# GW8245/46/47/48

16-bit Low Power Temperature and Relative Humidity Sensor

## 1 Description

The GW8245/46/47/48 is a new generation of single-chip integrated temperature and relative humidity sensor, which integrates high-sensitivity MEMS humidity-sensitive components on silicon-based CMOS wafers, thereby reducing signal transmission interference, reducing device area and improving product reliability. The GW8245/46/47/48 uses I²C protocol to communicate with the host. Internal Cyclic Redundancy Check (CRC) generator calculates 8-bit checksum and sends to host after each of 16-bit data. Each GW824x series has a unique 32-bit serial number.

It has a temperature measurement range of -40°C ~ +125°C. The test accuracy in the range of -40°C ~ +125°C is ±0.2 °C for GW8245/46/47, ±0.1 °C for GW8248. Relative humidity range is 0 ~ 100% with accuracy of ±1.8 %RH for GW8245/46/47, ±1.0 %RH for GW8248. The GW8245/46/47 has a heater inside of package, which can be used for anti-dew.

The GW8245/46/47/48 can be used to process temperature and relative humidity monitoring and control in various applications. The 4-pin dual-flat, no-leads package is suitable for surface mount technology (SMT).

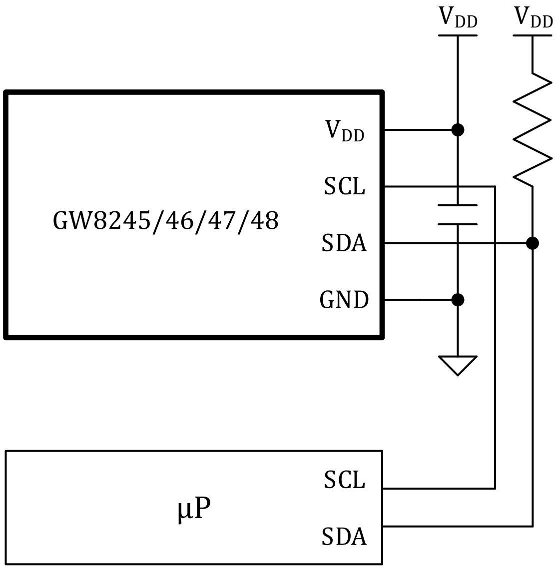
## 2 Features

- I²C protocol compatible, up to 1 MHz, with 2 slave addresses
- Wide supply voltage range (1.6 V ~ 5.5 V)
- Average current: 0.4 µA (1 Hz measurement rate)
- Idle current: 0.1 µA
- DFN4 package (1.5 mm x 1.5 mm x 0.54 mm)
- Typical accuracy, GW8245/46/47
  - Relative humidity: ±1.8 %RH
  - Temperature: ±0.2 °C
- Typical accuracy, GW8248
  - Relative humidity: ±1.0 %RH
  - Temperature: ±0.1 °C
- Resolution
  - Relative humidity: 0.01 %RH
  - Temperature: 0.01 °C
- Power controllable heater
- NIST traceability
- Support reflow soldering

## 3 Typical Applications

- Automotive cabin
- Industrial control
- Smart home
- Consumer electronics
- Medical devices

## 4 Basic Application Diagram




## 5 Ordering Information

| Device name | Package | Remark |
|---|---|---|
| GW8245ENGAR | 1.5 mm x 1.5 mm, 0.8 mm pitch, 4 DFN | Ordinary precision Slave address 0x44 |
| GW8246ENGAR | 1.5 mm x 1.5 mm, 0.8 mm pitch 4 DFN | Ordinary precision Slave address 0x45 |
| GW8247ENGAR | 1.5 mm x 1.5 mm, 0.8 mm pitch 4 DFN | High Precision Slave address 0x45 |
| GW8248ENGAR | 1.5 mm x 1.5 mm, 0.8 mm pitch 4 DFN | High Precision Slave address 0x45 |

