SENSIRION

Description of the SFA30 I²C Interface

Application Note for the SFA30 Formaldehyde Sensor Module

This application note describes the protocol to operate the SFA30 formaldehyde sensor module via the provided I²C interface.

Content

1 Introduction

This application note describes the protocol to operate the SFA30 formaldehyde sensor module via the provided I²C interface. Please refer to the sensor module datasheet for electrical specifications and further details.

IMPORTANT NOTE: The I²C interface is preliminary and should be used for R&D purposes only. Commands and parameters are subject to change without notice. The I²C interface has only been subject to limited testing.

General considerations for using the I²C interface: Remember that the I²C (IIC) protocol was originally designed as Inter-IC-protocol to connect two chips on a PCB. When the sensor is connected to the main PCB via a cable, particular attention must be paid to electromagnetic interference and crosstalk. Use as short as possible (< 10 cm) and/or well shielded connection cables. We recommend using the UART interface instead, whenever possible: it is more robust against electromagnetic interference, especially with long connection cables.

This document describes the command set for the sensor's I²C interface. For detailed information about the I²C protocol itself and its detailed implementation, please consult the document "NXP I2C-bus specification and user manual" (http://www.nxp.com/documents/user_manual/UM10204.pdf).
The physical interface consists of two bus lines, a data line (SDA) and a clock line (SCL) which need to be connected via pull-up resistors to the bus voltage of the system.

Important: For selecting the I²C interface, the interface select pin (SEL, pin 5) must be connected to GND before or when the sensor is powered-up.

2 Description of the SFA30 I²C Interface

2.1 I²C Address

The sensor's I²C address is 93 (decimal. Hex: 0x5D). The I²C header is formed by the I²C address followed by a read or write bit.

2.2 I²C Voltage Levels

The sensor's interface is compatible with 3.3 and 5.0 V I²C bus voltage levels depending on the supply voltage level.

2.3 I²C Protocol Speed

The sensor supports I²C standard mode, with a maximum clock frequency of 100 kHz.

2.4 Checksum Calculation

Data is transferred between the master and the sensor in multiples of 16-bit words, each followed by an 8-bit checksum to ensure communication reliability.

The checksum for each 2-byte data word is calculated as follows:

Property	Value
Name	CRC-8
Protected Data	read and/or write data
Width	8 bit
Polynomial	0x31 (x^8 + x^5 + x^4 + 1)
Initialization	0xFF
Reflect Input	false
Reflect Output	false
Final XOR	0x00
Example	CRC(0xBEEF) = 0x92

```
uint8_t CalcCrc(uint8_t data[2]) {
  uint8_t crc = 0xFF;
  for(int i = 0; i < 2; i++) {
    crc ^= data[i];
    for(uint8_t bit = 8; bit > 0; --bit) {
      if(crc & 0x80) {
        crc = (crc << 1) ^ 0x31u;
      } else {
        crc = (crc << 1);
      }
    }
  }
  return crc;
}
```

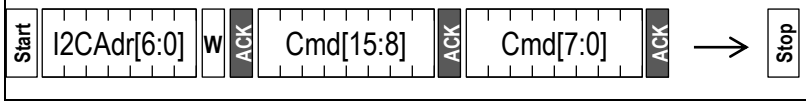
Note: Checksums are used only for the 2-byte data packets. The command code itself already contains a 3-bit CRC and therefore no checksum must be appended to it.

2.5 I²C Sequences

2.4.1 Execute Command

The sensor is controlled via 16-bit commands. The 16-bit commands themselves already contain a check-sum.

I²C master sends the write header and writes a 16 bit command

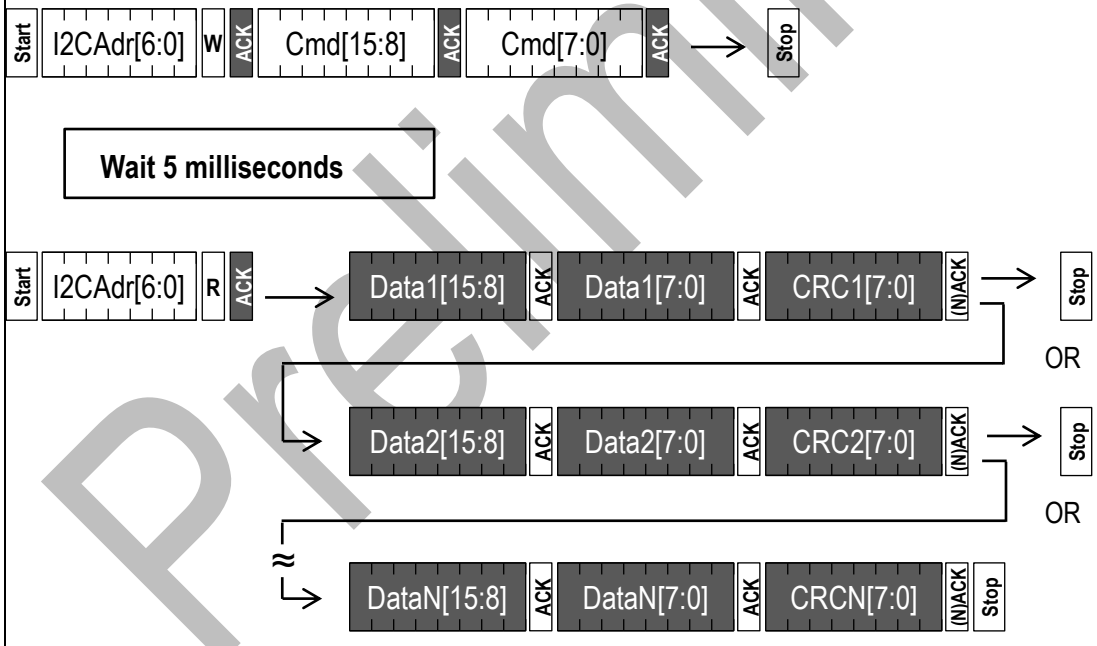


Dark areas indicate that the sensor controls the SDA (Data) line

2.4.2 Request Data

Note: A wait time between the write-command and the I²C read sequence is needed for the sensor to populate the I²C read buffer when requesting information from the sensor (read measured values or get device information). A wait time of 5 milliseconds is recommended and contains sufficient margin.

I²C master sends the write header and 16 bit command, then waits and then sends the read header and receives multiple 16bit words with CRC byte.



Dark areas indicate that the sensor controls the SDA (Data) line.

2.6 I²C Commands

The command set consists of the following commands:

- Start continuous measurement
- Stop continuous measurement
- Read measured values
- Get device marking
- Sensor reset

2.6.1 Start continuous measurement

Starts the continuous measurement.

After power up, the module is in Idle-Mode. Before any measurement values can be read, the Measurement-Mode needs to be started using this command.

Command	Command code (Hex)	Description
Start continuous measurement	0x00 06	This command starts the continuous measurement mode

2.6.2 Stop Continuous Measurement

The continuous measurement can be stopped using the following command.

Command	Command code (Hex)	Description
Stop continuous measurement	0x01 04	This command stops the continuous measurement mode.

2.6.3 Read Measured Values

The sensor output can be read with the following command:

Command	Command code (Hex)	Description
Read measured values	0x03 27	This command reads the measured values from the sensor. The sensor returns 3 x (2 bytes + CRC)

Byte number		Description	Value
0 … 2	0, 1	two bytes of value 0	int16 signed integer with scale factor 5 $(ppb)^{-1}$: Formaldehyde concentration in ppb = I16 output / 5.0
	2	CRC for bytes 0, 1	
3 … 5	3, 4	two bytes of value 1	int16 signed integer with scale factor 100 $(\%RH)^{-1}$: Relative humidity in % RH = I16 output / 100.0
	5	CRC for bytes 3, 4	
6 … 8	6, 7	two bytes of value 2	int16 signed integer with scale factor 200 $(°C)^{-1}$: Temperature in °C = I16 output / 200.0
	8	CRC for bytes 6, 7	

2.6.4 Get Device Marking

To identify individual sensors, the device marking string (as printed on the sensor as 2D bar code) can be read with the following command:

Command	Command code (Hex)	Description
Read device marking	0xD0 60	Read the device marking string from the device.

The device marking string is returned as ASCII formatted C-string including terminating Null character. Any following bytes are padded with Null characters, the total number of transmitted bytes is 48, i.e. 32 ASCII characters with corresponding checksums.

Byte number	Description	Value
0	ASCII character 0	
1	ASCII character 1	
2	CRC for bytes 0, 1	
…	…	
45	ASCII character 30	
46	ASCII character 31	
47	CRC for bytes 45, 46	

2.6.5 Sensor Reset

A soft-reset of the sensor can be performed with the following command. This brings the sensor into the same state as after power-up.

Command	Command code (Hex)	Description
Sensor Reset	0xD3 04	This command restarts the sensor

3 Application Circuit

A typical I²C application circuit is shown in Figure 1. Both SCL and SDA lines are open drain I/Os. They must be connected to external pull-up resistors (*e.g.*, R_p = 10 kΩ). Important notice: to correctly select I²C as interface, the interface select pin (SEL) must be pulled to GND before or at the same time the sensor is powered up.

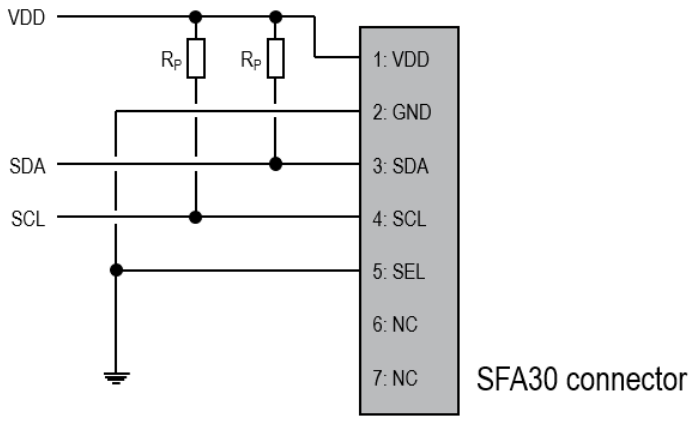


Figure 1 Typical I²C application circuit to connect the SFA30 sensor module.

4 Important Notices

Warning, Personal Injury

Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. Do not use this product for applications other than its intended and authorized use. Before installing, handling, using or servicing this product, please consult the data sheet and application notes. Failure to comply with these instructions could result in death or serious injury.

If the Buyer shall purchase or use SENSIRION products for any unintended or unauthorized application, Buyer shall defend, indemnify and hold harmless SENSIRION and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if SENSIRION shall be allegedly negligent with respect to the design or the manufacture of the product.

ESD Precautions
The inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation, take customary and statutory ESD precautions when handling this product.
See application note "ESD, Latchup and EMC" for more information.

Warranty
SENSIRION warrants solely to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product shall be of the quality, material and workmanship defined in SENSIRION's published specifications of the product. Within such period, if proven to be defective, SENSIRION shall repair and/or replace this product, in SENSIRION's discretion, free of charge to the Buyer, provided that:

- notice in writing describing the defects shall be given to SENSIRION within fourteen (14) days after their appearance;
- such defects shall be found, to SENSIRION's reasonable satisfaction, to have arisen from SENSIRION's faulty design, material, or workmanship;
- the defective product shall be returned to SENSIRION's factory at the Buyer's expense; and
- the warranty period for any repaired or replaced product shall be limited to the unexpired portion of the original period.

This warranty does not apply to any equipment which has not been installed and used within the specifications recommended by SENSIRION for the intended and proper use of the equipment. EXCEPT FOR THE WARRANTIES EXPRESSLY SET FORTH HEREIN, SENSIRION MAKES NO WARRANTIES, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THE PRODUCT. ANY AND ALL WARRANTIES, INCLUDING WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY EXCLUDED AND DECLINED.
SENSIRION is only liable for defects of this product arising under the conditions of operation provided for in the data sheet and proper use of the goods. SENSIRION explicitly disclaims all warranties, express or implied, for any period during which the goods are operated or stored not in accordance with the technical specifications.
SENSIRION does not assume any liability arising out of any application or use of any product or circuit and specifically disclaims any and all liability, including without limitation consequential or incidental damages. All operating parameters, including without limitation recommended parameters, must be validated for each customer's applications by customer's technical experts. Recommended parameters can and do vary in different applications.
SENSIRION reserves the right, without further notice, (i) to change the product specifications and/or the information in this document and (ii) to improve reliability, functions and design of this product.

Headquarters and Subsidiaries

Sensirion AG
Laubisruetistr. 50
CH-8712 Staefa ZH
Switzerland

phone: +41 44 306 40 00
fax: +41 44 306 40 30
info@sensirion.com
www.sensirion.com

Sensirion Taiwan Co. Ltd
phone: +886 3 5506701
info@sensirion.com
www.sensirion.com

Sensirion Inc., USA
phone: +1 312 690 5858
info-us@sensirion.com
www.sensirion.com

Sensirion Japan Co. Ltd.
phone: +81 3 3444 4940
info-jp@sensirion.com
www.sensirion.co.jp

Sensirion Korea Co. Ltd.
phone: +82 31 337 7700~3
info-kr@sensirion.com
www.sensirion.co.kr

Sensirion China Co. Ltd.
phone: +86 755 8252 1501
info-cn@sensirion.com
www.sensirion.com.cn

To find your local representative, please visit www.sensirion.com/distributors