
MR44V064B

64k(8,192-Word × 8-Bit) FeRAM (Ferroelectric Random Access Memory) I2C

GENERAL DESCRIPTION

The MR44V064B is a nonvolatile 8,192-word x 8-bit ferroelectric random access memory (FeRAM) developed in the ferroelectric process and silicon-gate CMOS technology. The MR44V064B is accessed using Two-wire Serial Interface (I2C BUS). Unlike SRAMs, this device, whose cells are nonvolatile, eliminates battery backup required to hold data. This device has no mechanisms of erasing and programming memory cells and blocks, such as those used for various EEPROMs. Therefore, the write cycle time can be equal to the read cycle time and the power consumption during a write can be reduced significantly.

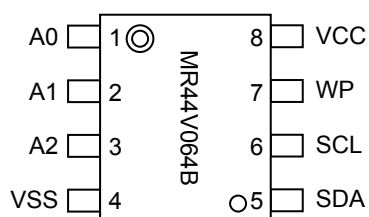
The MR44V064B can be used in various applications, because the device is guaranteed for the write/read tolerance of 10^{12} cycles per bit and the rewrite count can be extended significantly.

FEATURES

- 8,192-word × 8-bit configuration I2C BUS Interface
- A single 3.3 V typ (1.8V to 3.6V) power supply
- Operating frequency:
 - 3.4MHz(Max) HS-mode
 - 1MHz(Max) F/S-mode Plus
- Read/write tolerance
 - 10^{12} cycles/bit
- Data retention
 - 10 years
- Guaranteed operating temperature range
 - 40 to 85°C (Extended temperature version)
- Package options:
 - 8-pin plastic SOP (P-SOP8-200-1.27-T2K)

PIN CONFIGURATION

8-pin plastic SOP



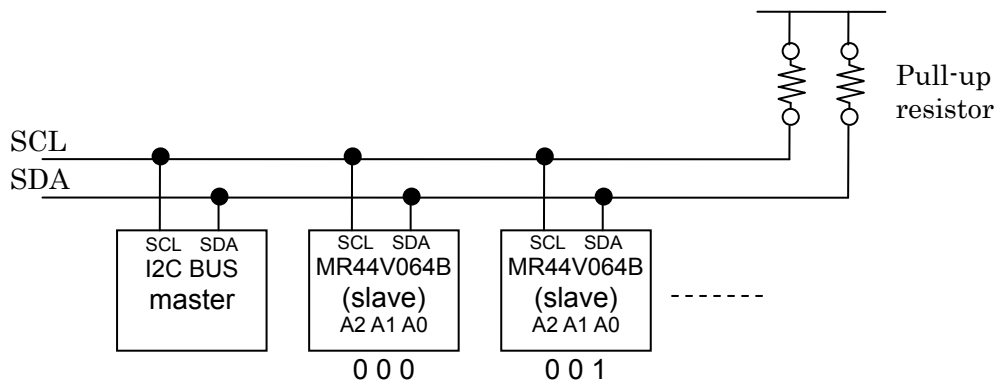
PIN DESCRIPTIONS

| Pin Name | Description |
|-----------------------------------|---|
| A0 – A2 | Address (input) Address pin indicates device address. When Address value is match the device address code from SDA, the device will be selected. The address pins are pulled down internally. |
| SDA | Serial data input serial data output (input / output) SDA is a bi-directional line for I2C interface. The output driver is open-drain. A pull-up resistor is required. |
| SCL | Serial Clock (input) Serial Clock is the clock input pin for setting for serial data timing. Inputs are latched on the rising edge and outputs occur on the falling edge. |
| WP | Write protect (input) Write Protect pin controls write-operation to the memory. When WP is high, all address in the memory will be protected. When WP is low, all address in the memory will be written. WP pin is pulled down internally. |
| V _{CC} , V _{SS} | Power supply Apply the specified voltage to V _{CC} . Connect V _{SS} to ground. |

I2C BUS

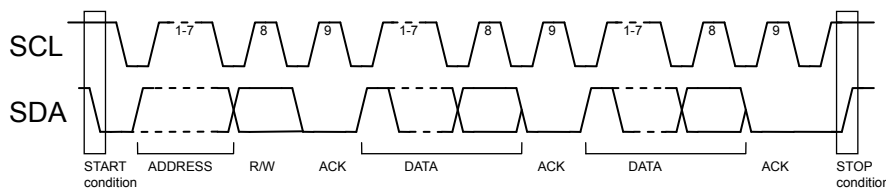
The MR44V064B employs a bi-directional two-wire I2C BUS interface, works as a slave device.

