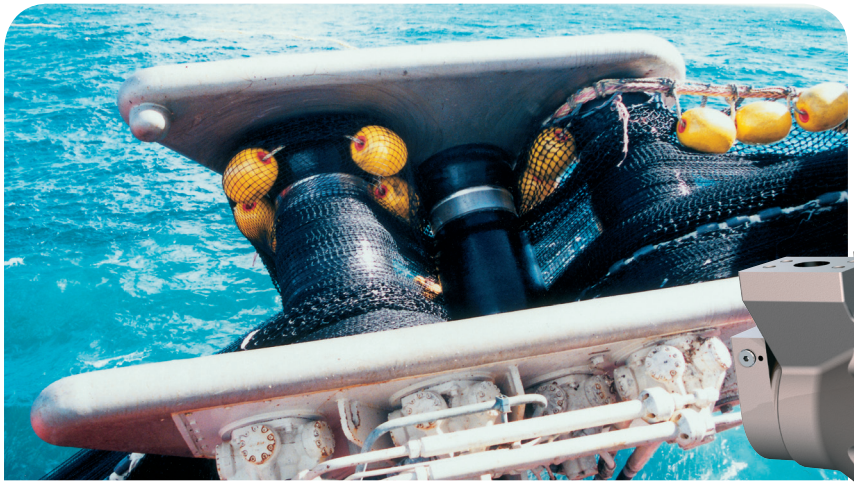
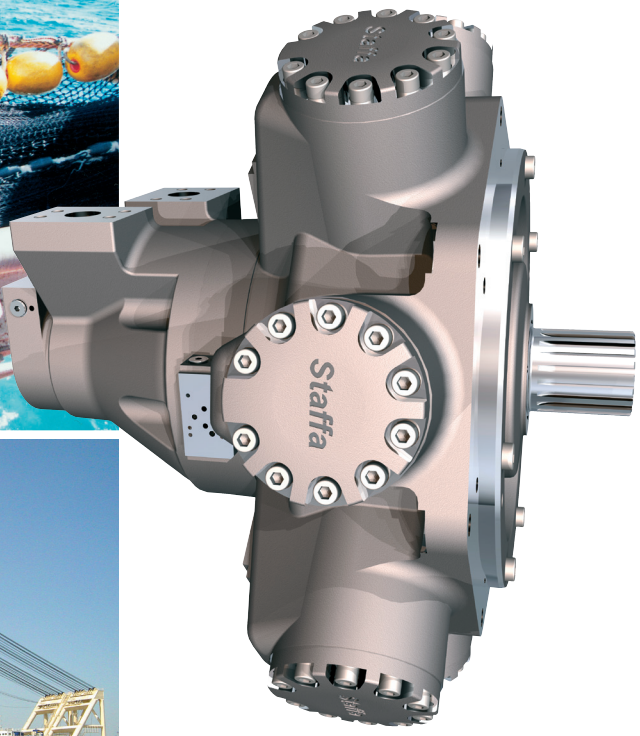
High Power HPC Series

Staffa

Dual Displacement Radial Piston Staffa Motor





Description

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 1600cc/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	6630	165	138
HPC125	8470	202	135
HPC200	12980	261	174
HPC270	19280	278	189
HPC325	22440	278	189

Key Features

- **Enhanced power performance**
- **Increased speed**
- **Improved starting and running efficiency**
- **Increased back pressure capability**
- High torques at low speed
- Smooth running
- Wide range of displacements to suit specific applications
- Displacements change with ease when the motor is running
- Electro-hydraulic or hydro-mechanical control methods available
- Various mounting options available

KPM
Kawasaki Precision Machinery

Content

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 electro-hydraulic control methods.

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

Note: To order the standard HMC series motor refer to bulletin data sheet M-1004

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 4 to 8. Refer to the table on this page for pressures and speed limits when using fire-resistant fluids.

Limits for fire resistant fluids

FLUID TYPE	CONTINUOUS PRESSURE (bar)	INTERMITTENT PRESSURE (bar)	MAX SPEED (r.p.m.)	MODEL TYPE
HFA 5/95 oil-in-water emulsion	130	138	50% of limits of petroleum oil	All models
HFB 60/40 water-in-oil emulsion	138	172	As for petroleum oil	All models
HFC water glycol	103	138	50% of limits of petroleum oil	All models
HFD phosphate ester	250	275	As for petroleum oil	All models

Specify make and type of fluid on your order if other than petroleum 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 50 r.p.m. 15% duty for periods up to 5 minutes maximum.
(b) Over 50 r.p.m. 2% duty for periods up to 30 seconds maximum.

Static pressure to DNV rules 380 bar.

HPC080 Motor (Crankcase flushing required)

Displacement Code		97.6	90	85	80	75	70	65	60	55	50
Displacement	cc/rev.	1600	1475	1393	1311	1229	1147	1065	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 start 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/SO3 valve assembly	r.p.m.	270	300	320	340	365	390	420	450	475	500
Max continuous speed F4/FM4/SO4 valve assembly	r.p.m.	365	400	415	430	445	460	475	490	500	515
Max continuous power F3/FM3/SO3 valve assembly	kW	165	157	152	147	145	140	134	131	125	120
Max continuous power F4/FM4/SO4 valve assembly	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 start 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/SO3 valve assembly	r.p.m.	550	600	615	630	630	630	630	630	1500
Max continuous speed F4/FM4/SO4 valve assembly	r.p.m.	530	545	560	575	585	600	615	630	1500
Max continuous power F3/FM3/SO3 valve assembly	kW	113	105	90	73	59	43	30	14	0
Max continuous power F4/FM4/SO4 valve assembly	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 250 bar. Intermediate displacements can be made available to special order.

HPC125 Motor (Crankcase flushing required)

Displacement Code		125	120	110	100	90	80	70	60	50	40
Displacement	cc/rev.	2048	1966	1802	1639	1475	1311	1147	983	819	655
Average actual running torque	Nm/bar	30.8	29.5	27.1	24.5	21.8	19.1	16.5	13.8	11.3	8.8
Average actual mechanical efficiency	%	94.5	94.4	94.3	94.0	93.0	91.7	90.3	88.5	86.5	84.3
Average actual start torque	Nm/bar	26.4	25.0	22.5	20.0	17.4	14.7	12.0	9.1	6.3	3.2
Average actual starting efficiency	%	81.0	80.1	78.4	76.6	74.2	70.6	65.4	58.1	48.3	30.6
Max continuous speed F3/FM3/SO3 valve assembly	r.p.m.	215	225	240	270	300	340	390	450	500	600
Max continuous speed F4/FM4/SO4 valve assembly	r.p.m.	300	310	340	365	400	430	460	490	515	545
Max continuous power F3/FM3/SO3 valve assembly	kW	173	173	171	170	157	147	123	101	86	65
Max continuous power F4/FM4/SO4 valve assembly	kW	202	196	183	171	157	147	123	101	86	65
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		30	20	10	00
Displacement	cc/rev.	492	328	164	0
Average actual running torque	Nm/bar	6.4	4.1	0.8	0
Average actual mechanical efficiency	%	81.6	78.0	30.0	0
Average actual start torque	Nm/bar	/	/	/	0
Average actual starting efficiency	%	/	/	/	0
Max continuous speed F3/FM3/SO3 valve assembly	r.p.m.	630	630	630	1500
Max continuous speed F4/FM4/SO4 valve assembly	r.p.m.	575	600	630	1500
Max continuous power F3/FM3/SO3 valve assembly	kW	48	30	5	0
Max continuous power F4/FM4/SO4 valve assembly	kW	48	30	5	0
Max continuous pressure	bar	250	250	250	17
Max intermittent pressure	bar	275	275	275	17

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

HPC200 Motor (Crankcase flushing required)

Displacement Code		188	180	170	160	150	140	130	120	110	100
Displacement	cc/rev.	3087	2950	2790	2620	2460	2290	2130	1970	1800	1639
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 start 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/SO3 valve assembly	r.p.m.	175	180	190	195	200	205	210	225	240	270
Max continuous speed F4/FM4/SO4 valve assembly	r.p.m.	230	235	240	245	250	265	285	310	340	365
Max continuous power F3/FM3/SO3 valve assembly	kW	216	213	212	204	195	186	176	173	171	170
Max continuous power F4/FM4/SO4 valve assembly	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.	1475	1311	1150	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 start 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/SO3 valve assembly	r.p.m.	300	340	390	450	500	600	630	630	630	1500
Max continuous speed F4/FM4/SO4 valve assembly	r.p.m.	400	430	460	485	515	545	575	600	630	1500
Max continuous power F3/FM3/SO3 valve assembly	kW	157	147	123	101	86	65	48	30	5	0
Max continuous power F4/FM4/SO4 valve assembly	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.

HPC270 Motor (Crankcase flushing required)

Displacement Code		280	250	220	200	180	160	140	120	100	80
Displacement	cc/rev.	4588	4097	3605	3277	2950	2622	2294	1966	1639	1311
Average actual running torque	Nm/bar	70.1	62.3	54.5	49.3	44.3	39.0	33.8	28.6	23.5	18.4
Average actual mechanical efficiency	%	96.0	95.6	95.0	94.6	94.3	93.5	92.5	91.5	90.0	88.0
Average actual start torque	Nm/bar	64.0	56.6	48.9	43.6	38.4	33.2	28.3	23.5	19.0	14.7
Average actual starting efficiency	%	87.6	86.9	85.2	83.7	81.8	79.7	77.5	75.1	72.6	70.2
Max continuous speed	r.p.m.	150	160	170	175	210	230	275	310	375	430
Max continuous power	kW	278	261	241	225	208	192	174	156	133	109
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		60	40	30	20	00
Displacement	cc/rev.	983	655	492	328	00
Average actual running torque	Nm/bar	13.4	8.6	6.3	4.0	0
Average actual mechanical efficiency	%	85.5	82.0	80.0	76.0	0
Average actual start torque	Nm/bar	9.1	4.3	1.9	/	0
Average actual starting efficiency	%	57.8	40.7	23.5	/	0
Max continuous speed	r.p.m.	460	490	515	545	1500
Max continuous power	kW	85	48	39	21	0
Max continuous pressure	bar	250	250	250	250	17
Max intermittent pressure	bar	275	275	275	275	17

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

HPC325 Motor (Crankcase flushing required)

Displacement Code		325	310	300	220	200	180	160	140	120	100
Displacement	cc/rev.	5326	5080	4916	3605	3277	2950	2622	2294	1966	1639
Average actual running torque	Nm/bar	81.6	77.8	75.2	54.5	49.3	44.1	38.8	33.6	28.5	23.3
Average actual mechanical efficiency	%	96.3	96.2	96.1	95.0	94.6	94.0	93.1	92.1	91.0	89.2
Average actual start torque	Nm/bar	74.5	71.1	68.7	49.0	43.9	38.8	33.8	28.8	24.0	19.3
Average actual starting efficiency	%	87.9	87.9	87.8	85.4	84.2	82.8	81.0	78.9	76.5	73.8
Max continuous speed	r.p.m.	130	135	140	170	190	215	230	275	330	370
Max continuous power	kW	278	278	278	241	225	208	192	174	156	133
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		95	80	60	40	30	00
Displacement	cc/rev.	1557	1311	983	655	492	0
Average actual running torque	Nm/bar	22.0	18.2	13.2	8.5	6.3	0
Average actual mechanical efficiency	%	88.8	87.2	84.6	81.6	80.0	0
Average actual start torque	Nm/bar	18.1	14.8	9.0	4.2	1.9	0
Average actual starting efficiency	%	73.0	70.7	57.8	40.7	23.5	0
Max continuous speed	r.p.m.	405	440	460	495	515	1500
Max continuous power	kW	127	110	86	48	39	0
Max continuous pressure	bar	250	250	250	250	250	17
Max intermittent pressure	bar	275	275	275	275	275	17

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

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	1639	9.5	45.7	5.8	7.9
HPC125	2048	6.1	38.5	3	4.25
HPC200	3087	6.1	38.5	2	4.25
HPC270	4310	6.5	37.3	1.5	6
HPC325	5210	6.8	40	1.3	6

FLUID VISCOSITY cSt	VISCOSITY FACTOR Kv
20	1.58
25	1.44
30	1.3
40	1.1
50	1
60	0.88

Q_t *(total leakage)* = $[K_1 + n/K_2] \times \Delta P \times K_v \times 0.005$ *(lpm)*

Creep speed = $K_3 \times \Delta P \times K_v \times 0.005$ *(rpm)*

Crankcase leakage = $K_4 \times \Delta P \times K_v \times 0.005$ *(lpm)*

ΔP = differential pressure *(bar)*

n = speed *(rpm)*

The motor volumetric efficiency can be calculated as follows:

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

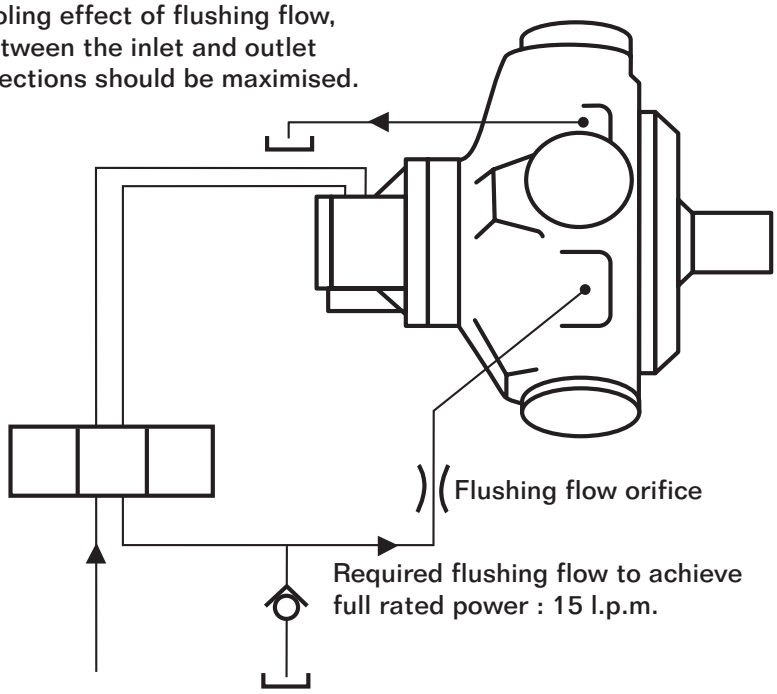
Example:
HPC200 motor with displacement of 3.087 l/rev.

