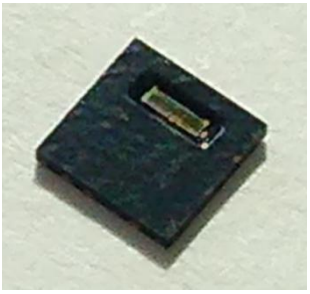
QM1H0P0073

Relative Humidity
/ Temperature Sensor



■ Description

QM1H0P0073 is a digital output relative humidity/temperature sensor. In addition to electrostatic capacitance type humidity sensor and temperature sensor elements, an analog-to-digital converter, signal processing unit, data storage for calibration data, and an interface circuit are integrated into 1 package. The device features wide operating range, small in size, high resolution and high response speed, and is suitable for use in a wide range of applications. Both the temperature and humidity sensors are factory-calibrated and no any further calibration is required after installing on electronic equipments.

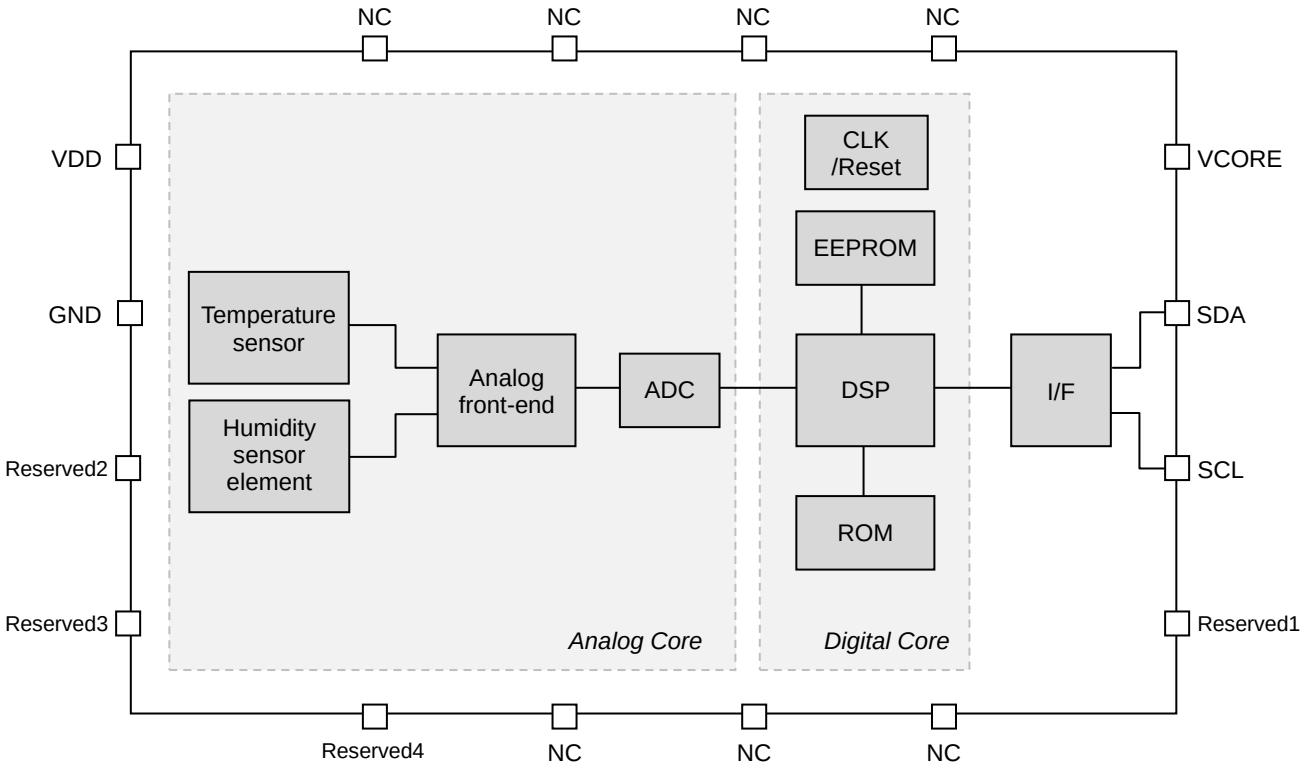
■ Features

- High precision
  - Relative humidity: ±2%RH (typ.)
  - Temperature: ±0.3℃(typ.)
- Wide operating range
  - Relative humidity: 0 to 100%RH
  - Temperature: -20 to 85℃
  - Operating voltage: 2.7 to 5.5V
- Low power consumption
  - 3.0uA (max) non-operation current
- I^2C digital interface
- Small, Low profile QFN 16pin package
  - footprint: 3mm × 3mm
  - Industry-leading levels of height: 0.8mm
- Factory calibrated
- RoHS Compliant

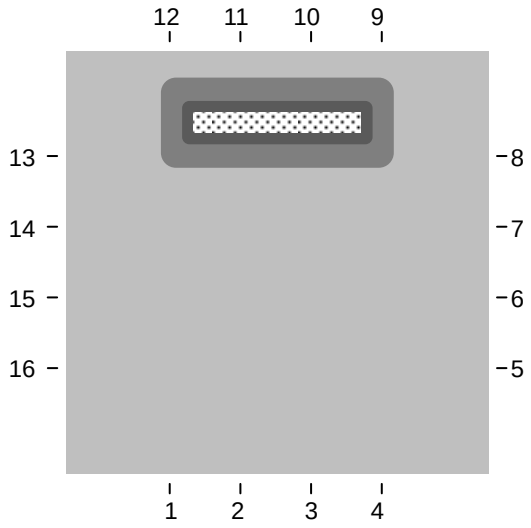
■ Applications

- Home electronics
  - Air conditioners, Air purifiers, Dehumidifiers
- Smart phones/Tablets
- Wearable devices
- Weather stations
- Wireless networks

