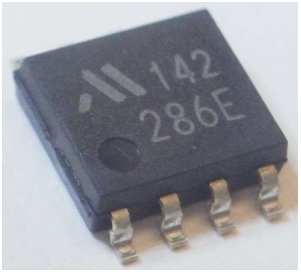
I²C-Bus Compatible Digital Temperature Sensor

MM3286 Datasheet

DESCRIPTION



The MM3286 is an I²C-bus compatible digital temperature sensor IC that incorporating a temperature sensor and a sigma-delta AD converter. The MM3286 offers I²C-bus compatible interface with low power consumption, making it ideal for a wide range of applications.
The MM3286 also has a built-in thermostat function to increase equipment safety.

FEATURES

- Low voltage operation: 3.0V to 5.5V
- Low current consumption: 75μA typ.
- Fast update of time: 2ms typ.
- Accuracy: ±2.0°C (-25°C to 100°C)
- Resolution: 9 bits (0.5°C)
- Shutdown mode minimizing current consumption
- I²C-bus compatible interface
- Up to 8 ICs can be built into a bus
- Built-in thermostat function (comparator mode, latch mode)

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BLOCK DIAGRAM

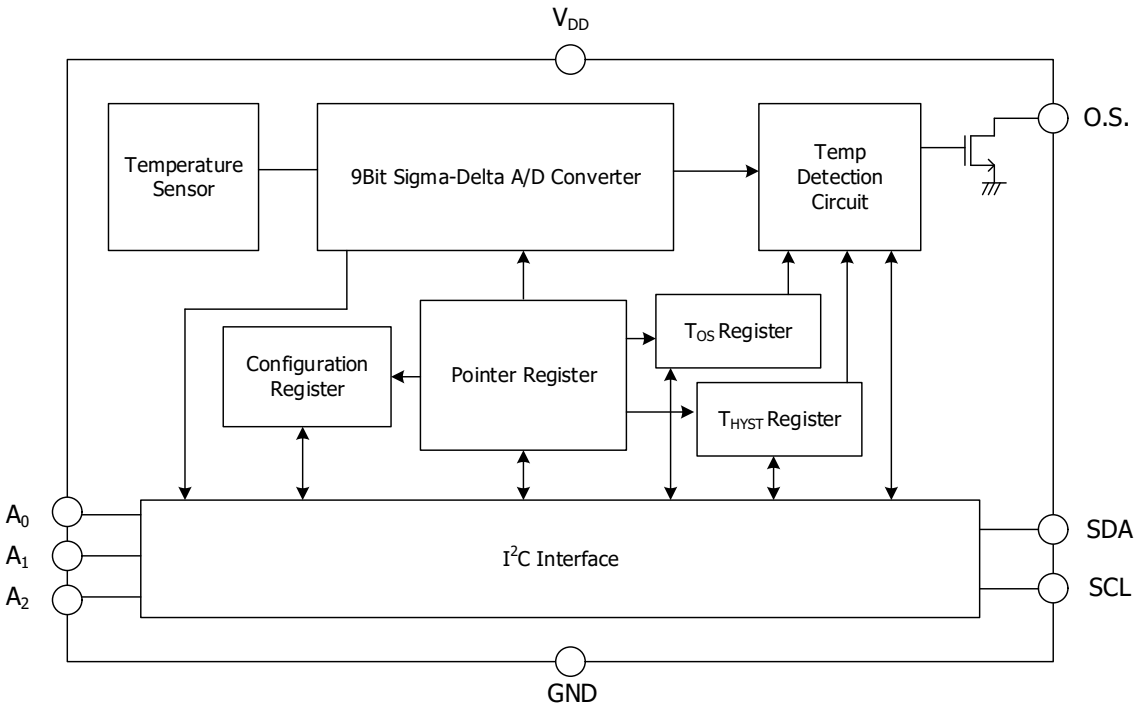

Fig. 1 Block Diagram

PIN CONFIGURATION

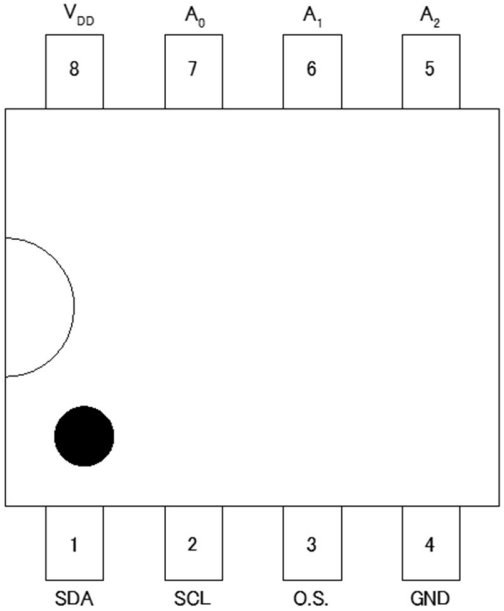

Fig. 2 Pin Configuration

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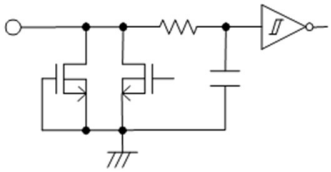
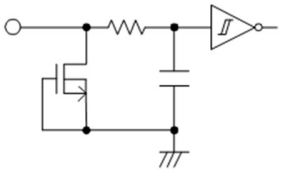
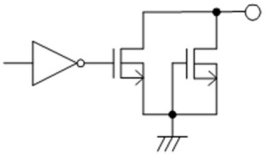
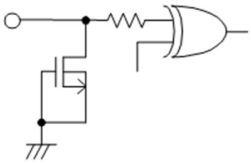
PIN DESCRIPTION

Table 1 Pin Description

PIN No.	SYMBOL	FUNCTION	INTERNAL EQUIVALENT CIRCUIT
1	SDA	I²C-Bus Data I/O	
2	SCL	I²C-Bus Clock Input	
3	O.S.	Temperature Detection Output	
4	GND	Ground	-
5	A_2	Slave Address Set	
6	A_1		
7	A_0		
8	V_{DD}	Power Supply	-

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ABSOLUTE MAXIMUM RATINGS

(Unless otherwise specified, Ta=25°C.)