Speed 60 rpm
Differential pressure 200 bar
Fluid viscosity 50 cSt

Total leakage = $(K_1 + n/K_2) \times \Delta P \times K_v \times 0.005$ *(lpm)*
= $(6.1 + 60/38.5) \times 200 \times 1 \times 0.005$
= 7.7 l.p.m.

Volume efficiency = $\left[\frac{(60 \times 3.087)}{(60 \times 3.087) + 7.7}\right] \times 100$
= **96%**

In order to achieve the maximum shaft power, a crankcase flushing flow of 15 l.p.m. 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.



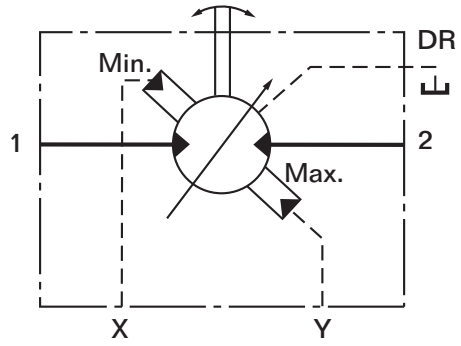
Check valve pressure (bar) *	Orifice diameter (mm)
3	4.4
4	4.1
5	3.9
6	3.7
7	3.6
8	3.5
9	3.4
10	3.3

* 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.

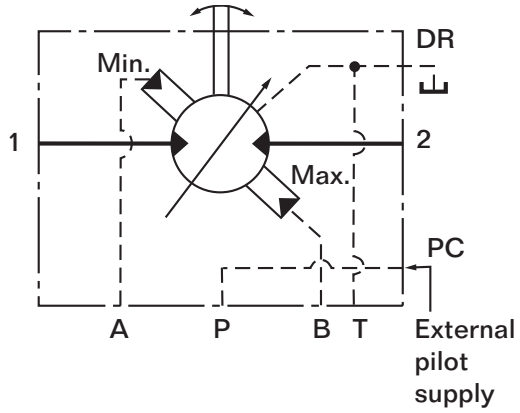
Example model code:
HPC***/P/***/**/FM3/X/...

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



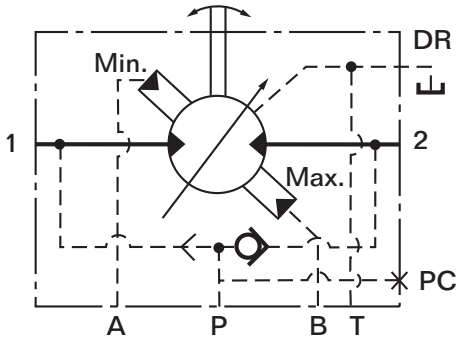
Example model code:
HPC***/P/***/**/FM3/C/...

C - single external supply to PC port



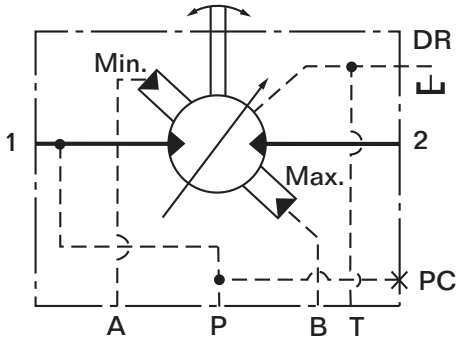
Example model code:
HPC***/P/***/**/FM3/CS/...

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.

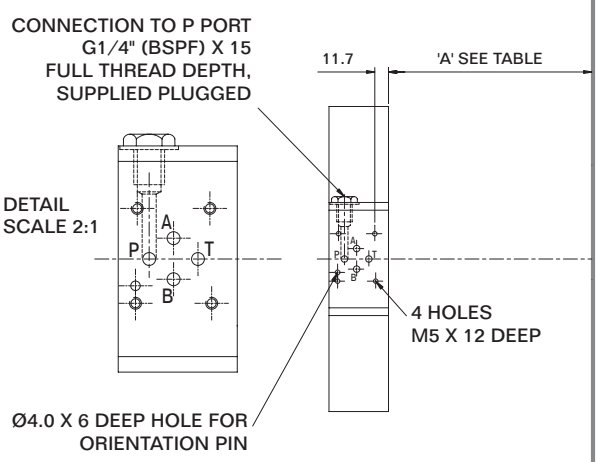
Pressure ports in FM3 & FM4 valve housings can be called up as special features when required.

Example model code - HPC270/S/280/FM4/X/70

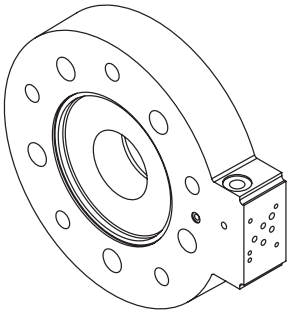
Types: C, CS & C1

MOUNTING INTERFACE FOR DIRECTIONAL CONTROL VALVE*
TO: ISO 4401 SIZE 03/ANSI B93,7M SIZE D03.
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR; SPECIFY & ORDER SEPARATELY

MOUNTING FACE

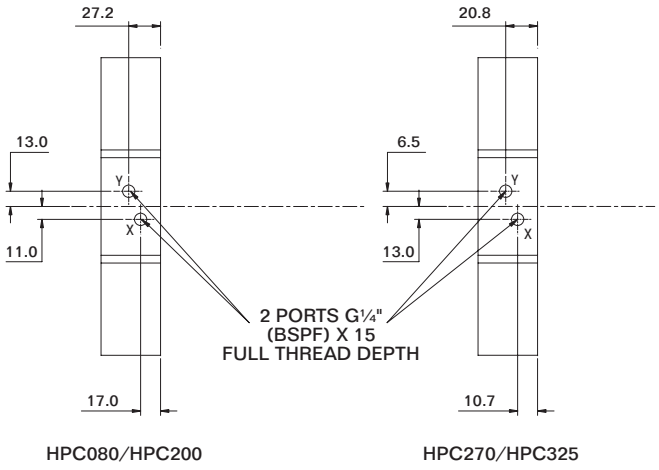


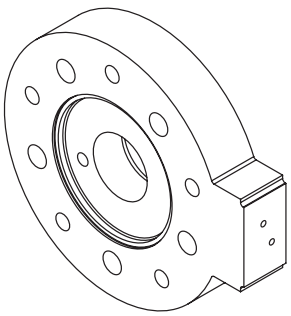
DISPLACEMENT SELECTION:
HIGH DISPLACEMENT: P TO B; A TO T
LOW DISPLACEMENT: P TO A; B TO T



Frame Size	Dim 'A'	Dim 'B'
HPC080	173.5	477.0
HPC125	203.8	507.0
HPC200	216.4	520.0
HPC270	232.4	538.0
HPC325	232.4	538.0

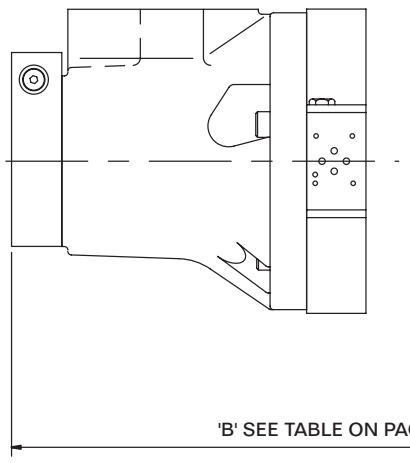
Type: X





DISPLACEMENT SELECTION (VIA REMOTELY LOCATED VALVE*)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR; SPECIFY & ORDER SEPARATELY

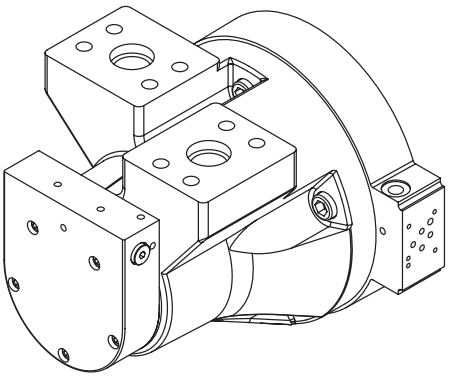
Example model code - HPC200/S3/180/60/FM4/CS/70

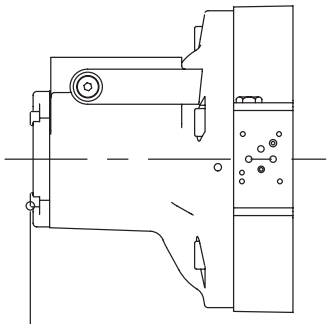


'B' SEE TABLE ON PAGE 12

MOUNTING FACE

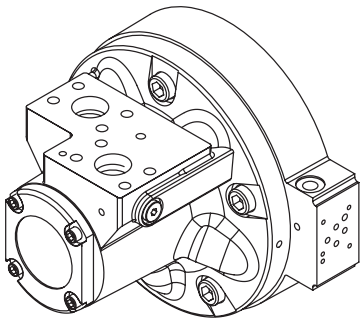
CS Type shuttle endcap on F4 & FM4 assemblies only





SEE VALVE HOUSING PAGE

CS Type shuttle on F3 & FM3 assemblies only



REFER TO CIRCUIT DIAGRAM ON PAGE 11 FOR 'CS' C-SPACERS

When applying large external radial loads, consideration should also be given to motor bearing lives, *(see page 14)*.

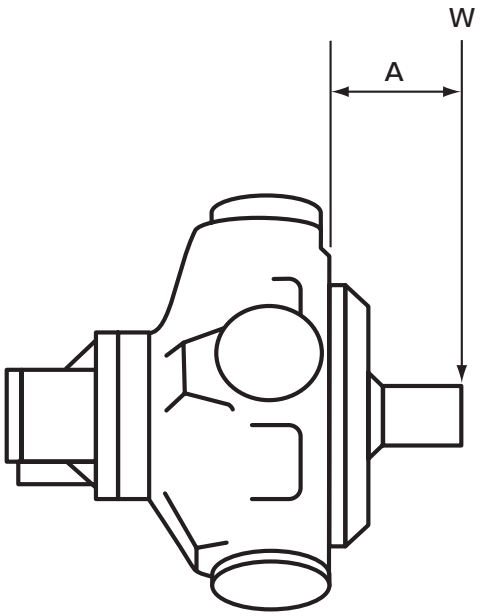
Motor type	Maximum external radial bending moment (kNmm)
HPC080	4500
HPC125	6500
HPC200	6750
HPHDC200	12200
HPC270	8250
HPHDC270	16000
HPC325	8250

Example:
Determine the maximum radial shaft load of a HPC080 motor:

Radial load offset, A = 100mm

Maximum radial load, W = 4500 *(see table)*/100

= 45kN (4587 kg)



A = Distance from mounting face to load centre

W = Side load

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

1. Duty cycle - time spent on and off load
2. Speed
3. Differential pressure
4. Fluid viscosity, type, cleanliness and temperature
5. External radial shaft load
6. External axial shaft load

A heavy duty HP(HD)C motor can be ordered to further improve bearing life. Consult KPM for further details.

Displacement selection

To select either displacement, a pressure at least equal to 2/3 of the motor inlet/outlet pressure *(whichever is higher)* is required. In most applications the motor inlet pressure will be used. 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 3-8).*

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 r.p.m., then consult KPM.

If possible, always start the motor in high displacement.

Small displacements

The pressures given in the table on pages 4 to 8 for displacement code "00" are based on 1000 r.p.m. output shaft speed. This pressure can be increased for shaft speeds less than 1000 r.p.m.; consult Kawasaki for details. Speeds greater than 1000 r.p.m. may be applied but only after the machine duty cycle has been considered in conjunction with KPM.

A zero swept volume displacement *(for freewheeling requirements)* is available on request, consult KPM.

High back pressure

When both inlet and outlet ports are pressurised continuously, the lower pressure port must not exceed **100 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:

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

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

Motor	Porting	Constant (K)
HPC080	FM3, S03, F3	1.6×10^{10}
HPC125	FM3, S03, F3	1.6×10^{10}
HPC200	F3, FM3, S03	1.6×10^{10}
	F4, FM4, S04	3.3×10^{10}
HPC270	S04, F4, FM4	4×10^{10}
HPC325	S04, F4, FM4	4×10^{10}

The flow rate of oil for the make-up system can be estimated from the crankcase leakage data *(see pages 9)* plus an allowance for changing displacement:

e.g.

