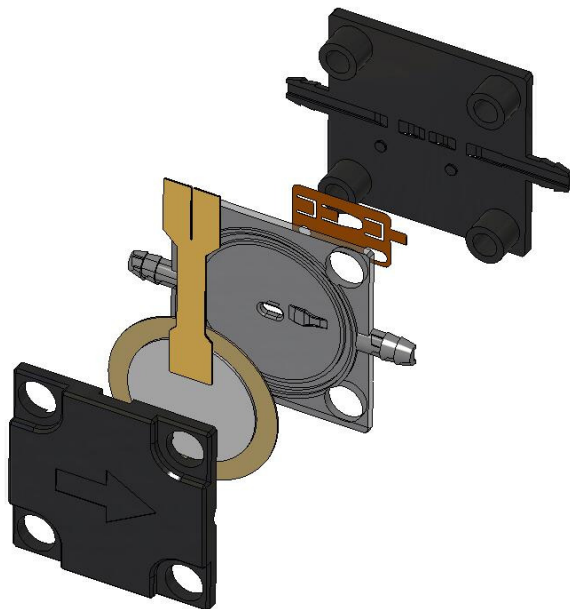


Operating Manual

Micropump mp5

and controller



Last update: 2009-08-05



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1. General

This operating manual contains all necessary instructions for the installation, commissioning, operation and maintenance of the mp5 micropump and of the controller mp-x and mp5-a with the mp5.

The unit has been designed with state-of-the-art technology and in accordance with all relevant safety regulations. However, a risk of damage to the units, other property, the operator and/or other persons cannot be fully excluded.

Always comply with the following general instructions:

- Before working with a pump, you must be fully familiar with its operation and functions.
- Prior to operating the pump, read this operating manual and adhere to all instructions.
- Refrain from any operations that might endanger the safety of the unit.

Bartels Mikrotechnik GmbH rejects any responsibility for damages to persons or property resulting from non-compliance with the instructions in this manual. In this case all warranties shall be void.

1.1 Declaration of conformity

Bartels Mikrotechnik GmbH is certified according to DIN EN ISO 9001:2000 and declares that the products are compliant to the RoHS directive and the controller comply with the requirements of EMC 89/336/EEC and CE markings have been affixed to the devices.

1.2 Description of functions

The micropump has been developed for the transport of gases or liquids. The mp-x controller and the mp5-a controller has been developed for operating one mp5.

Bartels Mikrotechnik can assume no liability for damages resulting from the pump media. This applies especially for hazardous fluids.

The pump must be operated with Bartels Mikrotechnik electronics. Bartels Mikrotechnik GmbH cannot guarantee the proper work of the unit with customer specific electronics. If other controllers than the ones from Bartels Mikrotechnik are used, Bartels Mikrotechnik disclaims any warranty.

Please make sure that only skilled personnel works with the pump control and micropump. The micropump shall be under constant supervision under running conditions. And please note that components of the controller and pump are operating with high-voltage. Therefore persons wearing pacemakers are recommended to avoid the operating system.

Bartels Mikrotechnik assumes no liability for abnormal handling, improper or negligent use of the micropump that is not conform to the specified purpose of the system. This applies especially for micropump controllers, components and systems of other manufacturers, which have not been certified by Bartels Mikrotechnik.

We guarantee that the micropump complies to the actual state of scientific and technical knowledge and due to this the operational risks are limited to a minimum.

Do not open the housing of the micropump. In those cases Bartels Mikrotechnik can not issue a guaranty anymore. Please keep this manual safe and give a copy to all users.

2. Proper use

2.1 Intended purpose

The micropump is intended for pumping liquids or gases with varying flowrates controlled by the electronics. The mp-x controller and the mp5-a is intended for operating one mp5. Any other use of the micropump or controller unit is deemed improper.

Do not make any modifications or extensions to the pump or controller without the prior written consent of the manufacturer. Such modifications may impair the safety of the unit and are prohibited. Bartels Mikrotechnik GmbH rejects any responsibility for damage to the unit caused by unauthorized modifications to the pump and risk and liability are automatically transferred to the operator.

2.2 Misuse

The use of liquids, which may alone or in combination create explosive or otherwise health-endangering conditions (including vapors) is not permitted.

2.3 Staff selection and qualification

All work in connection with the installation, assembly, commissioning/decommissioning, disassembly, operation, servicing, cleaning and repairing of the pump must be carried out by qualified, suitably trained and instructed personnel.

Work on electrical components and assemblies must be carried out by personnel with the necessary qualifications and skills.



2.4 About this operating manual

Warnings and important notes are clearly identified as such in the text. The relevant text sections feature a specific sign. However, this icon cannot replace the safety instructions. Therefore, carefully read all safety instructions in this manual. Warnings and important notes in this text are highlighted as shown below, according to the severity of the damage that might result from non-compliance.



