HYDROSTATIC STEERING UNITS TYPE HKU(S).../5(D)(T)(E)(TE)(TU) –

The HKU(S).../5(D)(T)(TU) range expands the steering units family of M+S Hydraulic with the *"Closed Center - Non Reaction and Load Sensing Outlet" version* (static and dynamic hydraulic connection to the priority valve).

This range is manufactured in two versions; for modularly and pipe mounting and therefore were developed the two versions of priority (tracing) valves: PRD... and PRT...

HKU.../5 is designed to be connected to priority valves with built-in relief valves for rated flow up to 160 lpm [42 GPM] - PRT.../160.

The control hydraulic circuits of the HKU(S).../5(T) steering units were designed to ensures minimal energy consumption (energy losses) in various hydraulic systems, such as those of: fork-lift trucks, agricultural and construction machines and others.

HKU.../5TU is a steering unit at which the ports R and L in neutral position are connected to the drain line T. This scheme contributes for the fast discharge of the residual pressure in lines L and R, that usually is "locked" when the steering wheel is jerky released at neutral position. These steering units do not drive directly the steering cylinders, but they are connected to hydraulic systems in which they drive the flow amplifiers or other devices.

M+S Hydraulic produces steering units type HKUS.../5E(5TE) which have additional EL-port. An electro-hydraulic relay can be mounted on this port, providing control of the hydraulic system. The relay can be pre-set to normally - open (N.O) or normally - closed (N.C) contacts, with control range from 0,1 to 50 bars.

HKUS…/5D(DT)... is a new generation steering unit, where the dynamic flow to LS-line allows easy and smooth control when starting the steering. Main features are: Low torque of the steering wheel 0,5÷2,0 Nm [4.5÷18 lb-in] at normal operating conditions; High steering speed, limited only by the operating flow and the pressure of the supplying pump.

Constant oil flow to LS-line at neutral position within 0,45÷0,9 lpm [.12÷.24 GPM]. The unit works in a system with a dynamic priority valve and is appropriate for machines with increased energy saving requirements.

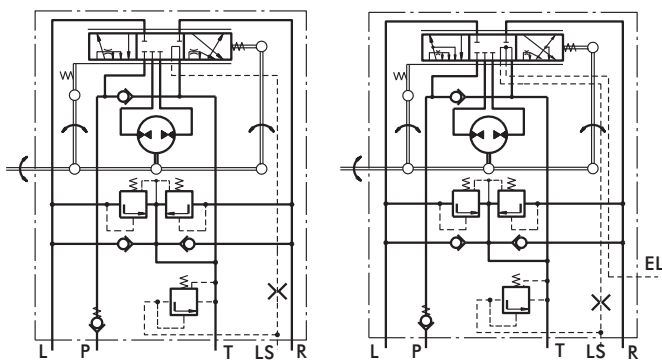*For operation in condition of Thermal Shock see the notes on page 6.

Pipe Mounting
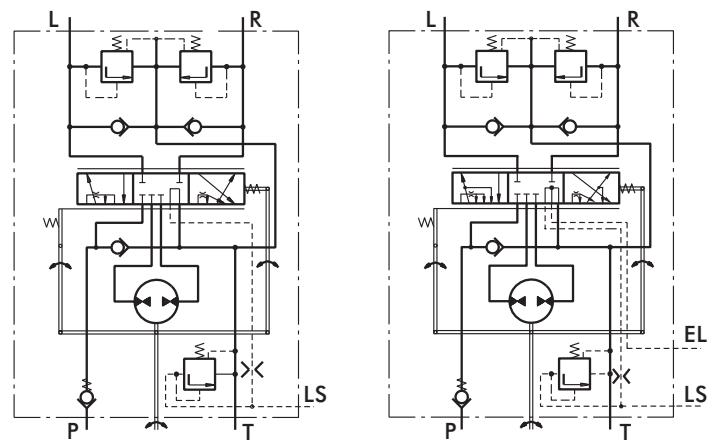
Closed Center - Non Reaction
Static Signal - HKUS.../5T
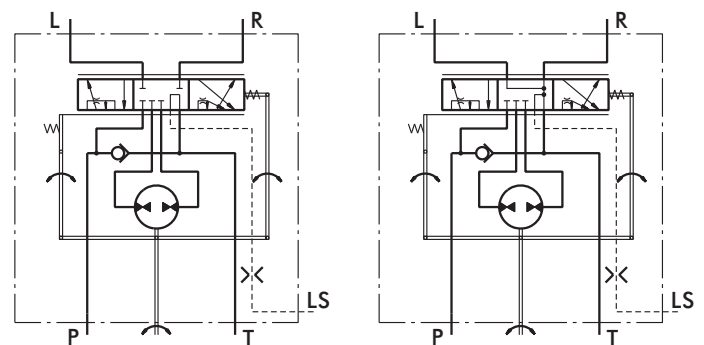Dynamic Signal - HKUS…/5DT

