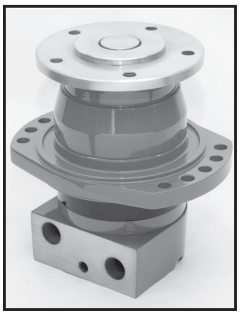
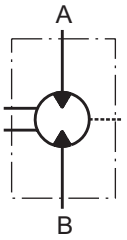
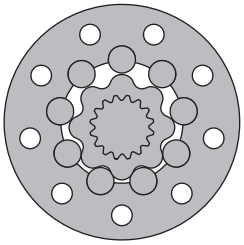
# HYDRAULIC MOTORS TMF



## APPLICATION

» Marine equipment
» Forestry equipment
» Metal working machines
» Agricultural machines
» Road building machines
» Mining machinery
» Special vehicles etc.



## CONTENTS



## OPTIONS

» Model - Disc valve, roll-gerotor
» Wheel mounting flange
» Side ports
» Shaft - thread hole flange
» SAE and BSPP ports
» Other special features

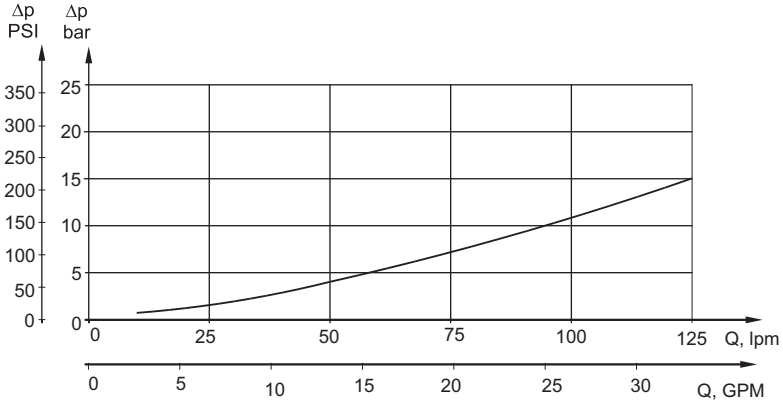
## GENERAL

| | |
|---|---|
| **Max. Displacement,** $in^3$/rev [$cm^3$/rev] | 44.2 [724] |
| **Max. Speed,** [RPM] | 750 |
| **Max. Torque,** lb-in [daNm] | cont.: 15490 [175] int.: 19206 [217] |
| **Max. Output,** HP [kW] | 94 [70] |
| **Max. Pressure Drop,** PSI [bar] | cont.: 3600 [250] int.: 5080 [350] |
| **Max. Oil Flow,** GPM [lpm] | 39.6 [150] |
| **Min. Speed,** [RPM] | 5 |
| **Permissible Shaft Loads,** lbs [daN] | $P_a$=2250 [1000] |
| **Pressure fluid** | Mineral based- HLP(DIN 51524) or HM(ISO 6743/4) |
| **Temperature range,** $^{O}F$ [$^{O}C$] | -40÷284 [-40÷140] |
| **Optimal Viscosity range,** SUS [$mm^2/s$] | 98÷347 [20÷75] |
| **Filtration** | ISO code: 18/16/13 According to ISO 4406-1999 |

### Oil flow in drain line

| Pressure drop PSI [bar] | Viscosity SUS [$mm^2/s$] | Oil flow in drain line GPM [lpm] |
|---|---|---|
| 2900 [200] | 98 [20] | .660 [2,5] |
| | 164 [35] | .400 [1,5] |
| 3990 [275] | 98 [20] | 1.057 [4] |
| | 164 [35] | .660 [2,5] |

### Pressure Losses



## SPECIFICATION DATA

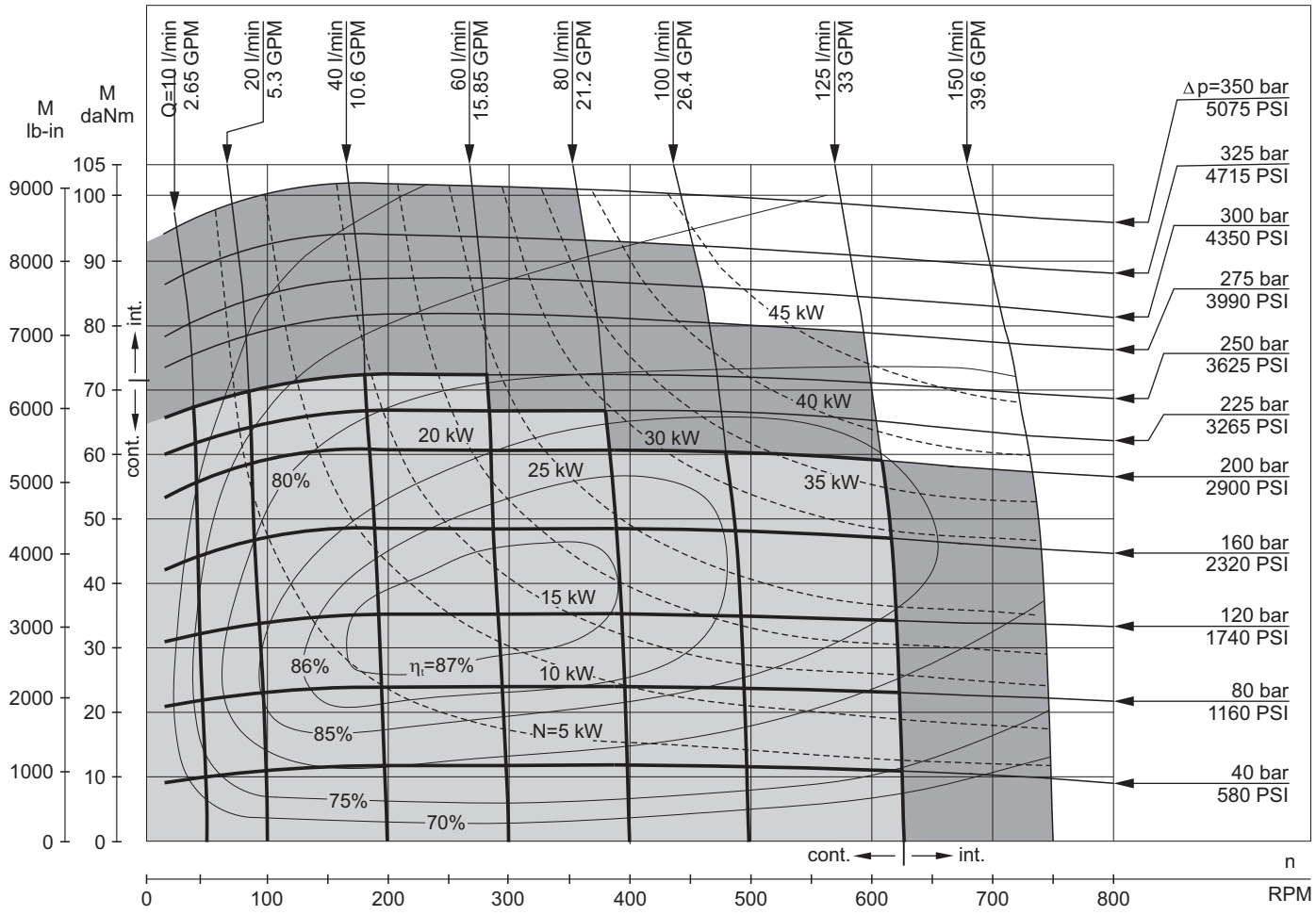
| Type | | TMF 200 | TMF 250 | TMF 315 | TMF 400 | TMF 470 | TMF 500 | TMF 630 | TMF 725 |
|---|---|---|---|---|---|---|---|---|---|
| Displacement, $cm^3/rev$ [$in^3/rev$] | | 12.29 [201,4] | 15.36 [251,8] | 19.9 [326,3] | 25.06 [410,9] | 28.97 [475] | 31.95 [523,6] | 38.52 [631,2] | 44.2 [724] |
| Max. Speed, [RPM] | Cont. | 625 | 500 | 380 | 305 | 260 | 240 | 190 | 170 |
| | Int.* | 750 | 600 | 460 | 365 | 315 | 285 | 230 | 210 |
| Max. Torque, daNm [lb-in] | Cont. | 6550 [74] | 7965 [90] | 10265 [116] | 13010 [147] | 15135 [171] | 15225 [172] | 15490 [175] | 14160 [160] |
| | Int.* | 9030 [102] | 11330 [128] | 14425 [163] | 18232 [206] | 19206 [217] | 19206 [217] | 19206 [217] | 17000 [192] |
| | Peak** | 10180 [115] | 12745 [144] | 16460 [186] | 20800 [235] | 21240 [240] | 21240 [240] | 22127 [250] | 21240 [240] |
| Max. Output, kW [HP] | Cont. | 55 [41] | 55 [41] | 55 [41] | 55 [41] | 55 [41] | 50 [37,5] | 37,5 [28] | 35 [26] |
| | Int.* | 87 [65] | 94 [70] | 94 [70] | 94 [70] | 74 [55] | 68 [51] | 56 [42] | 54 [40] |
| Max. Pressure Drop, bar [PSI] | Cont. | 3600 [250] | 3600 [250] | 3600 [250] | 3600 [250] | 3600 [250] | 3340 [230] | 2680 [185] | 2320 [160] |
| | Int.* | 5080 [350] | 5080 [350] | 5080 [350] | 5080 [350] | 320 [4640] | 4060 [280] | 3260 [225] | 3045 [210] |
| | Peak** | 5800 [400] | 5800 [400] | 5800 [400] | 5800 [400] | 5800 [400] | 320 [4640] | 3915 [270] | 3770 [260] |
| Max. Oil Flow, lpm [GPM] | Cont. | 33 [125] | 33 [125] | 33 [125] | 33 [125] | 33 [125] | 33 [125] | 33 [125] | 33 [125] |
| | Int.* | 40 [150] | 40 [150] | 40 [150] | 40 [150] | 40 [150] | 40 [150] | 40 [150] | 40 [150] |
| Max. Inlet Pressure, bar [PSI] | Cont. | 3920 [270] | 3920 [270] | 3920 [270] | 3920 [270] | 3920 [270] | 3920 [270] | 3920 [270] | 3920 [270] |
| | Int.* | 5370 [370] | 5370 [370] | 5370 [370] | 5370 [370] | 5370 [370] | 5370 [370] | 5370 [370] | 5370 [370] |
| | Peak** | 6100 [420] | 6100 [420] | 6100 [420] | 6100 [420] | 6100 [420] | 6100 [420] | 6100 [420] | 6100 [420] |
| Max. Return Pressure w/o Drain Line or Max. Pressure in Drain Line, bar [PSI] | Cont. 0-100 RPM | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] |
| | Cont.100-300 RPM | 580 [40] | 580 [40] | 580 [40] | 580 [40] | 580 [40] | 580 [40] | 580 [40] | 580 [40] |
| | Cont. >300 RPM | 290 [20] | 290 [20] | 290 [20] | 290 [20] | 290 [20] | - | - | - |
| | Int.* 0-max. RPM | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] | 1100 [75] |
| Max. Return Pressure with Drain Line, bar [PSI] | Cont. | 2000 [140] | 2000 [140] | 2000 [140] | 2000 [140] | 2000 [140] | 2000 [140] | 2000 [140] | 2000 [140] |
| | Int.* | 2500 [175] | 2500 [175] | 2500 [175] | 2500 [175] | 2500 [175] | 2500 [175] | 2500 [175] | 2500 [175] |
| | Peak** | 3000 [210] | 3000 [210] | 3000 [210] | 3000 [210] | 3000 [210] | 3000 [210] | 3000 [210] | 3000 [210] |
| Max. Starting Pressure with Unloaded Shaft, bar [PSI] | | 90 [6] | 90 [6] | 90 [6] | 90 [6] | 90 [6] | 90 [6] | 90 [6] | 90 [6] |
| Min. Starting Torque, daNm [lb-in] | | 5310 [60] | 6640 [75] | 8585 [97] | 10800 [122] | 12570 [142] | 12655 [143] | 12830 [145] | 13100 [148] |
| Min. Speed***, RPM | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Weight, kg [lb] | | 59.3 [26,9] | 60.2 [27,3] | 62 [28,1] | 64 [29] | 65.5 [29,7] | 66.6 [30,2] | 65.5 [29,7] | 68.4 [31] |