An example of I2C interface system with MR44V064B



I2C BUS COMMUNICATION

I2C BUS data communication starts by start condition input, and ends by stop condition input. Data is always 8bit long, acknowledge is always required after each byte. I2C BUS carries out data transmission with plural devices connected by 2 communication lines of serial data (SDA) and serial clock (SCL).



START CONDITION

Before executing each command, start condition (start bit) where SDA goes from “HIGH” down to “LOW” when SCL is “HIGH” is necessary. MR44V064B always detects whether SDA and SCL are in start condition (start bit) or not, therefore, unless this condition is satisfied, any command is executed.

STOP CONDITION

Each command can be ended by SDA rising from “LOW” to “HIGH” when stop condition (stop bit), namely,SCL is “HIGH”.

ACKNOWLEDGE (ACK) SIGNAL

This acknowledge (ACK) signal is a software rule to show whether data transfer has been made normally or not. In master and slave, the device (μ-COM at slave address input of write command, read command, and this IC at data output of read command) at the transmitter (sending) side releases the bus after output of 8bit data.

The device (this IC at slave address input of write command, read command, and μ-COM at data output of read command) at the receiver (receiving) side sets SDA “LOW” during 9 clock cycles, and outputs acknowledge signal (ACK signal) showing that it has received the 8bit data.

This IC, after recognizing start condition and slave address (8bit), outputs acknowledge signal (ACK signal) “LOW”.

Each write action outputs acknowledge signal (ACK signal) “LOW”, at receiving 8bit data (word address and write data).

Each read action outputs 8bit data (read data), and detects acknowledge signal (ACK signal) “LOW”.

When acknowledge signal (ACK signal) is detect, and stop condition is not sent from the master (μ-COM) side, this IC continues data output. When acknowledge signal (ACK signal) is not detected, this IC stops data transfer, and recognizes stop condition (stop bit), and ends read action. And this IC gets in status.

SLAVE ADDRESS

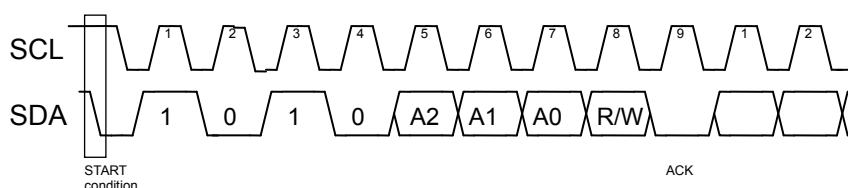
Output slave address after start condition from master.

The significant 4 bits of slave address are used for recognizing a device type. The device code of this IC is fixed to “1010”.

Next slave addresses (A2 A1 A0 ... device address) are for selecting devices, and plural ones can be used on a same bus according to the number of device addresses.

The most insignificant bit (R/W...READ/WRITE) of slave address is used for designating write or read action, and is as shown below.

| | |
|------------------|--|
| Setting R/W to 0 | write (setting 0 to word address setting of random read) |
| Setting R/W to 1 | read |



WRITE PROTECT

When WP terminal is set Vcc(H level), data rewrite of all addresses is prohibited. When it is set Vss(L level), data rewrite of all address is enabled. Be sure to connect this terminal to Vcc or Vss, or control it to H level or L level.

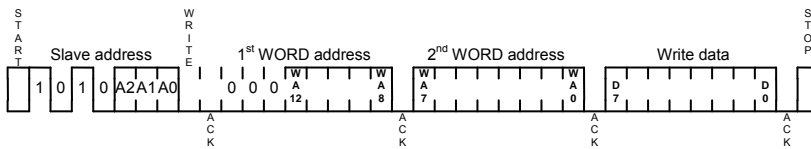
At extremely low voltage at power ON / OFF, by setting the WP terminal “H”, mistake write can be prevented.

COMMAND

BYTE WRITE CYCLE

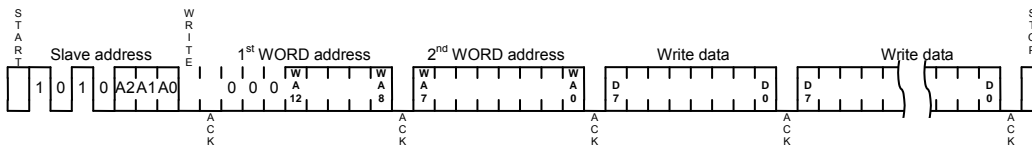
Arbitrary data is written to FeRAM. When to write only 1 byte, byte write is normally used.