⚠ DANGER

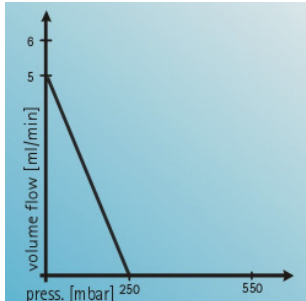
DANGER INDICATES A HAZARD WITH A HIGH LEVEL OF RISK WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY.



3. Technical specifications

	mp5	
Pump type	piezoelectric diaphragm pump	
Actuators	1	
Dimensions without fluidic connectors	14 x 14 x 3.5 mm ³	
Weight	0.8 g	
Fluidic connectors	tube clips (inner diameter 2 mm, length 3 mm)	
Electric connectors for	mp-x or mp5-a	
Current consumption	< 1 mA	
Self-Priming	yes (conditions: suction pressure < 10 mbar; DI water; settings mp-x: 100 Hz, 250 V, SRS)	
Pumped media	liquids or gases	
Viscosity	<~ 120 mPas	
Particle tolerance	Ø < 50 µm	
Hydrodynamic open	Yes	
Operating temperature	0 – 80°C	
Life time	> 5000 h	
Materials in contact with media	polyphenylene sulphone (PPSU) / polyimide (PI) / nitrile butadiene rubber (NBR)	
Flow and back pressure for selected media (Values defined with mp-x: 250 V, SRS):		
Gases	max. flow	15 ml/min (300 Hz) variation < 25 %
	linear range	0 - 5 ml/min @ 0 - 50 Hz
	max. back pressure	30 mbar (300 Hz)
Liquids		
Water	max. flow	5 ml/min (100 Hz) variation < 15 %
	linear range	0 - 3 ml/min @ 0 - 30 Hz
	max. back pressure	250 mbar (100 Hz)
	repeat accuracy (30 Hz, 250 V, SRS)	< 12 %

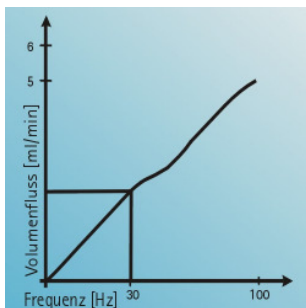
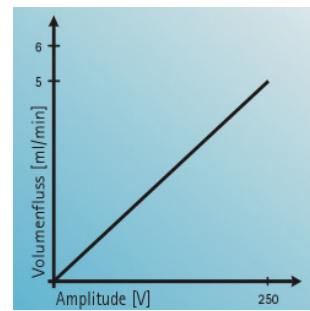
3.1 Typical flow characteristics



The flow rate of the pumps shows a linear dependency on the back pressure.

At 0 mbar back pressure the maximum pump rate can be achieved and at the maximum back pressure the flow rate is decreased to 0 ml/min.

Increase in amplitude linearly increases the flow rate to the maximum.
The amplitude defines the stroke of the actuator and therefore the displacement of the pumping media per pump cycles.

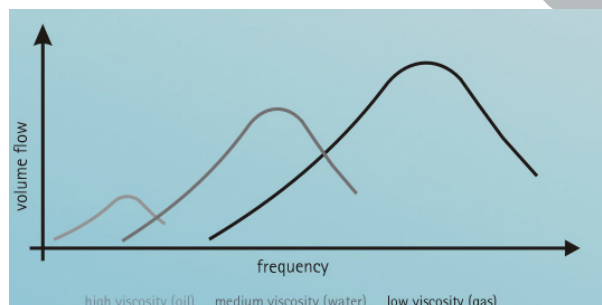


Rising frequencies result in a maximum flow rate at resonance frequency. At frequencies above the resonant point the flow rate decreases again.

The flow rate increases in a defined frequency range linearly, because the frequency determines the quantities of pump strokes per unit of time.

