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# A2FO

Fixed Displacement Bent Axis piston pump Series 61 Size 10 to 180 cc
Nominal pressure: 400 bar Maximum pressure: 450 bar

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## Features

- Fixed displacement pump A2FO of axial piston, bent axis design is made suitable for hydrostatic drives in open circuits.
- Favorable power/ Weight ratio.
- Output Flow is proportional to drive speed and displacement.
- The drive shaft bearings are designed to give the service life expected in these areas of operation.
- Careful selection of the displacements offered, permit sizes to be matched to practically every application.
- Compact and economical design
- Optimum efficiency
- One piece pistons with piston rings

**Specifications**

| Size | | | | 10 | 12 | 16 | 23 | 28 | 32 | 45 | 56 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | | $V_g$ | $cm^3$ | 10.3 | 12.0 | 16.0 | 22.9 | 28.1 | 32 | 45.6 | 56.1 |
| Max. speed | | $n_{max}$ 1) | rpm | 3150 | 3150 | 3150 | 2500 | 2500 | 2500 | 2240 | 2000 |
| Max. perm. speed with increased input pressure $P_{abs}$ | | $n_{max perm.}$ 2) | rpm | 6000 | 6000 | 6000 | 4750 | 4750 | 4750 | 4250 | 3750 |
| Max. perm. output flow at $n_{max}$ | | $q_{vmax}$ | l/min | 32.4 | 37.8 | 50 | 57 | 70 | 80 | 102 | 112 |
| Max. power at $q_{vmax}$ | Δp=350 bar | $P_{max}$ | kW | 18.9 | 22 | 29.2 | 33 | 41 | 47 | 59.5 | 65 |
| | Δp=400 bar | $P_{max}$ | KW | 21.6 | 25 | 34 | 38 | 47 | 53 | 68 | 75 |
| Perm. torque | Δp=350 bar | T | Nm | 57 | 67 | 88 | 126 | 156 | 178 | 254 | 312 |
| | Δp=400 bar | T | Nm | 65 | 76 | 101 | 145 | 178 | 203 | 290 | 356 |
| Case volume | | | L | 0.17 | 0.17 | 0.17 | 0.20 | 0.20 | 0.20 | 0.33 | 0.45 |
| Weight (approx.) | | m | kg | 6 | 6 | 6 | 9.5 | 9.5 | 9.5 | 13.5 | 18 |

| Size | | | | 63 | 80 | 90 | 107 | 125 | 160 | 180 |
|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | | $V_g$ | $cm^3$ | 63 | 80.4 | 90 | 106.7 | 125 | 160.4 | 180 |
| Max. speed | | $n_{max}$ 1) | rpm | 2000 | 1800 | 1800 | 1600 | 1600 | 1450 | 1450 |
| Max. perm. speed with increased input pressure $P_{abs}$ | | $n_{max perm.}$ 2) | rpm | 3750 | 3350 | 3350 | 3000 | 3000 | 2650 | 2650 |
| Max. perm. output flow at $n_{max}$ | | $q_{vmax}$ | l/min | 126 | 144 | 162 | 170 | 200 | 232 | 261 |
| Max. power at $q_{vmax}$ | Δp=350 bar | $P_{max}$ | kW | 73.5 | 84 | 95 | 100 | 117 | 135 | 152 |
| | Δp=400 bar | $P_{max}$ | KW | 84 | 96 | 108 | 114 | 133 | 155 | 174 |
| Perm. torque | Δp=350 bar | T | Nm | 350 | 445 | 501 | 594 | 696 | 893 | 1003 |
| | Δp=400 bar | T | Nm | 400 | 511 | 572 | 678 | 795 | 1020 | 1145 |
| Case volume | | | L | 0.45 | 0.55 | 0.55 | 0.8 | 0.8 | 1.1 | 1.1 |
| Weight (approx.) | | m | kg | 18 | 23 | 23 | 32 | 32 | 45 | 45 |

**1)** the values shown are valid for an absolute pressure (Pabs) of 1 bar at the suction inlet S and when operated on mineral oil (with a specific mass of 0.88kg/L).
**2)** by increase of the input pressure (Pabs >1 bar) the rotational speeds can be increased to the max. admissible speeds
nmax limit (speed limits)

**Determining the size:**

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

Torque $T = \frac{V_g \times \Delta P}{20\pi \times n_{mh}}$ [ Nm ]

Power $P = \frac{2\pi \times T \times n}{60000} = \frac{q_v \times \Delta P}{600 \times n_t}$ [ kW ]

Vg = Displacement per revolution in mL/r
ΔP = Differential pressure in bar
n = Speed in rpm
nv = Volumetric efficiency
nmh = Mechanical-hydraulic efficiency
nt = Overall efficiency

## Ordering code

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

Axial piston unit
Bent axis design, fixed displacement
for use with mineral oil = A2F

Mode of operations
Pump, Open circuit = 0

Size (Displacement V mL/rg³)
10, 12, 16, 23, 28, 32, 45, 56, 63, 80, 90, 107, 125, 160, 180

Series = 6

Index = 1

Direction of rotation(View on shaft end)
Clockwise = R
Anti-Clockwise = L

Seals
NBR (nitril- caoutchouc) = P
FKM (fluor- caoutchouc) = V

| Shaft end | 10 | 12 | 16 | 23 | 28 | 32 | 45 | 56 | 63 | 80 | 90 | 107 | 125 | 160 | 180 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Splined shaft DIN 5480 | ● | ● | ● | ● | ● | ● | - | ● | ● | ● | ● | ● | ● | ● | ● | A |
| | ● | ● | - | ● | ● | - | ● | ● | - | ● | - | ● | - | ● | - | Z |
| Parallel shaft with key, DIN 6885 | ● | ● | ● | ● | ● | ● | - | ● | ● | ● | ● | ● | ● | ● | ● | B |
| | ● | ● | - | ● | ● | - | ● | ● | - | ● | - | ● | - | ● | - | P |

| Flange mounting | 10 | 12 | 16 | 23 | 28 | 32 | 45 | 56 | 63 | 80 | 90 | 107 | 125 | 160 | 180 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ISO 4-hole | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | B |

| Service line connections | 10 | 12 | 16 | 23 | 28 | 32 | 45 | 56 | 63 | 80 | 90 | 107 | 125 | 160 | 180 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1)A(B) SAE, at side S SAE, at rear | - | - | - | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | 05 |
| A (B) threads at side S threads, at rear | ● | ● | ● | - | - | - | - | - | - | - | - | - | - | - | - | 06 |

▭ = preferred type
● = available
- = not available

1) fastening threads resp.threaded ports are metric

## Technical data

**Hydraulic fluid** The A2FO fixed displacement pump is suitable for use with mineral oil.

**Viscosity range** We recommend that a viscosity (at operating temperature)for optimum efficiency and service life purposes of Vopt = optimum viscosity16...36mm /s

Be chosen, taken the tank temperature(open circuit) into account.

**Limits of viscosity range**

The following values apply in extreme cases:

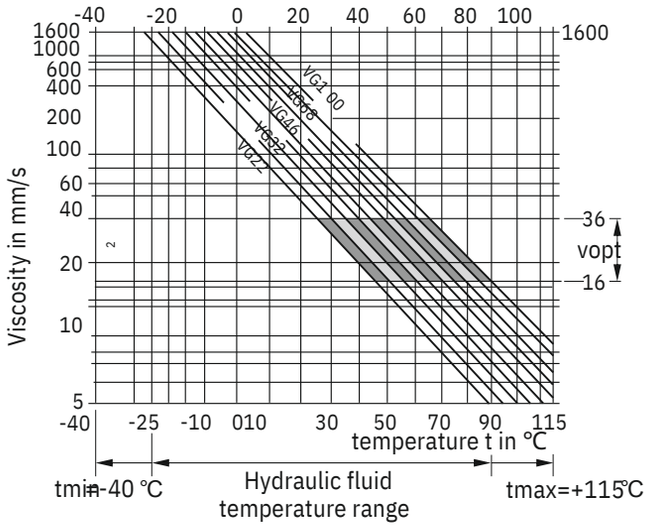
Vmin = 5 mm²/s

short term(t＜3 min)at max. permitted temperature tmax= 115℃ 2 Vmax = 1600 mm /s

short term(t＜3 min) with cold start(P＜30bar, n≤1000rpm tmin= -40℃)

Note that the maximum hydraulic fluid temperature must not be exceeded locally either (e.g. bearing area).The temperature in the bearing area is-depending on pressure and speed-up to 12 K higher than the average case drain temperature.