ITEM	SYMBOL	MIN.	MAX.	UNIT
Maximum Supply Voltage	V_{DDmax}	-0.3	6.0	V
Maximum Output Voltage	V_{OUT}	-0.3	V_{DD}+0.3	V
Power Dissipation	Pd	-	300	mW
Storage Temperature	T_{stg}	-65	150	°C

RECOMMENDED OPERATING CONDITIONS

(Unless otherwise specified, Ta=25°C.)

ITEM	SYMBOL	MIN.	MAX.	UNIT
Operating Voltage	V_{DDopr}	3.0	5.5	V
Operating Ambient Temperature	T_{opr}	-40	125	°C

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ELECTRICAL CHARACTERISTICS

TEMPERATURE-TO-DIGITAL CONVERRTER CHARACTERISTICS

(Unless otherwise specified, Ta=25°C, VDD=3.3V.)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Temperature Detection Accuracy (*1)	Ac	-25°C≤Ta≤100°C	-	-	±2.0	°C
		-40°C≤Ta≤125°C	-	-	±3.0	
Temperature Data Update Time	T		-	2.0	-	ms
Supply Current	I_{DD}	Normal Operation	-	75	150	μA
		Shutdown Mode	-	1.0	-	
O.S. Output Saturation Voltage	Vs	Iout=4.0mA	-	-	0.4	V
Start-up Reset Voltage	Reset		-	2.1	-	V
Reset Hysteresis(*2)	Rhys		-	0.3	-	V

*1 The specification values of temperature detection accuracy show values when supply voltage is 3.3V. Temperature data varies by +1°C/V (typ.) against supply voltage.

*2 Power-off Reset Voltage is 1.8V (typ.) due to hysteresis voltage of 0.3V (typ.).

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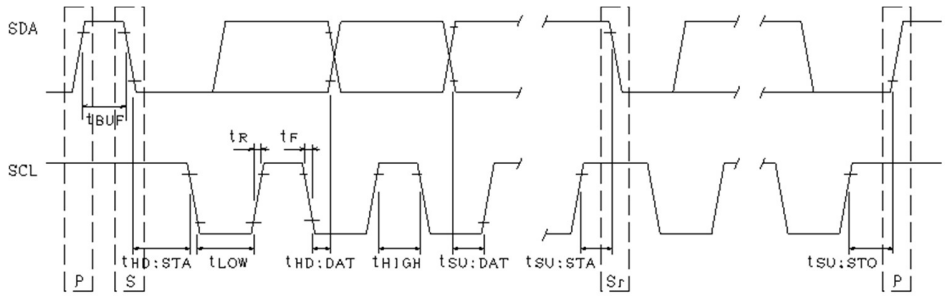
LOGIC ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, Ta=25°C, VDD=3.3V.)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Input voltage L	V_{IL}		-0.3	-	V_{DD}×0.3	V
Input voltage H	V_{IH}		V_{DD}×0.7	-	V_{DD}+0.3	V
SDA low level output voltage	V_{OL}	SDA sink 3mA	0	-	0.4	V
High level input current	I_{IH}	SDA , SCL=3.3V	-10	-	10	μA
Low level input current	I_{IL}	SDA , SCL=0.4V	-10	-	10	μA
Clock frequency	f_{SCL}		-	-	400	kHz
Data transfer wait time	t_{BUF}		1.3	-	-	μs
SCL start hold time	$t_{HD;STA}$		0.6	-	-	μs
SCL low level hold time	t_{LOW}		1.3	-	-	μs
SCL high level hold time	t_{HIGH}		0.6	-	-	μs
Start condition setup time	$t_{SU;STA}$		0.6	-	-	μs
SDA data hold time	$t_{HD;DAT}$		0.0	-	-	μs
SDA data setup time	$t_{SU;DAT}$		100	-	-	ns
SDA,SCL rise time	t_R		-	-	300	ns
SDA,SCL fall time	t_F		-	-	300	ns
Stop condition setup time	$t_{SU;STO}$		0.6	-	-	μs



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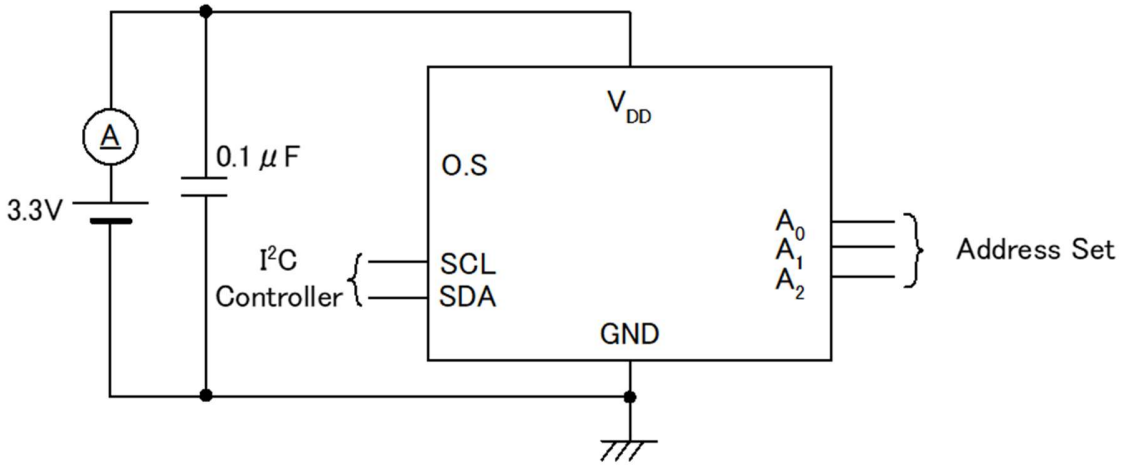
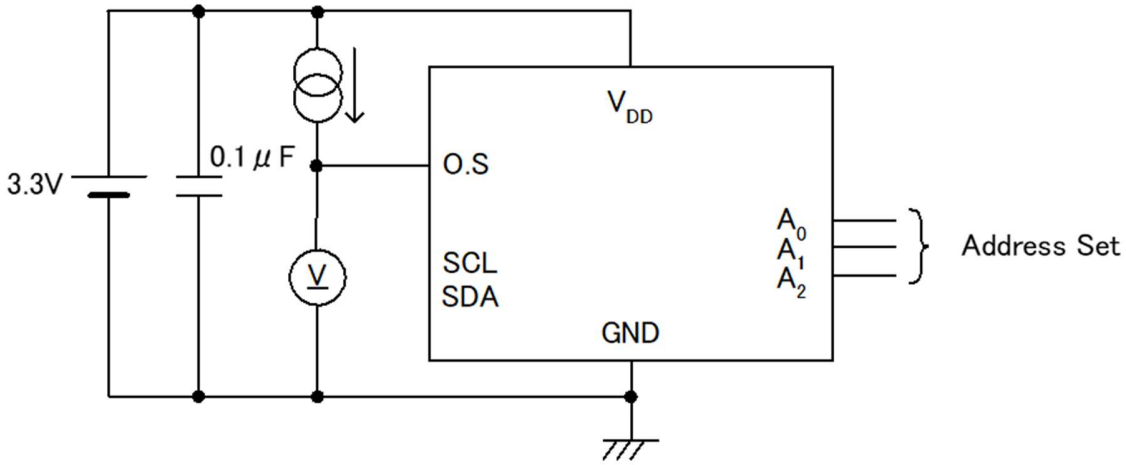
TEST CIRCUIT

