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
- Measurement range: 400 ppm – 10.000 ppm
- Accuracy: ± (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. Please refer to datasheet.

1.1 I2C Protocol

Maximal I2C speed is 100 kHz and the **master has to support clock stretching**. Clock stretching period in write- and read-frames is 12 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 prototype module is set to the address 0x61.

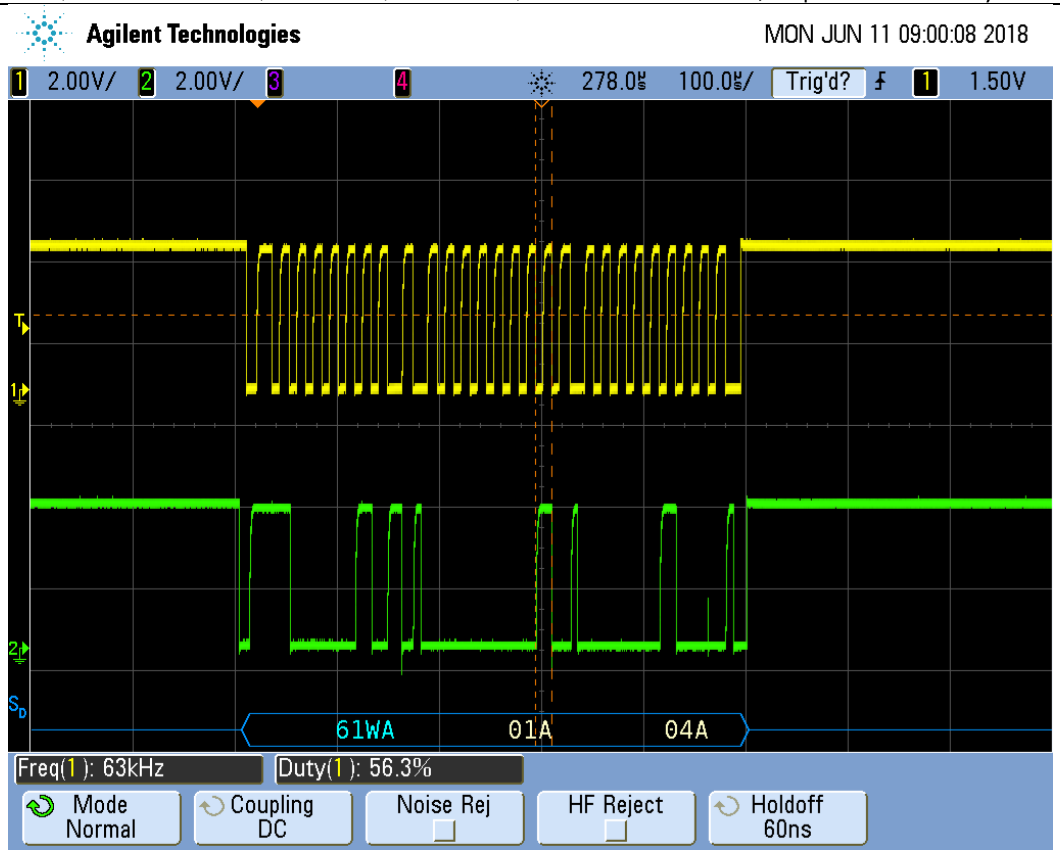
1.1.2 I2C Sequence

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

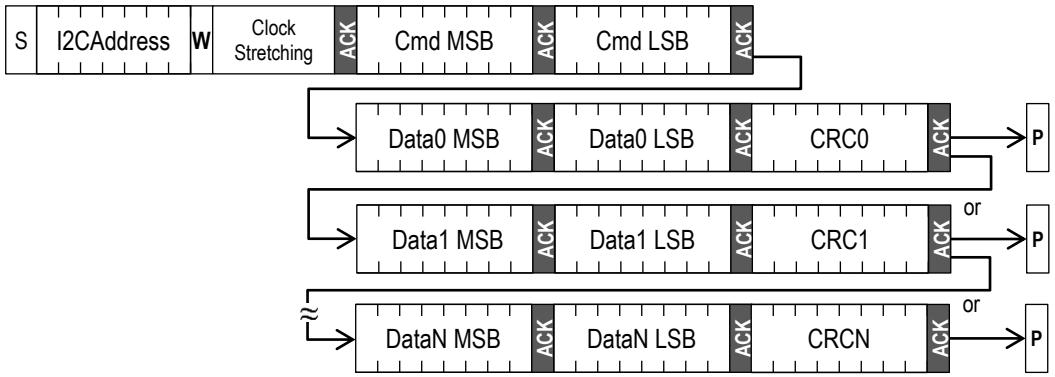
Example: Stop measurements 0x0104

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

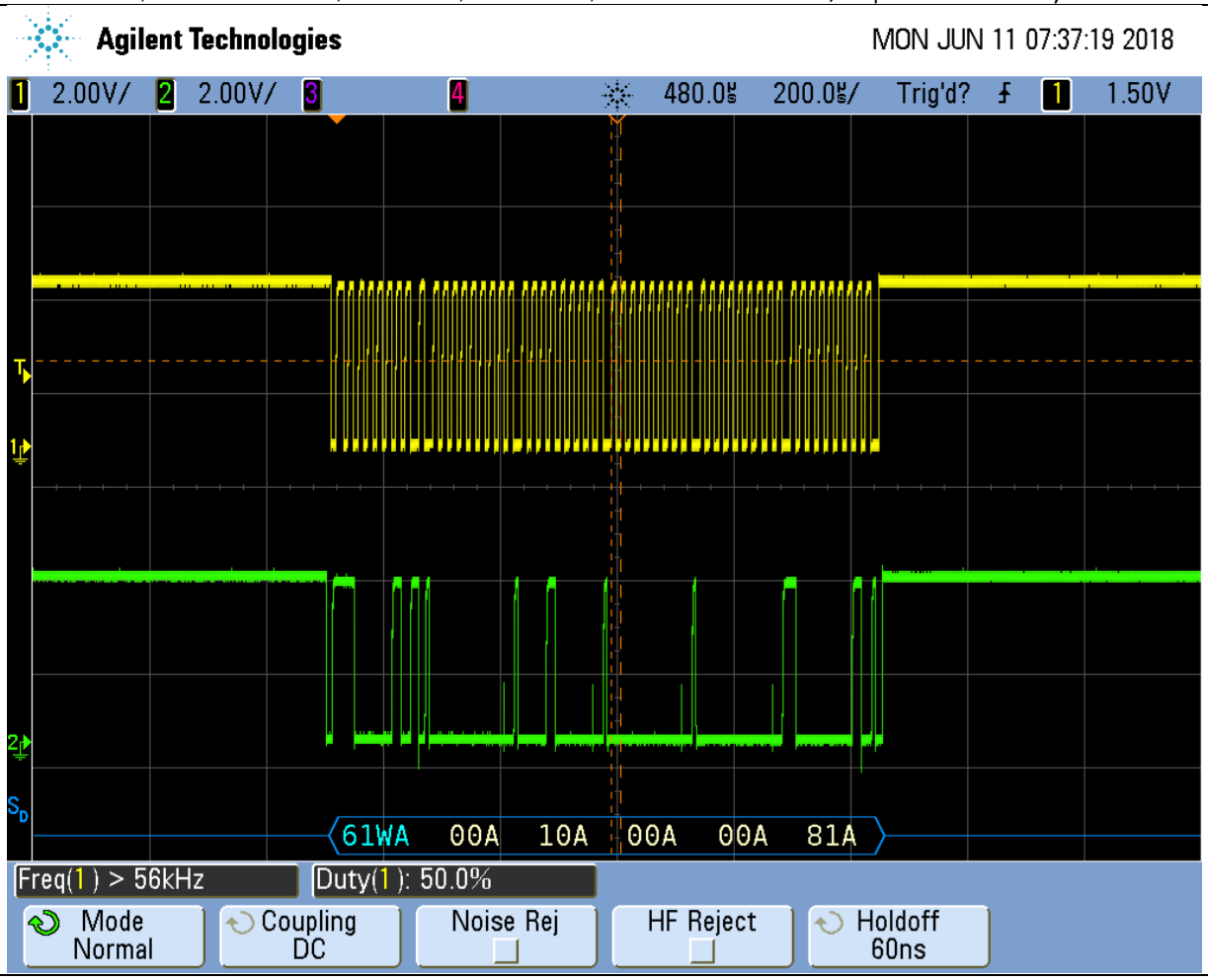


