RE 14 365/01.98

engineering mannesmann Rexroth

Steering unit
Type LAGC

Nominal sizes 50 to 630
Series 1X
Nominal pressure 175 bar
Maximum flow 63 L/min.

H/A/D 5898/98

Steering unit type LAGC...

Contents

Features

– The LAGC steering unit is used in hydraulic steering circuits on vehicles and mobile machines that have high axal loads and maximum travel speeds of 50 km/h.

– With the aid of a steering unit even heavy vehicles can be easily steered. By not having a mechanical connection between the steering unit and axal which is to be steered, the designer has opportunities that are not possible with conventional steering systems.

– The steering unit contains all of the valves which provide safety functions for the steering unit and steering cylinder that are required within the hydraulic steering circuit, this eliminates any additional pipework.

– If the hydraulic pump fails it is possible with vehicles fitted with the LAGC unit to be manually steered, the LAGC acts as a hand pump for the steering cylinder.

Rexroth Hydraulics

Ordering details

LAG	C			1X /		– /	*

Steering unit

Design

with integrated valves **= C**

Displacement volume (cm³/U)

Size	R [1]	LDA [2]	
50	●	●	**= 50**
63	●	●	**= 63**
80	●	●	**= 80**
100	●	●	**= 100**
125	●	●	**= 125**
160	●	●	**= 160**
200	●	●	**= 200**
250			**= 250**
320			**= 320**
400			**= 400**
500			**= 500**
630			**= 630**

Other versions are available
for all sizes

Noise characteristics

Standard **= –**
Low [3] **= N**

Series

Series 10 to 19 **= 1X**
(10 to 19: unchanged installation and connection dimensions)

Load Sensing

No code = without load signal in open centre (OC) version
LD = dynamic load signal
LDA = dynamic load signal, flangable

Reaction

No code = without reaction
R = with reaction

[4] **Shock valve setting**
(pressure differential)

150 = 150 bar
200 = 200 bar
240 = 240 bar

[4] **Pressure relief valve setting**
(pressure differential)

90 = 90 bar
140 = 140 bar
175 = 175 bar

[5] **Piping connections P, T, L, R / LD**

01 = ● pipe thread to DIN 3852
02 = ◑ metric ISO thread to DIN 3852
12 = ◑ UNF thread to SAE

– = Special specifications
Please clarify with our
sales organisation

● = Standard programme
◑ = Extended programme

1) With reaction
2) Dynamic load signal, flangable
3) Only with open centre (OC) version
up to size 200
4) The response pressure of the shock valves must be
50 bar higher, however, a maximum of 2.2 times that of
the hydraulic pump pressure relief valves.
(see §38 StVZO)
Preferrably 150 to 90; 200 to 140; 240 to 175
5) For thread dimensions see unit dimensions on
pages 9 and 10

Ordering example:

LAGC 200 -1X/LD150-90/01

Steering unit with integrated valves
Size 200, dynamic load signal
Shock valves 150 bar, pressure relief valve 90 bar
Piping connections P, T, L, R are G 1/2 , LD are G 1/4

LAGC 200 N1X/150-90/01

Steering unit with integrated valves
Size 200, low noise characteristics
Shock valves 150 bar, pressure relief valve 90 bar
Piping connections P, T, L, R are G 1/2

Function, section

Via the steering column the control spool (1) of the control valve is rotated in relation to the control bush (2). Thereby a cross-section is opened between the piston and the bush. The pressure oil acts on the rotor set (3) and causes this to move. The oil flows via the rotor set to the steering cylinder. The rotation of the rotor acts on the bush which causes it to follow the rotary movement of the spool.

The size of the cross-section opened is dependent on the rotational speed of the steering wheel and the steering pressure, and for the load sensoring version on the rotational speed.