**Selection diagram**



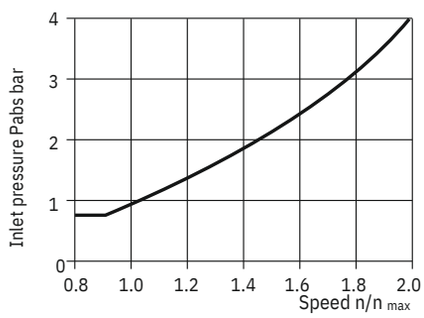

**Details regarding the choice of hydraulic fluid** The correct selection of hydraulic fluid requires knowledge of the operating temperature in relation to the ambient temperature, in an open circuit the tank temperature. The hydraulic fluid should be selected so that within the operating temperature range, the operating viscosity lies within the optimum range (Vopt) (see shaded section of the selection diagram).We recommend that the highest possible viscosity range should be choosen in each case. Example: At an ambient temperature of X°C an operating tempera ture of 60°C is set in the circuit. In the optimum operating viscosity range(Vopt; shaded area) this corresponds to the viscosity classes VG 46 or VG68; to be selected: VG 68. Please note: The leakage fluid temperature, which is affected by pressure and rotational spaad, is always higher than the tank te mperature . At no point in the system may the temperature be hi gher than 115°C.

**Filteration** The finer the filtration, the cleaner the fluid and the longer the service life of the axial piston unit. To ensure proper function of the axial piston unit,the hydraulic fluid must have a cleanliness level of at least 20/18/15 according to ISO 4406. At very high hydraulic fluid temperatures (90°C to max.115°C),a cleanliness level of at least 19/17/14 according to ISO 4406 is required. **Operational pressure range Inlet** Pressure at port S

The minimum inlet pressure depends on speed. The following limits must not be exceeded. Pabs min ----------0.8 bar

Pabs max ----------30 bar

**Minimum inlet pressure at suction port S with increased speed** In order to avoid damage of the pump a minimum inlet pressure at the suction port must be assured.The minimum inlet pressure is related to the rotational speed of the fixed pump.




Note: max. permissible speed nmax perm.(speed limit)
min. permissible inlet pressure at port S
admissible values for the drive shaft seal

**Outlet**

Maximum pressure on port A or B (pressure data according to DIN 24312)

| | Shaft end A, Z | Shaft end B, P |
|---|---|---|
| Nominal pressure PN | 400bar | 350bar |
| Peak pressure Pmax | 450bar | 400bar |

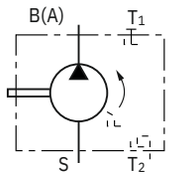
**Direction of flow** Direction of rotation,viewed on shaft end clockwise

| | |
|---|---|
| S to B | counter-clockwise |
| | S to A |

**Symbol**

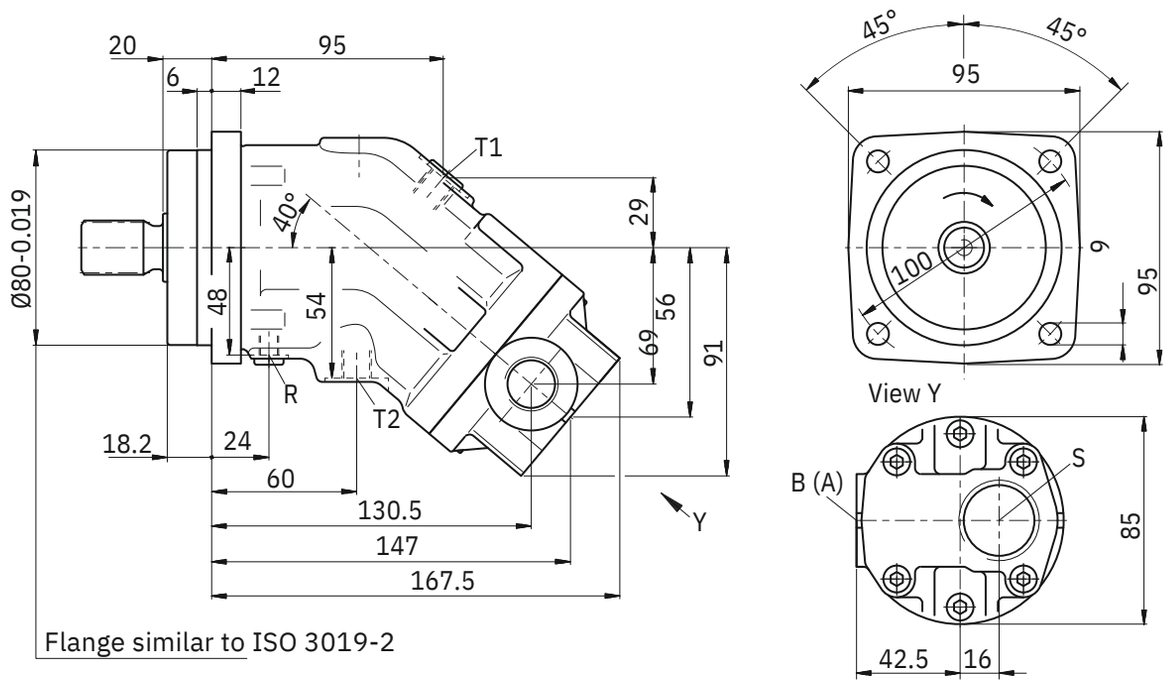
Connections

| | |
|---|---|
| A, B | Service line port |
| S | Suction port |
| T1,T2 | Drain ports |



## Unit Dimension Size 10, 12, 16 (Dimension in mm)

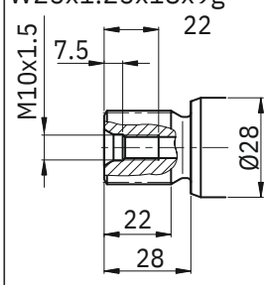
illustration: cw direction of rotation (on version “ccw direction of rotation” the port plate is rotated through 180°)




