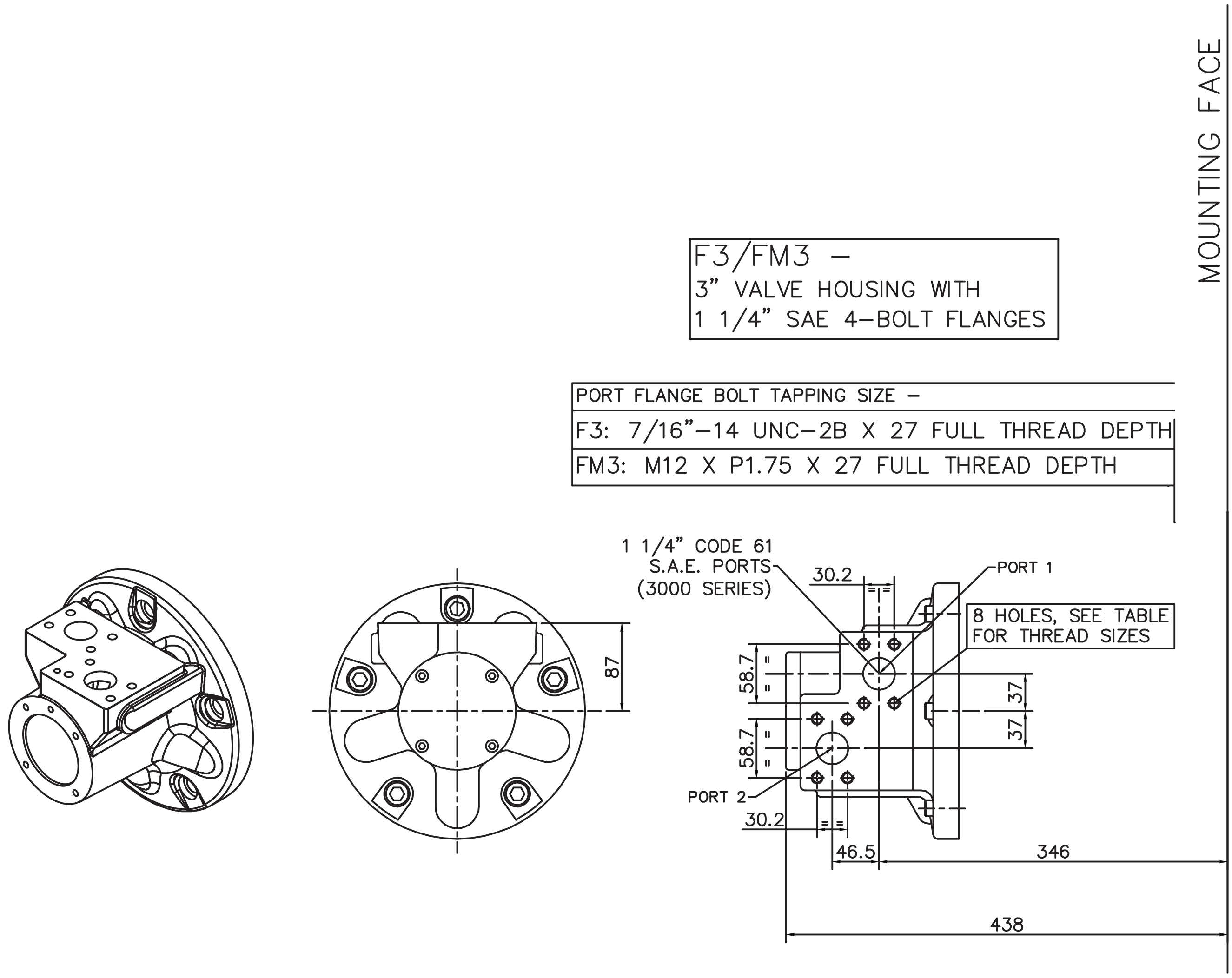
3-5 HMC200 (cont)

'SM3' Valve Housing



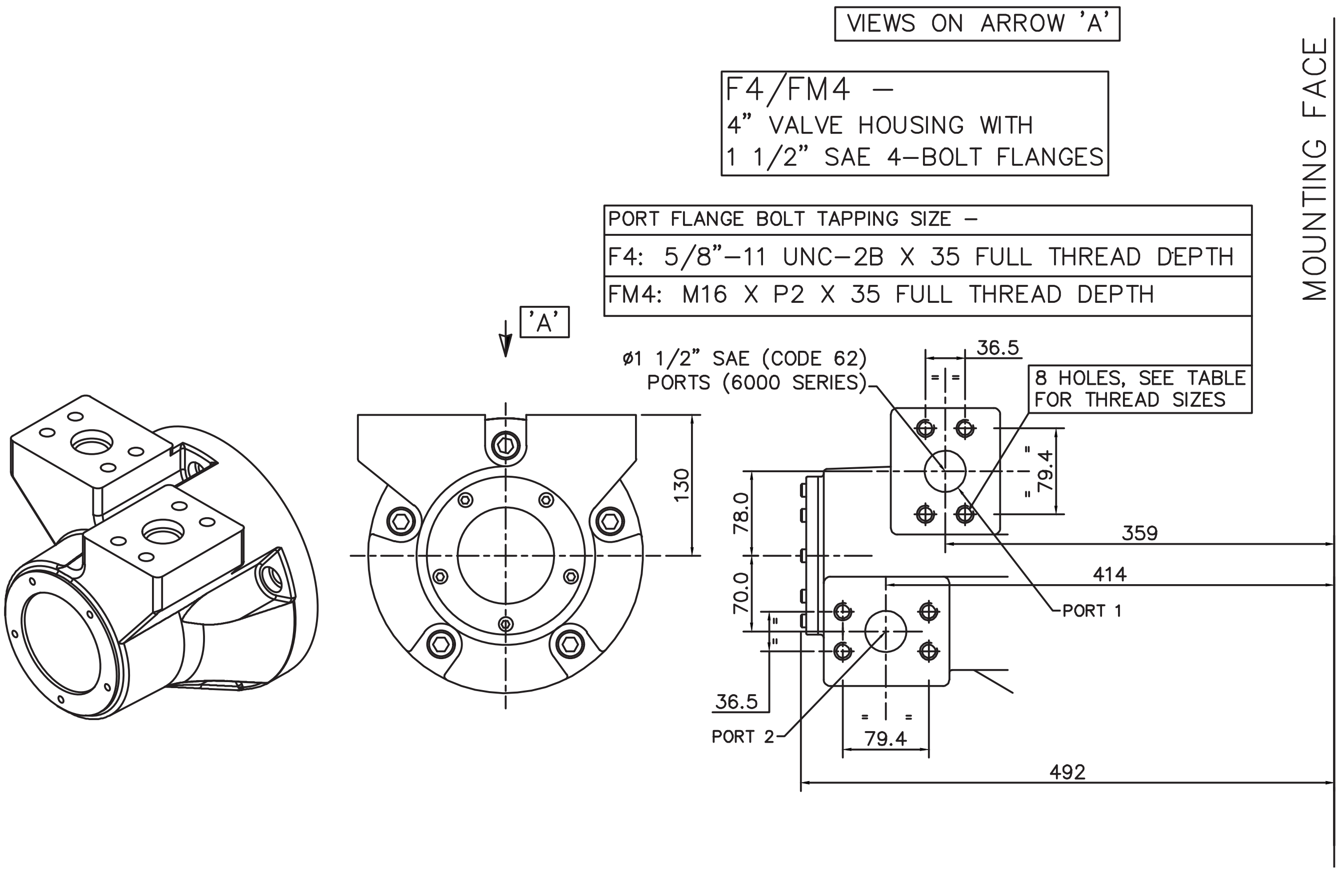
3-5 HMC200 (cont)

'F3' & 'FM3' Valve Housings



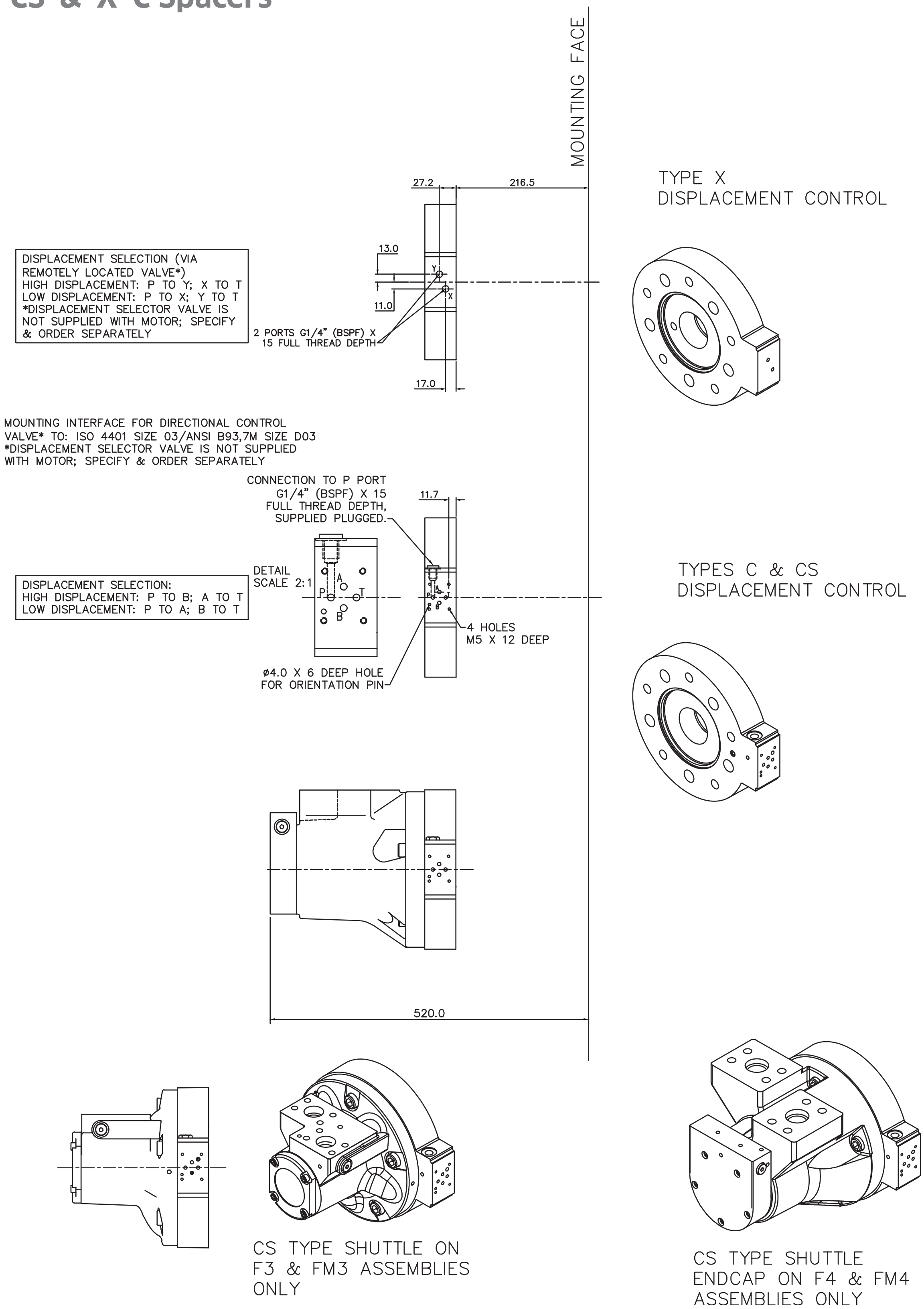
3-5 HMC200 (cont)

'F4' & 'FM4' Valve Housings



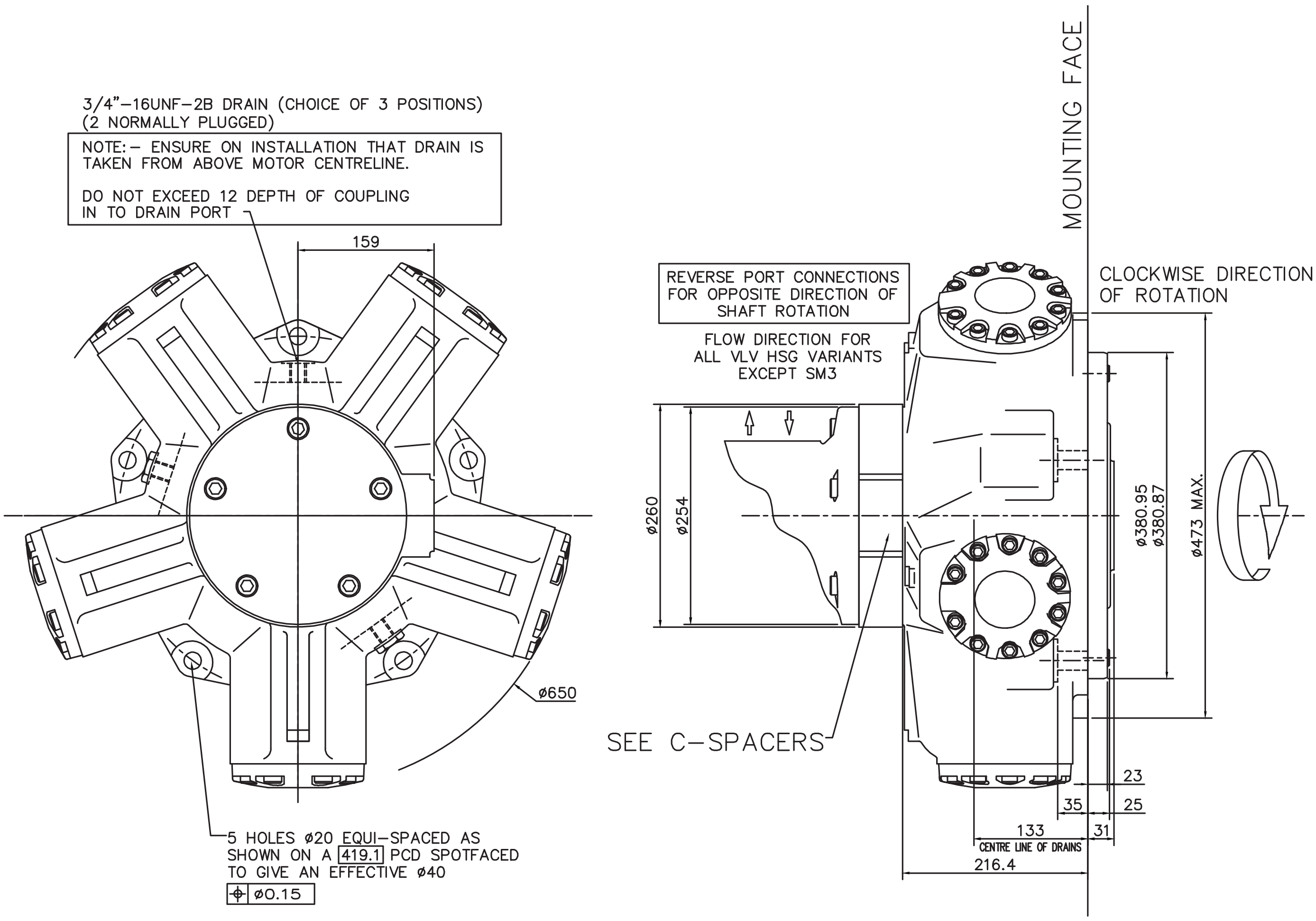
3-5 HMC200 (cont)

'C', 'CS' & 'X' C Spacers



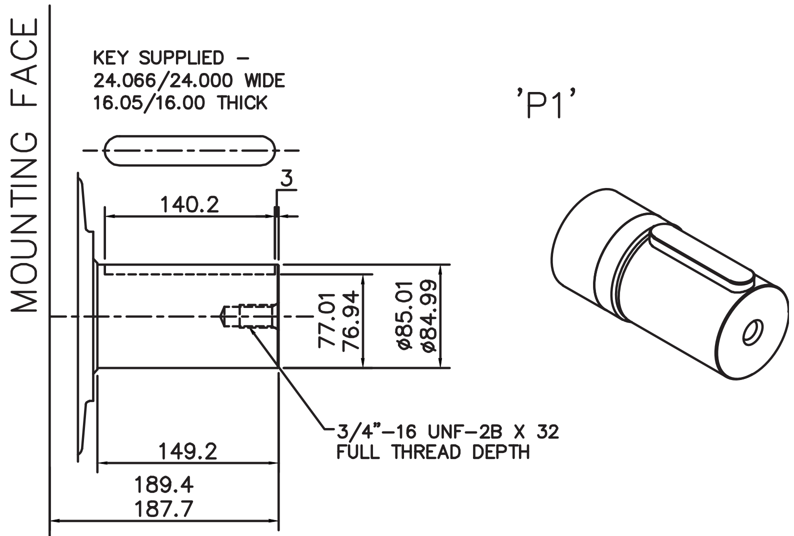
3-5 HMC200 (cont)

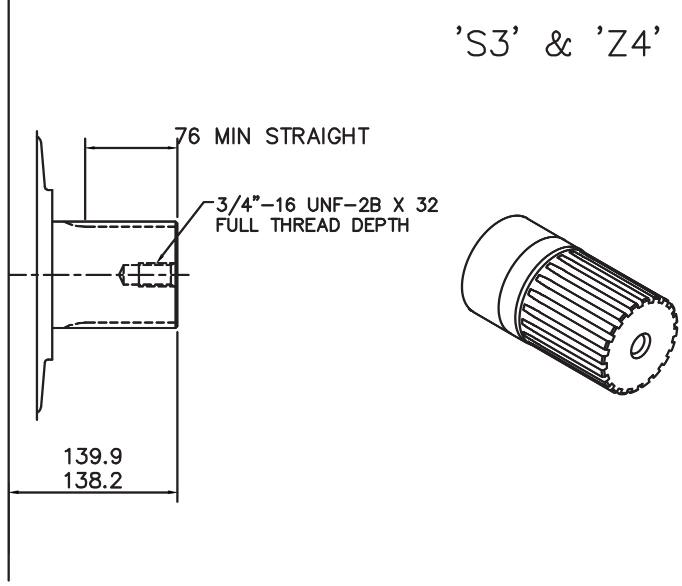
Installation



3-6 HMC270

'P1', 'S3' & 'Z4' Shafts





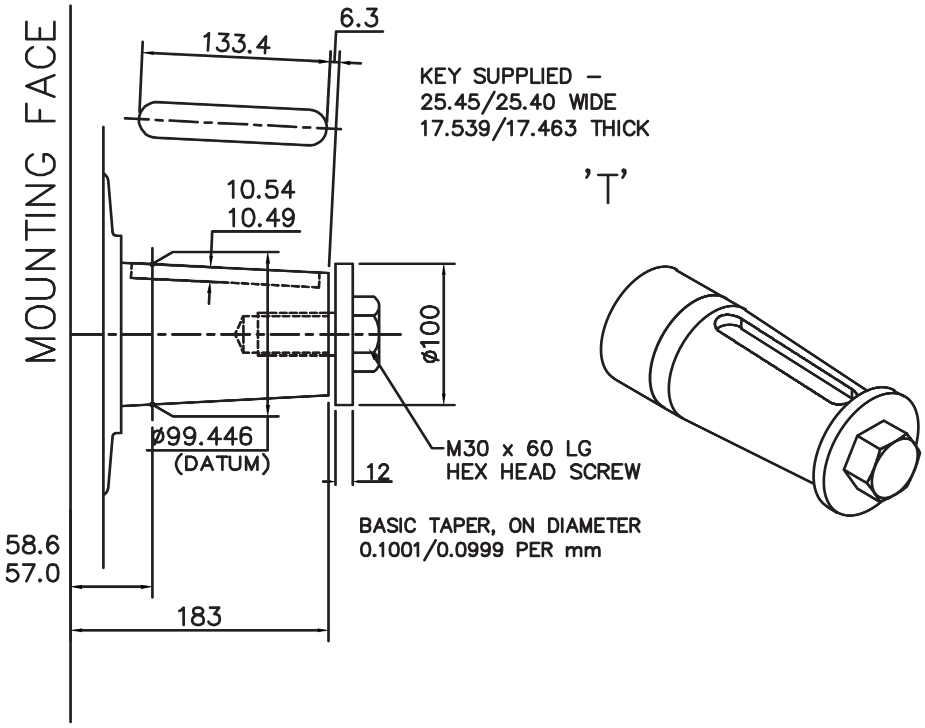
SPLINE DATA

'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z4'
DIN 5480 W90 x 4 x 21 x 7h

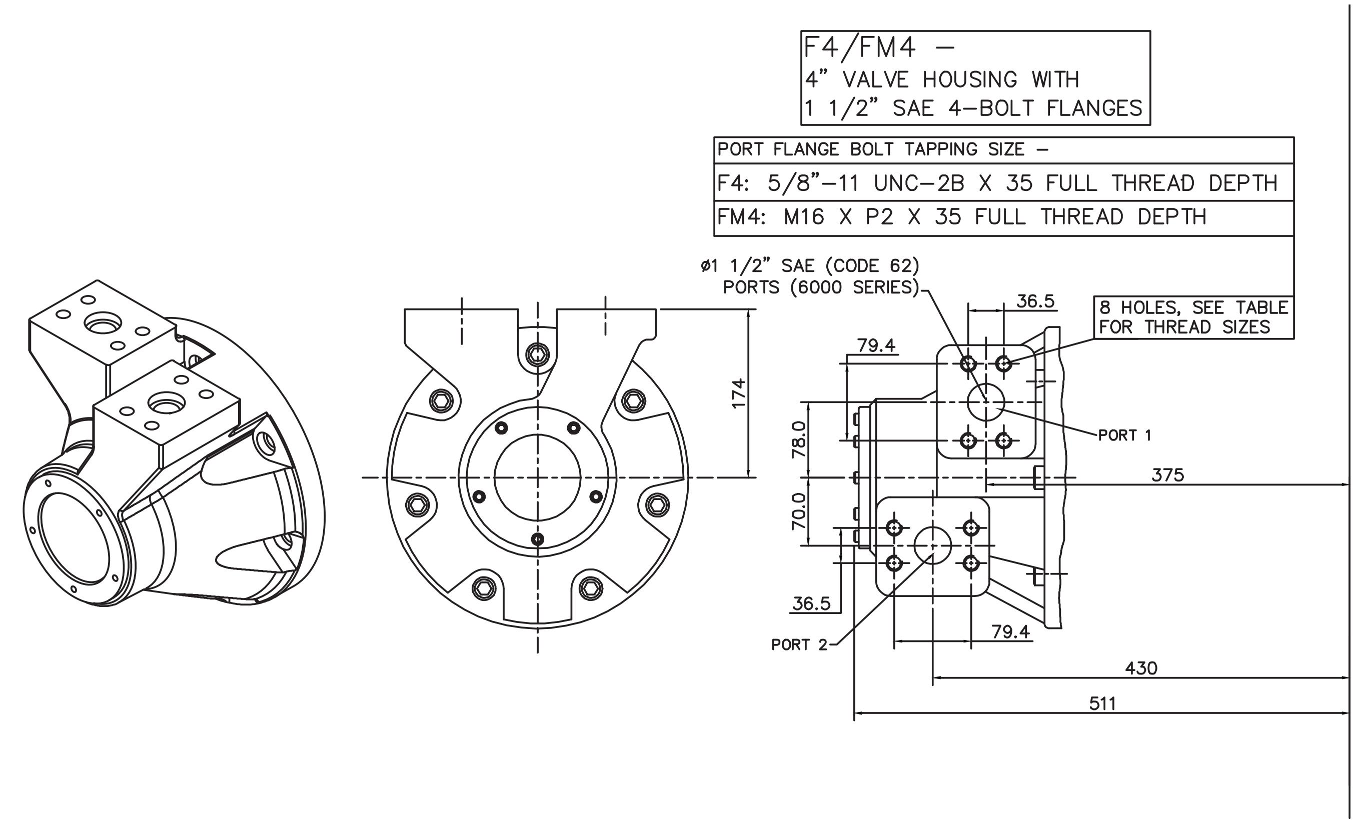
3-6 HMC270 (cont)

'T' Shaft



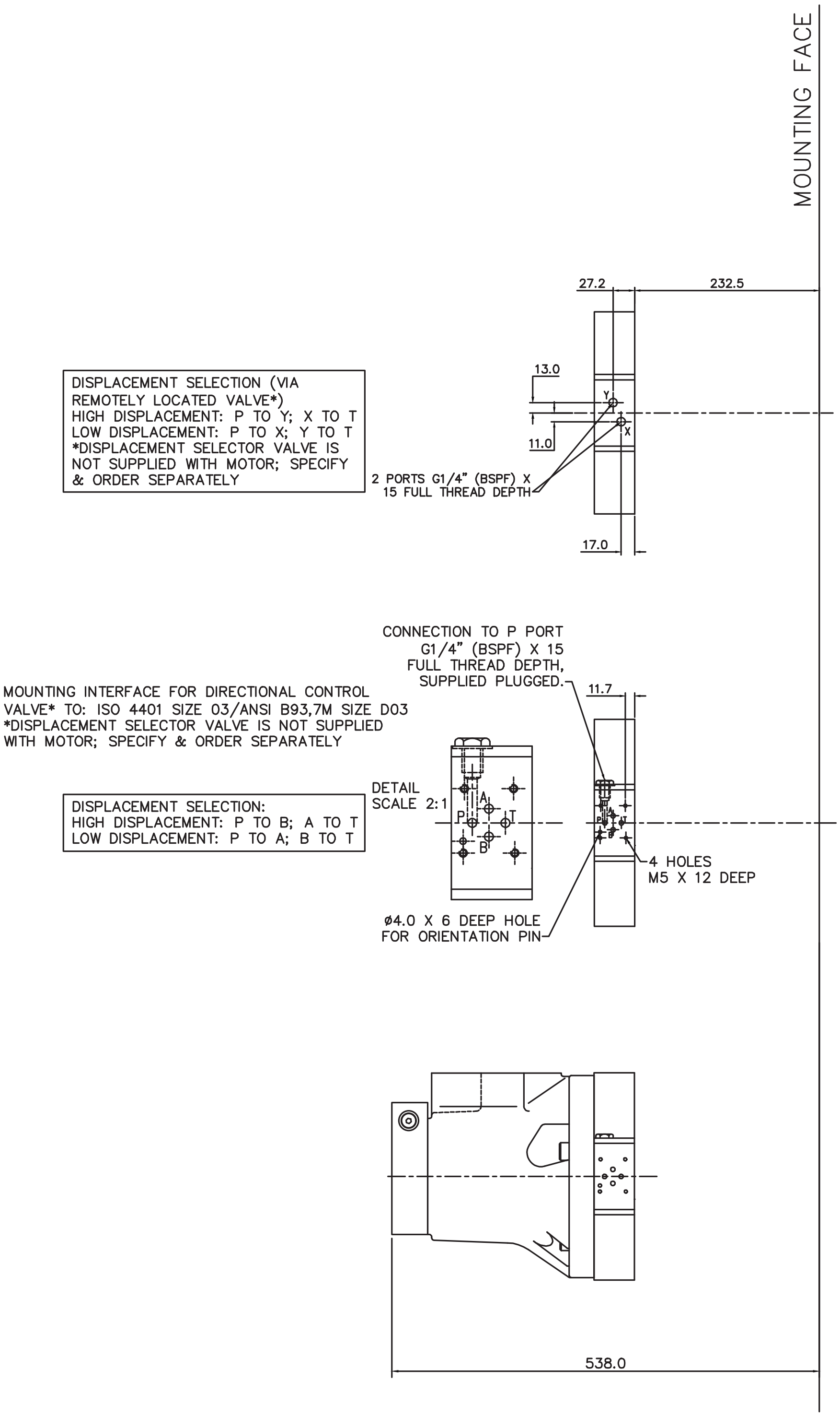
3-6 HMC270 (cont)

'F4' & 'FM4' Valve Housings

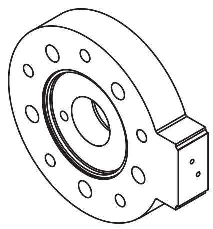


3-6 HMC270 (cont)

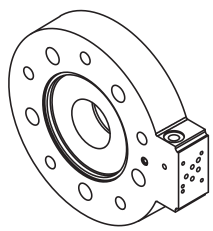
'C', 'CS' & 'X' C Spacers

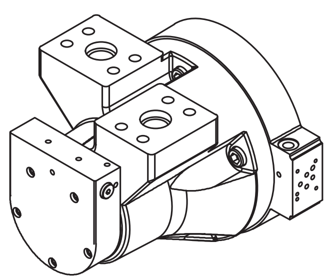


TYPE X
DISPLACEMENT CONTROL



TYPES C & CS
DISPLACEMENT CONTR

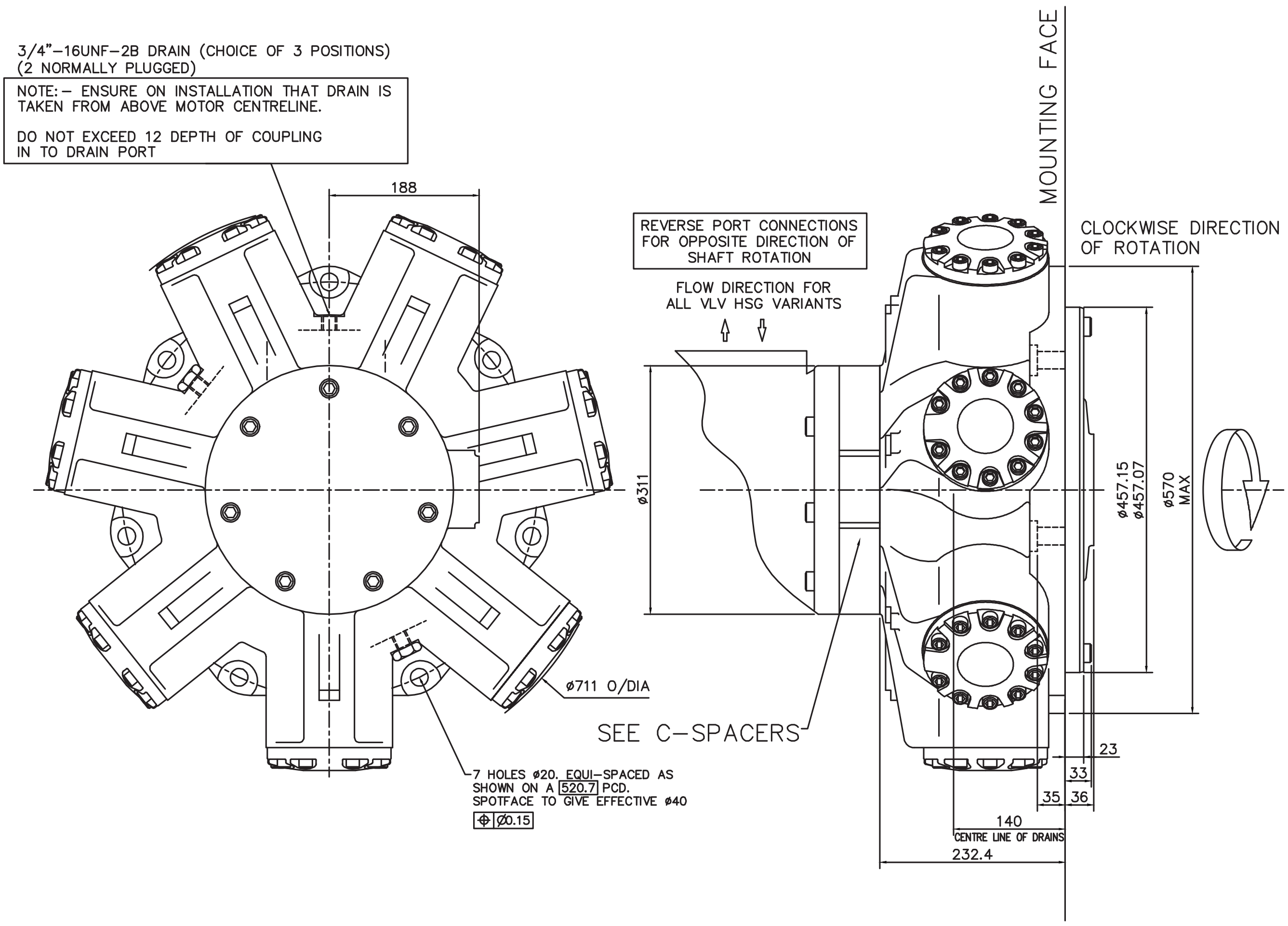




CS TYPE SHUTTLE
ENDCAP ON F4 & FM4
ASSEMBLIES ONLY

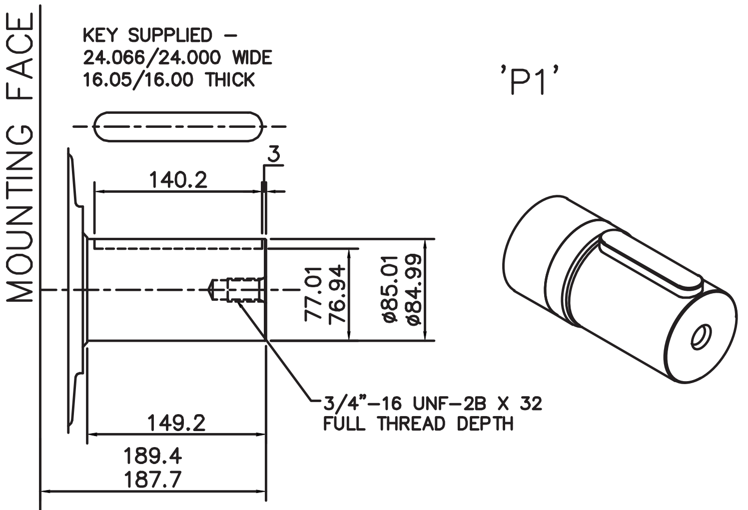
3-6 HMC270 (cont)

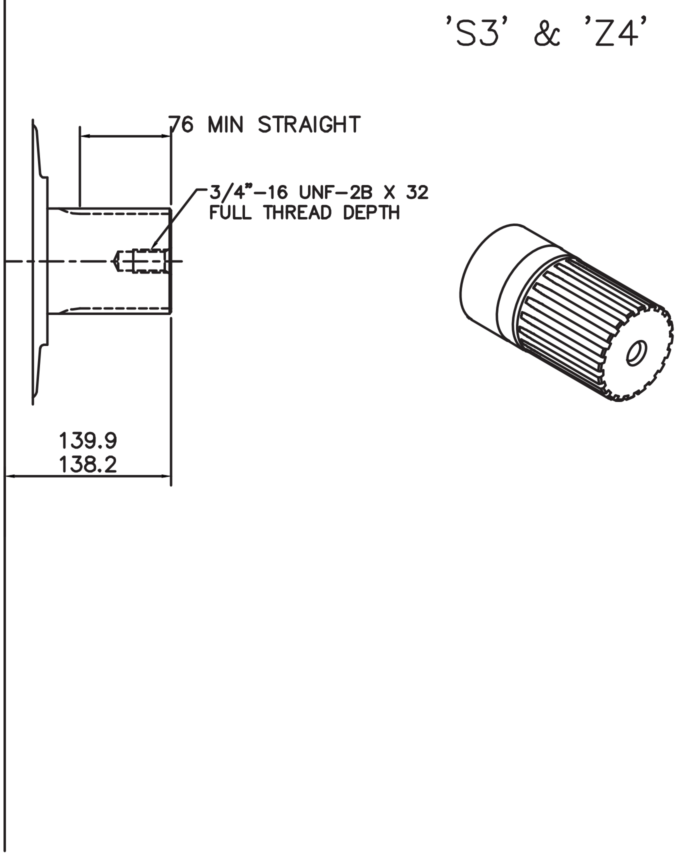
Installation



3-7 HMC325

'P1', 'S3' & 'Z4' Shafts





SPLINE DATA

'S'

TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

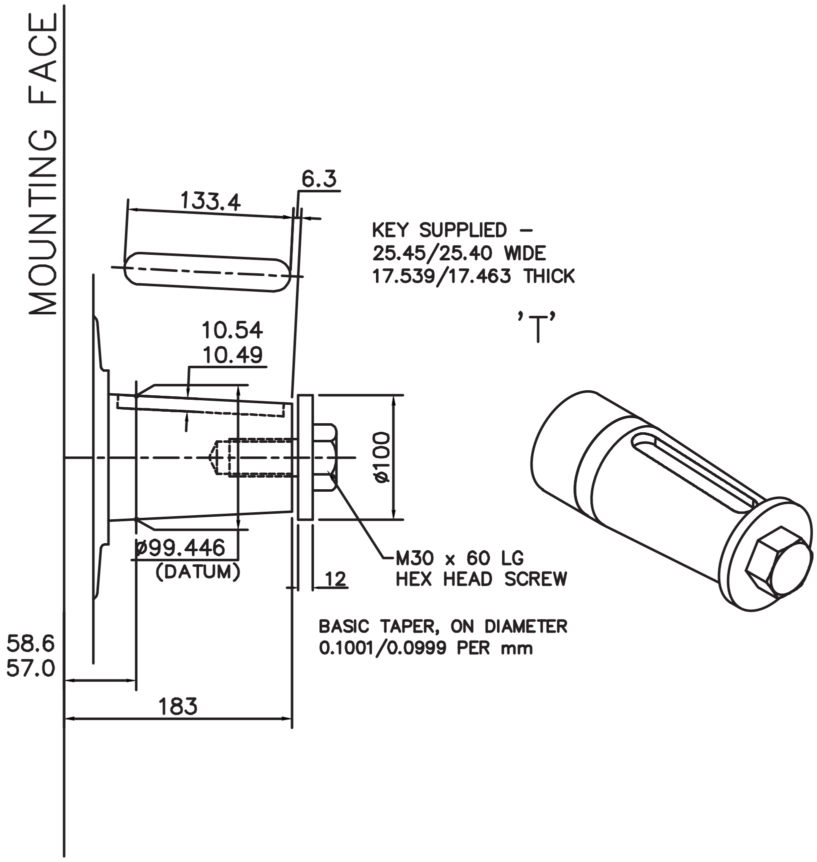
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z'

DIN 5480 W90 x 4 x 21 x 7h

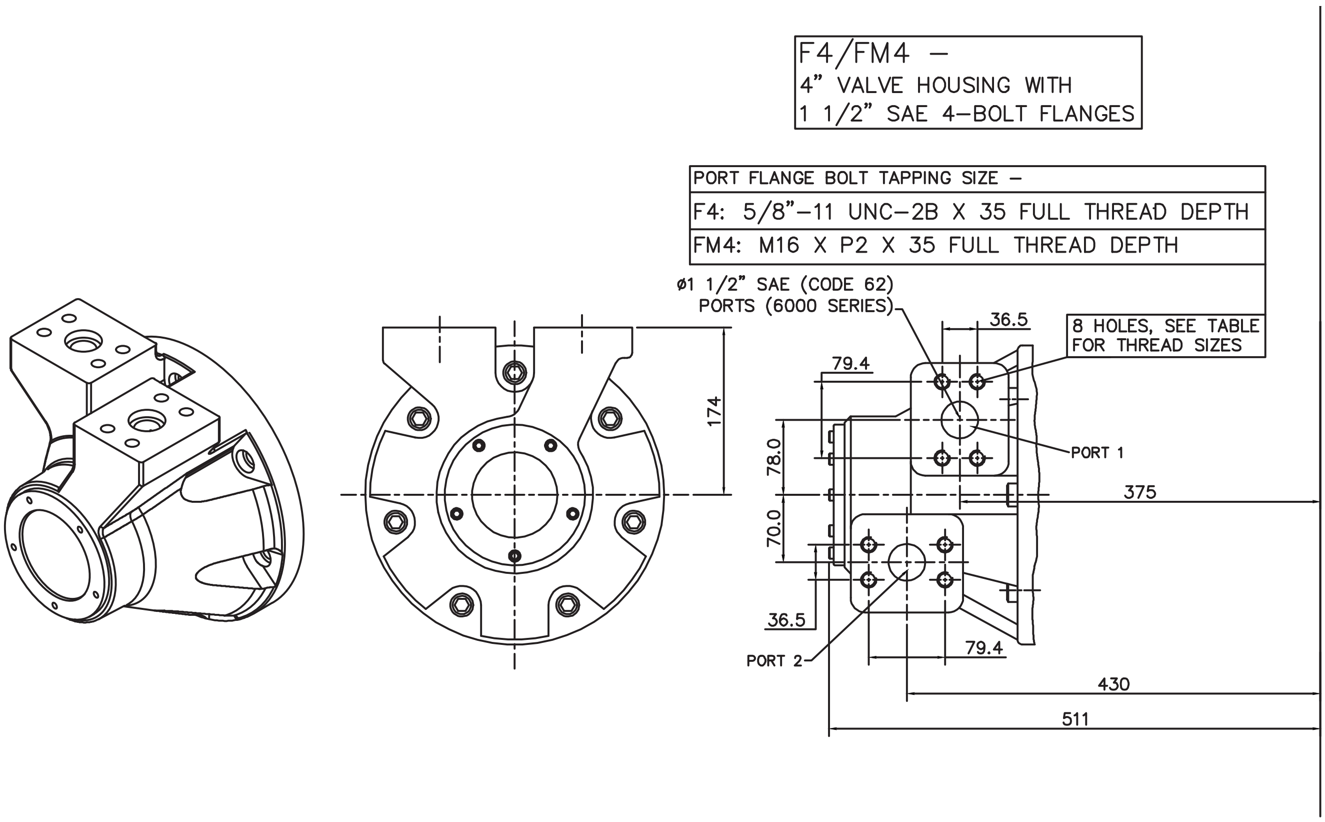
3-7 HMC325 (cont)

'T' Shaft



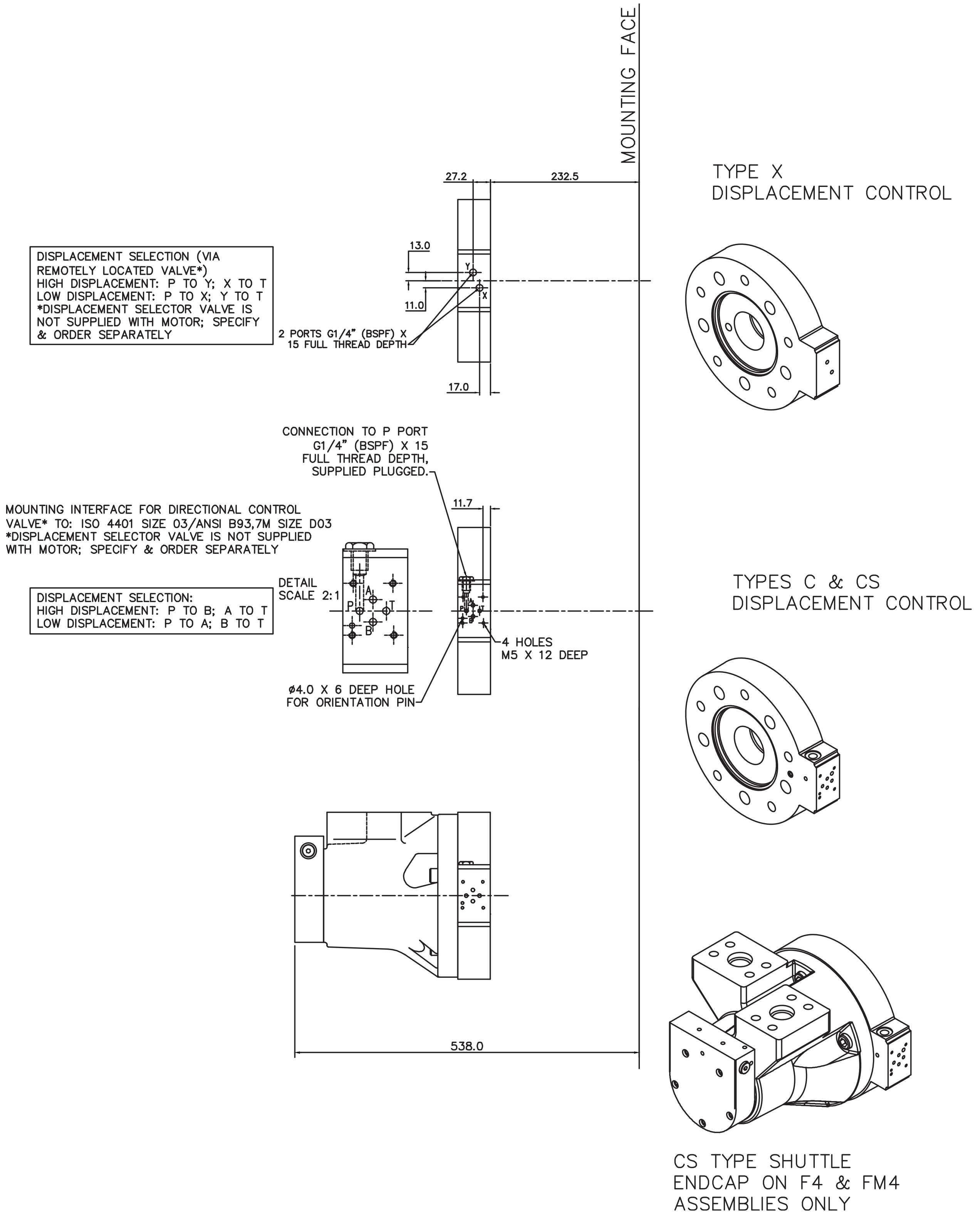
3-7 HMC325 (cont)

'F4' & 'FM4' Valve Housings



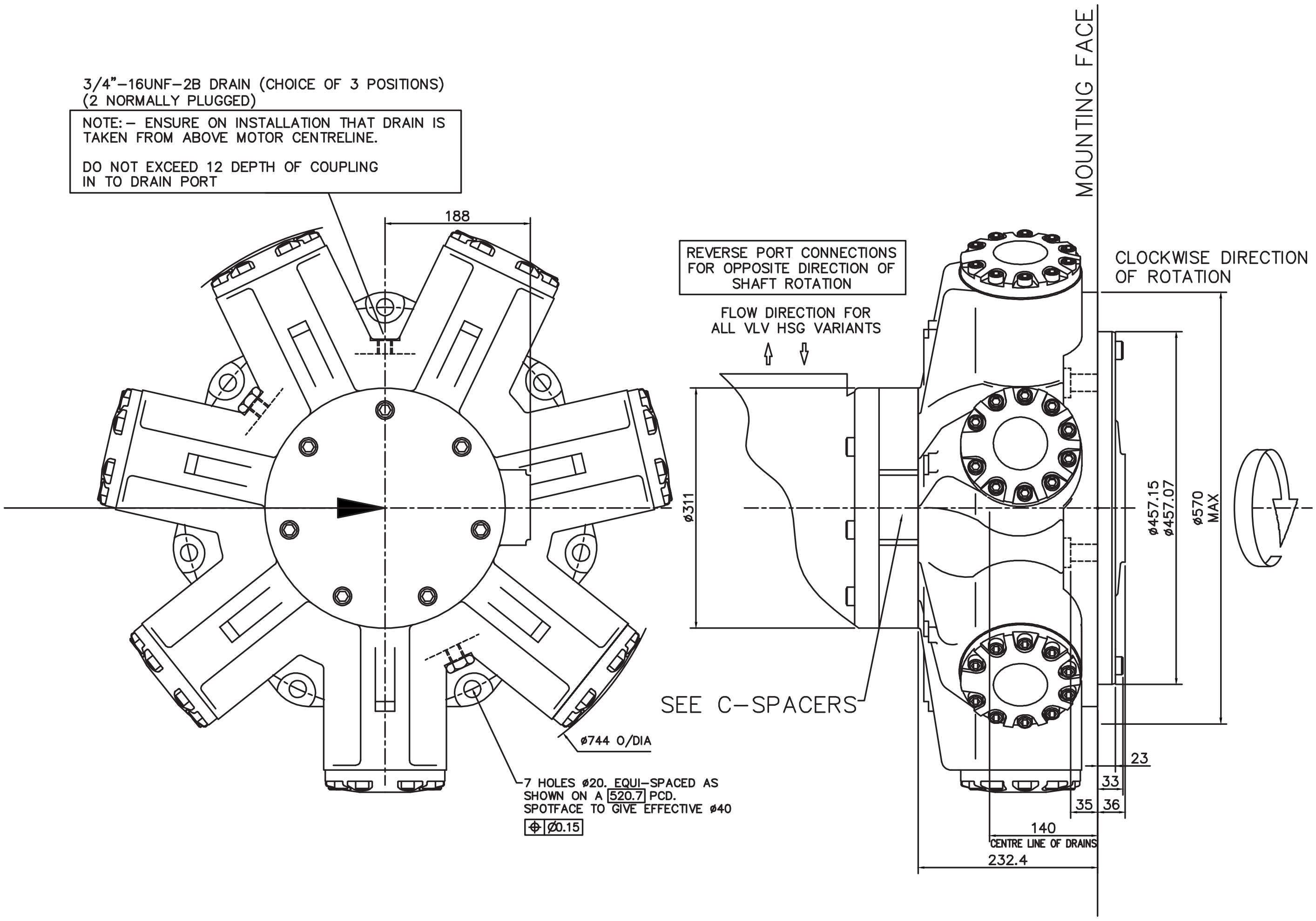
3-7 HMC325 (cont)

'C', 'CS' & 'X' C Spacers



3-7 HMC325 (cont)

Installation



3-12 Speed Sensing Options

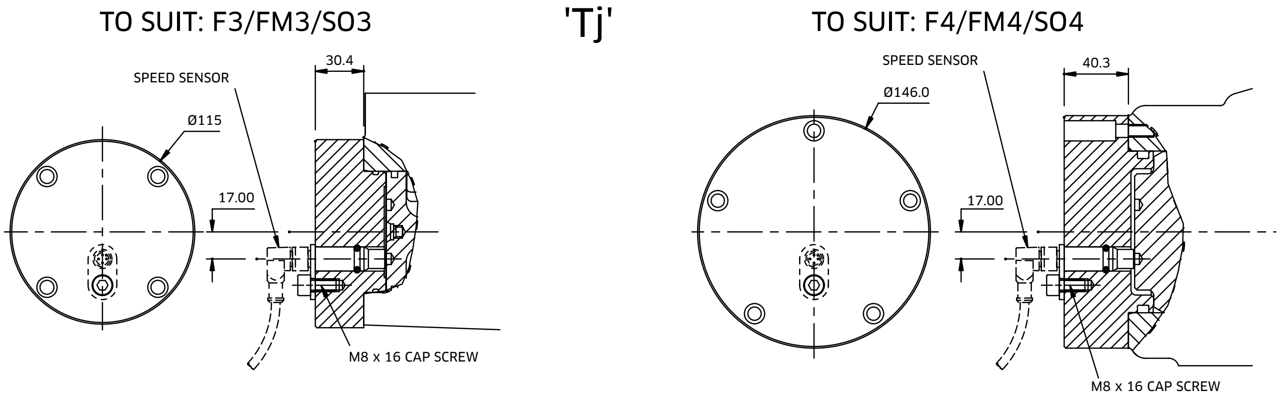
Tj speed sensor with Tk readout option

Tj Speed Sensor Technical Specification

The Tj speed sensor is a hall effect dual channel speed probe that can provide feedback of both speed and direction.

Signal Outputs:	Square wave plus directional signal
Power Supply:	8 to 32 V @ 40 mA
Protection class:	IP68
Output frequency:	16 pulses/revolution

Installation Details

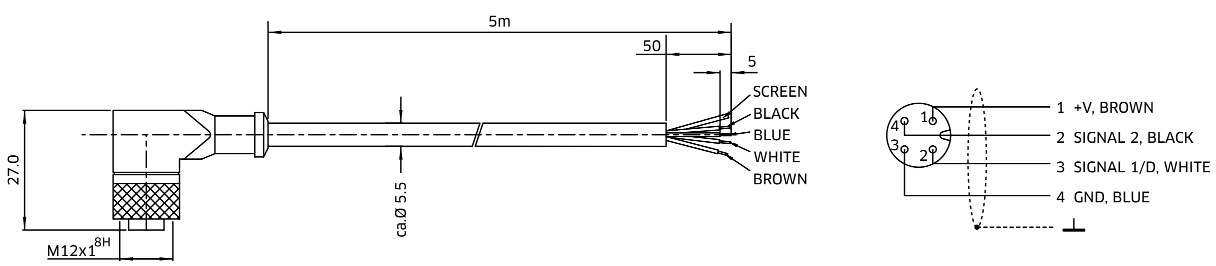


Tk Output Module

The Tk option consists of the Tj speed sensor together with the optional T401 output module.

The addition of the T401 module provides a software configured single channel tachometer and relay with a 0/4-20 mA analogue current output.

The software and calibration cable is also provided.



NOTES

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Tel: +81-3-3435-6862
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Korea
Tel: +82-55-286-5551
Website: www.flutek.co.kr

The specified data is for product description purposes only and may not be deemed to be guaranteed unless expressly confirmed in the contract.

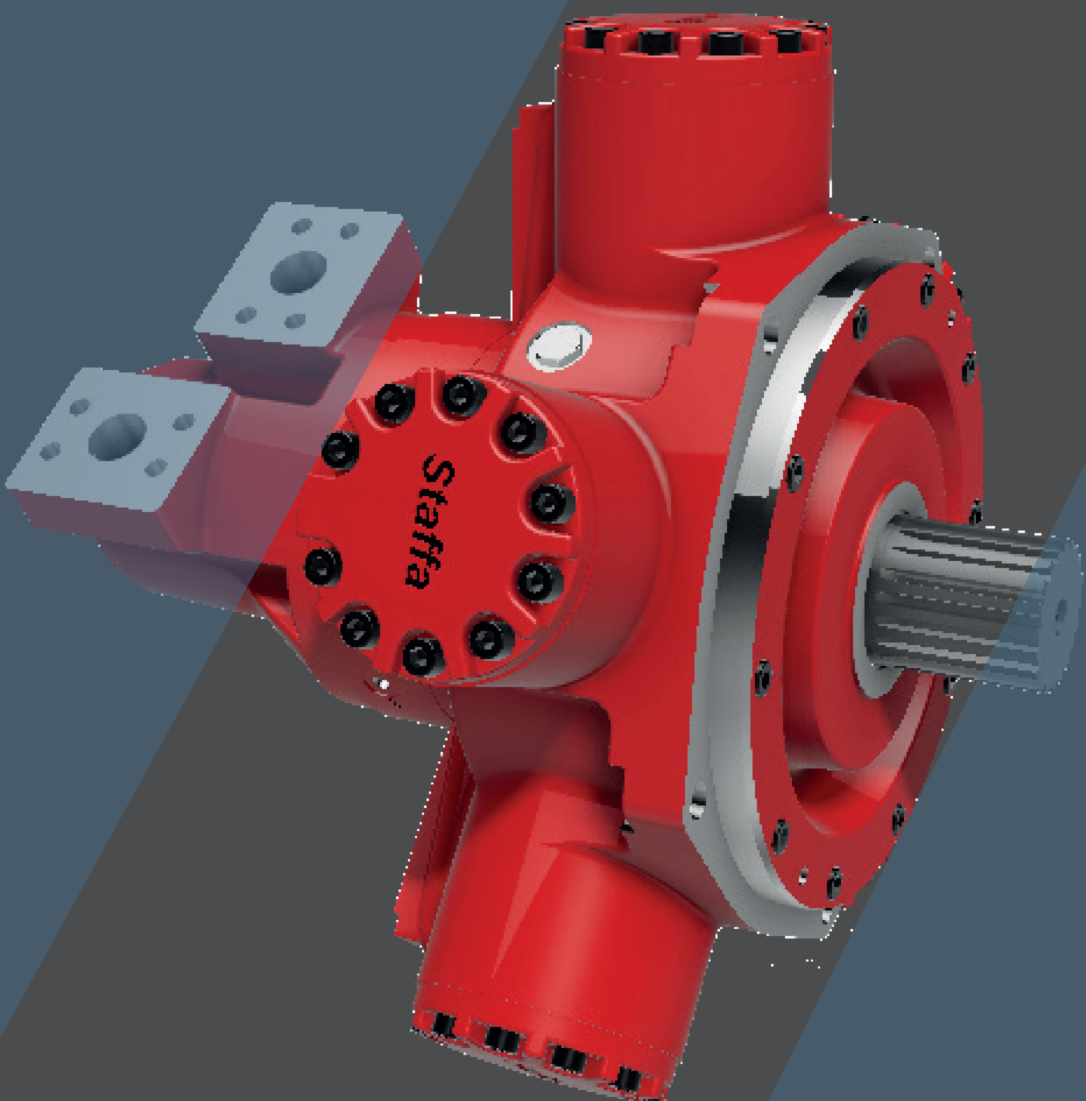
Data sheet: 10/18

Kawasaki
Powering your potential

Precision Machinery Company

Three-Speed Radial Piston Staffa Motor

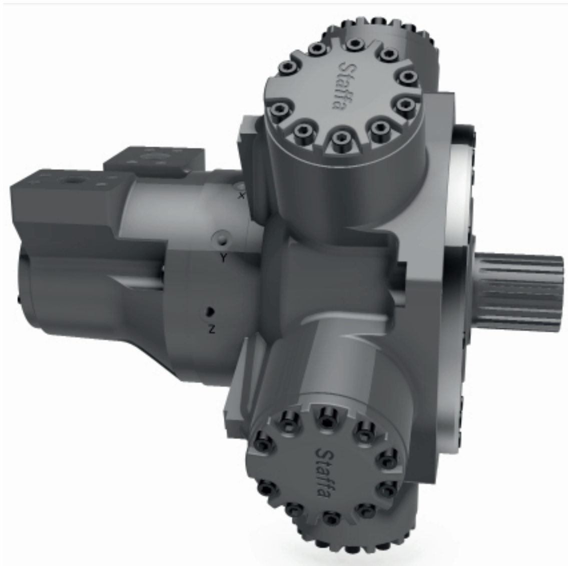
HMF Series



CONTENTS

HMF Series

Three-Speed Staffa Motor



General Descriptions

The HMF series three-speed models have three pre-set displacements which can be chosen from a wide range to suit specific application requirements. The displacement are hydraulically selected using remotely mounted directional control valves. Motor displacement can be changed with ease while the motor is running.

The range of three speed motors extends from the HMF100 in 1,524 cc/rev to the HMF325 in 5,326 cc/rev.

There are four frame sizes as shown in the table below:

Motor Type	Max torque @ 275 bar (Nm)	Continuous shaft power
HMF100	6,325	138
HMF200	12,820	174
HMF270	19,090	189
HMF325	22,110	189

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.

Features

3 displacement modes

Freewheel options available

High torque at low speed

Smooth running

Wide range of displacements to suit specific applications

Displacement changes with ease when the motor is running

Speed sensing options

1-1 Model Coding

F11/HMF270 / S3 V/280/140/00/FM4/X/Tj/10/P*****

Fluid Type

(refer to page 6 for performance data)	
Blank	Mineral oil
F3	Phosphate ester (HFD fluid)
F11	Water based fluids (HFA, HFB & HFC)
Alternative fluids contact Kawasaki	

Model Type

HM	Standard
HMHD	Heavy duty

Motor Frame Size

F100	F270
F200	F325

Shaft Type

See shaft type option list on Page 6

Shaft Orientation

Blank	Standard orientation
V	Vertically Up (extra drain)

High Displacement Code

###	See displacement code details on pages 24 to 27

Medium Displacement Code

###	See displacement code details on pages 24 to 27

Low Displacement Code

###	See displacement code details on pages 24 to 27

Special Features

P*****	Special features (see options on page 5)
PL***	Non-catalogued features, (***) = number assigned by Kawasaki as required.

Design Series Number

10	Current series for HMF motors

Tacho Encoder Drive

Blank	None
Tj	Square wave output with directional signal
Tk	Combines Tj with the T401 instrument to give a 4 to 20 mA output proportional to speed. Directional signal and speed relay output.

Displacement Control Ports

Threaded ports/bi-directional rotation	
X	X, Y and Z ports G 1/4" (BSPF to ISO 228/1)

Main Port Connections

###	See port connection details on pages 7

1-1 Model Coding

Special Features Suffix

/ P * * * * *

Shaft Seal Enhancements

A	High pressure shaft seal
B	Improved shaft seal life
C	High pressure shaft seal & improved shaft seal life
0	None

External Protection

A	Anti-pooling bolt heads
B	Marine-specification primer paint
C	Anti-pooling bolt heads & Marine-specification primer paint
0	None

Installation Features

A	Drain port adaptor x 1
B	Drain port adaptor x 2
C	Φ21 mm mounting holes
D	Φ22 mm mounting holes
E	Φ21 mm mounting holes & Drain port adaptor x 1
F	Φ21 mm mounting holes & Drain port adaptor x 2
G	Φ22 mm mounting holes & Drain port adaptor x 1
H	Φ22 mm mounting holes & Drain port adaptor x 2
0	None

Performance Enhancements

A	Increased starting torque
B	Increased power rating
C	Increased starting torque & increased power rating
0	None

Valve Enhancements

A	Improved cavitation resistance
B	Anti-clockwise
C	Thermal shock resistance
D	Improved caviation resistance & anti-clockwise
E	Improved cavitation resistance & thermal shock resistance
F	Anti-clockwise & thermal shock resistance
G	Improved cavitation resistance & anti-clockwise & thermal shock resistance
0	None

1-2 Shaft Options

Product type

HMF100

P	=	Parallel keyed 60mm diameter shaft
S	=	Splined shaft 14 teeth BS3550
Z	=	Splined shaft DIN5480 (W70x3x22x7h)
T	=	Long taper keyed shaft - 95.2 key slot

HMF200

P1	=	Parallel keyed 85mm diameter shaft
S3	=	Splined shaft 20 teeth BS3550
S4	=	Splined shaft 16 teeth BS3550
Z3	=	Splined shaft DIN5480 (W85x3x27x7h)
T	=	Long taper keyed shaft - 133.4 key slot

HMHDF200

P2	=	Parallel keyed 100mm diameter shaft
S5	=	Splined shaft 23 teeth BS3550
Z5	=	Splined shaft DIN5480 (W100x4x24x7h)

HMF270

P1	=	Parallel keyed 85mm diameter shaft
S3	=	Splined shaft 20 teeth BS3550
Z4	=	Splined shaft DIN5480 (W90x4x21x7h)
T	=	Long taper keyed shaft - 133.4 key slot

HMHDF270

P2	=	Parallel keyed 100mm diameter shaft
S5	=	Splined shaft 23 teeth BS3550
Z	=	Splined shaft DIN5480 (W100x4x24x7h)

HMF325

P1	=	Parallel keyed 85mm diameter shaft
S3	=	Splined shaft 20 teeth BS3550
Z4	=	Splined shaft DIN5480 (W90x4x21x7h)
T	=	Long taper keyed shaft - 133.4 key slot

HMHDF325

P2	=	Parallel keyed 100mm diameter shaft
S5	=	Splined shaft 23 teeth BS3550
Z	=	Splined shaft DIN5480 (W100x4x24x7h)

Note:
For installations where the shaft is vertically upwards specify “V” after the shaft type designator so as to ensure that an additional high level drain port is provided within the front cover of the motor.

1-3 Main Port Connections

Product type

HMF100

SM3	=	1¼” symmetrical ports with through-holes for manifold connection
F3	=	1¼” SAE 4-bolt flange
FM3	=	1 ¼” SAE 4-bolt flange
F4	=	SAE 1½” 4-bolt UNC flanges
FM4	=	SAE 1½” 4-bolt metric flanges

HMF200

SM3	=	1¼” symmetrical ports with through-holes for manifold connection
F3	=	1¼” SAE code 61 4-bolt flange
FM3	=	1¼” SAE code 61 4-bolt flange
F4	=	SAE 1½” 4-bolt UNC flanges
FM4	=	SAE 1½” 4-bolt metric flanges

HMF270

F4	=	1½” SAE code 62 4-bolt flange
FM4	=	1½” SAE code 62 4-bolt flange

HMF325

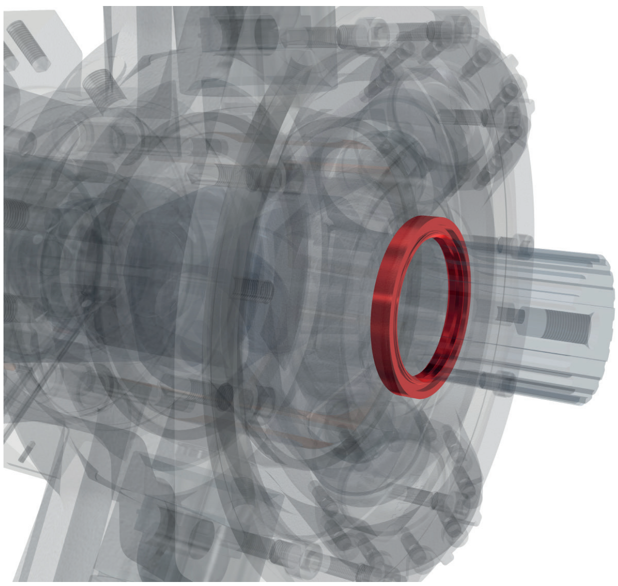
F4	=	1½” SAE code 62 4-bolt flange
FM4	=	1½” SAE code 62 4-bolt flange

See pages 40 to 65 for full dimensional details

1-4 Special Features

The HMF motor can be ordered with special features which can improve the motor's performance for different applications. Further details about each feature are given on pages 8-21.

High Pressure Shaft Seal



Description:

> 10 bar rated

> Recommended for cold climates

> Rugged aluminium construction

Technical Information

Where crankcase pressure will be higher than 3.5 bar, the high pressure shaft seal should be selected.

Case pressure	≤ 10 bar
Non-operating temperature limits	Below -30°C and above 120°C
Minimum operating temperature	-15°C
Maximum operating temperature	80°C
Minimum viscosity	2,000 cSt
Maximum viscosity	150 cSt

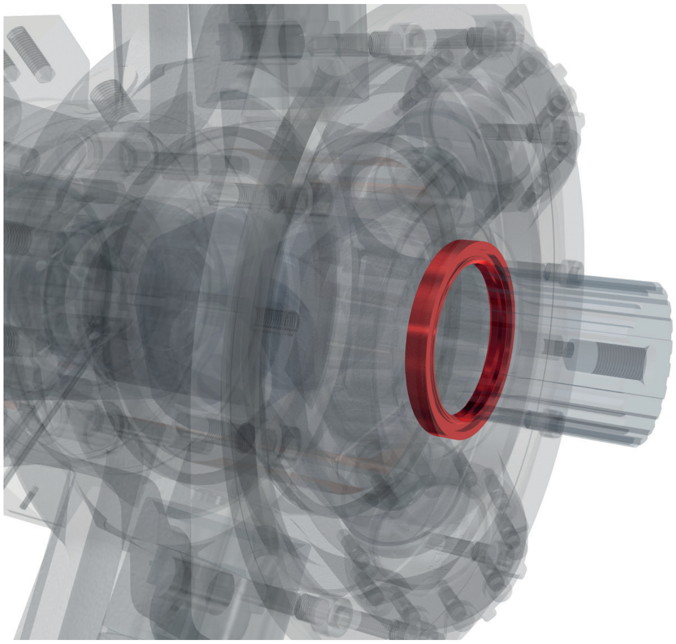
Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Improved Shaft Seal Life



Description:

> Stainless steel sleeve prevents corrosion

> Improved wear resistance

> Recommended for corrosive environments

Technical Information

A well-established method of increasing rotary seal life in corrosive environments is to fit a thin-walled, stainless steel sleeve to the rotating shaft to provide a corrosion-resistant, wear-resistant counterface surface for the seal to run against. All HMF motors can be fitted with such sleeves upon request.

Sleeve material	A304 Stainless Steel
Sleeve surface finish	R_a 0.25 to 0.5 μm (10 to 20 μin)

Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

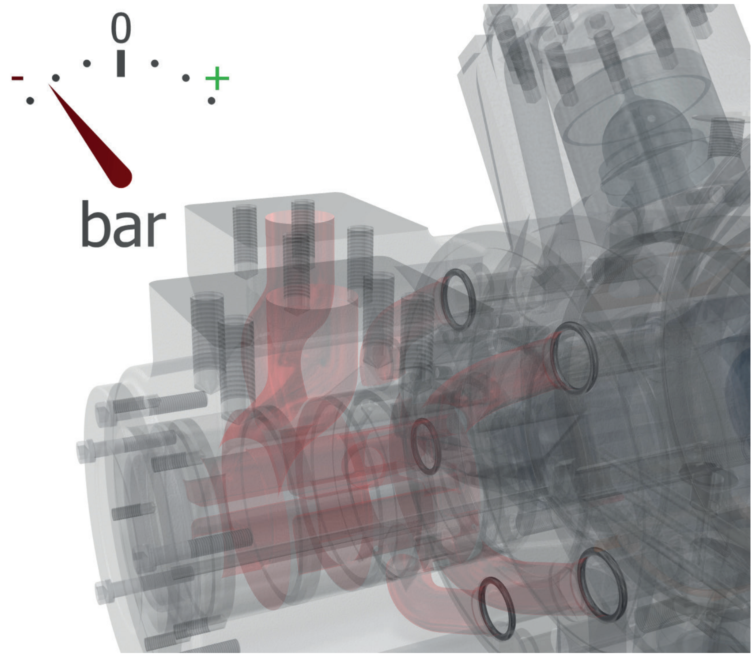
1-4 Special Features

Improved Cavitation Resistance

Description:

> Recommended for overrunning applications

> Protects against seal damage for short periods of operation in vacuum inlet conditions.



Cavitation can occur due to many different factors. Although it is not possible to make the HMF motor resistant to cavitation, certain features can be added to improve the motor's resistance to short periods of lost port pressure.

In applications where the HMF motor can be driven (like a pump) a risk arises that insufficient fluid will be provided to maintain a positive pressure at both main ports of the motor causing cavitation. The results of extended running at these conditions can be catastrophic to the motor's function.

The improved cavitation resistance feature should be considered where:

- Overrunning conditions may occur (load driving the motor)
- Loss of main port pressure while motor is rotating

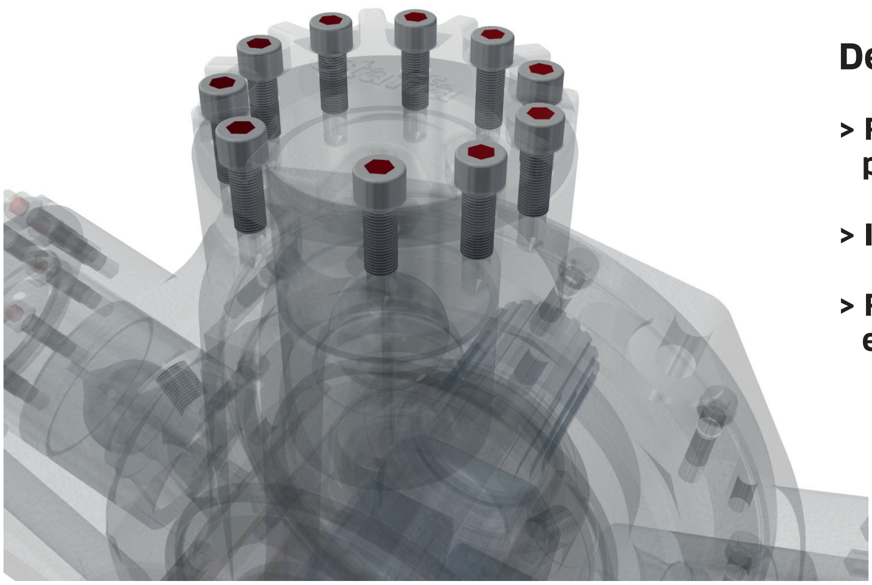
Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Anti-Pooling Bolt Heads



Description:

- > Removes potential for water pooling
- > Improved corrosion resistance
- > Recommended for marine environments

Technical Information

In many marine applications, water pooling in socket head cap screw heads presents a significant corrosion risk. Corroded cap screws can make service and repair of affected units impossible.

To significantly reduce the risk of water damage through pooling, HMF motors can be supplied with silicone filler in all the bolt heads.

