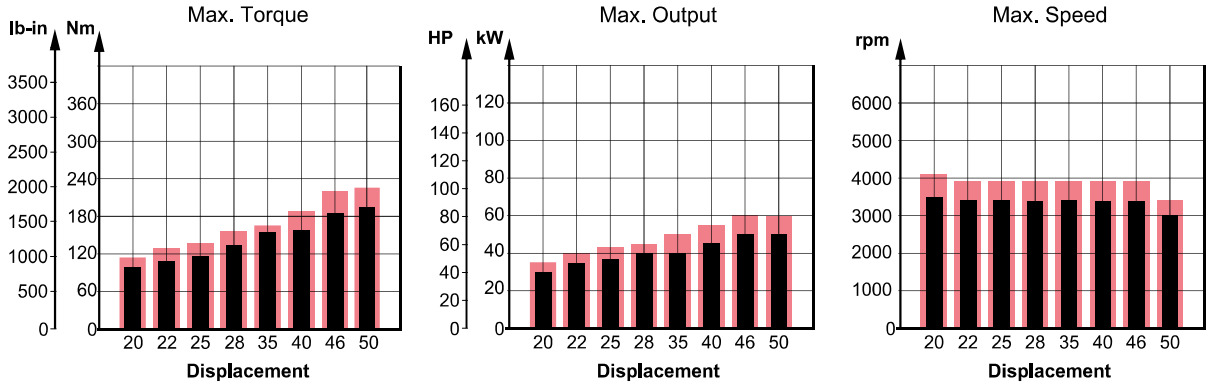
TECHNICAL DATA

Hydraulic Motors Type MAM



Intermittent values

Continuous values

Ports and Shafts

Cross Table - Shaft Types

SAE A	SAE B	Cartage WP	Type of shafts	
x	x		**WD**	ø**21.72** [0.855"] **Spline** SAE 13T 16/32 DP, M8 thread
x	x		**LD**	ø**21.72** [0.855"] **Spline** SAE 13T 16/32 DP, 5/16-18 UNC thread
		x	**PDA**	ø**21.72** [0.855"] **Spline** SAE 13T 16/32 DP, 1/4-20 UNC thread
x	x		**WF**	ø**24.9** [0.98"] **Spline** SAE 15T 16/32, M8 thread
x	x		**PF**	ø**24.9** [0.98"] **Spline** SAE 15T 16/32, 3/8-16 UNC thread
x	x		**LF**	ø**24.9** [0.98"] **Spline** SAE 15T 16/32, 3/8-16 UNC thread
		x	**PFA**	ø**24.9** [0.98"] **Spline** SAE 15T 16/32, 3/8-16 UNC thread
	x		**WK**	ø**31.75** [1.25"] **Spline** SAE 14T 12/24 DP, M10 thread
	x		**LK**	ø**31.75** [1.25"] **Spline** SAE 14T 12/24 DP, 7/16-14 UNC thread
x	x	x	**CK**	ø**22.2** [ø7/8"] **Straight**, M8 thread, parallel key 1/4"x1/4"x1" BS46
x	x		**MK**	ø**22.2** [ø7/8"] **Straight**, M8 thread, parallel key 1/4"x1/4"x1½" BS46
x	x		**ML**	ø**25** [ø0.984"] **Straight**, M8 thread, parallel key A8x7x25 DIN6885
x	x		**CM**	ø**25.4** [ø1"] **Straight**, M8 thread, parallel key 1/4"x1/4"x1" BS46
	x		**DO**	ø**28.75** [ø1.125"] **Straight**, key 7.95[5/16"], L31.7[1¼"], 3/8-16 UNC thread
	x		**CQ**	ø**30** [ø1.181"] **Straight**, M8 thread, parallel key A8x7x32 DIN6885
	x		**DR**	ø**31.75** [ø1.25"] **Straight**, key 7.95[5/16"], L31.7[1¼"], 3/8-16 UNC thread
	x		**CS**	ø**32** [ø1.26"] **Straight**, M8 thread, parallel key A10x8x45 DIN6885
		x	**KN**	ø**25.4** [1"] **Tapered** 1:8 [125:1000], Parallel key 1/4"x1/4"x1", M16x1.5 thread
		x	**KNA**	ø**25.4** [1"] **Tapered** 1:8 [125:1000], Parallel key 1/4"x1/4"x1", M16x1.5 thread

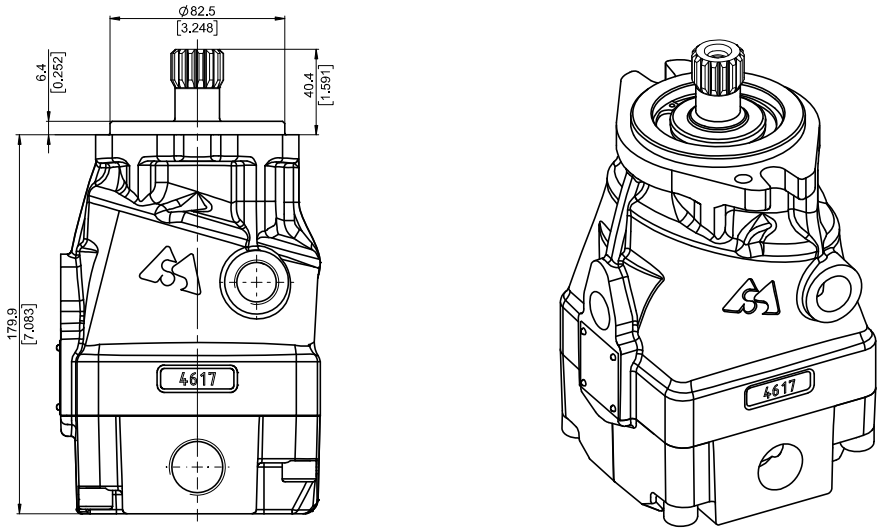
Cross Table - Port Types

PORTS SIZE - THREAD OPTION			Type of threads
Side ports	Twin ports	Rear ports	
default			2xISO 6162-2 DN19, metric, drain ports M18x1.5
5			2xSAE 3/4" PSI6000, SAE, drain ports 7/8-14 UNF
6	6	6	2xG1/2, drain ports G1/2
2	2	2	2xG3/4, drain ports G1/2
7	7	7	2xM22x2, drain ports M18x1.5
3	3	3	2xM27x2, drain ports M18x1.5
8	8	8	2x7/8-14 UNF Ports, drain ports 3/4-16 UNF
4	4	4	2x1 1/16 -12 UN, drain ports 7/8-14 UNF
9			2xISO 6162-2 DN19, drain ports G1/2

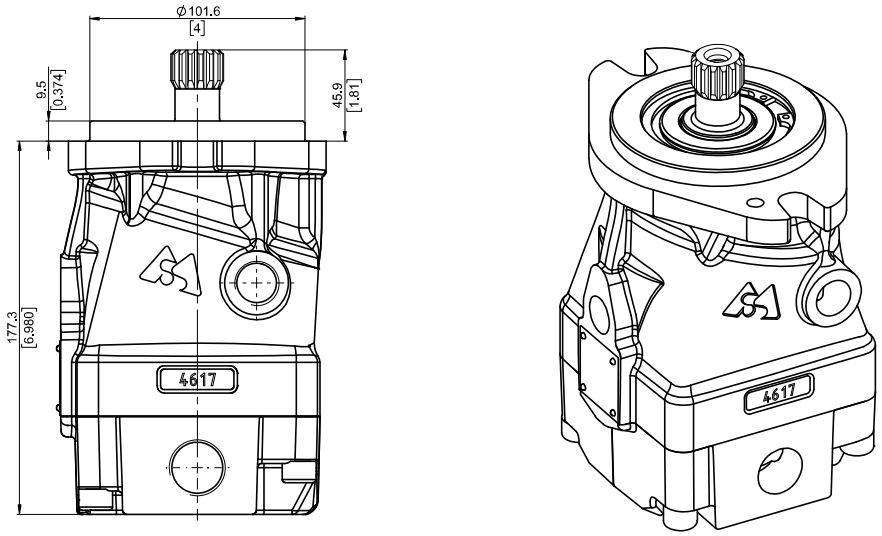
Hydraulic Motors Type MAM

The bellow dimensions are for **comparison only**. The motors can obtain different shafts and end covers.

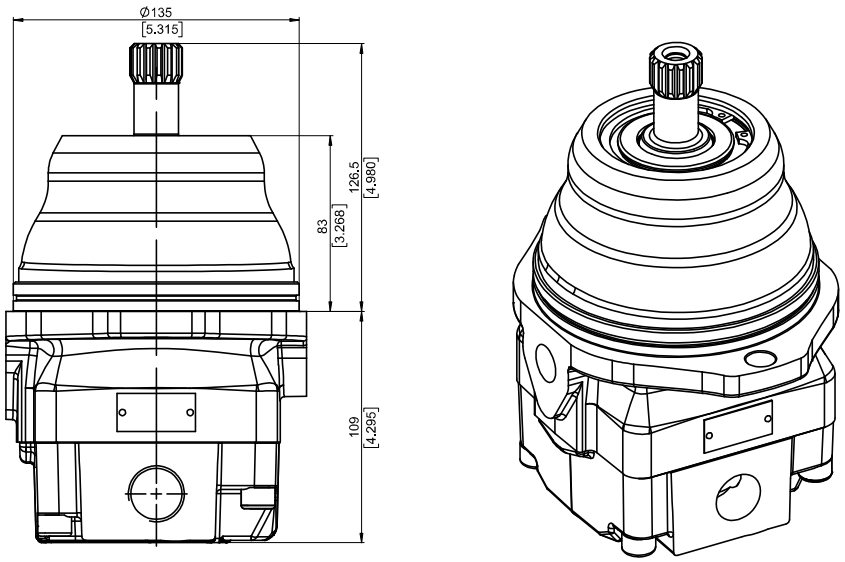
Mounting Flange-Type **SAE-A**



Mounting Flange-Type **SAE-B**



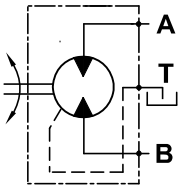
Mounting Flange- Cartage Type **WP**

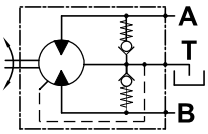


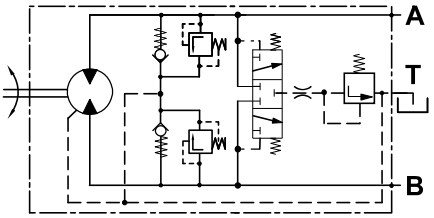
mm [in]

Hydraulic Motors Type MAM

Medium Duty Axial Piston Motors Fixed Displacement







open drain line is always required

APPLICATION

- » Agricultural machines
- » Road building machines
- » Mining machinery
- » Food industry machines
- » Swing drives
- » Hydraulic transmissions
- » Vibration machines
- » Fan drives
- » Special vehicles

OPTIONS

- » Port options
- » Flange options
- » Shaft options
- » Integrated valves
- » High pressure ports

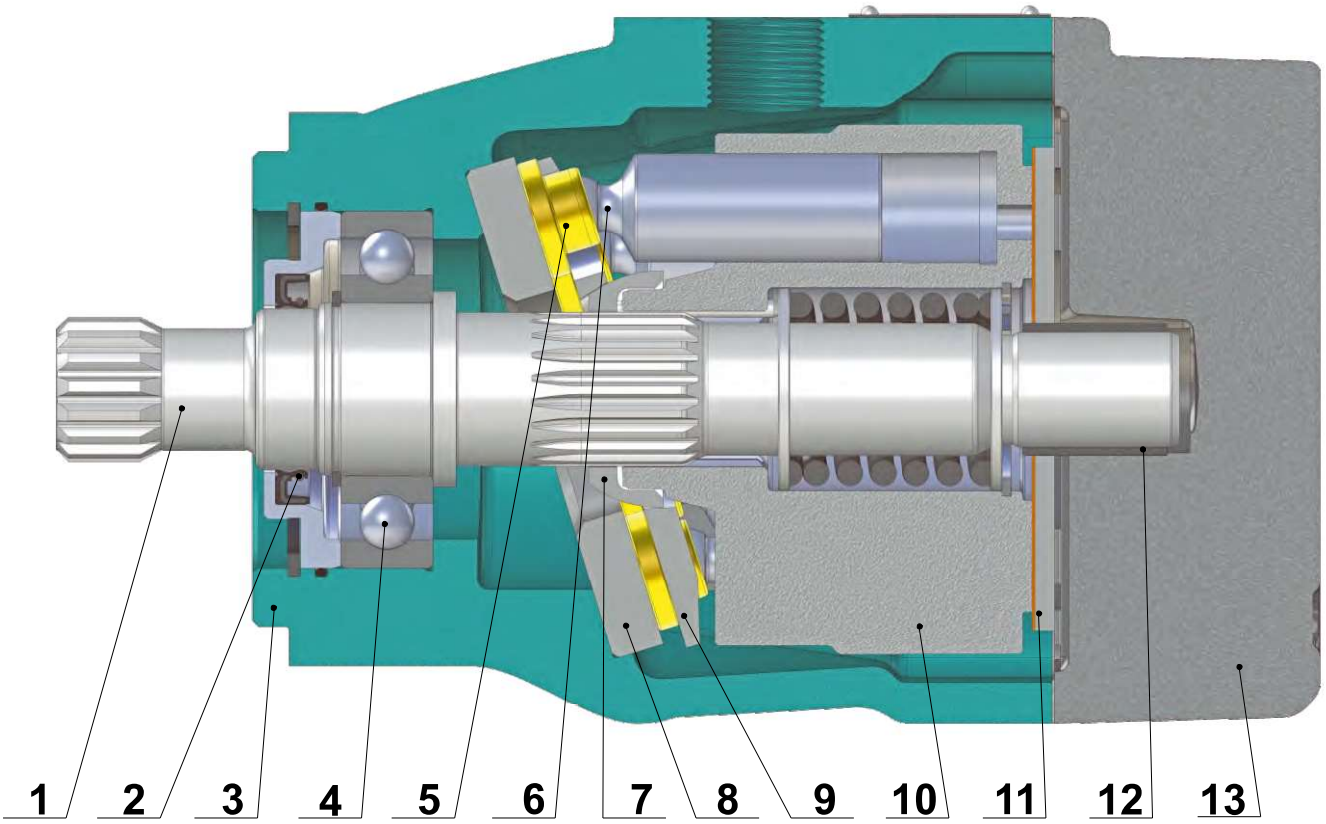
ADVANTAGES

- » Smooth operation
- » High power density
- » Compact size

GENERAL

Displacement,	cm^3/rev [in^3/rev]	**20.5÷49.2 [1.25÷3]**
Max. Speed,	RPM	**3600**
Max. Torque,	Nm [lb-in]	**195 [1725]**
Max. Output,	kW [HP]	**50 [67]**
Max. Pressure Drop,	bar [PSI]	**300 [4350]**
Max. Oil Flow,	l/min [GPM]	**160 [42]**
Min. Speed,	RPM	**500**
Fluid		**Mineral based- HLP(DIN 51524) or HM(ISO 6743/4)**
Temperature Range,	^{O}C [^{O}F]	**-40÷82 [-40÷180]**
Optimal Viscosity Range,	mm^2/s [SUS]	**12÷68 [66÷311]**
Filtration		**ISO code 18/16/13 (Min. recommended fluid filtration of 10 micron)**

SECTION VIEW



1. Hardened shaft
2. Shaft seal
3. Cast iron body
4. Ball or roller bearing
5. Piston shoes
6. Pistons
7. Hardened sphere
8. Thick support plate
9. Retainer plate
10. Cylinder block
11. Bimetal distributor
12. Plane bearing
13. Cast iron end cover

The medium duty design of the MAM is fix displacement motor for open and closed circuits. The motor compact construction is cost effective and has high power/weight ration. The design of the motor is maintenance friendly. We use swash plate which insures low levels of pulsation and noise.

SPECIFICATION DATA

Type		MAM 20	MAM 22	MAM 25	MAM 28	MAM 35	MAM 40	MAM 46	MAM 50
Displacement, cm ^{3}/rev [in ^{3}/rev]		20.5 [1.25]	22.9 [1.4]	24.5 [1.49]	27.9 [1.7]	34.5 [2.11]	39.4 [2.4]	46.1 [2.81]	49.2 [3]
Max. Speed, [RPM]	Cont.	3600	3500	3500	3500	3500	3500	3500	3000
	Int.*	4100	3900	3900	3900	3900	3900	3900	3500
Max. Torque,*** Nm [lb-in]	Cont.	98 [870]	109 [965]	117 [1035]	133 [1180]	154 [1360]	157 [1390]	185 [1630]	195 [1725]
	Int.**	114 [1010]	128 [1130]	136 [1200]	154 [1360]	165 [1460]	188 [1664]	220 [1950]	226 [2000]
Output, kW [HP]	Cont.	30 [40]	35 [40]	37 [50]	40 [54]	40 [54]	45 [60]	50 [67]	50 [67]
	Int.**	35 [47]	40 [54]	42 [56]	45 [60]	50 [67]	55 [74]	60 [80]	60 [80]
Max. Pressure, bar [PSI]	Cont.	300 [4350]	300 [5080]	300 [5080]	300 [5080]	280 [4060]	250 [3625]	250 [3625]	250 [3625]
	Int.**	350 [5080]	350 [5080]	350 [5080]	350 [5080]	300 [4350]	300 [4350]	300 [4350]	290 [4200]
	Peak	400 [5800]	400 [5800]	400 [5800]	400 [5800]	350 [5080]	350 [5080]	350 [5080]	320 [4640]
Max. Oil Flow, l/min [GPM]	Cont.	75 [19.8]	80 [21.1]	85 [22.5]	97 [25.6]	120 [31.7]	137 [36.2]	160 [42.3]	147 [38.8]
	Int.*	85 [22.5]	90 [23.8]	95 [25.1]	110 [29.1]	135 [35.7]	153 [40.4]	180 [47.6]	172 [45.4]
Torque Constant ***** Nm/bar [lb-in/PSI]		0.29 [0.18]	0.33 [0.2]	0.35 [0.214]	0.4 [0.244]	0.5 [0.302]	0.564 [0.344]	0.66 [0.403]	0.704 [0.43]
Speed Constant ***** RPM/(l/min) [RPM/GPM]		46.3 [175.4]	41.5 [156.9]	38.9 [147.1]	34.1 [128.9]	27.5 [104.3]	24.1 [91.4]	20.6 [78]	19.3 [73.2]
Permissible Shaft Load max Axial**** N[lb]		Fa=800 [180] for SAE-A flange; Fa=1000 [225] for SAE-B and WP flange							
max Radial**** N[lb]		Fr=250 [56] for SAE-A flange; Fr=300 [68] for SAE-B and WP flange							
Min. Speed, [RPM]		500							
Max. Pressure in Drain Line, bar [PSI]		5 [70] open drain line is always required							
Weight, kg [lb]		11.1[24.5] for SAE-A flange; 12.2[26.9] for SAE-B flange; 13.5[29.7] for WP cartage flange							

Peak pressure is the highest allowable pressure, may occur for max. 1% of every minute.
* Intermittent speed (flow): for pressure up to 150[2200] bar [PSI].
** Intermittent load: the permissible values may occur for max. 10% of motor lifetime.
*** Theoretical torque.
**** The calculated max values are based on the optimal direction of the forces Fr, Fa and optimal position of the shaft.
***** The constant values are used for calculation of torque and speed with motor efficiencies η_v=0.95 and η_{mh}=0.9.

1. The recommended output power for continuous operations should not be exceeded.
2. Recommended filtration as per ISO 4406 cleanliness code 18/16/13 or better. This filtration corresponds to SAE AS 4059 8A/7B/7C. Nominal filtration - 10 micron or better.
3. Recommended a premium quality, anti-wear type mineral based hydraulic oil, HLP(DIN51524) or HM(ISO6743/4).
4. Recommended oil viscosity - 12...68 cSt or see page 34.
5. Recommended maximum system operating temperature - 82°[180°] C[F].
6. To ensure optimum life of the motor, fill it up with fluid prior to load it and run with moderate load and speed for about 10-15 minutes.

