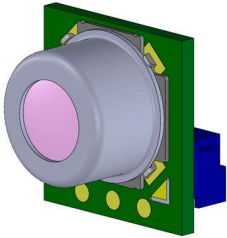


MEMS Infrared Thermal Sensor

MMS702M22A Datasheet

DESCRIPTION



MMS702 is an infrared sensor using MEMS thermopile technology. It is a multi-pixel type with an array of eight elements arranged in a single row, and can acquire temperature in each angular region divided over a wide range of angles. This sensor can measure surface temperature of objects without touching them by capturing infrared radiation from the objects. The product outputs digital values of surface temperature of objects. I2C is adopted for the interface. Temperature of the sensor itself can also be measured.

FEATURES

- Low noise level
 - Noise-equivalent temperature difference (NETD): below 0.06°C
- Eight elements in a single row, so pinpoint temperatures can be acquired over a wide angle.
 - Viewing angle: over 50 degrees (5.5 degrees per element)
- Temperature value is directly available.
 - Digital output of temperature values compensated by ambient temperature. Easy for rapid application engineering.
- Easily mountable with a connector.
 - No need to prepare dedicated board for the sensor.
- Good temperature accuracy.
 - High temperature accuracy using unique calibration technology

INDEX

DESCRIPTION..... 1

FEATURES..... 1

BLOCK DIAGRAM 3

PIN CONFIGURATION 3

ABSOLUTE MAXIMUM RATINGS 4

RECOMMENDED OPERATING CONDITIONS..... 4

CHARACTERISTICS..... 5

 Electrical characteristics 5

 Operating characteristics..... 5

 Field of view (FOV) characteristics..... 5

SERIAL COMMUNICATION INTERFACE 7

 Overview of the communication function 7

 Initialization..... 7

 Sending and receiving data timing diagram 8

 Command list 9

 The format of ambient temperature and object temperature 9

 PEC (Packet Error Checking)..... 10

 Communication time out..... 12

 Data update period 12

 Communication terminal 12

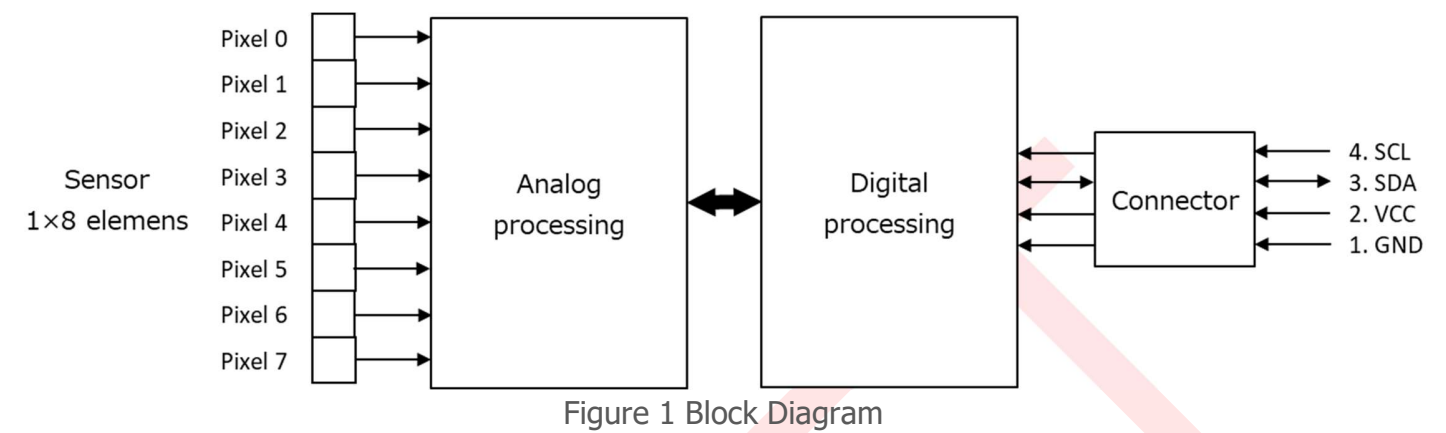
DIMENSIONS..... 13

NOTES 14

ATTENTION..... 15

ADDITIONAL NOTES..... 16

BLOCK DIAGRAM



PIN CONFIGURATION

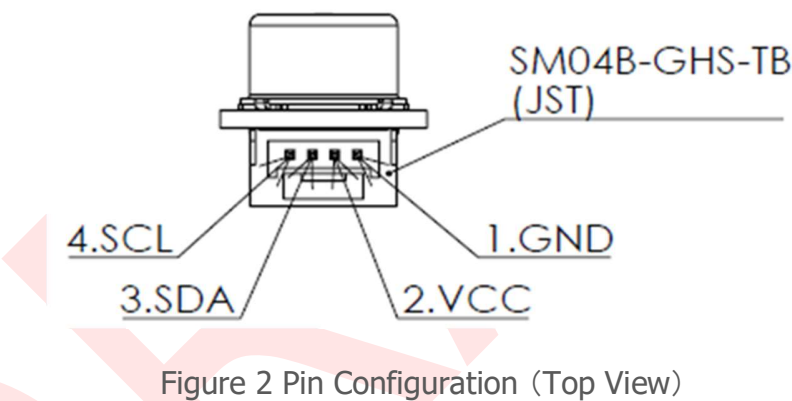


Table 1 Pin Table

Pin No.	Pin Name
1	GND
2	VCC
3	SDA
4	SCL

ABSOLUTE MAXIMUM RATINGS

(Unless otherwise specified, ambient temperature (Ta) =25°C)

Item	Symbol	Min.	Max.	Unit	Remark
