Standard EEPROMs
Plug & Play EEPROMs
(for Display)

BR24C21xxx Series (1K)

●General Description

BR24C21F,BR24C21FJ,BR24C21FV are serial EEPROMs that support DDC1™/DDC2™ interfaces for Plug and Play displays

●Features

- Compatible with both DDC1™/DDC2™
- Operating voltage range: 2.5V to 5.5V
- Page write function: 8bytes
- Low power consumption
  - Active (at 5V) : 1.5mA (typ)
  - Stand-by (at 5V) : 0.1μA (typ)
- Address auto increment function during Read operation
- Data security
  - Write enable feature (VCLK)
  - Write protection at low Vcc
- Initial data=FFh
- Data retention: 10years
- Rewriting possible up to 100,000 times

●Packages W(Typ.) x D(Typ.) x H(Max.)



DIP-T8
9.30mm x 6.50mm x 7.10mm



SOP8
5.00mm x 6.20mm x 1.71mm



SOP- J8
4.90mm x 6.00mm x 1.65mm



SSOP-B8
3.00mm x 6.40mm x 1.35mm

●BR24C21xxx series

Capacity	Type	Power source Voltage	DIP-T8	SOP8	SOP-J8	SSOP-B8
1Kbit	BR24C21	2.5V to 5.5V	●	●	●	●

●Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Remarks
Supply Voltage	V_{CC}	-0.3 to +6.5	V	
Power Dissipation	Pd	800(DIP-T8)	mW	When using at Ta=25℃ or higher 8.0mW to be reduced per 1℃.
		450 (SOP8)		When using at Ta=25℃ or higher 4.5mW to be reduced per 1℃.
		450 (SOP-J8)		When using at Ta=25℃ or higher 4.5mW to be reduced per 1℃.
		350(SSOP-B8)		When using at Ta=25℃ or higher 3.5mW to be reduced per 1℃.
Storage Temperature	Tstg	-65 to +125	℃	
Operating Temperature	Topr	-40 to +85	℃	
Terminal Voltage	-	-0.3 to Vcc+0.3	V	

●Memory cell characteristics

Parameter	Limits			Unit
	Min.	Typ.	Max	
Write/Erase Cycle	100,000	—	—	Times
Data Retention	10	—	—	Years

○Product structure : Silicon monolithic integrated circuit ○This product is not designed protection against radioactive rays

© 2012 ROHM Co., Ltd. All rights reserved.

●**Recommended Operating Ratings**

Parameter	Symbol	Ratings	Unit
Supply Voltage	Vcc	2.5 to 5.5	V
Input voltage	VIN	0 to Vcc	

●**Electrical characteristics**

DC (Unless otherwise specified, Ta=-40℃ to +85℃、V_{CC}=2.5V to 5.5V)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
“H” Input Voltage 1	VIH1	$0.7V_{CC}$	-	-	V	SCL, SDA
“L” Input Voltage 1	VIL1	-	-	$0.3V_{CC}$	V	SCL, SDA
“H” Input Voltage 2	VIH2	2.0	-	-	V	VCLK
“L” Input Voltage 2	VIL2	-	-	0.8	V	VCLK, V_{CC}≧4.0V
“L” Input Voltage 3	VIL3	-	-	$0.2V_{CC}$	V	VCLK, V_{CC}＜4.0V
“L” Output Voltage	VOL	-	-	0.4	V	SDA, IOL=3.0mA
Input Leakage Current	ILI	-1	-	1	μA	SCL, VCLK, VIN=0V to V_{CC}
Output Leakage Current	ILO	-1	-	1	μA	SDA, VOUT=0V to V_{CC}
Operating Current	ICC	-	-	3.0	mA	V_{CC}=5.5V, fSCL=400kHz
Standby Current	ISB	-	10	100	μA	V_{CC}=5.5V, SDA=SCL=V_{CC},VCLK=GND *1

*1 Transmit-Only Mode - After power on, the BR24C21/F/FJ/FV is in Standby mode and does not provide the clock to the VCLK pin.
After the clock is provided to VCLK, the device is switched from Standby to Transmit-Only Mode, and the operating current flows.
Bi-directional Mode - The BR24C21/F/FJ/FV is in Standby mode after each command is performed.

AC (Unless otherwise specified, Ta=-40℃ to +85℃,Vcc=2.5V to 5.5V)

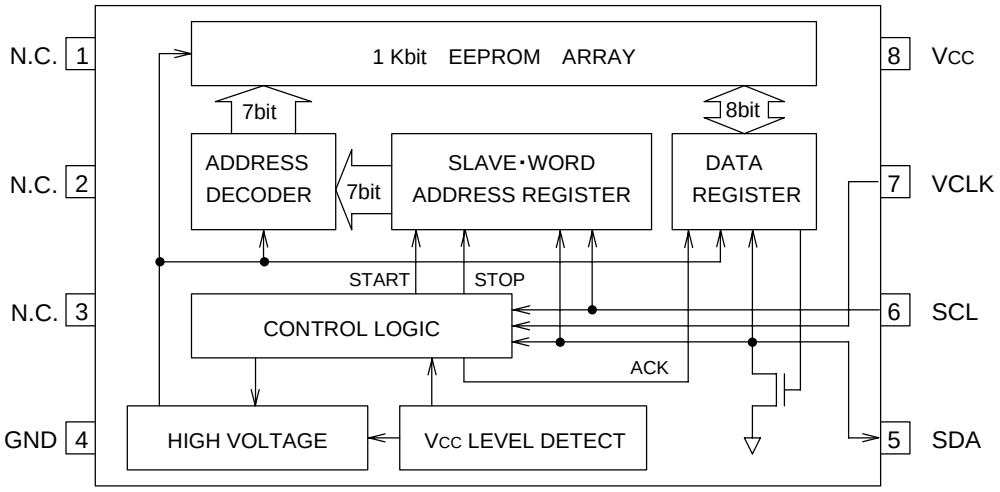
Parameter	Symbol	Fast-mode Vcc=2.5V to 5.5V			Standard-mode Vcc=2.5V to 5.5V			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Clock Frequency	fSCL	-	-	400	-	-	100	kHz
Data Clock High Period	tHIGH	0.6	-	-	4.0	-	-	μs
Data Clock Low Period	tLOW	1.3	-	-	4.7	-	-	μs
SDA and SCL Rise Time	tR	-	-	0.3	-	-	1.0	μs
SDA and SCL Fall Time	tF	-	-	0.3	-	-	0.3	μs
Start Condition Hold Time	tHD:STA	0.6	-	-	4.0	-	-	μs
Start Condition Setup Time	tSU:STA	0.6	-	-	4.7	-	-	μs
Input Data Hold Time	tHD:DAT	0	-	-	0	-	-	ns
Input Data Setup Time	tSU:DAT	100	-	-	250	-	-	ns
Output Data Delay Time(SCL)	tPD	-	-	0.9	0.2	-	3.5	μs
Stop Condition Setup Time	tSU:STO	0.6	-	-	4.0	-	-	μs
Bus Free Time	tBUF	1.3	-	-	4.7	-	-	μs
Write Cycle Time	tWR	-	-	10	-	-	10	ms
Noise Spike Width (SDA and SCL)	tI	-	-	0.1	-	-	0.1	μs

AC OPERATING CHARACTERISTICS (Transmit-Only Mode)

Output Data Delay Time(VCLK)	tVPD	-	-	1.0	-	-	2.0	μs
VCLK High Period	tVHIGH	0.6	-	-	4.0	-	-	μs
VCLK Low Period	tVLOW	1.3	-	-	4.7	-	-	μs
VCLK Setup Time	tVSU	0	-	-	0	-	-	μs
VCLK Hold Time	tVHD	0.6	-	-	4.0	-	-	μs
Mode Transition Time	tVHZ	-	-	0.5	-	-	1.0	μs
Transmit-Only Powerup Time	tVPU	0	-	-	0	-	-	μs
Noise Spike Width (VCLK)	tVI	-	-	0.1	-	-	0.1	μs

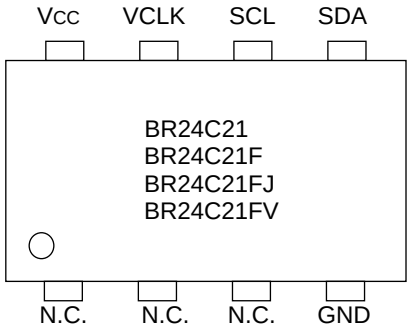
© 2012 ROHM Co., Ltd. All rights reserved.

