HNP Mikrosysteme

Operating manual for micro annular gear pumps **mzr-2505 / mzr-2905 / mzr-4005 / mzr-4605 / mzr-6305 / mzr-7205**

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Impressum

Original instructions

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This manual has been prepared with care. HNP Mikrosysteme does assume no liability for any errors in this manual and resulting consequences. Likewise, no liability is assumed direct or subsequent damages arising from an incorrect use of the devices.

While using micro annular gear pumps, the relevant standards regarding the specifications of this manual have to be followed.

Subject to change without notice.

Contents

1 General information

This operating manual contains basic instructions to be followed during integration, operation and maintenance of a mzr® micro annular gear pump. For this reason it is necessary to read it carefully before any handling of the device. The present manual should always be kept at the operation site of the micro annular gear pump.

In case assistance is needed, please indicate the pump type visible on the housing.

1.1 Application scope of the pumps

The micro annular gear pumps described in this manual are suitable for continuous delivery and discrete dosage of water, watery solutions, solvents, methanol, oils, lubricating liquids, paints and varnishes as well as many other liquids.

If you intend to treat any aggressive, poisonous, or radioactive liquids, you must conform to safety measures as according to the regulations in force. Any project concerning handling of corrosive liquids should be previously discussed with the pump manufacturer.

The micro annular gear pumps *must not* be used for invasive medical applications, in which the liquid having had contact with the pump is re-introduced to the body.

Micro annular gear pumps exclusively are provided for use in the industrial area. A private use is excluded.

The micro annular gear pumps are not to be used in motor vehicles, rail vehicles, aircraft and spacecraft. (Approval of the manufacturer necessary!)

Exception: The micro annular gear pumps can be used in or on watercrafts.

Data concerning resistance of the pumps to the manipulated liquids have been elaborated according to the best of HNPM's knowledge. However, operating parameters varying from one application case to another, no warranty for this information can be given.

Information given in this manual does not release the customer from the personal obligation to check the integrity, correct choice and suitability of the pump for the intended use. The use of the micro annular gear pumps should be conform with technical norms and regulations in force.

If you wish to receive more information than comprised in this operating manual please contact directly HNP Mikrosysteme.

1.2 Product information

The present operating manual is valid for the micro annular gear pump types mzr-2505, mzr-2905, mzr-4005, mzr-4605, mzr-6305 and mzr-7205 manufactured after 2001 by HNP Mikrosysteme GmbH, Bleicherufer 25, 19053 Schwerin, Germany.

The date of release of the present manual figures on the cover.

1.3 Technical data of the micro annular gear pumps

		mzr-2505	mzr-2905	mzr-4005
Technical data				
Displacement volume [µl]		1,5	3	6
Measurements [mm]	L x B x H	140 x 45 x 65	140 x 45 x 65	143 x 45 x 65
Weight [g]		780	780	800
Internal volume [µl]		80	85	86
Rotor material	tungsten carbide (WC-Ni)	●	●	●
Pump case material	stainless steel	1.4404	1.4404	1.4404
Bearing material	tungsten carbide (WC-Ni)	●	●	●
Dynamic sealing	graphite-reinforced PTFE	●	●	●
Static sealing	FKM (Viton®)	●	●	●
	EPDM	⊙	⊙	⊙
	FFKM	⊙	⊙	⊙
Threaded fluid supply connections	1/4"-28 UNF	●	●	●
	1/8"NPT (lateral)	–	–	–
	1/8"NPT (front)	–	–	–
Internal diameter of the tube		1/16''	1/16''	1/16''
External diameter of the tube		1/8''	1/8''	1/8''
Coupling	bellow coupling	●	●	●
Performance parameters				
Flow rate Q [ml/min]	min.	0.0015	0.003	0,006
[ml/min]	max.	9	18	36
[l/h]	max.	0,54	1.08	2,15
Min. dosage volume [µl]		0.25	0.5	1
Differential pressure [bar]	viscosity 1 mPas	2,5	5	2,5
	viscosity 16 mPas	15	30	50
Max. inlet pressure [bar]		5 (10 - 40 *)	5 (10 - 40 *)	5 (10 - 40 *)
Viscosity η [mPas]	min.	0.3	0.3	0,3
	max.	25,000	50,000	50.000
	accessories			
Dosage precision CV [%]		<1	<1	<1
Pulsation [%]		6	6	1,5
$NPSH_R$-value [m]	min.	0.9 (0.4 *)	0.9 (0.4 *)	0,9 (0,4 *)
Liquid temperature [°C]	min.	-5	-5	-5
	max.	60 (150 *)	60 (150 *)	60 (150 *)
Ambient temperature [°C]	min.	-5	-5	-5
	max.	60	60	60
Storage temperature [°C]	min.	-5	-5	-5
	max.	40	40	40

Legend:
- ● available
- ⊙ optional / on demand
- – not available
- * with supplementary modules

CV Coefficient of variation
$NPSH_R$ Net Positive Suction Head Required

table 1 Technical data and performance parameters of the micro annular gear pumps (part 1)

		mzr-4605	mzr-6305	mzr-7205
Technical data				
Displacement volume [µl]		12	24	48
Measurements [mm]	L x B x H	143 x 45 x 65	155 x 50 x 69	155 x 50 x 69
Weight [g]		800	1080	1080
Internal volume [µl]		109	525	525
Rotor material	tungsten carbide (WC-Ni)	●	●	●
Pump case material	stainless steel	1.4404	1.4404, ~~1.4435~~	1.4404, ~~1.4435~~
Bearing material	tungsten carbide (WC-Ni)	●	●	●
Dynamic sealing	graphite-reinforced PTFE	●	●	●
Static sealing	FKM (Viton®)	●	●	●
	EPDM	⊙	⊙	⊙
	FFKM	⊙	⊙	⊙
Threaded fluid supply connections	1/4"-28 UNF	●	–	–
	1/8"NPT (lateral)	–	●	●
	1/8"NPT (front)	–	⊙	⊙
Internal diameter of the tube		1/16''	4 mm	4 mm
External diameter of the tube		1/8''	6 mm	6 mm
Coupling	bellow coupling	●	●	●
Performance parameters				
Flow rate Q [ml/min]	min.	0.012	0.024	0.048
[ml/min]	max.	72	144	288
[l/h]	max.	4.3	8,64	17.28
Min. dosage volume [µl]		2	15	30
Differential pressure [bar]	viscosity 1 mPas	10	15	30
	viscosity 16 mPas	50	20	40
Max. inlet pressure [bar]		5 (10 - 40 *)	5 (10 - 40 *)	5 (10 - 40 *)
Viscosity η [mPas]	min.	0.3	0.3	0.3
	max.	50,000	25,000	50,000
	accessories			1,000,000 *
Dosage precision CV [%]		<1	<1	<1
Pulsation [%]		6	6	6
$NPSH_R$-value [m]	min.	5.7 (0.5 *)	0.5	0.5
Liquid temperature [°C]	min.	-5	-5	-5
	max.	60 (150 *)	60 (150 *)	60 (150 *)
Ambient temperature [°C]	min.	-5	-5	-5
	max.	60	60	60
Storage temperature [°C]	min.	-5	-5	-5
	max.	40	40	40

Legend:

● available
⊙ optional / on demand
– not available
* with supplementary modules

CV Coefficient of variation
$NPSH_R$ Net Positive Suction Head Required

table 2 Technical data and performance parameters of the micro annular gear pumps (part 2)

Warning The material properties of a liquid (e.g. viscosity, lubricating property, particle content, corrosiveness) impacts the technical data and the lifetime of pumps. Under appropriate conditions the characteristic values may be increased or decreased.

Warning If you intend to operate the pump out of the range of the above given specification, please consult the manufacturer. Modifications may be necessary to ensure successful operation. Otherwise the pump or the system may be damaged seriously.

1.4 Measurements and flow charts of the mzr-2505 pump

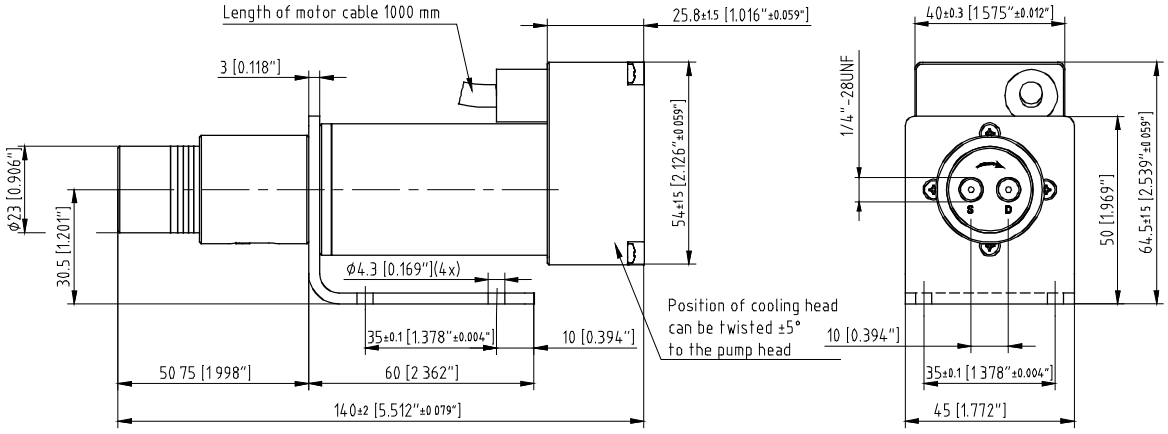


figure 1 Measurements of the micro annular gear pump mzr-2505

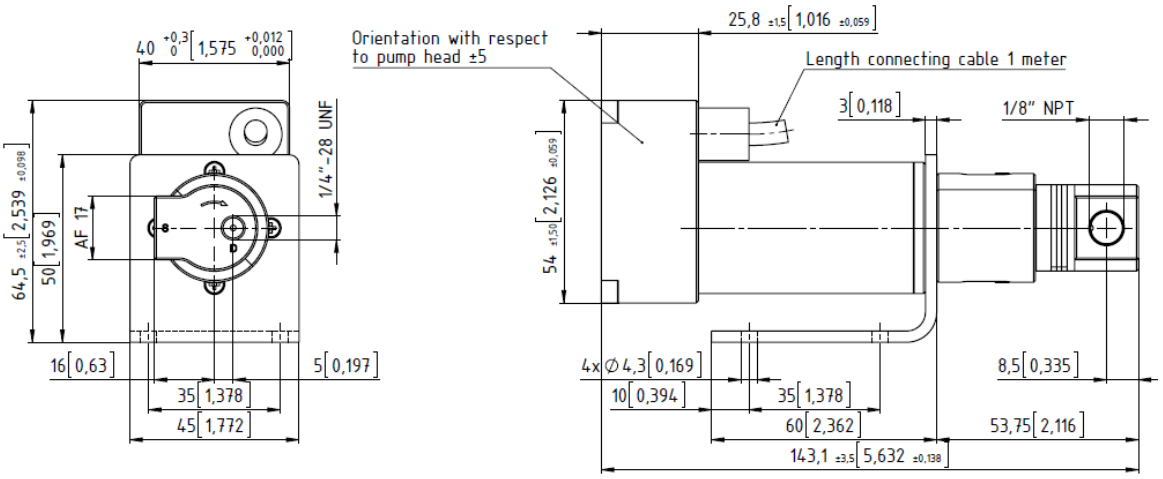


figure 2 Measurements of the micro annular gear pump mzr-2505 S/F

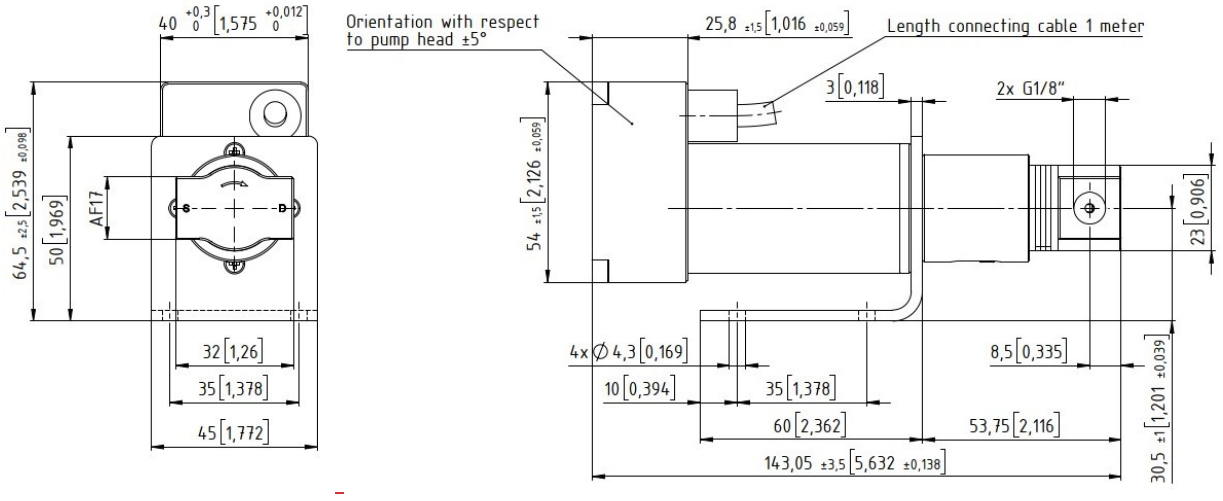


figure 3 Measurements of the micro annular gear pump mzr-2505 S G1/8"

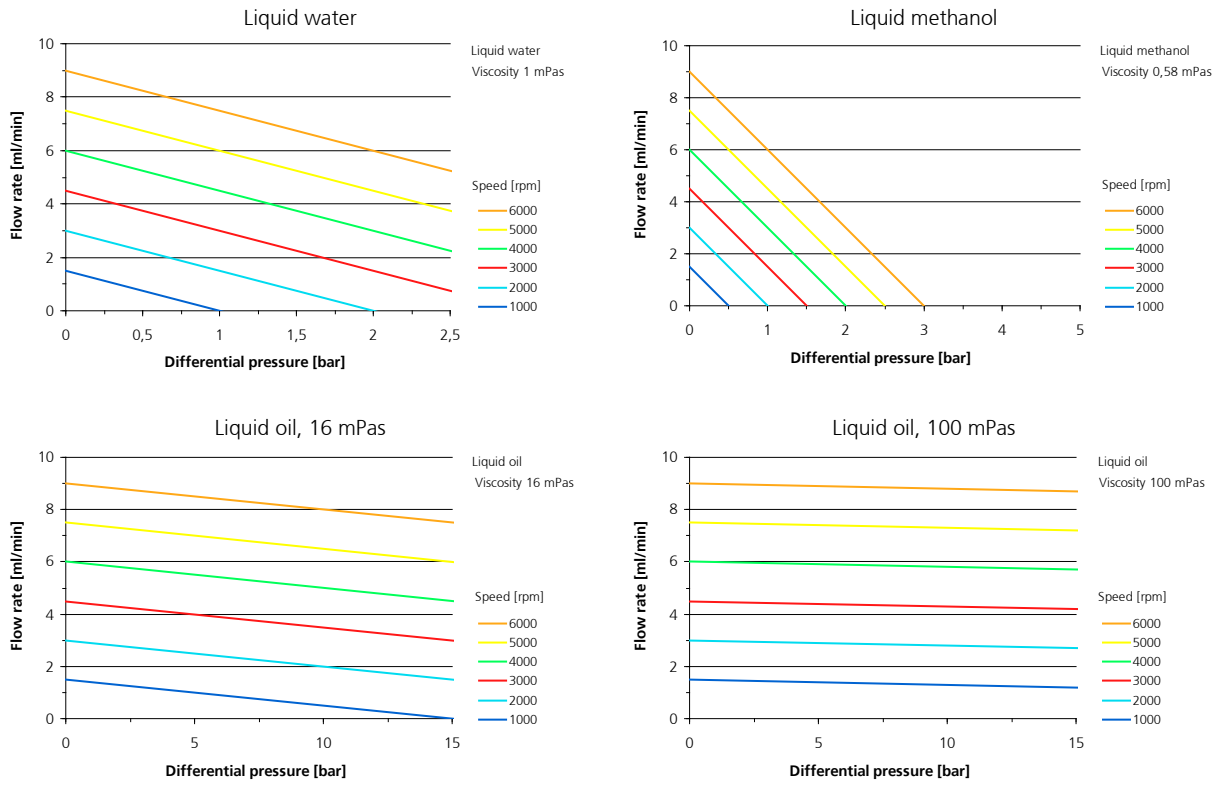


figure 4 Flow charts of the micro annular gear pump mzr-2505

1.5 Measurements and flow charts of the mzr-2905 pump

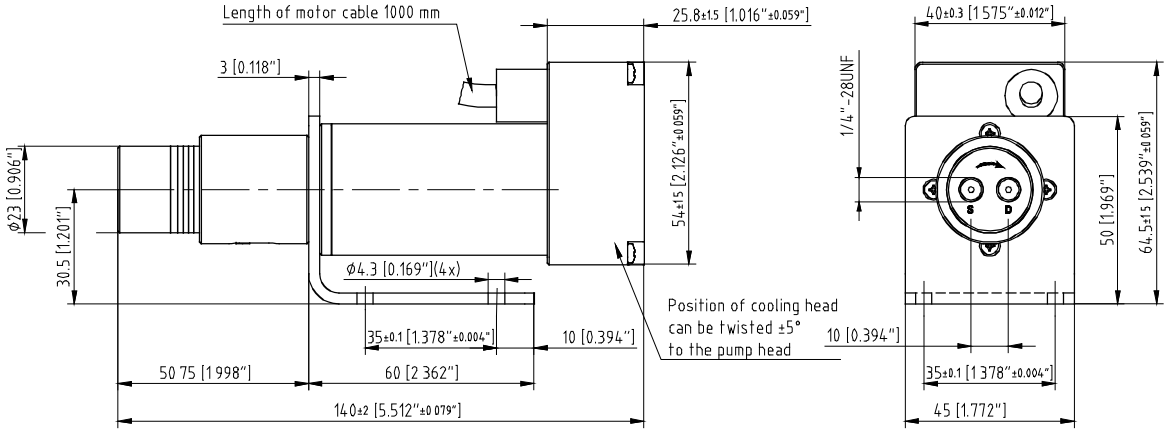


figure 5 Measurements of the micro annular gear pump mzr-2905

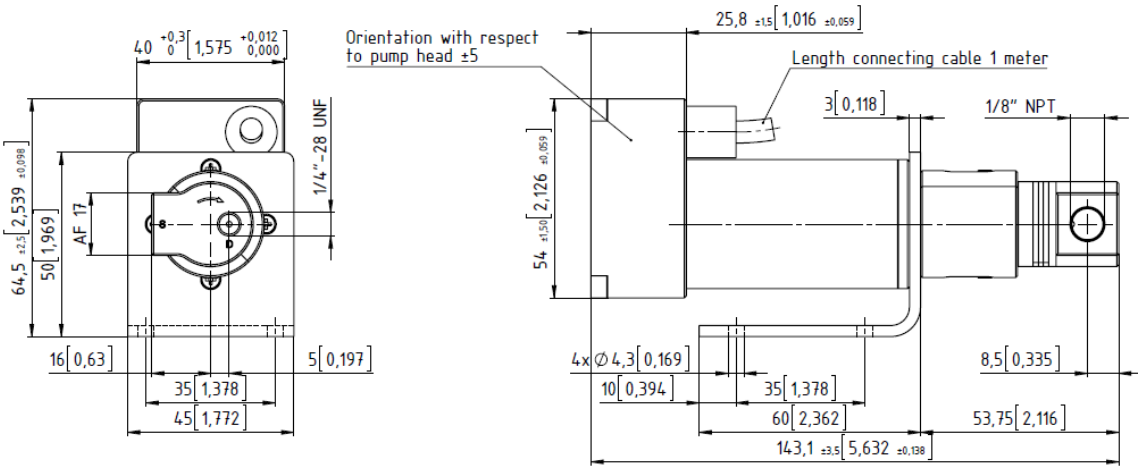


figure 6 Measurements of the micro annular gear pump mzr-2905 S/F

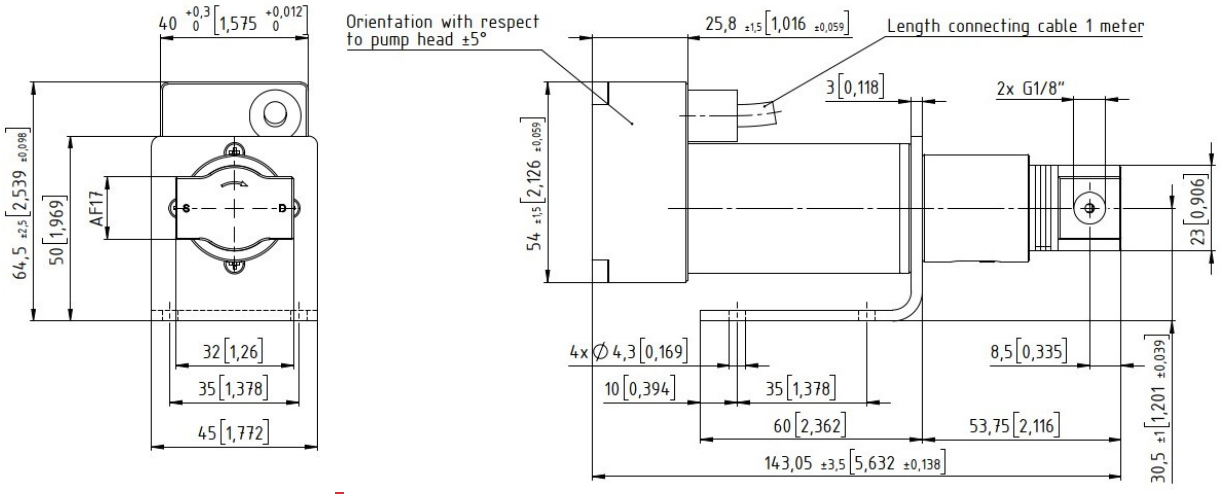


figure 7 Measurements of the micro annular gear pump mzr-2905 S G1/8"