Power-supply Voltage	Vcc	-0.2	6.0	V	
Voltage at I/O	-	-0.3	Vcc	V	SCL, SDA terminal

RECOMMENDED OPERATING CONDITIONS

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Operating Voltage	Vcc	4.5	5.0	5.5	V	
Storage Temperature	Ts	-40		100	°C	Note ¹
Operating Temperature	To	-20		100	°C	Note ¹
Storage Humidity	Hs	20		95	%RH	Note ¹
Operating Humidity	Ho	20		95	%RH	Note ¹

Note¹ : With no icing or condensation

CHARACTERISTICS

Electrical characteristics

(Unless otherwise specified, $V_{CC}=5V$, ambient temperature (T_a) =25°C)

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Input Voltage	VIL	0.0	-	$0.2 \times V_{CC}$	V	SCL, SDA Terminal
	VIH	$0.8 \times V_{CC}$	-	V_{CC}	V	SCL, SDA Terminal
Output Voltage	VOL	0.0	-	$0.2 \times V_{CC}$	V	SCL, SDA Terminal IOL = 200uA
Current Consumption	-	-	5.0	10.0	mA	

Operating characteristics

Item		Typ.	Unit	Remark
Temperature accuracy	Calibration point	± 1.5	°C	Note ²
	Test point	± 3.0	°C	Note ³
Output of Object temperature range		5 to 100	°C	
Output of Ambient temperature range		-20 to 100	°C	

Field of view (FOV) characteristics

Item		Pixel No	Center of FOV Note ⁴	FOV Note ⁵	Unit	Remark
Field of view (FOV)	Direction X	Pixel 0	24.5	5.5 (each pixel)	degree	
		Pixel 1	17.5			
		Pixel 2	10.5			
		Pixel 3	3.5			
		Pixel 4	-3.5			
		Pixel 5	-10.5			
		Pixel 6	-17.5			
		Pixel 7	-24.5			
	Direction Y	Pixel 0	0	5.5	degree	

Note² : Accuracy of the object temperature is guaranteed by our equipment at following conditions:

(1) $T_a=25^{\circ}\text{C}$, $T_x=25^{\circ}\text{C}$ (2) $T_a=25^{\circ}\text{C}$, $T_x=45^{\circ}\text{C}$ (3) $T_a=45^{\circ}\text{C}$, $T_x=45^{\circ}\text{C}$
where T_a is the ambient temperature and T_x is the object temperature.

Note³ : Accuracy of the object temperature is guaranteed by our equipment at following condition:

(4) $T_a=45^{\circ}\text{C}$, $T_x=25^{\circ}\text{C}$

Note⁴ : Definition of Center of FOV : Central angle is defined as the difference between the angle of sensor maximum output and the optical axis. (Refer to Figure 3 Center of FOV)

Note⁵ : Definition of FOV angle : The field of view is defined as angle range obtained 50% or more sensor output relative maximum output. (Refer to Figure 4 FOV characteristics)

