WÜRTH ELEKTRONIK

HUMIDITY SENSOR WITH INTEGRATED TEMPERATURE SENSOR

WSEN-HIDS USER MANUAL

2525020210001, 25250202100011

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1.6	1.0	• Overview of helpful application notes related to product added • Chapter 2: Sensor and electrical specifications text conditions updated • Chapter 10.4: Steps to calculate humidity and temperature updated • Chapter 14: MEMS sensor PCB design guidelines information added	March 2022

Abbreviations

Abbreviation	Description
BDU	Block update data
DRDY	Data ready
ESD	Electrostatic discharge
FIFO	First-in first-out
I^2C	Inter integrated circuit
LGA	Land grid array
LSB	Least significant bit
MEMS	Micro-Electro Mechanical system
MSB	Most significant bit
ODR	Output data rate
PCB	Printed circuit board
SPI	Serial peripheral interface

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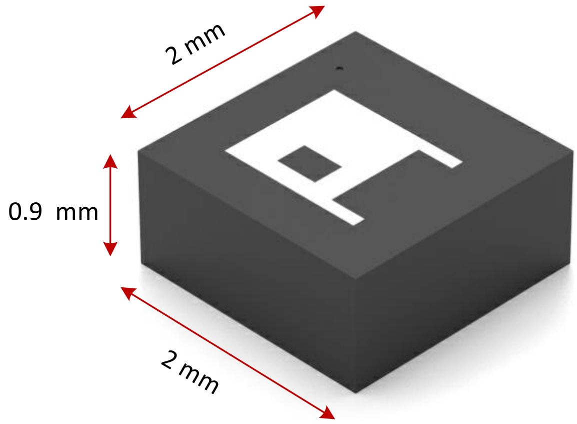
1 Product description

1.1 Introduction

The humidity sensor is a 16-bit digital ultra-low-power and high-performance sensor with digital output interface. It measures relative humidity from 0 to 100% rH in one shot mode or continuous mode operation with an output data rate of 1 Hz, 7 Hz and 12.5 Hz. It is also embedded with a temperature sensor for ambient temperature measurement. The sensor is fully calibrated and no further calibration is required. The dimension of the sensor is 2.0 mm×2.0 mm×0.9 mm. It is available in land grid array package (LGA).

1.2 Applications

- HVAC systems
- Home and building automation
- Goods and asset tracking
- Air conditioners
- Refrigerators



1.3 Sensor features

• Humidity measurement range :	0 to 100% rH
• Humidity noise :	0.35% rH RMS
• Temperature measurement range :	-40 to +120 ℃
• Temperature noise :	0.03 ℃ RMS
• Output data rate :	1 Hz, 7 Hz and 12.5 Hz
• Operating modes :	Continuous mode and one-shot mode
• Current consumption :	8.9µA @ODR 1Hz
• Communication interface :	I^2C, SPI and Interrupt pin

1.4 Block diagram

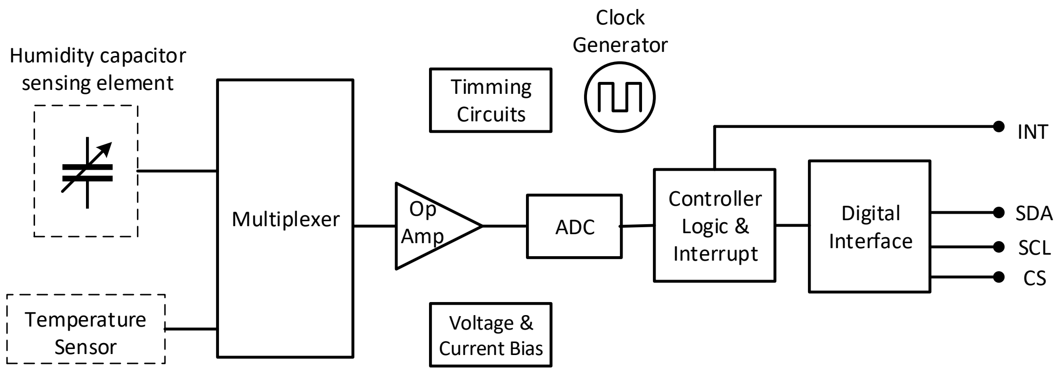


Figure 1: Block diagram

The sensor is a MEMS based capacitive humidity sensor with an integrated ASIC. MEMS sensing element is a planar fringed capacitor with a dielectric polymer which absorbs or releases water with proportional to the relative humidity in the environment. A silicon based temperature sensor is integrated in the same package. ASIC comprises of multiplier, operational amplifier, analog-to-digital converter and other signal conditioning blocks like controller logics and interrupts. ASIC converts the analog signal from the both humidity and temperature sensing element into a 16-bit digital humidity and temperature values. The sensor is factory calibrated for both humidity and temperature measurements. The trimming parameters are stored in on-chip flash memory. When the sensor is powered on, these trimming parameters are loaded from the flash memory to the registers. Hence, no further calibration is required for humidity and temperature values.

1.5 Ordering information

WE order code	Temperature Range	Description
2525020210001	-40° C to +120° C	Tape & reel packaging (1000 pcs/reel)
25250202100011	-40° C to +120° C	Tape & reel packaging (8000 pcs/reel)

Table 1: Ordering information

2 Handling humidity sensor

- It is important to understand that a humidity sensor is not a normal electronic component. It must be handled with care.
- Chemical vapours at high concentration in combination with long exposure time may offset the sensor reading.
- It is recommended to store the sensors within a temperature range of 10 °C and 40 °C and humidity with a range of 20% rH and 60% rH.
- Long-term exposure to conditions outside normal humidity and temperature range, especially at higher humidity range may temporarily offset the output value of humidity sensor.
- After returning to the normal exposure conditions, the humidity output value will usually slowly return to the calibration state by itself.
- To recover the sensor accuracy to the normal state after exposing to outside normal humidity and temperature range, it has to be reconditioned with the following procedure :

1. Baking: 100 °C to 110 °C at 5 % rH for 12h
2. Re-hydration: 20 °C to 30 °C at 75 % rH for 12h

STOP

WSEN_HIDS humidity sensor is not a normal electronic component. The sensing element of the humidity sensor is made of polymer. Long-term exposure above normal humidity (20% rH to 60% rH) and temperature (10 °C and 40 °C) range may offset the sensor value

3 Sensor and electrical specifications

T=25 ℃, supply voltage VDD = 3.3V, unless otherwise stated. Sensor parameter values are verified after soldering the sensor on a PCB. The PCB is designed by following the MEMS Sensor PCB design guidelines described in the 14.

3.1 Humidity sensor specifications

Parameters	Symbol	Test conditions	Min	Typ.	Max.	Unit
Measurement range	H_{RANGE}		0		100	% rH
Resolution	RES_H			16		bits
Sensitivity	SEN_H			0.004		% rH/digit
Accuracy	H_{ACC}	20% rH to 80% rH		±3.5		% rH
		0% rH to 100% rH		±5		% rH
Noise(RMS)	H_{NOISE}	Internal average: 32 samples[1]		0.35		% rH RMS
Hysteresis	HYS_H			±1		% rH
Long-term drift	H_{DRIFT}	20% rH to 80% rH		0.5		% rH/Year
Response time	H_{STEP}	Step response time of 63%		10		s
Output data rate	ODR		1		12.5	Hz

Table 2: Humidity sensor specification

[1] *Default setting*

3.2 Temperature sensor specifications

Parameters	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Measurement range	T_{RANGE}		-40		+120	℃
Resolution	RES_T			16		bits
Noise(RMS)	T_{NOISE}	Internal average: 16 samples [1]		0.03		℃ RMS
Sensitivity	SEN_T			0.016		℃/digit
Absolute accuracy	T_{ACC_ABS}	15 ℃ to 40 ℃		±0.5		℃
		0 ℃ to 60 ℃		±1		℃

Table 3: Temperature sensor specification

[1] *Default setting*

3.3 Electrical specifications

Parameters	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Operating supply voltage	V_{DD}		1.7	3.3	3.6	V
Current consumption	I_{DD}	ODR 1 Hz		8.9		µA
Current consumption in power down mode	I_{DD_PD}			0.5		µA

Table 4: Electrical specification

3.4 Absolute maximum rating

Parameter	Symbol	Test conditions	Min.	Max.	Unit
Input voltage V_{DD} pin	V_{DD}		-0.3	4.8	V
Input voltage *SDA*, *SCL* & *CS*	V_{IN} pins		-0.3	V_{DD_IO} + 0.3	V

Table 5: Absolute maximum rating

STOP Supply voltage on any pin should never exceed 4.8 V

3.5 General information

Parameters	Values
Operating temperature	-40 ℃ to +120 ℃
Storage temperature	-40 ℃ to +125 ℃
Communication interface	I^2C & SPI
Moisture sensitivity level (MSL)	3
Electrostatic discharge protection(HBM)	2 kV

Table 6: General information

The device is susceptible to damage by electrostatic discharge (ESD). Always use proper ESD precautions when handling. Improper handling of the device can cause performance degradation or permanent damage to the part

For better performance, the recommended storage condition for the humidity sensor is 10 ℃ to 40 ℃ with 20% rH to 60% rH

4 Pinning description

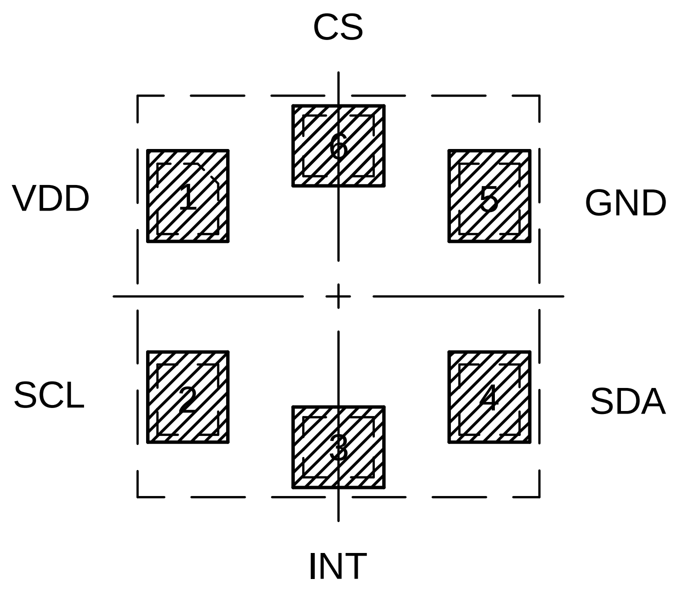


Figure 2: Pinout (top view)

No	Function	Description	Input/Output
1	*VDD*	Positive supply voltage	Supply
2	*SCL*	I^2C serial clock	Input
3	*INT*	Data ready output signal	Output
4	*SDA*	I^2C / SPI: serial data input/output	Input/Output
5	*GND*	Negative supply voltage	Supply
6	*CS*	I^2C/SPI enable/disable	Input

Table 7: Pin description

5 Application circuit

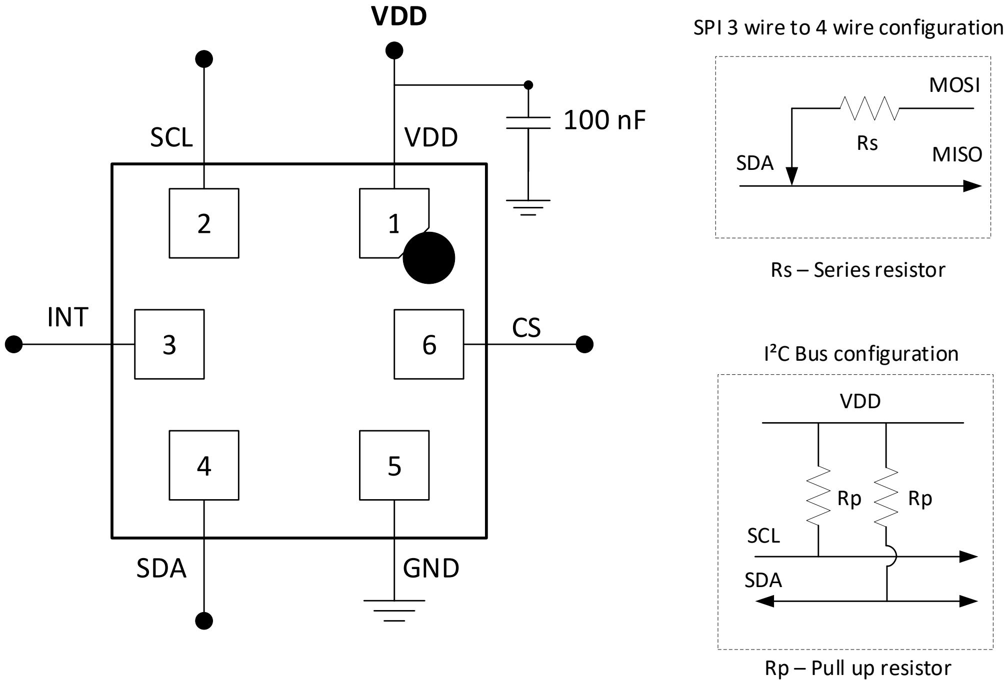


Figure 3: Electrical connection (top view)

A positive supply voltage is applied to the sensor through *VDD* pin and negative voltage to *GND*. The decoupling capacitor of 100 nF in parallel is highly recommended to prevent the voltage ripples on the *VDD* line. It should be placed as close as possible to the *VDD* pin. The *CS* pin shall be connected to *VDD_IO* in order to enable the I^2C communication interface. For SPI communication, the *CS* pin shall be connected to master side *CS* pin for active start and stop SPI communication. The pull up resistors R_p for I^2C communication interface should be connected parallel between supply voltage *VDD* and *SCL* and *SDA* pins.

