

# Memory FeRAM

## 1M (128 K × 8) Bit SPI

### MB85RS1MT

#### ■ DESCRIPTION

MB85RS1MT is a FeRAM (Ferroelectric Random Access Memory) chip in a configuration of 131,072 words × 8 bits, using the ferroelectric process and silicon gate CMOS process technologies for forming the nonvolatile memory cells.

MB85RS1MT adopts the Serial Peripheral Interface (SPI).

The MB85RS1MT is able to retain data without using a back-up battery, as is needed for SRAM.

The memory cells used in the MB85RS1MT can be used for  $10^{13}$  read/write operations, which is a significant improvement over the number of read and write operations supported by Flash memory and E<sup>2</sup>PROM.

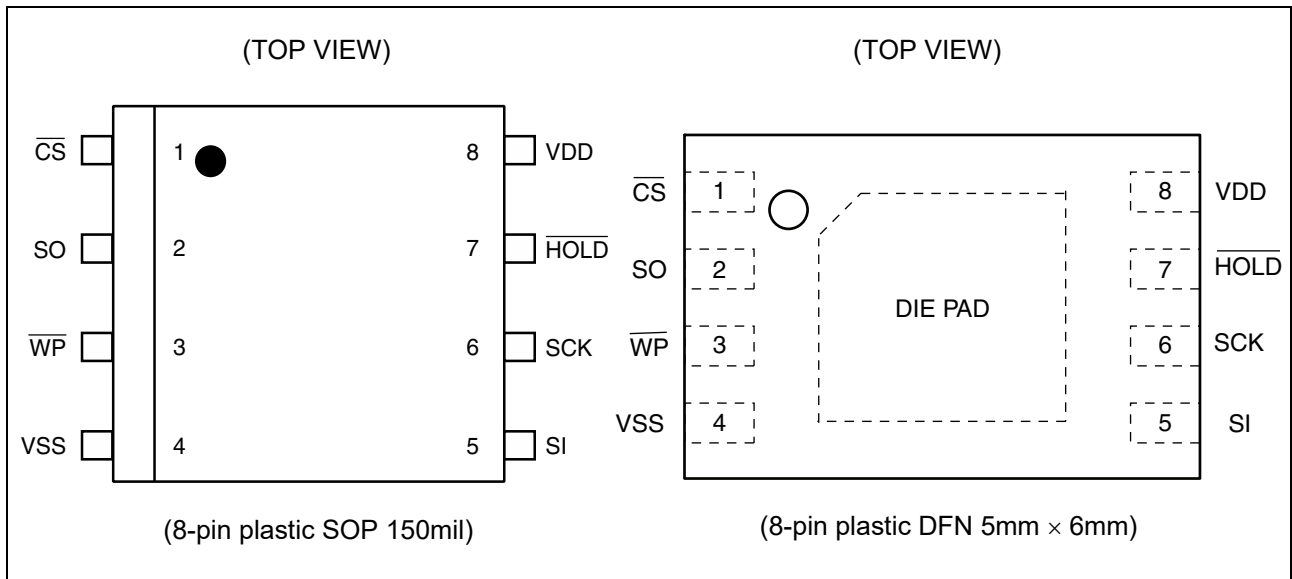
MB85RS1MT does not take long time to write data like Flash memories or E<sup>2</sup>PROM, and MB85RS1MT takes no wait time.

#### ■ FEATURES

- Bit configuration : 131,072 words × 8 bits
- Serial Peripheral Interface : SPI (Serial Peripheral Interface)  
Correspondent to SPI mode 0 (0, 0) and mode 3 (1, 1)
- Operating frequency : 1.8 V to 2.7 V, 25 MHz (Max)  
2.7 V to 3.6 V, 30 MHz (Max)  
For FSTRD command 2.7 V to 3.6 V, 40 MHz (Max)
- High endurance :  $10^{13}$  times / byte
- Data retention : 10 years (+85 °C), 95 years (+ 55 °C), over 200 years (+ 35 °C)
- Operating power supply voltage : 1.8 V to 3.6 V
- Low power consumption : Operating power supply current 9.5 mA (Max@30 MHz)  
Standby current 120 μA (Max)  
Sleep current 10 μA (Max)
- Operation ambient temperature range : -40 °C to +85 °C
- Package : 8-pin plastic SOP 150mil  
8-pin plastic DFN 5mm × 6mm  
RoHS compliant

# MB85RS1MT

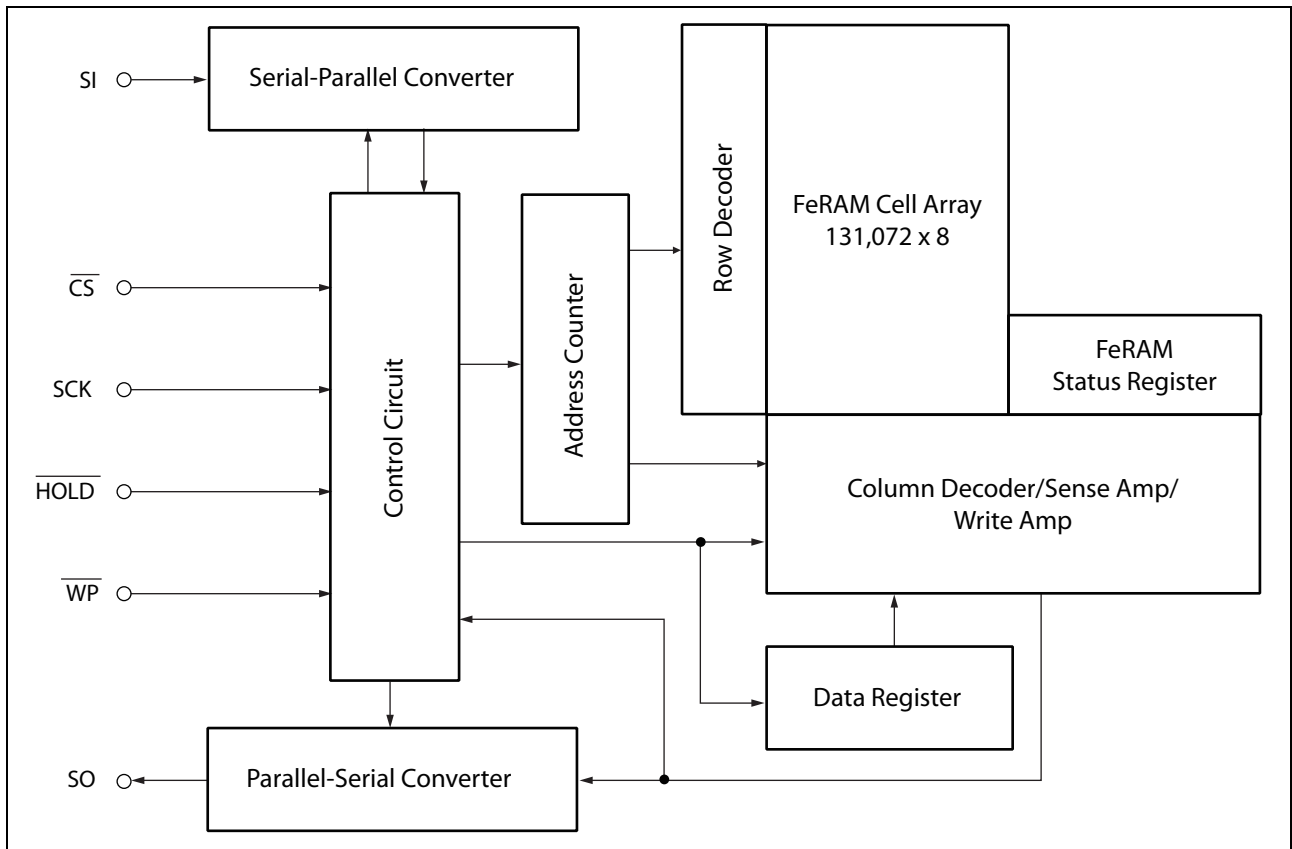
## ■ PIN ASSIGNMENT



## ■ PIN FUNCTIONAL DESCRIPTIONS

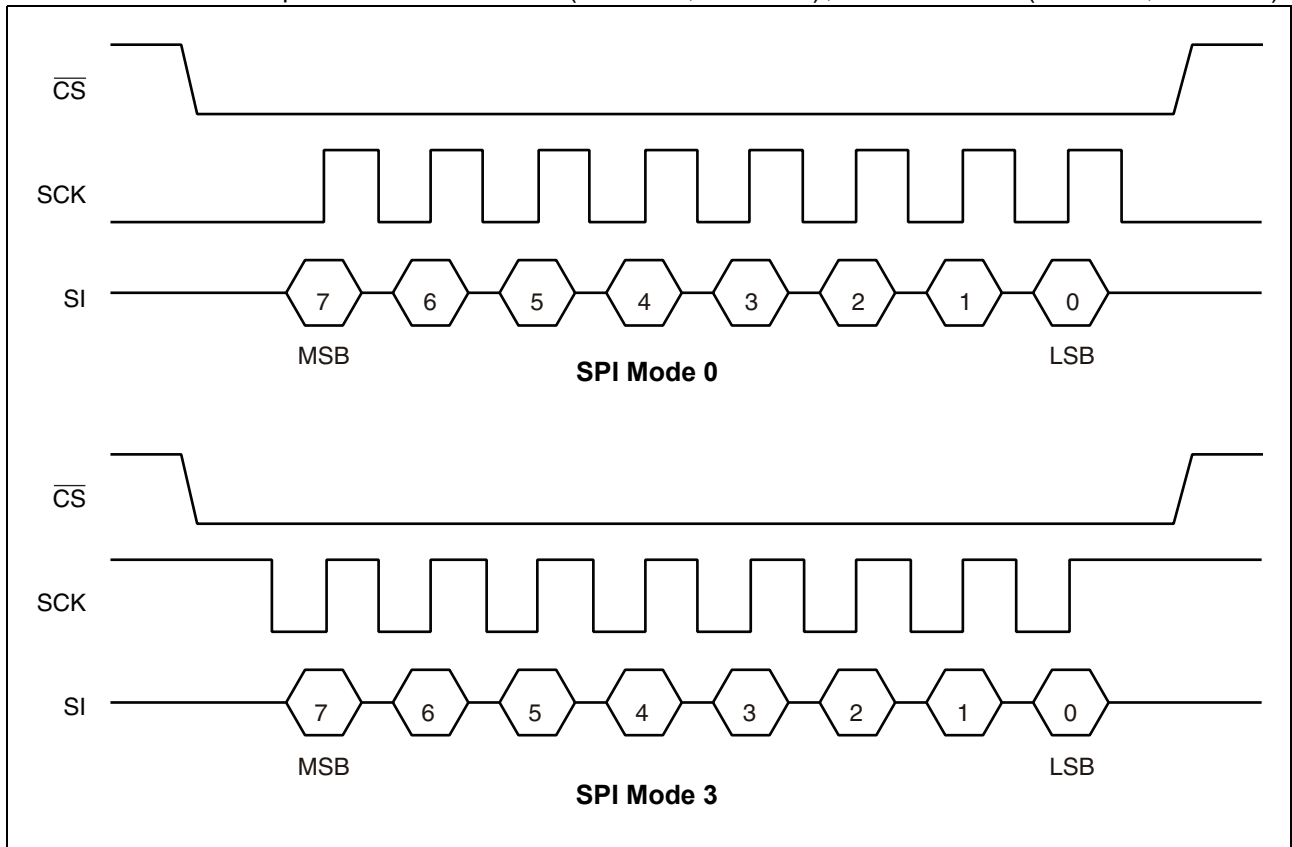
| Pin No. | Pin Name                 | Functional description  |
|---------|--------------------------|---|
| 1       | $\overline{\text{CS}}$   | Chip Select pin<br>This is an input pin to make chips select. When $\overline{\text{CS}}$ is "H" level, device is in deselect (standby) status and SO becomes High-Z. Inputs from other pins are ignored for this time. When $\overline{\text{CS}}$ is "L" level, device is in select (active) status. $\overline{\text{CS}}$ has to be "L" level before inputting op-code. The Chip Select pin is pulled up internally to the VDD pin. |
| 3       | $\overline{\text{WP}}$   | Write Protect pin<br>This is a pin to control writing to a status register. The writing of status register (see "STATUS REGISTER") is protected in related with WP and WPEN. See "WRITING PROTECT" for detail.  |
| 7       | $\overline{\text{HOLD}}$ | Hold pin<br>This pin is used to interrupt serial input/output without making chips deselect. When HOLD is "L" level, hold operation is activated, SO becomes High-Z, SCK and SI become do not care. See "HOLD OPERATION" for detail.  |
| 6       | SCK                      | Serial Clock pin<br>This is a clock input pin to input/output serial data. SI is loaded synchronously to a rising edge, SO is output synchronously to a falling edge.   |
| 5       | SI                       | Serial Data Input pin<br>This is an input pin of serial data. This inputs op-code, address, and writing data.   |
| 2       | SO                       | Serial Data Output pin<br>This is an output pin of serial data. Reading data of FeRAM memory cell array and status register data are output. This is High-Z during standby.   |
| 8       | VDD                      | Supply Voltage pin  |
| 4       | VSS                      | Ground pin  |
| DIE PAD | —                        | It is allowed for the DIE PAD on the bottom of the DFN8 package to be floating (no connection to anything) or to be connected to VSS.   |

## ■ BLOCK DIAGRAM



## ■ SPI MODE

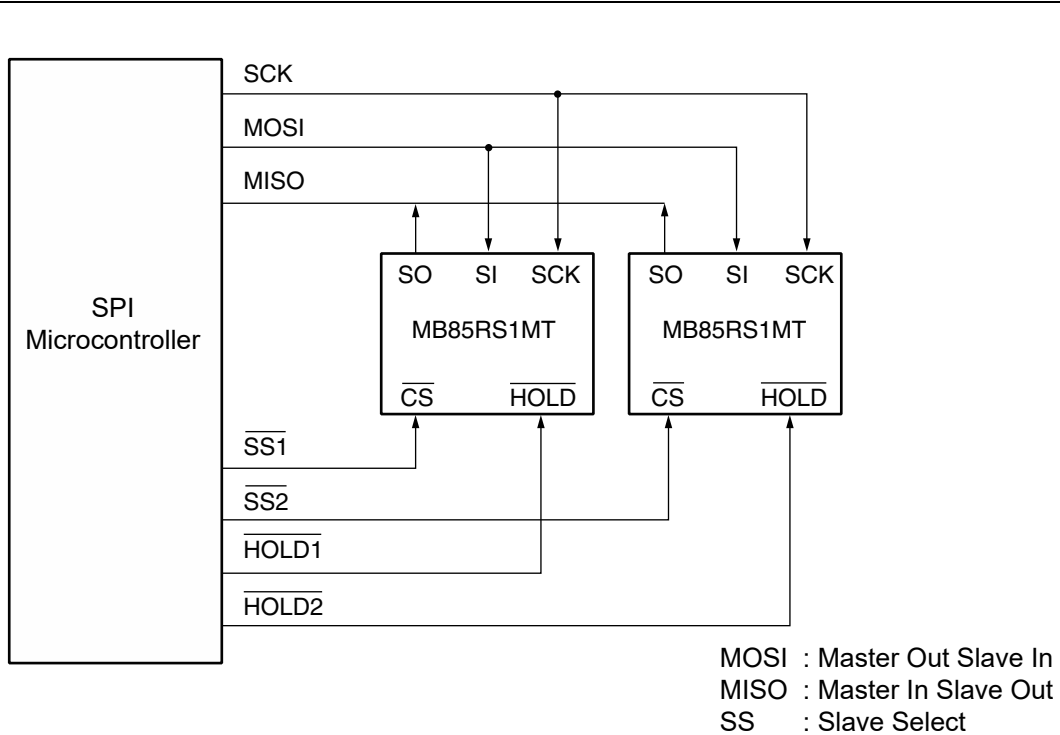
MB85RS1MT corresponds to the SPI mode 0 (CPOL = 0, CPHA = 0), and SPI mode 3 (CPOL = 1, CPHA = 1).



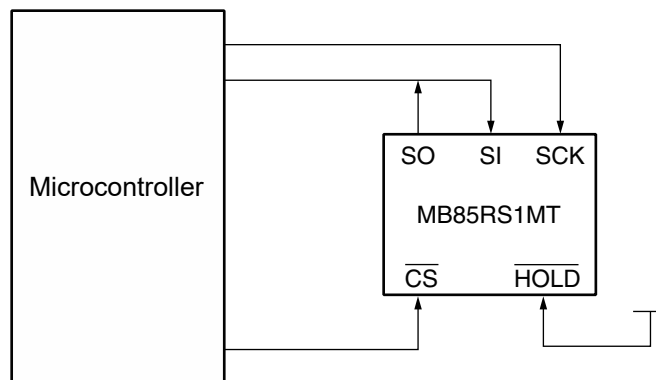
# MB85RS1MT

## ■ SERIAL PERIPHERAL INTERFACE (SPI)

MB85RS1MT works as a slave of SPI. More than 2 devices can be connected by using microcontroller equipped with SPI port. By using a microcontroller not equipped with SPI port, SI and SO can be bus connected to use.



**System Configuration with SPI Port**



**System Configuration without SPI Port**

## ■ STATUS REGISTER

| Bit No. | Bit Name | Function  |
|---------|----------|---|
| 7       | WPEN     | Status Register Write Protect<br>This is a bit composed of nonvolatile memories (FeRAM). WPEN protects writing to a status register (refer to " WRITING PROTECT") relating with $\overline{WP}$ input. Writing with the WRSR command and reading with the RDSR command are possible.  |
| 6 to 4  | —        | Not Used Bits<br>These are bits composed of nonvolatile memories, writing with the WRSR command is possible. These bits are not used but they are read with the RDSR command.   |
| 3       | BP1      | Block Protect<br>This is a bit composed of nonvolatile memory. This defines size of write protect block for the WRITE command (refer to " BLOCK PROTECT"). Writing with the WRSR command and reading with the RDSR command are possible.  |
| 2       | BP0      |   |
| 1       | WEL      | Write Enable Latch<br>This indicates FeRAM Array and status register are writable. The WREN command is for setting, and the WRDI command is for resetting. With the RDSR command, reading is possible but writing is not possible with the WRSR command. WEL is reset after the following operations.<br>After power ON.<br>After WRDI command recognition.<br>The rising edge of $\overline{CS}$ after WRSR command recognition.<br>The rising edge of $\overline{CS}$ after WRITE command recognition.<br>After return from SLEEP mode. |
| 0       | 0        | This is a bit fixed to "0".   |

## ■ OP-CODE

MB85RS1MT accepts 9 kinds of command specified in op-code. Op-code is a code composed of 8 bits shown in the table below. Do not input invalid codes other than those codes. If  $\overline{CS}$  is risen while inputting op-code, the command are not performed.