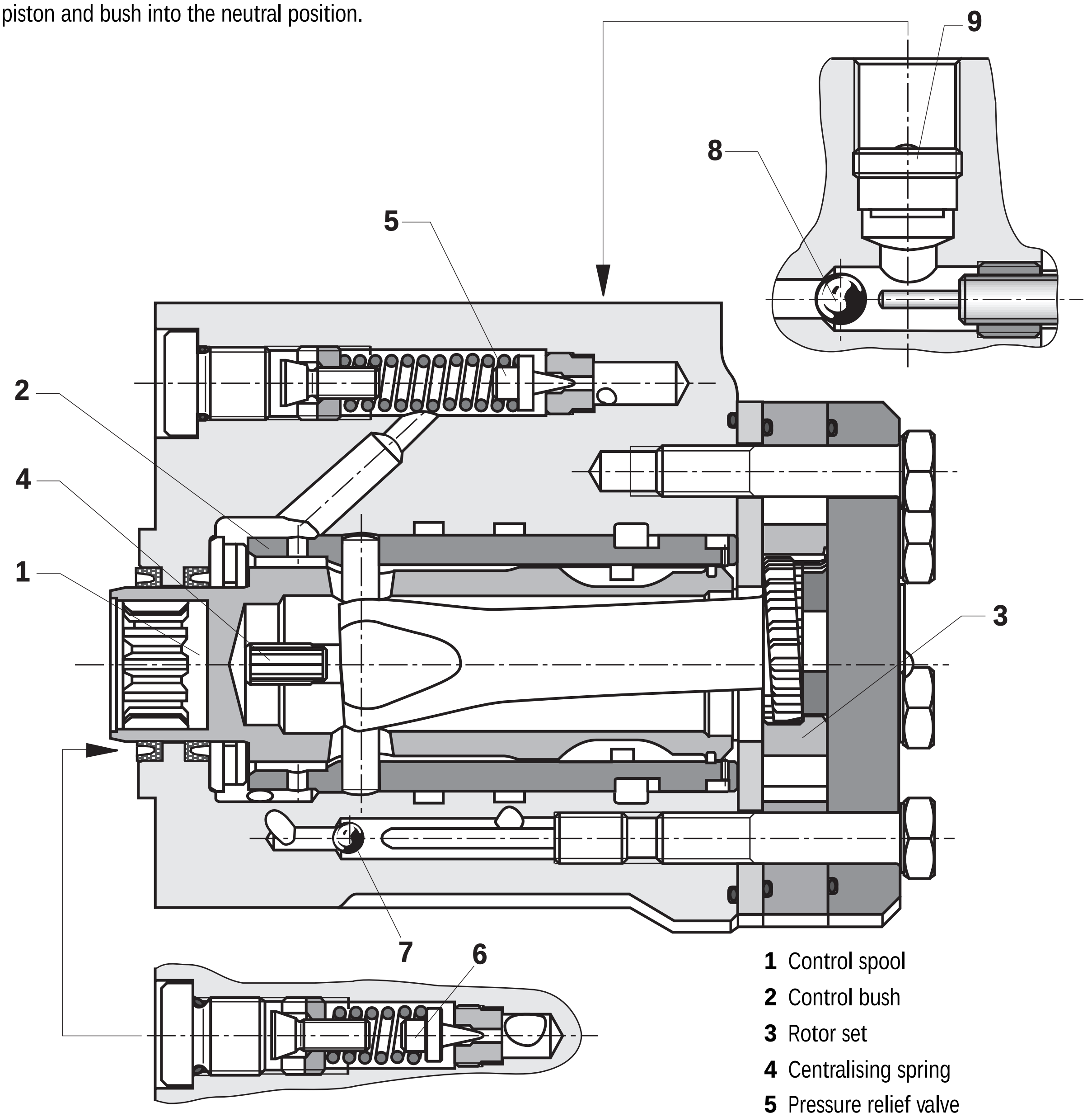
If the steering movement is stopped then the spool is stationary, oil however continues to flow via the open cross-section to the rotor, the rotor and bush therefore continue to rotate.

The cross-section then closes due to the rotary movement; the rotor is now also stationary and the steering cylinder is therefore, in the required position. The centralising spring (4) moves and then holds the piston and bush into the neutral position.

The system pressure is limited in the steering circuit via the pressure relief valve (5). At this location, for the load sensing version (see section), the pilot valve for the load signal is fitted.

The two shock valves (6) provide a safety function for the connections L and R to the steering cylinder. If a shock valve reacts then the displaced oil is passed to the opposite side via the anti-cavitation valve (7), or missing leakage fluid is drawn from the reservoir.

If the hydraulic pump fails then the LAGC unit acts as a hydraulic pump. Via the anti-cavitation valve (8) it is possible in this operating condition to draw oil from the reservoir, the check valve (9) however prevents air from being sucked in via the pump connection (P). In normal operation the same valve prevents high external load forces from causing shocks at the steering wheel.



