# HYDROSTATIC STEERING UNITS TYPE HKUL.../5DT

"M+S Hydraulic" introduce a new large size of steering unit HKUL *"Closed Center - Non Reaction and Load Sensing Outlet"* with Dynamic Load Signal.

HKUL is a load steering unit specially developed for large displacement in order to minimize flow loss. HKUL is extremely suitable for large vehicles, which maximum speed does not exceed 60 km/h and works together with dynamic priority valve.
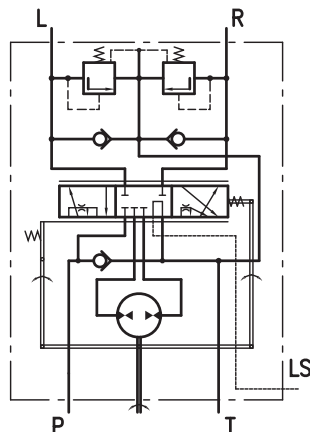
HKUL is available in versions with different valves that are required in hydraulic steering circuit for protection of the steering unit and steering cylinders.
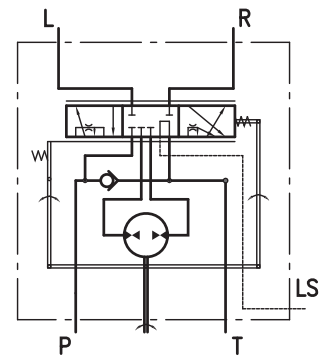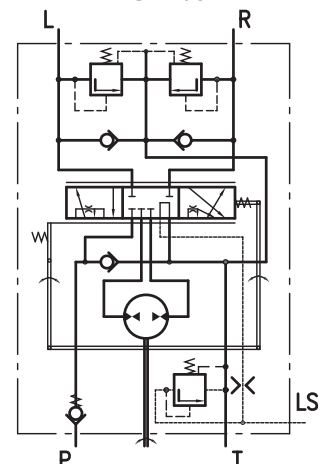
Closed Center - Non Reaction
HKUL.../5DT
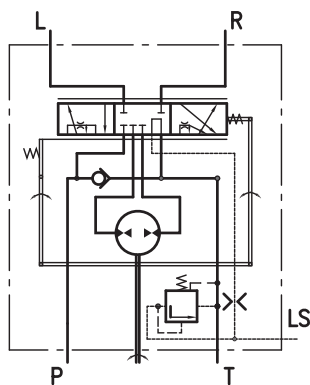
Closed Center - Non Reaction
HKULR.../5DT

Closed Center - Non Reaction
HKULV.../5DT

Closed Center - Non Reaction
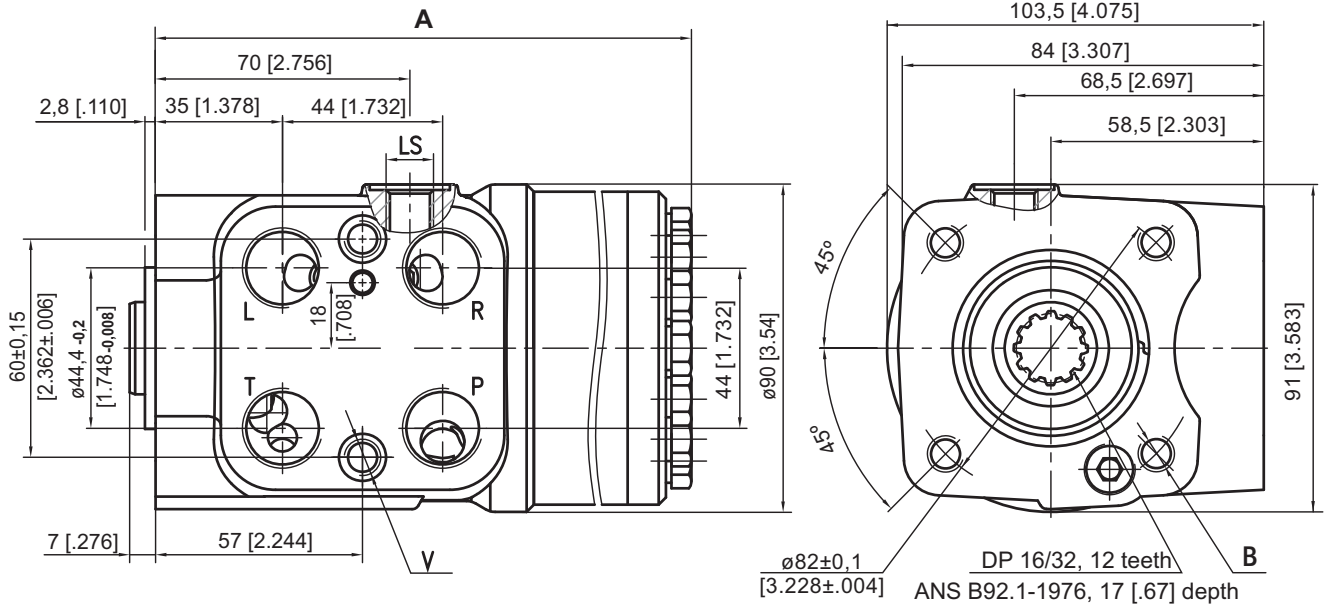HKULS.../5DT

