Rexroth
Bosch Group

Axial Piston Fixed Pump
A2FO

RE 91401/06.2012 **1**/34
Replaces: 03.08

Data sheet

Series 6

Size	Nominal pressure/Maximum pressure
5	315/350 bar
10 to 200	400/450 bar
250 to 1000	350/400 bar

Open circuit

Contents

Features

- Fixed pump with axial tapered piston rotary group of bent-axis design, for hydrostatic drives in an open circuit
- For use in mobile and stationary applications
- The flow is proportional to the drive speed and displacement
- The drive shaft bearings are designed for the bearing service life requirements usually encountered in these areas
- High power density
- Small dimensions
- High total efficiency
- Economical design
- One-piece tapered piston with piston rings for sealing

Ordering code for standard program

	A2F		O		/	6			–	V				
01	02	03	04	05		06	07	08		09	10	11	12	13

Hydraulic fluid

01	Mineral oil and HFD. HFD for sizes 250 to 1000 only in combination with long-life bearings "L" (without code)		
	HFB, HFC hydraulic fluid	Sizes 5 to 200 (without code)	
		Sizes 250 to 1000 (only in combination with long-life bearings "L")	**E-**

Axial piston unit

02	Bent-axis design, fixed	**A2F**

Drive shaft bearing

		5 to 200	250 to 500	710 to 1000	
03	Standard bearing (without code)	●	●	–	
	Long-life bearing	–	●	●	**L**

Operating mode

04	Pump, open circuit	**O**

Sizes (NG)

05	Geometric displacement, see table of values on page 7																				
		5	**10**	**12**	**16**	**23**	**28**	**32**	**45**	**56**	**63**	**80**	**90**	**107**	**125**	**160**	**180**	**200**	**250**	**355**	**500**	**710**	**1000**

Series

06		**6**

Index

07		NG10 to 180	**1**
		NG200	**3**
		NG5 and 250 to 1000	**0**

Directions of rotation

08	Viewed on drive shaft	clockwise	**R**
		counter-clockwise	**L**

Seals

09	FKM (fluor-caoutchouc)	**V**

Drive shafts

		5	**10**	**12**	**16**	**23**	**28**	**32**	**45**	**56**	**63**	**80**	**90**	**107**	**125**	**160**	**180**	**200**	**250 to 1000**	
10	Splined shaft DIN 5480	–	●	●	●	●	●	●	–	●	●	●	●	●	●	●	●	●	–	**A**
		–	●	●	–	●	●	–	●	●	–	●	–	●	–	●	–	–	●	**Z**
	Parallel keyed shaft DIN 6885	●	●	●	●	●	●	●	–	●	●	●	●	●	●	●	●	●	–	**B**
		–	●	●	–	●	●	–	●	●	–	●	–	●	–	●	–	–	●	**P**
	Conical shaft[1)]	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**C**

Mounting flanges

			5 to 250	355 to 1000	
11	ISO 3019-2	4-hole	●	–	**B**
		8-hole	–	●	**H**

● = Available ❍ = On request – = Not available ▭ = Preferred program

1) Conical shaft with threaded pin and woodruff key (DIN 6888). The torque must be transmitted via the tapered press fit.

Ordering code for standard program

	A2F		O		/	6			–	V				
01	02	03	04	05		06	07	08		09	10	11	12	13

	Port plates for service lines[2]	5	10 to 16	23 to 250	355 to 1000	
12	SAE flange port A/B at side and SAE flange port S at rear	–	–	●	–	05
	Threaded port A/B at side and threaded port S at rear	–	●	–	–	06
	SAE flange ports A/B and S at rear	–	–	–	●	11
	Threaded ports A/B and S at side	●	–	–	–	07

	Standard / special version	
13	Standard version (without code)	
	Standard version with installation variants, e. g. T ports against standard open or closed	–Y
	Special version	-S

● = Available ❍ = On request – = Not available ▭ = Preferred program

2) Fastening thread or threaded ports, metric

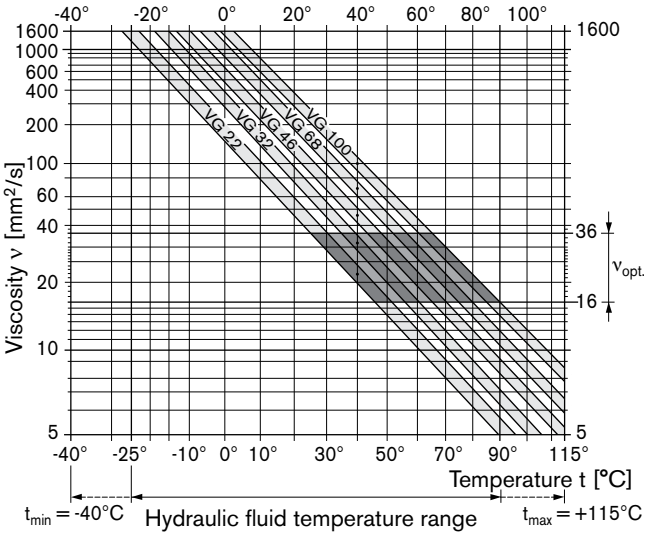
Technical data

Hydraulic fluid

Before starting project planning, please refer to our data sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids), RE 90222 (HFD hydraulic fluids) and RE 90223 (HFA, HFB, HFC hydraulic fluids) for detailed information regarding the choice of hydraulic fluid and application conditions.

The fixed pump A2FO is not suitable for operation with HFA hydraulic fluid. If HFB, HFC or HFD or environmentally acceptable hydraulic fluids are used, the limitations regarding technical data or other seals must be observed.

Selection diagram



Details regarding the choice of hydraulic fluid

The correct choice of hydraulic fluid requires knowledge of the operating temperature in relation to the ambient temperature: in an open circuit, the reservoir temperature.

The hydraulic fluid should be chosen so that the operating viscosity in the operating temperature range is within the optimum range (ν_{opt} see shaded area of the selection diagram). We recommended that the higher viscosity class be selected in each case.

Example: At an ambient temperature of X °C, an operating temperature of 60 °C is set in the circuit. In the optimum operating viscosity range ($\nu_{opt.}$, shaded area), this corresponds to the viscosity classes VG 46 or VG 68; to be selected: VG 68.

Note

The case drain temperature, which is affected by pressure and speed, can be higher than the reservoir temperature. At no point of the component may the temperature be higher than 115 °C. The temperature difference specified below is to be taken into account when determining the viscosity in the bearing.

If the above conditions cannot be maintained due to extreme operating parameters, we recommend flushing the case at port U (sizes 250 to 1000).

Viscosity and temperature of hydraulic fluid

	Viscosity [mm²/s]	Temperature	Comment
Transport and storage at ambient temperature		$T_{min} \geq$ -50 °C T_{opt} = +5 °C to +20 °C	factory preservation: up to 12 months with standard, up to 24 months with long-term
(Cold) start-up[1]	ν_{max} = 1600	$T_{St} \geq$ -40 °C	t ≤ 3 min, without load (p ≤ 50 bar), n ≤ 1000 rpm (for sizes 5 to 200), n ≤ 0.25 • n_{nom} (for sizes 250 to 1000)
Permissible temperature difference		ΔT ≤ 25 K	between axial piston unit and hydraulic fluid
Warm-up phase	ν < 1600 to 400	T = -40 °C to -25 °C	at p ≤ 0.7 • p_{nom}, n ≤ 0.5 • n_{nom} and t ≤ 15 min
Operating phase			
Temperature difference		ΔT = approx. 12 K	between hydraulic fluid in the bearing and at port T.
Maximum temperature		115 °C	in the bearing
		103 °C	measured at port T
Continuous operation	ν = 400 to 10 ν_{opt} = 36 to 16	T = -25 °C to +90 °C	measured at port T, no restriction within the permissible data
Short-term operation[2]	$\nu_{min} \geq$ 7	T_{max} = +103 °C	measured at port T, t < 3 min, p < 0.3 • p_{nom}
FKM shaft seal[1]		T ≤ +115 °C	see page 5

1) At temperatures below -25 °C, an NBR shaft seal is required (permissible temperature range: -40 °C to +90 °C).
2) Sizes 250 to 1000, please contact us.

Technical data

Filtration of the hydraulic fluid

Finer filtration improves the cleanliness level of the hydraulic fluid, which increases the service life of the axial piston unit.

To ensure the functional reliability of the axial piston unit, a gravimetric analysis of the hydraulic fluid is necessary to determine the amount of solid contaminant and to determine the cleanliness level according to ISO 4406. A cleanliness level of at least 20/18/15 is to be maintained.

At very high hydraulic fluid temperatures (90 °C to maximum 115 °C), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

If the above classes cannot be achieved, please contact us.

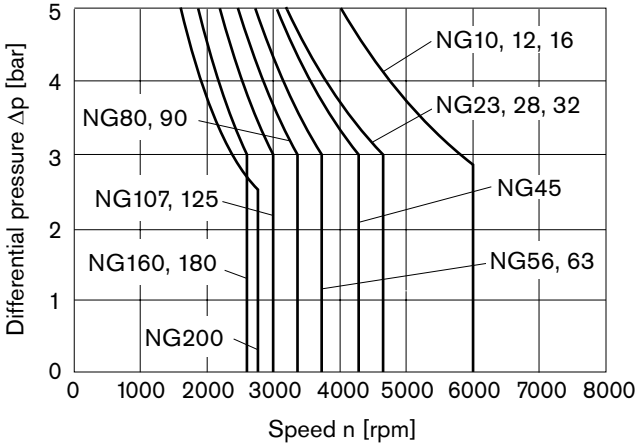
Shaft seal

Permissible pressure loading

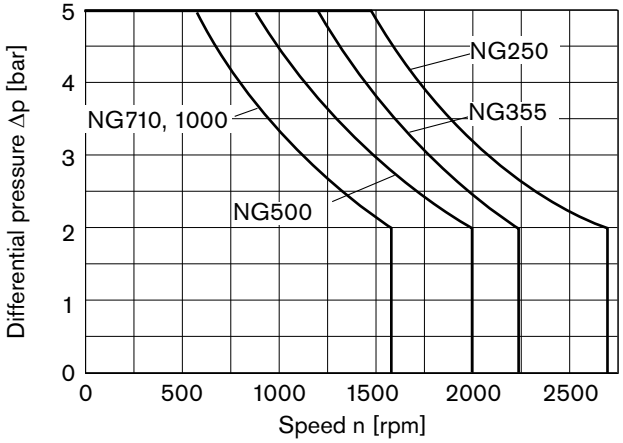
The service life of the shaft seal is influenced by the speed of the axial piston unit and the case drain pressure (case pressure). The mean differential pressure of 2 bar between the case and the ambient pressure may not be enduringly exceeded at normal operating temperature. For a higher differential pressure at reduced speed, see diagram. Momentary pressure spikes ($t < 0.1$ s) of up to 10 bar are permitted. The service life of the shaft seal decreases with an increase in the frequency of pressure spikes.

The case pressure must be equal to or higher than the ambient pressure.

Sizes 10 to 200



Sizes 250 to 1000



The values are valid for an ambient pressure $p_{abs} = 1$ bar.

Temperature range

The FKM shaft seal may be used for case drain temperatures from -25 °C to +115 °C.

Note
For application cases below -25 °C, an NBR shaft seal is required (permissible temperature range: -40 °C to +90 °C). State NBR shaft seal in plain text when ordering.
Please contact us.

Direction of flow

Direction of rotation, viewed on drive shaft	
clockwise	**counter-clockwise**
S to **B**	**S** to **A**

Long-life bearing

Sizes 250 to 1000
For long service life and use with HF hydraulic fluids. Identical external dimensions as motor with standard bearings. Subsequent conversion to long-life bearings is possible. Bearing and case flushing via port U is recommended.