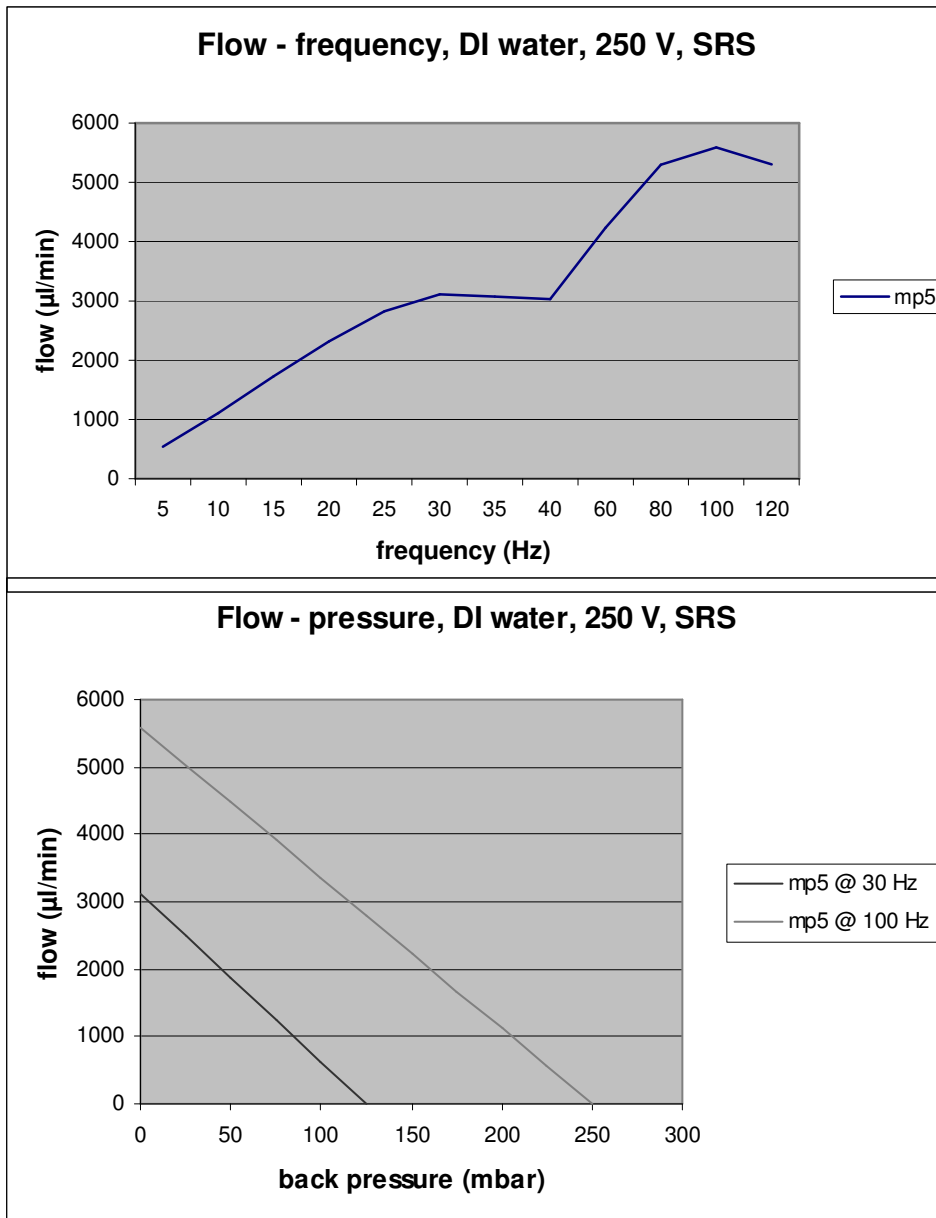
The linear range of selected pump media is shown in the technical specifications.

The resonance frequency and the maximum flow rate strongly depend on the viscosity of the media.
The lower the viscosity, the higher the maximum flow rate and the resonance frequency.

