HNP Mikrosysteme

Operating manual for

Micro Dispense Module – µDispense®

HNP Mikrosysteme GmbH
Bleicherufer 25
D-19053 Schwerin (Germany)
Telephone:0385/52190-301
Telefax: 0385/52190-333
Email: info@hnp-mikrosysteme.de
http://www.hnp-mikrosysteme.de

Last update: May 2023

Imprint

Original instructions

HNP Mikrosysteme GmbH
Bleicherufer 25
D-19053 Schwerin (Germany)

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 resulting from improper use of the equipment.

When using the μDispense®, the relevant regulations regarding the specifications of this operating manual must be observed.

Subject to change without notice.

Contents

1 General Information

This operation manual contains basic instructions to be followed during integration, operation and maintenance of the µDispense®. Therefore, it is necessary to read it carefully before handling the device. The present manual should always be kept at the operation site of the µDispense®.

If assistance is needed, please provide the serial number of your µDispense.

1.1 Application scope of the pumps

The µDispense® described in this manual are suitable for continuous delivery and discrete dosage of water, watery solutions, solvents, methanol and other alcohols as well as many other liquids.

If you intend to handle any aggressive, poisonous or radioactive liquids, you have to comply with safety measures according to regulations in force. Chemical resistance of wetted parts in the µDispense® for handling of corrosive liquids should be previously discussed with HNP Mikrosysteme.

The µDispense® should not be used for "invasive" medical applications where the liquid in contact with the µDispense® is returned to the body.

µDispense® are provided exclusively for use in the industrial area. Private use is excluded.

µDispense® must not be used in aircrafts and space crafts or other vehicles without prior consent of HNP Mikrosysteme.

HNP Mikrosysteme provides information about media resistance to the best of its knowledge. However, a guarantee for this information cannot be given due to varying parameters in different applications.

The information given in this manual does not absolve 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 compliant with technical norms and regulations in force.

If you need any further information beyond this manual, please contact HNP Mikrosysteme directly.

1.2 Product information

This manual is valid for the µDispense® manufactured by HNP Mikrosysteme GmbH, Bleicherufer 25, D-19053 Schwerin, Germany.

The cover sheet of the manual shows the release status.

1.3 Technical data of the µDispense®

		µDispense®
Technical data		
Dimensions	L x B x H	106.7 x 127.0 x 44.4 mm
Weight		approx. 800 g
Materials	different materiel combinations possible (see chapter 4.1.5)	
Fluid connection		1/4"–28 UNF
Performance parameters		
Flow rate (without control)	min.	0.01 ml/min
		9 ml/min (mzr-2521)
		18 ml/min (mzr-2921)
	max.	55 ml/min (mzr-4622)
Controlled flow rate	min.	0.01 / 0.03 ml/min
(water / methanol)	max.	1.0 / 2.5 ml/min
Differential pressure	at viscosity 1 mPas	1.5 bar
Viscosity η	min.	0.3 mPas
	max.	5 mPas
Operating temperature	min.	10 °C
	max.	50 °C
Storage temperature	min.	-5 °C
	max.	40 °C
Electrical characteristics		
Power supply		24 V± 10%, max. 1.5 A
Electrical connection		D-sub plug, 15-pole (male connector)
Motor		brushless DC-motor (BLDC) nominal voltage 24 V, torque 3.3 mNm analog hall sensors
Interface		RS232, RS485
Baud rate	RS232, RS485	9600 or 38400
Addressing		max. 15 devices with RS-485 Bus ("daisy-chaining")
Protocol		standard commands of syringe pumps, OEM Communication (OC) protocol and Data Terminal (DT) protocol

table 1 Technical data of a µDispense® with different micro annular gear pumps integrated

Warning The chemical and physical characteristics of a liquid (e.g. viscosity, lubricating properties, particle content, corrosiveness) influence the performance and the lifetime of a µDispense®. Under appropriate conditions the characteristic values may be undercut or exceeded.

Warning

If you intend to operate the µDispense® outside its specifications please consult HNP Mikrosysteme. Modifications may be necessary to ensure successful operation. Otherwise, the pump or the system may be damaged seriously.

1.4 Dimensions of the µDispense®

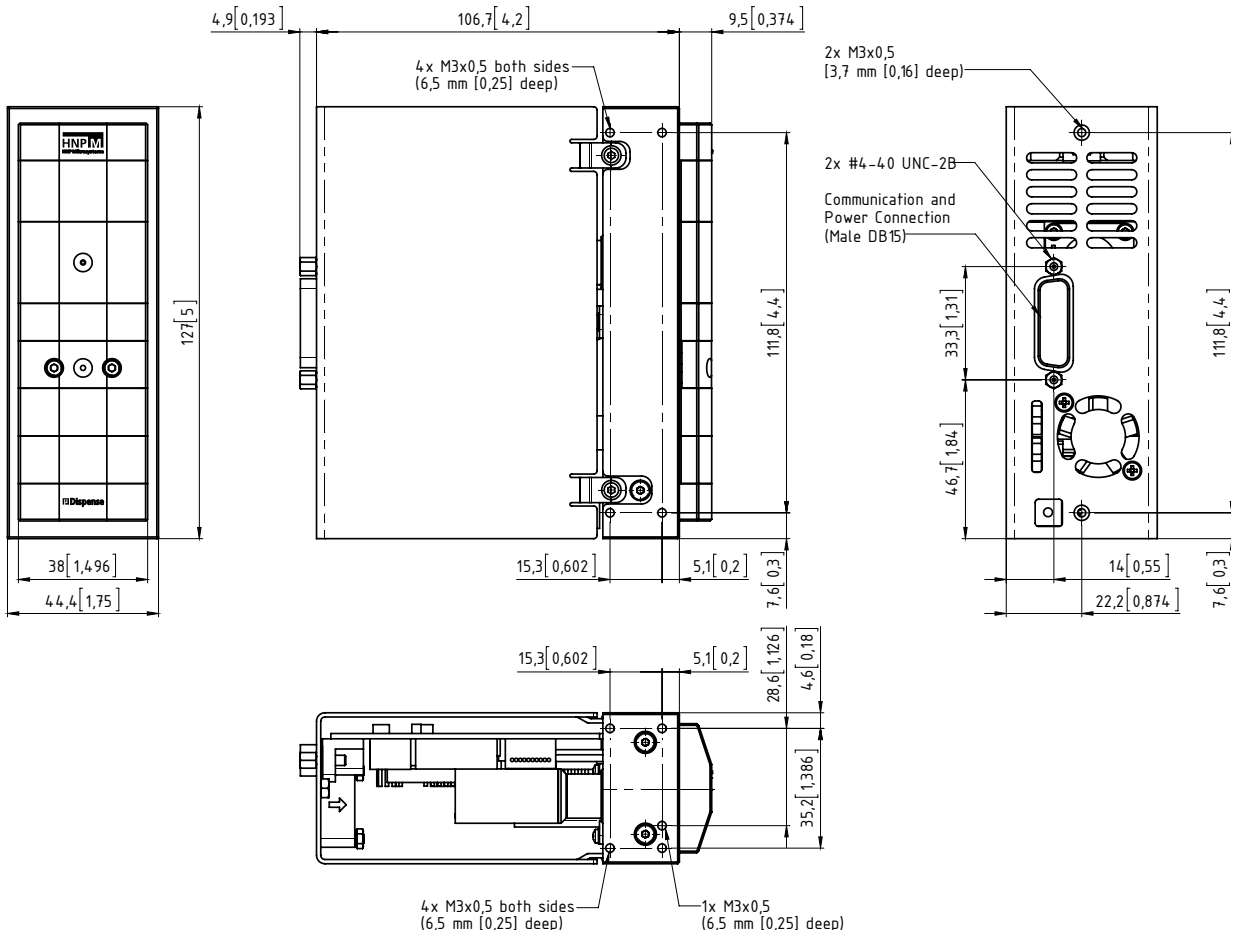


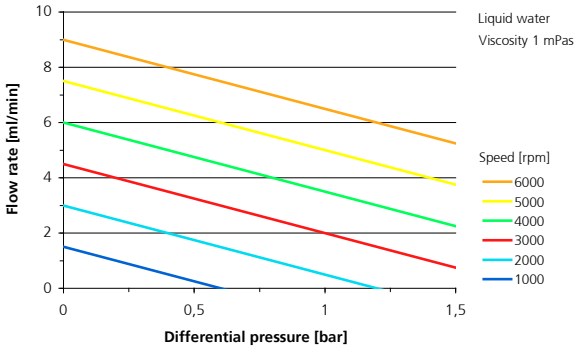
figure 1 Dimensions of the µDispense®

1.5 Flow chart

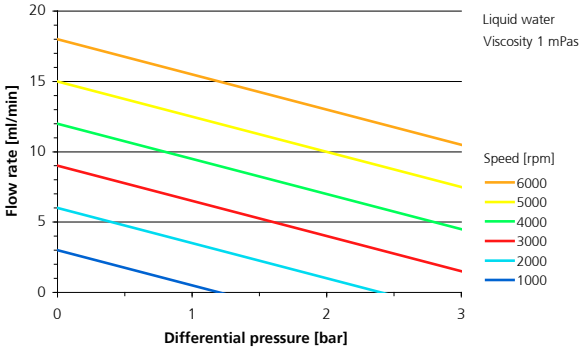
The flow chart characteristics will depend on the micro annular gear pump integrated into the µDispense®.

Liquid: water

Flow chart mzr-2521



Flow chart mzr-2921



liquid water

Flow chart mzr-4622

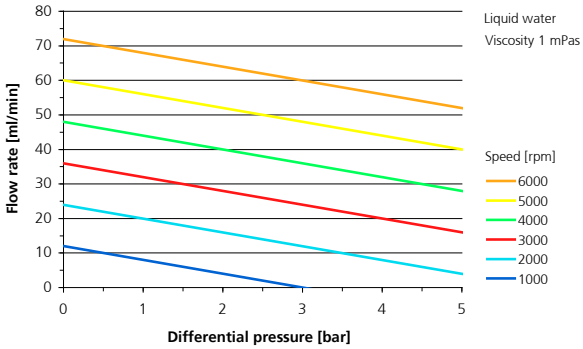


figure 2 Flow charts of µDispense® with integrated micro annular gear pumps mzr–2521, mzr–2921 or mzr-4622

2 Safety instructions

In addition to the general instructions listed under this main safety instructions also the special safety instructions mentioned in the other chapters have to be observed.

2.1 Safety symbols used in this operating manual

Disregarding of safety instructions marked with the following signs may result in hazards to people and the environment:

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

Disregarding of safety instructions marked with the following sign may result in a damage to the µDispense®:

Warning

Operating instructions labelled directly on the µDispense®such as the label for the fluid ports have to be observed and kept in well readable condition.