Closed Center - Non Reaction
Static Signal - HKUS…/5TE

Modulary Mounting

Closed Center - Non Reaction
Static Signal - HKUS.../5
Dynamic Signal - HKUS.../5D

Closed Center - Non Reaction
Static Signal - HKUS…/5E

Closed Center - Non Reaction
Static Signal - HKU…/5T

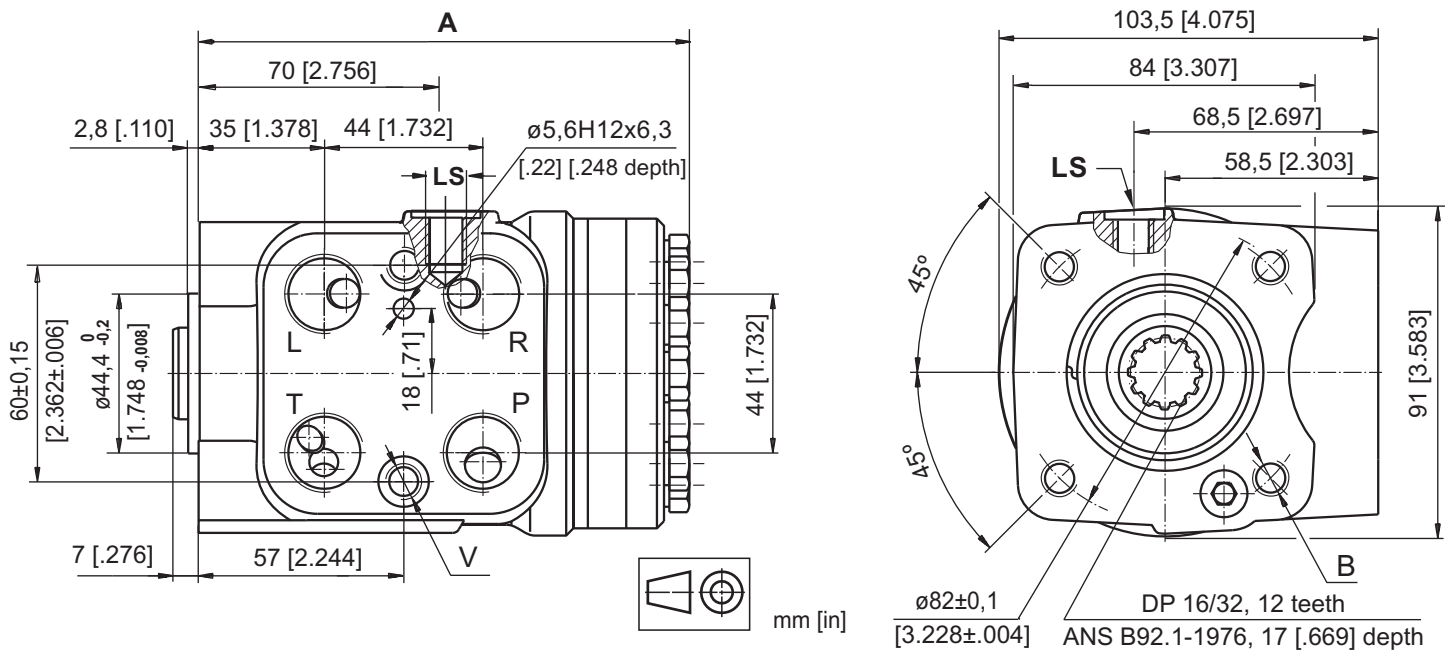Closed Center - Non Reaction
Static Signal - HKU…/5TU

