

Operating manual for micro annular gear pumps **mzr-2521X1 and mzr-2921X1**



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Last update: June 2021

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.

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1 General information

This operation manual contains basic instructions to be followed during integration, operation and maintenance of the m zr® 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 m zr-2521X1 and m zr-2921X1 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 handle 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 should not be used for "invasive" medical applications, in which the liquid having had contact with the pump is re-introduced to the body.



The micro annular gear pumps must not be used in aircrafts and spacecrafts or other vehicles without prior consent of the manufacturer.



The data concerning resistance of the pumps to manipulated liquids is elaborated according to the best of HNP Mikrosysteme's knowledge. However, operating parameters varying from one application case to another, no warranty for this information can be given.



The information given in this manual does not release the customer from 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 manual please contact directly HNP Mikrosysteme.

1.2 Product information

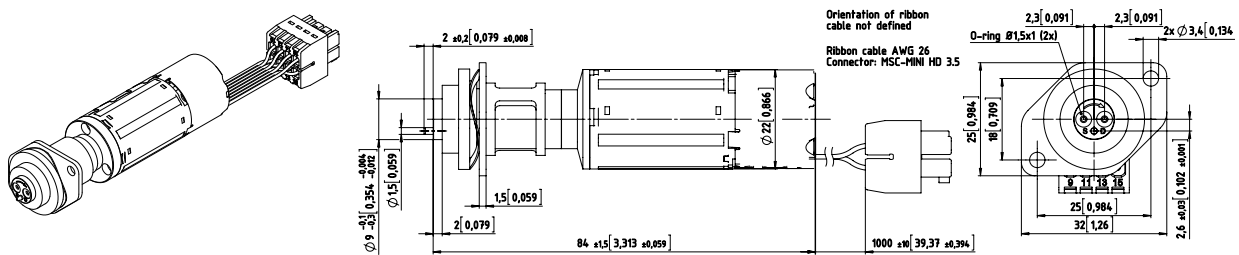
The present operating manual is valid for the micro annular gear pump types m zr-2521X1 and m zr-2921X1 manufactured by HNP Mikrosysteme GmbH, Bleicherufer 25, 19053 Schwerin, Germany.

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

1.3 Measurements

The micro annular gear pumps mzs-2521X1 and mzs-2921X1 have the same outer measurements.

The pumps are available in one versions featuring different liquid connectors. figure 1 shows the version with a manifold assembly, which is screwed and fixed with a holding nut to a preadapted support.



1.4 Flow charts

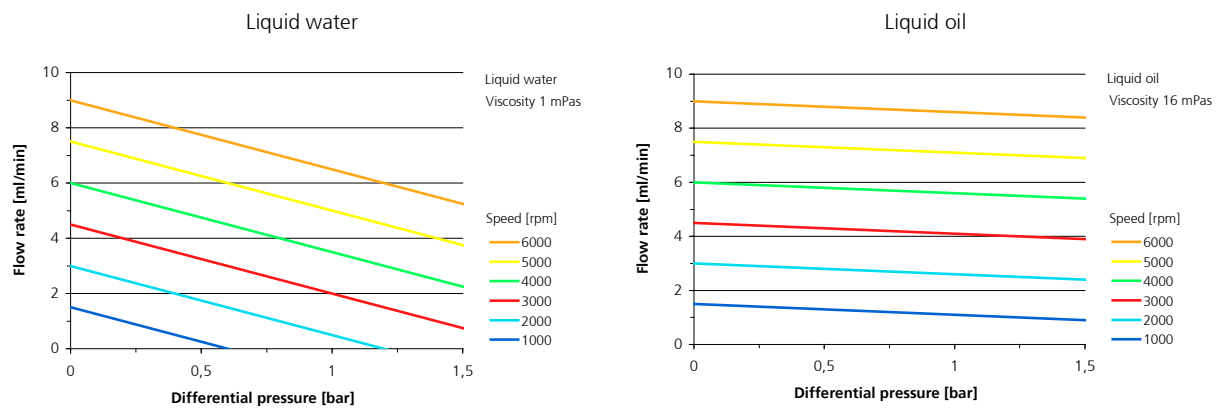


figure 2 Flow charts of mzs-2521X1

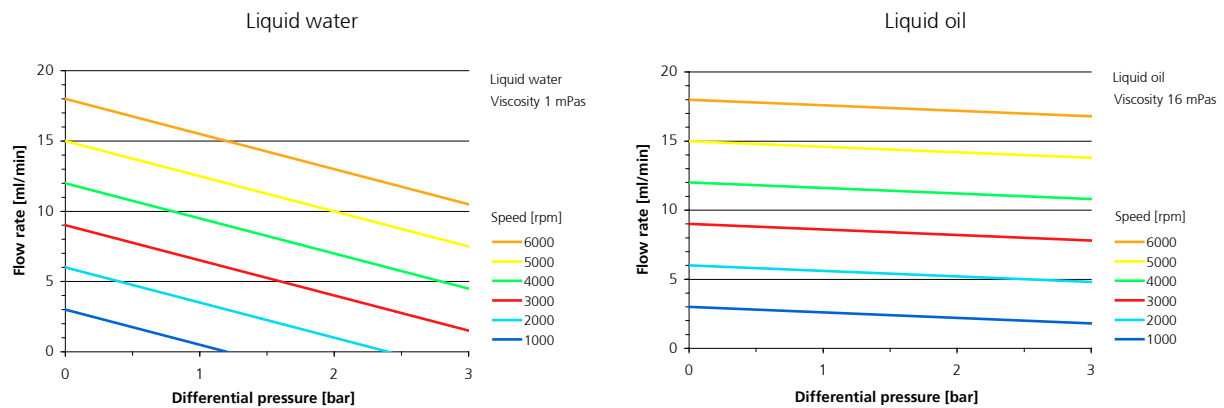


figure 3 Flow charts of mzs-2921X1

1.5 Technical data of the micro annular gear pump mzs-2521X1 and mzs-2921X1

	mzr-2521X1	mzr-2921X1
Technical data		
Displacement volume	1.5 µl	3 µl
Housing length without fluid connections	84,2 mm	84,2 mm
Housing length with fluid connections manifold assembly version	86,2 mm	86,2 mm
Diameter	22 mm	22 mm
Weight manifold assembly version	ca. 65 g	65 g
Internal volume	65 µl	67 µl
Pump materials	see chapter 4.3	see chapter 4.3
Performance parameters		
Min. flow rate Q (at 1 rpm)	0.0015 ml/min*	0.003 ml/min*
Max. flow rate Q (at 6000 rpm)	9 ml/min (= 0.54 l/h)	18 ml/min (= 1.08 l/h)
Min. dosage volume	0.25 µl	0.5 µl
Differential pressure (at viscosity 1 mPas)	1.5 bar	3 bar
Max. applied inlet pressure	1 bar	1 bar
Viscosity	0.3 – 100 mPas (1000 mPas*)	0.3 – 100 mPas (1000 mPas*)
Operating temperature	-20 ... 60 °C	-20 ... 60 °C
Ambient temperature	-20 ... 65 °C	-20 ... 65 °C
Storage temperature	10 ... 40 °C	10 ... 40 °C
Pulsation of flow (theoretical value)	1.5 %	6 %
NPSHR value	0.6 m	0,6 m

Legend:

* with supplementary modules	CV	Coefficient of variation
	NPSHR	Net Positive Suction Head Required

table 1

Technical data and performance parameters of the micro annular gear pumps mzs-2521X1 and mzs-2921X1

Warning

The material property of a liquid (e.g. viscosity, lubricating property, particle content, corrosiveness) impacts the technical data and the service life of pumps.

At 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.

1.6 Technical data of the drive

The micro annular gear pumps mzs-2521X1 and mzs-2921X1 are driven by brushless DC-motor. The motors are highly dynamic and suitable for programmed dosage tasks performed by the micro annular gear pump.

Measurements	
Diameter of the motor housing	22 mm
Length of the motor housing	49,6 mm
Performance parameters	
Nominal voltage	24 V
Max. continuous torque	4,75 mNm
Power	6,4 W
No-load speed	6800 rpm
Max. continuous current	440 mA
Terminal resistance	6,4 Ω
Terminal inductance	0.44 mH
Speed range	1 – 6000 rpm
Cable length	1 m
Operating temperature	-25 ... + 85°C

table 2

Technical data of the micro annular gear pumps mzs-2521X1 and mzs-2921X1

No.	Description
1	Digital Input
2	24VDC
3	GND
4	Analog input
5	Analog GND
6	Fault output
7	RS-232 RXD
8	RS-232 TXD

table 3

Pin configuration of the motor cable

Connector J2 Pin	Function	Wire	Labeling Terminal Box
9	Digital Input	1	Dig. Input
10	Voltage supply	2	24VDC
11	Ground	3	GND
12	Analog input	4	Analog In
13	Ground analog input	5	Analog GND
14	Fault output	6	Fault Out
15	RS-232 interface signal reception	7	RxD
16	RS-232 interface signal transmission	8	TxD

table 4

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

2 Safety instructions

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

2.1 Safety symbols in this operating manual

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

Danger symbol



Safety symbol according to
DIN 4844 – W9

High voltage symbol



Safety symbol according to
DIN 4844 – W8

Non compliance with the safety instructions marked with the following sign 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 operator in charge. 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 an adequate air ventilation and thus cooling of the motor.

The micro annular gear pumps m zr-2521X1 and m zr-2921X1 must not be used in areas exposed to explosion risks or in 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 complied with.

