Radial piston pumps type R and RG

Operating pressure p_{max} = 700 bar
Delivery flow Q_{max} = 91.2 lpm (at 1450 rpm)
Geometric displacement $V_{g\,max}$ = 64.2 cm³/rev.

Motor pumps and hydraulic power packs type R and RG	D 6010 H
Hydraulic power packs type R and RG with DC-drive motor	D 6010 HDC
Radial piston pumps type R and RG with several pressure outlets	D 6010 D
Hydraulic power packs type R and RG with several pressure outlets	D 6010 DB
Radial piston pumps type R and RG with one main and one or two auxiliary outlets	D 6010 S

1. General

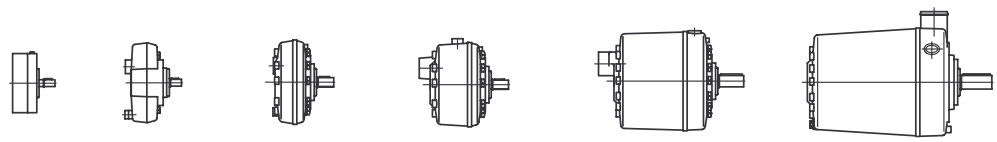
Hydraulic pumps apply the displacement principle for converting mechanical into hydrostatic energy (DIN ISO 1219-1). The pumps described in this pamphlet are constant delivery pumps.

- **Application**
  These pumps serve generally to supply pressuriced fluid to hydraulic consumers in hydraulic systems.
  The maximum permissible drive power is 30 kW, depending on size.

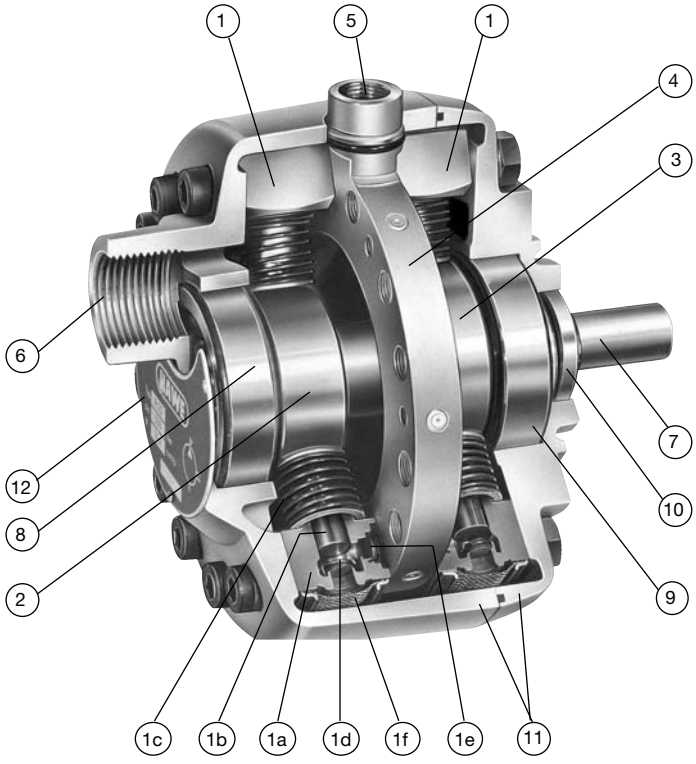
- **Basic types (bearing design)**
  R - Traditional version, where the eccenter is a roller bearing, suited even for very low speed ratings
  RG - New version, where the eccenter is a slide bearing, suited for fluids with bad lubrication characteristic (e.g. HFC) but not for low revolution ratings as this would prevent the generation of the necessary lubricating film.

- **Mechanical design**
  Radial piston pumps are valve controlled with cylinders in a radial arrangement. The cylinder radials in one, two or several superimposed layers (stars) are driven by bearings fitted eccentrically on the drive shaft (piston pressure stroke), then being returned to their idle position by springs (piston intake stroke).The fluid being delivered by the various cylinders is collected via manifolds feeding one joint pressure port. The pump housing shells are load-bearing elements supporting the cylinders and shaft bearings. The pumps run very smoothly as the drive shaft is statically balanced via counter weights. With the exception of the single- and double-cylinder pumps, there is always an uneven number of pistons per cylinder radial, which minimizes any pulse effect on the pump delivery.