SPECIFICATION DATA

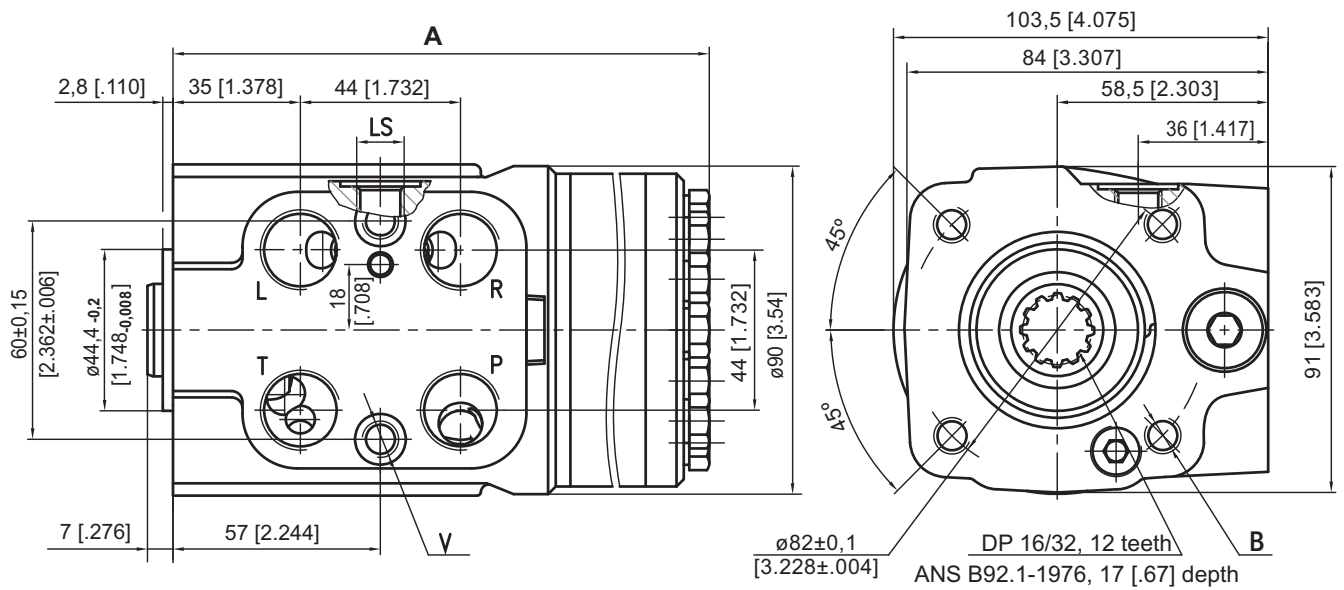| Parameters		Type			
		HKUL... 500/5DT	HKUL... 630/5DT	HKUL... 800/5DT	HKUL... 1000/5DT
Displacement	cm³/rev [in³/rev]	495 [30.2]	623,6 [38.05]	793 [48.4]	990 [60.4]
Rated Flow	lpm [GPM]	50 [13.2]*	63 [16.6]*	70 [18.5]**	70 [18.5]***
Rated Pressure	bar [PSI]	175 [2540]			
LS-Valve Pressure Settings	bar [PSI]	80 [1160] 100 [1450]	125 [1810]	150 [2175]	175 [2540]
Shock Valves Pressure Settings	bar [PSI]	140 [2030] 160 [2320]	180 [2610]	200 [2900]	240 [3480]
Max. Cont. Pressure in Line T bar [PSI] - standard - high pressure (H option)		20 [290] 40 [580]			
Max. Torque at Servoamplifing	Nm [lb-in]	3,0 [26]			
Max. Torque w/o Servoamplifing	Nm [lb-in]	120 [1065]			
Weight	kg [lb]	8,2 [18.1]	8,9 [19.6]	9,8 [21.6]	10,8 [23.8]
Dimension A	mm [in]	202 [7.95]	219,3 [8.64]	242,17 [9.54]	268,64 [10.58]

