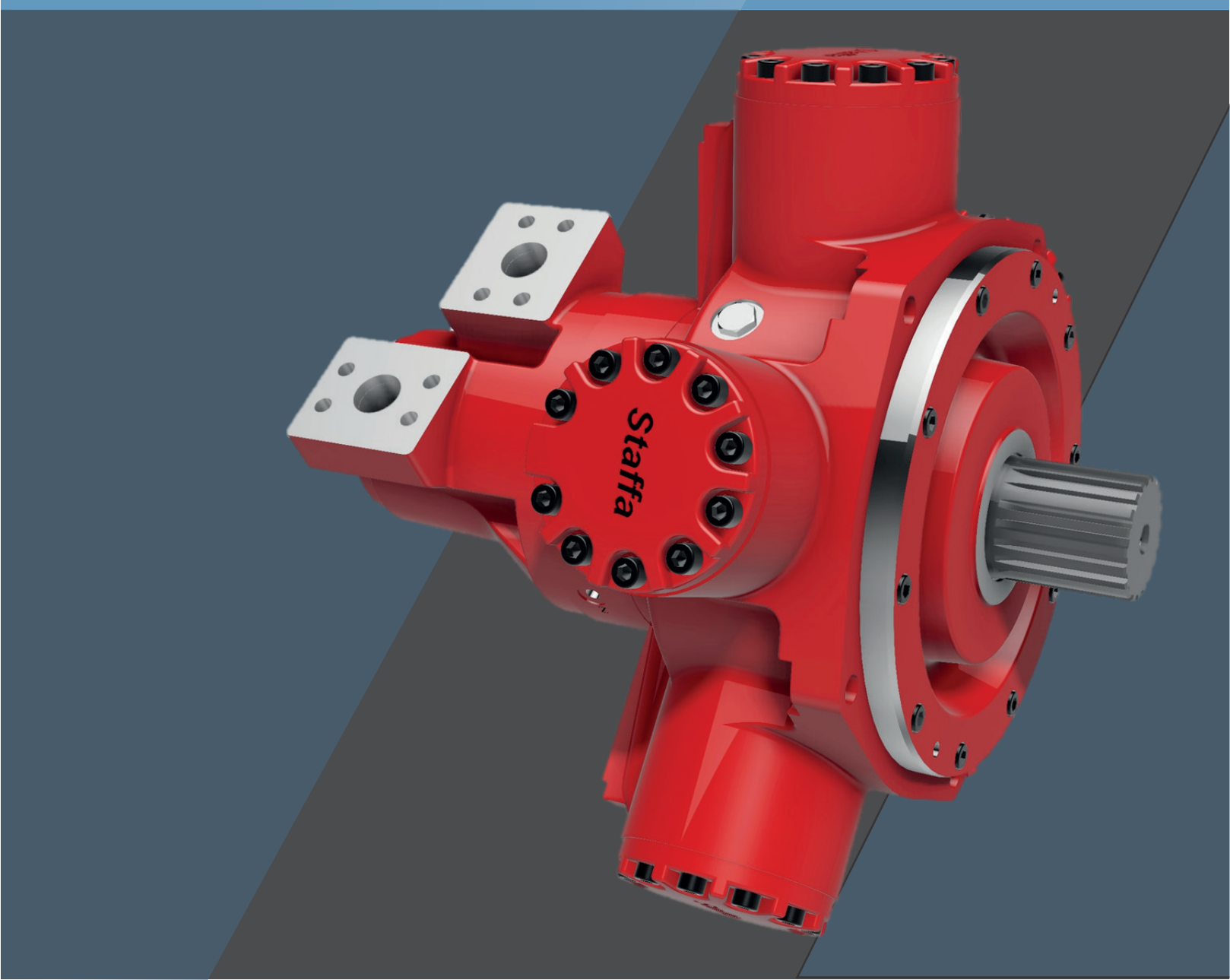
Kawasaki
Powering your potential

Precision Machinery Company

Three-Speed Radial Piston Motor

Staffa

HMF Series



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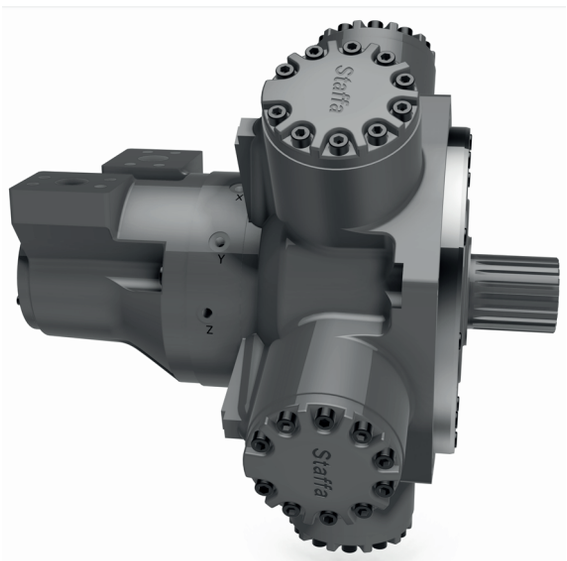
HMF Series

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 displacements 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 HMF080 in 1,475 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
HMF080	6,560	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 option 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 Ordering Code

1-1 Model Coding

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

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

F080	F270
F200	F325

Shaft Type

See shaft type option list on Page 4

Shaft Orientation

Blank	Standard orientation
V	Vertically Up (extra drain)

High Displacement Code

###	See displacement code details on pages 7 to 11

Medium Displacement Code

###	See displacement code details on pages 7 to 11

Low Displacement Code

###	See displacement code details on pages 7 to 11

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 etc.	

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 5

1-2 Shaft Options

Product type

HMF080

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

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

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

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

HMF080

SM3	=	1 1/4" symmetrical ports with through-holes for manifold connection
F3	=	1 1/4" SAE 4-bolt flange
FM3	=	1 1/4" SAE 4-bolt flange
F4	=	SAE 1 1/2" 4-bolt UNC flange
FM4	=	SAE 1 1/2" 4-bolt metric flange

HMF200

SM3	=	1 1/4" symmetrical ports with through-holes for manifold connection
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 flange
FM4	=	SAE 1 1/2" 4-bolt metric flange

HMF270

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

HMF325

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

See pages 24 to 45 for full dimensional details

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 10. 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 (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	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 to DNV rules 380 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
HMF080	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)

HMF080 Motor (see page 16 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	23.90	22.00	20.75	19.50	18.25	17.02	15.78	14.55	13.20	12.00
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	82.1	80.8	79.2	77.4	75.1
Max continuous speed (SM3/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	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 20: 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 16 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 20: 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 16 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 20: 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 16 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 20: 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**
HMF080	1,344	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:

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

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) x 200 x 1 x 0.005

= 7.7 l/min

Volumetric efficiency

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

= 96%

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.

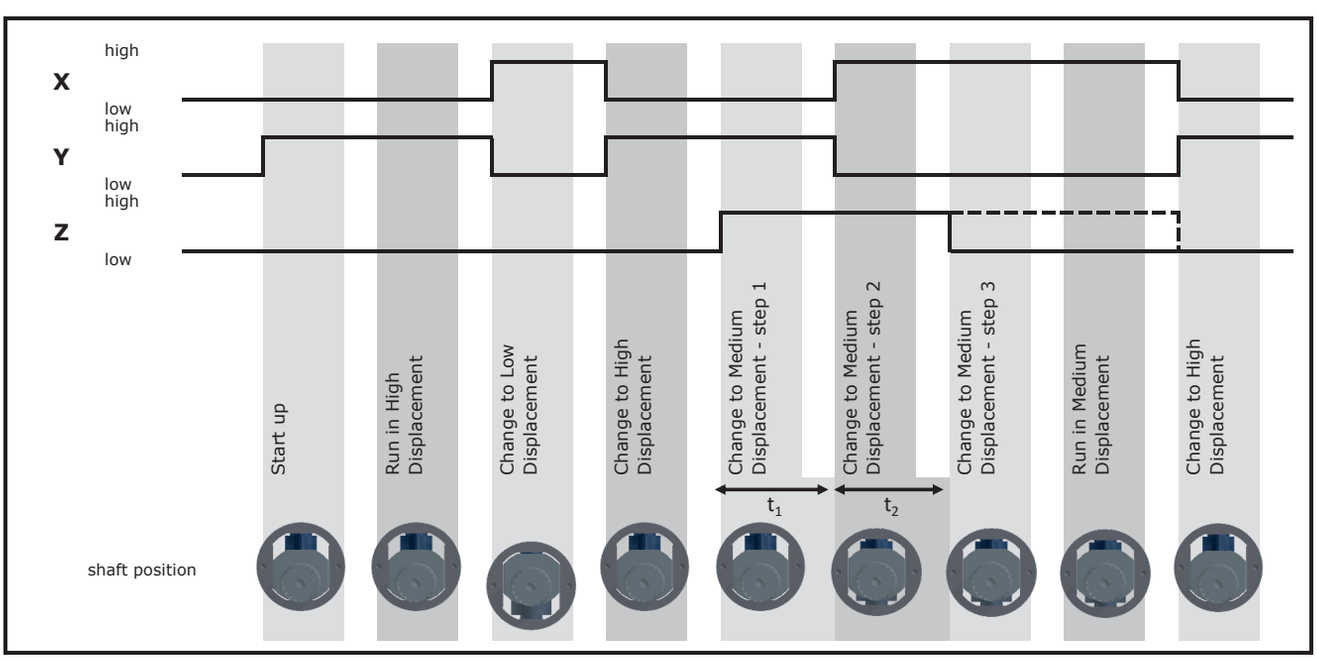
There now follow three representations of the same displacement change sequence just described: high to low, back to high, then to medium, and, finally, back to high. Firstly, a table showing the sequence in which the 'X', 'Y' and 'Z' ports are pressurised at each stage. Secondly, a timing chart showing 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

