

# iAQ-Core

## Indoor Air Quality Sensor Module

### General Description

The iAQ-Core sensor module is used to measure VOC levels and provide CO<sub>2</sub> equivalent and TVOC equivalent predictions. The data is available via I<sup>2</sup>C 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<sup>2</sup>C addressing instructions carefully. An undefined use of the I<sup>2</sup>C 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
<ul style="list-style-type: none"> <li>Reliable evaluation of indoor air quality</li> </ul>	<ul style="list-style-type: none"> <li>Output of relative CO<sub>2</sub> equivalents (ppm) and TVOC equivalents (ppb)</li> </ul>
<ul style="list-style-type: none"> <li>High sensitivity and fast response</li> </ul>	<ul style="list-style-type: none"> <li>Sensing range: 450 – 2000 ppm CO<sub>2</sub> equivalents 125 – 600 ppb TVOC equivalents</li> <li>I<sup>2</sup>C interface</li> </ul>
<ul style="list-style-type: none"> <li>Micro size for convenient installation</li> </ul>	<ul style="list-style-type: none"> <li>MEMS metal oxide sensor technology</li> <li>SMD type package</li> <li>Reflow capable</li> <li>Module with automatic baseline correction</li> </ul>
<ul style="list-style-type: none"> <li>Low power consumption</li> </ul>	<ul style="list-style-type: none"> <li>66 mW (maximum in continuous mode)</li> <li>9 mW (maximum in pulsed mode)</li> </ul>

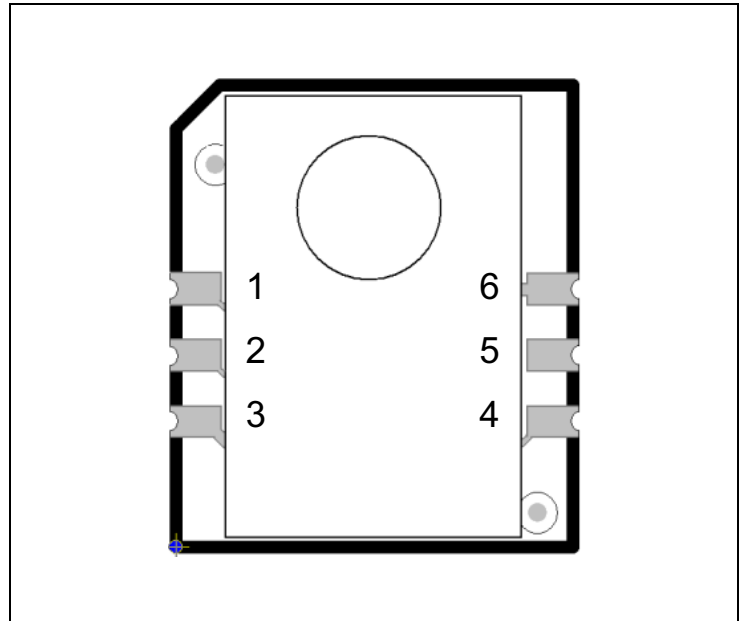
### Applications

- 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 <sup>2</sup> C serial clock
3	GND	Ground
4	SDA	I <sup>2</sup> C 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 <sup>2</sup> C
First functional reading after start up	5 minutes

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

1. For more communication details refer to [I<sup>2</sup>C 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 <sup>2</sup> C: 450 – 2000 ppm CO <sub>2</sub> equivalents (relative) 125 – 600 ppb TVOC equivalents (relative) Values above the defined sensing range are provided as well.
Module	Automatic baseline correction

## Detailed Description

### I<sup>2</sup>C 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 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))

#### Address

Standard 7 bit I<sup>2</sup>C 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
	7	6	5	4	3	2	1	
Bit	7	6	5	4	3	2	1	0
Data	1	0	1	1	0	1	0	1

