Axial piston fixed motor
A2FMT series 70

RE 91072
Edition: 07.2017
Replaces: 11.2016

- Fixed motor for drum drives in concrete mixer trucks
- Sizes 56 to 107
- Maximum pressure 420 bar (6100 psi)
- Closed circuit

Features

- Fixed motor with axial tapered piston rotary group of bent-axis design, for hydrostatic drum drives in concrete mixer trucks in closed circuit
- The output speed is dependent on the flow of the pump and the displacement of the motor.
- The output torque increases with the pressure differential between the high-pressure side and the low-pressure side.
- High power density
- Small dimensions – compact design
- High total efficiency
- Good starting efficiency
- Integrated flushing valve optional

Contents

Ordering code

01	02	03	04		05	06	07	08	09	10	11	12	13	14		15
A2F	**M**	**T**		**/**	**70**		**W**	**V**	**C4**	**V8**	**02**			**0**	–	

Axial piston unit

01	Bent-axis design, fixed displacement	**A2F**

Operating mode

02	Motor, standard version	**M**

Application		056	063	080	090	107	
03	Concrete mixer truck, Maximum pressure 420 bar (6100 psi)	●	●	●	●	●	**T**

Size (NG)

04	Geometric displacement, see technical data on page 6	**056**	**063**	**080**	**090**	**107**	

Series

05	Series 7, index 0	**70**

Design of ports and fastening threads

06	Metric, DIN 3852 with profile seal (Europe, ROW)	**N**
	ANSI (USA)	**A**

Direction of rotation

07	Viewed on drive shaft, bidirectional	**W**

Sealing material

08	FKM (fluoroelastomer)	**V**

Mounting flange			056	063	080	090	107	
09	SAE J744	127-4	●	●	●	●	●	**C4**

Drive shaft			056	063	080	090	107	
10	Splined shaft SAE J744 (ANSI B92.1a)	1 3/8 in 21T 16/32 DP	●	●	●	●	●	**V8**

Port for working lines		056	063	080	090	107	
11	SAE flange ports A and B at side, opposite	●	●	●	●	●	**02**

Valves				056	063	080	090	107	
12	Integrated flushing and boost-pressure valve Flushing flow when: $\Delta p = p_{ND} - p_G$ = 25 bar (365 psi) and ν = 10 mm²/s (60 SUS)	**Flushing flow [l/min (gpm)] /** Orifice-ø [mm (inches)]	**2.6 (0.69)** / 1.0 (0.04)	○	○	○	○	○	**C**
			6.0 (1.58) / 1.5 (0.06)	●	●	○	○	○	**E**
			7.4 (1.95) / 1.7 (0.067)	○	○	○	○	○	**F**
			8.5 (2.45) / 1.8 (0.071)	○	○	●	●	●	**G**
			11.4 (3.01) / 2.3 (0.09)	○	○	○	○	●	**I**
			12.5 (3.30) / 3 (0.12)	○	○	○	○	○	**J**

Speed sensor

13	Without speed sensor	**0**
	Prepared for DSA sensor	**A**
	Prepared for DSM sensor	**N**

Special version

14	Standard version	**0**

Standard / special version

15	Standard version	**0**
	Standard version with installation variants, e. g. T ports contrary to standard open or closed	**Y**
	Special version	**S**

● = Available ○ = On request

Note

▶ Note the project planning notes on page 14

Hydraulic fluids

The fixed motor A2FMT is designed for operation with HLP mineral oil according to DIN 51524.
Application instructions and requirements for hydraulic fluids should be taken from the following data sheets before the start of project planning:

- 90220: Hydraulic fluids based on mineral oils and related hydrocarbons
- 90221: Environmentally acceptable hydraulic fluids
- 90222: Fire-resistant, water-free hydraulic fluids (HFDR/HFDU)
- 90223: Fire-resistant, water-containing hydraulic fluids (HFAE, HFAS, HFB, HFC)

