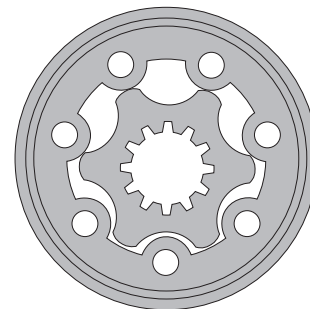


APPLICATION

- » Conveyors
- » Feeding mechanism of robots and manipulators
- » Metal working machines
- » Textile machines
- » Agricultural machines
- » Food industries
- » Grass cutting machinery etc.



CONTENTS

Specification data	56÷57
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OPTIONS

- » Model - Spool valve, gerotor
- » Flange mount
- » Side ports
- » Shafts - straight, splined and tapered
- » SAE and manifold ports
- » Speed sensing
- » Other special features

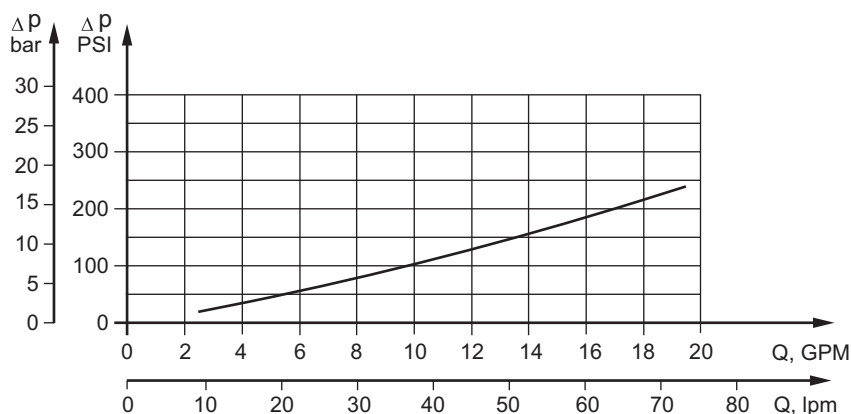
GENERAL

Max. Displacement, in ³ /rev [cm ³ /rev]	24.16 [396]
Max. Speed, [RPM]	1408
Max. Torque, lb-in [daNm]	cont.: 3665 [41,4] int.: 4520 [51,1]
Max. Output, HP [kW]	16.1 [12]
Max. Pressure Drop, PSI [bar]	cont.: 1815 [125] int.: 2540 [175]
Max. Oil Flow, GPM [lpm]	20 [75]
Min. Speed, [RPM]	10
Pressure fluid	Mineral based - HLP(DIN 51524) or HM(ISO 6743/4)
Temperature range, °F [°C]	-40 ÷ 284 [-40 ÷ 140]
Optimal Viscosity range, SUS [mm²/s]	98 ÷ 347 [20 ÷ 75]
Filtration	ISO code 20/16 (Min. recommended fluid filtration of 25 microns)

Oil flow in drain line

Pressure drop PSI [bar]	Viscosity SUS [mm ² /s]	Oil flow in drain line GPM [lpm]
1450 [100]	98 [20]	.660 [2,5]
	164 [35]	.476 [1,8]
2030 [140]	98 [20]	.925 [3,5]
	164 [35]	.740 [2,8]

Pressure Losses



SPECIFICATION DATA

Type		HP 25	HP 32	HP 40	HP 50	HP 80	HP 100
Displacement, in ³ /rev [cm ³ /rev]		1.73 [28,4]	2.11 [34,5]	2.47 [40,5]	3.02 [49,5]	4.83 [79,2]	6.04 [99,0]
Max. Speed, [RPM]	Cont.	1055	1160	900	909	758	606
	Int.*	1600	1300	1110	1111	947	758
Max. Torque, lb-in [daNm]	Cont.	290 [3,3]	460 [5,2]	575 [6,5]	717 [8,1]	1141 [12,9]	1434 [16,2]
	Int.*	400 [4,5]	620 [7,0]	795 [9,0]	990 [11,2]	1585 [17,9]	1974 [22,3]
	Peak**	610 [6,9]	780 [8,8]	975 [11]	1210 [13,7]	1930 [21,8]	2420 [27,3]
Max. Output, HP [kW]	Cont.	4.60 [3,4]	7.5 [5,6]	7.5 [5,6]	11.3 [8,4]	11.3 [8,4]	11.3 [8,4]
	Int.*	8.2 [6,1]	11.3 [8,4]	11.5 [8,6]	14.1 [10,5]	16 [12]	16 [12]
Max. Pressure Drop, PSI [bar]	Cont.	1450 [100]	1815 [125]	1815 [125]	1815 [125]	1815 [125]	1815 [125]
	Int.*	2030 [140]	2465 [170]	2540 [175]	2540 [175]	2540 [175]	2540 [175]
	Peak**	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]
Max. Oil Flow, GPM [lpm]	Cont.	8 [30]	10.5 [40]	10.5 [40]	11.9 [45]	15.9 [60]	15.9 [60]
	Int.*	10.5 [40]	11.9 [45]	11.9 [45]	14.5 [55]	19.8 [75]	19.8 [75]
Max. Inlet Pressure, PSI [bar]	Cont.	2030 [140]	2030 [140]	2030 [140]	2030 [140]	2030 [140]	2030 [140]
	Int.*	2540 [175]	2540 [175]	2540 [175]	2540 [175]	2540 [175]	2540 [175]
	Peak**	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]
Max. Return Pres- sure with Drain Line, PSI [bar]	Cont.	2030 [140]	2030 [140]	2030 [140]	2030 [140]	2030 [140]	2030 [140]
	Int.*	2540 [175]	2540 [175]	2540 [175]	2540 [175]	2540 [175]	2540 [175]
	Peak**	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]
Max. Starting Pressure with Unloaded Shaft, PSI [bar]		145 [10]	145 [10]	145 [10]	145 [10]	145 [10]	145 [10]
Min. Starting Torque, lb-in [daNm]	At max.press. drop Cont.	265 [3,0]	425 [4,8]	566 [6,4]	655 [7,4]	1045 [11,8]	1300 [14,7]
	At max.press. drop Int.*	362 [4,1]	565 [6,4]	725 [8,2]	900 [10,2]	1440 [16,3]	1800 [20,3]
Min. Speed***, [RPM]		20	15	10	10	10	10
Weight, lb [kg]	HP	11.5 [5,2]	11.5 [5,2]	11.5 [5,2]	11.7 [5,3]	11.9 [5,4]	12.3 [5,6]
	HPQ	10.6 [4,8]	10.6 [4,8]	10.6 [4,8]	10.8 [4,9]	11.25 [5,1]	11.69 [5,3]

* Intermittent operation: the permissible values may occur for max. 10% of every minute.

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

*** For speeds lower than given, consult factory or your regional manager.

- Intermittent speed and intermittent pressure must not occur simultaneously.
- Recommended filtration is per ISO cleanliness code 20/16. A nominal filtration of 25 micron or better.
- Recommend using a premium quality, anti-wear type mineral based hydraulic oil HLP (DIN51524) or HM (ISO 6743/4).
If using synthetic fluids consult the factory for alternative seal materials.
- Recommended minimum oil viscosity 70 SUS [13 mm²/s] at 122°F [50°C].
- Recommended maximum system operating temperature is 180°F [82°C].
- To assure optimum motor life fill with fluid prior to loading and run at moderate load and speed for 10-15 minutes.

