



Frequently Asked Questions Bartels micropump mp6

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1. General

Q What are the characteristics of the mp6 micropump?

A The mp6 has two piezo actuators in order to achieve a reliable and reproducible pumping performance. The mp6 reaches a back pressure range of up to 550 mbar and shows a good self-priming behavior and high bubble tolerance when pumping liquids. Since the mp6 has only material, polyphenylene sulphone (PSSU), in contact with the pumping fluid it exhibits a good media tolerance.

Q Is the micropump mp6 a dosing system?

A The micropump mp6 is a system to convey a certain volume of fluids over time. The flow rate is adjustable by frequency and amplitude changes of the piezo actuator. Only if the outer conditions are very stable the micropump can be used for dosing either controlled directly or in combination with a timer control. As soon as a temperature change, viscosity change or for example a gas bubble occurs, the flow range will change. Under this conditions or requirements of higher accuracies a flow control needs to be added. Currently we are working on the integration of a flow sensor into the micropump to create a controlled loop system. For more details, please contact us.

Q What about cascading micropumps mp6?

A To increase the flow rate or the pumping pressure, micropumps can be cascaded. Connecting pumps in parallel multiplies the flow rate while connecting pumps in series multiplies the pressure. The long term stability and performance of these configurations need to be tested individually.

Q Is the micropump mp6 capable to pump in two directions?

A No, due to the passive check valves the micropump mp6 can only pump in one direction. However, as the pumps are fluidically open while switched off, two pumps can be connected in opposite direction to provide bidirectional flow. Due to the fluidic resistance this will however limit the maximum performance.

Q Why do the micropumps mp6 generate a sound?

A The piezo actuators are driven by the electronic controller connected to the micropump. When the driving signal has fast amplitude changes and the set frequency is in the range of human perception, a sound can be heard. If a sinusoidal signal is used within low frequencies (e.g. up to 200 Hz), the lowest sound generation is reached.

Q What is the inner volume of the mp6?

A The approximate volumes are the following:

	mp6
max. pumpstroke (100 Hz, 250 V, SRS)	~ 1.6 μ l
dead volume (100 Hz, 250 V, SRS)	~ 3.5 μ l
total inner volume	~ 27 μ l

Q Can the pumps be immersed into water?

A As the pumps and especially the electrical connector are not fluid tight in the standard version, the pumps must not be immersed in water or other liquids.

Q Did the micropumps pass an inspection before delivery?

A The micropumps have to pass a final inspection, in which the max. flow of 6 ml/min (DI water, settings mp-x: 100 Hz, 250 V, SRS), the maximum pressure of 550 mbar and the self-priming characteristics (conditions: suction pressure 10 mbar, DI water, settings mp-x: 100 Hz, 250 V, SRS) are tested.



2. Pumping performance

Q What are the best parameters to start the pump evaluation with the mp6-go!?

A Using liquids, the signal form SRS should be used, a good starting point is 250V amplitude and 100 Hz frequency. For high viscous liquids, frequencies below 100 Hz are preferred, while for gases the frequency range above 100 Hz provide the best results. The optimal frequency needs to be determined individually.

If the application is very sensitive to noise, the sine signal should be used instead.

Q What is the best way to achieve low flow rates?

A In order to ensure stable pump performance, if possible the frequency should be lowered first and the amplitude should be kept as high as possible. If necessary a precision orifice can be used to limit the outlet flow additionally.

Q What is the lowest flow rate that can be achieved?

A The lowest flow rate is very dependent on the conditions in the customers test system. Generally a flow rate of about 20 $\mu\text{l}/\text{min}$ for liquids can be achieved in most cases. With thorough optimization much lower rates can be achieved.

Q What types of fluids can be pumped?

A The mp6 pumps liquids, gases and mixtures of both. The micropumps were designed to withstand a large variety of media. The function cannot be guaranteed for aggressive chemicals.

NOTE: Please check if your media can be used with the wetted materials of the micropumps.

The mp6 has only one material, polyphenylene sulphone (PPSU) in contact with the pumped media. In general it is possible to change the material of the pumps in correspondence to the customer's application. Contact us to discuss details.

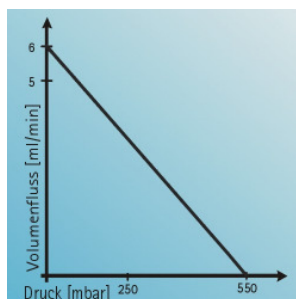
Q Which is the effect of different viscosities on the flow rate?

A As a rule of thumb, the maximum flow rates decreases by the dynamic viscosity in mPas. For example while water with a viscosity of about 1 mPas has a maximum flow rate of 6000 $\mu\text{l}/\text{min}$, with an oil of 100 mPas the maximum flow will be approximately limited to 60 $\mu\text{l}/\text{min}$. *Note: The real performance needs to be verified under full application conditions.*

Q What is the relation between pressure and flow rate?