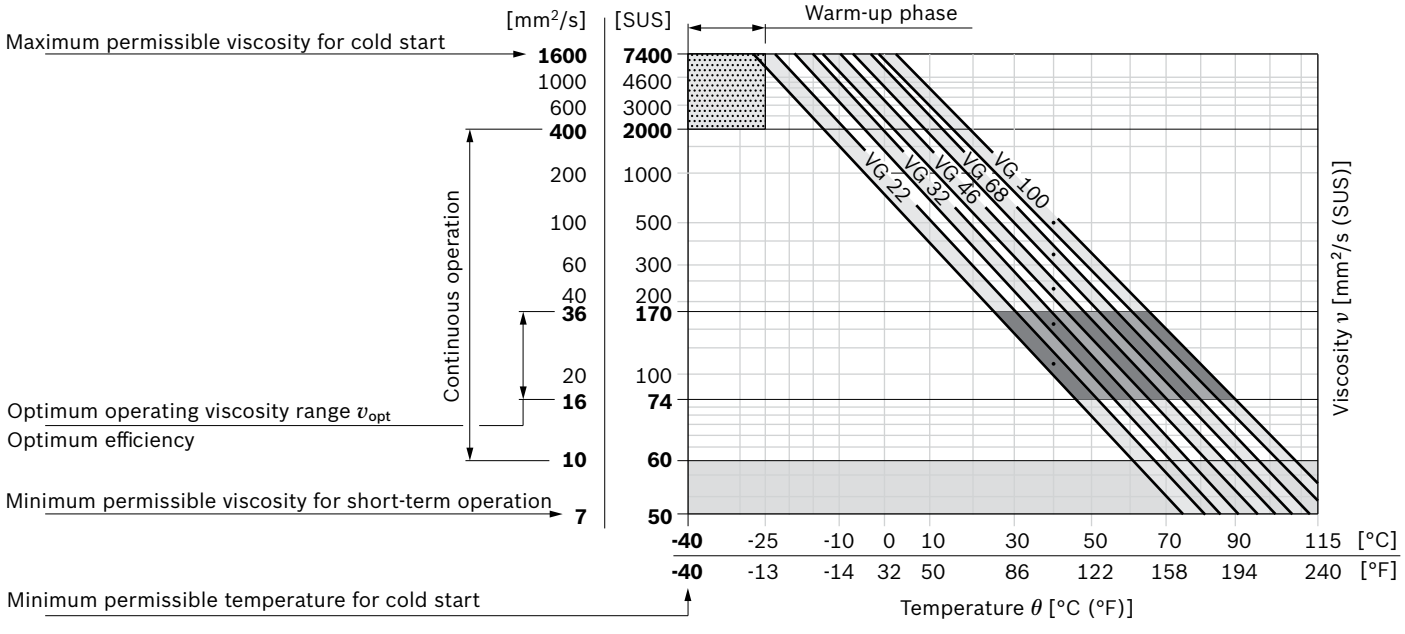
Details regarding the selection of hydraulic fluid
The hydraulic fluid should be selected such that the operating viscosity in the operating temperature range is within the optimum range (v_{opt}, see selection diagram).

Note
At no point of the component may the temperature be higher than +115 °C (+240 °F). The temperature difference specified in the table 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 the use of a flushing and boost pressure valve (see page 12).

Viscosity and temperature of hydraulic fluids

	Viscosity		Temperature		Comment	
Cold start	v_{max} ≤	1600 mm²/s (7400 SUS)	θ_{St} ≥	−40 °C (−40 °F)	t ≤ 3 min, n ≤ 1000 rpm	without load p ≤ 50 bar (without load p ≤ 725 psi)
Permissible temperature difference			ΔT ≤	25 K (45 °F)	between axial piston unit and hydraulic fluid in the system	
Warm-up phase	v <	1600 to 400 mm²/s (7400 to 1850 SUS)	θ =	−40 °C to −25 °C (−40 °F to −13 °F)	At p ≤ 0.7 × p_{nom}, n ≤ 0.5 × n_{nom} and t ≤ 15 min	
Continuous operation	v =	400 to 10 mm²/s (1850 to 59 SUS)			This corresponds, for example on the VG 46, to a temperature range of +5 °C to +85 °C (+41 °F to +185 °F) (see selection diagram)	
			θ =	−25 °C to +103 °C (−13 °F to +217 °F)	measured at port **T** Note the permissible temperature range of the shaft seal (ΔT = approx. 12 K between the bearing/shaft seal and port **T**)	
	v_{opt} =	36 to 16 mm²/s (170 to 82 SUS)			Range of optimum operating viscosity and efficiency	
Short-term operation	v_{min} ≥	7 mm²/s (49 SUS)			t < 3 min, p < 0.3 × p_{nom}	

▼ **Selection diagram**



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. A cleanliness level of at least 20/18/15 is to be maintained according to ISO 4406.

At very high hydraulic fluid temperatures 90 °C to maximum 103 °C (195 °F to maximum 217 °F) measured at port **T**, a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

Flow direction

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

Shaft seal

Permissible pressure loading

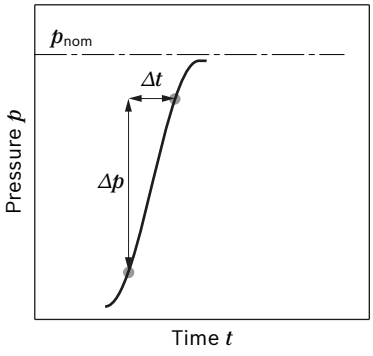
The service life of the shaft seal is influenced by the speed of the axial piston unit and the leakage pressure in the housing (case pressure). The mean differential pressure of 2 bar (30 psi) between the housing and the ambient pressure may not be exceeded for long durations at normal operating temperature. Momentary pressure peaks (t < 0.1 s) up to 10 bar (145 psi) are permitted. The service life of the shaft seal decreases with increasing frequency of pressure spikes and increasing mean differential pressure. The case pressure must be equal to or higher than the ambient pressure.

The FKM shaft seal may be used for leakage temperatures from −25 °C to +115 °C (−13 °F to +240 °F). For application cases below −25 °C (−13 °F), an NBR shaft seal is required (permissible temperature range: −40 °C to +90 °C (−40 °F to +195 °F)).