2.2 Staff qualification and training

The staff for operation, maintenance, inspection and assembly must have the appropriate qualifications for this work. Responsibility and supervision of staff must be strictly regulated by the operator. If the staff does not have the necessary knowledge, it must be trained and instructed accordingly. If required, this can be done by the manufacturer / supplier on behalf of the operator of the µDispense®. Furthermore, the operator must ensure that the contents of the operating instructions are fully understood by the staff.

2.3 Safety-conscious working

The safety instructions listed in this operating manual, the existing national accident prevention regulations as well as any internal work, company and safety regulations of the operator must be observed.

2.4 Safety instructions for the operator

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

The µDispense® must not be used in areas exposed to explosion risks or in proximity of inflammable gases and vapors.

Leaking fluids which may represent a hazard for staff and environment have to be removed securely. The µDispense® should be regularly checked for possible leakage. In this matter all legal requirements should be complied with.

Hazards due to electricity have to be excluded (for details see for example in the regulations of the VDE and the local energy supply companies).

Warning Please ensure, that components of the liquid supply system such as fittings, tubing, filters etc. are free of dust or particles. Impurities such as metal swarf, plastic or glass particles may impair or damage the µDispense® leading to its failure.

Warning Please operate the µDispense® with a filter with a mesh size of 10 µm or smaller. It will protect the µDispense®.

2.5 Safety instructions for maintenance, inspection and installation of the µDispense®.

As a rule, all maintenance work on the device should be performed when it is at standstill. The shutdown procedure described in this manual has to be followed. µDispense® delivering hazardous liquids must be decontaminated.

Before starting operation, please take notice of the instructions listed in chapter 6.

Warning In case of a malfunction of the µDispense® do not take apart the µDispense® on your own. Contact HNP Mikrosysteme service staff for professional assistance.

2.6 Unauthorized changes to µDispense®

Changes or modifications 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 void the liability of the µDispense® manufacturer for any resulting consequences.

2.7 Improper modes of operation

The operational safety of the supplied µDispense® is only guaranteed if it is used as intended in accordance with Chapter 1 of the operating instructions. The limit values specified in the operating instructions must under no circumstances be exceeded.

2.8 General safety instructions

The following safety instructions have to be observed:

In the case of a downstream blockage the µDispense® can generate high pressures up to 15 bars or more. Use only supplied accessories and ensure that fittings and tubings are specified and approved for these pressures.

Protect the µDispense® against mechanic blows and electric shocks.

The permissible electrical data of the µDispense® must not be exceeded. In particular, pay attention to the correct polarity of the supply voltage, otherwise the µDispense® can be destroyed.

3 Transport and intermediate storage

3.1 Shipment of µDispense® and protecting measures

µDispense® leaving the factory are secured against corrosion and shocks. The inlets and outlets of the µDispense® are protected with screw plugs in order to prevent any particles entering the device.

3.2 Transport

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

3.3 Intermediate storage

When storing the µDispense®, the following points should be noted:

- perform conservation procedure (see also chapter 6.5.1)
- attach screw plugs
- µDispense® should not be stored in humid places
- for storage temperature - refer to chapter 1.3 of this manual

4 Specification of the µDispense®

4.1 Configuration

The µDispense® is a modular dosing system for discrete dosing and continuous delivery of liquids with a micro annular gear pump and an integrated control board.

The following components and configurations can be selected based on a modular principle according to the customer's specific needs: filter, valve, flow sensor, different pump sizes, different materials and the number of fluid in- and outlets (see figure 3 and figure 4).

figure 3 Basic configuration (filter, pump, valve)

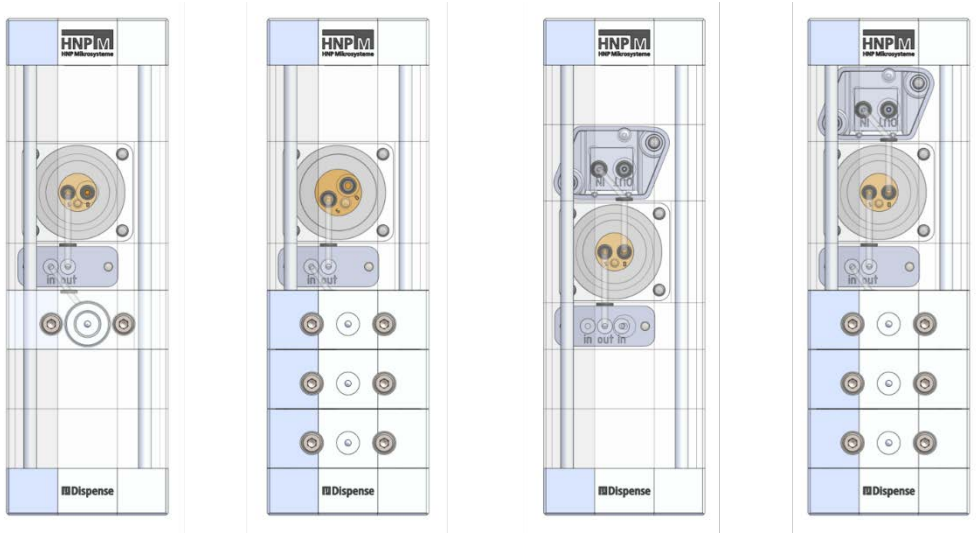


figure 4 Examples of available configurations

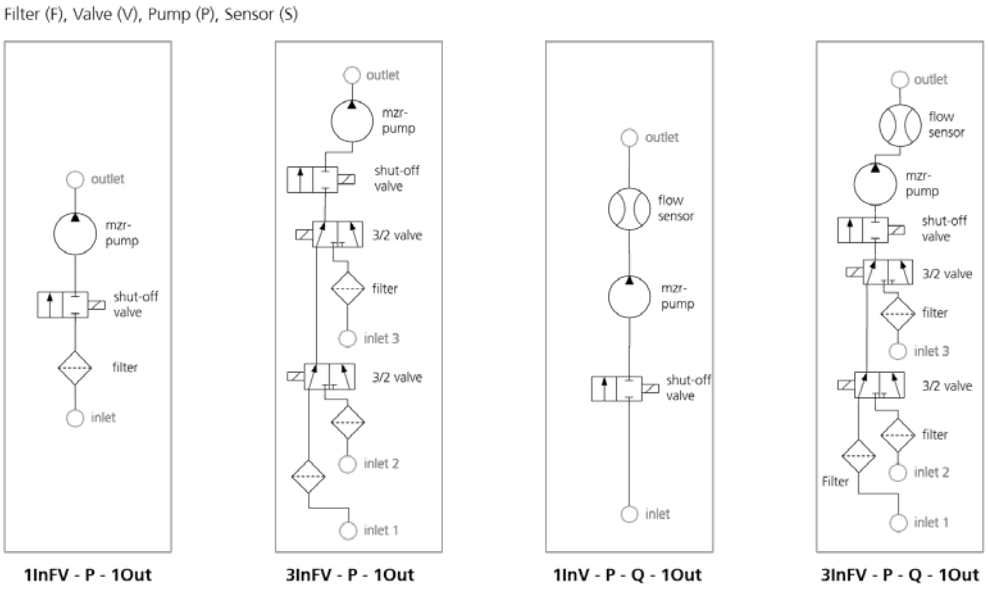


figure 5 Fluidic schemes of the µDispense® configurations of figure 4

The figure 6 shows the standard configuration of µDispense® and its components.

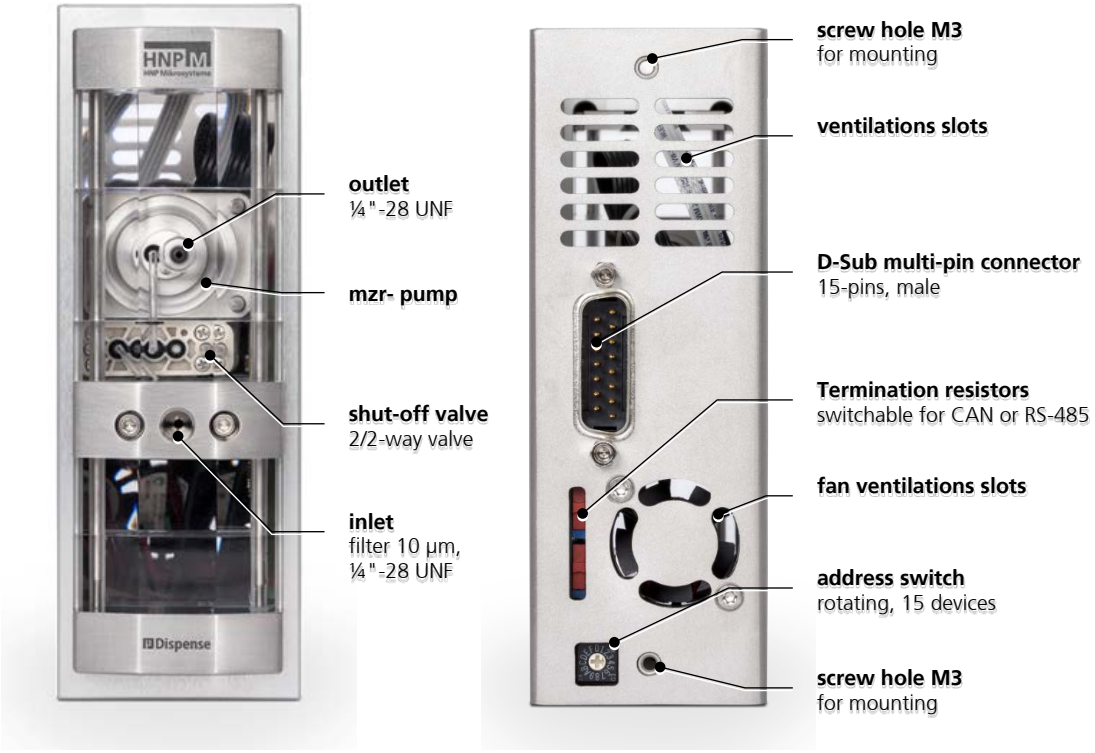


figure 6 Configuration of a standard µDispense®, front and backside

4.1.1 Micro annular gear pump (pump module)

Micro annular gear pumps are miniaturized positive displacement pumps. They are based on a so-called micro annular gear principle with an externally toothed internal rotor and an internally toothed external rotor (see figure 7). Both rotors, which are eccentrically mounted, are intermeshed with their cycloid gearing. As a result, a system of several sealed pumping chambers exists at all times. As the rotors turn around their offset axes, the volume of the pumping chambers increases on the induction side and simultaneously decreases on the delivery side of the pump (see figure 8). A homogeneous flow rate is generated between the kidney shaped inlet and outlet which also combines several pumping chambers at the same time.

