Capacitive Humidity Sensor

Application Manual

Part Number : HSU-CHM-xxx / HSU-CHU-xxx

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1. Reflow Mounting Method

The recommended foot pattern and reflow profile for HSU-CHM are shown in Figure 1-1 and Figure 1-2, respectively.
This product is leadless, but it has electrodes on the side so you can check the soldering condition. Please check the mounting condition yourself.
Please put the product through the reflow process only once. In case of double-sided mounting, please mount this product on the second mounting surface.

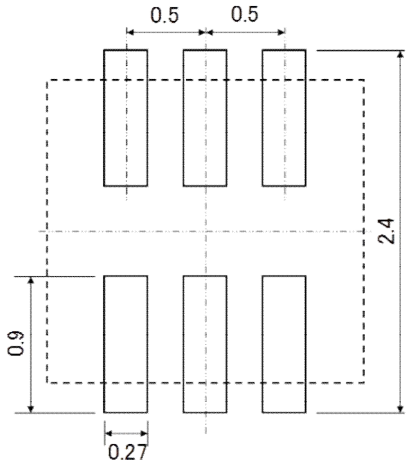


Figure 1-1. Recommended Foot Pattern

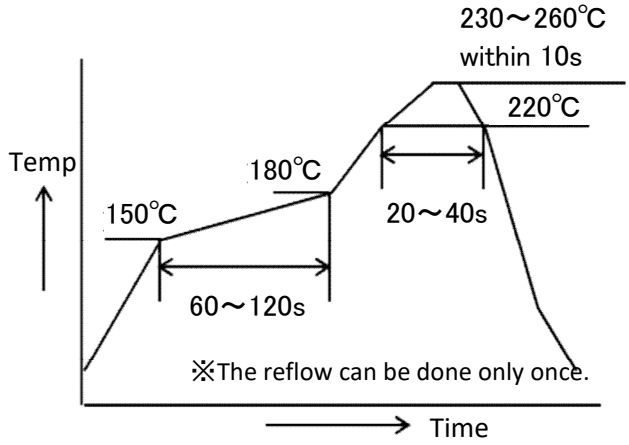


Figure 1-2. Recommended Reflow Profile

◆Precautions after Reflow Soldering

【Humidity】

High temperatures during reflow can cause excessive drying, resulting in a lower sensor output. This output shift will gradually return to normal when placed in a room temperature environment, usually within 2 to 3 days.
However, depending on the dryness or surrounding environment, it may not recover.
In that case, you can recover it by carrying out the humidification process described below.

Humidification Treatment Conditions : 20～30℃ / 75～95%RH / 24～48 hours

【Temperature】

The high temperatures during reflow can cause stresses that shift the temperature output. Therefore, please place it in a location where the stress is as small and stable as possible.
The shift value will vary depending on the reflow conditions and board, but will be a constant value under the same conditions, so it is necessary to correct the shift value due to reflow.

◆Other Points to Note when Mounting

Do not clean this product with cleaning agents or organic solvents.

Be careful not to allow flux or other substances to adhere to the sensor opening of this product (see item 2).
Please be especially careful when using a soldering iron around this product.

When correcting the soldered parts of this product, keep the soldering iron temperature below 350℃ and do not perform the work for more than 5 seconds.

When mounting or using this sensor, do not apply mechanical stress to any part of it.

When measuring temperature, accurate measurements are not possible if there are heat-generating parts nearby.
In addition, when measuring humidity, the measured value will change due to the effect of temperature caused by heat-generating components.
Please take note of these factors when designing the board and case to minimize them.

2. Effects of Chemical Substances such as Solvents, Dirt, and Foreign Matter

This product is a very precise environmental measurement part.
Unlike general electronic components, this product has an opening that exposes the moisture-sensitive film to the outside atmosphere, making it susceptible to contamination by chemicals.
There is no problem using it in a general environment, but please take note of the following points during storage, manufacturing, transportation and in the usage environment in the market.

2-1. Effects of Organic Solvents

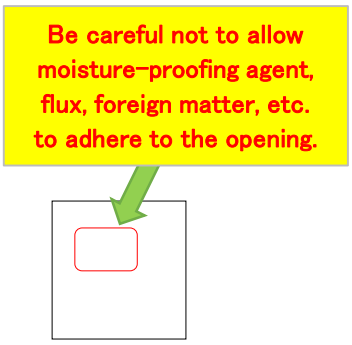
Sensors exposed to vapors of organic solvents such as acetone, ethanol, isopropyl alcohol (IPA), and toluene may experience output drift. In most cases, the output will not return to normal on its own.
Even in such cases, it may be possible to restore the original output by performing the following steps in the order ① and ② may restore the output to its original state.

①(Drying Process) : 100～105℃ / Less than 5%RH / 10～12 Hours
②(Humidification Process) : 20～30℃ / 75～95%RH / 24～48 Hours

※Prohibition of Cleaning

To ensure the functionality of this product, never clean it with organic solvents.

2-2. Effects of Moisture-proofing Material



Moisture-proofing materials also generally contain organic solvents.
When applying moisture-proofing material to the soldering parts or surrounding areas of this product, be sure to take in fresh air and provide sufficient ventilation.
Also, be careful not to allow the moisture-proofing material to come into contact with openings.
We have confirmed that the following moisture-proofing materials have no effect when the above precautions are observed.

Humiseal 1B51NS	(AR BROWN Co., Ltd.)
Humiseal 1B51NSLU	(AR BROWN Co., Ltd.)

2-3. Effects of Flux

If flux adheres to the sensor surface of the opening, it may cause the sensor output to drift.
Use no-clean type solder and take care to avoid adhesion due to flux smoke or scattering.

2-4. Effects of Foreign Matters

If sebum, oil, conductive materials, dielectric materials, etc. adhere to the sensor surface of the opening, it may cause sensor output drift. Be careful not to allow these materials to adhere to the sensor surface.
There is no problem with dust in general environments.
It has been confirmed that there are no problems in dust testing according to JIS D-0207-F3.

2-5. Effects of Acids and Alkalis

Exposure to acids (hydrochloric acid, sulfuric acid, nitric acid, etc.) or alkalis will affect the output of this sensor.
In particular, an ammonia atmosphere can damage the humidity-sensitive film of this sensor, severely affecting the output.
In addition, if the sensor comes into contact with high concentrations of ozone, hydrogen peroxide, or corrosive gases (sulfur dioxide gas, hydrogen sulfide gas, etc.), this may also have a significant effect on the output.

3. Precautions of Handring

3-1. Precautions of ESD (Electrostatic Discharge)

This product must be protected from ESD.
When handling this product, please take the following protective measures.

<Example>
- Wear a grounded wrist strap while working.
- The floor of the work area should be made of conductive material and grounded.
- Do not place in an environment where static electricity is likely to be generated (ground the shelves, eliminate insulating materials, etc.).

When outside an ESD protected area, protect this product with ESD protective packaging.

The electrostatic resistance specifications of this product are as follows:
- HBM Method : ±1000V
- MM Method : ±200V

3-2. Precautions of Radioactive Energy

This product is not designed to be radiation-resistant.
If the product is exposed to excessive radiation, its performance may be affected.
Please use with caution in relation to the surrounding environment.

3-3. Precautions for Use

This product is intended for use in general electrical equipment.
Please do not use it for applications that require extremely high reliability and for which the following situations are normally expected. Failure or malfunction of medical equipment, safety equipment, aerospace equipment, nuclear power control equipment, combustion control equipment, etc., directly or indirectly, causes serious damage to life (including death), body, property, etc. case.

3-4. Storage Conditions

This product should be stored under the following conditions.

Unopened Package	: Within 1 Year at 5～35℃ / ≦60%RH
After Opening the Package	: MSL2

4. About Sensor Specifications

4-1. Humidity Accuracy and Temperature Accuracy

The precision stated in the product specifications is defined as the standard deviation σ for a normal distribution. The standard accuracy tolerance at a given measurement point is that 95% of all products within the maximum accuracy will fall within ±2σ (σ: standard deviation).

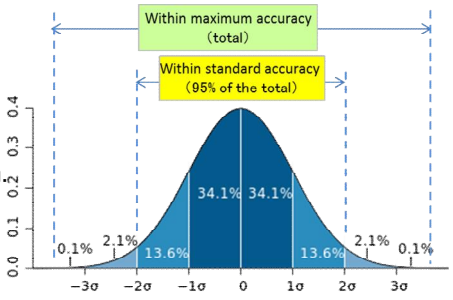


Figure 4-1. Accuracy Distribution

4-2. Current Consumption

The current consumption is the total of the sleep current, standby current, temperature detection current, and capacitance detection current (see Figure 4-2. Measurement timing chart). The average current consumption (Iavg1) calculated when measuring once per second is as follows.

$$Iavg1 = Islp + (Ist * Tst + It * Tt + Ih * Th) / 1000$$

Islp : Sleep Current [μA]
Ist : Standby Current [μA]
Tst : Standby Time [ms]
It : Temperature Detection Current [μA]
Tt : Temperature Detection Time [ms]
Ih : Capacitive Detection Current [μA]
Th : Capacitive Detection Time [ms]

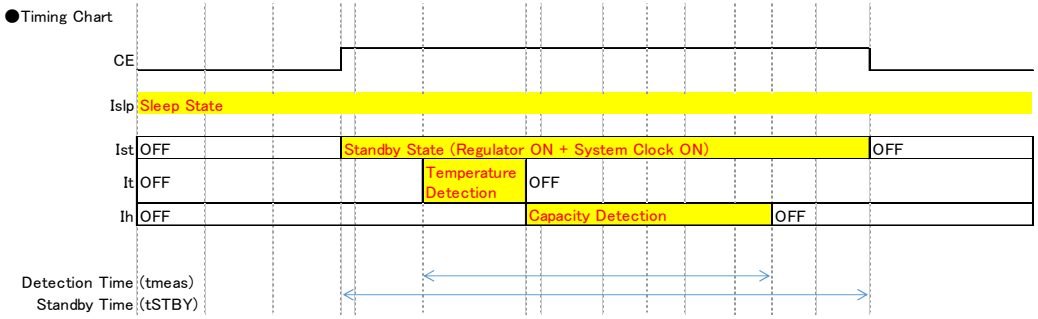


Figure 4-2. Measurement Timing Chart

4-3. Response Time

When the humidity changes suddenly, the response approaches the final output value exponentially. The response time is defined as the time it takes for the humidity change value to change by 63.2%, as shown in Figure 4-3.

<Ex : When the temperature suddenly changes from 10%RH to 90%RH>

(90−10) * 0.632 + 10 = 60.6%RH

The response time is the time it takes for the output to arrive.

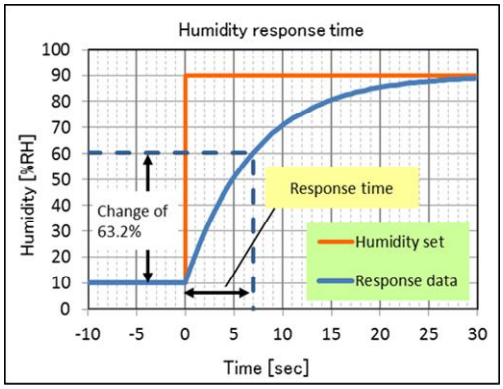


Figure 4-3. Response Time Definition

4-4. Hysteresis

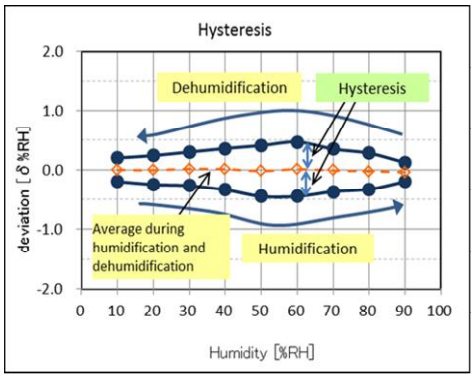


Figure 4-4. Definition of Hysteresis

When measuring humidity with this product, there will be a slight difference between the measured values when humidifying and when dehumidifying.
Based on the average of the measured values during humidification and dehumidification, the output will be negative during humidification and positive during dehumidification.
The difference between this average value and the output value is defined as hysteresis (see Figure 4-4).

4-5. Long-term Drift

The aging of this product is calculated based on the following accelerated testing method.

Acceleration Factor A = exp (Ea / K * (1 / T1 - 1 / T2))

Ea : Activation Energy [eV]
K : Boltzmann Constant $8.63 * 10^{-5}$ [eV/K]
T1 : Operating Temperature [K]
T2 : Test Temperature [K]

※Acceleration Factor

The components used in this product are an IC and a sensor element, and the activation energy (Ea) of these components is set to 0.6 according to the Arrhenius law.
(There is little track record of humidity sensor elements, so the activation energy is generally assumed to be 0.6.)

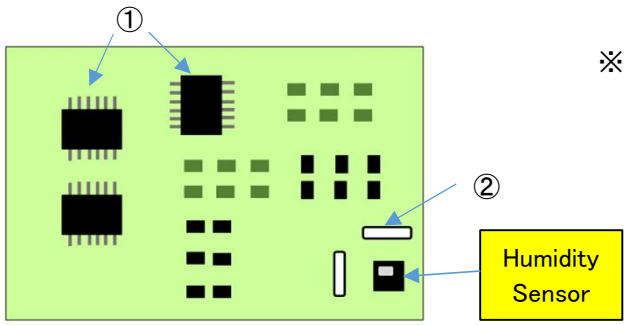
Based on the above accelerated testing concept, a test at 125℃/1,000hr or 85℃/1,000hr is equivalent to 15.9 years and 5.7 years at 25℃.
The change per year calculated from these test results is considered the long-term drift.

5. Board Design and Case Design

When measuring temperature, accurate measurements are not possible if there are heat-generating parts nearby.
In addition, when measuring humidity, the measured value will change due to the effect of temperature caused by heat-generating components.
This is because the saturated water vapor pressure changes with temperature.
If the temperature around the sensor rises due to heat generation, the measured humidity will be approximately 2 to 6% lower per degree Celsius.
The temperature rise caused by heat-generating components also varies depending on the surrounding wind speed, which causes the temperature and humidity measurements to change.
In order to minimize these effects, please take the following points into consideration when designing the board and case.

◆Board Design Considerations

①Keep the sensor as far away as possible from heat-generating components such as microcontrollers and ICs.
②Slits are made in the board to reduce thermal conduction.



※ If the temperature around the sensor rises due to heat generation, the measured humidity value will be approximately 2 to 6%RH lower per +1℃.

Figure 5-1. Precautions when Designing Printed Circuit Boards

◆Case Design Considerations

①The case creates a barrier to reduce the impact of heat-generating components.
②Consider wind flow and ensure good ventilation to the sensor.