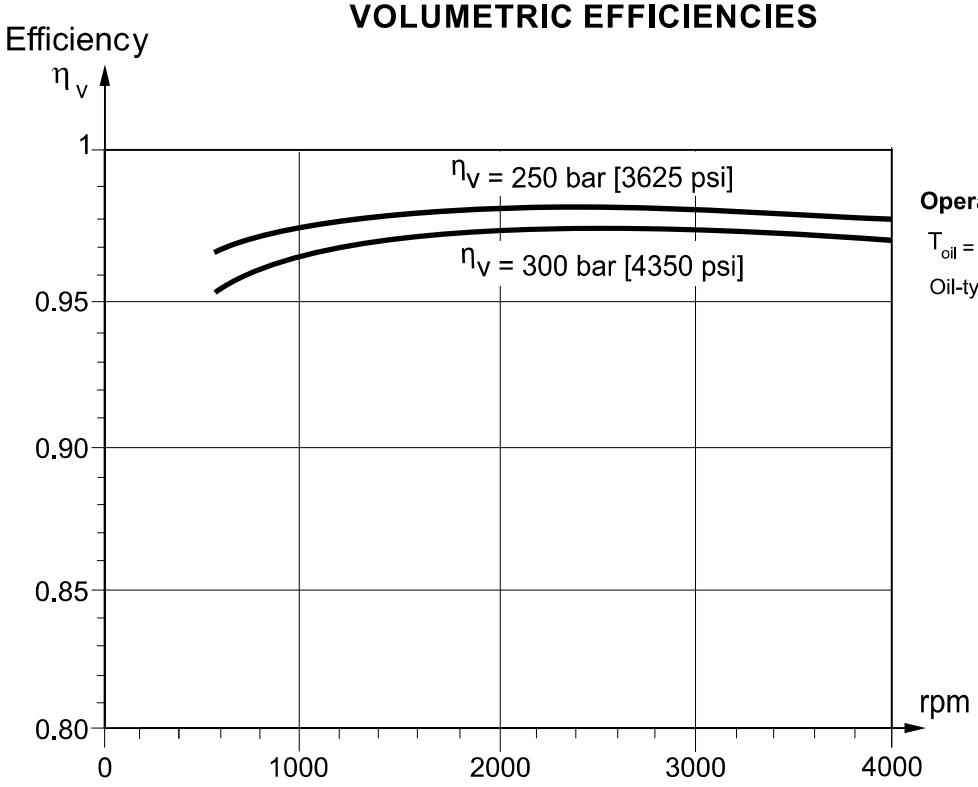
Hint: Motor Torque = Torque Constant * Pressure Drop **Rotation Speed = Speed Constant * Oil Flow**

The constant values are approximate. Motor torque and rotation speed for a particular project are depending on the real operating conditions. For more detailed calculations please see efficiencies on next page and formulas on page 35.

FUNCTION DIAGRAMS

The below efficiencies are applied to all displacements.

VOLUMETRIC EFFICIENCIES

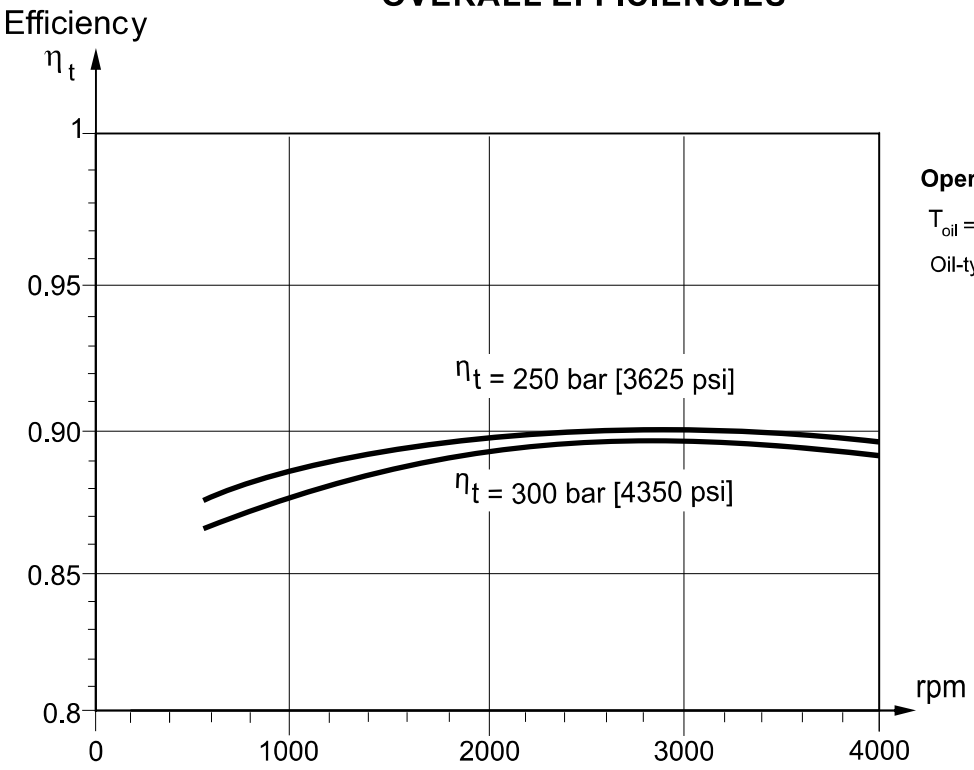


Operation conditions:

T_{oil} = 50°C [122° F]

Oil-type: HPL 46

OVERALL EFFICIENCIES



Operation conditions:

T_{oil} = 50°C [122° F]

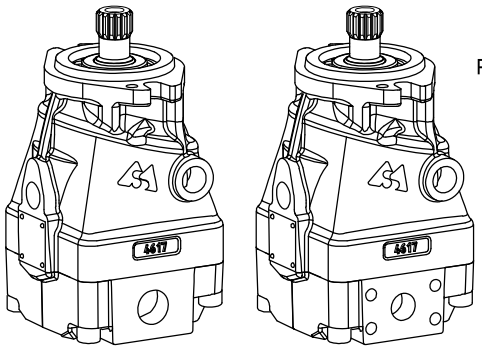
Oil-type: HPL 46

The motor size, pressure, torque, speed of rotation and flow rate required for a specific application can be calculated using the formulas on page 35

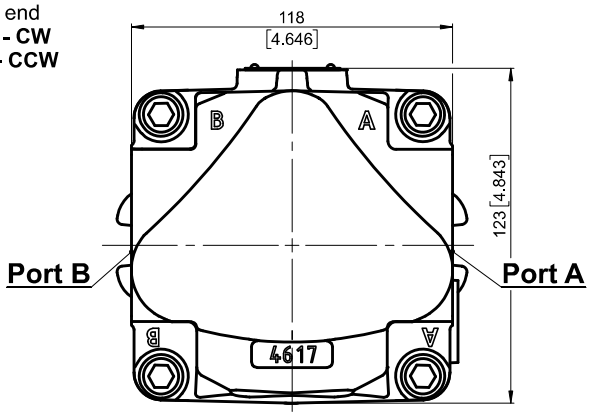
Efficiencies for a particular motor may vary from the shown in the diagram depending on the operating conditions.

OVERALL DIMENSIONS AND PORTS

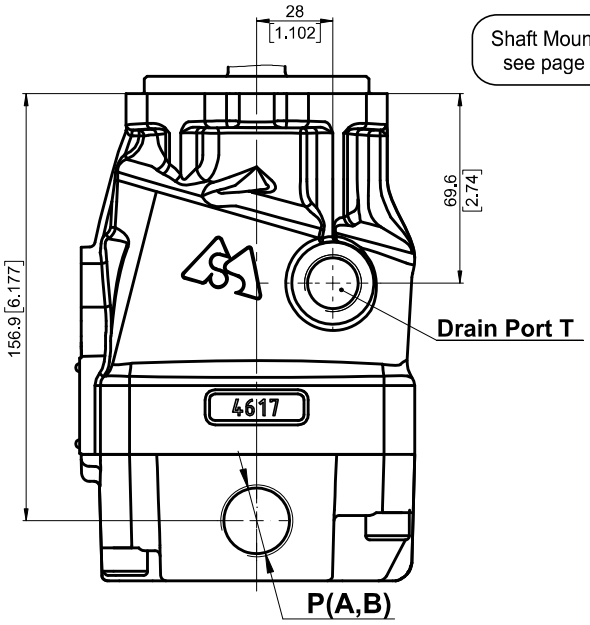
Side Ports - **Default** Mounting Flange - Type **SAE-A**



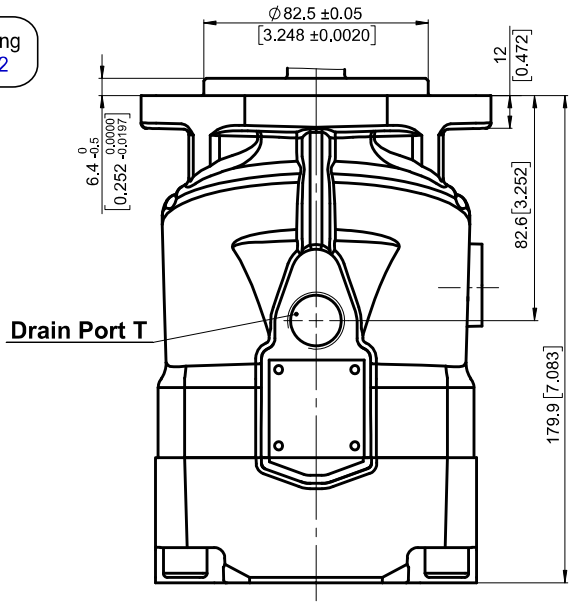
Standard Rotation
Viewed from shaft end
Port **A** Pressurized **- CW**
Port **B** Pressurized **- CCW**
see page 31



Side ports, port size **2**,**3**,**4**,**6**,**7** and **8**

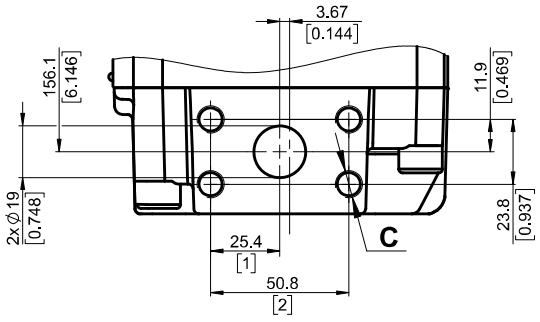


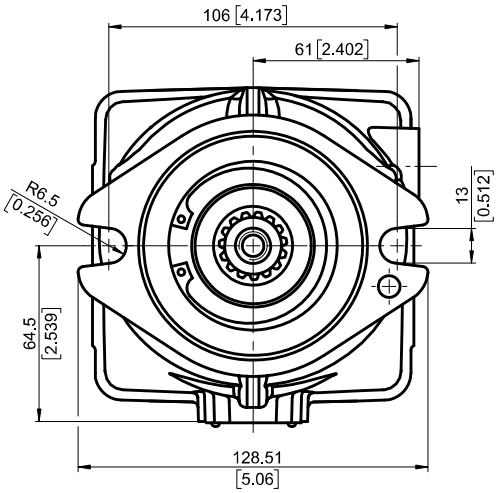
Shaft Mounting see page 12



	Port Size					
	2	3	4	6	7	8
$P_{(A,B)}$	2xG 3/4	2xM27x2	2x1 1/16-12UN	2xG 1/2	2xM22x1.5	2x 7/8-14UNF
T	G 1/2	M18x1.5	7/8 -14UNF	G 1/2	M18x1.5	3/4 -16UNF

Side ports, port size **default**, **5** and **9**





	Port Size		
	default	5	9
$P_{(A,B)}$	2xISO 6162-2 DN19	2xSAE J518 3/4 PSI6000	2xISO 6162-2 DN19
T	M18x1.5	7/8-14 UNF	G1/2
C	8xM10	8x3/8-16 UNC	8xM10

mm [in]

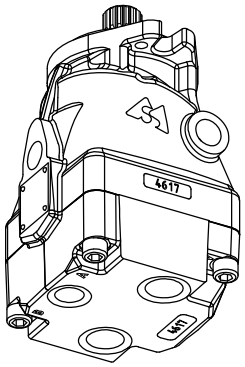
OVERALL DIMENSIONS AND PORTS

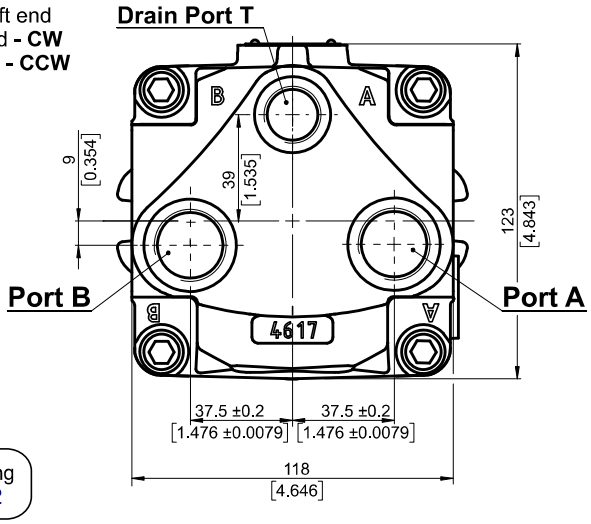
Rear Ports - Type **E** Mounting Flange - Type **SAE-A**

Side ports, port size **2**,**3**,**4**,**6**,**7** and **8**

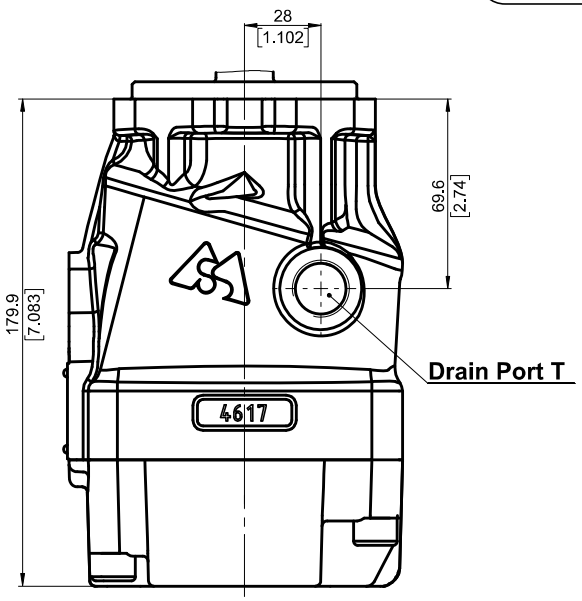
See the port sizes at the bottom of this page

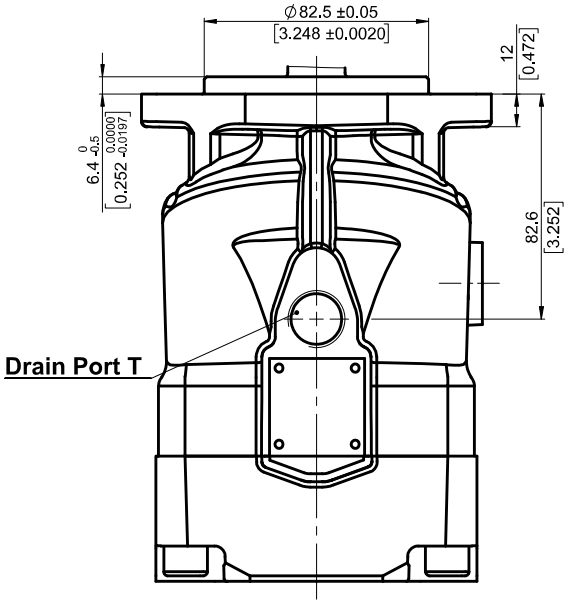
Standard Rotation
Viewed from shaft end
Port **A** Pressurized **- CW**
Port **B** Pressurized **- CCW**
see page 31

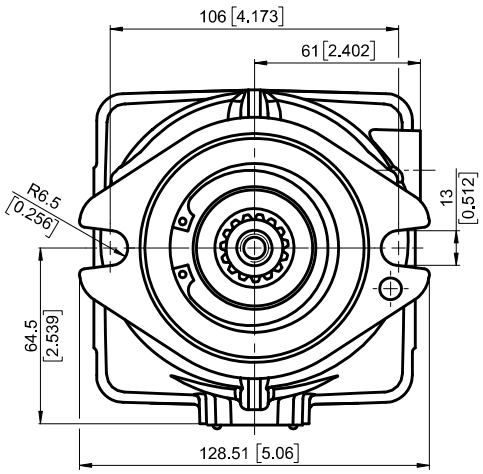




Shaft Mounting
see page 12







	Port Size					
	2	3	4	6	7	8
$P_{(A,B)}$	2xG 3/4	2xM27x2	2x1 1/16-12UN	2xG 1/2	2xM22x1.5	2x 7/8-14UNF
T	G 1/2	M18x1.5	7/8 -14UNF	G 1/2	M18x1.5	3/4 -16UNF

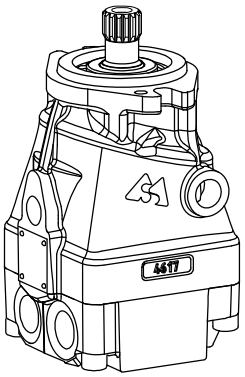
mm [in]

OVERALL DIMENSIONS AND PORTS

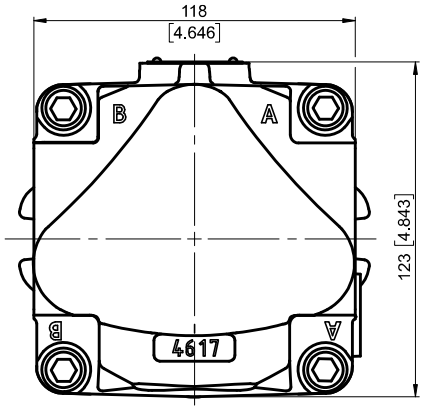
Twin Side Ports - Type **T** Mounting Flange - Type **SAE-A**

Side ports, port size **2**,**3**,**4**,**6**,**7** and **8**

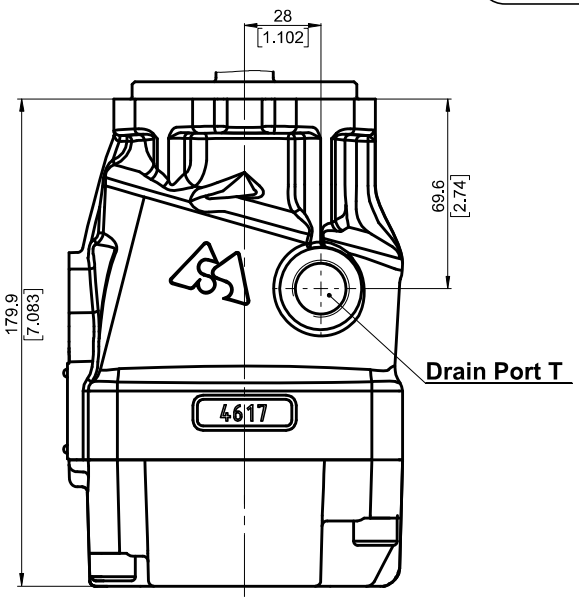
See the port sizes at the bottom of this page

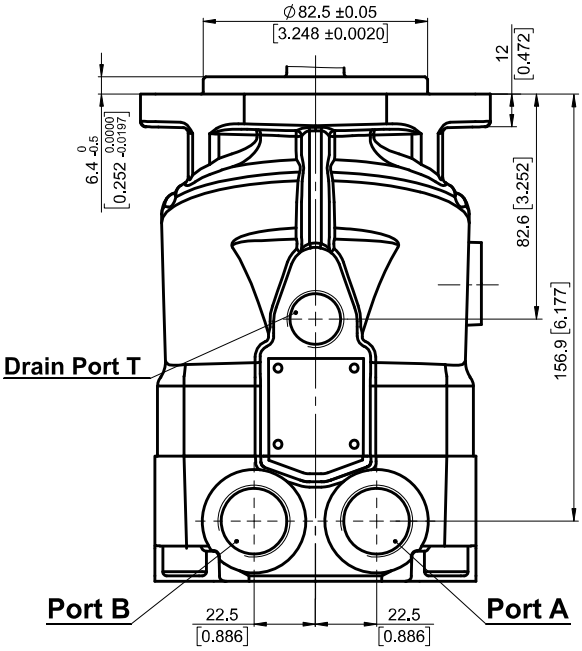


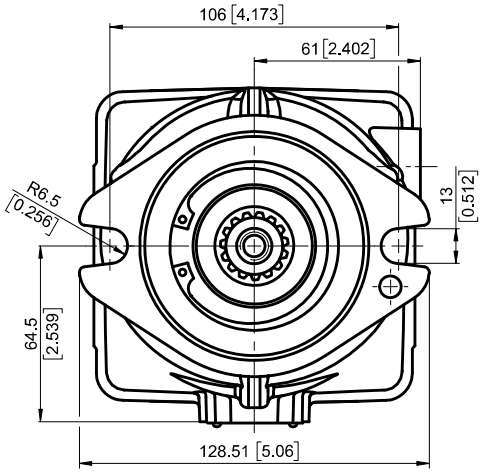
Standard Rotation
Viewed from shaft end
Port **A** Pressurized **- CW**
Port **B** Pressurized **- CCW**
see page 31