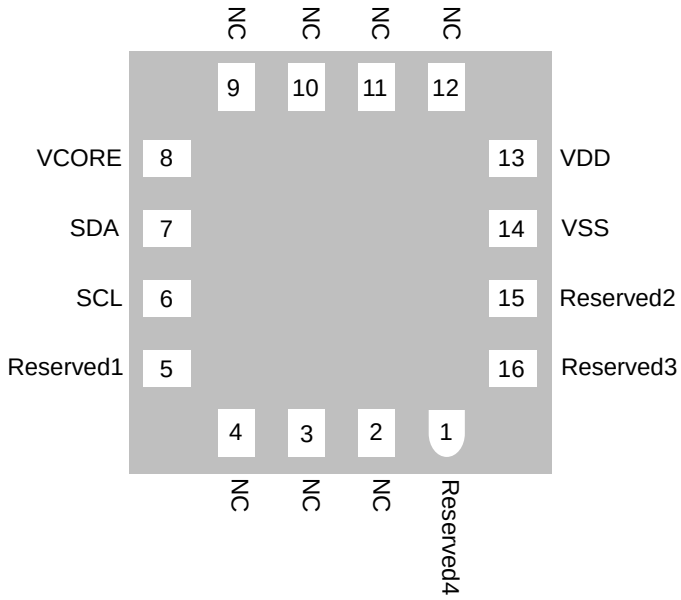
■ Block diagram



■ Pin Configuration



TOP VIEW
(Not to scale)



BOTTOM VIEW
(Not to scale)

Pin	Pin Name	Type	Function	Remarks
1	Reserved4	-	Test Terminal	Leave Open
2	NC	-	Not Connected	Leave Open
3	NC	-	Not Connected	Leave Open
4	NC	-	Not Connected	Leave Open
5	Reserved1	-	Test Terminal	Leave Open
6	SCL	I	I^2C Serial Clock	-
7	SDA	I/O	I^2C Serial Data	-
8	VCORE	Power	Core voltage: Decoupling input for internal circuitry.	Always connect to an external capacitor(0.1uF) to GND.
9	NC	-	Not Connected	Leave Open
10	NC	-	Not Connected	Leave Open
11	NC	-	Not Connected	Leave Open
12	NC	-	Not Connected	Leave Open
13	VDD	Power	Power Supply	-
14	VSS	Power	GND	-
15	Reserved2	-	Test Terminal	Leave Open
16	Reserved3	-	Test Terminal	Leave Open

■ Electrical Characteristics

Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Remarks
VDD to GND	-	-0.3 to 6.0	V	
SDA/SCL to GND	-	-0.3 to VDD+0.3	V	
Storage Temperature	-	-40 to 125	°C	

Note that operation of the device at these conditions is not implied and may affect the performance, reliability or life of the device.

This product is ESD sensitive. In order to prevent deterioration or damage due to ESD, this product must be protected against static electricity at all times.

Recommended Operating Conditions

Parameter	Symbol	Min	Typ.	Max	Unit	Remarks
Power Supply	VDD	2.7		5.5	V	
Ambient Temperature	T_A	-20		85	°C	
I^2C Pull-Up Register	R_P	1	2.2		kΩ	
External Capacitance between VCORE and GND	C_{VCORE}	0.09	0.1	0.33	µF	Must be connected between VCORE and GND

DC Electrical Characteristics

(Conditions at V_{DD}=3V or 5V, T_A=25°C unless otherwise noted.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operation Current	I_{DD}		-	750	1,100	µA
Non-operation Current	I_{NOP}	-20 to 85°C	-	1	3	µA
Power-on-Reset Level	V_{POR}		1.6	1.7	1.75	V
Output Low Voltage	V_{OL}		-	-	0.2	V_{DD}
Output Current	I_{OL}		1.5	-	-	mA
Input Low Voltage	V_{IL}		-	-	0.2	V_{DD}
Input High Voltage	V_{IH}		0.8	-	-	V_{DD}
Input Current	I_{IL}				10	µA

Relative Humidity Sensor

(Conditions at V_{DD}=3V, T_A=25°C unless otherwise noted.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Accuracy[1,2]		Typical at 25°C	-	±2	TBD	%RH
		-20 to 85°C	See figure "Relative humidity sensor accuracy" below			%RH
Resolution			-	0.1	-	%RH
Hysteresis			-	±1	-	%RH
Repeatability			-	0.1	-	%RH
Response Time[3]		1m/s air flow	-	TBD	-	sec
Operating Range[4]			0	-	100	%RH

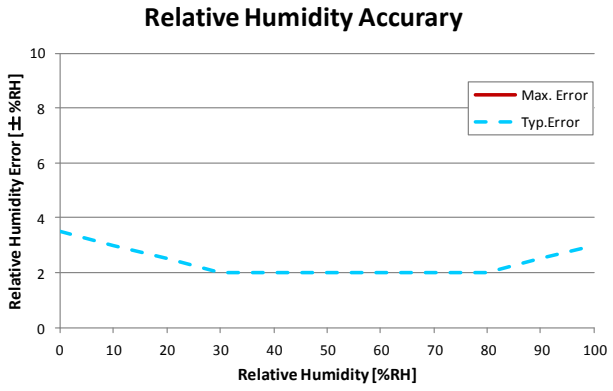
Notes
1: Applicable to non-condensing environments only. Excludes hysteresis and certain other factors.
2: Recommended humidity operating range is 20 to 80%RH (non-condensing) over 0 to 60°C.
Prolonged operation beyond these ranges may result in a shift of sensor reading.
3: Time to reach 63% of a step change.
4: Applicable to non-condensing environments only.