- **Design** 7631 6010 6011 6012 6014 6016



Cut-away demonstrator of double radial pump (Design 6012)



(1) Pump cylinder, existing:
- (1a) Cylinder
- (1b) Piston
- (1c) Return spring for the intake stroke
- (1d) Integrated suction valve
- (1e) Integrated pressure valve
- (1f) Strainer holds back coarse contamination

(2) Rear and (3) front eccenter bearing for the pressure stroke
(4) Manifold
(5) Pressure outlet (pressure port)
(6) Suction port
(7) Drive shaft
(8) Rear and (9) front shaft bearing

(10) Shaft seal
(11) Housing shells
(12) Type plate

1.2

2. Available versions, main data

Order example: **R 5,8 ... - PYD**

Table 1a:
Basic type coding,
see also sect. 1

R	Standard, roller beaing version
RG	Slide bearing version [4]

Table 3: Seals

No coding	NBR (standard)
PYD	FKM seals (Viton)
AT	EPDM seals

Table 2: Versions

No coding	Standard
A	Arrangement of the shaft seals e.g. R 3,6A (see description in sect. 5.2 on page 6
H	Hollow shaft (only avail. for design 7631)
HFA	Version for water based fluids; only avail. for design 6010 to 6016 and piston diameter 6, 7, 8, 10, and 12. Type RG should be used, see also note "Pressure fluids" in sect. 3.

Table 1b: Delivery flow coding

Design, cylinder arrangement	Number of pump cylinders	Delivery flow coding (guideline figure Q in (lpm) at 1450 rpm) Figures in brackets show the geometric displacement (cm^3/rev.)												Drive power (standard motor) (kW) [2]
		Piston diameter (mm)												
		4	5	6	7	8	9	10	12	13	14	15	16	
		Max. permissible operating pressure p_{max} (bar) [1]												
		700	550	700 (450) [3]	600 (350) [3]	550 (300) [3]	250	450	350	300	250	200	160	
Design 7631 2-, 3- and 5-cylinder pump	2	**0,18** (0.13)	**0,28** (0.20)	**0,43** (0.28)	**0,56** (0.38)	**0,73** (0.50)	**0,92** (0.64)							0.25 to 0.55
	3	**0,27** (0.19)	**0,42** (0.29)	**0,64** (0.42)	**0,81** (0.58)	**1,1** (0.75)	**1,35** (0.95)							0.25 to 0.75
	5	**0,46** (0.31)	**0,7** (0.49)	**1,08** (0.71)	**1,39** (0.96)	**1,77** (1.26)	**2,27** (1.59)							0.25 to 1.1
Design 6010 1- and 2-cylinder pump	1			**0,3** (0.21)	**0,41** (0.29)	**0,5** (0.38)		**0,8** (0.60)	**1,2** (0.86)	**1,45** (1.01)	**1,7** (1.17)	**1,9** (1.34)	**2,2** (1.53)	0.25 to 2.2
	2			**0,6** (0.43)	**0,83** (0.58)	**1,0** (0.76)		**1,6** (1.19)	**2,4** (1.72)	**2,8** (2.02)	**3,3** (2.34)	**3,8** (2.69)	**4,4** (3.06)	
Design 6010 3-cylinder pump	3			**0,9** (0.64)	**1,25** (0.88)	**1,5** (1.15)		**2,5** (1.79)	**3,6** (2.58)	**4,3** (3.03)	**5,1** (3.51)	**5,6** (4.03)	**6,5** (4.58)	0.25 to 3
Design 6011 1-radial pump	5			**1,4** (1.07)	**2,08** (1.46)	**2,6** (1.91)		**4,2** (2.98)	**6,0** (4.30)	**7,0** (5.04)	**8,3** (5.85)	**9,5** (6.72)	**10,9** (7.64)	0.25 to 4
	7			**2,1** (1.50)	**2,9** (2.05)	**3,7** (2.67)		**5,8** (4.18)	**8,4** (6.02)	**9,8** (7.06)	**11,8** (8.19)	**13,3** (9.40)	**15,3** (10.70)	0.55 to 5.5
Design 6012 2-radial pump	10			**2,7** (2.15)	**4,15** (2.92)	**5,3** (3.82)		**8,2** (5.97)	**12,0** (8.60)	**14,2** (10.09)	**16,8** (11.70)	**19,3** (13.43)	**21,7** (15.28)	2.2 to 7.5 (9)
	14			**4,0** (3.01)	**5,85** (4.09)	**7,4** (5.35)		**11,6** (8.36)	**17,0** (12.03)	**20,0** (14.12)	**23,5** (16.38)	**26,5** (18.80)	**30,4** (21.39)	2.2 to 11
Design 6014 4-radial pump	20			**6,1** (4.30)	**8,35** (5.85)	**11,0** (7.64)		**17,4** (11.94)	**25,0** (17.19)	**30,0** (20.18)	**35,0** (23.40)	**38,0** (26.86)	**43,4** (30.56)	5.5 to 18.5
	28			**8,0** (6.02)	**11,65** (8.19)	**15,0** (10.70)		**23,0** (16.71)	**34,0** (24.07)	**40,0** (28.24)	**47,0** (32.76)	**53,0** (37.60)	**60,8** (42.79)	5.5 to 22
Design 6016 6-radial pump	42			**12,7** (9.03)	**17,45** (12.28)	**22,0** (16.04)		**34,5** (25.07)	**51,0** (36.10)	**60,0** (42.37)	**70,0** (49.14)	**80,0** (56.41)	**91,2** (64.18)	11 to 30