### Shaft ends

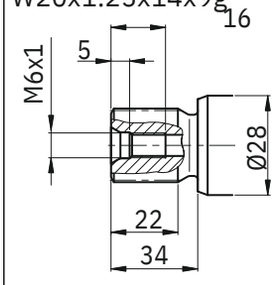
Sizes10, 12, 16

**“A”** Splined shaft DIN 5480 PN = 400 bar W25x1.25x18x9g



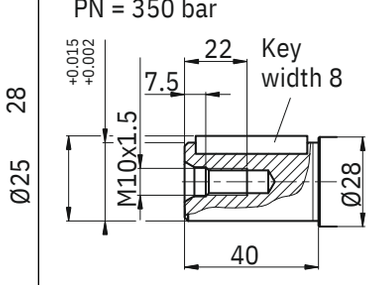

Sizes10, 12,

**“Z”** Splined shaft DIN 5480 PN = 400 bar W20x1.25x14x9g



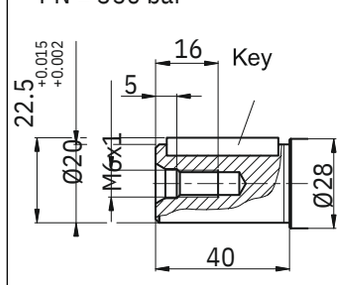

Sizes10, 12, 16 **“B”**

Parallel keyed shaft DIN 6885, AS8x7x32 PN = 350 bar




Sizes10, 12,

**“P”** Parallel keyed shaft DIN 6885, AS6x6x32 PN = 350 bar

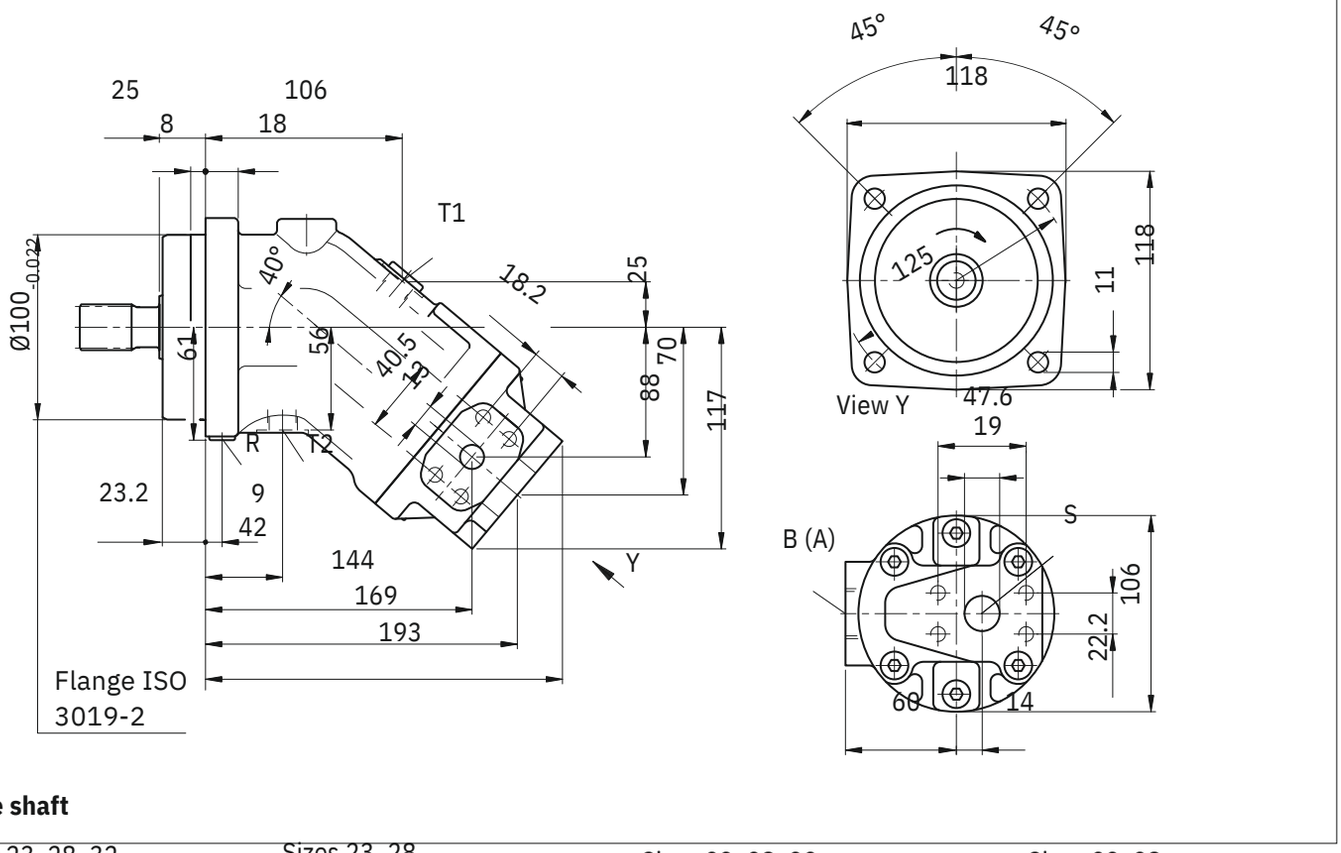



### Port details

| Designation | Port for | Standard | Maximum pressure (bar) |
|---|---|---|---|
| B/A | Service line, fastening thread B/A | M22x1.5;14 deep | 400 |
| S | Suction line, fastening thread | M33x2; 18 deep | 30 |
| T1 | Case drain line | M12x1.5;12 deep | 3 |
| T2 | Case drain line | M12x1.5;12 deep | 3 |
| R | Air bleed | M8x1; 8 deep | 3 |

## Unit Dimension Size 23, 28, 32 (Dimension in mm)

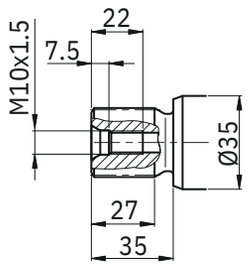
Port plate 05-SAE flange port A/B at side and SAE □ange port S at rear illustration: cw direction of rotation (on version “ccw direction of rotation” the port plate is rotated through 180°)




**Drive shaft**

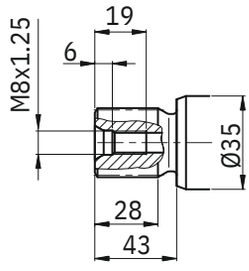
Sizes 23, 28, 32

**“A”** Splined shaft DIN 5480
W30x2x14x9g



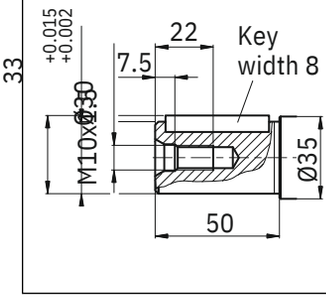

Sizes 23, 28

**“Z”** Splined shaft DIN 5480
W25x1.25x18x9g



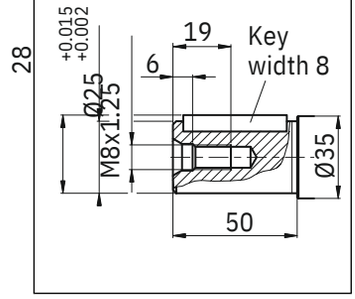

Sizes 23, 28, 32

**“B”** Parallel keyed shaft
DIN 6885, AS8x7x40




Sizes 23, 28

**“P”** Parallel keyed shaft
DIN 6885, AS8x7x40

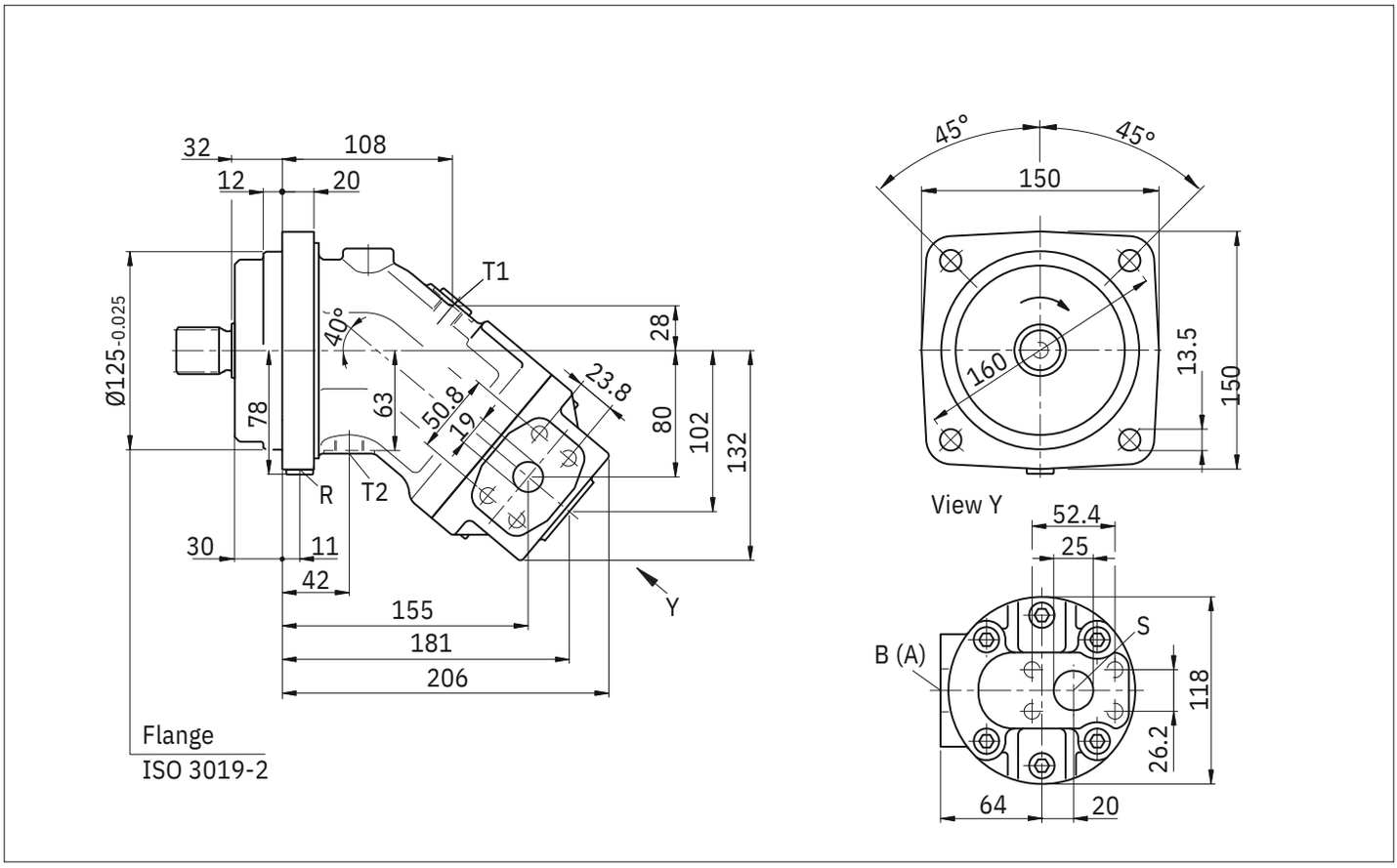



**Port details**

| Designation | Port for | Standard | Maximum pressure (bar) |
|---|---|---|---|
| B/A | Service line, fastening thread B/A | SAE 1/2 in M8x1.25;15 deep | 400 |
| S | Suction line, fastening thread | SAE 3/4 in M10x1.5; 17 deep | 30 |
| T1 | Case drain line | M16x1.5;12 deep | 3 |
| T2 | Case drain line | M16x1.5;12 deep | 3 |
| R | Air bleed | M10x1; 12 deep | 3 |

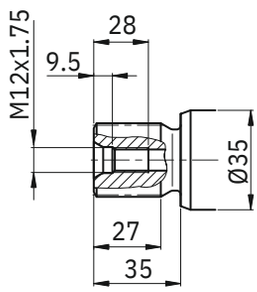
## Unit Dimension Size 45 (Dimension in mm)