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 system such as tubes, hoses, filters etc. are free from dust or dirt particles. Impurities such as metal swarf, plastic or glass splinters 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 it is at a standstill. The turning-off 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 notice of the instructions listed in the chapter 6.5.

Warning

Should a malfunction of the m zr-pump occur, do not dismantle the pump on your own but contact one of HNP Mikrosysteme 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 initial tank or back onto the suction side.



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



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 electrical parameters of the drive must 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 absolutely free from dust or dirt particles. Impurities such as metal swarf, plastic or glass splinters 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 transport-related damage, 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 caps must be put on
- the pump should not be stored in humid places
- for storage temperature - refer to chapter 1.5 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 4). 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 5). A homogenous flow is generated between the kidney-like inlet and outlet.

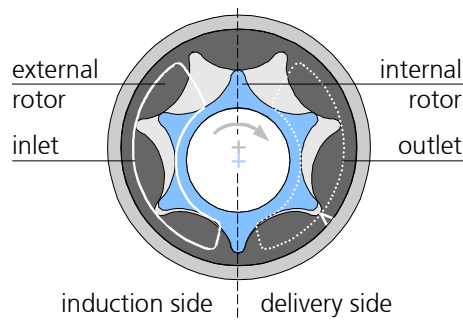


figure 4

Principle of the micro annular gear pump

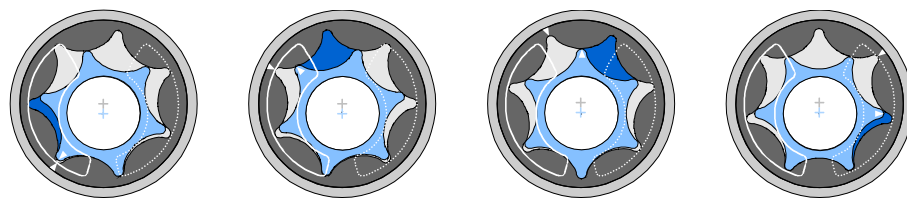


figure 5

Operating principle of the micro annular gear pump

In the case of rotary displacement pumps, the delivered amount of liquid may be easily calculated from 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 cycle of the rotor. This relation is illustrated by the following formula:

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

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

Example: According to the formula mentioned above the m zr-2521X1 pump featuring a displacement volume of 1.5 μl , delivers at 3000 rpm and with a volumetric efficiency of 100% 4.5 ml/min. The table 5 shows theoretical flow rate values depending on speed expressed in ml/min and ml/h.

Speed [rpm]	m zr-2521X1		m zr-2921X1	
	Q [ml/min]	Q [ml/h]	Q [ml/min]	Q [ml/h]
500	0.75	45	1.5	90
1000	1.5	90	3	180
2000	3	180	6	360
3000	4.5	270	9	540
4000	6	360	12	720
5000	7.5	450	15	900
6000	9	540	18	1080

table 5

Theoretical flow rate of the micro annular gear pumps m zr-2521X1 and m zr-2921X1

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

The *viscosity* of the handled 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 from a certain limit speed value, may reduce the volumetric efficiency of a pump. In the case of high viscosity liquids this limit speed value is lower. That happens because of the liquid-specific drop of vapor pressure in the induction (suction) tube which leads to gas formation inside the pump.

The particularity of the m zr-pumps is their highly precise construction design, 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 (figure 6) is composed of the pump head, the drive unit and the connection cable with plug. The micro annular gear pump head is available with two different fluid connection versions.

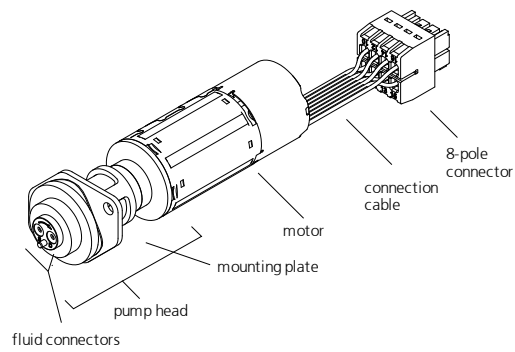


figure 6

Layout of the micro annular gear pumps mzs-2521X1 and mzs-2921X1

4.3 Construction materials

Wetted parts	m zr-2521X1-hs-vb / m zr-2921X1-hs-vb-
Housing	stainless steel 316L (1.4404) epoxy resin
Fluid connectors	stainless steel 316L (1.4404)
Rotors	tungsten carbide (WC-Ni))
Bearing	ceramics
Dynamic sealing (shaft sealing)	graphite-reinforced PTFE, spring: stainless steel 316L
Static sealing (O-rings)	FKM (fluoroelastomer), optional EPDM, FFPM (perfluoroelastomer)

Wetted parts	m zr-2521X1-cs-fb / m zr-2921X1-cs-fb-	m zr-2521X1-cy-fb / m zr-2921X1-cy-fb
Housing	stainless steel 316L (1.4404) epoxy resin	alloy C22 (2.4602), epoxy resin
Fluid connectors	stainless steel 316L (1.4404)	Alloy C22 (2.4602)
Rotors	partially stabilized ZrO2 or TAZ composite ceramics	partially stabilized ZrO2 or TAZ composite ceramics
Bearing	ceramics	ceramics
Dynamic sealing (shaft sealing)	graphite-reinforced PTFE, spring: stainless steel 316L	graphite-reinforced PTFE, spring: alloy C276 (2.4819)
Static sealing (O-rings)	FKM (fluoroelastomer), optional EPDM, FFPM (perfluoroelastomer)	FKM (fluoroelastomer), optional EPDM, FFPM (perfluoroelastomer)

table 6

Construction materials of the wetted parts m zr-2521X1 and m zr-2921X1

Resistance of the construction materials to the delivered liquids should be verified by the operator for each individual application. For non-lubricating liquids service life of the pumps is shorter.

4.4 Liquid supply

The micro annular gear pump head is available with two different liquid connector versions.

Slip fittings

The micro annular gear pump head is equipped with two front slip fittings with OD 2 mm for connection of flexible tubes with the ID < 2 mm (such as 1/8" hose).

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 by plastic caps. Please remove them before you assemble the pump.

Manifold assembly

The micro annular gear pump with manifold assembly has been designed for integration into systems. The benefit of the manifold assembly is diminished cubage for easier integration of the micro annular gear pump and higher pressure resistance.

You can see in figure 7 the assembly dimension and in figure 8 the installation position of sealing.

Installation space version mzs-2521X1 M2.1 and mzs-2921X1 M2.1

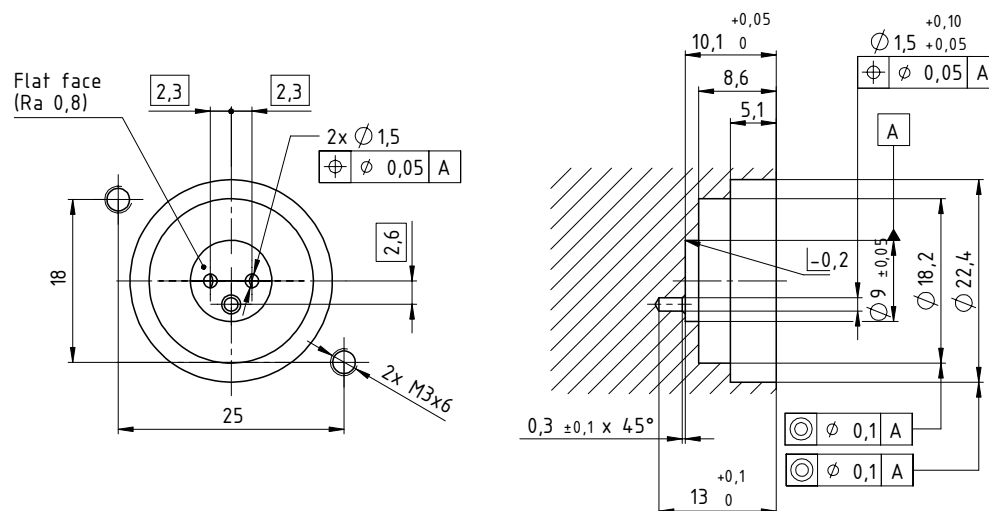


figure 7

Dimensions configuration version m2r-2521X1 M2.1 and m2r-2921X1 M2.1

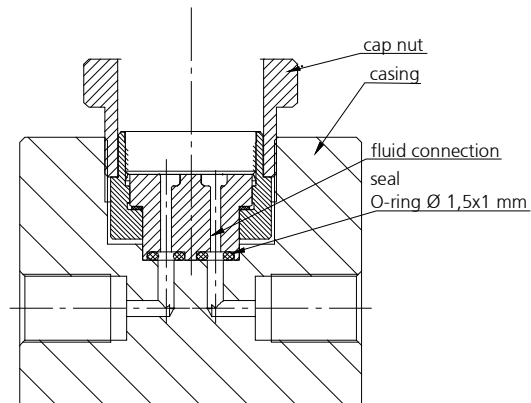


figure 8

Pump after installation with both gaskets (version M2)

In order to prevent foreign bodies from penetrating into the pump, the liquid inlet and outlet are protected by plastic plugs or screws.

Warning

It has to be taken care the packaging of the O-rings that these sit in the scheduled groove properly. At not proper location of the O-rings the fluid terminal connection can be or get leaky.

Warning

Tighten the cap nut only hand screwed!
Too firm tightening of the cap nut can rotate to one the pump housing to lead. The pump can block.

5 Optional modules

The spectrum of applications of the low pressure micro annular gear pump series may be expanded by using different additional modules. The modules allow for special dosage tasks, 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.