HPC080	To change high to low in 0.25 sec requires 32 l.p.m.
HPC125	To change high to low in 0.5 sec requires 15 l.p.m.
HPC200	To change high to low in 0.5 sec requires 15 l.p.m.
HPC270	To change high to low in 1 sec requires 24 l.p.m.
HPC325	To change high to low in 1 sec requires 20 l.p.m.

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 25 to 34)* for maximum crankcase drain fitting depth.

Hydraulic fluids

Dependent on motor *(see model code fluid type - page 38)* 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 3.
Viscosity limits when using any fluid except oil-in-water *(5/95)* emulsions are:

Max. off load:	2000 cSt *(9270 SUS)*
Max. on load:	150 cSt *(695 SUS)*
Optimum:	50 cSt *(232 SUS)*
Minimum:	25 cSt *(119 SUS)*

Temperature limits

Ambient min. -30°C
Ambient max. +70°C
Max. operating temperature range.

	Petroleum 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. Note: If a CP valve is used, then 17/13 or cleaner is recommended.

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 Inertia

Typical data:

Motor	Displacement code	Kgm^2
HPC080	90	0.052
	45	0.044
HPC125	125	0.20
	50	0.14
HPC200	188	0.23
	75	0.18
HPC270	280	0.83
	100	0.61
HPC325	325	0.87
	100	0.61

Mass

HPC080 Approx. all models 172kg.
HPC125 Approx. all models 235kg.
HPC200 Approx. all models 282kg.
HPC270 Approx. all models 450kg.
HPC325 Approx. all models 460kg.

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 2000 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 5 l/m 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
Medium pressure shaft seal	below minus 40 and above 100 degrees C	minus 30 degrees C
High pressure shaft seal	below minus 30 and above 120 degrees C	minus 15 degrees C

All seals are very brittle at minus 40^{O} 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^{O} C.

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

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 will be dependent on speed and displacement.

It should be noted that for 'B' series motors large flows will re-circulate around the motor. This will require a large re-circulating valve and consideration of circuit cooling as the motor will generate 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 10, 05 or 00.

Selecting the lowest available displacement of zero *(00)* will allow the motor shaft to be rotated at high speed without pumping fluid and with a minimum boost requirement. This will result in a minimum drive torque requirement for the freewheeling motor. Examples of the freewheeling feature on a winch are : dropping the load quickly in the case of an emergency and paying out cable. Consideration should be given when freewheeling such that the load does not drive the motor above its rated freewheeling speed.

Displacement selection

If the motor inlet/outlet pressure is below 3.5 bar, then a minimum 3.5 bar control pressure is required in order to ensure that the motor remains in minimum displacement. It should be noted that in the event of loss of control pressure, the motor will shift to its highest displacement, which could result in damage to the motor. When freewheeling with displacement codes: 00, 05 or 10, it can be difficult to generate a 3.5 bar pressure. In these circumstances it is necessary to feed the displacement change control circuit from a separate source thus ensuring a minimum control pressure of 3.5 bar. Under all operating conditions the control pressure port should be at least 2/3 of the motor inlet/outlet pressure ports.

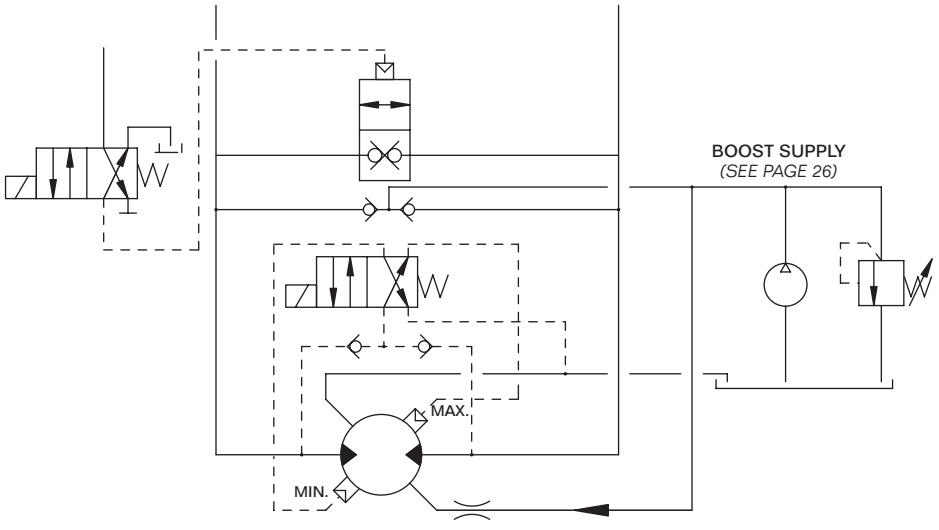
Boost requirement

The required boost pressure is detailed on page 15. The actual required level will be determined by the expected maximum speed in maximum displacement during the overrunning condition. A maximum motor and control pressure of 17 bar at 1000 r.p.m. is stated in the bulletins, although for purposes of freewheeling it is better to maintain a minimum boost level that satisfies all motor operating conditions. The Staffa motor bulletin boost formulae does not apply to freewheeling displacements. High boost levels will increase motor losses at the conrod slipper interface and valve assembly, which will 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.p.m. can be used to control and reduce the temperature rise of the motor during the freewheeling operation. This should not be necessary for motor speeds upto 1000 r.p.m. If operating at speeds above 1000 r.p.m., then consult KPM.



TYPICAL FREEWHEEL CIRCUIT
(EXAMPLE MODEL CODE - HPC200/S3/188/00/FM3/CS/70)

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 0.15mm. 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:

M18	312 +/– 7 Nm
5/8" UNF	265 +/– 14 Nm
M20	407 +/– 14 Nm
3/4" 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 0.13mm TIR.

Motor axis - horizontal
The crankcase drain must be taken from a position above the horizontal centre line of the motor, *(see page 22).*

Motor axis - vertical shaft up
The recommended minimum pipe size for drain line lengths up to approx. 5m is 12.0mm 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, G1/4" *(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.

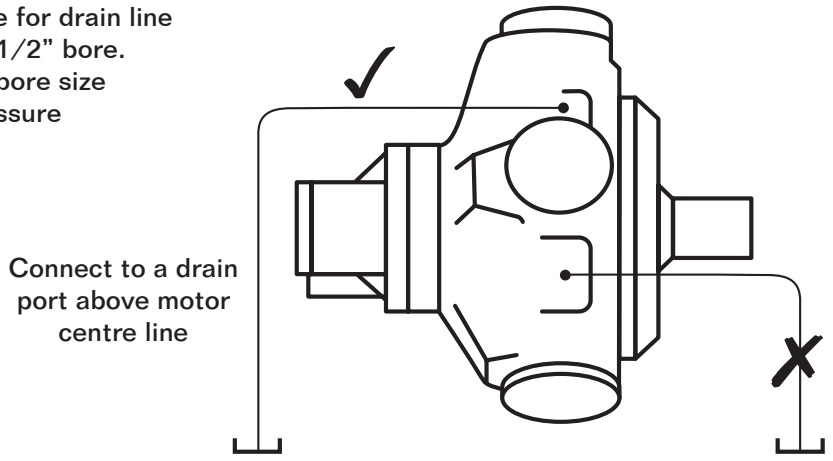
Any of the drain port positions can be used, but the drain line should be run above the level of the uppermost bearing and if there is risk of syphoning then a syphon breaker should be fitted.

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 set to its high displacement.

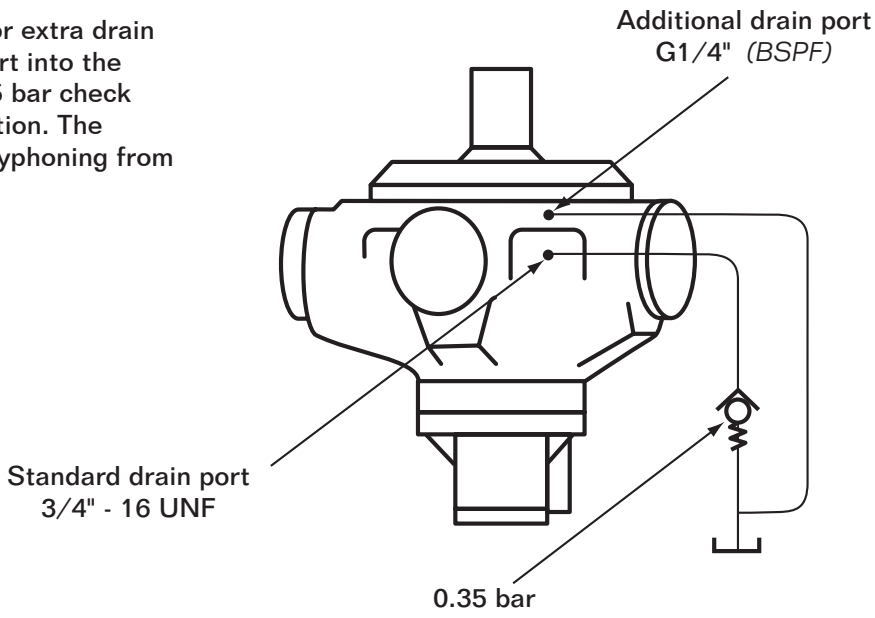
Motor axis - horizontal

The recommended minimum pipe size for drain line lengths up to approx. 5m is 12.0mm 1/2" bore. Longer drain lines should have their bore size increased to keep the crankcase pressure within limits.



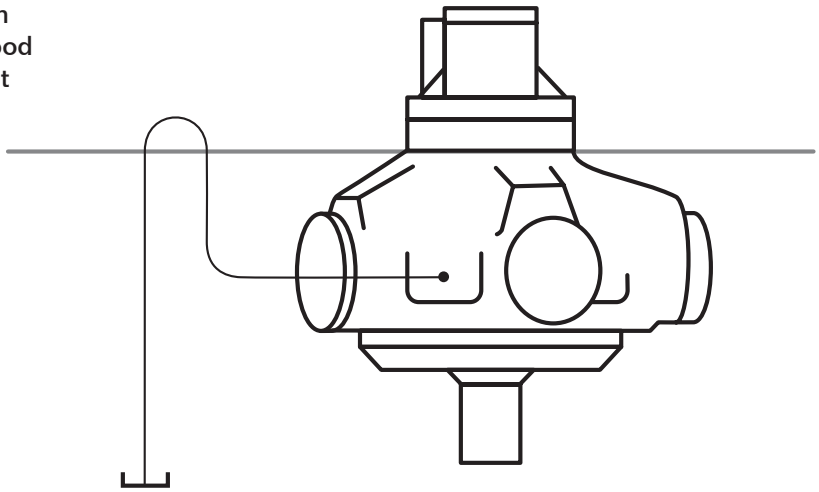
Motor axis - vertical shaft up

Specify "V" within the model code for extra drain port, G1/4" *(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.



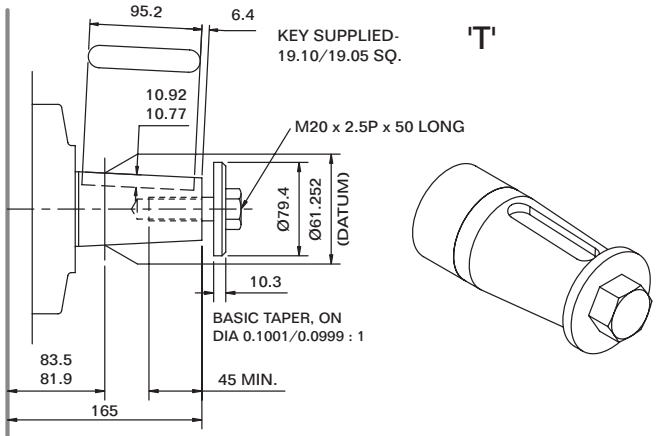
Motor axis - vertical shaft down

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.

