Axial Piston Variable Pump
HP3VO Series 01

Size：40/45/63/72/85 mL/r
Rated pressure：28 MPa
Max. pressure：32 MPa

Features

- Axial variable pump of swashplate design for hydrostatic drives in open circuits
- The flow is proportional to the drive speed and displacement and is infinitely varied
- The drive shaft allows axial and radial loading Various control options to satisfy different operating requirements
- High power to weight ratio
- Excellent suction characteristics
- Diverse control options, short control response time
- Compact structure, small size, low noise

Contents

Model Code

	b	c	A	B		I	J	K		M	N	P	R	S	X		Z
HP3V		O			/	0 1			-							-	

Axial piston unit

—	Swashplate design, variable piston pump	HP3V

Pressure rating

		40	45	63	72	85	
b	Conventional (without code)	●	●	●	●	●	
	Rated pressure: 21 MPa Max. pressure: 25 MPa	○	○	●	○	○	N

Operation

c	Open circuit	O

Displacement

		40	45	63	72	85	
A	Geometric displacement, in mL/r						

Variable control method

							40	45	63	72	85	
B	Pressure control						●	●	●	●	●	DR
		load sensitive control		X-T open			●	●	●	●	●	DRF
				X-T plugged	with flushing		●	●	●	●	●	DRS
					without flushing		○	○	○	○	○	DRSC
		remote control					●	●	●	●	●	DRG
	Power control With pressure cut-off			Beginning of control	10-35bar		●	●	●	●	—	LA5D
					36-70bar		●	●	●	●	—	LA6D
					71-105bar		●	●	●	●	—	LA7D
					106-140bar		●	●	●	●	●	LA8D
					141-230bar		●	●	●	●	●	LA9D
		remote control		Beginning of control	see LA.D		○	○	●	●	●	LA.DG
		load sensitive X-T plugged			see LA.D		●	●	●	●	●	LA.DS
			negative control	U=12V	see LA.D		○	○	●	●	○	LE1.DS
				U=24V	see LA.D		○	○	●	●	●	LE2.DS
	Electro proportional displacement control	pressure cut-off		positive control	U=12V		○	○	○	○	○	EP1D
					U=24V		○	○	○	○	○	EP2D

Model Code

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HP3V		O			/	01			-							-	

Series

I	Series 01	01

Oil port type

		40	45	63	72	85	
J	UN/UNF,O-ring seal,with standards SAE J1926-1	●	●	●	●	●	S
	BSPP,O-ring seal,with standards JIS B2351-1G	●	●	●	●	●	G
	Metric,ED seal,with standards ISO 9974-1	●	●	●	●	○	I

Direction of rotation (viewed on drive shaft)

		40	45	63	72	85	
K	CW	●	●	●	●	●	R
	CCW	●	●	●	●	●	L

Sealing material

		40	45	63	72	85	
M	NBR seal + FKM shaft seal	○	○	●	●	○	N
	NBR seal	○	○	●	●	●	P
	FKM shaft	●	●	●	●	○	V

Drive shaft

		40	45	63	72	85	
N	Splined shaft ANSI B92.1a						
	7/8" 13T 16/32DP	●	●	●[1]	—	—	S1
	1" 15T 16/32DP	●	●	●	●	—	S2
	1 1/4" 14T 12/24DP	—	—	●	●	●	S3
	1 1/2" 17T 12/24DP	—	—	—	—	○	S4

Mounting flange

		40	45	63	72	85	
P	SAE J744-2 hole	●	●	●	●	●	C
	SAE J744-2 hole(second series)	○	○	●	●	○	C2
	SAE J744-4 hole	○	○	○	○	●	D

Working ports

				40	45	63	72	85	
R	SAE port flange, metric fastening thread	rear	not used for through drive	●	●	●[2]	○	○	11
		side	used for through drive	●	●	●	●	●	12
		side, 90 ° offset	not used for through drive,for CCW	○	○	○	○	○	13
	SAE port flange, UNC fastening thread	side	used for through drive	○	○	○	○	●	62

1): 63cc for "HP3VNO".
2): 63cc for "HP3VNO".

Model Code

	b	c	A	B		I	J	K		M	N	P	R	S	X		Z
HP3V		O			/	01			-							-	

Through drive

S	UNC flange SAE J744	Splined shaft for ANSI B92.1	40	45	63	72	85	
	Without through drive		●	●	●	●	●	N00
	82-2(A)	5/8″ 9T 16/32DP	●	●	●	●	●	K01
		3/4″ 11T 16/32DP	○	○	○	○	○	K52
	101-2(B)	7/8″ 13T 16/32DP	○	○	○	○	●	K68
		1″ 15T 16/32DP	○	○	○	○	○	K04
	127-4(C)	1 1/4″ 14T 12/24DP	○	○	○	○	●	K15
		1 1/2″ 17T 12/24DP	○	○	○	○	○	K16
	127-2(C)	1 1/4″ 14T 12/24DP	○	○	○	○	●	K07
		1 1/2″ 17T 12/24DP	○	○	○	○	○	K24

Solenoid connector

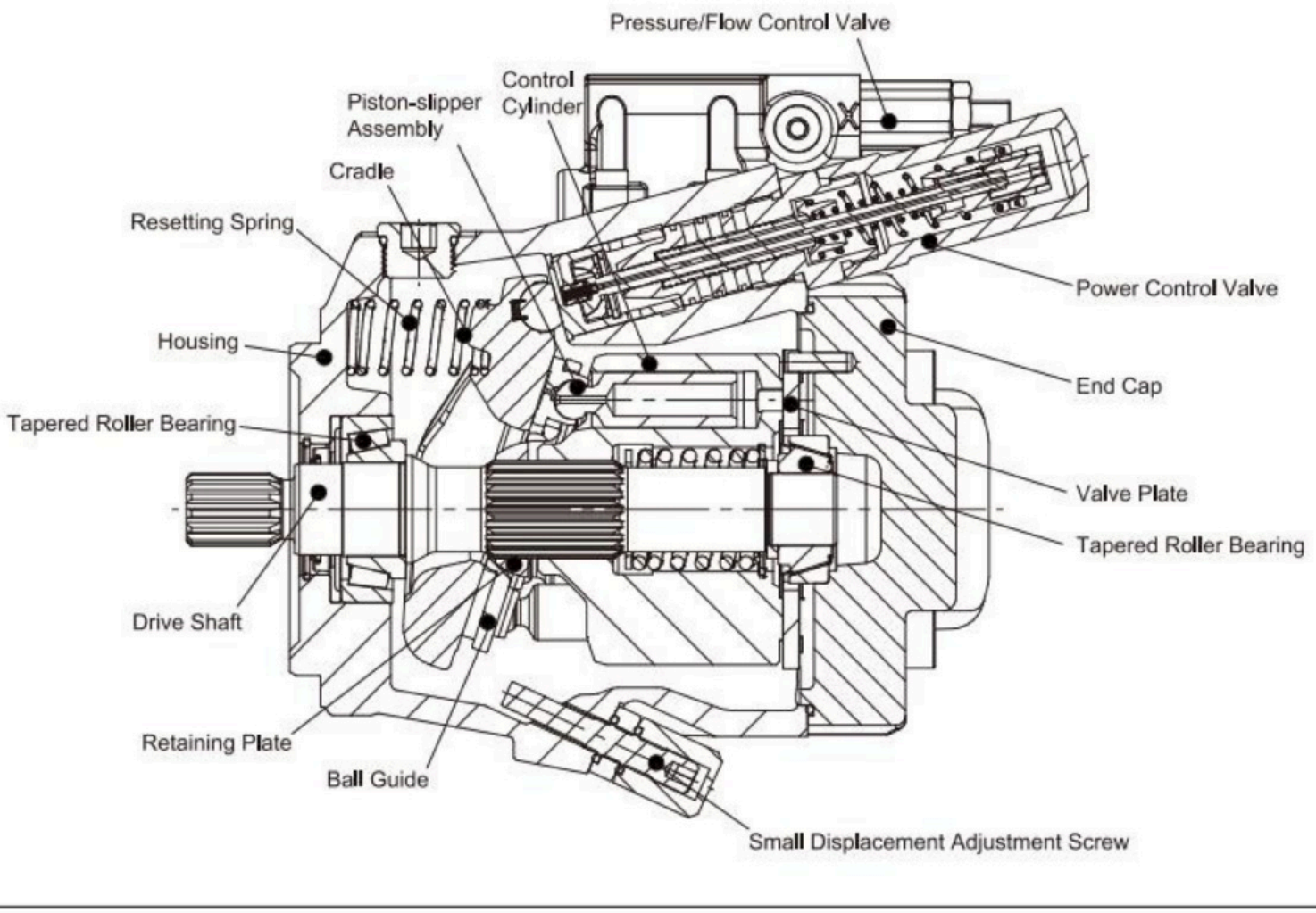
		40	45	63	72	85	
X	Without connector (without solenoid, only for hydraulic control(without code)	●	●	●	●	●	
	DEUTSCH DT04-2P, 2-pin plastic connector, without diode suppressor (electric control)	○	○	●	●	○	P
	AMP 17454-2, 2-pin plastic connector	○	○	●	●	○	A

Special configuration

		40	45	63	72	85	
Z	Without special configuration (without code)	●	●	●	●	●	
	Special configuration	○	○	○	○	○	***

● Available ○ On request — Not available ▭ Recommended model

Structure


Pressure/Flow Control Valve
Control Cylinder
Piston-slipper Assembly
Cradle
Resetting Spring
Power Control Valve
Housing
End Cap
Tapered Roller Bearing
Valve Plate
Tapered Roller Bearing
Drive Shaft
Retaining Plate
Ball Guide
Small Displacement Adjustment Screw

Hydraulic Fluid

Mineral oil

Working Viscosity

In order for the optimum efficiency and service life, it is recommended to select the working viscosity at working temperature within the range below:

V_{opt} = optimal working viscosity 16...36 mm^2/s

It is subject to the reservoir temperature of an open circuit.

Limit Viscosity

Limit viscosity:

V_{min}=10mm^2/s

Short-term operation, at permissible maximum leakage temperature of 90 ˚C

V_{max}=1000mm^2/s

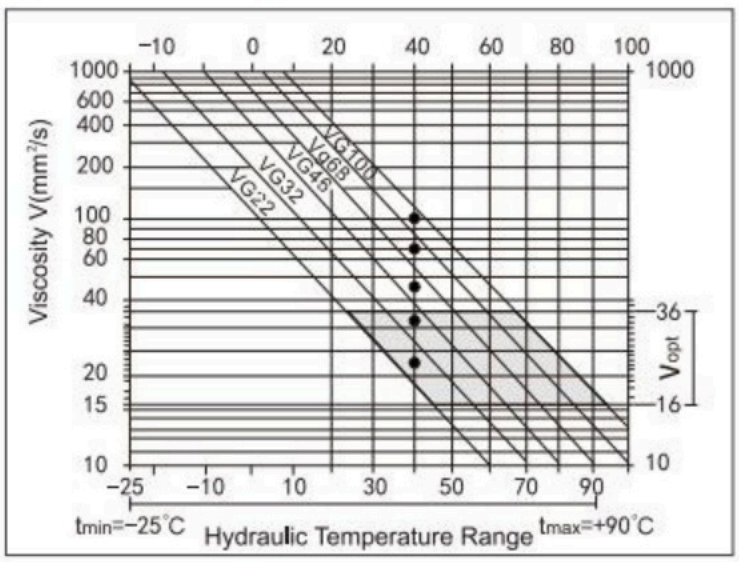
Short-term operation, cold star

Temperature Range

t_{min}=-25˚C

t_{max}=90˚C

Selection Diagram



Instructions on Selection of Hydraulic Fluid

The working temperature dependent on the ambient temperature is required for correct selection of hydraulic fluid. It refers to the circuit temperature of a closed circuit and the reservoir temperature of an open circuit.

The hydraulic fluid should be so selected that the working viscosity in the working range is within the optimum range (V_{opt} ,the shaded area on the selection diagram). The higher viscosity is recommended under the same conditions.

For example:

At an ambient temperature of X ˚C, the working temperature of the circuit is 60 ˚C. The viscosity within the optimum range (V_{opt},shaded area) is VG46 or VG68 and the latter should be selected.

Note:

The case drain temperature depends on the pressure and speed, and it is always higher than the circuit temperature. The temperature at any point within the system should not exceed +115 ˚C. Please contact us if the above condition cannot be maintained due to extreme working conditions.

Filtration

Finer filtration improves the cleanliness level of the hydraulic fluid, thus increasing the service life of the axial piston unit. To ensure normal operation of the axial piston unit, a cleanliness level of at least 20/18/15 according to ISO 4406 is to be maintained.

When the hydraulic fluid has a high temperature (+90 ˚C to +115 ˚C), the cleanliness level should at least reach 19/17/14 according to ISO 4406.

Please contact us if the above cleanliness level cannot be maintained.

Working Pressure Range

Input

Absolute pressure at port S

$p_{abs\ min}$ ____ 0.8bar

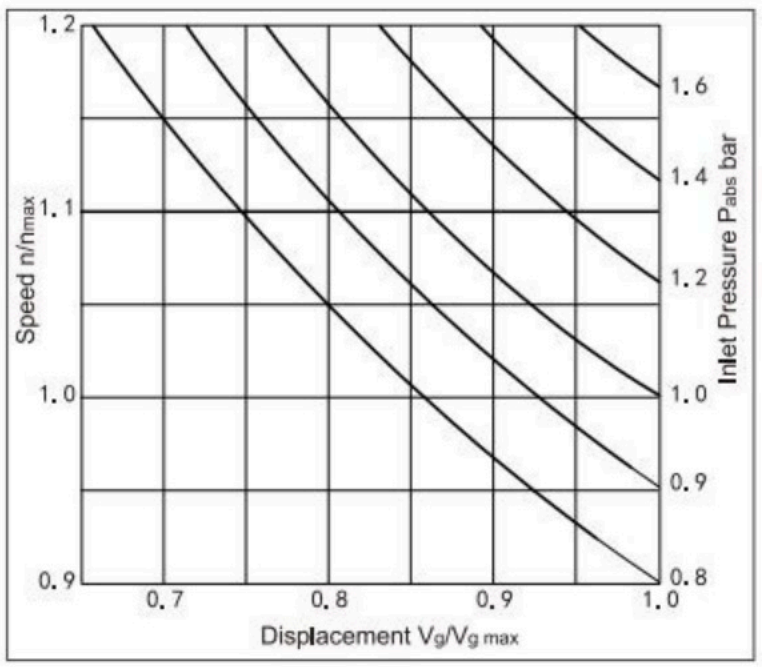
$p_{abs\ max}$ ____ 5bar

Output

Absolute pressure at port B

p_{nom} ____ 280bar

p_{max} ____ 320bar



Case Drain Pressure

Maximum permissible pressure at drain port（L1、L2、L3）

Maximum 0.5 bar higher than inlet pressure at port S

No higher than 2 bar absolute pressure

Flow Direction

From port S to B

Technical Data

Size				40	45	63	72	85
Displacement	Variable pump	$V_{g\,max}$	mL/r	40	45	63	72	85
Pressure	Rated pressure	P_{nom}	MPa	28	28	28	28	28
	Maximum pressure	P_{max}	MPa	32	32	32	32	32
Speed[1)]	$V_{g\,max}$	n_{nom}	rpm	2600	2600	2600	2600	2500
	$V_g < V_{g\,max}$	n_{max}	rpm	3120	3120	3140	3140	3000
Flow	n_{nom} and $V_{g\,max}$	q_v	L/min	104	117	163.8	187.2	212.5
Power	n_{nom} and $V_{g\,max}$, $\triangle p$=28MPa	n_{min}	KW	48.5	54.6	76.4	87.4	99.2
Torque	$V_{g\,max}$, $\triangle p$=28MPa	T_{max}	Nm	178	201	281	321	379
Case volume			L	0.5	0.5	0.8	0.8	1
Weight			KG	18	18	22	22	36
Hydraulic oil temperature range			℃	-25℃-110℃				
Hydraulic oil viscosity range			mm^2/s	16-36mm^2/S				

1) The above data is valid only when the inlet pressure at port S is 0.1 MPa absolute pressure.