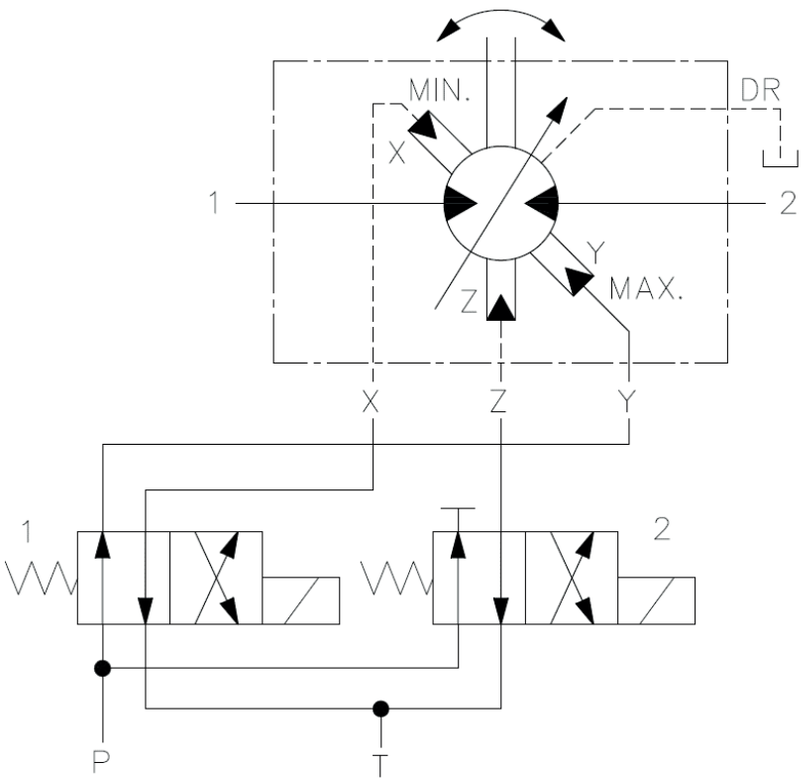
Sequence	Pressure to	Displacement
1	Y	High
2	X	Low
3	Y	High
4	Y&Z	High
5	X&Z	Medium
6	X	Medium
7	Y	High

Displacement Sequence Control Timing



2-3 Displacement Change Sequence (cont)

Displacement Sequence Control Schematic



Displacement	Valve 1	Valve 2
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: (see page 10)

HMF270 motor with a displacement code of 280:

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

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

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

$$\underline{\Delta P = 174 \text{ bar (max.)}}$$

Secondly, to find the maximum speed at rated pressure:

Rated shaft power (W):	189,000
Average actual running torque (Nm/bar):	69.4
Rated pressure (bar):	250

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

$$\underline{n = 104 \text{ rpm (max.)}}$$

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.

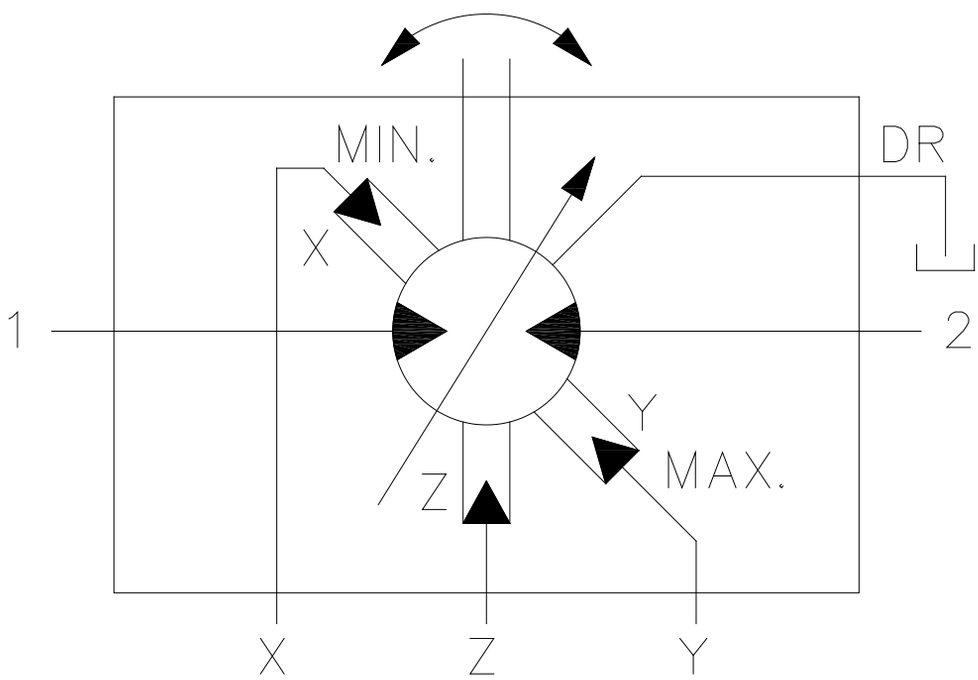
3) The maximum calculated differential pressure assumes that the low pressure motor port is less than 30 bar.

2-5 Functional Symbols

Example model code:

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

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



2-6 Stress Limits

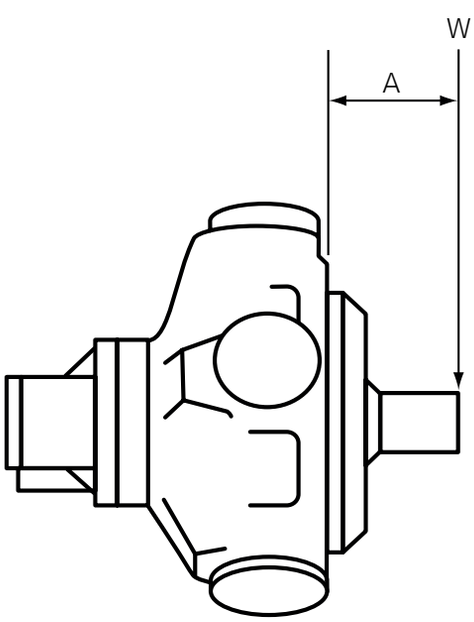
When applying large external radial loads, consideration should also be given to motor bearing lives (see page 19).

Motor Frame Size	Maximum External Radial Bending Moment [Nm]
HMF080	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 (0.1 m)
Maximum radial load, W = 4,500 (see table)/0.1
= 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 bearing 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 11).

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 7 to 11 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)
HMF080	SM3	1.6×10^{10}
	FM(3)	1.6×10^{10}
	FM(4)	3.3×10^{10}
HMF200	SM3	1.6×10^{10}
	FM(3)	1.6×10^{10}
	FM(4)	3.3×10^{10}
HMF270 & HMF325	FM(4) S04	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 12) plus an allowance for changing displacement:

e.g.

HMF080	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 27 to 48) 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.

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. 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 intertia and mass table

Typical data

Motor Frame Size	Displacement code	Polar Moment of Intertia ($kg.m^2$) (Typical)	Mass (kg) (Approx. all models)
HMF080	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

HMF080 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.

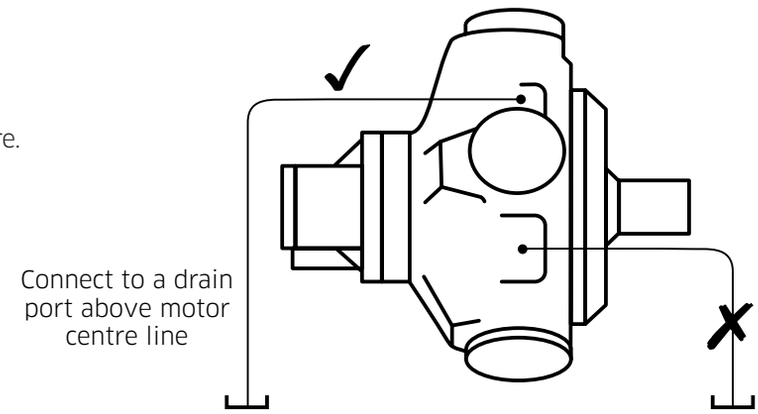
It should be noted that the maximum continuous operating temperature within the motor crankcase is plus 80°C.

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

2-10 Crankcase Drain Connections

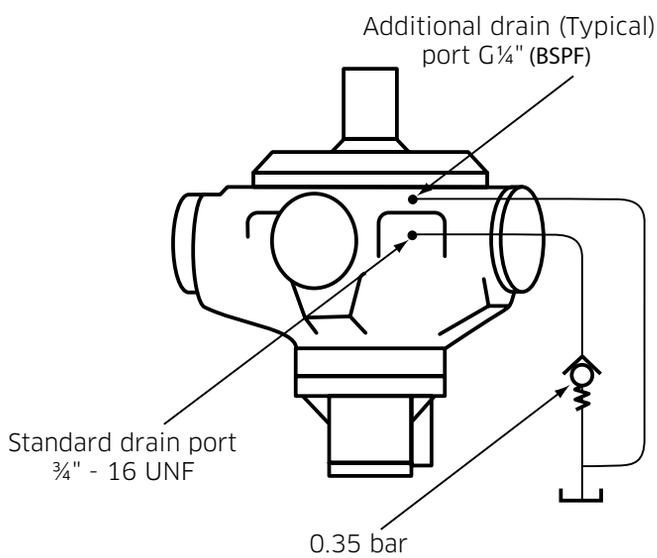
Motor axis - horizontal

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.



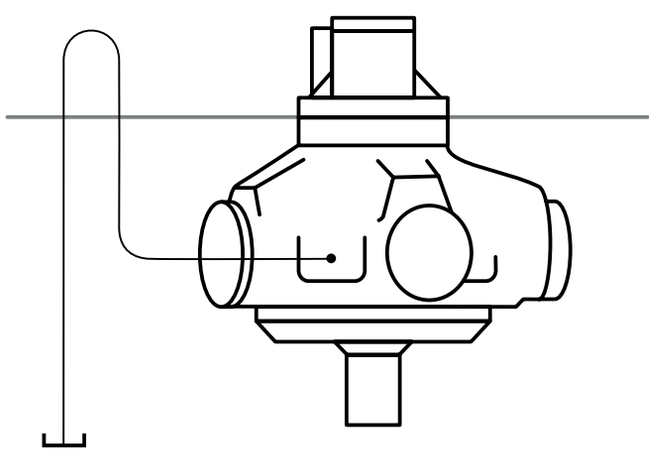
Motor axis - vertical shaft up

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 20).

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 7 to 11).