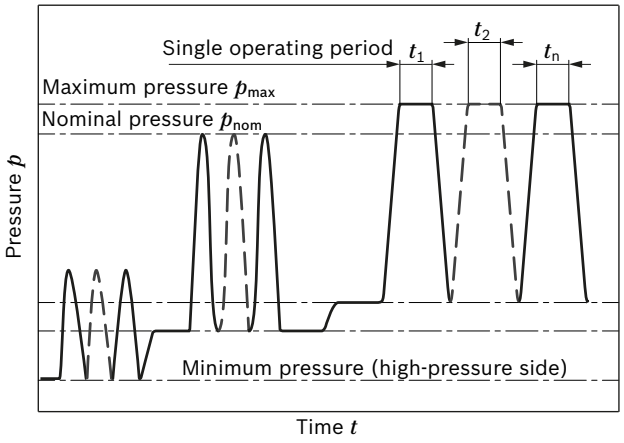
Working pressure range

Pressure at working ports A or B		Definition
Maximum pressure p_{max}	420 bar (6100 psi)	The maximum pressure corresponds the maximum working pressure within the single operating period. The sum of the single operating periods must not exceed the total operating period.
Single operating period	10 s	
Total operating period	200 h	
Minimum pressure (high-pressure side)	25 bar (365 psi)	Minimum pressure at the high-pressure side (**A** or **B**) required to prevent damage to the axial piston unit.
Minimum pressure – pump operating mode (inlet)	See characteristic	To prevent damage to the axial piston motor in pump mode (change of high-pressure side with unchanged direction of rotation, e.g. when braking), a minimum pressure must be guaranteed at the working port (inlet). The minimum pressure depends on the rotational speed and displacement of the axial piston unit.
Total pressure p_{Su} (pressure **A** + pressure **B**)	700 bar (10150 psi)	The summation pressure is the sum of the pressures at both work ports (**A** and **B**).
Rate of pressure change $R_{A\,max}$		Maximum permissible rate of pressure build-up and reduction during a pressure change over the entire pressure range.
with built-in pressure relief valve	9000 bar/s (130530 psi/s)	
without pressure relief valve	16000 bar/s (232060 psi/s)	

▼ **Rate of pressure change $R_{A\,max}$**

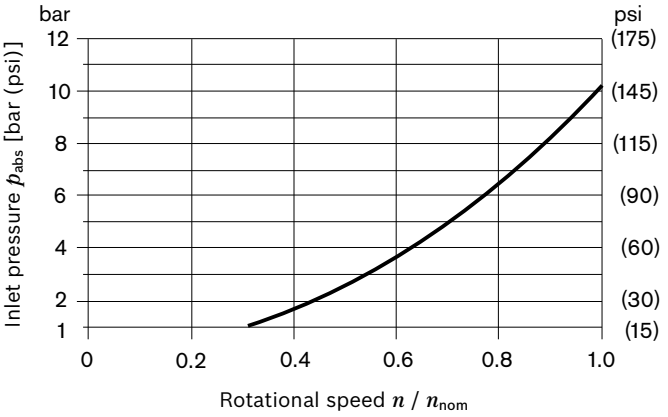


▼ **Pressure definition**



Total operating period = $t_1 + t_2 + ... + t_n$

▼ **Minimum pressure – pump operating mode (inlet)**



This diagram is only valid for the optimum viscosity range of v_{opt} = 36 to 16 mm²/s (170 to 73 SUS).
Please contact us if these conditions cannot be satisfied.

Note

Working pressure range valid when using hydraulic fluids based on mineral oils. Values for other hydraulic fluids, please contact us.

Technical data

Size	NG		56	63	80	90	107
Displacement geometric, per revolution	V_g	cm^3 (in^3)	56.6 (3.45)	63.0 (3.84)	81.7 (4.99)	90.5 (5.52)	108.8 (6.64)
Maximum rotational speed[1]	n_{nom}	rpm	3750	3750	3375	3375	3000
	n_{max}[2]	rpm	4125	4125	3700	3700	3300
Inlet flow	$q_{v\,max}$	l/min (gpm)	210 (55.5)	236 (62.3)	370 (97.7)	270 (71.3)	321 (84.8)
Torque[3] at Δp = 300 bar (4350 psi)	T	Nm (lb-ft)	270 (199)	301 (222)	390 (288)	432 (319)	519 (383)
Rotary stiffness	c_{min}	kNm/rad (klb-ft/rad)	6.83 (4.96)	8.09 (5.87)	7.94 (5.76)	9.84 (7.14)	10.9 (7.91)
Moment of inertia for rotary group	J_{GR}	kgm^2 ($lb\text{-}ft^2$)	0.0032 (0.076)	0.0032 (0.076)	0.0034 (0.081)	0.0054 (0.128)	0.0061 (0.145)
Maximum angular acceleration	α	rad/s^2	10000	12200	19800	4500	6000
Case volume	V	l (gal)	0.6 (0.16)	0.6 (0.16)	0.6 (0.16)	0.65 (0.17)	0.65 (0.17)
Weight approx.	m	kg (lbs)	17 (37.5)	17 (37.5)	17 (37.5)	23 (50.7)	23 (50.7)

Speed range

No limit to minimum speed n_{min}. If uniformity of motion is required, speed n_{min} must not be less than 50 rpm.