1 Control spool
2 Control bush
3 Rotor set
4 Centralising spring
5 Pressure relief valve
6 Shock valve
7 Anti-cavitation valve
8 Anti-cavitation valve
9 Check valve

Versions

Standard version

Open **C**entre with **N**on **R**eaction = **OC / NR**

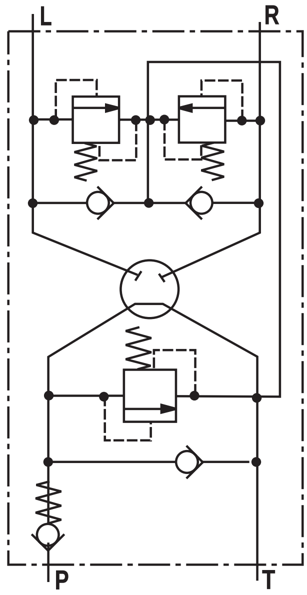
Mainly used in steering systems that utilise a fixed displacement hydraulic pump.

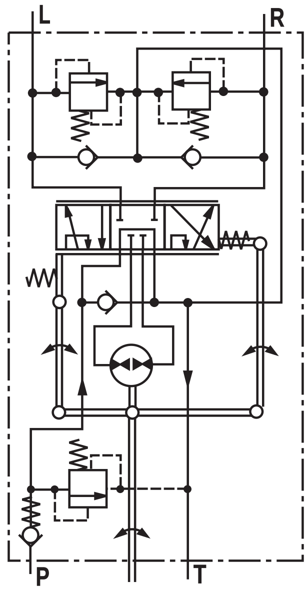
If steering is not taking place then the connection from pump (P) to tank connection (T) is open (**OC**) and the pump displacement volume is passed at vertually zero pressure to tank. The connections L[1)] (left) and R[1)] (right) are closed in the neutral position. In this manor, external forces, that act on the steering cylinder, are taken up without the driver feeling any reaction forces via the steering wheel (**N**on **R**eaction).

[1)] For steering systems the actuator lines are identified with L and R, not as is normal with A and B.

Note:

Steering units for vehicles with a pivoting frame or with rear axial steering **must** always use the **NR** version.

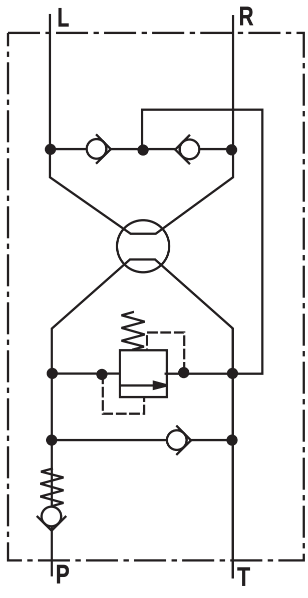


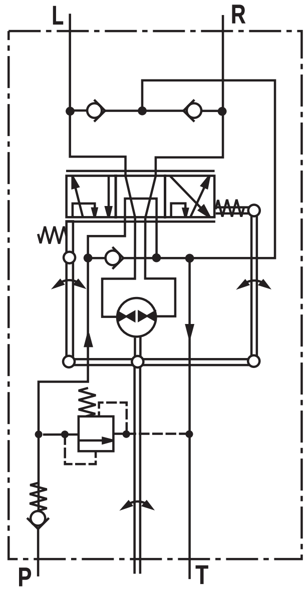


Special version

Open **C**entre with reaction = **OC / R**

The cylinder connections are in the neutral condition connected with each other. External forces acting on the steering cylinders are noticed as reaction forces by the driver via the steering wheel (**R**eaction). If the driver releases the steering wheel after the steering manoeuvre (curved line) then the wheels and steering wheel, with the relevant steering geometry, straigthen up by themselves and the vehicle carries on in a straight line.

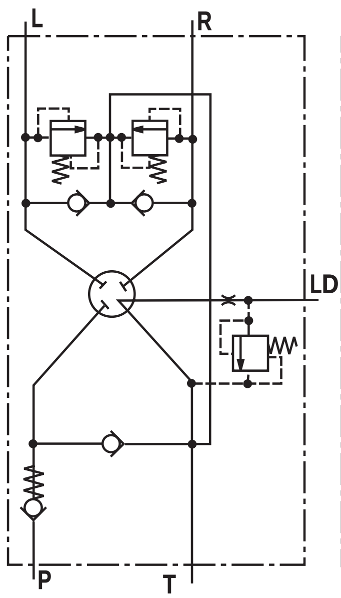


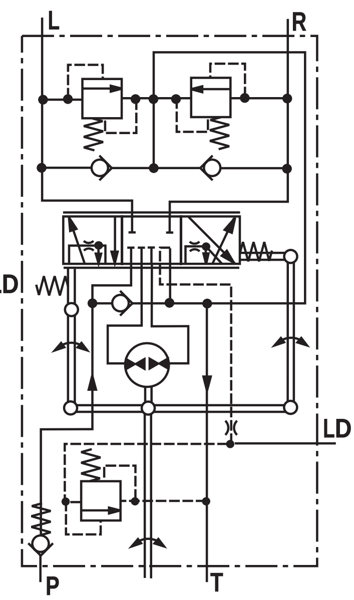


Load-Sensing version

Steering units with load sensing provide a load signal that can be used to control a priority valve and/or a pump. They are designed as closed centre steering systems whereby the connection: pump connection (P) to tank connection (T) is closed in the neutral position.

