iAQ-Core

Indoor Air Quality Sensor Module

General Description

The iAQ-Core sensor module is used to measure VOC levels and provide CO_2 equivalent and TVOC equivalent predictions. The data is 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(s): Please read the I^2C addressing instructions carefully. An undefined use of the I^2C interface could harm the iAQ-Core module and cause a loss of functionality.

Ordering Information and Content Guide appear at end of datasheet.

Key Benefits & Features

The benefits and features of iAQ-Core, Indoor Air Quality sensor module are listed below:

Figure 1:
Added Value of Using iAQ-Core Sensor Module

Benefits	Features
• Reliable evaluation of indoor air quality	• Output of relative CO_2 equivalents (ppm) and TVOC equivalents (ppb)
• High sensitivity and fast response	• Sensing range: 450 – 2000 ppm CO_2 equivalents 125 – 600 ppb TVOC equivalents • I^2C interface
• Micro size for convenient installation	• MEMS metal oxide sensor technology • SMD type package • Reflow capable • Module with automatic baseline correction
• Low power consumption	• 66 mW (maximum in continuous mode) • 9 mW (maximum in pulsed mode)

Applications

- Smart Home
- Internet of Things
- HVAC
- Thermostats

Pin Assignments

Figure 2:
Pin Diagram

Pin Diagram: iAQ-Core sensor module.

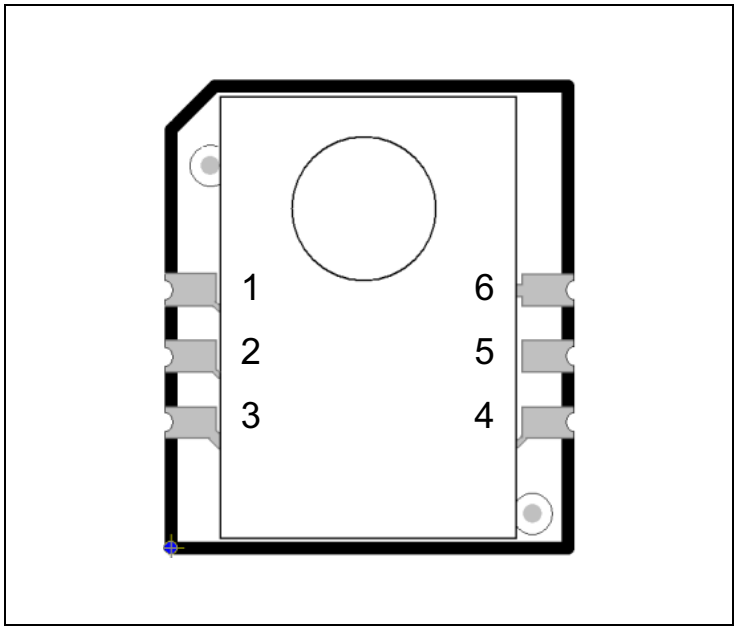


Figure 3:
Pin Description

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

Electrical Characteristics

Figure 4:
Power Supply

Description	Value
Voltage	3.3V ± 0.1V, max. 20mV ripple
Power consumption (continuous)	Max. 66mW @ 3.3VDC (20mA)
Measurement interval (continuous)	1s
Power consumption (pulsed)	Max. 9mW @ 3.3VDC (20mA)
Measurement interval (pulsed)	Max. 11s

Note(s) and/or Footnote(s):

1. Decoupling capacitor included in design.

Figure 5:
Communication

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

Note(s) and/or Footnote(s):

1. For more communication details refer to I^2C Interface Description.

Environmental Specifications

Figure 6:
Environmental Specifications

Description	Value
Temperature range operation	0 to 50°C
Temperature range storage	-25 to 50°C
Humidity range	5 to 95 % relative humidity, non-condensing

Figure 7:
Sensor Features

Description	Value
Sensing technology	MEMS metal oxide sensor
Sensing range	I^2C: 450 – 2000 ppm CO2 equivalents (relative) 125 – 600 ppb TVOC equivalents (relative) Values above the defined sensing range are provided as well.
Module	Automatic baseline correction

Detailed Description

I²C Interface Description

Physical Interface

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

Figure 8:
Interface Description

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

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)

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.

Note(s): Please 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.