Specification Calculation

Flow $q_v = \frac{V_g \cdot n \cdot \eta_v}{1000}$ [L/min]

Torque $T = \frac{V_g \cdot \Delta p}{2 \cdot \pi \cdot \eta_{mh}}$ [Nm]

Power $P = \frac{2\pi \cdot T \cdot n}{60000} = \frac{q_v \cdot \Delta p}{60 \cdot \eta_t}$ [KW]

V_g = Displacement,mL/r

Δp = Differential pressure,MPa

n = Speed,rpm

η_v = Volumetric efficiency

η_{mh} = Mechanical-hydraulic efficiency

η_t = Total efficiency

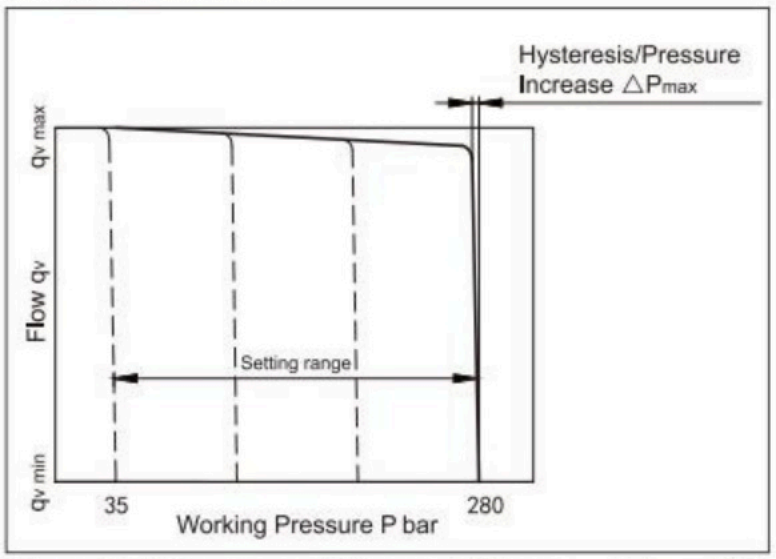
DR-Pressure Control

The pressure controller can maintain constant pressure of the hydraulic system within its control range despite changes in the flow. The variable pump only supplies as must hydraulic fluid as required by the actuator. If the working pressure exceeds the set point of the integrated pressure control valve, the pump will automatically swivel back until the pressure deviation is corrected.

Start position of depressurized state：$V_{g\,max}$

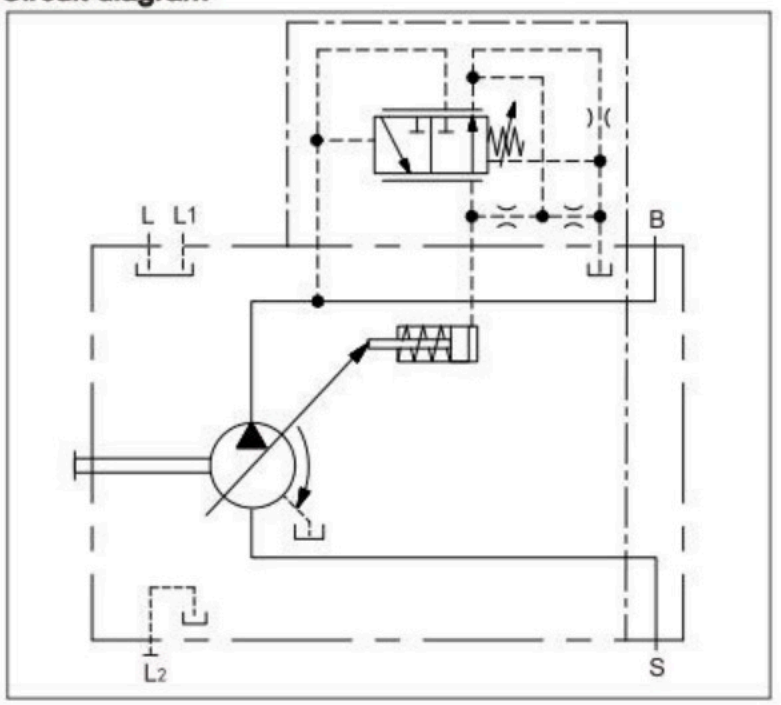
Setting range from 35-320bar(standard:280bar).

Characteristic Curve



Characteristic curve valid for n_1=1500rpm and t_{fluid}=50°C

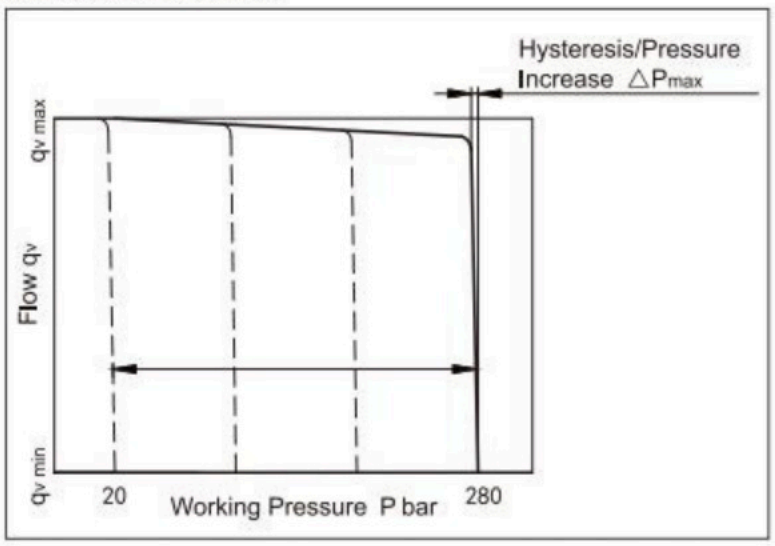
Circuit diagram



DRG-Remotely Pressure Control

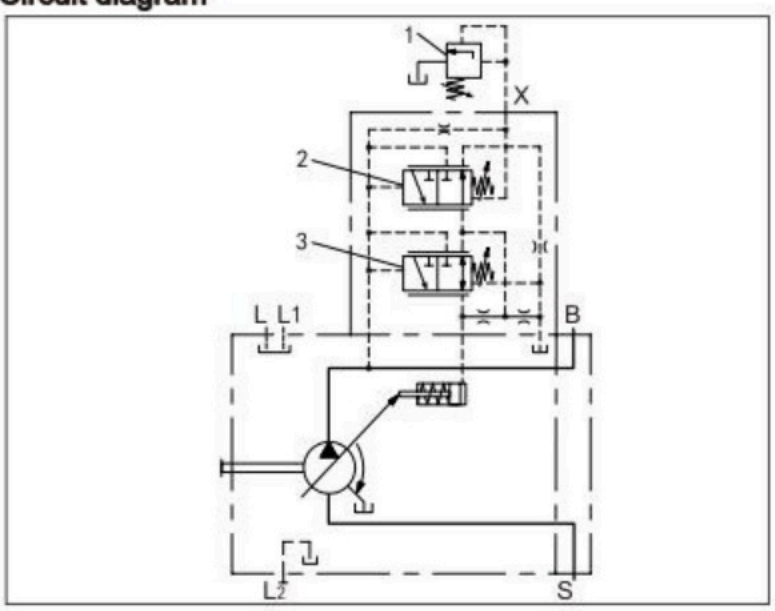
For the remote controlled pressure controller, the pressurelimitation is performed using a separately arrangedpressure relief valve.
any pressure control valueunder the pressure set on the pressure controller can beregulated.
A pressure relief valve is externally piped up to port X for remote control.
This relief valve is not included in the scope of delivery of the DRG control.
A differential pressure of 20bar Δp (standard setting) results in a control fluid quantity of approx. 1.5 l/min at port X.
If another setting is required (range from 14-22bar) please state in plain text.
Directly operated, hydraulically or electrically proportional, suitable for the control fluid quantity mentioned above.The maximum line length should not exceed 2m.
Basic position in depressurized state：$V_{g\,max}$
Setting range for pressure control 35-320bar(standard:280bar).
Setting range for differential pressure 14-22bar(standard:20bar).

Characteristic Curve



Characteristic curve valid for n_1=1500rpm and t_{fluid}=50°C

Circuit diagram



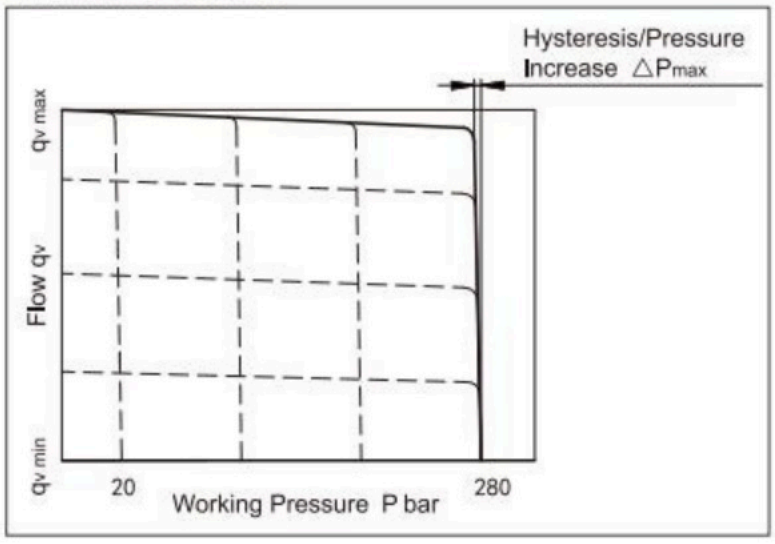
1.The separate pressure relief valve and the line are not included in the scope of delivery.
2.Remote controlled pressure cut-off (G)
3.Pressure controller (DR)
In order to prevent damage to the pump and the system,the permissible setting range must not be exceeded.The range of possible settings at the valve is higher.

DRF/DRS-Pressure Flow Control

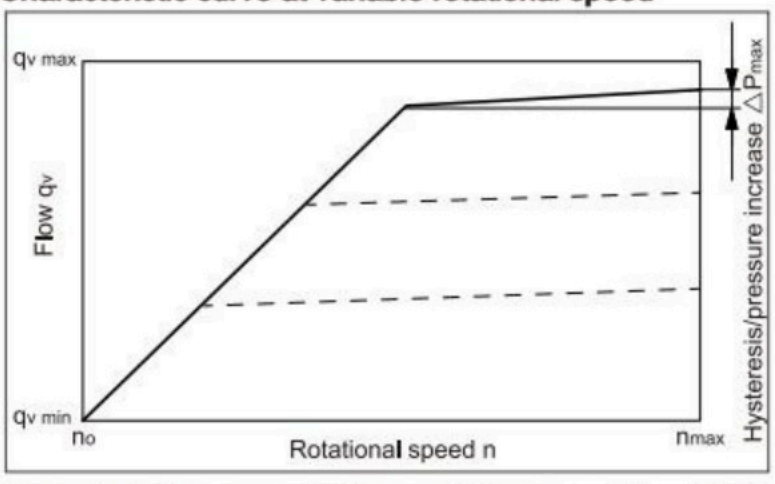
In addition to the pressure controller function, an adjustable orifice is used to adjust the differential pressure upstream and downstream of the orifice. This is used to control the pump flow. The pump flow is equal to the actual hydraulicfluid quantity required by the consumer. With all controller combinations, the V_g reduction has priority.
Basic position in depressurized state：$V_{g\,max}$

Setting range for pressure control 35-320bar(standard:280bar).

