# GW8231

## Analog Output Temperature and Humidity Sensor

## 1 Description

The GW8231 is a next generation of single-chip integrated temperature and humidity sensor. Integrating high-sensitivity MEMS moisture-sensitive components on silicon-based CMOS wafers, the GW8231 has benefit of removing the interference from transmission between multi-chip signal, reduced chip area, and improvement of packaging reliability.

The GW8231 generates separated Temperature, Relative Humidity analog output, and each of voltage are linearly response to the change of temperature or humidity.

The chip is packaged in a miniaturized 8 pin DFN package with an outline size of 2.5 x 2.5 mm$^2$ and a height of 0.9 mm. This enables the GW8231 to be integrated in various applications. In addition, the wide power supply voltage range of 2.0~5.5V makes it adaptable to various power supply environments.

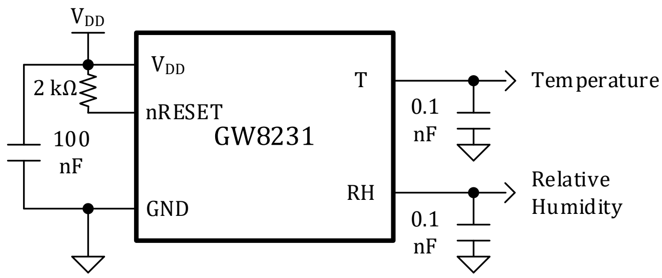
## 2 Features

- Single chip integrated Temperature and Relative Humidity sensor
- Separately measured Temperature and Relative Humidity
  - Separated analog voltage output
  - Fully calibrated and linearized
  - Temperature compensated
  - Output voltage linear ranges from 10 % to 90 % of $V_{DD}$
- Temperature measurement range: -45 °C~+130 °C
- Typical accuracy: ±3% RH / ±0.3 °C
- Wide supply voltage range: 2.0 V ~ 5.5 V
- High reliability and long-term stability
- DFN8 Package

## 3 Typical Applications

- Communication equipment
- Photovoltaic energy storage
- Consumer electronics
- Cold chain transportation
- Smart home
- Smart agriculture

## 4 Basic Application Diagram




## 5 Ordering Information

| Device name | Package | Remark |
|---|---|---|
| GW8231ENGLR | 2.5mm x 2.5mm, 0.5 mm pitch | 8 DFN |
| GW8231ECNGLR | 2.5mm x 2.5mm, 0.5 mm pitch | Covered with a dustproof breathable film |
| GW8231ECFNGLR | 2.5mm x 2.5mm, 0.5 mm pitch | Covered with a conformal coating film |

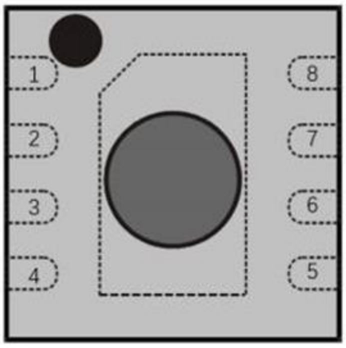
# Table of Contents



# 6 Revision History

| Version | Date | Description |
|---|---|---|
| 0.1 | March 11, 2025 | Initial release |
| 1.0 | April 15, 2025 | Changed P/N to GW8231 |
| 1.1 | April 22, 2025 | Added Temperature error rate |
| 1.2 | April 25, 2025 | Fully Revised |

# 7 Pin Configuration and Function




**Top View**

Note：Dashed lines are only visible viewed from below.
The middle pad is internally connected to $V_{SS}$.

