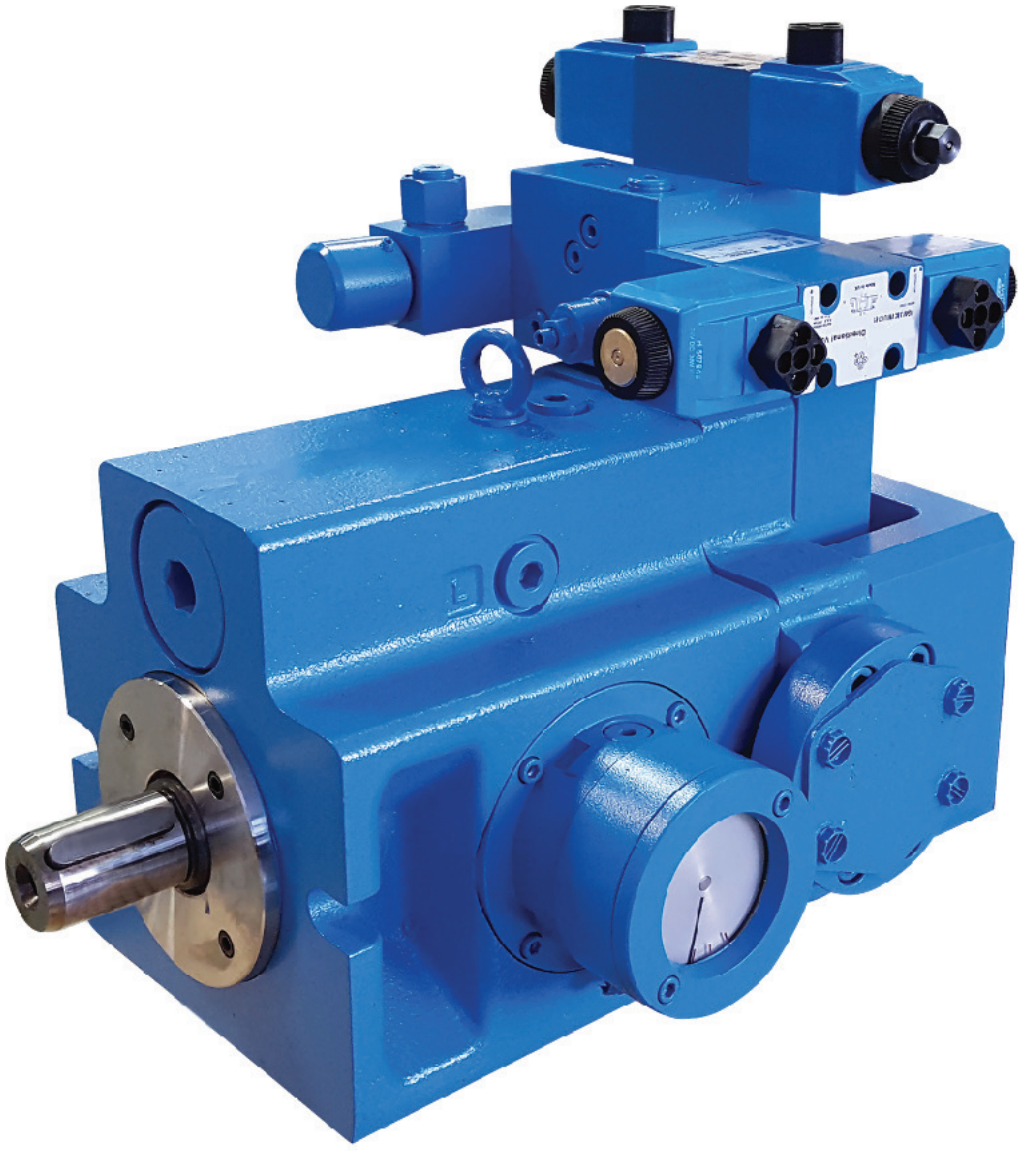
A class apart in today's hydraulics industry



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Introduction

General description

- Axial piston pumps with swash plate design for reliable operation and long life.
- Pressure up to 420 bar.
- Rated speed up to 1800 rev/min. Higher speeds possible.
- Oversize shafts and bearings.
- Rotating and pressure- loaded parts are pressure balanced.
- Through-drive enables multiple pump installations from a single shaft. Multiple pump combinations are also available.
- Integrated pilot pump, filter and pressure relief valves available.
- Modular design gives these pumps a wide range of applications.
- Fast response times.

Available displacement sizes

066 cm ³/rev (4.1 in ³/rev)

090 cm ³/rev (5.5 in ³/rev)

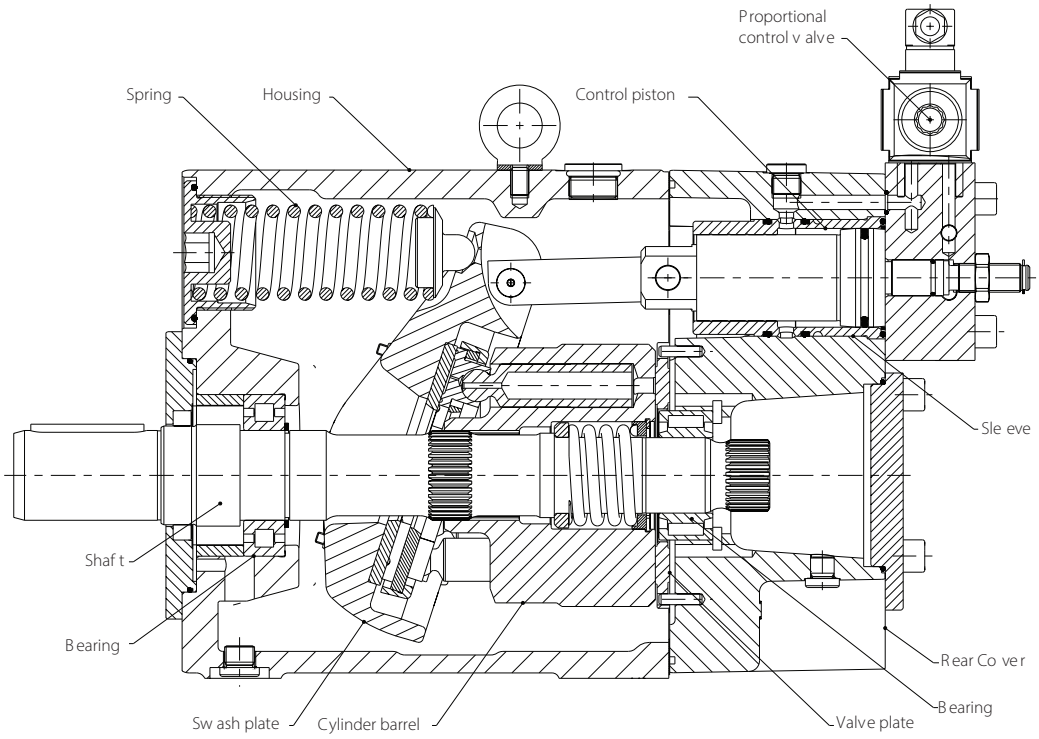
130 cm ³/rev (8.0 in ³/rev)

180 cm ³/rev (11.0 in ³/rev)

250 cm ³/rev (15.3 in ³/rev)

Typical applications

- Test-rigs and simulators
- Marine
- Offshore
- Materials handling and recycling
- Timber machinery
- Chemical industry
- Pulp and paper
- Sugar mills
- Tunnel boring
- Power generation
- Primary metals including steelworks, forging and extruding



Typical section of open loop PVX pump with ST Control

⚠ Dimensional data is subject to change without notice.

