

Variable displacement axial piston pump type V60N

Product documentation

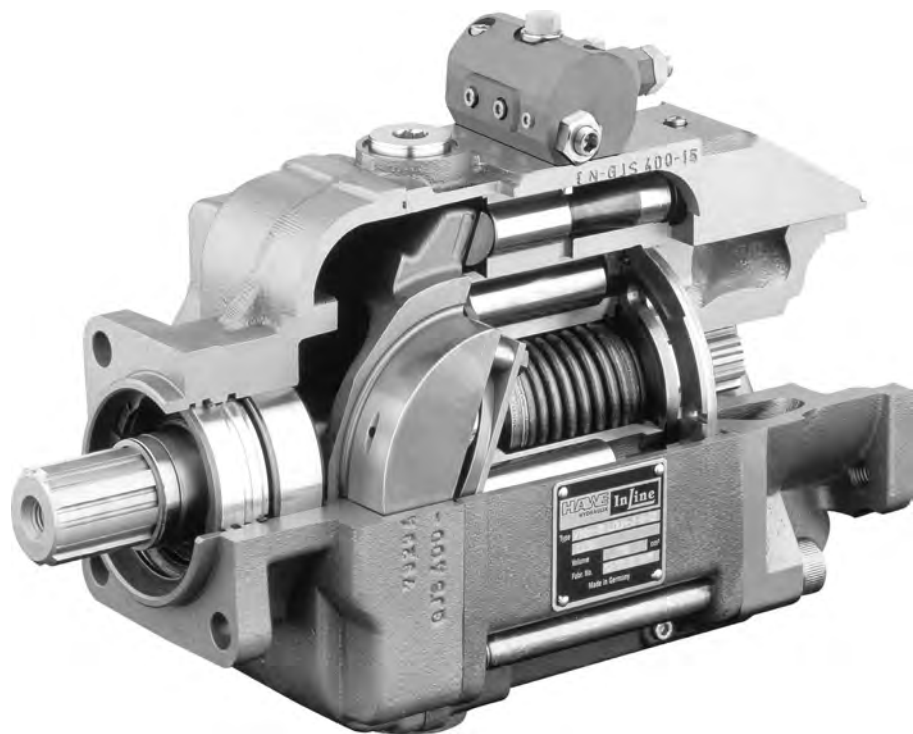


Open circuit,
for the power take-off of commercial vehicles

Nominal pressure $p_{\text{nom max}}$: 400 bar

Peak pressure p_{max} : 450 bar

Geometric displacement V_{max} : 130 cm³/rev



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1 Overview: variable displacement axial piston pump types V60N

Variable displacement axial piston pumps operate according to the bent axis principle. They adjust the geometric output volume from maximum to zero. As a result they vary the flow rate that is provided to the loads.

The axial piston pump type V60N is designed for open circuits in mobile hydraulics and operate according to the swash plate principle. They are available with the option of a thru-shaft for operating additional hydraulic pumps in series.

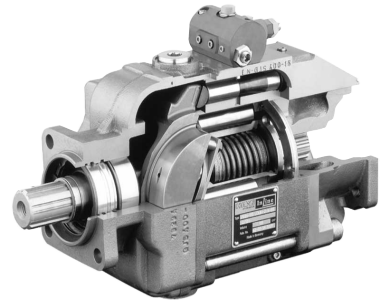
The pump is fitted above all to the power take-off on commercial vehicle transmissions. The range of pump controllers allows the axial piston pump to be used in a variety of applications.

Features and benefits:

- Optimized power-to-weight ratio
- High self-suction speed
- Wide controller options

Intended applications:

- Municipal trucks
- Cranes and lifting equipment
- Machines for forestry and agricultural purposes
- Truck-mounted concrete pumps



Variable displacement axial piston pump type V60N-110

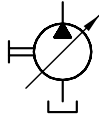


Variable displacement axial piston pump type V60N-130

2 Available versions, main data

2.1 Basic version

Circuit symbol:



Order coding example:

V60N	-090	R	D	Z	N	- 2	-0	03	/LSNR/ZL	- 2/65	- 350	-	A00/76	- C 022
														Flange version Table 13 Flange versions (output side)
														Suction intakes For suction intake see Chapter 6.1, "Accessories, spare parts and separate components"
														Ports Table 12 Ports
														Pressure specification (bar)
														Stroke limitation Table 11 Stroke limitations
														Controller Table 8 Controllers; Table 9 Intermediate plates; Table 10 Solenoid voltage and versions
														Release
														Additional function Table 7 Additional function
														Housing version Table 6 Housing versions
														Seal Table 5 Seals
														Flange version Table 4 Flange versions (input side)
														Shaft version Table 3 Shaft versions
														Rotating direction Table 2 Rotating directions
														Nominal size Table 1 Nominal sizes

Basic type

Table 1 Nominal size

Coding	Geometric displacement (cm ³ /rev)	Nominal pressure p _{nom} (bar)	Peak pressure p _{max} (bar)
060	60	350	400
090	90	350	400
110	110	350	400
130	130	400	450

Table 2 Rotation directions

Coding	Description
L	Anti-clockwise
R	Clockwise

When looking at the shaft journal

(for information on change of rotating direction, see [Chapter 3, "Parameters"](#))

Table 3 Shaft versions

Coding	Description	Designation/Standard	Max. drive torque (Nm)
D	Parallel key splined shaft	Similar to DIN ISO 14 (truck) B8x32x35	800
M	Spline shaft	W30x2x14x9g DIN 5480 (only V60N-090, V60N-110)	530
H	Spline shaft	SAE-B J 744 13T 16/32 DP 22-4 DIN ISO 3019-1 (only V60N-060)	210
U	Spline shaft	SAE-B J 744 short 13T 16/32 DP 22-4 DIN ISO 3019-1 short (only V60N-060)	210
T	Spline shaft	SAE-BB J 744 15T 16/32 DP 25-4 DIN ISO 3019-1 (only V60N-060)	340
S	Spline shaft	SAE-C J 744 14T 12/24 DP 32-4 DIN ISO 3019-1	640
Q	Spline shaft	SAE-CS 21T 16/32 DP 35-4 DIN ISO 3019-1 (only V60N-090, V60N-110, V60N-130)	900

Table 4 Flange versions (input side)

Coding	Description	Designation
Y	Flange	DIN ISO 7653 (for trucks)
P	Flange	DIN ISO 7653 10° - rotated (for trucks) (only V60N-110, V60N-130) ¹⁾
X	Flange	SAE-B 2-hole J 744 - 45° rotated 101-2 DIN ISO 3019-1 (only V60N-060)
Z	Flange	SAE-B 4-hole J 744 101-4 DIN ISO 3019-1 (only V60N-060)
F	Flange	SAE-C 4-hole J 744 127-4 DIN ISO 3019-1
G	Flange	125 B4 HW DIN ISO 3019-2 (only V60N-090)

Table 5 Seals

Coding	Description
N	NBR
V	FKM

Table 6 Housing versions

Coding	Description
1	Suction and pressure connection axial
2	Suction and pressure connection radial, with thru-shaft
3	Suction and pressure connection radial
4	Suction and pressure connection axial, connections SAE J 518 (only V60N-090)

Table 7 Additional functions

Coding	Description
0	None

¹⁾ For narrow installation spaces, e.g. Mercedes Benz NA 124 gear manufacturing

Table 8 Controllers

Coding	Description																																				
LSNR	<p>Load-sensing controller with integrated pressure limitation.</p> <p>The LSNR controller is a flow controller that generates a variable volumetric flow independently of the rotation speed. It sets a constant difference between the load pressure and pump pressure by continuously adapting the geometric displacement of the pump to the quantity required for the consumers.</p> <p>The integrated pressure limitation restricts the maximum pressure to a set value.</p> <p>Coding LSN: discontinued type, see Chapter 2.2, "Controller circuit symbols"</p>																																				
LSNRT	<p>Load-sensing controller with forced LS relief via a throttle and integrated pressure limitation.</p> <p>As well as the LSNR controller, the LSNRT contains internal LS signal relief. It is suited to hydraulic systems whose LS relief does not take place in proportional directional spool valves.</p> <p>Internal leakage flow ≤ 1.5 lpm</p>																																				
NR	<p>Pressure controller, adjustable directly at the pump.</p> <p>The pressure controller maintains a constant system pressure independently of the required delivery volumetric flow. It is suited to constant pressure systems where differing delivery volumetric flows are required or for efficient pressure limitation of a hydraulic system.</p> <p>Coding N: discontinued type, see Chapter 2.2, "Controller circuit symbols"</p>																																				
QNR/...	<p>volumetric flow controller with integrated pressure limitation for setting a constant volumetric flow rate independently of the speed.</p> <p>The flow controller generates a constant differential pressure via an orifice in the P gallery. The differential pressure can be set between 20 and 55 bar; the orifice is available in different graduations.</p> <p>This allows flexible adjustment of the volumetric flow.</p> <table border="1" data-bbox="316 936 1489 1357"> <thead> <tr> <th>Orifice (mm)</th> <th>Volumetric flow at 20 bar differential pressure (lpm)</th> <th>Orifice (mm)</th> <th>Volumetric flow at 20 bar differential pressure (lpm)</th> </tr> </thead> <tbody> <tr> <td>3</td> <td>approx. 23</td> <td>7</td> <td>approx. 127</td> </tr> <tr> <td>3.5</td> <td>approx. 32</td> <td>7.5</td> <td>approx. 146</td> </tr> <tr> <td>4</td> <td>approx. 42</td> <td>8</td> <td>approx. 166</td> </tr> <tr> <td>4.5</td> <td>approx. 53</td> <td>8.5</td> <td>approx. 188</td> </tr> <tr> <td>5</td> <td>approx. 65</td> <td>9</td> <td>approx. 210</td> </tr> <tr> <td>5.5</td> <td>approx. 79</td> <td>9.5</td> <td>approx. 234</td> </tr> <tr> <td>6</td> <td>approx. 94</td> <td>10</td> <td>approx. 260</td> </tr> <tr> <td>6.5</td> <td>approx. 110</td> <td></td> <td></td> </tr> </tbody> </table>	Orifice (mm)	Volumetric flow at 20 bar differential pressure (lpm)	Orifice (mm)	Volumetric flow at 20 bar differential pressure (lpm)	3	approx. 23	7	approx. 127	3.5	approx. 32	7.5	approx. 146	4	approx. 42	8	approx. 166	4.5	approx. 53	8.5	approx. 188	5	approx. 65	9	approx. 210	5.5	approx. 79	9.5	approx. 234	6	approx. 94	10	approx. 260	6.5	approx. 110		
Orifice (mm)	Volumetric flow at 20 bar differential pressure (lpm)	Orifice (mm)	Volumetric flow at 20 bar differential pressure (lpm)																																		
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6.5	approx. 110																																				

Table 8 Controllers


Coding	Description
PR	<p>Electric proportional pressure controller with increasing characteristic curve. The maximum pressure and minimum pressure can be adjusted mechanically; in between these values, electrical adjustment is possible.</p>
P1R	<p>Size 060, 090, 110: Electro-proportional pressure controller with falling characteristic curve. The controller is specifically developed for fan and generator drives. In the event of a power failure, the pump generates the maximum pressure. The maximum pressure and minimum pressure can be mechanically adjusted at the controller.</p> <div data-bbox="331 510 1493 595" style="border: 1px solid gray; padding: 5px;"> <p> Note Cannot be combined with power controller!</p> </div>
V	<p>Size 130: Electric proportional delivery volumetric flow controller with increasing characteristic curve. The V controller is an electrically actuated controller that sets an appropriate geometric displacement for the pump in accordance with a current value. Therefore, the pump generates a variable volumetric flow that is dependent on the rotation speed. When used in open centre systems with operating pressures of < 25 bar, an external charge pump or pump pre-load valve must be provided to ensure reliable adjustment. Only in combination with a pressure controller (coding NR)</p>
V1	<p>Size 130: Electric proportional delivery volumetric flow controller with decreasing characteristic curve. In contrast to the V controller, the V1 controller has a negative characteristic curve, i.e. in the event of power failure, the pump operates at a maximum geometric displacement. When used in open centre systems with operating pressures of < 25 bar, an external charge pump or pump pre-load valve must be provided to ensure reliable adjustment. Only in combination with a pressure controller (coding NR)</p>

Table 9 Intermediate plates

Intermediate plate version, only in combination with one of the controllers described above

Coding	Description
L	Adjustment range: 200 to 700 Nm Size 130 : Power controller (as standard)
ZL	Size 060, 090, 110 : Intermediate plate with power controller (torque limitation) Product "Pressure x Delivery flow" = constant Adjustment range: 25 ... 100% max. drive torque Coding LLSN, LN: discontinued types, see Chapter 2.2, "Controller circuit symbols"
ZW	Angled intermediate plate (45°) mandatory for mounting controllers at pumps with housing version -2, -3
ZV	Size 060, 090, 110 : Electric proportional flow controller with increasing characteristic curve. For use in open centre systems with operating pressures of < 25 bar, an external supply pump or pump pre-load valve must be provided to ensure reliable adjustment. The ZV controller is designed as an intermediate plate. (It records the set piston position from above and electrically adjusts the pivoting angle of the pump.)
ZV1	Size 060, 090, 110 : Electric proportional flow controller with decreasing characteristic curve. For use in open centre systems with operating pressures of < 25 bar, an external supply pump or pump pre-load valve must be provided to ensure reliable adjustment. The ZV1 controller is designed as an intermediate plate. (It records the set piston position from above and electrically adjusts the pivoting angle of the pump.)

Table 10 Solenoid voltage and version

Coding	Nominal voltage	Description
G 12	12 V DC	Version with connection DIN EN 175 301-803
G 24	24 V DC	With male connector
S 12	12 V DC	Version with quarter turn connection (bayonet PA 6, SCHLEMMER, suitable for cone with bayonet 10 SL).
S 24	24 V DC	The delivery does not include a male connector.

Table 11 Stroke limitation

Coding	Description
No designation	No stroke limitation
2	With adjustable stroke limitation (for housing version 1 and 4: all sizes; for housing version 2 and 3: only V60N-090, V60N-130)
2/...	Stroke limitation fixed with specification of the set geometric displacement V_g (cm ³ /rev.)

Table 12 Ports

Coding	Ports
No designation	DIN EN ISO 228-1
UN	SAE J 514

Order coding example:

V60N-110 RDYN-2-0-01/LSNR-350-A00/76- C 022

Table 13 Flange versions (output side)

Coding V60N			Flange	Shaft
060	090/110	130		
C 010	--	C 030	DIN ISO 7653	DIN ISO 14
C 011	C 021	C 031	SAE-A 2-hole J 744 82-2 DIN ISO 3019-1	SAE-A J 744 (16-4 DIN ISO 3019-1) 9T 16/32 DP
C 012	C 022	C 032	SAE-A 2-hole J 744 82-2 DIN ISO 3019-1	SAE-A J 744 (16-4 DIN ISO 3019-1) ¹⁾ 9T 16/32 DP ¹⁾
C 013	--	--	SAE-A 2-hole J 744 82-2 DIN ISO 3019-1	19-4 DIN ISO 3019-1 11T 16/32 DP
C 014	C 024	C 034	SAE-B 2-hole J 744 101-2 DIN ISO 3019-1	SAE-B J 744 (22-4 DIN ISO 3019-1) 13T 16/32 DP
--	--	--	SAE-B 2-hole J 744 101-2 DIN ISO 3019-1	SAE-BB J 744 (25-4 DIN ISO 3019-1) 15T 12/24 DP
C 015	C 025	C 035	SAE-B 4-hole J 744 101-4 DIN ISO 3019-1	SAE-B J 744 (22-4 DIN ISO 3019-1) 13T 16/32 DP
--	C 027	C 037	SAE-C 2-hole J 744 127-2 DIN ISO 3019-1	SAE-C J 744 (32-4 DIN ISO 3019-1) 14T 12/24 DP
--	C 028	C 038	SAE-C 4-hole J 744 127-4 DIN ISO 3019-1	SAE-C J 744 (32-4 DIN ISO 3019-1) 14T 12/24 DP


Note

Pay attention to the maximum permissible drive torque, as the flange or shaft may be damaged otherwise.