●Block Diagram



●Pin Configuration

(TOP VIEW)



●Pin Descriptions

Pin Name	I/O	Functions
V_{CC}	-	Power Supply
GND	-	Ground (0V)
N.C.	-	No Connection
SCL	IN	Serial Clock Input for Bi-directional Mode
SDA	IN/OUT	Slave and Word Address, Serial Data Input, Serial Data Output *1
VCLK	IN	Clock Input (Transmit-Only Mode) Write Enable (Bi-directional Mode)

*1 An open drain output requires a pull-up resistor.

© 2012 ROHM Co., Ltd. All rights reserved.

●Synchronous data timing

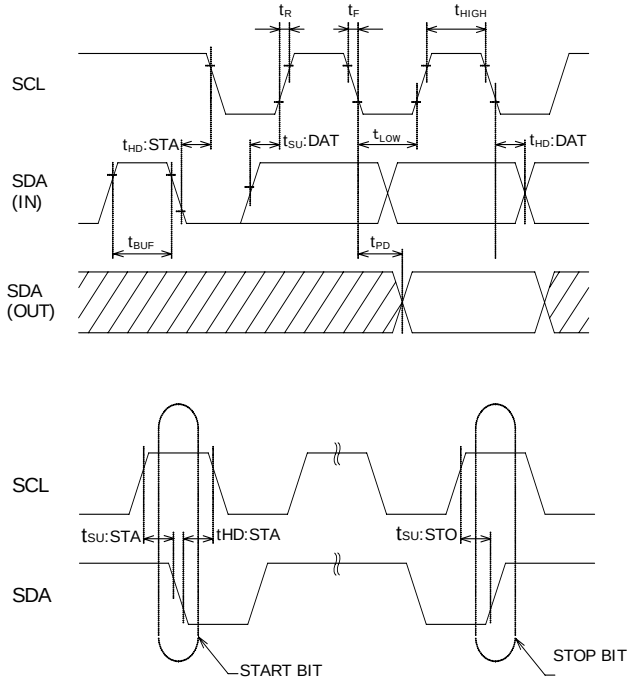


Figure 1. Synchronous Data Timing

・SDA data is latched into the chip at the rising edge of the SCL clock.
・Output data toggles at the falling edge of the SCL clock.

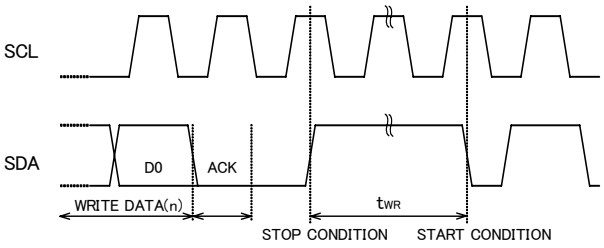


Figure 2. Write Cycle Timing

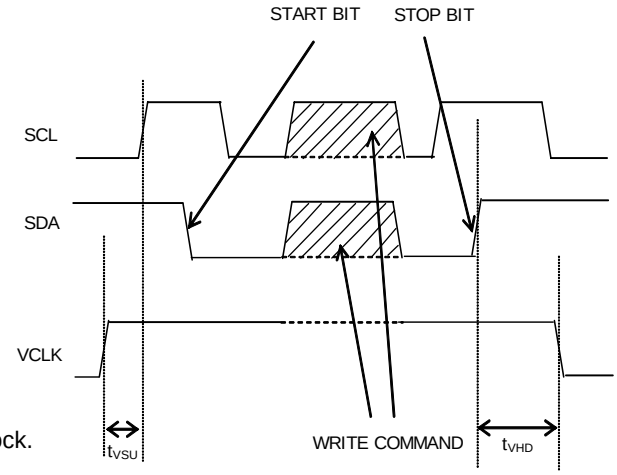


Figure 3. Write Enable Timing

●Transmit-only mode

・After power is on, the BR24C21/F/FJ/FV is in Transmit-Only Mode. In this mode data can be output by providing the clock to the VCLK pin.
・When the power is on, the SCL pin needs to be set to VCC(High level).
・SDA is at high-impedance during input of the first 9 clocks. At the 10th rising clock edge of VCLK data is output. After power on, the output data is as follows:
00h address data → 01h address data → 02h address data → …
The address is incremented by one, after every 9 clocks of VCLK. All addresses are output in this mode.
When the counter reaches the last address, the next output data is 00h address data. (See Figure 4.)
・In this mode, the NULL bit (High data) is output between the address data and the next address data. (See Figure 5.)
・The read operation is in Transmit-Only Mode and can be started after the power is stabilized.

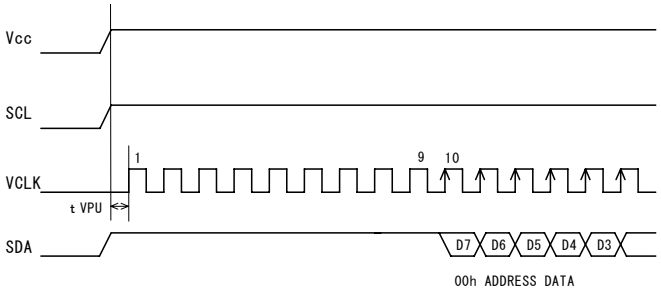


Figure 4. Transmit Only Mode

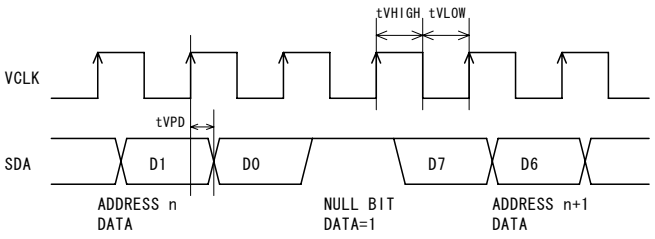


Figure 5. Null Bit

© 2012 ROHM Co., Ltd. All rights reserved.

●Bi-directional mode

○Bi-directional Mode and Recovery Function

- The BR24C21/F/FJ/FV can be switched from Transmit-Only Mode to Bi-directional Mode by providing a valid High to Low transition at the SCL pin, while the state of SDA is at high-impedance.
- After a valid high to low transition on the SCL pin, the BR24C21/F/FJ/FV begins to count the VCLK clock. If the VCLK counter reaches 128 clocks without the command for Bi-directional Mode, the device reverts to Transmit-Only Mode (Recovery function). The VCLK counter is reset by providing a valid high to low transition at the SCL pin. After reversal to Transmit-Only Mode the device begins to output data (00h address data) with the 129th rising clock edge of VCLK.
- If the BR24C21/F/FJ/FV is switched from Transmit-Only Mode and receives the command for Bi-directional Mode and responds with an Acknowledge, it is impossible to revert to Transmit-Only Mode. (Power down is the only way to revert to Transmit-Only Mode.) Unless the input device code is “1010”, the device does not respond with an Acknowledge. If the VCLK counter reaches 128 clocks afterwards, it is possible to revert to Transmit-Only Mode for Recovery function. If the Master generates a STOP condition during the Slave address, before an Acknowledge is input, it is possible to revert to Transmit-Only Mode.
- When the device is switched from Transmit-Only Mode to Bi-direction Mode, the period of tVHZ needs to be held.