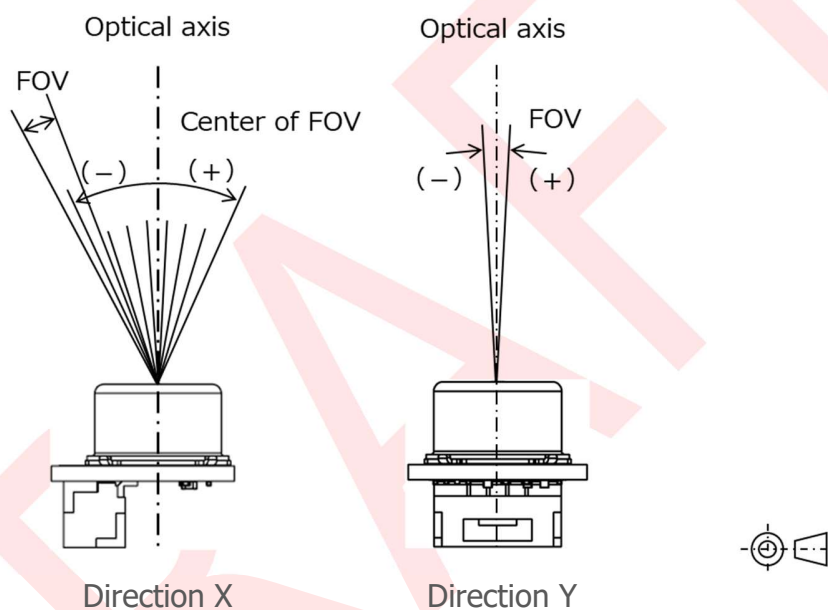


Figure 3 Center of FOV

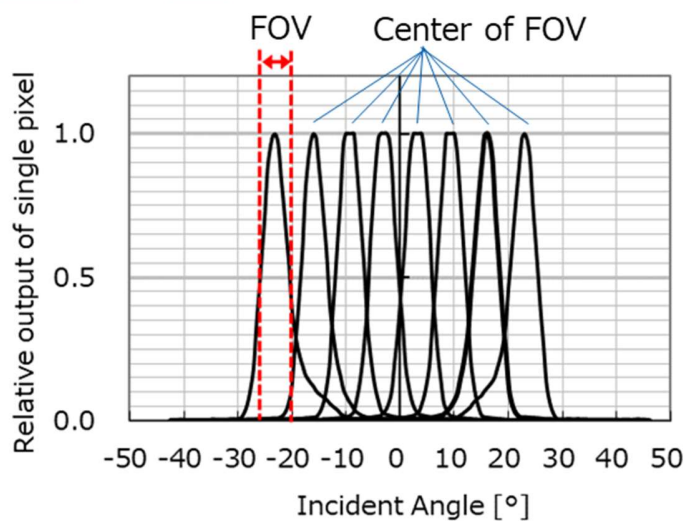


Figure 4 FOV characteristics

SERIAL COMMUNICATION INTERFACE

Overview of the communication function

The communication specification of this product is based on I2C protocol (SMBus compatible). This product works as a slave and has a 7-bit slave address according to the I2C specification. SCL is the clock input line and SDA is the serial data input/output line.

Item	Description
Communication method	I2C specification (SMBus compatible)
Communication speed	Max. 100kHz
Data length	8 bits
Packet Error Checking (PEC)	CRC-8 polynomial: $X^8 + X^2 + X^1 + 1$
Output data	Output data corresponding to the object temperature (Pixel 0 to Pixel 7) and output data corresponding to the ambient temperature (PTAT)
Output format	Binary data with Most Significant Bit (MSB) first
Slave Address	0x4D (0b100_1101)

Initialization

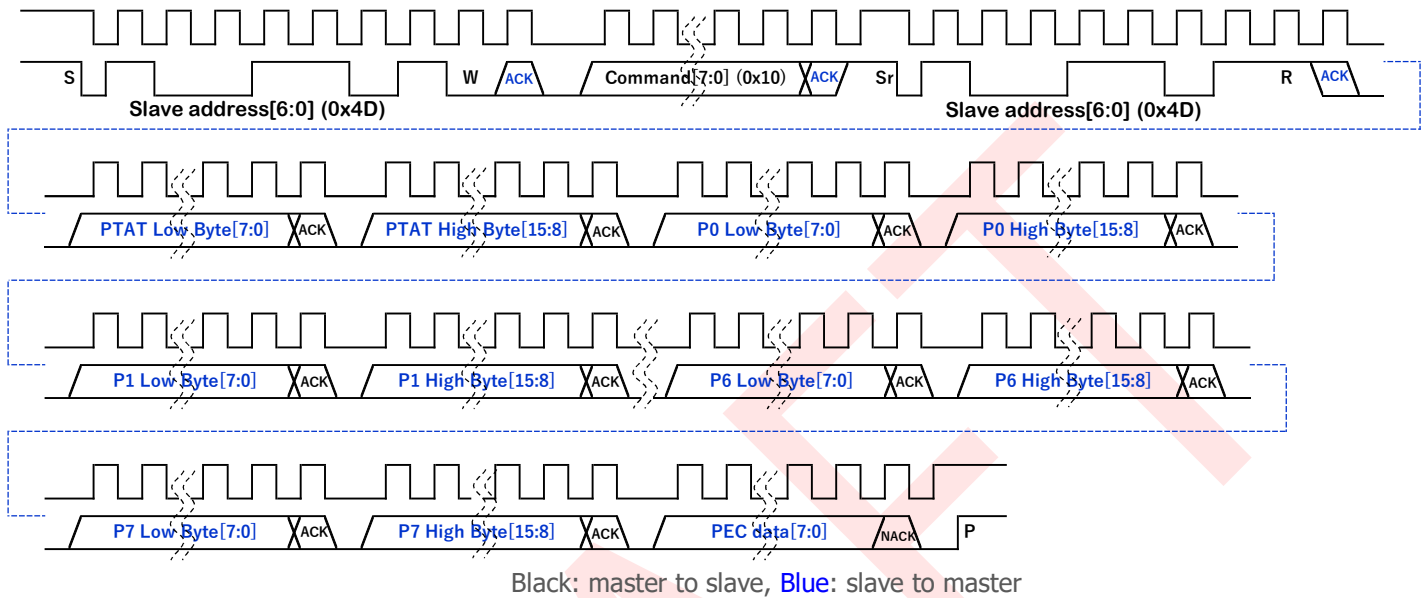
Initialization is required at every time turn on the power.
Send and receive commands as shown below.

