# Radial piston pumps type R and RG

**with several pressure ports**

| | |
|---|---|
| Operating pressure $p_{max}$ | = 700 bar |
| Delivery flow $Q_{max}$ | = 76,0 lpm (at 1450 rpm) |
| Geometric displacement $V_{g\,max}$ | = 53,5 cm³/rev. |

| | |
|---|---|
| Radial piston pumps type R and RG | D 6010 |
| Radial piston pumps type R and RG with one main and one or two auxiliary pressure ports | D 6010 S |
| Hydraulic power packs type R and RG with several pressure ports | D 6010 DB |

## 1. General



All pumps presented in D 6010 (with the exception of single-cylinder pumps) are available, depending on the pump design, with two or more individual pressure ports. This allows such pumps to cope with any overlap in consumer movement at various load conditions, as may occur in hydraulic systems due to sequence of functions involved, without requiring any significant design modifications and without such consumers affecting each other. Another application is the stepwise variation of the consumer speed via simple 2/2-way circulation valves by connecting or disconnecting individual pressure circuits to or from the joint pressure line. Additionally they can provide pressure fluid for control circuits with hydraulically controlled directional valves, which usually require a certain minimum pressure. For additional information regarding piloted directional spool valves type HSR, HSL, and HSF see D 7493 and D 7493 E.

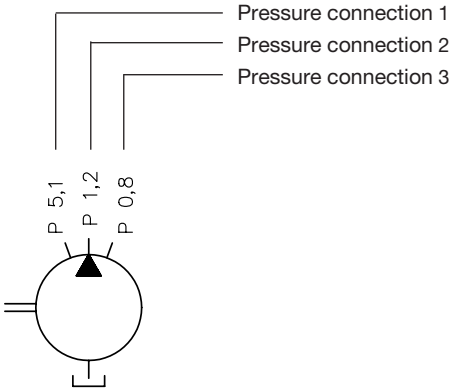
Ⓛ **Delivery flow subdivision**

The delivery of individual pump cylinders may be either led out separately or joint, depending on the pump design involved (see D 6010). The various versions available are shown in sect. 2 ++, where also the specific type (order) coding is detailed.

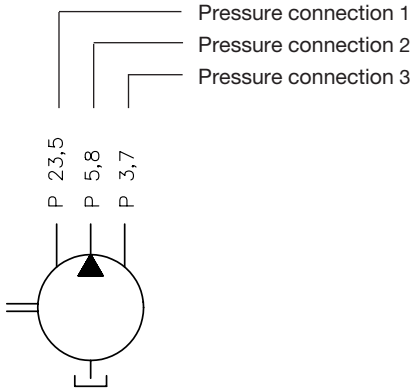
Ⓛ **Illustration of symbols**

The pump symbols in the following are illustrated basically in two different ways to distinguish whether a port is fed by only one cylinder or by two or more cylinders. The delivery line leaves the pump symbol radially when only one cylinder is led out individually whereas it leaves in parallel whenever several cylinders or even complete radials are grouped. This different style of illustration enables also to judge the flow consistency (smoothness) for the respective pressure port. Complete radials show almost no pulsation, due to the equal distribution of an uneven number of cylinders, while individual or externally grouped cylinders retain their typical delivery characteristic (pulsation) more or less. For more details, see sect. 4.1 „Delivery characteristic“. The port index No. count up clockwise in the following.

Typical example of a 1-radial pump with three pressure ports R 5,1 - 1,2 - 0,8. It is mandatory that the order coding specifies the grouped cylinders at port 1 and the individually led out cylinders subsequently i.e. port 2 and 3. For more details, see sect. 2.3.




Typical example of a 4-radial pump with three pressure ports (comprising complete cylinder radials) R 23,5 - 5,8 - 3,7. It is mandatory that the order coding specifies the grouped cylinder radials at port 1 and the individually led out cylinder radials subsequently i.e. port 2 and 3. For more details, see sect. 2.5.



# 2. Available versions, main data

Order example:

**R 5,7 - 1,7 - 1,7 - 0,8 - ...**

**R, RG** = Basic type coding acc. to D 6010; (Not referred to specifically in the following sect. 2.1 to 2.6)

Suffix (option), see table 2 and 3 in D 6010

Delivery flow coding for pressure ports 1, 2, 3, etc. detailed in the tables below depending on pump design.

It is mandatory that the order coding specifies the grouped cylinders (1-radial pumps) or complete radials (more-radial pumps) directly after the R (port 1), whereas the position (port index No.) of the other requested individual flows can be positioned as desired.
Attention: 1-radial pumps (design 6011) with 7-cylinders are not available with 6 ports. Also not available are 2-radial pumps (design 6012) where from one of the two radials several individual cylinders should be grouped. Where necessary the cylinders of such a pump with 7 ports had to be grouped externally. See sect. 2.3 ++.

**Delivery flow selection table**

Design 7631, for more details see sect. 2.1

| Piston-∅ (mm) | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|
| Operating pressure $p_{max}$ [1] (bar) | 700 | 550 | 450 | 350 | 300 | 250 |
| Delivery flow coding 1-cylinder | **0,09** | **0,14** | **0,22** | **0,29** | **0,36** | **0,45** |
| Delivery flow coding 3-cylinder [2] | **0,27** | **0,42** | **0,64** | **0,81** | **1,1** | **1,35** |

Design 6010, 6011, 6012, 6014, and 6016, for more details see sect. 2.2 to 2.6

| Joint pump cylinder per port | | Connection index | Delivery flow coding (guideline figure Q in (lpm) at 1450 rpm) Piston-∅(mm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 | 7 | 8 | 10 | 12 | 13 | 14 | 15 | 16 |
| | | | Operating pressure $p_{max}$ (bar) [1] | | | | | | | | |
| | | | 700 | 600 | 550 | 450 | 350 | 300 | 250 | 200 | 160 |
| Indiv. cylinder | | a | **0,3** | **0,41** | **0,5** | **0,8** | **1,2** | **1,45** | **1,7** | **1,9** | **2,2** |
| Cylinder group consisting of | 2-cylinder | b | **0,6** | **0,83** | **1,0** | **1,6** | **2,4** | **2,8** | **3,3** | **3,8** | **4,4** |
| | 3-cylinder | c | **0,9** | **1,25** | **1,5** | **2,5** | **3,6** | **4,3** | **5,1** | **5,6** | **6,5** |
| | 4-cylinder | d | **1,15** | **1,65** | **2,15** | **3,35** | **4,8** | **5,7** | **6,7** | **7,7** | **8,7** |
| | 5-cylinder | e | **1,4** | **2,08** | **2,6** | **4,2** | **6,0** | **7,0** | **8,3** | **9,5** | **10,9** |
| | 6-cylinder | f | **1,8** | **2,45** | **3,2** | **5,0** | **7,2** | **8,6** | **9,9** | **11,5** | **13,1** |
| Complete | 5-cylinder radial | g | **1,4** | **2,08** | **2,6** | **4,2** | **6,0** | **7,0** | **8,3** | **9,5** | **10,9** |
| | 7-cylinder radial | h | **2,1** | **2,9** | **3,7** | **5,8** | **8,4** | **9,8** | **11,8** | **13,3** | **15,3** |
| Number of joint radials per port (5- or 7-cylinder radials) | 2 x 5-cylinder | i | **2,7** | **4,15** | **5,3** | **8,2** | **12,0** | **14,2** | **16,8** | **19,3** | **21,7** |
| | 2 x 7-cylinder | k | **4,0** | **5,85** | **7,4** | **11,6** | **17,0** | **20,0** | **23,5** | **26,5** | **30,4** |
| | 3 x 5-cylinder | l | **4,6** | **6,2** | **8,25** | **13,0** | **18,8** | **22,5** | **25,2** | **28,5** | **32,6** |
| | 3 x 7-cylinder | m | **5,95** | **8,75** | **11,2** | **17,3** | **25,5** | **29,9** | **35,3** | **39,8** | **45,6** |
| | 4 x 7-cylinder | n | **8,0** | **11,65** | **15,0** | **23,0** | **34,0** | **40,0** | **47,0** | **53,0** | **60,8** |
| | 5 x 7-cylinder | o | **10,6** | **14,55** | **18,3** | **28,8** | **42,5** | **50,0** | **58,4** | **66,7** | **76,0** |
| Geometric displacement of one indiv. cylinder (connection index a) (cm³/rev.) | | | 0,21 | 0,29 | 0,38 | 0,59 | 0,84 | 1,0 | 1,15 | 1,32 | 1,53 |
| | | | The total geom. displacement $V_{g\ total}$ of a cylinder group or radial (connection index b to o) can be calculated by multiplying the indiv. geom. displacement with the respective number of cylinders. | | | | | | | | |
| Nom. delivery flow $Q_N$ (lpm) | | | The delivery flow coding is a guideline but it can be calculated with the formula below: $V_{g\ total}$ Motor speed $n_N$ in rpm Vol. efficiency $\sigma_{vol} \approx 0.98$ | | | | | | | | |

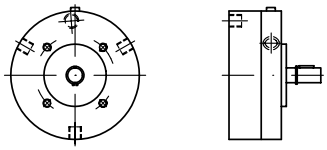
[1] The operating pressure should be restricted for applications with continuous operation where the subsequent load cycles are all at the upper end of the pressure range (>75%) e.g. accumulator charging etc.

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] Only available as combination with 2 x 3 pump cylinders, e.g. R 0,81 - 0,27

## 2.1 1-radial pump, design 7631

2-, 3-, and 5-cylinder pump



For design reasons each pump cylinder has its own pressure port. These ports must then be externally interconnected via pipes.

The only exception is a combination of 2 x 3 pump cylinders.