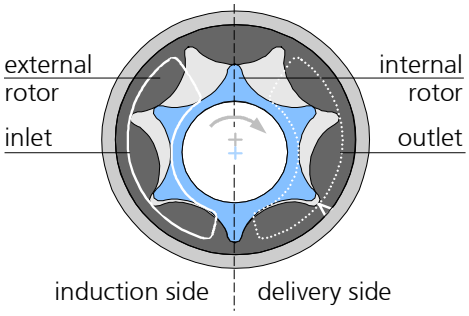


figure 7 Pump principle of micro annular gear pumps

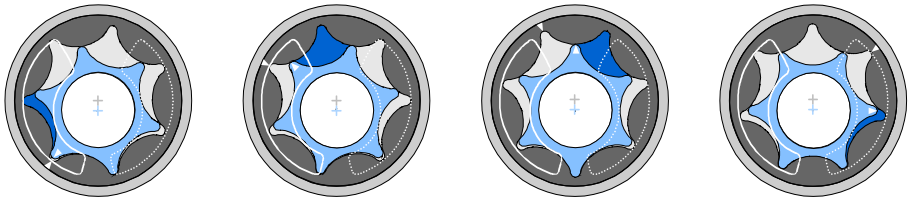


figure 8 Operating principle of micro annular gear pumps

For piston pumps and rotary pumps there is a direct relationship between displacement volume V_g of the pump and its actuator's number of revolutions n. The displacement volume describes the volume, which is theoretically transported with each revolution. The resulting flow rate (= volumetric flow rate) Q of the pump is:

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

The volumetric efficiency η_{Vol} describes the deviation of the actual flow rate from the theoretic flow rate. Differences occur because of leakage through the gaps between rotors, rotors and rotor bearing, and end gap. The volumetric efficiency depends on the viscosity of the media and the differential pressure.

µDispense® can be equipped with 3 different pump sizes (see table 2). Volume flow control is available only in combination with mzr-2521.

	mzr-2521	**mzr-2921**	**mzr-4622**
Flow rate [ml/min]	0.001-9	0.003-18	0.012-55
Displacement volume [µl]	1.5	3	12
Controlled flow rate	•	•	•

table 2 Pump sizes available in µDispense®

The pressure against which a pump has to work is composed of the pressure loss via the fluidic system (tubings, valves, etc.) and the hydrostatic pressure.

The viscosity of the pumped liquid has an important influence on the volumetric efficiency. The volumetric efficiency increases with higher viscosities because of the lower backflow through the gaps of the pump.

The special feature of mzr-pumps is their high precision design, which ensures both high operating pressure and high accuracy for discrete dosing and volume flow. Thus, the tooth and end gaps of the rotors and the gaps to the adjacent housing parts are in the range of a few micro meters. This precision allows for a high volumetric efficiency in a wide range of operating conditions.

4.1.2 Sensor-module

The sensor module includes a thermal flow sensor. With the flow sensor, a closed-loop controlled flow is possible (see figure 9). By default; the sensor is adjusted for water. For other liquids, the sensor has to be readjusted.

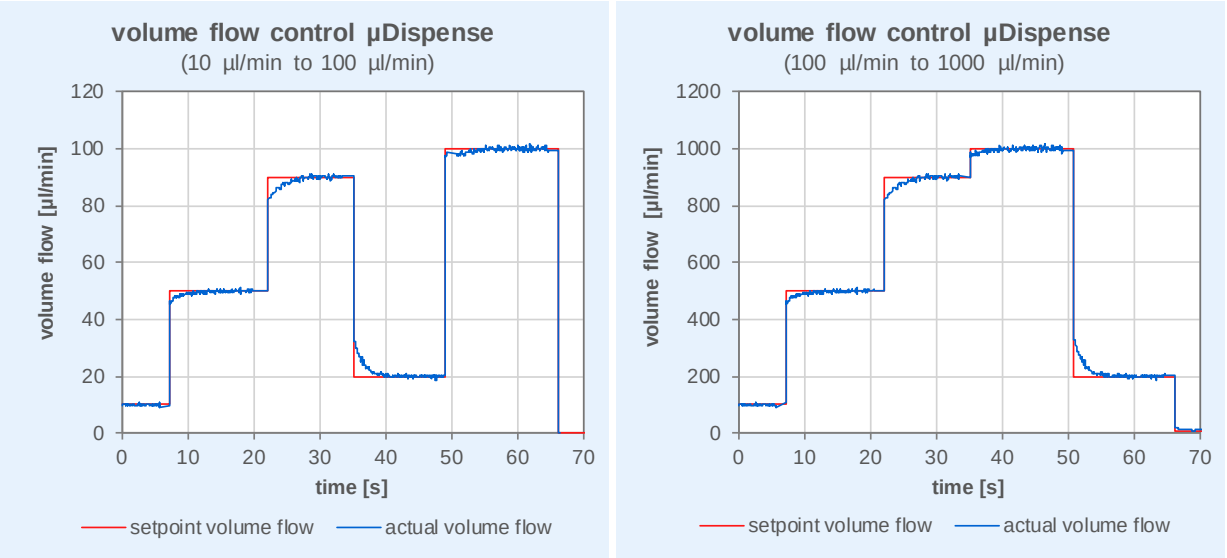


figure 9 Closed-loop controlled volume flow (water)

table 3 shows the different liquids for which a calibration for the controlled flow can be available. The list is customer specific. Please check if a calibration is available for your system.

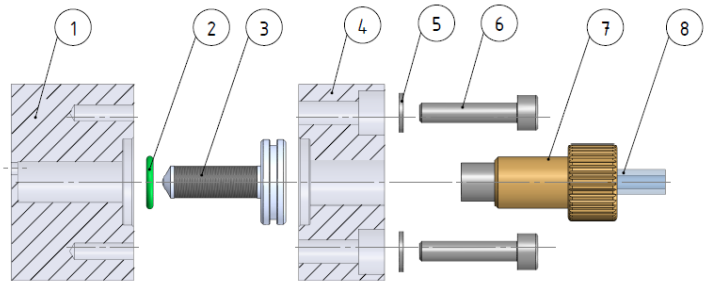
Liquid with calibration for controlled flow	Upper limit for controlled flow	Command/ address
Water 100%	1200 ml/min	|U0
Methanol 100%	2500 ml/min	|U1
Acetonitrile 100%	3000 ml/min	|U2
90% Methanol - 10% Water	1750 ml/min	|U3
80% Methanol - 20% Water	1550 ml/min	|U4
70% Methanol - 30% Water	1300 ml/min	|U5
60% Methanol - 40% Water	1200 ml/min	|U6
50% Methanol - 50% Water	1100 ml/min	|U7
90% Acetonitrile - 10% Water	2200 ml/min	|U8
80% Acetonitrile - 20% Water	2000 ml/min	|U9
70% Acetonitrile - 30% Water	1600 ml/min	|U10
60% Acetonitrile - 40% Water	1200 ml/min	|U11
50% Acetonitrile - 50% Water	1200 ml/min	|U12
40% Acetonitrile - 60% Water	1100 ml/min	|U13
30% Acetonitrile - 70% Water	1100 ml/min	|U14
20% Acetonitrile - 80% Water	1100 ml/min	|U15
10% Acetonitrile - 90% Water	1100 ml/min	|U16
90% Acetonitrile - 10% Methanol	2800 ml/min	|U17
80% Acetonitrile - 20% Methanol	2800 ml/min	|U18
70% Acetonitrile - 30% Methanol	2800 ml/min	|U19
60% Acetonitrile - 40% Methanol	2800 ml/min	|U20
50% Acetonitrile - 50% Methanol	2800 ml/min	|U21
40% Acetonitrile - 60% Methanol	2800 ml/min	|U22
30% Acetonitrile - 70% Methanol	2800 ml/min	|U23
20% Acetonitrile - 80% Methanol	2800 ml/min	|U24
10% Acetonitrile - 90% Methanol	2800 ml/min	|U25

table 3 List of liquids for flow controlled operation of the µDispense®

4.1.3 Filter module

The filter module consists of an inlet port with an integrated filter (see figure 10). The filter is made of stainless steel with a 10 µm mesh size and a filter surface of 0.95 cm². The filter protects the pump in the µDispense® from particles that can lead to a standstill of the pump.

The filter can be exchanged by simply loosening the screws on the cap (see No. 6 in figure 10). Carefully remove the O-ring from the old filter and mount it on the new or cleaned filter.



1	Manifold adapter
2	O-ring seal
3	Filter
4	Cap
5	Shim
6	Screw
7	Fitting
8	Tube

figure 10 Assembly filter

Do not touch the filter surface to handle it. Therefore, use the outer fixture.

4.1.4 Shut-off valve module

The shut-off valve module (see figure 3) increases dosing precision. It also prevents flow of liquid through the µDispense® caused by pressure differences between inlet and outlet.

Features of the shut-off valve:
– good chemical resistance
– fast response time: 3 ms
– switching cycles: 10,000,000
– switching noise: 30 dB

4.1.5 LED status display

This display is used to visually signal various states of the device. The following table describes the meaning of the colors and temporal patterns.

Color		Description
	LED off	µDispense switched off
	green flashing	µDispense waiting for initialization
	green	µDispense ready for operation
	blue flashing	µDispense running continuous flow
	blue	µDispense running discrete dispensing
	red	Fault on "Fault" of motor controller

table 4 Meaning of the colors and temporal patterns of the LED status display

4.1.6 Materials

The µDispense® is available in different material combinations.

Modul	Standard µDispense®	PEEK µDispense®
Filter module	PMMA, stainless steel 316L, EPDM or FPM	PEEK, stainless steel 316L, FFPM
Shut-off valve module	PMMA, PPS, EPDM or FPM	PEEK, FFPM
Pump module	stainless steel 316L, tungsten carbide Ni-based, ceramics, epoxy resin, graphite reinforced PTFE, PMMA, EPDM or FPM	Stainless steel 316L, tungsten carbide Ni-based, ceramics, epoxy resin, graphite reinforced PTFE, PEEK, FFPM
Sensor module	PEEK, borosilicate glass, EPDM or FPM	PEEK, borosilicate glass, FFPM

table 5 Materials of wetted parts of the µDispense®

Chemical resistance of wetted materials should be verified by the operator for each individual application.

For non-lubricating liquids service life of the µDispense® may be reduced.