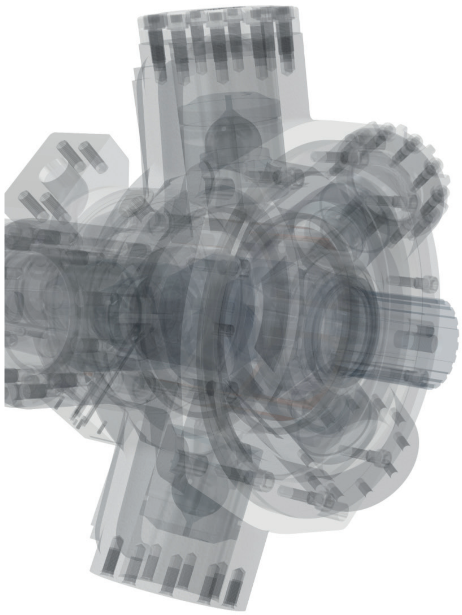
Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Increased Starting Torque



Description:

> Optimised for high break-out torque

> Recommended for low speed operation

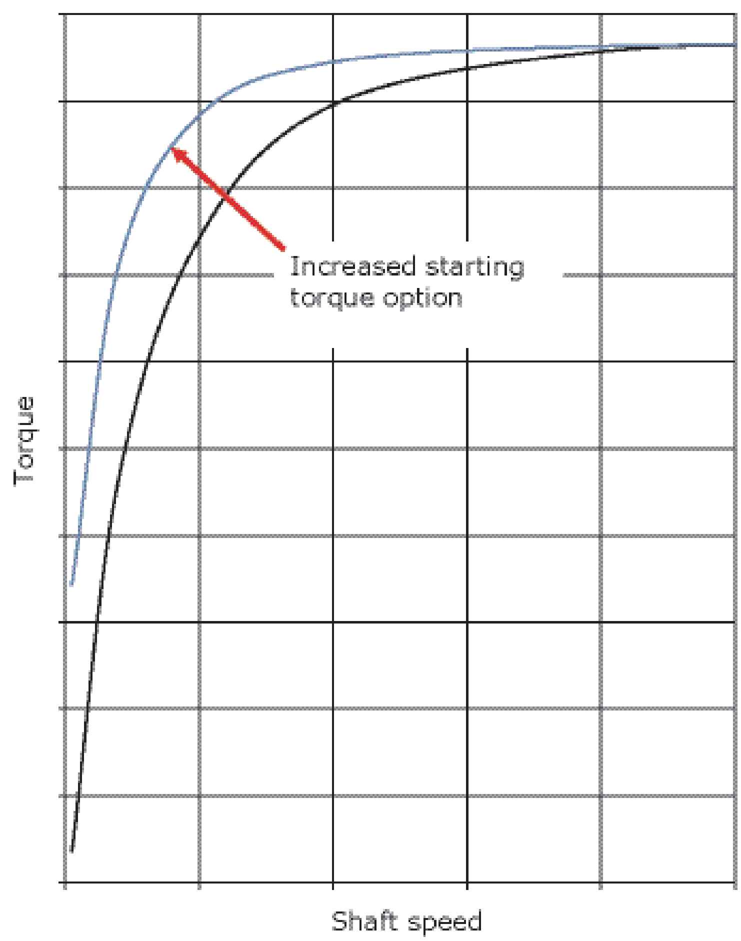
> Improved service life for low speed applications

Technical Information

If an application demands the drive motor be run at speeds of less than 10 rpm for most of the duty cycle, or involves frequent start/stop or forward/reverse operation, the Staffa HMF motor range has it covered.

By optimising the HMF motor's design for low speeds, it is possible to increase the break out torque and low speed mechanical efficiency performance.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.



1-4 Special Features

Increased Starting Torque (cont)

Volumetric Performance

In order to achieve increased torque at low speeds the volumetric characteristics of the motor performance are changed.

When calculating leakage and volumetric efficiency use the constants shown here in place of those given for the standard motor on page 28.

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HMF100	1,524	16.26	45.70	9.65	14.66
HM(HD)F200	3,084	12.86	38.50	3.02	11.01
HM(HD)F270	4,588	13.26	37.30	2.41	12.76
HM(HD)F325	5,326	13.26	40.00	2.08	12.76

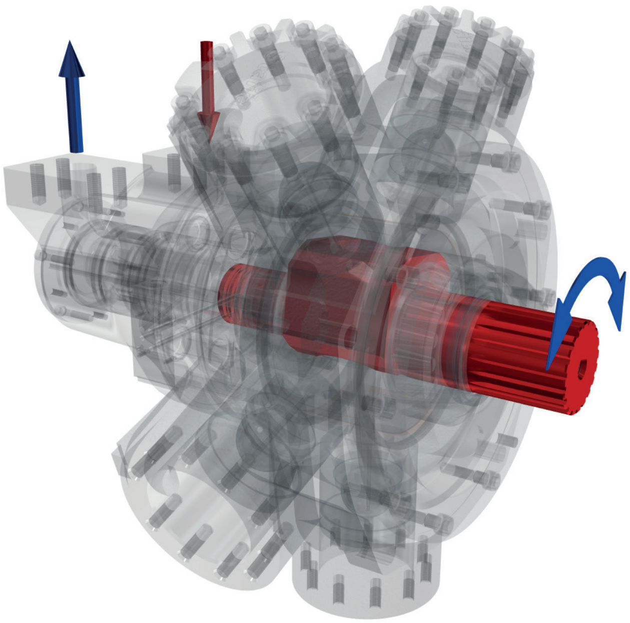
Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Anti-Clockwise Rotation



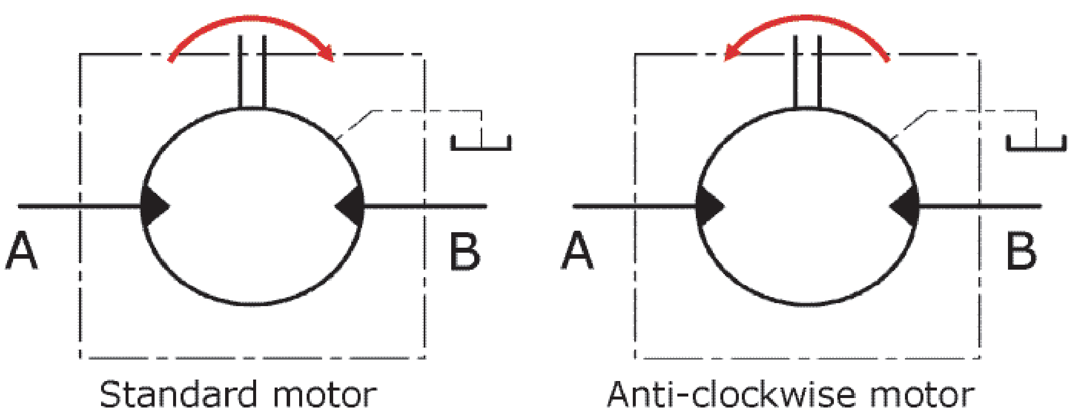
Description:

> Reduce installation complexity

> Standardise equipment designs

Technical Information

All HMF motors can be specified with an anti-clockwise rotation valve configuration. All performance and volumetric characteristics remain unchanged.



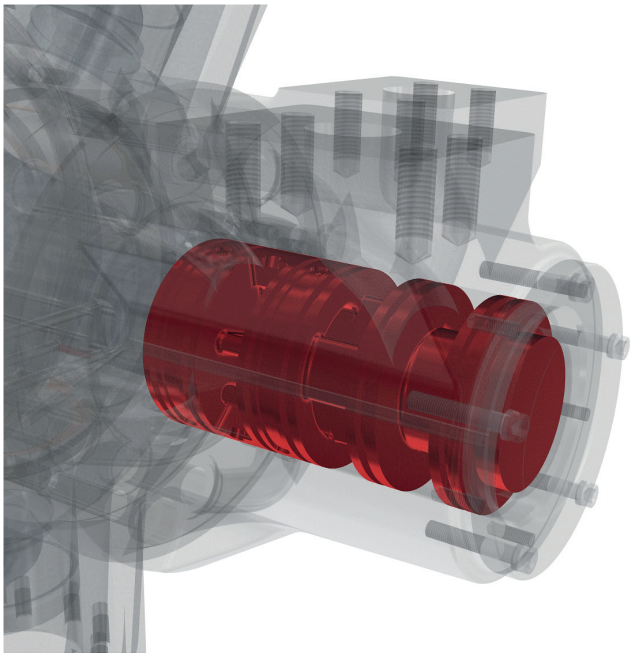
Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Thermal Shock Resistance



Description:

> Recommended for cold climates

> Optimised for start-up in freezing temperatures

> Engineered for total peace of mind

Technical Information

Starting up a cold motor with warm hydraulic fluid is a known cause of heavy wear and potential seizure of hydraulic machinery. To minimise this potential risk, the HMF motor can be configured to combat thermal shocks to give complete peace of mind when operating in very cold climates.

Volumetric Performance

In order to provide thermal shock resistance the volumetric characteristics of the motor performance are changed. When calculating leakage and volumetric efficiency use the constants shown on the next page in place of those given for the standard motor on page 28.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.

Note:
When operating at low temperature, consideration must be given to the guidance notes in Section 2-8 Motor Operation at Low Temperature (see page 36).

1-4 Special Features

Thermal Shock Resistance (cont)

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HMF100	1,524	11.10	45.70	6.99	7.90
HM(HD)F200	3,087	7.98	38.50	2.61	4.25
HM(HD)F270	4,588	8.38	37.30	1.91	6.00
HM(HD)F325	5,326	8.38	40.00	1.65	6.00

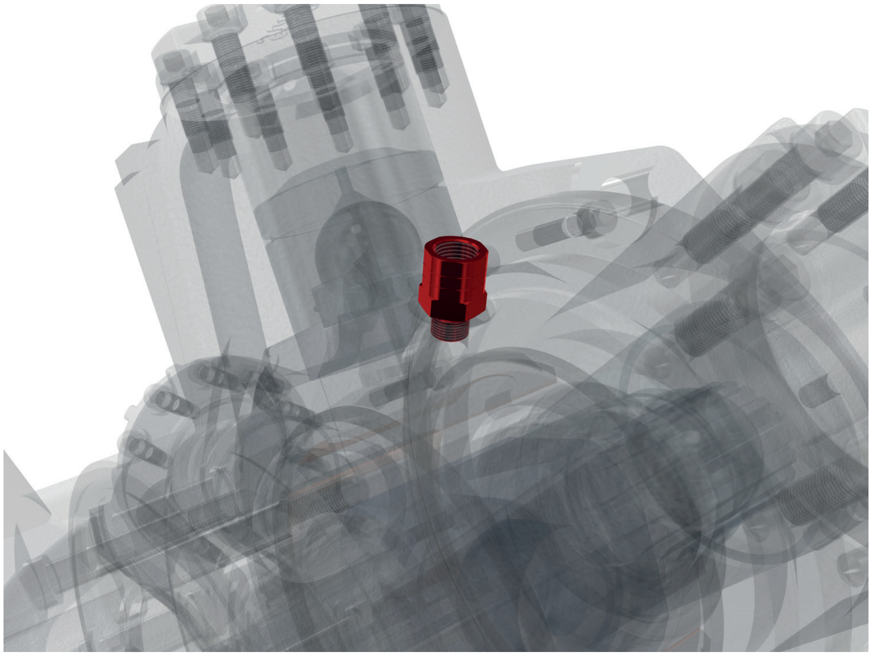
Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Drain Port Adaptors



Description:

> Improves manufacturing logistics

> Motor supplied ready for connection to 1½" BSPP male fitting

Technical Information

Motor Type	Adaptor Supplied
HMF100	¾" UNF 2B to ½" BSPP
HM(HD)F200	¾" UNF 2B to ½" BSPP
HM(HD)F270	¾" UNF 2B to ½" BSPP
HM(HD)F325	¾" UNF 2B to ½" BSPP

One or two drain adaptors can be supplied.

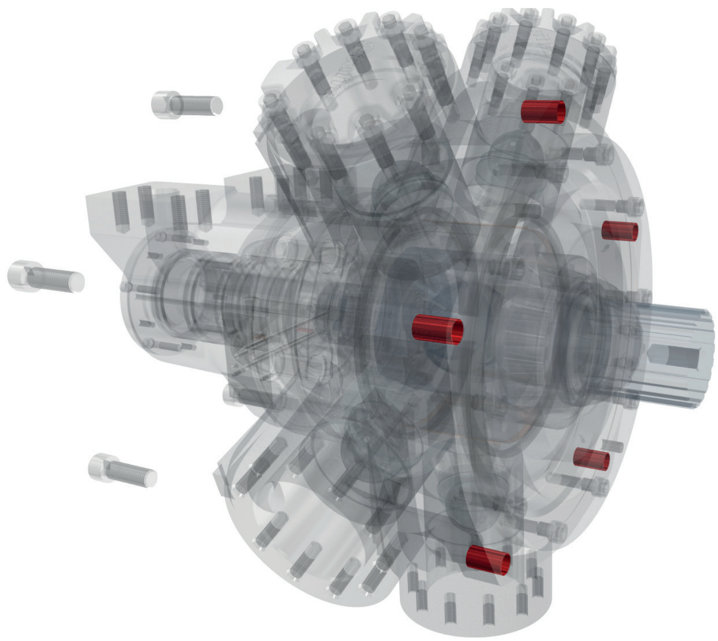
Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Mounting Hole Diameter



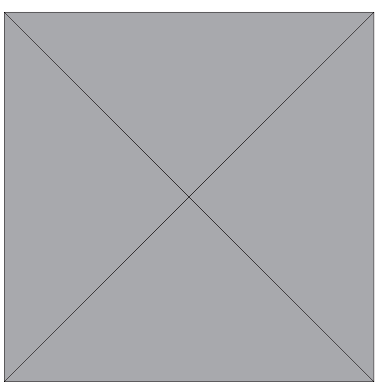
Description:

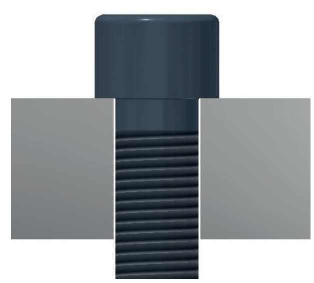
> **Matching mounting holes to bolts**

> **Φ21mm and Φ22mm options available**

Technical Information

In different markets, different bolt standards are adopted which may not be best suited to the standard Φ20 mm mounting hole diameter on the HMF motors. To give a correct fit and optimum installation, Φ21 mm or Φ22 mm holes can be selected on all frame sizes.





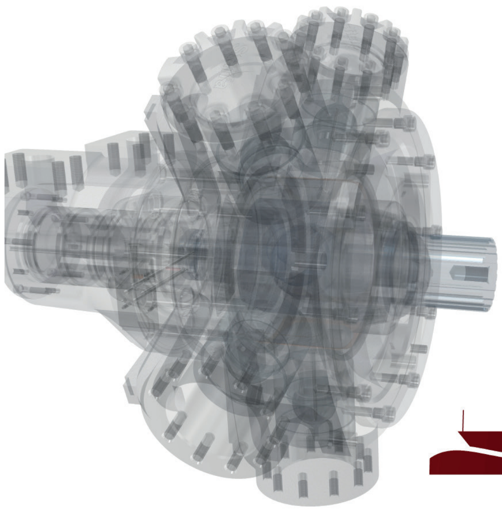
Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Marine Specification Primer Paint



Description:

- > Improves corrosion and water resistance of the finishing system
- > Excellent adhesion strength
- > Recommended for marine applications

Technical Information

Colour	Red oxide
Type	Single pack epoxy etching primer
Standard	BS 3900 part A 8
Dry film thickness	> 12 μm

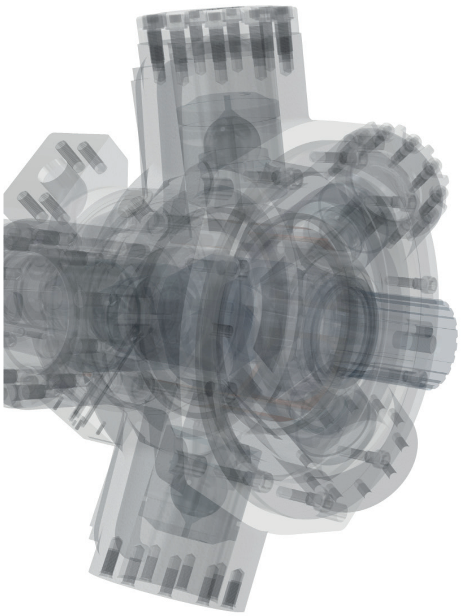
Applicable to:

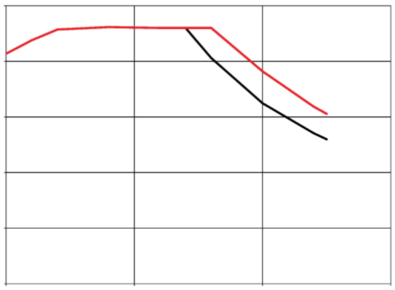
HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

High Power





Description:

> Enhanced power performance

> Improved efficiency

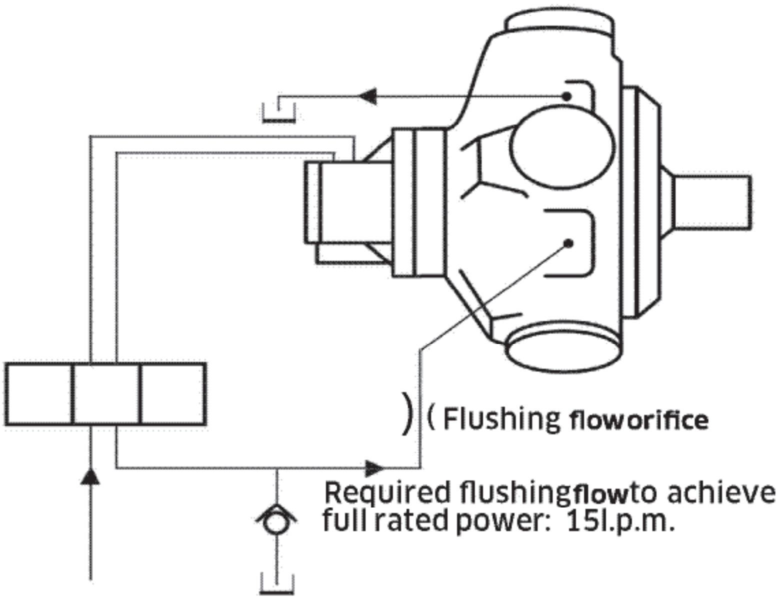
> Improved back pressure rating of 100 bar

Technical Information

The high power option for the HMF motors combines special low-friction components and a crankcase flushing flow to achieve increased shaft power limits. All other performance parameters are unchanged.

Crankcase Flushing

In order to achieve the maximum shaft power, a crankcase flushing flow of 15 l/min should be directed through the crankcase. To improve the cooling effect of the flushing flow the distance between the inlet and outlet drain port connections should be maximised.



1-4 Special Features

High Power (cont)

Check valve pressure (bar)*	Orifice diameter (mm)
3	4.4
4	4.1
5	3.9
6	3.7
7	3.6
8	3.5
9	3.4
10	3.3

*This assumes that the crankcase pressure is zero. If not, then the check valve pressure will need to be increased to maintain the pressure drop across the orifice.

Note:
If, due to crankcase flushing flow, the crankcase pressure continuously exceeds 3.5 bar, then the motor build should include a high pressure shaft seal.

Performance Data (crankcase flushing required):

Motor Type	Max. continuous output (kW)	Average actual running torque (Nm/bar)
HMF100	165	24.1
HM(HD)F200 FM3/SM3 valve assembly	216	47.2
HM(HD)F200 FM4 valve assembly	261	47.2
HM(HD)F270	278	70.1
HM(HD)F325	278	81.6

Note:
The speed limits and pressure limits remain unchanged from the standard motor.

Applicable to:

HMF100	HM(HD)F200	HM(HD)F270	HM(HD)F325
●	●	●	●

Please contact Kawasaki to order this feature.

2 Technical Information

2-1 Performance Data

Performance data is valid for the range of HMF motors when fully run-in and operating with mineral oil.

The appropriate motor displacements can be selected using performance data shown on pages 7 to 1 . Refer to the table on this page for pressures and speed limits when using re-resistant fluids.

Limits for fire resistant fluids

Fluid Type	Continuous Pressure (bar)	Intermittent Pressure (bar)	Max Speed (rpm)	Model Type
HFA 5/95 oil-in-water emulsion	103	138	50% of limits of mineral oil	All models
HFB 60/40 water-in-oil emulsion	138	172	As for mineral oil	All models
HFC water glycol	103	138	50% of limits of mineral oil	All models
HFD phosphate ester	250	275	As for mineral oil	All models

Specify make and type of fluid on your order if other than mineral oil.

Rating definitions

Continuous rating
The motor must be operated within each of the maximum values for speed, pressure and power.

Intermittent rating
Intermittent max pressure: 275 bar.

This pressure is allowable on the following basis:

a) Up to 50rpm 15% duty for periods up to 5 minutes maximum.
b) Over 50 rpm 2% duty for periods up to 30 seconds maximum.

Static Pressure
Static pressure to DNV rules 405 bar.

Intermittent power rating
This is permitted on a 15% duty basis for periods up to 5 minutes maximum.

2-1 Performance Data (cont)

Available displacements

When selecting displacement modes on the HMF motors, there is an important rule that must be followed: due to physical constraints there is a minimum achievable difference between the medium and low displacement modes which varies across the frame sizes as shown in the table below:

Motor Type	Minimum allowable difference between medium and low displacements	
	cc/rev	**in^3 /rev**
HMF100	655	40
HMF200	1,230	75
HMF270	1,720	105
HMF325	1,720	105

Minimum allowable medium displacement = low displacement + table value

Examples:

For HMF270 with 280 in^3/rev. (4,588 cc/rev.) maximum displacement and 00 in^3/rev. minimum displacement, the medium displacement must be above 105 in^3/rev. (1,720 cc/rev).

Minimum allowable medium displacement = 0 + 105 = 105 in^3/rev (1,720 cc/rev)

For HMF200 with 188 in^3/rev. (3,087 cc/rev.) maximum displacement and 40 in^3/rev. (655 cc/rev.) minimum displacement, the medium displacement must be above 115 in^3/rev. (1,885 cc/rev).

Minimum allowable medium displacement = 40 + 75 = 115 in^3/rev (1,885 cc/rev)

2-1 Performance Data (cont)

HMF100 Motor (see page 13 for power calculation limits)

Displacement Code		93	90	85	80	75	70	65	60	55	50
Displacement	cc/rev	1,524	1,475	1,393	1,311	1,229	1,147	1,065	983	901	819
Average actual running torque	Nm/bar	23.00	22.00	20.75	19.50	18.25	17.02	15.78	14.55	13.20	12.00
Average actual mechanical efficiency	%	93.8	93.7	93.6	93.5	93.3	93.2	93.1	93.0	92.6	92.1
Average actual starting efficiency	%	86.5	86.0	85.2	84.3	83.3	82.1	80.8	79.2	77.4	75.1
Max continuous speed (SM3/F3/FM3)	rpm	285	300	320	340	365	390	420	450	475	500
Max continuous speed (F4/FM4)	rpm	380	400	415	430	445	460	475	490	500	515
Max continuous power	kW	138	138	134	129	127	123	118	115	110	105
Max intermittent power	kW	170	170	165	159	156	151	145	142	135	129
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275	275

Displacement Code		45	40	35	30	25	20	15	10	5	00	00
Displacement	cc/rev	737	655	574	492	410	328	246	164	82	0	0
Average actual running torque	Nm/bar	10.60	9.24	7.87	6.48	5.31	3.93	2.56	1.57	0	0	0
Average actual mechanical efficiency	%	90.4	88.6	86.1	82.8	81.4	75.3	65.4	60.2	0	0	0
Average actual starting efficiency	%	72.4	69.0	64.4	58.6	50.3	38.0	17.5	/	/	/	/
Max continuous speed (SM3/F3/FM3)	rpm	550	600	615	630	630	630	630	630	1,000	1,000	1,500**
Max continuous speed (F4/FM4)	rpm	530	545	560	575	585	600	615	630	1,000	1,000	1,500**
Max continuous power	kW	99	92	79	64	52	38	26	12	0	0	0
Max intermittent power	kW	122	113	97	79	64	47	32	15	0	0	0
Max continuous pressure	bar	250	250	250	250	250	250	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

**See page 33: small displacements. **A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HMF200 Motor (see page 13 for power calculation limits)

Displacement Code		188	180	170	160	150	140	130	120	110	100	90
Displacement	cc/rev	3,087	2,950	2,790	2,620	2,460	2,290	2,130	1,970	1,800	1,639	1,475
Average actual running torque	Nm/bar	46.6	44.0	41.7	39.1	36.6	34.0	31.3	28.7	26.3	23.6	21.0
Average actual mechanical efficiency	%	94.8	93.7	93.9	93.8	93.5	93.3	92.3	91.5	91.8	90.5	89.5
Average actual starting efficiency	%	85.4	84.9	83.9	83.1	81.8	80.7	79.1	77.2	75.4	72.8	69.8
Max continuous speed (SM3/F3/FM3)	rpm	175	180	190	195	200	205	210	225	240	270	300
Max continuous speed (F4/FM4)	rpm	230	235	240	245	250	265	285	310	340	365	400
Max continuous power	kW	174	174	174	165	156	148	139	131	122	114	105
Max intermittent power	kW	195	195	195	185	175	166	156	147	137	128	118
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275	275	275

Displacement Code		80	70	60	50	40	30	20	10	5	00	00
Displacement	cc/rev	1,311	1,150	983	820	655	492	328	164	82	0	0
Average actual running torque	Nm/bar	18.3	15.7	12.8	10.6	8.1	5.9	3.8	0.6	0	0	0
Average actual mechanical efficiency	%	87.7	85.8	81.8	81.2	77.7	75.3	72.8	23.0	0	0	0
Average actual starting efficiency	%	66.1	61.1	54.8	45.7	32.1	/	/	/	/	/	/
Max continuous speed (SM3/F3/FM3)	rpm	340	390	450	500	600	630	630	630	1,000	1,000	1,500**
Max continuous speed (F4/FM4)	rpm	430	460	485	515	545	575	600	630	1,000	1,000	1,500**
Max continuous power	kW	98	88	81	72	62	48	25	5	0	0	0
Max intermittent power	kW	110	99	91	81	70	54	33	6	0	0	0
Max continuous pressure	bar	250	250	250	250	250	250	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

**See page 33: small displacements. **A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HMF270 Motor (see page 13 for power calculation limits)

Displacement Code		280	250	220	200	180	160	140	120	100
Displacement	cc/rev	4,588	4,097	3,605	3,277	2,950	2,622	2,294	1,966	1,639
Average actual running torque	Nm/bar	69.4	61.9	53.9	49.0	43.6	38.3	33.2	27.9	22.4
Average actual mechanical efficiency	%	95.0	94.9	93.9	94.0	92.9	91.8	90.9	89.2	85.9
Average actual starting efficiency	%	84.7	83.8	82.7	81.8	80.6	79.2	77.3	74.9	71.5
Max continuous speed	rpm	150	160	170	175	210	230	275	310	375
Max continuous power	kW	189	176	161	150	139	128	116	104	89
Max intermittent power	kW	213	198	181	169	156	144	132	120	107
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275

Displacement Code		80	60	40	30	20	10	00	00
Displacement	cc/rev	1,311	983	655	492	328	164	0	0
Average actual running torque	Nm/bar	17.1	12.2	7.9	5.2	2.4	0	0	0
Average actual mechanical efficiency	%	82.0	78.0	75.8	65.8	46.0	0	0	0
Average actual starting efficiency	%	66.3	57.8	40.7	23.5	/	/	/	/
Max continuous speed	rpm	430	460	490	515	545	1,000	1,000	1,500**
Max continuous power	kW	73	57	38	26	14	0	0	0
Max intermittent power	kW	95	80	55	38	20	0	0	0
Max continuous pressure	bar	250	250	250	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	275	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

**See page 33: small displacements.*

***A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HMF325 Motor (see page 13 for power calculation limits)

Displacement Code		325	310	300	280	250	220	200	180	160	140	120
Displacement	cc/rev	5,326	5,080	4,916	4,588	4,097	3,605	3,277	2,950	2,622	2,294	1,966
Average actual running torque	Nm/bar	80.4	76.6	74.1	69.1	61.6	53.9	49.0	43.6	38.3	33.2	27.9
Average actual mechanical efficiency	%	94.8	94.7	94.7	94.6	94.5	93.9	94.0	92.9	91.8	90.9	89.2
Average actual starting efficiency	%	85.7	85.4	85.2	84.7	83.8	82.7	81.8	80.6	79.2	77.3	74.9
Max continuous speed	rpm	130	135	140	150	160	170	190	215	230	275	330
Max continuous power	kW	189	189	189	189	176	161	150	139	128	116	104
Max intermittent power	kW	213	213	213	213	198	181	169	156	144	132	120
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275	275	275

Displacement Code		100	95	80	60	40	30	20	10	00	00
Displacement	cc/rev	1,639	1,557	1,311	983	655	492	328	164	0	0
Average actual running torque	Nm/bar	22.4	20.9	17.1	12.2	7.9	5.2	2.4	0	0	0
Average actual mechanical efficiency	%	85.9	84.3	82.0	78.0	75.8	65.8	46.0	0	0	0
Average actual starting efficiency	%	71.5	70.4	66.3	57.8	40.7	23.5	/	/	/	/
Max continuous speed	rpm	370	405	440	460	495	515	545	1,000	1,000	1,500**
Max continuous power	kW	89	85	73	57	38	26	14	0	0	0
Max intermittent power	kW	107	101	95	80	55	38	20	0	0	0
Max continuous pressure	bar	250	250	250	250	250	250	250	17*	17*	17*
Max intermittent pressure	bar	275	275	275	275	275	275	275	17*	17*	17*

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

**See page 33: small displacements.*

***A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-2 Volumetric Effciency Data

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
HMF	**cc/rev**	K_1	K_2	K_3	K_4
HMF100	1,524	9.50	45.70	5.80	7.90
HMF200	3,080	6.10	38.50	2.00	4.25
HMF270	4,310	6.50	37.30	1.50	6.00
HMF325	5,310	6.80	40.00	1.30	6.00

Fluid Viscosity	Viscosity Factor
cSt	**Kv**
20	1.58
25	1.44
30	1.30
40	1.10
50	1.00
60	0.88

Qt (total leakage)	=	$[K_1 + n/ K_2] \times \Delta P \times K_V \times 0.005$	l/min
Creep speed	=	$K_3 \times \Delta P \times K_V \times 0.005$	rpm
Crankcase leakage	=	$K_4 \times \Delta P \times K_V \times 0.005$	l/min
ΔP	=	differential pressure	bar
n	=	speed	rpm

The motor volumetric efficiency can be calculated as follows:

$$\text{Volumetric efficiency (\%)} = \left[\frac{(\text{speed x disp.})}{(\text{speed x disp.}) + Qt}\right] \times 100$$

Example:

HMF200 motor with displacement of 3.087 l/rev.

Speed 60 rpm
Differential pressure 200 bar
Fluid viscosity 50 cSt

Total leakage $= (K_1 + n/ K_2) \times \Delta P \times K_V \times 0.005$ l/min
$= (6.1+60/38.5) \times 200 \times 1 \times 0.005$
$= 7.7$ l/min

Volume efficiency $= \left[\frac{(60 \times 3.087)}{(60 \times 3.087) + 7.7}\right] \times 100$

= <u>96%</u>

2-3 Displacement Change Sequence

Displacement Sequence Rule

Due to the physical construction of the HMF motor series, all HMF motors must adhere to the following rule when changing the displacement mode of the motor. Failure to do so could result in damage to the motor and the invalidating of the warranty.

RULE: HMF series motors can only be moved to low or medium displacement modes from a starting position of high displacement mode.

The control system governing the displacement change mechanism must not allow the machine operator to contravene this rule.

Displacement Sequence Description

For most applications the HMF motor will start up in the high displacement mode. As with HMC and HPC motors, this is achieved by supplying pilot pressure to the 'Y' port only.

To change to the low displacement mode, pilot pressure is switched to the 'X' port only. As such, switching between the high and low displacement modes of an HMF series motor is the same as for an HMC or HPC series motor.

In order to select the medium displacement mode, the motor must first be returned to the high displacement mode, as stated by the rule above. Then, with pilot pressure maintained on the 'Y' port, pilot pressure is applied to the 'Z' port. After a short delay (see timing chart below) the pilot pressure is switched from the 'Y' port to the 'X' port to leave pilot pressure being supplied to both 'X' and 'Z' ports. The motor is now in medium displacement mode. When the medium displacement mode has been fully engaged, the pilot pressure to the 'Z' port may be switched off or maintained
without any effect on the motor's displacement mode.

To return to the high displacement mode, from either medium or low displacement mode, pilot pressure is applied to the 'Y' port only.

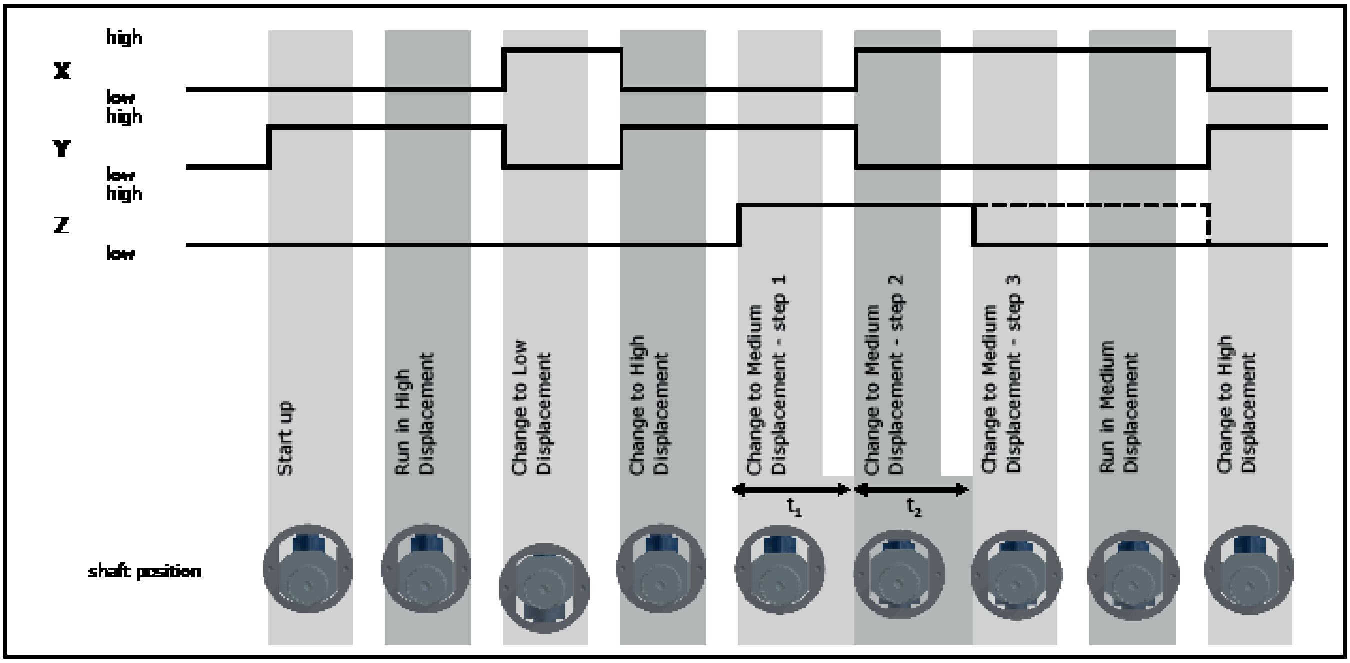
There now follow three representations of the same displacement change sequence just described: high to low, back to high, then to medium, and, finally, back to high. Firstly, a table showing the sequence in which the 'X', 'Y' and 'Z' ports are pressurised at each stage. Secondly, a timing chart showing when the pilot pressure can be switched between 'X', 'Y' and 'Z' ports. And thirdly, a schematic showing a possible control circuit with a valve firing chart.

2-3 Displacement Change Sequence (cont)

Displacement Sequence Control Table

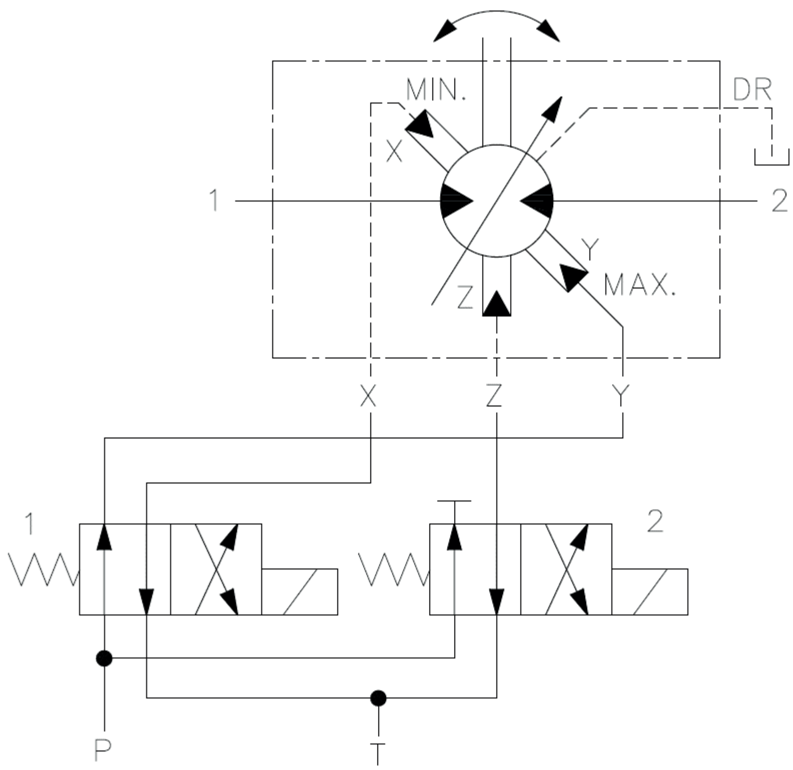
Sequence	Pressure to	Displacement
1	Y	High
2	X	Low
3	Y	High
4	Y&Z	High
5	X&Z	Medium
6	X	Medium
7	Y	High

Displacement Sequence Control Timing



2-3 Displacement Change Sequence (cont)

Displacement Sequence Control Schematic



Displacement	Valve 1 Solenoid	Valve 2 Solenoid
High	OFF	OFF
Low	ON	OFF
High	OFF	OFF
Medium	OFF ON ON	ON ON (OFF)
High	OFF	OFF

2-4 Shaft Power Calculation

Example:

Firstly, to find the maximum differential pressure ΔP at rated speed:

Select the rated shaft power (W) for the motor from the performance data table (page 24).
This is presented in kilowatts so must be converted to watts (x1000).

Then also take the Actual Average running torque in N.m/bar (T_o) and the rated shaft speed in rpm (n).

$$W = \frac{T_o \cdot \Delta P \cdot 2\pi \cdot n}{60}$$

Or to find maximum ΔP then use:

$$\Delta P = \frac{60 \cdot W}{2\pi \cdot T_o \cdot n}$$

HMF270 Example - with a displacement code of 280:

Rated shaft power (W):	189,000
Average actual running torque (Nm/bar):	69.4
Rated shaft speed (rpm):	150

$$\Delta P = \frac{60 \times 189{,}000}{2\pi \times 69.4 \times 150}$$

ΔP = 174 bar (max.)

Secondly, to find the maximum speed at rated pressure:(using the same information as before):

$$n = \frac{60 \cdot W}{2\pi \cdot T_o \cdot \Delta P}$$

Rated pressure (bar):	250

$$n = \frac{60 \times 189{,}000}{2\pi \times 69.4 \times 250}$$

n = 104 rpm (max.)

In summary, operating the motor within its shaft power limit, at rated speed, would give a maximum pressure of 174 bar, and operating the motor at rated pressure, would give a maximum speed of 104 rpm.

Notes:

1) The maximum calculated speed is based on a rated inlet pressure of 250 bar.

2) The maximum shaft power is only allowable if the motor drain temperature remains below 80°C.

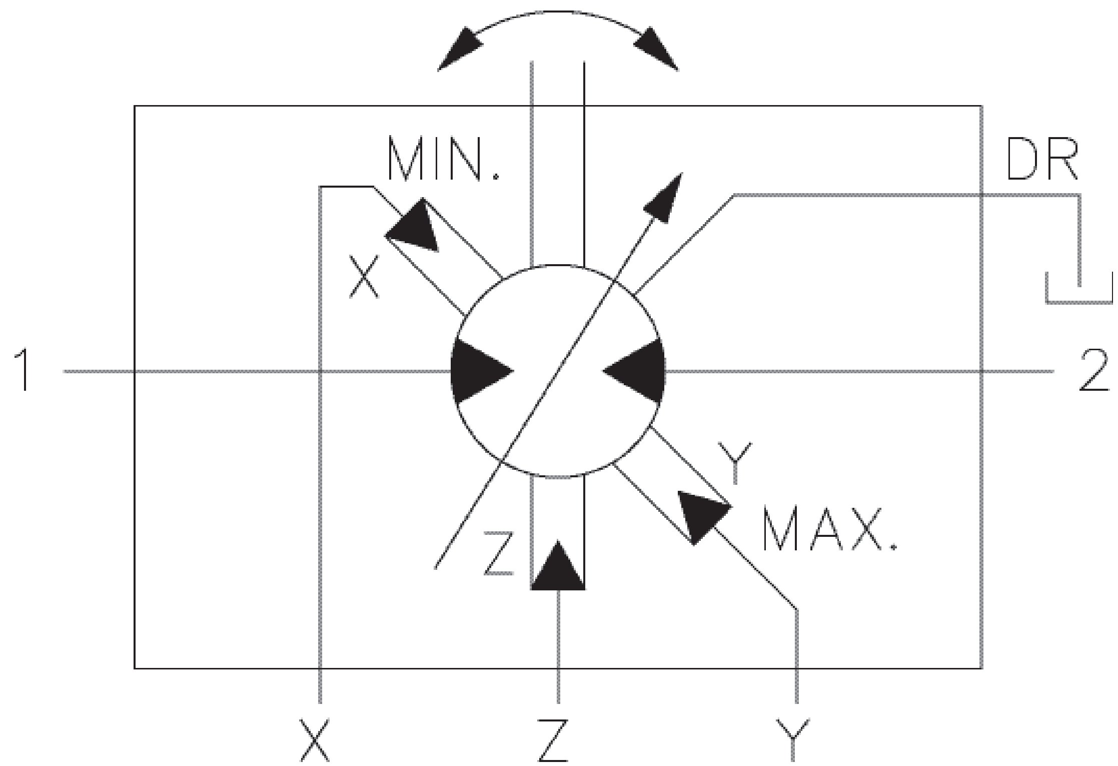
3) The maximum calculated differential pressure assumes that the low pressure motor port is less than 30 bar.

2-5 Functional Symbols

Example model code:

HMF*/P/***/**/**/FM3/X/. . .**

X - external pilot supply to ‘X’ and ‘Y’ ports



2-6 Stress Limits

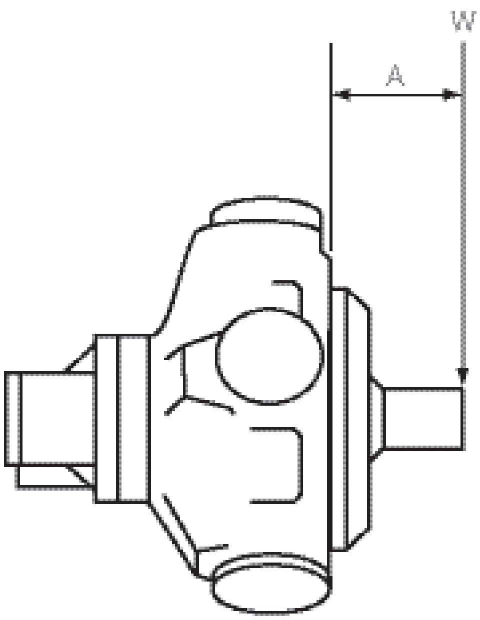
When applying large external radial loads, consideration should also be given to motor bearing lives (see page 16).

Motor Frame Size	Maximum External Radial Bending Moment [kNm]
HMF100	4,500
HMF200	6,750
HMF270	8,250
HMF325	8,250

Example:

Determine the maximum radial shaft load of a HMF motor:

Radial load offset, A = 100 mm
Maximum radial load, W = 4,500 (see table)/100
= 45kN (4,587 kg)



A = Distance from mounting face to load centre (mm)

W = Side load (N)

[Note}
The offset distance A is assumed to be greater than 50 mm.
Contact KPM UK if this is not the case.

2-7 Bearing Life Notes

Consideration should be given to the required motor bearing life in terms of baring service life. The factors that will determine bearing life include:

1) Duty cycle - time spent on and off load

2) Speed

3) Differential pressure

4) Fluid viscosity

5) External radial shaft load

6) External axial shaft load

2-8 Circuit and Application Notes

Limits for fire resistant fluids

To select either displacement, a pressure at least equal to 67% of the motor inlet/outlet pressure (whichever is higher) is required. In most applications the motor inlet pressure will be used. If the inlet/outlet pressure is below 3.5 bar, a minimum control pressure of 3.5 bar is required. In the event of loss of control pressure the motor will shift to its highest displacement.

Starting torque

Refer to performance data, (see pages 7 to 13).

Low speed operation

The minimum operating speed is determined by load inertia, drive elasticity, motor displacement and system internal leakage. If the application speed is below 3 rpm, then consult KPM UK.
If possible, always start the motor in high displacement.

Small displacements

The pressures given in the table on pages 24 to 27 for displacement code “00” are based on 1,000 rpm output shaft speed. This pressure can be increased for shaft speeds less than 1,000 rpm; consult KPM UK for details. Speeds greater than 1,000 rpm may be applied but only after the machine duty cycle has been considered in conjunction with KPM UK. A zero swept volume displacement (for freewheeling requirements) is available on request, consult KPM UK.

High back pressure

When both inlet and outlet ports are pressurised continuously, the lower pressure port must not exceed **70 bar** at any time. Note that high back pressure reduces 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) from the boost formula:

$$P = 1 + \frac{N2 \times V2}{K} + C$$

Where P is in bar, N = motor speed (rpm), V = motor displacement (cc/rev), C=Crankcase pressure (bar).

Motor Frame Size	Porting	Constant (K)
HMF100	SM3	1.6×10^{16}
	F(M)3	1.6×10^{10}
	F(M)4	3.3×10^{10}
HM(HD)F200	SM3	1.6×10^{10}
	F(M)3	1.6×10^{10}
	F(M)4	3.3×10^{10}
HM(HD)F270 & HM(HD)F325	F(M)4	4.0×10^{10}

2-8 Circuit and Application Notes (cont)

The flow rate of oil for the make-up system can be estimated from the crankcase leakage data (see page 28) plus an allowance for changing displacement:

e.g.

HMF100	To change high to low in 0.25 sec requires 32 l/min
HMF200	To change high to low in 0.5 sec requires 15 l/min
HMF270	To change high to low in 1 sec requires 24 l/min
HMF325	To change high to low in 1 sec requires 20 l/min

Allowances should be made for other systems losses and also for "fair wear and tear" during the life of the motor, pump and system components.

Motorcase pressure

The motorcase pressure should not continuously exceed 3.5 bar with a standard shaft seal fitted. On installations with long drain lines a relief valve is recommended to prevent over-pressurising the seal.

Notes

1) The motorcase 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: 10 bar continuous and 15 bar intermittent.

3) Check installation dimensions (pages 40 to 65) for maximum crankcase drain fitting depth.

Motorcase pressure

Dependent on motor (see model code fluid type - page 3) suitable fluids include:

a) Antiwear hydraulic oils

b) Phosphate ester (HFD fluids)

c) Water glycols (HFC fluids)

d) 60/40% water-in-oil emulsions (HFB fluids)

e) 5/95% oil-in-water emulsions (HFA fluids)

Reduce pressure and speed limits, as per table on page 6.

Viscosity limits when using any fluid except oil-in-water (5/95) emulsions are:

Max. off load: 2,000 cSt (9270 SUS)
Max. on load: 150 cSt (695 SUS)
Optimum: 50 cSt (232 SUS)
Minimum: 25 cSt (119 SUS)

Mineral oil recommendations

The fluid should be a good hydraulic grade, non-detergent mineral oil. It should contain anti-oxidant, antifoam and demulsifying additives. It must contain antiwear or EP additives. Automatic transmission fluids and motor oils are not recommended.

Biodegradable Fluid Recommendations

Well-designed environmentally acceptable lubricants (EALs) may be used with Staffa motors. The EAL must be designed for use in hydraulic systems and have a synthetic ester base. Additives should be as listed for mineral oils, above. The performance of EALs with hydraulic systems vary widely and so checks for seal compatibility, copper alloy compatibility, oxidation resistance and lubrication properties should be carried out before selecting an EAL. For help with EALs please contact KPMUK.

2-8 Circuit and Application Notes (cont)

Temperature limits

Ambient min. -30°C
Ambient max. +70°C

Max. operating temperature range.	**Mineral oil**	**Water containing**
Min	-20°C	+10°C
Max. *	+80°C	+54°C

* To obtain optimum services life from both fluid and hydraulic systems components, 65°C normally is the maximum temperature expected for water-containing fluids.

Filtration

Full flow filtration (open circuit), or full boost flow filtration (close circuit) to ensure system cleanliness to ISO4406/1986 code 18/14 or cleaner.

Noise levels

The airborne noise level is less than 66.7 dBA (DIN) through 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 resonance originating from liquid borne noise can be further attenuated by providing a return line back pressure of 2 to 5 bar.

Polar moment of intertia and mass table

Typical data

Motor Frame Size	Displacement code	Polar Moment of Intertia ($kg.m^2$) (Typical)	Mass (kg) (Approx. all models)
HMF100	90	0.0520	172
	45	0.0440	
HMF200	188	0.2300	282
	75	0.1800	
HMF270	280	0.4900	450
	100	0.4700	
HMF325	325	0.5000	460
	100	0.4700	

Mass

HMF100 Approx. all models 172 kg.
HMF200 Approx. all models 282 kg.
HMF270 Approx. all models 450 kg.
HMF325 Approx. all models 460 kg.

2-9 Motor Operation at Low Temperature

When operating the motor at low temperature consideration should be given to the fluid viscosity. The maximum fluid viscosity before the shaft should be turned is 2,000 cSt. The maximum fluid viscosity before load is applied to the motor shaft is 150 cSt.

If low ambient temperature conditions exist, then a crankcase flushing flow of at least 5 l/min should be applied to the motor during periods when the motor is not in use.

The shaft seal temperature limits for both medium and high pressure applications are shown in the table below.

	Non-operating temperature limits	Minimum operating temperature
Standard pressure shaft seal	below minus 40°C and above 100°C	minus 30°C
High pressure shaft seal	below minus 30°C and above 120°C	minus 15°C

All seals are very brittle below minus 40°C and are likely to break very easily and due to their sluggish response may not provide a 100% leak free condition.

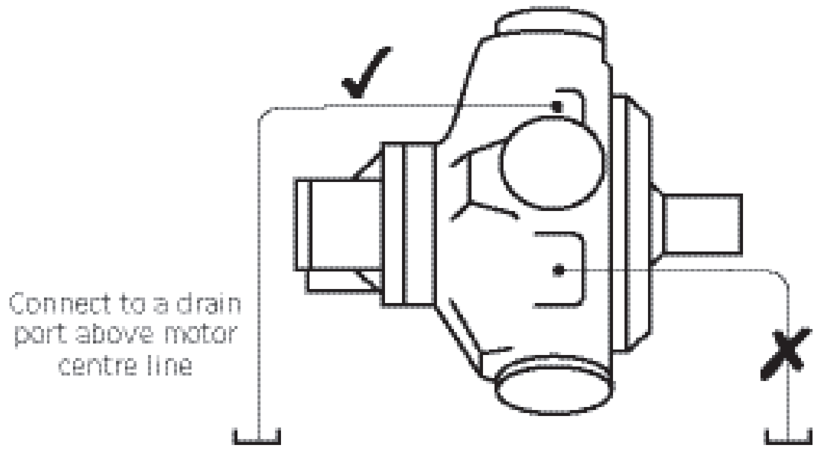
It should be noted that the maximum continuous operating temperature within the motor crankcase is plus 80°C.

It is recommended that the motor is operated by observing the rule for viscosity and the minimum operating temperature.

2-10 Crankcase Drain Connections

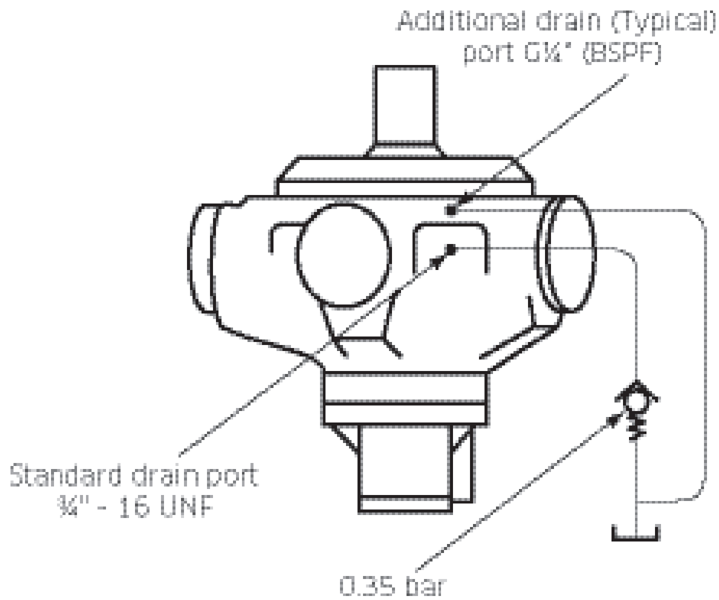
Motor axis - horizonta

The recommended minimum pipe size for
line lengths up to approx. 5m is 12.0 mm (
Longer drain lines should have their bore s
increased to keep the crankcase pressure
limits.



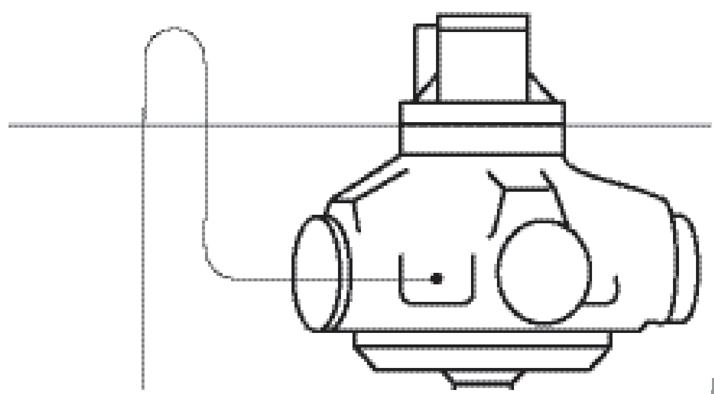
Motor axis - vertical s

Specify "V" within the model code for extra
G¼" (BSPF). Connect this port into the main
downstream of a 0.35 bar check valve to e
bearing lubrication. The piping arrangemen
not allow syphoning from the motorcase. (
installation drawing for details).



Motor axis - vertical s

The piping, from any drain port, must be ta
above the level of the motorcase to ensure
bearing lubrication. The arrangement must
syphoning from the motorcase.



2-11 Freewheeling Notes

All Staffa motors can be used in freewheeling applications. In all circumstances it is essential that the motor is unloaded (“A” and “B” ports connected together) and that the circuit is boosted. The required boost pressure is dependent on both the speed and displacement conditions of the motor determined by the maximum overrunning load condition (see boost pressure calculation method on page 33).

It should be noted that for “B” motors large flows will re-circulate around the motor. This will require a large recirculating valve and consideration of circuit cooling as the motor will be generating a braking torque. It is for these reasons that “C” and “F” series motors are the preferred option for freewheeling applications. It is normal to select displacement codes 00, 05 or 10.

Selecting the lowest zero displacement option (00) will allow the motor shaft to be rotated at high speed without pumping fluid and with a minimum boost and drive torque requirement. Consideration must also be given when freewheeling that the load does not drive the motor above its rated freewheeling speed condition. (see pages 24 to 27).

Displacement selection

Under all operating conditions the control pressure port should be at least 67% of the motor inlet/outlet pressure whichever is the higher.

A minimum control pressure at the low displacement selection port of 3.5 bar is necessary to ensure that the motor remains in its minimum displacement condition. A separate pressure supply may be necessary to ensure this condition is always maintained. It should be noted that with the loss of control pressure, the motor will shift to its high displacement condition, which could result in damage to the motor.

Boost requirement

The minimum required boost pressure as noted above can be ascertained utilising the calculation method shown on page 33. The maximum motor and control pressure at 1,000 rpm is 17 bar and must not be exceeded since higher pressures will increase motor losses at the conrod slipper interface and valve assembly and thereby will significantly increase the motor operating temperature.

The boost flow required should be sufficient to make-up circuit leakage loss and provide cooling for recirculating flow pressure drop.

Crankcase cooling

A crankcase flushing flow of up to 15 l/min can be used to control and reduce the temperature rise of the motor during the freewheel operation.

This should not be necessary for speeds below 1,000 rpm.

For speeds above this up to 1,500 rpm then crankcase flushing flow must be used.

2-12 Installation Data

General

Spigot
The motor should be located by the mounting spigot on a flat, robust surface using correctly sized bolts. The diametrical clearance between the motor spigot and the mounting must not exceed 0.15 mm. 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 bolts is as follows:

M12	97 +/- 7Nm
M14	160 +/- 21Nm
M18	312 +/- 14 Nm
M20	407 +/- 14 Nm
M24	690 +/- 27 Nm
½" UNF	97 +/- 7 Nm
⅝" UNF	265 +/- 14 Nm
¾" UNF	393 +/- 14 Nm
1"	810 +/- 27 Nm

Shaft coupling
Where the motor is solidly coupled to a shaft having independent bearings the shaft must be aligned to within 0.13 mm TIR.

Motor axis - horizontal
The crankcase drain must be taken from a position above the horizontal centre line of the motor, (refer to installation drawing for details).

Motor axis - vertical shaft up
The recommended minimum pipe size for drain line lengths up to approx. 5 m is 12.0 mm as an internal diameter. If using longer drain lines, then increase the pipe internal bore diameter to keep the motorcase pressure within specified limits.

Specify "V" in the model code for extra drain port, G¼" (BSPF). Connect this port into main drain line downstream of a 0.35 bar check valve.

Motor axis - vertical shaft down
Piping (from any drain port) must be taken above level of motorcase.

Bearing lubrication - piping
The installation arrangement must not allow syphoning from the motorcase. Where this arrangement is not practical, please consult KPM UK.

Any of the drain port positions can be used, but the drain line should be run above the level of the uppermost bearing and 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 unloaded and set to its high displacement.

3 Dimensions

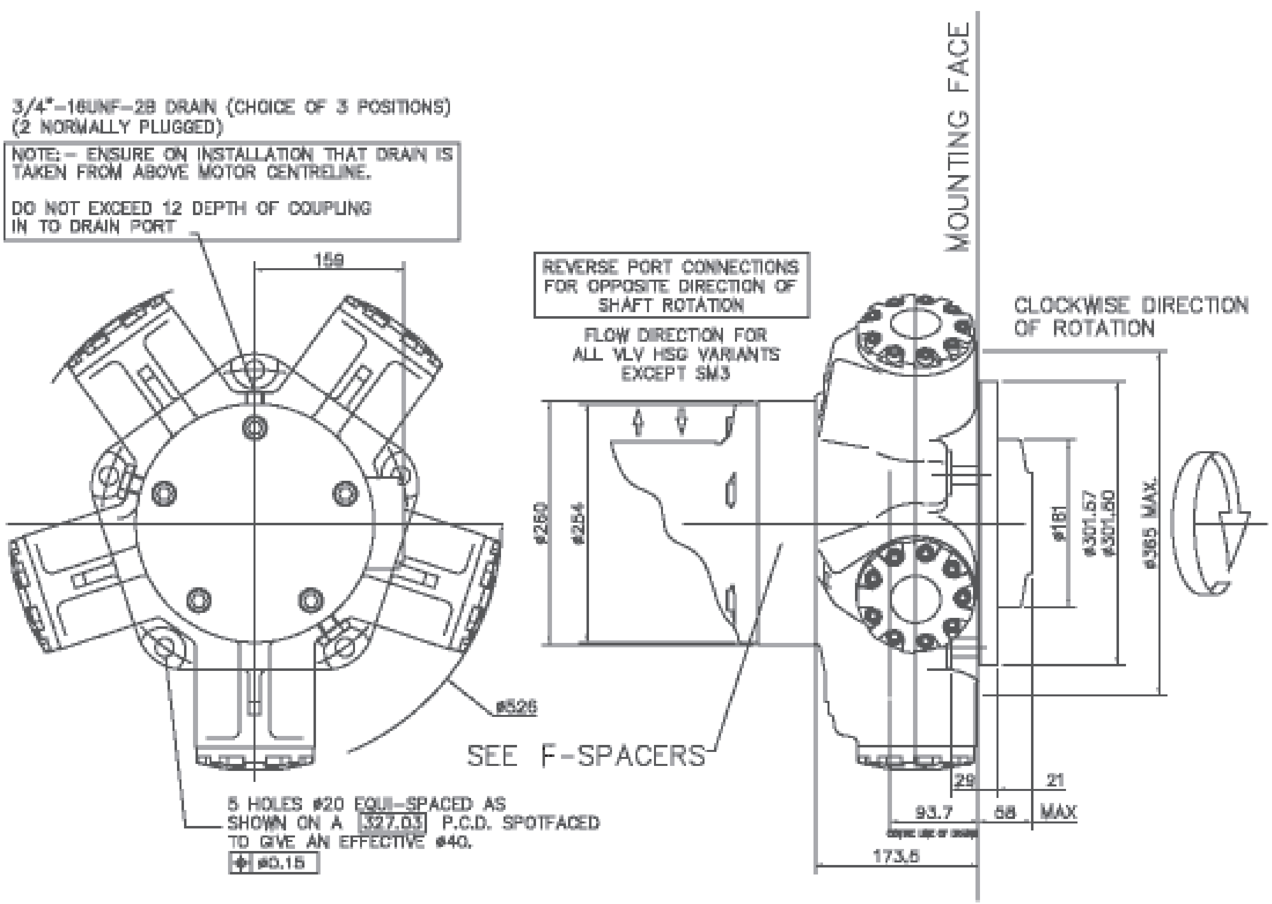
Conversion Table

Pressure	
bar	PSI
1	14.5
Flow	
l/min	gal/min
1	0.264 US
1	0.219 UK
Length	
mm	inch
25.4	1

Torque	
Nm	lbf ft
1	0.737
Power	
kW	hp
1	1.341
Mass	
kg	lb
1	2.2

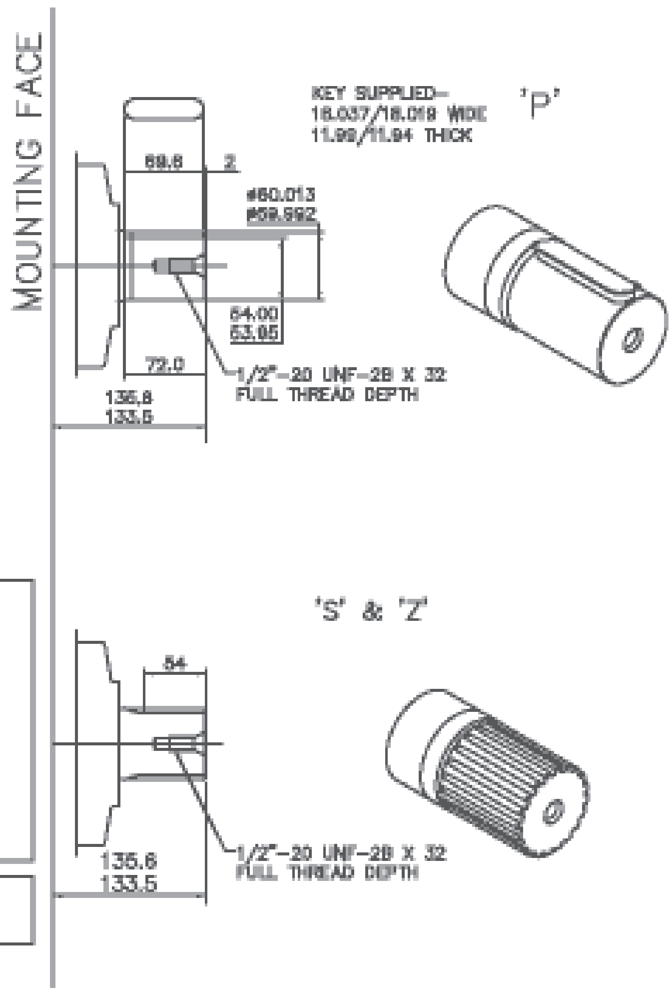
3-1 HMF100

Installation



3-1 **HMF100** (cont)

'P', 'S' and 'Z' Shafts



SPLINE DATA

'S'

TO BS 3550 (ANSI B92.1 CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

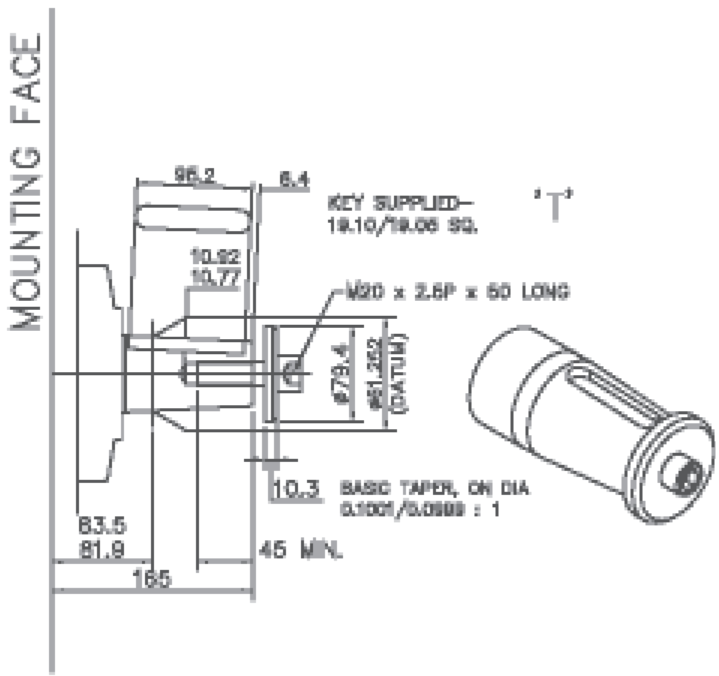
PRESSURE ANGLE	30°
NUMBER OF TEETH	14
PITCH	6/12
MAJOR DIAMETER	62.553/62.425
FORM DIAMETER	55.052
MINOR DIAMETER	54.084/53.525
PIN DIAMETER	8.128
DIAMETER OVER PINS	71.593/71.544

'Z'

DIN 5480 W70 x 3 x 30 x 22 x 7h

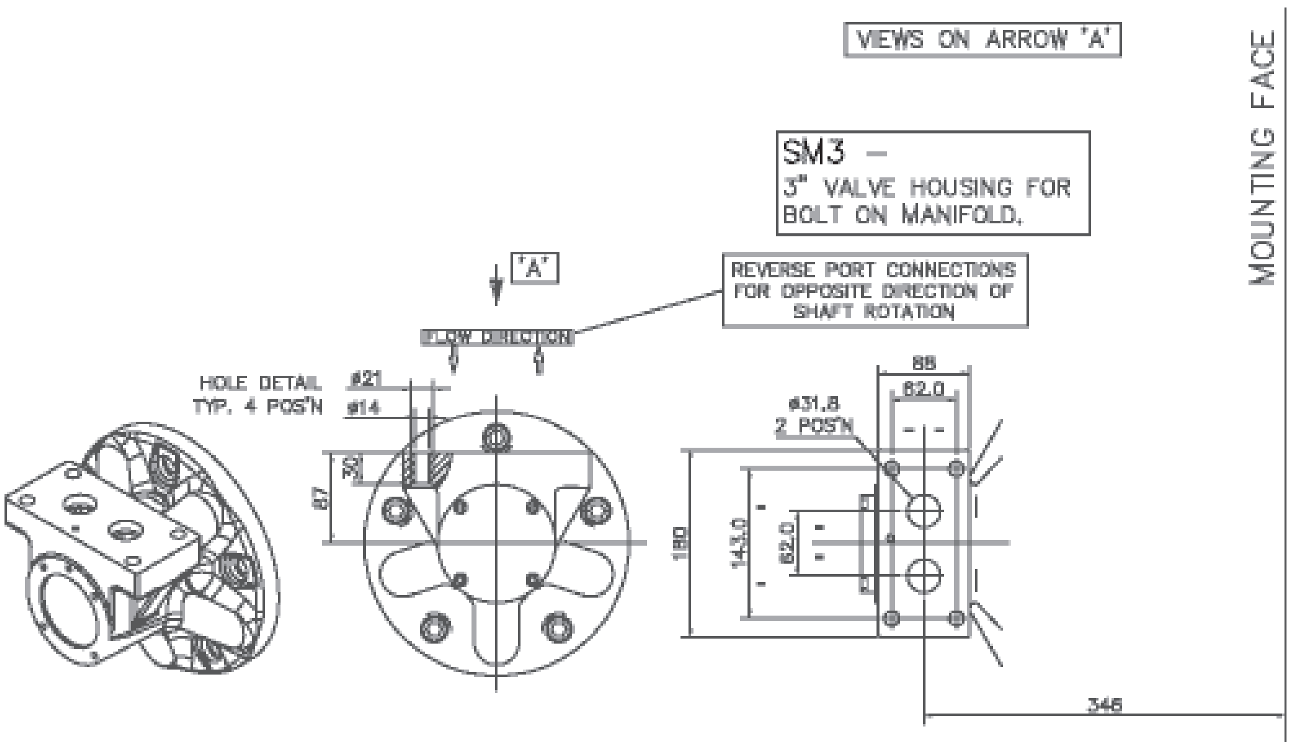
3-1 HMF100 (cont)

'T' Shaft



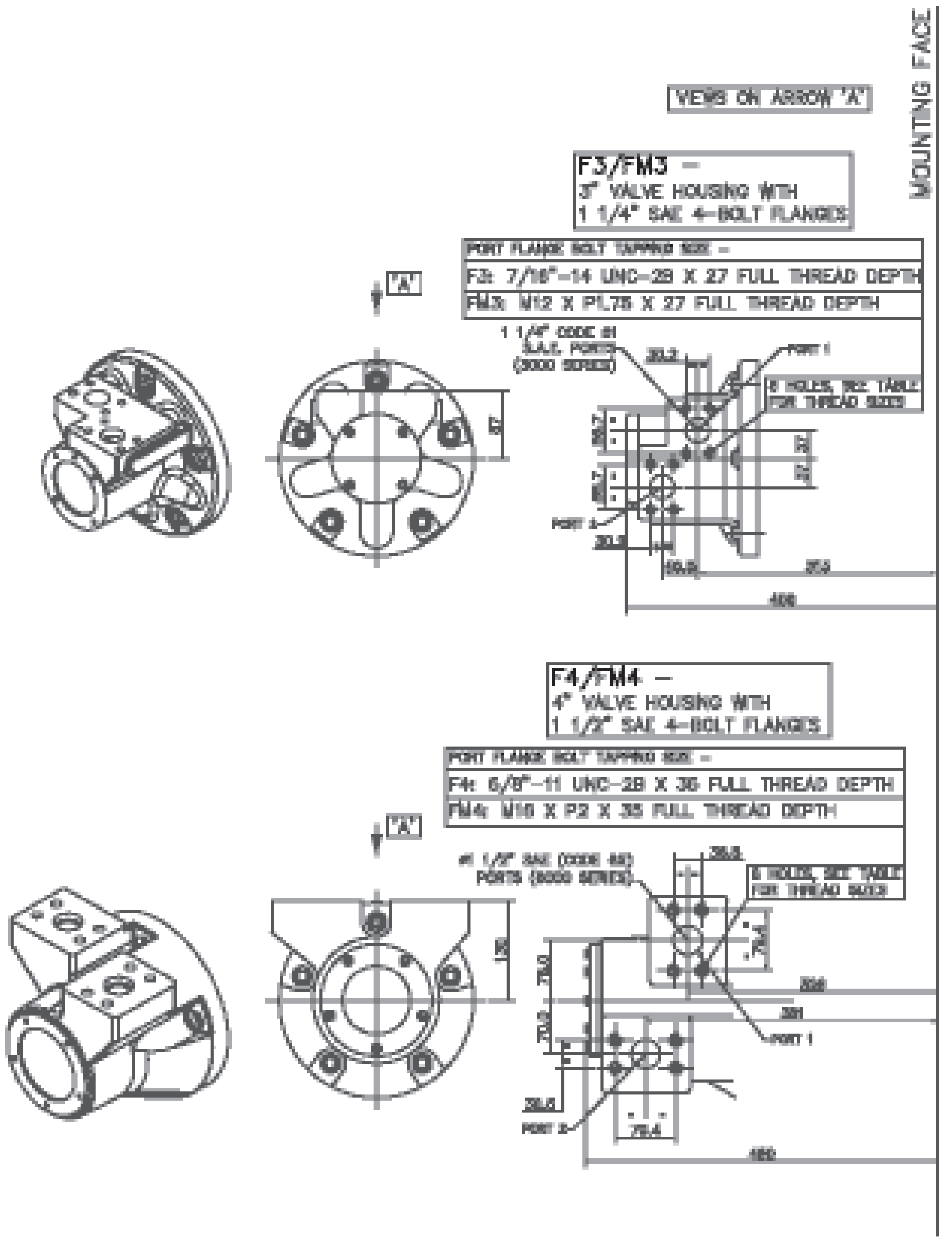
3-1 HMF100 (cont)

'SM3' Valve Housing



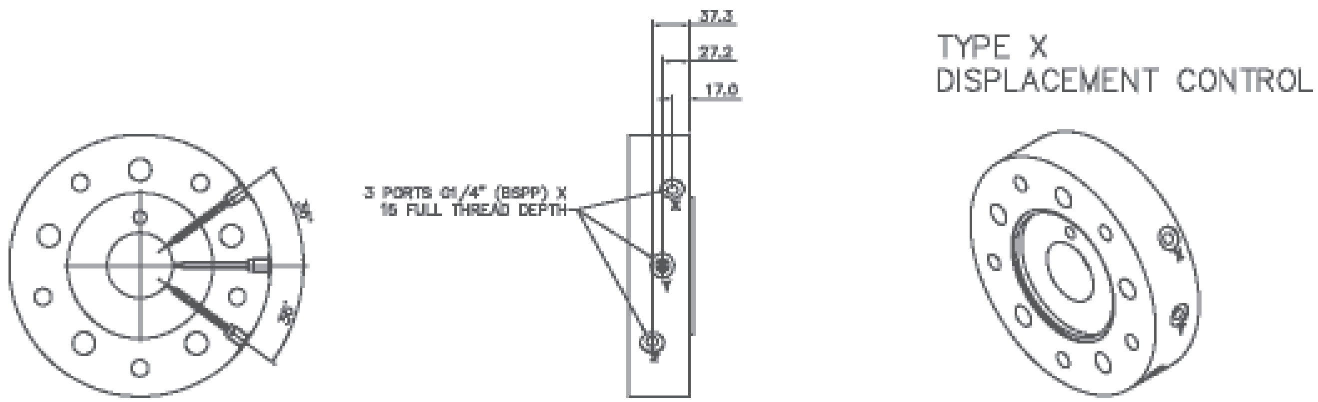
3-1 HMF100 (cont)

‘F3’, ‘FM3’, ‘F4’ & ‘FM4’ Valve Housings



3-1 HMF100 (cont)

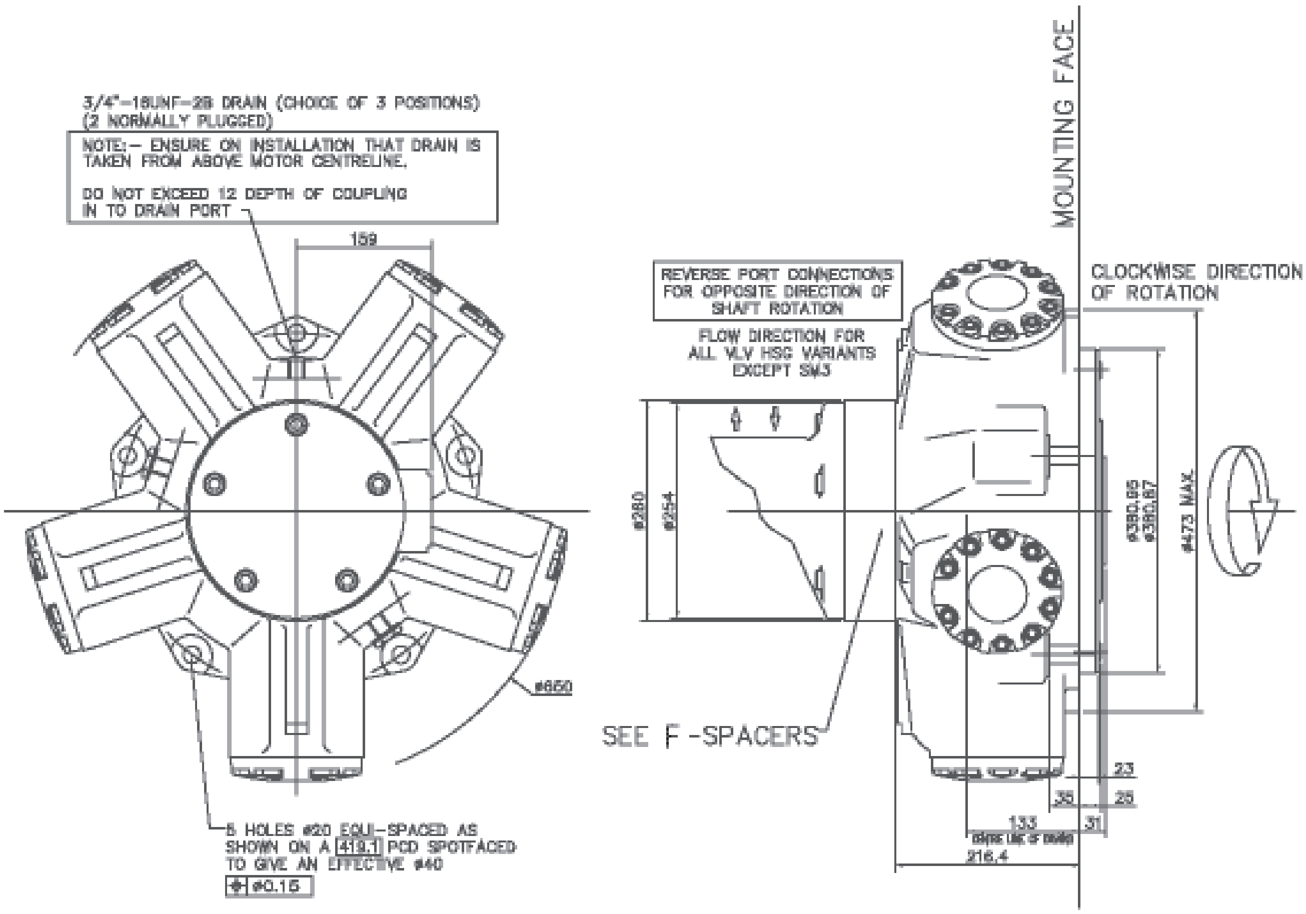
‘X’ F Spacer



DISPLACEMENT SELECTION (VIA REMOTELY LOCATED VALVE*)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
MID DISPLACEMENT: P TO X AND Z: Y TO T
SEE TIMING CHART.
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR.

