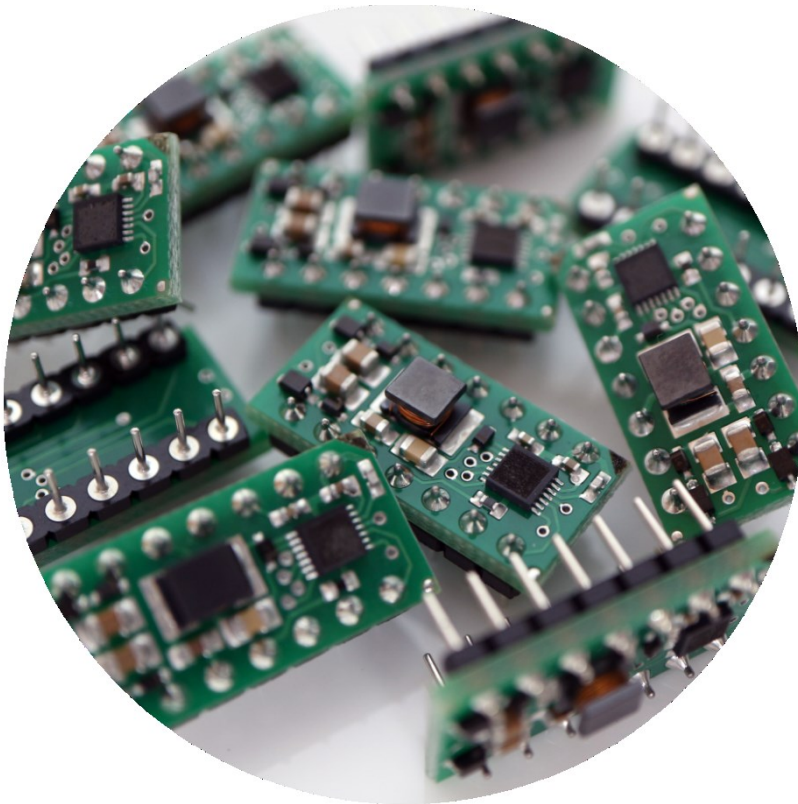


microComponents^m

Operating Manual for Controller mp6-OEM



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General

This operating manual contains all necessary instructions for the installation, commissioning, operation and maintenance of the mp6-OEM. The manual is intended to help you achieving optimal results in a short time and shall also assist avoiding possible sources of errors. The operating manual of the other controllers, micropumps and the accessories are available separately.

The products have 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 ensure that specialized and trained personnel will comply with the following general instructions.

Therefore, please keep this manual and hand out copies as required.

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.

Declaration of conformity

Bartels Mikrotechnik GmbH declares that the products are compliant to the RoHS directive 2011/65/EU. The controller complies with the requirements of EMV 2014/30/EU and CE markings have been affixed to the devices. Additionally, the controllers are also compliant to the EU Low Voltage Directive 2014/35/EU.

Description of functions

The micropumps have been developed for the transport of gases or liquids. The controllers have been developed for operating the micropumps. Bartels Mikrotechnik can assume no liability for damages resulting from the pump media. This applies especially for hazardous fluids.

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

Moreover, 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 and the controller 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 micropumps comply with the actual state of scientific and technical knowledge hence the operational risks are limited to a minimum.

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



Proper use

Intended purpose

The micropump is intended for pumping liquids or gases with varying flow rates controlled by the electronics. The controllers are intended for operating the micropumps. 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.

Misuse

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

Staff selection and qualification

All work in connection with the installation, assembly, commissioning/decommissioning, disassembly, operation, servicing, cleaning and repairing of the pump and the controller 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.

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 that, if not avoided, will result in death or serious injury.

The mp6-OEM controller

The mp6-OEM is a small, easy to use driving circuit developed for the micropumps of the mp6-series. It generates up to 270 Vpp voltage from a 3-5 V supply.

Its low power consumption makes it ideal for battery powered handheld devices or even solar powered devices.

The module can be integrated into a PCB design like a 14 pin DIL package.



The build-in interface allows the user to adapt frequency and/or amplitude to its application by the use of a few additional components or a microcontroller.

In order to locate Pin 1, please refer to the following figure. The pin is marked with a white spot.