Characteristic Curve

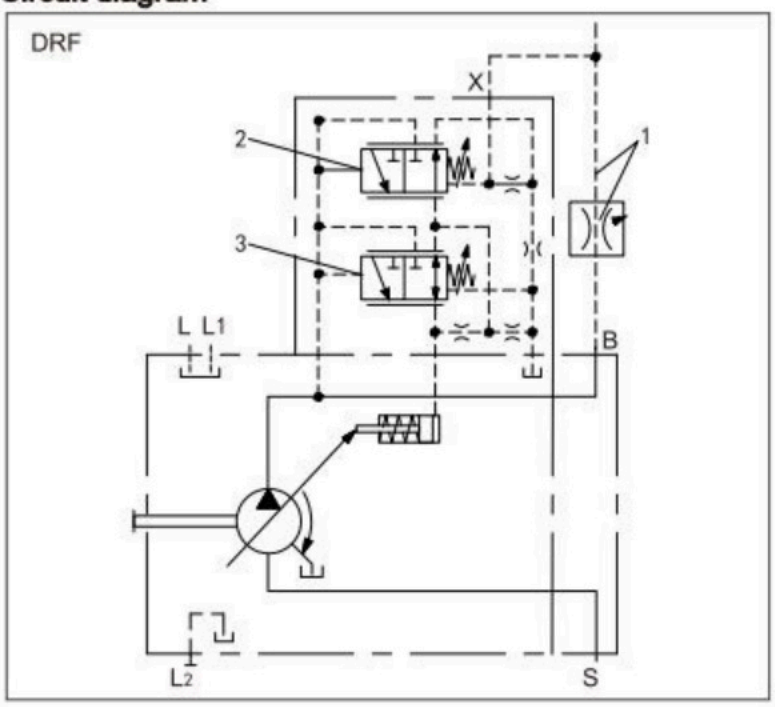


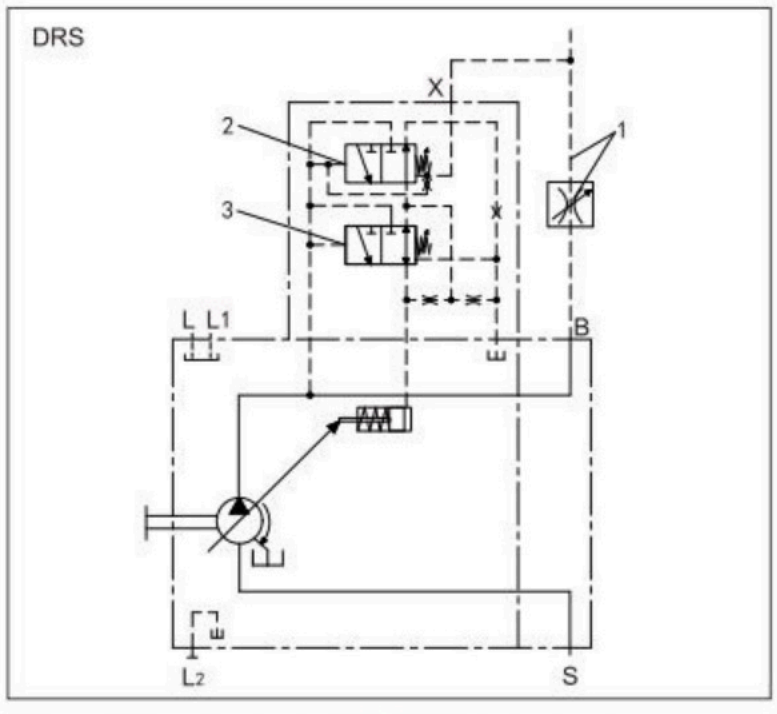
Characteristic curve at variable rotational speed



Characteristic curve valid for n_1=1500rpm and t_{fluid}=50°C

Circuit diagram





1.The metering orifice (control block) and the line is not included in the scope of delivery.
2.Pressure and Flow controller(FR)。
3.Pressure controller(DR)。

In order to prevent damage to the pump and the system,the permissible setting range must not be exceeded.The range of possible settings at the valve is higher.

Notice
The DRS version has no unloading between X and the reservoir. The LS must therefore be unloaded in the system. Because of the flushing function of the flow controller in the DRS control valve, sufficient unloading of the X line must also be ensured.

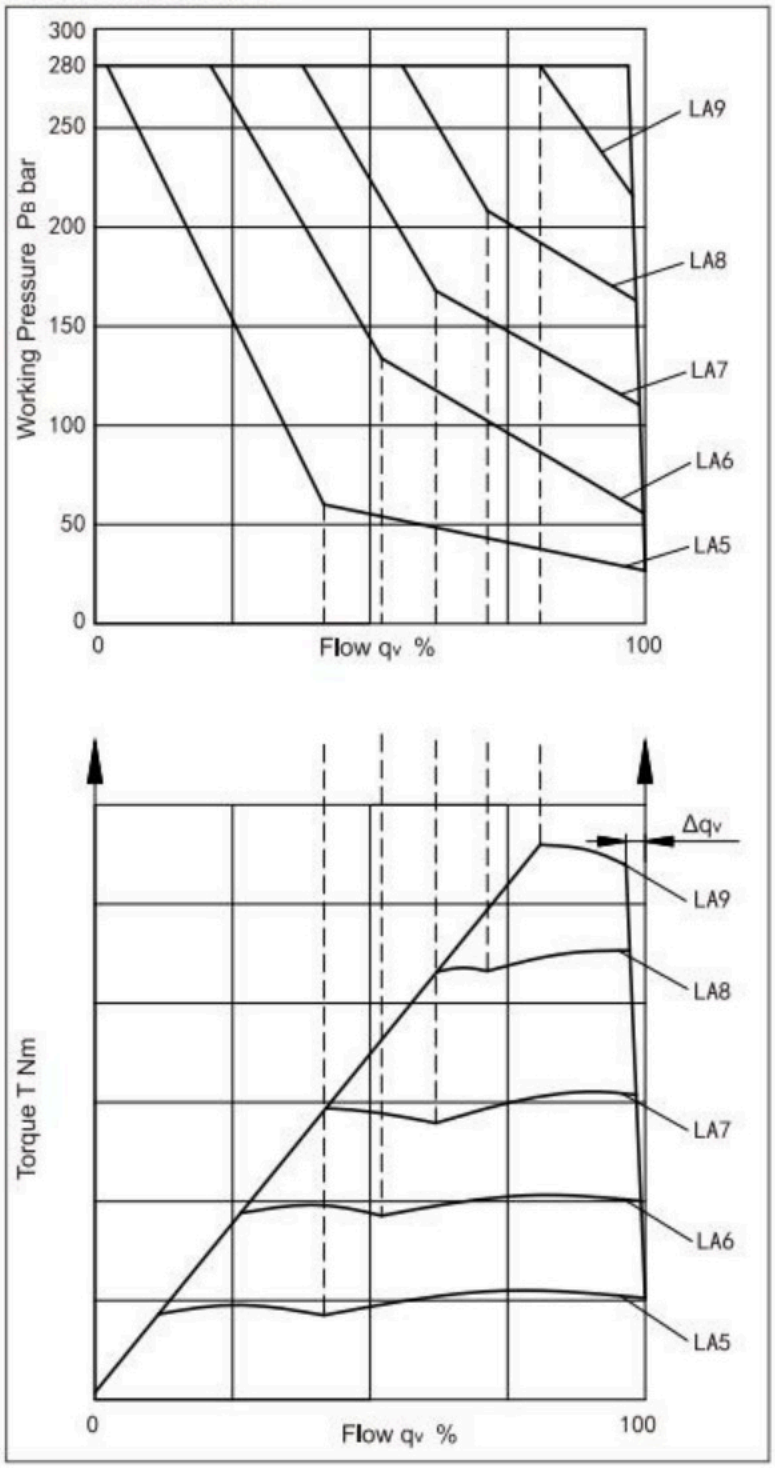
Differential pressure Δp
Standard setting：14bar，If another setting is required, please state in theplain text.
Setting range：14-22bar
Unloading port X to the reservoir results in a zero stroke pressure which is approx.1-2bar higher than the defined differential pressure Δp, in which system influences are not taken into account.

LA...-Power Control

In order to achieve a constant drive torque with varying working pressures, the swivel angle and also the output flow from the axial piston pump is varied so that the product of flow and pressure remains constant.
Flow control is possible below the power control curve.
When ordering please state the power characteristics.

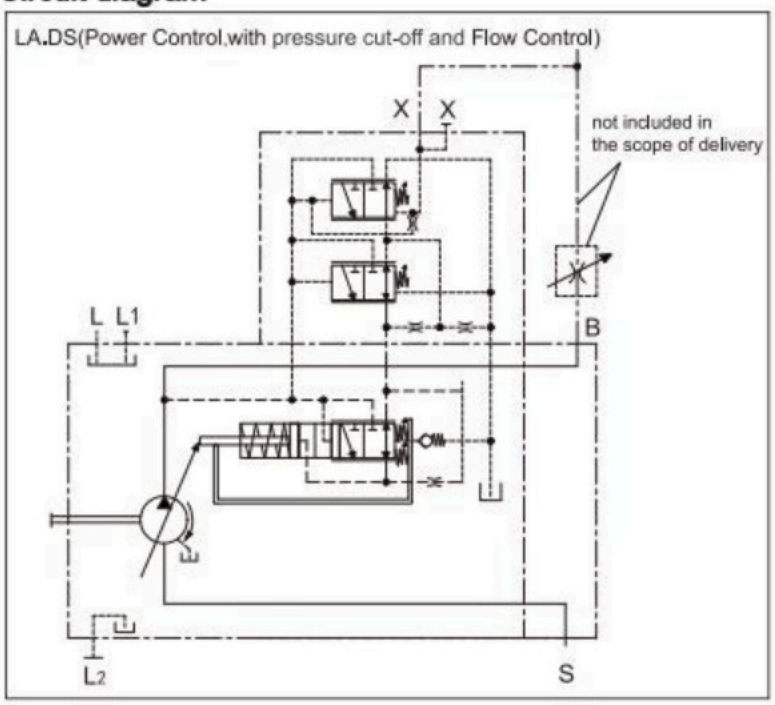
	Torque (Nm)					
Beginning of control	40	45	63	72	85	Type code
10–35bar	10–30	10–30	15–43	17–49.2	–	LA5
36–70bar	30.1–59	30.1–59	43.1–83	49.3–94.9	–	LA6
71–105bar	59.1–84	59.1–84	83.1–119	95–136	–	LA7
106–140bar	84.1–112	84.1–112	119.1–157	136.1–179.4	160.1–212	LA8
141–230bar	112.1–189	112.1–189	157.1–264	179.5–301.7	212.1–357	LA9

Characteristic Curve

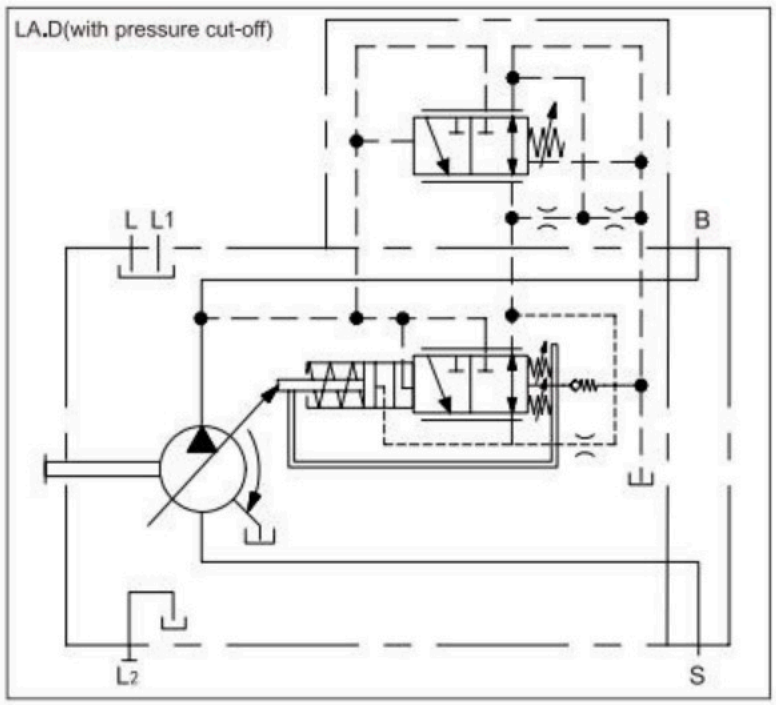


Circuit diagram

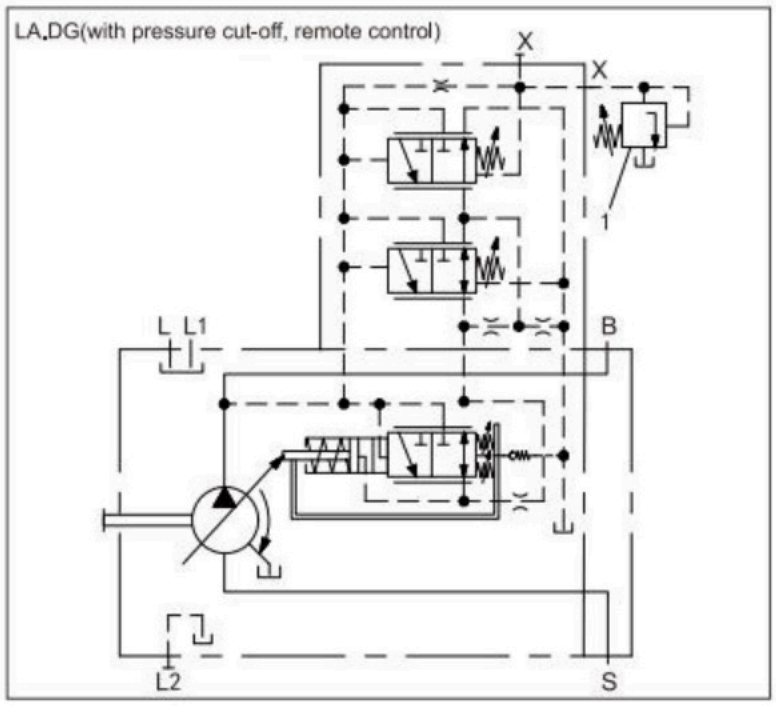
LA.DS(Power Control,with pressure cut-off and Flow Control)



LA.D(with pressure cut-off)



LA.DG(with pressure cut-off, remote control)



"1" The pressure relief valve is not included in the scope of delivery.

LE-Electro Proportional Power Control

Setting range for load sensitivity： 14-22bar(standard:14bar)

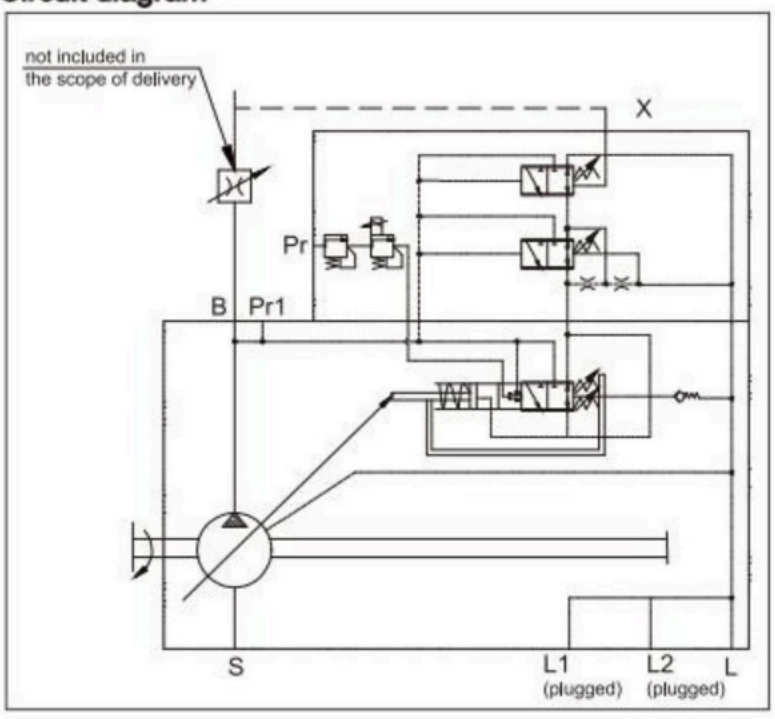
Setting range for pressure control： 35-320bar(standard:280bar)

Setting range for Pr port pressure： Connect the oil outlet, enter the pressure reducing valve for secondary pressure reduction.

