# VALVE BLOCKS FOR HKU AND XY TYPE BKH...

The BKH valves are developed to protect the components of the hydraulic circuit: pumps, steering units and cylinders - from overloads, impacts and cavitation. Some of their advantages are: easy integration into any hydraulic circuit, easy mounting to the steering unit, and quick and easy hose connections. Depending on the design and the built in valves the BKH valves can be divided into 6 types: BKH1 ... BKH5 and BKHR, with BKH5 designed for XY steering units only. The maximum flow rate is in compliance with the whole range of HKU and XY steering units but no more than 80 l/min. The pressure settings for the entry relief valves and the shock valves are presented in the table.
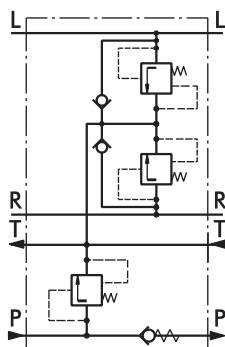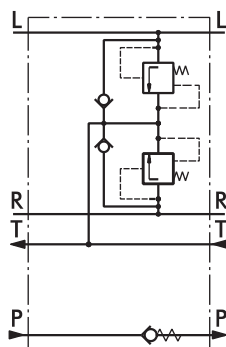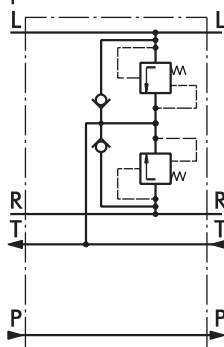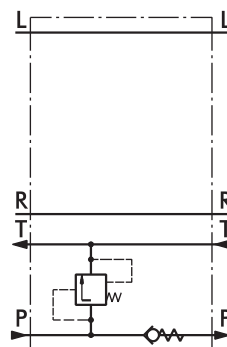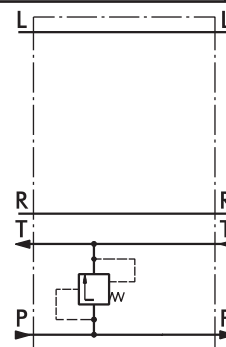
BKH1, BKHR	BKH2	BKH3	BKH4	BKH5

SPECIFICATION DATA

Parameters		Type			
		BKH1, BKHR	BKH2	BKH3	BKH4, BKH5
Rated Flow lpm [GPM]		80 [21.1]			
Rated Pressure bar [PSI]		160 [2320]			
Relief Valve Pressure Settings* bar [PSI]		80 [1160] 100 [1450] 125 [1810] 150 [2175]	-	-	80 [1160] 100 [1450] 125 [1810] 150 [2175]
Shock Valves Pressure Settings** bar [PSI]		140 [2030] 160 [2320] 180 [2610] 200 [2900]	200 [2900]	240 [3480]	- - - -
Weight kg [lb]		1,8 , 2,3 [4.0] , [5.1]	1,8 [4.0]		1,8 [4.0]

* Pressure Settings are at flow rate of 30 lpm [7.92 GPM] and viscosity 21 mml/s [105 SUS] at 50є C [122єF]
** Pressure Settings are at flow rate of 2 lpm [.53 GPM] and viscosity 21 mml/s [105 SUS] at 50є C [122єF]

DIMENSIONS AND MOUNTING DATA - BKH1, 2, 3, 4
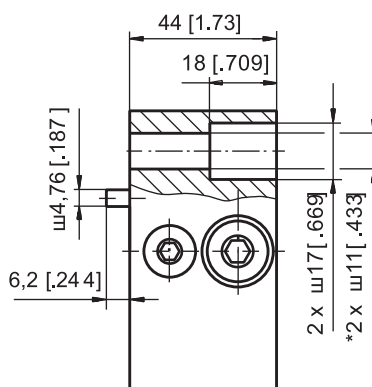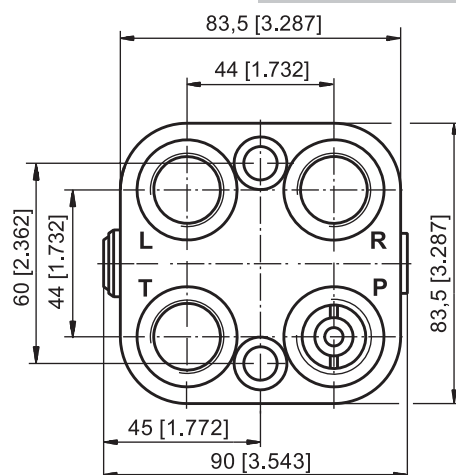
code	Ports - P, T, R, L Thread
-	G1/2 20 [.80] depth
M	M22x1,5 20 [.80] depth
A	3/4 - 16 UNF O-ring 20 [.80] depth

* Connection to the HKU is done with 2 screws M10x1x40 -8.8 DIN 912 or with 2 screws 3/8-24 UNF ANSI B18.3-76, long 1.5". Tightening torque: 2,5±0,5 daNm [177÷265 lb - in].

DIMENSIONS AND MOUNTING DATA - BKHR

49 [1.929]
*2x ш11 [.433] Thru
140 [5.512]
60 [2.362]
94 [3.701]
82 [3.228]
38 [1.496]
106 [4.173]
22 [.866]
44 [1.732]

c o d e	Ports - P, T, R, L Thread
M	M18x1,5 22 [.87] depth
A	3/4 - 16 UNF O-ring 22 [.87] depth

* Connection to the HKU is done with 2 screws M10x1x40 -8.8 DIN 912 or with 2 screws 3/8-24 UNF ANSI B18.3-76, long 1.5". Tightening torque: 2,5±0,5 daNm [1774265 lb - in].
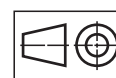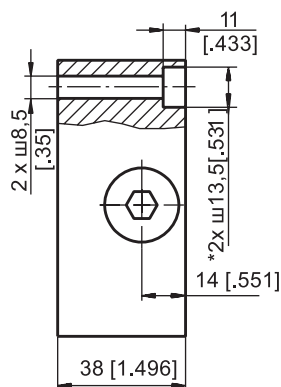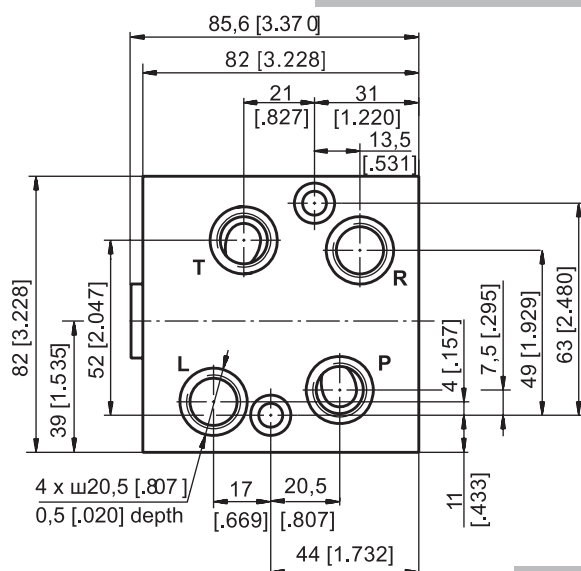
DIMENSIONS AND MOUNTING DATA - BKH5

85,6 [3.37 0]
82 [3.228]
21 [.827]
31 [1.220]
13,5 [.531]
82 [3.228]
52 [2.047]
39 [1.535]
4 [.157]
7,5 [.295]
49 [1.929]
63 [2.480]
11 [.433]
4 x ш20,5 [.807] 0,5 [.020] depth
17 [.669]
20,5 [.807]
44 [1.732]
11 [.433]
2 x ш8,5 [.35]
*2x ш13,5 [.531]
14 [.551]
38 [1.496]

mm [in]

c o d e	Ports - P, T, R, L Thread
M	M16x1,5 14 [.55] depth

* Connection to the XY is done with 2 screws M8x1x40 -8.8 DIN 912 . Tightening torque: 2,5±0,5 daNm [1774265 lb - in].

ORDER CODE

	1	2	3	4	5
B K H		-	-		

Pos.1 - **Versions***

R	1	2	3	4		with built-in valves:
•	•			•		- Input relief valve on line **"P "**
•	•	•		•		- Input check (non-return) valve on line **"P"**
•	•	•	•			- Shock valves on lines **"R"** and **"L"**
•	•	•	•			- Anti-cavitation valves on lines **"R"** and **"L"**

Pos.2 - **Relief Valve Pressure Settings, bar****

80	100	125	150

Pos.3 - **Ports*****

omit - BSPP (ISO 228)

A - SAE (ANSI B 1.1 - 1982)

M - Metric (ISO 262)

Pos.4 - **Option (Paint)*****

omit - No Paint

P - Painted Low Gloss Color

PC - Corrosion Protected Paint

Pos.5 - **Design Series**

omit - Factory specified

Notes: * Versions **R, 1, 2, 3, 4** -for **HKU**; **5** - for **XY**.
** That does not concern version **2** and **3**.
*** For Port size see drawings on page 19 and 20.
**** Colour at customer's request.

The valve blocks are mangano-phosphatized as standard.

PRIORITY VALVES FOR HKUS.../5... TYPE PR...

The Priority Valves distribute and trace the hydraulic flow from the supply pump of the hydraulic system to the hydraulic components which control and run the vehicle.

The Priority Valves are used only with the HKUS.../5(D)(T) hydrostatic steering units. When connected, the steering unit and the priority valve represent sophisticated hydraulic tracing system that controls the flow in both main pipelines of the hydraulic system (the working and control one) at any time of its operation.