* 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.

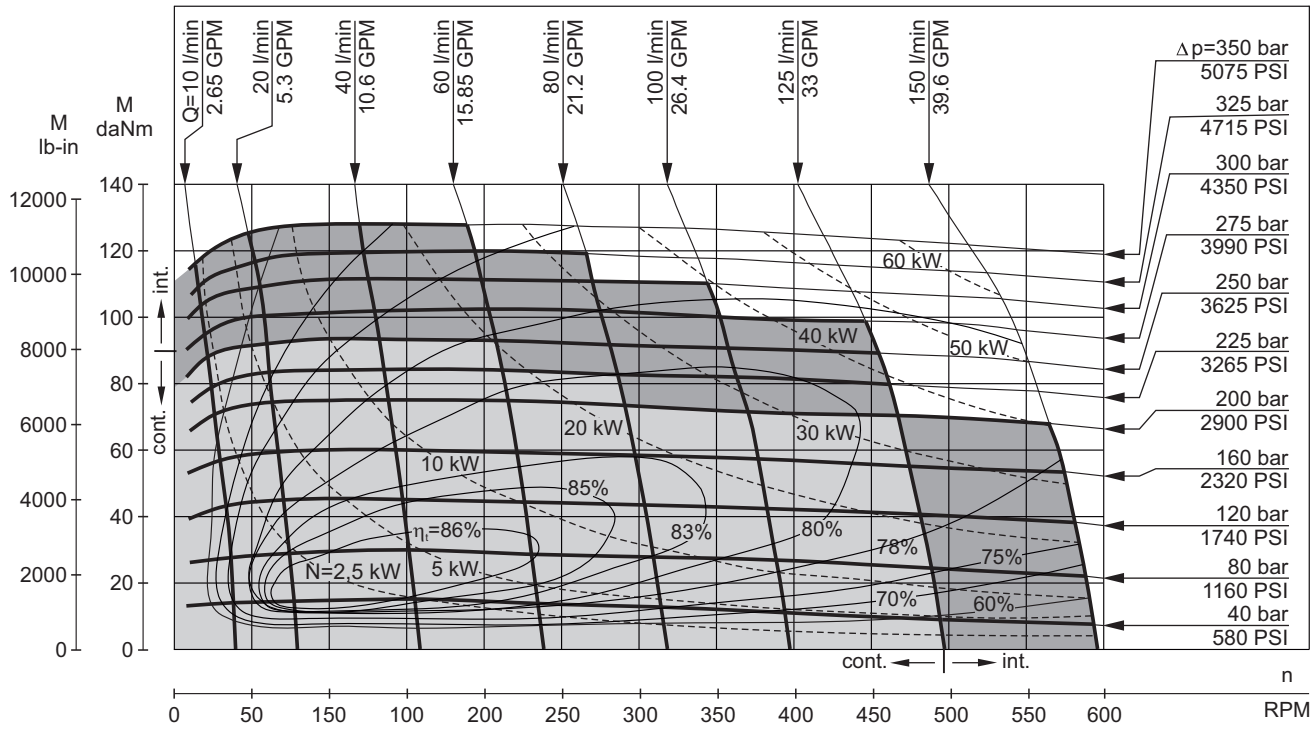
1. Intermittent speed and intermittent pressure must not occur simultaneously.
2. Recommended filtration is per ISO cleanliness code 20/16. A nominal filtration of 25 micron or better.
3. Recommend using a premium quality, anti-wear type mineral based hydraulic oil HLP(DIN51524) or HM (ISO 6743/4). If using synthetic fluids consult the factory for alternative seal materials.
4. Recommended minimum oil viscosity 70 SUS [13 $mm^2/s$] at 122°F [50°C].
5. Recommended maximum system operating temperature is 180°F [82°C].
6. To assure optimum motor life fill with fluid prior to loading and run at moderate load and speed for 10-15 minutes.