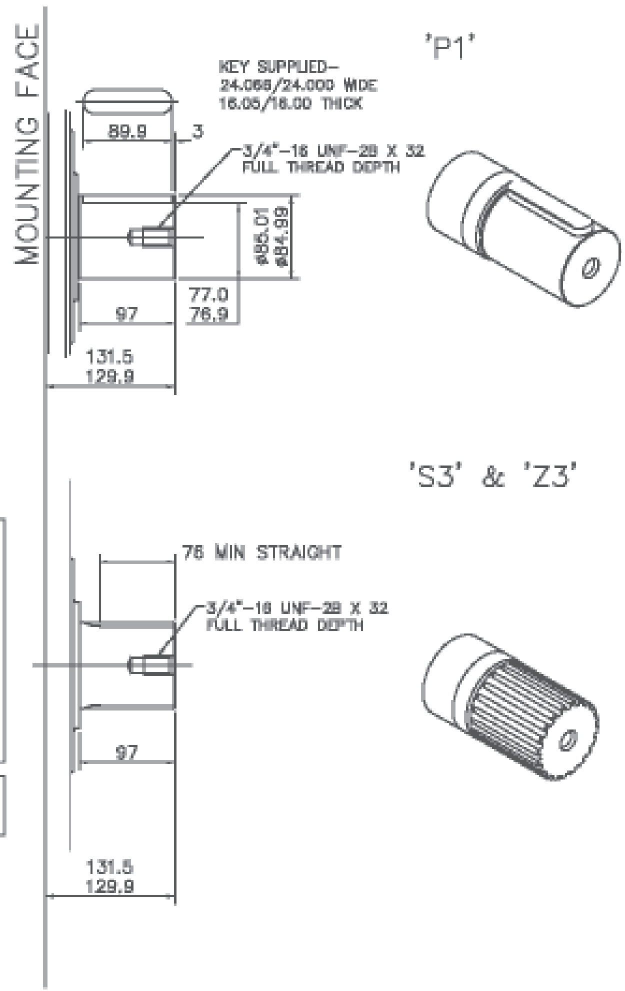
3-2 HM(HD)F200

Installation



3-2 HMF200 (cont)

‘P1’, ‘S3’ and ‘Z3’ Shafts



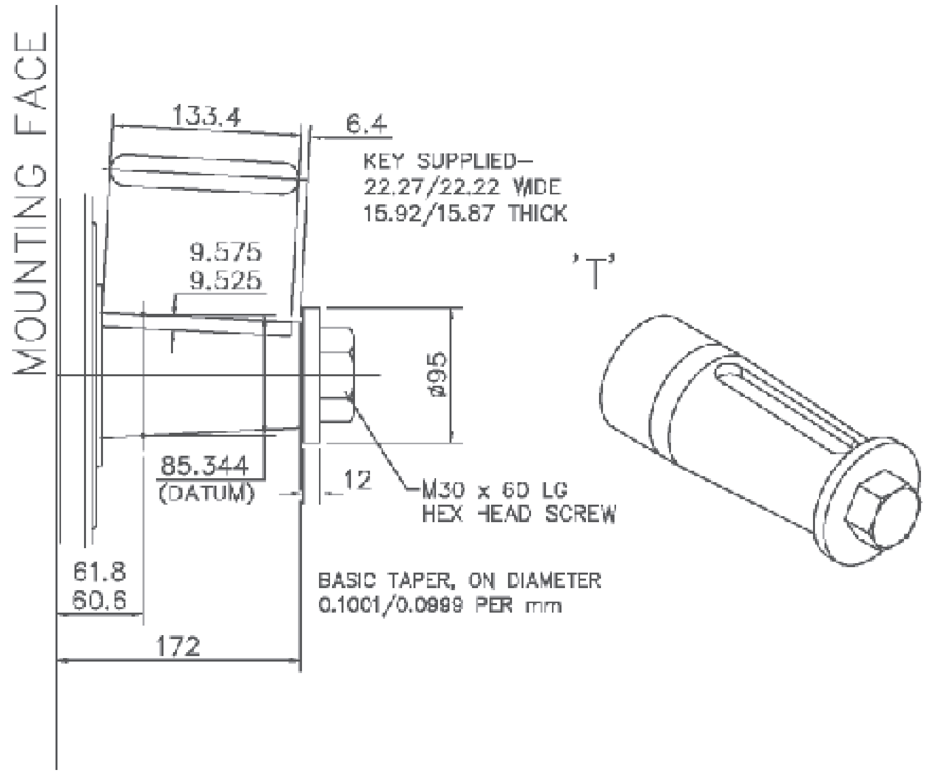
SPLINE DATA

'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.465/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z3'
DIN 5480 W85 x 3 x 27 x 7h

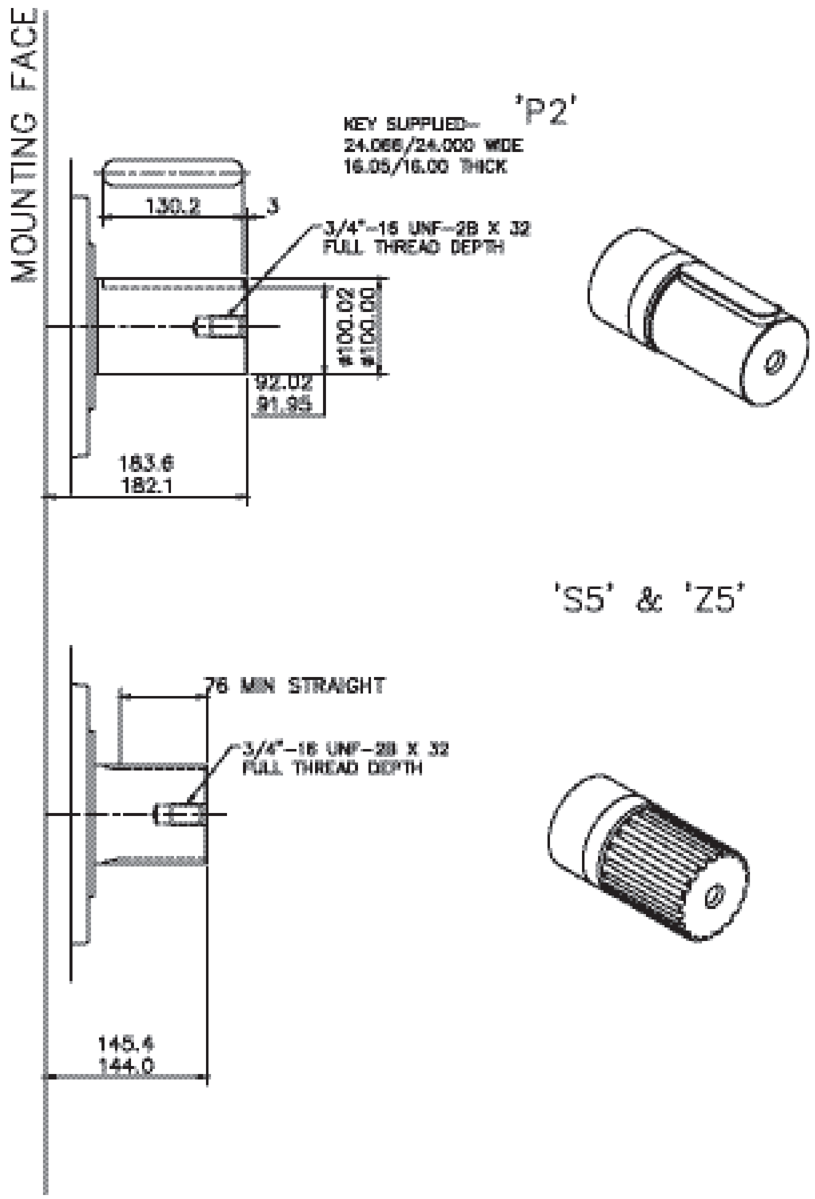
3-2 HMF200 (cont)

‘T’ Shaft



3-2 HMHDF200 (cont)

'P2', 'S5' and 'Z5' Shafts



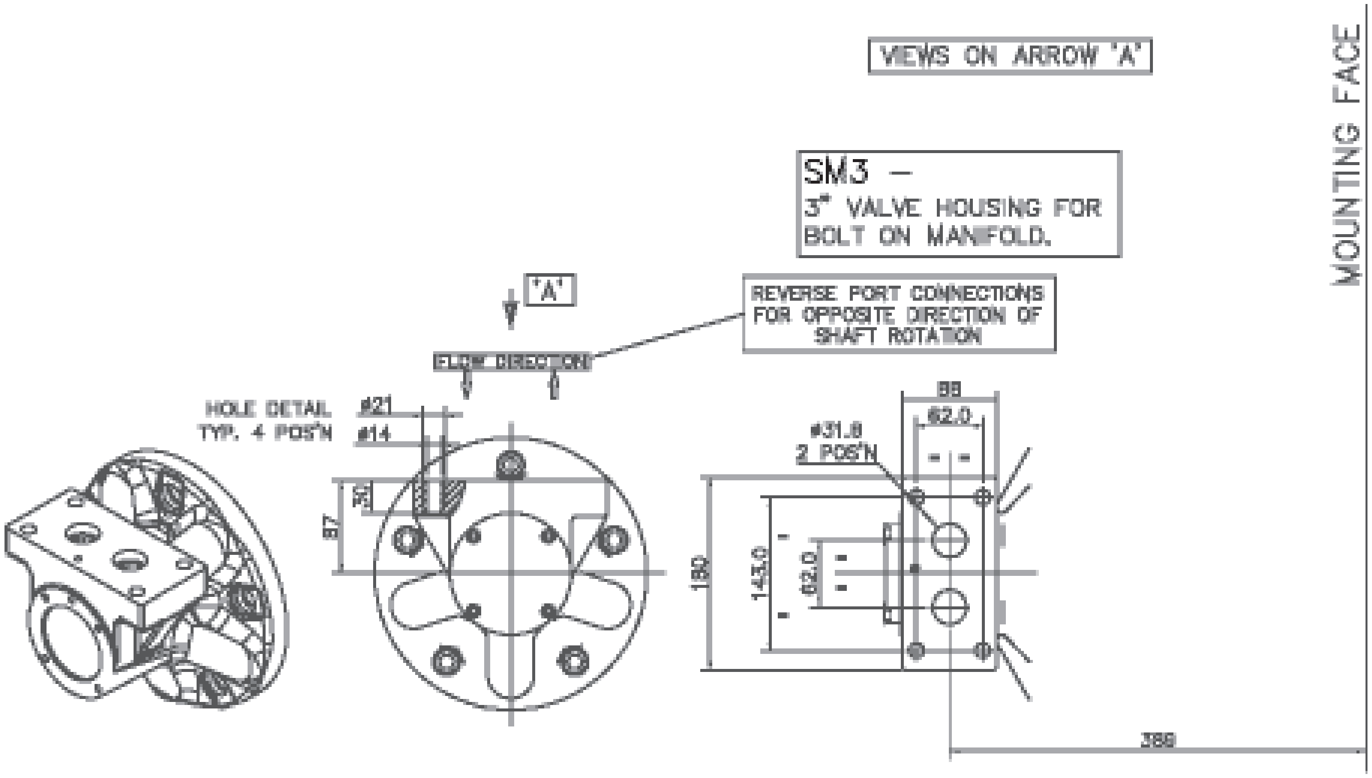
SPLINE DATA

'S5'	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.652/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.626
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

'Z5'
DIN 5480 W100 x 4 x 24 x 7h

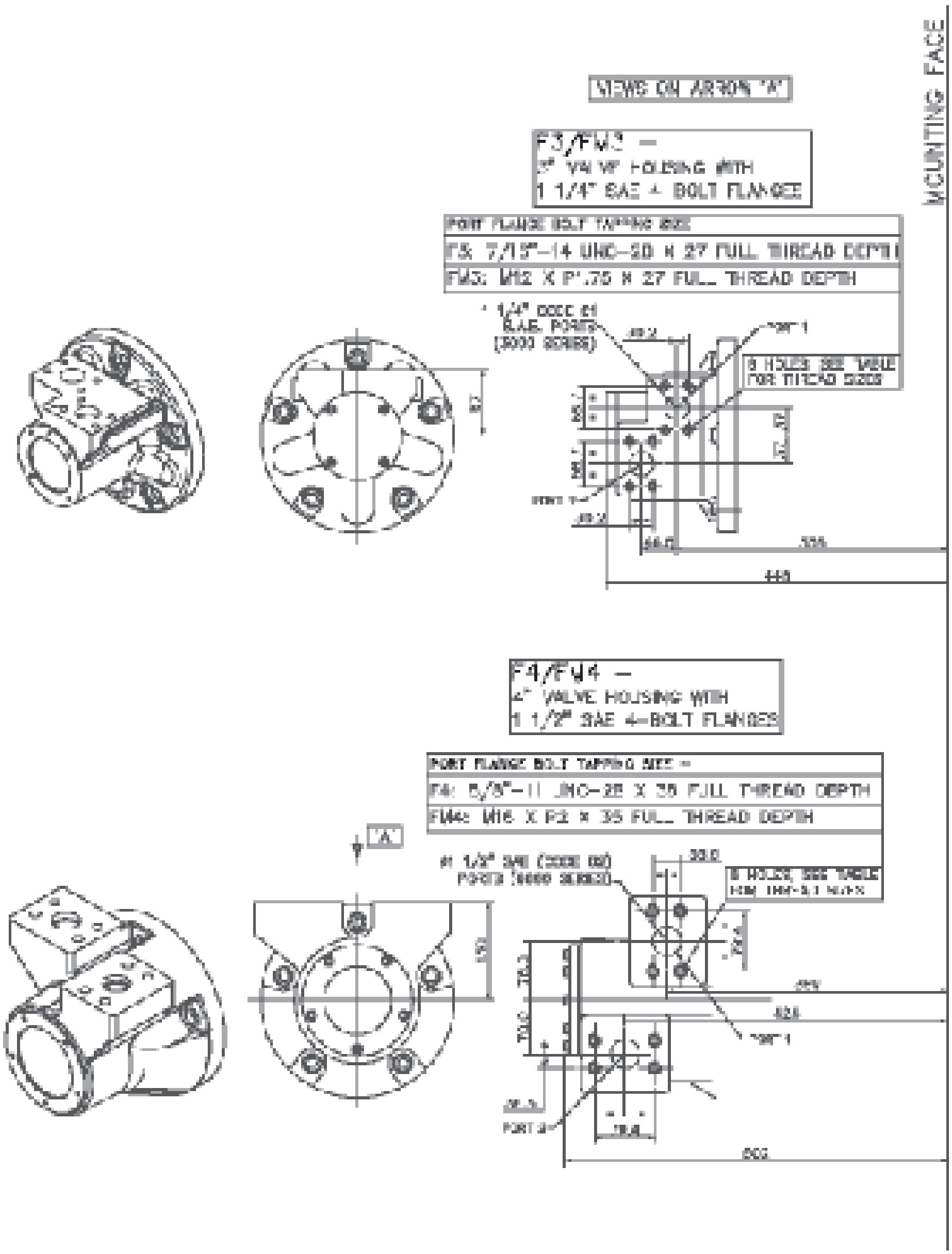
3-2 HM(HD)F200 (cont)

'SM3' Valve Housing



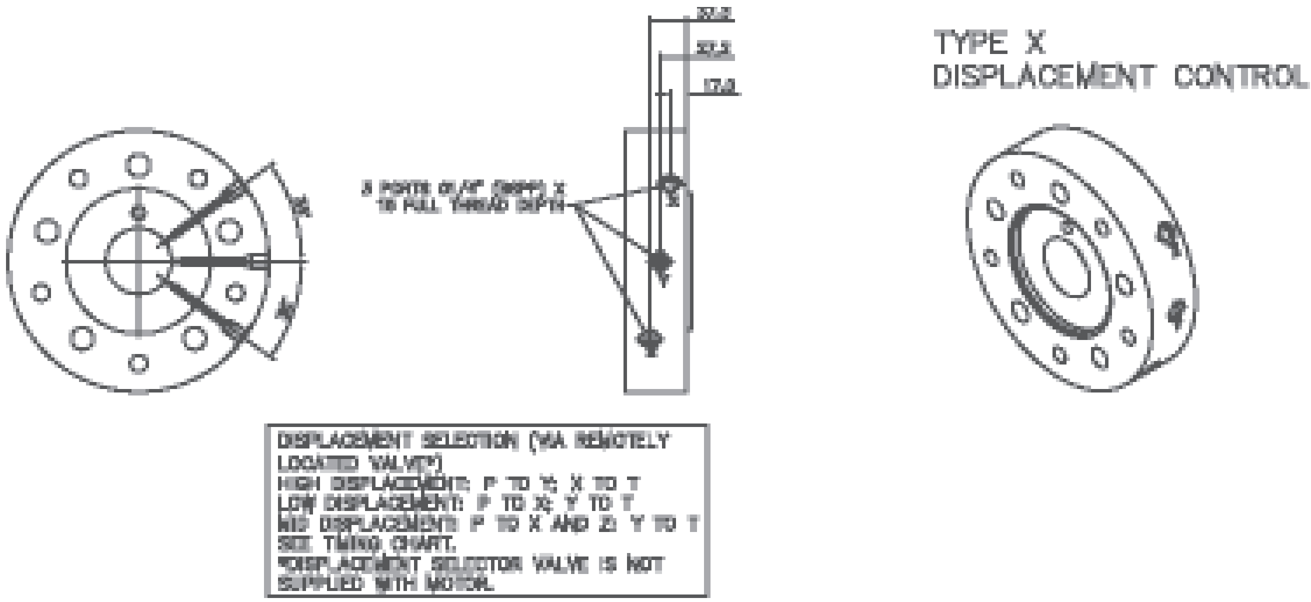
3-2 HM(HD)F200 (cont)

‘F3’, ‘FM3’, ‘F4’ & ‘FM4’ Valve Housings



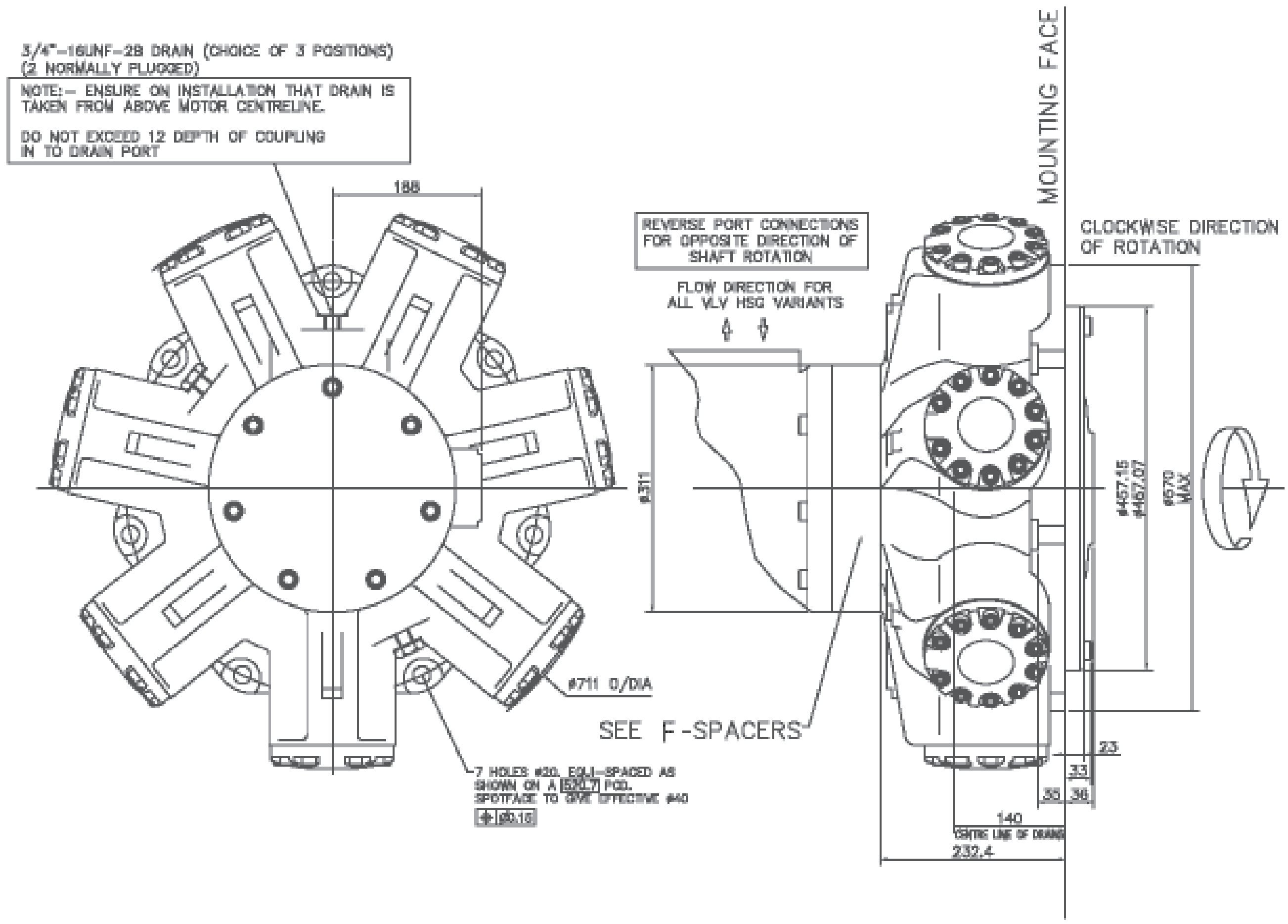
3-2 HM(HD)F200 (cont)

'X' F Spacer



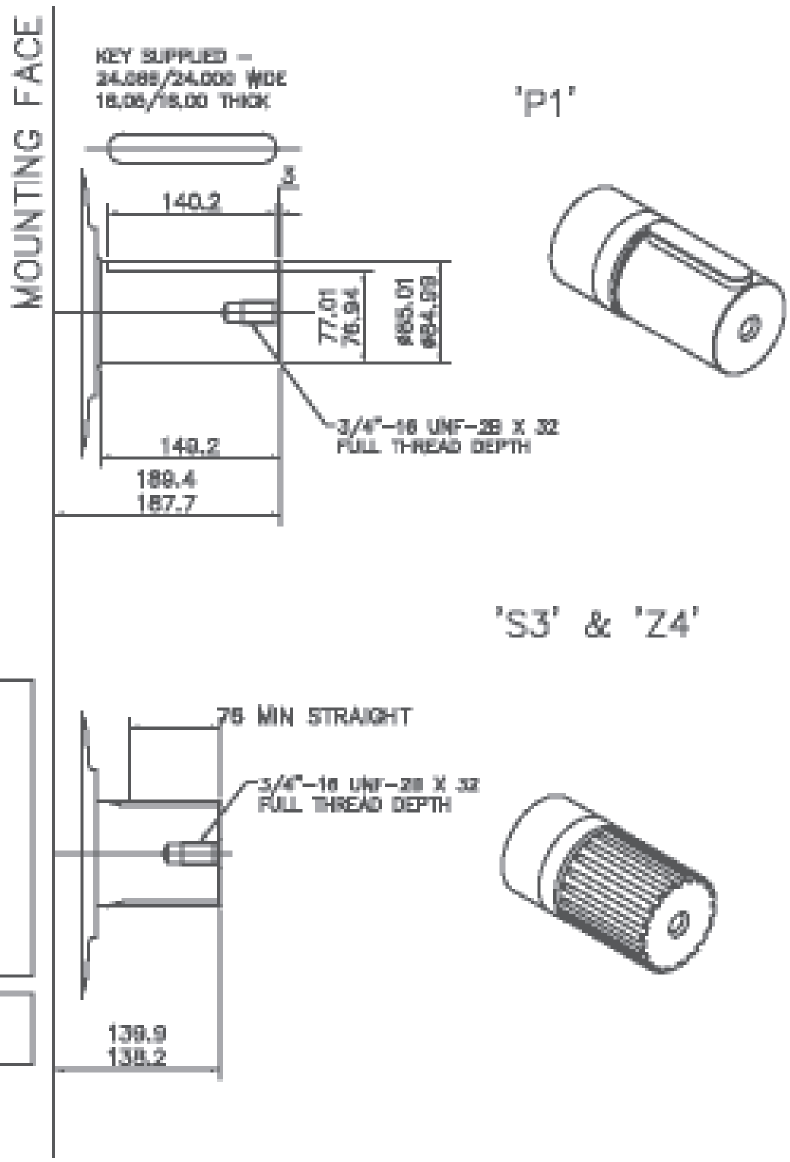
3-3 HM(HD)F270

Installation



3-3 HMF270 (cont)

‘P1’, ‘S3’ and ‘Z4’ Shafts



SPLINE DATA

'S3'

TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

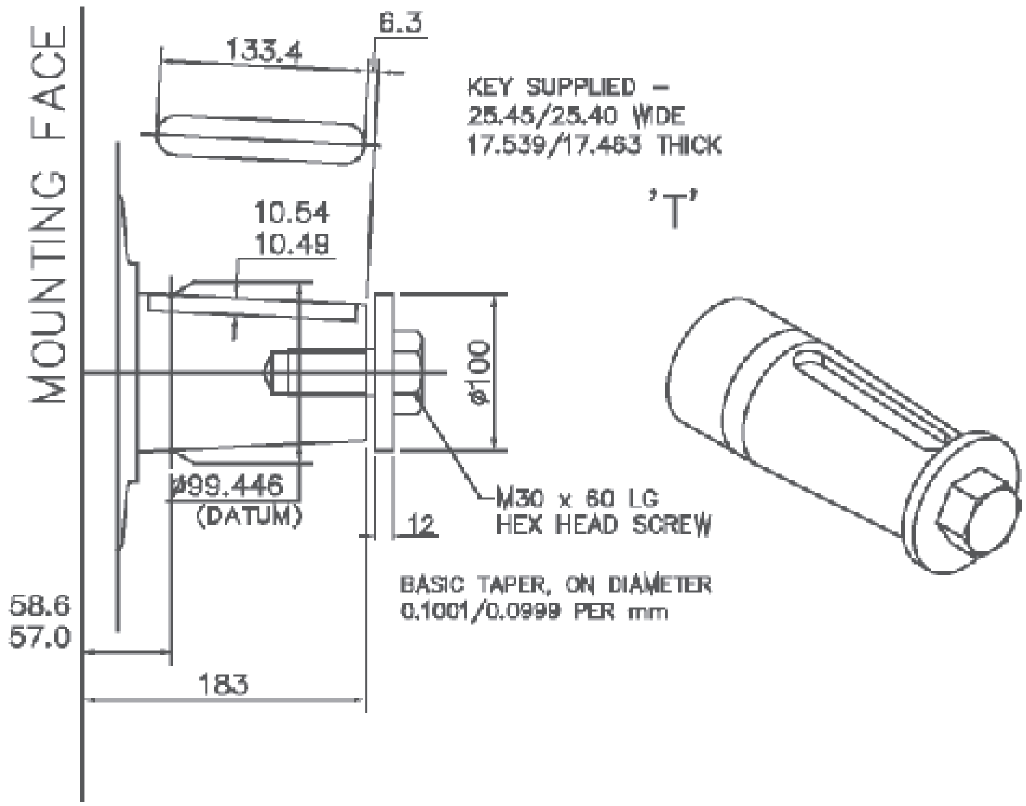
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z4'

DIN 5480 W90 x 4 x 21 x 7h

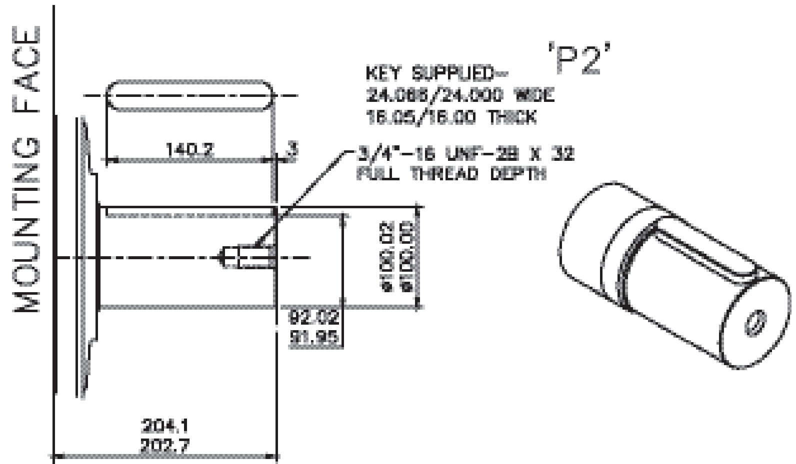
3-3 HMF270 (cont)

'T' Shaft



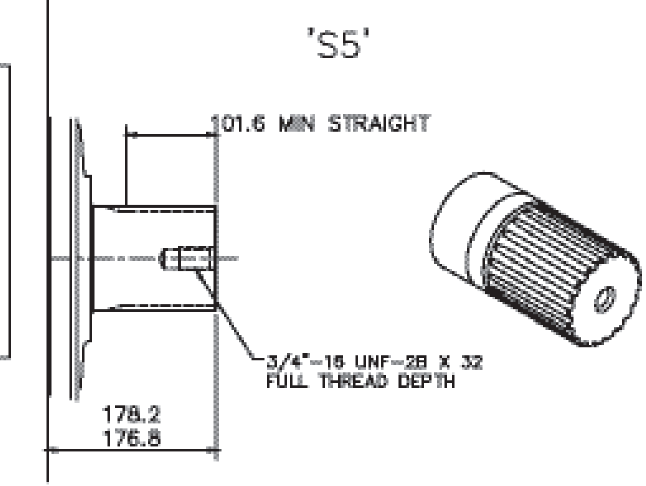
3-3 HMHDF270 (cont)

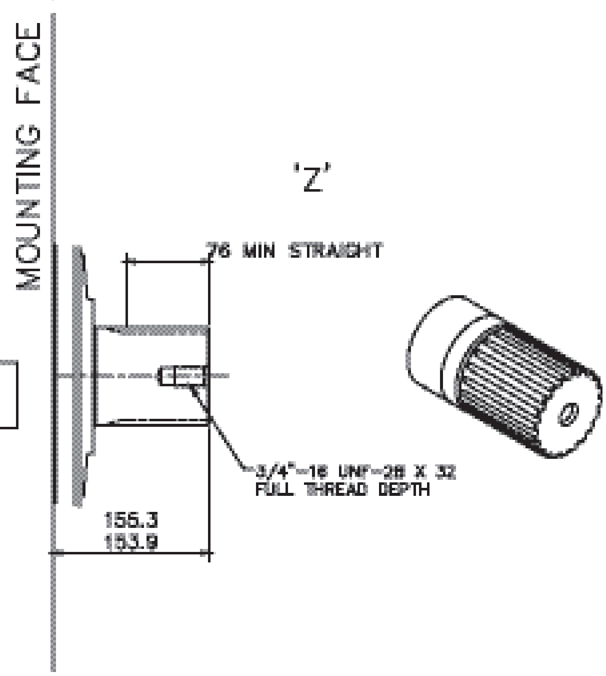
‘P2’, ‘S5’ and ‘Z’ Shafts



SPLINE DATA

'S5'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.653/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.625
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

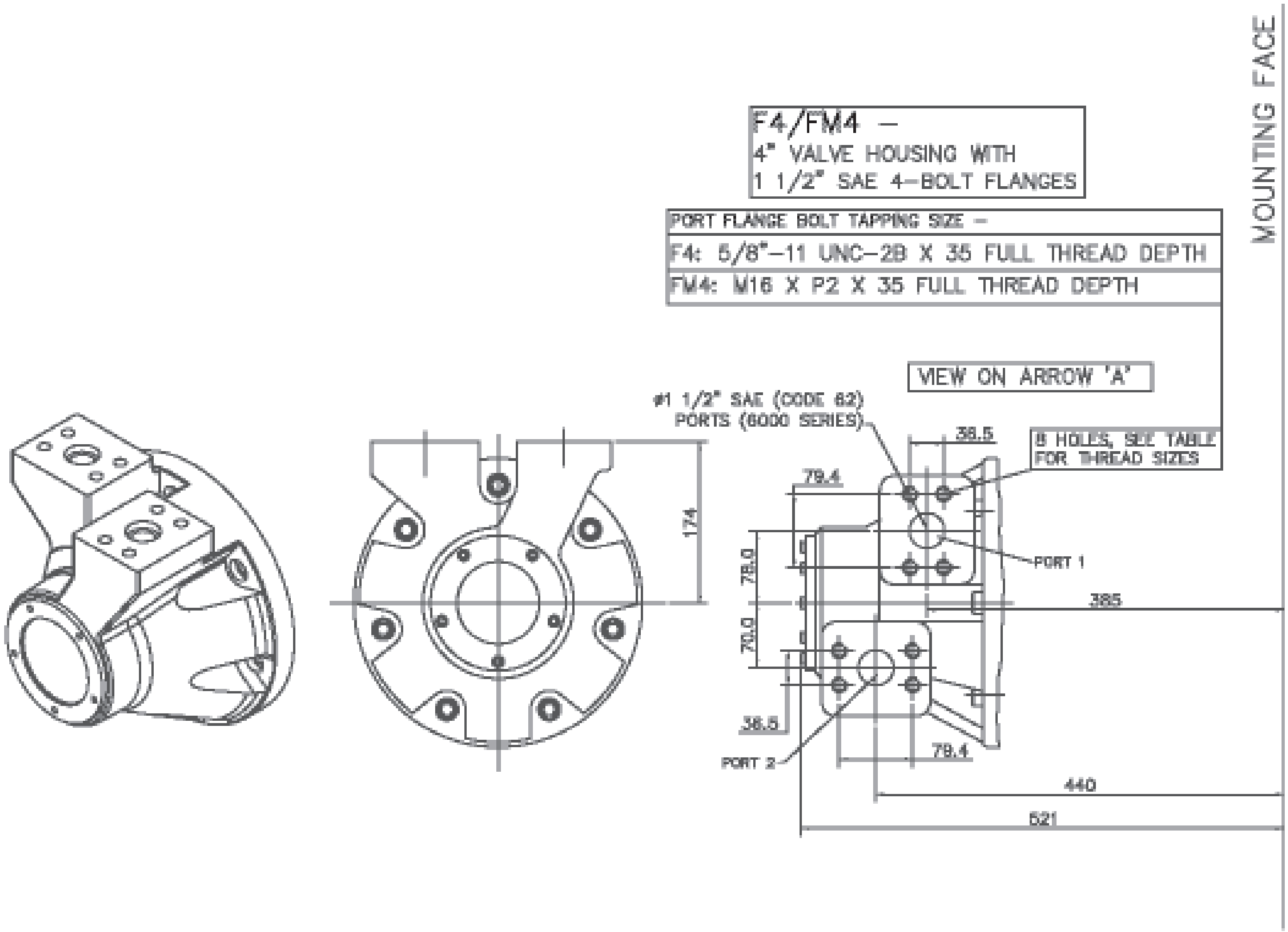




'Z'
DIN 5480 W100 x 4 x 24 x 7h

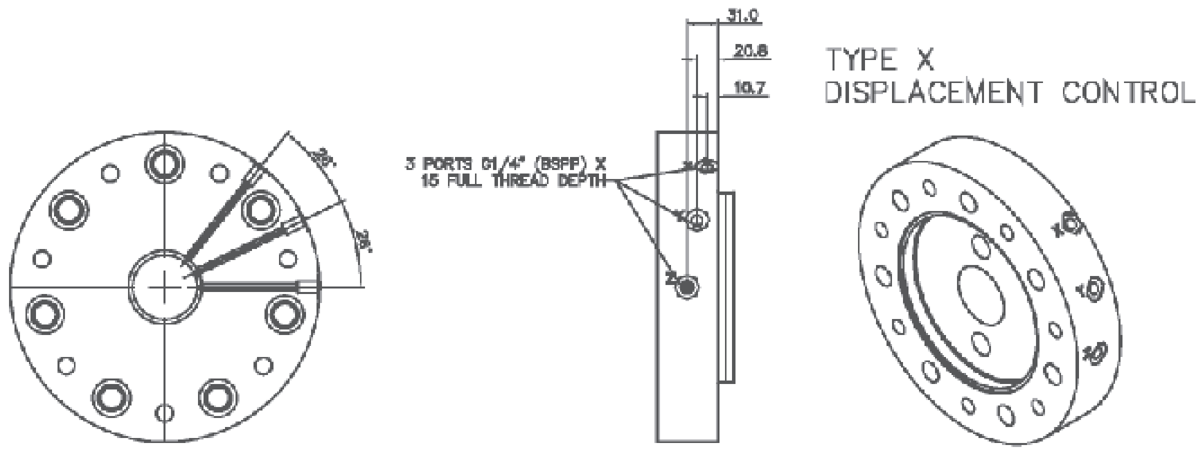
3-3 HM(HD)F270 (cont)

‘F4’ & ‘FM4’ Valve Housings



3-3 HM(HD)F270 (cont)

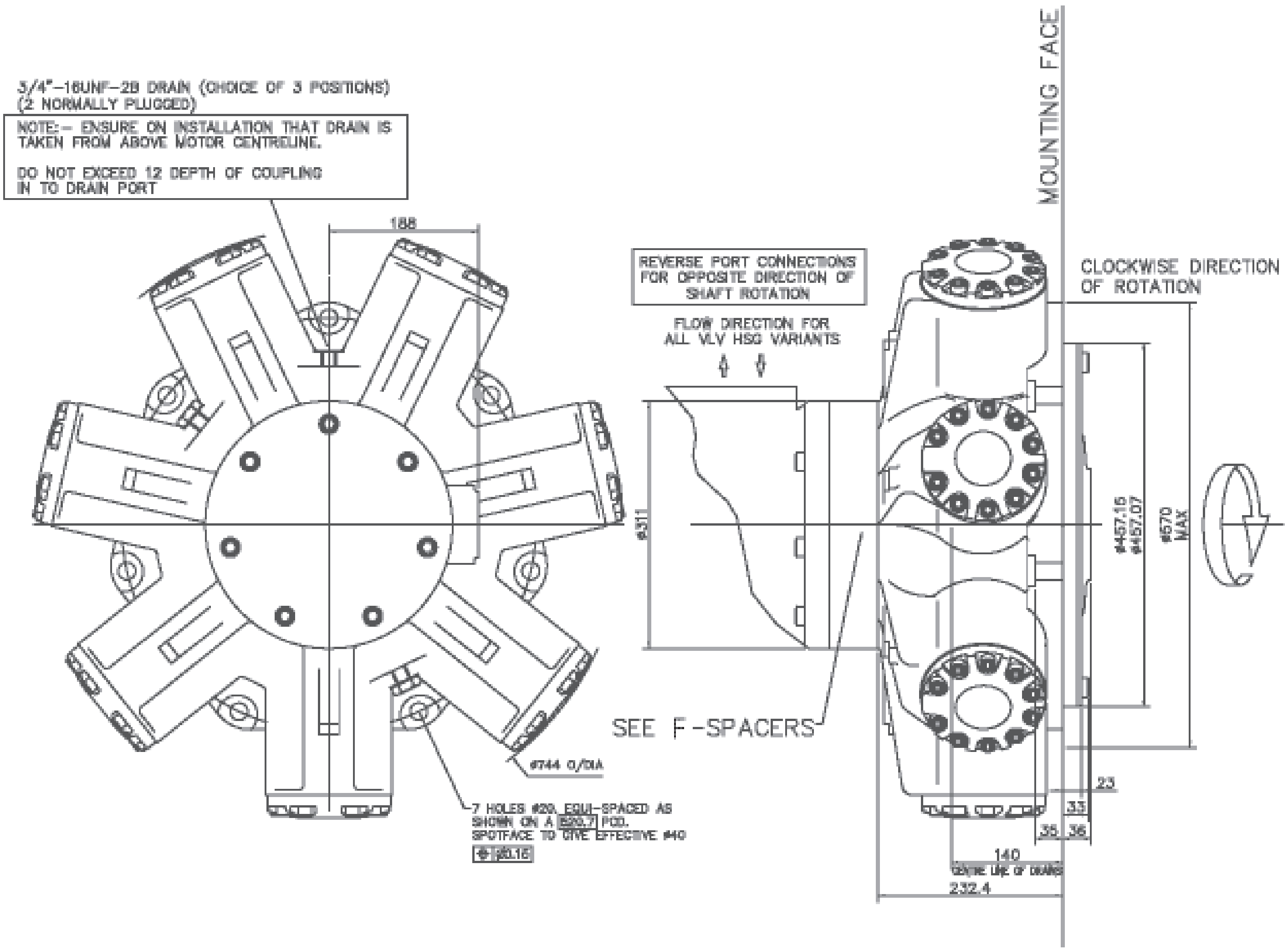
‘X’ F Spacer



DISPLACEMENT SELECTION (VIA REMOTELY LOCATED VALVE*)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
MID DISPLACEMENT: P TO X AND Z: Y TO T
SEE TIMING CHART.
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR.

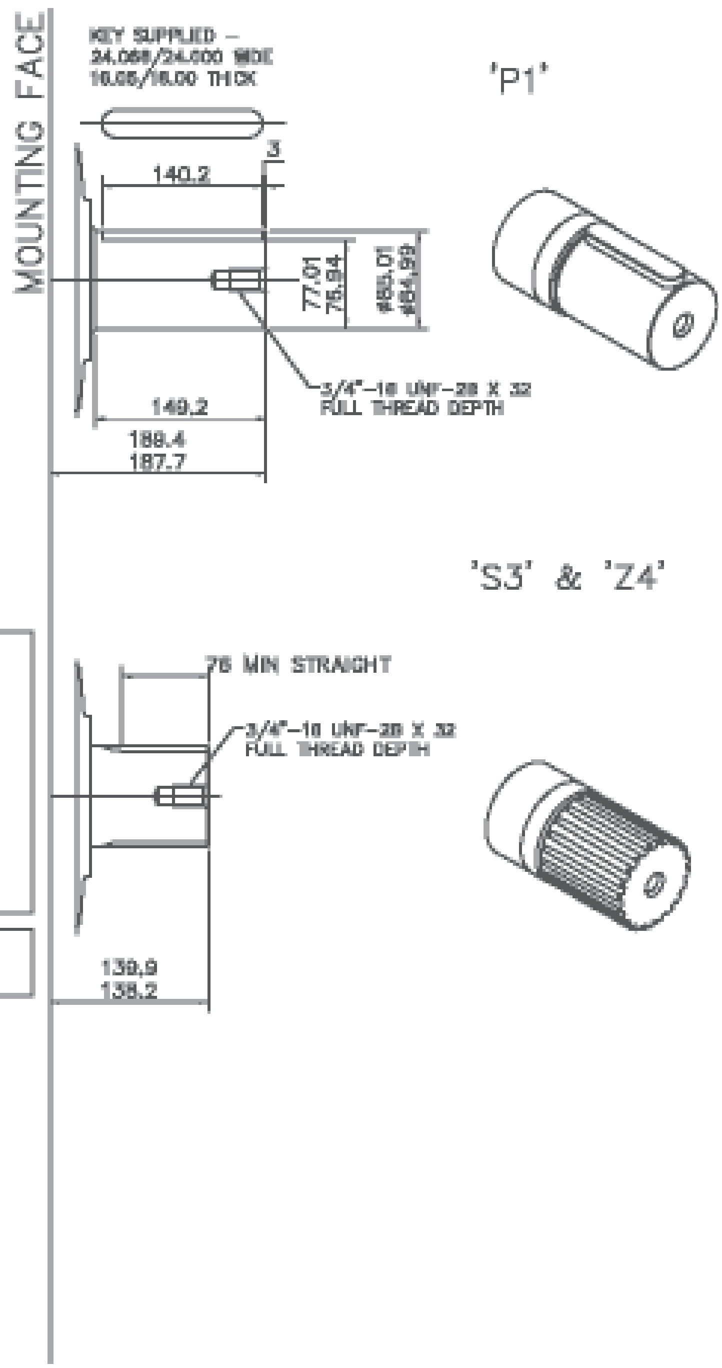
3-4 HM(HD)F325

Installation



3-4 HMF325 (cont)

‘P1’, ‘S3’ and ‘Z4’ Shafts



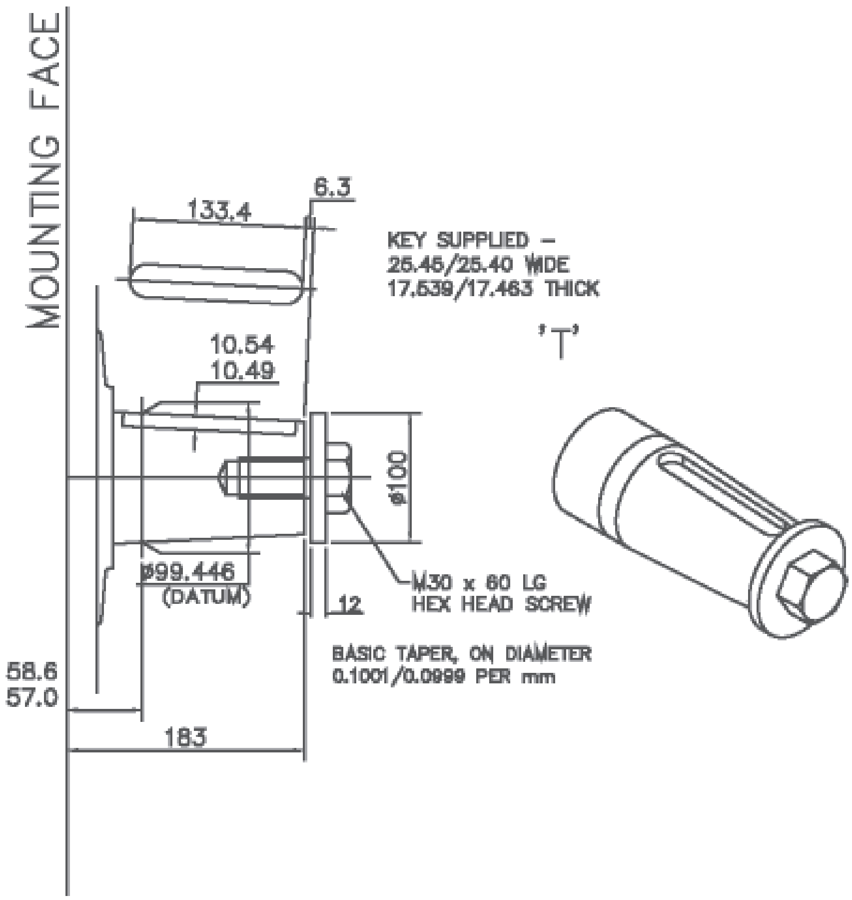
SPLINE DATA

'S'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z'
DIN 5480 W80 x 4 x 21 x 7h

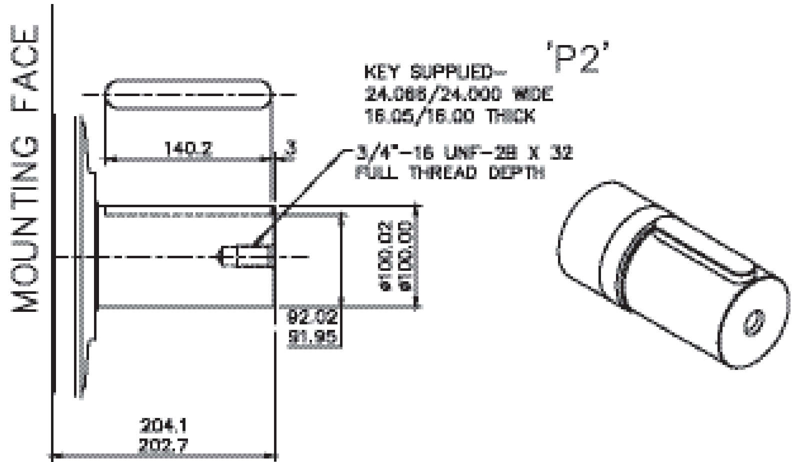
3-4 HMF325 (cont)

'T' Shaft



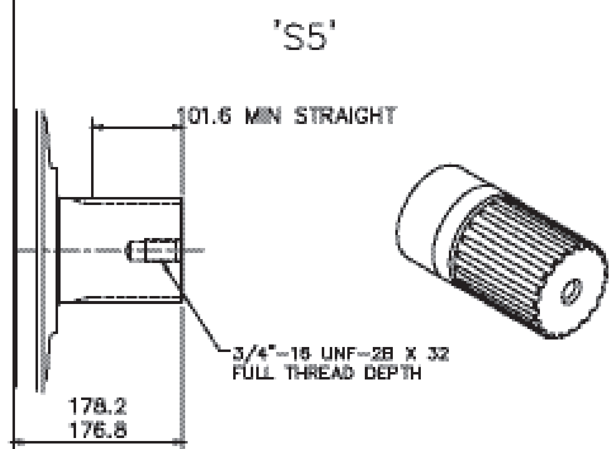
3-4 HMHDF325 (cont)

‘P2’, ‘S5’ and ‘Z’ Shafts

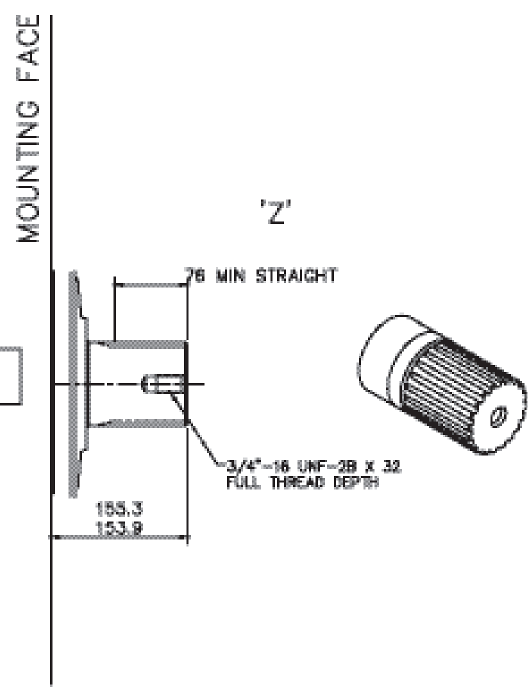


SPLINE DATA

'S5'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.653/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.625
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

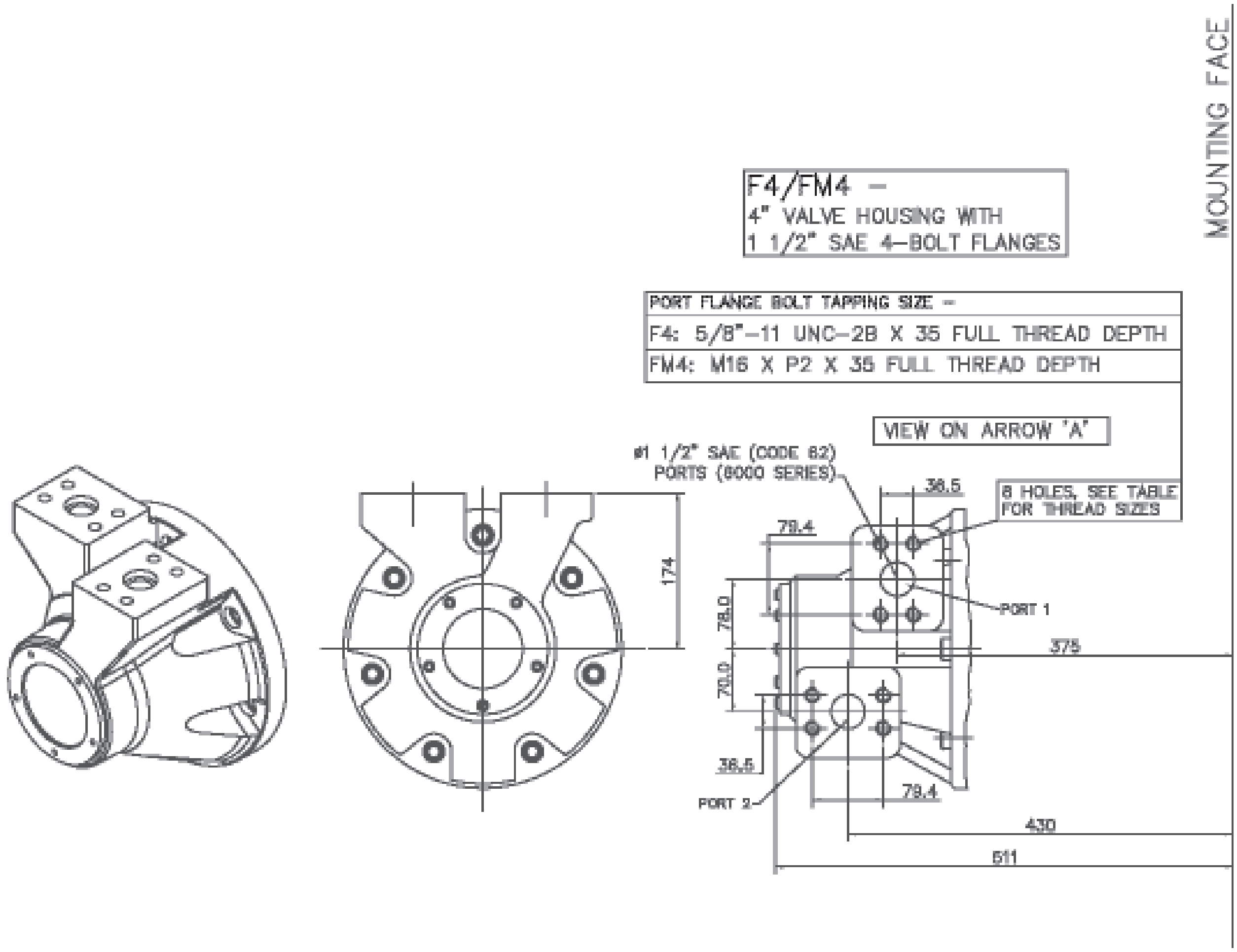


'Z'
DIN 5480 W100 x 4 x 24 x 7h



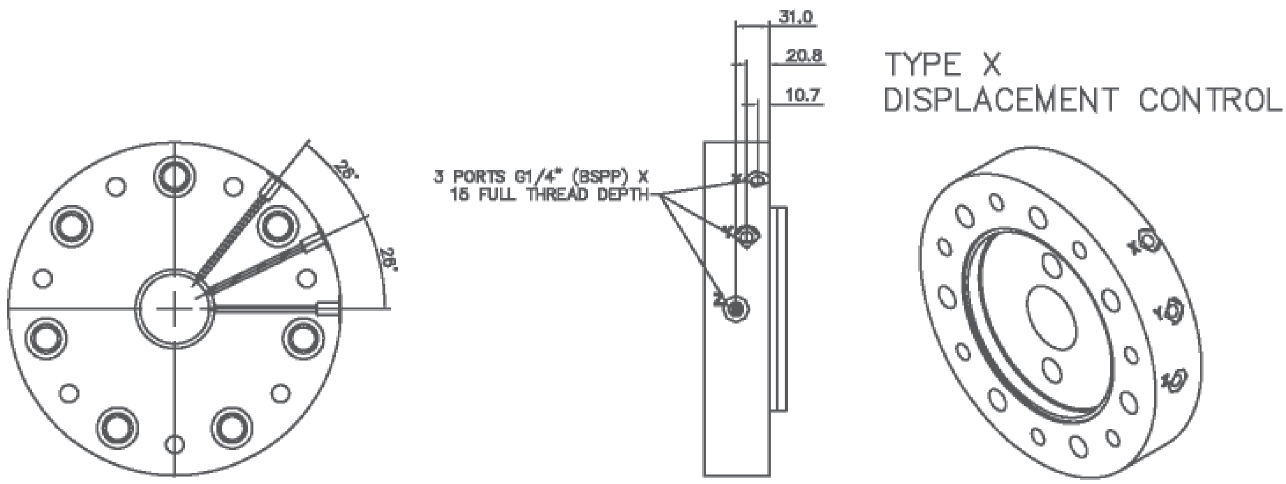
3-4 HM(HD)F325 (cont)

‘F4’ & ‘FM4’ Valve Housings



3-4 HM(HD)F325 (cont)

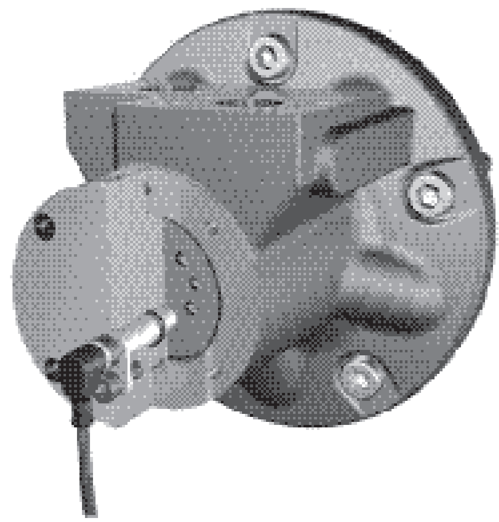
‘X’ F Spacer



DISPLACEMENT SELECTION (VIA REMOTELY LOCATED VALVE*)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
MID DISPLACEMENT: P TO X AND Z: Y TO T
SEE TIMING CHART.
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR.

3-5 Speed Sensing Options

Tj speed sensor with Tk readout option

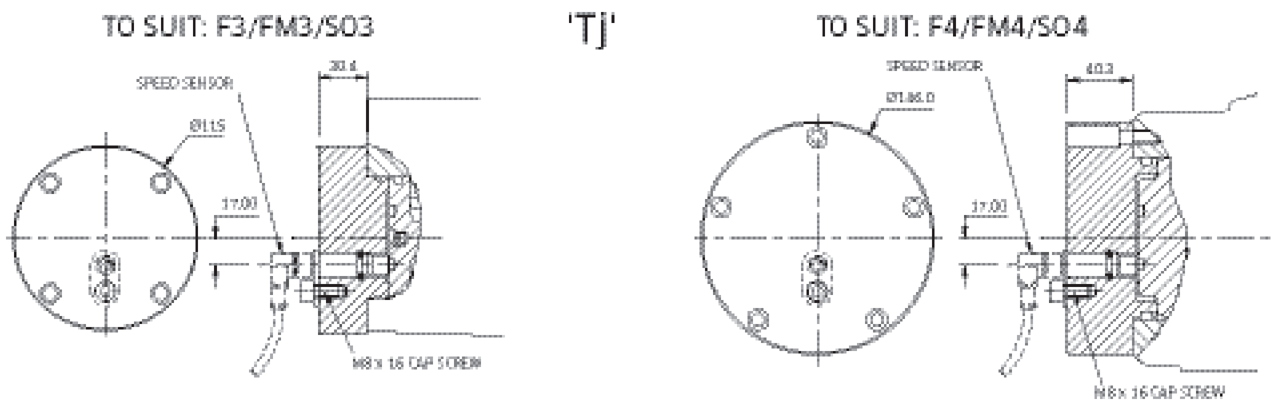


Tj Speed Sensor Technical Specification

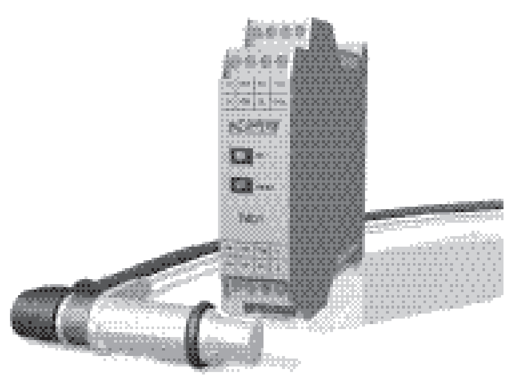
The Tj speed sensor is a hall effect dual channel speed probe that can provide feedback of both speed and direction.

Signal Outputs:	Square wave plus directional signal
Power Supply:	8 to 32 V @ 40 mA
Protection class:	IP68
Output frequency:	16 pulses/revolution

Installation Details



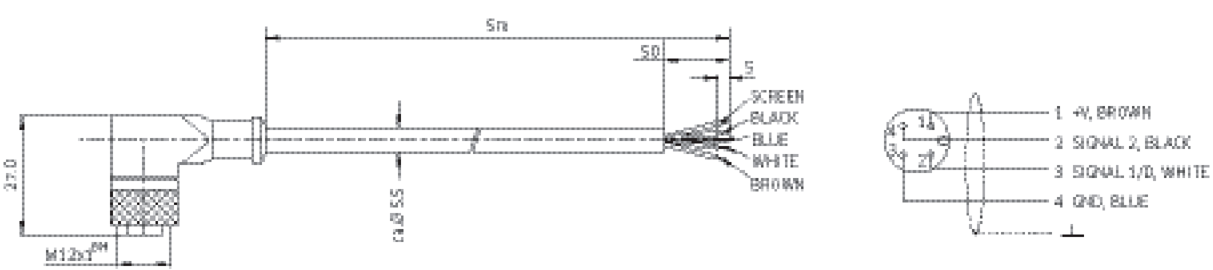
Tk Output Module



The Tk option consists of the Tj speed sensor together with the optional T401 output module.

The addition of the T401 module provides a software configured single channel tachometer and relay with a 0/4-20 mA analogue current output.

The software and calibration cable is also provided.



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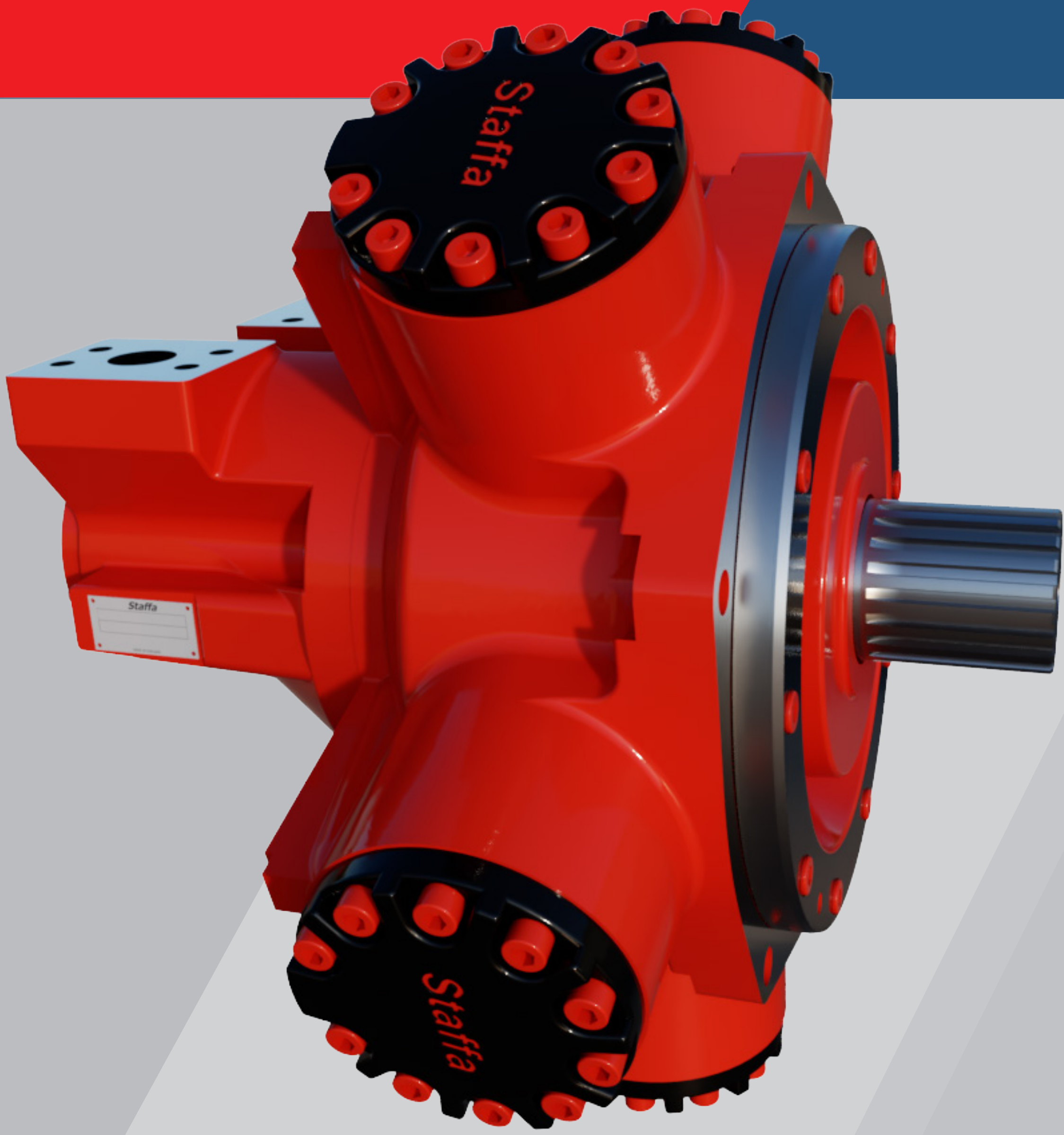
The specified data is for product description purposes only and may not be deemed to be guaranteed unless expressly confirmed in the contract.

Data sheet: M-10.18

Kawasaki
Powering your potential

Precision Machinery Company

Fixed Displacement Radial Piston
Staffa Motor
HPB Series



CONTENTS

HPB Series

Fixed Displacement Radial Piston Hydraulic Motor

■ General Descriptions

The Kawasaki Staffa range of high torque low speed fixed displacement radial piston hydraulic motors consists of 8 frame sizes ranging from the HPB060 to HPB325. Capacity ranges from 983 to 5,310cc/rev.

The rugged, well proven design incorporates high efficiency combined with good breakout torque and smooth running capability. Various features and options are available including, on request, mountings to match competitors' interfaces.

The Kawasaki Staffa range also includes dual and triple displacement motors. To obtain details of these product ranges please See HMC, HPC and HMF series datasheets.

