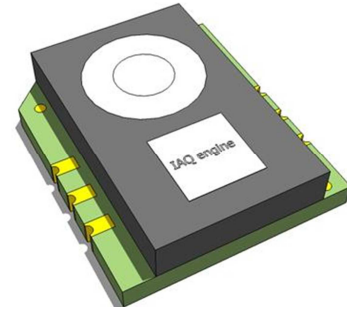


# Manual iAQ-engine

## Indoor Air Quality sensor

- Digital and analog I/O
- SMD type package

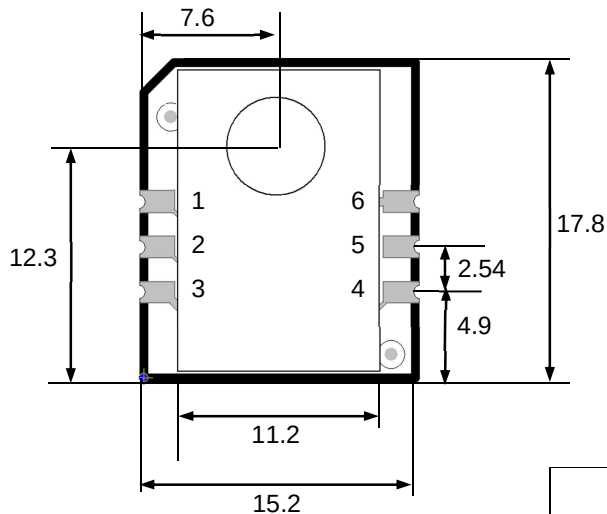


### Product summary

iAQ-engine is used for measuring VOC levels that can be read out as a prediction via the I<sup>2</sup>C bus. The iAQ-engine can also control equipment directly by an analog output with a 0-5 V DAC.

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 soldering.

### Dimensions



**Figure 1:** iAQ-engine sensor (dimensions in mm, Top View)

| Pin | Name | Comment        |
|-----|------|----------------|
| 1   | PRED | Prediction I/O |
| 2   | SCL  | Serial clock   |
| 3   | GND  | Ground         |
| 4   | SDA  | Serial data    |
| 5   | NC   | Not connected  |
| 6   | VCC  | +5V            |

|                                      |                                |
|--------------------------------------|--------------------------------|
| Dimensions (approximate values)      | PCB 15.24 x 17.78 mm           |
|                                      | HEIGHT PCB 1.7 mm              |
|                                      | HOOD 11.2 x 17.78 mm           |
|                                      | TOTAL HEIGHT 4.3 mm            |
| Sensor position (approximate values) | 7.6 x 12.3 mm<br>Radius 3,5 mm |
| Weight                               | Approximately 1g               |
| IP-Class                             | 00                             |
| Connector                            | Card edge (cut via)            |

## 1 Electrical specifications

### 1.1 Power supply

|                   |                               |
|-------------------|-------------------------------|
| Voltage           | 5.0 ± 0.25V, max. 20mV ripple |
| Power consumption | 225mW @ 5.0VDC                |

**Note:** Module features a decoupling capacitor.

### 1.2 Communication

|                                         |                  |
|-----------------------------------------|------------------|
| Output signal options                   | I <sup>2</sup> C |
|                                         | DAC (0-5)V       |
| First functional reading after start up | 15 minutes       |

→ For more communication details see chapter 4

## 2 Environmental

|                             |                               |
|-----------------------------|-------------------------------|
| 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      | I <sup>2</sup> C: 450 – 65535 ppm CO <sub>2</sub> equivalents (relative) |
|                    | DAC: 450 – 2000 ppm CO <sub>2</sub> equivalents (relative)               |
| Module             | Automatic baseline correction                                            |

## 4 I<sup>2</sup>C 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-engine module is ready for the next byte transfer in a type of handshake procedure. (See official I<sup>2</sup>C specification and user manual UM10204, [http://www.nxp.com/documents/user\\_manual/UM10204.pdf](http://www.nxp.com/documents/user_manual/UM10204.pdf))

#### 4.1.3 Address

Standard 7 bit I<sup>2</sup>C address for iAQ-engine is **decimal 90** or **hexadecimal 0x5A**. The addressing byte includes the read/write bit at the lowest significant bit. The communication with the iAQ-engine starts with **0xB5** for reading data.