- start condition
- slave address with LSB is 0 (write)
- 1st and 2nd word address
- byte of write data.
- stop condition

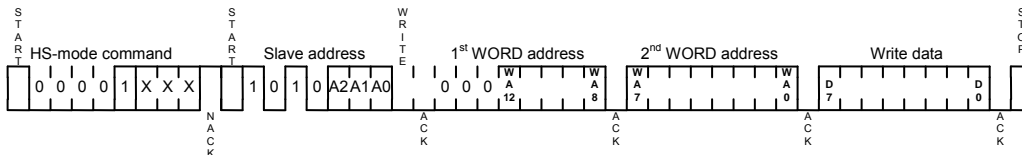


PAGE WRITE CYCLE

When to write continuous data of 2 bytes or more, simultaneous write is possible by page write cycle. By page write cycle, up to 8,192 bytes data can be written. When data of the maximum bytes or higher is sent, data from the first byte is overwritten.



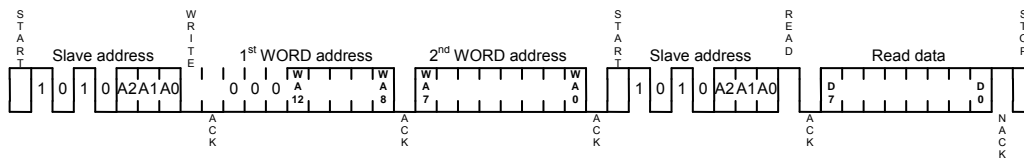
BYTE WRITE CYCLE (HS-MODE)



RANDOM READ CYCLE

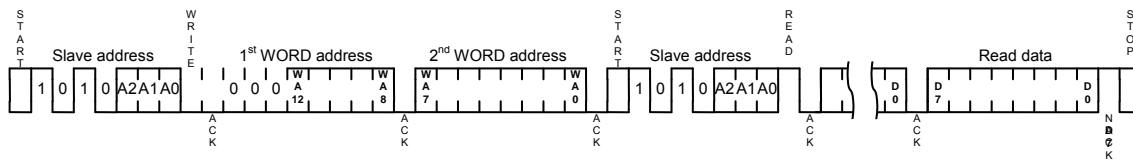
Random read cycle is a command to read data by designating address.

- start condition
- slave address with LSB is 0 (write)
- 1st and 2nd word address
- start condition
- slave address with LSB is 1 (read)
- read out byte of data.
- ACK to “H”
- stop condition



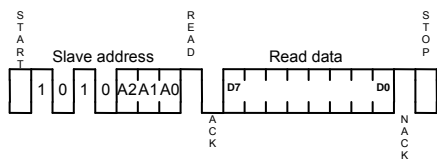
SEQUENTIAL READ CYCLE

When ACK signal “L” after D0 is detected, and stop condition is not sent from master side, the next address data can be read in succession.



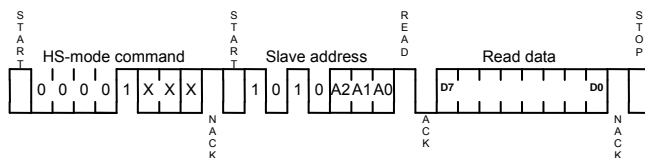
CURRENT ADDRESS READ CYCLE

Current address read cycle is a command to read data of internal address register without designating address. When the last read or write address is (n)-th address just before current read cycle, the current address read command outputs data of (n+1)-th address. The previous read or write sequence should be complete up to stop condition.



CURRENT ADDRESS READ CYCLE (HS-MODE)

The MR44V064B support a 3.4MHz high speed mode. When HS-mode operation is needed, the HS-mode command is required before any command. After the HS-mode command is issued, MR44V064B will be the HS-mode, until stop condition is issued.