2 x 3 pump cylinders

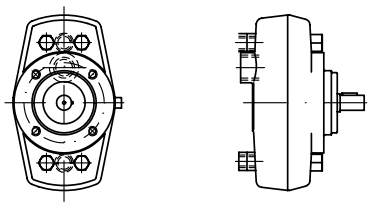
**R 0,27 - 0,64**

Port 1 Port 2

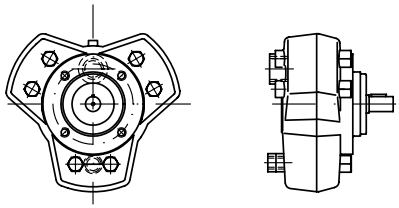
| Type coding | Symbols | Cylinder arrangement |
|---|---|---|
| 2-cylinder pump<br>**R 0,14 - 0,36**<br>Port 1 Port 2 | P 0,14 P 0,36<br>1 2 | 2<br>1 |
| 3-cylinder pump<br>**R 0,09 - 0,29 - 0,29**<br>Port 1 Port 2 Port 3 | P 0,09 P 0,29 P 0,29<br>1 2 3 | 3 2<br>1 |
| 5-cylinder pump<br>**R 0,09 - 0,36 - 0,09 - 0,36 - 0,36**<br>Port 1 Port 2 Port 3 Port 4 Port 5 | P 0,09 P 0,36 P 0,09 P 0,36 P 0,36<br>1 2 3 4 5 | 4 3<br>5 2<br>1 |

## 2.2 1-radial pump, design 6010

2-cylinder pump



3-cylinder pump



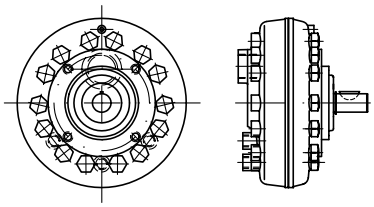
**Option 1:**
Delivery flow codings acc. to connection index a in table on page 2. The pump shows as many pressure ports as cylinders.

**Option 2:**
Two cylinders joint at port 1 (flow coding acc. to connection index b), the remaining cylinders joint at port 2 (flow coding acc. to connection index a).

| Type coding | Symbols | Cylinder arrangement |
|---|---|---|
| 2-cylinder pump<br>**R 0,8 - 1,7**<br>Port 1 connection index a<br>Port 2 connection index a | P 0,8 P 1,7<br>1 2 | 2<br>1 |
| 3-cylinder pump (option 1)<br>**R 1,2 - 1,2 - 1,2**<br>Port 1 connection index a<br>Port 2 connection index a<br>Port 3 connection index a | P 1,2 P 1,2 P 1,2<br>1 2 3 | 3 2<br>1 |
| 3-cylinder pump (option 2)<br>**R 1,6 - 0,8**<br>Port 1 connection index b<br>Port 2 connection index a | P 1,6 P 0,8<br>1 2 | 2<br>1 |

## 2.3 1-radial pump, design 6011

5- and 7-cylinder pump

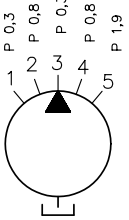


**Option 1 :**
Delivery flow codings acc. to connection index a in table on page 2. The pump shows 5 or 7 pressure ports.

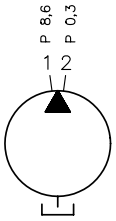
**Option 2:**
5-cylinder pump
Two, three or four cylinders joint at pressure port 1 (flow coding acc. to connection index b, c or d) ; the remaining cylinders led out individually to pressure ports 2, 3 etc. (delivery flow index as specified in line a).

7-cylinder pump
Three, four, five or six cylinders joint at pressure port 1 (flow coding acc. to connection index c - f), the remaining cylinders led out individually to pressure ports 2, 3 etc. (delivery flow index as specified in line a).

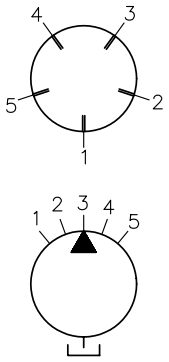
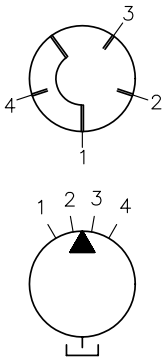
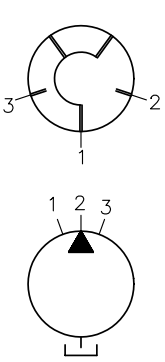
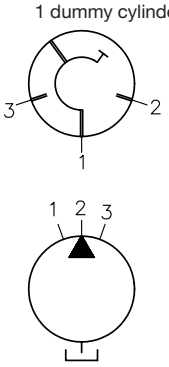
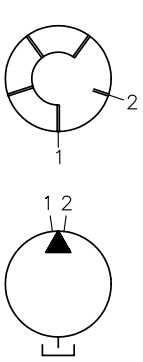
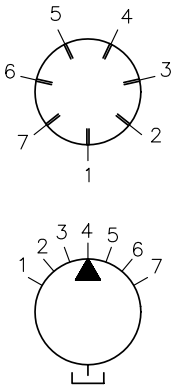
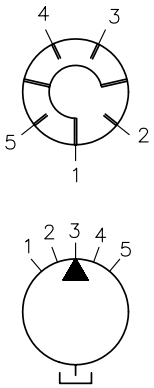
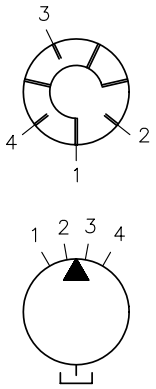
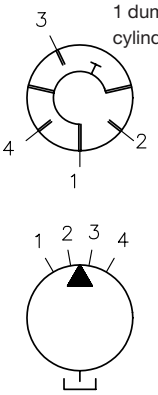
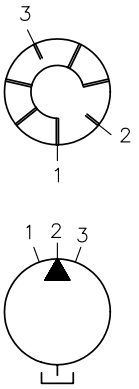
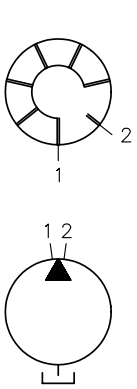
Order example (5-cylinder pump):
**R 0,3 - 0,8 - 0,3 - 0,8 - 1,9**
1 2 3 4 5
of connection index a




Order example (7-cylinder pump):
**R 8,6 - 0,3**
1 connection index f
2 connection index a




Cylinder combinations on versions available and appropriate symbols

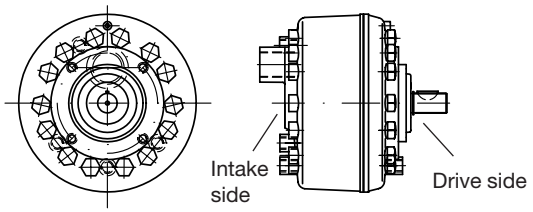
| | Option 1 | Option 2 | | | | |
|---|---|---|---|---|---|---|
| 5-cylinder pump |  |  |  |  |  | |
| Order example | R 0,3-0,8-0,3-0,8-1,9 | R 3,8-0,8-0,3-0,8 | R 4,3-0,5-0,5 | R 2,4-1,2-1,2 | R 4,8-0,5 | |
| Port 1 acc. to connection index a | a | b | c | b | d | |
| all other ports acc. to connection index | a | a | a | a | a | |
| 7-cylinder pump |  |  |  |  |  |  |
| Order example | R 1,2-1,2-1,2-1,2-1,2-1,2-0,5 | R 5,1-0,8-0,5-0,8-0,5 | R 7,7-1,2-1,2-0,5 | R 4,3-1,45-1,45-1,45 | R 7,0-0,8-0,8 | R 8,6-0,3 |
| Port 1 Connection index a | a | c | d | c | e | f |
| all other ports acc. to connection index | a | a | a | a | a | a |

[1]) e.g. for providing two pressure circuits with equal flow. Dummy cylinders are not indicated in the coding. The respective delivery flow coding for this group represents only the active pump cylinders.

## 2.4 2-radial pump, design 6012

10- and 14-cylinder pump

Each cylinder radial comprises either 5 or 7-cylinders




**Option 1 :**
One pressure port per radial = two pressure ports in total. Pressure port 1 on the shaft side, port 2 on the suction side. Flow coding acc. to connection index g (5-cylinder radial) or acc. to line h (7-cylinder radial).

**Option 2:**
The cylinder radial on the shaft side is joined completely at port 1, the second radial is split up as with design 6011 (1-radial pump) among ports 2, 3... etc.. The flow codings from the two radials are separated by a slash.

**Option 3 :**
Both cylinder radials split-up among several pressure ports as with group 6011 (1-radial pumps, flow ratings from each radial separated by a slash).
Attention: The usual intermediate flange acc. to D 6010 or D 6010 H or D 6010 Z can not be used. A suitable flange has to be customer furnished, for specifications see SK 6020 155.