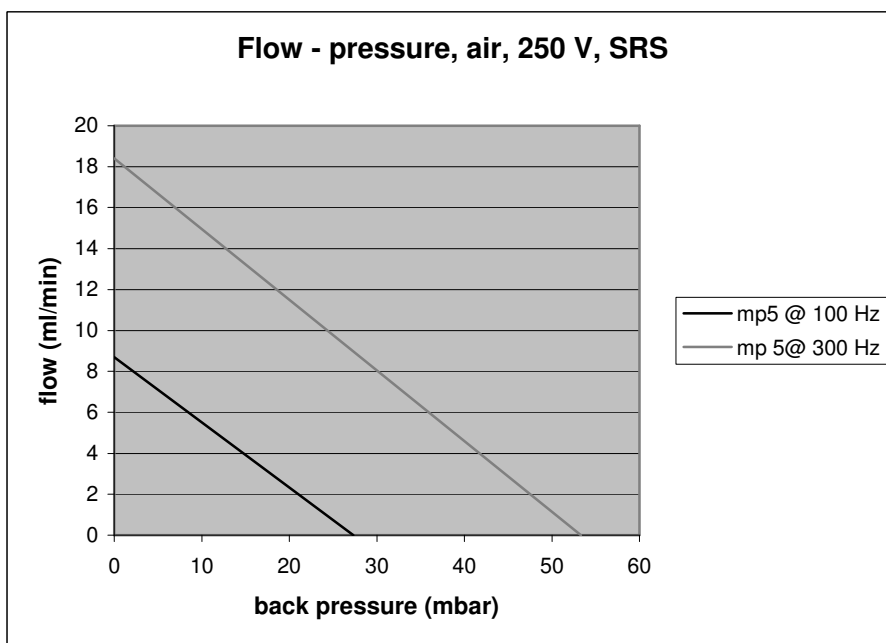
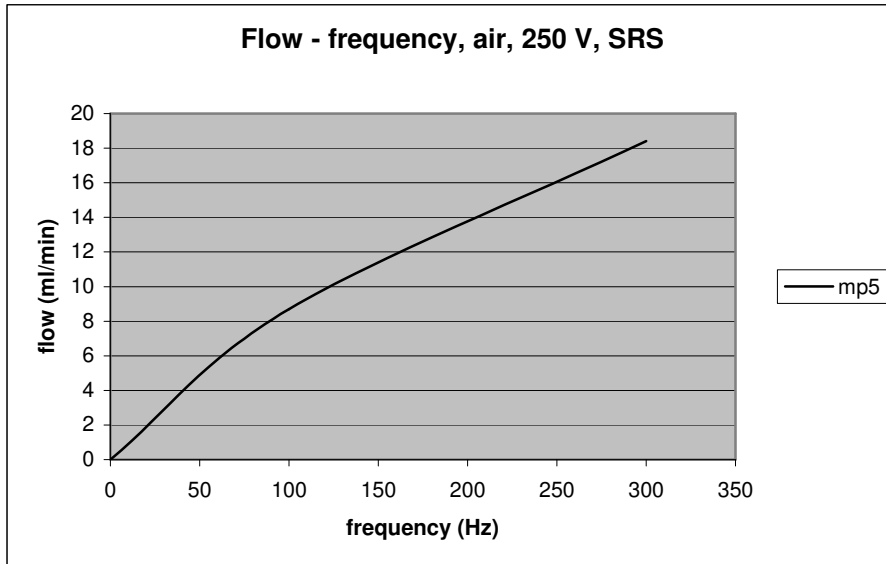


3.2 Flow curves mp5 for selected media

3.2.1 Medium: DI water



3.2.2 Medium: air



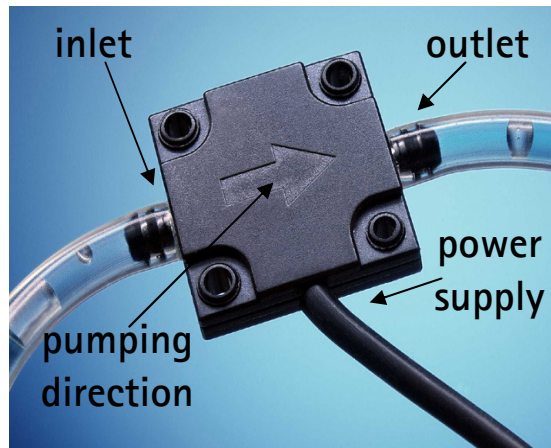
3.4 Final inspection

After production the micropumps have to pass a final inspection. They are tested concerning the maximum flow of 5 ml/min with DI water; settings mp-x: 100 Hz, 250 V, SRS-signal and the self-priming characteristic (conditions: suction pressure < 10 mbar; DI water; settings mp-x: 100 Hz, 250 V, SRS-signal, the maximum flowrate can be reached by manual priming).

In order to guarantee proper function of the delivered goods and exclude transportation damages please check the incoming devices according to specifications after receipt. On the basis of these results a replacement can be carried out within 14 days after delivery free of costs.

4 Operating the micropump

4.1 Connecting the micropump




For operating the micropump has to be connected to one of the controllers of Bartels Mikrotechnik GmbH. You can find more information in the corresponding manual.

Please connect suitable tubes to the inlet and outlet. The tubing should have an inner diameter of 1,3 mm.

The micropump can be driven with positive alternating voltages with a maximum amplitude of 250 V at a frequency between 0 and 300 Hz. A rectangular signal results in best fluidic performance while a sine wave minimizes the audible noise.

If a pump gets damaged while using a customer's controller we do not provide any warranty.

 DANGER
THE MP5-SERIES MICROPUMPS ARE OPERATED AT HIGH VOLTAGES. PEOPLE WHO WEAR HEART PACE-MAKERS ARE THEREFORE STRONGLY ADVISED NOT TO COME NEAR THEM.

4.2 Filling the micropump

In case of pumping gases, the pump can be operated instantly. For use with liquids, please follow the instructions below.

In general the micropump is self-priming. But during the quality control test the pump can be pre-filled with de-ionized water. If wettened, the valves can stick, requiring a manual priming of the pump prior to operation.

Manual priming should be carried out by flushing the pump with the help of a syringe.

