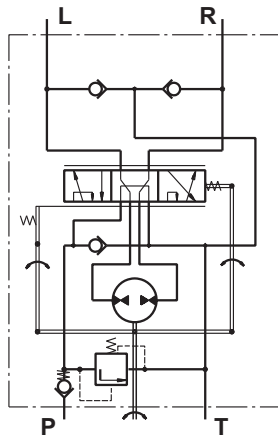


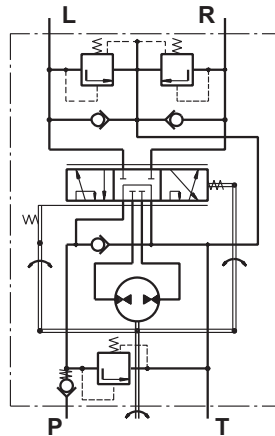
# HYDROSTATIC STEERING UNITS TYPE HKUS.../3, 4, 8



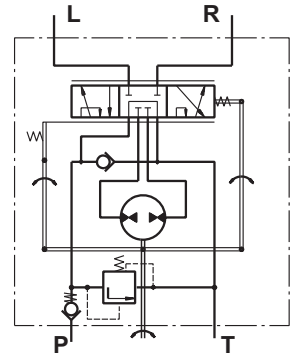
The HKUS Hydrostatic Steering unit is based on the HKU unit but has built-in relief and check valves. Thus M+S Hydraulic achieves one very compact steering unit which reduces the need for additional hydraulic components in the system.



"Open Center - Load Reaction"  
HKUS.../3



"Open Center - Non Load Reaction"  
HKUS.../4



"Open Center - Non Load Reaction"  
HKUS.../8

## SPECIFICATION DATA

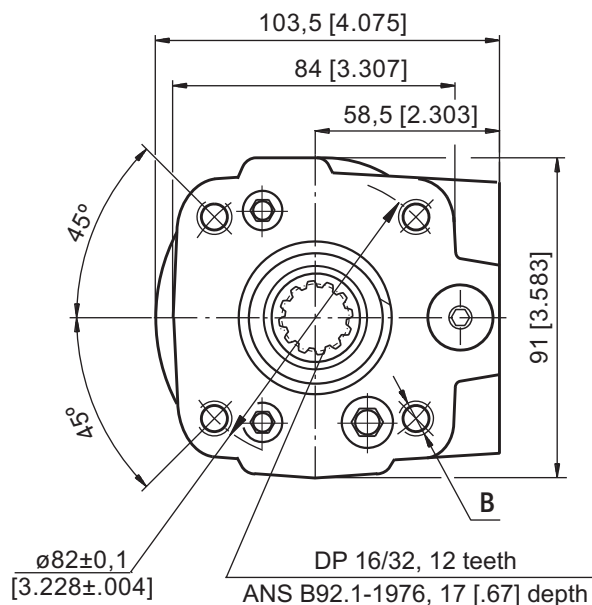
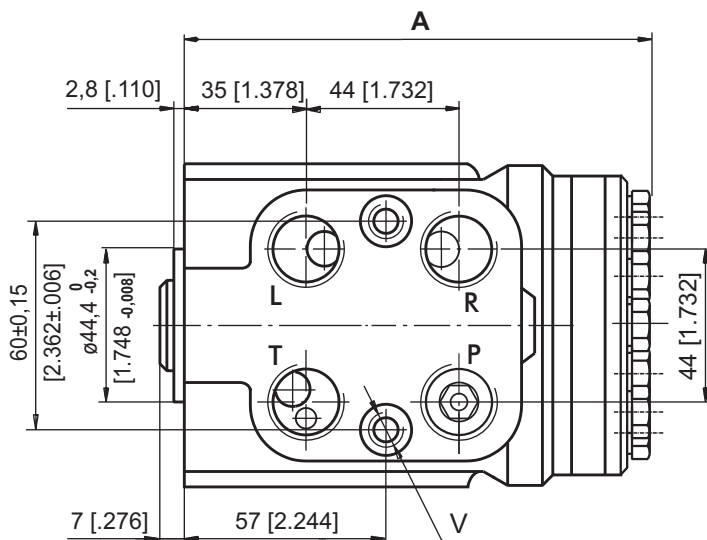
Parameters	Type												
	HKUS 40/3,4,8	HKUS 50/3,4,8	HKUS 63/3,4,8	HKUS 80/3,4,8	HKUS 100/3,4,8	HKUS 125/3,4,8	HKUS 160/3,4,8	HKUS 200/3,4,8	HKUS 250/3,4,8	HKUS 320/3,4,8	HKUS 400/3,4,8	HKUS 500/3,4,8	
Displacement	cm <sup>3</sup> /rev [in <sup>3</sup> /rev]	39,6 [2.42]	49,5 [3.0]	65,6 [4.0]	79,2 [4.83]	99,0 [6.04]	123,8 [7.56]	158,4 [9.67]	198 [12.1]	247,5 [15.1]	316,8 [19.3]	396 [24.2]	495 [30.2]
Rated Flow*	lpm [GPM]	4 [1.1]	5 [1.3]	6 [1.6]	8 [2.1]	10 [2.6]	13 [3.4]	16 [4.2]	20 [5.3]	25 [6.6]	32 [8.4]	40 [10.6]	50 [13.2]
Rated Pressure	bar [PSI]	140 [2030]			170 [2465]								
Relief Valve Pressure		80			100	125	150	170					
Settings**	bar [PSI]	[1160]			[1450]	[1810]	[2175]	[2465]					
Shock Valves Pressure		140			160	180	200	220					
Settings***	bar [PSI]	[2030]			[2320]	[2610]	[2900]	[3190]					
Max. Cont. Pressure in Line T	bar [PSI]	25 [363] (50 [725] by HKUS.../8) 40 [580]											
- standard													
- high pressure (H option)													
Max. Torque at Servoamplifying	Nm [lb-in]	3,0 [26]					3,0 [26]						
- with standard springs		1,8 [16]					-						
- with soft springs (LT option)													
Max. Torque w/o Servoamplifying	Nm [lb-in]	120 [1065]											
Weight	kg [lb]	5,3 [11.7]	5,4 [11.9]	5,5 [12.2]	5,6 [12.4]	5,7 [12.6]	5,8 [12.8]	6,0 [13.2]	6,3 [13.9]	6,5 [14.3]	7,0 [15.4]	7,4 [16.3]	8,0 [17.6]
Dimension A	mm [in]	130,8 [5.15]	132,2 [5.20]	133,9 [5.27]	136,2 [5.36]	138,8 [5.47]	142,2 [5.60]	146,8 [5.78]	152,2 [5.99]	158,8 [6.25]	168,2 [6.62]	178,8 [7.04]	192 [7.56]