Temperature Sensor

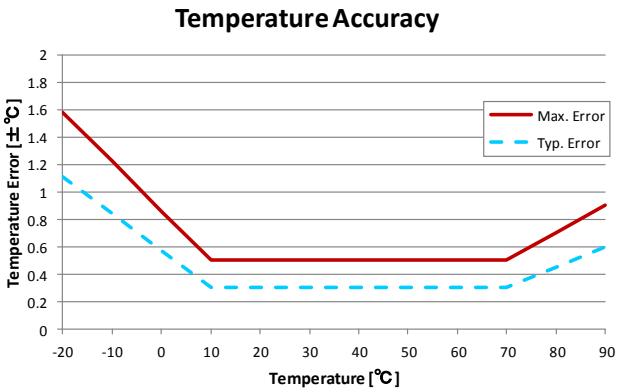
(Conditions at V_{DD}=3V, T_A=25°C unless otherwise noted.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Accuracy		Typical at 25°C	-	±0.3	±0.5	°C
		-20 to 85°C	See figure "Temperature sensor accuracy" below			°C
Resolution			-	0.015	-	°C
Repeatability			-	0.1	-	°C
Response Time[1]			-	TBD	-	sec
Operating Range			-20	-	85	°C

Notes
1: Time to reach 63% of a step change. Response time depends on system thermal mass and air-flow.



[Relative humidity sensor accuracy (T_A=25°C)]

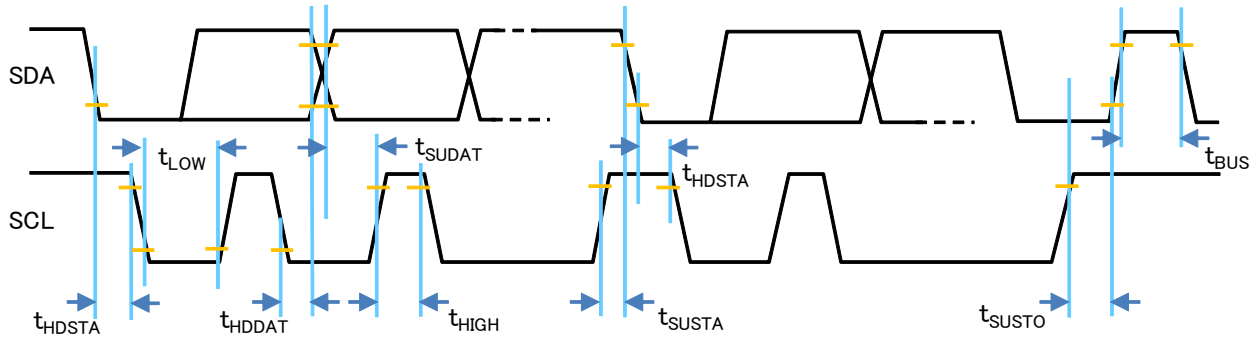


[Temperature sensor accuracy]

AC Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
SCL clock Frequency	f_{SCL}	100	-	400	kHz
Start Condition hold time relative to SCL edge	t_{HDSTA}	0.1	-	-	µs
Minimum SCL clock low width	t_{LOW}	0.6	-	-	µs
Minimum SCL clock high width	t_{HIGH}	0.6	-	-	µs
Start condition setup time relative to SCL edge	t_{SUSTA}	0.1	-	-	µs
Data hold time on SDA relative to SCL edge	t_{HDDAT}	0	-	0.5	µs
Data setup time on SDA relative to SCL edge	t_{SUDAT}	0.1	-	-	µs
Stop condition setup time on SCL	t_{SUSTO}	0.1	-	-	µs
Bus free time between stop condition and start condition	t_{BUS}	1	-	-	µs

Note)
For more information on I^2C specification, please refer to the following Website:
http://www.nxp.com/documents/other/UM10204_v5.pdf



I^2C Timing Diagram

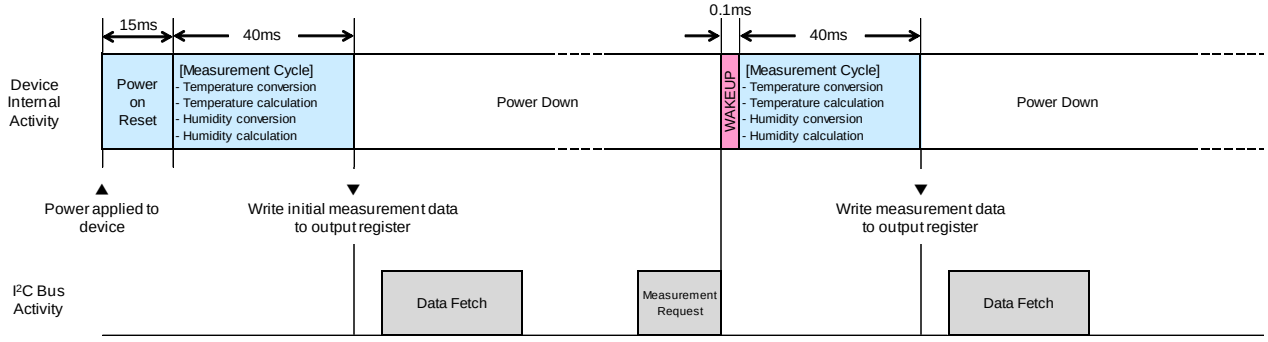
■ Operation

I²C Interface

This product communicates with I2C-compatible protocol with support for 100kHz and 400kHz bit rates. All sensors are set to the same I2C slave address (28H).

Note) For more information on I²C specification, please refer to the following Website:
http://www.nxp.com/documents/other/UM10204_v5.pdf

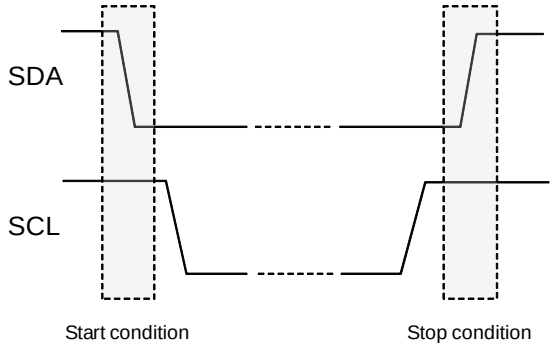
The overview of the measurement sequence is as follows:



[I²C Measurement Sequence]

I²C-BUS is a bi-directional 2-wire serial bus, consists of serial data line (SDA) and serial data clock (SCL). When the bus is free, both SDA and SCL are HIGH.