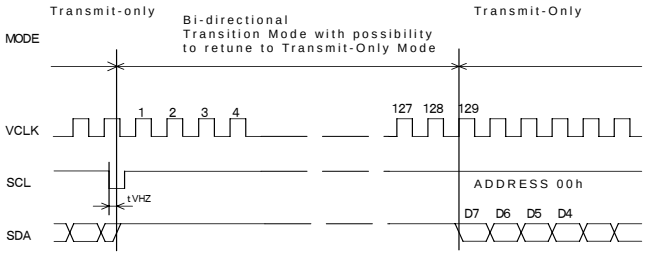


Figure 6. Recovery Mode

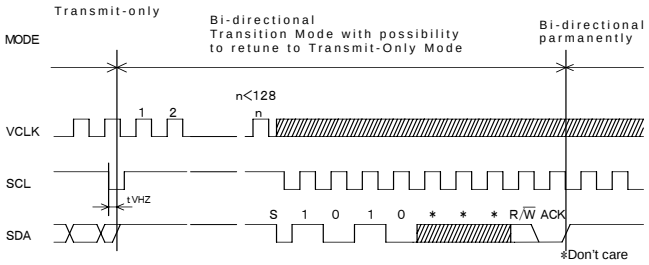


Figure 7. Mode Change

○Bi-directional Mode

START Condition

- All commands are proceeded by the START condition, which is a High to Low transition of SDA when SCL is High.
- The BR24C21/F/FJ/FV continuously monitors the SDA and SCL lines for the START condition and will not respond to any commands until this condition has been met.
  (See Figure 1 Synchronous Data Timing)

STOP Condition

- All commands must be terminated by a STOP condition, which is a Low to High transition of SDA when SCL is High.
- The STOP condition causes the internal write cycle to write data into the memory array after a write sequence.
- The STOP condition is also used to place the device into standby power mode after read sequences.
- A STOP condition can only be issued after the transmitting device has released the bus.
  (See Figure 1 Synchronous Data Timing)

Device Addressing

- Following the START condition, the Master outputs the device address of the Slave to be accessed. The most significant four bits of Slave address are the “device type indentifier,” For the BR24C21/F/FJ/FV this is fixed as “1010.”
- The next three bits of the slave address are inconsequential.
- The last bit of the stream determines the operation to be performed. When set to “1”, a READ operation is selected. When set to “0”, a WRITE operation is initiated.

R/$\overline{W}$ set to "0" ・・・・・・・・・ WRITE (This bit is also set to "0" for random read operation)
R/$\overline{W}$ set to "1" ・・・・・・・・・ READ

1010	*	*	*	R/$\overline{W}$

* : Don’t care

○Write Protect Function

- Write Enable (VCLK)

When using the BR24C21/F/FJ/FV in Bi-directional Mode, the VCLK pin can be used as a write enable pin. Setting VCLK High allows normal write operations, while setting VCLK low prevents writing to any location in the array.
(See Figure 3 Write Enable Timing)
Changing VCLK from High to Low during the self-timed program operation will not halt programming of the device.

© 2012 ROHM Co., Ltd. All rights reserved.

●Bidirectional mode command

○Byte Write

When the Master generates a STOP condition, the BR24C21/F/FJ/FV begins the internal write cycle to the nonvolatile array.

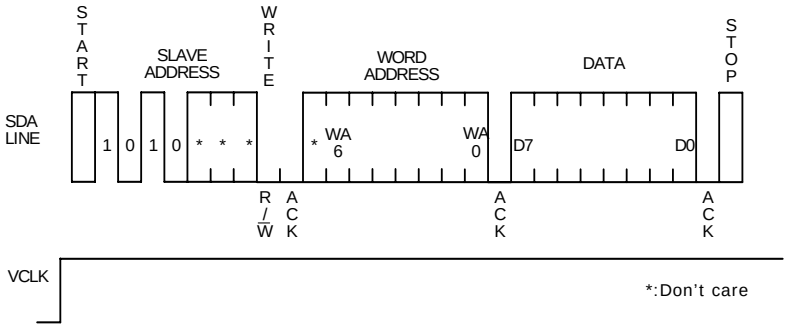


Figure 8. Byte Write Cycle Timing

○Page Write

If the Master transmits the next data instead of generating a STOP condition during the byte write cycle, the BR24C21/F/FJ/FV transfers from byte write function to page write function. After receipt of each word, the three lower order address bits are internally incremented by one, while the high order four bits of the word address remains constant.
If the master transmits more than eight words, prior to generating the STOP condition, the address counter will “roll over,” and the previous transmitted data will be overwritten.

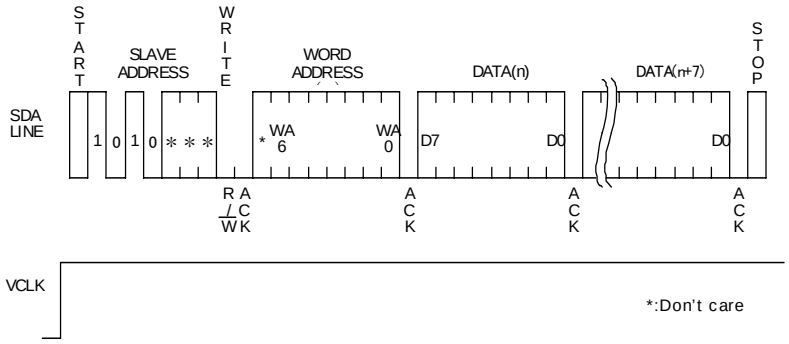


Figure 9. Page Write Cycle Timing

○Current Read

The BR24C21/F/FJ/FV contains an internal address counter which maintains the address of the last word accessed, incremented by one. If the last accessed address is address “n” in a Read operation, the next Read operation will access data from address “n+1” and increment the current address counter. If the last accessed address is address
”n” in a Write operation, the next Read operation will access data from address “n”. If the Master does not transfer an Acknowledge, but does generate a STOP condition, the current address read operation will only provide a single byte of data. At this point, the device discontinues transmission.
(See Figure 12 Sequential Read Cycle Timing)

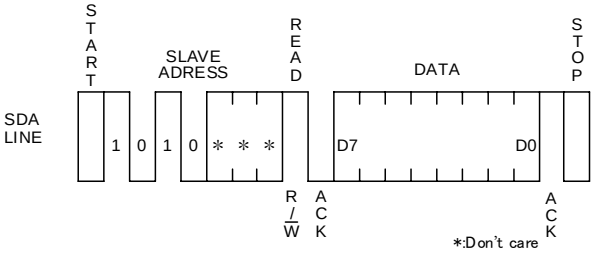


Figure 10. Current Read Cycle Timing

© 2012 ROHM Co., Ltd. All rights reserved.

○Random Read

The Random read operation allows the Master to access any memory location. This operation involves a two-step process. First, the Master issues a Write command that includes the START condition and the Slave address field (with R/$\overline{W}$ set to “0”) followed by the word address of the word to be read. This procedure sets the internal address counter of the BR24C21/F/FJ/FV to the desired address. After the word address Acknowledge is received by the Master, the Master immediately re-issues a START condition followed by the Slave address field with R/$\overline{W}$ set to “1.” The device will respond with an Acknowledge and then transmit the 8-data bits stored at the addressed location. If the Master does not acknowledge the transmission but does generate the STOP condition, the IC will discontinue transmission.

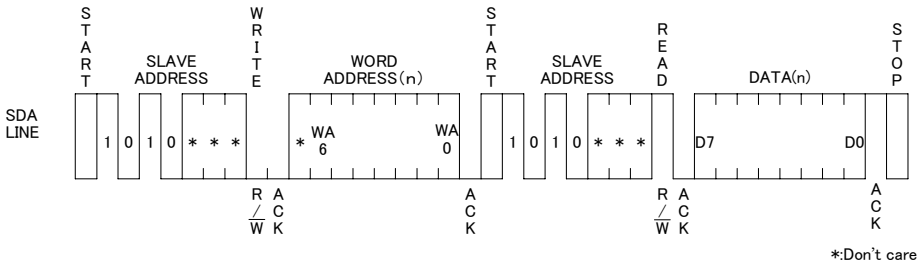


Figure 11. Random Read Cycle Timing

○Sequential Read

・If the Master does not transfer an Acknowledge and does not generate a STOP condition during the current Read operation, the BR24C21/F/FJ/FV continues to output the next address data in sequence. For Read operations, all bits in the address counter are incremented, allowing the entire array to be read during a single operation. When the counter reaches the top of the array, it will “roll over” to the bottom of the array and continue to transmit data.

