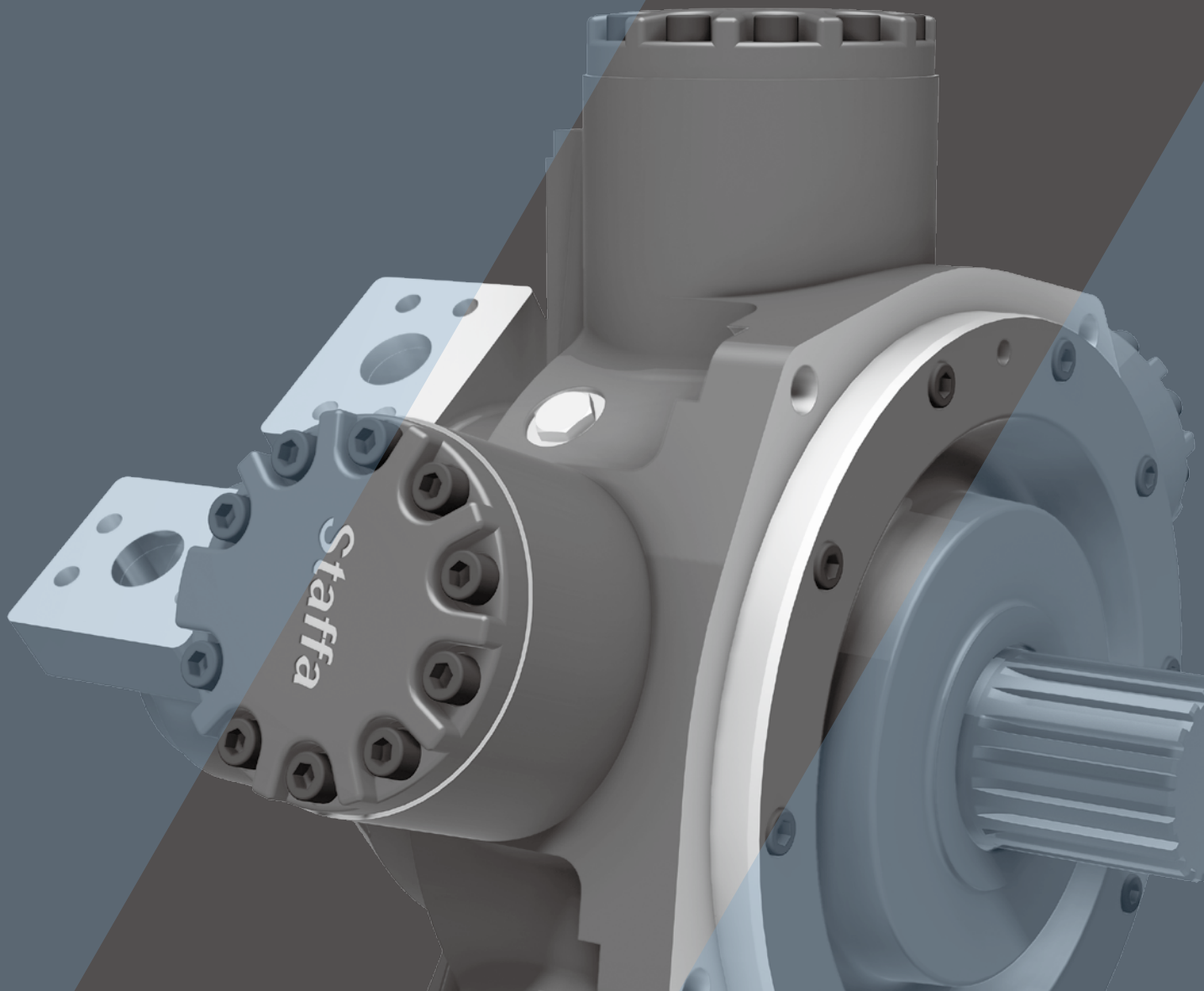


Fixed Displacement Radial Piston Staffa Motor HMB Series

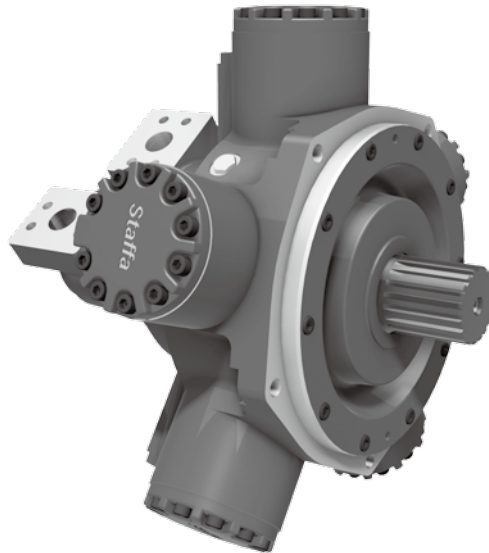


CONTENTS

Specifications and Features	2
1. Ordering Code	
1-1. Model Coding	3
1-2. Shaft Options	4
1-3. Main Port Connection Options	5
2. Technical Information	
2-1. Performance Data	6 - 10
2-2. Volumetric Efficiency Data	11
2-3. Shaft Power Calculations	12
2-4. Functional Symbols	13
2-5. Shaft Stress Limits	14
2-6. Bearing Life Notes	15
2-7. Circuit and Application Notes	16 - 18
2-8. Motor Operation at Low Temperatures	19
2-9. Freewheeling Notes	20
2-10. Crankcase Drain Connections	21
2-11. Installation Data	22
3. Dimensions	
3-1. HMB010 Installation	23 - 24
3-2. HMB030 Installation	25 - 31
3-3. HMB045 Installation	32 - 37
3-4. HMB060/080 Installation	38 - 42
3-5. HMB100 Installation	43 - 47
3-6. HM(HD)B125 Installation	48 - 55
3-7. HM(HD)B 150/200 Installation	56 - 63
3-8. HM(HD)B270 Installation	64 - 69
3-9. HM(HD)B325 Installation	70 - 75
3-9. HMHDB400 Installation	76 - 77
3-8. Speed Sensing Options	78

HMB Series

Fixed Displacement Radial Piston Hydraulic Motor



■ General Descriptions

The Kawasaki “Staffa” range of high torque low speed fixed displacement radial piston hydraulic motors consists of 12 frame sizes ranging from the HMB010 to HMHDB400. Capacity ranges from 50 to 6,800 cc/rev.

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

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

The Kawasaki “Staffa” range also includes dual and continuously variable displacement motors. To obtain details of this product range please refer to data sheet M-2002/09.14.

■ Features

Rugged, Reliable, Proven Design

Unique Hydrostatic Balancing provides minimum wear and extended life

High Volumetric and Mechanical Efficiency

Capacities Range from 50 to 6,800 cc/rev

Large Variety of Shaft and Porting Options

Output Torque up to 25,250 Nm

Wide Range Of Mounting Interfaces available

Alternative Displacements also available

1

Ordering Code

1-1 Model Coding

F11/HM*B/060/S3/V/FM3/Tk/*/PL**

Fluid Type

Blank	Mineral oil
F3	Phosphate ester (HFD fluid)
F11	Water-based fluids (HFA, HFB & HFC)
*:	Consult

Model Type

Blank	Standard (HMB)
HD	Heavy duty (HMHDB)

Frame Size

See options page 7

Shaft Type

See shaft type option list on Page 4

Shaft

Vertically Up

Main Port Connections

See Port Connection details on Page 5

Additional Control Options

PL**:	Non-catalogued features, (**) = number assigned as required
eg: Stainless steel shaft sleeves Alternative port connections Shaft variants Alternative displacement Special mountings Special paint etc.	

Design Series Number

Tacho Encoder Drive

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

● See page 78

1-2 Shaft Options

◆ Product type

HMB010

P	=	Parallel keyed 40 mm Diameter Shaft
S	=	Splined shaft 13 teeth BS3550

HMB030 & HMB045

P	=	Parallel keyed 55 mm Diameter Shaft
S	=	Splined shaft 17 teeth BS3550
Z	=	Splined shaft DIN5480 (W55x3x17x7h)

HMB060, HMB080 & HMB100

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

HMB125, HMB150 & HMB200

P1	=	Parallel keyed 85 mm 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

HMHDB125, HMHDB150 & HMHDB200

P2	=	Parallel keyed 100 mm Diameter Shaft
S5	=	Splined shaft 23 teeth BS3550
Z5	=	Splined shaft DIN5480 (W100x4x24x7h)
T	=	Long taper keyed shaft - 120.52 key slot

HMB270 & HMB325

P1	=	Parallel keyed 85 mm Diameter Shaft
S3	=	Splined shaft 20 teeth BS3550
Z	=	Splined shaft DIN5480 (W100x4x24x7h)
T	=	Long taper keyed shaft - 133.4 key slot

HMHDB270 & HMHDB325

P2	=	Parallel keyed 100 mm Diameter Shaft
S5	=	Splined shaft 23 teeth BS3550
Z	=	Splined shaft DIN5480 (W100x4x24x7h)
T	=	Long taper keyed shaft - 120.52 key slot

HMHDB400

P	=	Parallel keyed 100 mm Diameter Shaft (2 keys)
S	=	Splined shaft 23 teeth BS3550
Z	=	Splined shaft DIN5480 (W55x3x17x7h)

[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 Options

◆ Product type

HMB010

Blank = Two, four bolt flange ports of 20 mm Ø

HMB030 Monobloc

Blank = Rear entry ports G ¾" (BSPF)
 F = Side port SAE 1" 4-Bolt (UNC) flange
 FM = Side port SAE 1" 4-Bolt (Metric) flange

HMB045 Monobloc

Blank = Rear entry ports G 1" (BSPF)
 D = Dual entry ports G 1" (BSPF)

HMB030/045 Two part build (TPB)

See detail below

HMB060/080/100

F2 = SAE 1" 4-Bolt (UNC) flanges
 FM2 = SAE 1" 4-Bolt (Metric) flanges
 S03 = 6-Bolt (UNF) flange. (Staffa original valve housing)
 F3 = SAE 1¼" 4-Bolt (UNC) flanges
 FM3 = SAE 1¼" 4-Bolt (Metric) flanges
 S04 = 6 Bolt (UNF) flanges. (Staffa original valve housing)

HMB125/150/200 + Heavy Duty Variants Details

F2 = SAE 1" 4-Bolt (UNC) flanges
 FM2 = SAE 1" 4-Bolt (Metric) flanges
 S03 = 6-Bolt (UNF) flange. (Staffa original valve housing)
 F3 = SAE 1¼" 4-Bolt (UNC) flanges
 FM3 = SAE 1¼" 4-Bolt (Metric) flanges
 S04 = 6 Bolt (UNF) flanges. (Staffa original valve housing)
 F4 = SAE 1¼" 4-Bolt (UNC) flanges
 FM4 = SAE 1½" 4-Bolt (Metric) flanges

HM(HD)B270/325 + Heavy Duty Variants

F4 = SAE 1½" 4-Bolt (UNC) flanges
 FM4 = SAE 1½" 4-Bolt (Metric) flanges
 S04 = 6 Bolt (UNF) flanges. (Staffa original valve housing)

HMHDB400

Blank = Combined 6-Bolt flange and 4-Bolt SAE connection
 Ports 'B' and 'C' 6-Bolt UNF flange
 Ports 'A' and 'C' SAE, 2" 4-Bolt UNF flanges
 S045 = 2 x 6-Bolts (UNF) flanges (2 inlet and 2 outlet ports available)

2 Technical Information

2-1 Performance Data

◆ Rating definitions

Continuous rating

For continuous duty the motor must be operating within each of the maximum values for speed, pressure and power.

Intermittent rating

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

Intermittent max pressure

This pressure is allowable on the following basis:

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

◆ Limits for fire resistant fluids

	Pressure (bar)			
Fluid Type	Continuous	Intermittent	Max Speed (rpm)	Model type
HFA 5/95 oil-in-water emulsion	103	138	50% of limits for Mineral Oil	All models
HFB 60/40 water-in-oil emulsion	138	172	As for Mineral Oil	All models
HFC water glycolol	103	138	50% of limits or Mineral Oil	All models
HFD phosphate ester	207	241	As for Mineral Oil	B010
	207	293	-	B030
	250	293	-	B045 to B400 inc.

2-1 Performance Data (cont)

Motor type	Geometric displacement (cc/rev)	Average actual running torque (Nm/bar)	Max. continuous speed (rpm)	Max. continuous output (kW)	Max. continuous pressure. (bar)	Max. intermittent pressure (bar)
B10	188	2.79	500	25	207	241
B030	442	6.56	450	42	207	293
B045	740	10.95	400	60	250	293
B060	983	14.5	300	80	250	293
B060 F2/FM2	983	14.5	200	75	250	293
B080	1,344	19.9	300	100	250	293
B080 F2/FM2	1,344	19.9	150	77	250	293
B100	1,639	24.3	250	110	250	293
B100 F2/FM2	1,639	24.3	125	80	250	293
B125	2,050	30.66	220	100	250	293
B125 F2/FM2	2,050	30.66	100	75	250	293
B150	2,470	36.95	220	115	250	293
B150 F3/FM3/S03	2,470	36.95	168	115	250	293
B150 F2/FM2	2,470	36.95	80	75	250	293
B200	3,080	46.07	175	130	250	293
B200 F3/FM3/S03	3,080	46.07	135	130	250	293
B200 F2/FM2	3,080	46.07	65	75	250	293
B270	4,310	63.79	125	140	250	293
B325	5,310	79.4	100	140	250	293
B400	6800	101	120	190	250	293

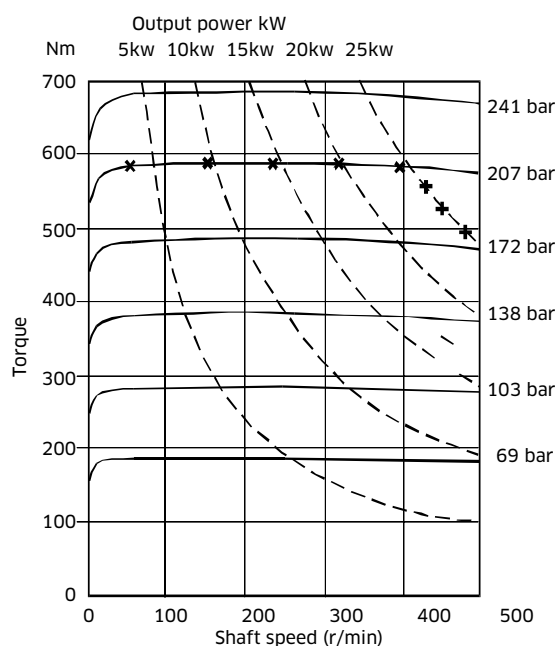
Other non standard displacements are possible - check with KPM UK for details.

2-1 Performance Data (cont)

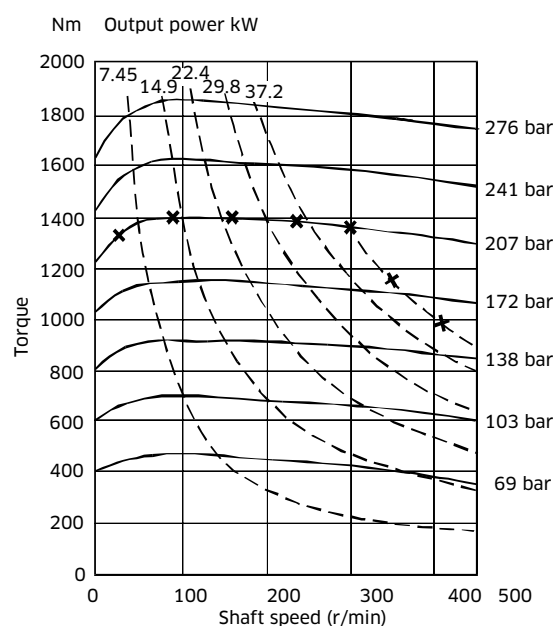
◆ Output Torque Curves

These torque curves indicate the maximum output torque and power of a fully run-in motor for a range of pressures and speeds when operating with zero outlet pressure on Mineral Oil of 50 cSt (232 SUS) viscosity. High return line pressures will reduce torque for a given pressure differential. - x - x - x - Upper limit of continuous rating envelope.

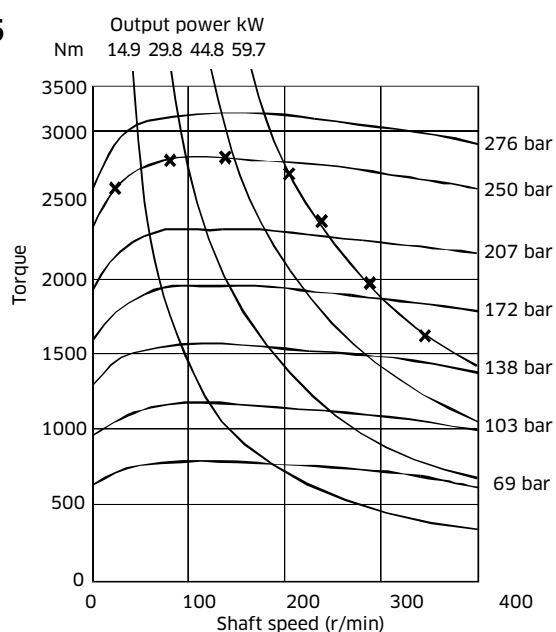
B010



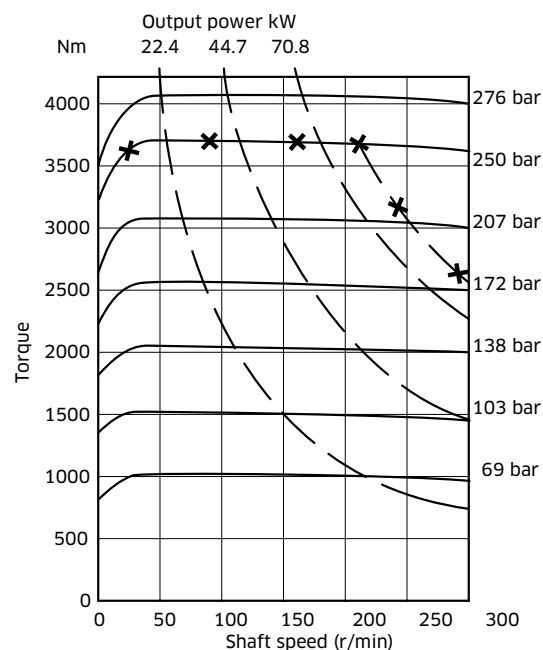
B030



B045



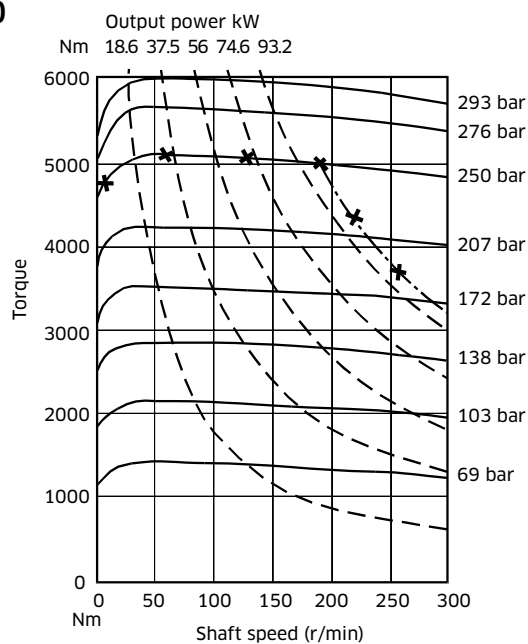
B060



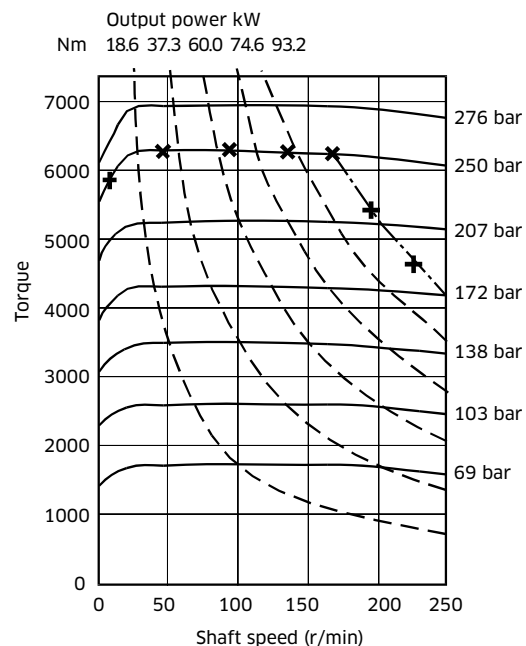
2-1 Performance Data (cont)

◆ Output Torque Curves (cont)

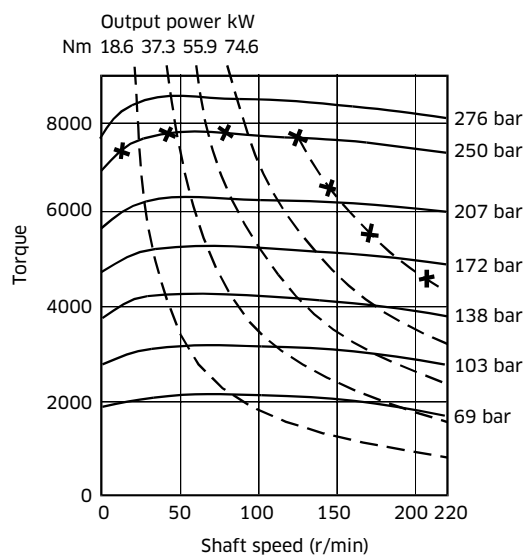
B080



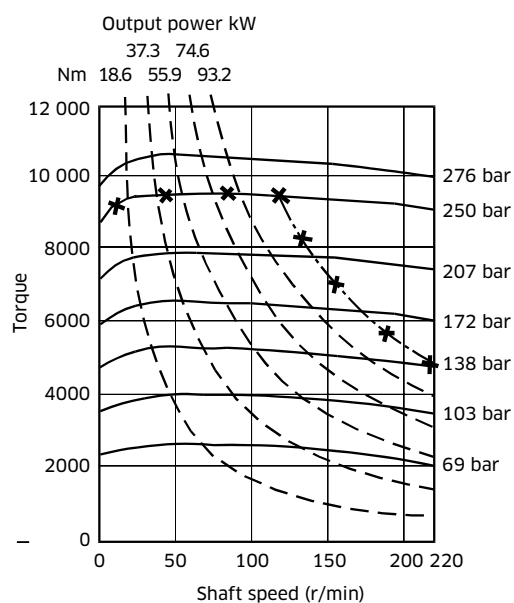
B100



B125



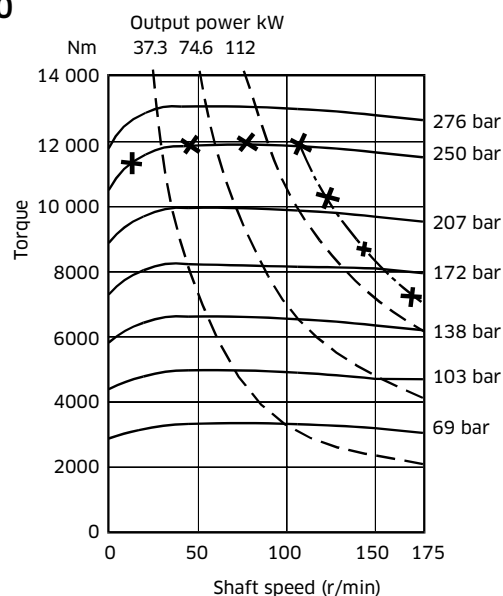
B150



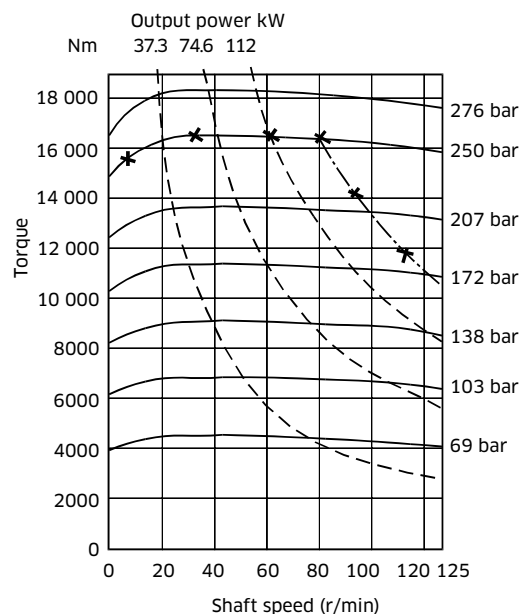
2-1 Performance Data (cont)

◆ Output Torque Curves (cont)

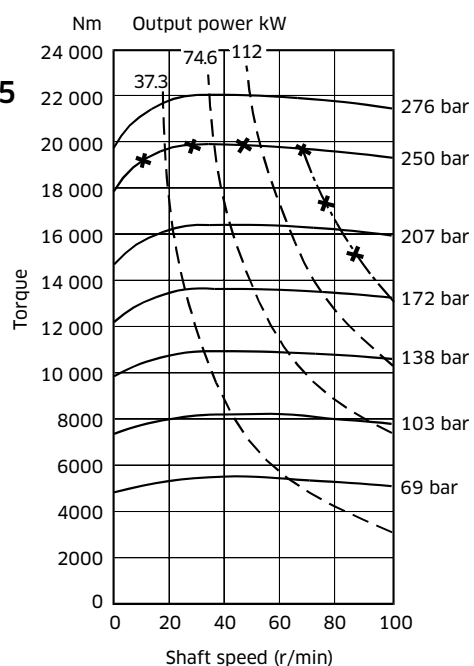
B200



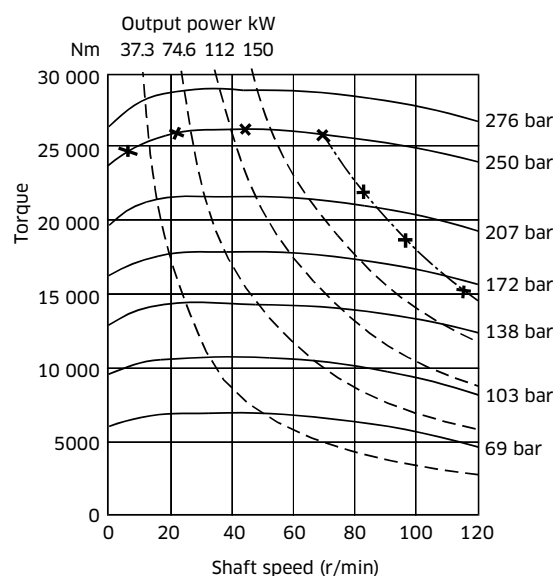
B270



B325



B400



2-2 Volumetric Efficiency Data

Motor Type	Geometric Displacement	Zero Speed Constant	Speed Constant	Creep Speed Constant	Crankcase Leakage Constant	Fluid Viscosity	Viscosity Factor
HMB	cc/rev	K ₁	K ₂	K ₃	K ₄	cSt	K _v
HMB010	188	1.34	534.05	7.31	0.51	20	1.58
HMB030	492	1.04	57.67	2.47	0.59	25	1.44
HMB045	740	1.92	43.36	2.71	1.76	30	1.30
HMB060	983	1.72	29.91	2.35	1.88	40	1.10
HMB080	1,344	1.71	21.62	1.84	1.84	50	1.00
HMB100	1,839	1.83	17.74	1.41	1.88	60	0.88
HMB125	2,050	2.06	11.45	1.24	1.35		
HMB150	2,470	1.62	9.98	1.00	1.39		
HMB200	3,080	2.53	14.99	0.78	1.39		
HMB270	4,310	3.17	21.16	0.68	1.80		
HMB325	5,310	3.14	18.21	0.55	1.80		
HMHDB400	6,800	4.06	10.18	0.53	2.35		

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:

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

Example:

HPC200 motor with displacement of 3.087 l/rev.