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°)

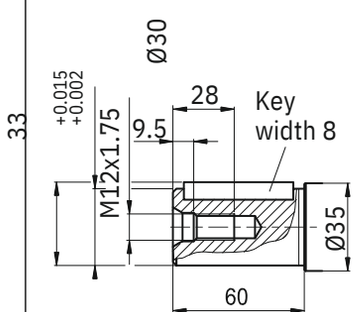



**Drive shaft**

**“Z”** Splined shaft DIN5480 W30x2x14x9g




**“P”** Parallel keyed shaft DIN5480, AS8x7x50



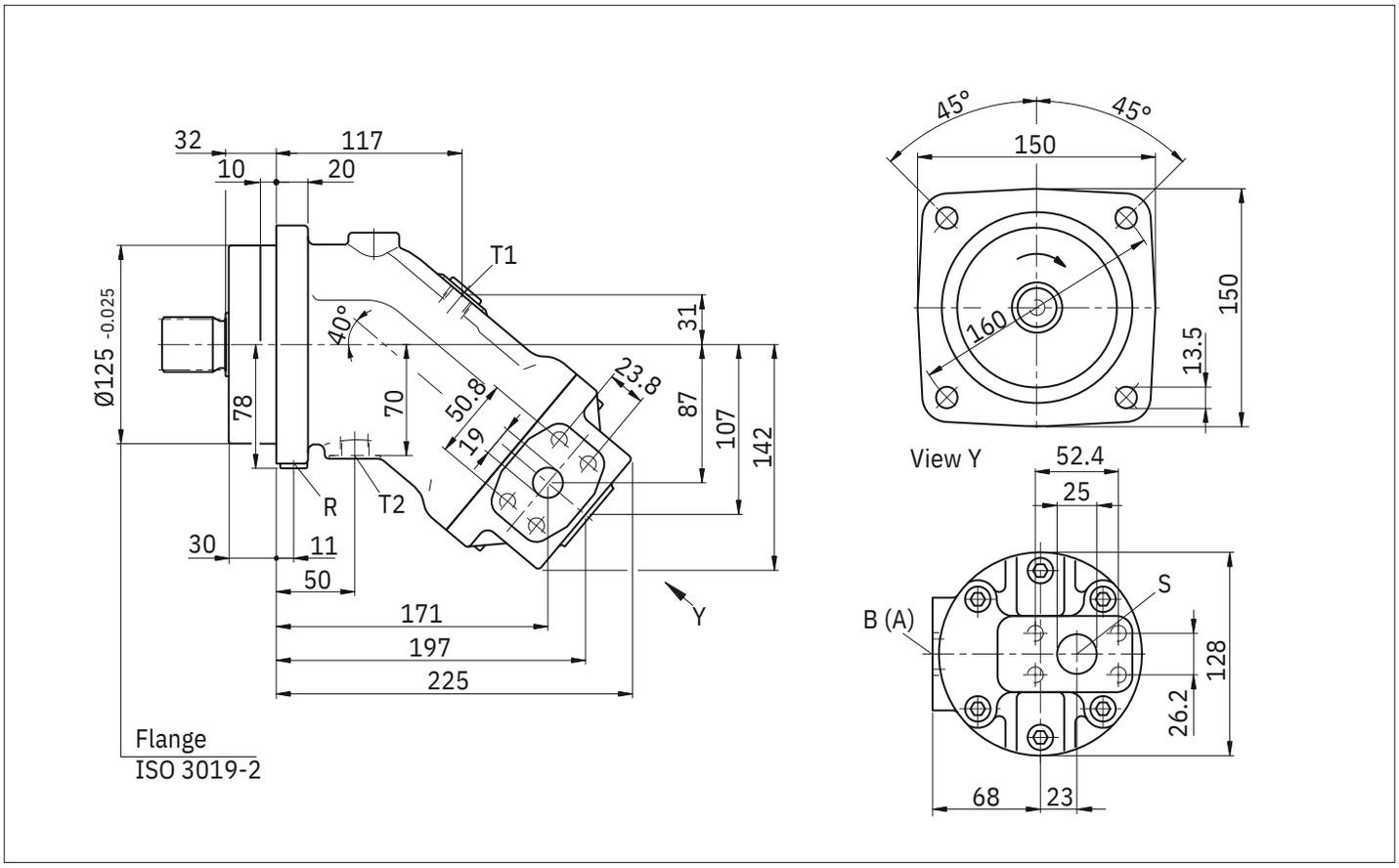

**Port details**

| Designation | Port for | Standard | Maximum pressure (bar) |
|---|---|---|---|
| B/A | Service line, fastening threadB/A | SAE 3/4 in M10x1.5;17 deep | 400 |
| S | Suction line, fastening thread | SAE 1 in M10x1.5; 17 deep | 30 |
| T1 | Case drain line | M18x1.5;12 deep | 3 |
| T2 | Case drain line | M18x1.5;12 deep | 3 |
| R | Air bleed | M12x1.5; 12 deep | 3 |

## Unit Dimension Size 56, 63

**(Dimension in mm)**

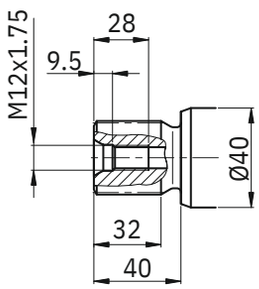
Port plate 05-SAE flange port A/B at side and SAE flange port S at rear illustration: cw direction of rotation (on version “ccw direction of rotation” the port plate is rotated through 180°)