Shaft Mounting
see page 12





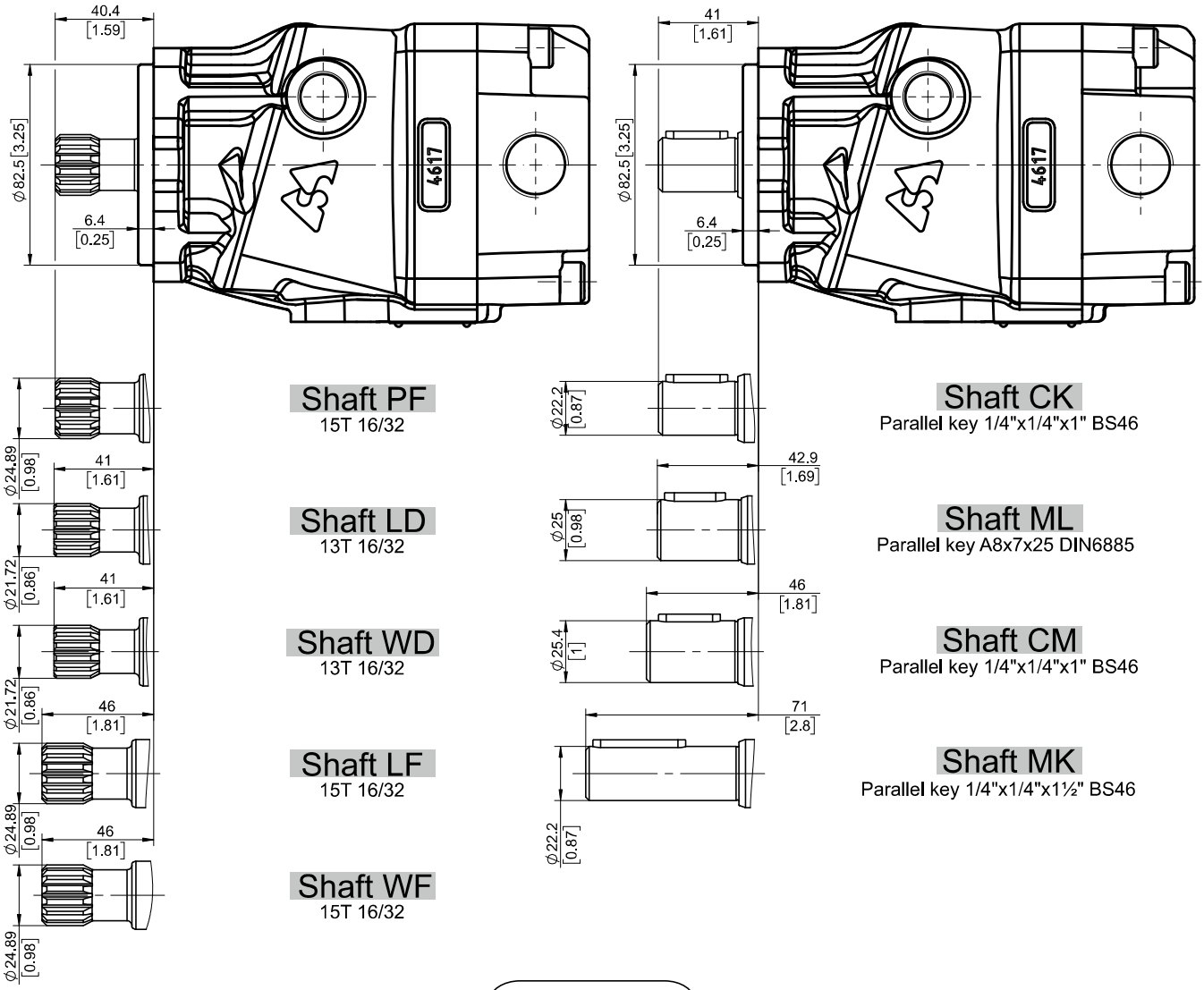


	Port Size					
	2	3	4	6	7	8
$P_{(A,B)}$	2xG 3/4	2xM27x2	2x1 1/16-12UN	2xG 1/2	2xM22x1.5	2x 7/8-14UNF
T	G 1/2	M18x1.5	7/8 -14UNF	G 1/2	M18x1.5	3/4 -16UNF

mm [in]

SHAFTS MOUNTING

Mounting Flange-Type **SAE-A**



Shaft Dimensions
See Page 24÷27

PERMISSIBLE SHAFT LOAD

Permissible shaft load		
max Axial	N[lb]	Fa=800 [180]
max Radial	N[lb]	Fr=250 [56]

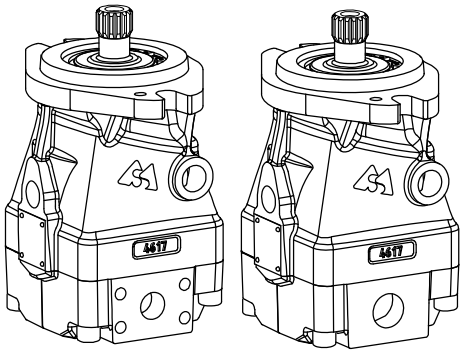
The calculated max values are based on the optimal direction of the forces Fr, Fa and optimal position of the shaft (see page 31).

For more information, please, feel free to contact us.

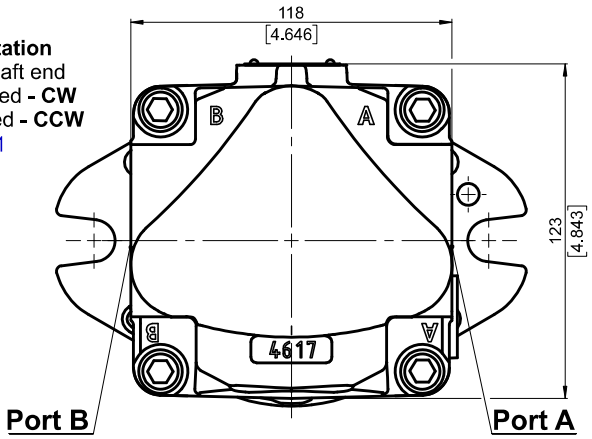
mm [in]

OVERALL DIMENSIONS AND PORTS

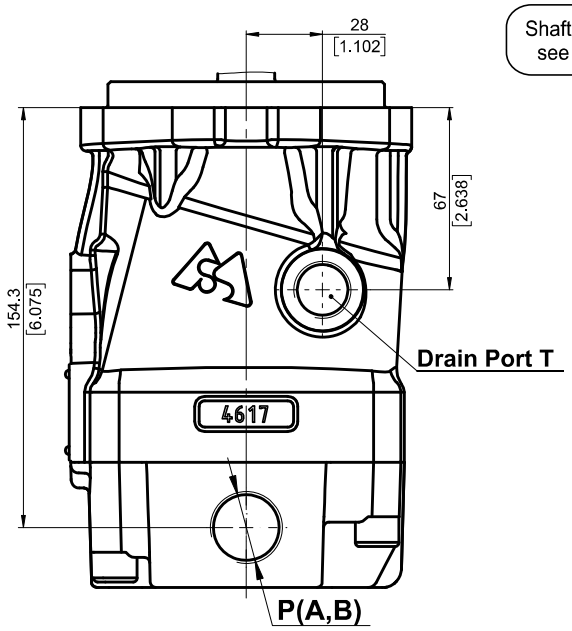
Side Ports - **Default** Mounting Flange - Type **SAE-B**



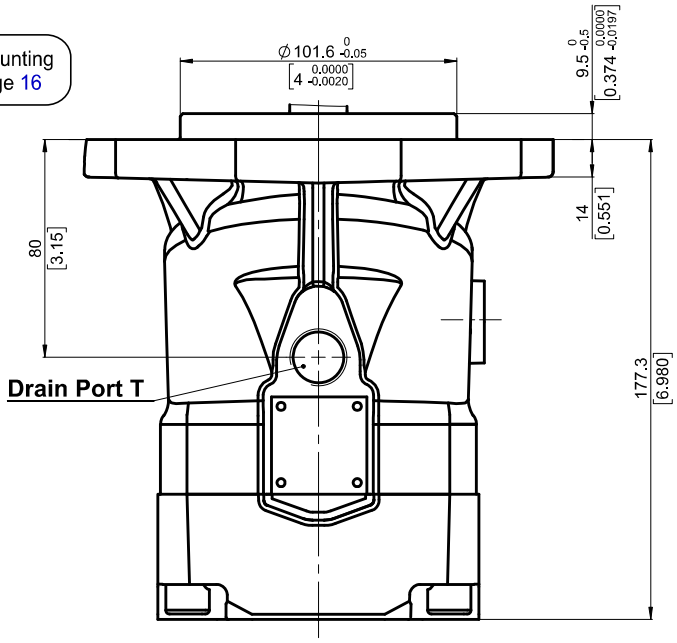
Standard Rotation
Viewed from shaft end
Port **A** Pressurized - **CW**
Port **B** Pressurized - **CCW**
see page 31



Side ports, port size **2**,**3**,**4**,**6**,**7** and **8**

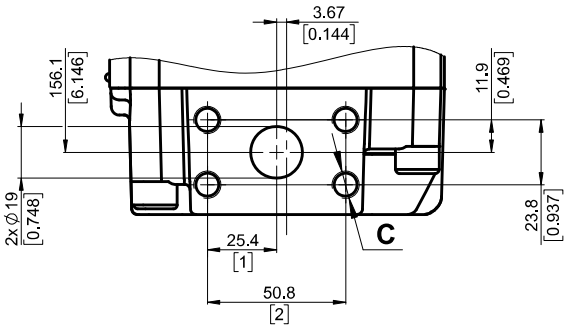


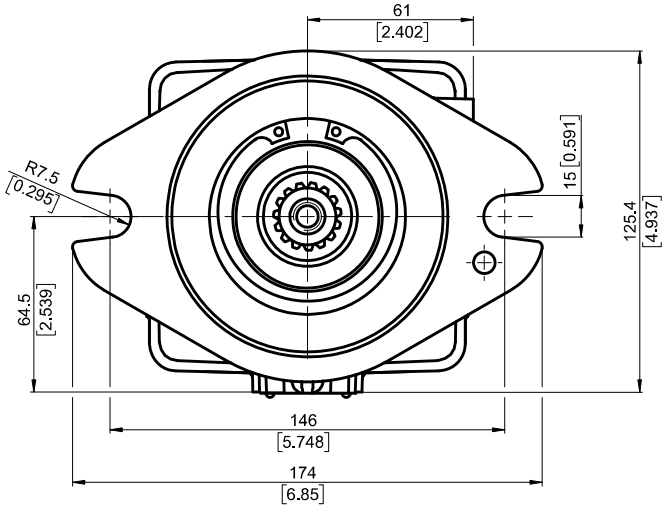
Shaft Mounting
see page 16



	Port Size					
	2	3	4	6	7	8
$P_{(A,B)}$	2xG 3/4	2xM27x2	2x1 1/16-12UN	2xG 1/2	2xM22x1.5	2x 7/8-14UNF
T	G 1/2	M18x1.5	7/8 -14UNF	G 1/2	M18x1.5	3/4 -16UNF

Side ports, port size **default, 5** and **9**





	Port Size		
	default	5	9
$P_{(A,B)}$	2xISO 6162-2 DN19	2xSAE J518 3/4 PSI6000	2xISO 6162-2 DN19
T	M18x1.5	7/8-14 UNF	G1/2
C	8xM10	8x3/8-16 UNC	8xM10

mm [in]

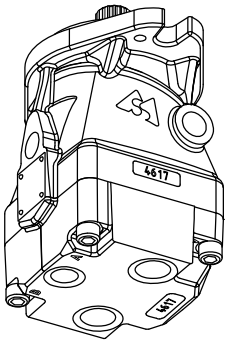
OVERALL DIMENSIONS AND PORTS

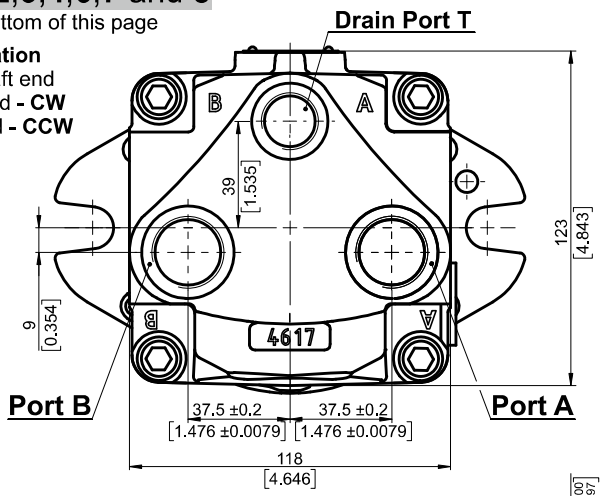
Rear Ports - Type **E** Mounting Flange - Type **SAE-B**

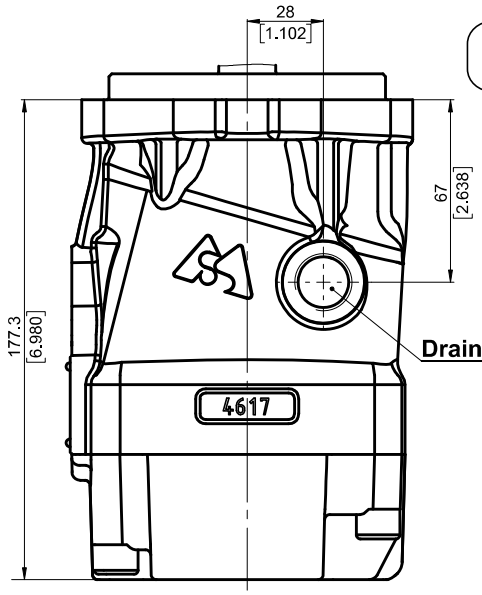
Side ports, port size **2**,**3**,**4**,**6**,**7** and **8**

See the port sizes at the bottom of this page

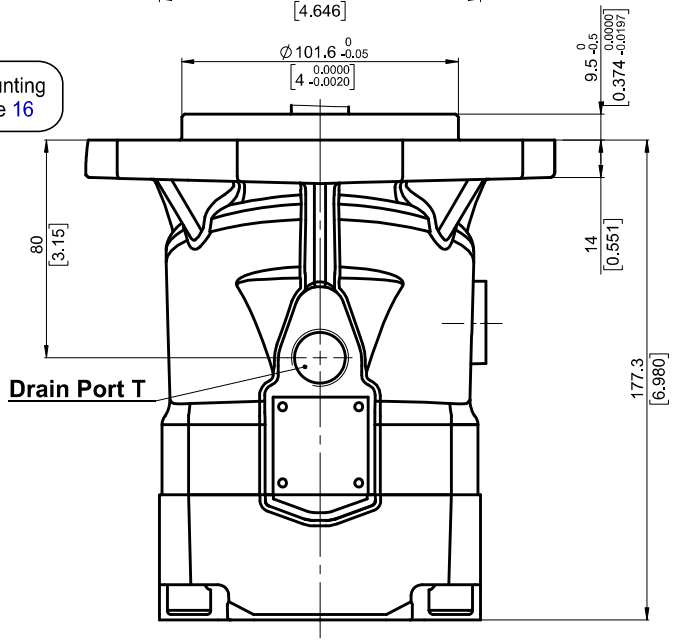
Standard Rotation
Viewed from shaft end
Port **A** Pressurized **- CW**
Port **B** Pressurized **- CCW**
see page 31

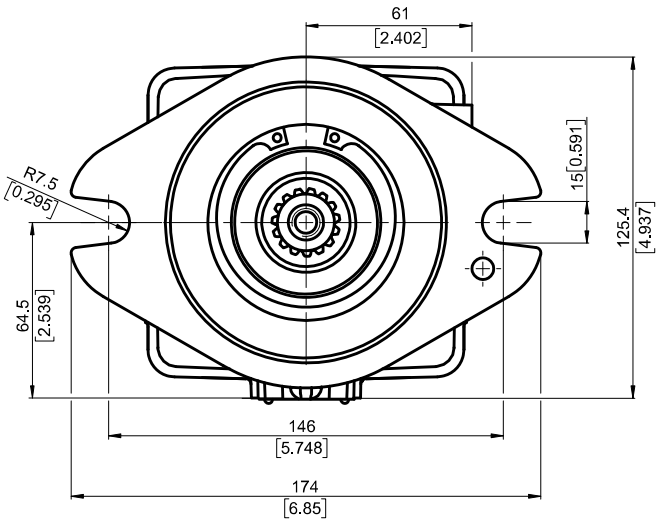






Shaft Mounting
see page 16





	Port Size					
	2	3	4	6	7	8
$P_{(A,B)}$	2xG 3/4	2xM27x2	2x1 1/16-12UN	2xG 1/2	2xM22x1.5	2x 7/8-14UNF
T	G 1/2	M18x1.5	7/8 -14UNF	G 1/2	M18x1.5	3/4 -16UNF

mm [in]

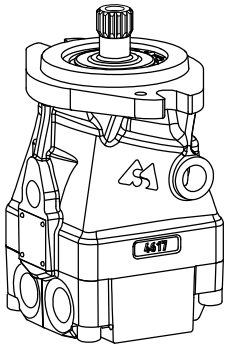
OVERALL DIMENSIONS AND PORTS

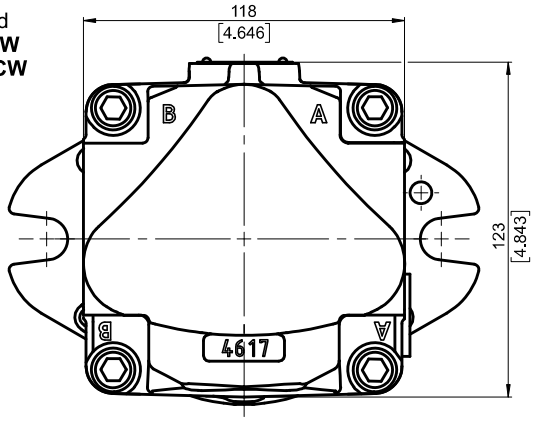
Twin Side Ports - Type **T** Mounting Flange - Type **SAE-B**

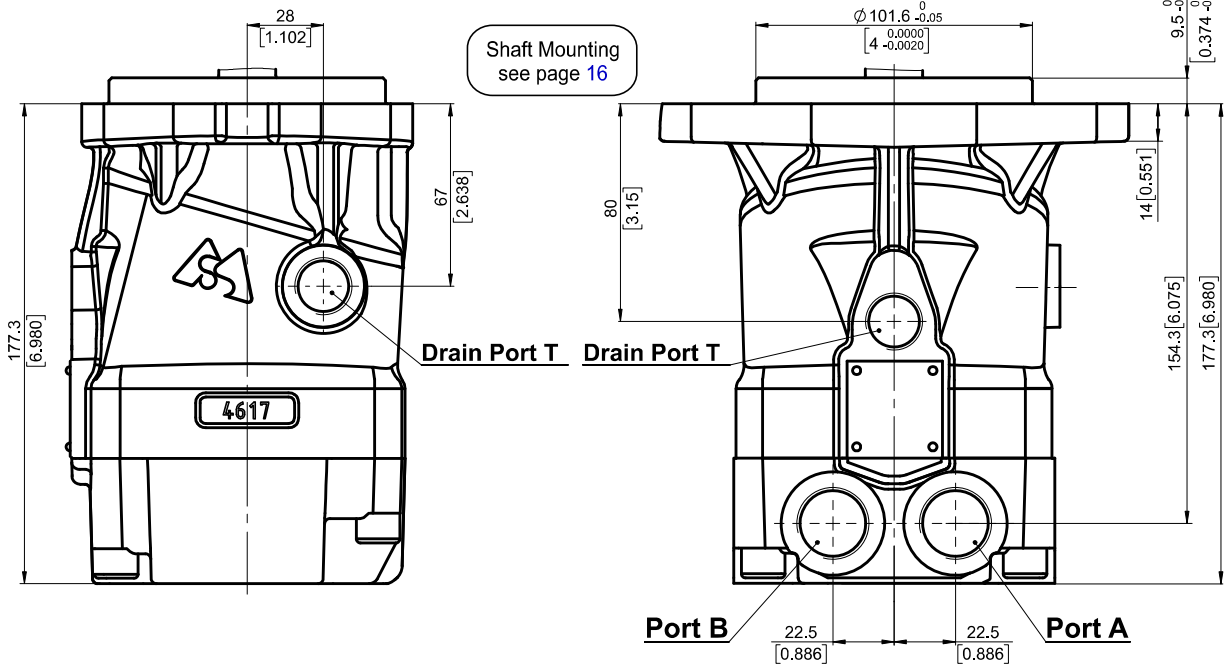
Side ports, port size **2**,**3**,**4**,**6**,**7** and **8**