Speed 60 rpm

Differential pressure 200 bar

Fluid viscosity 50 cSt

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

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

2-3 Shaft Power Calculation

◆ **Example:** (see page 7):

HMB270:

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

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

$$140,000 = 63.79 \times \Delta P \times 125 \times 2 \times \pi / 60$$

$$\Delta P = 167 \text{ bar (max.)}$$

Secondly, to find the maximum speed at rated pressure :

Rated shaft power (W) :	140,000
Average actual running torque (Nm/bar) :	63.79
Rated pressure (bar) :	250

$$140,000 = 63.79 \times 250 \times n \times 2 \times \pi / 60$$

$$n = 83 \text{ rpm (max.)}$$

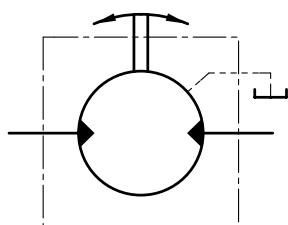
In summary, operating the motor within its shaft power limit, at rated speed, would give a maximum pressure of 167 bar, and operating the motor at rated pressure, would give a maximum speed of 83 rpm.

Notes

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

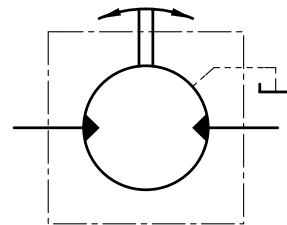
2-4 Functional Symbols

HMB010-
HMB030(Monobloc)

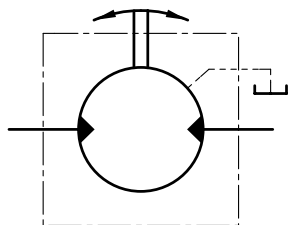


-S04-

HMB270
HMB325

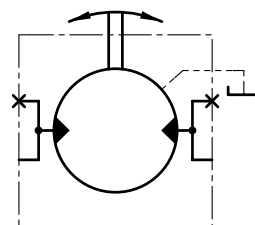


HMB045-**-
(Monobloc)

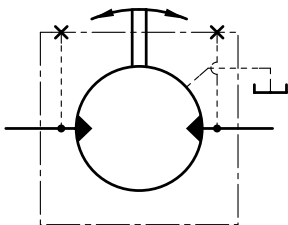


HMHDB400-**-

S045



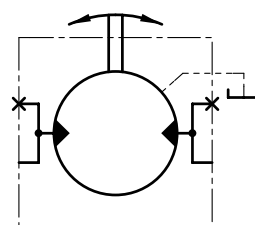
HMB045-**-D-
(Monobloc)



HMHDB400-**-

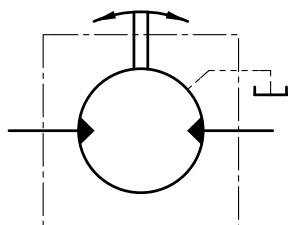
S045

Dual ports



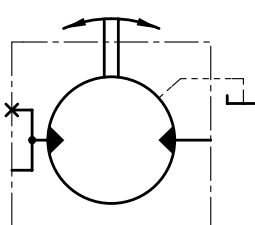
-F(M)2-;-S03-;-S04-

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



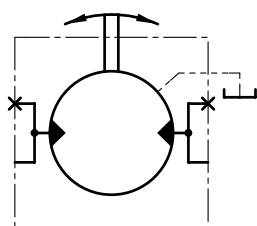
HMHDB400-**-

Removable plug



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

HMB030*/045*(TPB)
HMB060/080
HMB100/125
HMB150/200
*F(M)3 ONLY



2-5 Shaft Stress Limits

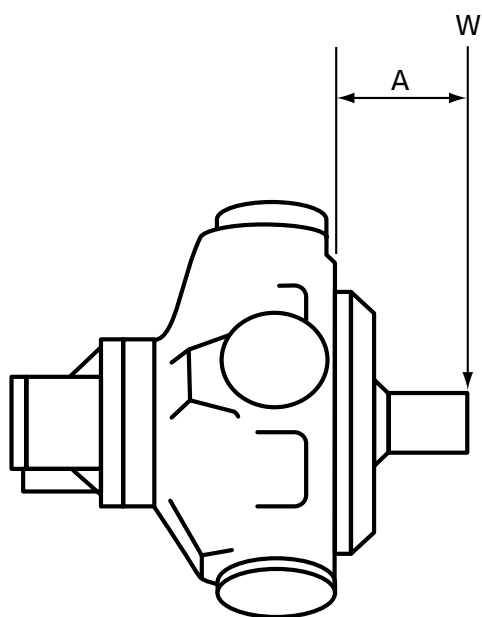
When applying large external radial loads, consideration should also be given to motor bearing lives, (see page 15).

Motor Frame Size	Shaft Types	Maximum External Radial bending Moment [kNm]
HMB010	P, S	1,550
HMB030	P, S & Z	2,400
HMB045	P, S & Z	3,240
HMB060, 080 & 100	P, S & Z	5,500
HMB125, 150 & 200	P1, S3, S4, Z3 & T	6,600
HMHDB125, 150 & 200	S5, Z5 & P2	12,750
HMB270 & 325	P1, S3, Z & T	7,500
HMHDB270 & 325	P2, S5, & Z	15,900
HMHDB400	P, S & Z	16,200

Example:

Determine the maximum radial shaft load of a HMB080 motor:

Radial load offset, A = 100 mm = 5,500 (see table)/100
 Maximum radial load, W = 4,500 (see table)/100 = 55N (5,607 kg)
= 45N (4,587 kg)



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

W = Side load (N)

[Note]

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

2-6 Bearing Life Notes

Consideration should be given to the required motor bearing life in terms of 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, type, cleanliness and temperature
- 5) External radial shaft load
- 6) External axial shaft load

[Note]

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

2-7 Circuit and Application Notes

◆ Starting Torque

The starting torques shown on the graphs on pages 8 to 10 are average and will vary with system parameters.

Low Speed Operations

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

Model Type	rpm
B010	20
B030	5
B045	6
B060/080/100/125/150/200	3
B270/B325/HMB400	2

High Back Pressure

When both inlet and outlet ports are pressurised continuously, the lower port pressure must not exceed 70 bar at any time.

Note: High back pressure reduces the effective torque output of the motor.

Boost Pressure

When operating as a motor the outlet pressure should equal or exceed the crankcase pressure . If pumping occurs (i.e. overrunning loads) then a positive pressure ,”P” ,is required at the motor ports. Calculate “P” (bar) from the operating formula Boost Formula $P = 1 + \frac{N^2 \times V^2}{K} + C$

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

Motor	Porting	Constant
HMB010	Standard	8.0×10^8
HMB030	Standard - Monobloc	3.7×10^9
	F(M)2	3.7×10^9
	FM(3) SO3	7.5×10^9
HMB045	Standard - Monobloc	1.3×10^{10}
	F(M)2	1.3×10^{10}
	FM(3) SO3	1.6×10^{10}
HMB060, HMB080 & HMB100	F(M)2	2.7×10^9
	FM(3) SO3	1.8×10^{10}
HM(HD)B125, HM(HD)B150 & HM(HD)B200	F(M)2	4.2×10^9
	FM(3) SO3	4.0×10^{10}
	FM(4) SO4	8.0×10^{10}
HM(HD)B270 & HM(HD)B325	FM(4) SO4	7.2×10^{10}
HMHDB400	SO4	6.0×10^{10}
	SO45	7.2×10^{10}

2-7 Circuit and Application Notes (cont)

The flow rate of oil needed for the make-up system can be estimated from the crankcase leakage figure (see page 11 for calculation method). Allowances should be made for other system losses and also for “fair wear and tear” during the life of the motor, pump and system components.

◆ Cooling Flow

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

For operating conditions above “continuous”, up to the “intermittent” rating, additional cooling oil may be required. This can be introduced through the spare crankcase drain holes, or in special cases through the valve spool end cap. Consult KPM UK about such applications.

◆ Motor Casing Pressure

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

Notes

- 1) The casing pressure at all times must not exceed either the motor inlet or outlet pressure.
- 2) High pressure shaft seals are available for casing pressures of:
 - 9 bar for HMB 010
 - 10 bar for all remaining frame sizes.
- 3) Check installation dimensions for maximum crankcase drain fitting depth.

◆ Hydraulic Fluids

Dependent on motor (see Ordering Code.) 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, see 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)

2-7 Circuit and Application Notes (cont)

◆ Mineral Oil recommendations

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

◆ Temperature limits

Ambient min.	-30°C (-22°F)
Ambient max.	+ 70°C (158°F)
Max. operating temperature range.	
Mineral Oil	Water-containing
Min -20°C (-4°F)	+10°C (50°F)
Max. + 80°C (175°F)	+54°C (130°F)

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

◆ Filtration

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

◆ Noise levels

The airborne noise level is less than 66.7 dB(A) DIN (&) dB (A) NFPA) through the “continuous” operating envelope. Where noise is a critical factor, installation resonances can be reduced by isolating the motor by elastomeric means from the structure and the return line installation. Potential return line resonances originating from liquid borne noise can be further attenuated by providing a return line back pressure of 2 to 5 bar.

Polar Moment of Inertia & Mass:

Model Type	Polar moment of Inertia (kg.m ²) (Typical data)	Mass (kg) (Approx. all models)
HMB010	0.0076	40
HMB030	0.0150	73
HMB045	0.0470	120
HMB060	0.0500	144
HMB080	0.0600	144
HMB100	0.0760	144
HMB125	0.2200	217
HMB150	0.2500	265
HMB200	0.2700	265
HMB270	0.4900	420
HMB325	0.5000	429
HMHDB400 - SO4	0.5400	481
HMHDB400 - SO45	0.5400	510

2-8 Motor Operation at Low Temperature

When operating the motor at low temperature consideration should be given to the fluid viscosity. The maximum fluid viscosity before the shaft should be turned is 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 at least 5 l/min should be applied to the motor during periods when the motor is not in use.

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

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

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

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

2-9 Freewheeling Notes

All Staffa motors can be used in freewheeling applications.

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

The required boost pressure will be dependent on the required speed and displacement conditions.

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

This will require a large re-circulating valve and consideration of circuit cooling as the motor will generate a large braking torque.

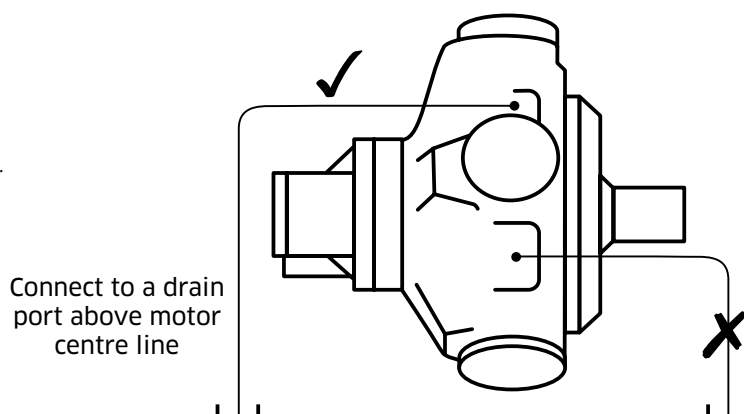
It is for these reasons that 'HMC' or 'HPC' series motors are the preferred option for freewheeling applications.

See catalogues M-2002/09.14 and M-2003/09.14 for details.

2-9 Crankcase Drain Connections

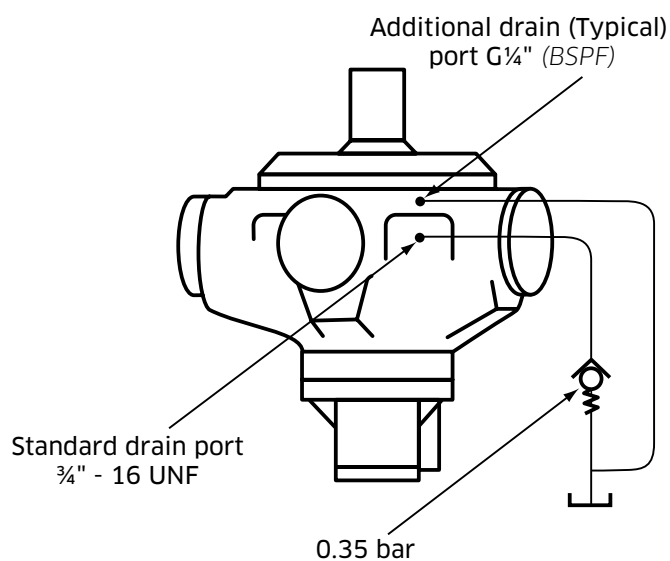
◆ Motor axis - horizontal

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



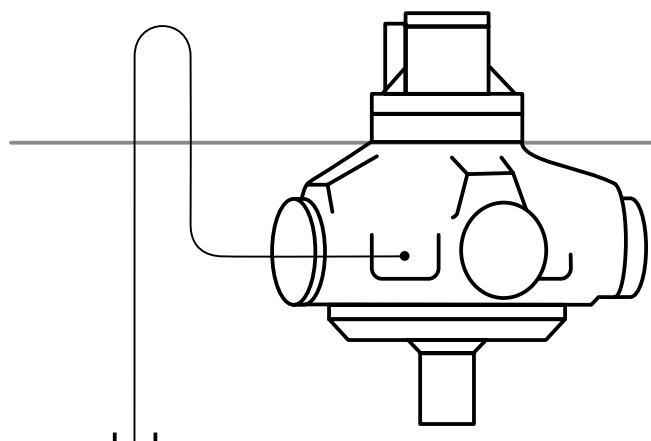
◆ Motor axis - vertical shaft up

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



◆ Motor axis - vertical shaft down

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



2-10 Installation Data

◆ Spigot

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

The diametrical clearance between the motor spigot and the mounting must not exceed 0.15 mm. If the application incurs shock loading, frequent reversing or high speed running, then high tensile bolts should be used, including one fitted bolt.

◆ Bolt Torque

The recommended torque wrench setting for bolts are as follows:

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

Shaft Coupling:

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

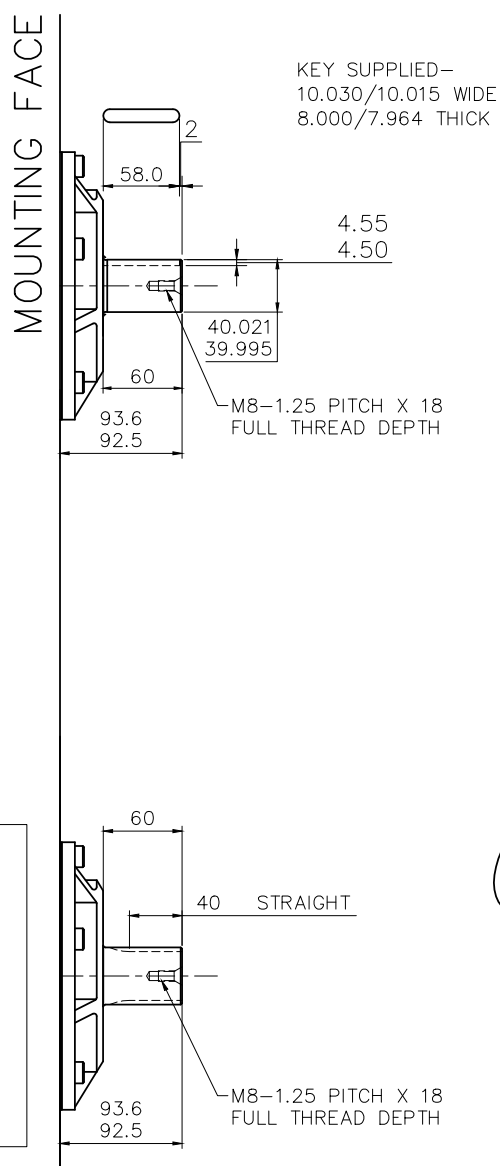
3 Dimensions

3-1 HMB010 Installation

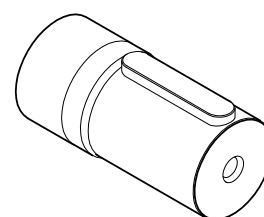
◆ 3-1-1 HMB010 - 'P' & 'S' Shafts

SPLINE DATA

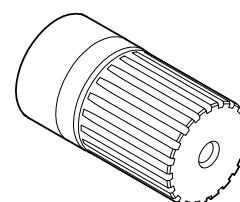
'S'	
TO BS 3550 (ANSI B92.1 CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	13
PITCH	8/16
MAJOR DIAMETER	43.71/43.59
FORM DIAMETER	38.136
MINOR DIAMETER	37.36/36.91
PIN DIAMETER	6.096
DIAMETER OVER PINS	50.104/50.152



'P'

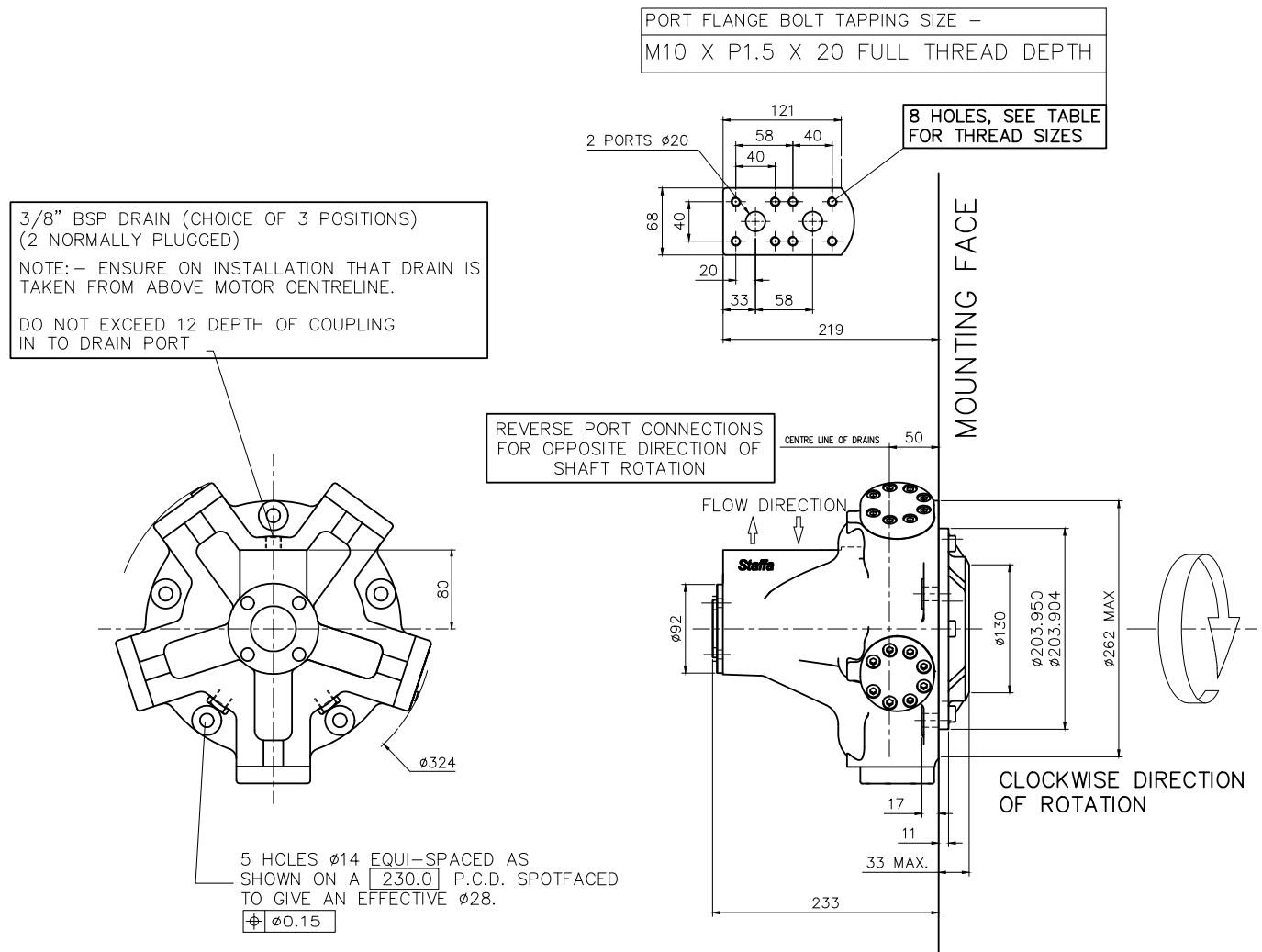


'S'



3-1 HMB010 Installation (cont)

◆ 3-1-2 HMB010 - Installation



3-2 HMB030 Installation

◆ 3-2-1 HMB030 Monobloc - 'P', 'S' & 'Z' Shafts

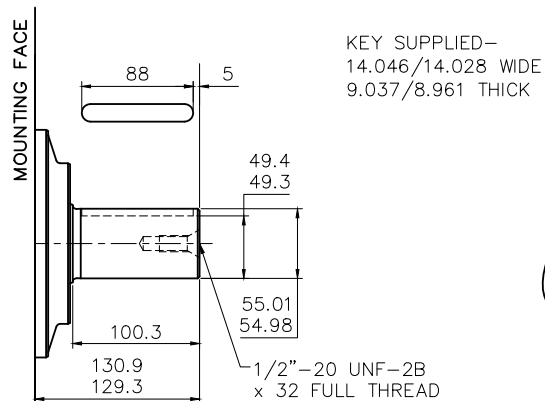
SPLINE DATA

'S'

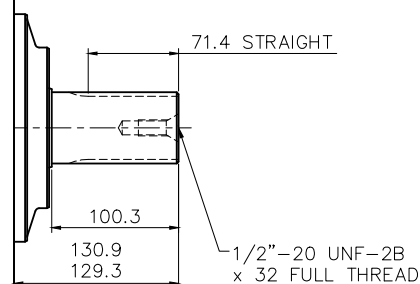
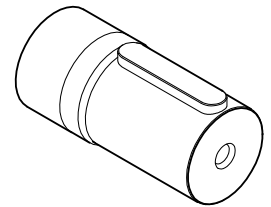
TO BS 3550 (ANSI B92.1 CLASS 5)
 FLAT ROOT SIDE FIT, CLASS 1
 PRESSURE ANGLE 30°
 NUMBER OF TEETH 17
 PITCH 8/16
 MAJOR DIAMETER 56.41/56.28
 FORM DIAMETER 50.703
 MINOR DIAMETER 50.07/49.60
 PIN DIAMETER 6.096
 DIAMETER OVER PINS 62.985/62.931

'Z'

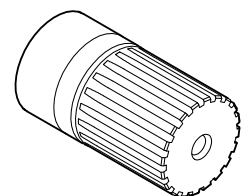
DIN 5480, W55 X 3 X 17 X 7h



'P'



'S' & 'Z'



3-2 HMB030 Installation (cont)