- By-pass module for the delivery of minimal constant flow rates down to the nanoliter range (see chapter 5.1)

Due to specific requirements of each application the configuration of a given pump version should be discussed with the technical service. Additional customized modules may be designed on demand.

5.1 By-pass module (optional)

The by-pass module allows constant minimal volume dosage with flow rates in the nanoliter range. The technology is based on the division of flow generated by the micro annular gear pump, according to the relationship of fluidic resistance of two predefined capillaries. The micro annular gear pump generates a master circulation from which a side dosage current is derived. This micro flow capillary allows to obtain flow rates starting at 1 $\mu\text{L/h}$. The minimal and the maximal flow rate may differ by a factor of 100 (dynamic factor). In order to determine the lower flow rate limit, both capillaries need to be carefully configured. It is possible to obtain flow rates between 1 and 10,000 $\mu\text{L/h}$.

The by-pass module assures dosage of minimal amounts of liquids at a very high constancy of flow and a pressure-resistant flow rate.



figure 9

The by-pass module

Performance parameters	
Operating flow rate range	1 – 10,000 $\mu\text{L/h}$
Differential pressure range	0 – 3 bar
Max. applied inlet pressure	1 bar
Pulsation	<1 %
Operating temperature	-20 ... +60 °C
Viscosity range	0.5 – 100 mPas
Fluid connections	Liquid intake: tube or hose, OD 1/8" Master capillary: tube, OD 1/8" (return line to the tank) Side current capillary: tube, OD 1/16" (dosage capillary)
Wetted parts	stainless steel 316L, PEEK
Measurements	□ 32 x 25 mm (by-pass module without pump)
Weight	approx. 140 g (by-pass module without pump)

table 7

Technical data of the by-pass module

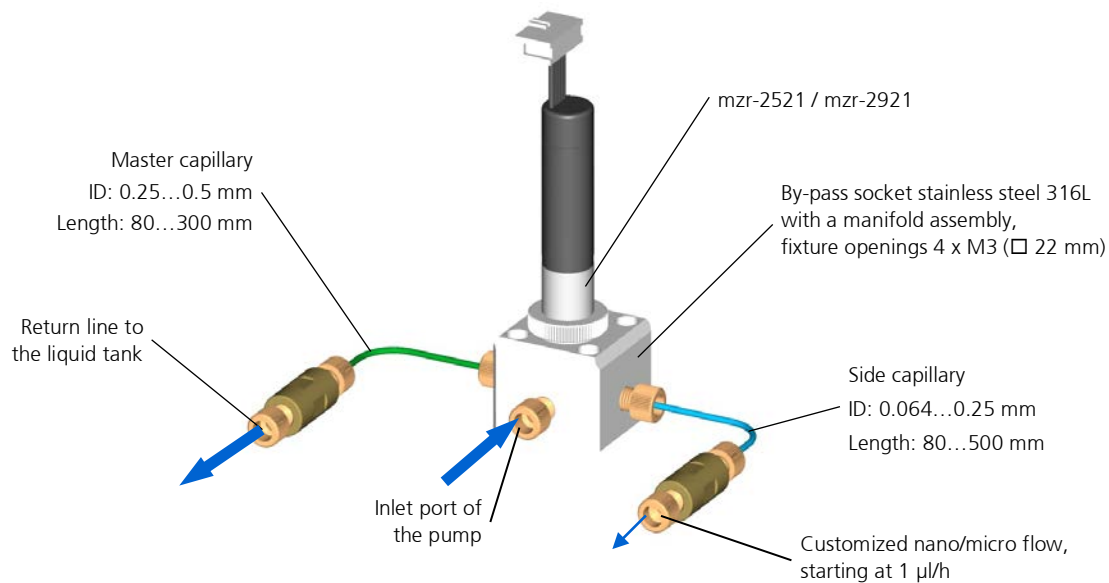


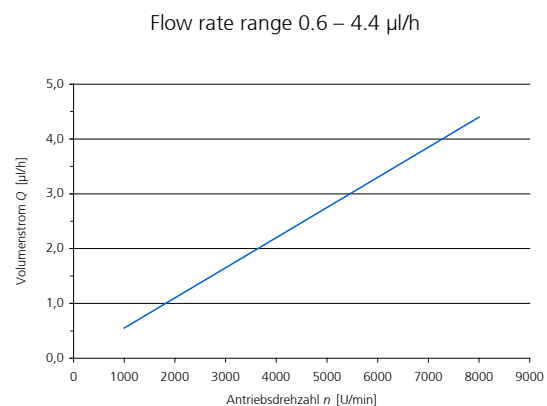
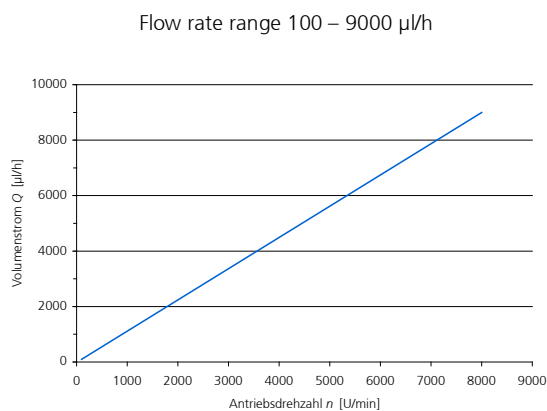
figure 10

Construction of a by-pass module

Working principle

The by-pass module shown in the figure 10 divides the flow generated by the micro annular gear pump into master and side circulation. The module serves at the same time as a support and fixture for the micro annular gear pump. The selection and configuration of the different components of the system is calculated by a PC. The master circulation capillary (the tube going back to the liquid tank) and the pump are selected and configured for each customer-specific dosage task. In this way the pump operates with the desired volumetric efficiency and can generate pressures reaching beyond the required pressure level. Depending on the difference of pressures between the delivery side of the pump and the system, a side current capillary is designed and precisely adjusted so that the desired minimal flow rate is obtained at its outlet. The flow charts of the by-pass module are verified before the shipment.

Flow chart examples



6 System integration

6.1 Checkup before the first assembly

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

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

- *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 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.

The pump may be installed on a plastic or stainless-steel cable screw M20.

Warning



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



If the pump is mounted flexibly or dosing tasks require change of pump position, please fasten the cable with an adapted cable tie at the motor in order to avoid strain. If the pump is moved over a longer time, the cable may break at its connection to the motor.



Take precautions that in case of leakage no surrounding objects or environment will be exposed to danger.

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

6.3 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 pore 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 filter.

In order to select the best adapted filter, such operating parameters as the flow rate, the viscosity and the 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 pressurization of the delivered liquid. In case no suitable filter for the given 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. As an alternative solution 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 induction (suction) tubing with already filtered liquid in order to avoid a too long dry run of the pump during the first operation.

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.

6.4 General instructions for the assembly of the liquid supply network

Foreign bodies and dirt particles can block the micro annular gear pump and lead to its damage.

Warning

Please note that all the components of the liquid supply system should be clean and flush them if needed before pump installation. Remember to remove all remaining splinters or swarf from connection fittings, rests from liquid containers and any dirt from valves, tubing and filters.

Warning

Operate the pump with a filter featuring 10 µm or smaller pores. The filter protects the pump from particles and dirt.



If the pump is connected once again with a hose that has already been used, the enlarged ending of the hose should be cut off in order to prevent it from slipping off and the liquid from flowing out of the connection.

6.4.1 Assembly of the fluid connection fittings

1. Cut the hose to a right angle by using an adapted hosecutter.

Warning

Remove the protection caps from the slip fittings of the pump.

2. If needed, warm up or widen the hose and slip it on the slip fitting till it touches to the housing.



Pay attention to the correct assembly of the tubing and the pump head in order to keep the default direction of flow. If you wish to operate the pump in a reverse direction, please contact one of HNP Mikrosysteme's application engineers since it is not possible in every case.

3. The intake tubing should be kept as short as possible and have a possibly large internal diameter in order to assure best intake performance.
4. In order to avoid dry operation, check before each use that enough liquid is supplied to the pump.

Warning

Dry run 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.

6.4.2 Installation with the manifold assembly

1. Put the pump in the desired position for installation. Ensure that the intake and the delivery fluid connections have not been inverted.

Warning

Check if the o-ring 1.5 x 1 mm lay correctly and are not damaged.

2. Screw on the holding nut.

3. In order to avoid dry operation of the device, provide before each operation for a sufficient liquid supply.

Warning

Dry run 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.

6.4.3 Assembly instruction for tubing and accessories manifold assembly

The manifold assembly has two ports 1/4"–28 UNF for liquid supply connection.

The fluid connection fittings feature standardized plastic tubing or stainless steel tubing with a diameter of 1/16" (1.588 mm), 3 mm 1/8" (3.175 mm). The fluid connection fittings are composed of a threaded part, a lock ring and a ferrule. The seal effect is obtained thanks to the plane ending of the ferrule and the tube. The threaded part assures the required pressing force.

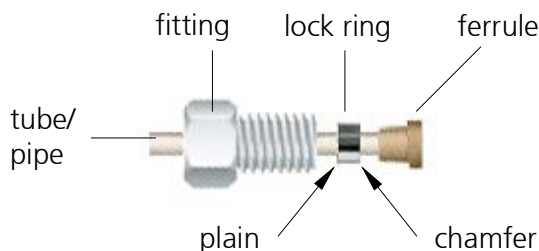


figure 11

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 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 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. In order to avoid dry operation of the device, provide before each operation for a sufficient liquid supply.

Warning

Prolonged 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.

6.5 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 m zr-2521X1 and m zr-2921X1.