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

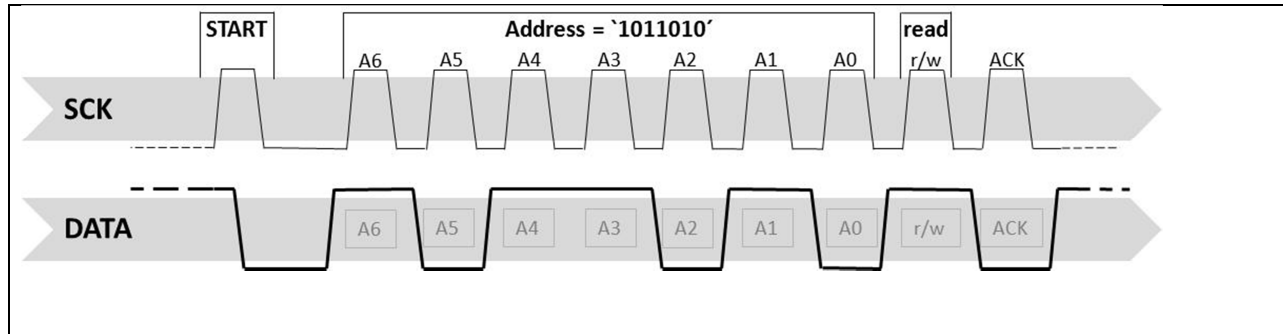
**Table 1:** Addressing byte for the iAQ-engine

### 4.2 Interface protocol

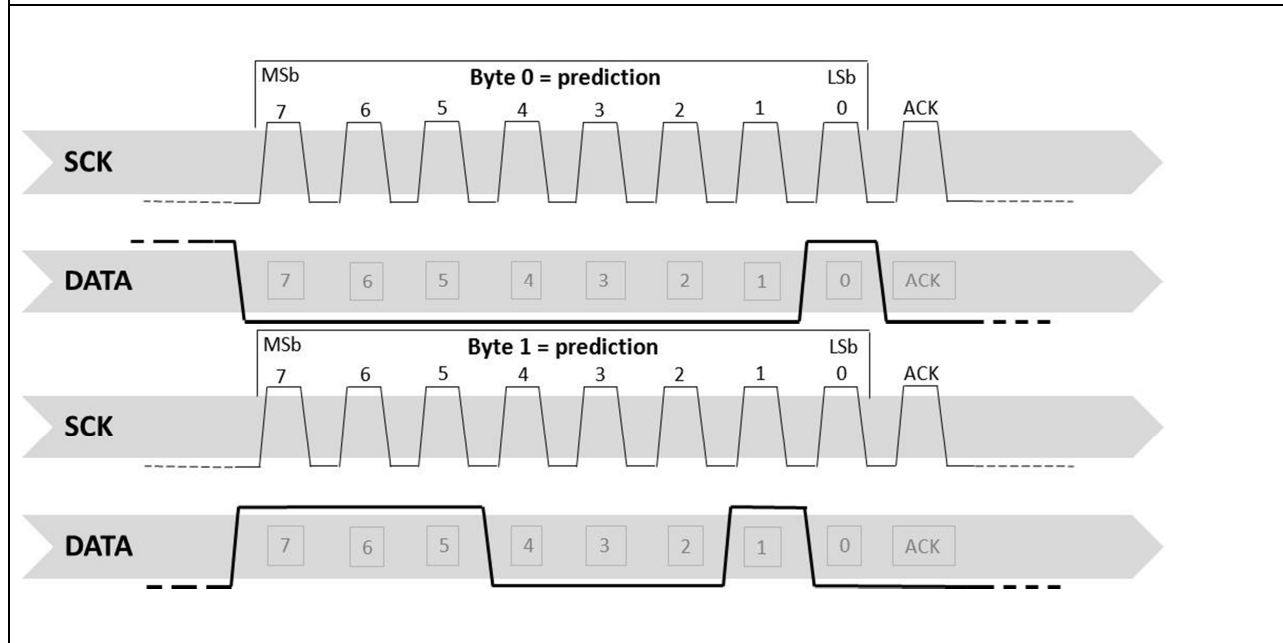
The standard I<sup>2</sup>C specification is used for the iAQ-engine interface protocol. The I<sup>2</sup>C bus master should request 7 bytes. These seven bytes include information about the indoor air quality value, the iAQ-engine status and the resistance of the sensor. If there is a need just for the indoor air quality value and the status, the master should request three bytes from the iAQ-engine. All bytes are reported back as shown in the following table. A graphical description for a standard I<sup>2</sup>C communication with the iAQ-engine module is shown in figure 2 – figure 5.