■ Features

- **Very high power limit**
- **Rugged, reliable, proven design**
- **Unique hydrostatic balancing provides minimum wear and extended life**
- **High volumetric and mechanical efficiency**
- **Capacities range from 983 to 5,310cc/rev**
- **Large variety of shaft and porting options**
- **Output torque up to 23,000Nm**
- **Wide range of mounting interfaces available**
- **Alternative displacements also available**

Motor Type	Displace-ment	Ideal Specific Torque	Mechanical Efficiency	Operating Pressure	Peak Pressure	Power Rating	Speed Rating
	cc/rev	N m/bar	%	bar	bar	kW	rpm
HPB060	983	15.6	93.3	300	405	131	450
HPB080	1344	21.4	94.4	300	405	147	340
HPB100	1600	25.5	95.4	300	405	165	270
HPB125	2050	32.6	94.5	300	405	202	300
HPB150	2470	39.3	95.1	300	405	234	250
HPB200	3087	49.1	96.1	300	405	261	230
HPB270	4310	68.6	96.1	300	405	278	150
HPB325	5310	84.5	96.1	300	405	278	150

*For detailed performance figures see Section 2-1

1 Ordering Code

1-1 Model Coding

F11/HPB 060 / S3 V/ FM3/Tj/ */ P*****

Fluid Type

Blank	Mineral oil
F3	Phosphate ester (HFD fluid)
F11	Water based fluids (HFA, HFB & HFC)
Alternative fluids contact Kawasaki	

Model Type

HPB	Standard
HPHDB	Heavy duty

Motor Frame Size

See options Section 2-1

Shaft Type

See Section 3. Dimensions

Shaft Orientation

Blank	Horizontal and vertically down
V	Vertically Up

Main Port Connections

See Section 3. Dimensions

Special Features

P*****	Special features (see Section 2-12)
PL****	Non-catalogued features, (****) = number assigned by Kawasaki as required

Design Series Number

Current series for HPB motors

Speed Sensor

Blank	None
Tj*	Square wave output with directional signal*
Tk	Combines Tj with the T401 instrument to give a 4 to 20 mA output proportional to speed. Directional signal and speed relay output.

See Section 2-13

1-1 Model Coding

Special Features Suffix

/ P * * * * *

Shaft Seal Enhancements

A	High pressure shaft seal
B	Improved shaft seal life
C	High pressure shaft seal & improved shaft seal life
0	None

See Section 2-12 for details

External Protection

B	Marine-specification primer paint
0	None
D	Marine-Style Cylinder Head

See Section 2-12 for details

Installation Features

A	Drain port adaptor x 1
B	Drain port adaptor x 2
C	Φ21 mm mounting holes
D	Φ22 mm mounting holes
E	Φ21 mm mounting holes & Drain port adaptor x 1
F	Φ21 mm mounting holes & Drain port adaptor x 2
G	Φ22 mm mounting holes & Drain port adaptor x 1
H	Φ22 mm mounting holes & Drain port adaptor x 2
0	None

See Section 2-12 for details

Performance Enhancements

A	Increased starting torque
0	None

See Section 2-12 for details

Valve Enhancements

A	Improved cavitation resistance
B	Anti-clockwise
C	Thermal shock resistance
D	Improved caviation resistance & anti-clockwise
E	Improved cavitation resistance & thermal shock resistance
F	Anti-clockwise & thermal shock resistance
G	Improved cavitation resistance & anti-clockwise & thermal shock resistance
0	None

See Section 2-12 for details

2-1 Performance Data

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

Intermittent max pressure: 300bar.
This pressure is allowable on the following basis:

a) Up to 50rpm 15% duty for periods up to 5 minutes maximum.
b) Over 50rpm 2% duty for periods up to 30 seconds maximum.

Static pressure to DNV rules 405bar (DNV-GL-RU-Ship Part 4).

Limits for fire resistant fluids

Fluid Type	Continuous Pressure (bar)	Intermittent Pressure (bar)	Max Speed (rpm)	Model Type
HFA 5/95 oil-in-water emulsion	130	138	50% of limits of mineral oil	All models
HFB 60/40 water-in-oil emulsion	138	172	As for mineral oil	All models
HFC water glycol	103	138	50% of limits of mineral oil	All models
HFD phosphate ester	250	300	As for mineral oil	All models

2-1 Performance Data

Specifications

Motor Type	Displace-ment (cc/rev)	Ideal Torque (N m/bar)	Average Running Mechanical Efficiency (%)	Average Starting Mechanical Efficiency (%)	Max Cont. Speed (rpm)	Max Cont. Power with Flushing (kW)	Max Cont. Power (kW)	Max Cont. Pressure (bar)	Max Int. Pressure (bar)
HPB060 (FM3)	983	15.6	93.0	80.1	450	131	115	250	300
HPB060 (FM4)	983	15.6	93.0	80.1	490	131	115	250	300
HPB080 (FM3)	1,344	21.4	94.4	100	340	147	130	250	300
HPB080 (FM4)	1,344	21.4	94.4	100	430	147	130	250	300
HPB100 (FM3)	1,600	25.5	94.5	110	270	165	140	250	300
HPB100 (FM4)	1,600	25.5	94.5	110	365	165	140	250	300
HPB125 (FM3)	2,050	32.6	94.5	100	215	173	135	250	300
HPB125 (FM4)	2,050	32.6	94.5	100	300	202	150	250	300
HPB150 (FM3)	2,470	39.3	95.4	115	200	195	156	250	300
HPB150 (FM4)	2,470	39.3	95.4	115	250	234	185	250	300
HPB200 (FM3)	3,087	49.1	96.3	130	175	216	174	250	300
HPB200 (FM4)	3,087	49.1	96.3	130	230	261	210	250	300
HPB270	4,310	68.6	95.8	140	150	278	215	250	300
HPB325	5,310	84.5	96.3	140	130	278	215	250	300

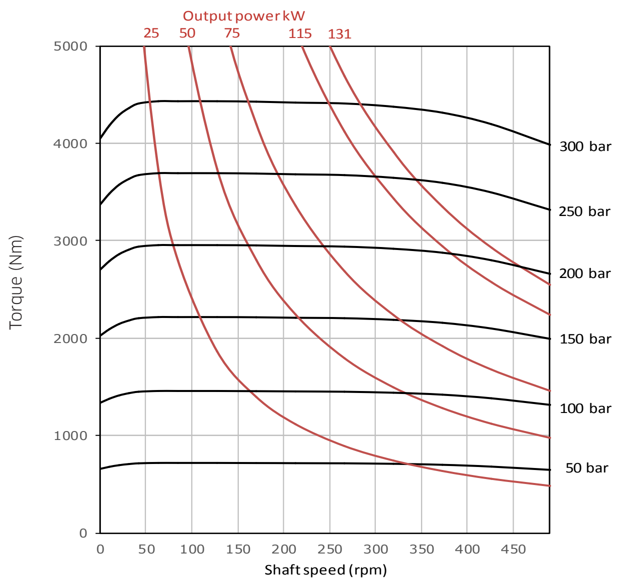
Other non-standard displacements are possible - check with Kawasaki for details.

2-1 Performance Data (cont)

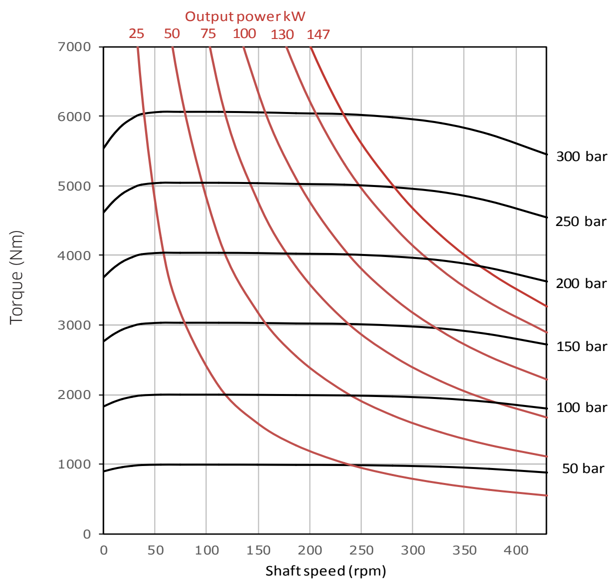
Output Torque Curves

These 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 Mineral Oil of 50cSt (232 SUS) viscosity. High return line pressures will reduce torque for a given pressure differential.

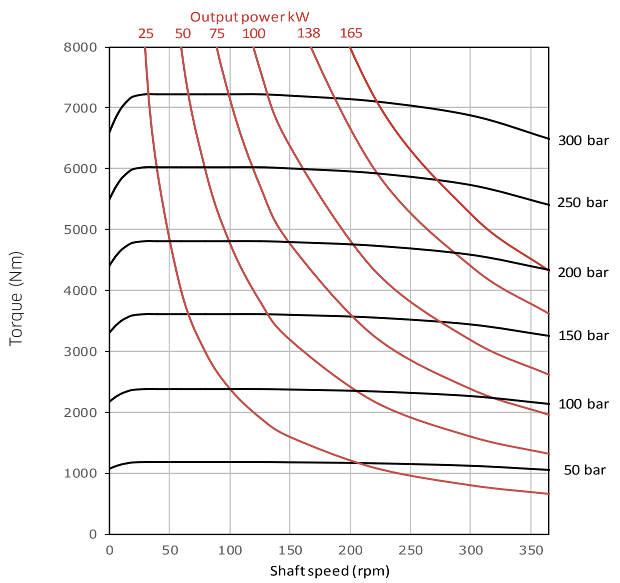
HPB060



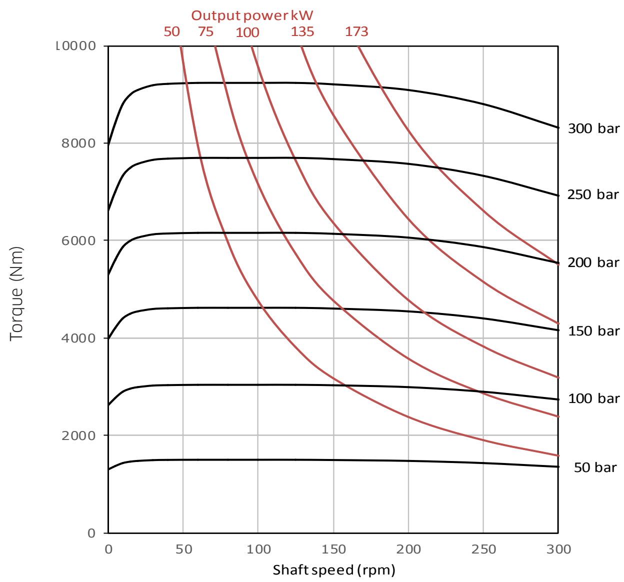
HPB080



HPB100



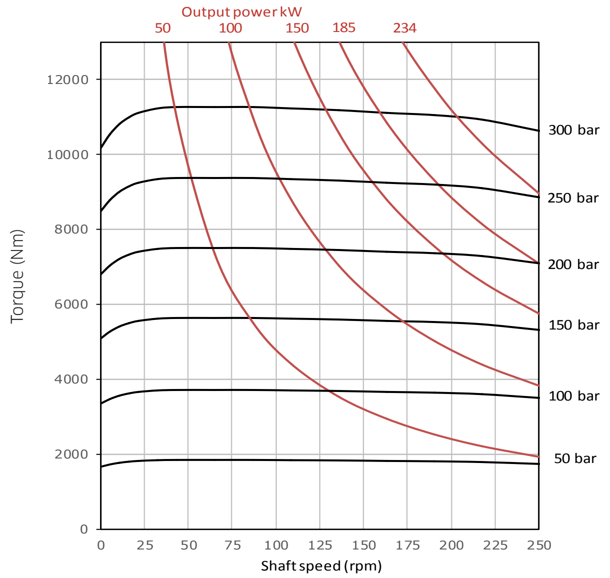
HPB125



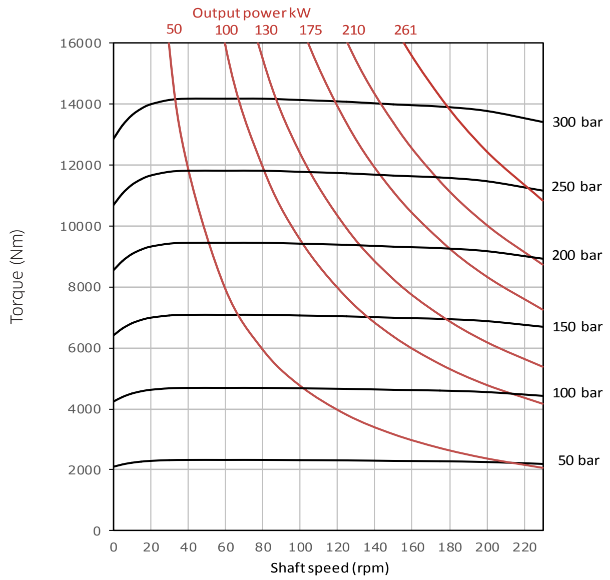
2-1 Performance Data (cont)

Output Torque Curves (cont)

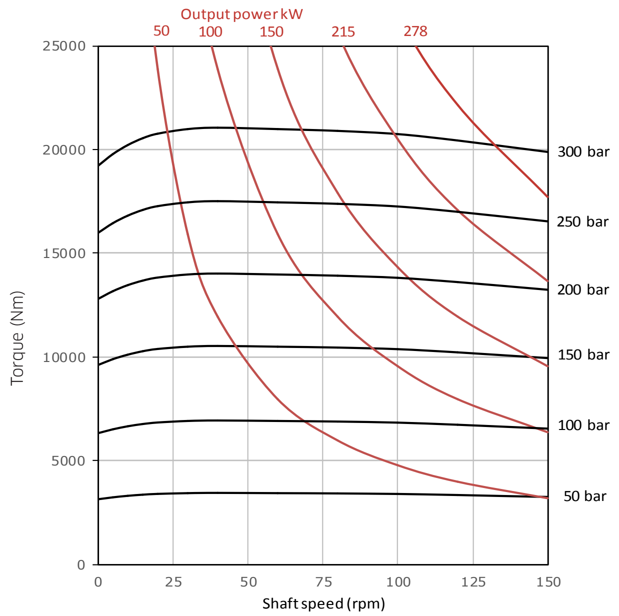
HPB150



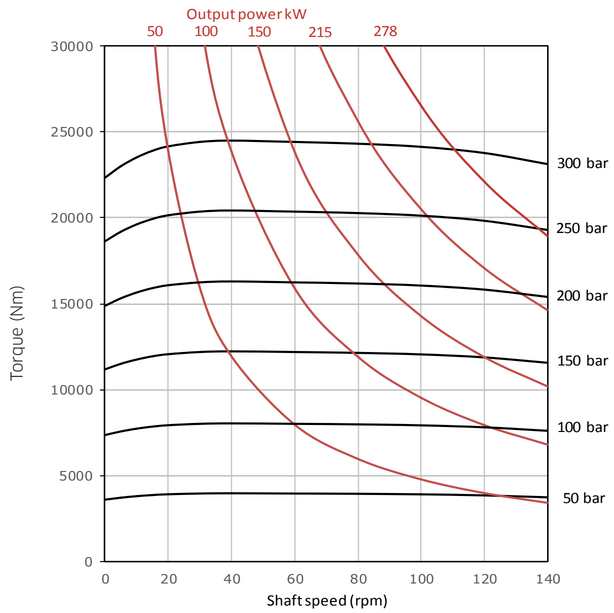
HPB200



HPB270



HPB325



2-2 Volumetric Efficiency Data

Motor Type	Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
HPB	cc/rev	K_1	K_2	K_3	K_4
HPB060	983	9.50	45.70	7.80	7.90
HPB080	1,344	9.50	45.70	5.80	7.90
HPB100	1,600	9.50	45.70	4.80	7.90
HPB125	2,050	6.10	38.50	3.00	4.25
HPB150	2,470	6.10	38.50	2.50	4.25
HPB200	3,087	6.10	38.50	2.00	4.25
HPB270	4,310	6.50	37.30	1.50	6.00
HPB325	5,310	6.50	40.00	1.30	6.00

Fluid Viscosity	Viscosity Factor
cSt	Kv
20	1.58
25	1.44
30	1.30
40	1.10
50	1.00
60	0.88

Qt (total leakage) = $[K_1 + n/K_2] \times \Delta P \times Kv \times 0.005$ l/min

Creep speed = $K_3 \times \Delta P \times Kv \times 0.005$ rpm

Crankcase leakage = $K_4 \times \Delta P \times Kv \times 0.005$ l/min

ΔP = differential pressure bar

n = speed rpm

The motor volumetric efficiency can be calculated as follows:

$$\text{Volumetric efficiency (\%)} = \left[\frac{(\text{speed x disp.})}{(\text{speed x disp.}) + Qt}\right] \times 100$$

Example:

HPB200 motor with displacement of 3.087 l/rev.

Speed 60rpm

Differential pressure 200bar

Fluid viscosity 50 cSt

Total leakage = $(K_1 + n/K_2) \times \Delta P \times Kv \times 0.005$ l/min

= $(6.10 + 60/38.50) \times 200 \times 1 \times 0.005$

= 7.66 l/min

$$\text{Volumetric efficiency} = \left[\frac{(60 \times 3.087)}{(60 \times 3.087) + 7.66}\right] \times 100$$

= <u>96.0%</u>

2-3 Shaft Power Calculation

Example

Firstly, to find the maximum differential pressure ΔP at rated speed:

Select the rated shaft power (W) for the motor from the performance data table (in Section 2-1).
This is presented in kilowatts so must be converted to watts (x1000).

Then also take the actual average running torque in N m/bar (T_o) and the rated shaft speed in rpm (n).

$$W = \frac{T_o \cdot \Delta P \cdot 2\pi \cdot n}{60}$$

Or to find maximum ΔP then use:

$$\Delta P = \frac{60 \cdot W}{2\pi \cdot T_o \cdot n}$$

HPB125-FM4 Example:

Rated shaft power, W (W):	150,000
Average actual running torque, T_o (Nm/bar):	32.6
Average running mechanical efficiency(Nm/bar):	94.5%
Rated shaft speed, n (rpm):	300

$$\Delta P = \frac{60 \times 150{,}000}{2\pi \times 32.6 \times 300}$$

$\underline{\Delta P = 146 \text{ bar (max.)}}$

Secondly, to find the maximum speed at rated pressure (using the same information as before):

$$n = \frac{60 \cdot W}{2\pi \cdot T_o \cdot \Delta P}$$

Rated pressure (bar): 250

$$n = \frac{60 \times 150{,}000}{2\pi \times 32.6 \times 250}$$

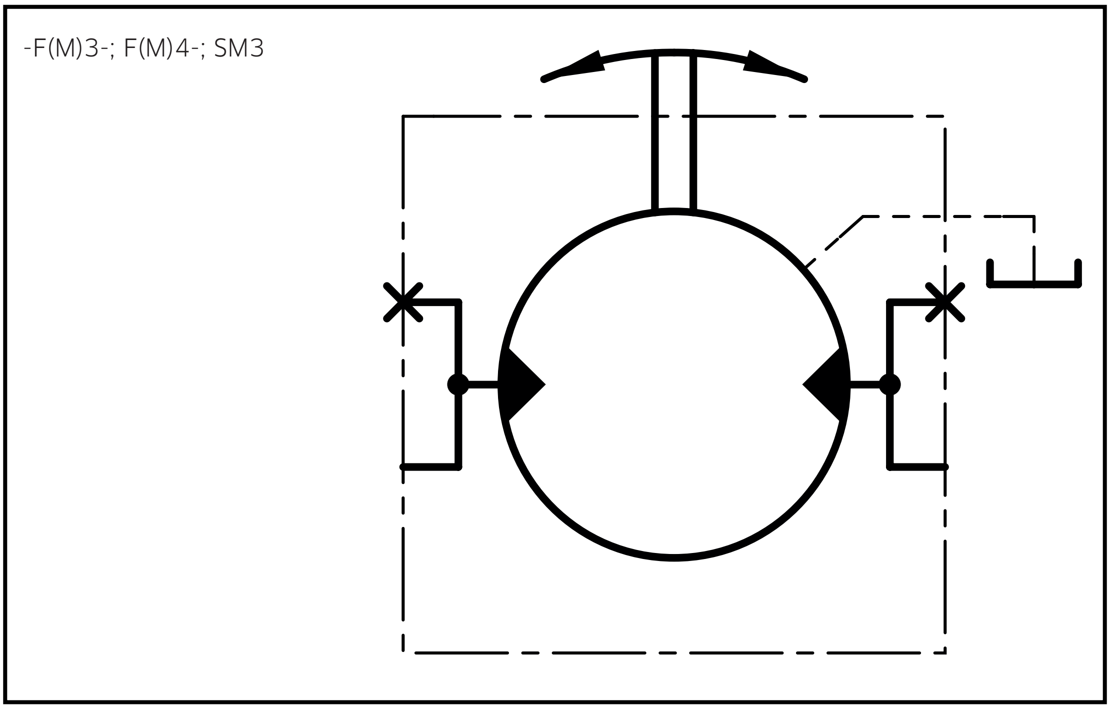
$\underline{n = 176\text{rpm (max.)}}$

In summary, operating the motor within its shaft power limit, at rated speed, would give a maximum pressure of 146 bar, and operating the motor at rated pressure, would give a maximum speed of 176rpm.

Notes

1) The maximum calculated speed is based on a rated inlet pressure of 250bar.
2) The maximum shaft power is only allowable if the motor drain temperature remains below 80°C.
3) The maximum calculated differential pressure assumes that the low pressure motor port is less than 30bar.

2-4 Functional Symbols



2-5 Stress Limits

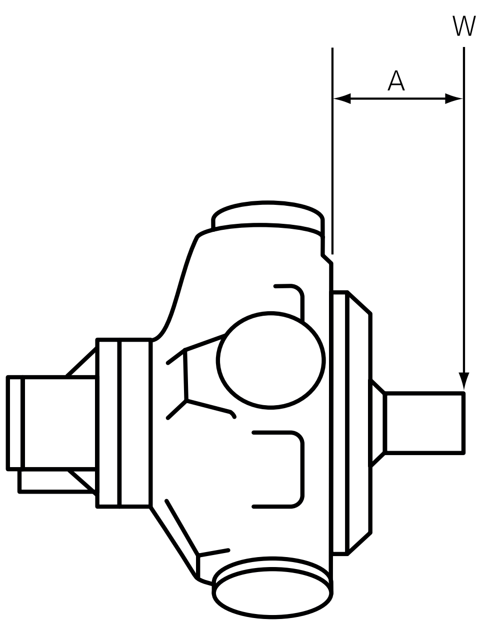
When applying large external radial loads, consideration should also be given to motor bearing lives (see Section 2-6).

Motor Frame Size	Shaft Types	Maximum External Radial Bending Moment [Nm]
HPB060, 080 & 100	P, S, Z & T	5,500
HPB125, 150 & 200	P1, S3, S4, Z3, & T	6,600
HPHDB125, 150, 200	S5, Z5 & P2	12,750
HPB270 & 325	P1, S3, Z3 & T	7,500
HPHDB270 & 325	P2, S5 & Z5	15,900

Example:

Determine the maximum radial shaft load of a HPB080 motor:

Radial load offset, A	= 100mm
Maximum radial load, W	= 5,500 (see table)/100
	= 55kN (5,607 kg)



A = Distance from mounting face to load centre (mm)

W = Side load (N)

NOTE:
The offset distance A is assumed to be greater than 50mm.
Contact Kawasaki if this is not the case.

2-6 Bearing Life Notes

Consideration should be given to the required motor bearing life in terms of baring service life. The factors that will determine bearing life include:

1) Duty cycle - time spent on and off load

2) Speed

3) Differential pressure

4) Fluid viscosity

5) External radial shaft load

6) External axial shaft load

NOTE:
A heavy duty HPB motor can be ordered to further improve bearing life.
Consult Kawasaki for a detailed bearing life calculation.

2-7 Circuit and Application Notes

Starting Torque

Staffa motors are very efficient even at low speeds. The starting mechanical efficiencies given in Section 2-1 should be used for speeds lower than 15rpm. These values, and the torque curves shown in Section 2-1 may vary with system parameters.

Low Speed Operations

Minimum operating speeds are determined by the hydraulic system and load conditions (load inertia, drive elasticity, etc.) Recommended minimum speeds are shown below:

Model Type	rpm
HPB060/080/100	3
HPB/125/150/200	3
HPB270/325	2

High Back Pressure

When both inlet and outlet ports are pressurised continuously, the lower port pressure must not exceed 100bar at any time.

NOTE: High back pressure reduces 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) from the operating formula Boost Formula $P = 1 + \frac{N^2 \times V^2}{K} + C$

Where P is in bar, N = motor speed (rpm), V = motor displacement (cc/rev), C = crankcase pressure (bar) and K=a constant from the table below:

Motor	Porting	Constant (K)
HPB060, HPB080 & HPB100	F(M)3 SM3	1.8×10^{10}
HPB125, HPB150 & HPB200	FM(3) SM3	4.0×10^{10}
	FM(4)	8.0×10^{10}
HPB270 & HPB325	FM(4)	7.2×10^{10}

2-7 Circuit and Application Notes (cont)

The flow rate of oil needed for the make-up system can be estimated from the crankcase leakage data (see Section 2-2 for calculation method). Allowances should be made for other system losses and also for “fair wear and tear” during the life of the motor, pump and system components.

Cooling Flow

Operating within the continuous rating does not require any additional cooling.

For operating conditions above “continuous”, up to the “intermittent” rating, additional cooling oil may be required. This can be introduced through the spare crankcase drain ports.

Consult Kawasaki about such applications.

Motorcase Pressure

With the standard shaft seal fitted, the motor casing pressure should not exceed 3.5bar.

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 for casing pressure of 10bar.

3) Check installation dimensions for maximum crankcase drain fitting depth.

CAUTION

For trouble free operation the motor's crankcase pressure must always be lower than both of the motor port pressures:

$P_{case} < P_{in}$ and $P_{case} < P_{out}$

Hydraulic Fluids

Dependent on motor (see model code fluid type - Section 1-1) suitable fluids include:

a) Antiwear hydraulic oils

b) Phosphate ester (HFD fluids)

c) Water glycols (HFC fluids)

d) 60/40% water-in-oil emulsions (HFB fluids)

e) 5/95% oil-in-water emulsions (HFA fluids)

f) Antiwear environmentally acceptable lubricants (EALs)

Some fluids require a reduction in pressure and speed limits. Please see table in Section 2-1.

Viscosity limits when using any fluid except oil-in-water (5/95) emulsions are:

Max. off load:	**2,000cSt** (9270 SUS)
Max. on load:	**150cSt** (695 SUS)
Optimum:	**50cSt** (232 SUS)
Minimum:	**25cSt** (119 SUS)

Temperature Limits

Ambient min.	-30°C (-22°F)
Ambient max.	+70°C (158°F)

Max. operating temperature range.

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

NOTE: To obtain optimum services life from both fluid and hydraulic systems components, a fluid operating temperature of 40°C is recommended.

2-7 Circuit and Application Notes (cont)

Mineral Oil Recommendations

The fluid should be a good hydraulic grade, non-detergent mineral oil. It should contain anti-oxidant, antifoam and demulsifying additives. It must contain antiwear or extreme pressure (EP) additives. Automatic transmission fluids and motor oils are not recommended.

Biodegradable Fluid Recommendations

Well-designed environmentally acceptable lubricants (EALs) may be used with Staffa motors. The EAL must be designed for use in hydraulic systems and have a synthetic ester base. Additives should be as listed for mineral oils, above. The performance of EALs with hydraulic systems vary widely and so checks for seal compatibility, copper alloy compatibility, oxidation resistance and lubrication properties should be carried out before selecting an EAL. For help with EALs please contact Kawasaki.

Filtration

Full flow filtration (open circuit), or full boost flow filtration (closed circuit) to ensure system cleanliness to ISO4406 code 22/18/13 or cleaner.

Noise Levels

The airborne noise level is less than 66.7dB(A) DIN & dB(A) NFPA through 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 5bar.

Polar moment of intertia and mass table

Motor Frame Size	Polar Moment of Intertia (kg m^2) (Typical data)	Mass (kg) (Approx. all models)
HPB060	0.0500	144
HPB080	0.0600	144
HPB100	0.0760	144
HPB125	0.2200	217
HPB150	0.2500	265
HPB200	0.2700	265
HPB270	0.4900	420
HPB325	0.5000	429

2-8 Motor Operation at Low Temperature

When operating the motor at low temperature consideration should be given to the fluid viscosity. The maximum fluid viscosity before the shaft should be turned is 2,000cSt. The maximum fluid viscosity before load is applied to the motor shaft is 150cSt.

If low ambient temperature conditions exist, then a crankcase flushing flow of at least 5 l/min should be applied to the motor during periods when the motor is not in use.

The shaft seal temperature limits for both medium and high pressure applications are shown in the table below.

	Non-operating temperature limits	Minimum operating temperature
Standard pressure shaft seal	below minus 40°C and above 100°C	minus 30°C
High pressure shaft seal	below minus 30°C and above 120°C	minus 15°C

All seals are very brittle below minus 40°C and are likely to break very easily and due to their sluggish response may not provide a 100% leak free condition.

It should be noted that the maximum continuous operating temperature within the motor crankcase is plus 80°C.

2-9 Freewheeling Notes

All Staffa motors can be used in freewheeling applications.

In all circumstances it is essential that the motor is unloaded (A and B ports connected together) and that the circuit is boosted.

The required boost pressure is dependent on both the speed and displacement conditions.

It should be noted that for HPB series motors, to achieve freewheel, large flows will have to re-circulate around the motor.

This will require a large recirculating valve and consideration of circuit cooling as the motor will be generating a braking torque.

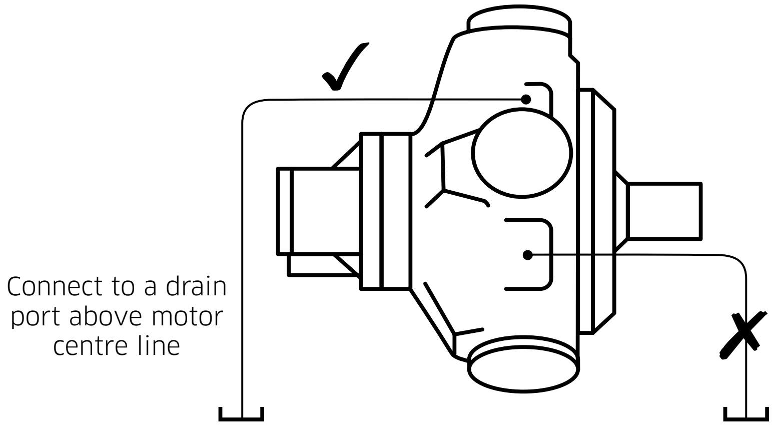
It is for these reasons that HMC, HPC or HMF series motors are the preferred option for freewheeling applications.

See HMB, HMC and HPC datasheets.

2-10 Crankcase Drain Connections

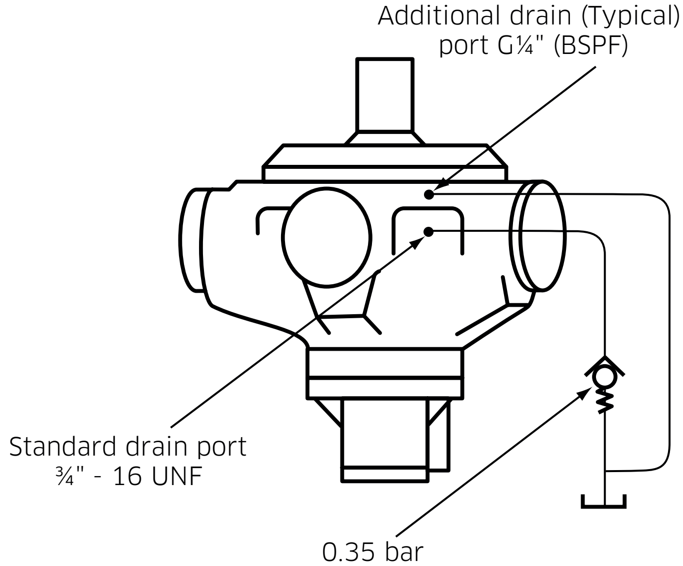
Motor Axis - horizontal

The recommended minimum pipe size for drain line lengths up to approx. 5m is 12.0mm (½") bore. Longer drain lines should have their bore size increased to keep the crankcase pressure within limits.



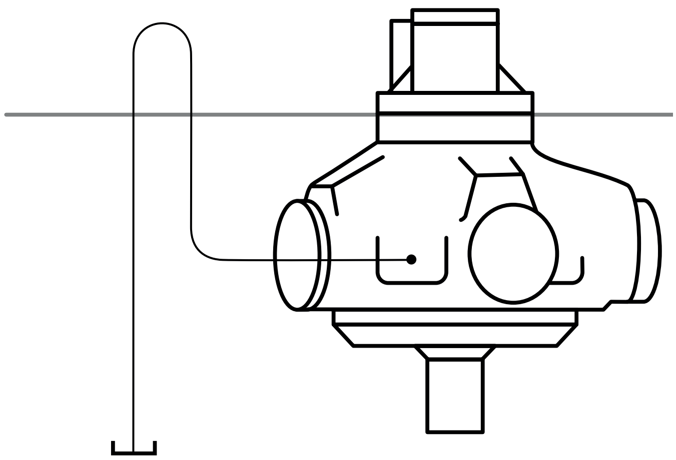
Motor Axis - vertical shaft up

Specify "V" within the model code for extra drain port, G¼" (BSPF). Connect this port into the main drain line downstream of a 0.35bar check valve to ensure good bearing lubrication. The piping arrangement must not allow syphoning from the motorcase. (refer to installation drawing for details).



Motor Axis - vertical shaft down

The piping, from any drain port, must be taken above the level of the motorcase to ensure good bearing lubrication. The arrangement must not allow syphoning from the motorcase.



2-11 Installation Data

Spigot

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

The diametrical clearance between the motor spigot and the mounting must not exceed 0.15mm. 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 bolts is as follows:

M12	97 +/- 7Nm
M14	160 +/- 12Nm
M18	312 +/- 14 Nm
M20	407 +/- 14 Nm
M24	690 +/- 27 Nm
½" UNF	97 +/- 7 Nm
⅝“ UNF	265 +/- 14 Nm
¾“ UNF	393 +/- 14 Nm
1"	810 +/- 27 Nm

Shaft Coupling

Where the motor is solidly coupled to a shaft having independent bearings the shaft must be aligned to within 0.13mm TIR.

End of Motor Life

The motor unit must be completely empty upon disposal. It must be disposed of according to national regulations and safety information for the disposal of hydraulic fluids.

All individual parts of the motor unit must be recycled. Separate the motor unit parts according to: cast iron, steel, aluminium, non-ferrous metal, electronic waste, plastic, and seals.

2-12 Special Features

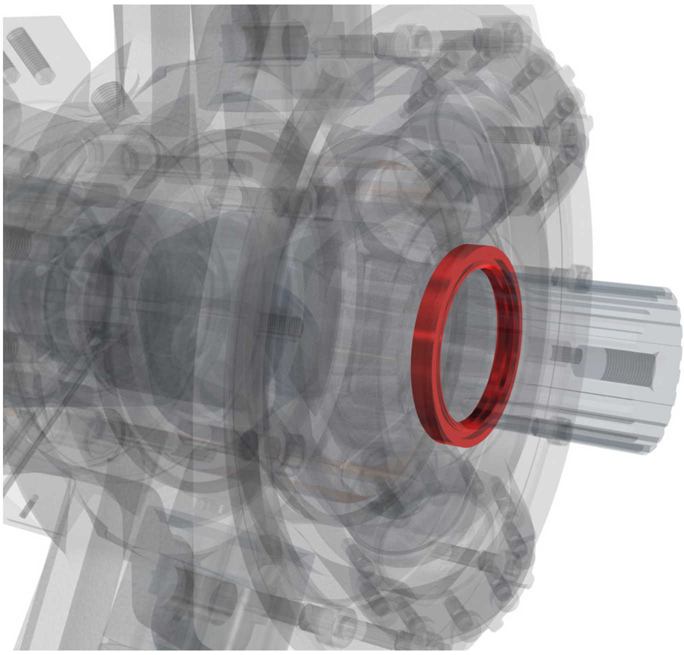
Feature	HPB 060/ 080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
High Pressure Shaft Seal	●	●	●	●	●	●
Improved Shaft Seal Life	●	●	●	●	●	●
Improved Cavitation Resistance	●	●	●	●	●	●
Increased Starting Torque	○	○	●	●	●	●
Anti-clockwise Rotation	●	●	●	●	●	●
Thermal Shock Resistance	●	●	●	●	●	●
Drain Port Adaptor - ½" BSPP	●	●	●	●	●	●
Φ21mm Mounting Holes	●	●	●	●	●	●
Φ22mm Mounting Holes	●	●	●	●	●	●
Marine-specification Primer Paint	●	●	●	●	●	●
Marine-Style Cylinder Head	●	●	●	●	●	●

● Available
○ Not available

If a motor is to be ordered with any special features listed, please contact Kawasaki.

2-12 Special Features (cont)

High Pressure Shaft Seal



Description:

> 10bar rated

> Recommended for cold climates

> Rugged aluminium construction

Technical Information

Where crankcase pressure will be higher than 3.5 bar, the high pressure shaft seal should be selected.

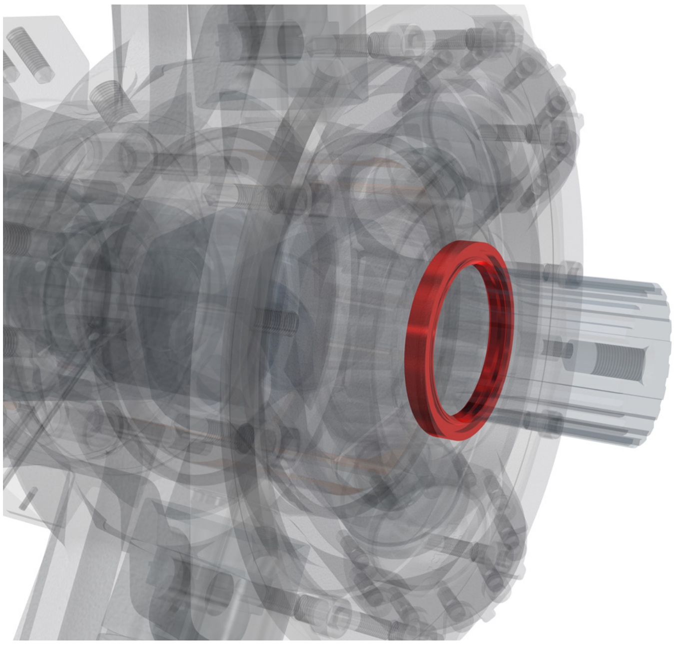
Case pressure	≤ 10bar
Non-operating temperature limits	Below -30°C and above 120°C
Minimum operating temperature	-15°C
Maximum operating temperature	80°C
Minimum viscosity	2,000cSt
Maximum viscosity	150cSt

Applicable to:

HPB 060/080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

2-12 Special Features (cont)

Improved Shaft Seal Life



Description:

- > Stainless steel sleeve prevents corrosion
- > Improved wear resistance
- > Recommended for corrosive environments

Technical Information

A well-established method of increasing rotary seal life in corrosive environments is to fit a thin-walled, stainless steel sleeve to the rotating shaft to provide a corrosion-resistant, wear-resistant counterface surface for the seal to run against. All HPB motors can be fitted with such sleeves upon request.

Sleeve material	A304/301 Stainless Steel
Sleeve surface finish	R_a 0.25 to 0.5µm (10 to 20µin)

Applicable to:

HPB 060/080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

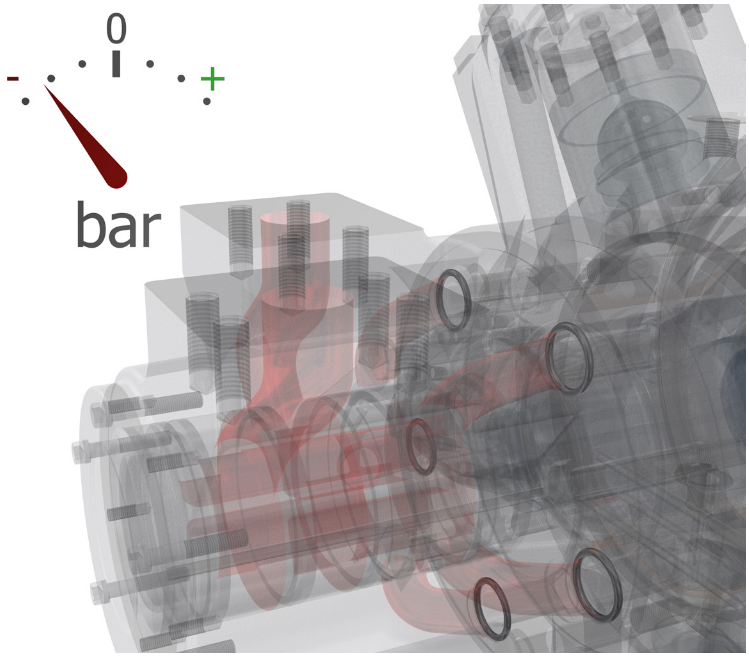
2-12 Special Features (cont)

Improved Cavitation Resistance

Description:

> **Recommended for overrunning applications**

> **Protects against seal damage for short periods of operation in vacuum inlet conditions.**



Cavitation can occur due to many different factors. Although it is not possible to make the HPB motor resistant to cavitation, certain features can be added to improve the motor's resistance to short periods of lost port pressure.

In applications where the HPB motor can be driven (like a pump) a risk arises that insufficient fluid will be provided to maintain a positive pressure at both main ports of the motor causing cavitation. The results of extended running at these conditions can be catastrophic to the motor's function.

The improved cavitation resistance feature should be considered where:

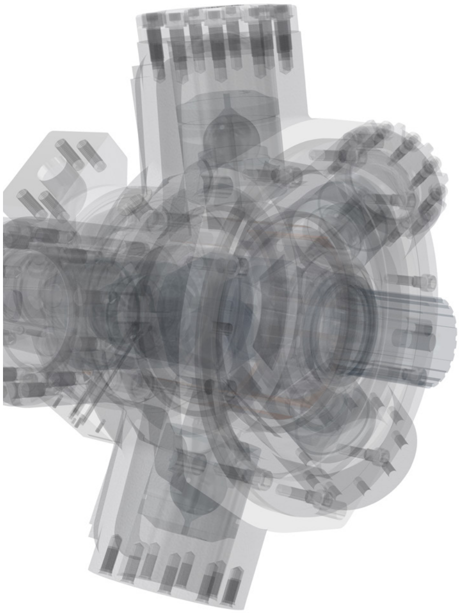
- Overrunning conditions may occur (load driving the motor)
- Loss of main port pressure while motor is rotating

Applicable to:

HPB 060/080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

2-12 Special Features (cont)

Increased Starting Torque



Description:

> **Optimised for high break-out torque**

> **Recommended for low speed operation**

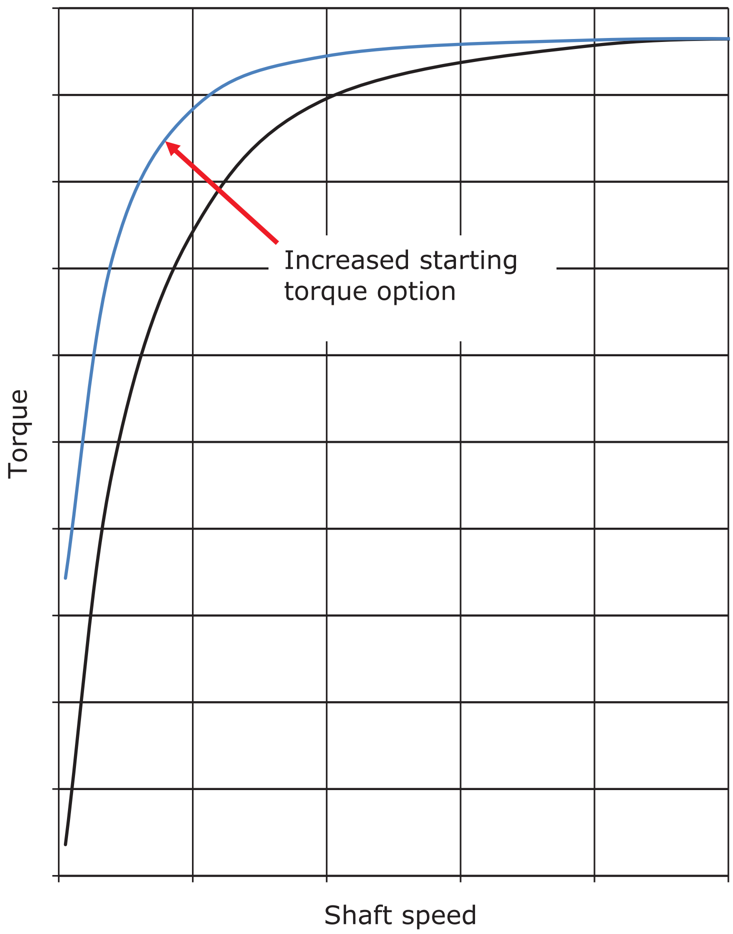
> **Improved service life for low speed applications**

Technical Information

If an application demands the drive motor be run at speeds of less than 10 rpm for most of the duty cycle, or involves frequent start/stop or forward/reverse operation, the Staffa HPB motor range has it covered.

By optimising the HPB motor's design for low speeds, it is possible to increase the break out torque and low speed mechanical efficiency performance.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.



2-12 Special Features (cont)

Increased Starting Torque (cont)

Volumetric Performance

In order to achieve increased torque at low speeds the volumetric characteristics of the motor performance are changed.

When calculating leakage and volumetric efficiency use the constants shown here in place of those given for the standard motor in Section 2-1.

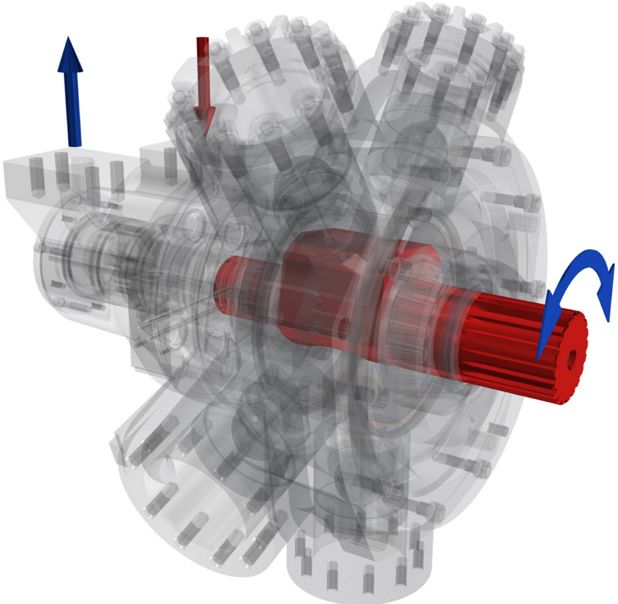
Motor Type	Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HPB125	2,050	12.86	38.50	4.55	11.01
HPB150	2,470	12.86	38.50	3.78	11.01
HPB200	3,087	12.86	38.50	3.02	11.01
HPB270	4,310	13.26	37.30	2.41	12.26
HPB325	5,310	13.26	40.00	2.08	12.26

Applicable to:

HPB 060/080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

2-12 Special Features (cont)

Anti-Clockwise Rotation



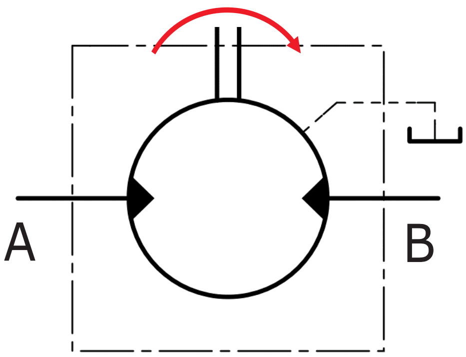
Description:

> **Reduce installation complexity**

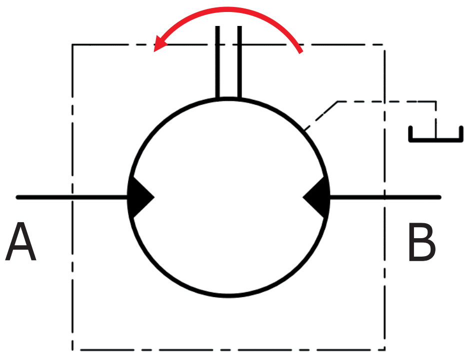
> **Standardise equipment designs**

Technical Information

All HPB motors can be specified with an anti-clockwise rotation valve configuration. All performance and volumetric characteristics remain unchanged.



Standard motor



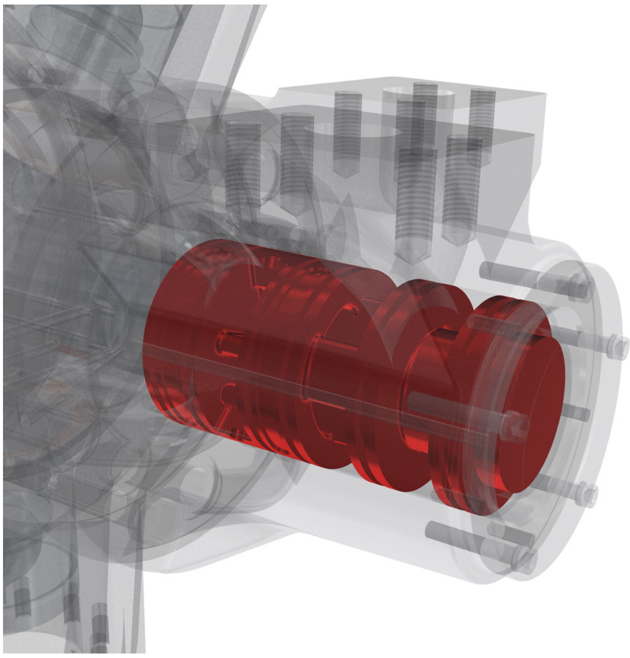
Anti-clockwise motor

Applicable to:

HPB 060/ 080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

2-12 Special Features (cont)

Thermal Shock Resistance



Description:

> Recommended for cold climates

> Optimised for start-up in freezing temperatures

> Engineered for total peace of mind

Technical Information

Starting up a cold system with warm hydraulic fluid is a known cause of heavy wear and potential seizure of hydraulic machinery. To minimise this potential risk, the HPB motor can be configured to combat thermal shocks to give complete peace of mind when operating in very cold climates.

Volumetric Performance

In order to provide thermal shock resistance the volumetric characteristics of the motor performance are changed. When calculating leakage and volumetric efficiency use the constants shown in Section 2-12 in place of those given for the standard motor in Section 2-1.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.

Note:
When operating at low temperature, consideration must be given to the guidance notes in Section 2-8 Motor Operation at Low Temperature.

2-12 Special Features (cont)

Thermal Shock Resistance (cont)

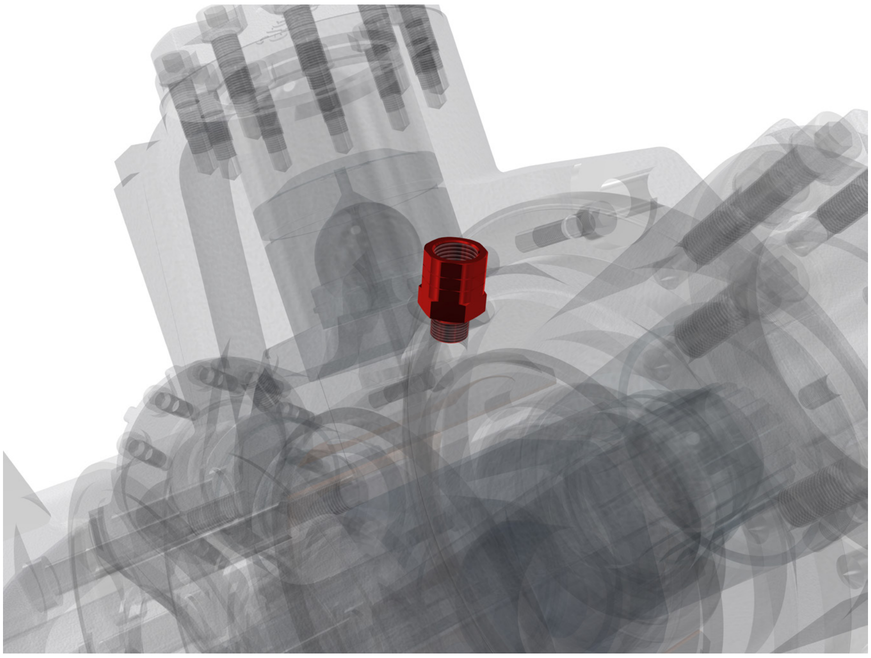
Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HPB060	983	11.10	45.70	11.38	7.90
HPB080	1,344	11.10	45.70	8.30	7.90
HPB100	1,600	11.10	45.70	6.99	7.90
HPB125	2,050	7.70	38.50	3.78	4.25
HPB150	2,470	7.80	38.50	3.52	4.25
HPB200	3,087	7.98	38.50	2.61	4.25
HPB270	4,310	8.38	37.30	1.91	6.00
HPB325	5,310	8.38	40.00	1.65	6.00

Applicable to:

HPB 060/ 080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

2-12 Special Features (cont)

Drain Port Adaptors



Description:

> Improves manufacturing logistics

> Motor supplied ready for connection to ½" BSPP male fitting

Technical Information

Motor Type	Adaptor Supplied
HPB060	¾" UNF 2B to ½" BSPP
HPB080	¾" UNF 2B to ½" BSPP
HPB100	¾" UNF 2B to ½" BSPP
HPB125	¾" UNF 2B to ½" BSPP

Motor Type	Adaptor Supplied
HPB150	¾" UNF 2B to ½" BSPP
HPB200	¾" UNF 2B to ½" BSPP
HPB270	¾" UNF 2B to ½" BSPP
HPB325	¾" UNF 2B to ½" BSPP

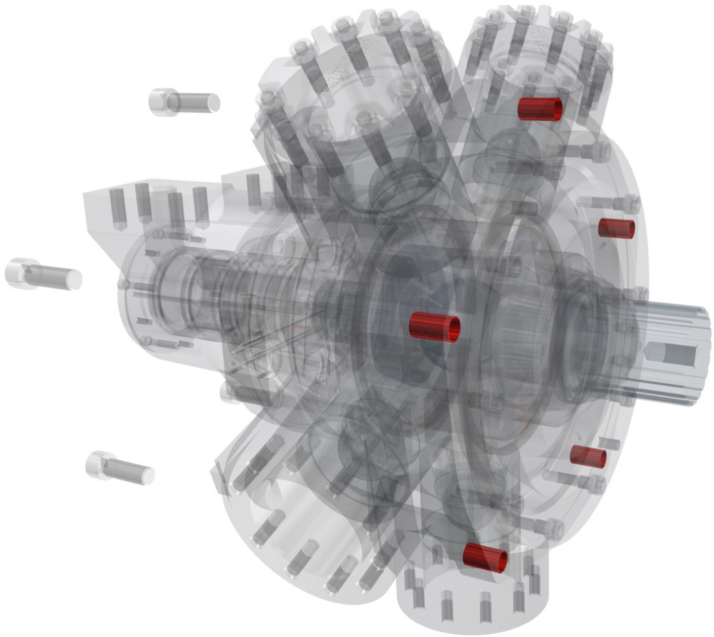
One or two drain adaptors can be supplied.

Applicable to:

HPB 060/ 080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

2-12 Special Features (cont)

Mounting Hole Diameter



Description:

> **Matching mounting holes to bolts**

> **Φ21mm and Φ22mm options available**

Technical Information

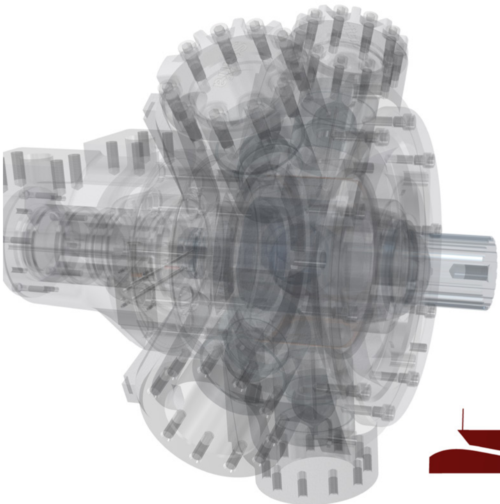
In different markets, different bolt standards are adopted which may not be best suited to the standard Φ20mm mounting hole diameter on the HPB motors. To give a correct fit and optimum installation, Φ21mm or Φ22mm holes can be selected on larger frame sizes.

Applicable to:

HPB 060/ 080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

2-12 Special Features (cont)

Marine Specification Primer Paint



Description:

- > **Improves corrosion and water resistance of the finishing system**
- > **Excellent adhesion strength**
- > **Recommended for marine applications**

Technical Information

Colour	Red oxide
Type	Single pack epoxy etching primer
Standard	BS 3900 part A 8
Dry film thickness	> 12µm

Applicable to:

HPB 060/080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

2-12 Special Features (cont)

Marine-Style Cylinder Head

Description:

> Reduces water entrapment

> Improves corrosion resistance

> Aids paint coverage

When top-coat paint solutions are applied to any surface, the coverage can easily become sub-optimal for very complex shapes. As the protection of the Staffa motor's external surfaces is critical in corrosive environments, the marine-style cylinder head, which is geometrically simplified in comparison to the standard design, can be specified for all HMF motors to aid in the optimal application of the top-coat paint solution.

Technical Information

No installation dimensions or after-market parts are affected when selecting this option as it is completely interchangeable with the standard cylinder head. Existing motors may be upgraded to use these cylinder heads without the need for any other replacement parts.

Applicable to:

HPB 060/ 080	HPB 100	HPB 125	HPB 150/200	HPB 270	HPB 325
●	●	●	●	●	●

2-13 Speed Sensing Options

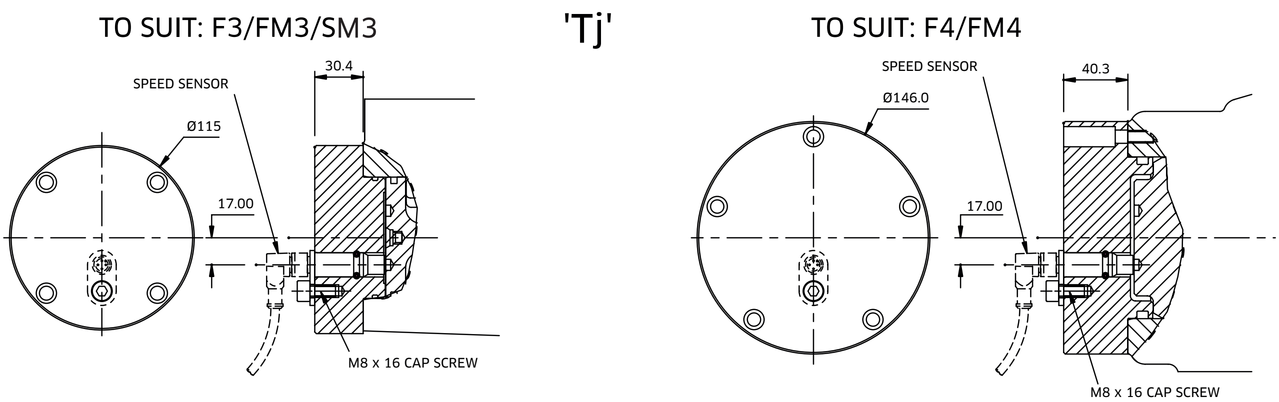
Tj speed sensor with Tk readout option

Tj Speed Sensor Technical Specification

The Tj speed sensor is a hall effect dual channel speed probe that can provide feedback of both speed and direction.

Signal Outputs:	Square wave plus directional signal
Power Supply:	8 to 32V @ 40mA
Protection class:	IP68
Output frequency:	16 pulses/revolution

Installation Details

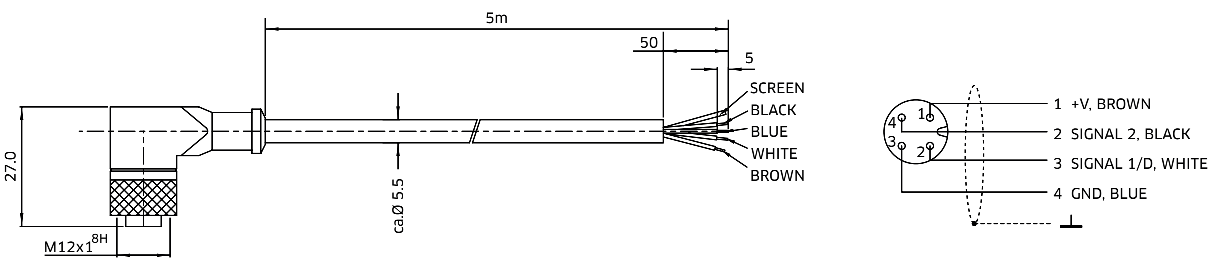


Tk Output Module

The Tk option consists of the Tj speed sensor together with the optional T401 output module.

The addition of the T401 module provides a software configured single channel tachometer and relay with a 0/4-20mA analogue current output.

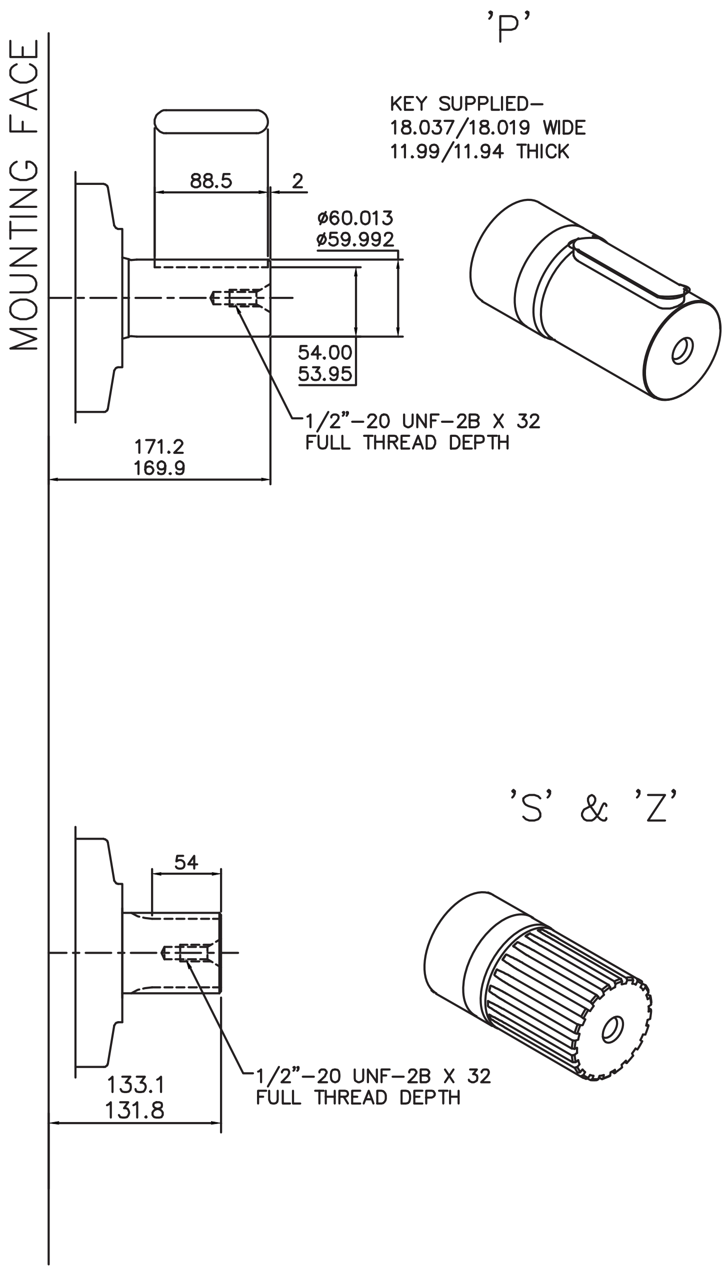
The software and calibration cable is also provided.