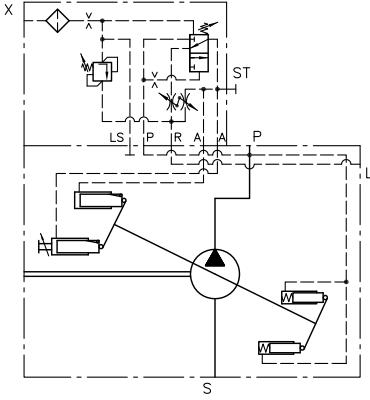

Note

- An additional support is to be provided for pump combinations.
- Additional versions on request.

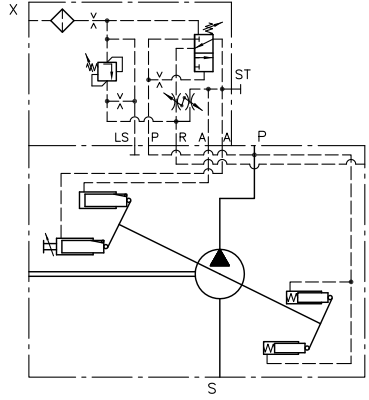
¹⁾ ANSI B 92.1, FLAT ROOT SIDE FIT, spline width deviating from the standard, s = 2.357-0.03

2.2 Controller circuit symbols

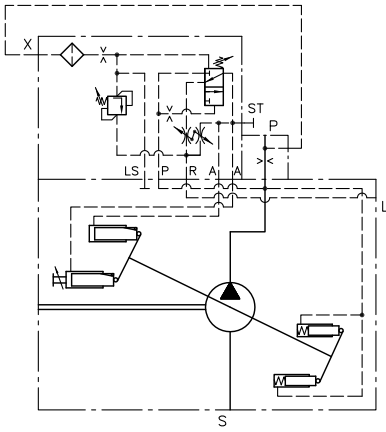
Coding **LSNR**



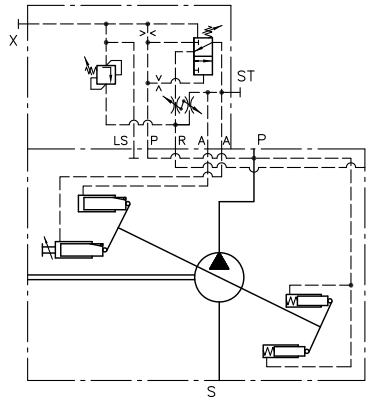
Coding **LSNRT**



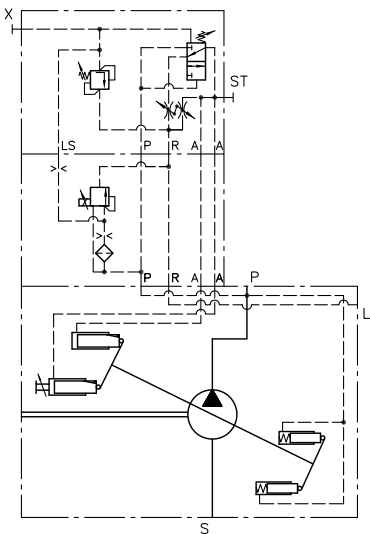
Coding **QNR**



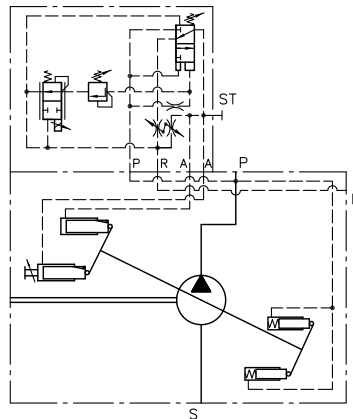
Coding **NR**



Coding **PR**

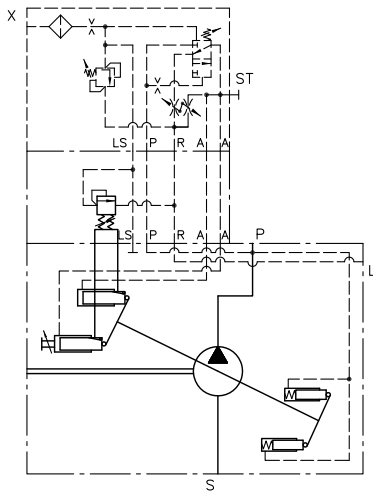


Coding **P1R**

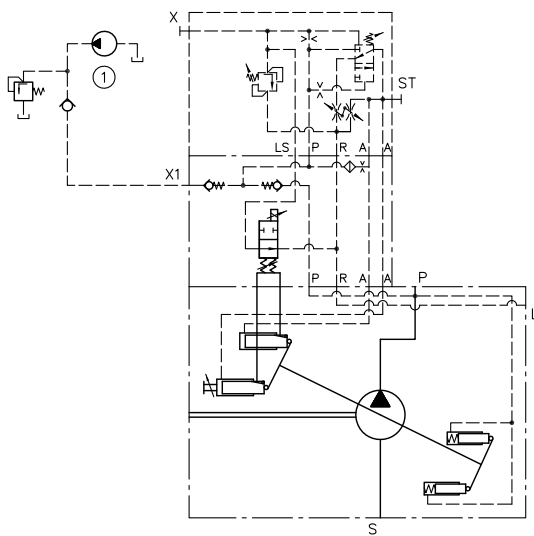


Types V60N-060, V60N-090, V60N-110

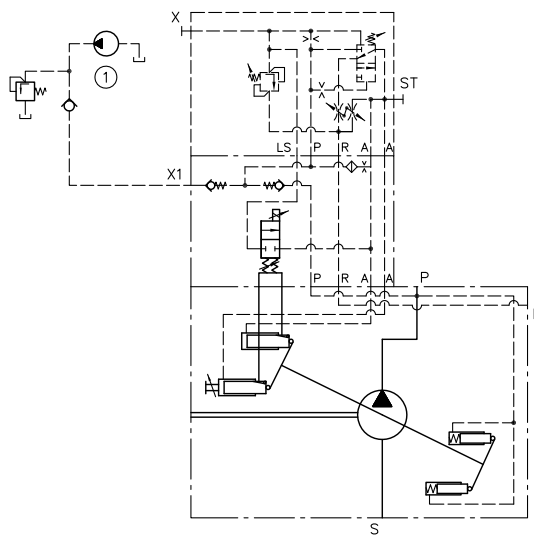
Coding .../ZL



Coding .../ZV



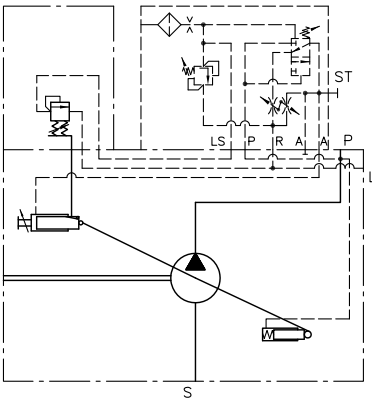
Coding .../ZV1



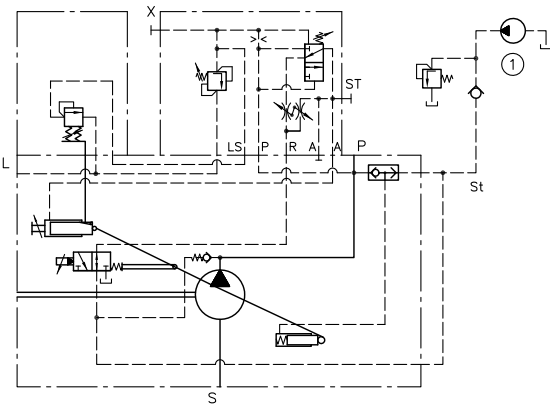
1 External charge pump with pressure-limiting valve and check valve (not included in scope of delivery)

Type V60N-130

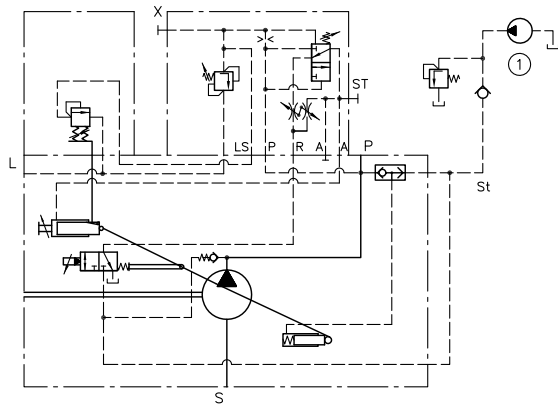
Coding .../L



Coding .../V



Coding .../V1



1 External charge pump with pressure-limiting valve and check valve (not included in scope of delivery)

3 Parameters

3.1 General

Description	Variable displacement axial piston pump
Design	Axial piston pump according to the swash plate principle
Mounting	Power take-off of commercial vehicle gearboxes (flange DIN ISO 7653 for trucks) or flange mounting
Surface	Primed
Drive/output torque	See Chapter 3, "Parameters" , under "Additional parameters"
Installation position	Any (for installation information see Chapter 5, "Assembly, operation and maintenance recommendations")
Rotating direction	Clockwise or anti-clockwise
Change of rotating direction	V60N-060/-090/-110: Turn the end plate of the pump (see dimension diagram) and replace the port plate; see also Assembly instructions for variable displacement axial piston pump type V60N: B 7960 N
Ports	<ul style="list-style-type: none"> ▪ Suction port ▪ Pressure port ▪ Drain port ▪ Pressure gauge connection
Hydraulic fluid	<ul style="list-style-type: none"> ▪ Hydraulic oil according to Part 1 to 3; ISO VG 10 to 68 according to DIN 51519 ▪ Viscosity range: min 10; max 1000 mm²/s ▪ Optimal operating range between 16 and 35 mm²/s ▪ Also suitable for biologically degradable hydraulic fluids type HEPG (polyalkylene glycol) and HEES (synthetic ester) at operating temperatures up to approx. +70°C.
Purity class	ISO 4406 <hr/> 19/17/14
Temperatures	<ul style="list-style-type: none"> ▪ Surrounding area: -40°C to +60°C (observe viscosity range) ▪ Oil: - 25°C to +80°C (observe viscosity range) ▪ Start temperature: To -40°C is permissible (observe start viscosity), as long as the steady-state temperature is at least 20K higher during operation ▪ Biologically degradable hydraulic fluids: Not above +70°C

Pressure and delivery flow

Operating pressure See [Chapter 2, "Available versions, main data"](#)

Geometric displacement See [Chapter 2, "Available versions, main data"](#)

Dimensions

Type V60N	Without controller (kg)	With controller (kg)					
		LSNR, LSNRT, NR	ZL	ZW	PR	P1R	ZV, ZV1
060		+1.1	+1.0	+0.7	+2.6	+1.2	+1.9
090		+1.1	+1.0	+0.7	+2.6	+1.2	+1.9
110		+1.1	+1.0	+0.7	+2.6	+1.2	+1.9
130		+1.1	--	--	+2.6	--	--

Additional parameters

Description	Nominal size			
	060	090	110	130
Max. swash plate angle	20.5°	21.5°	21.5°	21.5°
Absolute inlet pressure required in open circuit	0.85 bar	0.85 bar	0.85 bar	0.85 bar
Max. permissible housing pressure (static/dynamic)	2 bar/3 bar	2 bar/3 bar	2 bar/3 bar	2 bar/3 bar
Max. permissible inlet pressure (static/dynamic)	20 bar/30 bar	20 bar/30 bar	20 bar/30 bar	20 bar/30 bar
Max. rotation speed during suction operation and max. swash plate angle at 1 bar abs. Inlet pressure	2500 rpm	2300 rpm	2200 rpm	2100 rpm
Max. rotation speed with zero stroke and 1 bar abs. Inlet pressure	3000 rpm	3000 rpm	3000 rpm	3000 rpm
Min. rotation speed in continuous operation	500 rpm	500 rpm	500 rpm	500 rpm
Required drive torque at 100 bar	100 Nm	151 Nm	184 Nm	230 Nm
Drive power at 250 bar and 2000 rpm	53 kW	79.5 kW	97.2 kW	120 kW
Weight torque	30 Nm	35.5 Nm	40 Nm	40 Nm
Inertia torque	0.005 kg m ²	0.008 kg m ²	0.01 kg m ²	0.011 kg m ²
Noise level at 250 bar, 1500 rpm and max. swash plate angle (measured in acoustic measurement chamber according to with measuring distance 1 m)	75 dB(A)	75 dB(A)	75 dB(A)	75 dB(A)

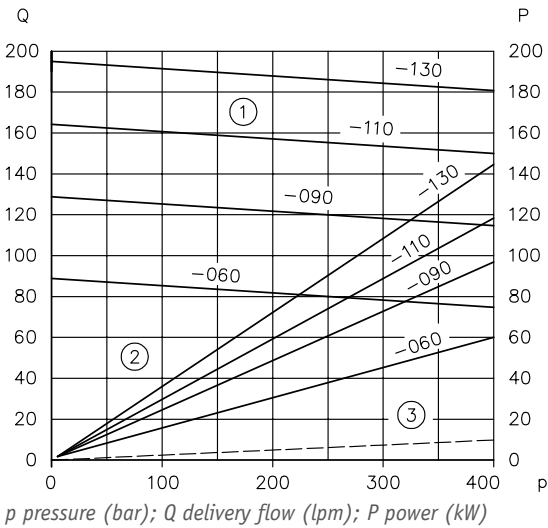
Max. permissible drive/output torque

Description		Nominal size			
		060	090	110	130
Parallel key splined shaft D	Drive/output	530 Nm/100 Nm	800 Nm/600 Nm	800 Nm/600 Nm	800 Nm/700 Nm
Spline shaft M	Drive/output	--	530 Nm/530 Nm	530 Nm/530 Nm	--
Spline shaft H	Drive/output	210 Nm/100 Nm	--	--	--
Spline shaft U	Drive/output	210 Nm/100 Nm	--	--	--
Spline shaft T	Drive/output	340 Nm/100 Nm	--	--	--
Spline shaft S	Drive/output	530 Nm/100 Nm	640 Nm/600 Nm	640 Nm/600 Nm	640 Nm/640 Nm
Spline shaft Q	Drive/output	--	900 Nm/600 Nm	900 Nm/600 Nm	900 Nm/700 Nm

3.2 Characteristic curves

Delivery flow and power (basic pump)

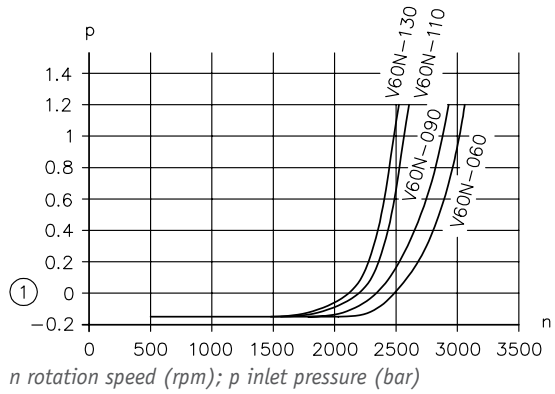
The diagrams show delivery flow and drive power over pressure without a controller at 1500 rpm.