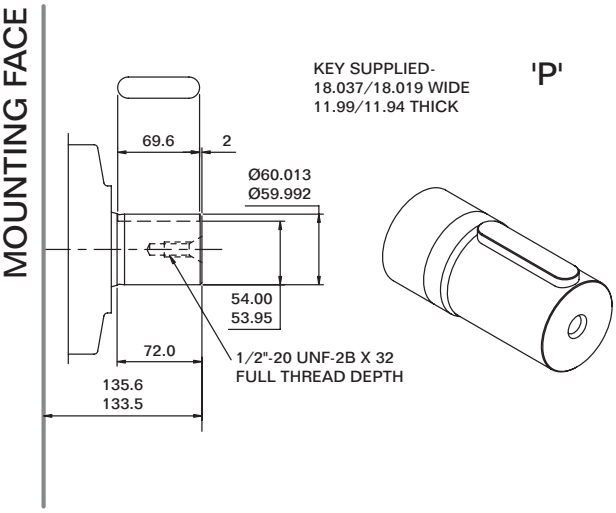


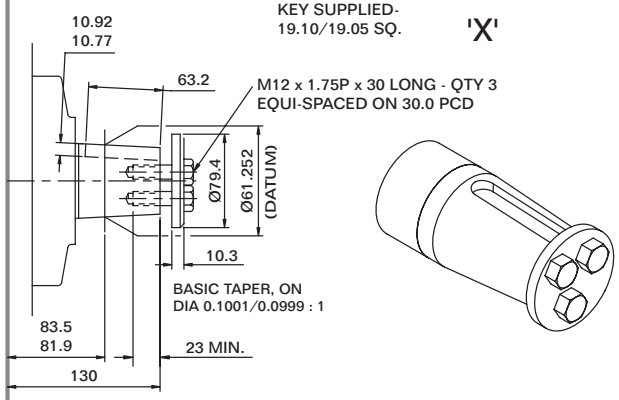
HPC080 - Example model code - HPC080/P/90/20/FM3/X/70

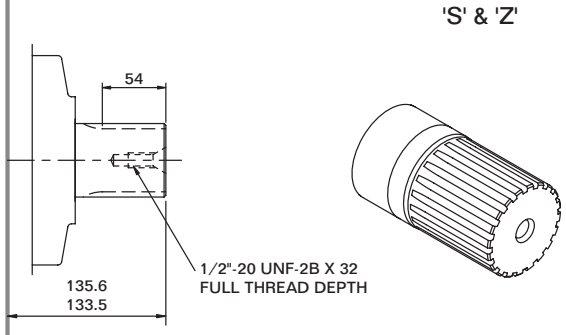
MOUNTING FACE



MOUNTING FACE







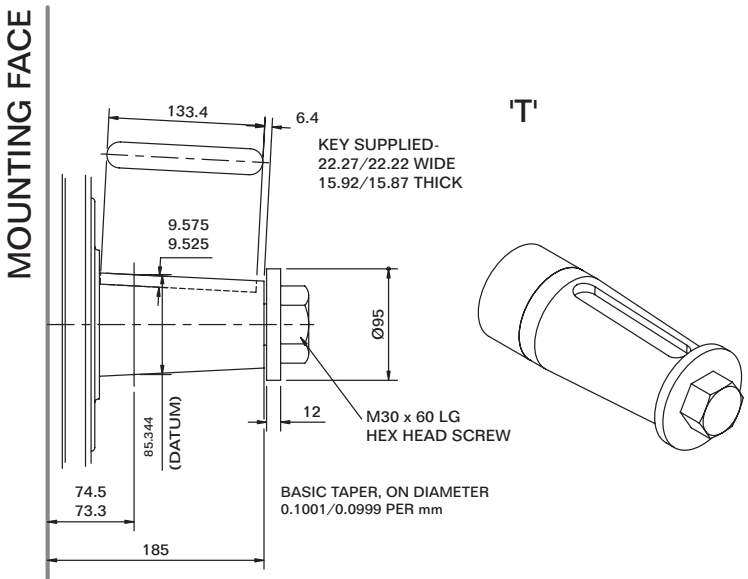
SPLINE DATA

'S'	
TO BS 3550-1963	
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

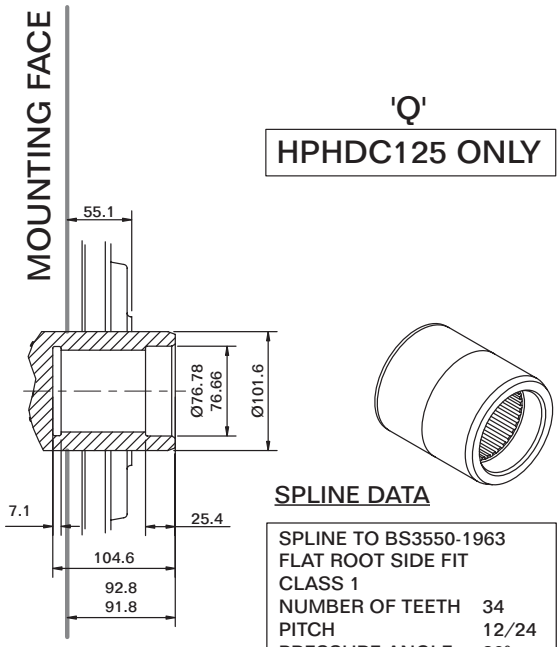
HPC125 - Example model code - HPC125/P1/125/100/FM3/X/70

'T'



'Q'

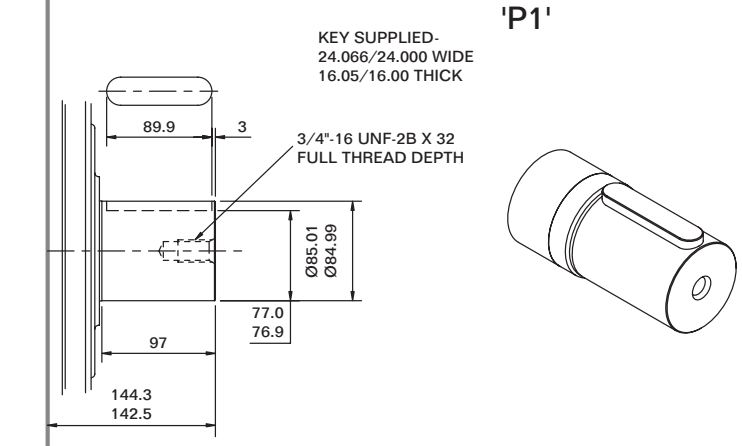
HPHDC125 ONLY



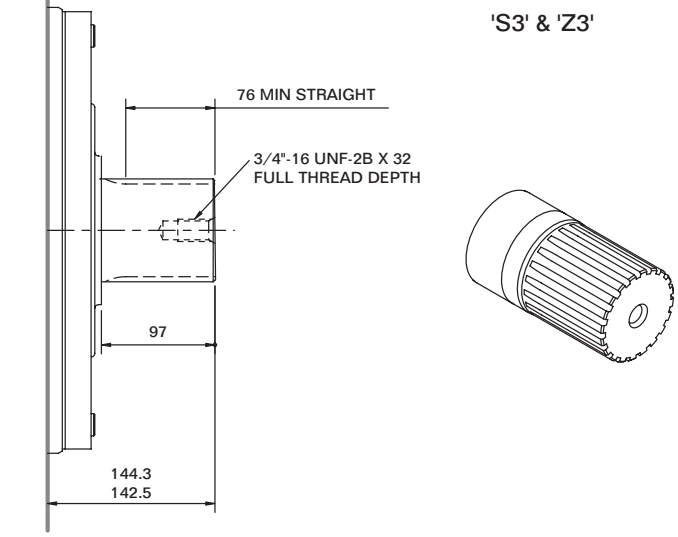
SPLINE DATA

SPLINE TO BS3550-1963	
FLAT ROOT SIDE FIT	
CLASS 1	
NUMBER OF TEETH	34
PITCH	12/24
PRESSURE ANGLE	30°

'P1'



'S3' & 'Z3'

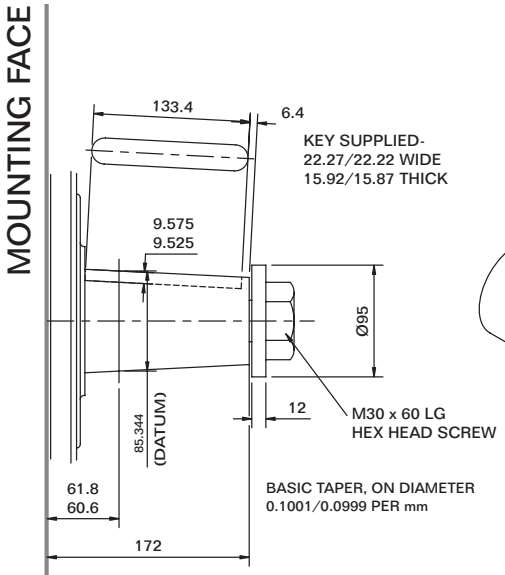


SPLINE DATA

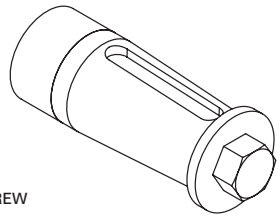
'S3'	
TO BS 3550-1963	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

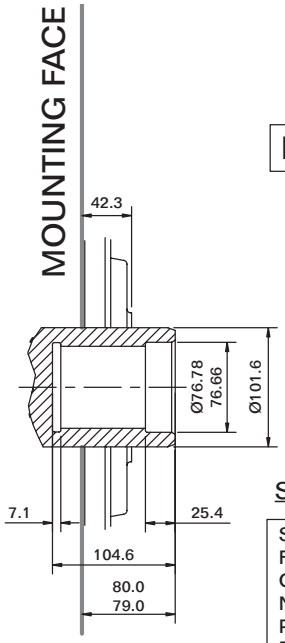
'Z3'
DIN 5480 W85 x 3 x 27 x 7h

HPC200 - Example model code - HPC200/P1/180/60/FM3/X/70



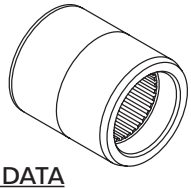
'T'





'Q'

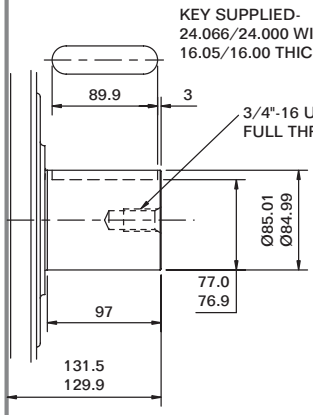
HPHDC200 ONLY

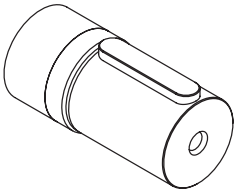


SPLINE DATA

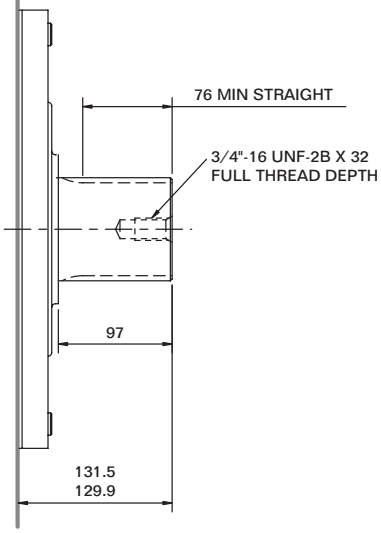
SPLINE TO BS3550-1963	
FLAT ROOT SIDE FIT	
CLASS 1	
NUMBER OF TEETH	34
PITCH	12/24
PRESSURE ANGLE	30°

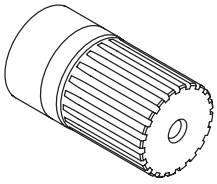
'P1'





'S3' & 'Z3'





SPLINE DATA

'S3'

TO BS 3550-1963	
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'

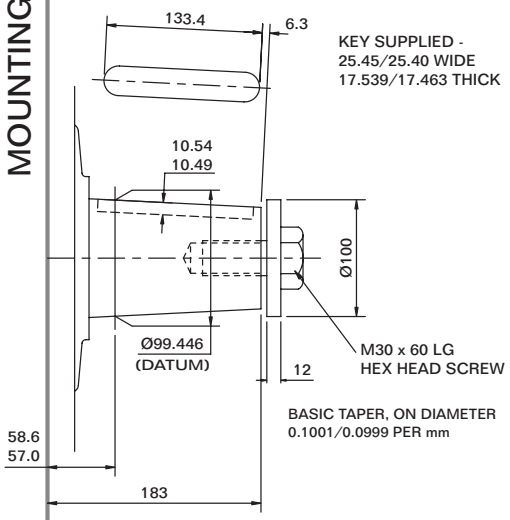
DIN 5480 W85 x 3 x 27 x 7h

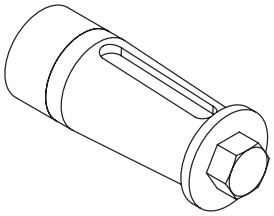
HPC270/HPC325 - Example model code - HPC270/S3/280/60/FM4/X/70

- Example model code - HPC325/S3/300/60/FM4/X/72

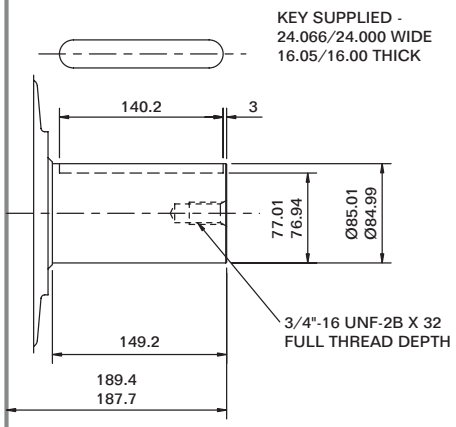
MOUNTING FACE

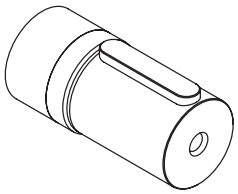
'T'



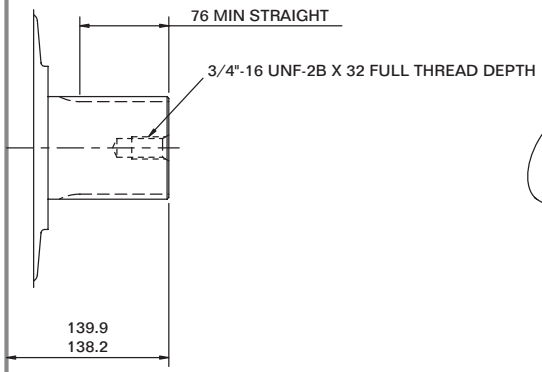


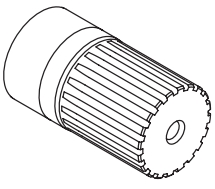
'P1'