As a static signal, the "LS" signal must be used in systems with circuit stability. The connection between the PRT, PRTA priority valves and the HKUS.../5T steering units has to be as short as possible, but should not exceed 1,5 m [4.92 ft] (for iron pipe with 4 mm [.157 in.] internal diameter). When a rubber hose is used this length has to be even shorter.

Priority valves with dynamic signal work in a system with dynamic hydrostatic steering units type HKUS.../5D (5DT).
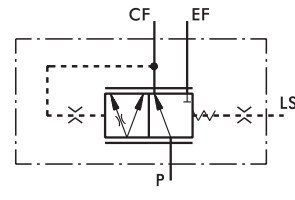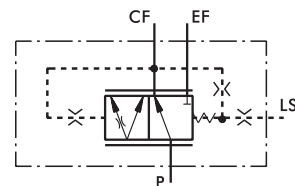
Modulary Mounting
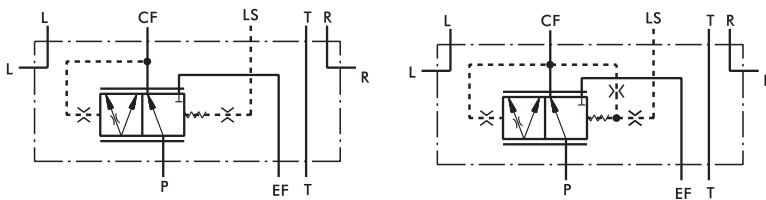
Static signal
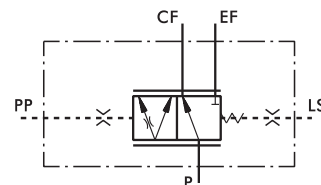PRD 40,80/...

Dynamic signal
PRDD 40,80/...

Pipe Mounting

Static signal
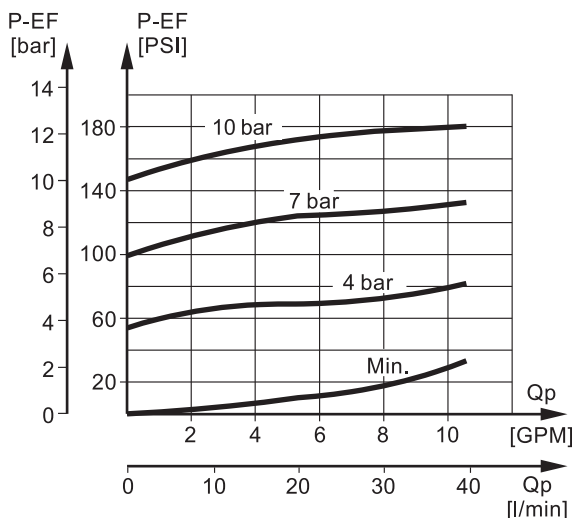PRT 40,80,120/...,   PRTA 40,80/...
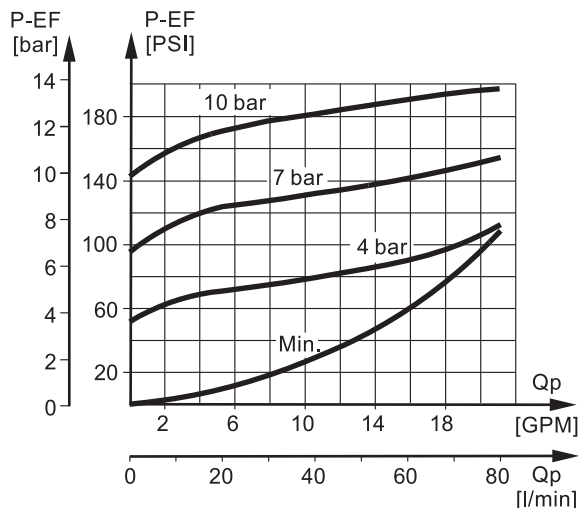

Dynamic signal
PRTD 40,80,120/...,PRTAD40,80/...
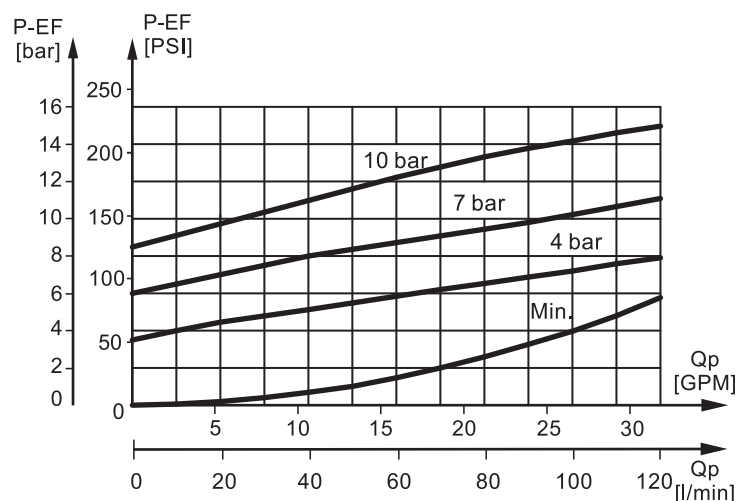

Static signal with External Port
PRTE120/...

PR...40

PR...80

PRT...120

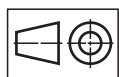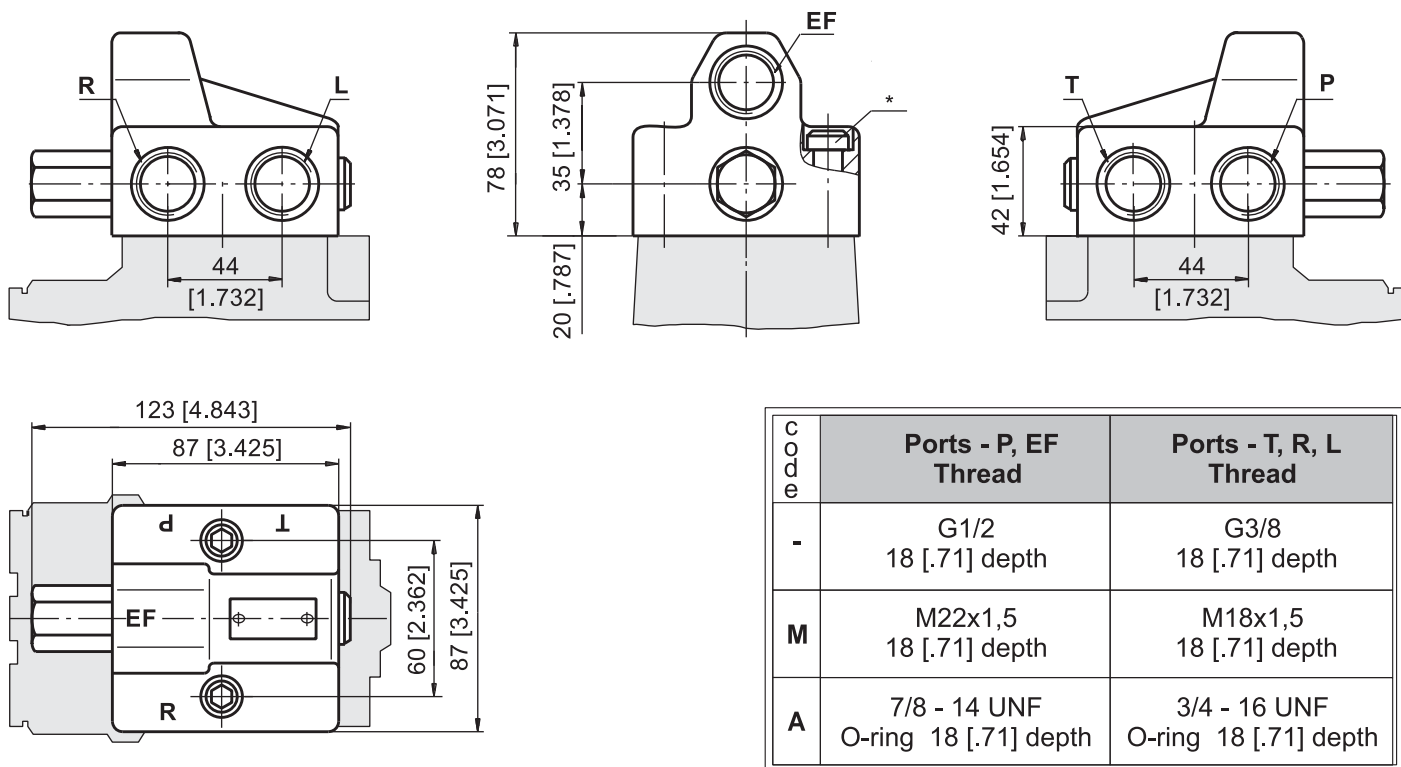## SPECIFICATION DATA

Parameters		Type								
		PRD(D), PRT(D)			**PRTA(D)**			**PRT(D)(E)**		
Rated Flow	lpm	40			80			120		
	[GPM]	[10.6]			[21.1]			[31.7]		
Control Spring Pressure	bar	4	7	10	4	7	10	4	7	10
	[PSI]	[58]	[101.5]	[145]	[58]	[101.5]	[145]	[58]	[101.5]	[145]
Max. Pressures in Oil Ports:										
	P, EF	250 [3625]								
	CF	210 [3045]								
bar [PSI]	R, L	280 [4061]			-					
	LS	210 [3045]								
	PP							210 [3045]		
	T	20 [290]								
Weight	kg	2,25			1,3			2,1		
	[lb]	[4.96]			[2.87]			[4.6]		

P - pump, **EF** - excess flow, **CF** - control flow (first priority oil flow),
L - left, **R** - right, **LS** - load sensing, **T** - tank, **PP**- pilot pressure (L,R and T - for PRD(D) only)

DIMENSIONS AND MOUNTING DATA - PRD(D) 40, 80/...

