



# M+S HYDRAULIC

## AXIAL PISTON VARIABLE MOTORS

*In cooperation with*



**NEW**  
PRODUCT



# MA2V

**MEDIUM DUTY AXIAL PISTON  
MOTOR DUAL DISPLACEMENT**

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## CONTENT

# Hydraulic Motors Type MA2V

Medium Duty Axial Piston Motors Dual Displacement

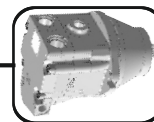
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### Version history

Date	Page	Changed	Ver.
July 2017		First official edition	1.1

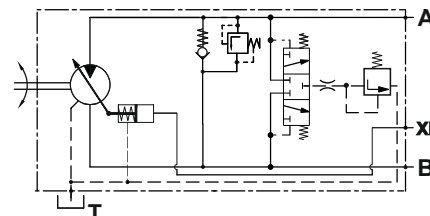
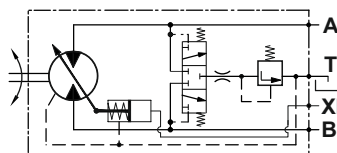
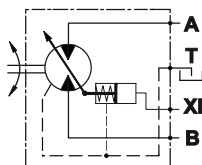
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# Hydraulic Motors Type MA2V

## Medium Duty Axial Piston Motors Dual Displacement



open drain line is always required

### APPLICATION

- » Agricultural machines
- » Road building machines
- » Food industry machines
- » Swing drives
- » Hydraulic transmissions
- » Special vehicles

### OPTIONS

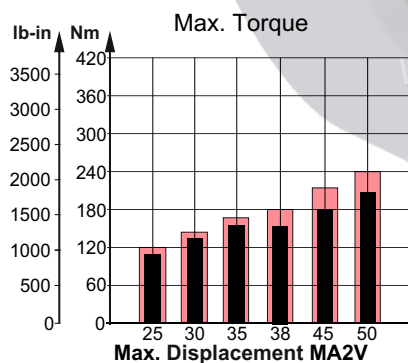
- » Swash plate
- » Port options
- » Shaft options
- » Integrated valves

### ADVANTAGES

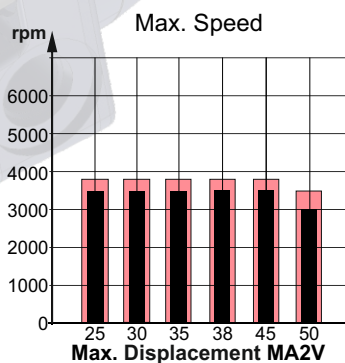
- » Smooth operation
- » High power density
- » Compact size

### GENERAL

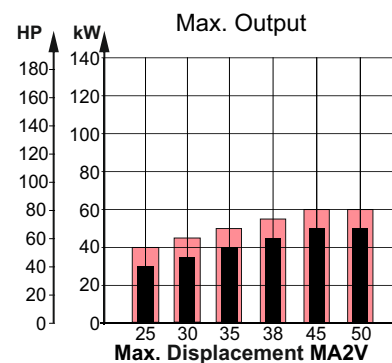
Displacement,	cm <sup>3</sup> /rev [in <sup>3</sup> /rev]	2÷50 [0.12÷3.06]
Max. Speed,	RPM	3500
Max. Torque,	Nm [lb-in]	200 [1770]
Max. Output,	kW [HP]	50 [67]
Max. Pressure Drop,	bar [PSI]	280 [4060]
Max. Oil Flow,	l/min [GPM]	160 [42]
Min. Speed,	RPM	500
Fluid	Mineral based- HLP(DIN 51524) or HM(ISO 6743/4)	
Temperature Range,	°C [°F]	-40÷82 [-40÷180]
Optimal Viscosity Range,	mm <sup>2</sup> /s [SUS]	12÷68 [66÷311]
Filtration	ISO code 18/16/13 (Min. recommended fluid filtration of 10 micron)	



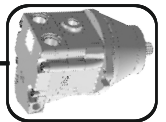
Intermittent values



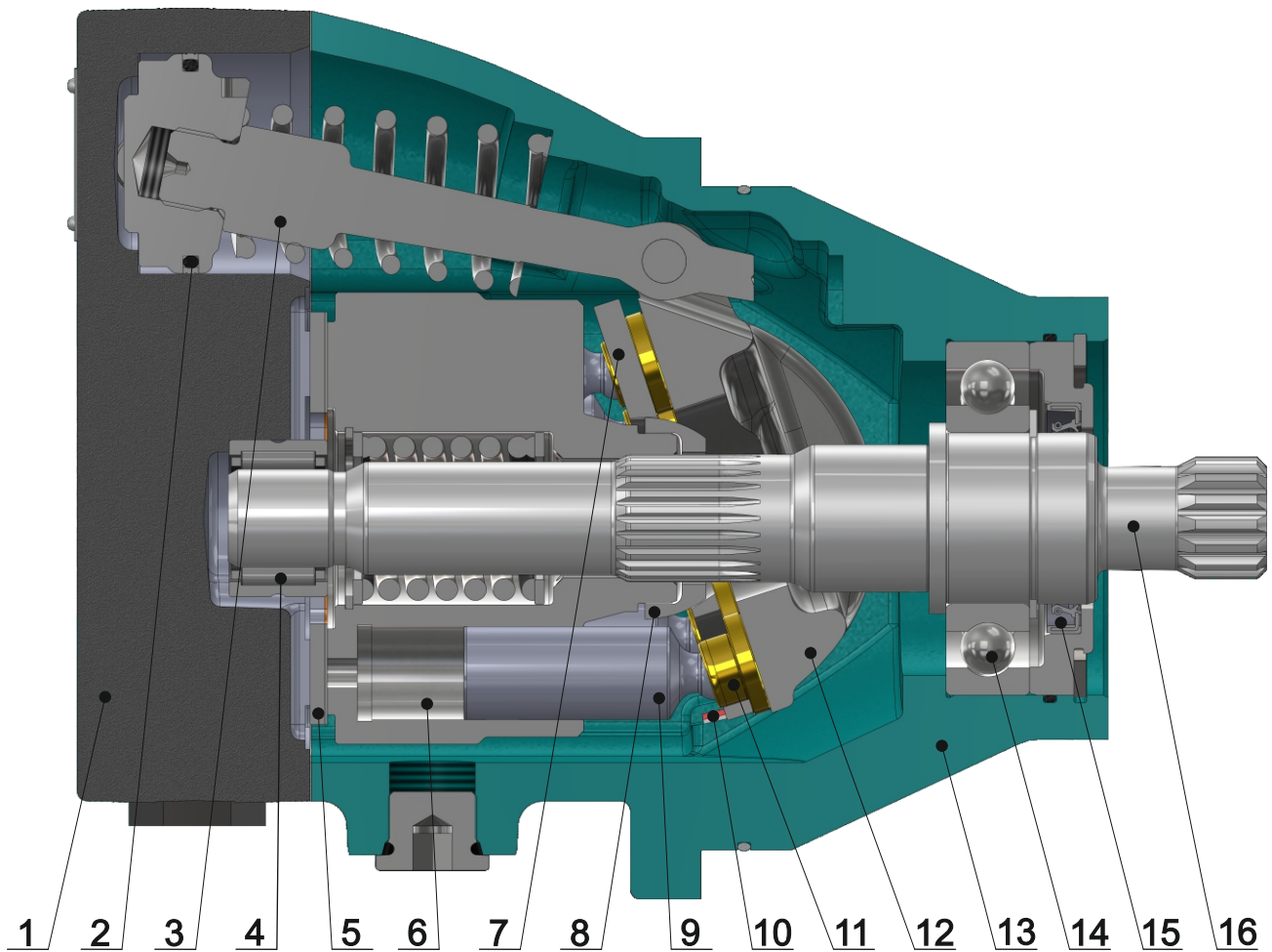
Continuous values







**SECTION VIEW**

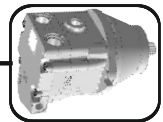


- |   |                          |
|---|--------------------------|
| 1. Cast iron end cover                            | 9. Pistons               |
| 2. High pressure displacement control system seal | 10. Cradle plain bearing |
| 3. Displacement control system                    | 11. Piston shoes         |
| 4. Needle bearing                                 | 12. Hardened cradle      |
| 5. Bimetal distributor                            | 13. Cast iron body       |
| 6. Cylinder block                                 | 14. Ball bearing         |
| 7. Retainer plate                                 | 15. Shaft seal           |
| 8. Hardened sphere                                | 16. Hardened shaft       |

The medium duty design of the MA2V is dual displacement motor with direct control for open and closed circuits. The motor compact construction is cost effective and have got high power / weight ration.

The design of the motor is maintain friendly. We using swash plate witch insure low level of pulsation and noise level.




**SPECIFICATION DATA**

Type		MA2V 25	MA2V 30	MA2V 35	MA2V 38	MA2V 45	MA2V 50
Max. Displacement, cm. <sup>3</sup> /rev. [in. <sup>3</sup> /rev.]		25 [1.53]	30 [1.83]	35 [2.14]	38 [2.32]	45 [2.75]	50 [3.06]
Max. Speed at	Cont.	3500	3500	3500	3500	3500	3000
Max. Displ. [RPM]	Int.*	3900	3900	3900	3900	3900	3500
Max. Speed at	Cont.	4000	4000	4000	4000	4000	4000
Min. Displ. [RPM]	Int.*	4500	4500	4500	4500	4500	4500
Max. Torque,***	Cont.	111 [982]	134 [1186]	156 [1380]	151 [1336]	179 [1584]	200 [1770]
Nm [lb-in]	Int.**	119 [1053]	143 [1265]	167 [1478]	182 [1610]	215 [1903]	240 [2124]
Output,	Cont.	30 [40]	35 [47]	40 [54]	45 [60]	50 [67]	50 [67]
kW [HP]	Int.**	40 [54]	45 [60]	50 [67]	55 [74]	60 [80]	60 [80]
Max. Pressure,	Cont.	280 [4060]	280 [4060]	280 [4060]	250 [3625]	250 [3625]	250 [3625]
bar [PSI]	Int.**	300 [4350]	300 [4350]	300 [4350]	300 [4350]	300 [4350]	300 [4350]
	Peak****	350 [5080]	350 [5080]	350 [5080]	350 [5080]	350 [5080]	350 [5080]
Max. Oil Flow,	Cont.	90 [23.8]	105 [27.7]	125 [33]	135 [35.7]	160 [42.3]	150 [42.3]
l/min [GPM]	Int.*	100 [26.4]	120 [31.7]	140 [37]	150 [39.6]	180 [47.6]	175 [47.6]
Speed Shifting Pressure,							
Minimum ,	bar [PSI]	14[200]					
Maximum,	bar [PSI]	70[1015]					
Permissible Shaft Load (for standard bearing)							
Max Axial*****	N[lb]	Fa=1000 [225]					
Max Radial*****	N[lb]	Fr=350 [80]					
Speed Constant ***** (for max. displacement)		38	31.7	27.1	25	21.1	19
RPM/(l/min) [RPM/GPM]		[143.8]	[119.9]	[102.75]	[94.6]	[79.91]	[72]
Torque Constant ***** (for max. displacement)		0.35	0.43	0.502	0.544	0.645	0.716
Nm/bar [lb-in/PSI]		[0.219]	[0.262]	[0.306]	[0.332]	[0.394]	[0.437]
Min. Speed,	[RPM]	500					
Max. Pressure in		5 [70]					
Drain Line,	bar [PSI]	open drain line is always required					
Weight,	kg [lb]	15.6 [34.4]					

\* Intermittent speed (flow) is for pressure up to 150[2200] bar[PSI].