Figure 9:
Address Byte for the iAQ-Core

Description	Address							R/W
Bit	7	6	5	4	3	2	1	0
Data	1	0	1	1	0	1	0	1

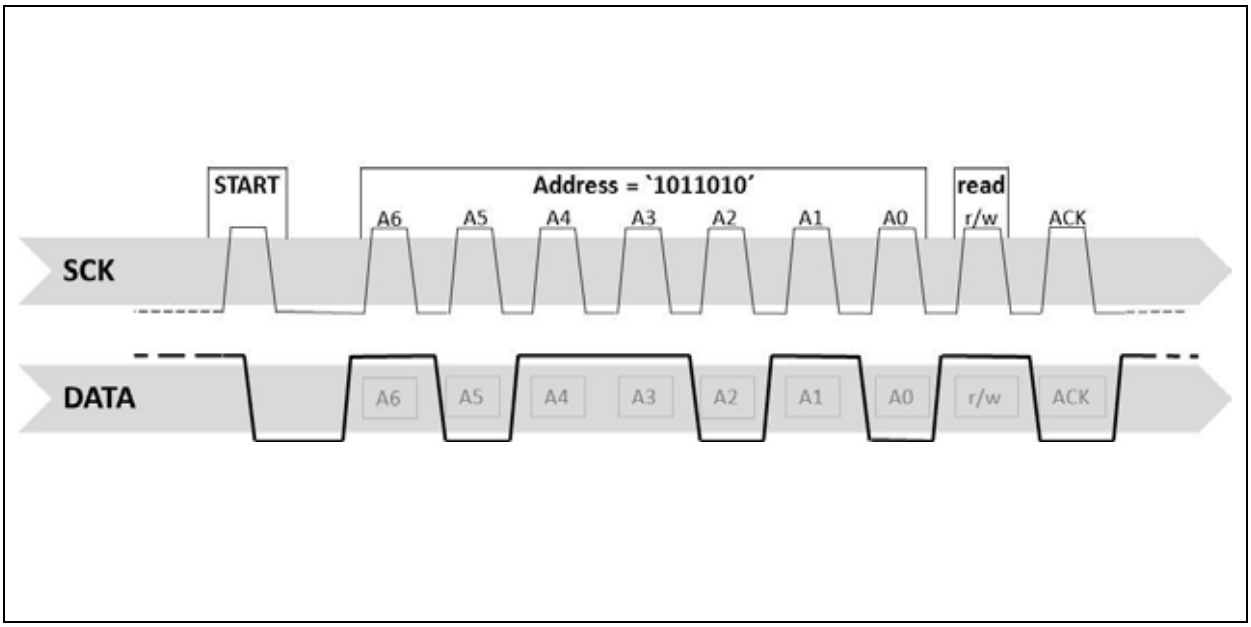
Interface Protocol

The standard I²C specification is used for the iAQ-Core interface protocol. The I²C master can request up to 9 bytes. These nine 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 11 – Figure 14.

Figure 10:
iAQ-Core Interface Protocol

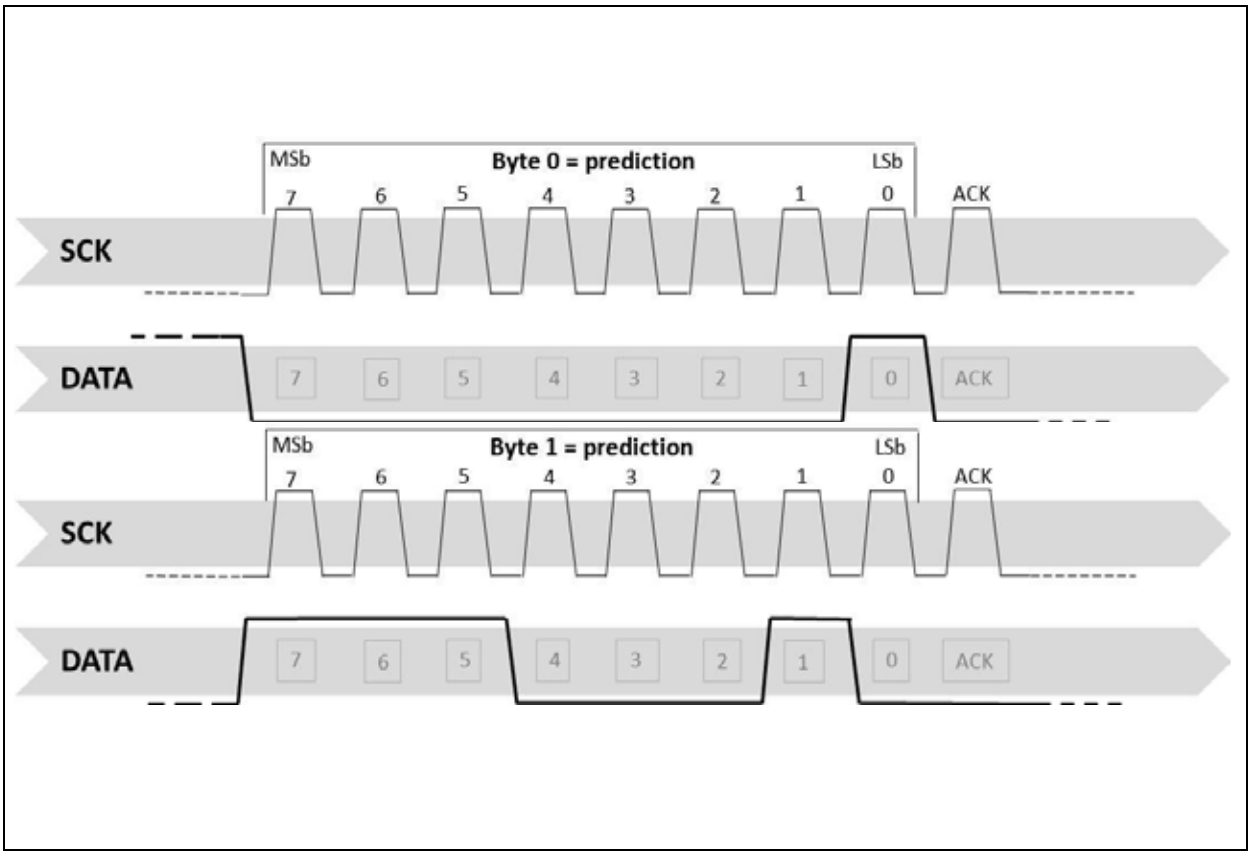
Byte	Name	Data Type	Typical Value	Description
0-1	pred	uint16	450	Prediction (CO2 eq. ppm)
2	status	uint8	0	0x00: OK (data valid) 0x10: RUNIN (module in warm up phase) 0x01: BUSY (re-read multi byte data!) 0x80: ERROR (if constant: replace sensor)
3-6	resistance	int32	256431	Sensor resistance [Ohm]
7-8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