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 "power / signal" J1
- alternative voltage supply via a DIN connector conform with DIN 45323
- separable pump connection "m zr-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

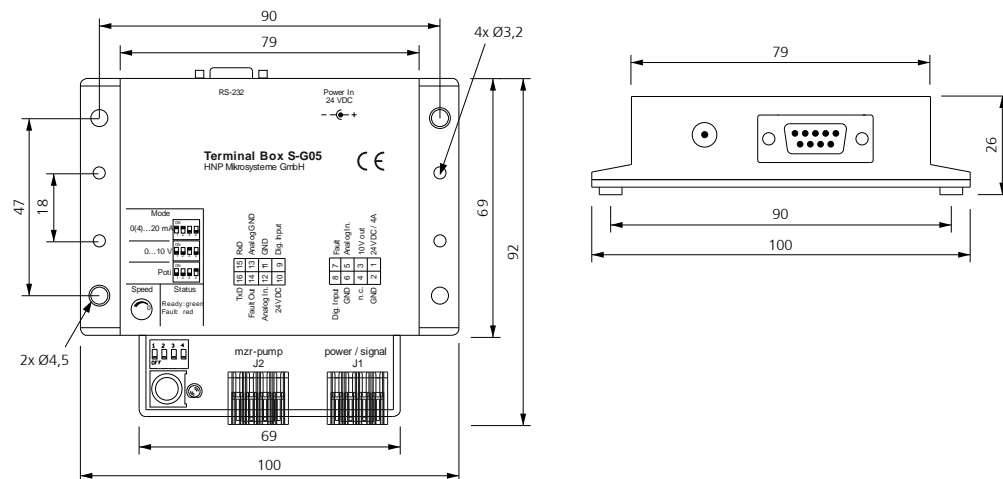


figure 12

Measurements of the Terminal Box S-G05

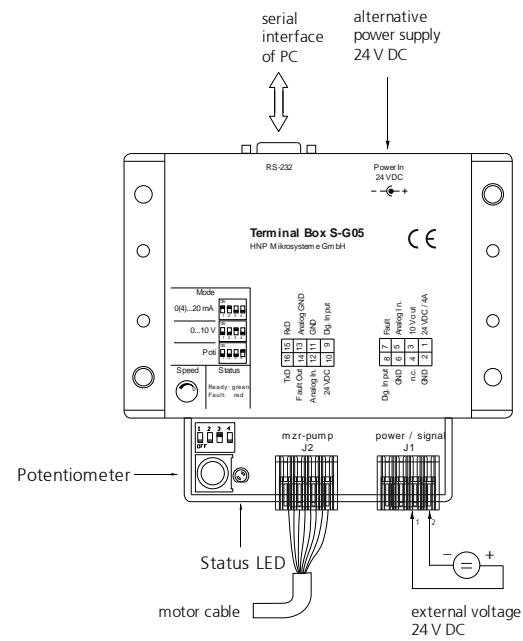


figure 13

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 8

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

Connector 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 9

Connector J2 "mzt-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 14

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 10

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.

6.5.1 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 9.
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.

6.5.2 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 9.
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 15)

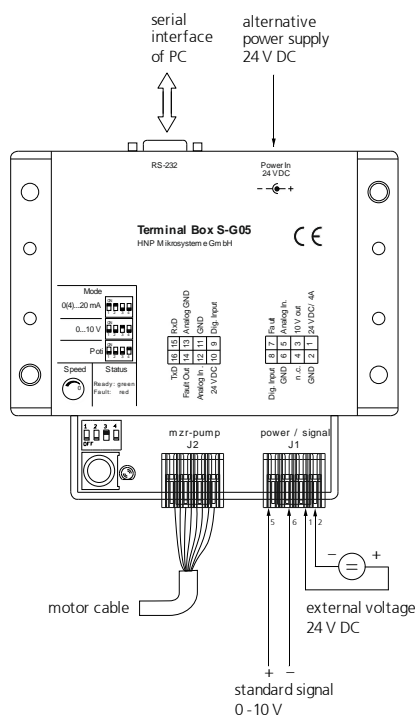


figure 15

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 laid 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 1.6).

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.

6.5.3 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 9.
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 16).

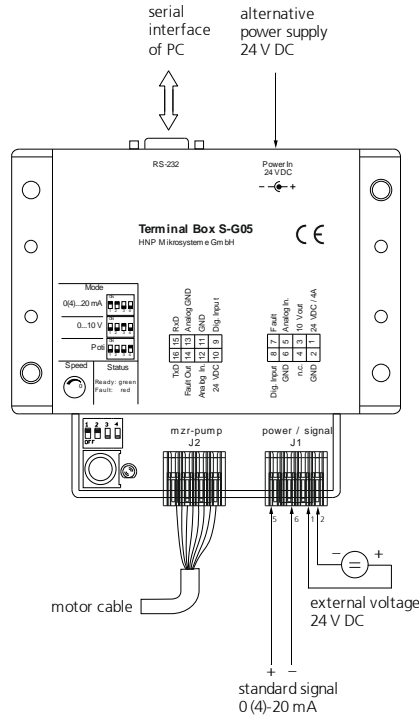


figure 16

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 1.6).

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.

6.5.4 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 9.
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 15)

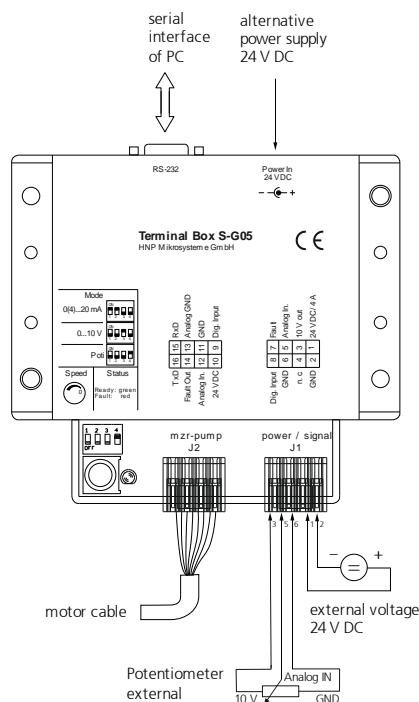


figure 17

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 1.6).

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.

6.5.5 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 9.
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.

6.5.6 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.

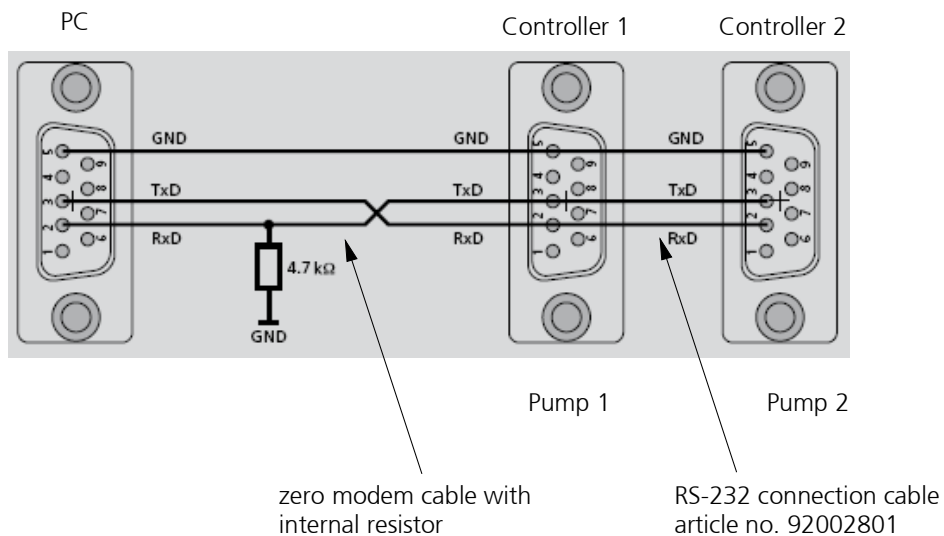


figure 18

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 9.



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.

7 The startup/shutdown of a 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 or hoses 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 first start?

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 the potentiometer knob, by sending a nominal external voltage signal or with the delivered software (see chapters 8, 9).
- 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 into 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 11 / table 12). During the flushing procedure the pump should operate at 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 be 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 liquid is suitable for this function or not, please ask the manufacturer of the liquid or HNP Mikrosysteme.

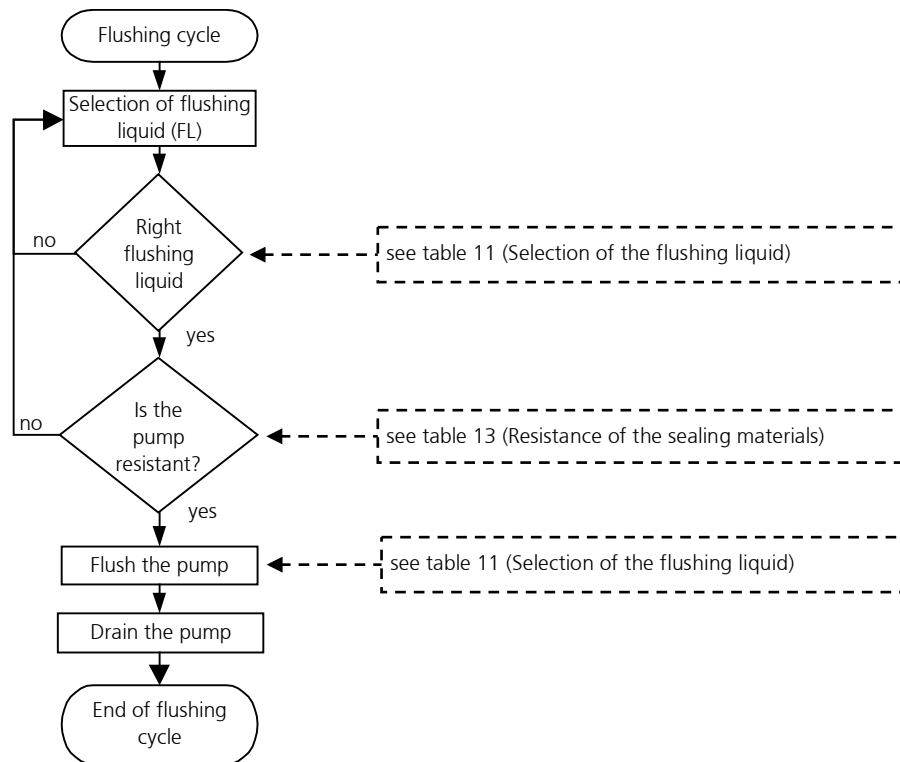


figure 19

Flushing procedure

Warning

Liquids remaining 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 12).