Temperature Data Update Time, Supply Current



O.S. Output Saturation Voltage



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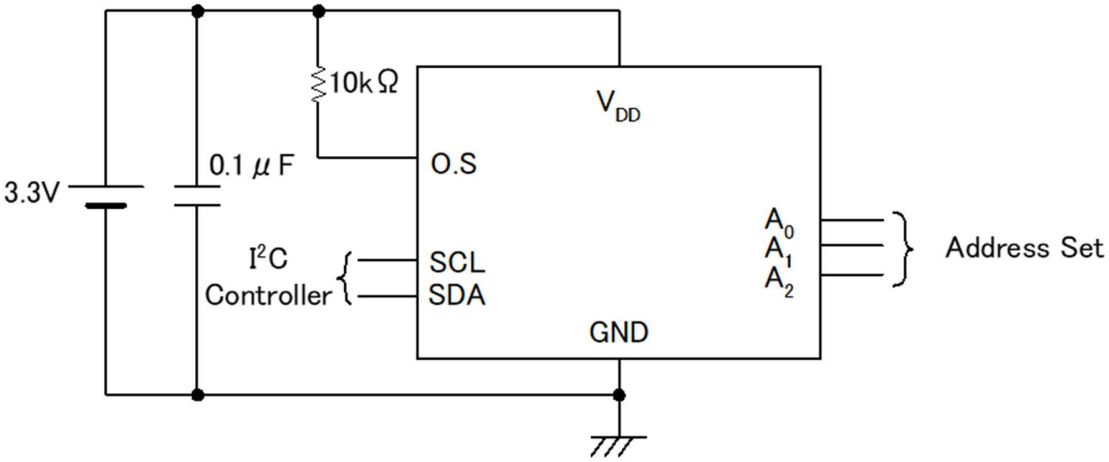
TYPICAL APPLICATION CIRCUIT



・Mitsumi shall not assume any liability for any accident or damage caused by use of this circuit.
・Mitsumi shall not assume any liability for any issues related to industrial property rights and/or other rights owned by third parties or shall not grant any license regarding use of this circuit.

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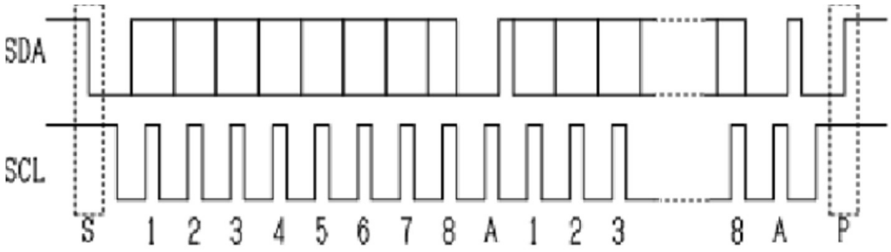
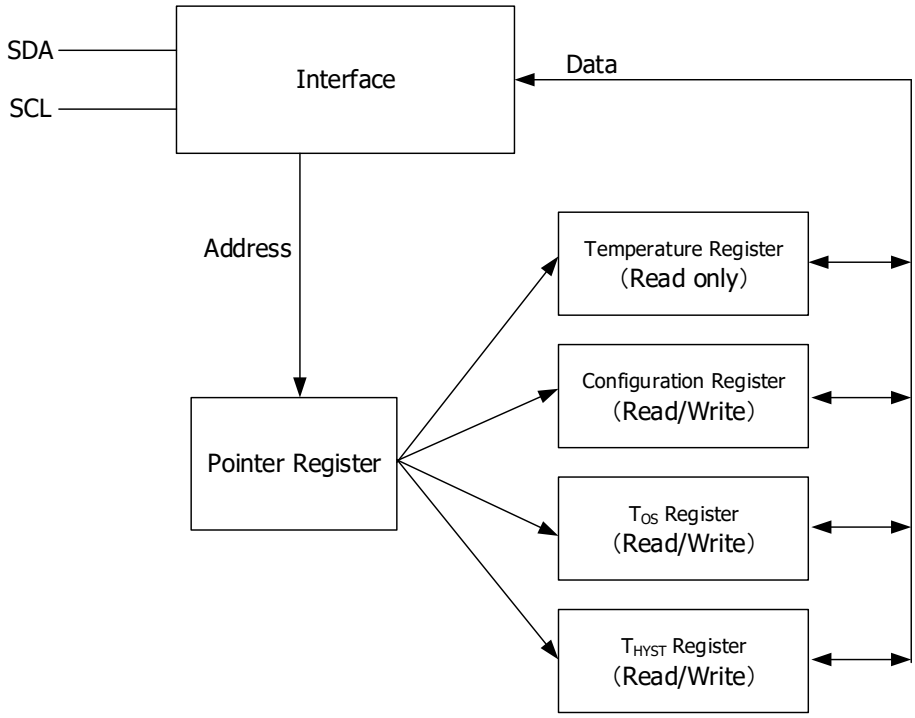
I2C-BUS CONDITIONS



S: Start condition
P: Stop condition
A: Acknowledge

I²C-bus is inter-IC bus system to transfer data by 2 lines of SDA and SCL. Data transfer is performed by 1 byte, and acknowledgement is sent when each byte is complete. Data transfer takes place MSB first from a start condition. There are a pointer register and four data registers selected by the pointer register in MM3286.