・If the Master does not acknowledge the transmission but does generate a STOP condition, at this point the device discontinues transmission.

・The sequential Read operation can be performed with both Current Read and Random Read.

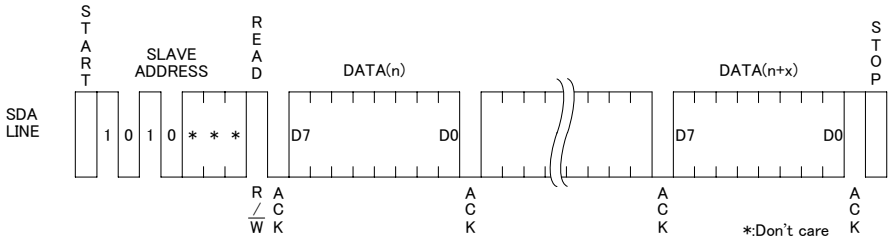


Figure 12. Sequential Read Cycle Timing
(Current Read)

© 2012 ROHM Co., Ltd. All rights reserved.

●Software Reset

Execute software reset in case the device is at an unexpected state after power up and/or the command input needs to be reset. The following figures (Figure 13-(a), Figure 13-(b), Figure 13-(c))

During dummy clock, please release SDA BUS (tied to Vcc by pull up resistor).

During that time, the device may pull the SDA line Low for acknowledge or outputting read data. If the master controls the SDA line High, it will conflict with the device output Low then it makes a current overload. It may cause instantaneous power down and may damage the device.

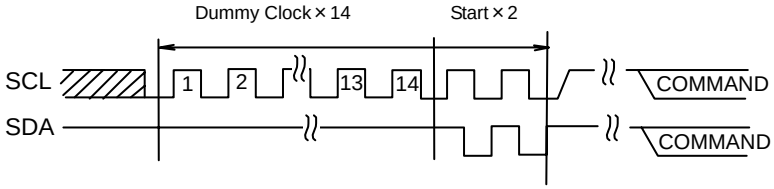


Figure 13-(a) Dummy Clock × 14 + Start + Start

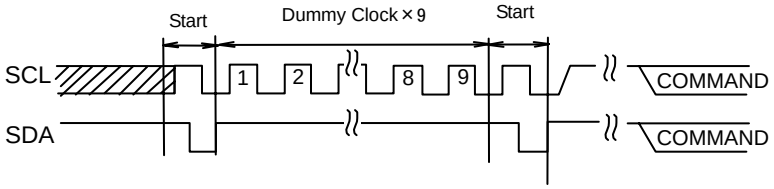


Figure 13-(b) Start + Dummy Clock × 9 + Start

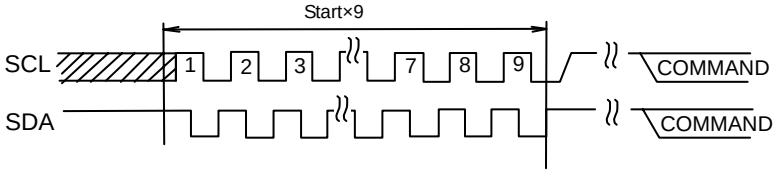


Figure 13-(c) Start × 9

●Acknowledge Polling

Since the device ignores all input commands during the internal write cycle, no ACK will be returned. When the master sends the next command following the write command, and the device returns the ACK, it means that the program is completed. If no ACK is returned, it means that the device is still busy. By using Acknowledge polling, the waiting time is minimized to less than tWR=5ms. To prevent operating Write or Current Read immediately after Write, first send the slave address (R/$\overline{W}$ is "High" or "Low"). After the device returns the ACK, continue word address input or data output, respectively.

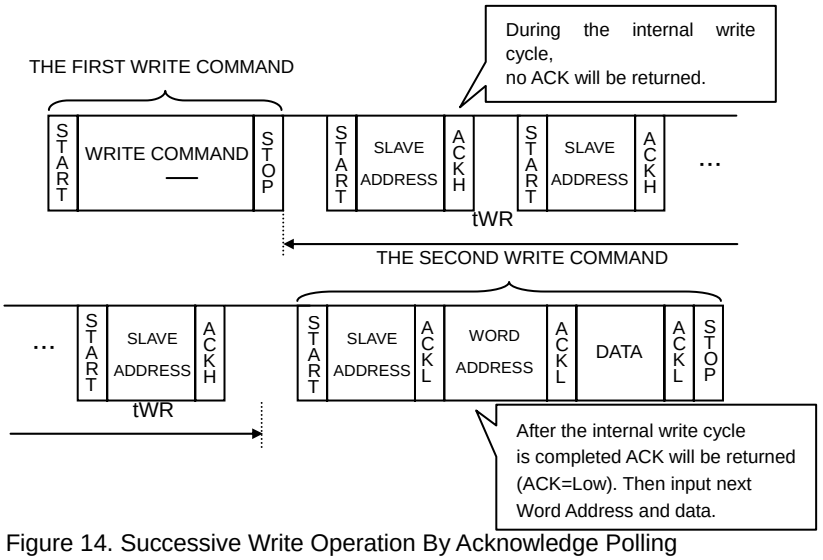


Figure 14. Successive Write Operation By Acknowledge Polling

© 2012 ROHM Co., Ltd. All rights reserved.

●Command Cancellation By Start And Stop Condition

During a command input, command is canceled by the successive inputs of start condition and stop condition (Figure 15.). However, during ACK or data output, the device may output the SDA line Low. In such cases, operation of start and stop condition is impossible, making the reset inoperable. Execute the software reset in the cases. (Figure 13.)
Operating the command cancel by start and stop condition during the command of Random Read or Sequential Read or Current Read, internal address counter is not confirmed. Therefore operation of Current Read after this is not valid. Operate a Random Read in this case.

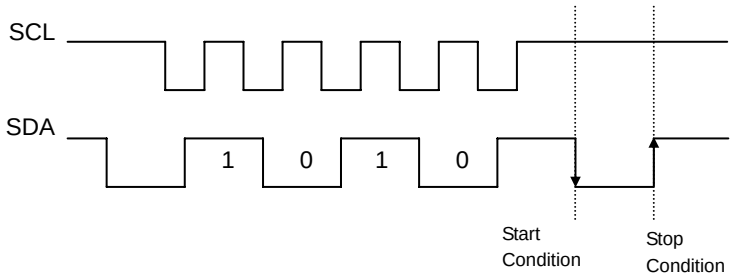


Figure 15. Command Cancellation

●I/O Circuit

○SDA Pin Pull-up Resister

The pull up resister is needed because SDA is NMOS open drain. Choose the correct value of this resister(R_{PU}), by considering VIL, IL characteristics of a controller which control the device and VOH, IOL characteristics of the device. If large R_{PU} is chosen, clock frequency needs to be slow. In case of small R_{PU}, the operating current increases.

○Maximum Rpu

Maximum value of R_{PU} is determined by following factors:

①SDA rise time determined by R_{PU} and the capacitance of bus line(CBUS) must be less than tR.

1) Other timing must keep the conditions of AC spec.