Technical specifications mp6-OEM

mp6-OEM controller	Order code: mp6-OEM
The OEM-controller drives the micropump at adjustable performance in a package similar to an integrated circuit. It enables integration into system electronics or on a PCB.	
Dimensions	10,5 x 20,5 x 6 mm 0.4134 x 0.8070 x 0.2362 in.
Adjustable parameters	amplitude, frequency
Amplitude range	85 – 250 Vpp ¹
Frequency range	25 - 226 Hz (Frequencies up to 1000 Hz are possible; please note that the amplitude will decrease in that case. Frequencies down to 1 Hz are possible with an external clock generator.)
Signal form	similar to rectangular
Power supply	2.5 – 5.5 VDC (5 V recommended for optimized performance)
Current consumption	ca. 30 mA at 5 V
Pin arrangement	DIL 14; horizontal ~2.54 mm, vertical ~7.62 mm
¹ amplitude range can go up to 270 Vpp but guaranteed is 250 Vpp	

¹ Before May 2014: mp6-OEM have an amplitude range of 85 – 235 Vpp



Electrical Characteristics

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Supply voltage	VDD		2.5	5	5.5	V
Average current consumption	IDD	VDD = 5 V (2)		30		mA
Setting range AMPLITUDE			0.35		1.3	VDC
min. voltage at pump	V _{pump}	AMPLITUDE = 0.5 VDC	80	85	90	V _{pp}
max. voltage at pump (2)	V _{pump}	AMPLITUDE = 1.3 VDC	240	250	270	V _{pp}
PWM-range AMPLITUDE			0,2		1	MHz
Frequency output	F	VDD = 5 V (1)	90	100	110	Hz
Digital Low-Signal				0		V
Digital High-Signal			2		VDD	V
Capacitance CLOCK			1.0	2.2	10	nF
Input current AMPLITUDE			1		3	μA
Operating current during Shutdown Mode				1.6		μA

2 The signal output is determined by internal components

Before May 2014: mp6-OEM have an amplitude range of 85 – 235 V_{pp}, typ.

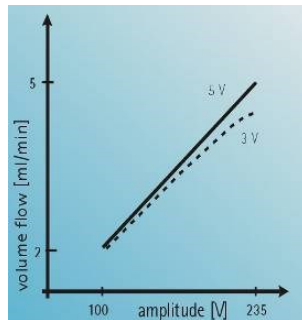


Pin layout

VDD	Supply voltage
GND	Ground
SHUTDOWN	If the micropump should be switched off, the mp6-OEM has to be set to the Shutdown Mode. Then AMPLITUDE <u>and</u> SHUTDOWN have to be set to 0 V.
CLOCK	Predefined clock signal. Frequency will be set to the nominal 100 Hz, when this pin is connected to CLOCK_INT (see image "Schematic 1" in chapter 0). (The internal capacitor is 2.2 nF.) A capacitor of 1 to 10 nF can be placed between CLOCK and GND to define other frequencies (see image "Schematic 2" in chapter 0). It is also possible to connect an external clock signal with a <u>quadruplicated</u> frequency of the micropumps frequency.
CLOCK_INT	When connected to CLOCK the frequency is set to 100 Hz.
AMPLITUDE	The amplitude can be set either with an analogue voltage between 0.35 V to 1.3 V, or with an equivalent pulse-width modulation (PWM) at a voltage level of 5 V and a pulse frequency of 0.2 to 1 MHz.
SLEWRATE	Setting of the slew rate. This pin will be connected to SLEW_INT.
SLEW_INT	Internal resistor against GND for set the slew rate. (The internal resistor is 360 k Ω .)
GND2, GND3	Connected internally with ground (GND). No need to connect.
+P1	Piezo actuator 1, positive electrode (see page 9)
-P1	Piezo actuator 1, negative electrode (see page 9)
+P2	Piezo actuator 2, positive electrode (see page 9)
-P2	Piezo actuator 2, negative electrode (see page 9)



Typical flow behavior



Connecting the micropump with the mp6-OEM

The micropumps of the mp6-series can be connected with the mp6-OEM via a FCC connector. More information concerning this connector and the pin layout of the micropump can be found in manual of the micropump mp6-series.

⚠ DANGER!

The "micropump out" connector can carry high voltage!