3 Dimensions

3-1 HPB060/080

'P', 'S' & 'Z' Shafts



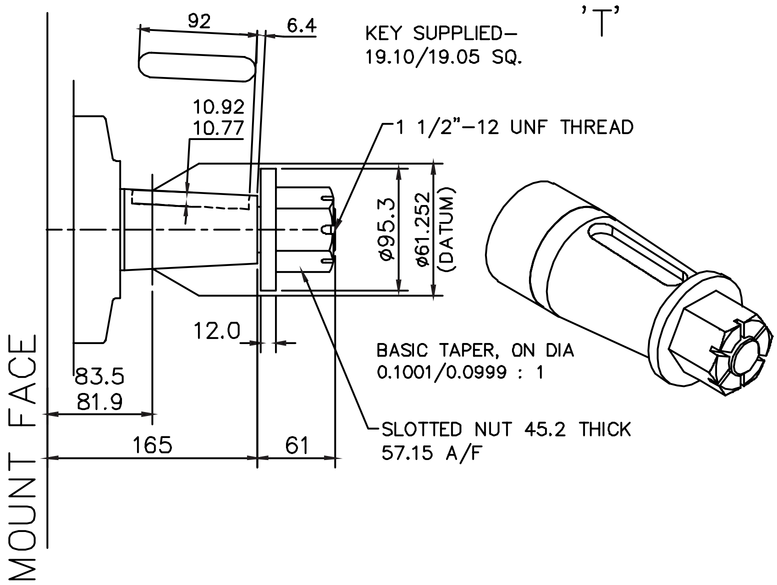
SPLINE DATA

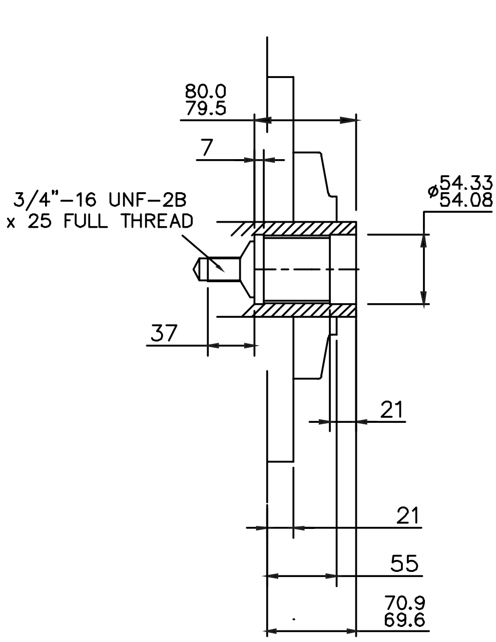
'S'	
TO BS 3550 (ANSI B92.1 CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	14
PITCH	6/12
MAJOR DIAMETER	62.553/62.425
FORM DIAMETER	55.052
MINOR DIAMETER	54.084/53.525
PIN DIAMETER	8.128
DIAMETER OVER PINS	71.593/71.544

'Z'
DIN 5480 W70 x 3 x 30 x 22 x 7h

3-1 HPB060/080 (cont)

'T' & 'Q' Shafts



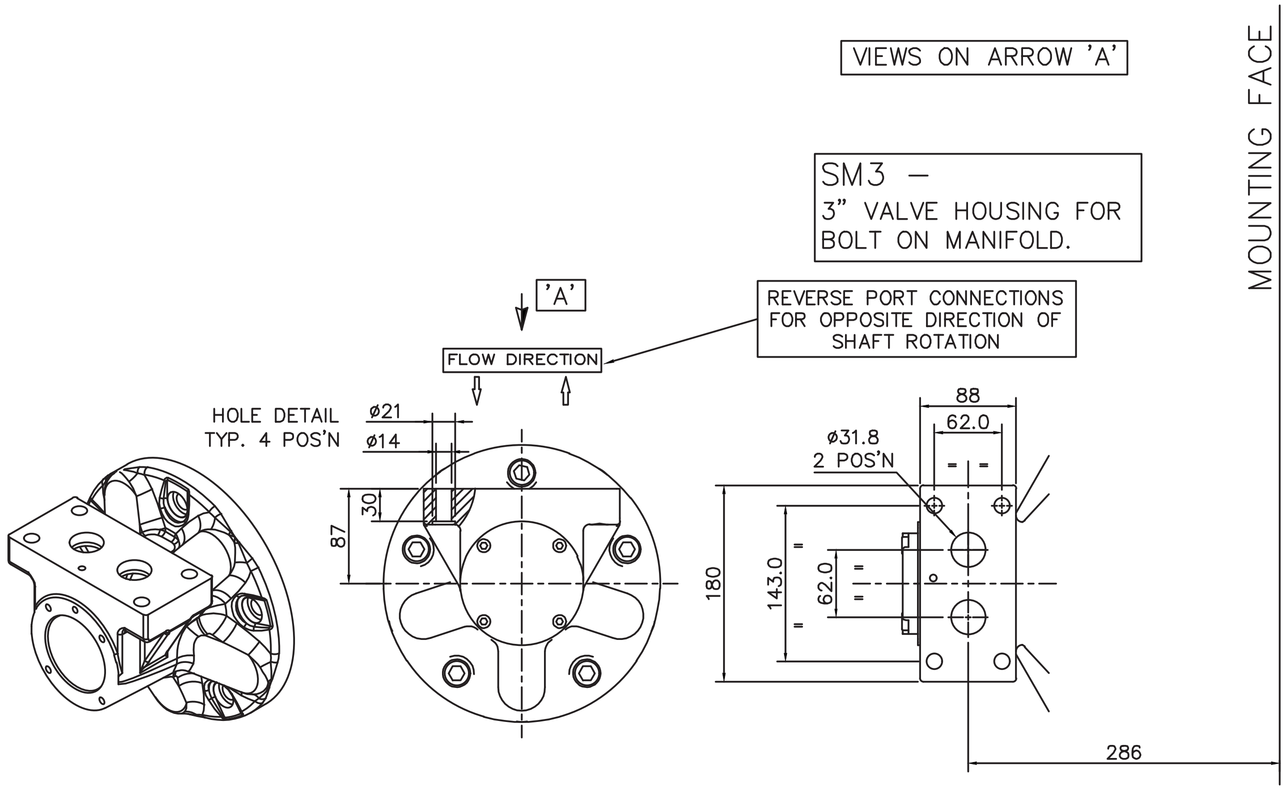


SPLINE DATA

TO BS 3550	
FLAT ROOT SIDE FIT	
PRESSURE ANGLE	30°
NUMBER OF TEETH	24
PITCH	12/24
MAJOR DIAMETER	53.25/52.92
MINOR DIAMETER	48.81/48.68
FORM DIAMETER	52.49
PIN DIAMETER	3.66 flatted to 3.56
DIMENSION BETWEEN PINS	45.63/45.55

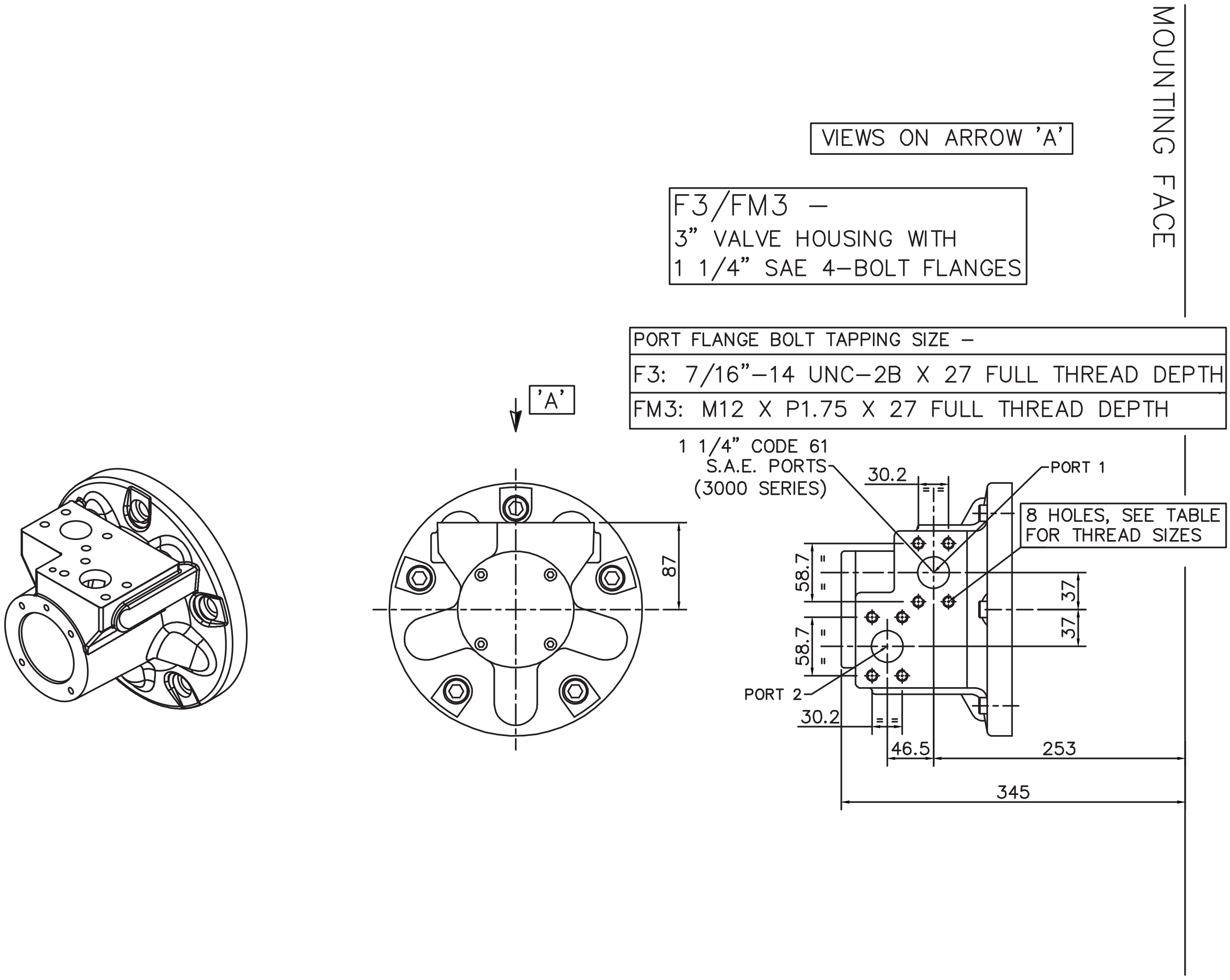
3-1 HPB060/080 (cont)

'SM3' Valve Housing



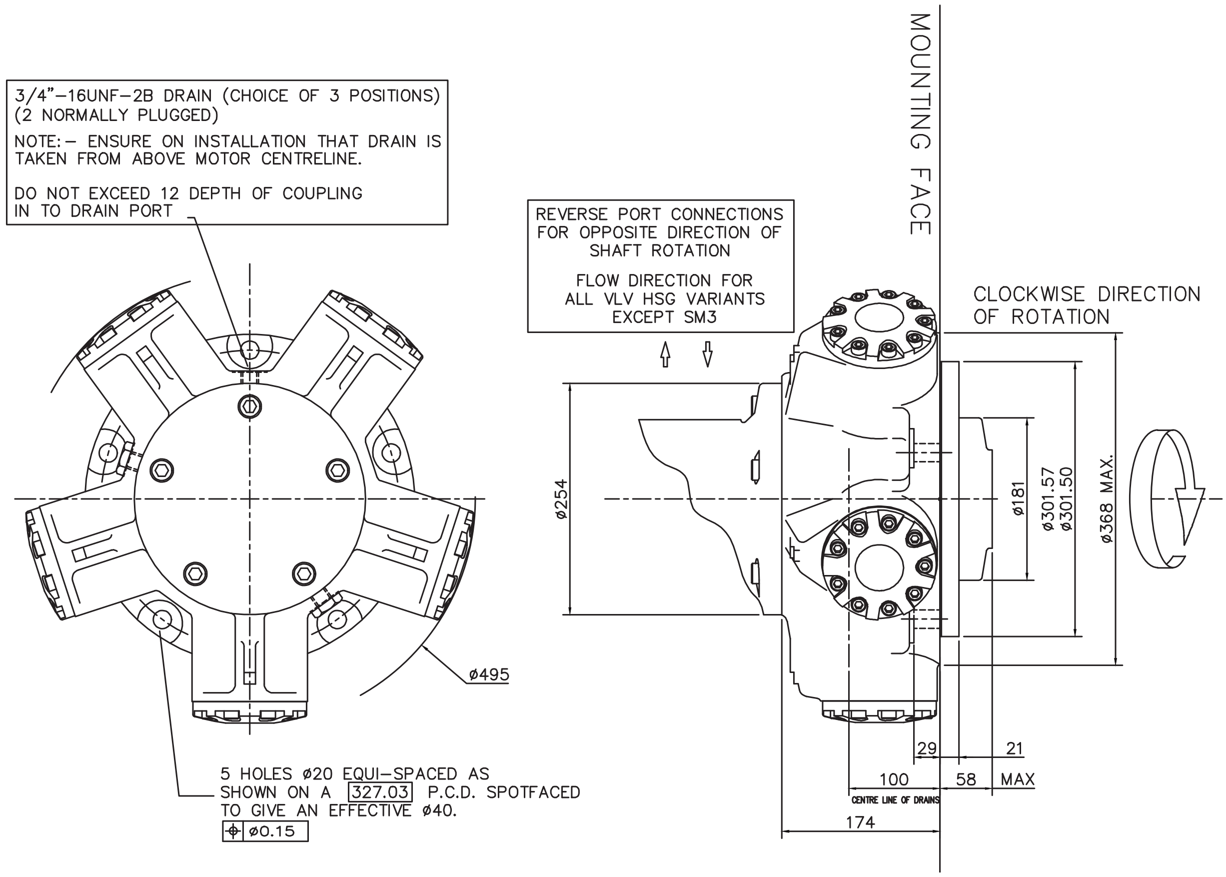
3-1 HPB060/080 (cont)

'F3' & 'FM3' Valve Housings



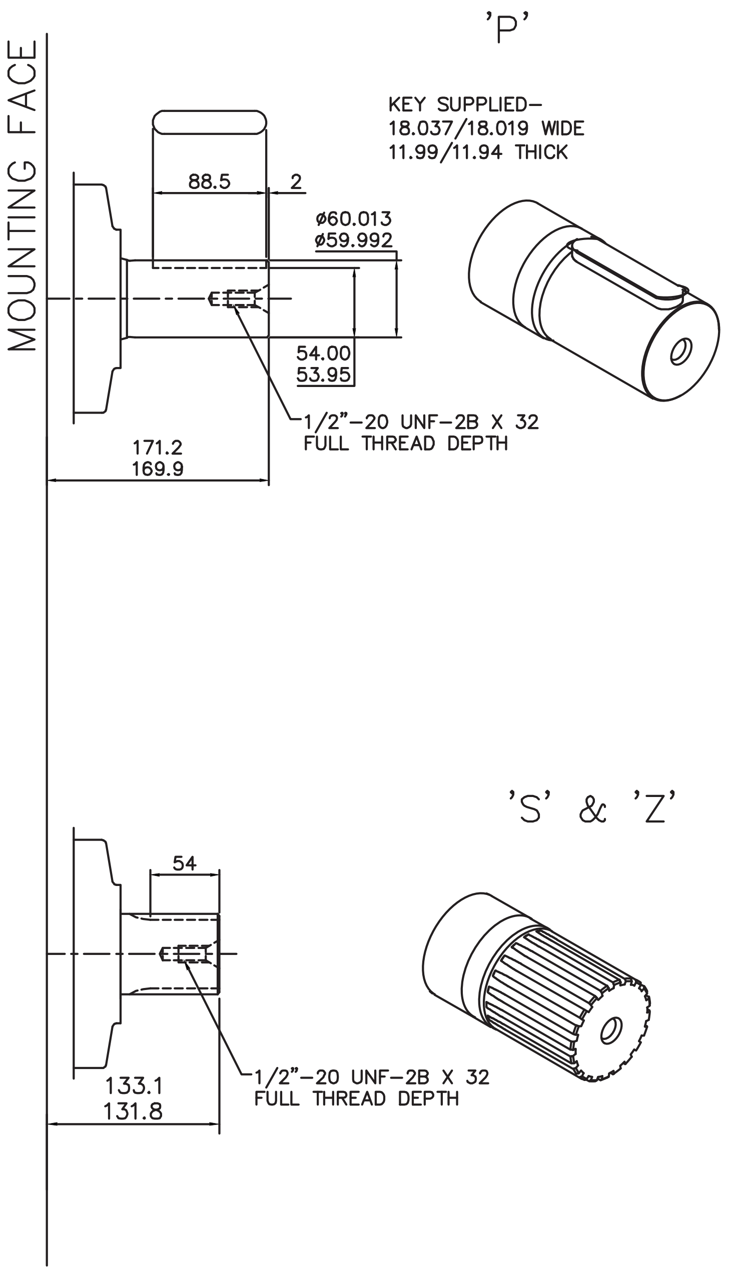
3-1 HPB060/080 (cont)

Installation



3-2 HPB100

'P', 'S' & 'Z' Shafts



SPLINE DATA

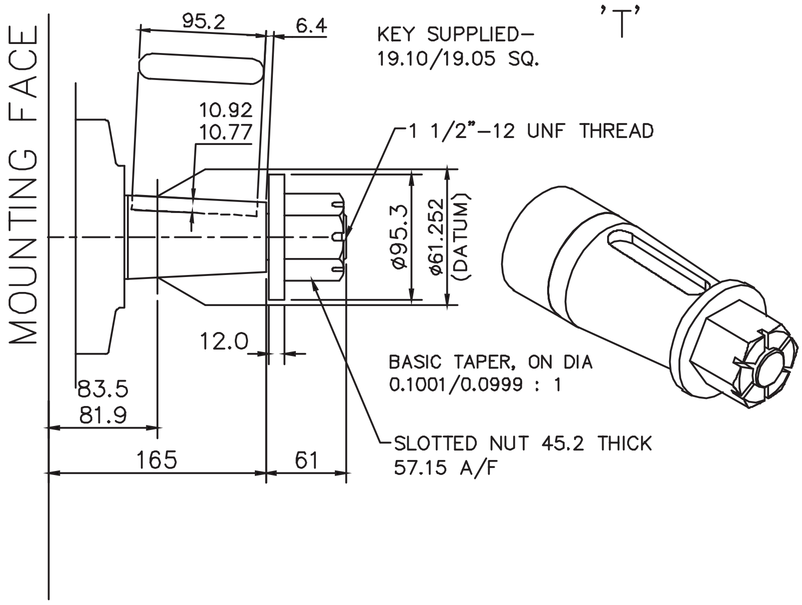
'S'	
TO BS 3550 (ANSI B92.1 CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	14
PITCH	6/12
MAJOR DIAMETER	62.553/62.425
FORM DIAMETER	55.052
MINOR DIAMETER	54.084/53.525
PIN DIAMETER	8.128
DIAMETER OVER PINS	71.593/71.544

'Z'
DIN 5480 W70 x 3 x 30 x 22 x 7h

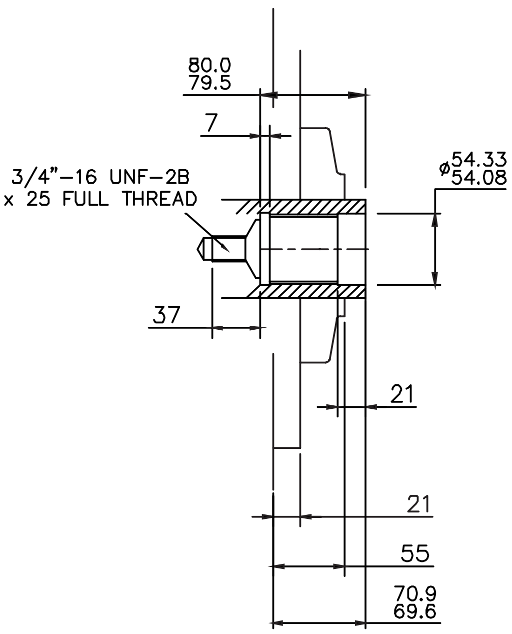
3-2 HPB100 (cont)

'T' & 'Q' Shafts

'T'



'Q'

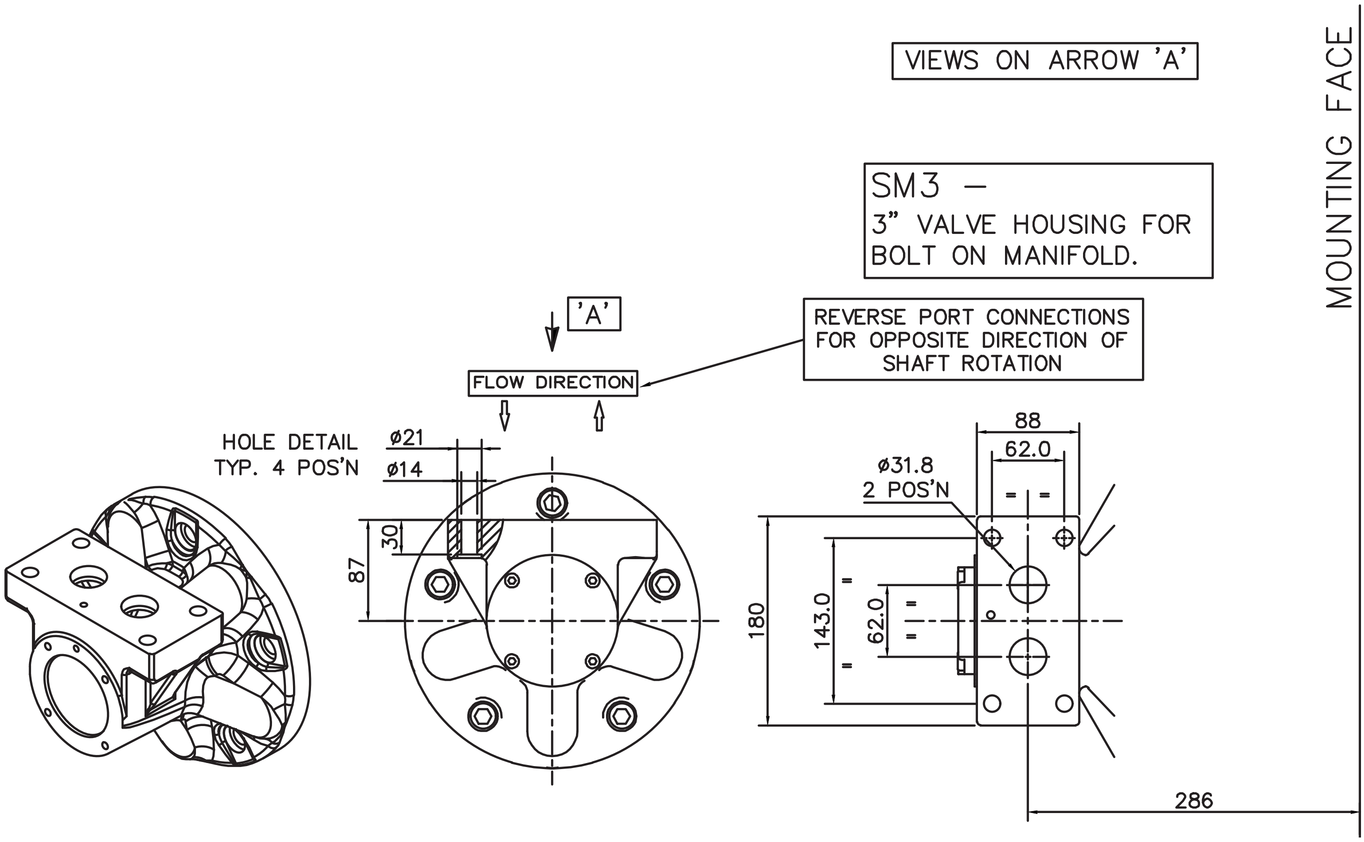


SPLINE DATA

TO BS 3550	
FLAT ROOT SIDE FIT	
PRESSURE ANGLE	30°
NUMBER OF TEETH	24
PITCH	12/24
MAJOR DIAMETER	53.25/52.92
MINOR DIAMETER	48.81/48.68
FORM DIAMETER	52.49
PIN DIAMETER	3.66 flatted to 3.56
DIMENSION BETWEEN PINS	45.63/45.55

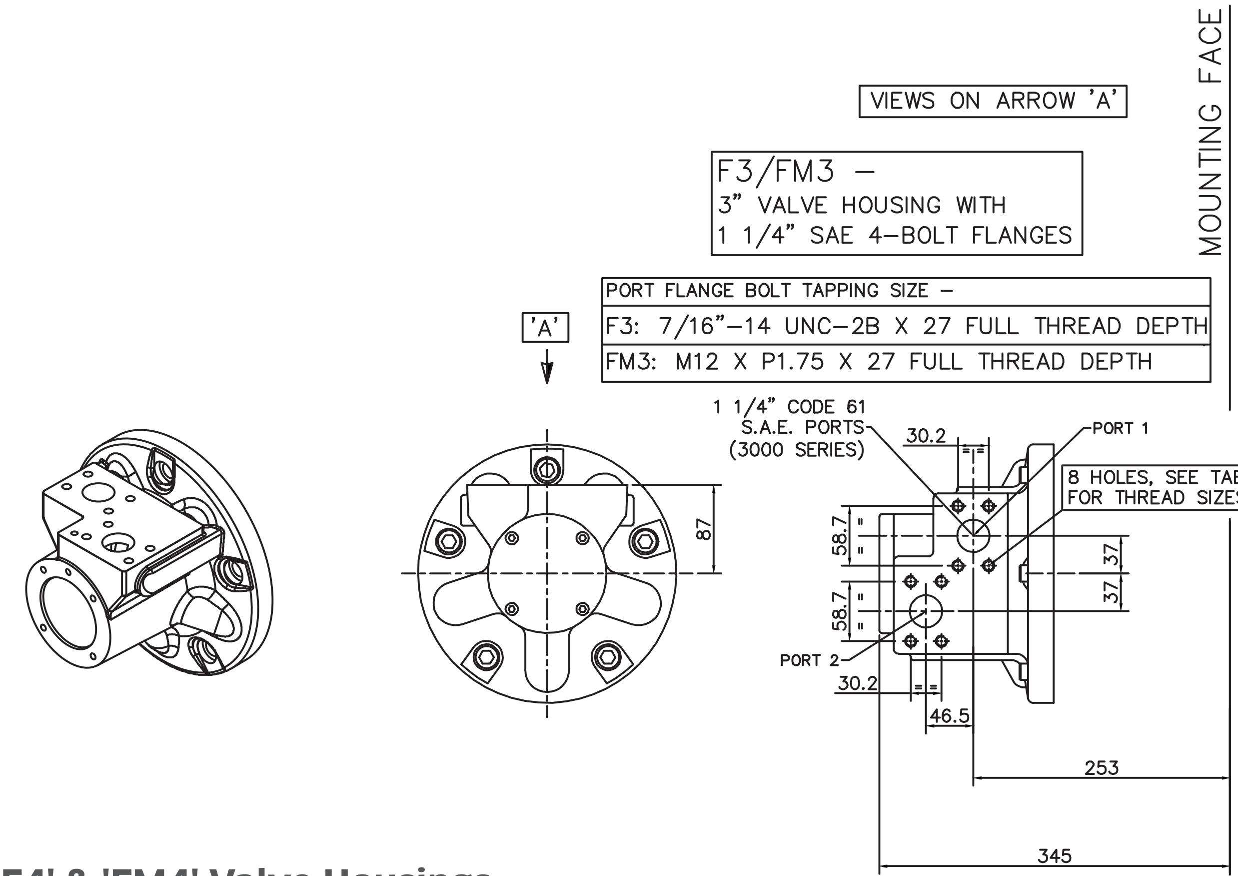
3-2 HPB100 (cont)

'SM3' Valve Housing

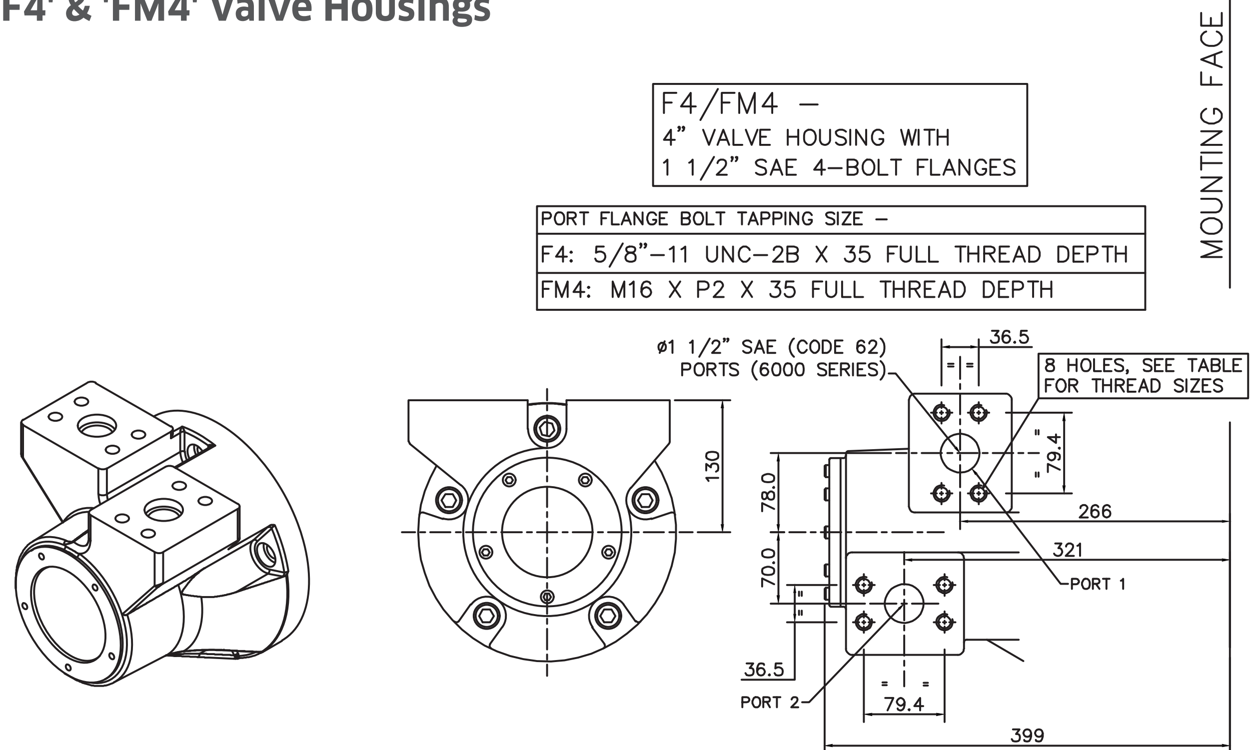


3-2 HPB100 (cont)

'F3' & 'FM3' Valve Housings

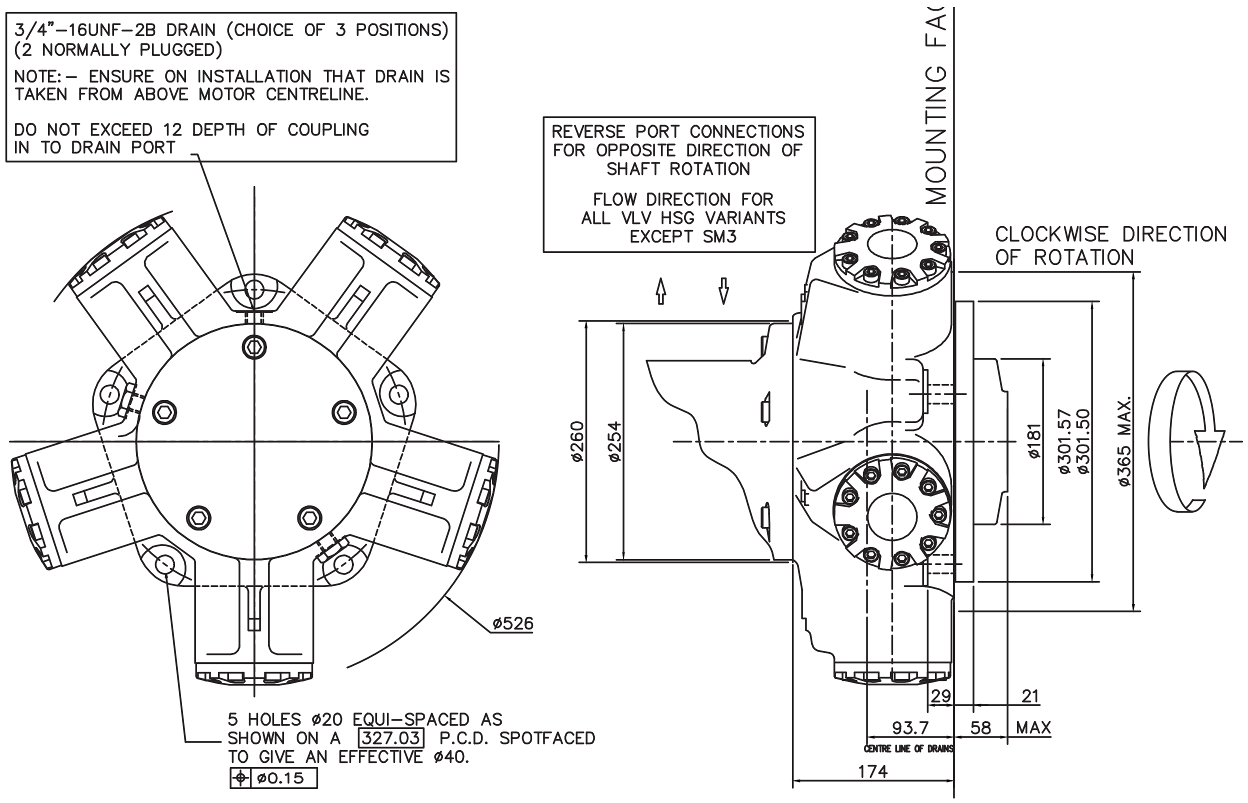


'F4' & 'FM4' Valve Housings



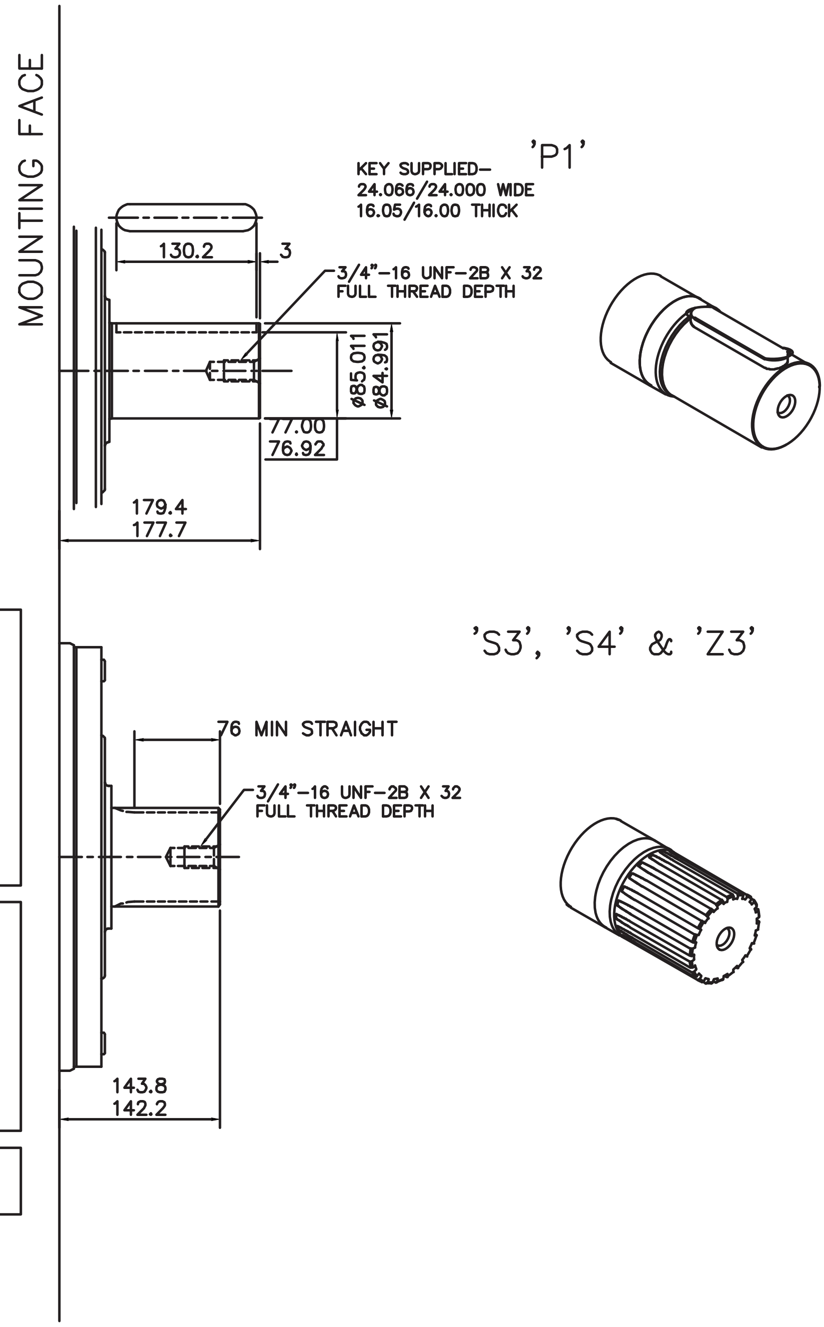
3-2 HPB100 (cont)

Installation



3-3 HPB125

HPB125 - 'P1', 'S3', 'S4' & 'Z3' Shafts



SPLINE DATA

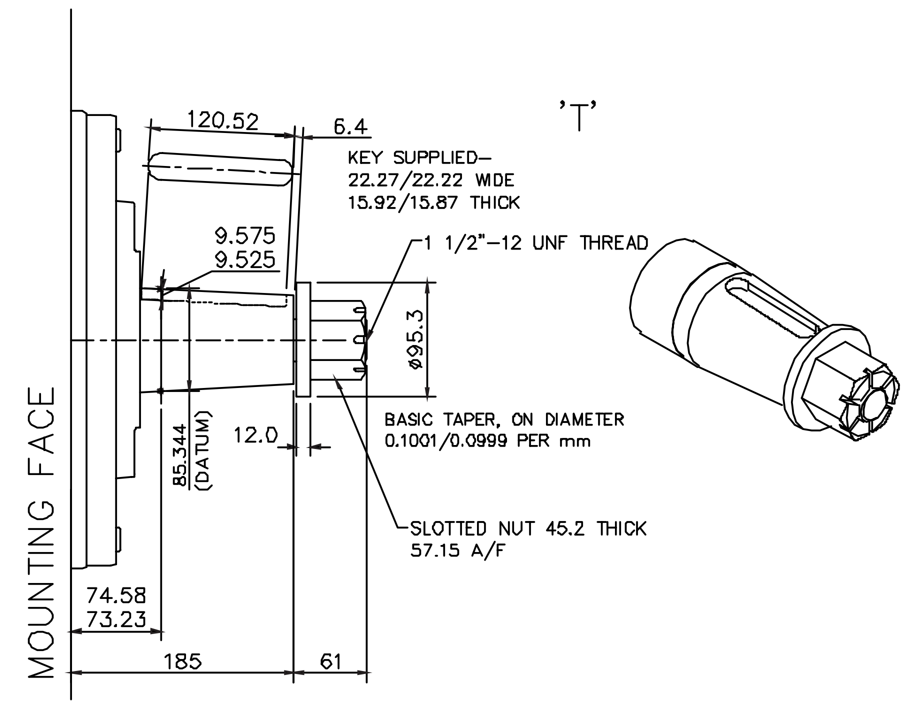
'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'S4'	
PRESSURE ANGLE	20°
NUMBER OF TEETH	16
PITCH	5/10
MAJOR DIAMETER	86.360/86.233
FORM DIAMETER	76.124
MINOR DIAMETER	74.93/72.39
PIN DIAMETER	8.636
DIAMETER OVER PINS	92.710/92.581

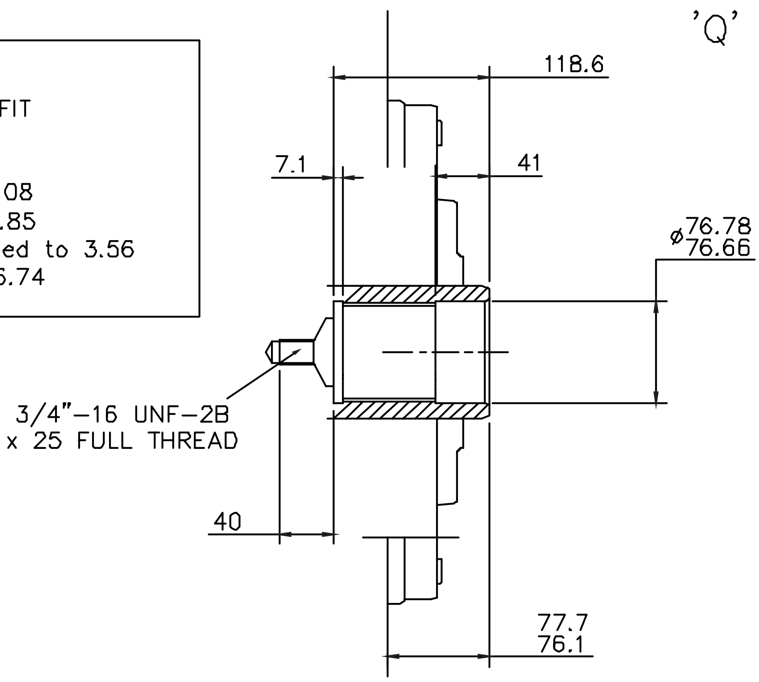
'Z3'
DIN 5480 W85 x 3 x 27 x 7h

3-3 HPB125 (cont)

HPB125 - 'T' & 'Q' Shafts

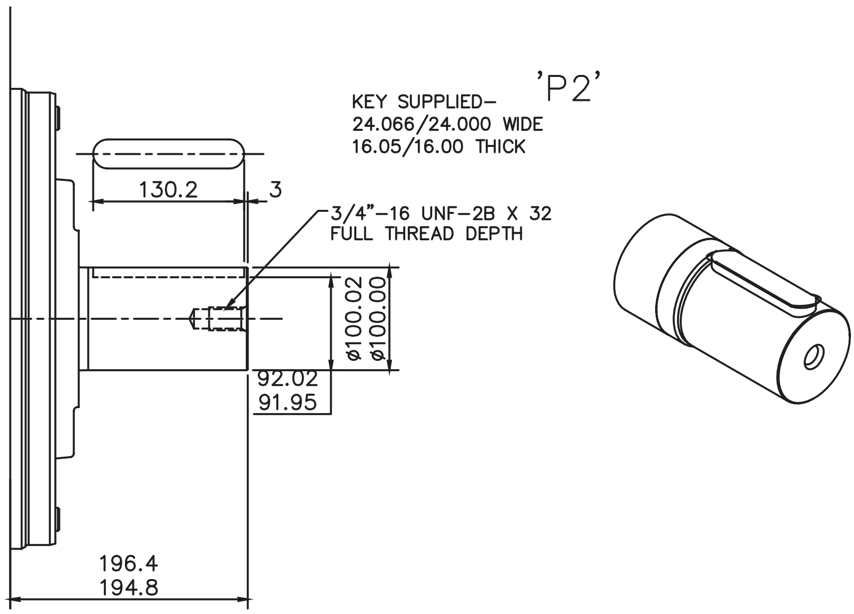


SPLINE DATA	
BS3550 : FLAT ROOT SIDE FIT	
NUMBER OF TEETH	34
PITCH	12/24
MAJOR DIAMETER	74.41/74.08
MINOR DIAMETER	69.98/69.85
PIN DIAMETER	3.66 flatted to 3.56
DIMENSION BETWEEN PINS	66.81/66.74



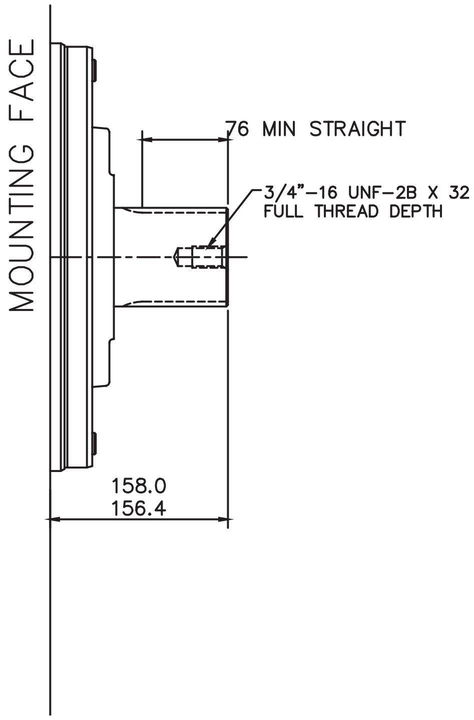
3-3 HPB125 (cont)

HPB125 - 'P2' Shafts

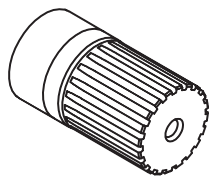


3-3 HPB125 (cont)

HPB125 - 'S5' & 'Z5' Shafts



'S5' & 'Z5'



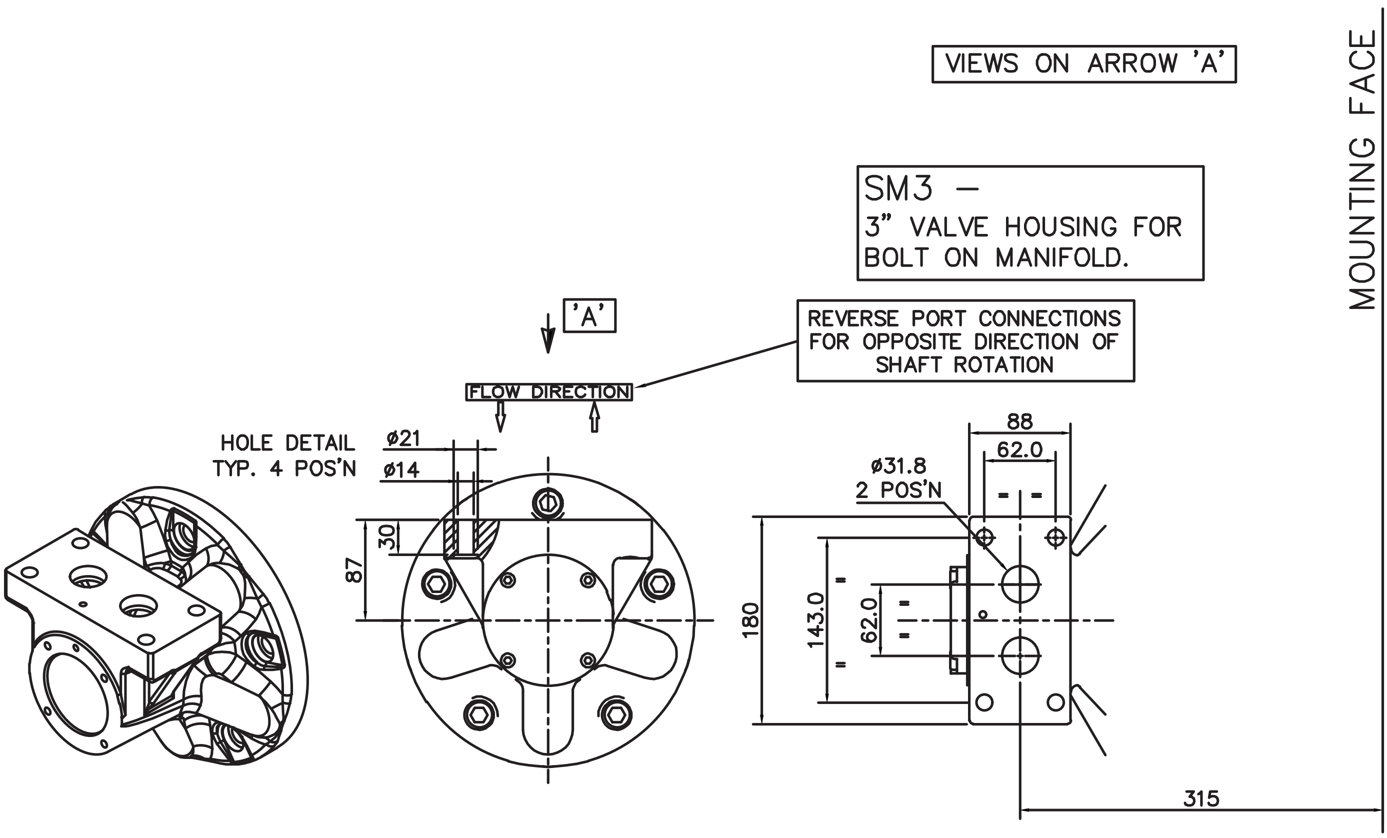
SPLINE DATA

'S5'	
PRESSURE ANGLE	20°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.652/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.626
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

'Z5'
DIN 5480 W100 x 4 x 24 x 7h

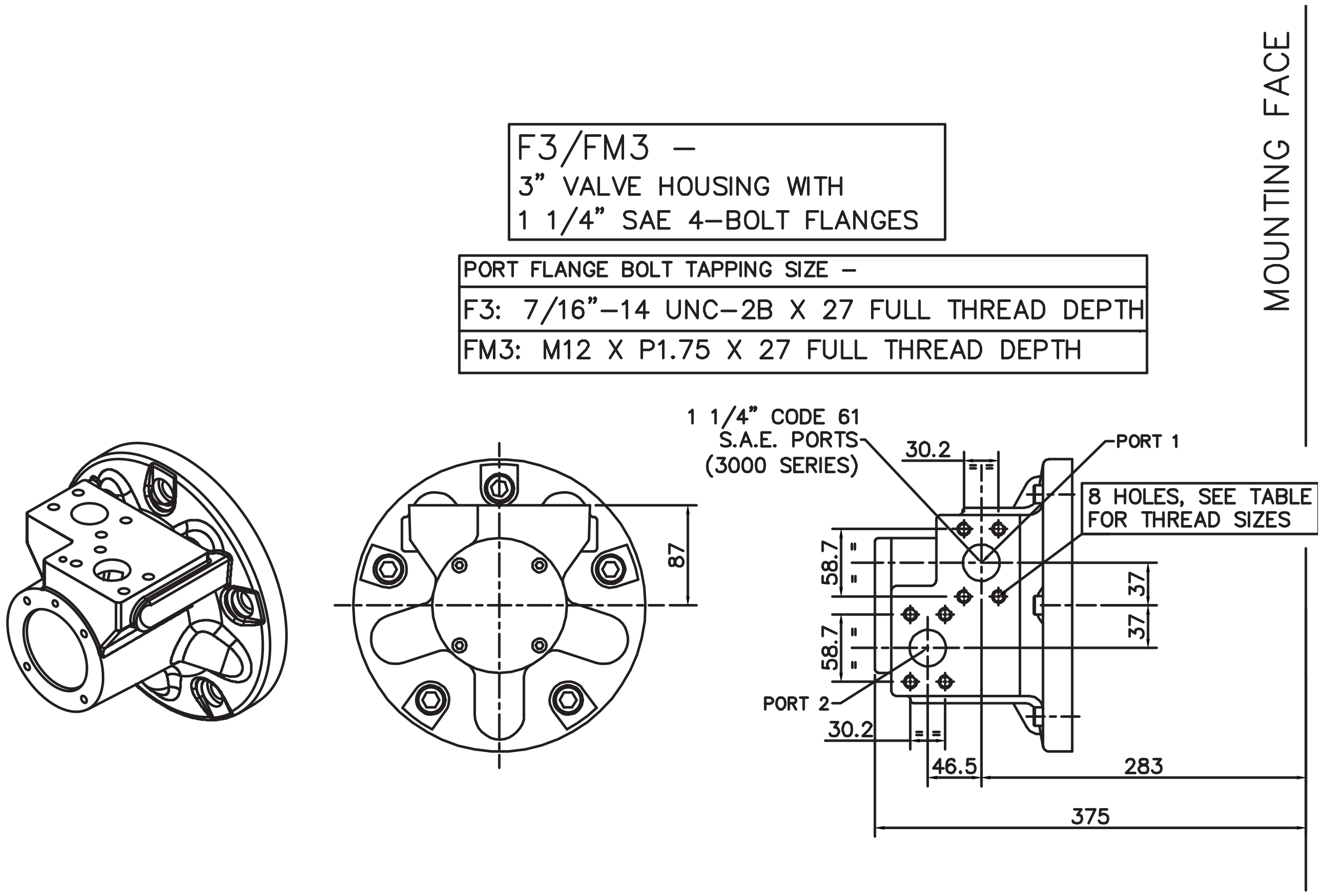
3-3 HPB125 (cont)

'SM3' Valve Housing



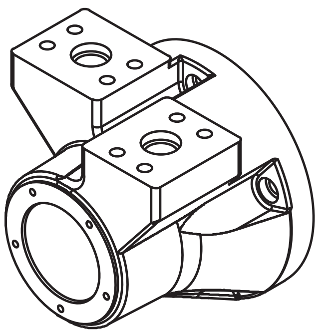
3-3 HPB125 (cont)

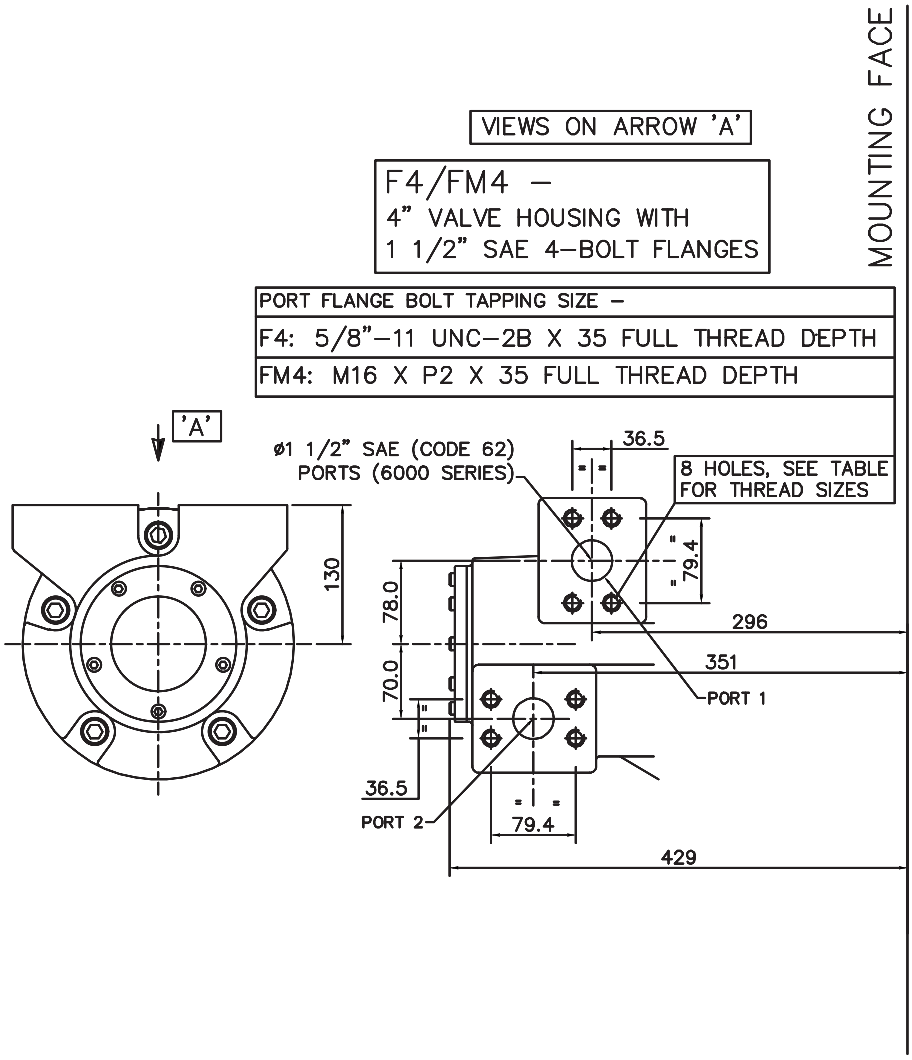
'F3' & 'FM3' Valve Housings



3-3 HPB125 (cont)

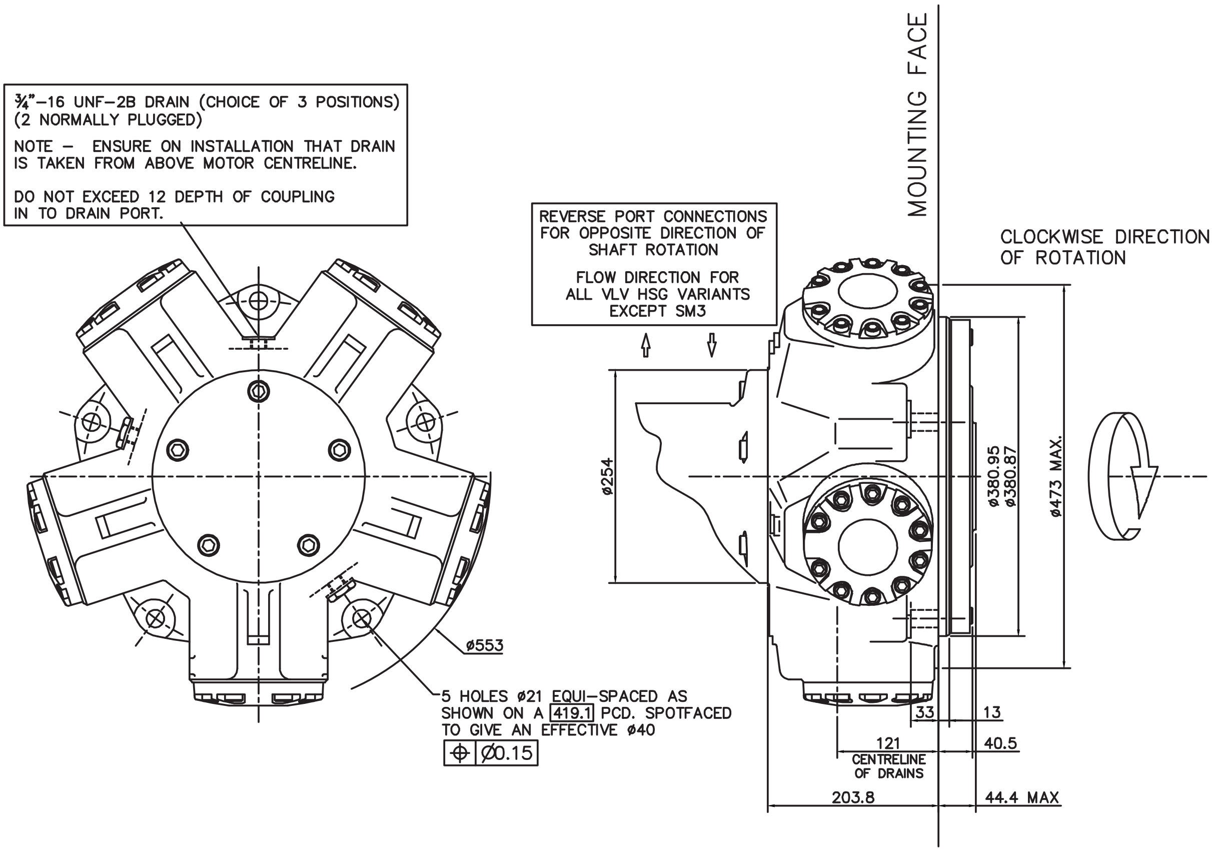
'F4' & 'FM4' Valve Housings

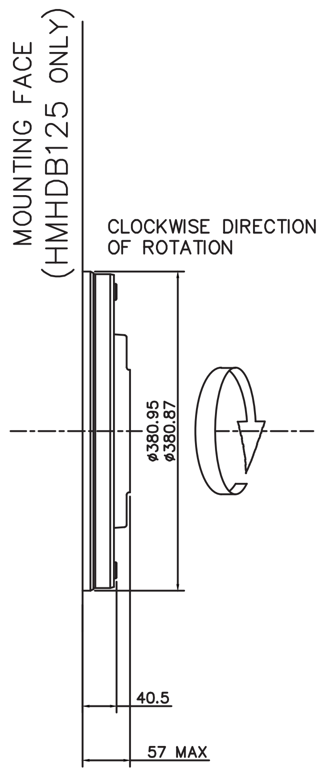




3-3 HPB125 (cont)

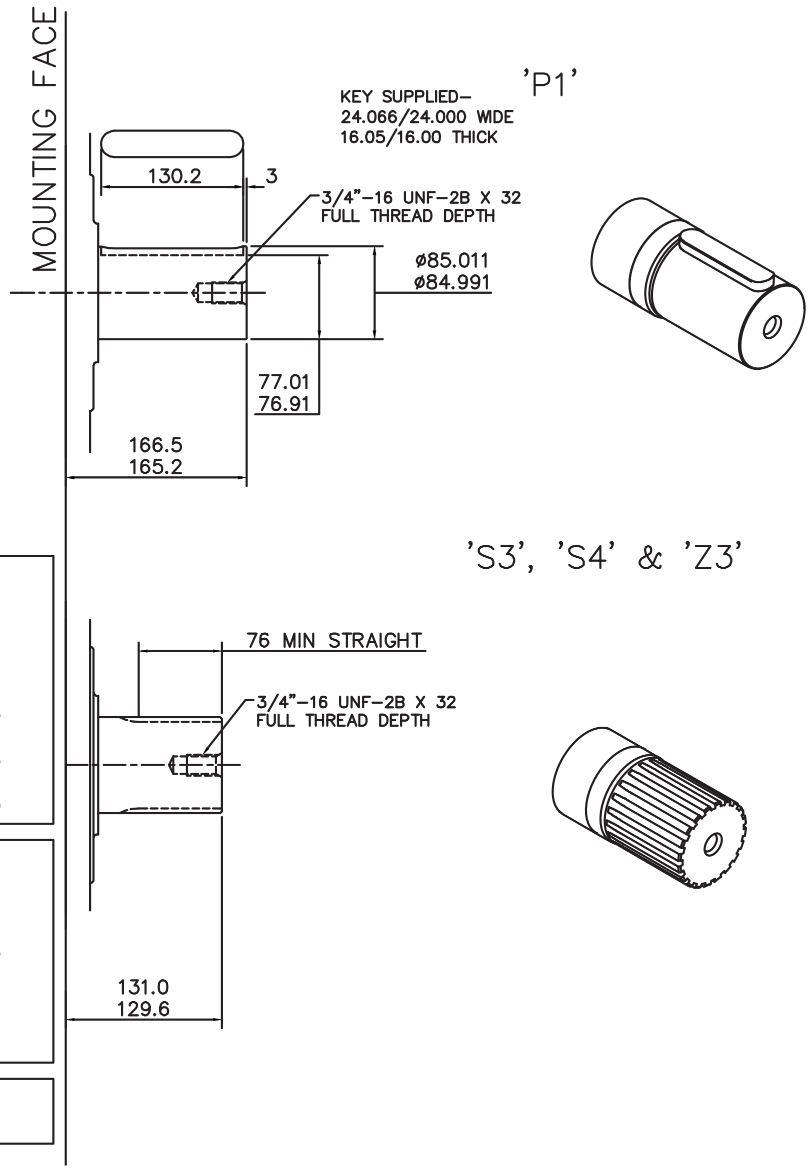
Installation





3-4 HPB150/200

HPB150/200 - 'P1', 'S3', 'S4' & 'Z3' Shafts



SPLINE DATA

'S3'

TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'S4'

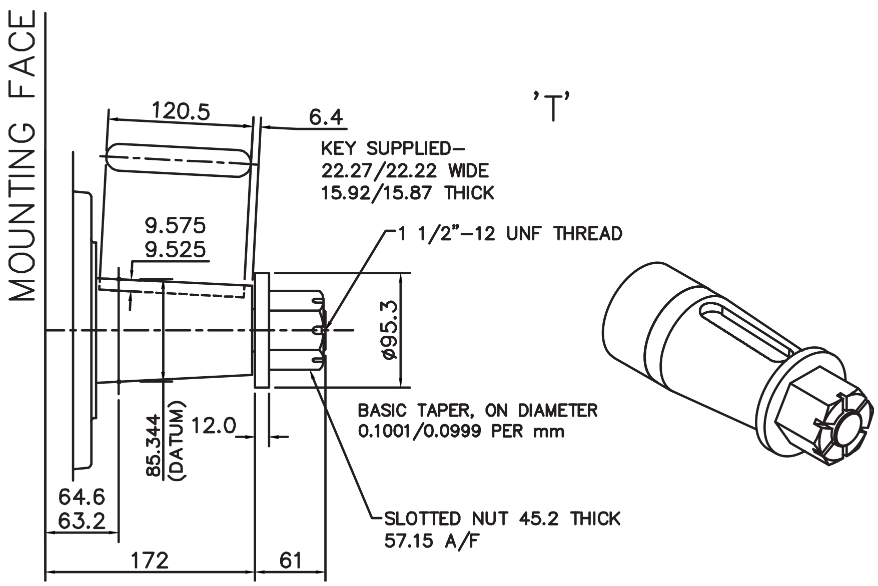
PRESSURE ANGLE	20°
NUMBER OF TEETH	16
PITCH	5/10
MAJOR DIAMETER	86.360/86.233
FORM DIAMETER	76.124
MINOR DIAMETER	74.93/72.39
PIN DIAMETER	8.636
DIAMETER OVER PINS	92.710/92.581

'Z3'

DIN 5480 W85 x 3 x 27 x 7h

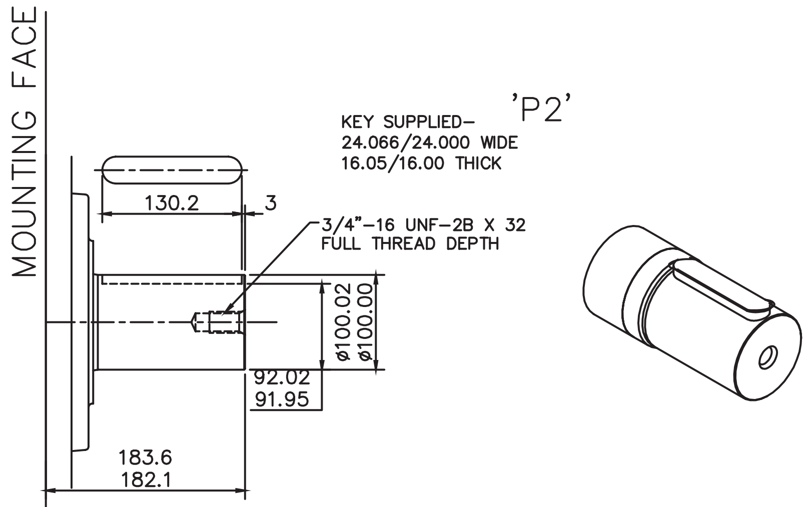
3-4 HPB150/200 (cont)

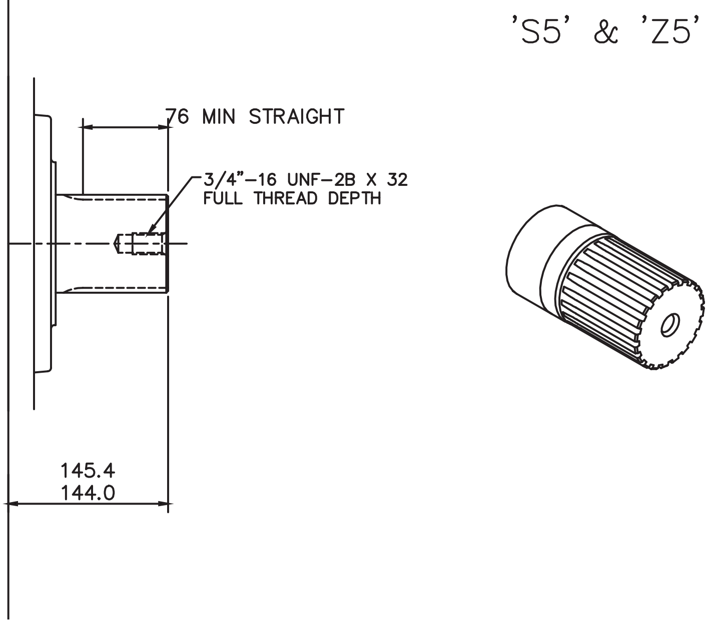
HPB150/200 - 'T' Shaft



3-4 HPB150/200 (cont)

HPB150/200 - 'P2', 'S5' & 'Z5' Shafts





SPLINE DATA

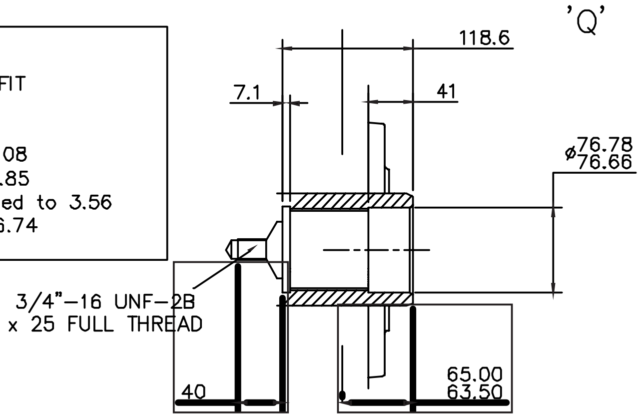
'S5'	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.652/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.626
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517

'Z5'
DIN 5480 W100 x 4 x 24 x 7h

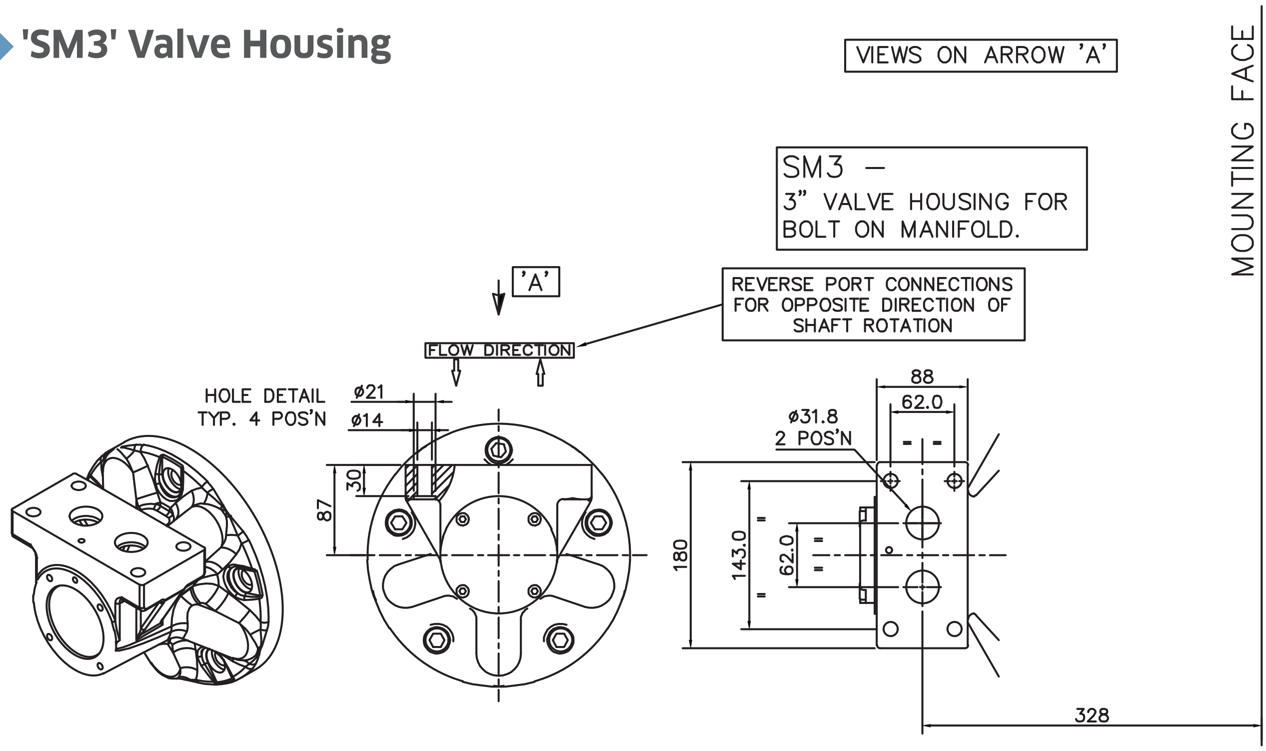
3-4 HPB150/200 (cont)

HPB150/200 - 'Q' Shafts

SPLINE DATA	
BS3550 : FLAT ROOT SIDE FIT	
NUMBER OF TEETH	34
PITCH	12/24
MAJOR DIAMETER	74.41/74.08
MINOR DIAMETER	69.98/69.85
PIN DIAMETER	3.66 flatted to 3.56
DIMENSION BETWEEN PINS	66.81/66.74

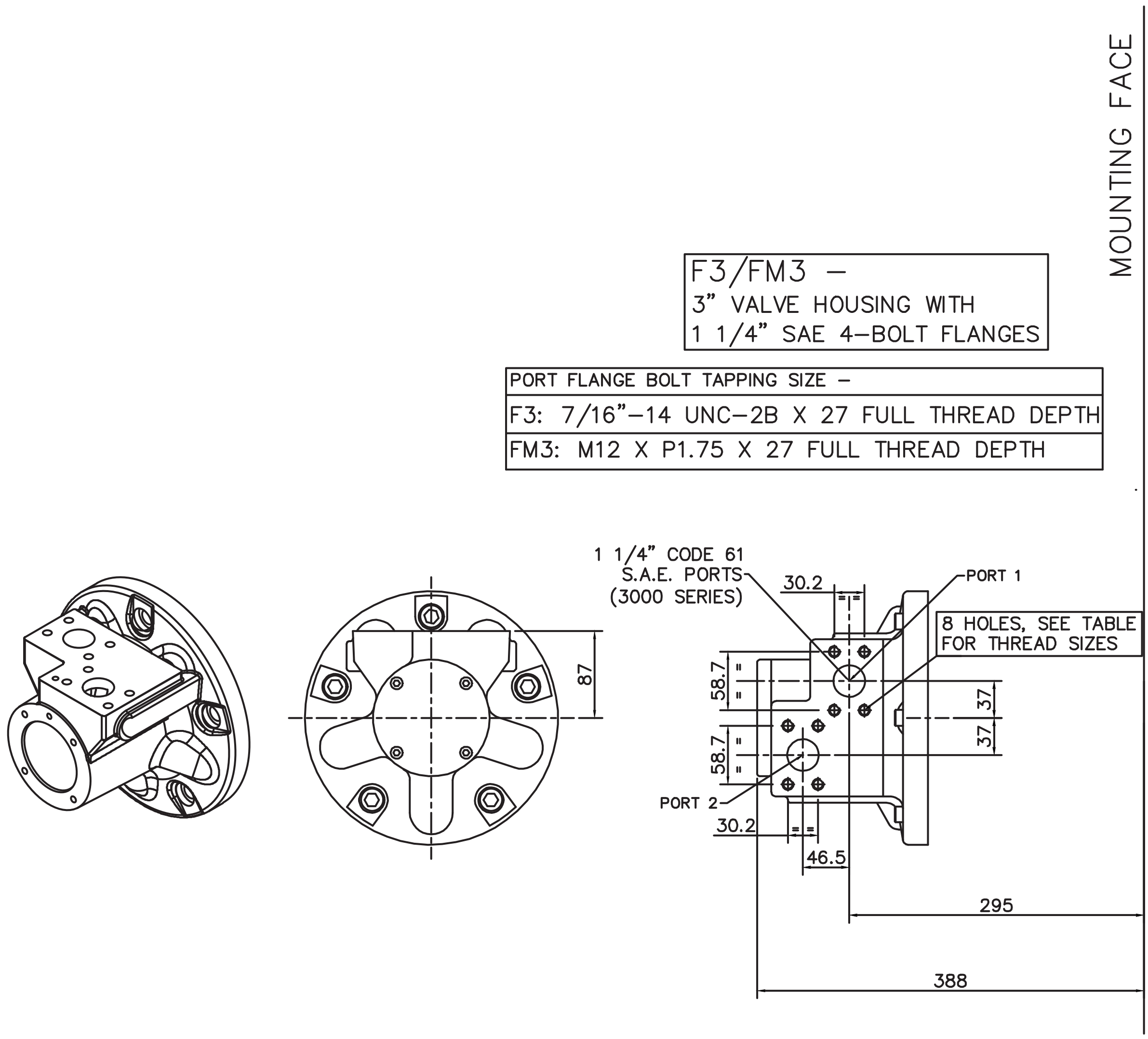


'SM3' Valve Housing



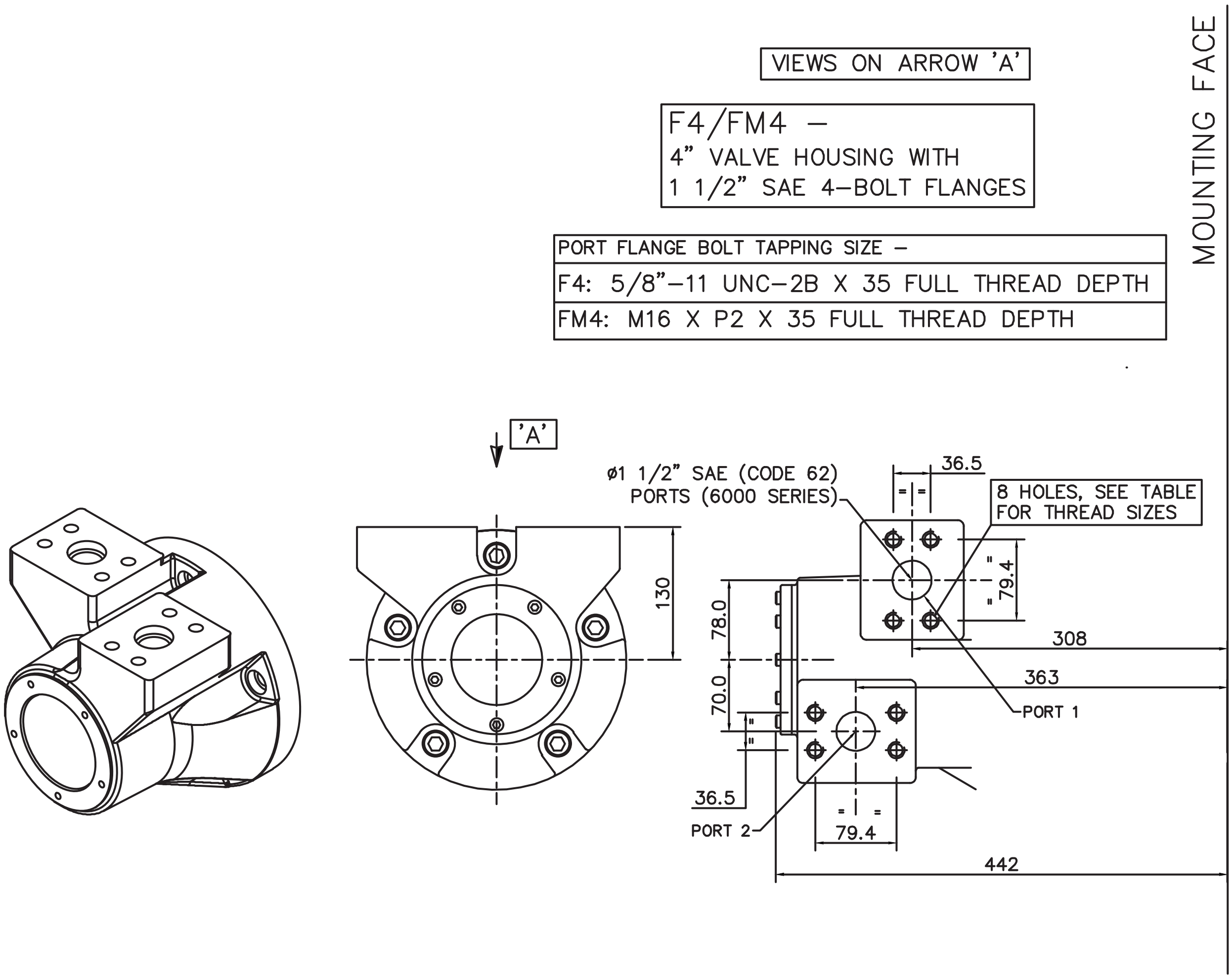
3-4 HPB150/200 (cont)