* Rated Flow at 100 RPM
** Max. Rated Flow at 87 RPM
*** Max. Rated Flow at 70 RPM

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DIMENSIONS AND MOUNTING DATA - HKUL.../5DT

A

70 [2.756]

2,8 [.110]   35 [1.378]   44 [1.732]

LS

L   R

18 [.708]

T   P

60±0,15 [2.362±.006]

ø44,4 -0,2 [1.748 -0,008]

44 [1.732]

ø90 [3.54]

7 [.276]   57 [2.244]

V

103,5 [4.075]

84 [3.307]

68,5 [2.697]

58,5 [2.303]

45°

45°

91 [3.583]

ø82±0,1 [3.228±.004]

DP 16/32, 12 teeth
ANS B92.1-1976, 17 [.67] depth

B

DIMENSIONS AND MOUNTING DATA - HKULR.../5DT

A

2,8 [.110]   35 [1.378]   44 [1.732]

LS

L   R

18 [.708]

T   P

60±0,15 [2.362±.006]

ø44,4 -0,2 [1.748 -0,008]

44 [1.732]

ø90 [3.54]

7 [.276]   57 [2.244]   V

103,5 [4.075]

84 [3.307]

58,5 [2.303]

36 [1.417]

45°

45°

91 [3.583]

ø82±0,1 [3.228±.004]

DP 16/32, 12 teeth
ANS B92.1-1976, 17 [.67] depth

B

mm [in]

M+S HYDRAULIC

DIMENSIONS AND MOUNTING DATA - HKULV.../5DT

A

70 [2.756]

35 [1.378] 44 [1.732]

2,8 [.110]

LS

60±0,15 [2.362±.006]
ø44,4 -0,2 [1.748 -0,008]

L

18 [.708]

R

44 [1.732] ø90 [3.54]

T

P

7 [.276]

57 [2.244]

V

103,5 [4.075]

84 [3.307]

68,5 [2.697]

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DP 16/32, 12 teeth
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DIMENSIONS AND MOUNTING DATA - HKULS.../5DT

A

35 [1.378] 44 [1.732]

2,8 [.110]

LS

60±0,15 [2.362±.006]
ø44,4 -0,2 [1.748 -0,008]

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18 [.708]

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44 [1.732] ø90 [3.54]

T

P

7 [.276]

57 [2.244]

V

103,5 [4.075]

84 [3.307]

58,5 [2.303]

36 [1.417]

45°

45°

91 [3.583]

ø82±0,1 [3.228±.004]

DP 16/32, 12 teeth
ANS B92.1-1976, 17 [.67] depth

B

mm [in]

code	Ports - P*, T, R, L Thread	Column Mounting Thread - B	Valve Mounting Thread- V	LS - Port
-	G1/2 17 [.67] depth	4 x M10 18 [.71] depth	2 x M10x1 16[.63] depth	G1/4 14 [.55] depth
M	M22x1,5 17 [.67] depth	4 x M10 18 [.71] depth	2 x M10x1 16 [.63] depth	M12x1 .14 [.55] depth
A	3/4 - 16 UNF O-ring 17 [.67] depth	4 x 3/8 - 16 UNC 15,7 [.62] depth	2 x 3/8 - 24 UNF 14,2 [.56] depth	7/16 - 20 UNF O-ring 12,7 [.50] depth

*Threaded Ports P min 15 [0.59] depth for pipe mounting.

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ORDER CODE for HKUL.../5DT...