\* Rated Flow at 100 RPM.

\*\* Pressure Settings are at Rated Flow (as in the table) and viscosity 21 mm<sup>2</sup>/s [105 SUS] at 50°C [122°F].

\*\*\* Pressure Settings are at flow rate of 2 lpm [.53 GPM] and viscosity 21 mm<sup>2</sup>/s [105 SUS] at 50°C [122°F].

**DIMENSIONS AND MOUNTING DATA - HKUS.../3, 4, 8**



Code	Ports - P*, T, R, L Thread	Column Mounting Thread - B	Valve Mounting Thread - V
-	G1/2 17 [.67] depth	4 x M10 18 [.71] depth	2 x M10x1 16 [.63] depth
M	M22x1,5 17 [.67] depth	4 x M10 18 [.71] depth	2 x M10x1 16 [.63] 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

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

	1	2	3	4	5	6	7	8	9
<b>HKUS</b>		/		-		-			

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

<b>40</b>	-	39,6	[2.42]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>50</b>	-	49,5	[3.00]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>63</b>	-	65,6	[4.00]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>80</b>	-	79,2	[4.83]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>100</b>	-	99,0	[6.04]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>125</b>	-	123,8	[7.56]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>160</b>	-	158,4	[9.67]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>200</b>	-	198,0	[12.10]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>250</b>	-	247,5	[15.10]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>320</b>	-	316,8	[19.30]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>400</b>	-	396,0	[24.20]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]
<b>500</b>	-	495,0	[30.20]	cm <sup>3</sup> /rev	[in <sup>3</sup> /rev]

**Pos.2 - Versions**

<b>3</b>	-	Version 3 "Open Center - Load Reaction"
<b>4</b>	-	Version 4 "Open Center - Non Load Reaction"
<b>8</b>	-	Version 8 "Open Center - Non Load Reaction"

**Pos.3 - Relief Valve Pressure Settings, bar**

**80, 100, 125, 150, 170**

**Pos.4 - Ports**

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

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

omit	-	Standard
<b>H</b>	-	High pressure

**Pos.6 - Input torque**

omit	-	Standard
<b>LT*</b>	-	Low

**Pos.7 - Noise level**

omit	-	Standard
<b>LN*</b>	-	Low

**Pos.8 - Option (Paint)\*\***

omit	-	No Paint
<b>P</b>	-	Painted
<b>PC</b>	-	Corrosion Protected Paint
<b>PS</b>	-	Special Paint***
<b>PCS</b>	-	Special Corrosion Protected Paint***

**Pos.9 - Design Series**

omit - Factory specified

Version	Manual Steering Check Valve	Relief Valve	Inlet Check Valve	Cylinder Relief Valve	Anti-Cavitation Valve
3	•	•	•		•
4	•	•	•	•	•
8	•	•	•		

**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.

# 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].

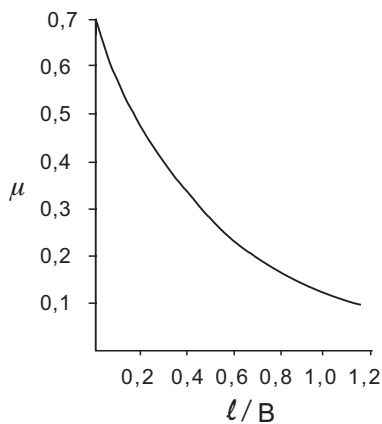
$G$  = Vehicle weight on steered axle daN [lbs] (use maximum estimated overload weight).