ELECTRICAL CHARACTERISTICS**ABSOLUTE MAXIMUM RATINGS**

The application of stress (voltage, current, or temperature) that exceeds the absolute maximum rating may damage the device. Therefore, do not allow actual characteristics to exceed any one parameter ratings

PIN VOLTAGES

| Parameter | Symbol | Rating | | Unit | Note |
|------------------------------------|---------------------|--------|----------------|------|------|
| | | Min. | Max. | | |
| Pin Voltage (Input Signal) | V_{IN} | -0.5 | $V_{CC} + 0.5$ | V | |
| Pin Voltage (Input/Output Voltage) | V_{INQ}, V_{OUTQ} | -0.5 | $V_{CC} + 0.5$ | V | |
| Power Supply Voltage | V_{CC} | -0.5 | 4.0 | V | |

TEMPERATURE RANGE

| Parameter | Symbol | Rating | | Unit | Note |
|---|-----------|--------|------|------|------|
| | | Min. | Max. | | |
| Storage Temperature (Extended Temperature Version) | T_{stg} | -55 | 125 | °C | |
| Operating Temperature (Extended Temperature Version) | T_{opr} | -40 | 85 | °C | |

OTHERS

| Parameter | Symbol | Rating | Note |
|-------------------|--------|---------|--------------------------|
| Power Dissipation | P_D | 1,000mW | $T_a=25^{\circ}\text{C}$ |

RECOMMENDED OPERATING CONDITIONS**POWER SUPPLY VOLTAGE**

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|----------------------|----------|------|------|------|------|------|
| Power Supply Voltage | V_{CC} | 1.8 | 3.3 | 3.6 | V | |
| Ground Voltage | V_{SS} | 0 | 0 | 0 | V | |

DC INPUT VOLTAGE

| Parameter | Symbol | Min. | Max. | Unit | Note |
|--------------------|----------|---------------------|---------------------|------|------|
| Input High Voltage | V_{IH} | $V_{CC} \times 0.7$ | $V_{CC} + 0.3$ | V | |
| Input Low Voltage | V_{IL} | -0.3 | $V_{CC} \times 0.3$ | V | |

DC CHARACTERISTICS**DC INPUT/OUTPUT CHARACTERISTICS**

| Parameter | Symbol | Condition | Min. | Max. | Unit | Note |
|------------------------|----------|--------------|------|------|---------|------|
| Output Low Voltage | V_{OL} | $I_{OL}=3mA$ | — | 0.4 | V | |
| Input Leakage Current | I_{LI} | — | -10 | 10 | μA | |
| Output Leakage Current | I_{LO} | — | -10 | 10 | μA | |

POWER SUPPLY CURRENT $V_{CC}=\text{Max.to Min, } T_a=T_{opr}$

| Parameter | Symbol | Condition | Max. | Unit | Note |
|----------------------------------|-----------|--|----------|---------------|------|
| Power Supply Current (Standby) | I_{CCS} | SCL,SDA= V_{CC} , A2,A1,A0= V_{CC} or V_{SS} | 10 | μA | |
| Power Supply Current (Operating) | I_{CCA} | $V_{IN}=0.3V$ or $V_{CC}-0.3V$, fSCL=3.4MHz fSCL=1MHz | 1 300 | mA μA | |

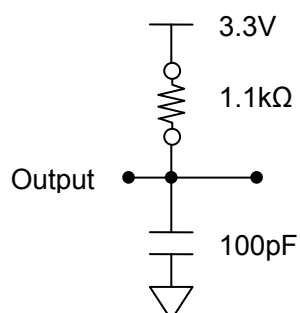
AC CHARACTERISTICS

 V_{CC} =Max. to Min., T_a =Topr.