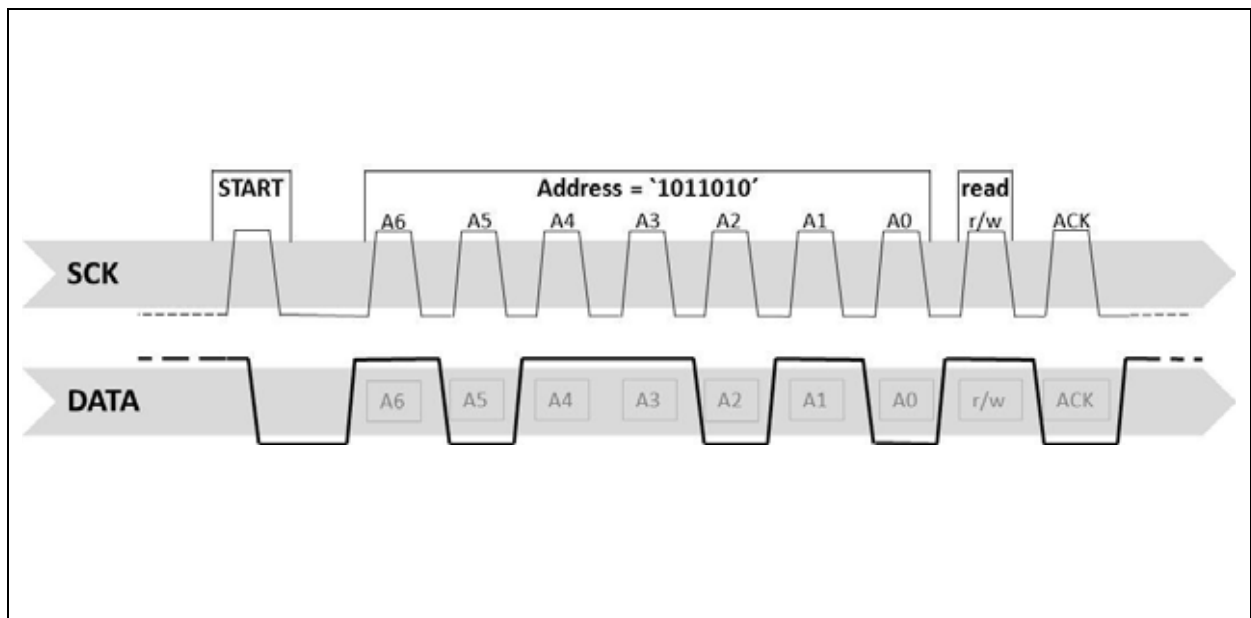
### Interface Protocol

The standard I<sup>2</sup>C specification is used for the iAQ-Core interface protocol. The I<sup>2</sup>C 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 I<sup>2</sup>C communication with the iAQ-Core module is shown in Figure 11 – Figure 14.

Figure 10:  
iAQ-Core Interface Protocol

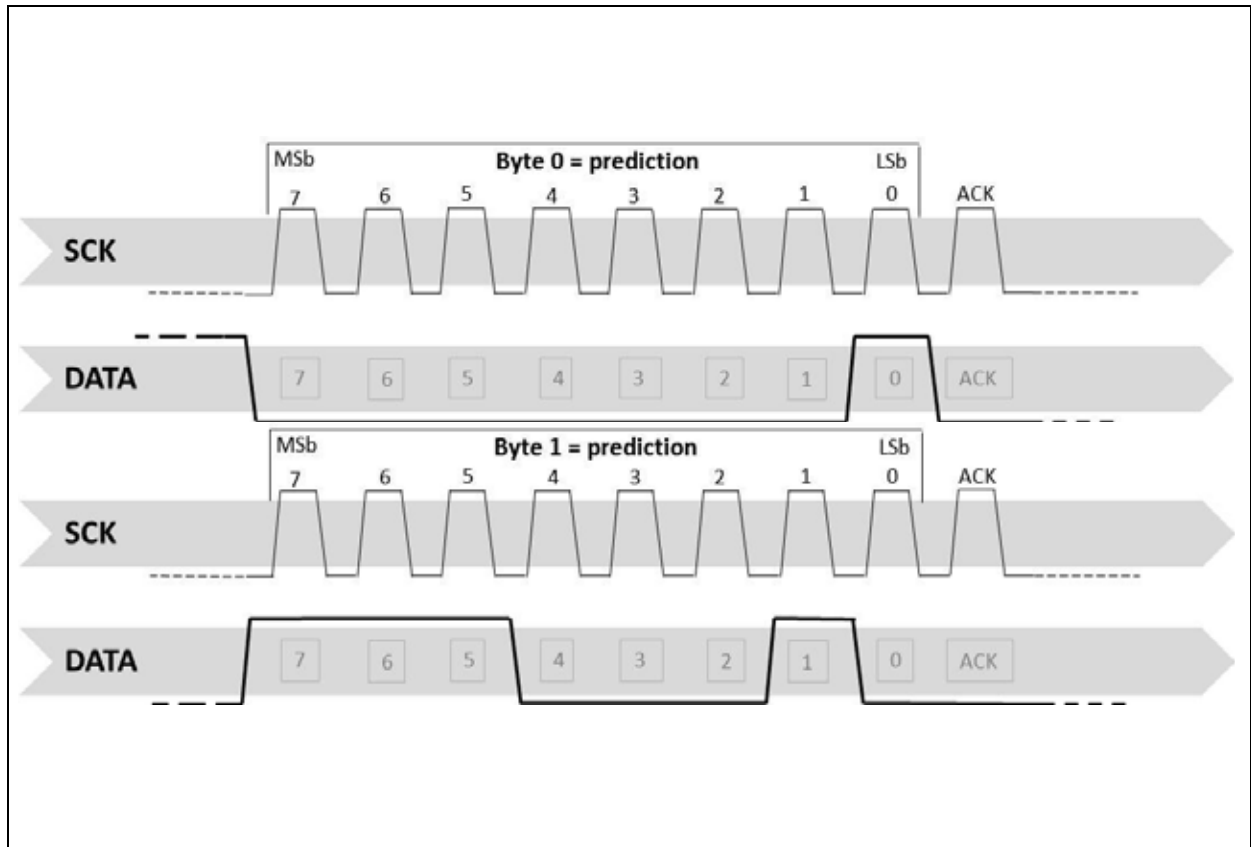
Byte	Name	Data Type	Typical Value	Description
0-1	pred	uint16	450	Prediction (CO2 eq. ppm)
2	status	uint8	0	0x00: OK (data valid) 0x10: RUNIN (module in warm up phase) 0x01: BUSY (re-read multi byte data!) 0x80: ERROR (if constant: replace sensor)
3-6	resistance	int32	256431	Sensor resistance [Ohm]
7-8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

Figure 11:  
Standard Communication via I<sup>2</sup>C (Address Byte)