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 20. 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 diameterical 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
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 0.13 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, 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 mjst 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

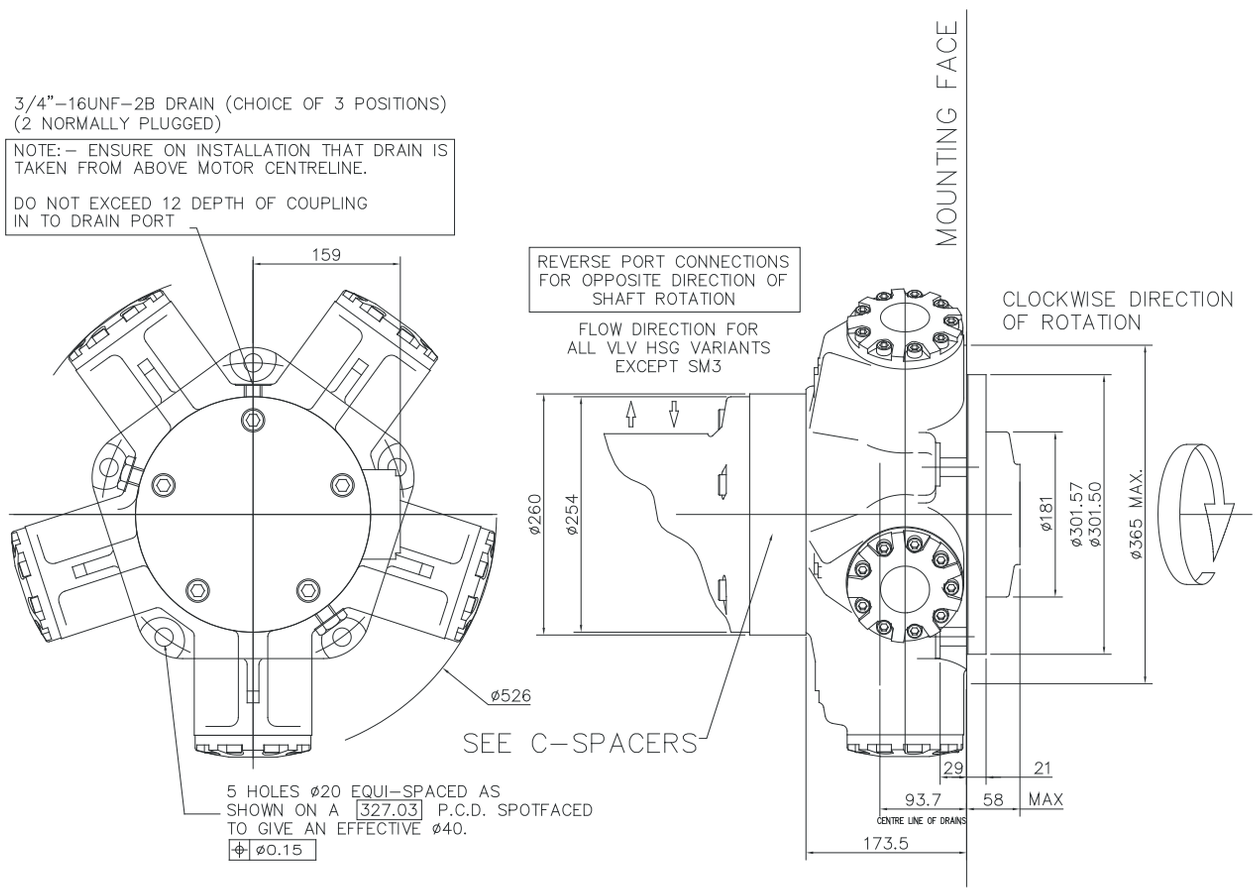
Conversion Table

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

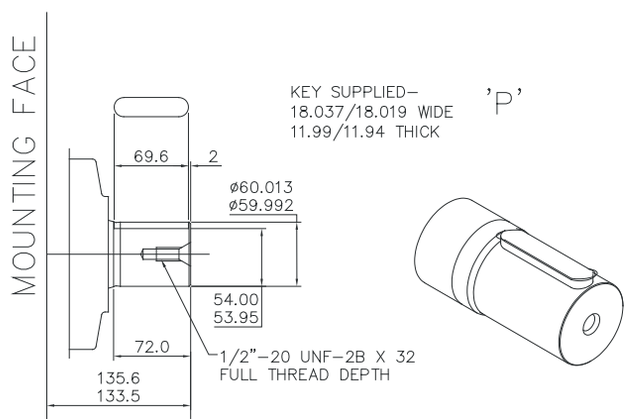
3-1 HMF080

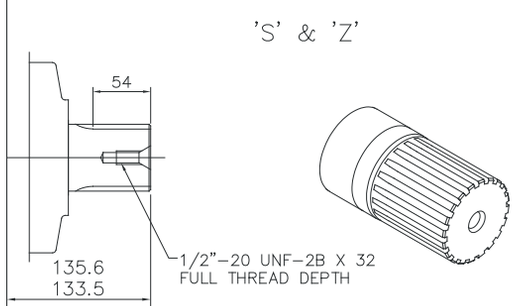
Installation



3-1 HMF080 (cont)

‘P’, ‘S’ and ‘Z’ Shafts





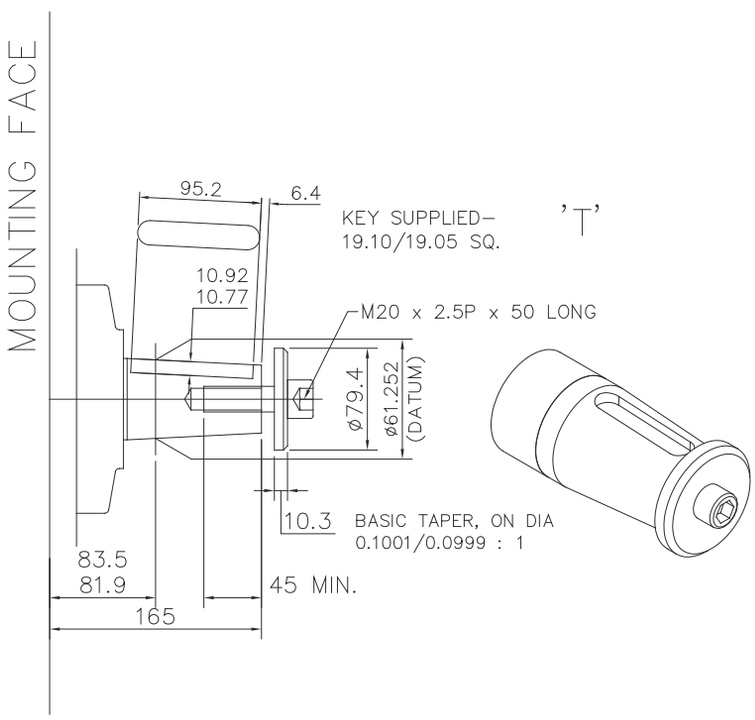
SPLINE DATA

'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

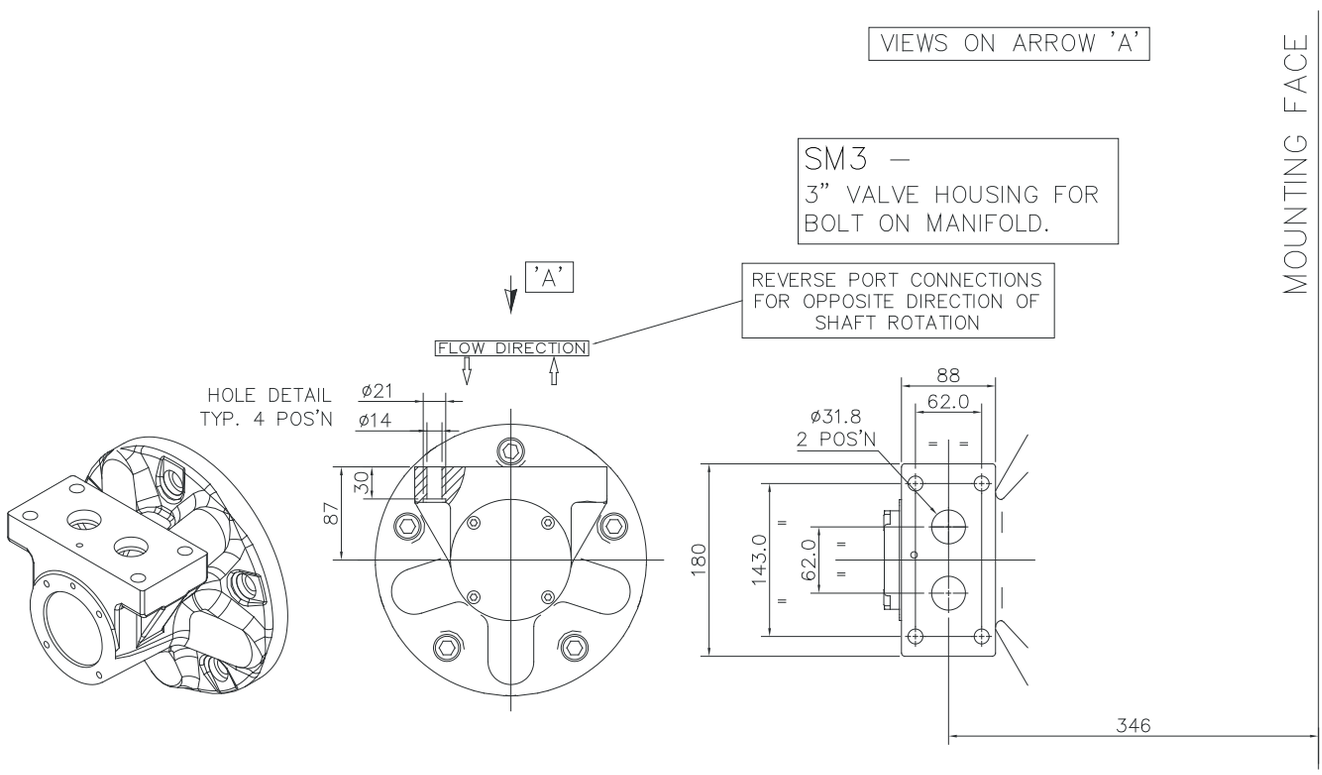
3-1 HMF080 (cont)