◆ 3-2-2 HMB030 2 Piece - 'P', 'S' & 'Z' Shafts

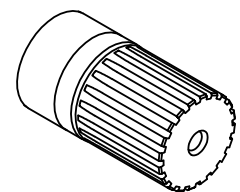
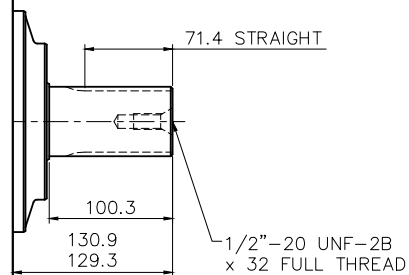
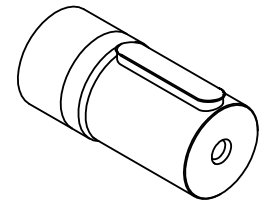
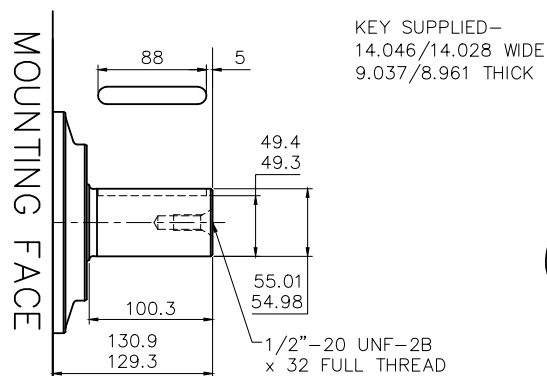
SPLINE DATA

'S'

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

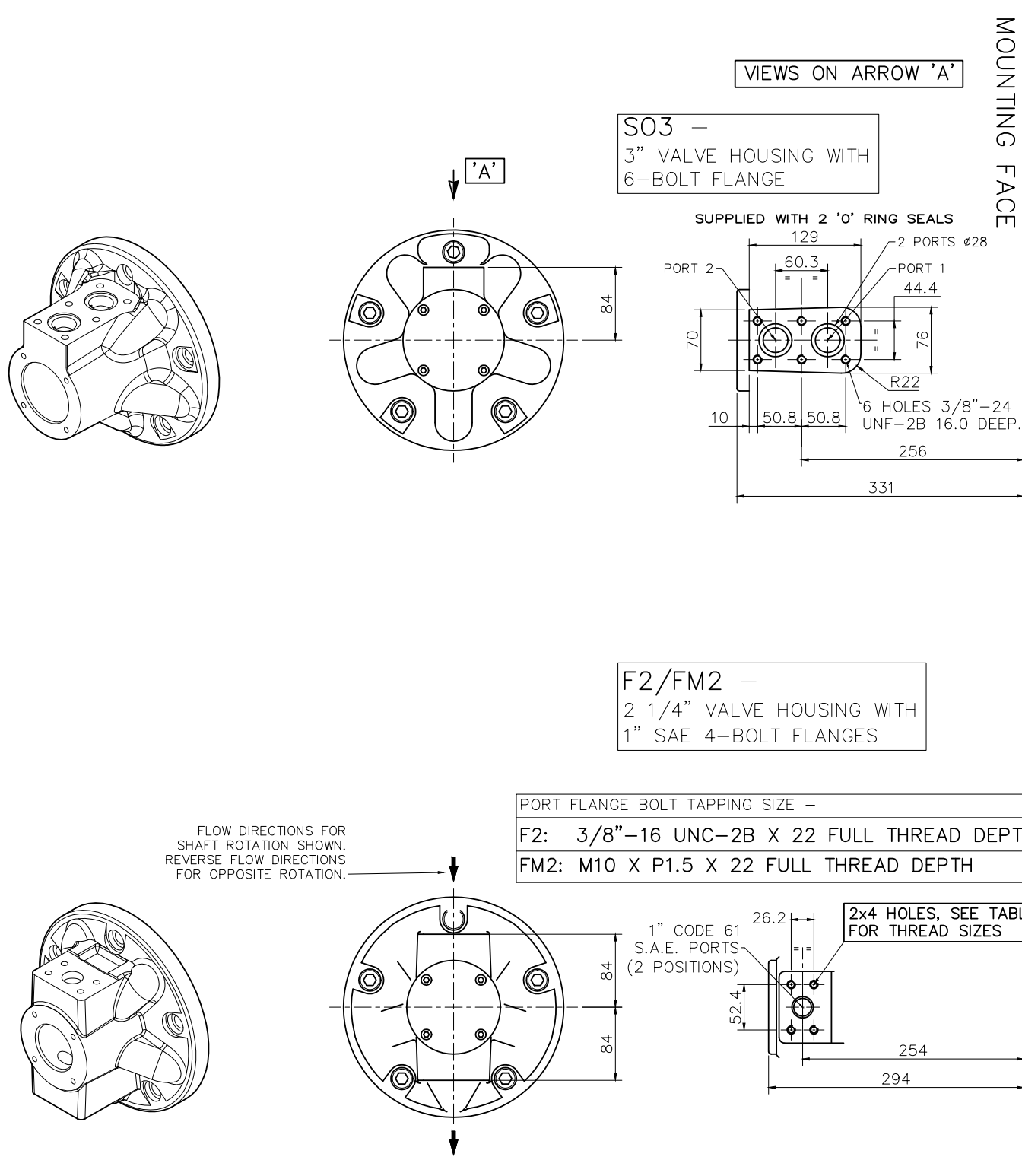
'Z'

DIN 5480, W55 X 3 X 17 X 7h



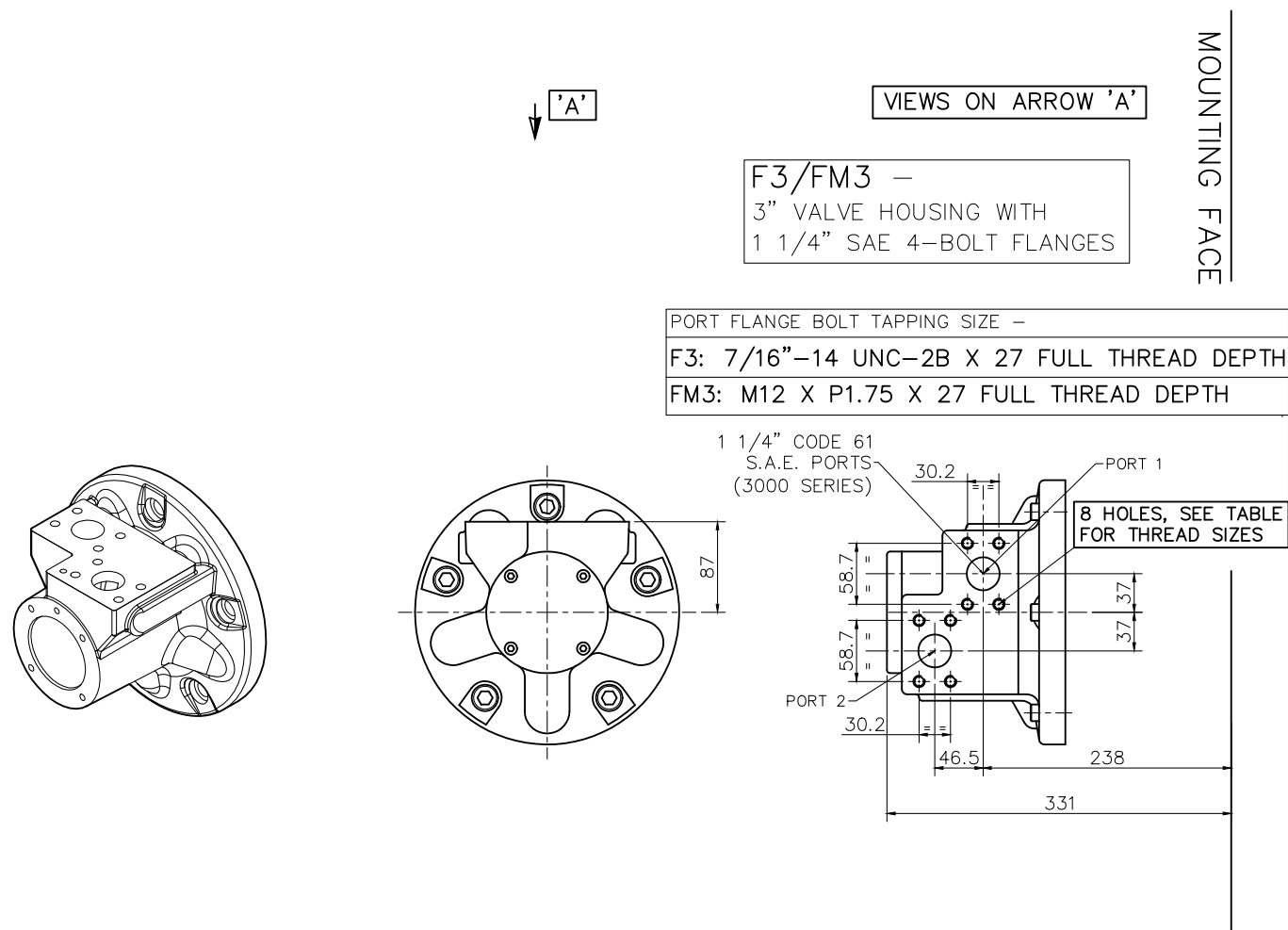
3-2 HMB030 Installation (cont)

◆ 3-2-3 HMB030 2 Piece - 'S03', 'F2' & 'FM2' Valve Housings



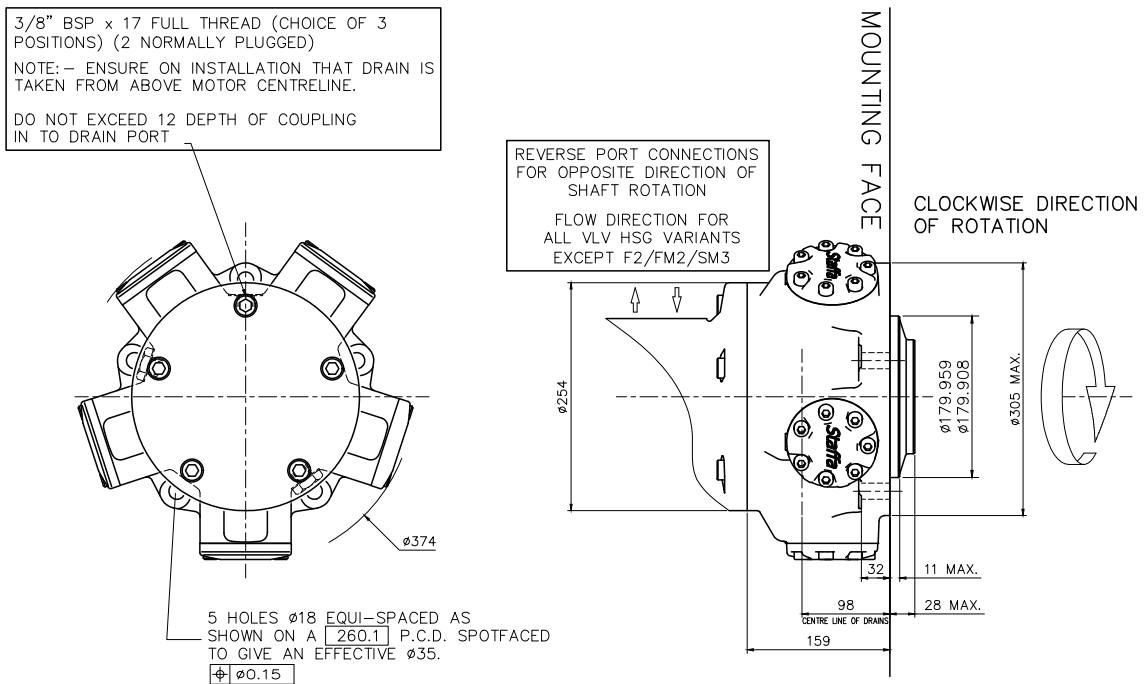
3-2 HMB030 Installation (cont)

◆ 3-2-4 HMB030 2 Piece - 'F3' & 'FM3' Valve Housings



3-2 HMB030 Installation (cont)

◆ 3-2-5 HMB030 2 Piece - Installation



3-2 HMB030 Installation (cont)

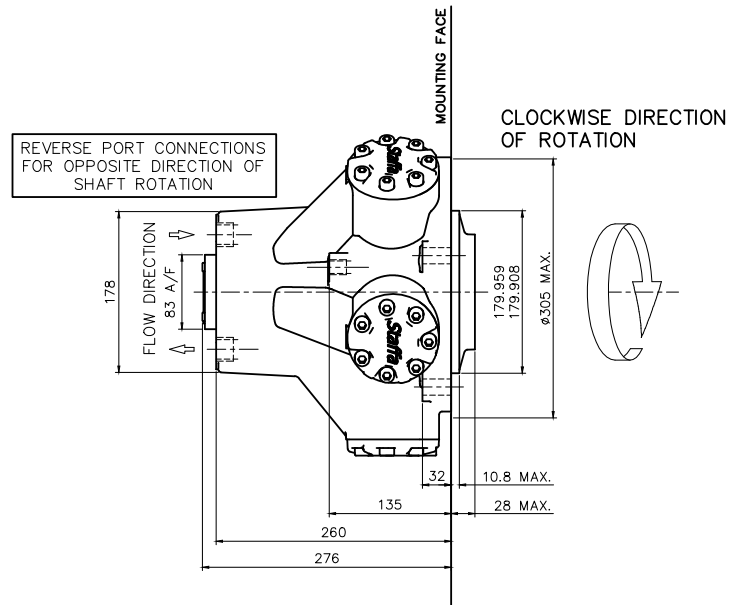
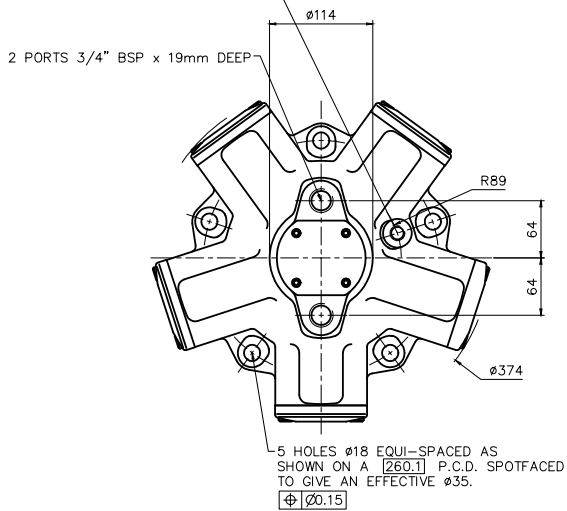
◆ 3-2-6 HMB030 Monobloc - Rear Port Installation

EXAMPLE FOR MODEL CODE.

REAR ENTRY MOTORCASE – HMB030/P/21

3/8" BSP DRAIN

NOTE: – ENSURE ON INSTALLATION THAT DRAIN IS CONNECTED TO PORT ABOVE MOTOR



3-2 HMB030 Installation (cont)

◆ 3-2-7 HMB030 Monobloc - Side Port Installation

2 PORTS $\phi 25$ TO SUIT SAE
CODE 61, 1" NOM. SPLIT FLANGE

PORT FLANGE BOLT TAPPING SIZE -

F: $3/8"$ -16 UNC-2B X 16 FULL THREAD DEPTH

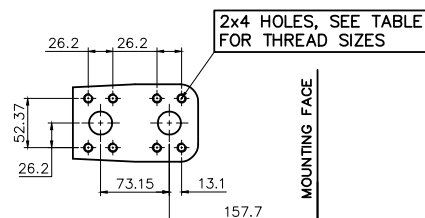
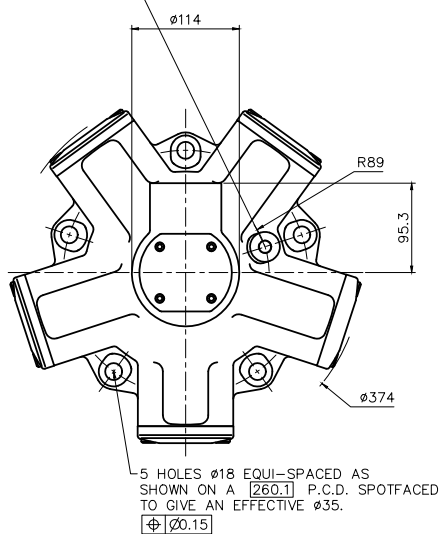
FM: M10 X P1.5 X 16 FULL THREAD DEPTH

EXAMPLE FOR MODEL CODE.

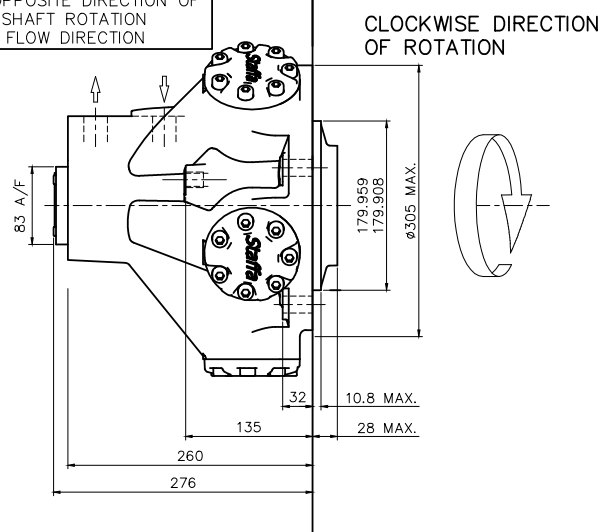
SIDE ENTRY MOTORCASE - HMB030/P/FM/21

$3/8"$ BSP DRAIN

NOTE: - ENSURE ON INSTALLATION THAT DRAIN IS
CONNECTED TO PORT ABOVE MOTOR



REVERSE PORT CONNECTIONS
FOR OPPOSITE DIRECTION OF
SHAFT ROTATION
FLOW DIRECTION



3-3 HMB045 Installation

◆ 3-3-1 HMB045 Monobloc - 'P', 'S' & 'Z' Shafts

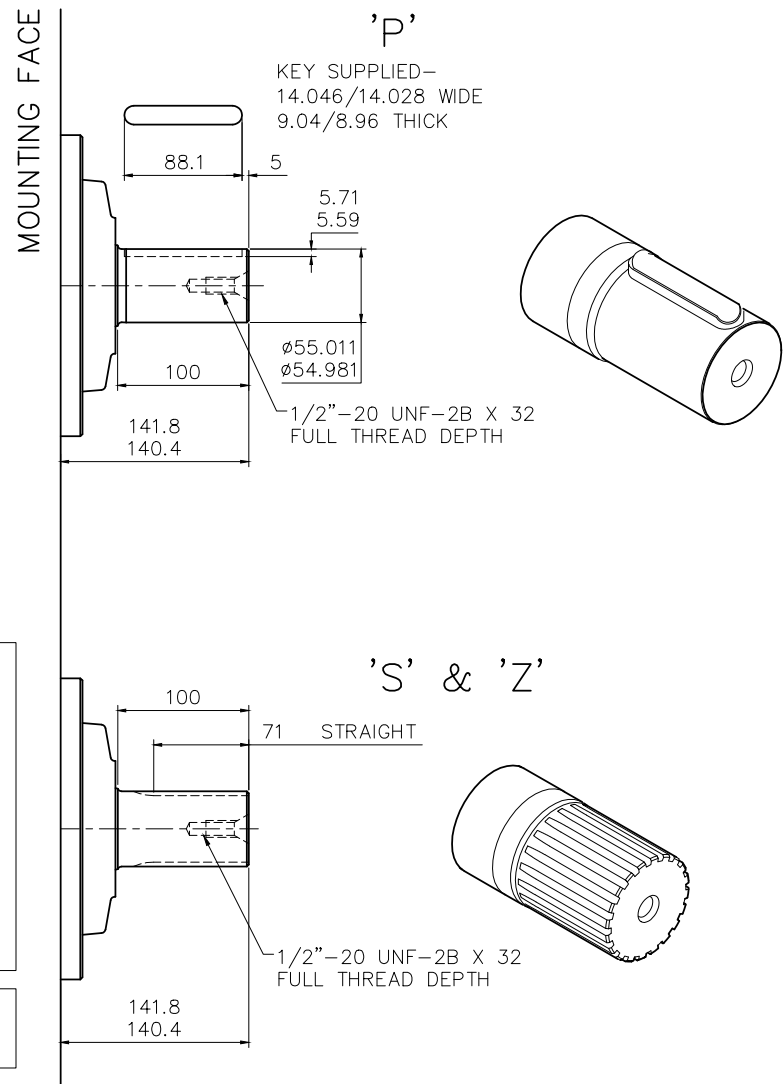
SPLINE DATA

'S'

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

'Z'

DIN 5480 W55 x 3 x 17 x 7h



3-3 HMB045 Installation (cont)

◆ 3-3-2 HMB045 2 Piece - 'P', 'S' & 'Z' Shafts

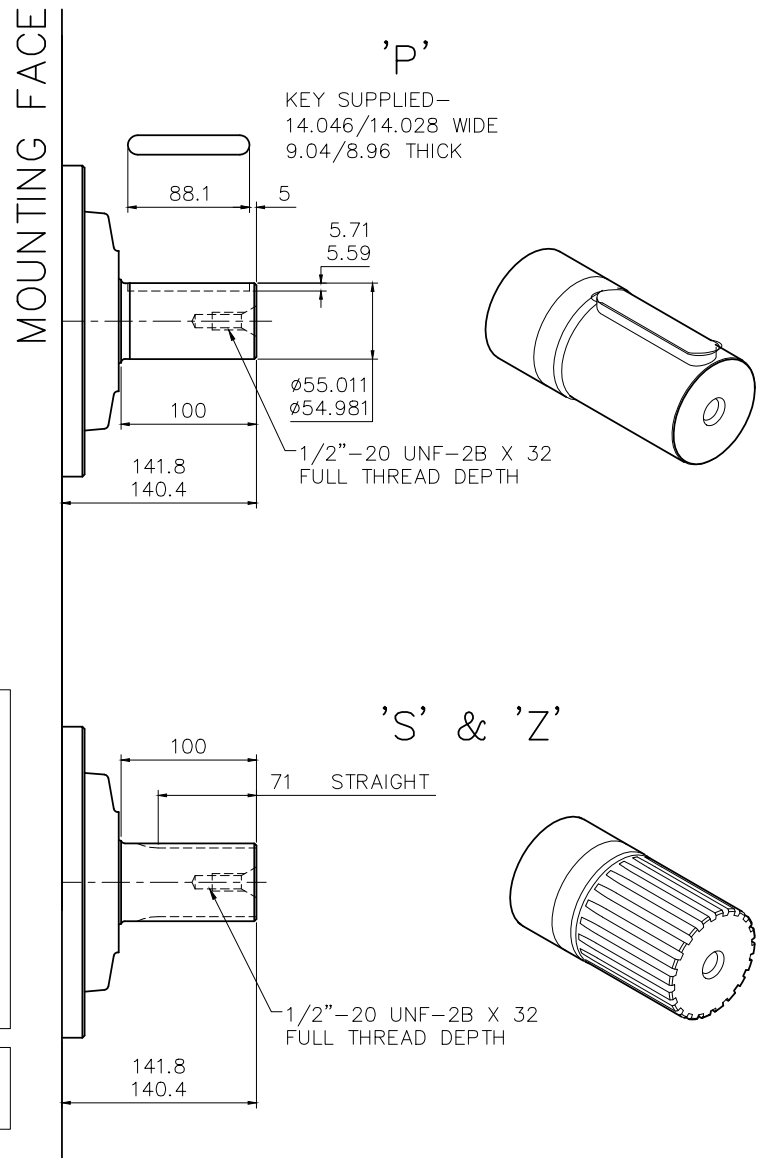
SPLINE DATA

'S'

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

'Z'

DIN 5480 W55 x 3 x 17 x 7h

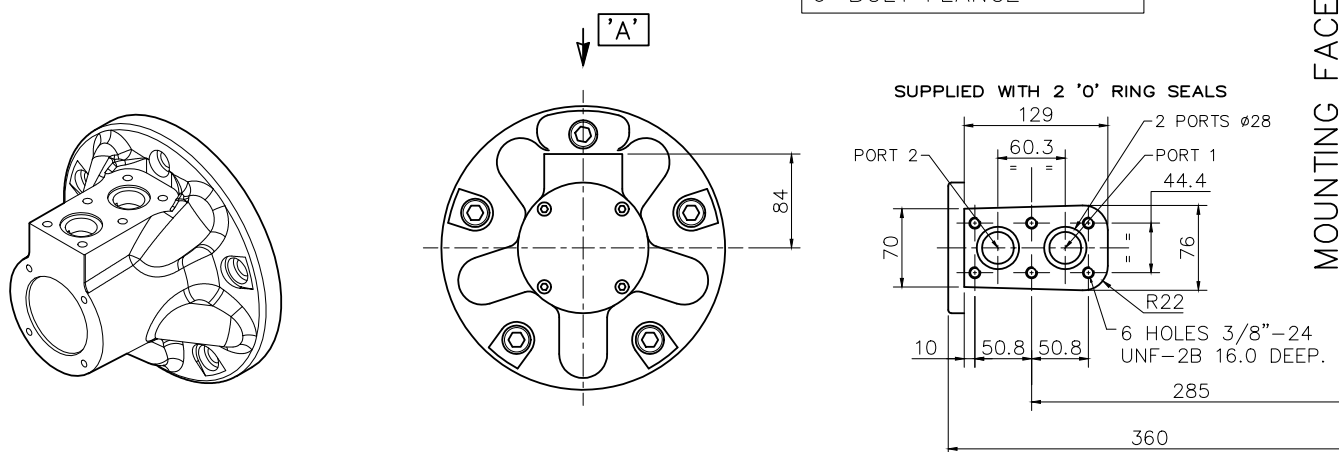


3-3 HMB045 Installation (cont)

◆ 3-3-3 HMB045 2 Piece - 'S03', 'F2' & 'FM2' Valve Housings

IEWS ON ARROW 'A'

S03 –
3" VALVE HOUSING WITH
6-BOLT FLANGE

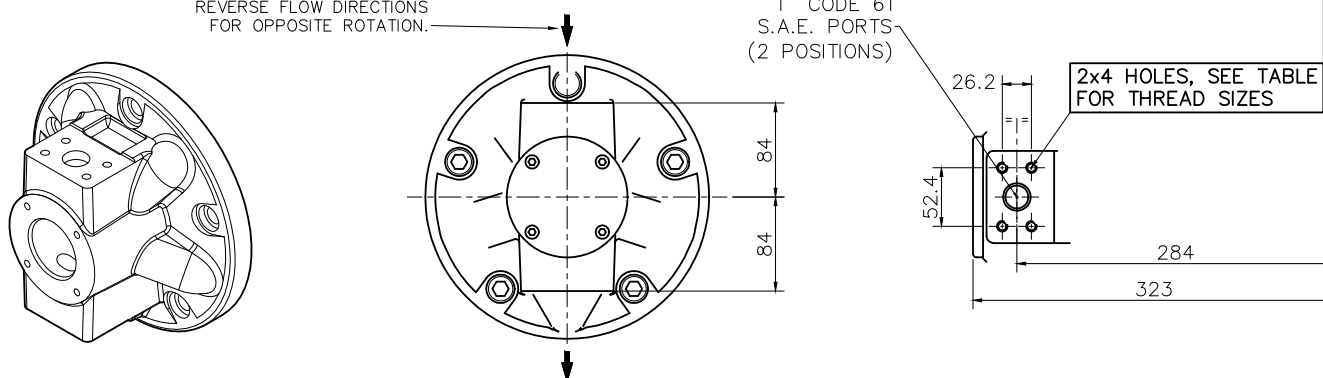


F2/FM2 –
2 1/4" VALVE HOUSING WITH
1" SAE 4-BOLT FLANGES

PORT FLANGE BOLT TAPPING SIZE –	
F2:	3/8"–16 UNC–2B X 22 FULL THREAD DEPTH
FM2:	M10 X P1.5 X 22 FULL THREAD DEPTH

FLOW DIRECTIONS FOR
SHAFT ROTATION SHOWN.
REVERSE FLOW DIRECTIONS
FOR OPPOSITE ROTATION.