Flushing flow (recommended)

NG	250	355	500	710	1000
$q_{v\,flush}$ (L/min)	10	16	16	16	16

Technical data

Operating pressure range

(operating with mineral oil)

Pressure at service line port A or B

Size 5

Nominal pressure p_{nom} _____ 315 bar absolute

Maximum pressure p_{max} _____ 350 bar absolute
Single operating period _____ 10 s
Total operating period _____ 300 h

Sizes 10 to 200

Nominal pressure p_{nom} _____ 400 bar absolute

Maximum pressure p_{max} _____ 450 bar absolute
Single operating period _____ 10 s
Total operating period _____ 300 h

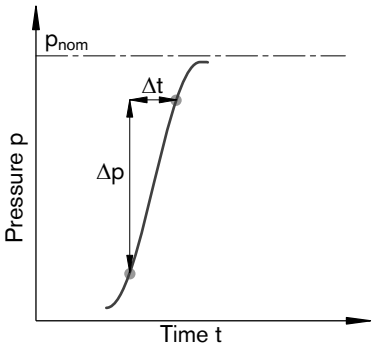
Sizes 250 to 1000

Nominal pressure p_{nom} _____ 350 bar absolute

Maximum pressure p_{max} _____ 400 bar absolute
Single operating period _____ 10 s
Total operating period _____ 300 h

Minimum pressure (high-pressure side) ___25 bar absolute

Rate of pressure change $R_{A\,max}$
Without pressure-relief valve _____ 16000 bar/s



Pressure at suction port S (inlet)

Minimum pressure $p_{S\,min}$ _____ 0.8 bar absolute

Maximum pressure $p_{S\,max}$ _____ 30 bar absolute

Note
Values for other hydraulic fluids, please contact us.

Definition

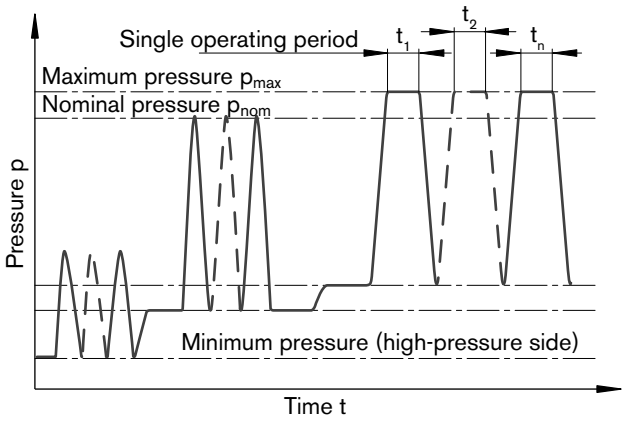
Nominal pressure p_{nom}
The nominal pressure corresponds to the maximum design pressure.

Maximum pressure p_{max}
The maximum pressure corresponds to the maximum operating pressure within the single operating period. The sum of the single operating periods must not exceed the total operating period.

Minimum pressure (high-pressure side)
Minimum pressure at the high-pressure side (A or B) which is required in order to prevent damage to the axial piston unit.

Minimum pressure (inlet)
Minimum pressure at suction port S (inlet) which is required in order to prevent damage to the axial piston unit. The minimum pressure is dependent on the speed of the axial piston unit (see diagram on page 7).

Rate of pressure change R_A
Maximum permissible rate of pressure rise and reduction during a pressure change over the entire pressure range.



Total operating period = $t_1 + t_2 + \ldots + t_n$

Technical data

Table of values (theoretical values, without efficiency and tolerances; values rounded)

Size		NG		5	10	12	16	23	28	32	45	56	63	80
Displacement geometric, per revolution		V_g	cm^3	4.93	10.3	12	16	22.9	28.1	32	45.6	56.1	63	80.4
Speed maximum[1]		n_{nom}	rpm	5600	3150	3150	3150	2500	2500	2500	2240	2000	2000	1800
		n_{max}[2]	rpm	8000	6000	6000	6000	4750	4750	4750	4250	3750	3750	3350
Flow at n_{nom}		q_V	L/min	27.6	32	38	50	57	70	80	102	112	126	145
Power at	$\Delta p = 350$ bar	P	kW	14.5[4]	19	22	29	33	41	47	60	65	74	84
	$\Delta p = 400$ bar	P	kW	–	22	25	34	38	47	53	68	75	84	96
Torque[3]														
at V_g and	$\Delta p = 350$ bar	T	Nm	24.7[4]	57	67	89	128	157	178	254	313	351	448
	$\Delta p = 400$ bar	T	Nm	–	66	76	102	146	179	204	290	357	401	512
Rotary stiffness		c	kNm/rad	0.63	0.92	1.25	1.59	2.56	2.93	3.12	4.18	5.94	6.25	8.73
Moment of inertia for rotary group		J_{GR}	kgm^2	0.00006	0.0004	0.0004	0.0004	0.0012	0.0012	0.0012	0.0024	0.0042	0.0042	0.0072
Maximum angular acceleration		α	rad/s^2	5000	5000	5000	5000	6500	6500	6500	14600	7500	7500	6000
Case volume		V	L		0.17	0.17	0.17	0.20	0.20	0.20	0.33	0.45	0.45	0.55
Mass (approx.)		m	kg	2.5	6	6	6	9.5	9.5	9.5	13.5	18	18	23

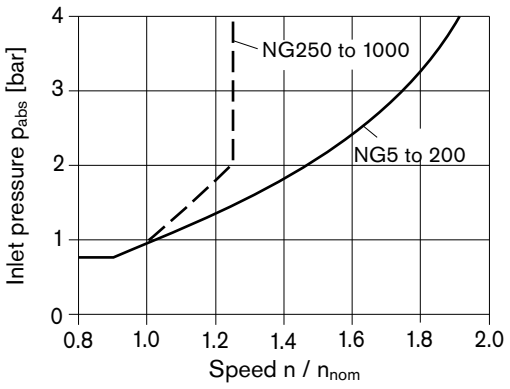
Size		NG		90	107	125	160	180	200	250	355	500	710	1000
Displacement geometric, per revolution		V_g	cm^3	90	106.7	125	160.4	180	200	250	355	500	710	1000
Speed maximum[1]		n_{nom}	rpm	1800	1600	1600	1450	1450	1550	1500	1320	1200	1200	950
		n_{max}[2]	rpm	3350	3000	3000	2650	2650	2750	1800	1600	1500	1500	1200
Flow at n_{nom}		q_V	L/min	162	171	200	233	261	310	375	469	600	852	950
Power at	$\Delta p = 350$ bar	P	kW	95	100	117	136	152	181	219	273	350	497	554
	$\Delta p = 400$ bar	P	kW	108	114	133	155	174	207	–	–	–	–	–
Torque[3]														
at V_g and	$\Delta p = 350$ bar	T	Nm	501	594	696	893	1003	1114	1393	1978	2785	3955	5570
	$\Delta p = 400$ bar	T	Nm	573	679	796	1021	1146	1273	–	–	–	–	–
Rotary stiffness		c	kNm/rad	9.14	11.2	11.9	17.4	18.2	57.3	73.1	96.1	144	270	324
Moment of inertia for rotary group		J_{GR}	kgm^2	0.0072	0.0116	0.0116	0.0220	0.0220	0.0353	0.061	0.102	0,178	0.55	0.55
Maximum angular acceleration		α	rad/s^2	6000	4500	4500	3500	3500	11000	10000	8300	5500	4300	4500
Case volume		V	L	0.55	0.8	0.8	1.1	1.1	2.7	2.5	3.5	4.2	8	8
Mass (approx.)		m	kg	23	32	32	45	45	66	73	110	155	325	336

1) The values are valid:
- at an absolute pressure $p_{abs} = 1$ bar at suction port S
- for the optimum viscosity range from $\nu_{opt} = 16$ to 36 mm^2/s
- with hydraulic fluid based on mineral oils

2) Maximum speed (limiting speed) with increased inlet pressure p_{abs} at suction port S, see adjacent diagram.

3) Torque without radial force, with radial force see page 8

4) Torque at $\Delta p = 315$ bar



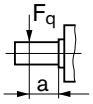
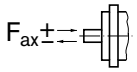
Note

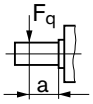
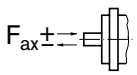
Operation above the maximum values or below the minimum values may result in a loss of function, a reduced service life or in the destruction of the axial piston unit. Other permissible limit values, with respect to speed variation, reduced angular acceleration as a function of the frequency and the permissible start up angular acceleration (lower than the maximum angular acceleration) can be found in data sheet RE 90261.

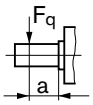
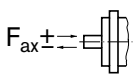
Technical data

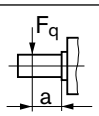
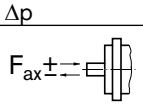
Permissible radial and axial forces of the drive shafts

(splined shaft and parallel keyed shaft)

Size	NG		5	5[3]	10	10	12	12	16	23	23
Drive shaft	ø	mm	12	12	20	25	20	25	25	25	30
Maximum radial force[1] at distance a (from shaft collar) 	$F_{q\,max}$	kN	1.6	1.6	3.0	3.2	3.0	3.2	3.2	5.7	5.4
	a	mm	12	12	16	16	16	16	16	16	16
with permissible torque	T_{max}	Nm	24.7	24.7	66	66	76	76	102	146	146
≙ permissible pressure Δp	Δp_{perm}	bar	315	315	400	400	400	400	400	400	400
Maximum axial force[2] 	$+F_{ax\,max}$	N	180	180	320	320	320	320	320	500	500
	$-F_{ax\,max}$	N	0	0	0	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$\pm F_{ax\,perm/bar}$	N/bar	1.5	1.5	3.0	3.0	3.0	3.0	3.0	5.2	5.2

Size	NG		28	28	32	45	56	56[4]	56	63	80
Drive shaft	ø	mm	25	30	30	30	30	30	35	35	35
Maximum radial force[1] at distance a (from shaft collar) 	$F_{q\,max}$	kN	5.7	5.4	5.4	7.6	9.5	7.8	9.1	9.1	11.6
	a	mm	16	16	16	18	18	18	18	18	20
with permissible torque	T_{max}	Nm	179	179	204	290	357	294	357	401	512
≙ permissible pressure Δp	Δp_{perm}	bar	400	400	400	400	400	330	400	400	400
Maximum axial force[2] 	$+F_{ax\,max}$	N	500	500	500	630	800	800	800	800	1000
	$-F_{ax\,max}$	N	0	0	0	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$\pm F_{ax\,perm/bar}$	N/bar	5.2	5.2	5.2	7.0	8.7	8.7	8.7	8.7	10.6

Size	NG		80[4]	80	90	107	107	125	160	160	180
Drive shaft	ø	mm	35	40	40	40	45	45	45	50	50
Maximum radial force[1] at distance a (from shaft collar) 	$F_{q\,max}$	kN	11.1	11.4	11.4	13.6	14.1	14.1	18.1	18.3	18.3
	a	mm	20	20	20	20	20	20	25	25	25
with permissible torque	T_{max}	Nm	488	512	573	679	679	796	1021	1021	1146
≙ permissible pressure Δp	Δp_{perm}	bar	380	400	400	400	400	400	400	400	400
Maximum axial force[2] 	$+F_{ax\,max}$	N	1000	1000	1000	1250	1250	1250	1600	1600	1600
	$-F_{ax\,max}$	N	0	0	0	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$\pm F_{ax\,perm/bar}$	N/bar	10.6	10.6	10.6	12.9	12.9	12.9	16.7	16.7	16.7

Size	NG		200	250	355	500	710	1000
Drive shaft	ø	mm	50	50	60	70	90	90
Maximum radial force[1] at distance a (from shaft collar) 	$F_{q\,max}$	kN	20.3	1.2[6]	1.5[6]	1.9[6]	3.0[6]	2.6[6]
	a	mm	25	41	52.5	52.5	67.5	67.5
with permissible torque	T_{max}	Nm	1273	[5]	[5]	[5]	[5]	[5]
≙ permissible pressure Δp	Δp_{perm}	bar	400	[5]	[5]	[5]	[5]	[5]
Maximum axial force[2] 	$+F_{ax\,max}$	N	1600	2000	2500	3000	4400	4400
	$-F_{ax\,max}$	N	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$\pm F_{ax\,perm/bar}$	N/bar	16.7	[5]	[5]	[5]	[5]	[5]

1) With intermittent operation
2) Maximum permissible axial force during standstill or when the axial piston unit is operating in non-pressurized condition.
3) Conical shaft with threaded pin and woodruff key (DIN 6888)
4) Restricted technical data only for splined shaft
5) Please contact us.
6) When at a standstill or when axial piston unit operating in non-pressurized conditions. Higher forces are permissible when under pressure, please contact us.