Slave Address	Write/Read	Command Address	Data [High]	Data [Low]	PEC
0x4D	W	0x02	0x00	0x01	0x1B
0x4D	W	0x05	0x90	0x3A	0x4D
0x4D	W	0x03	0x00	0x03	0x7E
0x4D	W	0x03	0x00	0x07	0x50
0x4D	W	0x02	0x00	0x00	0x1C
0x4D	R	0x02	0x00*	0x00*	0x45
0x4D	R	0x05	0x90*	0x3A*	0x02
0x4D	R	0x03	0x00*	0x03*	0x4C

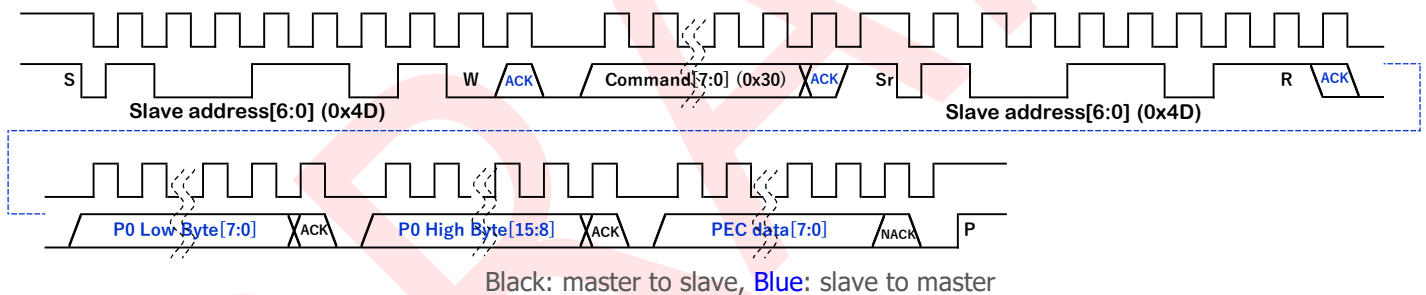
* Check if written correctly(optional)

Sending and receiving data timing diagram

Ex.) Continuous sensor output (Command: 0x10)



Ex.) Individual sensor output (Command: 0x30)



Description of the symbols

"S"	: Start Condition
"Address"	: Slave address of this product
"W"	: Write (0)
"R"	: Read (1)
"ACK"	: Acknowledge (0)
"NACK"	: No acknowledge (1)
"Command"	: Refer to section "Command list"
"Sr"	: Repeat Start Condition
"PEC"	: Packet Error Code
"P"	: Stop Condition

When this product receives Stop Condition, both SCL and SDA terminals become high impedance, and this product waits for commands from the master.

Command list

List of commands for reading output data

Command	Function
0x10	Output the ambient temperature (PTAT) and the object temperature (from Pixel 0 to Pixel 7) only once, in that order
0x11	Output the data of the ambient temperature (PTAT) only once
0x30	Output the data of the object temperature (Pixel 0) only once
0x31	Output the data of the object temperature (Pixel 1) only once
0x32	Output the data of the object temperature (Pixel 2) only once
0x33	Output the data of the object temperature (Pixel 3) only once
0x34	Output the data of the object temperature (Pixel 4) only once
0x35	Output the data of the object temperature (Pixel 5) only once
0x36	Output the data of the object temperature (Pixel 6) only once
0x37	Output the data of the object temperature (Pixel 7) only once
0x00 – 0x0F 0x80 - 0xFF	Do not issue these commands. Note ⁶

Note⁶ : These commands are reserved word, so please do not send them.