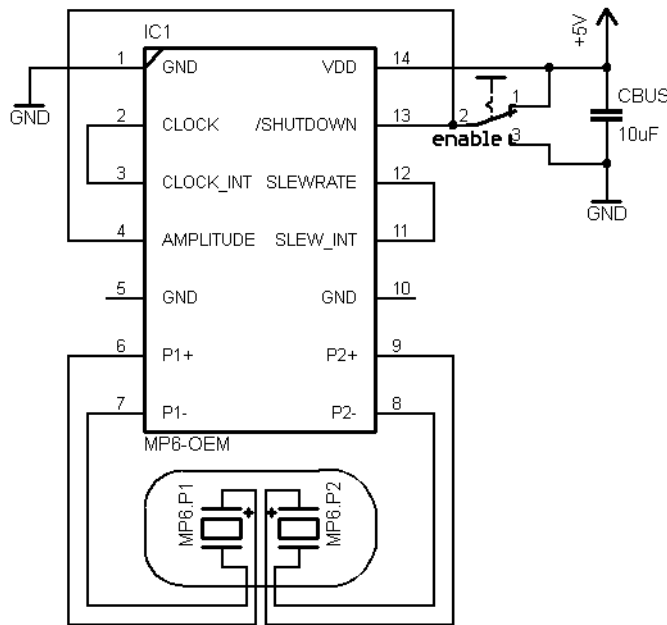
Only connect the cable when they are switched off!



Examples of circuiting the mp6-OEM

Operation with fixed settings

The mp6-OEM can operate the micropumps of the mp6-series without further external components. In this case, frequency and amplitude to the micropump are predefined to 270 V and 100 Hz by the internal circuit.



1 Schematic 1: Predefined amplitude of 270 V and frequency of 100 Hz by internal circuit.

Operation with variable settings via external components

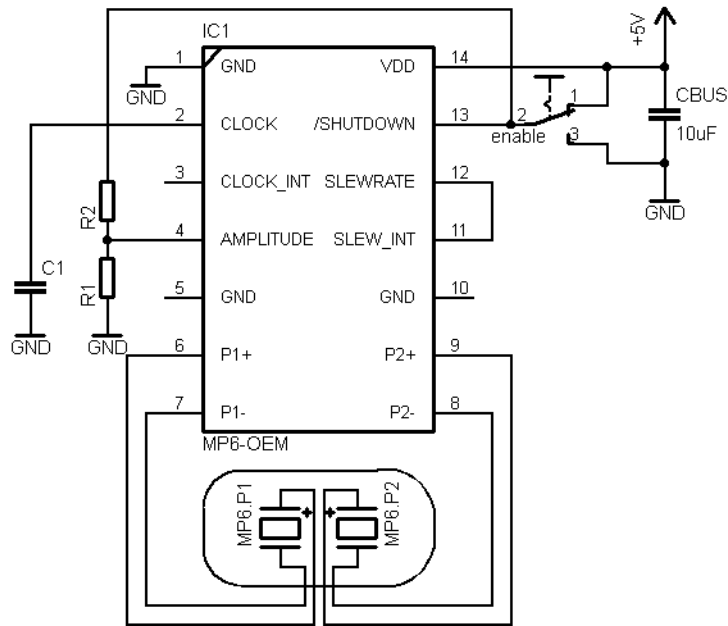
In this example, frequency and amplitude to the micropump will be defined by external components. The amplitude can be varied in the range from 85 V_{pp} to 270 V_{pp}, the frequency from 25 Hz to 226 Hz. With frequencies above 226 Hz it is possible that the maximal amplitude will decrease. Frequencies below 25 Hz are possible too, however, the stability of the signal form has to be verified then!

Using a potential divider it is possible to change the amplitude, see image "Schematic 2" below. The voltage at the AMPLITUDE-Pin can be calculated with this formula:

$$V_{AMPLITUDE} = V_{DD} \cdot \frac{R1}{R1 + R2}$$

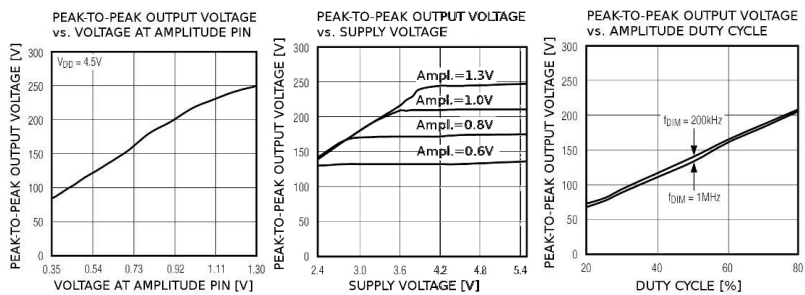
As an alternative to the potential divider, an appropriate potentiometer (e.g. 10 kΩ) is possible too.