[1] http://www.nxp.com/documents/user_manual/UM10204.pdf

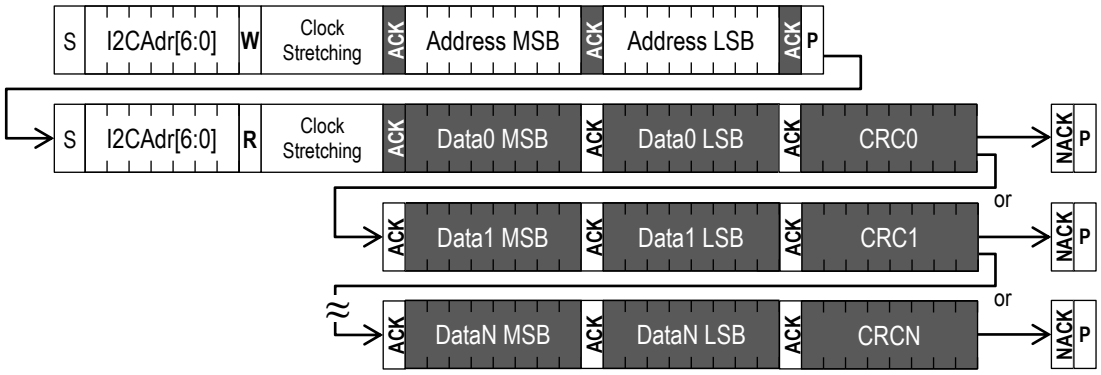
I2C write 16bit command with arguments



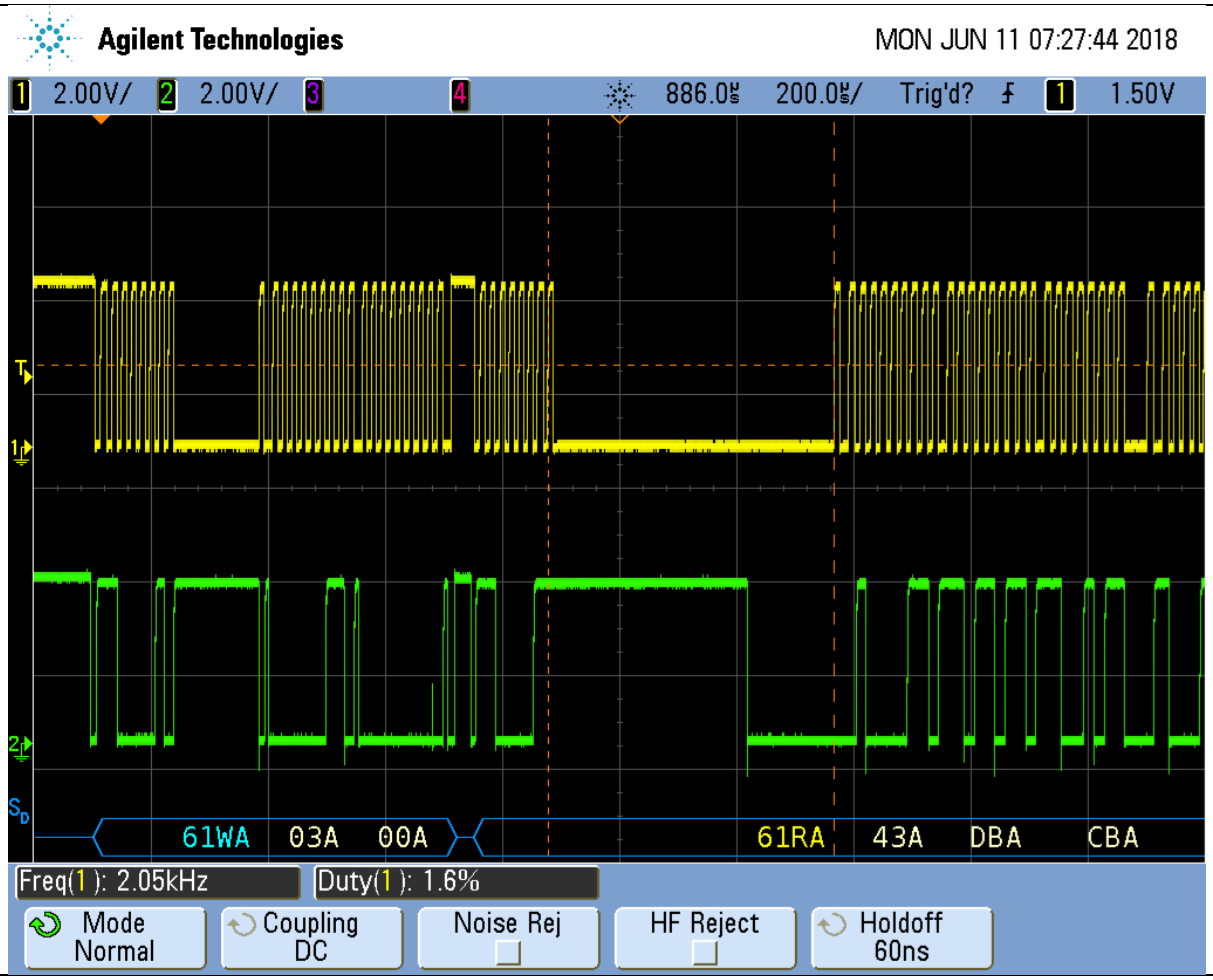
Example: Trigger continuous measurement (Pressure = 0mBar)
START 0xC2 0x00 0x10 0x00 0x00 0x81 **STOP**
(Red: Write Header; Blue: Read Header; Black: Data; Green: CRC; Start Condition: **START;** Stop Condition: **STOP)**



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)**



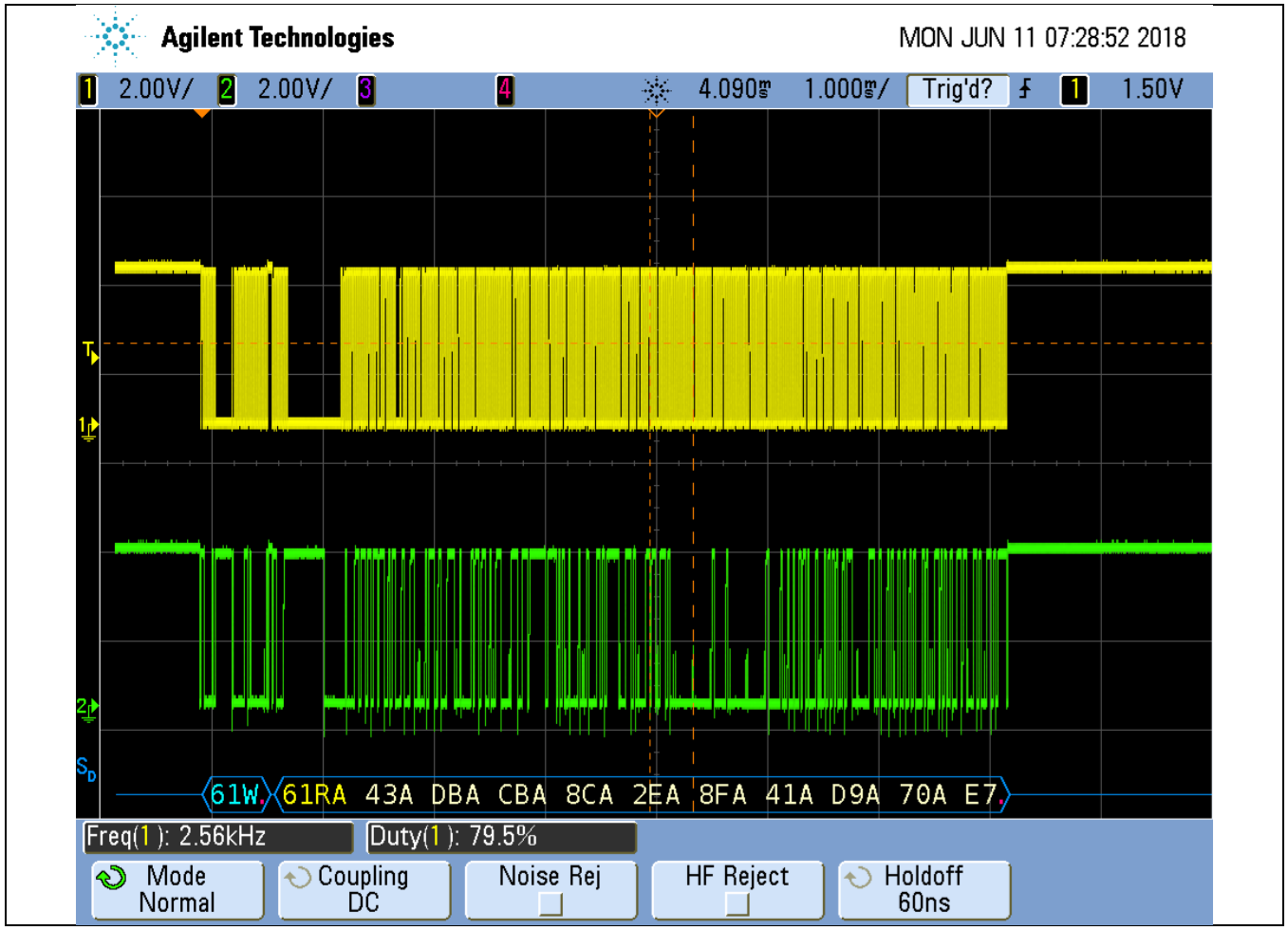


Table 1 I2C write and read communication frames. SDA is controlled by the I2C master in clear blocks and by the sensor in dark blocks.

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 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
- Soft reset

1.3.1 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 1.3.3, 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 and future settings of altitude compensation. Setting the argument to zero will deactivate the ambient pressure compensation. For setting a new ambient pressure when continuous measurement is running the whole command has to be written to SCD30.

Protocol	Command (hex)	Argument	Description
I2C	0x0010 *argument*	Format: uint16 Available range: 0 & [700 … 1200]. Pressure in mBar.	Triggers continuous measurement. Ambient pressure is compensated by setting *argument. argument* = 0 deactivates pressure compensation.

Protocol	Function Code	Address	Data to write
Modbus	6	0x0036	0x0000 or pressure in mBar

Full sequence examples:

Protocol	Data to write / read	Description
I2C	Start | Write Header | Cmd MSB | CMS LSB | Pressure MSB | Pressure LSB | CRC | Stop Stop | 0xC2 | 0x00 | 0x10 | 0x00 | 0x00 | 0x81 | Stop	Start continuous measurement without ambient pressure compensation
Modbus	Request: Slave Address | Function Code | Address MSB | Address LSB | Content MSB | Content LSB | CRC LSB | CRC MSB 0x61 | 0x06 | 0x00 | 0x36 | 0x00 | 0x00 | 0x60 | 0x64 Response: Slave Address | Function Code | Address MSB | Address LSB | Content MSB | Content LSB | CRC LSB | CRC MSB 0x61 | 0x06 | 0x00 | 0x36 | 0x00 | 0x00 | 0x60 | 0x64	

1.3.2 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
Modbus	6	0x0037	0x0001

Full sequence examples:

Protocol	Data to write	Description
I2C	Start: Stop; Write Header: 0xC2; Cmd MSB: 0x01; Cmd LSB: 0x07; Stop: Stop	Stops continuous measurement.
Modbus	Request: Slave Address: 0x61; Function Code: 0x06; Address MSB: 0x00; Address LSB: 0x37; Content MSB: 0x00; Content LSB: 0x01; CRC LSB: 0xF0; CRC MSB: 0x64 Response: Slave Address: 0x61; Function Code: 0x06; Address MSB: 0x00; Address LSB: 0x37; Content MSB: 0x00; Content LSB: 0x01; CRC LSB: 0xF0; CRC MSB: 0x64	

1.3.3 Set measurement interval

Sets the interval used by the SCD30 sensor to measure in continuous measurement mode (see chapter 1.3.1). 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
Modbus	6	0x0025	*argument*

Full sequence examples:

Protocol	Data to write	Description
I2C	Start: Stop; Write Header: 0xC2; Cmd MSB: 0x46; Cmd LSB: 0x00; Interval MSB: 0x00; Interval LSB: 0x02; CRC: 0xE3; Stop: Stop	Set measurement interval to 2s
Modbus	Request: Slave Address: 0x61; Function Code: 0x06; Address MSB: 0x00; Address LSB: 0x25; Content MSB: 0x00; Content LSB: 0x02; CRC LSB: 0x10; CRC MSB: 0x60 Response: Slave Address: 0x61; Function Code: 0x06; Address MSB: 0x00; Address LSB: 0x25; Content MSB: 0x00; Content LSB: 0x02; CRC LSB: 0x10; CRC MSB: 0x60	

1.3.4 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.

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
Modbus	3	0x0027

Full sequence examples:

Protocol	Data to write/Read	Description
I2C	Write: Start | Write Header | Cmd MSB | Cmd LSB | Stop Stop | 0xC2 | 0x02 | 0x02 | Stop Read: Start | Read Header | Data Ready MSB | Data Ready LSB | CRC | Stop Start | 0xC3 | 0x00 | 0x01 | 0xB0 | Stop	Reading Data Ready status (returning 1)
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 | 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.

1.3.5 Read measurement

When new measurement data is available it can be read out with the following command. 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	Write: Start | Write Header | Cmd MSB | Cmd LSB | Stop Stop | 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	Example with sensor returning: CO_2 Concentration = 439 PPM Humidity = 48.8 % Temperature = 27.2 °C
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 | 0x28 | 0x00 | 0x06 | 0xCC | 0x67 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 MMSB | 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.

Table 2 and Table 3 shows the data layout of the data read out from the sensor.

I2C read-out stream:

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:

Words for retrieving CO_2 concentration, humidity and temperature can be read out at the following addresses. The words can be read from the sensor in an arbitrary order.

Preceding Command	Consecutive read	Memory address	Description
Read measurement	Word0: CO_2 MSW Word1: CO_2 LSW Word2: Temperature MSW Word3: Temperature LSW Word4: Humidity MSW Word5: Humidity LSW	0x0028 0x0029 0x002A 0x002B 0x002C 0x002D	Data read-out table for Modbus communication. Measurement of CO_2 concentration, humidity and temperature has to be finished before read-out.

Table 3: Modbus data read-out table.

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

1.3.6 (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 1.3.7) 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		Example: deactivate ASC

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

Modbus

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

1.3.7 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 calibration command and sending the reference value. Setting a reference CO_2 concentration by the here described method will always overwrite the settings from ASC (see chapter 1.3.6) and vice-versa. The reference CO_2 concentration has to be within the range 400 ppm ≤ $c_{ref}(CO_2)$ ≤ 2000 ppm.

FRC value is saved in non-volatile memory, the last set FRC value will be used for field-calibration after repowering.

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	Start | Write Header | Cmd MSB | Cmd LSB | FRC MSB | FRC LSB | CRC | Stop Stop | 0xC2 | 0x52 | 0x04 | 0x01 | 0xC2 | 0x50 | Stop	Example: Set FRC with argument 450 ppm
Modbus	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	

1.3.8 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:

Protocol	Data to write	Description
I2C	<table><tr><td>Start</td><td>Write Header</td><td>Cmd MSB</td><td>Cmd LSB</td><td>SHT Offset MSB</td><td>SHT Offset LSB</td><td>CRC</td><td>Stop</td></tr><tr><td>Stop</td><td>0xC2</td><td>0x52</td><td>0x04</td><td>0x01</td><td>0xF4</td><td>0x33</td><td>Stop</td></tr></table>	Example: Set temperature offset to 5 K
Modbus	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>0x3B</td><td>0x01</td><td>0xF4</td><td>0xF1</td><td>0xB0</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>0x3B</td><td>0x01</td><td>0xF4</td><td>0xF1</td><td>0xB0</td></tr></table>	

1.3.9 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 1.3.1.

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	Data to write	Description
I2C	<table><tr><td>Start</td><td>Write Header</td><td>Cmd MSB</td><td>Cmd LSB</td><td>Altitude MSB</td><td>Altitude LSB</td><td>CRC</td><td>Stop</td></tr><tr><td>Stop</td><td>0xC2</td><td>0x51</td><td>0x02</td><td>0x03</td><td>0xE8</td><td>0xD4</td><td>Stop</td></tr></table>	Set altitude to 1000m above sea level
Modbus	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>0x38</td><td>0x03</td><td>0xE8</td><td>0x01</td><td>0x19</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>0x38</td><td>0x03</td><td>0xE8</td><td>0x01</td><td>0x19</td></tr></table>	

1.3.10 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		
Modbus	6	0x0034	*0x0001*		

Full sequence examples:

Protocol	Data to write	Description
I2C	Start: Write Header; Cmd MSB; Cmd LSB; Stop Stop: 0xC2; 0xD3; 0x04; Stop	Restarts the sensor
Modbus	Request: Slave Address: 0x61; Function Code: 0x06; Address MSB: 0x00; Address LSB: 0x34; Content MSB: 0x00; Content LSB: 0x01; CRC LSB: 0x00; CRC MSB: 0x64 Response: Slave Address: 0x61; Function Code: 0x06; Address MSB: 0x00; Address LSB: 0x34; Content MSB: 0x00; Content LSB: 0x00; CRC LSB: 0x00; CRC MSB: 0x64	

1.4 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

1 Important Notices

1.1 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.

1.2 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.

1.3 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.
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.

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