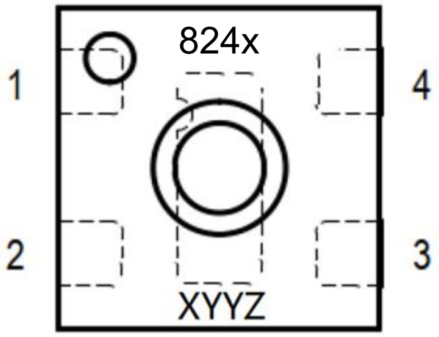
## Table of Contents



# 6 Revision History

| Version | Date | Description |
|---|---|---|
| 0.1 | April 9, 2025 | Initial release |
| 1.0 | April 15, 2025 | Changed P/N |

# 7 Pin Configuration and Function




**Top View**

**Pin Functions**

| Pin Name | No. | Type | Description |
|---|---|---|---|
| SDA | 1 | IO | I²C serial data, Need external pull-up resister |
| SCL | 2 | I | I²C serial clock |
| VDD | 3 | P | Power supply |
| GND | 4 | G | Ground supply |

# 8 Specifications

## 8.1 Absolute Maximum Ratings

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | -0.5 | 6 | V |
| Operating temperature range | $T_{OP}$ | -40 | 125 | ℃ |
| Storage temperature range | $T_{STG}$ | -40 | 150 | ℃ |
| ESD HBM (Human body model), per ANSI/ESDA/JEDEC JS001 | $ESD_{HBM}$ | -4,000 | 4,000 | V |
| Latch up, per JESD78 Class IA | LATCHUP | -200 | 200 | mA |

Note: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device, sensor performance can't be guaranteed under these extreme conditions.

## 8.2 Recommended Operating Conditions

| Parameter | Symbol | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Supply Voltage(1) | $V_{DD}$ | 1.6(2) | 3.3 | 5.5 | V |
| Ambient Temperature | $T_A$ | -40 | | 125 | ℃ |

1. I²C communication signals must not exceed the $V_{DD}$ voltage level.
2. For optimal analog device performance, it is recommended that $V_{DD}$ be equal to or greater than 1.6V.

## 8.3 Electrical Characteristics

Unless stated otherwise, all values are applicable within the complete range of operational conditions. Typical values are given for $T_A$ = + 25 ºC , $V_{DD}$ = 3.3 V

| Parameter | Symbol | Conditions | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **Relative Humidity Sensor** | | | | | | |
| Accuracy, GW8245/46/47 | $ACC_{RH,GW8245/46/47}$ | | - | ±1.8 | - | %RH |
| Accuracy, GW8248 | $ACC_{RH,GW8248}$ | | | ±1.0 | | %RH |
| High Repeatability | $REP_{HIGH}$ | | | 0.08 | | %RH |
| Medium Repeatability | $REP_{MID}$ | | | 0.15 | | %RH |
| Low Repeatability | $REP_{LOW}$ | | | 0.25 | | %RH |
| Resolution | $RES_{HUM}$ | | - | 0.01 | - | %RH |
| Hysteresis | $HYS_{HUM}$ | @25 ºC | - | ±0.8 | - | %RH |
| Measurement Range | $R_{HUM}$ | | 0 | - | 100 | %RH |
| Response Time | $RESP_{HUM}$ | 1 τ , 63% settling time | - | 85 | - | s |
| Long-Term Drift | $DRIFT_{HUM}$ | | - | < 0.3 | - | %RH/y |
| **Temperature Sensor** | | | | | | |
| Accuracy, GW8245/46/47 | $ACC_{TEMP,GW8245/46/47}$ | | - | ±0.2 | - | ºC |
| Accuracy, GW8248 | $ACC_{TEMP,GW8248}$ | | - | ±0.1 | - | ºC |
| High Repeatability | $REP_{HIGH}$ | | | 0.04 | | ºC |
| Medium Repeatability | $REP_{MID}$ | | | 0.07 | | ºC |
| Low Repeatability | $REP_{LOW}$ | | | 0.1 | | ºC |
| Resolution | $RES_{TEMP}$ | | - | 0.01 | - | ºC |
| Measurement Range | $R_{TEMP}$ | | -40 | | 125 | ºC |
| Response Time | $RESP_{TEMP}$ | 1 τ , 63% settling time | - | 2 | - | s |
| Long-Term Drift | $DRIFT_{LONG}$ | | | < 0.03 | | ºC/y |
| **Power On Reset** | | | | | | |
| Power on Reset Lockout voltage | $V_{POR}$ | | 0.8 | - | 1.0 | V |
| **DC Characteristics** | | | | | | |
| Input High Level | $V_{IH}$ | | - | 0.7 * $V_{DD}$ | - | V |
| Input Low Level | $V_{IL}$ | | - | - | 0.3 * $V_{DD}$ | V |

