

# Serial EEPROM Series Standard EEPROM Microwire BUS EEPROM(3-Wire)



## BU9888FV-W

### General Description

BU9888FV-W is a serial EEPROM of serial 3-line interface method.

### Features

- 256word×16bits architecture 4k bit serial EEPROM
- Operating voltage range(3.0V to 3.6V)
- Write Cycle time  $t_{E/W}=2\text{ms}(\text{Max})$
- Address auto increment function at read action
- Write mistake prevention function
  - Write prohibition at power on
  - Write prohibition by command code
  - Write mistake prevention function at low voltage
- Program cycle auto delete and auto end function
- Program condition display READY / BUSY
- Low current consumption
  - At write action(3.6V):  $I_{CC1} = 3.5\text{mA}(\text{Max.})$
  - At read action(3.6V):  $I_{CC2} = 2.0\text{mA}(\text{Max.})$
  - At standby action (3.6V):  $I_{SB} = 2.0\mu\text{A}(\text{Max.})$
- Data retention for 40 years
- Data rewrite up to 100,000 times
- Data at shipment all addresses FFFFh

### Package W(Typ.) x D(Typ.) x H(Max.)



### Absolute Maximum Ratings (Ta=25°C)

| Parameter             | Symbol    | Ratings              | Unit | Remarks  |
|-----------------------|-----------|----------------------|------|--|
| Supply Voltage        | $V_{CC}$  | -0.3 to +6.5         | V    |  |
| Power Dissipation     | $P_d$     | 300                  | mW   | Degradation is done at 3.0mW/°C for operation above 25°C |
| Storage Temperature   | $T_{stg}$ | -65 to +125          | °C   |  |
| Operating Temperature | $T_{opr}$ | -20 to +85           | °C   |  |
| Terminal Voltage      | —         | -0.3 to $V_{CC}+0.3$ | V    | The Max value of Terminal Voltage is not over 6.5V       |

### Memory cell characteristics(Ta=25°C, $V_{CC} = 3.0\text{V}$ to 3.6V)

| Parameter            | Limits  |      |      | Unit   |
|----------------------|---------|------|------|--------|
|                      | Min.    | Typ. | Max. |        |
| Erase/Write Cycle *1 | 100,000 | —    | —    | Cycles |
| Data Retention *1    | 40      | —    | —    | Years  |

\*1 Not 100% TESTED

### Recommended Operating Ratings

| Parameter      | Symbol   | Ratings       | Unit |
|----------------|----------|---------------|------|
| Supply Voltage | $V_{CC}$ | 3.0 to 3.6    | V    |
| Input Voltage  | $V_{IN}$ | 0 to $V_{CC}$ |      |

**●Electrical Characteristics -DC Operating** (Unless otherwise specified Ta=-20°C to +85°C, V<sub>CC</sub> =3.0V to 3.6V)

| Parameter              | Symbol          | Limits              |      |                      | Unit | Test Condition   |
|------------------------|-----------------|---------------------|------|----------------------|------|--|
|                        |                 | Min.                | Typ. | Max.                 |      |  |
| "L" Input Voltage      | V <sub>IL</sub> | -0.3                | —    | 0.2×V <sub>CC</sub>  | V    |  |
| "H" Input Voltage      | V <sub>IH</sub> | 0.8×V <sub>CC</sub> | —    | V <sub>CC</sub> +0.3 | V    |  |
| "L" Output Voltage     | V <sub>OL</sub> | 0                   | —    | 0.4                  | V    | I <sub>OL</sub> =2.1mA   |
| "H" Output Voltage     | V <sub>OH</sub> | 2.4                 | —    | V <sub>CC</sub>      | V    | I <sub>OH</sub> =-0.4mA  |
| Input Leakage Current  | I <sub>LI</sub> | -1                  | —    | 1                    | μA   | V <sub>IN</sub> =0 to V <sub>CC</sub>                                      |
| Output Leakage Current | I <sub>LO</sub> | -1                  | —    | 1                    | μA   | V <sub>OUT</sub> =0 to V <sub>CC</sub> , CS=0V                             |
| Operating Current      | ICC1            | —                   | —    | 3.5                  | mA   | f <sub>SK</sub> =2MHz, t <sub>E/W</sub> =2ms(WRITE), TEST1=V <sub>CC</sub> |
|                        | ICC2            | —                   | —    | 2.0                  | mA   | f <sub>SK</sub> =2MHz, (READ), TEST1=V <sub>CC</sub>                       |
| Standby Current        | ISB             | —                   | —    | 2.0                  | μA   | CS=0V, TEST1=V <sub>CC</sub> , DO=OPEN                                     |