1" CODE 61
S.A.E. PORTS
(2 POSITIONS)



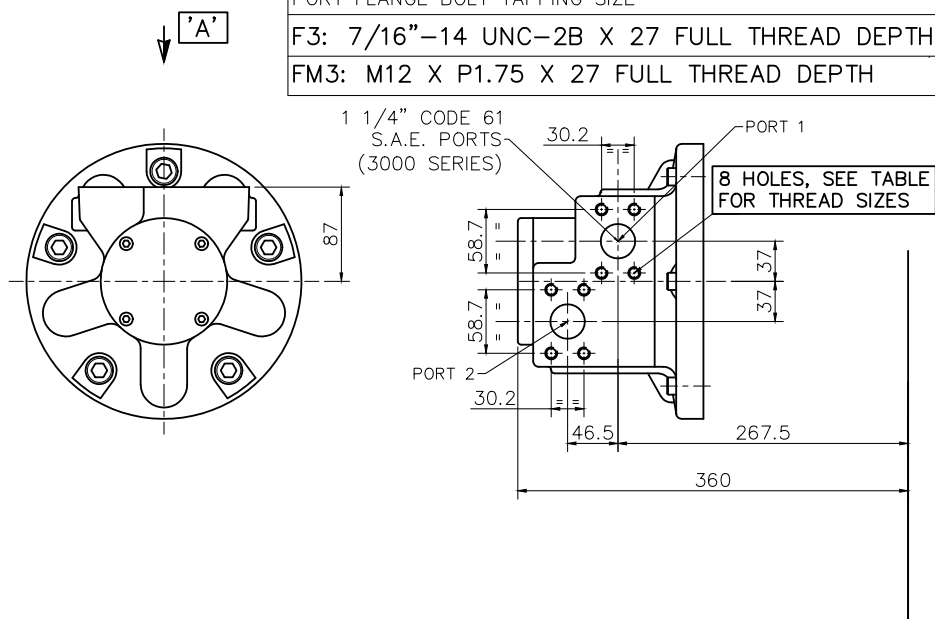
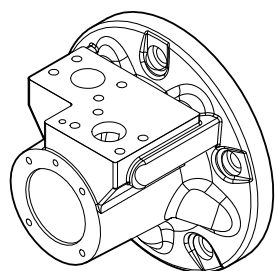
3-3 HMB045 Installation (cont)

◆ 3-3-4 HMB045 2 Piece - 'F3' & 'FM3' Valve Housings

VIEWS ON ARROW 'A'

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

MOUNTING FACE



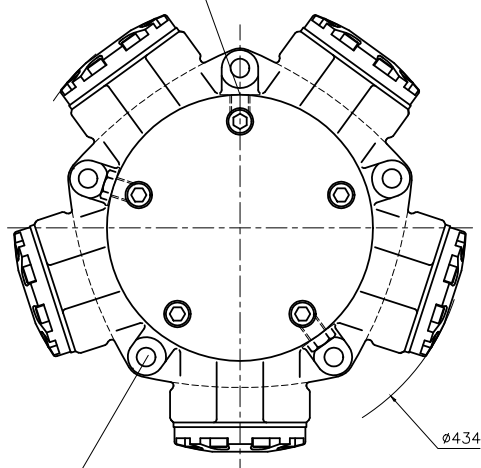
3-3 HMB045 Installation (cont)

◆ 3-3-5 HMB045 2 Piece - Installation

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 12 DEPTH OF COUPLING
IN TO DRAIN PORT

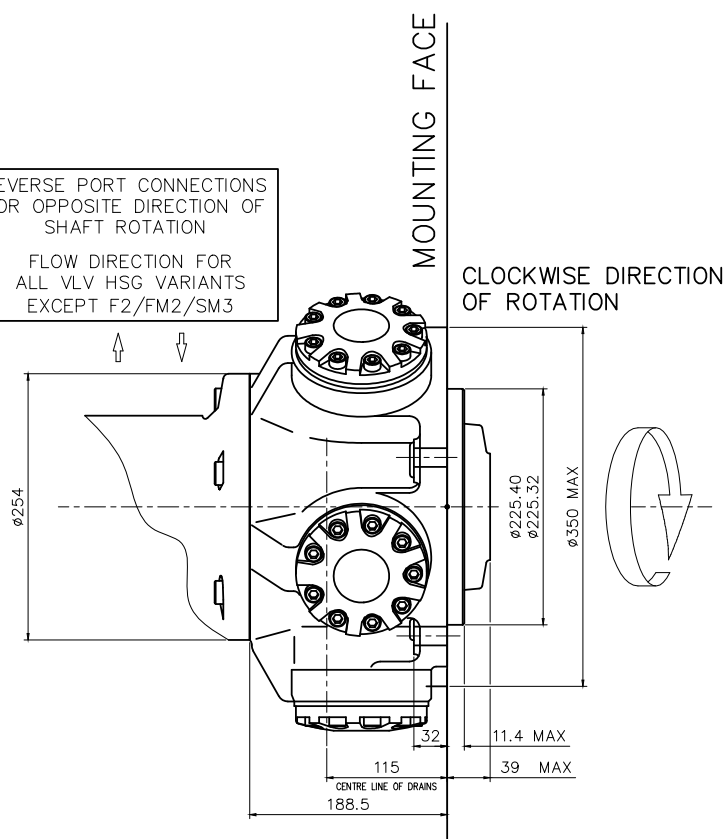


5 HOLES $\phi 18$ EQUI-SPACED AS
SHOWN ON A $\boxed{304.8}$ P.C.D. SPOTFACED
TO GIVE AN EFFECTIVE $\phi 38$.

$\boxed{\phi 0.15}$

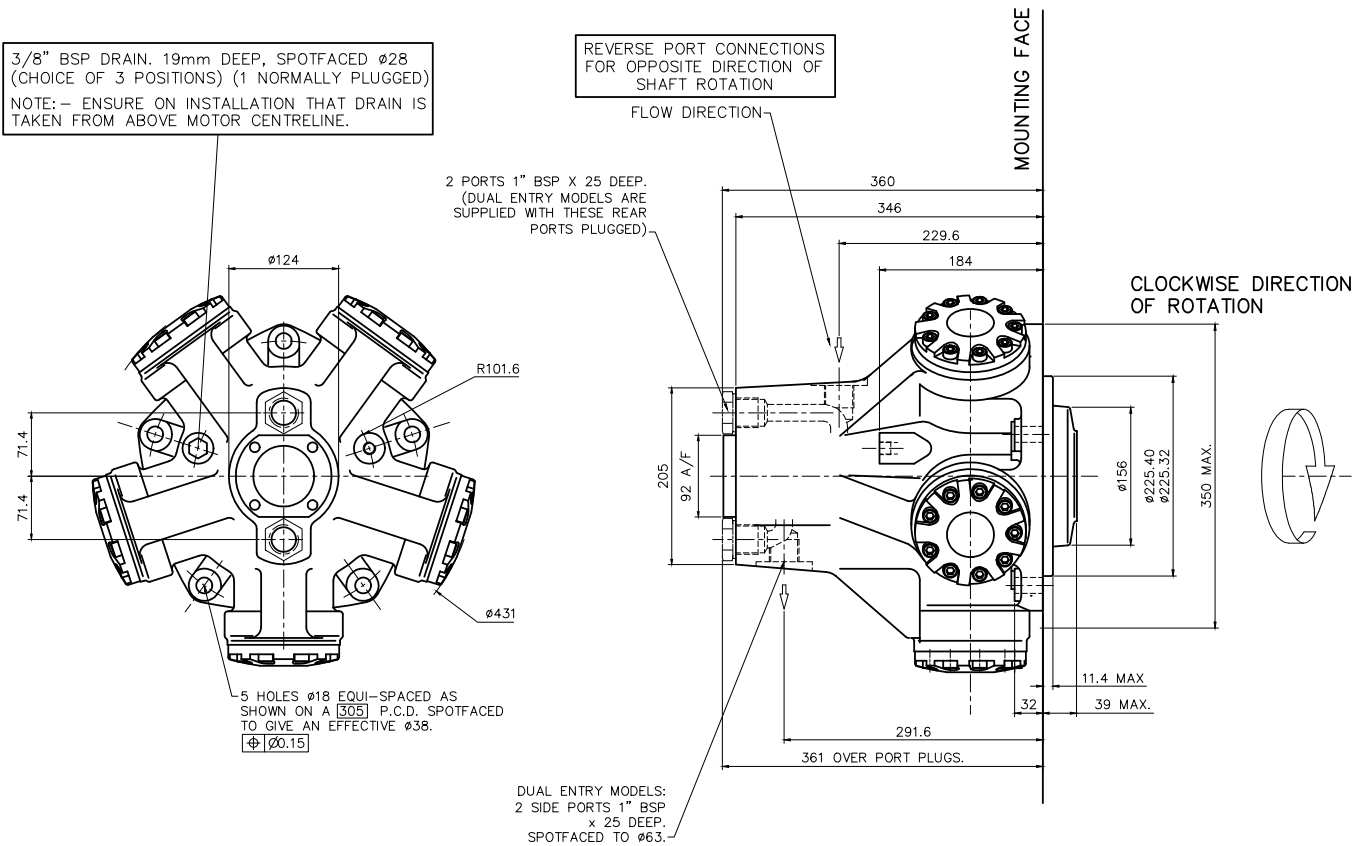
REVERSE PORT CONNECTIONS
FOR OPPOSITE DIRECTION OF
SHAFT ROTATION

FLOW DIRECTION FOR
ALL VLV HSG VARIANTS
EXCEPT F2/FM2/SM3



3-3 HMB045 Installation (cont)

3-3-6 HMB045 Monobloc - Installation



3-4 HMB060/080 Installation

◆ 3-4-1 HMB060/080 - 'P', 'S' & 'Z' Shafts

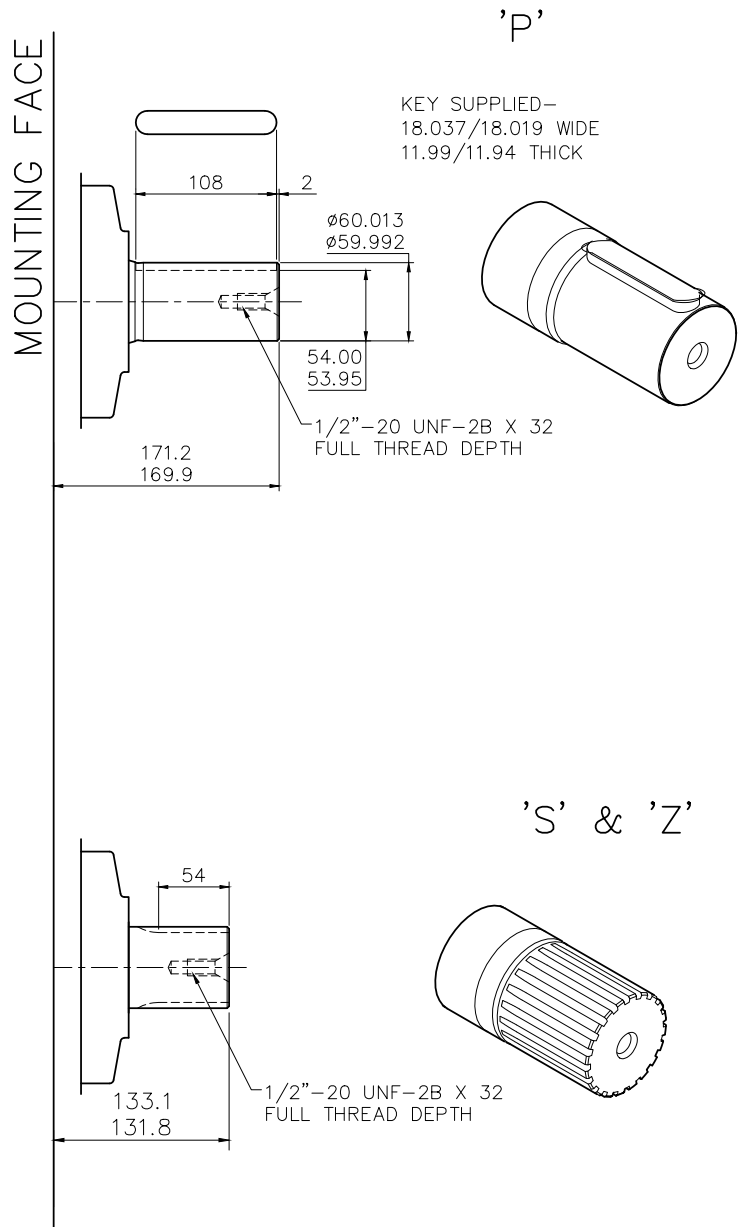
SPLINE DATA

'S'

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

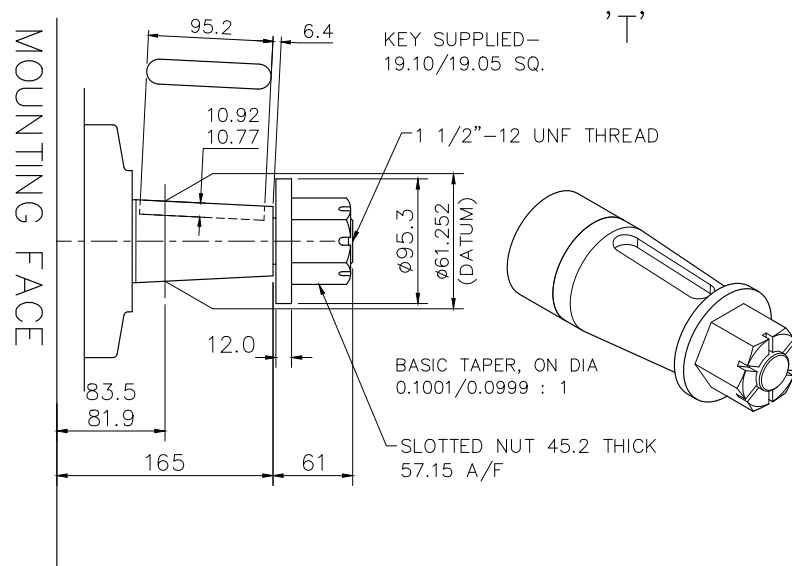
'Z'

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



3-4 HMB060/080 Installation (cont)

◆ 3-4-2 HMB060/080 - 'T' Shaft



3-4 HMB060/080 Installation (cont)

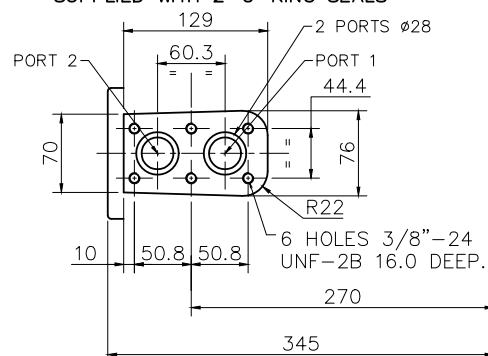
◆ 3-4-3 HMB060/080 - 'S03', 'F2' & 'FM2' Valve Housings

MOUNTING FACE

VIEWS ON ARROW 'A'

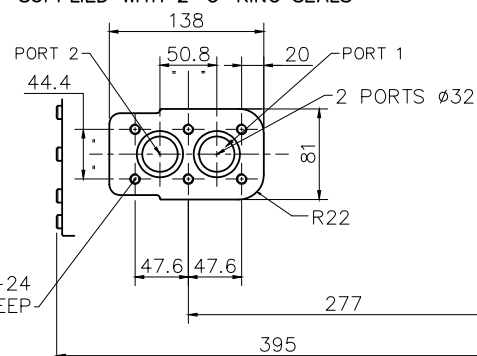
S03 –
3" VALVE HOUSING WITH
6-BOLT FLANGE

SUPPLIED WITH 2 'O' RING SEALS



S04 –
4" VALVE HOUSING WITH
6-BOLT FLANGE

SUPPLIED WITH 2 'O' RING SEALS



3-4 HMB060/080 Installation (cont)

◆ 3-4-4 HMB060/080 - 'F3' & 'FM3' Valve Housings

VIEWS ON ARROW 'A'

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

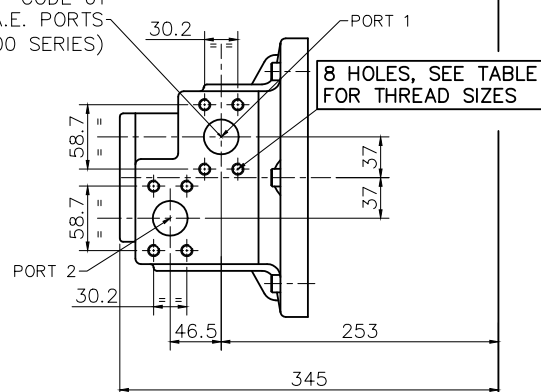
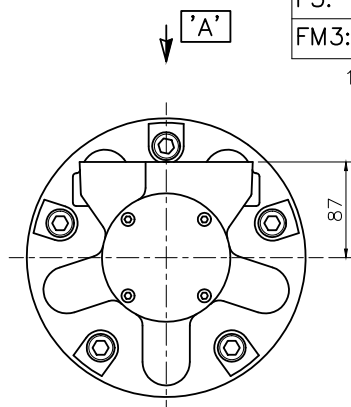
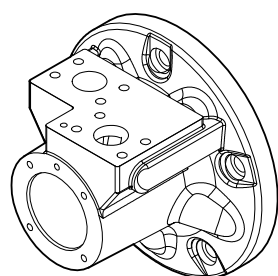
PORT FLANGE BOLT TAPPING SIZE –

F3: 7/16"–14 UNC–2B X 27 FULL THREAD DEPTH

FM3: M12 X P1.75 X 27 FULL THREAD DEPTH

1 1/4" CODE 61
S.A.E. PORTS
(3000 SERIES)

8 HOLES, SEE TABLE
FOR THREAD SIZES



MOUNTING FACE

3-5 HMB100 Installation

◆ 3-5-1 HMB100 - 'P', 'S' & 'Z' Shafts

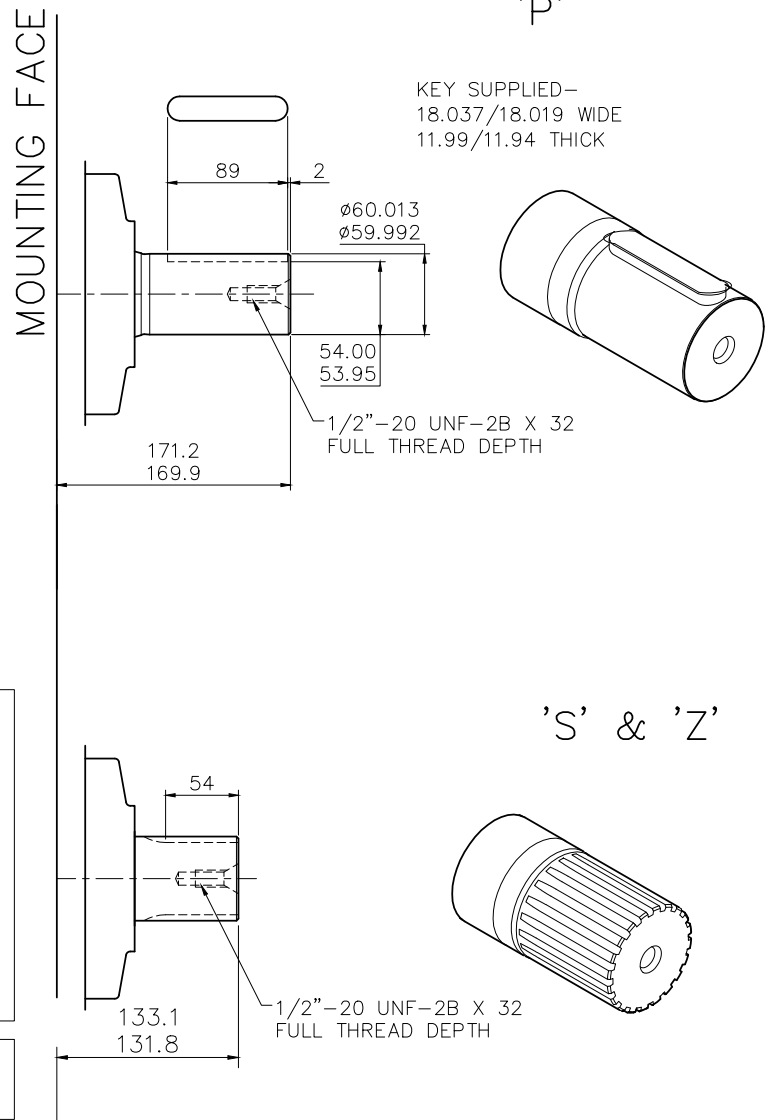
SPLINE DATA

'S'

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

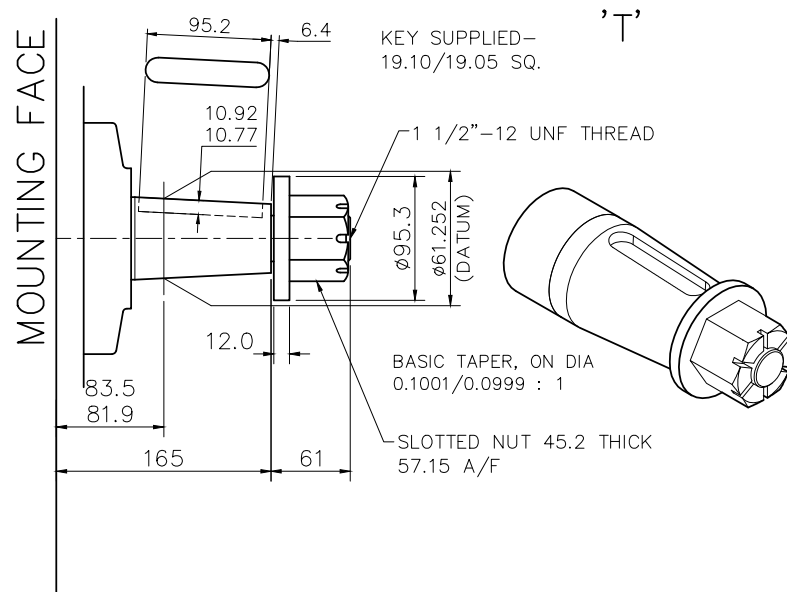
'Z'

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



3-5 HMB100 Installation (cont)

◆ 3-5-2 HMB100 - 'T' Shaft



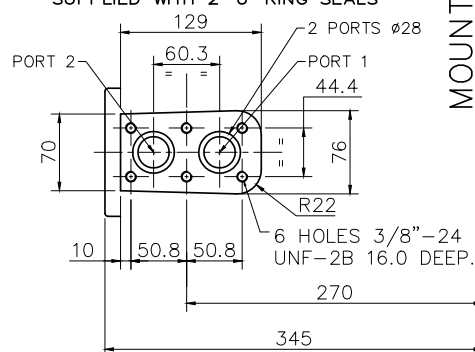
3-5 HMB100 Installation (cont)

◆ 3-5-3 HMB100 - 'SO3', 'F2' & 'FM2' Valve Housings

VIEWS ON ARROW 'A'

SO3 –
3" VALVE HOUSING WITH
6-BOLT FLANGE

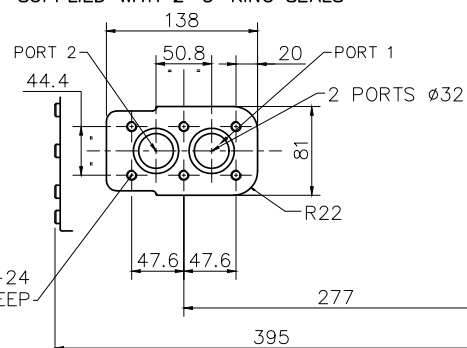
SUPPLIED WITH 2 'O' RING SEALS



MOUNTING FACE

SO4 –
4" VALVE HOUSING WITH
6-BOLT FLANGE

SUPPLIED WITH 2 'O' RING SEALS



3-5 HMB100 Installation (cont)