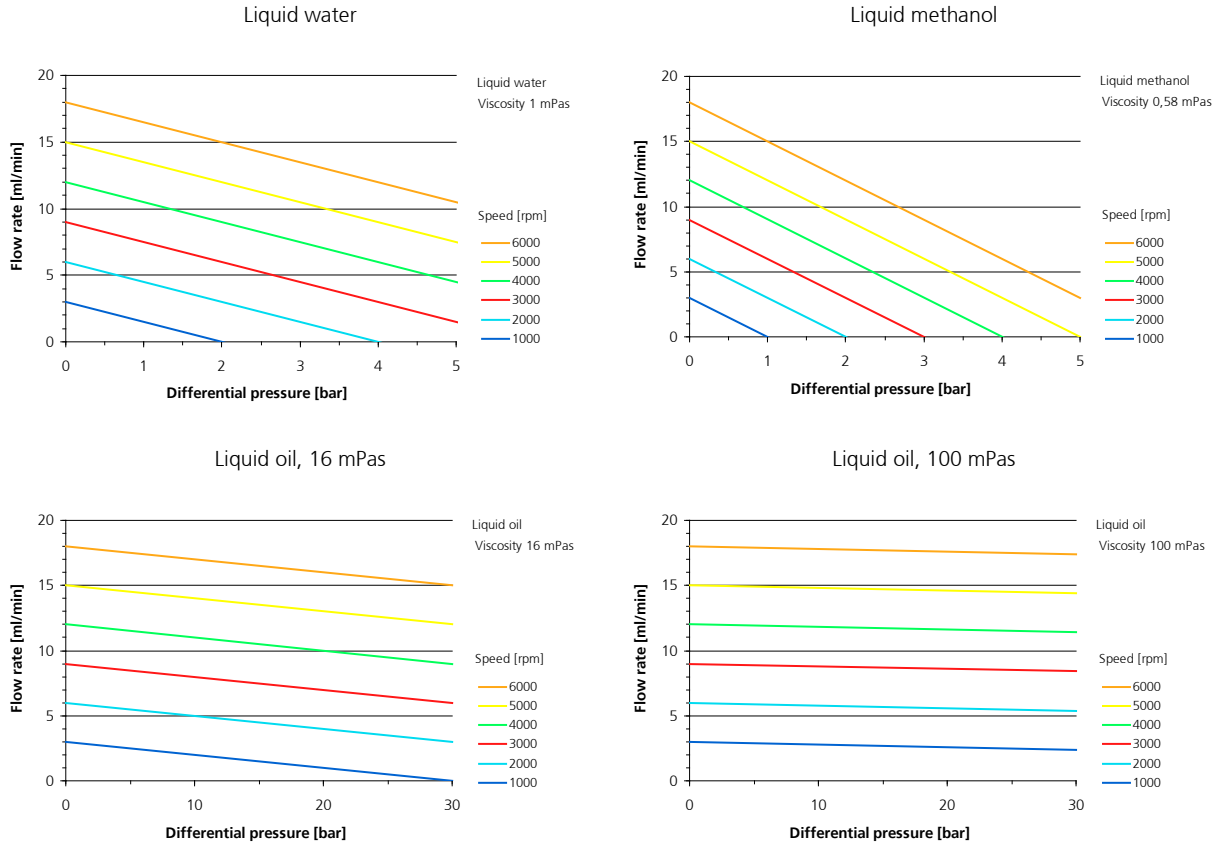


figure 8 Flow charts of the micro annular gear pump mzr-2905

1.6 Measurements and flow charts of the mzr-4005 pump

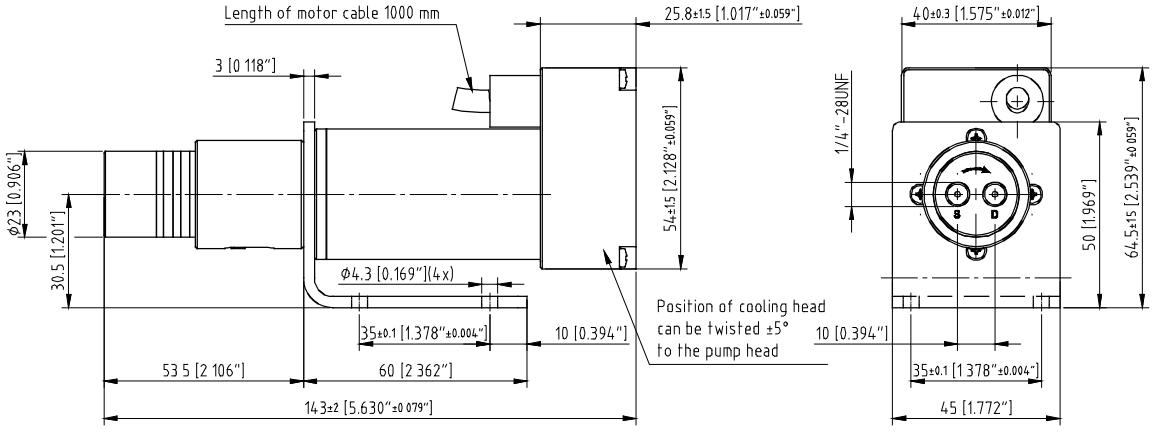


figure 9 Measurements of the micro annular gear pump mzr-4005

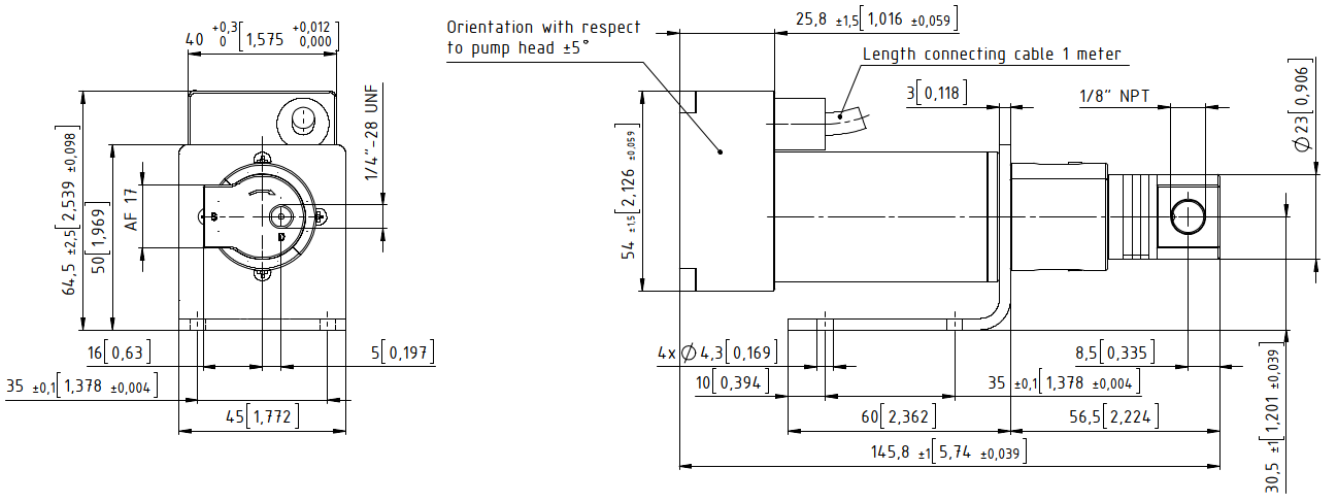


figure 10 Measurements of the micro annular gear pump mzr-4005 S/F

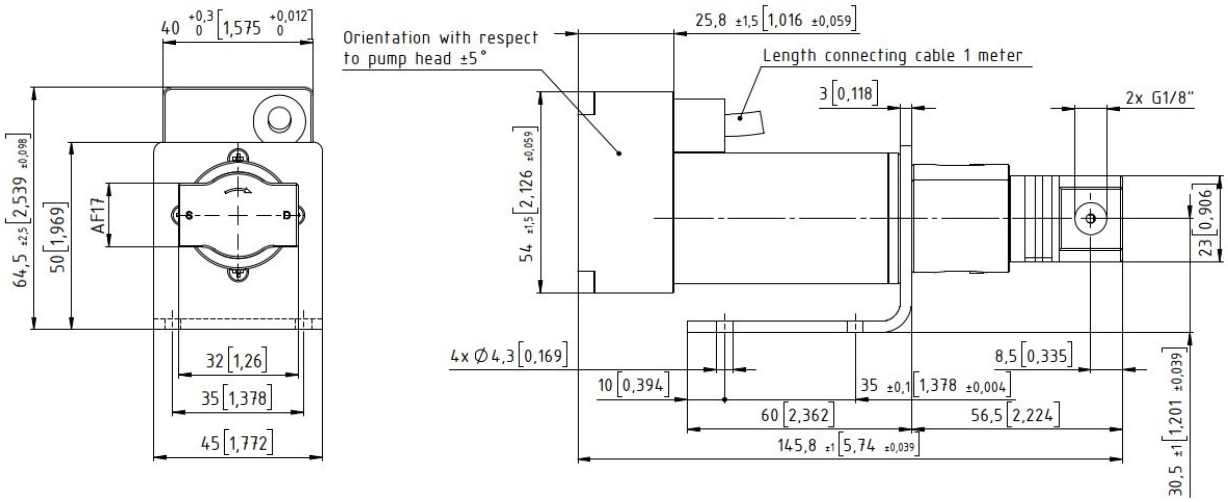


figure 11 Measurements of the micro annular gear pump mzr-4005 S G1/8"

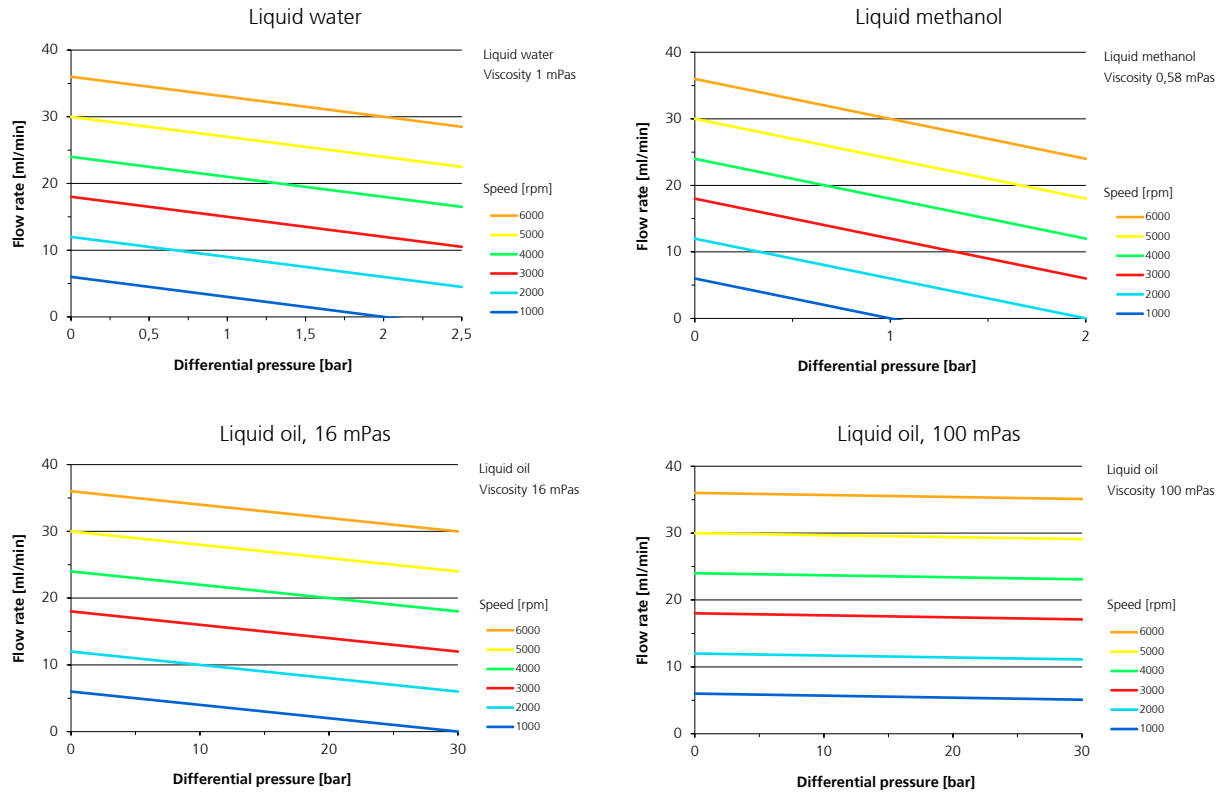


figure 12 Flow charts of the micro annular gear pump mzr-4005

1.7 Measurements and flow charts of the mzr-4605 pump

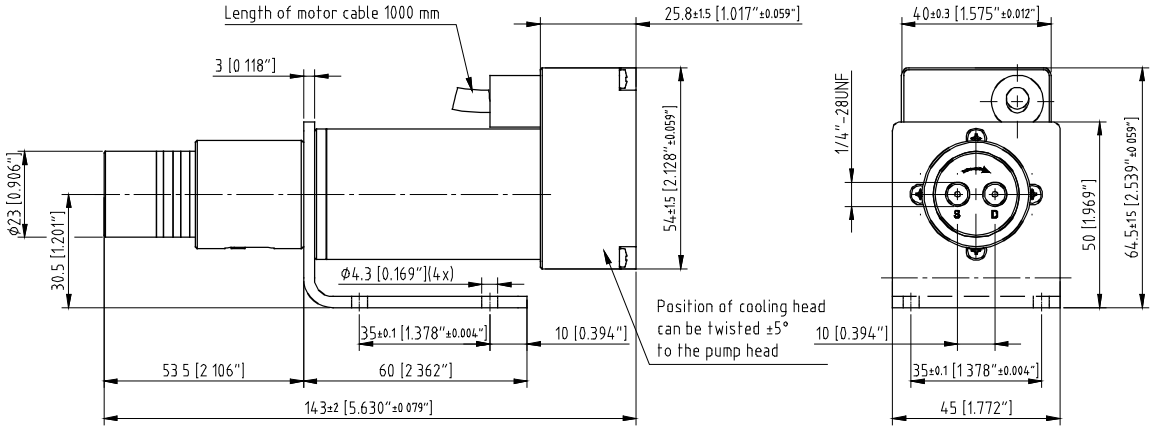


figure 13 Measurements of the micro annular gear pump mzr-4605

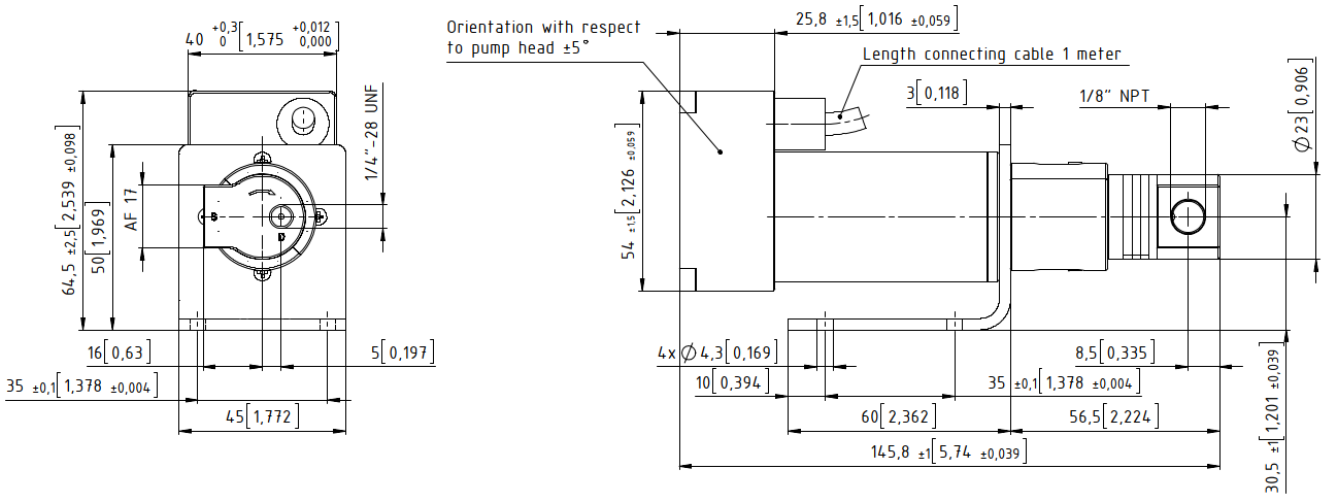


figure 14 Measurements of the micro annular gear pump mzr-4605 S/F

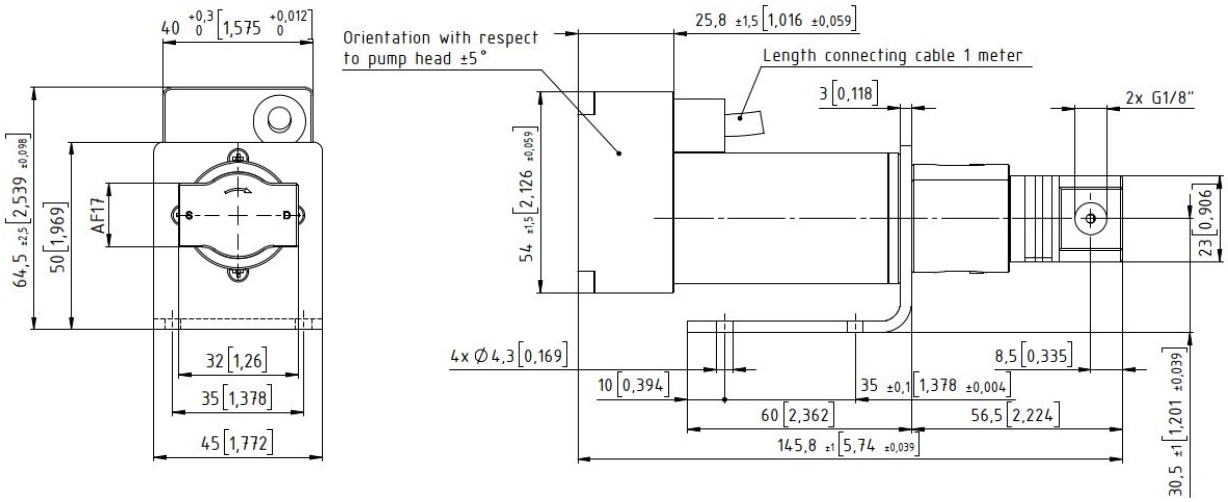


figure 15 Measurements of the micro annular gear pump mzr-4605 S G1/8”

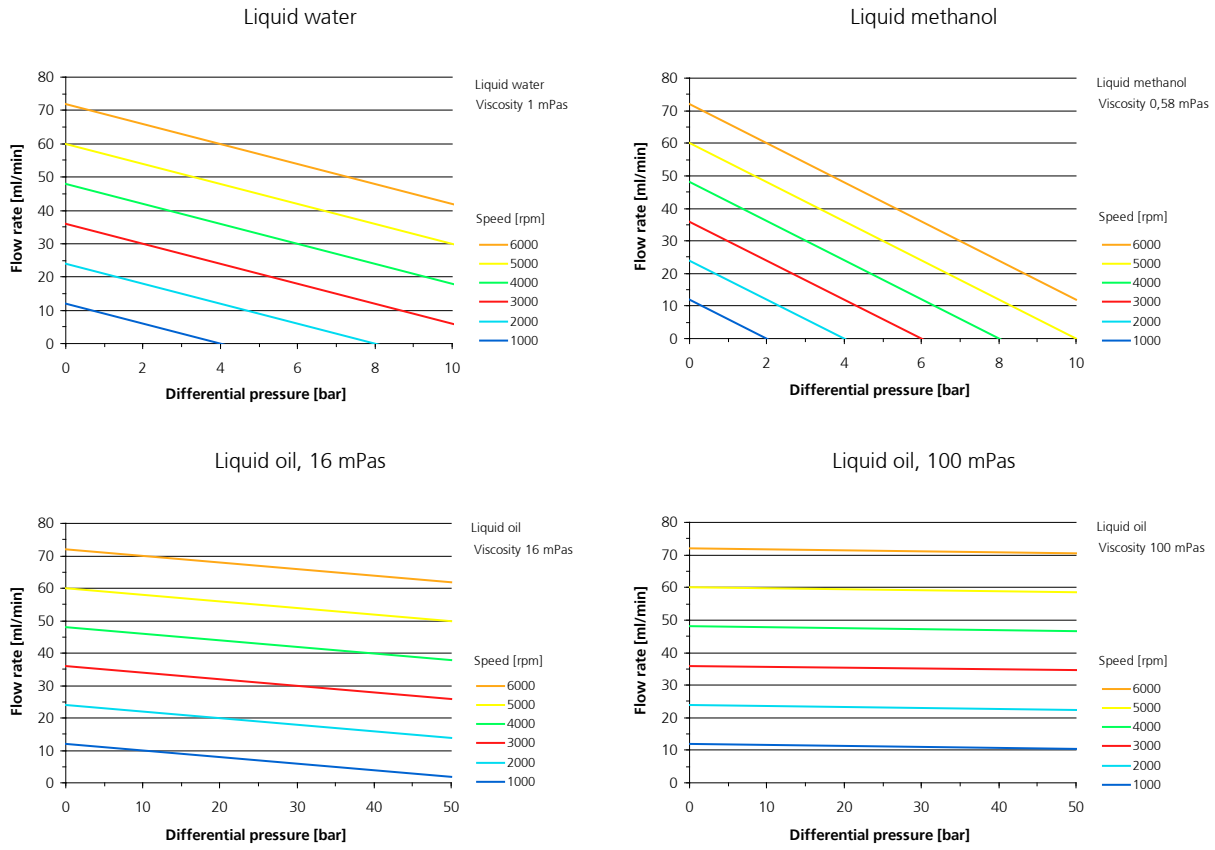


figure 16 Flow charts of the micro annular gear pump mzr-4605

1.8 Measurements and flow charts of the mzr-6305 pump

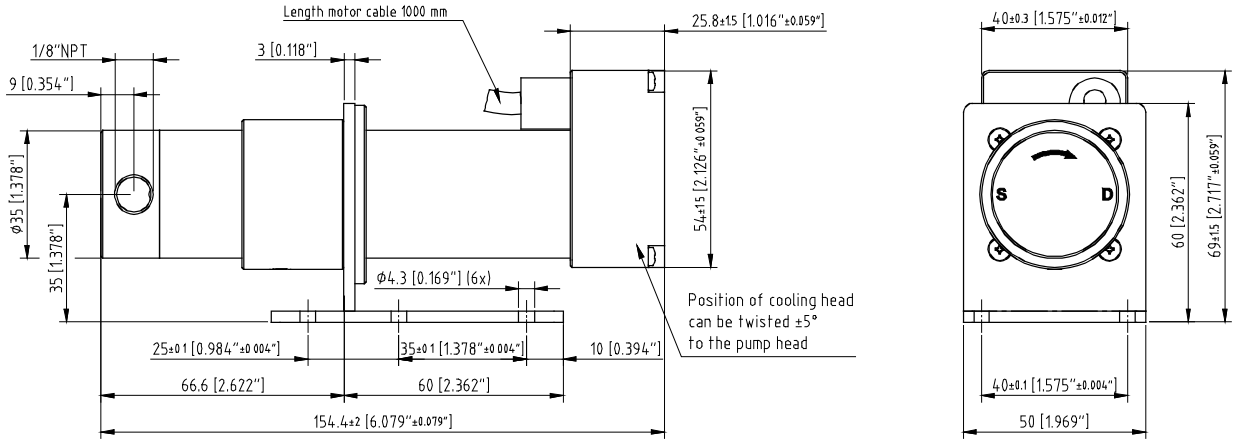


figure 17 Measurements of the micro annular gear pump mzr-6305 with lateral fluid connection 1/8" NPT

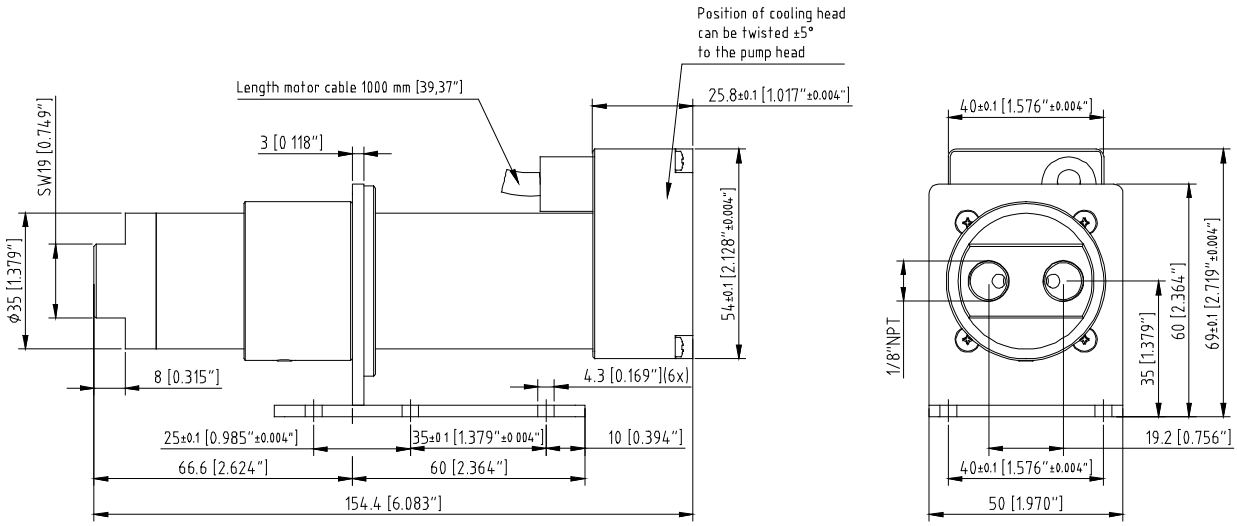


figure 18 Measurements of the micro annular gear pump mzr-6305 with front fluid connection 1/8" NPT