**●Electrical Characteristics -AC Operating** (Ta=-20°C to +85°C, V<sub>CC</sub> = 3.0V to 3.6V)

| Parameter                  | Symbol           | Limits |      |      | Unit |
|----------------------------|------------------|--------|------|------|------|
|                            |                  | Min.   | Typ. | Max. |      |
| SK Clock Frequency         | f <sub>SK</sub>  | —      | —    | 2    | MHz  |
| SK High Time               | t <sub>SKH</sub> | 230    | —    | —    | ns   |
| SK Low Time                | t <sub>SKL</sub> | 230    | —    | —    | ns   |
| CS Low Time                | t <sub>CS</sub>  | 200    | —    | —    | ns   |
| CS Setup Time              | t <sub>CSS</sub> | 200    | —    | —    | ns   |
| DI Setup Time              | t <sub>DIS</sub> | 100    | —    | —    | ns   |
| CS Hold Time               | t <sub>CSH</sub> | 0      | —    | —    | ns   |
| DI Hold Time               | t <sub>DIH</sub> | 100    | —    | —    | ns   |
| Data "1" Output Delay Time | t <sub>PD1</sub> | —      | —    | 200  | ns   |
| Data "0" Output Delay Time | t <sub>PD0</sub> | —      | —    | 200  | ns   |
| CS to Status Valid         | t <sub>SV</sub>  | —      | —    | 150  | ns   |
| CS to Output High-Z        | t <sub>DF</sub>  | —      | —    | 150  | ns   |
| Write Cycle time           | t <sub>E/W</sub> | —      | —    | 2    | ms   |