SPECIFICATION DATA (continued)

Type		HP 125	HP 160	HP 200	HP 250	HP 315	HP 400
Displacement, in ³ /rev [cm ³ /rev]		7.55 [123,8]	9.66 [158,4]	12.1 [198]	15.1 [247,5]	19.3 [316,8]	24.16 [396]
Max. Speed, [RPM]	Cont.	485	379	303	242	189	152
	Int.*	606	473	379	303	237	189
Max. Torque, lb-in [daNm]	Cont.	1790 [20,2]	2105 [23,8]	2400 [27,1]	2860 [32,3]	3290 [37,2]	3665 [41,4]
	Int.*	2470 [27,9]	2805 [31,7]	3390 [38,3]	3675 [41,5]	4340 [49,0]	4520 [51,1]
	Peak**	3025 [34,2]	3870 [43,7]	4830 [54,6]	4830 [54,6]	5500 [62,1]	5585 [63,1]
Max. Output HP [kW]	Cont.	11.3 [8,4]	10.3 [7,7]	9.5 [7,1]	9 [6,7]	8.2 [6,1]	7.2 [5,4]
	Int.*	16 [12]	16 [12]	16 [12]	14.3 [10,7]	13.1 [9,8]	11 [8,2]
Max. Pressure Drop, PSI [bar]	Cont.	1815 [125]	1670 [115]	1520 [105]	1450 [100]	1305 [90]	1160 [80]
	Int.*	2540 [175]	2250 [155]	2175 [150]	1885 [130]	1740 [120]	1450 [100]
	Peak**	3260 [225]	3260 [225]	3260 [225]	2610 [180]	2320 [160]	1885 [130]
Max. Oil Flow, GPM [lpm]	Cont.	15.9 [60]	15.9 [60]	15.9 [60]	15.9 [60]	15.9 [60]	15.9 [60]
	Int.*	19.8 [75]	19.8 [75]	19.8 [75]	19.8 [75]	19.8 [75]	19.8 [75]
Max. Inlet Pressure, PSI [bar]	Cont.	2030 [140]	2030 [140]	2030 [140]	2030 [140]	2030 [140]	2030 [140]
	Int.*	2540 [175]	2540 [175]	2540 [175]	2540 [175]	2540 [175]	2540 [175]
	Peak**	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]
Max. Return Pres- sure with Drain Line, PSI [bar]	Cont.	2030 [140]	2030 [140]	2030 [140]	2030 [140]	2030 [140]	2030 [140]
	Int.*	2540 [175]	2540 [175]	2540 [175]	2540 [175]	2540 [175]	2540 [175]
	Peak**	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]	3260 [225]
Max. Starting Pressure with Unloaded Shaft, PSI [bar]		145 [10]	145 [10]	100 [7]	100 [7]	100 [7]	100 [7]
Min. Starting Torque, lb-in [daNm]	At max.press. drop Cont.	1630 [18,4]	1910 [21,6]	2190 [24,7]	2600 [29,4]	3000 [33,9]	3330 [37,6]
	At max.press. drop Int.*	2250 [25,1]	2550 [28,8]	3090 [34,9]	3345 [37,8]	3950 [44,6]	4115 [46,5]
Min. Speed***, [RPM]		10	10	10	10	10	10
Weight, lb [kg]	HP	12.6 [5,7]	13.0 [5,9]	13.4 [6,1]	13.9 [6,3]	14.6 [6,6]	15.7 [7,1]
	HPQ	11.91 [5,4]	12.35 [5,6]	12.79 [5,8]	13.23 [6,0]	13.89 [6,3]	14.8 [6,7]

* Intermittent operation: the permissible values may occur for max. 10% of every minute.

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

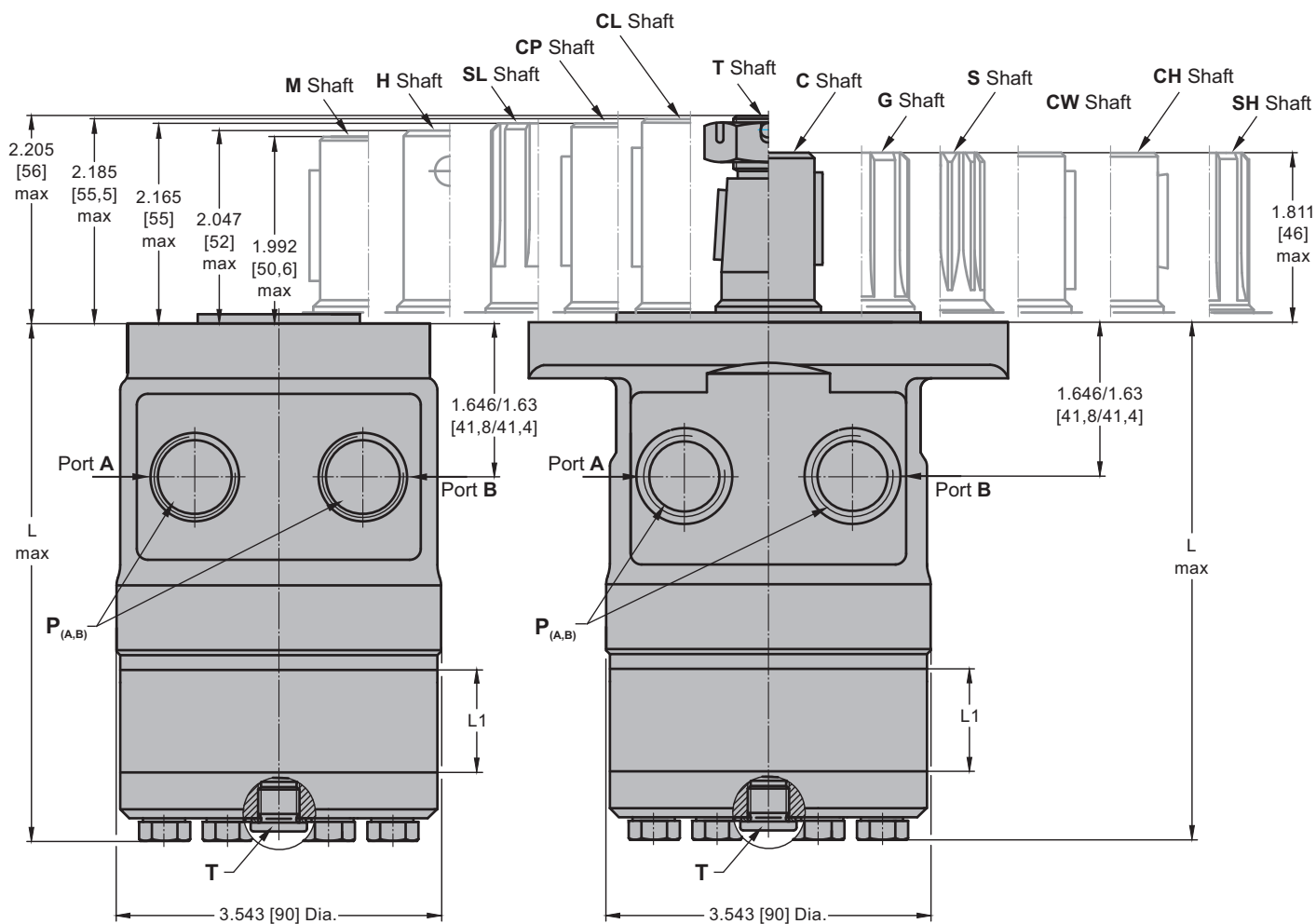
*** For speeds lower than given, consult factory or your regional manager.