### Drive shaft

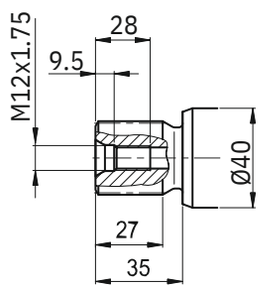
Size 56, 63

**“A”** Splined shaft DIN 5480
W35x2x16x9g



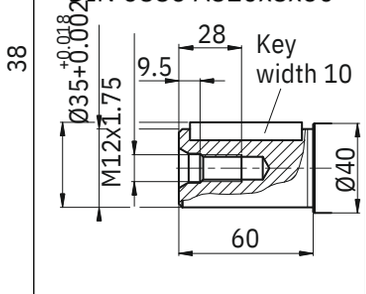

Size 56

**“Z”** Splined shaft DIN 5480
W30x2x14x9g



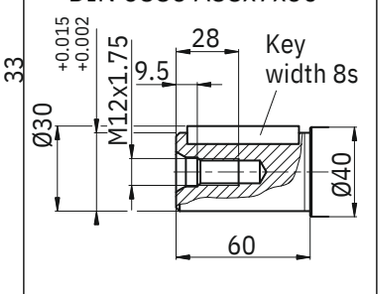

Size 56, 63

**“B”** Parallel keyed shaft
DIN 6885 AS10x8x50




Size 56

**“P”** Parallel keyed shaft
DIN 6885 AS8x7x50



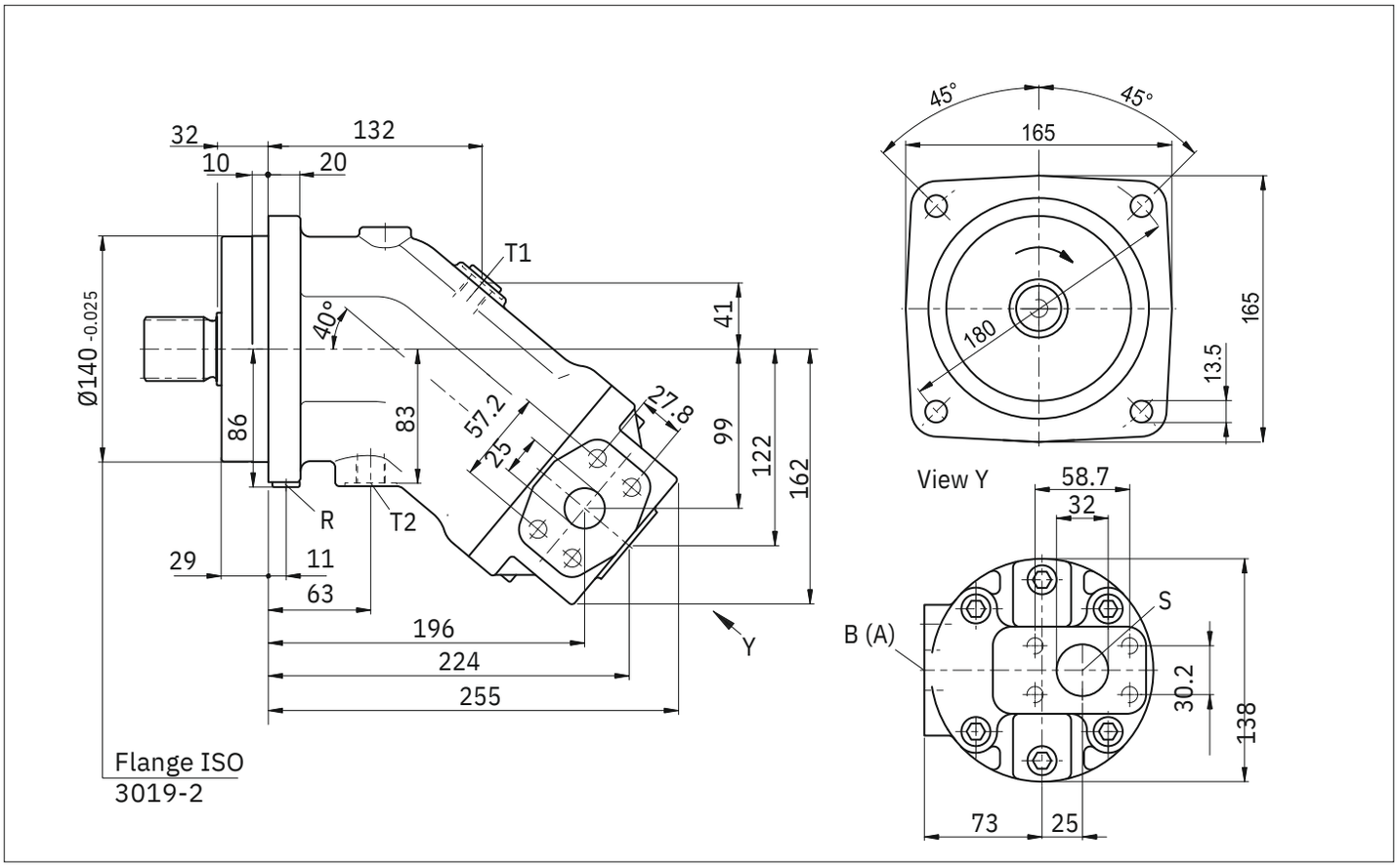

### Port details

| Designation | Port for | Standard | Maximum pressure (bar) |
|---|---|---|---|
| B/A | Service line, fastening threadB/A | SAE 3/4 in M10x1.5;17 deep | 400 |
| S | Suction line, fastening thread | SAE 1 in M10x1.5; 17 deep | 30 |
| T1 | Case drain line | M18x1.5;12 deep | 3 |
| T2 | Case drain line | M18x1.5;12 deep | 3 |
| R | Air bleed | M12x1.5; 12 deep | 3 |

# Unit Dimension Size 80, 90

**(Dimension in mm)**

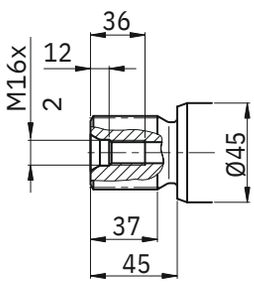
Port plate 05-SAE flange port A/B at side and SAE flange port S at rear illustration : cw direction of rotation (on version “ccw direction of rotation” the port plate is rotated through 180°)




**Drive shaft**

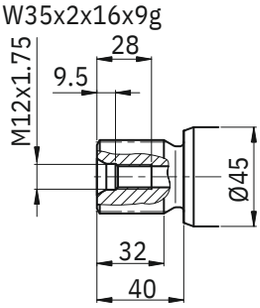
Size 80, 90

**“A”** Splined shaft
DIN 5480
W40x2x18x9g



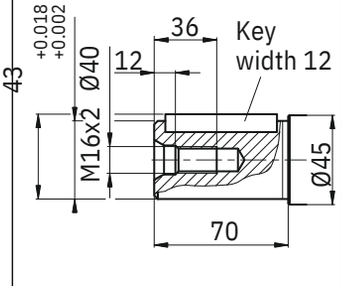

Size 80

**“Z”** Splined shaft
DIN 5480
W35x2x16x9g



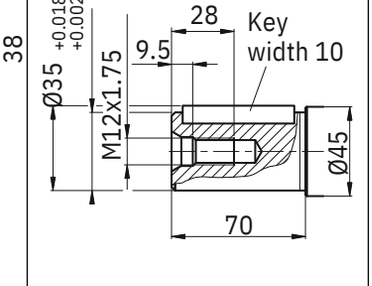

Size 80, 90

**“B”** Parallel keyed shaft
DIN 6885, AS12x8x56




Size 80

**“P”** Parallel keyed shaft
DIN 6885, AS10x8x56



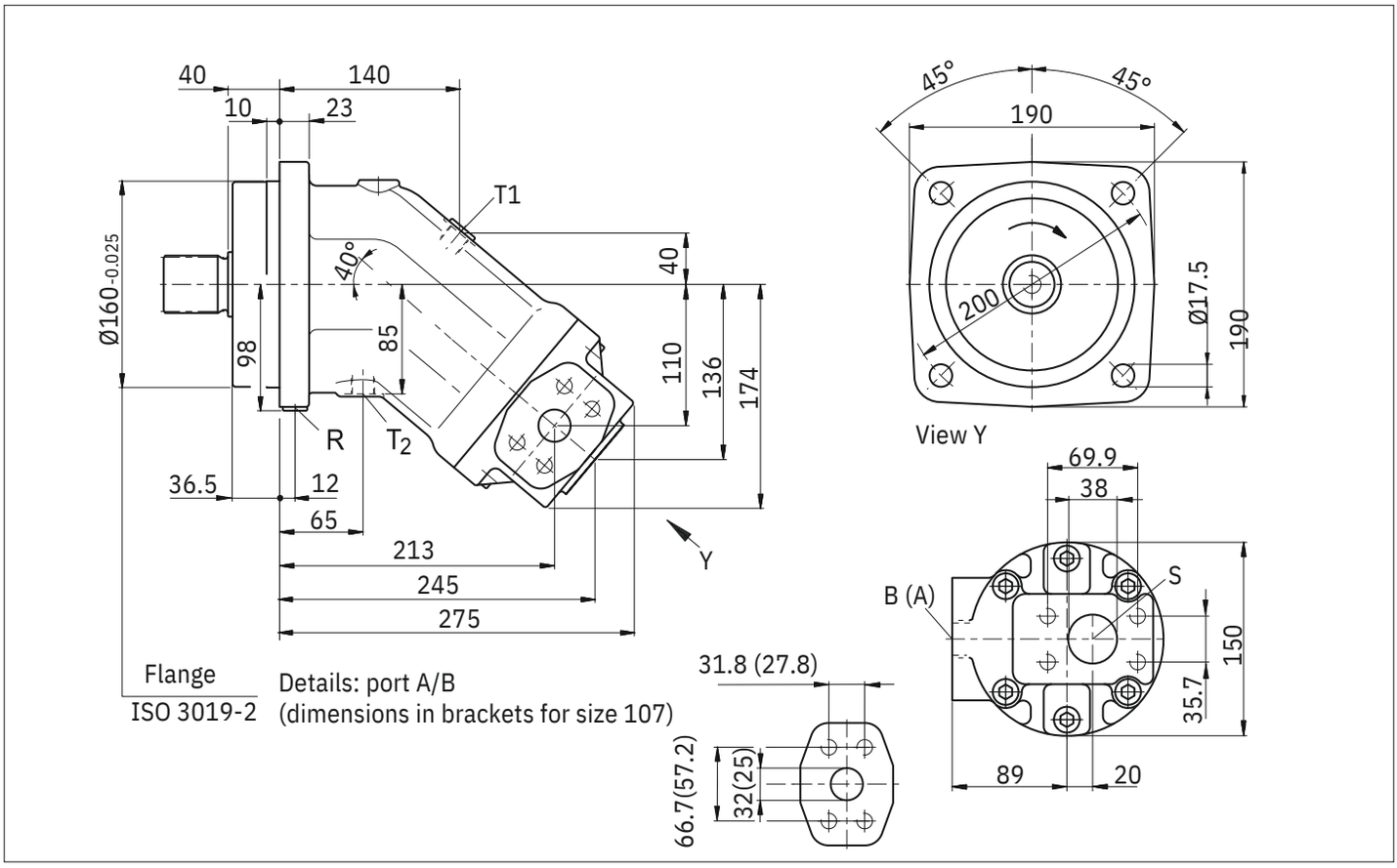

**Port details**

| Designation | Port for | Standard | Maximum pressure (bar) |
|---|---|---|---|
| B/A | Service line, fastening thread B/A | SAE 1 in M12x1.5;17 deep | 400 |
| S | Suction line, fastening thread | SAE 1 1/4 in M10x1.5; 17 deep | 30 |
| T1 | Case drain line | M18x1.5;12 deep | 3 |
| T2 | Case drain line | M18x1.5;12 deep | 3 |
| R | Air bleed | M12x1.5; 12 deep | 3 |