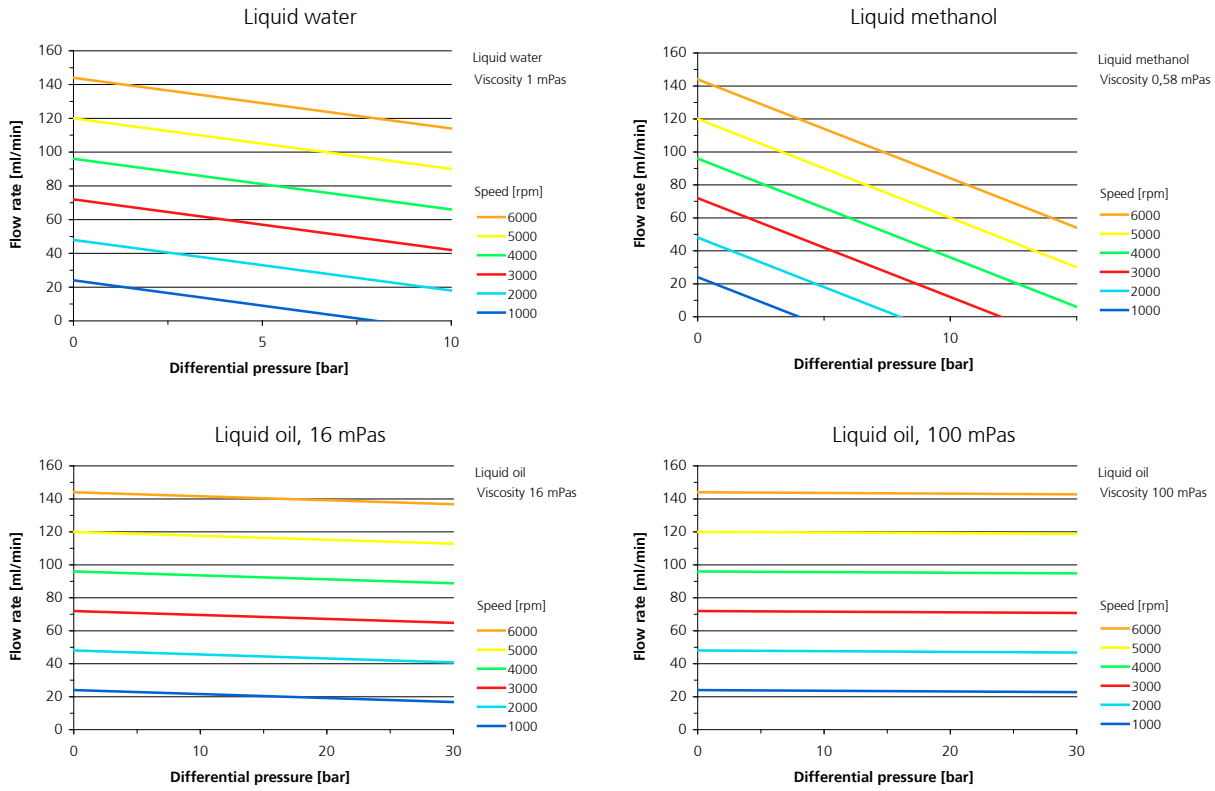


figure 19 Flow charts of the mzr-6305 pump

1.9 Measurements and flow charts of the mzr-7205 pump

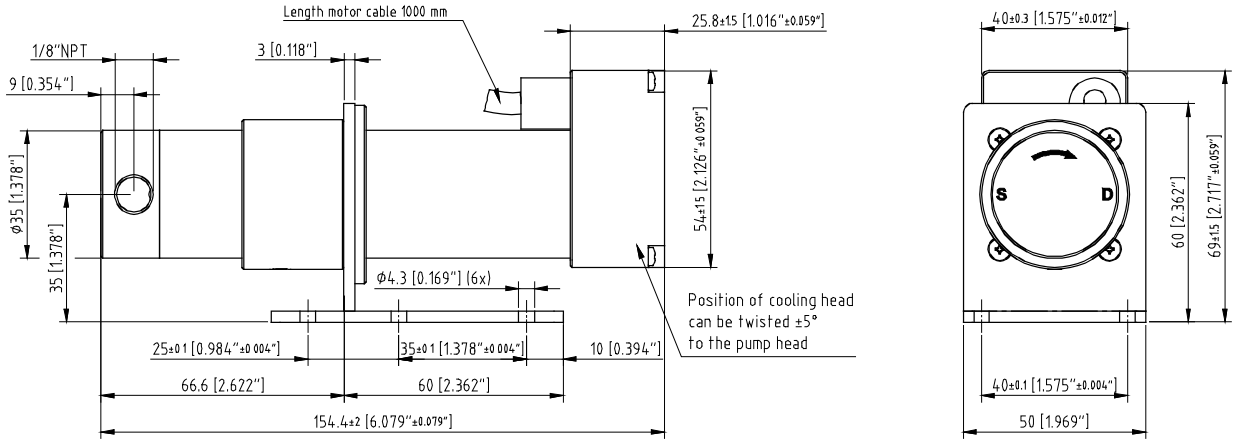


figure 20 Measurements of the micro annular gear pump mzr-7205 with lateral fluid connection 1/8" NPT

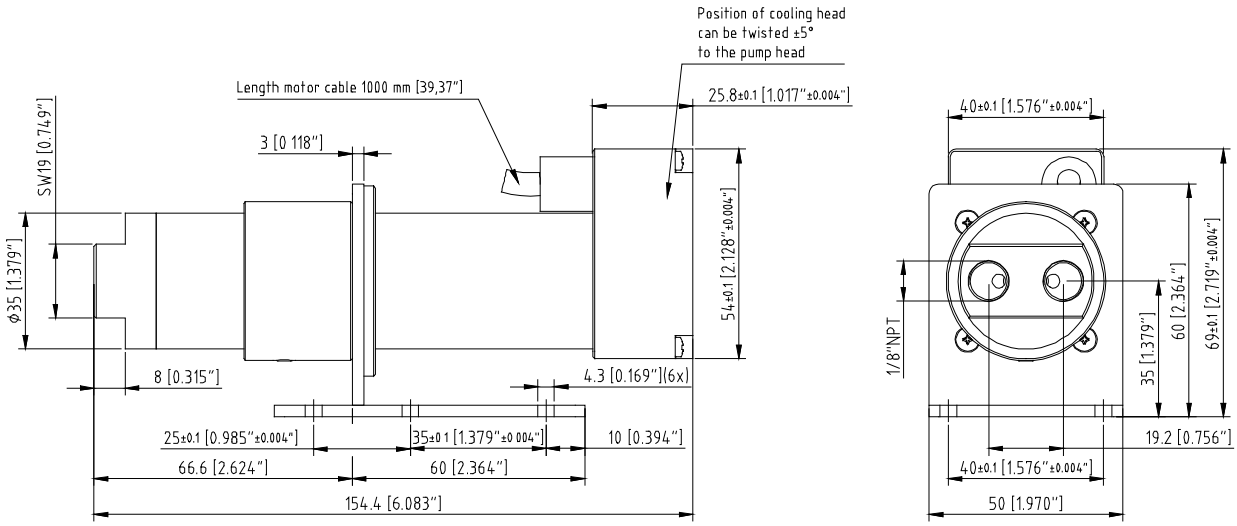


figure 21 Measurements of the micro annular gear pump mzr-7205 with front fluid connection 1/8" NPT

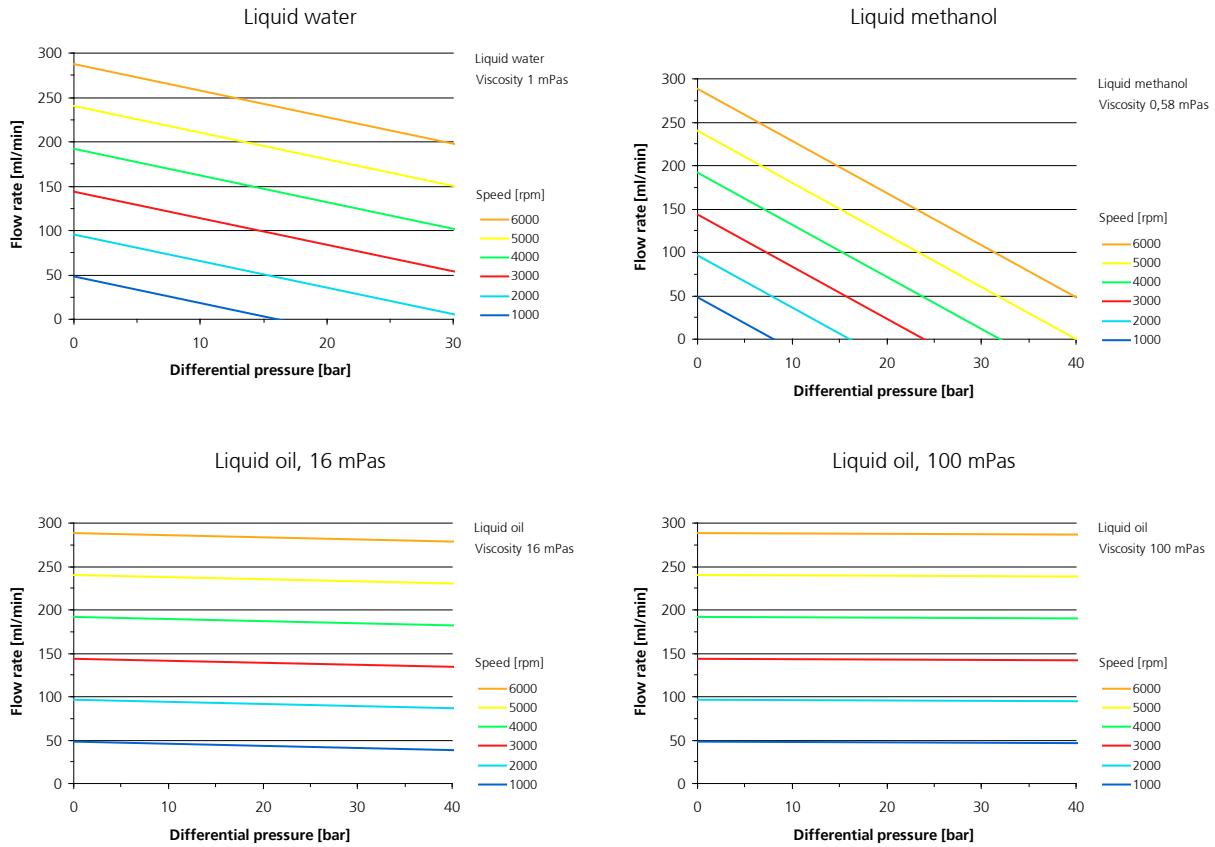


figure 22 Flow charts of the mzr-7205 pump

1.10 Technical data of the drive 3564K024BCS

The micro annular gear pumps are driven by electronically commutated, brushless motors with integrated control. The control unit is composed of a 16-bit microcontroller and power electronics. It enables to adjust both speed and position of the motor. The motor is highly dynamic and suitable for dosing tasks performed by the micro annular gear pump. CDs or diskettes containing software running under Windows® which permits to set the parameters, as well as to program and control the pump are included in the package. The package contains also a user-friendly terminal box and a null-modem cable for an easy connection to the serial port of a PC.

Performance characteristics of the motor	
Nominal voltage U_B	24 VDC
Supply voltage	12 – 30 V
Residual ripple	≤ 2 %
Max. continuous current	2.8 A
Max. peak current	8 A
Power	44 W
Max. continuous torque	50 mNm
Counts per turn	1000*
Speed range	1 – 6000 rpm
Max speed at 24 V	9000 rpm
Input No. 1 (speed input)	0 – 10 V
Resistance input No. 1	18 kΩ
Fault output (input No. 2)	Open collector max. U_B / 30 mA no error: switched to GND programmed as an input: low 0...0.5 V / high 4 V...U_B
Digital input No. 3	low 0...0.5 V / high 4...30 V
Serial port	RS-232
Protection class	IP 44
Connection cable length	1 m

table 3 Technical data for the drive of micro annular gear pumps

Wire	Description
blue	GND
pink	+24 V
brown	Analog input
white	Fault output
gray	Analog GND
yellow	RS-232 RXD
green	RS-232 TXD
red	Digital input

table 4 Pin configuration of the motor

Motor current parameters	mzr-2505	mzr-2905	mzr-4605	mzr-6305	mzr-7205
Peak current LPC [mA]	1100	1100	1200	8000	8000
Continuous current LCC [mA]	900	900	1000	2800	2800
Max. speed SP [rpm]	6000	6000	6000	6000	6000
Acceleration AC [rotation/s²]	500	500	500	500	500

table 5 Programmed current and acceleration parameters at the delivery of standard pumps

Parameter setting (at delivery)	mzr-4605	mzr-6305	mzr-7205
Peak current LPC [mA]	800	4000	4000
Continuous current LCC [mA]	700	2800	2800
Max. speed SP [rpm]	6000	6000	6000
Acceleration AC [rotation/s²]	500	500	500

table 6 Programmed parameters at the delivery with the gear box 3.71 : 1

Parameter setting (at delivery)	mzr-4605	mzr-6305	mzr-7205
Peak current LPC [mA]	600	1200	1200
Continuous current LCC [mA]	500	1000	1000
Max. speed SP [rpm]	6000	6000	6000
Acceleration AC [rotation/s²]	500	500	500

table 7 Programmed parameters at the delivery with gear box 14 : 1

pin plug / socket	Description
1	GND
2	analog input
3	+24 V
4	fault out
5	analog GND
6	RS-232 RxD
7	RS-232 TxD
8	digital Input 3

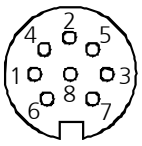


table 8 Pin configuration of the optional lengthening cable

1.11 Technical data of the alternative drive 3564K024BC2330 (optional)

The micro annular gear pumps are driven by electronically commutated, brushless motors with integrated control. The control unit is composed of a 16-bit microcontroller and power electronics. It enables to adjust both speed and position of the motor. The motor is highly dynamic and suitable for dosing tasks performed by the micro annular gear pump. CDs or diskettes containing software running under Windows® which permits to set the parameters, as well as to program and control the pump are included in the package. The package contains also a user-friendly terminal box and a null-modem cable for an easy connection to the serial port of a PC.

Performance characteristics of the motor	
Nominal voltage U_B	24 VDC
Supply voltage	12 – 28 V
Residual ripple	≤ 2 %
Max. continuous current	2.8 A
Max. peak current	8 A
Power	44 W
Max. continuous torque	50 mNm
Counts per turn	1000
Speed range	1 – 6000 rpm
Max speed at 24 V	9000 rpm
Max speed at 28 V	10,000 rpm
Input No. 1 (speed input)	0 – 10 V
Resistance input No. 1	18 kΩ
Fault output (input No. 2)	Open collector max. U_B / 30 mA no error: switched to GND programmed as an input: low 0...0.5 V / high 4 V...U_B
Digital input No. 3	low 0...0.5 V / high 4...30 V
Serial port	RS-232
Memory for operating programs	7936 Bytes
Protection class	IP 44
Connection cable length	1 m

table 9 Technical data for the drive of micro annular gear pumps

Wire	Description
blue	GND
pink	+24 V
brown	Analog input
white	Fault output
gray	Analog GND
yellow	RS-232 RXD
green	RS-232 TXD
red	Digital input

table 10 Pin configuration of the motor

Motor current parameters	mzr-2905	mzr-4605	mzr-7205
Peak current LPC [mA]	600	800	8000
Continuous current LCC [mA]	500	700	2500
Max. speed SP [rpm]	6000	6000	6000
Acceleration AC [rotation/s²]	500	500	500

table 11 Programmed current and acceleration parameters at the delivery of standard pumps

Parameter setting (at delivery)	mzr-4605	mzr-7205
Peak current LPC [mA]	600	1200
Continuous current LCC [mA]	500	1000
Max. speed SP [rpm]	6000	6000
Acceleration AC [rotation/s²]	500	500

table 12 Programmed parameters at the delivery with the gear box 3.71 : 1

Parameter setting (at delivery)	mzr-4605	mzr-7205
Peak current LPC [mA]	600	1200
Continuous current LCC [mA]	500	1000
Max. speed SP [rpm]	6000	6000
Acceleration AC [rotation/s²]	500	500

table 13 Programmed parameters at the delivery with gear box 14 : 1

pin plug / socket	Description
1	GND
2	analog input
3	+24 V
4	fault out
5	analog GND
6	RS-232 RxD
7	RS-232 TxD
8	digital Input 3

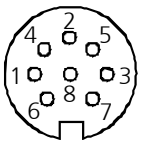


table 14 Pin configuration of the optional lengthening cable

2 Safety instructions

Comply with the general safety instructions listed in the safety section as well as with the special safety instructions listed under the other main sections. All legal and corporate safety instructions have to be obeyed.

2.1 Safety symbols in this operating manual

Please comply not only with the general safety instructions listed below, but also with specific safety instructions mentioned in the following chapters.

Non respect of the safety instructions marked with the following signs represents danger to *people*:

Danger symbol	High voltage symbol
	
Safety symbol according to DIN 4844 – W9	Safety symbol according to DIN 4844 – W8

Non compliance with the safety instructions marked with the following sign:

Warning

represents a risk of damage to the *micro annular gear pump*.

Operating instructions machined directly on the pump such as the indication of liquid input and output should be followed and kept in a clearly readable condition.

2.2 Staff qualification and training

The staff operating, servicing, inspecting and assembling the pumps must evidence the appropriate qualification for these works. Areas of responsibility and competence as well as monitoring of the staff must be precisely regulated by the decision maker. If the personnel do not have the necessary knowledge, they must be trained and instructed accordingly. If necessary, this can be implemented by the supplier or the manufacturer on behalf of the operator. Furthermore, the operator in charge must ensure that the content of the present manual has been fully understood by the personnel.

2.3 Safety-conscious work

The safety instructions listed in this operating manual, applicable national regulations concerning accident prevention as well as internal work, operation and safety regulations of the operator must be complied with.

2.4 Safety instructions for the operator

The surface temperature of the motor under full load may exceed 60°C. If needed, this surface should be protected on site against contact in order to avoid skin burns.

The drive should be protected against dust, water vapor condensation, humidity, splash water, aggressive gases and liquids. Please provide for adequate air ventilation and thus cooling of the motor.

The micro annular gear pumps mzr-2505, mzr-2905, mzr-4005, mzr-4605, mzr-6305 and mzr-7205 must not be used in areas exposed to explosion risks or in the proximity of inflammable gases and vapors.

Possible leaks of dangerous liquids (for example from the shaft sealing) should be guided away in a way not to represent any danger for the personnel and the environment. The pump should be regularly checked for possible leakage. All legal requirements in this matter should be followed.

The existing protections against contact for the moving parts of the pump (such as for example the coupling) must not be removed during operation.

Take care that all risks resulting from the electric energy are excluded. (For details please refer to the instructions provided by the authorities in charge or your power supplier.)

Warning Please insure, that the totality of the liquid supply accessories such as tubes, hoses, filters etc. are free from dust or dirt particles. Impurities such as metal, plastic or glass particles may impair or damage the pump leading to its failure.

Warning Please, operate the pump with a filter featuring 10 µm or smaller pores. It will protect the pump.

2.5 Safety instructions for maintenance, check and assembly of the pump

As a rule all maintenance work on the device should be performed when the device is at a standstill. The shutdown procedure described in this manual must be followed. Pumps delivering liquids hazardous to health must be decontaminated. Immediately after the work had been completed all safety equipment and protection measures should be applied.

Before starting the operation, please take into notice the instructions listed in the chapter 7.

Warning Should a malfunction of the pump occur, do not dismantle the pump on your own but contact one of HNP Mikrosysteme's service staff for professional assistance.

2.6 Unauthorized pump conversions and spare part manufacture

Conversions or modification to the device are only permitted with prior consent of the manufacturer. Original spare parts and accessories authorized by the manufacturer ensure safety. The use of other parts will annul the liability of the pump manufacturer for any resulting consequences.

2.7 Improper modes of operation

The safety of operation of the delivered device can only be insured by correct use, as described in chapter 1. The limit values given in this manual must not be exceeded in any case.

2.8 General safety instructions

Please observe the following safety instructions

The pump may operate at high pressures. For this reason please use only the delivered accessories and ensure that the employed fittings and tubing have been prescribed and approved for these pressures.

In order to decrease the pressure, provide the system with a *pressure control valve* directing the excess liquid to the storage tank or back to the suction side. In the case of blockage of the pressure side the operating pressure can multiply, this can lead to the damage of downstream components.

At a standstill, the liquid may flow through the pump in the direction of the falling pressure. In order to avoid this unwanted movement, please integrate *non-return valves* (see accessories).

Protect the micro annular gear pump and the electric drive against strokes and shocks.

Under normal working conditions the shaft sealing rings integrated in the pump prevent the liquid from leaking out of the device. The micro annular gear pumps are "technically leak-proof" however not "hermetically sealed" which means it may occur that gases or liquids enter to or escape from the pump.

The allowed operating parameters of the drive should not be exceeded. In particular an *incorrect polarity setting* of the supply voltage may lead to damage of the control unit.

Warning Please insure, that the totality of the liquid supply accessories such as tubes, hoses, filters etc. are free from dust or dirt particles. Impurities such as metal, plastic or glass particles may impair or damage the pump leading to its failure.

Warning Please operate the pump with a filter featuring 10 µm or smaller pores. It will protect the pump.

3 Transport and intermediate storage

3.1 Shipment of the pumps and protection measures

The pumps leaving the factory are secured against corrosion and shocks. The inlets and outlets of the pumps are protected with plastic plugs in order to prevent any foreign bodies from penetrating into the device.

3.2 Transport

In order to avoid any damage related to transport, the package must be protected against shocks. HNP Mikrosysteme guarantees, that all goods leave the factory in the best condition. Any noticed damage should be reported to the concerned forwarding agent, authorized dealer or to HNP Mikrosysteme, as manufacturer.

3.3 Intermediate storage

Following points concerning pump storage should be observed:

- Necessary conservation procedure (see also chapter 7.4.1)
- The protective plugs must be left screwed in
- The pump should not be stored in humid places
- For storage temperature - refer to chapter 1.3 of the present manual

4 Description of the micro annular gear pump

4.1 Operating principle of the micro annular gear pump

Micro annular gear pumps are positive displacement pumps. They contain two rotors, bearing slightly eccentrically to each other; an externally toothed internal rotor and an annular, internally toothed external rotor (see figure 23). Due to their cycloid indenting, the rotors remain interlocked at any time, forming during rotation a system of several sealed pumping chambers. As the rotors revolve around their offset axis, the pumping chambers increase on the induction (suction) side and simultaneously decrease on the delivery side of the pump (see figure 24). A homogenous flow is generated between the kidney-like inlet and outlet.

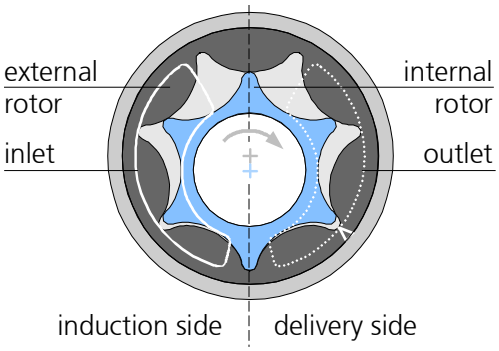


figure 23 Principle of the micro annular gear pump

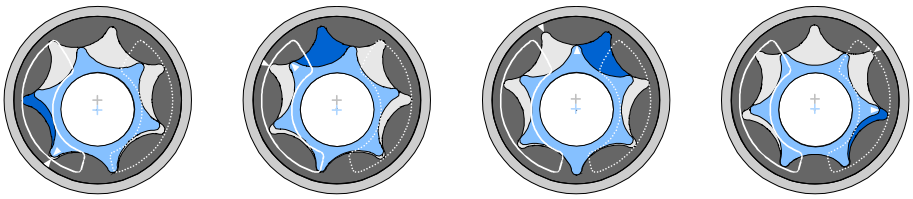


figure 24 Operating principle of the micro annular gear pump

In the case of rotary displacement pumps, the delivered amount of liquid may be easily calculated form the displacement volume V_g of the pump and the number of revolutions of the rotor n. Displacement volume stands for the volume of liquid that is moved within one revolution of the rotor. This relationship is illustrated by the following formula:

$$Q = \eta_{Vol} \cdot V_g \cdot n$$

The volumetric efficiency η_{Vol} shows the relationship between the actual and the theoretical flow rate. The existing differences result from internal movement of the liquid during the operation.