- 1 Delivery flow/pressure
- 2 Drive power/pressure (max. swash plate angle)
- 3 Drive power/pressure (zero stroke)

Inlet pressure and self-suction speed

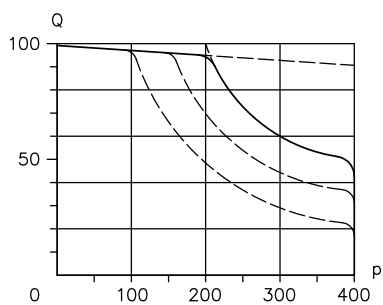
The diagrams show the inlet pressure/rotation speed at the max. swash plate angle and an oil viscosity of 75 mm²/s.



- 1 0 bar relative = 1 bar absolute

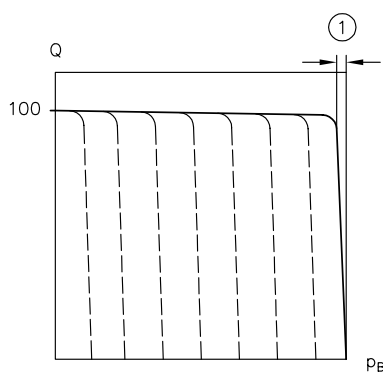
3.3 Controller characteristic curves

Coding **/ZL, /L**



p pressure (bar); Q delivery flow (%)

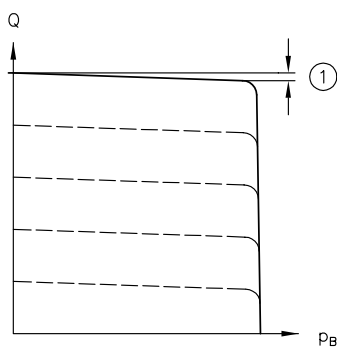
Coding **LSNR, PR, P1R**



1 Approx. 4 bar

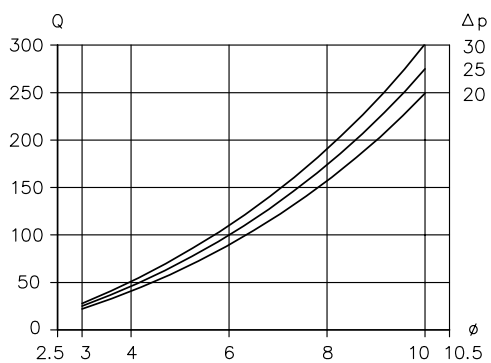
p_B operating pressure (bar); Q delivery flow (%)

Coding **V, V1, ZV, ZV1**



1 Approx. 5%

Coding **QNR**



Ø Orifice diameter (mm); Q delivery flow (%)

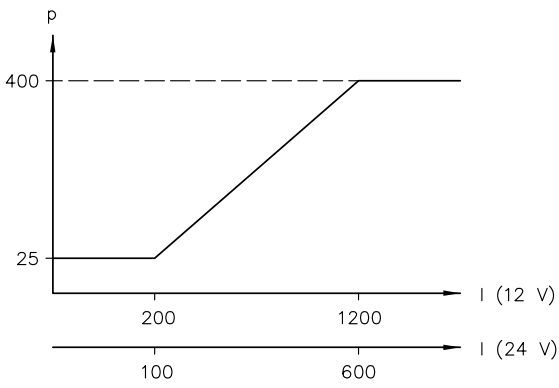
Determination of the delivery flow Q (lpm)

$$Q = 0,55 \cdot d^2 \sqrt{\Delta p}$$

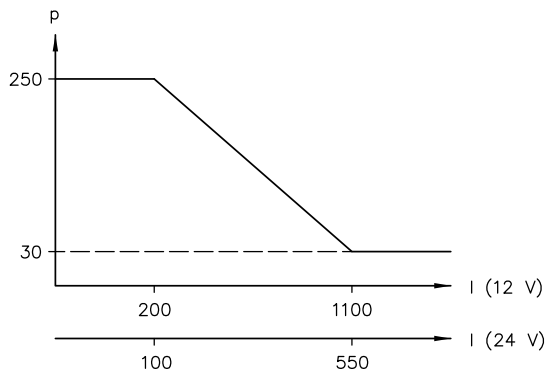
d = orifice diameter (mm)

Δp = pressure difference

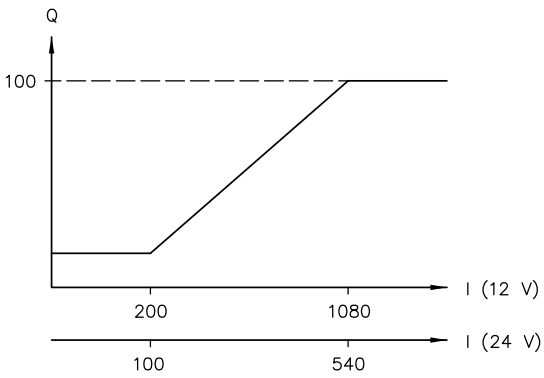
Coding **PR**



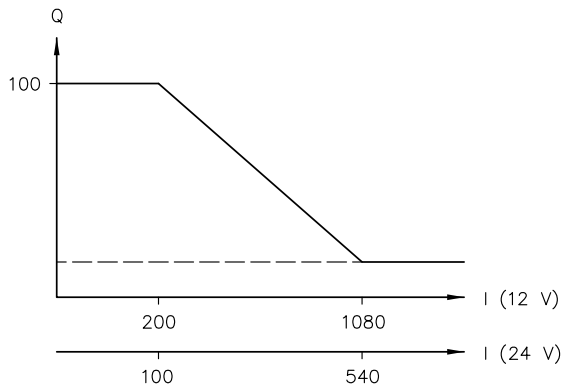
Coding **P1R**



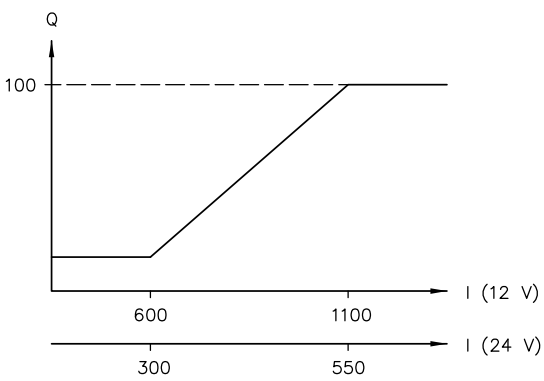
Coding **V**



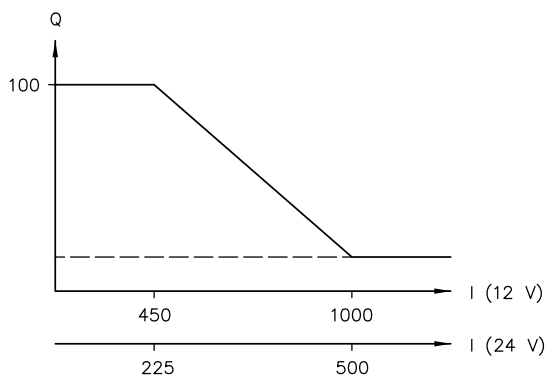
Coding **V1**



Coding **ZV**



Coding **ZV1**



I current (mA); Q delivery flow (%)

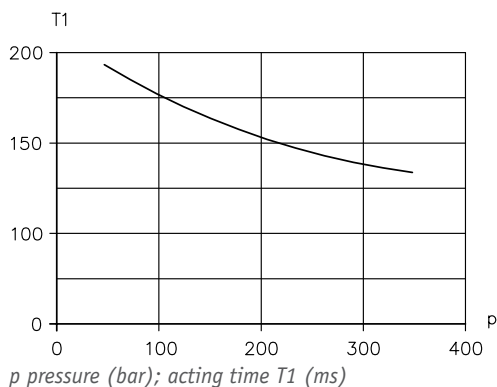


Note

Q = 0 lpm possible through the use of a charge pump.

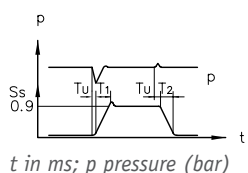
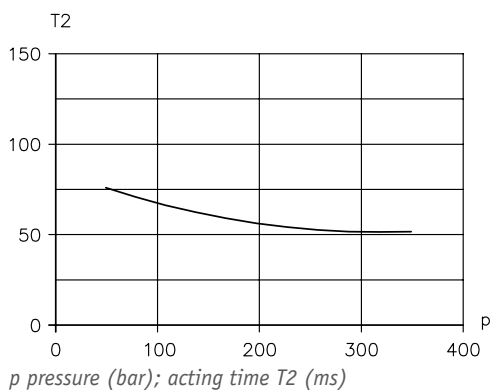
Acting times T1 (LSNR controller)

The diagram illustrates the on-stroke time/pressure for the LSNR controller, i.e. the time required to swing out the pump and to adjust the geometric displacement from the minimum to the maximum.



Acting times T2 (LSNR controller)

The diagram shows the destroke time/pressure for the LSNR controller, i.e. the time required to swing in the pump and to adjust the geometric displacement from the maximum to the minimum.



S_s	= positioning travel of actuator
T_u	= delay < 3 ms
T_1	= on-stroke time
T_2	= destroke time
p	= pressure

LS line approx. 10% of the volume of the P line

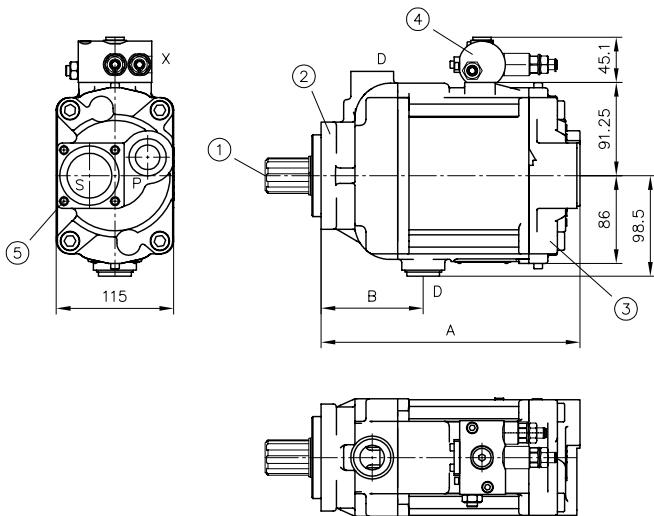
4 Dimensions

All dimensions in mm, subject to change.

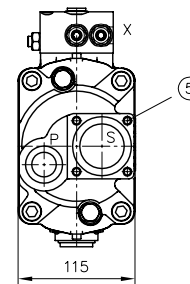
4.1 Basic pump

4.1.1 Type V60N-060

Rotating direction **clockwise** (viewed from shaft journal)



Rotating direction **anti-clockwise** (viewed from shaft journal)



- 1 Shaft version
- 2 Flange version
- 3 Housing version
- 4 Controllers and intermediate plates according to [Chapter 4.2, "Controllers and intermediate plates"](#)
- 5 Attachment kit for suction intake according to [Chapter 6.1.1, "Suction intakes"](#) is included in the delivery

Flange version	Housing version	A	B
Y	-1	253.5	100.0
F, Z, X	-1	249.8	96.3
Y	-2, -3	292.0	100.0
F, Z, X	-2, -3	288.3	96.3

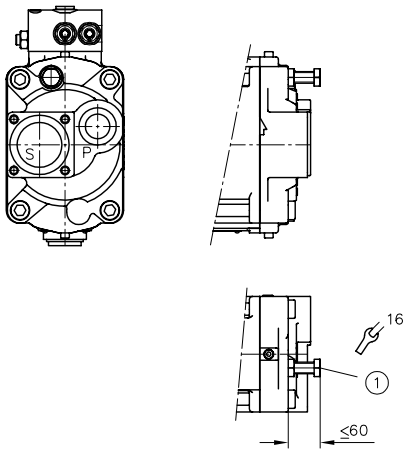
Ports P, S and D (DIN EN ISO 228-1)

P	Pressure port G 3/4 (BSPP)
S	Flange suction port
D	Drain port G 3/4 (BSPP)
X	G 1/4 (BSPP)

For coding UNF connections SAE J 514

P	Pressure connection 1 1/16-12 UN-2B
S	Flange suction port
D	Drain port 1 1/16-12 UN-2B
X	G 1/4 (BSPP) (DIN EN ISO 228-1) with adapter for 7/16-20 (SAE-4)

Stroke limitation

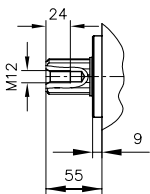


1 Stroke limitation (V_g approx. 4 cm³/rev.)

Shaft versions

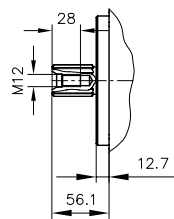
Parallel key splined shaft

Coding **D**
(similar to DIN ISO 14)
B8x32x35



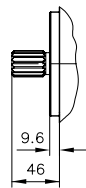
Spline shaft

Coding **S**
(SAE-C 14T 12/24DP)



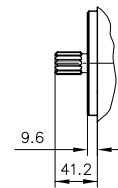
Spline shaft

Coding **T**
(SAE-B-B 15T 16/32DP)



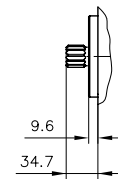
Spline shaft

Coding **H**
(SAE-B 13T 16/32DP)



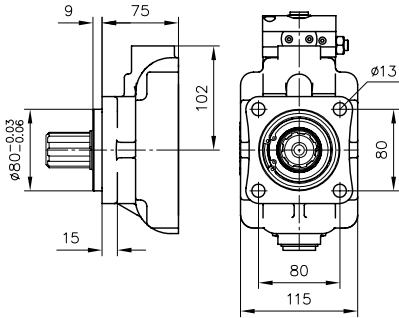
Spline shaft

Coding **U**
(SAE-B 13T 16/32DP short)

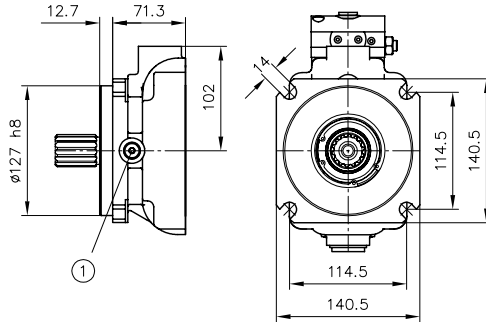


Flange versions

Coding Y
(DIN ISO 7653)