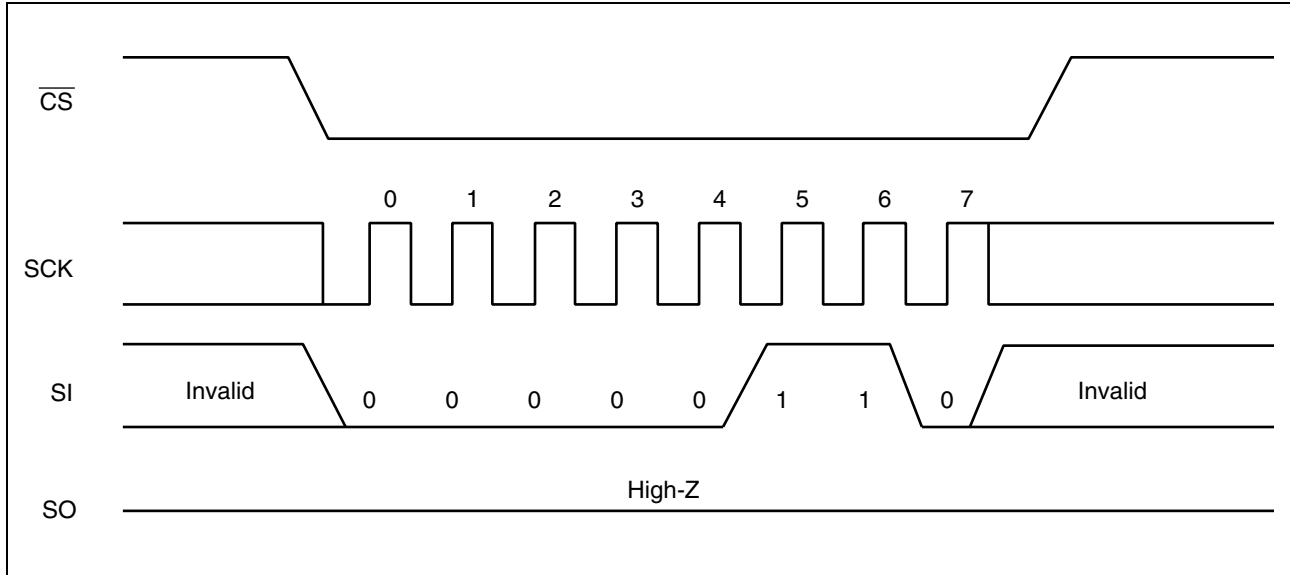
| Name  | Description              | Op-code                |
|-------|--------------------------|------------------------|
| WREN  | Set Write Enable Latch   | 0000 0110 <sub>B</sub> |
| WRDI  | Reset Write Enable Latch | 0000 0100 <sub>B</sub> |
| RDSR  | Read Status Register     | 0000 0101 <sub>B</sub> |
| WRSR  | Write Status Register    | 0000 0001 <sub>B</sub> |
| READ  | Read Memory Code         | 0000 0011 <sub>B</sub> |
| WRITE | Write Memory Code        | 0000 0010 <sub>B</sub> |
| RDID  | Read Device ID           | 1001 1111 <sub>B</sub> |
| FSTRD | Fast Read Memory Code    | 0000 1011 <sub>B</sub> |
| SLEEP | Sleep Mode               | 1011 1001 <sub>B</sub> |

# MB85RS1MT

## ■ COMMAND

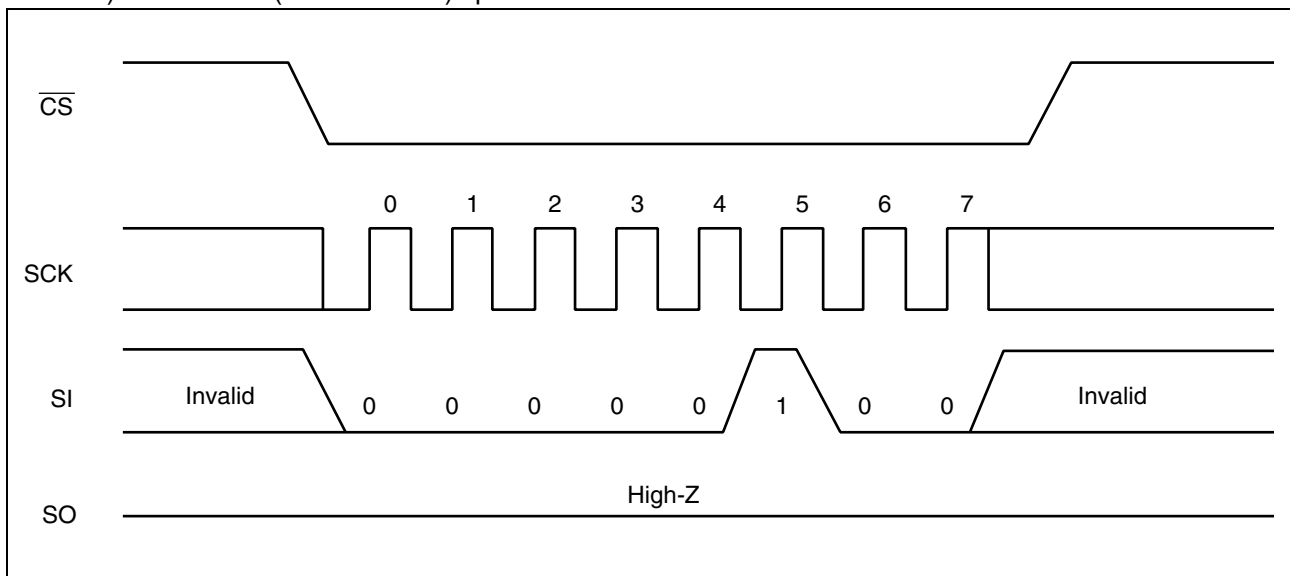
### • WREN

The WREN command sets WEL (Write Enable Latch) . WEL has to be set with the WREN command before writing operation (WRSR command and WRITE command) . WREN command is applicable to “Up to 25 MHz (1.8 V to 2.7 V) and 30 MHz (2.7 V to 3.6 V) operation”.



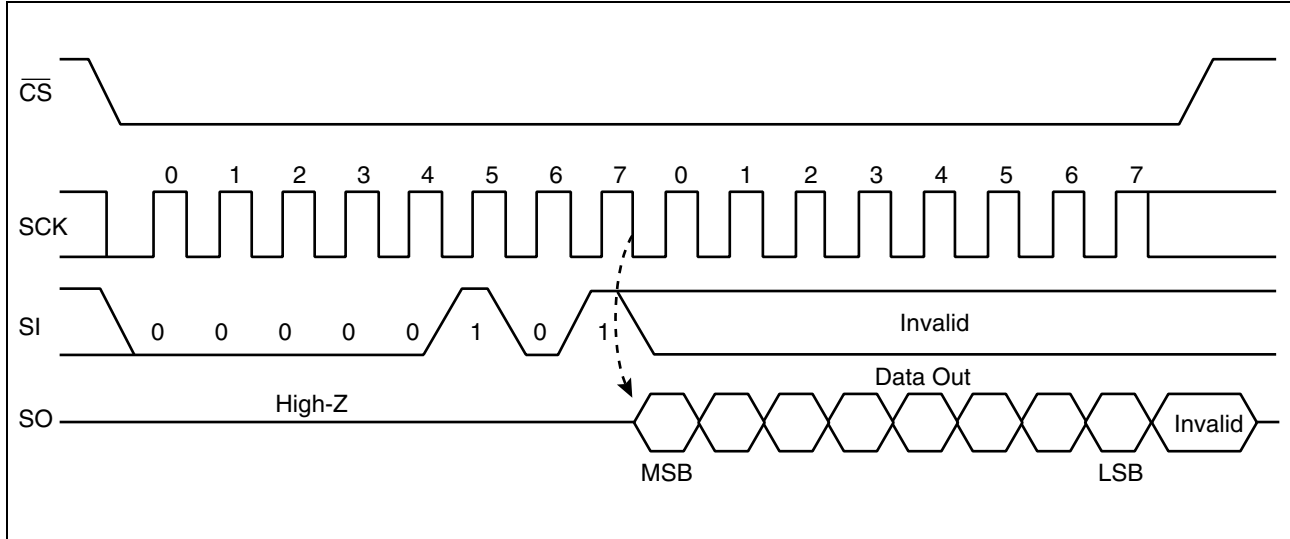
### • WRDI

The WRDI command resets WEL (Write Enable Latch) . Writing operation (WRSR command and WRITE command) are not performed when WEL is reset. WRDI command is applicable to “Up to 25 MHz (1.8 V to 2.7 V) and 30 MHz (2.7 V to 3.6 V) operation”.



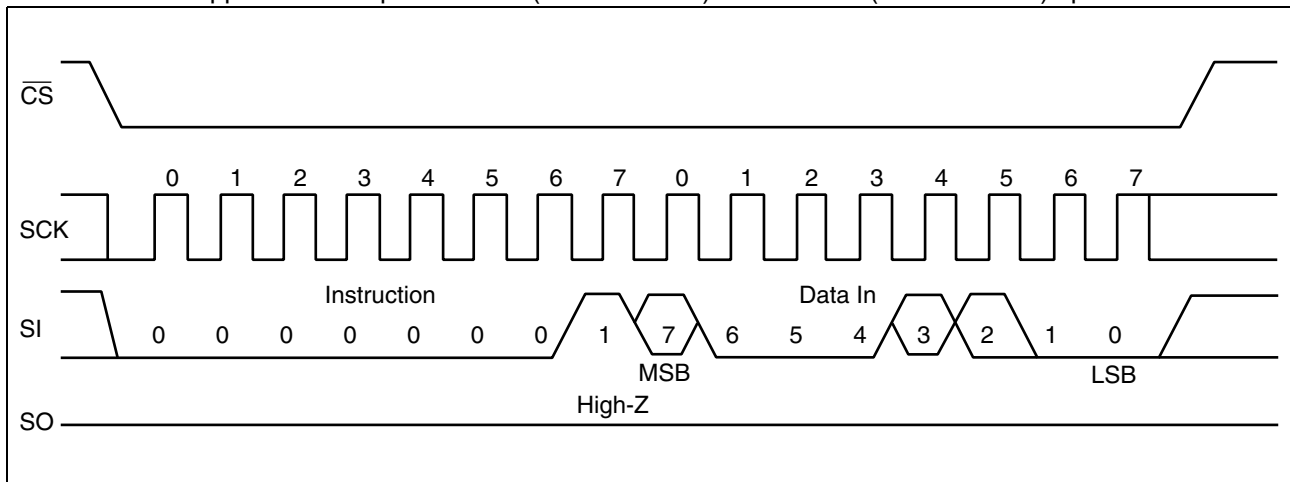
## • RDSR

The RDSR command reads status register data. After op-code of RDSR is input to SI, 8-cycle clock is input to SCK. The SI value is invalid for this time. SO is output synchronously to a falling edge of SCK. In the RDSR command, repeated reading of status register is enabled by sending SCK continuously before rising of  $\overline{CS}$ . RDSR command is applicable to “Up to 25 MHz (1.8 V to 2.7 V) and 30 MHz (2.7 V to 3.6 V) operation”.



## • WRSR

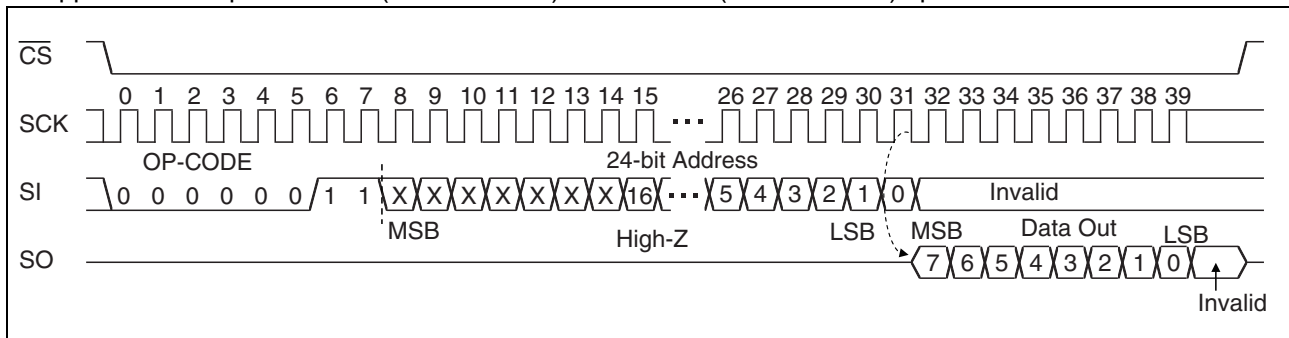
The WRSR command writes data to the nonvolatile memory bit of status register. After performing WRSR op-code to a SI pin, 8 bits writing data is input. WEL (Write Enable Latch) is not able to be written with WRSR command. A SI value correspondent to bit 1 is ignored. Bit 0 of the status register is fixed to “0” and cannot be written. The SI value corresponding to bit 0 is ignored.  $\overline{WP}$  signal level shall be fixed before performing WRSR command, and do not change the  $\overline{WP}$  signal level until the end of command sequence. WRSR command is applicable to “Up to 25 MHz (1.8 V to 2.7 V) and 30 MHz (2.7 V to 3.6 V) operation”.



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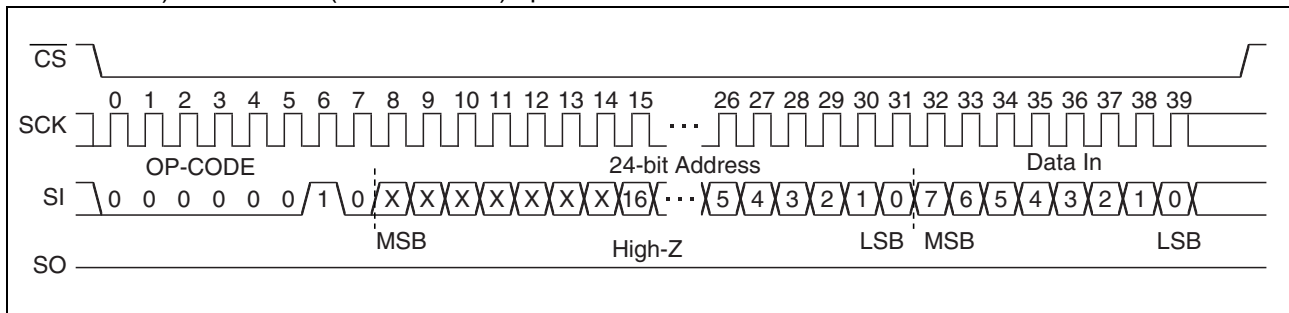
## • READ

The READ command reads FeRAM memory cell array data. Arbitrary 24 bits address and op-code of READ are input to SI. The 7-bit upper address bit is invalid. Then, 8-cycle clock is input to SCK. SO is output synchronously to the falling edge of SCK. While reading, the SI value is invalid. When  $\overline{CS}$  is risen, the READ command is completed, but keeps on reading with automatic address increment which is enabled by continuously sending clocks to SCK in unit of 8 cycles before  $\overline{CS}$  rising. When it reaches the most significant address, it rolls over to the starting address, and reading cycle keeps on infinitely. READ command is applicable to “Up to 25 MHz (1.8 V to 2.7 V) and 30 MHz (2.7 V to 3.6 V) operation”.



## • WRITE

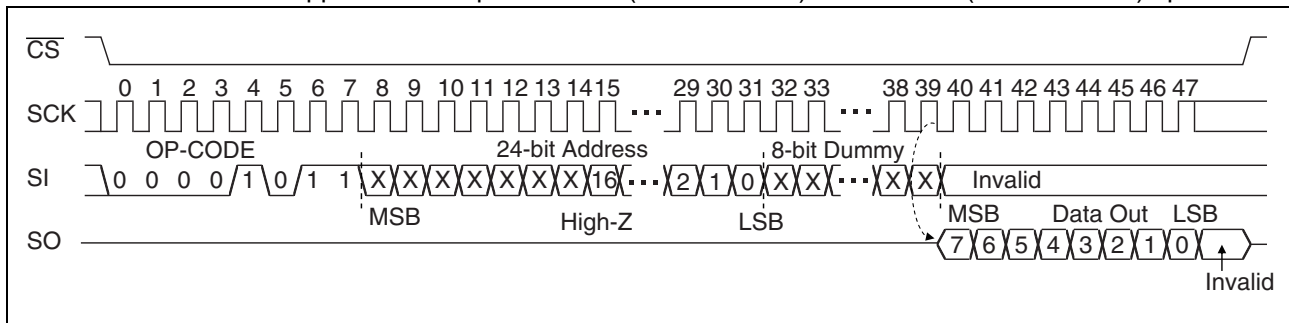
The WRITE command writes data to FeRAM memory cell array. WRITE op-code, arbitrary 24 bits of address and 8 bits of writing data are input to SI. The 7-bit upper address bit is invalid. When 8 bits of writing data is input, data is written to FeRAM memory cell array. Risen  $\overline{CS}$  will terminate the WRITE command, but if you continue sending the writing data for 8 bits each before  $\overline{CS}$  rising, it is possible to continue writing with automatic address increment. When it reaches the most significant address, it rolls over to the starting address, and writing cycle can be continued infinitely. WRITE command is applicable to “Up to 25 MHz (1.8 V to 2.7 V) and 30 MHz (2.7 V to 3.6 V) operation”.





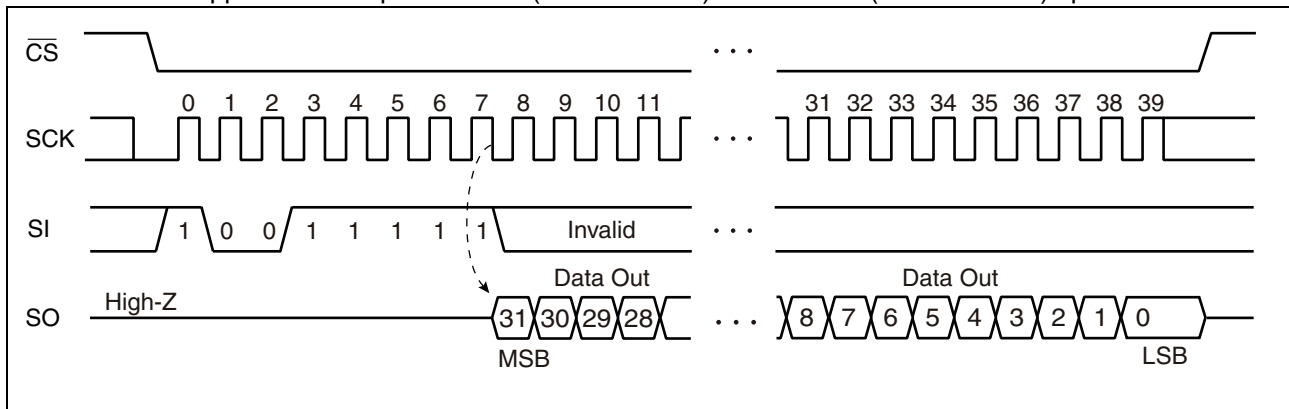
## • FSTRD

The FSTRD command reads FeRAM memory cell array data. Arbitrary 24 bits address and op-code of FSTRD are input to SI followed by 8 bits dummy. The 7-bit upper address bit is invalid. Then, 8-cycle clock is input to SCK. SO is output synchronously to the falling edge of SCK. While reading, the SI value is invalid. When  $\overline{CS}$  is risen, the FSTRD command is completed, but keeps on reading with automatic address increment which is enabled by continuously sending clocks to SCK in unit of 8 cycles before  $\overline{CS}$  rising. When it reaches the most significant address, it rolls over to the starting address, and reading cycle keeps on infinitely. FSTRD command is applicable to “Up to 25 MHz (1.8 V to 2.7 V) and 40 MHz (2.7 V to 3.6 V) operation”.