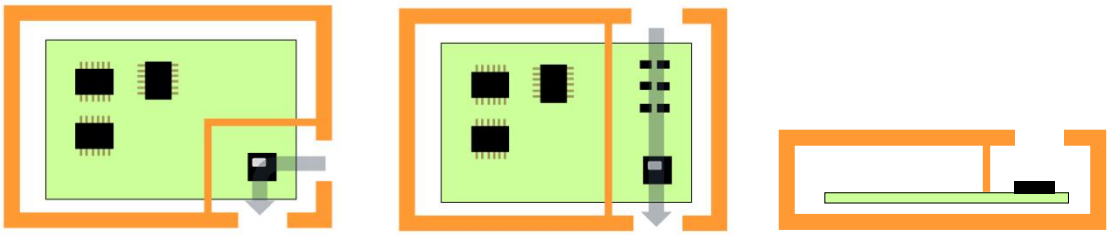


Figure 5-2. Precautions when Designing the Case

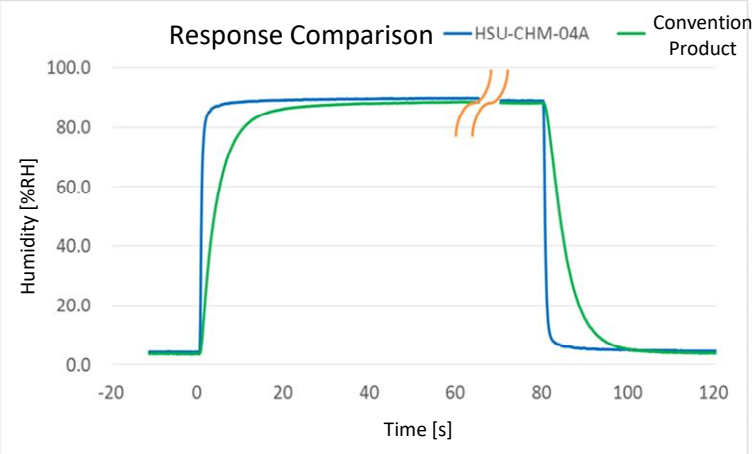
6. Humidity Sensor Applications

6-1. General Purpose

Capacitive humidity sensors have a wide humidity detection range (0 to 100% RH), making them suitable for use in a wide range of applications, including air conditioning equipment such as air conditioners and dehumidifiers, refrigerators (external/vegetable compartment humidity control), washing machines/dryers, and office equipment such as printers and copiers.

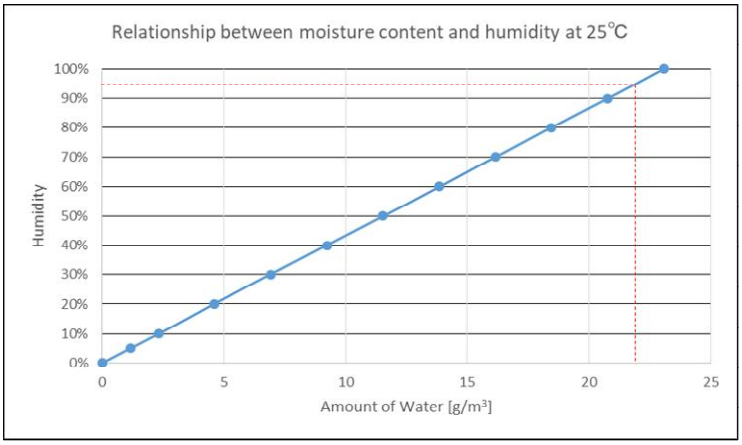
6-2. Applications that Utilize High-speed Response

The humidity response time of the HSU-CHM is approximately 1/10 that of conventional products.



The high-speed response can be used to detect moisture intrusion into waterproof equipment, humidity intrusion, and fogging of glass or mirrors. It can also be used to detect moisture intrusion into pipes in dry air atmospheres in industrial equipment.

【Example of Use】



If moisture or water gets in or just before fogging occurs, the humidity becomes high.

⇒It becomes highly hydrated.

By setting a threshold value for the output value of the humidity sensor, advance detection is possible.

7. About I2C Communication

7-1. How to Check Data Integrity

This product does not have a checksum function.
Follow the steps below to check the consistency of the data.
Since the temperature/humidity data is not updated unless "01h" is written to register address 01h, it is possible to check the consistency of the data by reading register addresses 04h to 07h multiple times.

7-2. How to Recover from Communication Failure

Symptom : SDA Line Fixed at Low

①Recovery Method by CE Control

SDA is released by changing the CE pin from "Hi" to "Lo". (SDA = "Hi")
After releasing SDA, change the CE pin from "Lo" to "Hi".

②Recovery Method by Pseudo Clock

Switch the SCL / SDA pin on the master side to a general-purpose port, output a pseudo clock from the SCL pin (pseudo clock output with Hi-z and Low output), and check that SDA is released on the slave side. (Confirm that SDA becomes "Hi")
At this time, if the slave side does not release SDA after a single pseudo clock output, output the pseudo clock repeatedly until the slave side releases SDA.
When the slave side releases SDA (SDA = "Hi"), return the setting on the master side to the I2C bus, issue a start condition (start condition) and a stop condition (stop condition), and terminate communication once.
After that, execute the reset command (Address: 00h Bit: D0).

③Recovery Method by Hard Reset

It can be reset by turning off the power supply (VCC).

The recommended method is ①.