Additional instructions

MPR-1 I²C-protocol

EN

Version 1.01

WIKA
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Content

1. I²C general

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1.1 Description

I²C is a simple, serial 8-Bit data bus that was developed for short distance communication between PCBs.
It is not a field-bus, so long wires from the sensor to the master electronics are not recommended. The maximum wire length is to be defined based on the surrounding during usage and the according disturbances.

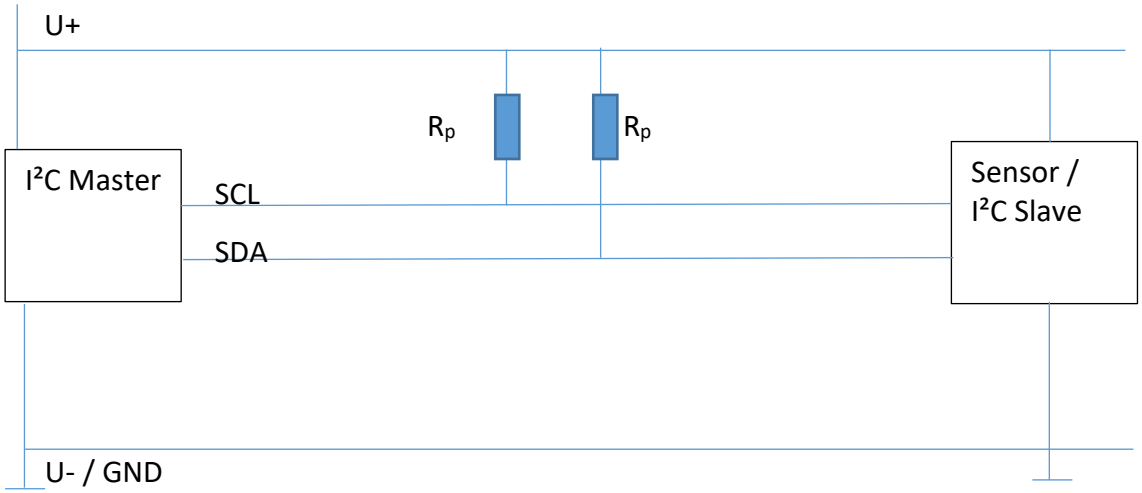
The pressure sensor module works as a slave. The I²C master communicates with the sensor using its I²C-address. The address is set as “0” as a standard but can be adapted customer specifically and can also be changed by the customer.

The I²C bus requires in its most simple variation only two lines additional to the power supply:

- SCL (Serial Clock)
- SDA (Serial Data)

1.2 Configuration

Pull-Up resistors (Rp) are needed at the SDA and SCL line..



An additional End of Conversion (EOC) Pin provides the possibility to stop the pressure measurement and data transfer quickly to save power.

2. I²C-protocol of the pressure sensor module MPR-1

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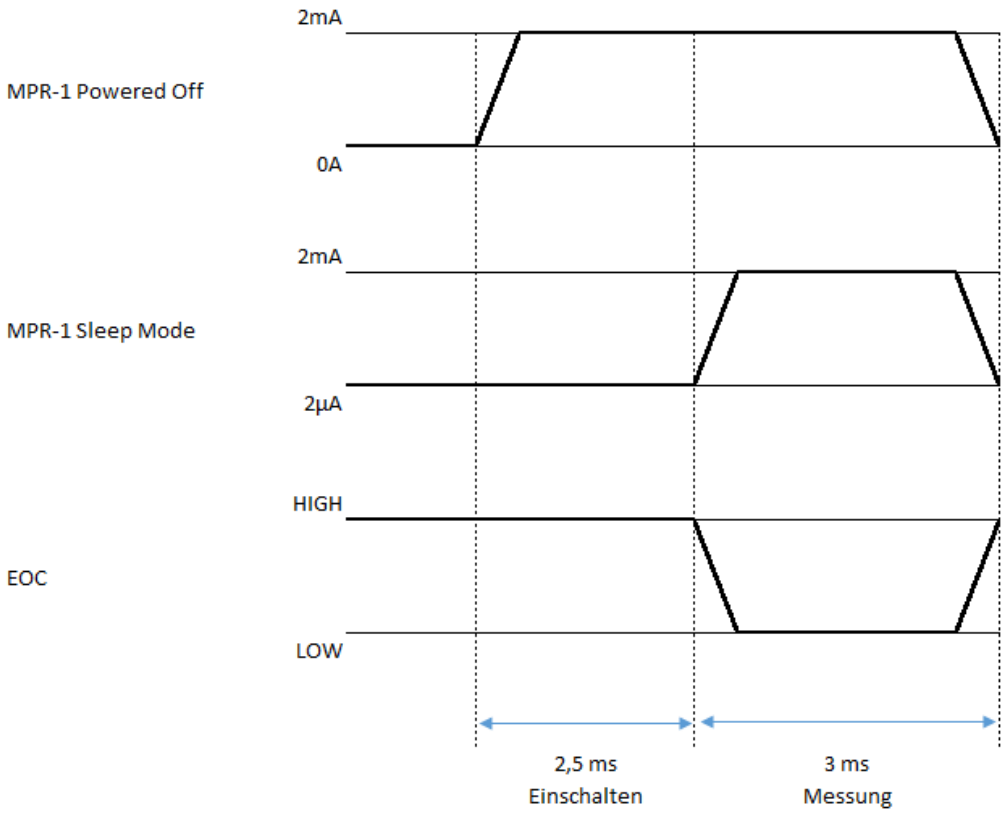
The I²C signal of the MPR-1 provides the possibility to read out both pressure and temperature values.
Using the status bit a diagnosis function is provided.