[1] The operating pressure should be restricted for applications with continuous operation where the subsequent load cycles are all at the upper end of the pressure range (>75%) e.g. accumulator charging etc.
It is advisable for an economic service life of the bearings to restrict the operating pressure of the respective pump element diameter to about 75% of its original specification. Another pump with smaller but more pump elements should be selected, if this is not possible.

[2] For ancillary parts, like bellhousings, flex-couplings etc., see D 6010 H

[3] Figures in brackets apply to design 7631

[4] Type RG not available for design 7631

3. Further characteristic data

Nomenclature	Radial piston pump, constant delivery pump
Type of fastening	Via the flange at the drive shaft side
Hydraulic connection	Via fittings DIN ISO 228/1 (BSPP); For port size, see dimensional drawings in sect. 4
Drive and direction of rotation	Via flex-coupling; direction of rotation as desired, see also "Direction of flow"
Drive speed range	100 ... 2000 rpm (continuous) 2800 rpm admissible for brief periods; note in this case that bellhousings, flex-couplings, etc. (D 6010 H) are available only for industrial standard motor sizes 71 to 200 L. The output generated by such motors (DIN 42 677) may require a reduction of the maximum pressure rating as the delivery flow will twice of the one stated in "Delivery flow" (sect.2).
Installed position	See sect. 5, any angle between horizontal and vertical
Direction of flow	Determined by intake and pressure port, independent of the direction of rotation
Operating pressure	Pressure side: Depending on piston diameter, see sect. 2 Suction side: - 0.3 bar ... + 1 bar (ca. 0.7 bar abs. ... ca. 2 bar abs.) + 2 bar (3 bar abs.) with type R(G)...-**A** Observe note in sect. 5.2 !
Delivery flow	See delivery flow coding in sect. 2 Guideline depending on speed $Q_{Pu} = V_g \; n \; \eta_{vol} \cdot 10^{-3}$ lpm With: V_{geo} in cm³/rev. Delivery flow, sect. 2 n in rpm Speed $\eta_{vol} \approx 0.98$ Volumetric efficiency **Attention:** The conditions listed below may cause reduced efficiency: - Viscosities > 500 mm²/s and < 10 mm²/s - Operating pressure < 20 bar - Speed > 2000 rpm; especially with small piston- ∅

Mass (weight)

Design	7631			6010		6011		6012		6014		6016
No. of cylinders	2	3	5	1 and 2	3	5	7	10	14	20	28	42
approx. (kg)	3	3.1	3.2	2.5	3.1	5.0	5.8	8.7	10.5	21.5	24.2	39.1

Hydraulic fluid:

Hydraulic oil acc. to DIN 51524 table 1 to 3
10 ... 68 mm²/s at 40°C (ISO VG 10 to 68 conf. DIN 51 519)
Viscosity range: 10 to 500 mm²/s
Viscosity limits (start viscosity):
Type R 0,18 ... R 2,27: min. approx. 4; max. approx. 800 mm²/s
R 0,3 ... R 91,2: min. approx. 4; max. approx. 1500 mm²/s
} see also note at "Delivery flow"
Also suitable are biologically degradable pressure fluids type HEPG (Polyalkylenglykol) and HEES (synth. Ester) at operation temperatures up to approx. +70°C.
Version type R..-HFA is also suited for water based pressure fluids, but their restricted lubrication abilities prevent their use above approx. 75% of the max. pressure ratings pmax (see table 1b).

Temperature:

Ambient: approx. -40...+80°C
Fluid: -25...+80°C, pay attention to the viscosity range!
Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 20K higher. Biological degradable pressure fluids: Pay attention to manufacturer's information. With regard to the compatibility with sealing materials do not exceed +70°C.

Power consumption

$$P_{kW} = \frac{p_{bar} \; Q_{lpm} \; c}{600 \; \eta_T}$$ Approximate figure common formula applying

Abbreviations:

P_{kW} = Required power at the pump drive shaft in kW

p_{bar} = Exploited pressure in bar
(consumer pressure + back pressure)

Q_{lpm} = Delivery flow in lpm, at 1450 rpm, see delivery flow codings in sect. 2;
At differing speed ratings n_x in Q_{lpm}, delivery flow coding multiplied with n_x / 1450

c = Theoretical factor which takes the pulsation of the pump into account
3 ... 42 cylinders: c = 1
2-cylinder pump: c ≈ 1.3 ... 1.5
1-cylinder pump: c ≈ 2.7 ... 3.1 (highest figure with piston-∅ 12 ... 16 mm)

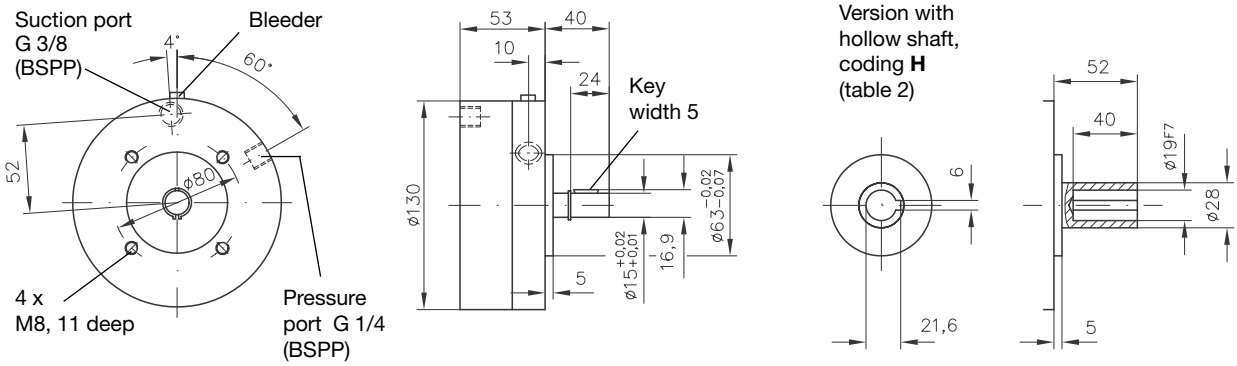
η_T = Total efficiency, average, 0.8 ... 0.85

4. Dimensions

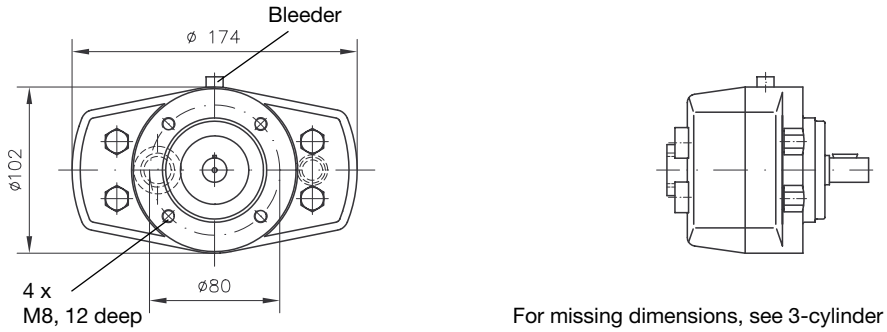
All dimensions in mm, subject to change without notice!