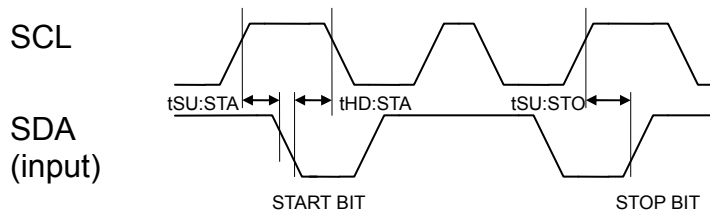
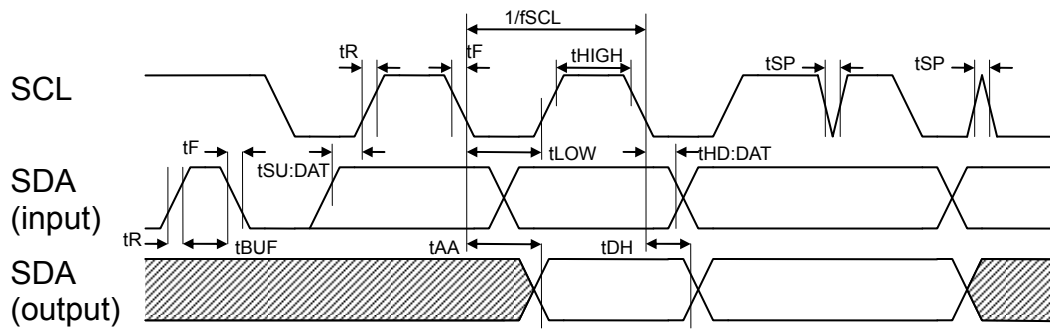
| Parameter | Symbol | F/S-mode | | F/S-mode Plus | | HS-mode | | Unit | Note |
|--|--------------|----------|------|---------------|------|---------|------|------|------|
| | | Min. | Max. | Min. | Max. | Min. | Max. | | |
| Clock frequency | f_{SCL} | D.C. | 400 | D.C. | 1000 | DC | 3400 | KHz | |
| Clock Low time | t_{LOW} | 1300 | | 500 | | 160 | | ns | |
| Clock High time | t_{HIGH} | 600 | | 300 | | 60 | | ns | |
| Output Data delay time | t_{AA} | | 900 | | 450 | | 130 | ns | |
| BUS release time before transfer start | t_{BUF} | 1300 | | 500 | | 300 | | ns | |
| Start condition hold time | $t_{HD:STA}$ | 600 | | 250 | | 160 | | ns | |
| Start condition setup time | $t_{SU:STA}$ | 600 | | 250 | | 160 | | ns | |
| Input data hold time | $t_{HD:DAT}$ | 0 | | 0 | | 0 | | ns | |
| Input data setup time | $t_{SU:DAT}$ | 100 | | 100 | | 10 | | ns | |
| SDA, SCL rise time | t_R | | 300 | | 300 | | 80 | ns | 1 |
| SDA, SCL fall time | t_F | | 300 | | 100 | | 80 | ns | 1 |
| Stop condition setup time | $t_{SU:STO}$ | 600 | | 250 | | 160 | | ns | |
| Output data hold time | t_{DH} | 0 | | 0 | | 0 | | ns | |
| Noise removal time (SDA, SCL) | t_{SP} | | 50 | | 50 | | 5 | ns | |

Note: 1. Not 100% tested

Equivalent AC Load Circuit



TIMING



●POWER-ON AND POWER-OFF CHARACTERISTICS

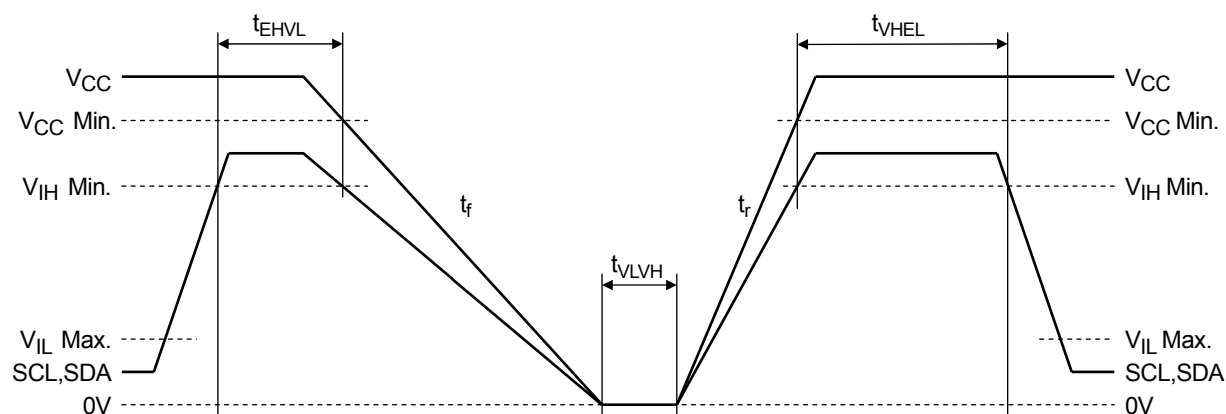
(Under recommended operating conditions)

| Parameter | Symbol | Min. | Max. | Unit | Note |
|-----------------------------------|------------|------|------|-----------|------|
| Power-On SCL,SDA High Hold Time | t_{VHEL} | 100 | — | ns | 1, 2 |
| Power-Off SCL, SDA High Hold Time | t_{EHVL} | 0 | — | ns | 1 |
| Power-On Interval Time | t_{VLVH} | 0 | — | μ s | 2 |
| V_{CC} Power-On ramp rate | t_r | 30 | | μ s/V | |
| V_{CC} Power-Off ramp rate | t_f | 30 | | μ s/V | |

Notes:

1. To prevent an erroneous operation, be sure to maintain SCL=SDA="H", and set the FeRAM in an inactive state (standby mode) before and after power-on and power-off.
2. Powering on at the intermediate voltage level will cause an erroneous operation; thus, be sure to power up from 0 V.
3. Enter all signals at the same time as power-on or enter all signals after power-on.