# FUNCTION DIAGRAMS

## TMF 200



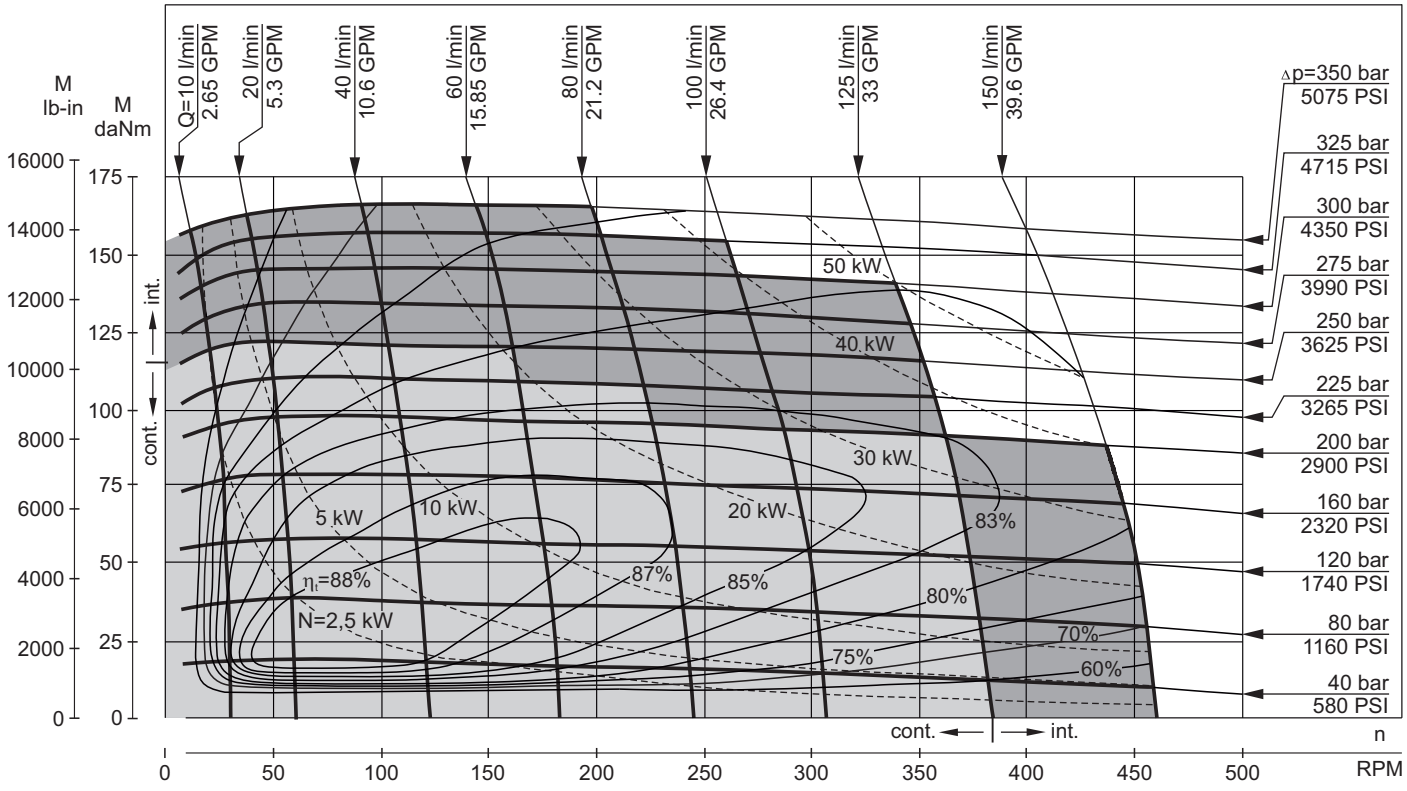

## TMF 250



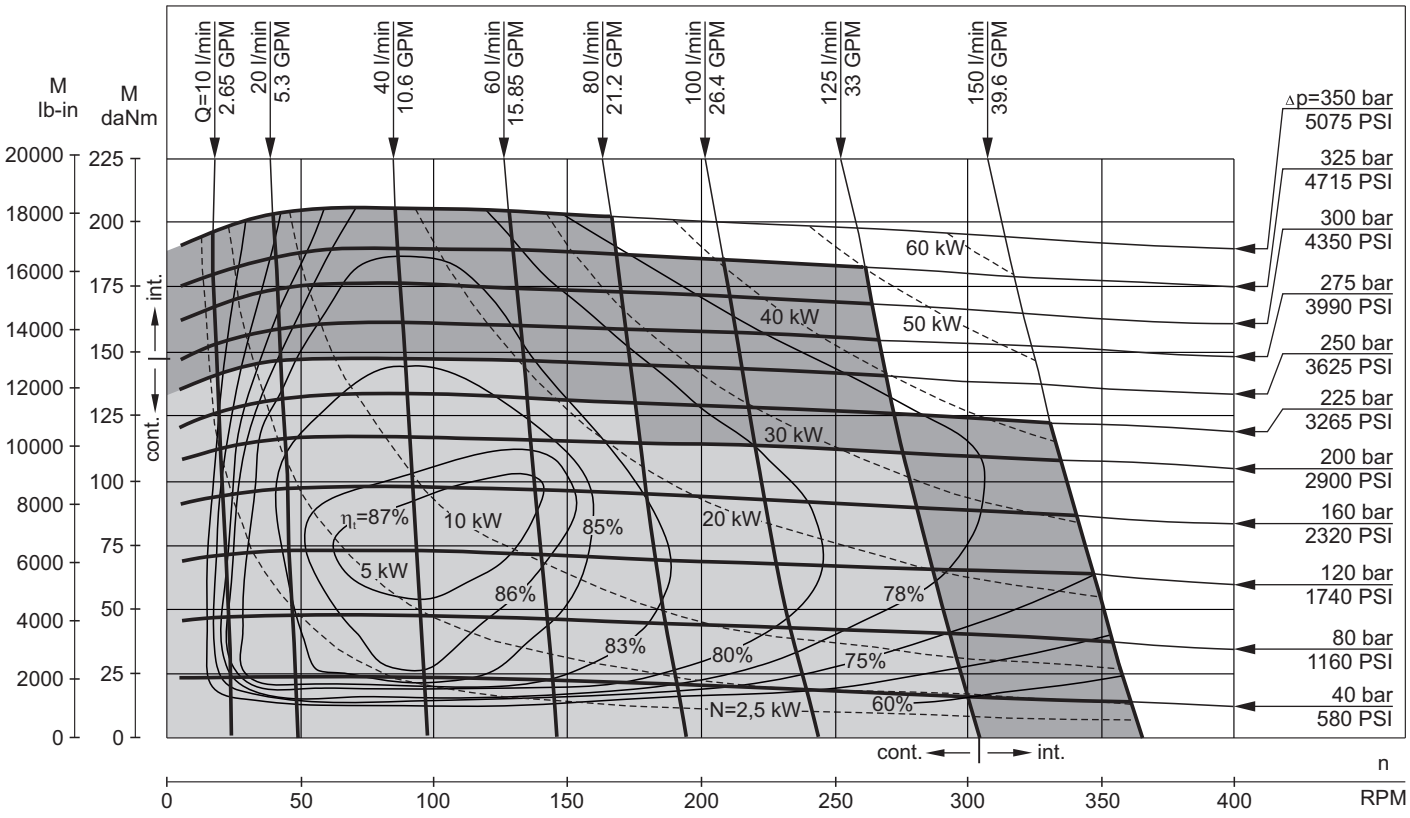

The function diagrams data is for average performance of randomly selected motors at back pressure 72.5 PSI÷145 PSI [5÷10 bar] and oil with viscosity of 150 SUS [32 mm²/s] at 122°F [50°C].