4.2 Fluid connection

	µDispense®
fluid connection	1/4"-28UNF screw-in fitting

table 6 Fluid connections of the µDispense®

To protect against contamination screw plugs for the fluid connections of µDispense® are included with delivery. These must be removed before installing the fluid connections.

4.3 Communication and interface

The following topics are explained in the chapter Communication and Interface:

- D-sub plug
- Sliding Switches
- Address switch
- Standard Protocol
- Terminal Protocol
- Commands
- Status and Error Values
- Communication with µDispense
- HNPM Firmware Updater

4.3.1 D-sub plug, 15 - pole (male connector)

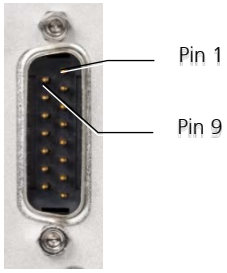


figure 11 D-sub plug

Pin	Function	Description
1	24 VDC	
2	RS-232 TxD line	Output data
3	RS-232 RxD line	Input data
4	RS-232 HI line	Line is high with power on
5	CAN high signal line	
6	CAN low signal line	
7	Auxiliary Input #1	Digital level
8	Auxiliary Input #2	Digital level
9	GNDIN	Power GND, Ground power supply
10	GND	Logic GND, Ground internal Logic
11	RS-485 A line	
12	RS-485 B line	
13	Auxiliary Output #1	Digital level
14	Auxiliary Output #2	Digital level
15	Auxiliary Output #3	Digital level

table 7 D-sub plug, pin configuration

Note

Pin 10 should not be used as power GND. If this is nevertheless technically necessary, then pin 9 and pin 10 must be connected directly in the connector to avoid equalizing currents via the µDispense®.

4.3.2 Sliding switches

Two sliding switches behind the housing slot are for activating the termination resistors. The lower slide switch activates the termination resistor for RS-485 and the upper for CAN. The termination resistors are activated when the red slider is pushed up.

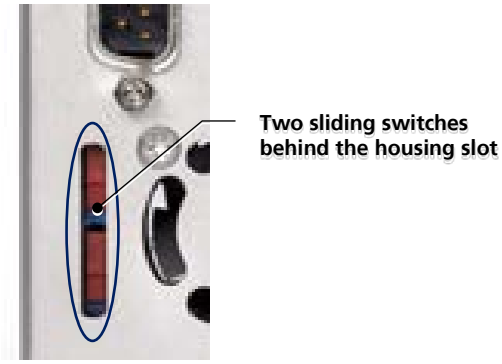


figure 12 Two sliding switches behind the housing slot (see also figure 6)

4.3.3 Address switch

The address switch is used to provide each µDispense® with a unique address in a multi-system application. The address switch has 16 locations (see table 8) whereby one address location is inactive. The address locations can be set by using a small flathead screwdriver and rotating the switch in either direction to the appropriate address.

Address switch	Number	Address character
0	1	1
1	2	2
2	3	3
3	4	4
4	5	5
5	6	6
6	7	7
7	8	8
8	9	9
9	10	:
A	11	;
B	12	<
C	13	=
D	14	>
E	15	?
F	16	@

table 8 Address switch setting. 15 addresses are active, "F" is inactive.

4.3.4 Standard protocol - OEM Communication Protocol (OC)

The standard protocol uses two standard characters and one non-standard character (see table 9 and table 10):

Notation	Name	ASCII code (decimal)	Description
<STX>	Start of Text	02	Beginning of Block
<ETX>	End of Text	03	End of Block

table 9 Standard protocol control characters

Notation	Character	ASCII code (decimal)	Description
<SYNC>	ÿ	255	Valid serial character

table 10 Non-standard protocol control characters

4.3.4.1 Standard protocol inquiry block

The standard protocol inquiry block is the basic unit of communication between the controlling device and the µDispense®.
A standard protocol inquiry block consists of the following:

<SYNC><STX><Address character><Sequence><Data><ETX><Checksum>

Notation	Description
<SYNC>	Valid serial character
<STX>	Beginning of block.
<Address character>	RS232 Address
<Sequence>	Sequence Data
<Data>	Inquiry String
<ETX>	End of Block
<Checksum>	Checksum

table 11 Standard Protocol Inquiry Block

4.3.4.2 Sequence data

The sequence data is included in communication from the controlling device to the µDispense® only. The sequence data consists of two parts, the sequence number and the repeat bit. The rest of the sequence data is fixed. The sequence field is defined as follows:

Notation	Description
Bit 7	Set to 0
Bit 6	Set to 0
Bit 5	Set to 0
Bit 4	Set to 0
Bit 3	Repeat Bit
Bit 2-0	Sequence Number

table 12 Sequence

4.3.4.3 Standard protocol response block

A standard protocol response block consists of the following:

<SYNC><STX><Address character><Status/Error><Data><ETX><Checksum>

Notation	Description
<SYNC>	Valid serial character
<STX>	Beginning of block.
<Address character>	Controlling device "0"
<Status/Error>	Status- and Error-Code
<Data>	Inquiry String
<ETX>	End of Block
<Checksum>	Checksum

4.3.4.4 Status- and error-code

The status- and error-code is included in communication from µDispense® to controlling device only. The status- and error-code consists of two parts, the status-code and the error-code. The rest of the sequence data is fixed. The status- and error-code is defined as follows:

Notation	Description
Bit 7	Set to 0
Bit 6	Set to 1
Bit 5	Status-Code = 0: Pump busy = 1: Pump ready
Bit 4	Set to 0
Bit 3-0	Error-Code

table 13 Status- and error-code

4.3.4.5 Checksum

The checksum for a data block consists of the bitwise exclusive OR (XOR) of the bytes in the data block from the STX to the ETX, inclusive. A data block received with a checksum that matches the computed checksum is considered to be received successfully. A data block received with an invalid checksum is ignored.

4.3.4.6 Example commands standard protocol

Description	Inquiry	Response
Initialization	STX 1 1 Z R ETX TAB 0x02 0x31 0x31 0x5A 0x52 0x03 0x09	STX 0 @ ETX q (µDispense® busy) 0x02 0x30 0x40 0x03 0x71
Check status	STX 1 1 Q R ETX STX 0x02 0x31 0x31 0x51 0x52 0x03 0x02	STX 0 ` ETX Q (µDispense® ready) 0x02 0x30 0x60 0x03 0x51
Move plunger to absolute position 0	STX 1 1 A 0 R ETX " 0x02 0x31 0x31 0x41 0x30 0x52 0x03 0x22	STX 0 ` ETX Q (µDispense® ready) 0x02 0x30 0x60 0x03 0x51
Move plunger to absolute position 300	STX 1 1 A 3 0 0 R ETX ! 0x02 0x31 0x31 0x41 0x33 0x30 0x30 0x52 0x03 0x21	STX 0 @ ETX q (µDispense® busy) 0x02 0x30 0x40 0x03 0x71
Move valve to Input position	STX 1 1 I R ETX SUB 0x02 0x31 0x31 0x49 0x52 0x03 0x1A	STX 0 @ ETX q (µDispense® busy) 0x02 0x30 0x40 0x03 0x71
Move valve to Output position	STX 1 1 O R ETX FS 0x02 0x31 0x31 0x4F 0x52 0x03 0x1C	STX 0 @ ETX q (µDispense® busy) 0x02 0x30 0x40 0x03 0x71

table 14 Example commands standard protocol

4.3.5 Terminal protocol (DT)

The terminal protocol uses two standard characters (see table 15)

Notation	Name	ASCII code (decimal)	Description
<CR>	Carriage Return	13	End of Block
<LF>	Line Feed	10	End of Block

table 15 Terminal protocol control characters

4.3.5.1 Terminal protocol inquiry block

The terminal protocol inquiry block is the basic unit of communication between controlling device and µDispense®.
A terminal protocol Inquiry Block consists of the following:

<SYNC>/<Address character><Data><CR>

Notation	Description
<SYNC>	Valid serial character
/	Beginning of Inquiry Block
<Address character>	RS232 Address
<Data>	Inquiry String
<CR>	End of Block

table 16 Terminal protocol inquiry block

4.3.5.2 Terminal protocol response block

A terminal protocol response block consists of the following:

<SYNC>/<Address character><Status/Error><Data><ETX><CR><LF>

Notation	Description
<SYNC>	Valid serial character
/	Beginning of Response Block
<Address character>	Controlling device "0"
<Status/Error>	Status- and Error-Code
<Data>	Response String
<ETX>	End of Block
<CR>	End of Block
<LF>	End of Block

table 17 Terminal protocol response block

4.3.5.3 Status- and error-code

The status- and error-code is included in communication from µDispense® to controlling device only. The status- and error-code consists of two parts, the status-code and the error-code. The rest of the sequence data is fixed. The status- and error-code is defined as follows:

Notation	Description
Bit 7	Set to 0
Bit 6	Set to 1
Bit 5	Status-Code = 0: Pump busy = 1: Pump ready
Bit 4	Set to 0
Bit 3-0	Error-Code

table 18 Status- and error-code

4.3.5.4 Example commands terminal protocol

Description	Inquiry	Response
Initialization	/ 1 Z R CR 0x2F 0x31 0x5A 0x52 0x0D	/ 0 @ ETX CR LF (µDispense® busy) 0x2F 0x30 0x40 0x03 0x0D 0x0A
Check status	/ 1 Q R CR 0x2F 0x31 0x51 0x52 0x0D	/ 0 ` ETX CR LF (µDispense® ready) 0x2F 0x30 0x60 0x03 0x0D 0x0A
Move plunger to absolute position 0	/ 1 A 0 R CR 0x2F 0x31 0x41 0x30 0x52 0x0D	/ 0 ` ETX CR LF (µDispense® ready) 0x2F 0x30 0x60 0x03 0x0D 0x0A
Move plunger to absolute position 300	/ 1 A 3 0 0 R CR 0x2F 0x31 0x41 0x33 0x30 0x30 0x52 0x0D	/ 0 @ ETX CR LF (µDispense® busy) 0x2F 0x30 0x40 0x03 0x0D 0x0A
Move valve to Input position	/ 1 I R CR 0x2F 0x31 0x49 0x52 0x0D	/ 0 @ ETX CR LF (µDispense® busy) 0x2F 0x30 0x40 0x03 0x0D 0x0A
Move valve to Output position	/ 1 O R CR 0x2F 0x31 0x4F 0x52 0x0D	/ 0 @ ETX CR LF (µDispense® busy)) 0x2F 0x30 0x40 0x03 0x0D 0x0A

table 19 Example commands terminal protocol

4.3.6 Commands

Please note the following:
- Inquiries consist of the address of the module (in this case: 2), the sequence (in this case: 1), at least one command and a resume (R)
- Commands consist of a text character and an optional integer value (e.g., 21N1); Decimals are not allowed
- Responses consist of the address of the controlling device (always 0), the status / error value, and an optional return value (e.g. "0`1000")