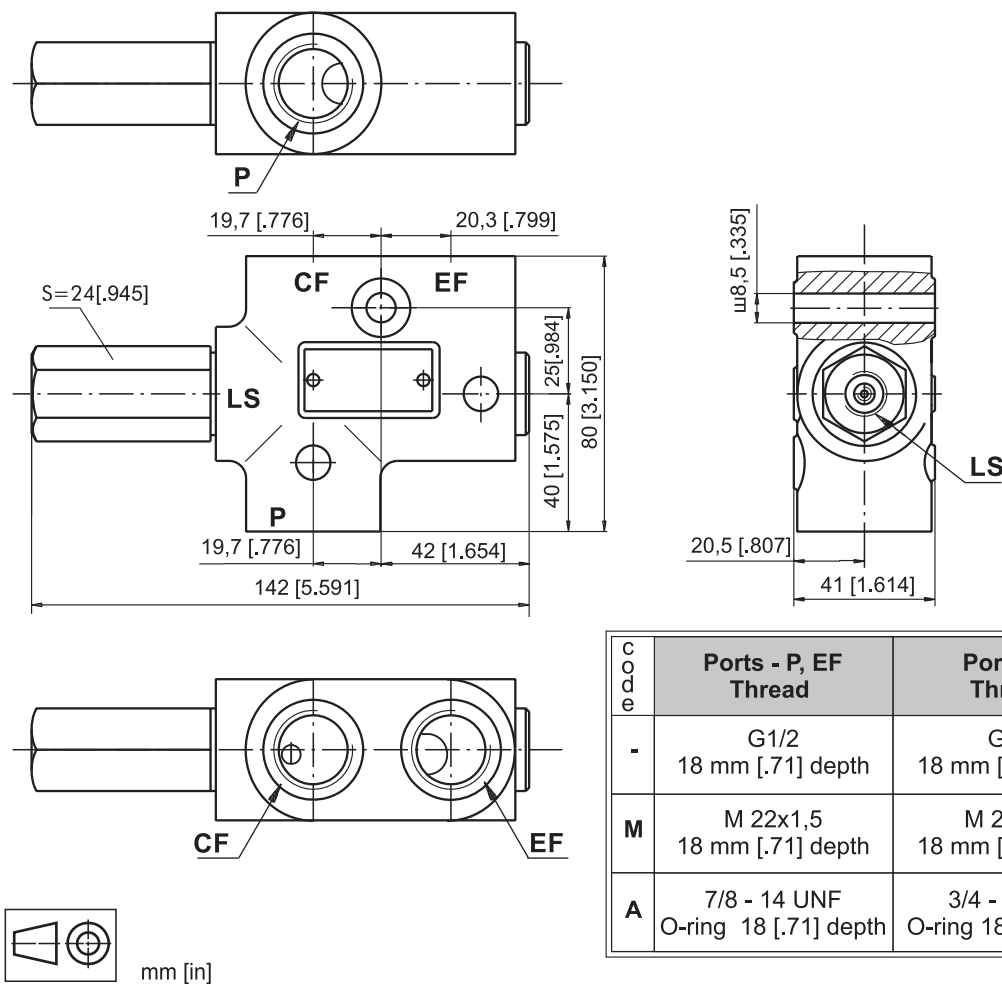| code	Ports - P, EF Thread	Ports - T, R, L Thread
-	G1/2 18 [.71] depth	G3/8 18 [.71] depth
M	M22x1,5 18 [.71] depth	M18x1,5 18 [.71] depth
A	7/8 - 14 UNF O-ring 18 [.71] depth	3/4 - 16 UNF O-ring 18 [.71] depth

* Connection to the HKUS.../5(D)... is done with 2 screws M10x1x45 -10.9 DIN 912 or with 2 screws 3/8-24 UNF ANSI B18.3-76, 1.75" long. Tightening torque: 4,5±0,5 daNm [360 ± 440 lb-in].

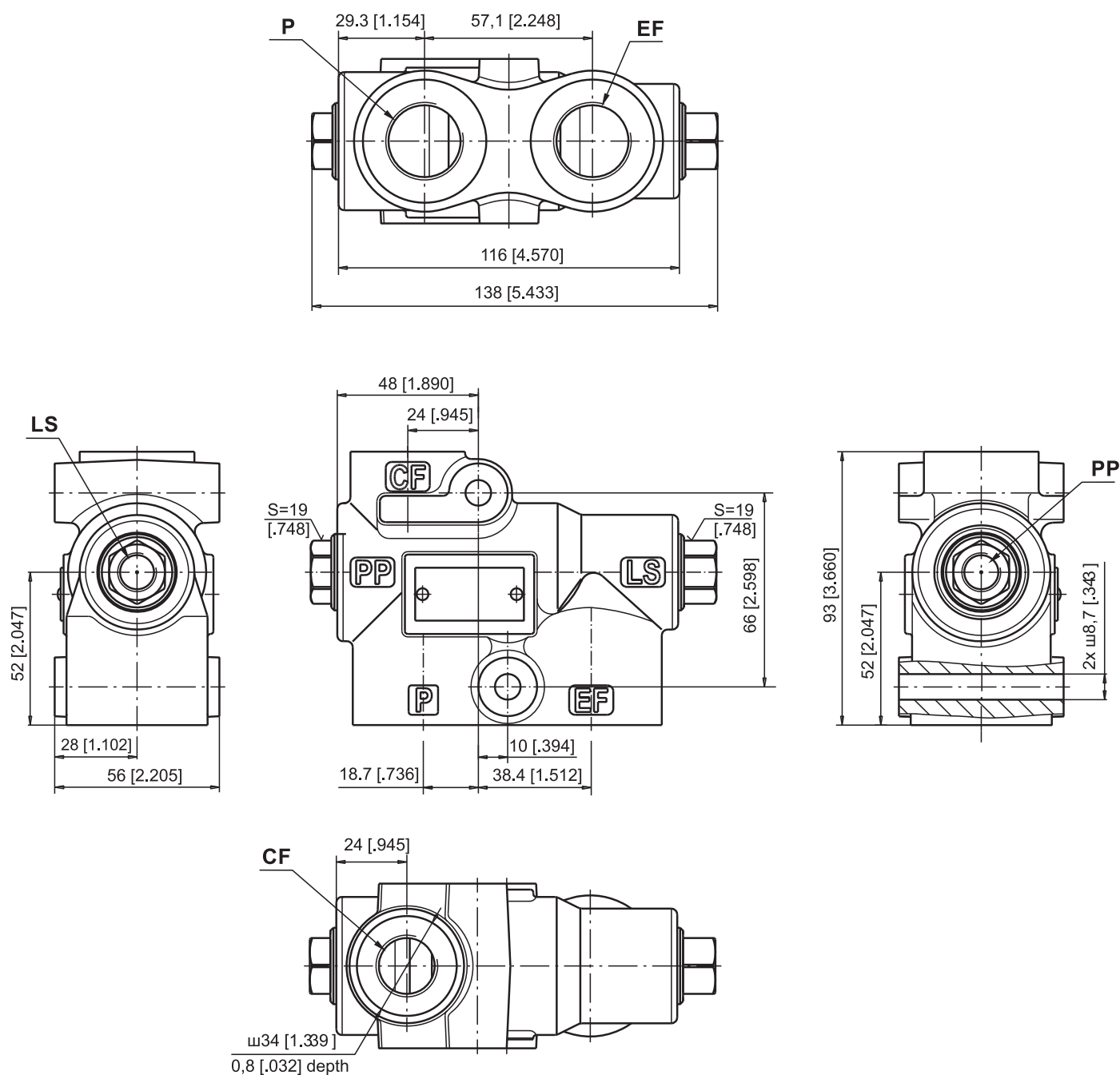mm [in]

DIMENSIONS AND MOUNTING DATA - PRT(D) 40, 80/...

CF

EF

2 x ⌀17 [.669]

78 [3.071]

35 [1.378]

11 [.431]

20 [.787]

LS

2 x ⌀10,5 [.413]

0,1 [.004]

P

42 [1.654]

22 [.866]

142 [5.6]

87 [3.43]

d

EF

CF

60 [2.36]

87 [3.43]