# FUNCTION DIAGRAMS

## TMF 315



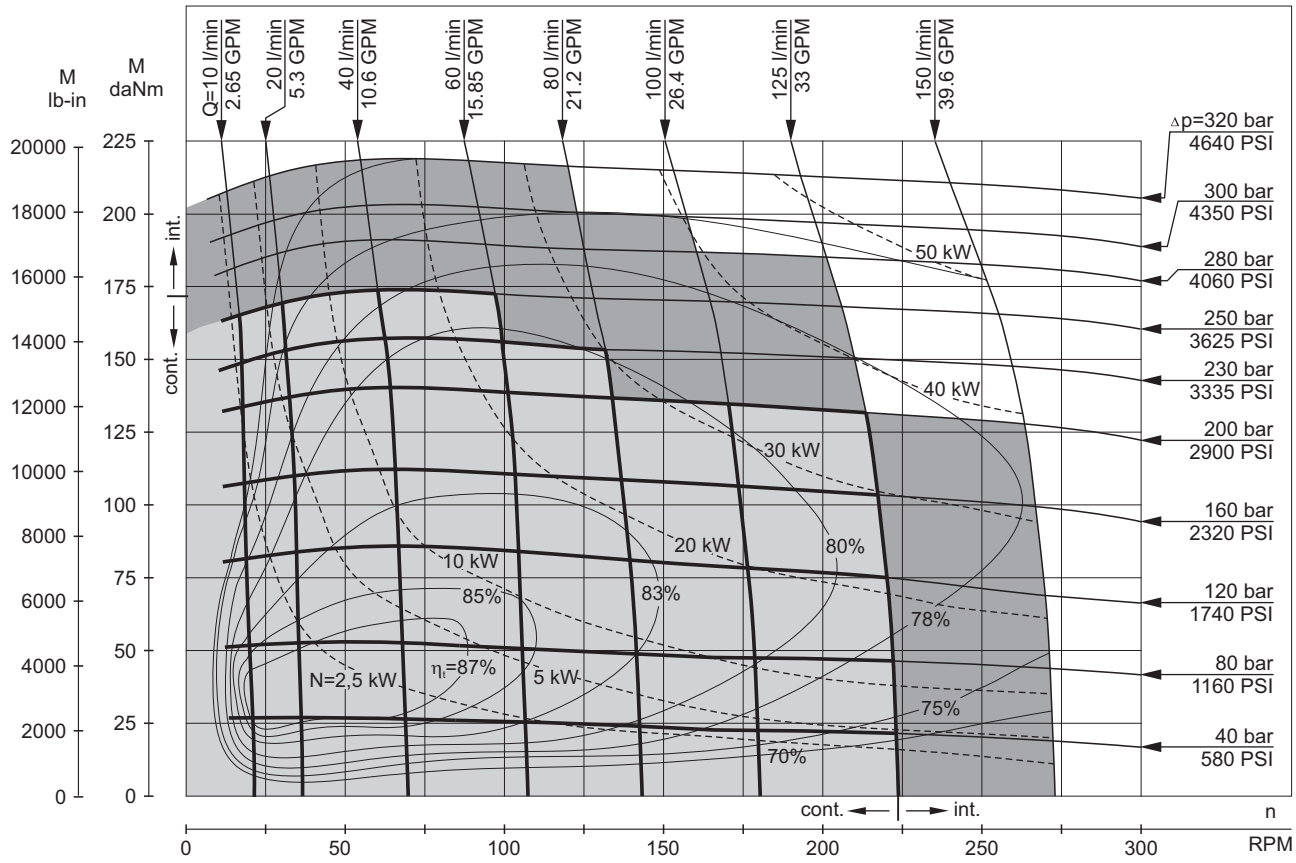

## TMF 400



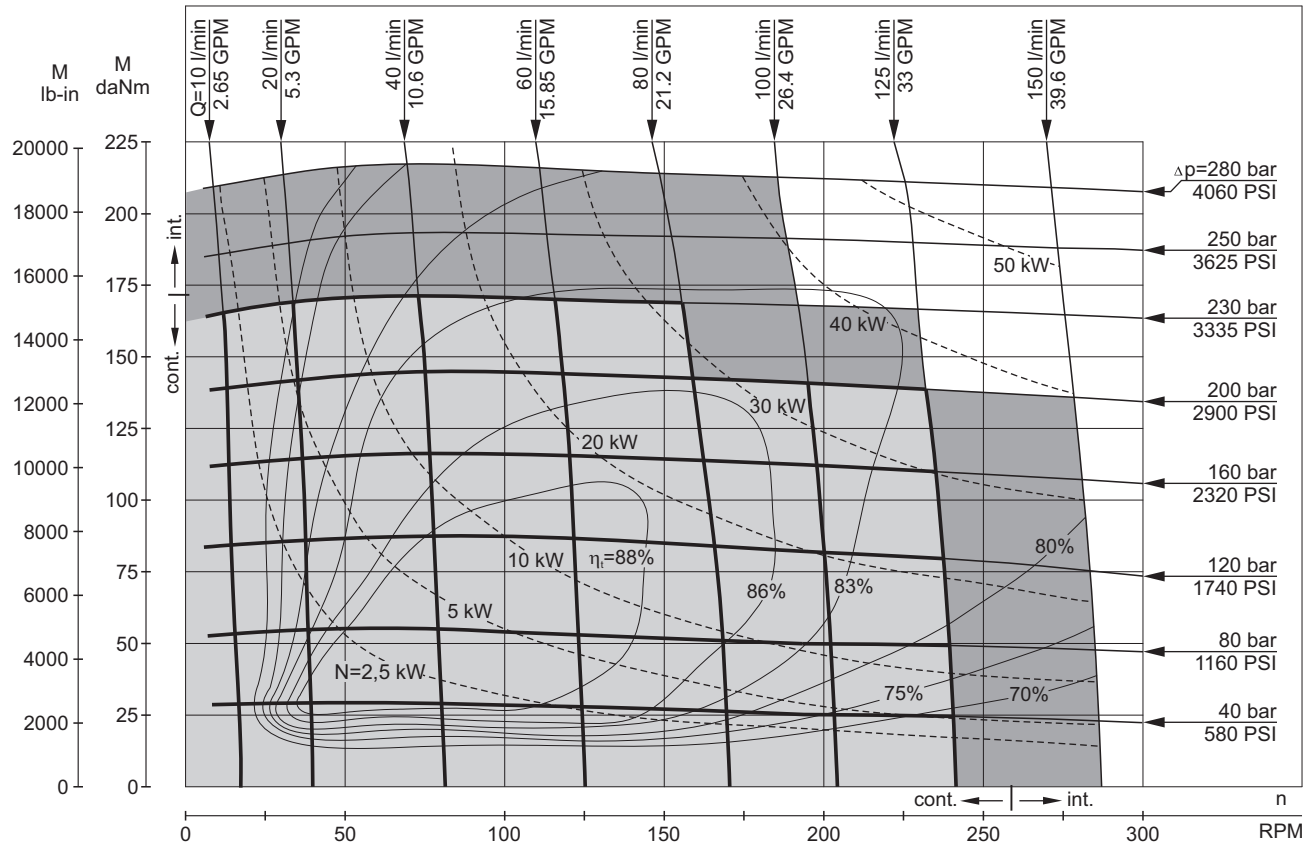

The function diagrams data is for average performance of randomly selected motors at back pressure 72.5 PSI÷145 PSI [5÷10 bar] and oil with viscosity of 150 SUS [32 mm²/s] at 122°F [50°C].