PVX Pump model code
Open Loop Piston Pumps

● Preferred standard option
◐ Other standard option
○ Special offer on request
x Not applicable or available

"X" Series - basic pump

P	V	X	•	-	•	•	•	M	•	•	•	•	•	•	1	•	•	•	S	•	•	A
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

			Pump size	66	90	130	180	250
1			Pump					
P	-		Open loop pumps	●	●	●	●	●
2			Displacement					
V	-		Variable	●	●	●	●	●
3			Pump series					
X	-		"X" series	●	●	●	●	●
4			Configuration					
S	-		Single unit	●	●	●	●	●
5			Separator	●	●	●	●	●
6	7	8	Displacement cm³/rev (in³/rev)					
066	-		066 cm³/rev (4 in³/rev)	●				
090	-		090 cm³/rev (5.5 in³/rev)		●			
130	-		130 cm³/rev (8 in³/rev)			●		
180	-		180 cm³/rev(11 in³/rev)				●	
250	-		250 cm³/rev (15.3 in³/rev)					●
9			Basic standards					
M	-		Metric	●	●	●	●	●
10	11		Mounting Flange					
02	-		ISO 3019/2-125A2HW	●	●			
04	-		ISO 3019/2-160A2HW			●	●	
06	-		ISO 3019/2-200A2HW					●
12			Rotation direction					
R	-		Clockwise	●	●	●	●	●
L	-		Anticlockwise	○	○	○	○	X
13			Maximum displacement screw					
0	-		Displacement adjusting screw					
			with control ST…..A"0"… 1)	●	●	●	●	●
			with control ST…..A"4"…	●	●	●	●	●
			with control ST…..A"5".. or ..A"6"..	X	X	X	X	X
4	-		Fixed mechanical stop ring side A	◐	◐	◐	◐	◐
5	-		Fixed mechanical stop ring side B	◐	◐	◐	◐	◐
6	-		Fixed mechanical stop ring side A & B	◐	◐	◐	◐	◐

Note: Customer adjustment required

4 used as max. volume adjustment side A
5 used as min. volume stop side A
(Variable min. adj. Stop by Screw NOT available)
[1]For explanation of option „0" …. „ 6" refer to model-code position. 30

		Pump size	66	90	130	180	250
14	15	Thru drive options					
00	-	None	●	●	●	●	●
0A	-	SAE A	◐	◐	◐	◐	◐
0B	-	SAE B	◐	◐	◐	◐	◐
0C	-	SAE C	○	○	○	○	○
0P	-	Pilot pump (8cm³/rev)	◐	◐	◐	◐	◐
16		Main ports					
1	-	SAE ports-metric bolts	●	●	●	●	●
17		Main port orientation					
A	-	Axial (in-line rear)	◐	◐	◐	◐	◐
R	-	Radial (side ports)	●	●	●	●	●
18	19	Main drive shaft end					
01	-	ISO straight key	●	●	●	●	●
02	-	ISO spline	◐	◐	◐	◐	◐
20		Drive shaft seal configuration					
S	-	Single shaft seal	●	●	●	●	●
21		Seal material					
V	-	FKM	●	●	●	●	●
C	-	Special shaft seal, for HFC fluids	◐	◐	◐	◐	◐
F	-	FKM + front bearing flushing prepared	◐	◐	◐	◐	◐
K	-	FKM with HP lubrication	◐	◐	◐	◐	◐
22		Yoke position indicator					
P	-	Position sensor	◐	◐	◐	◐	◐
M	-	Sensor with visual indicator	●	●	●	●	●
23		Surface coating					
A	-	Primer blue▼	●	●	●	●	●
0	-	Rust inhibitor oil	◐	◐	◐	◐	◐

▼ Other finishes on request.

- ◒ Preferred standard option
- ○ Other standard option
- ○ Special offer on request
- x Not applicable or available

PVX Pump model code
Open Loop Piston Pumps

"X" Series - ST control

S	T	*	*	*	A	*	*	?	?	?	*	*	0	0	0	0	*	*	*	*	*	*	1	0
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48

			Pump size	66	90	130	180	250
24	25		Control type					
ST	-		EL. Proportional valve displacement control	◒	◒	◒	◒	◒
26			Displacement adjustment option					
A	-		with CETOP 3 interface (no valve)	○	○	○	○	○
C	-		With CETOP3 Proportional valve	◒	◒	◒	◒	◒
27	28		Electronic controls					
00	-		Without electronics	○	○	○	○	○
03	-		With ER9.3 amplifier card	◒	◒	◒	◒	◒
29			Yoke displacement zone					
A	-		Single side of center "A"	◒	◒	◒	◒	◒
30			Extra functions					
0	-		Without additional options	◒	◒	◒	◒	◒
4	-		Pressure limiter override	○	○	○	○	○
5	-		Pressure & power limiter override	○	○	○	○	○
6	-		Power limiter override only	○	○	○	○	○
31			Pressure limiter control options					
0	-		Including pilot relief valve and remote port option	◒	◒	◒	◒	◒
F	-		Remote port only	○	○	○	○	○
K	-		Proportional relief valve	○	○	○	○	○
32	33	34	Power control setting options					
000			No power limiter override					
???			KW at 1500 RPM*	◒	◒	◒	◒	◒
35			Pilot oil filter					
0	-		Without filter	◒	◒	◒	◒	◒