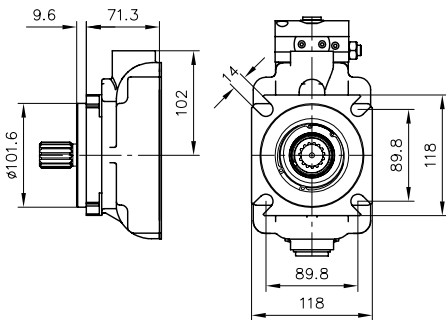


Coding F
(SAE-C 4-hole)
(127-4 DIN ISO 3019-1)

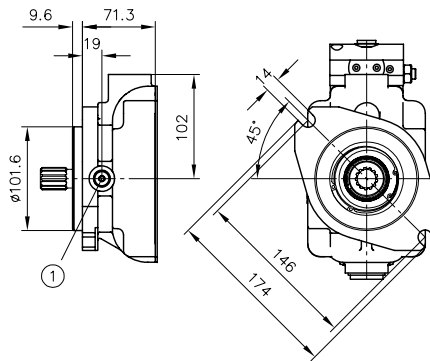


1 Bleeding G 1/8

Coding Z
(SAE-B 4-hole)
(101-4 DIN ISO 3019-1)

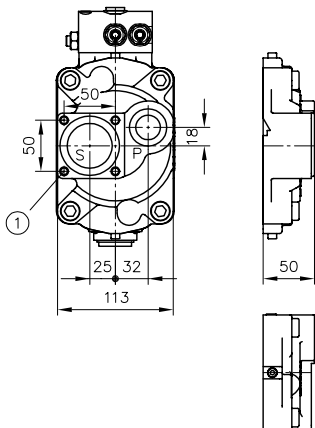


Coding X
(SAE-B 2-hole)
(101-2 DIN ISO 3019-1)



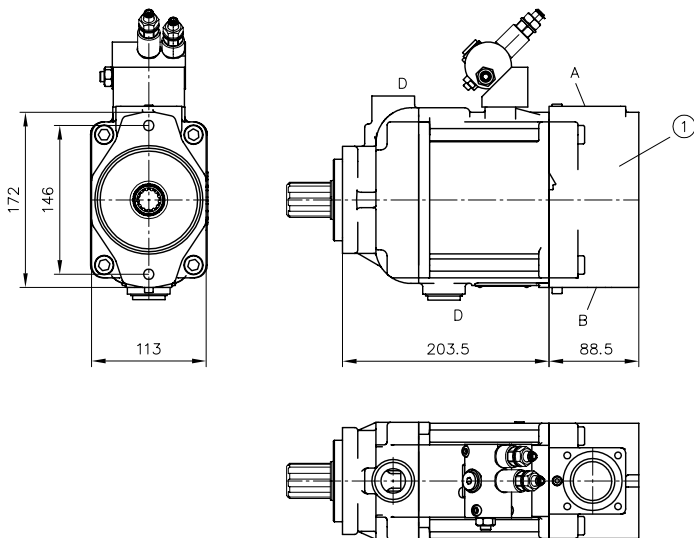
1 Bleeding G 1/8

Housing version -1 (axial ports)



1 Delivery includes attachment kit for suction intake according to [Chapter 6.1.1, "Suction intakes"](#)

Housing version -2 (radial ports, with thru-shaft)

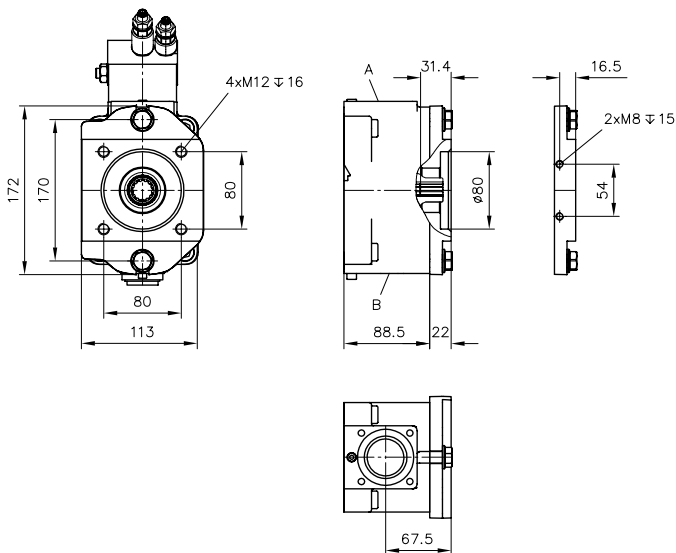


1 Flange version (output side)

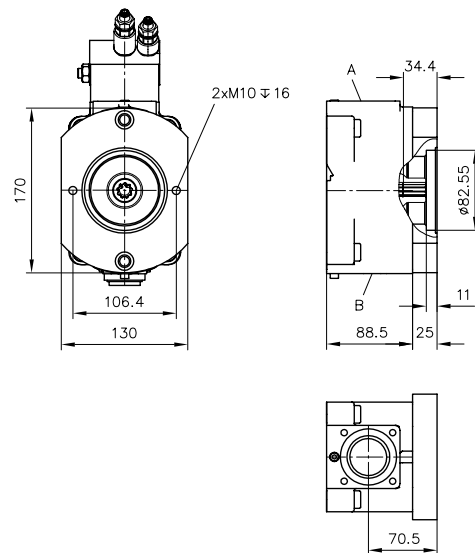
Rotating direction clockwise	Rotating direction anti-clockwise
A = suction port	A = pressure port
B = pressure port	B = suction port

Flange version (output side)

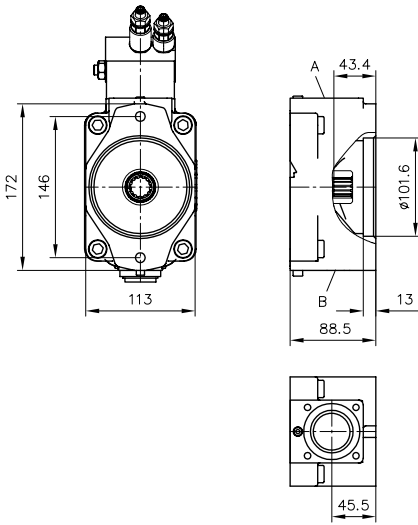
Coding **C 010**
(DIN ISO 7653)



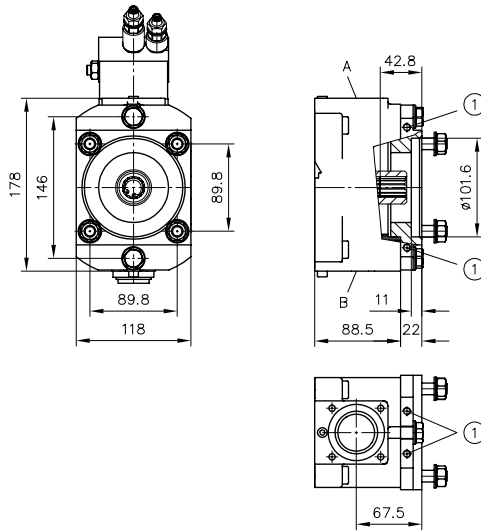
Coding **C 011, C 012**
(SAE-A 2-Hole)



Coding **C 014**
(SAE-B 2-hole)

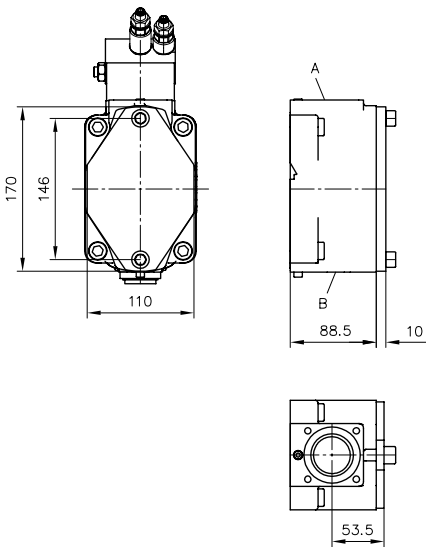


Coding **C 015**
(SAE-B 4-hole)



1 Support 8xM8

Housing version -3 (radial ports)



Rotating direction clockwise

A = suction port

B = pressure port

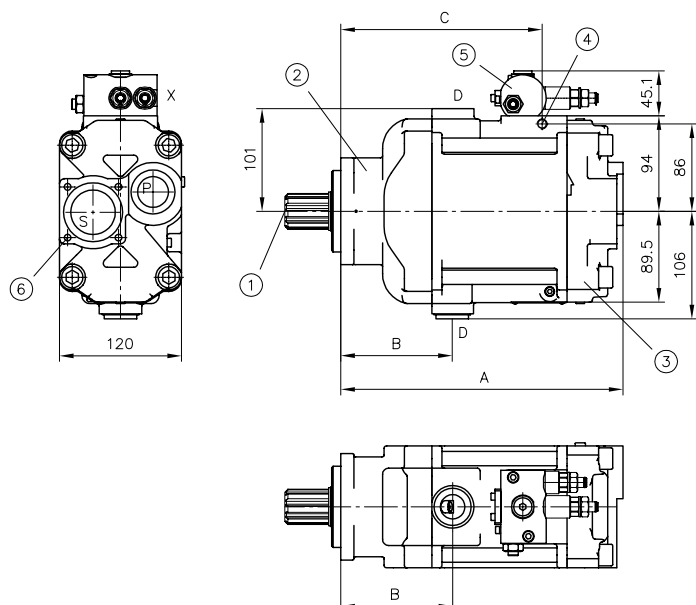
Rotating direction anti-clockwise

A = pressure port

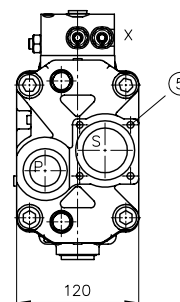
B = suction port

4.1.2 Type V60N-090

Rotation direction **clockwise** (viewed from shaft journal)



Rotation direction **anti-clockwise** (viewed from shaft journal)



- 1 Shaft version
- 2 Flange version
- 3 Housing version
- 4 Thread M10 for attaching a bracket
- 5 Controllers and intermediate plates according to [Chapter 4.2, "Controllers and intermediate plates"](#)
- 6 Attachment kit for suction intake according to [Chapter 6.1.1, "Suction intakes"](#) is included in the delivery

Flange version	Housing version	A	B	C
Y	-1	277.5	110.0	198.0
F, G	-1	273.8	106.3	194.3
Y	-2, -3	310.5	110.0	198.0
F, G	-2, -3	306.8	106.3	194.3

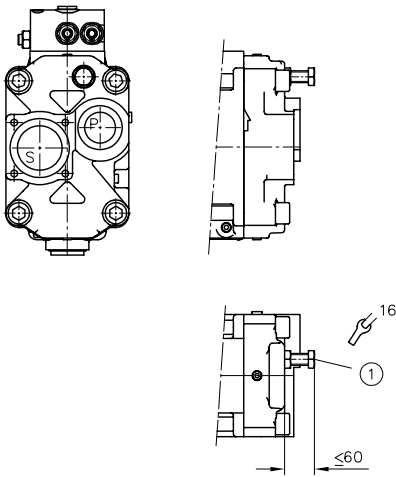
Ports P, S and D (DIN EN ISO 228-1)

P	Pressure port G 1 (BSPP)
S	Flange suction port
D	Drain port G 3/4 (BSPP)
X	G 1/4 (BSPP)

For coding UNF connections SAE J 514

P	Pressure port 1 5/16-12 UN-2B
S	Flange suction port
D	Drain port 1 1/16-12 UN-2B
X	G 1/4 (BSPP) (DIN EN ISO 228-1) with adapter for 7/16-20 (SAE-4)

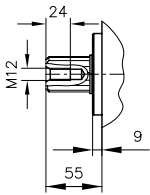
Stroke limitation



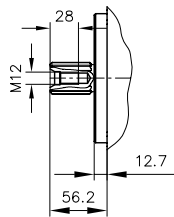
1 Stroke limitation (V_g approx. 5 cm³/rev.)

Shaft versions

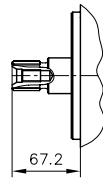
Parallel key splined shaft
Coding **D**
(similar to DIN ISO 14)
B8x32x35



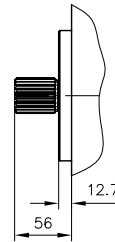
Spline shaft
Coding **S**
(SAE-C 14T 12/24DP)



Spline shaft
Coding **M**
(W30x2x14x9g DIN 5480)

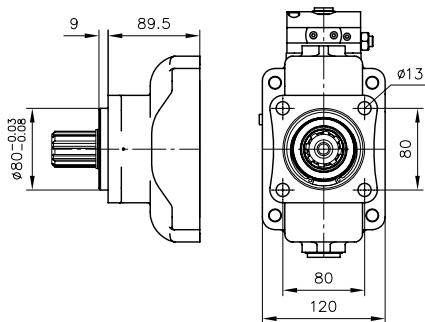


Spline shaft
Coding **Q**
(SAE-CS 21T 16/32 DP)

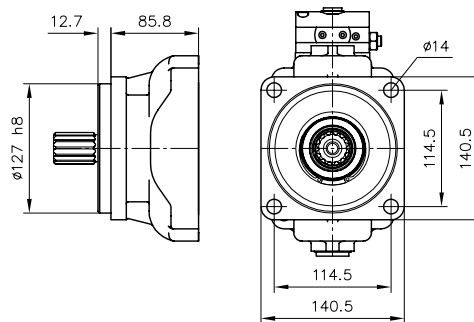


Flange versions

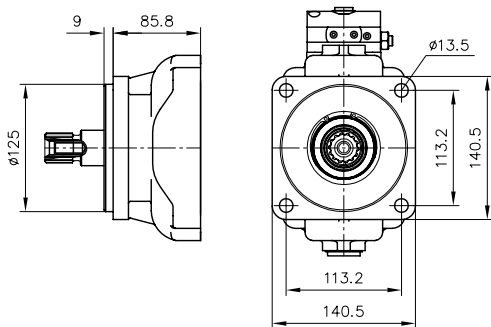
Coding **Y**
(DIN ISO 7653)



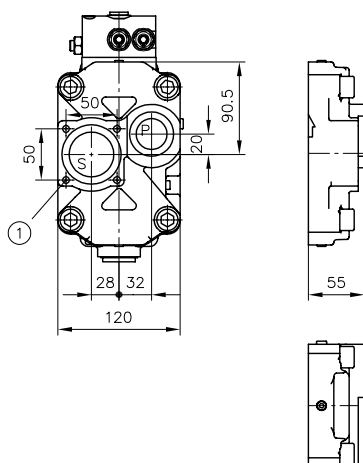
Coding **F**
(SAE-C 4-hole)
(127-4 DIN ISO 3019-1)



Coding **G**
(125 B4 HW DIN ISO 3019-2)