Order example (10-cylinder pump):

**R 7,0 - 2,6**

1 2
connection index
g g

Order example (14-cylinder pump):

**R 13,3 / 4,2 - 0,3 - 0,3**

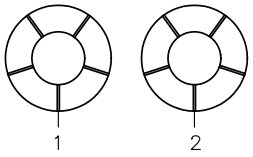
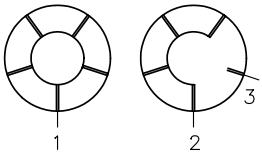
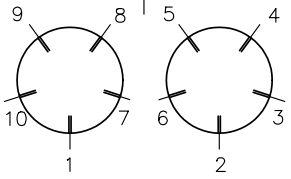
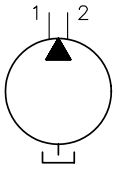
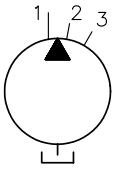
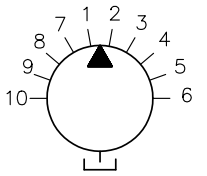
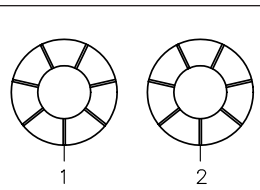
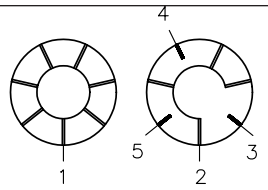
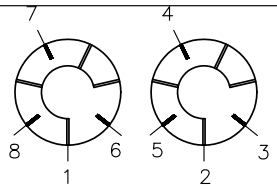
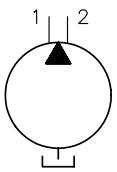
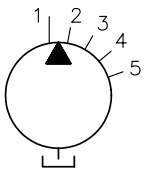
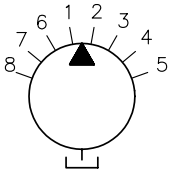
1 2 3 4
connection index
h e a a

Order example (10-cylinder pump):

**R 5,7 - 0,5 / 5,1 - 1,2 - 0,8**

1 5 2 3 4
connection index
d a c a a

Cylinder combinations and respective symbols (only exemples - there are many more versions) available

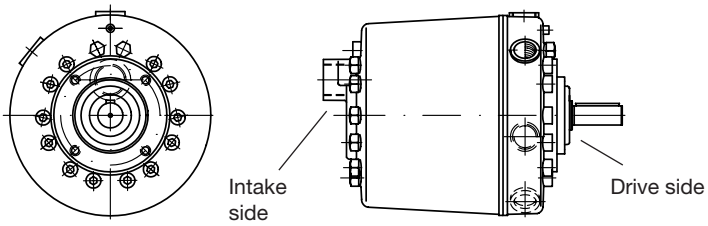
| | Option 1 Drive side | Option 1 Suction side | Option 2 Drive side | Option 2 Suction side | Option 3 Drive side | Option 3 Suction side |
|---|---|---|---|---|---|---|
| 10-cylinder pump<br>2 x 5-cylinder radials |  | |  | |  | |
| |  | |  | |  | |
| Order example | R 7,0-2,6 | | R 9,5 / 4,8-0,8 | | R 1,2-1,2-1,2-1,2-1,2 / 1,2-1,2-1,2-1,2-1,2 | |
| Port 1 acc.to conn. index | g | | g | | a | |
| Port 2 acc.to conn. index | g | | d | | a | |
| all other ports acc. to connection index | -- | | a | | a | |
| 14-cylinder pump<br>2 x 7-cylinder radials |  | |  | |  | |
| |  | |  | |  | |
| Order example | R 8,4-8,4 | | R 13,3 / 7,7-0,5-0,5-0,5 | | R 7,7-0,5-0,5-0,5 / 7,7-0,5-0,5-0,5 | |
| Port 1 acc.to conn. index | h | | h | | d | |
| Port 2 acc.to conn. index | h | | d | | d | |
| all other ports acc. to connection index | -- | | a | | a | |

These typical orders are examples of the many variations possible.

## 2.5 4-radial pump, design 6014

20- and 28-cylinder pump

Each cylinder radial comprises either 5 or 7-cylinders




**Option 1 :**
One pressure port per radial = four pressure ports in total. Flow coding acc. to connection index g (5-cylinder radial) or acc. to line h (7-cylinder radial).

Order example (28-cylinder pump):
**R 9,8 - 9,8 - 3,7 - 2,1**
1 2 3 4
all connection index h

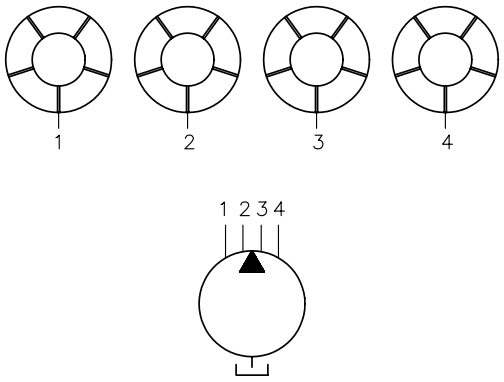
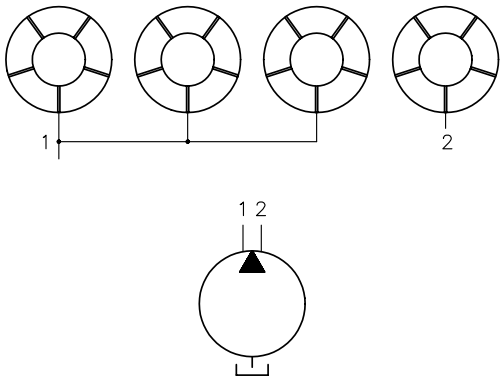
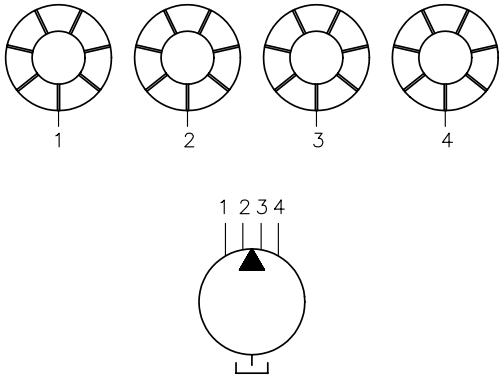
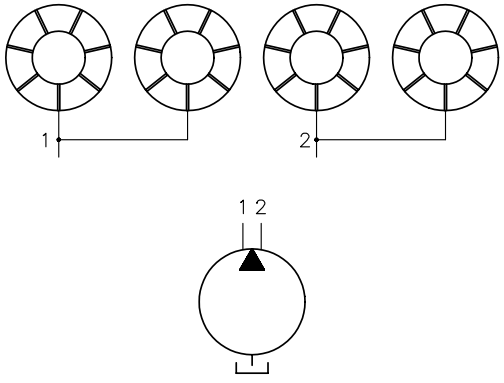
**Option 2:**
Two or three cylinder radials joint completely at port 1, the remaining on port 2 (3) acc. to connection index i + g + g, i + i or l + g (5-cylinder radials) or k + h + h, k + k or m + h (7-cylinder radials).

Order example (20-cylinder pump):
**R 19,3 - 2,6 - 1,4**
1 2 3
connection index
i g g

**Option 3 :**
One or two cylinders from the lowest radial (suction side) are led out at individual port(s) as supply for a control circuit for piloted valves. For more details, see D 6010S

Order example (28-cylinder pump):
**R 4,0 - 2,1 - 1,8 - 0,3**
1 2 3 4
connection index
k h f a
(indiv. cylinder for a control circuit)

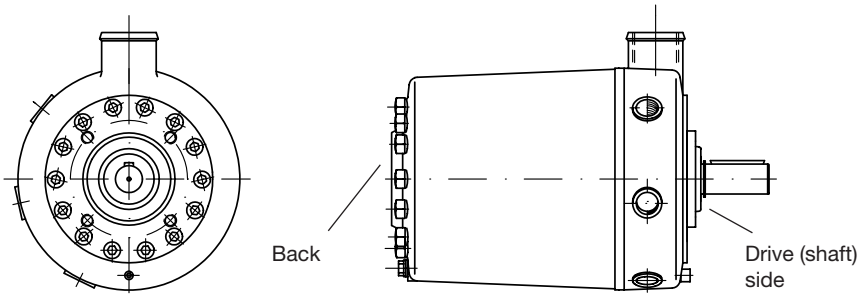
Cylinder combinations and respective symbols (only exemplary - there are many more versions)

| | Option 1 | Option 2 |
|---|---|---|
| 20-cylinder pump<br>4 x 5-cylinder radials |  |  |
| Order example | R 7,0-7,0-2,6-1,4<br>Connections 1 - 4 as specified in line g | R 18,8-5,3<br>Connection 1 as specif. in line l;<br>Connection 2 as specif. in line g |
| 28-cylinder pump<br>4 x 7-cylinder radials |  |  |
| Order example | R 8,4-8,4-8,4-8,4<br>Connections 1 - 4 as specified in line h | R 17,0-17,0<br>Connections 1 - 2 as specified in line k |

## 2.6 6-radial pump, design 6016

42-cylinder pump

Each cylinder radial comprises 7 cylinders




**Option 1 :**
One pressure port per radial = six pressure ports in total.
Flow coding acc. to connection index h (7-cylinder radial).

Order example:
**R 11,8 - 11,8 - 5,8 - 5,8 - 2,1 - 2,1**
1 2 3 4 5 6
all connection index h

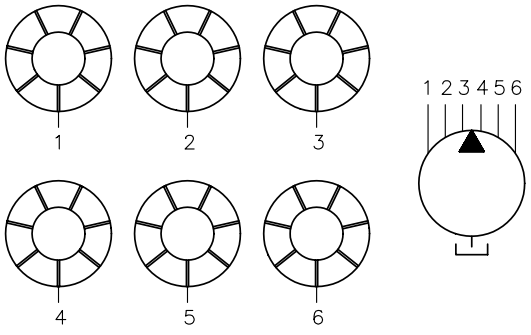
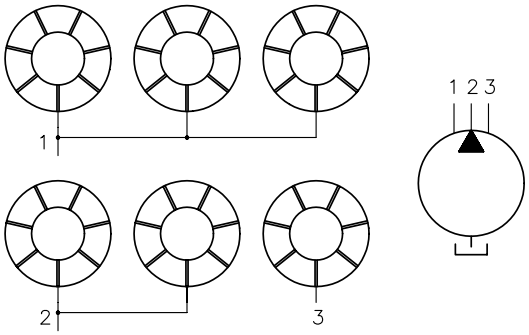
**Option 2 :**
Joint cylinder radials at (highest flow always at port 1):
Two ports, codings acc. to connection index m + m or n + k or o + h.
Three or five ports, codings acc. to connection index k + k + k, etc. or m + h + h + h, etc. or k + h + h + h + h

Order example:
**R 47,0 - 7,4**
1 2
connection index
n k

**R 17,0 - 17,0 - 4,0**
1 2 3
connection index
all connection index k

**R 20,0 - 11,6 - 3,7 - 2,1**
1 2 3 4
connection index
k h

**Option 3 :**
One or two cylinders from the lowest radial (suction side) are led out at individual port(s) as supply for a control circuit for piloted valves. For more details, see D 6010S.
The order coding example is similar to 4-radial pumps (design 6014), see option 3 in sect. 2.5.