Technical data, solenoids

Voltage(V)	Current limit(A)	Nominal resistance(Ω)	Insulation level
12	0.85	7.3±10%(20°C)	H(180°C)
24	0.75	21.2±10%	UP to IPK6/IPX9K

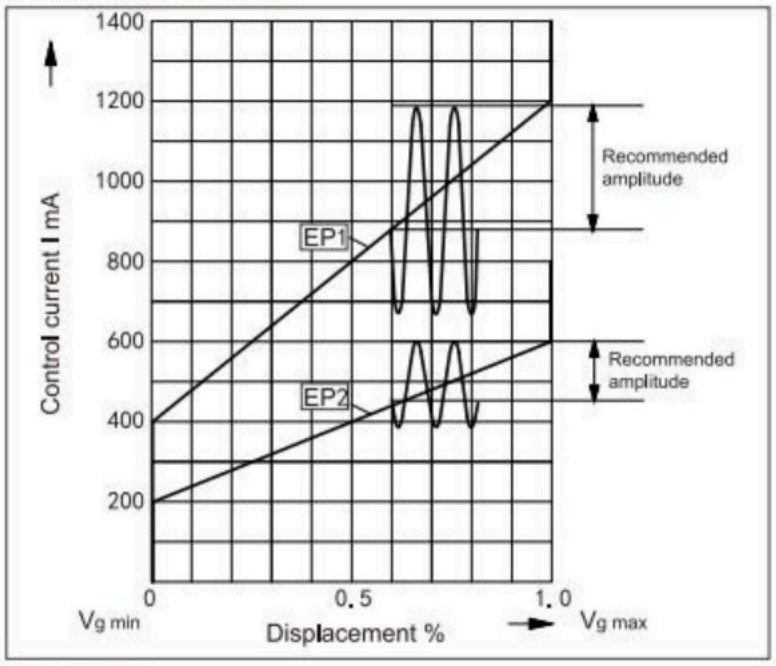
Circuit diagram



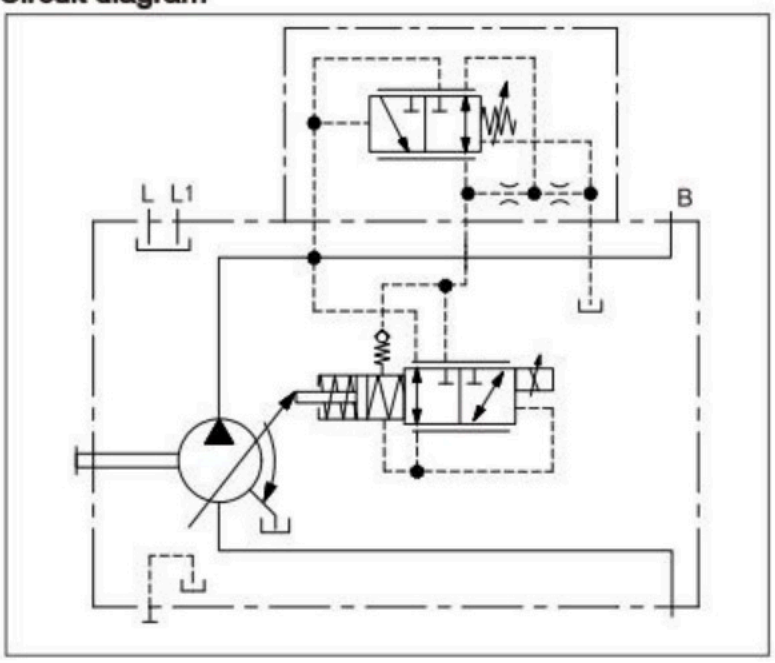
EP-Electro Proportional Displacement Control

Electro proportional control makes a continuous and reproducible setting of the pump displacement possible directly via the cradle.
The control force of the control piston is applied by a proportional solenoid.
The control is proportional to the current .
In a depressurized state, the pump is swiveled to its initial position ($V_{g\,max}$) by an adjusting spring.
If the working pressure exceeds a limit value of approx.14bar,the pump starts to swivel from $V_{g\,max}$ to Vg min without control by the solenoid (control current < start of control).
With a minimum swivel angle $V_{g\,min}$ and de-energized EP solenoids, a minimum pressure of 10bar must be maintained.
A PWM signal is used to control the solenoid.
EP.D： The pressure control regulates the pump displacement back to $V_{g\,min}$ after the pressure command value has been reached.
A minimum working pressure of 14bar is needed for safe and reproducible control. The required control fluid is taken from the high pressure.

Characteristic Curve



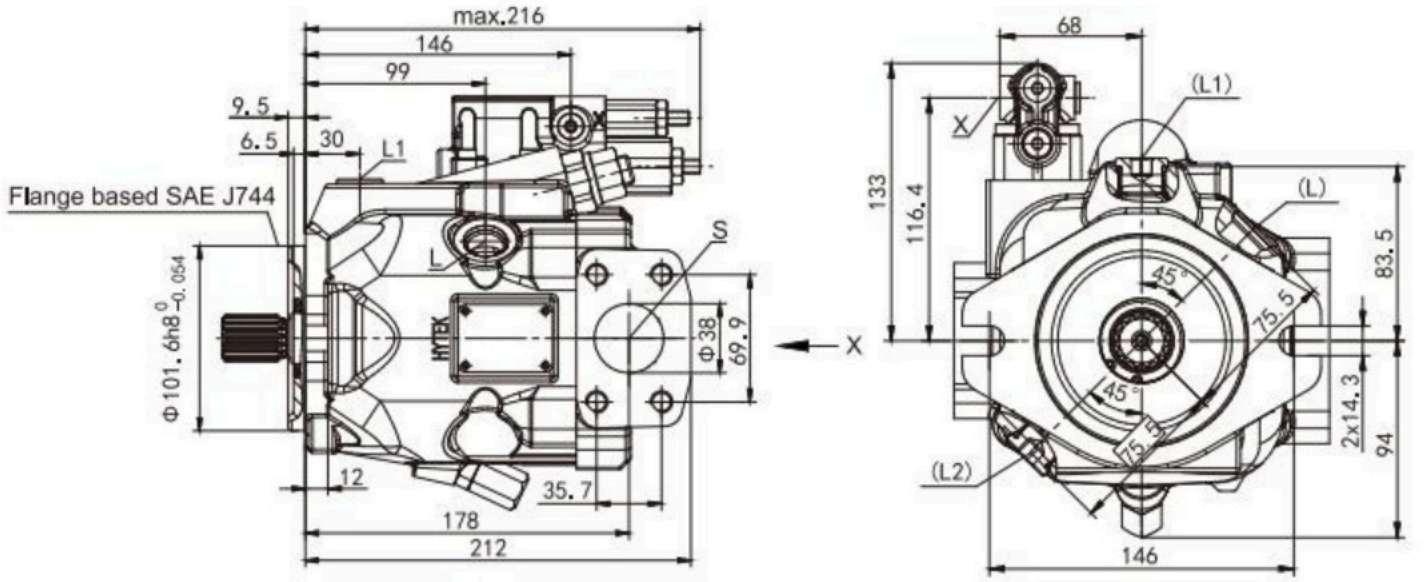
Circuit diagram



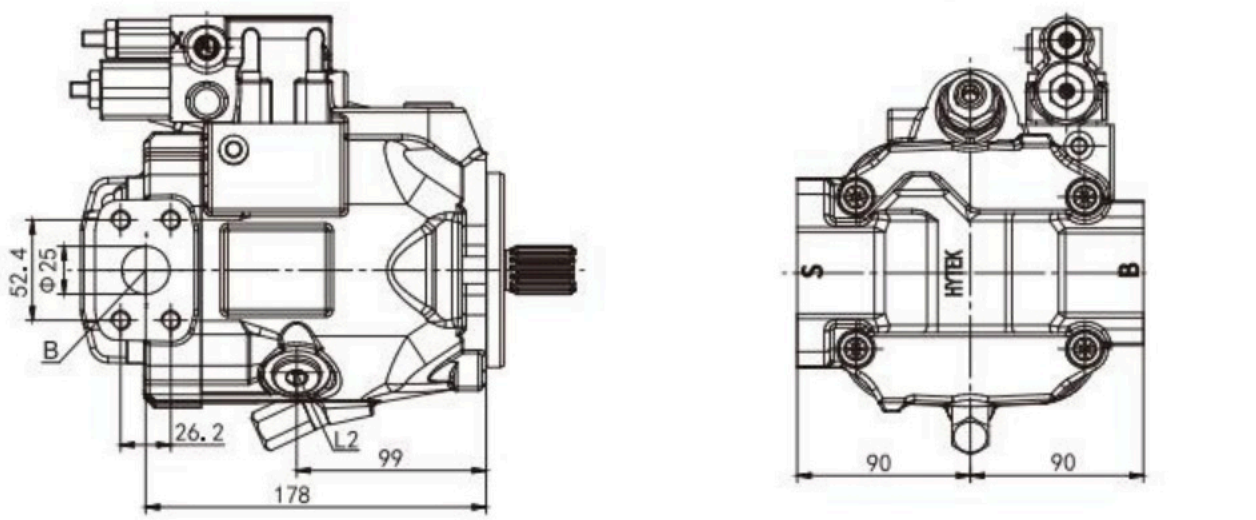
Installation Dimensions, 40/45, NO63

DRF/DRS-Pressure、Flow controller, clockwise rotation

SAE flange working oil port 12

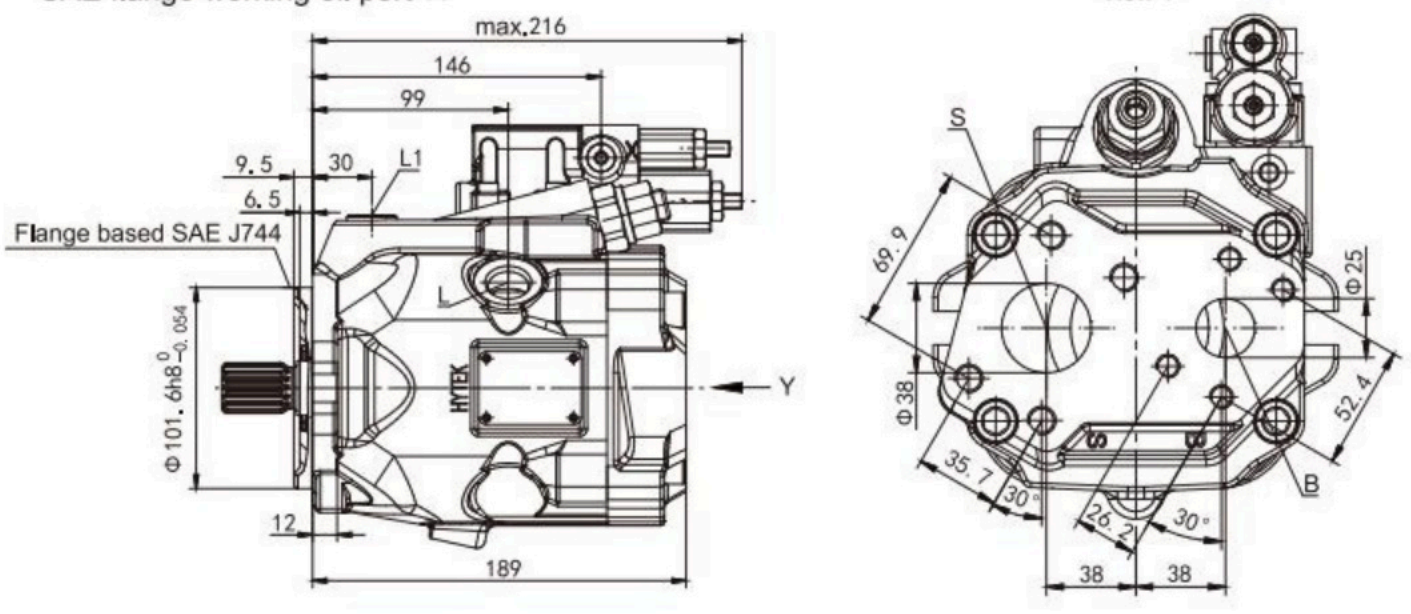


View X



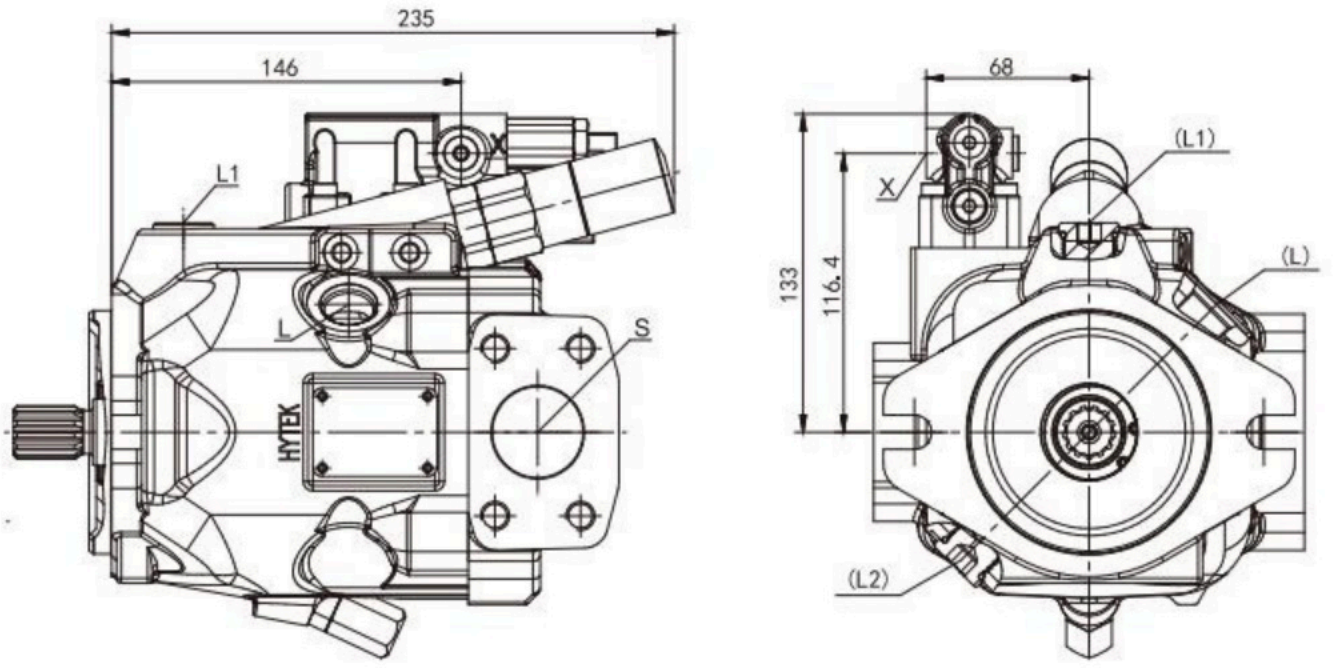
SAE flange working oil port 11

View Y

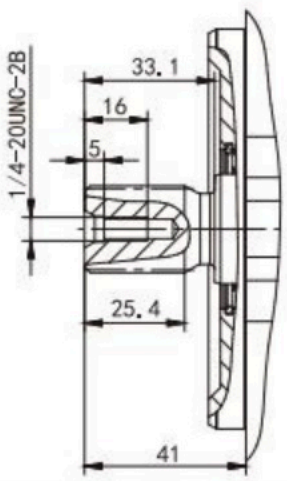


Installation Dimensions, 40/45, NO63

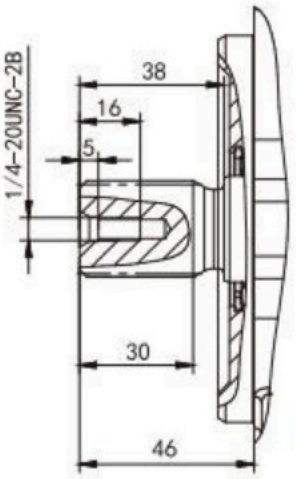
LA.DS-Pressure、Flow、Power controller, clockwise rotation