If the steering and acturator hydraulics are supplied by a common pump then the use of a priority valve is necessary. This valve ensures that the steering unit has a priority oil supply, the control of the valve is via the steering unit load signal. When steering is not taking place then the entire oil flow from the pump is made available to the actuator hydraulics. Fixed or variable displacement pumps can be used.





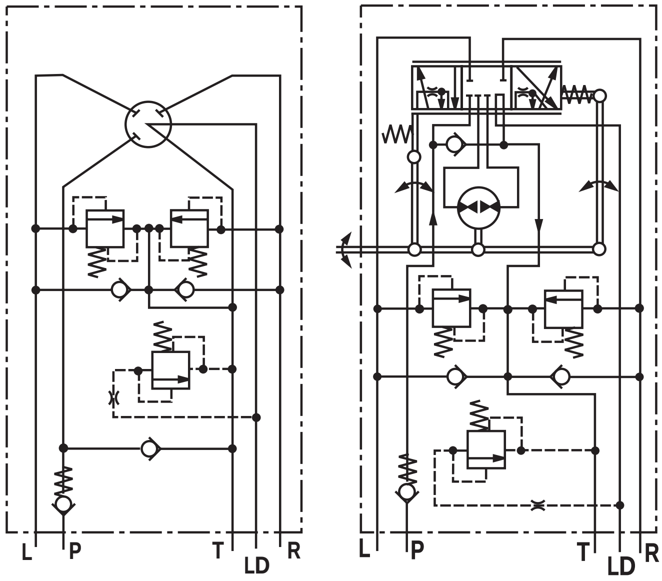
LAGC in the LD version for a priority valve which is **not** flanged on

Versions

Load signal, dynamic

The oil flowing in the load signal line transmits the load signal, whereby the control oil from the priority valves flows to the steering unit. In the neutral position there is a low continuous control oil flow of approx. 0.5 L/min. As a result the steering unit has virtually the same temperature as the oil.
Temperature shocks are vertually prevented.

The **LD** version causes a faster reaction of the priority valve. The hard point when starting to steer, also with a cold start, is normally no longer noticeable.



LAGC in the LD version for a priority valve which is flanged on

Noise reduced version

If the LAGC unit is to be installed in the driver's cabin, then it is possible to supply the OC/NR and OC/R in a noise reduced version. The noise level of the optimised version is, dependent on the flow and installation conditions, between 3 and 10 dBA lower.

AD version (with special specifications)

With increased return pressures: p_{Rmax} = 50 bar, we recommend the use of the LAGC unit with a suitably matched control valve.

The suffix „AD" must be stated in the ordering code under „special specifications".

Functions in the steering circuit

Servo operation

The LAGC series of steering units comprise of a hand operated servo valve of rotary spool design. A dosing pump that works to the gerotor principle and the valves that are required for the steering circuit.

The size of the dosing pump defines the oil flow that passes to the steering cylinder per rotation of the steering wheel. The size of the dosing pump is so selected that with 3 to 5 turns of the steering wheel it is possible to steer from one end stop to the other.

Emergency operation

During normal operation of the steering unit and when the pump is supplying an adequate flow of oil, the torque at the steering wheel is less than 0.5 daNm. If the hydraulic pump fails then the steering unit operates in an emergency mode, the dosing pump acts as a hand pump and the vehicle is manually steered without servo assistance. The pressure achieved by hand is dependent on the size of the dosing pump and the force at the steering wheel. The smaller the dosing pump the higher is the pressure that can be manually built up.

With a manul steering moment of 12 daNm the following pressures can be reached:

Size	050	063	080	100	125	160
p in bar	90	85	80	60	50	40

Size	200	250	320	400	500	630
p in bar	30	25	20	15	12	10

If for steering during emergency operation a higher pressure is required, then either a further hydraulic pump or a steering unit with a lower ratio could be fitted.

⚠ **Attention!**

The emergency operating mode is not intended for continuous operation!

Pressure relief valve

The pressure relief valve for the hydraulic pump is available in three pressure settings:

90 bar; 140 bar; 175 bar

Note:

The pressure in the T line increases the set pressure by the equivalent value.