\*\* Intermittent load: the permissible values may occur for max. 10% of motor lifetime.

\*\*\* Theoretical torque

\*\*\*\* Peak load: the permissible values may occur for max. 1% of every minute.

\*\*\*\*\* 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  $\eta_v=0.95$  and  $\eta_{mh}=0.9$ .

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 20.

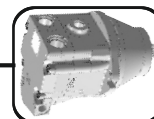
5. Recommended maximum system operating temperature - 82°C [180°F].

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**

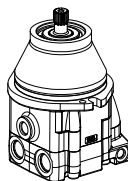
The constant values are mentioned for rough calculations. Motor torque and rotation speed for a particular project are depending on the real operating conditions. For more detail calculations please see formulas on page 21.



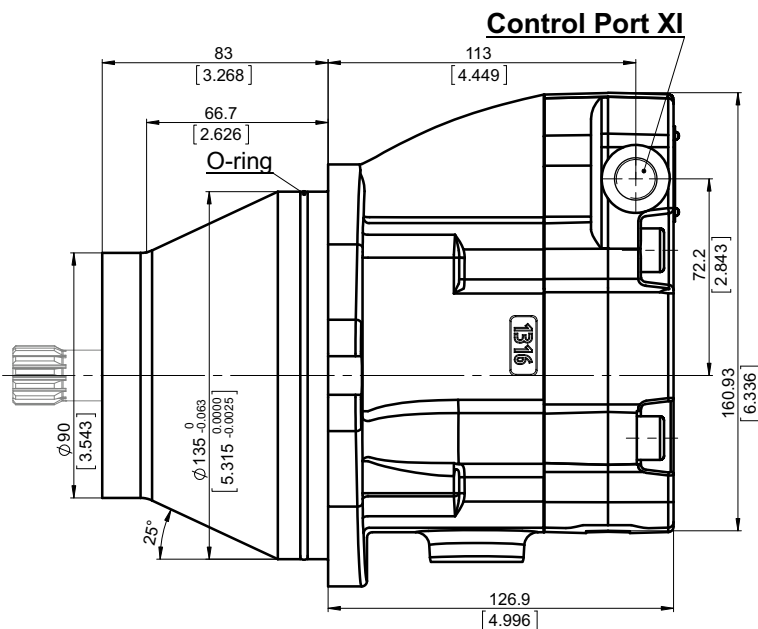
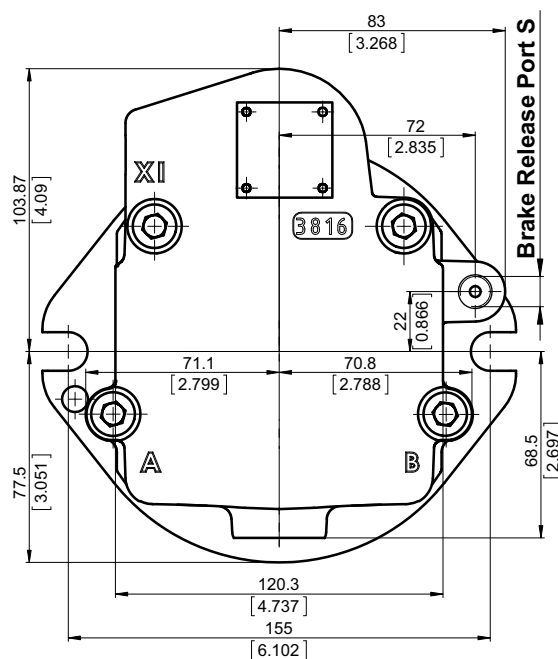
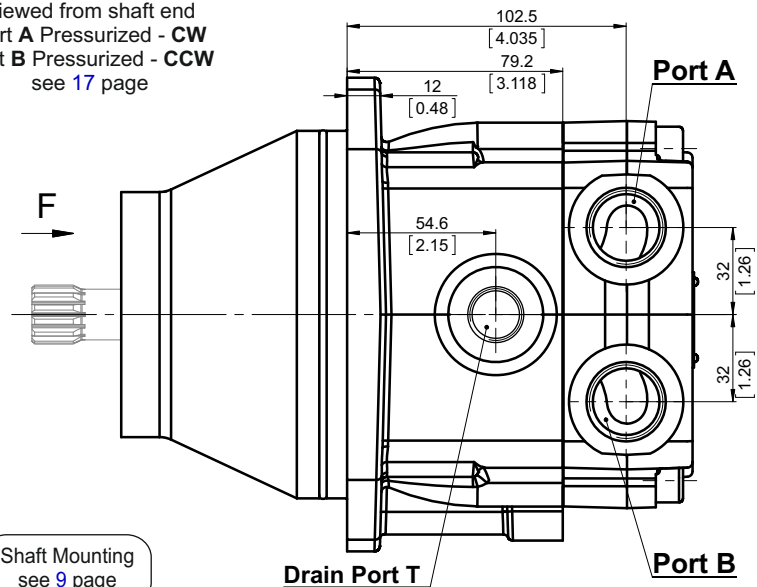
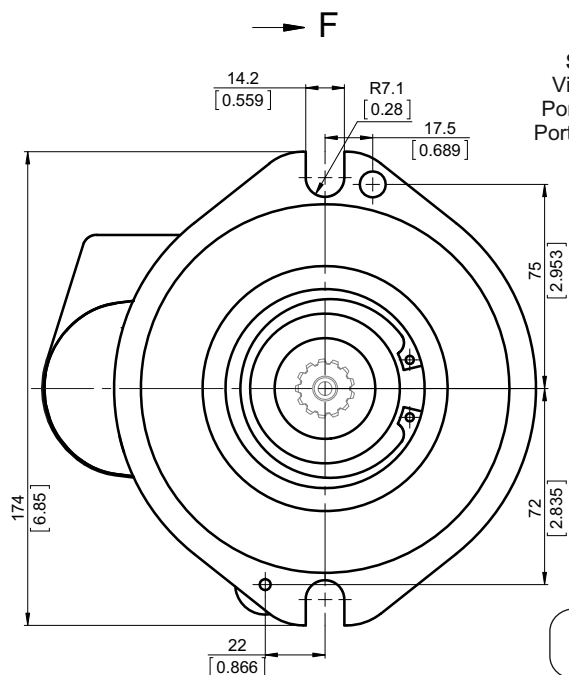
## Overall Dimensions and Ports

### Twin ports with side control port, port size 2,3 and 4

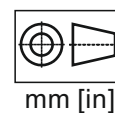
See the port sizes at the bottom of this page

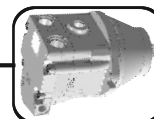


**Standard Rotation**  
Viewed from shaft end  
Port **A** Pressurized - **CW**  
Port **B** Pressurized - **CCW**  
see 17 page



	Port Size		
	<b>[2]</b>	<b>[3]</b>	<b>[4]</b>
<b>P<sub>(A,B)</sub></b>	2xG 3/4	2xM27x2	2x1 $\frac{1}{16}$ -12 UN -2B
<b>T</b>	G 3/4	7/8-14 UNF-2B	3/4-16 UNF-2B
<b>XI</b>	G 1/8	7/16-20 UNF-2B	9/16-18 UNF-2B
<b>S</b>	7/16-20 UNF-2B	7/16-20 UNF-2B	7/16-20 UNF-2B

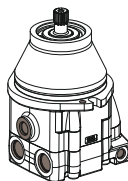




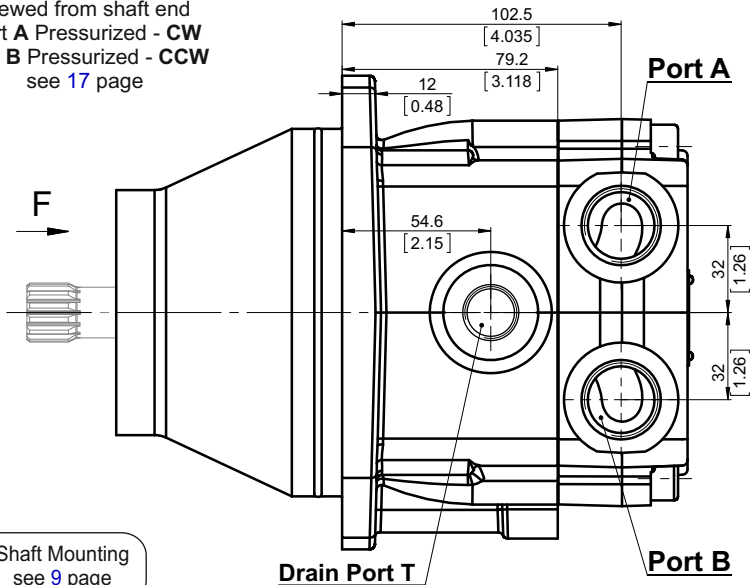
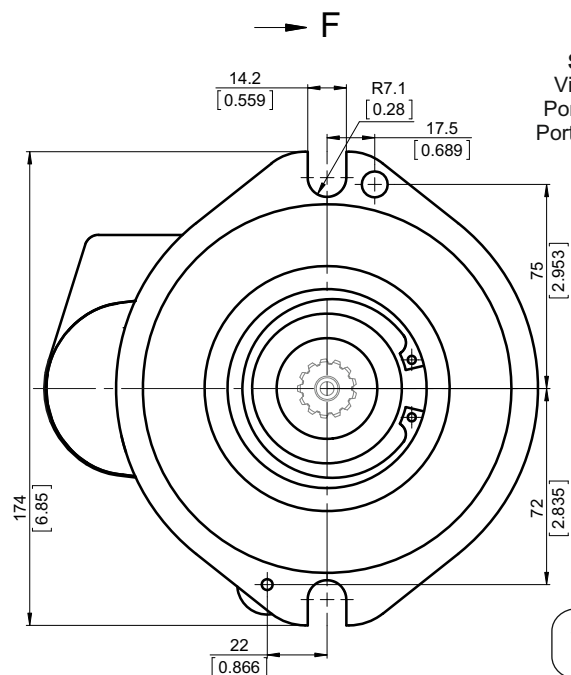
## Overall Dimensions and Ports