4.1. Hydraulic pumps

Design 7631
2-, 3-, and 5-cylinder pumps

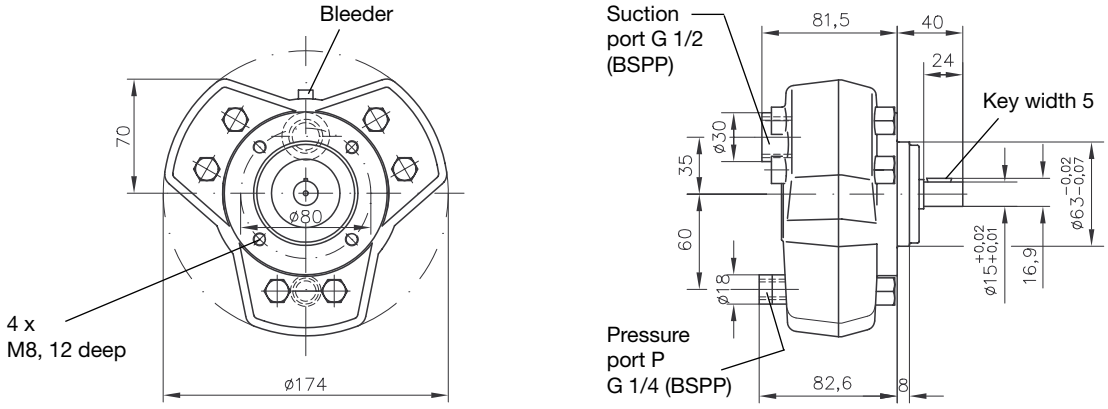


Design 6010
1- and 2-cylinder pump

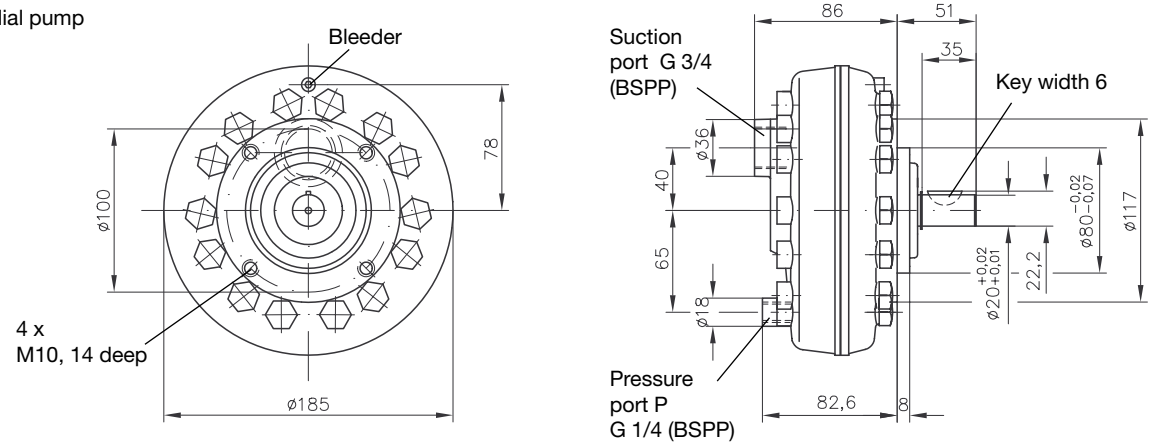


For missing dimensions, see 3-cylinder pump below !