| Parameter | Symbol | Conditions | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Output Low Level, 3 mA Current Sink | $V_{OL}$ | | - | - | 0.3 * $V_{DD}$ | V |
| Pull Up Resistance | $R_{PU}$ | | 390 | - | - | Ω |
| BUS Load Capacitance | $C_{BUS, LOAD}$ | | - | - | 400 | pF |
| Supply Slew Rate | $V_{DD, SLEW}$ | | - | - | 20 | V/ms |
| Current Consumption, at Idle State | $I_{DD, IDLE}$ | | 0.08 | 0.1 | 0.15 | µA |
| Current consumption, at Measurement | $I_{DD, MEAS}$ | | | 300 | 500 | µA |
| Current consumption, High Repetition Rate | $I_{DD, HIGH}$ | | - | 2 | - | µA |
| Current consumption, Mid Repetition Rate | $I_{DD, MID}$ | | - | 1.2 | - | µA |
| Current consumption, Low Repetition Rate | $I_{DD, LOW}$ | | - | 0.4 | - | µA |
| **Sensor System Timing** | | | | | | |
| Power Up Time | $t_{PU}$ | After hard reset, $V_{DD}$ > $V_{POR}$ | - | 300 | 1,000 | µs |
| Soft Reset Time | $t_{SR}$ | After soft reset | - | - | 1,000 | µs |
| Measure Time, High Repetition Rate | $t_{MEAS, HIGH}$ | | - | 6.9 | 8.3 | ms |
| Measure Time, Medium Repetition Rate | $t_{MEAS, MED}$ | | - | 3.7 | 4.5 | ms |
| Measure Time, Low Repetition Rate | $t_{MEAS, LOW}$ | | - | 1.3 | 1.6 | ms |
| Heater-on Duration, Long Pulse | $t_{HEATER, LONG}$ | | 0.9 | 1 | 1.1 | s |
| Heater-on Duration, Short Pulse | $t_{HEATER, SHORT}$ | | 0.9 | 1 | 1.1 | s |