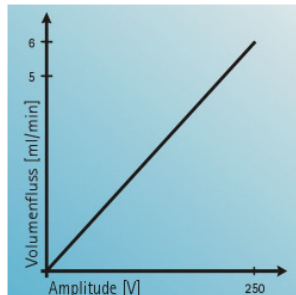
A The flow rate of the pumps shows a linear dependency on the back pressure.

At 0 mbar back pressure the pumps achieve the maximum pump rate, at maximum back pressure the flow rate of the pumps decreases to 0 ml/min. If the flow changes due to changing pressure conditions in the application are not acceptable, a close loop controlled pump can be used. Please contact us for further details.



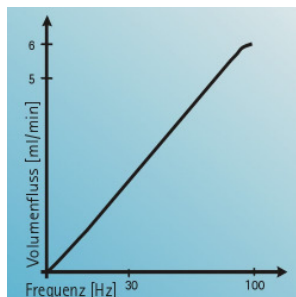
Q What is the relation between amplitude and flow rate?

A The amplitude defines the strokes of the actuator and therefore the displacement of the pumped medium per pump cycle. With rising amplitude of the controller voltage, the flow rate rises linearly to the maximum.

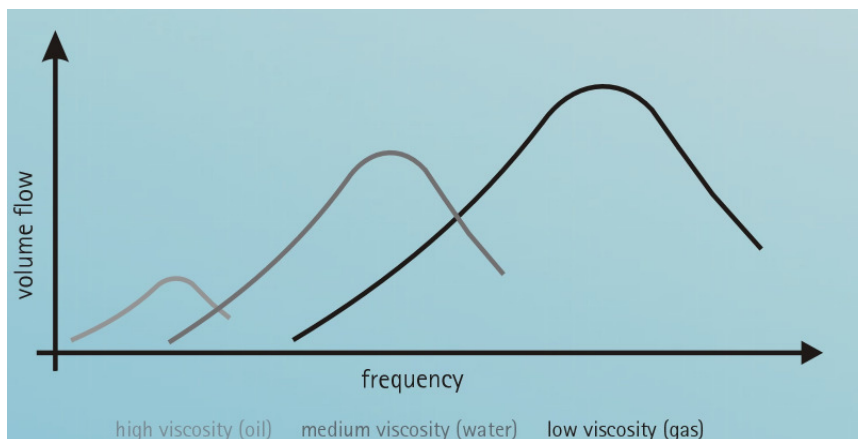


Q What is the relation between frequency and flow rate?

A The flow rate increases linearly in a defined frequency range, because the frequency determines the number of pump strokes per unit of time. The characteristic diagram shows a maximum at resonance frequency. At frequencies above the resonant point the flow rate decreases again.



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.
NOTE: The resonance frequency for water is roughly at 100 Hz.

Q How about pumping media with particles?

A The micropumps are capable of moving liquids with particles up to 20 μm , if these do not accumulate.
NOTE: Be careful with solids dissolved in solutions (e.g. saltwater). If the dilution rate is not high enough, crystals can form and clog the micropump.

Q Are the micropumps self-priming?

A Generally, yes. The testing conditions are: suction pressure < 10 mbar; DI water; setting mp-x: 100 Hz, 250 V, SRS. The mp6 normally is able to prime even with higher suction pressures.

Q What about the behaviour of bubbles inside the pumped liquids?

A The mp6 can generally handle bubbles within liquids. This is a result of the good compressing behavior due to the double actuator configuration. As a bubble presents an increased fluidic resistance, in order to achieve stable and reproducible behavior, tubings should be kept as short as possible when bubbles can occur in the application.

NOTE: Usually, the movement of the piezo membrane pushes a volume of liquid through the micropump. When a bubble is inside the pump chamber, the energy is partly used for compressing the gas-bubble instead of moving the fluid – depending on the size of the bubble. This changes the flow rate.

Q What about pumping gas when the micropump was wetted before?

A The micropump is capable to deliver gas. When a liquid has been pumped before, the micropump might show a non-linear behavior concerning the flow rate.

NOTE: Inside the micropump small check valves are used to give direction of the flow. If those valves are wetted, they might stick to the valve seat.

Q Can a flow rate be generated even though the micropump is switched off?

A The micropump is hydrodynamically open, the valves inside the pump are passive valves and only function during pumping operation, and therefore a flow can be generated if a differential pressure between inlet and outlet is present. In order to impede a back flow, Bartels Mikrotechnik offers the mp-cv passive check valves integrated in stainless steel. Please contact us for more information.

NOTE: Differential pressure is also given when the fill level of the reservoirs at in- and outlet differ.

Q Can a flow be generated without pulsation?