The format of ambient temperature and object temperature

Output of ambient temperature and object temperature are both 10 times the value of the detected temperature [°C] as 16-bit binary data.

Command Sequence Diagram	<table><tr><td>Low Byte Data D7→D0</td><td>ACK</td><td>High Byte Data D15→D8</td><td>ACK</td></tr></table>	Low Byte Data D7→D0	ACK	High Byte Data D15→D8	ACK																												
Low Byte Data D7→D0	ACK	High Byte Data D15→D8	ACK																														
Data format of ambient temperature and object temperature	<table><tr><td colspan="8">High Byte</td><td colspan="8">Low Byte</td></tr><tr><td>D15</td><td>D14</td><td>D13</td><td>D12</td><td>D11</td><td>D10</td><td>D9</td><td>D8</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr></table> Note: Since data is output from the MSB, the High Byte is output in the order D15 to D8, and Low Byte in the order D7 to D0.	High Byte								Low Byte								D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
High Byte								Low Byte																									
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0																		

Sign

Bit D15 of ambient temperature and object temperature is a sign bit. A negative number is expressed by 2's complement. Ex.)

In the case where D15 is "0": 250 (High Byte data = 0x00, Low Byte data = 0xFA)

In the case where D15 is "1": -250 (High Byte data = 0xFF, Low Byte data = 0x06)

Example of output data

The detected temperature [°C] is obtained by converting the 16-bit binary output data into decimal and dividing by 10. Ex.)

If the output data is 0x0131, the detected temperature is $305 / 10 = 30.5[°C]$.

When NACK is received

When this product receives NACK from a master, it is in the same state as if it had received Stop Condition.

PEC (Packet Error Checking)

This product supports Packet Error Checking (PEC) based on SMBus specification. PEC data is transmitted as the final byte of transmitted data. PEC byte is calculated based on CRC-8 method with $X^8+X^2+X^1+1$ polynomial. An example of the PEC byte calculation is shown below.

Target data

- Slave Address + W (8bits)
- Command (8bits)
- Slave Address + R (8bits)
- Low Byte of PTAT (8bits)
- High Byte of PTAT (8bits)
- Low Byte of Pixel 0 (8bits)
- High Byte of Pixel 0 (8bits)
- Low Byte of Pixel 1 (8bits)
- High Byte of Pixel 1 (8bits)
- Low Byte of Pixel 2 (8bits)
- High Byte of Pixel 2 (8bits)
- Low Byte of Pixel 3 (8bits)
- High Byte of Pixel 3 (8bits)
- Low Byte of Pixel 4 (8bits)
- High Byte of Pixel 4 (8bits)
- Low Byte of Pixel 5 (8bits)
- High Byte of Pixel 5 (8bits)
- Low Byte of Pixel 6 (8bits)
- High Byte of Pixel 6 (8bits)
- Low Byte of Pixel 7 (8bits)
- High Byte of Pixel 7 (8bits)

Example of calculating PEC value (Continuous sensor output)

- (1) Calculate CRC-8 of (Slave Address + W).
- (2) Take an exclusive OR (XOR) of (1) and Command.
- (3) Calculate CRC-8 of the result of (2).
- (4) Take an XOR of (3) and (Slave Address + R).
- (5) Calculate CRC-8 of the result of (4).
- (6) Take an XOR of (5) and (Low Byte of PTAT).
- (7) Calculate CRC-8 of the result of (6).
- (8) Take an XOR of (7) and (High Byte of PTAT).
- (9) Calculate CRC-8 of the result of (8).

- (10) Take an XOR of (9) and (Low Byte of Pixel 0).
- (11) Calculate CRC-8 of the result of (10).
- (12) Take an XOR of (11) and (High Byte of Pixel 0).
- (13) Calculate the result of (12) by CRC-8.
- (14) Take an XOR of (13) and (Low Byte of Pixel 1).
- (15) Calculate CRC-8 of the result of (14).
- (16) Take an XOR of (15) and (High Byte of Pixel 1).
- (17) Calculate the result of (16) by CRC-8.
- (18) Take an XOR of (17) and (Low Byte of Pixel 2).
- (19) Calculate CRC-8 of the result of (18).
- (20) Take an XOR of (19) and (High Byte of Pixel 2).
- (21) Calculate the result of (20) by CRC-8.
- (22) Take an XOR of (21) and (Low Byte of Pixel 3).
- (23) Calculate CRC-8 of the result of (22).
- (24) Take an XOR of (23) and (High Byte of Pixel 3).
- (25) Calculate the result of (24) by CRC-8.
- (26) Take an XOR of (25) and (Low Byte of Pixel 4).
- (27) Calculate CRC-8 of the result of (26).
- (28) Take an XOR of (27) and (High Byte of Pixel 4).
- (29) Calculate the result of (28) by CRC-8.
- (30) Take an XOR of (29) and (Low Byte of Pixel 5).
- (31) Calculate CRC-8 of the result of (30).
- (32) Take an XOR of (31) and (High Byte of Pixel 5).
- (33) Calculate the result of (32) by CRC-8.
- (34) Take an XOR of (33) and (Low Byte of Pixel 6).
- (35) Calculate CRC-8 of the result of (34).
- (36) Take an XOR of (35) and (High Byte of Pixel 6).
- (37) Calculate the result of (36) by CRC-8.
- (38) Take an XOR of (37) and (Low Byte of Pixel 7).
- (39) Calculate CRC-8 of the result of (38).
- (40) Take an XOR of (39) and (High Byte of Pixel 7).
- (41) Calculate the result of (40) by CRC-8. The result is used as the PEC value.