$\mu$  = Coefficient of friction (use Chart № 1, dimensionless) determined by  $\ell/B$  (see Diagram № 1).

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

$\ell$  = 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

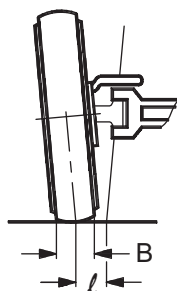
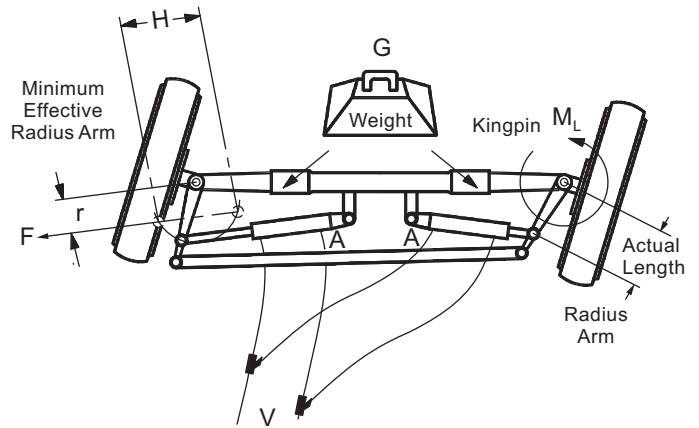


Diagram № 2



### STEP TWO:

Calculate approximate cylinder; force-area-stroke-volume.

**FORCE** 
$$F = \frac{M_L}{r}$$

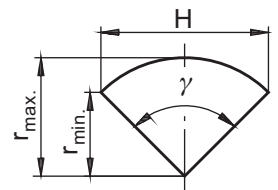
$F$  = Force required daN [lbs] to steer axle.

$M_L$  = 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,  $\text{cm}^2$  [in<sup>2</sup>].

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

$\Delta P$  = 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%.

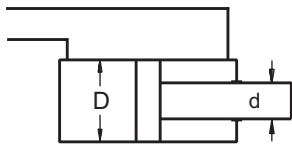
**DIAMETER**

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.

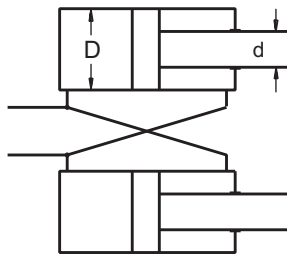
**Differential Cylinder**



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

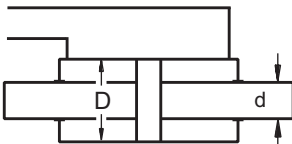
Note:  $\left(\frac{d}{D}\right)^2 \leq 0,15$

**Cross Connected Cylinders**



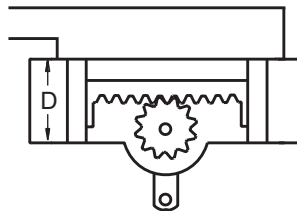
$$D = \sqrt{\frac{2A}{\pi} + \frac{d^2}{2}}$$

**Balanced Cylinder**



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

**Opposed Cylinder**



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

**VOLUME**  $V = H \cdot A$

V = Volume. The total amount of oil required to move the cylinder rod(s) through the entire stroke, cm<sup>3</sup> [in<sup>3</sup>].

H = Stroke, cm [in].

A = Area, cm<sup>2</sup> [in<sup>2</sup>].

**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<sub>D</sub> = Displacement, cm<sup>3</sup>/rev [in<sup>3</sup>/rev].

V = Volume of oil, cm<sup>3</sup> [in<sup>3</sup>].

n = Steering wheel turns lock to lock.

After completing the above displacement calculation, choose the closest standard hydrostatic steering unit in displacement size that incorporates circuitry 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<sup>3</sup> [in<sup>3</sup>].

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<sub>D</sub> = Unit displacement, cm<sup>3</sup>/rev [in<sup>3</sup>/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<sup>2</sup>/s [100 SUS]. Viscosity range 10 - 300 mm<sup>2</sup>/s [60 - 1500 SUS].

• **Temperature**

Normal operating temperature range from +30°C [+85°F] to +60°C [140°F].

Minimum operating temperature -40°C [-40°F].

Maximum operating temperature +80°C [+176°F].

**Note:** Extended periods of operation at temperature of 60°C and above will greatly reduce the life of the oil due to oxidation and will shorten the life of the product.

**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  $\mu m$  nominal (40 - 50  $\mu m$  absolute) or finer is recommended.

In extremely dusty conditions filtration of 10  $\mu m$  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  $\mu m$  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]