FEDR44V064B-02
Issue Date: Sep. 07, 2017

MR44V064B

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

GENERAL DESCRIPTION

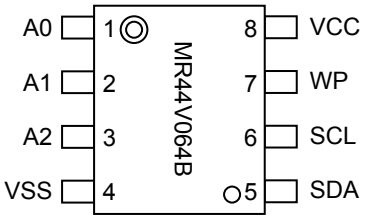
The MR44V064B is a nonvolatile 8,192-word x 8-bit ferroelectric random access memory (FeRAM) developed in the ferroelectric process and silicon-gate CMOS technology. The MR44V064B is accessed using Two-wire Serial Interface (I2C BUS).Unlike SRAMs, this device, whose cells are nonvolatile, eliminates 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
- Package options:
  8-pin plastic SOP (P-SOP8-200-1.27-T2K)
- RoHS (Restriction of hazardous substances) compliant

PIN CONFIGURATION

8-pin plastic SOP



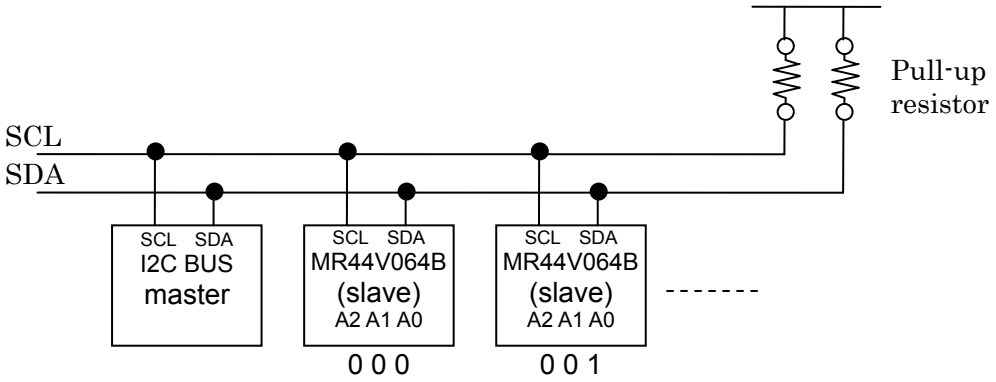
PIN DESCRIPTIONS

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

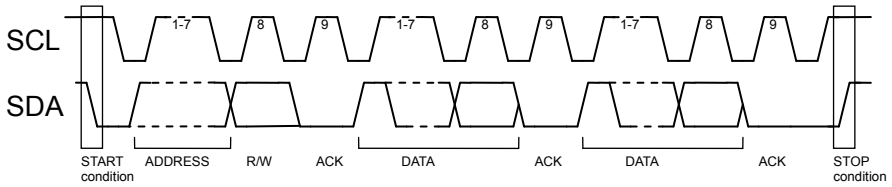
The MR44V064B employs a bi-directional two-wire I2C BUS interface, works as a slave device.

An example of I2C interface system with MR44V064B



I2C BUS COMUNICATION

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”.

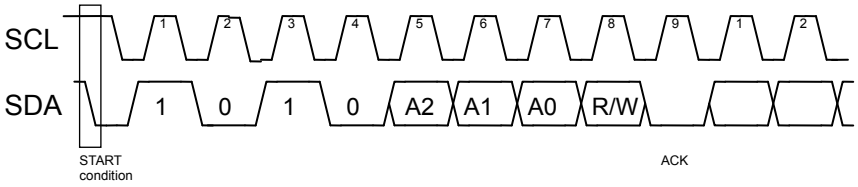
ACKNOWLEDGE (ACK) SIGNAL

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

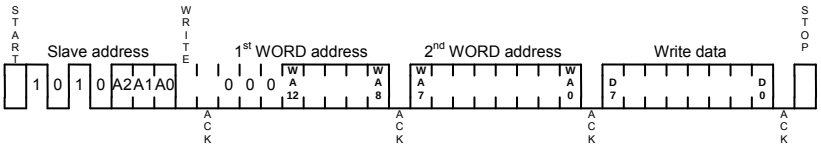
When WP terminal is set Vcc(H level), data rewrite of all addresses is prohibited. When it is set Vss(L level), data rewrite of all address is enabled. Be sure to connect this terminal to Vcc or Vss, or control it to H level or L level. Because this terminal is pulled down internally, in the case of Open the terminal will be recognized as L level
During write cycle WP terminal must be always "L" level. WP terminal must be fixed from start condition to stop condition.