# FUNCTION DIAGRAMS

## TMF 470



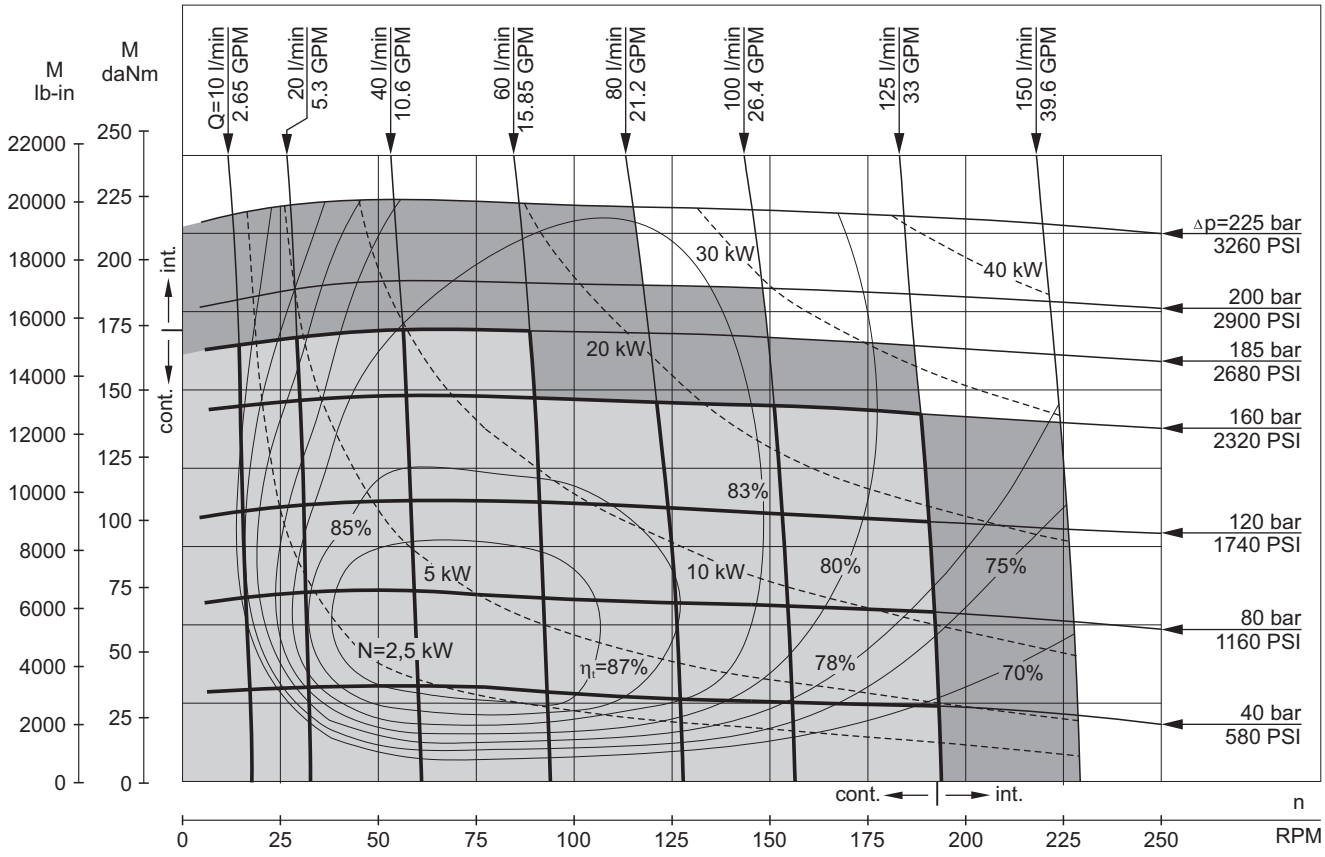

## TMF 500



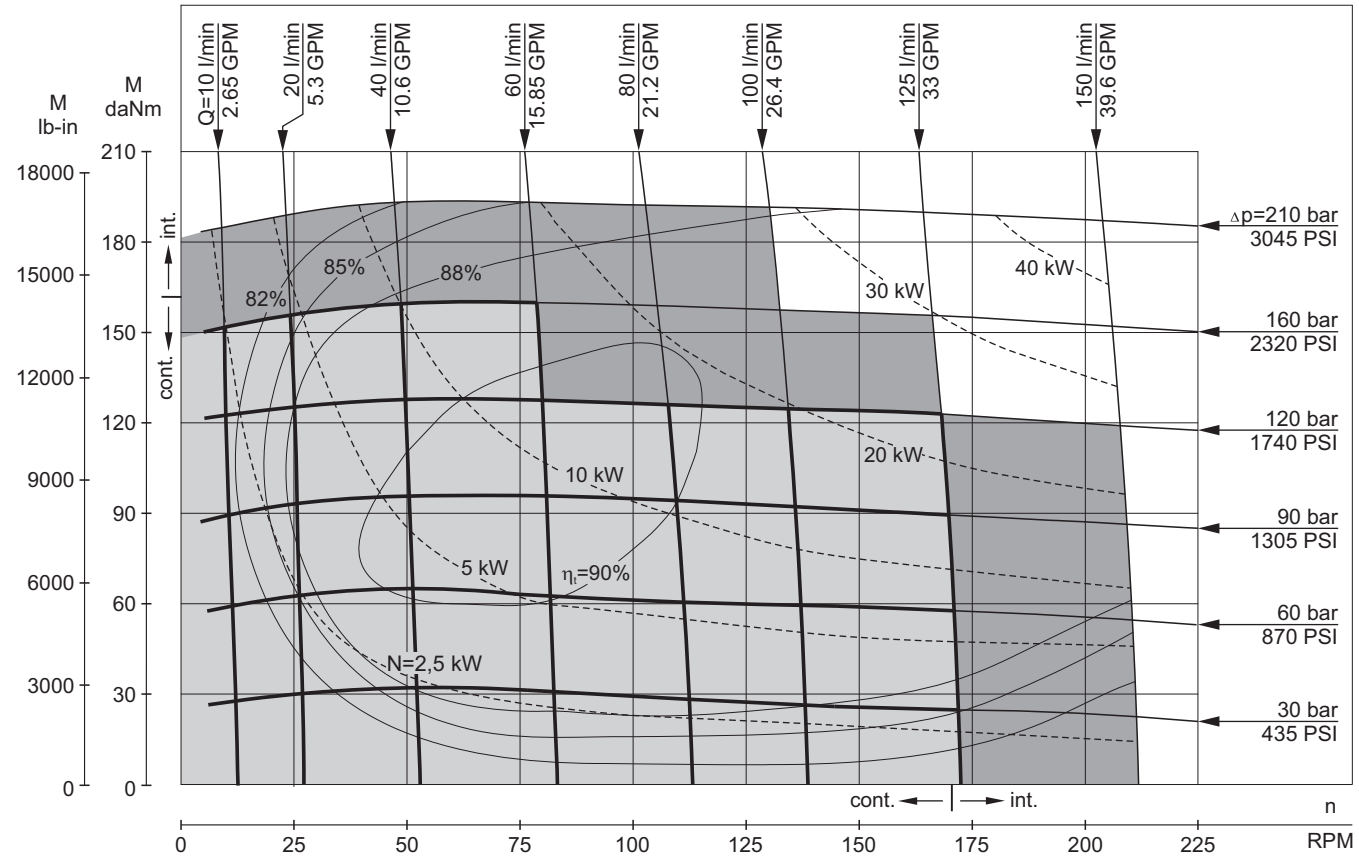

The function diagrams data is for average performance of randomly selected motors at back pressure 72.5 PSI÷145 PSI [5÷10 bar] and oil with viscosity of 150 SUS [32 mm²/s] at 122°F [50°C].

## FUNCTION DIAGRAMS

### TMF 630




### TMF 725




The function diagrams data is for average performance of randomly selected motors at back pressure 72.5 PSI÷145 PSI [5÷10 bar] and oil with viscosity of 150 SUS [32 mm²/s] at 122°F [50°C].

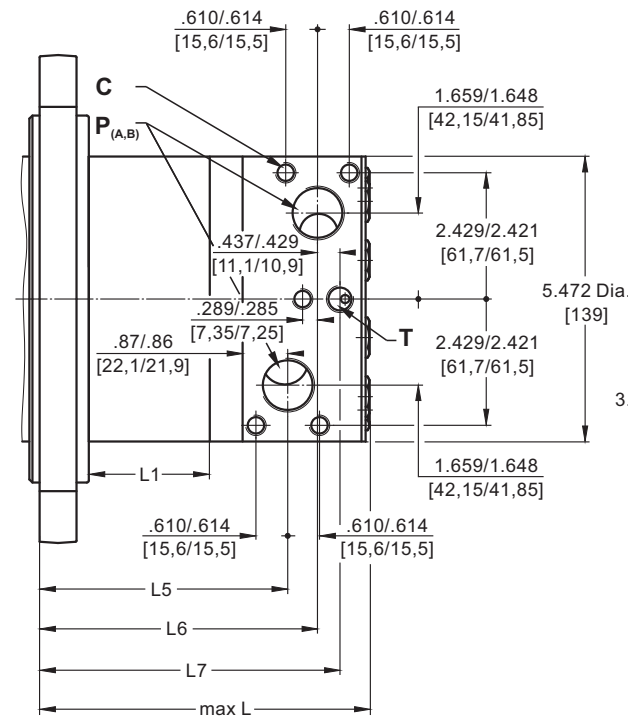
# DIMENSIONS AND MOUNTING DATA - TMF

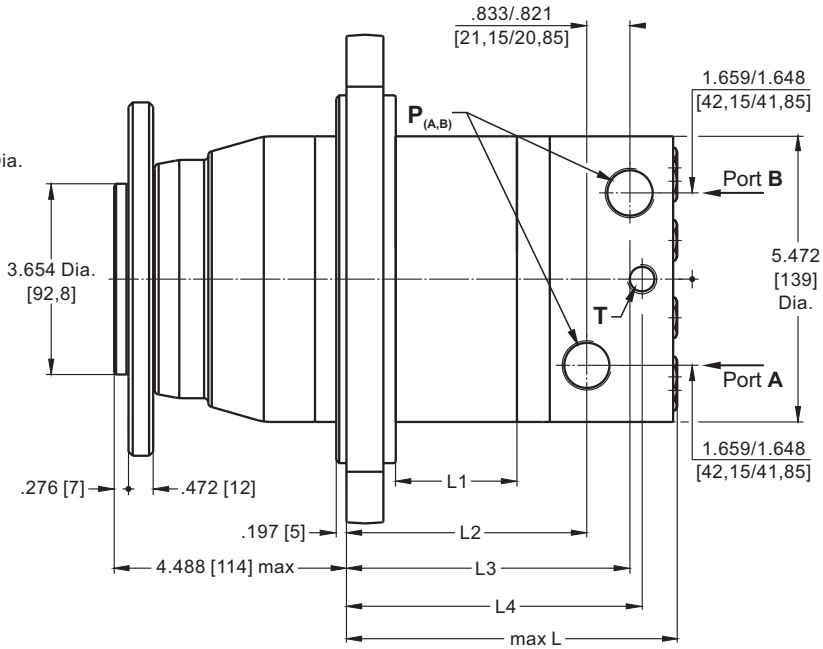
**Standard Rotation**
Viewed from Shaft End
Port **A** Pressurized - **CW**
Port **B** Pressurized - **CCW**

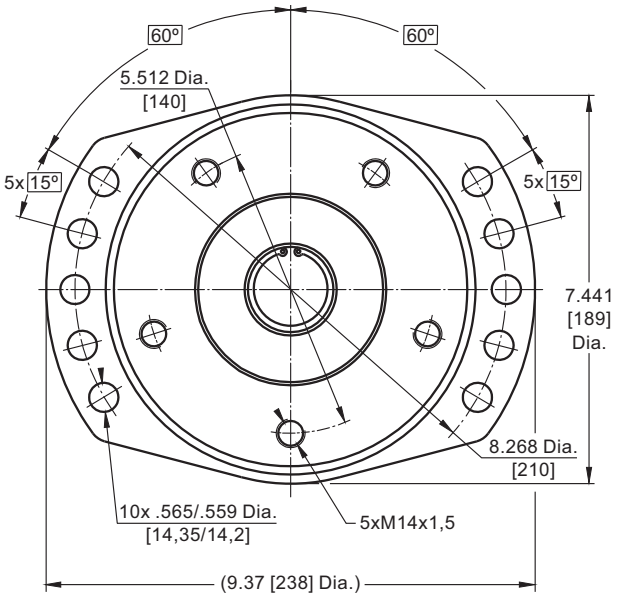
**Reverse Rotation**
Viewed from Shaft End
Port **A** Pressurized - **CCW**
Port **B** Pressurized - **CW**

