microComponents

Operating Manual for Controller mp-Lowdriver

Rev. 1.0 (03.2021)

with passion for microfluidics

Content

General

This operating manual contains all necessary instructions for the installation, commissioning, operation and maintenance of the mp-Lowdriver. 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 mp-Lowdriver controller

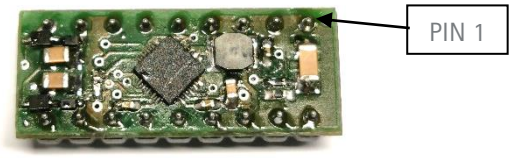
The mp-Lowdriver is a small, easy to use driving circuit developed for the micropumps of the mp6-series especially for low-flowrate applications as it has a high amplitude resolution and is thus ideally suited for controlled loop flow regulation systems. It generates amplitudes up to 150 Vpp from a 3-5 V DC 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 as a 18 pin DIL package.

The I²C interface allows the user to adapt frequency, amplitude and signal-shape to its application by the use of any simple microcontroller capable of I²C communication.

In order to locate Pin 1, please refer to the following figure. The pin is marked with a colored spot or triangular marking on the corner of the PCB.



Technical specifications mp-Lowdriver

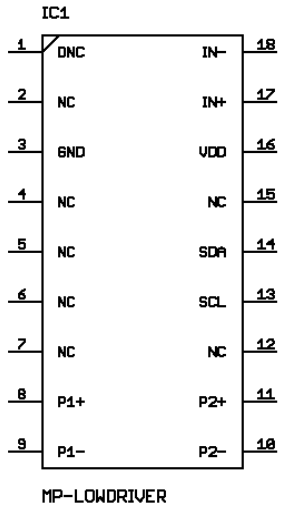
mp-Lowdriver controller	Order code: mp-Lowdriver
The controller drives the micropump at adjustable performance in a package similar to an integrated circuit. It enables integration into system electronics or on a PCB.	
Dimensions	10.16 x 25.4 x 2.64 mm 0.4 x 1.0 x 0.10 in
Adjustable parameters	amplitude, frequency, signal shape
Amplitude range	0 – 150 Vpp in 255 steps
Frequency range	8 – 2000 Hz in 7.8125 Hz steps
Signal form	sine, custom
Power supply	3 – 5.5 V DC (6.0V absolute maximum rating)
Pin arrangement	DIL 18; horizontal 2.54 mm, vertical 7.62 mm

Electrical Characteristics

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Supply voltage	VDD		3.0		5.5	V
Average current consumption	IDD	VDD = 5 V		40		mA
Voltage at pump	Vpump	VDD = 5 V	0		150	Vpp
Frequency range	Fpump	VDD = 5 V	7.8125		1992.1875	Hz
Digital Low-Signal					0.5	V
Digital High-Signal			1.4			V
Digital input current					1	µA
Shutdown current		VDD = 3.6V STANDBY=1		10		µA

Pin description

Pin	Name	Function
1, 2, 4, 5, 6, 7, 12, 15	NC	These pins should not be connected and left floating
3	GND	Ground
8	P1+	Piezo actuator 1, positive electrode (see schematic 1)
9	P1-	Piezo actuator 1, negative electrode (see schematic 1)
10	P2-	Piezo actuator 2, negative electrode (see schematic 1)
11	P2+	Piezo actuator 2, positive electrode (see schematic 1)
13	SCL	Serial-Clock Input. SCL requires an external pullup resistor.
14	SDA	Open-Drain, Serial Data Input/Output. SDA requires an external pullup resistor.
16	VDD	Input Supply voltage
17	IN+	Analog input voltage positive (WIP[1])
18	IN-	Analog input voltage negative (WIP[1])



[1]WIP: work in progress. Analog inputs are not implemented yet. There is no documentation currently available for the use of this feature.

Connecting the micropump with the mp-Lowdriver

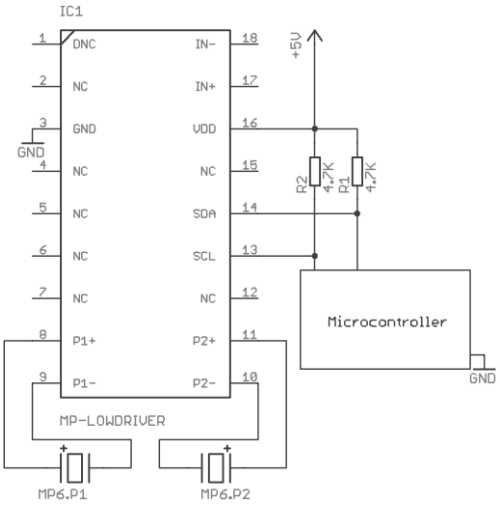
The micropumps of the mp6-series can be connected with the mp-Lowdriver using a FCC connector. More information concerning this connector and the pin layout of the micropump can be found in manual of the micropump mp6-series.