- Intermittent speed and intermittent pressure must not occur simultaneously.
- Recommended filtration is per ISO cleanliness code 20/16. A nominal filtration of 25 micron or better.
- Recommend using a premium quality, anti-wear type mineral based hydraulic oil HLP (DIN51524) or HM (ISO 6743/4).
If using synthetic fluids consult the factory for alternative seal materials.
- Recommended minimum oil viscosity 70 SUS [13 mm²/s] at 122°F [50°C].
- Recommended maximum system operating temperature is 180°F [82°C].
- To assure optimum motor life fill with fluid prior to loading and run at moderate load and speed for 10-15 minutes.

DIMENSIONS and MOUNTING DATA

HPQ

HP



Type	$L_{\max}$, in [mm]	L_1 , in [mm]
HP(Q) 25	4.69 [119,0]	.21 [5,20]
HP(Q) 32	4.72 [120,0]	.25 [6,30]
HP(Q) 40	4.76 [121,0]	.29 [7,40]
HP(Q) 50	4.74 [120,5]	.26 [6,67]
HP(Q) 80	4.90 [124,5]	.42 [10,67]
HP(Q) 100	5.00 [127,0]	.52 [13,33]
HP(Q) 125	5.14 [130,5]	.66 [16,67]
HP(Q) 160	5.32 [135,0]	.84 [21,33]
HP(Q) 200	5.53 [140,5]	1.05 [26,67]
HP(Q) 250	5.79 [147,0]	1.31 [33,33]
HP(Q) 315	6.16 [156,5]	1.68 [42,67]
HP(Q) 400	6.57 [167,0]	2.10 [53,33]

Shaft Dim.
See Page 60 and 61

Flange Dim.
See Page 59

Port Dim.
See Page 59

Standard Rotation

Viewed from Shaft End

Port **A** Pressurized - **CW**
Port **B** Pressurized - **CCW**

Reverse Rotation

Viewed from Shaft End

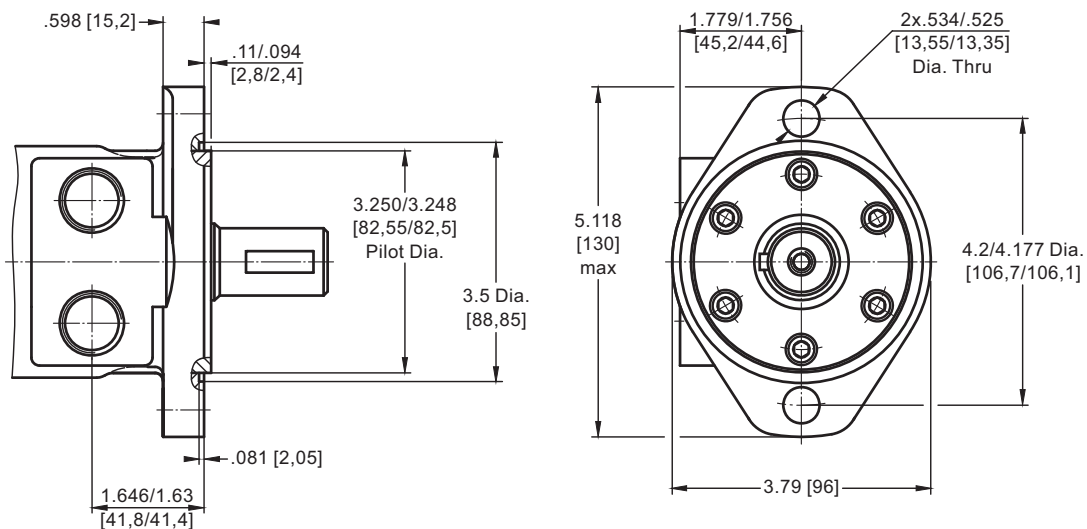
Port **A** Pressurized - **CCW**
Port **B** Pressurized - **CW**



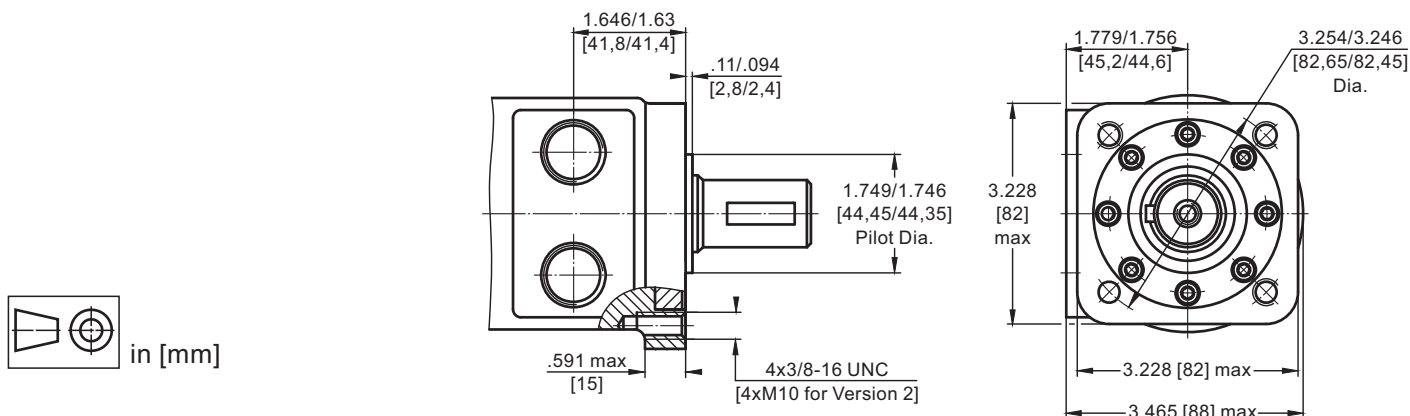
	Versions				
	[1]	[2]	[3]	[4]	[5]
C	4x ⁵ / ₁₆ - 18 UNF	-	4xM8	-	-
P_(A,B)	2x.39 Dia. [2x10]	2xG ¹ / ₂	2x.39 Dia. [2x10]	2x ⁷ / ₈ - 14 UNF	2x ¹ / ₂ - 14 NPTF
T	⁷ / ₁₆ - 20 UNF	G ¹ / ₄	⁷ / ₁₆ - 20 UNF	⁷ / ₁₆ - 20 UNF	⁷ / ₁₆ - 20 UNF