# Unit Dimension Size 107, 125

**(Dimension in mm)**

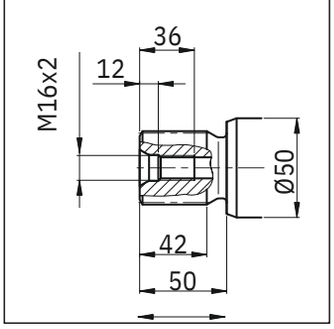
Port plate 05-SAE flange port A/B at side and SAE flange port S at rear illustration: cw direction of rotation (on version “ccw direction of rotation” the port plate is rotated through 180°)




**Drive shaft**

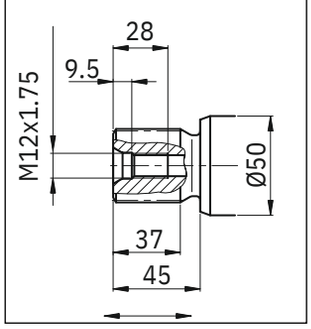
Size 107, 125

**“A”** Splined shaft DIN 5480 W45x2x21x9g



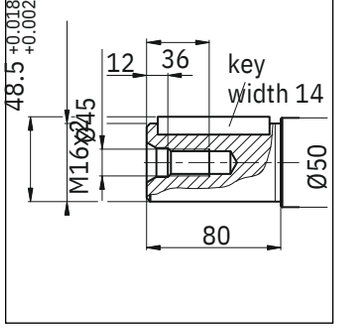

Size 107

**“Z”** Splined shaft DIN 5480 W40x2x18x9g



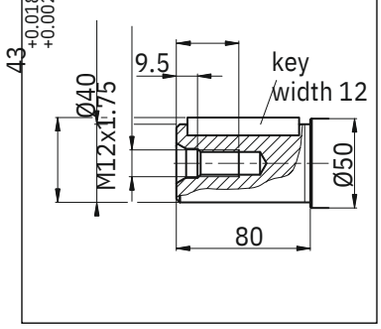

Size 107, 125

**“B”** Parallel keyed shaft DIN 6885, AS14x9x63




Size 107

**“P”** Parallel keyed shaft DIN 6885, AS12x9x63

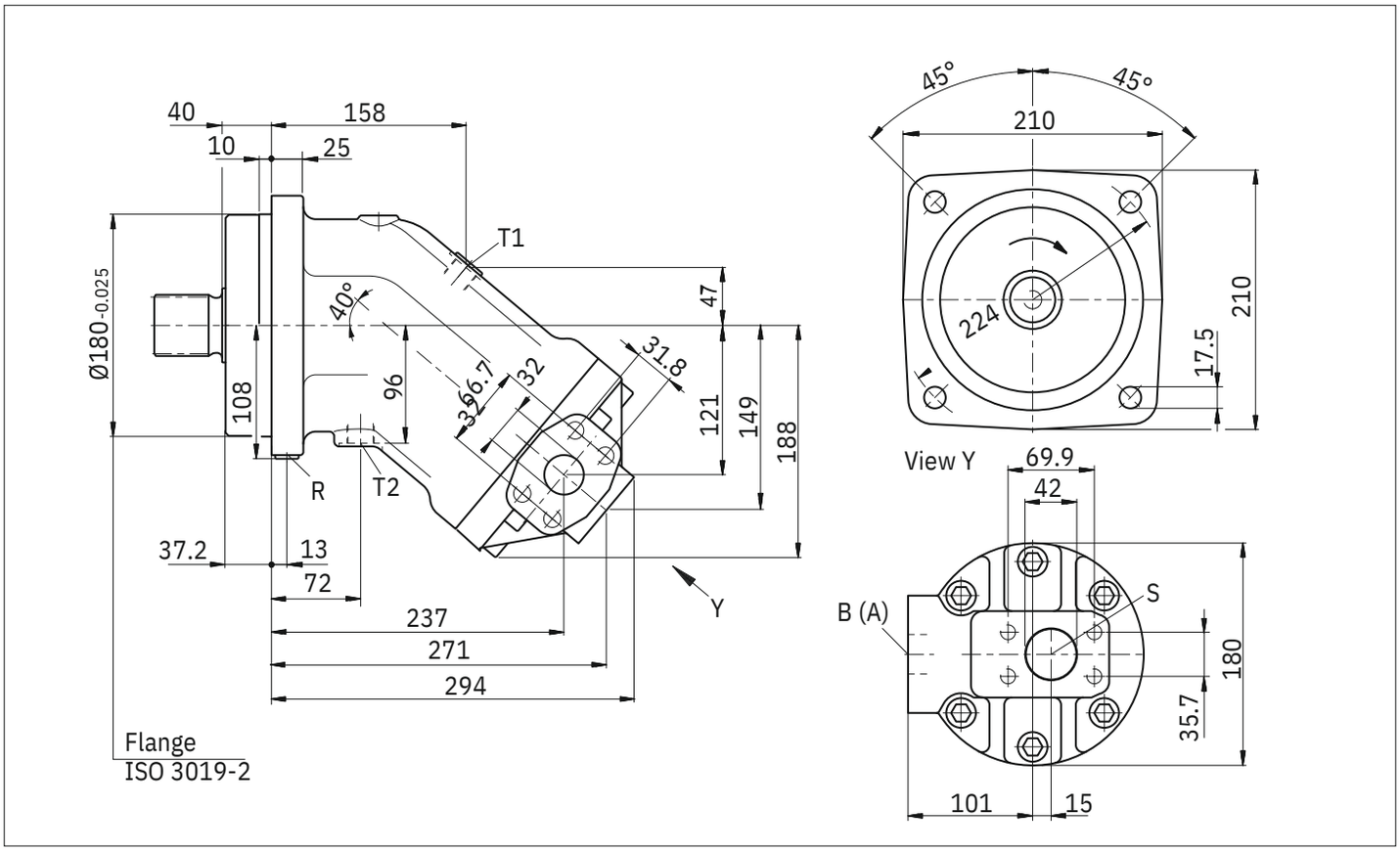



**Port details**

| Designation | Port for | Standard | Maximum pressure (bar) |
|---|---|---|---|
| B/A | Service line, fastening thread B/A | SAE 1 in (size107) M12x1.75;17 deep 11/4 in (size125) M14x2;19 deep | 400 |
| S | Suction line, fastening thread | SAE 1 1/2 in M12x1.75; 17 deep | 30 |
| T1 | Case drain line | M18x1.5;12 deep | 3 |
| T2 | Case drain line | M18x1.5;12 deep | 3 |
| R | Air bleed | M14x1.5; 12 deep | 3 |

# Unit Dimension Size 160, 180 (Dimension in mm)

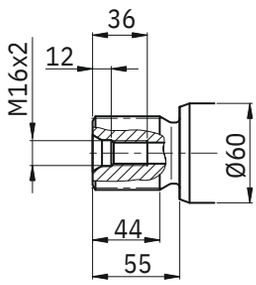
Port plate 05-SAE flange port A/B at side and SAE flange port S at rear illustration: cw direction of rotation (on version “ccw direction of rotation” the port plate is rotated through 180°)




**Drive shaft**

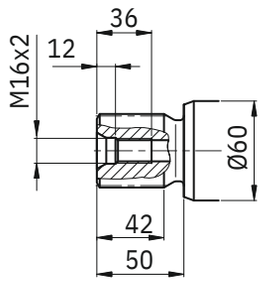
Size 160, 180

**“A”** Splined shaft DIN 5480 W50x2x24x9g



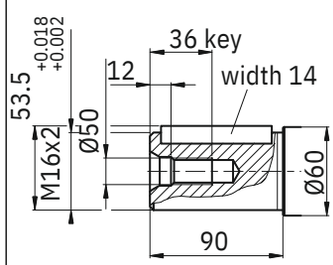

Size 160

**“Z”** Splined shaft DIN 5480 W45x2x21x9g



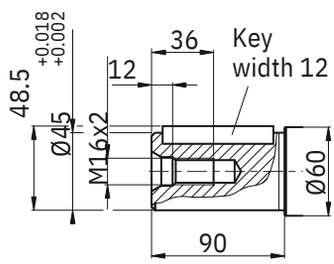

Size 160, 180

**“B”** Parallel keyed shaft DIN 6885, AS14x9x70




Size 160

**“P”** Parallel keyed shaft DIN 6885, AS14x9x70




**Port details**

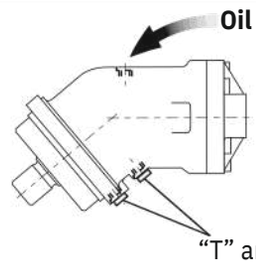
| Designation | Port for | Standard | Maximum pressure (bar) |
|---|---|---|---|
| B/A | Service line, fastening threadB/A | SAE 1 1/4 in M14x2;19 deep | 400 |
| S | Suction line, fastening thread | SAE 1 1/2 in M12x1.75; 20 deep | 30 |
| T1 | Case drain line | M22x1.5;14 deep | 3 |
| T2 | Case drain line | M22x1.5;14deep | 3 |
| R | Air bleed | M14x1.5; 12 deep | 3 |