Calculation of characteristics

Inlet flow	$q_v = \frac{V_g \times n}{1000 \times \eta_v}$	[l/min]	$\left(\frac{V_g \times n}{231 \times \eta_v}\right)$ [gpm]
Rotational speed	$n = \frac{q_v \times 1000 \times \eta_v}{V_g}$	[rpm]	$\left(\frac{q_v \times 231 \times \eta_v}{V_g}\right)$ [rpm]
Torque	$T = \frac{V_g \times \Delta p \times \eta_{hm}}{20 \times \pi}$	[Nm]	$\left(\frac{V_g \times \Delta p \times \eta_{hm}}{24 \times \pi}\right)$ [lb-ft]
Power	$P = \frac{2\pi \times T \times n}{60000} = \frac{q_v \times \Delta p \times \eta_t}{600}$	[kW]	$\left(\frac{2\pi \times T \times n}{33000} = \frac{q_v \times \Delta p \times \eta_t}{1714}\right)$ [HP]

Key

V_g = Displacement per revolution [cm^3 (in^3)]
Δp = Differential pressure [bar (psi)]
n = Rotational speed [rpm]
η_v = Volumetric efficiency
η_{hm} = Hydraulic-mechanical efficiency
η_t = Total efficiency ($\eta_t = \eta_v \bullet \eta_{hm}$)

Note

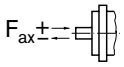
- Theoretical values, without efficiency and tolerances; values rounded
- Operation above the maximum values or below the minimum values may result in a loss of function, a reduced service life or the destruction of the axial piston unit. Other permissible limit values, such as speed variation, reduced angular acceleration as a function of the frequency and the permissible angular acceleration at start (lower than the maximum angular acceleration) can be found in data sheet 90261.

1) The valid values (observing the maximum permissible flow):
   – for the optimum viscosity range from v_{opt} = 36 to 16 mm^2/s (170 to 74 SUS)
   – with hydraulic fluid based on mineral oil

2) Intermittent maximum speed: Overspeed for unload and overhauling processes, t < 5 s and Δp < 150 bar (2200 psi)

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

Permissible radial and axial forces of the drive shafts

Size		NG		56	63	80	90	107
Drive shaft	type code			V8	V8	V8	V8	V8
	with splined shaft	ø	in	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8
Maximum radial force[1)] at distance a (from shaft collar) 		$F_{q\,max}$	kN	6.1	7.6	8.8	9.8	11.9
			lbf	1371	1709	1978	2203	2675
		a	mm	24	24	24	24	24
			in	0.94	0.94	0.94	0.94	0.94
Maximum torque at $F_{q\,max}$		$T_{q\,max}$	Nm	267	301	382	430	519
			lb-ft	197	222	282	317	382
Maximum differential pressure at $F_{q\,max}$		$\Delta p_{q\,max}$	bar	300	300	300	300	300
			psi	4350	4350	4350	4350	4350
Maximum axial force at standstill or pressure-free operation 		+ $F_{ax\,max}$	(lbf) N	0	0	0	0	0
		− $F_{ax\,max}$	N	800	800	800	1000	1000
			lbf	180	180	180	225	225
Permissible axial force per bar working pressure		+ $F_{ax\,perm}$/bar	N/bar	8.7	8.7	8.7	10.6	10.6
			lbf/psi	0.13	0.13	0.13	0.16	0.16

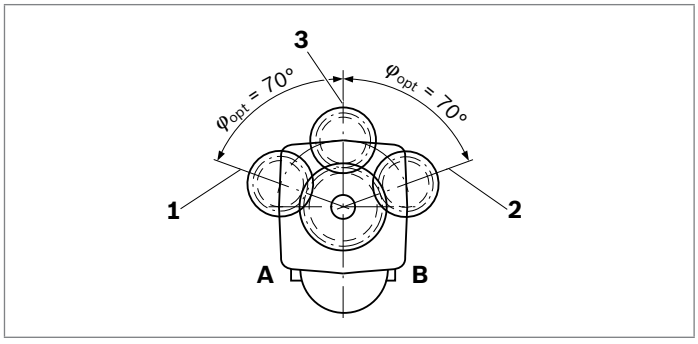
Note

- The values given are maximum values and do not apply to continuous operation.
- The permissible axial force in direction $-F_{ax}$ is to be avoided as the lifetime of the bearing is reduced.

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:

▼ **Gear output drive**

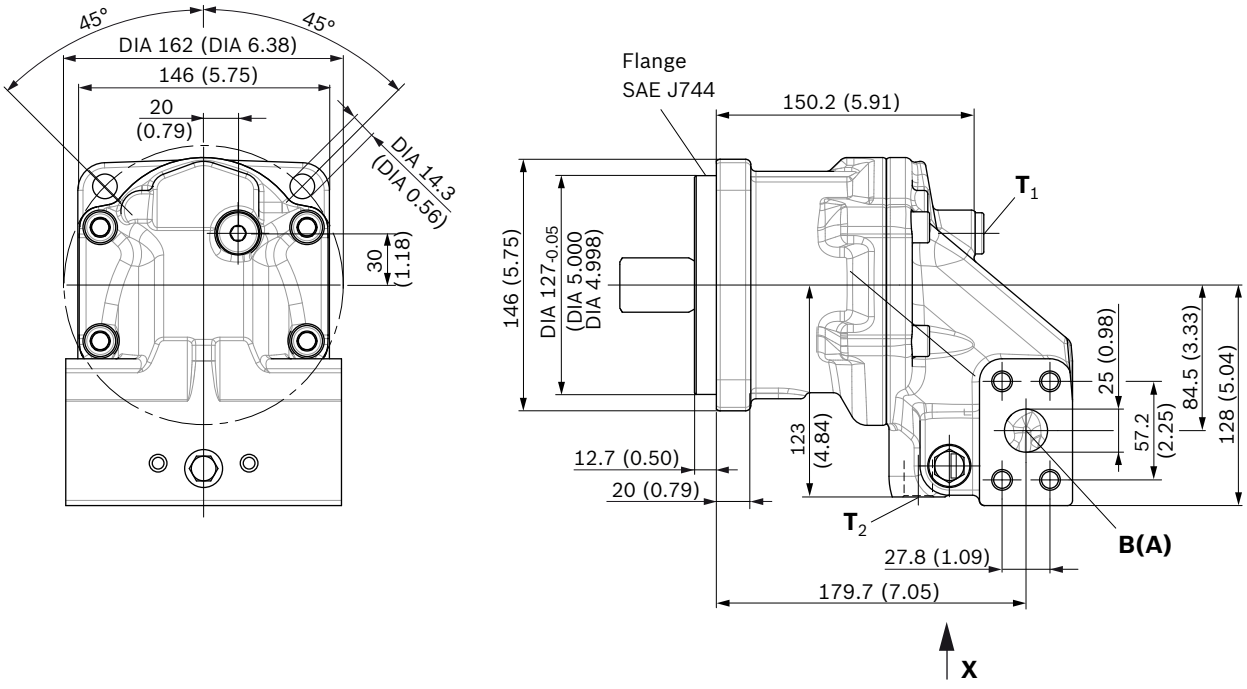


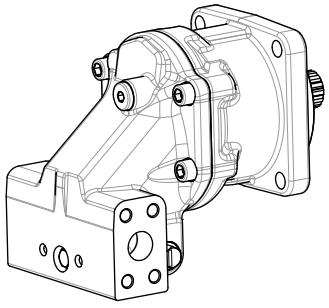
1 "Counter-clockwise" rotation. Pressure at port **B**

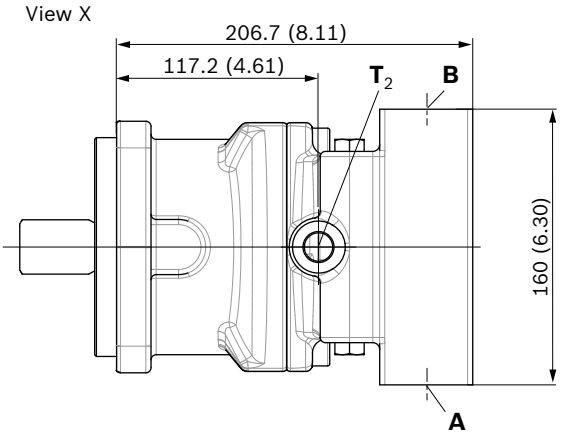
2 "Clockwise" rotation, Pressure at port **A**

3 "Bidirectional" direction of rotation

Dimensions sizes 56, 63 and 80

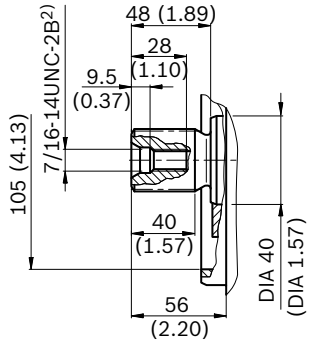






▼ **Splined shaft SAE J744, sizes 56, 63 and 80**

V8 – 1 3/8 in 21T 16/32 DP[1)]



Metric version (type code "N")