| Byte | Name       | Data type | Typical/example value | Explanation / notes                                                                                        |
|------|------------|-----------|-----------------------|------------------------------------------------------------------------------------------------------------|
| 0-1  | pred       | uint16    | 450                   | Prediction [ppm]                                                                                           |
| 2    | status     | uint8     | 0                     | 0x00: OK (data valid)<br>0x01: BUSY (re-read multi byte data!)<br>0x80: ERROR (if constant:replace sensor) |
| 3-6  | resistance | int32     | 256431                | Sensor resistance [Ohm]                                                                                    |

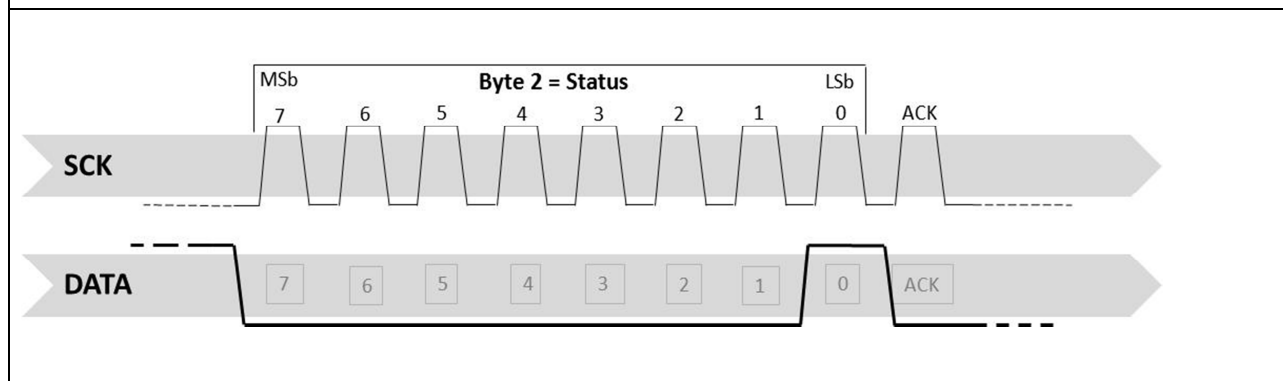
**Table 3:** Read data from the iAQ-engine