Warning

The flushing liquid (solvent) and the recommended duration of the flushing procedure depend on the delivered liquid (see table 11). The indicated flushing liquids are simple recommendations and should therefore be checked by the user as to their compatibility and suitability.



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

	Nature of the handled liquid	Flushing cycle [min]	Suitable flushing liquid
1	Oils, fats, plastifiers	15-20	isopropanol, ethanol, acetone, benzine
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 watery 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 11

Selection of the flushing liquid (solvent) and the duration of the flushing cycle 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 12).

Flushing liquid	Shaft sealing		O-ring material		
	PTFE, graphite-reinforced	UHMWPE	FPM	EPDM	FFPM
acetone	0	0	3	0	0
benzene	0	3	1	3	0
benzyl alcohol	0	-	0	2	0
benzine	0	0	0	3	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
oil / fine mechanics oil	0	0	0	3	0
styrene	0	-	1	3	1
toluene	0	1	2	3	0
water	0	0	0	0	0
xylene	0	1	2	3	0

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

table 12

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

7.4 Shutdown of the micro annular gear pump

During the shutdown of the pump the following steps should be followed

- Flush the pump with a filtered and particle-free flushing liquid (solvent) (see 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 20) you may prepare the pump for a longer standstill.

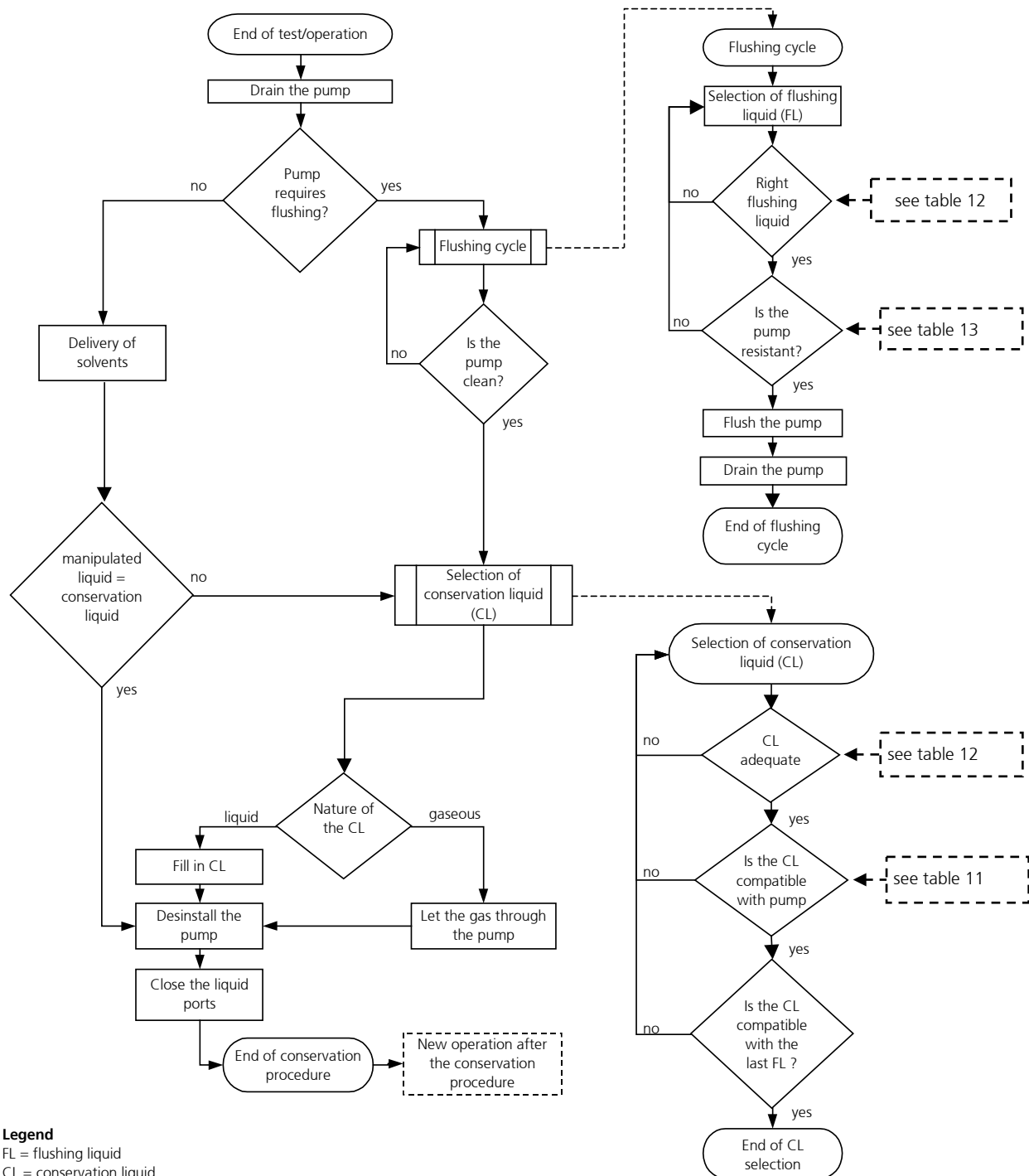


figure 20

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 13 depending on the duration of the standstill and the resistance of the pump to the manipulated liquid (table 12). The indicated conservation liquids are simple recommendations and should therefore be checked by the user as to their compatibility and suitability. The figure 21 presents the diagram of conservation liquid selection.

Remark: This diagram is repeated as a part of the figure 20 »Shutdown procedure«.

After the cleansing procedure the pump should be filled with a suitable conservation agent. You will find a choice of possible conservation liquids in the table 13.

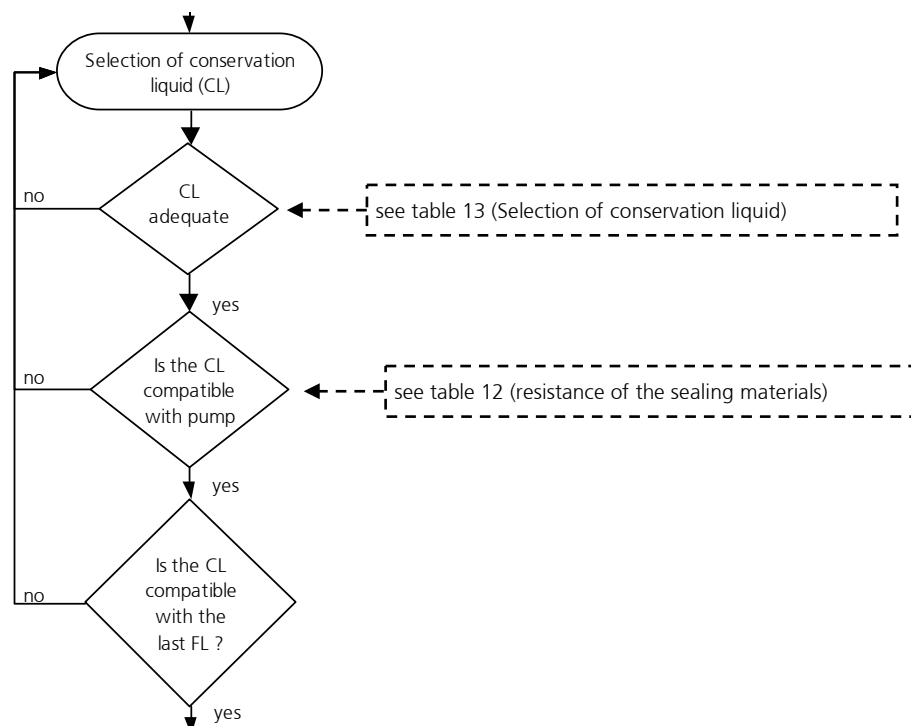


figure 21

Selection of the 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 (<i>Warning</i> : 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 13

Selection of the conservation liquid

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

Warning

Water or deionized water (DI-water) *should not* be used as conservation agents. These liquids 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 caps or screws.

7.5 Trouble shooting

If the pump does not start to operate or stops the operation abruptly, please proceed as follows:

Try to liberate the micro annular gear pump:

- by turning the potentiometer knob back and forth or by sending an analog voltage signal
- via the control software
- by pressing with a syringe a suitable flushing liquid (see table 11 and table 12) 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 dismantle 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 carry out the repair should be informed about the condition of the used micro annular gear pump. This is done by means of the "Declaration of media in contact with the micro annular gear pump and components" (see chapter 19). This form may also be downloaded from the web site <https://www.hnp-mikrosysteme.de/service/download-center.html>.



