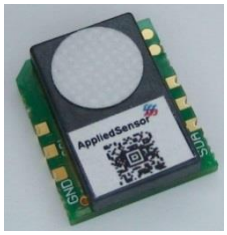
Manual iAQ-core

Indoor Air Quality sensor module

- I²C interface
- SMD type package
- Reflow capable



Product summary

The iAQ-core is used to measure VOC levels and provide CO_2 equivalent and TVOC equivalent predictions. The data are available via I^2C bus.

The sensor itself is protected by a plastic cap and a filter membrane. The sensor module can be soldered directly to a host circuit board with selective or reflow soldering via the edge connectors. The sensor is protected by a membrane, which should not be removed.

Note: Please read the I²C addressing instructions carefully. An undefined use of the I²C interface could harm the iAQ-core module and cause a loss of functionality.

Dimensions

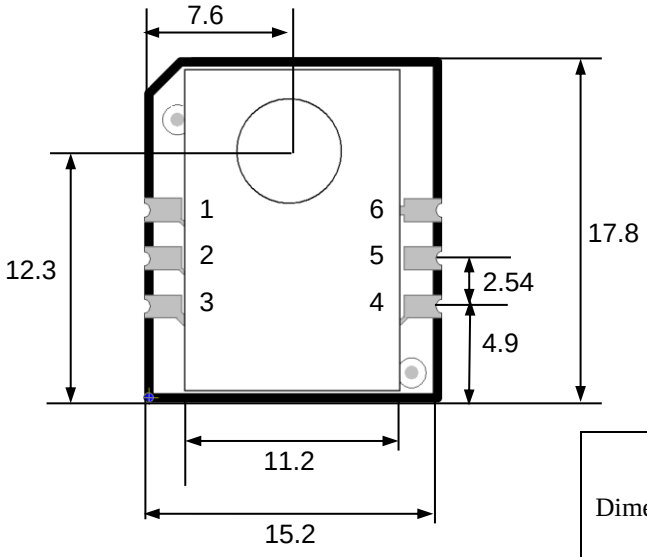


Figure 1: iAQ-core sensor.
(dimensions in mm, Top View)

Pin	Name	Comment
1	NC	Not connected
2	SCL	I²C serial clock
3	GND	Ground
4	SDA	I²C serial data
5	NC	Not connected
6	VCC	+3.3V

Dimensions (approximate values)	PCB 15.24 x 17.78 x 1.7 mm
	CAP 11.2 x 17.78 x 2.6 mm
	TOTAL HEIGHT 4.3 mm
Sensor position (approximate values)	7.6 x 12.3 mm Radius 3.5 mm
Weight	Approximately 1g
IP-Class	00 (at proper installation)
Connector	Card edge (cut via)

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1 Electrical specifications

1.1 Power supply

Voltage	3.3V ± 0.1V, max. 20mV ripple
Power consumption	Max. 66mW @ 3.3VDC (20mA)

Note: decoupling capacitor included in design.

1.2 Communication

Output signal options	I^2C
First functional reading after start up	5 minutes

➔ For more communication details see chapter 4

2 Environmental specifications

Temperature range operation	0 to 50°C
Temperature range storage	-25 to 50°C
Humidity range	5 to 95 %r.h., non-condensing

3 Sensor features

Sensing technology	MEMS metal oxide sensor
Sensing range	I²C: 450 – 2000 ppm CO_2 equivalents (relative) 125 – 600 ppb TVOC equvalents (relative) Values above the defined sensing range are provided as well.
Module	Automatic baseline correction

4 I²C Interface

4.1 Interface description

4.1.1 Physical interface

The physical interface is two-wire open drain SCL (clock) and SDA (data).

Pull-up resistors	External pull-up resistor required
Clock speed	100kHz
Clock stretching	Bus master clock stretching support is required

4.1.2 Clock stretching

Clock stretching pauses a transaction by holding the clock line low. The transaction cannot continue until the line is released to high again. Although the module could send the bytes of data at a fast rate, it could happen that the module is busy at the request time. It can then hold the clock line low after reception and acknowledgement of a byte to force the master into a wait state until the iAQ-core module is ready for the next byte transfer in a type of handshake procedure. (See official I²C specification and user manual UM10204, http://www.nxp.com/documents/user_manual/UM10204.pdf)

4.1.3 Address

Standard 7 bit I²C address for iAQ-core is **decimal 90** or **hexadecimal 0x5A**. The addressing byte includes the read/write bit at the lowest significant bit. The communication with the iAQ-core starts with **0xB5** for reading data.
Please note: avoid addressing the iAQ-core with write bit. This could cause a loss of communication relevant information on modules side and the iAQ-core is no longer contactable.

	Address							R/ W
Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
data	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**1**

Table 1: Addressing byte for the iAQ-core.

4.2 Interface protocol

The standard I²C specification is used for the iAQ-core interface protocol. The I²C bus master should request 7 bytes. These seven bytes include information about the indoor air quality value, the iAQ-core status and the resistance of the sensor. If only the indoor air quality value and the status byte is required, the master should request three bytes from the iAQ-core. All bytes are reported back as shown in the following table. A graphical description for a standard I²C communication with the iAQ-core module is shown in figure 2 – figure 5.

Byte	Name	Data type	Typical/example value	Explanation / notes
0-1	pred	uint16	450	Prediction (CO2 eq.)
2	status	uint8	0	0x00: OK (data valid) 0x10: RUNIN (module in warm up phase) 0x01: BUSY (re-read multi byte data!) 0x80: ERROR (if constant:replace sensor)
3-6	resistance	int32	256431	Sensor resistance [Ohm]
7-8	Tvoc	uint16	125	Prediction (TVOC eq.)

Table 3: Read data from the iAQ-core.

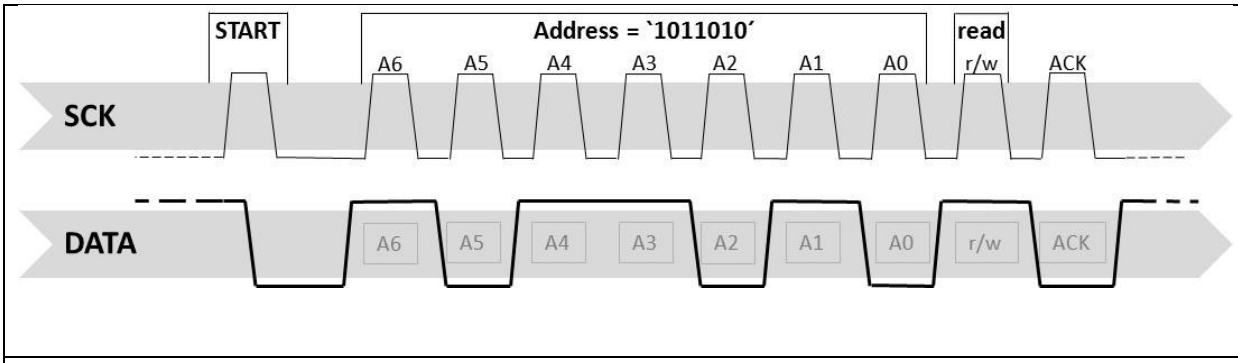


Figure 2: The first byte is send by the master, containing address (0x5A) and read/write bit. The slave sends an acknowledgement (ACK) by pulling the data line to low.

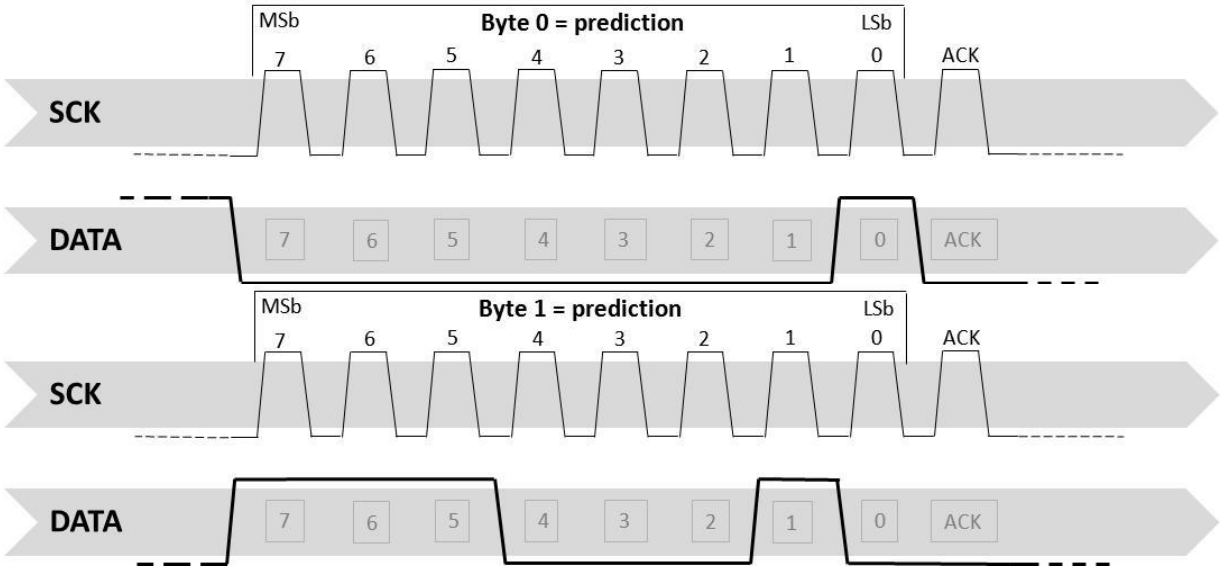


Figure 3: The slave will answer by sending bytes with MSB first. Byte0 and byte1 contain the prediction value. All bytes are acknowledged by the master.

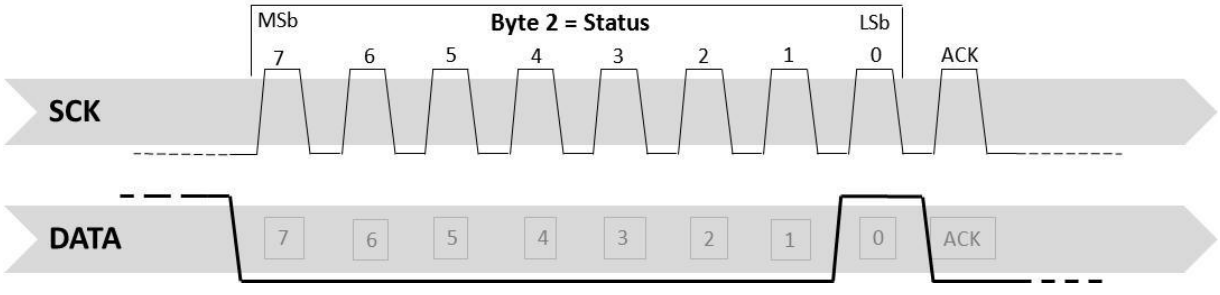


Figure 4: The third byte contains the information of the iAQ-core module state, in this case status = 1. The master answers with acknowledge.

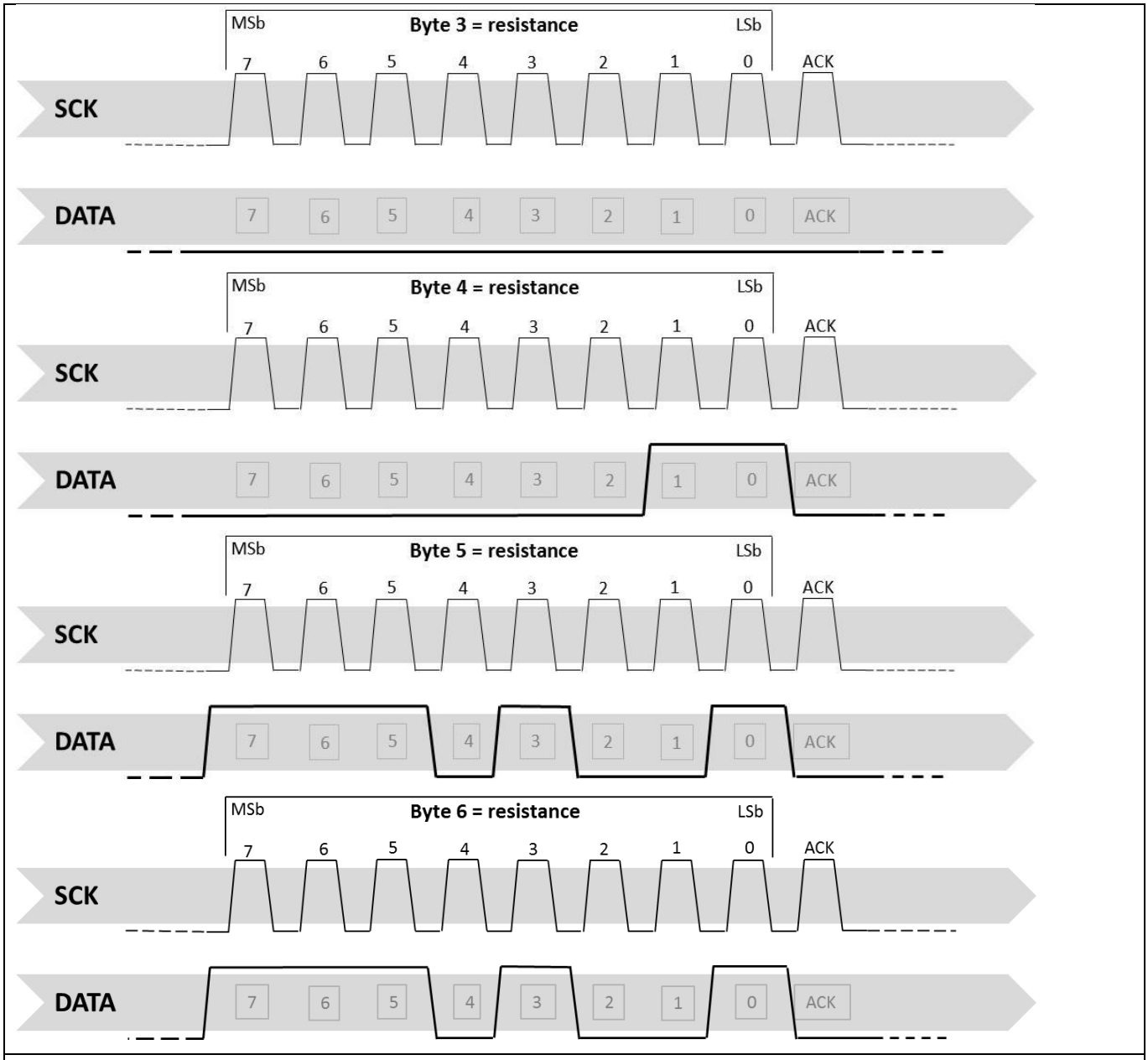
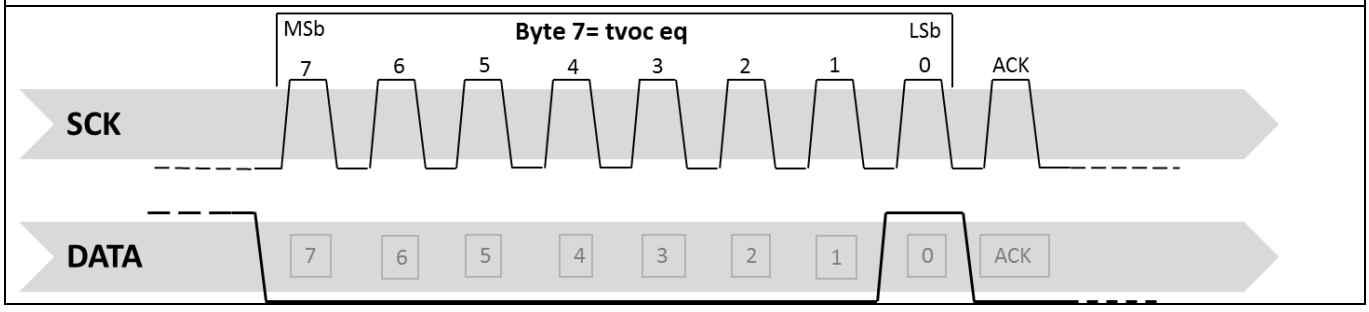


Figure 5: The next four bytes contain the resistance value. For the calculation of the resistance only byte4, byte5 and byte6 are relevant, because byte3 is zero.