code	Ports - P, EF Thread	Port - CF Thread	LS - Port
-	G1/2 18 mm [.71] depth	G1/2 18 mm [.71] depth	G1/4 14 mm [.55] depth
M	M 22x1,5 18 mm [.71] depth	M 22x1,5 18 mm [.71] depth	G1/4 14 mm [.55] depth
A	7/8 - 14 UNF O-ring 18 [.71] depth	3/4 - 16 UNF O-ring 18 [.71] depth	7/16 - 20 UNF O-ring 12,7 [.50] depth
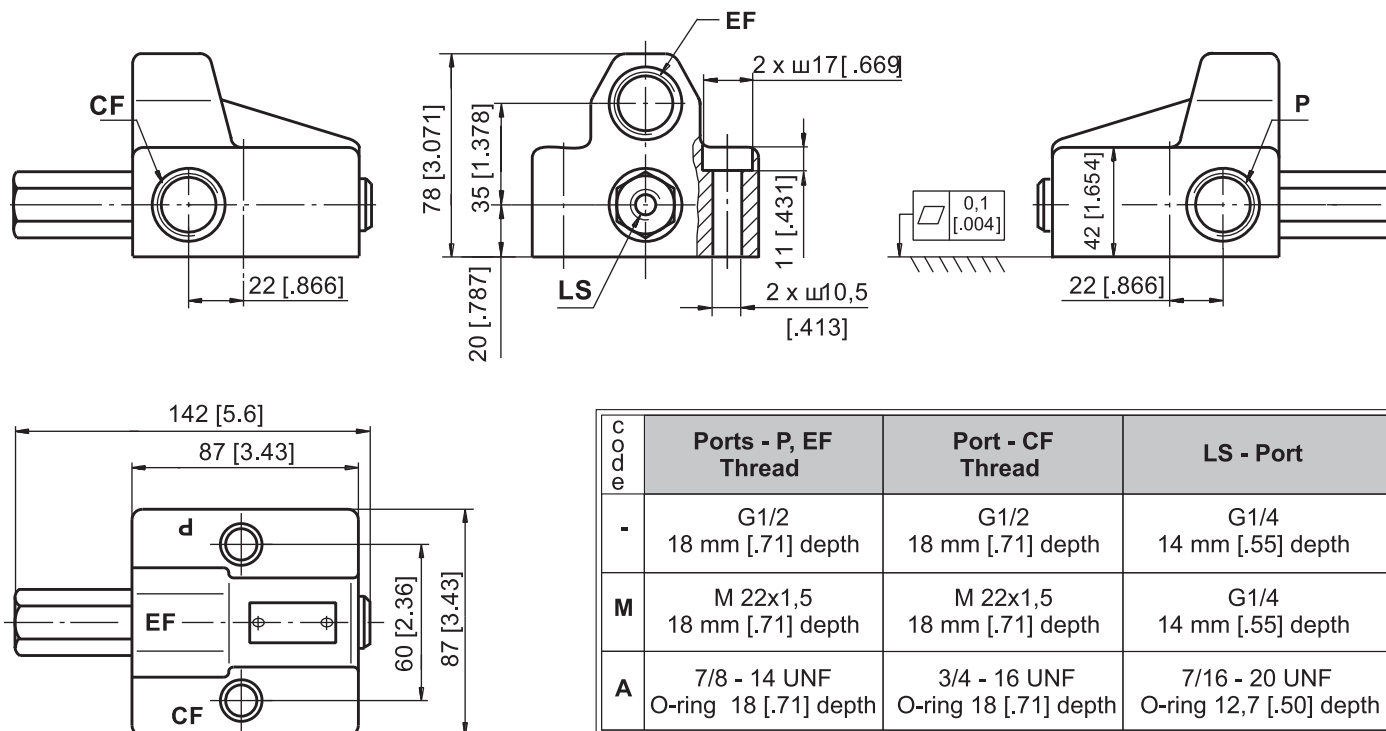
DIMENSIONS AND MOUNTING DATA - PRTA(D) 40, 80/...

P

19,7 [.776]

20,3 [.799]

S=24 [.945]

CF

EF

LS

25 [.984]

80 [3.150]

40 [1.575]

P

19,7 [.776]

42 [1.654]

142 [5.591]

⌀8,5 [.335]

LS

20,5 [.807]

41 [1.614]

CF

EF

code	Ports - P, EF Thread	Port - CF Thread	LS - Port
-	G1/2 18 mm [.71] depth	G1/2 18 mm [.71] depth	G1/4 14 mm [.55] depth
M	M 22x1,5 18 mm [.71] depth	M 22x1,5 18 mm [.71] depth	G1/4 14 mm [.55] depth
A	7/8 - 14 UNF O-ring 18 [.71] depth	3/4 - 16 UNF O-ring 18 [.71] depth	7/16 - 20 UNF O-ring 12,7 [.50] depth

mm [in]

DIMENSIONS AND MOUNTING DATA - PRT...120/...

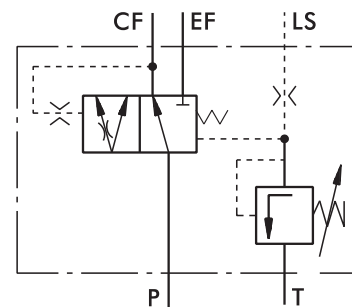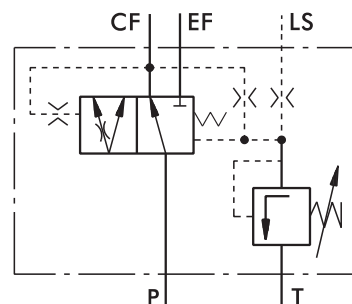| c o d e	Ports - P, EF Thread	Port - CF Thread	LS, PP - Ports
-	G3/4 20,5 [.81] depth	G1/2 18,5 [.73] depth	G1/4 12,5 [.49] depth
M	M27x2 20,5 [.81] depth	M18x1,5 18,5 [.73] depth	M12x1,5 12,5 [.49] depth
A	1 1/16 - 12 UN O-ring 20,5 [.81] depth	3/4 - 16 UNF O-ring 18,5 [.73] depth	7/16 - 20 UNF O-ring 12,5 [.49] depth
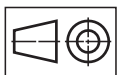
mm [in]

The Priority Valves PRT...160 have a built-in pilot pressure relief valve, which protects the steering unit against excessive pressure. The pilot pressure relief valve operates with the Shuttle of the Priority valve to limit the maximum steering pressure P-T measured across the ports of the steering unit.
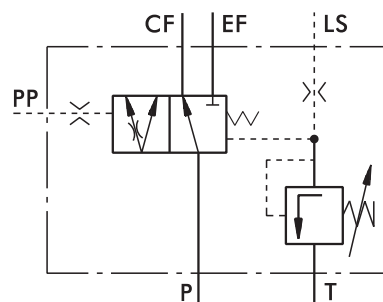
Static signal
PRT 160/...

Dynamic signal
PRTD 160/...

Static signal with External Pilot
PRTE 160/...

SPECIFICATION DATA

Parameters		Type		
		PRT(D), PRTE		
Rated Flow	lpm [GPM]	160 [42.3]		
Control Spring Pressure	bar [PSI]	4 [58]	7 [101.5]	10 [145]
Max. Pressures in Oil Ports: P, EF		350 [5076]		
bar [PSI]	CF	210 [3045]		
	LS	210 [3045]		
	PP	210 [3045]		
	T	15 [217]		
Standard Relief Valve Pressure Settings bar [PSI] *		175 [2540]		
Weight	kg [lb]	4,4 [9.70]		

* - Adjusted valve pressure from 80 bar [1160 PSI] to 210 bar [3045 PSI] upon customer request.
P - pump, **EF** - excess flow, **CF** - control flow (first priority oil flow),
LS - load sensing, **T** - tank, **PP** - pilot pressure

PR...160/...

DIMENSIONS AND MOUNTING DATA - PRT(D)(E)160/...

EF CF

59 [2.32 3]

122 [4.803]

PP

177,5 [6.988]

32,8 [1.291] 75 [2.953]

24 [.945] 59 [2.323]

T

132,5 [5.217] max

121[4.764]

60,5 [2.382]

32,5 [1.280]

65 [2.559]

75 [2.953]

32 [1.260]

T

LS

P

PP

EF CF

35[1.378] 63 [2.480]

130 [5.118]

35 [1.378]

60,5 [2.382]

28,5 [1.122]

2x ⌀9 [.354]

LS

99 [3.898]

40 [1.575]