| | Cylinder combinations and respective symbols (only exemplary - there are many more versions) | |
|---|---|---|
| | Option 1 | Option 2 |
| 42-cylinder pump<br>6 x 7-cylinder radials |  |  |
| Order example | R 11,8-11,8-5,3-5,3-2,1-2,1<br>Connections 1 - 6 as specified in line h | R 25,5-11,6-2,1<br>Connection 1 as specif. in line m<br>Connection 1 as specif. in line k<br>Connection 1 as specif. in line h |

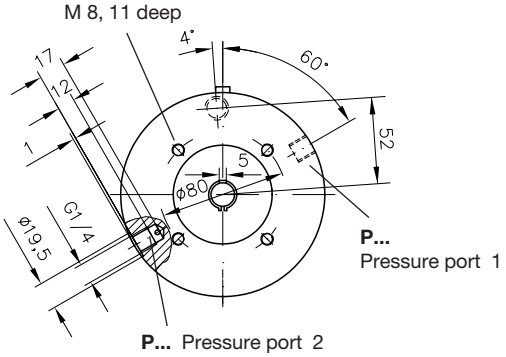
# 3. Dimensions

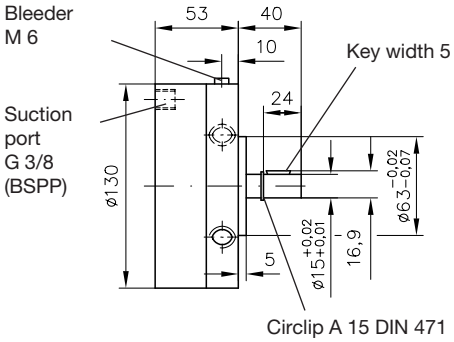
All dimensions in mm, subject to change without notice!

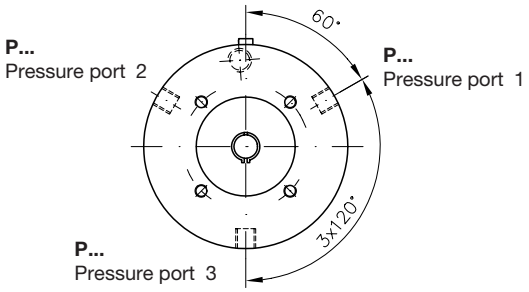
## 3.1 Design 7631

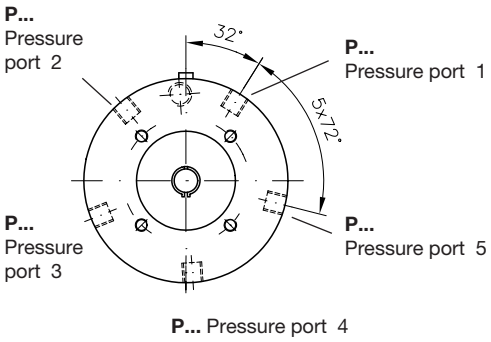
2-, 3-, and 5-cylinder pumps

**Coding 0,09 to 0,45**

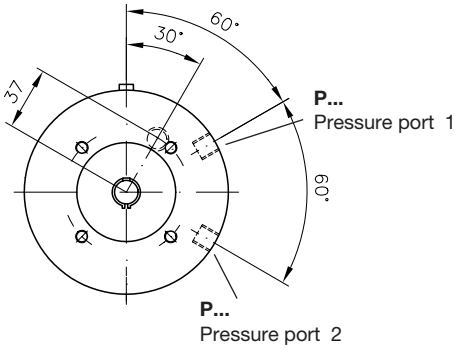


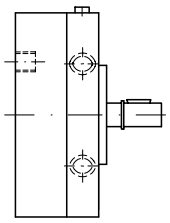




**Coding 0,27 to 1,35**



For missing dimensions,
see coding 0,09 to 0,45

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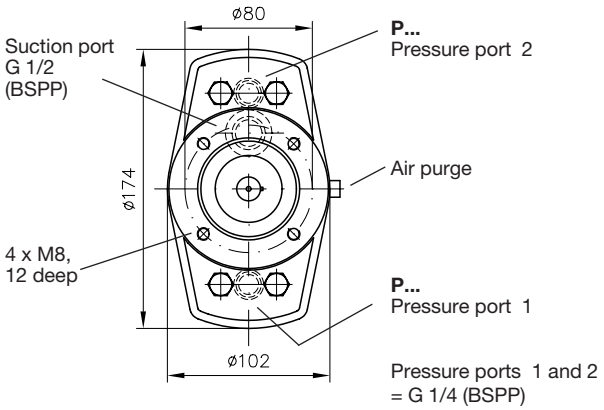
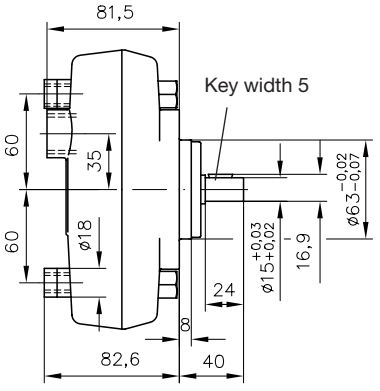
## 3.2 Design 6010

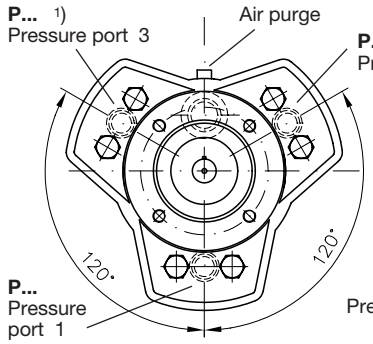
2-cylinder pumps



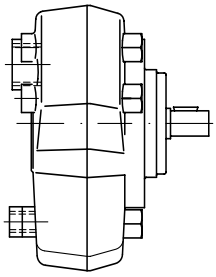
## 3.3 Design 6010

3-cylinder pumps




1) Not applicable in the case of two press. connections

Pressure ports 1... 3 = G 1/4 (BSPP)

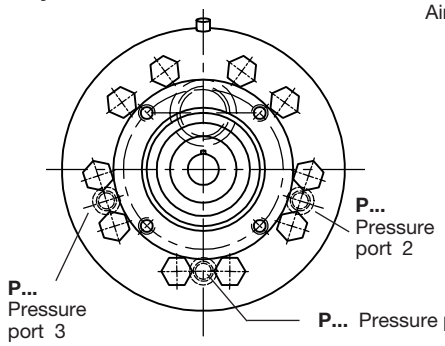


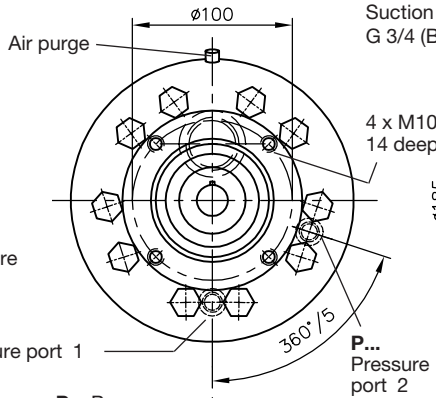
For missing dimensions see pamphlet 3.2

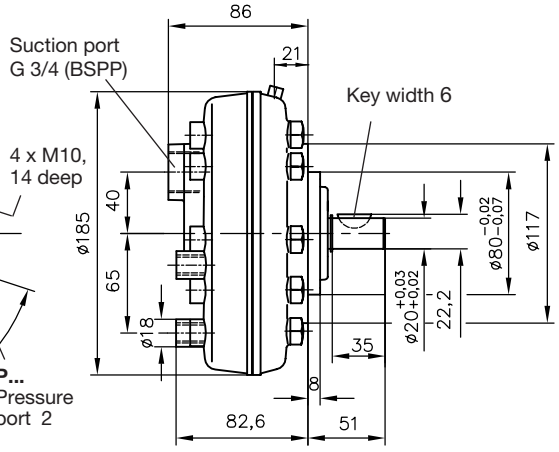
## 3.4 Design 6011

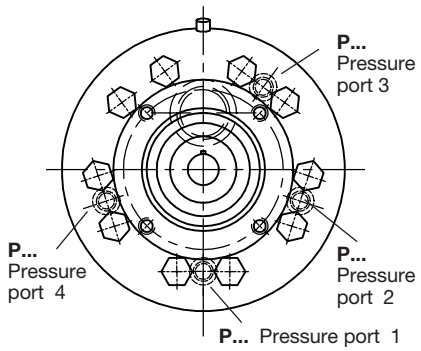
1-radial pump

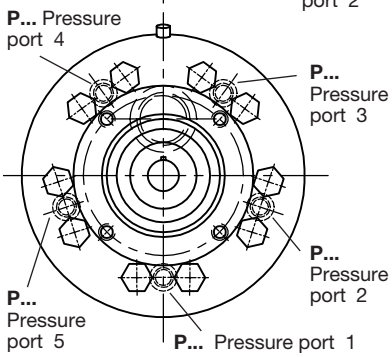
**5-cylinder**



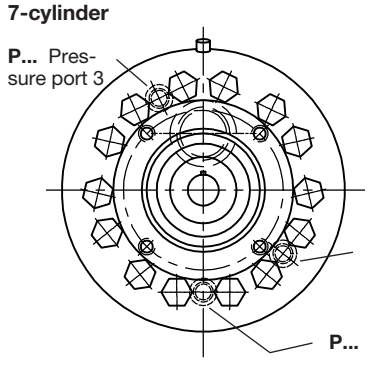



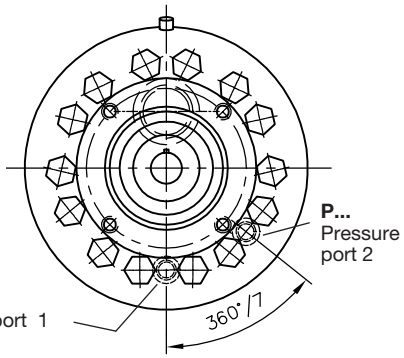



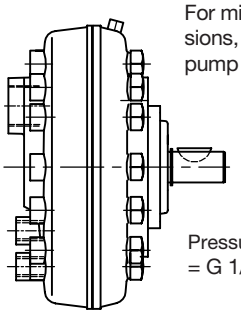




Pressure ports 1... 5 = G 1/4 (BSPP)