			Pump size	66	90	130	180	250
36			Pilot oil supply					
A	-		Internal pilot oil supply only	◒	◒	◒	◒	◒
B	-		External pilot oil supply only	○	○	○	○	○
C	-		Internal & external pilot oil supply by check valve	○	○	○	○	○
37			Position monitoring (ES)					
0	-		Not required for this control type	X	X	X	X	X
38			Electric motor type (ES)					
0	-		Not required for this control type	X	X	X	X	X
39			Control voltage of venting valve					
0	-		Not required for this control type	X	X	X	X	X
40	41	42 43	Customer adjustment specification					
0000	-		None (standard setting as shown in below table	◒	◒	◒	◒	◒
????	-		Yes (final number will be assigned by Danfoss) specify in detail separately	○	○	○	○	○
44	45	46	Special feature					
000	-		None	◒	◒	◒	◒	◒
???	-		Defined by Danfoss	○	○	○	○	○
47	48		Design number					
10	-		Design number	◒	◒	◒	◒	◒

*Only if extra function power limiter override is selected

	Unit	Standard adjustment	Customer adjustment	Remarks
All revolution adjustment below set at	RPM	1500	-	-
Max. Mechanical stop side A	l/min	Qmax	-	-
Max. Software-stop by control side A	l/min	Qmax	El. Card adjustment done by customer	Refer to E. card manual
Pressure Override side A	bar	90	-	-

Notes:

- ST control requires a min. operation pressure of > 25 bar for operation. For internal pilot oil supply it must be assured that this load pressure can be provided. Below this min. pressure value pump will automatically go on max. stroke.
- Pressure level for external pilot oil supply should be equal or more than 60 bar

Pump specifications

Metric

Model			66	90	130	180	250
Design			Swashplate - Axial piston pump				
Type of mounting			Flange or foot-mounted. Combination units foot mounted only				
Pipe connection Flange ISO 6162-1 (SAE J518 code 61) ISO 6162-2 (SAE J518 code 62)	 B A	 psi	 P38M (1 1/2" - 500) P25M (1" - 6000)	 P51M (2" - 500) P25M (1" - 6000)	 P64M (2 1/2" - 500) P25M (1" - 6000)	 P64M (2 1/2" - 500) P32M (1 1/4" - 6000)	 P89M (3 1/2" - 500) P32M (1 1/4" - 6000)
Direction of rotation			Clockwise, Counterclockwise on request				
Mounting altitude			Horizontal, other mounting options are available on request				
Ambient temperature range	Min Max	°C	-20 50				
Weight	M	Kg	55	75	106	114	212
Moment of inertia	J	Kg m^2	0.016	0.016	0.045	0.045	0.146
Hydraulic characteristics							
Rated pressure (100% duty cycle)	p_N	bar	350				
Inlet pressure	$p1_{min}$ $p1_{max}$	bar	0.85 abs 10	0.85 abs 10	0.95 abs 10	0.95 abs 10	1.0 abs 10
Maximum pressure to ISO 5598:2008	$p2_{max}$	bar	420				
Hydraulic fluid			Hydraulic oil to DIN 51524 part 2. See fluid recommendations in application data.				
Hydraulic fluid temperature range	min max	°C	-25 (on start up) 90				
Viscosity range for continuous operation	min max	cSt	10 75				
Maximum permissible start viscosity	max	cSt	1000				
Cleanliness	ISO 4406		18/15/13				
Maximum geometric displacement	Vg	cm^3/rev	66	90	130	180	250
Speed range	n_{min} n_{max}	rev/min	150 1800				
Case pressure (over pressure) n = 1200 rev/min n = 1500 rev/min n = 1800 rev/min	p_{case}	bar	 3.5 2.7 2.2	 3.5 2.7 2.2	 3.2 2.5 2.0	 3.2 2.5 2.0	 2.8 2.1 1.7
Drive							
Driving torque (p_N=350bar, Vg at 1500 rev/min, 100%)	$M1_{Single}$	Nm	367	501	724	1002	1392
Power consumption (p_N=350bar, n= 1500 rev/min, η_v = 100%)	$P1_{Single}$	kW	57,8	78,8	113,8	739,5	1027
Combination units							
Maximum driving torque limited to splined shaft only - comb. unit	M1 Comb.	Nm	2x367	2x501	2x724	2x1002	2x1392