'S3' & 'Z4'





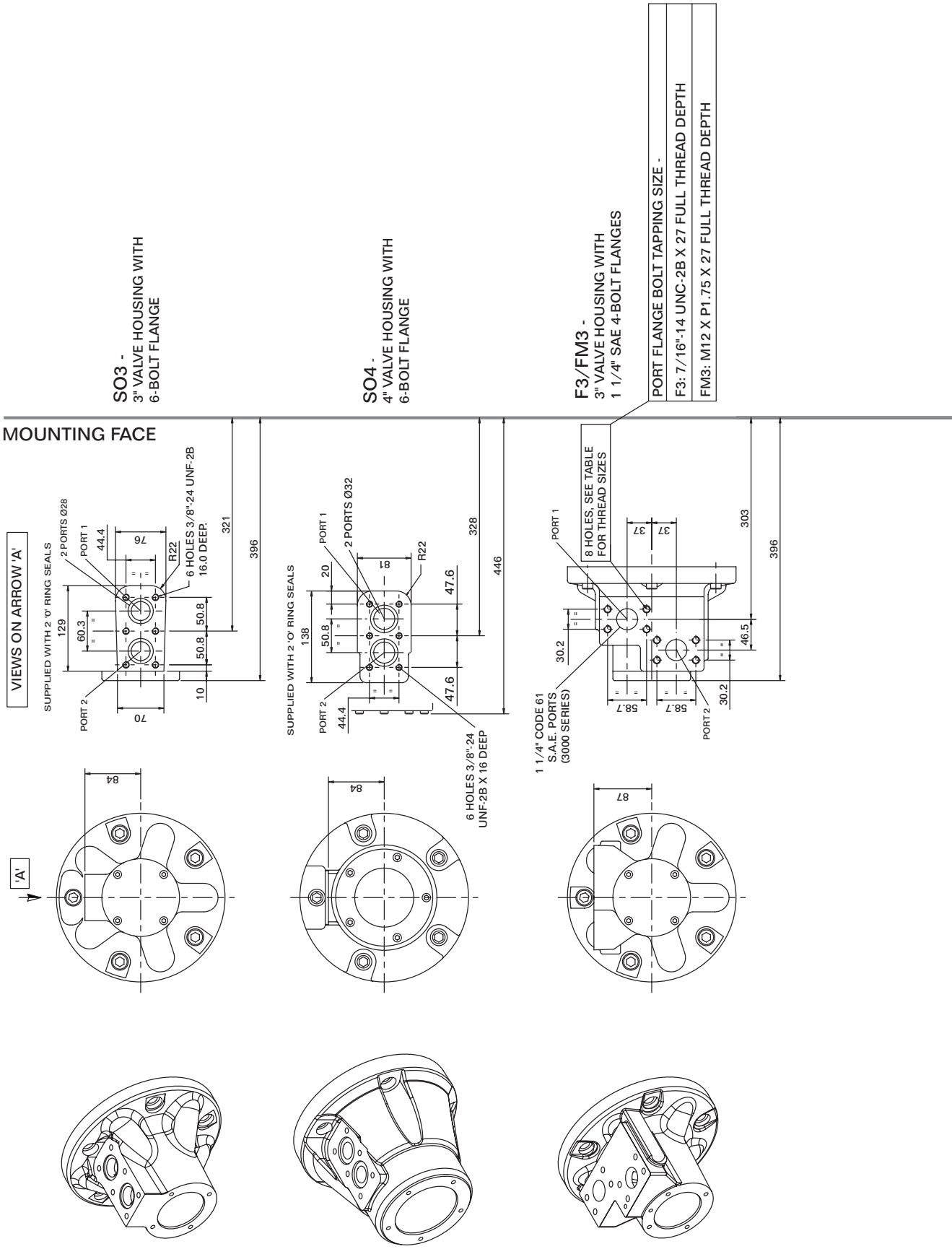
SPLINE DATA

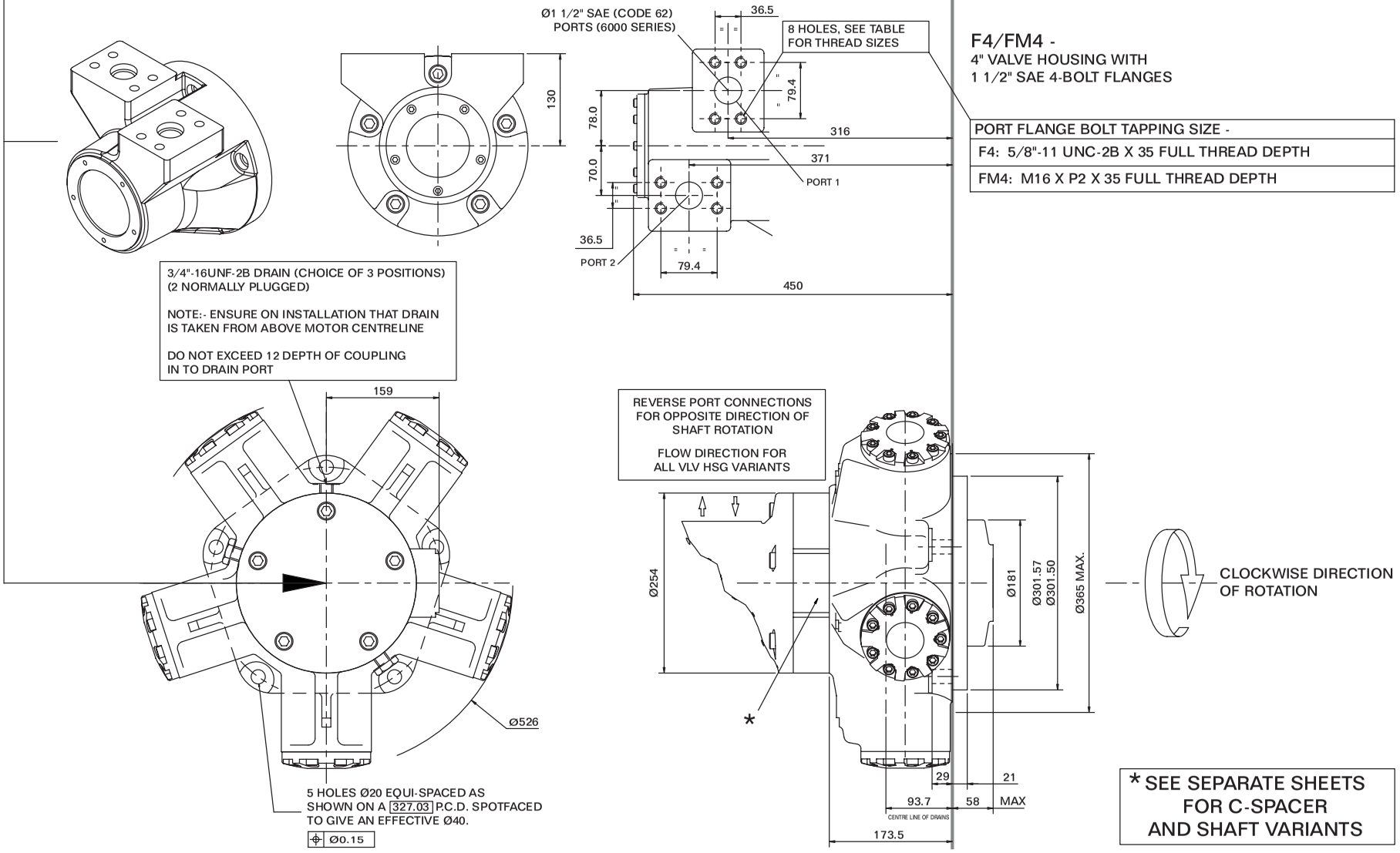
'S3'
TO BS 3550-1963
FLAT ROOT SIDE FIT, CLASS 1