3-cylinder pump

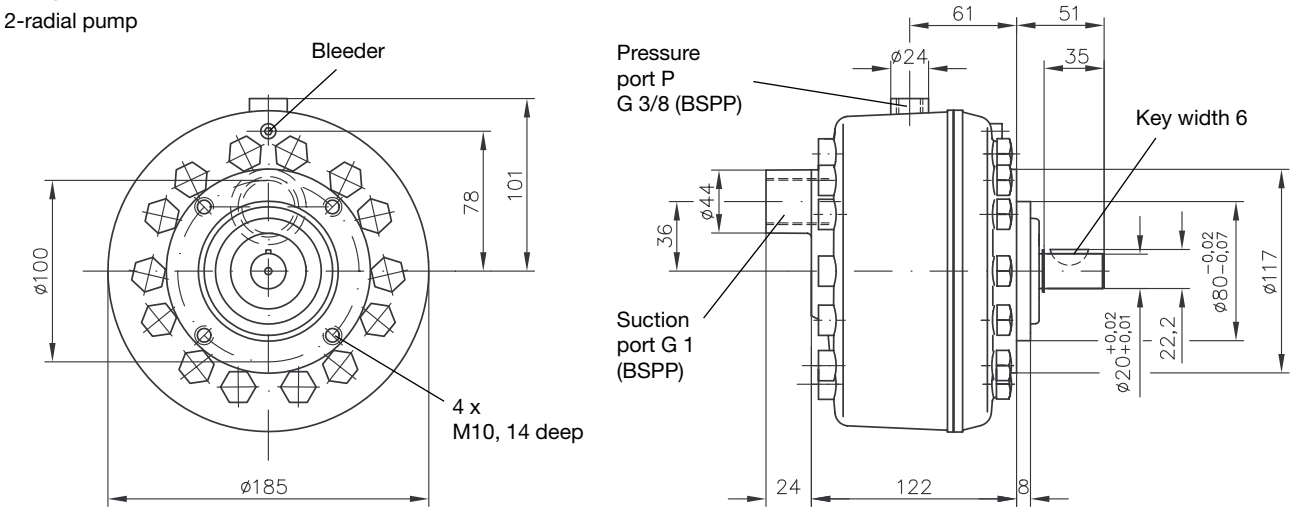


Design 6011
1-radial pump



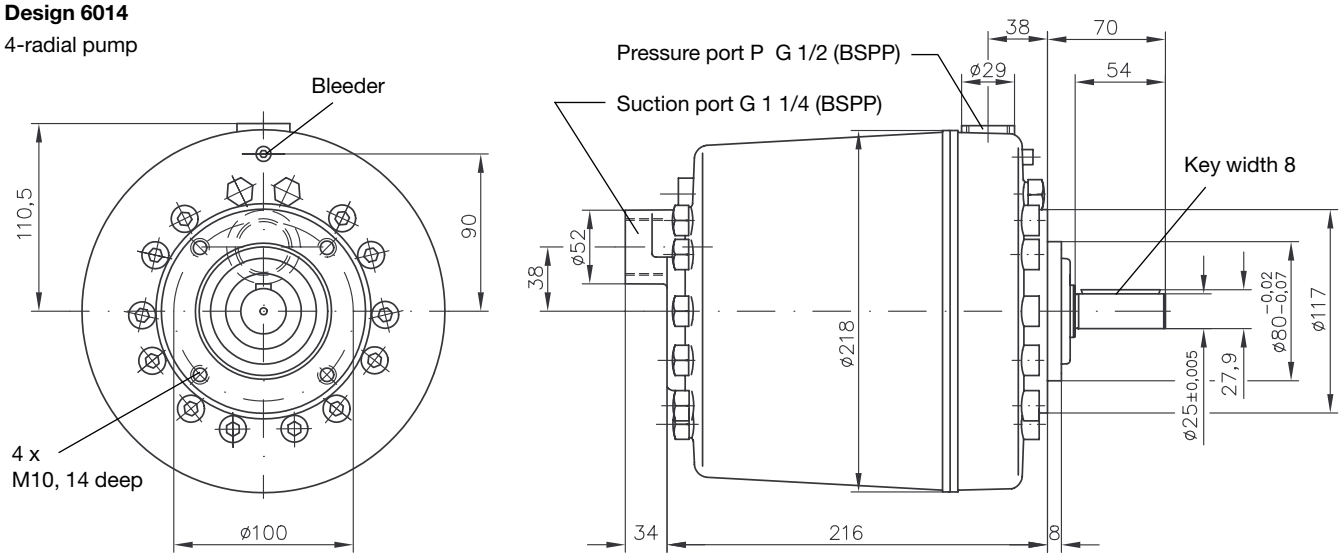
Design 6012

2-radial pump



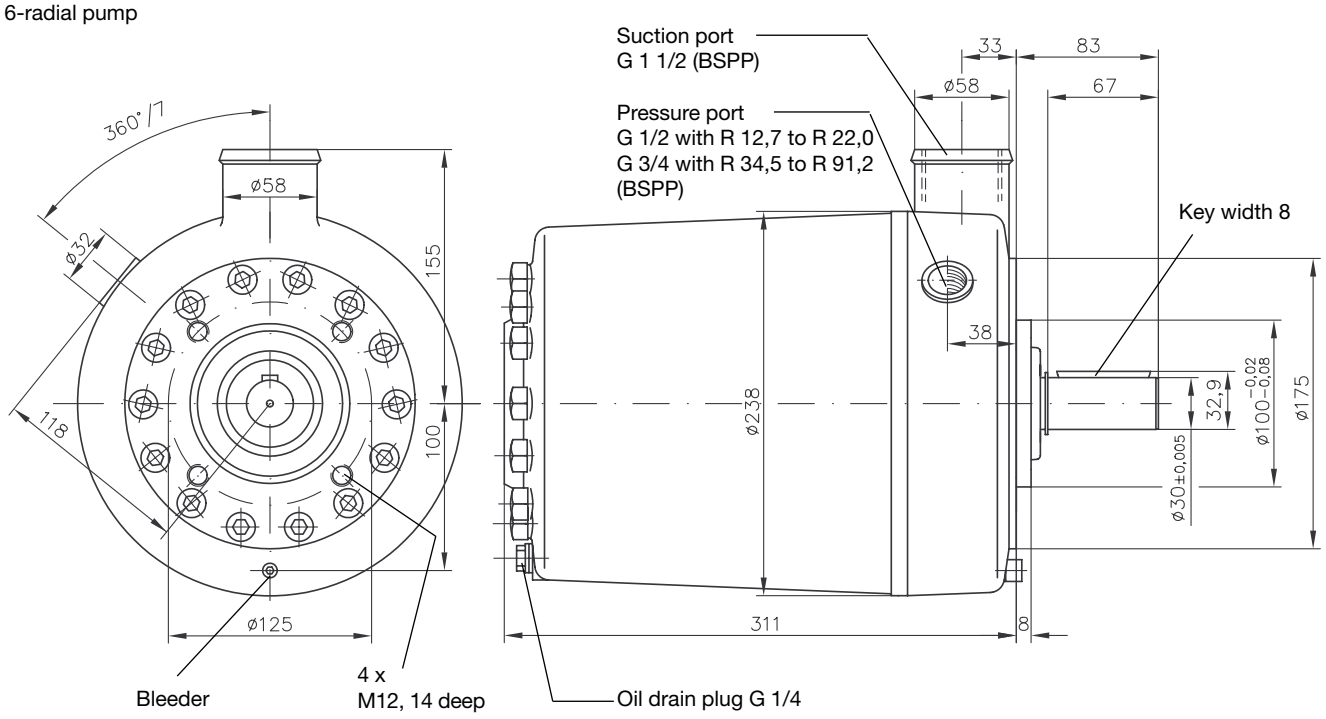
Design 6014

4-radial pump



Design 6016

6-radial pump



The pump must always be located below the anticipated minimum fluid level during operation no matter whether the pump is installed inside the tank (hydraulic power packs) or outside (motor pump). The housing shell forms a complete, self-contained unit around the cylinders radials, and can be only properly bled (after a refill) if it is completely immersed in the fluid.
For a detailed description of installation, bleeding and initial operation, see sect. 5 in D 6010 H.