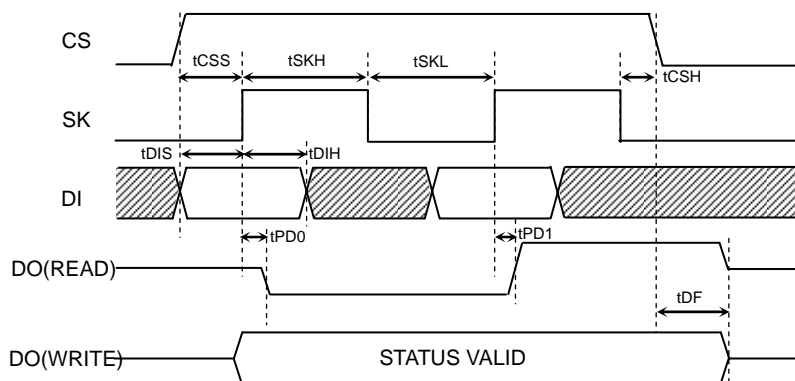
**●Sync Data Input / Output Timing**


Figure 1. Sync data input / output timing

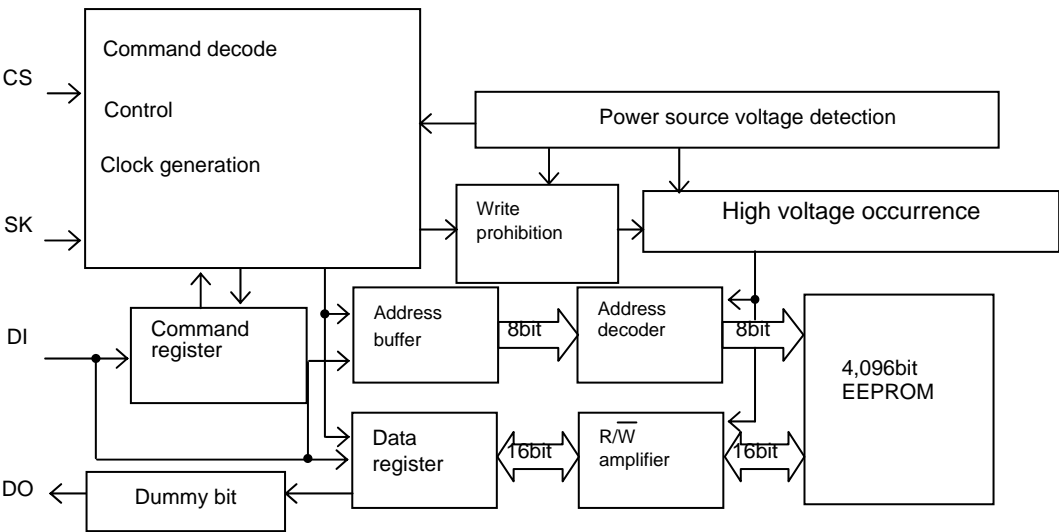
○Data is taken by DI in sync with the rise of SK.

○At read action, data is output from DO in sync with the rise of SK.

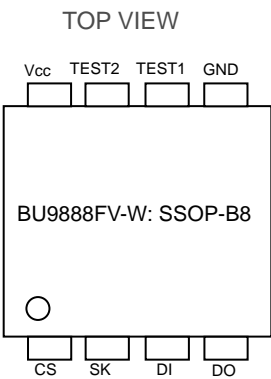
○The status signal at write (READY / BUSY) is output after t<sub>CS</sub> from the fall of CS after write command input, at the area DO where CS is "H", and valid until the next command start bit is input. And, while CS is "L", DO becomes High-Z.

○After completion of each mode execution, set CS "L" once for internal circuit reset, and execute the following action mode.

●Block Diagram



●Pin Configuration



●Pin Descriptions

| Pin name | I / O  | Function                                 |
|----------|--------|--|
| CS       | Input  | Chip select input                        |
| SK       | Input  | Serial clock input                       |
| DI       | Input  | Serial data input                        |
| DO       | Output | Serial data output                       |
| TEST1    | Input  | Test pin. Please connect to power.       |
| TEST2    | -      | Test pin. Please open at using.          |
| Vcc      | -      | Power source                             |
| GND      | -      | All input / output reference voltage, 0V |

# ● Typical Performance Curves

(The following characteristic data are Typ. Values.)