Splined shaft
7/8" SAE J744
S1-13T 16/32DP



Splined shaft
1" SAE J744
S2-15T 16/32DP



Port type

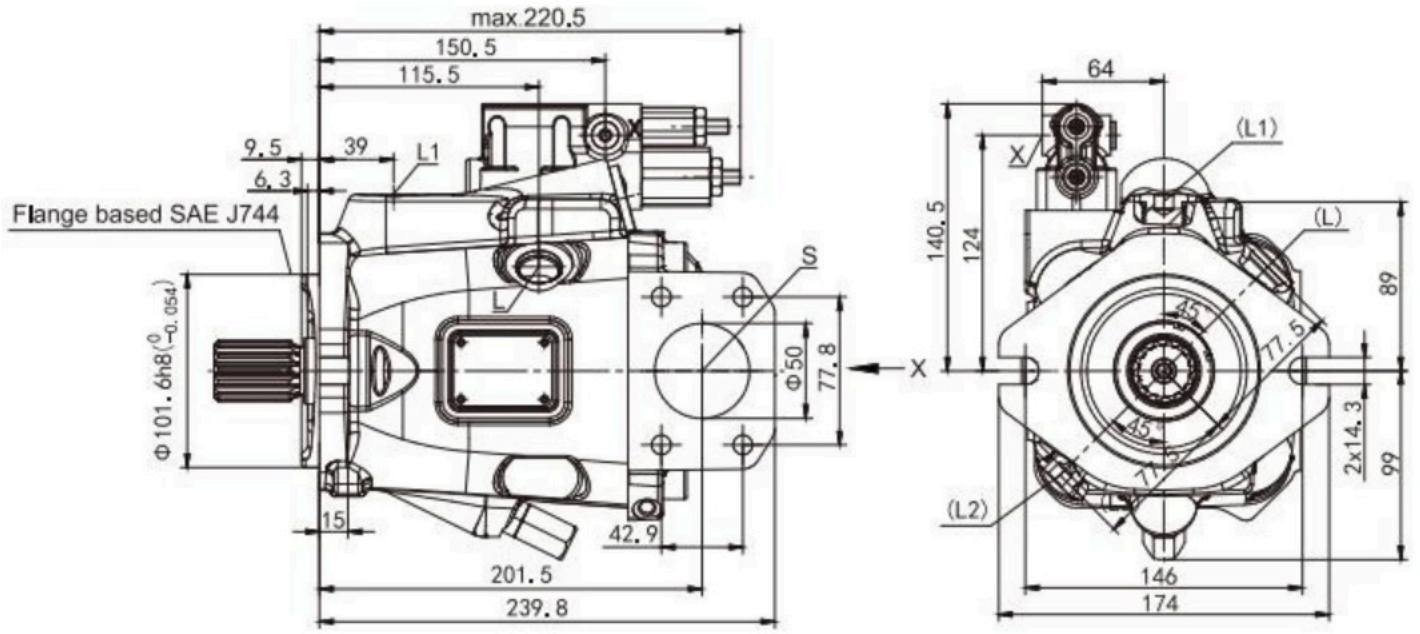
Port		Standard	Size	Code
L/L1/L2	Drain port	SAE J1926-1	7/8-14UNF-2B,17deep,O-ring seal	S
X	Pilot pressure	SAE J1926-1	7/16-20UNF-2B,11.5deep,O-ring seal	
L/L1/L2	Drain port	JIS B2351-1G	G1/2,20.5deep,O-ring seal	G
X	Pilot pressure	ISO 1179-1	G1/4,12deep,ED seal	
L/L1/L2	Drain port	ISO 9974-1	M22×1.5,17deep,EDseal	I
X	Pilot pressure(M)	ISO 9974-1	M14×1.5,12deep,EDseal	

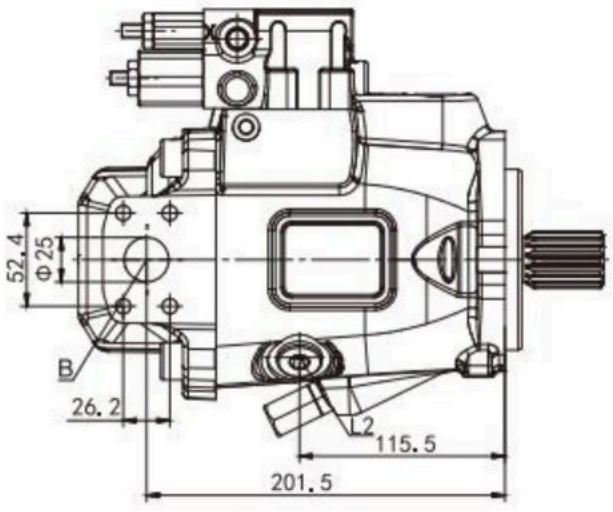
Working port

Port		Standard	Size	Code
B	Working port	SAE J518C	Φ25	12
	Fastening thread		M10,18deep	
S	Suction port		Φ50	
	Fastening thread		M12,22deep	