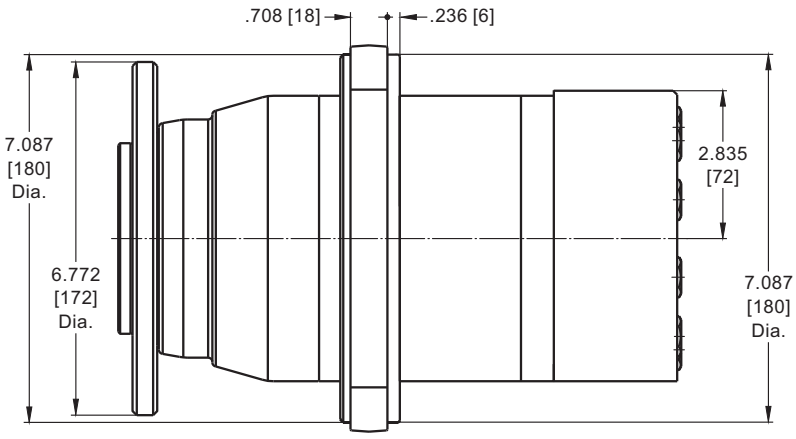
| | Versions | | |
|---|---|---|---|
| | 2 | 3 | 4 |
| $P_{(A,B)}$ | 2xG3/4<br>.669 in [17 mm] depth | 2xG3/4<br>.669 in [17 mm] depth | 2x1 1/16-12 UN<br>.669 in [17 mm] depth<br>O-ring |
| T | G1/4<br>.472 in [12 mm] depth | G1/4<br>.472 in [12 mm] depth | 9/16-18 UN<br>.472 in [12 mm] depth<br>O-ring |
| C | - | 5xM10<br>.669 in [17 mm] depth | - |

## TMF - version 3




in [mm]

**Warning:** Drain line should always be used.

| Type | $L_{max}$, in [mm] | $L_1$, in [mm] | $L_2$, in [mm] | $L_3$, in [mm] | $L_4$, in [mm] | $L_5$, in [mm] | $L_6$, in [mm] | $L_7$, in [mm] |
|---|---|---|---|---|---|---|---|---|
| TMF 200 | 5.04 [128,0] | .98 [25,0] | 3.27 [ 83,0] | 4.09 [104,0] | 4.34 [110,3] | 3.43 [ 87,0] | 3.99 [101,5] | 4.43 [112,5] |
| TMF 250 | 5.28 [134,0] | 1.23 [31,3] | 3.52 [ 89,3] | 4.34 [110,3] | 4.59 [116,6] | 3.68 [ 93,5] | 4.25 [108,0] | 4.68 [118,8] |
| TMF 315 | 5.65 [143,5] | 1.59 [40,5] | 3.88 [ 98,5] | 4.70 [119,5] | 4.95 [125,8] | 4.04 [102,5] | 4.61 [117,0] | 5.04 [128,0] |
| TMF 400 | 6.06 [154,0] | 20.1 [51,0] | 4.29 [109,0] | 5.12 [130,0] | 5.37 [136,3] | 4.45 [113,0] | 5.02 [127,5] | 5.45 [138,5] |
| TMF 470 | 6.38 [162,0] | 2.32 [59,0] | 4.61 [117,0] | 5.43 [138,0] | 5.68 [144,3] | 4.76 [121,0] | 5.33 [135,0] | 5.77 [146,5] |
| TMF 500 | 6.61 [168,0] | 2.56 [65,0] | 4.84 [123,0] | 5.67 [144,0] | 5.92 [150,3] | 5.00 [127,0] | 5.57 [141,5] | 6.00 [152,5] |
| TMF 630 | 6.46 [164,0] | 2.40 [61,0] | 4.69 [119,0] | 5.51 [140,0] | 5.76 [146,3] | 4.84 [123,0] | 5.41 [137,5] | 5.85 [148,5] |
| TMF 725 | 6.81 [173,0] | 2.76 [70,0] | 5.04 [128,0] | 8.87 [149,0] | 6.11 [155,3] | 5.20 [132,0] | 5.77 [146,5] | 6.20 [157,5] |

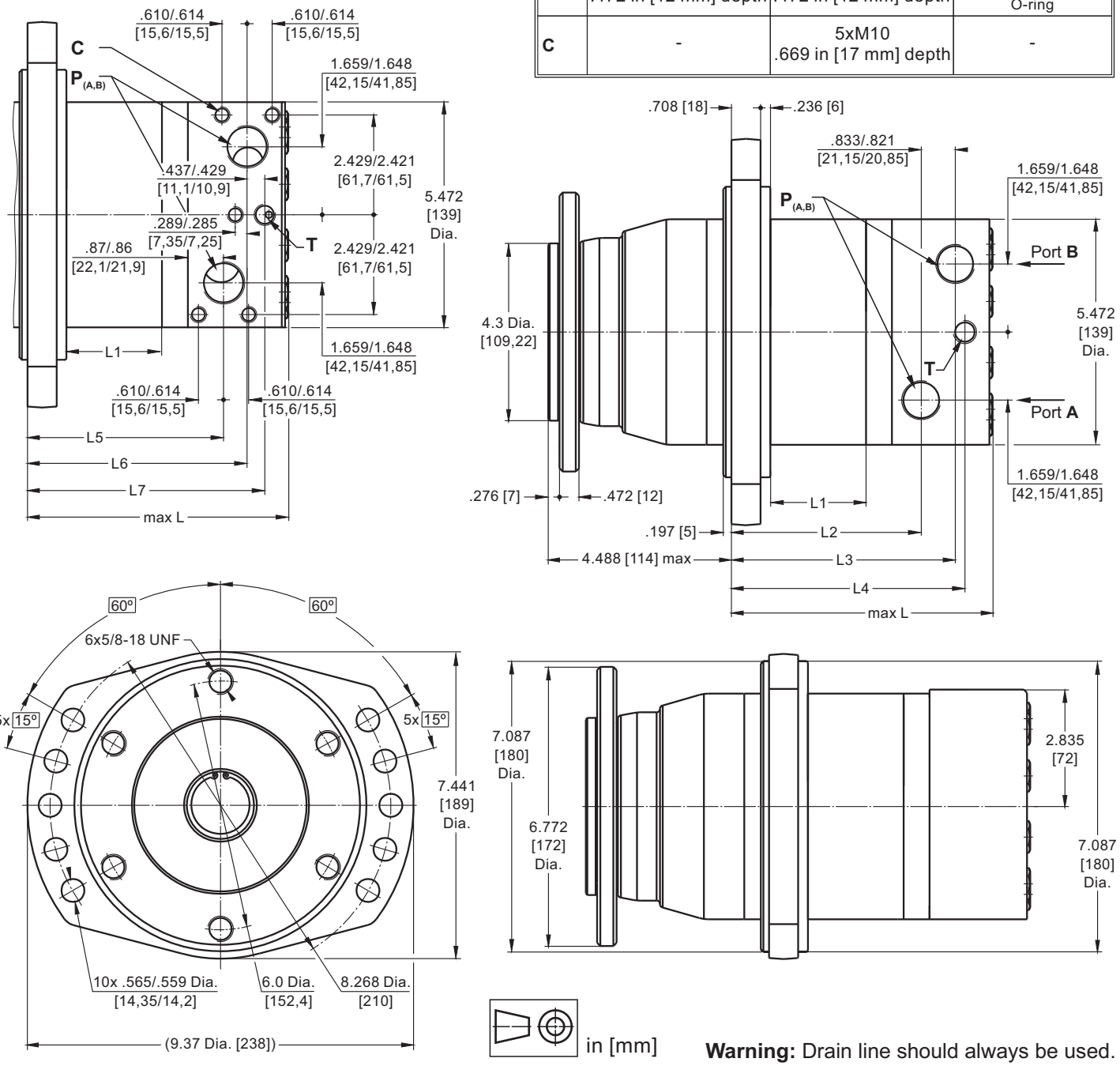
# DIMENSIONS AND MOUNTING DATA - TMFA

**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 | | |
|---|---|---|---|
| | 2 | 3 | 4 |
| $P_{(A,B)}$ | 2xG3/4<br>.669 in [17 mm] depth | 2xG3/4<br>.669 in [17 mm] depth | 2x1 1/16-12 UN<br>.669 in [17 mm] depth<br>O-ring |
| T | G1/4<br>.472 in [12 mm] depth | G1/4<br>.472 in [12 mm] depth | 9/16-18 UN<br>.472 in [12 mm] depth<br>O-ring |
| C | - | 5xM10<br>.669 in [17 mm] depth | - |