2.1 Parameters

	Min	Max	Unit
V_{IL} (Input low level voltage)	-0,3	0,9	V
V_{IH} (Input high level voltage) for 2,3V ≤ U+ ≤ 3V	U+ -0,1	U+ +0,5	V
V_{IH} (Input high level voltage) for U+ > 3V	2,9	3,5	V
V_{OL} (Output low level voltage)		0,45	V
Clock Frequency	0,01	3,4	MHz
Pull-up-resistors each at SDA and SCL	1,5	10	k Ω

2.2 Current-EOC-time graph



Time until the pressure and temperature value is available after the request by the I²C master:

- using Sleep-Mode: ~3ms
- complete power-off: ~5,5ms

2.3 I²C address

MPR-1 I²C works as I²C-slave and has to be addressed and controlled by an I²C master.

Preset Standard-address: 0
Possible addresses that can be set: 0…3, 8…127
(4…7 are reserved and must not be used)

3. Communication Services

3.1 Reading pressure and temperature value

Command Request (Oversampling = 1):

Slave-Address << 1 + 0 (Write-Bit) (1 Byte)	0xAA (1 Byte)
Master	**Master**

Option 1:
Wait time: ≥ 3ms

Option 2: (recommended)
Use EOC-pin, see **"3.5 Using the EOC-pin"**

Command Response:

Slave-Address << 1 + 1 (Read-Bit) (1 Byte)	Status (1 Byte)	PD-pressure Bits <23:16> (1 Byte)	PD- pressure Bits <15:8> (1 Byte)	PD- pressure Bits <7:0> (1 Byte)
Master	**Slave**	**Slave**	**Slave**	**Slave**

PD-temperature Bits <23:16> (1 Byte)	PD- temperature Bits <15:8> (1 Byte)	PD- temperature Bits <7:0> (1 Byte)
Slave	**Slave**	**Slave**

Slave-Address: set 7-Bit Slave-Address
PD-pressure: PD - pressure >>6
→ Interpretation of PD-pressure: MBA…MBE = 50000…250000 digits
PD-temperature: PD - temperature >>6
→ Interpretation of PD-temperature: -45…+110°C = 0…263143 digits

The master can stop the data transmission after 4 byte in case the temperature sensor is not required.

Calculation of the pressure value:
([unit] = bar, MPa or psi)

Sensitivity: $S = \frac{MBE[digits]-MBA[digits]}{MBE\ [unit]-MBA[unit]}$

Pressure: $p = \frac{p\ [digits]-MBA\ [digits]}{S} + MBA[unit]$

Example:
A Sensor with pressure range 0…25 bar is used. Digital pressure value: 125000 digits.

$$S = \frac{MBE[digits]-MBA[digits]}{MBE\ [unit]-MBA[unit]} = \frac{250000\ digits-50000\ digits}{25\ bar-0\ bar} = 8000\ digits/bar$$

$$p = \frac{p\ [digits]-MBA\ [digits]}{S} + MBA[unit] = \frac{125000\ digits-50000\ digits}{8000\ digits/bar} + 0\ bar = 9{,}375\ bar$$