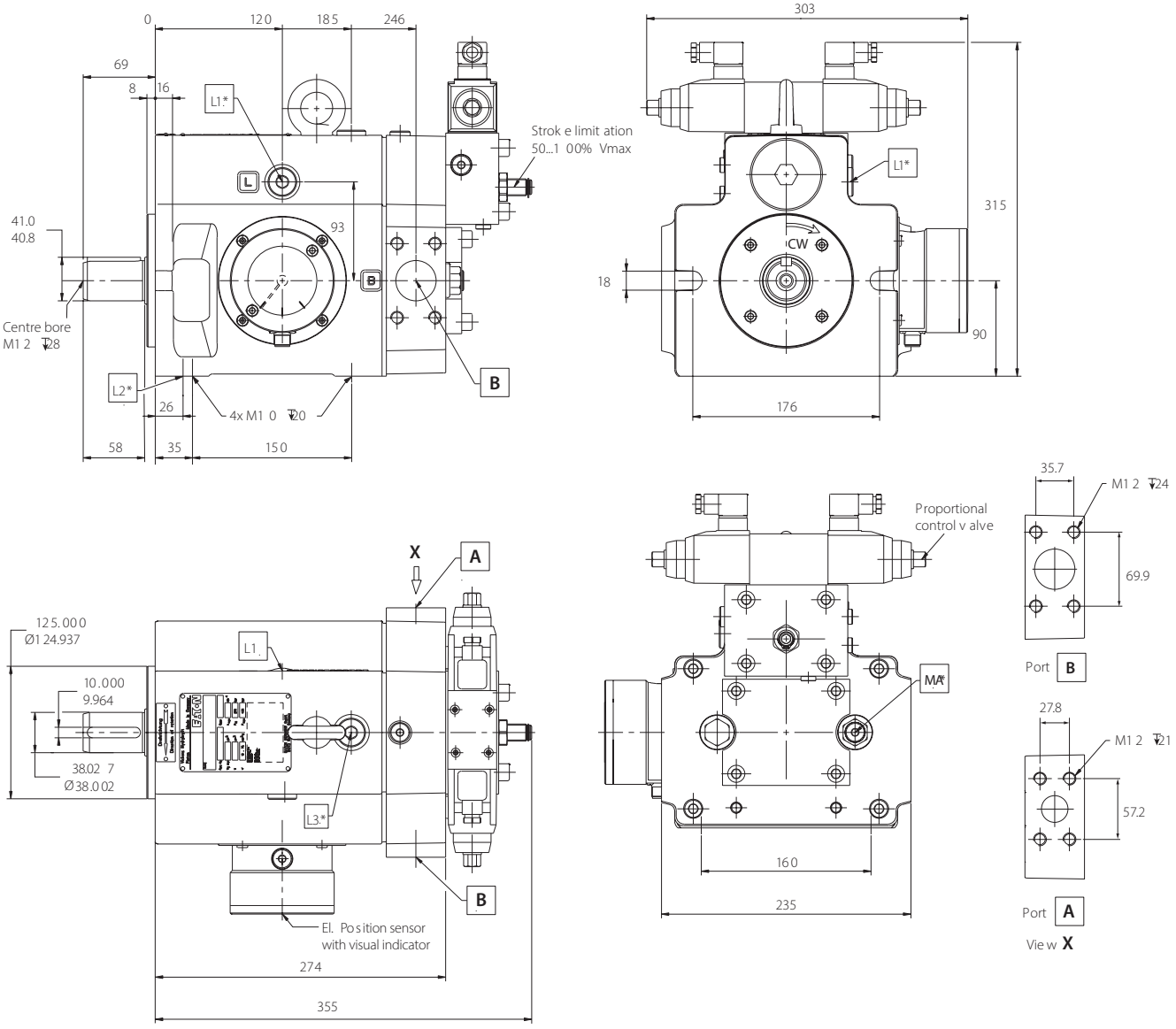
Pump specification

US

Model			66	90	130	180	250
Design			Swashplate - Axial piston pump				
Type of mounting			Flange or foot-mounted. Combination units foot mounted only				
Pipe connection Flange ISO 6162-1 (SAE J518 code 61) ISO 6162-2 (SAE J518 code 62)	 B A	 psi	 P38M (1 1/2" - 500) P25M (1" - 6000)	 P51M (2" - 500) P25M (1" - 6000)	 P64M (2 1/2" - 500) P25M (1" - 6000)	 P64M (2 1/2" - 500) P32M (1 1/4" - 6000)	 P89M (3 1/2" - 500) P32M (1 1/4" - 6000)
Direction of rotation			Clockwise, Counterclockwise on request.				
Mounting altitude			Horizontal, other mounting options are available on request				
Ambient temperature range	Min Max	°F	-4 122				
Weight	M	lb	121	165	234	251	467
Moment of inertia	J	lb ft^2	0.38	0.38	1.068	1.068	3.465
Hydraulic characteristics							
Rated pressure (100% duty cycle)	p_N	psi	5000				
Inlet pressure	$p1_{min}$ $p1_{max}$	psi	12.3 145	12.3 145	13.8 145	13.8 145	14.5 145
Maximum pressure to ISO 5598:2008	$p2_{max}$	psi	6000				
Hydraulic fluid			Hydraulic oil to DIN 51524 part 2 See fluid recommendations in application data				
Hydraulic fluid temperature range	min max	°F	-13 (on startup) 194				
Viscosity range for continuous operation	min max	cSt	10 75				
Maximum permissible start viscosity	max	cSt	1000				
Cleanliness	ISO 4406		18/15/13				
Maximum geometric displacement	V_g	in^3	4.0	5.5	8.0	11.0	15.3
Speed range	n_{min} n_{max}	rev/min	150 1800				
Case pressure (over pressure) n = 1200 rev/min n = 1500 rev/min n = 1800 rev/min	p_{case}	psi	 50 39 32	 50 39 32	 46 36 29	 46 36 29	 40 30 24
Drive							
Driving torque (p_N = 5075psi, Vg at 1500 rev/minη_v = 100%)	$M1_{Single}$	lbf*ft.	271	369	534	739	1027
Power consumption (p_N = 5075psiη = 1500 rev/min, η = 100%)	$P1_{Single}$	hp	77.5	105.5	152.5	211	293
Combination units							
Maximum driving torque limited by splined shaft only - comb. unit	M1 Comb	lb*ft.	2x271	2x369	2x534	2x739	2x1027

Pump dimensions

PVX 066 STC03A0



A System pressure port
ISO 6162-2 P25M
(SAEJ 518
Code 62 - 1" - 6000 PSI)

B Inlet port
ISO 6162-1 P38M
(SAEJ 518
Code 61 - 1 ½" - 500 PSI)

L1 Drain port M-22x1.5
(according to mounting
position use upper port)

L2 M18x1.5-12 Deep
supplementary drain
or bleed plug. Must be
drained in addition to L1
if pump is installed
with the shaft input end
pointing upwards

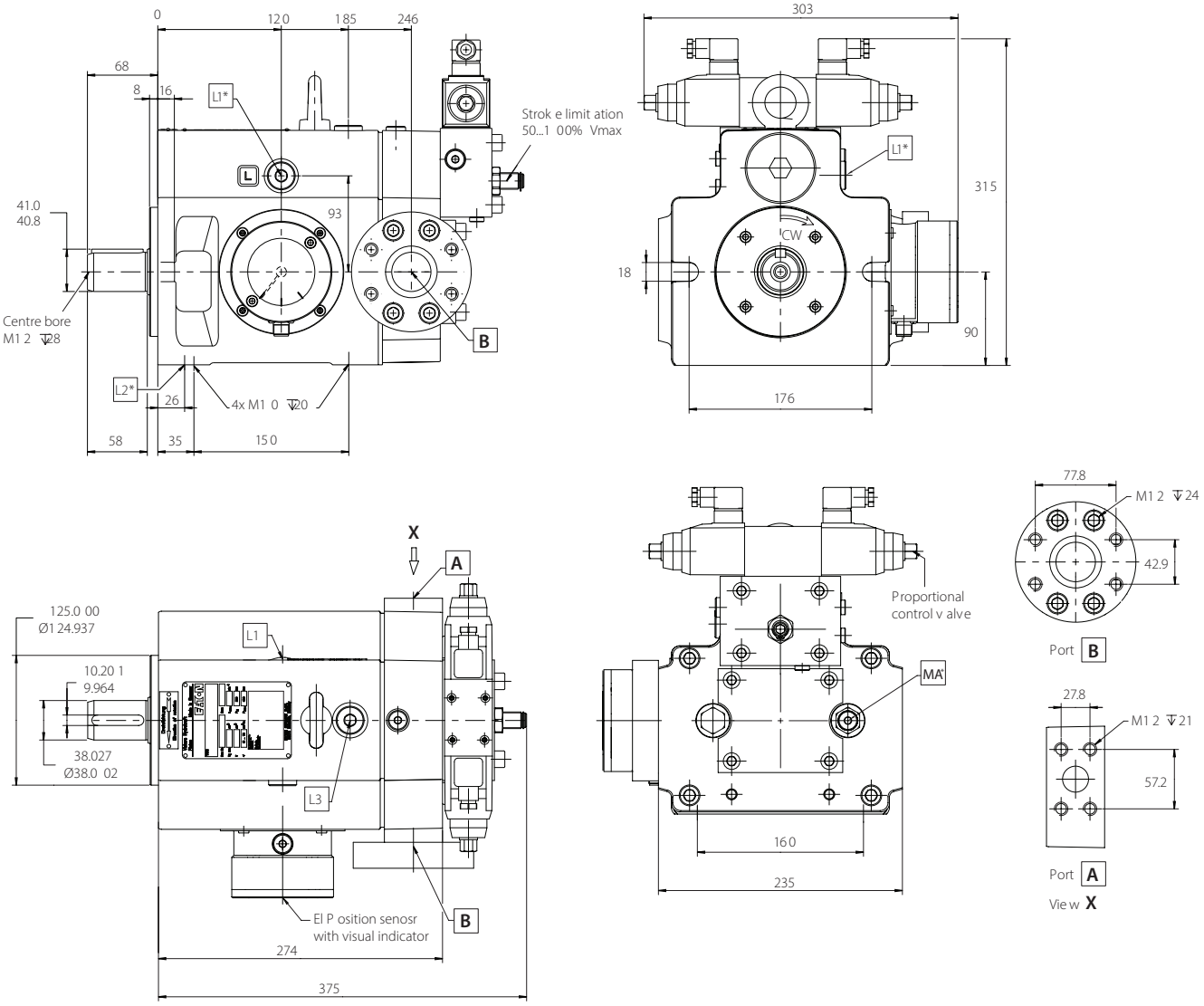
L3 Oil filling $^{7}/_{8}$"-14 UNF
or bleed plug