M+S HYDRAULIC

SPECIFICATION DATA

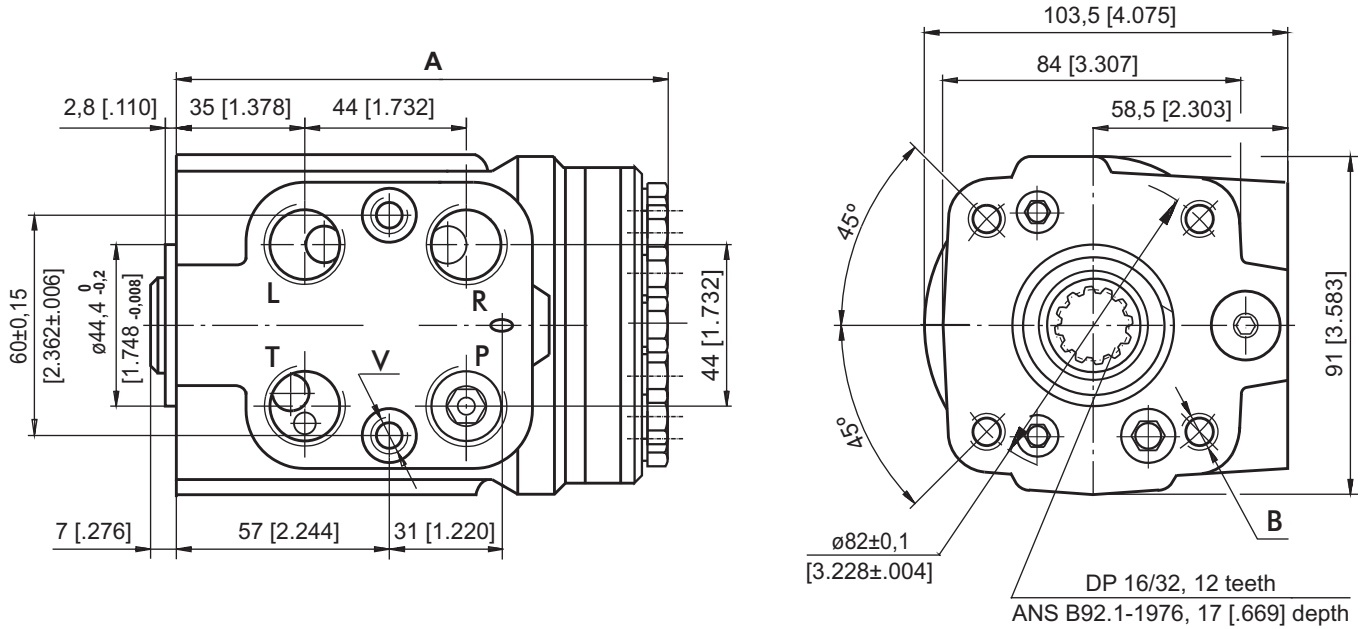| Parameters		HKU 40/5T HKUS 40/5...	HKU 50/5T HKUS 50/5...	HKU 63/5T HKUS 63/5...	HKU 80/5T HKUS 80/5...	HKU 100/5T HKUS 100/5...	HKU 125/5T HKUS 125/5...	HKU 160/5T HKUS 160/5...	HKU 200/5T HKUS 200/5...	HKU 250/5T HKUS 250/5...	HKU 320/5T HKUS 320/5...	HKU 400/5T HKUS 400/5...	HKU 500/5T	HKU 630/5T
								Type						
Displacement	cm³/rev	39,6	49,5	65,6	79,2	99,0	123,8	158,4	198	247,5	316,8	396	495	623,6
	[in³/rev]	[2.42]	[3.0]	[4.0]	[4.83]	[6.04]	[7.56]	[9.67]	[12.1]	[15.1]	[19.3]	[24.2]	[30.2]	[38.05]
Rated Flow*	lpm	4	5	6	8	10	13	16	20	25	32	40	50	63
	[GPM]	[1.1]	[1.3]	[1.6]	[2.1]	[2.6]	[3.4]	[4.2]	[5.3]	[6.6]	[8.4]	[10.6]	[13.2]	[16.6]
Rated Pressure	bar	125	150	175										
	[PSI]	[1810]	[2175]	[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 Servoamplifying Nm [lb-in] -with standard springs -with soft springs (LT option)					3,0 [26] 1,8 [16]						3,0 [26] -			
Max. Torque w/o Servoamplifying Nm [lb-in]							120 [1065]							
Weight	kg	5,3	5,4	5,5	5,6	5,7	5,8	6,0	6,3	6,5	7,0	7,4	8,0	8,7
	[lb]	[11.7]	[11.9]	[12.2]	[12.4]	[12.6]	[12.8]	[13.2]	[13.9]	[14.3]	[15.4]	[16.3]	[17.6]	[19.2]
Dimension A	mm	130,8	132,2	133,9	136,2	138,8	142,2	146,8	152,2	158,8	168,2	178,8	192	209,3
	[in]	[5.15]	[5.20]	[5.27]	[5.36]	[5.47]	[5.60]	[5.78]	[5.99]	[6.25]	[6.62]	[7.04]	[7.56]	[8.24]