## TMFA - version 3



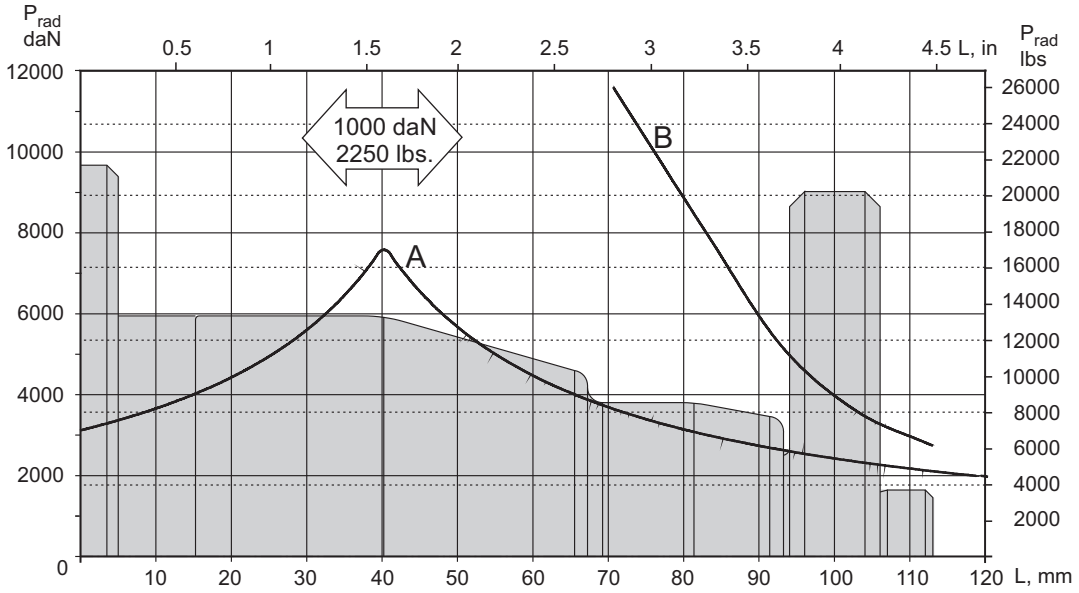

in [mm]

**Warning:** Drain line should always be used.

| Type | $L_{max}$, in [mm] | $L_1$, in [mm] | $L_2$, in [mm] | $L_3$, in [mm] | $L_4$, in [mm] | $L_5$, in [mm] | $L_6$, in [mm] | $L_7$, in [mm] |
|---|---|---|---|---|---|---|---|---|
| TMF 200 | 5.04 [128,0] | .98 [25,0] | 3.27 [ 83,0] | 4.09 [104,0] | 4.34 [110,3] | 3.43 [ 87,0] | 3.99 [101,5] | 4.43 [112,5] |
| TMF 250 | 5.28 [134,0] | 1.23 [31,3] | 3.52 [ 89,3] | 4.34 [110,3] | 4.59 [116,6] | 3.68 [ 93,5] | 4.25 [108,0] | 4.68 [118,8] |
| TMF 315 | 5.65 [143,5] | 1.59 [40,5] | 3.88 [ 98,5] | 4.70 [119,5] | 4.95 [125,8] | 4.04 [102,5] | 4.61 [117,0] | 5.04 [128,0] |
| TMF 400 | 6.06 [154,0] | 20.1 [51,0] | 4.29 [109,0] | 5.12 [130,0] | 5.37 [136,3] | 4.45 [113,0] | 5.02 [127,5] | 5.45 [138,5] |
| TMF 470 | 6.38 [162,0] | 2.32 [59,0] | 4.61 [117,0] | 5.43 [138,0] | 5.68 [144,3] | 4.76 [121,0] | 5.33 [135,0] | 5.77 [146,5] |
| TMF 500 | 6.61 [168,0] | 2.56 [65,0] | 4.84 [123,0] | 5.67 [144,0] | 5.92 [150,3] | 5.00 [127,0] | 5.57 [141,5] | 6.00 [152,5] |
| TMF 630 | 6.46 [164,0] | 2.40 [61,0] | 4.69 [119,0] | 5.51 [140,0] | 5.76 [146,3] | 4.84 [123,0] | 5.41 [137,5] | 5.85 [148,5] |
| TMF 725 | 6.81 [173,0] | 2.76 [70,0] | 5.04 [128,0] | 8.87 [149,0] | 6.11 [155,3] | 5.20 [132,0] | 5.77 [146,5] | 6.20 [157,5] |

## PERMISSIBLE SHAFT LOADS

The load diagram is valid for an average bearings life of 2000 hours at 100 RPM




**A** - Permissible radial shaft load.
**B** - Max. radial shaft load. Any shaft load exceeding the values shown by the curve will involve a risk of breakage.

## ORDER CODE

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **TMF** | | | | **HD** | |

Pos.1 - **Mounting Flange**

omit - Thread hole flange, 5xM14x1,5 on 5.512 Dia. [140]

**A** - Thread hole flange, 6x5/8-18 UNF on 6.0 Dia. [152,4]

Pos.2 - **Displacement code**

**200** - 12.29 $in^3$/rev [201,4 $cm^3$/rev]
**250** - 15.36 $in^3$/rev [251,8 $cm^3$/rev]
**315** - 19.90 $in^3$/rev [326,3 $cm^3$/rev]
**400** - 25.06 $in^3$/rev [410,9 $cm^3$/rev]
**470** - 28.97 $in^3$/rev [475,0 $cm^3$/rev]
**500** - 31.95 $in^3$/rev [523,6 $cm^3$/rev]
**630** - 38.52 $in^3$/rev [631,2 $cm^3$/rev]
**725** - 44.20 $in^3$/rev [724,3 $cm^3$/rev]

Pos.3 - **Ports**

**2** - side ports, 2xG3/4, G1/4, BSP thread, ISO 228
**3** - side ports, 2xG3/4, G1/4, 5xM10 BSP thread, ISO 228
**4** - side ports, $2x1^{1}/_{16}$-12 UN, O-ring, $^{9}/_{16}$-18 UNF

Pos.4 - **Additional Options**

**HD** - Reinforced motor **HD***
For Other **Additional Options** see page 69

Pos.5 - **Design Series**

omit - Factory specified

**NOTES:** * Drain line should always be used.

The hydraulic motors are mangano-phosphatized as standard.

# MOTOR ADDITIONAL OPTIONS

| Additional Options Description | Order Code | Motor type | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | MLHSEM | MTK | MLHTM | TMF | TMYF | MVM | VMF |
| Speed Sensor* | RS | O | O | O | O | O | O | O |
| Reinforced motor | HD | – | S | S | S | S | S | S |
| Low Leakage | LL | O | O | O | O | O | O | O |
| Low Speed Valving | LSV | O | O | O | O | O | O | O |
| Free Running | FR | – | O | O | – | O | O | – |
| Reverse Rotation | R | O | O | O | O | O | O | O |
| Paint** | P | O | O | O | O | O | O | O |
| Corrosion Protected Paint** | PC | O | O | O | O | O | O | O |
| Special Paint*** | PS | O | O | O | O | O**** | O | O |
| | PCS | | | | | | | |
| Check Valves | | S | O | O | – | O | O | – |

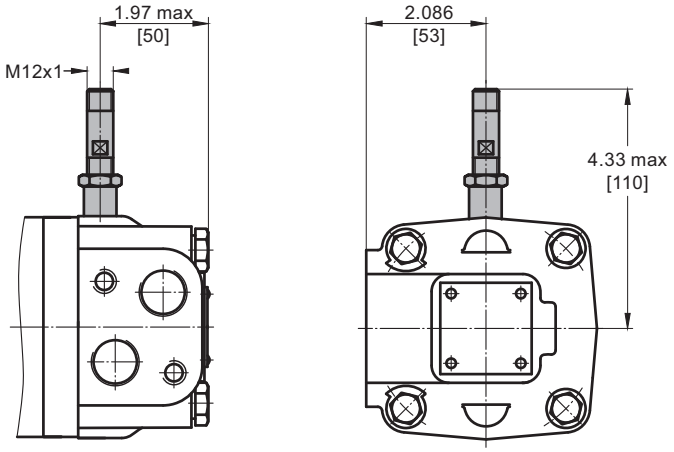
| | |
|---|---|
| **O** | Optional |
| **-** | Not applicable |
| **S** | Standard |

* For sensor ordering see pages 70÷71.
** Colour at customer's request.
*** Non painted feeding surfaces, colour at customer's request.