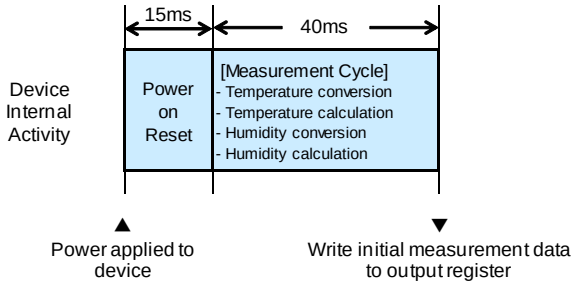
Each communication sequence begins with a Start Condition, and ends with a Stop Condition.
A Start Condition is defined as a HIGH to LOW transition on the SDA line while SCL is HIGH.
A Stop Condition is defined as a LOW to HIGH transition on the SDA line while SCL is HIGH.
Between the Start and Stop conditions, the data on the SDA can change when SCL is LOW and the data is fetched during SCL is HIGH. Each data bit is transferred by one clock pulse of SCL.



[I²C Start/Stop Condition]

Startup

Through the system power-on reset (POR) after power-up, the sensor will perform an initial measurement cycle. This initial measurement data is written to the output register. The sensor needs at most 55ms to be ready for fetching data. SCL keeps HIGH during this period.



[Power-On sequence]

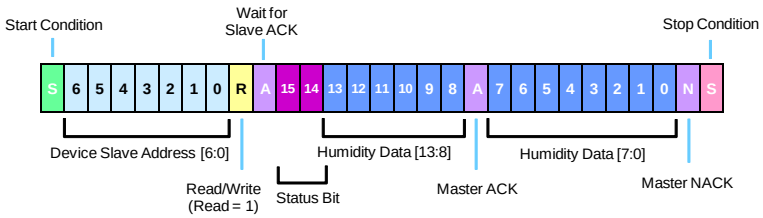
Data Fetch

The Data Fetch (DF) command is used to fetch humidity and temperature measurement data from the output register. The master issues a Start Condition, followed by the 7-bit slave address 28H ('010'1000') and the 8th bit=1 (Read). The sensor sends an acknowledge (ACK) when receiving the command from the master properly. The 14 bits of humidity data are fetched in the first two bytes. The higher 2 bits of the first byte are the status bits. After the humidity data, the 14 bits of temperature data can be fetched. The last two bits of the fourth byte are undetermined and should be masked off in the application.

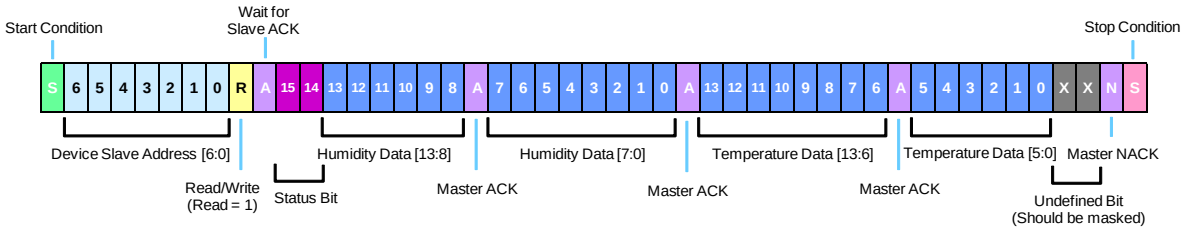
[I^2C slave address]

A6	A5	A4	A3	A2	A1	A0
0	1	0	1	0	0	0

■ I^2C Data Fetch - 2 Bytes: Slave returns only 2 humidity data bytes to master



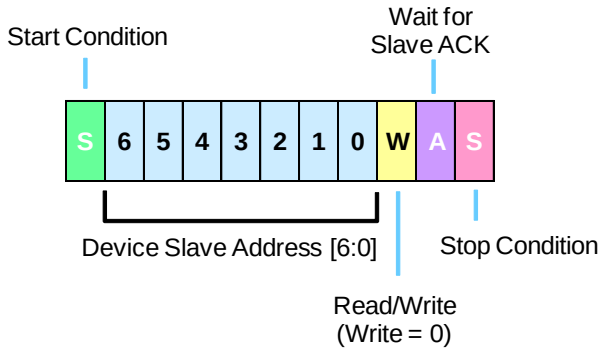
■ I^2C Data Fetch - 4 Bytes: Slave returns 2 humidity data bytes & 2 temperature data bytes to master



[I2C Data Fetch Command]

Measurement Request

After the measurement cycle, the sensor goes to power down to suppress power consumption. To wake up the part from power down and start a new measurement cycle, the master sends an MR (Measurement Request) command. The master issues a Start Condition, followed by the 7-bit slave address 28H('010'1000') and the 8th bit=0(Write). When receiving the command from the master properly, the sensor sends an acknowledge (ACK) by lowering SDA automatically. Then the master sends a Stop Condition. When a MR is received properly, the part wakes up with a small period and then a new measurement cycle is performed.
Another MR can be sent to start a new measurement cycle without fetching the previous data.