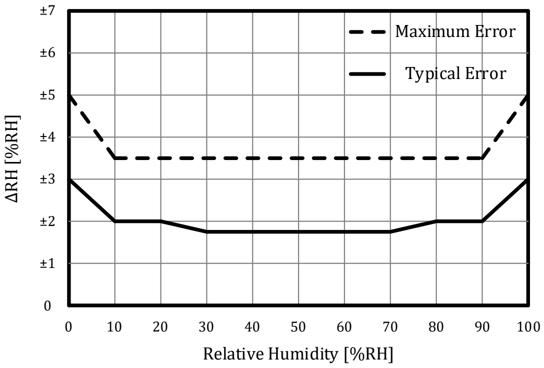



**Figure 1 GW8245/46 relative humidity accuracy at 25 °C**

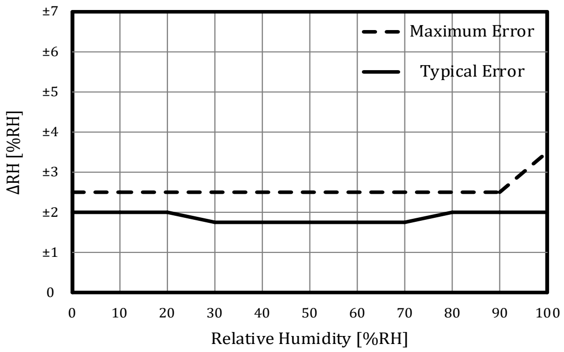



**Figure 2 GW8247 relative humidity accuracy at 25 °C**

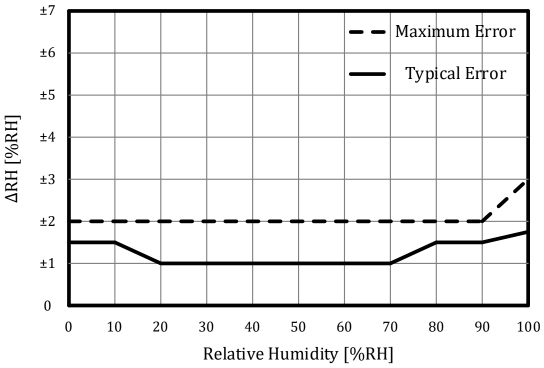



**Figure 3 GW8248 relative humidity accuracy at 25 °C**

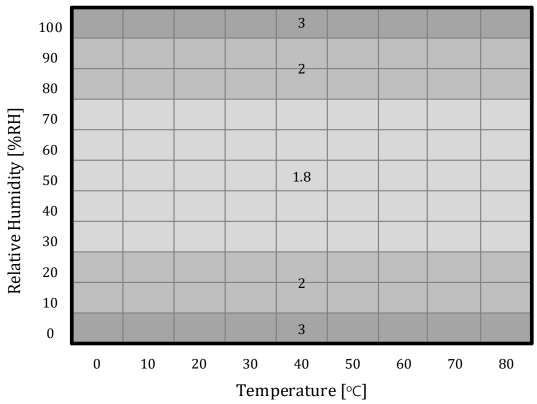



**Figure 4 GW8245/46 typical relative humidity accuracy over humidity and temperature**

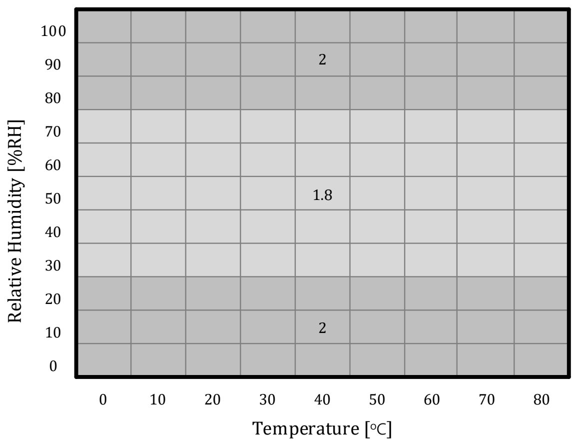



**Figure 5 GW8247 typical relative humidity accuracy over humidity and temperature**

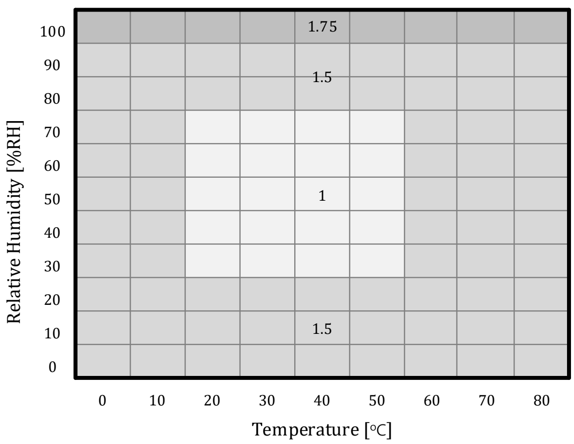



**Figure 6 GW8248 typical relative humidity accuracy over humidity and temperature**

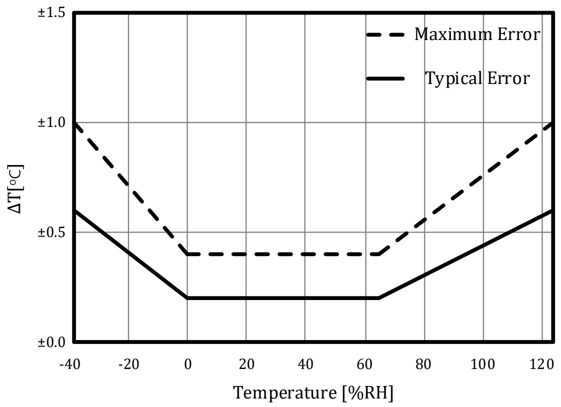



**Figure 7 GW8245/46 temperature accuracy**

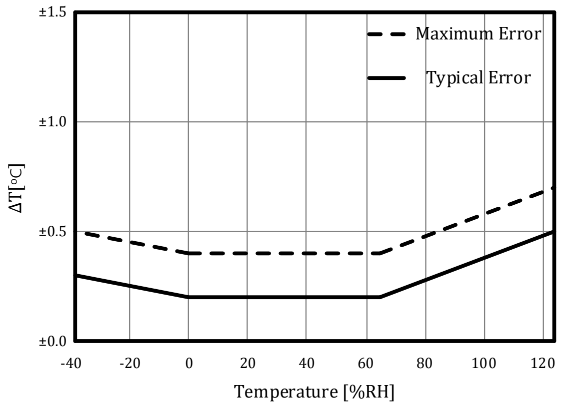



**Figure 8 GW8247 temperature accuracy**

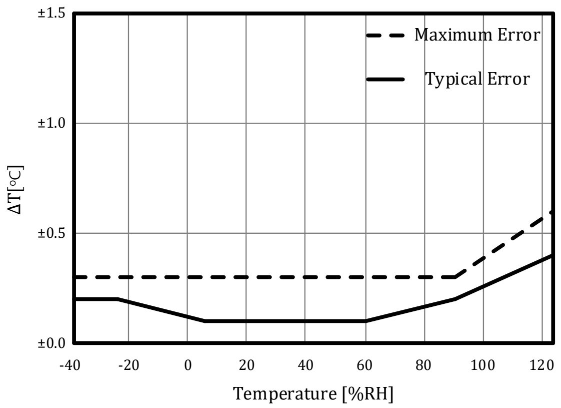



**Figure 9 GW8248 temperature accuracy**

# 9 Functional Description

## 9.1 Overview

The GW8245/46/47/48 is a new generation of single-chip integrated temperature and relative humidity sensor, which integrates high-sensitivity MEMS humidity-sensitive components on silicon-based CMOS wafers, thereby reducing signal transmission interference, reducing device area and improving product reliability. The GW8245/46/47/48 uses I2C protocol to communicate with the host. Internal Cyclic Redundancy Check (CRC) generator calculates 8-bit checksum and sends to host after each of 16-bit data. Each GW824x has a unique 32-bit serial number.

It has a temperature measurement range of -40°C ~ +125°C. The test accuracy in the range of -40°C ~ +125°C is ±0.2 °C for GW8245/46/47, ±0.1 °C for GW8248. Relative humidity range is 0 ~ 100% with accuracy of ±1.8 %RH for GW8245/46/47, ±1.0 %RH for GW8248. The GW8245/46/47/48 has a heater inside of package, which can be used for anti-dew. GW8245/46/47/48 can be used to process temperature and relative humidity monitoring and control in various applications. The 4-pin dual-flat, no-leads package is suitable for surface mount technology (SMT).