Figure 11:
Standard Communication via I²C (Address Byte)



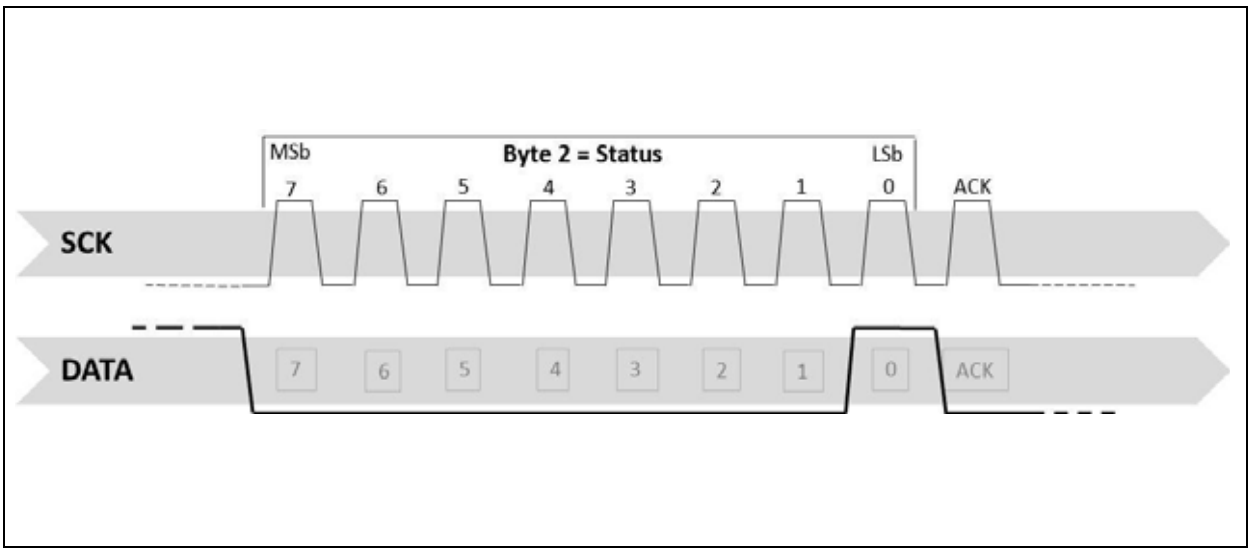
Address Byte: The first byte is send by the master, containing address (0x5A) and read/write bit. The slave sends an acknowledgement (ACK) by pulling the data line to low.

Figure 12:
Standard Communication via I²C (Prediction Value CO_2)