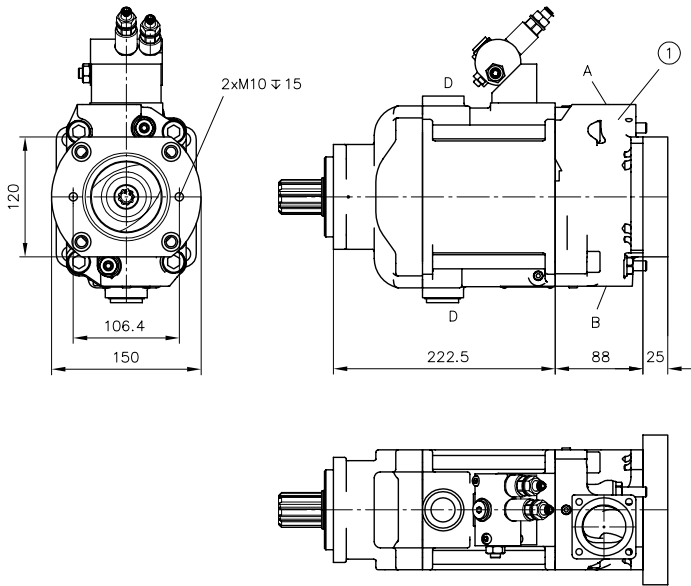


Housing version -1 (axial ports)



1 Delivery includes attachment kit for suction intake according to [Chapter 6.1.1, "Suction intakes"](#)

Housing version -2 (radial ports, with thru-shaft)



1 Flange version (output side)

Rotation direction clockwise

A = suction port

B = pressure connection

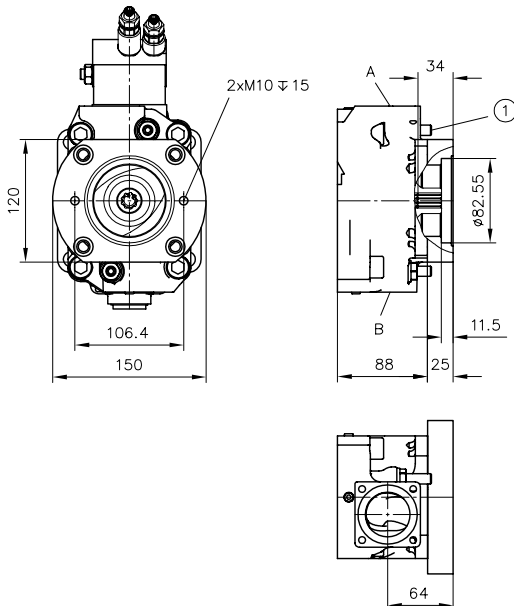
Rotation direction anti-clockwise

A = pressure connection

B = suction port

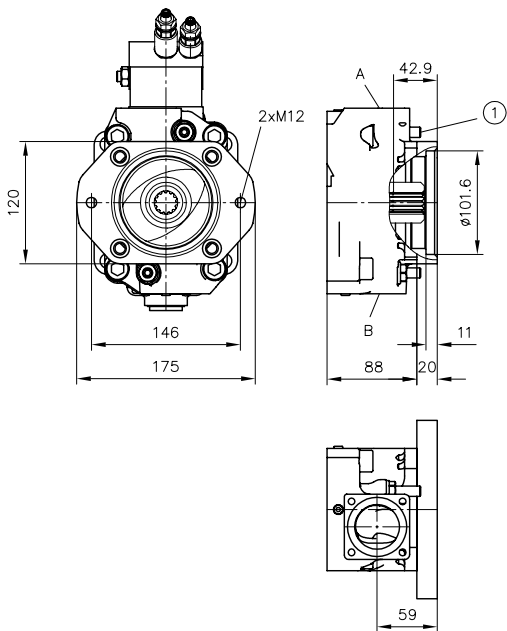
Flange version (output side)

Coding **C 021, C 022**
(SAE-A 2-hole)



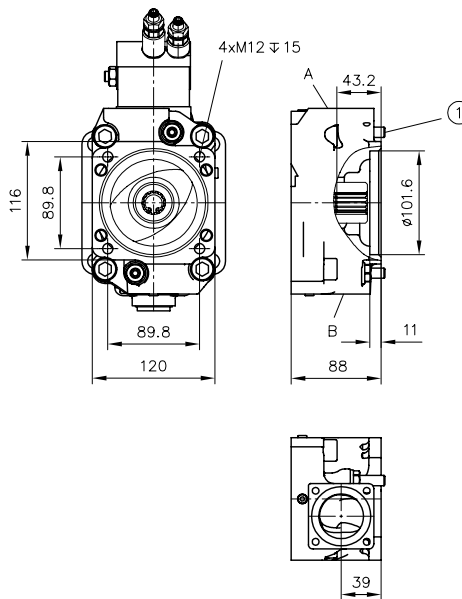
1 Stroke limitation

Coding **C 024**
(SAE-B 2-hole)



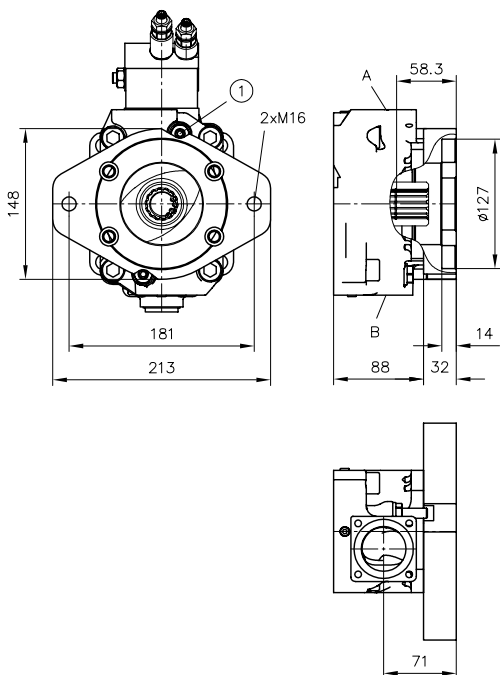
1 Stroke limitation

Coding **C 025**
(SAE-B 4-hole)



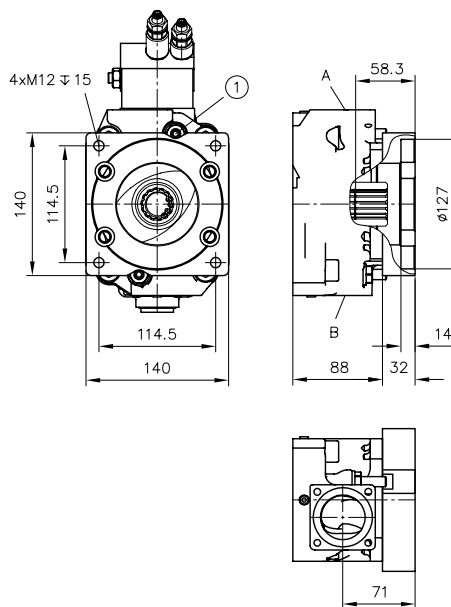
1 Stroke limitation

Coding **C 027**
(SAE-C 2-hole)



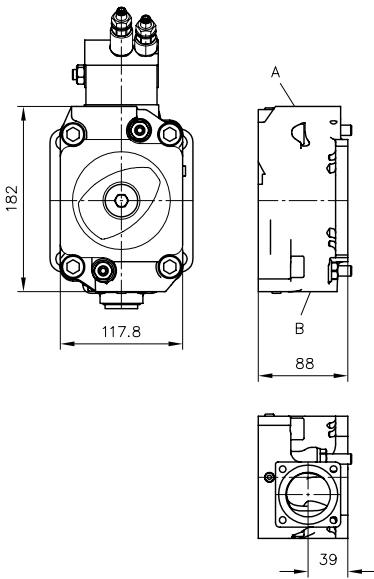
1 Stroke limitation

Coding **C 028**
(SAE-C 4-hole)



1 Stroke limitation

Housing version -3 (radial ports)



Rotation direction clockwise

A = suction port

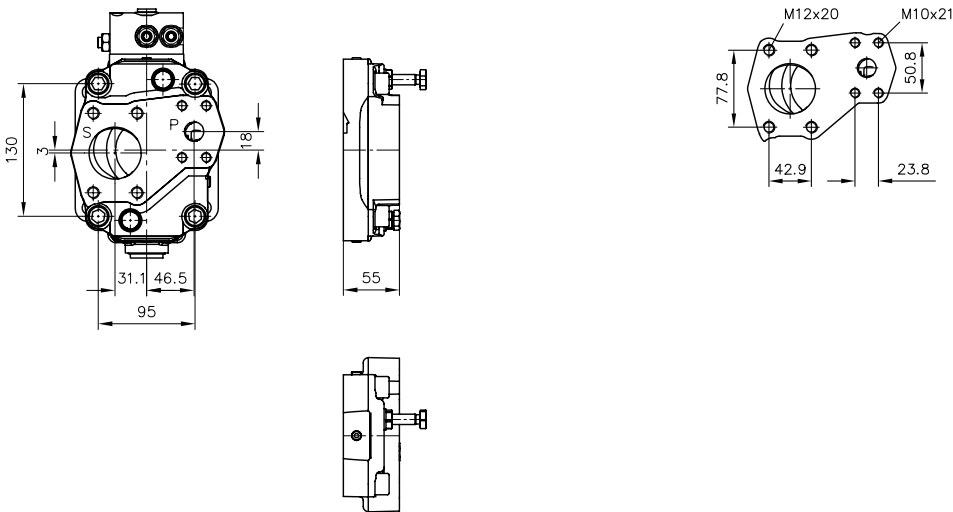
B = pressure connection

Rotation direction anti-clockwise

A = pressure connection

B = suction port

Housing version -4 (axial ports)

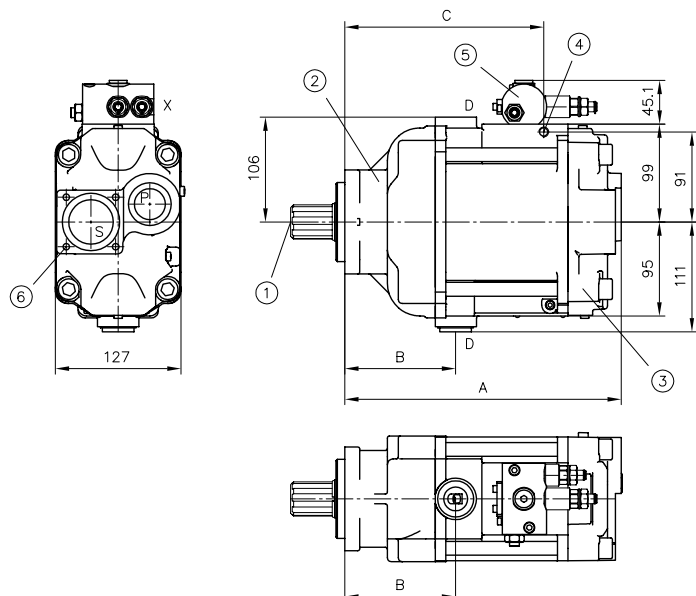


Ports P, S (SAE J 518)

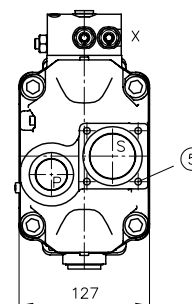
P	Pressure connection SAE 3/4"	(6000 psi)
S	Suction port SAE 2"	(3000 psi)

4.1.3 Type V60N-110

Rotation direction **clockwise** (viewed from shaft journal)



Rotation direction **anti-clockwise** (viewed from shaft journal)



- 1 Shaft version
- 2 Flange version
- 3 Housing version
- 4 Thread M10 for attaching a bracket
- 5 Controllers and intermediate plates according to [Chapter 4.2, "Controllers and intermediate plates"](#)
- 6 Attachment kit for suction intake according to [Chapter 6.1.1, "Suction intakes"](#) is included in the delivery

Flange version	Housing version	A	B	C
Y	-1	279.5	112.0	201.0
F	-1	275.7	108.7	197.7
P	-1	278.5	111.0	200.0
Y	-2, -3	313.5	112.0	201.0
F	-2, -3	309.7	108.2	197.7
P	-2, -3	312.5	111.0	200.0

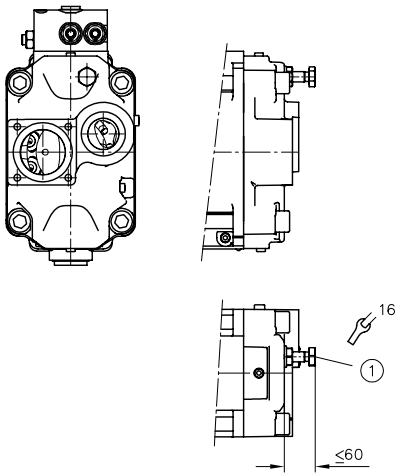
Ports P, S and D (DIN EN ISO 228-1)

P	Pressure port G 1 (BSPP)
S	Flange suction port
D	Drain port G 3/4 (BSPP)
X	G 1/4 (BSPP)

For coding UNF connections SAE J 514

P	Pressure port 1 5/16-12 UN-2B
S	Flange suction port
D	Drain port 1 1/16-12 UN-2B
X	G 1/4 (BSPP) (DIN EN ISO 228-1) with adapter for 7/16-20 (SAE-4)

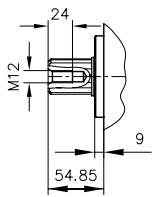
Stroke limitation



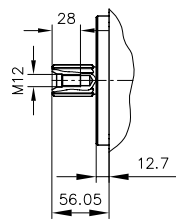
1 Stroke limitation (V_g approx. 6 cm³/rev.)