P

2x ⌀42[1.654]
0,8 [.031] depth
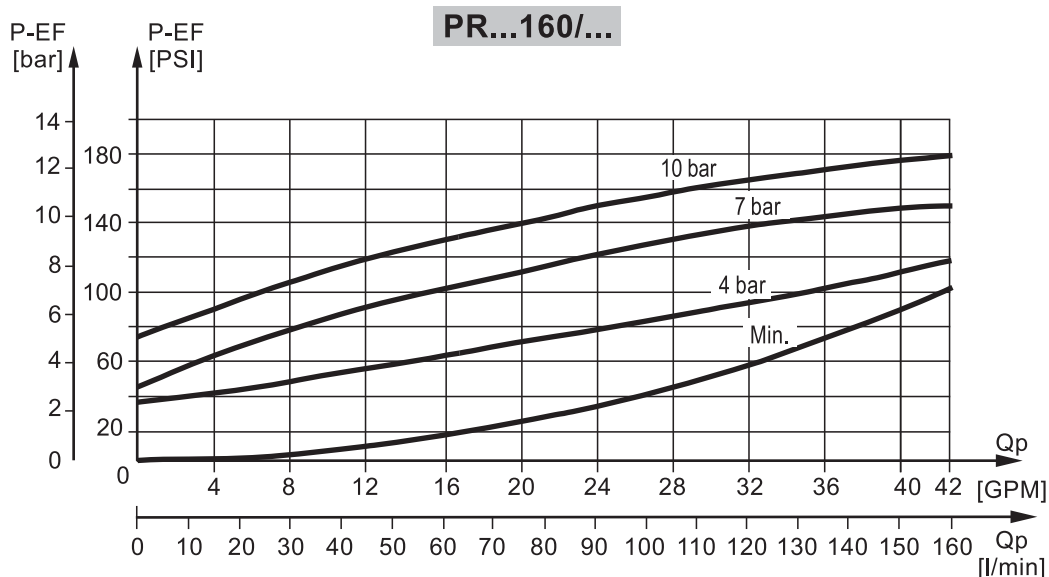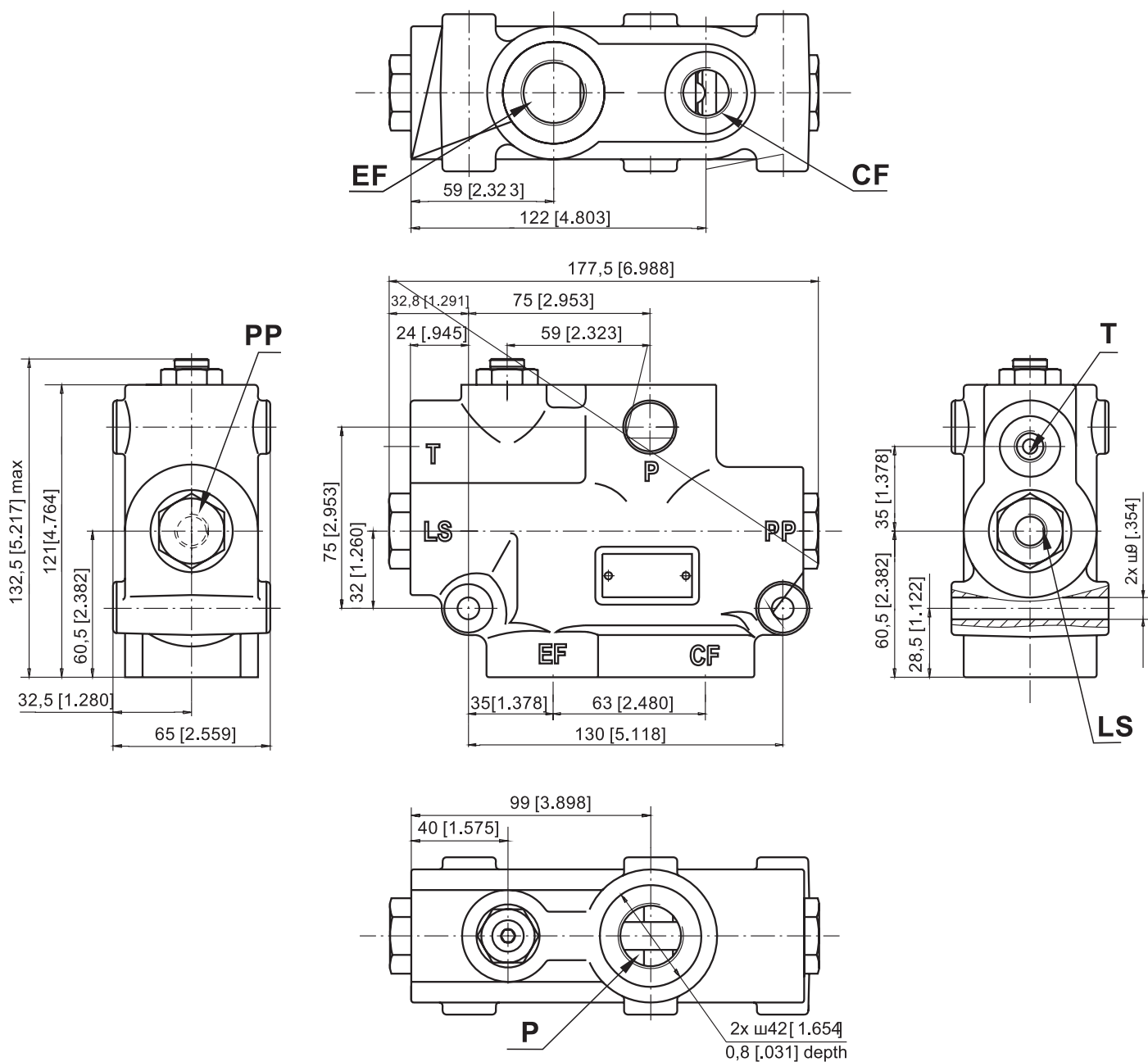
code	Ports - P, EF Thread	Port - CF Thread	LS, PP, T - Ports
-	G3/4 20,5 [.81] depth	G1/2 18,5 [.73] depth	G1/4 12,5 [.49] depth
M	M27x2 20,5 [.81] depth	M18x1,5 18,5 [.73] depth	M12x1,5 12,5 [.49] depth
A	1 1/16 - 12 UN O-ring 20,5 [.81] depth	3/4 - 16 UNF O-ring 18,5 [.73] depth	7/16 - 20 UNF O-ring 12,5 [.49] depth

mm [in]

ORDER CODE

P R				/		-			
	1	2	3		4		5	6	7
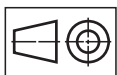
Pos.1 - Mounting

D	- Modularly Mounting
T	- Pipe Mounting (Model 1)
TA	- Pipe Mounting (Model 2)

Pos.2 - Signal Type

omit	- with Static signal
D	- with Dynamic signal
E*	- with Static signal and External Pilot

Pos.3 - Rated Flow, l/min

40	80	120**	160**

Pos.4 - Control Spring Pressure , bar

4	7	10

Pos.5 - Ports

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

Pos.6 - Option [Paint]***

omit	- No Paint
P	- Painted Low Gloss Color
PC	- Corrosion Protected Paint

Pos.7 - Design Series

omit	- Factory specified

Notes:*   For PRT 1 20/... and PRT 160/... only
      ** For PRT only
   *** Colour at customer's request.

The priority valves are mangano-phosphatized as standard.

TORQUE AMPLIFIERS TYPE UVM...

the UVM Torque Amplifiers amplify the applied torque to the control shaft and thus ease the running of various transport vehicles such as:

- agricultural and wood working machines;
- road rollers and road cleaning machines;
- fork-lift trucks and construction machinery.
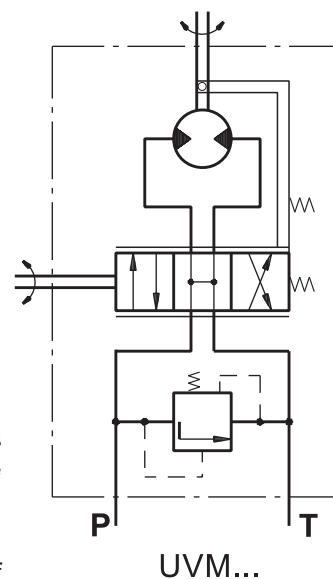
The totally transferred power in terms of output torque is up to 1,1 kW [1.47 HP].

The UVM torque amplifiers with their simple design, consisted of a pump and an amplifier, ensure 40 times higher output torque than the applied one. The amplifying is achieved as follows; by rotating the input shaft to the left or right, the spool and the bushing are displaced, and the hydraulic flow enters the system turning the gerotor set, which transfers the already amplified torque to the output shaft.

One advantage of the UVM torque amplifier is that it allows manual steering in case of engine (pump) failure.
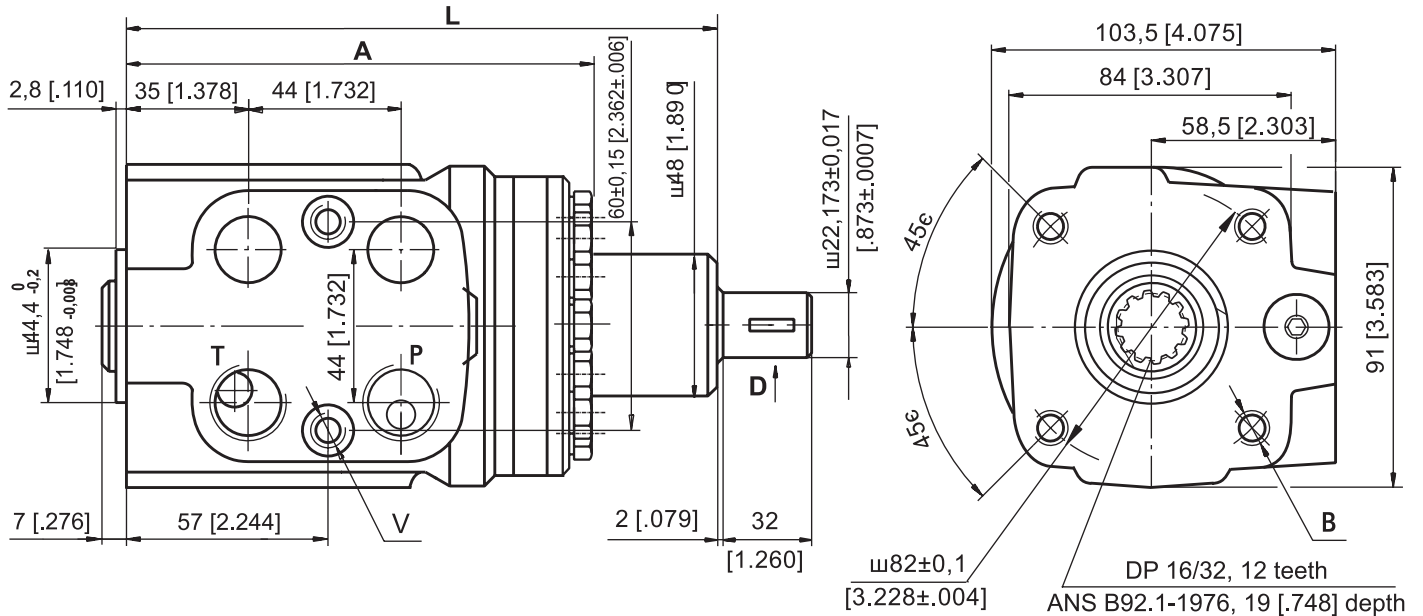
UVM...