	1	2		3	4	5		6	7		8	9	10	11
H K U L			/	5	D	T	–			–				

Pos.1 - Versions (build-in valves)

Version	Manual Steering Check Valve	Relief Valve	Inlet Check Valve	Cylinder Relief Valve	Anti-Cavitation Valve
omit	•				
R	•	•			
V	•			•	•
S	•	•	•	•	•

Pos.2 - Displacement code (see Specification Data)

500	- 495,0 cm³/rev [30.20 in³/rev]
630	- 623,6 cm³/rev [38.05 in³/rev]
800	- 793,0 cm³/rev [48.40 in³/rev]
1000	- 990,0 cm³/rev [60.40 in³/rev]

Pos.3 - Versions

5 - Version 5 *"Closed Center - Non Reaction and Load Sensing Outlet"*

Pos.4 - Signal Type

D - Dynamic Load Signal

Pos.5 - Priority Valve Connection

T - Pipe Mounting

Pos. 6 - LS - Valve Pressure Settings, bar*

80	**100**	**125**	**150**	**175**

Pos. 7 - Shock Valves Pressure Settings, bar**

140	**160**	**180**	**200**	**240**

Pos. 8 - Ports

omit	- BSPP (ISO 228)
A	- SAE (ANSI B 1.1 - 1982)
M	- Metric (ISO 262)

Pos. 9 - Max. Cont. Pressure in line T

omit	- Standard
H	- High pressure

Pos.10 - Option (Paint)**

omit	- No Paint
P	- Painted
PC	- Corrosion Protected Paint
PS	- Special Paint****
PCS	- Special Corrosion Protected Paint****

Pos.11 - Design Series

omit	- Factory specified

Notes:
* Only for HKULR and HKULS
** Only for HKULV
*** Colour at customer's request.
**** Non painted feeding surfaces, colour at customer's request.

The steering units are mangano-phosphatized as standard.

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GENERAL APPLICATION AND SPECIFICATION INFORMATION

APPLICATION
(SIZING AND STEERING SYSTEM DESIGN PROCESS)

STEP ONE:
Calculate approximate kingpin torque (M_L).

$$M_L = G \cdot \mu \sqrt{\frac{B^2}{8} + \ell^2}$$

Note: Double M_L if steered wheels are powered.
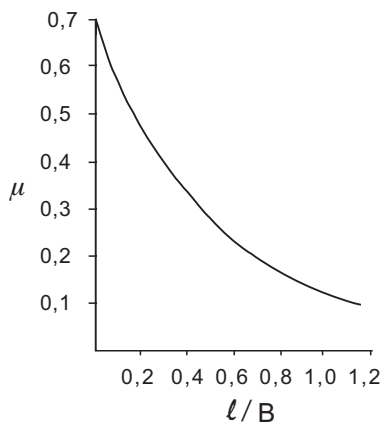
M_L = Kingpin torque in daNm [*lb-in*].

G = Vehicle weight on steered axle daN [*lbs*] (use maximum estimated overload weight).

μ = Coefficient of friction (use Chart № 1, dimensionless) determined by ℓ/B (see Diagram № 1).

B = Nominal width of tyre print, m [*in*]
(see Diagram № 1).

ℓ = Kingpin offset. The distance between tyre centerline intersection at ground and kingpins centerline intersection at ground in, m [*in*] (see Diagram№1).

Chart № 1

Rubber tyres on dry concrete.

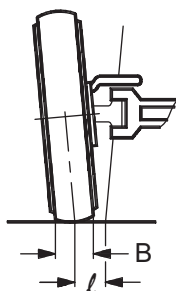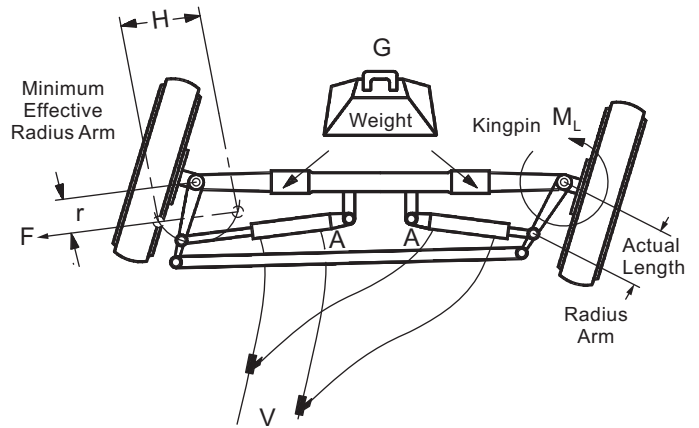### Diagram № 1

Diagram № 2

STEP TWO:
Calculate approximate cylinder; force-area-stroke-volume.
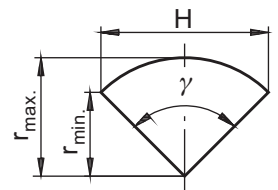
FORCE
$$F = \frac{M_L}{r}$$

F = Force required daN [*lbs*] to steer axle.