[I^2C Measurement Request: slave starts a measurement cycle]

Output Data Conversion

[Relative Humidity Conversion]
The Humidity Data bytes (14 bits raw value) can be converted to %RH using the following equation:

$$\text{Relative Humidity}[\%\text{RH}] = \frac{\text{Humidity Data}[13:0]}{2^{14}} \times 100$$

[Temperature Conversion]
The Temperature Data bytes (14 bits raw value) can be converted to °C using the following equation:

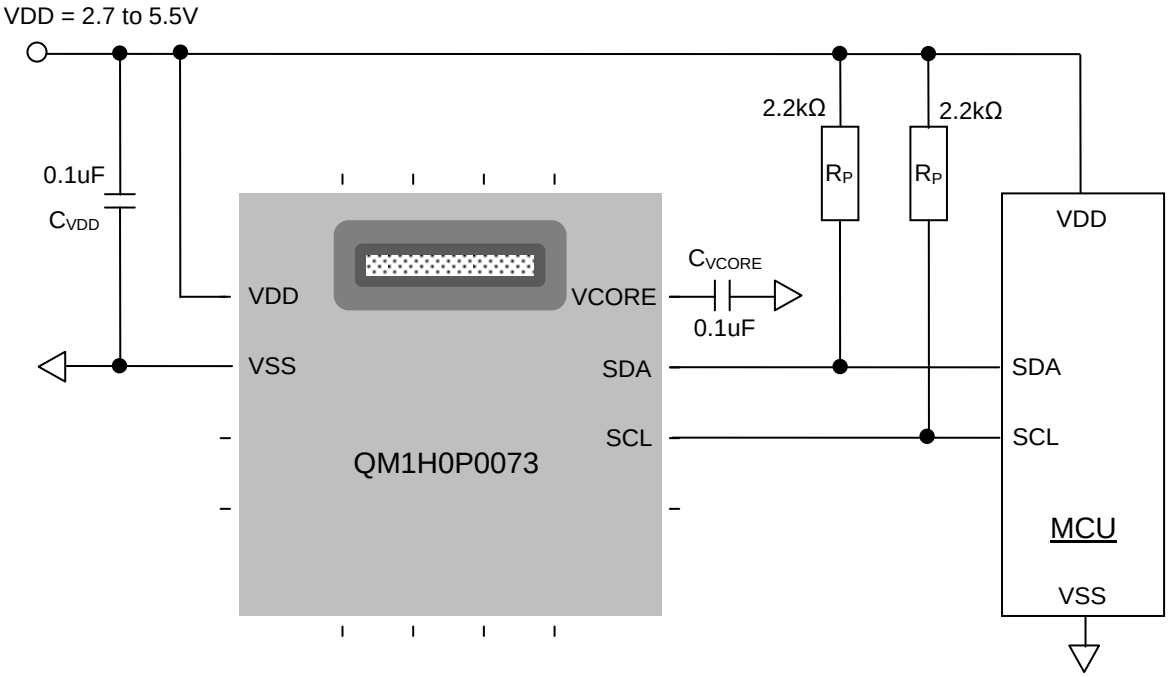
$$\text{Temperature}[^{\circ}\text{C}] = \frac{\text{Temperature Data}[13:0]}{2^{14}} \times 165 - 40$$

■ Application circuit example

The following shows the application circuit example.
Both SDA and SCL are connected to VDD via pull-up resisters R_P. When the bus is free, both lines are HIGH.
The values of the pull-up resisters are determined in consideration of the capacitance of the I^2C bus lines.
Note that I^2C pull-up resisters may be integrated in I/O of MCUs.

⚠ Be sure to connect C_{VCORE} with appropriate value between VCORE terminal and GND. If C_{VCORE} is not connected, or if the value is not appropriate, it may affects the measurement accuracy of temeperature and relative humidity.

⚠ In order to stably operate this product, C_{VDD} and C_{VCORE} should be as close to this device as possible.



■ Soldering Conditions

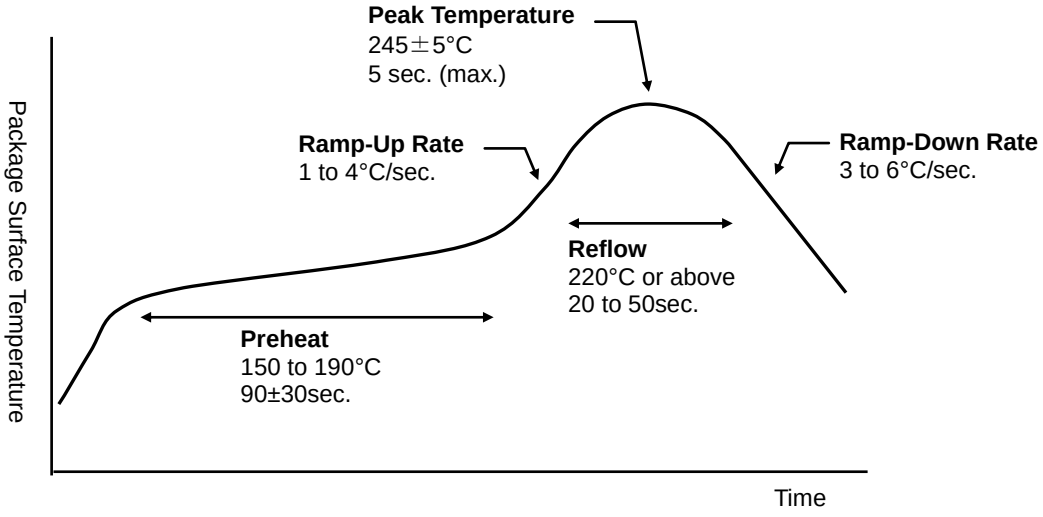
Soldering methods and suitability of this product

Soldering methods	Reflow soldering	Flow(dip, wave) soldering	Hand soldering by soldering iron	Hot plate Soldering
Suitability	○	× Not suitable for this product	× Not suitable for this product	○

Reflow Soldering

The following conditions are recommended for reflow soldering this product by lead-free solder.