SPECIFICATION DATA

Parameters		Type	
		UVM 100	UVM 160
Displacement	cm³/rev [in³/rev]	99,0 [6.04]	158,4 [9.67]
Rated Flow*	lpm [GPM]	10 [2.6]	16 [4.2]
Rated Pressure**	bar [PSI]	70 [1015]	70 [1015]
Input Torque	daNm [lb-in]	0,35...0,5 [31...44]	0,35...0,5 [31...44]
Max. Input Torque	daNm [lb-in]	20 [178]	20 [178]
Torque Output at 70 bar [1015 PSI]	daNm [lb-in]	80 [708]	120 [1062]
Pressure Drop between P and T at Rated Flow	bar [PSI]	1... 2 [14.5...29]	1,6...2,5 [23.2...36.3]
Max. Speed of Rotation at Rated Flow and Pressure	RPM	100	100
Max. Continuous Pressure in Line T	bar [PSI]	20 [290]	20 [290]
Weight	kg [lb]	5,8 [12.8]	6,2 [13.7]

*   Rated Flow at 100 RPM
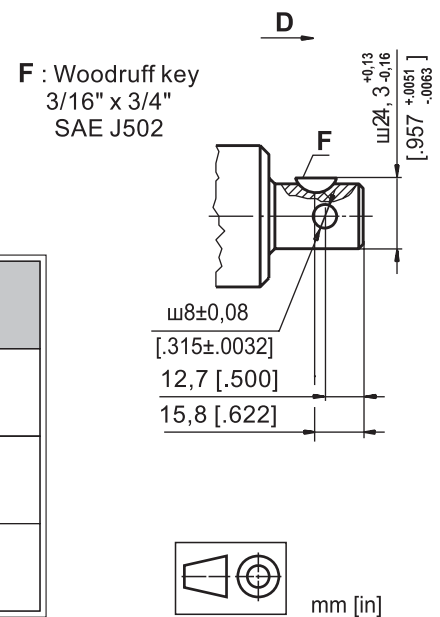** Pressure Settings are at Rated Flow (as in the table) and viscosity
     21 mm²/s [105 SUS] at 50° C [122°F].

DIMENSIONS AND MOUNTING DATA

L

A

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

ш48 [1.89]

60±0,15 [2.362±.006]

ш22,173±0,017 [.873±.0007]

ш44,4 $^{0}_{-0.2}$ [1.748 $^{0}_{-.008}$]

44 [1.732]

T   P

D

7 [.276]   57 [2.244]   V

2 [.079]   32 [1.260]

103,5 [4.075]

84 [3.307]

58,5 [2.303]

45°   45°

91 [3.583]

B

ш82±0,1 [3.228±.004]

DP 16/32, 12 teeth
ANS B92.1-1976, 19 [.748] depth

Dimensions		Type	
		UVM 100	**UVM 160**
A	mm	143,3	151,3
	[in]	[5.64]	[5.96]
L	mm	181,2	189,2
	[in]	[7.13]	[7.45]

code	Ports - P, T Thread	Column Mounting Thread - B	Port 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

D

F : Woodruff key 3/16" x 3/4" SAE J502

ш24,3 $^{+0,13}_{-0,16}$ [.957 $^{+.0051}_{-.0063}$]

F

ш8±0,08 [.315±.0032]
12,7 [.500]
15,8 [.622]

mm [in]

ORDER CODE

U V M	1	2	3	4

Pos.1 - **Displacement code**

100 - 99,0 [6.04] cm³/rev [in³/rev]

160 - 158,4 [9.67] cm³/rev [in³/rev]

Pos.2 - **Ports**

omit - BSPP (ISO 228)

M - Metric (ISO 262)

A - SAE (ANSI B 1.1 - 1982)

Pos.3 - **Option (Paint)***

omit - No Paint

P - Painted Low Gloss Color

PC - Corrosion Protected Paint

Pos.4 - **Design Series**

omit - Factory specified

Notes: * Colour at customer's request.

The steering units are mangano-phosphatized as standard.

29

STEERING COLUMNS TYPE KK...

The KK Steering Columns transfer the torque from the steering wheel of the vehicle to the HKU, HKUS or other steering units of the same class. The KK steering columns consist of a pipe in which the control shaft is centred.
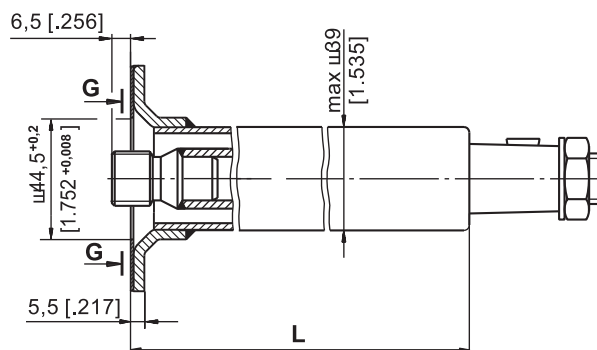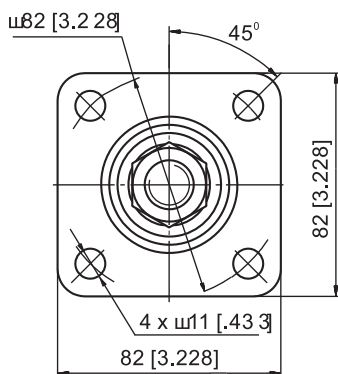
Permissible loads of the steering column are as follows: The length L depends on the transport vehicle construction.

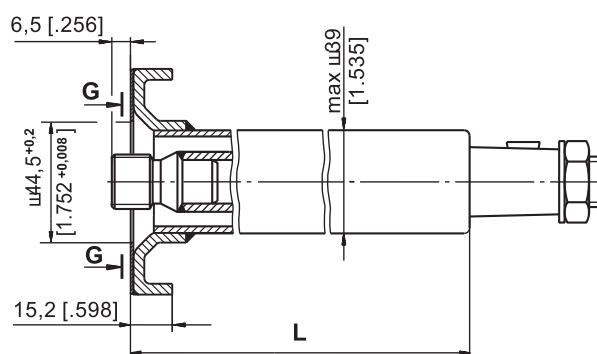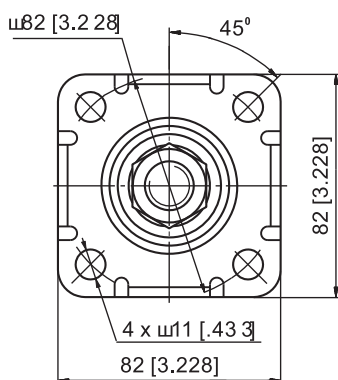| Max. torque applied to the steering wheel | 24 daNm | [2124 lb-in] |
| Max. bending moment | 20 daNm | [1770 lb-in] |
| Max. axial load | 100 daN | [225 lbs] |

The steering column must be additionally supported when the length L exceeds 150 mm [5.91 in].

DIMENSIONS AND MOUNTING DATA

Type KK

Type KKF
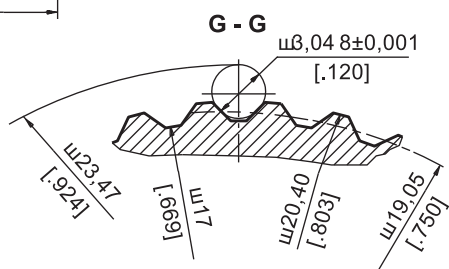
G - G

ш3,04 8±0,001 [.120]

ш23,47 [.924] ш17 [.669] ш20,40 [.803] ш19,05 [.750]

mm [in]

Involute Spline Data		
Modul	m	1.5875
Number of Teeth	z	12
Pressure Angle	α	30°
Diametral Pitch	DP	16/32

SPECIFICATION DATA

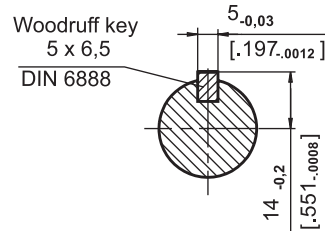| Parameters		Type				
		KK 75	KK 150	KK 390	KK 441	KK 750
L	mm [in]	78 [3.07]	168,2 [6.62]	393 [15.47]	441 [17.36]	777,8 [30.62]
Weight	kg [lb]	0,75 [1.65]	1,1 [2.43]	1,9 [4.19]	5,05 [11.13]	3,3 [7.28]

Note:
For more information regarding other lengths and shaft versions, please refer
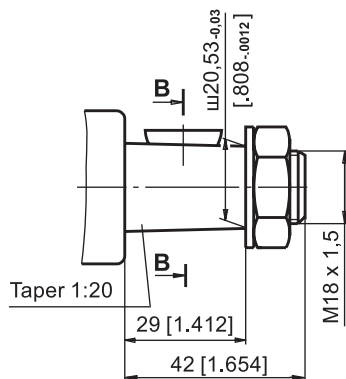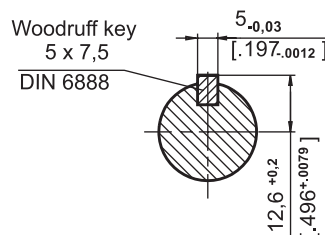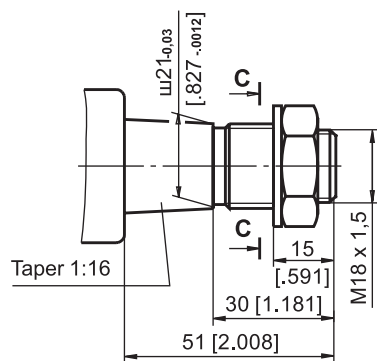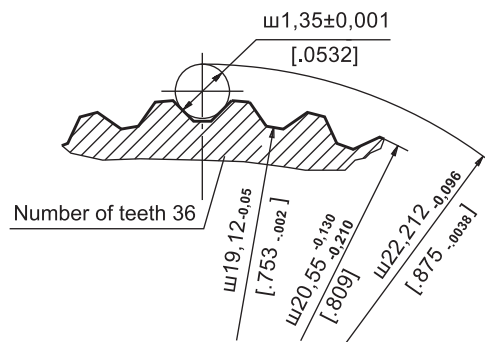
SHAFT VERSIONS

TYPE I

ш23,2 -0,04
[.913 -.0016]

A

A

Taper 1:20

32 [1.260]

48 [1.890]

M18 x 1,5

A - A

Woodruff key
5 x 6,5
DIN 6888

5 -0,03
[.197 -.0012]

14 -0,2
[.551 -.0008]

TYPE II

ш20,53 -0,03
[.808 -.0012]

B

B

Taper 1:20

29 [1.412]

42 [1.654]