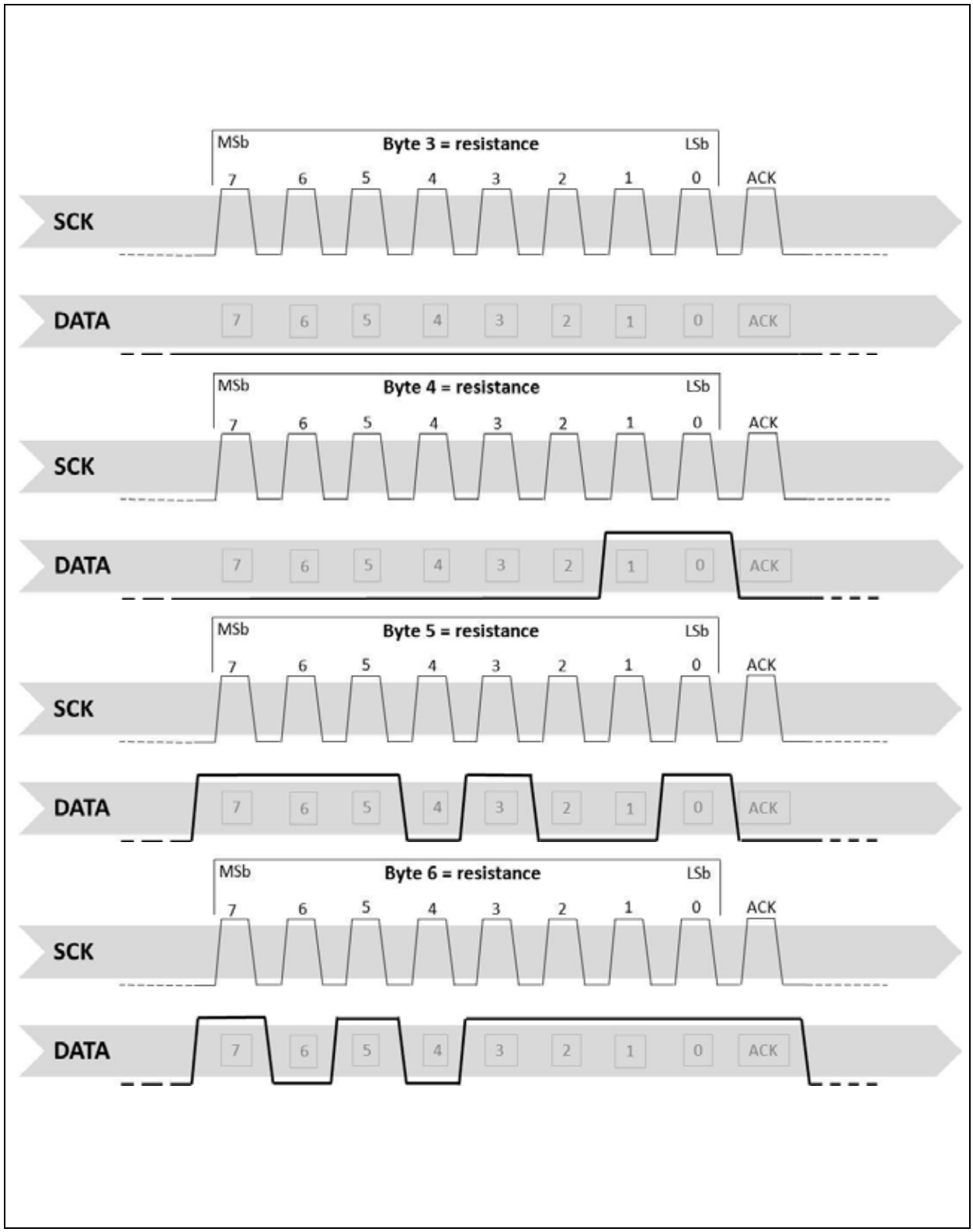
Prediction Value CO_2: The slave will answer by sending bytes with MSB first. Byte0 and byte1 contain the prediction value. All bytes are acknowledged by the master.

Figure 13:
Standard Communication via I²C (Status Byte)



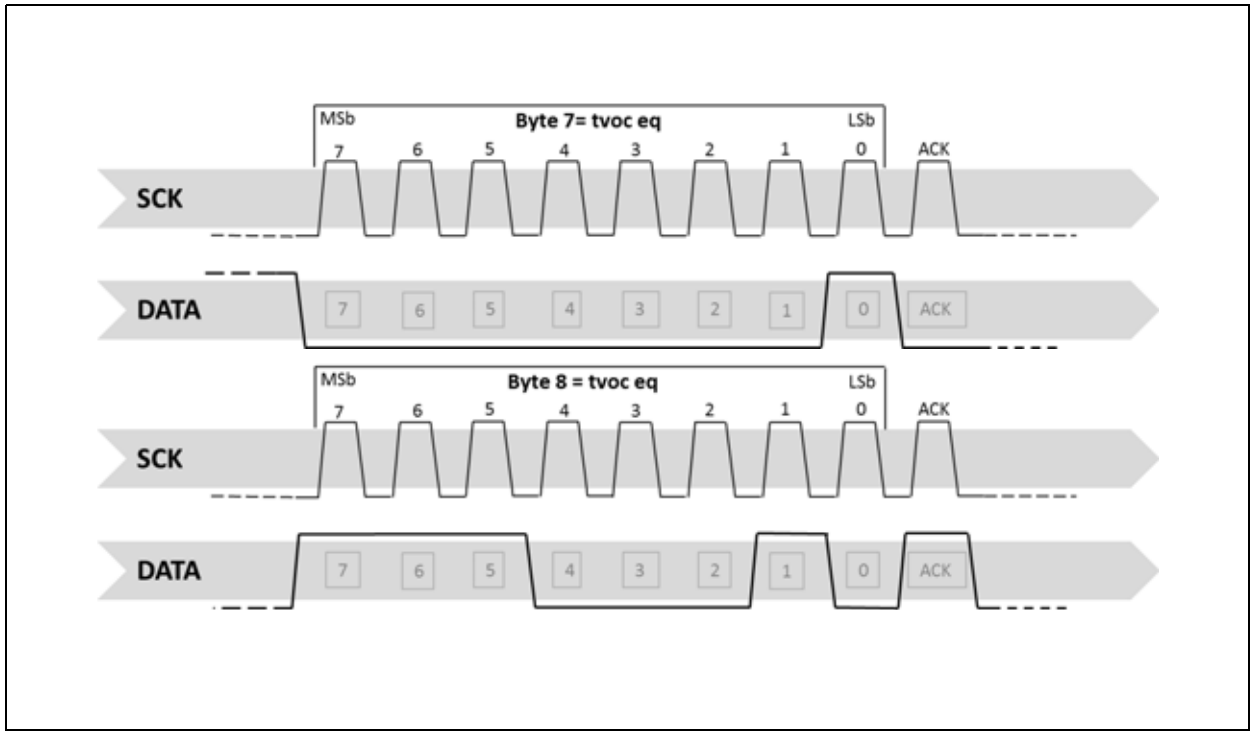
Status Byte: The third byte contains the information of the iAQ-Core module state, in this case status = 1. The master answers with acknowledge.