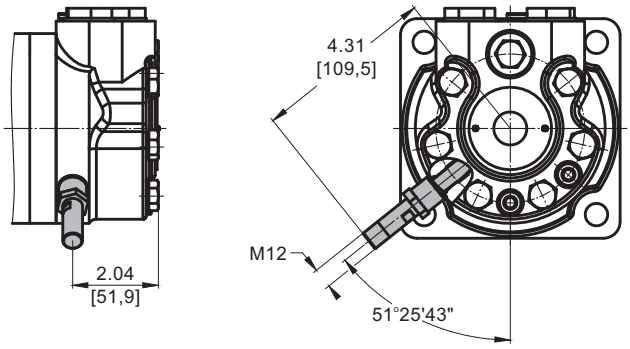
⚠ For more information about **HD** option please contact with "M+S Hydraulic".

# MOTORS WITH SPEED SENSOR

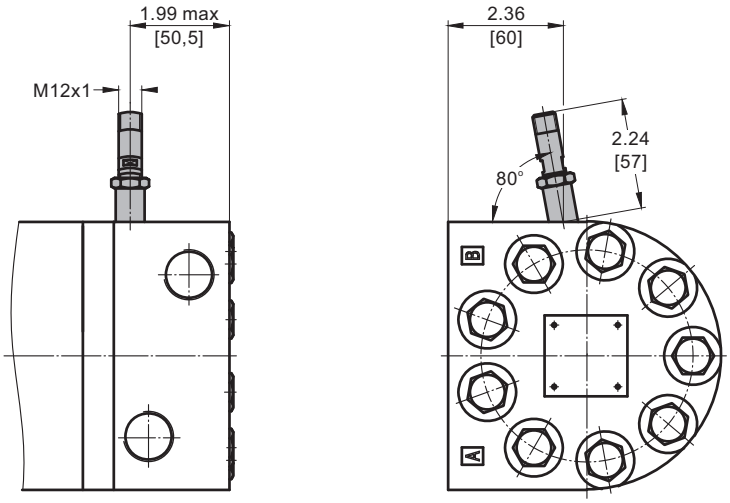
## MLHSEM...RS



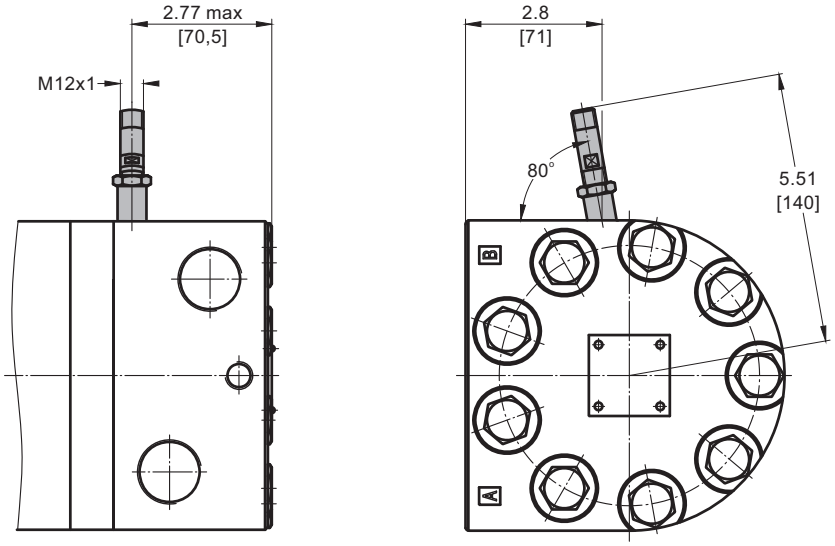

## MTK...RS




## MLHTM...RS
## TMF...RS



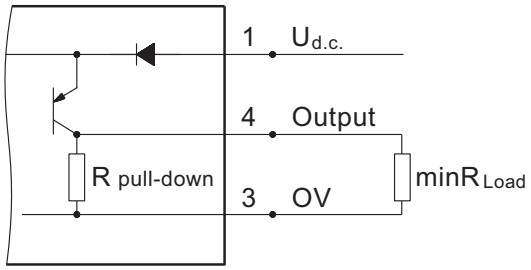

## MVM...RS
## VMF...RS



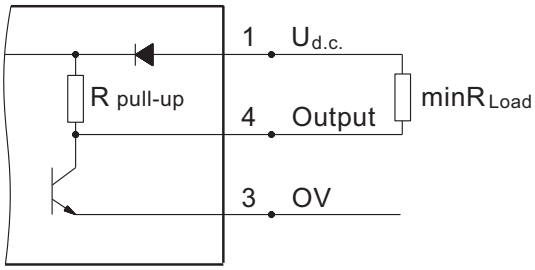
# TECHNICAL DATA of the SPEED SENSOR

## Wiring diagrams

**PNP**



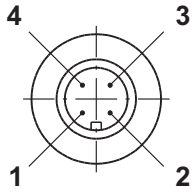

**NPN**




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

| Motor type | MLHSEM MTK | MLHTM TMF | MVM VMF | DW |
|---|---|---|---|---|
| Pulses per revolution | 54 | 84 | 102 | 30 |

## 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]**

$$n=\frac{168 \times V_{ml} \times i}{R_{in}} \qquad n=\frac{2.65 \times V_{km} \times i}{R_m}$$

$\mathbf{v_{km}}$ - vehicle speed, km/h;
$\mathbf{v_{ml}}$ - vehicle speed, mil/h;
$\mathbf{R_m}$ - wheel rolling radius, m;
$\mathbf{R_{in}}$ - 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, daN [lbs];
$\rho$ - 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, daN [lbs]**

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

$\alpha$ - gradient negotiation angle (Table 2).

Table 2

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

**4. Accelerarion force: FA, lbs [daN]**

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

$$FA=\frac{V_{ml} \times G}{22 \times t}, \text{[lbs]} \qquad FA=\frac{V_{km} \times G}{36 \times t}, \text{[daN]}$$

**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;
$\eta_M$ - mechanical gear efficiency (if it is available).

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

Necessary torque moment for every hydraulic motor:

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

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

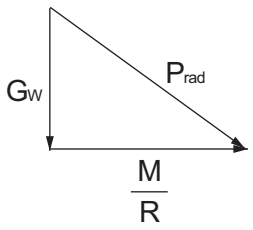
**f** - frictional factor;
$\mathbf{G_W}$ - total weight over the wheels, lbs [daN].

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]**

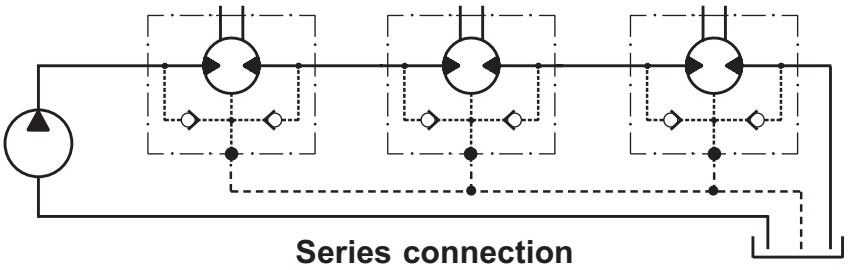
When motor is used for vehicle motion with wheels mounted directly on motor shaft, the total radial loading of motor shaft **Prad** is a sum of motion force and weight force acting on one wheel.



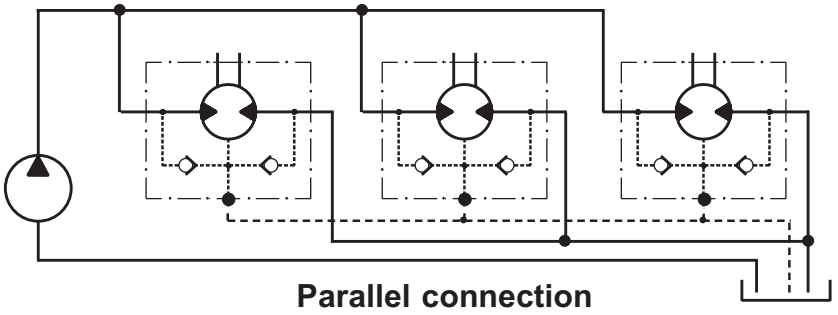

$$P_{rad}=\sqrt{G_W^2+\left(\frac{M}{R}\right)^2}$$

**$G_w$** - weight held by wheel;
**$P_{rad}$** - total radial loading of motor shaft;
**M/R** - motion force.

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



**Series connection**



**Parallel connection**