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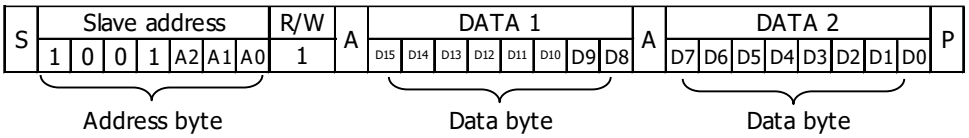
I²C Data Format

Read Mode

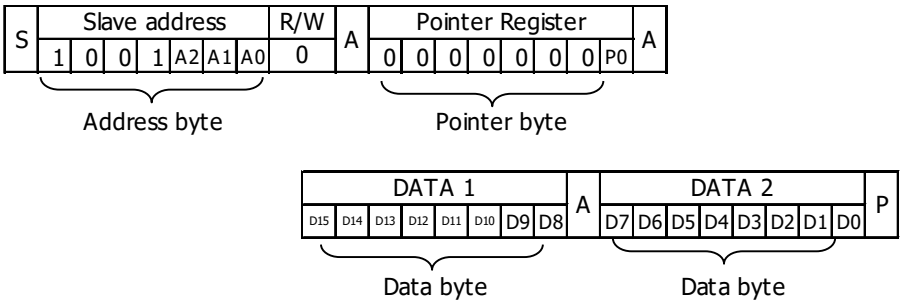
The data format for read mode is set in the temperature, configuration, TOS, and THYST registers as shown below.



*If a register selected with a pointer byte, data byte is 1 byte only.

Write Mode

The data format for write mode is set in the configuration, TOS, and THYST registers as shown below.



* If a register selected with a pointer byte, data byte is 1 byte only.

Register Structure

Pointer Register

P7	P6	P5	P4	P3	P2	P1	P0
0	0	0	0	0	Register Select		

(1) P0: Register select

P2	P1	P0	Register
0	0	0	Temperature Register (Read only, Power-up default)
0	0	1	Configuration Register (Read/Write)
0	1	0	THYST Register (Read/Write)
0	1	1	TOS Register (Read/Write)
1	0	0	Test Mode Resister

(2)Must be kept to zero.
"*It enters the static test mode when 1 is input to P2. Please always input 0 to P2. "

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Temperature Register (Read only)

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
MSB	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	LSB	X	X	X	X	X	X	X

(1) D0-D6: Undefined
(2) D7-D15: Temperature data. 1 LSB = 0.5°C. Two's complement format.

Configuration Register (Read/Write)

D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	O.S. Delay Set		O.S. Polarity Select	O.S. Mode Select	Shutdown Mode Select

(1) D0: Shutdown Mode Select

D0	Shutdown Mode
0	Normal Operation
1	Shutdown

(2)D1: O.S. Mode Select

D1	O.S. Mode
0	Comparator Mode
1	Latch Mode

(3)D2: O.S. Polarity Select

D2	O.S. Polarity
0	Active Low
1	Active High

(4)D3-D4: O.S. Delay Set

D4	D3	O.S. Delay
0	0	1
0	1	2
1	0	4
1	1	6

(5)D5-D7: Must be kept zero for normal operation.

* Power-up default is with all bits (D0 to D7) "0" (zero).

TOS and THYST Registers (Read/Write)

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
MSB	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	LSB	X	X	X	X	X	X	X

(1)D0-D6: Undefined
(2)D7-D15: Trip temperature data

* Power-up default is TOS = 80°C, THYST = 75°C.

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FUNCTIONAL DESCRIPTION

Temperature Data Format

Temperature data is represented by a 9-bit (8 bits plus a sign bit), two's complement word with an LSB equal to 0.5°C.

Temperature	Digital Output	
	Binary Code	Hex
125°C	0 1111 1010	0FAh
100°C	0 1100 1000	0C8h
80°C	0 1010 0000	0A0h
60°C	0 0111 1000	078h
40°C	0 0101 0000	050h
25°C	0 0011 0010	032h
0.5°C	0 0000 0001	001h
0°C	0 0000 0000	000h
-0.5°C	1 1111 1111	1FFh
-10°C	1 1110 1100	1ECh
-25°C	1 1100 1110	1CEh
-40°C	1 1011 0000	1B0h

Temperature Detection Function of O.S. Output

There are two modes in the temperature detection function of the O.S. output; comparator mode and latch mode. The output polarity can be two types (either active low (default) or active high) in both modes. O.S. delay can be selected up to 6 conversions to prevent false tripping in noisy environments.
O.S. output mode, polarity, and delay can be selected via the configuration register.

Comparator Mode

In comparator mode, the O.S. output becomes active when temperature exceeds TOS and becomes inactive when temperature drops below THYST.

Latch Mode

The O.S. output becomes active when temperature exceeds TOS and remains active until it is reset. To reset O.S., perform a read to any register or select shutdown mode. Once O.S. has been activated by crossing TOS and is then reset, it can be activated again only when temperature drops below THYST.

Timing Diagram of Temperature Detection Operation

The below shows the timing diagram of the temperature detection operation when the O.S. polarity is in active low mode. The polarity is reversed in active high mode. However, the operation is the same as that in active low mode.

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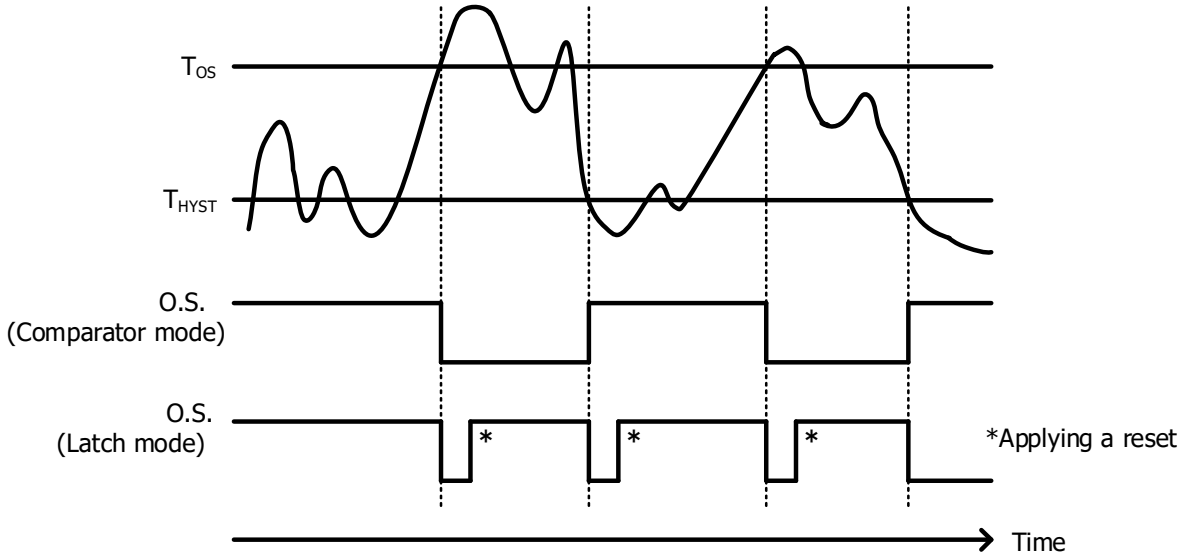