Communication time out

If SCL or SDA Low input continues for min. 22.8 ms and max. 70 ms, a communication timeout occurs. The process is disabled and this product enters a state waiting for a new command to be received.

Data update period

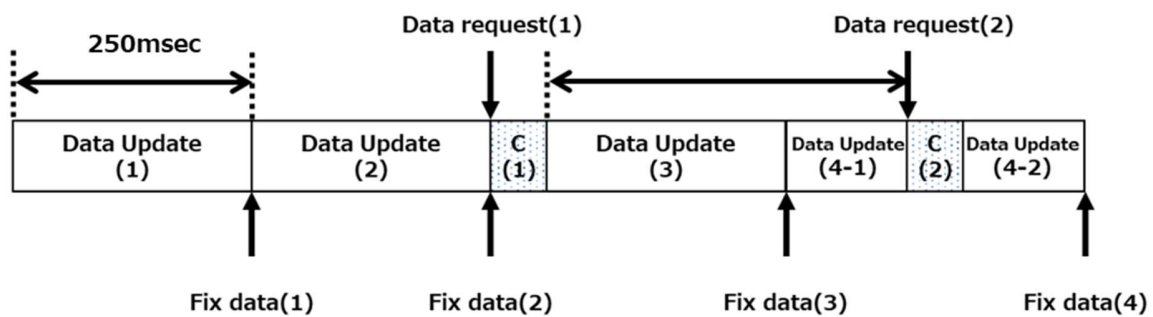
The period of computation process (data update) is Max.250ms.

The computation process stops in the communication time.

Please wait at least 500ms after completing the initial settings before acquiring data. Also, take more than 250ms period from end of communication to start of communication.

Example of output data (Figure below)

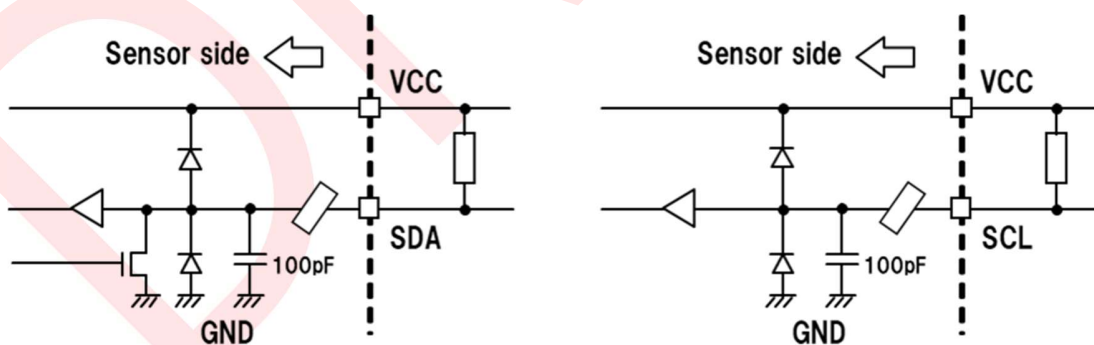
- If a data request (1) is made **after** data update (2), the updated data "Fix data(2)" is output.
- If a data request (2) is made **during** data update (4), the previous data "Fix data(3)" is output.