* Rated Flow at 100 RPM.

** Pressure Settings are at flow rate of 25 lpm [6.6 GPM] and viscosity 21 mm²/s [105 SUS] at 50° C [122°F], supplied through priority valve.

***Pressure Settings are at flow rate of 2 lpm [.53 GPM] and viscosity 21 mm²/s [105 SUS] at 50° C [122°F].
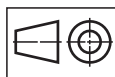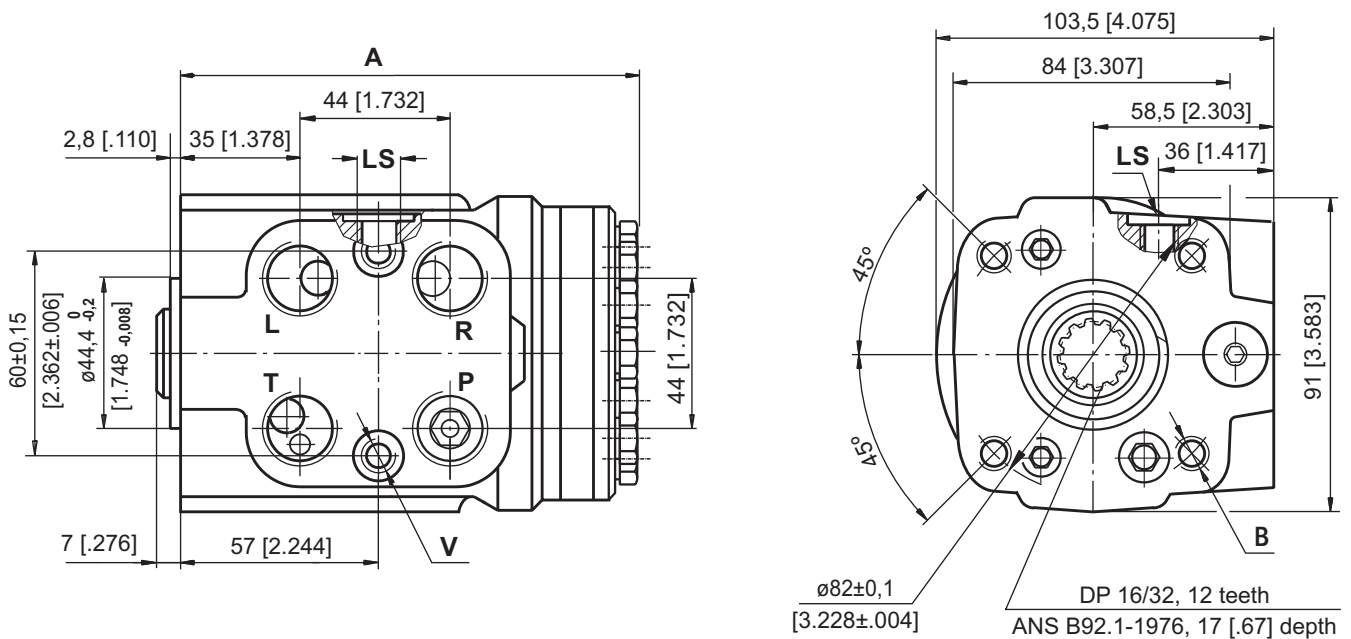
DIMENSIONS AND MOUNTING DATA - HKU.../5T(TU)