'F3' & 'FM3' Valve Housings



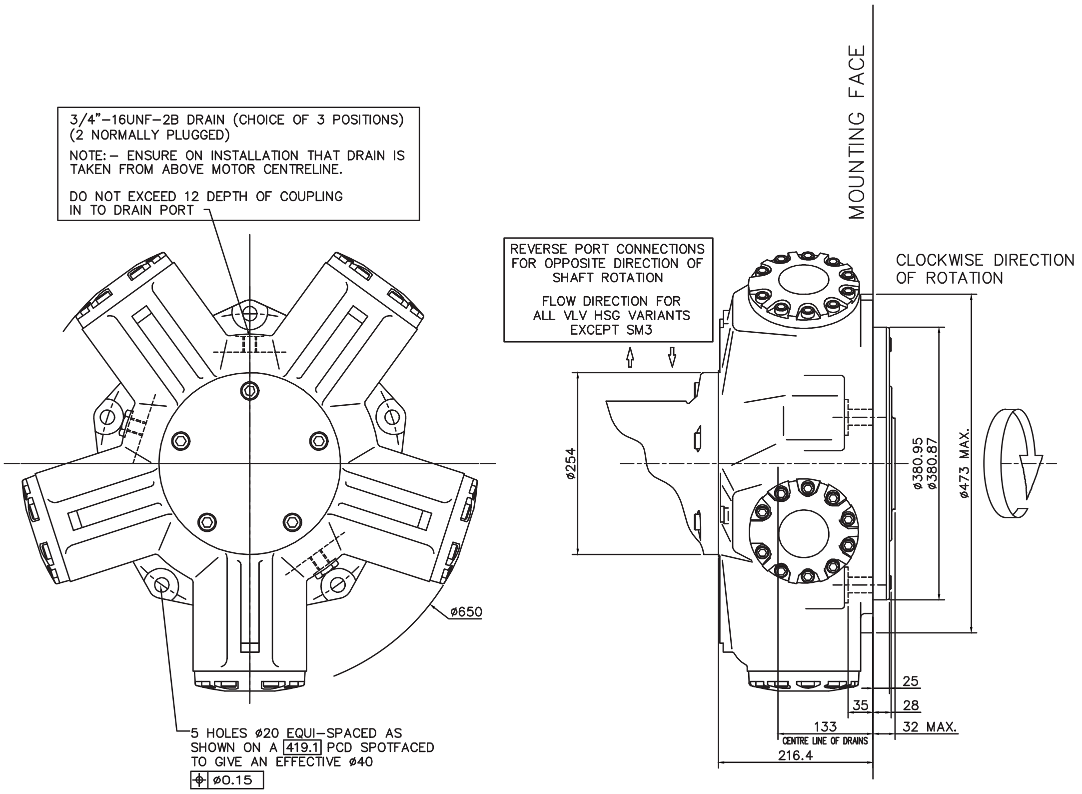
3-4 HPB150/200 (cont)

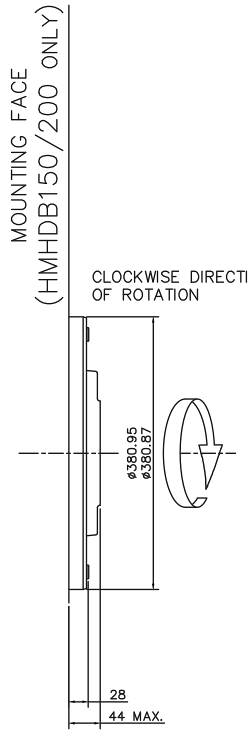
'F4' & 'FM4' Valve Housings



3-4 HPB150/200 (cont)

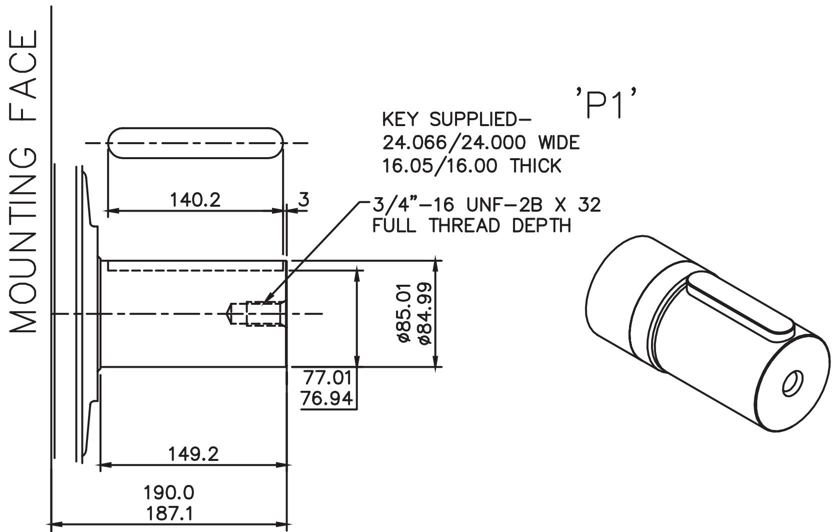
Installation





3-5 HPB270

HPB270 - 'P1', 'S3' & 'Z' Shafts



SPLINE DATA

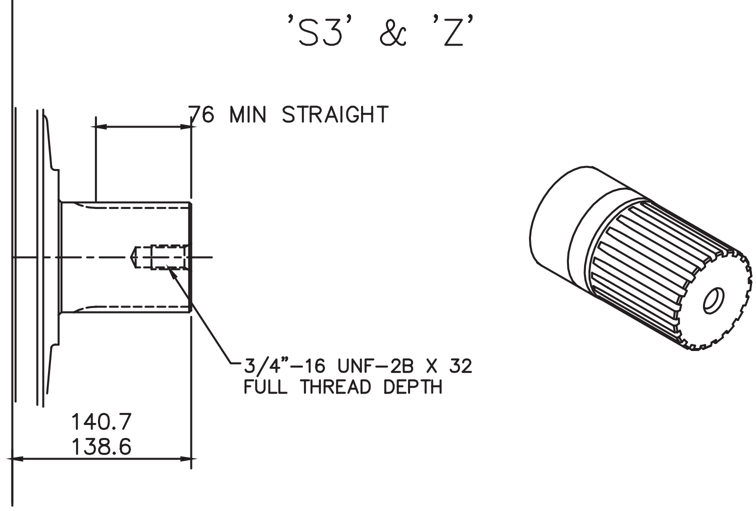
'S3'

TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

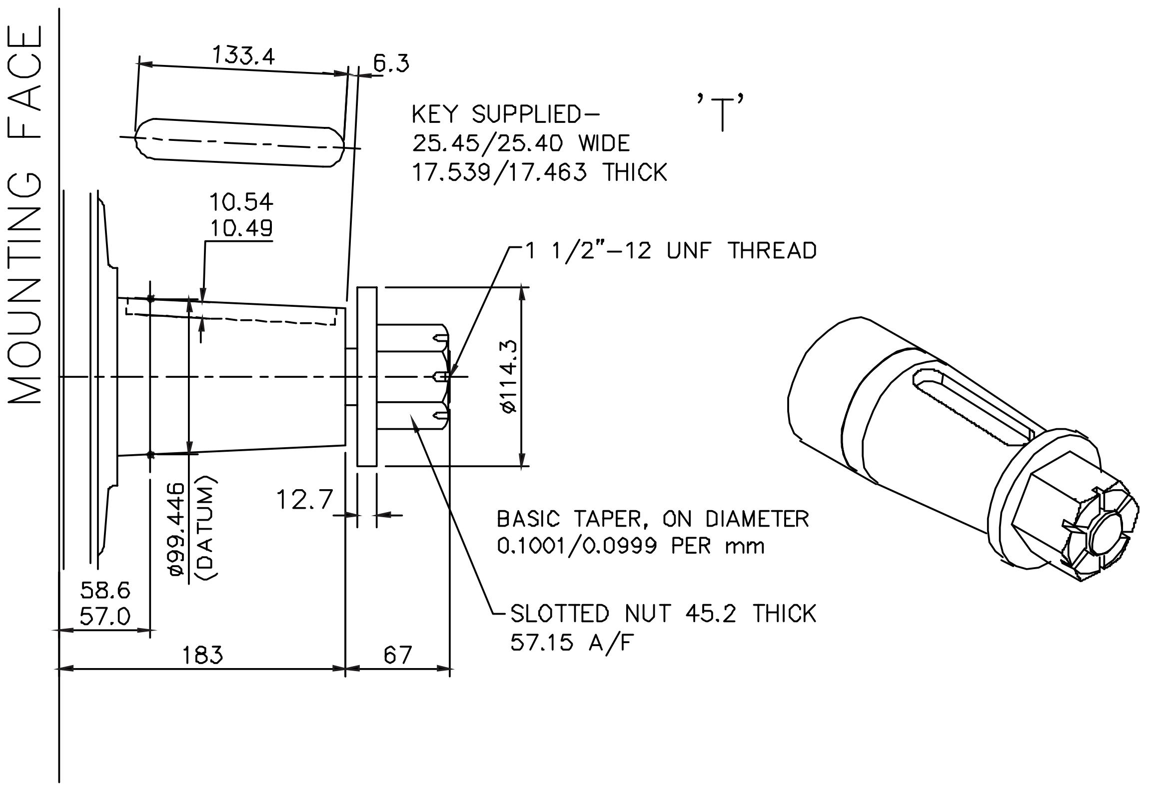
'Z'

DIN 5480 W100 x 4 x 24 x 7h



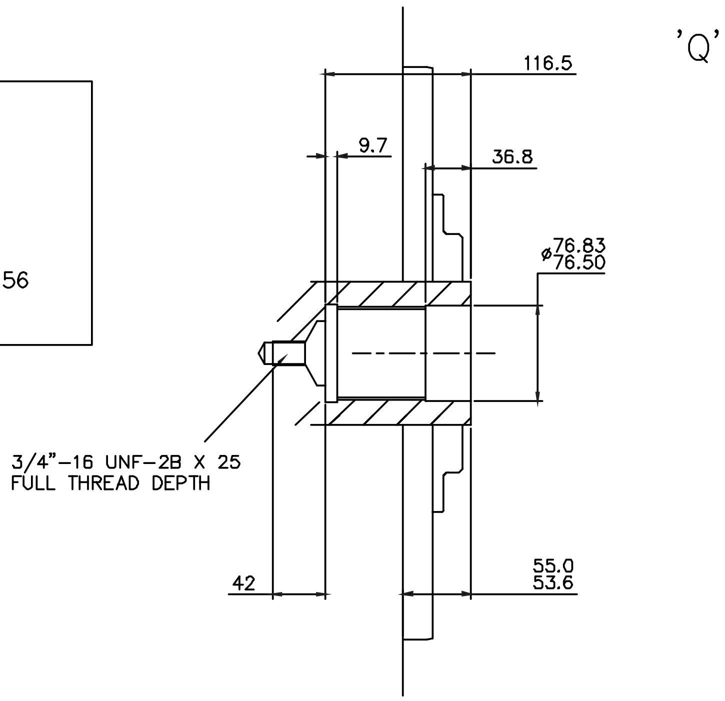
3-5 HPB270 (cont)

HPB270 - 'T' & 'Q' Shaft



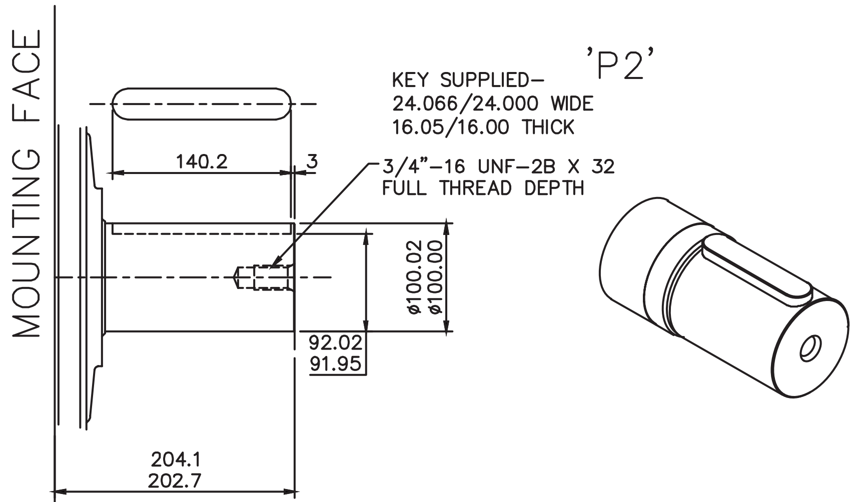
SPLINE DATA
BS3550 : FLAT ROOT SIDE FIT

NUMBER OF TEETH	34
PITCH	12/24
MAJOR DIAMETER	74.41/74.08
MINOR DIAMETER	69.98/69.85
PIN DIAMETER	3.66 flatted to 3.56
DIMENSION BETWEEN PINS	66.81/66.74



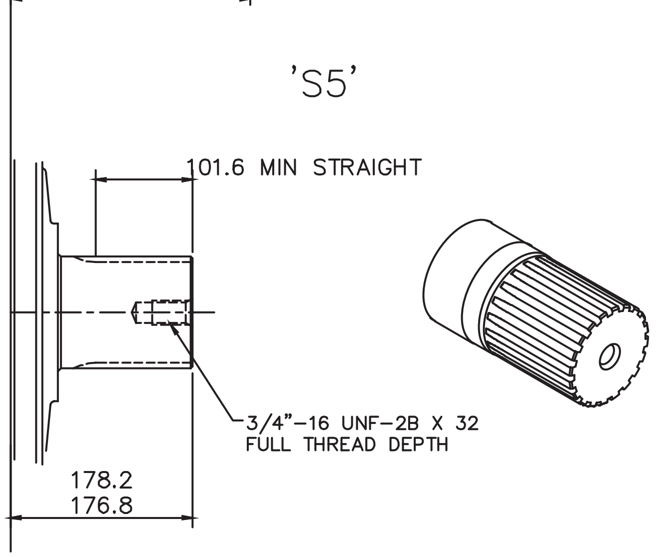
3-5 HPB270 (cont)

HPB270 - 'P2' & 'S5' Shafts



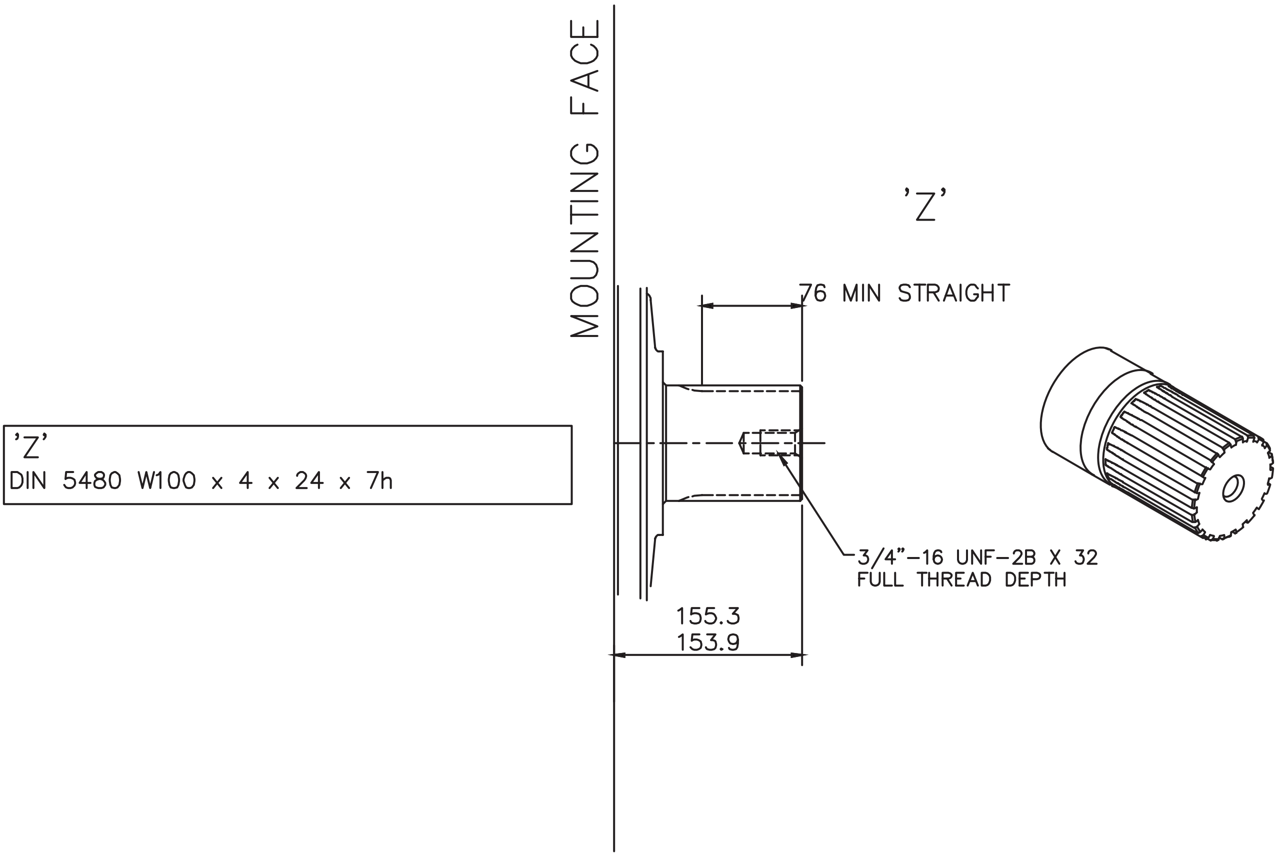
SPLINE DATA

'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.653/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.625
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517



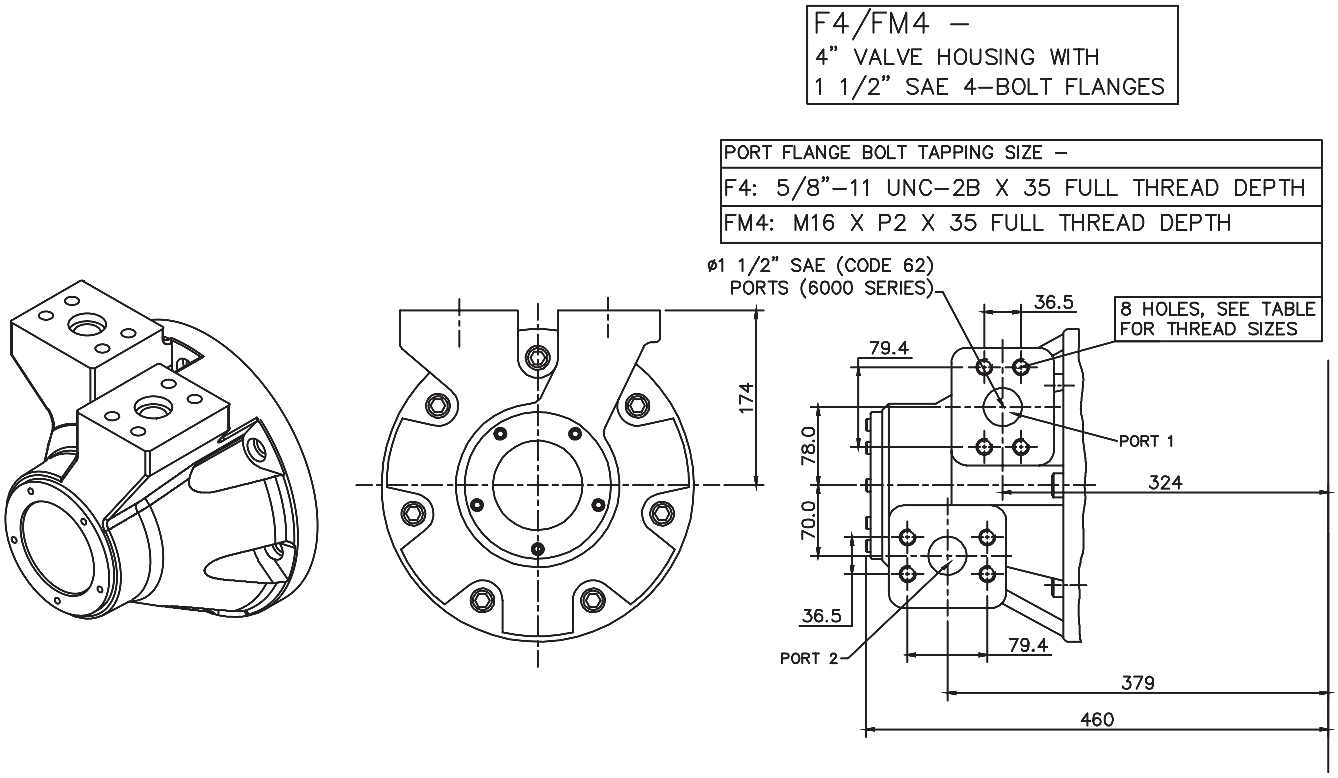
3-5 HPB270 (cont)

HPHDB270 - 'Z' Shaft



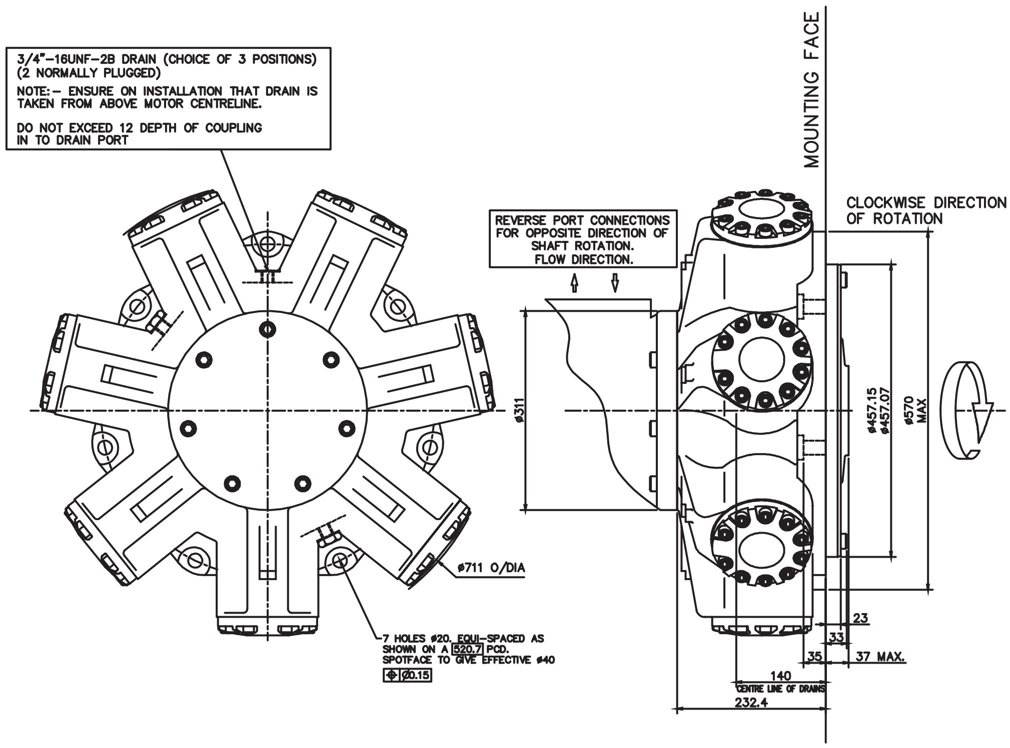
3-5 HPB270 (cont)

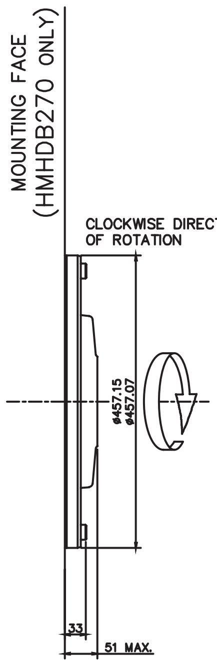
'F4' & 'FM4' Valve Housings



3-5 HPB270 (cont)

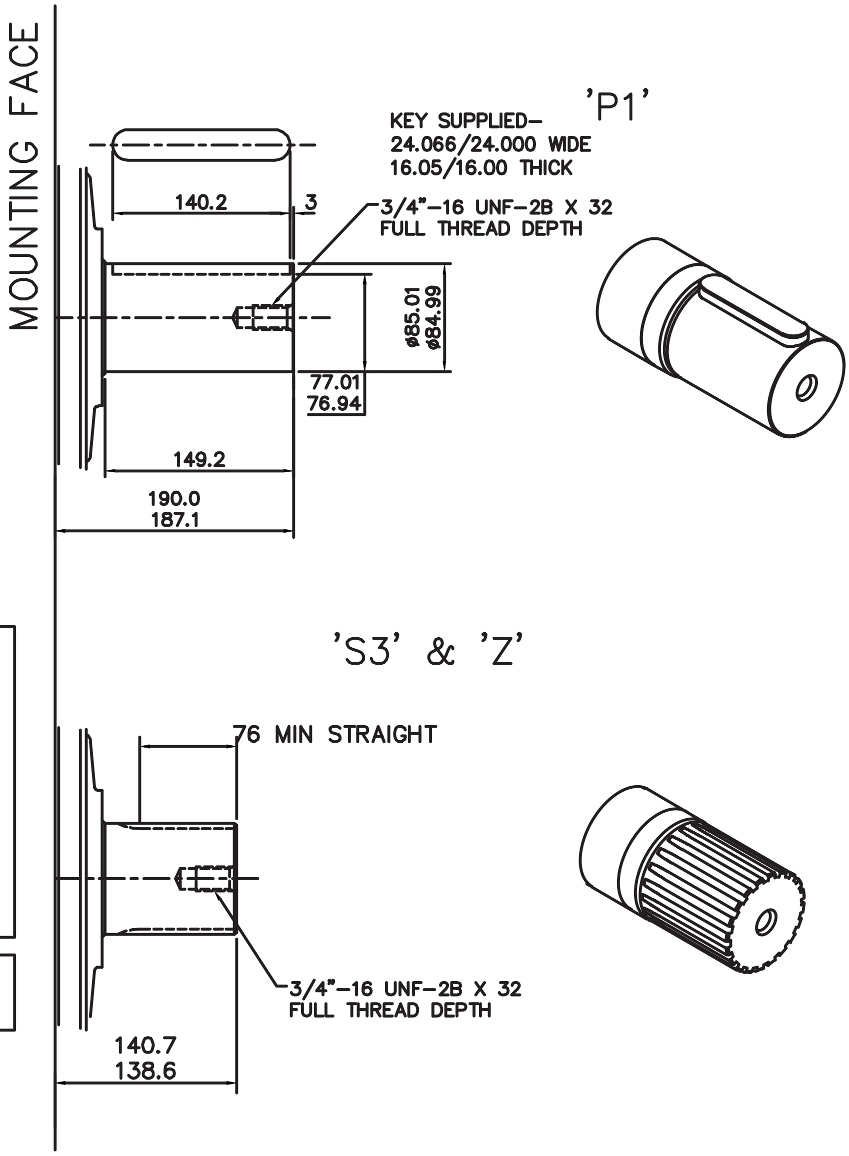
Installation





3-6 HPB325

HPB325 - 'P1', 'S3' & 'Z' Shafts



SPLINE DATA

'S3'

TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

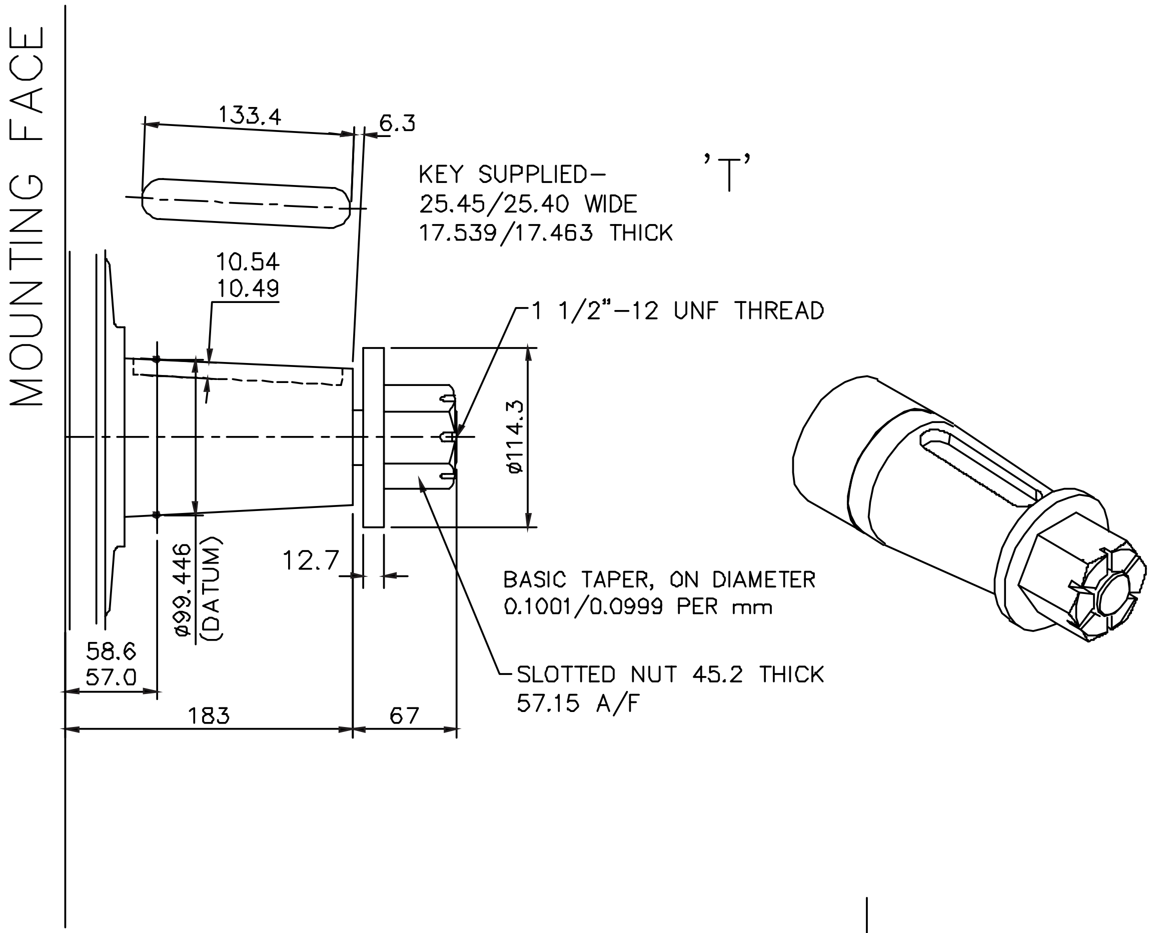
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z'

DIN 5480 W100 x 4 x 24 x 7h

3-6 HPB325 (cont)

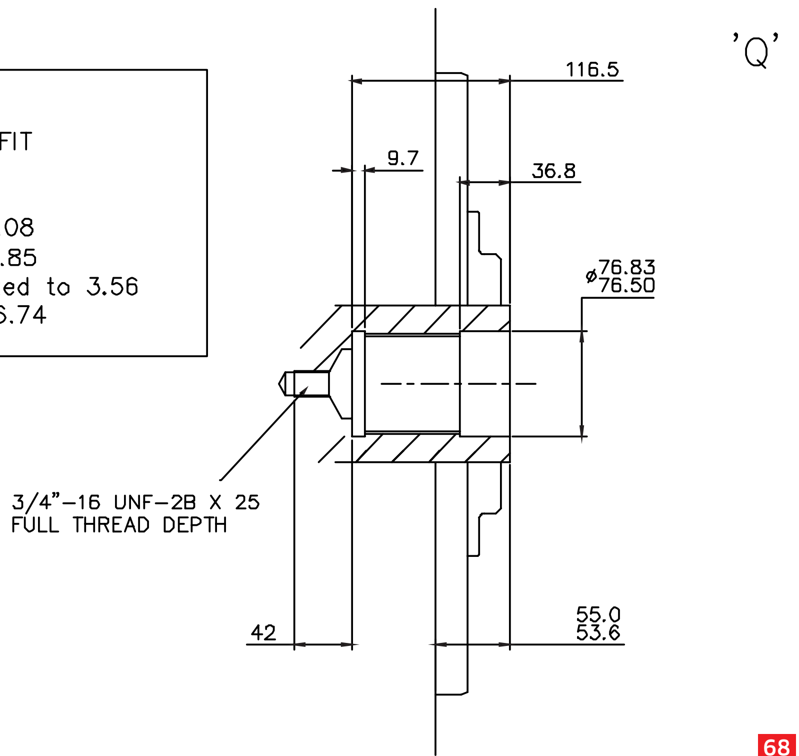
HPB325 - 'T' & 'Q' Shaft



SPLINE DATA

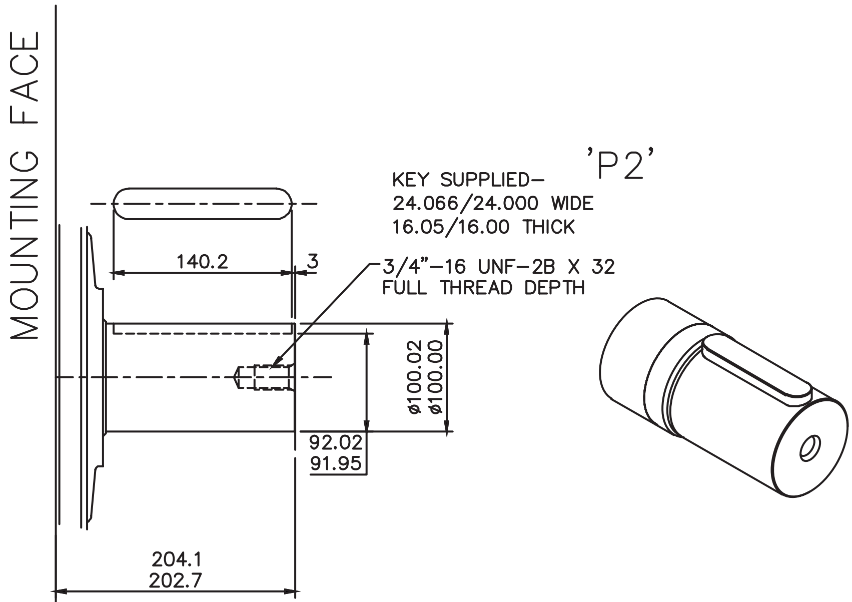
BS3550 : FLAT ROOT SIDE FIT

NUMBER OF TEETH	34
PITCH	12/24
MAJOR DIAMETER	74.41/74.08
MINOR DIAMETER	69.98/69.85
PIN DIAMETER	3.66 flatted to 3.56
DIMENSION BETWEEN PINS	66.81/66.74



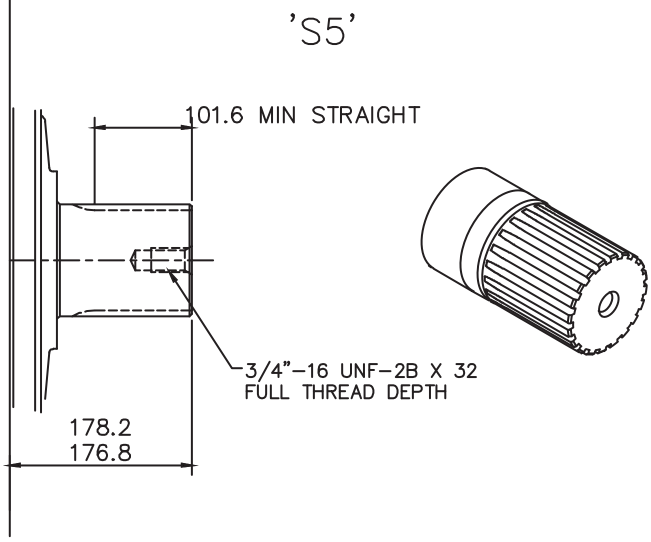
3-6 HPB325 (cont)

HPB325 - 'P2' & 'S5' Shafts



SPLINE DATA

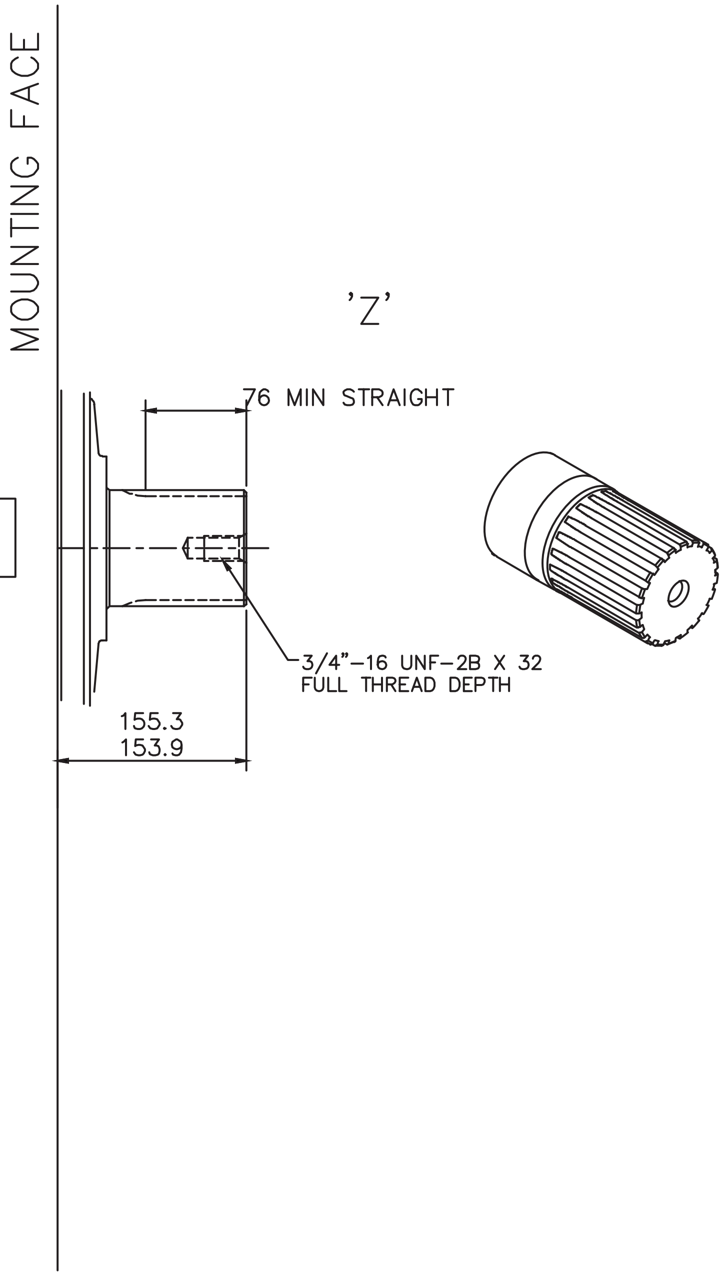
'S3'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	23
PITCH	6/12
MAJOR DIAMETER	100.653/100.526
FORM DIAMETER	92.939
MINOR DIAMETER	92.184/91.625
PIN DIAMETER	8.128
DIAMETER OVER PINS	109.573/109.517



3-6 HPB325 (cont)

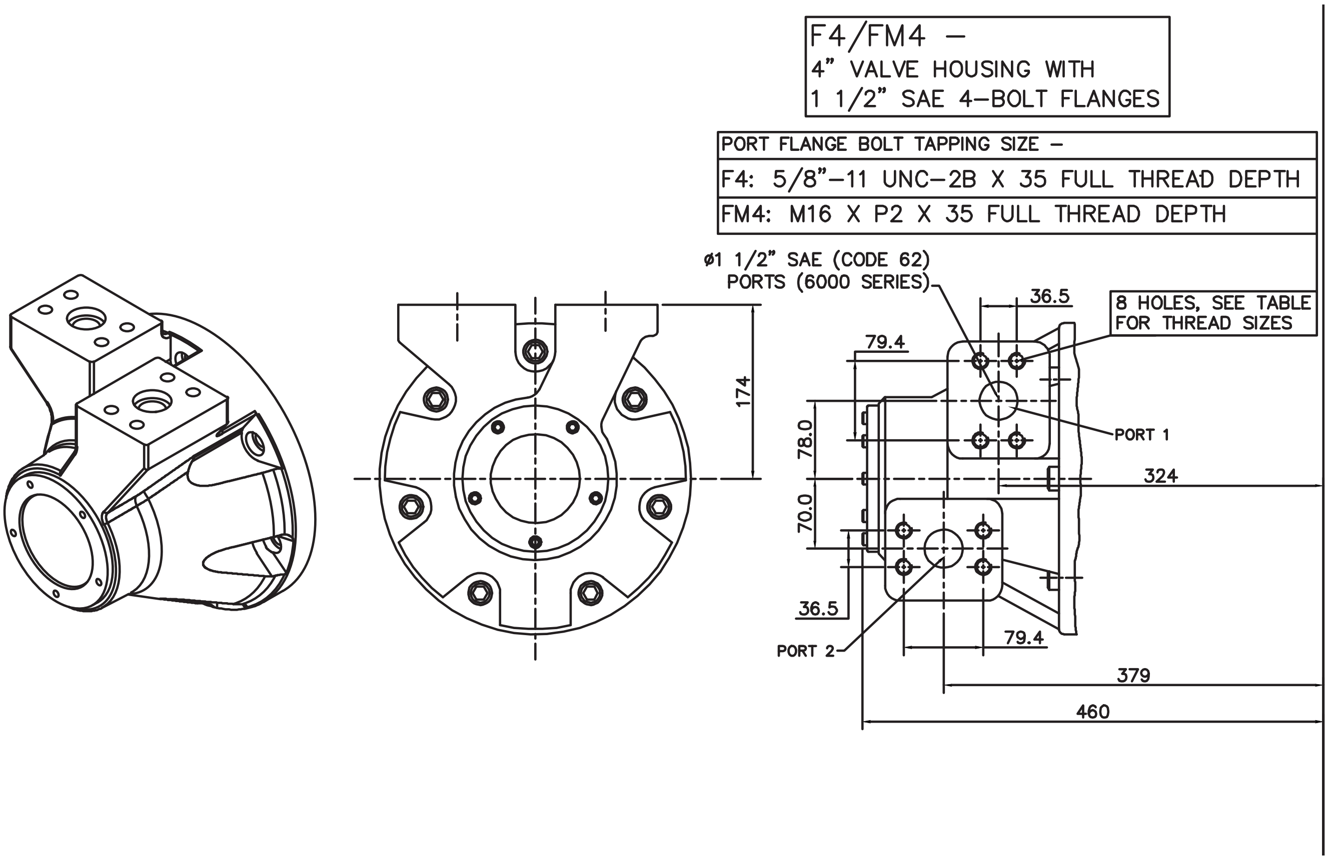
HPHDB325 - 'Z' Shaft

'Z'
DIN 5480 W100 x 4 x 24 x 7h



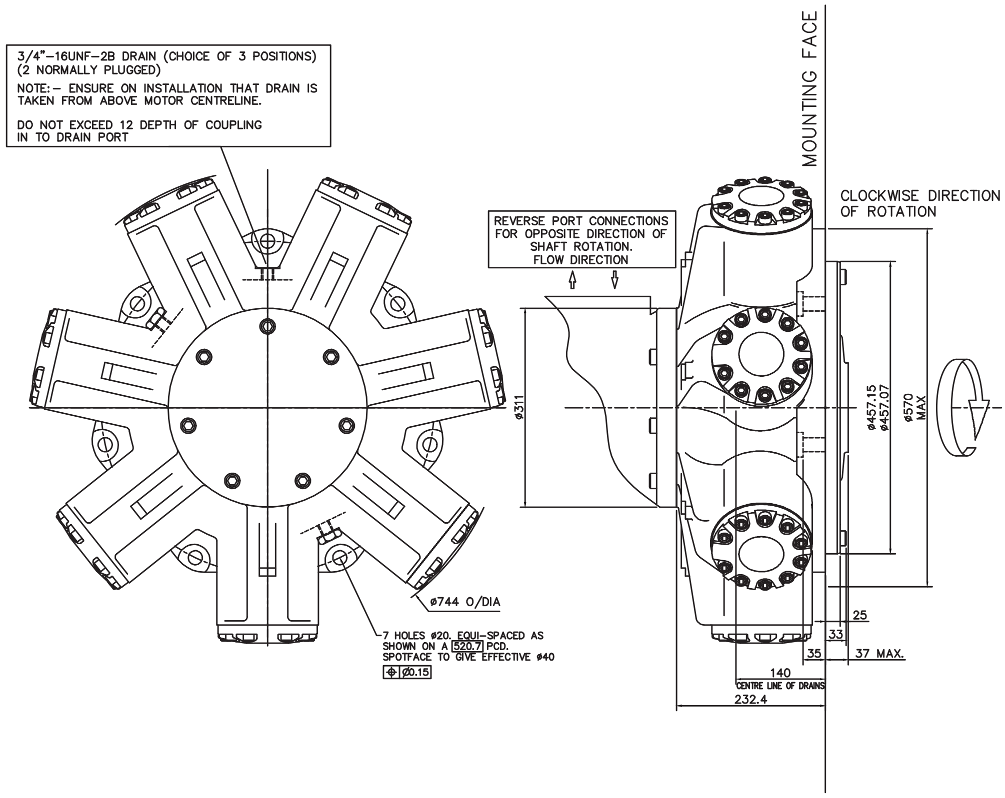
3-6 HPB325 (cont)

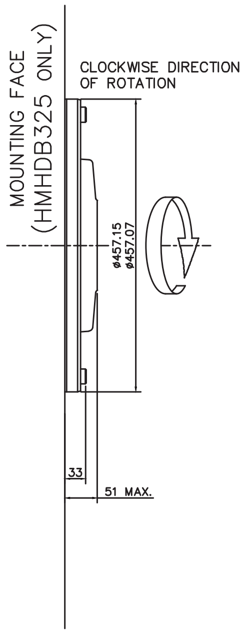
'F4' & 'FM4' Valve Housings



3-6 HPB325 (cont)

Installation





NOTES

Conversion Table

Pressure	
bar	PSI
1	14.5
Flow	
l/min	gal/min
1	0.264 US
1	0.219 UK
Length	
mm	inch
25.4	1
Torque	
Nm	lbf ft
1	1.737
Power	
kW	hp
1	1.341
Mass	
kg	lb
1	2.2

NOTES

NOTES

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The specified data is for product description purposes only and may not be deemed to be guaranteed unless expressly confirmed in the contract.

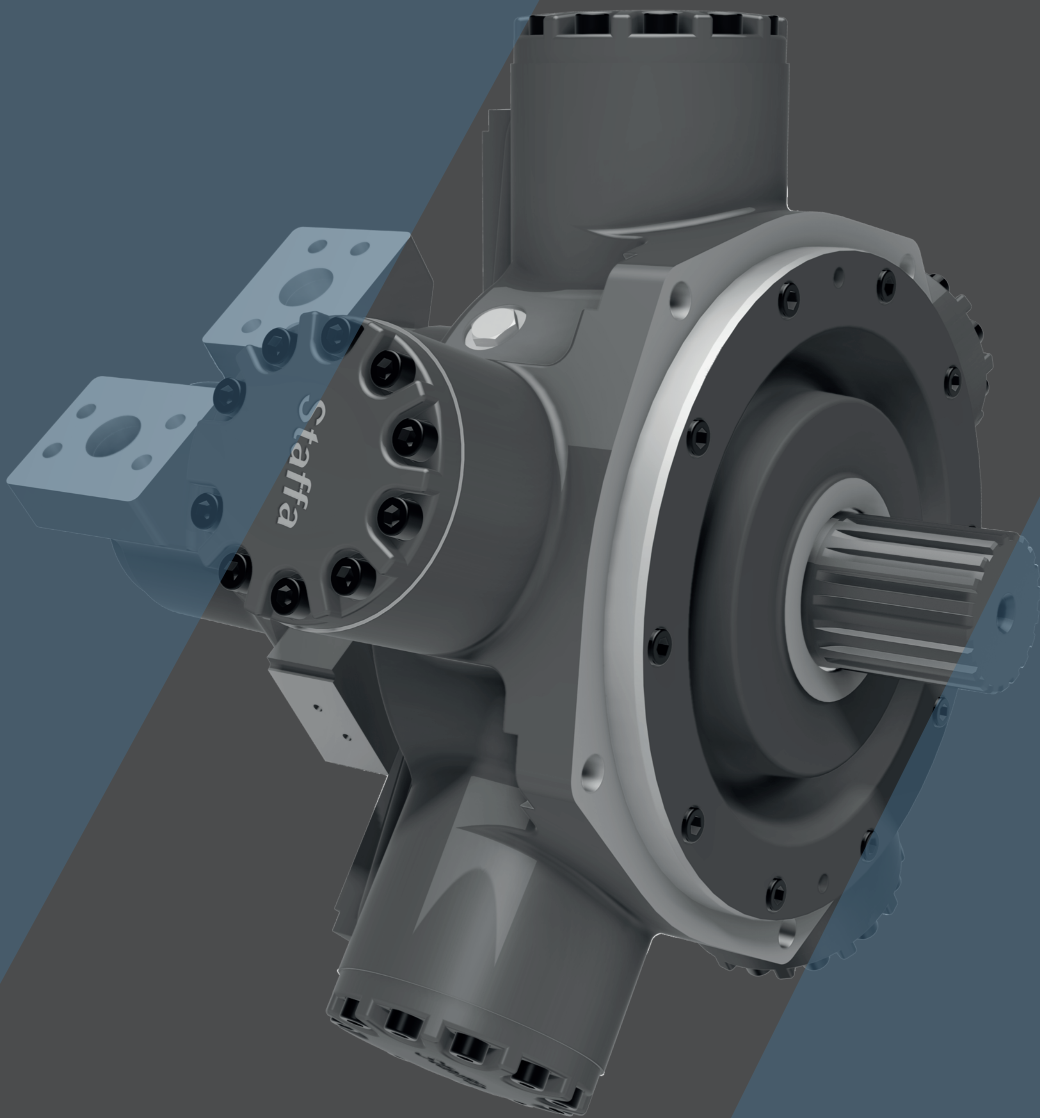
Data sheet: M-10.18

Kawasaki
Powering your potential

Precision Machinery Company

Dual Displacement Radial Piston High Power Staffa Motor

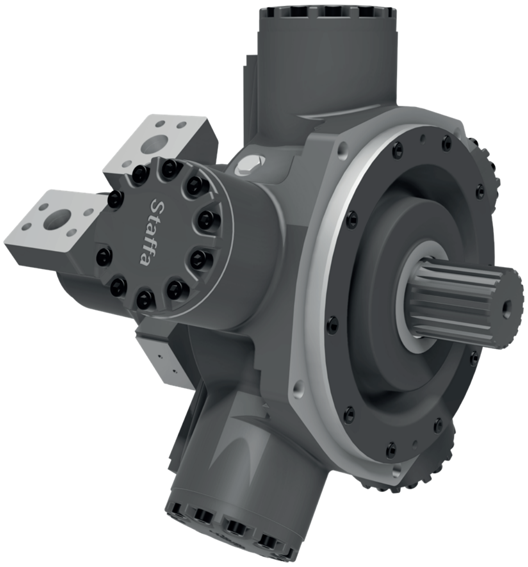
HPC Series



CONTENTS

HPC Series

Dual Displacement Radial Piston Hydraulic Motor



General Descriptions

The enhanced version of the standard C series motor includes special low friction components combined with crankcase flushing flow to achieve increased shaft power.

The range of HP motors extends from the HPC080 of 1,600 cc/rev to the HPC325 of 5326 cc/rev. There are 5 frame sizes in this product range for performance details see table below:

Motor Type	Max. Torque @275 bar (Nm)	Continuous shaft power with flushing (kW)	Continuous shaft power without flushing (kW)
HPC080	6,630	165	138
HPC125	8,470	202	135
HPC200	12,980	261	174
HPC270	19,280	278	189
HPC325	22,440	278	189

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 HPC 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 mounted or directly on the motor. Motor displacement can be changed with ease when the motor is running.

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

Other mounting options are available on request to match many of the competitor interfaces.variable version using either hydro-mechanical or electro-hydraulic control methods.

Features

Enhanced power performance

Increased speed

Improved starting and running efficiency

Increased back pressure capability

Speed sensing options

High torques at low speed

Smooth running

Wide range of displacements to suit specific applications

Displacement changes with ease when the motor is running

Various mounting options

1 Ordering Code

1-1 Model Coding

F11/HPC270/S3 V/250/100/FM3/CS/TJ/ */ P*****

Fluid Type

(refer to page 21 for performance data)	
Blank	Mineral oil
F3	Phosphate ester (HFD fluid)
F11	Water based fluids (HFA, HFB & HFC)
Alternative fluids contact Kawasaki	

Motor Frame Size

080	200	325
125	270	

Shaft Type

See shaft type option list on page 6

Shaft

Vertically Up

High Displacement Code

###	See displacement code details on pages 21 to 26

Low Displacement Code

###	See displacement code details on pages 21 to 26

Special Features

P*****	See options on page 5.
PL***	Non-catalogued features, (*****) = number assigned by Kawasaki as required

Design Series Number

Current series for HPC motors

Tacho Encoder Drive

Blank	None
Tj	Square wave output with directional signal
Tk	Combines Tj with the T401 instrument to give a 4 to 20 mA output proportional to speed. Directional signal and speed relay output.

Displacement Control Ports

Threaded ports/ bi directional shaft rotation	
X	X and Y ports G¼" (BSPF to ISO 228/1)

ISO 4401 size 03 mounting face / bi-directional shaft rotation	
C	No shuttle
CS	With shuttle
ISO4401 size 03 mounting face/uni-directional shaft rotation (viewed on shaft end).	

Main Port Connections

See Port Connection details on page 7

1-1 Model Coding

Special Features Suffix

/ P * * * * *

Shaft Seal Enhancements

A	High pressure shaft seal
B	Improved shaft seal life
C	High pressure shaft seal & improved shaft seal life
0	None

External Protection

A	Anti-pooling bolt heads
B	Marine-specification primer paint
C	Anti-pooling bolt heads & Marine-specification primer paint
0	None

Installation Features

A	Drain port adaptor x 1
B	Drain port adaptor x 2
C	Φ21 mm mounting holes
D	Φ22 mm mounting holes
E	Φ21 mm mounting holes & Drain port adaptor x 1
F	Φ21 mm mounting holes & Drain port adaptor x 2
G	Φ22 mm mounting holes & Drain port adaptor x 1
H	Φ22 mm mounting holes & Drain port adaptor x 2
0	None

Performance Enhancements

A	Increased starting torque
0	None

Valve Enhancements

A	Improved cavitation resistance
B	Anti-clockwise
C	Thermal shock resistance
D	Improved caviation resistance & anti-clockwise
E	Improved cavitation resistance & thermal shock resistance
F	Anti-clockwise & thermal shock resistance
G	Improved cavitation resistance & anti-clockwise & thermal shock resistance
0	None

1-2 Shaft Options

Product type

HPC080

P	=	Parallel keyed 60mm diameter shaft
S	=	Splined shaft 14 teeth BS3550
Z	=	Splined shaft DIN5480 (W70x3x22x7h)
T	=	Long taper keyed shaft- 95.2 key slot

HPC125 & HPC200

P1	=	Parallel keyed 85mm diameter shaft
S3	=	Splined shaft 20 teeth BS3550
S4	=	Splined shaft 16 teeth BS3550
Z3	=	Splined shaft DIN5480 (W85x3x27x7h)
T	=	Long taper keyed shaft - 133.4 key slot

HPC270 & HPC325

P1	=	Parallel keyed 85mm diameter shaft
S3	=	Splined shaft 20 teeth BS3550
Z4	=	Splined shaft DIN5480 (W90x4x21x7h)
T	=	Long taper keyed shaft - 133.4 key slot

Note:
For installations where the shaft is vertically upwards specify “V” after the shaft type designator so as to ensure that an additional high level drain port is provided within the front cover of the motor.

1-3 Main Port Connections

Product type

HPC080

F3	=	1¼" SAE 4-bolt flange
FM3	=	1¼" SAE 4-bolt flange
F4	=	SAE 1½" 4-bolt UNC flanges
FM4	=	SAE 1½" 4-bolt metric flanges

HPC125

F3	=	3000 series SAE 4-bolt flange
FM3	=	SAE 1½" 4-bolt UNC flanges
F4	=	SAE 1½" 4-bolt UNC flanges
FM4	=	SAE 1½" 4-bolt metric flanges

HPC200

F3	=	1¼" SAE 61 4-bolt flange
FM3	=	1¼" SAE 61 4-bolt flange
F4	=	SAE 1½" 4-bolt UNC flanges
FM4	=	SAE 1½ 4-bolt metric flanges

HPC270

F4	=	1½" SAE code 62 4-bolt flange
FM4	=	1½" SAE code 62 4-bolt flange

HPC325

F4	=	1½" SAE code 62 4-bolt flange
FM4	=	1½" SAE code 62 4-bolt flange

See pages 40 to 67 for full dimensionsal details

1-4 Special Features

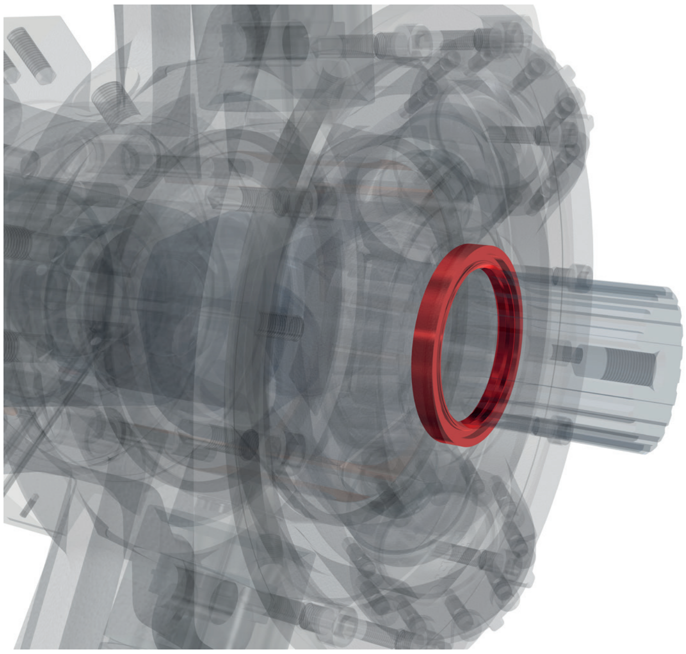
Feature	Page	HPC080	HPC125	HPC200	HPC270	HPC325
High Pressure Shaft Seal	9	●	●	●	●	●
Improved Shaft Seal Life	10	●	●	●	●	●
Improved Cavitation Resistance	11	●	●	●	●	●
Anti-pooling Bolt Heads	12	●	●	●	●	●
Increased Starting Torque	13	●	●	●	●	●
Anti-clockwise Rotation	15	●	●	●	●	●
Thermal Shock Resistance	16	●	●	●	●	●
Drain Port Adaptor - ½" BSPP	18	●	●	●	●	●
Φ21mm Mounting Holes	19	●	●	●	●	●
Φ22mm Mounting Holes	19	●	●	●	●	●
Marine-specification Primer Paint	20	●	●	●	●	●

● Available
○ Not available

If a motor is to be ordered with any special features listed, please contact Kawasaki.

1-4 Special Features

High Pressure Shaft Seal



Description:

> 10 bar rated

> Recommended for cold climates

> Rugged steel and PTFE construction

Technical Information

Where crankcase pressure will be higher than 3.5 bar, the high pressure shaft seal should be selected.

Case pressure	≤ 10 bar
Non-operating temperature limits	Below -30°C and above 120°C
Minimum operating temperature	-15°C
Maximum operating temperature	80°C
Minimum viscosity	2,000 cSt
Maximum viscosity	150 cSt

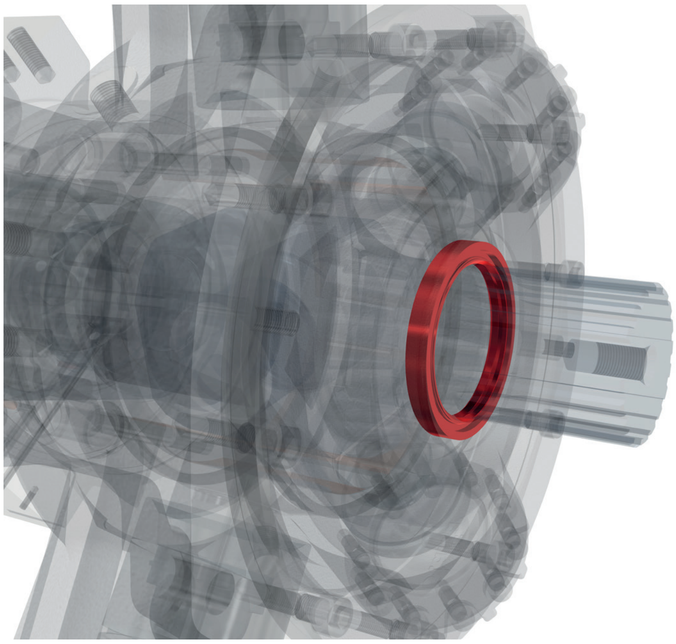
Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Improved Shaft Seal Life



Description:

> Stainless steel sleeve prevents corrosion

> Improved wear resistance

> Recommended for corrosive environments

Technical Information

A well-established method of increasing rotary seal life in corrosive environments is to fit a thin-walled, stainless steel sleeve to the rotating shaft to provide a corrosion-resistant, wear-resistant counterface surface for the seal to run against. All HPC motors can be fitted with such sleeves upon request.

Sleeve material	A304/301 Stainless Steel
Sleeve surface finish	R_a 0.25 to 0.5 µm (10 to 20 µin)

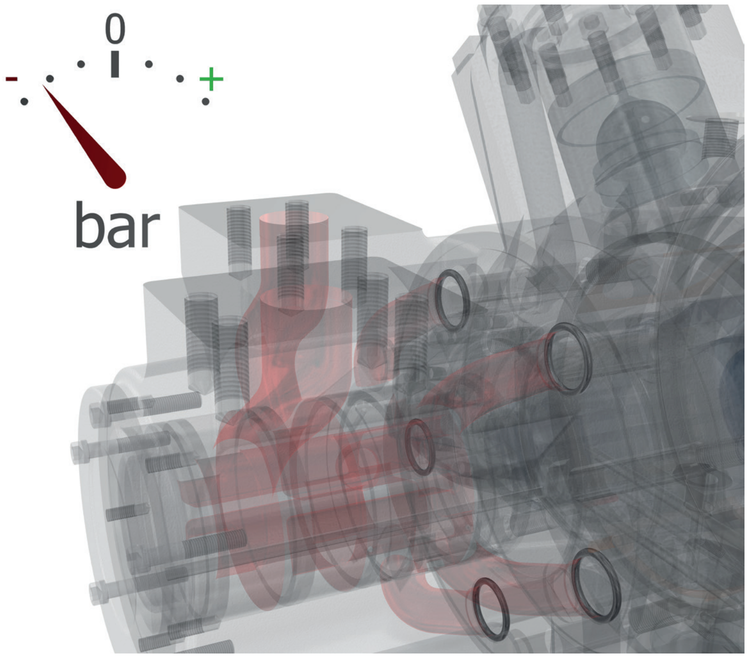
Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Improved Cavitation Resistance



Description:

> **Recommended for overunning applications**

> **Protects against seal damage for short periods of operation in vacuum inlet conditions.**

Cavitation can occur due to many different factors. Although it is not possible to make the HMC motor resistant to cavitation, certain features can be added to improve the motor's resistance to short periods of lost port pressure.

In applications where the HPC motor can be driven (like a pump) a risk arises that insufficient fluid will be provided to maintain a positive pressure at both main ports of the motor causing cavitation. The results of extended running at these conditions can be catastrophic to the motor's function.

The improved cavitation resistance feature should be considered where:

- Overrunning conditions may occur (load driving the motor)
- Loss of main port pressure while motor is rotating

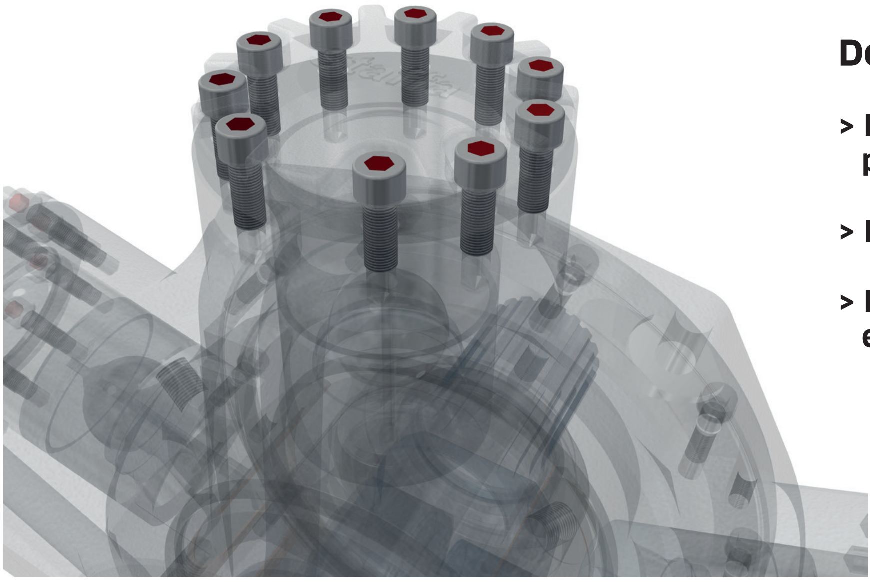
Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Anti-pooling Bolt Heads



Description:

> Removes potential for water pooling

> Improved corrosion resistance

> Recommended for marine environments

Technical Information

In many marine applications, water pooling in socket head cap screw heads presents a significant corrosion risk. Corroded cap screws can make service and repair of affected units impossible.

To significantly reduce the risk of water damage through pooling, HPC motors can be supplied with silicone filler in all the bolt heads.

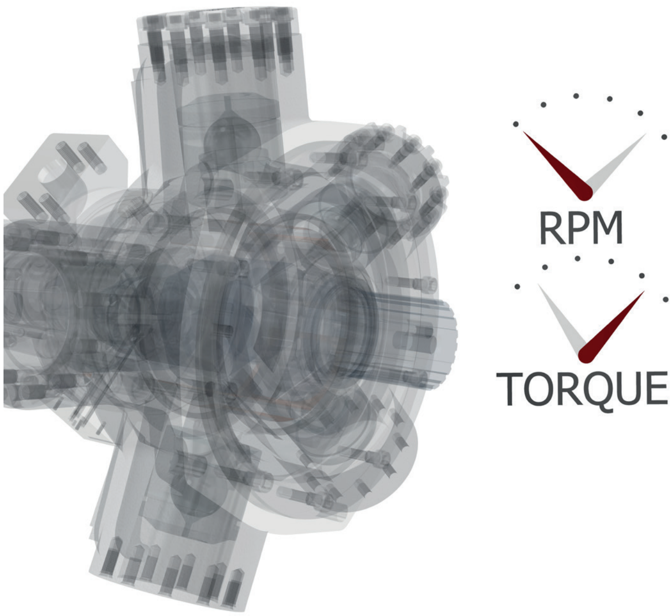
Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Increased Starting Torque



Description:

> Optimised for high break-out torque

> Recommended for low speed operation

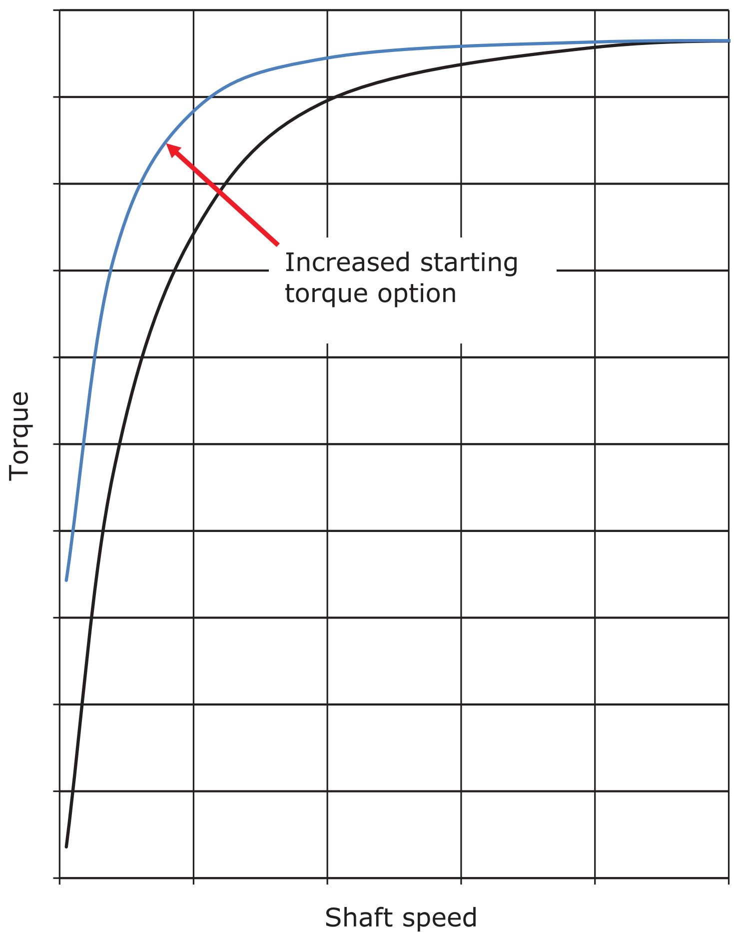
> Improved service life for low speed applications

Technical Information

If an application demands the drive motor be run at speeds of less than 10 rpm for most of the duty cycle, or involves frequent start/stop or forward/reverse operation, the Staffa HMC motor range has it covered.

By optimising the HPC motor's design for low speeds, it is possible to increase the break out torque and low speed mechanical efficiency performance.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.



1-4 Special Features

Increased Starting Torque (cont)

Volumetric Performance

In order to achieve increased torque at low speeds the volumetric characteristics of the motor performance are changed.

When calculating leakage and volumetric efficiency use the constants shown here in place of those given for the standard motor on page 27.

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HPC080	1,344	16.26	45.70	9.65	14.66
HPC125	2,048	12.86	38.50	4.55	11.01
HPC200	3,087	12.86	38.50	3.02	11.01
HPC270	4,588	13.26	37.30	2.41	12.76
HPC325	5,326	13.26	40.00	2.08	12.76

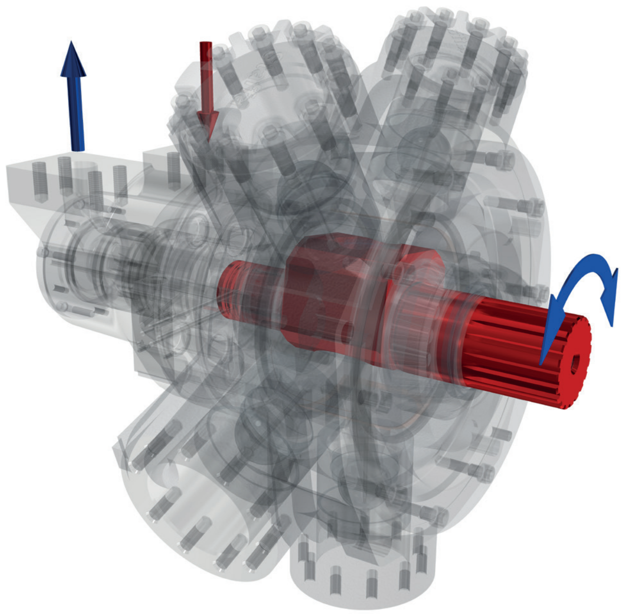
Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Anti-Clockwise Rotation



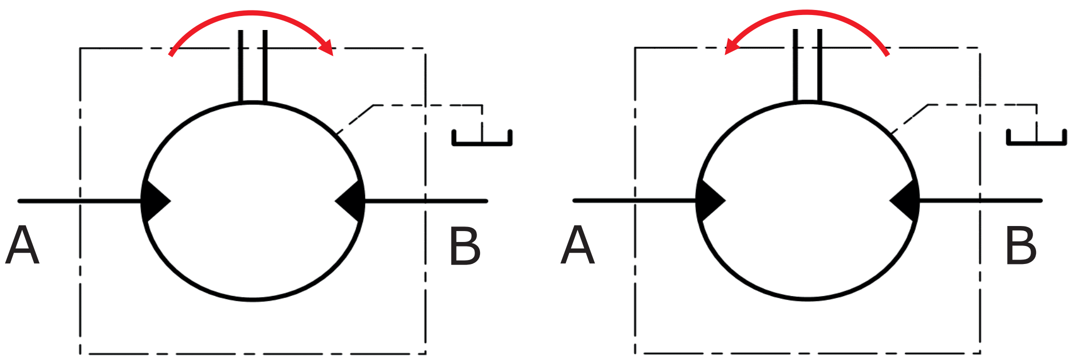
Description:

> Reduce installation complexity

> Standardise equipment designs

Technical Information

All HPC motors can be specified with an anti-clockwise rotation valve configuration. All performance and volumetric characteristics remain unchanged.