!!Only pull the fluid from the outlet in pumping direction. Do not exceed 1 bar of internal pressure!!

This also helps to get the system primed free of gas bubbles. If operation is paused, the pump can be stored in a filled condition in order to avoid catching gas bubbles and going through the priming procedure again.

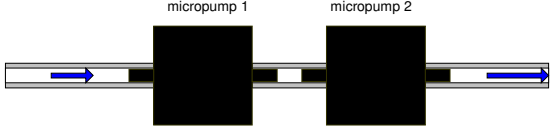
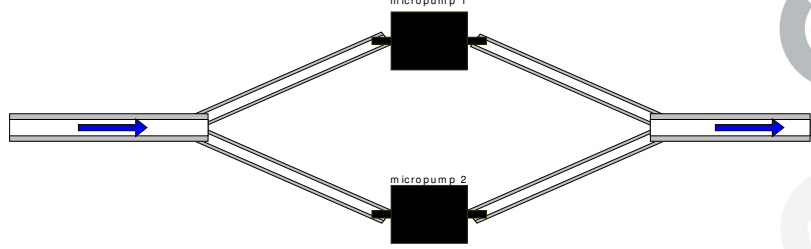
4.3 Cleaning the system

The pump can be washed with water, alcohol (iso-propanol) or if necessary with weak acid by pumping or by flushing with the help of a syringe.

!! Only use the syringe pulling from the outlet in pumping direction !!

4.4 Serial or parallel operation

To increase the flow rate or the pumping pressure, several micropumps can be cascaded.

<p>Serial</p>	 <p>Increases the pressure, the flow rate will not be increased. Generally the pressure multiplies by the number of pumps.</p> <p>Basic settings for high pressure for viscosities of water: signal: SRS / frequency: 100 Hz / amplitude: 250 V</p> <p>Please note: to reach the best result the tubing connection between the two micropumps should be as short as possible.</p>
<p>Parallel</p>	 <p>Increases the flow rate, the pressure will not be increased. Generally the flow rate multiplies by the number of pumps.</p> <p>Basic settings for high flow rate for viscosities of water: signal: SRS / frequency: 100 Hz / amplitude: 250 V.</p>

5. The mp-x controller

5.1 Technical specifications mp-x controller

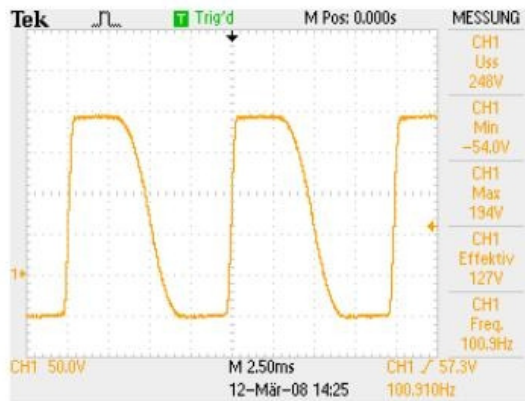
Dimensions	7.5 x 16 x 20 cm ³
Weight	approx. 800 g
Pumping media	liquids, gases and mixtures
Max. flow	5 ml/min (water) ¹ 15 ml/min (air) ¹
Controlling parameters	amplitude, frequency, signal form
Amplitude range	0 – 250 V
Frequency range	0 - 300 Hz
Signal form	SRS, rectangular, sine
Power supply	mains adaptor
Current consumption	500 mA with 7.5V
USB (port)	one, a CD with driver software is enclosed.

¹ depending on the settings and the pump



5.2 Electrical signal form

SRS:



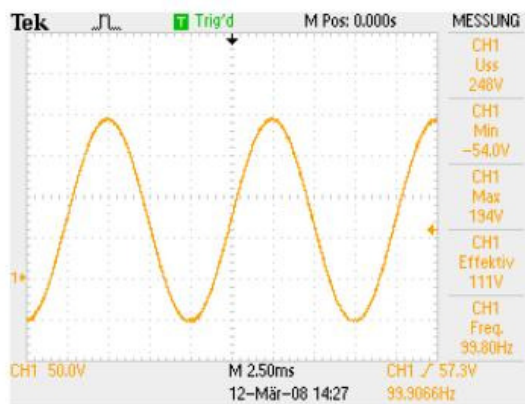
mpx, SRS-Signal, 250Vpp, 100Hz

Rectangular:



mpx, Rectangel-Signal, 250Vpp, 100Hz

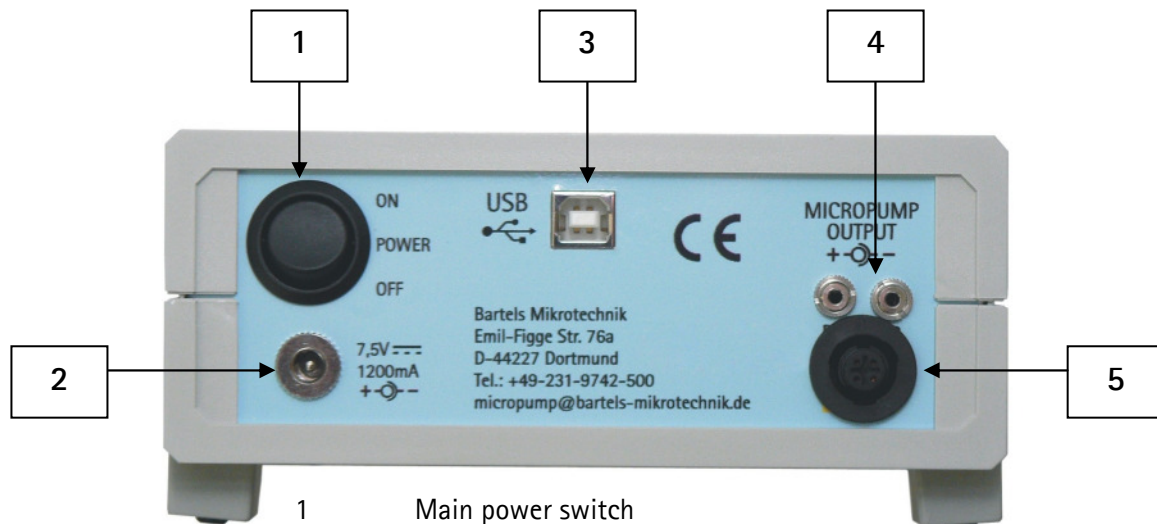
Sine:



mpx, Sine-Signal, 250Vpp, 100Hz



5.3 Connecting the pump to the mp-x



- 1 Main power switch
- 2 Power supply connector
- 3 USB interface for computer connection
- 4 Two connectors for the mp5
- 5 One connector for the mp6

Please note that it is only possible to connect either one mp6 or a maximum of two mp5 to the mp-x otherwise a maximum voltage drop is possible!

Step 1: Plug the micropump control cable into the corresponding micropump connector.

Step 2: Check the mains adaptor plug polarity. It is pictured next to the power supply connector at the back of the controller. If the plug polarity is wrong, the controller can't work. Please make sure that the setting on the included connector is attuned to 7.5 V.

Step 4: Connect the mains adaptor with the power supply connection.

Step 5: Plug the mains adaptor into a mains socket.

Step 6: Now you can start the control unit with the main power switch.

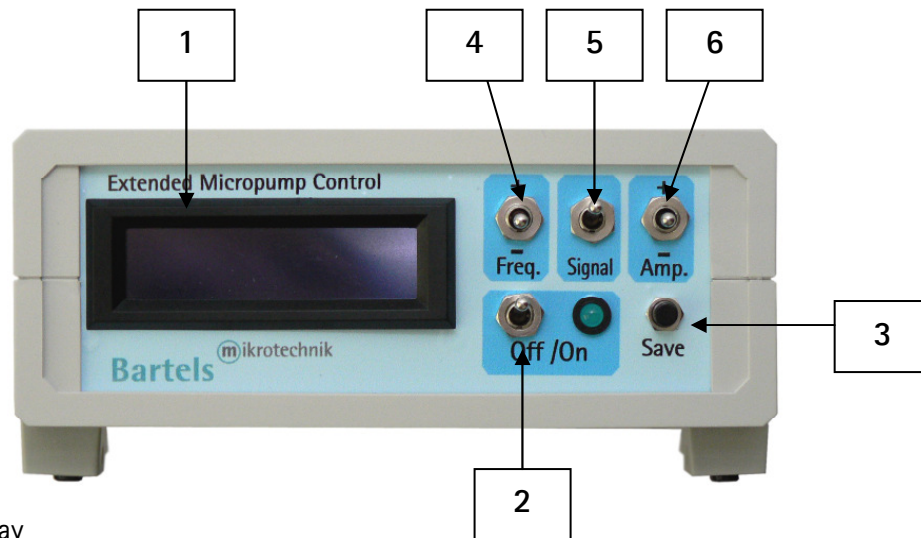
⚠ DANGER

**THE "MICROPUMP OUT" CONNECTOR CAN CARRY HIGH VOLTAGE !
BE CAREFUL, WHEN YOU PLUG IN THE MICROPUMP CONTROL CABLE!**

5.4 Operation of the mp-x

The mp-x provides three parameters to be selected independently of each other to control the micropumps: frequency, amplitude and signal wave form.

It is possible to change the settings while the pump is operating. But to extend the life time it is advisable to turn off the micropump first before changing the settings.