**7-cylinder**

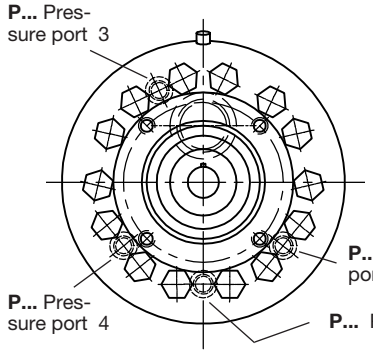


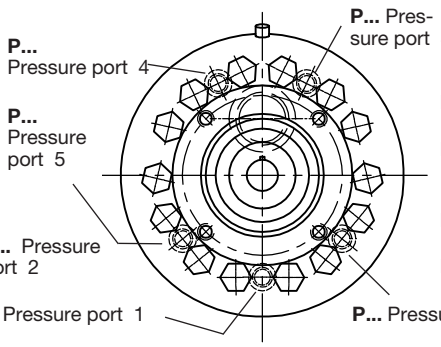



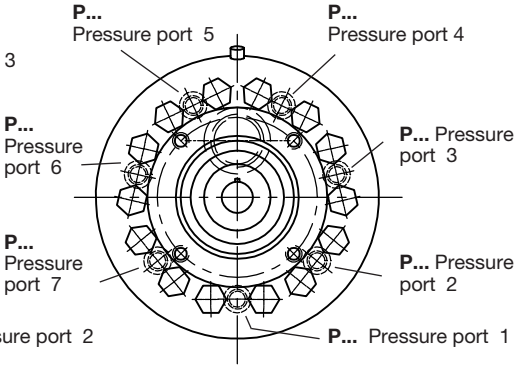



For missing dimensions, see 5-cylinder pump

Pressure ports 1... 7 = G 1/4 (BSPP)



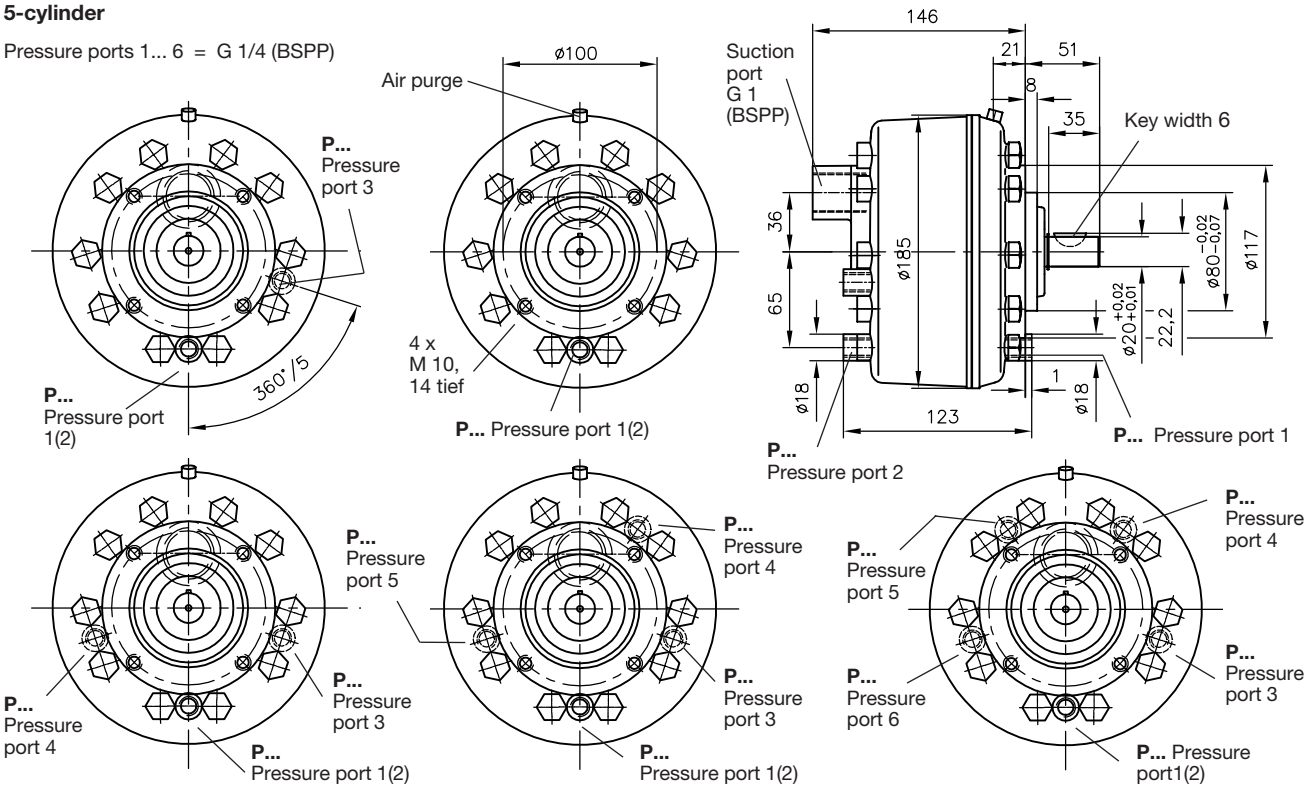
## 3.5 Design 6012

2-radial pump

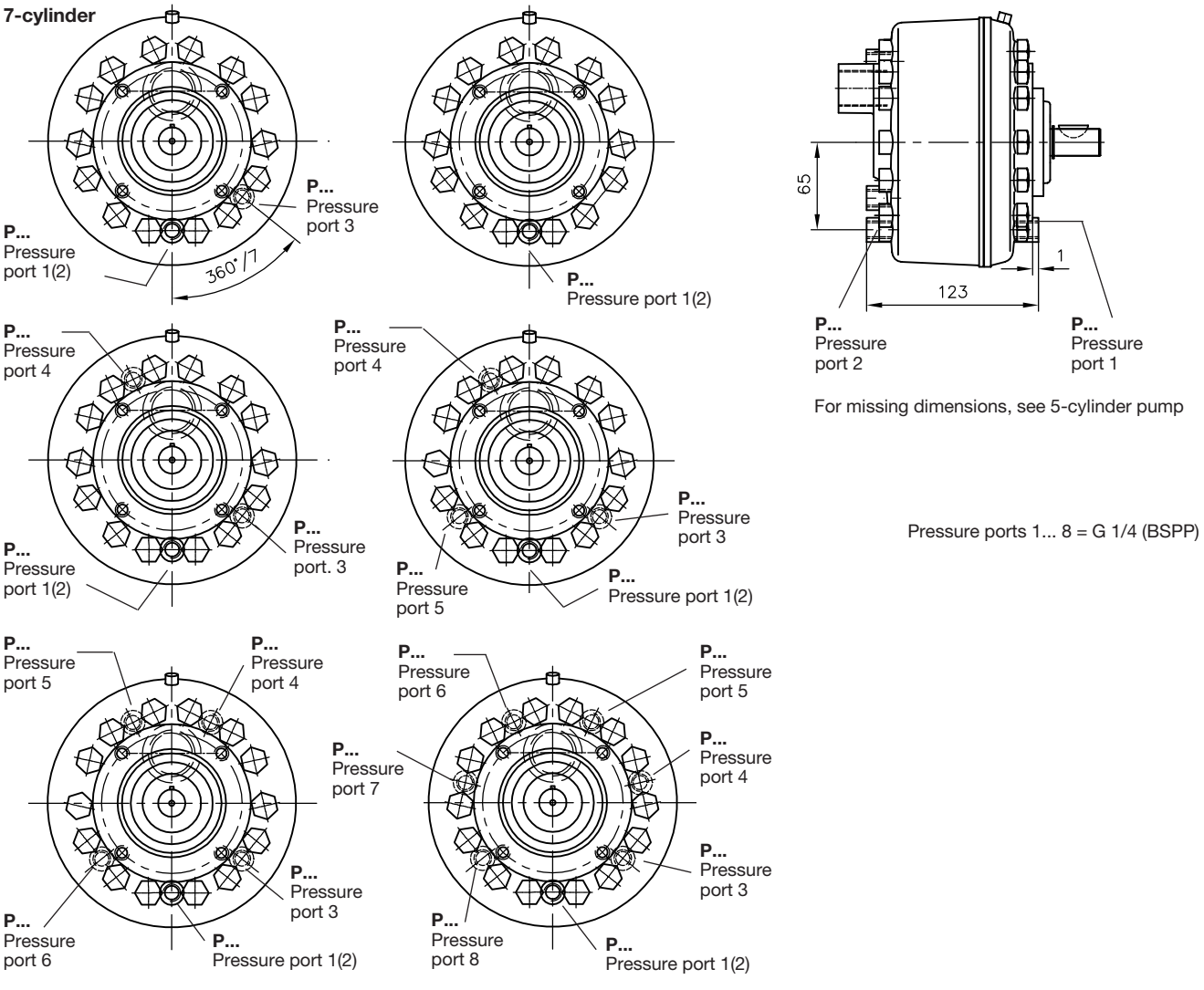
Attention: Not all versions for 2-radial pumps are listed here, due to spatial reasons. The pressure port dimensions are like with the standard version.