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

Example model code - HPC080/P/90/20/FM3/X/70





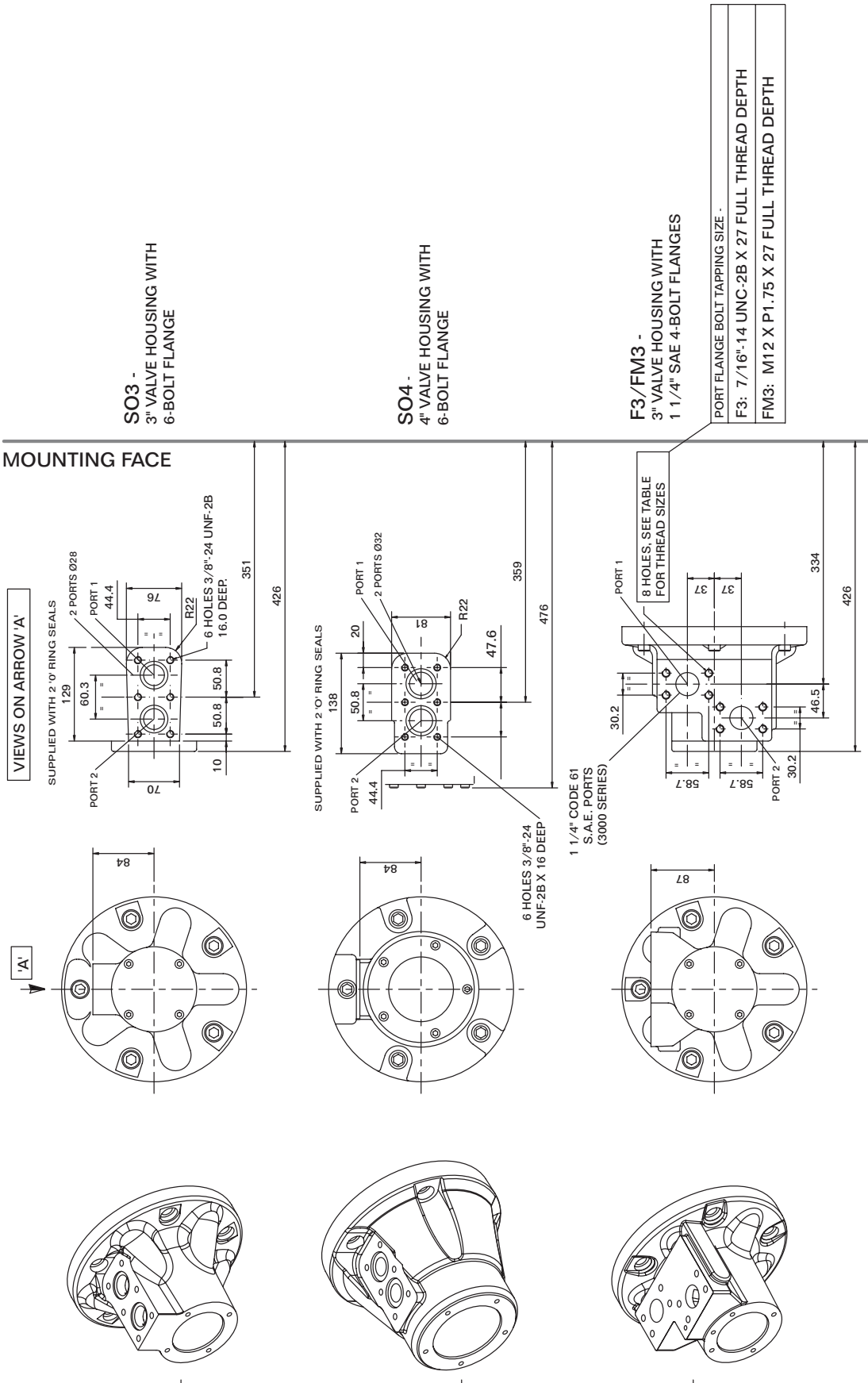
F4/FM4 -

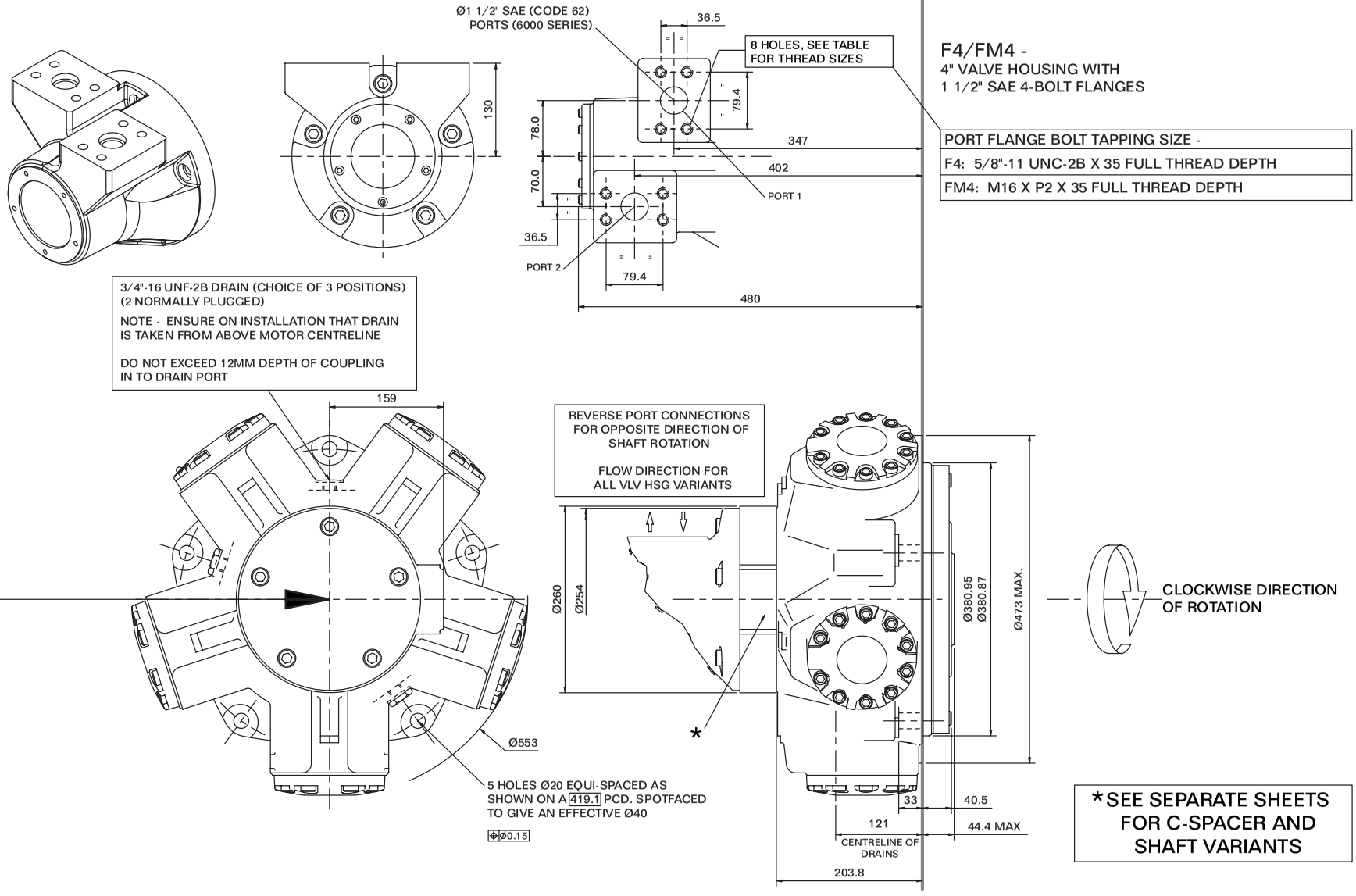
4" VALVE HOUSING WITH
1 1/2" SAE 4-BOLT FLANGES

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

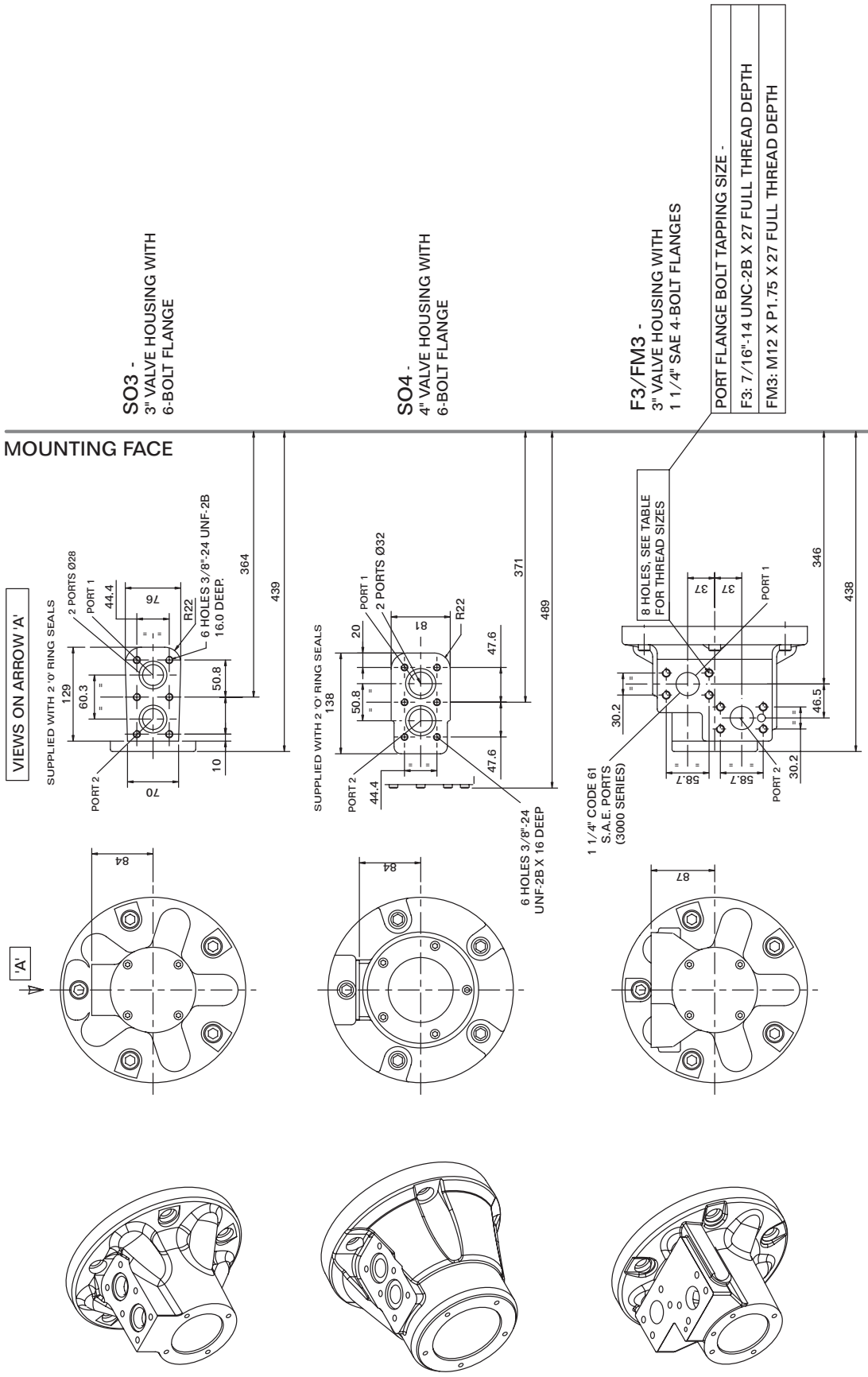
*SEE SEPARATE SHEETS
FOR C-SPACER
AND SHAFT VARIANTS

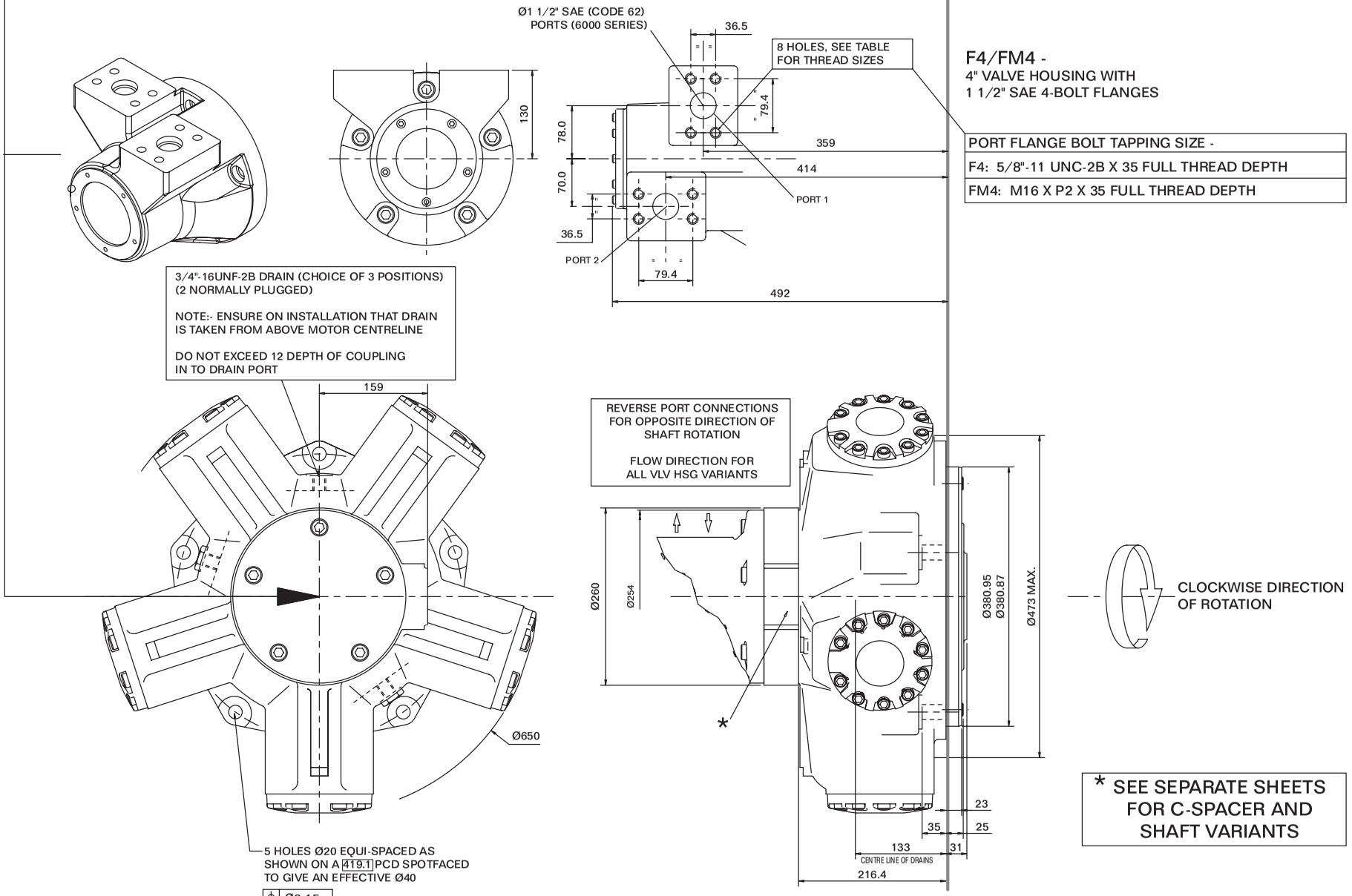
Example model code - HPC125/S3/125/100/FM3/X/70