## • RDID

The RDID command reads fixed Device ID. After performing RDID op-code to SI, 32-cycle clock is input to SCK. The SI value is invalid for this time. SO is output synchronously to a falling edge of SCK. The output is in order of Manufacturer ID (8bit)/Continuation code (8bit)/Product ID (1st Byte)/Product ID (2nd Byte). In the RDID command, SO holds the output state of the last bit in 32-bit Device ID until  $\overline{CS}$  is risen. RDID command is applicable to “Up to 25 MHz (1.8 V to 2.7 V) and 30 MHz (2.7 V to 3.6 V) operation”.



|                   | bit |   |   |   |   |   |   |   | Hex             |         |
|-------------------|-----|---|---|---|---|---|---|---|-----------------|---------|
|                   | 7   | 6 | 5 | 4 | 3 | 2 | 1 | 0 |                 |         |
| Manufacturer ID   | 0   | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 04 <sub>H</sub> | Fujitsu |
| Continuation code | 0   | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7F <sub>H</sub> |         |

|                       | Proprietary use |   |   |   | Density |   |   |   | Hex             |                                      |
|-----------------------|-----------------|---|---|---|---------|---|---|---|-----------------|--------------------------------------|
|                       | 7               | 6 | 5 | 4 | 3       | 2 | 1 | 0 |                 |                                      |
| Product ID (1st Byte) | 0               | 0 | 1 | 0 | 0       | 1 | 1 | 1 | 27 <sub>H</sub> | Density: 00111 <sub>B</sub> = 1 Mbit |

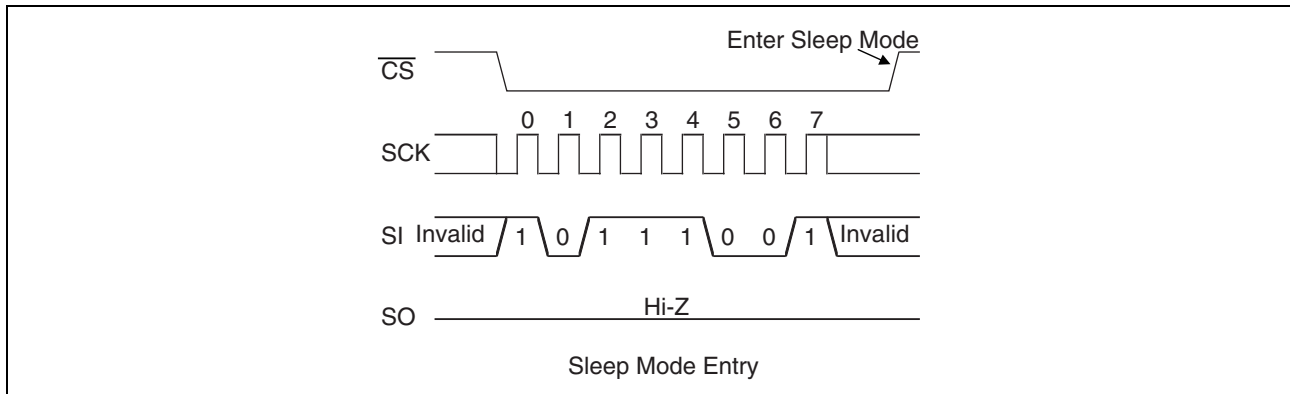
|                       | Proprietary use |   |   |   |   |   |   |   | Hex             |
|-----------------------|-----------------|---|---|---|---|---|---|---|-----------------|
|                       | 7               | 6 | 5 | 4 | 3 | 2 | 1 | 0 |                 |
| Product ID (2nd Byte) | 0               | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 03 <sub>H</sub> |

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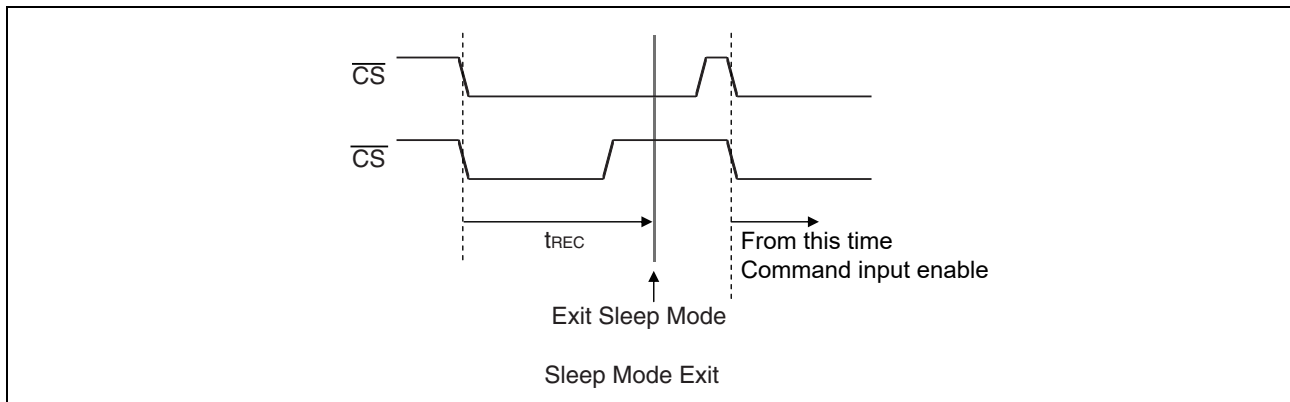
## • SLEEP

The SLEEP command shifts the LSI to a low power mode called “SLEEP mode”. The transition to the SLEEP mode is carried out at the rising edge of  $\overline{CS}$  after operation code in the SLEEP command. However, when at least one SCK clock is inputted before the rising edge of  $\overline{CS}$  after operation code in the SLEEP command, this SLEEP command is canceled.

After the SLEEP mode transition, SCK and SI inputs are logically ignored and SO changes to a Hi-Z state. If input pin(s) other than  $\overline{CS}$  pin is (are) not fixed to VSS or VDD, flow-through current may flow.



Returning to a normal operation from the SLEEP mode is carried out after  $t_{REC}$  (Max 400  $\mu$ s) time from the falling edge of  $\overline{CS}$  (see the figure below). It is possible to return  $\overline{CS}$  to H level before  $t_{REC}$  time. However, it is prohibited to bring down  $\overline{CS}$  to L level again during  $t_{REC}$  period.



## ■ BLOCK PROTECT

Writing protect block for WRITE command is configured by the value of BP0 and BP1 in the status register.

| BP1 | BP0 | Protected Block                                      |
|-----|-----|--|
| 0   | 0   | None   |
| 0   | 1   | 18000 <sub>H</sub> to 1FFFF <sub>H</sub> (upper 1/4) |
| 1   | 0   | 10000 <sub>H</sub> to 1FFFF <sub>H</sub> (upper 1/2) |
| 1   | 1   | 00000 <sub>H</sub> to 1FFFF <sub>H</sub> (all)       |

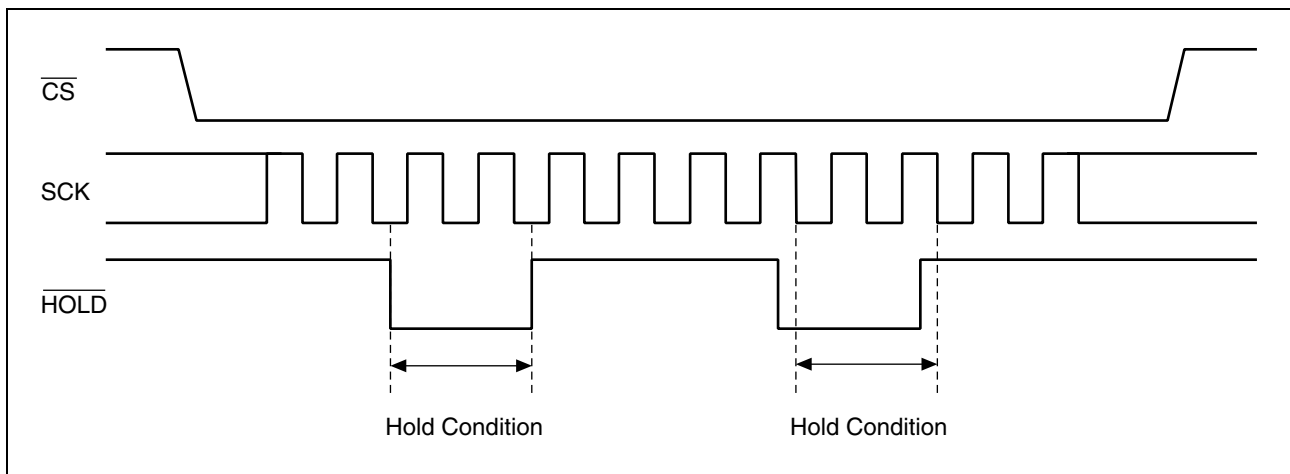
## ■ WRITING PROTECT

Writing operation of the WRITE command and the WRSR command are protected with the value of WEL, WPEN, WP as shown in the table.

| WEL | WPEN | WP | Protected Blocks | Unprotected Blocks | Status Register |
|-----|------|----|------------------|--------------------|-----------------|
| 0   | X    | X  | Protected        | Protected          | Protected       |
| 1   | 0    | X  | Protected        | Unprotected        | Unprotected     |
| 1   | 1    | 0  | Protected        | Unprotected        | Protected       |
| 1   | 1    | 1  | Protected        | Unprotected        | Unprotected     |

## ■ HOLD OPERATION

Hold status is retained without aborting a command if  $\overline{\text{HOLD}}$  is "L" level while  $\overline{\text{CS}}$  is "L" level. The timing for starting and ending hold status depends on the SCK to be "H" level or "L" level when a  $\overline{\text{HOLD}}$  pin input is transitioned to the hold condition as shown in the diagram below. In case the  $\overline{\text{HOLD}}$  pin transitioned to "L" level when  $\overline{\text{SCK}}$  is "L" level, return the  $\overline{\text{HOLD}}$  pin to "H" level at SCK being "L" level. In the same manner, in case the  $\overline{\text{HOLD}}$  pin transitioned to "L" level when SCK is "H" level, return the  $\overline{\text{HOLD}}$  pin to "H" level at SCK being "H" level. Arbitrary command operation is interrupted in hold status, SCK and SI inputs become do not care. And, SO becomes High-Z while reading command (RDSR, READ). If  $\overline{\text{CS}}$  is rising during hold status, a command is aborted. In case the command is aborted before its recognition, WEL holds the value before transition to hold status.



# MB85RS1MT

## ■ ABSOLUTE MAXIMUM RATINGS

| Parameter                     | Symbol    | Rating |                            | Unit |
|-------------------------------|-----------|--------|----------------------------|------|
|                               |           | Min    | Max                        |      |
| Power supply voltage*         | $V_{DD}$  | - 0.5  | + 4.0                      | V    |
| Input voltage*                | $V_{IN}$  | - 0.5  | $V_{DD} + 0.5 (\leq 4.0V)$ | V    |
| Output voltage*               | $V_{OUT}$ | - 0.5  | $V_{DD} + 0.5 (\leq 4.0V)$ | V    |
| Operation ambient temperature | $T_A$     | - 40   | + 85                       | °C   |
| Storage temperature           | $T_{stg}$ | - 55   | + 125                      | °C   |

\*: These parameters are based on the condition that  $V_{SS}$  is 0 V.

WARNING: Semiconductor devices may be permanently damaged by application of stress (including, without limitation, voltage, current or temperature) in excess of absolute maximum ratings.  
Do not exceed any of these ratings.

## ■ RECOMMENDED OPERATING CONDITIONS

| Parameter                       | Symbol   | Value |     |      | Unit |
|---------------------------------|----------|-------|-----|------|------|
|                                 |          | Min   | Typ | Max  |      |
| Power supply voltage*1          | $V_{DD}$ | 1.8   | 3.3 | 3.6  | V    |
| Operation ambient temperature*2 | $T_A$    | - 40  | —   | + 85 | °C   |

\*1: These parameters are based on the condition that  $V_{SS}$  is 0 V.

\*2: Ambient temperature when only this device is working. Please consider it to be the almost same as the package surface temperature.

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated under these conditions.

Any use of semiconductor devices will be under their recommended operating condition. Operation under any conditions other than these conditions may adversely affect reliability of device and could result in device failure.

No warranty is made with respect to any use, operating conditions or combinations not represented on this data sheet. If you are considering application under any conditions other than listed herein, please contact sales representatives beforehand.

## ■ ELECTRICAL CHARACTERISTICS

### 1. DC Characteristics

(within recommended operating conditions)

| Parameter                              | Symbol          | Condition   | Value                 |      |                       | Unit |
|--|-----------------|---|-----------------------|------|-----------------------|------|
|  |                 |   | Min                   | Typ  | Max                   |      |
| Input leakage current*1                | I <sub>LI</sub> | $0 \leq \overline{CS} < V_{DD}$   | —                     | —    | 200                   | μA   |
|  |                 | $\overline{CS} = V_{DD}$  | —                     | —    | 1                     |      |
|  |                 | $\overline{WP}, \overline{HOLD}, \overline{SCK}$<br>$SI = 0 \text{ V to } V_{DD}$ | —                     | —    | 1                     |      |
| Output leakage current*2               | I <sub>LO</sub> | $SO = 0 \text{ V to } V_{DD}$   | —                     | —    | 1                     | μA   |
| Operating power supply current         | I <sub>DD</sub> | SCK = 1 MHz   | —                     | 0.77 | —                     | mA   |
|  |                 | SCK = 10 MHz  | —                     | 2.3  | —                     | mA   |
|  |                 | SCK = 25 MHz  | —                     | 4.85 | —                     | mA   |
|  |                 | SCK = 30 MHz  | —                     | 5.7  | 9.5                   | mA   |
| Standby current                        | I <sub>SB</sub> | SCK = SI = $\overline{CS} = V_{DD}$   | —                     | 25   | 120                   | μA   |
| Sleep current                          | I <sub>ZZ</sub> | $\overline{CS} = V_{DD}$<br>All inputs V <sub>SS</sub> or V <sub>DD</sub>         | —                     | —    | 10                    | μA   |
| Input high voltage                     | V <sub>IH</sub> | V <sub>DD</sub> = 1.8 V to 3.6 V  | V <sub>DD</sub> × 0.7 | —    | V <sub>DD</sub> + 0.5 | V    |
| Input low voltage                      | V <sub>IL</sub> | V <sub>DD</sub> = 1.8 V to 3.6 V  | − 0.5                 | —    | V <sub>DD</sub> × 0.3 | V    |
| Output high voltage                    | V <sub>OH</sub> | I <sub>OH</sub> = − 2 mA  | V <sub>DD</sub> − 0.5 | —    | —                     | V    |
| Output low voltage                     | V <sub>OL</sub> | I <sub>OL</sub> = 2 mA  | —                     | —    | 0.4                   | V    |
| Pull up resistance for $\overline{CS}$ | R <sub>P</sub>  | —   | 18                    | 33   | 80                    | kΩ   |

\*1 : Applicable pin :  $\overline{CS}$ ,  $\overline{WP}$ ,  $\overline{HOLD}$ , SCK, SI

\*2 : Applicable pin : SO

# MB85RS1MT

## 2. AC Characteristics

| Parameter  | Symbol           | Value  |     |  |     | Unit |
|--|------------------|--|-----|--|-----|------|
|  |                  | Up to 25 MHz operation*1<br>(V <sub>DD</sub> = 1.8 V to 2.7 V) |     | Up to 30 MHz operation*2<br>(V <sub>DD</sub> = 2.7 V to 3.6 V) |     |      |
|  |                  | Min  | Max | Min  | Max |      |
| SCK clock frequency<br>(All commands except FSTRD command) | f <sub>CK</sub>  | 0  | 25  | 0  | 30  | MHz  |
| SCK clock frequency<br>(for FSTRD command)                 | f <sub>CK</sub>  | 0  | 25  | 0  | 40  | MHz  |
| Clock high time  | t <sub>CH</sub>  | 15   | —   | 11   | —   | ns   |
| Clock low time   | t <sub>CL</sub>  | 15   | —   | 11   | —   | ns   |
| Chip select set up time                                    | t <sub>CSU</sub> | 10   | —   | 10   | —   | ns   |
| Chip select hold time                                      | t <sub>CSH</sub> | 10   | —   | 10   | —   | ns   |
| Output disable time  | t <sub>OD</sub>  | —  | 12  | —  | 12  | ns   |
| Output data valid time                                     | t <sub>ODV</sub> | —  | 18  | —  | 9   | ns   |
| Output hold time   | t <sub>OH</sub>  | 0  | —   | 0  | —   | ns   |
| Deselect time  | t <sub>D</sub>   | 40   | —   | 40   | —   | ns   |
| Data in rising time  | t <sub>R</sub>   | —  | 50  | —  | 50  | ns   |
| Data falling time  | t <sub>F</sub>   | —  | 50  | —  | 50  | ns   |
| Data set up time   | t <sub>SU</sub>  | 5  | —   | 5  | —   | ns   |
| Data hold time   | t <sub>H</sub>   | 5  | —   | 5  | —   | ns   |
| HOLD set uptime  | t <sub>HS</sub>  | 10   | —   | 10   | —   | ns   |
| HOLD hold time   | t <sub>HH</sub>  | 10   | —   | 10   | —   | ns   |
| HOLD output floating time                                  | t <sub>HZ</sub>  | —  | 20  | —  | 20  | ns   |
| HOLD output active time                                    | t <sub>LZ</sub>  | —  | 20  | —  | 20  | ns   |
| SLEEP recovery time  | t <sub>REC</sub> | —  | 400 | —  | 400 | μs   |

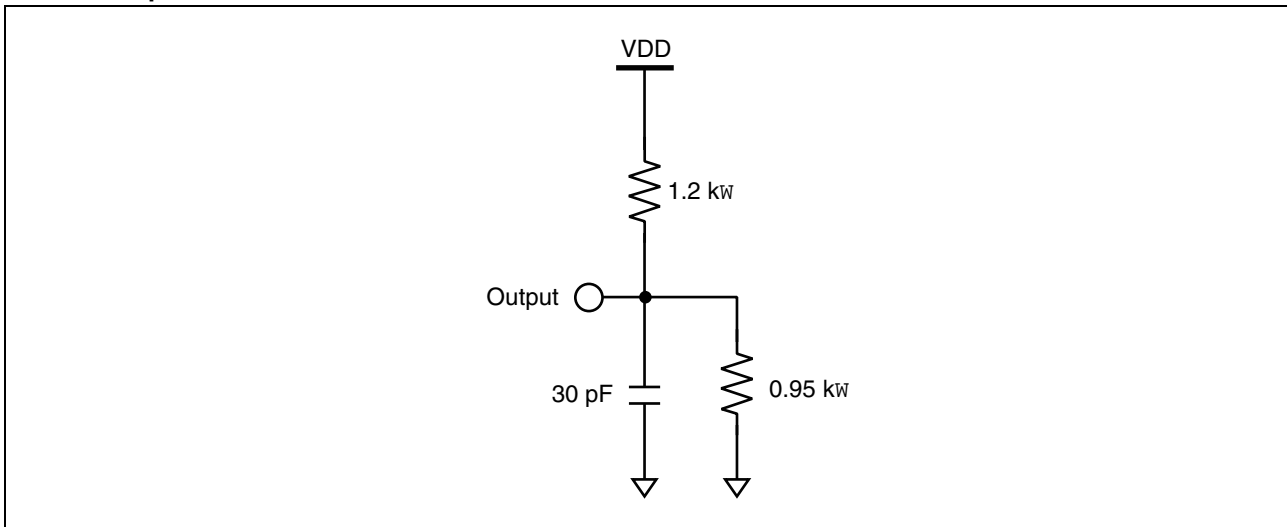
\*1 : All commands except FSTRD are applicable to "Up to 25 MHz operation" in V<sub>DD</sub> = 1.8 V to 2.7 V.