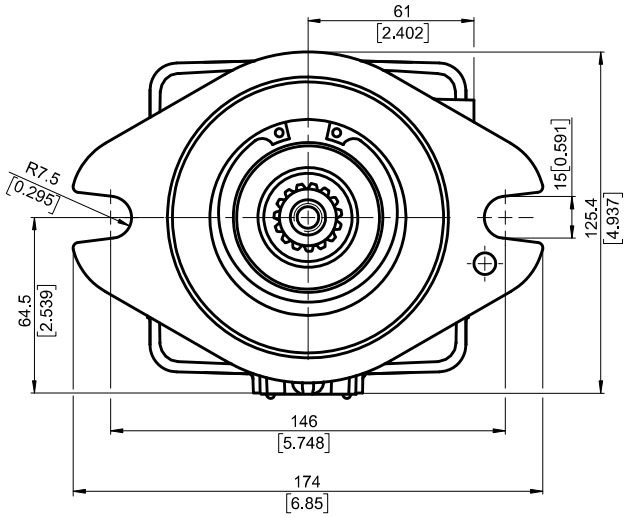
See the port sizes at the bottom of this page

Standard Rotation
Viewed from shaft end
Port **A** Pressurized **- CW**
Port **B** Pressurized **- CCW**
see page 31







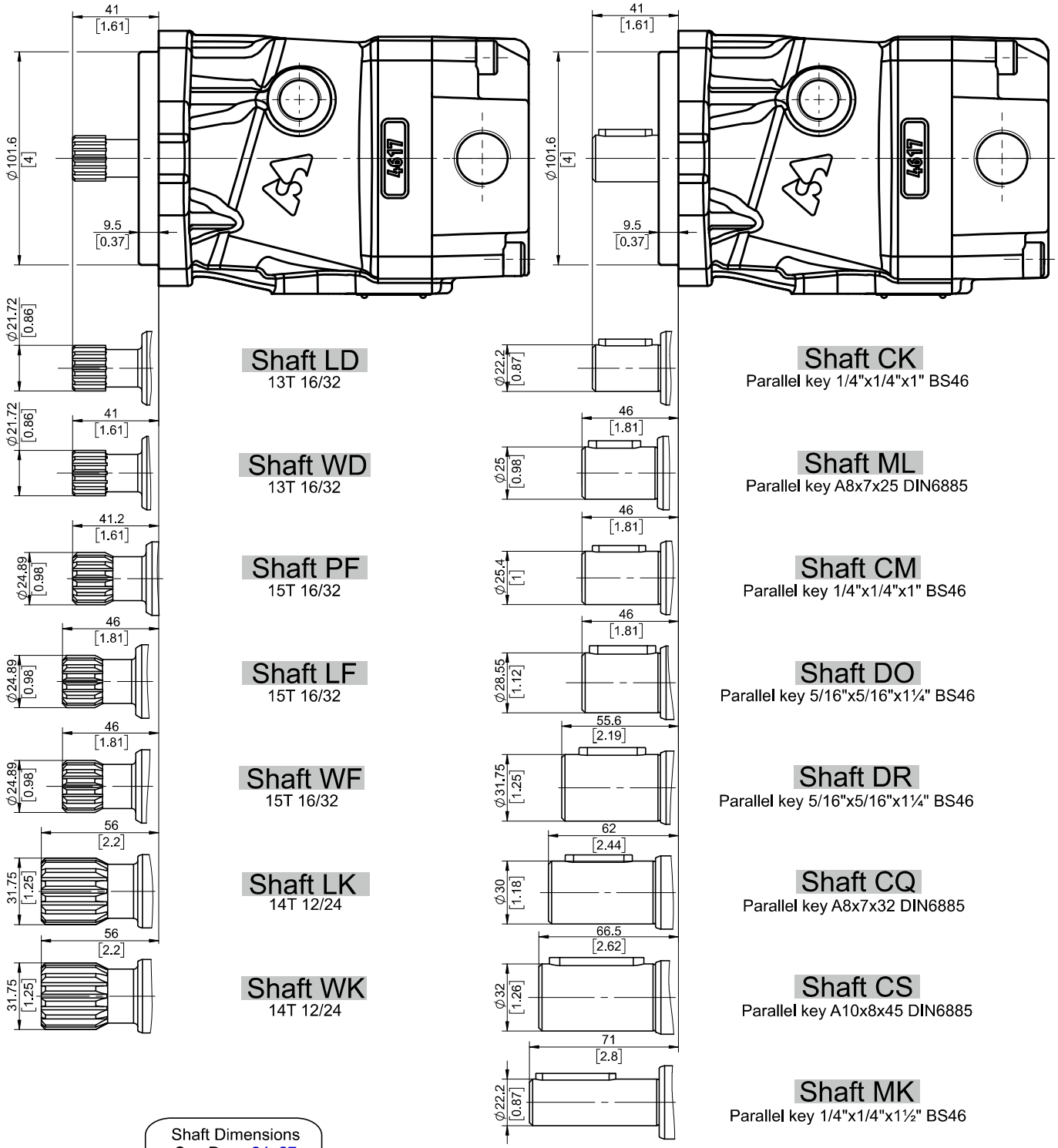


	Port Size					
	2	3	4	6	7	8
$P_{(A,B)}$	2xG 3/4	2xM27x2	2x1 1/16-12UN	2xG 1/2	2xM22x1.5	2x 7/8-14UNF
T	G 1/2	M18x1.5	7/8 -14UNF	G 1/2	M18x1.5	3/4 -16UNF

mm [in]

SHAFTS MOUNTING

Mounting Flange-Type **SAE-B**



Shaft LD
13T 16/32

Shaft WD
13T 16/32

Shaft PF
15T 16/32

Shaft LF
15T 16/32

Shaft WF
15T 16/32

Shaft LK
14T 12/24

Shaft WK
14T 12/24

Shaft CK
Parallel key 1/4"x1/4"x1" BS46

Shaft ML
Parallel key A8x7x25 DIN6885

Shaft CM
Parallel key 1/4"x1/4"x1" BS46

Shaft DO
Parallel key 5/16"x5/16"x1¼" BS46

Shaft DR
Parallel key 5/16"x5/16"x1¼" BS46

Shaft CQ
Parallel key A8x7x32 DIN6885

Shaft CS
Parallel key A10x8x45 DIN6885

Shaft MK
Parallel key 1/4"x1/4"x1½" BS46

Shaft Dimensions
See Page 24÷27

PERMISSIBLE SHAFT LOAD

Permissible shaft load		
max Axial	N[lb]	Fa=1000 [225]
max Radial	N[lb]	Fr=300 [68]

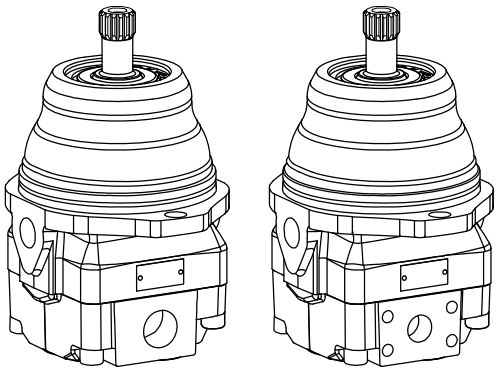
The calculated max values are based on the optimal direction of the forces Fr, Fa and optimal position of the shaft (see page 31).

For more information, please, feel free to contact us.

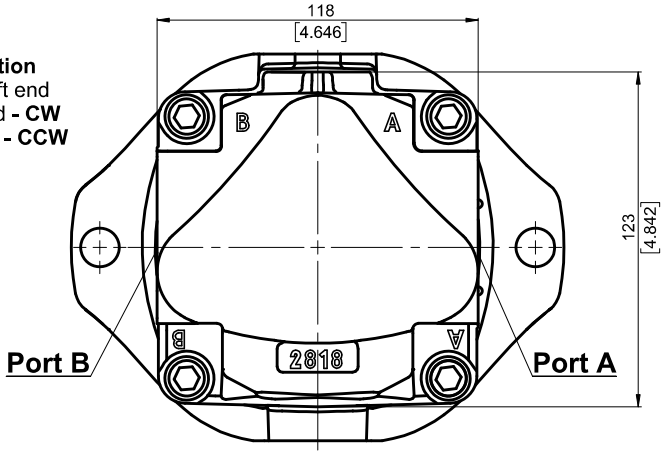
mm [in]

OVERALL DIMENSIONS AND PORTS

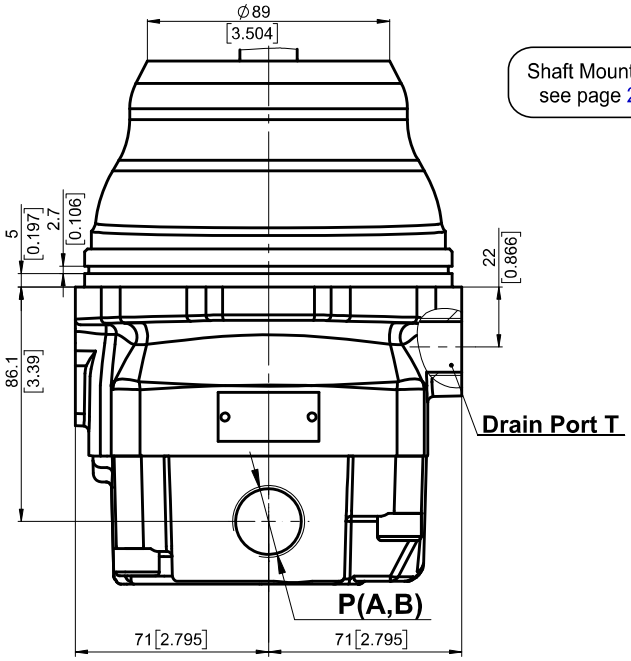
Side Ports - **Default** Mounting Flange - Cartage Type **WP**



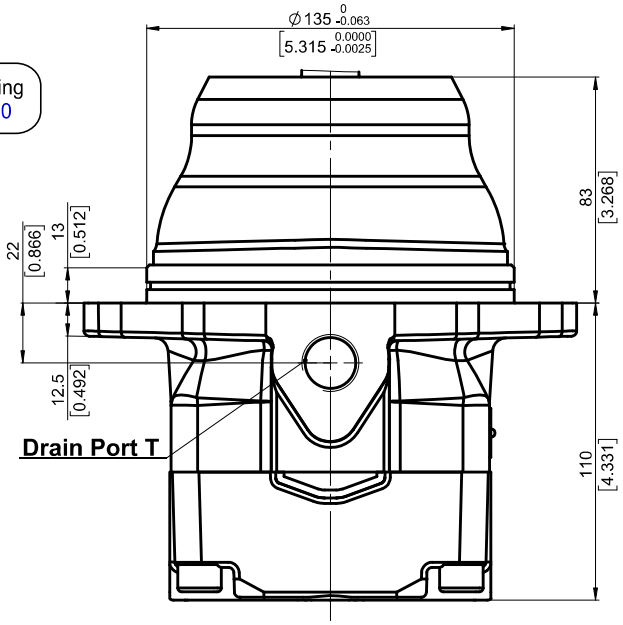
Standard Rotation
Viewed from shaft end
Port **A** Pressurized - **CW**
Port **B** Pressurized - **CCW**
see page 31



Side ports, port size **2**,**3**,**4**,**6**,**7** and **8**

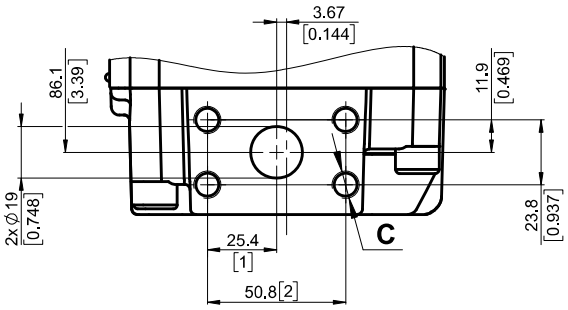


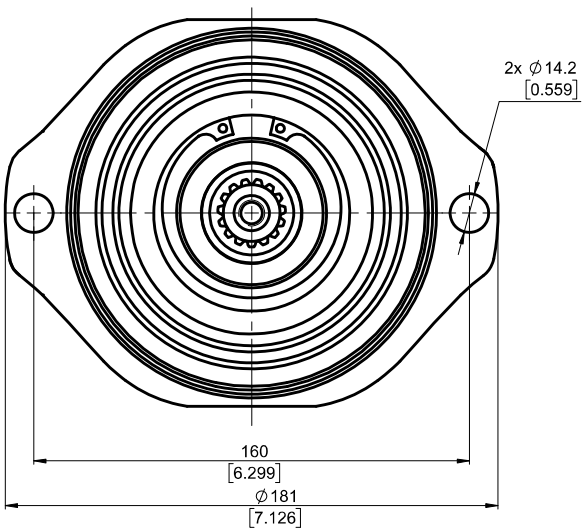
Shaft Mounting
see page 20



	Port Size					
	2	3	4	6	7	8
$P_{(A,B)}$	2xG 3/4	2xM27x2	2x1 1/16-12UN	2xG 1/2	2xM22x1.5	2x 7/8-14UNF
T	G 1/2	M18x1.5	7/8 -14UNF	G 1/2	M18x1.5	3/4 -16UNF

Side ports, port size **default, 5** and **9**





	Port Size		
	default	5	9
$P_{(A,B)}$	2xISO 6162-2 DN19	2xSAE J518 3/4 PSI6000	2xISO 6162-2 DN19
T	M18x1.5	7/8-14 UNF	G1/2
C	8xM10	8x3/8-16 UNC	8xM10

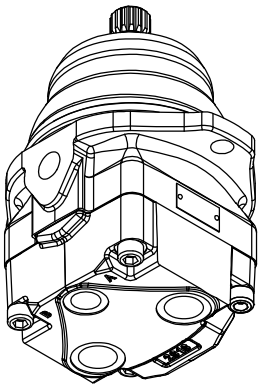
mm [in]

OVERALL DIMENSIONS AND PORTS

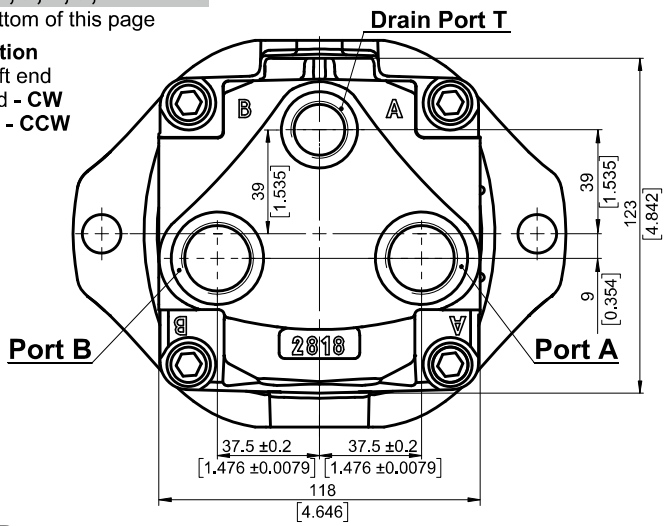
Rear Ports - Type **E** Mounting Flange - Cartage Type **WP**

Side ports, port size **2**,**3**,**4**,**6**,**7** and **8**

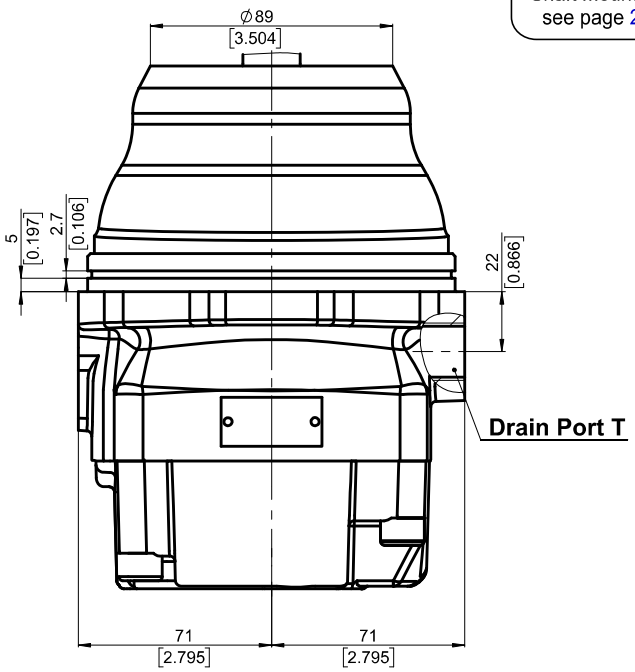
See the port sizes at the bottom of this page

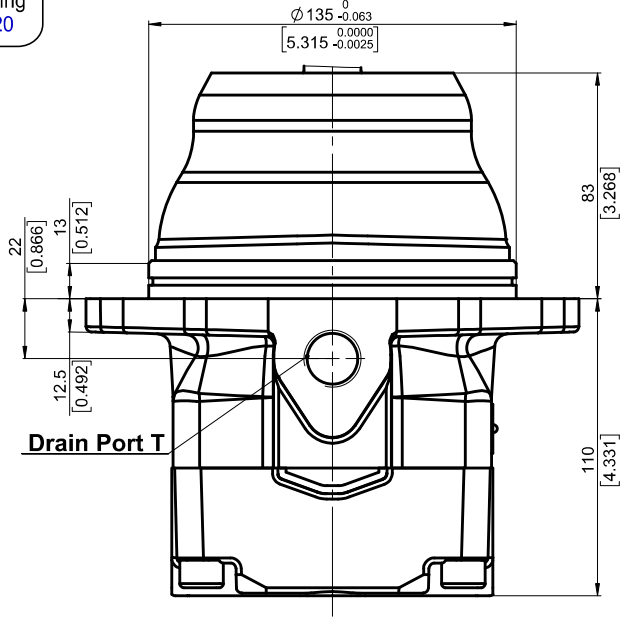


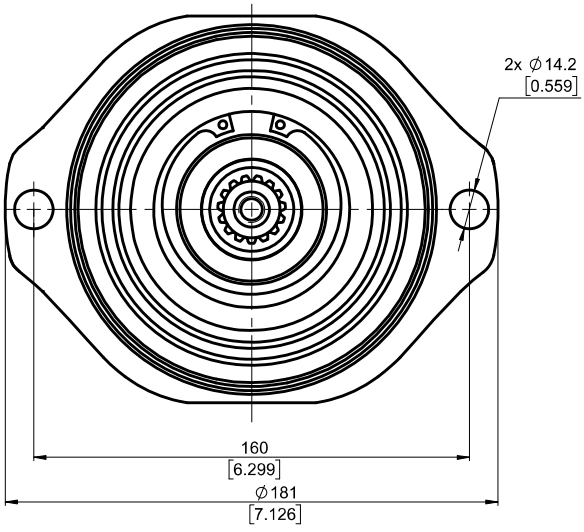
Standard Rotation
Viewed from shaft end
Port **A** Pressurized **- CW**
Port **B** Pressurized **- CCW**
see page 31



Shaft Mounting
see page 20







	Port Size					
	2	3	4	6	7	8
$P_{(A,B)}$	2xG 3/4	2xM27x2	2x1 1/16-12UN	2xG 1/2	2xM22x1.5	2x 7/8-14UNF
T	G 1/2	M18x1.5	7/8 -14UNF	G 1/2	M18x1.5	3/4 -16UNF

mm [in]