Shock and anti-cavitation valves

The cylinder side valves that are built into the LAGC unit are available in three pressure settings:

150 bar; 200 bar; 240 bar

Anti-cavitation valve

If the hydraulic pump fails then the fluid is drawn from the reservoir via this valve, which is fitted between the P and T connections.

Check valve

This valve which is fitted in the P connection prevents:

- The return flow of oil from the steering cylinder into the hydraulic system when the cylinder pressure, due to travel obstructions, is greater than the system pressure. Steering shocks at the steering wheel are thereby suppressed.
- Sucking air via the P connection during emergency operation.

Technical data, general

Nominal pressure	p	bar	175
Ambient temperature	ϑ	°C	–20 to +80
Pressure fluid			see below
Pressure fluid temperature range	ϑ	°C	–20 to +80
Viscosity range	ν	mm²/s	10 to 800
Degree of contamination			Max. permissible degree of fluid contamination is to ISO 4406 class 19/15. We, therefore recommend the use of a filter with a minimum retention rate of $\beta_{25} \geq 75$ to ISO 4572
Steering moment - normal	M	Nm	≤ 5
Steering moment- emergency operation	M	Nm	≤ 160

Fluid technical data

Pressure fluids

Before selecting a pressure fluid would you please refer to the extensive information regarding pressure fluid selection and application conditions in our catalogue sheets RE 90 220 (mineral oil) and RE 90 221 (environmentally compatible fluids). These catalogue sheets refer to axial piston units, however, the details can be analogously appled to the steering units. For pressure fluids that require FPM seals please contact ourselves.

Operating viscosity

We recommend that the operating viscosity (at operating temperature) for efficiency and service life, is selected within the optimum range of

ν_{opt} = optimum operatiang viscosity range 16 to 46 mm²/s

with reference to the temperature.

Limiting viscosity

For the limiting conditions the following values apply:

ν_{opt} = 10 mm²/s at a maximum permissible temperature of ϑ_{max} = 80 °C

ν_{opt} = 800 mm²/s at a minimum permissible temperature of ϑ_{min} = –20 °C

If there is the possibility of there being a temperature difference of more than 20 °C between the steering unit and the pressure fluid, then either a LD or LDA version or an open-centre version for warming the steering unit should be fitted.

Further on the selection of pressure fluids

A prerequisite to being able to select the correct pressure fluid is knowing the operating temperature and the ambient temperature.

The pressure fluid should be so selected that the operating viscosity ν_{opt} at the working temperature lies within the optimum range (see selection diagram).

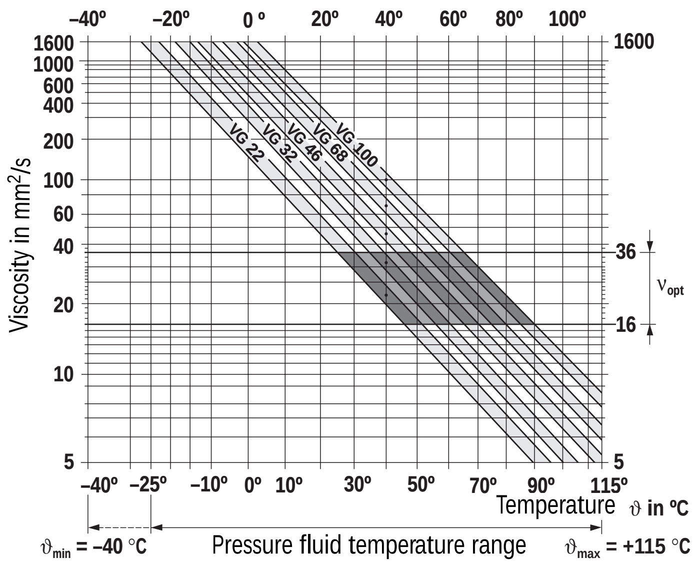
We recommend that the higher viscosity class is selected.

Example: For an ambient temperature of X °C the tank temperature stabilises at 60 °C. To achieve the optimum viscosity, this relates to the viscosity classes of VG 46 or VG 68;
VG 68 should be selected.

Pressure fluid filtration

The finer the filtration the higher the cleanliness class achieved and so the higher the service life of the entire hydraulic system.

To ensure the functionibility of the steering pump a minimum pressure fluid cleansliness class of 19/15 to ISO 4406 is necessary.