# Installation notes for A2FO Axial piston units

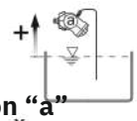
**Fixed pump A2FO, Series 6.1**

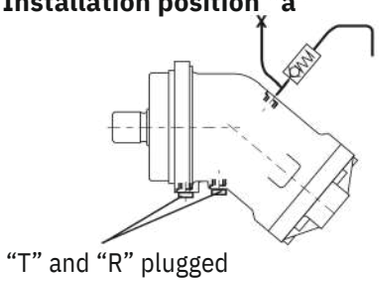
**Optimum filling orientation:**

Air bleed port “R” standard in A2FO

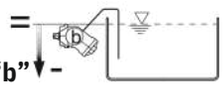


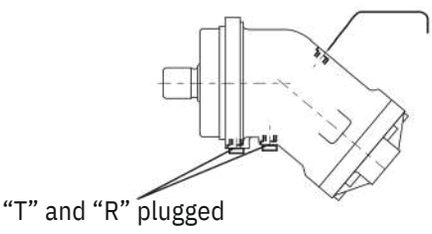

**Installation position “a”**



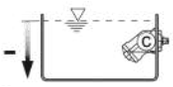



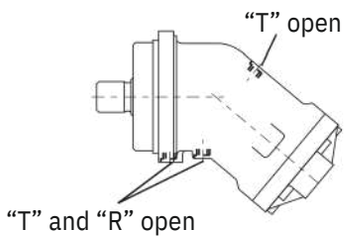

**Installation position “b”**

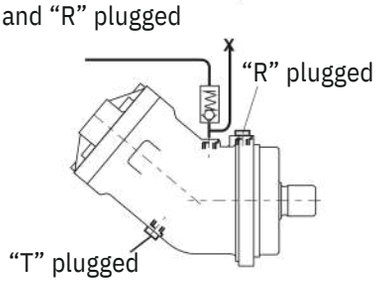


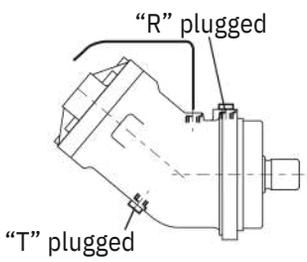



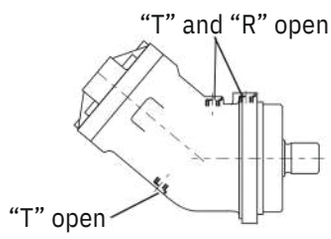

**Installation position “c”**

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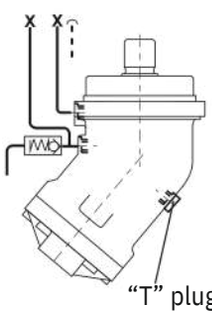


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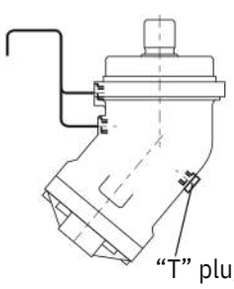


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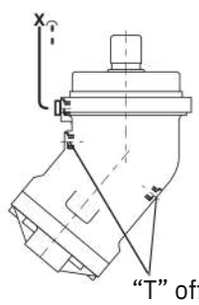
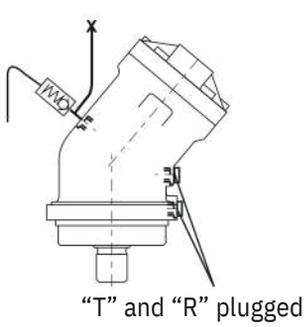
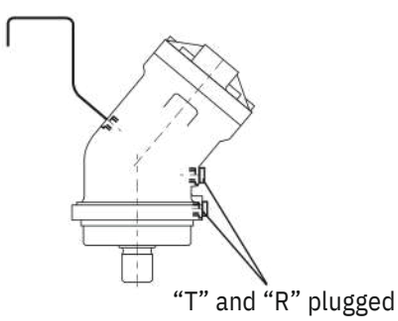
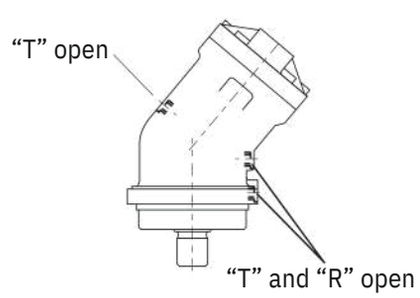
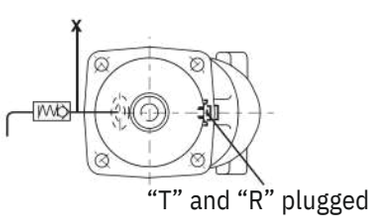
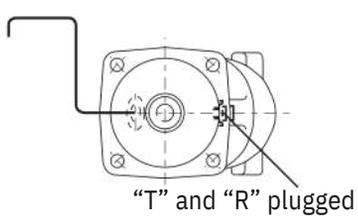


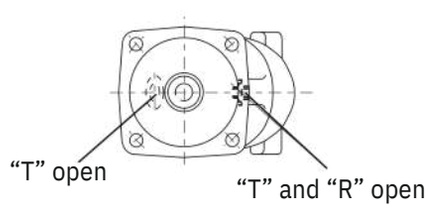



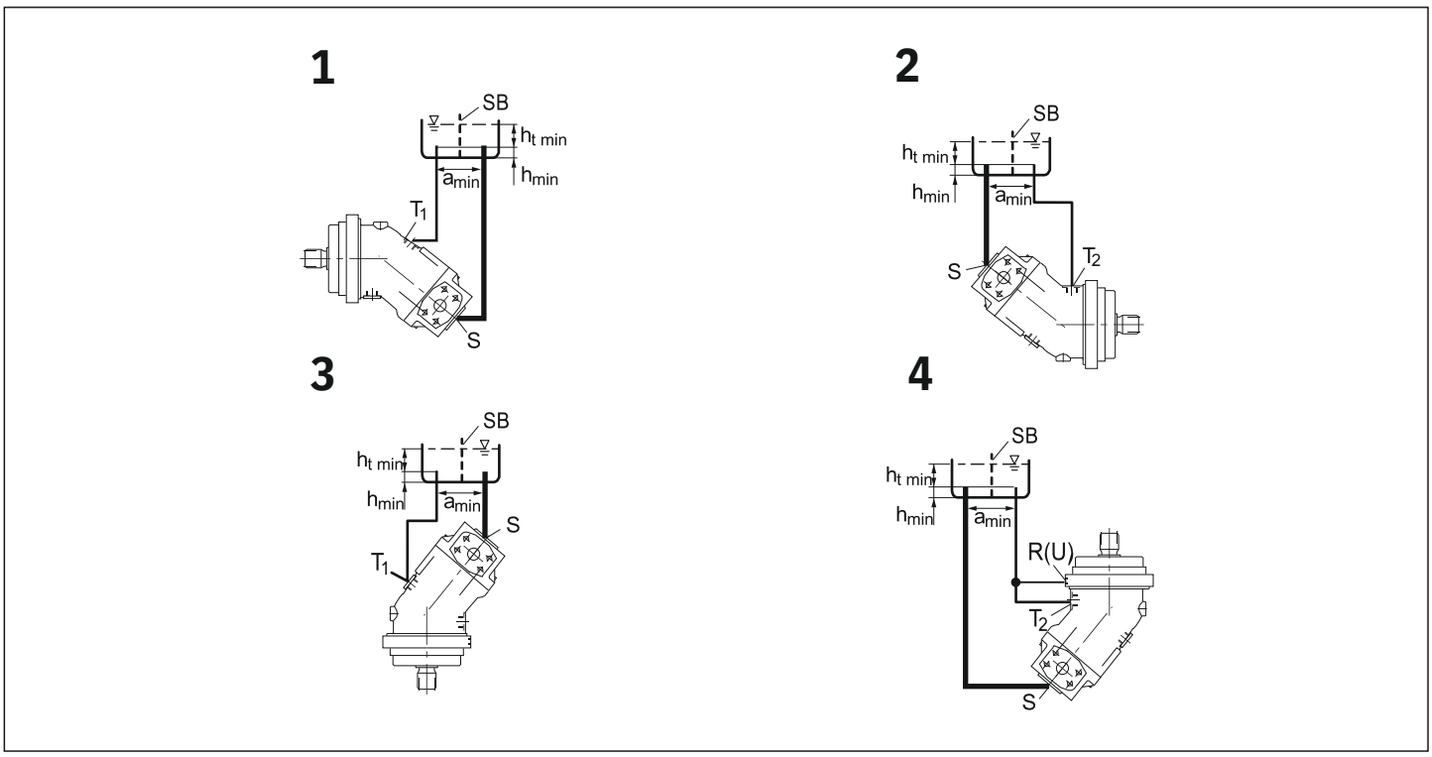



# Installation notes for A2FO Axial piston units

**General** During commissioning and operation, the axial piston unit must be filled with hydraulic Buid 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 upward” 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 pump housing must be directed to the reservoir via the highest available drain port1 (TT2). For combinations of multiple units, make sure that the respective case pressure in each units is not exceed. 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 fluif level. The permissible suction height hs results from the overall loss of pressure; it must not, however, be higher than hsmax =800mm. The minimum suction pressure at port S must also not fall below 0.8bar absolute during operation and during cold start.