Command	Parameter	Description	Example
Control commands			
R	–	Continue execution with the next instruction of the command chain (Resume)	
Z	–	Initialization	Execute initialization: "21ZR"
Valve commands			
O	–	Set valve to Output	Set Output: "21OR"
I	–	Set valve to Input	Set Input: "21IR"
wx	x = 2 … 4	Set number of ports	Set 4 ports: "21w4R"
Action commands			
g	–	Marks positions in Command String that can be matched with G commands.	see Repeat Commands
Gx	x = none, 0 (Sequence is repeated until terminate), 1 … 65535	Repeat Commands	Dispense 300 steps 3 times: "A2000gD300G3R"
Motor commands			
Nx	x = 0: 0 … 3000 x = 1: 0 … 24000	Switching between standard and high resolution (Fine Positioning Mode)	Set high resolution: "21N1R"
Vx	x = 5 … 6000	Set maximum velocity to x motor steps/second	Set max speed 1000 µl/min: "21V1000R"
Sx	x = 0 … 40	Speed of plunger movement, Speed of the pump (Speed Code: small numbers indicate high speed)	Set 600 µl/min: "21S15R"
Syringe commands			
Ax	x = 0 … 3000 (N0) x = 0 … 24000 (N1)	Move plunger to absolute position	Move to position 5000: "21N1A5000R" (end position: 5000 steps)
Px	x = 0 … 3000 (N0) x = 0 … 24000 (N1)	Move plunger aspirating (Pickup, Aspirate)	Move 3000 steps: "21P3000R" (end position: 8000 steps)
Dx	x = 0 … 3000 (N0) x = 0 … 24000 (N1)	Move plunger dispensing (Dispense)	Move 7000 steps: "21D7000R" (end position: 1000 steps)
Async command			
T	–	Stop execution of the command buffer.	Terminate command buffer: "21TR"
Query commands			
Q	–	Query status and error	Inquiry: "21QR" Response device ready, no error: "0`" Response device busy, no error: "0@"
?	–	Query current position	Inquiry: "21?R" Response position 1000: "0'1000"
&	–	Query firmware version	Inquiry: "21&R" Response: "0'1.0.00"
*	–	Query actual value from flow sensor in nl/min	Inquiry: "21*R" Response: "0'1234567"
HNPM extended commands			
|B	–	Start bootloader	Inquiry: "21|BR"
|Cx	x = 0 … 100000	Set calibration factor	Set factor 1.2345: "21|C12345R"
|c	-	Query calibration factor	Inquiry actual factor: "21|cR" Response factor 1.2345: "0`12345"

Command	Parameter	Description	Example
|Fx	x = 0 … 9 x 10^{18}	Set continuous closed loop controlled volume flow in nl/min (if setpoint within the measuring range of sensor, otherwise fixed speed volume flow)	Set 1 ml/min: "21|F1000000R" Stop pump: "21|F0R"
|S	-	Query continuous closed loop controlled volume flow in nl/min	nquiry: "21|SR" Response flow 1 ml/min: "0'1000000"
|fx	x = -9 x 10^{18} … 9 x 10^{18}	Set continuous fixed speed volume flow in nl/min (valid for complete volume flow range)	Set 200 µl/min: "21|f200000R" Stop pump: "21|f0R"
|s	-	Query continuous fixed speed volume flow in nl/min	Inquiry: "21|sR" Response flow 200 µl/min: "0'200000"
|n	–	Query device name	Inquiry: "21|nR" Response: "0'µ Dispense"
|Rx001	X=1…65535	HNPM Write Parameter Serial Number (command works without secret PIN only on first write)	Write serial number 12345: "21|R12345001R"
|r001	-	HNPM Read Parameter Serial Number	Inquiry actual serial number: "21|r001R" Response serial number 12345: "0`12345"
|Ux	x = 0 (water) 1 (methanol)	Set flow medium	Inquiry: "21|UR"
|u	-	Query flow medium	Inquiry actual medium: "21|uR" Response medium water: "0`0"

table 20 Main commands (example terminal protocol (DT))

4.3.6.1 Speed code *S* and maximum velocity *V*

Speed code is a predefined maximum velocity and is defined as follows:

Motorsteps per second [steps/s]	**Speed Code** [-]	**Volume flow** [µl/min]	**Motorsteps per second** [steps/s]	**Speed Code** [-]	**Volume flow** [µl/min]
6.000	0	6.000	160	21	160
5.600	1	5.600	150	22	150
5.000	2	5.000	140	23	140
4.400	3	4.400	130	24	130
3.800	4	3.800	120	25	120
3.200	5	3.200	110	26	110
2.600	6	2.600	100	27	100
2.200	7	2.200	90	28	90
2.000	8	2.000	80	29	80
1.800	9	1.800	70	30	70
1.600	10	1.600	60	31	60
1.400	11	1.400	50	32	50
1.200	12	1.200	40	33	40
1.000	13	1.000	30	34	30
800	14	800	20	35	20
600	15	600	18	36	18
400	16	400	16	37	16
200	17	200	14	38	14
190	18	190	12	39	12
180	19	180	10	40	10
170	20	170			

figure 13 Speed codes with corresponding motor step rate (Syringe Sizes 100 µl)

The maximum velocity is calculated as follows:

$$Volume\ flow\ \left[\frac{\mu l}{min}\right] = \frac{Vx\ [\frac{steps}{s}]}{6000\ [steps]} \cdot \text{syringe size [µl]} \cdot \frac{60\ [s]}{1\ [min]}$$

Example:

$$Volume\ flow\ \left[\frac{\mu l}{min}\right] = \frac{2000\ [\frac{steps}{s}]}{6000\ [steps]} \cdot 100[\mu l] \cdot \frac{60\ [s]}{1\ [min]} = 2000\ \left[\frac{\mu l}{min}\right]$$

4.3.7 Status and error values

Values	Response	Description
Status values	"@"	Pump busy
	"`"	Pump ready
Error values	0x00	No error
	0x01	Initialization error
	0x02	Invalid command
	0x03	Parameter out of range
	0x04	Too many loops
	0x06	EEPROM error
	0x07	Syringe not initialized
	0x09	Syringe overload
	0x09	HNPM motor overload
	0x0A	Valve overload
	0x0B	Syringe move not allowed
	0x0F	Pump busy error

table 21 Status- and error-code

4.3.8 Communication with µDispense

Communication with µDispense® is possible in different modes. As described in chapter 4.3 we do distinguish between two protocols. Currently, the DT-protocol is the standard setting. To change this setting an alternative firmware is necessary. Please contact HNP Mikrosysteme for such an alternative firmware.

Communication with µDispense® is possible via serial interface. Depending on the protocol the commands have to be implemented. To start, the initializing command (z) has to be sent.

For initial testing, µDispense® can be operated using HNP Mikrosysteme Dispense Modul Quickstart V2.0.

In figure 14 the user interface is shown with its functions.

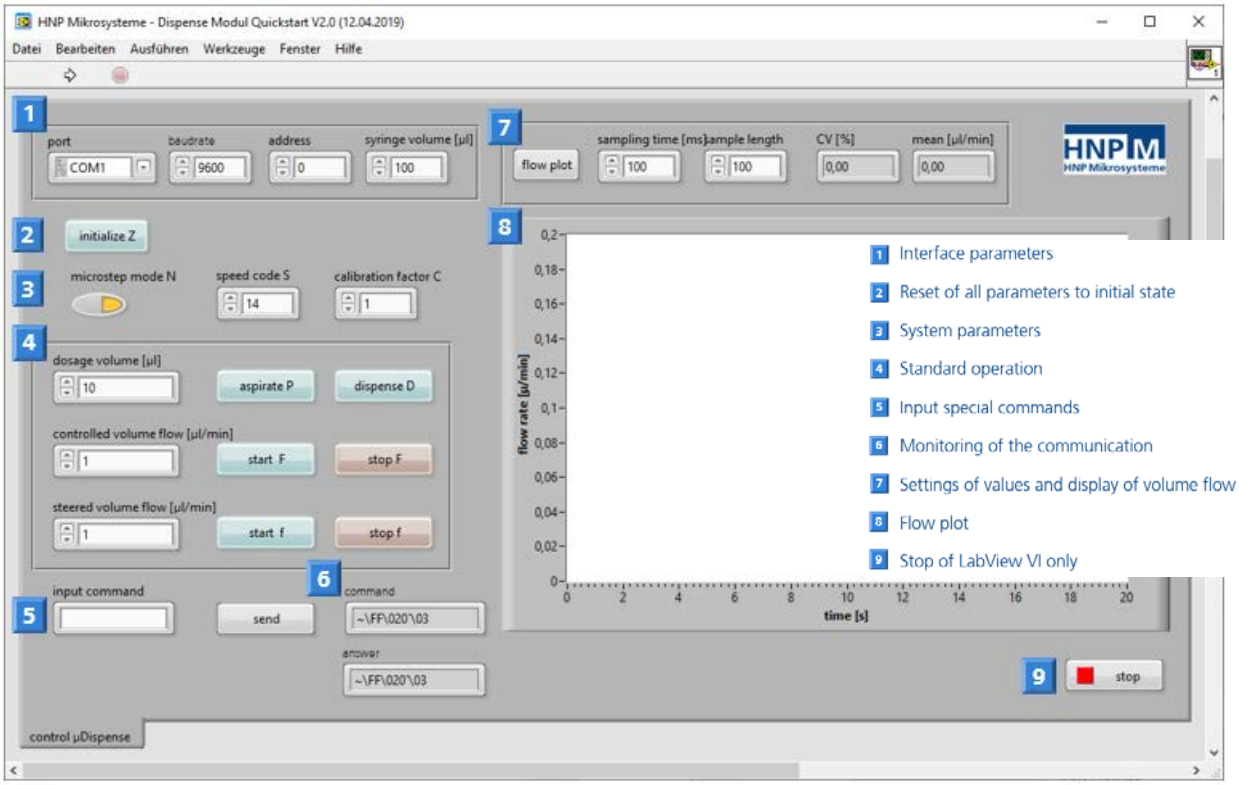


figure 14 Software: HNP Mikrosysteme µDispense Quickstart V2.0

- Install program (setup.exe)
- Run program
- Choose port, address and baud rate
- Execute program
- Choose volume values or enter commands and execute it by pushing the buttons aspirate, dispense, start or send.

You may also choose negative values for the volume flow. In this case the pump runs backwards. Valid values for the volume flows depend on the pump size and/or flow sensor.