MOUNTING

SAE A Flange



Q - Square Flange



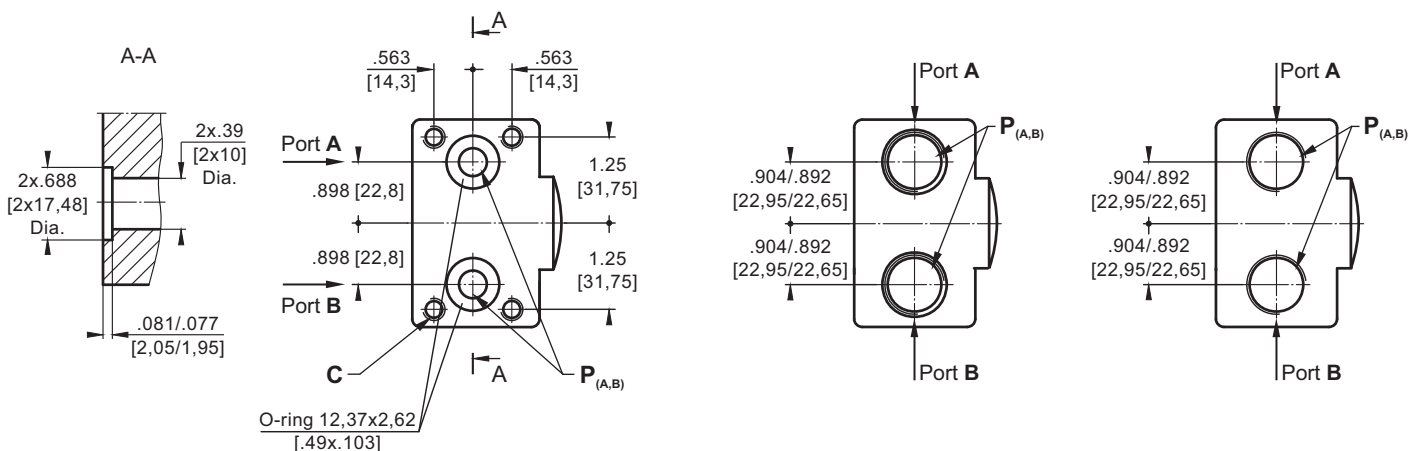
PORTS

Side Ports

Version 1, 3

Version 4

Version 2, 5



Standard Rotation

Viewed from Shaft End
Port A Pressurized - CW
Port B Pressurized - CCW

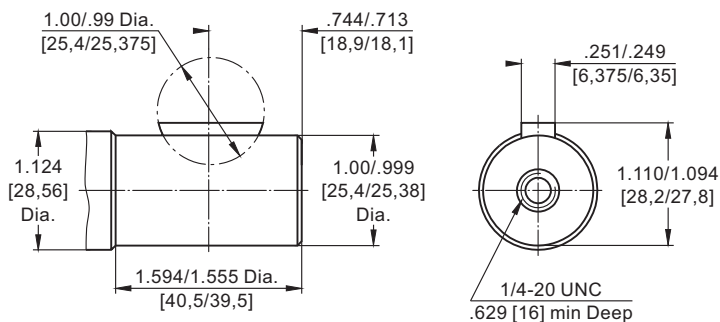
Reverse Rotation

Viewed from Shaft End
Port A Pressurized - CCW
Port B Pressurized - CW

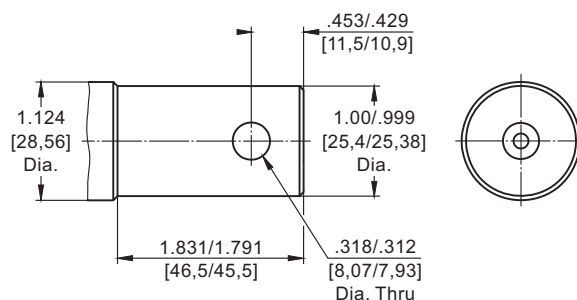
	Versions				
	1	2	3	4	5
C	4x ⁵ / ₁₆ - 18 UNF	-	4xM8	-	-
P _(A,B)	2x.39 Dia. [2x10]	2xG ¹ / ₂	2x.39 Dia. [2x10]	2x ⁷ / ₈ - 14 UNF	2x ¹ / ₂ - 14 NPTF
T	⁷ / ₁₆ - 20 UNF	G ¹ / ₄	⁷ / ₁₆ - 20 UNF	⁷ / ₁₆ - 20 UNF	⁷ / ₁₆ - 20 UNF

SHAFT EXTENSIONS for HP and HR MOTORS

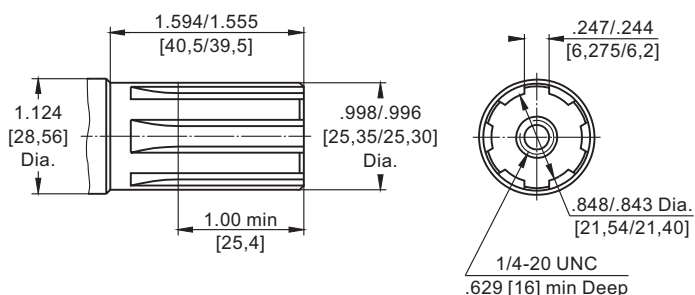
C - 1" [25,4] straight, Woodruff key $\frac{1}{4}$ "x1" SAE J502
Max. Torque 3009 lb-in [34 daNm]



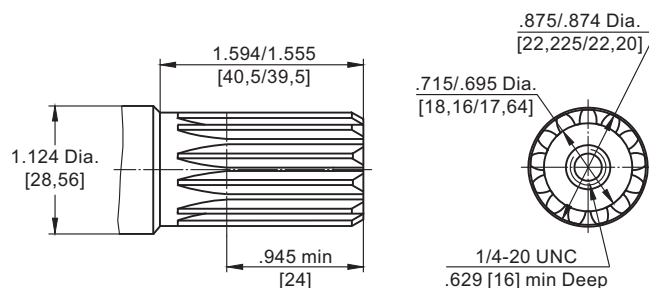
H - 1" [25,4] straight, w/ .315 [8] Crosshole
Max. Torque 3009 lb-in [34 daNm]



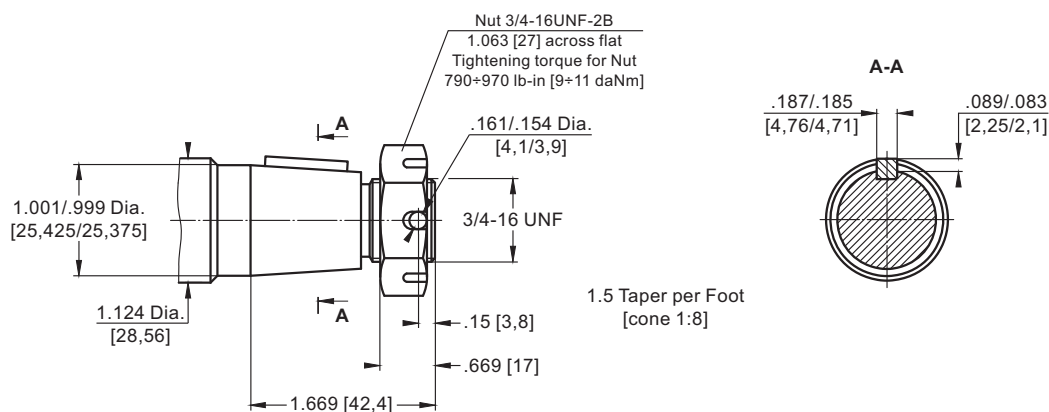
G - 1" [25,4] splined, SAE 6B
Max. Torque 3540 lb-in [40 daNm]