The "Declaration of media in contact with the micro annular gear pump and components" must imperatively be filled in. The nature of liquid which entered into contact with the micro annular gear pump and the components must be specified.

In case of non-compliance, the sender will be liable for any resulting injury to persons or any object damage.

8 Software »mzr-pump control«

Install the delivered software »mzr-pump control« from both diskettes or CDs by starting the program »Setup« on the diskette »Disk 1« or CD. The delivered software is compatible with Windows 95®, Windows 98®, Windows NT, Windows 2000® and Windows XP®.

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

If the diskettes »mzr-pump control« are not available because you have received for example the »Motion Manager« software instead, you may download this software from the web site www.hnp-mikrosysteme.de/downloads.htm. The updated version is always available in English and German.

After a successful installation the program »mzr-pump control« can be found in the start menu under »Programs - HNP Mikrosysteme«. After the program had been initiated, data such as the pump type »mzr-2521« and »mzr-2921«, the encoder resolution and the gear reduction should be set.

The »Dosage« operating mode (see figure 22) 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 as according to speed profile which is set for such values as »Max. velocity« and the »Acceleration«. The maximal allowable speed values extend from 1 to 6000 rpm and the acceleration values from 1 to 2000 rotation/s².

A dosage task 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.

In the »Continuous flow« operating mode (see figure 23) continuous flow rates in units such as ml/min, g/min and rpm may be set. The operation of the micro annular gear pump for the indicated »Duration« value may be initiated with the »Start« button or by pressing the enter key. Checking of the »endless« box will put the pump to continuous operation. Pressing on the »Stop« button or on 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 control unit.

The input of the »Fluid density« enables to convert units of weight to the given volumes or flow rates expressed in volume units.

Remark: if you are only working with volumes, the indication of liquid density will not be necessary and the standard value »1« can be left.

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 liquid. 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 value of the calibration factor will only slightly exceed 1.

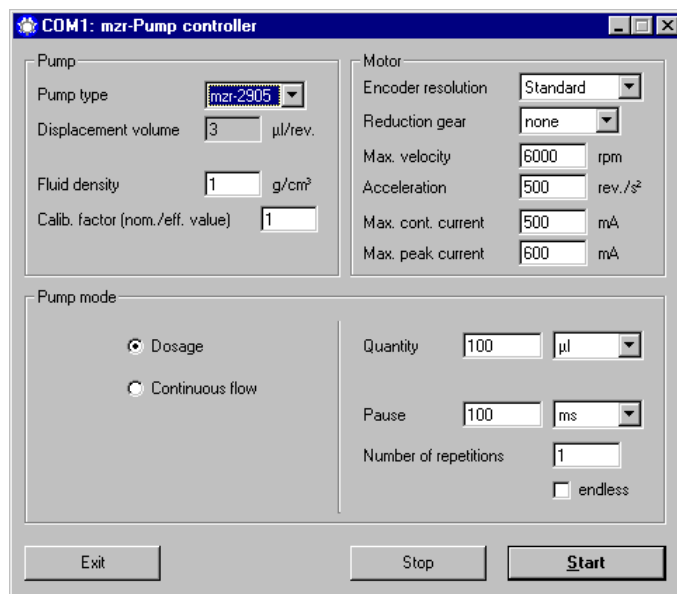


figure 22

Setup window in the »Dosage« operating mode

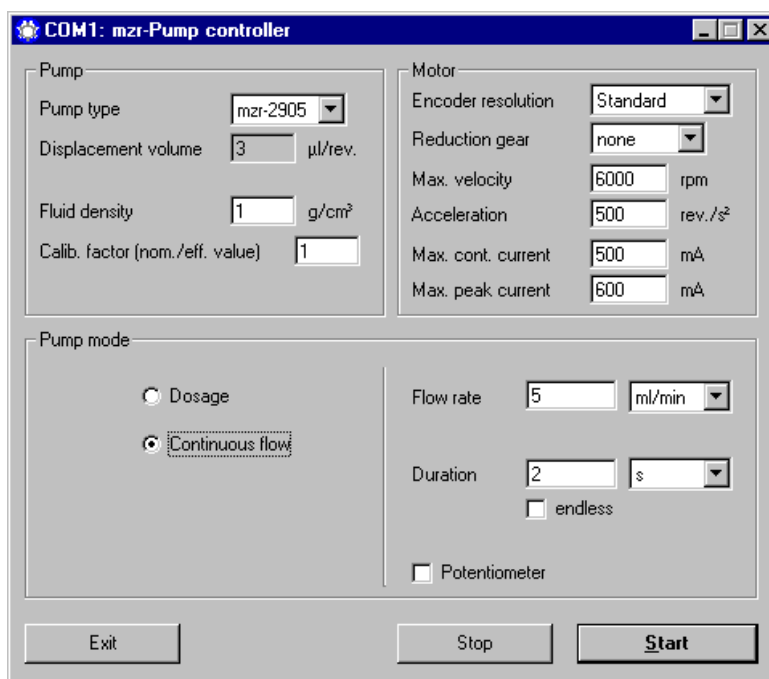


figure 23

Setup window in the »Continuous flow« operating mode

9 »Motion Manager« software (optional)

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 8.1 or Windows 10® operating systems.

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

If the »Motion Manager« CD are not available, and you have received for example the »mzt-pump control« software, 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

The »Motion Manager« software enables to send the input commands directly to the drive. This allows execution of movement commands and modification of the drive parameters. (see figure 24)

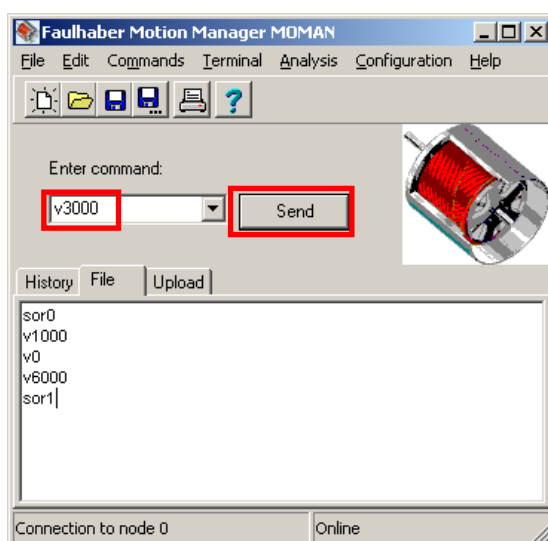


figure 24

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 24). The commands may be given alternatively in capital or lowercase letters. Excess space characters will be ignored by the drive.

An example for continuous delivery

Command	Description
SOR0	Set the nominal speed via the RS-232 interface
V1000	Operate the pump at 1000 rpm (for the mzs-2521X1 with a displacement volume of 1.5 µl a flow rate of 1.5 ml/min is obtained; for the mzs-2921X1 a flow rate of 3 ml/min)
V0	Pump at rest (speed 0 rpm)
V6000	Operate the pump at 6000 rpm (Flow rate: mzs-2521X1 = 9 ml/min; mzs-2921X1 = 18 ml/min)
SOR1	Analog input operating mode: Set the nominal speed with potentiometer or by connecting a voltage signal to the analog input

An example for discrete dosage

Command	Description
SOR0	Set the nominal speed via the RS-232 interface
LR15000	Load a relative position of 3000 to the control unit 15000 = 5 rotation cycles, displaced volume mzs-2521X1 ≈ 7.5 µl; mzs-2921X1 ≈ 15 µl (Remark: 3000 steps = 1 rotation)
M	Execute the task / start positioning
LR30000	Load a relative position of 30000 to the control unit (30000 = 10 rotation cycles, displaced volume mzs-2521X1 ≈ 15 µl; mzs-2921X1 ≈ 30 µl)
M	Execute the task / start positioning
SOR1	Analog input operating mode: Set the nominal speed with potentiometer or by connecting a voltage signal to the analog input

For detailed information as to the use of Motion Manager, please read the program online help.

9.2 Programming of the control unit

The S-ND control unit of the micro annular gear pump may be adapted by the user to a specific application 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 "motion controller language". Various parameters of the drive such as the maximal speed, the acceleration, the number of rotations to be executed, the allowable current load and the parameters of the PI-controller may be programmed. Furthermore, it is possible to program short movement sequences which will be saved in the independent memory of the drive and then autonomously executed.

A diskette with mcl-programs is included in the delivery and may be saved in the control unit.

9.3 Transfer of a mcl-file to the drive

The existing mcl-files may be downloaded to the editor window by selecting File – Open (see figure 25).

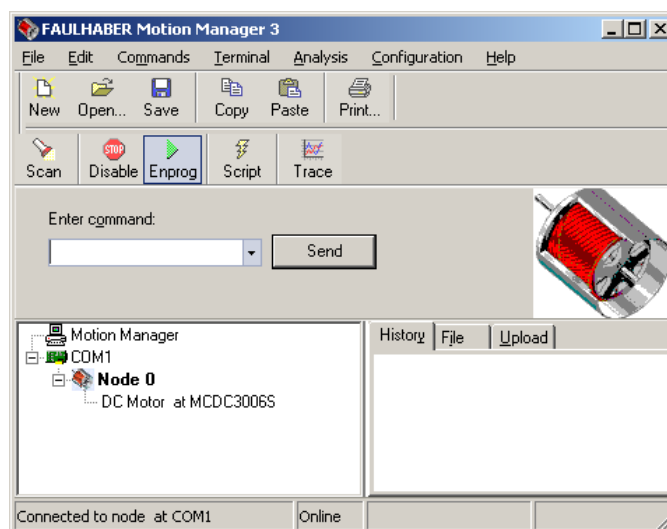


figure 25

Menu file- open

The required mcl file may be selected and loaded from the file selection window (see figure 26).