COMMAND

BYTE WRITE CYCLE

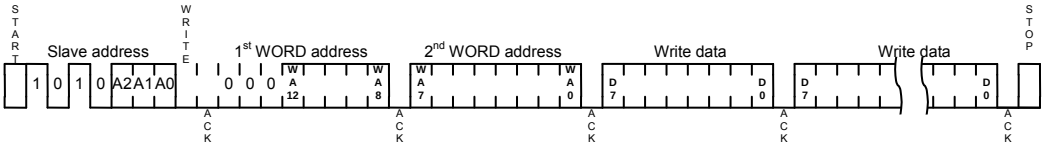
Arbitrary data is written to FeRAM. When to write only 1 byte, byte write is normally used.

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



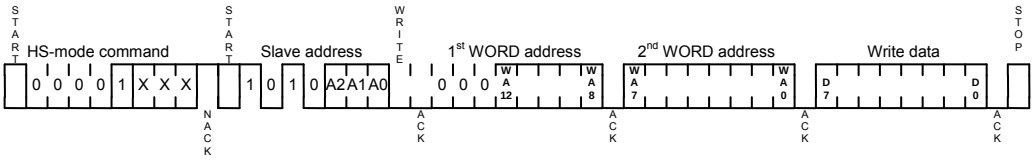
PAGE WRITE CYCLE

When to write continuous data of 2 bytes or more, simultaneous write is possible by page write cycle. The address reaches the final address, the address will be rolled over to the first address. By page write cycle, up to 8,192 bytes data can be written. When data above the maximum bytes are sent, data from the first byte will be overwritten.



BYTE WRITE CYCLE (HS-MODE)

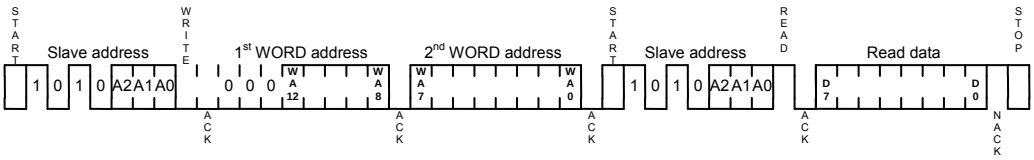
The MR44V064B support a maximum 3.4MHz high speed mode. When HS-mode operation is needed, the HS-mode command is required before any command. After the HS-mode command is issued, MR44V064B will be the HS-mode, until stop condition is issued.



RANDOM READ CYCLE

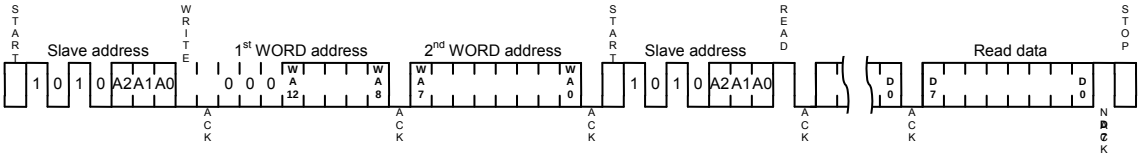
Random read cycle is a command to read data by designating address.

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



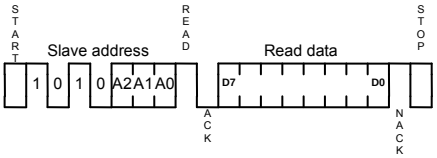
SEQUENTIAL READ CYCLE

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. The address reaches the final address, the address will be rolled over to the first address.



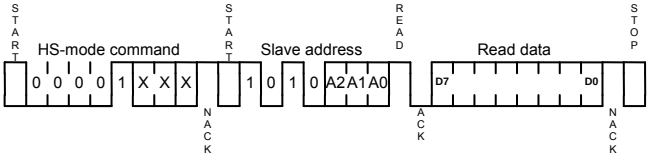
CURRENT READ CYCLE

Current 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 read command outputs data of (n+1)-th address. The previous read or write sequence should be complete up to stop condition.
Just after POWER ON, the internal address resister is unstable.