'T' Shaft



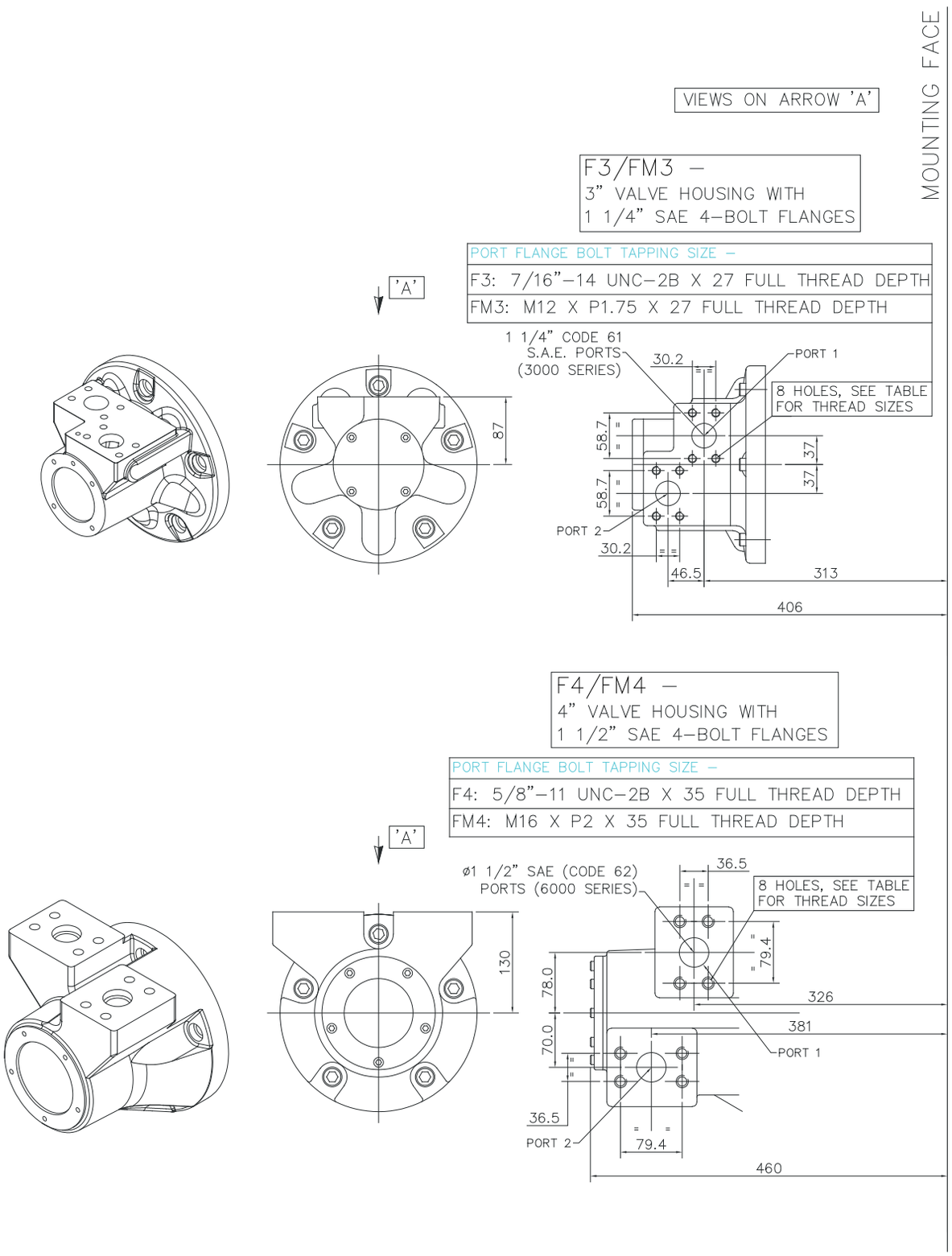
3-1 HMF080 (cont)

‘SM3’ Valve Housing



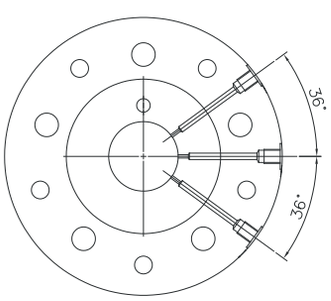
3-1 HMF080 (cont)

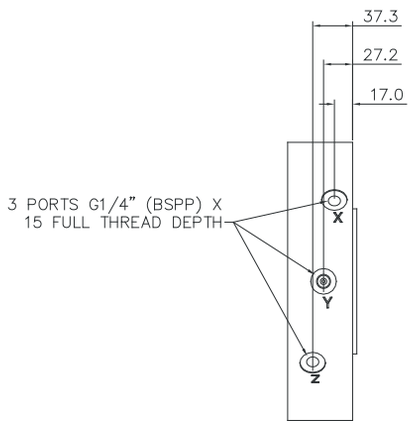
‘F3’, ‘FM3’, ‘F4’ & ‘FM4’ Valve Housings



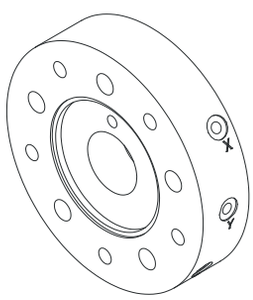
3-1 HMF080 (cont)

'X' C Spacers





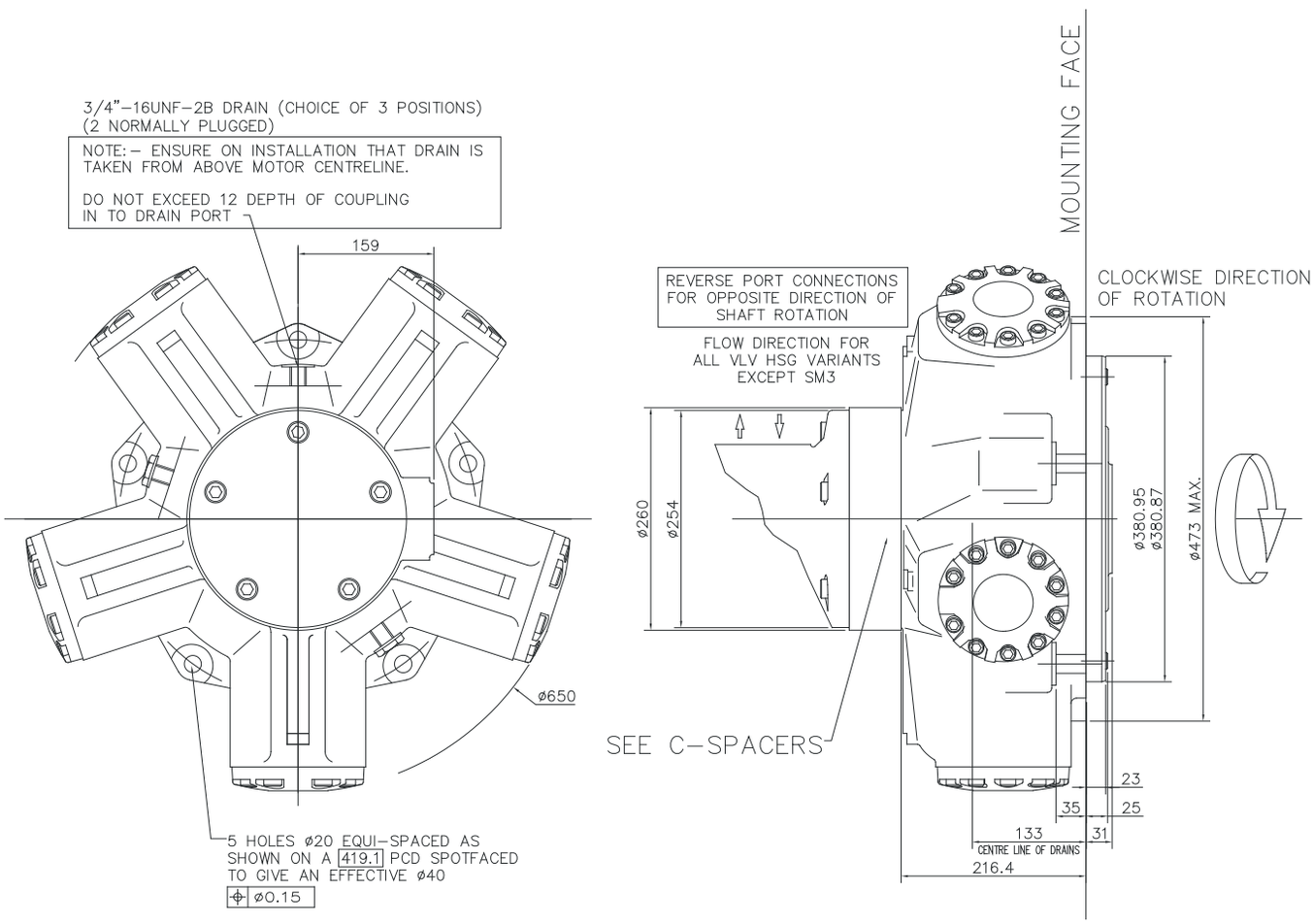
TYPE X
DISPLACEMENT CONTROL



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.

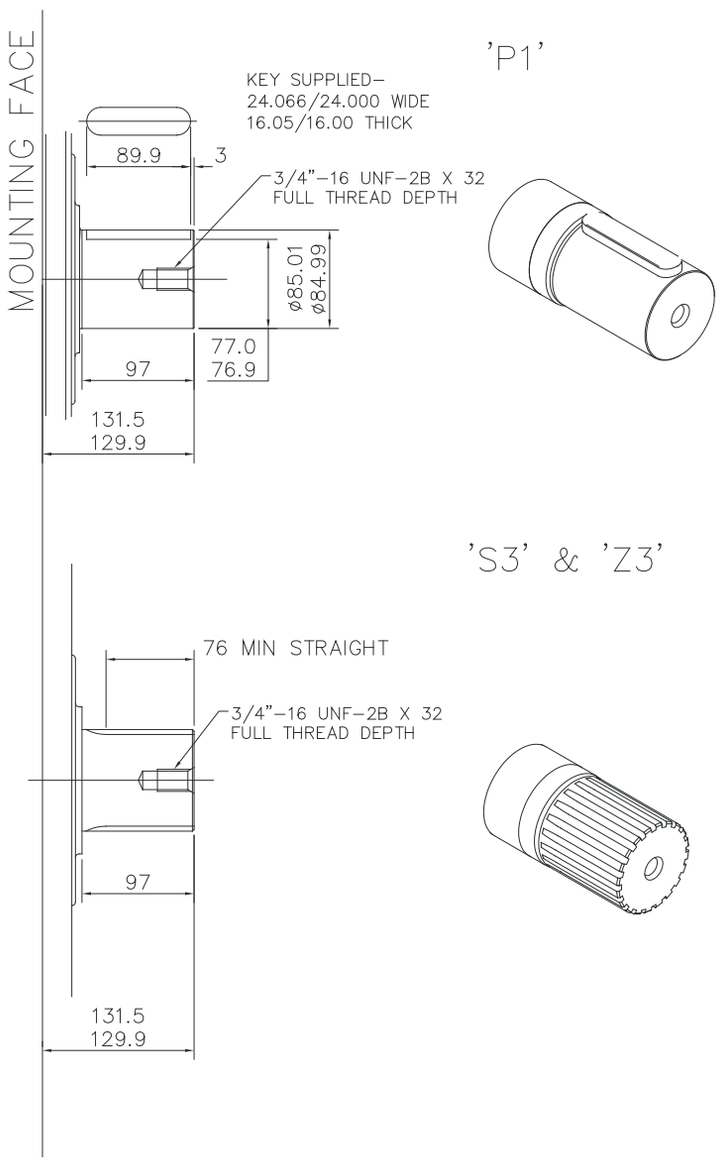
3-2 HMF200

Installation



3-2 HMF200 (cont)