**Twin** ports with rear control port, port size **2,3** and **4**

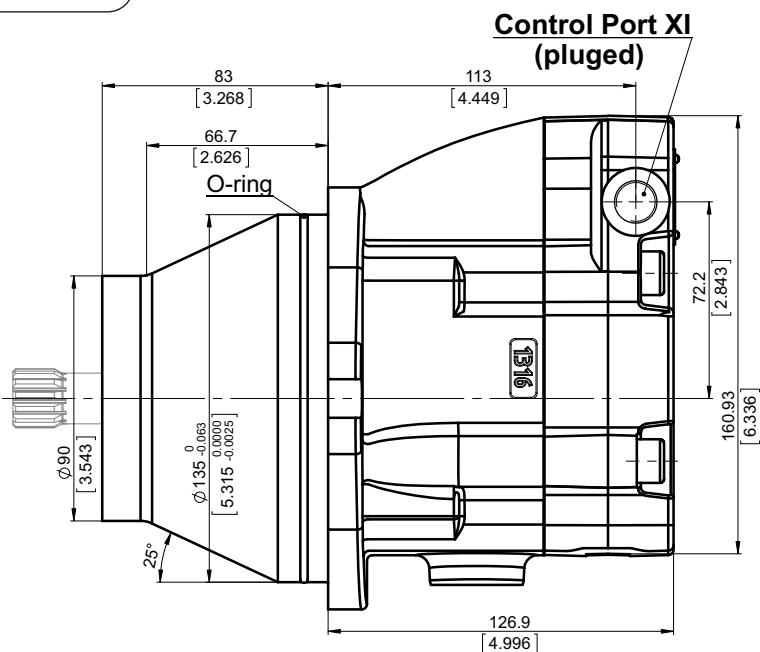
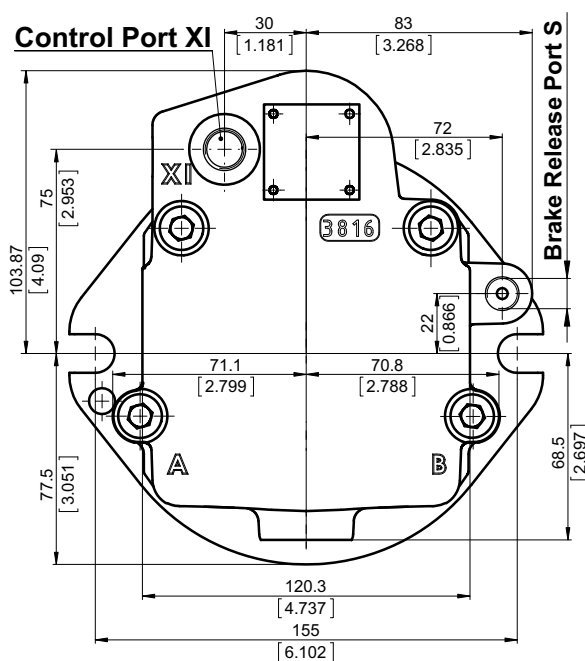
See the port sizes at the bottom of this page



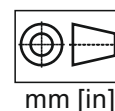
**Standard Rotation**  
Viewed from shaft end  
Port **A** Pressurized - **CW**  
Port **B** Pressurized - **CCW**  
see 17 page



Shaft Mounting  
see 9 page



	Port Size		
	<b>[2]</b>	<b>[3]</b>	<b>[4]</b>
<b>P<sub>(A,B)</sub></b>	2xG 3/4	2xM27x2	2x1 $\frac{1}{16}$ -12 UN -2B
<b>T</b>	G 3/4	7/8-14 UNF-2B	3/4-16 UNF-2B
<b>XI</b>	G 1/8	7/16-20 UNF-2B	9/16-18 UNF-2B
<b>S</b>	7/16-20 UNF-2B	7/16-20 UNF-2B	7/16-20 UNF-2B







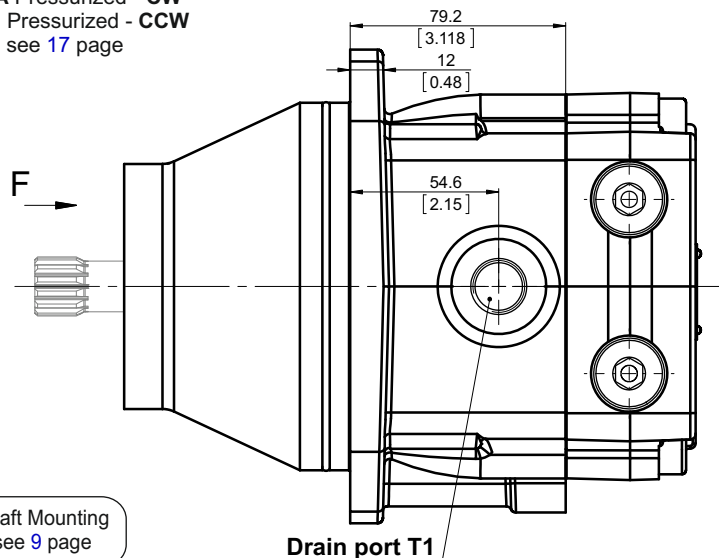
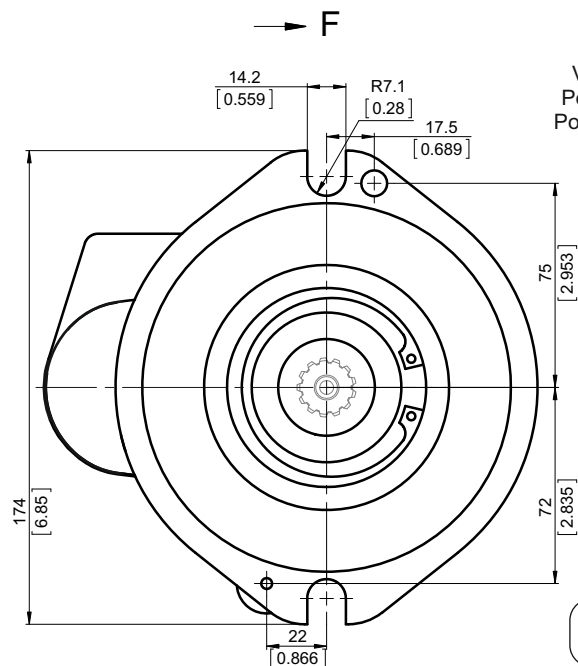
## Overall Dimensions and Ports

### Rear ports with rear control port, port size 2,3 and 4

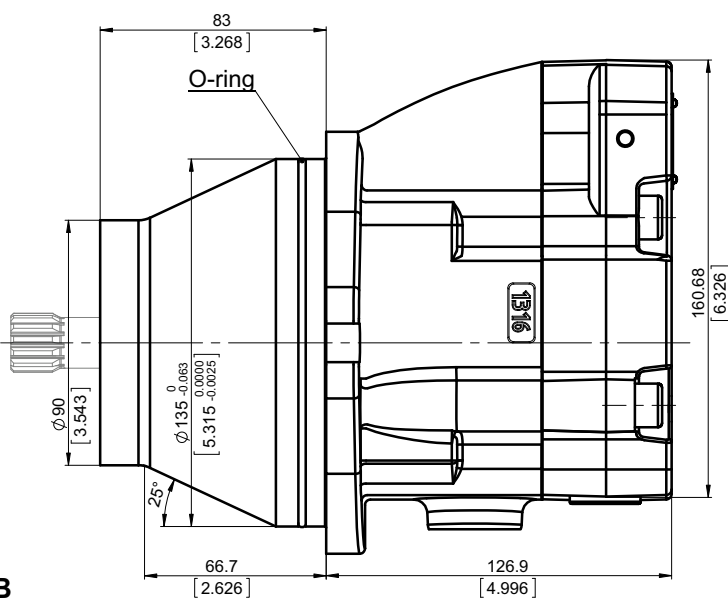
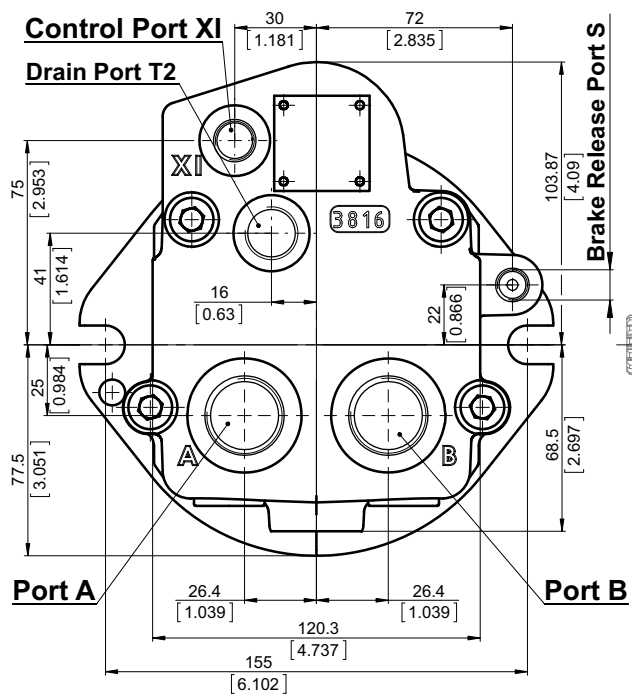
See the port sizes at the bottom of this page



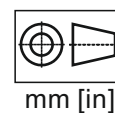
**Standard Rotation**  
Viewed from shaft end  
Port **A** Pressurized - **CW**  
Port **B** Pressurized - **CCW**  
see 17 page