Shaft versions

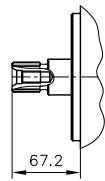
Parallel key splined shaft
Coding **D**
(similar to DIN ISO 14)
B8x32x35



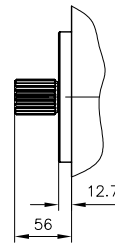
Spline shaft
Coding **S**
(SAE-C 14T 12/24DP)



Spline shaft
Coding **M**
(W30x2x14x9g DIN 5480)

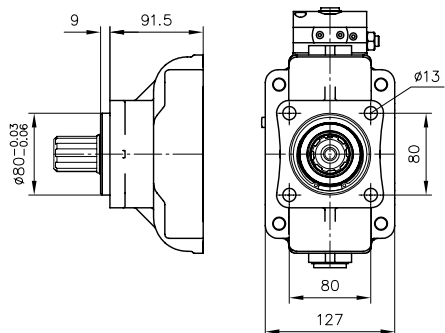


Spline shaft
Coding **Q**
(SAE-CS 21T 16/32 DP)

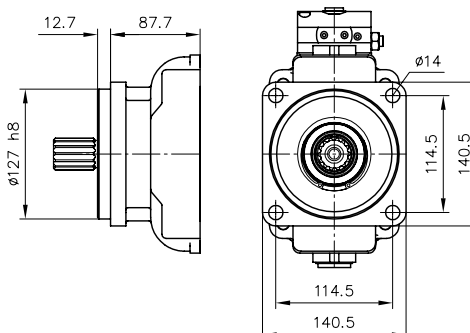


Flange versions

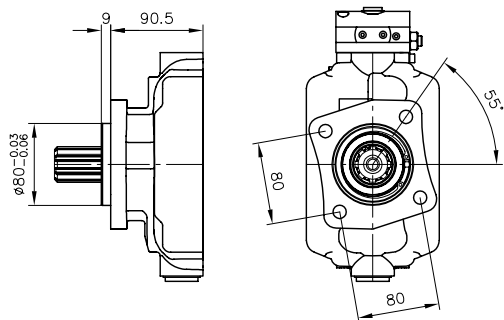
Coding Y
(DIN ISO 7653)



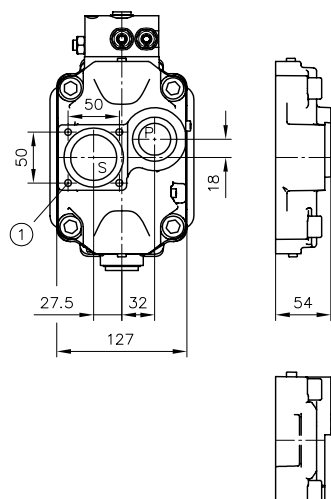
Coding F
(SAE-C 4-hole)
(127-4 DIN ISO 3019-1)



Coding P
(DIN ISO 7653)

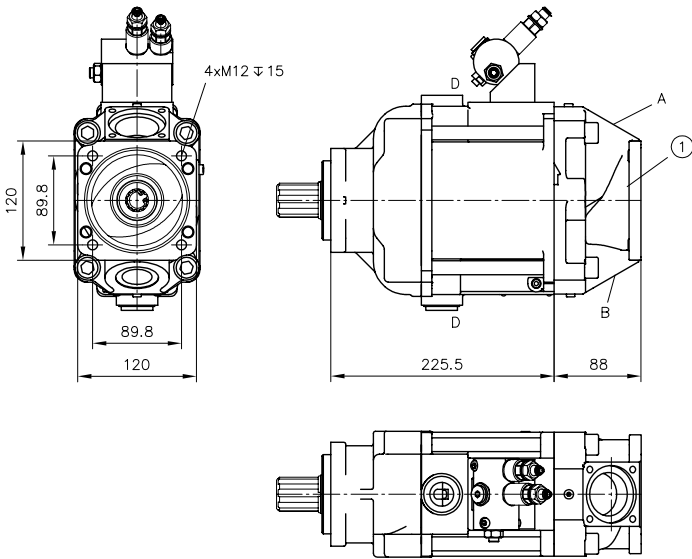


Housing version -1 (axial ports)



1 Delivery includes attachment kit for suction intake according to [Chapter 6.1.1, "Suction intakes"](#)

Housing version -2 (radial ports with thru-shaft)



1 Flange version (output side)

Rotation direction clockwise

A = suction port

B = pressure connection

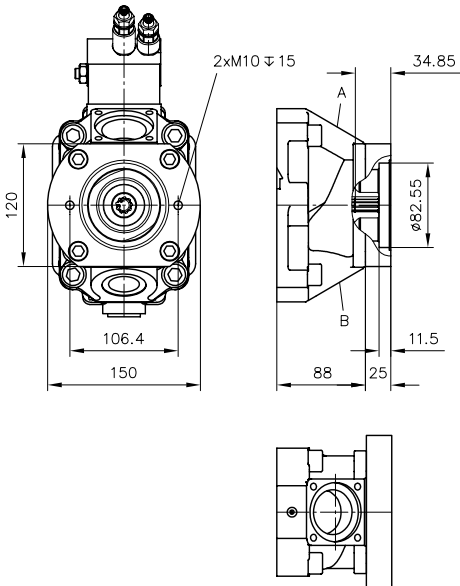
Rotation direction anti-clockwise

A = pressure connection

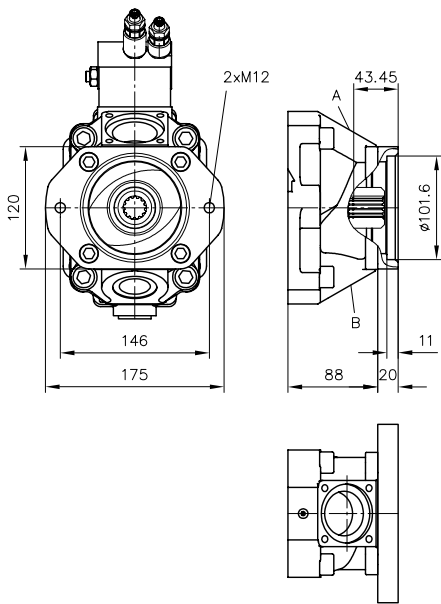
B = suction port

Flange version (output side)

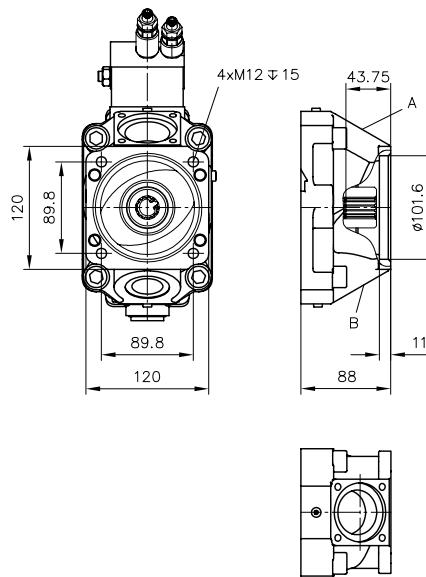
Coding **C 021, C 022**
(SAE-A 2-hole)



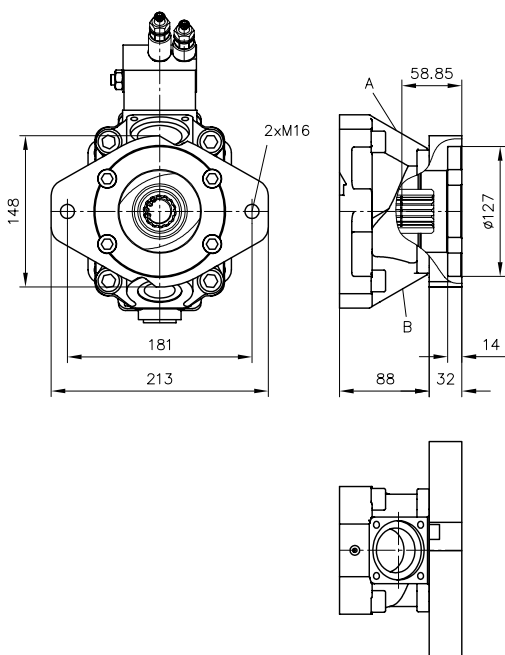
Coding **C 024**
(SAE-B 2-hole)



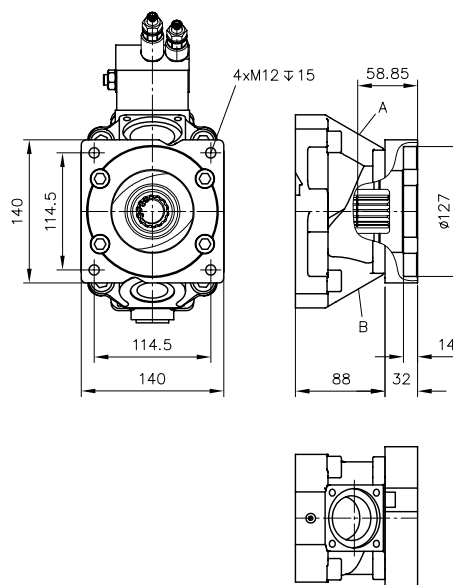
Coding **C 025**
(SAE-B 4-hole)



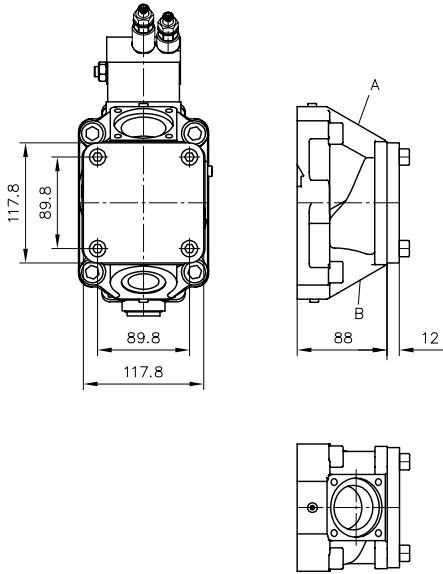
Coding **C 027**
(SAE-C 2-hole)



Coding **C 028**
(SAE-C 4-hole)



Housing version -3 (radial ports)



Rotation direction clockwise

A = suction port

B = pressure connection

Rotation direction anti-clockwise

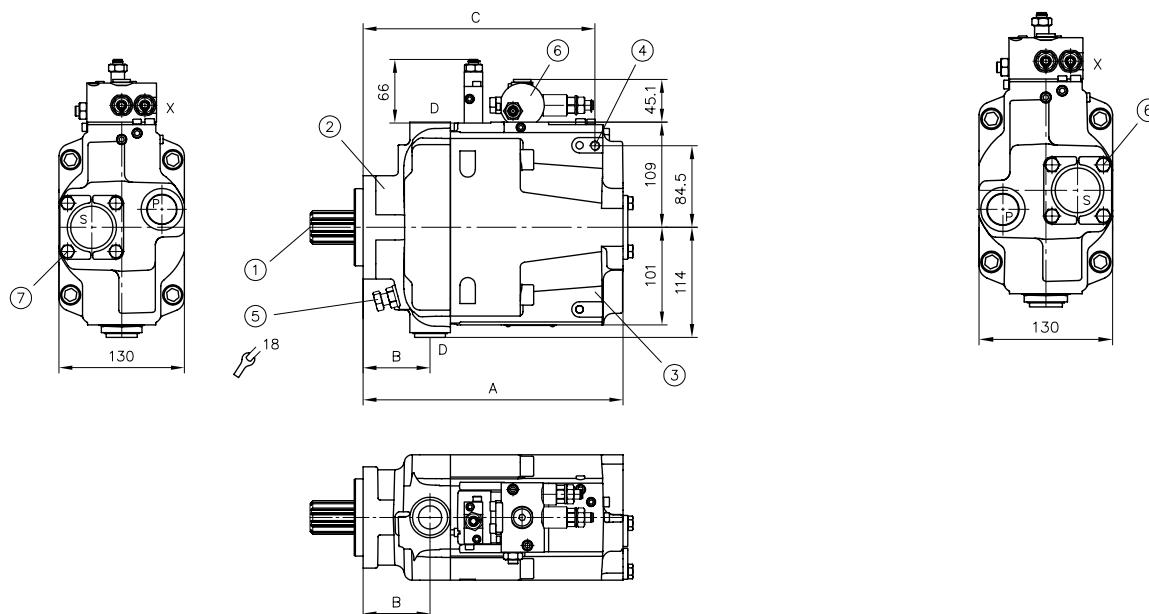
A = pressure connection

B = suction port

4.1.4 Type V60N-130

Rotation direction **clockwise** (viewed from shaft journal)

Rotation direction **anti-clockwise** (viewed from shaft journal)



- 1 Shaft version
- 2 Flange version
- 3 Housing version
- 4 Thread M10 for attaching a bracket
- 5 Stroke limitation (13 cm³/rev.)
- 6 Controllers and intermediate plates according to [Chapter 4.2, "Controllers and intermediate plates"](#)
- 7 Attachment kit for suction intake according to [Chapter 6.1.1, "Suction intakes"](#) is included in the delivery

Flange version	Housing version	A	B	C
Y, P	-1	269.5	69.5	240.5
F	-1	266.8	66.8	237.8
Y, P	-2	323.5	69.5	240.5
F	-2	320.8	66.8	237.8

Ports P, S and D (DIN EN ISO 228-1)

P	Pressure port G 1 (BSPP)
S	Flange suction port
D	Drain port G 3/4 (BSPP)
X	G 1/4 (BSPP)

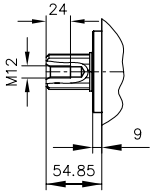
For coding UNF connections SAE J 514

P	Pressure port 1 5/16-12 UN-2B
S	Flange suction port
D	Drain port 1 1/16-12 UN-2B
X	G 1/4 (BSPP) (DIN EN ISO 228-1) with adapter for 7/16-20 (SAE-4)

Shaft versions

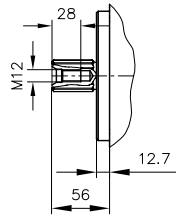
Spline shaft

Coding **D**
(similar to DIN ISO 14)
B8x32x35



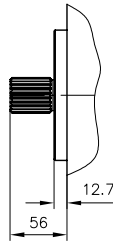
Spline shaft

Coding **S**
(SAE-C 14T 12/24DP)



Spline shaft

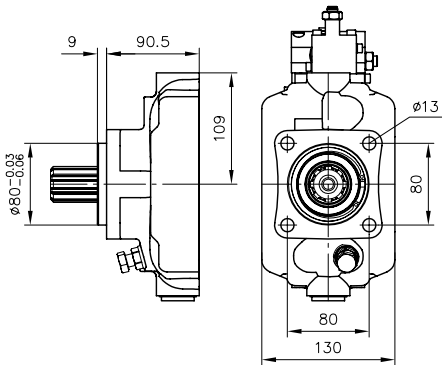
Coding **Q**
(SAE-CS 21T 16/32 DP)



Flange versions

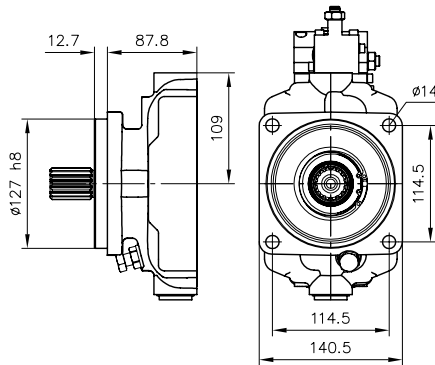
Coding Y

(DIN ISO 7653)



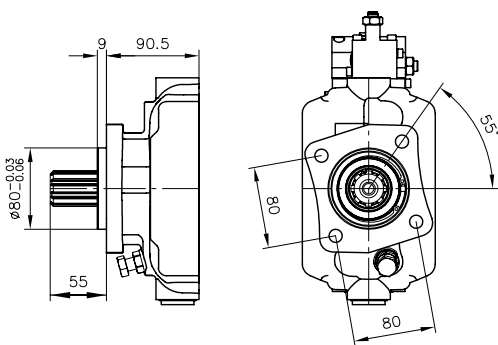
Coding F

(SAE-C 4-hole)
(127-4 DIN ISO 3019-1)

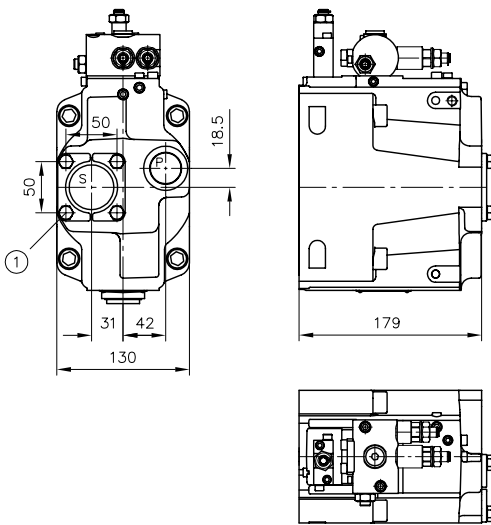


Coding P

(DIN ISO 7653)