**Table 1 Pin Description**

| No. | Pin Name | Type | Description |
|---|---|---|---|
| 1 | RH | A | Analog voltage output proportional to measured relative humidity |
| 2 | S1 | Not Used | No electrical function; to be connected to $V_{SS}$ |
| 3 | S2 | Not Used | No electrical function; to be connected to $V_{SS}$ |
| 4 | T | A | Analog voltage output proportional to measured temperature |
| 5 | $V_{DD}$ | P | Supply voltage |
| 6 | nRESET | I | Reset, active low, if not used, it is recommended to be left floating |
| 7 | R | Not Used | No electrical function; to be connected to $V_{SS}$ |
| 8 | $V_{SS}$ | G | Ground |

## 7.1 Power Pins ($V_{DD}$, $V_{SS}$)

The electrical specifications of the GW8231 are described in Table 5. A 100nF decoupling capacitor should be connected between the power supply pins and ground, and the capacitor should be placed as close as possible to the sensor chip. A schematic diagram of a typical application circuit is shown in Figure 1.

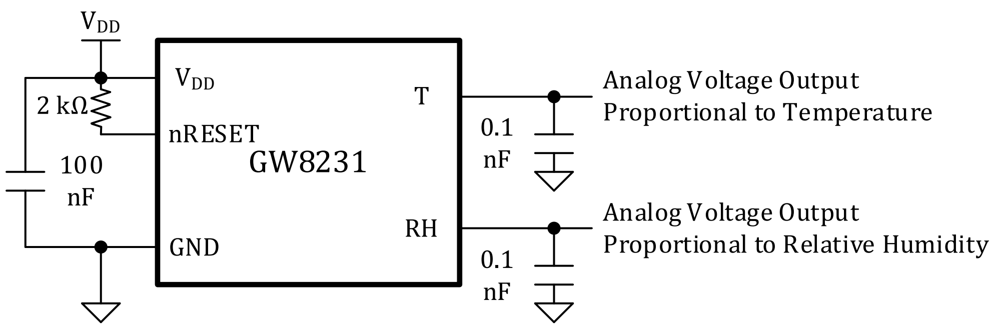



**Figure 1 Typical Application Circuit**

## 7.2 Temperature and Relative Humidity Output Pins (RH, T)

As shown in Table 1, the outputs of temperature and relative humidity are on separate pins, and the measured value are linearly proportional to output voltage. The relation between specific analog voltage output and physical temperature/relative humidity values are explained in Part 9.

## 7.3 Center Pin

The center pin on the middle of the backside of the chip is connected to $V_{SS}$ inside the sensor chip so there is no need to consider the electrical connection of the center pin. However, based on mechanical stress considerations, the center pin should be soldered firmly on the PCB.

## 7.4 nRESET Pin

An external reset signal can be given to the sensor through the nRESET pin. The reset signal should be active low with a minimum pulse width of 1 μs. If not used, it is recommended to leave this pin floating or use a resistor greater than 2 kΩ to pull this pin up to $V_{DD}$. Be aware that this pin pulled up to $V_{DD}$ by a 50kΩ resistor inside the chip.

# 8 Specifications

## 8.1 Absolute Maximum Ratings

**Table 2 Absolute Maximum Ratings**

| Parameter | Rating | Unit |
|---|---|---|
| Supply Voltage | -0.3 to 6 | V |
| Maximum voltage on pins<br>(1 (RH) ; 2 (S1); 3 (S2); 4 (T); 6 (nRESET)) | -0.3 to $V_{DD}$+0.3 | V |
| Max Input Current on Any Pin | ±100 | mA |
| Operating Temperature | -45 to 125 | ℃ |
| Storage Temperature | -45 to 150 | ℃ |
| ESD HBM (human body model) | 6,000 | V |
| ESD CDM (charged device model) | 850 | V |

## 8.2 Recommended Operating Conditions

The sensor shows optimum performance when operating within the recommended normal temperature and humidity ranges (5°C ~ 60°C and 20%RH ~ 80%RH, respectively). Long-term exposure to conditions outside the normal range, especially at high humidity, may temporarily shift the relative humidity signal. After returning to normal temperature and humidity ranges, the sensor will slowly return to calibration state by itself.

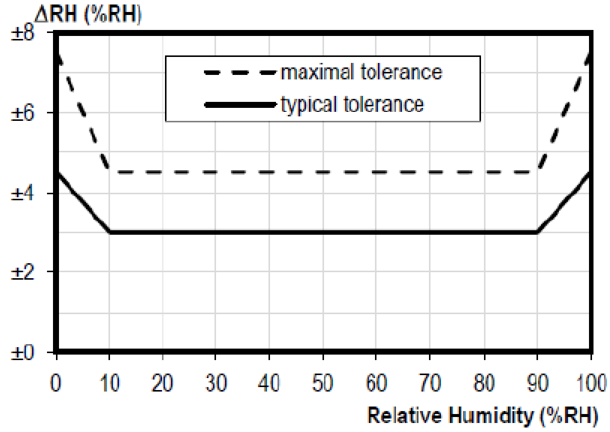
## 8.3 Sensor Performance

**Table 3 Humidity Sensor Specification**

| Parameter | Condition | Value | Unit |
|---|---|---|---|
| Accuracy | Typical | ±3 | % Relative humidity |
| | Maximum | Figure 2 | - |
| Repeatability | - | 0.10 | % Relative humidity |
| Resolution | Typical | 0.01 | % Relative humidity |
| Hysteresis | At 25°C | ±1.0 | % Relative humidity |
| Specified range | Measurement range | 0-100 | % Relative humidity |
| Response time | τ63% | 8 | Second |
| Long-term stability | Typical | <0.25 | % Relative humidity / year |
| Sensitivity | $V_{DD}$=2.4V | 19.2 | mV/%RH |
| | $V_{DD}$=3.3V | 26.4 | mV/%RH |
| | $V_{DD}$=5.5V | 44.0 | mV/%RH |

**Table 4 Temperature Sensor Specification**

| Parameter | Condition | Value | Unit |
|---|---|---|---|
| Accuracy | Typical, 0°C~65°C | ±0.3 | ℃ |
| Repeatability | - | 0.24 | ℃ |
| Resolution | Typical | 0.015 | ℃ |
| Specified range | Measurement range | -45 to +130 | ℃ |
| Response time | τ63% | >2 | Second |
| Long-term stability | Maximum | <0.03 | Second / year |
| Sensitivity | VDD=2.4V | 11.0 | mV/℃ |
| | VDD=3.3V | 15.1 | mV/℃ |
| | VDD=5.5V | 25.1 | mV/℃ |



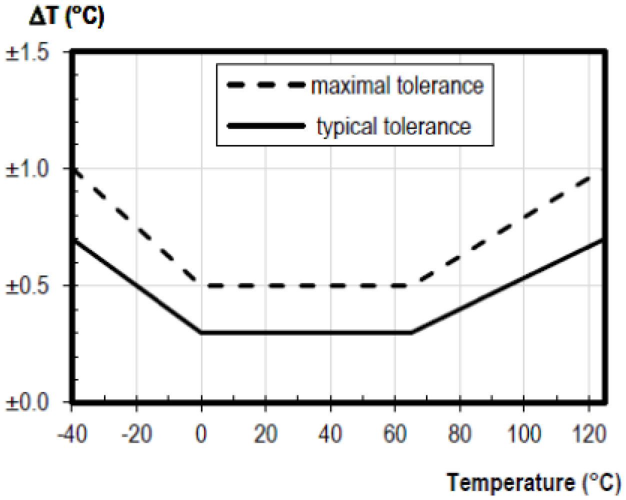




**Figure 2 Relative Humidity and Temperature Tolerance**

## 8.4 Electrical Characteristics

**Table 5 Electrical Characteristics**

| Parameter | Symbol | Condition | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | | 2.0 | 3.3 | 5.5 | V |
| Power-on Reset Voltage | $V_{POR}$ | | 1.8 | 1.9 | 2.0 | V |
| Supply Voltage Swing[1] | $V_{DD}$, slew | | | | 20 | V/ms |
| Operating Current[2] | $I_{DD}$ | Average | - | 220 | 350 | μA |
| Output Current | $AO_{IOUT}$ | | -100 | | 100 | μA |
| Capacitive Load[3] | $C_L$ | | - | - | 5 | nF |

[1] Changes in supply voltage should be less than the maximum slew rate, changing too fast may lead to reset.
[2] At an operating frequency of two conversions per second. Relative to the load resistance connected to the output.
[3] Capacitance that can be driven on the sensor signal line
Note: Typical values correspond to temperatures of 25 ° C, while maximum and minimum values correspond to temperatures of -40 ° C and 125 ° C, respectively.

## 8.5 Timing Specification for the Sensor

**Table 6 Timing Specification (@ -40℃~+125℃ , 2.4V~5.5V)**

| Parameter | Symbol | Condition | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Power-on Time(1) | $t_{PU}$ | $V_{DD} \geq V_{POR}$ | - | 0.5 | 1 | ms |
| Establishment time of analog output(2) | $AO_{settle}$ | Step up to $V_{DD}/2$ | - | 0.3 | | ms |
| Capacitive Load | $t_{RESETN}$ | | 1 | - | - | μs |

(1) The time between when VDD exceeds the power-on reset voltage and when the sensor is in the free state.
(2) This is the time to adapt to changing supply voltages and measurements. It is related to the output load capacitance and the typical load capacitance is 1nF.

# 9 Functional Description

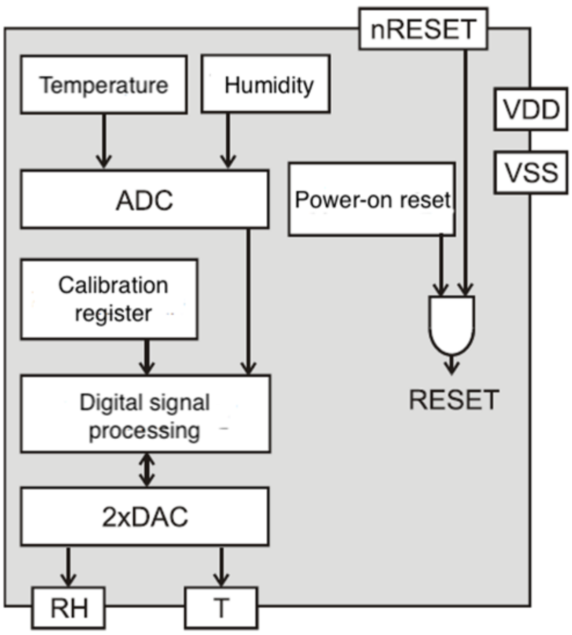



**Figure 3 Functional Diagram**

## 9.1 Power-Up

When the power supply voltage exceeds $V_{POR}$, the sensor starts to initialize. After reaching this threshold voltage the sensor needs the time $t_{PU}$ to enter idle state. The temperature and relative humidity pins output undefined state during this period.

## 9.2 Temperature and Humidity Measurement

Humidity ranges from 10%-90% and the physical values measured by the sensors are mapped to a linear output of analog voltage. The sensor outputs were temperature compensated and linearized before conversion to analog voltage outputs, and each sensor was calibrated.

Equations (1), (2) and (3) give the relationship between the physical values of relative humidity and RH output voltage, the relationship between temperature and T output voltage, which are plotted in Figure 4 and Figure 5.

$$RH = -\frac{19.7}{0.54} + \frac{100}{0.54} \times \frac{V_{RH}}{V_{DD}} \quad (1)$$