## 9.2 Functional Block Diagram

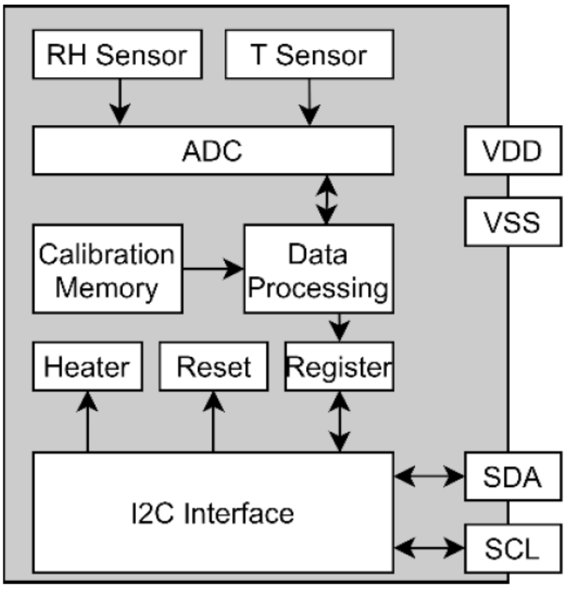



**Figure 10 Block Diagram**

## 9.3 I²C Communication

Supported I²C modes are standard, fast mode, and fast mode plus. Data is transferred into multiples of 16-bit words. To increase reliability of data transfer, I²C glitch protection is offered in form of 8-bit checksum (cyclic redundancy check = CRC). All transfers must begin with a start condition (S) and terminate with a stop condition (P). To finish a read transfer, send not acknowledge (NACK) and stop condition (P). Addressing a specific slave device is done by sending its 7-bit I²C address followed by an eighth bit, denoting the communication direction: "zero" indicates transmission to the slave, i.e. "write", a "one" indicates a "read" request. The sensor does not support clock-stretching. In case the sensor receives a read header and if the conversion remains unfinished, it will return a NACK. Measurement data can only be received once and will be deleted from the sensor's register after the first acknowledged I²C read header.

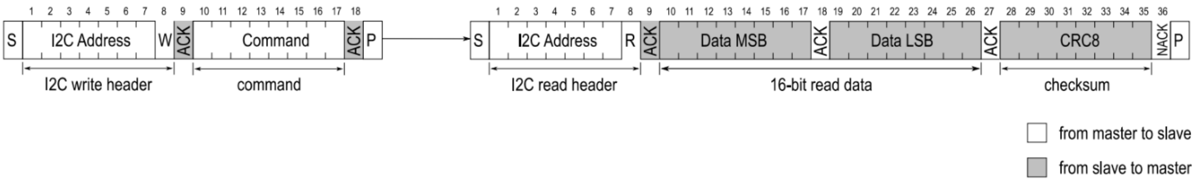



**Figure 11 Typical I²C communication diagram**

The figure is the typical I²C communication for the GW8245/46/47/48 series. First, a write header is sent to the I²C slave, followed by a command, for example "measure RH&T with highest precision". After the measurement is finished, the read request directed to this I²C slave will be acknowledged and transmission of data will be started by the slave.

I²C bus operates with 8-bit data frame. Information from the sensor to the master has a checksum after every second 8-bit data frame. Humidity and temperature data will always be transmitted in the following way: The first value is the temperature signal (2 * 8-bit data + 8-bit CRC), the second is the humidity signal (2 * 8-bit data + 8-bit CRC). The checksum (CRC) property is listed on the table below.

| Item | Symbol |
|---|---|
| Type | CRC-8 |
| Data Length | 16-bit |
| Polynomial | 0x31($X^8+X^5+X^4+1$) |
| Initial Value | 0xFF |
| Reflect Input/Output False/False | False/False |
| Final XOR | 0x00 |
| Example | CRC(0xBEEF) = 0x92 |

## 9.4 Command

Below table is the command instruction of GW8245/46/47/48.

| Command (HEX) | Return # (Bytes) | Description |
|---|---|---|
| 0xFD | 6 | Measure temperature and relative humidity with high repetition<br>[2 byte temperature data + 1 byte CRC + 2 byte relative humidity data + 1 byte CRC] |
| 0xF6 | 6 | Measure temperature and relative humidity with mid repetition<br>[2 byte temperature data + 1 byte CRC + 2 byte relative humidity data + 1 byte CRC] |
| 0xE0 | 6 | Measure temperature and relative humidity with low repetition<br>[2 byte temperature data + 1 byte CRC + 2 byte relative humidity data + 1 byte CRC] |
| 0x89 | 6 | Read serial number<br>[2 byte serial number data + 1 byte CRC + 2 byte serial number data + 1 byte CRC] |
| 0x94 | - | Soft reset<br>[ACK] |
| 0x39 | 6 | Activate heater as 200 mW power for 1 sec, read a high precision measurement just before deactivation |
| 0x32 | 6 | Activate heater as 200 mW power for 0.1 sec, read a high precision measurement just before deactivation |
| 0x2F | 6 | Activate heater as 110 mW power for 1 sec, read a high precision measurement just before deactivation |
| 0x24 | 6 | Activate heater as 110 mW power for 0.1 sec, read a high precision measurement just before deactivation |
| 0x1E | 6 | Activate heater as 20 mW power for 1 sec, read a high precision measurement just before deactivation |
| 0x15 | 6 | Activate heater as 20 mW power for 0.1 sec, read a high precision measurement just before deactivation |

Note: If the sensor is not ready to process a command, e.g. busy to measure, the response will be NACK ono $I^2C$ read header. Given heater power values are typical and valid for VDD = 3.3 V.