Example: According to the formula mentioned above the mzr-7205 pump featuring a displacement volume of 48 µl delivers at 3000 rpm and with a volumetric efficiency of 100% 144 ml/min. The table 15 shows theoretical flow rate values depending on speed expressed in ml/min and ml/h.

Rotation speed	**mzr-2505**		**mzr-2905**		**mzr-4605**	
[rpm]	**Q** [ml/min]	**Q** [ml/h]	**Q** [ml/min]	**Q** [ml/h]	**Q** [ml/min]	**Q** [ml/h]
500	0,75	45	1,5	90	3	180
1000	1,5	90	3	180	6	360
2000	3	180	6	360	12	720
3000	4,5	270	9	540	18	1080
4000	6	360	12	720	24	1440
5000	7,5	450	15	900	30	1800
6000	9	540	18	1080	36	2160

table 15 Theoretical flow rate of the micro annular gear pumps mzr-2505, mzr-2905, mzr-4005

Rotation speed	**mzr-4605**		**mzr-6305**		**mzr-7205**	
[rpm]	**Q** [ml/min]	**Q** [ml/h]	**Q** [ml/min]	**Q** [ml/h]	**Q** [ml/min]	**Q** [ml/h]
500	6	360	12	720	24	1440
1000	12	720	24	1440	48	2880
2000	24	1440	48	2880	96	5760
3000	36	2160	72	4320	144	8640
4000	72	2880	96	5760	192	11520
5000	60	3600	120	7200	240	14400
6000	72	4320	144	8640	288	17280

table 16 Theoretical flow rate of the micro annular gear pumps mzr-4605, mzr-6305, mzr-7205

Pressure generated by the pump is determined by the configuration of the fluid delivery system and results from both the hydraulic pressure and the hydraulic resistance (tubing, narrow passes etc.). The *volumetric efficiency* of a pump decreases when the differential pressure rises.

The *viscosity* of the manipulated liquid has an important impact on the volumetric efficiency. The volumetric efficiency increases for higher viscosity values because the *internal leakage* values go down.

Cavitation is an effect which, starting form a certain limit speed value, may reduce the volumetric efficiency of a pump. In the case of highly viscous liquids this limit speed value is lower. That happens because of the liquid-specific drop of vapor pressure in the suction tube which leads to gas formation inside the pump.

The particularity of the mzr-pumps is their highly precise construction, which provides for both high operating pressures and a high dosage precision. The gap between both rotors and between the rotors and the adjacent case parts lies in the range of a few micrometers. This precision is the key factor enabling to achieve volumetric efficiency close to 100%.

4.2 Construction

The micro annular gear pump is composed of the pump head, the coupling unit, the drive and the angle support (see figure 25).

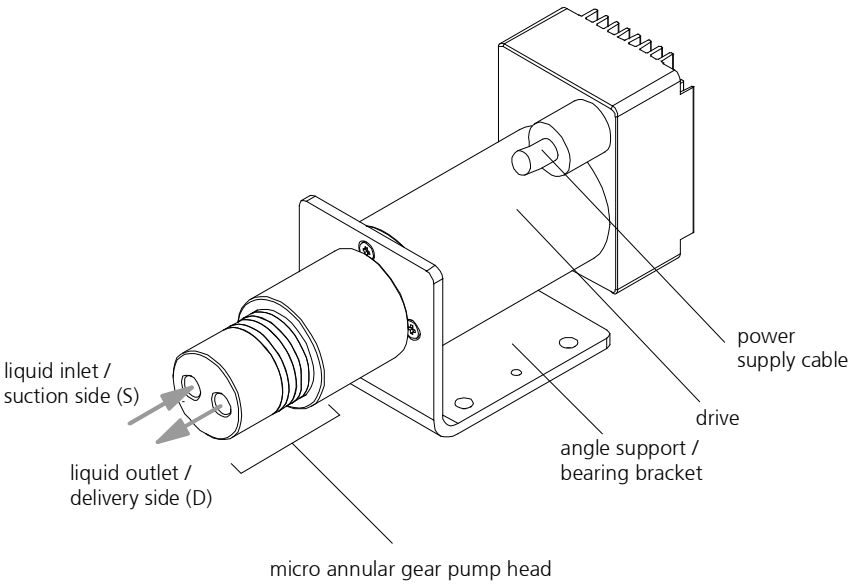


figure 25 Construction of the micro annular gear pump

4.3 Construction materials

Wetted parts	mzr-2505, mzr-2905, mzr-4005, mzr-4605	mzr-6305, mzr-7205
Pump housing	stainless steel 316 L (1.4404, 1.4435)	stainless steel 316 L (1.4404, 1.4435)
Rotors, shaft, bearing	tungsten carbide Ni-based	tungsten carbide Ni-based
Shaft sealing	graphite-reinforced PTFE, 316L spring	graphite-reinforced PTFE, 316L spring
Static sealing	FKM, optional: EPDM, FFKM	FKM, optional: EPDM, FFKM

table 17 Construction materials of the wetted parts

The resistance of the construction materials to the delivered liquids should be verified by the operator for each individual application. Pumps handling non-lubricating liquids have shorter service lives.

4.4 Liquid supply

	mzr-2505, mzr-2905, mzr-4005, mzr-4605	**mzr-6305, mzr-7205**
Liquid inlet/outlet	- 1/4"–28 UNF internal thread, frontal - 1/8" NPT internal thread, lateral (S) 1/4"–28 UNF internal thread, frontal (D) - G1/8" internal thread, lateral	- 1/8" NPT internal thread, lateral - 1/8" NPT internal thread, frontal - G1/8" internal thread, lateral
Tubing	OD 1/8" plastic tubes or stainless steel tubes (optional outer diameter 1/16")	tube/hose OD 6 mm

table 18 Liquid supply

The suction side is indicated with the letter »S« the delivery side with the letter »D«. An arrow in the front of the pump indicates the operating direction of the shaft.

In order to prevent foreign bodies from penetrating into the pump, the liquid inlet and outlet are protected with plastic plugs or screws. Please remove them before you assembly the pump.

5 Optional modules

The spectrum of applications of the high performance micro annular gear pump series may be expanded by using different additional modules. The modules allow for special applications, which could otherwise not be accomplished with a standard pump version. The modules may be combined with each other and with almost all available pump heads and motor versions.

- *Fluidic seal module* prevents possible chemical reactions between the delivered liquid and the surrounding environment
- *Thermal insulation module* extends the operating temperature range of the pump by protecting the motor from overheating
- *Heating module* enables to regulate the temperature of the fluid-containing parts of the pump
- *Gear box module* increases the torque of the drive allowing to deliver high viscosity liquids and provides for a constant operation of the motor at low speeds.
- *Gas-tight sealed* version: almost hermetically sealed pump, delivered as standard with the high performance mzr-pumps

The configuration of a given pump version should in each case be discussed with consideration to the specific requirements of the application. *Additional* customized modules may be designed on demand.

5.1 Fluidic seal module

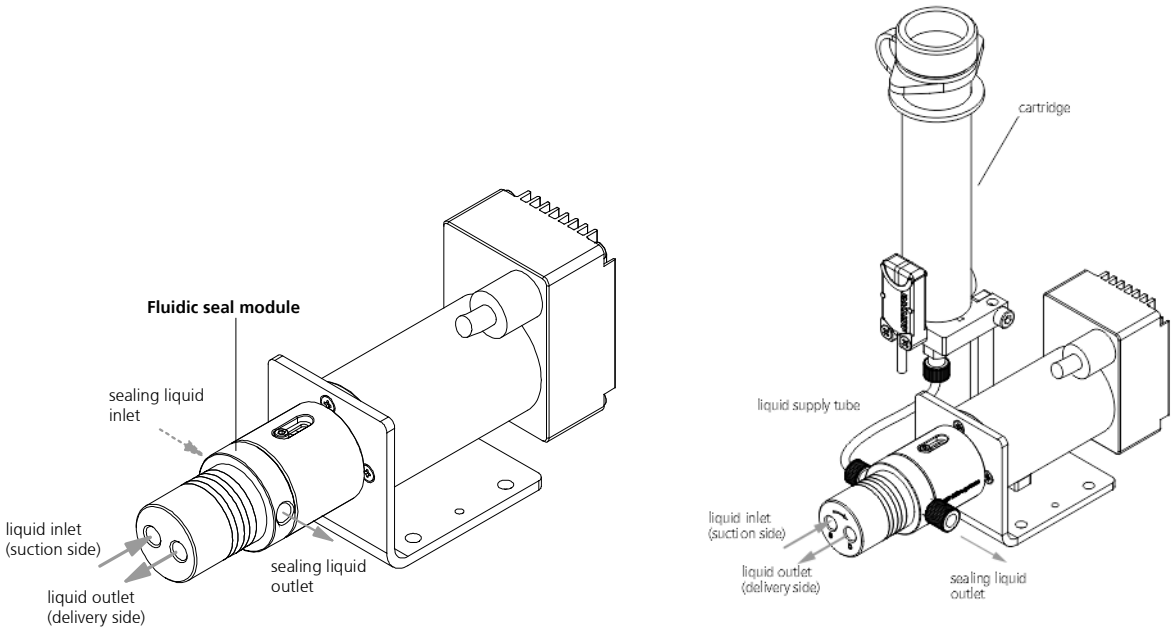


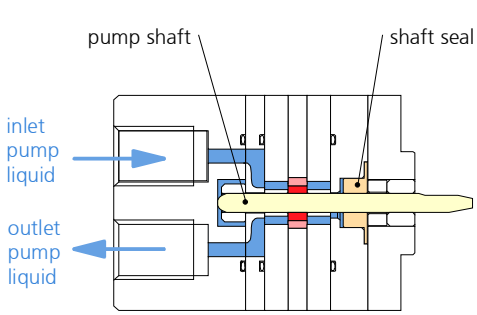
figure 26 Layout of the micro annular gear pump with the fluidic seal module, example of mzr-4605 +S (the layout on the right: with optional reservoir plastic and level sensor)

The role of the fluidic seal module is to prevent moisture and oxygen in the surrounding atmosphere from penetrating into the pump. This eliminates the risk of unwanted chemical reaction between the atmospheric gases and the handled liquid (such as for example the crystallization reaction). The module limits at the same time the possibility for the manipulated liquids to escape from the pump.

The function of the fluidic seal module

The shaft seal of pumps from the high performance series is technically tight. However, there is a liquid film between the surface of the shaft and the lip of the shaft seal. Here surrounding atmosphere is in contact with the liquid which might lead to crystallization due to solvent evaporation or precipitation due to reaction of dissolved matter with Oxygen or water. Both might lead to enhanced wear of the shaft seal. The fluidic seal module is to avoid this.

With the fluidic seal module, a second sealing is added to the existing shaft sealing. A cylindrical chamber with input and output openings on opposite sides is located between the two seals (see figure 27). When the chamber is filled with an appropriate sealing liquid, the manipulated liquid does not enter into contact with water vapor and oxygen, but dilutes at a small ratio in the sealing liquid. The dilution ratio depends on the existing pressure relations and drops with increasing viscosity.



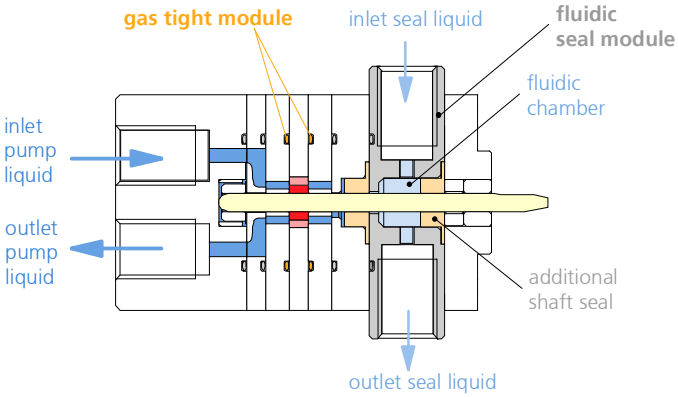


figure 27 Pump head without the fluidic seal module Pump head with the fluidic seal module

Pump operation with the fluidic seal module

Only liquids compatible with the delivered liquid may be used as sealing liquids. That means no liquids that could possibly react with the delivered liquid should be employed. The composition of the sealing liquid shall be defined by the operator.

While filling up the fluidic seal chamber a particular attention should be paid to proper venting of the chamber through the two openings featuring a 1/4 - 28 UNF thread. These openings are slightly shifted downwards and upwards to facilitate the degassing of the sealing chamber (see figure 34). The chamber is filled through the bottom opening. The sealing liquid should be filled in so long, till it flows free of air bubbles out of the top opening.

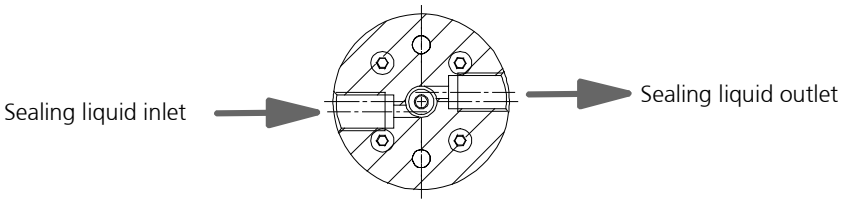


figure 28 Sectional view of the fluidic seal module

A cartridge may be used to supply the sealing liquid to the chamber (see

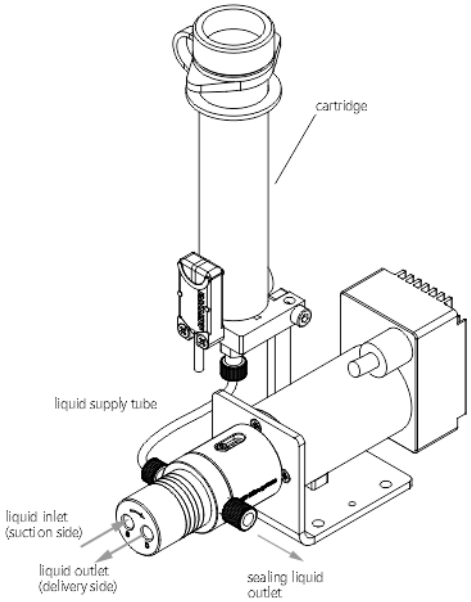


figure 26). In special cases compressed air may be applied to the sealing liquid in order to enhance the sealing function. The sealing chamber may be flushed.

⚠ Make sure that enough sealing liquid is supplied to the fluidic seal chamber in order to prevent any penetration of air and water vapor to the module.

⚠ If the fluidic seal chamber is empty, the pump should immediately be stopped. Dry operation may lead to shaft seal damage.

In case the pump is not installed in the standard way (pump name read horizontally), it is possible to shift the outlet and inlet openings of the pump. However an appropriate supply of the sealing liquid should still be ensured and all presence of air bubbles within the fluidic seal chamber should be avoided.

5.1.1 Reservoir Plastic

The reservoir plastic is an additional module for mzr®-pumps with a fluidic seal module. It is used to store the sealing liquid and supplies the fluidic seal chamber between the two shaft seals of the mzr®-pump with sealing liquid. Depending on the application, cartridge sizes of 3, 5, 30 and 55 ml can be selected (see figure 29).

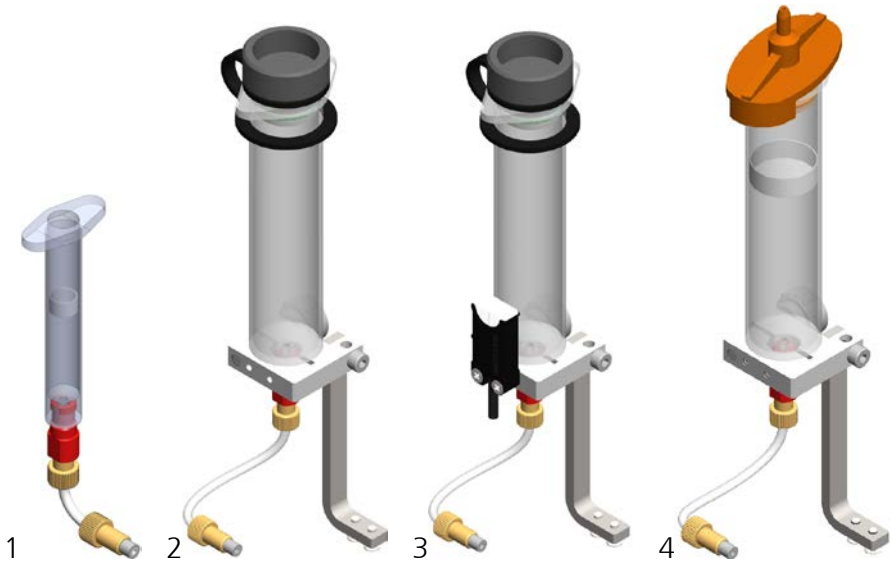


figure 29 Reservoir plastic, 1: 3 ml, 2: 30 ml, 3: with level sensor, 4: with compressed air adapter

A capacitive level sensor is available for the reservoir plastic from 30 ml cartridge capacity. This can be used to monitor the cartridge fill level. For increased requirements, the system can be pressurized and flushed.

Mounting examples

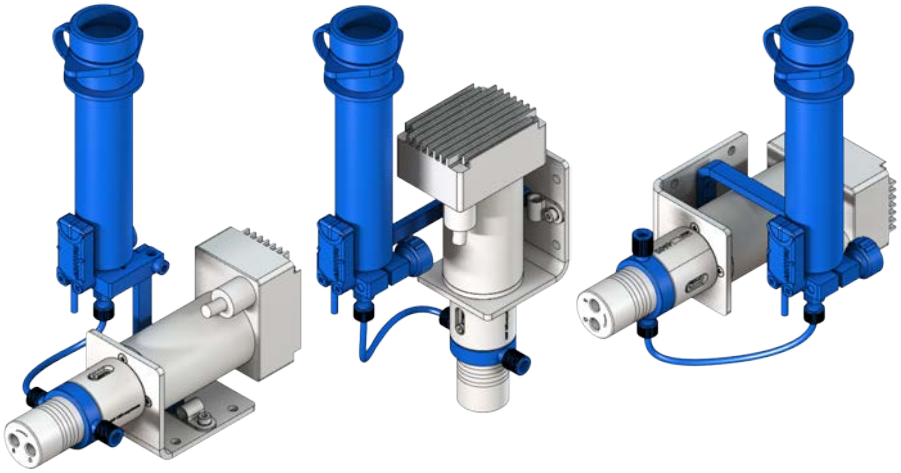


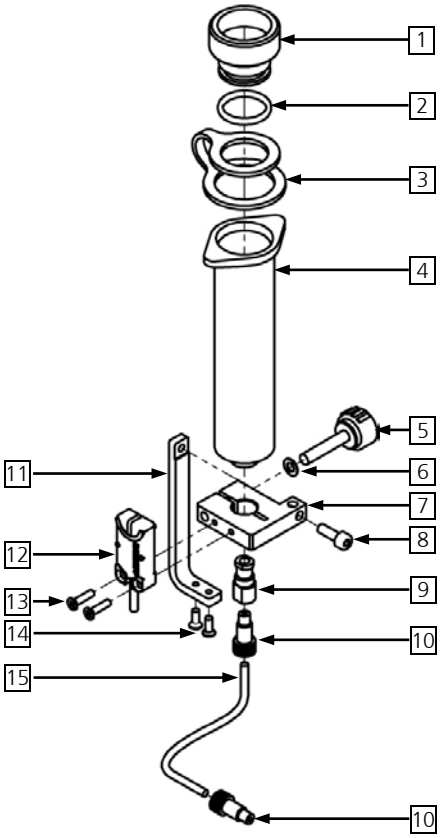
figure 30 Micro annular gear pump mzr-4605 with fluidic seal module (layout with reservoir plastic 30 ml and additional optional level sensor)

figure 31 Wall mounting reservoir plastic 30 ml

Depending on the installation position of the mzr®-pump, the position of the cartridge holder 7 can be adjusted (see figure 31). To do this, remove the cap screw 8 from the cartridge holder 7 and mount it as shown in the examples.

The support arm 11 and the screws 14 are not required for wall mounting.

Reservoir plastic 30 ml



Nr.	Bezeichnung
1	Sealing cap pressureless, O-ring choosable
2	O-ring (FPM / FFPM / EPDM)
3	Bracket sealing cap
4	Cartridge 30 ml
5	Knurled screw M5x25
6	Washer Ø4,3 DIN 433
7	Cartridge holder
8	Cap screw M4x12 DIN 912 A2
9	Adapter Luer-Lock
10	Fitting 1/4"-28 UNF, lock ring, ferrule (2x)
11	Support arm
12	Level sensor (optional)
13	Screw M3x12 DIN965 A2 (2x) for level sensor (optional)
14	Flat head screw M3x8 DIN 7991 A2 (2x) for angle support mzr®-pump
15	Liquid supply hose 1/8"

figure 32 Reservoir plastic with 30 ml cartridge and level sensor (exploded view)

Mounting the reservoir plastic on the mzr®-pump

The reservoir plastic is delivered pre-assembled. It can be mounted rigidly on the angle support of the mzr® pump by means of the support arm 11 and the screws 14 (see figure 32). To do this, insert the two screws from the underside into the angle support of the pump and screw them into the support arm 11. Alternatively, a wall-mounting of the cartridge holder 7 is possible, as shown in figure 32.

The cartridge of the reservoir plastic must be installed above the pump such that the liquid can flow down.

Mounting the liquid supply hose

1. Shorten the hose 15 to the required length. Preferably use a hose cutter for the 90° angle.
2. Push the fitting 10 onto the hose 15 and place the lock ring with the chamfer towards the end of hose (see figure 32).
3. Push the ferrule onto the hose such that the end of the hose and the flat side of the ferrule are flush.
4. Remove the lower screw plug from the fluidic seal module of the mzr® pump (see figure 28).
5. Screw the threaded part, prepared in this way, tightly into the fluidic seal inlet of the mzr® pump. During assembly, make sure that the connection is compressed by screwing in.

Mounting the level sensor (additional module)

The sensor is mounted with screws 13 on the cartridge holder, as shown in figure 32. This is to be mounted and electrically connected according to the enclosed data sheet. Detailed operating instructions for the sensor BCS012U are available on the Internet at www.balluff.com.

Commissioning of the reservoir plastic

Before commissioning, the compatibility of the sealing medium with the process medium to be pumped must be checked.

The pump operator must verify the compatibility of the wetted parts material with the liquids to be handled.

1. Remove the sealing cap [1] from cartridge [4].
2. Fill cartridge with sealing liquid
3. Close cartridge tightly

⚠ The sealing cap [1] has a lateral opening for the supply of air flow.

4. Remove the upper sealing cap from the fluidic seal module carefully and ventilate the fluidic seal chamber until sealing liquid comes out the sealing outlet. Following, tighten the sealing cap again.

⚠ Sealing liquid flows out.

5. Check tightness of the system.
6. When using the level sensor, the detection of the sealing liquid must be tested before commissioning.

The fluidic seal module of the mzr®-pump is now ready for operation.