**5-cylinder**

Pressure ports 1... 6 = G 1/4 (BSPP)




**7-cylinder**



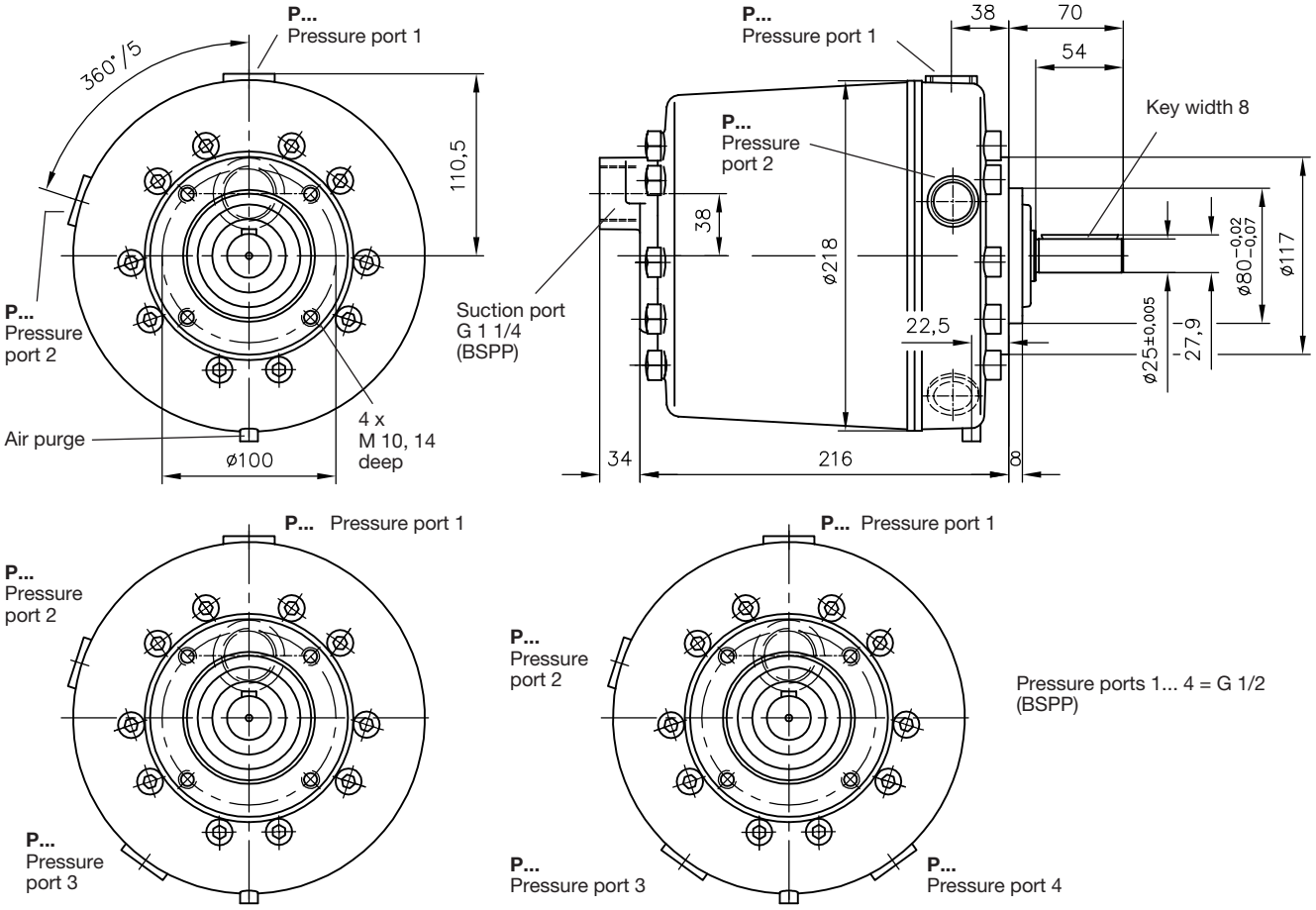

For missing dimensions, see 5-cylinder pump

Pressure ports 1... 8 = G 1/4 (BSPP)