MA Gauge port system
pressure G ¼"

...* Connection with plug

Pump dimensions

PVX 090 STC03A0



A System pressure port
ISO 6162-2 P25M
(SAEJ 518
Code 62 - 1"- 6000 PSI)

B Inlet port
ISO 6162-1 P51M
(SAEJ 518
Code 61 - 2" - 500 PSI)

L1 Drain port M22x1.5
(according to mounting
position use upper port)

L2 M18x1.5-12 Deep
supplementary drain
or bleed plug. Must be
drained in addition to L1
if the pump is installed
with the shaft input end
pointing upwards

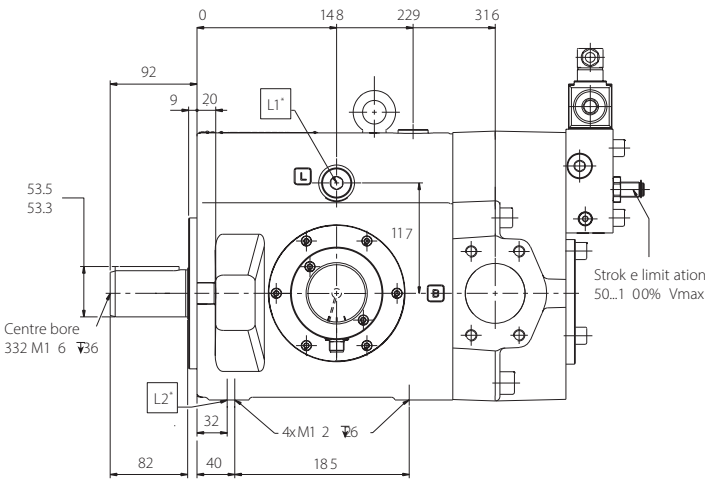
L3 Oil filling $^{7}/_{8}$"-14 UNF or
bleed plug

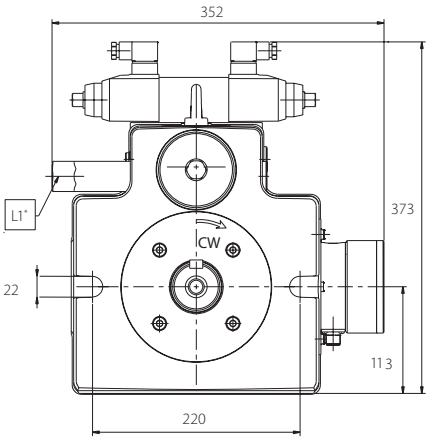
MA Gauge port system
pressure G ¼"

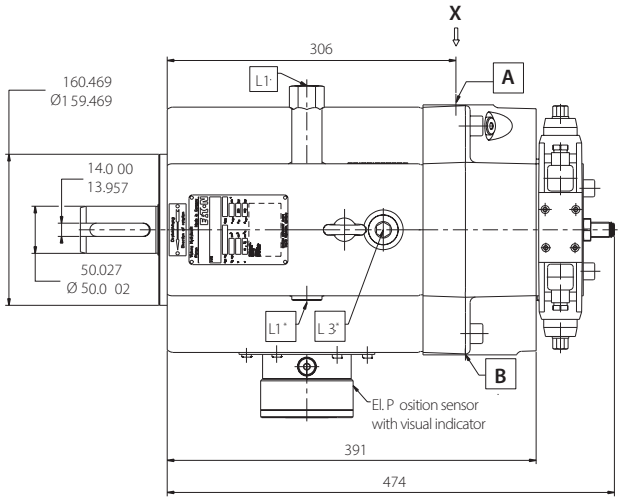
...* Connection with plug

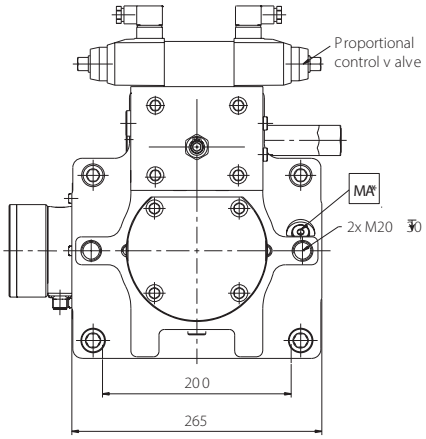
Pump dimensions

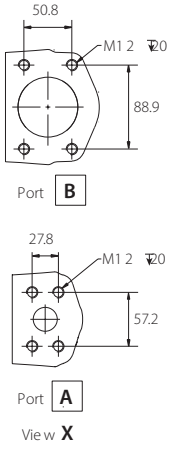
PVX 130 STC03A0











A System Pressure port
ISO 6162-2 P25M
(SAEJ 518
Code 62 - 1" - 6000 PSI)

B Inlet Port
ISO 6162-1P64M
(SAEJ 518
Code 61 - 2 ½" - 500 PSI)

L1 Drain port M26x1.5,
(according to mounting
position use upper port)

L2 M18x1.5-12 Deep
supplementary drain
or bleed plug. Must be
drained in addition to L1
if the pump is installed
with the shaft input end
pointing upwards