◆ 3-5-4 HMB100 - 'F3' & 'FM3' Valve Housings

MOUNTING FACE

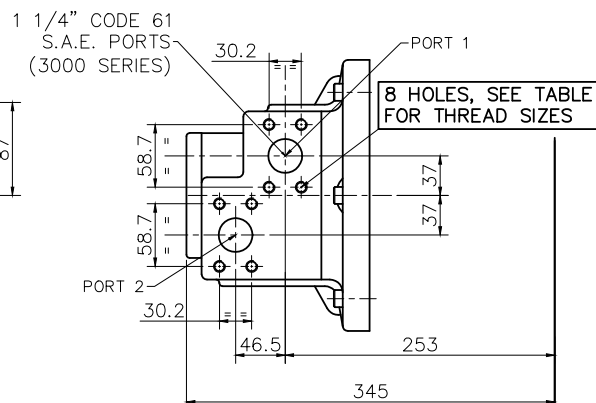
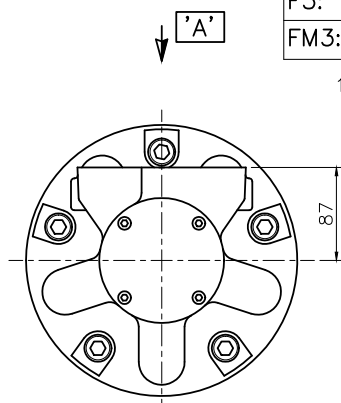
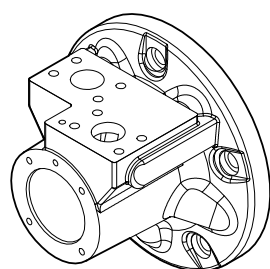
VIEWS ON ARROW 'A'

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

PORT FLANGE BOLT TAPPING SIZE –

F3: 7/16"–14 UNC–2B X 27 FULL THREAD DEPTH

FM3: M12 X P1.75 X 27 FULL THREAD DEPTH

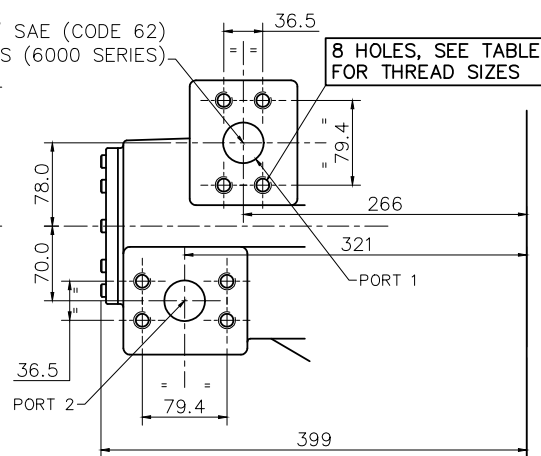
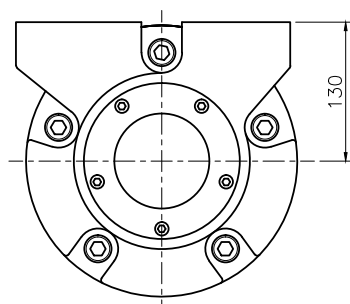
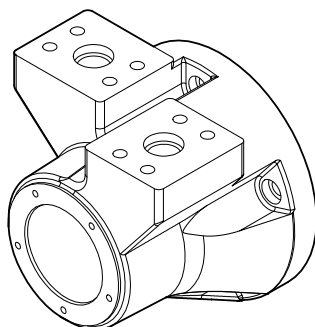


F4/FM4 –
4" VALVE HOUSING WITH
1 1/2" SAE 4-BOLT FLANGES

PORT FLANGE BOLT TAPPING SIZE –

F4: 5/8"–11 UNC–2B X 35 FULL THREAD DEPTH

FM4: M16 X P2 X 35 FULL THREAD DEPTH



3-5 HMB100 Installation (cont)

◆ 3-5-5 HMB100 - Installation

3/4"-16UNF-2B DRAIN (CHOICE OF 3 POSITIONS)
(2 NORMALLY PLUGGED)

NOTE: – ENSURE ON INSTALLATION THAT DRAIN IS TAKEN FROM ABOVE MOTOR CENTRELINE.

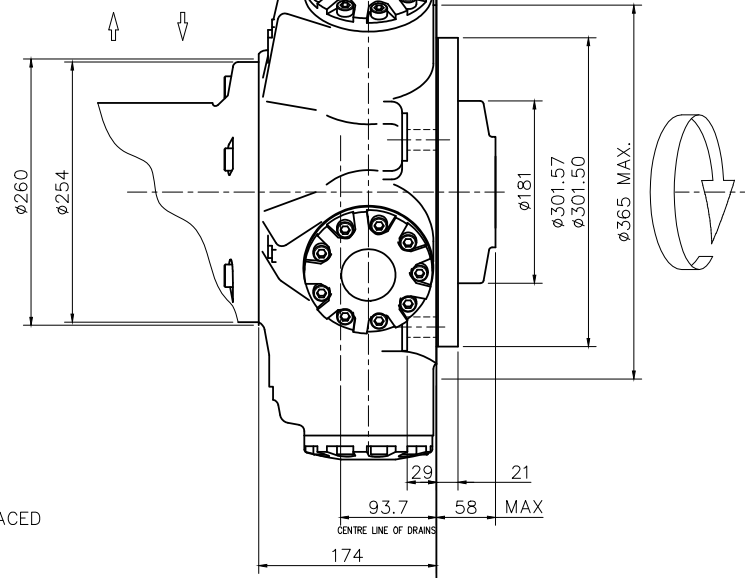
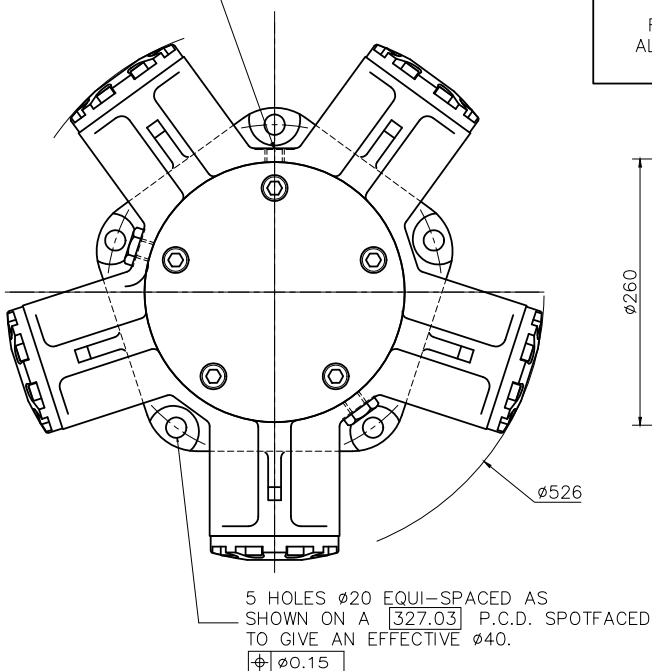
DO NOT EXCEED 12 DEPTH OF COUPLING
IN TO DRAIN PORT

REVERSE PORT CONNECTIONS
FOR OPPOSITE DIRECTION OF
SHAFT ROTATION

FLOW DIRECTION FOR
ALL VLV HSG VARIANTS
EXCEPT SM3

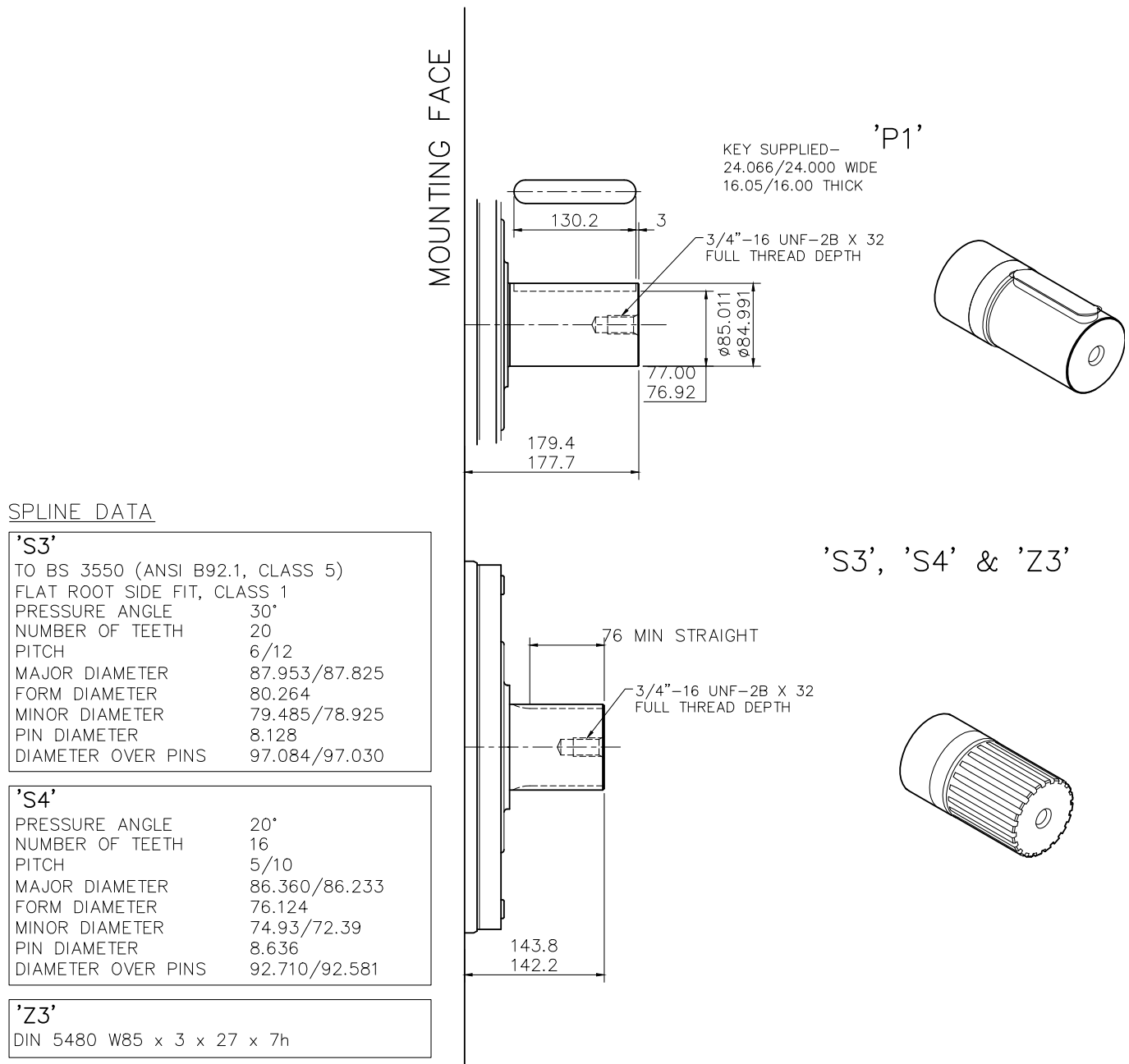
MOUNTING FACE

CLOCKWISE DIRECTION
OF ROTATION



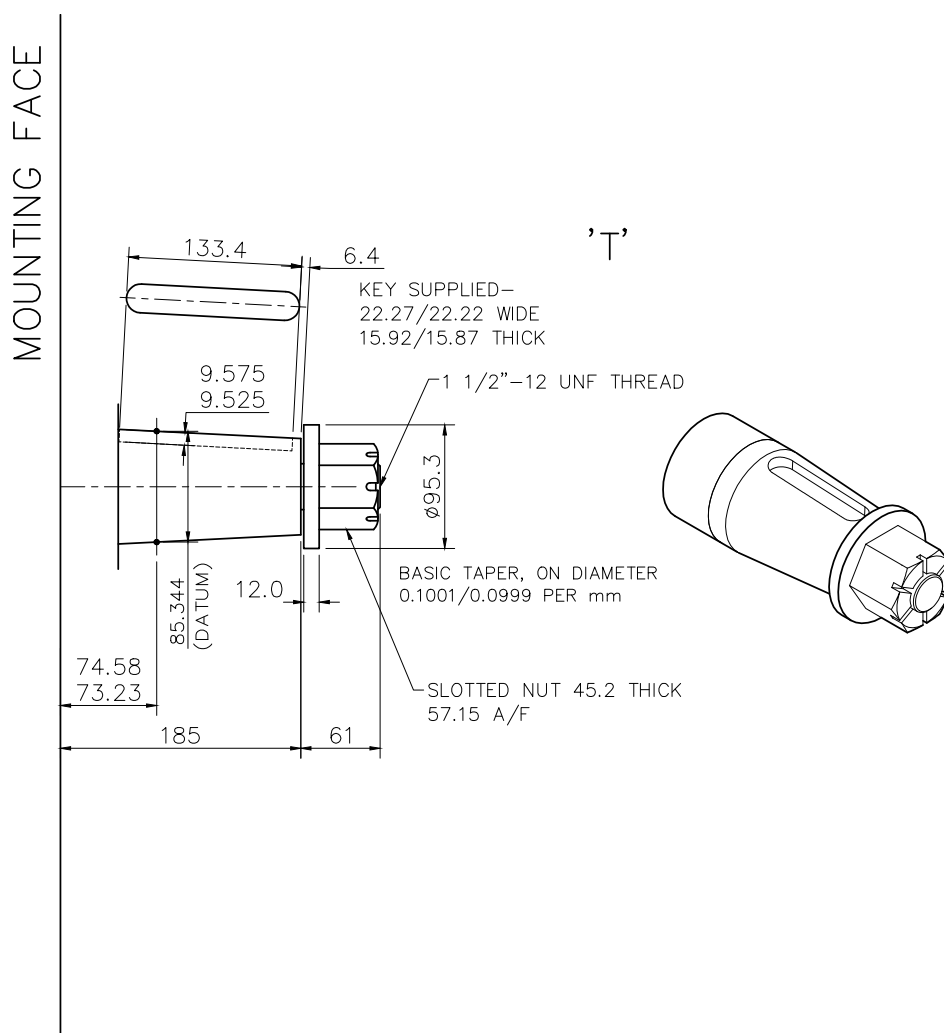
3-6 HM(HD)B125 Installation

◆ 3-6-1 HMB125 - 'P1', 'S3', 'S4' & 'Z3' Shafts



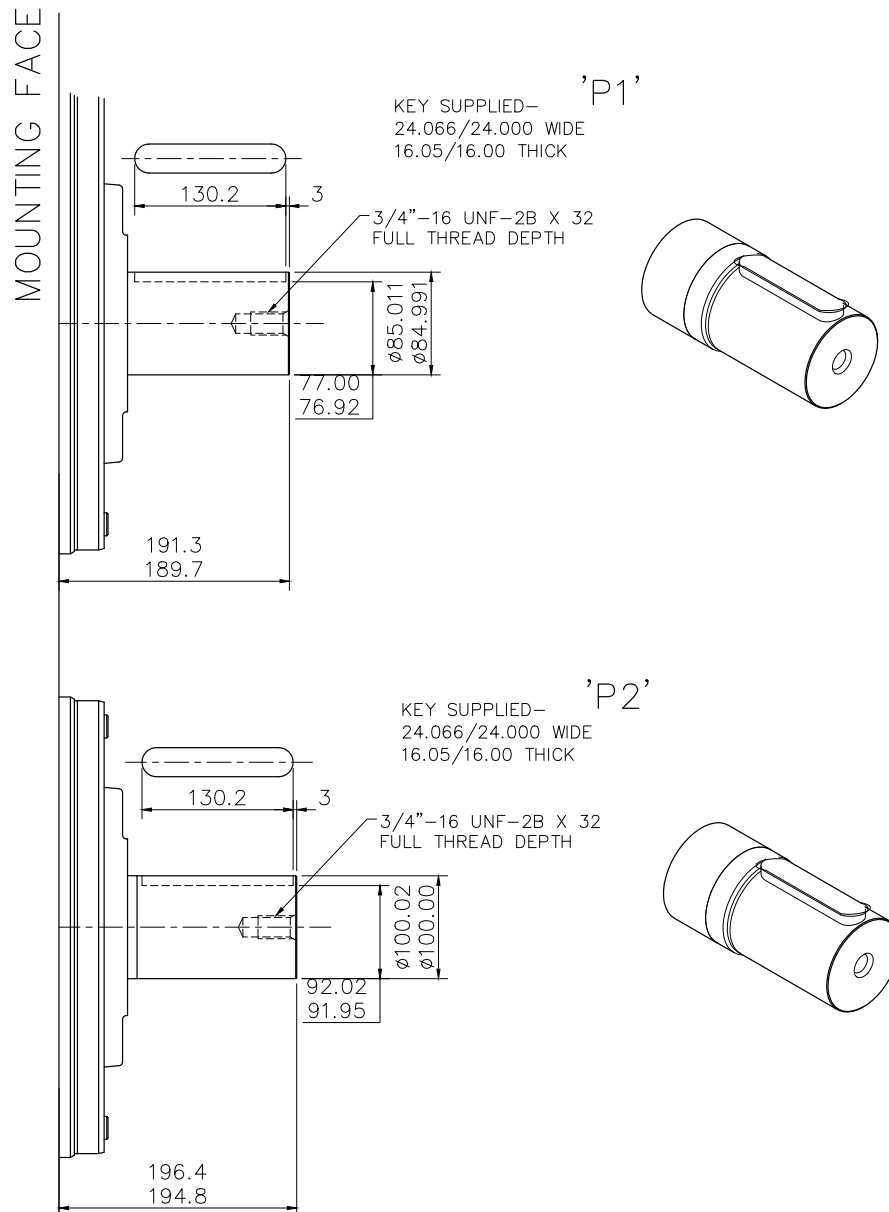
3-6 HM(HD)B125 Installation (cont)

◆ 3-6-2 HMB125 - 'T' Shaft



3-6 HM(HD)B125 Installation (cont)

◆ 3-6-3 HMHDB125 - 'P1' & 'P2' Shafts



3-6 HM(HD)B125 Installation (cont)

◆ 3-6-4 HMHDB125 - 'S3', 'S5', 'Z5' & T Shafts

SPLINE DATA

'S3'

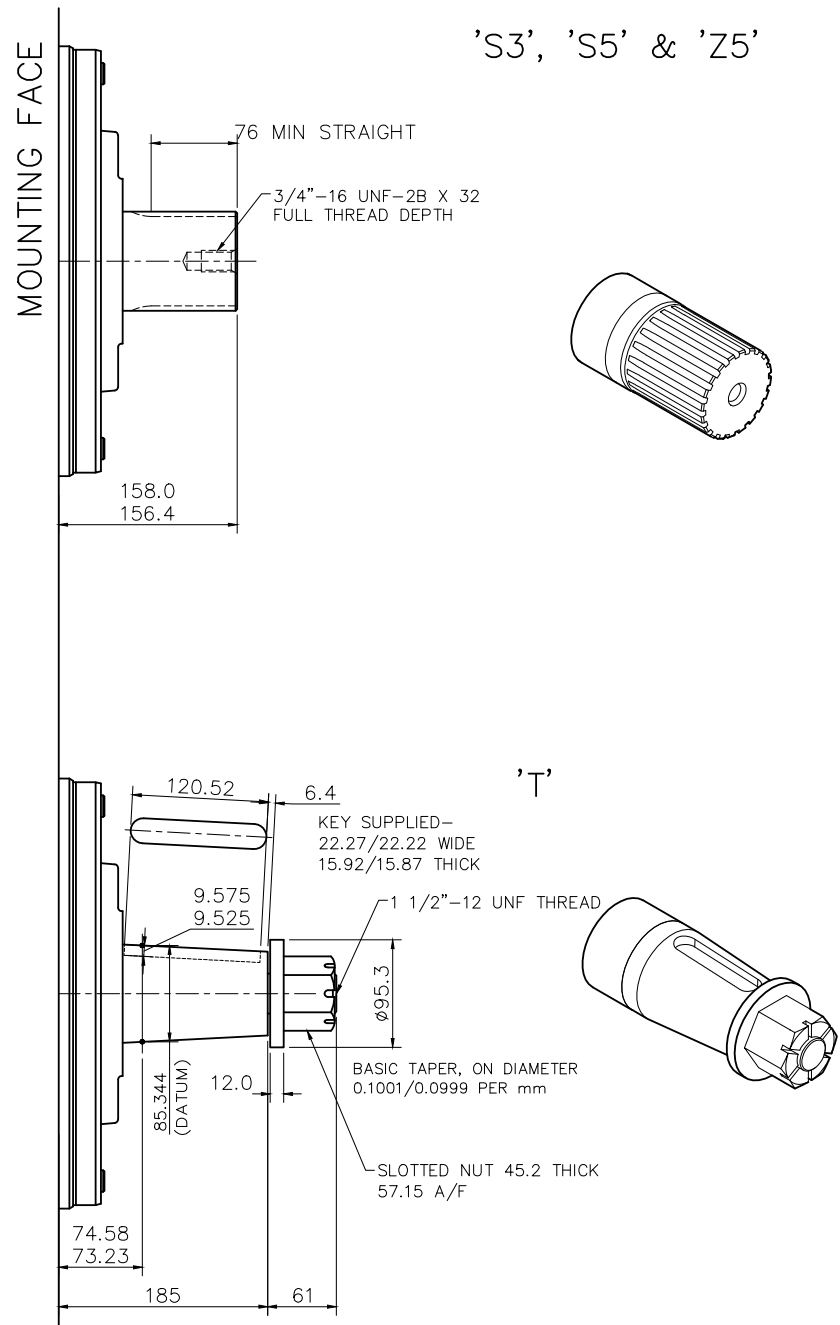
TO BS 3550 (ANSI B92.1, CLASS 5)	
FLAT ROOT SIDE FIT, CLASS 1	
PRESSURE ANGLE	30°
NUMBER OF TEETH	20
PITCH	6/12
MAJOR DIAMETER	87.953/87.825
FORM DIAMETER	80.264
MINOR DIAMETER	79.485/78.925
PIN DIAMETER	8.128
DIAMETER OVER PINS	97.084/97.030

'S5'

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

'Z5'

DIN 5480 W100 x 4 x 24 x 7h



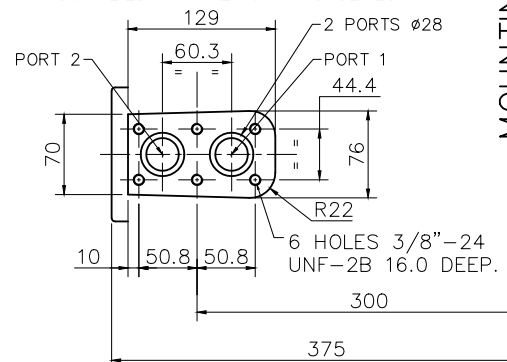
3-6 HM(HD)B125 Installation (cont)

◆ 3-6-5 HMB125 & HMHDB125 - 'S03' & 'S04' Valve Housings

IEWS ON ARROW 'A'

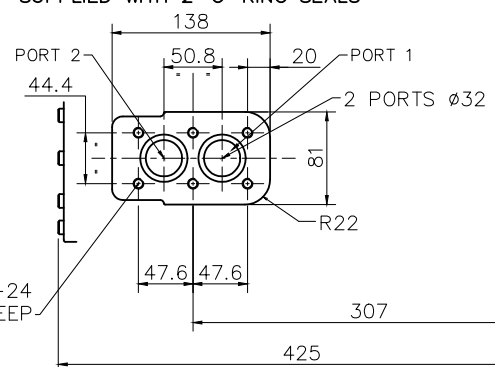
S03 –
3" VALVE HOUSING WITH
6-BOLT FLANGE

SUPPLIED WITH 2 'O' RING SEALS



S04 –
4" VALVE HOUSING WITH
6-BOLT FLANGE

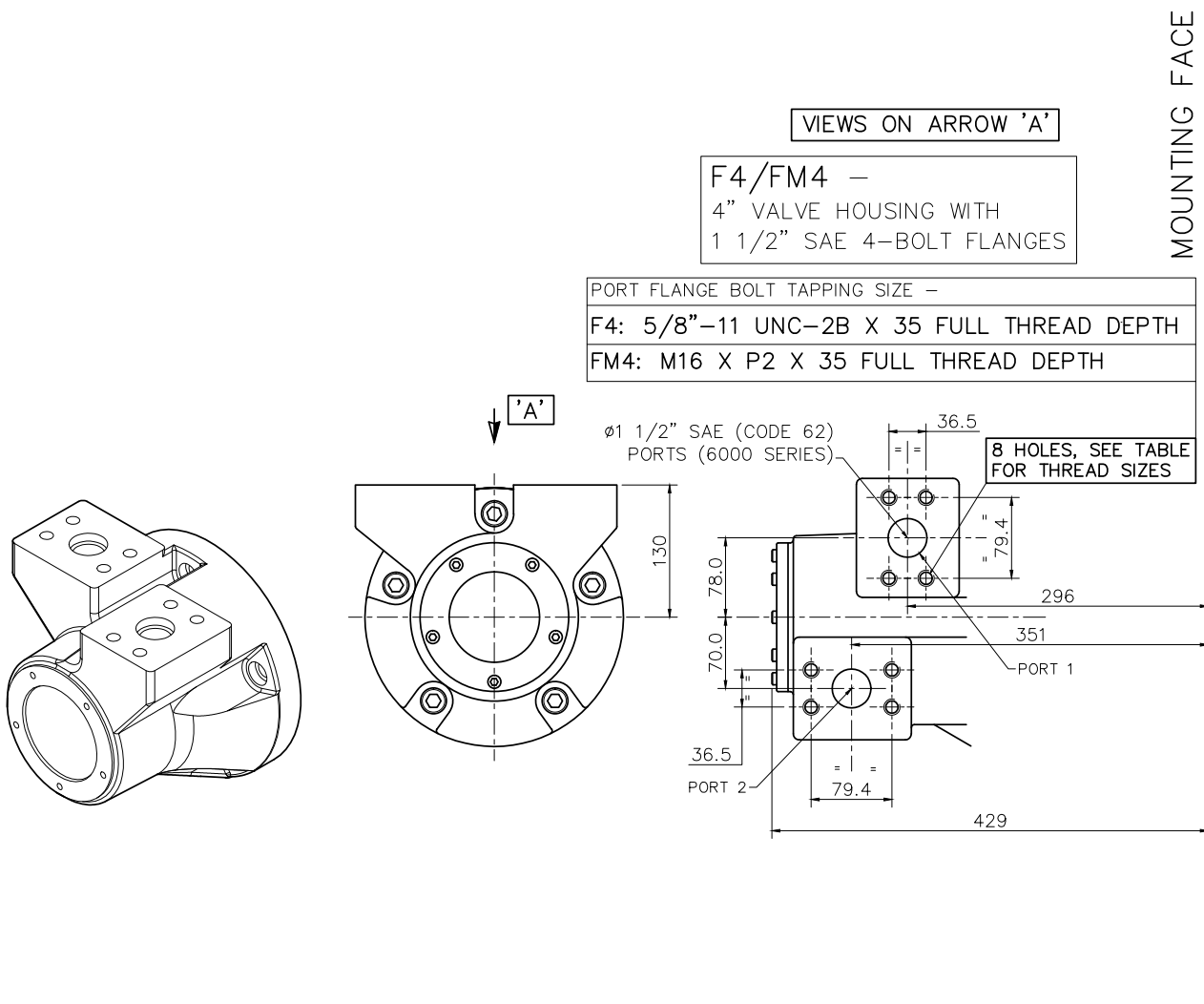
SUPPLIED WITH 2 'O' RING SEALS



MOUNTING FACE

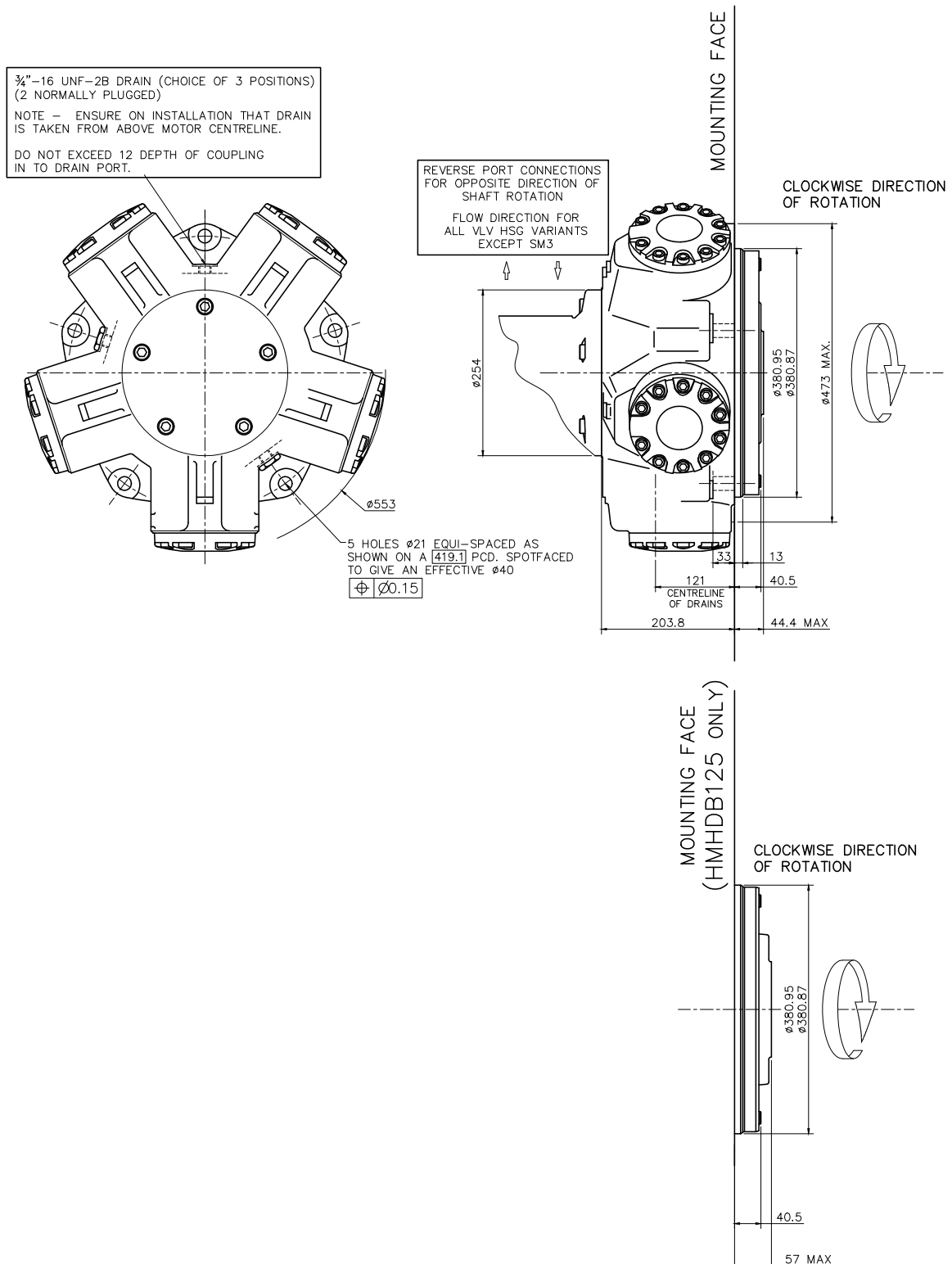
3-6 HM(HD)B125 Installation (cont)

◆ 3-6-7 HMB125 & HMHDB125 - 'F4' & 'FM4' Valve Housings



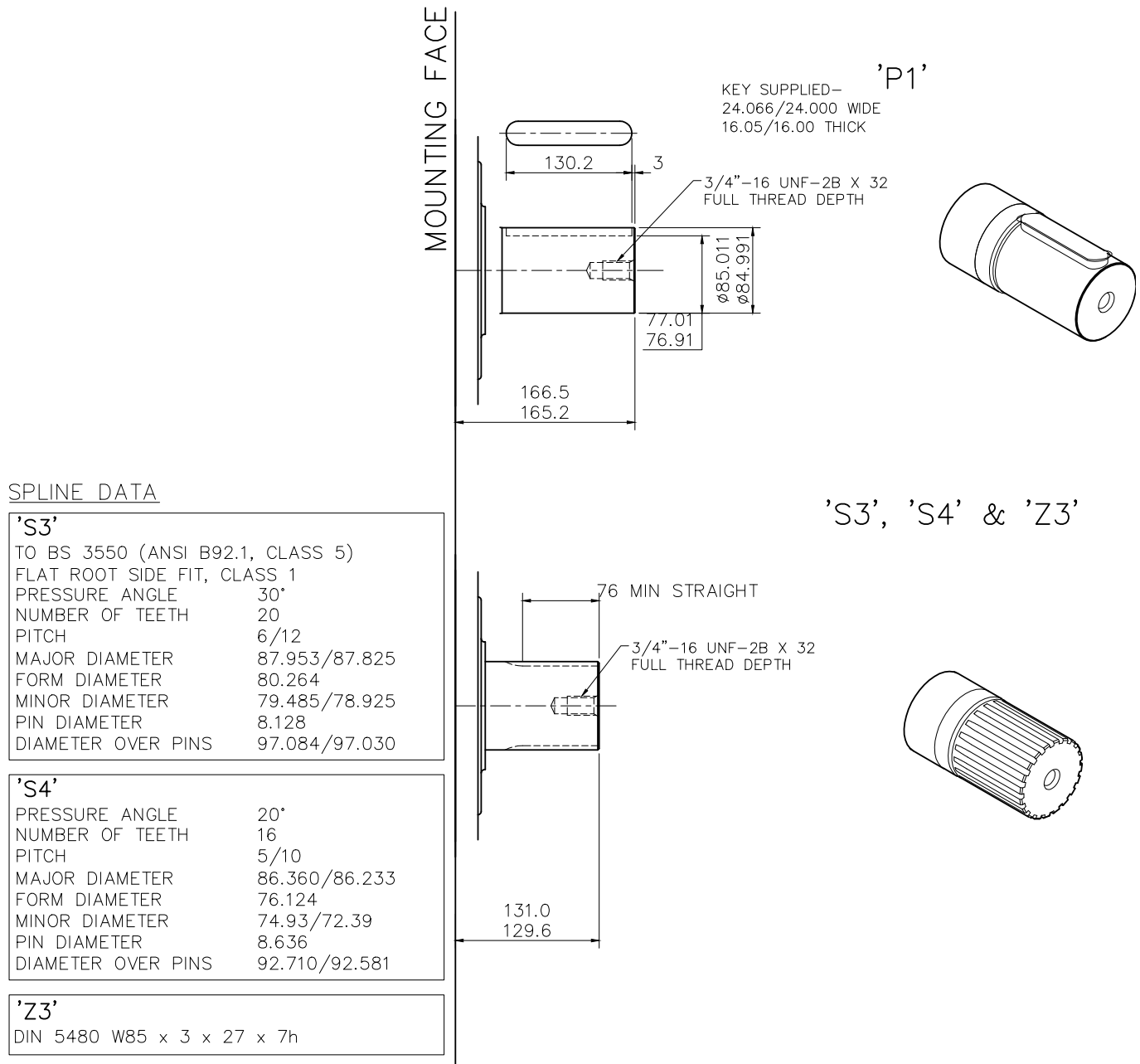
3-6 HM(HD)B125 Installation (cont)

◆ 3-6-8 HMB125 & HMHDB125 - Installation



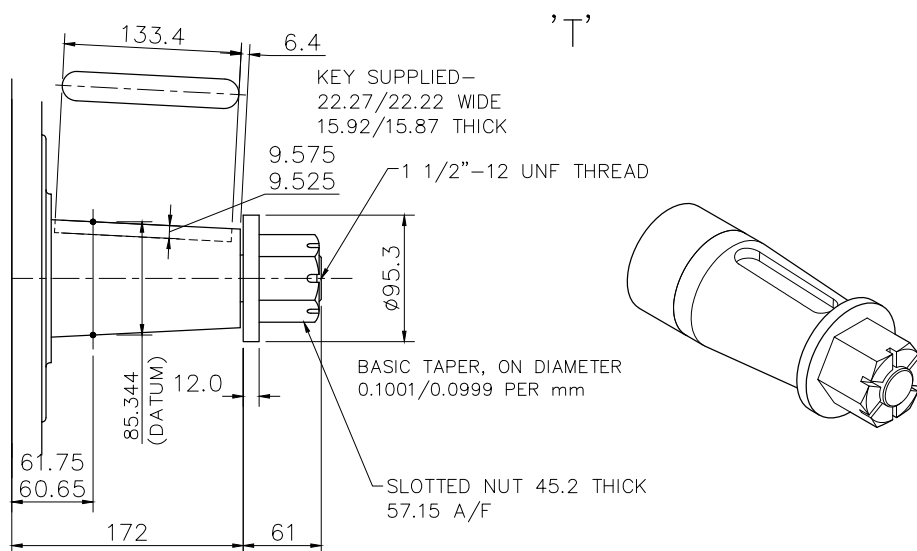
3-7 HMB(HD)150/200 Installation

◆ 3-7-1 HMB150/200 - 'P1', 'S3', 'S4' & Z3 Shafts



3-7 HMB(HD)150/200 Installation (cont)

◆ 3-7-2 HMB150/200 - 'T' Shaft



3-7 HMB(HD)150/200 Installation (cont)

◆ 3-7-3 HMBHD150/200 - 'P2', 'S3', 'S5' & 'Z5' Shafts

SPLINE DATA

'S3'

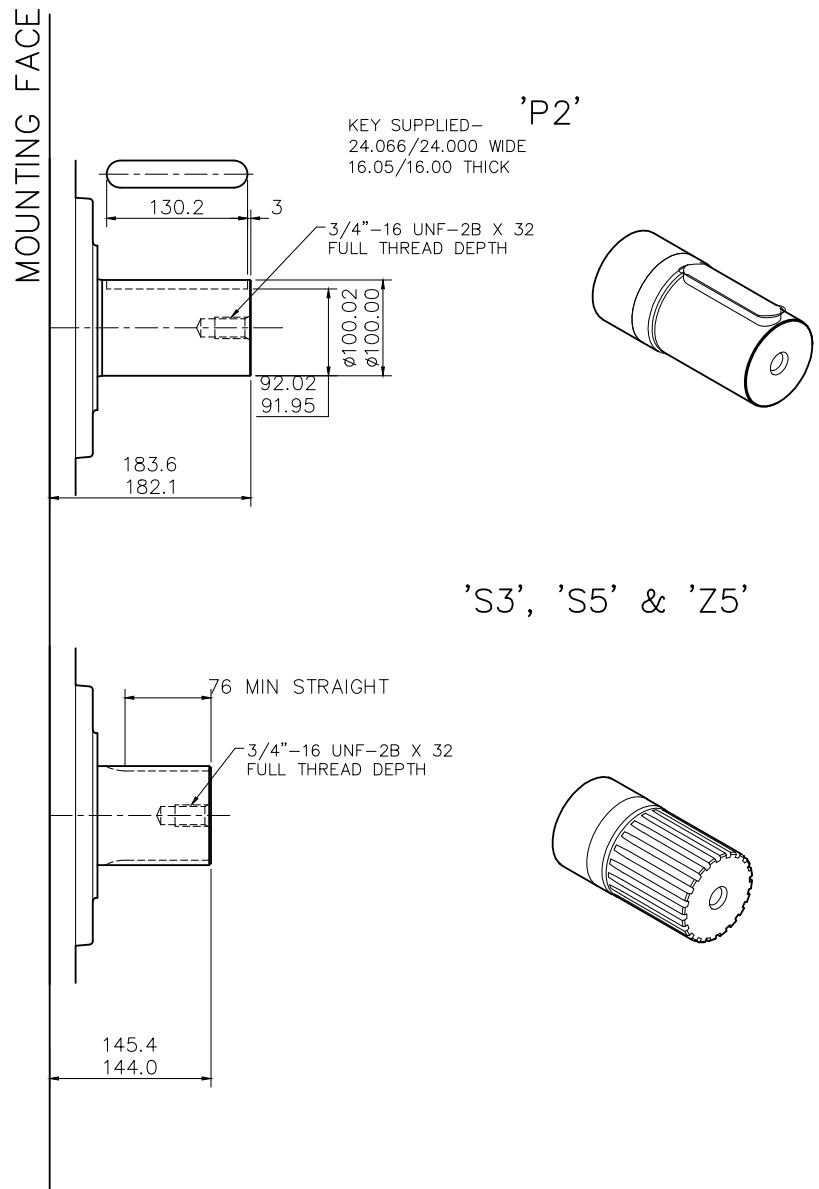
TO BS 3550 (ANSI B92.1, CLASS 5)
 FLAT ROOT SIDE FIT, CLASS 1
 PRESSURE ANGLE 30°
 NUMBER OF TEETH 20
 PITCH 6/12
 MAJOR DIAMETER 87.953/87.825
 FORM DIAMETER 80.264
 MINOR DIAMETER 79.485/78.925
 PIN DIAMETER 8.128
 DIAMETER OVER PINS 97.084/97.030

'S5'

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

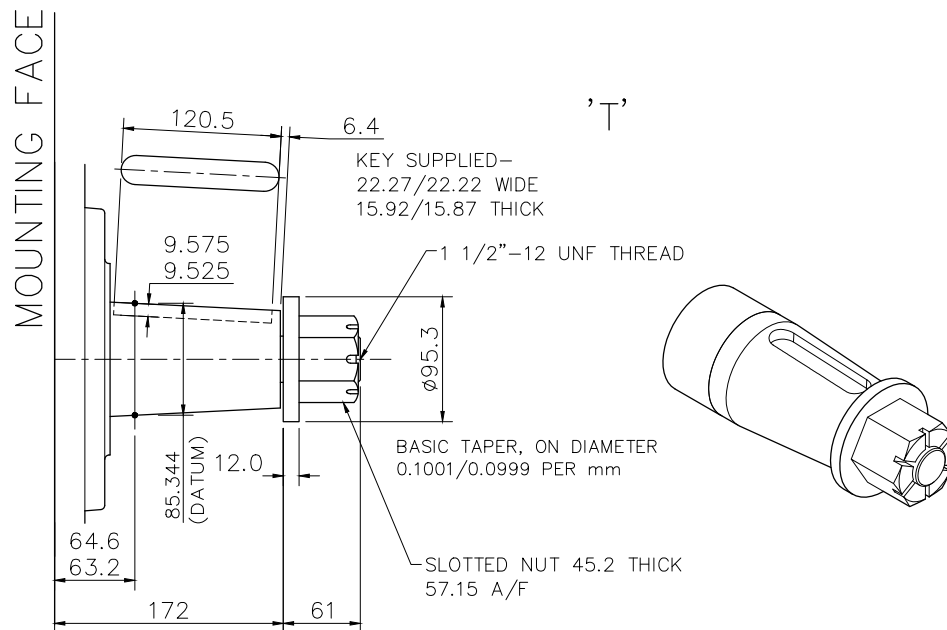
'Z5'

DIN 5480 W100 x 4 x 24 x 7h



3-7 HMB(HD)150/200 Installation (cont)

◆ 3-7-4 HMBHD150/200 - 'T' Shaft



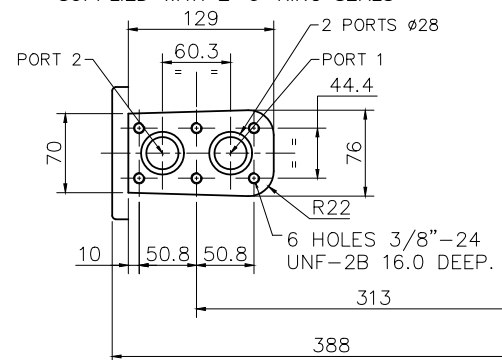
3-7 HMB(HD)150/200 Installation (cont)

◆ 3-7-5 HMB150/200 & HMBHD150/200 - 'S03' & 'S04' Valve Housings

VIEWS ON ARROW 'A'

S03 –
3" VALVE HOUSING WITH
6-BOLT FLANGE

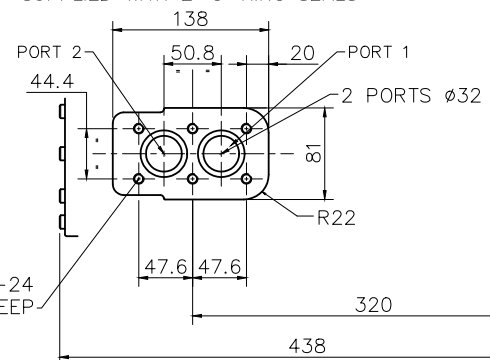
SUPPLIED WITH 2 'O' RING SEALS



MOUNTING FACE

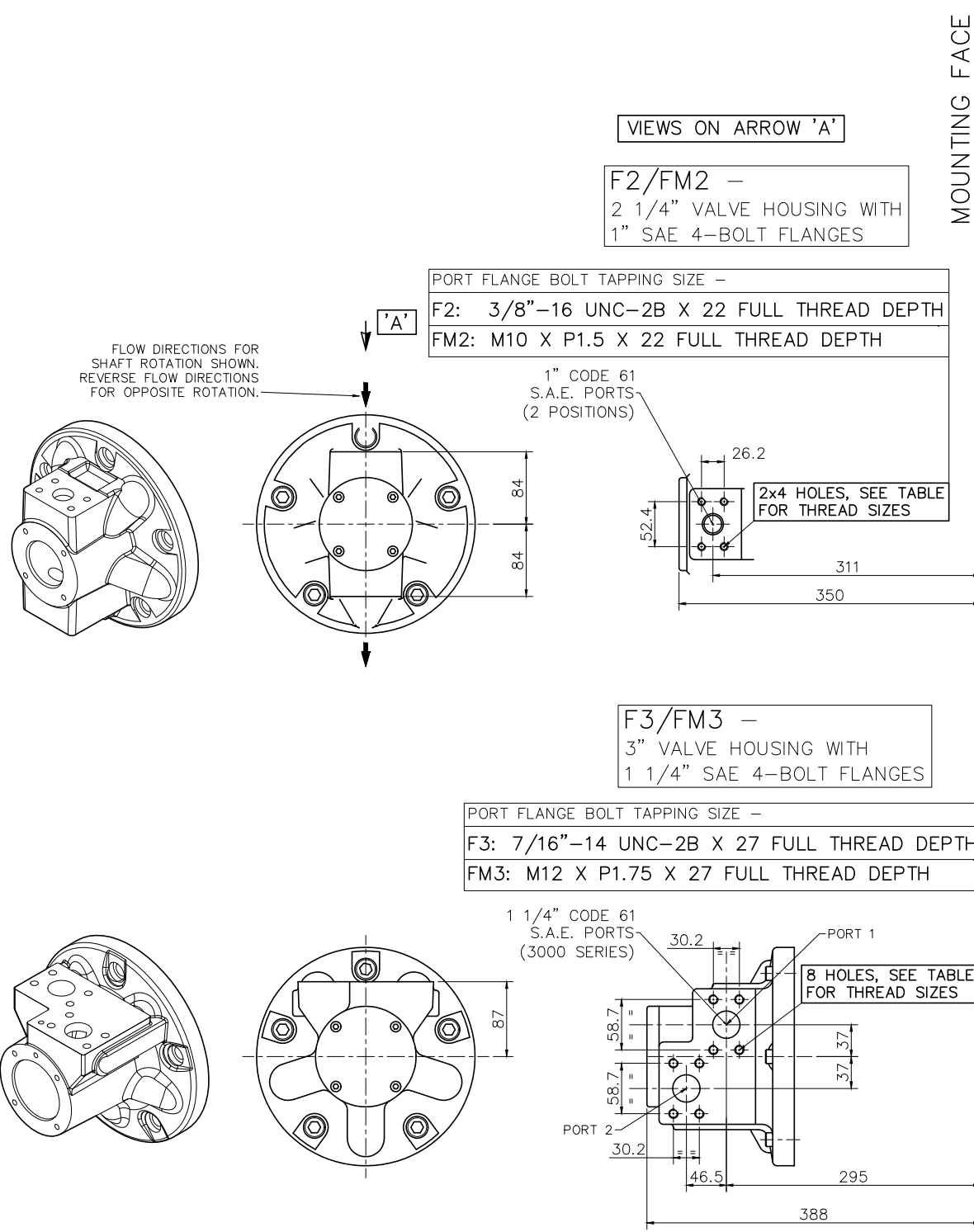
S04 –
4" VALVE HOUSING WITH
6-BOLT FLANGE

SUPPLIED WITH 2 'O' RING SEALS



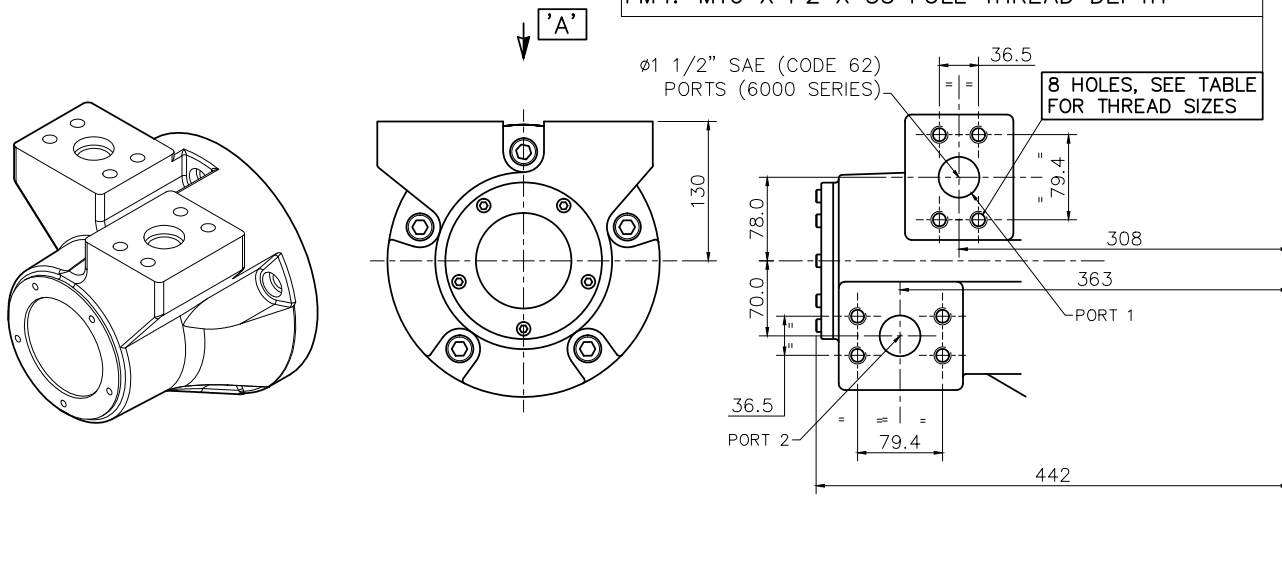
3-7 HMB(HD)150/200 Installation (cont)

◆ 3-7-6 HMB150/200 & HMBHD150/200 - 'F2', 'FM2', 'F3' & 'FM3' Valve Housings



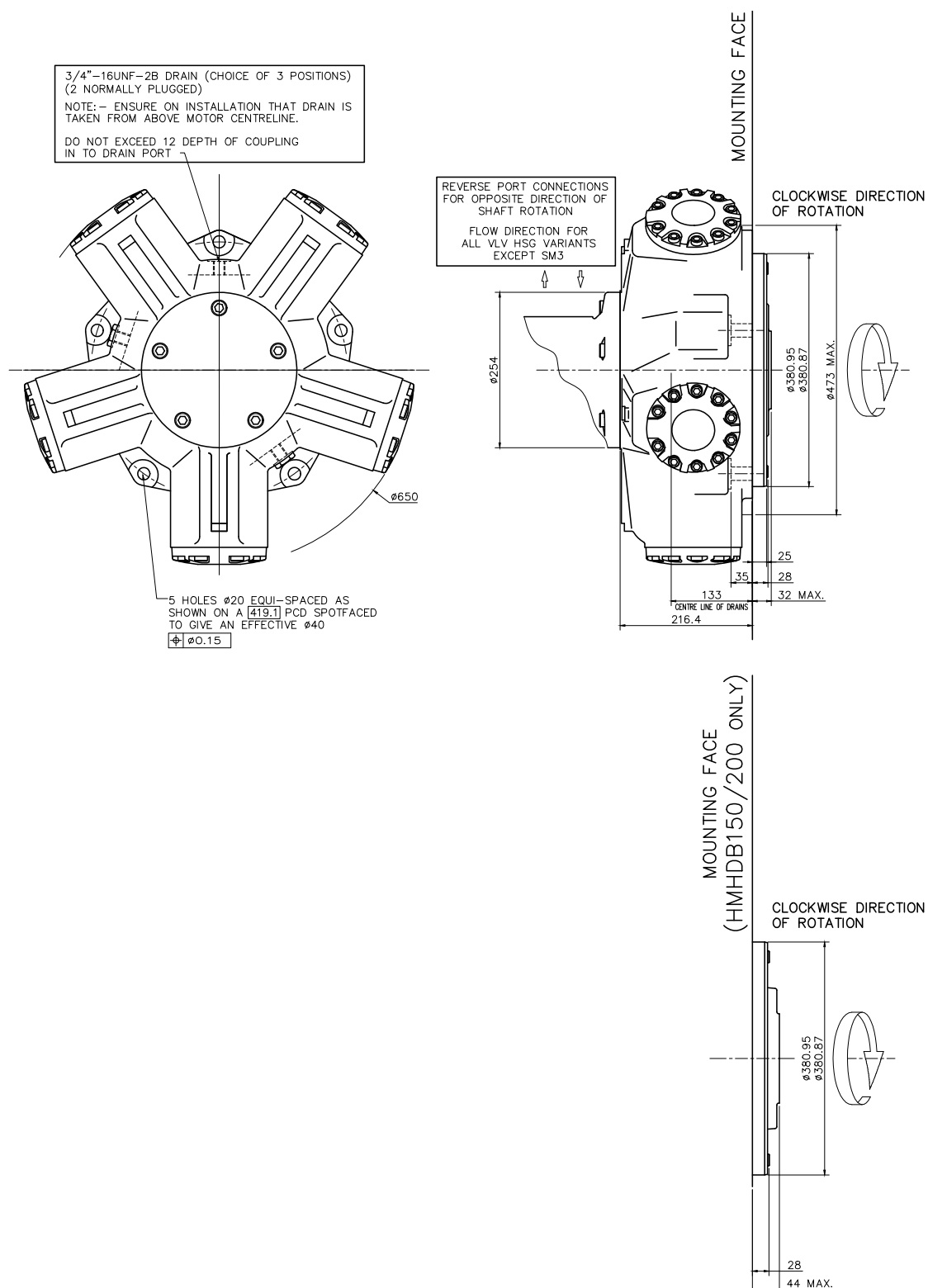
3-7 HMB(HD)150/200 Installation (cont)

◆ 3-7-7 HMB150/200 & HMBHD150/200 - 'F4' & 'FM4' Valve Housings



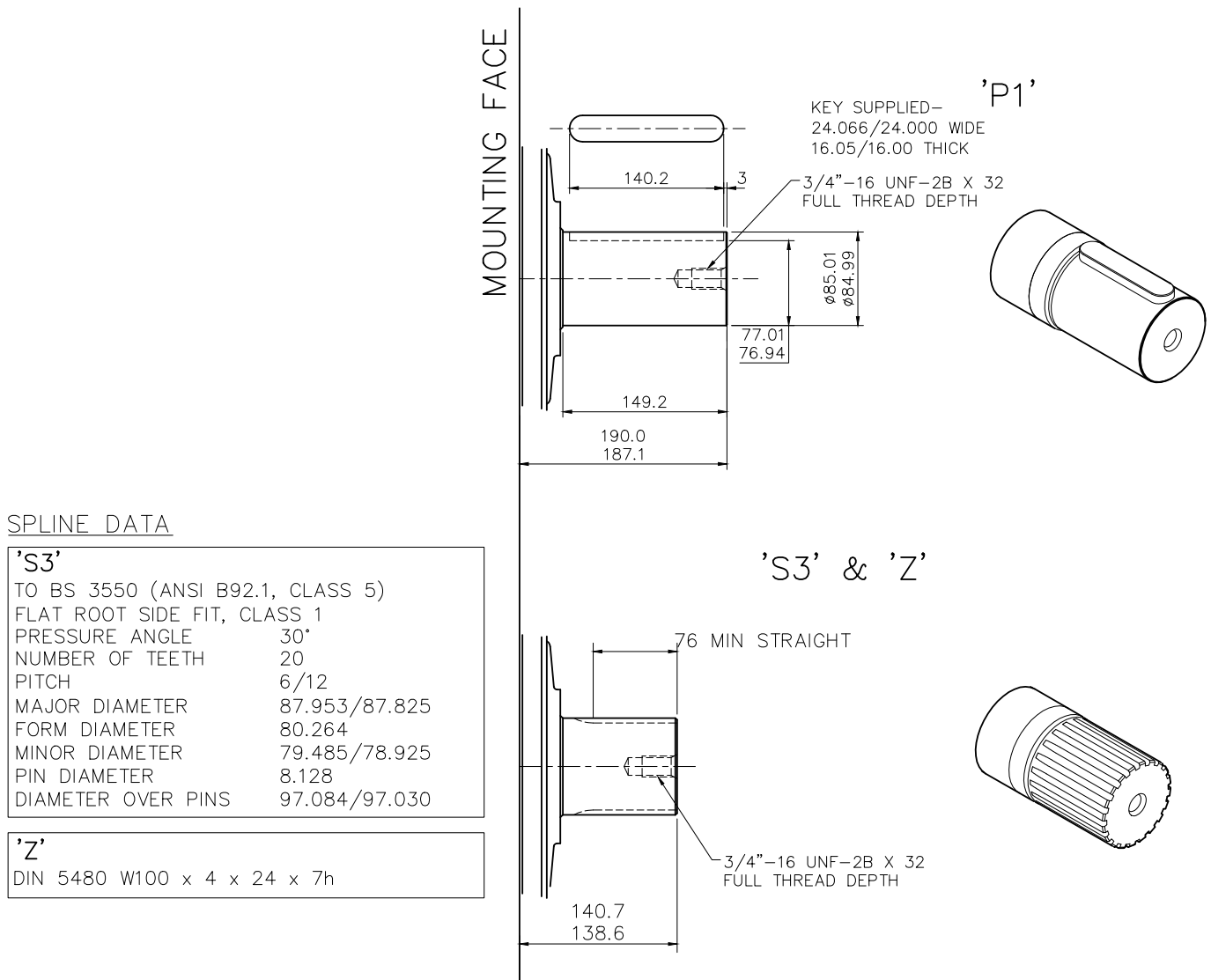
3-7 HMB(HD)150/200 Installation (cont)

◆ 3-7-8 HMB150/200 & HMBHD150/200 - Installation



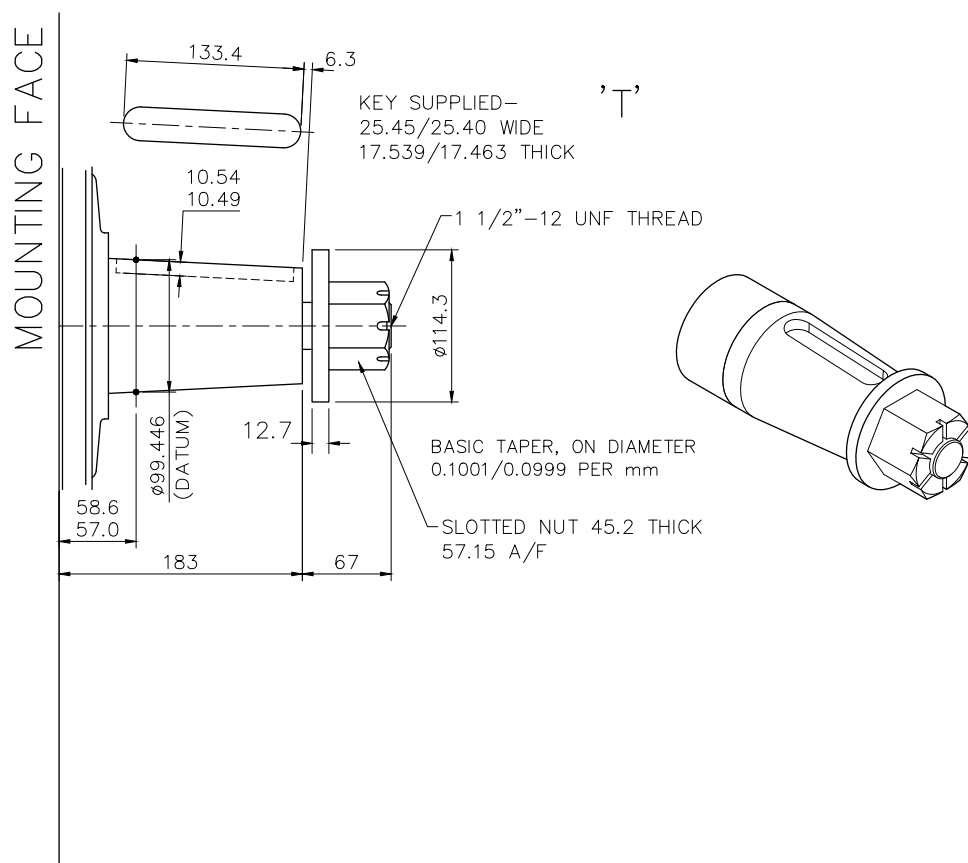
3-8 HMB(HD)270 Installation

◆ 3-8-1 HMB270 - 'P1', 'S3' & 'Z' Shaft



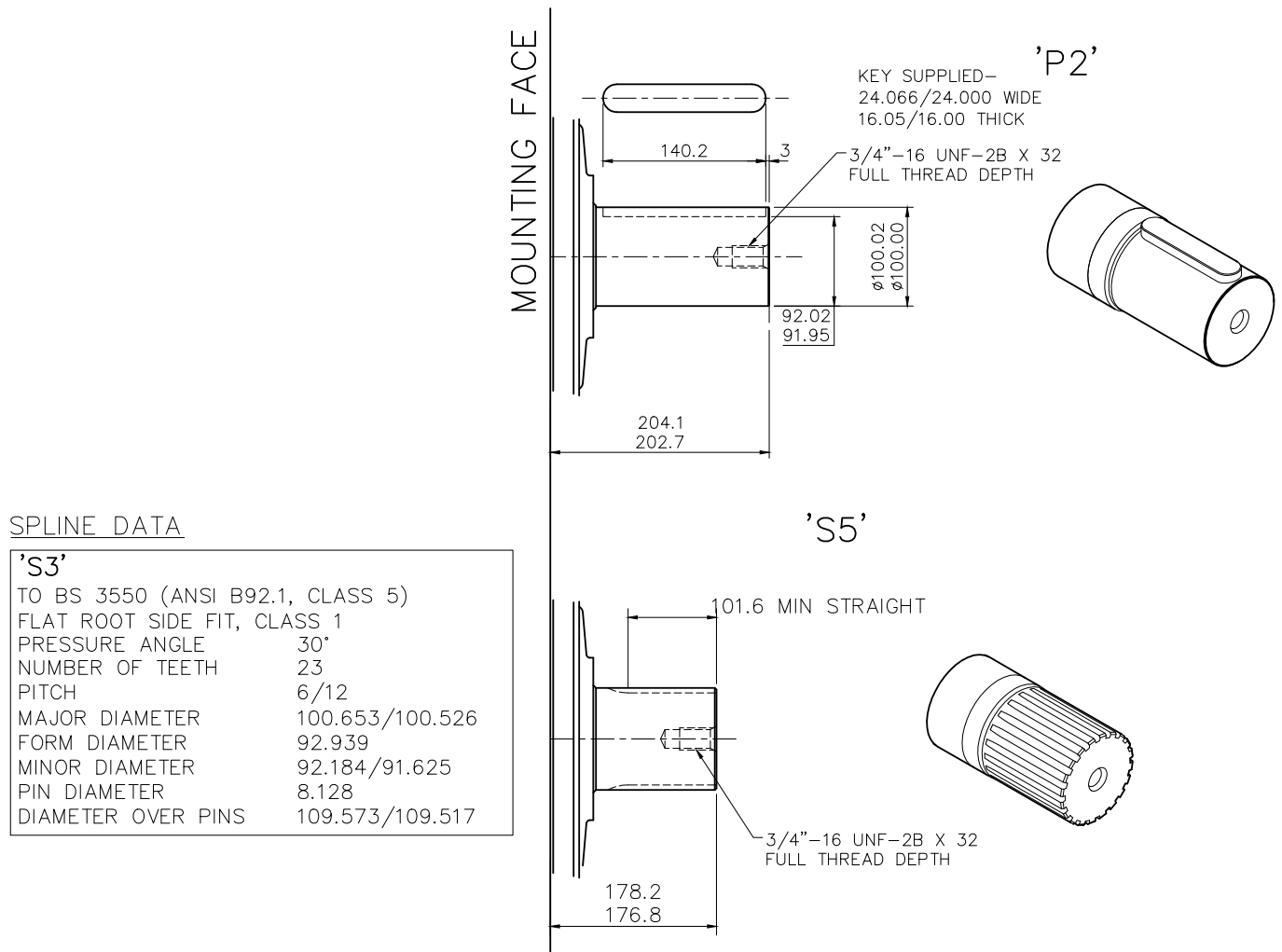
3-8 HMB(HD)270 Installation (cont)

◆ 3-8-2 HMB270 - 'T' Shaft



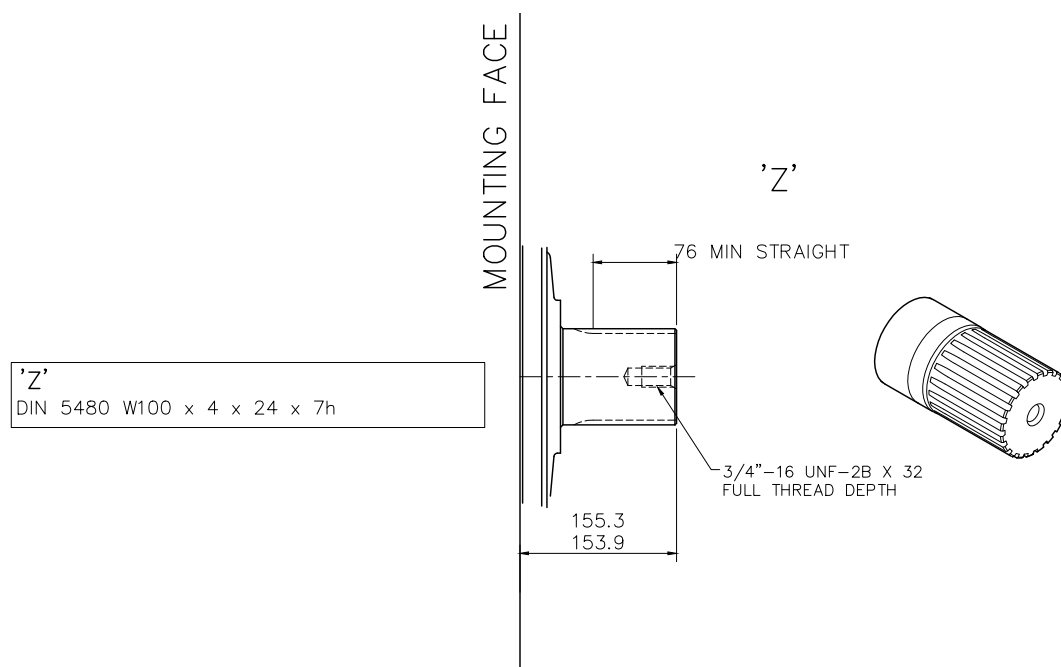
3-8 HMB(HD)270 Installation (cont)

◆ 3-8-3 HMBHD270 - 'P2' & 'S5' Shafts



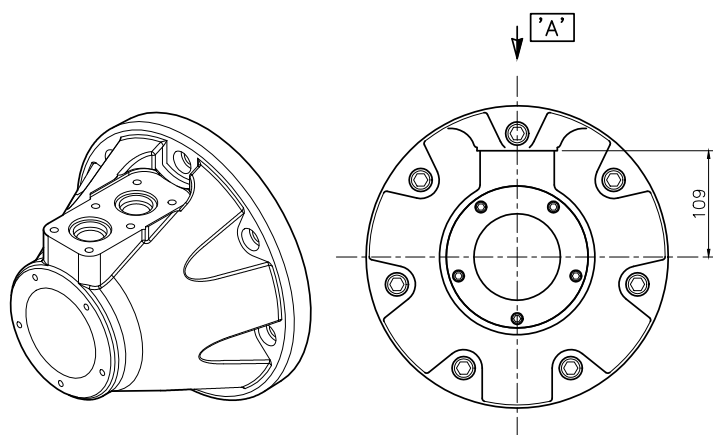
3-8 HMB(HD)270 Installation (cont)

◆ 3-8-4 HMBHD270 - 'Z' Shaft



3-8 HMB(HD)270 Installation (cont)

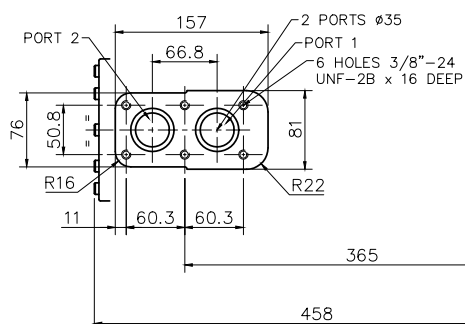
◆ 3-8-5 HMB270 & HMB270 - 'F4', 'FM4' & 'SO4' Valve Housings



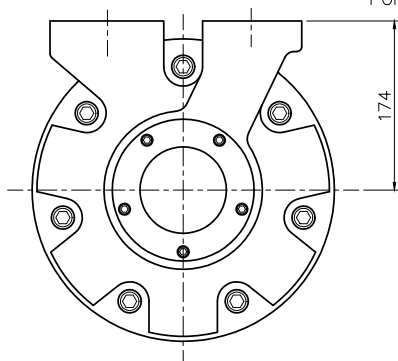
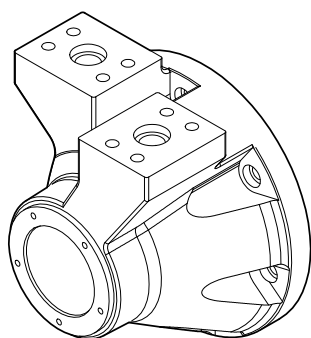
IEWS ON ARROW 'A'

SO4 –
4" VALVE HOUSING WITH
6-BOLT FLANGE

SUPPLIED WITH 2 'O' RING SEALS



MOUNTING FACE



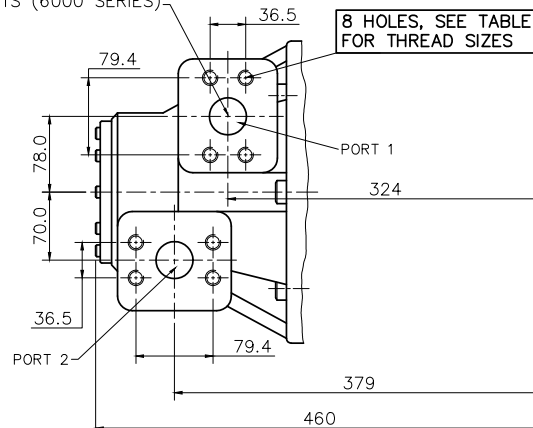
F4/FM4 –
4" VALVE HOUSING WITH
1 1/2" SAE 4-BOLT FLANGES

PORT FLANGE BOLT TAPPING SIZE –

F4: 5/8"–11 UNC–2B X 35 FULL THREAD DEPTH

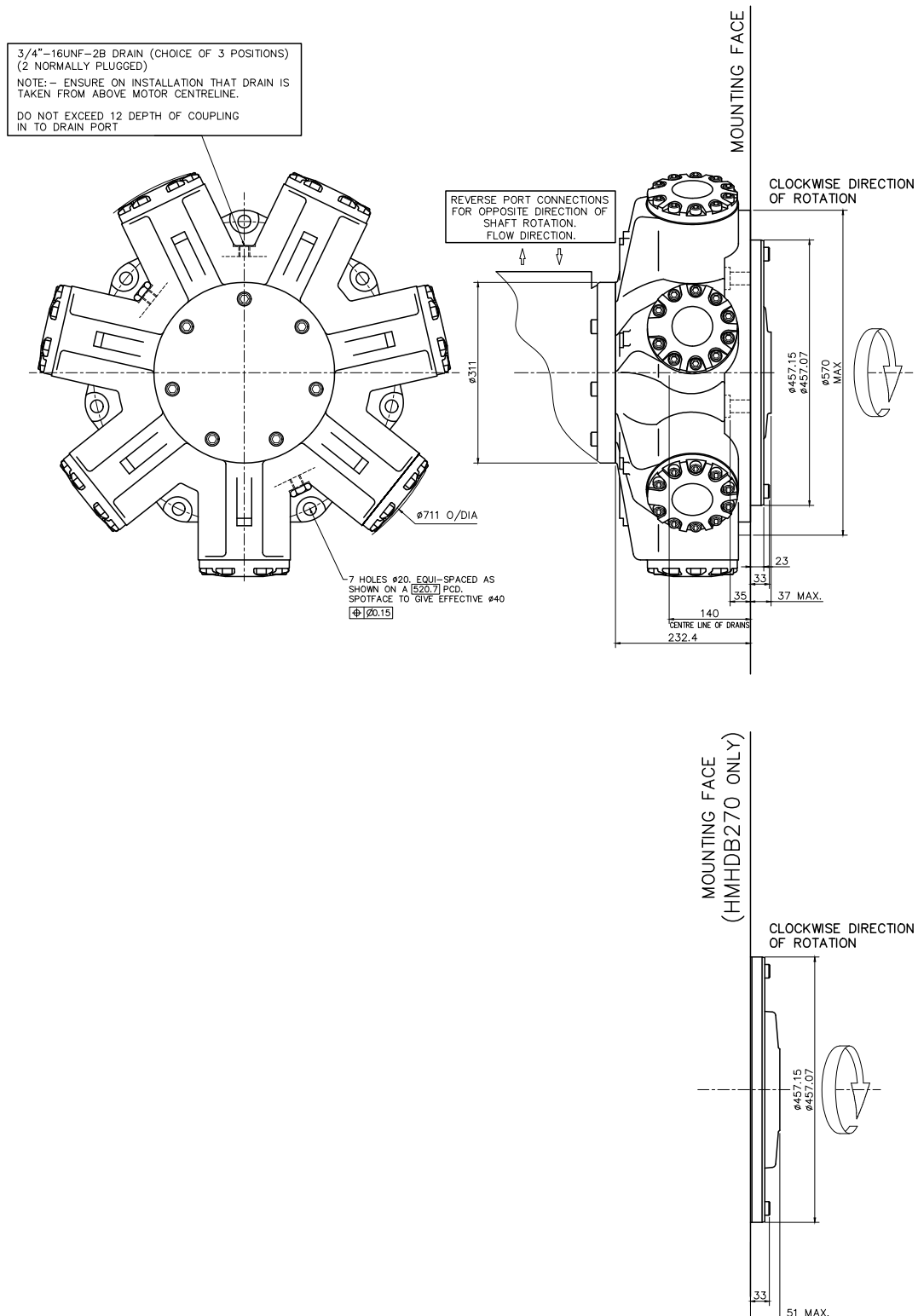
FM4: M16 X P2 X 35 FULL THREAD DEPTH

Ø1 1/2" SAE (CODE 62)
PORTS (6000 SERIES)



3-8 HMB(HD)270 Installation (cont)