O.S. Delay

To prevent false tripping in noisy environments, O.S. delay can be set to multiple conversions. The O.S output is set after performing temperature detection by the set O.S. delay. That is, the active state of the O.S. output varies only when all the detection results for the set O.S. delay are over TOS or below THYST. Other than that, the active state does not vary. O.S. delay can be selected among 1, 2, 4, and 6 conversions.

Shutdown Mode

Shutdown mode is enabled by setting the shutdown mode select bit in the configuration register. Current consumption during shutdown mode is 1μA (typ.), which achieves reduction in power consumption during standby mode. TOS, THYST, and configuration registers can be read from and written to in shutdown mode.

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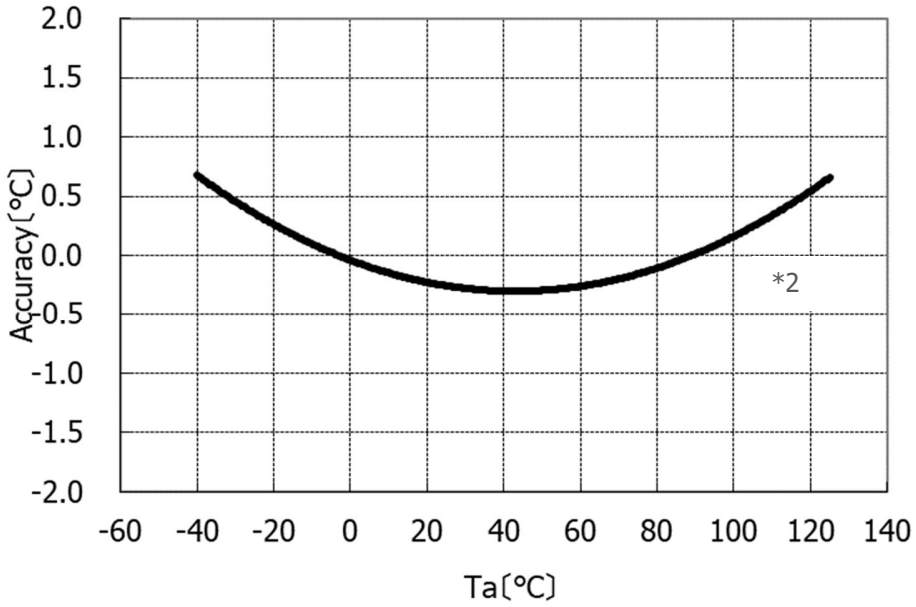
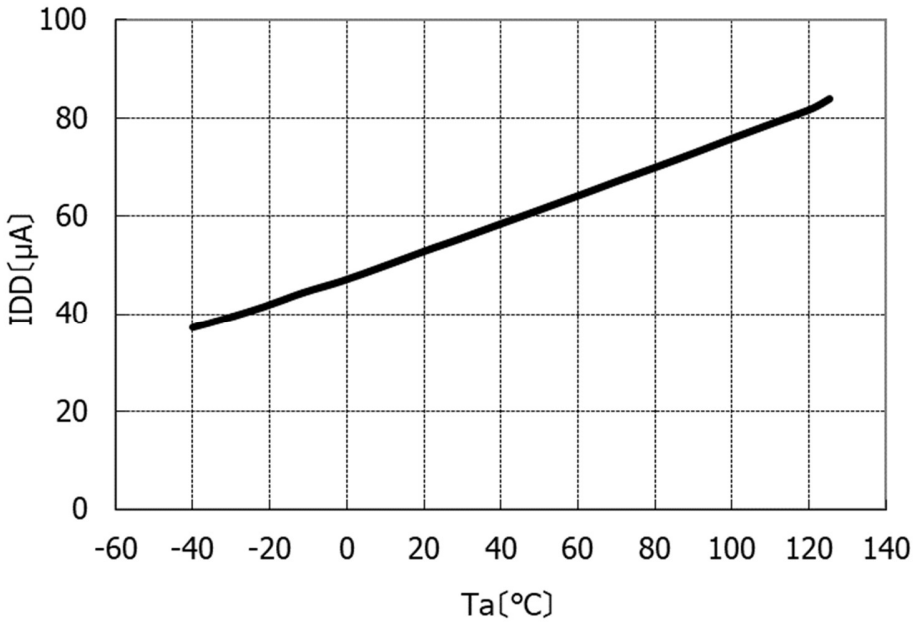
TYPICAL PERFORMANCE CHARACTERISTICS

Ambient Temperature – Accuracy



*2 The characteristic graph shows an approximate curved line.