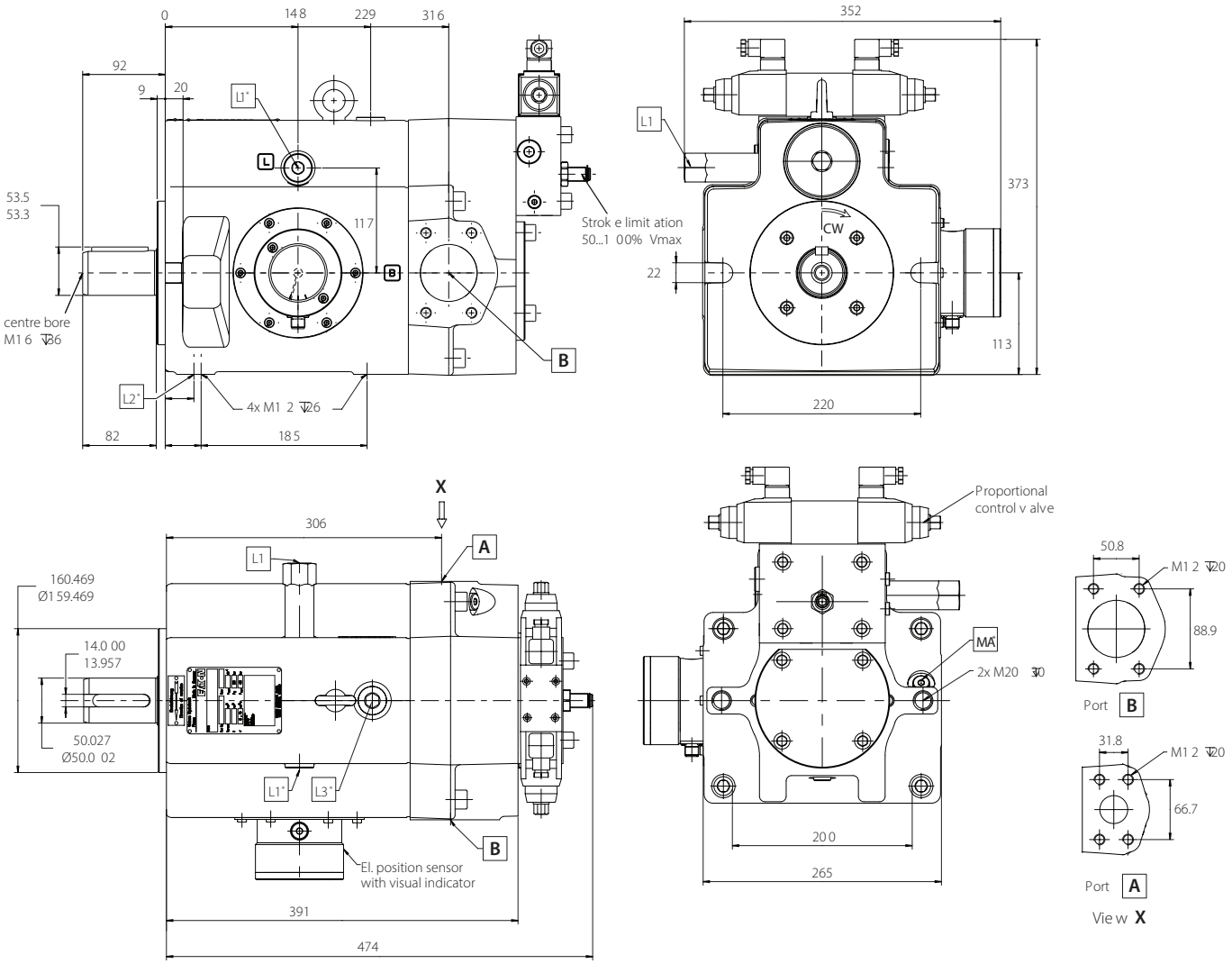
L3 Oil filling 1 $^{1}/_{16}$"-12
or bleed plug

MA Guage port system
pressure G ¼"

...* Connection with plug

Pump dimensions

PVX 180 STC03A0



A System pressure port
ISO 6162-2 P32M
(SAEJ 518
Code 62 - 1 ¼" - 6000 PSI)

B Inlet port
ISO 6162-1 P64M
(SAEJ 518
Code 61 - 2 ½" - 500 PSI)

L1 Drain port M26x1.5,
(according to mounting
position use upper port)

L2 M18x1.5-12 deep
supplementary drain,
or bleed plug. Must be
drained in addition to L1
if the pump is installed
with the shaft input end
pointing upwards

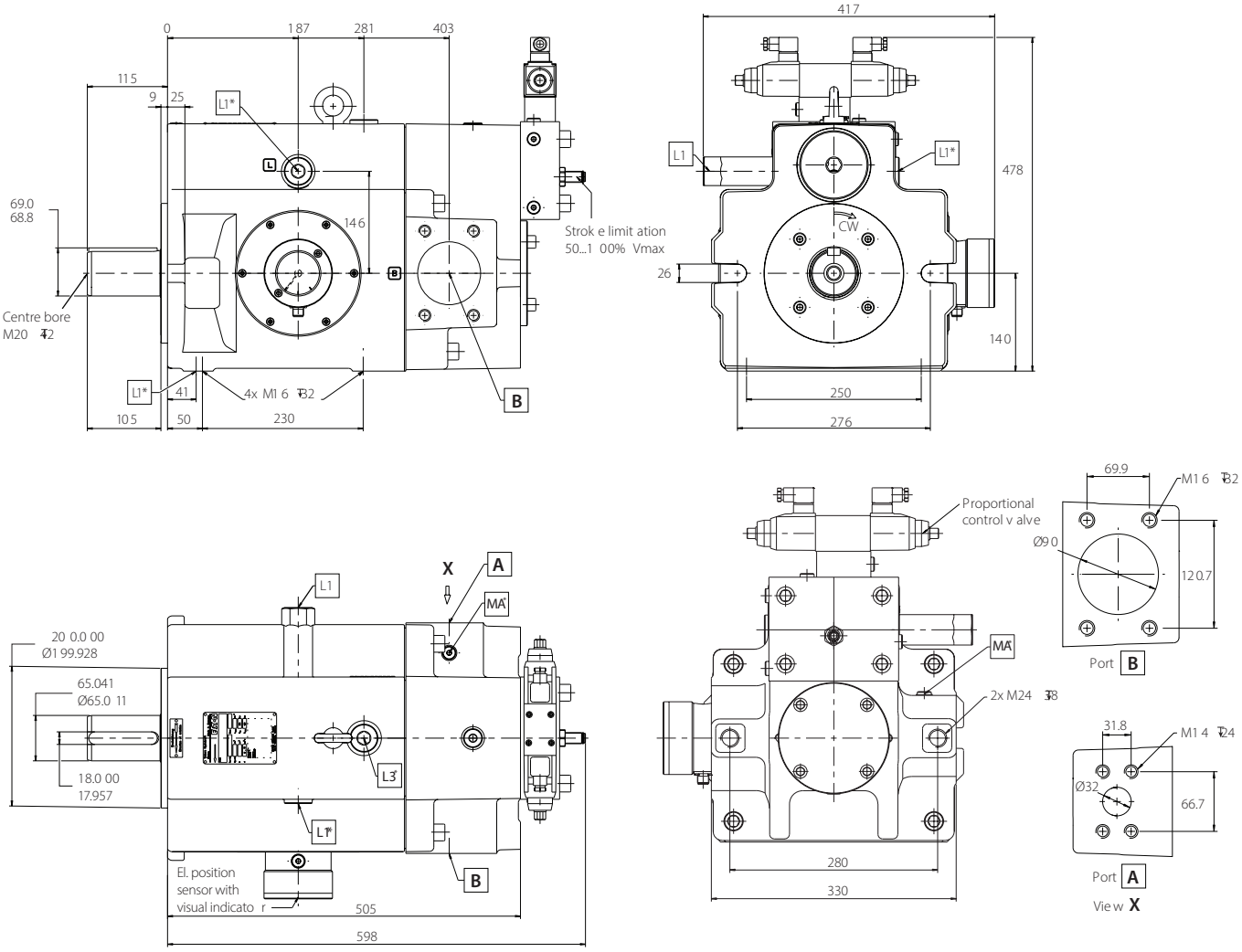
L3 Oil filling 1 $^{1}/_{16}$" -12
or bleed plug