②When SDA bus is High, the voltage Ⓐ of SDA bus determined by a total input leak(IL) of the all devices connected to the bus. R_{PU} must be significantly higher than the High level input of a controller and the device, including a noise margin 0.2V_{CC}.

$$V_{CC}-IL R_{PU}-0.2\,V_{CC} \geqq V_{IH}$$

$$\therefore \quad R_{PU} \leqq \frac{0.8Vcc-V_{IH}}{IL}$$

Examples: When V_{CC}=3V IL=10μA VIH=0.7V_{CC}
According to ②

$$R_{PU} \leqq \frac{0.8x3-0.7x3}{10x10^{-6}}$$

$$\leqq 300\ [k\Omega]$$

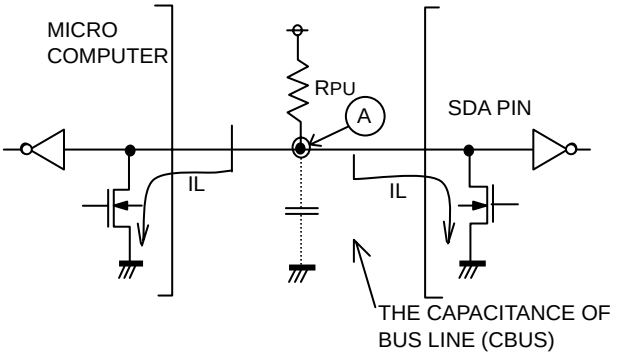


Figure 16. I/O Circuits

© 2012 ROHM Co., Ltd. All rights reserved.

○Minimum RPU

The minimum value of RPU is determined by following factors:

①Meets the condition that VOLMAX=0.4V, IOLMAX=3mA when the output is Low.

$$\frac{V_{CC}-V_{OL}}{R_{PU}} \leqq I_{OL}$$

$$\therefore \quad R_{PU} \geqq \frac{V_{CC}-V_{OL}}{I_{OL}}$$

② VOLMAX=0.4V must be lower than the input Low level of the microcontroller and the EEPROM including the recommended noise margin of 0.1VCC.

VOLMAX ≦ VIL-0.1 VCC

Examples: VCC=3V, VOL=0.4V, IOL=3mA, the VIL of the controller and

According to ①

エラー! 編集中のフィールド コードからは、オブジェクトを作成できません。

the EEPROM is VIL=0.3VCC,

and VOL=0.4［V］

VIL=0.3×3

=0.9［V］

so that condition② is met

○SCL Pin Pull-up Resister

When SCL is controlled by the CMOS output the pull-up resistor at SCL is not required.

However, should SCL be set to Hi-Z, connection of a pull-up resistor between SCL and VCC is recommended.

Several kΩ are recommended for the pull-up resistor in order to drive the output port of the microcontroller.

●Notes For Power Supply

VCC rises through the low voltage region in which the internal circuit of the IC and the controller are unstable. Therefore, the device may not work properly due to an incomplete reset of the internal circuit. To prevent this, the device has a P.O.R. and LVCC feature. At power up, maintain the following conditions to ensure functions of P.O.R and LVCC.

1. "SDA='H'" and "SCL='L' or 'H'".
2. Follow the recommended conditions of tR, tOFF, Vbot for the P.O.R. function during power up.

エラー! 編集中のフィールド コードからは、オブジェクトを作成できません。

3. Prevent SDA and SCL from being "Hi-Z".

In case conditions 1 and/or 2 cannot be met, take following actions:

A)If unable to keep condition 1 (SDA is "Low" during power up):

→Control SDA, SCL to be "High" as shown in figure below.

Figure 17.

エラー! 編集中のフィールド コードからは、オブジェクトを作成できません。

B)If unable to keep condition 2.

→After power becomes stable, execute software reset. (See Figure 13.)

C)If unable to keep both conditions 1 and 2.

→Follow the instruction A first, then the instruction B.

Recommended conditions of tR, tOFF, Vbot		
tR	tOFF	Vbot
Below 10ms	Above 10ms	Below 0.3V
Below 100ms	Above 10ms	Below 0.2V

●LVcc Circuit

LVCC circuit inhibits write operation at low voltage, and prevents an inadvertent write. Write operation is inhibited below the LVCC voltage (Typ.=1.2V).

●Vcc NOI Figure 18. Figure 19.

○Bypass Condenser

Noise and surges on power line may cause abnormal function. It is recommended that the bypass condensers (0.1μF) are attached on the Vcc and GND line beside the device. It is also recommended to attach bypass condensers on the board close to the connector.

●Notes for Use

1) Described numeric values and data are design representative values, and the values are not guaranteed.

2) We believe that application circuit examples are recommendable, however, in actual use, confirm characteristics further sufficiently. In the case of use by changing the fixed number of external parts, make your decision with sufficient margin in consideration of static characteristics and transition characteristics and fluctuations of external parts and our LSI.

© 2012 ROHM Co., Ltd. All rights reserved.

3) Absolute maximum ratings
If the absolute maximum ratings such as impressed voltage and operating temperature range and so forth are exceeded, LSI may be destructed. Do not impress voltage and temperature exceeding the absolute maximum ratings. In the case of fear exceeding the absolute maximum ratings, take physical safety countermeasures such as fuses, and see to it that conditions exceeding the absolute maximum ratings should not be impressed to LSI.

4) GND electric potential
Set the voltage of GND terminal lowest at any action condition. Make sure that each terminal voltages is lower than that of GND terminal.

5) Heat design
In consideration of permissible dissipation in actual use condition, carry out heat design with sufficient margin.

6) Terminal to terminal shortcircuit and wrong packaging
When to package LSI onto a board, pay sufficient attention to LSI direction and displacement. Wrong packaging may destruct LSI. And in the case of shortcircuit between LSI terminals and terminals and power source, terminal and GND owing to foreign matter, LSI may be destructed.

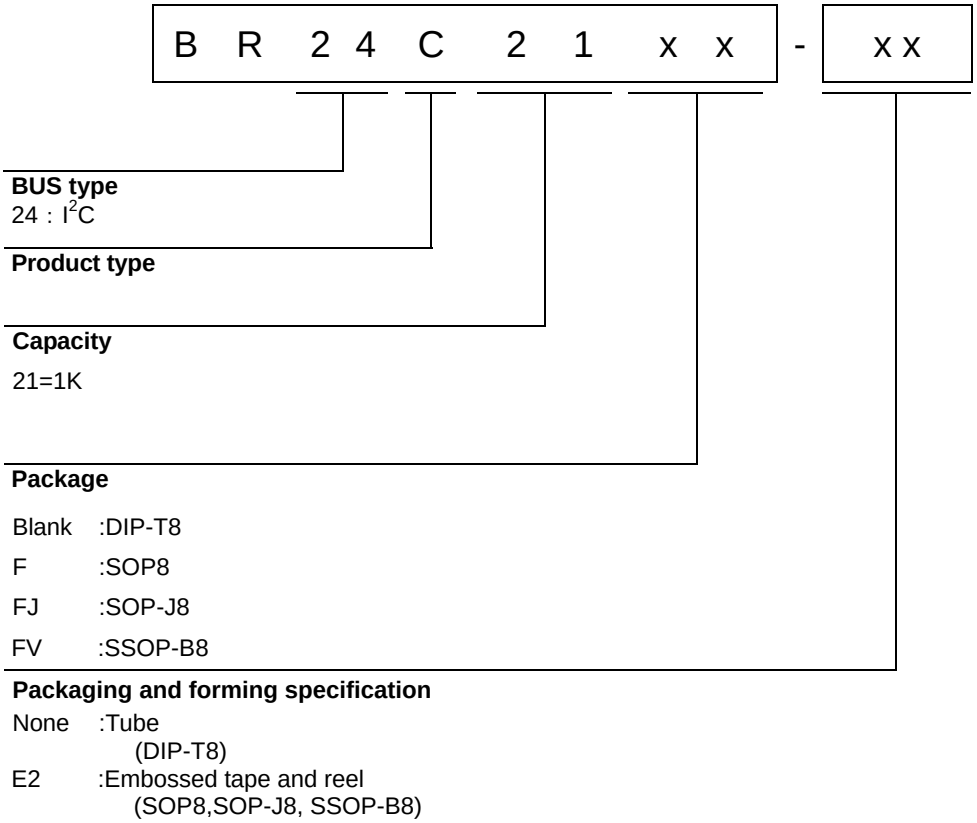
7) Use in a strong electromagnetic field may cause malfunction, therefore, evaluated design sufficiently

Status of this document
The Japanese version of this document is formal specification. A customer may use this translation version only for a reference to help reading the formal version.
If there are any differences in translation version of this document formal version takes priority.