mm [in]

M+S HYDRAULIC

DIMENSIONS AND MOUNTING DATA - HKUS.../5(D)

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

A

60±0,15
[2.362±.006]

ø44,4 -0,2 0
[1.748 -0.008]

L   R

T   V   P

7 [.276]   57 [2.244]   31 [1.220]

44 [1.732]

103,5 [4.075]

84 [3.307]

58,5 [2.303]

45°

45°

91 [3.583]

B

ø82±0,1
[3.228±.004]

DP 16/32, 12 teeth
ANS B92.1-1976, 17 [.669] depth

DIMENSIONS AND MOUNTING DATA - HKUS.../5T(DT)

A

44 [1.732]

2,8 [.110]   35 [1.378]   **LS**

60±0,15
[2.362±.006]

ø44,4 -0,2 0
[1.748 -0.008]

L   R

T   V   P

7 [.276]   57 [2.244]   **V**

44 [1.732]

103,5 [4.075]

84 [3.307]

58,5 [2.303]

LS   36 [1.417]

45°

45°

91 [3.583]

B

ø82±0,1
[3.228±.004]

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

mm [in]

The ports are shown in the Table on page 20.

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DIMENSIONS AND MOUNTING DATA - HKUS.../5E

103,5 [4.075]
84 [3.307]
58,5 [2.303]
91 [3.583]

A
2,8 [.110]   35 [1.378]   44 [1.732]
60±0,15 [2.362±.006]
ø44,4 $^{0}_{-0,2}$
[1.748 $^{0}_{-0.008}$]
44 [1.732]
L   R
T   V   P
EL
7 [.276]   50 [1.969]
57 [2.244]   31 [1.220]

45°
45°
ø82±0,1
[3.228±.004]
EL   B
55 [2.265]

DP 16/32, 12 teeth
ANS B92.1-1976, 17 [.669] depth

DIMENSIONS AND MOUNTING DATA - HKUS.../5TE

103,5 [4.075]
84 [3.307]
58,5 [2.303]
36 [1.417]
91 [3.583]

A
44 [1.732]
2,8 [.110]   35 [1.378]   LS
60±0,15 [2.362±.006]
ø44,4 $^{0}_{-0,2}$
[1.748 $^{0}_{-0.008}$]
44 [1.732]
L   R
T   V   P
EL
7 [.276]   50 [1.969]
57 [2.244]

LS
45°
45°
ø82±0,1
[3.228±.004]
EL   B
55 [2.265]