M_L = Kingpin torque in daNm [*lb-in*] from step one. Double M_L if steered wheels are powered.

r = Effective radius Arm mm [*in*] is the minimum distance from the centerline of the cylinders minimum and maximum stroke points parallel to the kingpin center pivot. This is not the physical length of the radius Arm (see Diagram № 2 and Chart № 2).

Chart № 2

$$r_{min.} = r_{max.} \cdot \cos \frac{\gamma}{2}$$

STROKE
H = Stroke, cm [*in*].
Calculate stroke of cylinder using Diagram № 2 and Chart № 2 as shaft.

$$H = 2\, r_{max.} \cdot \sin \frac{\gamma}{2}$$

AREA
$$A = \frac{F}{\Delta P}$$

A = Cylinder area for axle cylinder set, cm^2 [*in*^{2}].

F = Force required from step two force formula, daN [*lbs*].

ΔP = Hydraulic pressure bar [*PSI*] use following percentage of relief valve setting by amount of load on steered axle. Severe load 25% - medium load 55% - no load 75% .
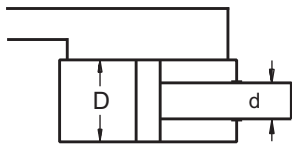
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DIAMETER

After the cylinder set area is determined, the cylinder diameter can be calculated.

D = Inside diameter of cylinder, cm [*in*].
d = Road diameter of cylinder, cm [*in*].

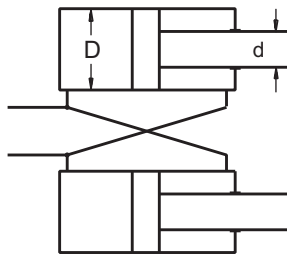Choose type of cylinder arrangement and formula shown for that type.

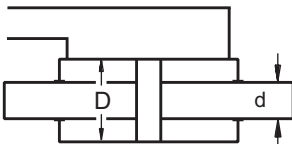### Differential Cylinder

$$D = \sqrt{\frac{4A}{\pi} + d^2}$$

Note: $\left(\dfrac{d}{D}\right)^2 \le 0{,}15$
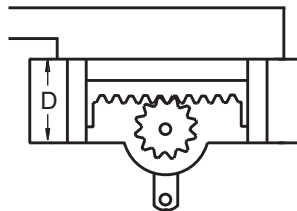
Cross Connected Cylinders

$$D = \sqrt{\frac{2A}{\pi} + \frac{d^2}{2}}$$

Balanced Cylinder

$$D = \sqrt{\frac{4A}{\pi} + d^2}$$

Opposed Cylinder

$$D = \sqrt{\frac{4A}{\pi}}$$

VOLUME

$$V = H \cdot A$$

V = Volume. The total amount of oil required to move the cylinder rod(s) through the entire stroke, cm^3 [*in^3*].
H = Stroke, cm [*in*].
A = Area, cm^2 [*in^2*].
Note: For differential cylinders it is important to calculate average cylinder volume for step three using below formula.

$$V_{avg.} = H \cdot \frac{\pi}{4} (2 \cdot D^2 - d^2)$$

STEP THREE:

Selecting displacement of hydrostatic steering unit.

At this point determine number of steering wheel revolutions desired for your application to steer the wheels from one side to the other (lock to lock). Depending on the type of vehicle and its use, this will vary from 3 to 5 turns.

DISPLACEMENT

$$V_D = \frac{V}{n}$$

V_D = Displacement, cm^3/rev [*in^3/rev*].
V = Volume of oil, cm^3 [*in^3*].
n = Steering wheel turns lock to lock.

After completing the above displacement calculation, choose the <u>closest standard</u> hydrostatic steering unit in displacement size that incorporates circuity you require. Recalculate the number of steering wheel turns using the displacement of selected standard hydrostatic steering unit outlined above. Use the formula shown below.

$$n = \frac{V}{V_D}$$

V = Volume of oil, cm^3 [*in^3*].
n = Steering wheel turns lock to lock.
Note: For differential cylinders applications the cylinder volume will be different for left and right turns - this means the value *n (*steering wheel turns lock to lock) will vary when turning to the left or right.