© 2012 ROHM Co., Ltd. All rights reserved.

●Ordering Information

Product Code Description



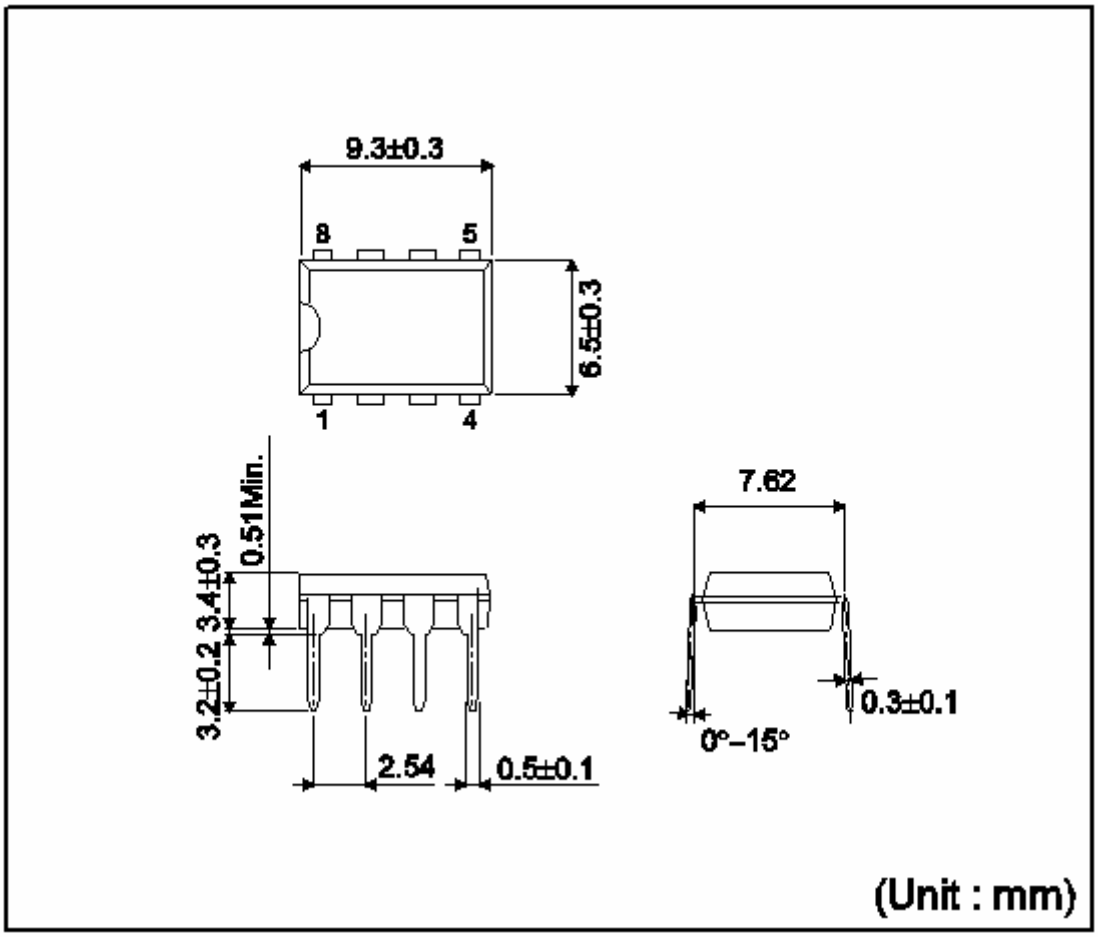
●Lineup

Capacity	Package	
	Type	Quantity
1K	DIP-T8	Tube of 2000
	SOP8	Reel of 2500
	SOP-J8	
	SSOP-B8	

© 2012 ROHM Co., Ltd. All rights reserved.

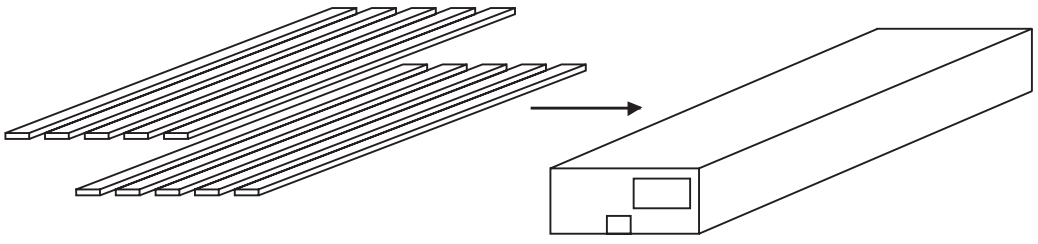
●**Physical Dimension Tape and Reel Information**

DIP-T8



<Tape and Reel information>

Container	Tube
Quantity	2000pcs
Direction of feed	Direction of products is fixed in a container tube

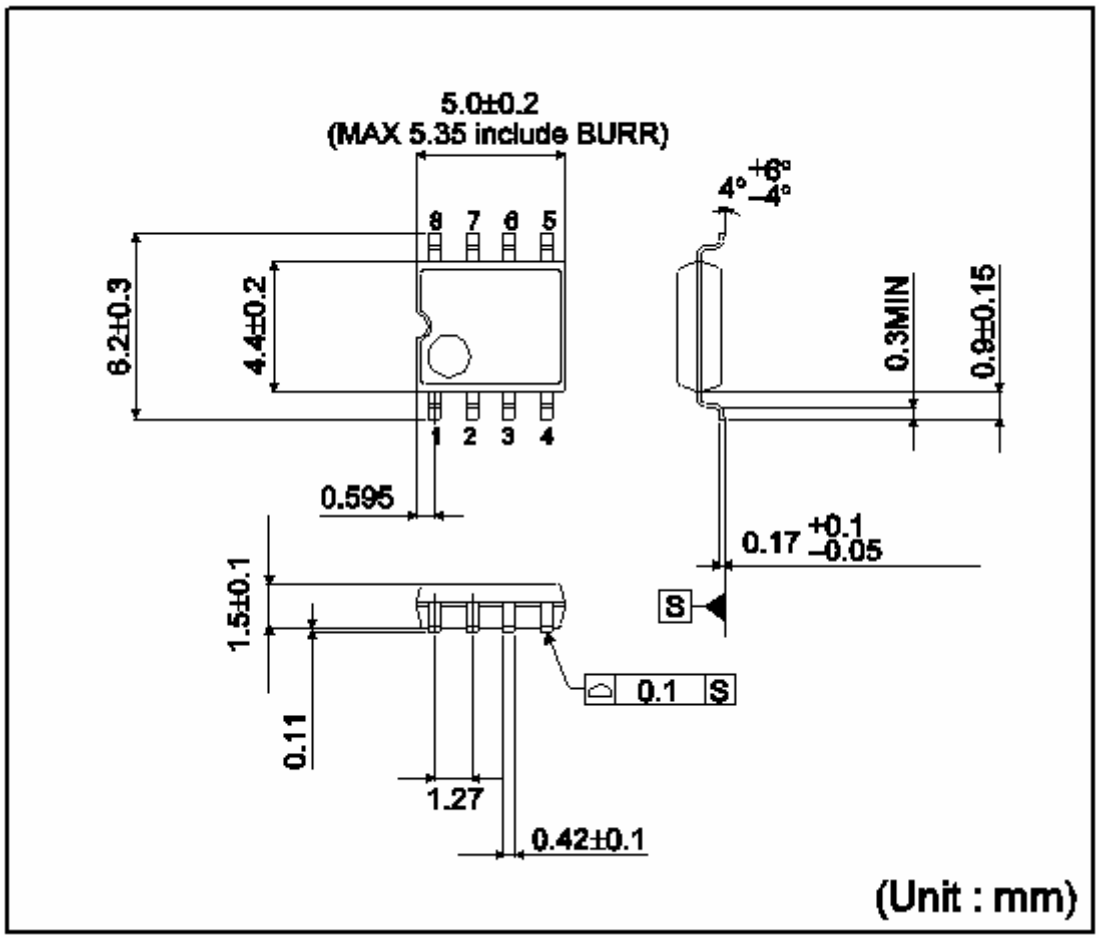


∗Order quantity needs to be multiple of the minimum quantity.