CURRENT ADDRESS READ CYCLE (HS-MODE)

The MR44V064B support a maximum 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	Tstg	–55	125	°C	
Operating Temperature	Topr	–40	85	°C	

OTHERS

Parameter	Symbol	Rating	Note
Power Dissipation	P_D	1,000mW	Ta=25°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} x 0.7	V_{CC}+0.3	V	
Input Low Voltage	V_{IL}	–0.3	V_{CC} x 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}=Max.to Min, Ta=Topr

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

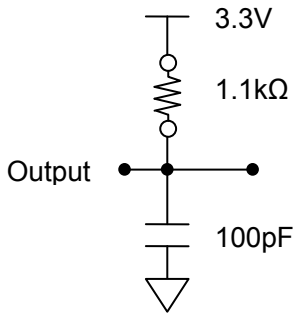
AC CHARACTERISTICS

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

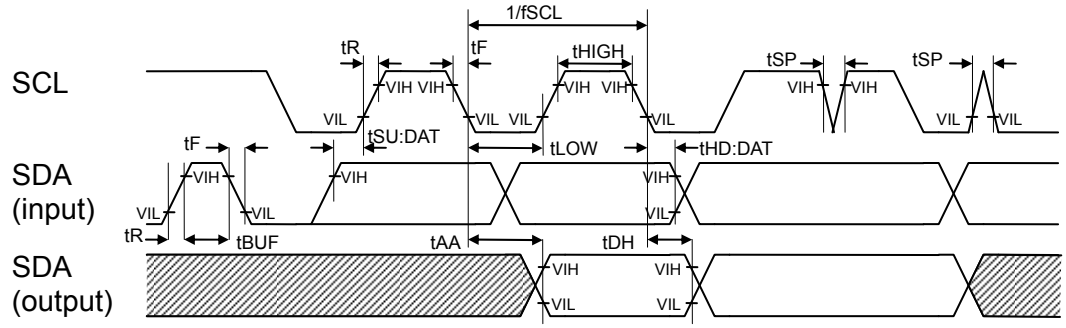
Parameter	Symbol	F/S-mode		F/S-mode Plus		HS-mode		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Clock frequency	f_{SCL}	D.C.	400	D.C.	1000	DC	3400	KHz	
Clock Low time	tLOW	1300		500		160		ns	
Clock High time	tHIGH	600		300		60		ns	
Output Data delay time	tAA		900		450		130	ns	
BUS release time before transfer start	tBUF	1300		500		300		ns	
Start condition hold time	tHD:STA	600		250		160		ns	
Start condition setup time	tSU:STA	600		250		160		ns	
Input data hold time	tHD:DAT	0		0		0		ns	
Input data setup time	tSU:DAT	100		100		10		ns	
SDA, SCL rise time	tR		300		300		80	ns	1
SDA, SCL fall time	tF		300		100		80	ns	1
Stop condition setup time	tSU:STO	600		250		160		ns	
Output data hold time	tDH	0		0		0		ns	
Noise removal time (SDA, SCL)	tSP		50		50		5	ns	

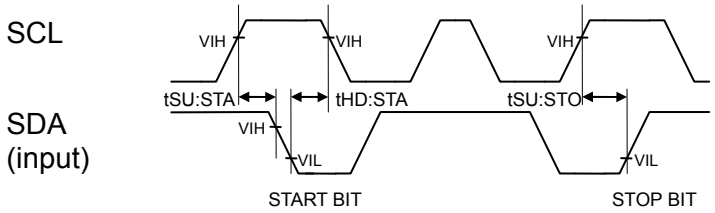
Note: 1. Not 100% tested

Equivalent AC Load Circuit



TIMING


1/fSCL
tR
tF
tHIGH
tSP
tSP
SCL
VIH
VIL
tSU:DAT
tLOW
tHD:DAT
tF
SDA
(input)
tR
tBUF
tAA
tDH
SDA
(output)