5.1.2 Reservoir Plastic 3 ml

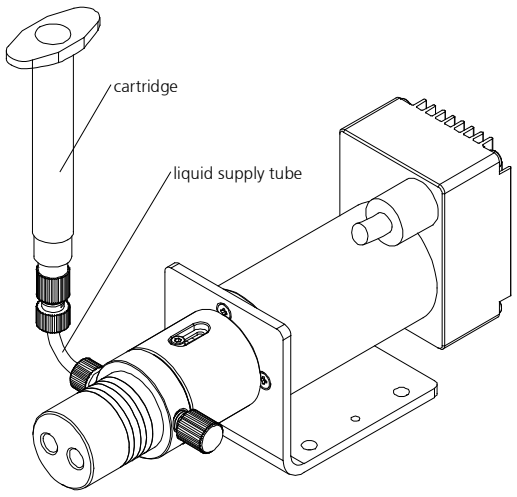


figure 33 Layout of the micro annular gear pump with the fluidic seal module, example of mzr-4605 (layout with reservoir plastic 3 ml)

Use of the fluidic seal accessories

The fluidic seal set is mounted at the bottom inlet (see figure 28).

During assembly it is important to check if the ferrule is tightly attached to the tube and that the tube is tightly screwed to the inlet of the fluidic chamber.

figure 34 Assembly of the reservoir plastic 3 ml

Reservoir stainless steel 5 ml

Stainless steel liquid supply set is available on request. The use is the same as with the standard version. The liquid supply is done by a glass syringe.

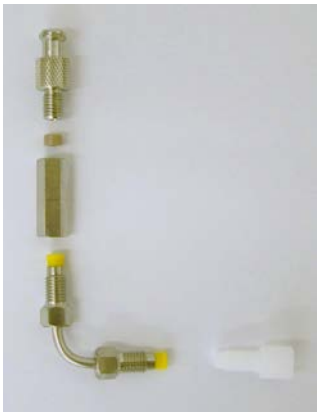


figure 35 Assembly of the reservoir stainless steel

5.2 Heat insulation module

The heat insulation module enables to deliver hot liquids up to temperatures of 150° C (302 °F). It comprises thermally insulating coupling components made of plastic (PEEK) located between the pump and the drive. The drive should not be exposed to overheating. For this reason, the heat transfer from the pump to the drive should be limited. An additional thermal barrier is provided by the

plastic motor housing. If the surrounding temperature rises, the pump is working over a longer period or the manipulated liquid features a high temperature, convection cooling of the motor is recommended.

5.3 Heating module

5.3.1 Electric heating module

The electric heating module enables active heating of the pump head up to 150° C (302 °F) operating temperature. The heating module consists of a heating jacket covering the pump head and a thermal element type J. Depending on the pump size, the thermal element will be integrated on the pump head in different ways. In order to adjust the temperature of the pump head, an additional heat regulating device may be delivered.

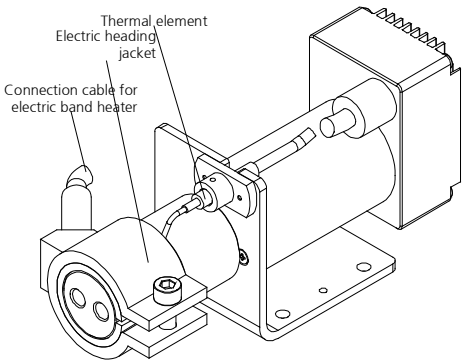


figure 36 Micro annular gear pump mzr-2905 with the electric heating module

⚠ Before connecting the heating jacket and the thermal element to the power supply, please observe the following technical data.

Thermal element	
Type	MT-1.5
Thermal element	Type J (Fe-CuNi IEC 584) alternativ: Type L (Fe-CuNi DIN 43710)
Temperature measuring range	0 to 400 °C
Diameter of the sensing device	1.5 mm
Material	V4A (1.4541)

Heating jacket	**mzr-2505/2905 mzr-4005/4605**	**mzr-6305/7205**
Voltage	230 VAC	230 VAC
Power output	80 W	120 W / 150 W
Diameter	28 mm	35 mm
Width	25 mm	20 mm / 25 mm

table 19 Technical data of the electric heating module

5.3.2 Fluidic heating- and cooling module

The fluidic heating and cooling module permits active heating or cooling of the pump head in the operating temperature range from -20 °C (-4 °F) to a maximum of 150 °C (302 °F). The module consists of a double casing covering the pump head and a thermoelectric couple type J, whose mode of integration varies depending on the pump size. Oil, water, superheated steam or adapted cooling liquids may be used as thermal liquids. If you are not sure, which heat transfer liquid is the best adapted in your case, HNP Mikrosysteme will help you find the suitable one. The thermal liquid ports 2 x G1/8" are displaced by 45°. The inlet for the heat transfer liquid is situated at the back (beveled) and the outlet is in the front (see figure 37).

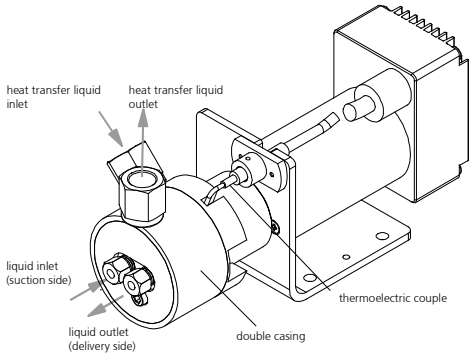


figure 37 Micro annular gear pump with integrated fluidic heating- and cooling module (example of mzr-2905)

⚠ This heating module is not certified for use in areas exposed to explosion hazards!

⚠ Before connecting the liquid supply, please observe the following technical data! The maximal pressure of the heat transfer liquid should not exceed 20 bar.

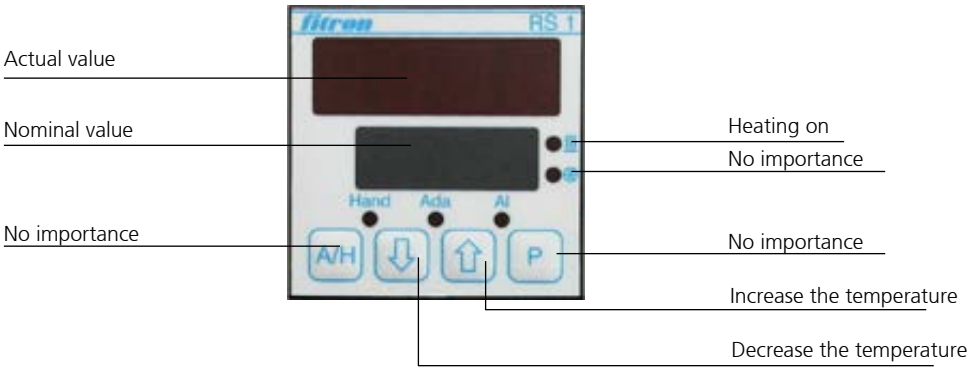
Thermal element	
Type	MT-1.5
Thermal element	Type L (Fe-CuNi DIN 43710)
Temperature measuring range	0 to 400 °C
Diameter of the sensing device	1.5 mm
Material	1.4541

Double jacket	**mzr-2505/2905**	**mzr-4005/4605**	**mzr-6305/7205**
Length	34.25 mm	37.0 mm	45.5 mm
Diameter	42.5 mm	42.5 mm	48.3 mm
Double jacket material	stainless steel 316L	stainless steel 316L	stainless steel 316L
Inlet	2xG1/8“ (45° distance)	2xG1/8“ (45° distance)	2xG1/8“ (45° distance)
Operating temperature range	-20 to 150 °C	-20 to 150 °C	-20 to 150 °C
Max. pressure	max. 20 bar	max. 20 bar	max. 20 bar
Flow rate	max. 0.5 l/min	max. 0.5 l/min	max. 0.5 l/min

table 20 Technical data of the heating and cooling module

5.4 Heating device „*JET*micro“

The heating device „*JET*micro“ has been designed for use with the electric heating module (see chapter 5.3.1).



Hand: Blinks during temperature set in the manual input mode

Ada: Ada display blinks during the automatic control adjustment

AL: Alarm display – not configured, no importance

Actual value display:

OPEN = sensor failure

cLLo = sensor reverse polarity

With ⇩ or ⇧ the nominal temperature may be set.

Power supply

90-230 VAC, Shock-proof plug, 2 m long

Electrical connection

10-pole bush insert, 16 A/250 V

	Heating		Sensor	
	L	N	+	-
Zone 1	1	6	2	7

table 21 Pin configuration of the heating device

5-pole bush insert, 16 A/250 V

	Heating			Sensor	
	L	N	PE	+	-
Zone 1 and 2	3	4	PE	1	2

table 22 Pin configuration of the heating device

5.5 Gear box module

The gear box module enables to increase the torque of the drive in order to deliver high viscosity liquids or to handle liquids at high differential pressure. The gear box module is available with a 3.71 : 1 and 14 : 1 reductions for the pump types mzr-4605 and mzr-7205. The micro annular gear pump with the gear box module is longer of about 30 mm. The position of the controller housing to the pump head may be shifted at about ± 10° depending on the pump head.

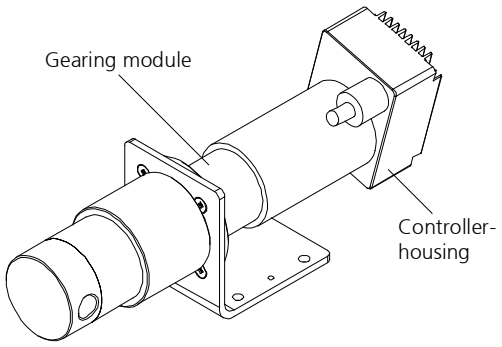


figure 38 mzr-7205 with the gear box module

Please take into notice that for the micro annular gear pump with the gear box module the power supply should be specifically set (see chapter 1.10)

Please take into notice that the operating temperature range is changed from -20 °C (-4 °F) to a maximum of 120 °C (248 °F), if the gear box module and the heating module are combined.

5.6 Gas-tight seal module

Under normal operating conditions the sealing rings employed in the construction of the micro annular gear pump prevent the liquid from escaping out of the pump. The micro annular gear pumps are "technically tight" but not hermetically sealed, which means, it may occur that gases or liquids enter into or escape from the pump. In the case of a gas-tight version, the pump housing is sealed with supplementary rings.

Used together with the gas-tight seal module and the fluidic seal module the pumps are almost perfectly hermetic.

Up from March 2006 all micro annular gear pumps are delivered in a gas-tight version as a standard.

6 System integration

6.1 Check before the first assembly

Inspect the pumps for potential damage during the shipment (see chapter 3.2).

Please check, if the right pump type has been delivered, as according to the following points:

- Compatibility with the delivered liquid
- Viscosity range
- Pump performance (displacement volume, dosage volumes, operating pressures)
- Operating temperature range

If you notice any difference between the required and the delivered pump type, please contact HNP Mikrosysteme. Do not put the pump into operation without prior approval.

6.2 Mounting of the micro annular gear pump

The micro annular gear pump is mounted on an angle support with M4 screws. The favored mounting position of the micro annular gear pump is horizontal. However, if the pump has to be operated vertically, the motor must be located above the pump head in order to prevent the liquid from entering into the motor.

Warning

Install the pump in such a way that in case of failure no liquid can enter the motor or controller.

Take precautions that in case of leakage no surrounding objects or environment will be damaged.

Install the micro annular gear pump only in places that fulfill the required conditions for safe pump operation.

The motor must be protected against humidity, dust or sweat.

6.3 General instructions for the assembly of the liquid supply network

Please always cut the tubing at a right angle with an adapted hose cutter. If metal tubes are used, an intensive cleansing procedure will be necessary. After machining the tubing has to be cleansed and flushed throughoutly. The smallest piece of swarf within the liquid delivery system may cause failure of the micro annular gear pump.

Please note that correct integration of the tubing with the pump head is a necessary condition to ensure the right direction of flow. If you wish to operate the pump in a reverse direction, please contact HNP Mikrosysteme, since it is not possible in every case.

In order to protect the interior of the pump from pollution, the pump heads are delivered with protective plugs. They should be put on when the pump is at a standstill.

For the best performance the suction tube should be as short as possible and have a large internal diameter.

Warning

In most cases the pump should be operated with a filter featuring pores that do not exceed 10 µm. The filter protects the pump from particles and dirt.

6.4 Assembly instruction for tubing and accessories for mzr-2505, mzr-2905 and mzr-4605

The micro annular gear pump head is available in three connection variants - with frontal (F), with lateral (S) and frontal, -lateral (S/F) connections. Details on the dimensions and connection threads can be found in paragraphs 1.4 to 1.7. When using a heating module, only the frontal (F) connection variant can be used for the pump head.

Frontal fluid connection 1/4"-28 UNF

The fluid connection fittings feature standardized plastic tubing or stainless steel tubing with an outer diameter of 1/16" (1.588 mm), 1/8" (3.175 mm). The fluid connection fittings consist of a threaded part, a lock ring and a ferrule. The seal effect is obtained by the plane ending of the ferrule and the tube. The threaded part assures the required pressing force.

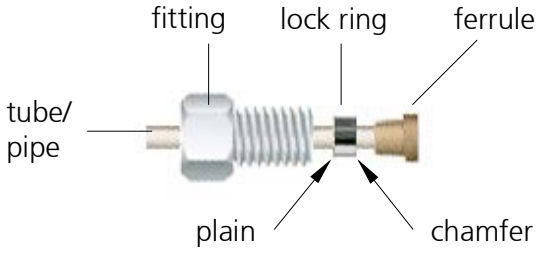


figure 39 Fluid connection fitting 1/4"-28 UNF, stainless steel

1. Cut the tube with a hose cutter to the 90° angle. Metal tubing, that produce swarf during cutting must be thoroughly cleansed and flushed. Even smallest swarf in the delivery system may cause failure of the micro annular gear pump.

2. Slide the fitting on the hose or tube.

3. Slide on the lock ring, chamfer towards the end of the hose or tube.

4. The ferrule should be stuck on the hose or tube in a way that the end of the tubing and the ferrule fit tightly together. The conical part of the ferrule should be directed towards the thread.

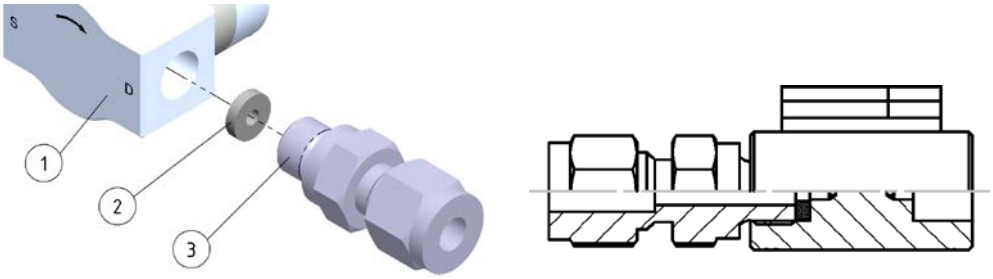
5. Put the hose or tube with the ferrule into the liquid supply ports of the micro annular gear pump. Hold the tube or hose firmly and screw in the threaded part. Retighten the stainless steel threads with a wrench by turning it about 1-1½ times. It is important that during this operation the tube remains pressed against the bottom of the liquid supply port.

6. To avoid dry operation of the device, provide liquid supply.

Warning

Prolonged dry operation of the micro annular gear pump may damage the bearing and the sealing. However, a short dry working phase at the beginning of the operation is harmless.

Lateral fluid connection G 1/8”



① Pump head
② Gasket PEEK™
③ Fluid connection G 1/8"

figure 40 Fluid connection G 1/8"

1. Insert the gasket ② into the bottom of the G 1/8" thread of the pump head ①.

2. Screw the fluid connection G 1/8"③ into the thread hand-tight, as shown in figure 32 (right).

3. Then hold the pump head by the spanner flats with a spanner AF 17 and tighten the fluid connection by a quarter turn (90°). This corresponds to a torque of approx. 12 to 15 Nm to achieve the complete sealing effect of the PEEK gasket.

With re-use, the gasket can be permanently deformed to such an extent that it is jammed into the internal thread. We therefore recommend the single use of the gasket.

Warning To avoid damaging the micro annular gear pump, it is essential to hold the pump head itself by the provided spanner flats AF 17 while tightening the screw connection.

Warning Dry running of your micro annular gear pump can damage the bearing and the seal in particular. A short dry-running phase during commissioning of the pump is harmless.

6.5 Assembly of the fluid connection fittings for mzr-6305 / mzr-7205

The micro annular gear pumps mzr-6305 and mzr-7205 is available in two versions. The liquid supply openings may be lateral or front with a 1/8" NPT thread screw. Pump heads equipped with the heating module are available with front liquid ports only.

Alternative we can deliver the front fluid supply connection M10x1 or M12x1.

Lateral screw connection 1/8" NPT

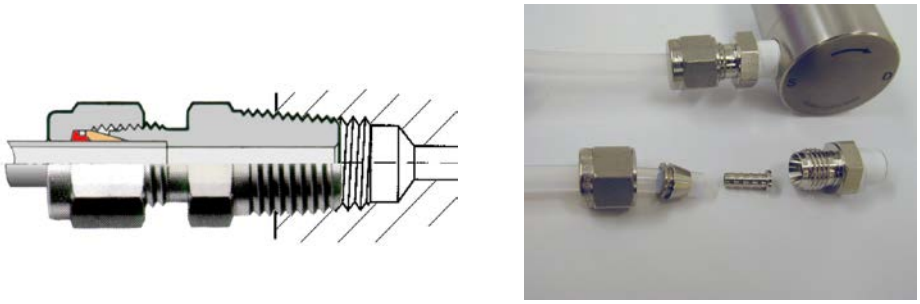
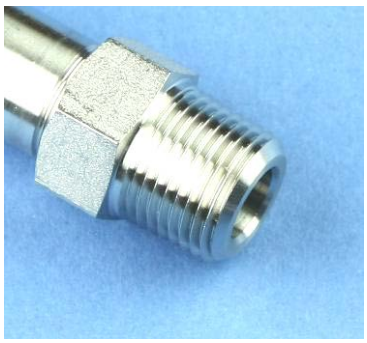


figure 41 Fluid connection fitting 1/8" NPT, stainless steel

1. The thread of the fitting should be wrapped with 2-3 layers of PTFE tape and screwed in the NPT thread (see table 23). First manually, then tightened with ½ to ¾ wrench turns.



Clean the internal and external screw threads leaving no residues.

Make sure the internal and external screw threads are not dented or deformed.

Wrap the PTFE tape around the screw thread clockwise beginning with the second pitch of screw thread..

The PTFE tape should be wrapped tightly around the screw thread approx. 3 - 4 times.

Cut the PTFE tape off and wind the end of the tape tightly around the screw thread.

The PTFE tape should not stick out over screw thread because pieces can be cut off and get into the system.

table 23 Use of PTFE Tape

2. Cut the tube or hose to the right angle with an adapted hose cutter. Metal tubing, that produces swarf during cutting must be throughoutly cleansed and flushed. The smallest piece of swarf in the liquid delivery system may cause failure of the micro annular gear pump.

3. Screw the tube or hose (the latter always with a support tube) in the fluid inlet/outlet port of the pump first manually then tighten it with 1¼ wrench turns. During this operation use a second wrench to hold the hose against the bottom of the inlet/outlet port.

4. In order to avoid dry operation, provide for a sufficient liquid supply before each use.

Front fluid supply connection M10x1

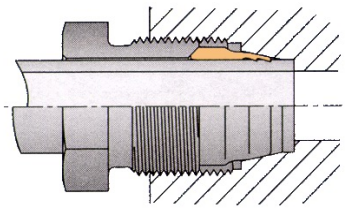


figure 42 Fluid connection fitting M10x1, stainless steel

1. Cut the tube or hose to the right angle with an adapted hose cutter. Metal tubing, that produces swarf during cutting must be throughoutly cleansed and flushed. The smallest piece of swarf in the delivery system may cause failure of the micro annular gear pump.

2. Slide the pressure screw on the tube (the latter always with a metal support tube).

3. Slide on the clamping ring, bevel towards the end of the tube or hose.

4. Screw the tube or hose (the latter always with a metal support tube) in the liquid supply port first manually then tighten it with 1¼ wrench turns

5. In order to avoid dry operation, check before each use that enough liquid is supplied to the pump.

Warning Dry operation of the micro annular gear pump may damage in particular the bearing and the sealing. However, a short dry working phase at the beginning of the operation is harmless.

6.6 Filter selection and use

In majority of cases it is recommended to integrate a filter on the suction side of the micro annular gear pump to ensure its secure operation. The recommended filter pores or mesh size should not exceed 10 µm. The penetration of particles or swarf that could cause a blockage or damage to the pump can only be avoided by using an adapted filter.

HNP Mikrosysteme offers a choice of standard filters covering a broad spectrum of applications. You may count on our assistance for the selection of the most suitable one.

In order to select the best adapted filter, such operating parameters as flow rate, viscosity and degree of pollution of the liquid will be needed. An increase in at least one of the mentioned terms will require the use of a bigger filtering element or the pressurization of the delivered liquid. In case no suitable filter for high viscosity liquid can be found, it is possible to use a filter with slightly larger pore size. Prior discussion with HNP Mikrosysteme is here recommended. A filter with larger pores is still better than no filter at all. Alternatively an already filtered liquid may be used.

Warning Because filters have a large internal volume, it is recommended to fill in the filter and the suction tube with already filtered liquid in order to avoid a longer dry operation of the pump during the startup.

Warning Please control regularly the filtering elements for pollution. Cleanse regularly the filter or replace it with a new one. A polluted filter may considerably decrease the volumetric efficiency of a pump. Furthermore, because of the cavitation effects dosage imprecision and even pump damage may occur.

Warning A too small filter (too little filtering surface) may considerably decrease the volumetric efficiency of the micro annular gear pump. What is more, because of the cavitation effects dosage imprecision and even pump damage may occur.

6.7 Connection of the micro annular gear pump to the power supply

In order to operate the pump a supplementary source of 24 VDC will be required. The ampacity of the voltage source should amount to around 3 A for the micro annular pumps mzr-2505, mzr-2905 and mzr-4605 and 5 A for the mzr-6305 and mzr-7205.