## 9.5 Measurement Conversion

The relation between sensor signals and relative humidity and temperature values are as below:

$$\mathrm{RH} = \left(-6 + 125 \cdot \frac{S_{RH}}{2^{16}-1}\right) \%\mathrm{RH} \quad (1)$$

$$\mathrm{T} = \left(-45 + 175 \cdot \frac{S_T}{2^{16}-1}\right) {}^\circ\mathrm{C} \quad (2)$$

$$\mathrm{T} = \left(-49 + 315 \cdot \frac{S_T}{2^{16}-1}\right) {}^\circ\mathrm{F} \quad (3)$$

The RH conversion formula (1) allows values to be reported which are outside of the range of 0%RH to 100%RH. Relative humidity values which are smaller than 0 %RH and larger than 100 %RH are non-physical, however, these "uncropped" values might be found beneficial in some cases (e.g. when the distribution of the sensors at the measurement boundaries are of interest). For all users who do not want to engage in evaluation of these non-physical values, cropping of the RH signal to the range of 0 %RH to 100 %RH is advised.

## 9.6 Serial Number

Each of the GW8245/46/47/48 has a unique serial number, that is assigned with specific rules during production. It is stored in the OTP (one-time-programmable) memory and cannot be manipulated after production. The serial number is accessible via $I^2C$ command 0x89 and is transmitted as two 16-bit words, each followed by an 8-bit CRC.

## 9.7 Reset & Abort

A reset of the GW8245/46/47/48 can be achieved in three ways:

1. Soft reset: send the reset command described in Table 9.

2. $I^2C$ general call reset: all devices on $I^2C$ bus are reset by sending the command 0x06 to the $I^2C$ address 0x00.

3. Power down (incl. pulling SCL and SDA low).

Any command that triggers an action at the sensor can be aborted via $I^2C$ general call reset or soft reset.

## 9.8 Heater

The sensor incorporates an integrated on-chip heater which can be switched on by the set of different commands. Three heating powers and two heating durations are selectable. After reception of a heater-on command, the sensor executes the following procedure:

1. The heater is enabled, and the timer starts count-down

2. On timer expiration a temperature and relative humidity measurement with the highest repeatability is started, the heater remains enabled

3. After the measurement is finished the heater is turned off

4. Temperature and relative humidity values are now available for readout

The maximum on time of the heater commands is one second in order to prevent overheating of the sensor by unintended usage of the heater. In cases where periodic heating is required, it is necessary to ensure that the duty cycle of the heater's on and off times is less than 10%.

Possible Heater Use Cases:

1. Removal of condensed / spray water on the sensor surface. Although condensed water is not a reliability / quality problem to the sensor, it will however make the sensor non-responsive to RH changes in the air as long as there is liquid water on the surface.

2. Creep-free operation in high humid environments. Periodic heating pulses allow for creep-free high-humidity measurements for extended times.

Important notes for operating the heater:

1. The heater is designed for a maximum duty cycle of 10%, meaning the total heater-on-time should

not be longer than 10% of the sensor's lifetime.