◆ 3-8-6 HMB270 & HMBHD270 - Installation



3-9 HMB(HD)325 Installation

◆ 3-9-1 HMB325 - 'P1', 'S3' & 'Z' Shafts

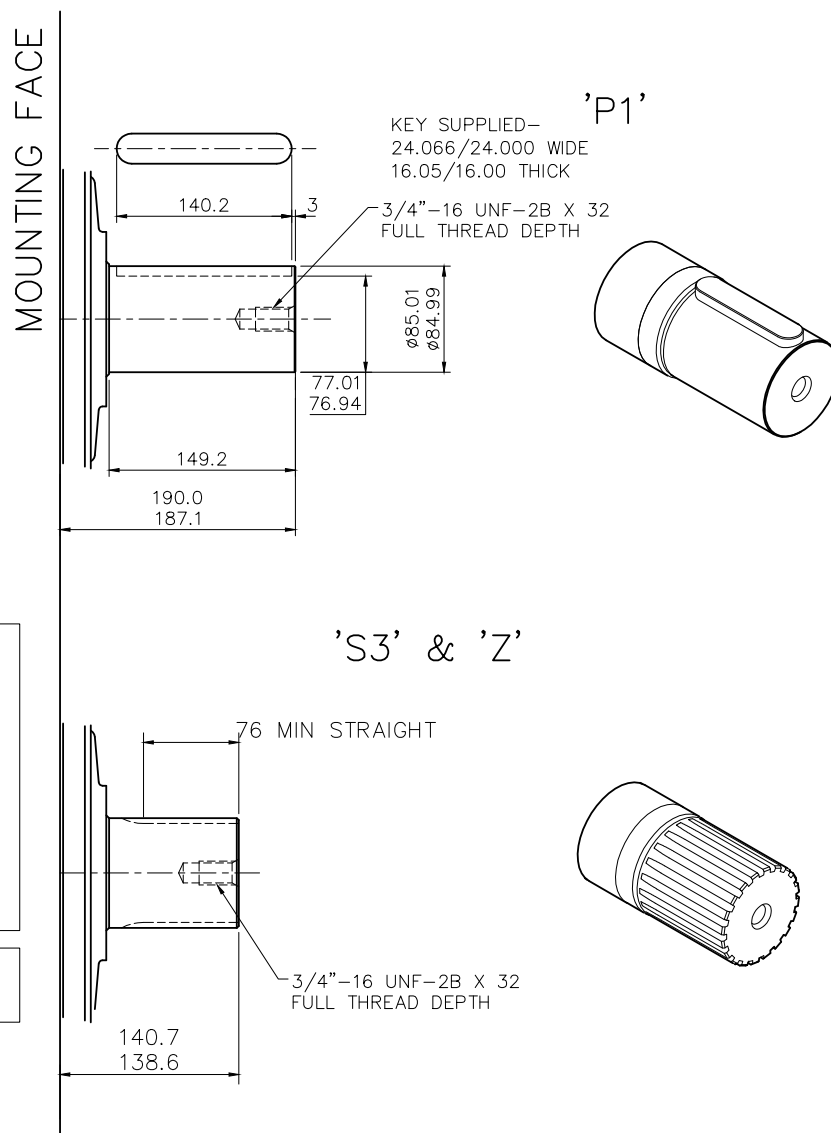
SPLINE DATA

'S3'

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

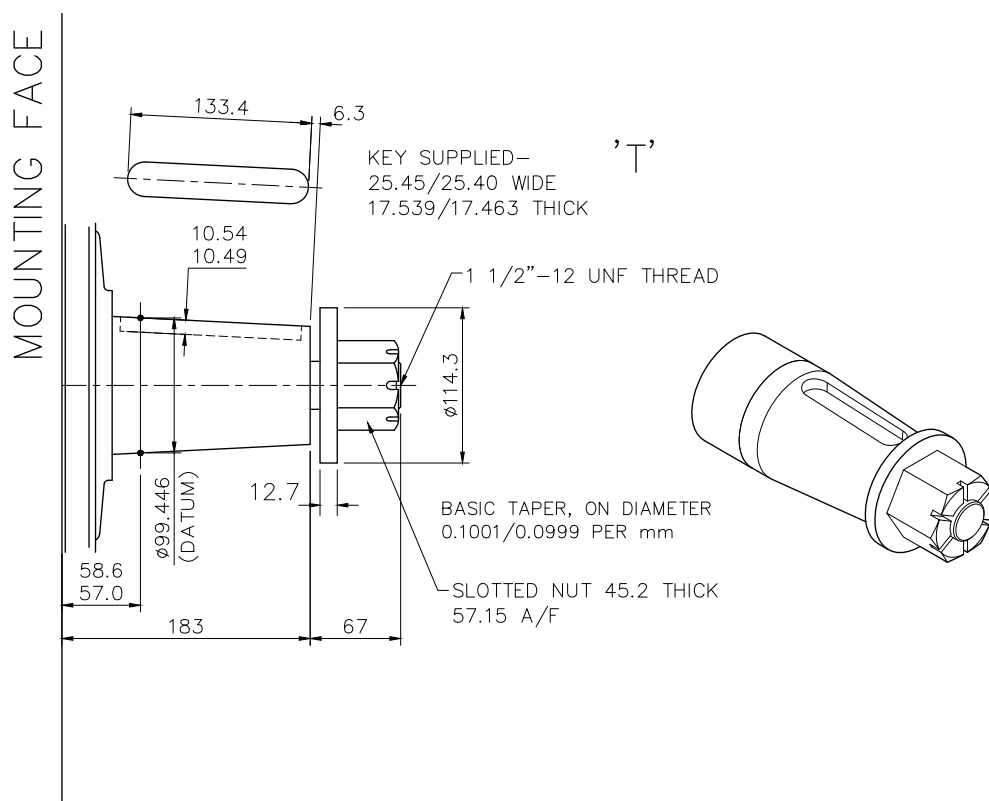
'Z'

DIN 5480 W100 x 4 x 24 x 7h



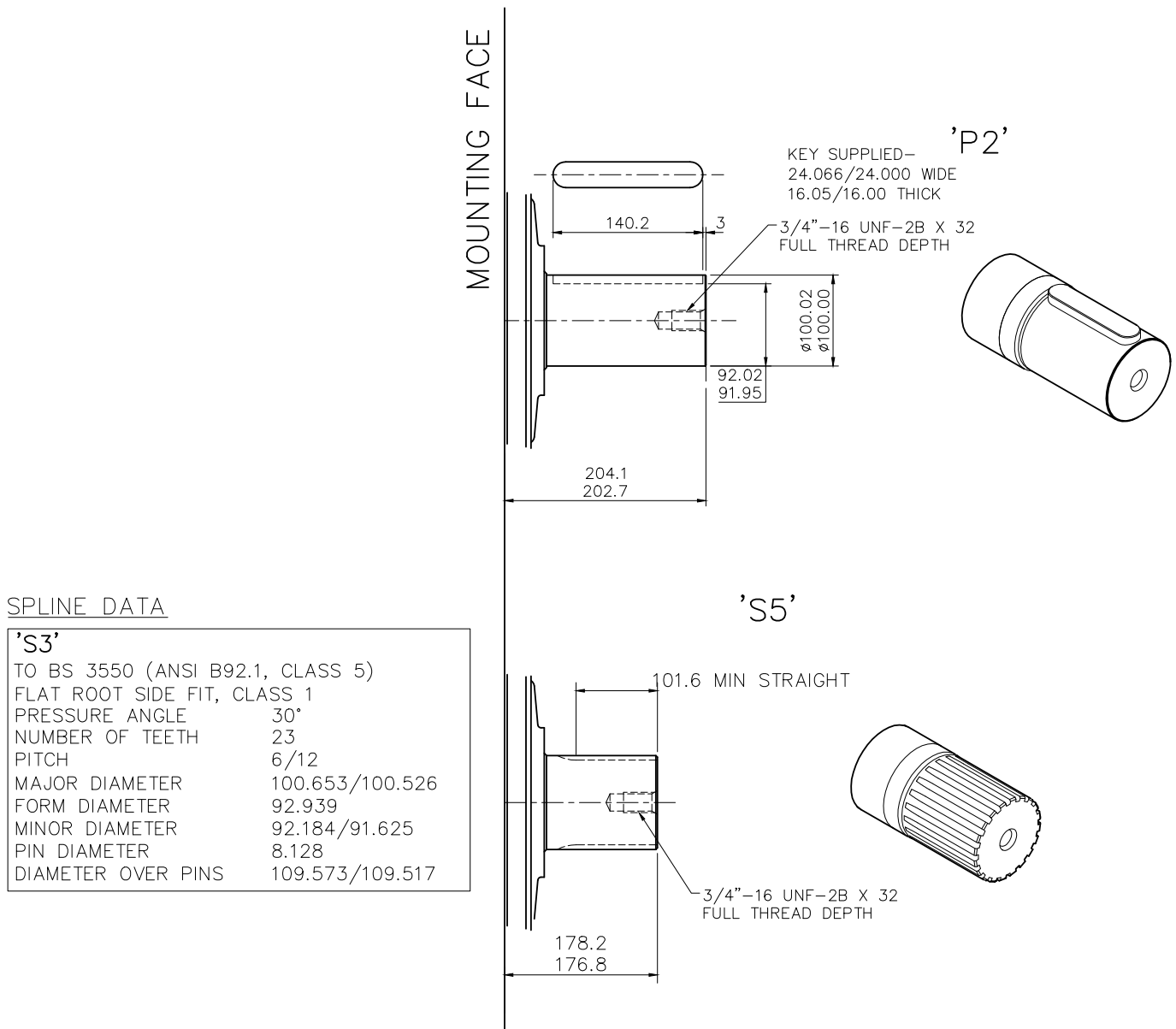
3-9 HMB(HD)325 Installation (cont)

◆ 3-9-2 HMB325 - 'T' Shaft



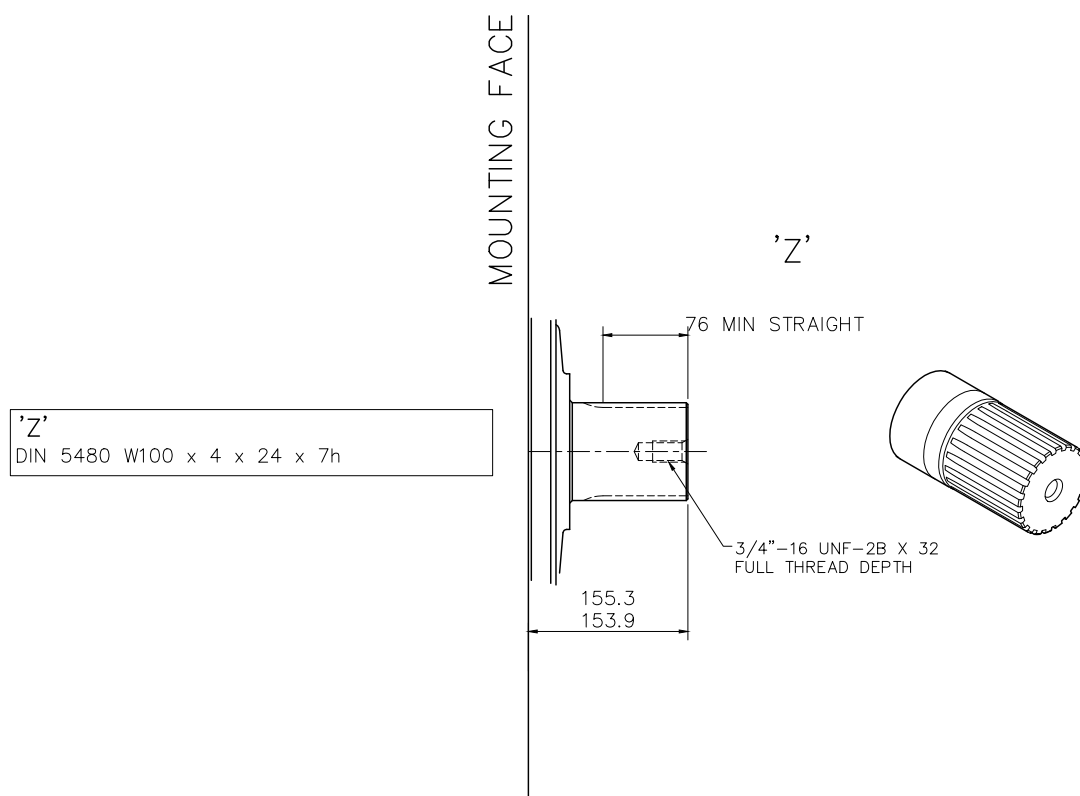
3-9 HMB(HD)325 Installation (cont)

◆ 3-9-3 HMBHD325 - 'P2' & 'S5' Shafts



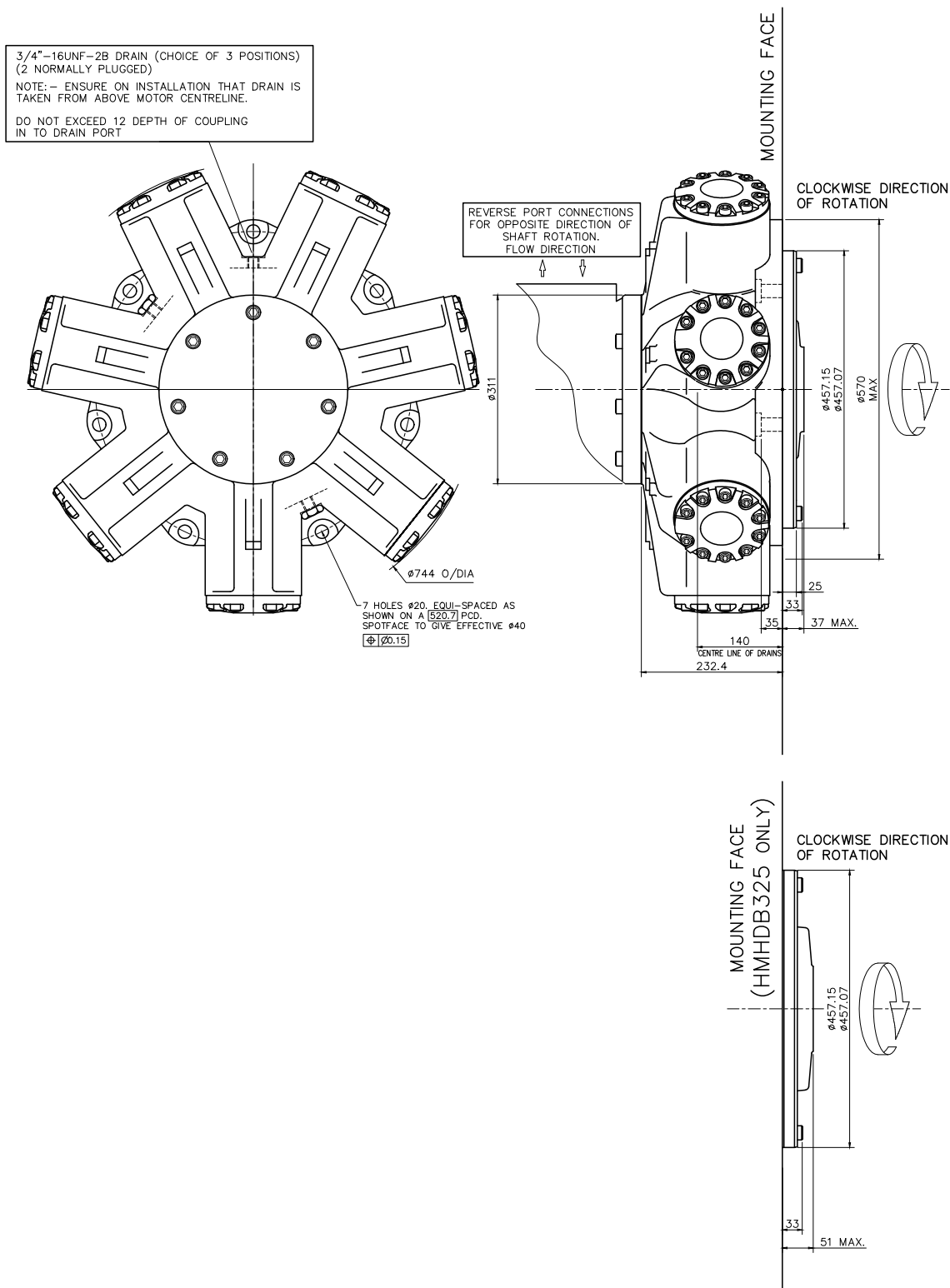
3-9 HMB(HD)325 Installation (cont)

◆ 3-9-4 HMBHD325 - 'Z' Shaft



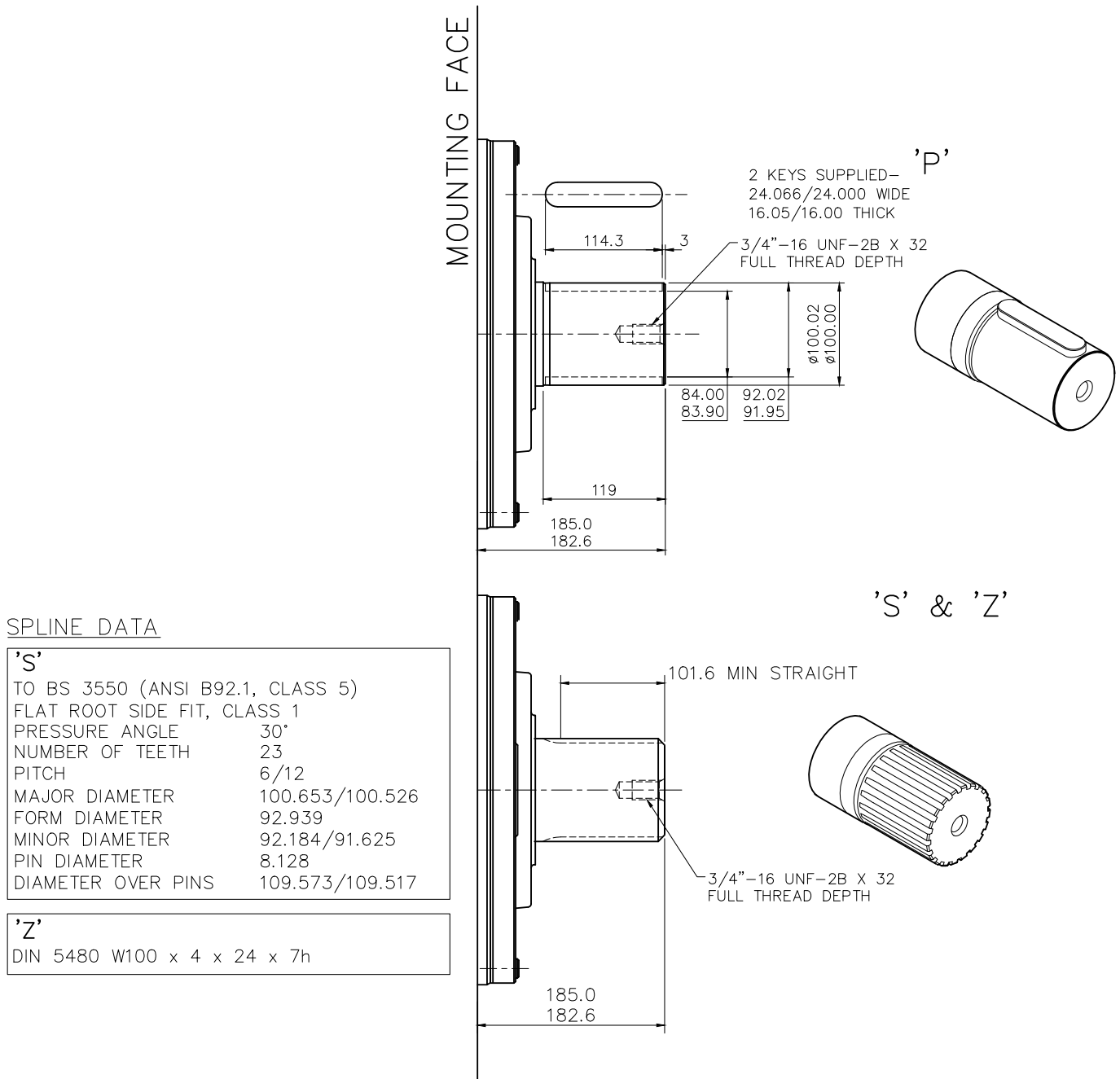
3-9 HMB(HD)325 Installation (cont)

◆ HMB325 & HMBHD325 - Installation



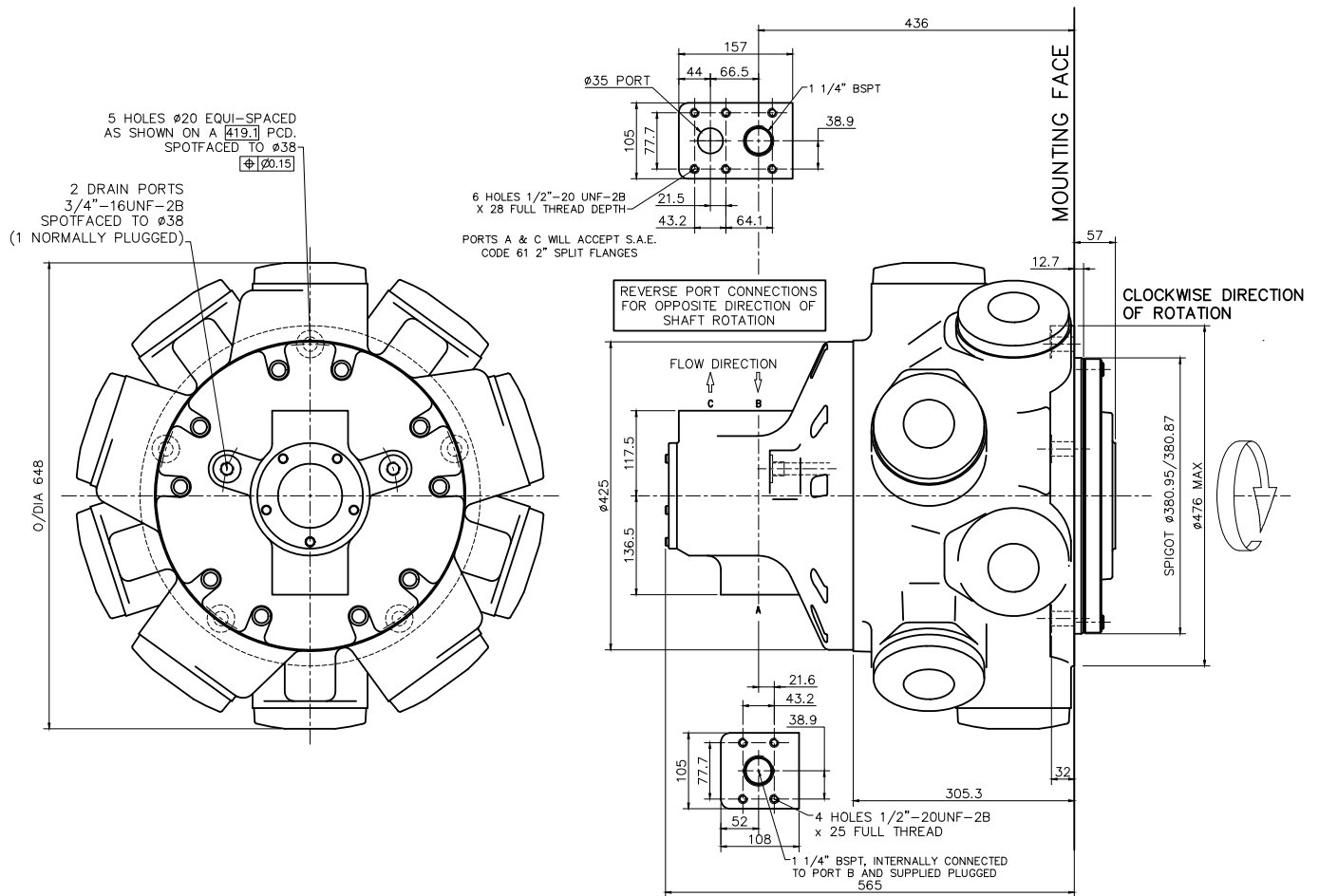
3-10 HMBHD400 Installation

◆ 3-10-1 HMBHD400 - 'P', 'S' & 'Z' Shafts



3-10 HMBHD400 Installation (cont)

3-10-2 HMBHD400 - Installation



3-11 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

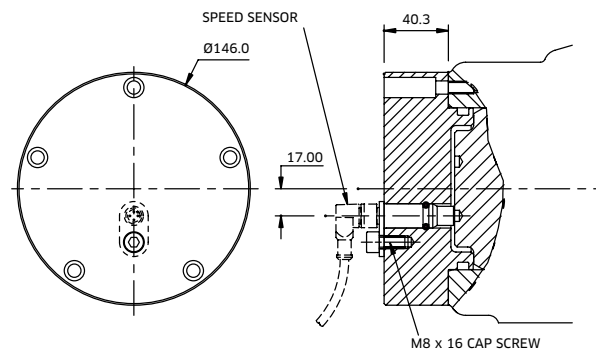
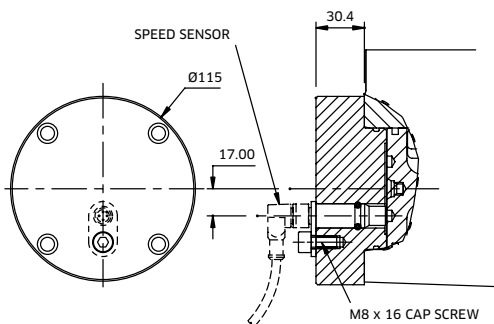


Installation Details

TO SUIT: F3/FM3/SO3

'Tj'

TO SUIT: F4/FM4/SO4

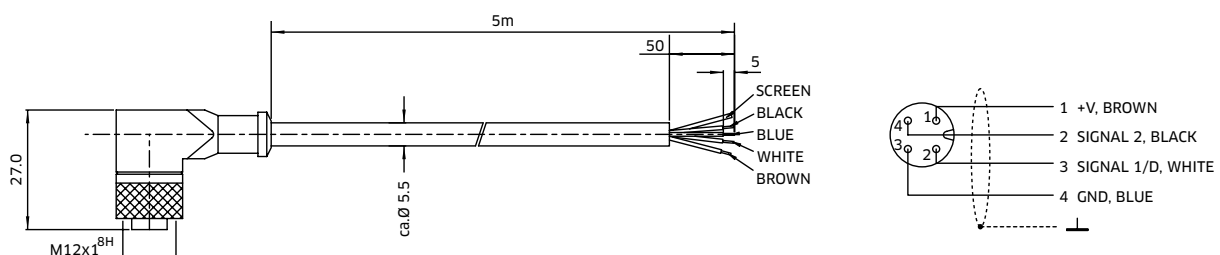


Tk Output Module

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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2-chome, Minato-ku

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Michigan 49512

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confirmed in the contract.**