- 1 LCD display
- 2 On/Off switch: push the on/off switch to turn the pump and control diode on or off
- 3 Save: push the save switch to save the present settings
- 4 Frequency (0 – 300 Hz): push the switch up to raise and down to reduce the frequency
- 5 Signal form modus: push the switch once to choose between SRS, rectangular or sine
- 6 Amplitude (0 – 250 V): push the switch up to raise and down to reduce the amplitude

To operate the micropump, prepare the controller as described in point 5.3 and follow the steps below:

Step 1: Choose a frequency by pushing the frequency switch up and down.

Step 2: Choose one of the signal forms by pushing the signal switch.

Step 3: Set the amplitude by pushing the amplitude switch up and down.

Step 4: Push the on/off switch to turn on the micropump and the control diode.

Step 5: Push the on/off switch again and the micropump will stop while the control diode turns off.

Before the control unit is turned off, you can save the present settings by pushing the save switch.

For shutdown of the pump please switch off the mp-x first and then disconnect the power plug. Do not unplug the micropump before switching off the controller.

5.4.1 Installation of the drivers "USB Micropump Control" and "USB Serial Port"

Step 1: Connect the control unit with the USB port and turn it on. A message appears that new hardware was found and the hardware assistant starts automatically. Please click "next" to continue.

Step 2: Choose "find a suitable driver for the device" and click "next" to continue.

Step 3: Activate the box "search for new driver" and insert the accompanying CD.

Step 4: After you have found the driver "USB Micropump Control", click "next" to start the installation. Maybe a message appears that the windows-logo-test has failed. This warning can be ignored. After installation click "complete" to finish the installation.

Step 5: After finishing the installation the assistant will start again to install the corresponding USB serial port by repeating the described above.

5.4.2 Operation via USB port (after installation of the drivers)

The driving parameters can be set via your PC. For this purpose you can use any software (or programming language) capable of sending commands to a COM-Port, like the Hyperterminal shown in the example below. As the pump will be switched off during data transfer, this is not suitable for continuous control.

Example with Hyperterminal

Step 1: Connect the control unit to your computer and turn it on.

Step 2: Start Windows Hyperterminal. Every new session has to be titled.

Step 3: Choose the com-port specified in the device manager.

Step 4: The connection-settings have to be (9600, 8, n,1).

Possible commands (followed by the enter key)

bon	turns the micropump on
boff	turns the micropump off
<i>F(1-300)</i>	sets the required frequency between 1 and 300 Hertz:
F100	...for example 100 Hertz.
<i>A(0-250)</i>	sets the required amplitude between 5 and 250 Volt:
A100,5	...for example 100,5 Volt. (in increments of 0,5 Volt)
MS	sets signal form modus (S)inus
MR	sets signal form modus (R)ectangle
MC	sets signal form modus SRS
<i>(enter key)</i>	displays present settings of the control unit



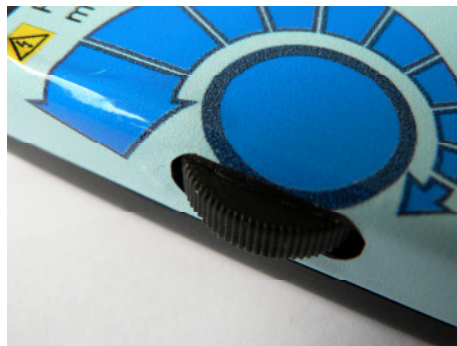
If required we can send you a package of LabView-Routines as an example of implementation.