Standard motor   Anti-clockwise motor

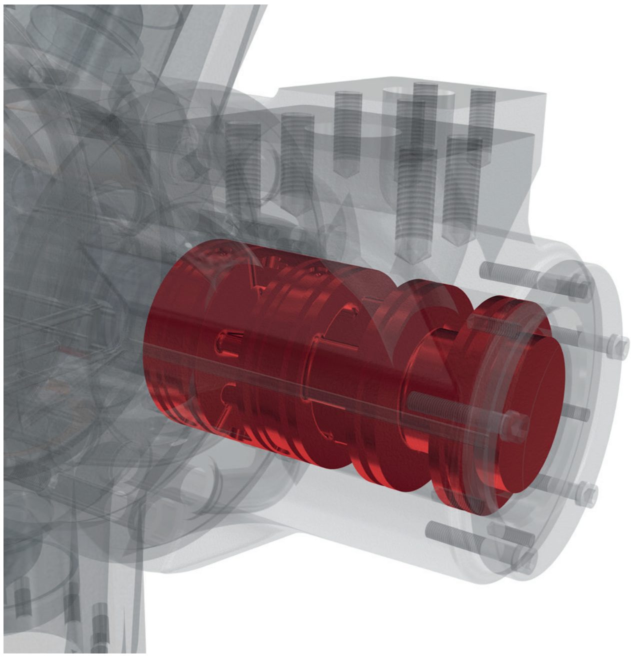
Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Thermal Shock Resistance



Description:

> Recommended for cold climates

> Optimised for start-up in freezing temperatures

> Engineered for total peace of mind

Technical Information

Starting up a cold system with warm hydraulic fluid is a known cause of heavy wear and potential seizure of hydraulic machinery. To minimise this potential risk, the HPC motor can be configured to combat thermal shocks to give complete peace of mind when operating in very cold climates.

Volumetric Performance

In order to provide thermal shock resistance the volumetric characteristics of the motor performance are changed. When calculating leakage and volumetric efficiency use the constants shown on the next page in place of those given for the standard motor on page 27.

All figures given in Section 2-1 Performance Data are still valid when selecting this feature.

Note:
When operating at low temperature, consideration must be given to the guidance notes in Section 2-9 Motor Operation at Low Temperature (see page 36).

1-4 Special Features

Thermal Shock Resistance (cont)

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
	cc/rev	K1	K2	K3	K4
HPC080	1,344	11.10	45.70	6.99	7.90
HPC125	2,048	7.70	38.50	3.78	4.25
HPC200	3,087	7.98	38.50	2.61	4.25
HPC270	4,588	8.38	37.30	1.91	6.00
HPC325	5,326	8.38	40.00	1.65	6.00

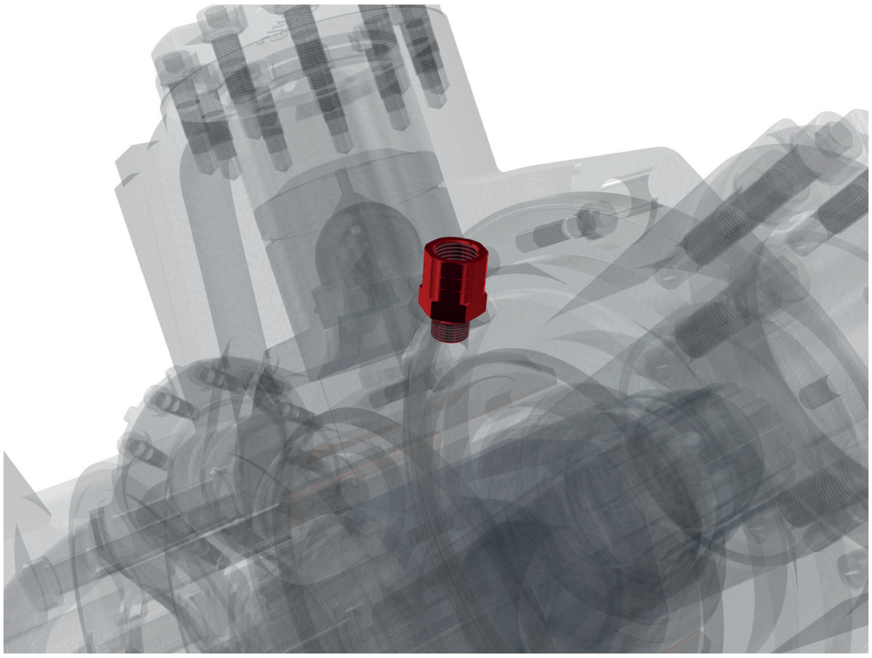
Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Drain Port Adaptors



Description:

> **Improves manufacturing logistics**

> **Motor supplied ready for connection to 1½" BSPP male fitting**

Technical Information

Motor Type	Adaptor Supplied
HMC030	¾" UNF 2B to ½" BSPP
HMC045	¾" UNF 2B to ½" BSPP
HMC080	¾" UNF 2B to ½" BSPP
HM(HD)C125	¾" UNF 2B to ½" BSPP
HM(HD)C200	¾" UNF 2B to ½" BSPP
HM(HD)C270	¾" UNF 2B to ½" BSPP
HM(HD)C325	¾" UNF 2B to ½" BSPP

One or two drain adaptors can be supplied.

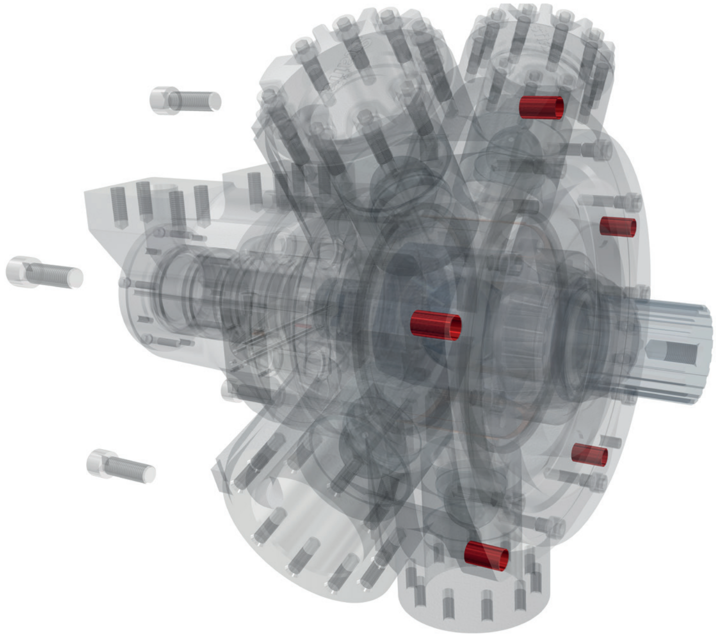
Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Mounting Hole Diameter



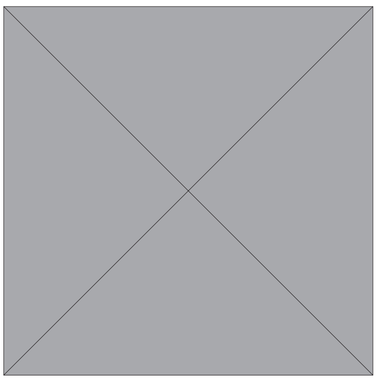
Description:

> **Matching mounting holes to bolts**

> **Φ21mm and Φ22mm options available**

Technical Information

In different markets, different bolt standards are adopted which may not be best suited to the standard Φ20 mm mounting hole diameter on the HMC motors. To give a correct fit and optimum installation, Φ21 mm or Φ22 mm holes can be selected.



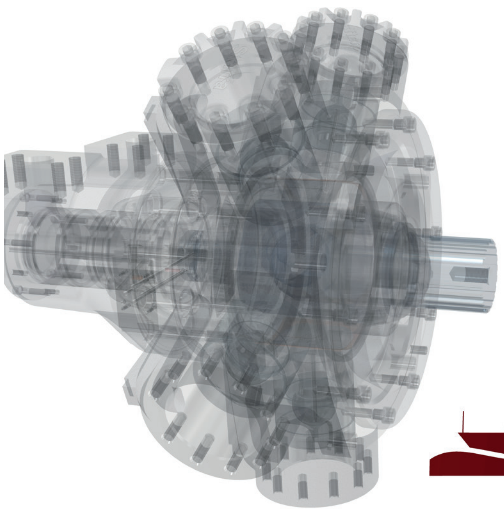
Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

1-4 Special Features

Marine Specification Primer Paint



Description:

- > Improves corrosion and water resistance of the finishing system
- > Excellent adhesion strength
- > Recommended for marine applications

Technical Information

Colour	Red oxide
Type	Single pack epoxy etching primer
Standard	BS 3900 part A 8
Dry film thickness	> 12 μm

Applicable to:

HPC080	HPC125	HPC200	HPC270	HPC325
●	●	●	●	●

Please contact Kawasaki to order this feature.

2-1 Performance Data

Performance data is valid for the range of HPC motors when fully run-in and operating with mineral oil.

The appropriate motor displacements can be selected using performance data shown on pages 22 to 26. Refer to the table on this page for pressures and speed limits when using fire-resistant fluids.

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

Intermittent max pressure: 275 bar.

This pressure is allowable on the following basis:

a) Up to 50 rpm 15% duty for periods up to 5 minutes maximum.
b) Over 50 rpm 2% duty for periods up to 30 seconds maximum.

Static pressure to DNV rules 380 bar.

Limits for fire resistant fluids

Fluid Type	Continuous Pressure (bar)	Intermittent Pressure (bar)	Max Speed (rpm)	Model Type
HFA 5/95 oil-in-water emulsion	130	138	50% of limits of mineral oil	All models
HFB 60/40 water-in-oil emulsion	138	172	As for mineral oil	All models
HFC water glycol	103	138	50% of limits of mineral oil	All models
HFD phosphate ester	250	293	As for mineral oil	All models

2-1 Performance Data (cont)

HPC080 Motor (crankcase flushing required)

Displacement Code		97.6	90	85	80	75	70	65	60	55	50
Displacement	cc/rev	1,600	1,475	1,393	1,311	1,229	1,147	1,065	983	901	819
Average actual running torque	Nm/bar	24.1	22.2	20.9	19.7	18.4	17.1	15.9	14.6	13.2	11.9
Average actual mechanical efficiency	%	94.5	94.5	94.3	94.2	94.0	93.8	93.5	93.0	92.2	91.5
Average actual starting torque	Nm/bar	22.0	20.1	18.8	17.6	16.3	15.1	13.9	12.6	11.2	9.9
Average actual starting efficiency	%	86.2	85.7	84.9	84.1	83.4	82.6	81.5	80.1	78.2	75.8
Max continuous speed (F3/FM3)	rpm	270	300	320	340	365	390	420	450	475	500
Max continuous speed (F4/FM4)	rpm	365	400	415	430	445	460	475	490	500	515
Max continuous power (F3/FM3)	kW	165	157	152	147	145	140	134	131	125	120
Max continuous power (F4/FM4)	kW	165	157	152	147	145	140	134	131	125	120
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275	275

Displacement Code		45	40	35	30	25	20	15	10	00
Displacement	cc/rev	737	655	574	492	410	328	246	164	0
Average actual running torque	Nm/bar	10.6	9.3	8.0	6.6	5.3	4.1	2.8	1.6	0
Average actual mechanical efficiency	%	90.4	89.1	87.2	84.8	81.8	77.7	71.0	60.2	0
Average actual starting torque	Nm/bar	8.5	7.2	5.9	4.5	3.3	2.0	0.7	/	0
Average actual starting efficiency	%	72.6	68.7	63.8	57.9	50.8	38.0	17.5	/	0
Max continuous speed (F3/FM3)	rpm	550	600	615	630	630	630	630	630	1,500
Max continuous speed (F4/FM4)	rpm	530	545	560	575	585	600	615	630	1,500
Max continuous power (F3/FM3)	kW	113	105	90	73	59	43	30	14	0
Max continuous power (F4/FM4)	kW	113	105	90	73	59	43	30	14	0
Max continuous pressure	bar	250	250	250	250	250	250	250	250	17
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	17

Data shown is at 207 bar. Intermediate displacements can be made available to special order.

** See page 32: small displacements. ** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HPC125 Motor (crankcase flushing required)

Displacement Code		125	120	110	100	90	80	70
Displacement	cc/rev	2,048	1,966		1,639	1,475	1,311	1,147
Average actual running torque	Nm/bar	30.8	29.5	27.1	24.5	21.8	19.1	16.5
Average actual mechanical efficiency	%	94.5	94.4	94.3	94.0	93.0	91.7	90.3
Average actual starting torque	Nm/bar	26.4	25.0	22.5	20.0	17.4	14.7	12.0
Average actual starting efficiency	%	810	80.1	78.4	76.6	74.2	70.6	65.4
Max continuous speed (F3/FM3)	rpm	215	225	240	270	300	340	390
Max continuous speed (F4/FM4)	rpm	300	310	340	365	400	430	460
Max continuous power (F3/FM3)	kW	173	173	171	170	157	147	123
Max continuous power (F4/FM4)	kW	202	196	183	171	157	147	123
Max continuous pressure	bar	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275

Displacement Code		60	50	40	30	20	10	00
Displacement	cc/rev	983	819	655	492	328	164	0
Average actual running torque	Nm/bar	13.8	11.3	8.8	6.4	4.1	0.8	0
Average actual mechanical efficiency	%	88.5	86.5	84.3	81.6	78.0	30.0	0
Average actual starting torque	Nm/bar	9.1	6.3	3.2	/	/	/	0
Average actual starting efficiency	%	58.1	48.3	30.6	/	/	/	0
Max continuous speed (F3/FM3)	rpm	450	500	600	630	630	630	1,500
Max continuous speed (F4/FM4)	rpm	490	515	545	575	600	630	1,500
Max continuous power (F3/FM3)	kW	101	86	65	48	30	5	0
Max continuous power (F4/FM4)	kW	101	86	65	48	30	5	0
Max continuous pressure	bar	250	250	250	250	250	250	17
Max intermittent pressure	bar	275	275	275	275	275	275	17

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 32: small displacements. ** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HPC200 Motor (crankcase flushing required)

Displacement Code		188	180	170	160	150	140	130	120	110	100
Displacement	cc/rev	3,067	2,950	2,790	2,620	2,460	2,290	2,130	1,970	1,800	1,639
Average actual running torque	Nm/bar	47.2	45.2	42.6	40.0	37.3	34.7	32.0	29.4	26.7	24.1
Average actual mechanical efficiency	%	96.3	96.2	96.0	95.8	95.4	95.0	94.5	94.0	93.2	92.5
Average actual starting torque	Nm/bar	42.6	40.6	38.0	35.5	33.0	30.6	28.0	25.5	22.9	20.2
Average actual starting efficiency	%	87.0	86.4	85.7	85.1	84.5	83.8	82.8	81.5	79.8	77.5
Max continuous speed (F3/FM3) rpm		175	180	190	195	200	205	210	225	240	270
Max continuous speed (F4/FM4) rpm		230	235	240	245	250	265	285	310	340	365
Max continuous power	kW	216	213	212	204	195	186	176	173	171	170
Max intermittent power	kW	261	261	261	247	234	222	208	196	183	171
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275	275

Displacement Code		90	80	70	60	50	40	30	20	10	00
Displacement	cc/rev	1,475	1,311	1,150	983	820	655	492	328	164	0
Average actual running torque	Nm/bar	21.5	18.9	16.3	13.8	11.3	8.8	6.4	4.2	1.0	0
Average actual mechanical efficiency	%	91.5	90.5	89.4	88.0	86.3	84.5	82.4	80.0	40.0	0
Average actual starting torque	Nm/bar	17.5	14.8	12.0	9.4	6.0	3.4	/	/	/	0
Average actual starting efficiency	%	74.5	70.7	65.9	60.1	45.7	33.1	/	/	/	0
Max continuous speed (F3/FM3) rpm		300	340	390	450	500	600	630	630	630	1,500
Max continuous speed (F4/FM4) rpm		400	430	460	485	515	545	575	600	630	1,500
Max continuous power	kW	157	147	123	101	86	65	48	30	5	0
Max intermittent power	kW	157	147	123	101	86	65	48	30	5	0
Max continuous pressure	bar	250	250	250	250	250	250	250	250	250	17
Max intermittent pressure	bar	275	275	275	275	275	275	275	275	275	17

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 32: small displacements. ** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HPC270 Motor (crankcase flushing required)

Displacement Code		280	250	220	200	180	160	140	120
Displacement	cc/rev	4,588	4,097	3,605	3,277	2,950	2,622	2,294	1,966
Average actual running torque	Nm/bar	70.1	62.3	54.5	49.3	44.3	39.0	33.8	28.6
Average actual mechanical efficiency	%	96.0	95.6	95.2	94.6	94.3	93.5	92.5	91.5
Average actual starting torque	Nm/bar	64.0	56.6	48.9	43.6	38.4	33.2	28.3	23.5
Average actual starting efficiency	%	87.6	86.9	85.2	83.7	81.8	79.7	77.5	75.1
Max continuous speed	rpm	150	160	170	175	210	230	275	310
Max continuous power	kW	278	261	241	225	208	192	174	156
Max continuous pressure	bar	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275

Displacement Code		100	80	60	40	30	20	00
Displacement	cc/rev	1,639	1,311	983	655	492	328	00
Average actual running torque	Nm/bar	23.5	18.4	13.4	8.6	6.3	4.0	0
Average actual mechanical efficiency	%	90.0	88.0	85.5	82.0	80.0	76.0	0
Average actual starting torque	Nm/bar	19.0	14.7	9.1	4.3	1.9	/	0
Average actual starting efficiency	%	72.6	70.2	57.8	40.7	23.5	/	0
Max continuous speed	rpm	375	430	460	490	515	545	1,500
Max continuous power	kW	133	109	85	56	39	21	0
Max continuous pressure	bar	250	250	250	250	250	250	17
Max intermittent pressure	bar	275	275	275	275	275	275	17

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 32: small displacements.*

*** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-1 Performance Data (cont)

HPC325 Motor (crankcase flushing required)

Displacement Code		325	310	300	220	200	180	160	140
Displacement	cc/rev	5,326	5,080	4,916	3,605	3,277	2,950	2,622	2,294
Average actual running torque	Nm/bar	81.6	77.8	75.2	54.5	49.3	44.1	38.8	33.6
Average actual mechanical efficiency	%	96.3	96.2	96.1	95.0	94.6	94.0	93.1	92.1
Average actual starting torque	Nm/bar	74.5	71.1	68.7	49.0	43.9	38.8	33.8	28.8
Average actual starting efficiency	%	87.9	87.9	87.8	85.4	84.2	82.8	81.0	78.9
Max continuous speed	rpm	130	135	140	170	190	215	230	275
Max continuous power	kW	278	278	278	241	225	208	192	174
Max continuous pressure	bar	250	250	250	250	250	250	250	250
Max intermittent pressure	bar	275	275	275	275	275	275	275	275

Displacement Code		120	100	95	80	60	40	30	00
Displacement	cc/rev	1,966	1,639	1,557	1,311	983	655	492	0
Average actual running torque	Nm/bar	28.5	23.3	22.0	18.2	13.2	8.5	6.3	0
Average actual mechanical efficiency	%	91.0	89.2	88.8	87.2	84.6	81.6	80.0	0
Average actual starting torque	Nm/bar	24.0	19.3	18.1	14.8	9.0	4.2	1.9	0
Average actual starting efficiency	%	76.5	73.8	73.0	70.7	57.8	40.7	23.5	0
Max continuous speed	rpm	330	370	405	440	460	495	515	1,500
Max continuous power	kW	156	133	127	110	86	48	39	0
Max continuous pressure	bar	250	250	250	250	250	250	250	17
Max intermittent pressure	bar	275	275	275	275	275	275	275	17

Data shown is at 250 bar. Intermediate displacements can be made available to special order.

** See page 32: small displacements.*

*** A crankcase flushing flow of 15 l/min is required when freewheeling at 1,500 rpm.*

2-2 Volumetric Efficiency Data

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant
HPC	cc/rev	K_1	K_2	K_3	K_4
HPC080	1,639	9.5	45.7	5.8	7.9
HPC125	2,048	6.1	38.5	3	4.25
HPC200	3,087	6.1	38.5	2	4.25
HPC270	4,310	6.5	37.3	1.5	6
HPC325	5,210	6.8	40	1.3	6

Fluid Viscosity	Viscosity Factor
cSt	Kv
20	1.58
25	1.44
30	1.30
40	1.10
50	1.00
60	0.88

Qt (total leakage) = $[K_1 + n/K_2] \times \Delta P \times Kv \times 0.005$ l/min

Creep speed = $K_3 \times \Delta P \times Kv \times 0.005$ rpm

Crankcase leakage = $K_4 \times \Delta P \times Kv \times 0.005$ l/min

ΔP = differential pressure bar

n = speed rpm

The motor volumetric efficiency can be calculated as follows:

$$\text{Volumetric efficiency (\%)} = \left[\frac{(\text{speed x disp.})}{(\text{speed x disp.}) + Qt}\right] \times 100$$

Example:

HPC200 motor with displacement of 3.087 l/rev.

Speed 60 rpm

Differential pressure 200 bar

Fluid viscosity 50 cSt

Total leakage = $(K_1 + n/K_2) \times \Delta P \times Kv \times 0.005$ l/min

= $(6.1+60/38.5) \times 200 \times 1 \times 0.005$

= 7.7 l/min

$$\text{Volumetric efficiency} = \left[\frac{(60 \times 3.087)}{(60 \times 3.087) + 7.7}\right] \times 100$$

= <u>96%</u>

2-3 Shaft Power Calculation

Example

Firstly, to find the maximum differential pressure ΔP at rated speed:

Select the rated shaft power (W) for the motor from the performance data table (page 24).
This is presented in kilowatts so must be converted to watts (x1000).

Then also take the Actual Average running torque in N.m/bar (T_o) and the rated shaft speed in rpm (n).

$$W = \frac{T_o \cdot \Delta P \cdot 2\pi \cdot n}{60}$$

Or to find maximum ΔP then use:

$$\Delta P = \frac{60 \cdot W}{2\pi \cdot T_o \cdot n}$$

HPC270 example - with a displacement code of 140:

Rated shaft power (W):	174,000
Average actual running torque (Nm/bar):	28.3
Rated shaft speed (rpm):	275

$$\mathbf{\Delta P = \frac{60 \times 189{,}000}{2\pi \times 69.4 \times 150}}$$

<u>ΔP= 213 bar (max.)</u>

Secondly, to find the maximum speed at rated pressure:

$$n = \frac{60 \cdot W}{2\pi \cdot T_o \cdot \Delta P}$$

Rated shaft power (W):	174,000
Average actual running torque (Nm/bar):	28.3
Rated pressure (bar):	250

$$\mathbf{n = \frac{60 \times 174{,}000}{2\pi \times 28.3 \times 250}}$$

<u>n=235 rpm (max.)</u>

In summary, operating the motor within its shaft power limit, at rated speed, would give a maximum pressure of 213 bar, and operating the motor at rated pressure, would give a maximum speed of 235 rpm.

Notes

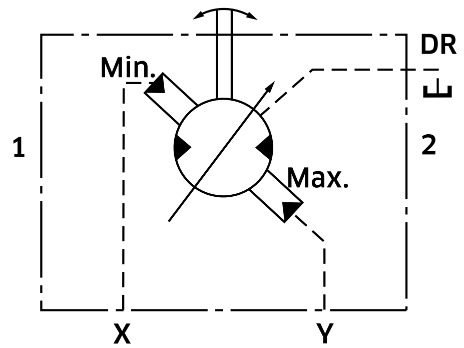
1) The maximum calculated speed is based on a rated inlet pressure of 250 bar.
2) The maximum shaft power is only allowable if the motor drain temperature remains below 80°C.
3) The maximum calculated differential pressure assumes that the low pressure motor port is less than 30 bar.

2-4 Functional Symbols

Example model code:

HPC***/P/***/**/FM3/X/...

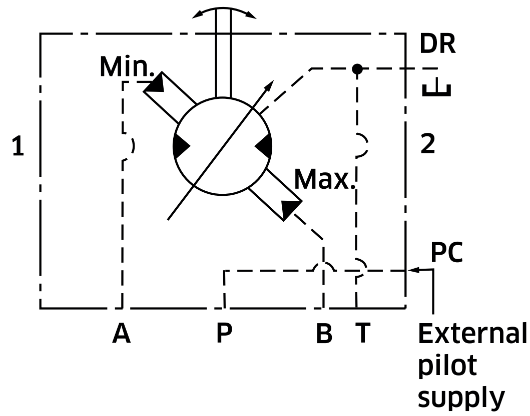
X - external pilot supply to 'X' and 'Y' ports



Example model code:

HPC***/P/***/**/FM3/C/...

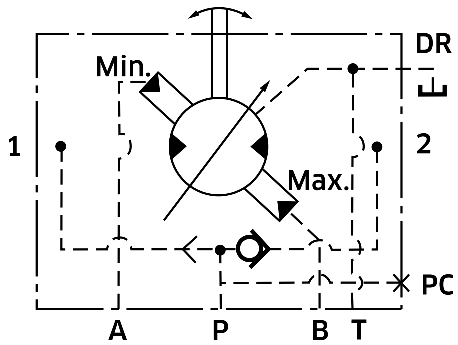
C - single external supply to PC port



Example model code:

HPC***/P/***/**/FM3/CS/...

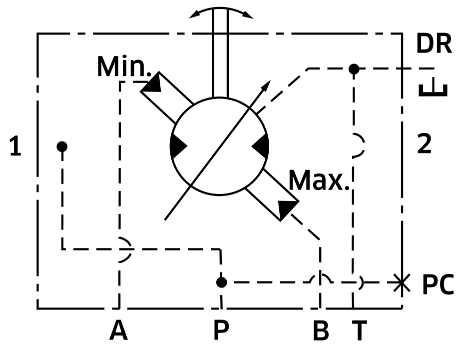
CS - internally shuttled pilot supply



Example model code:

HPC***/P/***/**/FM3/C1/...

C1 - internal pilot supply from port 1 for clockwise rotation only



There is a single port (PC) in the ‘C’ spacer.

Pressure ports in FM3 & FM4 valve housings can be called up as special features when required.

2-5 Stress Limits

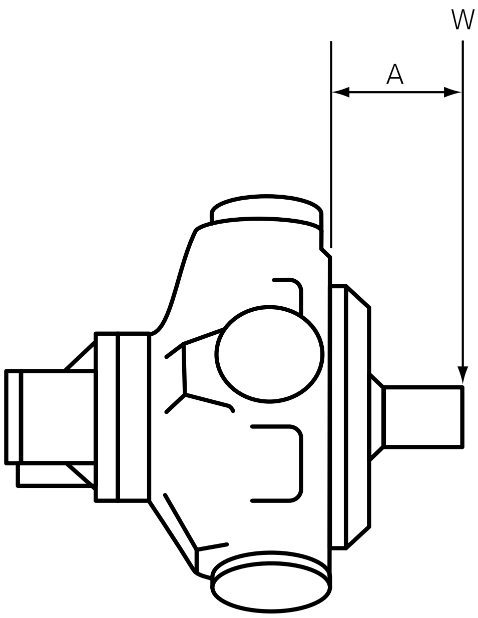
When applying large external radial loads, consideration should also be given to motor bearing lives (see page 33).

Motor Frame Size	Maximum External Radial Bending Moment [kNm]
HPC080	4,500
HPC125	6,500
HPC200	6,750
HPHDC200	12,200
HPC270	8,250
HPHDC270	16,000
HMC325	8,250

Example:

Determine the maximum radial shaft load of a HPC080 motor:

Radial load offset, A = 100 mm
Maximum radial load, W = 4,500 (see table)/100
= 45kN (4,587 kg)



A = Distance from mounting face to load centre (mm)

W = Side load (N)

[Note}
The offset distance A is assumed to be greater than 50 mm. Contact KPM UK if this is not the case.

2-6 Bearing Life Notes

Consideration should be given to the required motor bearing life in terms of baring service life. The factors that will determine bearing life include:

1) Duty cycle - time spent on and off load

2) Speed

3) Differential pressure

4) Fluid viscosity

5) External radial shaft load

6) External axial shaft load

2-7 Circuit and Application Notes

Limits for fire resistant fluids

To select either displacement, a pressure at least equal to 67% of the motor inlet/outlet pressure (whichever is higher) is required. In most applications the motor inlet pressure will be used. If the inlet/outlet pressure is below 3.5 bar, a minimum control pressure of 3.5 bar is required. In the event of loss of control pressure the motor will shift to its highest displacement.

Starting torque

Refer to performance data, (see pages 7 to 13).

Low speed operation

The minimum operating speed is determined by load inertia, drive elasticity, motor displacement and system internal leakage. If the application speed is below 3 rpm, then consult KPM UK.

If possible, always start the motor in high displacement.

Small displacements

The pressures given in the tables on pages 22 to 28 for displacement code “00” are based on 1,000 rpm output shaft speed. This pressure can be increased for shaft speeds less than 1,000 rpm; consult KPM UK for details. Speeds greater than 1,000 rpm may be applied but only after the machine duty cycle has been considered in conjunction with KPM UK. A zero swept volume displacement (for freewheeling requirements) is available on request, consult KPM UK.

High back pressure

When both inlet and outlet ports are pressurised continuously, the lower pressure port must not exceed **70 bar** at any time. Note that high back pressure reduces 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) from the operating formula Boost Formula

$$P = 1 + \frac{N^2 \times V^2}{K} + C$$

Where P is in bar, N = motor speed (rpm), V = motor displacement (cc/rev), C = Crankcase pressure (bar) and K=a constant from the table below:

Motor	Porting	Constant (K)
HPC080	F(M)3	1.6×10^{10}
	F(M)4	3.3×10^{10}
HPC125	F(M)3	1.6×10^{10}
HPC200	F(M)3	1.6×10^{10}
	F(M)4	3.3×10^{10}
HPC270	F(M)4	4.0×10^{10}
HPC325	F(M)4	4.0×10^{10}

2-7 Circuit and Application Notes (cont)

The flow rate of oil for the make-up system can be estimated from the crankcase leakage data (see page 29) plus an allowance for changing displacement:

e.g.

HPC080	To change high to low in 0.25 sec requires 32 l/min
HPC125	To change high to low in 0.5 sec requires 15 l/min
HPC200	To change high to low in 0.5 sec requires 15 l/min
HPC270	To change high to low in 1 sec requires 24 l/min
HPC325	To change high to low in 1 sec requires 20 l/min

Allowances should be made for other systems losses and also for “fair wear and tear” during the life of the motor, pump and system components.

Motorcase pressure

The motorcase pressure should not continuously exceed 3.5 bar with a standard shaft seal fitted. On installations with long drain lines a relief valve is recommended to prevent over-pressurising the seal.

Notes

1) The motorcase 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: 10 bar continuous and 15 bar intermittent.

3) Check installation dimensions (pages 27 to 67) for maximum crankcase drain fitting depth.

Hydraulic Fluids

Dependent on motor (see model code fluid type - page 4) suitable fluids include:

a) Antiwear hydraulic oils

b) Phosphate ester (HFD fluids)

c) Water glycols (HFC fluids)

d) 60/40% water-in-oil emulsions (HFB fluids)

e) 5/95% oil-in-water emulsions (HFA fluids)

Reduce pressure and speed limits, as per table on page 21.

Viscosity limits when using any fluid except oil-in-water (5/95) emulsions are:

Max. off load:	**2,000 cSt** (9270 SUS)
Max. on load:	**150 cSt** (695 SUS)
Optimum:	**50 cSt** (232 SUS)
Minimum:	**25 cSt** (119 SUS)

Mineral oil recommendations

The fluid should be a good hydraulic grade, non-detergent Mineral Oil. It should contain anti-oxidant, antifoam and demulsifying additives. It must contain antiwear or EP additives. Automatic transmission fluids and motor oils are not recommended.

Biodegradable Fluid Recommendations

Well-designed environmentally acceptable lubricants (EALs) may be used with Staffa motors. The EAL must be designed for use in hydraulic systems and have a synthetic ester base. Additives should be as listed for mineral oils, above. The performance of EALs with hydraulic systems vary widely and so checks for seal compatibility, copper alloy compatibility, oxidation resistance and lubrication properties should be carried out before selecting an EAL. For help with EALs please contact KPMUK.

2-7 Circuit and Application Notes (cont)

Temperature limits

Ambient min. -30°C (-22ºF)
Ambient max. +70°C (158ºF)

Max. operating temperature range.

Mineral oil	**Water containing**
Min -20ºC (-4ºF)	+10ºC (50ºF)
Max. +80ºC (175ºF)	+54ºC (130ºF)

Note: To obtain optimum services life from both fluid and hydraulic systems components, a fluid operating temperature of 40ºC is recommended.

Filtration

Full flow filtration (open circuit), or full boost flow filtration (close circuit) to ensure system cleanliness to ISO4406/1986 code 18/14 or cleaner.

Noise levels

The airborne noise level is less than 66.7 dB(A) DIN & dB(A) NFPA through 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.

Polar moment of intertia and mass table

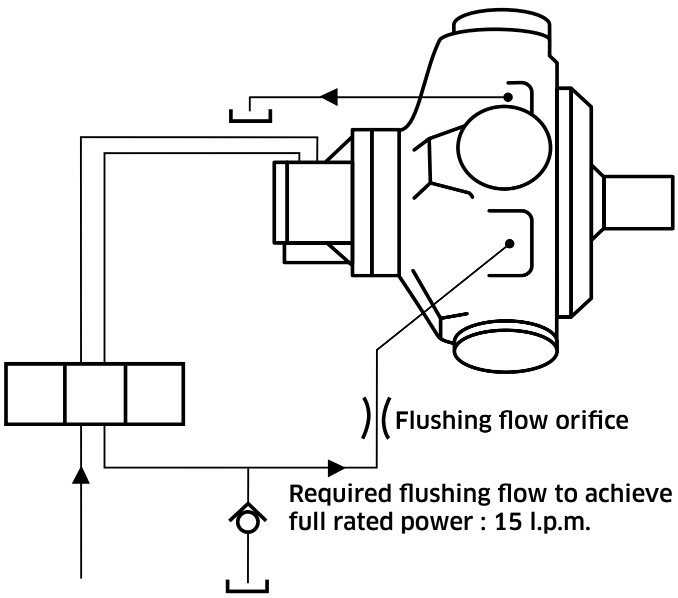
Motor Frame Size	Displacement code	Polar Moment of Intertia (kg.m^2) (Typical data)
HPC080	90	0.0520
	45	0.0440
HPC125	125	0.2000
	50	0.1400
HPC200	188	0.2300
	75	0.1800
HPC270	280	0.4900
	100	0.4700
HPC325	325	0.5000
	100	0.4700

Mass

HPC080 Approx. all models 172 kg.
HPC125 Approx. all models 235 kg.
HPC200 Approx. all models 282 kg.
HPC270 Approx. all models 450 kg.
HPC325 Approx. all models 460 kg.

2-8 Crankcase Flushing Flow

In order to achieve the maximum shaft power, a crankcase flushing flow of 15 l/min should be directed through the motorcase. To improve the cooling effect of flushing flow, the distance between the inlet and outlet drain port connections should be maximised. If a flushing flow is not used, please consult KPM UK to verify performance parameters.



Check valve pressure (bar) *	Orifice diameter (mm)
3	4.4
4	4.1
5	3.9
6	3.7
7	3.6
8	3.5
9	3.4
10	3.3

* This assumes that the crankcase pressure is zero, if not then the check valve pressure will need to be increased to maintain the pressure drop across the orifice.

[Note]

If due to crankcase flushing flow, the crankcase pressure continuously exceeds 3.5 bar, then the motor build should include a high pressure shaft seal.

2-9 Motor Operation at Low Temperature

When operating the motor at low temperature consideration should be given to the fluid viscosity. The maximum fluid viscosity before the shaft should be turned is 2,000 cSt. The maximum fluid viscosity before load is applied to the motor shaft is 150 cSt.

If low ambient temperature conditions exist, then a crankcase flushing flow of at least 5 l/min should be applied to the motor during periods when the motor is not in use.

The shaft seal temperature limits for both medium and high pressure applications are shown in the table below.

	Non-operating temperature limits	Minimum operating temperature
Standard pressure shaft seal	below minus 40°C and above 100°C	minus 30°C
High pressure shaft seal	below minus 30°C and above 120°C	minus 15°C

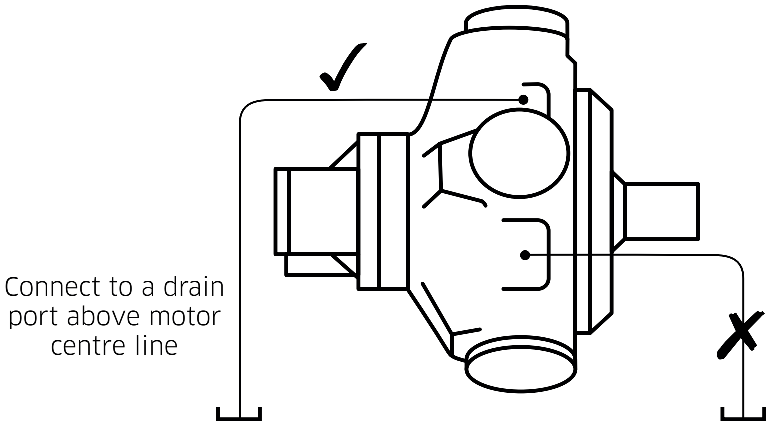
All seals are very brittle below minus 40°C and are likely to break very easily and due to their sluggish response may not provide a 100% leak free condition.

It should be noted that the maximum continuous operating temperature within the motor crankcase is plus 80°C.

2-10 Crankcase Drain Connections

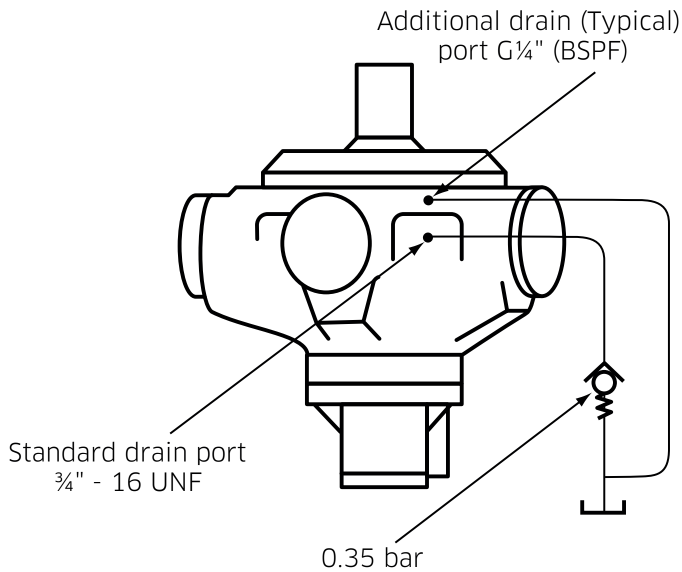
Motor axis - horizontal

The recommended minimum pipe size for drain line lengths up to approx. 5m is 12.0 mm (½") bore. Longer drain lines should have their bore size increased to keep the crankcase pressure within limits.



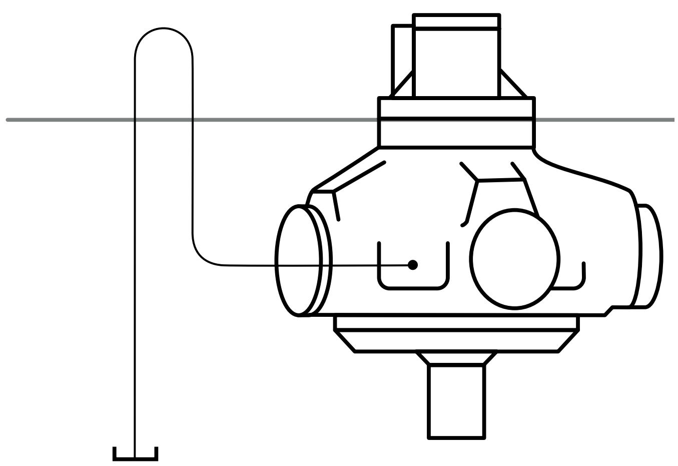
Motor axis - vertical shaft up

Specify "V" within the model code for extra drain port, G¼" (BSPF). Connect this port into the main drain line downstream of a 0.35 bar check valve to ensure good bearing lubrication. The piping arrangement must not allow syphoning from the motorcase. (refer to installation drawing for details).



Motor axis - vertical shaft down

The piping, from any drain port, must be taken above the level of the motorcase to ensure good bearing lubrication. The arrangement must not allow syphoning from the motorcase.



2-11 Freewheeling Notes

All Staffa motors can be used in freewheeling applications. In all circumstances it is essential that the motor is unloaded ("A" and "B" ports connected together) and that the circuit is boosted. The required boost pressure is dependent on both the speed and displacement conditions of the motor determined by the maximum overrunning load condition (see boost pressure calculation method on page 32)

It should be noted that for "B" motors large flows will re-circulate around the motor. This will require a large recirculating valve and consideration of circuit cooling as the motor will be generating a braking torque. It is for these reasons that "C" series motors are the preferred option for freewheeling applications. It is normal to select displacement codes 00, 05 or 10.

Selecting the lowest zero displacement option (00) will allow the motor shaft to be rotated at high speed without pumping fluid and with a minimum boost and drive torque requirement. Consideration must also be given when freewheeling that the load does not drive the motor above its rated freewheeling speed condition. (see pages 22 to 26).

Displacement selection

Under all operating conditions the control pressure port should be at least 67% of the motor inlet/outlet pressure whichever is the higher.

A minimum control pressure at the low displacement selection port of 3.5 bar is necessary to ensure that the motor remains in its minimum displacement condition. A separate pressure supply may be necessary to ensure this condition is always maintained. It should be noted that with the loss of control pressure, the motor will shift to its high displacement condition, which could result in damage to the motor.

Boost requirement

The minimum required boost pressure as noted above can be ascertained utilising the calculation method shown on page 19. The maximum motor and control pressure at 100 rpm is 17 bar and must not be exceeded since higher pressures will increase motor losses at the conrod slipper interface and valve assembly and thereby will significantly increase the motor operating temperature.

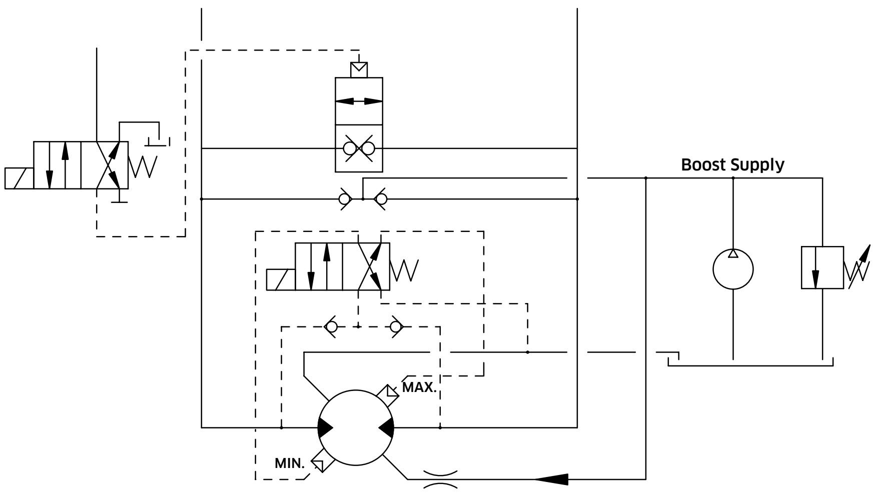
The boost flow required should be sufficient to make-up circuit leakage loss and provide cooling for recirculating flow pressure drop.

Crankcase cooling

A crankcase flushing flow of up to 15 l/min can be used to control and reduce the temperature rise of the motor during the freewheel operation.

This should not be necessary for speeds below 1,000 rpm.

For speeds above this up to 1,500 rpm then crankcase flushing flow must be used.



2-12 Installation Data

General

Spigot

The motor should be located by the mounting spigot on a flat, robust surface using correctly sized bolts.
The diametrical clearance between the motor spigot and the mounting must not exceed 0.15 mm. 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 bolts is as follows:

M18	312 +/_ 7 Nm
⅝" UNF	265 +/_ 14 Nm
M20	407 +/_ 14 Nm
¾" UNF	393 +/_ 14 Nm

Shaft coupling:

Where the motor is solidly coupled to a shaft having independent bearings the shaft must be aligned to within 0.13 mm TIR.

Motor axis - horizontal

The crankcase drain must be taken from a position above the horizontal centre line of the motor, (refer to installation drawing for details).

Motor axis - vertical shaft up

The recommended minimum pipe size for drain line lengths up to approx. 5 m is 12.0 mm as an internal diameter. If using longer drain lines, then increase the pipe internal bore diameter to keep the motorcase pressure within specified limits.

Specify "V" in the model code for extra drain port, G¼" (BSPF). Connect this port into main drain line downstream of a 0.35 bar check valve.

Motor axis - vertical shaft down

Piping (from any drain port) must be taken above level of motorcase.

Bearing lubrication - piping

The installation arrangement must not allow syphoning from the motorcase. Where this arrangement is not practical, please consult KPM UK.

Any of the drain port positions can be used, but the drain line should be run above the level of the uppermost bearing and 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 unloaded and set to its high displacement.

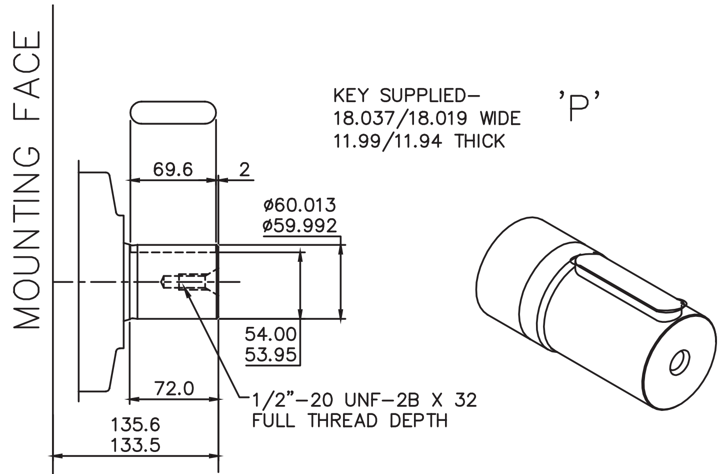
Conversion Table

Pressure	
bar	PSI
1	14.5
Flow	
l/min	gal/min
1	0.264 US
1	0.219 UK
Length	
mm	inch
25.4	1

Torque	
Nm	lbf ft
1	1.737
Power	
kW	hp
1	1.341
Mass	
kg	lb
1	2.2

3-1 HPC080

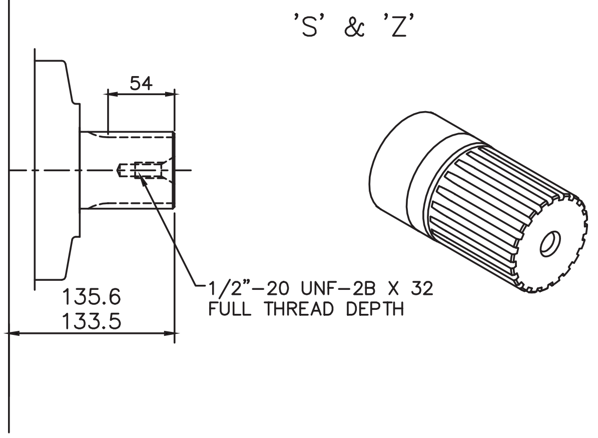
'P', 'S' & 'Z' Shafts



SPLINE DATA

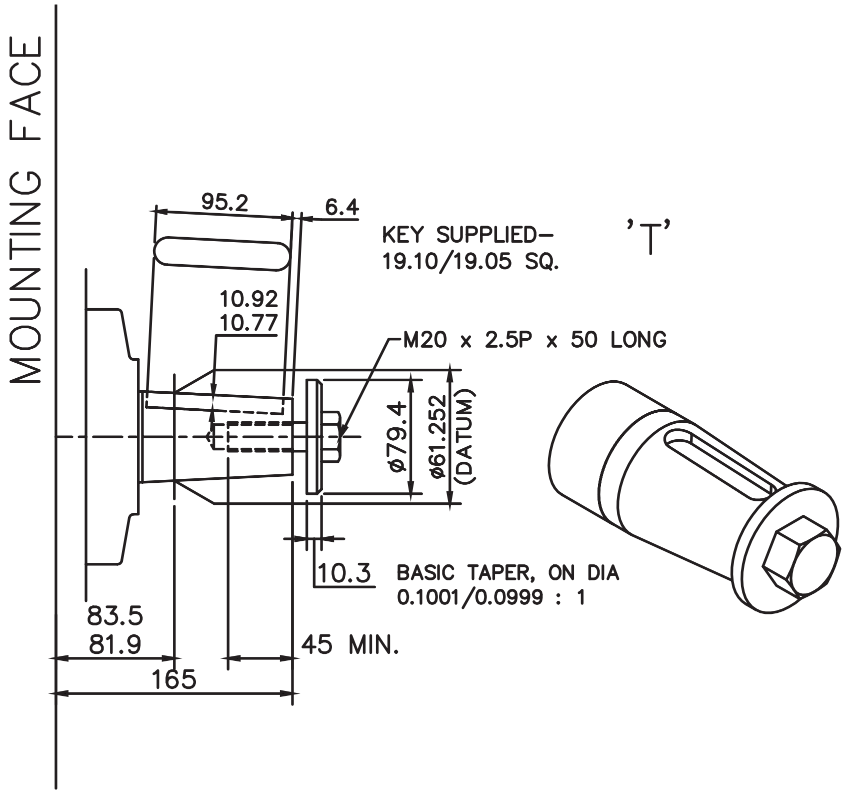
'S'	
TO BS 3550 (ANSI B92.1 CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	14
PITCH	6/12
MAJOR DIAMETER	62.553/62.425
FORM DIAMETER	55.052
MINOR DIAMETER	54.084/53.525
PIN DIAMETER	8.128
DIAMETER OVER PINS	71.593/71.544

'Z'
DIN 5480 W70 x 3 x 30 x 22 x 7h



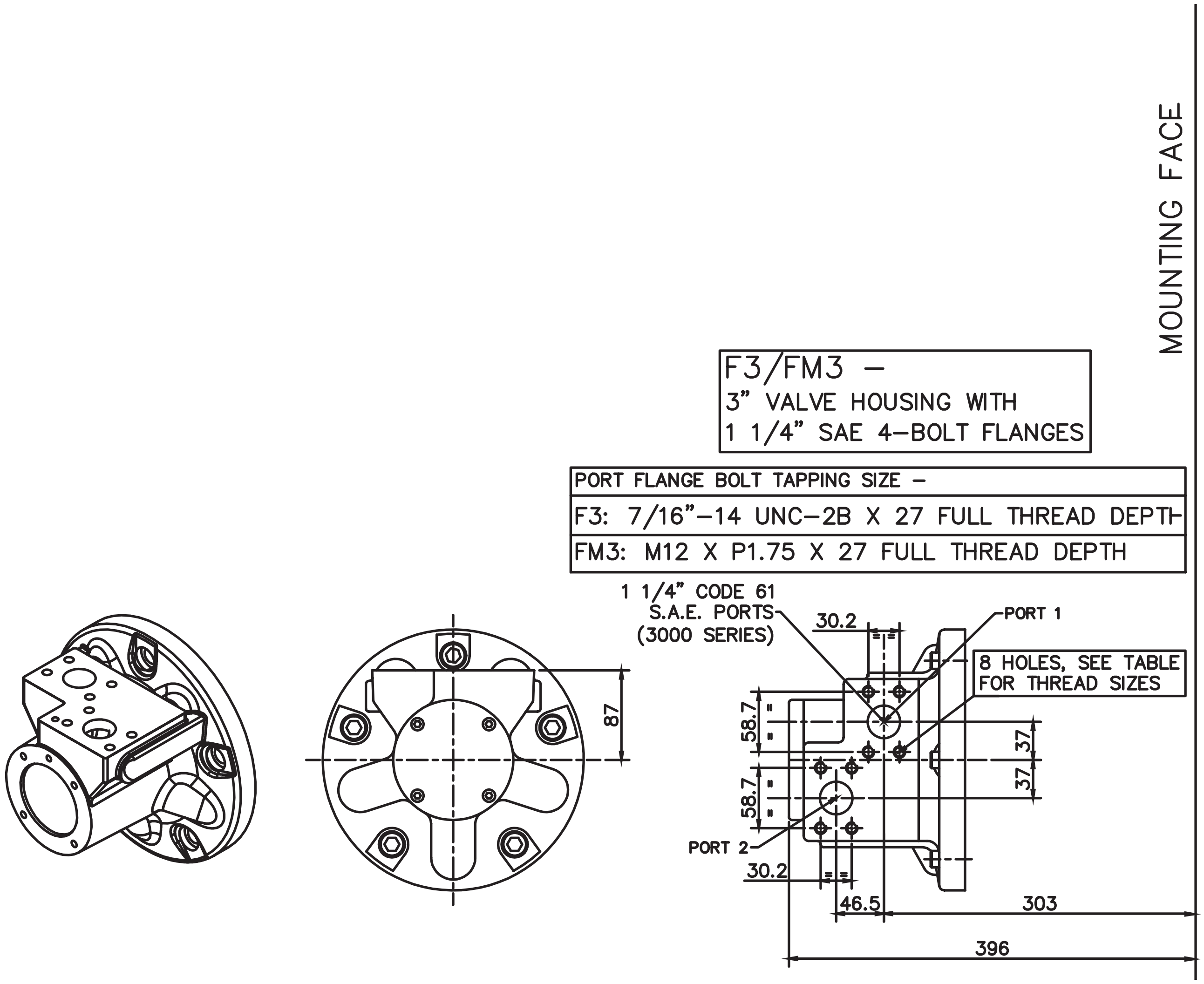
3-1 HPC080 (cont)

'T' Shaft



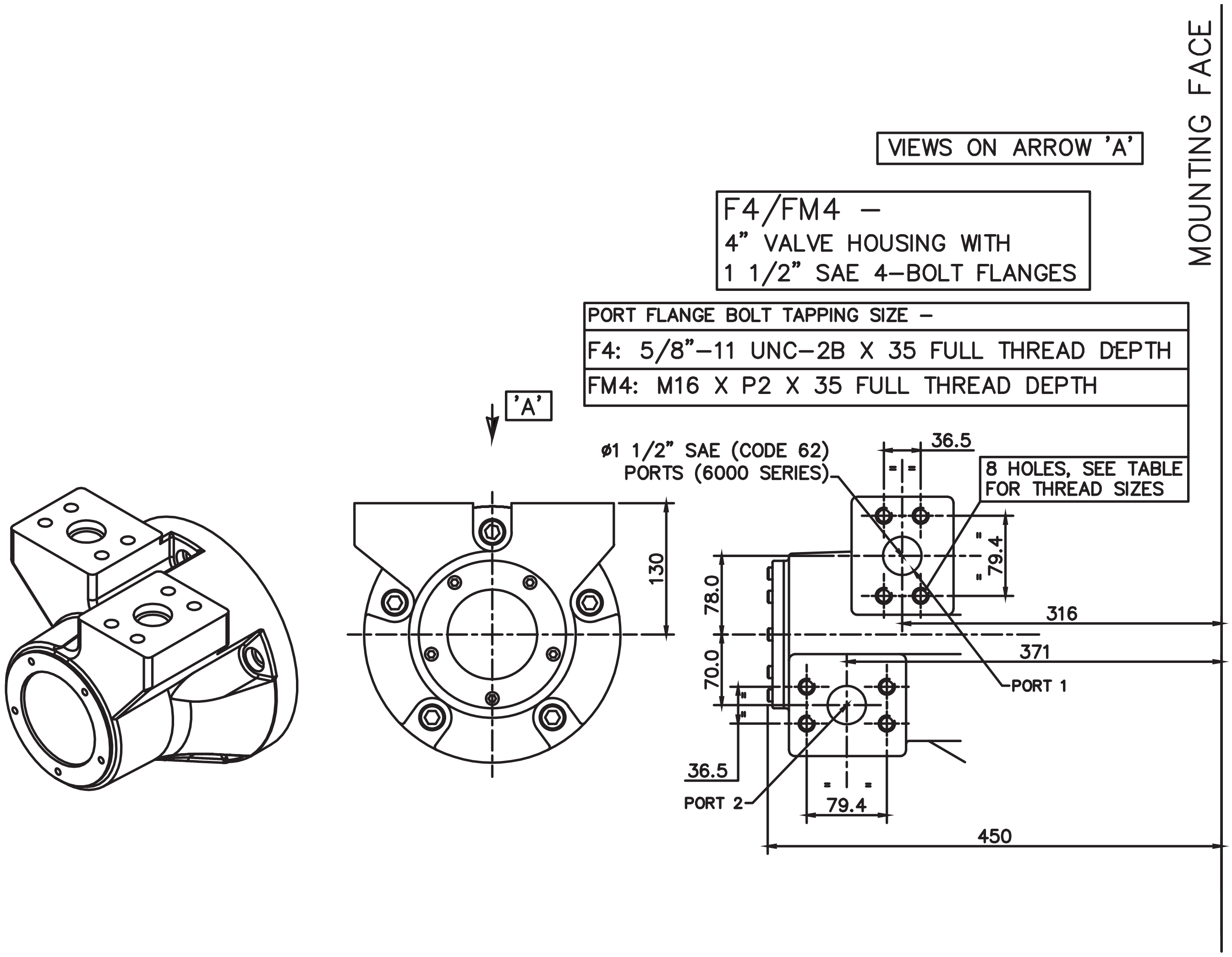
3-1 HPC080 (cont)

'F3' & 'FM3' Valve Housings



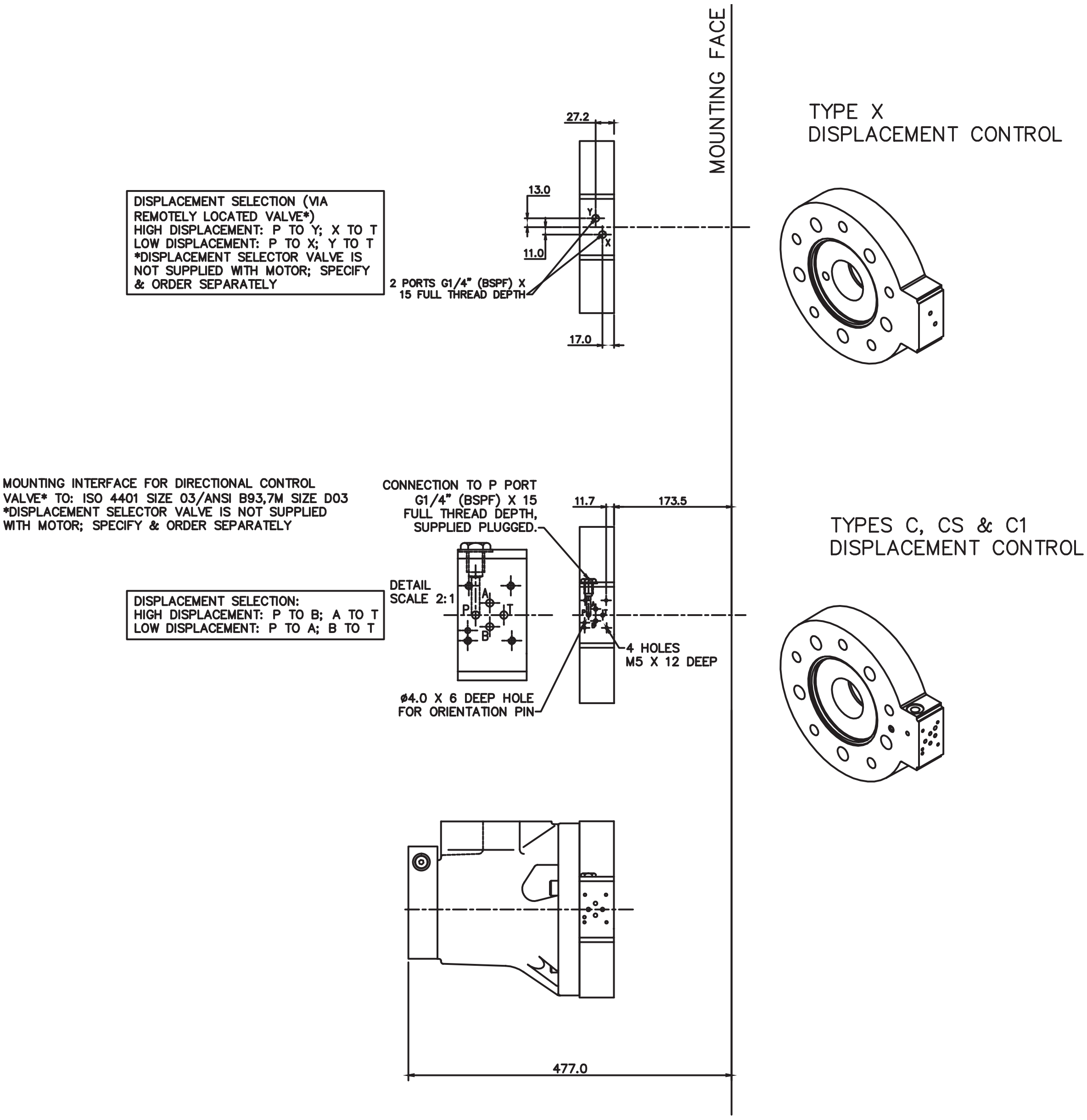
3-1 HPC080 (cont)

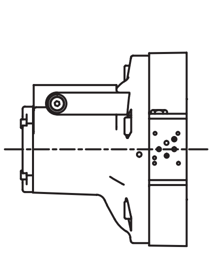
'F4' & 'FM4' Valve Housings

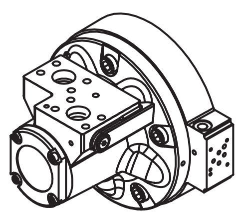


3-1 HPC080 (cont)

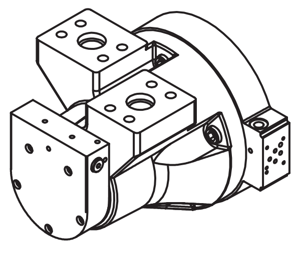
'C', 'CS' & 'X' C Spacers







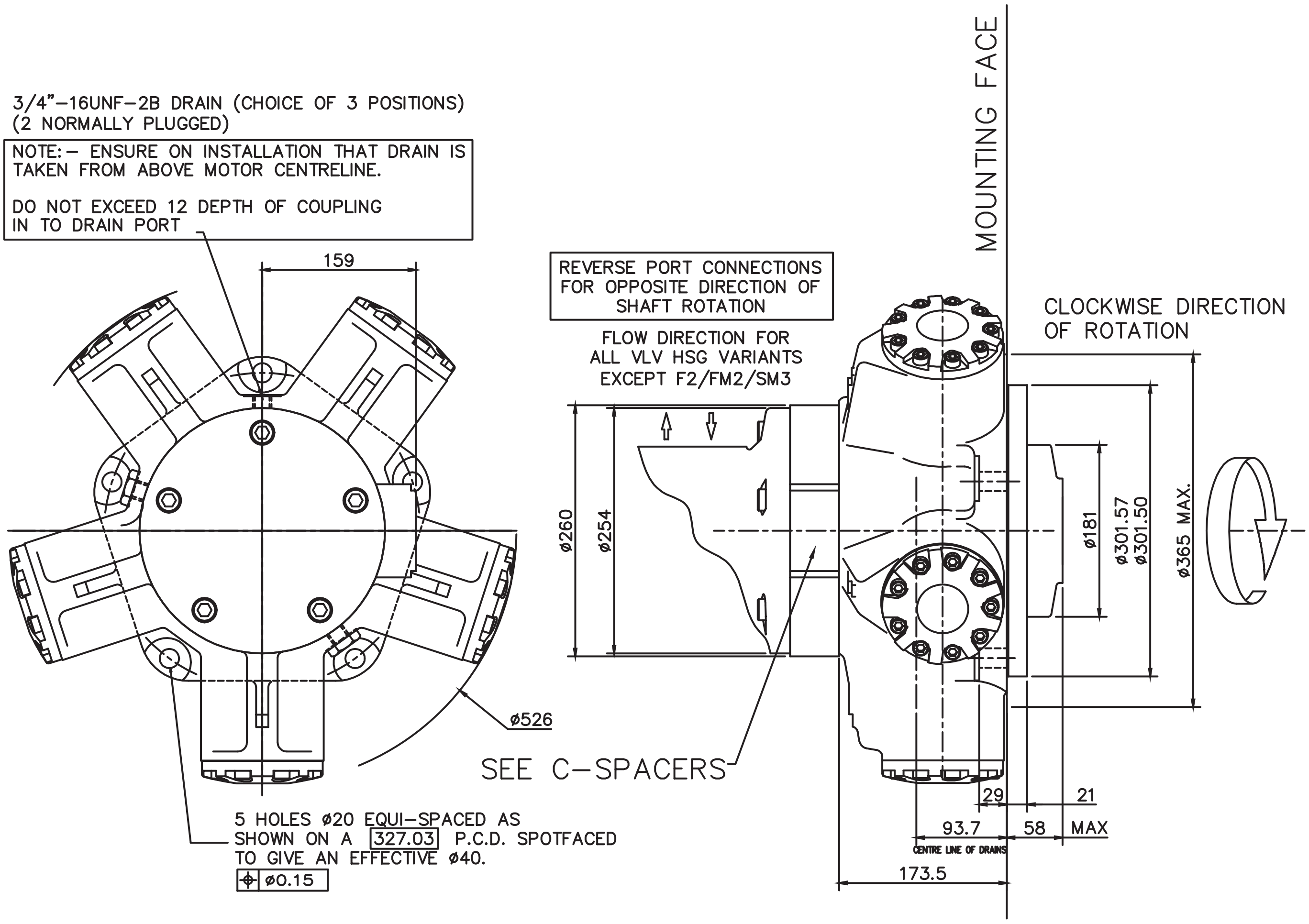
CS TYPE SHUTTLE ON F3 & FM3 ASSEMBLIES ONLY



CS TYPE SHUTTLE ENDCAP ON F4 & FM4 ASSEMBLIES ONLY

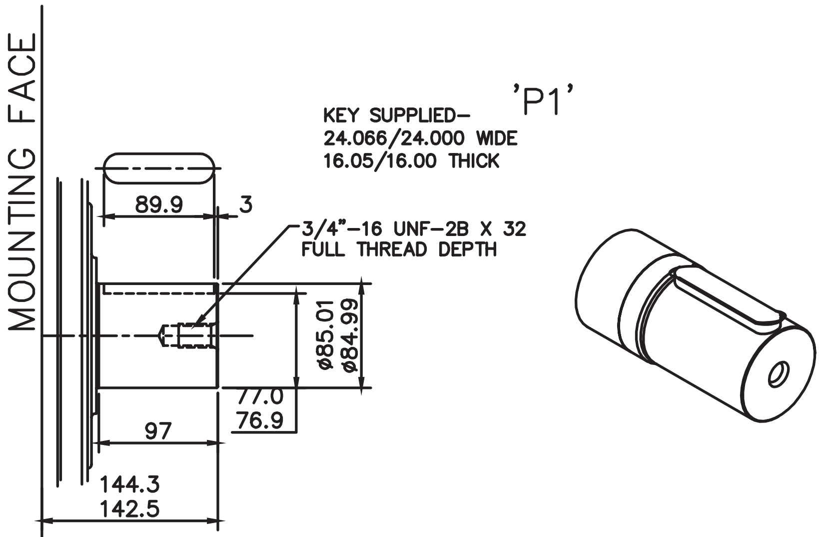
3-1 HPC080 (cont)

Installation



3-2 HPC125

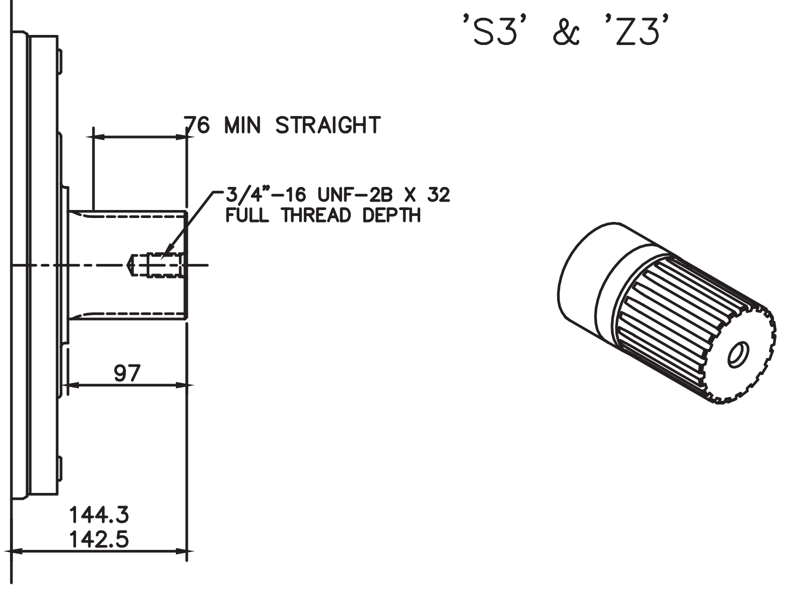
'P1', 'S3' & 'Z3' Shafts



SPLINE DATA

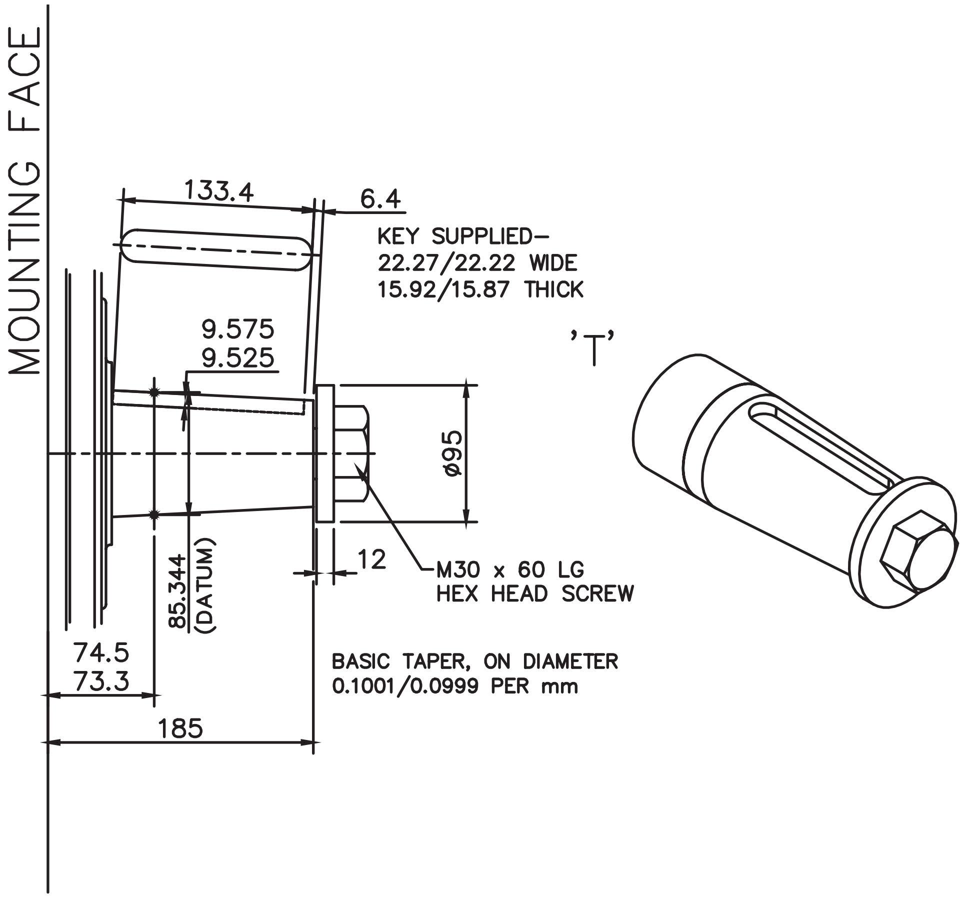
'S'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z'
DIN 5480 W85 x 3 x 27 x 7h