© 2012 ROHM Co., Ltd. All rights reserved.

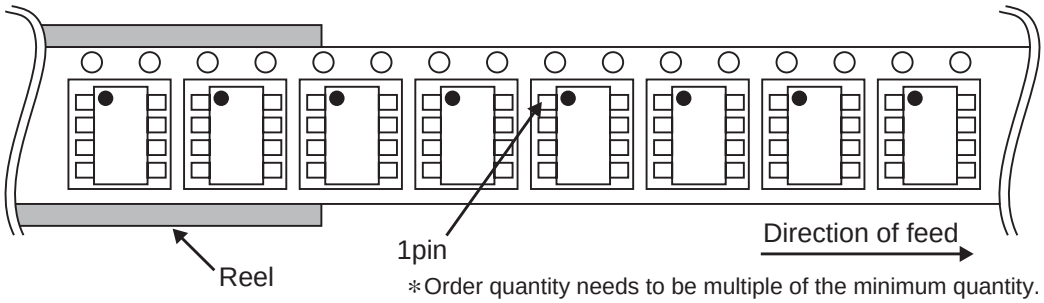
●**Physical Dimension Tape and Reel Information - Continued**

SOP8



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)

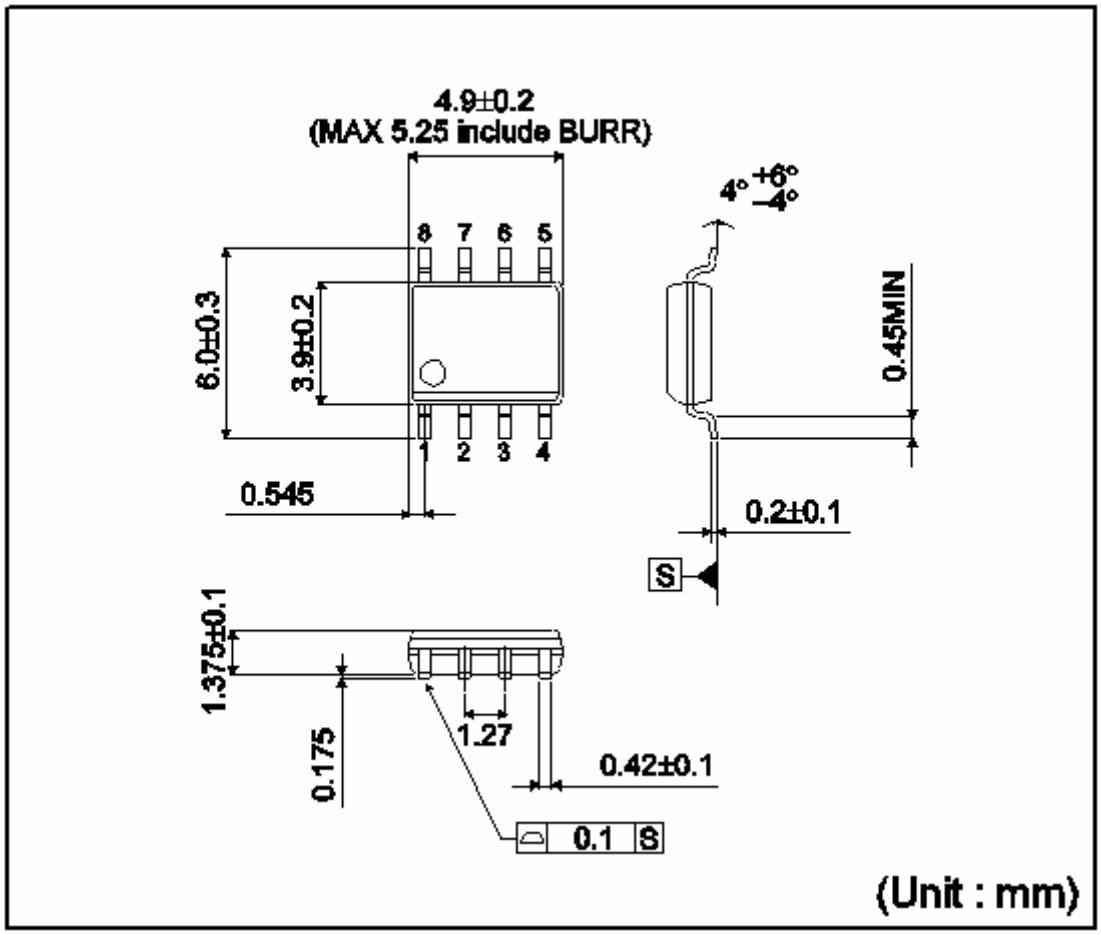


∗Order quantity needs to be multiple of the minimum quantity.

© 2012 ROHM Co., Ltd. All rights reserved.

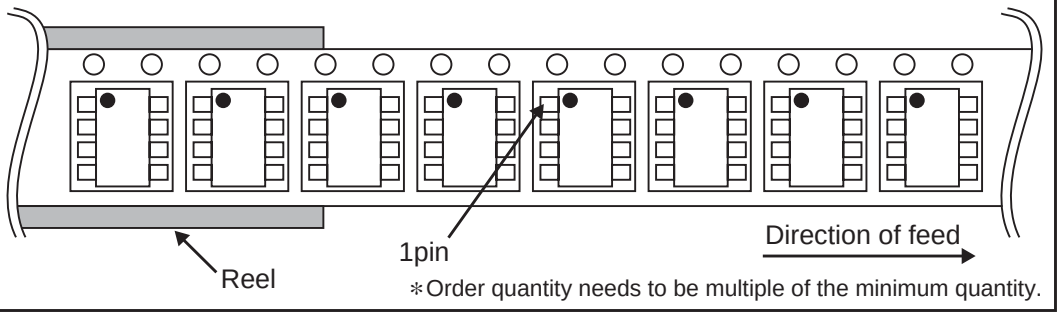
●**Physical Dimension Tape and Reel Information - Continued**

SOP-J8



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)