S - $\frac{7}{8}$ " [22,2] splined 13T, ANS B 92.1-1976
Max. Torque 3200 lb-in [36 daNm]



T - 1" [25,4] tapered SAE J501, Parallel key $\frac{3}{16}$ "x $\frac{3}{16}$ "x $\frac{3}{4}$ "
Max. Torque 3540 lb-in [40 daNm]



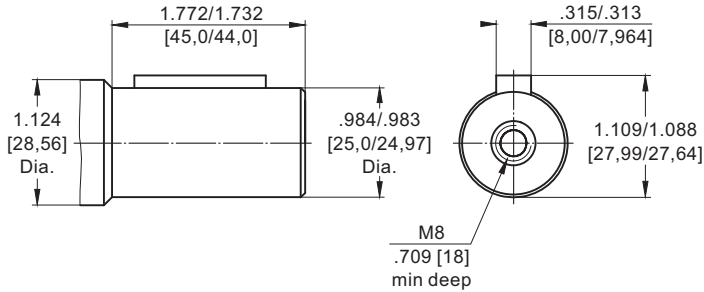
Requirement max. Torque must not be exceeded.



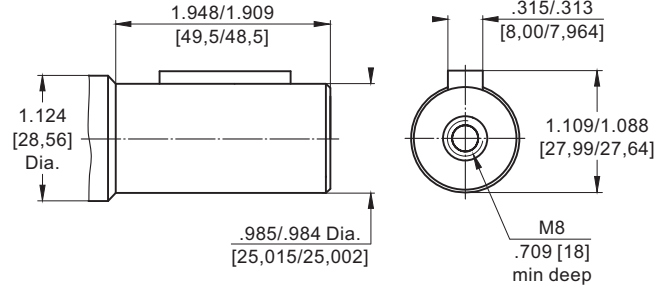
in [mm]

SHAFT EXTENSIONS for HP and HR MOTORS

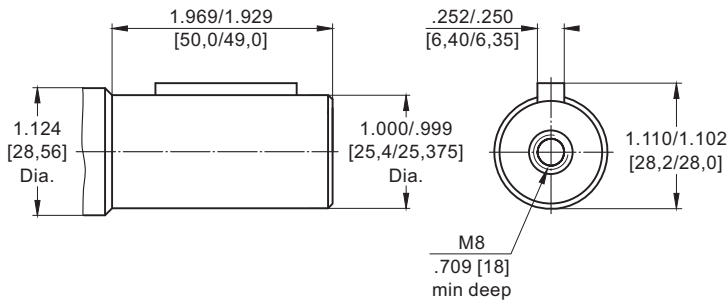
M - ø25 straight, Parallel key A8x7x32 DIN 6885
Max. Torque 3009 lb-in [34 daNm]



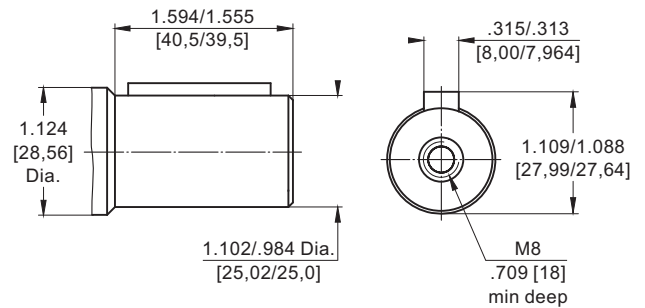
CP - ø25 straight, Parallel key A8x7x32 DIN 6885
Max. Torque 3009 lb-in [34 daNm]



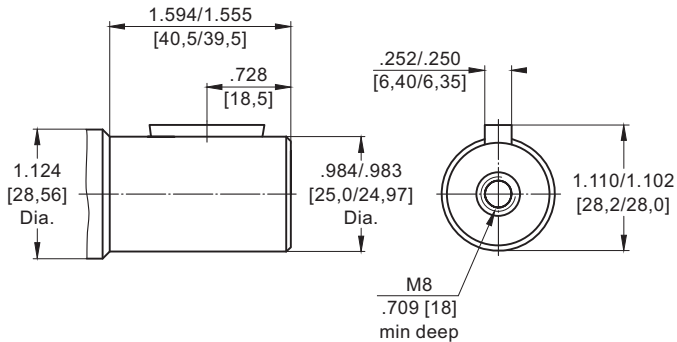
CL - 1" [25,4] straight, Parallel key ¼"x¼"x1¼" BS46
Max. Torque 3009 lb-in [34 daNm]



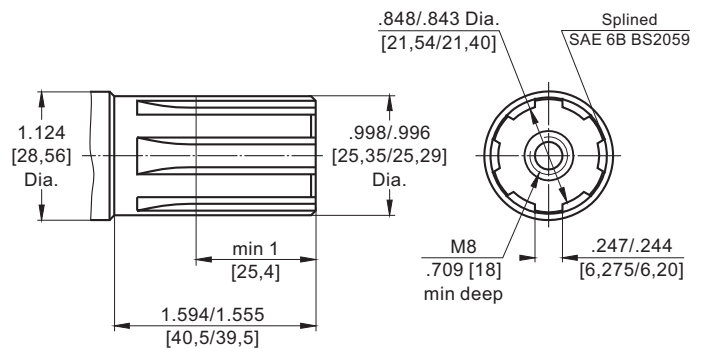
CW - ø25 straight, Parallel key A8x7x32 DIN 6885
Max. Torque 3009 lb-in [44 daNm]



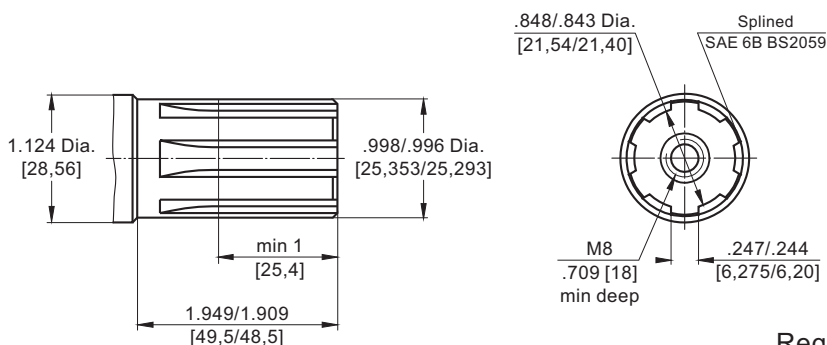
CH - ø25 straight, Woodruff key ¼"x1" SAE J502
Max. Torque 3009 lb-in [34 daNm]



SH - 1" [25,4] splined, SAE 6B
Max. Torque 3540 lb-in [40 daNm]



SL - 1" [25,4] splined, SAE 6B
Max. Torque 3540 lb-in [40 daNm]



Requirement max. Torque must not be exceeded.