Figure 14:
Standard Communication via I²C (Resistance Value)



Resistance Value: The last four bytes contain the resistance value. For the calculation of the resistance only byte4, byte5 and byte6 are relevant, because byte3 is zero. After the last requested byte, the master sends a not acknowledge.

Figure 15:
Standard Communication via I²C (Prediction Value TVOC)



Prediction Value TVOC: 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.

Prediction

Figure 16:
Information Structure (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 CO2 (ppm) equivalent and the calculation is shown in the following example.

(EQ1) $$Prediction = byte0 * 2^8 + byte1$$

Status Flag

Figure 17:
Information Structure (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.

Resistance

Figure 18:
Information Structure (Resistance)

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8

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

(EQ2) $$Resistance = byte4 * 2^{16} + byte5 * 2^8 + byte6$$

TVOC

Figure 19:
Information Structure (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

(EQ3) $tvoc\ eq = byte\mathbf{7} * 2^8 + byte\mathbf{8}$

Application Information

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.

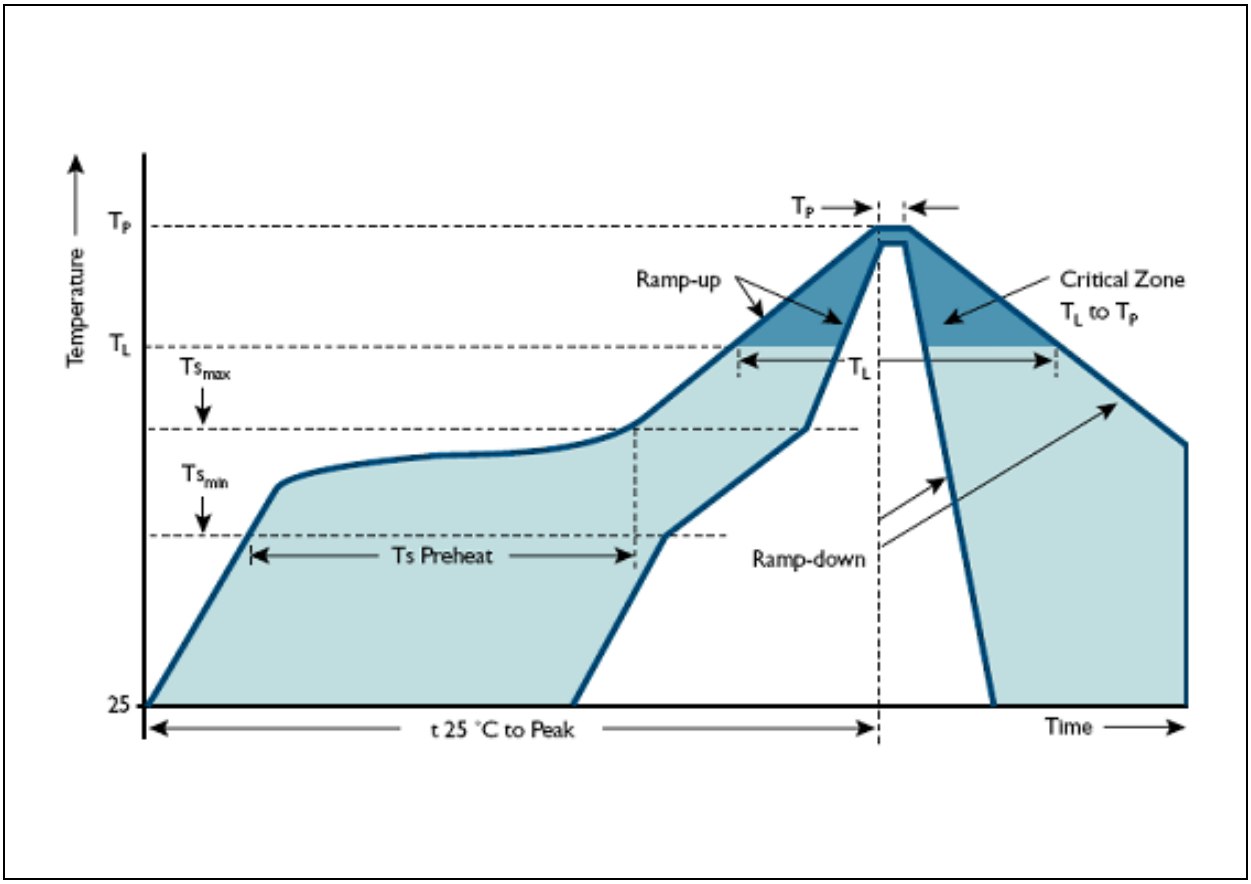
Soldering Instructions

For soldering the iAQ-Core sensor module, 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 20 for more detailed description.