Note

Influence of the direction of the permissible axial force:

$+F_{ax\,max}$ = Increase in service life of bearings

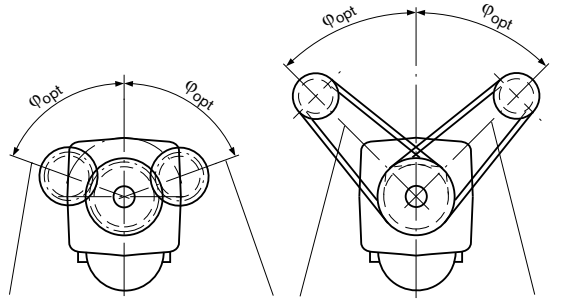
$-F_{ax\,max}$ = Reduction in service life of bearings (avoid)

Technical data

Effect of radial force F_q on the service life of bearings

By selecting a suitable direction of radial force F_q, the load on the bearings, caused by the internal rotary group forces can be reduced, thus optimizing the service life of the bearings. Recommended position of mating gear is dependent on direction of rotation. Examples:

	Toothed gear drive	V-belt output
NG	$\varphi_{opt.}$	$\varphi_{opt.}$
5 to 180	± 70°	± 45°
200 to 1000	± 45°	± 70°



Clockwise direction of rotation
Pressure at port **B**

Counter-clockwise direction of rotation
Pressure at port **A**

Clockwise direction of rotation
Pressure at port **B**

Determining the operating characteristics

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

Torque $$T = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_{mh}}$$ [Nm]

Power $$P = \frac{2\,\pi \cdot T \cdot n}{60000} = \frac{q_v \cdot \Delta p}{600 \cdot \eta_t}$$ [kW]

V_g = Displacement per revolution in cm^3

Δp = Differential pressure in bar

n = Speed in rpm

η_v = Volumetric efficiency

η_{mh} = Mechanical-hydraulic efficiency

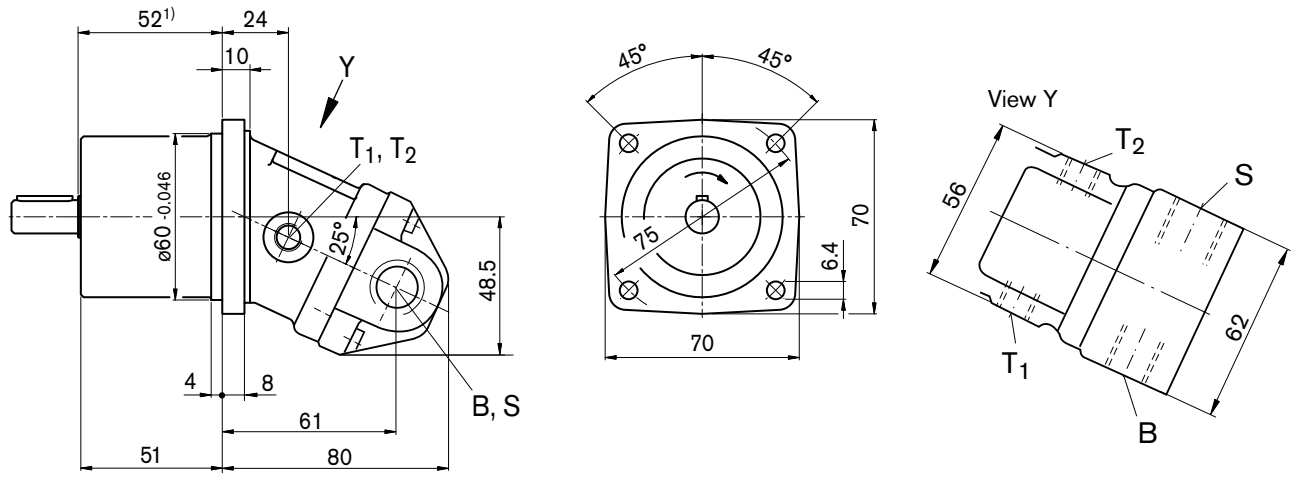
η_t = Total efficiency ($\eta_t = \eta_v \cdot \eta_{mh}$)

Dimensions size 5

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

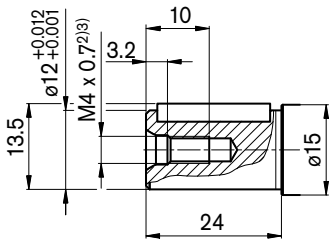
Port plate 07 – Threaded ports A/B and S at side

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)

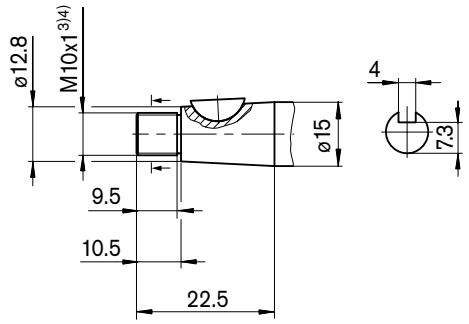


Drive shafts

B Parallel keyed shaft
DIN 6885, A4x4x20



C Conical shaft with threaded pin and woodruff key, 3x5 (DIN 6888), (tapering 1:10)



Ports

Designation	Port for	Standard[6)]	Size[3)]	Maximum pressure [bar][5)]	State[7)]
B (A)	Service line	DIN 3852	M18 x 1.5; 12 deep	350	O
S	Suction line	DIN 3852	M22 x 1.5; 14 deep	30	O
T_1	Drain line	DIN 3852	M10 x 1; 8 deep	3	O
T_2	Drain line	DIN 3852	M10 x 1; 8 deep	3	O

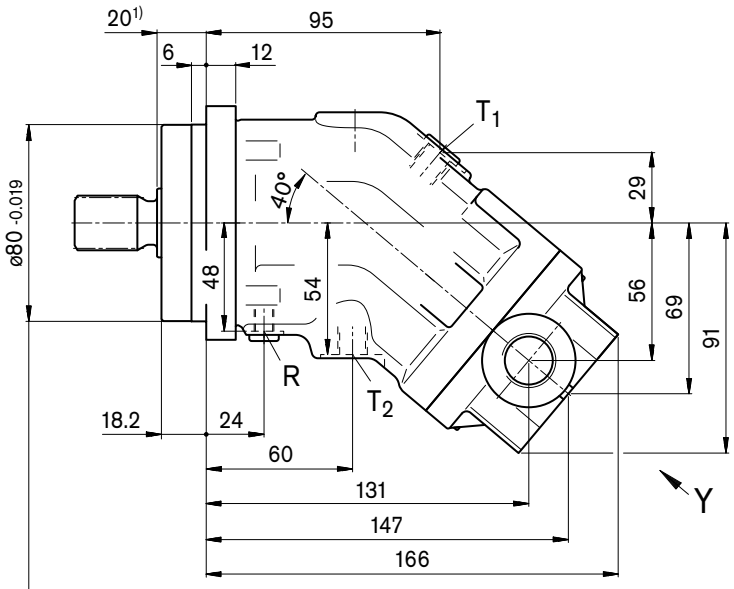
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 34 for the maximum tightening torques.
4) Thread according to DIN 3852, maximum tightening torque: 30 Nm
5) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)

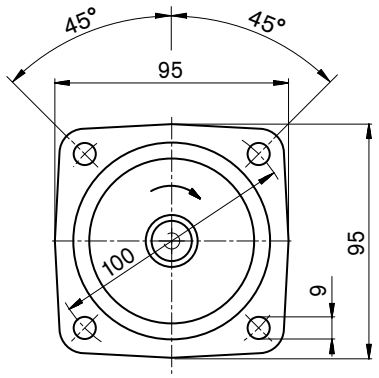
Dimensions sizes 10, 12, 16

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

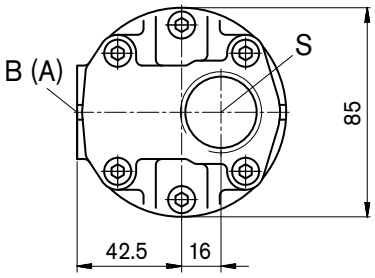
Port plate 06 – Threaded port A/B at side and threaded port S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)





View Y



1) To shaft collar

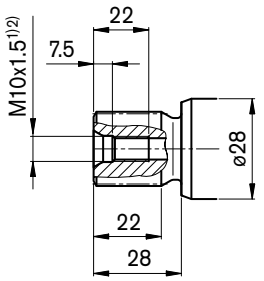
Dimensions sizes 10, 12, 16

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Drive shafts

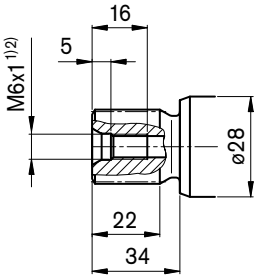
Sizes 10, 12, 16

A Splined shaft DIN 5480
W25x1.25x18x9g



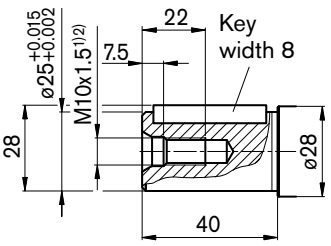
NG10, 12

Z Splined shaft DIN 5480
W20x1.25x14x9g



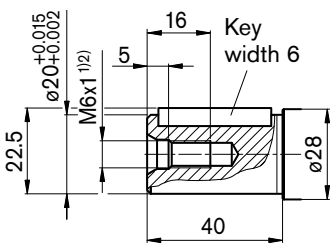
Sizes 10, 12, 16

B Parallel keyed shaft
DIN 6885, AS8x7x32



NG10, 12

P Parallel keyed shaft
DIN 6885, AS6x6x32



Ports

Designation	Port for	Standard[5)]	Size[2)]	Maximum pressure [bar][3)]	State[6)]
B (A)	Service line	DIN 3852	M22 x 1.5; 14 deep	450	O
S	Suction line	DIN 3852	M33 x 2; 18 deep	30	O
T_1	Drain line	DIN 3852	M12 x 1.5; 12 deep	3	X[4)]
T_2	Drain line	DIN 3852	M12 x 1.5; 12 deep	3	O[4)]
R	Air bleed	DIN 3852	M8 x 1; 8 deep	3	X