PERMISSIBLE SHAFT LOADS for HP and HR MOTORS

The permissible radial shaft load P_{rad} depends on the speed RPM and distance L from the point of load to the mounting flange.

$$\text{Radial Shaft Load } P_{rad} = \frac{650}{\text{RPM}} \times \frac{23200}{89+L}, \text{ daN}^*$$

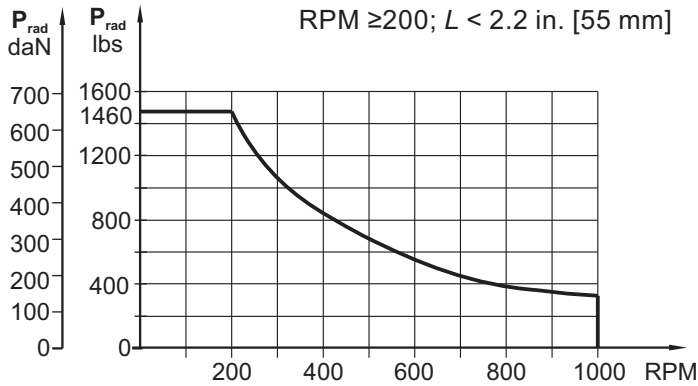
* L - in mm.

$$\text{Radial Shaft Load: } P_{rad} = \frac{1460}{\text{RPM}} \times \frac{913}{3.5+L}, \text{ lbs}^*$$

* L - in inch

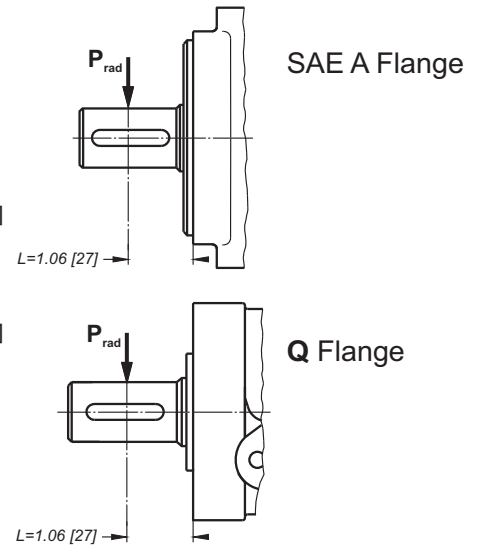
RPM < 200 => max P_{rad} = 1460 lbs [650 daN]

RPM ≥ 200; $L < 2.2$ in. [55 mm]



$P_{a \max}$ = 330 lbs
[150 daN]

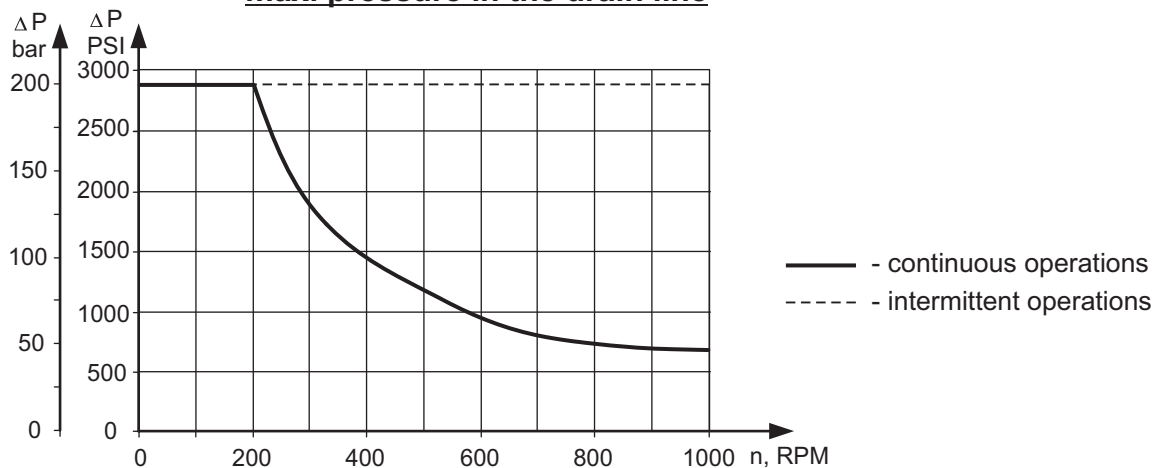
$P_{a \max}$ = 440 lbs
[200 daN]



MAX. PERMISSIBLE SHAFT SEAL PRESSURE for HP and HR MOTORS

<i>HP...1 and HR...1 motors without drain connection:</i>	<i>HP... and HR... motors with drain connection:</i>	<i>HP...K and HR...K motors with check valves and drain connection:</i>	<i>HP...K1 and HR...K1 motors with check valves and without drain connection:</i>
The shaft seal pressure equals the average of input pressure and return pressure. $P_{seal} = \frac{P_{input} + P_{return}}{2}$	The shaft seal pressure equals the pressure in the drain line.	The shaft seal pressure equals the pressure in the drain line.	The shaft seal pressure never exceeds the pressure in the return line.

Max. return pressure without drain line or max. pressure in the drain line



ORDER CODE

	1	2	3	4	5	6	7	8	9
HP					U				

Pos.1 - Mounting Flange

- omit - SAE A, two holes
Q - Square, four bolts

Pos.2 - Displacement code*

- | | |
|------------|---|
| 25 | - 1.73 in ³ /rev [28,4 cm ³ /rev] |
| 32 | - 2.11 in ³ /rev [34,5 cm ³ /rev] |
| 40 | - 2.47 in ³ /rev [40,5 cm ³ /rev] |
| 50 | - 3.02 in ³ /rev [49,5 cm ³ /rev] |
| 80 | - 4.83 in ³ /rev [79,2 cm ³ /rev] |
| 100 | - 6.04 in ³ /rev [99,0 cm ³ /rev] |
| 125 | - 9.66 in ³ /rev [123,8 cm ³ /rev] |
| 160 | - 9.74 in ³ /rev [158,4 cm ³ /rev] |
| 200 | - 12.10 in ³ /rev [198,0 cm ³ /rev] |
| 250 | - 15.10 in ³ /rev [247,5 cm ³ /rev] |
| 315 | - 19.30 in ³ /rev [316,8 cm ³ /rev] |
| 400 | - 24.16 in ³ /rev [396,0 cm ³ /rev] |

Pos.3 - Shaft Extensions**

- | | |
|-----------|--|
| C | - 1" [25,4] straight, Woodruff key |
| G | - 1" [25,4] SAE 6B Splined |
| H | - 1" [25,4] straight, w/.315 [8] Cross-hole |
| S | - 7/8" [22,2] 13T Splined |
| T | - 1" [25,4] SAE J501 Tapered |
| M | - ø 25 straight, Parallel key A8x7x32 DIN 6885 |
| CP | - ø 25 straight, Parallel key A8x7x32 DIN 6885 |
| CL | - 1" [25,4] straight, Parallel key 1/4"x1/4"x1 1/4" BS46 |
| CW | - ø 25 straight, Parallel key A8x7x32 DIN 6885 |
| CH | - ø25 straight, Woodruff key 1/4"x1" SAE J502 |
| SH | - 1" [25,4], SAE 6B Splined |
| SL | - 1" [25,4], SAE 6B Splined |

Pos.4 - Port Size/Type [standard manifold to each]

- | | |
|----------|--|
| 1 | - side ports, Manifold [5/16-18 UNC Mounting Threads], 7/16-20 UNF |
| 2 | - side ports, 2xG1/2, G1/4 |
| 3 | - side ports, Manifold [M8 Mounting Threads], 7/16-20 UNF |
| 4 | - side ports, 2x7/8-14 UNF, O-ring, 7/16-20 UNF |
| 5 | - side ports, 2x1/2-14 NPTF, 7/16-20 UNF |

Pos.5 - Shaft Seal Version [see page 60]

- | | |
|----------|----------------------------|
| U | - high pressure shaft seal |
|----------|----------------------------|

Pos.6 - Check Valves

- omit - without check valves
K - with check valves

Pos.7 - Drain Port

- omit - with drain port
1 - without drain port

Pos.8 - Additional Options [see page 110]

Pos.9 - Design Series

- omit - Factory specified

NOTES:

- * For the Function Diagrams please look at "M+S Hydraulic" Catalogue for MLHP motors, [pages 18÷24](#).
 ** The permissible output torque for shafts must not be exceeded!