DP 16/32, 12 teeth
ANS B92.1-1976, 17 [.669] depth

mm [in]

code	Ports - P*, T, R, L Thread	Column Mounting Thread - B	Valve Mounting Thread- V	LS - Port	EL - Port
-	G1/2 17 [.67] depth	4 x M10 18 [.71] depth	2 x M10x1 16 [.63] depth	G1/4 14 [.55] depth	M10x1 10 [.39] depth
M	M22x1,5 17 [.67] depth	4 x M10 18 [.71] depth	2 x M10x1 16 [.63] depth	G1/4 .14 [.55] depth	M10x1 10 [.39] 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	7/16 - 20 UNF O-ring 12,7 [.50] depth

*Threaded Ports P min 15 [.59] depth for pipe mounting.

M+S HYDRAULIC

ORDER CODE for HKUS.../5...

	1		2	3	4	5		6		7	8	9	10	11
H K U S		**/**	**5**					**-**		**-**				

Pos. 1 - **Displacement code** (see Specification Data)

40	-	39,6 cm³/rev [2.42 in³/rev]
50	-	49,5 cm³/rev [3.00 in³/rev]
63	-	65,6 cm³/rev [4.00 in³/rev]
80	-	79,2 cm³/rev [4.83 in³/rev]
100	-	99,0 cm³/rev [6.04 in³/rev]
125	-	123,8 cm³/rev [7.56 in³/rev]
160	-	158,4 cm³/rev [9.67 in³/rev]
200	-	198,0 cm³/rev [12.10 in³/rev]
250	-	247,5 cm³/rev [15.10 in³/rev]
320	-	316,8 cm³/rev [19.30 in³/rev]
400	-	396,0 cm³/rev [24.20 in³/rev]

Pos.2 - **Versions**

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

Pos.3 - **Signal Type**

omit - Static Load Signal
D - Dynamic Load Signal

Pos.4 - **Priority Valve Connection**

omit - Modulary Mounting
T - Pipe Mounting

Pos.5 - **Electric Signal Connection**

omit - Without electric signal connection
E - With electric signal connection*

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

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

Pos. 7 - **Ports**

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

Pos. 8 - **Max. Cont. Pressure in line T**

omit - Standard
H - High pressure

Pos. 9 - **Input torque**

omit - Standard
LT** - Low

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:
* Available with Static Load Signal only.
** Available for displacement from 40 to 200 only.
*** Colour at customer's request.
**** Not for HKUS.../5 and HKUS.../5D.
***** Non painted feeding surfaces, colour at customer's request.
The steering units are mangano-phosphatized as standard.

ORDER CODE for HKU.../5T...

	1		2	3		4	5	6	7	8
H K U		**/**	**5**		**-**					

Pos.1 - **Displacement code** (see Specification Data)

40	-	39,6 cm³/rev [2.42 in³/rev]
50	-	49,5 cm³/rev [3.00 in³/rev]
63	-	65,6 cm³/rev [4.00 in³/rev]
80	-	79,2 cm³/rev [4.83 in³/rev]
100	-	99,0 cm³/rev [6.04 in³/rev]
125	-	123,8 cm³/rev [7.56 in³/rev]
160	-	158,4 cm³/rev [9.67 in³/rev]
200	-	198,0 cm³/rev [12.10 in³/rev]
250	-	247,5 cm³/rev [15.10 in³/rev]
320	-	316,8 cm³/rev [19.30 in³/rev]
400	-	396,0 cm³/rev [24.20 in³/rev]
500	-	495,0 cm³/rev [30.20 in³/rev]
630	-	623,6 cm³/rev [38.05 in³/rev]

Pos.2 - **Versions**

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

Pos.3 - **Priority Valve Connection**

T - Pipe Mounting (only)
TU - Pipe Mounting (ports R and L in neutral position are connected to the drain line T)

Pos.4 - **Ports**

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

Pos.5 - **Max. Cont. Pressure in line T**

omit - Standard
H - High pressure

Pos.6 - **Input torque**

omit - Standard
LT* - Low

Pos.7 - **Option (Paint)****

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

Pos.8 - **Design Series**

omit - Factory specified

Notes:
* Available only for displacement from 40 to 200.
** Colour at customer's request.
*** Non painted feeding surfaces, colour at customer's request.
The steering units are mangano-phosphatized as standard.