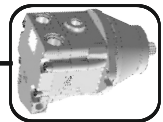


Shaft Mounting  
see 9 page

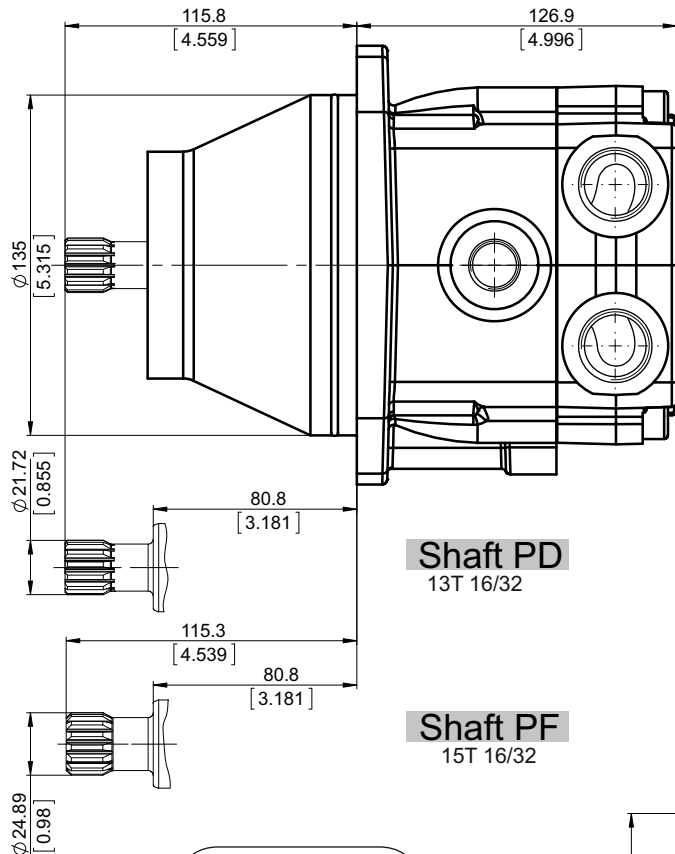


	Port Size		
	<b>2</b>	<b>3</b>	<b>4</b>
<b>P<sub>(A,B)</sub></b>	2xG 3/4	2xM27x2	2x1 <sup>1</sup> / <sub>16</sub> -12 UN -2B
<b>T1</b>	G 3/4	3/4-16 UNF-2B	3/4-16 UNF-2B
<b>T2</b>	G 1/4	3/4-16 UNF-2B	3/4-16 UNF-2B
<b>XI</b>	G 1/8	7/16-20 UNF-2B	9/16-18 UNF-2B
<b>S</b>	7/16-20 UNF-2B	7/16-20 UNF-2B	7/16-20 UNF-2B





## Shafts Mounting



**Shaft PD**  
13T 16/32

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

**Shaft PF**  
15T 16/32

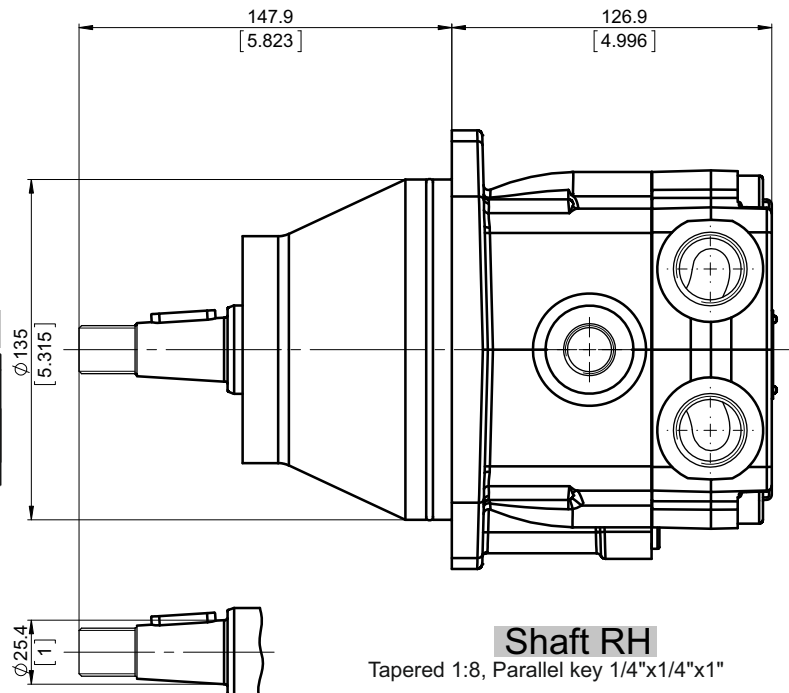
Shaft Dimensions  
See Page 13,14

### PERMISSIBLE SHAFT LOAD

Permissible shaft load		Standard bearing	Improved bearing
max Axial	N[lb]	Fa=1000 [225]	Fa=2000 [450]
max Radial	N[lb]	Fr=350 [80]	Fr=3000 [495]

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

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

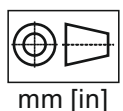
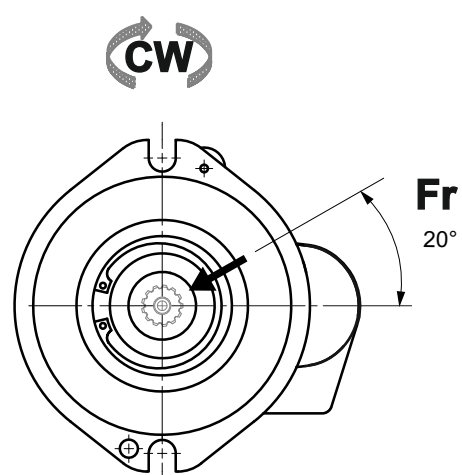
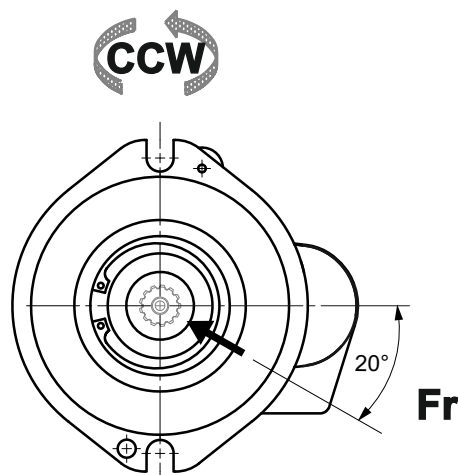


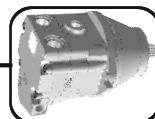
**Shaft RH**

Tapered 1:8, Parallel key 1/4"x1/4"x1"

### BEST POSITION FOR APPLYING RADIAL LOAD

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



[illegible]

**Pos.1 - Mounting Flange**

omit - Wheel flange, cartage - 2-Bolt flange  
spigot diam. 135 mm [5.315"] - BC 155 mm [6.102"]

**Pos.2 - Port Type**

<b>T</b>	- Twin side ports on one side, side control port
<b>H</b>	- Twin side ports on one side, rear control port
<b>E</b>	- Rear ports, rear control port

Pos.3 - **Max Displacement Code\*** (see table bellow)

### Cross Reference Displacement Table

	Pos.3 Max. Displacement cm3./rev					
	25	30	35	38	45	50
2	x	x	x	x	x	x
8	x	x	x	x	x	x
9	x	x	x	x	x	x
10	x	x	x	x	x	x
11	x	x	x	x	x	x
12	x	x	x	x	x	x
13	x	x	x	x	x	x
14	x	x	x	x	x	x
15	x	x	x	x	x	x
16	x	x	x	x	x	x
17	x	x	x	x	x	x
18	x	x	x	x	x	x
19	x	x	x	x	x	x
20	x	x	x	x	x	x
22		x	x	x	x	x
23		x	x	x	x	x
25		x	x	x	x	x
27			x	x	x	x
29			x	x	x	x
32				x	x	x

On Table are Shown:

- Min./Max. Displacement Combinations  
other combinations are possible

Pos.4 - **Min. Displacement Code\*** (see table above)

## Pos.5 - Shaft Extensions\*\*

**PD** -  $\varnothing 21,72$  [0.855"] Spline SAE 13T 16/32 DP,  
1/4-20 UNC-2B thread

**PF** -  $\varnothing 24,9$  [0.98"] Spline SAE 15T 16/32 DP,  
1/4-20UNC-2B thread

**CK** -  $\varnothing 22,2$  [ $\varnothing 7/8$ " ] Straight, M8-6H thread  
Parallel key 1/4"x1/4"x1" BS46

**RH** -  $\varnothing 25,4$  [1"] Tapered 1:8 [125:1000],  
Parallel key 1/4"x1/4"x1", 3/4-16 UNF-2A

**Pos.6 -Improved radial load**

omit	- standard bearing
<b>N</b>	- Improved bearing

## Pos.7 - Port Size

<b>2</b>	- 2xG3/4
<b>3</b>	- 2xM27x2
<b>4</b>	- 2x1 1/16 -12 UN

**Pos.8 - Seal, Corrosion Resistant Seal Surface**

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

### Pos.9 - Integrated Valves

omit	- None
<b>PU</b>	- Purge valve
<b>FLU</b>	- Flush valve
<b>SAR</b>	- Single anti-cavitation and relief valve
<b>SARF</b>	- Single anti-cavitation, relief and flush valve

**Pos.10 - Valve's Port for Single Valves**

omit	- None
<b>A</b>	- Port A
<b>B</b>	- Port B

## Pos.11 - Pressure Setting of Integrated Valves

omit - None

☒ - For value - see next page

## Pos.12 - Flow Setting of Integrated Valves

**Lx** - For value - see next page

## Pos.13 - Special Features\*\*\*\*

**R2S** - Speed Sensor Two Directional

## Pos.14 - Paint and Coating\*\*\*

omit	- No paint or coating
<b>P</b>	- Painted
<b>PC</b>	- 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.15 - Design Series

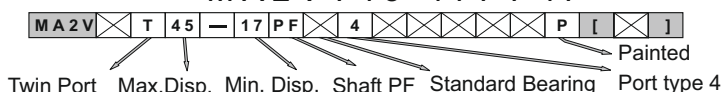
omit - Factory specified

- \* Other combination are available please ask on enquiry
- \*\*The permissible output torque for shafts must not be exceeded!
- \*\*\*Non painted feeding surface
- \*\*\*\*Available on enquiry

**We remain open to meet your special requirements upon request.**

### EXAMPLE

MA2VT45-17PF4P



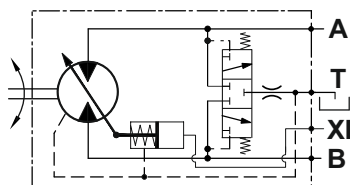




## Valve Options

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)** - **3.5 ÷ 4.9 l/min.**
- For other options, please see Pos.12 of ordering code, considering the following possible values:

Pos.12 

omit	L2	L6	L7.5
------	----	----	------

 → flow rate

#### EXAMPLE

**MA2VT45-17PF4PU**

purge valve flow rate  $4.2 \pm 0.7$  l/min

**MA2VT45-17PF4PUL2**

purge valve flow rate  $2 \pm 2.5$  l/min

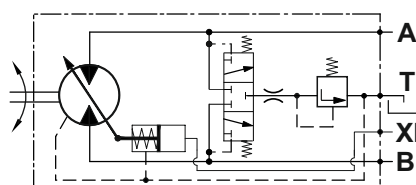
**MA2VT45-17PF4PUL7.5**

purge valve flow rate  $7.5 \pm 1$  l/min

**MA2VT45-17PF4PUL6**

purge valve flow rate  $6 \pm 0.8$  l/min

### 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)** - **3.5 ÷ 4.9 l/min and cracking (opening) pressure 10.3 bar** with 15 bar feed pressure for close loop circuit.
- For other options, please see Pos.11 and Pos. 12 of ordering code, considering the following possible values:

Pos.11 

omit	7
------	---

 → pressure

Pos.12 

omit	L2	L6	L7.5
------	----	----	------

 → flow rate

#### EXAMPLE

**MA2VT45-17PF4FLU**

flow rate  $4.2 \pm 0.7$  l/min,  
crack pressure 10.3 bar

**MA2VT45-17PF4FLU7L7.5**

flow rate  $7.5 \pm 1$  l/min,  
crack pressure 7 bar

**MA2VT45-17PF4FLUL2**

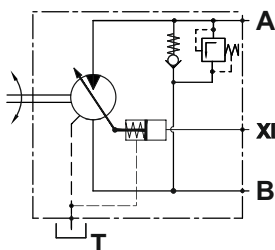
flow rate  $2 \pm 2.5$  l/min,  
crack pressure 10.3 bar

## Option SARA, SARB

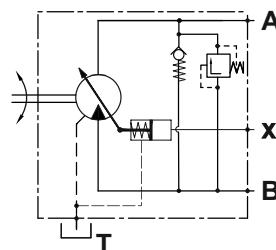
### Combined Anti-Cavitation and Relief Valve

- Anti-cavitation check valve is used for applications such as Fan drive control;
- Pressure relief valves prevent excessive pressures in the high pressure loop.