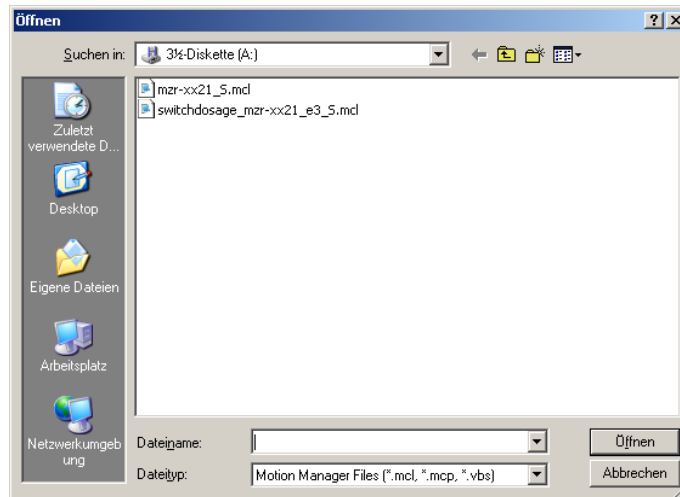


figure 26

File selection window

The mcl-file is transferred to the drive by selecting *Terminal - Transfer Configuration file* from the menu (see figure 27).

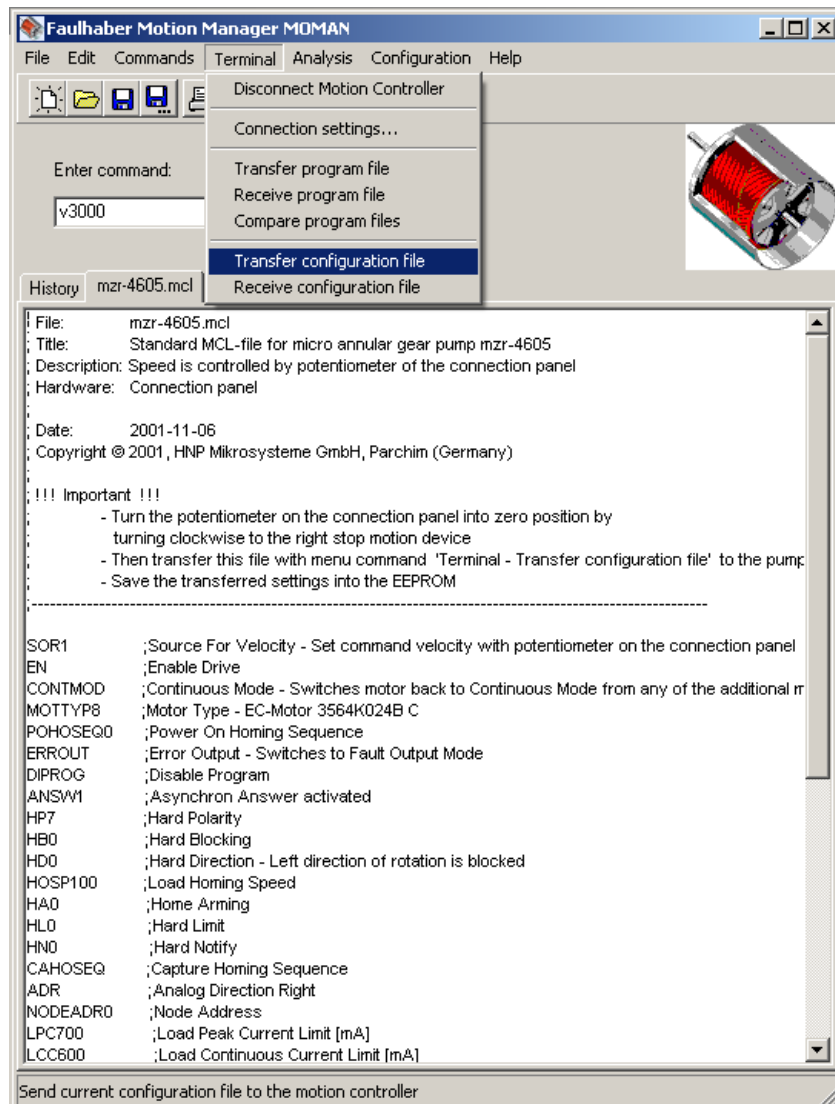


figure 27

Transfer of a mcl-file as a 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, please confirm the dialogue window with »OK« (see figure 28). With this confirmation the program will be saved in the memory with a resident status and will be available for future operation.

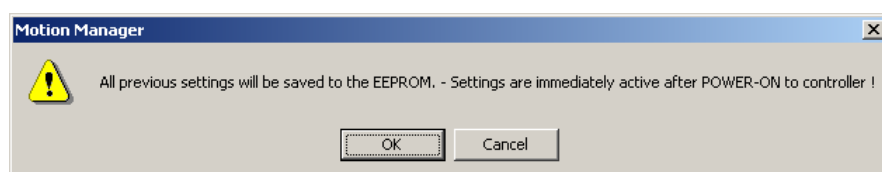


figure 28

Storage confirmation

10 Accessories for microfluidic systems

The accessory range for the liquid delivery systems of HNP Mikrosysteme comprises complementary equipment such as supplementary modules, hoses, tubing, fluid connection 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 for damages resulting from the non-respect of instructions comprised in this operating manual.

It remains at the responsibility of the user to conform to all laws, rules and regulations in force. This applies above all to the handling of aggressive, poisonous, corrosive and other dangerous liquids as well as to the electromagnetic compatibility (EMC).

12 Problems and their removal

Disturbance	Cause	Solution
1 The pump does not start operation.	No power supply	Check the power supply.
2 The pump does not deliver any 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 system (such as in the delivery tube or hose, the needle or external non-return valve)	Check the components for possible disturbances to be eliminated. Cleanse the accessories if 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 conditions have been fulfilled start signals (PLC, start input) and the programming.
	Motor fault: Status LED of the control unit S-ND turns red.	Check the error status of the S-ND control unit with the Motion Manager software.
		Read the operating manual for the motor control unit.
3 The pump does not start to operate.	The pump does not take in the liquid.	The tubing on the suction side is too long or has a too small internal diameter (a too low NPSHA value).
		The tubing or the fluid connection on the suction side are not tight. Please check the intake connection and the tubing.
		Air bubbles in the 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	Cleanse, flush or exchange 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 status LED has turned red 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 in a reverse direction for 1 s with - 1000 rpm.
		Adapt the motor current of 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

Disturbance	Cause	Solution
		in a reverse direction for 1 s with - 1000 rpm.
		Flush the pump with a syringe.
		Return the pump to the manufacturer for cleansing. Use a filter, flush the liquid delivery system.
	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.
6 Dosage volume does not correspond to the desired values.	Air bubbles in the liquid delivery system (tubing, valves)	Fill in the pump and the liquid delivery system with liquid.
	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 unit to the manufacturer.
	Encoder cable disconnected	The motor works at high speed. Check the installation, return the pump to the manufacturer for checkup.
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 at a higher level than the dosing needle.	Place the liquid tank at the same or slightly lower level as the pump.
9 Liquid leaks out of the sealing module.	Too high pressure on the sealing liquid supply cartridge or defective sealing	Stop pressurizing the sealing liquid supply cartridge. If needed return the pump to the manufacturer.
10 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 in order to change the shaft sealing.
13 Leakage from the fluid connections	Untight locking rings	Exchange or tighten the fluid connections, exchange the fluid connection.
14 Air bubbles on the delivery side.	Loose fluid connections (particularly on the induction (suction) side)	Check and tighten the fluid connections.
	The shaft seal is untight or worn.	Return the pump to the manufacturer.
15 The error status of the pump cannot be retrieved.	No connection with the pump	Check the supplied voltage.
		Check the connection of the interface with the null-modem cable. Replace the cable if needed.
	The motor control unit does not respond.	Turn off the voltage supply for a short time, then turn it on again. Start the pump automatically with the integrated control unit.

Disturbance	Cause	Solution
16 Minimal leakage during standstill	No error, cause relative to the operating principle	Use a non-return valve. Place the liquid tank at the same or slightly lower level as the pump.
17 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 manufacturer.
18 The pump is noisy.	Wear out of the pump or defective components.	Do not continue to operate the pump, return it to the manufacturer for maintenance.
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 the 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 unit may be damaged. Return the pump to the manufacturer.

table 14

Problem shooting



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 HNP Mikrosysteme (see chapter 16). If needed return the pump to the manufacturer for checkup.

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)



Disposal of micro annular gear pumps has to be environmentally sound. All materials and liquids have to be recycled in accordance with the relevant regulations. Electrical parts can not be disposed of as household waste. They have to be delivered to designated collection points.

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 values!

Installation instructions

For the control unit S-KG no further conditions must be fulfilled in order to comply with the EMC-protection requirements.

14 Declaration 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.

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

We hereby declare that the following micro annular gear pumps of the low pressure series:

mzr-2521X1, mzr-2921X1

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: December 30, 2016

Signature manufacturer:

Dr. Thomas Weisener
CEO

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

We hereby declare that the following micro annular gear pumps of the low pressure series:

mzr-2521X1, mzr-2921X1

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: December 30, 2016

Signature manufacturer:

Dr. Thomas Weisener
CEO

15 Service, maintenance and warranty

Maintenance of the micro annular gear pump should be carried out depending on the delivered liquid:

- *for lubricating liquids* after 4000 working hours, but not later than 15 months after the initial operation
- *for non-lubricating liquids, crystallizing liquids or liquids containing particles*, after 3000 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 4000 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 changing 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 7.3. 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 or dismantle the micro annular gear pumps. The warranty extinguishes 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 media (liquids) having had contact with the micro annular gear pump and components must imperatively be completed. The nature of media (liquids) must be specified. In case of non-compliance the sender will be liable for any resulting injury to persons or any object damage.