Calculation of the temperature value:

Sensitivity: $S = \frac{MBE[digits]-MBA[digits]}{MBE\ [unit]-MBA[unit]} = \frac{262143\ digits-0\ digits}{110°C-(-45°C)} \approx 1691$ digits/°C

Temperature: $t = \frac{t\ [digits]-0}{S} + (-45°C) = \frac{t\ [digits]}{1691{,}25\ digits/°C} - 45°C$

Example:
A Sensor delivers hex-value 112500 as temperature.

$$t = \frac{t\ [digits]}{1691\ digits/°C} - 45°C = \frac{112500\ digits}{1691 digits/°C} - 45°C = 21{,}5°C$$

3.2 Interpretation status-byte

Status:

Bit	7	6	5	4	3	2	1	0
Meaning	0	1	Busy?	Mode1	Mode0	Memory error?	0	ALU Saturation

- **Busy indication (bit 5):** 1 if the device is busy, which indicates that the data for the last command is not available yet. No new commands are processed if the device is busy.
- **Memory integrity/error flag (bit 2):** 0 if integrity test passed, 1 if test failed. This bit indicates whether the checksum-based integrity check passed or failed. The memory error status bit is calculated only during the power-up sequence, so a newly written CRC will only be used for memory verification and status update after a subsequent device power-on reset (POR) or reset by means of the RES pin.
- **ALU saturation (bit 0):** If the last command was a measurement request, this bit is 0 if any intermediate value and the final SSC result are in a valid range and no SSC-calculation internal saturation occurred, respectively. If the last command was a measurement request, this bit is 1 if an SSC-calculation internal saturation occurred. This bit is also 0 for any non-measurement command.

3.3 Writing the Slave-address

Because during a write mode always 16 Bit are written into the MTP but the I²C address is only 7 Bit long the content of the remaining 9 Bit has to be read.

Reading the existing Slave-address:

Command Request (Read MTP):

Slave-Address << 1 + 0 (Write-Bit) (1 Byte)	MTP-Address **0x02** (1 Byte)
Master	**Master**

Command Response (Read MTP):

Slave-Address << 1 + 1 (Read-Bit) (1 Byte)	Status (1 Byte)	MTP-Data Bits <15:8> (1 Byte)	MTP-Data Bits <7:0> (1 Byte)
Master	**Slave**	**Slave**	**Slave**

Set new I²C-Address:
MTP-Data <6:0> = new address that will be written

Command Request (Write MTP):

Slave-Address << 1 + 0 (Write-Bit) (1 Byte)	MTP-Address **0x42** (1 Byte)	MTP-Data Bits <15:8> (1 Byte)	MTP-Data Bits <7:0> (1 Byte)
Master	**Master**	**Master**	**Master**

After writing the slave address the MTP check sum should be generated newly and written (see "**3.4. MTP-checksum calculation and writing**")
If this is not done the status byte will show the checksum error "Memory integrity/error flag (bit 2)" (see "**3.2 Interpretation of the status-byte**").
To finalize writing the slave address a Power On Reset has to be done.

Recommended:
As an alternative to a power-on-reset, a reset and new power-up sequence can be triggered by an IC-reset signal (high low) at the RES pin.

Attention: an I²C address from 4 to 7 must not be used . If such an address is set a communication with the sensor is no longer possible!

3.4 Calculate and write MTP-checksum

Slave-Address << 1 + 0 (Write-Bit) (1 Byte)	**0x90** (1 Byte)
Master	**Master**

3.5 Using the EOC-pins

Measurement duration is defined as the time from the high/low transition on the EOC pin at the beginning of the measurement until the next low/high transition on the EOC signal at the end of a single measurement.

4. Abbreviations … 5. Change log

4. Abbreviations

MBA = Start of measuring range (“**M**ess-**B**ereichs-**A**nfang”)

MBE = End of measuring range (“**M**ess-**B**ereichs-**E**nde”)

MTP = multiple-time programmable memory

ALU = arithmetic logic unit

SSC = sensor signal conditioner

5. Change log

Document Version	Reason for change	Date
1.0	Initial release	01.08.2018
1.01	- Changed „Busy indication“: Note regarding cyclic mode eliminated cyclic mode not available! - Actual mode (bits 4:3) eliminated from “Status Bit” used internally only	29.08.2018

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