#### SARA



#### SARB



Please, consider the following possible values:

Pos.11 

280	300	345
-----	-----	-----

 → pressure

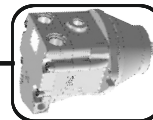
#### EXAMPLE

**MA2VT45-17PF4SARA280**

Single Anti-Cavitation and Relief Valve, relief valve setting 280 bar  
The valve is placed on port A

**MA2VT45-17PF4SARB300**

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

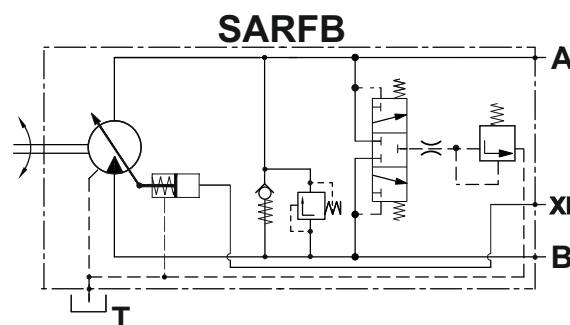
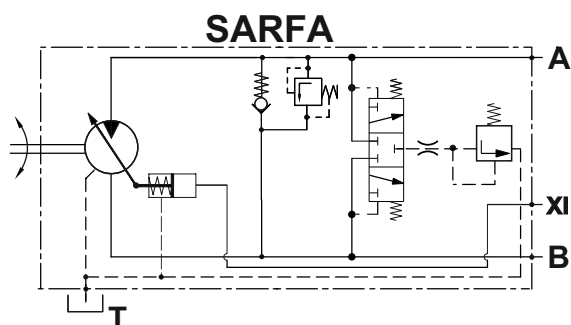


## Valve Options

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

### Option SARFA, SARFB

Single Anti-Cavitation, Relief and Flush Valve



- Mainly used in close loop circuit;
- The valve is a combination between a dual anti-cavitation, 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.11 

280	300	345
-----	-----	-----

 → pressure

- Flow rate of flush valve by **default (omit)** - **3.5 ÷ 4.9 l/min** and **cracking pressure 10.3 bar** with 15 bar feed pressure for close loop circuit. The possible values are as follow:

Pos.12 

omit	L2	L6	L7.5
------	----	----	------

 → flow rate

- Other values for **cracking** pressure are possible. Please see Pos.11. Example: For cracking pressure 7 bar the options are as follow:

Pos.11 

280-7	300-7	345-7
-------	-------	-------

Relief valve opening pressure      Flush valve cracking pressure (charge pressure)

### EXAMPLE

#### MA2VT45-17PF4SARFA345

Single Anti-Cavitation, Relief and Flush Valve, relief valve setting 345 bar  
flush valve cracking pressure 10.3 bar, flush valve flow rate 4.2±0.7 l/min  
The valve is placed on port A

#### MA2VT45-17PF4SARFB345-7

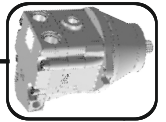
Single Anti-Cavitation, Relief and Flush Valve, relief valve setting 345 bar  
flush valve cracking pressure 7 bar, flush valve flow rate is 4.2±0.7 l/min  
The valve is placed on port B

#### MA2VT45-17PF4SARFA280L2

Single Anti-Cavitation, Relief and Flush Valve, relief valve setting 280 bar  
flush valve cracking pressure 10.3 bar, flush valve flow rate is 2±2.5 l/min  
The valve is placed on port A

#### MA2VT45-17PF4SARFB300-7L7.5

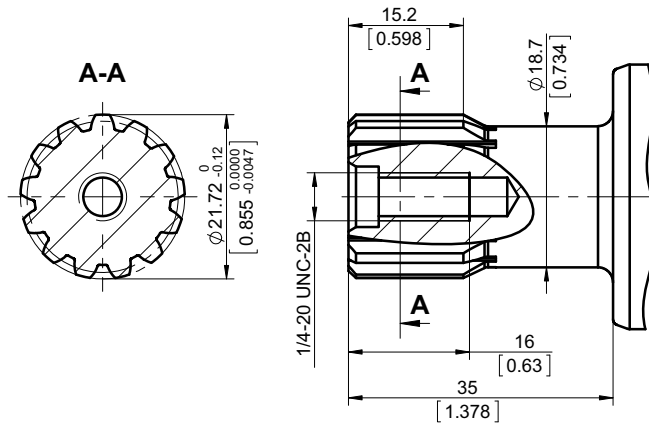
Single Anti-Cavitation, Relief and Flush Valve, relief valve setting 300 bar  
flush valve cracking pressure 7 bar, flush valve flow rate 7.5±1 l/min  
The valve is placed on port B



## Shaft Types and Dimensions

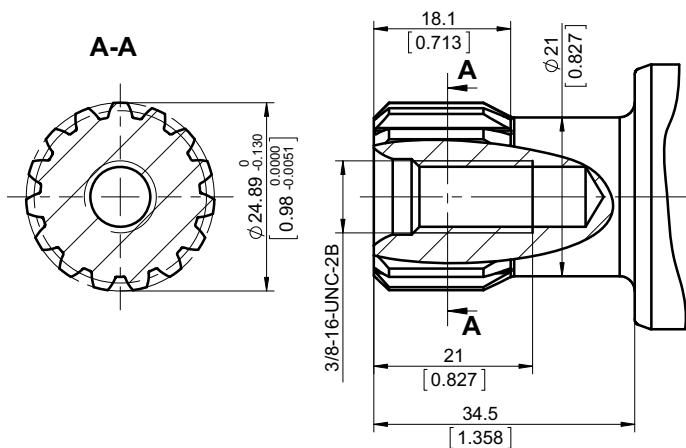
### PD

$\phi 21.72$  [ $\phi 0.855$ "], 1/4-20 UNC-2B thread  
13T 16/32 DP splined ANSI B92.1-1996  
Max. torque 200 Nm [1770 lb-in]

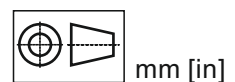


### PF

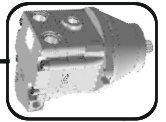
$\phi 24.89$  [ $\phi 0.98$ "], 3/8-16 UNC-2B thread  
15T 16/32 DP splined ANSI B92.1-1970  
Max. torque 330 Nm [2920 lb-in]



The required max. torque  
must not be exceeded



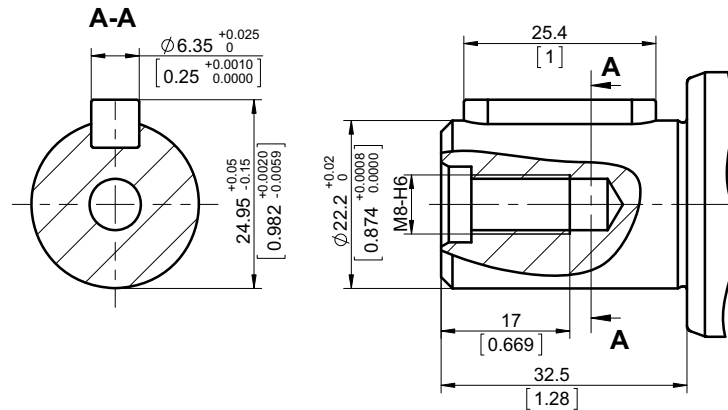




## Shaft Types and Dimensions

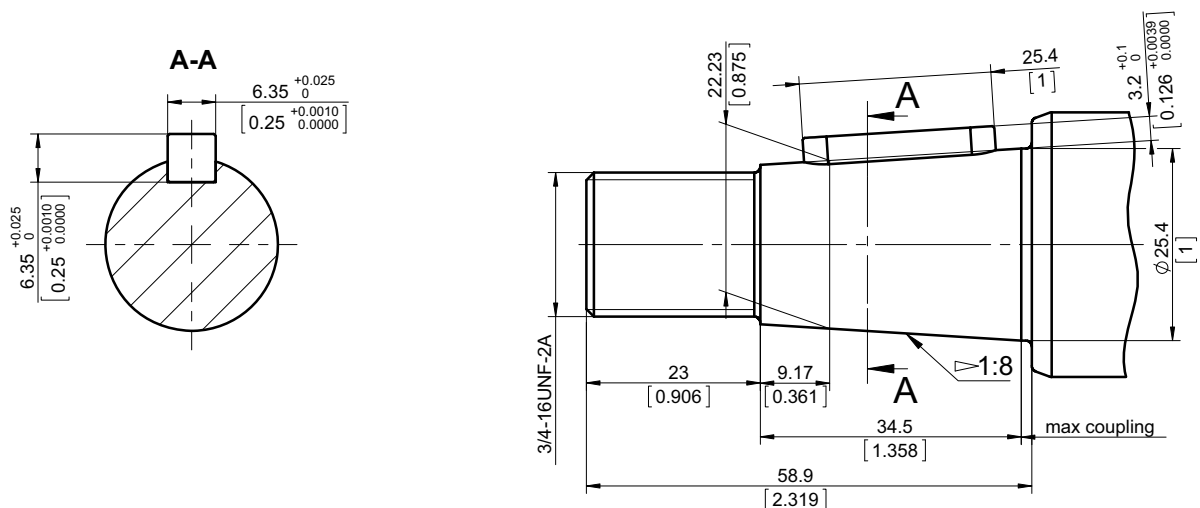
### CK

$\phi 22.2$  [ $\phi 7/8$ ] straight, M8-6H thread  
Parallel key  $1/4 \times 1/4 \times 1$  BS46  
Max. torque 180 Nm [1600 lb-in]