Technical data, hydraulic

Steering unit type	Displacement volume cm^3	Flow[1] Nom. L/min	Max. L/min	P bar	Max. perm. pressure in connection T bar	T – AD-Version[2] bar	L and R bar
LAGC 050	50	5.0	15	175	20	50	240
LAGC 063	63	6.3	20	175	20	50	240
LAGC 080	80	8.0	25	175	20	50	240
LAGC 100	100	10.0	30	175	20	50	240
LAGC 125	125	12.5	35	175	20	50	240
LAGC 160	160	16.0	50	175	20	50	240
LAGC 200	200	20.0	50	175	20	50	240
LAGC 250	250	25.0	50	175	20	50	240
LAGC 320	320	32.0	63	175	20	50	240
LAGC 400	400	40.0	63	175	20	50	240
LAGC 500	500	50.0	63	175	20	50	240
LAGC 630	630	63.0	63	175	20	50	240

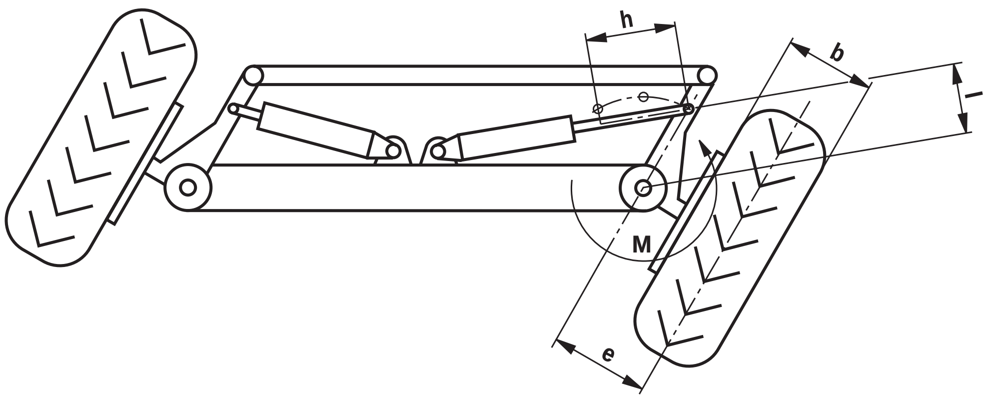
[1] Referring to a steering velocity of 100 steering turns / min.

[2] The AD version of the steering unit can withstand a loading of up to 50 bar in the return line. Higher pressures only after consultation.

Calculating the steering moment

Steering moment $M = 0.05 \cdot F_A \cdot \frac{1}{1+\frac{e}{b}} \cdot \frac{b}{200} \cdot \frac{\mu}{0.7}$ [Nm]

Steering force $F = \frac{M}{l} \cdot 10^3$ [N]



Formula symbols

A	=	Cylinder piston area	[mm^2]
A_1	=	Cylinder piston area differential cylinder	[mm^2]
A_2	=	Cylinder ring area differential cylinder	[mm^2]
b	=	Tyre width	[mm]
d	=	Piston rod diameter	[mm]
D	=	Cylinder diameter	[mm]
e	=	Distance of swivel bearing to centre of tyre	[mm]
F	=	Steering force	[N]
F_A	=	Steering axle load	[N]
f	=	Amplification factor	
h	=	Cylinder stroke	[mm]
i	=	No. of steering wheel turns	
l	=	Smallest, effective steering lever	[mm]
M	=	Steering moment	[Nm]
n	=	Steering wheel rotational speed	[min^{-1}]
n_{idling}	=	Motor idling RPM	[min^{-1}]
n_{motor}	=	Motor operating RPM	[min^{-1}]
p	=	Steering pressure	[bar]
q_{vp}	=	Pump flow	[L/min]
V	=	Steering unit displacement	[cm^3/U]
V_P	=	Steering pump displacement	[cm^3/U]
V_{CYL}	=	Cylinder displacement	[cm^3]
μ	=	Co-efficienct of friction	

Defining the steering cylinder and steering pump

Steering cylinder

Required cylinder area $A = \frac{F}{p} \cdot 10$ [mm²]

Cylinder area (piston side) $A_1 = \frac{\pi}{4} \cdot D^2$ [mm²]

Cylinder area (rod side) $A_2 = \frac{\pi}{4} \cdot (D^2 - d^2)$ [mm²]

When using a differential or synchronising cylinder A_2 must be greater than the required cylinder area.

If two cross connected differential cylinders are to be used, then $A_1 + A_2$ must be greater than the required cylinder area.

The nominal size of steering unit results from the cylinder volume and the required no. of steering wheel turns.

Cylinder volume $V_{CYL} = A \cdot h \cdot 10^3$ [cm³]

Displacement LAGC $V = \frac{V_{ZYL}}{i}$ [cm³/U]

Normally there are 3 to 5 turns of the steering wheel from end stop to end stop.