SCL
SDA
(input)
VIH
VIL
tSU:STA
tHD:STA
tSU:STO
START BIT
STOP BIT

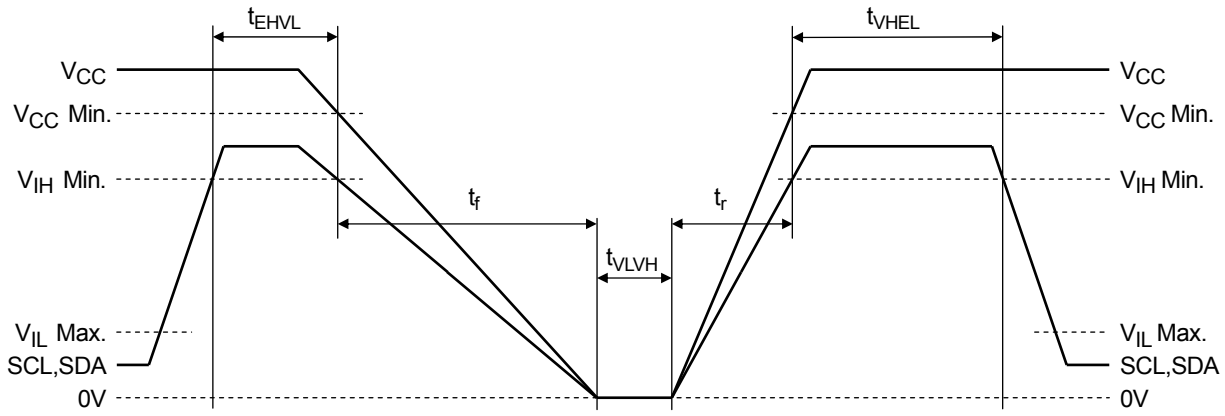
•POWER-ON AND POWER-OFF CHARACTERISTICS

(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	—	µs	2
V_{CC} Power-On ramp rate	tr	30		µs/V	
V_{CC} Power-Off ramp rate	tf	30		µs/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



•After Power-Off, terminal state

When MR44V064B only goes power-off while the other IC's on I2C bus are active, all the input pins including I/O pin of MR44V064B must be GND level.

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

Vcc=3.3V, $V_{IN} = V_{OUT}$ = GND, f = 1MHz, and Ta = 25°C

Signal	Symbol	Min.	Max.	Unit	Note
Input Capacitance	C_{IN}	—	10	pF	1
Input/Output Capacitance	C_{OUT}	—	10	pF	1

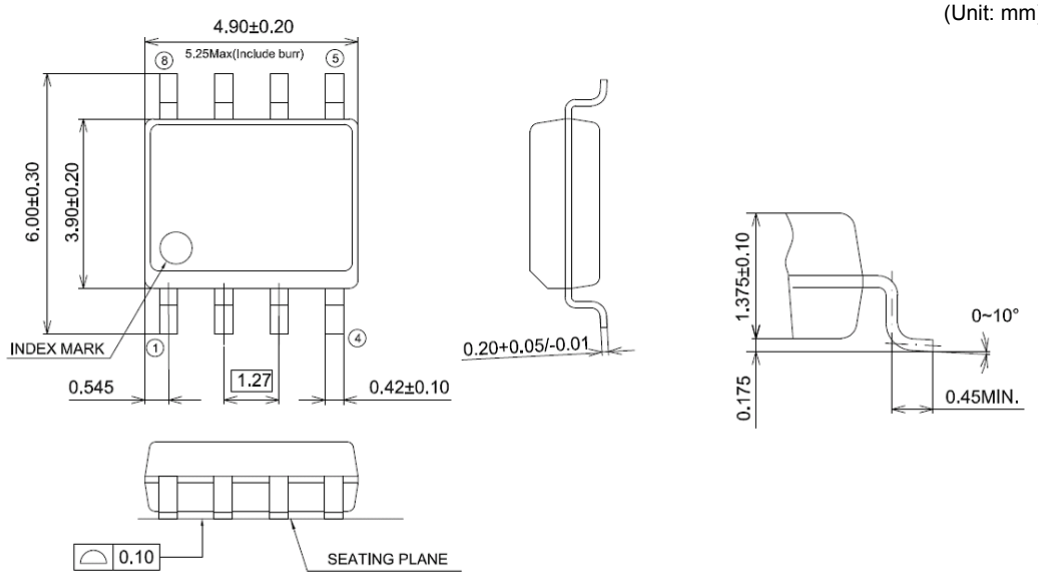
Note:

1. Sampling value.

PACKAGE DIMENSIONS

P-SOP8-200-1.27-T2K

(Unit: mm)



NOTES:
1. LEAD WIDTH DOES NOT INCLUDE TRIM OFFSET.
2. PACKAGE WIDTH AND LENGTH DO NOT INCLUDE MOLD PROTRUSION DIEPAD SUPPORT PROTRUSION AND CAVITY OFFSET BETWEEN TOP AND BOTTOM CAVITY.
3. THE SEATING PLANE IS THE SURFACE WHICH THE PACKAGE IS MOUNTED ON AND GETS IN CONTACT WITH.

LAPIS Semiconductor Co.,Ltd.

Package material	Epoxy resin
Lead frame material	Cu alloy
Lead finish	Sn (100%)
Solder thickness	10μm Typ.
Package weight (g)	0.077 TYP.
Rev. No./Last Revised	5 / Oct. 19, 2011

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
FEDR44V064B-02	Sep. 07,2017	– 9 11 12	– 9 11 12	Corrected a vague description. Corrected a condition of power supply current Added VIH/VIL Added “After Power-Off, terminal state”

Notes

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