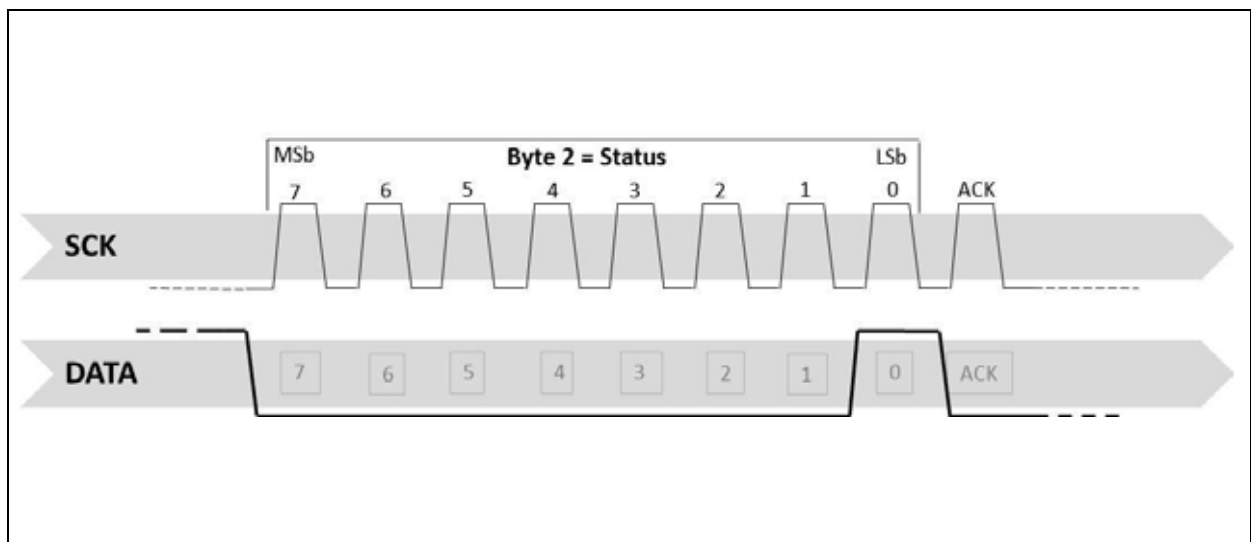
**Address Byte:** The first byte is sent by the master, containing address (0x5A) and read/write bit. The slave sends an acknowledgement (ACK) by pulling the data line to low.

**Figure 12:**  
**Standard Communication via I<sup>2</sup>C (Prediction Value CO<sub>2</sub>)**



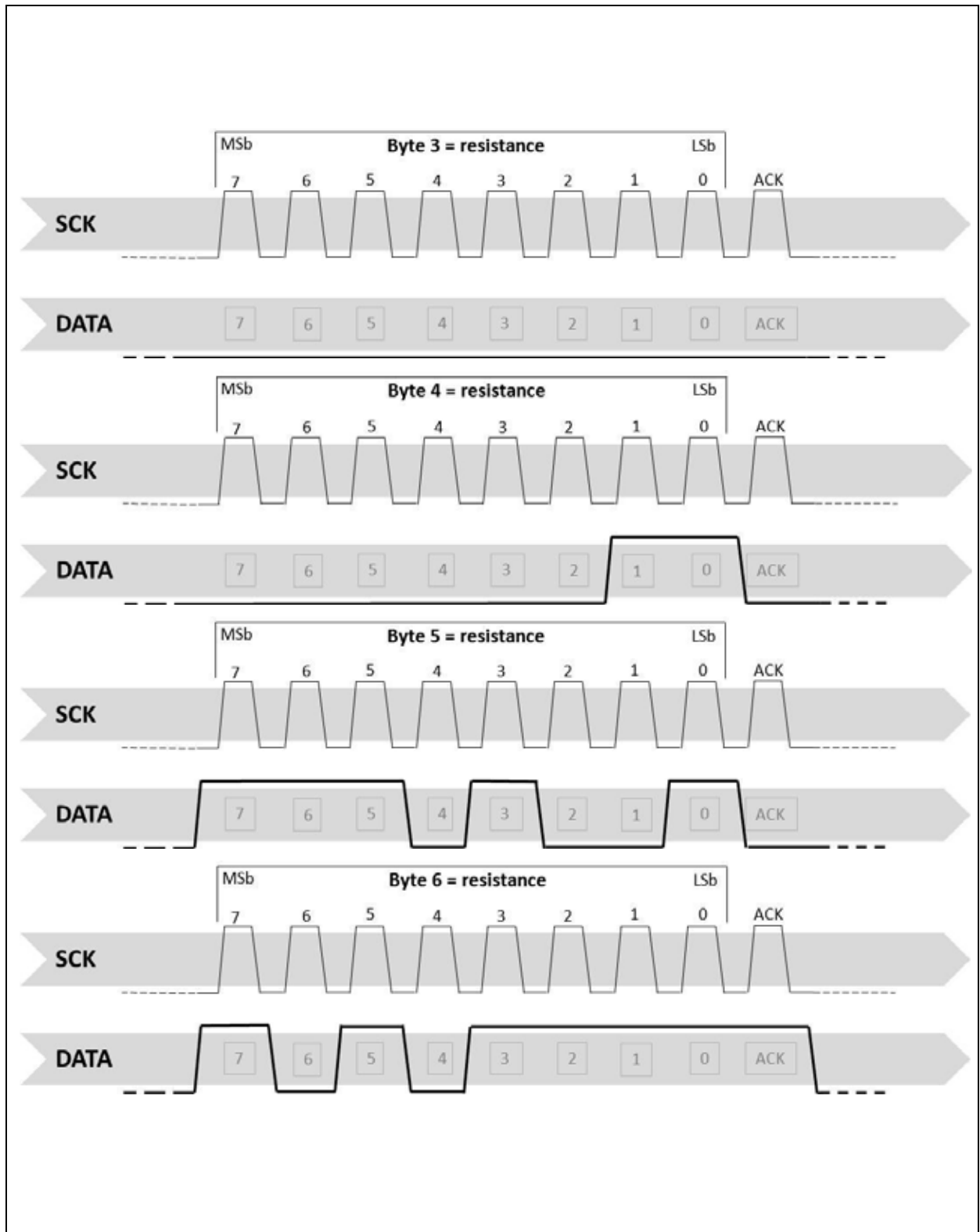
**Prediction Value CO<sub>2</sub>:** The slave will answer by sending bytes with MSB first. Byte0 and byte1 contain the prediction value. All bytes are acknowledged by the master.