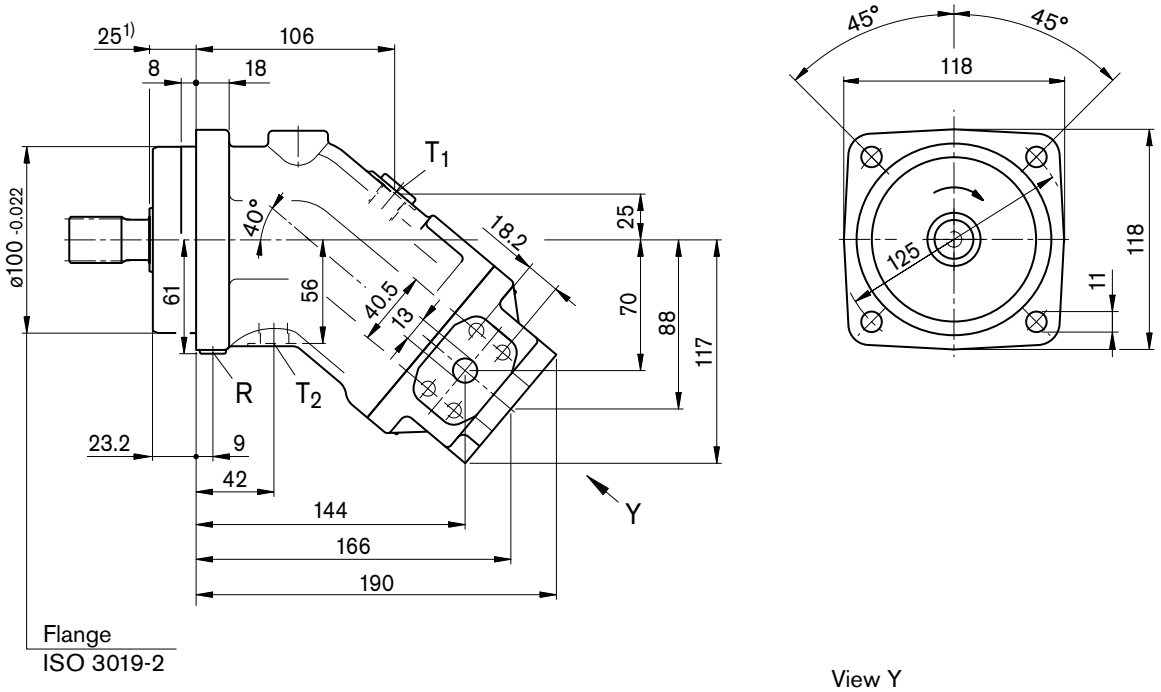
1) Center bore according to DIN 332 (thread according to DIN 13)
2) Observe the general instructions on page 34 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions sizes 23, 28, 32

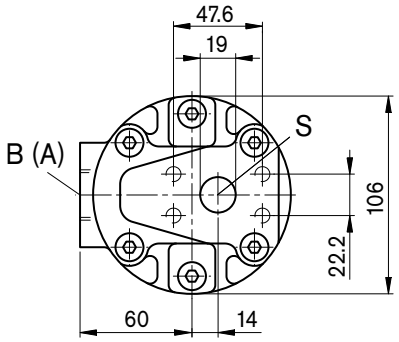
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 05 – SAE flange port A/B at side and SAE flange port S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)



View Y



1) To shaft collar

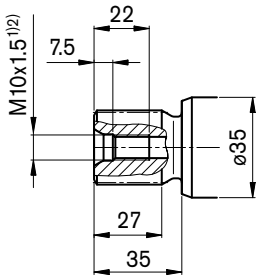
Dimensions sizes 23, 28, 32

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Drive shafts

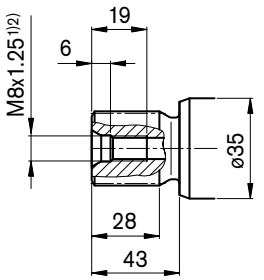
Sizes 23, 28, 32

A Splined shaft DIN 5480 W30x2x14x9g



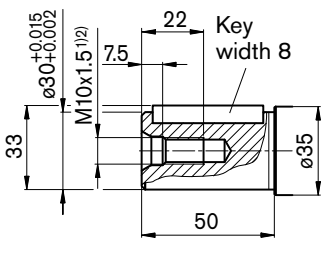
NG23, 28

Z Splined shaft DIN 5480 W25x1.25x18x9g



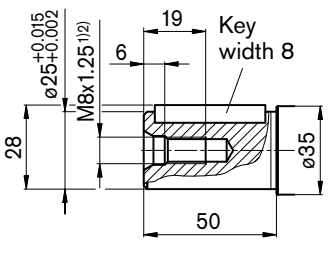
Sizes 23, 28, 32

B Parallel keyed shaft DIN 6885, AS8x7x40



NG23, 28

P Parallel keyed shaft DIN 6885, AS8x7x40



Ports

Designation	Port for	Standard	Size[2)]	Maximum pressure [bar][3)]	State[7)]
B (A)	Service line Fastening thread B/A	SAE J518[5)] DIN 13	1/2 in M8 x 1.25; 15 deep	450	O
S	Suction line Fastening thread	SAE J518[5)] DIN 13	3/4 in M10 x 1.5; 17 deep	30	O
T_1	Drain line	DIN 3852[6)]	M16 x 1.5; 12 deep	3	X[4)]
T_2	Drain line	DIN 3852[6)]	M16 x 1.5; 12 deep	3	O[4)]
R	Air bleed	DIN 3852[6)]	M10 x 1; 12 deep	3	X

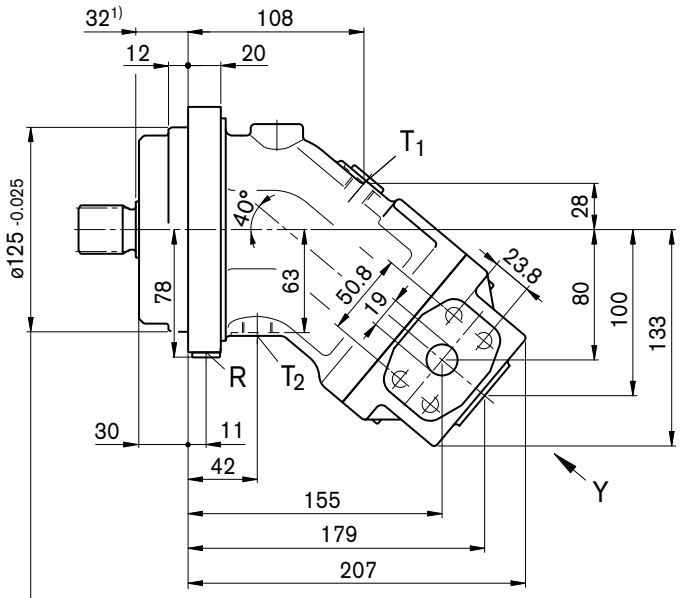
1) Center bore according to DIN 332 (thread according to DIN 13)
2) Observe the general instructions on page 34 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions size 45

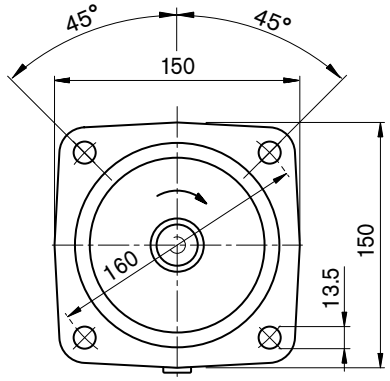
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 05 – SAE flange port A/B at side and SAE flange port S at rear

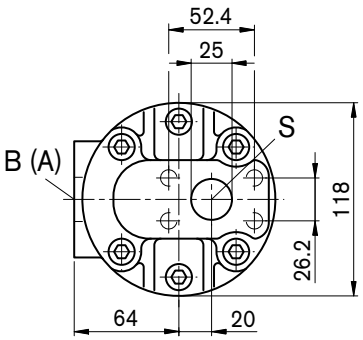
Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)



Flange
ISO 3019-2



View Y



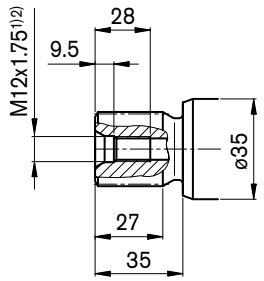
1) To shaft collar

Dimensions size 45

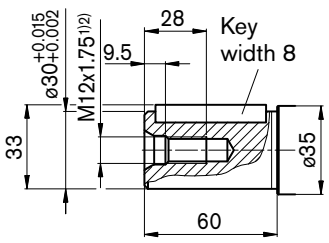
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Drive shafts

Z Splined shaft DIN 5480
W30x2x14x9g



P Parallel keyed shaft
DIN 6885, AS8x7x50



Ports

Designation	Port for	Standard	Size[2)]	Maximum pressure [bar][3)]	State[7)]
B (A)	Service line Fastening thread B/A	SAE J518[5)] DIN 13	3/4 in M10 x 1.5; 17 deep	450	O
S	Suction line Fastening thread	SAE J518[5)] DIN 13	1 in M10 x 1.5; 17 deep	30	O
T_1	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	X[4)]
T_2	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	O[4)]
R	Air bleed	DIN 3852[6)]	M12 x 1.5; 12 deep	3	X

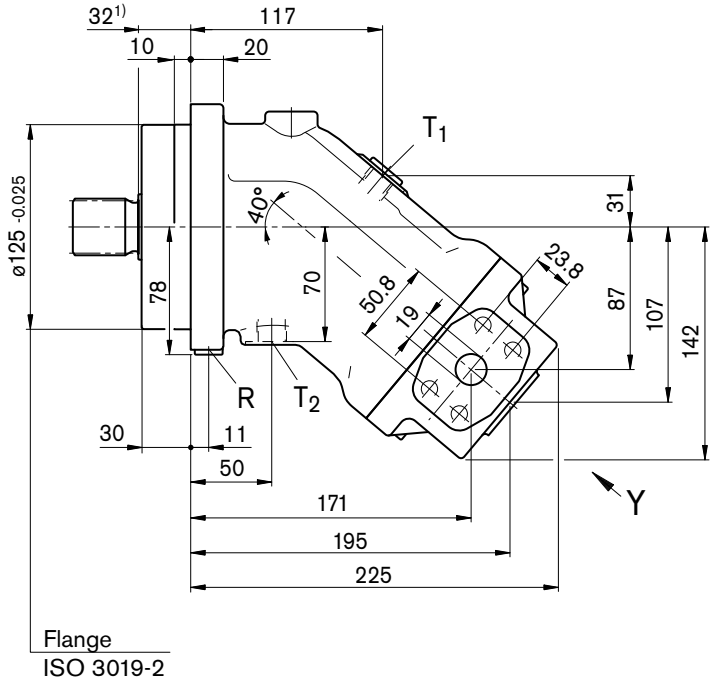
1) Center bore according to DIN 332 (thread according to DIN 13)
2) Observe the general instructions on page 34 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

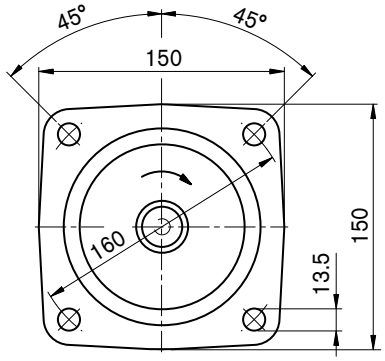
Dimensions sizes 56, 63

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

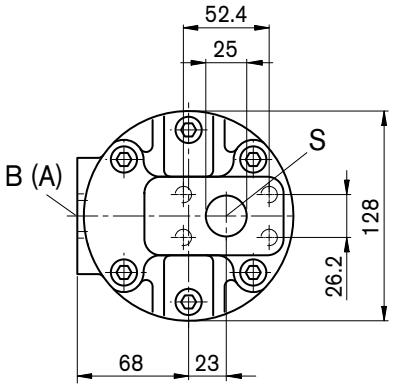
Port plate 05 – SAE flange port A/B at side and SAE flange port S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)





View Y



1) To shaft collar

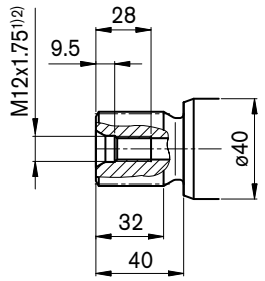
Dimensions sizes 56, 63

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Drive shafts

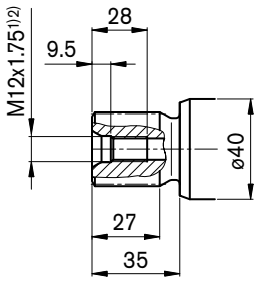
NG56, 63

A Splined shaft DIN 5480 W35x2x16x9g



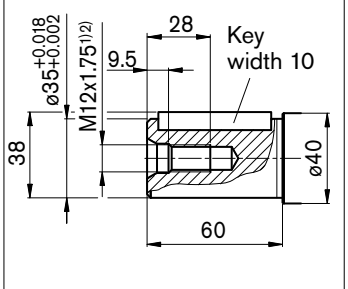
NG56

Z Splined shaft DIN 5480 W30x2x14x9g



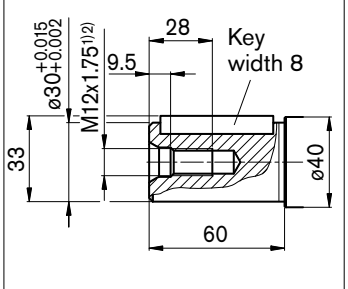
NG56, 63

B Parallel keyed shaft DIN 6885, AS10x8x50



NG56

P Parallel keyed shaft DIN 6885, AS8x7x50



Ports

Designation	Port for	Standard	Size[2)]	Maximum pressure [bar][3)]	State[7)]
B (A)	Service line Fastening thread B/A	SAE J518[5)] DIN 13	3/4 in M10 x 1.5; 17 deep	450	O
S	Suction line Fastening thread	SAE J518[5)] DIN 13	1 in M10 x 1.5; 17 deep	30	O
T_1	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	X[4)]
T_2	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	O[4)]
R	Air bleed	DIN 3852[6)]	M12 x 1.5; 12 deep	3	X