The micro annular gear pump is connected via the Terminal Box S-G05. This enables an easy startup of the pump due to:

- the possibility to connect the voltage supply with the delivered plug connector J1
- alternative voltage supply via a DIN connector conform with DIN 45323
- separable pump connection "mzr-pump"
- speed set via potentiometer
- analog voltage input 0-10 V and 0 (4)-20 mA for speed control
- change of speed setting mode with a DIP-switch
- 9-pole connection plug for the RS-232 interface
- error output programmable also as trigger input or frequency output
- digital input with a screw connection
- possibility of installation on a 35 mm top hat rail

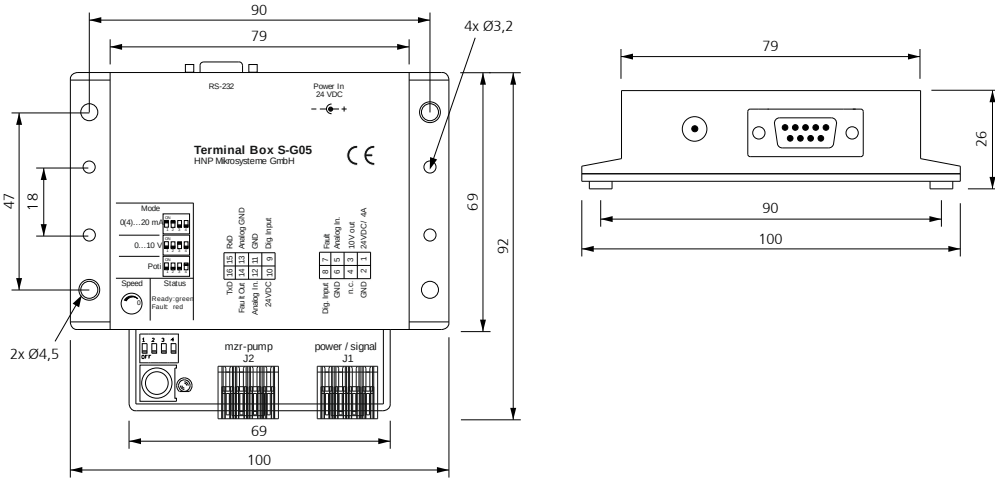


figure 43 Measurements of the Terminal Box S-G05

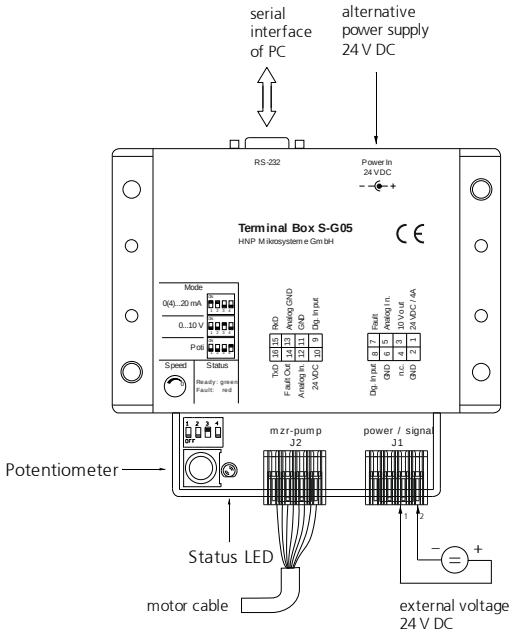


figure 44 Connection of the micro annular gear pump to the power supply

Connector J1 Pin	Function	Labeling Terminal Box
1	Voltage supply	24 VDC / 4 A
2	Ground	GND
3	10 V output voltage	10 V Out
4	not used	n.c.
5	Analog input	Analog In
6	Ground	GND
7	Fault output	Fault
8	Digital Input	Dig. Input

table 24 Connector J1 "power / signal" pin assignment of Terminal Box S-G05

Connnector J2 Pin	Function	Wire	Labeling Terminal Box
9	Digital Input	red	Dig. Input
10	Voltage supply	pink	24VDC
11	Ground	blue	GND
12	Analog input	brown	Analog In
13	Ground analog input	grey	Analog GND
14	Fault output	white	Fault Out
15	RS-232 interface signal reception	yellow	RxD
16	RS-232 interface signal transmission	green	TxD

table 25 Connector J2 " mzr-pump" pin assignment configuration between the motor and terminal box S-G05

Installation of the cable wires
– tool: screwdriver blade 2.5 x 0.4 mm
– open the spring clamp with the screwdriver through the side slot
– cable in cable opening place (cable can be used with or without ferrule)
– remove the screwdriver

figure 45 Installation of cable wires in the connectors

LED Status	Definition
green	Power supply to the controller is active, no error
red	Motor error (current limitation or pump blocked)

table 26 LED for status indication

The operating speed of the micro annular gear pump may be set with:

– the potentiometer of the Terminal Box S-G05
– an external voltage signal 0-10 V
– an external, analog current signal 0 (4)-20 mA
– an external potentiometer and
– the RS-232 interface

Individual start up procedures are described in the following points.

6.7.1 Startup with potentiometer

1. Connect the drive with the eight colored wires to the terminal box S-G05. The colors of the corresponding wire connections are described in the table 25.

2. Bring the potentiometer knob to null position by turning it clockwise to the limit stop.

3. Put the DIP-switch to the »Poti« position.

4. Connect the 24 VDC voltage supply to the terminal or to the DIN connector.

Make sure that the polarity of the supplied direct current is correct, otherwise electronics will be damaged.

5. Provide for a steady liquid supply to the pump in order to avoid dry operation.

6. The pump may now be put into operation by turning on the potentiometer knob.

Remarks:

– You may adjust speed of the micro annular gear pump without the need to connect it to the serial interface.
– In case error occurs for example due to motor overload - the green status LED on the Terminal Box S-G05 will turn red.

6.7.2 Startup with external 0-10 V signal

1. Connect the drive with the eight colored wires to the terminal box S-G05. The colors of the corresponding wire connections are described in the table 25.

2. Bring the potentiometer knob to the null position by turning it clockwise to the limit stop.

3. Put the DIP-switch to »0…10 V« position.

4. Connect an external 0-10 V voltage supply to the terminal clamps »AnalogIn« and »GND« to the S-G05. (see figure 46)

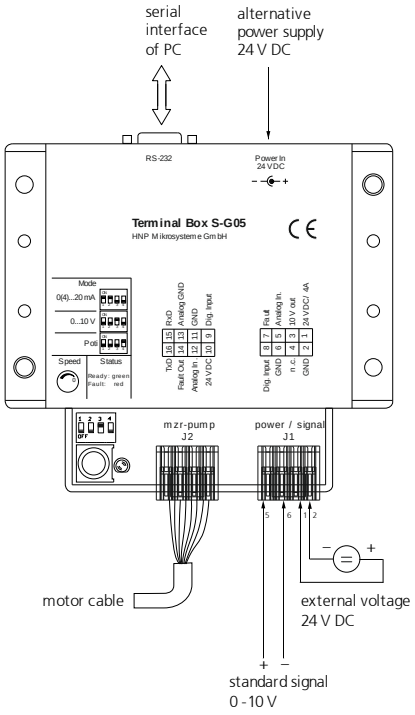


figure 46 Startup with an external 0-10 V voltage signal

5. Provide for a steady liquid supply to the pump in order to avoid dry operation of the device.

6. Connect the 24 VDC voltage supply to the terminal or to the DIN connector.

Make sure that the polarity of the supplied direct current is correct, otherwise electronics will be damaged.

The input circuit at the analog input is layed out as a differential amplifier. If the analog input is "open" there is already a voltage of 2 V. That means in this case that the motor would be turning at a speed of about 2000 rpm. In order to set 0 rpm the input must be connected over a low ohm resistor to the analog ground (AGND) or connected to the AGND-voltage level.

7. The micro annular gear pump may now be put into operation by increasing the external voltage signal. A voltage signal of 0 V corresponds to 0 rpm and 10 V to the maximal programmed speed (see table 6).

Remarks:

– You may adjust speed of the micro annular gear pump without the need to connect it to the serial interface.
– In case error occurs for example due to the motor overload - the green status LED on the terminal Box S-G05 will turn red.

6.7.3 Startup with an external 0(4)-20 mA current signal

1. Connect the drive with the eight colored wires to the terminal box S-G05. The colors of the corresponding wire connections are described in the table 25.

2. Bring the potentiometer knob to the zero position by turning it clockwise to the limit stop.

3. Put the DIP-switch to »0(4)…20 mA« position.

4. Connect the external current source to the screw clamps »AnalogIn« and »GND« to the S-G05. (see figure 47).

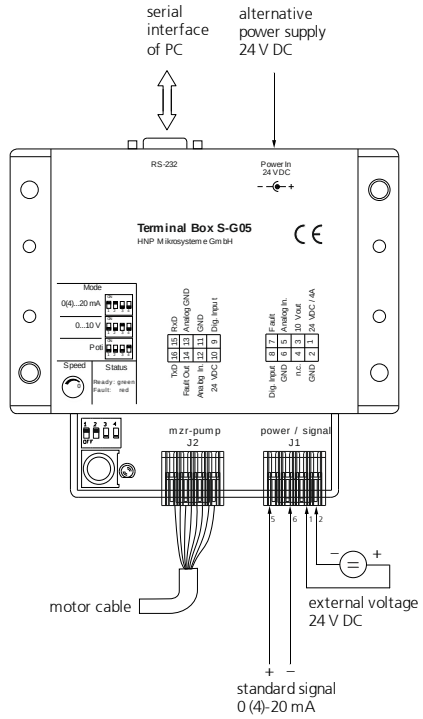


figure 47 Operation via an external 0 (4)-20 mA voltage

5. Provide for a sufficient liquid supply to the pump in order to avoid dry operation of the device.

6. Connect the 24 VDC voltage supply to the screw clamp terminal or to the DIN connector.

Make sure that the polarity of the supplied direct current is correct, otherwise electronics may be damaged.

7. The micro annular gear pump may now be put into operation by increasing the external current signal. 0 mA corresponds to 0 rpm and 20 mA to the maximal programmed speed (see table 6).

Remarks:

– For operation with the signal 4…20 mA an offset of about 2.1 V should be set by entering the command MAV2170. In order to set the nominal values the micro annular gear pump must be put into operation via the RS-232 interface and start with the » Motion Manager « software. Save the command in the EEPROM with the command EEPSAV (see chapter 9.1).
– Speed of the micro annular gear pump may be set by sending an external voltage signal without the need to connect the pump to the serial interface.
– In case error occurs for example due to a motor overload - the green status LED on the Terminal Box S-G05 will extinguish and a red one will light up.

6.7.4 Startup with external potentiometer

1. Connect the drive with the eight colored wires to the terminal box S-G05. The colors of the corresponding wire connections are described in the table 25.

2. Bring the internal potentiometer knob to the null position by turning it clockwise to the limit stop.

3. Put the DIP-switch to »0…10 V« position.

4. Connect an external 0-10 V voltage supply to the terminal clamps »AnalogIn«, »10 V« and »GND« to the S-G05.(see figure 46)

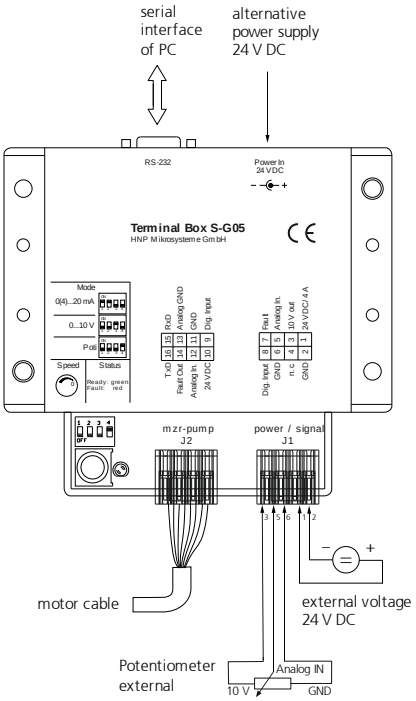


figure 48 Startup with an external potentiometer

5. Provide for a steady liquid supply to the pump in order to avoid dry operation of the device.

6. Connect the 24 VDC voltage supply to the terminal or to the DIN connector.

Make sure that the polarity of the supplied direct current is correct, otherwise electronics will be damaged.

The input circuit at the analog input is layed out as a differential amplifier. If the analog input is "open" there is already a voltage of 2 V. That means in this case that the motor would be turning at a speed of about 2000 rpm. In order to set 0 rpm the input must be connected over a low ohm resistor to the analog ground (AGND) or connected to the AGND-voltage level.

7. The micro annular gear pump may now be put into operation by increasing the external voltage signal. A voltage signal of 0 V corresponds to 0 rpm and 10 V to the maximal programmed speed (see table 6).

Remarks:

– You may adjust speed of the micro annular gear pump without the need to connect it to the serial interface.
– In case error occurs for example due to the motor overload - the green status LED on the terminal Box S-G05 will turn red.

6.7.5 Startup with the RS-232 interface

1. Connect the drive with the eight colored wires to the S-G05. The colors of the corresponding wire connections are in the table 25.

2. In order to prevent uncontrolled startup of the pump, bring the potentiometer knob to the null position by turning it clockwise to the limit stop.

3. Put the DIP-switch to »Poti« position.

4. Connect the RS-232 interface of the Terminal Box S-G05 with a free serial interface of a PC. Use for that the delivered 9-pole null-modem cable.

5. Now install the delivered software as described in the chapter 8 or Chapter 9.

6. Connect the 24 VDC voltage supply to the terminal or to the DIN connector.

7. Provide for a steady liquid supply to the pump in order to avoid dry operation of the device.

8. The micro annular gear pump may now be put into operation with the available software (operating mode RS-232 see chapter 9.1).

Remarks:

– In case error occurs for example due to the motor overload - the green error status LED on the Terminal Box S-G05 will turn red.

6.7.6 Startup of the pump units with network mode (NET1 Command)

All standard units are delivered with node number 0. In order to prepare the units for network operation, they must first be individually connected to the PC and set to the desired node address using the FAULHABER Motion Manager.

A serial network can be constructed using the so-called daisy-chain technique, in which the transmit cable of the Master (PC, PLC) is connected to the receive cable of the first node, from where it is looped through to the receive cable of the second node, and so on. The same procedure is followed with the receive cable of the Master, which is looped through to all transmit cables of the drive node. The current generation of Motion Controllers do not require a multiplexer board for serial network operation. The multiplex mode is activated with a command NET1.

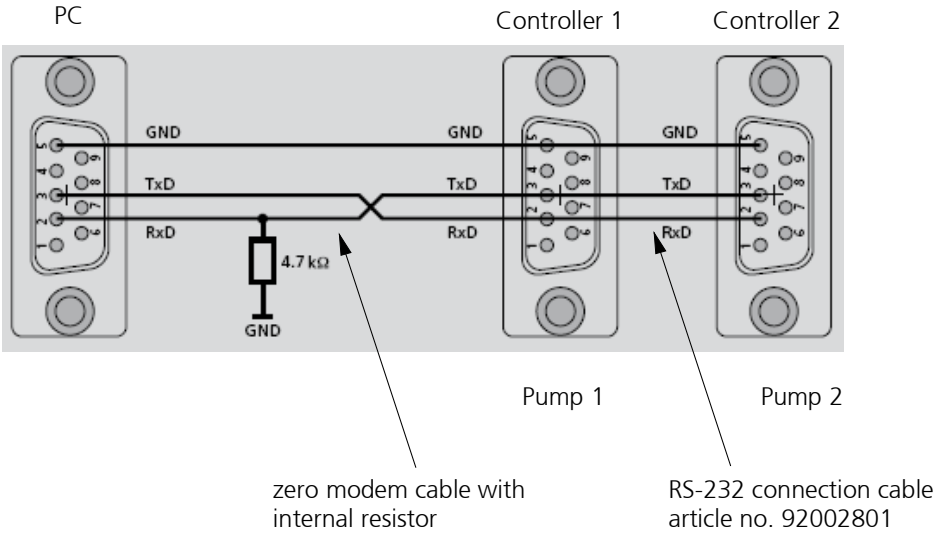


figure 49 Connection between PC, Controller Pump 1 and Controller Pump 2

1. Connect the RS-232 port of the controller Pump 2 with the RS-232 of the controller Pump 1. For this purpose use the delivered 9-pole RS-232 connection cable.

2. Connect the In Port of the RS-232 connection cable with a free serial interface of a PC. For this purpose use the delivered 9-pole null-modem cable with internal resistor.

3. Put the potentiometer of the control units to zero position by turning it clockwise to the limit stop.

4. Connect the voltage supply 24 VDC. This can be done with the integrated DIN connector or, alternatively the 2-pole screw clamp (24 V = »+«; GND = »-«). Pay attention to the correct polarity.

5. You may now install the delivered software as described in the chapter 8.

While connecting the DC voltage pay attention to the correct polarity, otherwise electronics may be damaged.

Remarks:

- Controller which the manufacturer specifically shipped for the network modus were with the command NET1, SOR0, ANSW0 and DIPROG programmed.
- In order to address the individual drives in the network, the node number must be specified before each ASCII command to be sent (e.g. 2V500). Commands without a node number are adopted by all drive nodes in the network.
- No unaddressed query commands may be sent in network mode, as otherwise all units will answer simultaneously and the message frames will mix, resulting in communication errors. It must also be ensured that no asynchronous responses are sent by several units simultaneously, and that the command acknowledgement is switched off when using unaddressed transmit commands. Use the ANSW0 command to set the response behaviour.

6.8 Connection of the micro annular gear pump with terminal box S-G05 with screw clamp terminal

In order to operate the pump a supplementary source of 24 VDC will be required. The ampacity of the voltage source should amount to around 3 A for the micro annular pumps mzr-2505, mzr-2905 and mzr-4605 and 5 A for the mzr-7205.

The micro annular gear pump is connected via the Terminal Box S-G05. This enables an easy startup of the pump due to:

- the possibility to connect the voltage supply with the delivered screw clamp terminal
- an alternative voltage supply via a DIN connector conform with DIN 45323
- speed set via potentiometer
- analog voltage input 0-10 V and 0 (4)-20 mA for speed control
- change of speed setting mode with a DIP-switch
- 9-pole connection plug for the RS-232 interface
- error output programmable also as trigger input or frequency output
- digital input with a screw connection
- possibility of installation on a 35 mm top hat rail

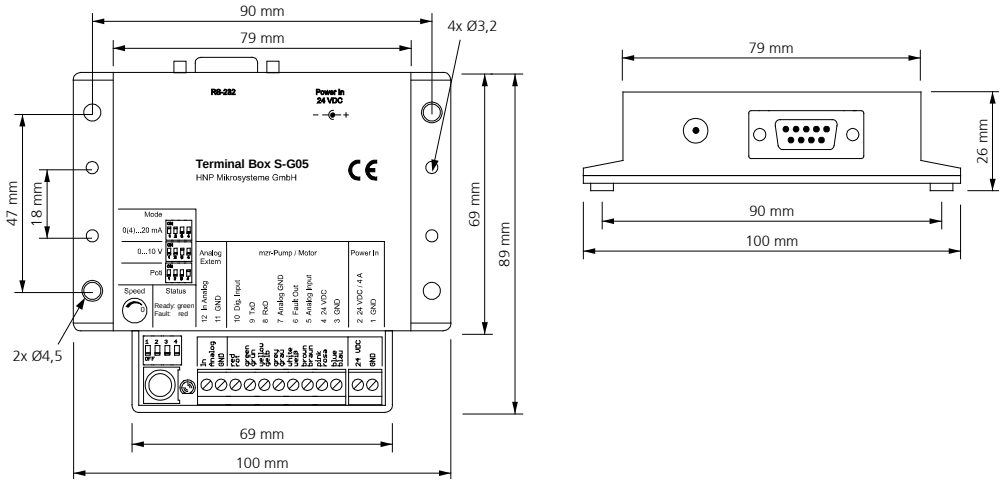


figure 50 Measurements of the Terminal Box S-G05

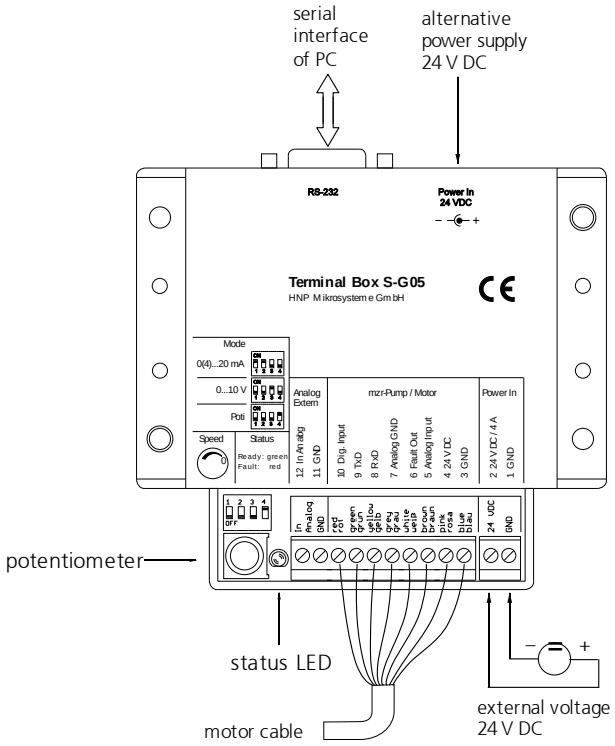


figure 51 Connection of the micro annular gear pump to the power supply

Wire	Function	Terminal Box
blue	Ground	GND
pink	Voltage supply	24VDC
brown	Analog input	Analog Input
white	Error output	Error Out
gray	Ground analog input	Analog GND
yellow	RS-232 interface signal reception	RxD
green	RS-232 interface signal transmission	TxD
red	Digital input	Dig.Input

table 27 Wire configuration between the drive and the Terminal Box S-G05

The speed setting in operation of the micro annular gear pump is to implement the functions from chapter 6.7. The connection of an external potentiometer can't be realized.

7 Startup/shutdown of a mzr-pump

7.1 Preparing for operation

After the liquid supply system had been completed, please check once again the operating conditions of the micro annular gear pump as according to the following points:

- Are the inlet and outlet tubes correctly connected?
- Is the entire liquid supply system clean - that means free of particles, foreign bodies, pollution or swarf?
- Has a filter been installed on the suction side?
- Has a sufficient amount of the right liquid been supplied?
- The pump does not run the risk of a longer dry operation?
- The entire liquid supply system has been checked for leakage?
- Is it possible to stop the pump by an emergency switch if an unexpected malfunction occurs at the startup?

7.2 Startup of the micro annular gear pump

Switch on the voltage supply. The micro annular gear pump can now be put into operation by turning on the potentiometer knob or by sending a nominal external voltage signal.

Start the filling in of the pump at low or middle speed (1000 - 3000 rpm).

Warning Avoid dry operation of the pump over a longer time. The pump should be filled in before it is put to operation.

7.3 Flushing procedure after use

After each service the micro annular gear pump should be carefully flushed with a non-corrosive, filtered and particle-free flushing liquid (see table 28 and table 29). During flushing procedure the pump should operate at a speed of about 3000 rpm and if possible against a low pressure (that can be obtained by using a restrictor, a capillary or similar). The flushing liquid must be compatible with the delivered liquid and suitable for solving the remaining liquid rests. Depending on the application for example water, or isopropanol may be used. If you have doubts whether a particular liquid is suitable for this function or not, please ask the manufacturer of the liquid or HNP Mikrosysteme.

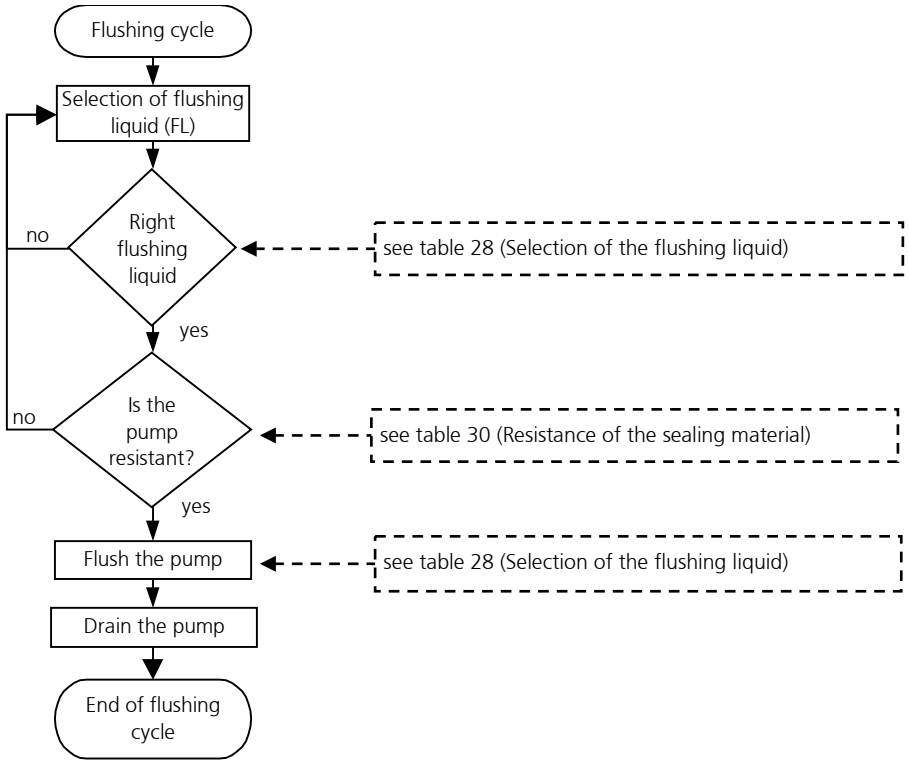


figure 52 Diagram of the flushing procedure

Warning Liquids that remain in the pump may crystallize, coagulate or lead to corrosion and as a consequence impair the work of the micro annular gear pump.

Warning Please make sure that the pump components and particularly O-rings and sealing are resistant to the employed flushing liquid. (see table 29).

Warning The flushing liquid (solvent) and the recommended duration of the flushing procedure depend on the delivered liquid (see table 29). The indicated flushing liquids are simple recommendations and should therefore be checked by the user as to their compatibility and suitability.

Regulations concerning use of substances dangerous to health should be followed!