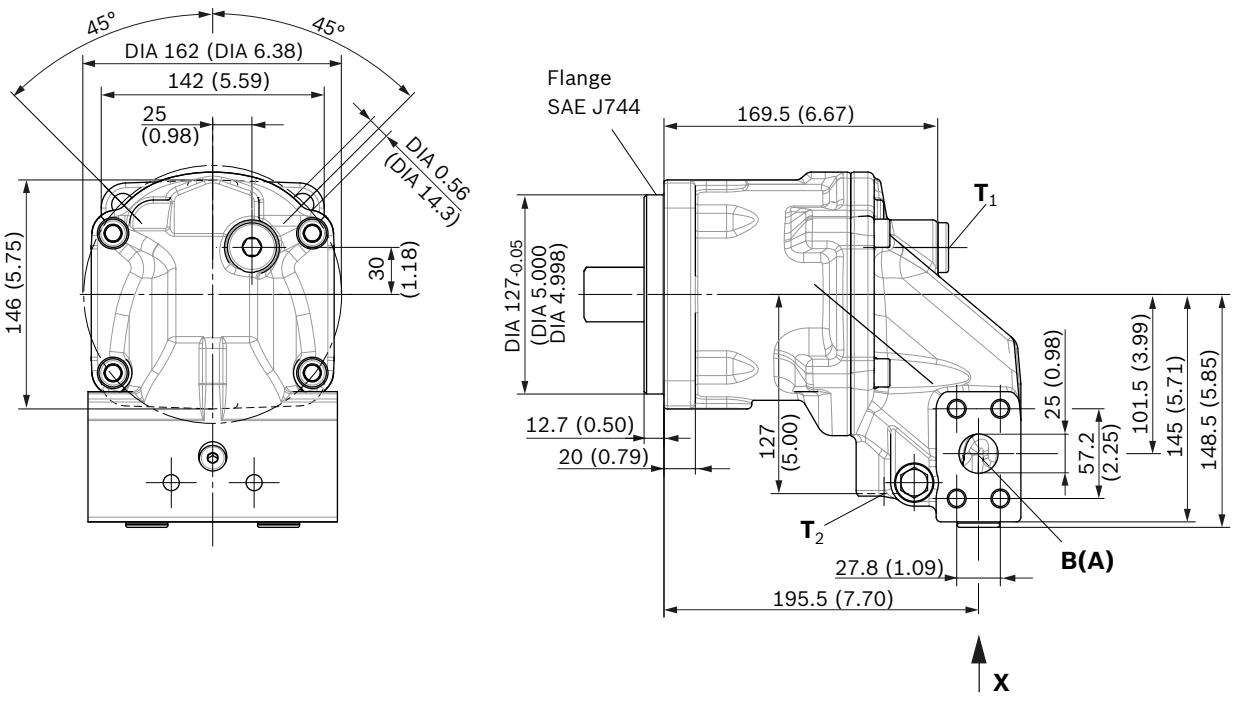
Ports		Standard	Size	$p_{max\ abs}$ [bar (psi)][3)]	Status[6)]
A, B	Working port Fastening thread	SAE J518 DIN 13	1 in M12 × 1.75; 17 (0.67) deep	420 (6100)	O
T_1	Drain port	DIN 3852[5)]	M18 × 1.5; 12 (0.47) deep	3 (45)	X[4)]
T_2	Drain port	DIN 3852[5)]	M18 × 1.5; 12 (0.47) deep	3 (45)	O[4)]

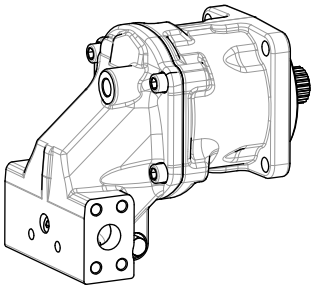
ANSI version (type code "A")

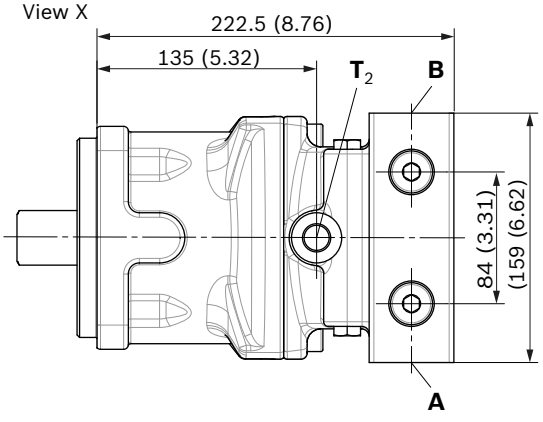
Ports		Standard	Size	$p_{max\ abs}$ [bar (psi)][3)]	Status[6)]
A, B	Working port Fastening thread	SAE J518 ASME B1.1	1 in 7/16-14UNC-2B; 19 (0.75) deep	420 (6100)	O
T_1	Drain port	ISO 11926[5)]	3/4-16UNF-2B; 15 (0.59) deep	3 (45)	X[4)]
T_2	Drain port	ISO 11926[5)]	3/4-16UNF-2B; 15 (0.59) deep	3 (45)	O[4)]

1) Involute spline acc. to ANSI B92.1a, 30° pressure angle, flat root,side fit, tolerance class 5
2) Thread according to ASME B1.1
3) Depending on the application, momentary pressure peaks can occur. 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 page 13).
5) The spot face can be deeper than as specified in the standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions sizes 90 and 107

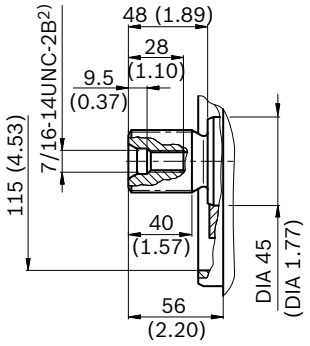






▼ **Splined shaft SAE J744, sizes 90 and 107**

V8 – 1 3/8 in 21T 16/32 DP[1)]



Metric version (type code "N")

Ports		Standard	Size	$p_{max\ abs}$ [bar (psi)][3)]	Status[6)]
A, B	Working port Fastening thread	SAE J518 DIN 13	1 in M12 × 1.75; 17 (0.67) deep	420 (6100)	O
T_1	Drain port	DIN 3852[5)]	M18 × 1.5; 12 (0.47) deep	3 (45)	X[4)]
T_2	Drain port	DIN 3852[5)]	M18 × 1.5; 12 (0.47) deep	3 (45)	O[4)]