Ambient Temperature – Supply Current



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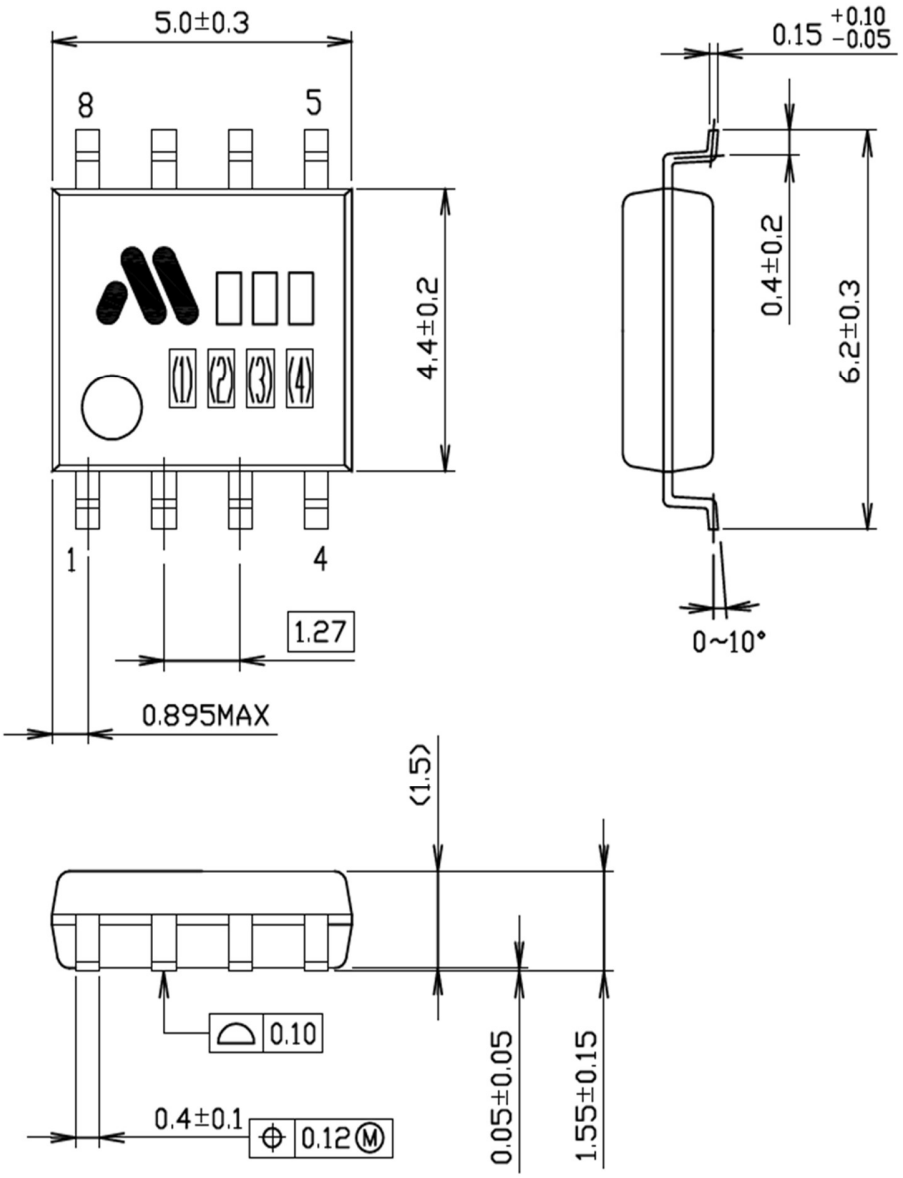
DIMENSIONS

PACKAGE: SOP-8D

UNIT	mm



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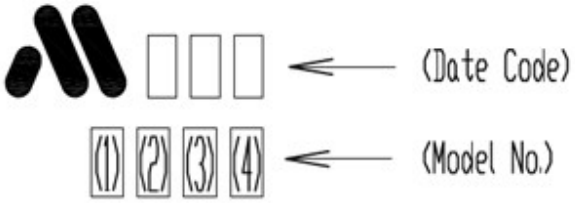
MARKING CONTENTS



Model name	Model No.			
	(1)	(2)	(3)	(4)
M M 3 2 8 6 E F B E	2	8	6	E

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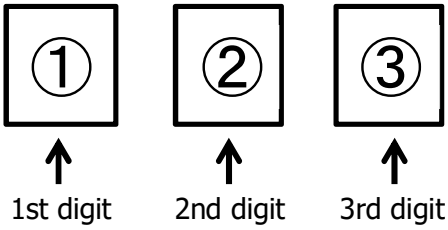
How to identify 3 characteristic lot numbers.



(1) The 1st digit (①) shows the last digit of a production year (western calendar).

(2) The 2nd (②) and 3rd (③) digit show a production week of mass production.

【How to indicate a production year】

The 1st digit (①)	
the last digit of a production year	mark
xxx1	1
xxx2	2
xxx3	3
xxx4	4
xxx5	5
xxx6	6
xxx7	7
xxx8	8
xxx9	9
xxx0	0

The 2nd and 3rd digit (②③)			
production week	mark	production week	mark
1	01	27	27
2	02	28	28
3	03	29	29
4	04	30	30
5	05	31	31
6	06	32	32
7	07	33	33
8	08	34	34
9	09	35	35
10	10	36	36
11	11	37	37
12	12	38	38
13	13	39	39
14	14	40	40
15	15	41	41
16	16	42	42
17	17	43	43
18	18	44	44
19	19	45	45
20	20	46	46
21	21	47	47
22	22	48	48
23	23	49	49
24	24	50	50
25	25	51	51
26	26	52	52
		53	53

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PACKING SPECIFICATIONS

1. APPLICATION LIMIT
   IT APPLIES TO THE PACKING SPECIFICATION OF SOP-8D

2. QUANTITY

(1) REEK PACKING	2000 pcs / REEL
(2) BOX PACKING	MAX 2000 pcs / BOX（1REEL）
	THE QUANTITY IS FILLED IN THE PACKING SLIP

3. PACKING SPECIFICATIONS

(1) HOUSING SPECTICATION	REFER TO DRAWING
(2) REEL DIMENSIONS	REFER TO DRAWING
(3) BOX DIMENSIONS	REFER TO DRAWING

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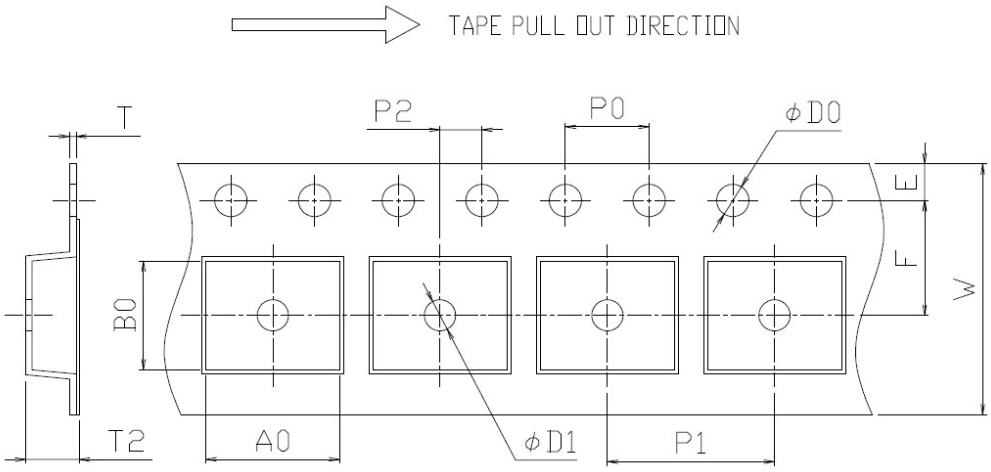
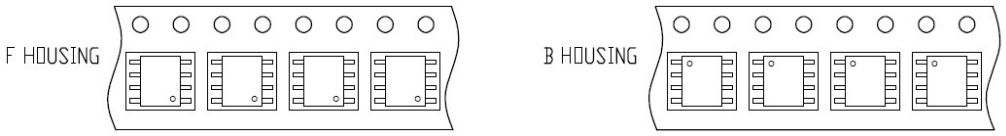
EMBOSS TAPE HOUSING SPECIFICATION