Parameter	Recommended Condition
Type of process	Convection or IR/Convection reflow
Atmosphere	Air or Nitrogen
Number of reflow cycle	⚠ 1time only



Reflow Profile for Lead-free solders

Hot Plate Soldering

Recommended hot plate soldering conditions is as follows :

Parameter	Recommended Condition
PCB surface temperature	< 250°C
Soldering time	< 5 sec.

Rework

⚠ Hot air reworking is not recommended as the hot air may cause irreversible damage for humidity sensor elements.

⚠ Removed device should not be reused because of the possibility of thermal and mechanical damage in rework.

Notice of soldering

⚠ Only one reflow process is allowed for this product. In case the PCB passes through multiple solder cycles, it is strongly recommended to assemble this product only in the last solder cycle.

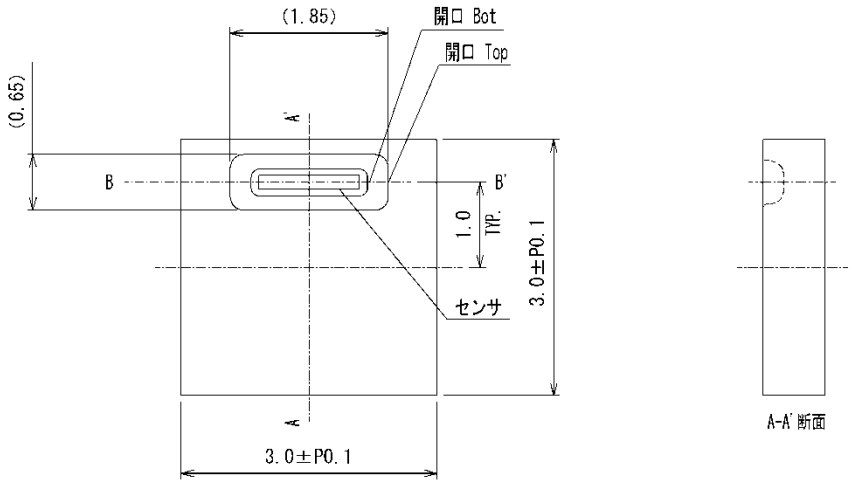
- Ensure good ventilation in assembly lines. If any volatile gas exists, it may cause damage to this product.
- If possible, it is recommended to mount this product after all materials that are used in the assembly process have completely cured or dried out.
- After soldering, the devices may read a slight offset. One of the following rehydration processes(TBD) may eliminate the offset.
  a) Store the devices at >75%RH for at least 12 hours
  b) Expose the devices to >40%RH for at least 5 days
- Keep the opening of humidity sensors clean and undamaged.
- Do not wash the PCB after reflow soldering or hand soldering. It may affect the accuracy of humidity sensors. “No clean” type solder paste is strongly recommended.
- Contamination of the humidity sensor element by flux shall be avoided. Liquid flux is not recommended.

■ Package Outline

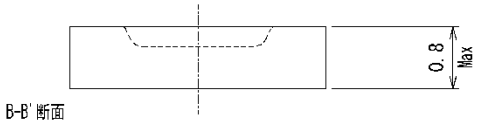
All dimensions in units of [mm]