M18 x 1,5

B - B

Woodruff key
5 x 7,5
DIN 6888

5 -0,03
[.197 -.0012]

12,6 +0,2
[.496 +.0079]

TYPE III

ш21 -0,03
[.827 -.0012]

C

C

Taper 1:16

15
[.591]

30 [1.181]

51 [2.008]

M18 x 1,5

C - C

ш1,35±0,001
[.0532]

Number of teeth 36

ш19,12 -0,05
[.753 -.002]

ш20,55 -0,130
[.809 -.210]

ш22.212 -0,096
[.875 -.0038]

TYPE IV

ш21,55 +0,05
[.849 -.002]

D

D

Taper 1:19,26

14
[.551]

24,9 [.980]

43 [1.693]

M18 x 1,5

D - D

ш1,587±0,0025
[.0625]

Number of teeth 36

ш20,72±0,05
[.816±.002]

ш21,79±0,05
[.858±.002]

ш24,12±0,025
[.95±.001]

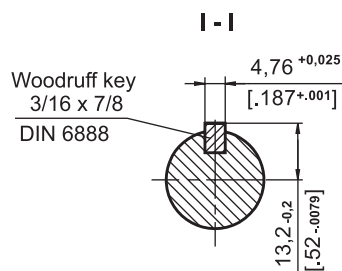**TYPE V**

ш21,84 -0,04
[.860 -.0016]

D

D

Taper 1:19,26

11,2
[.441]

24,9 [.980]

39 [1.535]

M18 x 1,5
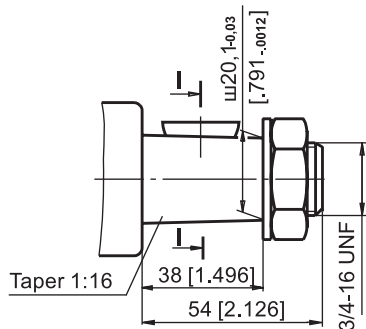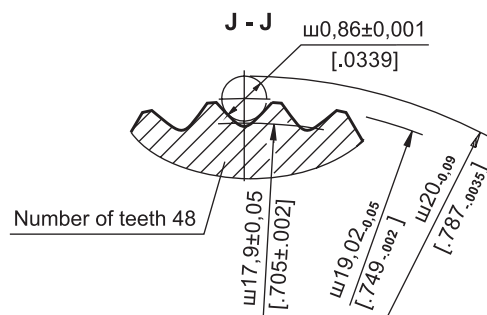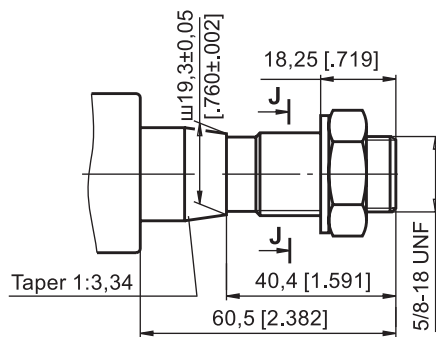
mm [in]

SHAFT EXTENSIONS

TYPE VI

ш20,1-0,03 [.791-.0012]

I

I

Taper 1:16

38 [1.496]

54 [2.126]

3/4-16 UNF

I - I

Woodruff key
3/16 x 7/8
DIN 6888

4,76 +0,025 [.187+.001]

13,2 -0,2 [.52 -.0079]

TYPE VII

ш19,3±0,05 [.760±.002]

18,25 [.719]

J

J

Taper 1:3,34

40,4 [1.591]

60,5 [2.382]

5/8-18 UNF

J - J

ш0,86±0,001 [.0339]

Number of teeth 48

ш17,9±0,05 [.705±.002]

ш19,02-0,05 [.749-.002]

ш20-0,09 [.787-.0035]

TYPE VIII

K

16±0,1 [.630±.004]

K

12,9±0,1 [.509±.004]

45 [1.772]

ш8+0,036 [.315 +.0036]

ш22,173±0,017 [.873±.0007]

K - K

Woodruff key
3/16 x 7/8
DIN 6888

4,76 +0,025 [.187+.001]

24,3 +0,13 -0,16 [.957 +.0051 -.0063]

TYPE IX

10,9±0,1 [.429±.004]

24,9 [.980]

ш9,5±0,08 [.374±.0032]

ш22,173±0,017 [.873±.0007]

mm [in]

INSTALLING

For column type KK

For assembling the Steering column to the Steering units use four bolts through mounting bracket.

Tightening torque for bolts 1,5±0,5 daNm [133±44 lb-in]

ш65 [2.165]

a

Mounting Bracket

Four Bolts M10 or 3/8-16 UNC x(a+20)
ш82±0,1 [3.2 28±.0039] Bolt Circle

For column type KKF

Two Bolts M10x20 mm
or 3/8-16 UNC x .75 in.
ш82±0,1 [3.2 28±.0039]
Bolt Circle

ш65 [2.165]

a
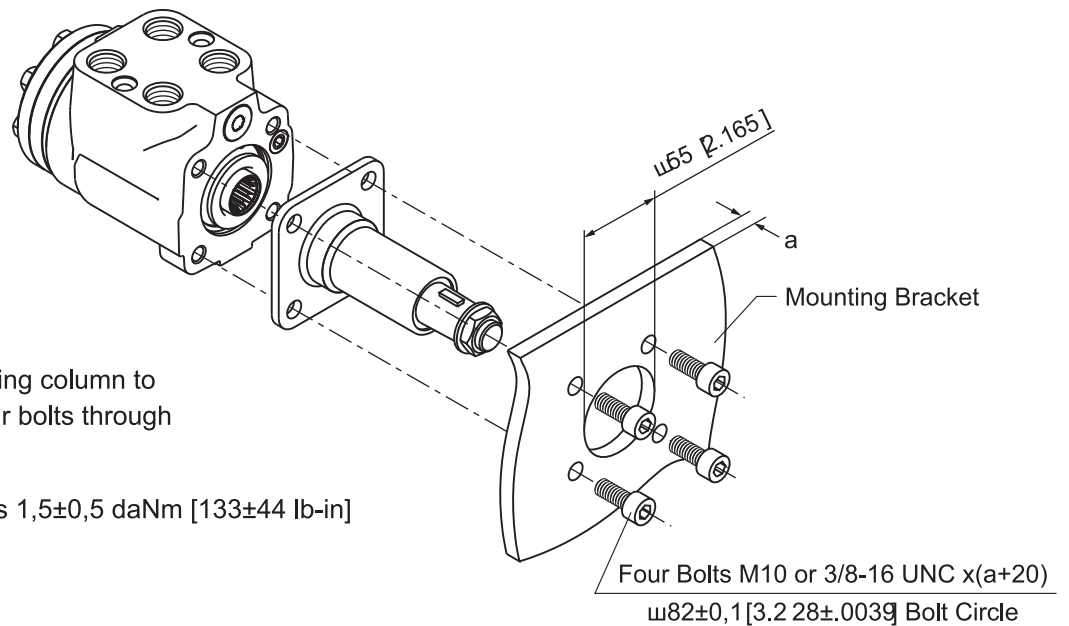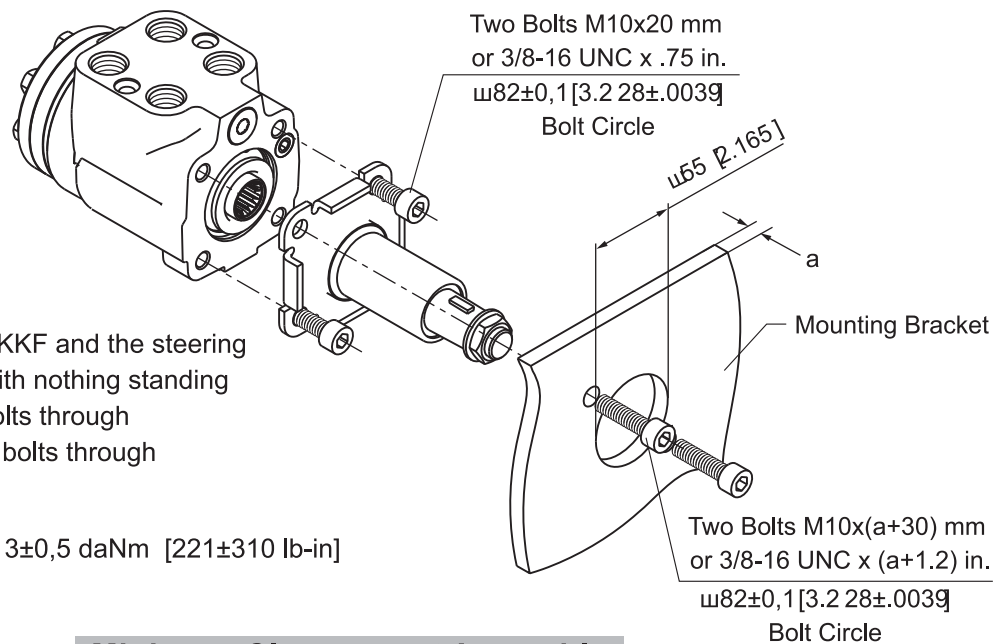
Mounting Bracket
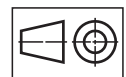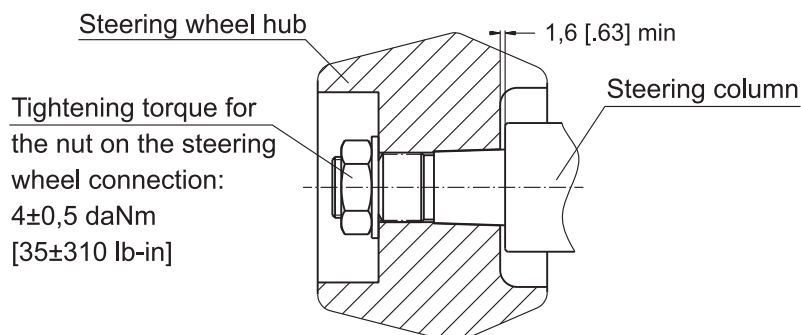
The steering column type KKF and the steering unit must be assembled with nothing standing between them. Use two bolts through mounting bracket and two bolts through just the steering column.