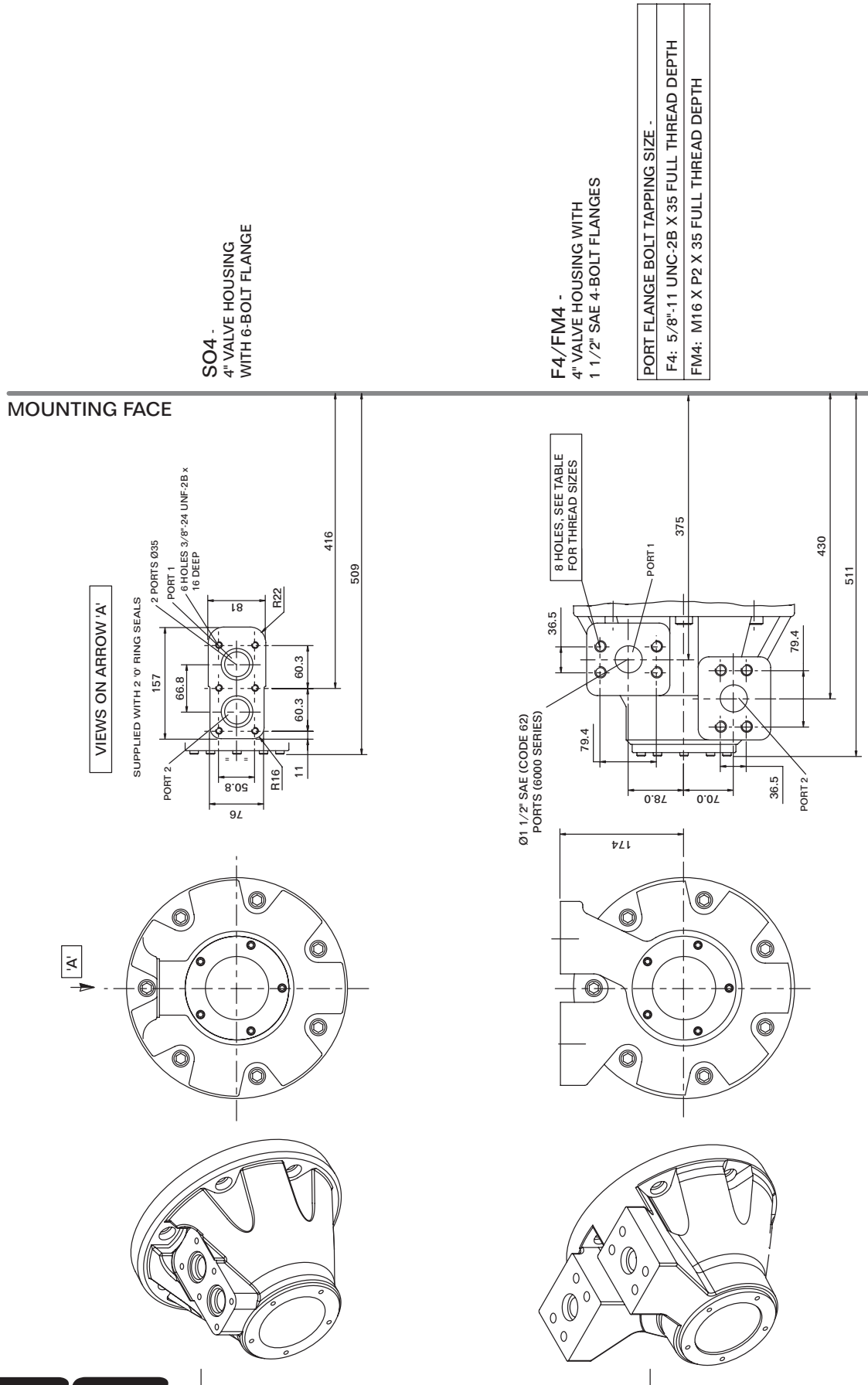

Ø1 1/2" SAE (CODE 62)
PORTS (6000 SERIES)
36.5
8 HOLES, SEE TABLE
FOR THREAD SIZES
F4/FM4 -
4" VALVE HOUSING WITH
1 1/2" SAE 4-BOLT FLANGES
130
78.0
79.4
347
402
70.0
PORT 1
36.5
PORT 2
79.4
480
PORT FLANGE BOLT TAPPING SIZE -
F4: 5/8"-11 UNC-2B X 35 FULL THREAD DEPTH
FM4: M16 X P2 X 35 FULL THREAD DEPTH
3/4"-16 UNF-2B DRAIN (CHOICE OF 3 POSITIONS)
(2 NORMALLY PLUGGED)
NOTE - ENSURE ON INSTALLATION THAT DRAIN
IS TAKEN FROM ABOVE MOTOR CENTRELINE
DO NOT EXCEED 12MM DEPTH OF COUPLING
IN TO DRAIN PORT
159
REVERSE PORT CONNECTIONS
FOR OPPOSITE DIRECTION OF
SHAFT ROTATION
FLOW DIRECTION FOR
ALL VLV HSG VARIANTS
Ø260
Ø254
Ø380.95
Ø380.87
Ø473 MAX.
CLOCKWISE DIRECTION
OF ROTATION
*
Ø553
5 HOLES Ø20 EQUI-SPACED AS
SHOWN ON A 419.1 PCD. SPOTFACED
TO GIVE AN EFFECTIVE Ø40
⌖Ø0.15
33
40.5
121
44.4 MAX
CENTRELINE OF
DRAINS
203.8
*SEE SEPARATE SHEETS
FOR C-SPACER AND
SHAFT VARIANTS

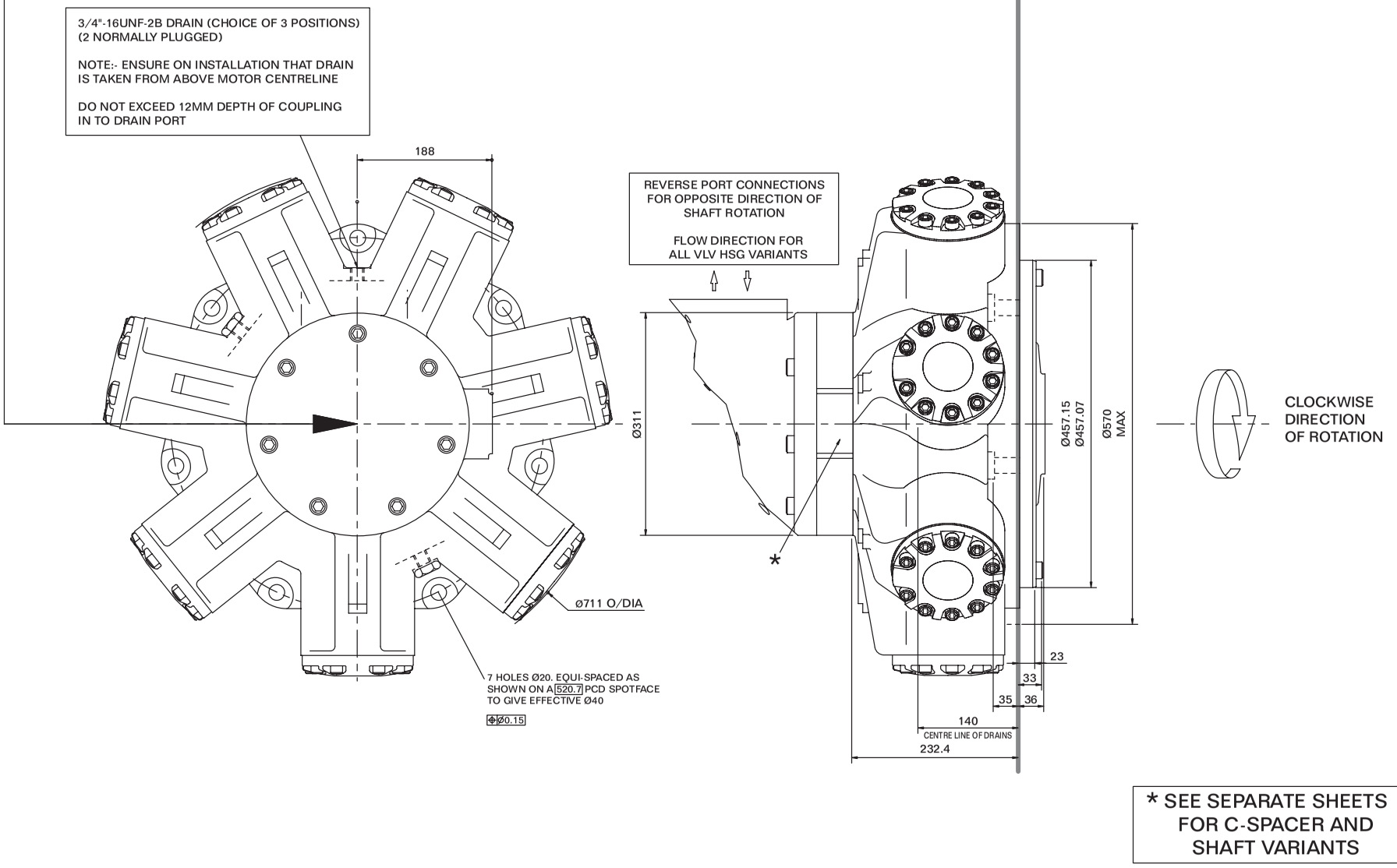
Example model code - HPC200/S3/180/60/FM3/X/70




Ø1 1/2" SAE (CODE 62)
PORTS (6000 SERIES)
36.5
8 HOLES, SEE TABLE
FOR THREAD SIZES
79.4
130
78.0
359
414
70.0
PORT 1
36.5
PORT 2
79.4
492
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
3/4"-16UNF-2B DRAIN (CHOICE OF 3 POSITIONS)
(2 NORMALLY PLUGGED)
NOTE:- ENSURE ON INSTALLATION THAT DRAIN
IS TAKEN FROM ABOVE MOTOR CENTRELINE
DO NOT EXCEED 12 DEPTH OF COUPLING
IN TO DRAIN PORT
159
REVERSE PORT CONNECTIONS
FOR OPPOSITE DIRECTION OF
SHAFT ROTATION
FLOW DIRECTION FOR
ALL VLV HSG VARIANTS
Ø260
Ø254
Ø380.95
Ø380.87
Ø473 MAX.
CLOCKWISE DIRECTION
OF ROTATION
*
Ø650
23
35
25
133
31
CENTRE LINE OF DRAINS
216.4
5 HOLES Ø20 EQUI-SPACED AS
SHOWN ON A 419.1 PCD SPOTFACED
TO GIVE AN EFFECTIVE Ø40
Ø0.15
* SEE SEPARATE SHEETS
FOR C-SPACER AND
SHAFT VARIANTS

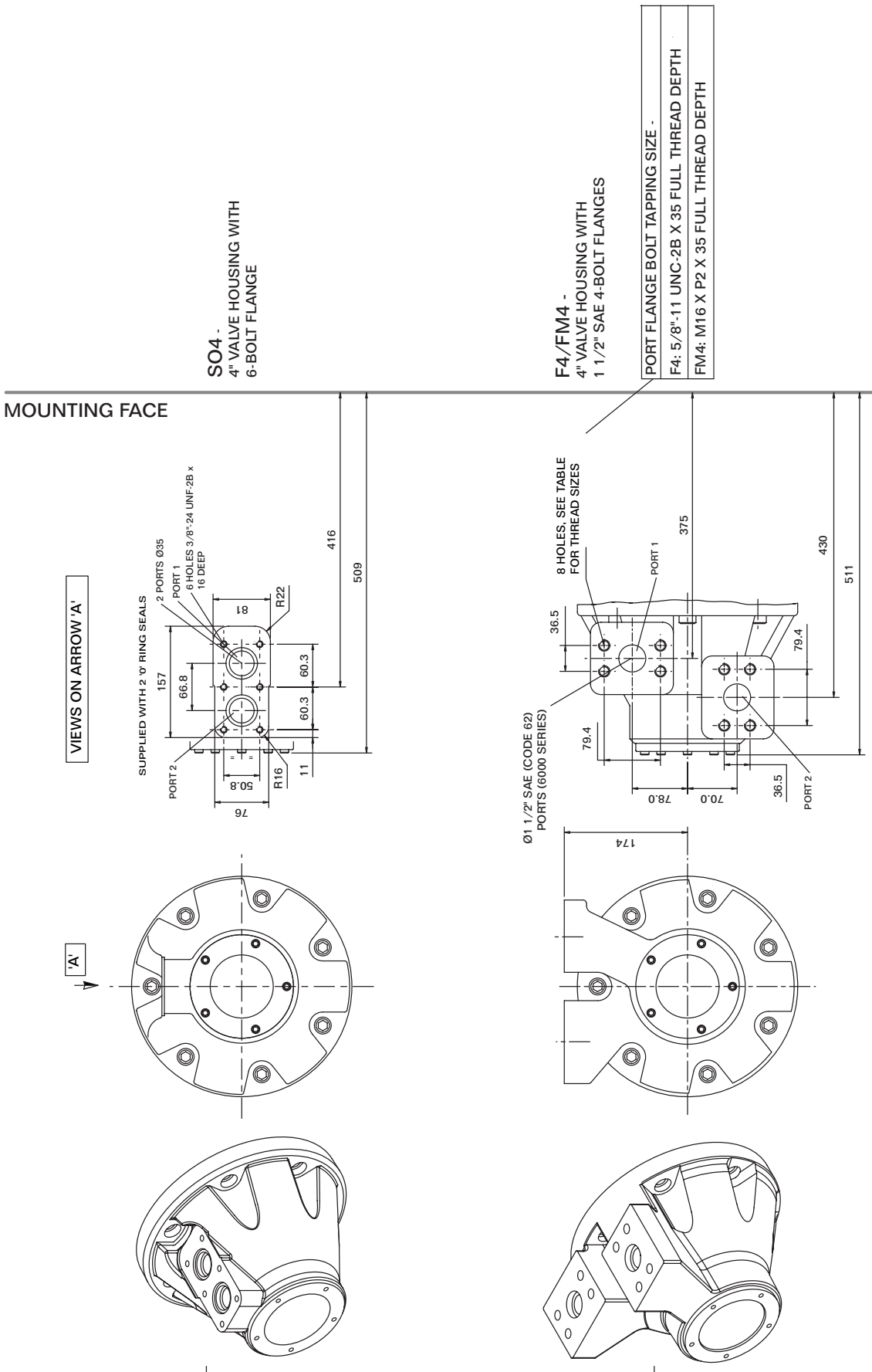
Example model code - HPC270/S3/280/60/FM4/X/70

