

# HT-01D

**Humidity & Temperature  
Sensor Module**

**User's Manual**

*MiCo SnP*

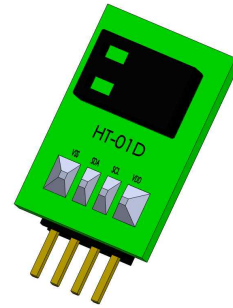
**History**

| <b>Date</b> | <b>Description</b>                                |
|-------------|---|
| 2013-03-30  | Initial Release. (Manual Integration)             |
| 2013-08-06  | Addition output voltage table                     |
| 2014-02-27  | Interface circuit(Fig.10) and I2C address(Fig.12) |
|             |   |
|             |   |
|             |   |

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## 1. Features

- On-Chip humidity & temperature sensors
- Fully calibrated, various output (I<sup>2</sup>C, Voltage)
- Excellent long-term stability
- Low power consumption
- Serial interface control (I<sup>2</sup>C)
- Small size



## HT-01D Product Summary

The HT-01D is a humidity & temperature sensor. The device includes a relative capacitive humidity sensor elements and a band-gap temperature sensor with capacitive-to-voltage converter (C-V Converter). This results in superior signal quality, a fast response time and insensitivity to external disturbances at a very competitive price. Each HT-01D is individually calibrated in a precision chamber. The calibration coefficients are programmed into the memory. These coefficients are used internally during measurements to calibrate the signals from the sensors. The serial interface and internal voltage regulation allows easy and fast system integration. Its small size and low power consumption makes it the ultimate choice for even the most demanding applications. The device is supplied in single-in-line type devices. Customer specific packaging options may be available on request.

|                  |   |                  |                   |
|------------------|---|------------------|-------------------|
| <b><u>HT</u></b> | : | <b><u>01</u></b> | <b><u>(D)</u></b> |
| ①                |   | ②                | ③                 |

|   |                      |
|---|----------------------|
| ① | Humidity-Temperature |
| ② | Product Number       |
| ③ | Pin Type (D)         |

## Application

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>- HVAC</li> <li>- Automotive</li> <li>- Consumer Goods</li> <li>- Weather Stations</li> <li>- Humidifiers</li> </ul> | <ul style="list-style-type: none"> <li>- Test &amp; Measurement</li> <li>- Data Logging</li> <li>- Automation</li> <li>- White Goods</li> <li>- Medical</li> </ul> |
|---|--|

## 2. Specification

Table.1 Specification for humidity sensor

| Parameter       | Condition | min            | typ         | max | Units |
|-----------------|-----------|----------------|-------------|-----|-------|
| Resolution      |           |                | 14          |     | bit   |
| Operating Range |           | 0              |             | 100 | %RH   |
| Accuracy        | Typical   |                | $\pm 2.5$   |     | %RH   |
|                 | Maximal   | See figure 1,3 |             |     |       |
| Hysteresis      |           |                | $< \pm 1.5$ |     | %RH   |
| Response time   |           |                |             | 10  | sec   |

Table.2 Specification for temperature sensor

| Parameter       | Condition | min          | typ       | max | Units              |
|-----------------|-----------|--------------|-----------|-----|--------------------|
| Resolution      |           |              | 14        |     | Bit                |
| Operating Range |           | -40          |           | 120 | $^{\circ}\text{C}$ |
| Accuracy        | Typical   |              | $\pm 0.5$ |     | $^{\circ}\text{C}$ |
|                 | Maximal   | See figure 2 |           |     |                    |
| Response time   |           | 15           |           | 25  | sec                |

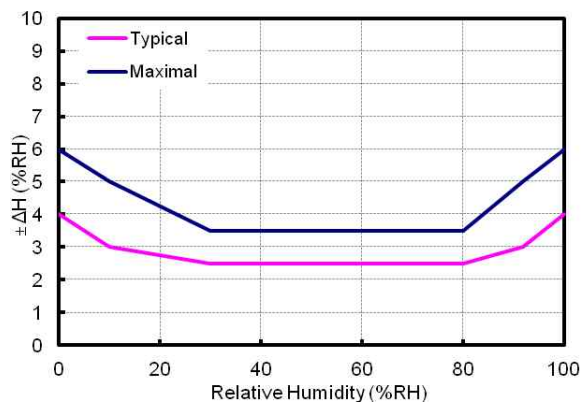


Fig.1 Humidity-accuracy at 25°C

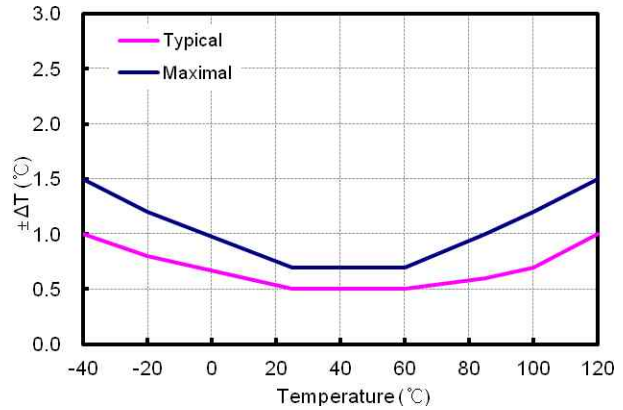


Fig.2 Temperature-accuracy.

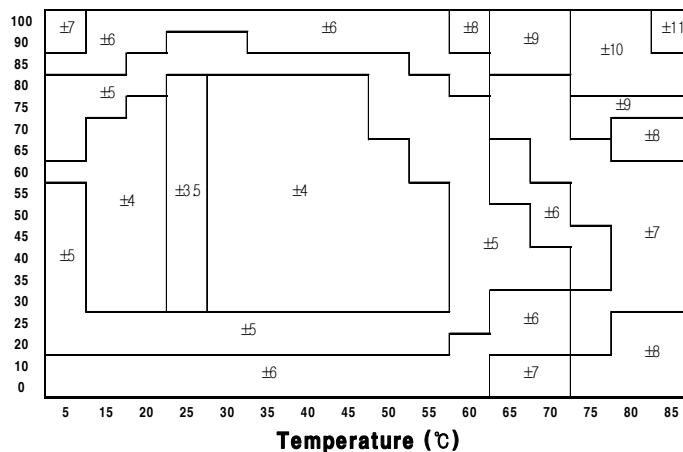


Fig.3 Maximal tolerance of relative humidity at different temperature

### 3. Reliability of Humidity Sensor

#### 1) Normal operating Range

The sensor works stable within recommended normal range(see Figure. 3). Long term exposures to conditions outside normal range, especially at humidity >80%RH, may temporarily offset the RH signal. After return to normal range it will slowly return towards calibration state by itself.

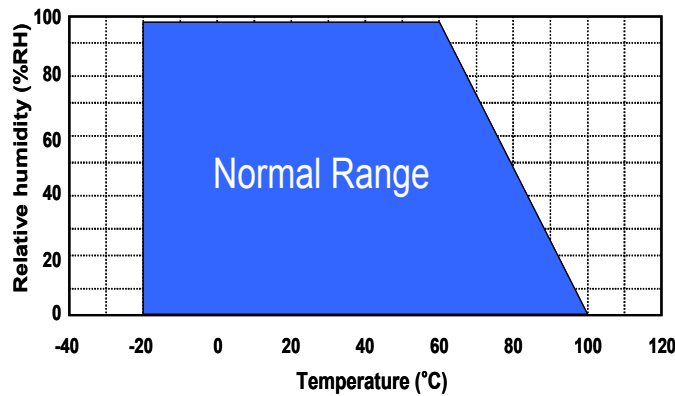


Fig.4 Normal operating range.

#### 2) Hysteresis of Characteristics

The graph shows the hysteresis curve of HT-01D sensor. Considering the relative humidity of the sensor, the hysteresis formula is give by

$$\text{Hysteresis Value} = H(10\%RH \rightarrow 90\%RH) - H(90\%RH \rightarrow 10\%RH)$$

The hysteresis variety of samples indicate  $\Delta H < \pm 1.5\%RH$  at each humidity point. This result shows that the sensor satisfies our specification. The meter is set to measure humidity value at  $V_{DD} = 5V$ . For the precise measurement, we used the hygrometer and compared with the humidity of temperature-humidity chamber.

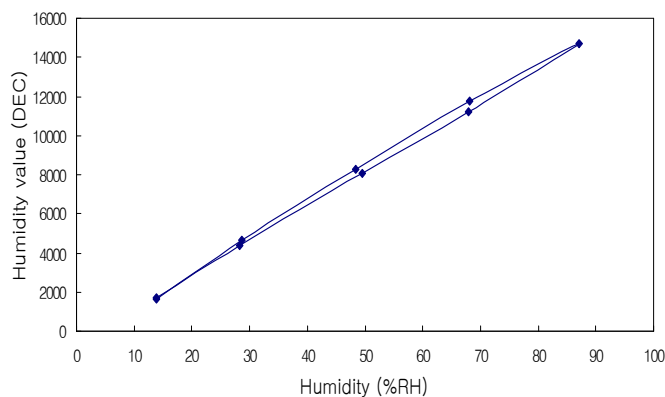
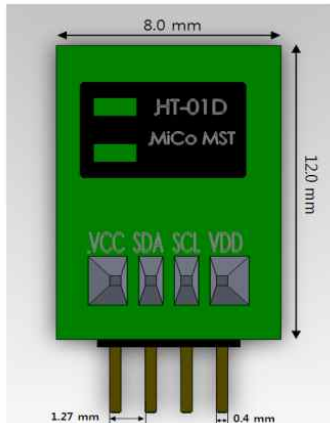


Fig.5 Hysteresis of Humidity Sensor

## 4. Dimension

### 1) HT-01D



| Name | Pin Function |
|------|--------------|
| VSS  | Ground       |
| SDA  | Serial Data  |
| SCL  | Serial Clock |
| VDD  | DC Power     |

## 6. Reconditioning Procedure

The sensor exposed to extreme conditions or chemical solvents may have offset. The following reconditioning procedure may bring back to the calibrated state of device.

- Baking : 100 °C for 8 hours
- Re-Hydration : 25°C, >80 %RH for 48 hours

## 7. Shipping details

HT-01D was packaged in plastic trays. Please be careful opening from side of the tray cover to avoid damage of sensors.

## 8. Storage instructions

The storage instructions must be followed precisely in order to guarantee specification. Guarantees are one-year storage of the sensor package. Chemical vapors at high concentration in combination with long exposure times may offset the sensor reading.

## 9. Block Diagram

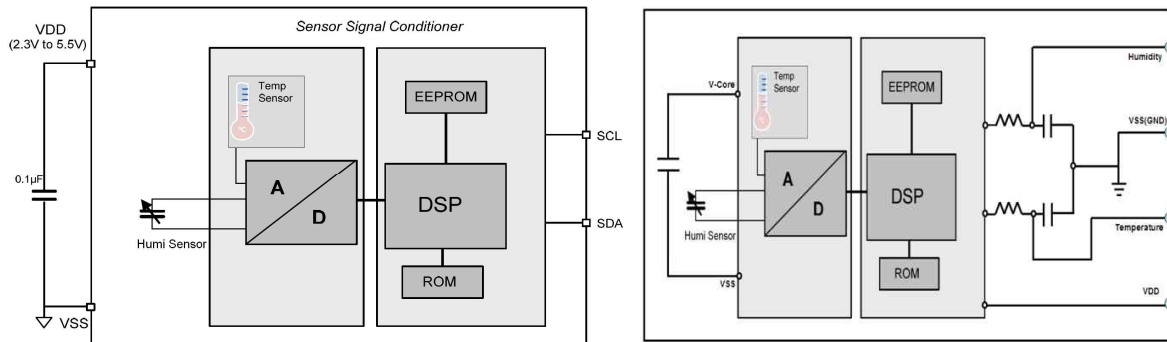


Fig.9 HT-01D Block diagram

## 10. Operating Condition

### 1) Absolute Maximum Ratings

| Parameter                      | Symbol     | Min  | Typ | Max          | Units |
|--------------------------------|------------|------|-----|--------------|-------|
| Analog Supply Voltage          | $V_{DD}$   | -0.3 |     | 6.0          | V     |
| Voltages at Analog I/O In Pin  | $V_{INA}$  | -0.3 |     | $V_{DD}+0.3$ | V     |
| Voltages at Analog I/O Out Pin | $V_{OUTA}$ | -0.3 |     | $V_{DD}+0.3$ | V     |
| Storage Temperature Range      | $T_{STOR}$ | -55  |     | 150          | °C    |

### 2) Operating Conditions

| Parameter   | Symbol         | Min         | Typ | Max | Units |    |
|---|----------------|-------------|-----|-----|-------|----|
| Supply Voltage to GND                               | $V_{SUPPLY}$   | 2.3         | 5   | 5.5 | V     |    |
| Ambient Temperature Range                           | $T_{AMP}$      | -40         |     | 125 | °C    |    |
| External Capacitance between $V_{DD}$ pin and GND   | $C_{VSUPPLY}$  | 100         | 220 | 470 | nF    |    |
| External Capacitance between $V_{CORE}$ pin and GND | $C_{VCORE}$    | 10          |     | 110 | nF    |    |
| I <sup>2</sup> C Pull-up Resistor                   | $R_{PU}$       | 1           | 2.2 | 10  | kΩ    |    |
| SDA Load Capacitance                                | $C_{SDA}$      |             |     | 0.2 | nF    |    |
| Current   | Digital output | $I_{sleep}$ |     | 1   | 3     | µA |

## 11. Circuit Interface

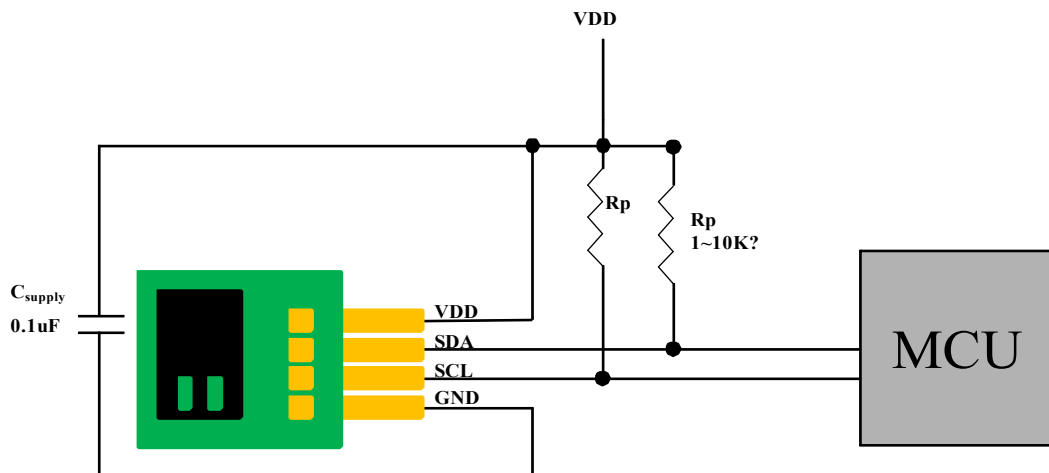


Fig.10 HT-01D I<sup>2</sup>C Interface

### 1) Power

The HT-01D requires a voltage supply between 2.3 and 5.5V. After power on, the device needs 10ms to reach measurement state. No commands should be sent. If you send command at that time, you cannot receive correct data from sensors.

### 2) Serial Clock (SCL)

The SCLK is used to synchronize the communication between a microcontroller and the HT-01D. Since the interface consists of fully static logic there is no minimum SCL frequency.

### 3) Serial Data (SDA)

The SDA pin is used to transfer data in and out of the device. Data changes after the falling edge and is valid on the rising edge of the serial clock SCL. During transmission the SDAT line must remain stable while SCL is high. An external pull-up resistor is required to pull the signal high.



## 12. I<sup>2</sup>C Interface

For integration with the micro-controller, the HT-01D has a I<sup>2</sup>C-compatible interface which supports both 100 kHz and 400 kHz bit rate. The I<sup>2</sup>C slave address is programmed by default on 28<sub>H</sub> and can be adjusted in the entire address range of (00<sub>H</sub> to 7F<sub>H</sub>).

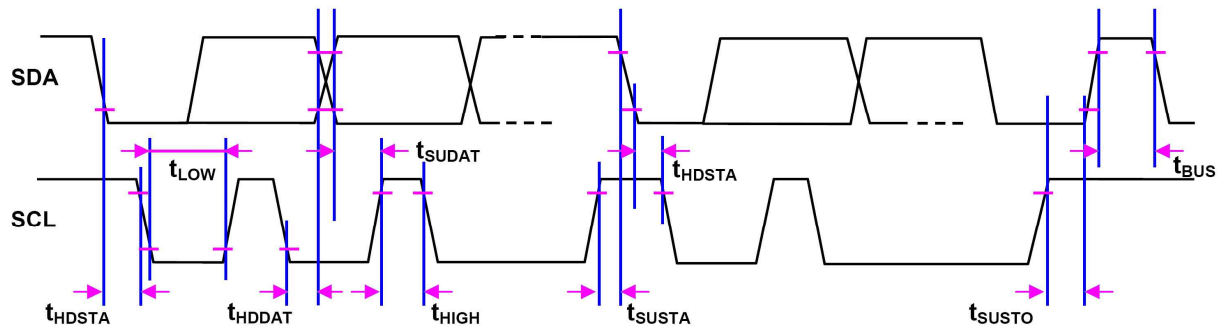


Fig.11 I<sup>2</sup>C Timing Diagram

### 1) I<sup>2</sup>C Parameters

| Parameter  | Symbol      | Min | Max | Units   |
|--|-------------|-----|-----|---------|
| SCL clock frequency                                      | $f_{SCL}$   | 100 | 400 | kHz     |
| Start condition hold time relative to SCL edge           | $t_{HDSTA}$ | 0.1 |     | $\mu$ S |
| Minimum SCL clock low width                              | $t_{LOW}$   | 0.6 |     | $\mu$ S |
| Minimum SCL clock high width                             | $t_{HIGH}$  | 0.6 |     | $\mu$ S |
| Start condition setup time relative to SCL edge          | $t_{SUSTA}$ | 0.1 |     | $\mu$ S |
| Data hold time on SDA relative to SCL edge               | $t_{HDDAT}$ | 0   |     | $\mu$ S |
| Data setup time on SDA relative to SCL edge              | $t_{SUDAT}$ | 0.1 |     | $\mu$ S |
| Stop condition setup time on SCL                         | $t_{SUSTO}$ | 0.1 |     | $\mu$ S |
| Bus free time between stop condition and start condition | $t_{BUS}$   | 1   |     | $\mu$ S |

### 13. I<sup>2</sup>C commands

As detailed in below table, there are two types of commands for user operating a HT-01D. The Measurement Request (MR) is wake up command sent by the master for a new measurement cycle. The Data Fetch (DF) command is used to fetch data in I<sup>2</sup>C communication. With the start of communication the entire output packet will be loaded in a serial output register. The register will be updated after the communication is finished. The output is always scaled to 14-bits programmed resolution.

#### I<sup>2</sup>C command types

| Type                    | Descriptions                           |
|-------------------------|--|
| Measurement Request(MR) | Start measuring cycle                  |
| Data Fetch(DF)          | Used to fetch data in any digital mode |

Humidity modules do not carry out internal arithmetic operation to minimize on the current consumption. A measurement process is carried out only after the command measuring request (MR) is received.

#### 1) Measurement Requests (MR)

By a measurement request command, the HT-01D is woke up and it executes a measuring cycle. The measuring cycle begins with the temperature measurement, followed by humidity measurement, digital signal processing and finally writing the measured values into the output register.