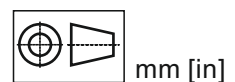


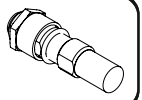
### RH

$\phi 25.4$  [ $\phi 1$ ] Tapered 1:8 [123:1000],  
Parallel key  $1/4 \times 1/4 \times 1$ , 3/4-16 UNF-2A  
Max. torque 300Nm [2650 lb-in]



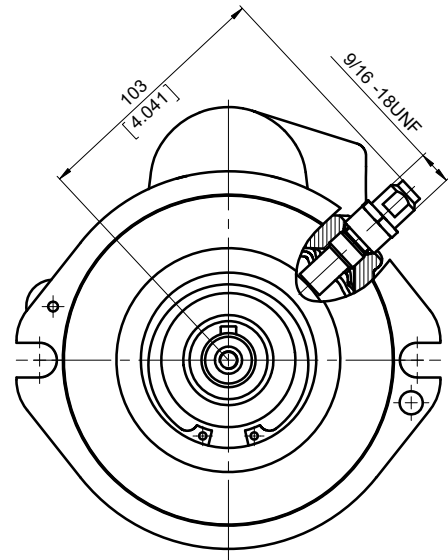
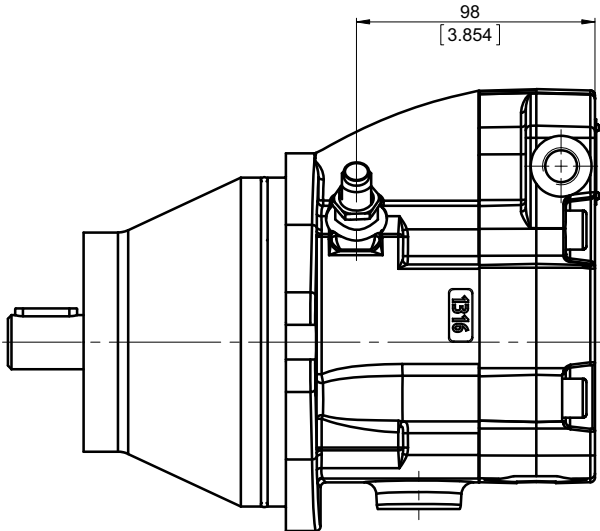
The required max. torque  
must not be exceeded





## MOUNTING DIMENSIONS

## MA2V



## TECHNICAL DATA

Power supply	4.5 ... 30 VDC
Power consumption	< 15 mA without load
Pin connector	universal /PUSH-PULL/ 4P Delphi Connector DJ3042&-2.5-21
Output measurements	Speed, Direction
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
Frequency range	0 ... 15 000 Hz
Degree of protection	IP 67
Temperature	-40 ... + 100 °C
Humidity	0 ... 95% RH

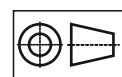
## OUTPUT PULSES

per revolution

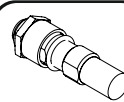
Motor Type	MA2V
Output Pulses	45

## INSTALLATION

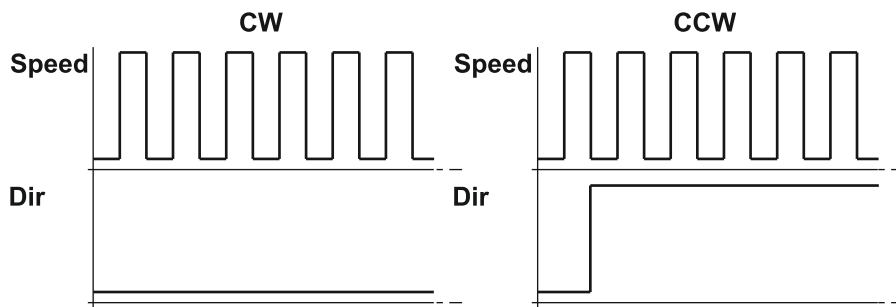
1. Turn in (CW) by hand until bottom end gently touches the speed ring.
2. Back out (CCW) 1/4 turn. Continue backing out until the flats are 22° either side of pump or motor shaft center line (20° to 30° is acceptable). Do not back out the sensor more than 3/4 of a turn from touching.
3. Using the 1/2 inch wrench to hold the sensor, torque the lock nut to 13[115] Nm [lb-in] with an 11/16 inch hew wrench.



mm [in]

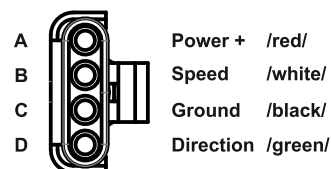


## OUTPUT DIAGRAMS



## PIN CONNECTOR

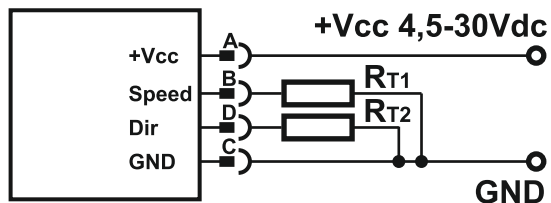
4 pin Delphi Connector



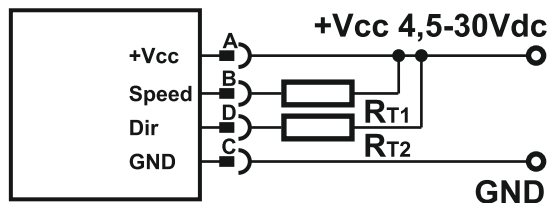
## WIRING DIAGRAMS

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

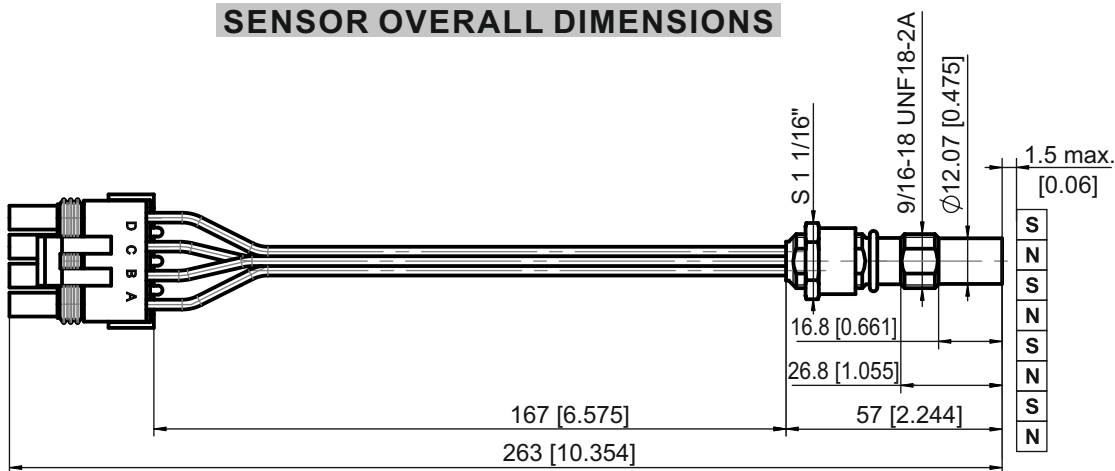
### PNP



### NPN



## SENSOR OVERALL DIMENSIONS





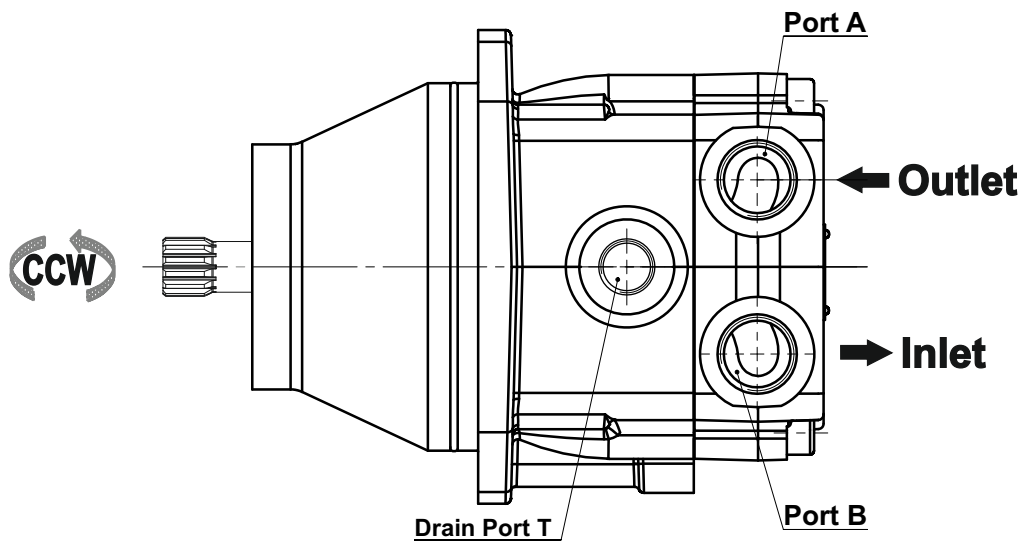
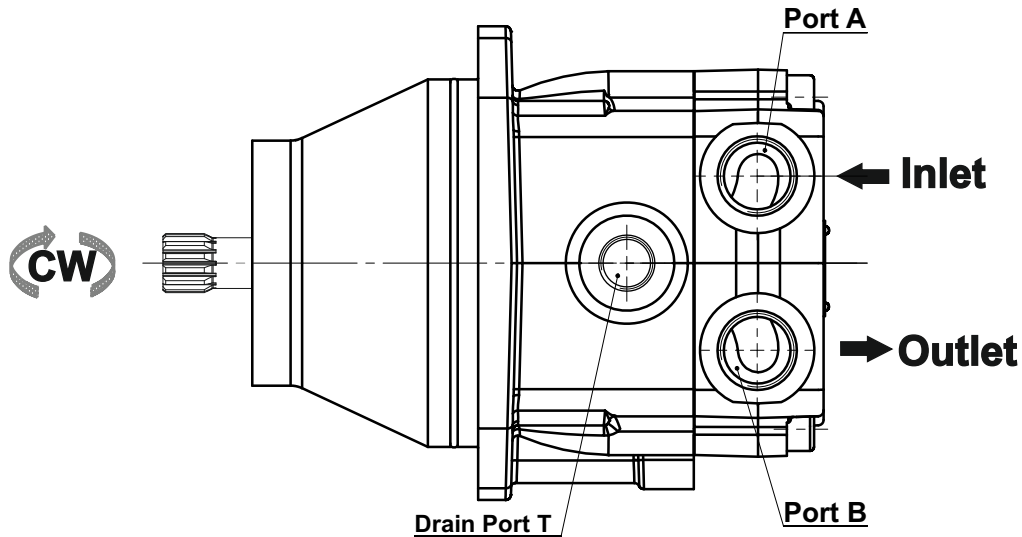