●Power-On and Power-Off Sequences



READ/WRITE CYCLES AND DATA RETENTION

(Under recommended operating conditions)

| Parameter | Min. | Max. | Unit | Note |
|------------------|------------------|------|-------|------|
| Read/Write Cycle | 10 ¹² | — | Cycle | |
| Data Retention | 10 | — | Year | |

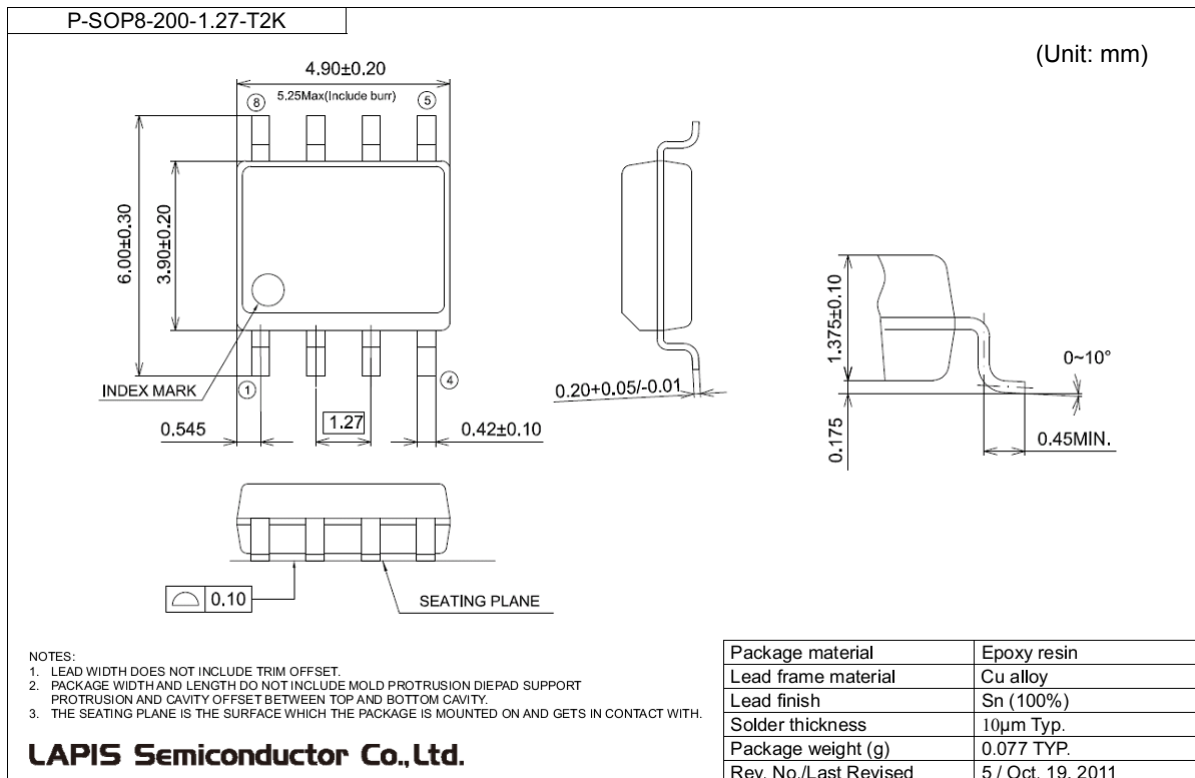
CAPACITANCE

| Signal | Symbol | Min. | Max. | Unit | Note |
|--------------------------|------------------|------|------|------|------|
| Input Capacitance | C _{IN} | — | 10 | pF | 1 |
| Input/Output Capacitance | C _{OUT} | — | 10 | pF | 1 |

Note1:

Sampling value. Measurement conditions are V_{IN} = V_{OUT} = GND, f = 1MHz, and Ta = 25°C

PACKAGE DIMENSIONS



Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact a ROHM sales office for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

REVISION HISTORY

| Document No. | Date | Page | | Description |
|----------------|---------------|------------------|-----------------|-----------------|
| | | Previous Edition | Current Edition | |
| FEDR44V064B-01 | Jan. 08, 2016 | – | – | Final edition 1 |

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