Note(s): 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 5 seconds at a maximum temperature of 350°C.

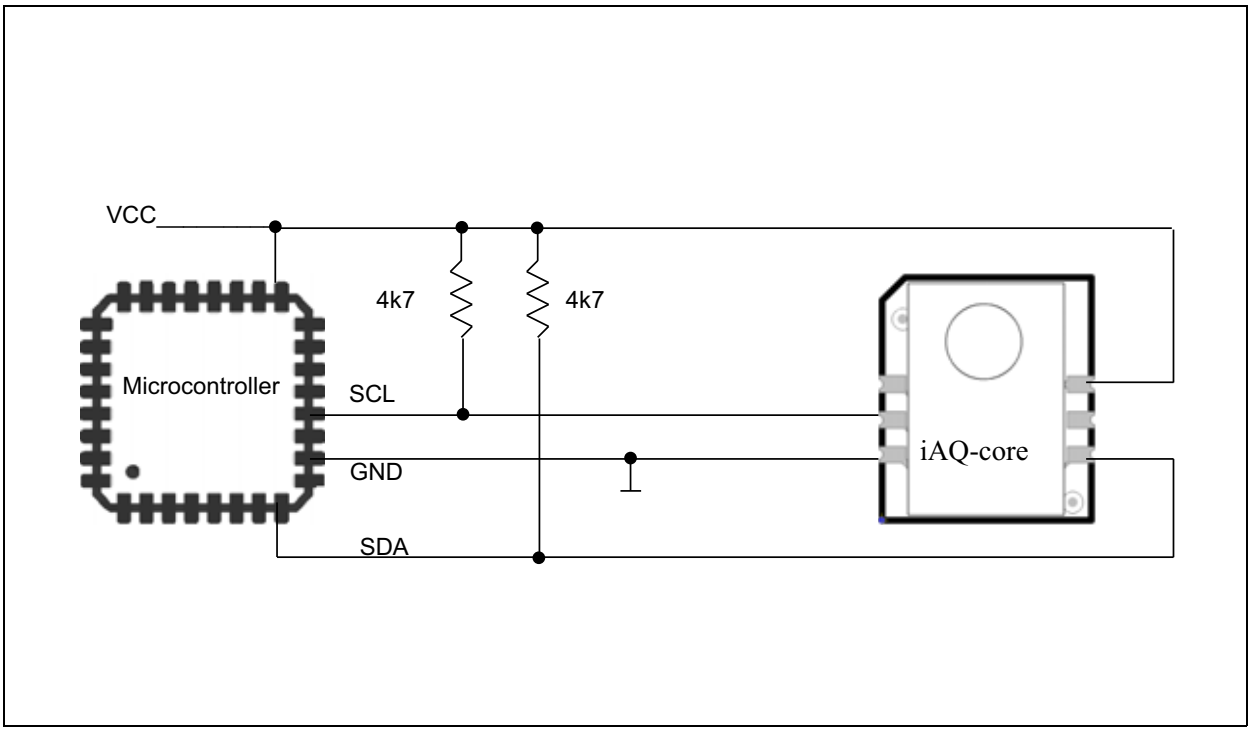
Figure 20:
Reflow Soldering Profile



Reflow Soldering Profile: 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.