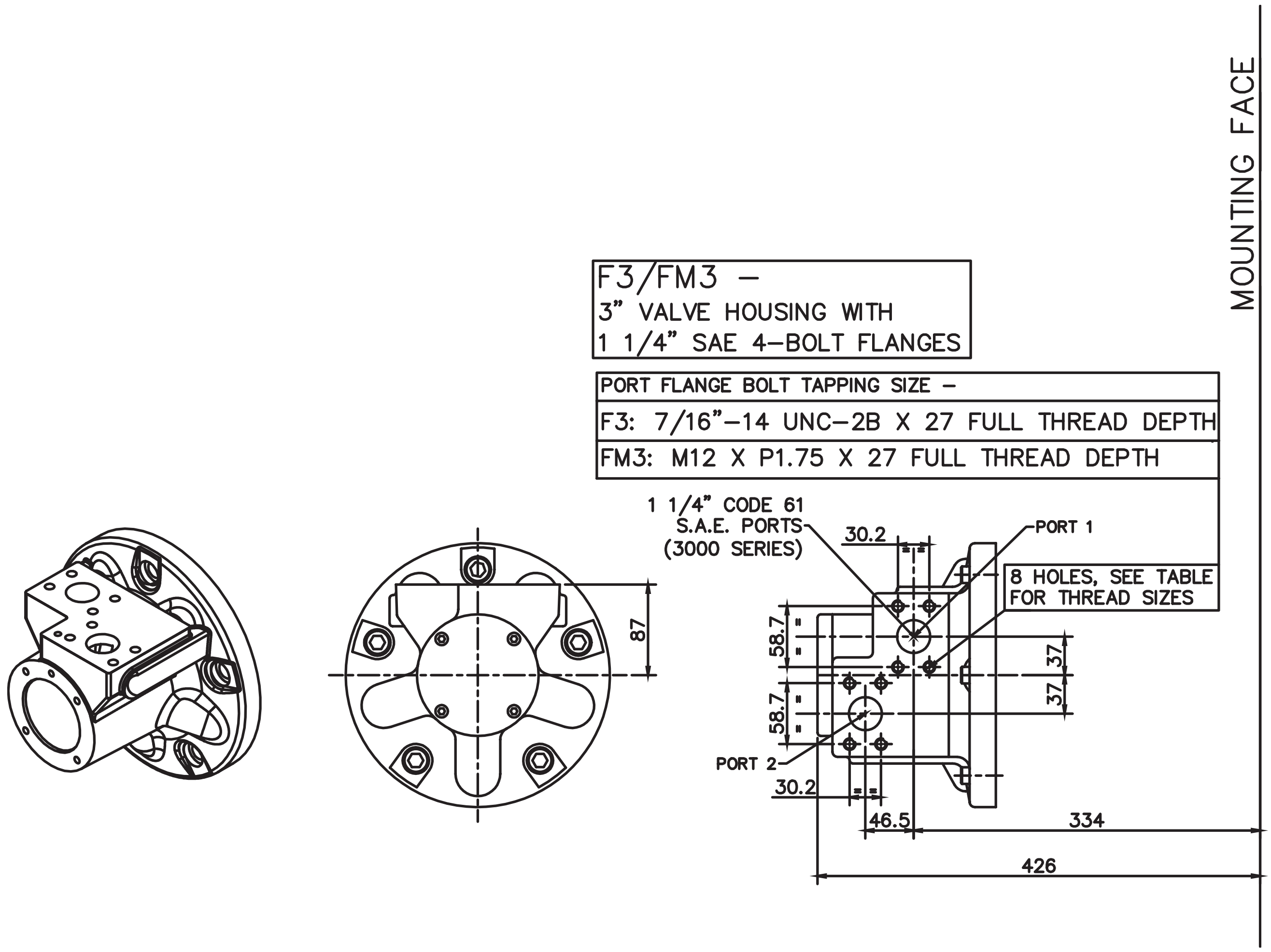
3-2 HPC125 (cont)

'T' Shaft



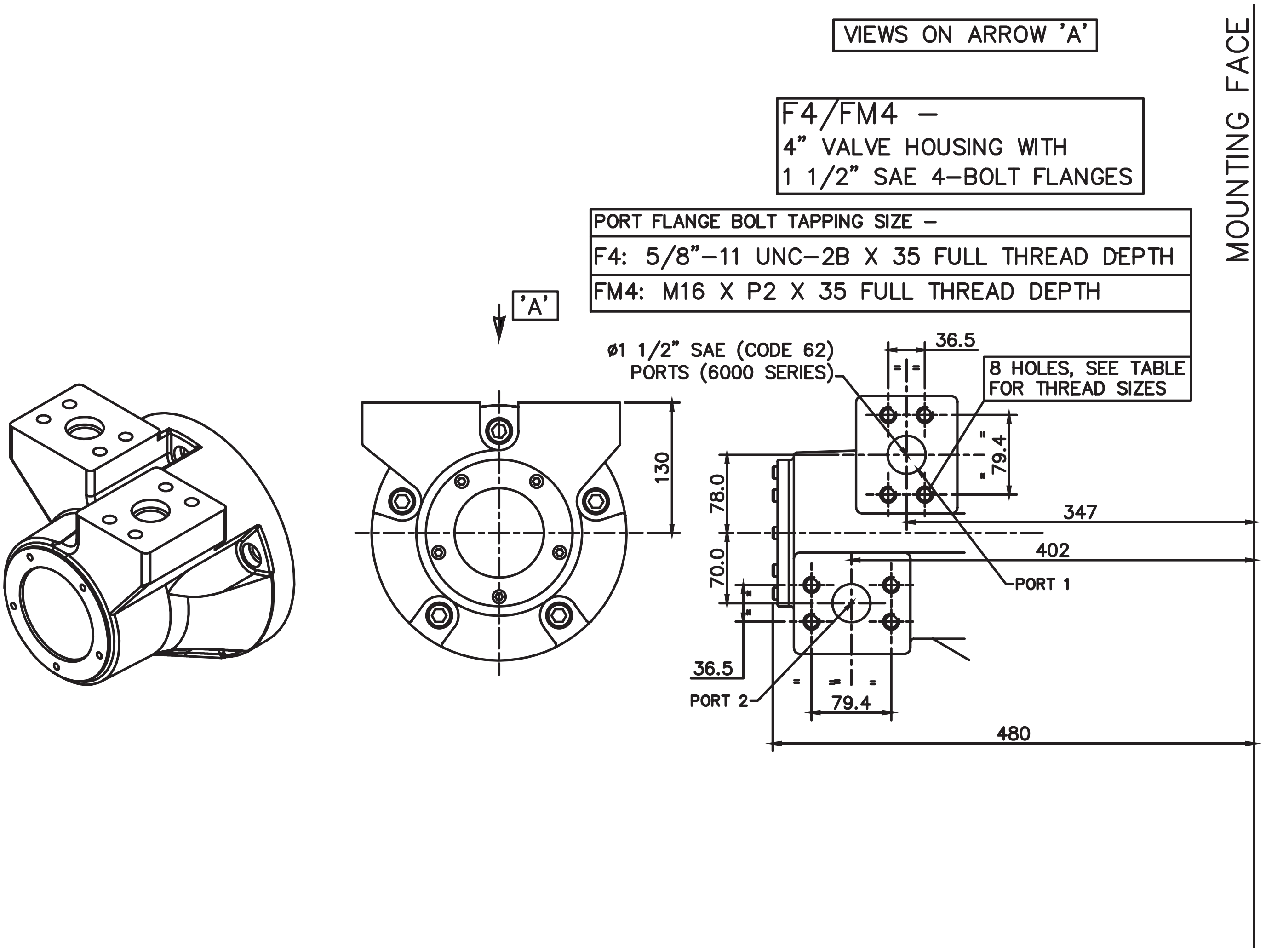
3-2 HPC125 (cont)

'F3' & 'FM3' Valve Housings



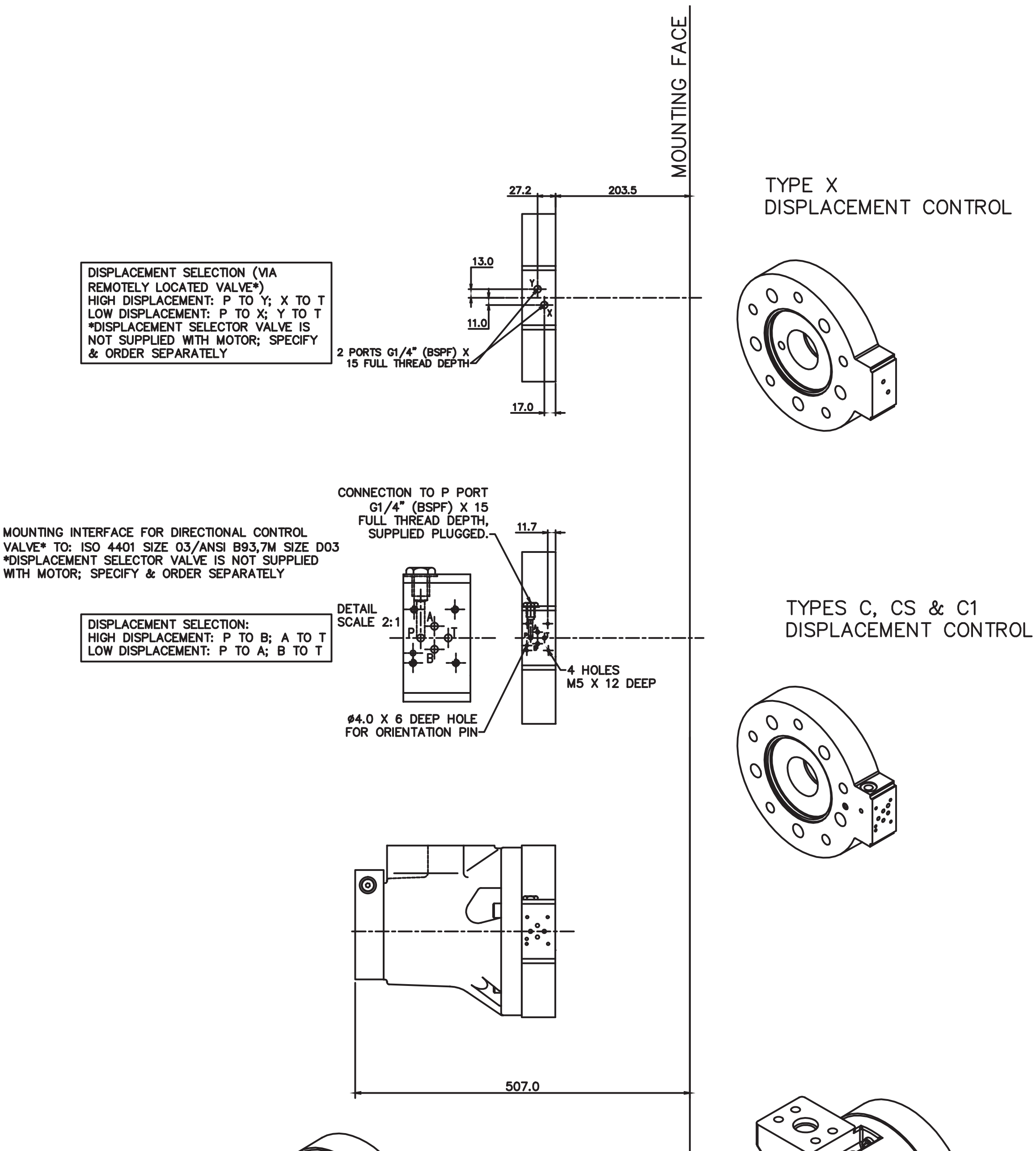
3-2 HPC125 (cont)

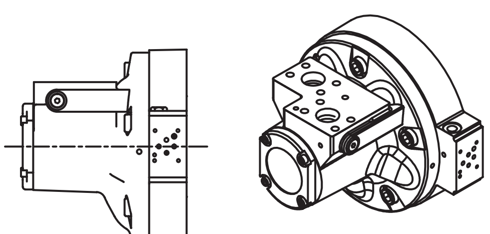
'F4' & 'FM4' Valve Housings



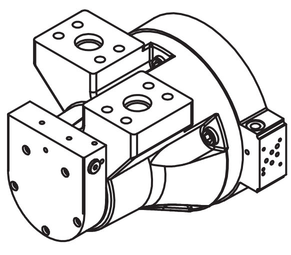
3-2 HPC125 (cont)

'C', 'CS' & 'X' C Spacers





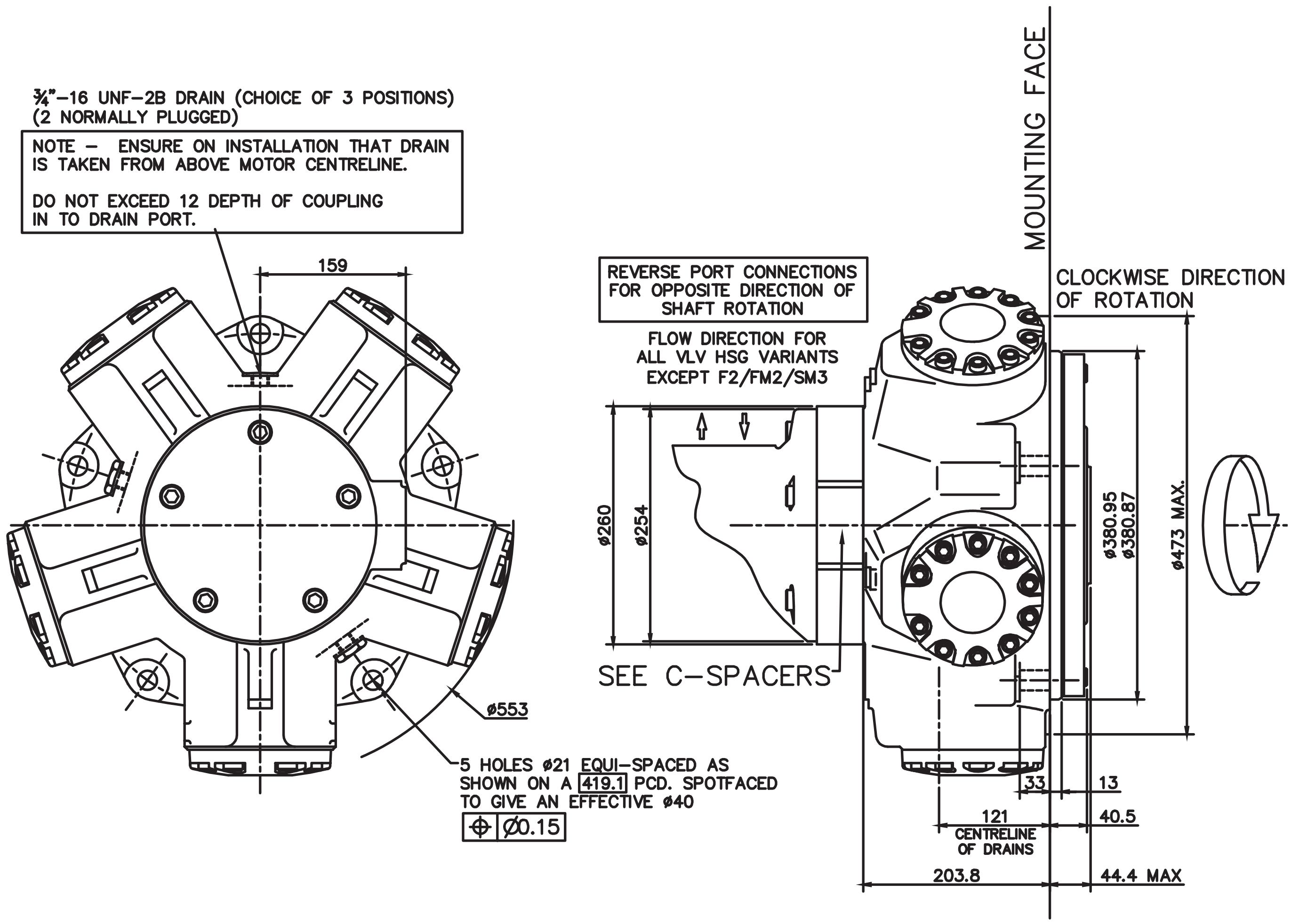
CS TYPE SHUTTLE ON F3 & FM3 ASSEMBLIES ONLY



CS TYPE SHUTTLE ENDCAP ON F4 & FM4 ASSEMBLIES ONLY

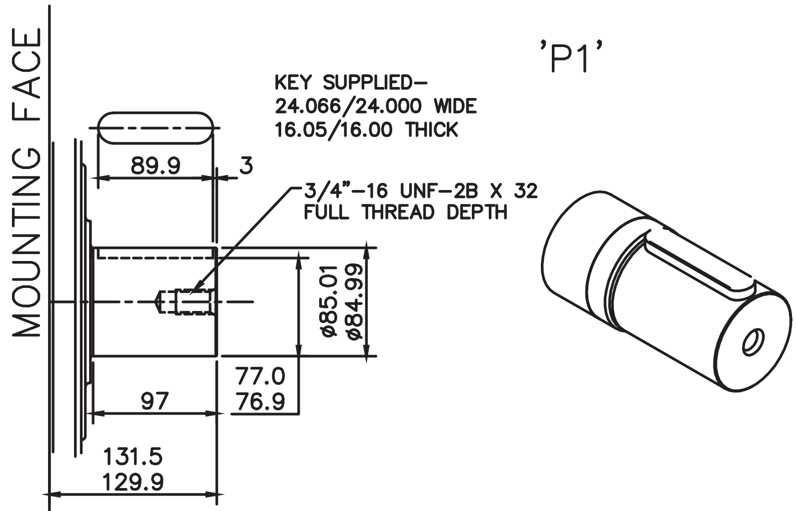
3-2 HPC125 (cont)

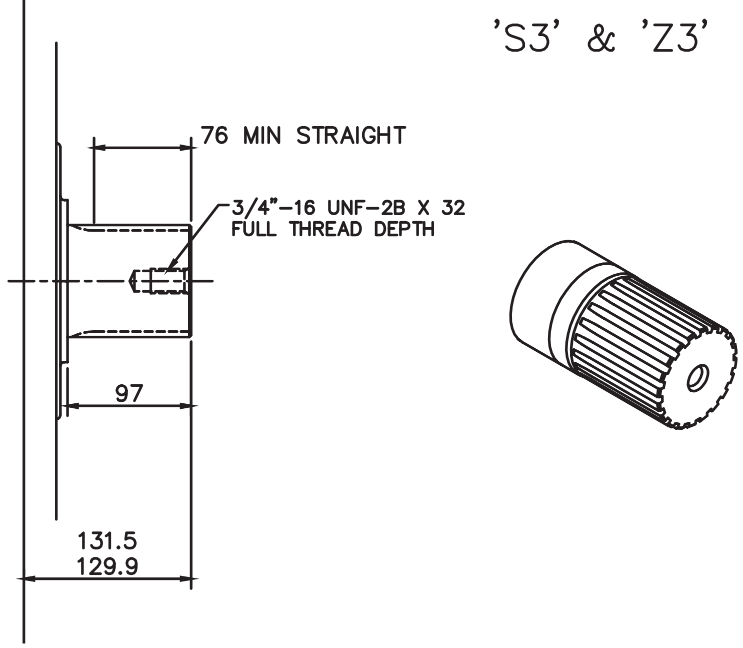
Installation



3-3 HPC200

'P1', 'S3' & 'Z3' Shafts





SPLINE DATA

'S'

TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

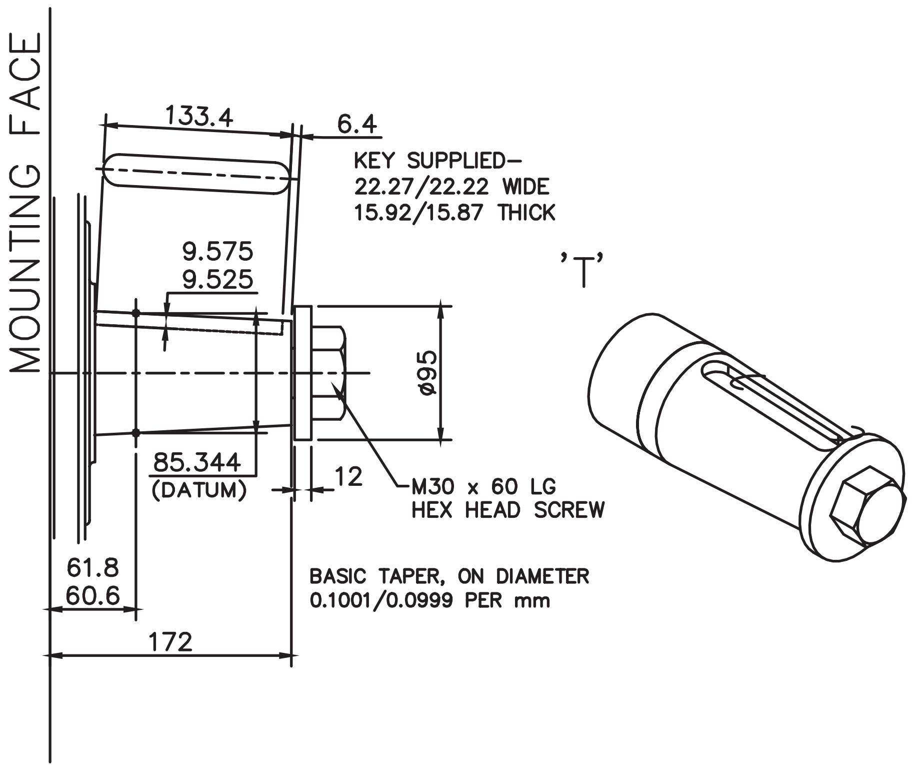
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z'

DIN 5480 W85 x 3 x 27 x 7h

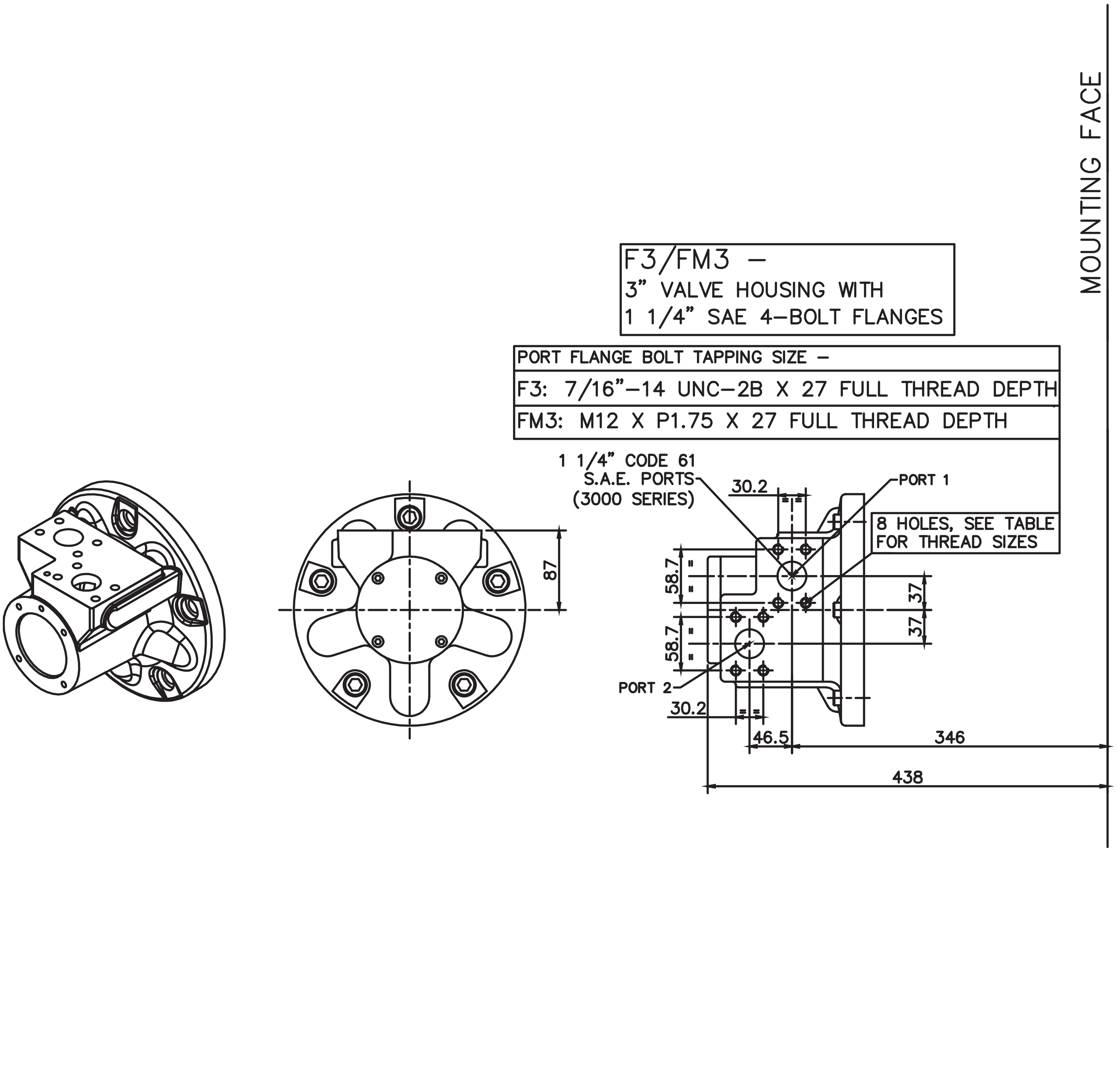
3-3 HPC200 (cont)

'T' Shaft



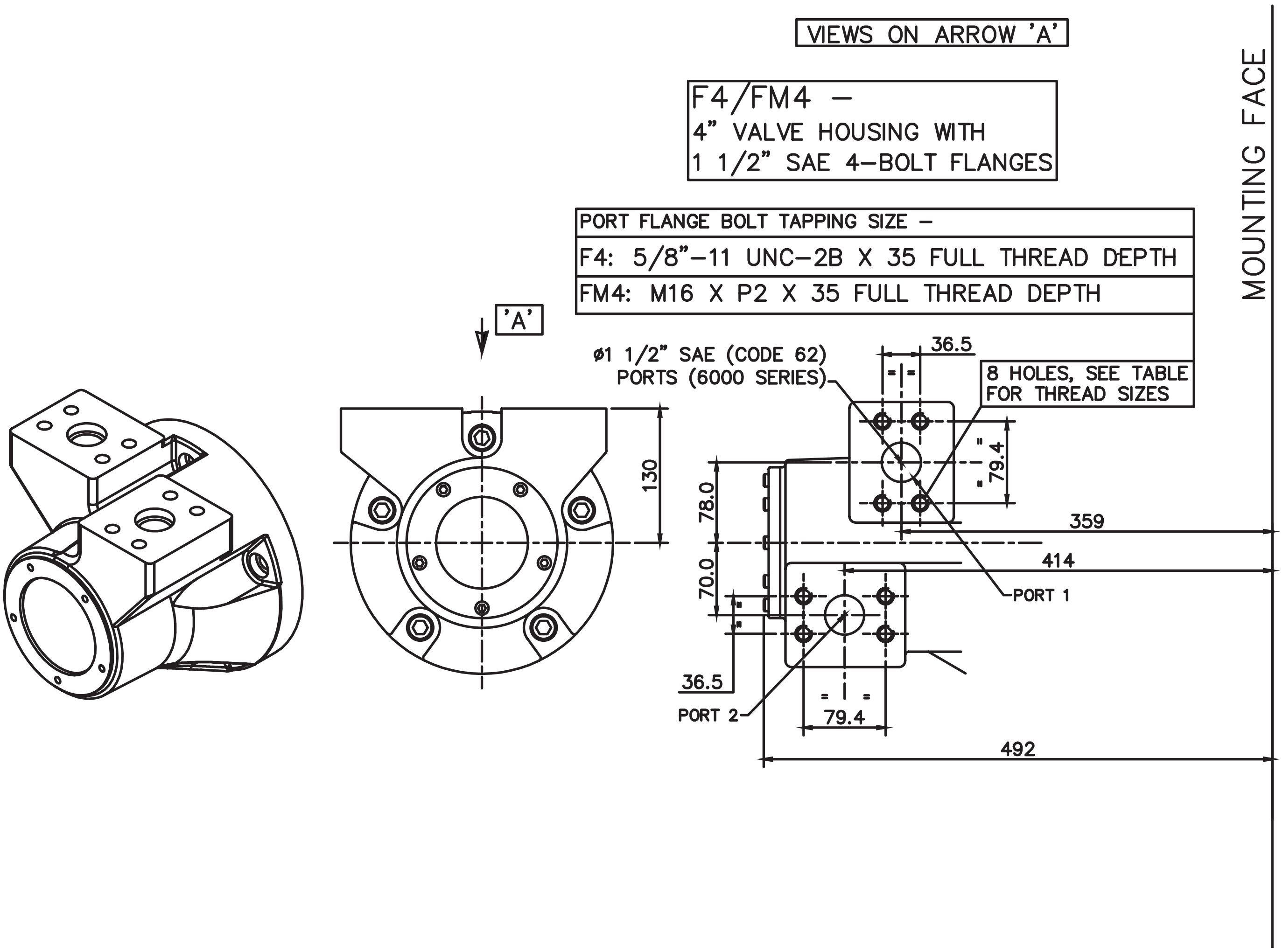
3-3 HPC200 (cont)

'F3' & 'FM3' Valve Housings



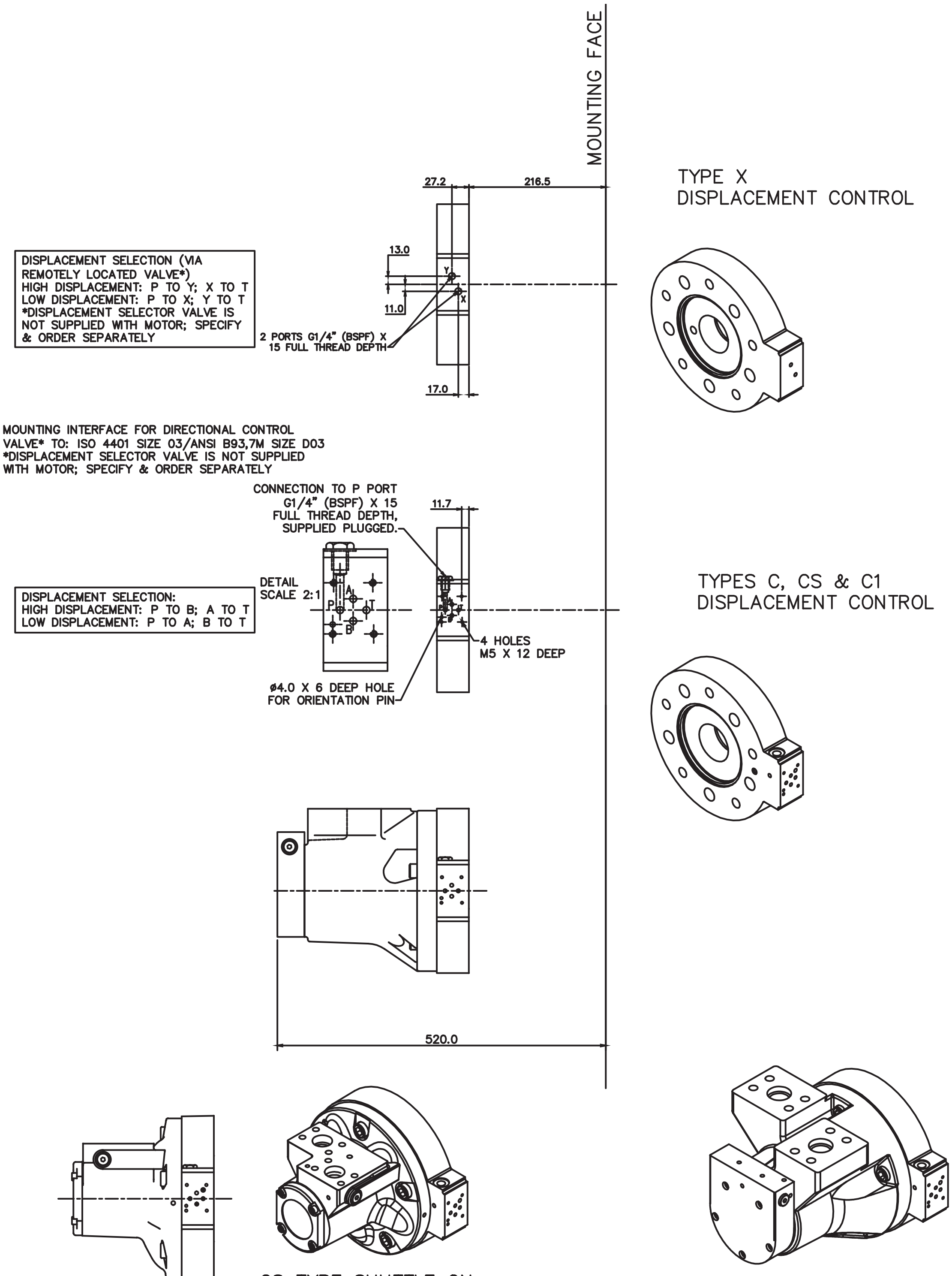
3-3 HPC200 (cont)

'F4' & 'FM4' Valve Housings



3-3 HPC200 (cont)

'C', 'CS' & 'X' C Spacers

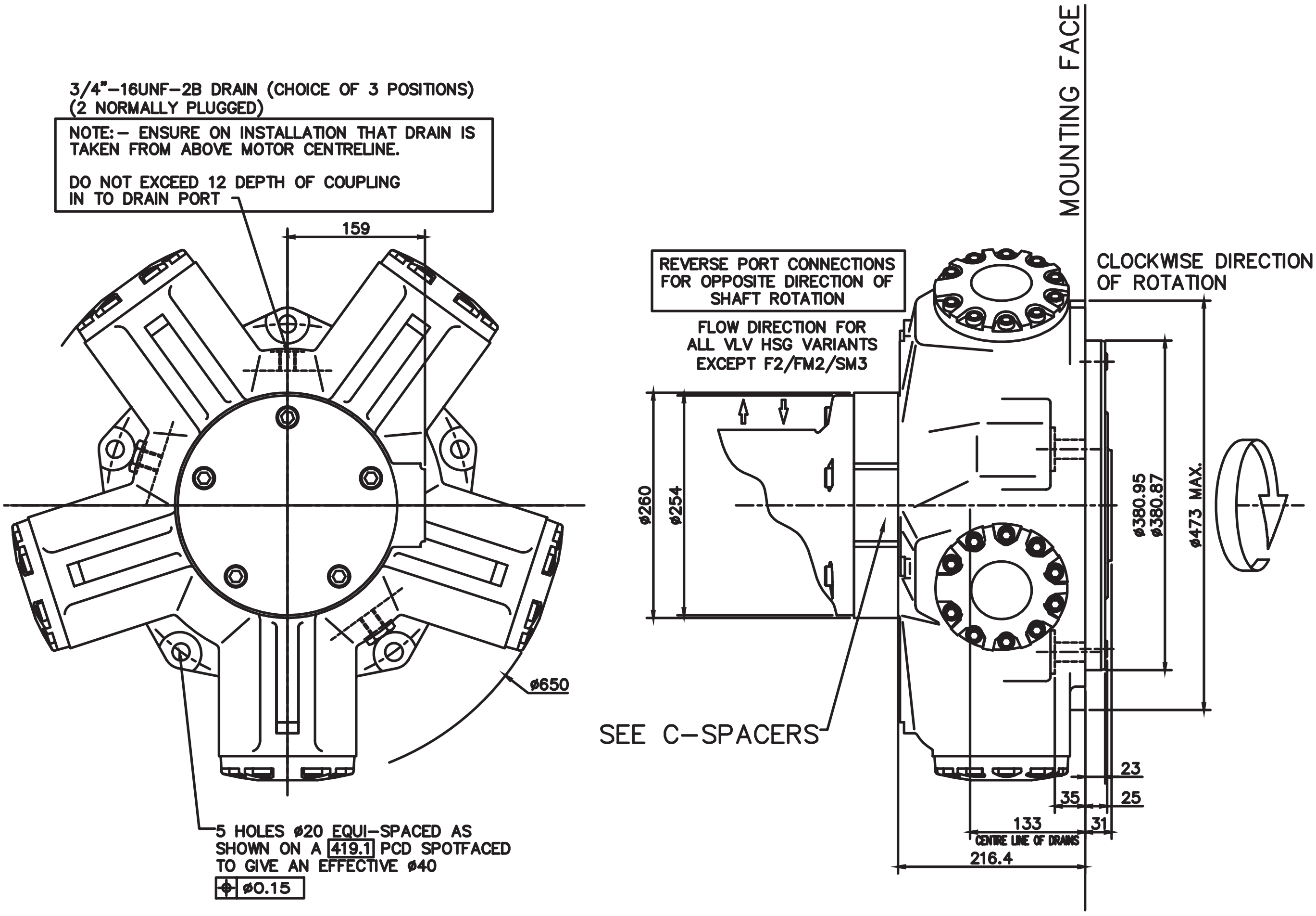


CS TYPE SHUTTLE ON F3 & FM3 ASSEMBLIES ONLY

CS TYPE SHUTTLE ENDCAP ON F4 & FM4 ASSEMBLIES ONLY

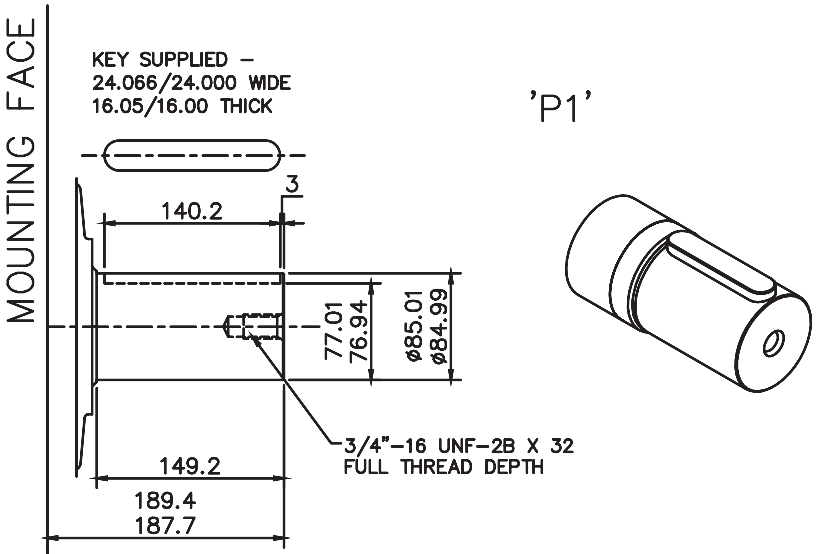
3-3 HPC200 (cont)

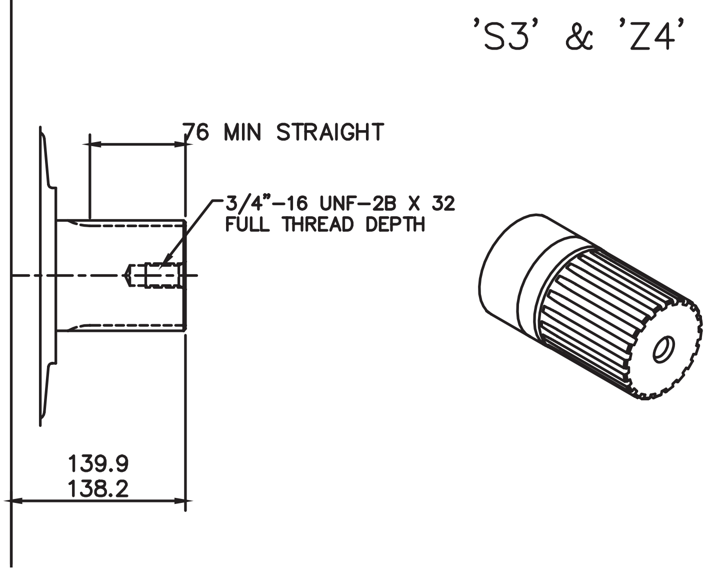
Installation



3-4 HPC270

'P1', 'S3' & 'Z4' Shafts





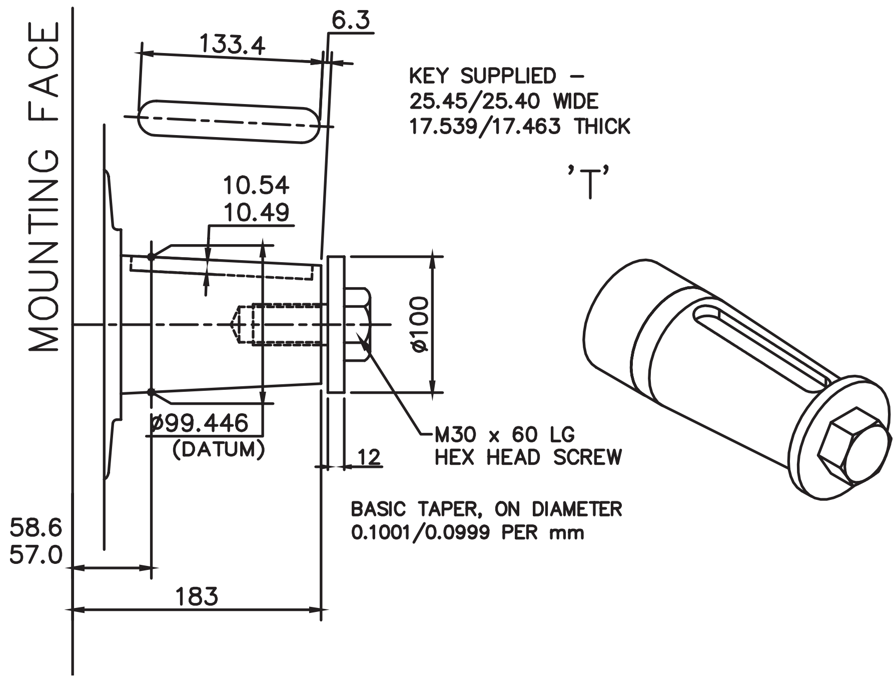
SPLINE DATA

'S'	
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z'
DIN 5480 W90 x 4 x 21 x 7h

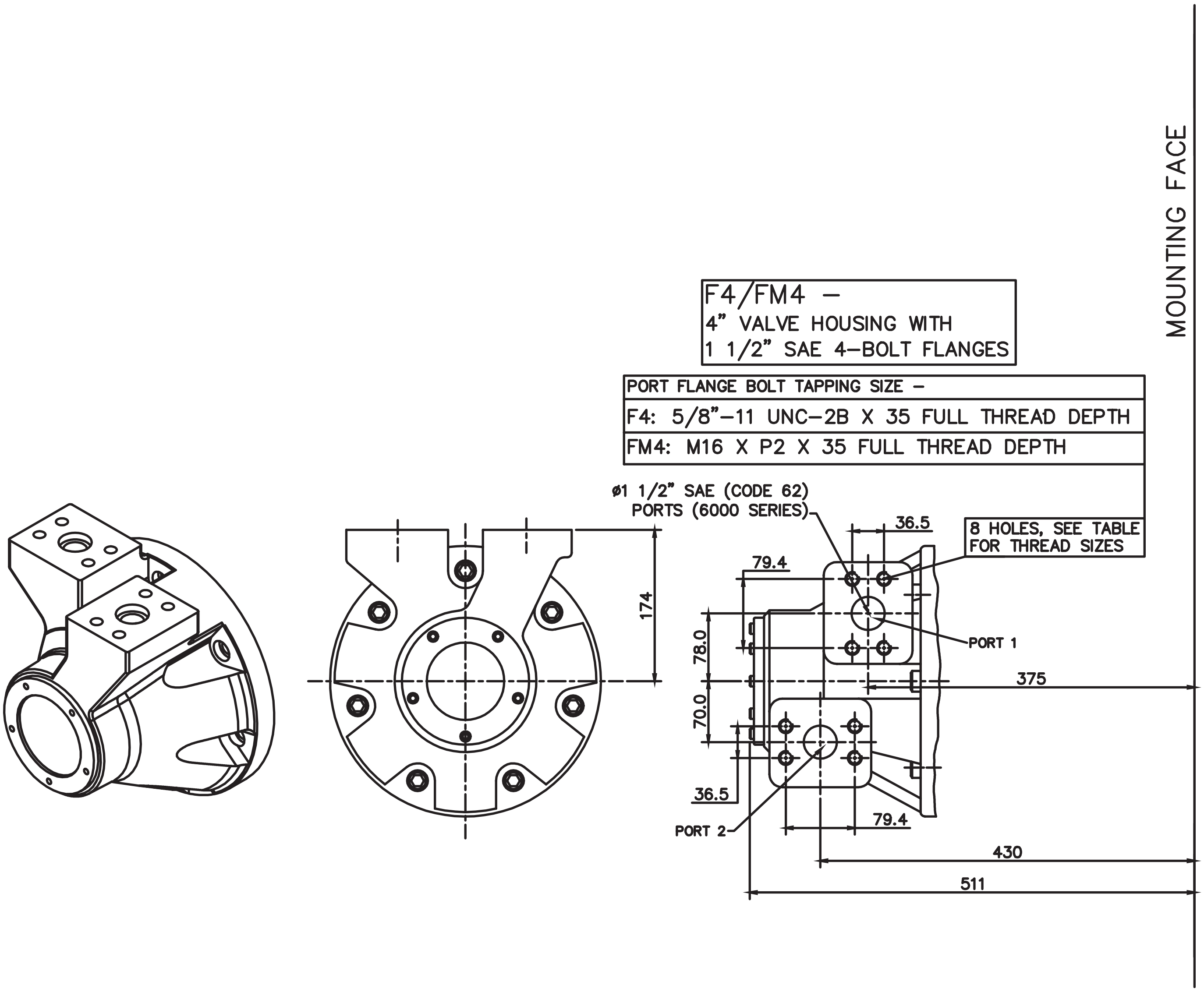
3-4 HPC270 (cont)

'T' Shaft



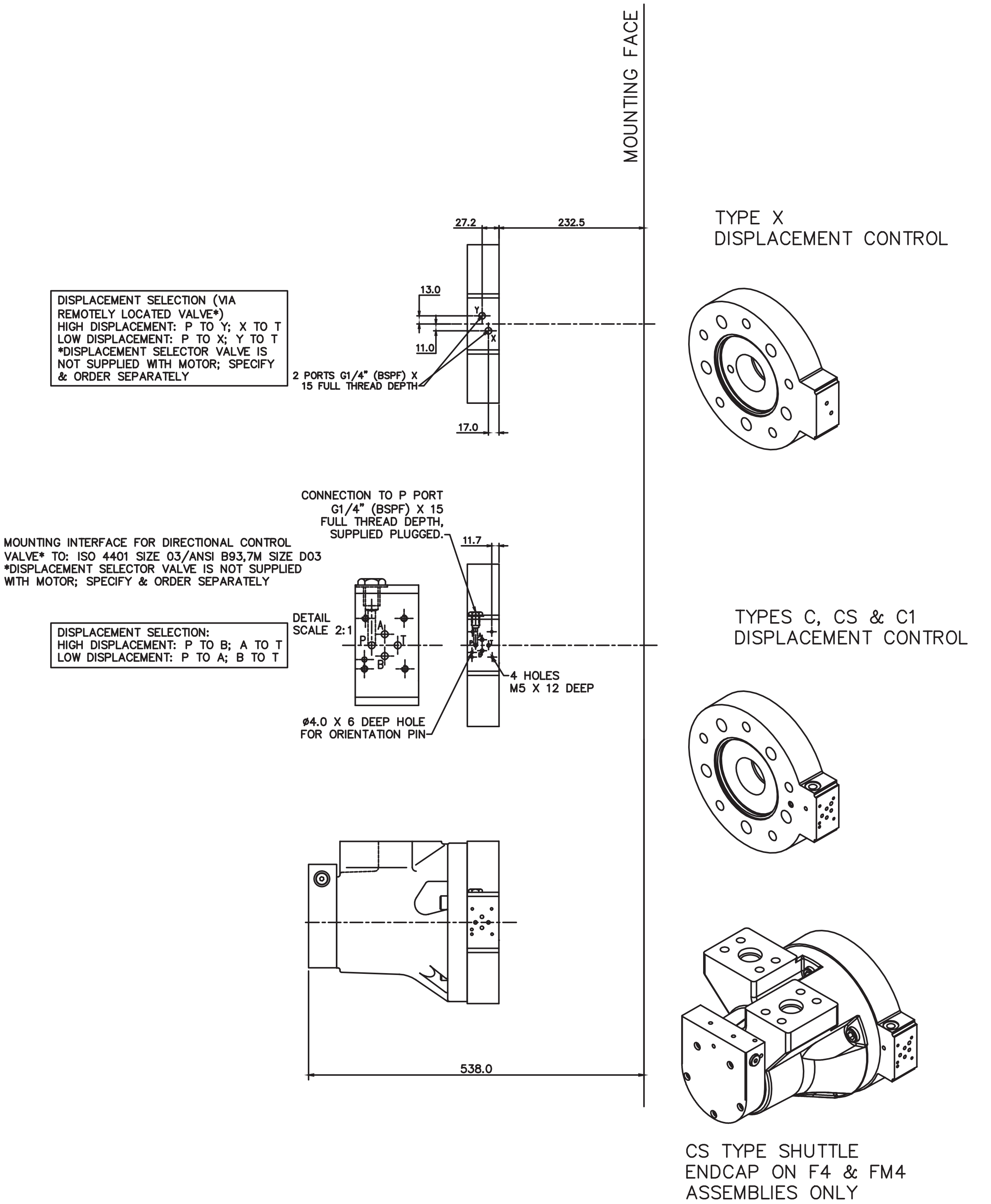
3-4 HPC270(cont)

‘F4' & 'FM4' Valve Housings



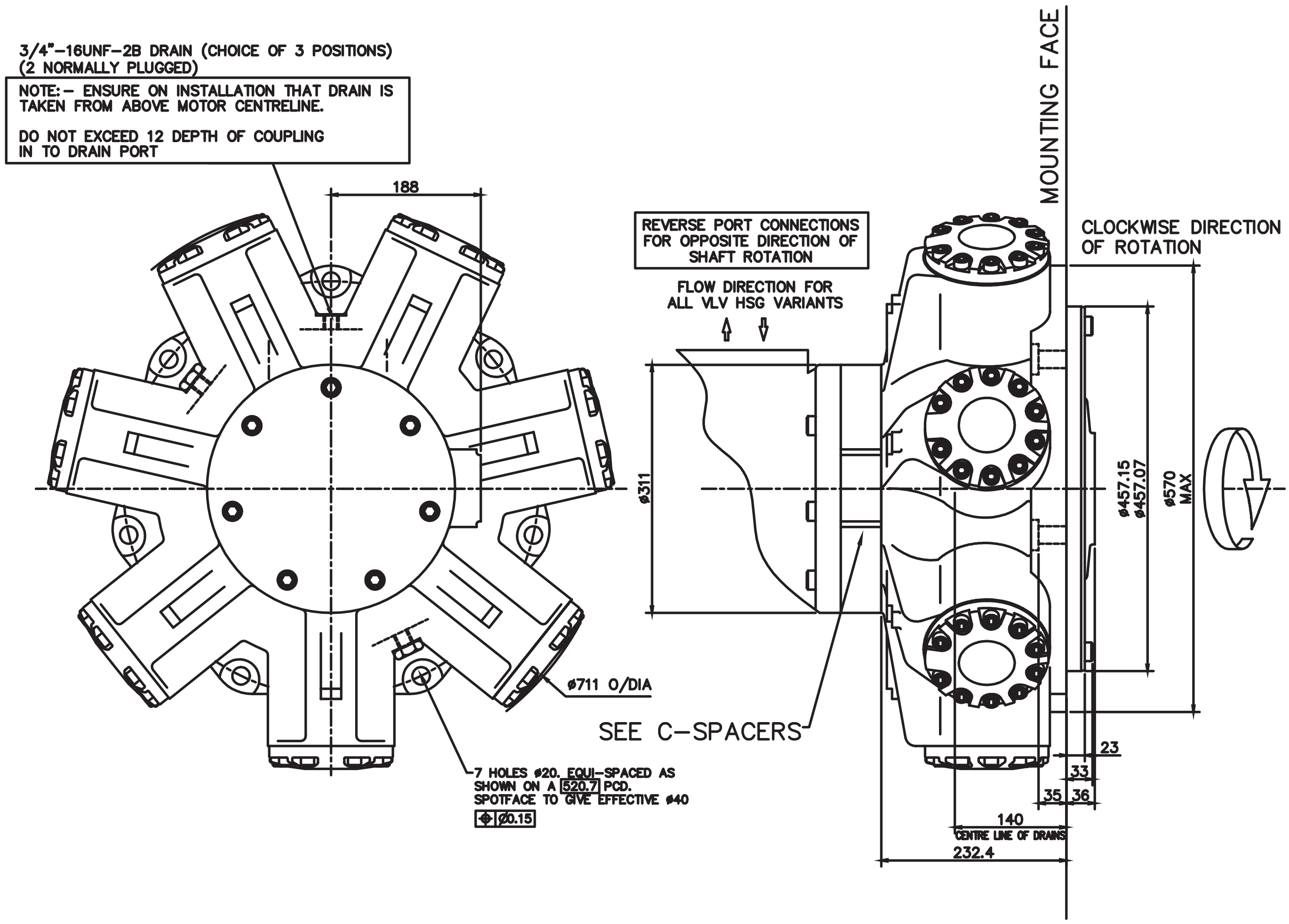
3-4 HPC270(cont)

'C', 'CS' & 'X' C Spacers



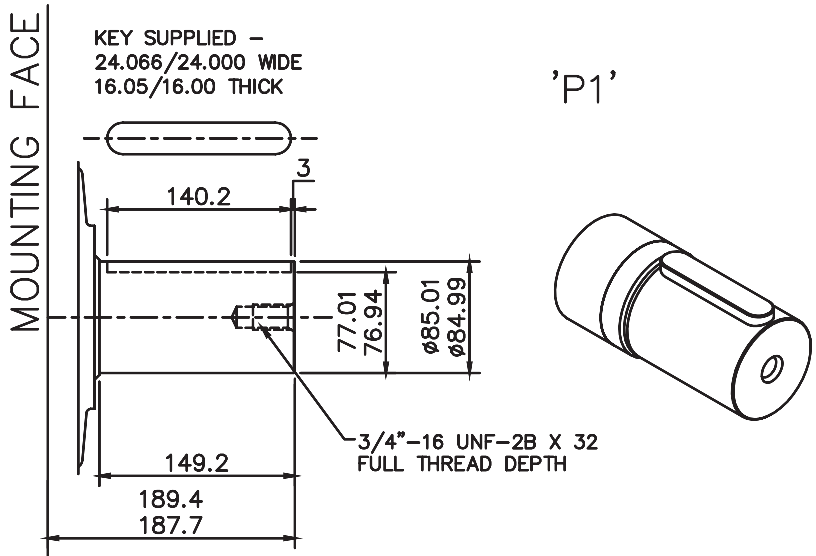
3-4 HPC270 (cont)

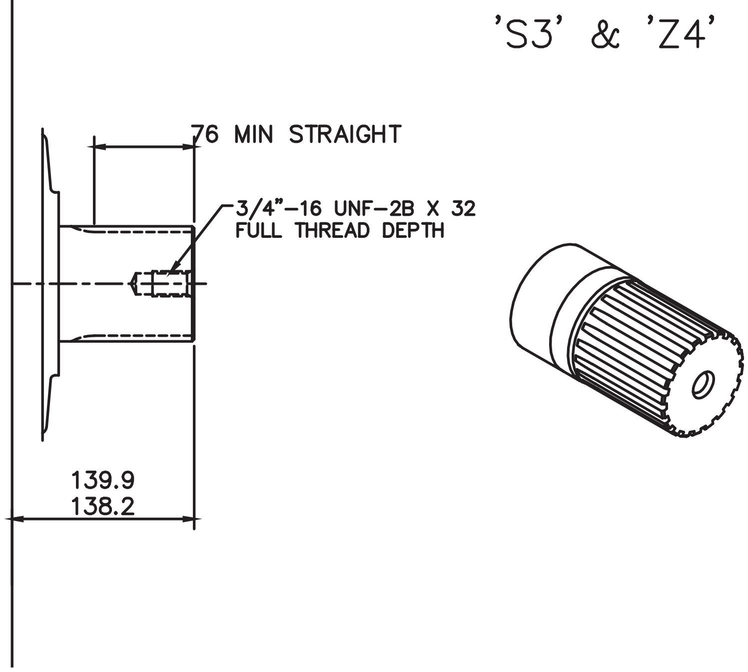
Installation



3-5 HPC325

'P1', 'S3' & 'Z4' Shafts





SPLINE DATA

'S'

TO BS 3550 (ANSI B92.1, CLASS 5)
FLAT ROOT SIDE FIT, CLASS 1

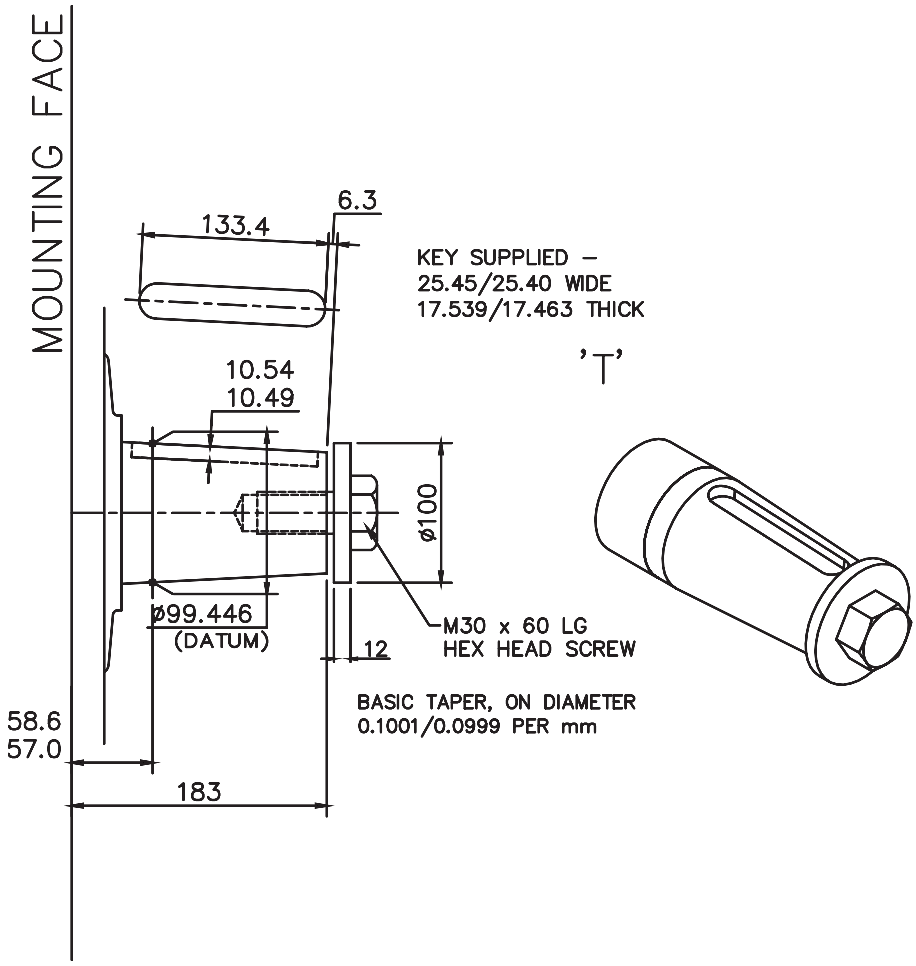
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'Z'

DIN 5480 W90 x 4 x 21 x 7h

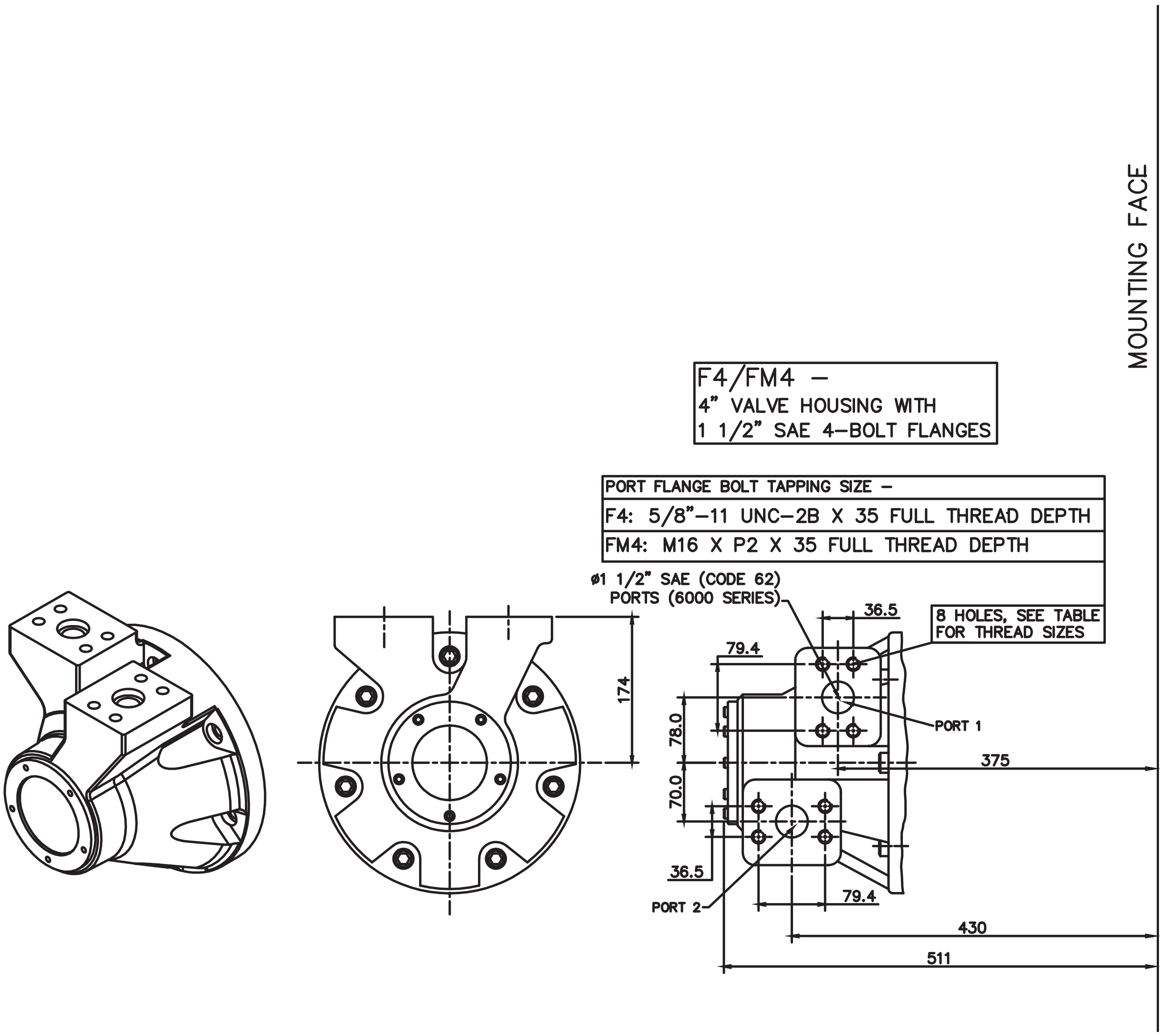
3-5 HPC325 (cont)

'T' Shaft



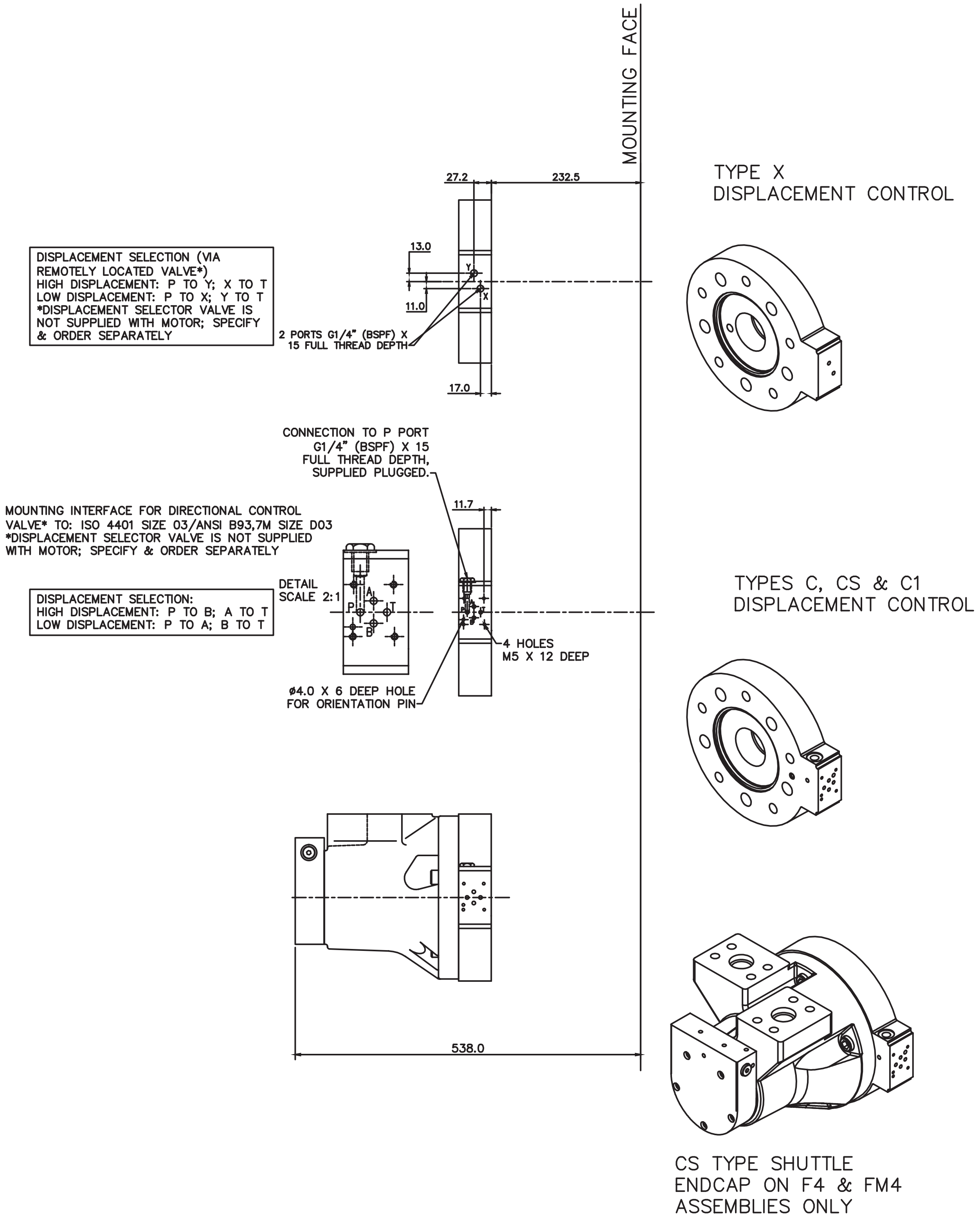
3-5 **HPC325** (cont)

'F4' & 'FM4' Valve Housings



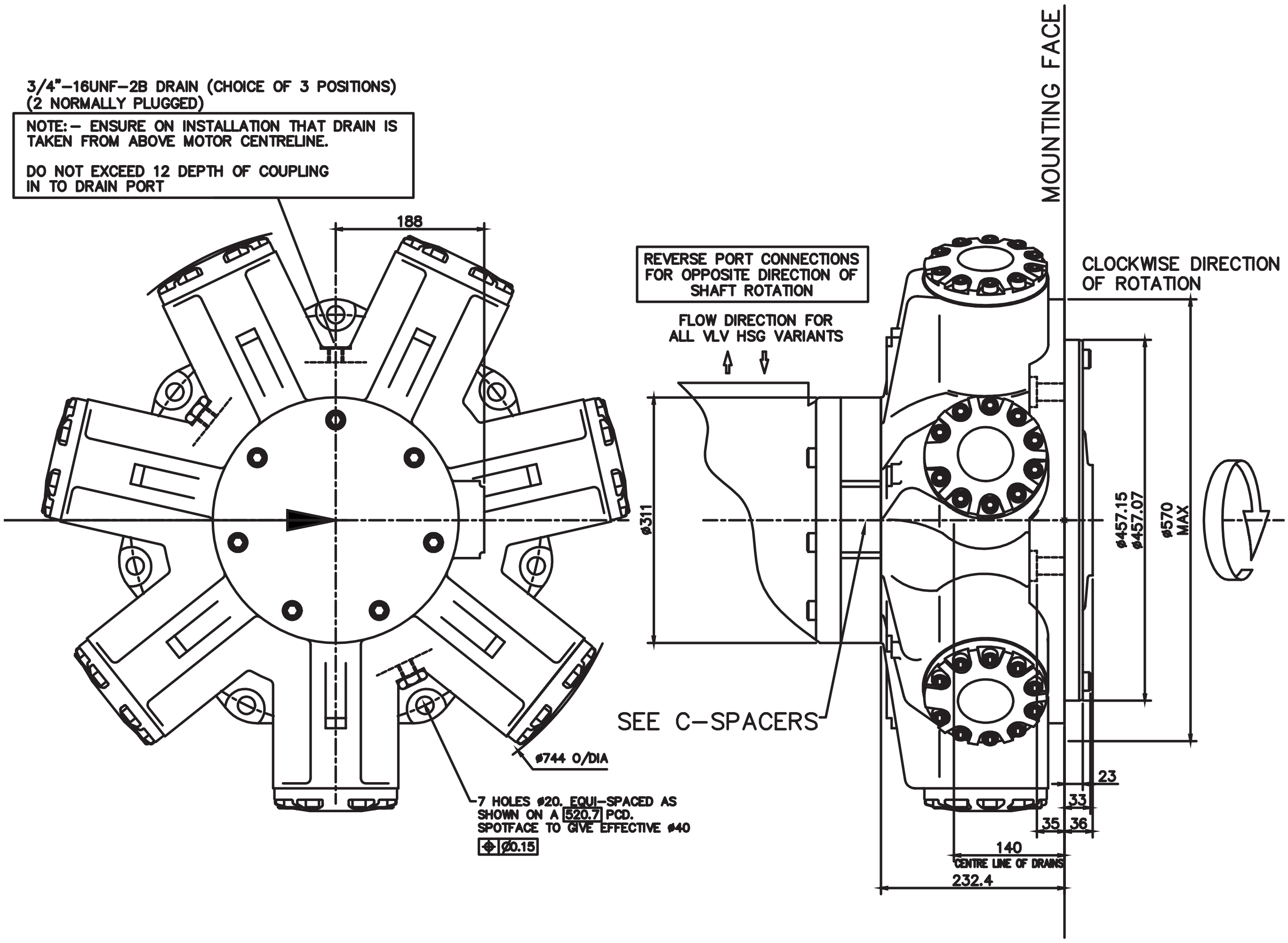
3-5 HPC325 (cont)

'C', 'CS' & 'X' C Spacers



3-5 HPC325 (cont)

Installation



3-12 Speed Sensing Options

Tj speed sensor with Tk readout option

Tj Speed Sensor Technical Specification

The Tj speed sensor is a hall effect dual channel speed probe that can provide feedback of both speed and direction.

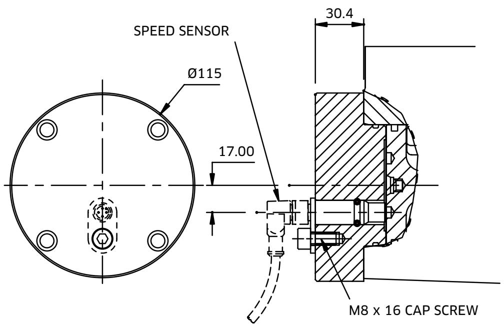
Signal Outputs:	Square wave plus directional signal
Power Supply:	8 to 32 V @ 40 mA
Protection class:	IP68
Output frequency:	16 pulses/revolution

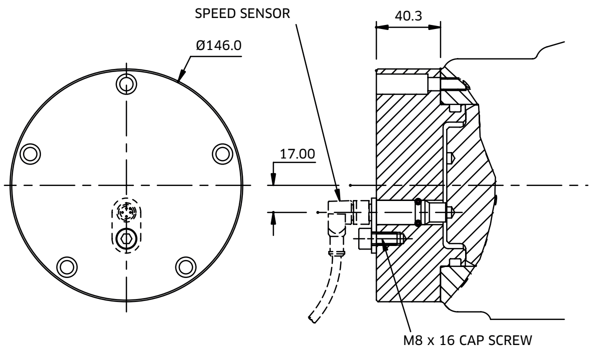
Installation Details

TO SUIT: F3/FM3/SO3

'Tj'

TO SUIT: F4/FM4/SO4



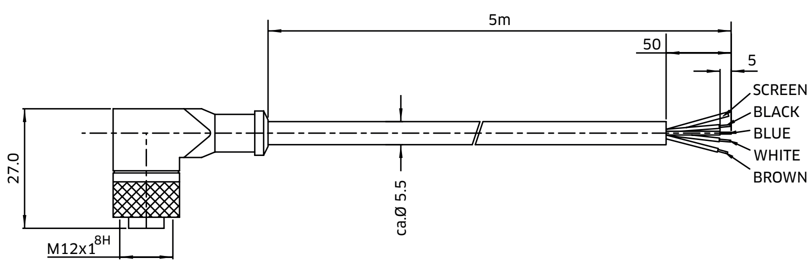


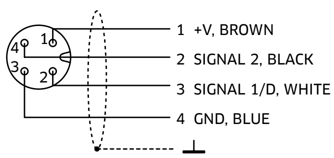
Tk Output Module

The Tk option consists of the Tj speed sensor together with the optional T401 output module.

The addition of the T401 module provides a software configured single channel tachometer and relay with a 0/4-20 mA analogue current output.

The software and calibration cable is also provided.





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