Communication Protocol
I^2C & 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 (Rp). In a system with master-slave configuration, the Flow Sensor Module is the slave.

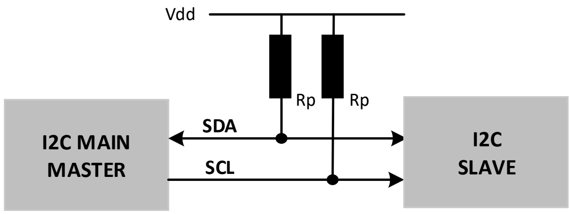

Figure 1: *I2C master-slave configuration*

The recommended pull-up resistor (Rp) values depend on the system implementation, but a value between 2.2kΩ and 10kΩ can be used for prototyping. Please refer to NXPs 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							
Send By Master		0xA0									0xD0											0xA1							
	S	1	0	1	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:

checksum = 1 + ~(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:

sum = 0x0B + 0x28 + 0x04 + 0x00 = 0x37

Then the checksum is calculated as:

checksum = 0x01 + ~(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.

checksum + 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

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