ANSI version (type code "A")

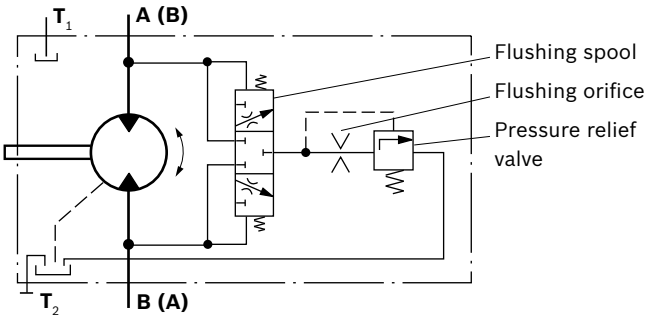
Ports		Standard	Size	$p_{max\ abs}$ [bar (psi)][3)]	Status[6)]
A, B	Working port Fastening thread	SAE J518 ASME B1.1	1 in 7/16-14UNC-2B; 19 (0.75) deep	420 (6100)	O
T_1	Drain port	ISO 11926[5)]	7/8-14UNF-2B; 17 (0.67) deep	3 (45)	X[4)]
T_2	Drain port	ISO 11926[5)]	7/8-14UNF-2B; 17 (0.67) deep	3 (45)	O[4)]

1) ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to ASME B1.1
3) Depending on the application, momentary pressure peaks can occur. 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 page 13).
5) The spot face can be deeper than as specified in the standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Integrated flushing and boost pressure valve

The flushing and boost pressure valve is used to remove heat from the hydraulic circuit.
In the closed circuit it is used for the case flushing and for the ensurance of the minimum boost pressure.
Hydraulic fluid is directed from the respective low pressure side into the motor case. This is then fed into the reservoir, together with the leakage. The hydraulic fluid removed from the closed circuit must be replaced by cooled hydraulic fluid from the boost pump.

Schematic



Opening pressure of pressure relief valve
(observe when adjusting the primary valve)

- Sizes 56 to 107, fixed setting 16 bar (230 psi)

Switching pressure of flushing spool

- Sizes 56 to 107
  Δp = 8 ±1 bar (115 ±15 psi)

Flushing flow
Orifices can be used to adjust the flushing flows as required. The following information is based on:
$\Delta p_{ND} = p_{ND} - p_G$ = 25 bar (365 psi) and
ν = 10 mm²/s (60 SUS)
(p_{ND} = low pressure, p_G = case pressure)

Size	Orifices DIA [ø mm (inch)]	Flushing flow q_v [l/min (gpm)]
56, 63, 80, 90, 107	1.0 (0.04)	2.6 (0.69)
	1.5 (0.06)	6 (1.58)
	1.7 (0.067)	7.4 (1.95)
	1.8 (0.071)	8.5 (2.45)
	2.3 (0.09)	11.4 (3.01)
	3 (0.12)	12.3 (3.25)

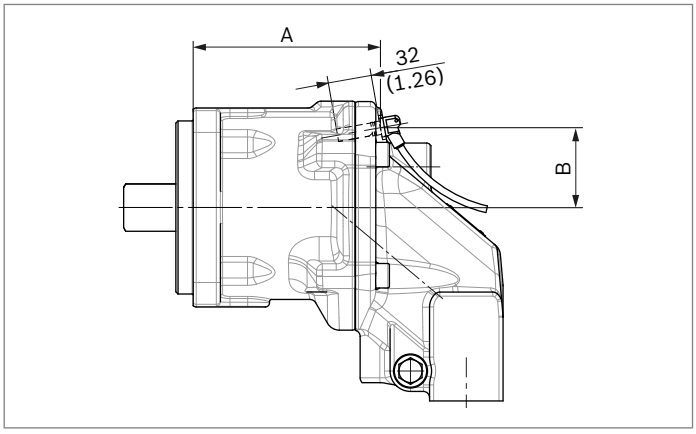
Speed sensors DSA and DSM

The versions A2FM...A and A2FM...N (“prepared for speed sensor”, i.e. without sensor) is equipped with splines on the rotary group.
A signal proportional to motor speed can be generated with the fitted DSA/DSM speed sensor. The DSA/DSM sensor detects the speed and direction of rotation.
Ordering code, technical data, dimensions and details on the connector, plus safety instructions about the sensor can be found in the relevant data sheet 95133 (DSA) and 95132 (DSM).
On delivery without sensor, the port provided for this purpose is plugged with a pressure-resistant cover.