Calibration factors have to be entered as decimal number (0,001 to 9,999)

To send additional commands, only enter the command string. The control characters, address and sequence are added automatically.

4.3.9 HNPM Firmware Updater

The following section describes how new software can be uploaded to the µDispense®:

1. Install the HNPM Firmware Updater (hnpm_firmware_updater_setup.exe)
2. Open the program (see figure 15) HNPM Firmware Updater

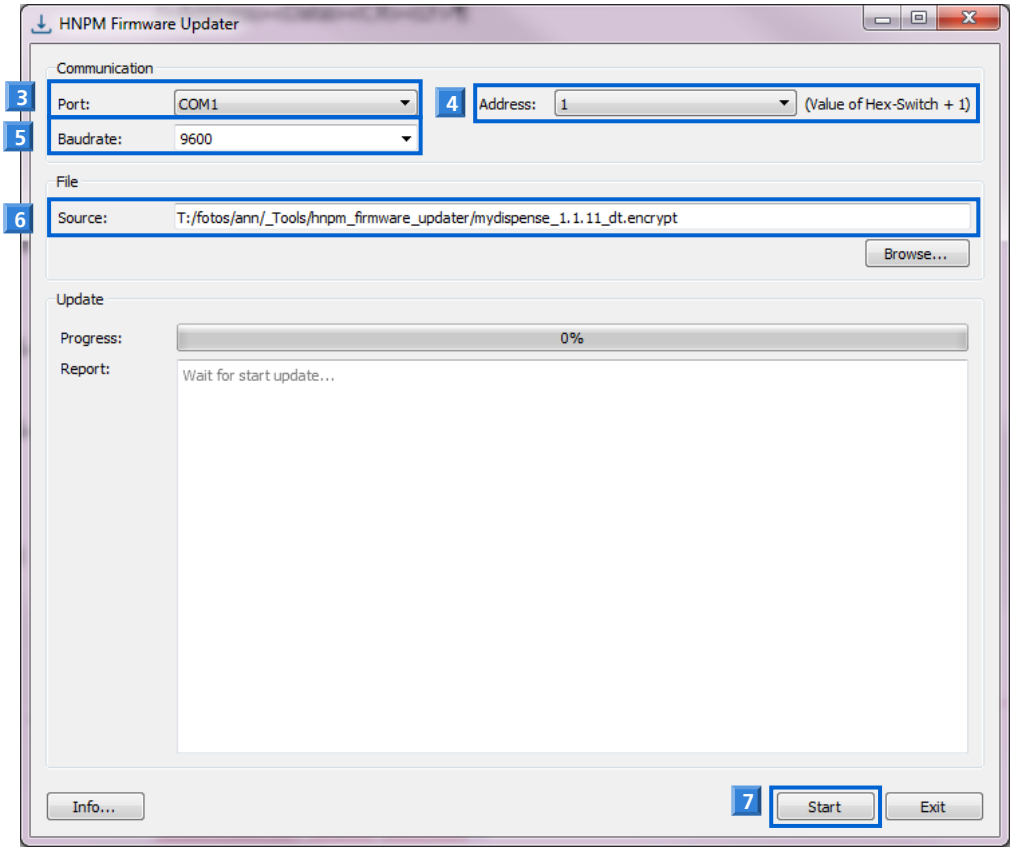


figure 15 HNPM Firmware Updater

3. Set correct port (COM x)
4. Set correct address
5. Set Baud rate 9600
6. Set source
7. Press start

5 System integration

5.1 Check before initial operation

Inspect µDispense® for potential damage during shipment (see chapter 3.2).

Please check if the delivered µDispense® fits to the application data:

1. Chemical compatibility with application
2. Viscosity range
3. Pump performance (displacement volume, dosage volumes, operating pressures)
4. Operating temperature range

If you notice any difference between the required and the delivered µDispense®, please contact HNP Mikrosysteme. Do not operate the µDispense® without prior approval.

5.2 Mounting of µDispense®

µDispense® can be mounted via the housing frame with M3 screws (see figure 6). The correct position of the µDispense® is upright (see figure 6).

Take precautions that leaking fluids do not represent a hazard to staff or the environment.

The µDispense® must be protected against humidity, dust and condensate.

5.2.1 Assembly instruction for tubing and accessories

The µDispense® (standard) has at least two ports (1/4"–28 UNF) for fluid connections.

Screw-in fittings for tubing with an outer diameter of 1/16" or 1/8" (1.588 mm or 3.175 mm) can be used. Tubing material may be plastic or stainless steel. The screw-in fittings consist of a threaded part, a lock ring and a ferrule. The sealing effect is obtained by the plain end of the ferrule and the tubing. The threaded part creates the required sealing force.
Do not use stainless steel screw-in fittings as they may destroy the screw-in threads of the µDispense®.

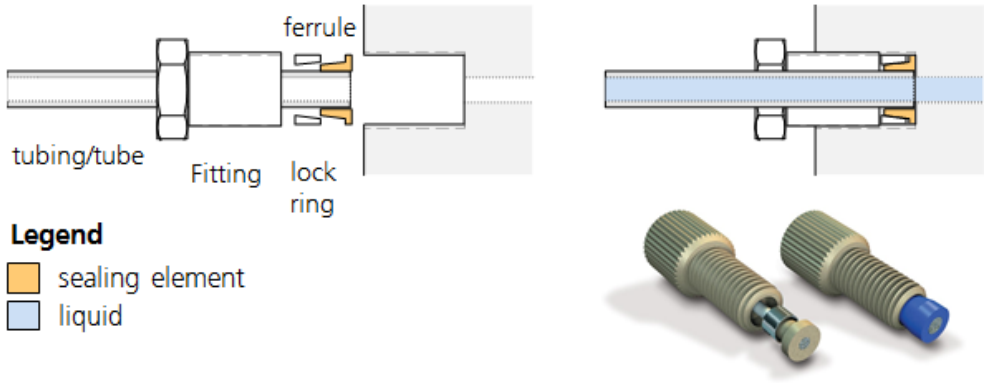


figure 16 Screw-in fitting 1/4"-28 UNF

1. Cut the tube with a tubing cutter at an 90° angle. Metal tubing have to be cleaned and flushed thoroughly after cutting as swarf may be produced. The smallest piece of swarf in the fluid system may cause failure of the µDispense
2. Slide the fitting on the tubing.
3. Slide on the lock ring, chamfer towards the end of the tubing.
4. The ferrule should be positioned on the tubing so that the end of the tubing and the ferrule fit tightly together.
5. Place tubing with the ferrule into the liquid ports of the µDispense®. Hold the tubing firmly and screw in the threaded part. Retighten the threads with a wrench by turning it about 1-1½ times. It is important that during installation the tubing remains pressed against the bottom of the liquid port.
6. In order to avoid dry operation of the device, ensure before each operation that a sufficient liquid supply is available.

Warning Dry operation of the µDispense® during longer periods (i.e. 30 s) may damage the bearing and the sealing of the pump. However, a short dry operation at the beginning of the operation is harmless.

5.3 Selection and use of Filter

It is recommended to integrate a filter on the suction side of the µDispense® to ensure an operation free of particles. The recommended filter pore or mesh size is 10 µm.

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 most suitable filter, operating parameters like flow rate and viscosity have to be considered. In case no suitable filter for a given liquid can be found, it is possible to use a filter with slightly larger pore size. As an alternative solution, an already filtered liquid may be used. Please contact HNP Mikrosysteme for assistance.

Warning The filter should be checked regularly for contamination. Cleanse the filter regularly or replace it with a new one. A clogged filter may considerably decrease the volumetric efficiency of a µDispense®. If cavitation or degassing effects occur, dosing may become imprecise and even damage of the µDispense® may occur.

Warning If the filter surface is too small a considerable decrease in volumetric efficiency of the µDispense® will result. If cavitation or degassing effects occur, dosing may become imprecise and even damage of the µDispense® may occur.

6 The start-up / shut-down procedure

6.1 Preparing for operation

After complete installation of the fluidic system, the operating status of the µDispense® and the fluidic components have to be checked:

1. Are the suction and discharge side connected correctly?
2. Is the entire liquid supply system clean - this means free of particles and impurities?
3. Is a filter installed on the suction side?
4. Is a supply of sufficient and correct liquid guaranteed?
5. Is a longer dry run of the µDispense® prevented?
6. Has the entire liquid system been checked for leakage?
7. Can the µDispense® be switched off if an unexpected malfunction occurs during the first start-up?

6.2 Start-up of the µDispense®

1. Switch on the voltage supply. The supplied interface and power supply cable may be used together with a separate power supply. For pin assignment see chapter 4.3.1

figure 17 D-Sub multi-pin connector and supplied interface and power supply cable

2. Check the address value at the address switch (see chapter 4.3.3).
3. The µDispense® can be operated with the supplied software (see chapter 4.3).

4. Start operating µDispense® at low or medium flow rates. Use commands for continuous volume flow.
   (e.g. 21|f2000000R for 2 ml/min and 21|f-2000000R for -2 ml/min)

Warning

Avoid dry operation of µDispense® for more than 30 seconds.

Rinse µDispense® sufficiently forwards and backwards with at least 3,000 rpm for a complete removal of air. If necessary use different velocities.

6.3 Calibration of the µDispense®

Calibration is not necessary, if following three requirements are simultaneously fulfilled:

– the configuration of the µDispense® includes a flow sensor, and
– is operated in continuous flow mode, and
– accuracy is only needed in the measuring range of the flow sensor.

Calibration of the µDispense® may be necessary if any of the following requirements occur:

– the configuration of the µDispense® does not include a flow sensor, or
– for discrete dosing, or
– for accuracy outside the measuring range of the flow sensor.

The dosing process is influenced by:

– pressure
– viscosity
– leakage of the individual micro annular gear pump

The calibration factor has to be calculated for the discrete dosage and continuous flow separately.

Example continuous flow:

Calibration of 1000 µl/min Q_{set}

actual flow rate Q_{act}

$Q_{act} = 850\ \mu l/min$

calculating calibration factor C

$$C = \frac{Q_{set}}{Q_{act}} = \frac{1000\ \mu l/min}{850\ \mu l/min} = 1.18$$

Example discrete dosage:

Calibration of 1000 µl V_{set}

actual volume V_{act}

$V_{act} = 950\ \mu l$

calculating calibration factor C

$$C = \frac{V_{set}}{V_{act}} = \frac{1000\ \mu l}{950\ \mu l} = 1.0526$$

The calculated calibration factor can be uploaded to the µDispense® with the command **|C11800** or **|C10526** (see table 20).