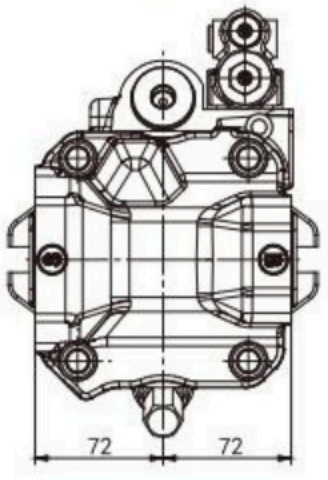
Installation Dimensions, 63/72

DRF/DRS-Pressure、Flow controller, clockwise rotation, mounting flange C



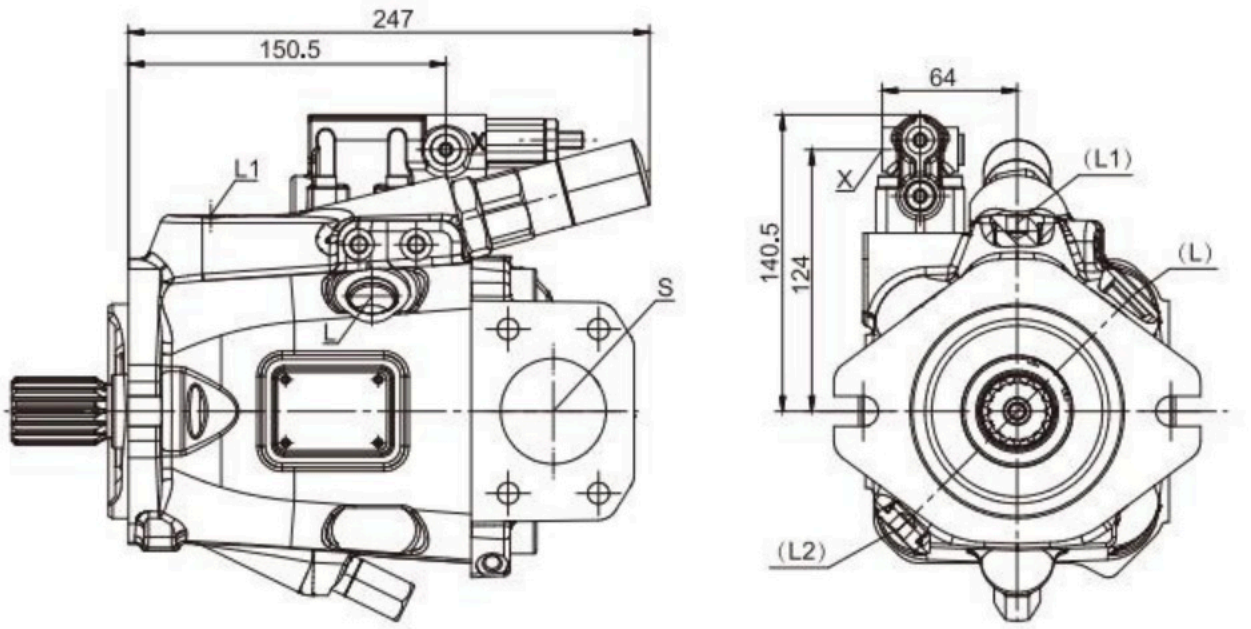


View X

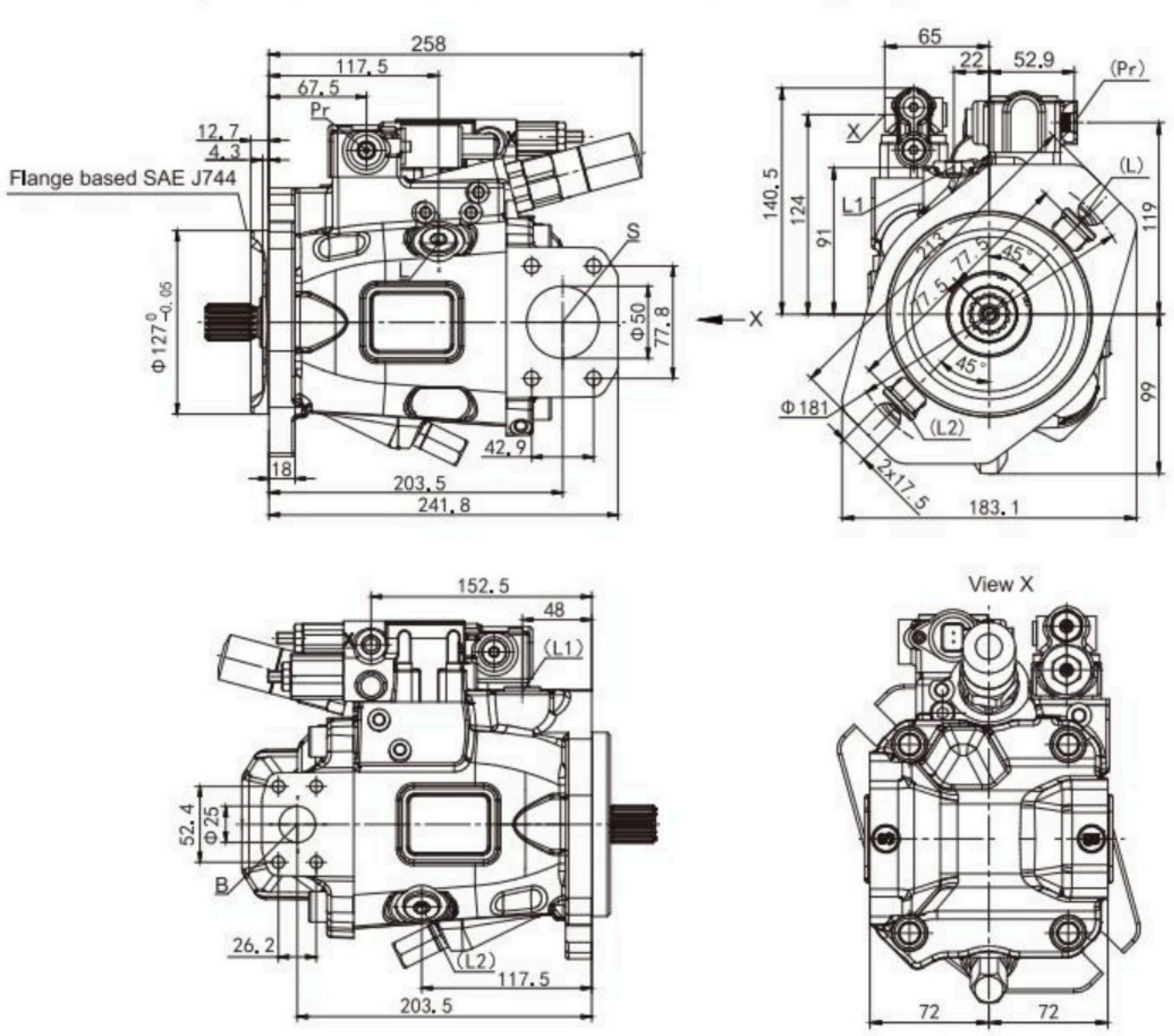


Installation Dimensions, 63/72

LA.DS-Pressure、Flow、Power controller, mounting flange C

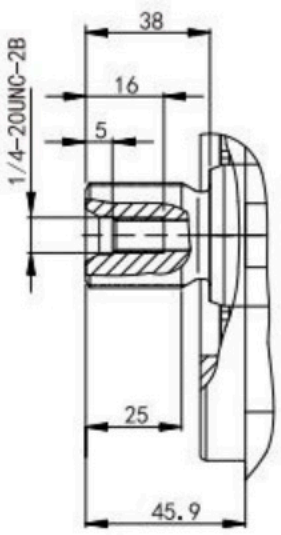


LE.DS-Electro Proportional Power Control, clockwise rotation, mounting flange C2

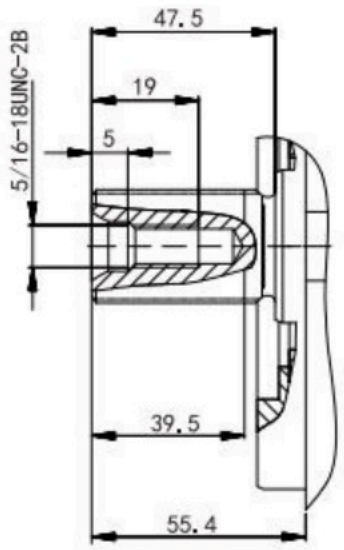


Installation Dimensions, 63/72

Splined shaft
1" SAE J744
S2-15T 16/32DP



Splined shaft
1 1/4" SAE J744
S3-14T 12/24DP



Port type

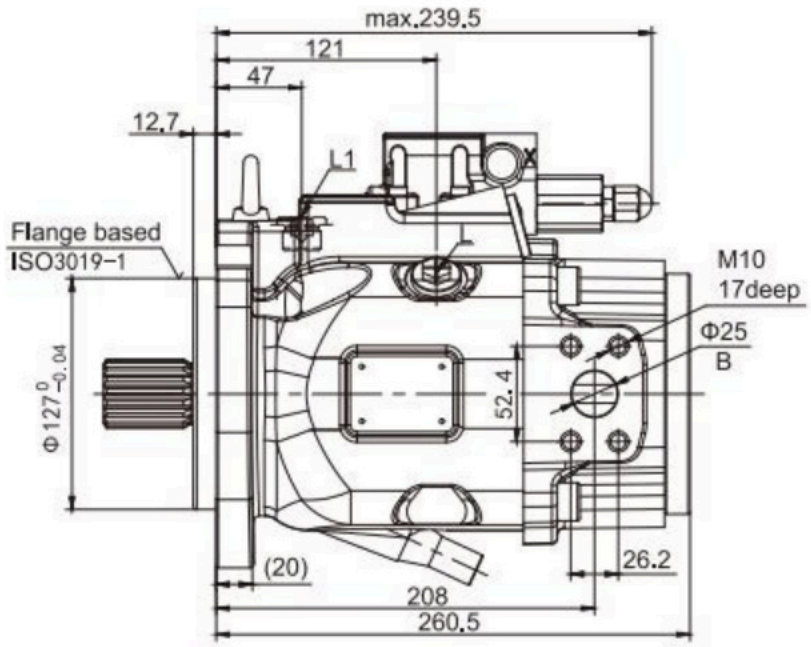
Port		Standard	Size	Code
L/L1/L2	Drain port	SAE J1926-1	7/8-14UNF-2B,13deep,O-ring seal	S
X	Pilot pressure	SAE J1926-1	7/16-20UNF-2B,11.5deep,O-ring seal	
L/L1/L2	Drain port	JIS B2351-1G	G1/2,20.5deep,O-ring seal	G
X	Pilot pressure	ISO 1179-1	G1/4,12deep,ED seal	
L/L1/L2	Drain port	ISO 9974-1	M22×1.5,17deep,EDseal	I
X	Pilot pressure(M)	ISO 9974-1	M14×1.5,12deep,EDseal	

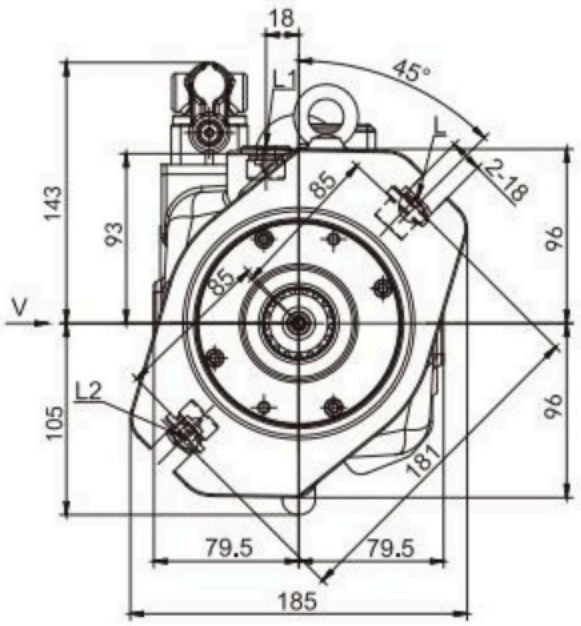
Working port

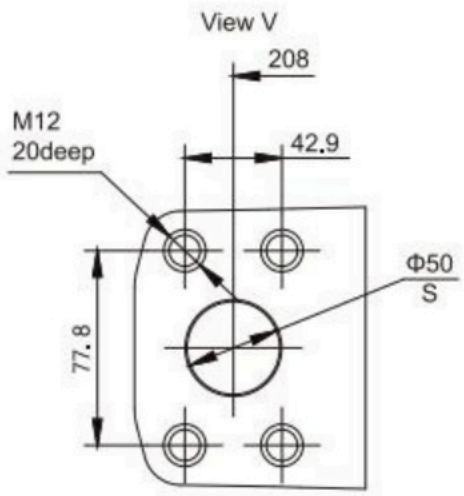
Port		Standard	Size	Code
B	Working port	SAE J518C	Φ25	12
	Fastening thread		M10,18deep	
S	Suction port		Φ50	
	Fastening thread		M12,22deep	