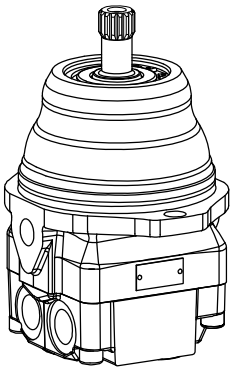
OVERALL DIMENSIONS AND PORTS

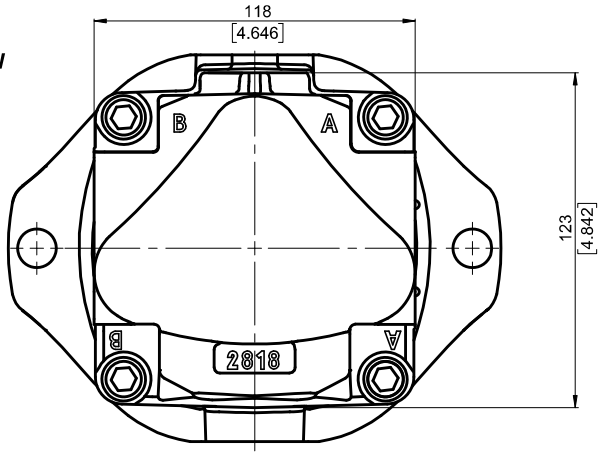
Twin Side Ports - Type **T** Mounting Flange - Cartage Type **WP**

Side ports, port size **2**,**3**,**4**,**6**,**7** and **8**

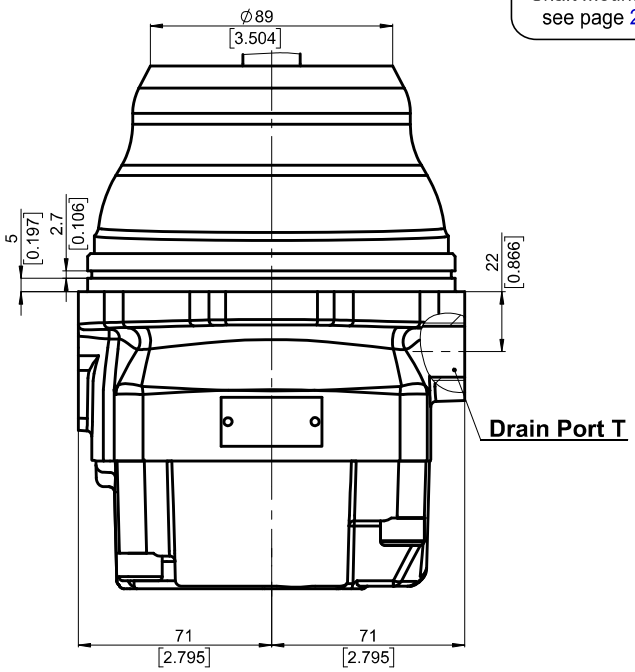
See the port sizes at the bottom of this page

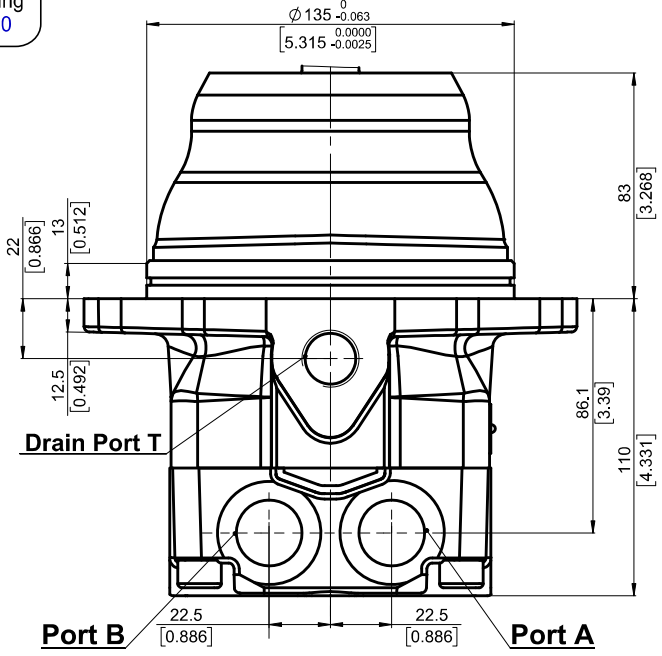
Standard Rotation
Viewed from shaft end
Port **A** Pressurized **- CW**
Port **B** Pressurized **- CCW**
see page 31

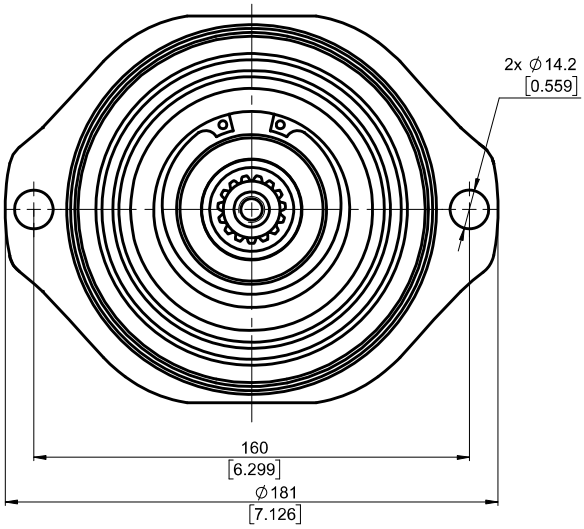




Shaft Mounting
see page 20





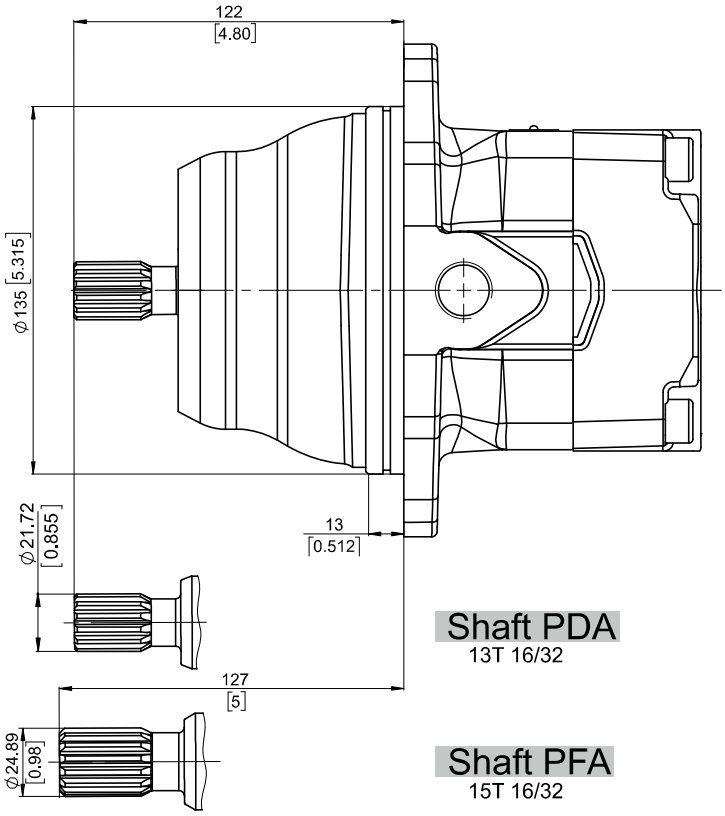


	Port Size					
	2	3	4	6	7	8
$P_{(A,B)}$	2xG 3/4	2xM27x2	2x1 1/16-12UN	2xG 1/2	2xM22x1.5	2x 7/8-14UNF
T	G 1/2	M18x1.5	7/8 -14UNF	G 1/2	M18x1.5	3/4 -16UNF

mm [in]

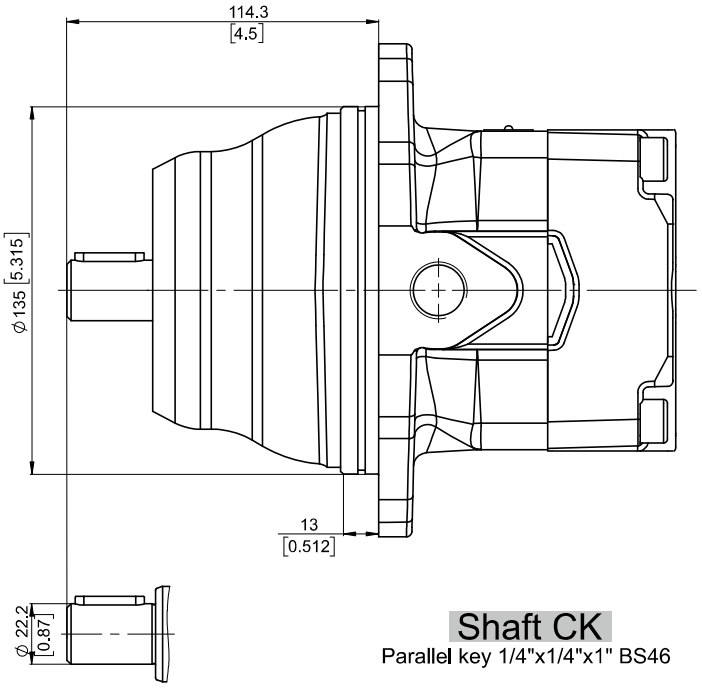
SHAFTS MOUNTING

Mounting Flange-Type **SAE-W**

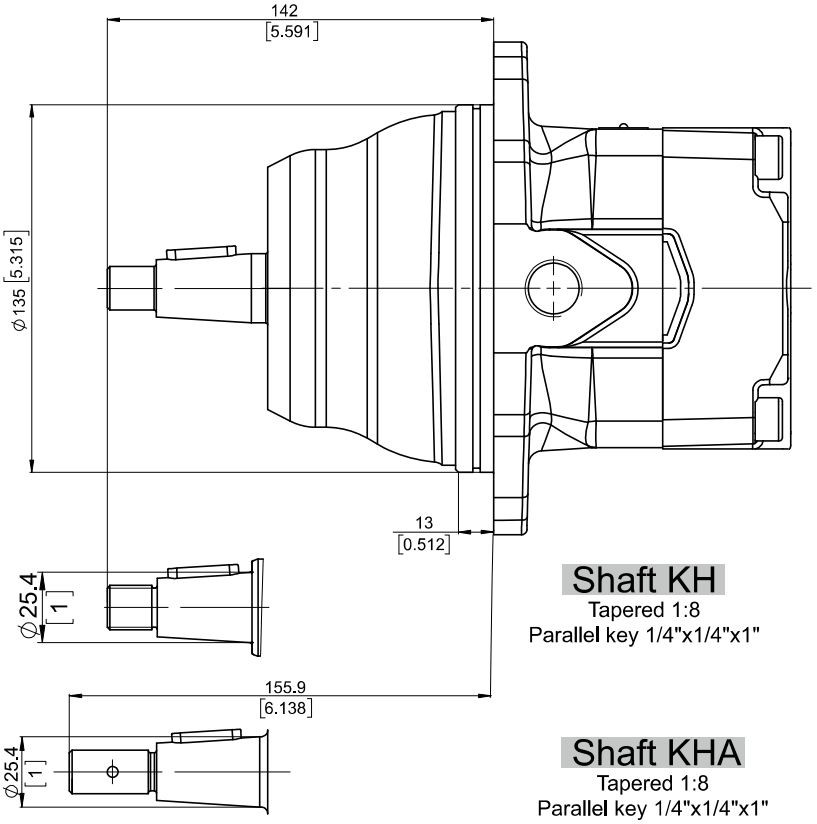


Shaft PDA
13T 16/32

Shaft PFA
15T 16/32



Shaft CK
Parallel key 1/4"x1/4"x1" BS46



Shaft KH
Tapered 1:8
Parallel key 1/4"x1/4"x1"

Shaft KHA
Tapered 1:8
Parallel key 1/4"x1/4"x1"

Shaft Dimensions
See Page 24÷27

PERMISSIBLE SHAFT LOAD

Permissible shaft load		
max Axial	N[lb]	Fa=1000 [225]
max Radial	N[lb]	Fr=300 [68]

The calculated max values are based on the optimal direction of the forces Fr, Fa and optimal position of the shaft (see page 31).

For more information, please, feel free to contact us.

mm [in]

ORDERING CODE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14	14
M A M														[		]

Pos.1 - Mounting Flange

- **A** - SAE A, 2-Bolt flange, spigot dia. 82.5[3.25"] Bolt circle 106.35 [4.19"]
- **B** - SAE B, 2-Bolt flange, spigot dia.101.6 mm [4"] Bolt circle 146 mm [5.75"]
- **WP** - WP, 2-Bolt cartage flange, spigot dia.135 mm [5.315"] Bolt circle 160 mm [6.3"]

Pos.2 - Port Type

- omit - Side ports on opposite sides
- **T** - Twin (Two) side ports on one side
- **E** - Rear ports

Pos.3 - Displacement Code

- **20** - 20.5 cm^3/rev [1.25 in^3/rev]
- **22** - 22.9 cm^3/rev [1.4 in^3/rev]
- **25** - 24.5 cm^3/rev [1.49 in^3/rev]
- **28** - 27.9 cm^3/rev [1.7 in^3/rev]
- **35** - 34.5 cm^3/rev [2.11 in^3/rev]
- **40** - 39.4 cm^3/rev [2.4 in^3/rev]
- **46** - 46.1 cm^3/rev [2.81 in^3/rev]
- **50** - 49.2 cm^3/rev [3 in^3/rev]

Pos.4 - Shaft Extensions**

- **WD** - ø21.72 [0.855"] Spline SAE 13T 16/32 DP, M8
- **LD** - ø21.72 [0.855"] Spline SAE 13T 16/32 DP, 5/16-18 UNC thread
- **PDA** - ø21.72 [0.855"] Spline SAE 13T 16/32 DP, 1/4-20 UNC thread
- **WF** - ø24.9 [0.98"] Spline SAE 15T 16/32, M8 thread
- **PF** - ø24.9 [0.98"] Spline SAE 15T 16/32, 3/8-16UNC
- **LF** - ø24.9 [0.98"] Spline SAE 15T 16/32, 3/8-16UNC
- **PFA** - ø24.9 [0.98"] Spline SAE 15T 16/32,3/8-16UNC
- **WK** - ø31.75 [1.25"] Spline SAE 14T 12/24 DP, M10
- **LK** - ø31.75 [1.25"] Spline SAE 14T 12/24 DP, 7/16-14UNC thread
- **CK** - ø22.2 [ø7/8"] Straight, M8 thread Parallel key 1/4"x1/4"x1" BS46
- **MK** - ø22.2 [ø7/8"] Straight, M8 thread Parallel key 1/4"x1/4"x1½" BS46
- **ML** - ø25 [ø0.984"] Straight, M8 thread Parallel key A8x7x25 DIN6885
- **CM** - ø25.4 [ø1"] Straight, M8 thread Parallel key 1/4"x1/4"x1" BS46
- **DO** - ø28.57 [ø1.125"] Straight, 3/8-16UNC Parallel key 5/16"x5/16"x1¼" BS46
- **CQ** - ø30 [ø1.181"] Straight, M8 thread Parallel key A8x7x32 DIN6885
- **DR** - ø31.75 [ø1.25"] Straight, 3/8-16UNC Parallel key 5/16"x5/16"x1¼" BS46
- **CS** - ø32 [ø1.26"] Straight, M8 thread Parallel key A10x8x45 DIN6885
- **KH** - ø25.4 [1"] Tapered 1:8 [125:1000], Parallel key 1/4"x1/4"x1", M16x1.5
- **KHA** - ø25.4 [1"] Tapered 1:8 [125:1000], Parallel key 1/4"x1/4"x1", M16x1.5

Shafts type WK, LK, DO, DR, CQ, and CS are only for Pos.1 option **B**
Shafts type PDA, PFA, KH, and KHA are only for Pos.1 option **WP**

Pos.5 - Improved radial load

- omit - standard bearing
- **N** - Improved bearing

EXAMPLE

M A M B E 4 0 W D 4 P

MAM	B	E	40	WD	4	P	[	]
Flange B	Rear Ports	Disp. 40cc	Shaft WD	Std.Bearing	Port size 4	Painted		

Pos.6 - Port Size

- omit - 2xISO 6162-2 DN19, drain port M18x1.5
- **2** - 2xG3/4, drain ports G1/2
- **3** - 2xM27x2, drain ports M18x1.5
- **4** - 2x1_1/16 -12 UN, drain ports 7/8-14 UNF
- **5** - 2xSAE 3/4" PSI6000, drain port 7/8-14 UNF
- **6** - 2xG1/2, drain ports G1/2
- **7** - 2xM22x1.5, drain ports M18x1.5
- **8** - 2x7/8-14 UNF Ports, drain ports 3/4-16 UNF
- **9** - 2xISO 6162-2 DN19, drain port G1/2

Options omit, 5 and 9 are not available for Pos.2 option **T** and **E**

Pos.7 - Seal, Corrosion Resistant Seal Surface

- omit - NBR seal type material
- **V** - FKM seal type material

Pos.8 - Integrated Valves

See next page for information about valves

- omit - None
- **HR** - Single anti-cavitation valve
- **AR** - Dual anti-cavitation valve
- **PU** - Purge valve
- **FLU** - Flush valve
- **SAR** - Single anti-cavitation and relief valve
- **DAR** - Dual anti-cavitation and relief valve
- **DARP** - Dual anti-cavitation, relief and purge valve
- **DARF** - Dual anti-cavitation, relief and flush valve

Pos.9 - Valve's Port for Single Valves

- omit - None
- **A** - Port A
- **B** - Port B

Pos.10 - Pressure Setting of Integrated Valves

- omit - None
- **x** - For value - see next page

Pos.11 - Flow Setting of Integrated Valves

- omit - None
- **Lx** - For value - see next page

Pos.12 - Special Features*

- omit - None
- **R2S** - Speed Sensor Two Directional (see page 27)
- **RS** - Speed Sensor (see page 27)

Pos.13 - Paint and Coating

- omit - No paint or coating
- **P** - Painted
- **PC** - Corrosion protected paint

If a painting option is required, the standard color is black-Alkyd-Styrenated Enamel, Black RAL 9005.
Other color by customer's request.

Pos.14 - Design Series

- omit - Factory specified

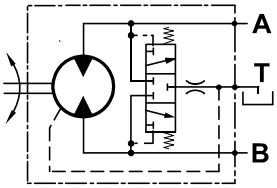
**The permissible output torque for shafts must not be exceeded!

VALVE OPTIONS

The overall dimensions of the motor with integrated valves could vary compared to the standard motors.

Option **PU**

PURGE VALVE



- Mainly used in open loop circuit;
- Used for cooling purpose or oil cleanliness requirements;
- Flow rate by **default (omit) - 3 ÷ 7 l/min**
- For other options, please see Pos.10 of ordering code, considering the following possible values:

Pos.10	omit	L3.5	L5.5	⇨ flow rate

EXAMPLE

M A M B 4 6 L F 2 **P U** purge valve flow rate 5±2 l/min

M A M B 4 6 L F 2 **P U L 3 . 5** purge valve flow rate 3.5±1 l/min

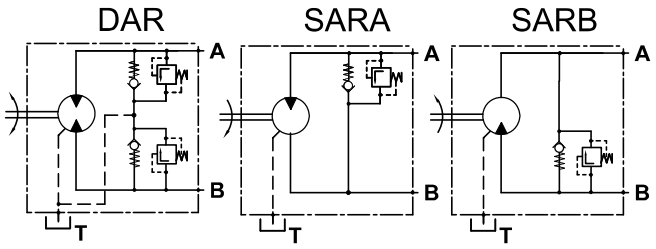
M A M B 4 6 L F 2 **P U L 5 . 5** purge valve flow rate 5.5±1 l/min

Option **DAR, SARA, SARB**

Combined Anti-Cavitation and Reliev Valve

- Anti-cavitation check valve is used for applications such as Fan drive control;

- Pressure relief valves prevent excessive pressures in the high pressure loop.



Please, consider the following possible values:

Pos.9	200	250	300	⇨ pressure

EXAMPLE

M A M B 4 6 L F 2 **D A R 2 0 0**

Double Anti-Cavitation and Relief Valve, relief valve setting 200 bar

M A M B 4 6 L F 2 **S A R A 2 5 0**

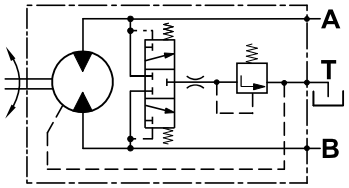
Single Anti-Cavitation and Relief Valve, relief valve setting 250 bar
The valve is placed on port A

M A M B 4 6 L F 2 **S A R B 3 0 0**

Single Anti-Cavitation and ReliefValve, relief valve setting 300 bar
The valve is placed on port B

Option **FLU**

FLUSH VALVE



- Mainly used in close loop circuit;
- The valve is a combination between a purge valve and check valve;
- Flow rate by **default (omit) - 3 ÷ 7 l/min and charge (opening) pressure 16 bar** with 20 bar feed pressure for close loop circuit;
- For other options, please see Pos.9 and Pos. 10 of ordering code, considering the following possible values:

Pos.9	omit	10	⇨ pressure
Pos.10	omit	L3.5	L5.5 ⇨ flow rate

EXAMPLE

M A M B 4 6 L F 2 **F L U** flow rate 5±2 l/min, charge pressure 16 bar

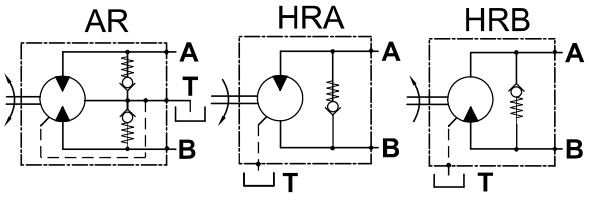
M A M B 4 6 L F 2 **F L U 1 0 L 5 . 5** flow rate 5.5±1 l/min, charge pressure 10 bar

M A M B 4 6 L F 2 **F L U L 3 . 5** flow rate 3.5±1 l/min, charge pressure 16 bar

Option **AR, HRA, HRB**

Anti-Cavitation Valve

- Anti-cavitation check valve is used for applications such as Fan drive control.