SYM.	A0	B0	W	F	E	P1	P2	P0	φD0	T	T2	φD1
UNIT mm	6.65	5.4	12.0	5.5	1.75	8.0	2.0	4.0	1.55	0.3	2.2	1.55
	±0.1	±0.1	±0.3	±0.1	±0.1	±0.1	±0.1	±0.1	±0.05	±0.05	±0.1	±0.1

NOTE

1. IC PULL DUT DIRECTION



2. CARRIER TAPE MATERIAL: DISPOSED ELECTRICATION PREVENTION.

3. LENGTH OF LEADER TAPE: MORE THAN 400mm INCLUDING 40 OR MORE ENBOSSES IN WHICH NO COMPONENT IS PLACED.

4. LENGTH LEADER TAPE: MORE THAN 40mm INCLUDING ENBOSSES IN WHICH NO COMPONENT IS PLACED

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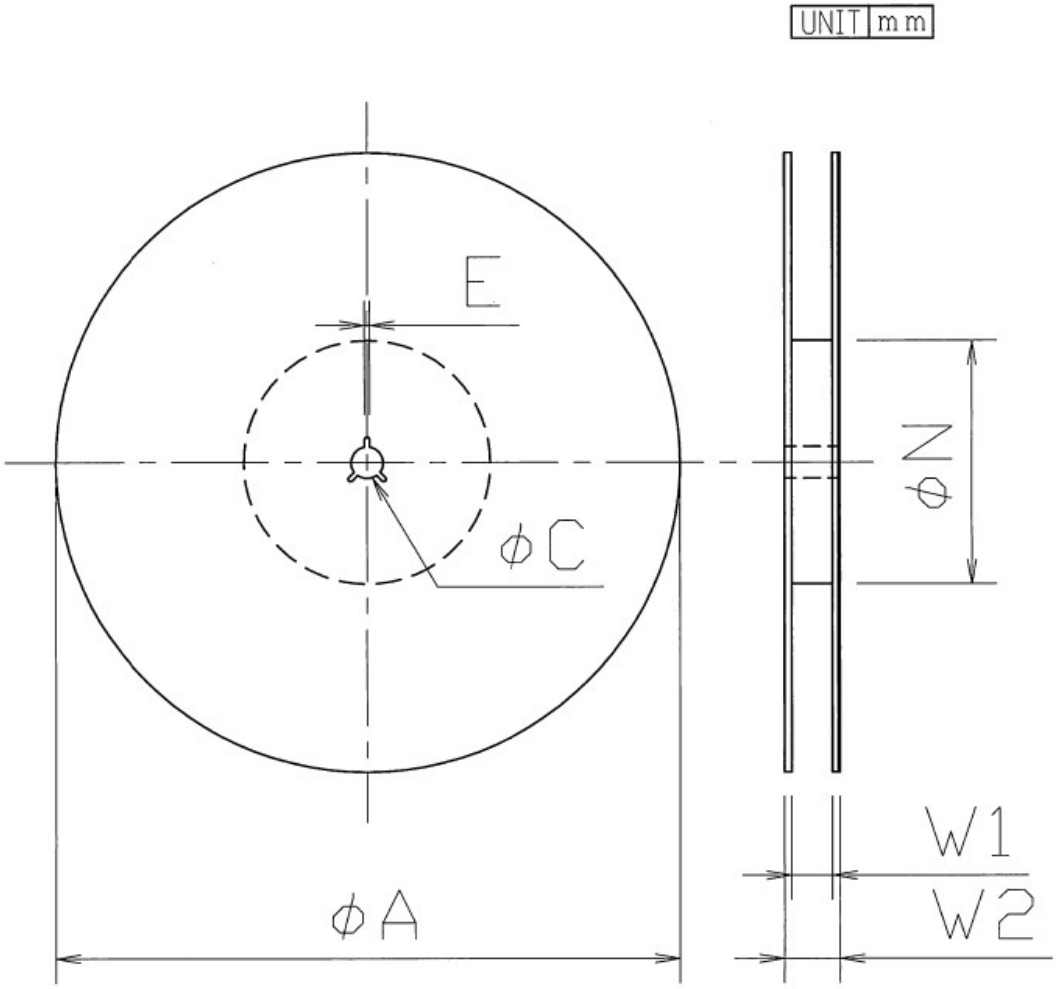
REEL DIMENSIONS



記号 SYM.	φA	φC	φN	E	W1	W2
UNIT mm	330	13.0	80	2.0	13.5	17.5
	±2.0	±0.2	±1.0	±0.5	±0.5	±1.0

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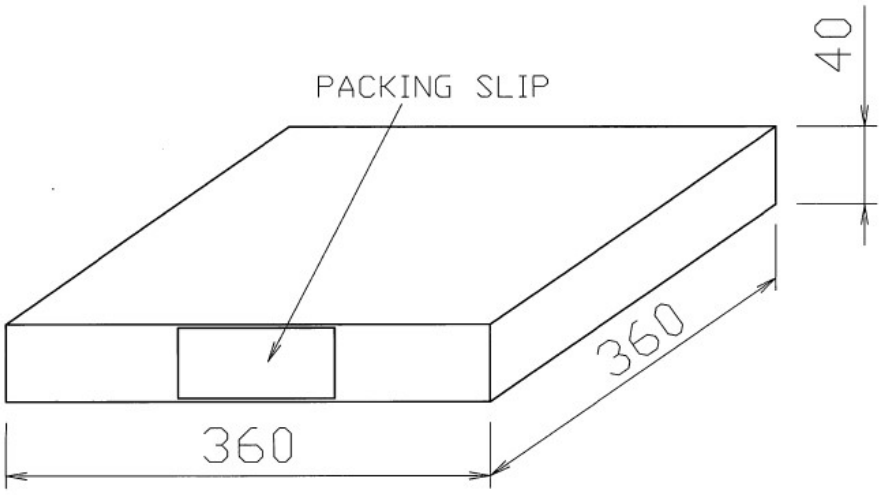
BOX DIMENSIONS

UNIT	mm



PACKING SLIP

MITSUMI ELECTRIC CO., LTD. 現品票 PACKING SLIP	
納入先 MESSRS	
品番 PART NO.	
品名 DESCRIPTION	
注番 P/O NO.	
特記 NOTE	
TOTALQ'TY/BOXES 個	Q'TY/BOX 個入
荷姿	個口/ 箱
DATE	
LOT NO.	
R 番 SPEC. R.	