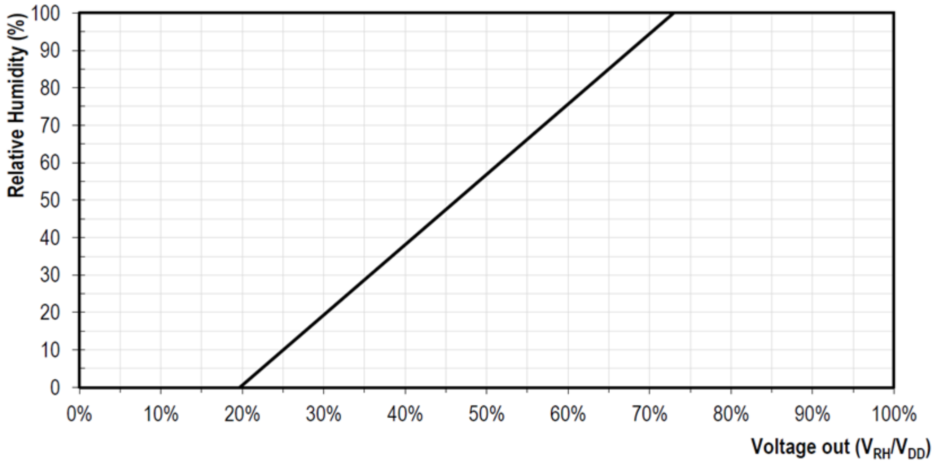



**Figure 4 Relation between relative humidity and RH output voltage**

$$T[°C] = -66.875 + 218.75 \times \frac{V_T}{V_{DD}} = -45 - \frac{17.5}{0.8} + \frac{175}{0.8} \times \frac{V_T}{V_{DD}} \quad (2)$$

$$T[°F] = -88.375 + 393.75 \times \frac{V_T}{V_{DD}} = -49 - \frac{31.5}{0.8} + \frac{315}{0.8} \times \frac{V_T}{V_{DD}} \quad (3)$$

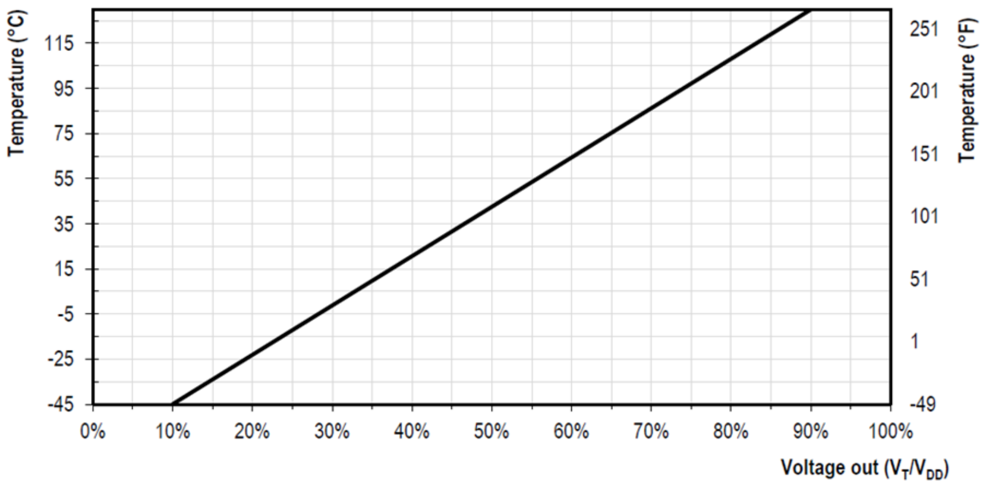



**Figure 5 Relation between temperature and T output voltage**

# 10 Package Information

The GW8231 are provided in an 8 pin DFN package. The opening for the humidity sensor is centered on top side of the DFN package. The temperature and humidity sensor are integrated on a single CMOS die and then mounted to a lead frame.

The chip is packaged in accordance with the Small-Scale Plastic Quad and Dual Inline, Square and Rectangular, No-LEAD packages as described in 4.20 of JEDEC 95 and also in Small Scale (QFN/SON) Specification D.01, 2009. The GW8231 is compliant with IPC/JEDEC J-STD-020 Moisture sensitivity Level of 1.