EXAMPLE

M A M B 4 6 L F 2 **A R**

Double Anti-Cavitation Valve

M A M B 4 6 L F 2 **H R A**

Single Anti-Cavitation Valve, the valve is placed on port A

M A M B 4 6 L F 2 **H R B**

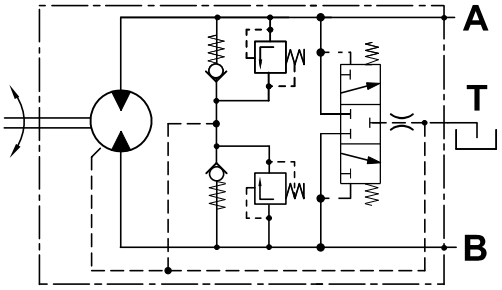
Single Anti-Cavitation Valve, the valve is placed on port B

VALVE OPTIONS

The overall dimensions of the motor with integrated valves could vary compared to the standard motors.

Option **DARP**

Dual Anti-Cavitation, Relief and Purge Valve



- Mainly used in open loop circuit;
- The valve is a combination between a dual anti-cavitaion, relief and purge valve;
- Purge Valve is used for cooling purpose or cleanliness requirements;
- Anti-Cavitation Check Valve is used for applications such as Fan drive control;
- Pressure relief valves prevent excessive pressures in the high pressure loop;
- Please, consider the following possible values for pressure set of the relief valve:

Pos.9 | **200** | **250** | **300** ⇒ pressure

- Flow rate of purge valve by **default (omit) - 3 ÷ 7 l/min.** The possible values are as follow:

Pos.10 | **omit** | **L3.5** | **L5.5** ⇒ flow rate

EXAMPLE

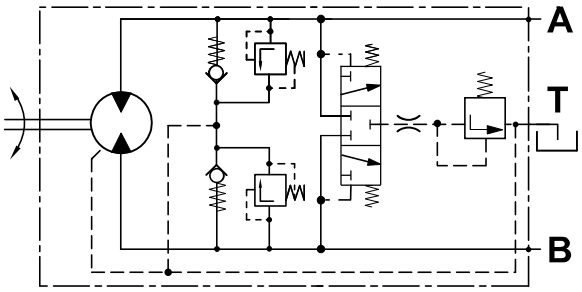
M A M B 4 6 L F 2 **D A R P 2 0 0**
Double Anti-Cavitation, Relief and Purge Valve,
relief valve setting 200 bar, purge valve flow rate 5±2 l/min

M A M B 4 6 L F 2 **D A R P 2 5 0 L 3 . 5**
Double Anti-Cavitation, Relief and Purge Valve,
relief valve setting is 250 bar, purge valve flow rate 3.5±1 l/min

M A M B 4 6 L F 2 **D A R P 3 0 0 L 5 . 5**
Double Anti-Cavitation, Relief and Purge Valve,
relief valve setting 300 bar, purge valve flow rate 5.5±1 l/min

Option **DARF**

Dual Anti-Cavitation, Relief and Flush Valve



- Mainly used in close loop circuit;
- The valve is a combination between a dual anti-cavitaion, relief and flush valve;
- Flush valve is used for cooling purpose or cleanliness requirements;
- Anti-Cavitation Check valve is used for applications such as Fan drive control;
- Pressure Relief Valves prevent excessive pressures in the high pressure loop;
- Please, consider the following possible values for pressure set of the relief valve:

Pos.9 | **200** | **250** | **300** ⇒ pressure

- Flow rate of flush valve by **default (omit) - 3 ÷ 7 l/min and charge pressure 16 bar** with 20 bar feed pressure for close loop circuit. The possible values are as follow:

Pos.10 | **omit** | **L3.5** | **L5.5** ⇒ flow rate

- Other values for charge pressure are possible. Please see Pos.9.
Example: For charge pressure 10 bar the options are as follow:

Pos.9 | 200-**10** | 250-**10** | 300-**10**

Relief valve opening pressure

Flush valve opening pressure (charge pressure)

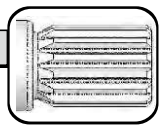
EXAMPLE

M A M B 4 6 L F 2 **D A R F 3 0 0**
Double Anti-Cavitation, Relief and Flush Valve, relief valve setting 300 bar
flush valve charge pressure 16 bar, flush valve flow rate 5±2 l/min

M A M B 4 6 L F 2 **D A R F 3 0 0 - 1 0**
Double Anti-Cavitation, Relief and Flush Valve, relief valve setting 300 bar
flush valve charge pressure 10 bar, flush valve flow rate is 5±2 l/min

M A M B 5 0 L F 2 **D A R F 2 5 0 L 3 . 5**
Double Anti-Cavitation, Relief and Flush Valve, relief valve setting 250 bar
flush valve charge pressure 16 bar, flush valve flow rate is 3.5±1 l/min

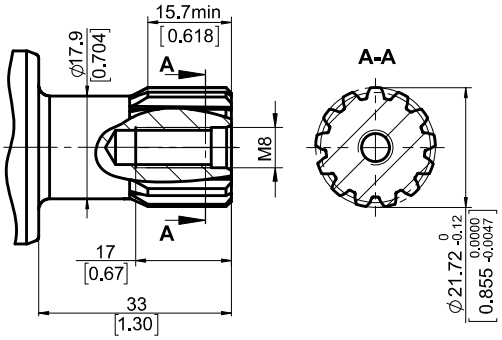
M A M B 4 6 L F 2 **D A R F 3 0 0 - 1 0 L 5 . 5**
Double Anti-Cavitation, Relief and Flush Valve, relief valve setting 300 bar
flush valve charge pressure 10 bar, flush valve flow rate 5.5±1 l/min



SHAFT TYPES AND DIMENSIONS

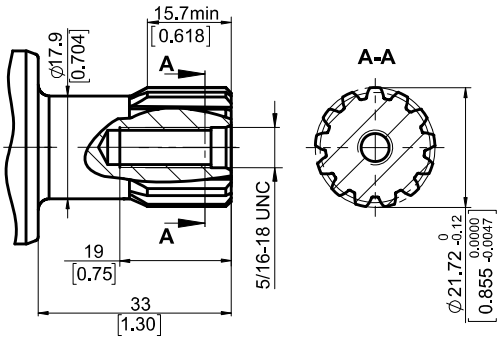
WD

ø21.72 [0.855], M8 thread
13T 16/32 DP splined ANSI B92.1-1970
Max. torque 200 Nm [1770 lb-in]



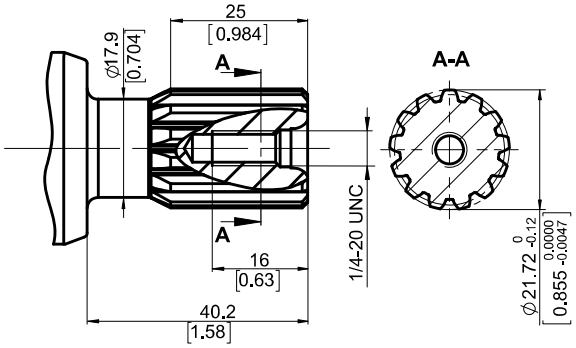
LD

ø21.72 [0.855], 5/16-18 UNC thread
13T 16/32 DP splined ANSI B92.1-1970
Max. torque 200 Nm [1770 lb-in]



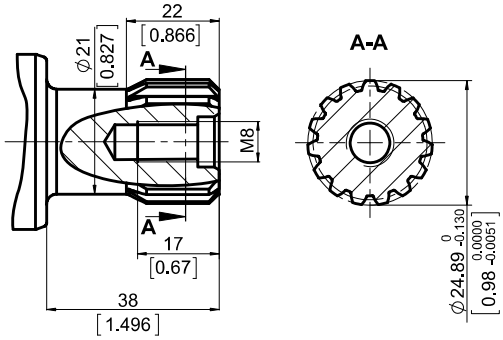
PDA

ø21.72 [0.855], 1/4-20 UNC thread
13T 16/32 DP splined ANSI B92.1-1996
Max. torque 200 Nm [1770 lb-in]

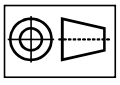


WF

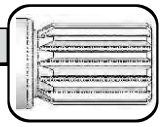
ø24.89 [0.98], M8 thread
15T 16/32 DP splined ANSI B92.1-1970
Max. torque 330 Nm [2920 lb-in]



The required max. torque must not be exceeded



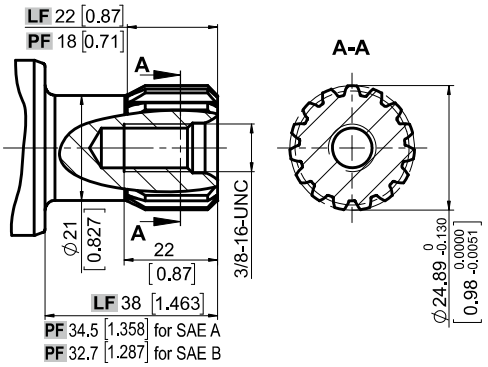
mm [in]



SHAFT TYPES AND DIMENSIONS

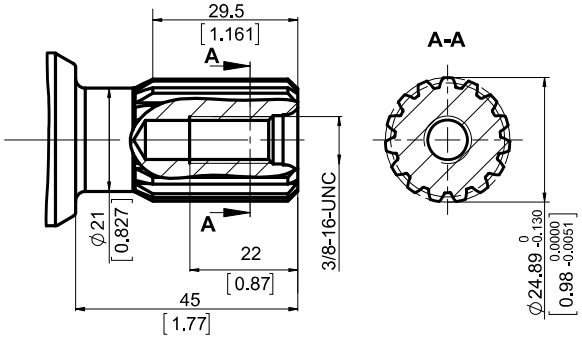
LF PF

ø24.89 [0.98], 3/8-16 UNC thread
15T 16/32 DP splined ANSI B92.1-1970
Max. torque 330 Nm [2920 lb-in]



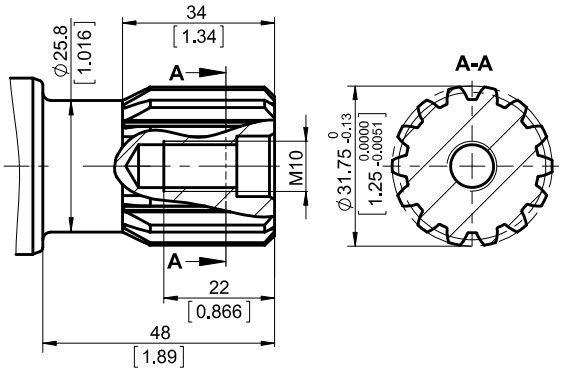
PFA

ø24.89 [0.98], 3/8-16 UNC thread
15T 16/32 DP splined ANSI B92.1-1970
Max. torque 330 Nm [2920 lb-in]



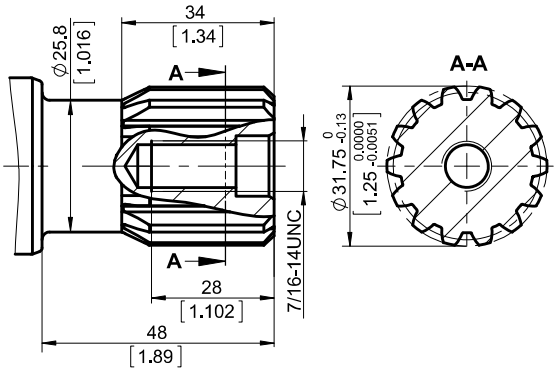
WK

ø31.75 [1.25], M10 thread
14T 12/24 DP splined ANSI B92.1-1970
Max. torque 380 Nm [3360 lb-in]

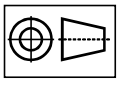


LK

ø31.75 [1.25], 7/16-14 UNC thread
14T 12/24 DP splined ANSI B92.1-1970
Max. torque 380 Nm [3360 lb-in]



The required max. torque must not be exceeded

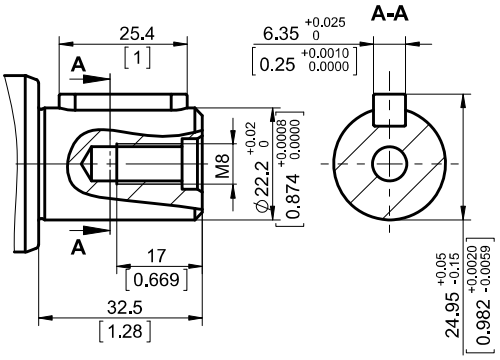


mm [in]

SHAFT TYPES AND DIMENSIONS

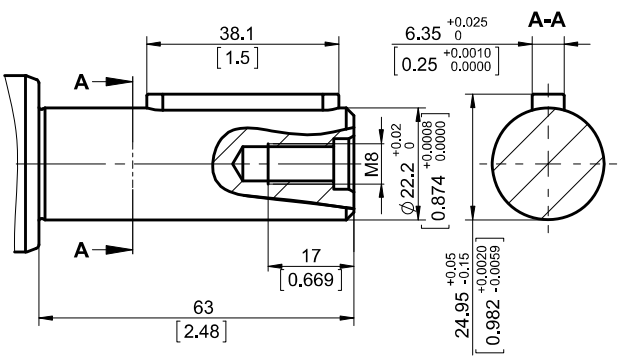
CK

ø22.2 [7/8] straight, M8 thread
Parallel key **1/4"x1/4"x1**" BS46
Max. torque 180 Nm [1600 lb-in]



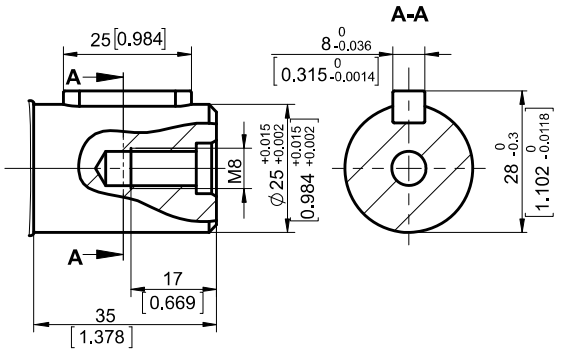
MK

ø22.2 [7/8] straight, M8 thread
Parallel key **1/4"x1/4"x1½**" BS46
Max. torque 180 Nm [1600 lb-in]



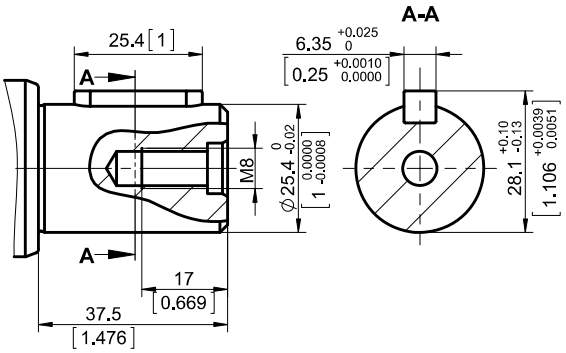
ML

ø25 [0.984] straight, M8 thread
Parallel key **A8x7x25** DIN6885
Max. torque 250 Nm [2210 lb-in]



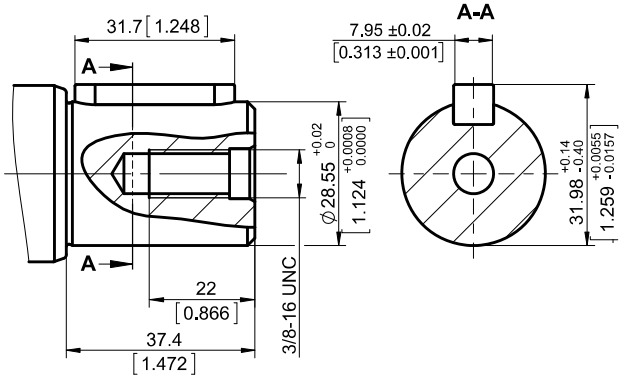
CM

ø25.4 [1] straight, M8 thread
Parallel key **1/4"x1/4"x1**" BS46
Max. torque 250 Nm [2210 lb-in]



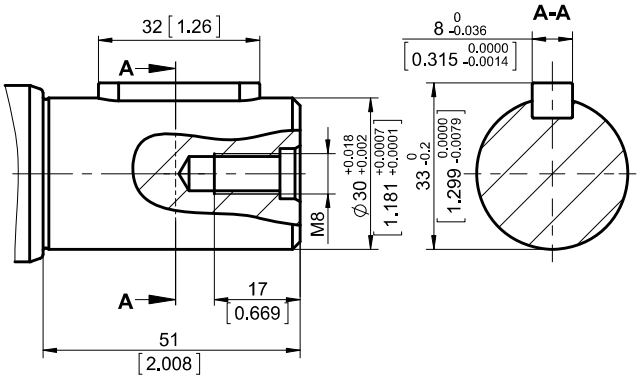
DO

ø28.55 [1.125] straight, 3/8-16 UNC thread
Parallel key **5/16"x5/16"x1¼"**
Max. torque 280 Nm [2480 lb-in]



CQ

ø30 [1.181] straight, M8 thread
Parallel key **A8x7x32** DIN6885
Max. torque 300 Nm [2655 lb-in]



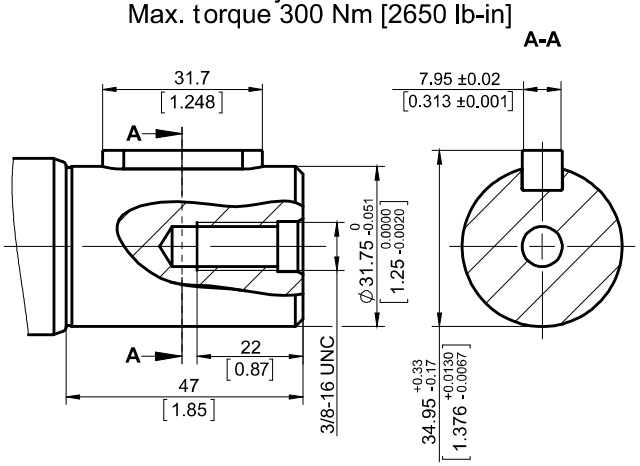
The required max. torque must not be exceeded

mm [in]

SHAFT TYPES AND DIMENSIONS

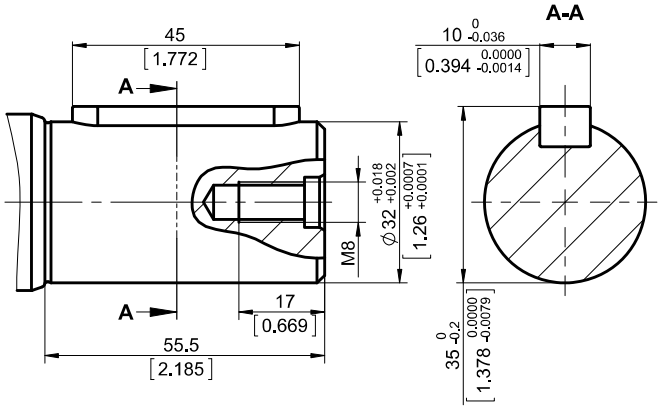
DR

ø31.75 [1.25] straight, 3/8-16 UNC thread
Parallel key **5/16"x5/16"x1¼"**
Max. torque 300 Nm [2650 lb-in]