Tightening torque for bolts 3±0,5 daNm [221±310 lb-in]

Two Bolts M10x(a+30) mm
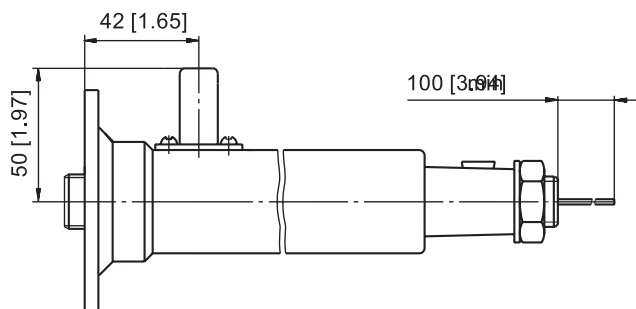or 3/8-16 UNC x (a+1.2) in.
ш82±0,1 [3.2 28±.0039]
Bolt Circle

Minimum Clearance at Assembly

Steering wheel hub

1,6 [.63] min

Steering column

Tightening torque for the nut on the steering wheel connection:
4±0,5 daNm
[35±310 lb-in]

mm [in]

SOUND SIGNAL CONNECTION

E Option

42 [1.65]

50 [1.97]

100 [3.94]

EE Option

76 [3.0]

42 [1.65]

50 [1.97]

ORDER CODE

	1	2	3	4	5	6
K K						
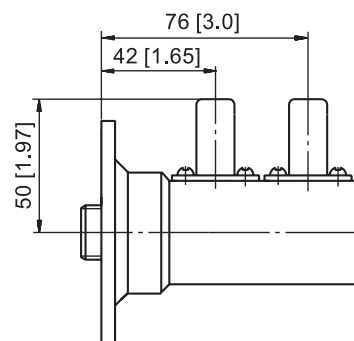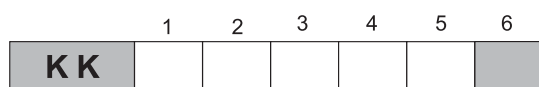
Pos.1 - Mounting Flange

omit - Flange without Tabs

F - Flange with Tabs

Pos.2 - Length, mm (acc. to table)

Pos.3 - Shaft Extensions

I, II, III, IV, V, VI, VII, VIII, IX

Pos.4 - Signal Connection (Option)

omit - without electric signal connection

E - with one electric signal connection

EE* - with two electric signal connection

Pos.5 - Option (Paint)**

omit - No Paint

P - Painted Low Gloss Color

PC - Corrosion Protected Paint
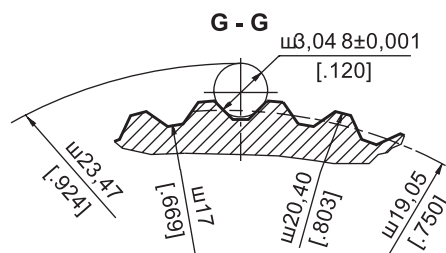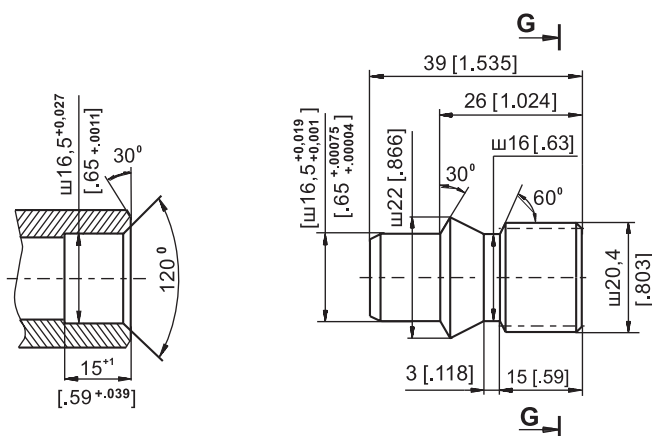
Pos.6 - Design Series

omit - Factory specified

Notes: * For steering column's length L>150 mm [5.9 in] only.
** Colour at customer's request.
The steering columns are yelow galvanized as standard.

Shaft End Part

Order No: 46415 001 00

Ш16,5 +0,027 [.65 +.0011]

30°

120°

15 +1
[.59 +.039]

G

39 [1.535]

26 [1.024]

Ш16,5 +0,019 [.65 +.001]
[+.00075 +.00004]

Ш22 [.866]

30°

Ш16 [.63]

60°

Ш20,4 [.803]

3 [.118]

15 [.59]

G

G - G

Ш3,048±0,001
[.120]

Ш23,47
[.924]

Ш17
[.669]

Ш20,40
[.803]

Ш19,05
[.750]

Involute Spline Data		
Modul	m	1.5875
Number of Teeth	z	12
Pressure Angle	α	30°
Diametral Pitch	DP	16/32
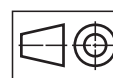
mm [in]

GENERAL APPLICATION AND SPECIFICATION INFORMATION

APPLICATION
(SIZING AND STEERING SYSTEM DESIGN PROCESS)

STEP ONE:
Calculate approximate kingpin torque (M_L).

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

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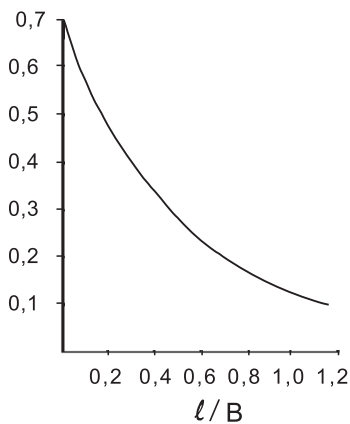
M_L = Kingpin torque in daNm [*lb-in*].

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

 = 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

0,7
0,6
0,5
0,4
0,3
0,2
0,1

0,2 0,4 0,6 0,8 1,0 1,2

ℓ / B

Rubber tyres on dry concrete.

Diagram № 1

B

ℓ

Diagram № 2

H
G
Minimum Effective Radius Arm
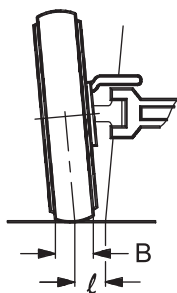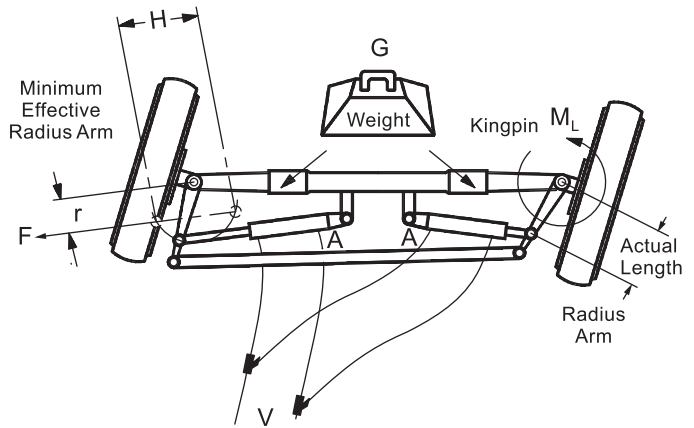Weight   Kingpin M_L
r
F
A   A
Actual Length
Radius Arm
V

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

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

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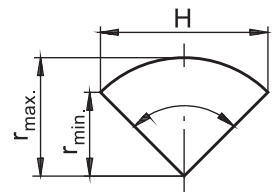
STROKE
H = Stroke, cm [*in*].
Calculate stroke of cylinder using Diagram № 2 and Chart № 2 as shaft.

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

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

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

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

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% .
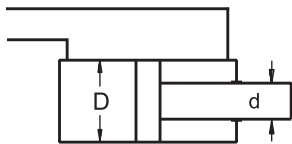
DIAMETER

After the cylinder set area is determined, the cylinder diameter can be calculated.
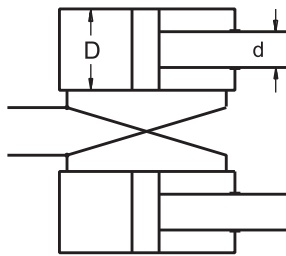
D = Inside diameter of cylinder, cm [in].
d = Road diameter of cylinder, cm [in].

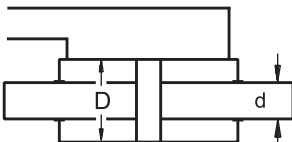Choose type of cylinder arrangement and formula shown for that type.

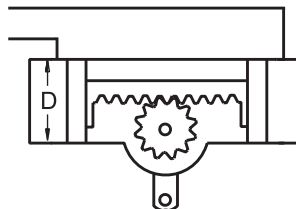### Differential Cylinder

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

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^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.

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

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 closest standard 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 $+30^0C$ [$+85^0F$] to $+60^0C$ [140^0F].
Minimum operating temperature -40^0C [-40^0F].
Maximum operating temperature $+80^0C$ [$+176^0F$].
Note: Extended periods of operation at temperature of 60^0C 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 m nominal (40 - 50 m absolute) or finer is recommended.

In extremely dusty conditions filtration of 10 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 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 ч 310]
M 10 x 1	6,5 ± 0,5 [540 ч 620]
M 10	3,0 ± 0,5 [230 ч 310]