C(Communication)

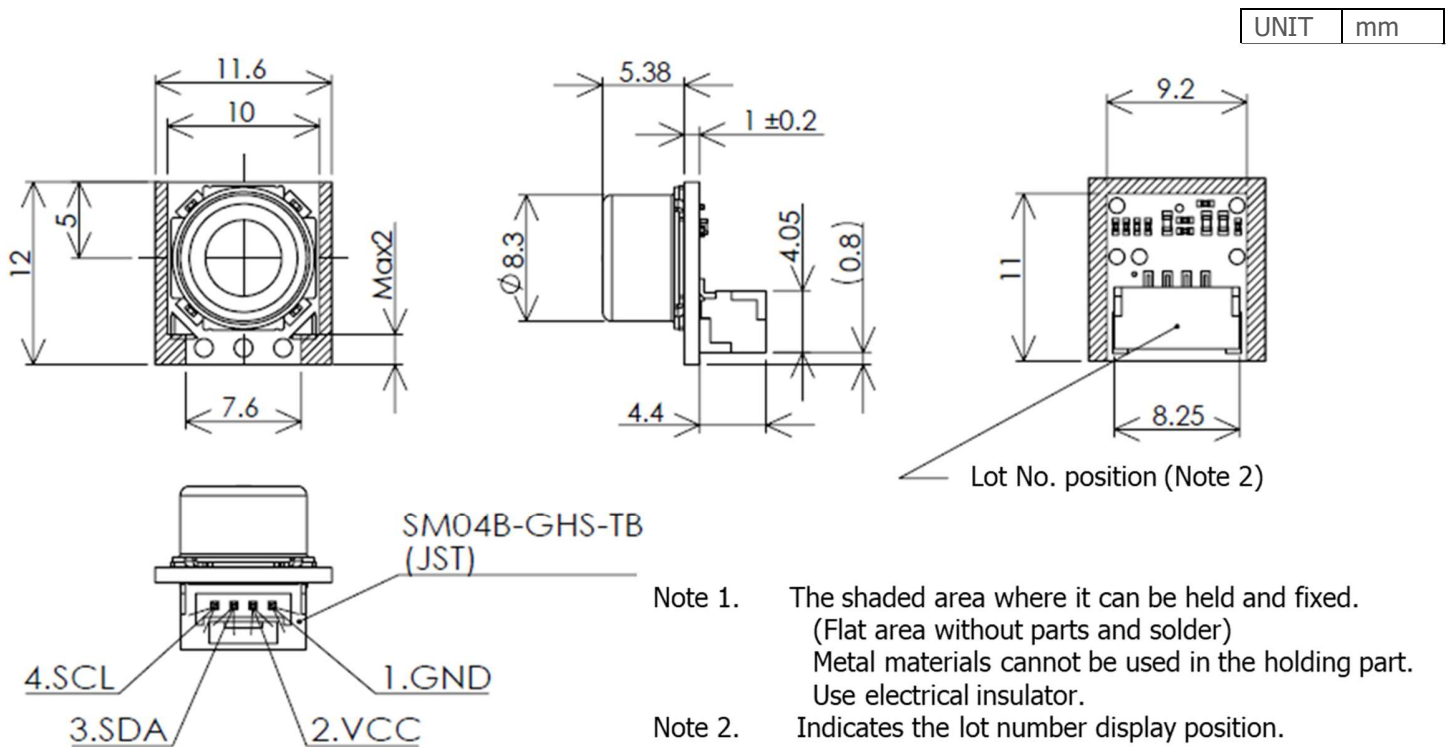
Communication terminal

Internal circuits of the I2C terminals (SCL and SDA) are shown below. A pull-up resistor must be connected to each of the SCL and SDA pins, and a resistance of about 3kΩ to 7kΩ is recommended. The pull-up voltage should be the same as or lower than VCC. If the pull-up voltage is higher than VCC, the circuit may be damaged.



Note : The SDA terminal and the SCL terminal are connected to GND with a 100pF capacitor respectively. Please check that there are no problems with data transmission before use.

DIMENSIONS



NOTES

Safety Precautions

- Though Mitsumi Electric Co., Ltd. (hereinafter referred to as "Mitsumi") works continually to improve our product's quality and reliability, semiconductor products may generally malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of this product could cause loss of human life, bodily injury, or damage to property, including data loss or corruption. Before customers use this product, create designs including this product, or incorporate this product into their own applications, customers must also refer to and comply with (a) the latest versions or all of our relevant information, including without limitation, product specifications, data sheets and application notes for this product and (b) the user's manual, handling instructions or all relevant information for any products which is to be used, or combined with this products. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. Mitsumi assumes no liability for customers' product design or applications.
- This product is intended for applying to computers, OA units, communication units, instrumentation units, machine tools, industrial robots, AV units, household electrical appliances, and other general electronic units.
- If you have any intentions to apply this product to the units related to the control and safety of transportation units (vehicles, trains, etc.), traffic signaling units, disaster-preventive & burglar-proof units, or the like, contact our sales representatives in advance.
- Don't apply this product to any aeronautical & space systems, submarine repeaters, nuclear power controllers, medical units involving the human life, or the like.
- Before using this product, even when it is not used for the usage written above, notify and present us beforehand if special care and attention are needed for its application, intended purpose, environment of usage, risk, and the design or inspection specification corresponding to them.
- If any damage to our customer is objectively identified to be caused by the defect of this product, Mitsumi is responsible for it. In this case, Mitsumi is liable for the cost limited to the delivery price of this product.