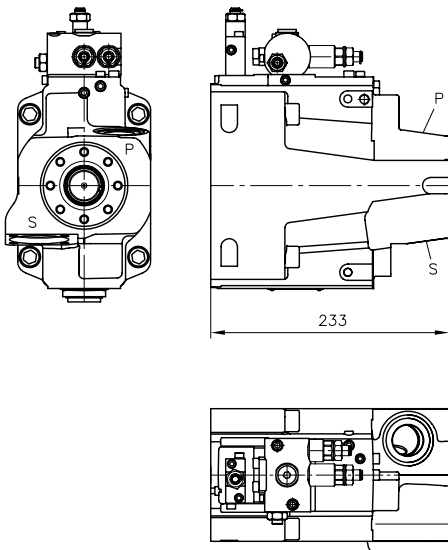
Housing version -1 (axial ports)



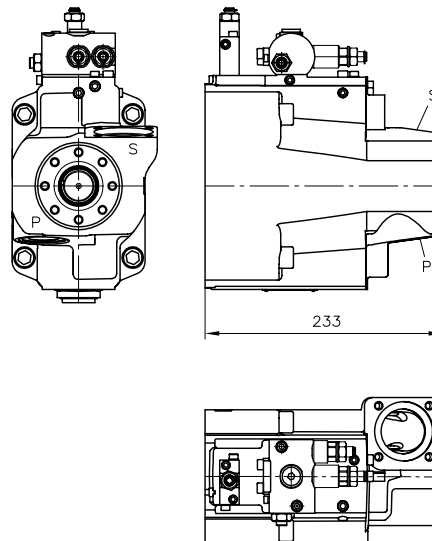
1 Delivery includes attachment kit for suction intake according to [Chapter 6.1.1, "Suction intakes"](#)

Housing version -2 (radial ports, with thru-shaft)

Rotation direction **clockwise**

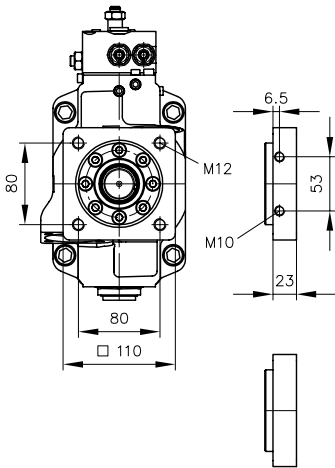


Rotation direction **anti-clockwise**

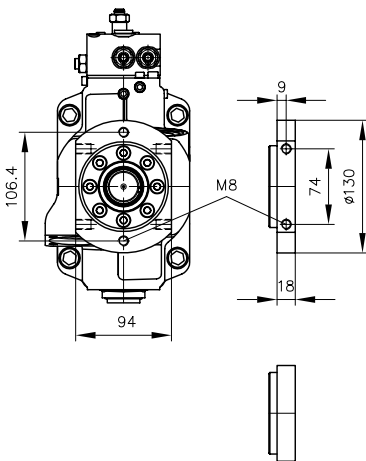


Flange version (output side)

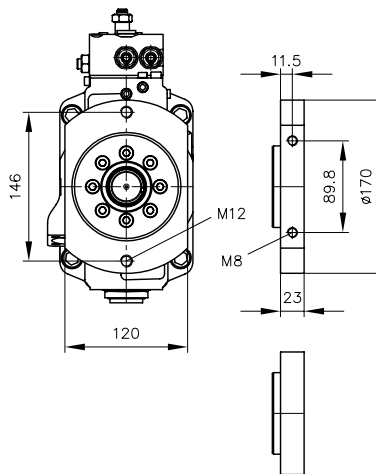
Coding C 030
(ISO 7653-1985)



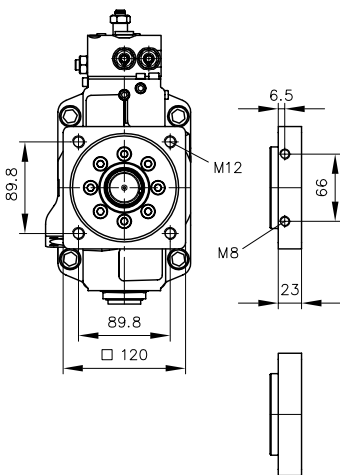
Coding C 031, C 032
(SAE-A 2-hole)



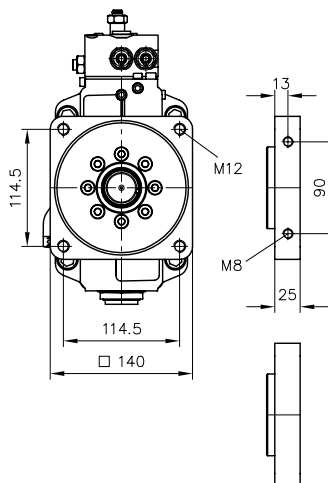
Coding C 034
(SAE-B 2-hole)



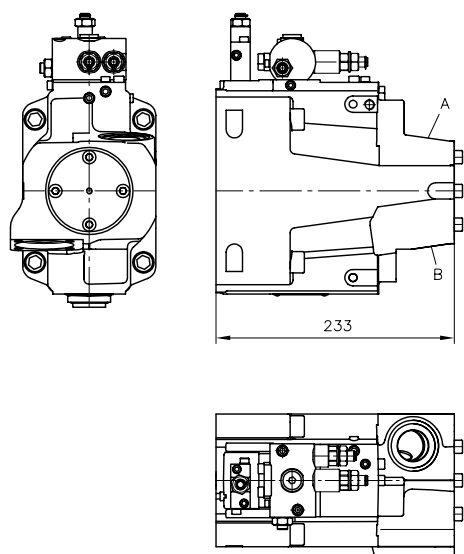
Coding C 035
(SAE-B 4-hole)



Coding C 038
(SAE-C 4-hole)



Housing version -3 (radial ports)



Rotation direction clockwise

A = pressure connection

B = suction port

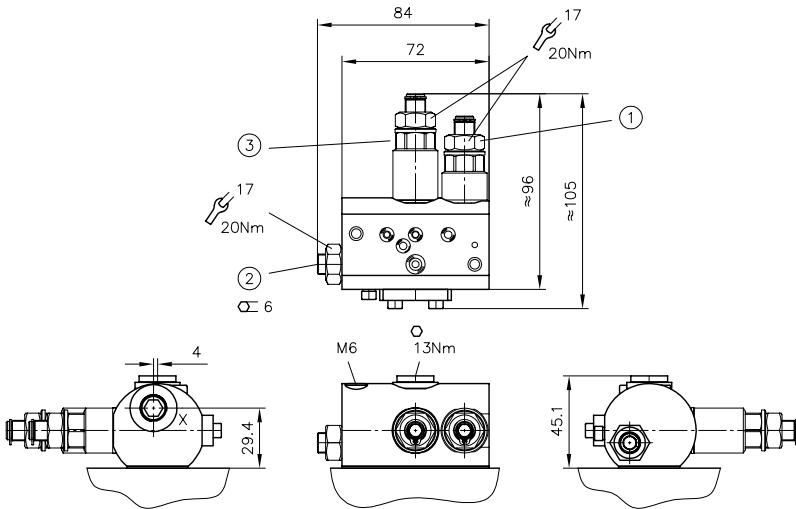
Rotation direction anti-clockwise

A = suction port

B = pressure connection

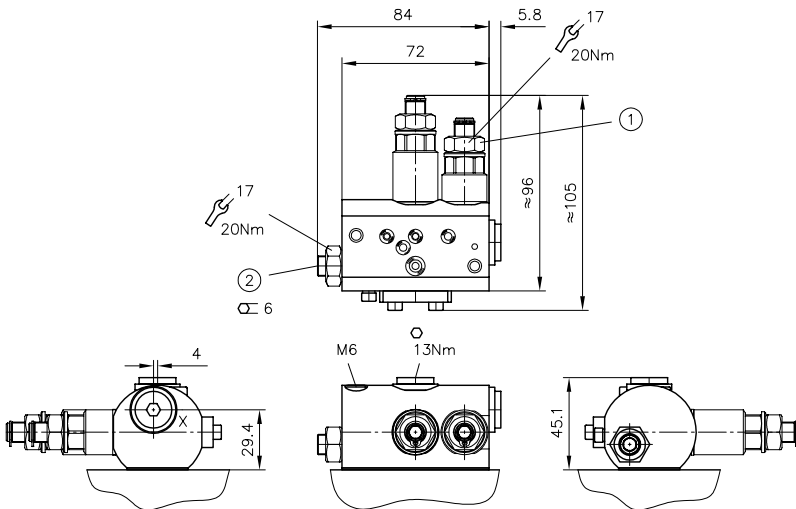
4.2 Controllers and intermediate plates

Coding **LSNR, LSNRT**



- 1 Pressure limitation
- 2 Dynamic throttle
- 3 Differential pressure Δp (stand-by pressure) (only coding LSNR and LSNRT)

Coding **NR**



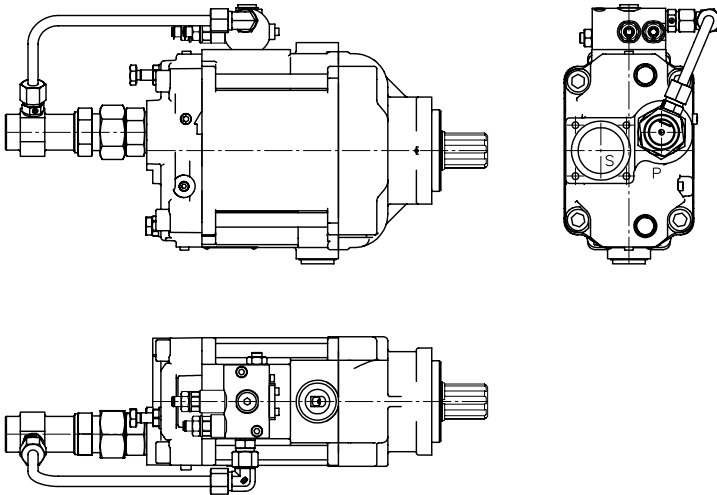
- 1 Pressure limitation
- 2 Dynamic throttle

Connection X: G 1/4 (BSPP)

LS signal port order coding for adapter for UNF thread 79 93245 00

Adjustment range for ① and ③ restricted by retaining ring

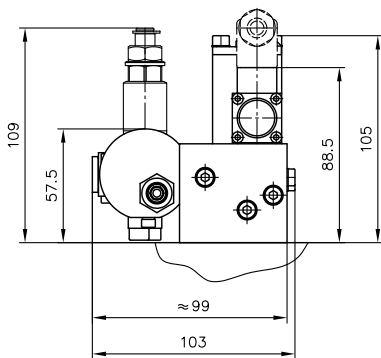
Coding **QNR**



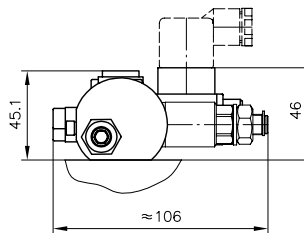
Note

The piping varies depending on the size and direction of rotation.

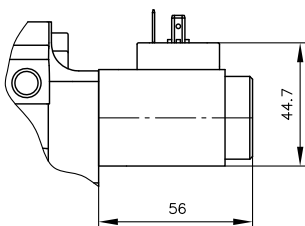
Coding **PR**



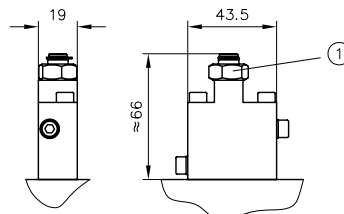
Coding **P1R**



Coding **V, V1**



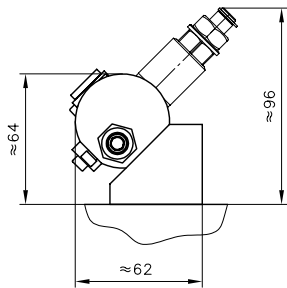
Coding **L** (only for type V60N-130)



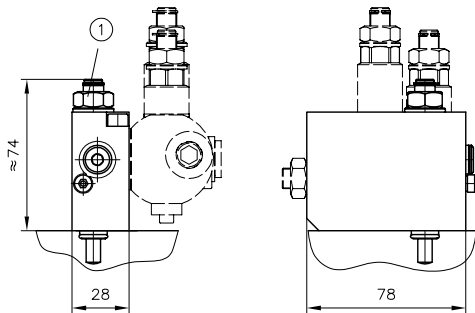
1 Torque setting

Intermediate plates

Version with thru-shaft, coding **ZW**

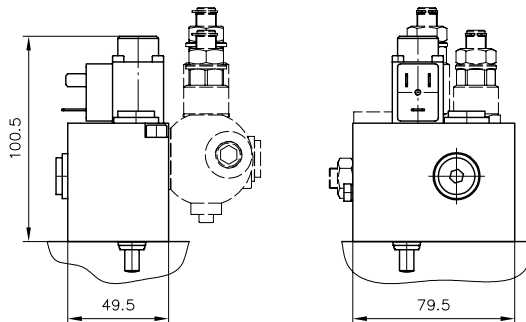


Coding **ZL**
Intermediate plate version



1 Torque setting

Coding **ZV, ZV1**



Pressure adjustment

	Pressure range (bar)	Δp (bar) / revolution	Factory-set pressure setting (bar)
Pressure limitation	20 to 400	approx. 50	300
Differential pressure Δp (only type LSNR and LSNRT)	20 to 55	approx. 10	27
Differential pressure Δp (only type QNR)	20 to 55	approx. 10	20

Torque setting

	ΔM (Nm) / revolution	Factory-set torque setting (Nm)
Power controller ZL	approx. 190	200
Power controller L	approx. 190	700



Caution

Risk of injury on overloading components due to incorrect pressure settings!

Risk of minor injury.

- Always monitor the pressure gauge when setting and changing the pressure.

5 Assembly, operation and maintenance recommendations

5.1 Intended application

This product is intended exclusively for hydraulic applications (fluid engineering). The product meets high technical safety standards and regulations for fluid and electrical engineering.

The user must observe the safety measures and warnings in this documentation.

Essential requirements for the product to function correctly and safely:

- All information in this documentation must be observed. This applies in particular to all safety measures and warnings.
- The product must only be assembled and put into operation by qualified personnel.
- The product must only be operated within the specified technical parameters. The technical parameters are described in detail in this documentation.
- The operating and maintenance manual of the specific complete system must also always be observed.

If the product can no longer be operated safely:

Remove the product from operation and mark it accordingly. It is then not permitted to continue using or operating the product.

5.2 Assembly information

The hydraulic system must only be installed in the complete system with standard connection components that comply with market requirements (screw fittings, hoses, pipes, etc.).

The hydraulic system must be shut down correctly prior to dismantling; this applies in particular to hydraulic systems with hydraulic accumulators.



Danger

Risk to life caused by sudden movement of the hydraulic drives when dismantled incorrectly!

Risk of serious injury or death.

- Depressurise the hydraulic system.
- Perform safety measures in preparation for maintenance.

5.2.1 General information

The V60N variable displacement axial piston pump is designed for use in an open circuit.