Installation Dimensions, 85

DR-Hydraulic controller,clockwise rotation,mounting flange C,series 01

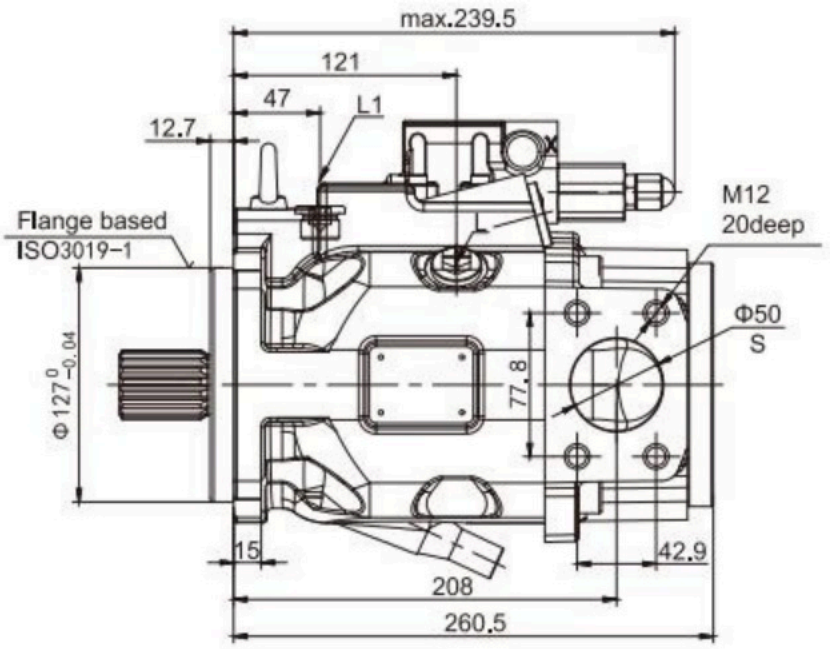


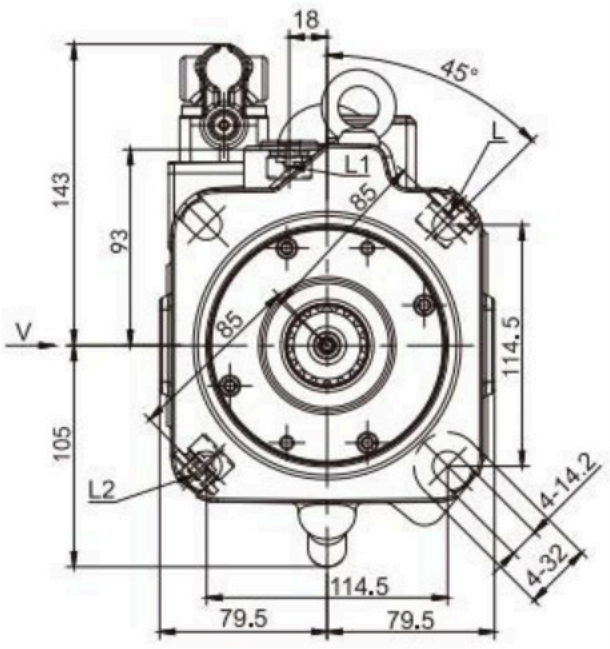


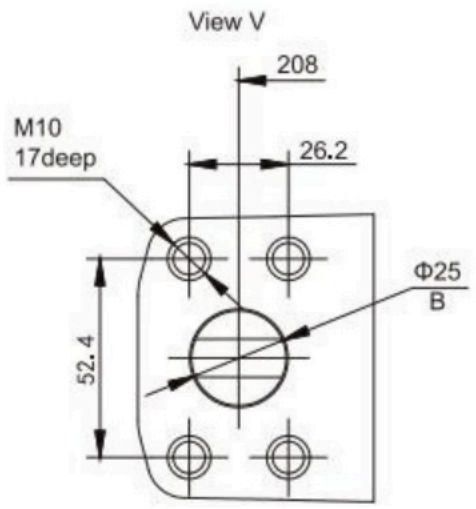


Installation Dimensions, 85

DR-Hydraulic controller,clockwise rotation,mounting flange D,series 01

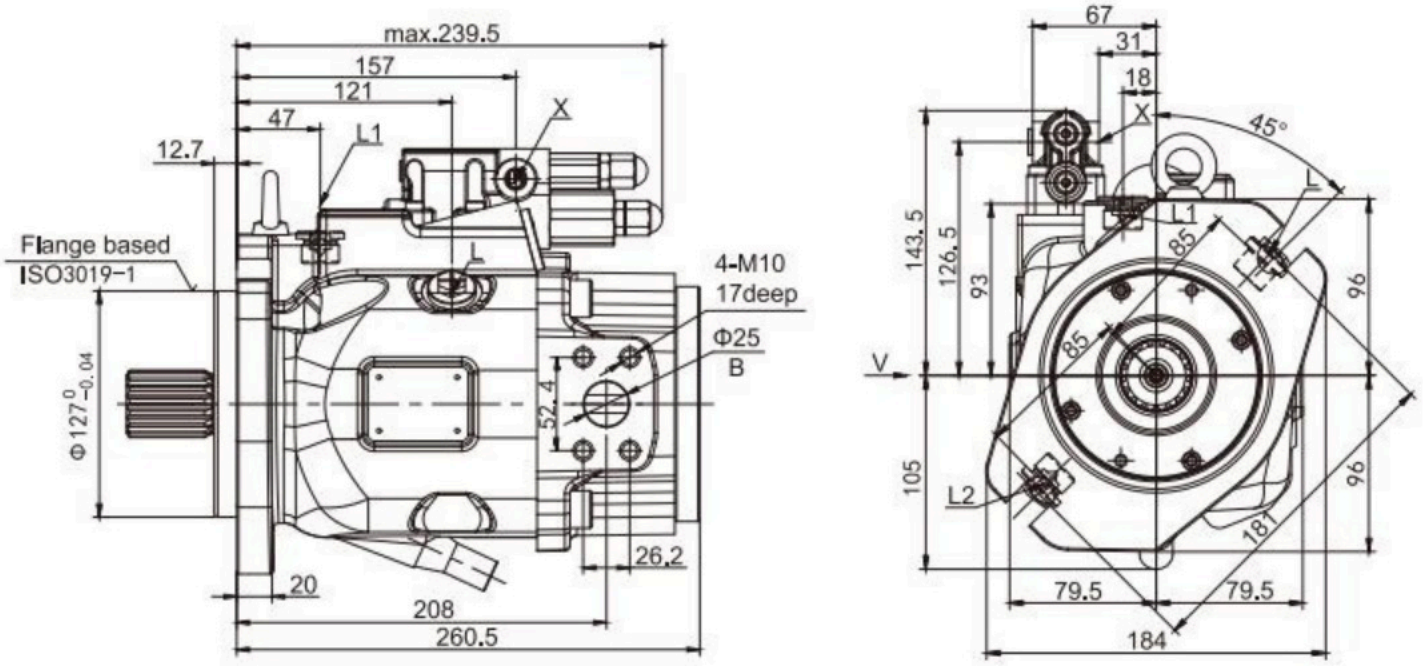




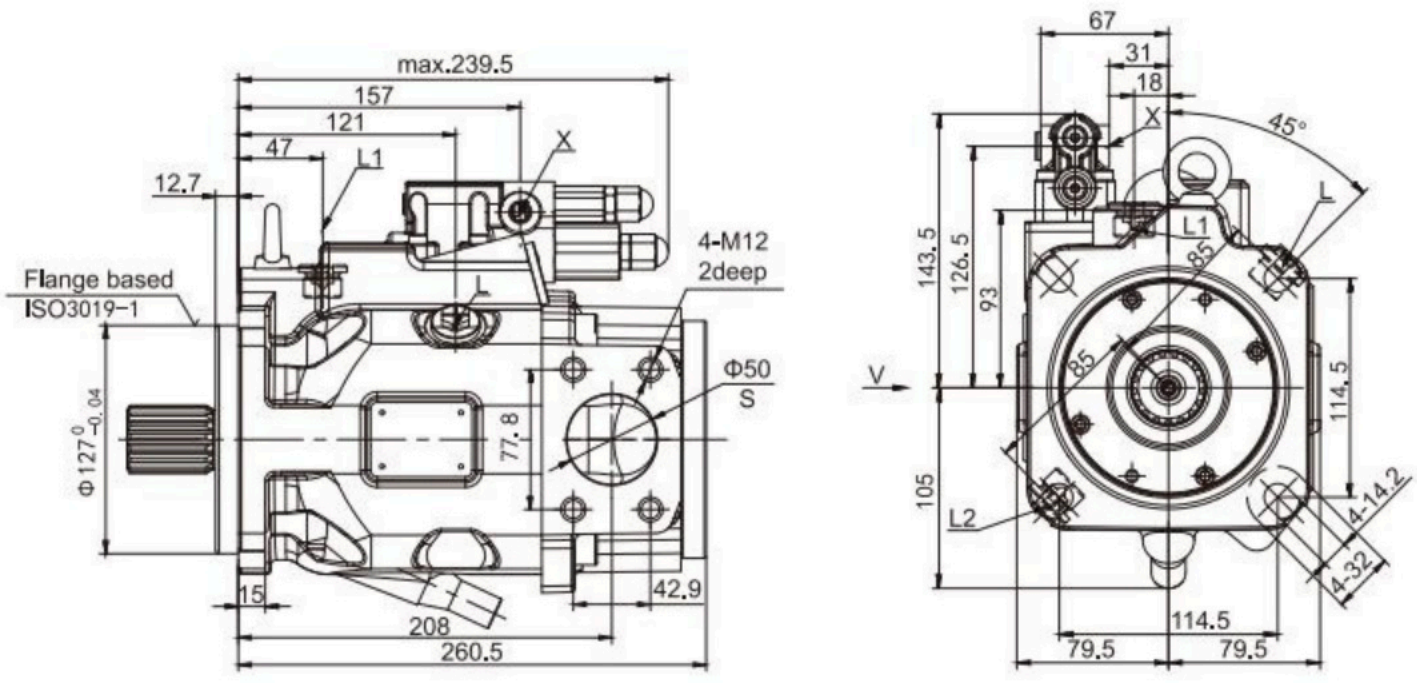


Installation Dimensions, 85

DRF/DRS/DRSC-Pressure、Flow controller,mounting flange C,series 01

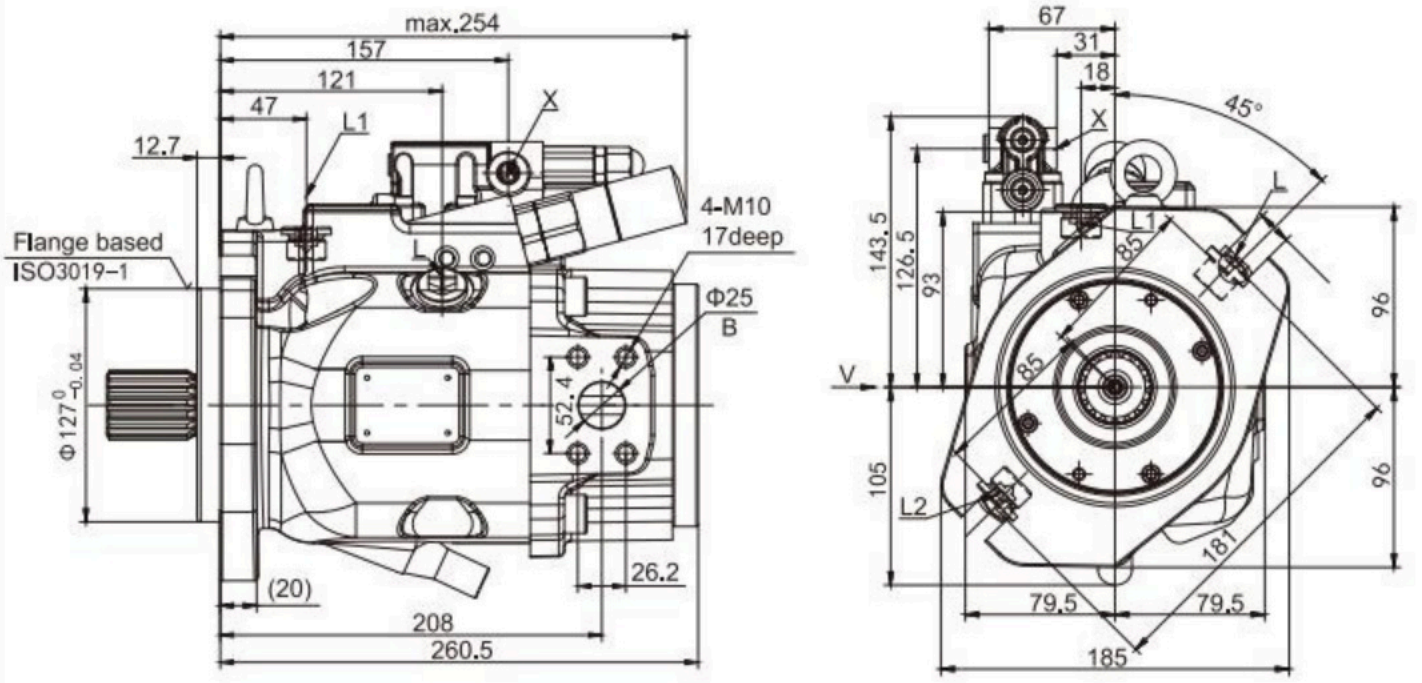


DRF/DRS/DRSC-Pressure、Flow controller,mounting flange D,series 01

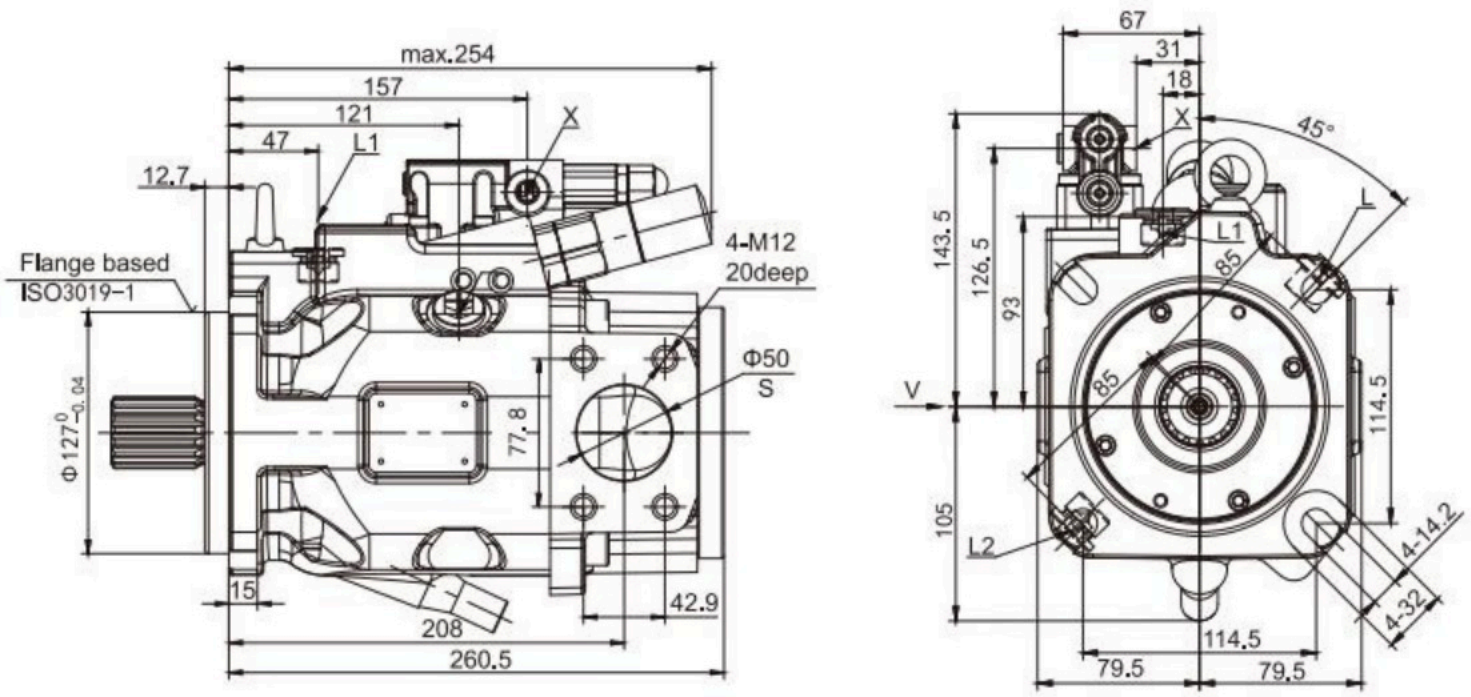


Installation Dimensions, 85

LA.D.-Pressure、Flow、Power controller,mounting flange C,series 01

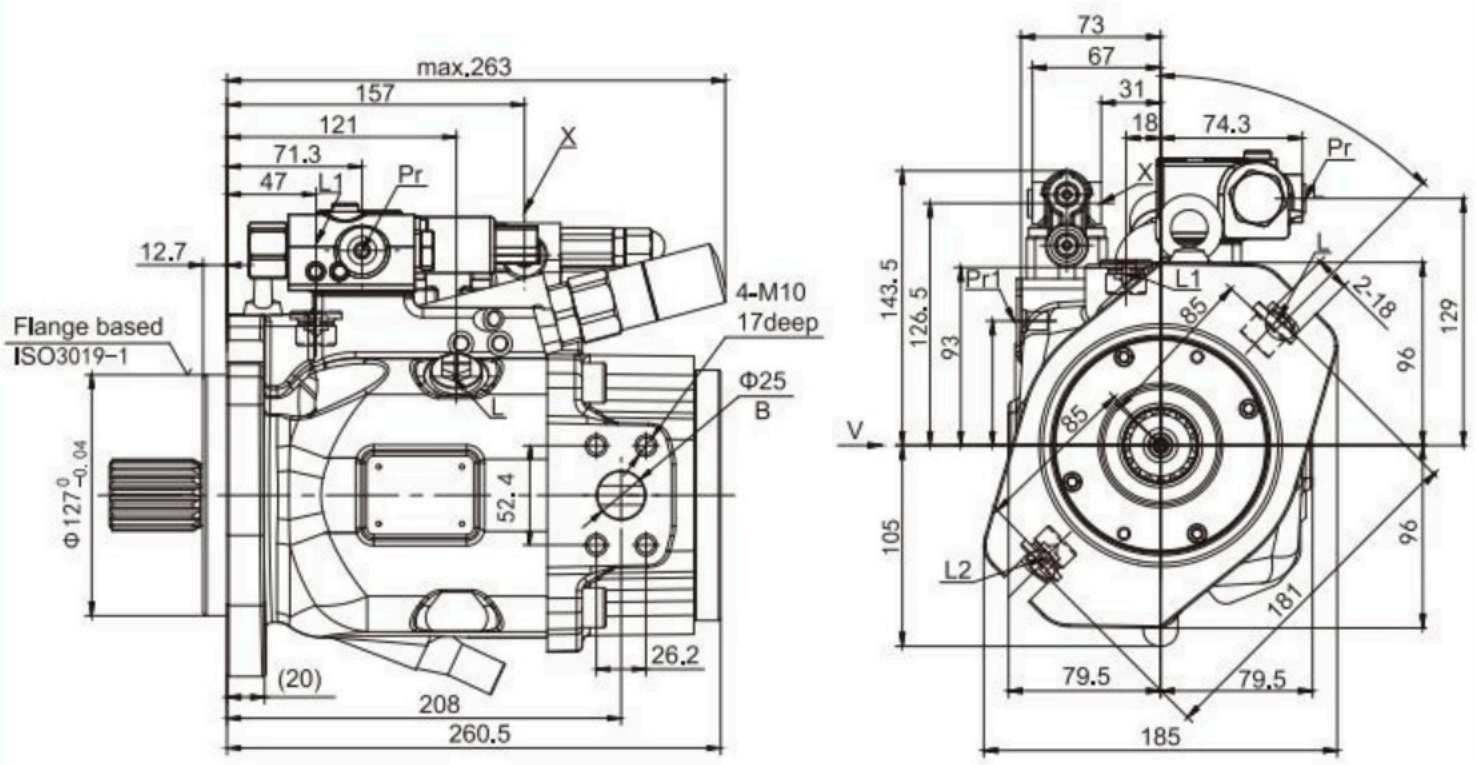


LA.D.-Pressure、Flow、Power controller,mounting flange D,series 01

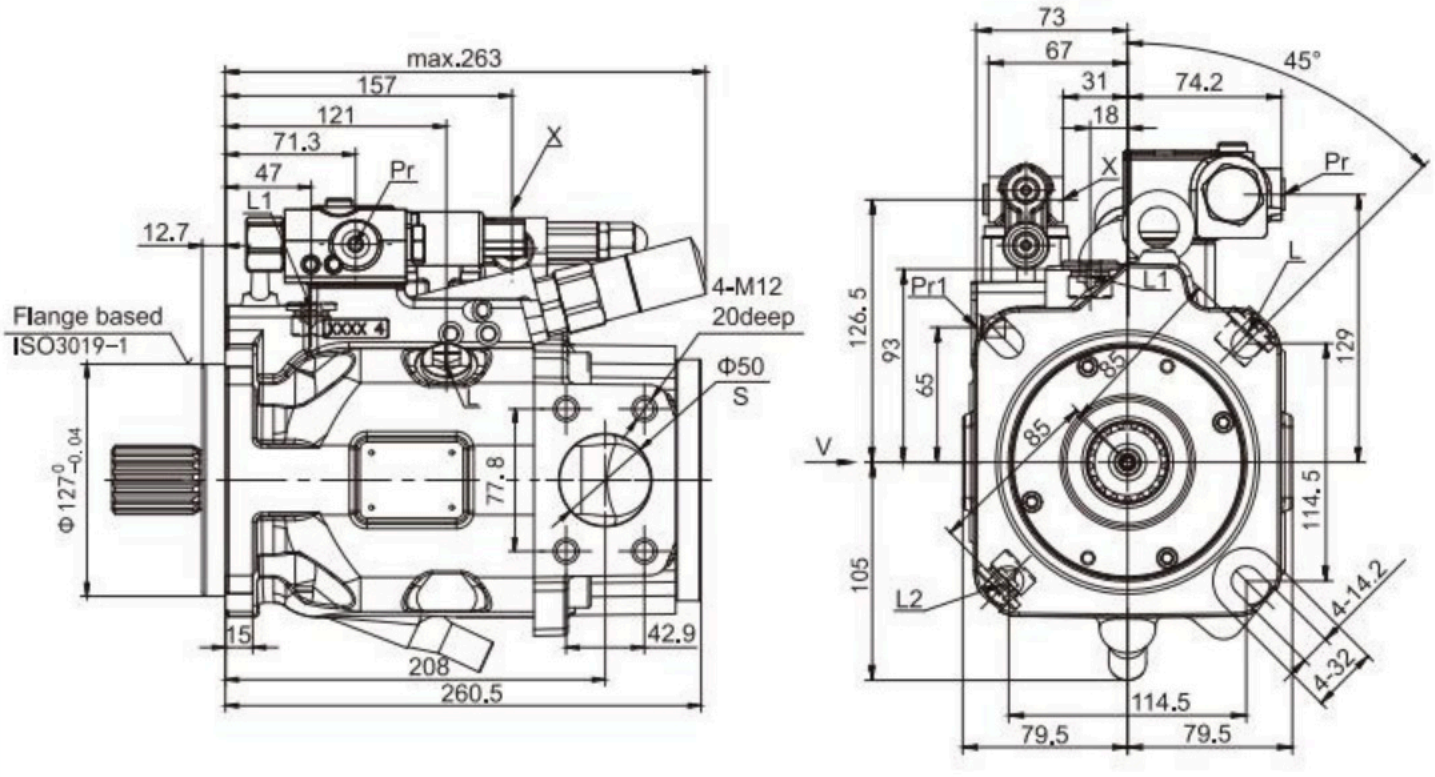


Installation Dimensions, 85

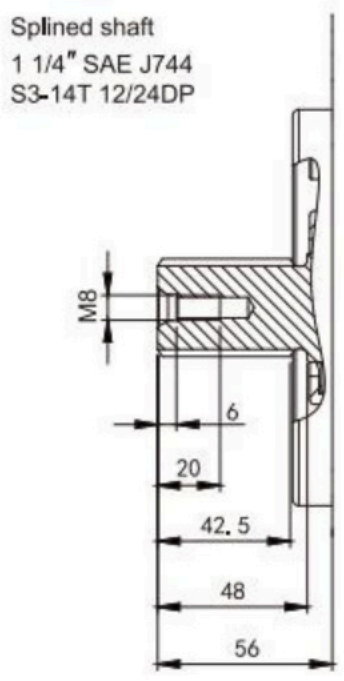
LEDS.-Pressure、Flow、Power controller,mounting flange C,series 01