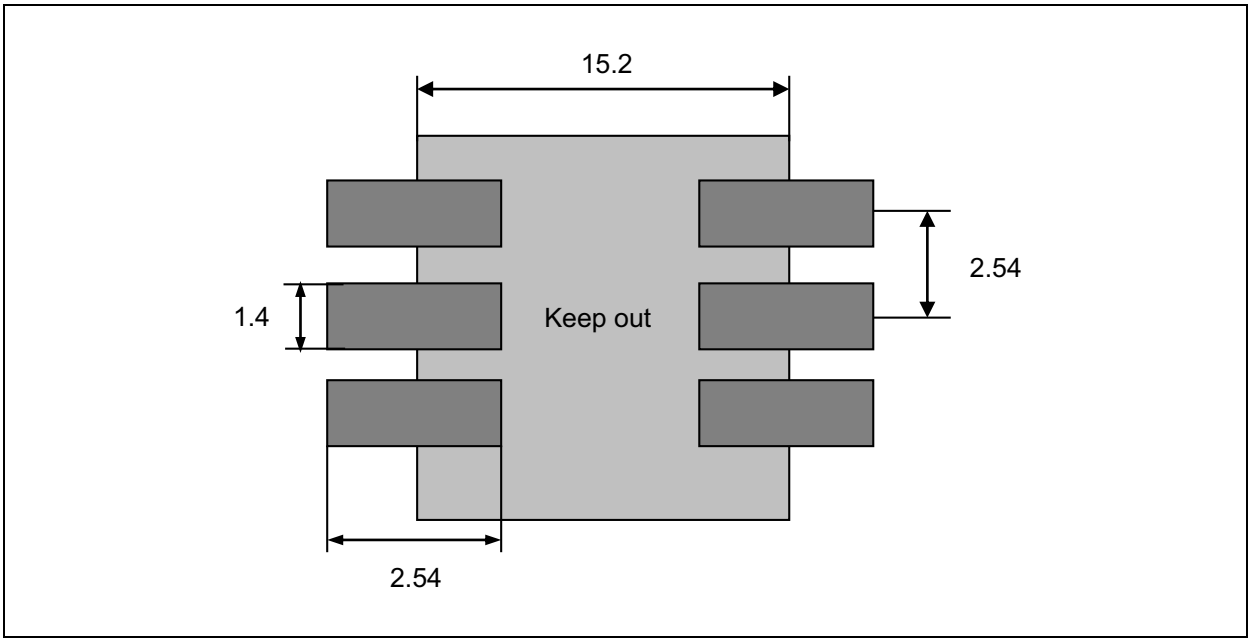
Typical Application

Figure 21:
Simple Microcontroller Application



Recommended Footprint

Figure 22:
Recommended Footprint (standard)

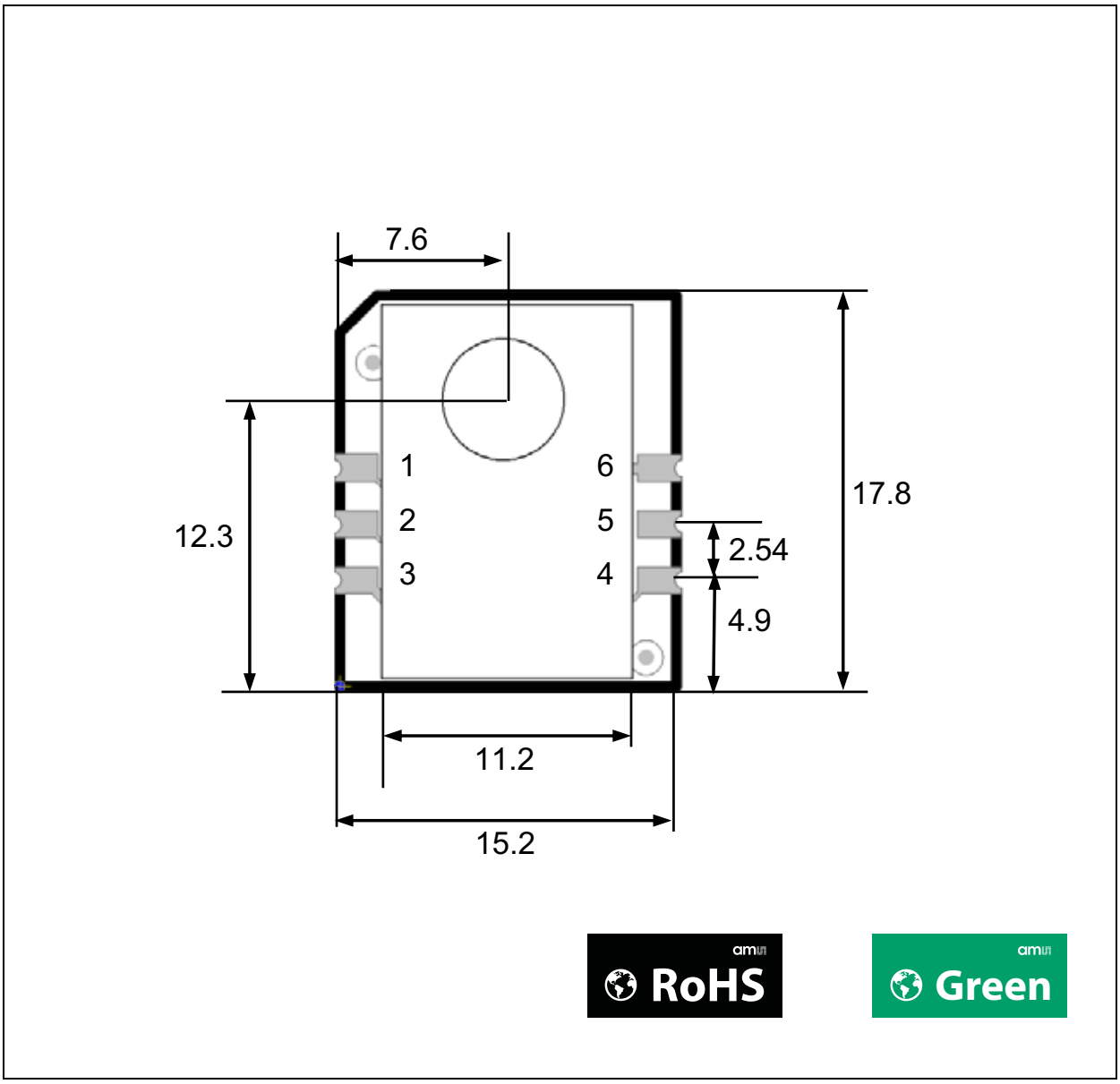


Note(s) and/or Footnote(s):