\*2 : All commands except FSTRD are applicable to "Up to 30 MHz operation" in V<sub>DD</sub> = 2.7 V to 3.6 V.

### AC Test Condition

|                               |  |
|-------------------------------|--|
| Power supply voltage          | : 1.8 V to 3.6 V   |
| Operation ambient temperature | : -40 °C to +85 °C   |
| Input voltage magnitude       | : V <sub>DD</sub> × 0.7 ≤ V <sub>IH</sub> ≤ V <sub>DD</sub><br>0 ≤ V <sub>IL</sub> ≤ V <sub>DD</sub> × 0.3 |
| Input rising time             | : 5 ns   |
| Input falling time            | : 5 ns   |
| Input judge level             | : V <sub>DD</sub> /2   |
| Output judge level            | : V <sub>DD</sub> /2   |

## AC Load Equivalent Circuit

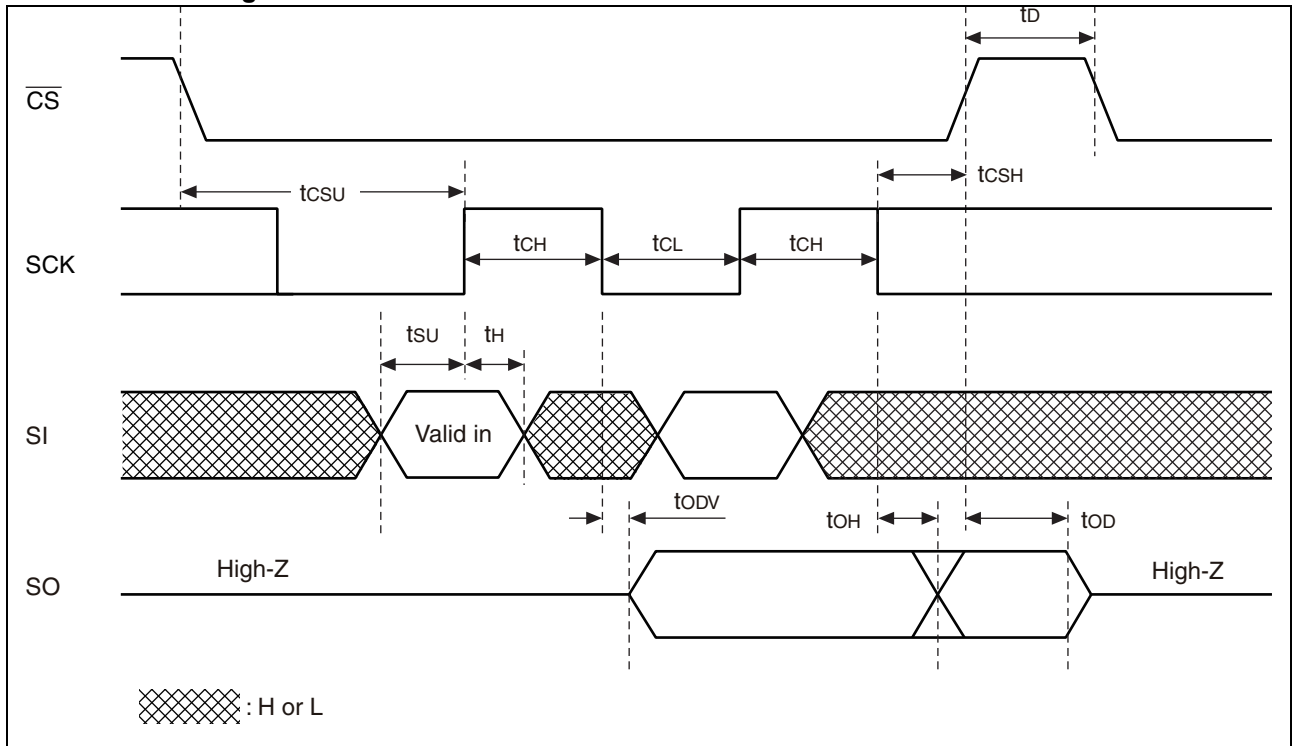


## 3. Pin Capacitance

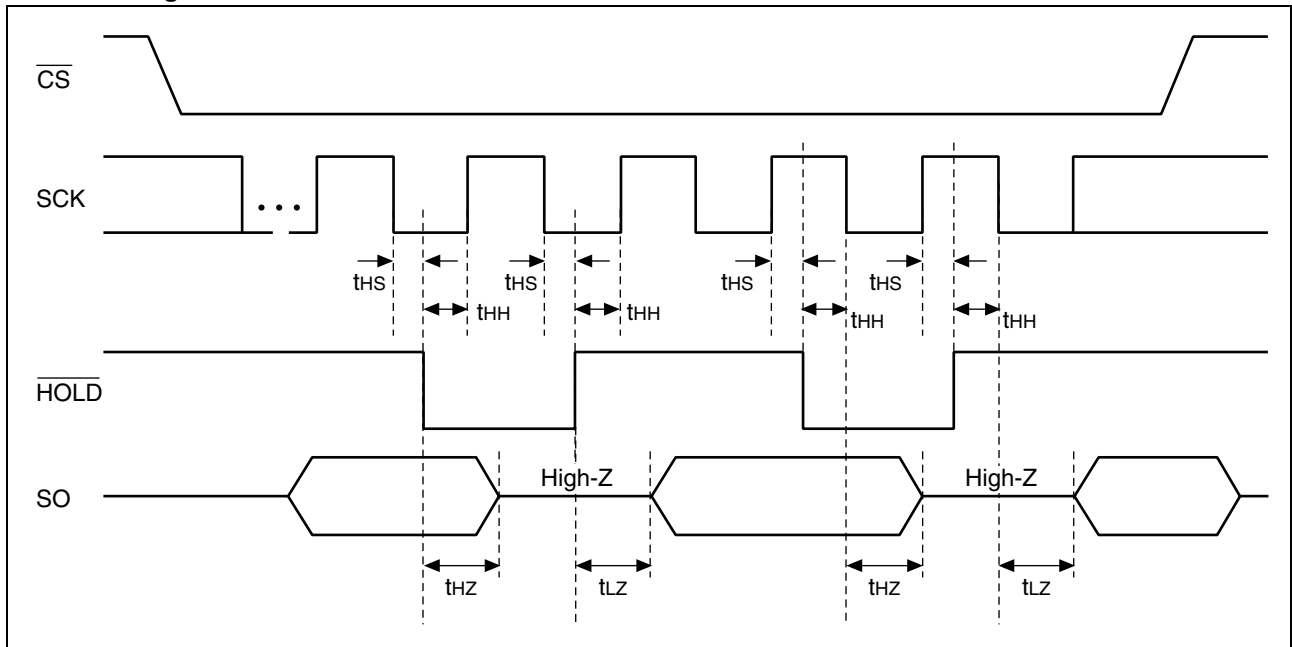
| Parameter          | Symbol | Condition  | Value |     | Unit |
|--------------------|--------|--|-------|-----|------|
|                    |        |  | Min   | Max |      |
| Output capacitance | $C_o$  | $V_{DD} = V_{IN} = V_{OUT} = 0\text{ V}$ ,<br>$f = 1\text{ MHz}$ , $T_A = +25\text{ }^\circ\text{C}$ | —     | 8   | pF   |
| Input capacitance  | $C_i$  |  | —     | 6   | pF   |

## ■ TIMING DIAGRAM

### • Serial Data Timing

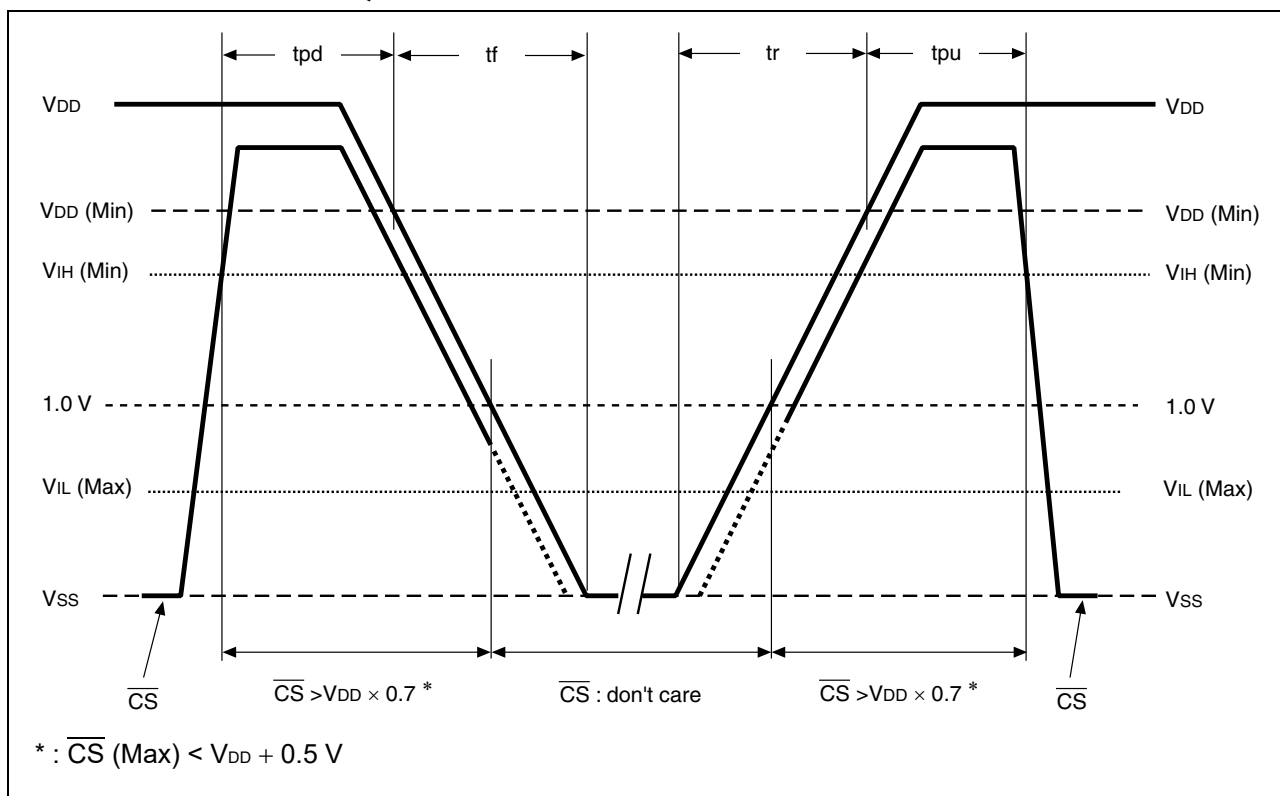


### • Hold Timing





## POWER ON/OFF SEQUENCE



| Parameter                                    | Symbol | Value |     | Unit          |
|--|--------|-------|-----|---------------|
|  |        | Min   | Max |               |
| $\overline{CS}$ level hold time at power OFF | tpd    | 400   | —   | ns            |
| $\overline{CS}$ level hold time at power ON  | tpu    | 250   | —   | $\mu\text{s}$ |
| Power supply rising time                     | tr     | 0.05  | —   | ms/V          |
| Power supply falling time                    | tf     | 0.1   | —   | ms/V          |

If the device does not operate within the specified conditions of read cycle, write cycle or power on/off sequence, memory data can not be guaranteed.

## FeRAM CHARACTERISTICS

| Item                   | Min        | Max | Unit       | Parameter  |
|------------------------|------------|-----|------------|--|
| Read/Write Endurance*1 | $10^{13}$  | —   | Times/byte | Endurance of the sum of read counts and write counts.<br>Operation Ambient Temperature $T_A = +85\text{ }^\circ\text{C}$ |
| Data Retention*2       | 10         | —   | Years      | Operation Ambient Temperature $T_A = +85\text{ }^\circ\text{C}$  |
|                        | 95         | —   |            | Operation Ambient Temperature $T_A = +55\text{ }^\circ\text{C}$  |
|                        | $\geq 200$ | —   |            | Operation Ambient Temperature $T_A = +35\text{ }^\circ\text{C}$  |

\*1 : Total number of reading and writing defines the minimum value of endurance, as an FeRAM memory operates with destructive readout mechanism.

\*2 : Minimum values define retention time of the first reading/writing data right after shipment, and these values are calculated by qualification results.

# MB85RS1MT

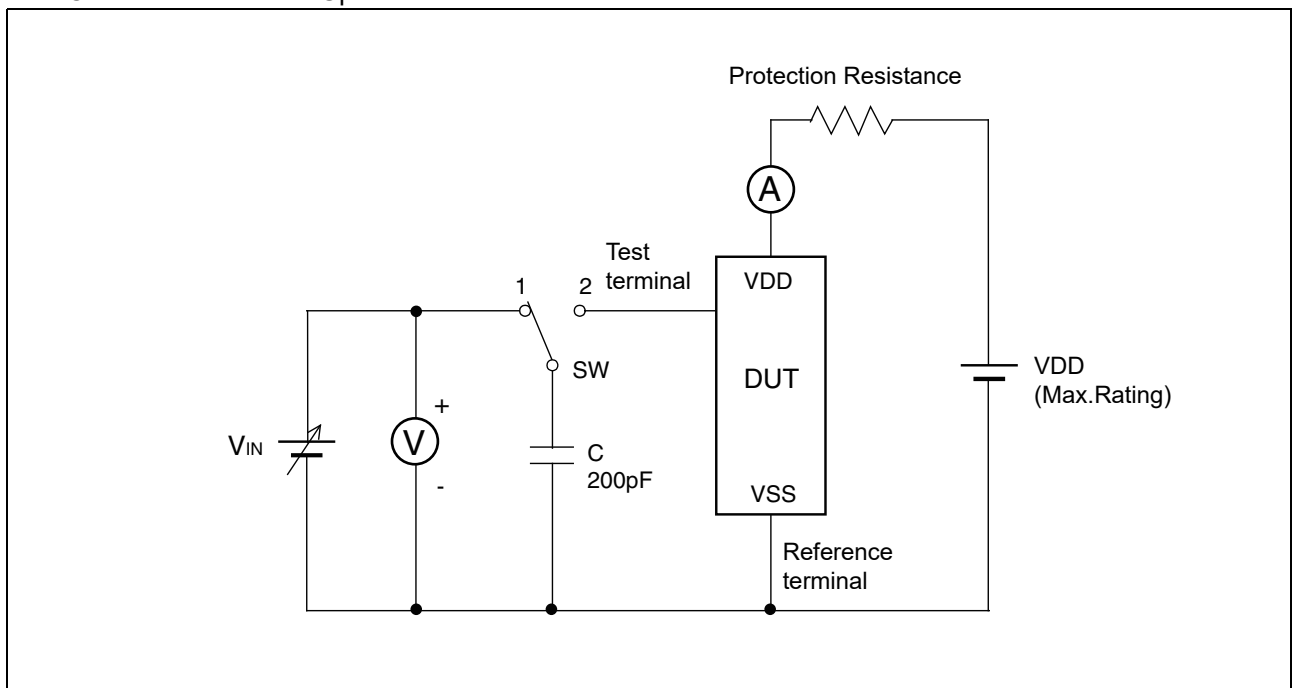
## ■ NOTE ON USE

We recommend programming of the device after reflow. Data written before reflow cannot be guaranteed.

## ■ ESD AND LATCH-UP

| Test  | DUT  | Value                   |
|---|--|-------------------------|
| ESD HBM (Human Body Model)<br>JESD22-A114 compliant     | MB85RS1MTPNF-G-JNE1<br>MB85RS1MTPNF-G-JNERE1<br>MB85RS1MTPN-G-AWEWE1 | $\geq  2000 \text{ V} $ |
| ESD CDM (Charged Device Model)<br>JESD22-C101 compliant |  | $\geq  1000 \text{ V} $ |
| Latch-Up (C-V Method)<br>Proprietary method             |  | $\geq  200 \text{ V} $  |

- C-V method of Latch-Up Resistance Test



Note : Charge voltage alternately switching 1 and 2 approximately 2 sec interval. This switching process is considered as one cycle. Repeat this process 5 times. However, if the latch-up condition occurs before completing 5times, this test must be stopped immediately.

## ■ REFLOW CONDITIONS AND FLOOR LIFE

[ JEDEC MSL ] : Moisture Sensivity Level 3 (IPC/JEDEC J-STD-020E)

## ■ Current status on Contained Restricted Substances

This product complies with the regulations of REACH Regulations, EU RoHS Directive and China RoHS.