Sealing elements, 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

m zr® 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 media 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 the pump from any remaining liquid
- 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

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:

<input type="checkbox"/> explosive	<input type="checkbox"/> oxidizing	<input type="checkbox"/> sensitive to moisture		
<input type="checkbox"/> toxic (toxic byproducts)	<input type="checkbox"/> radioactive	pH-value: approx. <table><tr><td></td></tr></table> to <table><tr><td></td></tr></table>		
<input type="checkbox"/> carcinogenic	<input type="checkbox"/> microbiological	other: <table><tr><td></td></tr></table>		
<input type="checkbox"/> irritant	<input type="checkbox"/> corrosive	<table><tr><td></td></tr></table>		

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:	<table><tr><td></td></tr></table>		<input type="checkbox"/> Mrs <input type="checkbox"/> Mr title: <table><tr><td></td></tr></table>	
division:	<table><tr><td></td></tr></table>		name: <table><tr><td></td></tr></table>	
street, no.:	<table><tr><td></td></tr></table>		phone: <table><tr><td></td></tr></table>	
ZIP/city:	<table><tr><td></td></tr></table>		e-mail: <table><tr><td></td></tr></table>	
country:	<table><tr><td></td></tr></table>			

city, date:	<table><tr><td></td></tr></table>		authorized signature / company stamp:

20 Appendix

– Layouts

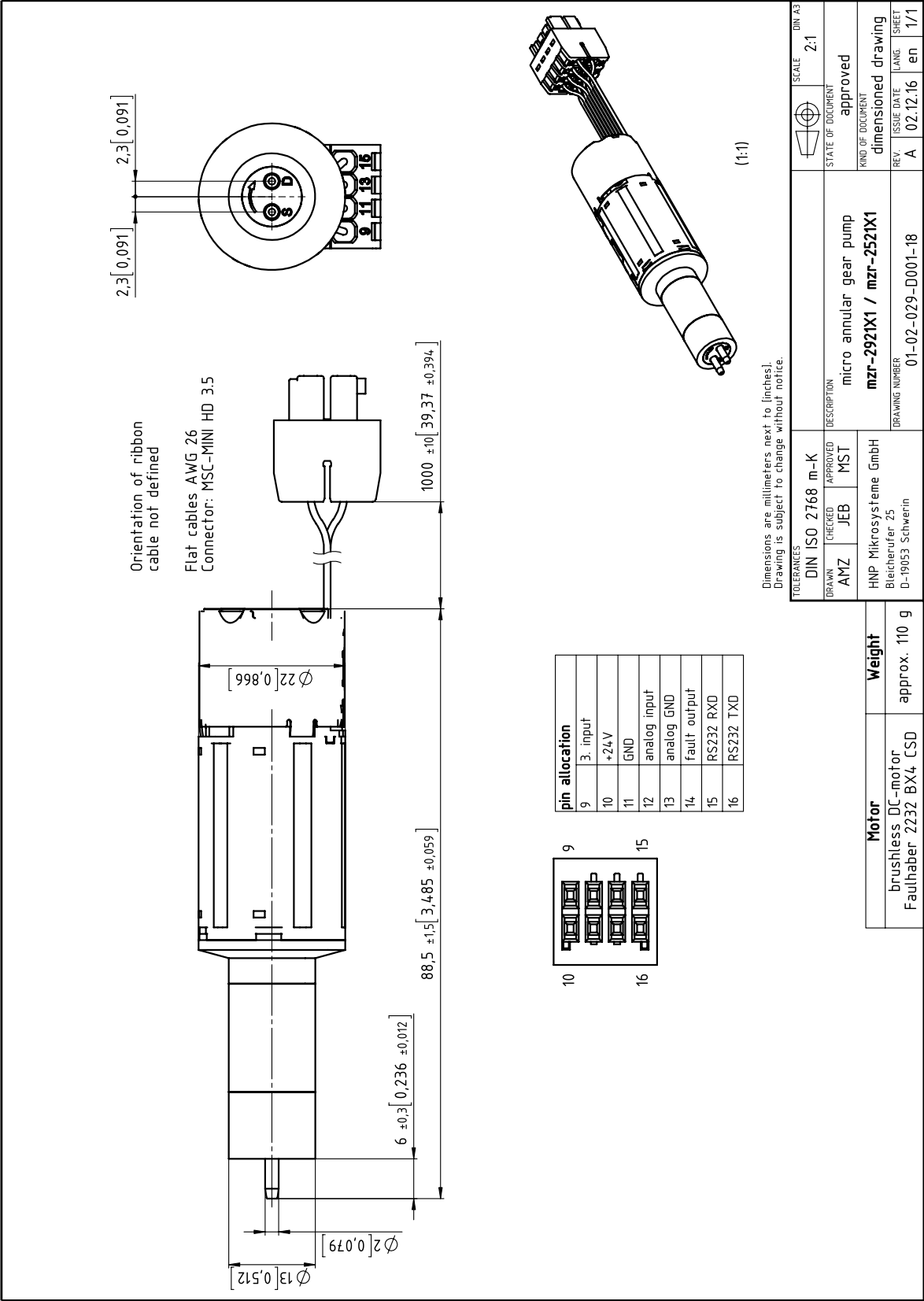


figure 29 Layout mZR-2521X1 / mZR-2921X1

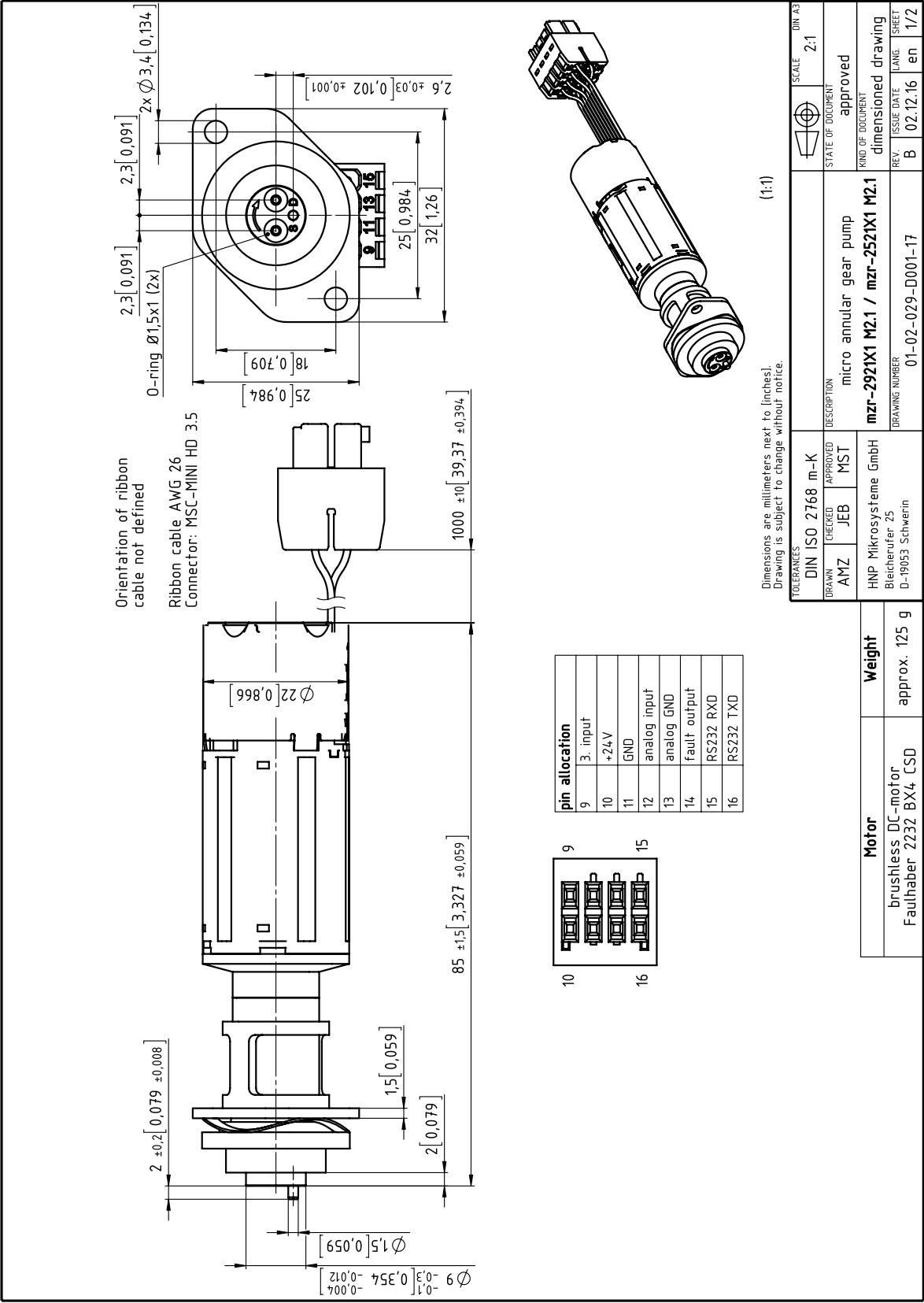


figure 30 Layout m zr-2521X1 M2.1 / m zr-2921X1 M2.1