1. Dimensions in mm.

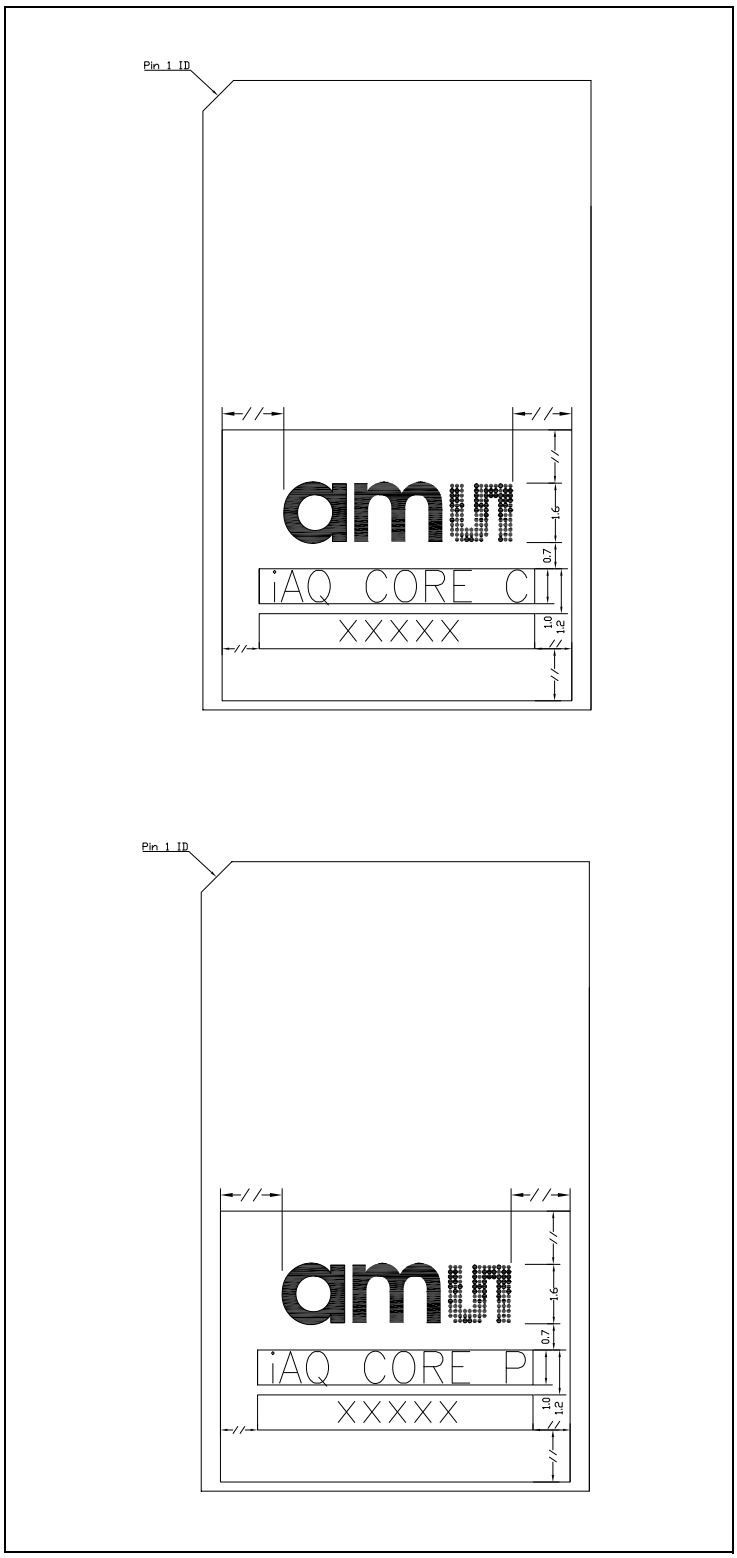
Mechanical Information

Figure 23:
iAQ-Core Sensor Module



iAQ-Core Sensor Module: Dimensions in mm

Figure 24:
iAQ-Core Marking



Note(s) and/or Footnote(s):

1. Drawing not to scale.
2. All dimensions in mm.

Figure 25:
Package Code

XXXXX
Tracecode

Figure 26:
Dimensions of iAQ-Core Sensor Module

Description	Value
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)

Ordering & Contact Information

Figure 27:
Ordering Information

Ordering Code	Marking	Delivery Form	Delivery Quantity	Comment
iAQ-Core C	iAQ CORE C	Tray	90	iAQ-Core (continuous operation mode)
iAQ-Core P	iAQ CORE P	Tray	90	iAQ-Core (pulsed operation mode)

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Revision Information

Changes from (2014-Oct) to current revision 1-00 (2015-Apr-30)	Page
Content of Applied Sensor datasheet was updated to the latest **ams** design	

Note(s) and/or Footnote(s):

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
2. Correction of typographical errors is not explicitly mentioned.

Content Guide