## INSTALLATION

### DIRECTION OF ROTATION

#### Standard Rotation

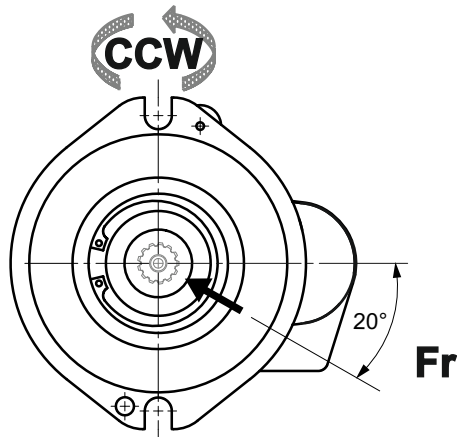
Viewed from shaft end  
Port A Pressurized - CW  
Port B Pressurized - CCW



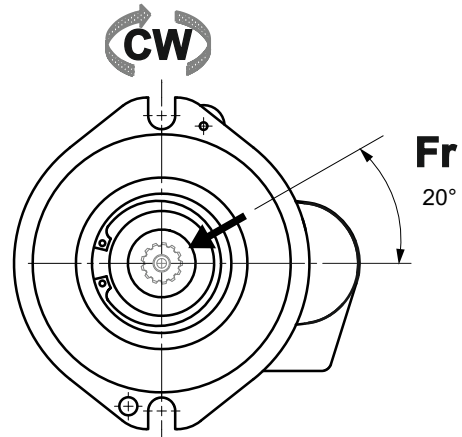
### BEST POSITION FOR APPLYING RADIAL LOAD

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

#### Reverse Rotation

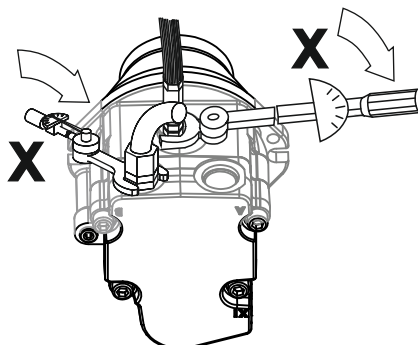


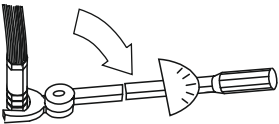
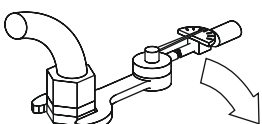
#### Standard Rotation





## Recommended max. tightening torque X for metal plugs

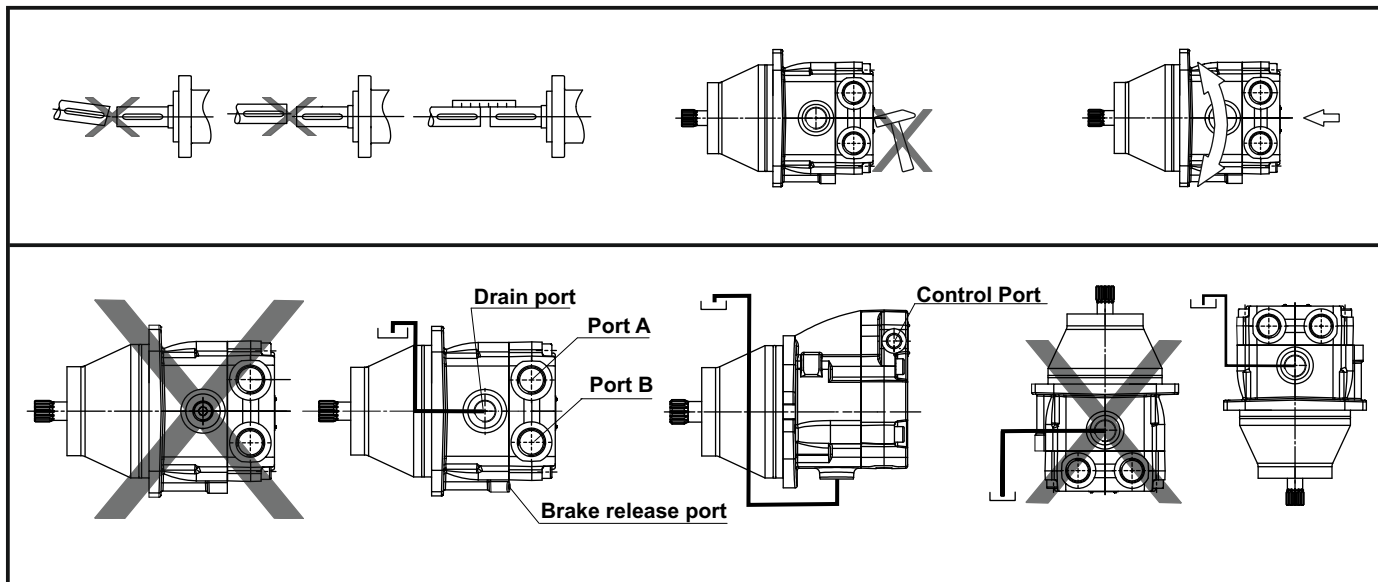


Screwed connection Anschlussart Raccord Tipo di collegamento Especie de unir Присоединительные резьбы	 <b>Max. Tightening Torque X, Nm [lb-in]</b> <b>Max. Anzugsmoment X, Nm [lb-in]</b> <b>Couple de serrage maxi X, Nm [lb-in]</b> <b>Momento di serraggio max. X, Nm [lb-in]</b> <b>Momento d'apretadura max. X, Nm [lb-in]</b> <b>Момент затяжки X, Nm [lb-in]</b>				
	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	
G 1/4	20 [180]	30 [265]	40 [360]	20 [180]	
G 3/8	20 [180]	50 [450]	60 [550]	20 [180]	
G 1/2	30 [265]	80 [700]	100 [885]	30 [265]	
G 3/4	50 [450]	130 [1150]	160 [1400]	50 [450]	
G 1	80 [700]	200 [1770]	250 [2200]	80 [700]	
1/8-14 UNF				70 [620]	
3/8-24(16) UNF(UNC)				15 [130]	
7/16-20(16) UNF				20 [180]	
9/16-18 UNF				20 [180]	
9/16-20 UNF				35 [310]	
3/4-16 UNF				60 [550]	
7/8-14(16) UNF				70 [620]	
1 1/16-12 UN				90 [800]	
1 5/16-12 UN				160 [1400]	
1/2-14 NPTF				30 [265]	
1/4-18 NPTF				30 [265]	
M 8	20 [180]	10 [88.5]	20 [180]		
M 10	20 [180]	10 [88.5]	20 [180]		
M 12	20 [180]	30 [265]	40 [360]		
M 14x1,5	20 [180]	30 [265]	40 [360]	30 [265]	
M 16x1,5	20 [180]	50 [450]	60 [550]	50 [450]	
M 18x1,5	20 [180]	50 [450]	60 [550]	50 [450]	
M 20x1,5	30 [265]	80 [700]	100 [885]	80 [700]	
M 22x1,5	30 [265]	80 [700]	100 [885]	80 [700]	
M 24x1,5	20 [180]	30 [265]	40 [360]	100 [885]	
M 27x2	50 [450]	130 [1150]	100 [885]	100 [885]	



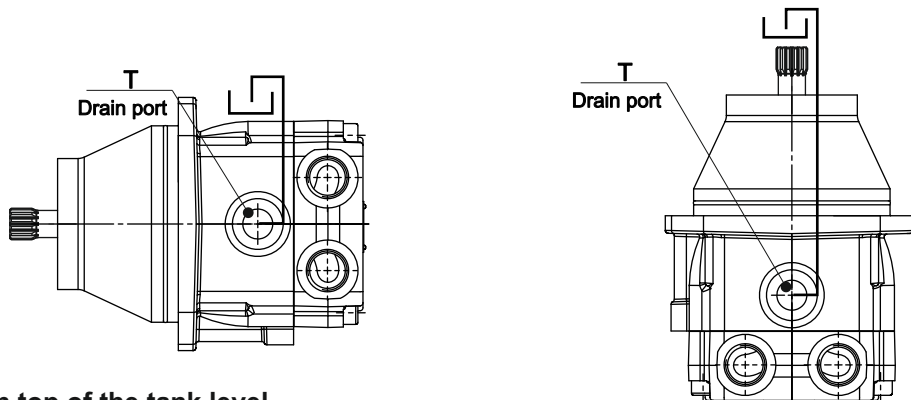
## INSTALLATION

At start-up and during operation the motor(pump) 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 bar [725 PSI]) till the motor(pump) 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 bar.



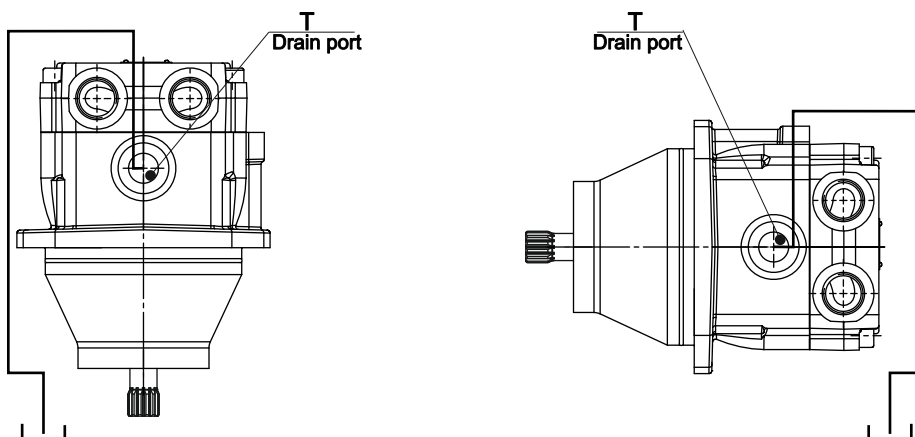
### Installation below the tank level (recommended)

- Fill up the axial piston motor(pump) before the start-up through the highest positioned drain port T;
- Operate the motor(pump) 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