2 Schematic 2: Defining frequency and amplitude with external components.

The relation of the voltage at the AMPLITUDE-Pin to the output voltage is shown in image "OEM-Behavior 1" below.

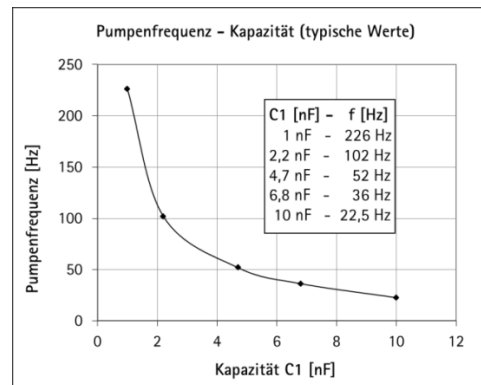


3 OEM-Behavior 1: Output voltage changed with external components.

Variation of frequency is realized with a capacitor of 1 to 10 nF. Typical capacitances are shown in the image "OEM-Behavior 2" below.

For frequencies lower than 25 Hz an external frequency signal has to be used, as explained on page 11!





OEM-Behavior 2: Typical capacitances for different

Operation with variable settings via microcontroller frequencies.

Using a microcontroller to operate the micropump, a quadruplicated frequency of the final micropumps frequency has to be connected to the CLOCK Pin. With this procedure, single-digit frequencies can be achieved.

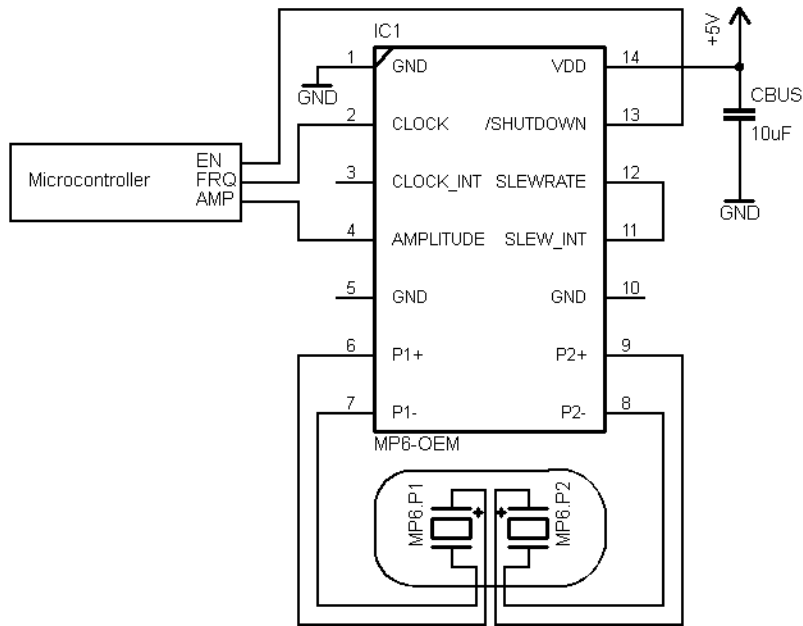
Please take into account to set the pulse-width of the frequency duty cycle at a level of 95% when operating at frequencies lower than 25 Hz.

The amplitude can be set either with an analogue voltage between 0.35 V to 1.3 V, or with an equivalent pulse-width modulation (PWM) at a voltage level of 5 V and a pulse frequency of 0.2 to 1 MHz at the pin AMPLITUDE.

The PWM signal must have an amplitude of at least 1.3 V and maximal the same as the supply voltage to ensure that the output voltage is only dependent on the duty cycle!

For minimizing the power consumption, the mp6-OEM can be switched off. One way is to set the mp6-OEM into the Shutdown Mode; then AMPLITUDE and SHUTDOWN have to be set to 0 V. The other way is to interject the power supply.





4 Schematic 3: Microcontroller as an external component.

Noise reduction

If the noise generated by the pump is critical, a series resistor of 2-10 kΩ in the P1+ and the P2+ line between the mp6-OEM and the pump will help. There is no limit for the resistor value but it will decrease the maximum pump performance.

All values are approximate and no guarantee of specific technical properties.

Changes in the course of technical progress are possible without notice.



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