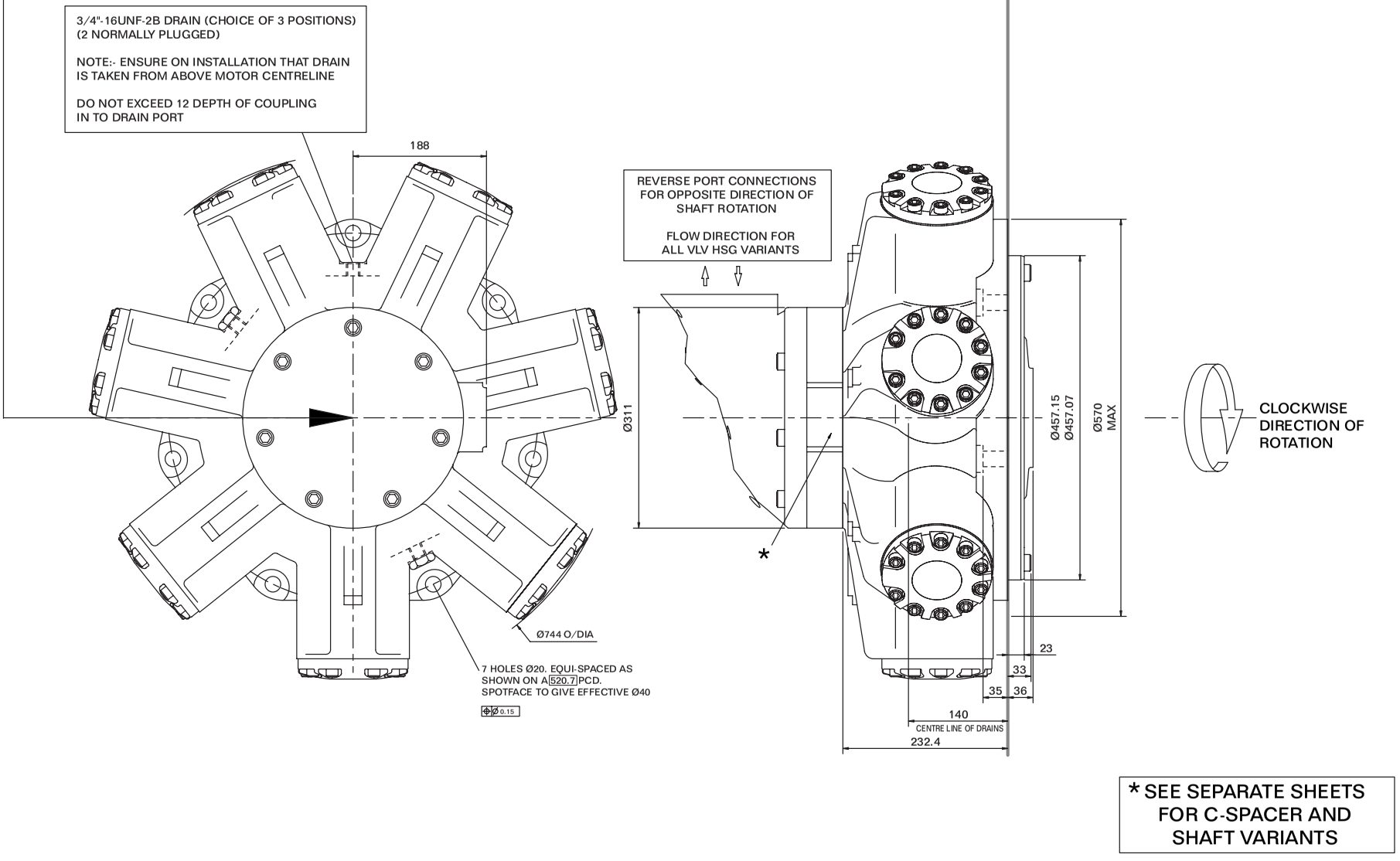




* SEE SEPARATE SHEETS FOR C-SPACER AND SHAFT VARIANTS

Example model code - HPC325/S3/300/60/FM4/X/72





* SEE SEPARATE SHEETS FOR C-SPACER AND SHAFT VARIANTS

Product type

HPC080

SO3	=	Staffa 3" 6-bolt flange
SO4	=	6-bolt UNF flange Staffa original valve housing
F3	=	1 1/4" SAE 4-bolt flange
FM3	=	1 1/4" SAE 4-bolt flange
F4	=	SAE 1 1/2" 4-bolt UNC flanges
FM4	=	SAE 1 1/2" 4-bolt metric flanges

HPC125

S03	=	Staffa 3" 6-bolt flange
SO4	=	6-bolt UNF flange Staffa original valve housing
F3	=	1 1/4" 3000 series SAE 4-bolt flange
FM3	=	1 1/4" 3000 series SAE 4-bolt flange
F4	=	SAE 1 1/2" 4-bolt UNC flanges
FM4	=	SAE 1 1/2" 4-bolt metric flanges

HPC200

SO3	=	Staffa 3" 6-bolt flange
SO4	=	6-bolt UNF flange Staffa original valve housing
F3	=	1 1/4" SAE code 61 4-bolt flange
FM3	=	1 1/4" SAE code 61 4-bolt flange
F4	=	SAE 1 1/2" 4-bolt UNC flanges
FM4	=	SAE 1 1/2" 4-bolt metric flanges

HPC270

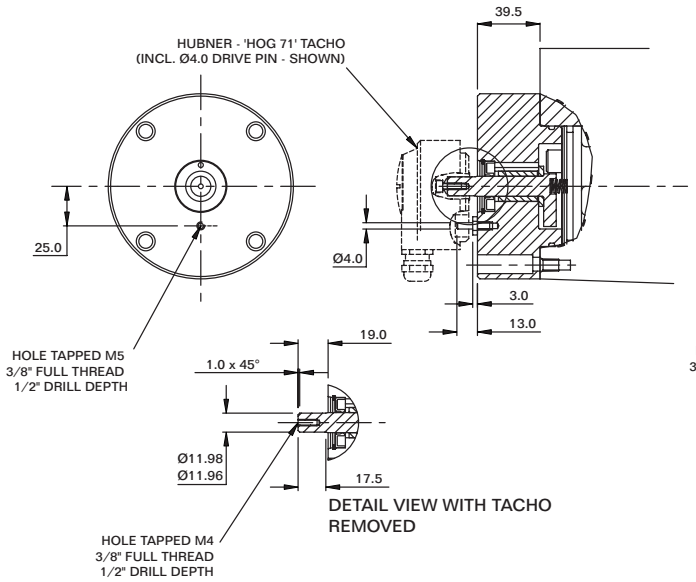
S04	=	Staffa 4" 6-bolt flange
F4	=	1 1/2" SAE code 62 4-bolt flange
FM4	=	1 1/2" SAE code 62 4-bolt flange

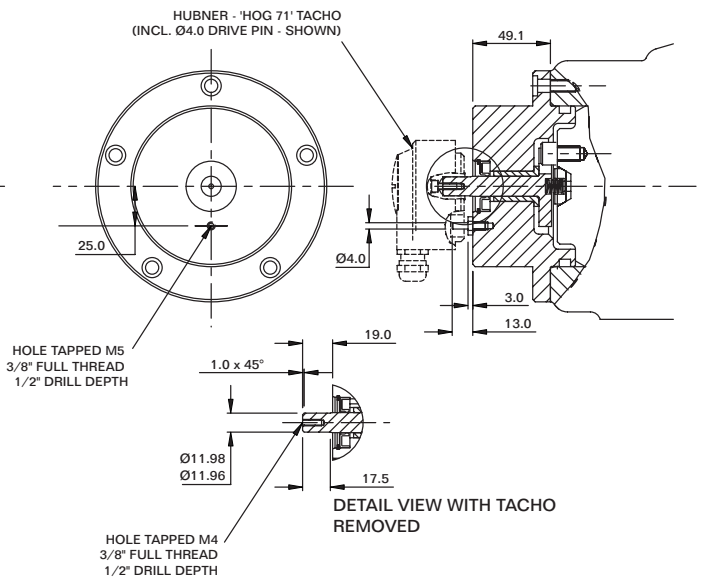
HPC325

SO4	=	Staffa 4" 6-bolt flange
F4	=	1 1/2" SAE code 62 4-bolt flange
FM4	=	1 1/2" SAE code 62 4-bolt flange

HOG 71 - encoder

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



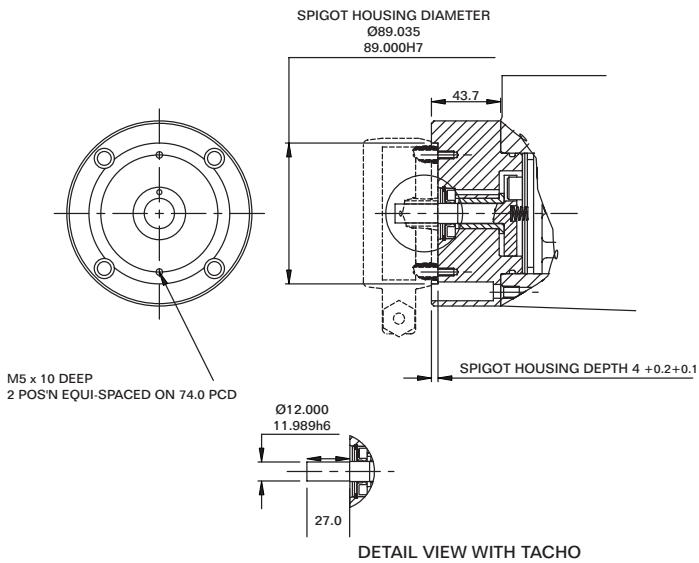


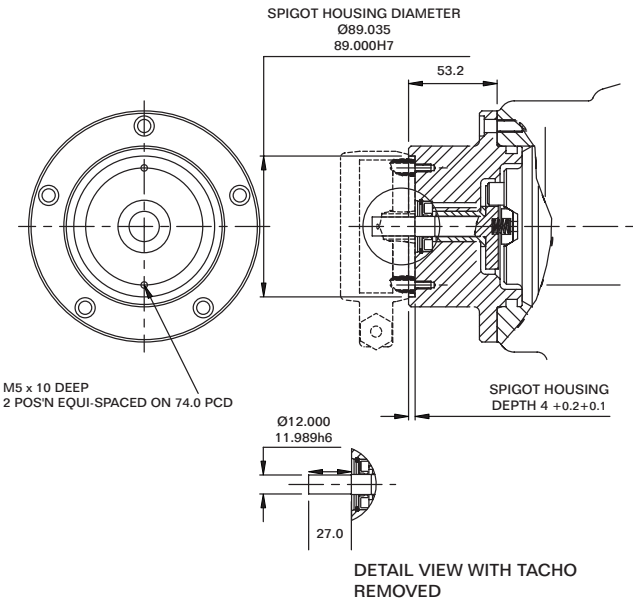
Model code:
HOG71 DN 1024 TTL
IP66
Power supply: 5V @ 100 mA
Output signal: Two TTL signals displaced by 90 deg. plus maker and inverted signals

Model code:
HOG71 DN 1024 HTL
IP66
Power supply: 9 TO 26V @ 100 mA
Output signal: As per TTL but with HTL signals

GTB 9 - tacho

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



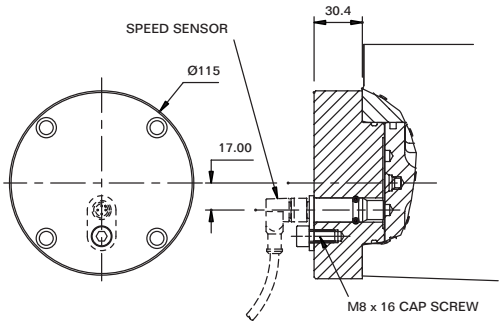


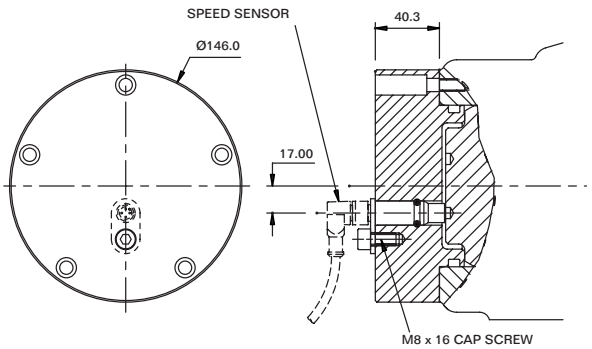
Model code:
GTB9.06 L 420 H04 (12mm Ø shaft)
IP68
Output signal: 20V/1000 r.p.m.

Note: Speed sensors should be ordered as a separate item from Hubner.

Tj speed sensor with Tk option

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

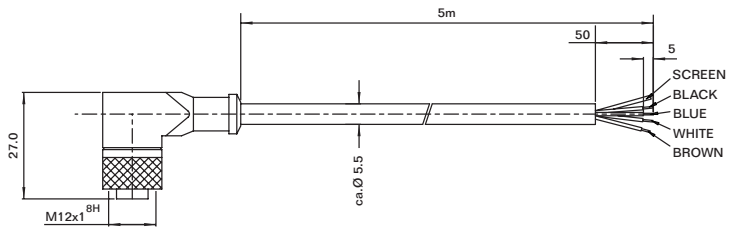


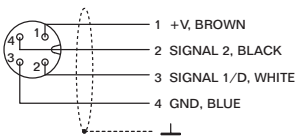


Technical specification:

Description: Hall effect dual channel speed probe
Signal outputs: Square wave plus direction signal
Power supply: 8 to 32V @ 40 mA
Protection class: IP68
Output frequency: 16 pulses/revolution

Tj cable assembly





Tj speed probe and Tk optional T401 module. See model code detail on page 40. The T401 is software configured for both speed calibration and relay speed trip setting.

HPC series motor

F11	HP	C125	S	V	125	70	FM3	CS	Tj	70	PL****

Fluid type
Blank: Mineral oil.
F3: Phosphate ester *(HFD fluid)*.
F11: Water-based fluids *(HFA, HFB & HFC)*.
Alternative fluids contact Kawasaki Precision Machinery UK Ltd.
Nominate fluid type and make on order.

Model type
HP: High Power
HPHD: High Power Heavy Duty

Motor frame size

C080	C270
C125	C325
C200	

Shaft type
See shaft type option list on pages 22-26

Shaft
Vertically up

High displacement code
See displacement code details on pages 4 to 8

Low displacement code
See displacement code details on pages 4 to 8

Main port connections
See port connection details on page 37

Special features
PL**:
Non-catalogued features, (****)= number assigned as required.
eg:
High pressure shaft seals.
Alternative port connections.
Stainless steel shaft sleeves.
Alternative encoder and tacho drives.
Motor valve housing orientation.
Special paint.

Design number

Tacho/Encoder drive
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.
Th: Encoder system with a pulsed frequency output proportional to speed.
Tg: Tachogenerator with a D.C. output signal proportional to speed.

Displacement control ports *(pages 11-12)*
Threaded ports/bi-directional shaft rotation:
X: X and Y ports G1/4" *(BSPF to ISO 228/1)*
ISO 4401 size 03 mounting face/bi-directional shaft rotation:
C: No shuttle
CS: With shuttle valve *(see options by product type)*
ISO 4401 size 03 mounting face/uni-directional shaft rotation *(viewed on shaft end)*:
C1: Control pressure from main port 1 (*shaft rotation clockwise with flow into port 1)*

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Devon, PL5 2SA, England

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Fax: +44 1752 364816
Mail: info@kpm-uk.co.uk
Website: www.kpm-eu.com

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Data sheet: M-1003/06.10