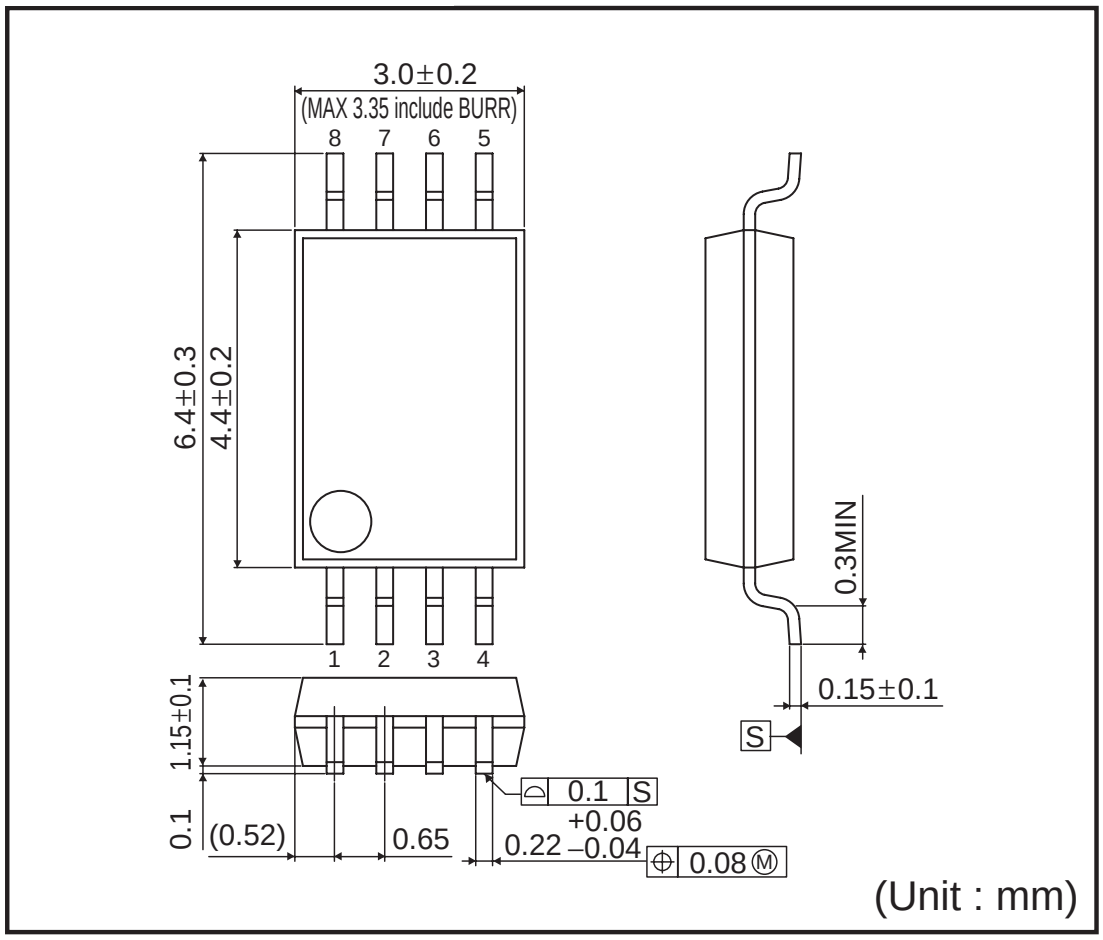


∗Order quantity needs to be multiple of the minimum quantity.

© 2012 ROHM Co., Ltd. All rights reserved.

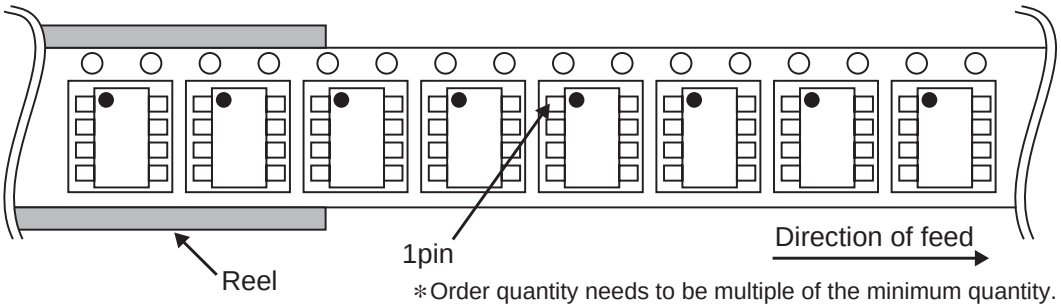
●**Physical Dimension Tape and Reel Information - Continued**

SSOP-B8



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)

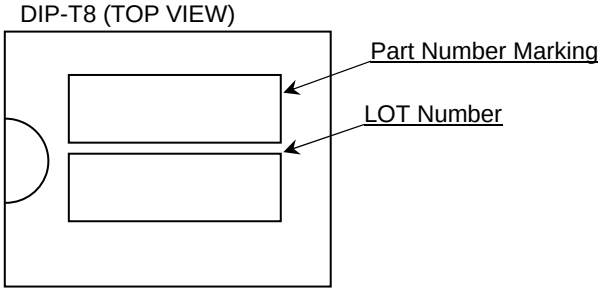


∗Order quantity needs to be multiple of the minimum quantity.

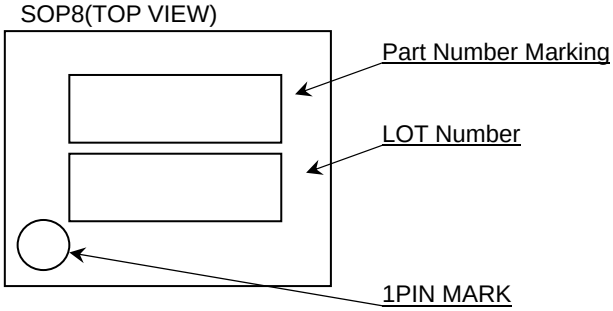
© 2012 ROHM Co., Ltd. All rights reserved.

●**Marking Diagrams**

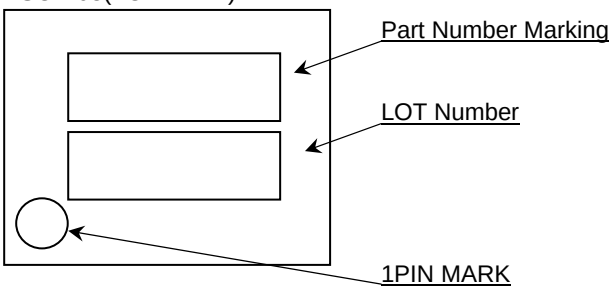
DIP-T8 (TOP VIEW)



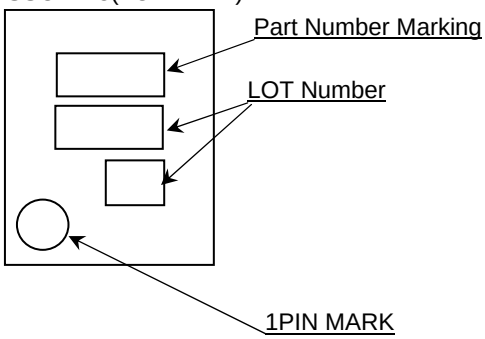
SOP8(TOP VIEW)



SOP-J8(TOP VIEW)



SSOP-B8(TOP VIEW)



●**Marking Information**

Capacity	Product Name Marking	Package Type
1K	BR24C21	DIP-T8
	C21	SOP8
		SOP-J8
		SSOP-B8

© 2012 ROHM Co., Ltd. All rights reserved.

●**Revision History**

Date	Revision	Changes
10.Jul.2012	001	New Release

© 2012 ROHM Co., Ltd. All rights reserved.

Notice

●General Precaution

1) Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

2) All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.

●Precaution on using ROHM Products

1) Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment, transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

2) ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3) Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4) The Products are not subject to radiation-proof design.

5) Please verify and confirm characteristics of the final or mounted products in using the Products.

6) In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse) is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7) De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8) Confirm that operation temperature is within the specified range described in the product specification.

9) ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

© 2012 ROHM Co., Ltd. All rights reserved.

●Precaution for Mounting / Circuit board design

1) When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2) In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

●Precautions Regarding Application Examples and External Circuits

1) If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2) You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

●Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

●Precaution for Storage / Transportation

1) Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2) Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3) Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4) Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

●Precaution for Product Label

QR code printed on ROHM Products label is for ROHM's internal use only.

●Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

●Precaution for Foreign Exchange and Foreign Trade act

Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

●Precaution Regarding Intellectual Property Rights

1) All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data. ROHM shall not be in any way responsible or liable for infringement of any intellectual property rights or other damages arising from use of such information or data.:

2) No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the information contained in this document.

© 2012 ROHM Co., Ltd. All rights reserved.

●Other Precaution

1) The information contained in this document is provided on an “as is” basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.

2) This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.

3) The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

4) In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.

5) The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

© 2012 ROHM Co., Ltd. All rights reserved.