2. During operation of the heater, sensor specifications are not valid.

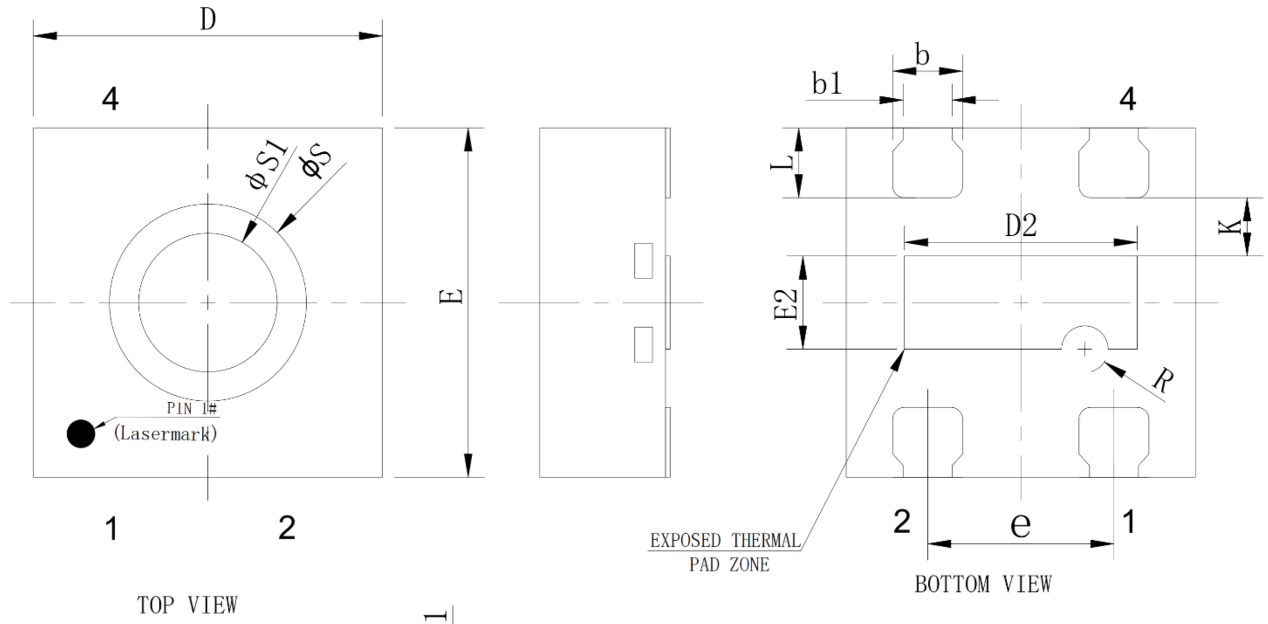
3. The temperature sensor can additionally be affected by the thermally induced mechanical stress, offsetting the temperature reading from the actual temperature.

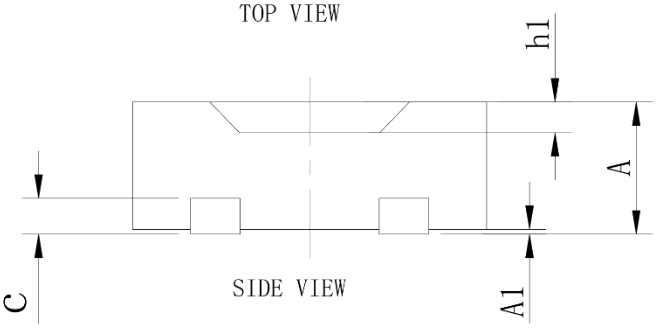
4. The sensor's temperature (base temperature + temperature increase from heater) must not exceed $T_{MAX}$ = 125 °C in order to have proper electrical functionality of the chip.

5. The heater draws a large amount of current once enabled (up to 70 mA in the highest power setting). Although a dedicated circuitry draws this current smoothly, the power supply must be strong enough to avoid large voltage drops that could provoke a sensor reset.

6. If higher heating temperatures are desired, consecutive heating commands must be sent to the sensor. The heater shall only be operated in ambient temperatures below 65 °C or else it could drive the sensor outside of its maximal operating temperature (125℃).

# 10 Package Information




| SYMBOL | MILLIMETER | | | |
|---|---|---|---|---|
| | MIN | NOM | MAX | |
| A | 0. 49 | 0.54 | 0. 59 | |
| A1 | 0 | 0.02 | 0. 05 | |
| b | 0. 25 | 0. 30 | 0. 35 | |
| b1 | 0.21REF | | | |
| c | 0.152REF | | | |
| D | 1. 45 | 1. 50 | 1. 55 | |
| D2 | 0. 90 | 1. 00 | 1. 10 | |
| E | 1. 45 | 1. 50 | 1. 55 | |
| E2 | 0. 30 | 0. 40 | 0. 50 | |
| e | 0. 80BSC | | | |
| K | 0. 25REF | | | |
| L | 0. 25 | 0. 30 | 0. 35 | |
| R | 0. 10REF | | | |
| ϕS | 0. 846BSC | | | ⚠ |
| ϕS1 | 0. 595BSC | | | ⚠ |
| h1 | 0. 08 | 0. 13 | 0. 18 | |

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