‘P1’, ‘S3’ and ‘Z3’ Shafts



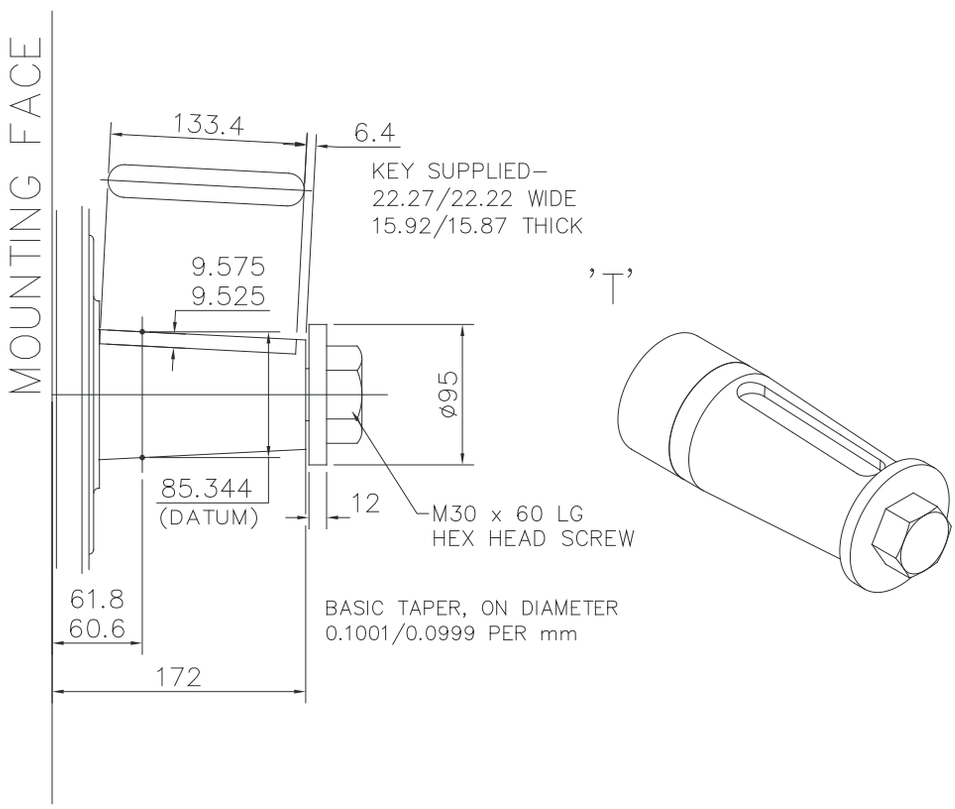
SPLINE DATA

’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	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

’Z3’
DIN 5480 W85 x 3 x 27 x 7h

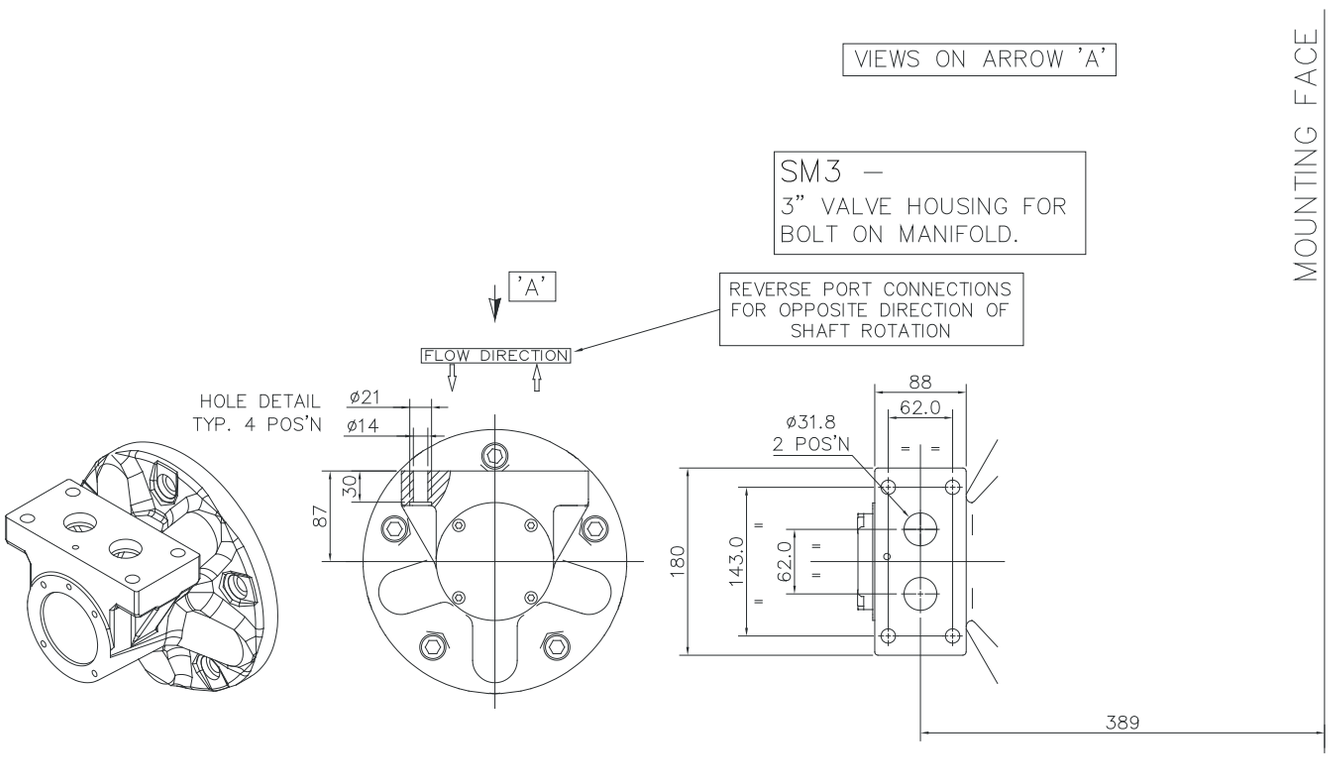
3-2 HMF200 (cont)

'T' Shaft



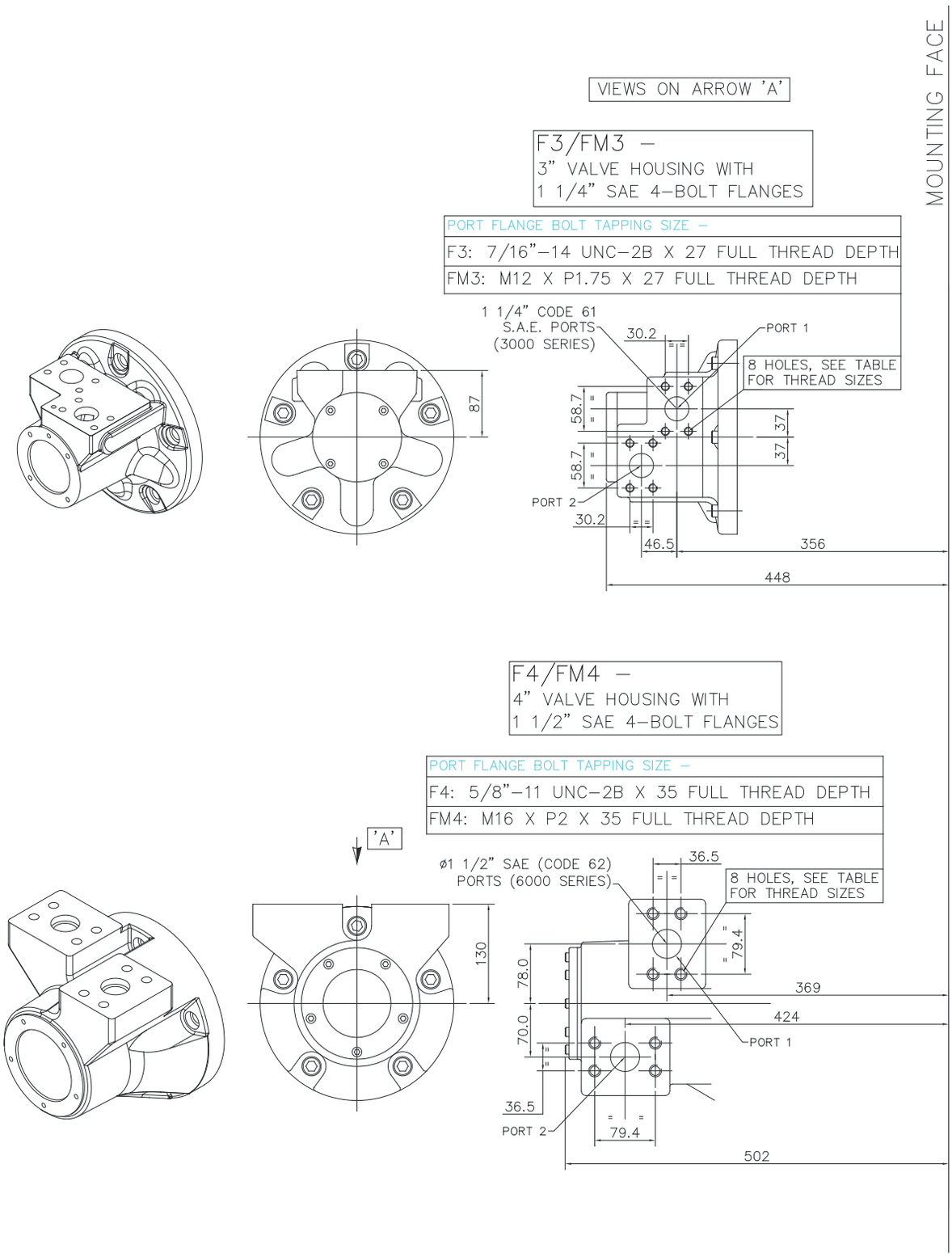
3-2 HMF200 (cont)