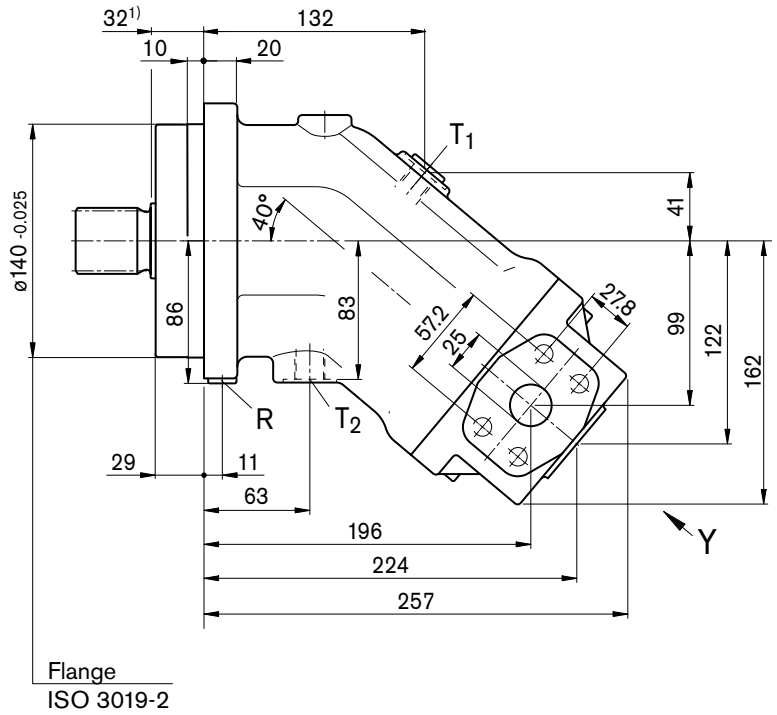
1) Center bore according to DIN 332 (thread according to DIN 13)
2) Observe the general instructions on page 34 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

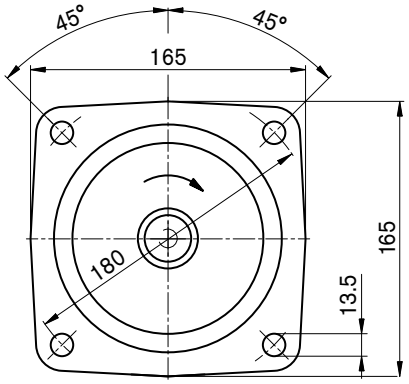
Dimensions sizes 80, 90

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

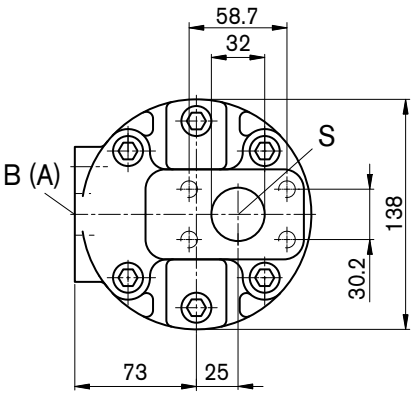
Port plate 05 – SAE flange port A/B at side and SAE flange port S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)





View Y



1) To shaft collar

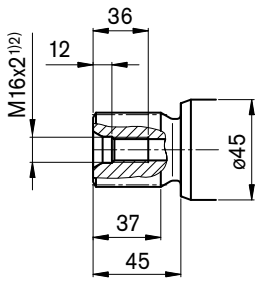
Dimensions sizes 80, 90

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Drive shafts

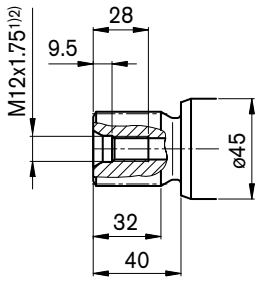
NG80, 90

A Splined shaft DIN 5480 W40x2x18x9g



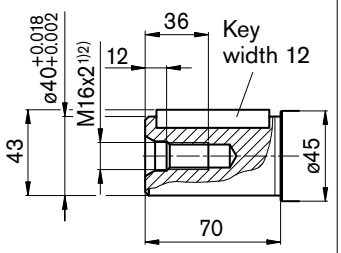
NG80

Z Splined shaft DIN 5480 W35x2x16x9g



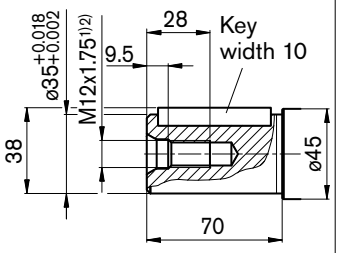
NG80, 90

B Parallel keyed shaft DIN 6885, AS12x8x56



NG80

P Parallel keyed shaft DIN 6885, AS10x8x56



Ports

Designation	Port for	Standard	Size[2)]	Maximum pressure [bar][3)]	State[7)]
B (A)	Service line Fastening thread B/A	SAE J518[5)] DIN 13	1 in M12 x 1.5; 17 deep	450	O
S	Suction line Fastening thread	SAE J518[5)] DIN 13	1 1/4 in M10 x 1.5; 17 deep	30	O
T_1	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	X[4)]
T_2	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	O[4)]
R	Air bleed	DIN 3852[6)]	M12 x 1.5; 12 deep	3	X

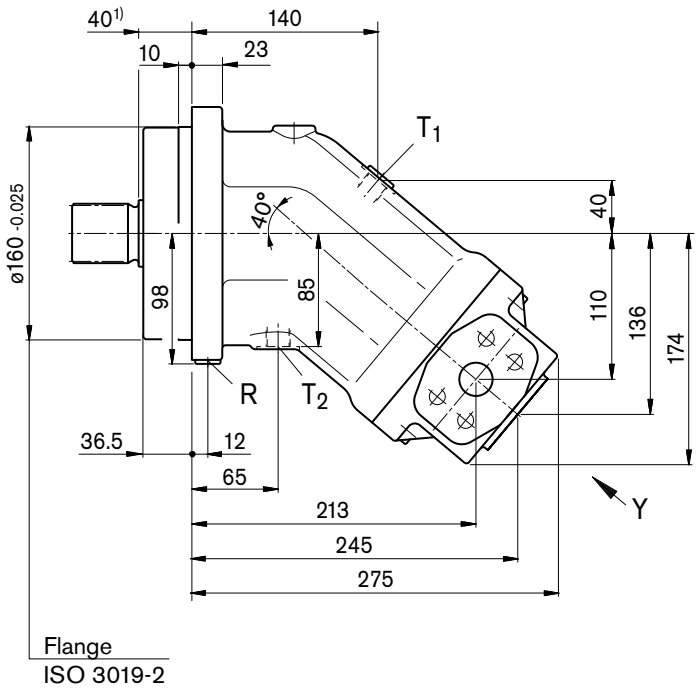
1) Center bore according to DIN 332 (thread according to DIN 13)
2) Observe the general instructions on page 34 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

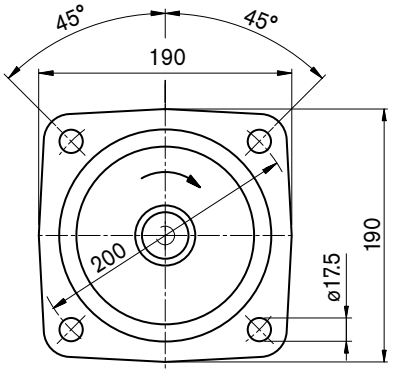
Dimensions sizes 107, 125

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 05 – SAE flange port A/B at side and SAE flange port S at rear

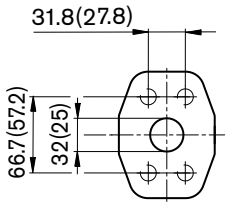
Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)

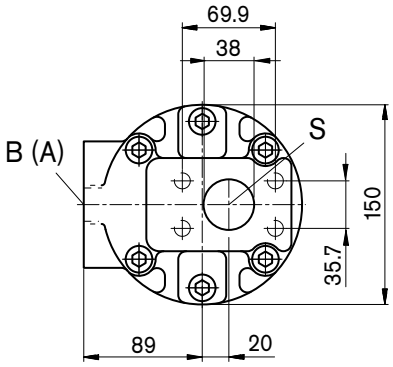




View Y

Detail: port A/B
(dimensions in brackets for size 107)





1) To shaft collar

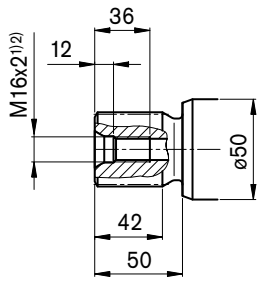
Dimensions sizes 107, 125

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Drive shafts

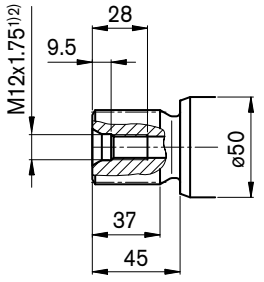
NG107, 125

A Splined shaft DIN 5480 W45x2x21x9g



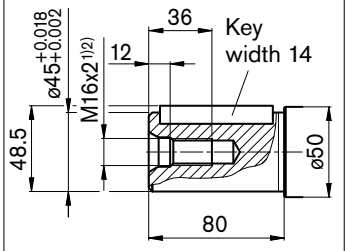
NG107

Z Splined shaft DIN 5480 W40x2x18x9g



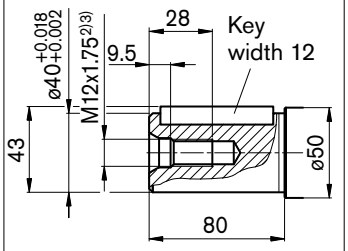
NG107, 125

B Parallel keyed shaft DIN 6885, AS14x9x63



NG107

P Parallel keyed shaft DIN 6885, AS12x8x63



Ports

Designation	Port for	Standard	Size[2)]	Maximum pressure [bar][3)]	State[7)]
B (A)	Service line	SAE J518[5)]	1 in (size 107) 1 1/4 in (size 125)	450	O
	Fastening thread B/A	DIN 13	M12 x 1.75; 17 deep (size 107) M14 x 2; 19 deep (size 125)		
S	Suction line	SAE J5185[1)]	1 1/2 in	30	O
	Fastening thread	DIN 13	M12 x 1.75; 20 deep		
T_1	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	X[4)]
T_2	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	O[4)]
R	Air bleed	DIN 3852[6)]	M14 x 1.5; 12 deep	3	X