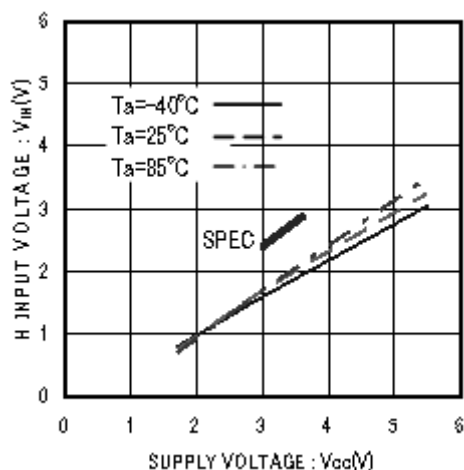


Figure 2. 'H' input voltage  
 $V_{IH}(CS,SK,DI)$

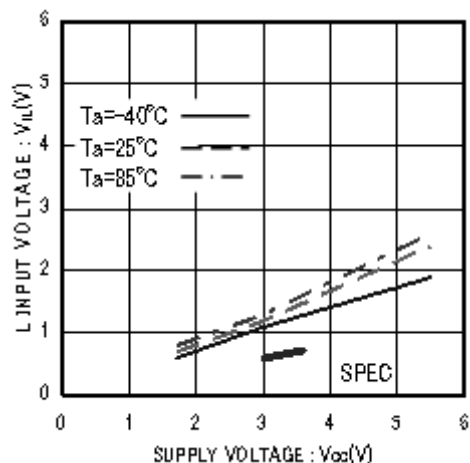


Figure 3. 'L' input voltage  
 $V_{IL}(CS,SK,DI)$

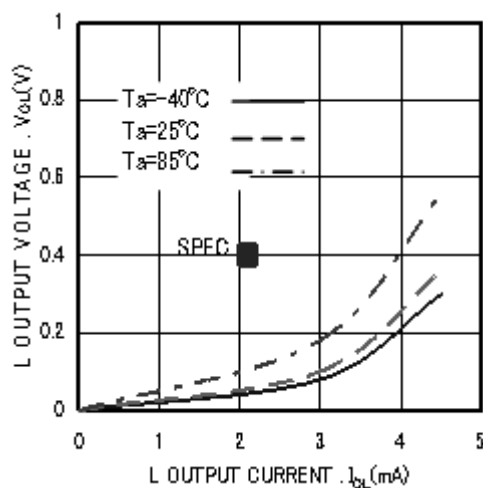


Figure 4. 'L' output voltage  
 $V_{OL-IOL}(V_{CC}=3.0V)$

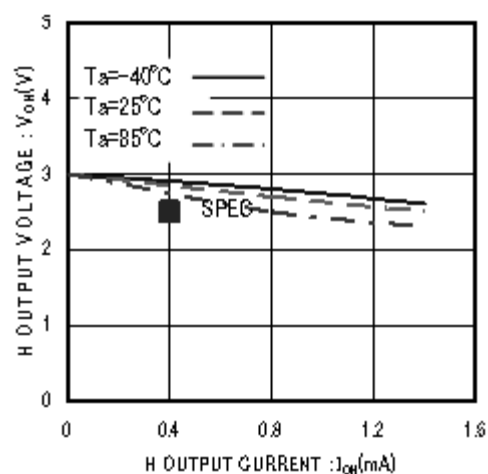
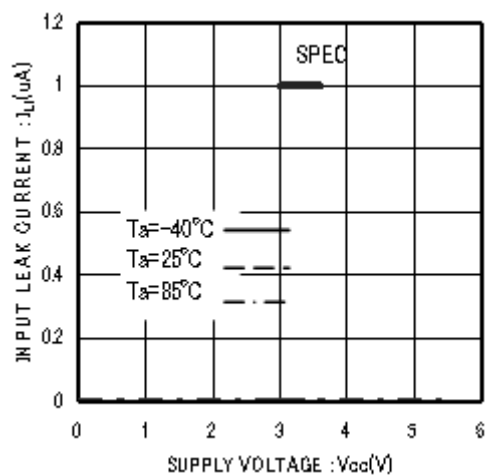
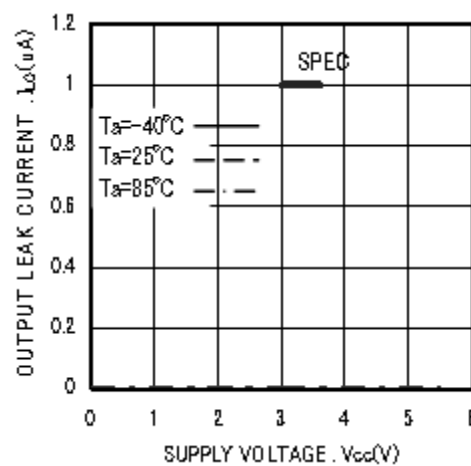
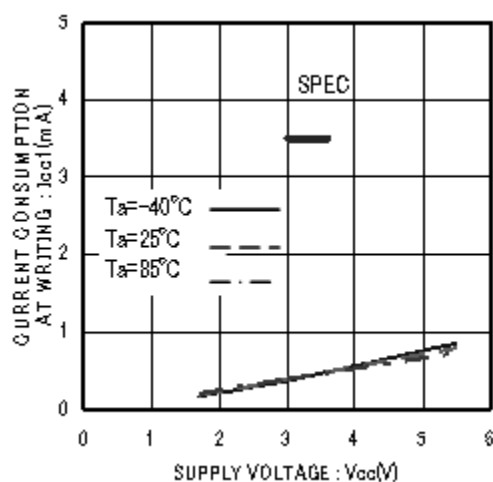
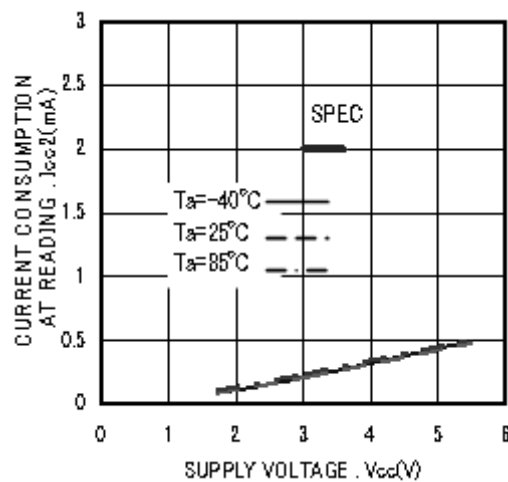


