

Communication Protocol I²C & SPI – V1/V3 Series

AN -14

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Version: 1

The Flow Sensor Module includes an I²C digital, two-wire interface with a bidirectional data line (SDA) and a clock line (SCL). The two lines are open drain and connected to the supply voltage via two pull-up resistors (R_p). In a system with master-slave configuration, the Flow Sensor Module is the slave.

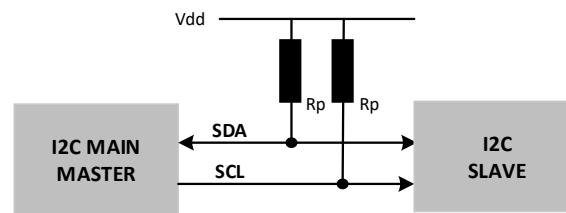


Figure 1: I2C master-slave configuration

The recommended pull-up resistor (R_p) values depend on the system implementation, but a value between 2.2k Ω and 10k Ω can be used for prototyping. Please refer to NXP's I²C specification for more information.

The capacitive load on both SDA and SCL should be the same, hence the signal lengths should be similar to avoid asymmetry. It is recommended to use shielded cabled for wire lengths above 10cm and I²C buffers should be used if signal paths are longer than 30cm.

• Read Example(Normal Data):

Byte#	0									
Send By Master	0xA1									
	S	1	0	1	0	0	0	0	1	A
	Address(0x50)									R

Byte#	0		1		2	
Receive From Slave	CRC	A	High Byte	A	Low Byte	A P
	Checksum		Calibrated data			

- S : Start bit
- P : Stop bit
- A : ACK
- W: i2c write mode
- R: i2c read mode
- Length = 3 bytes to read

• Read Example(Raw Data):

Byte#	0								1								2														
	0xA0								0xD0								0xA1														
Send By Master	S	1	0	1	0	0	0	0	0	0	A	1	1	0	1	0	0	0	0	A	P	S	1	0	1	0	0	0	0	1	A
	Address(0x50)								W	Command											Address(0x50)								R		

Byte#	0		1		2		3		4		5		
Receive From Slave	CRC	A	High Byte	A	Low Byte	A	0xFF	A	High Byte	A	Low Byte	A	P
	Checksum		Raw data						Calibrated data				

- S : Start bit
- P : Stop bit
- A : ACK
- W: i2c write mode
- R: i2c read mode
- Length = 6 bytes to read

Checksum

The checksum used for data integrity is the 2's complement (negative) of the 256-modulo (8-bit) sum of the data bytes (does not include I2C address). This can be calculated using:

$$\text{checksum} = 1 + \sim(\text{sum})$$

Example:

If the I2C payload bytes from a normal read operation are { 0xC9, 0x0B, 0x28, 0x04, 0x00 }, the 256-modulo (8-bit) sum is calculated as:

$$\text{sum} = 0x0B + 0x28 + 0x04 + 0x00 = 0x37$$

Then the checksum is calculated as:

$$\text{checksum} = 0x01 + \sim(0x37) = 0x01 + 0xC8 = 0xC9$$

Validating the data payload is done by calculating the sum and adding it to the checksum. If the result is 0x00, then the data is valid.

$$\text{checksum} + \text{sum} = 0xC9 + 0x37 = 0x00$$

Limitations

The I²C bus is susceptible to noise and can lock up, especially if there are glitches on SCL or the Master does not acknowledge the first byte sent from the Slave.

The following guidelines are best practices for the I²C bus and to avoid lock up:

- Minimize signal length between sensor and microcontroller (< 30cm). Signal lengths over 10cm should be shielded
- Every data read from a Slave should be acknowledged by an ACK from the Master
- It should be possible to hard-reset the sensor should the I²C bus lock up

Headquarter Switzerland:
Pewatron AG
Thurgauerstrasse 66
CH-8050 Zurich
Phone +41 44 877 35 00
info@pewatron.com

Office Germany:
Pewatron Deutschland GmbH
Edisonstraße 16
D-85716 Unterschleißheim
Phone +49 89 374 288 87 00
info.de@pewatron.com



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SENSORS · POWER SOLUTIONS

We are here for you. Addresses and Contacts.

Sales Germany & Austria

**Geometrical sensors
Other products**

Kurt Stritzelberger
Phone +49 89 374 288 87 22
kurt.stritzelberger@pewatron.com

**Pressure sensors
Other products**

Gerhard Vetter
Phone +49 89 374 288 87 26
gerhard.vetter@pewatron.com

Gas sensors and modules

Peter Felder
Phone +41 44 877 35 05
peter.felder@pewatron.com

Sales Switzerland & Liechtenstein

Postcode 3000 – 9999

Basil Frei
Phone +41 44 877 35 18
basil.frei@pewatron.com

Postcode 1000 – 2999

Christian Mohrenstecher
Phone +41 76 444 57 93
christian.mohrenstecher@pewatron.com

Sales International Key Accounts

Peter Felder
Phone +41 44 877 35 05
peter.felder@pewatron.com

Sales Other Countries / Product Management

**Pressure Sensors
Load Cells**

Philipp Kistler
Phone +41 44 877 35 03
philipp.kistler@pewatron.com

**Gas sensors
Gas sensor modules**

Dr. Thomas Clausen
Phone +41 44 877 35 13
thomas.clausen@pewatron.com

Flow / Level / Medical products

Dr. Adriano Pittarelli
Phone +49 89 374 288 87 67
adriano.pittarelli@pewatron.com

Power supplies

Sebastiano Leggio
Phone +41 44 877 35 06
sebastiano.leggio@pewatron.com

**Linear position sensors
Angle sensors**

Eric Letsch
Phone +41 44 877 35 14
eric.letsch@pewatron.com

**Accelerometers
Sensor elements**

Christoph Kleye
Phone +49 89 374 288 87 61
christoph.kleye@pewatron.com

Drive technology

CH Postcode 5000 – 9999 / DE

Roman Homa
Phone +41 76 444 00 86
roman.homa@pewatron.com

Drive technology

CH Postcode 1000 – 4999 / AT / IT / FR

Christian Mohrenstecher
Phone +41 76 444 57 93
christian.mohrenstecher@pewatron.com

Harald Thomas

Phone +49 89 374 288 87 23
harald.thomas@pewatron.com