A Due to the functional principle of the piezoelectric diaphragm pumps a pulsation free flow can't be generated. However as the displaced volumes are very low the pulsations are much lower than the ones from conventional membrane pumps. The pulsation can be further minimized by using the sine signal and an elastic tubing.



3. Electronics

Q What is needed to drive the micropump?

A Everything needed is supplied by the electronic controllers offered by Bartels Mikrotechnik. The combination of signal, amplitude and frequency defines the performance of the micropump.

NOTE: If other controllers than the ones from Bartels Mikrotechnik are used, Bartels Mikrotechnik disclaims any warranty.

Q How many micropumps can be driven by the electronic controllers?

A All standard controllers from Bartels Mikrotechnik are optimized for driving a single mp6 pump. For serial applications we offer customized electronics that can be tailored to the customers' requirements. Please contact us for more details.

Q Should the flow rate be adjusted by the amplitude or by the frequency?

A In general both parameters can be used. As lower amplitudes lead to lower compression in the pump chamber, it is better to do fewer large pump strokes over time. Therefore try to work at a high amplitude level and decrease the frequency until you reach the required flow rate level. In case the flow pulsation is too high, the amplitude should be lowered and frequency increased.

Q How many signal forms can be chosen?

A The mp-x controller generates three different signal forms: SRS, Sine, Rectangular. The mp6-OEM generates only one signal form, it is similar to rectangular.

Q What is the SRS signal?

A The SRS signal is an optimized waveform generated by the mp-x controller to drive the actuator more efficiently. It makes the pump work at a lower sound level with increased long term stability of the flow rate. The SRS signal is used as the standard driving waveform.

Q What is the power consumption of the controllers?

A The current consumption of the mp6-OEM is roughly 50 mA (3 V), the mp-x consumption is 500 mA (7.5 V).

NOTE: For applications which need to be having even lower power consumption, adequate electronics can be developed.

Q Can the micropump mp6 be driven with a small voltage supply of 3-4 V?

A The mp6-OEM provides a standard electronics to drive the pumps from these low voltages.

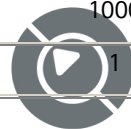


4. Volume Conversion Table

	nl μm^3	μl mm^3	ml cm^3	l m^3	in^3	1 fl oz (US)
nl μm^3	1	1000	10^6	10^9	$16.4 \cdot 10^6$	$29.6 \cdot 10^6$
μl mm^3	0.001	1	1000	10^6	16387	29574
ml cm^3	10^{-6}	0.001	1	1000	16.387	29.574
l m^3	10^{-9}	10^{-6}	0.001	1	0.016	0.030
in^3	$61 \cdot 10^{-9}$	$61 \cdot 10^{-6}$	0.061	61.024	1	1.805
fl oz (US)	$34 \cdot 10^{-9}$	$34 \cdot 10^{-6}$	0.034	33.814	0.554	1

Volume to Weight conversion if density = 1

	nl μm^3	μl mm^3	ml cm^3	l m^3
μg	1	1000	10^6	10^9
mg	0.001	1	1000	10^6
g	10^{-6}	0.001	1	1000
kg	10^{-9}	10^{-6}	0.001	1



Pressure Conversion Table

	bar	mbar	Pa N/m ²	kPa kN/m ²	at kp/cm ²	mmWS kp/m ²	Torr mmHg	psi lbf/in ²
bar	1	1000	10 ⁵	100	1.02	1.02*10 ⁴	750	14.5
mbar	0.001	1	100	0.1	1.02*10 ⁻³	10.2	0.75	0.0145
Pa N/m ²	10 ⁻⁵	0.01	1	0.001	1.02*10 ⁻⁵	0.102	0.0075	1.45*10 ⁻⁴
kPa kN/m ²	0.01	10	1000	1	0.0102	102	7.5	0.145
at kp/cm ²	0.981	981	0.981*10 ⁵	98.1	1	10 ⁴	736	14.22
mmWS kp/m ²	0.981*10 ⁻⁴	0.098	9.807	9.81*10 ⁻³	10 ⁻⁴	1	0.0736	1.422*10 ⁻³
Torr mmHg	1.333*10 ⁻³	1.333	133.322	0.133	1.36*10 ⁻³	13.595	1	1.934*10 ⁻²
psi lbf/in ²	6.895*10 ⁻²	68.95	6895	6.895	7.031*10 ⁻²	703.1	51.7	1

Generally: The micropumps are developed to suit many different requirements. Since there are many areas of applications, these standard micropumps might not meet your requirements on all aspects. Then the micropumps can be seen as a basis for customer specific optimizations and developments. All parameters, starting with the materials and ending with the fluidic design, can be changed to suit an application.

Please contact us to discuss your requirements.

For further questions, please contact: microComponents@bartels-mikrotechnik.de
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