M+S HYDRAULIC

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.
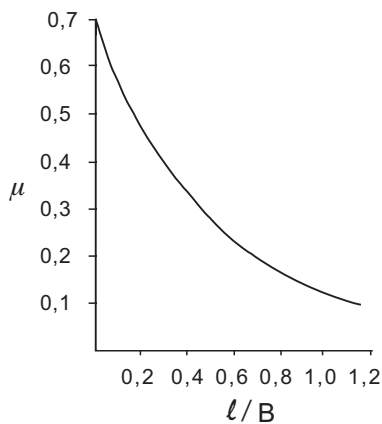
M_L = Kingpin torque in daNm [*lb-in*].

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.

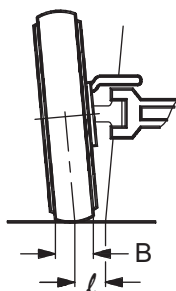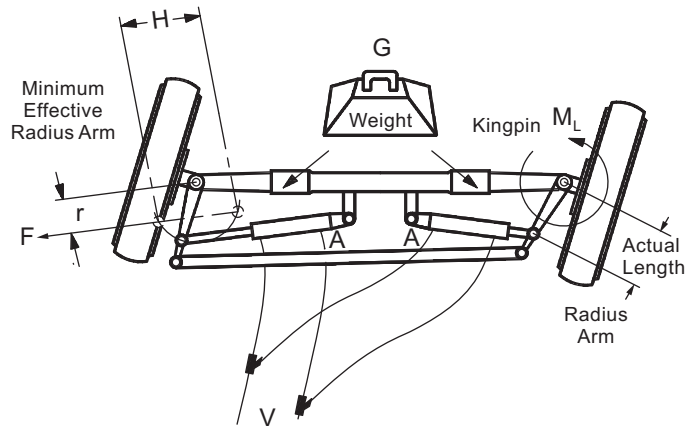### Diagram № 1

Diagram № 2

STEP TWO:
Calculate approximate cylinder; force-area-stroke-volume.

FORCE $F = \dfrac{M_L}{r}$

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

$$r_{min.} = r_{max.} \cdot \cos \frac{\gamma}{2}$$
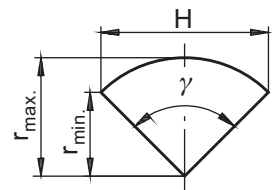
STROKE
H = Stroke, cm [*in*].
Calculate stroke of cylinder using Diagram № 2 and Chart № 2 as shaft.

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

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

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% .
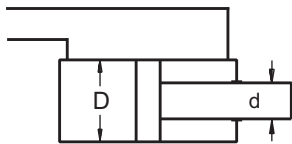
M+S HYDRAULIC

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.
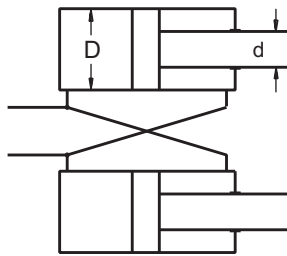
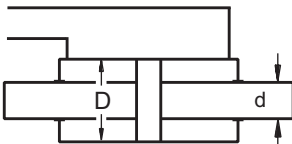**Differential Cylinder**

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

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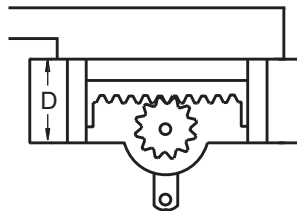
Cross Connected Cylinders

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

Balanced Cylinder

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

Opposed Cylinder

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

VOLUME $V = H . A$

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.

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

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

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.

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

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]

M+S HYDRAULIC