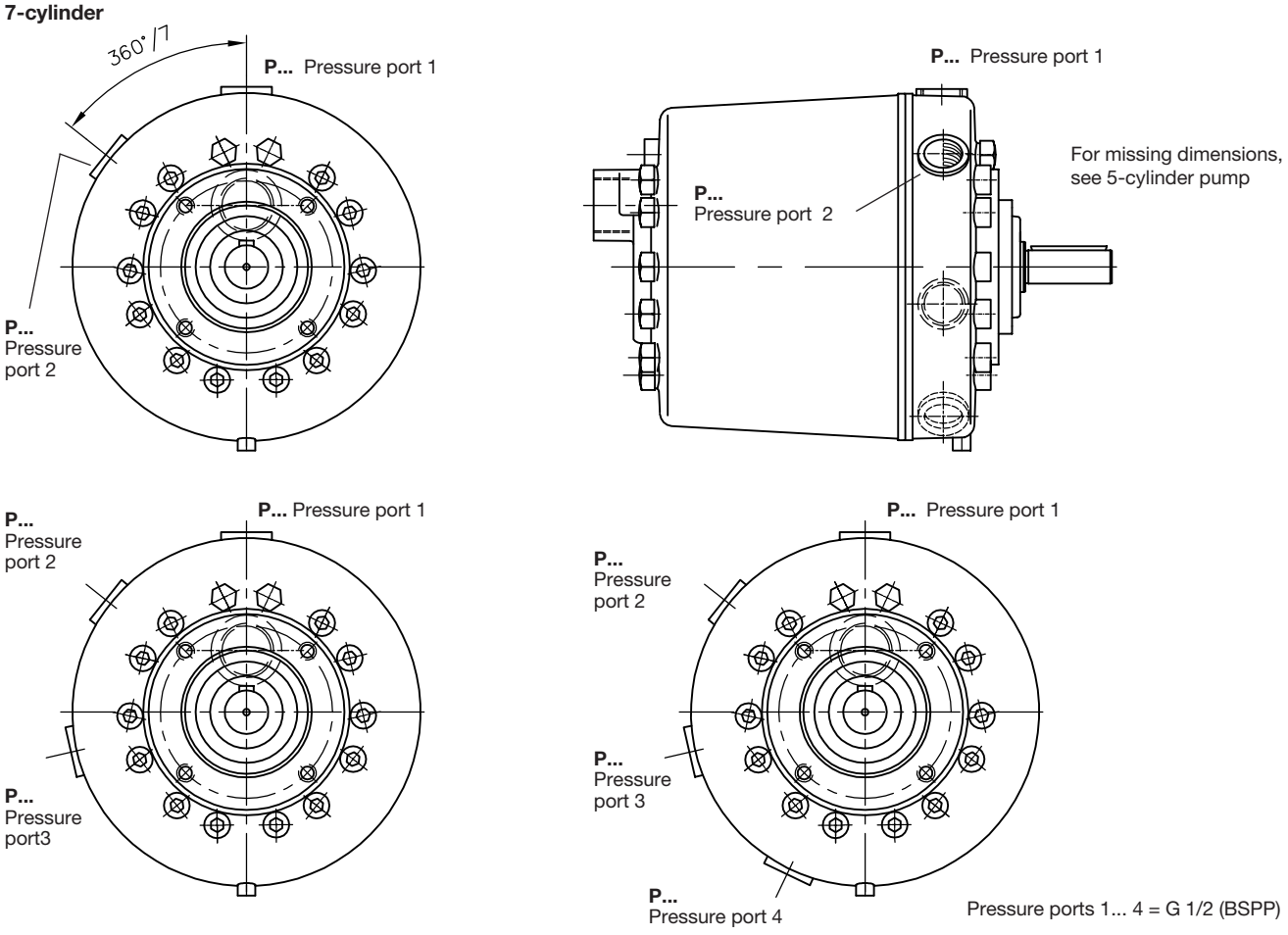
## 3.6 Design 6014

4-radial pump

**5-cylinder**

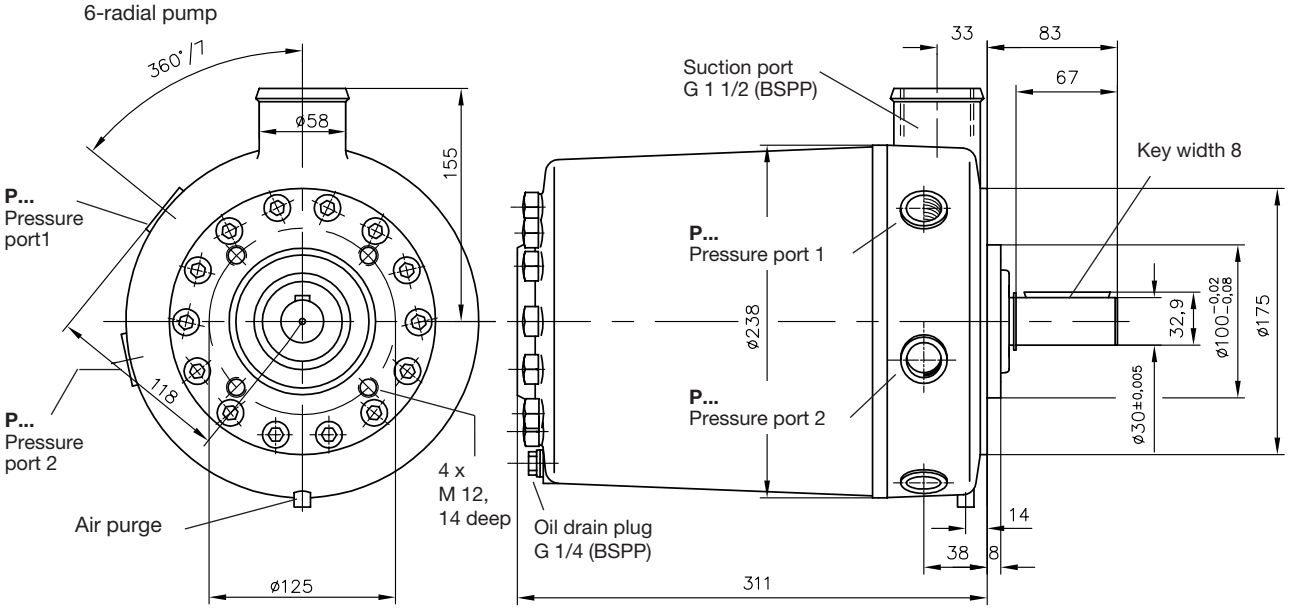


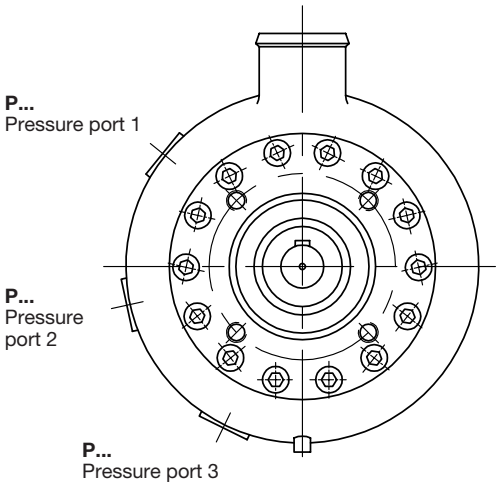

**7-cylinder**

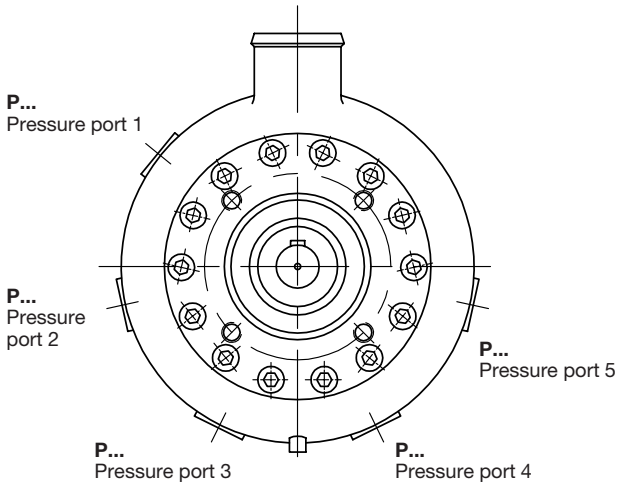


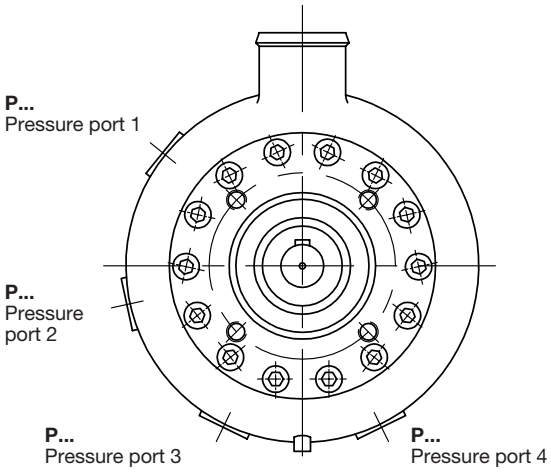
## 3.7 Design 6016

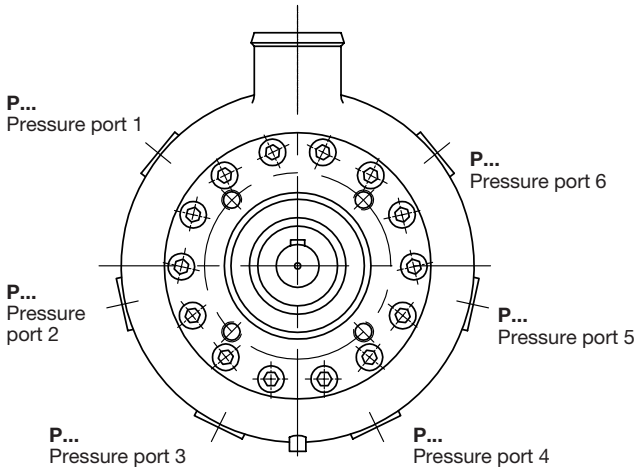
6-radial pump




**Size of pressure ports:**
The exact size of the pressure ports is determined by the delivery flow coding of each cylinder group (see table opposite)
The position of the pressure ports is determined by the sequence of delivery flow codings within the order coding (see also sect. 2).

Order example: **R 53,0 - 5,8 - 5,8**

* (BSPP)

4-radial pump with 4 x 7-cylinders at pressure port 1= G 1/2*

Single radial with 7-cylinders at pressure port 2 = G 3/8*

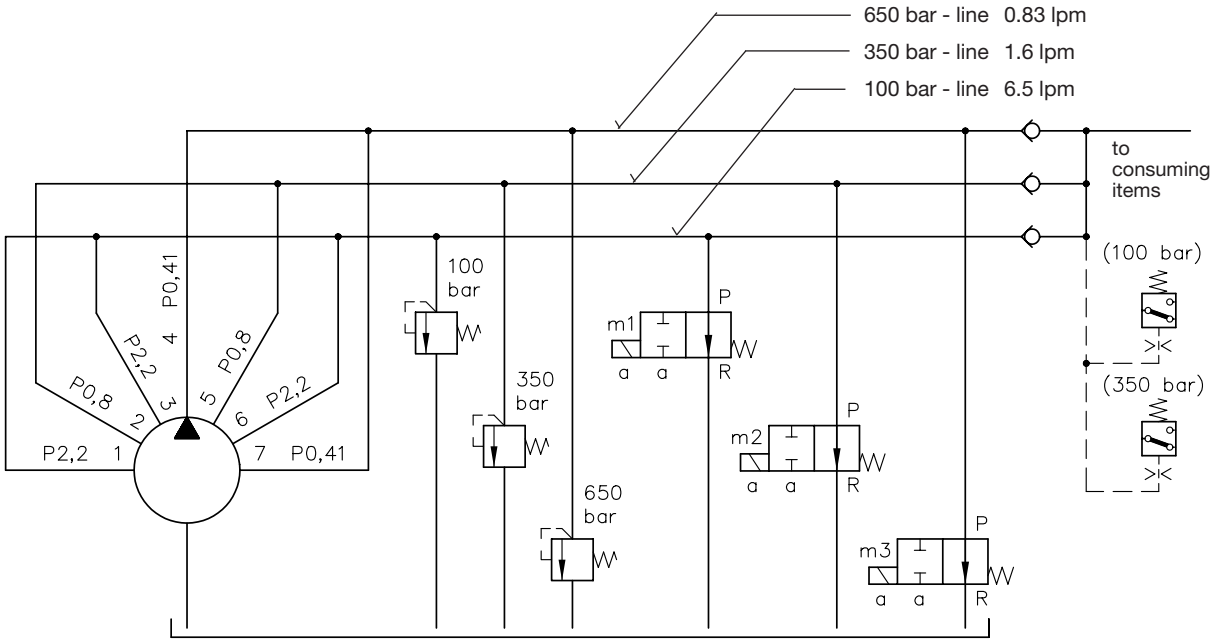
Single radial with 7-cylinders at pressure port 3 = G 3/8*

| Number of grouped cylinder radials x No of cylinders per radial | Delivery flow coding | | | | | | | Ports conf. DIN ISO 228/1 (BSPP) |
|---|---|---|---|---|---|---|---|---|
| 1 x 7 | 2.1 | 3.7 | 5.8 | 8.4 | 9.8 | 11.8 | 13.3 | G 3/8 |
| 2 x 7 | 4.0 | 7.4 | 11.6 | 17.0 | 20.0 | 23.5 | 26.5 | |
| 3 x 7 | 5.95 | 11.2 | 17.3 | 25.5 | 29.9 | 35.3 | 39.8 | G 1/2 |
| 4 x 7 | 8.0 | 15.0 | 23.0 | 34.0 | 40.0 | 47.0 | 53.0 | |
| 5 x 7 | 10.6 | 18.3 | 28.8 | 42.5 | 50.0 | 58.4 | 66.7 | G 3/4 |

# 4. Appendix

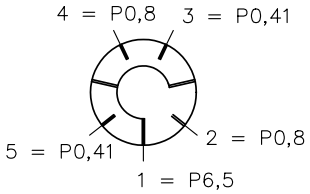
## 4.1 Characteristic features of pressure connections

The pump delivery will show a certain degree of pulsation (usually not pronounced at the usual operating speed of approx. 1450 rpm), whenever cylinder radials are split-up and fed to individual ports (design 7631, 6010, 6011, and 6012) or groups of cylinders (groups 6010, 6011 and 6012). At cylinder groups from 5- or 7-cylinder pumps, the respective pump cylinders are already grouped internally in such a way, that the remaining indiv. cylinders are distributed as far apart as possible (see the combination schemes for groups 6011 or 6012 in sect. 2.2 and 2.3). This ensures a good, superimposed arrangement of cylinders, keeping any pulse effect at a minimum. Whenever pump cylinders, with individual ports, are grouped together outside the pump an appropriate spread of cylinders should be ensured as well by choosing the sequence of delivery flow index ratings accordingly (see the example with five-cylinder pumps design 7631 in sect. 2.1 or design 6011 in sect. 2.3.
The example below shows a pump (design 6011) where all 7 ports are joint externally in such a way that three lines with different flow and pressure levels are generated.