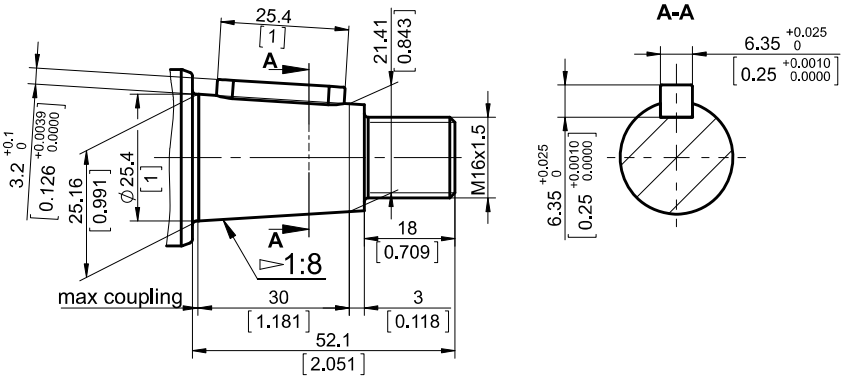
CS

ø32 [1.26] straight, M8 thread
Parallel key **A10x8x45** DIN6885
Max. torque 350 Nm [3100 lb-in]



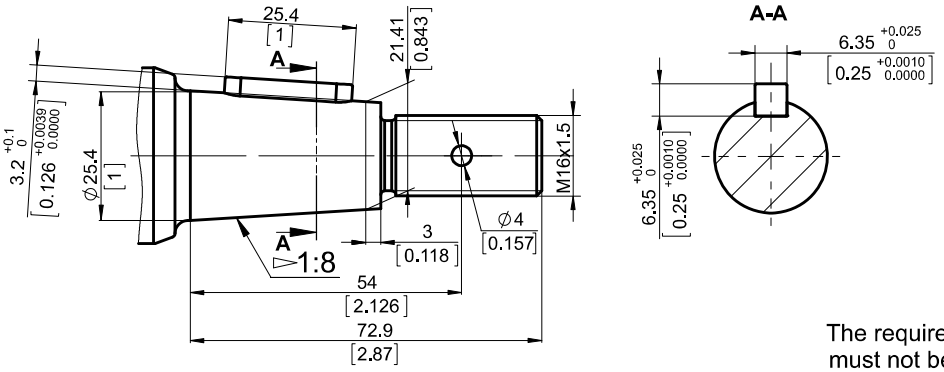
KH

ø25.4 [1] Tapered **1:8 [125:1000],**
Parallel key **1/4"x1/4"x1"**, M16x1.5
Max. torque 300 Nm [2650 lb-in]



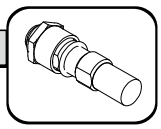
KHA

ø25.4 [1] Tapered **1:8 [125:1000],**
Parallel key **1/4"x1/4"x1"**, M16x1.5
Max. torque 300 Nm [2650 lb-in]



The required max. torque must not be exceeded

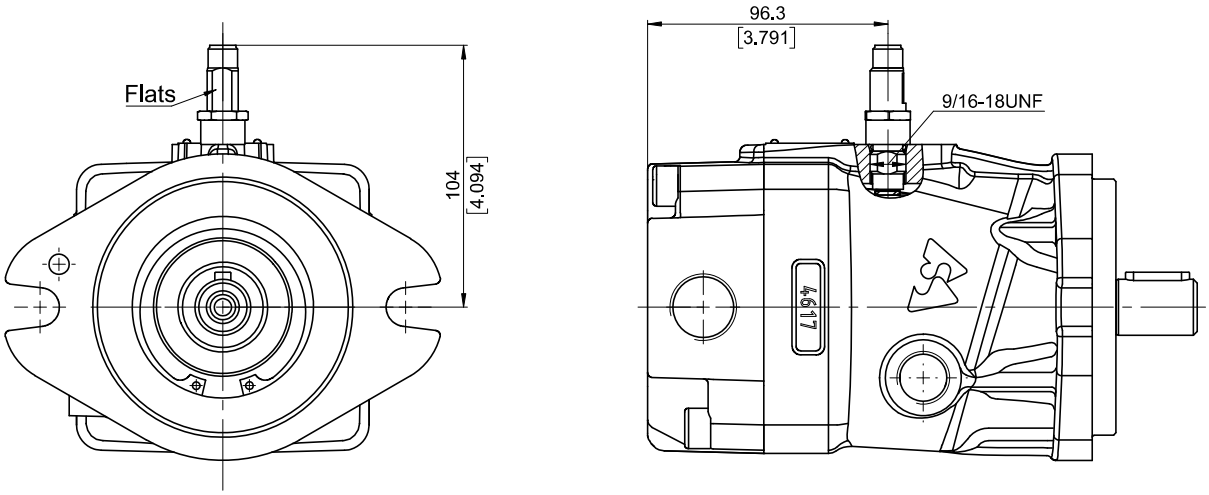
mm [in]

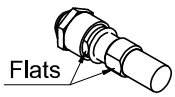


SPEED SENSORS

MOUNTING DIMENSIONS AND INSTALLATION

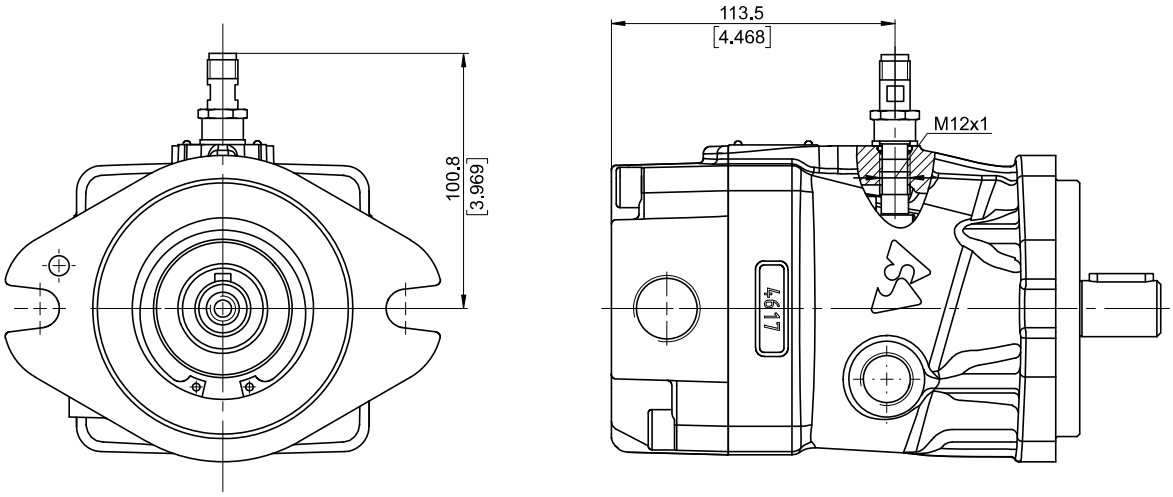
MAM with R2S - Dual Channel Hall Sensor





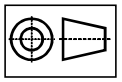
1. Remove the plug.
2. Screw in the (CW) sensor by hand until the bottom end gently touches the speed ring.
3. Unscrew (CCW) sensor 1/4 turn. Continue unscrew until the flats are perpendicular to motor or pump shaft center line (tolerance 20° to 30° is acceptable). Do not unscrew the sensor more than 3/4 of a turn from the touching.
4. Using the 1/2" wrench to hold the sensor, tighten the lock nut to 10^{+5} Nm [115 lb-in]. with an 11/16" hew wrench.

MAM with RS - Single Channel Hall Sensor

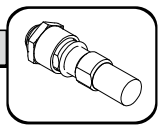


1. Remove the plug.
2. Rotate the motor shaft until any of the pistons are centered in the speed sensor port.
   If this is not done, the sensor may be damaged during the motor operation.
3. Unscrew the lock nut and move the washer and the O-ring up as it is shown on.
4. By wrench S=10 lightly tighten the sensor body in the motor until the sensor face reaches the motor piston.
   Do not force the sensor, because it could be damaged.
   Make sure that the washer and the O-ring do not touch the housing.
5. Unscrew the sensor body with 1/4 revolution (90^0)
6. Hold the sensor body in this position while tightening the lock nut to the prescribed torque 10^{+5} Nm [115 lb-in] with wrench S=17mm.

NOTE: *- The speed sensor is not fitted at the factory, but is supplied in a plastic bag with the motor.
For installation see enclosed instructions.



mm [in]



SPEED SENSORS R2S

TECHNICAL DATA OF THE DUAL CHANNEL HALL SPEED SENSOR

TECHNICAL DATA

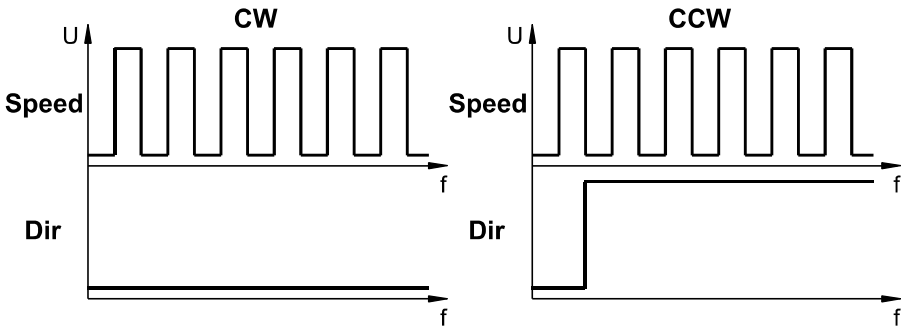
Frequence range	0 ... 15 000 Hz
Output measurements	Speed, Direction
Power supply	4.5 ... 30 VDC
Output maximum current	100 mA
Resident output voltage	1.5 V with 100 mA of the output 0.5 V without load of the output
Power consummation	< 15 mA without load
Temperature	-40 ... + 100 °C
Degree of protection	IP 67
Pin connector	universal /PUSH-PULL/ 4P Delphi Connector DJ3042-2.5-21
Humidity	0 ... 95% RH

OUTPUT PULSES

per revolution

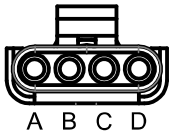
Motor Type	MAM20-50
Output Pulses	45

OUTPUT DIAGRAMS



PIN CONNECTOR

4 pin Delphi Connector

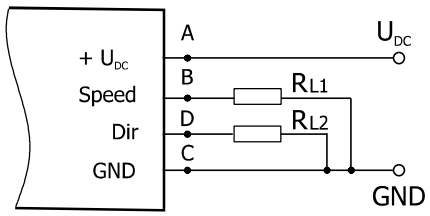


Pin	Connection	Cable Output
A	Power+	Red
B	Speed	White
C	Ground	Black
D	Direction	Green

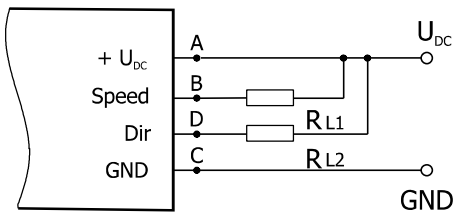
WIRING DIAGRAMS

Sensor could be in use for both type of connections - PNP or NPN

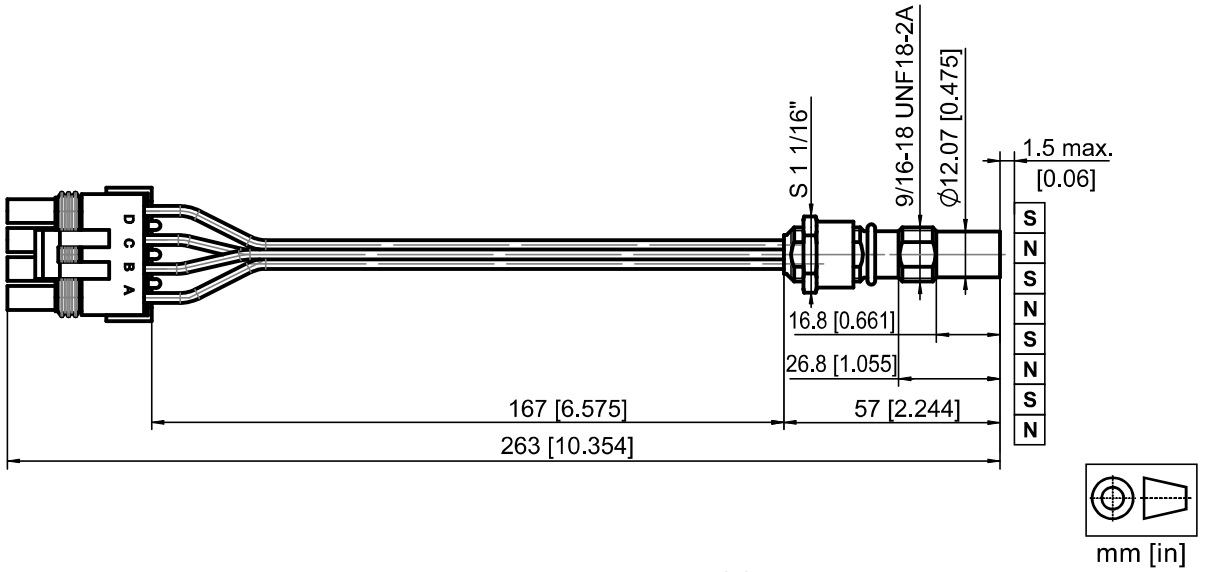
PNP



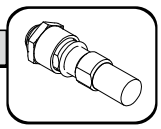
NPN



SENSOR R2S OVERALL DIMENSIONS



mm [in]



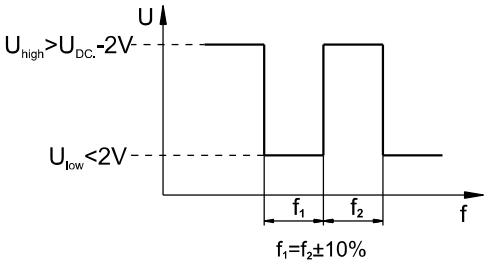
SPEED SENSORS RS

TECHNICAL DATA OF THE SINGLE CHANNEL HALL SPEED SENSOR

TECHNICAL DATA

Frequency range	0...15 000 Hz
Output measurements	Speed
Power supply	10...36 VDC
Output maximum current	50 mA
Current input	20 mA
Temperature	-40...+125°C [-40...+257°F]
Degree of protection	IP 67
Pin connector	M12-Series
Mounting principle	ISO 6149
Humidity	0 ... 95% RH

OUTPUT DIAGRAMS



Load max.:I_{high}=I_{low}<50mA

OUTPUT PULSES

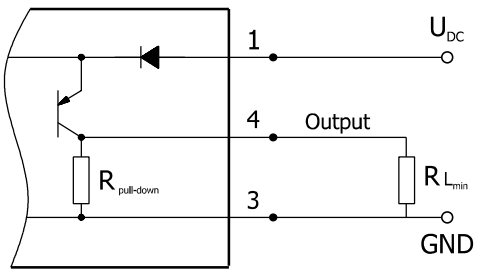
per revolution

Motor Type	MAM20-50
Output Pulses	9

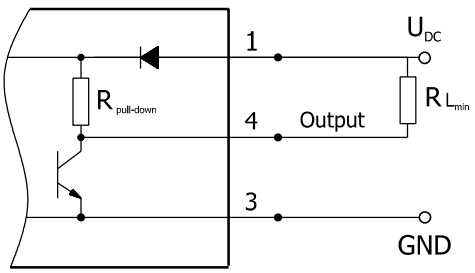
WIRING DIAGRAMS

Sensor could be in use for both type of connections - PNP or NPN

PNP

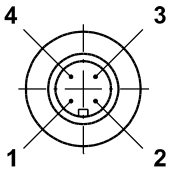


NPN



$R_L[k\Omega]=U_{DC}[V]/I_{max}[mA]$

PIN CONNECTOR

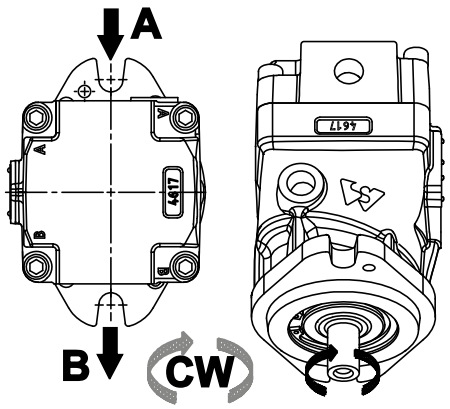


Pin	Connection	Cable Output
1	+U_{DC}	Brown
2	No connection	White
3	GND	Blue
4	Output signal	Black

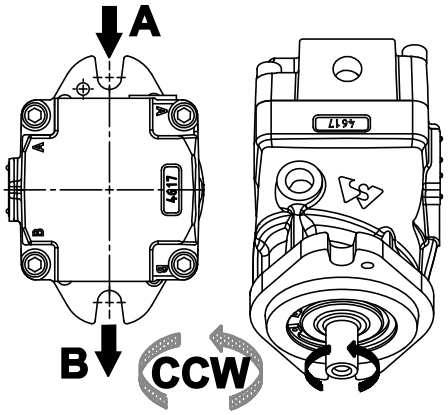
INSTALLATION

DIRECTION OF ROTATION

Standard Rotation
Viewed from shaft end
Port **A** Pressurized **- CW**
Port **B** Pressurized **- CCW**



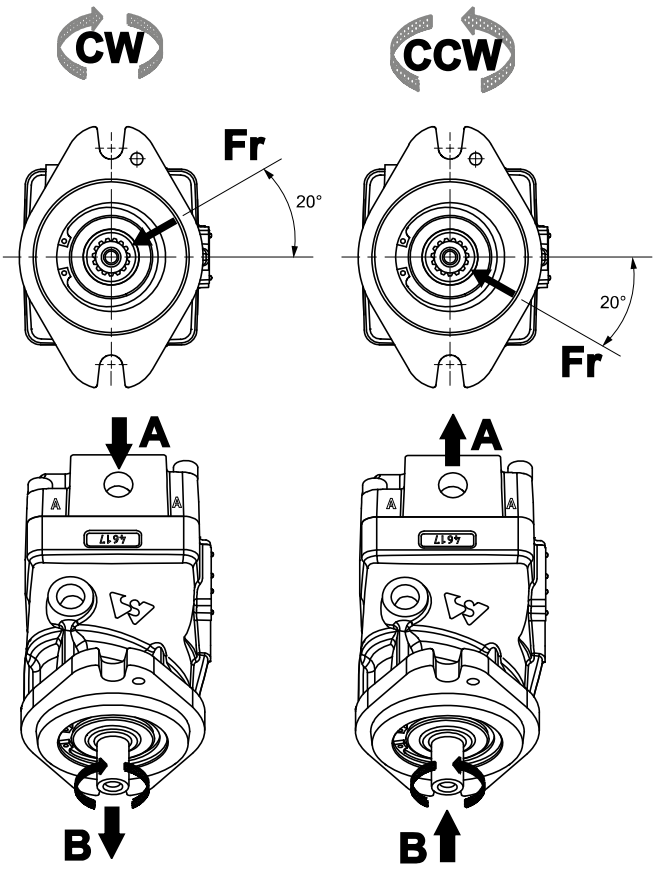
Reverse Rotation
Viewed from shaft end
Port **A** Pressurized **- CCW**
Port **B** Pressurized **- CW**



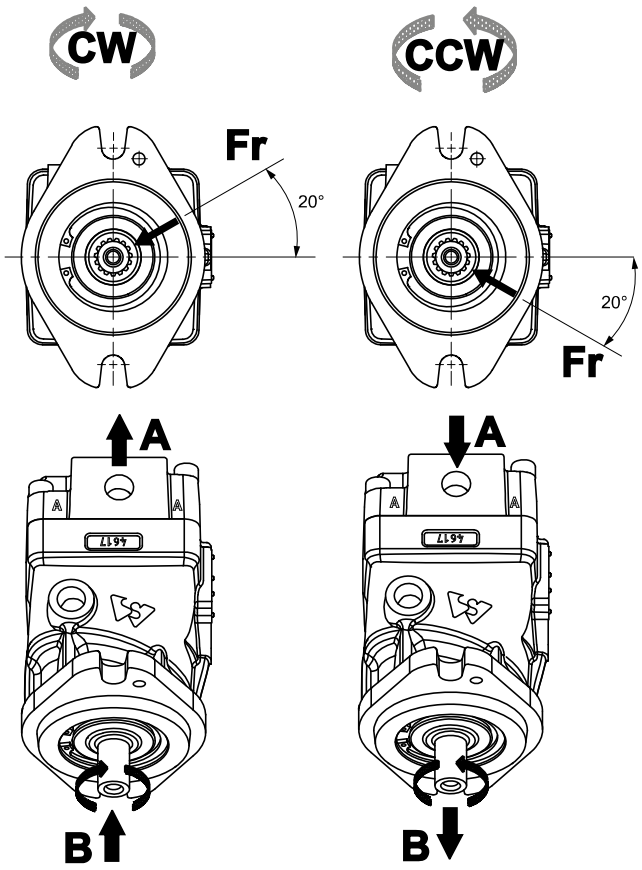
BEST POSITION FOR APPLYING RADIAL LOAD

Optimal position for applying radial load depending on the direction of rotation

Standard Rotation

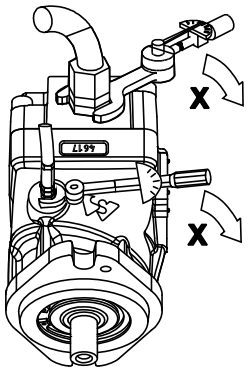


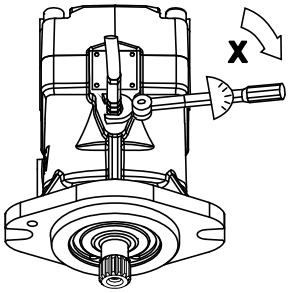
Reverse Rotation

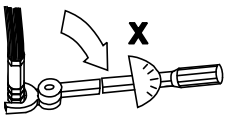
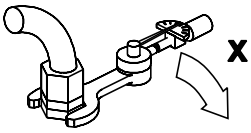