Depending on the internal resistance of I^2C pins at the master side, the pull up resistors R_p can be selected for proper rise and fall time of the digital signals. The 3-pin to 4-pin SPI configuration can be configured as mentioned in the figure 3.

6 Digital interface

The humidity sensor supports standard I^2C (Inter-IC) bus protocol. Further information of the I^2C interface can be found at *https://www.nxp.com/docs/en/user-guide/UM10204.pdf*. I^2C is a serial 8-bit protocol with two-wire interface, which supports communication between different ICs. For example, between the microcontroller and other peripheral devices.

6.1 General characteristics

A serial data line (*SDA*) and a serial clock line (*SCL*) are required for the communication between the devices connected via I^2C bus. Both *SDA* and *SCL* lines are bidirectional. The output stages of devices connected to the bus must have an open-drain or open-collector. Hence, the *SDA* and *SCL* lines are connected to a positive supply voltage via pull-up resistors. In I^2C protocol, the communication is realized through master-slave principle. The master device generates the clock pulse, a start command and a stop command for the data transfer. Each connected device on the bus is addressable via a unique address. Master and slave can act as a transmitter or a receiver depending upon whether the data needs to be transmitted or received.

> The sensor implements the I^2C role "slave"

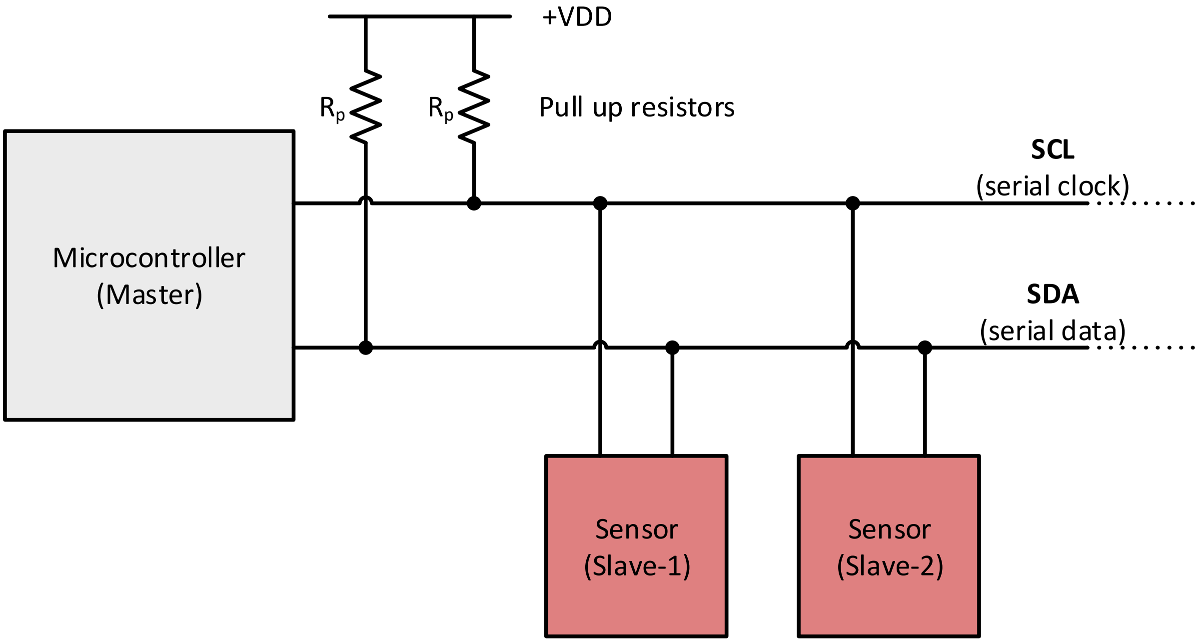


Figure 4: Master-slave concept

6.2 *SDA* and *SCL* logic levels

The positive supply voltage to which *SDA* and *SCL* lines are pulled up (through pull-up resistors), in turn determines the high level input for the slave devices. The sensor has separate supply voltage *VDD_IO* for the *SDA* and *SCL* lines. The logic high '1' and logic low '0' levels for the *SDA* and *SCL* lines then depend on the *VDD*.

6.3 Communication phase

6.3.1 Idle state

During the idle state, the bus is free and both *SDA* and *SCL* lines are in logic high '1' state.

6.3.2 START(S) and STOP(P) condition

Data transfer on the bus starts with a START command, which is generated by the master. A start condition is defined as a high-to-low transition on the *SDA* line while the *SCL* line is held high. The bus is considered busy after the start condition.

Data transfer on the bus is terminated with a STOP command, which is also generated by the master. A low-to-high transition on the *SDA* line, while the *SCL* line being high is defined as a STOP condition. After the stop condition, the bus is again considered free and is in idle state. Figure 5 shows the I^2C bus START and STOP conditions.

Master can also send a REPEATED START (SR) command instead of STOP command. REPEATED START condition is same as the START condition.

6.3.3 Data validity

After the start condition, one data bit is transmitted with each clock pulse. The transmitted data is only valid when the *SDA* line data is stable (high or low) during the high period of the clock pulse. High or low state of the data line can only change when the clock pulse is in low state.

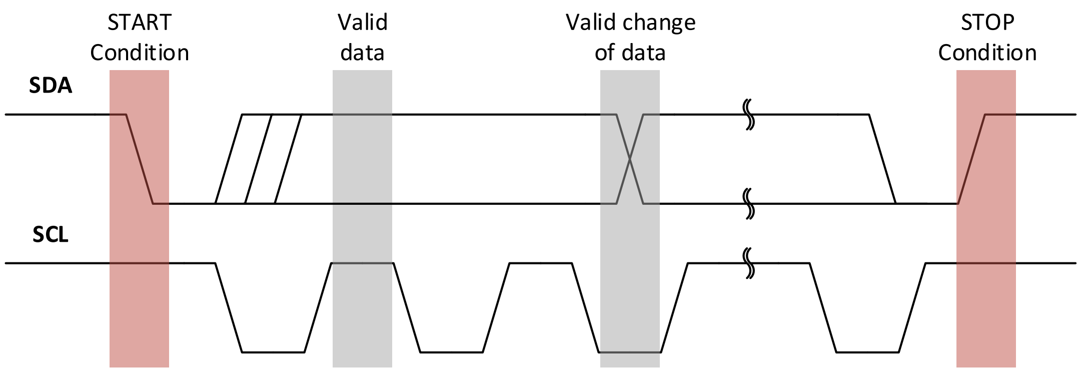


Figure 5: Data validity, START and STOP condition

6.3.4 Byte format

Data transmission on the *SDA* line is always done in bytes, with each byte being 8-bits long. Data is transmitted with the most significant bit (MSB) followed by other bits.

If the slave cannot receive or transmit another complete byte of data, it can force the master into a wait state by holding *SCL* LOW. Data transfer continues when the slave is ready which is indicated by releasing the *SCL* pin.

6.3.5 Acknowledge (ACK) and No-Acknowledge (NACK)

Each byte transmitted on the data line must follow an Acknowledge bit. The receiver (master or slave) generates an Acknowledge signal to indicate that the data byte was received successfully and ready to receive next data byte.

After one byte is transmitted, the master generates an additional Acknowledge clock pulse to continue the data transfer. The transmitter releases the *SDA* line during this clock pulse so that the receiver can pull the *SDA* line to low state in such a way that the *SDA* line remains stable low during the entire high period of the clock pulse. It is considered as an Acknowledge signal.

If the receiver does not want to receive any further byte, it will not pull down the *SDA* line and it remains in stable high state during the entire clock pulse. It is considered as a No-Acknowledge signal and the master can generate either a stop condition to terminate the data transfer or a repeated start condition to initiate a new data transfer.

6.3.6 Slave address for the sensor

The slave address is transmitted after sending the start condition. Each device on the I^{2}C bus has a unique address. Master selects the slave by sending corresponding slave address after the start condition. A slave address is a 7 bits long followed by a Read/Write bit.

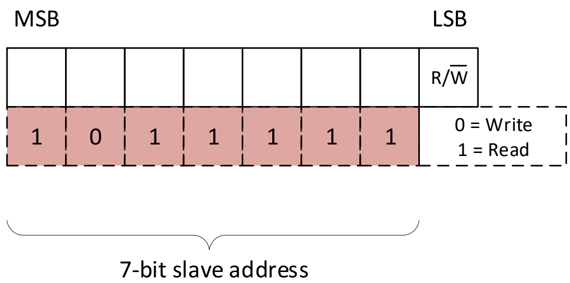


Figure 6: Slave address format

The 7-bit slave address of the humidity sensor is 1011111b ("0x5F"). The R/W bit determines the data direction. ’0’ indicates a write operation (transmission from master to slave) and a ’1’ indicates a read operation (data request from slave).

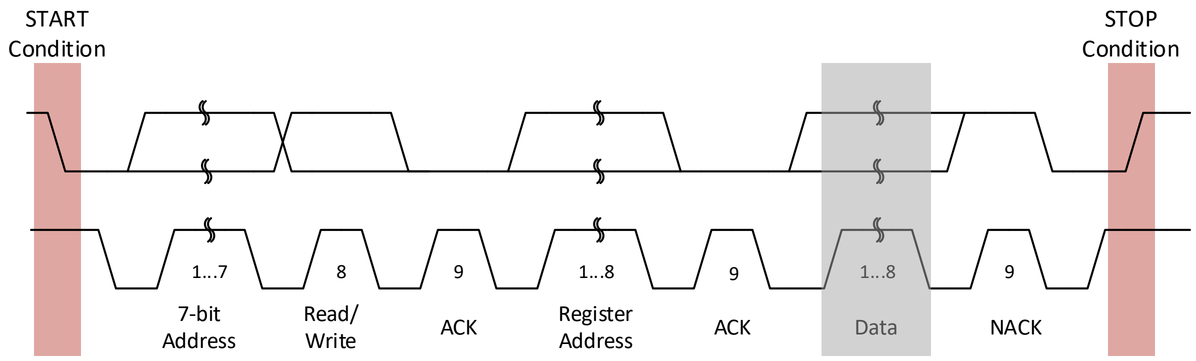


Figure 7: Complete data transfer

7-bit slave address of the humidity sensor is 1011111b ("0x5F"). Depending on the used micro-controller, left shifting this 7 bits by 1 may be required. Check host micro-controller of the user manual for device specific information

6.3.7 Read/Write operation

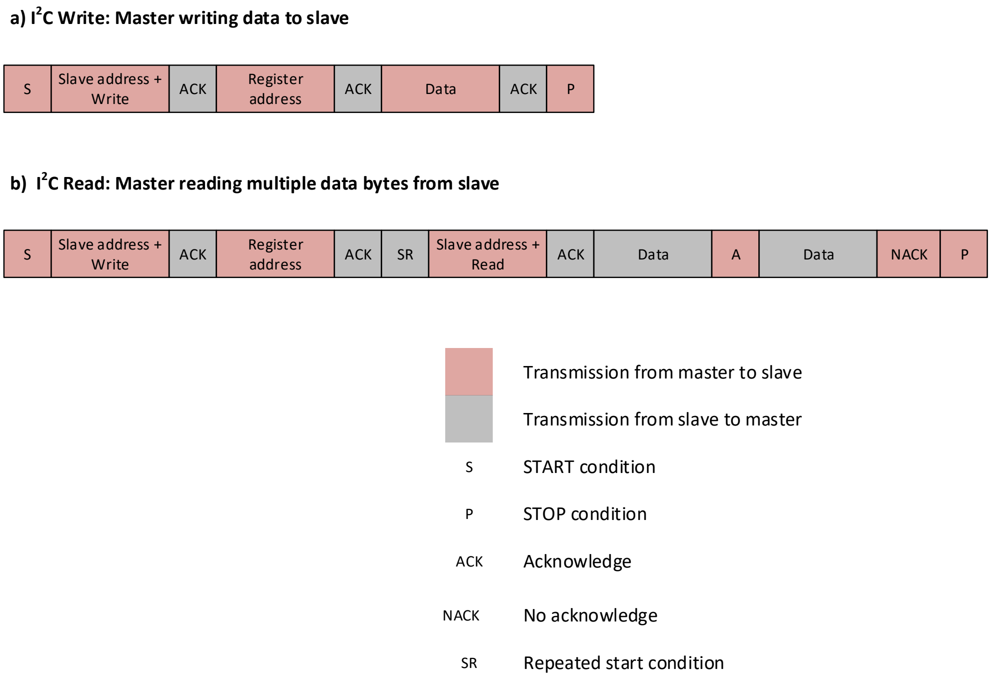


Figure 8: Write and read operations of the sensor

Once the slave-address and data direction bit is transmitted, the slave acknowledges the master. The master transmits the next byte, which must be a register-address of the sensor. It indicates the address of the register where data needs to be written to or read from.

After receiving the register address, the slave sends an Acknowledgement (ACK). If the master is still writing to the slave (R/W bit = 0), it will transmit the data to slave in the same direction. If the master wants to read from the addressed register (R/W bit =1), a repeated start (SR) condition must be transmitted to the slave. Master acknowledges the slave after receiving each data byte. If the master no longer wants to receive further data from the slave, it would send No-Acknowledge (NACK). Afterwards, master can send a STOP condition to terminate the data transfer. Figure 8 shows the writing and reading procedures between the master and the slave device (sensor).

6.4 I²C Multiple bytes read operation

In order to read multiple bytes incrementing the register address, it is necessary to assert the most significant bit of the sub-address field (output register address). The bit [7] must be equal to 1 while bit [6-0] represents the address of the first register to be read. Here is an example of how to read 4 bytes of data from output registers by requesting the data only from 0x28.

- To read multiple bytes from the output registers 0x28 to 0x2B, the first register address must be changed from 0x28 (b0010 1000) to 0xA8(b1010 1000 (MSB is changed from ’0’ to ’1’).
- After sending I²C address, start with reading from the register 0xA8 and request 4 bytes to read.
- The received 4 bytes gives the content from registers 0x28 to 0x2B.

! There is no auto increment bit (enable/disable) implemented in the control register for multiple bytes of read.

6.5 I²C timing parameters

Parameter	Symbol	Standard mode		Fast mode		Unit
		Min	Max	Min	Max	
SCL clock frequency	f_{SCL}	0	100	0	400	kHz
LOW period for *SCL* clock	t_{LOW_SCL}	4.7		1.3		µs
HIGH period for *SCL* clock	t_{HIGH_SCL}	4.0		0.6		µs
Hold time for START condition	t_{HD_S}	4		0.6		µs
Setup time for (repeated) START condition	f_{SCL}	4.7		0.6	400	µs
SDA setup time	t_{SU_SDA}	250		100		ns
SDA data hold time	t_{HD_SDA}	0	3.45	0	0.9	µs
Setup time for STOP condition	t_{SU_P}	4		0.6		µs
Bus free time between STOP and START condition	t_{BUF}	4.7		1.3		µs

Table 8: I²C timing parameters

7 Serial Peripheral Interface (SPI)

Serial Peripheral Interface (SPI) is a synchronous serial communication bus system for the communication between host microcontroller and other peripheral ICs such as ADCs, EEPROMs, sensors, etc. SPI is a full-duplex master-slave based interface allowing the communication to happen in both directions simultaneously. The data from the master or the slave is synchronized either on the rising or falling edge of clock pulse. SPI can be either 4-wire or 3-wire interface. 4-wire interface consists of two signal lines and two data lines. All of these bus lines are unidirectional. In case of 3 wire SPI data line (SDA) is shared and used for either sending or receiving.

1. Clock (SCL)
2. Chip select (CS)
3. Master out, slave in (MOSI)
4. Master in, slave out (MISO)

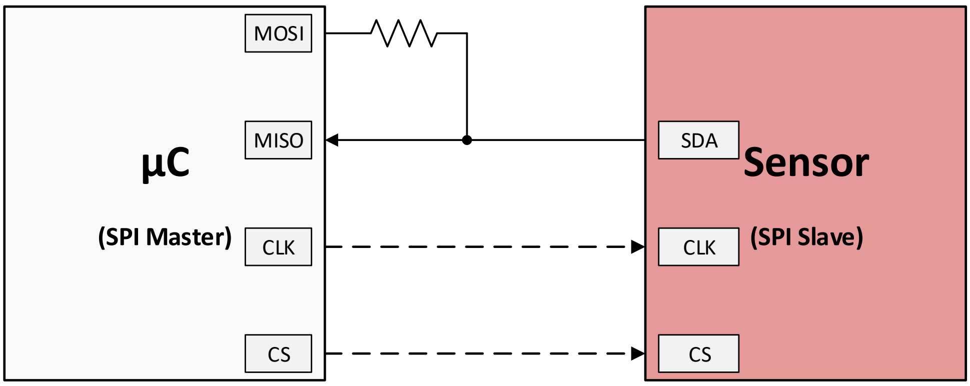


Figure 9: SPI Interface

Master generates the clock signal and is connected to all slave devices. Data transmission between the master and salves is synchronized to the clock signal generated by the master.

One master can be connected to one or more slave devices. Each slave device is addressed and controlled by the master via individual chip select (CS) signals. CS is controlled by the master and is normally an active low signal.

MOSI and MISO are data lines. MOSI transmits data from the master to the slave. MISO transmits data from the slave to the master.

The humidity sensor supports only 3-wire SPI communication.

7.1 Data transfer

Communication begins when the master selects a slave device by pulling the CS line to LOW. The clock and data lines (MOSI/MISO) are available for the selected slave device. Data stored in the specific shift registers are exchanged synchronously between master and the slave through MISO and MOSI lines. The data transmission is over when the chip select line is pulled up to the HIGH state. 4-wire SPI uses both data lines for the synchronous data exchange in both the direction. 3-wire SPI shares a single data line for the data transfer, where the master and slave alternate the read and write operation synchronously.

7.2 Communication modes

In SPI, the master can select the clock polarity (CPOL) and clock phase (CPHA). The CPOL bit sets the polarity of the clock signal during the idle state. The CPHA bit selects the clock phase. Depending on the CPHA bit, the rising or falling clock edge is used to sample and shift the data. Depending on the CPOL and CPHA bit selection in the SPI control registers, four SPI modes are available as per table 9. In order to ensure proper communication, master and the slave must be set to same communication modes.

CPOL	CPHA	Description
0	0	Clock polarity LOW in idle state; Data sampled on the rising clock edge
0	1	Clock polarity LOW in idle state; Data sampled on the falling clock edge
1	1	Clock polarity HIGH in idle state; Data sampled on the falling clock edge
1	0	Clock polarity HIGH in idle state; Data sampled on the rising clock edge

Table 9: SPI communication modes

7.3 Sensor SPI Communication

3-Wire SPI of this sensor uses following lines: SDA (data input, MOSI), SCL (serial clock) and CS (chip select). For more information, please refer to pin description in the section 4.

CS is pulled LOW by the master at the start of communication. The SCL polarity is HIGH in the idle state (CPOL = 1). The data lines (SDA & SAO) are sampled at the falling clock edge and latched at the rising clock edge (CPHA = 1). Data is transmitted with MSB first and the LSB last.

SPI read and write operations are completed in 2 or more bytes (multiple of 16 or more clock pulses). Each block consists of a register address byte and a data byte. The first byte is the register address. In the SPI communication, the register address is specified in the 7-bits and the MSB of the register address is used as an SPI read/write bit (Figure 10). When R/W is '0', the data is written on to the sensor. When '1', the data is read from the sensor.

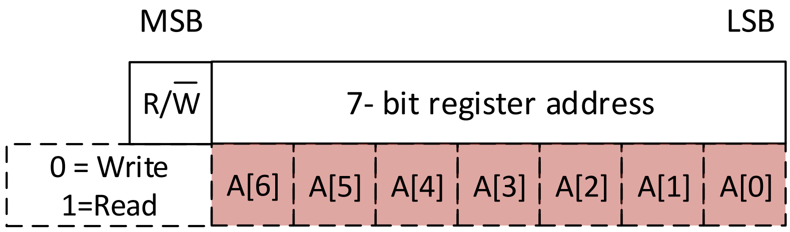


Figure 10: SPI register address

The next bytes of data, depending on the R/W bit, is either written to or read from the indexed register. Figure 11 shows the complete SPI data transfer protocol.

> The sensor supports 3-wire SPI communication uses *SDA* pin for both data read and write operations. Communication protocol remains the same.

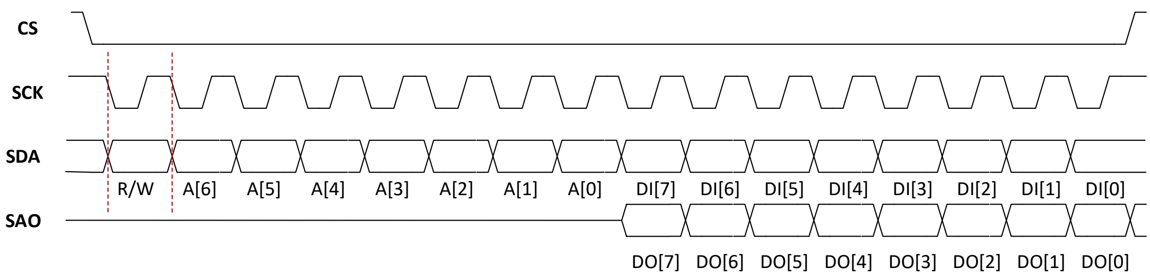


Figure 11: 4-wire SPI data transfer (CPOL = 1, CPHA = 1)

7.3.1 SPI write operation

The write operation starts with the CS = LOW and sending the 7-bit register address with R/W bit = '0' (write command). Next byte is the data byte that is the data to be written to the indexed register. Several write command pairs can be sent without raising the CS back to HIGH. The operation is ended with CS = HIGH. The SPI write protocol is shown in the figure 12.

Start	$R/\overline{W}$	Register address							Data to be written								Stop
CS = LOW	**0**	A[6]	A[5]	A[4]	A[3]	A[2]	A[1]	A[0]	DI [7]	DI [6]	DI [5]	DI [4]	DI [3]	DI [2]	DI [1]	DI [0]	CS = HIGH

Figure 12: SPI write protocol

7.3.2 SPI read operation

The read operation starts with the CS = LOW and sending the 7-bit register address with R/W bit = '1' (read command). Data is sent out from the sensor through the SDA line. The SPI read protocol is shown in the figure 13.

Start	$R/\overline{W}$	Register address							Data from indexed register								Stop
CS = LOW	**1**	A[6]	A[5]	A[4]	A[3]	A[2]	A[1]	A[0]	DI [7]	DI [6]	DI [5]	DI [4]	DI [3]	DI [2]	DI [1]	DI [0]	CS = HIGH

Figure 13: SPI read protocol

7.3.3 SPI timing parameters

Table 10 shows general SPI timing parameters. They are subject to VDD and the operating temperature.

Parameter	Symbol	Min	Max	Unit
SCL clock frequency	f_{SCL}		10 (1)	MHz
SPI clock cycle	t_{SCL}	100		ns
CS setup time	t_{SU_CS}	6		ns
CS hold time	t_{h_CS}	6		ns
SDA input setup time	t_{SU_SDA}	5		ns
SDA input hold time	t_{h_SDA}	15		ns
SAO valid output time	t_{v_SAO}		50	ns
SAO output hold time	t_{h_SAO}	9		ns
SAO output disable time	t_{dis_SAO}		50	ns

Table 10: SPI timing parameters

1. *Recommended maximum SPI clock frequency for ODR $\leq$ 50 Hz is 8 MHz*

8 Quick start guide

This chapter describes the sensor communication check and operation sequence of the humidity sensor.

8.1 Communication check

After proper powering of the sensor, the first step is to check the communication of the sensor with an I^2C or SPI digital interface. It can be verified by reading the *DEVICE_ID* register (0x0F). If the value from the *DEVICE_ID* register (0x0F) is 0xBC, then communication from master to sensor is successful.

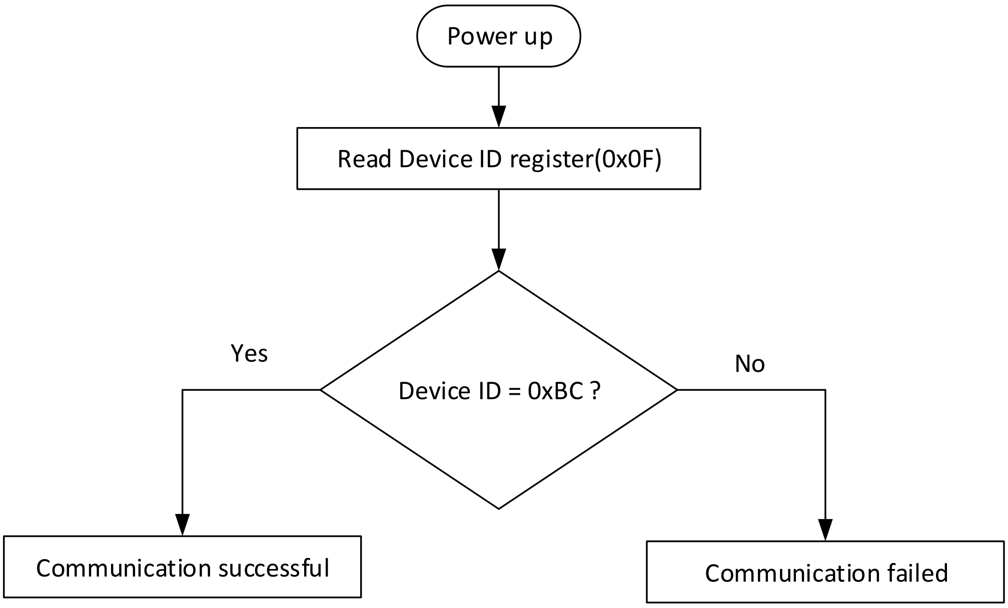


Figure 14: Communication check

8.2 Sensor in operation

The following flow chart is an example for sensor initialization in continuous mode operation with output data rate of 1 Hz.

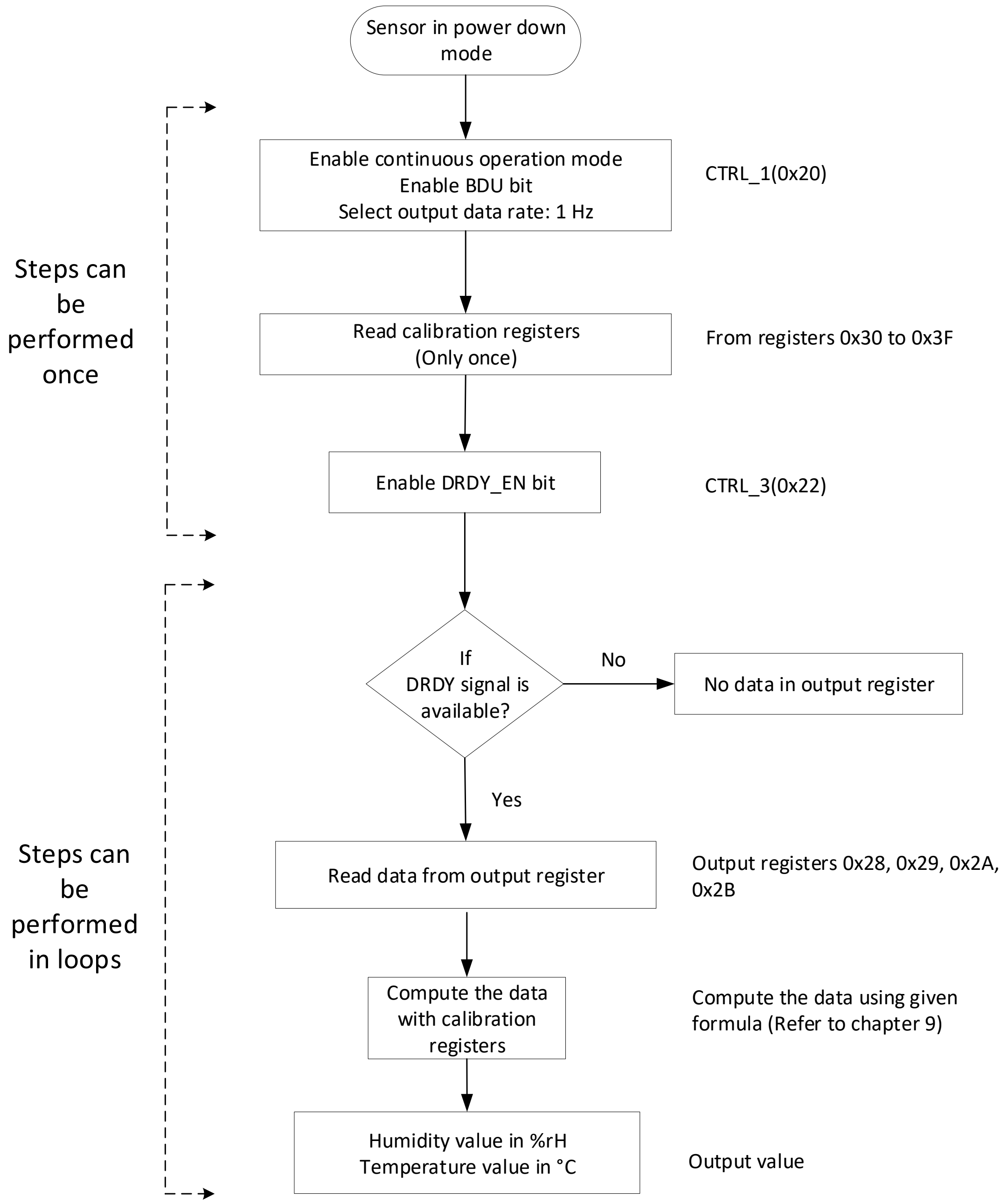


Figure 15: Sensor in continuous mode operation

The initialization of the sensor can be performed by selecting the operation mode and output data rate. After initialization of the sensor, it is recommended to check the availability of data samples using DRDY signal at *INT* pin.

One shot mode can be triggered using ONE SHOT bit in *CTRL_2* register (0x21). After triggering the one shot mode, it is recommended to check the availability of data samples using H_DA and T_DA bit status in *STATUS* register (0x22). When new measurement is completed ONE SHOT bit automatically set to '0'. The H_DA and T_DA bits are automatically set to '0' after output values are read by host controller.

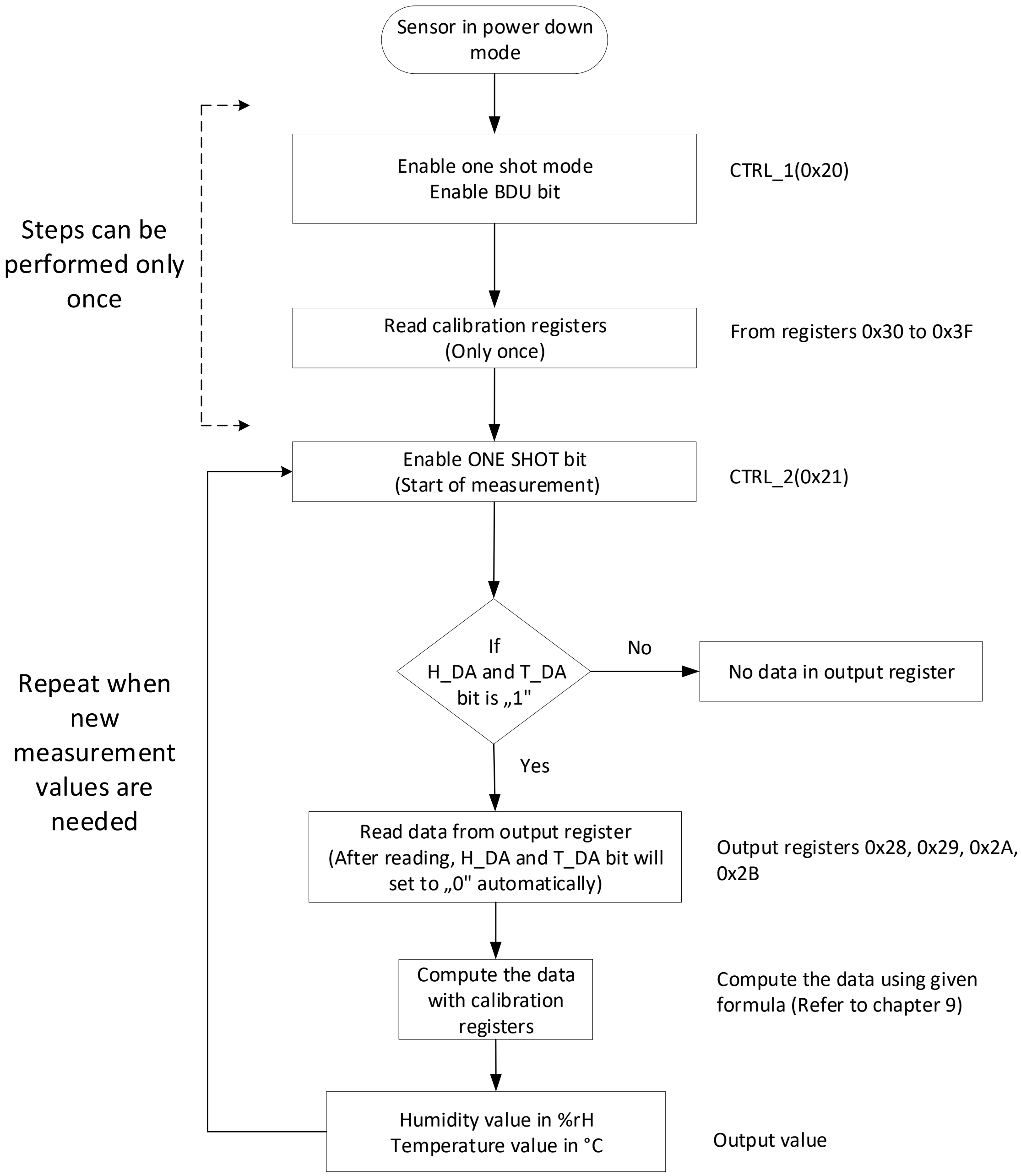


Figure 16: Sensor in one shot mode operation

9 Operating modes

The humidity sensor can be operated in two different modes. Operating modes can be selected by PD bit and ODR[1:0] bits in the *CTRL_1* register(0x20) and ONE SHOT bit in the *CTRL_2* register(0x21).

- Continuous mode
- One shot mode

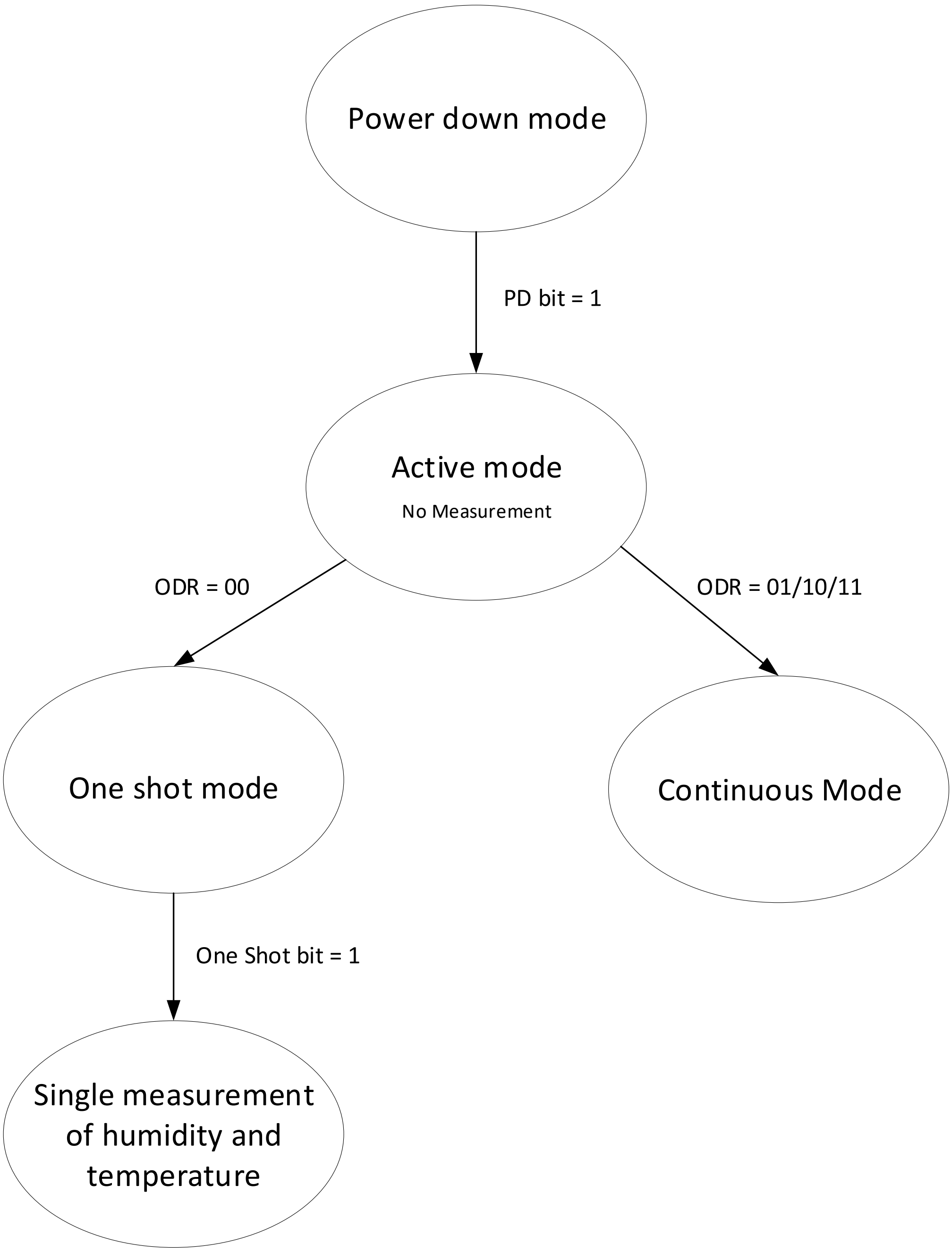


Figure 17: Operating modes

By default after powering up, the sensor goes to power down mode. In power down mode, all internal blocks are turned off to minimize the power consumption. After selecting one of the two operating mode, the sensor is in active measurement state depending on the output data rate.

9.1 Continuous mode

In the continuous mode, the sensor is in active measurement state for humidity and temperature values. The humidity and temperature values are available at a rate of selected output data rate in the table 11.

Three possible output data rates in the continuous mode are mentioned in table 11.

ODR[1:0]	Output data rate
00	One shot mode
01	1 Hz
10	7 Hz
11	12.5 Hz

Table 11: Output data rate

9.2 One shot mode

One shot mode can be used when the humidity and/or temperature values are necessary in much less than 1Hz period instead of continuous measurement value. An application example could be a room monitoring system where humidity and temperature changes slowly with one measurement per 30 seconds is intended. This will also reduce the average power consumption of the sensor in comparison to continuous mode operation with 1Hz ODR.

Writing ONE SHOT bit to '1' in the *CTRL_2* register (0x21) will trigger a new measurement. After the new measurement is done, ONE SHOT bit in *CTRL_2* register (0x21) will automatically set to '0'. When new samples are available in the output registers, data ready bits H_DA and T_DA in *STATUS* register (0x27) will set to '1' notifying host controller that one shot measurement is completed and the values are ready to read.

10 Sensor output data

10.1 Humidity sensor

The humidity sensor values are obtained from two 8-bit output registers H_OUT_L (0x28) and H_OUT_H (0x29). These two 8-bit values are concatenated to form a 16-bit word, which is represented in 2's complement. The relative humidity value is calculated by linear interpolation method using values from humidity output registers H_OUT_L (0x28) and H_OUT_H (0x29) along with calibration registers.

10.2 Steps to calculate humidity output value

Step 1 to step 6 can be performed only once

1. Read the coefficient values from the registers H0_rH_x2 (0x30) and H1_rH_x2 and (0x31)
2. Divide the coefficient values by 2 to get H0_rH and H1_rH:
   H0_rH = (H0_rh_x2)/2 and H1_rH = (H1_rh_x2)/2
3. Read the values from registers HIDS_H0_T0_OUT_L_REG (0x36) and HIDS_H0_T0_OUT_H_REG (0x37)
4. Concatenate the values using the content of registers HIDS_H0_T0_OUT_L_REG (0x36) as LSB and HIDS_H0_T0_OUT_H_REG (0x37) as MSB to obtain a signed 16-bit value H0_T0_OUT (this is the humidity calibration value H0)
5. Read the values from register HIDS_H1_T0_OUT_L_REG (0x3A) and HIDS_H1_T0_OUT_H_REG (0x3B).
6. Concatenate the values using the content of registers HIDS_H1_T0_OUT_L_REG (0x3A) as LSB and HIDS_H1_T0_OUT_H_REG (0x3B) as MSB to obtain a signed 16-bit value H1_T0_OUT (this is the humidity calibration value H1)
7. Read the raw values from humidity output register HIDS_H_OUT_L_REG (0x28) and HIDS_H_OUT_H_REG (0x29)
8. Concatenate the values using the content of registers HIDS_H_OUT_L_REG (0x28) as LSB and HIDS_H_OUT_H_REG (0x29) as MSB to obtain 16-bit signed value H_T_OUT (this is the RAW humidity value)
9. Calculate the relative humidity value in % rH using below formula (linear interpolation) from calibration values and humidity RAW value.

$$Humidtiy = \frac{(H1\_rH - H0\_rH).(H\_T\_OUT - H0\_T0\_OUT)}{(H1\_T0\_OUT - H0\_T0\_OUT)} \quad (1)$$

$$Humidity(\%\ relative\ Humidity) = Humidity + H0\_rH \quad (2)$$

Equation 2 gives the humidity values in %rH. The software drivers must clip output value exceeding the measurement range of the humidity sensor.

This scheme is implemented in our sensor SDK in the WSEN_HIDS folder and available as sourcecode via Github

10.3 Temperature sensor

The temperature sensor values are obtained from two 8-bit output registers T_OUT_L (0x2A) and T_OUT_H (0x2B). These two 8-bit values are concatenated to form a 16-bit word, which is represented in 2's complement.

The most significant bit (MSB) of the T_OUT_H register indicates the polarity of temperature output value.

- If the sign bit is '0', then the value read is positive.
- If the sign bit is '1', then the value read is negative. In this case, take 2's complement of the entire word.

The temperature value is calculated by linear interpolation method using values from the temperature output registers T_OUT_L (0x2A) and T_OUT_H (0x2B) along with calibration registers.

10.4 Steps to calculate temperature output value

> Step 1 to step 13 can be performed only once

1. Read the coefficient value from the register T1_T0 (0x35) and store it in a variable 'tmp'.
2. Read the coefficient value from the register T0_degC_x8 (0x32) and store it in a variable 'buffer'.
3. Perform logic AND operation between 'tmp' and 0x03 and left shift by 8 bits.
   x = ((tmp & 0x03) << 8)
4. Perform logic OR operation between x and 'buffer' to get T0_degC_x8.
   T0_degC_x8 = x | buffer
5. Divide the coefficient value of T0_degC_x8 by 8 to get T0_degC.
   T0_degC = (T0_degC_x8)/8
6. Read the coefficient value from the register T1_degC_x8 (0x33) and store it in a variable 'buffer'.
7. Perform logic AND operation between 'tmp' and 0x0C and left shift by 6 bits.
   y = ((tmp & 0x0C) << 6)
8. Perform logic OR operation between y and 'buffer' to get T1_degC_x8.
   T1_degC_x8 = y | buffer
9. Divide the coefficient value of T1_degC_x8 by 8 to get T1_degC.
   T1_degC = (T1_degC_x8)/8

10. Read the values from register HIDS_T0_OUT_L_REG (0x3C) and HIDS_T0_OUT_H_REG (0x3D)
11. Concatenate the values using the content of registers HIDS_T0_OUT_L_REG (0x3C) as LSB and HIDS_T0_OUT_H_REG (0x3D)to obtain a signed 16-bit value of T0_OUT (this is the temperature calibration T0)
12. Read the values from register HIDS_T1_OUT_L_REG (0x3E) and HIDS_T1_OUT_H_REG (0x3F)
13. Concatenate the values using the content of registers HIDS_T1_OUT_L_REG (0x3E) as LSB and HIDS_T1_OUT_H_REG (0x3F) as MSB to obtain a signed 16-bit value of T1_OUT (this is the temperature calibration value T1)
14. Read the raw temperature values from the registers HIDS_T_OUT_L (0x2A) and HIDS_T_OUT_M (0x2B)
15. Concatenate the values using the content of registers HIDS_T_OUT_L (0x2A) as LSB and HIDS_T_OUT_H (0x2B) as MSB to obtain 16-bit word of T_OUT (this is the RAW temperature value)
16. Calculate the temperature value in °C using below formula from calibration values and temperature RAW value.

$$Temperature = \frac{(T1\_degC - T0\_degC) * (T\_OUT - T0\_OUT)}{(T1\_OUT - T0\_OUT)} \quad (3)$$

$$Temperature(degree\ Celsius) = Temperature + T0\_degC \quad (4)$$

Equation 4 gives the temperature values in °C.

WSEN_HIDS humidity sensor SDK is implemented with the above steps. The sensor SDK is available in github. *https://github.com/WurthElektronik*

11 Sensor register mapping

Register Addr (Hex)	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type	Comments
0x0F	*DEVICE_ID*	1	0	1	1	1	1	0	0	R	Device ID of the sensor
0x10	Average	Reserved[1]		AVG_T[2:0]			AVG_H[2:0]			R/W	Internal average register
0x20	*CTRL_1*	PD	Reserved[1]				BDU	ODR[1:0]		R/W	Control registers
0x21	*CTRL_2*	BOOT	Reserved[1]					Heater	ONE SHOT	R/W	
0x22	*CTRL_3*	DRDY_H_L	PP_OD	Reserved[1]			DRDY_EN	Reserved[1]		R/W	
0x27	*STATUS*	Reserved[1]						H_DA	T_DA	R/W	Status register
0x28	*H_OUT_L*	H_OUT_L[7:0]								R	Output registers
0x29	*H_OUT_H*	H_OUT_H[7:0]								R	
0x2A	*T_OUT_L*	T_OUT_L[7:0]								R	
0x2B	*T_OUT_H*	T_OUT_H[7:0]								R	
0x30 - 0x3F	*Calibration*	-								R	Calibration registers

11.1 Calibration Register mapping

Register Addr (Hex)	Name	Format	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
0x30	*H0_rH_x2*	u8	H_0[7:0]								R
0x31	*H1_rH_x2*	u8	H_1[7:0]								R
0x32	*T0_degC_x8*	u8	T_degC_0[7:0]								R
0x33	*T1_degC_x8*	u8	T_degC_1[7:0]								R
0x35	*T1_T0*	u2	Reserved[1]				T_1[1:0]		T_0[1:0]		R
0x36	*H0_T0_OUT*	s16	H0_T0_OUT_L[7:0]								R
0x37			H0_T0_OUT_H[7:0]								R
0x3A	*H1_T0_OUT*	s16	H1_T0_OUT_L[7:0]								R
0x3B			H1_T0_OUT_H[7:0]								R
0x3C	*T0_OUT*	s16	T0_OUT_L[7:0]								R
0x3D			T0_OUT_H[7:0]								R
0x3E	*T1_OUT*	s16	T1_OUT_L[7:0]								R
0x3F			T1_OUT_H[7:0]								R

- u8: unsigned 8-bit
- s16: signed 16-bit using 2’s complement
- 10-bit T0 Temperature calibration value: 8-bit T_degC_0[7:0] from the register (0x32) and 2 bit T_0[1:0] from the register (0x35)
- 10-bit T1 Temperature calibration value: 8-bit T_degC_1[7:0] from the register (0x33) and 2 bit T_1[1:0] from the register (0x35)

[1] *The registers contents are loaded at boot procedure should not be changed. They contain the factory calibration values and their content is automatically restored when the device is powered up.*

Writing to Reserved marked in the registers is not allowed. Writing to those reserved marked bits may cause permanent damage to the sensor.

The content of the calibration registers should not be changed.

12 Register description

12.1 Device_ID (0x0F)

The value of this register gives the device ID: 0xBC (b10111100)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
1	0	1	1	1	1	0	0	R

Table 12: *Device_ID* register

12.2 Average (0x10)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
Reserved		AVG_T[2:0]			AVG_H[2:0]			R/W

Table 13: *Average* register

bits	Description
AVG_T[2:0]	Internal averaging of the samples for temperature output values
AVG_H[2:0]	Internal averaging of the samples for humidity output values

Table 14: Average register description

AVG_T[2:0] / AVG_H[2:0]	Number of samples averaged (Temperature)	Number of samples averaged (Humidity)	Noise (°C)	Noise (% rH)
000	2	4	0.08	1.14
001	4	8	0.05	0.54
010	8	16	0.04	0.37
011[1]	16	32	0.03	0.35
100	32	64	0.02	0.11
101	64	128	0.015	0.009
110	128	256	0.01	0.05
111	256	512	0.007	0.03

Table 15: Number of internal averaging samples

1. Default configuration after power up

12.3 CTRL_1 (0x20)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
PD	Reserved				BDU	ODR[1:0]		R/W

Table 16: *CTRL_1* register

bits	Description
PD	Power down. By default, PD: 0 which is power down mode. PD: 1 Continuous mode for active measurement
BDU	Block data update. 0: Continuous update, 1: Output registers are not updated until MSB and LSB is read
ODR[1:0]	Output data rate of the humidity and temperature value

Table 17: CTRL_1 register description

12.3.1 Block data update (BDU)

It is strongly recommended to set the BDU bit to '1' in the *CTRL_1* register. By default the BDU bit is '0' and the output registers are continuously updated. When the BDU bit is set to '1' the content of the output registers is not updated until both MSB and LSB are read. It avoids reading values related to different samples. As soon as the BDU is activated, the output registers always contain the most recent output data produced by the sensor. If the processor initiate the read function of the output registers *T_OUT_L*, *T_OUT_H*, *H_OUT_L* and *H_OUT_H*, the update for that pair is blocked until both MSB and LSB of the data is read.

ODR[1:0]	Output data rate
00	One shot mode
01	1 Hz
10	7 Hz
11	12.5 Hz

Table 18: Output data rate

12.4 CTRL_2 (0x21)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
BOOT	Reserved					Heater	ONE SHOT	R/W

Table 19: *CTRL_2* register

bits	Description
BOOT	Reboot memory content. 0: normal mode, 1: reboot memory content
Heater	Heater enable/disable. By default 0: disable, 1: enable
ONE SHOT	One shot mode enable. By default 0: conversion done, 1: start of new conversion

Table 20: *CTRL_2* register description

12.4.1 BOOT

The content of the internal registers stored in the flash memory block can be refreshed using BOOT bit. After proper powering of the sensor, content of the flash memory is loaded to the internal registers. When the BOOT bit is set to '1' the content of the internal flash memory block is copied to the internal registers and also calibrates the sensor. Each sensor has different factory trimmed values stored in the internal flash memory. The content in the flash memory copied to internal registers permit good performance of the sensor. Therefore the content of the internal registers should not be modified.

12.4.2 Heater

In case of condensation on the sensor, heater can be turned on using Heater bit. The heating of the sensor element will speed up the recovery time of the sensor after condensation. During active heating, the humidity and temperature output values should not be read. It is also recommended that output values should not be read immediately after turning off the heater.

Supply voltage (V)	Current consumption (mA)
3.3	33

Table 21: Current consumption of the heater

12.5 CTRL_3 (0x22)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
DRDY_H_L	PP_OD	Reserved			DRDY_EN	Reserved		R/W

Table 22: *CTRL_3* register

bits	Description
DRDY_H_L	DRDY output signal on INT pin: Active high/low. Default value: 0 (0: active high, 1: active low)
PP_OD	Push pull or open drain selection on INT pin. Default value: 0 (0: Push-pull, 1: open drain)
DRDY_EN	Data ready interrupt enable on INT pin. Default value: 0 (0: disabled, 1: enabled)

Table 23: *CTRL_3* register description

12.6 STATUS (0x27)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
Reserved						H_DA	T_DA	R

Table 24: *STATUS* register

bits	Description
H_DA	Humidity data available (0: no humidity data is available in the output registers, 1: new humidity data is available in the output registers). As soon as the H_OUT_H register is read, the H_DA bit is set to '0'
T_DA	Temperature data available (0: no temperature data is available in the output registers, 1: new temperature data is available in the output register). As soon as the T_OUT_H is read, the T_DA bit is set to '0'

Table 25: STATUS register description

12.7 H_OUT_L (0x28)

The value of the humidity output registers *H_OUT_L*(0x28) and *H_OUT_H*(0x29) is expressed in 16-bit resolution. Please refer chapter `10.1` to obtain the humidity value from 16-bit values of the output registers.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
HUMIDITY[7:0]								R

Table 26: *H_OUT_L* register

bits	Description
HUMIDITY[7:0]	8 least significant bits (LSB) of the humidity sensor output

Table 27: *H_OUT_L* register description

12.8 H_OUT_H (0x29)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
HUMIDITY[7:0]								R

Table 28: *H_OUT_H* register

bits	Description
HUMIDITY[7:0]	8 most significant bits (MSB) of the humidity sensor output

Table 29: *H_OUT_H* register description

The software drivers must clip output values exceeding the measurement range of the humidity sensor.

12.9 T_OUT_L (0x2A)

The value of the temperature output registers *T_OUT_L*(0x2A) and *T_OUT_H*(0x0E) is expressed in 16-bit resolution. Please refer chapter `10.3` to obtain the temperature value from 16-bit values of the output registers.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
TEMP[7:0]								R

Table 30: *T_OUT_L* register

bits	Description
TEMP[7:0]	8 least significant bits (LSB) of the temperature sensor output

Table 31: *T_OUT_L* register description

12.10 T_OUT_H (0x2B)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Type
TEMP[7:0]								R

Table 32: *T_OUT_H* register

bits	Description
TEMP[7:0]	8 most significant bits (MSB) of the temperature sensor output

Table 33: *T_OUT_H* register description

13 Physical specifications

13.1 Module drawing

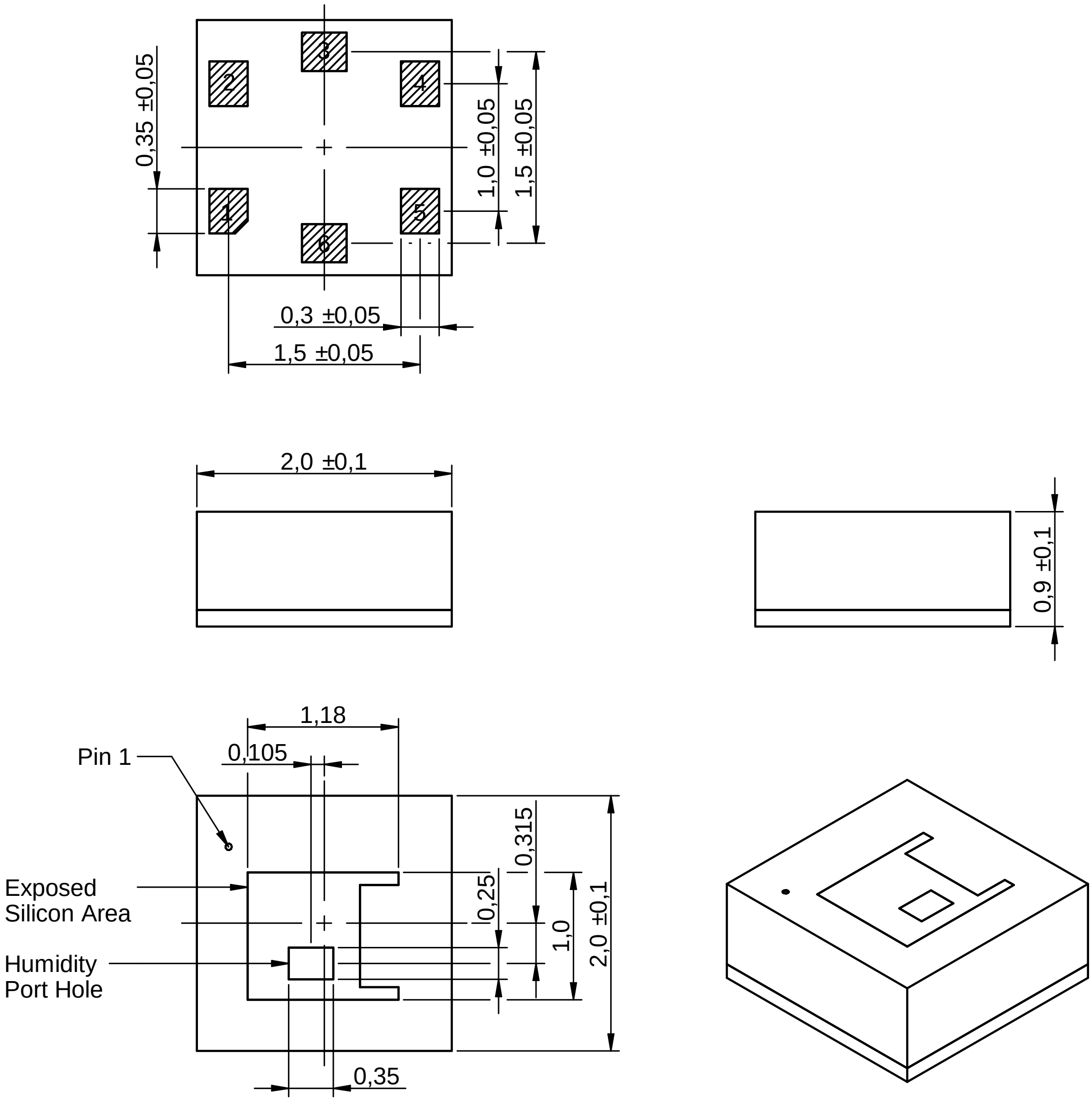


Figure 18: Sensor dimension [mm]

13.2 Footprint

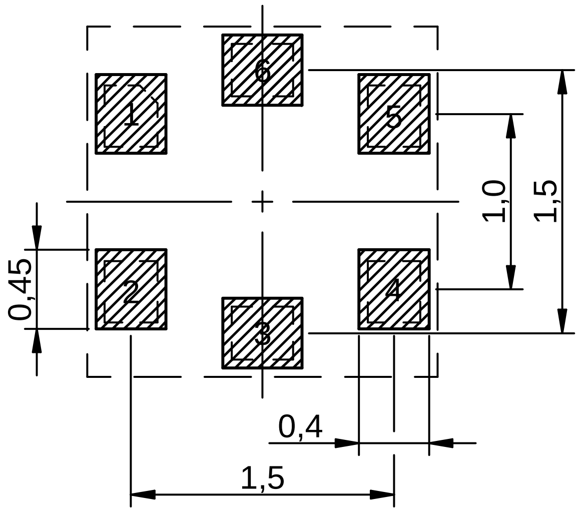


Figure 19: Recommended land pattern [mm] (top view)

14 MEMS Sensor PCB Design Guidelines

The following design guidelines for PCB, soldering, solder paste, stencil and re-flow process must be considered as a good hardware design practice for Würth Elektronik eiSos MEMS sensor products. Not following these guidelines will result in poor performance from the Würth Elektronik eiSos MEMS Sensors. e.g. offset, offset vs temperature, accuracy and accuracy vs temperature.

14.1 PCB Design rules

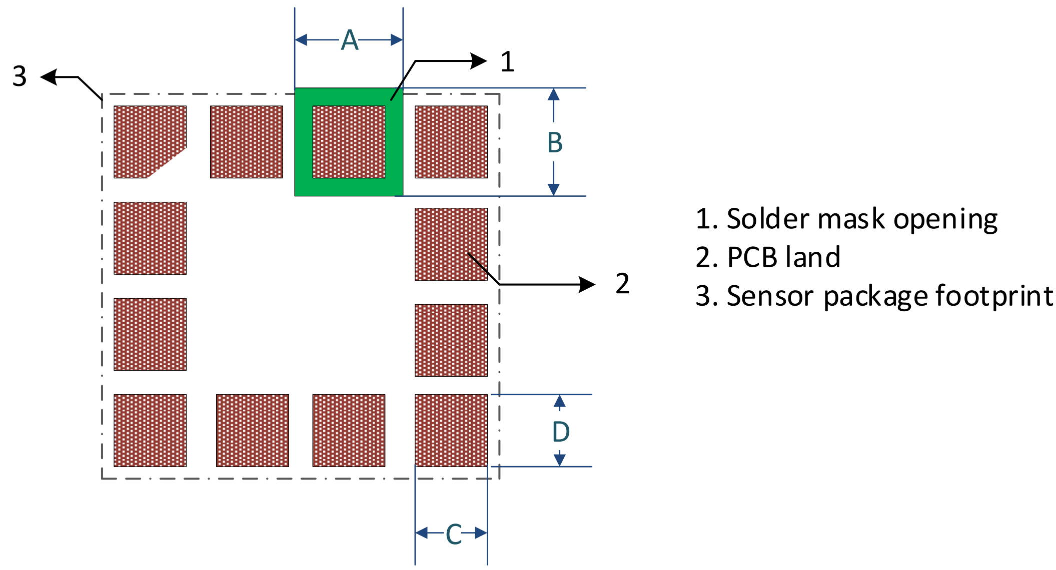


Figure 20: PCB land and solder mask recommendations for sensors with LGA package

Dimension	LGA pad spacing > 200 μm	LGA pad spacing $\leq$ 200 μm
PCB land width: C	LGA solder pad width + 0.1 mm	LGA solder pad width
PCB land length: D	LGA solder pad length + 0.1 mm	LGA solder pad length

Table 34: PCB land design dimensions

Dimension	Description
Solder mask opening width: A	PCB land length + 0.1 mm
Solder mask opening length: B (when applicable)	PCB land length + 0.1 mm

Table 35: Solder mask opening dimensions

Any structure underneath the sensor should be avoided

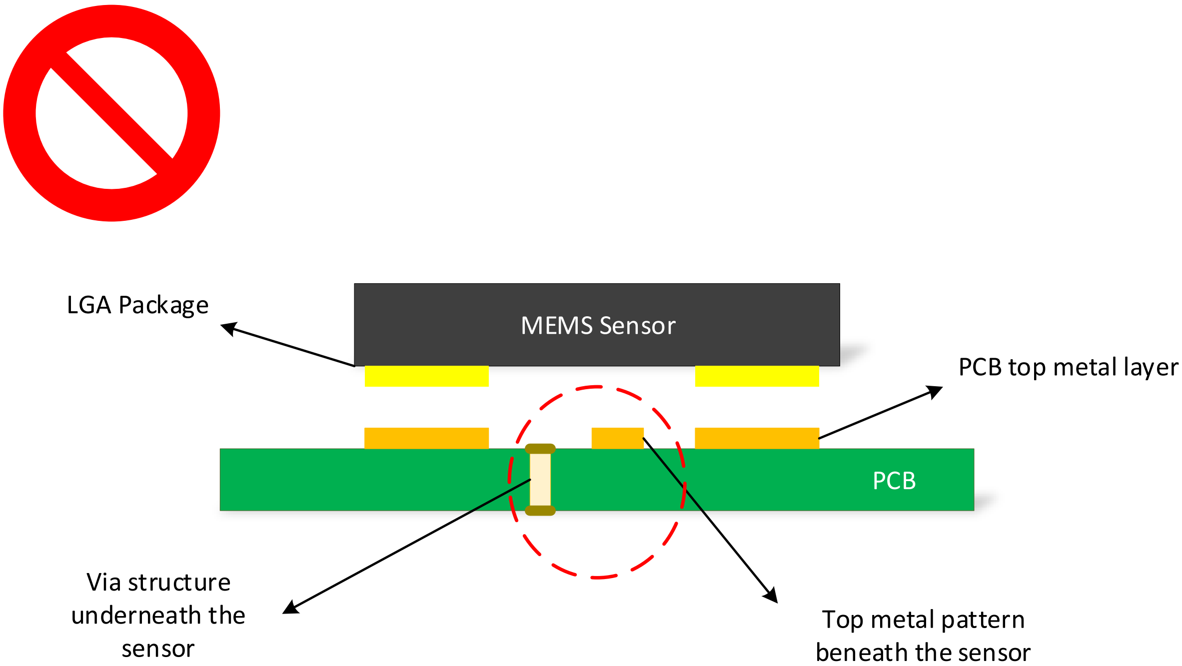


Figure 21: Incorrect PCB design

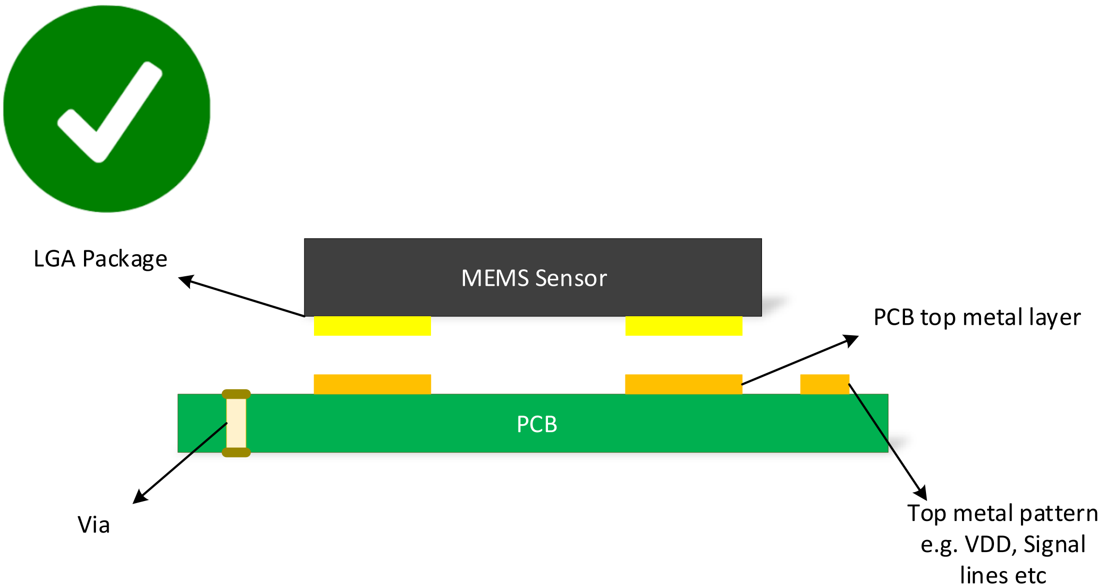


Figure 22: Correct PCB design

Placing any Screw mounting holes, vias and components at a distance greater than 2mm away from the sensor is highly recommended to get optimal performance of the sensor.

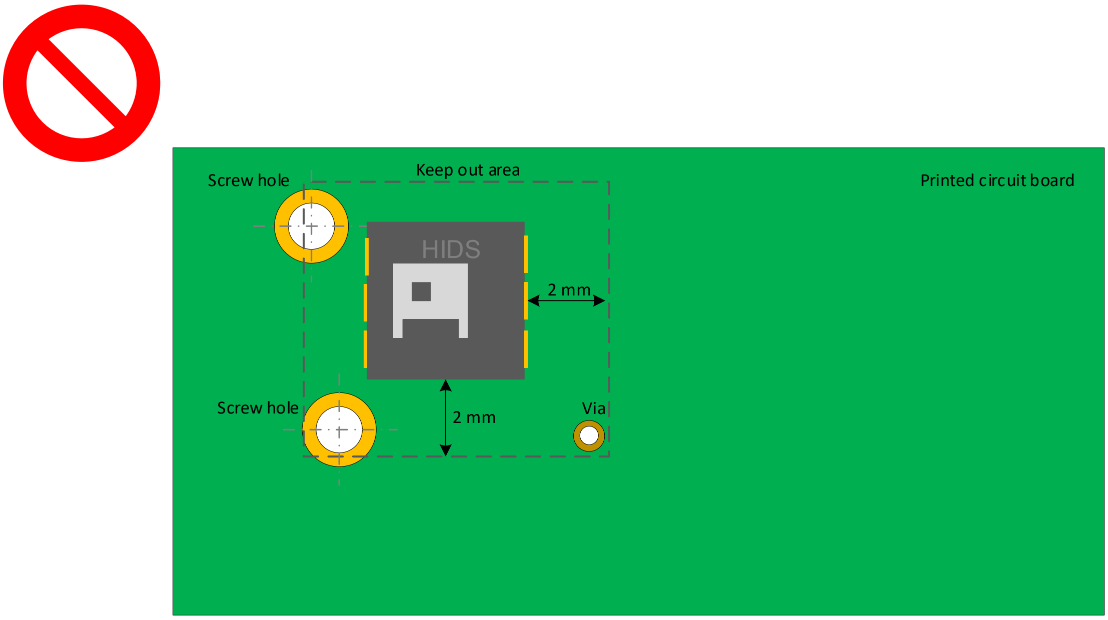


Figure 23: Components inside sensor keep out area

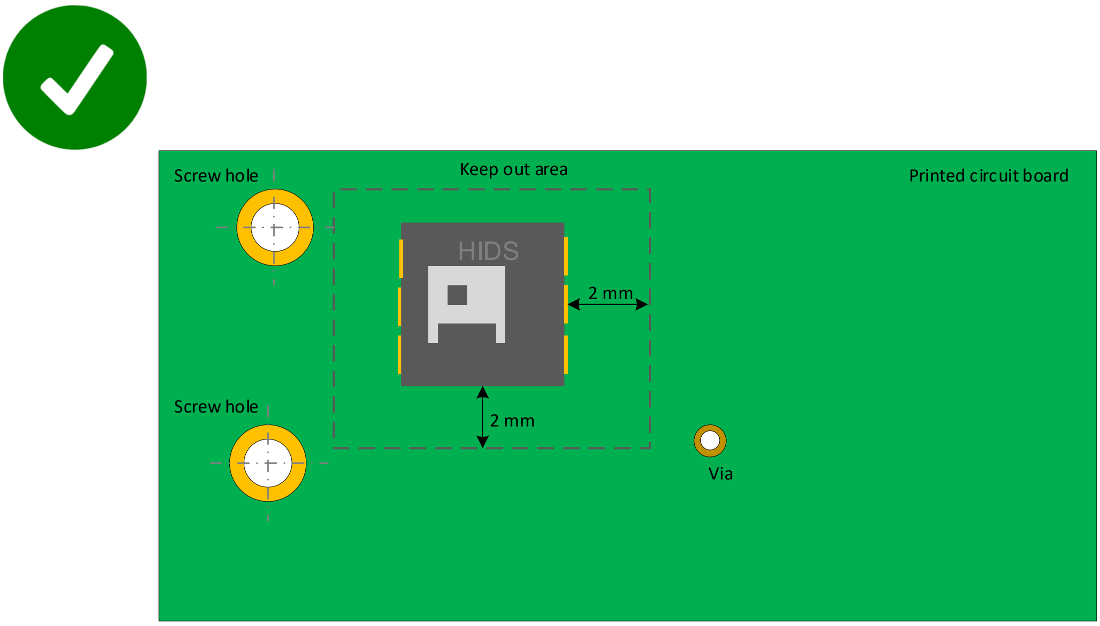


Figure 24: Components outside sensor keep out area

In order to improve the sensor thermal decoupling from the system/PCB, it is recommended to have thermal cut around the sensor which removes all unnecessary metal from the PCB around the sensor.

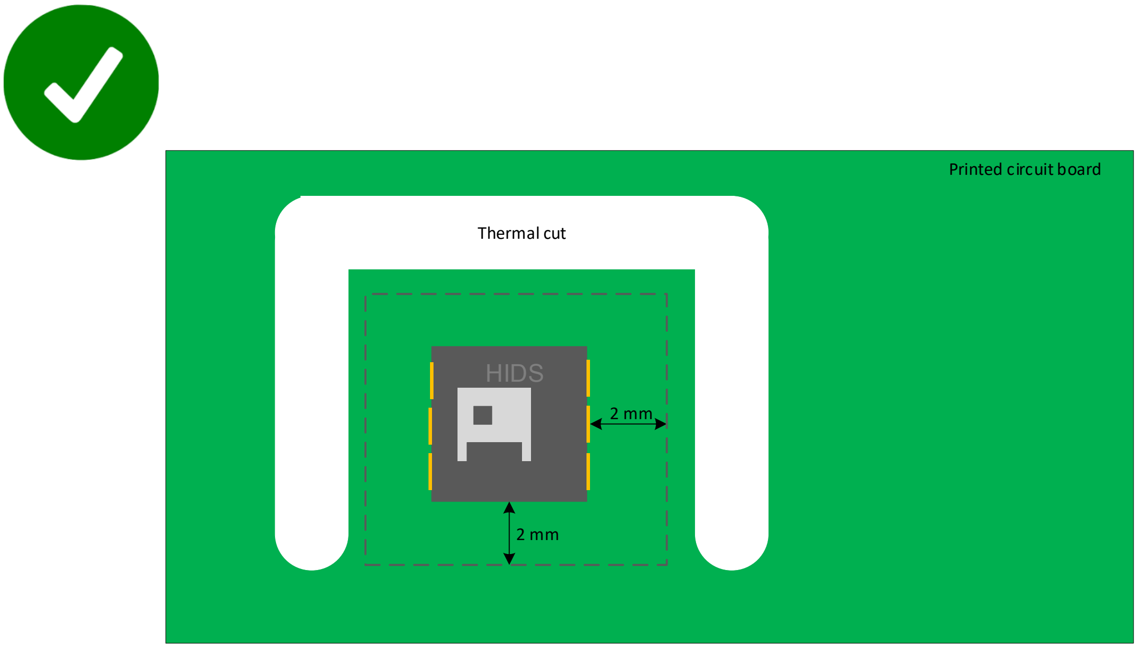


Figure 25: Thermal cut around the sensor

14.2 Guidelines for PCB Design

- The solder mask opening external to the PCB land is highly recommended. Please refer to figure 20.
- It is recommended to define a keep-out area for the sensor. Any structure underneath the sensor should be avoided.
- The traces connected to the pads should be as symmetrical as possible. Symmetry and balance to the pad connections will help the sensor self-align which leads to better control of solder paste reduction after reflow.
- Screw mounting holes at a distance greater than 2mm from the sensor is highly recommended to get optimal performance of the sensor.
- We recommend to separate digital ground from analog ground in the PCB, if enough space or layer is available. The relatively large, sharp pulses of digital current transitions might affect the precise analog signals if the two signals are not separated.

It is generelly recommended to reduce the PCB thickness (e.g. $\leq$ 1.6 mm). Intrinsic stress during PCB bending is less in thin PCBs

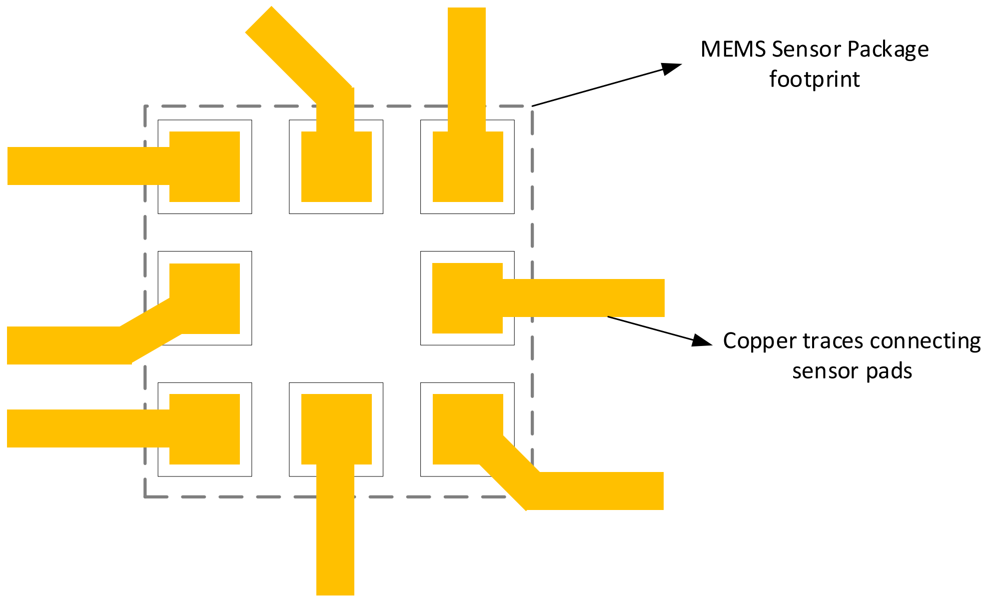


Figure 26: Asymmetrical trace and sensor pad connections

Information of the PCB design and soldering processes provided in this document is considered for use as a reference.

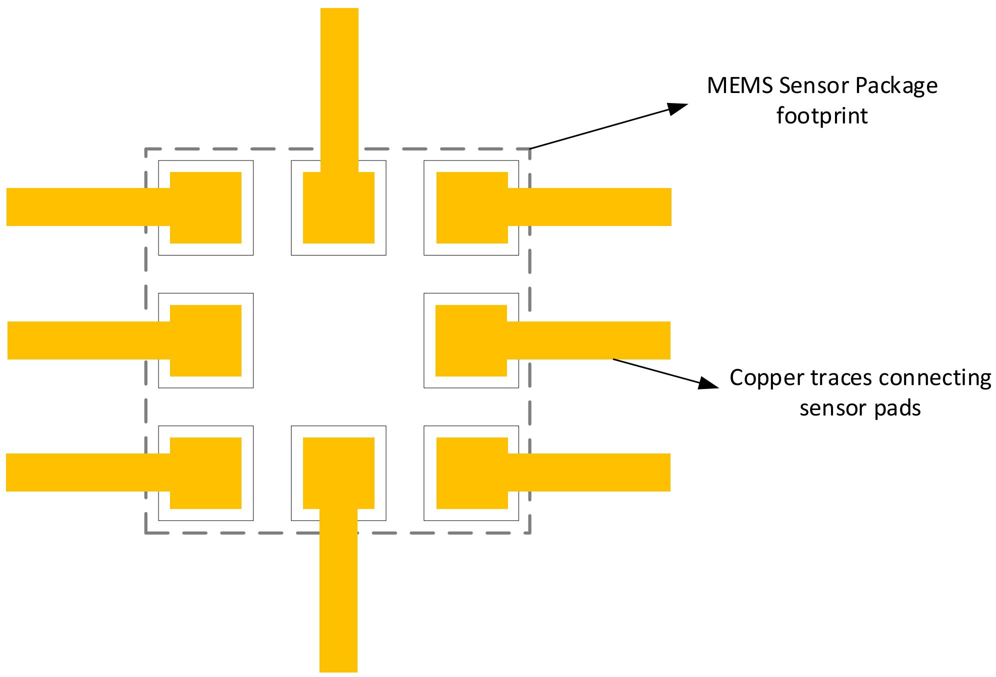


Figure 27: Symmetrical trace and sensor pad connections

PCB land design and connecting traces should be designed symmetrically

For sensor specific information please refer to corresponding data sheet of the product.

14.3 Guidelines for soldering

The following soldering guidelines should be taken into consideration for a common PCB design and industrial practices.

14.3.1 Before soldering

- Routing traces and vias below the sensor should be avoided. The active signals that are routed under may interfere with the MEMS sensor, which will affect the sensor performance.
- It is not necessary to have large traces on VDD/GND line, as the power consumption of the MEMS sensors are very low.
- For best performance of the sensor, design a ground plane under the sensor in order to reduce the PCB signal noise from the board.
- The placement of the MEMS sensor on the PCB should avoid locations in close proximity to heat sources e.g. microprocessors, batteries, graphic controllers etc.
- Push-buttons, screws and PCB anchor points can produce mechanical stress onto the PCB, hence the sensor placement close to these components should be avoided.
- PCB bending will induce mechanical stress to the sensor therewith influence the sensor performance.

14.3.2 After soldering

- In general, high-amplitude resonant vibrations of the PCB should be avoided. It could possibly damage the MEMS structure.
- The thickness of solder paster must be uniform to reduce the inconsistent stress on the sensor.
- Solder paste must be as thick as possible to reduce the decoupling stress and to avoid the PCB solder mask touching the device package.

14.4 Guidelines for stencil design and solder paste

For proper mounting process of the MEMS sensor, thickness and soldering paste pattern are very important.

- Stencil thickness of 90 - 150 μm (3.5 - 6 mils) is recommended for screen printing.
- Stainless steel stencils are recommended for solder paste application.
- The signal pad openings of the stencil should be between 70% and 90% of the PCB pad area.
- It is recommended that for better solder paste release, the aperture walls should be trapezoidal and the corners rounded.
- The stencil and printed circuit assembly should be aligned to within 25 μm (1 mil) before applying the solder paste.

14.5 Guidelines for process considerations

- To reduce the residual stress on the components, the recommended ramp-down temperature slope should not exceed -3 ℃/s.
- LGA packages show metal traces on the side of the package, hence no solder material reflow on the side of the package is allowed.
- The final volume of the solder paste applied to a single PCB land should be less than 20% of the volume of the solder paste of all pads of one device.
- It is not possible to define a specific soldering profile only for the sensors. The soldering profile depends on the number, size and placement of the components in the application board.
- Customer should use a time and temperature reflow profile based on PCB design and manufacturing knowledge.
- No-clean solder paste is recommended for assembly of the MEMS sensor to prevent further cleaning steps.
- Sensor with opening surface on top should be handled carefully. Do not pick the component with vacuum tools which make direct contact with the opening of the sensor.

It is recommended to use a standard pick and place process and equipment. Do not use the hand soldering process.

15 Manufacturing information

15.1 Moisture sensitivity level

The sensor product is categorized as JEDEC Moisture Sensitivity Level 3 (MSL3), which requires special handling.

More information regarding the MSL requirements can be found in the IPC/JEDEC J-STD-020 standard on www.jedec.org. More information about the handling, picking, shipping and the usage of moisture/re-flow and/or process sensitive products can be found in the IPC/JEDEC J-STD-033 standard on www.jedec.org.

15.2 Soldering

15.2.1 Reflow soldering

Attention must be paid on the thickness of the solder resist between the host PCB top side and the modules bottom side. Only lead-free assembly is recommended according to JEDEC J-STD020.

Profile feature		Value
Preheat temperature Min	$T_{S\ Min}$	150 °C
Preheat temperature Max	$T_{S\ Max}$	200 °C
Preheat time from $T_{S\ Min}$ to $T_{S\ Max}$	t_S	60 - 120 seconds
Ramp-up rate (T_L to T_P)		3 °C / second max.
Liquidous temperature	T_L	217 °C
Time t_L maintained above T_L	t_L	60 - 150 seconds
Peak package body temperature	T_P	see table below
Time within 5 °C of actual peak temperature	t_P	20 - 30 seconds
Ramp-down Rate (T_P to T_L)*		6 °C / second max.
Time 20 °C to T_P		8 minutes max.

Table 36: Classification reflow soldering profile, Note: refer to IPC/JEDEC J-STD-020E

*** In order to reduce residual stress on the sensor component, the recommended ramp-down temperature slope should be lower than 3 °C /s.**

Package thickness	Volume mm^3 <350	Volume mm^3 350-2000	Volume mm^3 >2000
< 1.6mm	260 °C	260 °C	260 °C
1.6mm - 2.5mm	260 °C	250 °C	245 °C
> 2.5mm	250 °C	245 °C	245 °C

Table 37: Package classification reflow temperature, PB-free assembly, Note: refer to IPC/-JEDEC J-STD-020E

It is recommended to solder the sensor on the last re-flow cycle of the PCB. For solder paste use a LFM-48W or Indium based SAC 305 alloy (Sn 96.5 / Ag 3.0 / Cu 0.5 / Indium 8.9HF / Type 3 / 89%) type 3 or higher.

The reflow profile must be adjusted based on the thermal mass of the entire populated PCB, heat transfer efficiency of the re-flow oven and the specific type of solder paste used. Based on the specific process and PCB layout the optimal soldering profile must be adjusted and verified. Other soldering methods (e.g. vapor phase) have not been verified and have to be validated by the customer at their own risk. Rework is not recommended.

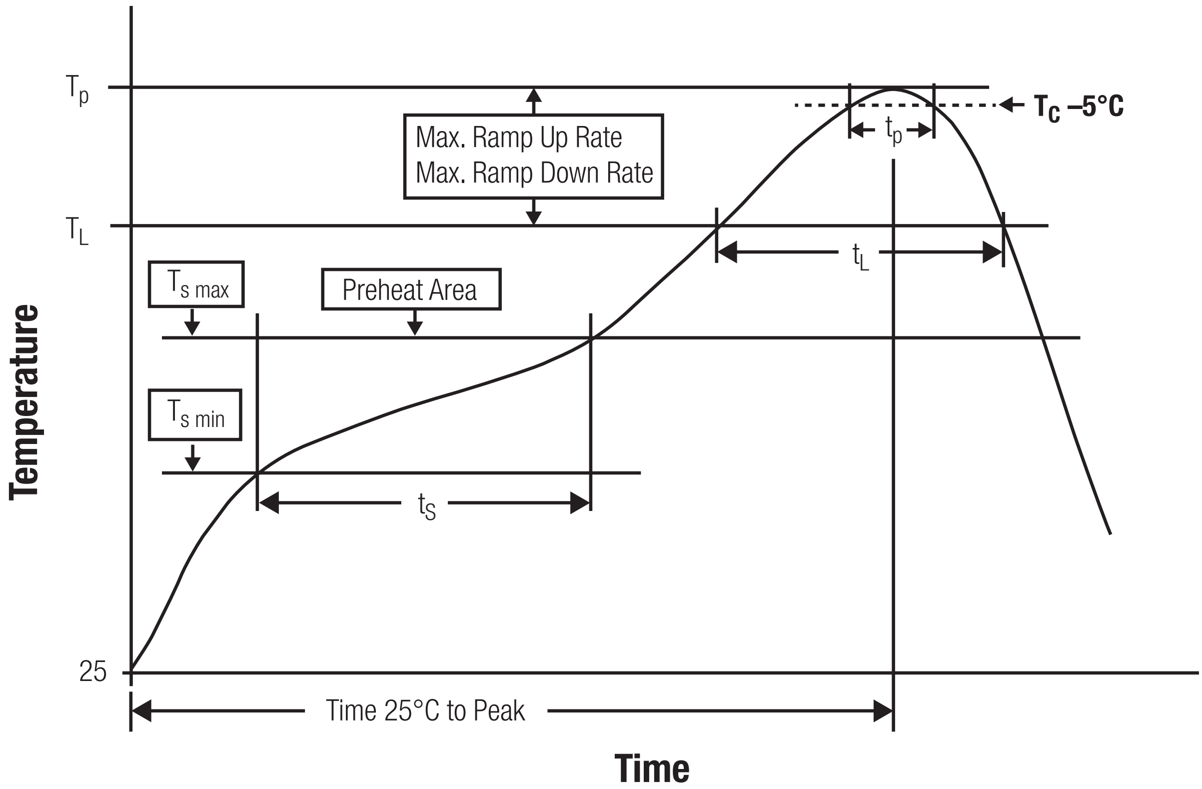


Figure 28: Reflow soldering profile

After reflow soldering, visually inspect the board to confirm proper alignment

15.2.2 Cleaning and washing

Do not clean the product. Any residue cannot be easily removed by washing. Use a "no clean" soldering paste and do not clean the board after soldering.

- Washing agents used during the production to clean the customer application might damage or change the characteristics of the component. Washing agents may have a negative effect on the long-term functionality of the product.
- Using a brush during the cleaning process may damage the component. Therefore, we do not recommend using a brush during the PCB cleaning process

15.2.3 Potting and coating

- Potting material might shrink or expand during and after hardening. This might apply mechanical stress on the components, which can influence the characteristics of the transfer function. In addition, potting material can close existing openings in the housing. This can lead to a malfunction of the component. Thus, potting is not recommended.
- Conformal coating may affect the product performance. We do not recommend coating the components.

15.2.4 Storage conditions

- A storage of Würth Elektronik eiSos products for longer than 12 months is not recommended. Within other effects, the terminals may suffer degradation, resulting in bad solderability. Therefore, all products shall be used within the period of 12 months based on the day of shipment.
- Do not expose the components to direct sunlight.
- The storage conditions in the original packaging are defined according to DIN EN 61760 - 2.
- For a moisture sensitive component, the storage condition in the original packaging is defined according to IPC/JEDEC-J-STD-033. It is also recommended to return the component to the original moisture proof bag and reseal the moisture proof bag again.

15.2.5 Handling

- Violation of the technical product specifications such as exceeding the nominal rated supply voltage, will void the warranty.
- Violation of the technical product specifications such as but not limited to exceeding the absolute maximum ratings will void the conformance to regulatory requirements.
- ESD prevention methods need to be followed for manual handling and processing by machinery.
- The edge castellation is designed and made for prototyping, i.e. hand soldering purposes only.
- The applicable country regulations and specific environmental regulations must be observed.
- Do not disassemble the product. Evidence of tampering will void the warranty.

16 Important notes

The following conditions apply to all goods within the sensors product range of Würth Elektronik eiSos GmbH & Co. KG:

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Some goods within the product range of Würth Elektronik eiSos GmbH & Co. KG contain statements regarding general suitability for certain application areas. These statements about suitability are based on our knowledge and experience of typical requirements concerning the areas, serve as general guidance and cannot be estimated as binding statements about the suitability for a customer application. The responsibility for the applicability and use in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to the customer to evaluate, where appropriate to investigate and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not. Accordingly, the customer is cautioned to verify that the documentation is current before placing orders.

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It has to be clearly pointed out that the possibility of a malfunction of electronic components or failure before the end of the usual lifetime cannot be completely eliminated in the current state of the art, even if the products are operated within the range of the specifications. The same statement is valid for all software and software parts contained in or used with or for products in the sensor product range of Würth Elektronik eiSos GmbH & Co. KG. In certain customer applications requiring a high level of safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health, it must be ensured by most advanced technological aid of suitable design of the customer application that no injury or damage is caused to third parties in the event of malfunction or failure of an electronic component.

16.3 Best care and attention

Any product-specific data sheets, manuals, application notes, PCN's, warnings and cautions must be strictly observed in the most recent versions and matching to the products revisions. This documents can be downloaded from the product specific sections on the wireless connectivity and sensors homepage.

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