MA Gauge port system
pressure G ¼"

...* Connection with plug

Pump dimensions

PVX 250 STC03A0



A System presssure port
ISO 6162-2 P32M
(SAEJ 518
Code 62 - 1 ¼" - 6000 PSI)

B Inlet Port
ISO 6162-1 P89M
(SAEJ 518
Code 61 - 3 ½" - 500 PSI)

L1 Drain port M33x2,
(according to mounting
position use upper port)

L2 M18x1.5-12 Deep
supplementary drain,
or bleed plug. Must be
drained in addition to L1
if the pump is installed
with the shaft input end
pointing upwards

L3 Oil filling 1 $^{5}/_{16}$"-12 UNF
or bleed plug

MA Gauge port system
pressure G ¼"

...* Connection with plug

Controls option - ST

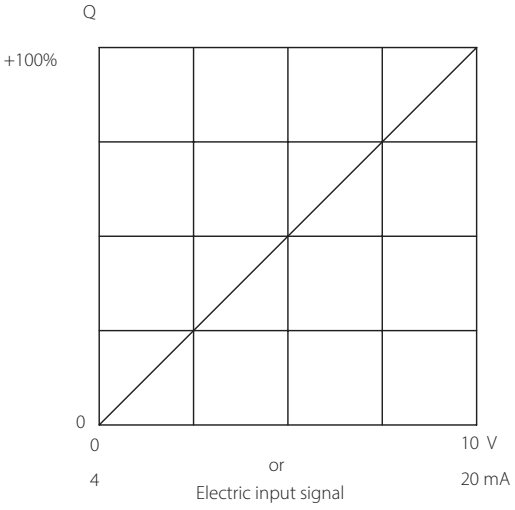
"X" series - open loop pump

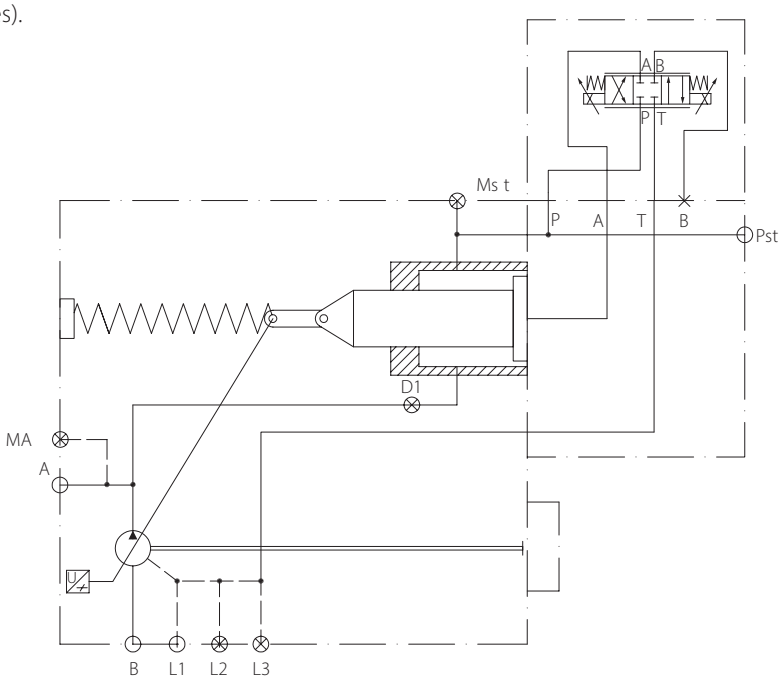
The ST control operates a hydrostatic drive and works without throttle losses within electrically adjustable limits. This is done by controlling delivery flow with electrical swashplate angle feedback (electric closed-loop control). All control values are recorded as an electrical signal and lead back to the control card.

The proportional valve and servo piston transform the output signal of the control card to the desired setting. This results in a very precise and dynamic control. Pressure limiter override available on request. Power limiter override not available (for such and other options please refer to PVW series).

As an additional option the maximum (and/or minimum) flow can be limited by a spacer inside the control cylinder (position number 13 in model coding, options 4, 5 or 6 in combination with customer adjustment specifications position 40-43 for the set values).

This solution is also recommended for very rough operating conditions and the need of a very exact repeatability over a long time period. The setting must be defined before ordering and cannot be modified during operation.