## 10.1 Package Outline

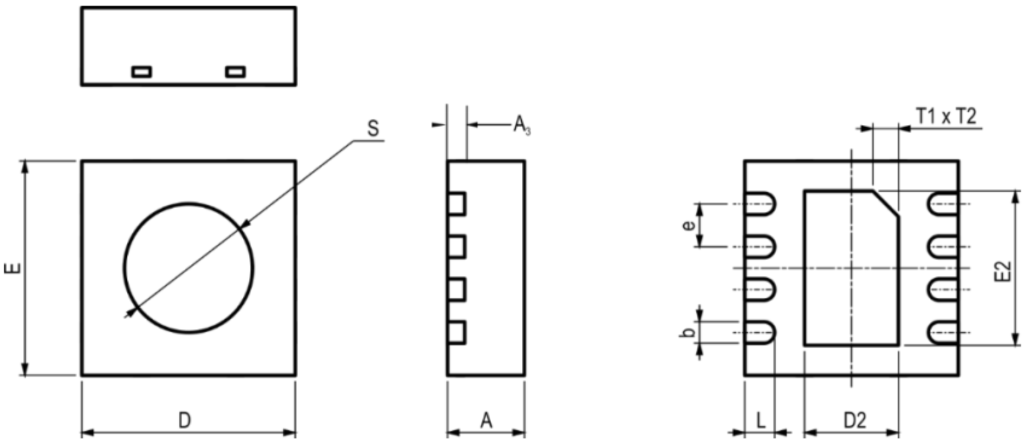



**Figure 6 Package Dimension Drawing**

| Parameter | Symbol | MIN | TYP | MAX | Unit |
|---|---|---|---|---|---|
| Package height | A | 0.8 | 0.9 | 1 | mm |
| Lead frame height | A3 | - | 0.2 | - | mm |
| Pad width | b | 0.2 | 0.25 | 0.3 | mm |
| Package width | D | 2.4 | 2.5 | 2.6 | mm |
| Center pad length | D2 | 1 | 1.1 | 1.2 | mm |
| Package length | E | 2.4 | 2.5 | 2.6 | mm |
| Center pad width | E2 | 1.7 | 1.8 | 1.9 | mm |
| Pad pitch | e | - | 0.5 | | mm |
| Pad length | L | 0.25 | 0.35 | 0.45 | mm |
| Max cavity | S | | 1 | 1.5 | Mm |
| Center pad marking(1) | T1xT2 | - | 0.3x0.45 | - | mm |

(1): Indicates the position of pin 1

## 10.2 Land Pattern

Figure 7 shows the land pattern of the sensor chip. The land pattern is understood to be the open metal areas on the PCB, onto which DFN pads are soldered.

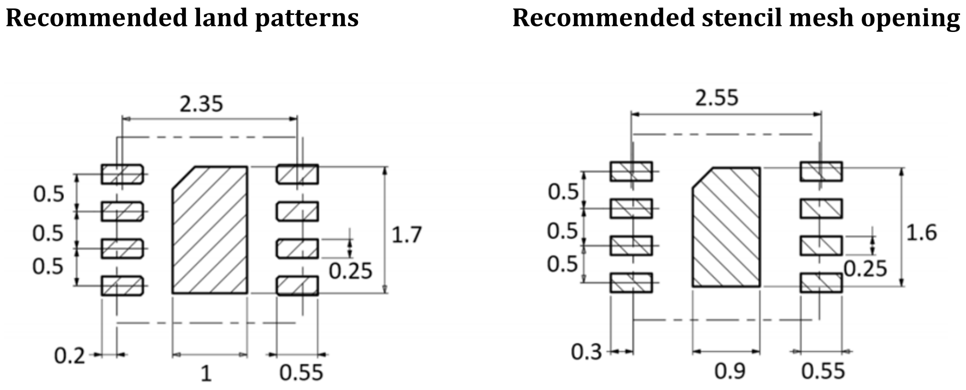



**Figure 7 Recommended Land Pattern and Stencil Apertures**

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