## ■ ORDERING INFORMATION

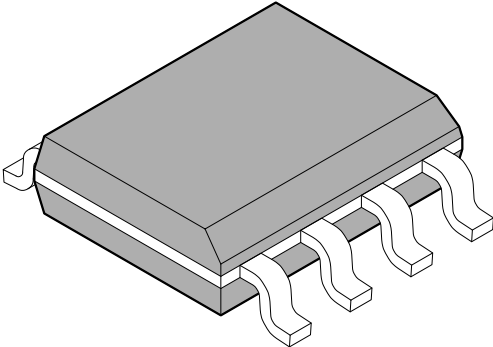
| Part number           | Package           | Shipping form         | Minimum shipping quantity |
|-----------------------|-------------------|-----------------------|---------------------------|
| MB85RS1MTPNF-G-JNE1   | 8-pin plastic SOP | Tube                  | — *1                      |
| MB85RS1MTPNF-G-JNERE1 | 8-pin plastic SOP | Embossed Carrier tape | 1500                      |
| MB85RS1MTPNF-G-AWE2   | 8-pin plastic SOP | Tube                  | — *1                      |
| MB85RS1MTPNF-G-AWERE2 | 8-pin plastic SOP | Embossed Carrier tape | 1500                      |
| MB85RS1MTPN-G-AWEWE1  | 8-pin plastic DFN | Embossed Carrier tape | 1500                      |

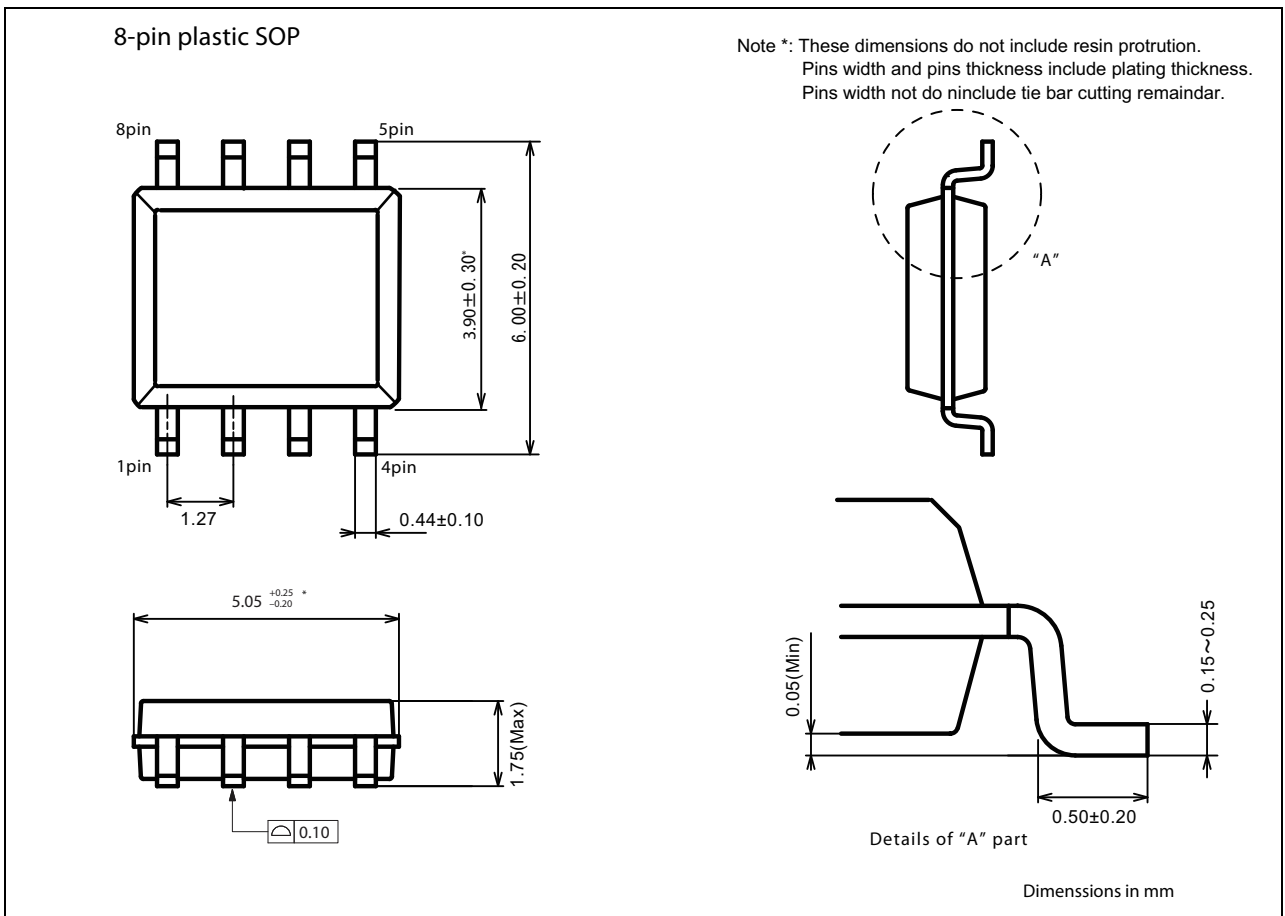
\*1 : Please contact our sales office about minimum shipping quantity.

# MB85RS1MT

## ■ PACKAGE DIMENSION

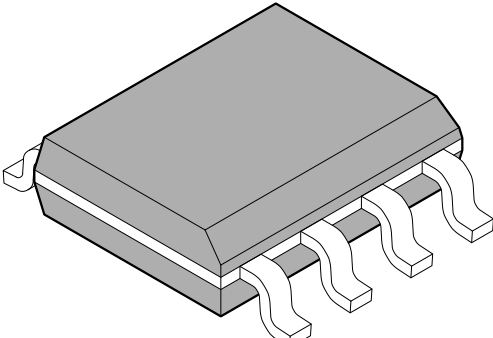
(1) MB85RS1MTPNF-G-JNE1/MB85RS1MTPNF-G-JNERE1

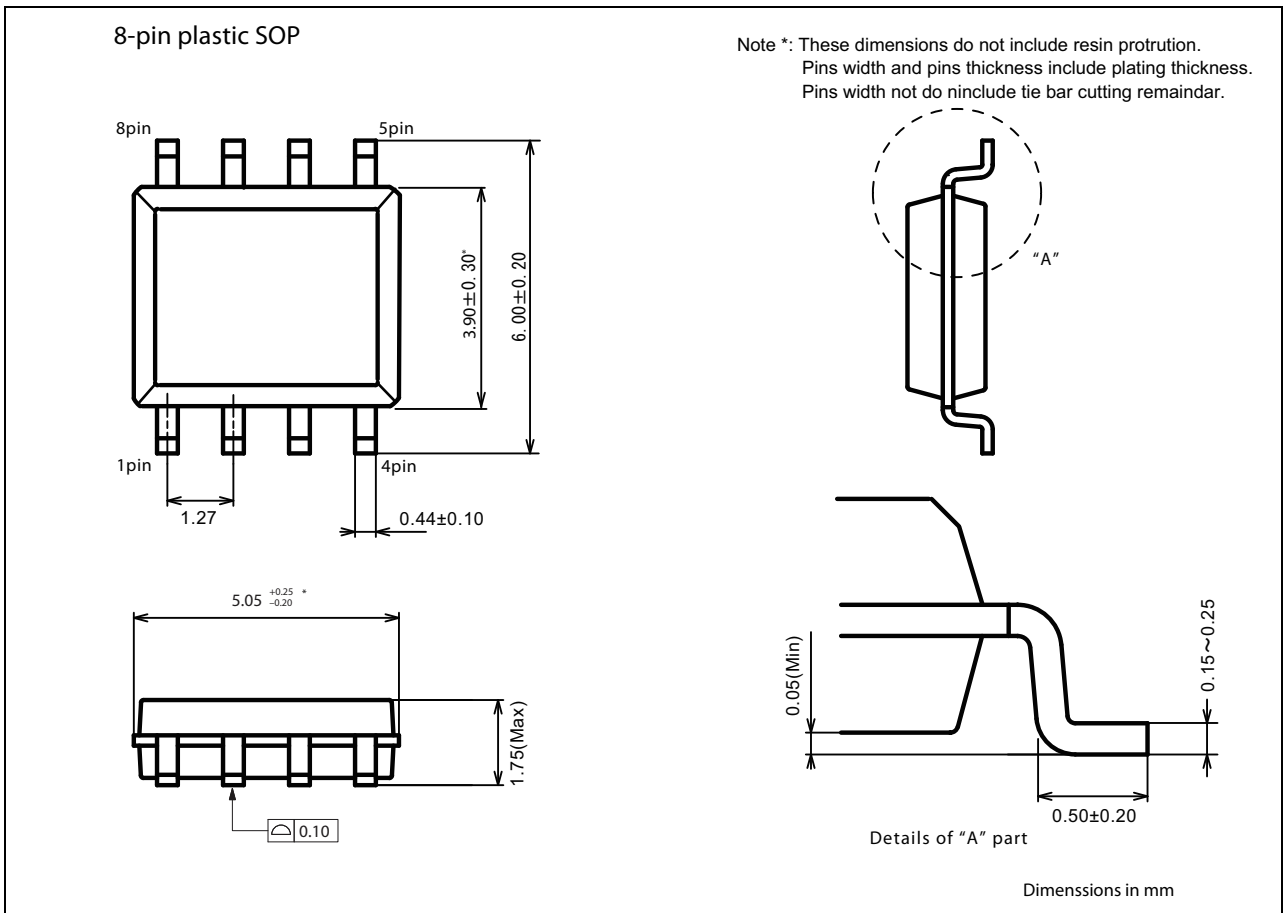
|   |                                |                   |  |
|---|--------------------------------|-------------------|--|
| <p>8-pin plastic SOP</p>  <p>MB85RS1MTPNF-G-JNE1<br/>MB85RS1MTPNF-G-JNERE1</p> | Lead pitch                     | 1.27 mm           |  |
|   | Package width × package length | 3.90 mm × 5.05 mm |  |
|   | Lead shape                     | Gullwing          |  |
|   | Sealing method                 | Plastic mold      |  |
|   | Mounting height                | 1.75 mm MAX       |  |
|   |                                |                   |  |
|   |                                |                   |  |



(Continued)

## (2)MB85RS1MTPNF-G-AWE2/MB85RS1MTPNF-G-AWERE2

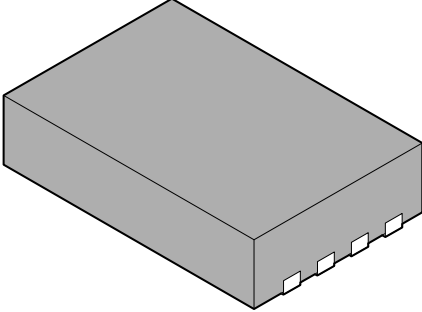
|   |                                |                   |  |
|---|--------------------------------|-------------------|--|
| <p style="text-align: center;">8-pin plastic SOP</p>  <p>MB85RS1MTPNF-G-AWE2<br/>MB85RS1MTPNF-G-AWERE2</p> | Lead pitch                     | 1.27 mm           |  |
|   | Package width × package length | 3.90 mm × 5.05 mm |  |
|   | Lead shape                     | Gullwing          |  |
|   | Sealing method                 | Plastic mold      |  |
|   | Mounting height                | 1.75 mm MAX       |  |
|   |                                |                   |  |
|   |                                |                   |  |

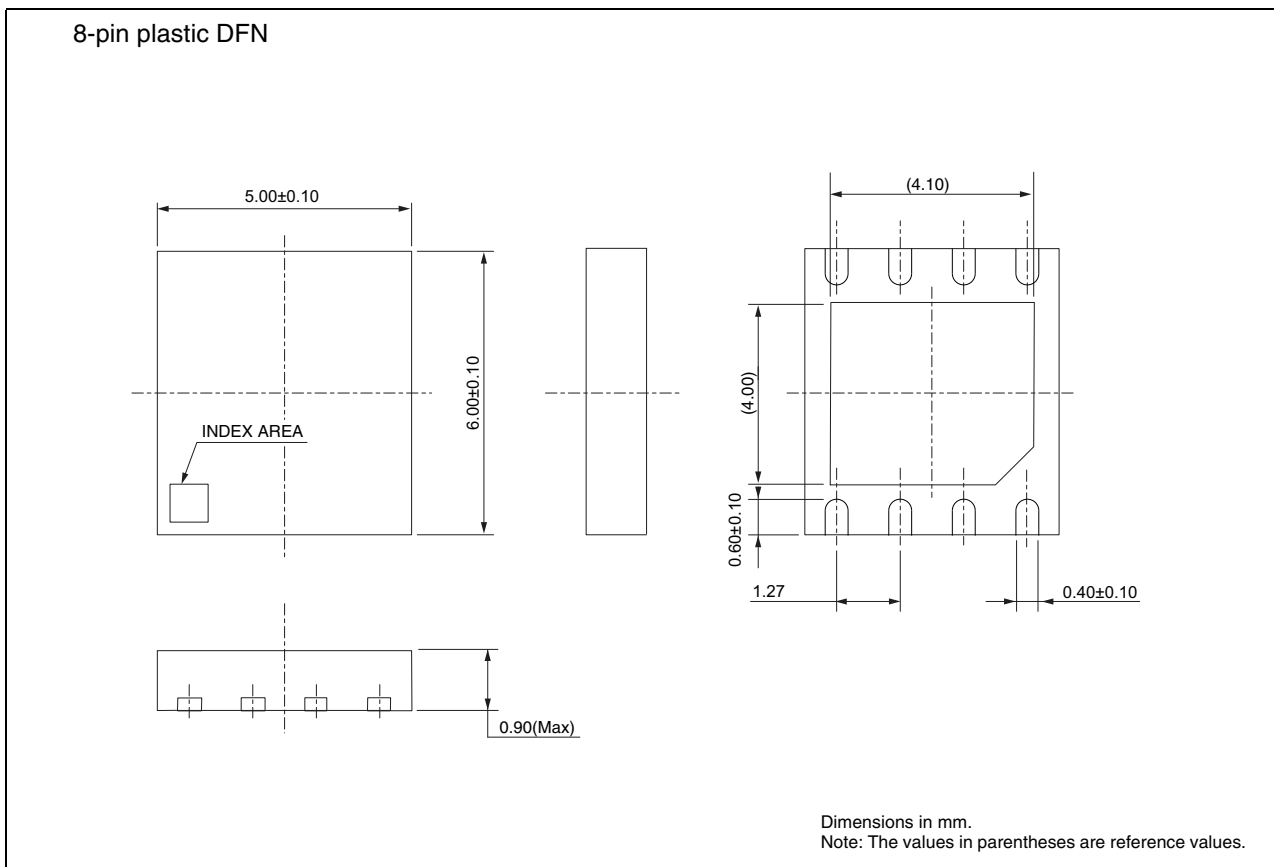


# MB85RS1MT

(Continued)

## (3)MB85RS1MTPN-G-AWEWE1

|  |                                |                 |
|--|--------------------------------|-----------------|
| <p>8-pin plastic DFN</p>  | Lead pitch                     | 1.27 mm         |
|  | Package width × package length | 5.0 mm × 6.0 mm |
|  | Sealing method                 | Plastic mold    |
|  | Mounting height                | 0.9 mm MAX      |
|  |                                |                 |
| MB85RS1MTPN-G-AWEWE1   |                                |                 |



## ■ MARKING (Example)

[MB85RS1MTPNF-G-JNE1]  
[MB85RS1MTPNF-G-JNERE1]

The diagram shows a square marking area with a double border. Inside, the text is arranged as follows: 'RS1MT' on the top line, 'E11900' on the second line, and '300' on the third line. A solid black dot is positioned to the left of the '300'.

[8-pin plastic SOP 150mil]

RS1MT: Product name  
E11900: E1(Environmental code) + 1900(Year and Week code)  
300: Trace code

[MB85RS1MTPNF-G-AWE2]  
[MB85RS1MTPNF-G-AWERE2]

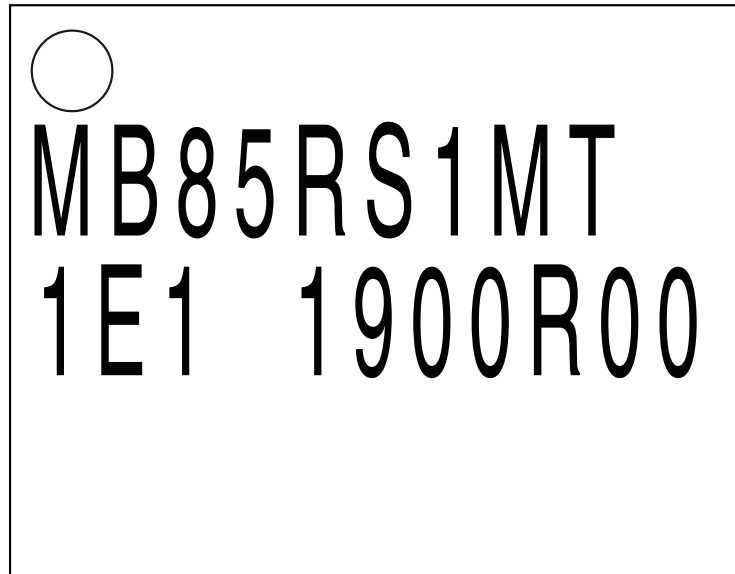
The diagram shows a square marking area with a double border. Inside, the text is arranged as follows: 'RS1MT' on the top line, '11900' on the second line, and 'R00' on the third line. An empty circle is positioned to the left of the 'R00'.

[8-pin plastic SOP 150mil]

RS1MT: Product name  
11900: 1(CS code) + 1900(Year and Week code)  
R00: Trace code

# MB85RS1MT

[MB85RS1MTPN-G-AWEWE1]



[8-pin plastic DFN 5mm × 6mm]

MB85RS1MT: Product name  
1E1: 1(CS code) + E1(Environmental code)  
1900R00: 1900(Year and Week code) + R00(Trace code)



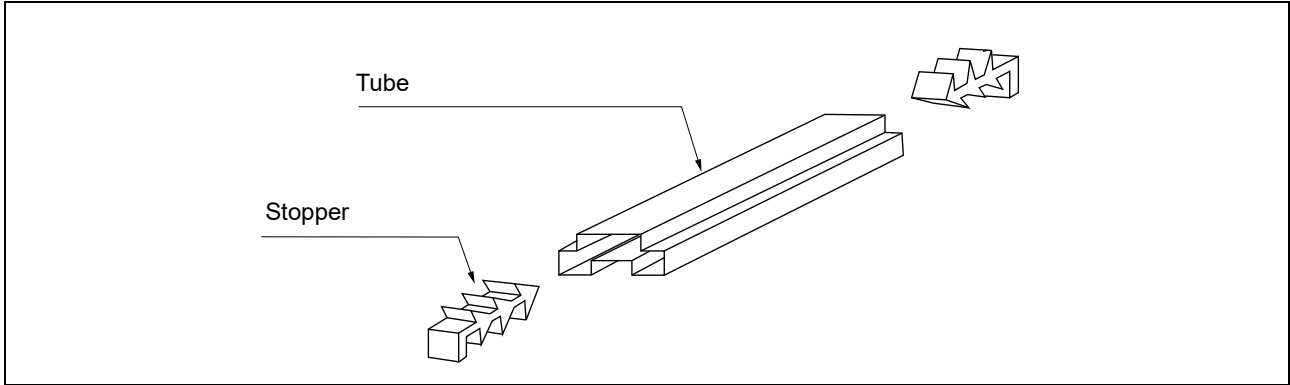
## ■ PACKING INFORMATION

(1)MB85RS1MTPNF-G-JNE1/MB85RS1MTPNF-G-JNERE1

### 1. Tube (MB85RS1MTPNF-G-JNE1)

#### 1.1 Tube Dimensions

- Tube/stopper shape (example)



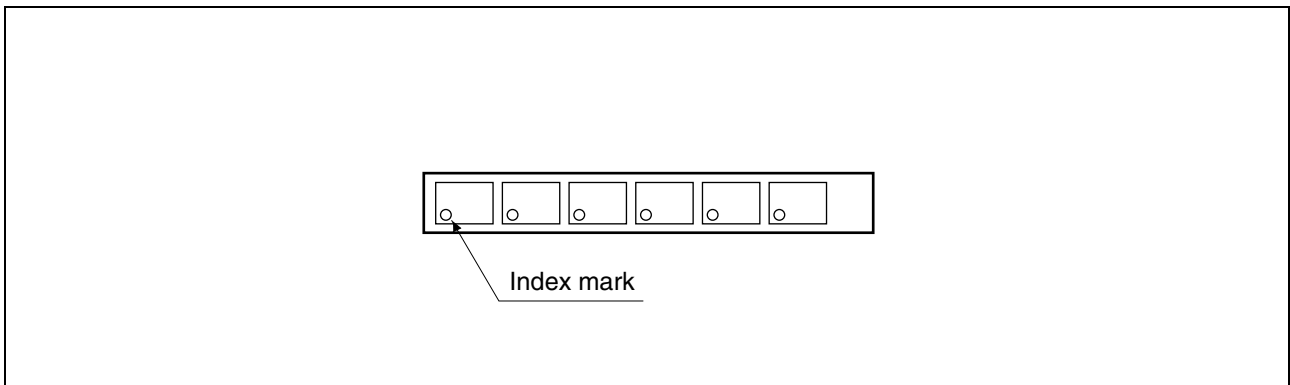
- Tube cross-sections and Maximum quantity

| Maximum quantity |               |               |
|------------------|---------------|---------------|
| ICs/tube(509mm)  | ICs/inner box | ICs/outer box |
| 95               | 7,600         | 30,400        |

No heat resistance.  
Package should not be baked by using tube.