The hydraulic motors are mangano-phosphatized as standard.

MOTOR ADDITIONAL OPTIONS

Additional Options Description	Order Code	Motor type											
		MLHM	MLHP	MLHPW, MLHP(W)N	HP	MLHR	MLHRN	HR	MLHPL	MLHRL	MLHRW	MLHH	HW
Speed Sensor*	RS	O	O	-	O	O	-	O	-	-	-	O	O****
Low Leakage	LL	O	-	-	-	O	O	O	-	O	O	O	O
Low Speed Valving	LSV	-	-	-	-	O	-	-	-	-	-	O	O
Free Running	FR	O	O	O	O	O	O	O	O	O	O	O	O
Reverse Rotation	R	O	O	O	O	O	O	O	O	O	O	O	O
Paint**	P	O	O	O	O	O	O	O	O	O	O	O	O
Corrosion Protected Paint**	PC	O	O	O	O	O	O	O	O	O	O	O	O
Special Paint***	PS	O	O	O	O	O	O	O	O	O	O	O	O
	PCS												
Check Valves		S	S****	S	O	S****	S	O	S	S	S****	S****	S

O	Optional
-	Not applicable
S	Standard

* For sensor ordering see pages 111÷112.

** Colour at customer's request.

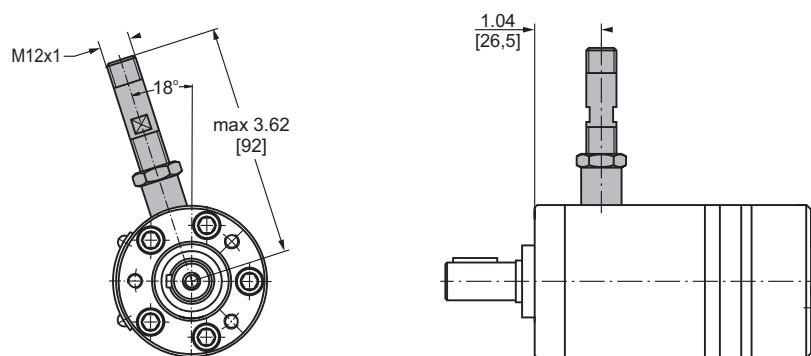
*** Non painted feeding surfaces, colour at customer's request.

**** Without check valves for "U" shaft seal versions.

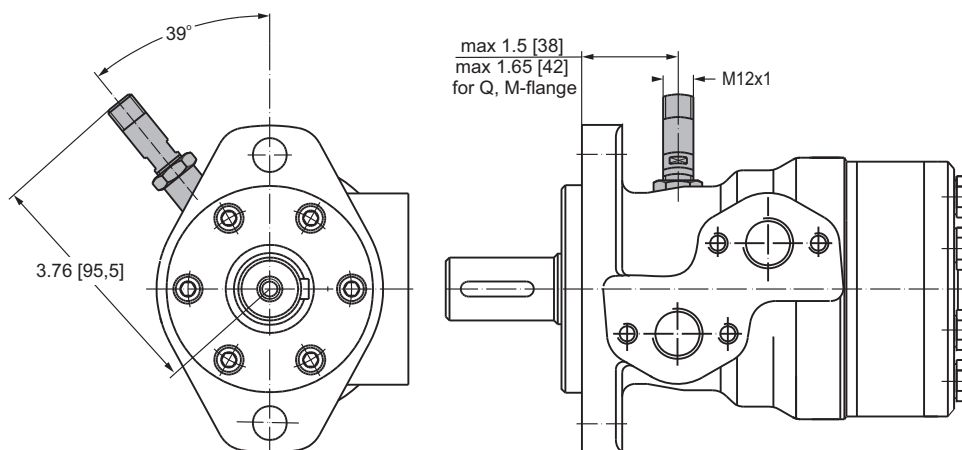
***** RS option is not available at HW...R (with relief valves).