‘SM3’ Valve Housing



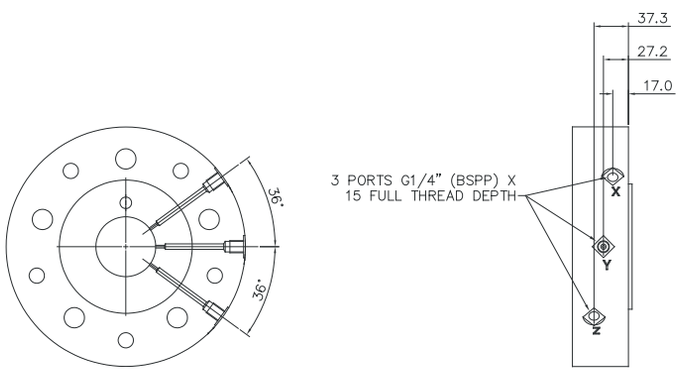
3-2 HMF200 (cont)

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



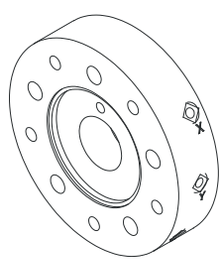
3-2 HMF200 (cont)

'X' C Spacers



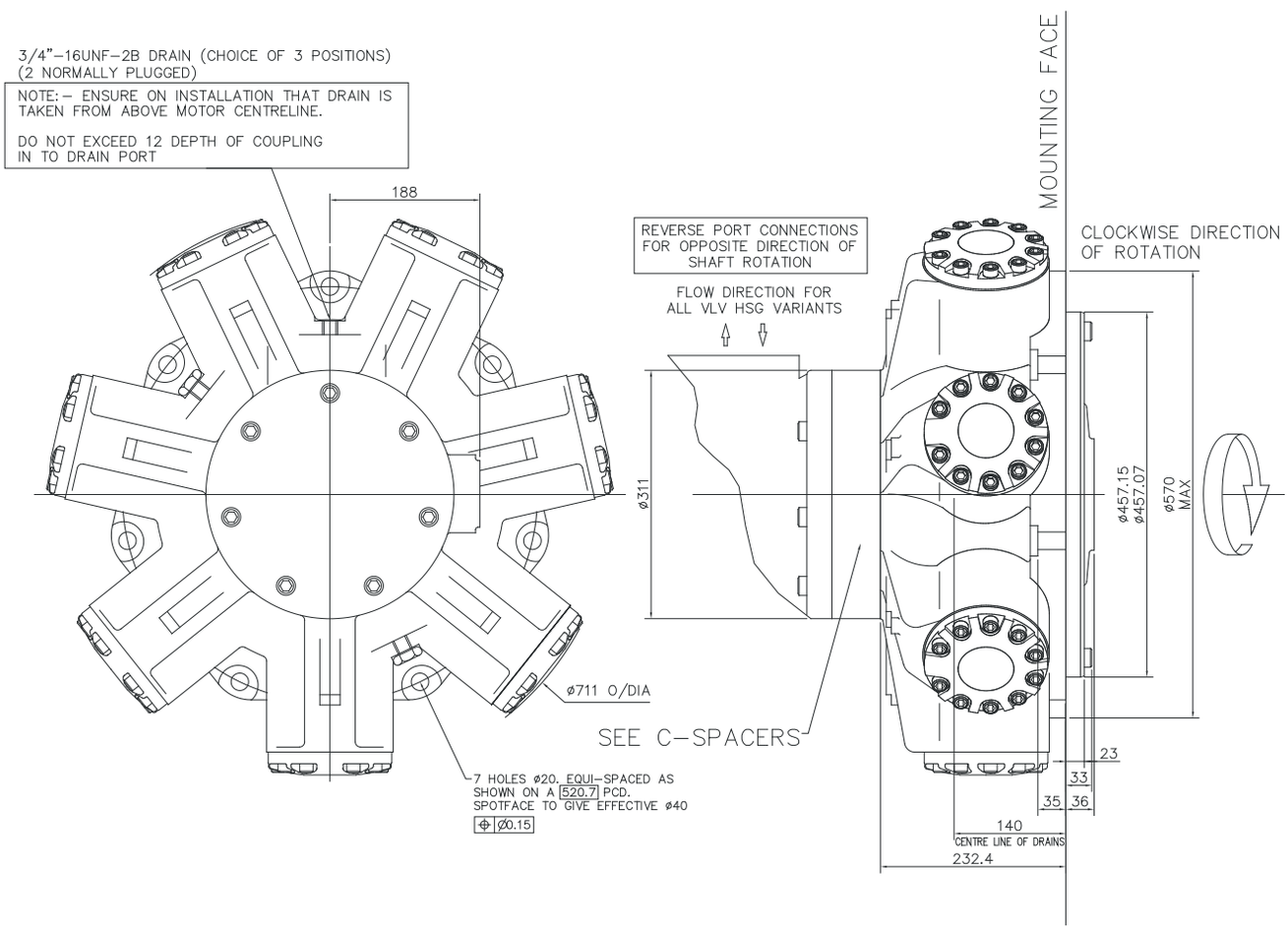
DISPLACEMENT SELECTION (VIA REMOTELY LOCATED VALVE*)
HIGH DISPLACEMENT: P TO Y; X TO T
LOW DISPLACEMENT: P TO X; Y TO T
MID DISPLACEMENT: P TO X AND Z: Y TO T
SEE TIMING CHART.
*DISPLACEMENT SELECTOR VALVE IS NOT SUPPLIED WITH MOTOR.

TYPE X
DISPLACEMENT CONTROL



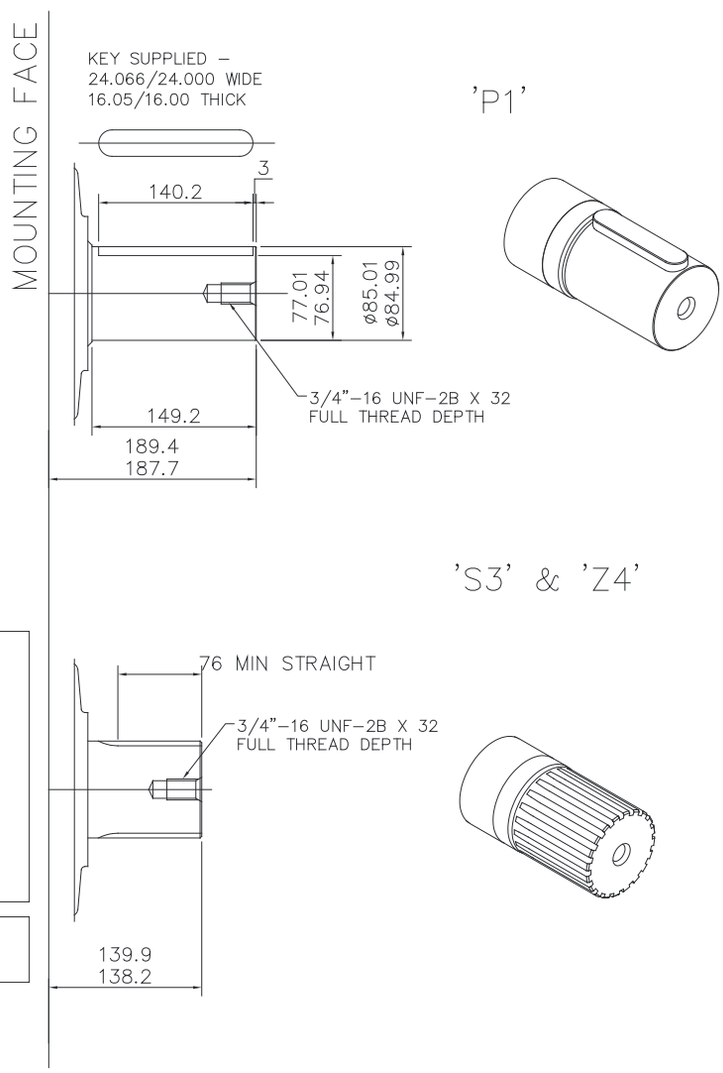
3-3 HMF270

Installation



3-3 HMF270 (cont)