The µDispense® can be operated with and without flow sensor control.
With flow sensor control the set-point of the volume flow is reached with the help of the volume flow controller.
Without flow sensor control (in case that no flow sensor is present or the volume flow is outside the measuring range of the sensors), the pump speed results mathematically from the desired volume flow, the theoretical displacement volume of the integrated pump and the calibration factor. The calibration factor corrects for influences due to pressure, viscosity and internal leakage of the pump. The calibration factor may be determined as explained above.

6.4 Flushing procedure after use

After each use the µDispense® should be carefully flushed with a non-corrosive, filtered and particle-free flushing liquid (see table 22/table 23). During the flushing procedure the µDispense® should be operated at a motor speed of 3000 rpm - 5000 rpm and preferably against a low pressure. The pressure can be build up by using a restrictor, a capillary or a check valve. The flushing liquid must be compatible with the liquids used in the previous process and be suitable for removing contaminations. Depending on the application water or isopropanol may be suitable. If you have doubts whether a liquid is suitable for this process, please ask the manufacturer of the liquid or HNP Mikrosysteme.

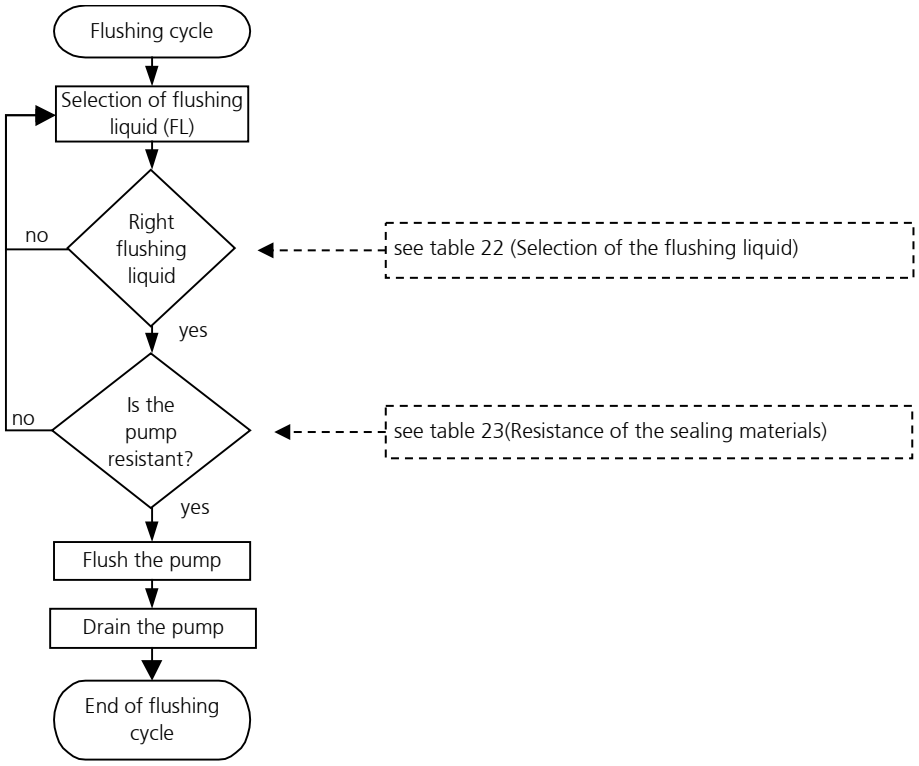


figure 18 Flushing procedure

Warning Liquids remaining in the µDispense® may crystallize, coagulate or lead to corrosion and as a consequence impair the work of µDispense®

Warning Please make sure that the components of the µDispense® and particularly O-rings and shaft seal are resistant to the flushing liquid used (see table 23).

Warning The selection of the flushing liquid (solvent) and duration of the flushing procedure depend on the liquids used during normal operation (see table 22). The indicated flushing liquids are suggestions and should therefore be checked by the user for their compatibility and suitability.

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

	Nature of the handled liquid	Flushing cycle [min]	Suitable flushing liquid
1	Oils, fats, grease, plasticizer	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, aqueous 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 22 Selection of flushing liquid (solvent) and duration of flushing cycle depend on the liquids used during normal operation.

	Shaft seal		O-ring material		
Flushing liquid	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 ... suitable 2 ... conditionally suitable 3 ... not suitable - ... not specified

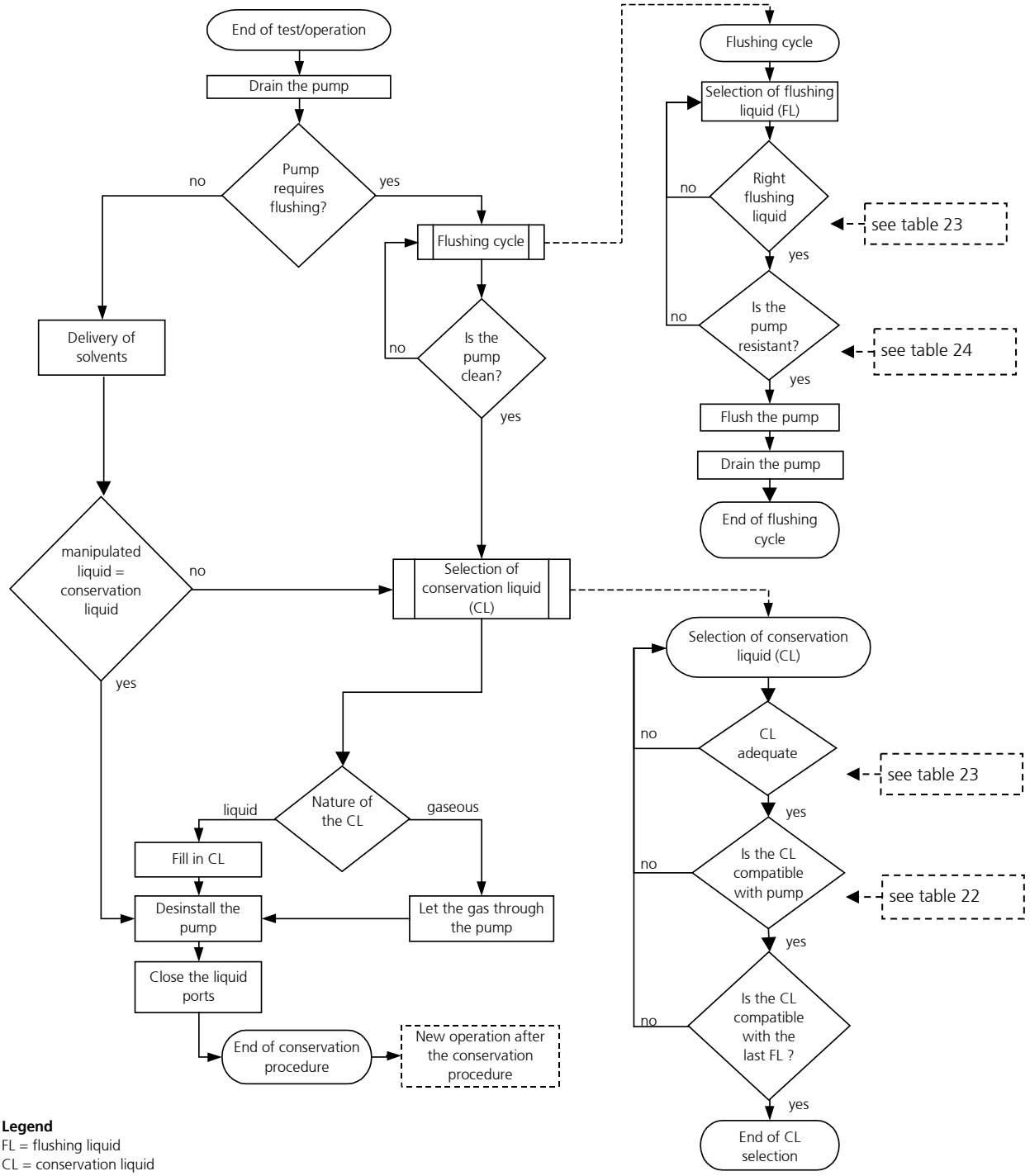
table 23 Resistance of the sealing materials depending on the flushing liquid (solvent)

6.5 Shutdown of the µDispense®

The following steps should be followed during shutdown of the µDispense®:

1. Flush the µDispense® with a filtered and particle-free flushing liquid /solvent (see chapter 6.4)
2. Stop the pump after the flushing procedure has been finished.
3. Fill µDispense® with a suitable conservation liquid at a low speed (see chapter 6.5.1).

By proceeding as shown in the diagram (see figure 19) you may prepare µDispense® for a longer standstill.



Legend
FL = flushing liquid
CL = conservation liquid

figure 19 Shutdown procedure

6.5.1 Conservation

If the µDispense® will not be used for a longer period of time, it should be filled with a suitable conservation liquid following the flushing procedure (see chapter 6.4).

The conservation liquid may be selected from table 24 depending on the duration of the standstill and the chemical resistance of the µDispense® to the conservation liquid (table 23). The listed conservation liquids are only suggestions and should therefore be checked by the user for their compatibility and suitability.

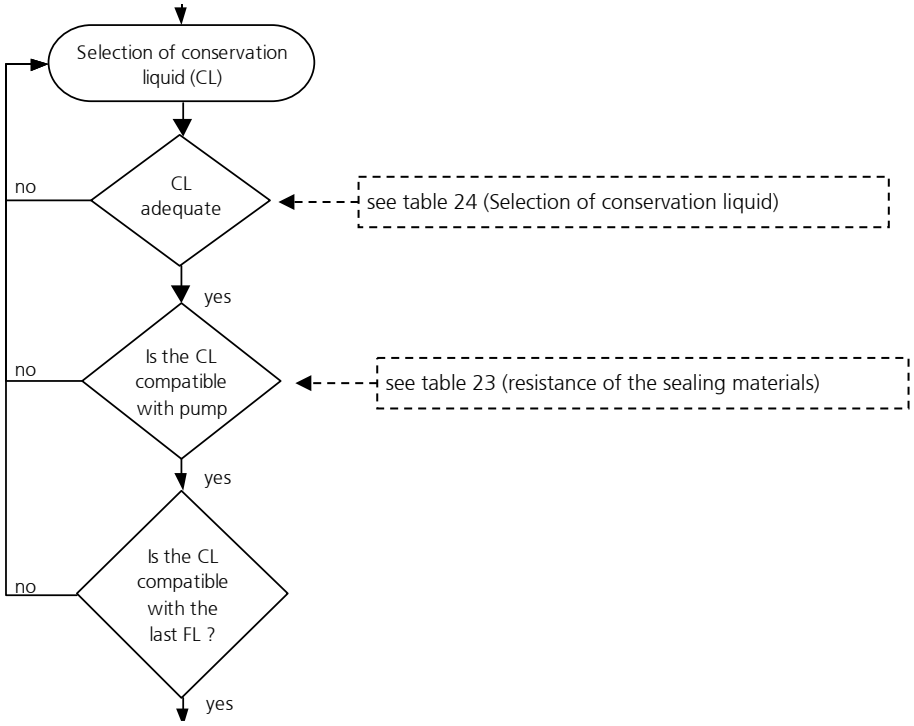


figure 20 Selection of the conservation liquid (CL)

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, antifreeze, antiseptic agents
acetone	+	+	o	o	o	+	solvent for a number of organic compounds, unlimited solubility in water, dissolves natural and synthetic resins, grease, oils and commonly used plasticizer
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 grease, tar, rubber or adhesive substances, protects against corrosion)
hydraulic oil	-	-	+	+	+	-	lubricating and preserving properties (*Warning*: may resinify 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 - ... inadequate

table 24 Selection of the conservation liquid

Close the liquid inlet and outlet port with the provided screw plugs. This prevents dust or particles from entering the µDispense® and the conservation liquid from leaking.