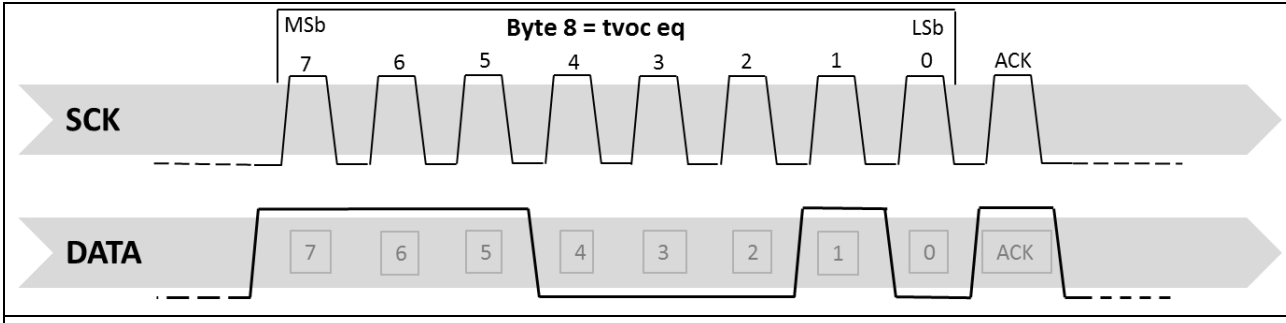


Figure 6: The last two bytes contain the tvoc equivalence value. After the last requested byte, the master has to send a not acknowledge and the communication shall be ended with a STOP condition.

4.2.1 Prediction

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8

The first two bytes contain the prediction value, which gives the information about the indoor air quality. The value is a CO_2 (ppm) equivalent and the calculation is shown in the following example.

Equation 1 :

$$\boldsymbol{Prediction = byte0 * 2^8 + byte1}$$

4.2.2 Status flag

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8

The third byte indicates status of the module.

- 0x00: OK
- 0x01: BUSY
- 0x80: ERROR

If status is OK the data is valid. If the status is BUSY, the data integrity is not guaranteed for variables of size > 8 bits, because the module may be updating a part of the variable.
If the status is ERROR constantly (or very frequently) this indicates that the module is reading non-realistic values, and the sensor element is probably defective.

4.2.3 Resistance

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8

The next four bytes contain the sensor resistance in Ohm. Byte3 is always 0.

Equation 2:

$$\boldsymbol{Resistance = byte4 * 2^{16} + byte5 * 2^8 + byte6}$$

4.2.4 TVOC

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8

The last two bytes contain the tvoc equivalent values, which gives the information about the relative indoor air quality. The value is given in TVOC (ppb) equivalent and the calculation is shown in the following example

Equation 3:

$$\boldsymbol{tvoc\ eq} = byte\mathbf{7} * 2^8 + byte\mathbf{8}$$

5 Application information

5.1 Handling instructions

The iAQ-core module should be handled carefully, shear stress should be avoided. The sensor is protected by a membrane. This membrane should not be removed or touched.

5.2 Soldering instructions

For soldering the iAQ-core, standard reflow soldering ovens could be used. The reflow ovens shall be purged with clean air. Other gases must be avoided. For the lead free reflow process a standard process IPC/JEDEC J-STD-020 with peak temperature up to max 230°C is suggested. See figure 6 for more detailed description.
Please note: The device shall be kept clear of liquids; therefore a PCB washing process must be avoided in any case.

For manual soldering, contact time must be limited to 5seconds at a maximum temperature of 350°C.

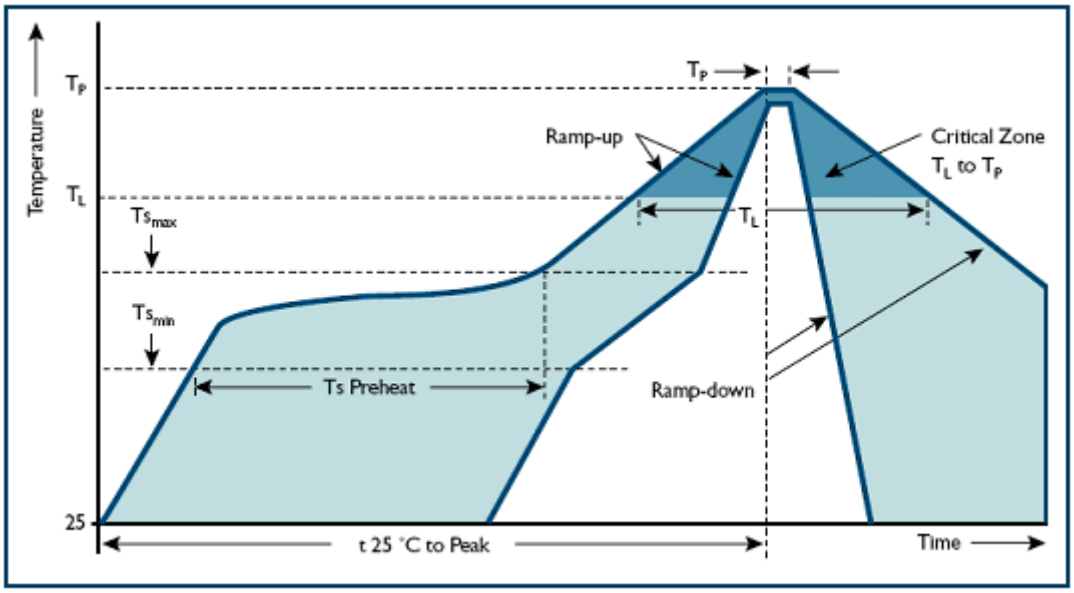


Figure 6: Ts min = 150°C; Ts max = 200°C; Ts Preheat = 60-120sec; TL < 220°C for < 150sec; TP <= 230°C for < 30sec; Ramp-up/down speed shall be < 5°C/sec.

5.3 Typical application

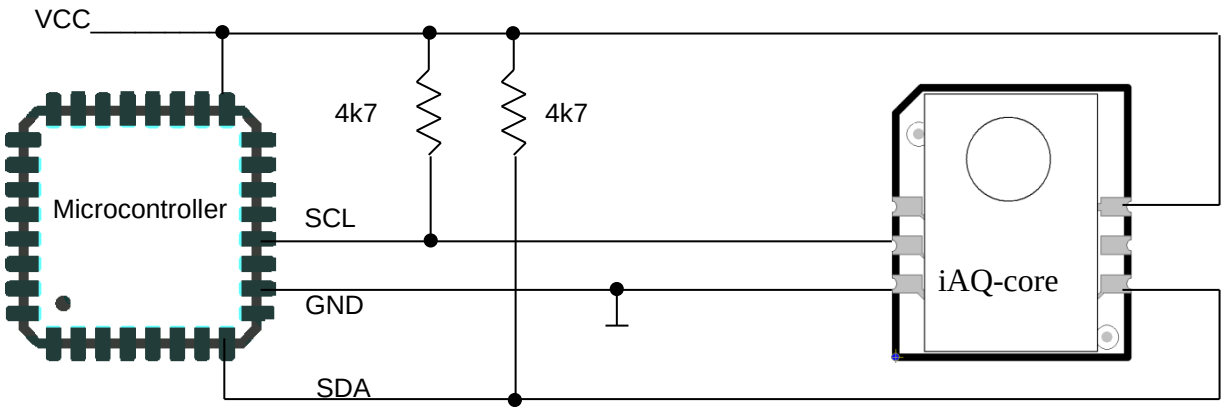


Figure 7: Simple microcontroller application.

5.4 Recommended footprint

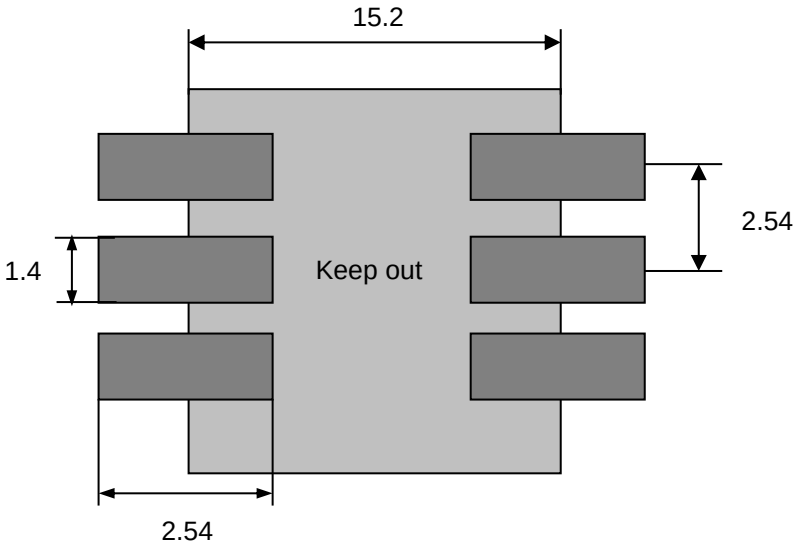


Figure 8: Recommended footprint (standard).

5.5 Ordering information

Order code	Comment
70-0100	iAQ-core C (continuous operation mode)
70-0200	iAQ-core P (pulsed operation mode)