PVX response times ST - control

Proportional valve	Pilot oil flow	Control electronics	Response time[1]	Unit size	Servo piston		
		(Amp. Card)	0 < > Vmax	cm³	Diameter	Stroke	Volume
			[ms]		mm (in)	mm (in)	cm³ (in³)
			250	066 / 090	40/30 (1.57/1.18)	28 (1.10)	15,4 (0.939)
KDG4V3-2C20NMUH760	Internal	ER 9.3-10	350	130 / 180	55/48 (2.16/1.88)	35 (1.37)	43,5 (2.654)
(CETOP 3)			550	250	70/60 (2.75/2.36)	43,5 (1.71)	81 (4.942)

[1] Response time is depending on pressure and flow provided to control piston. Shown values are average values with internal pilot **oil supply.**

ST control amplifier card ER9.3 features & benefits

- Low cost version of SP control
- Neutral/starting position by spring: max displacement
- Pilot pump not required
- With control piston ratio 4:1, spring centering at max flow
- With internal or external pilot oil supply
- Reduced installation space
- Universal, full digital amplifier card ER 9.x
- 2 x 14 bit analog inputs, 0- +/-10V or 4-20mA
- 4 recallable digital adjustable set points
- Preset with parameters for SP/ST-control
- Programmable by customer via Display on card or via RS 232 Interface (PC- Software for free)

Application data and fluid recommendations

Fluid type	Classification DIN/ISO	Rated pressure p_N (bar)	Maximum speed (rev/min) ■ 66-180cc	250cc	Recommended seal material	Maximum operating temperature °C	Bearing life
Water Glycol▲	HFC	250	1500 (1800)	1200 (1500)	NBR	45	25-100%
HFDR (phosphate ester based)	HFDR	350	1500	1200	FKM	60	100%▼
HFDU (glycol based)	HFDU	350	1500	1200	FKM	60	100%▼
HFDU (ester based)	HFDU	350	1800	1500	FKM	60	100%▼
HEES (synthetic ester)	HEES	350	1800	1500	FKM	60	100%▼

■ *See general specifications for speed limitation depending on displacement.*

▲ *For HFC operation, bearing flushing is mandatory. Highest speed only recommended at optimized application conditions.*

Use Model Code 21 = "C" for seal option, and contact your Danfoss Representative for validation.

Seal material can differ on an individual pump depending on specific seal function.

Bearing life with HFC fluid depends significantly on fluid temperature, cleanliness, quality, flushing and application parameters,

Typical values vary between 25% and 100% compared to mineral oil.

▼ *Only fluids with fully saturated esters (iodine value <10) should be used.*

HFDU and HEES fluids can be used at full ratings, but need to be monitored continuously to maintain quality and performance.

The following important values should always be checked:

- Water content (<= 500 ppm)
- Fluid cleanliness (18/15/13 per ISO 4406)
- *TAN value (no significant change from new oil)*
- *Viscosity (no significant change from new oil)*
- *Additives (no significant change from new oil)*

Under harsh operation conditions, especially with regard to temperature and water content, ester-based HFDU and HFDR fluids are prone to hydrolysis, the resulting chemical processes and products of which could damage seal and other pump components. In general, the susceptibility to temperatureand and contamination is significantly higher than with standard minerlal oils.

In line with Danfoss Germany GmbH T&C warranty conditions covering use of HFDR/HFDU/Fluids, Fluids-related damage is excluded.

Case/bearing flushing

Case and bearing flushing are mandatory for HFC fluid operation, and recommended for all other conditions where the pump is operating for longer intervals at low pressure i.e. <20 bar (<300 psi) and/ or low flow at high pressure (compensated mode).

Estimated flushing flow values at 1500 rev/min

Pump size (cm^3/rev)	Flushing flow (l/min)
066/090	3,5
130/180	4,5
250	6

Vertical mounting

Vertical mounting of Hydrokraft pumps is possible, but venting and lubrication of shaft bearings can require special flushing and installation procedures. For details, please refer to the Hydrokraft Application Guideline Presentation available from your Danfoss Representative.

High pressure lubrication / hydrostatic balancing for yoke bearings (half-cup bearings)

High-pressure bearing lubrication and balancing (Model Code 21 = "K") is recommeded for operating conditions with either high cycle frequencies (very short up/downstroke times) and/or where the swashplate is constantly maintained at a certain angle for long periods of time (compensated mode).

⚠

For details and additional information, please refer to the "HydroKraft Application Guideline Presentation" available from your Danfoss Representative.

Warning:

Care should be taken that mechanical and hydraulic resonances are avoided in the application of the pump. Such resonances can seriously compromise the life and/or safe operation of the pump.

Drive data

Mounting attitude should be horizontal using the appropriate case drain ports to ensure that the case remains full of fluid at all times. Consult your local Danfoss Representative if a different arrangement is required. In those cases where geometric tolerances of mounting are critical, or where specific tolerance ranges are required and not specified, consult Danfoss Engineering for specific limits.

Direction of shaft rotation, viewed from the prime mover end, must be as indicated in the model designation on the pump – either right hand (clockwise) or left hand (counterclockwise). Direct coaxial drive through a flexible coupling is recommended. If drives imposing radial shaft loads are considered, please consult your Danfoss Representative.

Start-up procedure

Make sure the reservoir and circuit are clean and free of dirt/debris prior to filling with hydraulic fluid. Fill the reservoir with filtered oil and fill to a level sufficient enough to prevent vortexing at the suction connection to pump inlet. It is good practice to clean the system by flushing and filtering, using an external slave pump.

Caution:

Before the pump is started, fill the case through the uppermost drain port with hydraulic fluid of the type to be used. The case drain line must be connected directly to the reservoir and must terminate below the oil level. Once the pump is started, it should prime within a few seconds. If the pump does not prime, check to make sure that there are no restrictions between the reservoir and the inlet to the pump, and that the pump is being rotated in the proper direction, and that there are no air leaks in the inlet line and connections. Also check to make sure that trapped air can escape at the pump outlet. After the pump is primed, tighten the loose outlet connections, then operate for five to ten minutes (unloaded) to remove all trapped air from the circuit. If the reservoir has a sight gage, make sure the fluid is clear – not milky.

Fluid cleanliness

Hydrokraft pumps are rated in anti-wear petroleum fluids with a contamination level of 18/15/13 per ISO 4066. Operation in fluids with levels more contaminated than this is not recommended. Fluids other than petroleum, severe service cycles, or temperature extremes are cause for adjustment of these codes. Please contact your Danfoss Representative for specific duty cycle recommendation.

Danfoss Hydrokraft pumps, as with any variable displacement piston pumps, will operate with apparent satisfaction in fluids up to the rating specified here. Experience has shown however, that pump and hydraulic system life is not optimized with high fluid contamination levels (high ISO cleanliness codes).

Proper fluid condition is essential for long and satisfac tory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials, and additives for protection against wear of components, elevated viscosity and inclusion of air.

Essential information on the correct methods for treating hydraulic fluid is included in Danfoss publication 561 “Danfoss Guide to Systemic Contamination Control" available from your local Danfoss distributor. In this publication, filtration and cleanliness levels for extending the life of axial piston pumps and other system components are listed. Included is an excellent discussion of the selection of products needed to control fluid condition.

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