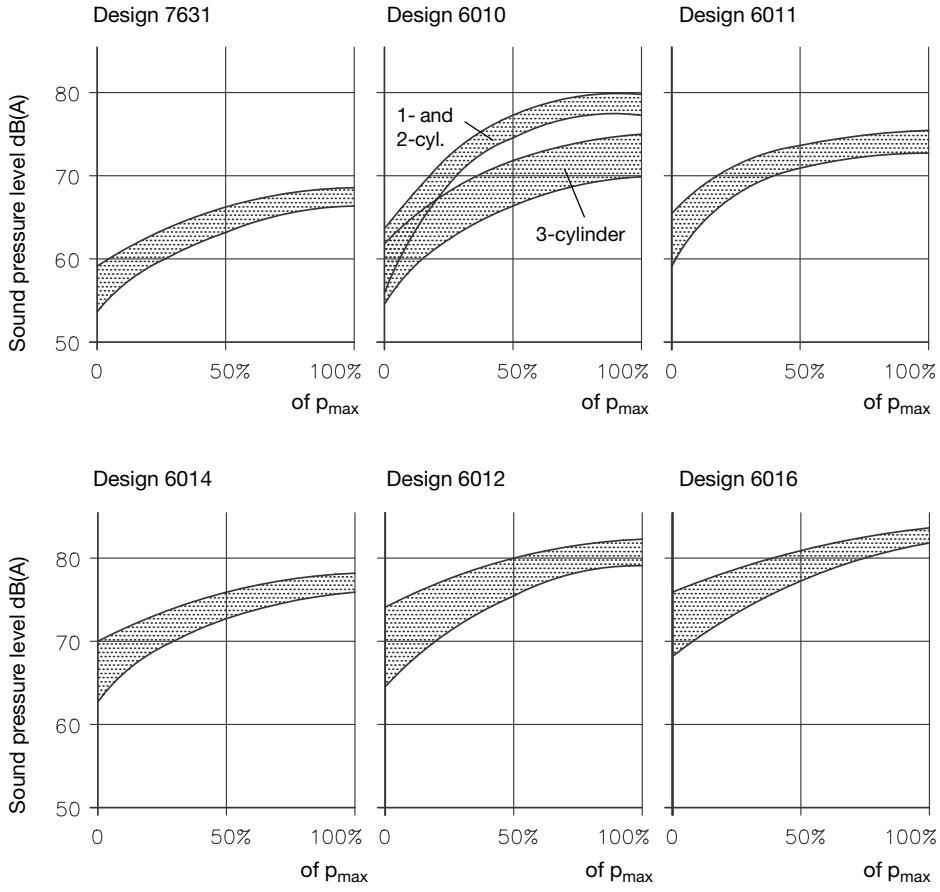
5.1. Running noise

The noise level curves shown here present the results of practical measurements in a test area, making allowance for any deviation of the noise levels measured. Pumps with a small delivery flow (small piston diameter) within each group will generally provide results shown by the lower curve, pumps with a larger delivery flow (13-16 mm piston diameter) will generally be in the middle or top of the range shown.

Measuring conditions:
Quiet operating area
interference noise level
approx. 37dB(A)
Measured 1m above
ground, 1m away from
measured object

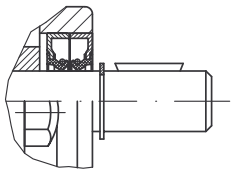
Measuring unit:
Precision sound
level meter
DIN IEC 651 Kl. I

Viscosity of oil during
measurement:
approx. 50 mm²/s

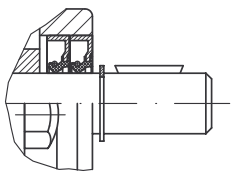


5.2. Slightly charged pumps (above approx. 0.4 ... 0.5 bar)

Standard:
Sealing lips facing
towards each other-
no suffix



Version R .. **A** :
Sealing lips facing to
the inside, for intake
pressure exceeding
approx. 0.4 bar



The drive shaft is sealed to the outside on the shaft journal by two subsequent shaft seals. The sealing lips of these seal rings face towards each other with standard applications. This is advantageous as it prevents air entering during the intake (vacuum in the pump housing) and no fluid can escape even if the fluid level is located higher than the suction port (slight overpressure in the pump housing, due to the weight of the oil column).

The pumps are also available with both sealing lips facing to the inside advisable for conditions where the tank is located much higher than the pump (i.e. several meters) or a tank is permanently pressurized ($p_s >$ 0.4 bar).
Please note, however, that any charge pressure above 1 bar (2 ... 3 bar is still admissible) may considerably reduce the service life of the sealing lips. It is therefore only acceptable, when the pump stands still for prolonged periods between operation.