**Figure 13:**  
**Standard Communication via I<sup>2</sup>C (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.

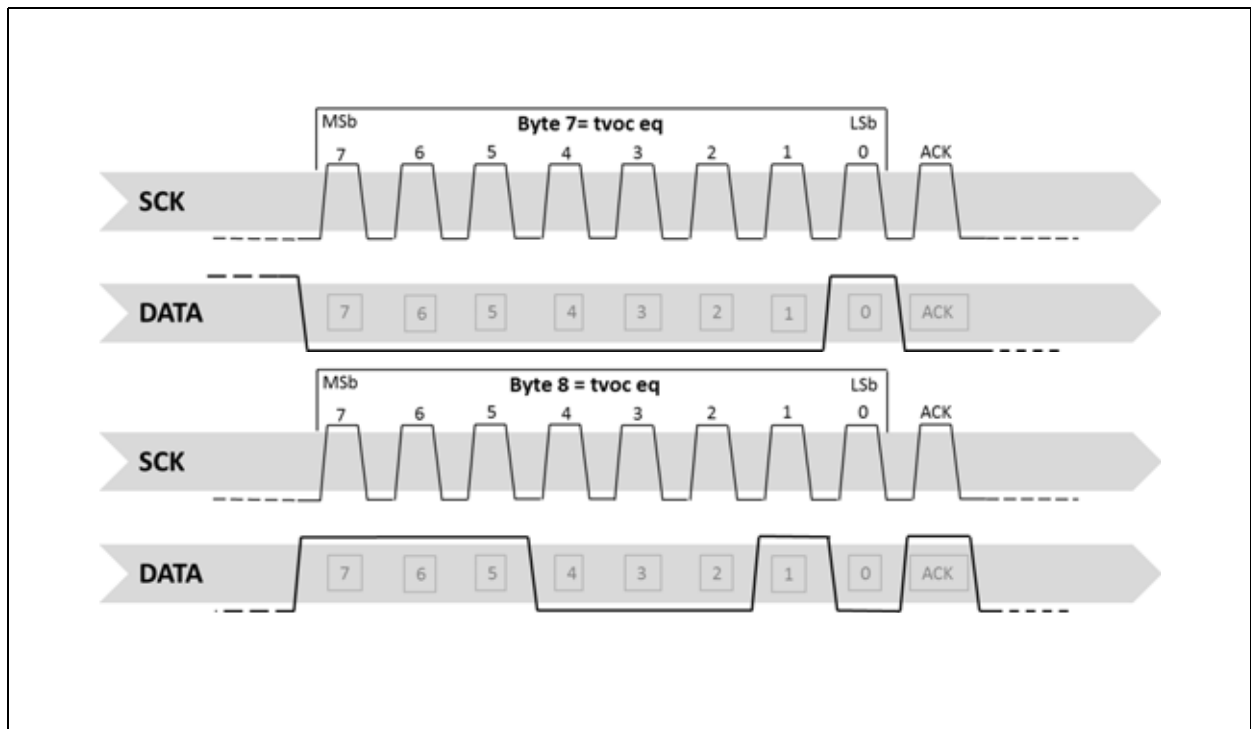
Figure 14:  
Standard Communication via I<sup>2</sup>C (Resistance Value)



**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 I<sup>2</sup>C (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.