Application considerations during actual circuit design

- The outline of parameters described herein has been chosen as an explanation of the standard parameters and performance of the product. When you actually plan to use the product, please ensure that the outside conditions are reflected in the actual circuit and assembling designs.
- Before using this product, please evaluate and confirm the actual application with this product mounted and embedded.
- To investigate the influence by applied transient load or external noise, It is necessary to evaluate and confirm them with mounting this product to the actual application.
- Any usage above the maximum rating may destroy this product or shorten the lifetime. Be sure to use this product under the maximum rating.
- If you continue to use this product highly-loaded (applying high temperature, large current or high voltage; or variation of temperature) even under the absolute maximum rating and even in the operating range, the reliability of this product may decrease significantly. Please design appropriate reliability in consideration of power dissipation and voltage corresponding to the temperature and designed lifetime after confirming our individual reliability documents (such as reliability test report or estimated failure rate). It is recommended that, before using this product, you appropriately derate the maximum power dissipation (typically, 80% or less of the maximum value) considering parameters including ambient temperature, input voltage, and output current.

Precautions for Foreign Exchange and Foreign Trade Control Act

- If you export or take products and technologies in this document which are subject to security trade control based on the Foreign Exchange and Foreign Trade Act to overseas from Japan, permission of the Japanese government is required.

Prohibitions for Industrial Property Rights

- Since this document contains the contents related to our copyright and know-how, you are requested not to use this document for any purpose other than the application of this product.
- If a use of this product causes a dispute related to the industrial property rights of a third party, Mitsumi has no liability for any disputes except those which arise directly from the manufacturing and manufacturing method of our products.

Precautions for Product Liability Act

- No responsibility is assumed by us for any consequence resulting from any wrong or improper use or operation, etc. of this product.

Others

- Any part of the contents contained herein must not be reprinted or reproduced without our prior permission.
- In case of any question arises out of the description in this document, it shall be settled by the consultation between both parties promptly.

ATTENTION

- This product is designed and manufactured with the intention of normal use in general electronics. No special circumstance as described below is considered for the use of it when it is designed. With this reason, any use and storage under the circumstances below may affect the performance of this product. Prior confirmation of performance and reliability is requested to customers.
 - Environment with strong static electricity or electromagnetic wave
 - Environment with high temperature or high humidity where dew condensation may occur
- This product is not designed to withstand radioactivity, and must avoid using in a radioactive environment.

ADDITIONAL NOTES

- Please review in advance in your actual equipment before using sensor. The above-mentioned characteristics may not exhibit, depending on the mounted location and the ambient environment.
- Please do not use the sensor in environments where dust, water, oil, solvents, cleaning solution or other contaminants are likely to adhere to the sensor cover. Otherwise, the temperature may not be measured correctly.
- Do not use, transport or store this product in the following environments:
 - Environments with water or oil
 - Outdoor
 - Locations subject to direct sunlight or ultra-violet rays
 - Environments with corrosive gases (chlorine, sulfide gas, ammonia gas, etc.)
 - Environments with extreme temperature changes
 - Locations where icing or condensation may occur
 - Locations of high impact shock and vibration
- About handling
 - Please do not touch the sensor cover with bare hands.
 - Please do not apply an electrical load exceeding the absolute maximum rating, even momentarily. This may cause damage to the circuit. Please install protection circuits as necessary to ensure that the absolute maximum ratings are not exceeded.
 - This product is a precision instrument. Please do not drop or give excessive force or shock to the product, as the product will malfunction or change its characteristics.
 - Please consider a proper method to remove static electricity.
 - Please install this product with the power supply switched OFF.
 - Please fix this product so that the optical axis does not shift.
 - Please fix this product so that it will not be deformed. Please ensure that the resist on the substrate is not peeled off.
 - Please use the specified connector (GHR-04V). Please avoid soldering directly to the connector pins.

MITSUMI ELECTRIC CO., LTD.

Strategy Engineering Department Semiconductor Business Division

Tel: +81-46-230-3470 / <https://www.mitsumi.co.jp/profile/contact.html>

Notes:

Any products mentioned this datasheet are subject to any modification in their appearance and others for improvements without prior notification. The details listed here are not a guarantee of the individual products at the time of ordering. When using the products, you will be asked to check their specifications.

©2024 Mitsumi Electric co., Ltd. All rights reserved.

The contents of this document are subject to change without notice. The details listed here are not a guarantee.

MITSUMI ELECTRIC CO., LTD. Semiconductor Business Div.

<https://product.minebeamitsumi.com/en/product/category/ics/>