CONFIDENTIAL

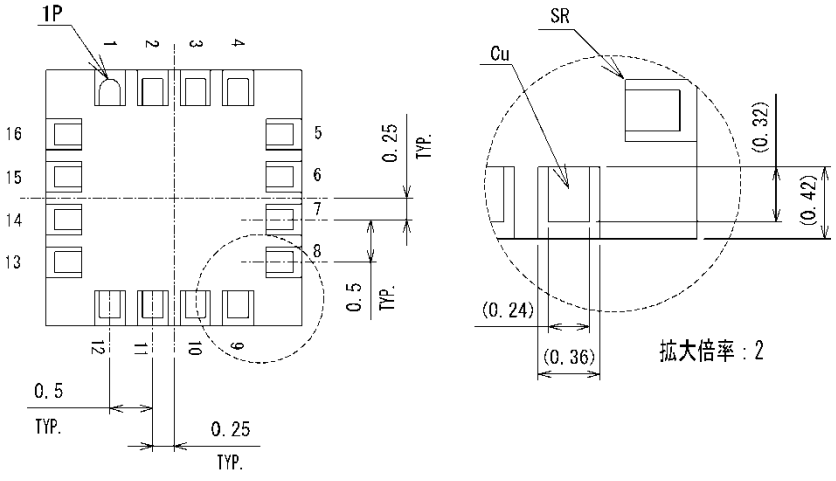
TOP VIEW



SIDE VIEW



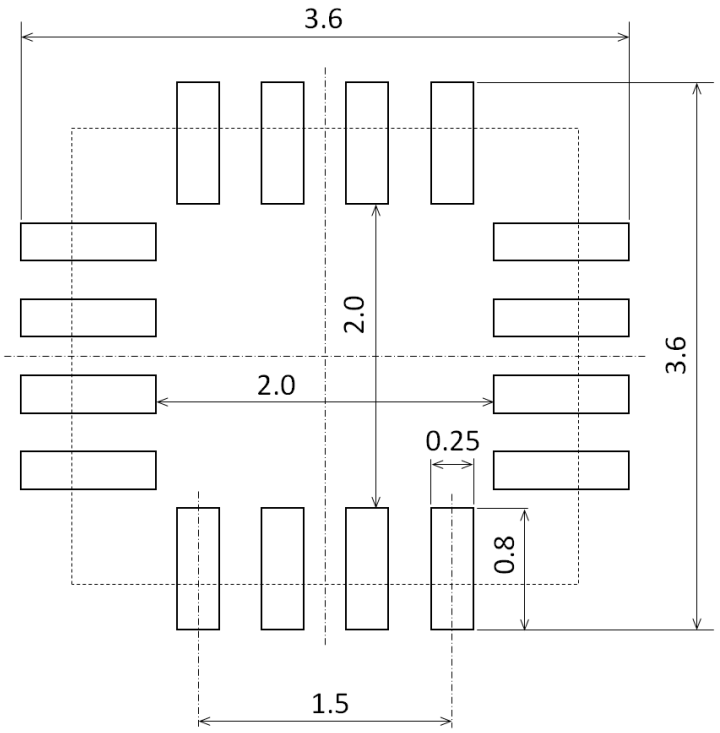
BOTTOM VIEW



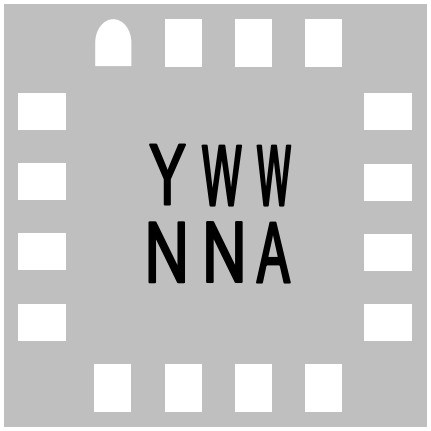
Product mass : 0.013±0.005g

■ PCB Land Pattern

All dimensions in units of [mm]



■ Marking



BOTTOM VIEW
(Not to scale)

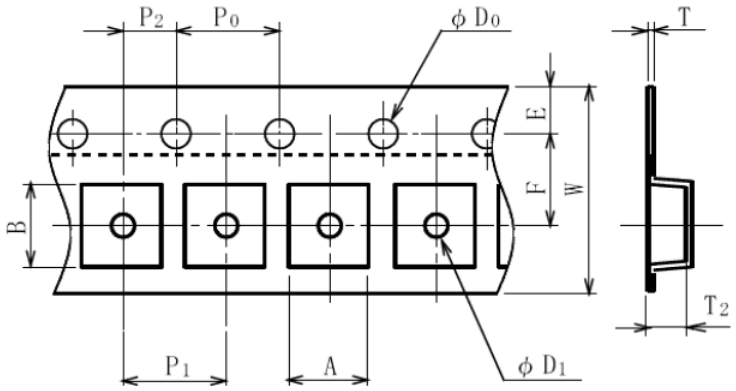
Symbol	Name	Remarks
Y	Last one digit of the year	1 digit number Y=”0” to “9”
WW	Week	2 digit number WW=”00” to “53”
NN	Assembly lot	2 digit number NN=”00” to “99”
A	Product name	1 alphabetic digit A=“1” : QM1H0P0073

■ Tape and Reel Specifications

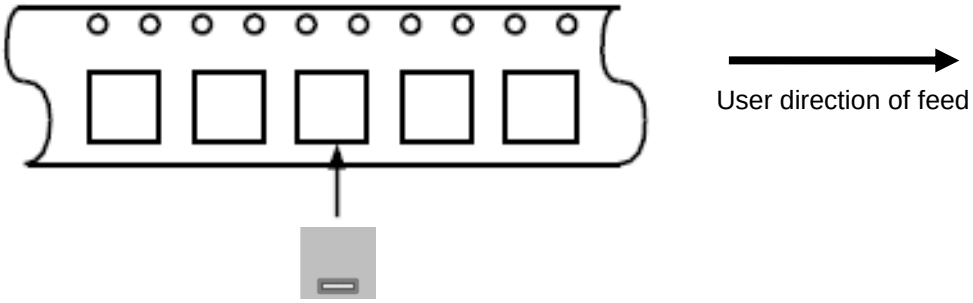
Tape structure and dimensions

Index	Dimensions
A	3.3±0.1
B	3.3±0.1
D0	ϕ1.5 +0.1/-0
D1	ϕ1.5 +0.1/-0
E	1.75±0.1
F	5.5±0.05
P0	4.0±0.1
P1	8.0±0.1
P2	2.0±0.05
T	0.3±0.05
T2	0.9±0.05
W	12.0 +0.3/-0.1

All dimensions in units of [mm]



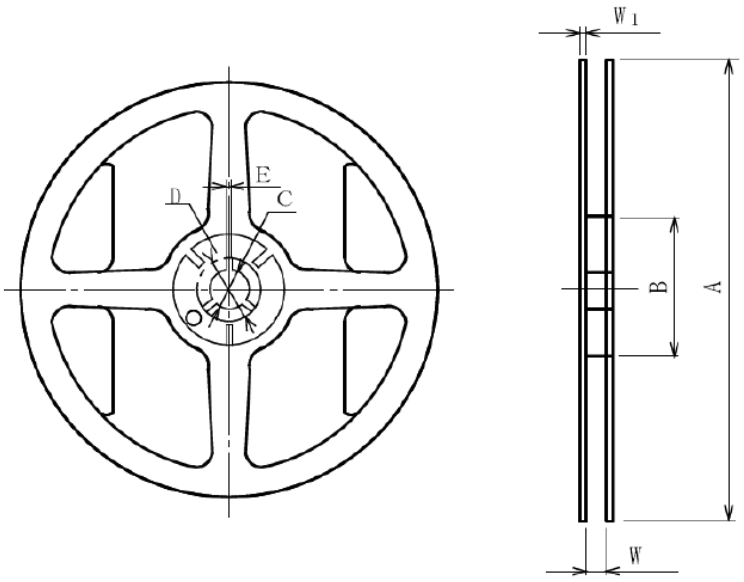
1pin orientation in tape



Reel structure and dimensions

Index	Dimensions
A	ϕ180 +0/-1.5
B	ϕ60 +1/-0
C	ϕ13±0.2
D	ϕ21±0.8
E	2.0±0.5
W	13.0 +1.0/-0
W1	1.2

All dimensions in units of [mm]



■ Precaution for Use

Effect of temperature

Since the relative humidity strongly depends on temperature, be careful of the following points:

- Keep the temperature of humidity sensors same as temperature of the air which is measurement subject of relative humidity.
- If this product is mounted close to the heating component, it should be considered to prevent heat transfer or to keep it as low as possible.