MOTORS WITH SPEED SENSOR

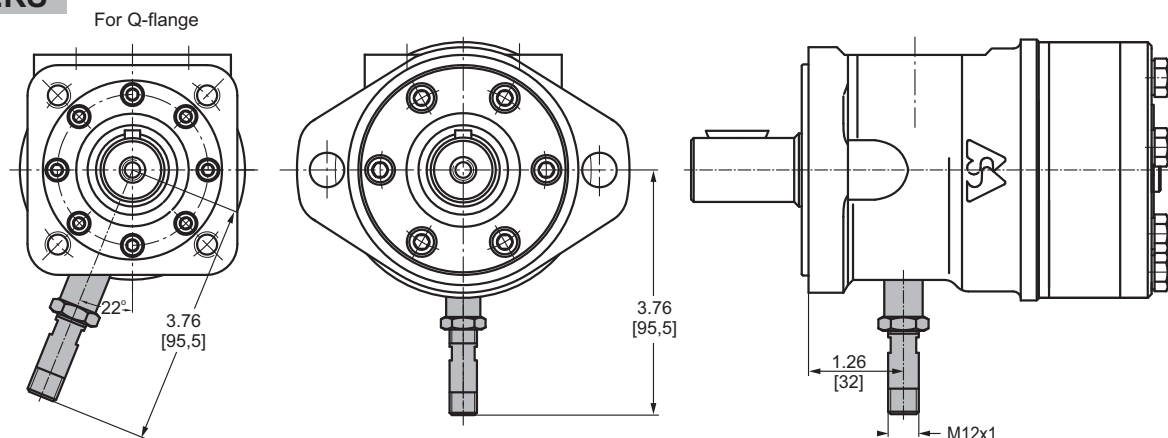
MLHM...RS



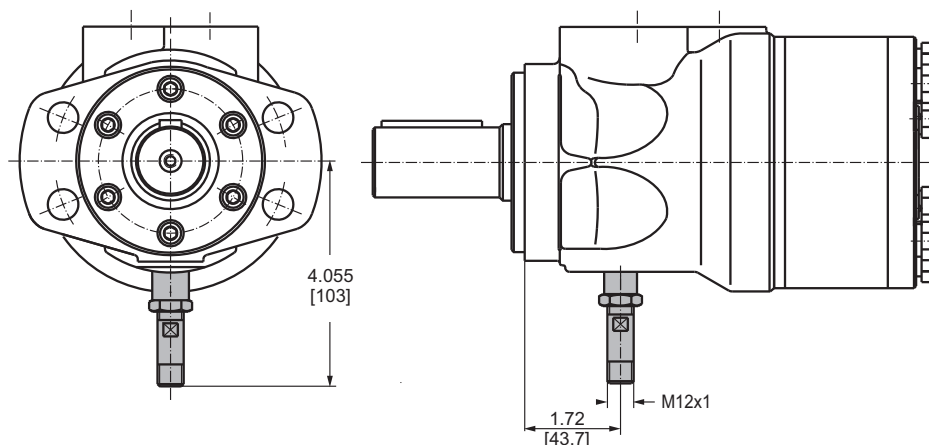
MLHP...RS MLHR...RS

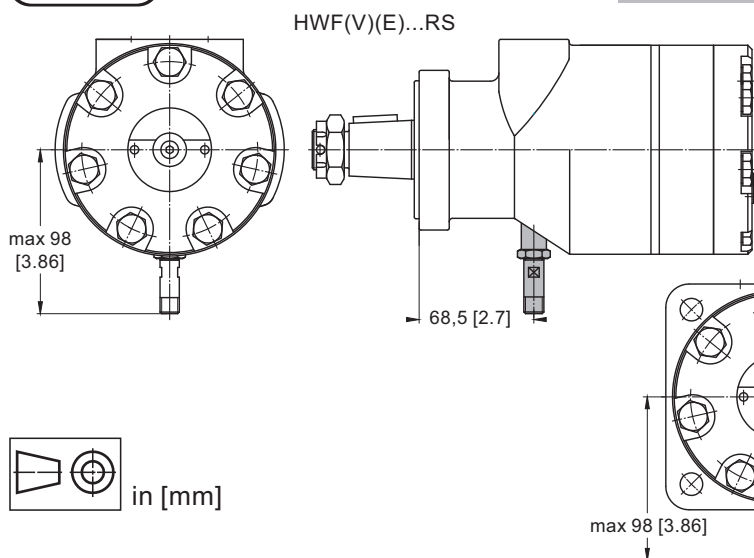


HP...RS HR...RS



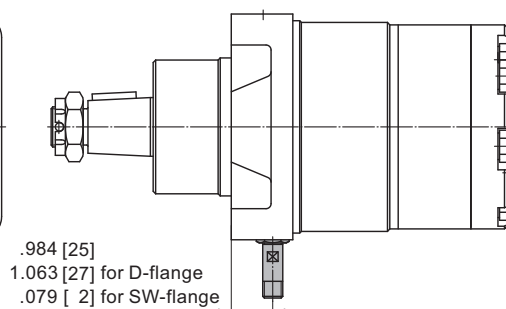
MLHH...RS





RS option is not available at HW...R (with relief valves).

HW(S)(D)(SW)(V)(E)...RS

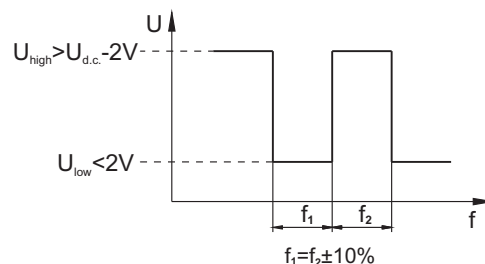


TECHNICAL DATA of the SPEED SENSOR

Technical data

Frequency range	0...15 000 Hz
Output	Universal PUSH PULL
Power supply	10-30 VDC
Current input	<20 mA (@24 VDC)
Maximum output current	500 mA
Ambient Temperature	-40...+125°C [-40...+257°F]
Protection	IP 67
Plug connector	M12-Series
Mounting principle	ISO 6149

Output signal

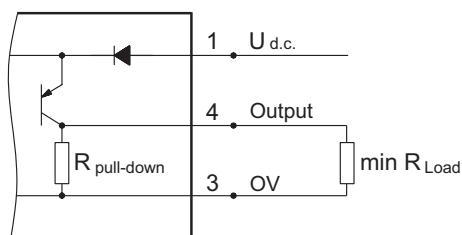


Load max.: $I_{high} = I_{low} < 50\text{mA}$

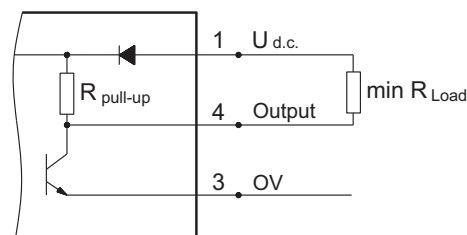
Motor type	MLHM	MLHP	MLHR	HP, HR	MLHH	HW
Pulses per revolution	30	36	36	36	42	12

Wiring diagrams

PNP

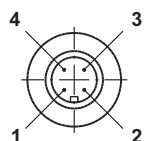


NPN



$$R_{Load} [\text{k}\Omega] = U_{d.c.} [\text{V}] / I_{max} [\text{mA}]$$

Stick type



Terminal No.	Connection	Cable Output
1	$U_{d.c.}$	Brown
2	No connection	White
3	0V	Blue
4	Output signal	Black

Order Code for Speed Sensor

Sensor Code	Electric connection
RS	Connector BINDER 713 series
RSL2,5	Cable output 3x0,25; 98 in [2,5 m] long
RSL3,5	Cable output 3x0,25; 138 in [3,5 m] long
RSL5	Cable output 3x0,25; 196 in [5 m] long
RSL10	Cable output 3x0,25; 394 in [10 m] long

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.

APPLICATION CALCULATION

VEHICLE DRIVE CALCULATIONS

1. Motor speed: n , RPM

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

v_{km} - vehicle speed, km/h;
 v_{mi} - vehicle speed, mile/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 , lbs [daN]

The resistance force resulted in wheels contact with different surfaces:

$$RR = G \times \rho$$

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

Table 1

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

3. Grade resistance: GR , lbs [daN]

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

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°

4. Acceleration force: FA , lbs [daN]

Force FA necessary for acceleration from 0 to maximum speed v and time t can be calculated with a formula:

$$FA = \frac{v_{mi} \times G}{22 \times t}, [\text{lbs}]; \quad FA = \frac{v_{km} \times G}{36 \times t}, [\text{daN}]$$

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

5. Tractive effort: DP , lbs [daN]

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 , lbs [daN]

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.

$$TE = 1,1 \times (RR + GR + FA + DP)$$

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

7. Motor Torque moment: M , lb-in [daNm]

Necessary torque moment for every hydraulic motor:

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

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

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

$$M_w = \frac{G_w \times f \times R_{in} [R_m]}{i \times \eta_M}$$

To avoid wheel slipping, the following condition should be observed $M_w > M$

f - frictional factor;

G_w - total weight over the wheels, lbs [daN].

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

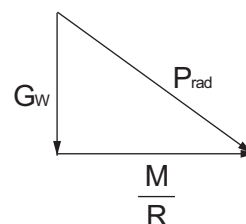
9.Radial motor loading: P_{rad} , lbs [daN]

When motor is used for vehicle motion with wheels mounted directly on motor shaft, the total radial loading of motor shaft P_{rad} is a sum of motion force and weight force acting on one wheel.

G_w - Weight held by wheel;

P_{rad} - Total radial loading of motor shaft;

M/R - Motion force.



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

In accordance with calculated loadings the suitable motor from the catalogue is selected.

DRAINAGE SPACE AND DRAINAGE PRESSURE

Advantages in oil drainage from drain space: Cleaning; Cooling and Seal lifetime prolonging.