Further information!

Suitable steering attachments can be found in RE 50 140 and the associated priority valves for steering systems contained in load signal circuits can be found in RE 27 548

Steering pump

The pump should be so selected that when the motor is idling, a steering velocity of approx. 50 min^{-1} can be achieved. The maximum steering speed, which is dependent on the steering wheel diameter, is approx. 100 to 150 min^{-1}.

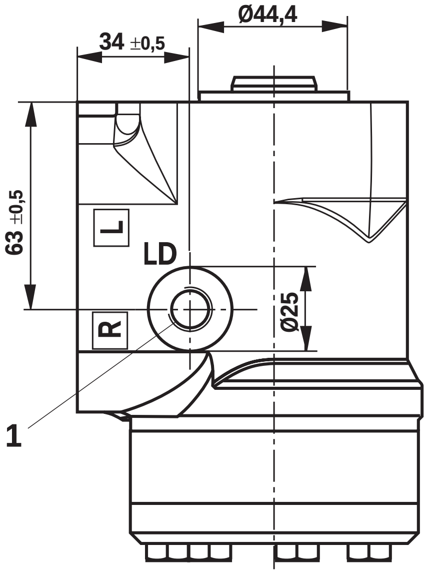
Pump flow $q_{VP} = V \cdot (n + 10) \cdot 10^{-3}$ L/min.

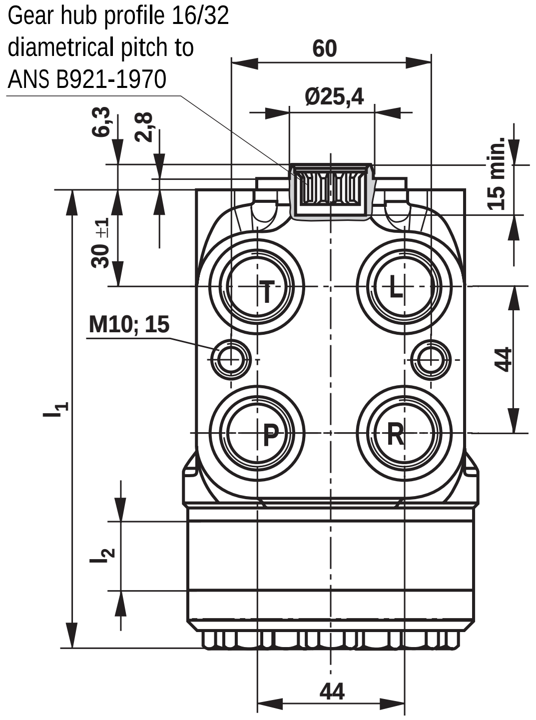
The required pump displacement (≙ BS) is to be calculated from the vehicle idling and operating RPM.

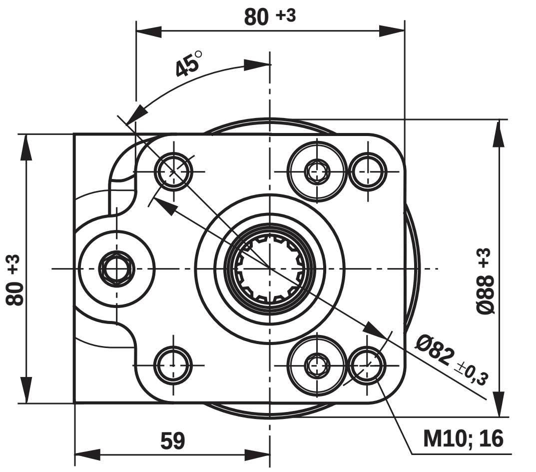
Pump size with pump running at idle $V_P = \frac{q_{VP} \cdot 10^3}{n_{idling}}$ [cm³/U]

Pump size with pump running at operating RPM $V_p = \frac{q_{VP} \cdot 10^3}{n_{motor}}$ [cm³/U]

Unit dimensions: types LAGC... / LAGC...LD... (Dimensions in mm)





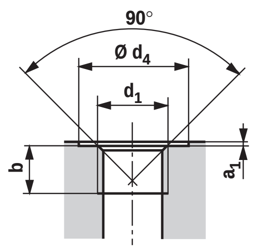


Size	l_1	l_2
050	125	6.8
063	127	8.3
080	129	10.5
100	132	13.2
125	135	16.5
160	139	21.1
200	145	26.4
250	151	33.0
320	161	42.3
400	172	52.9
500	186	68.0
630	204	85.7

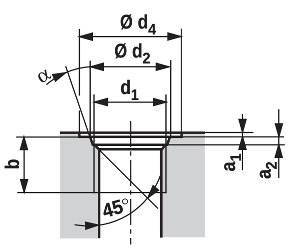
1 LD drilling with version LAGC...**LD**...