$$(EQ1) \text{ Prediction} = \text{byte0} * 2^8 + \text{byte1}$$

**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.

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

### 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

$$(EQ3) \quad tvoc \ eq = byte7 * 2^8 + byte8$$

## 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.

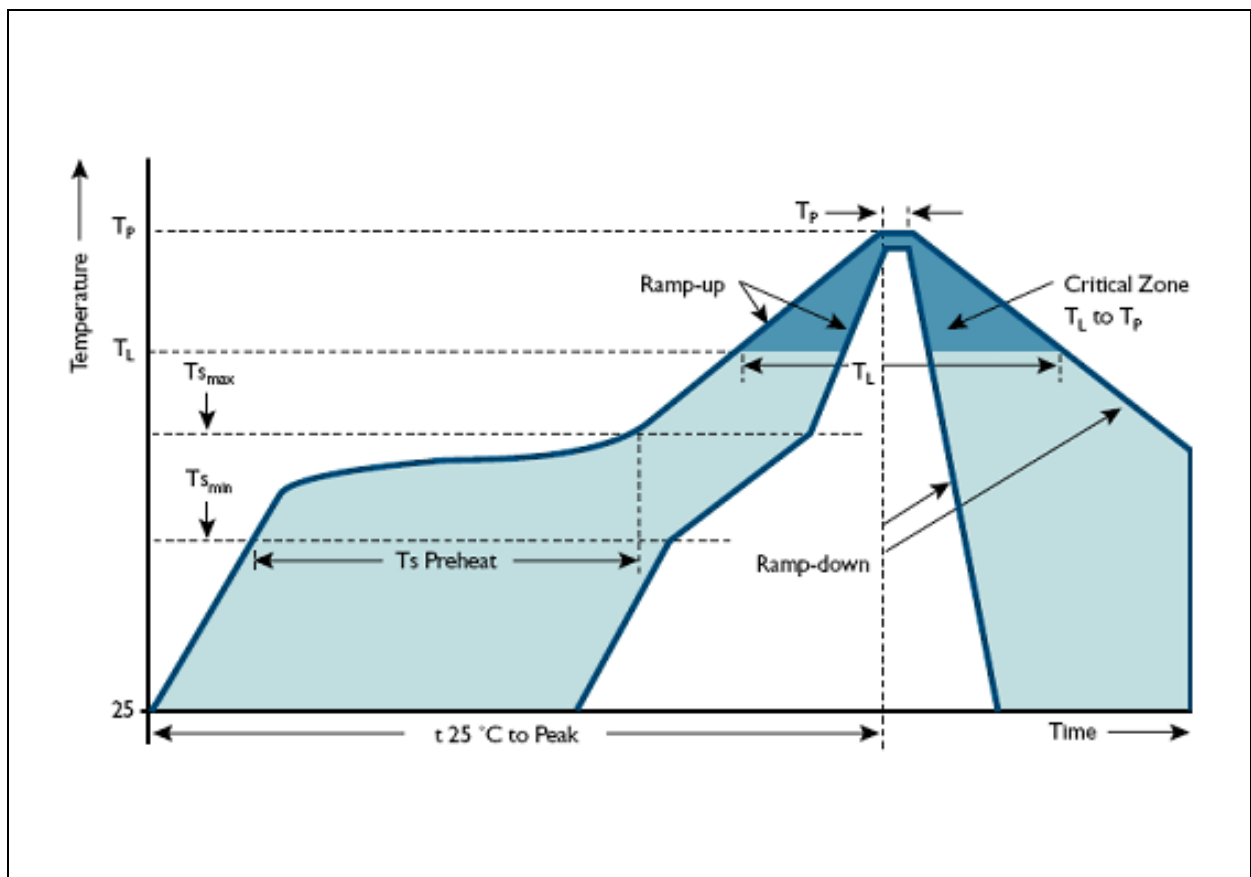
### Soldering Instructions

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.

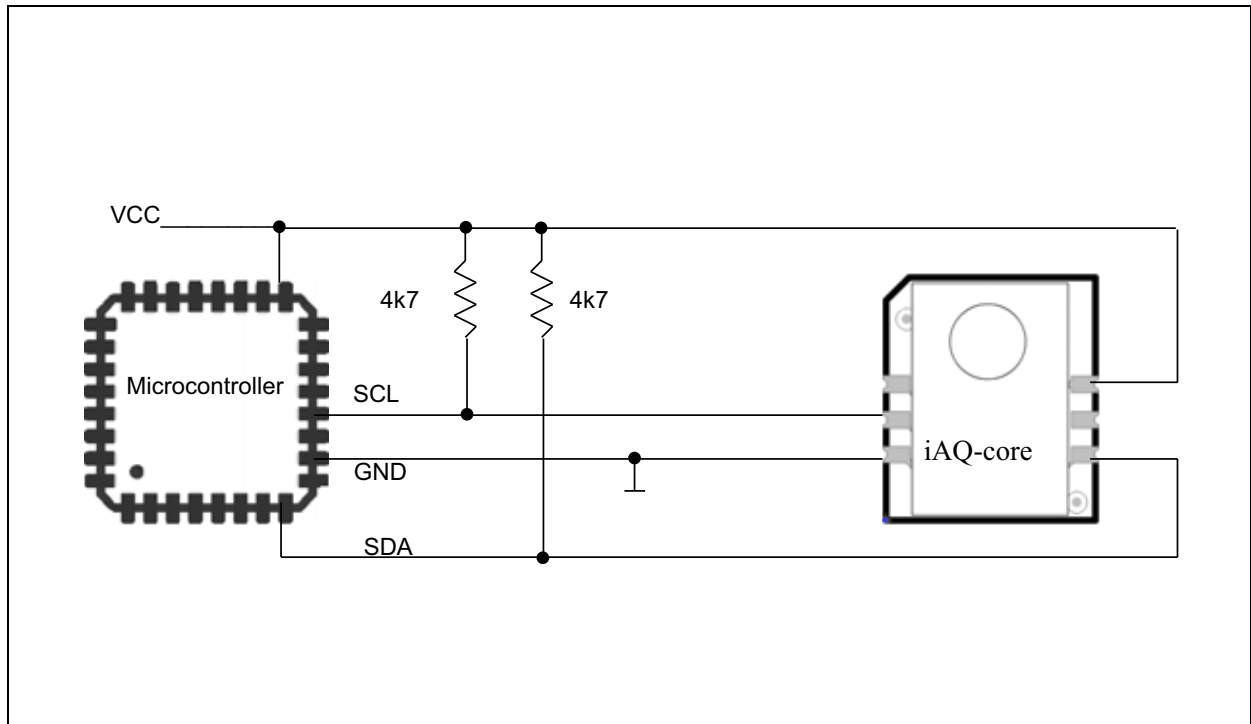
**Figure 20:**  
Reflow Soldering Profile