	Nature of the delivered liquid	Flushing time [min]	Suitable flushing liquid
1	Oils, fats, plastifierss	15-20	isopropanol, ethanol, acetone, benzine/petroleum ether
2	Solvents (polar + nonpolar)	5-10	isopropanol, ethanol
3	Other organic liquids	10-15	isopropanol , ethanol
4	Refrigerating and cooling agents	15-20	isopropanol, ethanol
5	Neutral water/y solutions	20-25	isopropanol, ethanol
6	Basic solutions	25-30	DI-water (deionized water)
7	Organic acids	30-40	isopropanol, ethanol
8	Weak mineral acids	25-30	DI- water
9	Strong mineral acids	35-45	DI- water
10	Strong oxidizing liquids	35-45	DI- water
11	Paints, varnishes, adhesives	50-60	not specified - for further information please contact HNP Mikrosysteme.

table 28 Selection of the flushing liquid (solvent) and the duration of the flushing procedure depending on the delivered liquid.

Warning Please make sure that the pump components and particularly O-rings and sealing are resistant to the employed flushing liquid (see table 29).

	Shaft sealing		O-ring material		
Flushing liquid	PTFE (Teflon®), graphite-reinforced	UHMWPE	FPM (Viton®)	EPDM	FFPM
acetone	0	0	3	0	0
benzene	0	3	1	3	0
benzyl alcohol	0	-	0	2	0
butanol	0	-	1	0	0
dimethyl sulfoxide (DMSO)	0	0	3	0	0
ethanol	0	0	0	0	0
isopropanol	0	0	0	0	0
methanol	0	0	2	0	0
methylethylketone (MEK)	0	0	3	1	0
styrene	0	-	1	3	1
toluene	0	1	2	3	0
water	0	0	0	0	0
xylene	0	1	2	3	0
benzine/petroleum ether	0	0	0	3	0
oil / fine mechanics oil	0	0	0	3	0

Legend: 0 ... good suitability 1 ... suitability 2 ... conditional suitability 3 ... labile - ... not specified

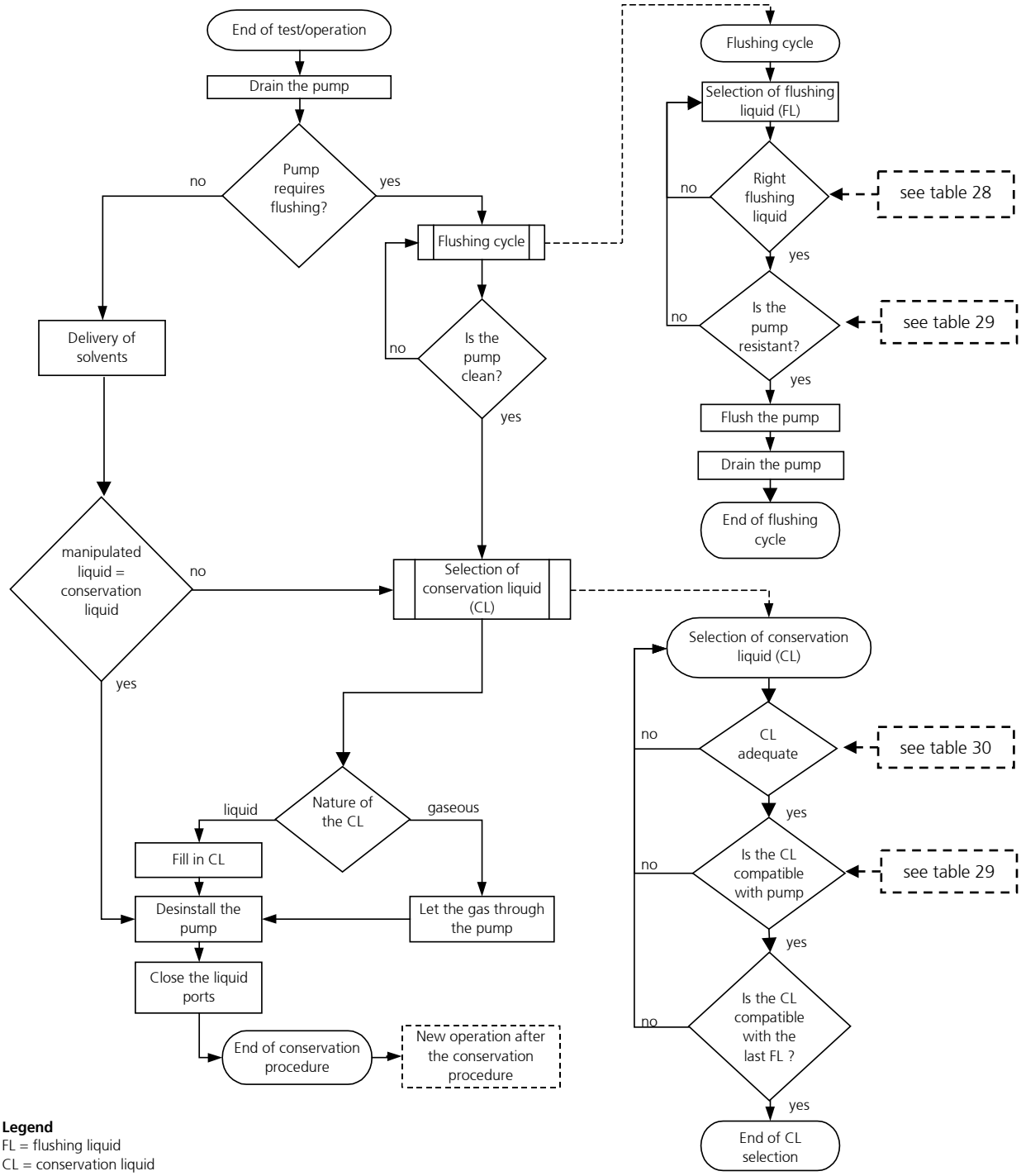
table 29 Resistance of the sealing materials depending on the flushing liquid (solvent)

7.4 Shutdown of the micro annular gear pump

In order to shut down a mzr-pump the following steps should be followed:

- Flush the pump with a filtered and particle-free flushing liquid (solvent) as described in the chapter 7.3.
- After the flushing procedure decrease speed of the pump to 0 rpm
- Fill the pump with a suitable conservation liquid (see chapter 7.4.1)
- Remove the pump from the system (see chapter 7.4.2)

By proceeding as shown in the diagram (see figure 54) you may prepare the pump for a longer standstill.



Legend
FL = flushing liquid
CL = conservation liquid

figure 53 Diagram of the shutdown procedure

7.4.1 Conservation

If the micro annular gear pump operates at irregular intervals or for other reasons should be put out of operation for a longer period, it should, after service and flushing procedure (see chapter 7.3), be filled in with a suitable conservation liquid.

The conservation liquid may be selected from the table 30 depending on the duration of the standstill and the resistance of the pump to the manipulated liquid. The indicated conservation liquids are simple recommendations and should therefore be checked by the user as to their compatibility and suitability. The figure 54 presents a diagram of conservation agent selection.

Remark: This diagram is repeated as a part of the figure 53 (shutdown procedure of the micro annular gear pump).

After the cleansing procedure the pump should be filled with a suitable conservation agent. You will find a choice of possible conservation agents in the table 30.

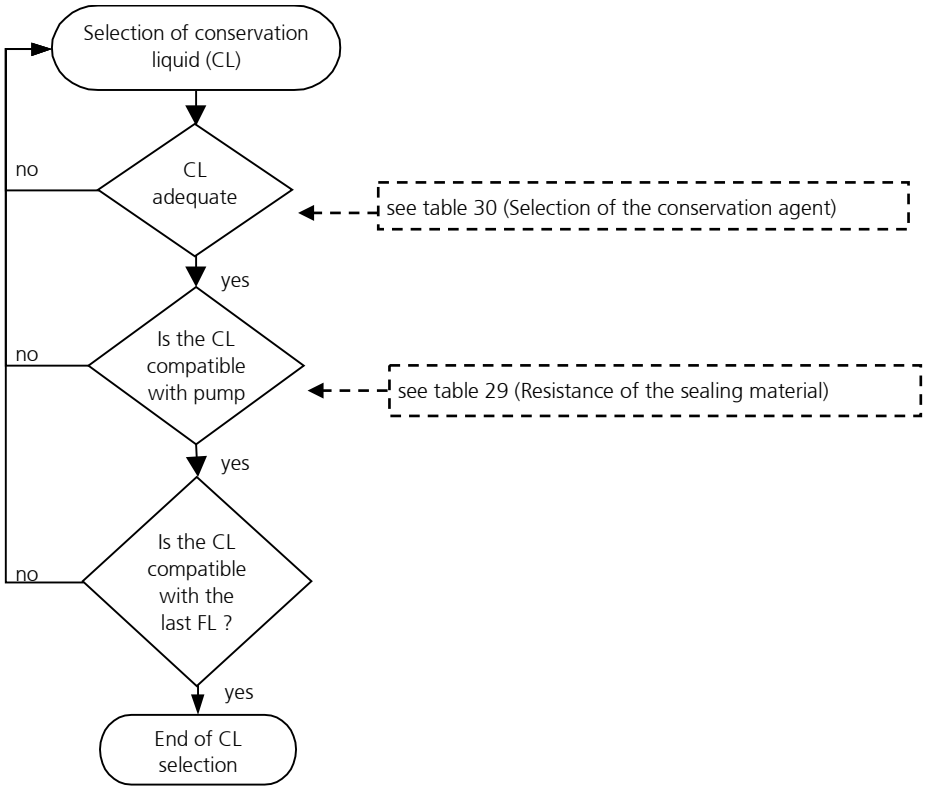


figure 54 Diagram - selection of conservation liquid (CL)

Liquids	Solubility in water	Compatibility with the delivered liquid	Duration of storage	Breakaway torque	Toxicology	Viscosity	Description
isopropanol	+	+	o	o	o	+	solvent for organic compounds, cosmetics, essential oils waxes, and esters, antifreezers, antiseptic agents
acetone	+	+	o	o	o	+	solvent for a number of organic compounds, unlimited solubility in water, dissolves natural and synthetic resins, fats, oils and commonly used plastifiers
ethanol	+	+	o	o	o	+	solvent for organic compounds, fats, oils and resins
DI-water	+	+	-	-	+	+	solvent for many organic and mineral liquids
fine mechanics oil	-	-	+	+	+	+	cleansing and protective action (dissolves fats, tar, rubber or adhesive substances, protects against corrosion).
hydraulic oil	-	-	+	+	+	-	lubricating and preserving properties (*Warning*: may resinate or deteriorate with time)
nitrogen	-	+	+	+	o	+	is not a solvent, may leave deposits after drying out
air / compressed air		+	+	+	+	+	is not a solvent, may leave deposits after drying out

Legend: + ... good/suitable o ... satisfactory; - ... bad/inadequate

table 30 Selection of the conservation agent

In order to prevent dust particles and foreign bodies from penetrating into the pump or the conservation agent from leaking out, please secure the liquid input and output openings with the delivered protective plugs or screws.

Warning

Water or DI-water should not be used as conservative liquids. They germinate already after a few days and build a biofilm which can later block the pump.

7.4.2 Dismantling of the system

- Put the drive out of operation by turning down speed to 0 rpm and by switching off the voltage supply. Make sure that the procedure described in the chapter 7.3 has been completed.
- Now that the pump has been stopped you may remove it from the system.
- Protect the inlet and outlet openings of the pump with adapted protective plugs or screws.

7.5 Trouble shooting

If the pump stops operating abruptly or has difficulties with starting operation, please undertake the following steps:

Try to liberate the micro annular gear pump:

- by turning the potentiometer knob back and forth or by connecting an analog voltage
- via the control software
- by pressing with a syringe a suitable flushing liquid (see table 28 and table 29) through the micro annular gear pump
- by changing the operating direction of the pump.

If these measures turn out to be ineffective, please contact the service staff of HNP Mikrosysteme (see chapter 16) and send the pump back to the manufacturer for inspection.

Warning *You should under no condition* try to disassemble the pump by yourself. This may cause damage to the pump components and consequently annul your warranty claims.

7.6 Return of the micro annular gear pump to the manufacturer

For the return of a micro annular gear pump and components that have already been employed, please follow the instructions:

- drain any remaining rests of the delivered liquid from the pump
- flush the pump with an adapted solvent
- remove the filter elements from integrated or loosely delivered filters
- protect all openings against dust with the delivered protective plugs or screws
- return the pump in its original packing

The service personnel which carries out the repair should be informed about the condition of the already used micro annular gear pump. This is done by means of the "Declaration of media in contact with the micro annular gear pump and its components" (see chapter 19). This form may also be downloaded from the web site *www.hnp-mikrosysteme.de/download*.

The "Declaration of liquids in contact with the micro annular gear pump and its components" must imperatively be filled in. The nature of liquid which entered into contact with the micro annular gear pump and its components must be specified.
In case of non-compliance, the sender will be liable for any resulting injure to persons or any object damage.

8 Software »mzr-pump controller«

Install the delivered software »mzr-pump controller« from both diskettes by starting the program »Setup« on CD. The delivered software is compatible with Windows 7® and Windows 10®.

After a successful installation the program »mzr-pump controller« can be found in the start menu under »Programs - HNP Mikrosysteme«. After the program has been initiated, data such as the pump type »mzr-2505«, »mzr-2905«, »mzr-4005«, »mzr-4605«, »mzr-6305«, »mzr-7205« and the gear reduction should be set.

The program enables to coordinate metering or continuous delivery tasks. The operating parameters of the micro annular gear pump are set via included user interface.

The »Dosage« operating mode (see figure 55) enables to set constant volumes in units such as ml, mg or rpm as well as pauses for a fixed number of sequences or for continuous operation. Each metering procedure will be configured according to the speed profile which is set for such values as »Max. velocity« and the »Acceleration«. The allowable speed values extend from 1 to 6000 rpm and the acceleration values from 1 to 2000 rotation/s².

The metering procedure can be initiated with the »Start« button or by pressing the enter key. The task may be stopped either with the »Stop« button or by pressing once again the enter key.

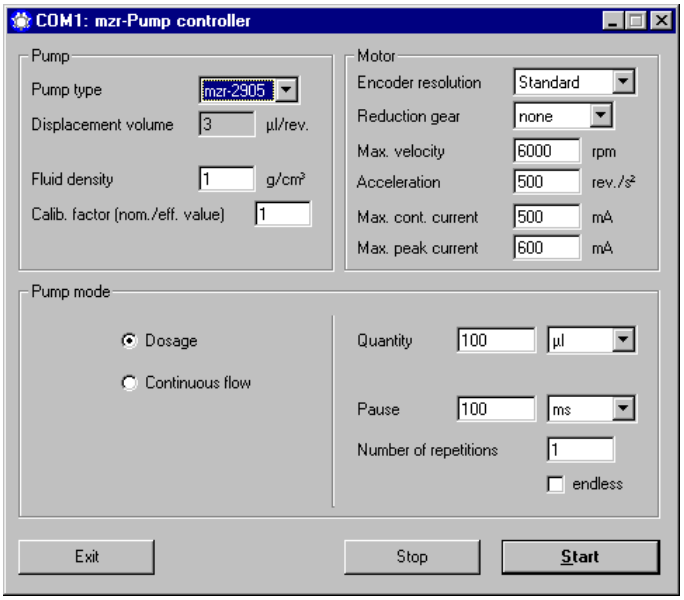


figure 55 Setup window of the »Dosage« operating mode

In the »Continuous flow« operating mode (see figure 56) continuous flow rates in units such as ml/min, g/min and rpm may be set. Operation of the micro annular gear pump may be initiated with the »Start« button or by pressing the enter key for the indicated »Duration« value. Checking of the »endless« box will put the pump to continuous operation. The »Stop« button or pressing of the enter key once again will stop the delivery. If you check the »Potentiometer« box, speed may be set by turning the potentiometer knob in the front of the control module or on the terminal box.

The input of the »Fluid density« enables to convert units of weight to the given volumes or to the given flow rates expressed in volume units. *Remark*: if you are only working with volumes, the indication of the fluid density will not be necessary and the standard value »1« can be left.

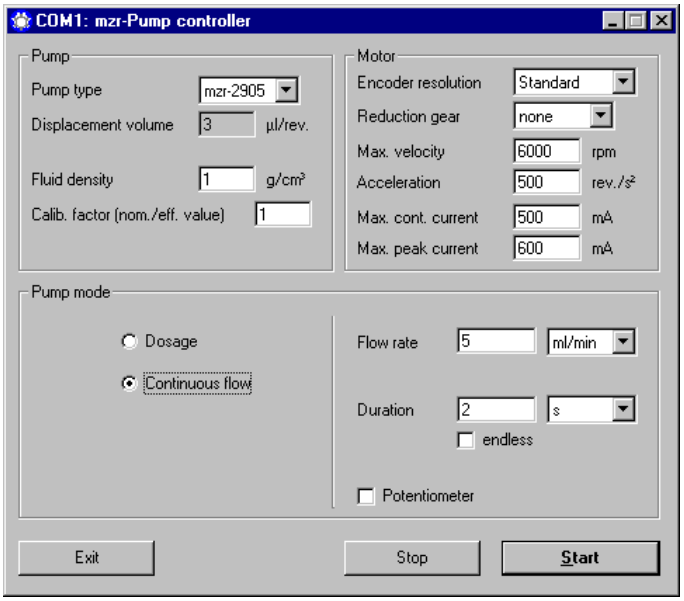


figure 56 Setup window of the »Continuous flow« operating mode

The »Calibration factor« enables to find the relation between the actually delivered quantities or flow rates (= actual value) and the set up quantities or flow rates (=nominal value). The calibration factor is specific to every pump and each application case and therefore should be determined by the user as according to the volume or weight of the delivered fluid. The calibration factor may be calculated according to the following formula:

$$\text{Calibration factor} = \frac{\text{Desired quantity}}{\text{Actual quantity}} = \frac{\text{Desired delivery value}}{\text{Actual delivery value}}$$

In practice, due to the high precision of the system the calibration factor value will only slightly exceed 1.

9 Software »Motion Manager«

The »Motion Manager« software enables operation and configuration of the drive and offers a possibility of an online graphic analysis of the operating data. The software is delivered on CD. The program may be installed on a PC running under Windows 7®, Windows 8 or Windows 8.1® operating systems.

Install the software »Motion Manager« by starting the program »Setup« from the CD.

If the CD are not available you may still download this program from the web site http://www.hnp-mikrosysteme.de/download-center.html or the web site www.faulhaber.com (menu support - download). Here, the latest version is always available in English and German.

After the installation the »Motion Manager« program may be loaded from the »Faulhaber Motors« folder from the Windows start menu.

In order to program the drive, the micro annular gear pump should be put into operation. The drive should be connected to the PC with the delivered null-modem cable.

9.1 Direct drive control

In the »Motion Manager« software the input commands may be sent directly to the drive. This enables to execute the movement commands and to modify the drive parameters.

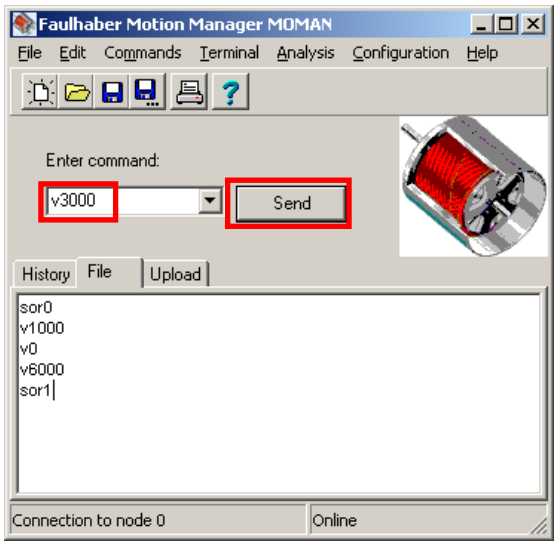


figure 57 Motion Manager software for direct control of the drive

The commands are entered in the field »Enter command:«. The button »Send« will send the command to the drive for execution (see figure 57). The commands may be given alternatively in capital letters or low case. The drive will ignore excess space characters.

An example for continuous delivery

Commands	Description
SOR0	Operating mode RS-232: Set the nominal speed via the RS-232 interface
V1000	Rotation speed of 1000 rpm
V0	Standstill of the pump (speed 0 rpm)
V6000	Speed value 6000 rpm
SOR1	Analog input of the operating mode: setup of the nominal speed with the potentiometer knob or by connecting an external voltage signal to the analog input

An example for discrete dosage

Command	Description
SOR0	Operating mode RS-232: set the position via RS-232 interface
LR10000	Load a relative position of 1000 to the control unit 10,000 = 10 rotations (*Remark: 1000 steps = 1 rotation)*
M	Execute the task / start positioning
LR20000	Load a relative position of 2000 to the control unit 20,000 = 20 rotations
M	Execute the task / start positioning
SOR1	Analog input operating mode: Set nominal speed with potentiometer or by connecting a voltage signal to the analog input

In case of the mzr-2505, mzr-2905, mzr-4005, mzr-4605 and mzr-7205 micro annular gear pumps 1 revolution of the rotor corresponds to 1000 steps. The gear reduction is to be considered while using a gear reduction module.

For more details concerning the operation of the Motion Manager, please read the online program help.

9.2 Programming of the control

The control of the micro annular gear pump may be adapted by the user to a specific task by means of an easy programming language. The program files are available in the ASCII code and have by default the »mcl« extension which stands for "*m*otion *c*ontroller *l*anguage". Various parameters of the drive such as the maximal speed, the acceleration, the number of rotations, the allowable current load and the parameters of the PI-controller may be programmed with this language. Furthermore, it is possible to program short movement sequences which will be saved in the internal memory of the drive and then autonomously executed.

9.3 Transfer of a mcl file to the drive

The existing mcl files may be loaded to the file editor window using the menu command *File - Open…* (in the program window).

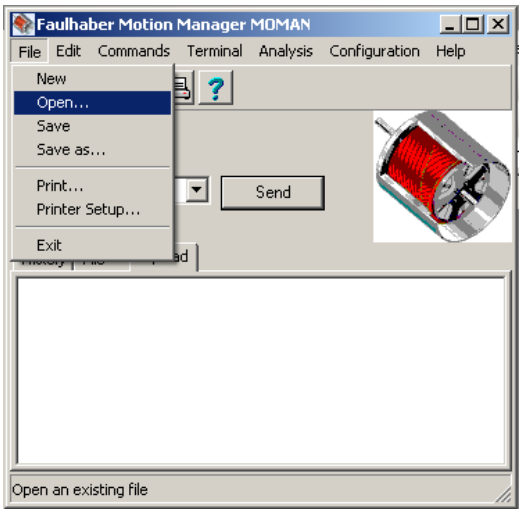


figure 58 Menu file- open

The required mcl file may be selected and loaded via the file selection window (see figure 58). By using the menu command *Terminal - Transfer configuration file* the mcl file will be transferred to the drive (see figure 59).