Figure 5. 'H' output voltage  
 $V_{OH-IOH}(V_{CC}=3.0V)$

## ● Typical Performance Curves - Continued

Figure 6. Input leak current  
 $I_{LI}(\text{CS}, \text{SK}, \text{DI})$ Figure 7. Output leak current  
 $I_{LO}(\text{DO})$ Figure 8. Current consumption at WRITE  
Action  $I_{CC1}(\text{fSK}=2\text{MHz})$ Figure 9. Consumption current at READ  
Action  $I_{CC2}(\text{fSK}=2\text{MHz})$

●Typical Performance Curves - Continued

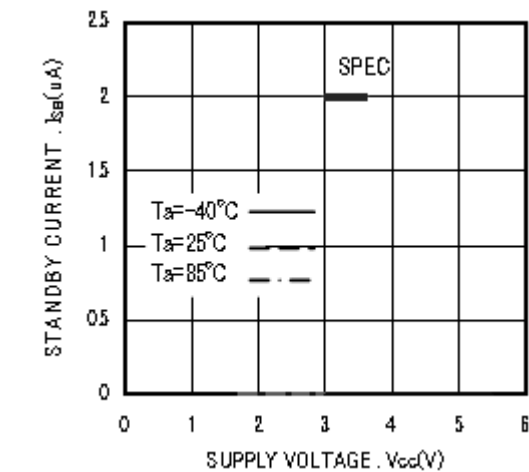


Figure 10. Consumption current at standby action  $I_{ss}$

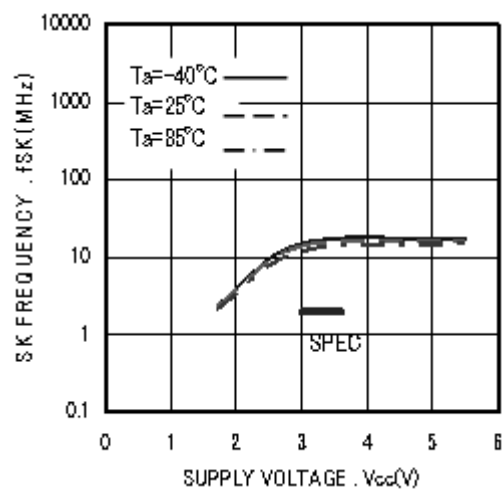


Figure 11. SK frequency  $f_{sk}$

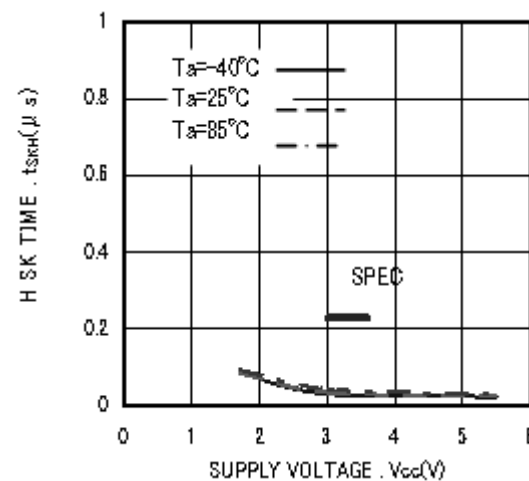


Figure 12. SK high time  $t_{skH}$

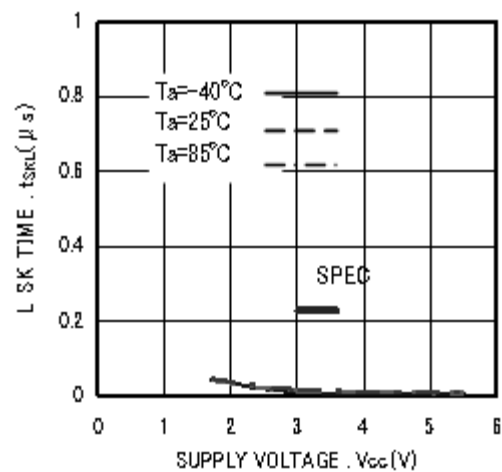


Figure 13. SK low time  $t_{skL}$

## ● Typical Performance Curves - Continued

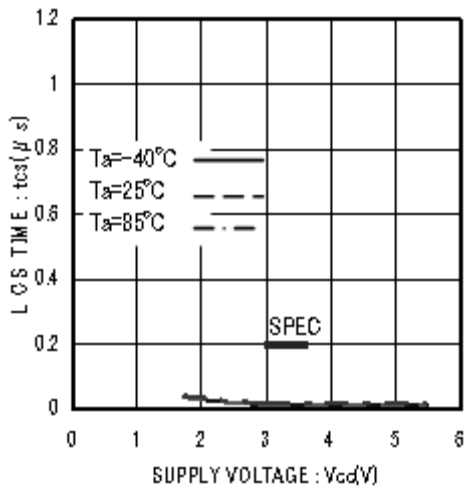


Figure 14. CS Low time tcs

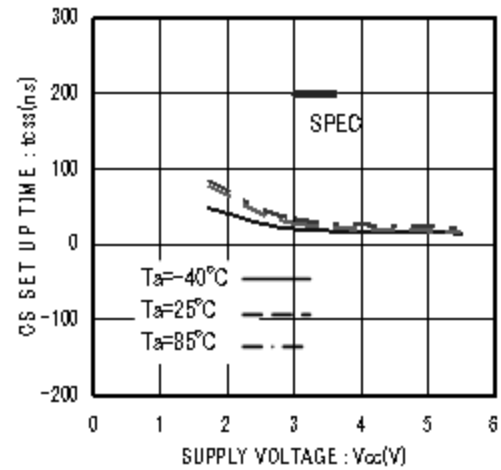


Figure 15. CS Setup time tcss

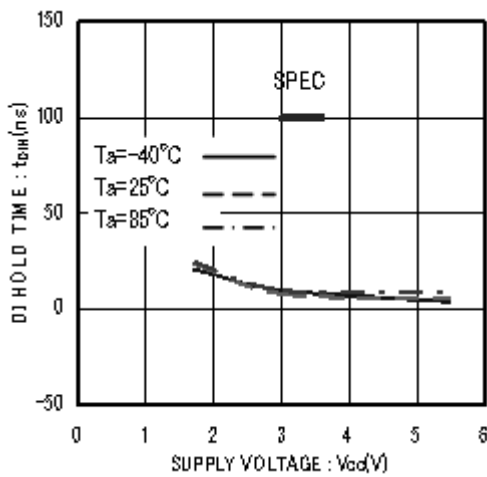