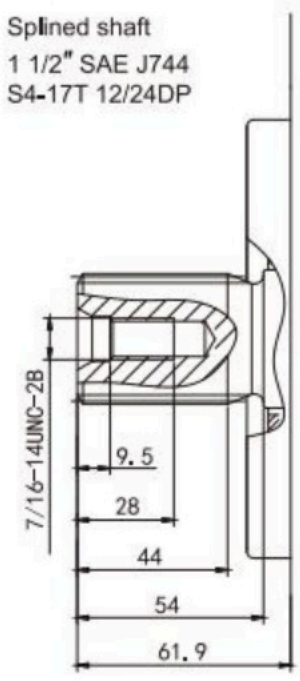


LEDS.-Pressure、Flow、Power controller,mounting flange D,series 01



Installation Dimensions, 85





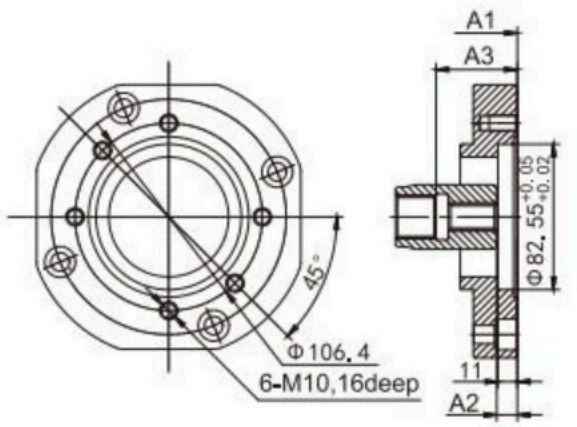
Port type

Port		Standard	Size	Code
L/L1/L2	Drain port	SAE J1926	7/8-14UNF-2B, 13deep, O-ring seal	S
X	Pressure control	SAE J1926	7/16-20UNF-2B, 11.5deep, O-ring seal	
L/L1/L2	Drain port	JIS B2351-1G	G1/2, O-ring seal	G
X	Pressure control	JIS B2351-1G	G1/4, 12deep, O-ring seal	

Working port

Port		Standard	Size	Code
B	Drain port,metric thread flange SAE	SAE J518C	Φ25,M14,17deep	12
S	Suction port,metric thread flange SAE		Φ50,M12,20deep	
B	Drain port,UN thread flange SAE		Φ25,3/8-16NUF-2B,18deep	62
S	Suction port,UN thread flange SAE		Φ50,1/2-13NUF-2B,19deep	

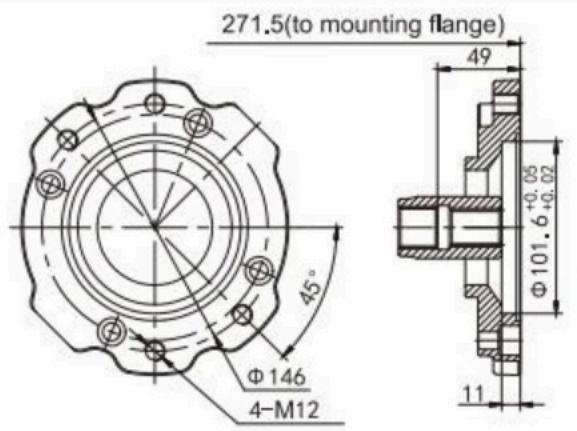
Dimensions through drive



K01

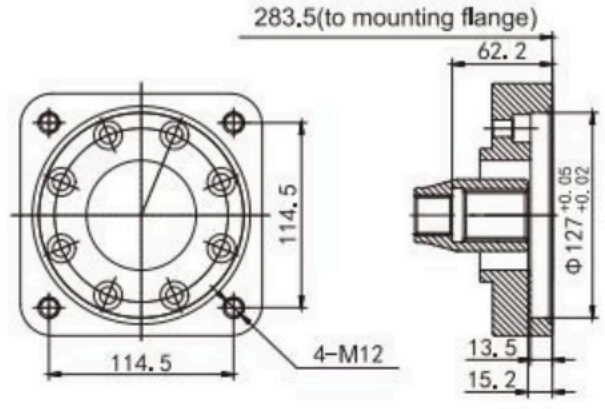
Flange SAE J744-82-2(A)
Hub for splined shaft
ANSI B92.1a-1996
5/8″ 9T 16/32DP

K01	40/45	63/72	85
A1	229	254.5	271.5
A2	9.5	9.2	11.7
A3	53	59	46.2



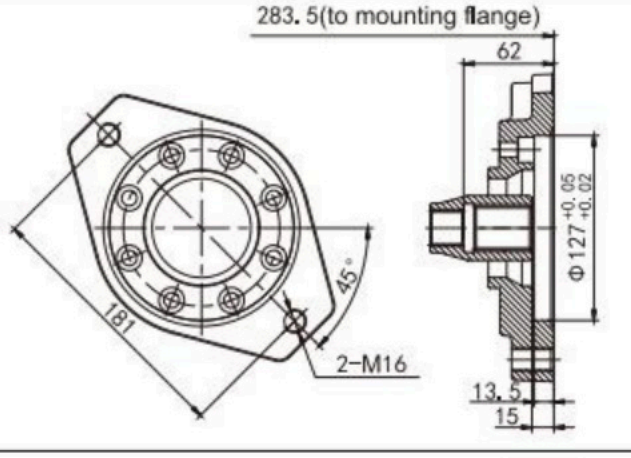
K68

Flange SAE J744-101-2(B)
Hub for splined shaft
ANSI B92.1a-1996
7/8″ 13T 16/32DP



K15

Flange SAE J744-127-4(D)
Hub for splined shaft
ANSI B92.1a-1996
1 1/4″ 14T 12/24DP

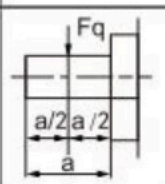
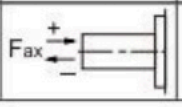


K07

Flange SAE J744-127-2(C)
Hub for splined shaft
ANSI B92.1a-1996
1 1/4″ 14T 12/24DP

Flange SAE J744	Hub for splined shaft	Availability across sizes					Code
Diameter	Diameter	40	45	63	72	85	
82-2（A）	5/8″ 9T 16/32DP	●	●	●	●	●	K01
101-2（B）	7/8″ 13T 16/32DP	○	○	○	○	●	K68
127-4（C）	1 1/4″ 14T 12/24DP	○	○	○	○	●	K15
127-2（C）	1 1/4″ 14T 12/24DP	○	○	○	○	●	K07

Allowable radial and axial forces on the drive shaft

Size		NG	40	45	63	72	85
Maximum radial force at a/2		$F_{q\ max}$(N)	1500	1500	1700	1700	1700
Maximum axial force		$F_{ax\ max}$(N)	1500	1500	2000	2000	3000

Installation Instructions

General

The pump must be filled with hydraulic fluid during commissioning and operation.
To reduce noise, all connecting lines (inlet line, pressure line and case drain line) must be isolated from the reservoir with flexible components.
Do not install any check valve in the case drain line.
You must consult us before implementation in special cases.

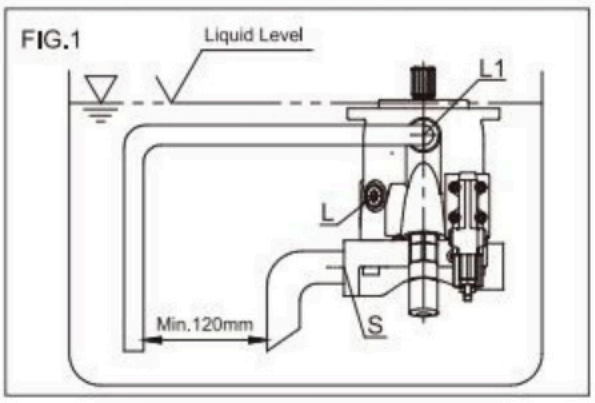
Vertical Installation (drive shaft upwards)

The installation below is for your reference:

a.Inside-reservoir installation

Fill the pump and lay it horizontal before installation.
a)If the minimum fluid level of the reservoir is equal to or higher than the mounting flange surface of the pump, plug port L, and open ports L1 and S; connect pipes to ports L1 and S as shown in FIG. 1.
b)If the minimum fluid level of the reservoir is below the mounting flange surface of the pump, connect pipes to ports L1 and S as shown in FIG. 2.

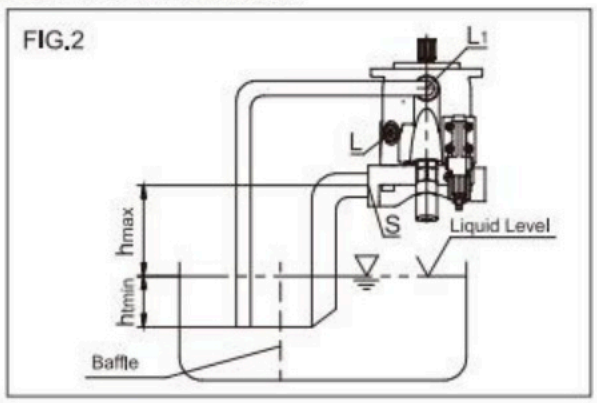
FIG.1



b.Outside-reservoir installation

Fill the pump and lay it horizontal before installation. See FIG. 2 for above-reservoir installation.

FIG.2



Restriction: Minimum inlet pressure under static and dynamic conditions P_{absmin}=0.8bar.
Note: Do not install the pump above the reservoir as far as possible to reduce noise.
The permissible suction height h results from the total pressure loss, but it should not exceed h_{max}=800mm(pipe immersion depth h_{tmin}=200mm).

Total pressure loss

$\triangle p_{tot}=\triangle p_1+\triangle p_2+\triangle p_3 \leqslant (1-P_{absmin})=0.02bar$

$\triangle p_1$: pipe pressure loss from fluid column acceleration

$$\triangle p_1 = \frac{\rho \cdot l \cdot dv}{dt} \cdot 10^{-6}(MPa)$$

$\triangle p_2$: pressure loss from hydrostatic head

$$\triangle p_2 = h \cdot \rho \cdot g \cdot 10^{-6}(MPa)$$

$\triangle p_3$: pipe loss (elbow, etc.)

ρ = viscosity(kg/m^2)
dv/dt = rate of change in fluid velocity(m/s^2)
g = acceleration of gravity = $9.81m/s^2$
l = pipe length(m)
h = height(m)

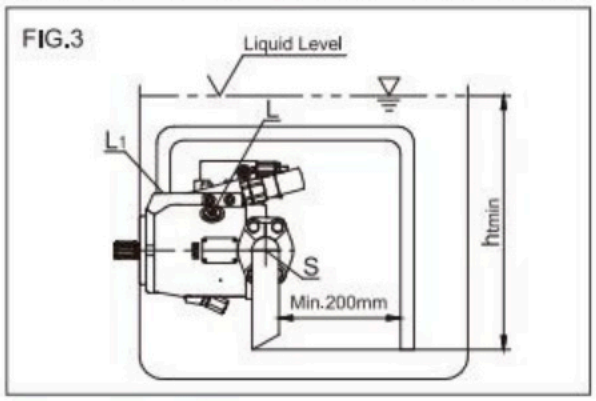
Horizontal Installation

For horizontal installation, set port L or L1 on the top.
The installation below is for your reference:

a.Inside-reservoir installation

1a)If the minimum fluid level of the reservoir is above the top of the pump, plug port L; you may open ports L1 and S, and connect pipes to the two ports (as shown in FIG. 3).
2a)If the minimum fluid level of the reservoir is below the top of the pump, plug port L; see FIG.4 for pipe connection of port L1 and possibly port S.

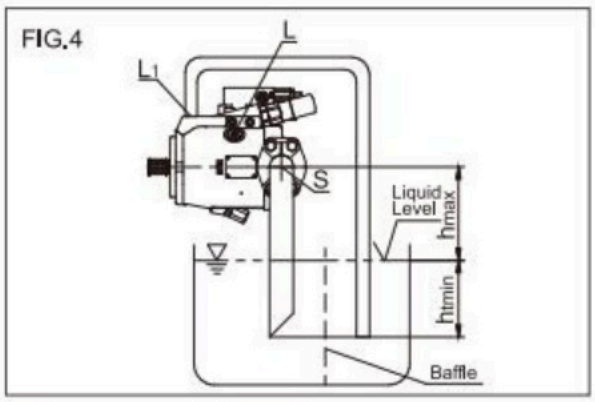
FIG.3



b.Outside-reservoir installation

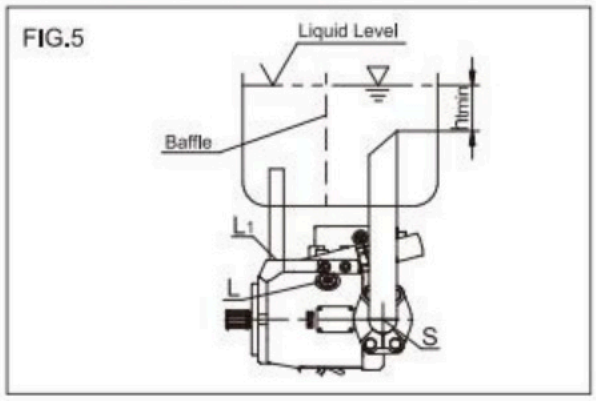
Fill the pump before commissioning.
Connect pipes to port S and the top port L or L1.
1b)See FIG. 4 for above-reservoir installation.

FIG.4



2b)Below-reservoir installation
See FIG. 5 for pipe connection of ports L1 and S. Port L is plugged.

FIG.5



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