It can be mounted directly on a truck power take-off (PTO) using a flange in accordance with ISO 7653-1985 or using a flange in accordance with specifications. It is possible to attach a support on the pump flange to reduce the weight torque (not for type V60N-060). The positioning of the bore can be found in [Chapter 4, "Dimensions"](#).

Further connection options are available with a cardan shaft and suitable coupling sleeves (see [Chapter 6.1, "Accessories, spare parts and separate components"](#))

A change of rotating direction is available for types V60N-060, V60N-090 and V60N-110 variable displacement axial piston pumps. For conversion instructions, please contact HAWE Hydraulik SE.

During assembly, note the following principles:

Only trained persons are allowed to mount or remove the pump. Always ensure absolute cleanliness so that no contamination can influence the pump.

- Remove all plastic plugs before operation.
- Avoid installation above the tank (see installation positions in [Chapter 5.2.3, "Installation positions"](#)).
- For electric reference values [Chapter 6.1, "Accessories, spare parts and separate components"](#) "Suction intakes" must be adhered to.
- Before initial use, fill the pump with hydraulic fluid and bleed. The pump automatically fills via the suction line when the drain ports are opened.
- Never drain the pump.
- Always supply the pump with hydraulic fluid from the start. Even just a short period with insufficient hydraulic fluid can damage the pump. Such damage is not immediately visible once the pump is put into operation.
- Hydraulic fluid which flows back into the tank must not be sucked back in immediately (install baffles!).
- Before first use, run the pump for approx. 10 minutes at max. 50 bar after initial start-up.
- Only use the entire pressure range of the pump once thorough bleeding and flushing have taken place.
- From the start, always keep the temperature in the specified range (see [Chapter 3, "Parameters"](#)). Never exceed maximum temperatures.
- Always comply with the cleanliness level of the hydraulic fluid. In addition, always filter the hydraulic fluid appropriately (see [Chapter 3, "Parameters"](#)).
- Self-installed filters in the suction line must be approved beforehand by HAWE Hydraulik SE.
- A system pressure-limiting valve must be installed in the pressure line so that the maximum system pressure is not exceeded.

5.2.2 Ports

The nominal diameter of the connecting lines depends on the specified operating conditions, the viscosity of the hydraulic fluid, the start-up and operating temperatures and the rotation speed of the pump. In principle we recommend the use of hose lines due to the superior damping characteristics.

Pressure port

The pressure port connection on type V60N-060 is established via a threaded connection G 3/4" (BSPP); on type V60N-090/110/130 via a threaded connection G 1" (BSPP).

Observe the tightening torque specified by the fitting manufacturer.

Suction port

The suction port on all pumps is established via standardised suction intakes with a size that is dependent on the max. delivery flow of the pump.

The specifications of the max. delivery flow Q_{max} must be observed. These can be found in the following table.

Nominal width (N)	38 (1 1/2")	42	50 (2")	64 (2 1/2")	74 (3")	6 (G 1 1/4)	7 (G 1 1/2)
Q_{max} (lpm)	75	90	125	190	250	90	125

The suction intakes can be ordered as an option with the pump.

If possible, route the suction line to the tank in such a way that it is steadily rising. This allows trapped air to escape. Observe the specifications in "Installation positions" [Chapter 5, "Assembly, operation and maintenance recommendations"](#). The absolute suction pressure must not fall below 0.85 bar. A hose line should generally be used in preference to a rigid pipe.

Drain port

The V60N pumps have 2 drain ports G 3/4" (BSPP) or 1 1/16-12-UN-2B. A G 1/8" (BSPP) threaded connection is also available for the flange version SAE-B2, SAE-B4 and SAE-4. This is used for bleeding in the case of vertical installation positions.

The nominal diameter of the leakage line must not be less than 16 mm. The cross-section is determined by the max. permissible housing pressure.

Integrate the leakage line in the system in such a way as to prevent direct connection with the suction line of the pump. Both drain ports can be used simultaneously.

A separate leakage line from the controller to the tank is not required. Observe the specifications in [Chapter 5.2.3, "Installation positions"](#).

LS port for versions LSNR, LSNRT

The LS line is connected to the controller via a G 1/4" (BSPP) threaded connection.

The nominal diameter of the line depends on the installation position of the pump and should be 10% of the pressure line nominal volume. A hose line should generally be used in preference to a rigid pipe.

- When the proportional directional spool valve is in a neutral position, the LS line must be fully relieved (only controller type LSNR, LSN). In the case of controller type LSNRT, relief takes place internally in the controller.

5.2.3 Installation positions

The variable displacement axial piston pump V60N can be installed in any installation position.

Observe the truck manufacturer's specifications if installing the pump directly on a PTO (power take-off)

A support is required for tandem pumps or two hydraulic pumps mounted in series. The following points must be observed:

Horizontal installation: (pump below the min. fill level)

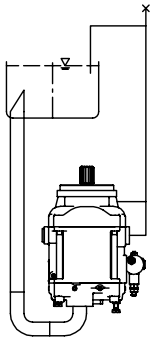
⇒ For horizontal installation, use the uppermost drain port



Vertical installation: (pump below the min. fill level)

- ⇒ Mount the pump so that the pump mounting flange is facing upwards
- ⇒ For vertical installation, use the uppermost drain port
- ⇒ Also connect the G 1/8" bleeding port on the pump flange.
- ⇒ Take appropriate measures to ensure continuous bleeding of this line (line routing/bleeding)

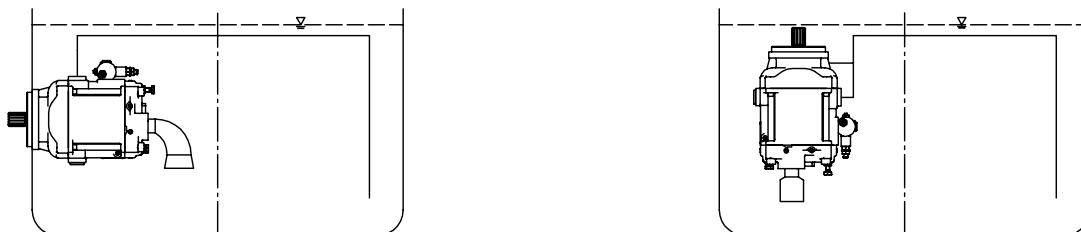
For installation with the pump flange facing downwards, please contact HAWE Hydraulik.



5.2.4 Tank installation

Tank installation (pump below the min. fill level)

The pump can be operated either with or without a suction tube. Using a short suction intake is recommended.



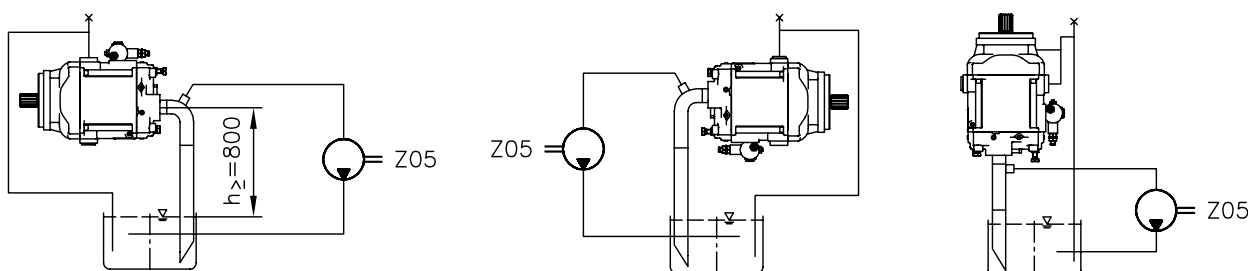
Additional notes regarding installation above the fill level

Special measures are required if the pump is installed above the fill level. The pump must not run dry via the pressure, intake, drain, bleed or control lines. This applies in particular to long periods of downtime.

- The leakage line must be installed in the tank in such a way that it ends below the oil level.
- Facilitate bleeding of connecting lines via separate bleed openings.
- Adjust the bleeding sequence to the specific installation.
- If necessary, a gear pump should be provided in order to draw air from the suction line.

For specialist advice on designing axial piston pumps, the following contact form is available:

[Checklist for designing variable displacement axial piston pumps: B 7960 checklist.](#)



For further information on installation, operation and maintenance, see the relevant assembly instructions:

[B 7960](#), [B 5488](#).

5.3 Operating instructions

Product, pressure and/or flow settings

All statements in this documentation must be observed for all product, pressure and/or flow settings on or in the hydraulic system.



Caution

Risk of injury on overloading components due to incorrect pressure settings!

Risk of minor injury.

- Always monitor the pressure gauge when setting and changing the pressure.

Filtering and purity of the hydraulic fluid

Soiling in the fine range, e.g. abraded material and dust, or in the macro range, e.g. chips, rubber particles from hoses and seals, can cause significant malfunctions in a hydraulic system. It is also to be noted that new hydraulic fluid "from the drum" does not necessarily meet the highest purity requirements.

Pay attention to the purity of the hydraulic fluid in order to maintain faultless operation (also see cleanliness level in [Chapter 3, "Parameters"](#)).

For further information on installation, operation and maintenance, see the relevant assembly instructions: [B 7960](#), [B 5488](#).

6 Other information

6.1 Accessories, spare parts and separate components

6.1.1 Suction intakes

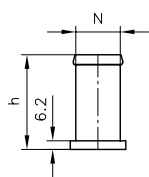
Order coding example:

V60N - 090 R DZ N - 1 - 0 - 01/LSNR - 350 - A00/76

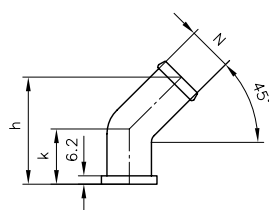
Table of suction intakes (including attachment kit)

Nominal width (N)	Flow rate Q_{max} (lpm)	Geometric shape									
		Straight		45°		90°		Thread A.	Order number		
		Order number	Order number		Order number						
		A00/.. h	h	k	A90/.. h	k	h				
38 (1 1/2")	75	65	79 93336 00	-	-	-	53	70	79 93344 00	-	-
42	90	-	-	85	40	79 93340 00	-	-	-	-	-
50 (2")	125	65	79 93337 00	96	40	79 93341 00	53	84	79 93345 00	-	-
64 (2 1/2")	190	90	79 93338 00	96	40	79 93342 00	109	129	79 93346 00	-	-
76 (3")	250	106	79 93339 00	106	40	79 93343 00	-	-	-	-	-
7 (1 1/2")	125	-	-	-	-	-	-	-	-	28.5	79 40717 00
7 UNF (7/8-12 UN-2B)	125	-	-	-	-	-	-	-	-	28.5	79 41595 00

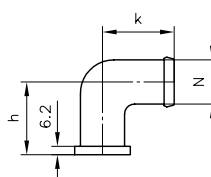
A00/...



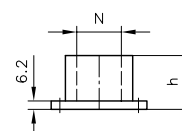
45/...



A90/...



A6
A7



For pump orders, delivery includes the attachment kit for suction intakes, comprising:

- 4x hex bolt M8x16-8.8
- Sealing ring 44.2x3 NBR 70 Sh
- 2 mounting flange halves

(Order no. 79 93355 00)



Note

Use nominal width 38 (1 1/2") for reduced displacement volume only!

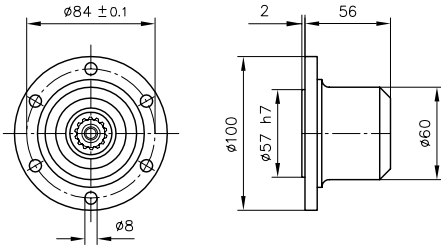
Observe installation information in [Chapter 5, "Assembly, operation and maintenance recommendations"](#).

6.1.2 Coupling flange for cardan shafts

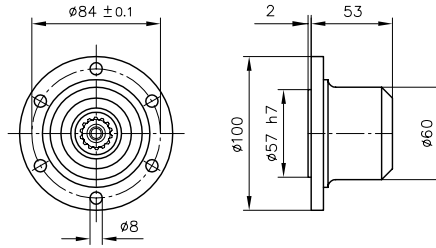
Special coupling flanges for cardan shaft ($\varnothing 100$ -6- $\varnothing 8$) according to ISO 7646.

For telescopic cardan shafts also with spacer ring and connecting screw for attachment to the drive shaft of the pump.

Coding SAE-C, SAE-CS



Coding DIN ISO 014

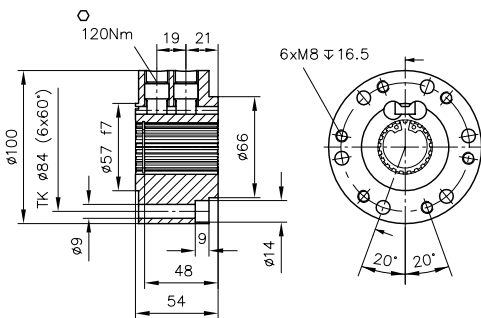


Coding	Spline profile	Order number
SAE C	14T 12/24 DP	79 29555 00
SAE CS	21T 16/32 DP	79 42793 00
DIN ISO 14	B8x32x36	79 29709 00

Special clampable coupling flanges for cardan shafts ($\varnothing 100$ -6- $\varnothing 8$) according to ISO 7646.

Coding	Spline profile	Order number
SAE-C	14T 12/24 DP	79 94495 00
SAE-CS	21T 16/32 DP	79 94479 00
DIN ISO 14	B8x32x36	79 94496 00

Coding SAE-C, SAE-CS, DIN ISO 014



6.2 Planning information

Determination of nominal sizes

Delivery flow	$Q = \frac{V_g \cdot n \cdot \eta_v}{1000} \text{ (l/min)}$	V_g	= Geom. output volume (cm ³ /rev.)
Drive torque	$M = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_{mh}} \text{ (Nm)}$	Δp	= Differential pressure
Drive power	$P = \frac{2\pi \cdot M \cdot n}{60000} = \frac{Q \cdot \Delta p}{600 \cdot \eta_t} \text{ (kW)}$	n	= Rotation speed (rpm)
		η_v	= Volumetric efficiency
		η_{mh}	= Mechanical-hydraulic efficiency
		η_t	= Overall efficiency ($\eta_t = \eta_v \cdot \eta_{mh}$)

Further information

Additional versions

- General operating manual for the assembly, initial operation and maintenance of hydraulic components and systems: B 5488
- Variable displacement axial piston pump type V30D: D 7960
- Variable displacement axial piston pump type V30E: D 7960 E
- Fixed displacement axial piston pump type K60N: D 7960 K
- Axial piston motors type M60N: D 7960 M
- Proportional directional spool valve, type PSL and PSV size 2: D 7700-2
- Proportional directional spool valve, type PSL, PSM and PSV size 3: D 7700-3
- Proportional directional spool valve, type PSL, PSM and PSV size 5: D 7700-5
- Proportional directional spool valve type PSLF, PSVF and SLF size 3: D 7700-3F
- Proportional directional spool valve type PSLF, PSVF and SLF size 5: D 7700-5F
- Proportional directional spool valve banks type PSLF and PSVF size 7: D 7700-7F
- Load-holding valve type LHT: D 7918
- Load-holding valve type LHDV: D 7770
- Proportional amplifier type EV1M3: D 7831/2
- Proportional amplifier type EV1D: D 7831 D
- Proportional amplifier type EV2S-CAN: D 7818/1