(Dimensions in mm)

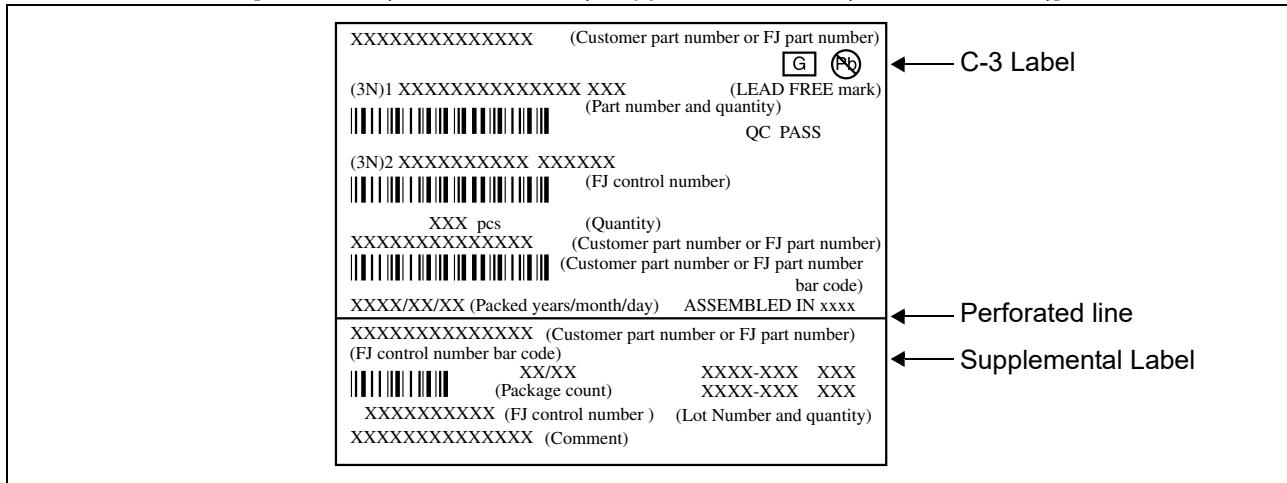
- Direction of index in tube



# MB85RS1MT

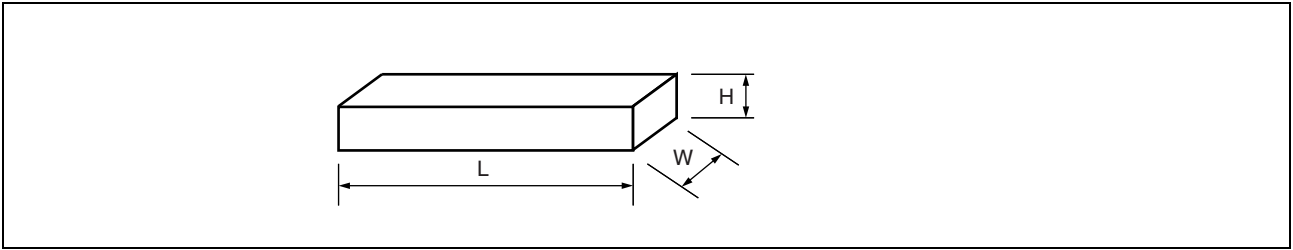
## 1.2 Product label indicators

Label I: Label on Inner box/Moisture Barrier Bag/ (It sticks it on the reel for the emboss taping)  
 [C-3 Label (50mm × 100mm) Supplemental Label (20mm × 100mm)]



## 1.3 Dimensions for Containers

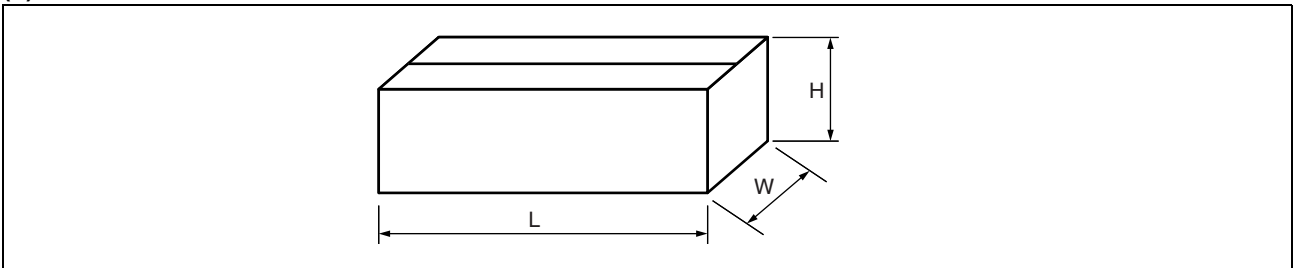
### (1) Dimensions for inner box



| L   | W   | H  |
|-----|-----|----|
| 540 | 125 | 75 |

(Dimensions in mm)

### (2) Dimensions for outer box



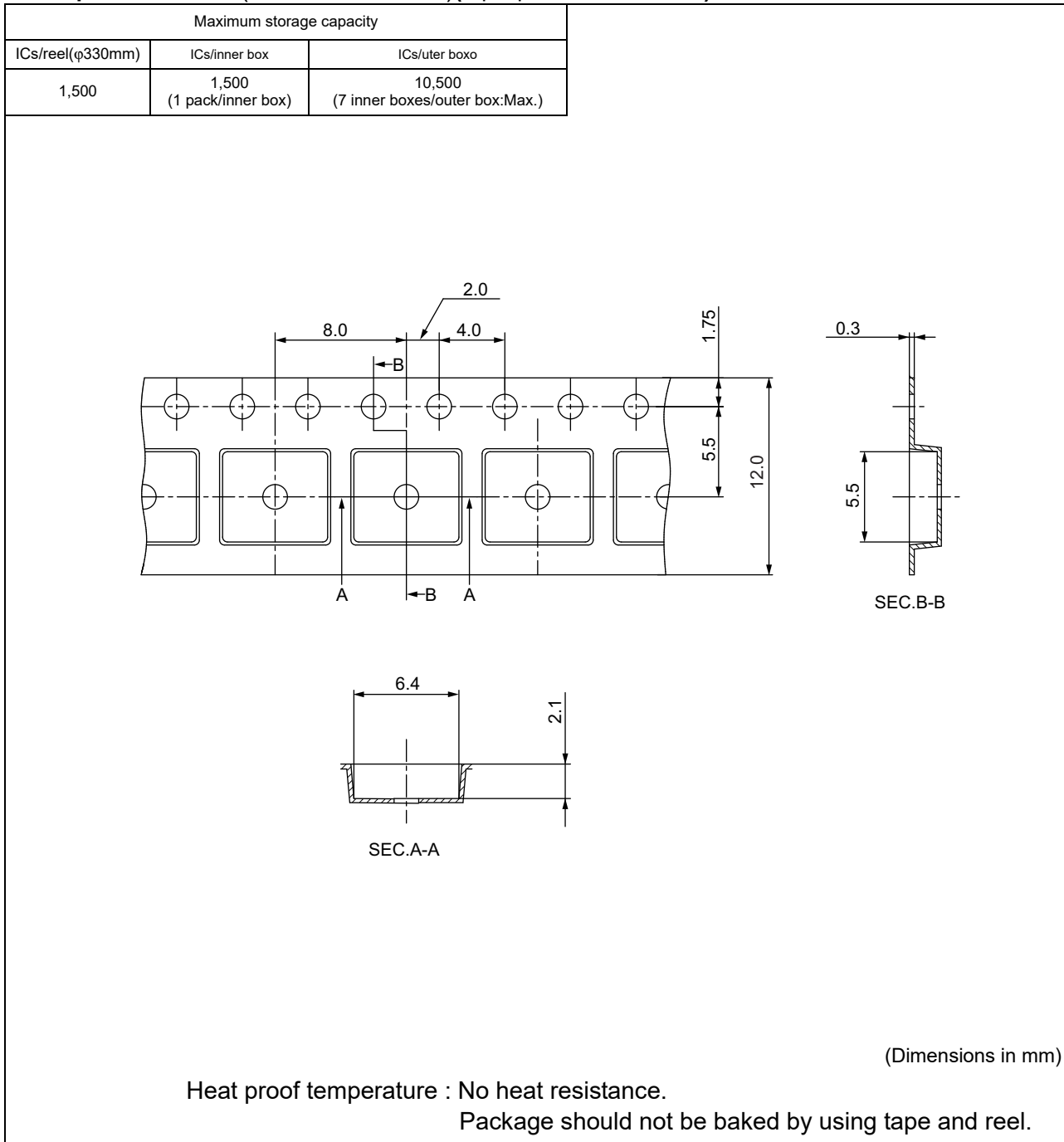
| L   | W   | H   |
|-----|-----|-----|
| 565 | 270 | 180 |

(Dimensions in mm)

# MB85RS1MT

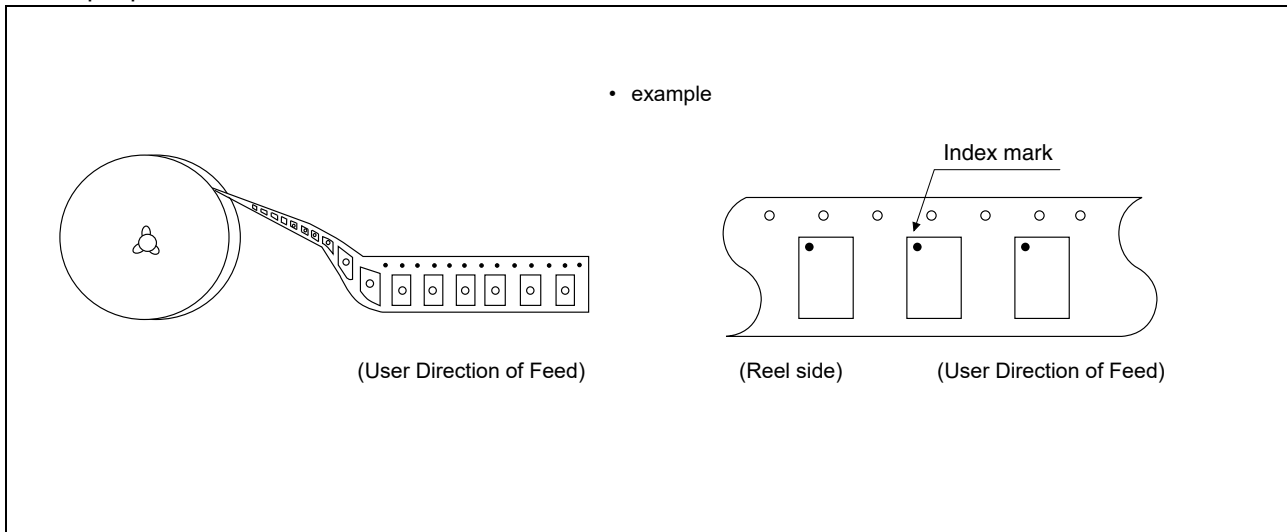
## 2. Emboss Tape (MB85RS1MTPNF-G-JNERE1)

### 2.1 Tape Dimensions (not drawn to scale)(8-pin plastic SOP 150mil)

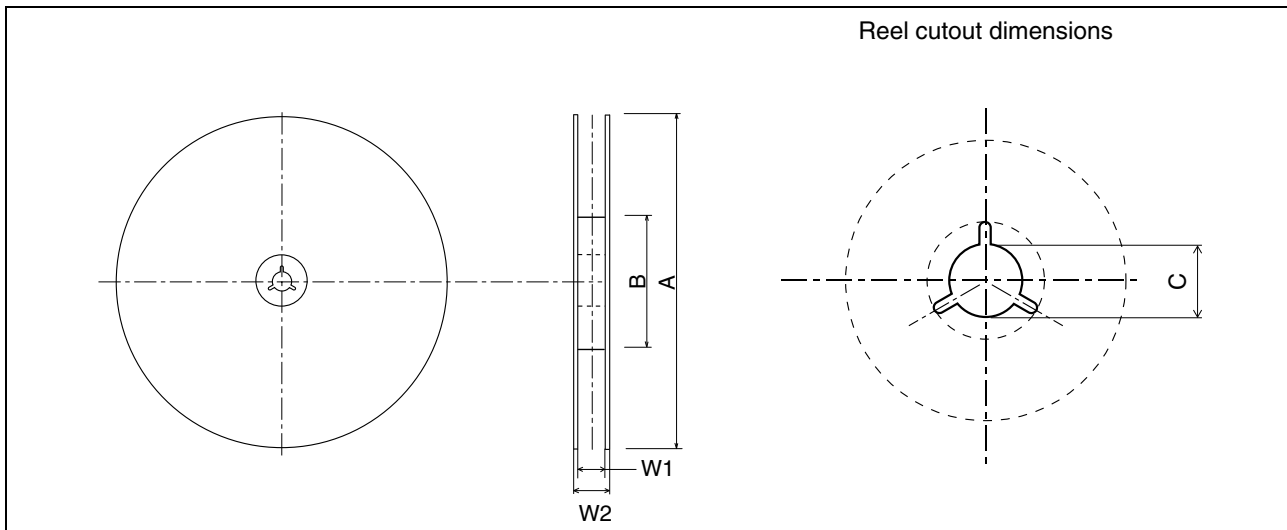


## 2.2 IC orientation

8-pin plastic SOP 150mil



## 2.3 Reel dimensions







Dimensions in mm

| A   | B   | C  | W1   | W2   |
|-----|-----|----|------|------|
| 330 | 100 | 13 | 12.4 | 18.4 |

# MB85RS1MT

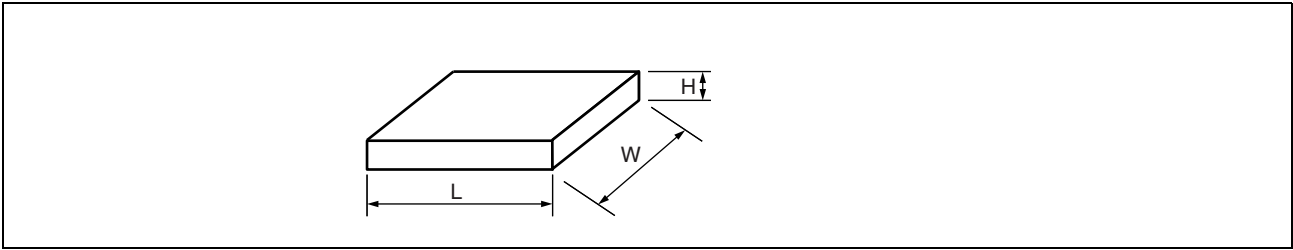
## 2.4 Product label indicators (example)

Label I: Label on Inner box/Moisture Barrier Bag/ (It sticks it on the reel for the emboss taping)  
 [C-3 Label (50mm × 100mm) Supplemental Label (20mm × 100mm)]

|   |  |
|---|--|
| XXXXXXXXXXXXXXXX (Customer part number or FJ part number)<br>(3N)1 XXXXXXXXXXXXXXXX XXX (LEAD FREE mark)<br> (Part number and quantity)<br>QC PASS<br>(3N)2 XXXXXXXXXXXXXXXX XXXXXXX<br> (FJ control number)<br>XXX pcs (Quantity)<br>XXXXXXXXXXXXXXXX (Customer part number or FJ part number)<br> (Customer part number or FJ part number bar code)<br>XXXX/XX/XX (Packed years/month/day) ASSEMBLED IN xxxx | ← C-3 Label<br><br><br><br><br><br><br><br><br><br>← Perforated line<br><br>← Supplemental Label |
| XXXXXXXXXXXXXXXX (Customer part number or FJ part number)<br>(FJ control number bar code)<br> XX/XX (Package count) XXXX-XXX XXX<br>XXXXXXXXXXXXXXXX (FJ control number) XXXX-XXX XXX<br>XXXXXXXXXXXXXXXX (Lot Number and quantity)<br>XXXXXXXXXXXXXXXX (Comment)  |  |

## 2.5 Dimensions for Containers

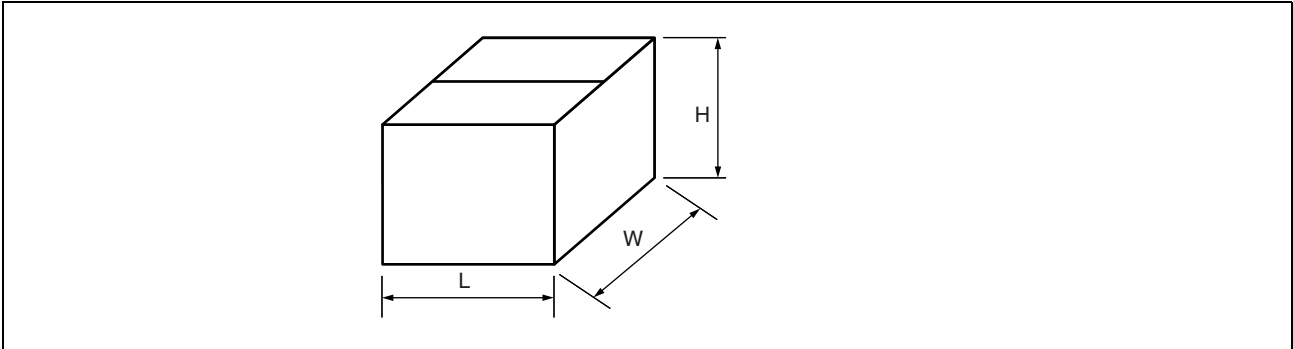
### (1) Dimensions for inner box



| Tape width | L   | W   | H  |
|------------|-----|-----|----|
| 12         | 365 | 345 | 40 |