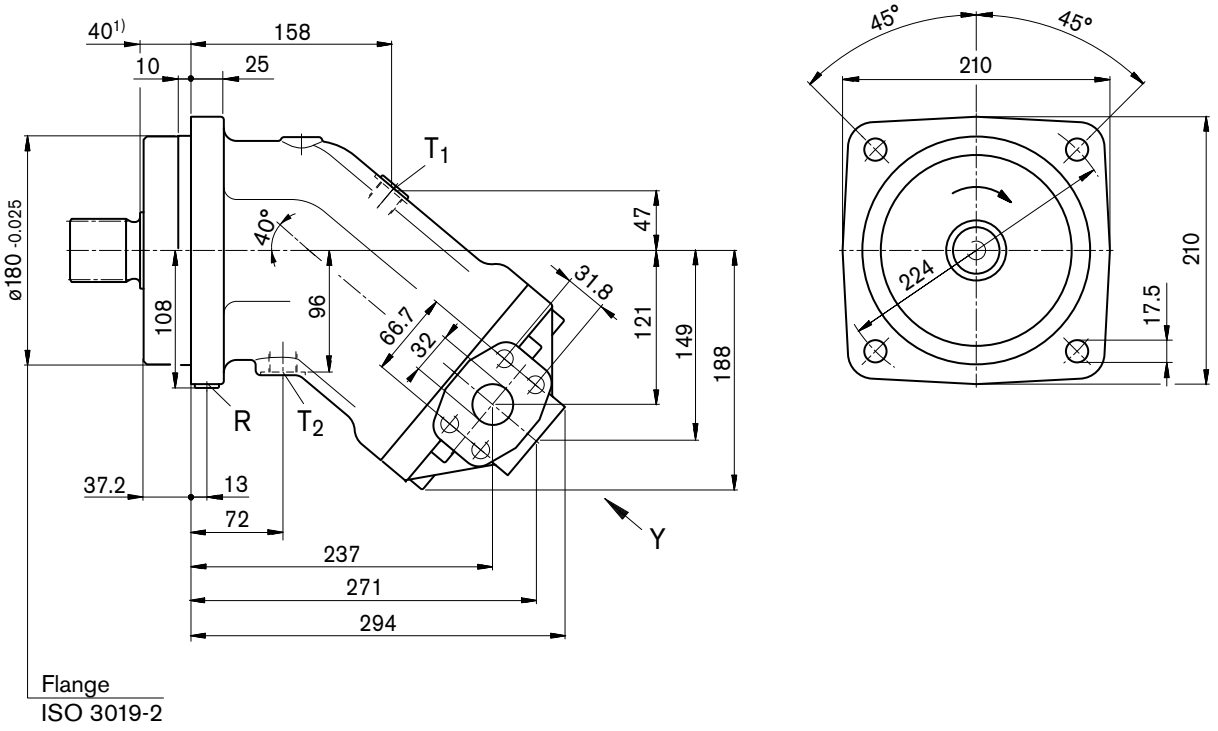
1) Center bore according to DIN 332 (thread according to DIN 13)
2) Observe the general instructions on page 34 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions sizes 160, 180

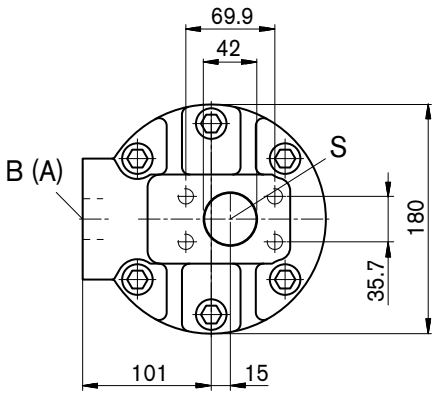
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 05 – SAE flange port A/B at side and SAE flange port S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)



View Y



1) To shaft collar

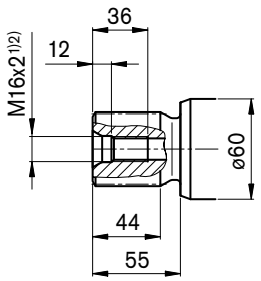
Dimensions sizes 160, 180

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Drive shafts

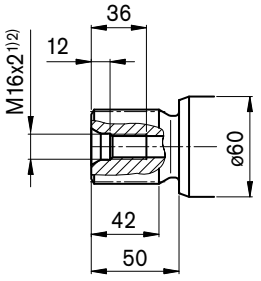
NG160, 180

A Splined shaft DIN 5480
W50x2x24x9g



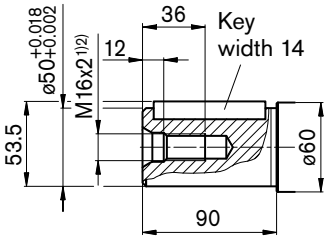
NG160

Z Splined shaft DIN 5480
W45x2x21x9g



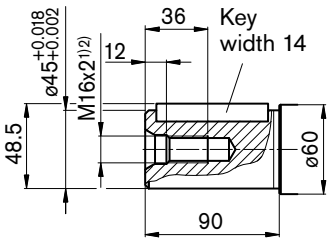
NG160, 180

B Parallel keyed shaft
DIN 6885, AS14x9x70



NG160

P Parallel keyed shaft
DIN 6885, AS14x9x70



Ports

Designation	Port for	Standard	Size[2)]	Maximum pressure [bar][3)]	State[7)]
B (A)	Service line Fastening thread B/A	SAE J518[5)] DIN 13	1 1/4 in M14 x 2; 19 deep	450	O
S	Suction line Fastening thread	SAE J518[5)] DIN 13	1 1/2 in M12 x 1.75; 20 deep	30	O
T_1	Drain line	DIN 3852[6)]	M22 x 1.5; 14 deep	3	X[4)]
T_2	Drain line	DIN 3852[6)]	M22 x 1.5; 14 deep	3	O[4)]
R	Air bleed	DIN 3852[6)]	M14 x 1.5; 12 deep	3	X

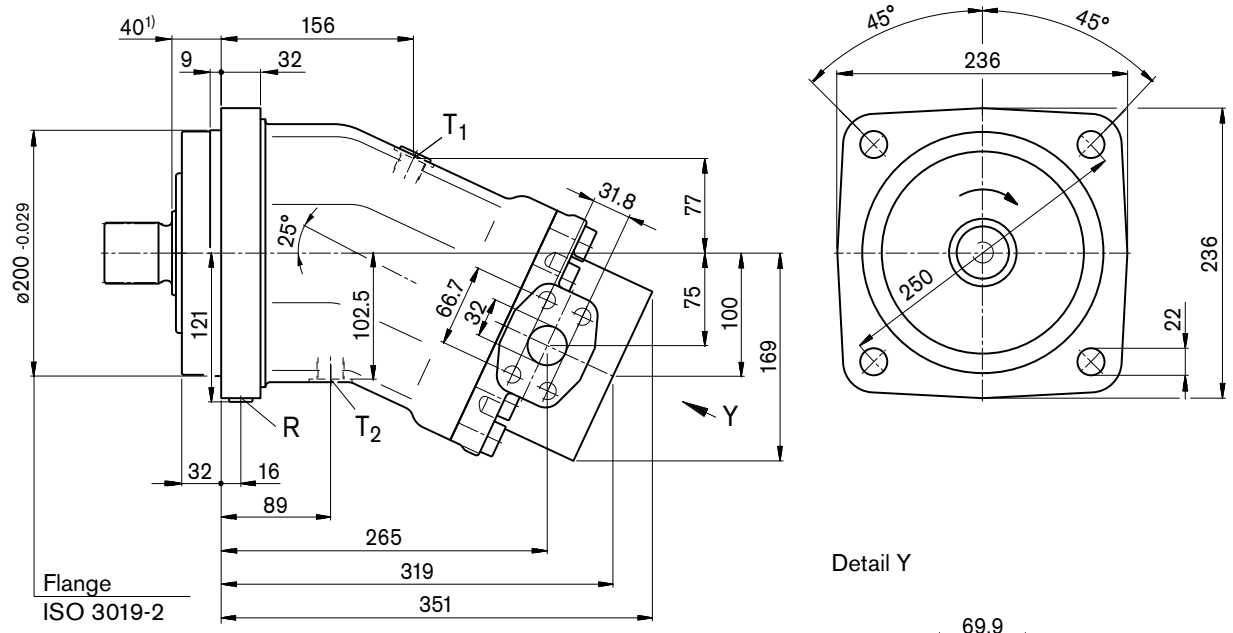
1) Center bore according to DIN 332 (thread according to DIN 13)
2) Observe the general instructions on page 34 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions size 200

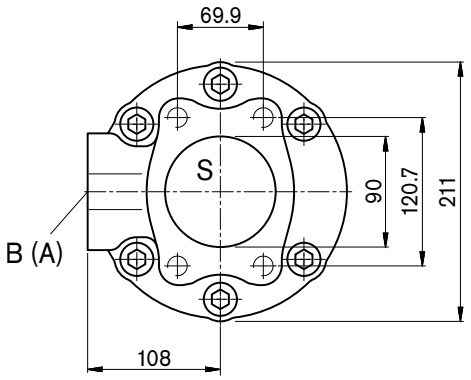
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 05 – SAE flange port A/B at side and SAE flange port S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)

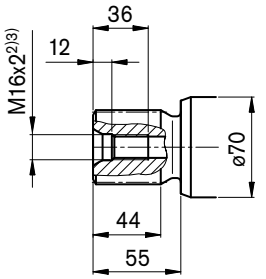


Detail Y

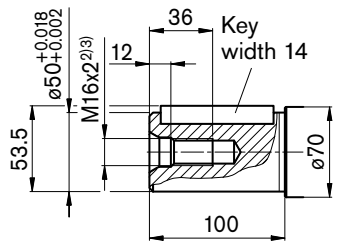


Drive shafts

A Splined shaft DIN 5480
W50x2x24x9g



B Parallel keyed shaft
DIN 6885, AS14x9x80



Ports

Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[8)]
B (A)	Service line Fastening thread B/A	SAE J518[6)] DIN 13	1 1/4 in M14 x 2; 19 deep	450	O
S	Suction line Fastening thread	SAE J518[6)] DIN 13	3 1/2 in M16 x 2; 24 deep	30	O
T_1	Drain line	DIN 3852[7)]	M22 x 1.5; 14 deep	3	X[5)]
T_2	Drain line	DIN 3852[7)]	M22 x 1.5; 14 deep	3	O[5)]
R	Air bleed	DIN 3852[7)]	M14 x 1.5; 12 deep	3	X

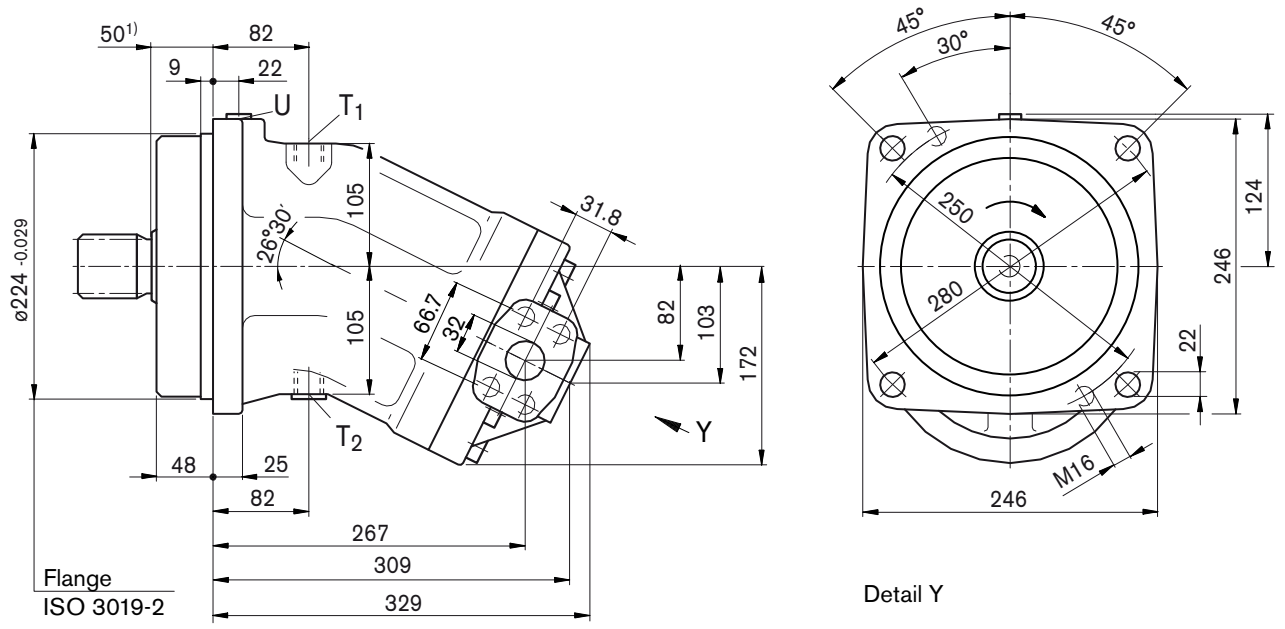
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 34 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
6) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions size 250