Figure 16. DI Hold time tDIH

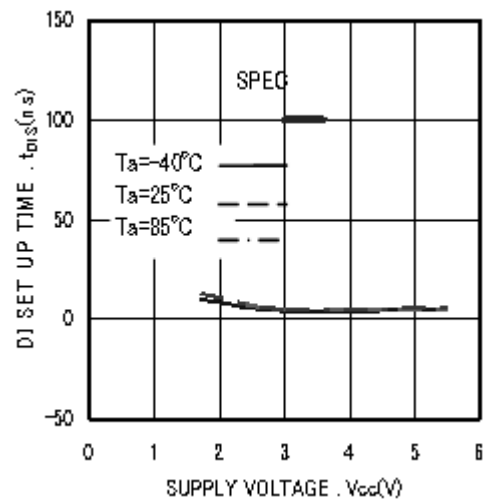


Figure 17. DI Setup time tDIS

● Typical Performance Curves - Continued

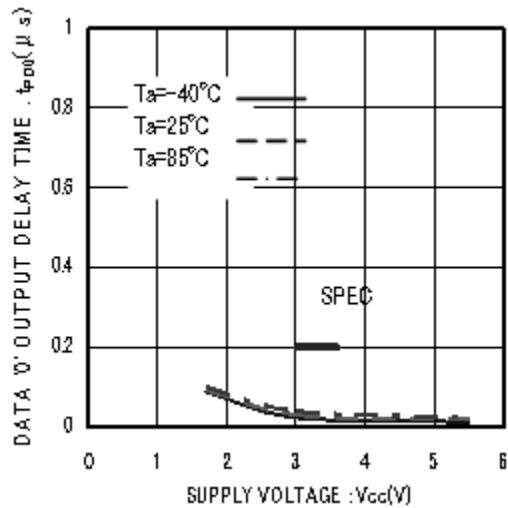


Figure 18. Data '0' output delay time tPD0

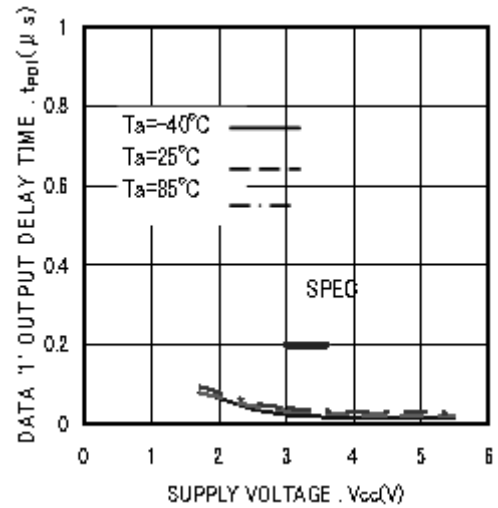


Figure 19. Data '1' output delay time tPD1

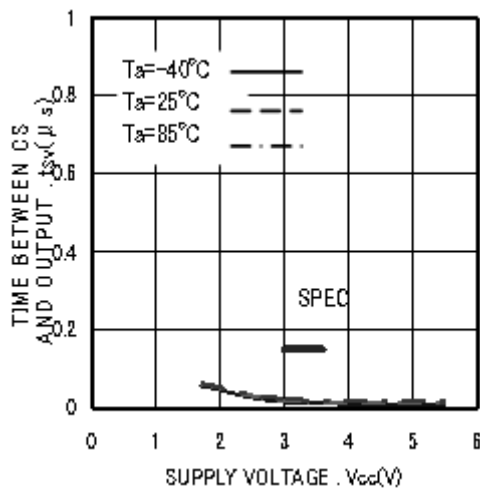


Figure 20. Time from CS to output establishment tsv

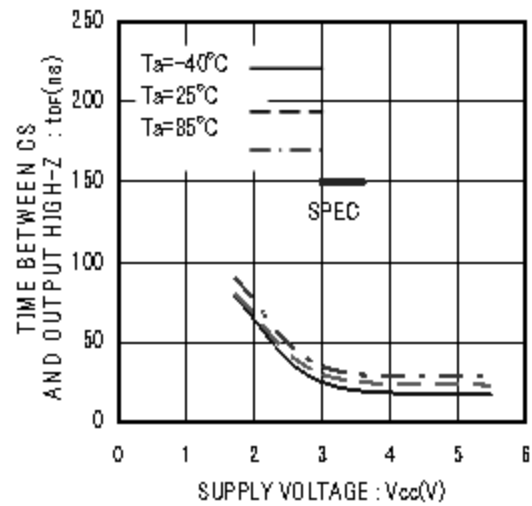


Figure 21. Time from CS to High-Z tHF



●Typical Performance Curves - Continued

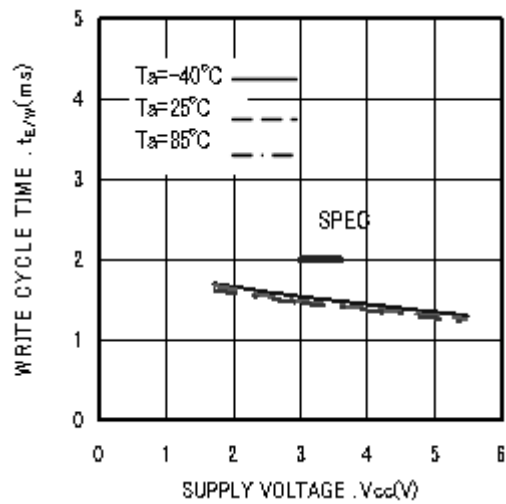


Figure 22. Write cycle time  $t_{EW}$

## ●Command mode

| Command                       | Start bit | Ope code | Address                        | Data                  |
|-------------------------------|-----------|----------|--------------------------------|-----------------------|
| Read (READ) <sup>(*)1</sup>   | 1         | 10       | A7, A6, A5, A4, A3, A2, A1, A0 | D15 to D0(READ DATA)  |