6. The mp5-a controller

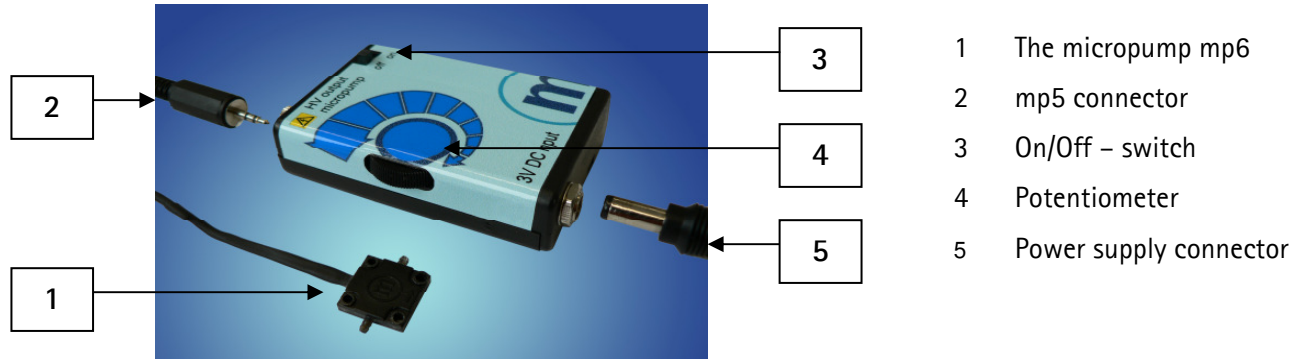
6.1 Technical specifications mp5-a

Dimensions	7 x 5 x 2 cm ³
Weight	approx. 80 g (including batteries)
Pumping media	liquids
Max. flow	3 ml/min (water)
Controlling parameters	voltage
Frequency	approx. 100 Hz
Amplitude range	100 - 220 V
Signal form	similar to rectangular
Power supply	2 AA batteries ¹ or mains adaptor
Current consumption	approx. 50 mA (3 V)

¹The flow range decreases by potential drop of battery.



6.2 Connecting the mp5 to the mp5-a



Step 1: Connect the mp5 with the control unit. For connecting the pump to the cable see chapter 4.2.1.

Step 2: Adjust the flowrate by turning the potentiometer.

6.3 Operation of the mp5-a with batteries

Slide the lid off, insert two 1.5 V AA batteries and switch on the micropump with the On/Off – switch. The flow range decreases by potential drop of battery.

6.4 Operation of the mp5-a with mains adaptor

Connect the controller with the included adapter, plug it in a mains socket and switch on the micropump with the On/Off – switch and it will operate immediately. Please make sure that the setting on the included connector is attuned to 3V. The function of the controller and the micropumps will not be influenced, if the batteries have not been removed.

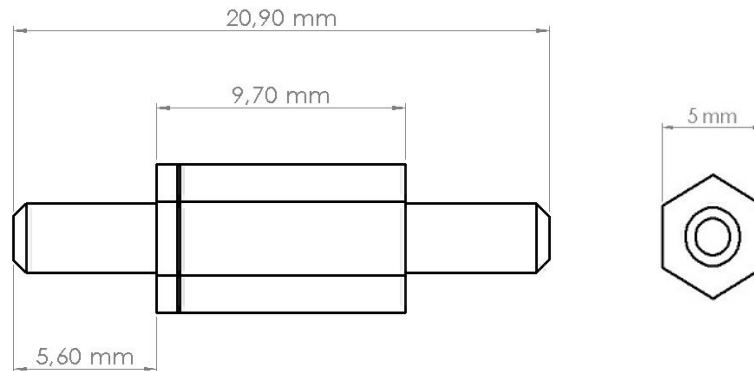


7. Passive check valve mp-cv

When the micropump is switched off, a back flow of the pumping medium, depending on a differential pressure between in- and outlet is possible. In order to impede a back flow Bartels Mikrotechnik offers a passive check valve integrated in stainless steel.

The connection of the valves with the micropump can be done easily with a suitable tubing. The valve should be placed between the micropump and the outlet reservoir.

Dimensions:



Flow direction: free flow \longrightarrow

Slitted side of valve shows towards micropump.

Technical specifications:

Material	silicone, stainless steel
Fluidic connectors	barb inner diameter: 1.6 mm length: 5.6 mm
Cracking pressure	typically < 35 mbar
Max. back pressure	500 mbar
Leak rate	< 4 μ l/h for liquids

Please note that the volume flow of the micropump will be influenced by the check valve.



8. Trouble shooting

Observation	Trouble shooting
Maximum flow rate cannot be achieved	<ul style="list-style-type: none"> - Gas bubbles within the system, the compressible gas volume in the pump can result in decrease of pump rate = system should be primed with a syringe as described in 4.1 - Tubing is too long = shorten tubing - Tubing diameter is too small = use appropriate tubing with an inner diameter of 1.3 mm - Back pressure is too high = reduce pressure or lower outlet reservoir - Check signal form used to drive pump = highest flow rate is achieved by SRS signal and at resonance frequency (100 Hz for water) - The flow rate is viscosity dependent as described in 3.1
Non-linear flow behavior	<ul style="list-style-type: none"> - The linear range of the pump characteristic is described for selected media in 3 - Gas bubbles in the pump act as compressible volume and when they are digested through the pump this can lead to non-linear flow behavior = system should be primed with a syringe as described in 4.1
Fluid is flowing through the system although pump is switched off	<ul style="list-style-type: none"> - The valves inside the pump are opening and closing by differential pressure of in- and outlet = lower in- or outlet reservoir to avoid hydrodynamic behaviour or add check valve as described in 4.5
No buzzing sound = pump is not working	<ul style="list-style-type: none"> - Please check if the mains adaptor is correctly connected - Please check if the output switch is set in the current mode - Defect piezo actuator = contact Bartels Mikrotechnik for support