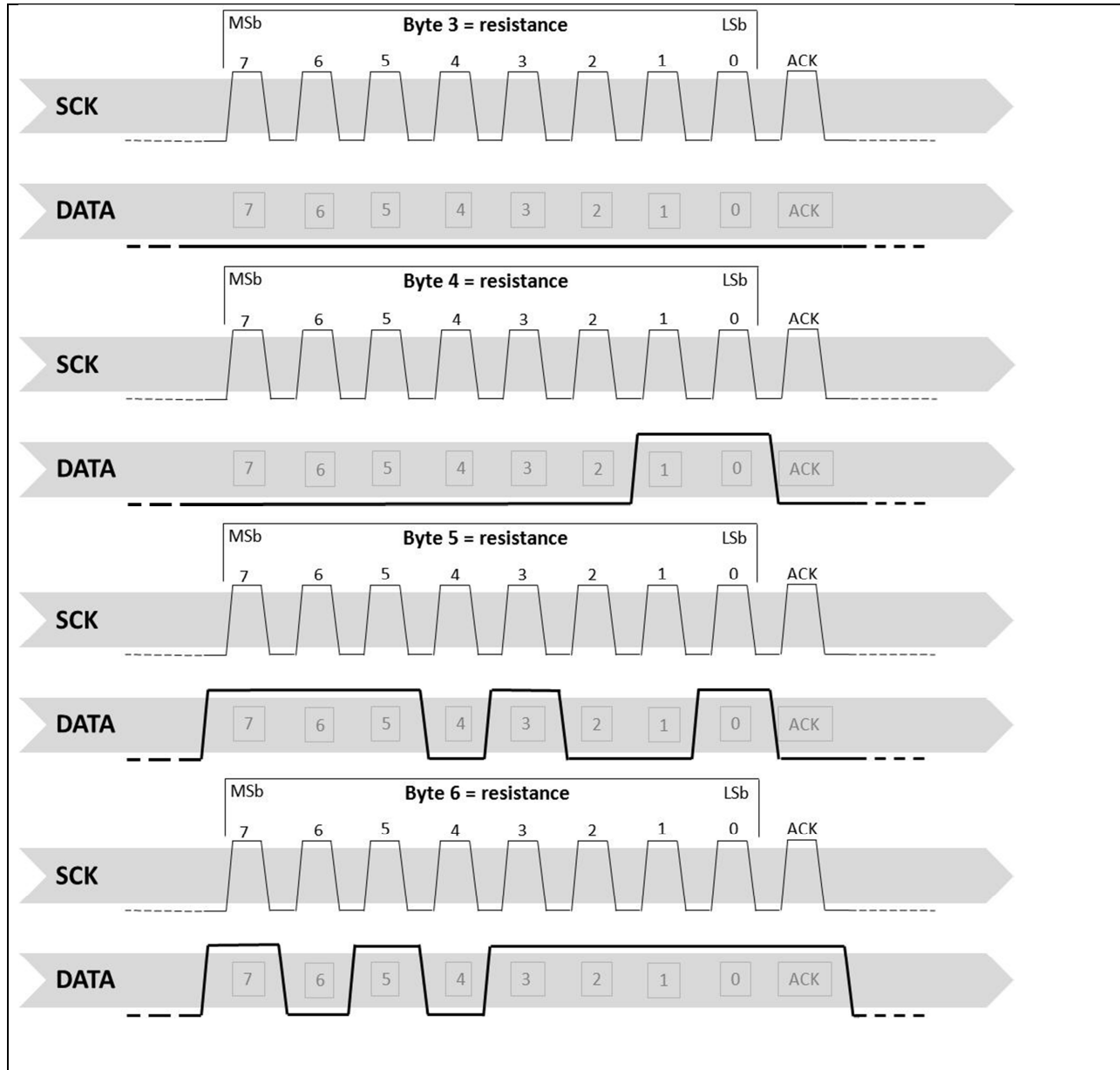
**Figure 2:** The first byte is send by the master, containing address (0x5A) and read/write bit. The slave sends an acknowledgement (ACK) by pulling the data line to low.



**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-engine module state, in this case status = 1. The master answers with an Acknowledge.



**Figure 5:** The last four bytes contain the resistance value. For the calculation of the resistance only byte4, byte5 and byte 6 are relevant, because byte3 is zero .After the last requested byte, the master sends a not Acknowledge.