Warning

Water or deionized water (DI-water) *should not* be used as conservation agents. These liquids may promote microbiological growth after a few days and build a biofilm which can block the pump.

6.5.2 Deinstallation of the µDispense® from the system

– Stop the flow rate of the µDispense® and switch off the power supply. Make sure that the flushing procedure described in chapter 6.4 has been completed.
– Remove the µDispense® from the system.
– Protect the liquid inlet and outlet ports of the µDispense® with the provided screw plugs.

6.6 Trouble shooting

In case the µDispense® does not start to operate, stops working abruptly, or behaves in an irregular manner, then proceed as follows:

Try to restart the µDispense® (see also chapter 11):

– via the control software
– by changing the operating direction of the µDispense®.

If these measures turn out to be ineffective, please contact the service staff at HNP Mikrosysteme (see chapter 9) and send the µDispense® back to the manufacturer for inspection.

Warning

You should under no condition try to take apart the µDispense® by yourself. This may cause damage to the components of the µDispense®.

6.7 Return of the µDispense®

For returning a µDispense® follow the subsequent instructions:

– drain any remaining liquid from the µDispense® (if possible)
– flush the µDispense® with a suitable solvent (if possible)
– protect all input and output ports with the delivered screw plugs
– return the µDispense® in its original packaging (if possible)
– fill in the "Declaration media contact" form

Please fill in the "Declaration of media in contact with the micro annular gear pump and its components" together with a short description of the failure. (see chapter 16). This declaration can be downloaded from:

https://www.hnp-mikrosysteme.de/en/service/download-center.html.

The "Declaration of media in contact with the micro annular gear pump and its components" must be filled in. Any liquid which may be present in the µDispense must be specified.
In case of non-compliance, the sender will be liable for any resulting injury to people or any resulting damage.

7 Accessories for microfluidic systems

HNP Mikrosysteme offers accessories such as supplementary modules, tubing, fluid connection fittings, filters, check valves and shut-off valves that are best compatible with the µDispense®. If you need assistance choosing suitable components for a specific application, please contact us.

8 Non-liability clause

HNP Mikrosysteme GmbH shall not be liable for damages resulting from the disregard 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).

9 EC Directive

A Directive or EC 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 µDispense®:

Low-Voltage Directive (2006/95/EU)

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

Machinery Directive (2006/42/EU)

A µDispense® is a machine and is consequently covered by this Directive. However, it may be a part of a machine or installation.

EMC Directive (2004/108/EU)

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

RoHS Directive (2011/65/EU)

To our knowledge our products 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 forbidden by the Directive.

WEEE Directive 2012/19/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®, µDispense®, MoDoS®, colorDoS®, LiquiDoS® and smartDoS® 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.

9.1 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.

9.1.1 EMC Directive and Standards

Conformity 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 standardized 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 25 Standards Summary

All tests were conducted successfully.

9.1.2 Information on use as intended

For µDispense®, note the following:
Requirement for the intended operation is the operation according to the technical data and this manual.

Restrictions

If the µDispense® 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!

10 Declaration of conformity

The delivered µDispense® falls within the 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 µDispense® from us separately.

HNP Mikrosysteme

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

We hereby declare that the following

µDispense®

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 µDispense® shall be installed corresponds to the regulations of the EC 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 authorized to compile the technical file according to Annex VII A.

Date: 10. April 2017

Signature manufacturer:

Dr. Thomas Weisener
CEO

HNP Mikrosysteme

EC-manufacturer's certificate following Machinery Directive 2014/30/EU

We hereby declare that the following

µDispense®

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 µDispense® shall be installed corresponds to the regulations of the EC 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: 10. April 2017

Signature manufacturer:

Dr. Thomas Weisener
CEO

11 Problems and solutions

Disturbance	Cause	Solution
1. The µDispense® does not respond to commands	No power supply	Check power supply.
	No connection to controlling device	Check interface cable
2. The µDispense® does not deliver any liquid.	No liquid in the primary tank	Fill the reservoir/tank with liquid.
	Malfunction of the liquid supply system (such as in the delivery tubing, the dosing needle or external check valve)	Check the components for possible contamination / clogging. Cleanse or replace accessories if needed.
	Self-priming of the µDispense® does not occur.	The tubing on the suction side is too long or internal diameter is too small, resulting in too high pressure drop
		The tubing or the fluid connection on the suction side are not tight. Please check the fittings and the tubing.
	Air bubbles in the liquid supply system (tubing, valves, ...)	Fill the reservoir/tank with liquid, check the fluidic connections on suction side, check filters
	Blocked tubing or dosing needle	Cleanse, flush or exchange the tubing or dosing needle.
3. Dosage volumes do not correspond to the desired values.	Air bubbles in the liquid delivery system (tubing, valves, ...)	Vent the liquid delivery system by running the pump in both directions at approx. 3000 rpm and check for leaky fluid connections.
	µDispense® shows cavitation or degassing.	Tubing on the inlet side is too long or diameter too small. Shorten the tubing or change the position of the µDispense® or the reservoir.
	Filter clogged	Exchange or cleanse the filter.
4. Liquid drops from the dosing needle when µDispense® is in stand still.	The shut-off valve does not close.	Flush the µDispense®.
5. Dosage volumes decrease with time.	Clogged filter	Exchange or cleanse the filter.
	Deposits in the µDispense® (pump)	Flush the µDispense® or return it to the manufacturer for maintenance and cleaning.
	Particles in the delivered liquid	Flush the µDispense®.
	The µDispense® (pump) is worn after a long operating period or after use with abrasive liquids.	Calibrate the µDispense® or return for service.
6. Leakage from the µDispense®	The sealing does not function correctly.	Return the µDispense® to the manufacturer.
	Defective shaft seal	Return the µDispense® to the manufacturer.
	Leaky fittings	Exchange or tighten the fluid connections.
7. Air bubbles on the delivery side.	Loose fluid connections	Check and tighten the fluid connections.
	The shaft seal is leaky or worn.	Return the µDispense® to the manufacturer.
	Filter is clogged	Clean or exchange filter
8. Excess temperature	The µDispense® (pump) operates with difficulty.	The µDispense® should be flushed. If that does not help, send back to manufacturer for cleaning.
	Particles in the delivered liquid or deposits in the µDispense® (pump)	The operation of the µDispense® should be stopped immediately! Return the µDispense® to the manufacturer for cleaning.
	Grinding noise	The operation of the µDispense® should be stopped immediately! Return the µDispense® to the manufacturer for cleaning and repair.

Disturbance	Cause	Solution
9. The µDispense® (pump) is noisy.	Wear of the µDispense® (pump) or defective components.	Do not continue operating the µDispense®, return it to the manufacturer for maintenance.
10. Undervoltage	Voltage supply < 22 VDC	Check the power supply 24 VDC
11. Overvoltage	Voltage supply > 28 VDC	Check the power supply 24 VDC. The drive control unit may be damaged. Return the µDispense® to the manufacturer.

table 26 Trouble shooting

If a disturbance occurs that has not been mentioned in the above list, or that makes the use of the µDispense® unsafe, please stop the operation of the µDispense® immediately and contact HNP Mikrosysteme (see chapter 13). If needed, return the µDispense® to the manufacturer for inspection.

12 Service, maintenance and warranty

Maintenance of the µDispense® should be carried out depending on the delivered liquid:

- *for lubricating liquids* after 6000 working hours, but not later than 15 months after the initial operation

- *for non-lubricating liquids, crystallizing liquids or liquids containing particles*, after 4000 working hours but not later than 12 months after the initial operation. If during the first inspection no substantial wear of the pump is observed, the following inspection under the same working conditions can be performed after 6000 working hours, yet not later than 15 months following the last inspection.

If during the first inspection the µDispense® shows a particularly strong wear, the maintenance intervals should be readapted to the changing operation parameters.

In order to prevent a strong wear of the µDispense®, the µDispense® should be shut down properly after every operation as described in chapter 6.4
A supplementary flushing procedure with a neutral flushing liquid (see chapter 6.4) also slows down the wear of the µDispense®.

It is not allowed to open or take apart the µDispense®. The warranty expires with the end of the legal warranty period or with the opening of the µDispense®. HNP Mikrosysteme cannot give any warranty of exchange for parts whose damage result from incorrect use.

For service and maintenance please return your µDispense® to HNP Mikrosysteme. You will find the address on the cover of this operating manual.

The declaration of media (liquids) in contact with the µDispense® and components must always 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.

13 Contact persons

Development and application assistance, service and accessories

Mrs. Elisabeth Westphal
Phone +49| (0) 385|52190-363

Service and maintenance

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

Drive technology

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

Software

Mr. Andres Neumann
Phone +49| (0) 385|52190-358

14 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.

µDispense® 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.

15 Safety information for the return of used µDispense® and components

15.1 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 µDispense® and its components during repair or maintenance works. The nature of media (liquids) coming into contact with µDispense® and its components must be specified in the corresponding declaration form.

15.2 Declaration of media in contact with the µDispense®

The staff performing the repair or maintenance works must be informed about the condition of the µDispense® before starting any work on the device. The "Declaration of media in contact with the µDispense®" 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.

15.3 Shipment

The following instructions should be observed for the shipment of the µDispense®.

1. drain the µDispense® from any remaining liquid
2. flush the µDispense® with an adapted flushing liquid
3. all openings should be air-tight plugged
4. return the µDispense® in the original packaging

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

Type of the device

Pump type/serial number/article no.: _____

Operating hours/running time: _____

Number of delivery note or delivery date: _____

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 packaging 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	_____

H-statements: _____ 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: