

## XENSIV™ Integrated Thermal Conductivity Gas Sensor ASIL B

### Features

- Thermal conductivity sensing principle
- Insensitive to sensor poisoning
- Low lifetime offset drift of maximal  $\pm 0.1$  vol%H<sub>2</sub>
- Fully factory calibrated sensor, no need for further recalibration in the field
- Firmware compensates temperature, humidity- and pressure-effects
- Hydrogen measurement range 0 to 16 vol%
- Fast response time < 100 ms
- Measurement accuracy up to  $\pm 0.12$  vol%H<sub>2</sub>
- Ultra-low power consumption: typ. 112  $\mu$ A @1 meas./sec
- 1 Mbit/s I<sup>2</sup>C interface and 3.3 V supply voltage
- Autonomous operating mode for system level power saving
- ISO 26262 safety element out of context for safety requirements up to ASIL B
- 15 Years lifetime
- UL Recognition (FTAM2/FTAM8) according to UL 2075 and ULC 588



### Potential applications

- Automotive fuel cell hydrogen leakage measurement
- Automotive battery monitoring systems (thermal runaway detection)
- General industrial hydrogen leakage measurement

### Product validation

- Qualified for automotive applications according to AEC-Q100, grade 2
- Qualified for industrial applications according to the relevant tests of JEDEC JESD47L, JESD22, and J-STD-020

### Description

The product is designed for measuring the thermal conductivity of gases, e.g. hydrogen in air. It comprises a resistive full sensor bridge and an ASIC which provides a calibrated and temperature compensated digital output signal.

| Product name | Package        | Marking | Ordering code |
|--------------|----------------|---------|---------------|
| TCI-B        | PG-DSOSP-14-84 | TCIB    | SP006101806   |

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## 1 Functional block diagram

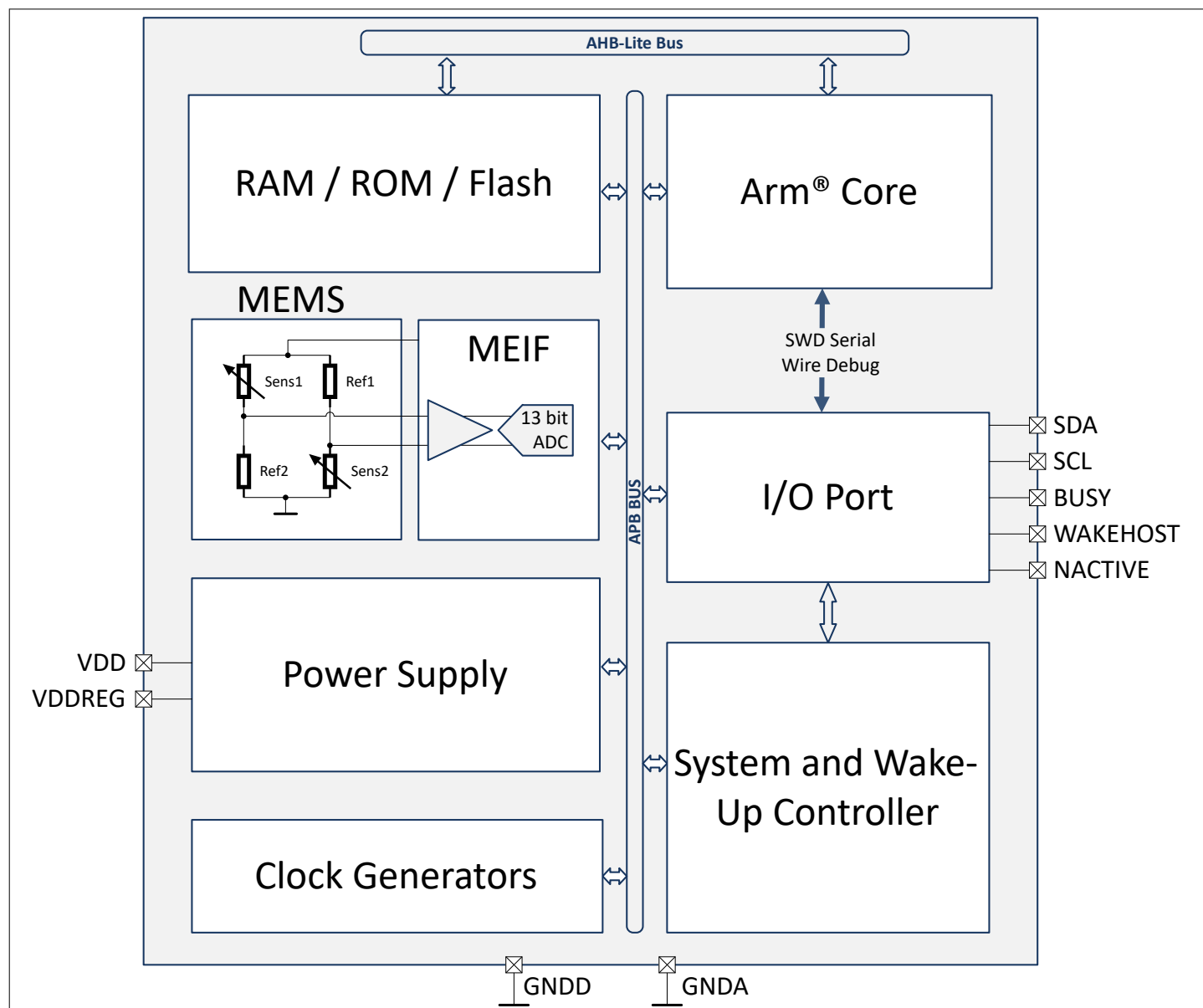


Figure 1 Functional block diagram

## 2 Pin configuration

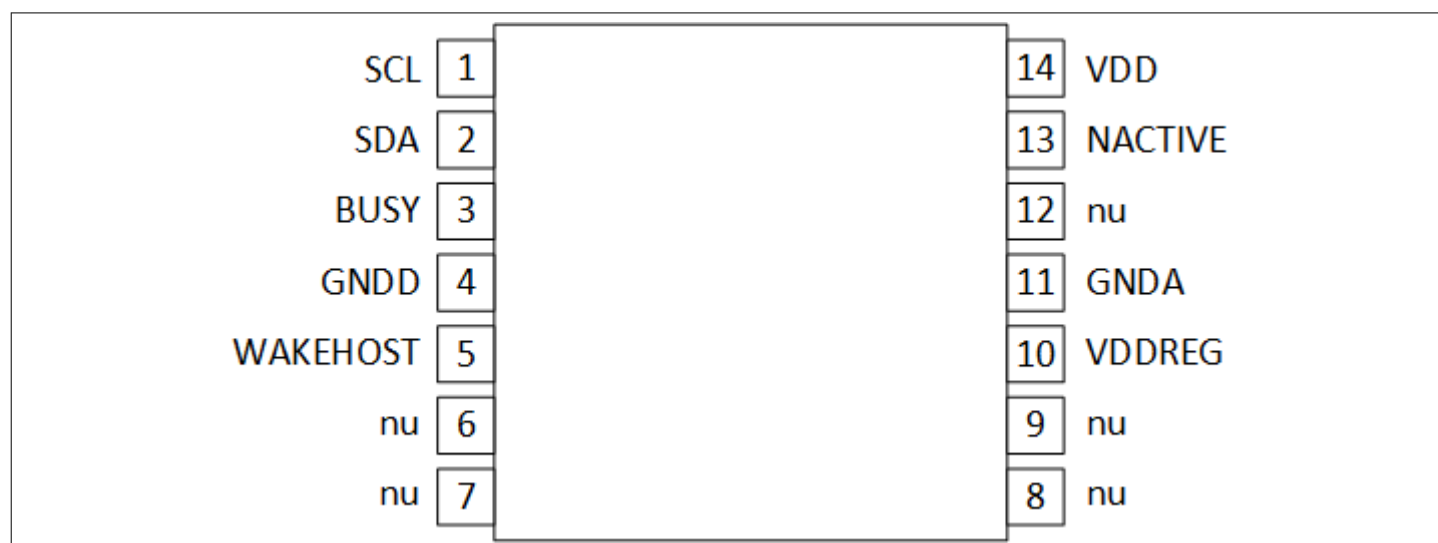


**Figure 2** Pin configuration

**Table 1** Pin definitions and function

| Pin no. | Symbol   | Function                                                                                                                             |
|---------|----------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1       | SCL      | I2C-SCL                                                                                                                              |
| 2       | SDA      | I2C-SDA or wake-up input <sup>1)</sup>                                                                                               |
| 3       | BUSY     | Device busy output (active high) or wake-up input <sup>1)</sup>                                                                      |
| 4       | GNDD     | Digital ground                                                                                                                       |
| 5       | WAKEHOST | Output for host wake-up                                                                                                              |
| 6       | nu       | not used, do not connect                                                                                                             |
| 7       | nu       | not used, do not connect                                                                                                             |
| 8       | nu       | not used, do not connect                                                                                                             |
| 9       | nu       | not used, do not connect                                                                                                             |
| 10      | VDDREG   | Internal power supply stabilization, connect via 10nF±10% capacitor to ground.                                                       |
| 11      | GNDA     | Analog and power amplifier Ground                                                                                                    |
| 12      | nu       | Not used, do not connect                                                                                                             |
| 13      | NACTIVE  | Active high output for indicating device not in active state. If pin 3 is configured as wake-up this pin also indicates device busy. |
| 14      | VDD      | Power supply                                                                                                                         |

<sup>1)</sup> only SDA pin or BUSY pin can be configured as wake-up at a time.

### 3 General product characteristics

#### 3.1 Absolute maximum ratings

**Table 2** Absolute maximum ratings

| Parameter                       | Symbol        | Values     |      |          | Unit | Note or condition                                                                                                                                                                                        |
|---------------------------------|---------------|------------|------|----------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                 |               | Min.       | Typ. | Max.     |      |                                                                                                                                                                                                          |
| DC current                      | $I_{DC}$      | -10        |      | 10       | mA   | Maximum input/output current at any pin                                                                                                                                                                  |
| Transient latch-up current      | $I_{LU}$      | $\pm 100$  |      |          | mA   | Maximum transient current at any pin according JEDEC78 class II level A                                                                                                                                  |
| ESD robustness HBM              | $V_{HBM}$     | $\pm 2000$ |      |          | V    | All pins tested according to AEC-Q100-002                                                                                                                                                                |
| ESD robustness CDM, corner pins | $V_{CDM\ C}$  | $\pm 750$  |      |          | V    | Corner pins tested according to AEC-Q100-011                                                                                                                                                             |
| ESD robustness CDM              | $V_{CDM}$     | $\pm 500$  |      |          | V    | Non-corner pins tested according to AEC-Q100-011                                                                                                                                                         |
| Storage temperature             | $T_{STORAGE}$ | -50        |      | 150      | °C   | Maximal 1000 hours accumulated over lifetime between 125°C and 150°C.<br>Maximum 1000 hours between -40°C and -50°C.<br>Device not powered.<br>Temperature cycling only allowed between -40°C and 125°C. |
| Maximum pressure                | $p_{MAX}$     |            |      | 600      | kPa  | Static                                                                                                                                                                                                   |
| Max. supply voltage             | $V_{DD\_MAX}$ | -0.3       |      | 3.8      | V    | Voltage at VDDBAT pin                                                                                                                                                                                    |
| Pin input voltage               | $V_{IN\_Pin}$ | -0.3       |      | VDD+ 0.3 | V    |                                                                                                                                                                                                          |

**Attention:** Stresses above those listed under “Absolute maximum ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the section “functional range” is not implied. Furthermore, only single error cases are assumed. More than one stress/error case may also damage the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. During absolute maximum rating overload conditions the voltage on VDD pins with respect to ground shall not exceed the values defined by the absolute maximum ratings. Lifetime statements are an anticipation based on an extrapolation of Infineon’s qualification test results. The actual lifetime of a component depends on its form of application and type of use etc. and may deviate from such statement. Lifetime statements shall in no event extend the agreed warranty period.

## 3.2 Functional range

The following functional range shall not be exceeded in order to ensure correct operation of the device. All parameters specified in the following sections refer to these operating conditions unless otherwise indicated.

**Table 3 Functional range**

| Parameter                           | Symbol         | Values   |      |          | Unit | Note or condition                                                     |
|-------------------------------------|----------------|----------|------|----------|------|-----------------------------------------------------------------------|
|                                     |                | Min.     | Typ. | Max.     |      |                                                                       |
| Operating ambient temperature       | $T_{amb}$      | -40      |      | 105      | °C   |                                                                       |
| Flash programming temperature range | $T_{FLASH}$    | -20      |      | 90       | °C   | Temperature range for flash erasing/programming.                      |
| Flash write cycles                  | $N_{WRITE}$    |          |      | 100      |      | $-20^{\circ}\text{C} \leq T_{amb} \leq 90^{\circ}\text{C}$            |
| Analysis gas pressure               | $p_{GAS}$      | 50       |      | 130      | kPa  | Absolute pressure                                                     |
| Supply voltage range                | $V_{DD}$       | 3.3 - 5% | 3.3  | 3.3 + 5% | V    | Target supply voltage is 3.3 V                                        |
| External capacitor at VDDREG        | $C_{VDD\_REG}$ | 7        | 10   | 13       | nF   |                                                                       |
| Relative humidity                   | $RH$           | 0        |      | 100      | %    | no condensation                                                       |
| Hydrogen measurement range          | $c_{H_2}$      | 0        |      | 4        | vol% | Without external ignition protection                                  |
| Extended hydrogen measurement range | $c_{extH_2}$   | 4        |      | 16       | vol% | External ignition protection in place                                 |
| Operating hours                     | $t_{op}$       |          |      | 15       | y    | Valid for the specified <a href="#">temperature mission profile</a> . |

## 3.3 Current consumption

**Table 4 Supply currents**

| Parameter                 | Symbol          | Values |      |      | Unit | Note or condition              |
|---------------------------|-----------------|--------|------|------|------|--------------------------------|
|                           |                 | Min.   | Typ. | Max. |      |                                |
| Stand-by current, RT      | $I_{STDBY\_RT}$ |        | 2.3  | 6    | μA   | $T_{amb} = 25^{\circ}\text{C}$ |
| Sensor peak current at RT | $I_{Peak\_RT}$  |        | 5    | 7    | mA   |                                |

**(table continues...)**

**Table 4** (continued) Supply currents

| Parameter                         | Symbol                    | Values |      |      | Unit | Note or condition                     |
|-----------------------------------|---------------------------|--------|------|------|------|---------------------------------------|
|                                   |                           | Min.   | Typ. | Max. |      |                                       |
| Current during flash write access | $I_{\text{FLASH\_WRITE}}$ |        |      | 6    | mA   | $T_{\text{amb}} = 25^{\circ}\text{C}$ |

## 4 Product features

### 4.1 Functional description

#### 4.1.1 Firmware

##### 4.1.1.1 Device states

The device has three states:

- Active state where the I2C interface is active and I2C commands can be executed.
- Stand-by state where no commands or measurements are executed and the I2C interface is disabled.
- Autonomous state where measurements are automatically executed and the I2C interface is disabled.

The following diagram shows how and when transitions between the states take place.

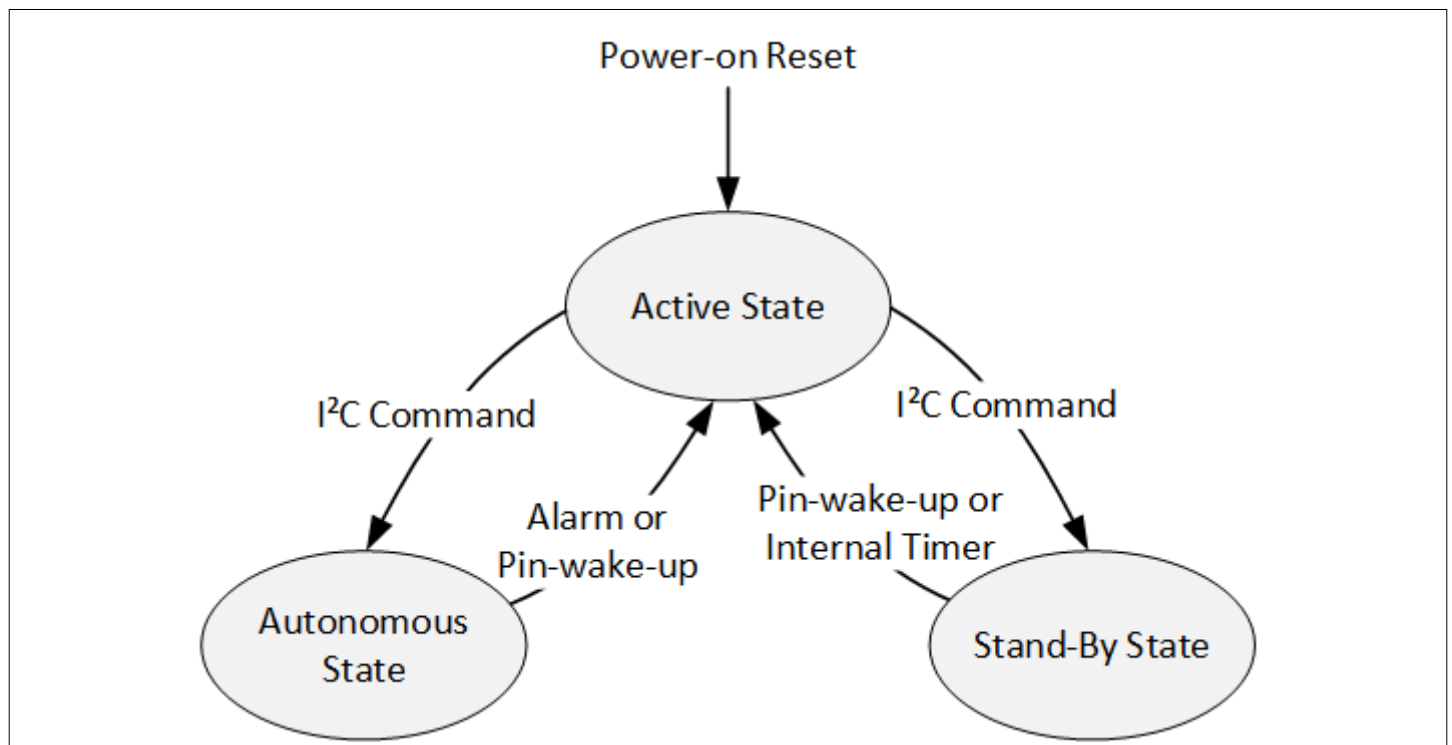


**Figure 3** Device State Transitions

#### 4.1.1.2 Sensor operating concept

##### 4.1.1.2.1 I2C operation

- The device is implemented as I2C slave. The 7 bit slave address is 0x36.
- The device also acknowledges the address byte with the reserved I2C address 0x2E. However, full I2C commands send to this address are not acknowledged, not executed, and will block the I2C interface. The interface blocking can only be canceled by a device reset.
- The master writes an I2C command, then waits for a defined processing time and finally reads a result from the slave.
- In case the I2C write command initiates a transition from active state to stand-by state or autonomous state the read command can be sent only after wake-up from stand-by state or autonomous state.
- In the I2C protocol all values (including the CRC) are transmitted with highest byte first.

- The I2C commands as well as the I2C reply are secured by a 16 bit CRC value. The CRC is calculated according to CRC-16/CCITT-FALSE standard with initialization value = 0xFFFF.
- Commands are not executed in case of an erroneous CRC value.
- The device provides a BUSY signal that, in any device state, is high whenever measurements are executed, or data is processed.
- The device provides the NACTIVE signal which is always high when the device is in stand-by state or in autonomous state.
- The I2C interface is disabled when either the BUSY or the NACTIVE or both signals are high.

#### 4.1.1.2.2 Stand-by control

- The device may be configured such that it goes automatically into stand-by state after the measurement result has been read. The automatic stand-by functionality is disabled by default.
- Alternatively the device may be put into stand-by state via a dedicated I2C command.
- The device provides an output pin that indicates the device is in stand-by state.
- If the device is in stand-by state and before sending the actual measurement triggering command, the master needs to wake-up the slave.
- Wake-up can be either accomplished via a separate pin or by pulling SDA low for  $t_{pull}$ . The time between the wake-up and the following I2C command must be greater than the stand-by resume time  $t_{RES\_STBY}$ .
- The wake-up method (via dedicated pin or via SDA line) is configurable by the user.

**Note:** If the device is not periodically resumed from stand-by by the host-controller, it will resume automatically after typically 15.9 min. (This time has a tolerance, the minimum is 12.2 min, the maximum is 22.7 min.) In this situation the NACTIVE pin can be used to wake-up the host-controller.

#### 4.1.1.2.3 Invalid I2C commands

- If the device receives a command with invalid CRC it will reply with status 0x40, followed by the CRC bytes 0xA9 and 0x34.
- In case of an invalid command the status 0x80 is transmitted, followed by the CRC bytes 0x70 and 0x78
- Note: During stand-By state, autonomous state and if the device is busy, I2C commands are not acknowledged

#### 4.1.1.3 Trigger concentration measurement command

This command triggers a concentration measurement. For humidity compensation an external humidity and external temperature value may be provided via this command. This temperature is the temperature from the external humidity sensor and is only used for calculating the absolute humidity. For the actual temperature compensation an internal temperature sensor is used. Therefore, if the sensor is configured to perform only the temperature compensation this value is ignored. Further an external pressure value may be provided if pressure compensation is required. The command contains following fields:

|         |      |        |    |   |   |      |      |
|---------|------|--------|----|---|---|------|------|
| Address | 0xA8 | Config | RH | T | p | CRCH | CRCL |
|---------|------|--------|----|---|---|------|------|

Definition of the fields:

|         |                                                |
|---------|------------------------------------------------|
| Address | Bit <7...1>=7 bit slave address<br>Bit <0> = 0 |
| 0xA8    | Command identifier                             |

4 Product features

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Config      | Bit <7...6>: RH resolution enhancement. 1LSB=0.25%, see note 1<br>Bit <5> = 1: Field contamination check enabled, see note 2<br>Bit <5> = 0: Field contamination check disabled<br>Bit <4> = 1: EoL contamination check enabled, see note 2<br>Bit <4> = 0: EoL contamination check disabled<br>Bit <3> = 1: MEMS voltage regulator bypassed, see note 3<br>Bit <3> = 0: MEMS voltage regulator not bypassed (recommended)<br>Bit <2>: unused, must be 0<br>Bit <1...0> = 11 <sub>b</sub> : The raw value is provided, no compensation<br>Bit <1...0> = 10 <sub>b</sub> : Only temperature and humidity compensation<br>Bit <1...0> = 01 <sub>b</sub> : Only temperature compensation<br>Bit <1...0> = 00 <sub>b</sub> : The fully compensated concentration is provided |
| RH          | RH (relative humidity): 1%/LSB, range: 0 to 100, see note 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| T           | T (temperature at RH sensor): 1°C / LSB, range: -40 to 105 (signed), see note 4<br>This value is used to calculate the absolute humidity. If this value is set to 0x7F the value is not used, but the on-chip temperature value instead.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| p           | Ambient pressure used for compensation. 1 kPa / LSB, range: 50 to 130. If no pressure value is available p=100 is recommended.<br>See also note 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| CRCH, CRC L | 16 bit CRC value calculated from 5 bytes, 0xA8 to p                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

*Note 1:* This bit field may be used to increase the resolution of the input parameter RH by two bits to achieve a more accurate humidity compensation. If the external humidity sensor does not provide this accuracy the bitfield should be set to zero. Config<7> represents 0.5%RH and Config<6> 0.25%RH.

*Note 2:* The End of Line (EoL) contamination check is more sensitive than the field contamination check and should not be used in the field. If the EoL contamination check is enabled then Config<5> will be ignored, i.e. for Config<4>=Config<5> = 1 only the EoL check will be executed.

*Note 3:* Depending on the supply voltage, bypassing the MEMS regulator can increase the concentration measurement sensitivity. However, the concentration value will no longer be correctly calibrated and it is the user's responsibility to do the calibration based on the raw value. Furthermore, bypassing the MEMS regulator requires a well regulated supply voltage.

*Note 4:* If the parameter is out of range the concentration measurement command is still executed and the corresponding status bit is set in the response.

This read command is used to fetch the reply from the device after a processing time of  $t_{conc\_meas}$ :

| Address                   | Status                                           | Conc_H | Conc_L | CRCH | CRCL |
|---------------------------|--------------------------------------------------|--------|--------|------|------|
| Definition of the fields: |                                                  |        |        |      |      |
| Address                   | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1 |        |        |      |      |

|                   |                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Status            | Status = 0: measurement valid.<br>Bit<7...6> unused, always 0<br>Bit<5> indicates a flash ECC1 error<br>Bit<4> indicates a RAM or software execution error<br>Bit<3> indicates a MEMS error or contamination check fail<br>Bit<2> indicates an "input parameter out of range" condition.<br>Bit<1> indicates VDD out of range, concentration not in spec.<br>Bit<0> indicates a MEIF or an ADC error |
| Conc_H,<br>Conc_L | Depending on "Config" a fully compensated, a partially compensated, or the ADC raw value is provided. (see note 1.)                                                                                                                                                                                                                                                                                  |
| CRCH, CRC<br>L    | 16 bit CRC value calculated from 3 bytes, Status to Conc_L                                                                                                                                                                                                                                                                                                                                           |

*Note 1:* The fully and partially compensated concentration values are 16 bit signed integer values with unit 0.01%H2/LSB if H2 calibration is selected. The sensitivity of the uncompensated concentration raw value is individual for each device.

#### 4.1.1.4 Trigger temperature measurement command

This command triggers a temperature measurement. The command contains following fields:

|         |      |      |      |
|---------|------|------|------|
| Address | 0xA9 | CRCH | CRCL |
|---------|------|------|------|

Definition of the fields:

|                |                                                  |
|----------------|--------------------------------------------------|
| Address        | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0 |
| 0xA9           | Command identifier                               |
| CRCH, CRC<br>L | 16 bit CRC value calculated from 1 byte, 0xA9    |

This read command is used to fetch the reply from the device after a processing time of  $t_{T\_meas}$ :

|         |        |   |      |      |
|---------|--------|---|------|------|
| Address | Status | T | CRCH | CRCL |
|---------|--------|---|------|------|

Definition of the fields:

|                |                                                                                                                                                    |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Address        | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1                                                                                                   |
| Status         | Status = 0: measurement valid.<br>Bit<7...2> unused, always 0<br>Bit<1> indicates an ADC overflow error<br>Bit<0> indicates an ADC underflow error |
| T              | Signed 8 bit on-chip temperature 1°C / LSB                                                                                                         |
| CRCH, CRC<br>L | 16 bit CRC value calculated from 2 bytes, Status and T                                                                                             |

#### 4.1.1.5 Configuration command

This command has following purposes:

1. enable the automatic Stand-By after reading the measurement result.
2. select the wake-up pin.
3. select the sensitive level of the wake-up pin

|         |      |       |       |       |      |      |
|---------|------|-------|-------|-------|------|------|
| Address | 0xC4 | Cfg_1 | Cfg_2 | Cfg_3 | CRCH | CRCL |
|---------|------|-------|-------|-------|------|------|

Definition of the fields:

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address     | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 0xC4        | Command identifier                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Cfg_1       | Bit <7...4> Not used, should be 0<br>Bit <3> = 1: Spike filter enabled, see note 1<br>Bit <3> = 0: Spike filter disabled<br>Bit <2> = 1: "Busy pin" wake-up on high level<br>Bit <2> = 0: "Busy pin" wake-up on low level<br>Bit <1> = 1: "Busy pin" is used as wake-up pin and busy signal is put on NACTIVE<br>Bit <1> = 0: SDA pin is used as wake-up pin (default), see note 2<br>Bit <0> = 1: Automatic stand-By after reading result from command 0xA8 or 0xA9<br>Bit <0> = 0: Automatic stand-By disabled (default) |
| Cfg_2       | reserved, should be 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Cfg_3       | reserved, should be 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| CRCH, CRC L | 16 bit CRC value calculated from 4 bytes, 0xC4 to Cfg_3                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

Notes:

1. The spike filter is disabled by default after power on. It can be enabled if spikes on the I2C lines are expected. If the filter is enabled the I2C communication speed is limited to 800 kbit/s.
2. In case SDA pin is used for wake-up, wake-up is always triggered on low level.

This read command is used to fetch the reply from the device after a processing time of  $t_{STWU\_cfg}$ :

|         |        |      |      |
|---------|--------|------|------|
| Address | Status | CRCH | CRCL |
|---------|--------|------|------|

Definition of the fields:

|             |                                                                               |
|-------------|-------------------------------------------------------------------------------|
| Address     | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1                              |
| Status      | Always 0. In case of an invalid command a dedicated error message is replied. |
| CRCH, CRC L | 16 bit CRC value calculated from 1 byte, Status                               |

#### 4.1.1.6 Stand-by command

This command puts the sensor into Stand-by:

|         |      |      |      |
|---------|------|------|------|
| Address | 0xC3 | CRCH | CRCL |
|---------|------|------|------|

Definition of the fields:

|             |                                                  |
|-------------|--------------------------------------------------|
| Address     | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0 |
| 0xC3        | Command identifier                               |
| CRCH, CRC L | 16 bit CRC value calculated from byte 0xC3       |

*Note:* If the SDA line is configured as wake-up line any I2C command (read or write) following the 0xC3 command will immediately resume the device from stand-by. The command used for resuming the device will not be executed and not acknowledged.

#### 4.1.1.7 Read ID command

This command allows to read the following parameter from the sensor:

- Unique sensor ID.
- Product code
- FW revision number
- Manufacturer identifier

The command contains following fields:

|         |      |      |      |
|---------|------|------|------|
| Address | 0xC2 | CRCH | CRCL |
|---------|------|------|------|

Definition of the fields:

|             |                                                  |
|-------------|--------------------------------------------------|
| Address     | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0 |
| 0xC2        | Command identifier                               |
| CRCH, CRC L | 16 bit CRC value calculated from byte 0xC2       |

This read command is used to fetch the reply from the device after a processing time of  $t_{\text{read\_ID}}$ :

|         |        |     |     |     |     |      |      |      |      |      |      |      |
|---------|--------|-----|-----|-----|-----|------|------|------|------|------|------|------|
| Address | Status | ID3 | ID2 | ID1 | ID0 | PC_H | PC_L | FW_H | FW_L | MANU | CRCH | CRCL |
|---------|--------|-----|-----|-----|-----|------|------|------|------|------|------|------|

Definition of the fields:

|                    |                                                                               |
|--------------------|-------------------------------------------------------------------------------|
| Address            | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1                              |
| Status             | Always 0. In case of an invalid command a dedicated error message is replied. |
| ID3, ID2, ID1, ID0 | 32 bit Sensor ID                                                              |

|                |                                                           |
|----------------|-----------------------------------------------------------|
| PC_H,<br>PC_L  | 16 bit Product Code, PC = 0x0001                          |
| FW_H,<br>FW_L  | 16 bit Firmware revision number                           |
| MANU           | 8 bit Manufacturer Code                                   |
| CRCH, CRC<br>L | 16 bit CRC value calculated from 10 bytes, Status to MANU |

#### **4.1.1.8 Autonomous state**

- The autonomous state (AS) is controlled via I2C commands which are used to configure the autonomous sampling interval, the alarm thresholds, and the output-wake-up pin (WAKEHOST pin) for waking up the host controller in case of an alarm.
- The AS is entered with a dedicated command which is also used to provide the device with the external humidity-, pressure-, and temperature-value used for compensating the concentration measurement.
- Once the device is in AS no I2C communication is possible, but communication is carried out via the wake-up lines.
- Once in autonomous state (AS) the firmware automatically carries out compensated measurements and compares the result with all four user defined thresholds. If no threshold is exceeded/underrun, the device waits in stand-by until the next measurement is triggered by an internal timer.
- In case a threshold is exceeded/underrun an alert is raised. Also, an alert is raised if any self-diagnosis test (carried out at the measurement) fails.
- If AS is configured to "stop after alarm" (default setting) it will stop regardless of the alarm source. If it is configured to "continue after alarm" (optional) it will stop in case of a diagnosis fail but continue in case of a threshold violation.
- The alert (WAKEHOST signal) is kept until the next valid I2C command is received from the host.
- The WAKEHOST active level is high.
- The host can always terminate AS via wake-up pin.
- The sensor is either woken-up from AS by the host controller via the configured input-wake-up pin or the AS is stopped in case of an alarm.
- The input-wake-up pin in AS is the same pin which is configured to wake-up from stand-by.
- When the device receives a wake-up, an ongoing measurement is not interrupted but completed and after that the transition to active state is done, i.e. the NACTIVE line stays asserted until the measurement is done.

#### **4.1.1.9 Configure autonomous state command**

This command defines the following parameters of the autonomous state:

1. The interval at which measurements are performed autonomously.
2. The alarm thresholds.
3. Behavior of autonomous state after an alarm.

| Address | 0xC5 | Config | SIH | SIL | UAAT | LAAT | UCAT | LCAT | CRCH | CRCL |
|---------|------|--------|-----|-----|------|------|------|------|------|------|
|---------|------|--------|-----|-----|------|------|------|------|------|------|

Definition of the fields:

|         |                                                  |
|---------|--------------------------------------------------|
| Address | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0 |
| 0xC5    | Command identifier                               |

|            |                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Config     | Bit <7...4>: number n of measurements for gradient calculation. $2 \leq n \leq 12$ .<br>Bit <3...1>: unused<br>Bit <0> = 1: Autonomous state continuous after alarm<br>Bit <0> = 0: Autonomous state stops after alarm (default setting) |
| SIH, SIL   | 16 bit Sampling Interval (SI). 1 LSB = 100 ms. Range: $1 \leq SI \leq 600$ .                                                                                                                                                             |
| UAAT       | Upper Absolute Alarm Threshold. Range: 0 to 255. 1 LSB = 0.1%H2                                                                                                                                                                          |
| LAAT       | Lower Absolute Alarm Threshold. Range: 0 to 255. 1 LSB = -0.1%H2                                                                                                                                                                         |
| UCAT       | Upper Change Alarm Threshold. Range: 0 to 255. 1 LSB = 0.1%H2/SI                                                                                                                                                                         |
| LCAT       | Lower Change Alarm Threshold. Range: 0 to 255. 1 LSB = -0.1%H2/SI                                                                                                                                                                        |
| CRCH, CRCL | 16 bit CRC value calculated from 8 bytes, 0xC5 to LCAT                                                                                                                                                                                   |

*Note: Any threshold set to 0 means it is disabled*

This read command is used to fetch the reply from the device after a processing time of  $t_{STWU\_cfg}$ :

| Address | Status | CRCH | CRCL |
|---------|--------|------|------|
|---------|--------|------|------|

Definition of the fields:

|            |                                                                                                                                                   |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Address    | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1                                                                                                  |
| Status     | Status = 0: ok<br>Bit <7...3> unused, always 0<br>Bit <2> indicates an "input parameter out of range" condition.<br>Bit <1...0>: unused, always 0 |
| CRCH, CRCL | 16 bit CRC value calculated from 1 byte, Status                                                                                                   |

*Note: In case a non-zero Status is returned the command was not executed, i.e. no configuration change was performed.*

#### 4.1.1.10 Enter autonomous state command

This command starts the autonomous state if at least one threshold is enabled. If no threshold was enabled with the *Configure Autonomous State Command* the AS will not be entered.

The command contains following fields:

| Address | 0xC6 | RH | T | p | CRCH | CRCL |
|---------|------|----|---|---|------|------|
|---------|------|----|---|---|------|------|

Definition of the fields:

|         |                                                                                                                                                                                                                                          |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0                                                                                                                                                                                         |
| 0xC6    | Command identifier                                                                                                                                                                                                                       |
| RH      | RH (relative humidity): 1% / LSB, range: 0 to 100, see note 1                                                                                                                                                                            |
| T       | T (temperature at RH sensor): 1°C / LSB, range: -40 to 105 (signed), see note 1<br>This value is used to calculate the absolute humidity. If this value is set to 0x7F the value is not used, but the on-chip temperature value instead. |

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|                |                                                                                                                                                   |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| p              | Ambient pressure used for compensation. 1kPa / LSB, range: 50 to 130. If no pressure value is available p=100 is recommended.<br>See also note 1. |
| CRCH, CRC<br>L | 16 bit CRC value calculated from 4 bytes, 0xC6 to p.                                                                                              |

*Note 1:* If the parameter is out of range Autonomous State will not be entered.

This read command is used to fetch a status from the device after wake-up from Autonomous State or if Autonomous State was not entered.

It must be executed right after wake-up from Autonomous State and before any other write command is sent.

| Address | Status | M_Status | RSRVD | CRCH | CRCL |
|---------|--------|----------|-------|------|------|
|---------|--------|----------|-------|------|------|

Definition of the fields:

|                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address        | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Status         | Status = 0: ok<br>Bit<7> unused, always 0<br>Bit<6> indicates that no alarm threshold is enabled, see note 2<br>Bit<5...3> unused, always 0<br>Bit<2> indicates an "input parameter out of range" condition.<br>Bit<1...0> unused, always 0                                                                                                                                                                                                                                       |
| M_Status       | ORed status of all measurements since entering AS<br>M_Status = 0: all measurements are valid.<br>Bit<7> unused, always 0<br>Bit<6> indicates a measurement interval timer error<br>Bit<5> indicates a flash ECC1 error<br>Bit<4> indicates a RAM or software execution error<br>Bit<3> indicates a MEMS error or contamination check fail<br>Bit<2> unused, always 0<br>Bit<1> indicates VDD out of range, concentration not in spec.<br>Bit<0> indicates a MEIF or an ADC error |
| RSRVD          | Reserved byte, always 0x00                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| CRCH, CRC<br>L | 16 bit CRC value calculated from 3 bytes, Status to RSRVD.                                                                                                                                                                                                                                                                                                                                                                                                                        |

*Note 2:* If all alarm thresholds are disabled autonomous state is not entered.

#### **4.1.1.11 Retrieve past concentration measurements command**

The last 12 concentration measurements are continuously stored in a ring buffer. This command allows to read the ring buffer.

The command contains following fields:

|         |      |      |      |
|---------|------|------|------|
| Address | 0xAA | CRCH | CRCL |
|---------|------|------|------|

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Definition of the fields:

|             |                                                  |
|-------------|--------------------------------------------------|
| Address     | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0 |
| 0xAA        | Command identifier                               |
| CRCH, CRC L | 16 bit CRC value calculated from byte 0xAA       |

This read command is used to fetch the reply from the device after a processing time of  $t_{\text{retrieve}}$ :

|         |        |     |     |     |     |     |      |      |      |      |
|---------|--------|-----|-----|-----|-----|-----|------|------|------|------|
| Address | Status | C0H | C0L | C1H | C1L | ... | C11H | C11L | CRCH | CRCL |
|---------|--------|-----|-----|-----|-----|-----|------|------|------|------|

Definition of the fields:

|             |                                                                                                                                                                              |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address     | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1                                                                                                                             |
| Status      | Status = 0: ok<br>Bit <7...4>: unused, always 0<br>Bit <3...0>: 4 bit value representing the number of invalid concentration values. Possible values are 0 to 12. See note1. |
| C0H, C0L    | Latest 16 bit signed concentration value in the ring buffer. Scaling: 0.01%H2 / LSB                                                                                          |
| ...         | ...                                                                                                                                                                          |
| C11H, C11L  | Oldest 16 bit signed concentration value in the ring buffer. Scaling: 0.01%H2 / LSB                                                                                          |
| CRCH, CRC L | 16 bit CRC value calculated from 25 bytes, Status to C11L                                                                                                                    |

*Note 1: the number of invalid values refers to a situation when the ring buffer is not yet full. If, for example, the number is 3 then the oldest 3 concentration values (C9, C10, C11) are invalid. If the number is 0, all 12 concentration values (C0 to C11) are valid.*

#### 4.1.1.12 Retrieve past temperature measurements command

The last 12 temperature measurements are continuously stored in a ring buffer. This command allows to read the ring buffer.

The command contains following fields:

|         |      |      |      |
|---------|------|------|------|
| Address | 0xAB | CRCH | CRCL |
|---------|------|------|------|

Definition of the fields:

|            |                                                  |
|------------|--------------------------------------------------|
| Address    | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0 |
| 0xAB       | Command identifier                               |
| CRCH, CRCL | 16 bit CRC value calculated from byte 0xAB       |

This read command is used to fetch the reply from the device after a processing time of  $t_{\text{retrieve}}$ :

|         |        |    |    |    |     |     |      |      |
|---------|--------|----|----|----|-----|-----|------|------|
| Address | Status | T0 | T1 | T2 | ... | T11 | CRCH | CRCL |
|---------|--------|----|----|----|-----|-----|------|------|

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Definition of the fields:

|            |                                                                                                                                                                              |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address    | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1                                                                                                                             |
| Status     | Status = 0: ok<br>Bit <7...4>: unused, always 0<br>Bit <3...0>: 4 bit value representing the number of invalid concentration values. Possible values are 0 to 12. See note1. |
| T0         | Latest 8 bit signed temperature value in the ring buffer. Scaling: 1°C / LSB                                                                                                 |
| ...        | ...                                                                                                                                                                          |
| T11        | Oldest 8 bit signed temperature value in the ring buffer. Scaling: 1°C / LSB                                                                                                 |
| CRCH, CRCL | 16 bit CRC value calculated from 13 bytes, Status to T11                                                                                                                     |

*Note 1: the number of invalid values refers to a situation when the ring buffer is not yet full. If, for example, the number is 3 then the oldest 3 temperature values (T9, T10, T11) are invalid. If the number is 0, all 12 temperature values (T0 to T11) are valid.*

#### 4.1.1.13 Write user flash line

This command is used to write a line of 16 bytes into the freely usable user flash memory.

|         |      |     |       |       |       |     |        |      |      |
|---------|------|-----|-------|-------|-------|-----|--------|------|------|
| Address | 0xB1 | Key | ADDRH | ADDRL | Data0 | ... | Data15 | CRCH | CRCL |
|---------|------|-----|-------|-------|-------|-----|--------|------|------|

Definition of the fields:

|              |                                                                  |
|--------------|------------------------------------------------------------------|
| Address      | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0                 |
| 0xB1         | Command identifier                                               |
| Key          | 0x9D                                                             |
| ADDRH, ADDRL | 16 bit address. Valid range is 0x0000 to 0x03E0 in steps of 0x20 |
| Data0        | 1st byte of the 16 byte flash line to be written.                |
| ...          |                                                                  |
| Data15       | 16th byte of the 16 byte flash line to be written.               |
| CRCH, CRCL   | 16 bit CRC value calculated from 20 bytes, 0xB1 to Data15        |

This read command is used to fetch the reply from the device after a processing time of  $t_{write\_line}$ :

|         |        |      |      |
|---------|--------|------|------|
| Address | Status | CRCH | CRCL |
|---------|--------|------|------|

Definition of the fields:

|         |                                                  |
|---------|--------------------------------------------------|
| Address | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1 |
|---------|--------------------------------------------------|

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|             |                                                                                                                                                                                                                                                                 |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Status      | Status =0: ok<br>Bit<7>: write verification failed<br>Bit<6...4>: reserved, always 0<br>Bit<3>: indicates a key mismatch<br>Bit<2>: reserved, always 0<br>Bit<1>: indicates address out of range or not multiple of 0x20<br>Bit<0>: ORing of status bits 1 to 7 |
| CRCH, CRC L | 16 bit CRC value calculated from 1 byte, Status                                                                                                                                                                                                                 |

Note: If Status<1> or Status<3> is set the command was not executed.

#### 4.1.1.14 Read user flash line

This command is used to read a line of 16 bytes from the user flash memory.

|         |      |       |       |      |      |
|---------|------|-------|-------|------|------|
| Address | 0xB2 | ADDRH | ADDRL | CRCH | CRCL |
|---------|------|-------|-------|------|------|

Definition of the fields:

|              |                                                                  |
|--------------|------------------------------------------------------------------|
| Address      | Bit <7...1> = 7 bit slave address<br>Bit <0> = 0                 |
| 0xB2         | Command identifier                                               |
| ADDRH, ADDRL | 16 bit address. Valid range is 0x0000 to 0x03E0 in steps of 0x20 |
| CRCH, CRC L  | 16 bit CRC value calculated from 3 bytes, 0xB2 to ADDRL          |

This read command is used to fetch the reply from the device after a processing time of  $t_{read\_line}$ :

|         |        |       |     |        |      |      |
|---------|--------|-------|-----|--------|------|------|
| Address | Status | Data0 | ... | Data15 | CRCH | CRCL |
|---------|--------|-------|-----|--------|------|------|

Definition of the fields:

|             |                                                                                                                                                          |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address     | Bit <7...1> = 7 bit slave address<br>Bit <0> = 1                                                                                                         |
| Status      | Status =0: ok<br>Bit<7...2>: reserved, always 0<br>Bit<1>: indicates address out of range or not multiple of 0x20<br>Bit<0>: ORing of status bits 1 to 7 |
| Data0       | 1st byte of the user flash line                                                                                                                          |
| ...         |                                                                                                                                                          |
| Data15      | 16th byte of the user flash line                                                                                                                         |
| CRCH, CRC L | 16 bit CRC value calculated from 17 bytes, Status to Data15                                                                                              |

Note: If Status<1> is set the command was not executed.

## 4.2 Electrical characteristics

### 4.2.1 TC sensor characteristics

#### 4.2.1.1 General TC sensor characteristics

**Table 5** TC sensor characteristics

| Parameter                                                     | Symbol             | Values |       |      | Unit        | Note or condition                                                 |
|---------------------------------------------------------------|--------------------|--------|-------|------|-------------|-------------------------------------------------------------------|
|                                                               |                    | Min.   | Typ.  | Max. |             |                                                                   |
| Response / recovery time (t <sub>90</sub> , t <sub>10</sub> ) | t <sub>90,10</sub> |        |       | 100  | ms          | Analysis-gas present at device gas-inlet at start of measurement. |
| Digital resolution                                            | Sens <sub>H2</sub> |        | 0.01  |      | vol%H2 /LSB |                                                                   |
| RMS noise level                                               | σ <sub>H2</sub>    |        | 0.015 | 0.02 | vol%H2      |                                                                   |

#### 4.2.1.2 Total measurement error

Notes:

- The following accuracy values are valid if the external humidity sensor used for compensation does not exceed a tolerance of ±1.5%RH and ±1°C. For the accuracy values with pressure compensation, the external pressure sensor must not exceed a tolerance of ±2 kPa.
- %RD stands for percent of concentration reading.
- Note that for fulfilling the total measurement error specification at c<sub>H2</sub> > 5% the following output signal correction is required:

$$c_{H2\_corrected} = 1.15 * c_{H2\_uncorrected} - 0.75 \text{ vol}\%H2$$

This correction must be done on system level, it is not performed in the TCI.

##### 4.2.1.2.1 Total measurement error with pressure compensation

**Table 6** Total thermal conductivity measurement error with pressure compensation

| Parameter               | Symbol | Values |      |      | Unit   | Note or condition                                                                                                              |
|-------------------------|--------|--------|------|------|--------|--------------------------------------------------------------------------------------------------------------------------------|
|                         |        | Min.   | Typ. | Max. |        |                                                                                                                                |
| Total measurement error | TME    | -0.12  |      | 0.12 | vol%H2 | 0 vol.% ≤ c <sub>H2</sub> ≤ 1 vol.%<br>80 kPa ≤ p <sub>GAS</sub> ≤ 120 kPa<br>0% ≤ RH ≤ 100%<br>-5°C ≤ T <sub>amb</sub> ≤ 35°C |

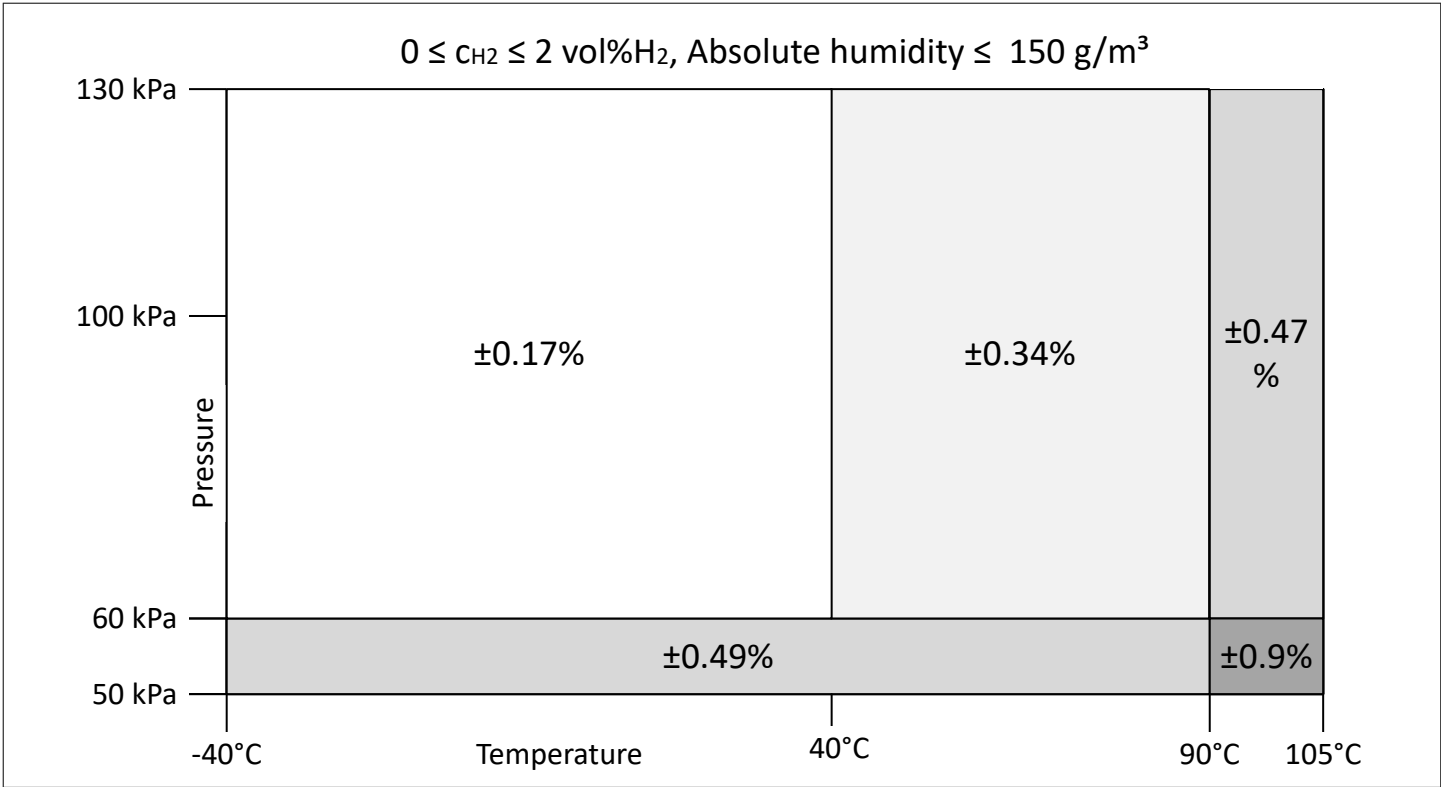


Figure 4 Total measurement error with p-compensation, low concentration range

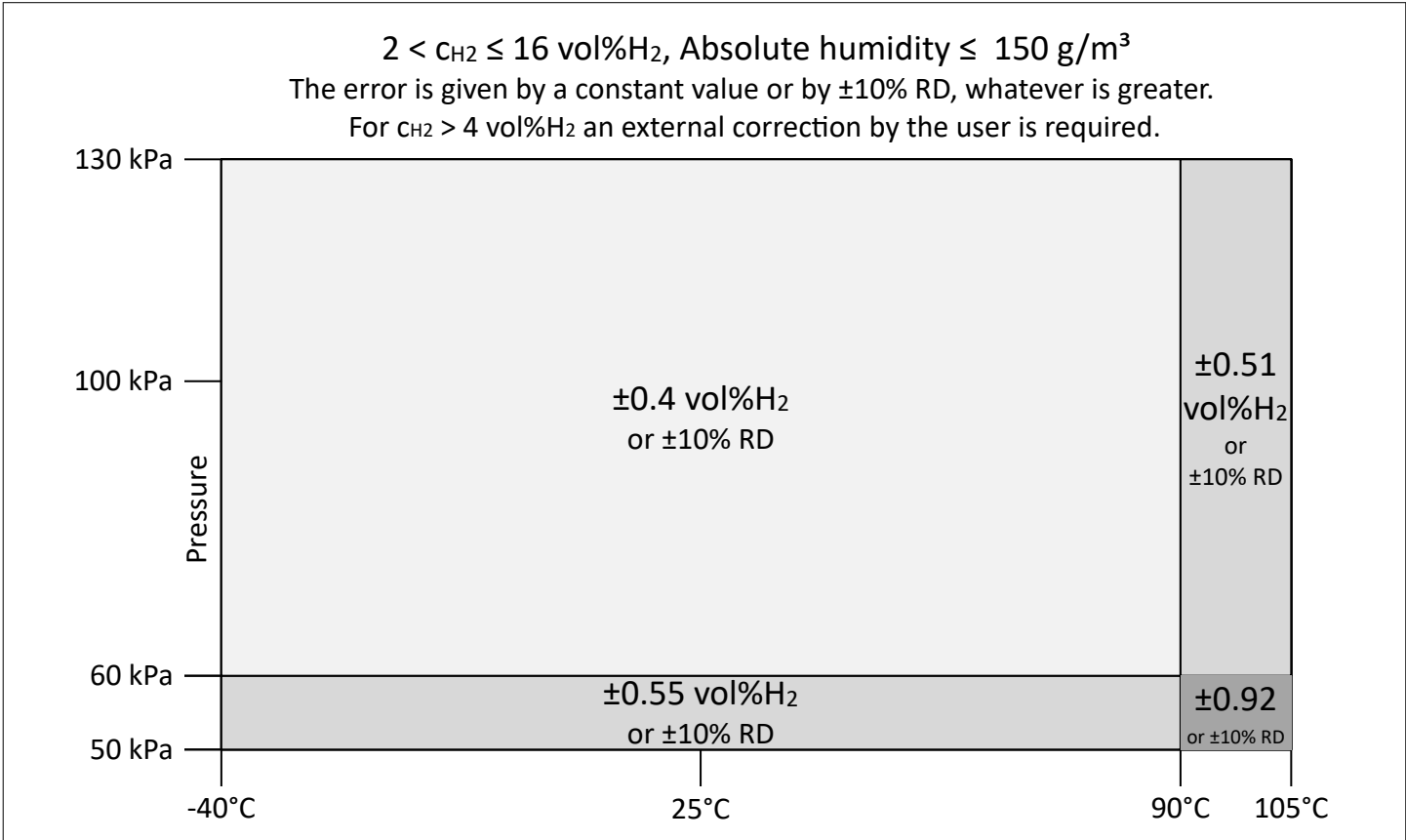


Figure 5 Total measurement error with p-compensation, high concentration range

#### 4.2.1.2.2 Total measurement error w/o pressure compensation

**Table 7** Total thermal conductivity measurement error without pressure compensation

| Parameter                                  | Symbol              | Values |      |      | Unit               | Note or condition                                                                                                                                                                                |
|--------------------------------------------|---------------------|--------|------|------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                            |                     | Min.   | Typ. | Max. |                    |                                                                                                                                                                                                  |
| Total measurement error w/o p-compensation | $TME_{no\_p\_comp}$ | -0.2   |      | 0.2  | vol%H <sub>2</sub> | $0 \text{ vol.\%} \leq c_{H_2} \leq 1 \text{ vol.\%}$<br>$80 \text{ kPa} \leq p_{GAS} \leq 120 \text{ kPa}$<br>$0\% \leq RH \leq 100\%$<br>$-5^\circ\text{C} \leq T_{amb} \leq 35^\circ\text{C}$ |

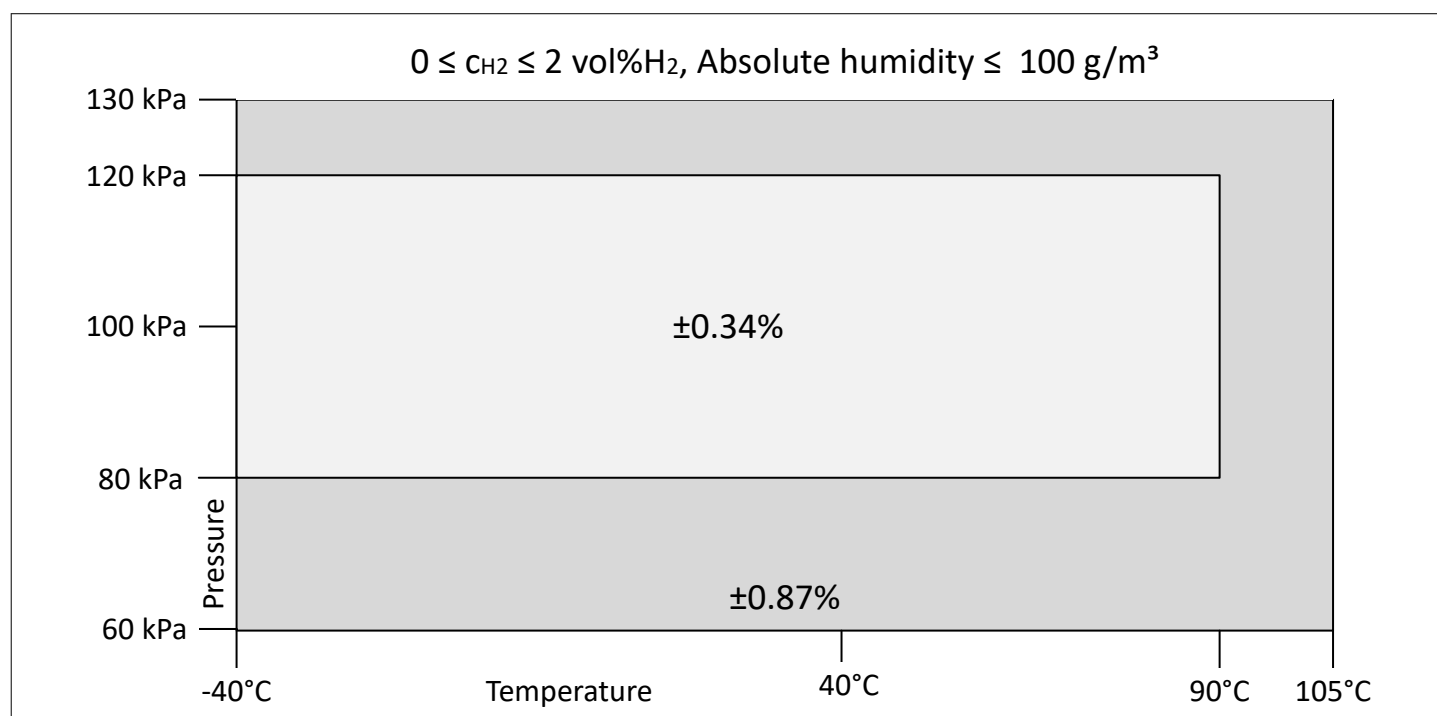


**Figure 6** Total measurement error w/o p-compensation, low concentration range

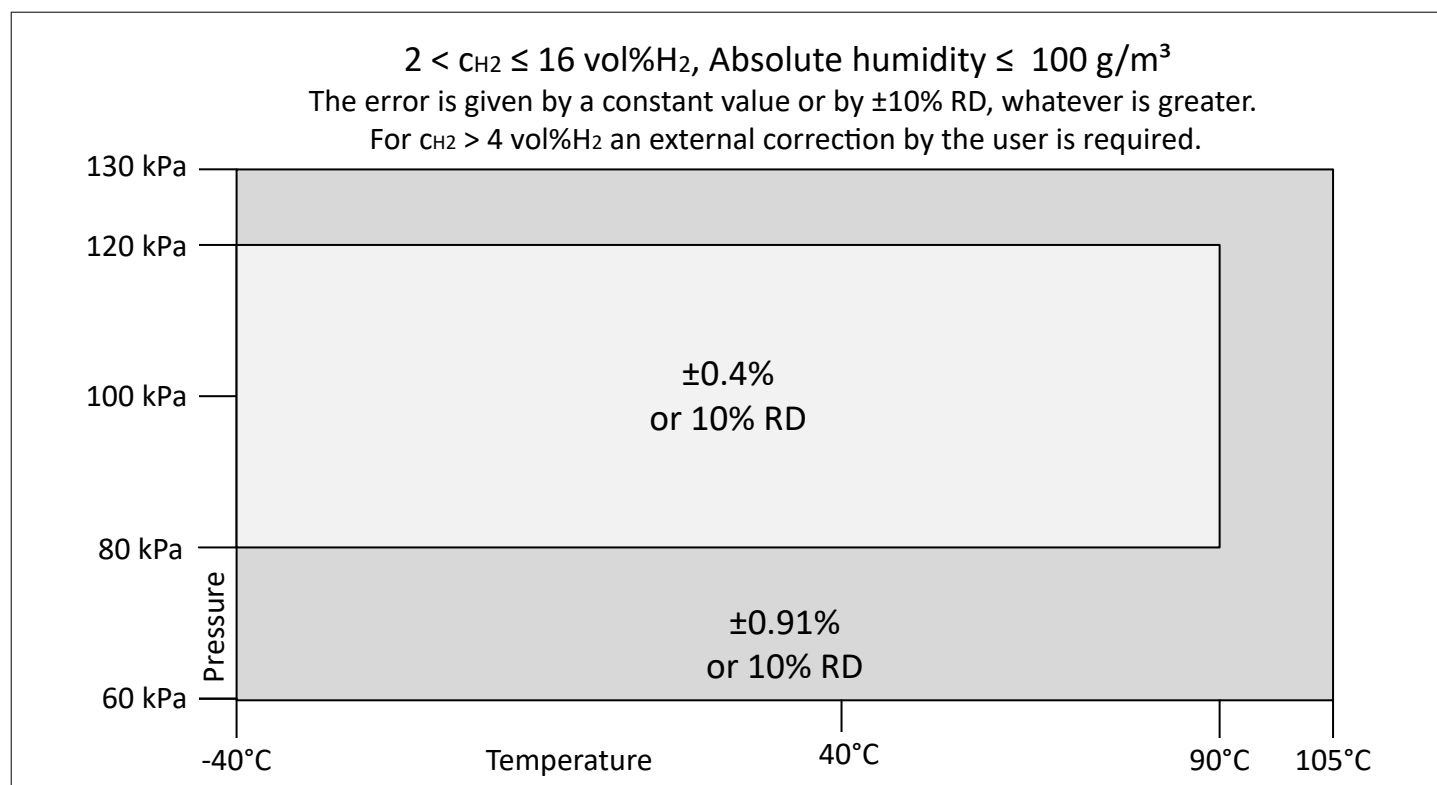


**Figure 7** Total measurement error w/o p-compensation, high concentration range

## 4.2.2 Temperature sensor

**Table 8** Temperature sensor

| Parameter                              | Symbol                   | Values |      |      | Unit | Note or condition                                                                             |
|----------------------------------------|--------------------------|--------|------|------|------|-----------------------------------------------------------------------------------------------|
|                                        |                          | Min.   | Typ. | Max. |      |                                                                                               |
| Temperature measurement range          | $T_{\text{MEAS\_RANGE}}$ | -40    |      | 125  | °C   |                                                                                               |
| Temperature sensor physical resolution | $T_{\text{RES}}$         |        | 0.2  | 1    | °C   |                                                                                               |
| Temperature sensor total error         | $T_{\text{ERR}}$         | -5     |      | 5    | °C   | The measurement error is understood as total error, including random error (noise)            |
| Temperature sensor total error, RT     | $T_{\text{ERR\_RT}}$     | -3     |      | 3    | °C   | $T_{\text{amb}} = -20^\circ\text{C}$ to $+90^\circ\text{C}$                                   |
| Temperature RMS noise                  | $T_{\text{NOISE}}$       |        |      | 0.25 | °C   | Refers to compensated temperature values.<br>The random error is included in the total error. |

### 4.2.3 Digital input and output pins

**Table 9** Input and output pins

| Parameter                         | Symbol           | Values         |      |             | Unit          | Note or condition                                                                                   |
|-----------------------------------|------------------|----------------|------|-------------|---------------|-----------------------------------------------------------------------------------------------------|
|                                   |                  | Min.           | Typ. | Max.        |               |                                                                                                     |
| Output high voltage               | $V_{OH}$         | $V_{DD} - 0.3$ |      |             | V             | $I_{load} = 1 \text{ mA}$                                                                           |
| Output low voltage                | $V_{OL}$         |                |      | 0.3         | V             | $I_{load} = -1 \text{ mA}$                                                                          |
| Input high voltage                | $V_{IH}$         | $0.8V_{DD}$    |      |             | V             |                                                                                                     |
| Input low voltage                 | $V_{IL}$         |                |      | $0.2V_{DD}$ | V             |                                                                                                     |
| Pin input capacitance             | $C_{IN}$         |                |      | 10          | pF            |                                                                                                     |
| Input pin leakage current         | $I_{IN\_Pin}$    | -2             |      | 2           | $\mu\text{A}$ |                                                                                                     |
| Equivalent pull resistor at pin 3 | $R_{PULL}$       | 10             |      | 70          | $k\Omega$     | $V_{IN} = 1.5 \text{ V}$ , $V_{DD} = 3.3 \text{ V}$ .<br>Applies if pin 3 is configured as wake-up. |
| Equivalent I2C pull-up resistor   | $R_{PULL\_I2C}$  | 5.9            | 8.4  | 11          | $k\Omega$     | $V_{IN} = 1.5 \text{ V}$ , $V_{DD} = 3 \text{ V}$ .<br>Internal pull-up at SCL and SDA pin.         |
| I2C high data rate                | $DR_{I2C\_HIGH}$ | 1000           |      |             | kbit/s        | Maximum load capacitance at SCL or SDA is 80 pF                                                     |
| I2C medium data rate              | $DR_{I2C\_med}$  | 400            |      |             | kbit/s        |                                                                                                     |
| I2C low data rate                 | $DR_{I2C\_low}$  | 100            |      |             | kbit/s        |                                                                                                     |

### 4.2.4 Voltage monitoring

**Table 10** Voltage monitoring

| Parameter               | Symbol    | Values |      |      | Unit | Note or condition                                                           |
|-------------------------|-----------|--------|------|------|------|-----------------------------------------------------------------------------|
|                         |           | Min.   | Typ. | Max. |      |                                                                             |
| Under voltage reset     | $V_{UVR}$ | 1.6    |      | 1.7  | V    | Measured at $V_{DD}$ pin.                                                   |
| Reset release threshold | $V_{THR}$ | 1.8    |      | 1.9  | V    | Device releases from reset when voltage at $V_{DD}$ pin exceeds $V_{THR}$ . |

## 4.2.5 Timing

**Table 11** Timing

| Parameter                                        | Symbol                      | Values |      |      | Unit          | Note or condition                                                 |
|--------------------------------------------------|-----------------------------|--------|------|------|---------------|-------------------------------------------------------------------|
|                                                  |                             | Min.   | Typ. | Max. |               |                                                                   |
| Stand-by resume time                             | $t_{\text{RES\_STBY}}$      |        |      | 400  | $\mu\text{s}$ | <sup>1)</sup>                                                     |
| Autonomous state resume time                     | $t_{\text{wupAS}}$          |        |      | 50   | ms            | <sup>1)</sup>                                                     |
| Concentration measurement time                   | $t_{\text{conc}}$           |        |      | 30   | ms            | <sup>2)</sup>                                                     |
| Concentration measurement interval               | $t_{\text{conc\_int}}$      | 50     |      |      | ms            | Time between two consecutive concentration measurement commands.  |
| Temperature measurement time                     | $t_{\text{T}}$              |        |      | 250  | $\mu\text{s}$ | <sup>2)</sup>                                                     |
| Read ID time                                     | $t_{\text{read\_ID}}$       |        |      | 200  | $\mu\text{s}$ | <sup>2)</sup>                                                     |
| Configuration command time                       | $t_{\text{CFG\_CMG}}$       |        |      | 200  | $\mu\text{s}$ | <sup>2)</sup>                                                     |
| Configure autonomous state command time          | $t_{\text{CFG\_AM}}$        |        |      | 300  | $\mu\text{s}$ | <sup>2)</sup>                                                     |
| Retrieve concentration measurements command time | $t_{\text{retrieve\_conc}}$ |        |      | 600  | $\mu\text{s}$ | <sup>2)</sup>                                                     |
| Retrieve temperature measurements command time   | $t_{\text{retrieve\_T}}$    |        |      | 200  | $\mu\text{s}$ | <sup>2)</sup>                                                     |
| Write flash line time                            | $t_{\text{write\_line}}$    |        |      | 8    | ms            | $-20^{\circ}\text{C} \leq T_{\text{amb}} \leq 90^{\circ}\text{C}$ |
| Read flash line time                             | $t_{\text{read\_line}}$     |        |      | 1    | ms            | $-20^{\circ}\text{C} \leq T_{\text{amb}} \leq 90^{\circ}\text{C}$ |
| Autonomous state sampling interval tolerance     | $Tol_{\text{SI}}$           | -30    |      | +30  | %             |                                                                   |

(table continues...)

**Table 11** (continued) Timing

| Parameter     | Symbol          | Values |      |      | Unit | Note or condition                                                                     |
|---------------|-----------------|--------|------|------|------|---------------------------------------------------------------------------------------|
|               |                 | Min.   | Typ. | Max. |      |                                                                                       |
| Power on time | $t_{INI}$       |        |      | 20   | ms   | Time from $V_{DD}$ exceeding $V_{THR}$ until serial interface ready.<br><sup>3)</sup> |
| VDD rise time | $t_{RISE\_VDD}$ |        |      | 1    | s    | Linear rise to $V_{DD} = 2.2\text{ V}$                                                |

- 1) Time from change of level at wake-up pin until device ready for receiving a new I2C command.
- 2) Time from I2C command fully received until device ready for receiving the next I2C command. It does not include the I2C communication time.
- 3) The power on time is only valid if at least one of the two pins SCL and SDA is either not connected or connected to high level. If both pins are actively connected to ground the power on time will prolong to approx. 3 seconds.

## 5 Package

### 5.1 Package outline

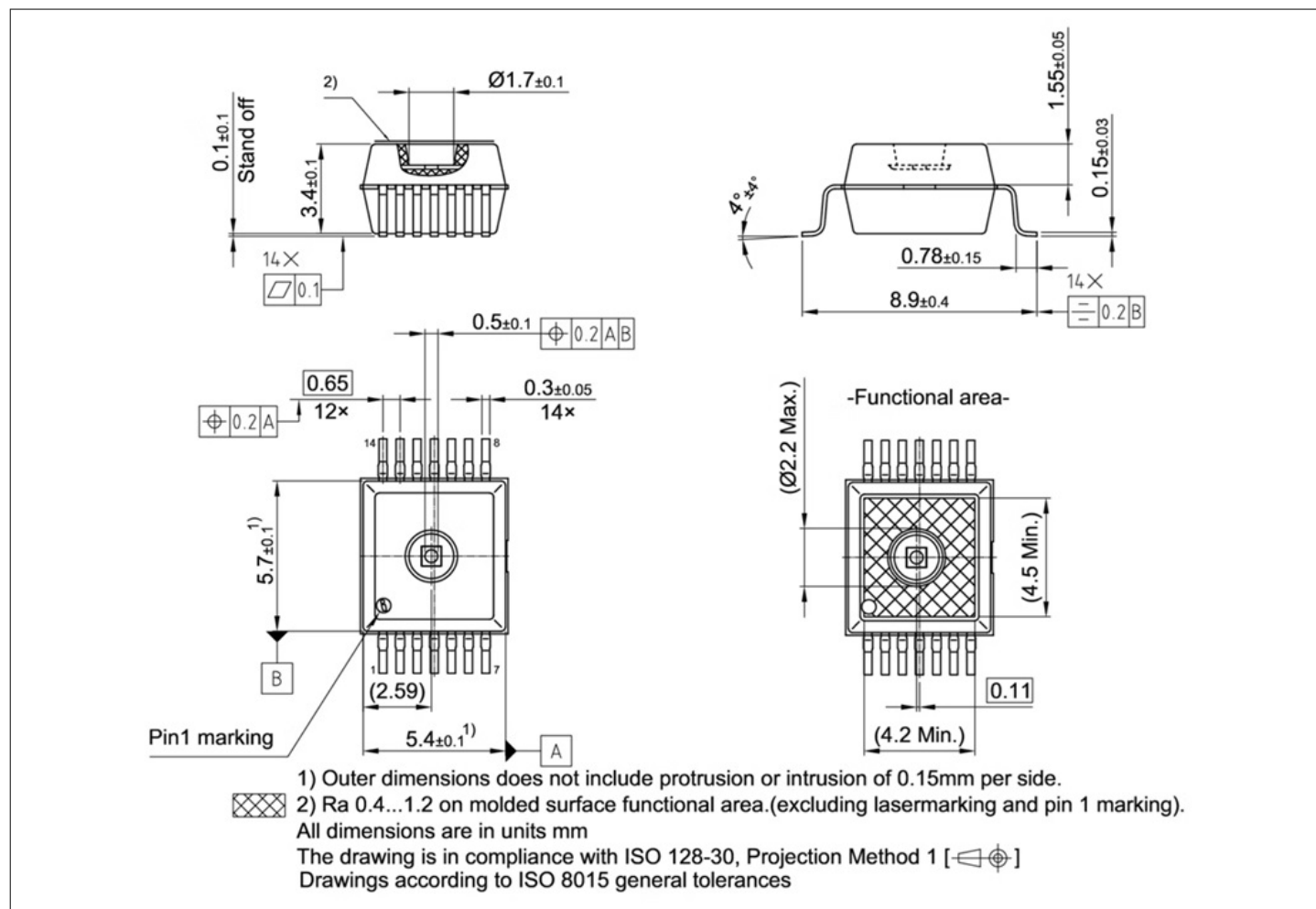


Figure 8 PG-DSOSP-14-84 package outline

## 5.2 Package marking

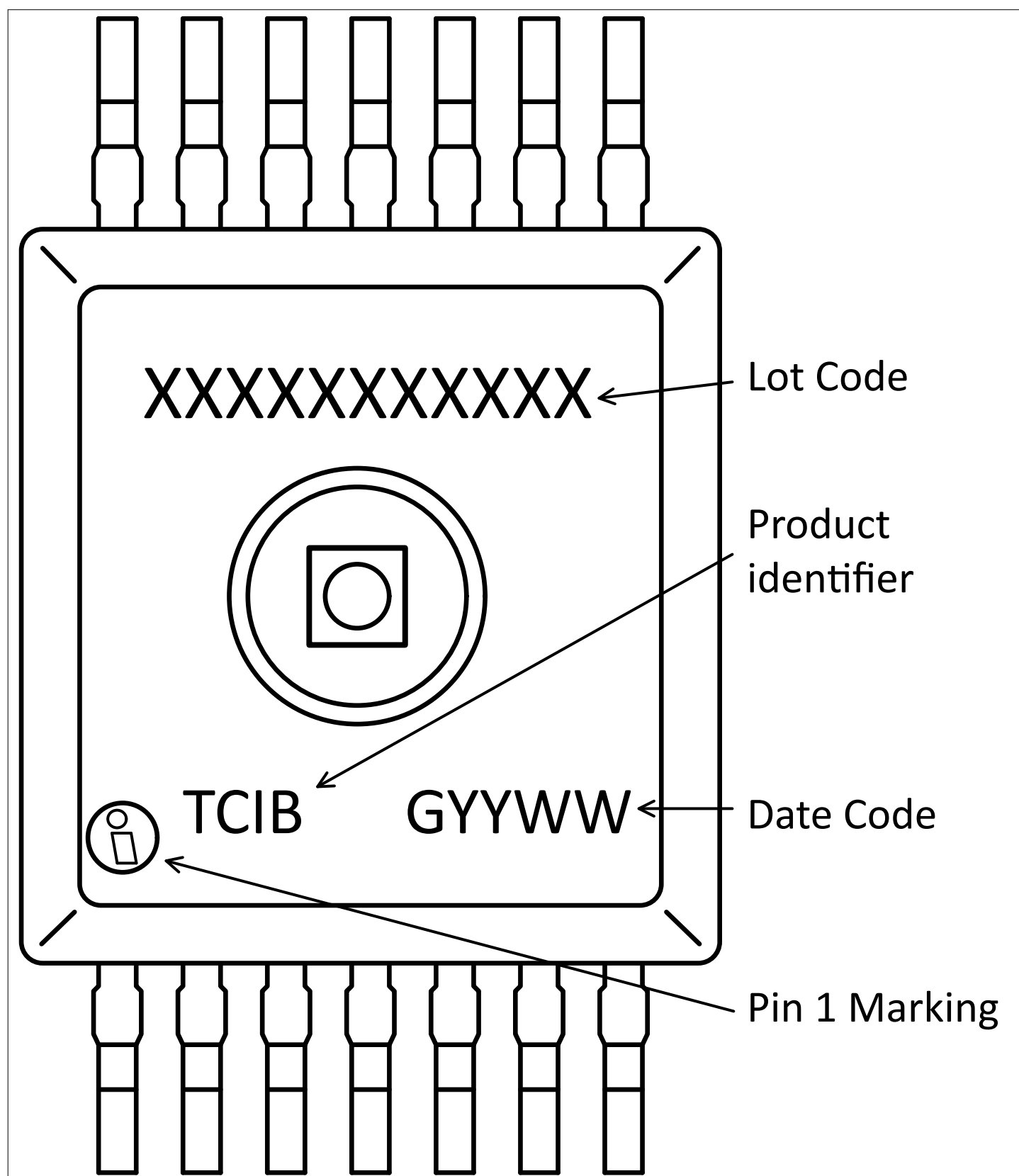


Figure 9 Package marking

## 6 Temperature mission profile

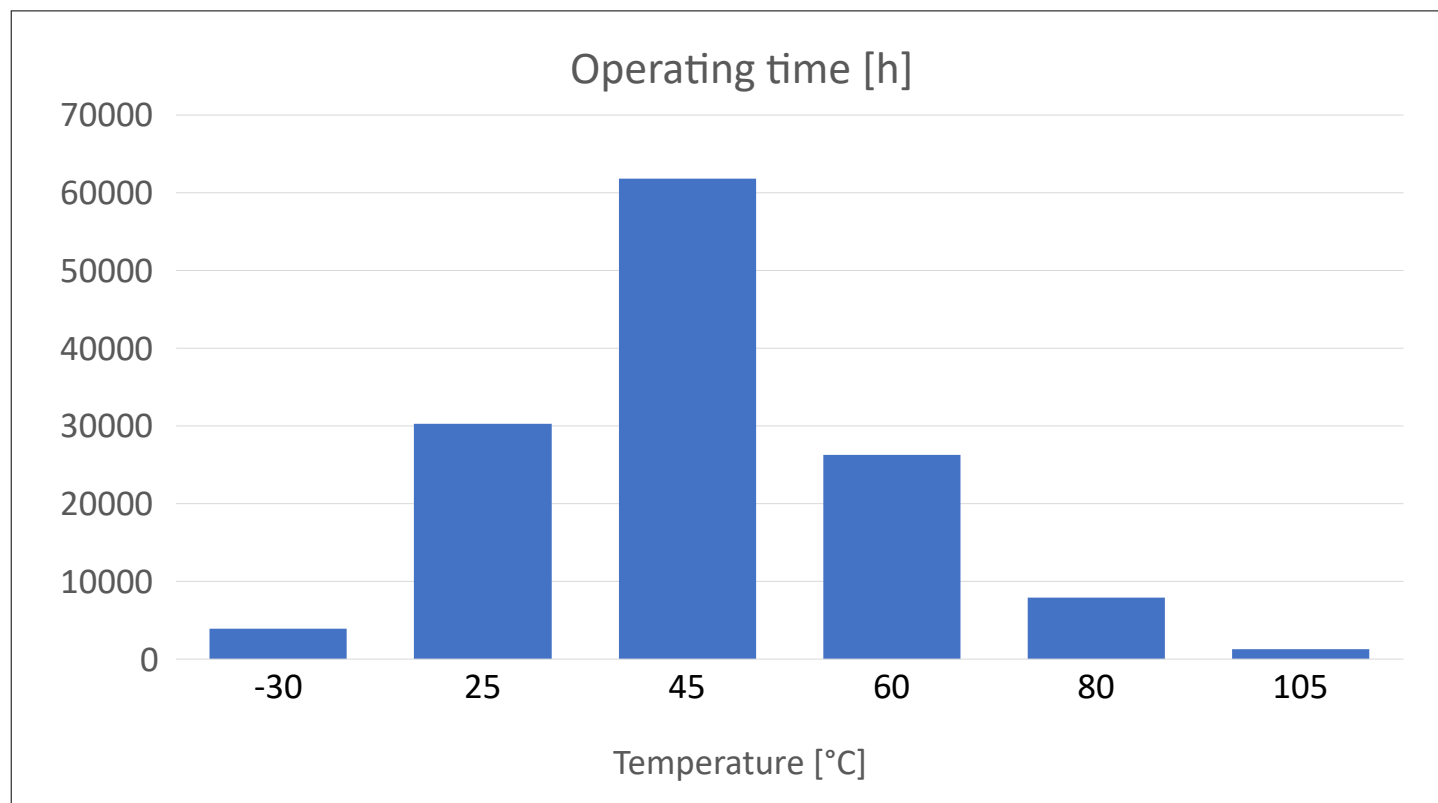


**Figure 10** Temperature mission profile

*Note:* This is a typical temperature mission profile for which the lifetime of 15y is valid

## **7 Device contamination**

The very fine gas-sensitive structures are nested inside the component and are therefore protected from direct contact. However, contaminants in the form of small particles can still reach these structures and alter the sensor properties. Therefore, depending on the environmental conditions, the sensor must be installed in a way that protects it from such particles.

See the app note “Appnote\_TCIx\_Assembly&Testing” for more information.

8                    Revision history

Table 12                    Revision History

| Document version | Date of release | Description of changes   |
|------------------|-----------------|--------------------------|
| 1.00             | 2025-11-21      | Initial revision         |
| 1.10             | 2026-05-28      | Added UL2075 recognition |

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