#### 4.2.1 Prediction

| Byte0 | Byte1 | Byte2 | Byte3 | Byte4 | Byte5 | Byte6 |
|-------|-------|-------|-------|-------|-------|-------|
|-------|-------|-------|-------|-------|-------|-------|

The first two bytes contain the prediction value, which gives the information about the indoor air quality. The value is a CO<sub>2</sub> equivalent and the calculation is shown in the following example.

**Equation 1 :**

## 4.2.2 Status Flag

| Byte0 | Byte1 | Byte2 | Byte3 | Byte4 | Byte5 | Byte6 |
|-------|-------|-------|-------|-------|-------|-------|
|-------|-------|-------|-------|-------|-------|-------|

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.

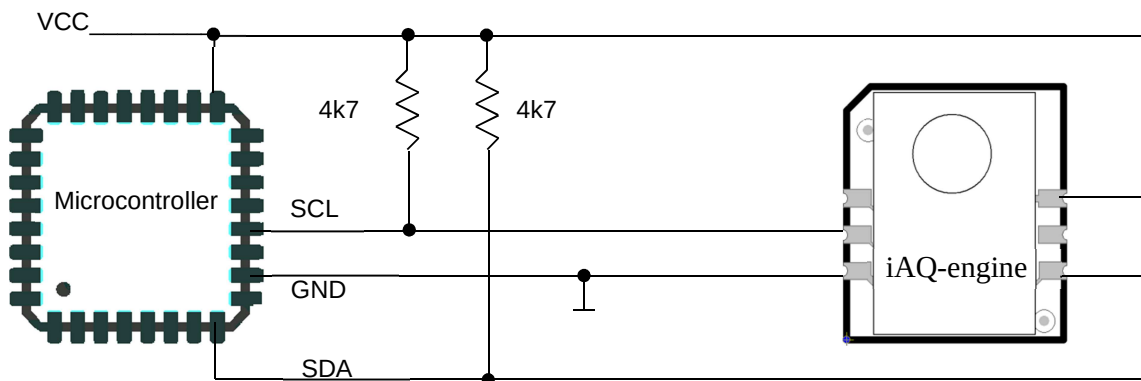
## 4.2.3 Resistance

| Byte0 | Byte1 | Byte2 | Byte3 | Byte4 | Byte5 | Byte6 |
|-------|-------|-------|-------|-------|-------|-------|
|-------|-------|-------|-------|-------|-------|-------|

The next four bytes contain the sensor resistance in Ohm. The fourth byte of the int32 variable is 0.

**Equation 2:**

## 4.3 Typical applications



**Figure 6:** Simple microcontroller application

## 4.4 Recommended footprint

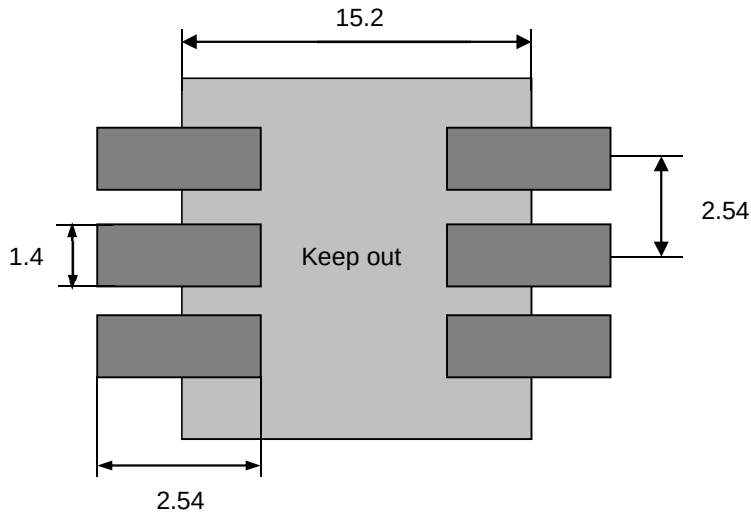


Figure 7: Recommended footprint (standard)

## 4.5 Ordering information

| Order code | Comment    |
|------------|------------|
| 60-0100    | iAQ-engine |

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