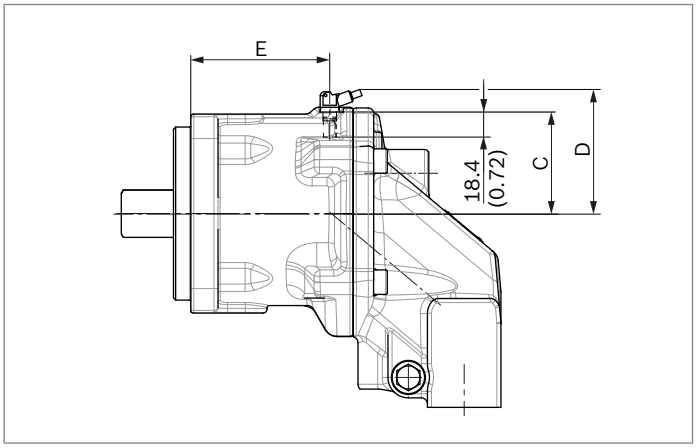
Size		56, 63, 80	90, 107
Number of teeth		47	53
Dimensions	A	120.6 (4.75)	132.2 (5.20)
	B	54.6 (2.15)	58.8 (2.31)
	C	70.3 (2.77)	75 (2.95)
	D	94.8 (3.73)	99.5 (3.92)
	E	85.2 (3.35)	96.7 (3.81)

Dimensions

▼ **A2FMT with speed sensor DSA mounted**



▼ **A2FMT with speed sensor DSM mounted**



Installation instructions

General

The axial piston unit must be filled with hydraulic fluid and air bled during commissioning and operation. This must also be observed following a longer standstill as the axial piston unit empty via the hydraulic lines.
The leakage in the housing area must be directed to the reservoir via the highest drain port (**T_1**, **T_2**).
If a shared drain line is used for several units, make sure that the relevant case pressure is not exceeded. The shared drain line must be dimensioned to ensure that the maximum permissible case pressure of all connected units is not exceeded under any operational circumstances, particularly during cold start. 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 drain line must flow into the reservoir below the minimum fluid level.

Key	
F	Filling / air bleeding
T_1, T_2	Drain port
$h_{t\,min}$	Minimum required immersion depth (200 mm (7.87 inch))
h_{min}	Minimum required spacing to reservoir base (100 mm (3.94 inch))

Note

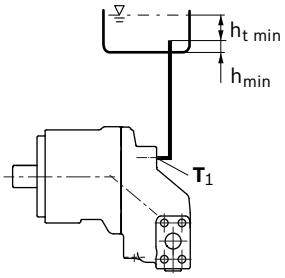
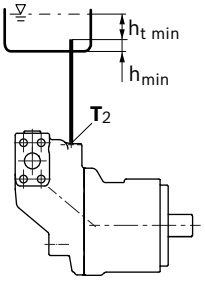
- Port **F** is not part of the motor and must be provided by the customer to make filling and air bleeding easier.

Installation position

See the following examples **1** to **4**.
Additional installation positions are available upon request.
Recommended installation position: **1** and **2**

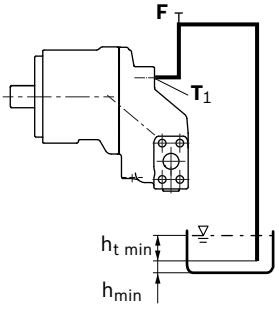
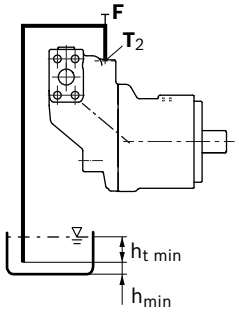
Below-reservoir installation (standard)

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

Installation position	Air bleeding	Filling
1 	–	**T_1**
2 	–	**T_2**

Above-reservoir installation

Above-reservoir installation means the axial piston unit is installed above the minimum fluid level of the reservoir.

Installation position	Air bleeding	Filling
3 	**F**	**T_1 (F)**
4 	**F**	**T_2 (F)**

Project planning notes

- The A2FMT motor is designed to be used as a drum drive in concrete mixer trucks in closed circuits.
- The motor has been specifically designed and constructed for the duty cycle in this particular application. The performance data given is based on this duty cycle.
- The project planning, installation and commissioning of the axial piston unit requires the involvement of qualified skilled person.
- Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, these can be requested from Bosch Rexroth.
- Before finalizing your design, request a binding installation drawing.
- The data and notes contained herein must be adhered to.
- Preservation: Our axial piston units are supplied as standard with preservative protection for a maximum of 12 months. If longer preservative protection is required (maximum 24 months), please specify this in plain text when placing your order. The preservation times apply under optimal storage conditions, details of these conditions can be found in the data sheet 90312 or the instruction manual.
- Not all variants of the product are approved for use in safety functions according to ISO 13849. Please consult the responsible contact person at Bosch Rexroth if you require reliability parameters (e.g. $MTTF_d$) for functional safety.
- Depending on the type of control used, electromagnetic effects can be produced when using solenoids. Applying the recommended direct voltage signal (DC) to solenoids does not create electromagnetic interference (EMI) nor is the solenoid affected by EMI. Electromagnetic interference (EMI) potential exists when operating and controlling a proportional electrohydraulic coil with a Pulse Width Modulated (PWM) signal. Appropriate testing and measures should be taken by the machine manufacturer to ensure other components or operators (e.g. with pacemaker) are not affected by this potential.
- A pressure relief valve must be provided in the hydraulic system.
- Please note the details regarding the tightening torques of port threads and other threaded joints
- Working ports
  - The ports and fixing 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 operating conditions (pressure, volume flow, hydraulic fluid, temperature) with the required safety factors.
  - The service and function ports are only designed to accommodate hydraulic lines

Safety instructions

- 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).

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