⚠ DANGER!
The output of the mp-Lowdriver carries high voltage! Only plug in the micropump when the mp-Lowdriver controller is unpowered or switched off

Operation with variable settings via I²C-Interface

The mp-Lowdriver can only be operated using the I²C-Interface. Using this interface all the features of the chip can be accessed. A complete interface and protocol description will be released on our website in the future. At the moment the mp-Multiboard source-code is the best source for initializing and changing parameters of the mp-Lowdriver using the I²C-Interface. The source-code is available for download on our website. An excerpt is included in the last chapter of this document.

Use external pullup resistors for the SDA and SCL signals to set the logic-high level for the bus. Pullup resistors with values between 660Ω and 4.7 kΩ are recommended. Do not allow the SDA and SCL voltages to exceed the mp-Lowdriver supply voltage VDD. The mp-Lowdriver device operates as an I2C-slave with 1.8-V logic thresholds, but can operate up to the VDD voltage.



Schematic 1: Controlling settings via I²C

Slave address

The slave address for the device is 0x59 (7-bit), or 1011001 in binary, which is equivalent to 0xB2 (8-bit) for writing and 0xB3 (8-bit) for reading.

Register Map

The register map of the mp- Lowdriver is shown in Figure 2. A full register description and functionality will be added in later revisions of this document.

REG NO.	DEFAULT	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0x00	0x02	Reserved					ILLEGAL_ADDR	FIFO_EMPTY	FIFO_FULL
0x01	0x38	Reserved	CHIPID[3:0]				INPUT_MUX	GAIN[1:0]	
0x02	0x40	DEV_RST	STANDBY	Reserved		TIMEOUT[1:0]		EN_OVERRIDE	GO
0x03	0x00	WAVFORM0[7:0]							
0x04	0x00	WAVFORM1[7:0]							
0x05	0x00	WAVFORM2[7:0]							
0x06	0x00	WAVFORM3[7:0]							
0x07	0x00	WAVFORM4[7:0]							
0x08	0x00	WAVFORM5[7:0]							
0x09	0x00	WAVFORM6[7:0]							
0x0A	0x00	WAVFORM7[7:0]							
0x0B	0x00	FIFO[7:0]							
0xFF	0x00	PAGE[7:0]							

Figure 3: Register Map Overview

Example code

```
#define I2C_LOWDRIVER_ADRESS (0x59)   //Defaultadress for Lowdriver 1011001

extern boolean bPumpState[4];
extern uint8_t nPumpVoltageByte[4];
extern uint8_t nFrequencyByte;

void selectControlRegisters() {
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0xFF);
  Wire.write(0x00);
  Wire.endTransmission();
}
void selectMemoryRegisters() {
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0xFF);
  Wire.write(0x01);
  Wire.endTransmission();
}

void Lowdriver_init() {
  selectControlRegisters();
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0x01); //Select (Control) Register 0x01
  Wire.write(0x02); //Set Gain 0-3 (0x00-0x03 25v-100v)
  Wire.write(0x00); //Take device out of standby mode
  Wire.write(0x01); //Set sequencer to play WaveForm ID #1
  Wire.write(0x00); //End of sequence
  Wire.endTransmission();
  selectMemoryRegisters();
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0x00); //Select Register 0x00
  Wire.write(0x05); //Header size –1
  Wire.write(0x80); //Start address upper byte (page), also indicates Mode 3
  Wire.write(0x06); //Start address lower byte (in page address)
  Wire.write(0x00); //Stop address upper byte
  Wire.write(0x09); //Stop address Lower byte
  Wire.write(0x00); //Repeat count, 0 = infinite loop
  Wire.write((bPumpState[2] ? nPumpVoltageByte[2] : 0));
//Amplitude
  Wire.write(0x0C); //Frequency. (100Hz)
  Wire.write(100);  //cycles
  Wire.write(0x00); //envelope
  Wire.endTransmission();
  delay(10);
  selectControlRegisters();
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0x02); //Set page register to control space
  Wire.write(0x01); //Set GO bit (execute WaveForm sequence)
  Wire.endTransmission();
}

void Lowdriver_setvoltage(uint8_t _voltage) {
  nPumpVoltageByte[2]=_voltage;
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0x02); //Stop Waveform playback
  Wire.write(0x00);
  Wire.endTransmission();
  selectMemoryRegisters();
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0x06); //Set page register to control space
  Wire.write((bPumpState[2] ? nPumpVoltageByte[2] : 0));
//0-255
  Wire.endTransmission();
  delay(10);
  selectControlRegisters();
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0x02); //Start Waveform playback
  Wire.write(0x01);
  Wire.endTransmission();
}

void Lowdriver_setfrequency(uint16_t _frequency) {
  float temp = _frequency; temp/=7.8125;
  nFrequencyByte = temp;
  if (nFrequencyByte==0) nFrequencyByte=1;
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0x02); //Stop Waveform playback
  Wire.write(0x00);
  Wire.endTransmission();
  selectMemoryRegisters();
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0x07); //Set page register to control space
  Wire.write(nFrequencyByte);   //0-255
  Wire.endTransmission();
  delay(10);
  selectControlRegisters();
  Wire.beginTransmission(I2C_LOWDRIVER_ADRESS);
  Wire.write(0x02); //Start Waveform playback
  Wire.write(0x01);
  Wire.endTransmission();
}
```

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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