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

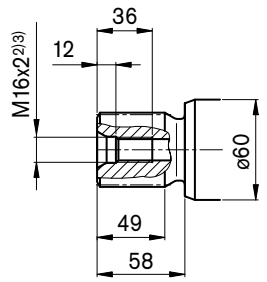
Port plate 05 – SAE flange port A/B at side and SAE flange port S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)

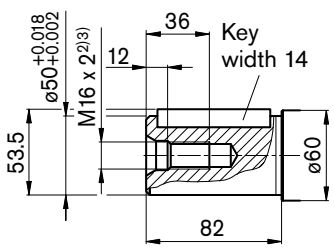


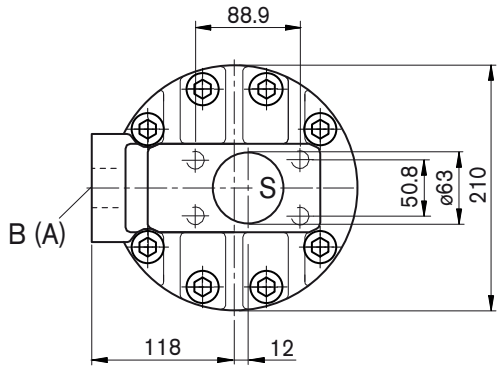
Drive shafts

Z Splined shaft DIN 5480
W50x2x24x9g



P Parallel keyed shaft
DIN 6885, AS14x9x80





Ports

Designation	Port for	Standard	Size[3]	Maximum pressure [bar][4]	State[8]
B (A)	Service line Fastening thread B/A	SAE J518[6] DIN 13	1 1/4 in M14 x 2; 19 deep	400	O
S	Suction line Fastening thread	SAE J518[6] DIN 13	2 1/2 in M12 x 1.75; 17 deep	30	O
T_1	Drain line	DIN 3852[7]	M22 x 1.5; 14 deep	3	O[5]
T_2	Drain line	DIN 3852[7]	M22 x 1.5; 14 deep	3	X[5]
U	Bearing flushing	DIN 3852[7]	M14 x 1.5; 12 deep	3	X

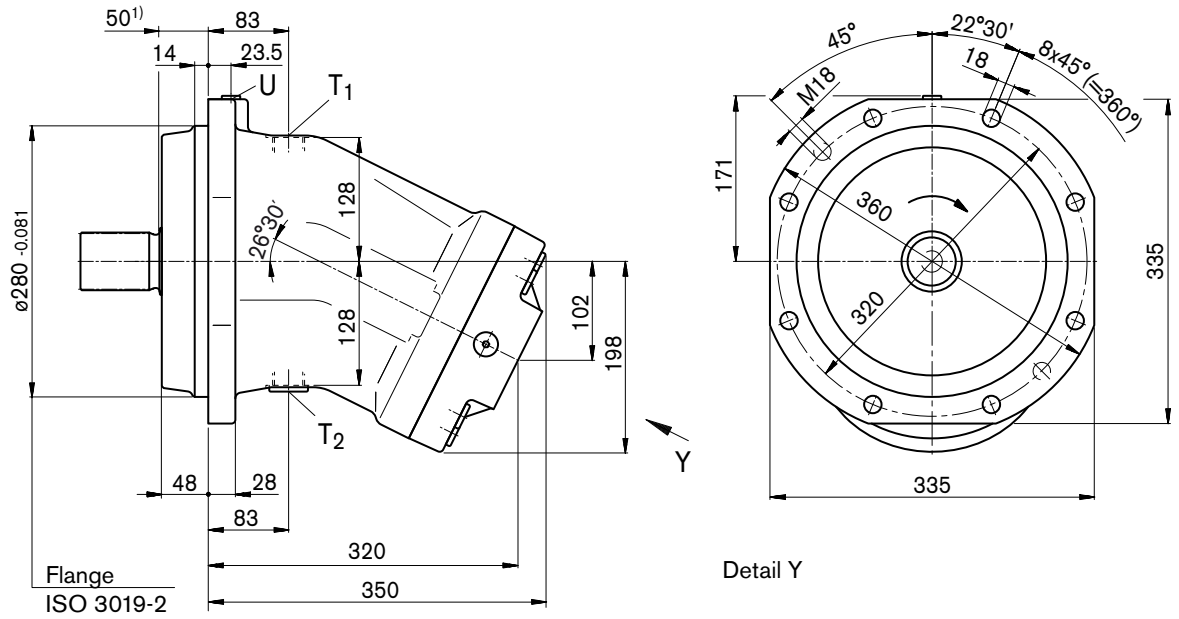
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 34 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
6) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions size 355

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

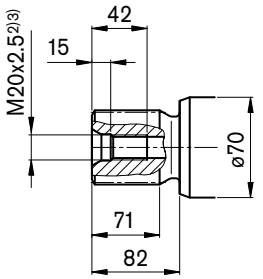
Port plate 11 – SAE flange ports A/B and S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)

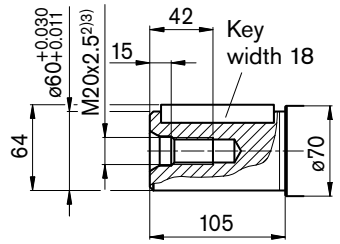


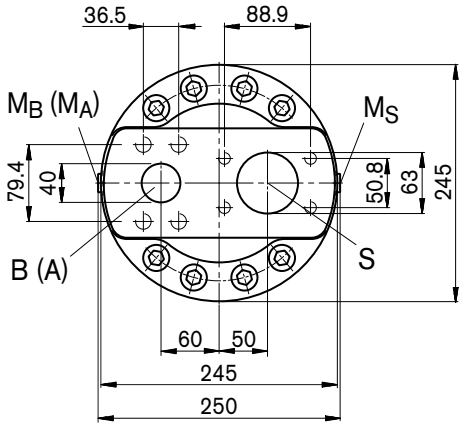
Drive shafts

Z Splined shaft DIN 5480
W60x2x28x9g



P Parallel keyed shaft
DIN 6885, AS18x11x100





Ports

Designation	Port for	Standard	Size[3]	Maximum pressure [bar][4]	State[8]
B (A)	Service line Fastening thread B/A	SAE J518[6] DIN 13	1 1/2 in M16 x 2; 21 deep	400	O
S	Suction line Fastening thread	SAE J518[6] DIN 13	2 1/2 in M12 x 1.75; 17 deep	30	O
T_1	Drain line	DIN 3852[7]	M33 x 2; 18 deep	3	O[5]
T_2	Drain line	DIN 3852[7]	M33 x 2; 18 deep	3	X[5]
U	Bearing flushing	DIN 3852[7]	M14 x 1.5; 12 deep	3	X
M_A, M_B	Measuring operating pressure	DIN 3852[7]	M14 x 1.5; 12 deep	400	X
M_S	Measuring suction pressure	DIN 3852[7]	M14 x 1.5; 12 deep	30	X

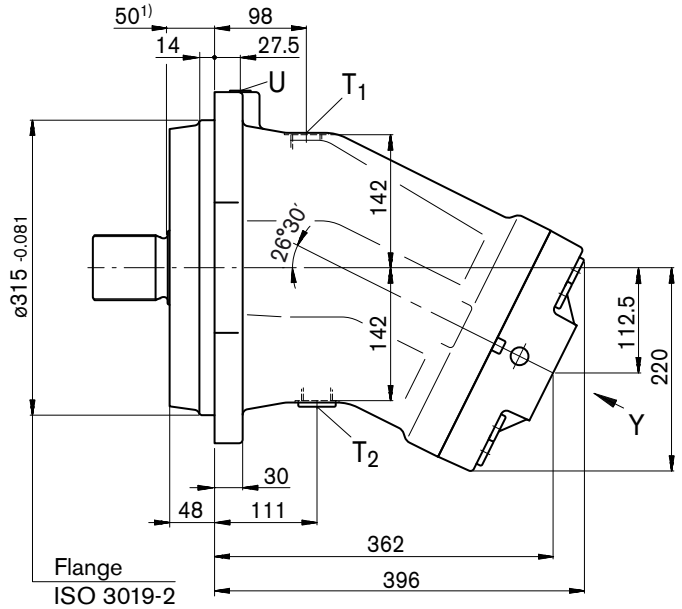
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 34 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
6) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

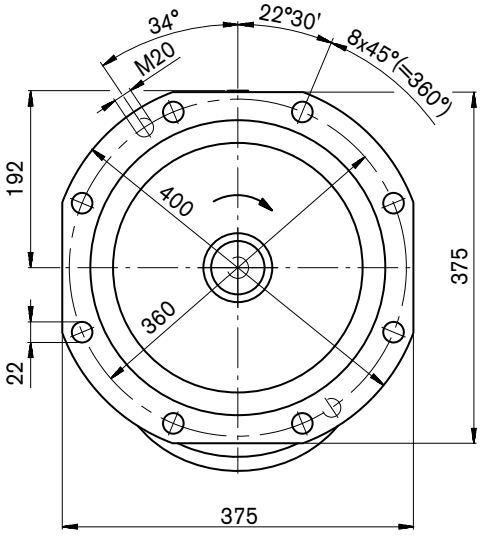
Dimensions size 500

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 11 – SAE flange ports A/B and S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)

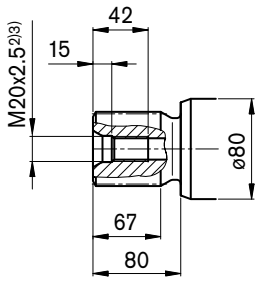




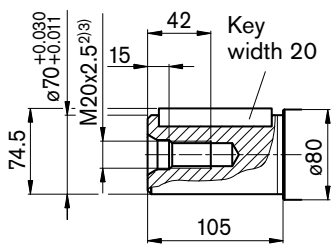
Detail Y

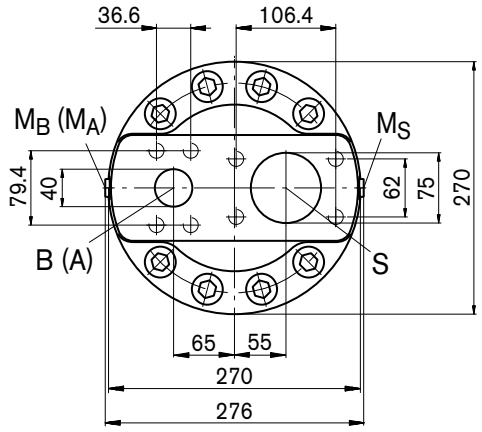
Drive shafts

Z Splined shaft DIN 5480
W70x3x22x9g



P Parallel keyed shaft
DIN 6885, AS20x12x100





Ports

Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[8)]
B (A)	Service line fastening thread B/A	SAE J518[6)] DIN 13	1 1/2 in M16 x 2; 21 deep	400	O
S	Suction line fastening thread	SAE J518[6)] DIN 13	3 in M16 x 2; 24 deep	30	O
T_1	Drain line	DIN 3852[7)]	M33 x 2; 18 deep	3	O[5)]
T_2	Drain line	DIN 3852[7)]	M33 x 2; 18 deep	3	X[5)]
U	Bearing flushing	DIN 3852[7)]	M18 x 1.5; 12 deep	3	X
M_A, M_B	Operating pressure measurement	DIN 3852[7)]	M14 x 1.5; 12 deep	400	X
M_S	Suction pressure measurement	DIN 3852[7)]	M14 x 1.5; 12 deep	30	X