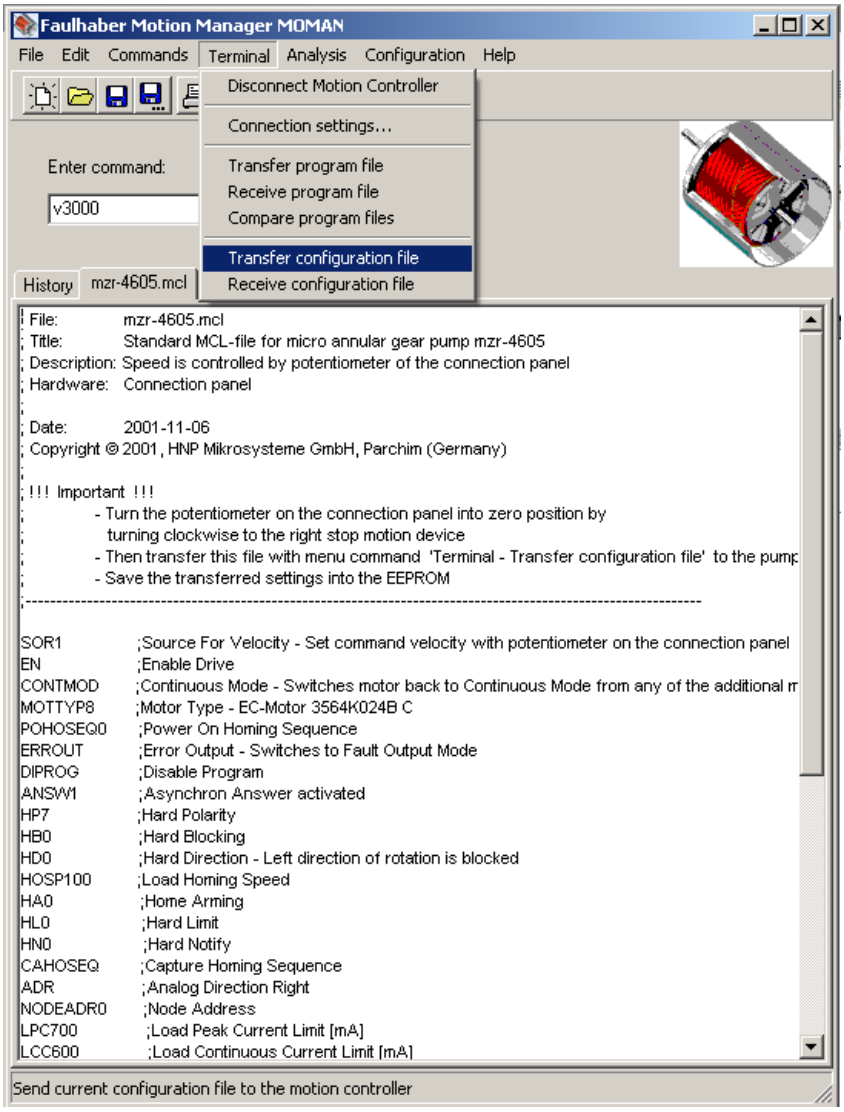


figure 59 Transfer of the mcl files as parameter data

When a window appears with the enquiry if the mcl files should be transferred to the »Motion-Controller«, answer by clicking on the »Yes« button.

In order to save the configuration and the programmed operation files in the EEPROM, confirm the dialogue window with »OK« (see figure 60). By this confirmation the program will be saved in the memory with a resident status and will be available for future operation.

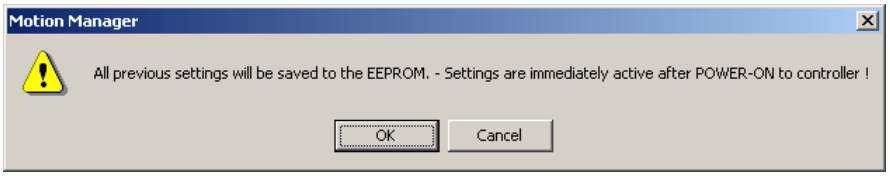


figure 60 Storage confirmation

A CD with sample mcl programms is delivered along with the Motion Manager. At the delivery the pump has a standard program configuration. Moreover, a sample program that may be started with an external switch is available for discrete dosage tasks.

Pump type	Standard program	Sample program for dosage tasks
mzr-2505	mzr-2505.mcl	dosage_2505_e3.mcl
mzr-2905	mzr-2905.mcl	dosage_2905_e3.mcl
mzr-4005	mzr-4005.mcl	dosage_4005_e3.mcl
mzr-4605	mzr-4605.mcl	dosage_4605_e3.mcl
mzr-6305	mzr-6305.mcl	dosage_6305_e3.mcl
mzr-7205	mzr-7205.mcl	dosage_7205_e3.mcl

table 31 Overview of mcl sample programs

10 Accessories for microfluidic systems

The accessory range for the liquid delivery systems of HNP Mikrosysteme comprises complementary equipment such as hoses, tubes, fluid fittings, filters and non-return valves that are best adapted to your micro annular gear pump. We will eagerly share our long date experience as far as component selection is concerned.

11 Non-liability clause

HNP Mikrosysteme GmbH shall not be liable any damage resulting form the non-respect of instructions comprised in this operating manual.

It belongs to the user to check the integrity, the correct choice and the suitability of the product for the intended use.

It remains at the responsibility of the user to conform to all laws, rules and regulations in force. This applies above all to the treatment of aggressive, poisonous, corrosive and other dangerous liquids.

12 Problems and their removal

Disturbance	Cause	Solution
1 The pump does not work.	No power supply	Check the power supply.
2 The pump does not pump the liquid.	No liquid in the primary tank	Fill the recipient/tank with liquid.
	Presence of air or gas in the pump	The pump cannot run dry against the system pressure. Fill in the pump at no pressure or at reduced system pressure.
	Malfunction of the liquid supply components (such as in the delivery tube, the needle or external non-return valve)	Check the components for possible disturbances to be eliminated. Cleanse the accessories where needed.
	Failure of the electric installation	Check the electric installation for the correct cable configuration, loose contacts, etc.
	The pump did not receive the start signal or start conditions are not fulfilled.	Check if the start condition have been fulfilled start signals (software control, PLC, start signal) and the programs.
	Motor disturbance: the red error LED is on.	Check the failure condition of the motor control with the Motion Manager software.
3 The pump does not start to operate.	The pump does not take in the liquid.	The tubing on the induction side is too long or has a too small internal diameter (a too low NPSHA value).
		The tubing or the fluid connection on the induction (suction) side are not tight. Please check the intake connection and the tubing.
		Air bubbles in the fluid system (tubes, valves, ...)
		If the viscosity of the liquid is too high, apply pressure on the suction side.
		Check the pressure exerted on the primary liquid tank.
		An external non-return valve does not open. Check the non-return valves.
		Submit the non-return valve to a higher pressure, so that the pump may fill in.
4 The motor turns, but the pump does not operate.	No liquid in the pump	Fill the pump with liquid.
	Air bubbles in the liquid supply system (tubing, valves, ...)	Fill the pump and the liquid supply system with liquid.
	The non-return valve does not open.	Rinse the non-return valve.
	Blocked delivery tubing or needle	Cleansing, flushing or exchange of the delivery tubing or dosage needle
	The coupling between the motor and the pump is out of position.	Return the pump to the manufacturer.
	The pump shaft is broken.	Return the pump to the manufacturer.
5 The pump is filled with liquid, but does not pump it.	Error indicator (the red status LED on the terminal box is on and the motor control has set the error output).	Check the motor error status with the Motion Manager software (command GFS). Try to liberate the pump by making it operate for 1 s in a reverse direction with -100 rpm.
		Adapt the motor current to the control. Contact the manufacturer of the pump.
	Presence of particles in the delivered liquid or blockage of the pump.	Check the motor error status with the Motion Manager software. Try to liberate the pump by making it operate for 1 s in a reverse direction with -100 rpm.
		Return the pump to the manufacturer for cleansing. Use a filter, flush the liquid delivery

Disturbance	Cause	Solution
		system.
		Flush the pump with a syringe.
	The non-return valve does not open.	Rinse the non-return valve.
	Blockage of the delivery tubing or the needle.	Cleanse, flush or exchange the delivery tubing or the needle.
	Air bubbles in the liquid delivery system, (tubing, valves)	Fill in the pump and the delivery system with liquid.
6 Dosage volume does not correspond to the set values.	Air bubbles in the liquid delivery system, (tubing, valves ,...) and the pump	Vent the liquid delivery system and check for untight fluid connections.
	Pump shows cavitation.	Too long or too narrow intake tubing. Shorten the intake tubing or change the position of the pump.
	Polluted or too small filter	Change the filter to a new or bigger one.
	The non-return valve does not open.	Rinse the non-return valve.
7 Speed of the pump cannot be adjusted.	Defective electric installation	Check the electric installation for correct cable configuration and loose contacts.
	Defective drive control	Return the drive control to the manufacturer.
8 Liquid drops from the dosing needle.	The non-return valve does not close.	Rinse the non-return valve.
	Too high pressure on the primary liquid tank	Stop the delivery of compressed air on the primary liquid tank.
	The liquid tank is placed at a higher level than the dosing needle.	Place the liquid tank at the same or slightly lower level than the pump.
9 Liquid leaks from the fluidic seal.	The connection kit of the fluidic seal module is untight.	Check the assembly, tighten the threaded connections.
	Pressure on the induction tank of the fluidic seal liquid	Stop the delivery of compressed air on the sealing liquid tank Defective sealing - if necessary return the pump to the manufacturer.
10 The dosage volume decreases with time.	Polluted filter.	Exchange the filter.
	Deposits in the pump.	Flush the pump or return it to the manufacturer for dismantling and cleaning.
	The pump is worn after a long operating period or after use with abrasive liquids.	New definition of the calibration factor of the pump, by modifying the pump characteristics graph necessary.
11 Leakage from the pump	The sealing does not function correctly.	Return the pump to the manufacturer.
12 Leakage from the coupling assembly	Defective shaft seal	Return the pump to the manufacturer to change the shaft sealing.
13 Leakage from the fluid connections	Untight lock rings	Exchange or tighten the fluid connections, exchange the fluid connection fittings.
14 Air bubbles on the delivery side	Loose fluid connections (particularly on the induction side)	Check and tighten the fluid connections.
	The shaft seal is untight or worn.	Return the pump to the manufacturer.
15 Minimal leakage during standstill	No error, cause relative to the operating principle	Employ a non-return valve. Place the liquid tank at the same or slightly lower level than the pump
16 Excess temperature	The surface of the pump is hot.	Clean the surface of the pump, rinse the pump
	The pump operates with difficulty.	The pump should be flushed.
	Particles in the delivered liquid or deposits in the pump	The operation of the pump should immediately be stopped! Return the pump to the manufacturer for cleansing.
	Noise of beveling	The operation of the pump should immediately be stopped! Return the pump to the manufacturer for cleansing and repair.
	The motor surface or the motor interior are too hot.	High temperature indicator in the drive is on. The motor has been shut down by the thermistor. Return the pump to the

Disturbance	Cause	Solution
		manufacturer.
17 The pump is noisy	Wearout of the pump or defective components	Do not continue to operate the pump, return it to the manufacturer for maintenance.
18 Lack of connection with the RS-232 interface	The pump is not connected.	Check the power supply 24 VDC.
		Check the connection of the interface and the null-modem cable. Change the cable if necessary.
	The drive control does not respond.	Interrupt the voltage supply for about 10 s, connect the voltage supply again. Automatic start of the integrated drive control
19 Overcurrent	Particles in the delivered liquid	Rinse the pump.
	The pump operates with difficulty.	Dosing needle is damaged. Needle should be cleansed, flushed or exchanged.
		Tubing on the delivery side, dosing needle or non-return valve are blocked. Cleanse, flush or exchange the components.
	Deposits inside the pump.	Flush the pump. If necessary return the pump to the manufacturer.
20 Undervoltage	Voltage supply < 12 VDC	Check the power supply 24 VDC.
21 Overvoltage	Voltage supply > 28 VDC	Check the power supply 24 VDC. The drive control may be damaged. Return the pump to the manufacturer.

table 32 Problem shooting - causes and solutions.

If a disturbance that has not been mentioned in the above list, or that makes the use of the micro annular gear pump unsafe appears, please stop the operation of the pump without delay and contact the manufacturer.

13 EU Directive

A Directive or EU Directive is a legal instrument of the European Community addressing at the member states and forcing them to implement specific regulations or targets. Leastwise, micro annular gear pumps are covered, by the scope of application of the following Directives: The following directives are of importance for the user of the described micro annular gear pumps:

Low-Voltage Directive (2014/35/EU)

The Low-Voltage Directive is not relevant for micro annular gear pumps described in this manual, because the supply voltage is limited to a maximum of 30 VDC.

Machinery Directive (2006/42/EU)

A micro annular gear pump is a machine and is consequently covered by this Directive. However, it may be a part of a machine or installation.

EMC Directive (2014/30/EU)

The Directive on Electromagnetic Compatibility (EMC) applies to all electronic and electrical devices, installations and systems. Consequently, the Motion Controller of the micro annular gear pump is covered by the EMC Directive.

RoHS Directive (2011/65/EU)

To our knowledge our products delivered to you do not contain substances or applications in concentrations that are forbidden by this directive. No substances contain our products delivered to you after our current knowledge in concentrations or application, the placing on the market in products according to the valid requirements forbade to the Directive.

WEEE Directive (2002/96/EU)

In Germany, the implementation of the WEEE Directive 2012/19/EU is regulated in the Electrical and Electronic Equipment Act (ElektroG). This law also holds the manufacturer responsible for the disposal of electrical and electronic equipment at the end of its life.

The symbol of the crossed-out wheeled bin on the electrical appliances indicates that they must not be disposed of with household waste, but require separate collection. Furthermore, we advise you to delete any existing personal data on the devices to be disposed of.

As a manufacturer, we offer our business customers (B2B) to take back and recycle all electrical equipment placed on the market according to certain ecological standards.

In order to avoid long logistics chains, we generally recommend giving old appliances to regionally based specialist disposal companies for disposal. Irrespective of this, HNP Mikrosysteme offers its business customers to send all devices of the brands mzr® that are in circulation in Germany to the following address at the end of their service life:

HNP Mikrosysteme GmbH | Brunnenstraße 38 | D-19053 Schwerin, Germany. Please inform us in advance via the e-mail address service@hnp-mikrosysteme.de.

HNP Mikrosysteme GmbH will then ensure that they are disposed of in an environmentally friendly and legally compliant manner.

REACH regulation (EU) No. 1907/2006

HNP Mikrosysteme is not a manufacturer or importer of chemical substances subjected to registration, but in terms of regulation, a downstream user. As downstream user, we conduct the necessary communication with our suppliers to ensure future deliveries of all components necessary to us. We will notify you of all relevant, changes in our products, their availability and the quality of parts/products delivered by us within our business and coordinate the appropriate action in individual cases with you. Previous inspection did not show any limitation in the supply of material from our upstream suppliers.

13.1 Electromagnetic Compatibility (EMC)

Electromagnetic compatibility is defined as the ability of a electric or electronic device to function satisfactorily as intended in its electromagnetic environment without introducing intolerable electromagnetic disturbances in that environment.

13.1.1 EMC Directive and Standards

Comformity was proven by proof of compliance with the following harmonized standards by the company Dr. Fritz Faulhaber:

– EN 61000-6-4 (10/01): Generic standards – Emission standard for industrial environments
– EN 61000-6-2 (10/01): Generic standards – Immunity for industrial environments

These standards prescribe certain standardised tests for the emitted-interference and interference-immunity tests. The following tests are required due to the connections on the controller:

Generic Standard on Emitted Interference:	**Description**
EN 55011 (05/98)+A1(08/99)+A2(09/02):	Radio disturbance characteristics
Generic Standard on Interference Immunity	
EN 61000-4-2 (05/95)+A1(4/98)+A2(02/01):	Electrostatic discharge immunity test
EN 61000-4-3 (04/02)+A1(10/02):	Radiated, radio-frequency, electromagnetic field immunity test
EN 61000-4-4 (09/04):	Electrical fast transient/burst immunity test
EN 61000-4-5 (03/95)+A1(02/01	Surge immunity test
EN 61000-4-6 (07/96)+A1(02/01):	Immunity to conducted disturbances, induced by radio-frequency fields
EN 61000-4-8 (09/93)+A1(02/01):	Power frequency magnetic field immunity test

Table 1 Standards Summary

All tests were conducted successfully.

13.1.2 Information on use as intended

For micro annular gear pumps, note the following:
Requirement for the intended operation is the operation according to the technical data and the manual.

Restrictions

If the micro annular gear pumps are used at home, in business or in commerce or in small businesses, appropriate measures must be taken to ensure that emitted interferences are below the permitted limit a values!

Installation instructions:

The power supply and motor supply cable must be connected directly to the terminal box S-G05.

During the operation of micro annular gear pumps with a multiplexer board the connection of the terminal box S-G05 is not possible.

14 Declarations of conformity

The delivered micro annular gear pump falls within scope of the following EU directives:

– Machinery Directive (2006/42/EU)
– EMC Directive (2014/30/EU)

You may request the declarations of conformity for the micro annular gear pumps from us separately.

HNP Mikrosysteme

EU-manufacturer's certificate
(following Machinery Directive 2006/42/EU)

We hereby declare that the following micro annular gear pumps of the high performance series:

mzr-2505, mzr-2905, mzr-4005, mzr-4605, mzr-6305, mzr-7205

are intended for installation into another machinery/plant and that start of operation is forbidden until it is identified that the machinery/plant into which these micro annular gear pumps shall be installed corresponds to the regulations of the EU guidelines regarding safety and health requirements.

We confirm the conformity of the product described above to the following standards in terms of applied directives

– Machinery Directive (2006/42/EU)

Applied standards are particularly

DIN EN 809	DIN EN 60204-1	DIN EN 294
DIN EN ISO 12100 part 1		DIN EN 953
DIN EN ISO 12100 part 2		UVV

This statement does not warrant any characteristics in terms of product liability. Please note the safety instructions in the manual.

Mr. Lutz Nowotka, HNP Mikrosysteme GmbH, Bleicherufer 25,
D-19053 Schwerin is authorised to compile the technical file according to Annex VII A.

Date: April 30, 2020

Signature manufacturer:

Dr. Thomas Weisener
CEO

HNP Mikrosysteme

EU-manufacturer's certificate (following EMC Directive 2014/30/EU)

We hereby declare that the following micro annular gear pumps of the high performance series:

mzr-2505, mzr-2905, mzr-4005, mzr-4605, mzr-6305, mzr-7205

are intended for installation into another machinery/plant and that start of operation is forbidden till it is identified that the machinery/plant into which these micro annular gear pumps shall be installed corresponds to the regulations of the EU guidelines regarding safety and health requirements.

We confirm the conformity of the product described above to the following standards in terms of applied directives

– EMC Directive (2014/30/EU)

Applied standards are particularly

EN 61000-6-4 (10/01):	Generic standards – Emission standard for industrial environments
EN 61000-6-2 (10/01):	Generic standards – Immunity for industrial environments

This statement does not warrant any characteristics in terms of product liability. Please note the safety instructions in the manual.

Date: April 30, 2020

Signature manufacturer:

Dr. Thomas Weisener
CEO

HNP Mikrosysteme

15 Service, maintenance and warranty

The maintenance of the micro annular gear pump should be carried out depending on the delivered liquid

– *for lubricating liquids* after 12,000 h working hours, but not later than 24 months after the initial operation

– *for non-lubricating liquids, crystallizing liquids or liquids containing particles,* after 5000 h working hours but not later than 12 months after the initial operation. If during the first inspection no substantial wearout of the pump is observed, the following inspection under the same working conditions should be performed after 8000 h working hours, yet not later than 15 months following to the last inspection.

If during the first inspection the pump shows a particularly strong wearout, the maintenance intervals should be readapted to the operating parameters.

In order to prevent a strong wearout of the pump, the pump should be shut down properly after every application as described in the chapter 7.4. A supplementary flushing procedure with a neutral flushing liquid (see chapter 7.3) also slows down the wearout process of the pump.

It is not allowed to open the micro annular gear pumps. The warranty extincts with the expiry of the legal warranty period or with the opening of the pump. Furthermore HNP Mikrosysteme cannot give any warranty of exchange for parts whose damage result from incorrect use.

For service and maintenance please return your micro annular gear pump to HNP Mikrosysteme (You will find the address on the cover of the present operating manual).

The declaration of liquids having had contact with the micro annular gear pump and components must imperatively be completed. The nature of the liquids must be specified. In case of non-compliance the sender will be liable for any resulting injure to persons or any object damage.

Sealings, rotors and shaft are parts that undergo wear and will be replaced by HNP Mikrosysteme GmbH during maintenance depending on their degree of wear.

16 Contact person

Development and application assistance, service and accessories

Mr. Sven Reimann
Phone +49| (0) 385|52190-349

Service and maintenance

Mr. Ronny Haberland
Phone +49| (0) 385|52190-325

Drive and control technology

Mr. Lutz Nowotka
Phone +49| (0) 385|52190-346

17 Legal information

Marks

mzr® is a registered German trademark of HNP Mikrosysteme GmbH.

MoDoS® is a registered German trademark of HNP Mikrosysteme GmbH.

µ-Clamp® is a registered German trademark of HNP Mikrosysteme GmbH.

HNPM® is a registered German trademark of HNP Mikrosysteme GmbH.

Teflon® is a registered trademark of DuPont.

Viton® is a registered trademark of DuPont Dow Elastomers.

Kalrez® Spectrum™ is a registered trademark of DuPont.

PEEK™ is a registered trademark of Victrex plc.

HASTELLOY® is a registered trademark of Haynes International, Inc.

Aflas® is a registered trademark of ASAHI Glass Ltd.

Microsoft®, Windows® are registered trademarks of Microsoft Corporation in the USA and in the other countries.

Cavro® is a registered trademark of Tecan Systems, Inc.

Other product names or descriptions not mentioned above are possibly registered trademarks of related companies.

Patents

Micro annular gear pumps (and housings) are protected by assigned patents: EP 1115979 B1, US 6,520,757 B1, EP 852674 B1, US 6,179,596 B1, EP 1354135, US 7,698,818 B2. Patents pending DE 10 2011 001 041.6, PCT/IB2011/055108, EP 11 81 3388.3, US 13/884,088, CN 2011 8006 5051.7, HK 13 11 2934.9, DE 10 2011 051 486.4, PCT/EP2012/061514, EP 12 728264.8, US 9,404,492 B2, CN 2012 8003 8326.2. In the US, Europe and China additional patents are pending.

18 Safety information for the return of already employed micro annular gear pumps and components

18.1 General information

The operator carries the responsibility for health and safety of his/her employees. The responsibility extends also to employees not belonging to the company that have a direct contact with the micro annular gear pump and its components during repair or maintenance works. The nature of media (liquids) coming into contact with the micro annular gear pump and its components must be specified in the corresponding declaration form.

18.2 Declaration of liquids in contact with the micro annular gear pump

The staff performing the repair or maintenance works must be informed about the condition of the micro annular gear pump before starting any work on the device. The »Declaration of media in contact with the micro annular gear pump« should be filled in for this purpose.

The declaration should be sent directly to the supplier or to the company designated by the supplier. A second copy of the declaration must be attached to the shipment documents.

18.3 Shipment

The following instructions should be observed for the shipment of the micro annular gear pump.

- drain any remaining liquid from the pump
- flush the pump with an adapted flushing liquid
- remove the filter elements from the integrated or loosely delivered filters
- all the openings should be air-tight plugged
- return the pump in the original packing

18.4 Return address

Please send the micro annular gear pumps and components to this address.

HNP Mikrosysteme GmbH
Service
Brunnenstraße 38
D-19053 Schwerin
Germany

19 Declaration of media in contact with the micro annular gear pump and its components

Type of the device

Pump type/article no.: _____

Serial number: _____

Operating hours/running time: _____

Reason of return: _____

_____

_____

Contact with media (liquids)

The micro annular gear pump was in contact with:

_____

and has been rinsed with:

_____

Product info sheet / Material Safety Data Sheet: ☐ yes* ☐ no

* Please attach file

or is available on the following web site: www. _____

If a pump which had contact with dangerous substances could not be properly cleansed prior to shipment, we reserve the right to entrust a specialized company with cleansing of the device. The return of the pump in original packing is advisable. It is necessary in order to protect the employees and delivery staff.

Nature of media contact:

☐ explosive	☐ oxidizing	☐ sensitive to moisture
☐ toxic (toxic byproducts)	☐ radioactive	pH-value: approx. ____ to ____
☐ carcinogenic	☐ microbiological	other: _____
☐ irritant	☐ corrosive	_____

Hazard (H-statements): _____ Precautionary (P-statements): _____

Declaration

Hereby I/we affirm that the stated information is complete and correct. Micro annular gear pump and accessories are shipped in conformity with the applicable regulations.

company: _____ ☐ Mrs ☐ Mr title: _____

division: _____ name: _____

street, no.: _____ phone: _____

ZIP/city: _____ e-mail: _____

country: _____

city, date: _____ authorized signature / company stamp: