Interface Description Sensirion SCD30 Sensor Module

CO_2, humidity, and temperature sensor

- NDIR CO_2 sensor technology
- Integrated temperature and humidity sensor
- Best performance-to-price ratio
- Dual-channel detection for superior stability
- Small form factor: 35 mm x 23 mm x 7 mm
- Accuracy CO_2 sensor: ± (30 ppm + 3%)
- Fully calibrated with digital interface UART or I^2C

Contents

1 Digital interface description

The SCD30 digital interface is compatible with the I2C protocol and the Modbus protocol. For selecting Modbus protocol, the SEL pin needs to be pulled to VDD Voltage during power-up of the SCD30 sensor module. It is not possible to switch the communication protocol during operation. Please refer to datasheet.

1.1 I2C Protocol

Maximal I2C speed is 100 kHz and the **master has to support clock stretching**. Sensirion recommends to operate the SCD30 at a baud rate of 50 kHz or smaller. Clock stretching period in write- and read-frames is 30 ms, however, due to internal calibration processes a maximal clock stretching of 150 ms may occur once per day. For detailed information to the I2C protocol, refer to NXP I2C-bus specification[1]. SCD30 does not support repeated start condition. Clock stretching is necessary to start the microcontroller and might occur before every ACK. I2C master clock stretching needs to be implemented according to the NXP specification. The boot-up time is < 2 s.

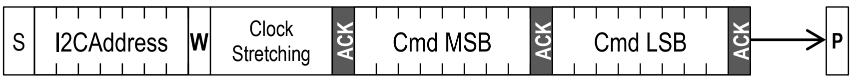
1.1.1 I2C Address

After power-up of the sensor, the I2C address of the module is set to the address 0x61.

1.1.2 I2C Sequence

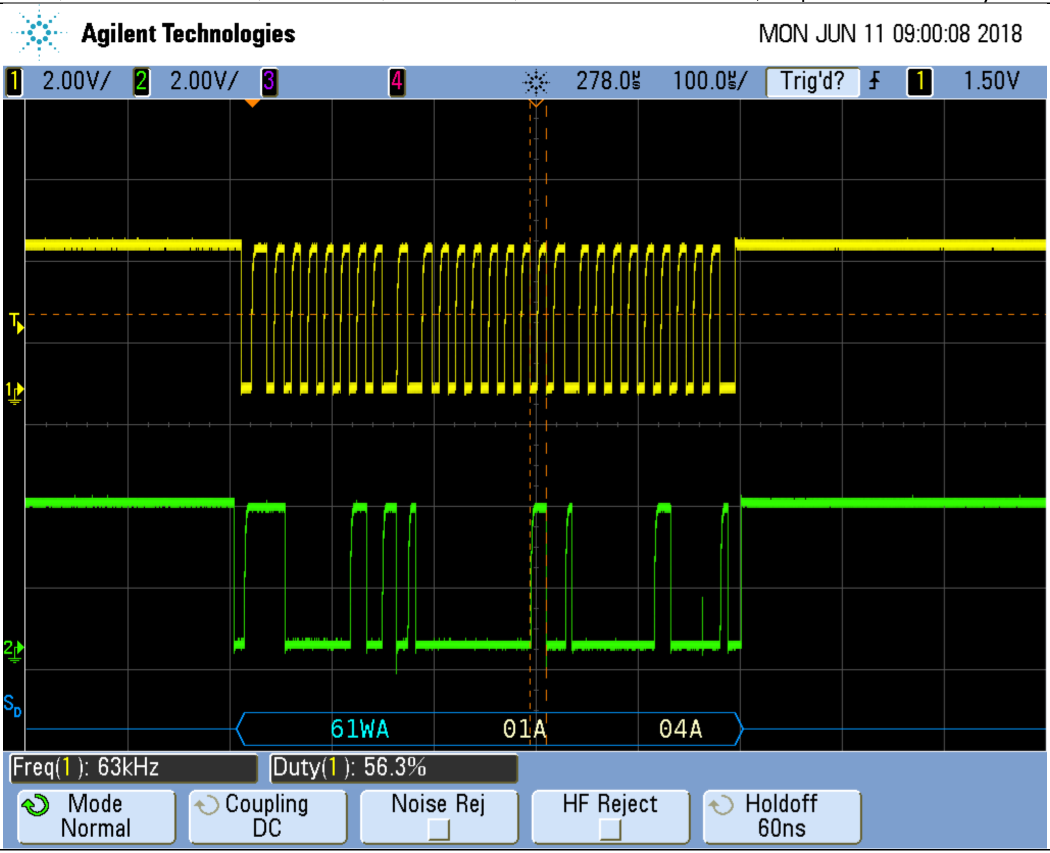
The commands issued by the I2C master are 16 bit with an optional parameter. Data sent to the master is protected by a CRC. This also applies to data arguments sent to the sensor, please see chapter 1.1.3 for CRC checksum calculation. 2 byte data sent from or received by the sensor is always succeeded with an 8 bit CRC. Examples are shown below.

I2C write 16bit command without arguments



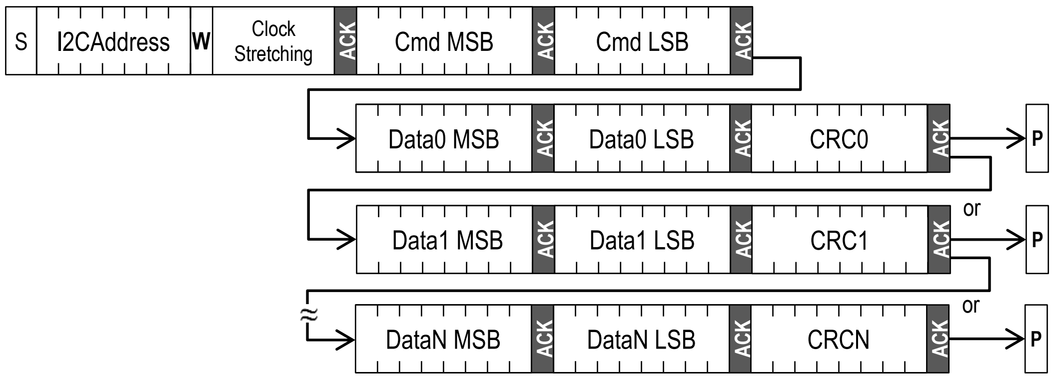
Example: Stop measurements 0x0104

START 0xC2 0x01 0x04 **STOP**
(Red: Write Header; Blue: Read Header; Black: Data; Green: CRC; Start Condition: **START;** Stop Condition: **STOP)**

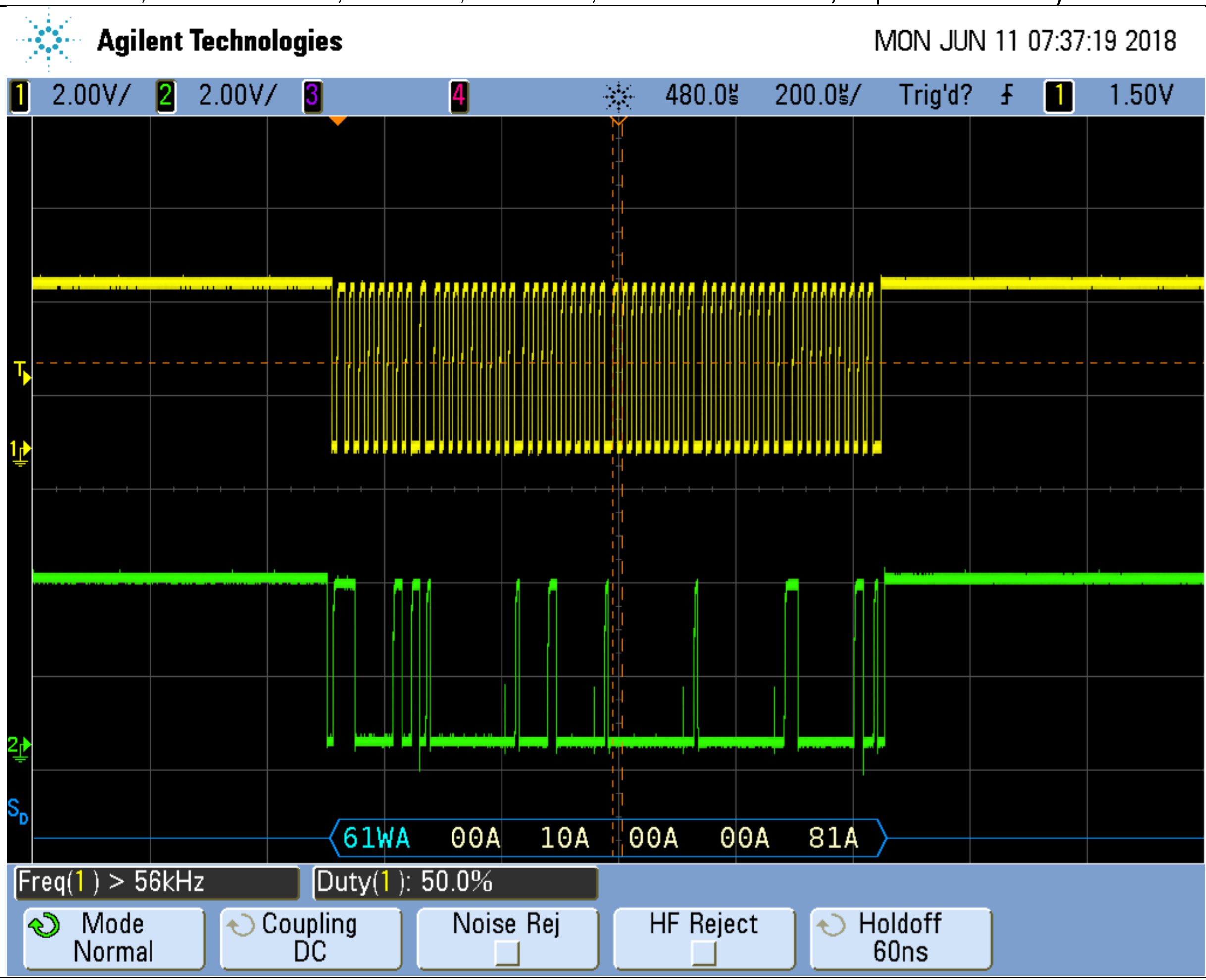


[1] http://www.nxp.com/documents/user_manual/UM10204.pdf

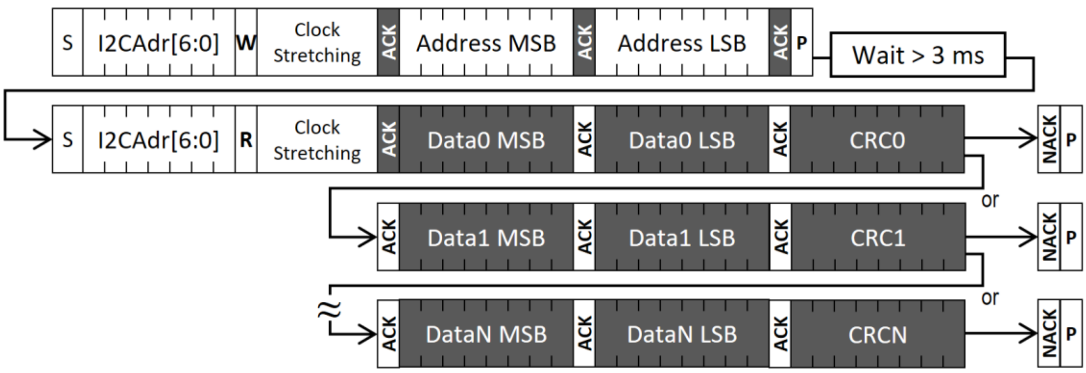
I2C write 16bit command with arguments



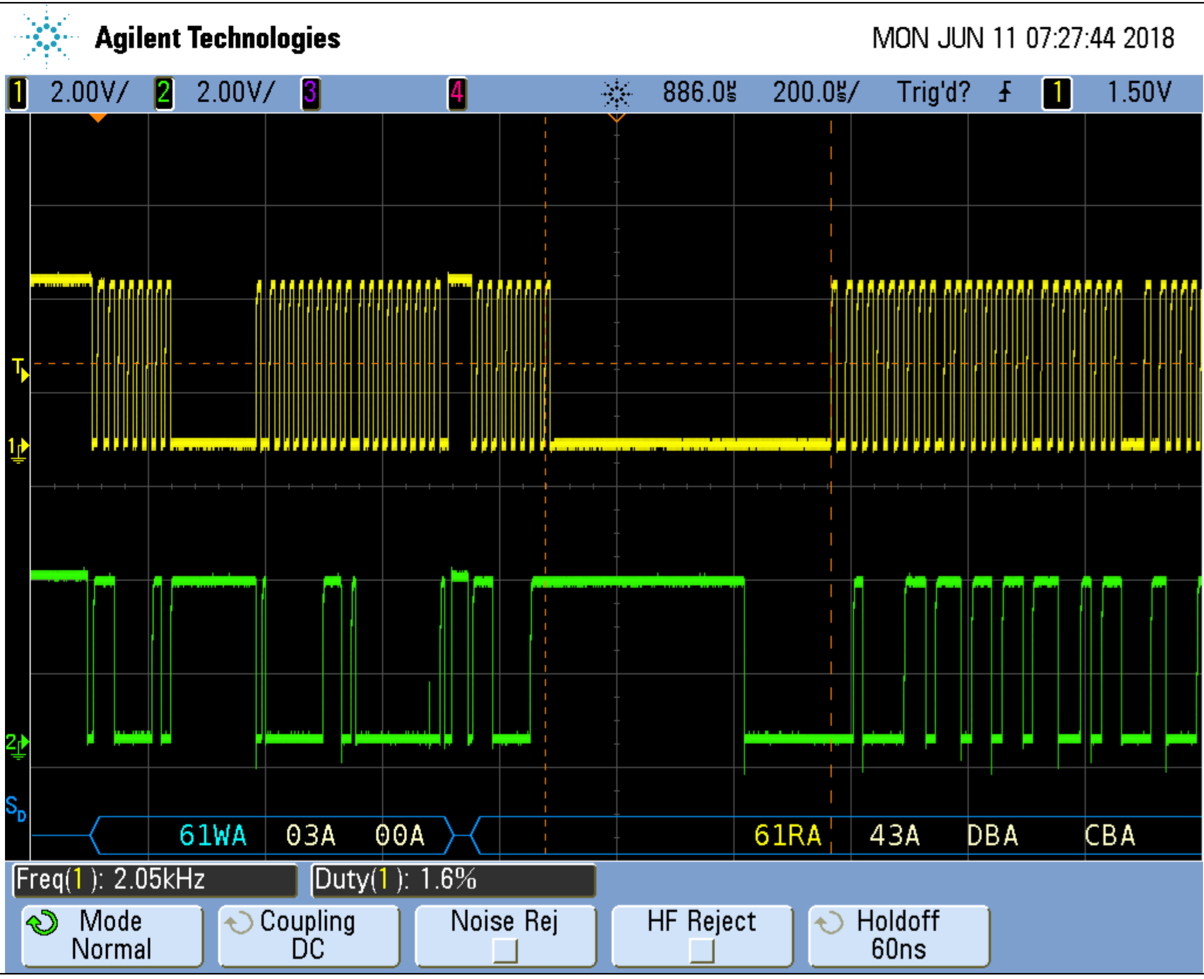
Example: Trigger continuous measurement (Pressure = 0mBar)
START 0xC2 0x00 0x10 0x00 0x00 0x81 **STOP**
(Red: Write Header; Blue: Read Header; Black: Data; Green: CRC; Start Condition: **START;** Stop Condition: **STOP**)



I2C read multiple 16bit words



Example: Read Measurement (example with 439 PPM, 48.8% RH, 27.2 °C)
START 0xC2 0x03 0x00 **STOP** **START** 0xC3 0x43 0xDB 0xCB 0x8C 0x2E 0x8F 0x41 0xD9 0x70 0xE7 0xFF 0xF5 0x42 0x43 0xBF 0x3A 0x1B 0x74 **STOP**
(Red: Write Header; Blue: Read Header; Black: Data; Green: CRC; Start Condition: **START**; Stop Condition: **STOP**)



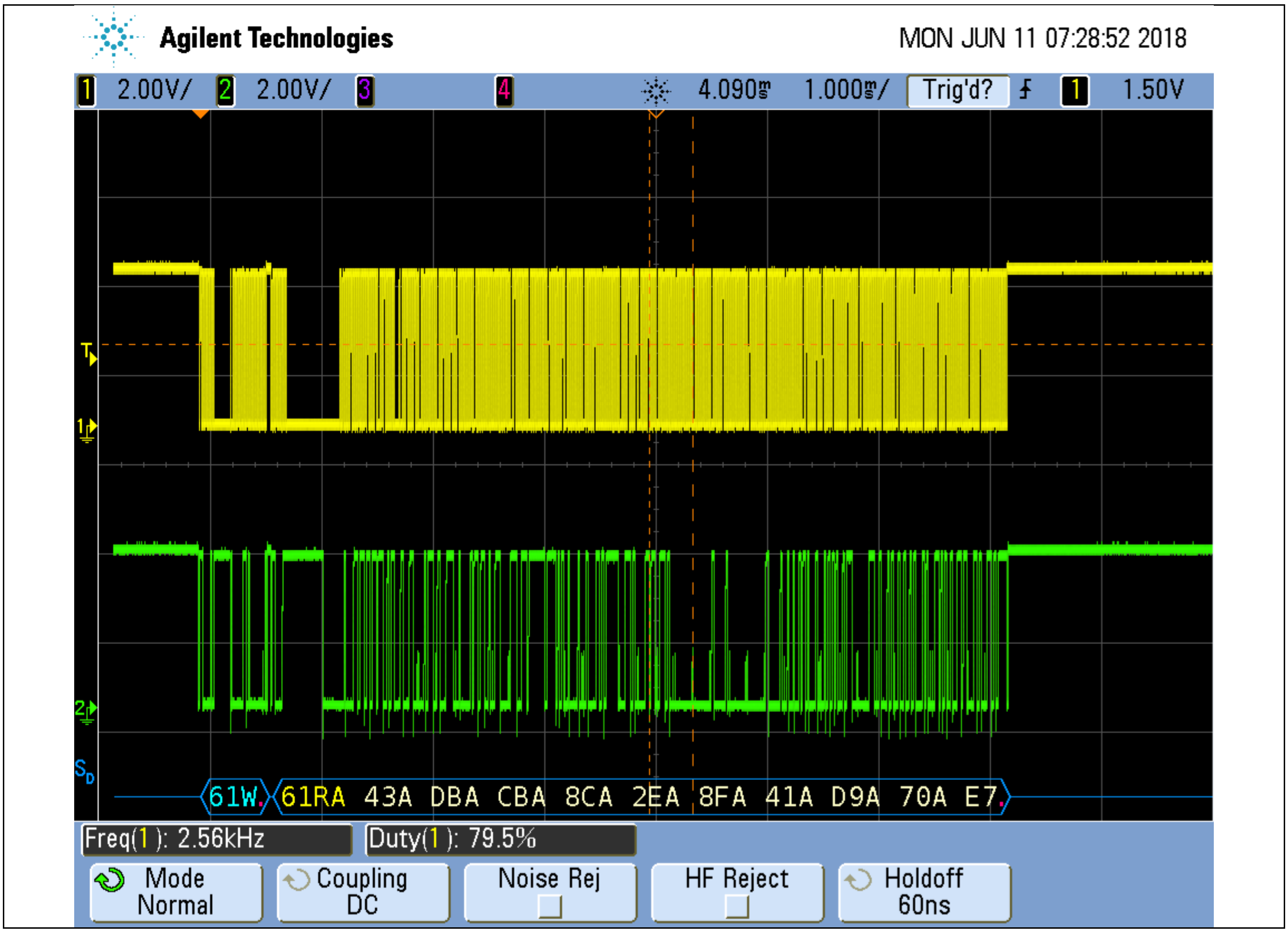


Table 1 I2C write and read communication frames. SDA is controlled by the I2C master in clear blocks and by the sensor in dark blocks.

1.1.3 I²C Checksum calculation

The checksum byte for I²C communication is generated by a CRC algorithm with the following properties:

Preceding Command	Value
Name	CRC-8
Protected Data	read data
Width	8 bits
Polynomial	0x31 ($x^8 + x^5 + x^4 + 1$)
Initialization	0xFF
Reflect Input	false
Reflect Output	false
Final XOR	0x00
Example	CRC(0xBEEF) = 0x92

1.2 Modbus protocol

For selecting Modbus protocol, the SEL pin needs to be pulled to VDD Voltage. Please refer to datasheet.

The supported baud rate is 19200 Baud with 8 Data bits, 1 Start bit and 1 Stop bit, no Parity bit.

More details on the Modbus protocol can be found here:

Description	Link
General introduction	http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf
Modbus frame generator	http://modbus.rapidscada.net/
Modbus CRC generator	https://www.lammertbies.nl/comm/info/crc-calculation.html

1.2.1 Modbus address

Modbus address is 0x61.

1.2.2 Modbus function codes

Available function codes are

Function code	Description
3	Read holding registers
4	Read input registers
6	Write single holding register

1.3 PWM output

The SCD30 features the possibility to read out the CO_2 concentration via the PWM protocol. During operation, the SCD30 must be connected via the VDD-pin (supply voltage), the GND-pin (ground) and the PWM-pin. Please refer to the data sheet for pin assignment.

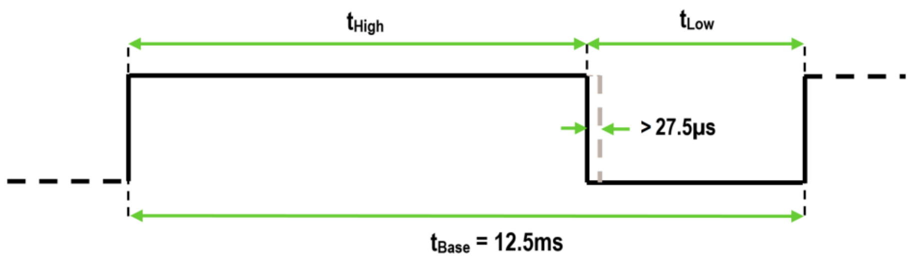
1.3.1 Sensor configuration and measurement start

The SCD30 must be configured via the I2C or the Modbus protocol according to this interface description. This can either be done by the host system or alternatively in the assembly line with temporary connector pins. Sensor output is only provided after sending the start measurement command to the SCD30.

1.3.2 Technical specification PWM output

Below, the technical specifications of the PWM protocol are provided. The output signal can be converted by either directly measuring the pulse-duration or alternatively by employing a low-pass filter and measuring the output voltage.

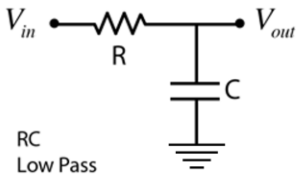
Base Frequency	80 Hz
DutyCycle	linear from 0 to 100% (0 ppm to 5000 ppm)
Minimal Stepsize of DutyCycle	11 ppm
Output	3.0V Push/Pull Driver
Signal Conversion	CO_2 concentration [ppm] = $t_{high}/t_{base} * 5'000$



1.3.3 Low pass filter parametrization

Typically, the PWM signal is converted to a voltage signal via a low pass filter. Upon conversion of the PWM signal to a voltage signal the CO2 concentration is defined as follows: CO_2 concentration [ppm] = $V_{measure}/3 * 5'000$.

Since there's an inherent trade-off between settling time, the ripple and the current consumption, the ideal parameterization of the low pass filter differs depending on the application. Nevertheless, an example parameter set for a first order low-pass is provided below:



R = 470 kOhm
C = 220nF

Cut Off Frequenz: 1.53 Hz
Ripple Voltage (Peak to Peak): 90mV (3%)
Maximal Settling Time: 0.23 s

1.4 Sensor commands

The command set of the SCD30 is defined as follows. All commands are available via Modbus and I2C.

- Trigger continuous measurement with optional ambient pressure compensation
- Stop continuous measurement
- Set measurement interval
- Get data ready status
- Read measurement
- (De-)Activate continuous calculation of reference value for automatic self-calibration (ASC)
- Set external reference value for forced recalibration (FRC)
- Set temperature offset for onboard RH/T sensor
- Altitude compensation
- Read firmware version
- Soft reset

1.4.1 Trigger continuous measurement with optional ambient pressure compensation

Starts continuous measurement of the SCD30 to measure CO_2 concentration, humidity and temperature. Measurement data which is not read from the sensor will be overwritten. The measurement interval is adjustable via the command documented in chapter 1.4.3, initial measurement rate is 2s.

Continuous measurement status is saved in non-volatile memory. When the sensor is powered down while continuous measurement mode is active SCD30 will measure continuously after repowering without sending the measurement command.

The CO_2 measurement value can be compensated for ambient pressure by feeding the pressure value in mBar to the sensor. Setting the ambient pressure will overwrite previous settings of altitude compensation. Setting the argument to zero will deactivate the ambient pressure compensation (default ambient pressure = 1013.25 mBar). For setting a new ambient pressure when continuous measurement is running the whole command has to be written to SCD30.

<table>
<tr><th>Protocol</th><th colspan="3">Command (hex)</th><th>Argument</th><th>Description</th></tr>
<tr><td>I2C</td><td colspan="3">0x0010 argument</td><td rowspan="3">Format: uint16 Available range:
0 & [700 … 1400]. Pressure in mBar.</td><td rowspan="3">Triggers continuous measurement. Ambient pressure is compensated by setting argument. argument = 0 deactivates pressure compensation.</td></tr>
<tr><th>Protocol</th><th>Function Code</th><th>Address</th><th>Data to write</th></tr>
<tr><td>Modbus</td><td>6</td><td>0x0036</td><td>0x0000 or pressure in mBar</td></tr>
</table>

Full sequence examples:

<table>
<tr><th>Protocol</th><th>Data to write / read</th><th>Description</th></tr>
<tr><td>I2C</td><td>
<table>
<tr><td>Start</td><td>Write Header</td><td>Cmd MSB</td><td>CMS LSB</td><td>Pressure MSB</td><td>Pressure LSB</td><td>CRC</td><td>Stop</td></tr>
<tr><td>Start</td><td>0xC2</td><td>0x00</td><td>0x10</td><td>0x00</td><td>0x00</td><td>0x81</td><td>Stop</td></tr>
</table>
</td><td rowspan="2">Start continuous measurement without ambient pressure compensation</td></tr>
<tr><td>Modbus</td><td>
Request:
<table>
<tr><td>Slave Address</td><td>Function Code</td><td>Address MSB</td><td>Address LSB</td><td>Content MSB</td><td>Content LSB</td><td>CRC LSB</td><td>CRC MSB</td></tr>
<tr><td>0x61</td><td>0x06</td><td>0x00</td><td>0x36</td><td>0x00</td><td>0x00</td><td>0x60</td><td>0x64</td></tr>
</table>
Response:
<table>
<tr><td>Slave Address</td><td>Function Code</td><td>Address MSB</td><td>Address LSB</td><td>Content MSB</td><td>Content LSB</td><td>CRC LSB</td><td>CRC MSB</td></tr>
<tr><td>0x61</td><td>0x06</td><td>0x00</td><td>0x36</td><td>0x00</td><td>0x00</td><td>0x60</td><td>0x64</td></tr>
</table>
</td></tr>
</table>

1.4.2 Stop continuous measurement

Stops the continuous measurement of the SCD30.

Protocol	Command (hex)	Description
I2C	0x0104, no argument	Stops continuous measurement.

Protocol	Function Code	Address	Data to write	Description
Modbus	6	0x0037	0x0001	Stops continuous measurement.

Full sequence examples:

Protocol	Data to write	Description
I2C	see I2C sequence below	Stops continuous measurement.
Modbus	see Modbus request/response below	Stops continuous measurement.

I2C:

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0x01	0x04	Stop

Modbus

Request:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x37	0x00	0x01	0xF0	0x64

Response:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x37	0x00	0x01	0xF0	0x64

1.4.3 Set measurement interval

Sets the interval used by the SCD30 sensor to measure in continuous measurement mode (see chapter 1.4.1). Initial value is 2 s. The chosen measurement interval is saved in non-volatile memory and thus is not reset to its initial value after power up.

Protocol	Command (hex)	Argument	Description
I2C	0x4600 *argument*	Format: unit16 Interval in seconds. Available range: [2 … 1800] given in 2 byte in the order MSB, LSB.	Sets the interval for continuous measurement mode. Standard measurement interval is 2.

Protocol	Function Code	Address	Data to write	Argument	Description
Modbus	6	0x0025	*argument*	Format: unit16 Interval in seconds. Available range: [2 … 1800] given in 2 byte in the order MSB, LSB.	Sets the interval for continuous measurement mode. Standard measurement interval is 2.

Full sequence examples:

Protocol	Data to write	Description
I2C	see sequences below	Set measurement interval to 2s

Set measurement interval

Start	Write Header	Cmd MSB	Cmd LSB	Interval MSB	Interval LSB	CRC	Stop
Start	0xC2	0x46	0x00	0x00	0x02	0xE3	Stop

Get measurement interval

Write:

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0x46	0x00	Stop

Read:

Start	Read Header	Interv al MSB	Inter val LSB	CRC	Stop
Start	0xC3	0x00	0x02	0xE3	Stop

Modbus

Set measurement interval

Request:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x25	0x00	0x02	0x10	0x60

Response:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x25	0x00	0x02	0x10	0x60

Get measurement interval

Request

Slave Address	Function Code	Address MSB	Address LSB	No. of registers MSB	No. of registers LSB	CRC LSB	CRC MSB
0x61	0x03	0x00	0x25	0x00	0x01	0x9C	0x61

Response:

Slave Address	Function Code	No. of Bytes	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x03	0x02	0x00	0x02	0xB9	0x8D

1.4.4 Get data ready status

Data ready command is used to determine if a measurement can be read from the sensor's buffer. Whenever there is a measurement available from the internal buffer this command returns 1 and 0 otherwise. As soon as the measurement has been read by the return value changes to 0. Note that the read header should be send with a delay of > 3ms following the write sequence.

It is recommended to use data ready status byte before readout of the measurement values.

Protocol	Address (hex)	Description
I2C	0x0202, no argument needed	Data ready status. Status equals "1" when a measurement is available to be read from the sensor.

Protocol	Function Code	Address	Description
Modbus	3	0x0027	Data ready status. Status equals "1" when a measurement is available to be read from the sensor.

Full sequence examples:

Protocol: I2C — Description: Reading Data Ready status (returning 1)

Write:

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0x02	0x02	Stop

Read:

Start	Read Header	Data Ready MSB	Data Ready LSB	CRC	Stop
Start	0xC3	0x00	0x01	0xB0	Stop

Protocol: Modbus — Description: Reading Data Ready status (returning 1)

Request

Slave Address	Function Code	Address MSB	Address LSB	No. of registers MSB	No. of registers LSB	CRC LSB	CRC MSB
0x61	0x03	0x00	0x27	0x00	0x01	0x3D	0xA1

Response:

Slave Address	Function Code	No. of Bytes	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x03	0x02	0x00	0x01	0xF9	0x8C

I2C: SDA is controlled by the I2C master in clear blocks and by the sensor in dark blocks.

1.4.5 Read measurement

When new measurement data is available it can be read out with the following command. Note that the read header should be send with a delay of > 3ms following the write sequence. Make sure that the measurement is completed by reading the data ready status bit before read out.

Protocol	Address (hex)		Description
I2C	0x0300, no argument needed		Reads a single measurement of CO_2 concentration.
Protocol	Function Code	Address	
Modbus	3	0x0028 - 0x002D	

Full sequence examples:

Protocol	Data to write/read	Description
I2C	(see I2C sequence below)	Example with sensor returning: CO_2 Concentration = 439 PPM Humidity = 48.8 % Temperature = 27.2 °C
Modbus	(see Modbus sequence below)	

I2C

Write:

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0x03	0x00	Stop

Read:

Start	Read Header	CO2 MMSB	CO2 MLSB	CRC	CO2 LMSB	CO2 LLSB	CRC
Start	0xC3	0x43	0xDB	0xCB	0x8C	0x2E	0x8F

T MMSB	T MLSB	CRC	T LMSB	T LLSB	CRC
0x41	0xD9	0x70	0xE7	0xFF	0xF5

RH MMSB	RH MLSB	CRC	RH LMSB	RH LLSB	CRC	Stop
0x42	0x43	0xBF	0x3A	0x1B	0x74	Stop

Modbus

Request

Slave Address	Function Code	Address MSB	Address LSB	No. of register s MSB	No. of register s LSB	CRC LSB	CRC MSB
0x61	0x03	0x00	0x28	0x00	0x06	0x4C	0x60

Response:

Slave Address	Function Code	No. of Bytes	CO2 MMSB	CO2 MLSB	CO2 LMSB	CO2 LLSB
0x61	0x03	0x0C	0x43	0xDB	0x8C	0x2E

T MMSB	T MLSB	T LMSB	T LLSB	RH MMS B	RH MLSB	RH LMSB	RH LLSB
0x41	0xD9	0xE7	0xFF	0x42	0x43	0x3A	0x1B

CRC LSB	CRC MSB
0x50	0x07

SDA is controlled by the I2C master in clear blocks and by the sensor in dark blocks.

I2C read-out stream:

Table 2 shows the data layout of the data read out from the sensor.

Using I2C for read-out the sensor will stream out the data in the given order.

Preceding Command	Consecutive read	Description
Read measurement	Byte1: CO_2 concentration MMSB Byte2: CO_2 concentration MLSB Byte3: CRC Byte4: CO_2 concentration LMSB Byte5: CO_2 concentration LLSB Byte6: CRC Byte7: Temperature MMSB Byte8: Temperature MLSB Byte9: CRC Byte10: Temperature LMSB Byte11: Temperature LLSB Byte12: CRC Byte13: Humidity MMSB Byte14: Humidity MLSB Byte15: CRC Byte16: Humidity LMSB Byte17: Humidity LLSB Byte18: CRC	Data read-out table for I2C communication. Measurement of CO_2 concentration, humidity and temperature has to be finished before read-out.

Table 2: I2C data read-out table. Read-out of measurement data can be aborted by sending a NACK followed by a stop condition after any data byte.

Example: The CO_2 concentration 400 ppm corresponds to 0x43c80000 in Big-Endian notation.

Modbus read-out stream:

Using Modbus for read-out the sensor will stream out the data in the given order.

Table 3: Modbus data read-out table.

Preceding Command	Consecutive read	Description
Read measurement	Word0: CO_2 MSW Word1: CO_2 LSW Word2: Temperature MSW Word3: Temperature LSW Word4: Humidity MSW Word5: Humidity LSW	Data read-out table for Modbus communication. Measurement of CO_2 concentration, humidity and temperature has to be finished before read-out.

Example: The CO_2 concentration 400 ppm corresponds to 0x43c80000 in Big-Endian notation.

1.4.6 (De-)Activate Automatic Self-Calibration (ASC)

Continuous automatic self-calibration can be (de-)activated with the following command. When activated for the first time a period of minimum 7 days is needed so that the algorithm can find its initial parameter set for ASC. The sensor has to be exposed to fresh air for at least 1 hour every day. Also during that period, the sensor may not be disconnected from the power supply, otherwise the procedure to find calibration parameters is aborted and has to be restarted from the beginning. The successfully calculated parameters are stored in non-volatile memory of the SCD30 having the effect that after a restart the previously found parameters for ASC are still present. Note that the most recently found self-calibration parameters will be actively used for self-calibration disregarding the status of this feature. Finding a new parameter set by the here described method will always overwrite the settings from external recalibration (see chapter 0) and vice-versa. The feature is switched off by default.

To work properly SCD30 has to see fresh air on a regular basis. Optimal working conditions are given when the sensor sees fresh air for one hour every day so that ASC can constantly re-calibrate. ASC only works in continuous measurement mode.

ASC status is saved in non-volatile memory. When the sensor is powered down while ASC is activated SCD30 will continue with automatic self-calibration after repowering without sending the command.

Protocol	Command (hex)	Argument	Description
I2C	0x5306 *argument*	Format: uint16 "1": Activate continuous ASC "0": Deactivate continuous ASC	See notes above, feature is switched off by default.

Protocol	Function Code	Address	Data to write
Modbus	6	0x003A	*Argument*

Full sequence examples:

Protocol	Data to write	Description
I2C	See I2C sequences below	Example: deactivate ASC
Modbus	See Modbus sequences below	

I2C

Deactivate Automatic Self-Calibration

Start	Write Header	Cmd MSB	Cmd LSB	ASC MSB	ASC LSB	CRC	Stop
Start	0xC2	0x53	0x06	0x00	0x00	0x81	Stop

Get Automatic Self-Calibration Status

Write:

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0x53	0x06	Stop

Read:

Start	Read Header	ASC MSB	ASC LSB	CRC	Stop
Start	0xC3	0x00	0x00	0x81	Stop

Modbus

Deactivate Automatic Self-Calibration

Request:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x3A	0x00	0x00	0xA0	0x67

Response:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x3A	0x00	0x00	0xA0	0x67

Get Automatic Self-Calibration

Request

Slave Address	Function Code	Address MSB	Address LSB	No. of registers MSB	No. of registers LSB	CRC LSB	CRC MSB
0x61	0x03	0x00	0x3A	0x00	0x01	0xAD	0xA7

Response:

Slave Address	Function Code	No. of Bytes	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x03	0x02	0x00	0x00	0x38	0x4C

Set Forced Recalibration value (FRC)

Forced recalibration (FRC) is used to compensate for sensor drifts when a reference value of the CO_2 concentration in close proximity to the SCD30 is available. For best results, the sensor has to be run in a stable environment in continuous mode at a measurement rate of 2s for at least two minutes before applying the FRC command and sending the reference value. Setting a reference CO_2 concentration by the method described here will always supersede corrections from the ASC (see chapter 1.4.6) and vice-versa. The reference CO_2 concentration has to be within the range 400 ppm ≤ $c_{ref}(CO_2)$ ≤ 2000 ppm.

The FRC method imposes a permanent update of the CO_2 calibration curve which persists after repowering the sensor. The most recently used reference value is retained in volatile memory and can be read out with the command sequence given below. After repowering the sensor, the command will return the standard reference value of 400 ppm.

Protocol	Command (hex)	Argument	Description
I2C	0x5204 *argument*	Format: uint16 CO_2 concentration in ppm	See notes above.

Protocol	Function Code	Address	Data to write
Modbus	6	0x0039	*Argument*

Full sequence examples:

Protocol	Data to write	Description
I2C	(see I2C sequences below)	Example: Set FRC with argument 450 ppm
Modbus	(see Modbus sequences below)	

I2C

Set Forced Recalibration value

Start	Write Header	Cmd MSB	Cmd LSB	FRC MSB	FRC LSB	CRC	Stop
Start	0xC2	0x52	0x04	0x01	0xC2	0x50	Stop

Get Forced Recalibration value

Write:

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0x52	0x04	Stop

Read:

Start	Read Header	FRC MSB	FRC LSB	CRC	Stop
Start	0xC3	0x01	0xC2	0x50	Stop

Modbus

Set Forced Recalibration value

Request:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x39	0x01	0xC2	0xD0	0x66

Response:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x39	0x01	0xC2	0xD0	0x66

Get Forced Recalibration value

Request:

Slave Address	Function Code	Address MSB	Address LSB	No. of registers MSB	No. of registers LSB	CRC LSB	CRC MSB
0x61	0x03	0x00	0x39	0x00	0x01	0x5D	0xA7

Response:

Slave Address	Function Code	No. of Bytes	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x03	0x02	0x01	0xC2	0xB8	0x4D

1.4.7 Set Temperature Offset

The on-board RH/T sensor is influenced by thermal self-heating of SCD30 and other electrical components. Design-in alters the thermal properties of SCD30 such that temperature and humidity offsets may occur when operating the sensor in end-customer devices. Compensation of those effects is achievable by writing the temperature offset found in continuous operation of the device into the sensor.

Temperature offset value is saved in non-volatile memory. The last set value will be used for temperature offset compensation after repowering.

Protocol	Command (hex)	Argument	Description
I2C	0x5403 *argument*	Format: uint16 Temperature offset, unit [°C x 100], i.e. one tick corresponds to 0.01°C	See notes above.

Protocol	Function Code	Address	Data to write
Modbus	6	0x003B	*argument*

Full sequence examples:

Description: Example: Set temperature offset to 5 K

I2C

Set Temperature Offset Start	Write Header	Cmd MSB	Cmd LSB	SHT Offset MSB	SHT Offset LSB	CRC	Stop
Start	0xC2	0x54	0x03	0x01	0xF4	0x33	Stop

Get Temperature Offset
Write:

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0x54	0x03	Stop

Read:

Start	Read Header	SHT Offset MSB	SHT Offset LSB	CRC	Stop
Start	0xC3	0x01	0xF4	0x33	Stop

Modbus

Set Temperature Offset
Request:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x3B	0x01	0xF4	0xF1	0xB0

Response:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x3B	0x01	0xF4	0xF1	0xB0

Get Temperature Offset
Request:

Slave Address	Function Code	Address MSB	Address LSB	No. of registers MSB	No. of registers LSB	CRC LSB	CRC MSB
0x61	0x03	0x00	0x3B	0x00	0x01	0xFC	0x67

Response:

Slave Address	Function Code	No. of Bytes	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x03	0x02	0x01	0xF4	0x38	0x5B

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1.4.8 Altitude Compensation

Measurements of CO_2 concentration based on the NDIR principle are influenced by altitude. SCD30 offers to compensate deviations due to altitude by using the following command. Setting altitude is disregarded when an ambient pressure is given to the sensor, please see section 1.4.1.

Altitude value is saved in non-volatile memory. The last set value will be used for altitude compensation after repowering.

Protocol	Command (hex)	Argument	Description
I2C	0x5102 *argument*	Format: uint16 Height over sea level in [m] above 0.	See notes above.

Protocol	Function Code	Address	Data to write
Modbus	6	0x0038	*argument*

Full sequence examples:

Protocol: I2C — Description: Set altitude to 1000m above sea level

Set altitude:

Start	Write Header	Cmd MSB	Cmd LSB	Altitude MSB	Altitude LSB	CRC	Stop
Start	0xC2	0x51	0x02	0x03	0xE8	0xD4	Stop

Get altitude:
Write:

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0x51	0x02	Stop

Read:

Start	Read Header	Altitude MSB	Altitude LSB	CRC	Stop
Start	0xC3	0x03	0xE8	0xD4	Stop

Protocol: Modbus — Description: Set altitude to 1000m above sea level

Set altitude:
Request:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x38	0x03	0xE8	0x01	0x19

Response:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x38	0x03	0xE8	0x01	0x19

Get altitude:
Request:

Slave Address	Function Code	Address MSB	Address LSB	No. of registers MSB	No. of registers LSB	CRC LSB	CRC MSB
0x61	0x03	0x00	0x38	0x00	0x01	0x0C	0x67

Response:

Slave Address	Function Code	No. of Bytes	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x03	0x02	0x03	0xE8	0x38	0xF2

1.4.9 Read firmware version

Following command can be used to read out the firmware version of SCD30 module

Protocol	Address (hex)	Description
I2C	`0xD100`, no argument needed	Returns the firmware version

Protocol	Function Code	Address	Description
Modbus	3	0x0020	Returns the firmware version

Full sequence examples:

Protocol	Data to write/Read	Description
I2C	Write: (see below) Read: (see below)	Firmware version: Major.Minor
Modbus	Request (see below) Response: (see below)	Firmware version: Major.Minor

I2C Write:

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0xD1	0x00	Stop

I2C Read:

Start	Read Header	Firmware version major	Firmware version minor	CRC	Stop
Start	0xC3	0x03	0x42	0xF3	Stop

Modbus Request

Slave Address	Function Code	Address MSB	Address LSB	No. of registers MSB	No. of registers LSB	CRC LSB	CRC MSB
0x61	0x03	0x00	0x20	0x00	0x01	0x8C	0x60

Modbus Response:

Slave Address	Function Code	No. of Bytes	Firmware version major	Firmware version minor	CRC LSB	CRC MSB
0x61	0x03	0x02	0x03	0x42	0xB8	0x8D

I2C: SDA is controlled by the I2C master in clear blocks and by the sensor in dark blocks.

1.4.10 Soft reset

The SCD30 provides a soft reset mechanism that forces the sensor into the same state as after powering up without the need for removing the power-supply. It does so by restarting its system controller. After soft reset the sensor will reload all calibrated data. However, it is worth noting that the sensor reloads calibration data prior to every measurement by default. This includes previously set reference values from ASC or FRC as well as temperature offset values last setting.

The sensor is able to receive the command at any time, regardless of its internal state. In order to start the soft reset procedure the following command should be sent.

Protocol	Command (hex)	Argument	Description
I2C	0xD304		Restarts the sensor

Protocol	Function Code	Address	Data to write	Description
Modbus	6	0x0034	*0x0001*	Restarts the sensor

Full sequence examples:

I2C (Description: Restarts the sensor)

Start	Write Header	Cmd MSB	Cmd LSB	Stop
Start	0xC2	0xD3	0x04	Stop

Modbus (Description: Restarts the sensor)

Request:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x34	0x00	0x01	0x00	0x64

Response:

Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
0x61	0x06	0x00	0x34	0x00	0x01	0x00	0x64

1.5 Signal conversion to physical values

All data read from the sensor are float numbers in big-endian format[2]. Conversion of digital values S_x, (x = c(CO2), RH, T) to physical values and respective units are shown in the following table

Physical quantity	Conversion formula	Units	Range
CO_2 concentration $c(CO_2)$	$c(CO_2) = S_{c(CO2)}$	ppm	0 – 10000
Temperature T	$T = S_T$	°C	-40 – 125°C
Relative humidity RH	$RH = S_{RH}$	%RH	0 – 100

Table 4: Signal conversion table.

Conversation of temperature to °F as well as relative humidity to absolute humidity and dew point temperature can be found in Sensirion's online support center[3]

Sample pseudo code for converting data read from the sensor to physical value can be found below.

```
// CO2 concentration
float co2Concentration;
unsigned int tempU32;

// read data is in a buffer. In case of I2C CRCs have been removed
// beforehand. Content of the buffer is the following
unsigned char buffer[4];

buffer[0] = 0x43; //  MMSB CO2
buffer[1] = 0xDB; //  MLSB CO2
buffer[2] = 0x8C; //  LMSB CO2
buffer[3] = 0x2E; //  LLSB CO2

// cast 4 bytes to one unsigned 32 bit integer
tempU32 = (unsigned int)((((unsigned int)buffer[0]) << 24) |
                         (((unsigned int)buffer[1]) << 16) |
                         (((unsigned int)buffer[2]) << 8)  |
                          ((unsigned int)buffer[3]));

// cast unsigned 32 bit integer to 32 bit float
co2Concentration = *(float*)&tempU32; // co2Concentration = 439.09f
```

[2] IEEE 754 applies.
[3] https://www.sensirion.com/fileadmin/user_upload/customers/sensirion/Dokumente/2_Humidity_Sensors/Sensirion_Humidity_Sensors_at_a_Glance_V1.pdf

Revision History

Date	Revision	Page (s)	Changes
May 2020	1.0	All	General makeover, correction of typos

2 Important Notices

2.1 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.

2.2 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.

2.3 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.
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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.

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