**Reflow Soldering Profile:**  $T_{s_{min}} = 150\text{°C}$ ;  $T_{s_{max}} = 200\text{°C}$ ;  $T_s$  Preheat = 60-120sec;  $T_L < 220\text{°C}$  for  $< 150\text{sec}$ ;  $T_P \leq 230\text{°C}$  for  $< 30\text{sec}$ ; Ramp-up/down speed shall be  $< 5\text{°C/sec}$ .

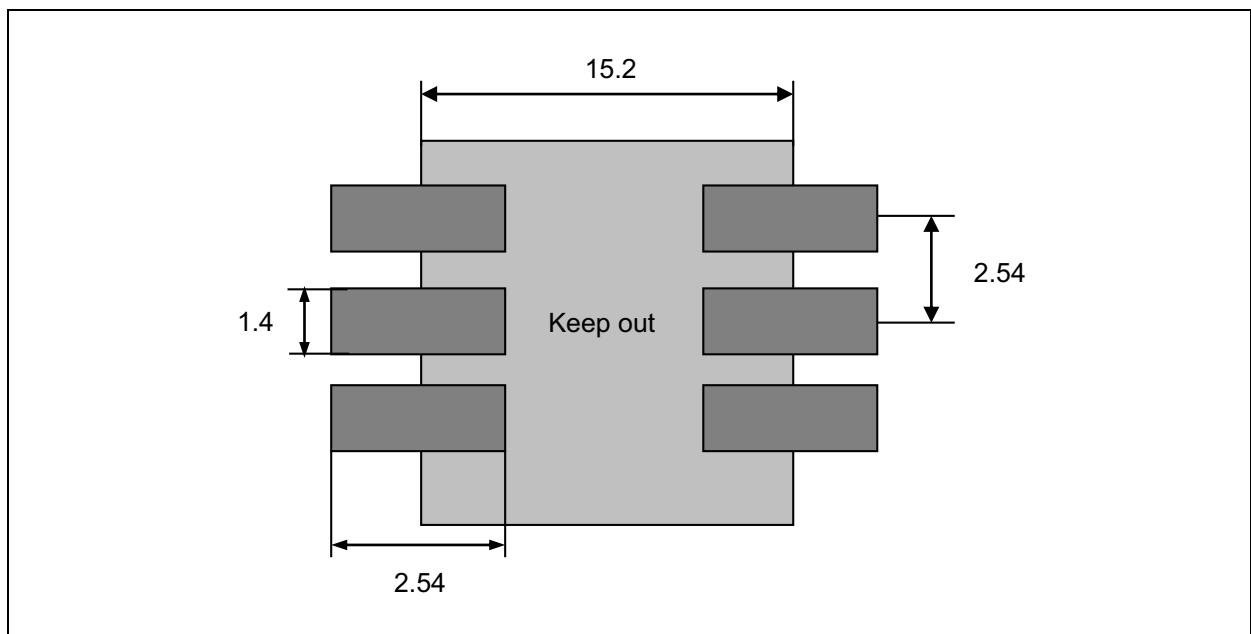
## Typical Application

**Figure 21:**  
Simple Microcontroller Application



## Recommended Footprint

**Figure 22:**  
Recommended Footprint (standard)

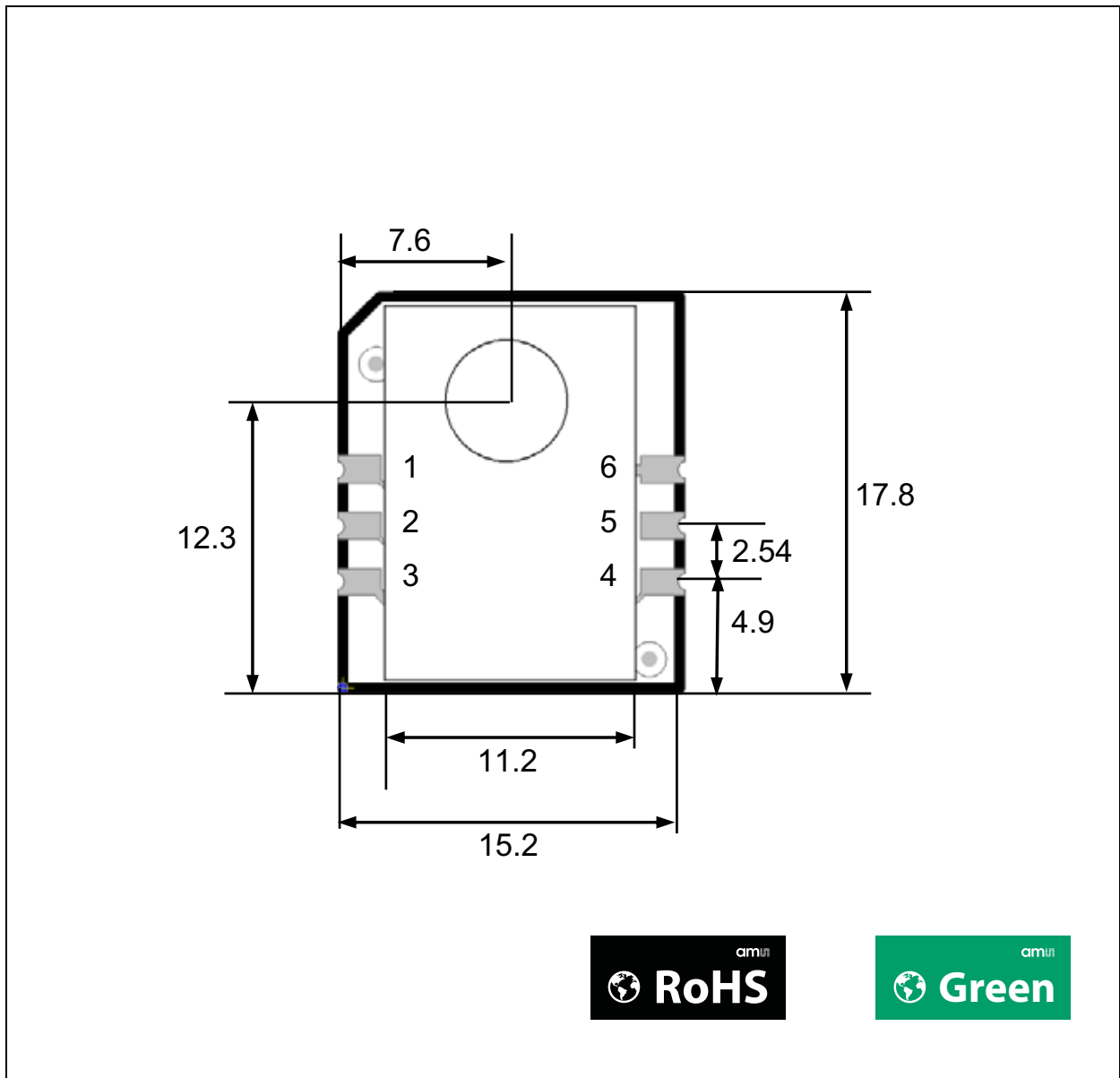


**Note(s) and/or Footnote(s):**

1. Dimensions in mm.

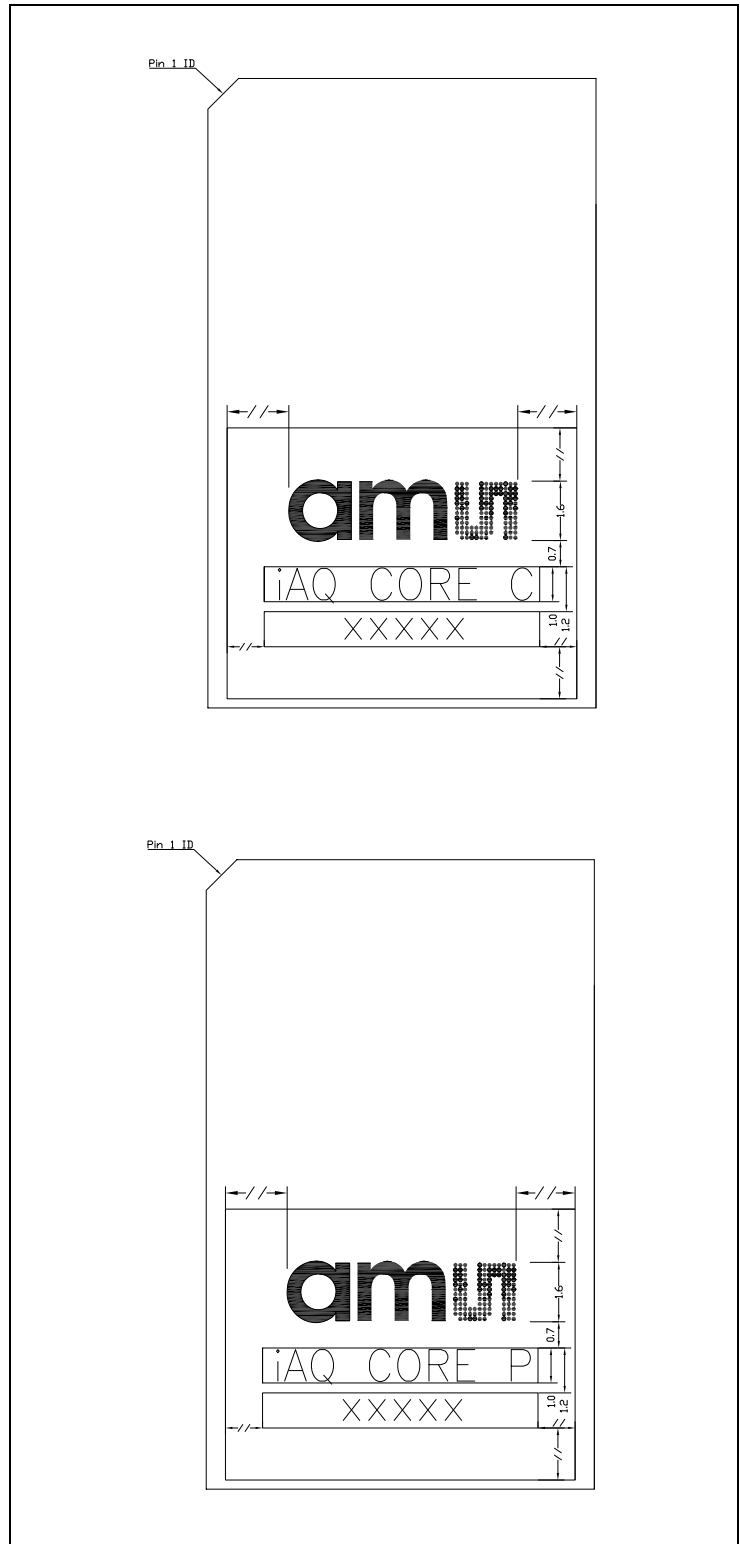
**Mechanical Information**

**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)

Buy our products or get free samples online at:

[www.ams.com/ICdirect](http://www.ams.com/ICdirect)

Technical Support is available at:

[www.ams.com/Technical-Support](http://www.ams.com/Technical-Support)

Provide feedback about this document at:

[www.ams.com/Document-Feedback](http://www.ams.com/Document-Feedback)

For further information and requests, e-mail us at:

[ams\\_sales@ams.com](mailto:ams_sales@ams.com)

For sales offices, distributors and representatives, please visit:

[www.ams.com/contact](http://www.ams.com/contact)

### Headquarters

ams AG  
Tobelbaderstrasse 30  
8141 Unterpremstaetten  
Austria, Europe

Tel: +43 (0) 3136 500 0

Website: [www.ams.com](http://www.ams.com)

## RoHS Compliant & ams Green Statement

**RoHS:** The term RoHS compliant means that ams AG products fully comply with current RoHS directives. Our semiconductor products do not contain any chemicals for all 6 substance categories, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, RoHS compliant products are suitable for use in specified lead-free processes.

**ams Green (RoHS compliant and no Sb/Br):** ams Green defines that in addition to RoHS compliance, our products are free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material).