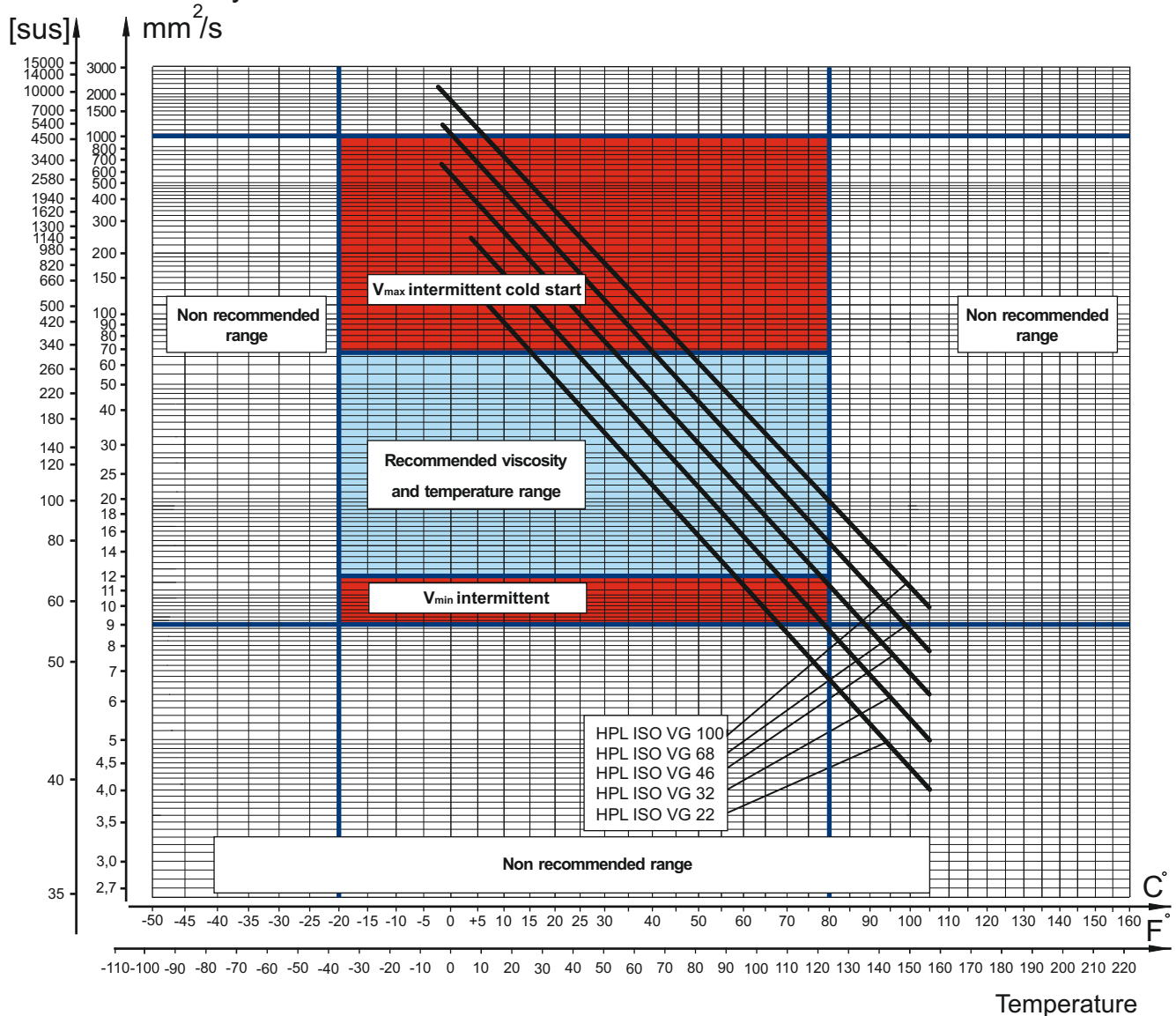
- Fill up the axial piston motor(pump) before the start-up through the highest positioned drain port T;
- Operate the motor(pump) at low speed till the motor system is completely filled up;
- The minimum immersion depth of the drain line in the tank is 200 mm relative to the minimum oil level in the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





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.

### Kinematic viscosity



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

## Basic Formulas

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

## Metric System

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

**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**  $P = \frac{M \cdot n}{9550} = \frac{Q \cdot \Delta p \cdot \eta_t}{60}$  [kW]

**Speed**  $n = \frac{Q \cdot 1000 \cdot \eta_v}{Vg}$  or  $n = Q \cdot N_{con.}$  [min<sup>-1</sup>]

$Vg =$  Displacement per rev. [cm<sup>3</sup>]

$\Delta p =$   $p_{HP} - p_{LP}$  [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)]

$\eta_v =$  Volumetric efficiency

$\eta_{mh} =$  Mechanical-hydraulic efficiency

$\eta_t =$  Overall efficiency

## Inch System

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

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

**Output torque**  $M = \frac{Vg \cdot \Delta p \cdot \eta_{mh}}{2 \cdot \pi}$  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<sup>-1</sup>]

$Vg =$  Displacement per rev. [in<sup>3</sup>]

$\Delta p =$   $p_{HP} - p_{LP}$  [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]

$\eta_v =$  Volumetric efficiency

$\eta_{mh} =$  Mechanical-hydraulic efficiency

$\eta_t =$  Overall efficiency

## Application Formulas

Motor speed:  $n$  [RPM]

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

$v_{km}$  - vehicle speed [km/h]

$v_{mi}$  - vehicle speed [mi/h]

$R_m$  - wheel rolling radius [m]

$R_{in}$  - wheel rolling radius [in]

$i$  - gear ratio between motor and wheels.

If no gearbox, use  $i=1$ .

Radial motor loading:  $P_{rad}$ , N [lbs]

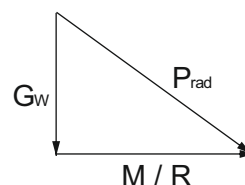
When the motor is used for motion with a ring or gear mounted directly on the motor shaft, the total radial load of the motor shaft  $P_{rad}$  is the sum of the motion force and the weight force acting on ring.

$G_w$  - Weight held by the shaft

$P_{rad}$  - Total radial load of the motor shaft

$M/R$  - Motion force

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

Total tractive effort:  $TE$ , N [lbs]

Total tractive effort  $TE$  is the total effort necessary for vehicle motion i.e. the sum of the calculated forces increased by 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)

Motor Torque moment:  $M$ , Nm [lb-in]

Necessary torque for the hydraulic motor:

$$M = \frac{TE \cdot R_m [R_{in}]}{N \cdot I \cdot \eta_m}$$

$I$  - motor numbers

$\eta_m$  - mechanical gearbox efficiency (if it is available)





# WARRANTY

M+S Hydraulic warrants, that its products, supplied directly to original equipment manufacturer, authorized distributor or other customer, will be free of defects in material or workmanship at the time of shipment from M+S Hydraulic and will conform to the products technical documentation (drawings and specifications) under sale agreement with Buyer.

This warranty will apply only to defects appearing within applicable Warranty period, mentioned below. If Buyer notifies M+S Hydraulic within the Warranty period about any such defects, M+S, at its sole option will replace or repair the defective products or their parts found by M+S Hydraulic to be defective in material or workmanship.

THE FOREGOING LIMITED WARRANTY IS AVAILABLE ONLY IF "M+S HYDRAULIC" IS PROMPTLY NOTIFIED IN WRITTEN OF THE ALLEGED DEFECT AND DOES NOT COVER FAILURE TO FUNCTION CAUSED BY DAMAGE TO THE PRODUCT, IMPROPER INSTALLATION, UNREASONABLE USE OR ABUSE OF THE PRODUCT, FAILURE TO PROVIDE OR USE OF IMPROPER MAINTENANCE OR USUAL, DEGRADATION OF THE PRODUCT DUE TO PHYSICAL ENVIRONMENTS OF AN USUAL NATURE. THE FOREGOING REMEDIES ARE THE SOLE AND EXCLUSIVE REMEDIES AVAILABLE TO CUSTOMER. To facilitate the inspection, M+S Hydraulic may require return of the product/part, which Buyer claims to be defective.

M+S Hydraulic shall not be liable for labor costs or any other expenses incurred during the disassembling or reinstalling of the product/part.

In case the claimed products are returned to M+S Hydraulic in bad condition: dirty, disassembled, with damaged or missing parts during transportation, the warranty will be considered as not applicable and the products will not be liable to repair.

## Warranty periods

**New products:** The Warranty period is limited to 24 consecutive months (2 years) from the date of production of the product.

**Repaired products:** If the product is repaired in M+S Hydraulic during its warranty period, the warranty period of the repaired item shall continue for the balance of original Warranty period or for a period equal to 50% of the original new product Warranty period, whichever is later.

**Spare parts:** The Warranty period for Spare parts is 12 consecutive months (1 year) from the dispatch date of such parts from M+S Hydraulic.

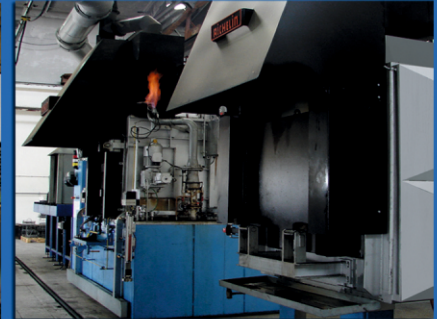
**LIMITATION OF LIABILITY** M+S Hydraulic's liability for claim of any kind, for loss or damage arising out of, connected with or resulting from an order, or from the performance or branch thereof, or from the design, manufacture, sale delivery, operation or use of any of its products shall be limited to, at M+S 's sole option, replacement, repair of any defective product or the issuance of a credit to Customer against any future purchases. Cash refunds will not be made under any circumstances and Customer will not be entitled to recover any damages of any kind against M+S Hydraulic, including but not limited to incidental or consequential damages, whether direct or indirect, known or unknown, foreseen or unforeseen.

## HES HYDRAULIC ELEMENTS AND SYSTEMS OVERVIEW



Hydraulic Elements and Systems PLC is a public stock company located in the town of Yambol, South-East Bulgaria. The factory has a long history and traditions in the design and manufacture of hydraulic cylinders. The product range includes Piston cylinders, Telescopic cylinders, Plunger cylinders and Rack cylinders.

## M+S HYDRAULIC OVERVIEW



M+S Hydraulic is a leading manufacturer of Hydraulic Motors, Hydrostatic Steering Units and accessories, Hydraulic brakes Motor-brakes and Valve Blocks in Europe and all over the world.

The main advantage of our company is that we offer hydraulic solutions to the specific needs of the customers meeting their technical requirements thanks to the various product's options. M+S Hydraulic commodities are guaranteed with after-sales services, technical support and warranty period of 24 months.

M+S Hydraulic has an enlarging world-wide distributors' network. The company has Agency contracts and Consignment agreements with more than 35 companies in the world. We have the know-how to develop solutions for productivity and efficiency on every continent.

## DEVOTED TO THE QUALITY