‘P1’, ‘S3’ and ‘Z4’ Shafts



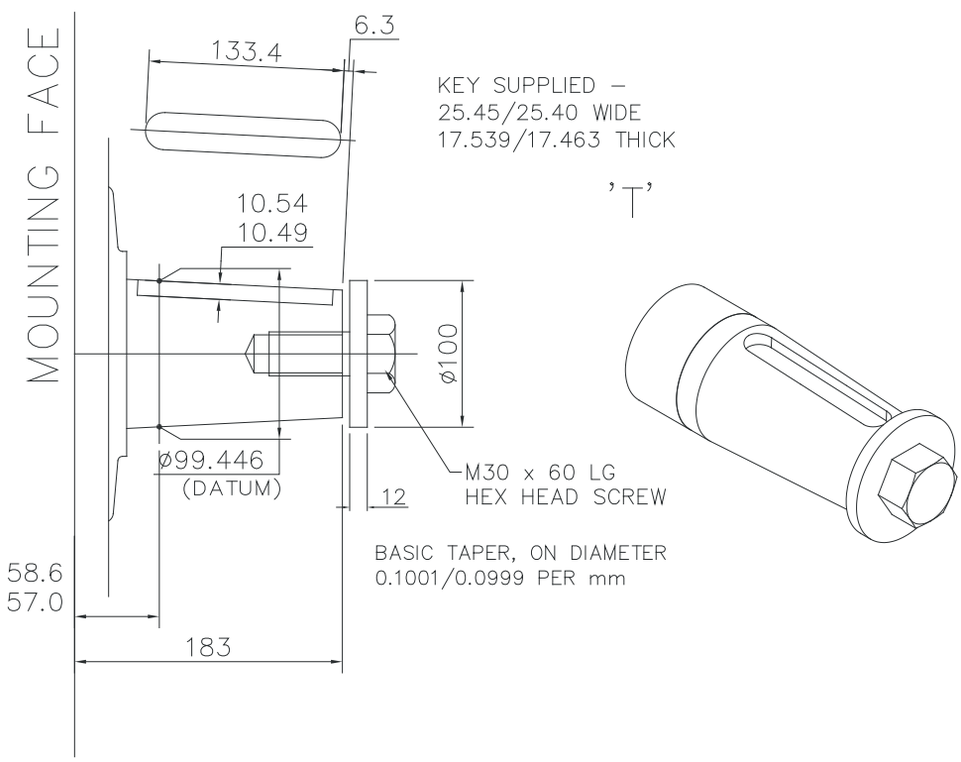
SPLINE DATA

'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

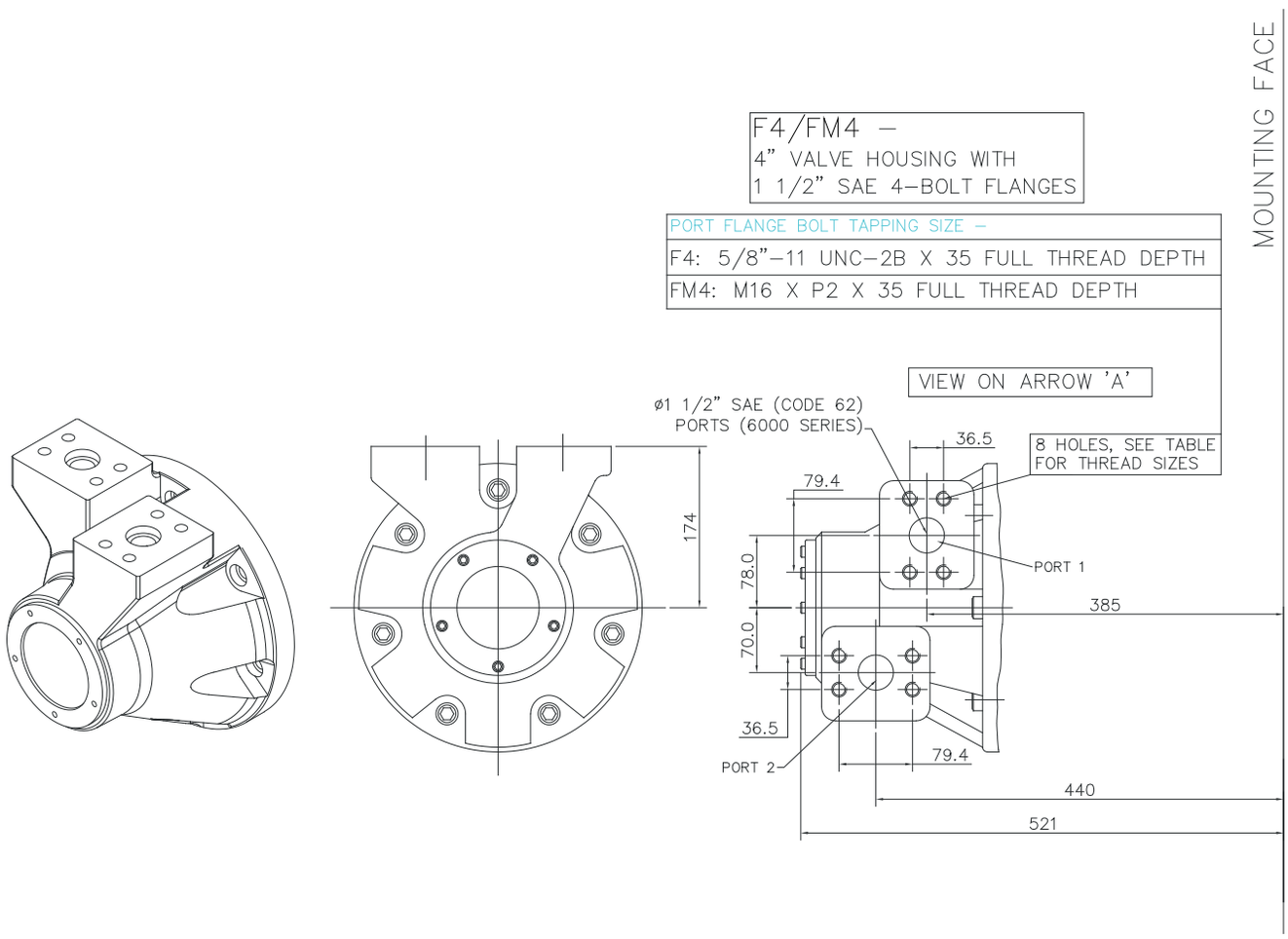
3-3 HMF270 (cont)

'T' Shaft



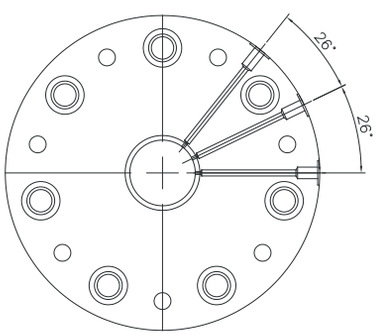
3-3 HMF270 (cont)

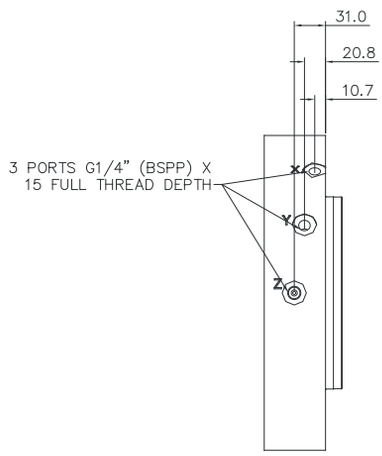
‘F4’ & ‘FM4’ Valve Housings



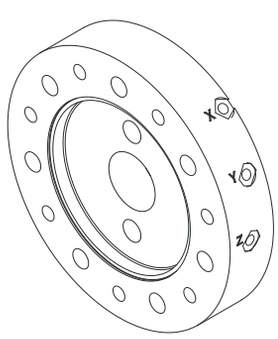
3-3 HMF270 (cont)

'X' C Spacers





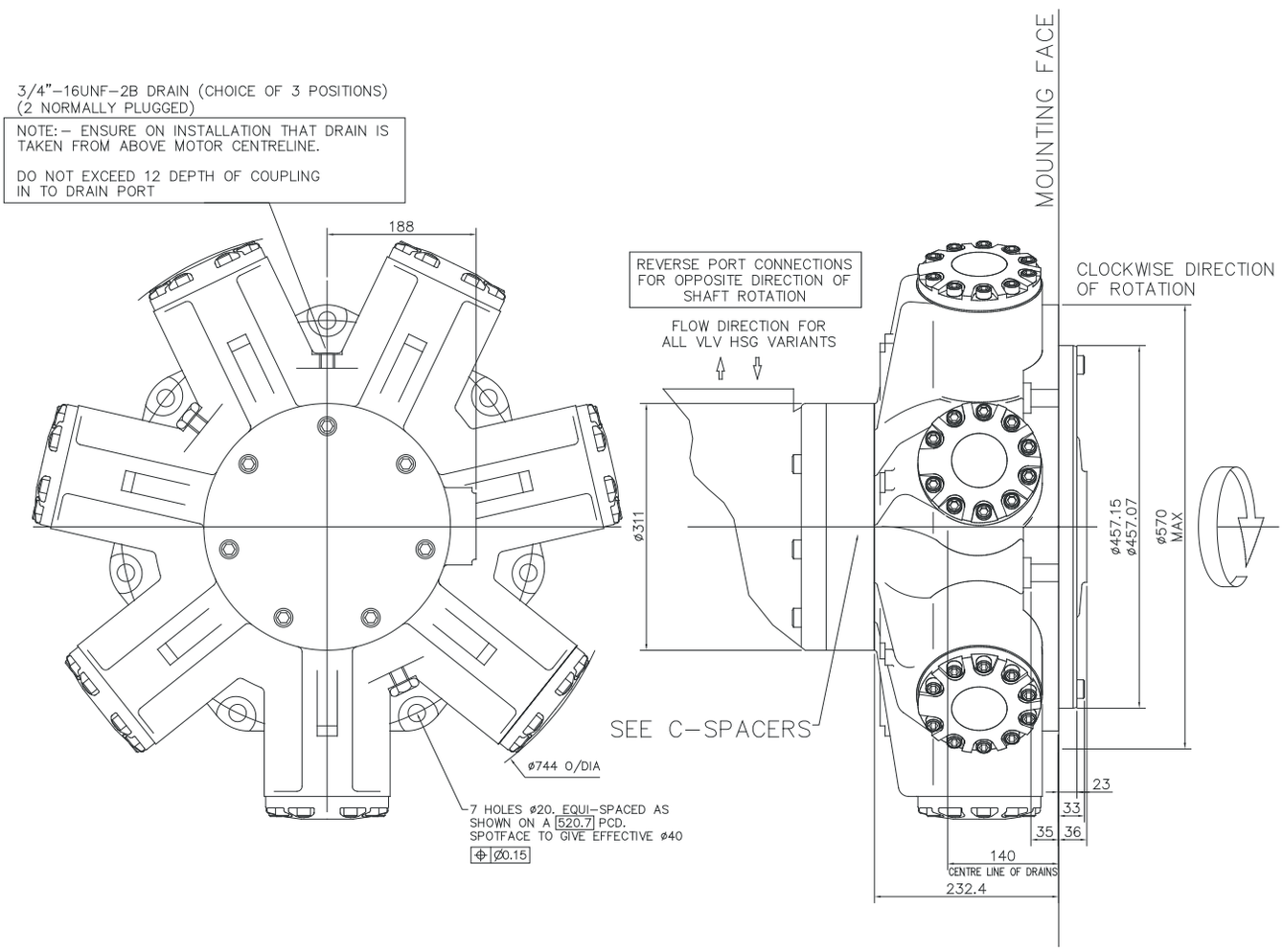
TYPE X
DISPLACEMENT CONTROL



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.

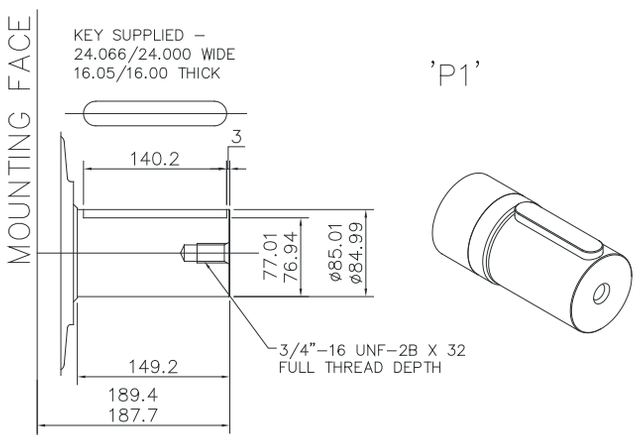
3-4 HMF325

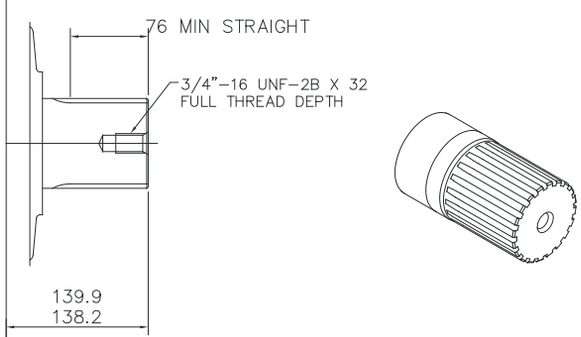
Installation



3-4 HMF325 (cont)