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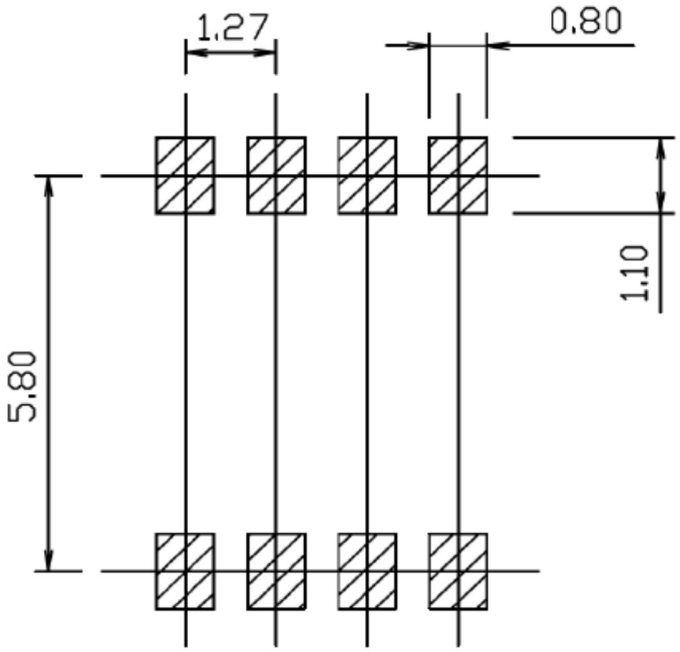
CONDITION FOR PACKAGE MOUNTING

Design example of mount pad
Package: SOP-8D

UNIT	mm



The dimension are for reference only and not guaranteed by design.
To design practically, correction should be made for optimized dimensions considering the effects of the board type to be mounted, mount (soldering) method, type and coating thickness of cream solder.

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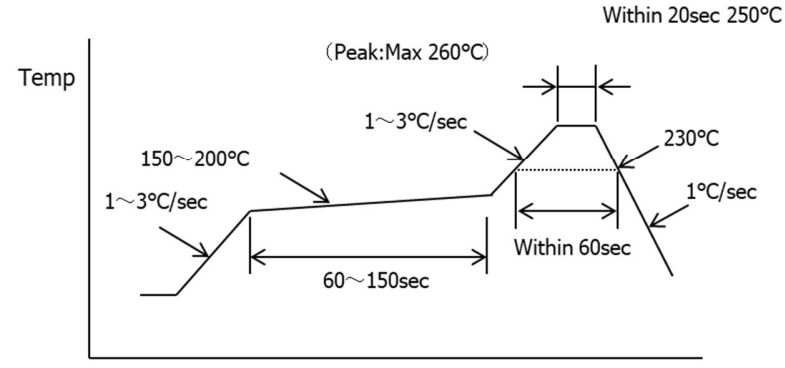
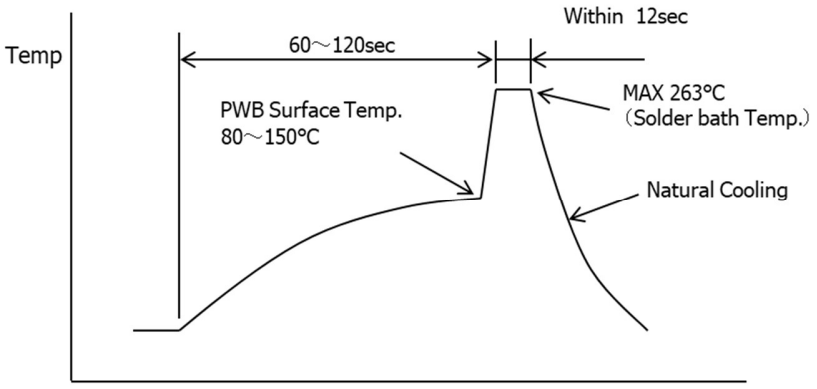
Pb-Free recommended profile condition

Reflow Soldering (max 2 times)



Flow Soldering (max 1 times)



Note: For double-wave soldering, the peak time is the total of two peaks (maximum temperature).

Manual Soldering

Iron tip temp./time	times
max 400°C/within 3s	max2

This profile gives recommended values, which are not guaranteed.
For mounting the package, evaluate the profile with the equipment, conditions, and materials to be used.

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Storage method

Storage condition
Store the device under the following conditions.
Temperature: 5～30℃
Humidity: 40～70%RH
Storage life: 1 year
For the product in the moisture-proof packaging, follow these conditions after unpacking.
Temperature: 5～30℃
Humidity: 40～70%RH
Storage life: 168hours
Do not store this device where a large amount of dust or harmful volatile gas exists, electrostatic is easily charged, condensation is generated, or changes in temperature and humidity are wide, or under the direct sunlight.

Baking
If the storage time specified above has passed, mounting by soldering may cause cracks on the moisture absorbed package. Before mounting, the package should be baked under the following conditions.
Temperature: 125℃
Treating time: 16 to 24 hours
Embossing tapes and reels are not heat-resistant type.
Before baking, the device should be placed in a heat-resistant container.
In consideration of the time-consuming baking process and the possibility of deformed terminal, the device should be mounted promptly within the time observing the storage conditions.
If a long-term storage is needed, a desiccator or a dry box should be used.

Handling instructions
Shipping boxes must be handled with care because any drop or shock may damage the device.
Additionally, the device must be handled in the place with the protection against electrostatic charge and without extreme changes of temperature/humidity.

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NOTES

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- Before using this product, even when it is not used for the applications written previous paragraph, 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.

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  - 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.

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Strategy Engineering Department Semiconductor Business Division
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