INSTALLATION

Recommended max. tightening torque X for metal plugs and orifice

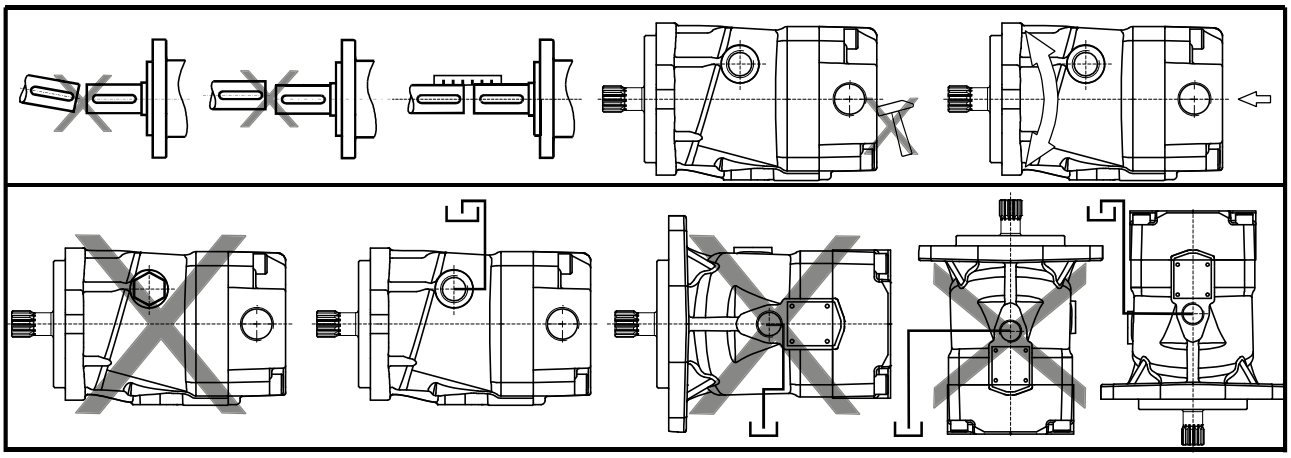




Screwed connection Anschlussart Raccord Tipo di collegamento Especie de unir Присоединительные резбы	 Max. Tightening Torque X, daNm [lb-in] Max. Anzugsmoment X, daNm [lb-in] Couple de serrage maxi X, daNm [lb-in] Momento di serraggio max. X, daNm [lb-in] Momento d'apretadura max. X, daNm [lb-in] Момент затяжки X, daNm [lb-in] 			
	With copper washer Mit Kupferscheibe Avec rondelle en cuivre Con rondella di rame De arandela de cobre С медной шайбой	With aluminium washer Mit Aluminiumscheibe Avec rondelle en aluminium Con rondella di alluminio De arandela d'aluminio С алюминиевой шайбой	With cutting edge Mit Dichtkante Tranchant Con tagliente di guarnizione De borde compactar С крутым бортиком	With "O" ring Mit "O" Ring Avec joint torique Con "O"-anello De "O"-anillo С резиновым кольцом
M 8	1.6 [150]	1 [88.5]	2 [180]	
M 10	3.2 [300]	1 [88.5]	2 [180]	
M 12	3.5 [310]	3 [265]	4 [360]	
M14x1.5	4 [360]	3 [265]	4 [360]	3 [265]
M16x1.5	5 [450]	5 [450]	6 [550]	5 [450]
M18x1.5	6 [550]	5 [450]	6 [550]	5 [450]
M20x1.5	8 [710]	8 [700]	10 [885]	8 [700]
M22x1.5	10 [900]	8 [700]	10 [885]	8 [700]
M24x1.5	12 [1070]	10 [885]	10 [885]	10 [885]
M27x2	16 [1420]	13 [1150]	10 [885]	10 [885]
G 1/4	4 [360]	3 [265]	4 [360]	2 [180]
G 3/8	5 [450]	5 [450]	6 [550]	2 [180]
G 1/2	8 [710]	8 [700]	10 [885]	3 [265]
G 3/4	16 [1420]	13 [1150]	16 [1400]	5 [450]
G 1	20 [1800]	20 [1770]	25 [2200]	8 [700]
1/8 - 14(UNF)	2.5 [230]			0.7 [62]
3/8-24(16)UNF(UNC)	3 [270]			1.5[130]
7/16-20(16) UNF	3.5 [310]			2 [180]
9/16-18 UNF	4 [360]			2 [180]
9/16-20 UNF	5 [450]			3.5[310]
3/4 - 16 UNF	6 [550]			6 [550]
7/8 - 14(16)UNF	10 [900]			7 [620]
1 1/16 - 12 UN	16 [1420]			9 [800]
1 5/16 - 12 UN	20 [1800]			16 [1400]
1/2 - 14 NPTF				3 [265]
1/4 - 18 NPTF				3 [265]

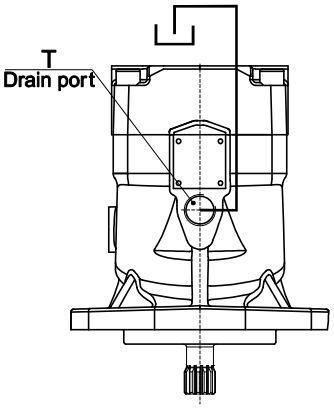
INSTALLATION

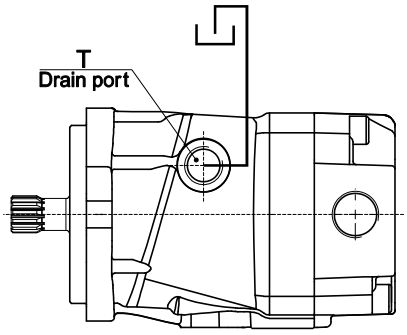
At start-up and during operation the motor housing has to be filled up with hydraulic fluid. Start-up has to be carried out at low or moderate speed and without load (for example 1000 rpm and pressure 50 [725] bar [PSI]) till the motor and the hydraulic scheme are filled up with oil. Generally the start-up needs 10-15 minutes to finish. The leakage oil in the housing has to be discharged to the tank through the highest positioned drain port T. The max. pressure in the drain line is 5 [70] bar [PSI].



Installation below the tank level (recommended)

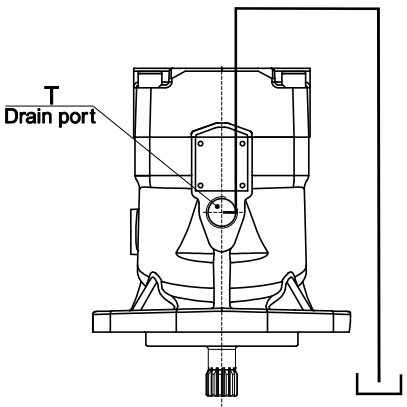
- Fill up the axial piston motor before the start-up through the highest positioned drain port T.
- Operate the motor at low speed till the motor system is completely filled up.
- The minimum immersion depth of the drain line in the tank is 200 mm relative to the minimum oil level in the tank.

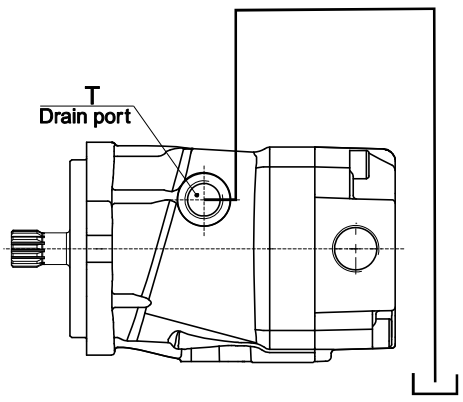




Installation on top of the tank level

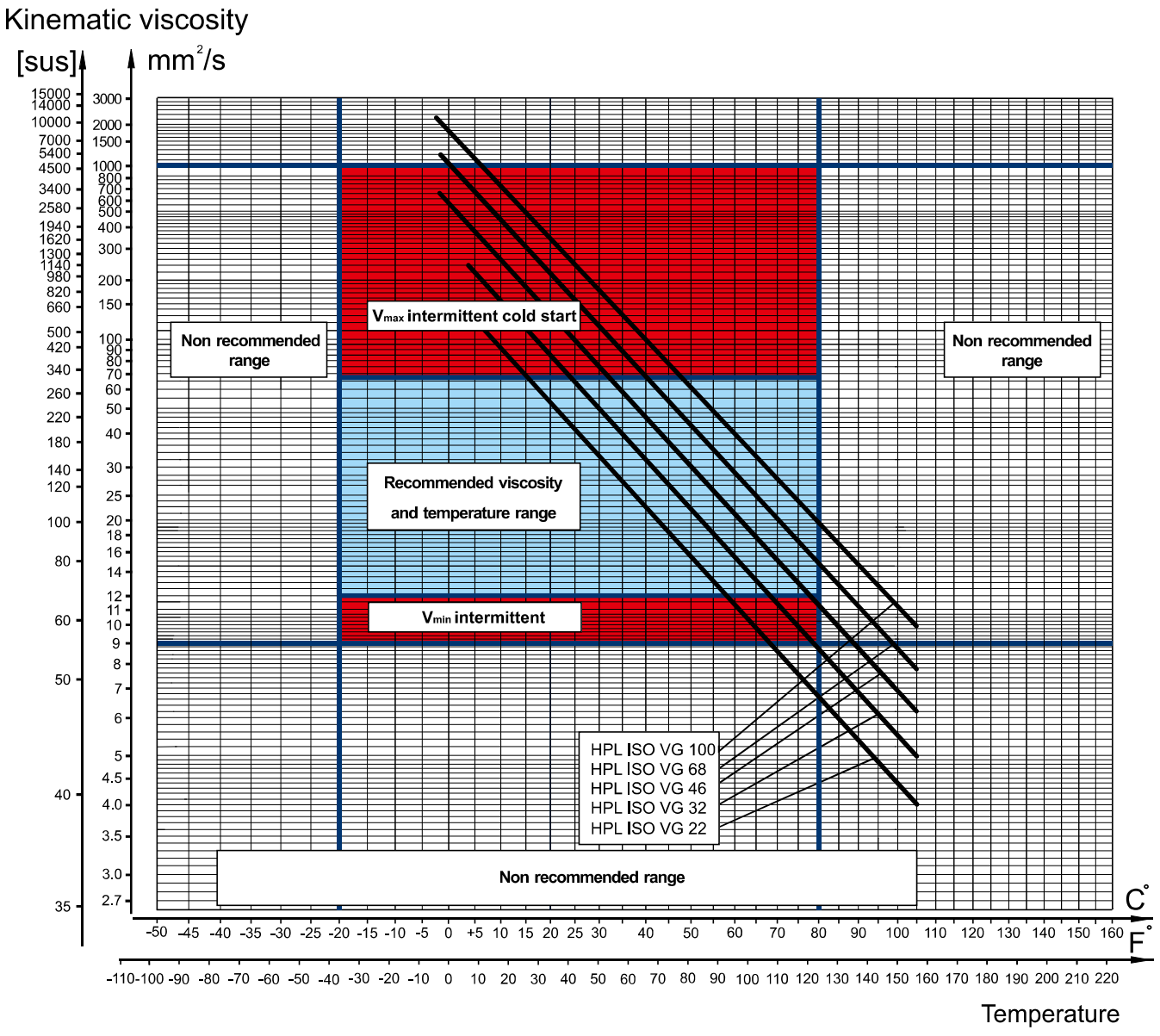
- Fill up the axial piston motor before the start-up through the highest positioned drain port T.
- Operate the motor at low speed till the motor system is completely filled up.
- The minimum immersion depth of the drain line in the tank is 200 mm relative to the minimum oil level in the tank.





FLUID VISCOSITY LIMITS

In order to obtain optimum efficiency and service life, we recommend to select the operating viscosity (at operating temperature) within the range shown on diagram below.



The above - shown viscosity characteristics are for reference only. Please, check the actual viscosity with the manufacturer of the fluid.

BASIC FORMULAS

The motor size, pressure and flow required for a specific application can be calculated using the formulas below.

Metric System

Efficiency $\eta_t = \eta_{mh} \cdot \eta_v \quad \eta_{mh} = \frac{\eta_t}{\eta_v} \quad \eta_v = \frac{\eta_t}{\eta_{mh}}$

Input flow $Q = \frac{Vg \cdot n}{1000 \cdot \eta_v}$ [l/min]

Output torque $M = \frac{Vg \cdot \Delta p \cdot \eta_{mh}}{62,8}$ or $M = \Delta p \cdot T_{con.}$ [Nm]

Output power $P = \frac{M \cdot n}{9550} = \frac{Q \cdot \Delta p \cdot \eta_t}{600}$ [kW]

Speed $n = \frac{Q \cdot 1000 \cdot \eta_v}{Vg}$ or $n = Q \cdot N_{con.}$ [min^{-1}]

Vg =	Displacement per rev.	[cm^3]
Δp =	$p_{HP} - p_{LP}$	[bar]
p_{HP} =	High pressure	[bar]
p_{LP} =	Low pressure	[bar]
n =	Rotation speed	[RPM]
Q =	Oil flow	[l/min]
$T_{con.}$ =	Toque constant	[Nm/bar]
$N_{con.}$ =	Speed constant	[RPM/(l/min)]
η_v =	Volumetric efficiency	
η_{mh} =	Mechanical-hydraulic efficiency	
η_t =	Overall efficiency	

Inch System

Efficiency $\eta_t = \eta_{mh} \cdot \eta_v \quad \eta_{mh} = \frac{\eta_t}{\eta_v} \quad \eta_v = \frac{\eta_t}{\eta_{mh}}$

Input flow $Q = \frac{Vg \cdot n}{231 \cdot \eta_v}$ [GPM]

Output torque $M = \frac{Vg \cdot \Delta p \cdot \eta_{mh}}{2,\pi}$ or $M = \Delta p \cdot T_{con.}$ [lb-in]

Output power $P = \frac{Vg \cdot n \cdot \Delta p \cdot \eta_t}{396000}$ [hp]

Speed $n = \frac{Q \cdot 231 \cdot \eta_v}{Vg}$ or $n = Q \cdot N_{con.}$ [min^{-1}]

Vg =	Displacement per rev.	[in^3]
Δp =	$p_{HP} - p_{LP}$	[PSI]
p_{HP} =	High pressure	[PSI]
p_{LP} =	Low pressure	[PSI]
n =	Rotation speed	[RPM]
Q =	Oil flow	[GPM]
$T_{con.}$ =	Toque constant	[lb-in/PSI]
$N_{con.}$ =	Speed constant	[RPM/GPM]
η_v =	Volumetric efficiency	
η_{mh} =	Mechanical-hydraulic efficiency	
η_t =	Overall efficiency	

Depending on the results of the load calculations, the most appropriate type of motor from the catalogue is selected.

Table 1

Rolling resistance coefficient In case of rubber tire rolling on different surfaces			
Surface	**ρ**	**Surface**	**ρ**
Concrete- faultless	0.010	Macadam- bad	0.037
Concrete- good	0.015	Snow- 5 cm	0.025
Concrete- bad	0.020	Snow- 10 cm	0.037
Asphalt- faultless	0.012	Polluted covering- smooth	0.025
Asphalt- good	0.017	Polluted covering- sandy	0.040
Asphalt- bad	0.022	Mud	0.037÷0.150
Macadam- faultless	0.015	Sand- Gravel	0.060÷0.150
Macadam- good	0.022	Sand- loose	0.160÷0.300

APPLICATION FORMULAS

1.Motor speed: n, RPM

$$n = \frac{2{,}65 \cdot v_{km} \cdot i}{R_m} \qquad n = \frac{168 \cdot v_{mi} \cdot i}{R_{in}}$$

v_{km} - vehicle speed [km/h]
v_{mi} - vehicle speed [mil/h]
R_m - wheel rolling radius [m]
R_{in} - wheel rolling radius [in]
i - gear ratio between motor and wheels.
If no gearbox, use i=1.

2.Rolling resistance: RR, daN [lbs]
The resistance force resulted in wheels contact with different surfaces:

$$RR = G \cdot \rho$$

G - total weight loaded on vehicle, daN [lbs];
ρ - rolling resistance coefficient (Table 1).

3.Grade resistance: GR, daN [lbs]

$$GR = G \cdot (\sin\alpha + \rho \cdot \cos\alpha)$$

α - gradient negotiation angle (Table 2)

Table 2

Grade %	α Degrees	Grade %	α Degrees
1%	0° 35'	12%	6° 5'
2%	1° 9'	15%	8° 31'
5%	2° 51'	20%	11° 19'
6%	3° 26'	25%	14° 3'
8%	4° 35'	32%	18°
10%	5° 43'	60%	31°

Table 3

Surface	Frictional factor f
Steel on steel	0.15 ÷ 0.20
Rubber tire on polluted surface	0.5 ÷ 0.7
Rubber tire on asphalt	0.8 ÷ 1.0
Rubber tire on concrete	0.8 ÷ 1.0
Rubber tire on grass	0.4

4. Acceleration force: FA, daN [lbs]
Force **FA** necessary for acceleration from 0 to maximum speed **v** and time **t** can be calculated with a formula:

$$FA = \frac{v_{km} \cdot G}{3{,}6 \cdot t}\ [daN] \qquad FA = \frac{v_{mi} \cdot G}{2{,}2 \cdot t}\ [lbs]$$

FA - acceleration force, daN [lbs]
t - time, [s]

5.Tractive effort: DP, daN [lbs]
Tractive effort DP is the additional force of trailer. This value will be established as follows:
-acc.to constructor's assessment;
-as calculating forces in items 2, 3 and 4 of trailer. The calculated sum corresponds to the tractive effort requested.

6.Total tractive effort: TE, daN [lbs]
Total tractive effort **TE** is total effort necessary for vehicle motion; that the sum of forces calculated in items from 2 to 5 and increased with 10 % because of air resistance.

$$TE = 1{,}1 \cdot (RR + GR + FA + DP)$$

RR - force required to overcome the rolling resistance;
GR - force required to slope upwards;
FA - force required to accelerate (acceleration force);
DP - additional tractive effort (trailer).

7.Motor Torque moment: M, daNm [in-lb]
Necessary torque moment for every hydraulic motor:

$$M = \frac{TE \cdot R_m [R_{in}]}{N \cdot i \cdot \eta_M}$$

N - motor numbers;
η_M - mechanical gear efficiency (if it is available).

8.Cohesion between tire and road covering: M_w, daNm [in-lb]

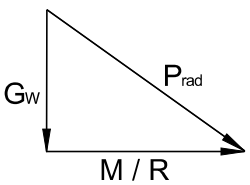
$$M_W = \frac{G_W \cdot f \cdot R_m [R_{in}]}{i \cdot \eta_M}$$

To avoid wheel slipping, the following condition should be observed $M_W > M$
f - frictional factor;
G_W - total weight over the wheels, daN [lbs].

9.Radial motor loading: P_{rad}, daN [lbs]
When the motor is used for motion with a ring or gear mounted directly on the motor shaft, the total radial load of the motor shaft P_{rad} is the sum of the motion force and the weight force acting on the ring .

G_W - Weight held by wheel;
P_{rad} - Total radial loading of motor shaft;
M/R - Motion force.

$$P_{rad} = \sqrt{G_W^2 + \left(\frac{M}{R}\right)^2}$$



Depending on the results of the load calculations, the most appropriate type of motor from the catalogue is selected.