STEP FOUR:

Calculate approximate minimum and maximum steering circuit flow requirements.

$$Q = \frac{V_D \cdot N}{\text{Unit Conversion for Imperial or [1000] Metric}}$$

Q = Steering circuit flow, lpm [*GPM*].
V_D = Unit displacement, cm^3/rev [*in^3/rev*]
N = Steering wheel input speed, RPM.
  Recommended steering speed is 50 to 100 *RPM*.

Many variables are involved in sizing the pump. We suggest that the manufacturer should test and evaluate for the desired performance.

GENERAL INFORMATION

FLUID DATA:

To insure maximum performance and life of the Hydrostatic steering units, use premium quality hydraulic oils. Fluids with effective quantities of anti-wear agents or additives are highly recommended. If using synthetic fluids consult the factory for alternative seal materials.

- **Viscosity**

Viscosity at normal operating temperature should be approx. 20 mm^2/s [100 SUS]. Viscosity range 10 - 300 mm^2/s [60 - 1500 SUS].

- **Temperature**

Normal operating temperature range from +30^{0}C [+85^{0}F] to +60^{0}C [140^{0}F].
Minimum operating temperature -40^{0}C [-40^{0}F].
Maximum operating temperature +80^{0}C [+176^{0}F].
Note: Extended periods of operation at temperature of 60^{0}C and above will greatly reduce the life of the oil due to oxidation and will shorten the life of the product.

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- **Filtration**

The maximum degree of contamination per ISO 4406 or CETOP RP is:
- 20/17 open center units
- 19/16 closed center and load sensing
- 16/12 priority valves

Return line filtration of 25 μm nominal (40 - 50 μm absolute) or finer is recommended.

In extremely dusty conditions filtration of 10 μm absolute should be used.

START UP

All air must be purged from system before operating unit. It is extremely important that any external lines or units with load sensing or priority feature be completely bled. Lines going to and from cylinders as well as lines to and from pump be purged of all air. It is recommended that a 10-15 μm filter be used between pump and steering unit before start up.

MOUNTING UNITS

All hydrostatic steering units should be installed for ease of access. It is recommended that the steering unit be located outside the vehicle cabin.

It is important that no radial axial load be applied to the hydrostatic steering unit input shaft. Some or all radial and axial loads must be absorbed by the steering column or other operating devices supplied by the vehicle manufacturer.

Ports on the steering cylinder(s) should face upward to prevent damage.

During installation of the hydrostatic steering unit, cleanliness is of the utmost importance. Pipe plugs should be left in place during mounting and only removed when hydraulic lines are to be connected.

CONVERSIONS

to convert inches and millimeters:

1 in = 25,4 mm
1 mm = .03973 in

to convert gallons per minute and liters per minute:

1 GPM = 3,785 lpm
1 lpm = .2642 GPM

to convert pounds per square inch and bar:

1 PSI = 0,0689 bar
1 bar = 14.51 PSI

to convert pounds-inch and newton-meters:

1 lb-in = 0,113 Nm
1 Nm = 8.85 lb-in

TORQUE TIGHTENING VALUES

Fluid connections

Fluid connection	Max. tightening torque daNm [lb-in]			
	metal edge	copper washer	aluminum washer	O - ring
G 1/4	4,0 [350]	3,5 [309]	3,5 [309]	
G 3/8	7,0 [620]	4,5 [398]	5,0 [442]	
G 1/2	10,0 [885]	5,5 [486]	8,0 [708]	
G 3/4	18,0 [1593]	9,0 [796]	13,0 [1150]	
M 10 x 1	4,0 [350]	2,0 [180]	3,0 [265]	
M 18 x 1,5	8,0 [708]	5,5 [486]	7,0 [620]	
M 22 x 1,5	10,0 [885]	6,5 [575]	8,0 [708]	
7/16 - 20 UNF				2,0 [180]
9/16 - 18 UNF				5,0 [442]
3/4 - 16 UNF				6,0 [531]
7/8 - 14 UNF				9,0 [796]
1 1/16 - 12 UN				12,0 [1062]

Mounting bolts

Mounting bolts	Tightening torque daNm [lb - in]
3/8 - 16 UNC	3,0 ± 0,5 [230 ÷ 310]
M 10 x 1	6,5 ± 0,5 [540 ÷ 620]
M 10	3,0 ± 0,5 [230 ÷ 310]

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