(Dimensions in mm)

### (2) Dimensions for outer box



| L   | W   | H   |
|-----|-----|-----|
| 415 | 400 | 315 |

(Dimensions in mm)

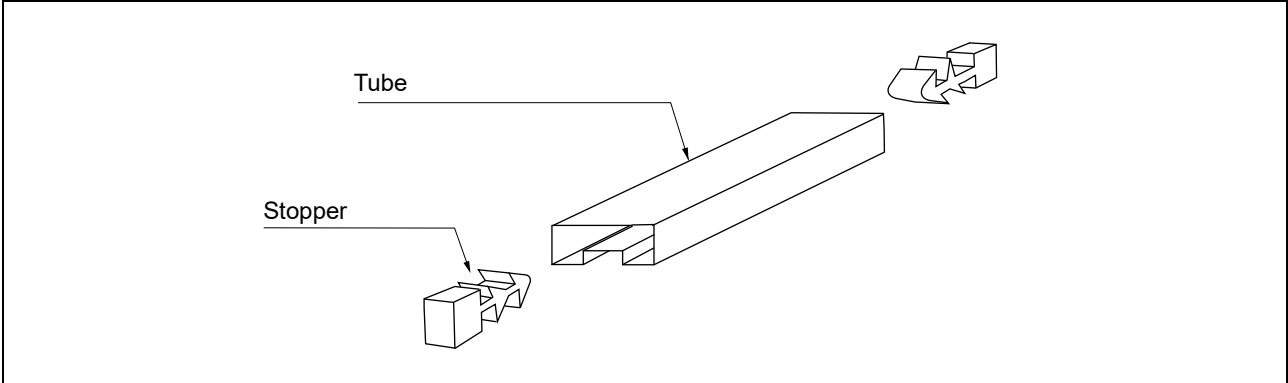
# MB85RS1MT

(2)MB85RS1MTPNF-G-AWE2/MB85RS1MTPNF-G-AWERE2

## 1. Tube (MB85RS1MTPNF-G-AWE2)

### 1.1 Tube Dimensions

- Tube/stopper shape (example)



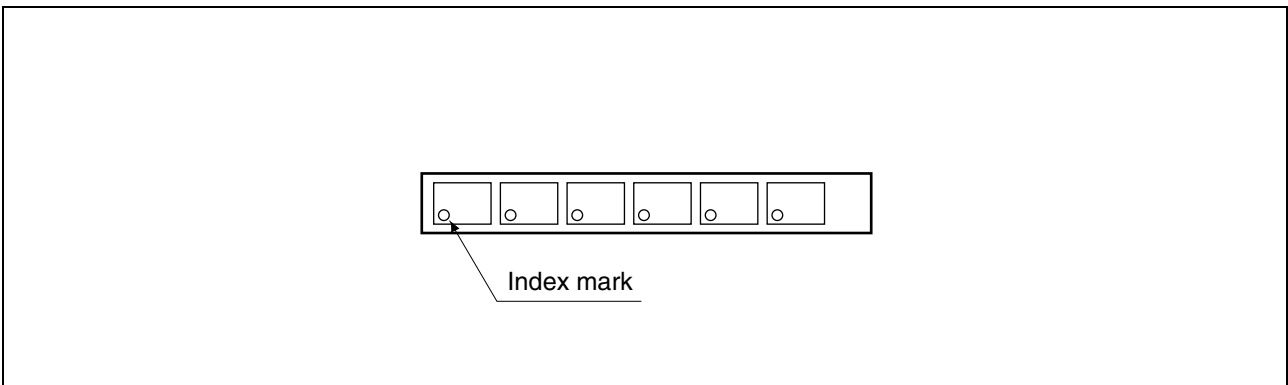
- Tube cross-sections and Maximum quantity

| Maximum quantity |               |               |
|------------------|---------------|---------------|
| ICs/tube(509mm)  | ICs/inner box | ICs/outer box |
| 85               | 2,450         | 25,500        |

No heat resistance.  
Package should not be baked by using tube.

(Dimensions in mm)

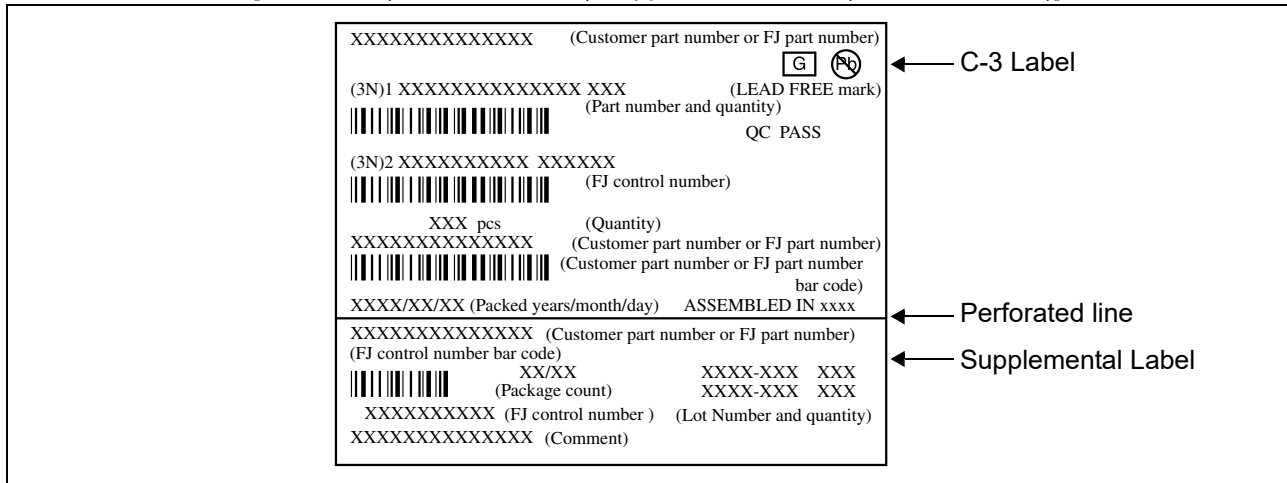
- Direction of index in tube





## 1.2 Product label indicators

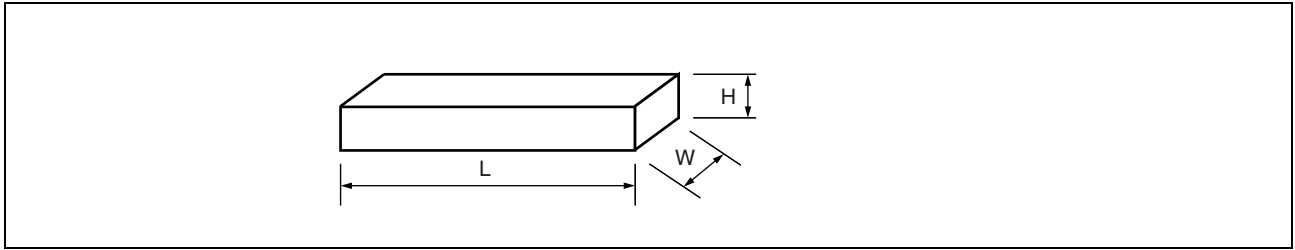
Label I: Label on Inner box/Moisture Barrier Bag/ (It sticks it on the reel for the emboss taping)  
 [C-3 Label (50mm × 100mm) Supplemental Label (20mm × 100mm)]



# MB85RS1MT

## 1.3 Dimensions for Containers

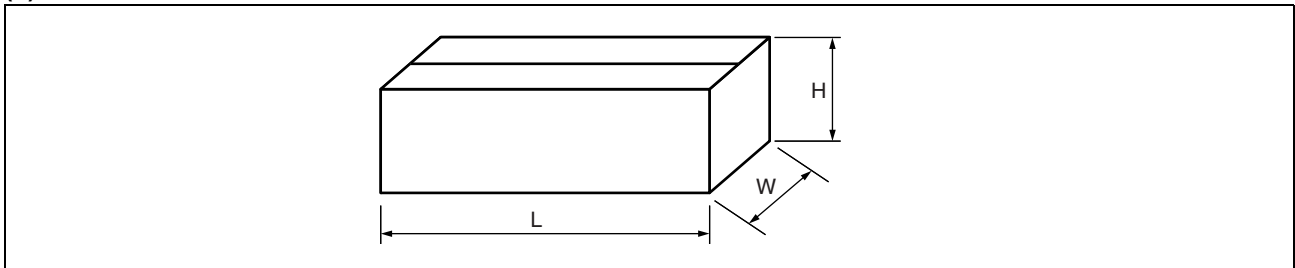
### (1) Dimensions for inner box



| L   | W   | H  |
|-----|-----|----|
| 549 | 125 | 81 |

(Dimensions in mm)

### (2) Dimensions for outer box



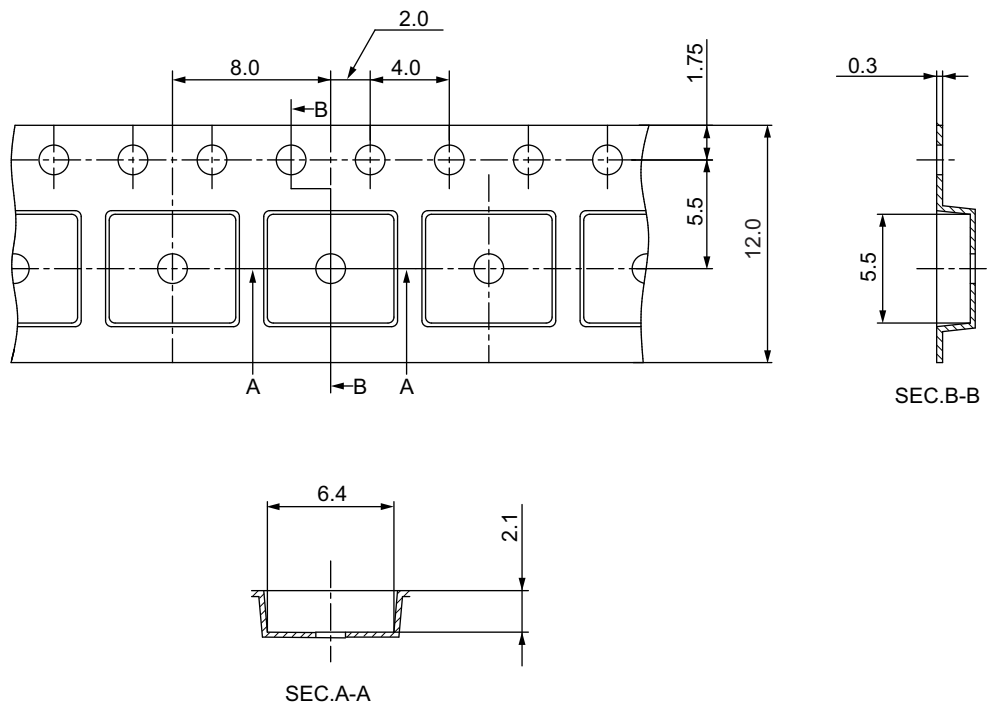
| L   | W   | H   |
|-----|-----|-----|
| 567 | 272 | 269 |

(Dimensions in mm)

## 2. Emboss Tape (MB85RS1MTPNF-G-AWERE2)

### 2.1 Tape Dimensions (not drawn to scale)(8-pin plastic SOP 150mil)

| Maximum storage capacity |                             |   |
|--------------------------|-----------------------------|---|
| ICs/reel(φ330mm)         | ICs/inner box               | ICs/uter boxo                           |
| 1,500                    | 1,500<br>(1 pack/inner box) | 9,000<br>(6 inner boxes/outer box:Max.) |



(Dimensions in mm)

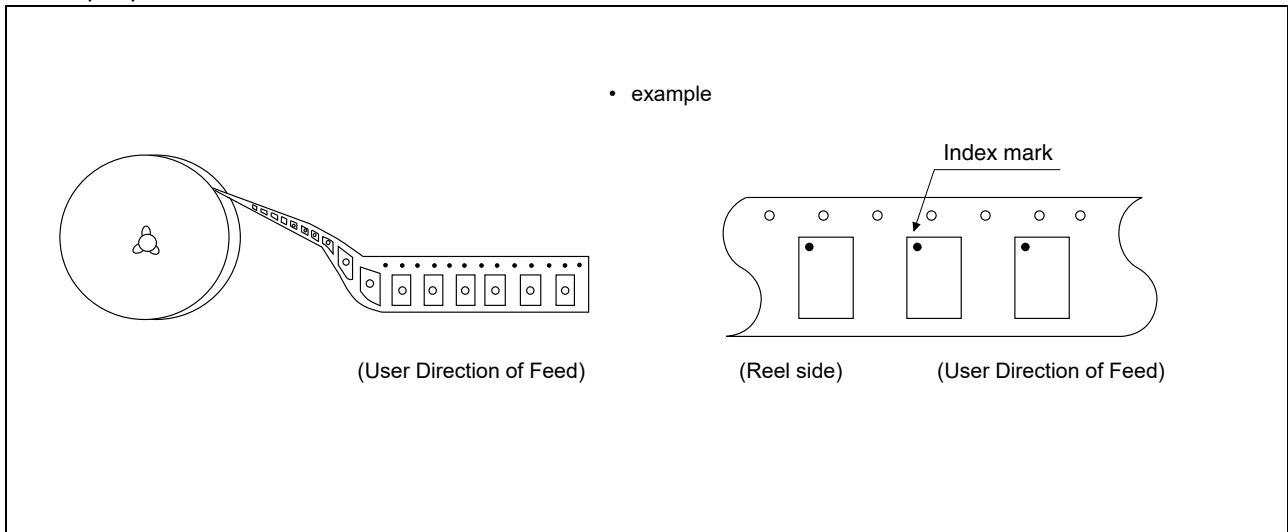
Heat proof temperature : No heat resistance.

Package should not be baked by using tape and reel.

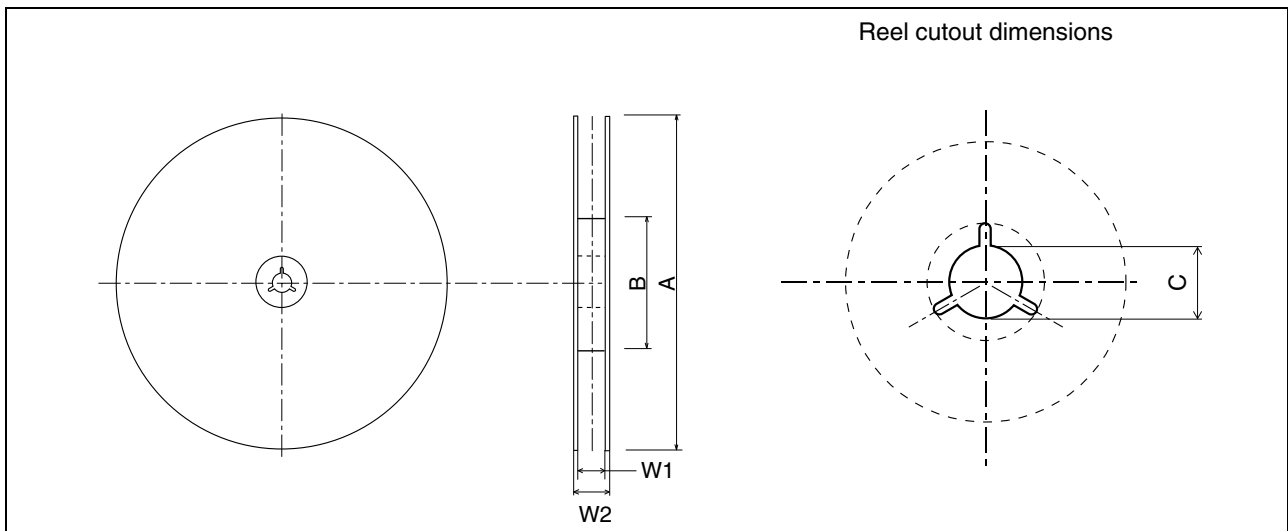
# MB85RS1MT

## 2.2 IC orientation

8-pin plastic SOP 150mil



## 2.3 Reel dimensions



Dimensions in mm

| A   | B   | C  | W1   | W2   |
|-----|-----|----|------|------|
| 330 | 100 | 13 | 13.5 | 17.5 |

## 2.4 Product label indicators (example)

Label I: Label on Inner box/Moisture Barrier Bag/ (It sticks it on the reel for the emboss tapping)  
 [C-3 Label (50mm × 100mm) Supplemental Label (20mm × 100mm)]

|   |              |                      |
|---|--------------|----------------------|
| XXXXXXXXXXXXXXXXX (Customer part number or FJ part number)                |              | ← C-3 Label          |
| (3N)1 XXXXXXXXXXXXXXXX XXX (LEAD FREE mark)<br>(Part number and quantity) | QC PASS      |                      |
| (3N)2 XXXXXXXXXXXXXXXX XXXXXX (FJ control number)                         |              |                      |
| XXX pcs (Quantity)  |              |                      |
| XXXXXXXXXXXXXXXXX (Customer part number or FJ part number)                |              |                      |
| XXXXXXXXXXXXXXXXX (Customer part number or FJ part number bar code)       |              | ← Perforated line    |
| XXXX/XX/XX (Packed years/month/day) ASSEMBLED IN xxxx                     |              | ← Supplemental Label |
| XXXXXXXXXXXXXXXXX (Customer part number or FJ part number)                |              |                      |
| (FJ control number bar code)  |              |                      |
| XX/XX (Package count)   | XXXX-XXX XXX |                      |
| XXXXXXXXXXXXX (FJ control number)   | XXXX-XXX XXX |                      |
| XXXXXXXXXXXXXXXXX (Comment)   |              |                      |