The MR command consists of the address of the HT-01D, with which the R/W bit is transferred as 0(= write). The real signal of MR is 0x50 adding write bit(0) to address(0x28). After the humidity module is answered with ACK (= measurement started), the master finalized the transfer with NACK (=stop condition).

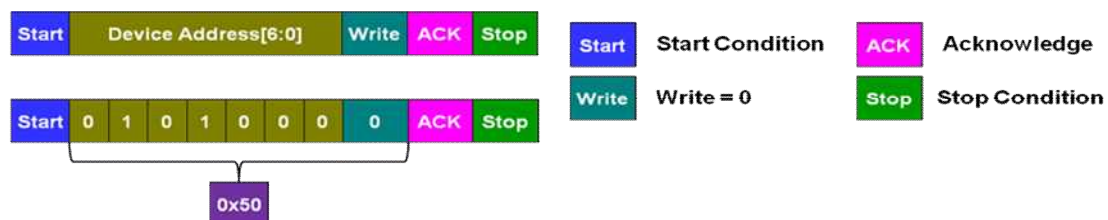


Fig.12 Measurement Request Command

### 2) Data Fetch(DF)

The DF command is began by the micro-controller (master) as sending address(7bit : 0x28) and read bit (1bit : 1). The real signal is 0x51. The HT-01D sends back an acknowledgement (ACK) to indicate success. The others data are two status bit and measurement data with humidity and temperature to sending a NACK (= stop condition) by the master. The first two bytes of measurement data contain the two status bits as MSB, and then followed by the humidity value with 14 bits.

If the temperature data is also needed, then these can be read after the humidity value. The most significant 8 bits of the temperature value will be transferred as third byte. Then the least significant 6 bits of the temperature value can be read as the fourth byte. The last two bits are not used and should be masked away. But if the temperature data is not needed, the master can send a NACK signal. If it doesn't appear "state bit 00", does not communicate.

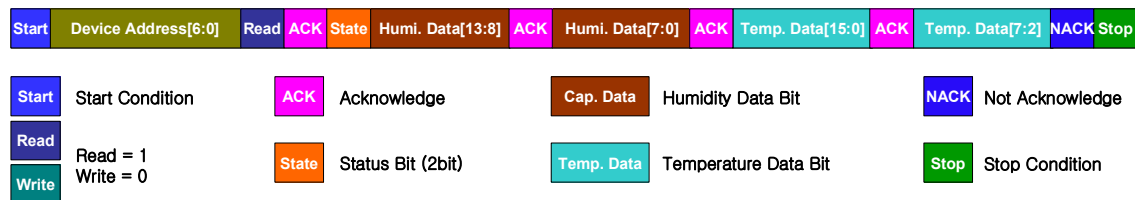


Fig.13 Measurement Packet Reads

#### Status Bit Table

| Status Bits | Output                | Definition   |
|-------------|-----------------------|--|
| 00B         | Clipped normal output | Data that has not been fetched since the last measurement cycle.     |
| 01B         | Not applicable        | Data that has already been fetched since the last measurement cycle. |
| 10B         | Not used              | Not used   |
| 11B         | Not used              | Not used   |

### 3) Relative Humidity and Temperature Raw Data Collection

Raw data are collected for the HT-01D. The Raw data should also be the average of several samples to minimize noise effects. To collect relative humidity and temperature raw data in measurement, the expression as follows;

The Humidity\_High and Humidity\_Low bytes can be read in %.

$$\text{Humidity [\%RH]} = (\text{Humidity\_High}[5:0] \times 256 + \text{Humidity\_Low}[7:0]) / 2^{14} \times 100$$

The Temp\_High and the Temp\_Low bytes can be read as temperature output in °C.

$$\text{Temp output [C]} = (\text{Temp\_High}[7:0] \times 64 + \text{Temp\_Low}[7:2]/4) / 2^{14} \times 165 - 40$$

Using bit range [MSB:LSB]