**Example:**

R 2,2 - 0,8 - 2, 2 - 0,41 - 0,8 - 2,2 - 0,41 ⑤d ③f
In practice a pump R 6,5 - 0,8 - 0,41 - 0,8 - 0,41 ③f
would be chosen in such a case, the three P 2,2 ③f
pump cylinders being grouped together internally. ③f




## 4.2 Power consumption

It is usually sufficient to apply approximate figures in the manner shown below, since an exact calculation of the power consumption is rather complicated for such pumps,:
The approximate drive power required can be determined by calculating and adding up the power requirements of all deliveries apparent at the same time with their respective maximum pressure rating. Should there still be any inaccuracy in the case of pumps (design 7631, 6010, 6011, and 6012), due to pump cylinders delivering fluid simultaneously but without pressure, multiply the aggregate figure obtained in the above calculation with a correction factor making allowance for any imbalance. If necessary, the calculation may be conducted several times for various load cycles - the highest power demand obtained this way should then be used to sizing the motor.

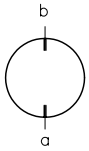
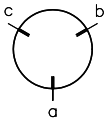
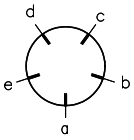
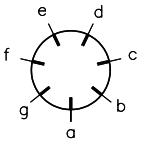
$R_{req}=(P_{c1}+P_{c2}+...)\ c$ Total power requirement in kW

Where :

Power requirement of individual cylinder or group of cylinders in kW

| | | |
|---|---|---|
| $p_Z$ | (bar) | Max. operating pressure of a group of cylinders |
| $Q_Z$ | (lpm) | Delivery flow of a group of cylinders = delivery flow index sect. 2.1 or 2.3 |
| $\sigma_Z$ | ( - ) | ≈ 0.85 mechanical/hydraulic efficiency of the group of cylinders |
| c | ( - ) | Correction factor, if required |

Correction factor c, takes the influence of pulsation on the power demand in account, in case of asymmetrically arranged pump cylinders delivering pressure fluid either in consecutive steps or simultaneously, depending on their angle of installation. All cylinders in idle circulation (p = 0) up to a load that is less than 10% of the simultaneously highest loaded cylinder remain unconsidered.

| Type of pump | 2-cyl.-pump | | | 3-cyl.-pump | | | 5-cylinder pump | | | | | | | 7-cylinder pump | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| |  | | |  | | |  | | | | | | |  | | | | | | | | | | | | | |
| cylinder a | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cylinder b | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cylinder c | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cylinder d | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cylinder e | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cylinder f | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cylinder g | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| correction factor c ≈ | 3 | | 1,5 | 3 | 1,5 [1] | 1 [4] | 3 | 1,5 [1] | 1,3 [3] | 1,3 [1] | 1 [4] | 1,6 [1] | 1,9 [2] | 3 | 1,7 [1] [2] | 1,5 | 1,3 [1] [3] | 1,2 | | 1,2 [1] | 1 [4] | 3 | 1,6 [1] | 1,5 [2] | 1,2 | 1,3 [1] | 1,3 | 1,5 [1] [2] |

= Cylinder against load

= Cylinder in idle circulation
( p = 0 to approx. 10% of )

[1]) Also applies to any other group of cylinders positioned at the same angle to one another
[2]) Not recommendable; avoid wherever possible. Do not interconnect the pressure connections of individual cylinders to one pressure line in this way, significant pulse effect.
[3]) Best combination when grouping cylinders in one pressure line
[4]) Applicable in all cases to a full cylinder radial

**Typical calculation** based in each case on the circuit arrangement shown in sect. 4.1 with a group 6011 7-cylinder pump: (R 6,5-0,8-0,41-0,8-0,41)

**Case 1:** All three pressure circuits operate together up to appr. 100 bar (switch pos. m1 + m2 + m3 = a)

Since all pump cylinders deliver fluid against pressure, c = 1
$P_{req\ 1}$ = (1.27 + 0.32 + 0.16) · 1 = 1.75 kW

**Case 2:** P 6.5 circuit in circulation (m1 = 0), other pressure ranges up to approx. 350 bar

The load interruptions P are shown in column 5 of table section c: c ≈1.2
$P_{req\ 2}$ = (1.10 + 0.57) · 1.2 = 2.00 kW

**Case 3:** P 6,5- a. 2 x P 0,8 circuits in circulation (m1 + m2 = 0)

2 x P 0,41-circuit ap to 650 bar

P 6,5 and P 1,6 = $P_{Z1}$ and $P_{Z2}$ = 0

2 x P 0,41 ... $P_{Z3}$ =

The load interruptions for P 6,5 and 2 x P 0,8 are shown in column 3 of table sect. c: = c ≈ 1.5
$P_{req\ 3}$ = 1.06 · 1.5 = 1.59 kW

**Case 4:** Motor acting during start-up against press.-limit. valves (failure mode circulat. ml + m2+ m3 = a, should circulat. signal for m1,m2 and m3 fail)

All pump cylinder deliver fluid against press., c = 1
$P_{req\ 4}$ = (1.27 + 1.10 + 1.06) · 1 = 3.43 kW

A 2.2 kW motor is suited for cases 1-3. The calculated load of 3.4 kW determined for case 4, on the other hand, represents an overload of roughly 55%. The resulting current consumption will 60% higher than the motor rating. A common bimetallic protective motor switch set to the motor's nom. Current rating will probably cut-off after approx. 1...1.5 min. (cold state), in case such malfunction occurs and remains unnoticed. Should the load interval with the highest power requirement (case 2: 1.97 kW) allow an overload of the motor one level further down (in this case, for example, the 1.5 kW motor running with a 31% overload), such a motor may be chosen provided that periods $t_1$, $t_2$, t ... for $P_{req\ 1}$, $P_{req\ 2}$ ... etc. in the individual load intervals including possible breaks, with the system idling or switched off (S 6 or S 3 operation), result in a mean load, equal to or smaller than the motor's nominal power. Assuming an overall period T of $t_1 + t_2 + t_3 + ...$, this mean load may be approximated in one of the successive operating cycles by means of the following equation:

Should, for example, the three 1.75 kW ($P_{req\ 1}$) load intervals follow one another as $t_1$ = 10 sec, 2.00 kW ($P_{req\ 2}$), $t_2$ = 12 sec and 1.59 kW ($P_{req\ 3}$), and 8 sec, without any interruption due to idling or system shutdown, one could again choose the 2.2 kW motor selected from the start:

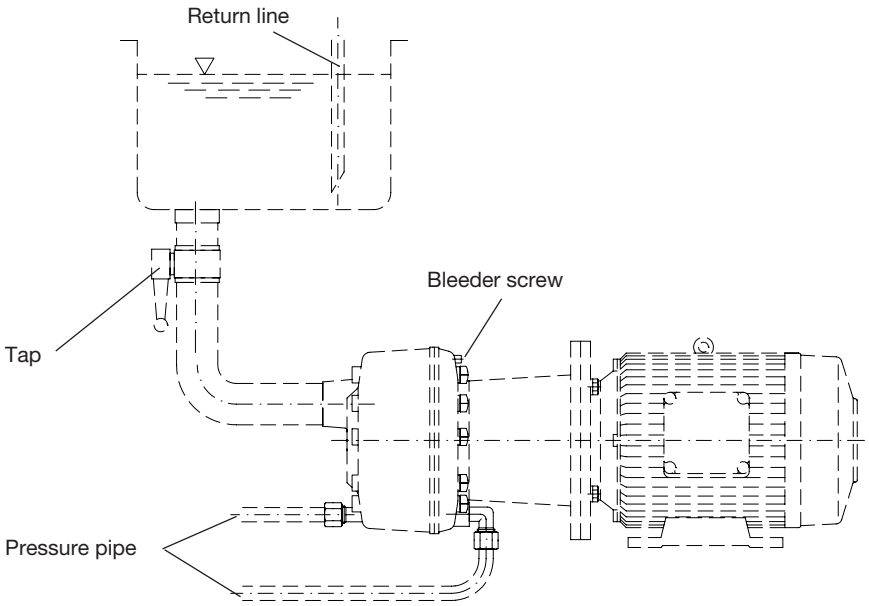
Should there be an idling period $t_L$ prior to the next load cycle (S6 operation), this period would have to last approx. 22...25 sec in order to reduce $P_{req\ m}$ to approximately 1.5 kW.

## 4.3 Bleeding and initial operation

The pump has to be bled prior to initial operation and after every fluid service to prevent intake problems and air to be fed into the hydraulic system.
See also notes in pamphlets D 6010, D 6010 H and operation manual B 6010.

**Pumps installed outside the tank**

When installed outside the tank, these pumps should preferably be positioned beneath or below the min. fluid level that a sufficient amount of fluid can flow in automatically via a feed line facing steadily downwards. This makes sure that the pump housing is always filled up with fluid and that no air is dragged into the system. The line connecting pump and tank should be equipped with a tap easing removal of the pump for maintenance without the necessity of draining the tank. Slacken, but do not remove the bleeder screw during or after filling the tank and leave it open until fluid without bubbles comes out. Retighten the screw and let the pump run or switch the pump on and off several times in idle circulation mode if possible with your circuitry. Another way is to set the main pressure limiting valve to zero bar, thereby enabling pressure less circulation. Next any air dragged into the system should be removed by operating all functions of the circuitry without load until all cylinders, motors, etc. move steadily and without any hesitation. Next the pressure limiting valve has to be reset to the system requirements (monitored by a pressure gauge).

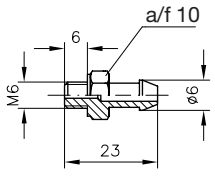



**Installation inside the tank**
For additional information, see also D 6010 DB

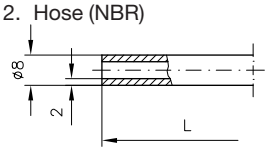
When using your own tank and tank cover plates, replace the bleeder screw at the pump by nipple 6020 070 and install a proper bleeding point at the cover plate, as illustrated below. Both nipples have to be connected via an oil-proof hose (8x2).

**Available bleeder components:**

1. Nipple
   part No. 6020 070




2. Hose (NBR)




| Part No. | Length L |
|---|---|
| 6020 077 a | 220 |
| 6020 077 b | 260 |
| 6020 077 c | 310 |
| 6020 077 d | 420 |
| 6020 077 e | 500 |