‘P1’, ‘S3’ and ‘Z4’ Shafts





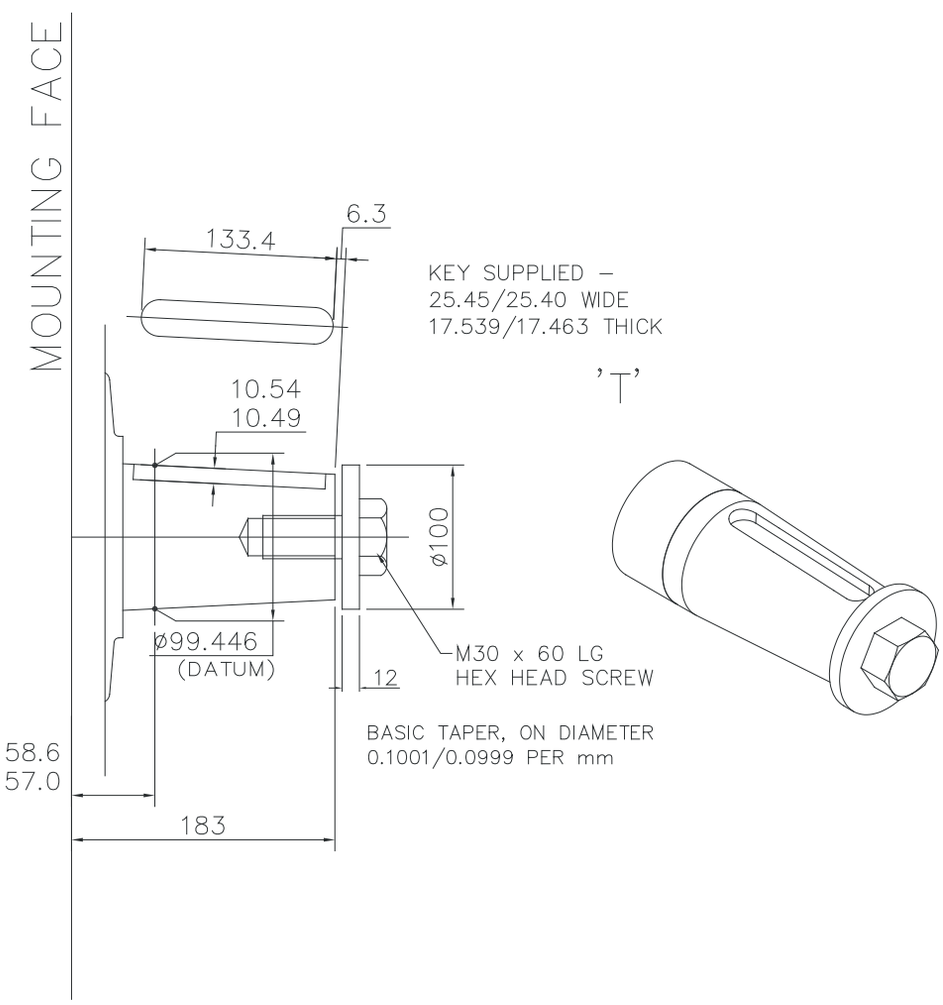
SPLINE DATA

'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 W90 x 4 x 21 x 7h

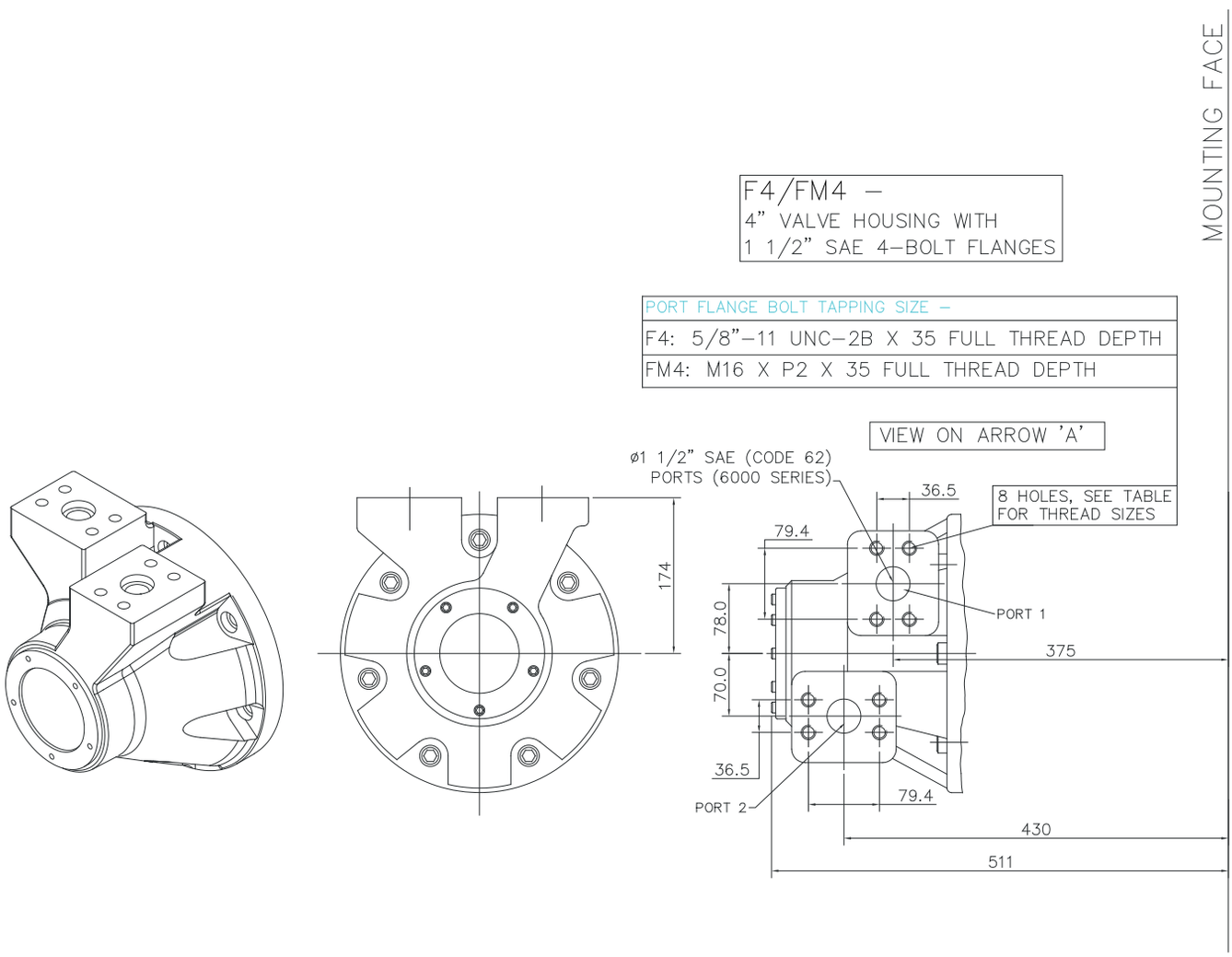
3-4 HMF325 (cont)

'T' Shaft



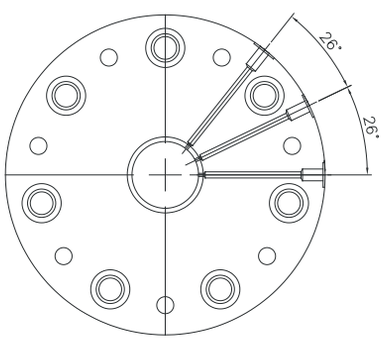
3-4 HMF325 (cont)

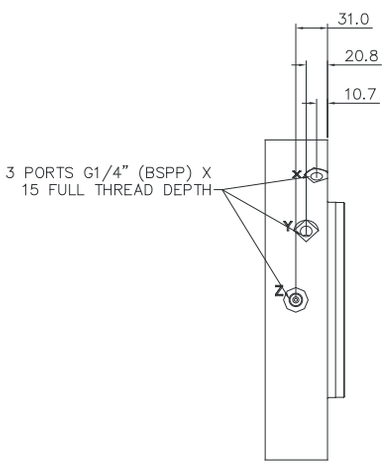
‘F4’ & ‘FM4’ Valve Housings



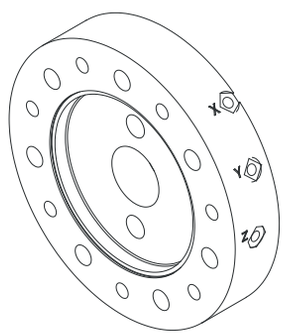
3-4 HMF325 (cont)

'X' C Spacers





TYPE X
DISPLACEMENT CONTROL



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

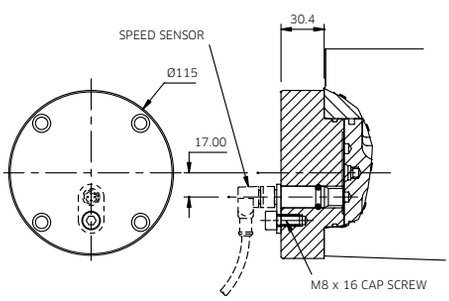
Tj Speed Sensor Technical Specification

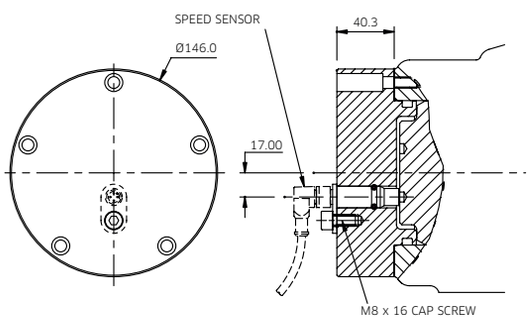
The Tj speed sensor is a hall effect dual channel speed probe that can provide feedback of both speed and direction.

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

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



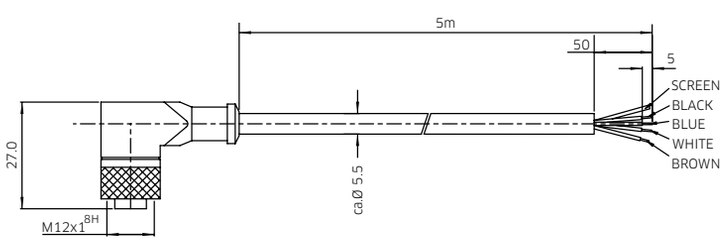


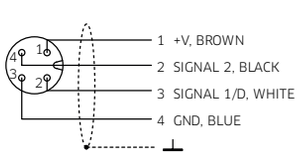
Tk Output Module

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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