**Important Information:** The information provided in this statement represents ams AG knowledge and belief as of the date that it is provided. ams AG bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. ams AG has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. ams AG and ams AG suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

## Copyrights & Disclaimer

Copyright ams AG, Tobelbader Strasse 30, 8141 Unterpremstaetten, Austria-Europe. Trademarks Registered. All rights reserved. The material herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner.

Devices sold by ams AG are covered by the warranty and patent indemnification provisions appearing in its General Terms of Trade. ams AG makes no warranty, express, statutory, implied, or by description regarding the information set forth herein. ams AG reserves the right to change specifications and prices at any time and without notice. Therefore, prior to designing this product into a system, it is necessary to check with ams AG for current information. This product is intended for use in commercial applications. Applications requiring extended temperature range, unusual environmental requirements, or high reliability applications, such as military, medical life-support or life-sustaining equipment are specifically not recommended without additional processing by ams AG for each application. This product is provided by ams AG "AS IS" and any express or implied warranties, including, but not limited to the implied warranties of merchantability and fitness for a particular purpose are disclaimed.

ams AG shall not be liable to recipient or any third party for any damages, including but not limited to personal injury, property damage, loss of profits, loss of use, interruption of business or indirect, special, incidental or consequential damages, of any kind, in connection with or arising out of the furnishing, performance or use of the technical data herein. No obligation or liability to recipient or any third party shall arise or flow out of ams AG rendering of technical or other services.