Connection	Version	d_1	Ø d_2	Ø d_4	b min.	a_1	a_2	a
P, T, L, R	**01**	G 1/2	–	$28^{+0,4}$	14	max. 0.3	–	–
	02	M22x1.5	–	$28^{+0,4}$	14	max. 0.3	–	–
	12	3/4-16 UNF	$20.6^{+0,1}$	$30^{+0,5}$	14.3	max. 0.3	$2.4^{+0,4}$	$15° ^{\pm 1°}$
LD	**01**	G 1/4	–	$25^{+0,4}$	12	$1^{\pm 0,5}$	–	–
	02	M12x1.5	–	$25^{+0,4}$	12	$1^{\pm 0,5}$	–	–
	12	7/16-20 UNF	$12.4^{+0,1}$	$21^{+0,5}$	11.5	$1^{\pm 0,5}$	$2.3^{+0,4}$	$12° ^{\pm 1°}$

Inch, metric thread

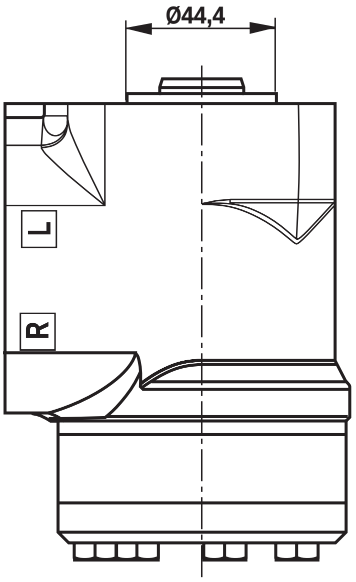


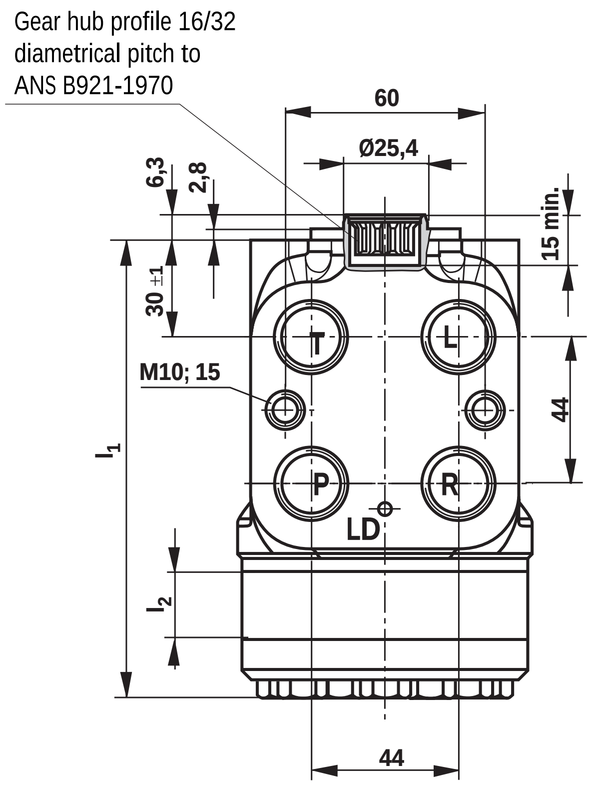
UNF - thread

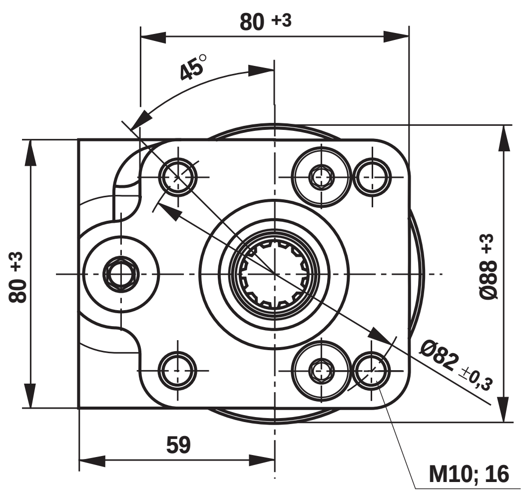


Unit dimensions: type LAGC... LDA..

(Dimensions in mm)







Size	l_1	l_2
050	125	6.8
063	127	8.3
080	129	10.5
100	132	13.2
125	135	16.5
160	139	21.1
200	145	26.4

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