**Installation position** See the following examples 1 to 8 Further instllation positions are possible upon request. Recommended installation positions: 1 and 2

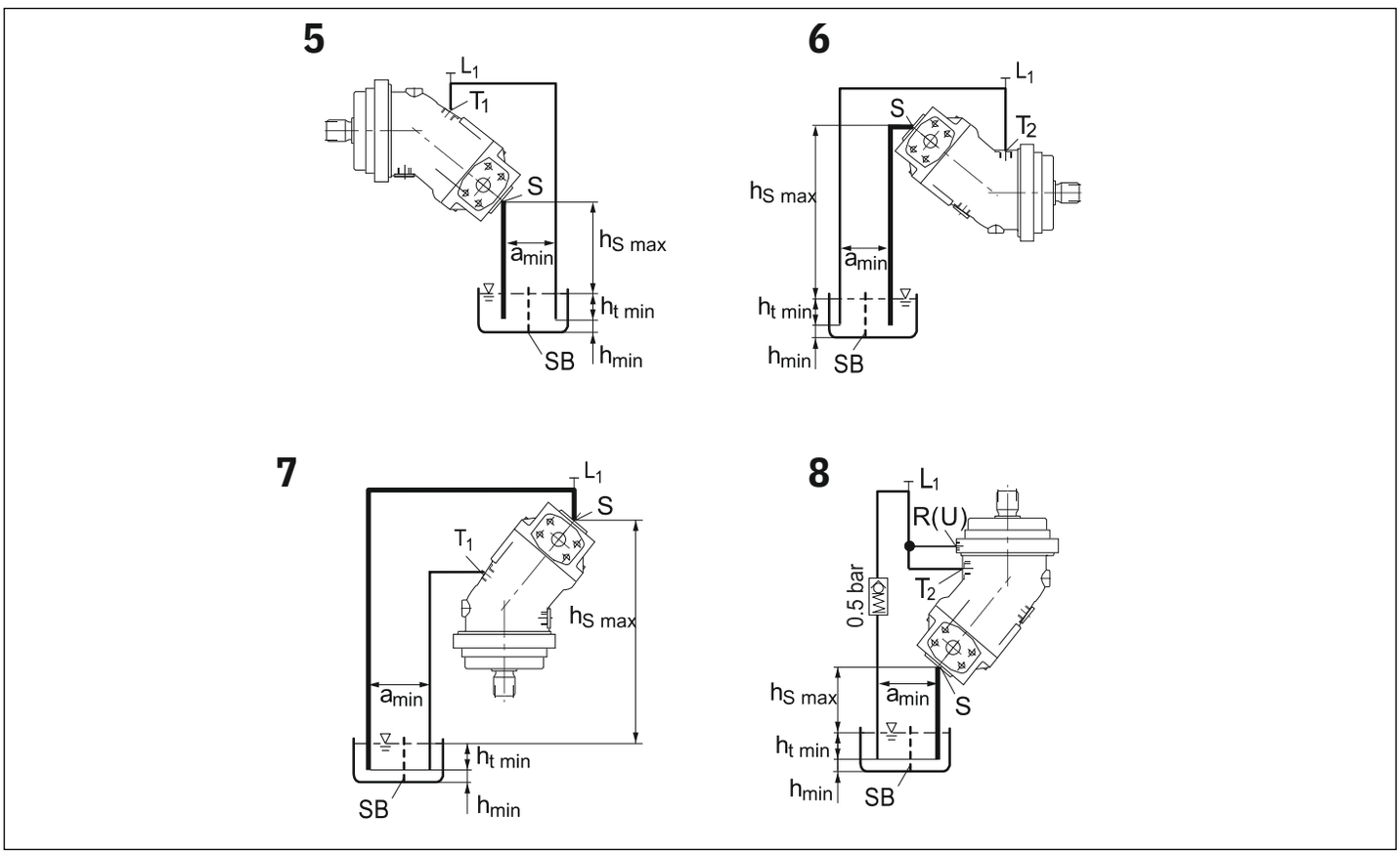
**Below-reservoir installation (standard)** Below-reservoir installation means that the axial piston unit is installed outside of the reservoir below the minimum fluid level.




| Installation position | Air bleed | Filling |
|---|---|---|
| 1 | - | T1 |
| 2 | - | T2 |
| 3 | - | T1 |
| 4 | R (U) 2 | T |

# Installation notes for A2FO Axial piston units

**Above-reservoir installation** Above -reservoir installation means that the axial piston unit is installed above the minimum fluid level of the reservoir. Recommendation for installation position 8 (drive shaft upward): A check valve in the drain line (cracking pressure 0.5 bar) A ceck valve in the drain line (cracking pressure 0.5bar) can prevent draining of the pump housing.




| Installation position | Air | Filling |
|---|---|---|
| 5 | bleed | T1 (L1) |
| 6 | L1 L1 | T2 (L1) |
| 7 | L1 R | T1(L1) |
| 8 | (U)2 | T(L1) |

| | |
|---|---|
| L1 | Filling / air bleed |
| R | Air bleed port |
| U | Bearing flushing/ air bleed port |
| S | Suction port |
| T1, T2 | Drain port Minimum |
| ht min | required immersion depth (200mm) |
| hmin | Minimum required spacing to reservoir bottom (100mm) |
| SB | Bafle (Bafle plate) Maximum permissible suction height (800mm) |
| hs max | When designing the reservoir, ensure adequate space between the suction line and the |
| amin | drain line This prevents the heated, return □ow from being |

## General Instructions

- The pump A2FO is designed to be used in open circuits.
- The project planning, installation and commissioning of the axial piston unit requires the involvement of qualified personnel. Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. During and shortly after operation, there is a risk of burns on the axial piston unit. Take appropriate safety measures (e. g. by wearing protective clothing). Depending on the operating conditions of the axial piston unit (operating pressure, fluid temperature), the characteristic may shift. Service line ports: The ports and fastening threads are designed for the specified maximum pressure. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors. The service line ports and function ports can only be
- used to accommodate hydraulic lines.
- The data and notes contained herein must be adhered to. The product is not approved as a component for the safety concept of a general machine according to ISO 13849. A pressure-relief valve is to be fitted in the hydraulic system. The following tightening torques apply:
- **Fittings:** Observe the manufacturer's instructions regarding tightening torques of the fittings used.
- **Mounting bolts:** For mounting bolts with metric ISO thread according to DIN 13 or with thread according to ASME B1.1, we recommend checking the tightening torque in individual cases in accordance with VDI 2230. **Female threads in the axial piston unit:** The maximum permissible tightening torques MG max are maximum values for the female threads and must not be exceeded. For values, see the following table.
- **Threaded plugs:** For the metallic threaded plugs supplied with the axial piston unit, the required tightening torques of threaded plugs MV apply. For values, see the following table.

| Ports standard | Size of standard | Maximum permissible tightening torque of the female threads MG max | Required tightening torque of the threaded plugs MV **1)** | WAF hexagon socket in the threaded plugs |
|---|---|---|---|---|
| DIN3852 | M8 x 1 | 10 Nm | 7 Nm | 3 mm |
| | M10 x 1 | 30 Nm | 15 Nm **2)** | 5 mm |
| | M12 x 1.5 | 50 Nm | 25 Nm **2)** | 6 mm |
| | M14 x 1.5 | 80 Nm | 35 Nm | 6 mm |
| | M16 x 1.5 | 100 Nm | 50 Nm | 8 mm |
| | M18 x 1.5 | 140 Nm | 60 Nm | 8 mm |
| | M22 x 1.5 | 210 Nm | 80 Nm | 10 mm |
| | M33 x 2 | 540 Nm | 225 Nm | 17 mm |
| | M42 x 2 | 720 Nm | 360 Nm | 22 mm |

**1)** The tightening torques apply for screws in the "dry" state as received on delivery and in the "lightly oiled" state for installation.

**2)** In the "lightly oiled" state, the MV is reduced to 10 Nm for M10 x 1 and 17 Nm for M12 x 1.5.