## Document Status

Document Status	Product Status	Definition
Product Preview	Pre-Development	Information in this datasheet is based on product ideas in the planning phase of development. All specifications are design goals without any warranty and are subject to change without notice
Preliminary Datasheet	Pre-Production	Information in this datasheet is based on products in the design, validation or qualification phase of development. The performance and parameters shown in this document are preliminary without any warranty and are subject to change without notice
Datasheet	Production	Information in this datasheet is based on products in ramp-up to full production or full production which conform to specifications in accordance with the terms of ams AG standard warranty as given in the General Terms of Trade
Datasheet (discontinued)	Discontinued	Information in this datasheet is based on products which conform to specifications in accordance with the terms of ams AG standard warranty as given in the General Terms of Trade, but these products have been superseded and should not be used for new designs

## 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 <b>ams</b> 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**

<b>1</b>	<b>General Description</b>
1	Key Benefits & Features
1	Applications
<b>2</b>	<b>Pin Assignments</b>
<b>3</b>	<b>Electrical Characteristics</b>
<b>4</b>	<b>Environmental Specifications</b>
<b>5</b>	<b>Detailed Description</b>
5	I <sup>2</sup> C Interface Description
5	Physical Interface
5	Clock Stretching
5	Address
6	Interface Protocol
10	Prediction
10	Status Flag
10	Resistance
11	TVOC
<b>12</b>	<b>Application Information</b>
12	Handling Instructions
12	Soldering Instructions
13	Typical Application
13	Recommended Footprint
<b>14</b>	<b>Mechanical Information</b>
<b>15</b>	<b>Ordering &amp; Contact Information</b>
<b>16</b>	<b>RoHS Compliant &amp; ams Green Statement</b>
<b>17</b>	<b>Copyrights &amp; Disclaimer</b>
<b>18</b>	<b>Document Status</b>
<b>19</b>	<b>Revision Information</b>