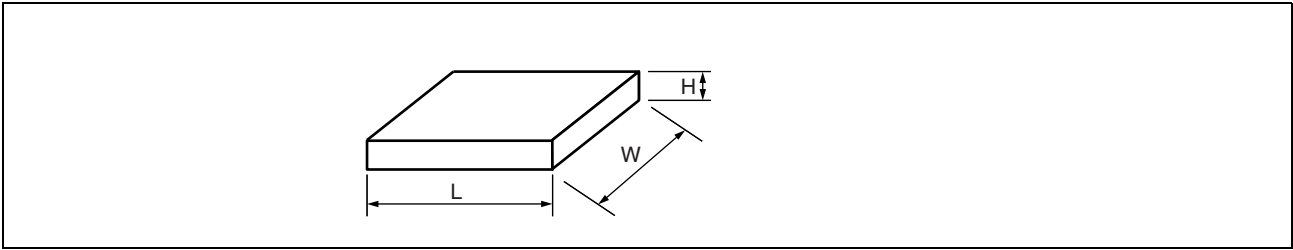
Label II: Moisture Barrier Bag (It sticks it on the Aluminum laminated bag)  
 [MSL Label (100mm × 70mm)]

|  |                              |             |
|--|------------------------------|-------------|
| <p>MOISTURE-SENSITIVE DEVICES</p> <p><b>注意</b></p> <ol style="list-style-type: none"> <li>ドライバック包装の保管期限は、24ヶ月（25℃/80%RH未満）です。</li> <li>本製品の耐熱温度は、<u>260℃</u> です。</li> <li>袋開封後は、下記a) b)条件下で、ご使用ください。                     <ol style="list-style-type: none"> <li><u>168</u> 時間以内 (30℃/60%RH以下)</li> <li>J-STD-033条件</li> </ol> </li> <li>以下の条件の場合は、実装前にバークしてください。                     <ol style="list-style-type: none"> <li>23±5℃の環境下でインジケータカードの10%を超えた場合</li> <li>3a、3bの条件に合致しない場合</li> </ol> </li> <li>バークが必要な場合はIPC/JEDEC J-STD-033 参照してください。</li> </ol> <p><b>CAUTION</b></p> <ol style="list-style-type: none"> <li>Calculated shelf life in sealed bag: 24 months at &lt;25℃ / 80% RH</li> <li>Peak package body temperature: <u>260℃</u></li> <li>After bag is opened, devices that will be subjected to reflow solder or other high temperature process must                     <ol style="list-style-type: none"> <li>Mounted within: <u>168</u> hours of factory conditions ≤30℃/60%RH</li> <li>Stored per J-STD-033</li> </ol> </li> <li>Devices require bake, before mounting, if:                     <ol style="list-style-type: none"> <li>Humidity Indicator Card is &gt; 10% when read at 23±5℃</li> <li>3a or 3b not met.</li> </ol> </li> <li>If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure.</li> </ol> | <p>LEVEL</p> <p><b>3</b></p> | ← MSL label |
| <p>包装日：品名ラベルをご確認下さい<br/>                 Bag Seal Date: See adjacent bar code label</p> <p>* F 0 0 0 1 *</p> <p>Note: Level and body temperature defined by IPC/JEDEC J-STD-020</p>  |                              |             |

# MB85RS1MT

## 2.5 Dimensions for Containers

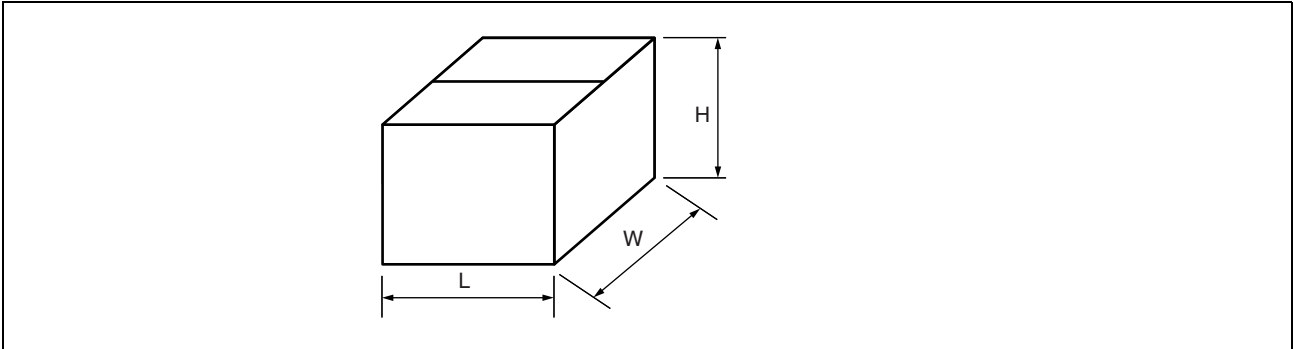
### (1) Dimensions for inner box



| Tape width | L   | W   | H  |
|------------|-----|-----|----|
| 12         | 350 | 335 | 35 |

(Dimensions in mm)

### (2) Dimensions for outer box



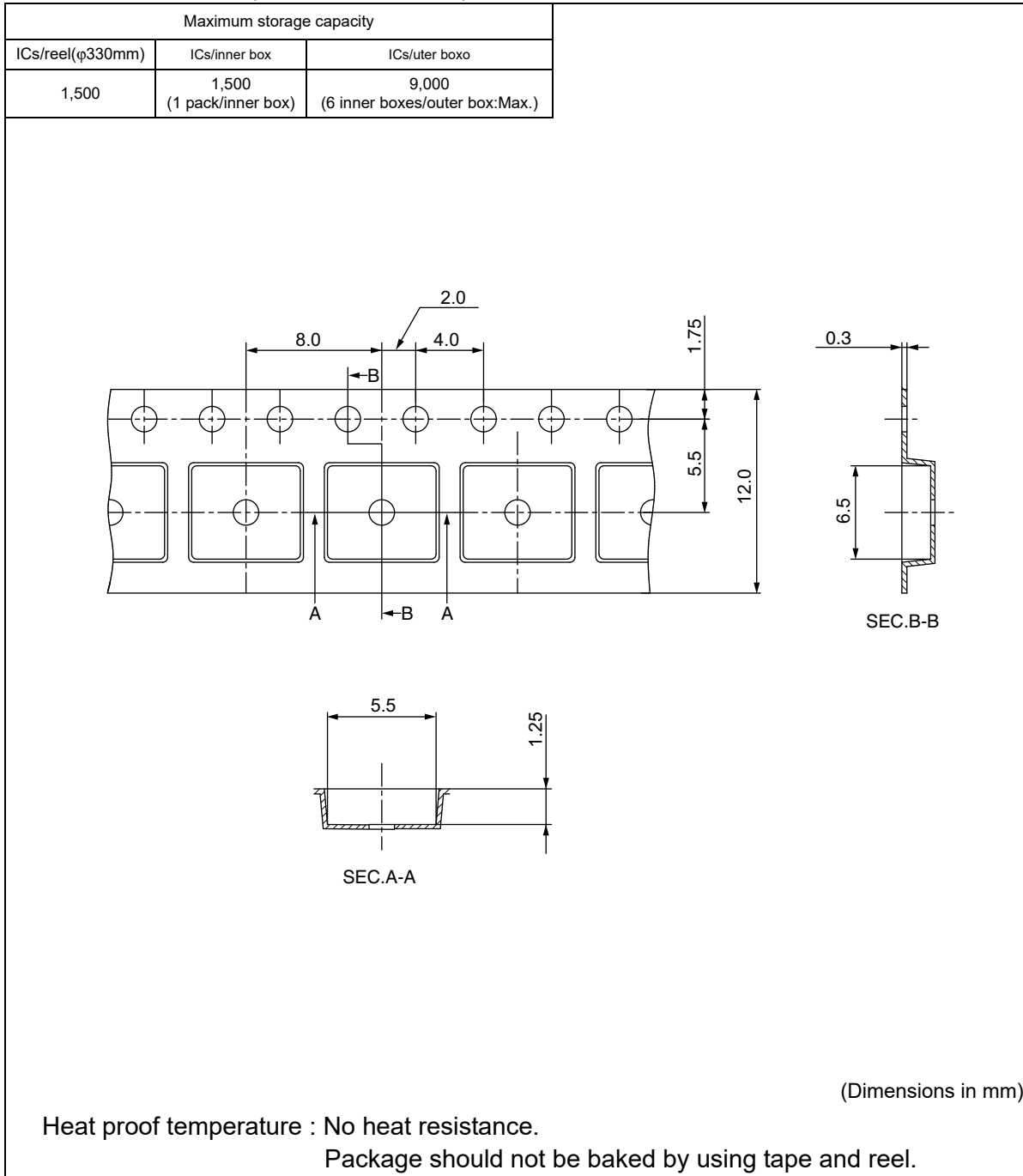
| L   | W   | H   |
|-----|-----|-----|
| 384 | 368 | 225 |

(Dimensions in mm)

## (3)MB85RS1MTPN-G-AWEWE1

### 1. Emboss Tape

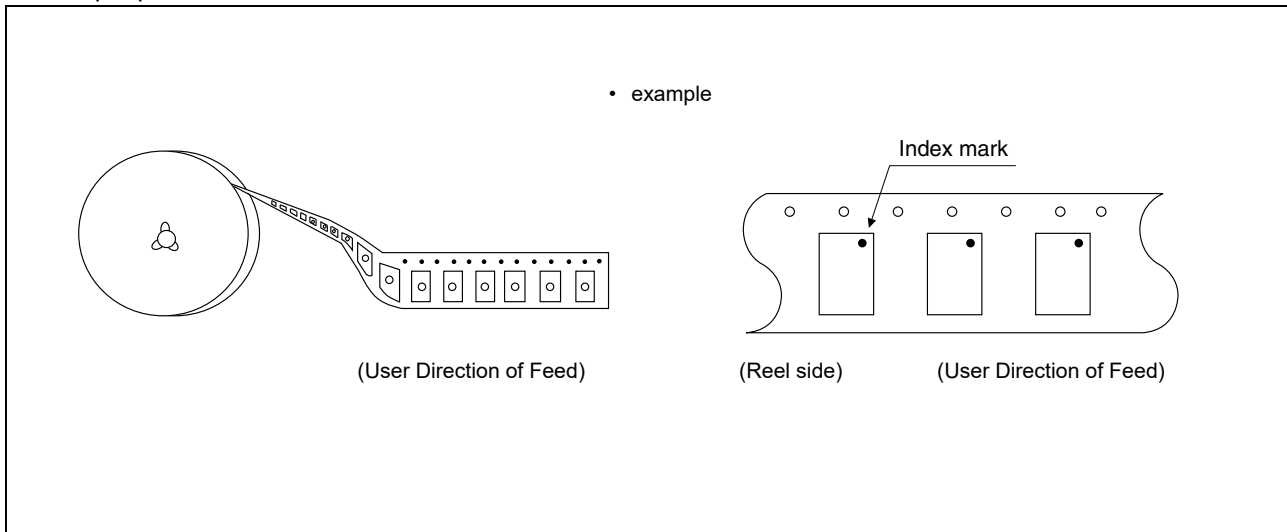
#### 1.1 Tape Dimensions (not drawn to scale)(8-pin plastic DFN 5mm × 6mm)



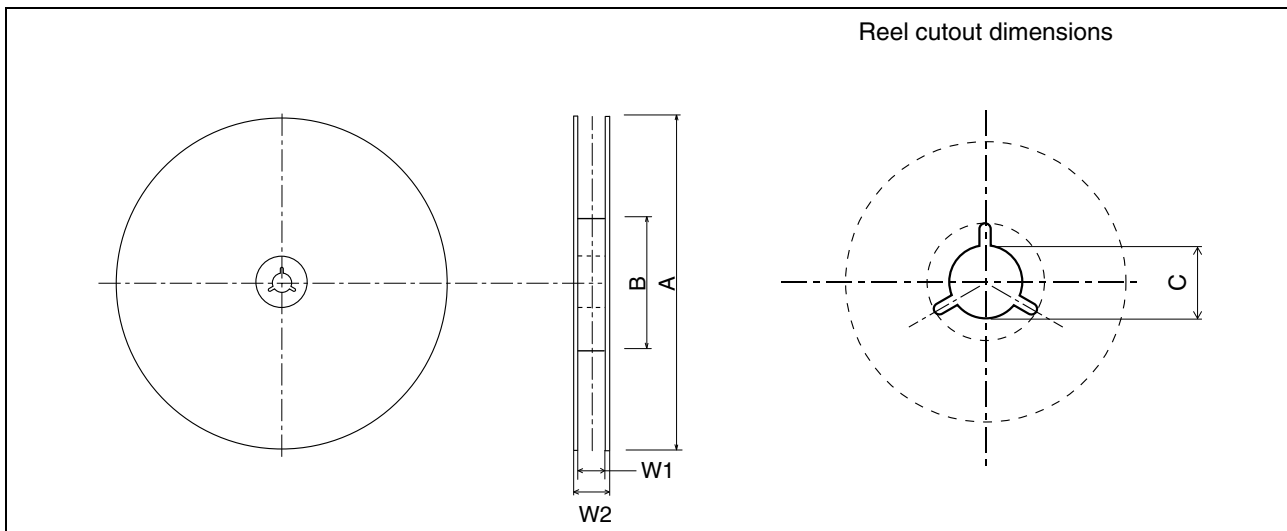
# MB85RS1MT

## 1.2 IC orientation

8-pin plastic DFN 5mm × 6mm



## 1.3 Reel dimensions



Dimensions in mm

|      | A   | B   | C  | W1   | W2   |
|------|-----|-----|----|------|------|
| DFN8 | 330 | 100 | 13 | 13.5 | 17.5 |



## 1.4 Product label indicators (example)

Label I: Label on Inner box/Moisture Barrier Bag/ (It sticks it on the reel for the emboss tapping)  
 [C-3 Label (50mm × 100mm) Supplemental Label (20mm × 100mm)]

|   |              |                      |
|---|--------------|----------------------|
| XXXXXXXXXXXXXXXXX (Customer part number or FJ part number)                |              | ← C-3 Label          |
| (3N)1 XXXXXXXXXXXXXXXX XXX (LEAD FREE mark)<br>(Part number and quantity) | QC PASS      |                      |
| (3N)2 XXXXXXXXXXXXXXXX XXXXXX (FJ control number)                         |              |                      |
| XXX pcs (Quantity)  |              |                      |
| XXXXXXXXXXXXXXXXX (Customer part number or FJ part number)                |              |                      |
| XXXXXXXXXXXXXXXXX (Customer part number or FJ part number bar code)       |              | ← Perforated line    |
| XXXX/XX/XX (Packed years/month/day) ASSEMBLED IN xxxx                     |              | ← Supplemental Label |
| XXXXXXXXXXXXXXXXX (Customer part number or FJ part number)                |              |                      |
| (FJ control number bar code)  |              |                      |
| XX/XX (Package count)   | XXXX-XXX XXX |                      |
| XXXXXXXXXXXXX (FJ control number)   | XXXX-XXX XXX |                      |
| XXXXXXXXXXXXXXXXX (Comment)   |              |                      |

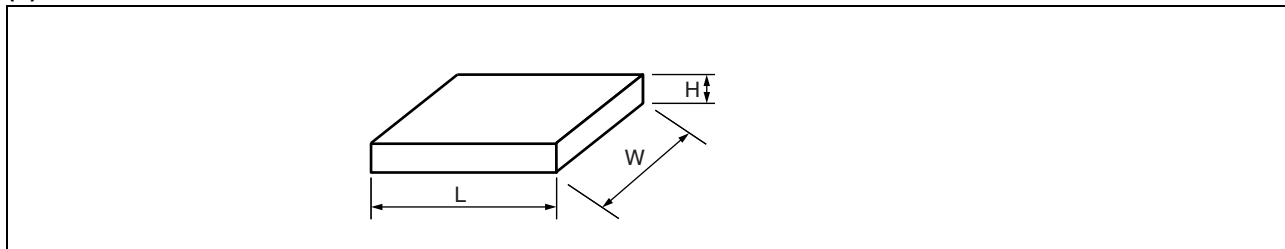
Label II: Moisture Barrier Bag (It sticks it on the Aluminum laminated bag)  
 [MSL Label (100mm × 70mm)]

|  |                              |             |
|--|------------------------------|-------------|
| <p>MOISTURE-SENSITIVE DEVICES</p> <p><b>注意</b></p> <ol style="list-style-type: none"> <li>ドライバック包装の保管期限は、24ヶ月（25℃/80%RH未満）です。</li> <li>本製品の耐熱温度は、<u>260℃</u> です。</li> <li>袋開封後は、下記a) b)条件下で、ご使用ください。             <ol style="list-style-type: none"> <li><u>168</u> 時間以内 (30℃/60%RH以下)</li> <li>J-STD-033条件</li> </ol> </li> <li>以下の条件の場合は、実装前にバークしてください。             <ol style="list-style-type: none"> <li>23±5℃の環境下でインジケータカードの10%を超えた場合</li> <li>3a、3bの条件に合致しない場合</li> </ol> </li> <li>バークが必要な場合はIPC/JEDEC J-STD-033 参照してください。</li> </ol> <p><b>CAUTION</b></p> <ol style="list-style-type: none"> <li>Calculated shelf life in sealed bag: 24 months at &lt;25℃ / 80% RH</li> <li>Peak package body temperature: <u>260℃</u></li> <li>After bag is opened, devices that will be subjected to reflow solder or other high temperature process must             <ol style="list-style-type: none"> <li>Mounted within: <u>168</u> hours of factory conditions ≤30℃/60%RH</li> <li>Stored per J-STD-033</li> </ol> </li> <li>Devices require bake, before mounting, if:             <ol style="list-style-type: none"> <li>Humidity Indicator Card is &gt; 10% when read at 23±5℃</li> <li>3a or 3b not met.</li> </ol> </li> <li>If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure.</li> </ol> | <p>LEVEL</p> <p><b>3</b></p> | ← MSL label |
| <p>包装日：品名ラベルをご確認下さい<br/>                 Bag Seal Date: See adjacent bar code label</p> <p>* F 0 0 0 1 *</p> <p>Note: Level and body temperature defined by IPC/JEDEC J-STD-020</p>  |                              |             |

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## 1.5 Dimensions for Containers

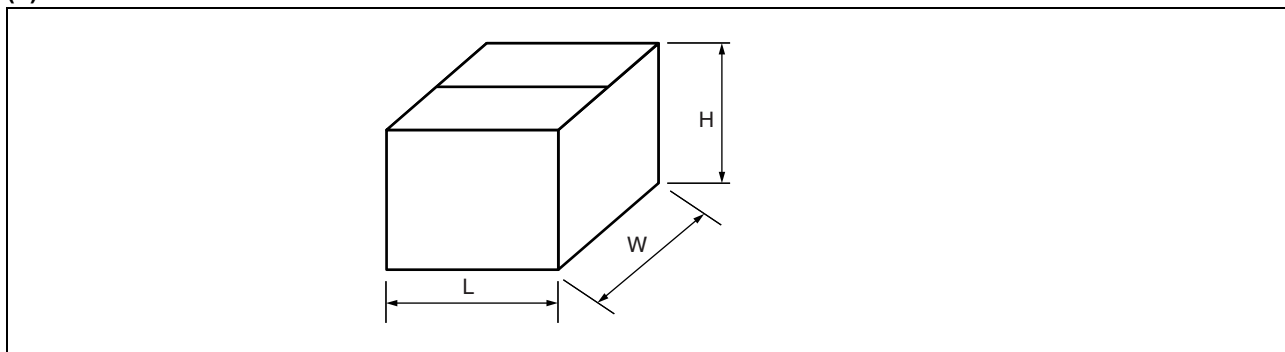
### (1) Dimensions for inner box



|      | Tape width | L   | W   | H  |
|------|------------|-----|-----|----|
| DFN8 | 12         | 350 | 335 | 35 |

(Dimensions in mm)

### (2) Dimensions for outer box



|      | L   | W   | H   |
|------|-----|-----|-----|
| DFN8 | 384 | 368 | 225 |

(Dimensions in mm)

## ■ MAJOR CHANGES IN THIS EDITION

A change on a page is indicated by a vertical line drawn on the left side of that page.

| Page | Section | Change Results  |
|------|---------|---|
| —    | Overall | Following technical word is revised to more commonly used one.<br>FRAM to FeRAM |

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