Exposure to chemicals

Exposure to the following chemicals may cause irreversible effects. Avoid exposure to such chemicals and provide sufficient ventilation.

- Volatile chemicals
  Example: Acetone, Ethanol, Isopropyl Alcohol, Toluene, etc.
  These volatile chemicals also exist in epoxy compounds, adhesives, adhesive tapes, etc, and may be emitted as outgas component.
- Acids and bases
  Example: HCl, H_2SO_4, HNO_3, NH_3, etc.
- High concentration Ozone or H_2O_2
- Cleaning agents
  Example: Alcohol, detergents, brominated/fluorinated solvents, etc
  Do not apply PCB board wash after soldering.

Exposure to extreme environment

Prolonged exposure to very low/high humidity environment may cause gradual shifts of the relative humidity reading and errors may increase. In order to eliminate these errors, the following procedure is useful.

[In case of very low humidity]

The performance of the humidity sensor can be recovered after a few days under typical ambient conditions(40 - 60%RH).

[In case of very high humidity]

Compared with exposure to very low humidity, recovery of sensor performance may be slower. In this case, the following bake and rehydration procedure can accelerate recovery.

Baking : TBD
Rehydration: TBD

Following this procedure, the performance of the humidity sensor will recover after a few days under typical ambient conditions.

Packing material

Because both sensors as a part and sensors mounted on the final product need to avoid contamination by outgas emitted from packing materials, careful attention must be paid in the selection of the packaging materials.

- Avoid using adhesives, adhesive tapes and stickers as much as possible.
- Do not use antistatic polyethylene bags.
- Be very careful to use foamed plastics.

Hygroscopic material

Since hot melts may absorb moisture and affect the response time of the relative humidity sensor, using hot melt sparingly is recommended.

Protection of the sensor opening

Avoid adhering contaminants (e.g. liquids (especially salt water), solvents, fats, dust, etc.) so as not to affect sensor performance. Care must also be taken to the following points for protection of the sensor opening.

- Do not cover the sensor opening by any adhesive tapes (e.g. Scotch Tape, Sellotape, etc.) which may affect sensor performance by outgas.
- Avoid covering the sensor opening with coatings.
- Do not directly touch the sensor opening.

Others

- This product is NOT intended for use in the following special environments, such as:
  - Use in liquids such as water, oil, chemical, and organic solvent.
  - Use under direct sunlight, in outdoor, heat and dusty atmospheres.
  - Use in places full of corrosive gases such as sea breeze, SO_2, H_2S, Cl_2, NH_3,acid, and alkali.
  - Use in environment with strong electromagnetic waves or large static electricity.
  - Use in such a place where the product is condensation or freezing.
- This product is not designed to be radiation-resistant.

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- When using this product, please observe the absolute maximum ratings and the instructions for use outlined in this document, as well as the precautions mentioned below. Sharp assumes no responsibility for any damage resulting from use of the product which does not comply with the absolute maximum ratings and the instructions included in this document, and the precautions mentioned below:

  (Precautions)

  1. Please do verify the validity of this part after assembling it in customer's products, when customer wants to make catalogue and instruction manual based on the specification sheet of this part.

  2. This product is designed for use in the following application areas:
     - Personal computers
     - Office automation equipment
     - Telecommunication equipment (terminal)
     - Test and measurement equipment
     - Industrial control
     - Audio visual equipment
     - Consumer electronics

     If the use of the product in the above application areas is for equipment listed in paragraphs(3) or (4), please be sure to observe the precautions given in those respective paragraphs.

  3. Appropriate measures, such as fail-safe design and redundant design considering the safety design of the overall system and equipment, should be taken to ensure reliability and safety when this product is used for equipment which demands high reliability and safety in function and precision, such as:
     - Transportation control and safety equipment (aircraft, train, automobile etc.)
     - Traffic signals
     - Gas leakage sensor breakers
     - Rescue and security equipment
     - Other safety equipment etc

  4. Please do not use this product for equipment which require extremely high reliability and safety in function and precision, such as:
     - Space equipment
     - Telecommunication equipment (for trunk lines)
     - Nuclear power control equipment
     - Medical equipment

  5. Please contact and consult with a Sharp sales representative if four are any questions regarding interpretation of the above four paragraphs.

- Please contact and consult with Sharp sales representative for any questions about this product.

■ Revision History

Date	Rev.	Changes
2013.08.09	0.1	Created preliminary version
2013.08.27	A	・ Updated Features/Pin name and Functions ・ Updated Pin layout and lock diagram
2013.10.03	0.2	Fully revised
2013.10.30	0.3	Added Model No.
2014.02.07	0.4	Fully revised
2014.04.17	0.5	・ p.14-15 Soldering Conditions: Fully modified ・ p.16 Package Outline: Modified package thickness
2014.06.18	0.6	・ Revised the following drawings Block Diagram, Pin Configuration, Application Circuit Example, Package Outline ・ Added capacitance(0.1uF) of VCORE terminal on Pin Configuration ・ Added “Storage Temperature” to Absolute Maximum Ratings ・ Added “External Capacitance between VCORE and GND” to Recommended Operating Conditions ・ Revised voltage condition on DC Electrical Characteristics to “V_{DD}=3V or 5V” ・ Revised voltage condition on Relative Humidity Sensor and Temperature Sensor to “V_{DD}=3V” ・ Added max value of accuracy(typical at T_A=25°C) on Relative Humidity Sensor ・ Added charts of relative humidity sensor accuracy and temperature sensor accuracy ・ Added notices to “Application Circuit Example” ・ Updated notices on Soldering Conditions ・ Added product mass information to Package Outline ・ Added “PCB Land Pattern” section ・ Updated Marking ・ Added “Tape and Reel Specification” section ・ Removed “Storage Conditions” section ・ Updated Precaution for Use