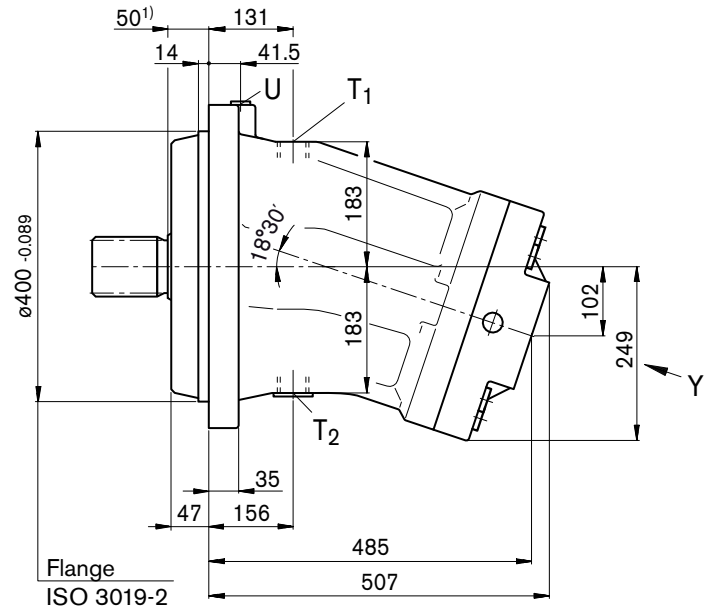
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 34 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
6) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

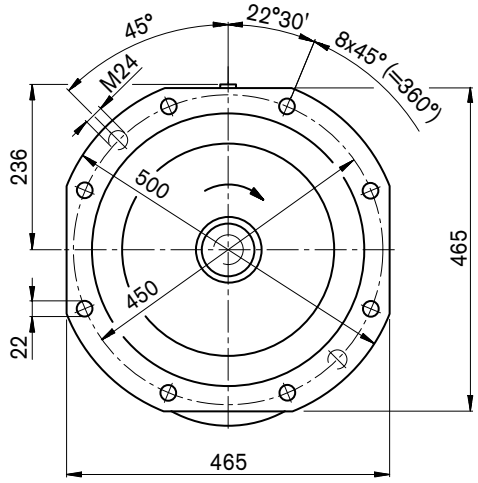
Dimensions size 710

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

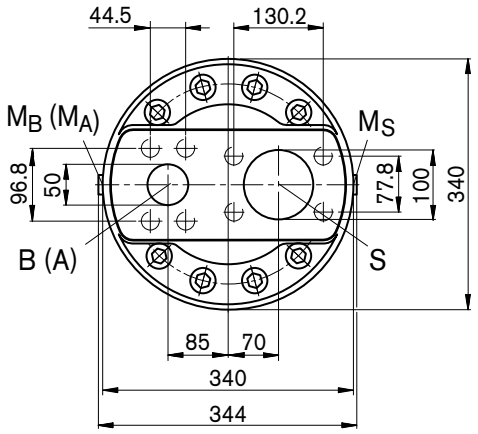
Port plate 11 – SAE flange ports A/B and S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)



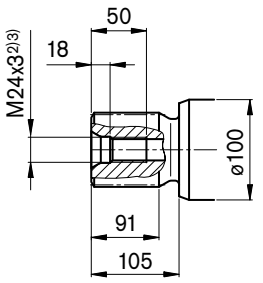


Detail Y

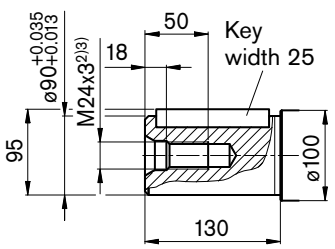


Drive shafts

Z Splined shaft DIN 5480
W90x3x28x9g



P Parallel keyed shaft
DIN 6885, AS25x14x125



Ports

Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[8)]
B (A)	Service line Fastening thread B/A	SAE J518[6)] DIN 13	2 in M20 x 2.5; 30 deep	400	
S	Suction line Fastening thread	SAE J518[6)] DIN 13	4 in M16 x 2; 24 deep	30	O
T_1	Drain line	DIN 3852[7)]	M42 x 2; 20 deep	3	O[5)]
T_2	Drain line	DIN 3852[7)]	M42 x 2; 20 deep	3	X[5)]
U	Bearing flushing	DIN 3852[7)]	M18 x 1.5; 12 deep	3	X
M_A, M_B	Measuring operating pressure	DIN 3852[7)]	M14 x 1.5; 12 deep	400	X
M_S	Measuring suction pressure	DIN 3852[7)]	M14 x 1.5; 12 deep	30	X

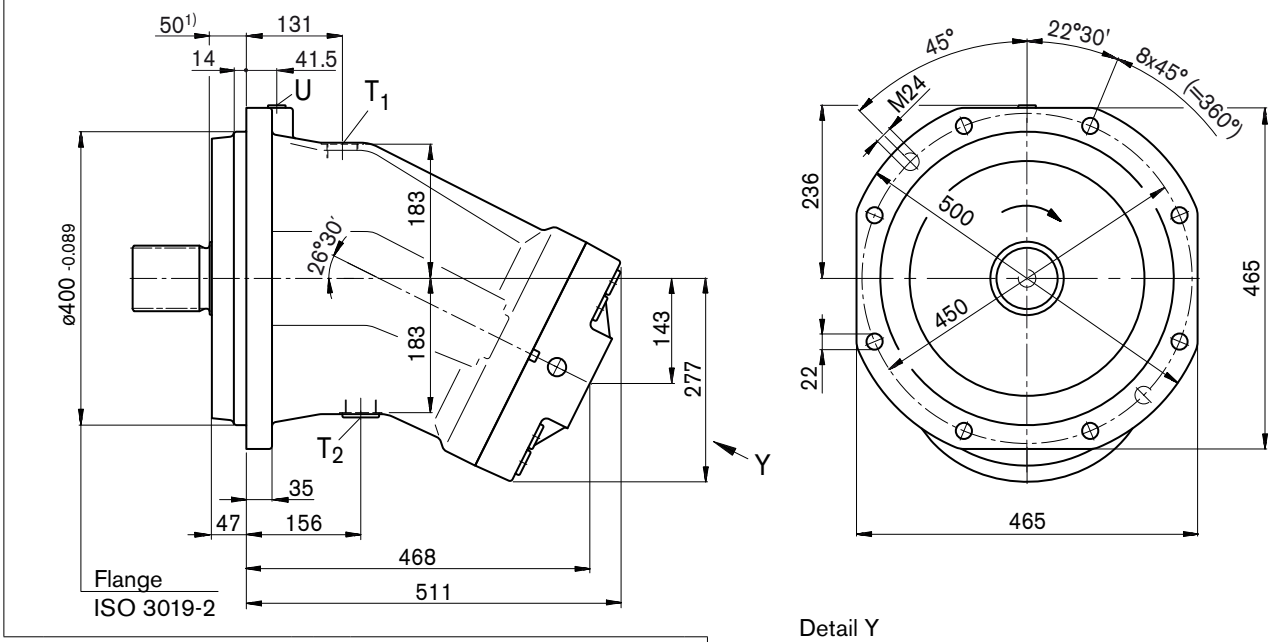
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 34 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 32 and 33).
6) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions size 1000

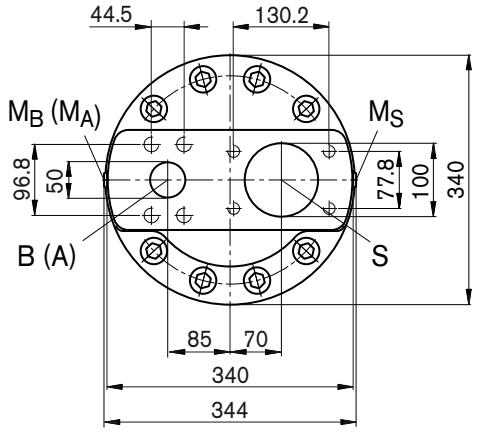
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 11 – SAE flange ports A/B and S at rear

Illustration: cw direction of rotation (on version "ccw direction of rotation" the port plate is rotated through 180°)

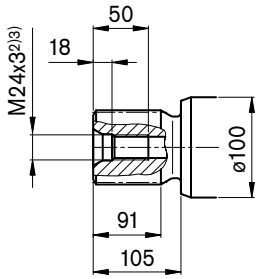


Detail Y

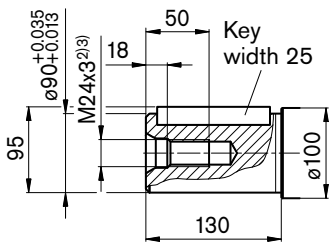


Drive shafts

Z Splined shaft DIN 5480
W90x3x28x9g



P Parallel keyed shaft
DIN 6885, AS25x14x125



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X = Plugged (in normal operation)

Installation instructions

General

During commissioning and operation, the axial piston unit must be filled with hydraulic fluid and air bled. This must also be observed following a relatively long standstill as the axial piston unit may drain back to the reservoir via the hydraulic lines.

Particularly in the installation position "drive shaft upwards" filling and air bleeding must be carried out completely as there is, for example, a danger of dry running.

The case drain fluid in the motor housing must be directed to the reservoir via the highest available drain port (T_1, T_2).

For combinations of multiple units, make sure that the respective case pressure in each unit is not exceeded. In the event of pressure differences at the drain ports of the units, the shared drain line must be changed so that the minimum permissible case pressure of all connected units is not exceeded in any situation. If this is not possible, separate drain lines must be laid if necessary.

To achieve favorable noise values, decouple all connecting lines using elastic elements and avoid above-reservoir installation.

In all operating conditions, the suction and drain lines must flow into the reservoir below the minimum fluid level. The permissible suction height h_S results from the overall loss of pressure; it must not, however, be higher than $h_{S\,max} = 800$ mm. The minimum suction pressure at port S must also not fall below 0.8 bar absolute during operation and during cold start.

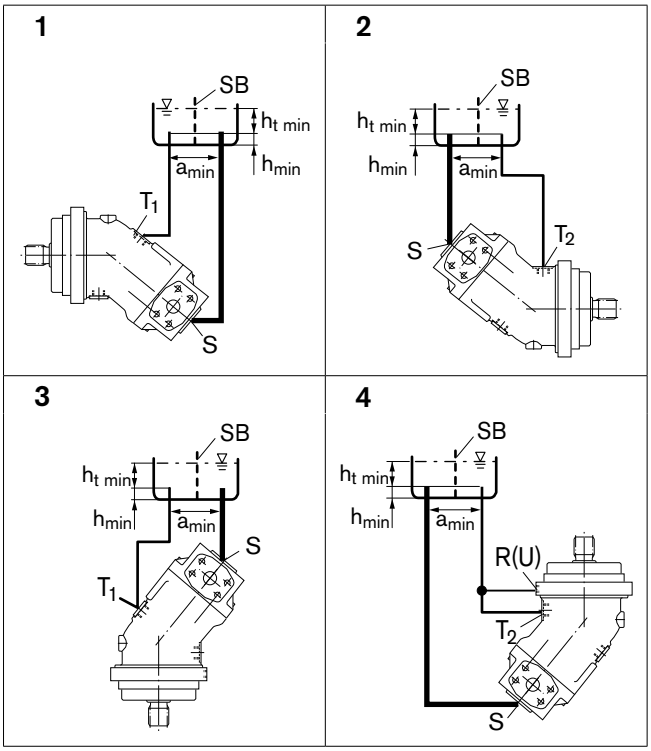
Installation position

See the following examples 1 to 8.
Further installation positions are possible upon request.

Recommended installation positions: 1 and 2.

Below-reservoir installation (standard)

Below-reservoir installation means that the axial piston unit is installed outside of the reservoir below the minimum fluid level.



Installation position	Air bleed	Filling
1	–	T_1
2	–	T_2
3	–	T_1
4	R (U)	T_2