| Write enable (WEN)            | 1         | 00       | 1 1 * * * * * *                |                       |
| Write (WRITE) <sup>(*)2</sup> | 1         | 01       | A7, A6, A5, A4, A3, A2, A1, A0 | D15 to D0(WRITE DATA) |
| Write disable (WDS)           | 1         | 00       | 0 0 * * * * * *                |                       |

- Input the address and the data in MSB first manners.
- As for \*, input either VIH or VIL.

### \*Start bit

Acceptance of all the commands of this IC starts at recognition of the start bit.

The start bit means the first "1" input after the rise of CS.

\*1As for read, by continuous SK clock input after setting the read command, data output of the set address starts, and address data in significant order are sequentially output continuously. (Auto increment function)

\*2When the read and the write all commands are executed, data written in the selected memory cell is automatically deleted, and input data is written.

## ●Timing chart

### 1. Read cycle (READ)

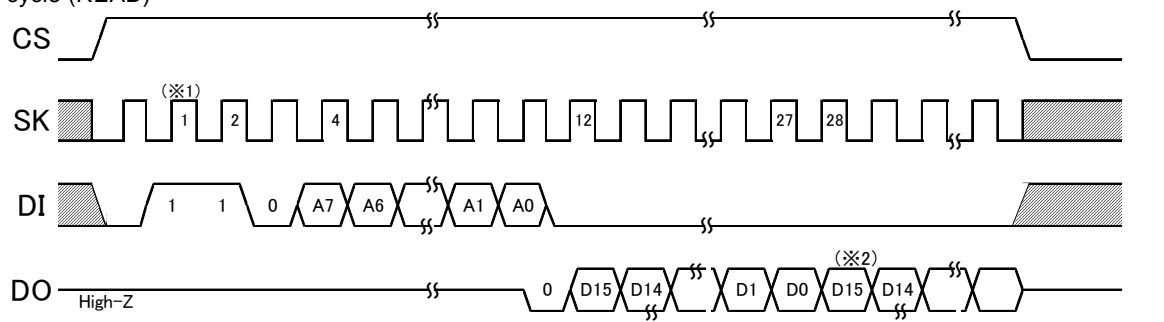


Figure 23. Read cycle

(※2) Next address data(Auto increment function)

### (※1) Start bit

When data "1" is input for the first time after the rise of CS, this is recognized as a start bit. And when "1" is input after plural "0" are input, it is recognized as a start bit, and the following operation is started. This is common to all the commands to be described hereafter.

○When the read command is recognized, input address data (16bit) is output to serial. And at that moment, at taking A0, in sync with the rise of SK, "0" (dummy bit) is output. And, the following data is output in sync with the rise of SK. This IC has an address auto increment function valid only at read command. This is the function where after the above read execution, by continuously inputting SK clock, the above address data is read sequentially. And, during the auto increment, keep CS at "H".

### 2. Write cycle (WRITE)

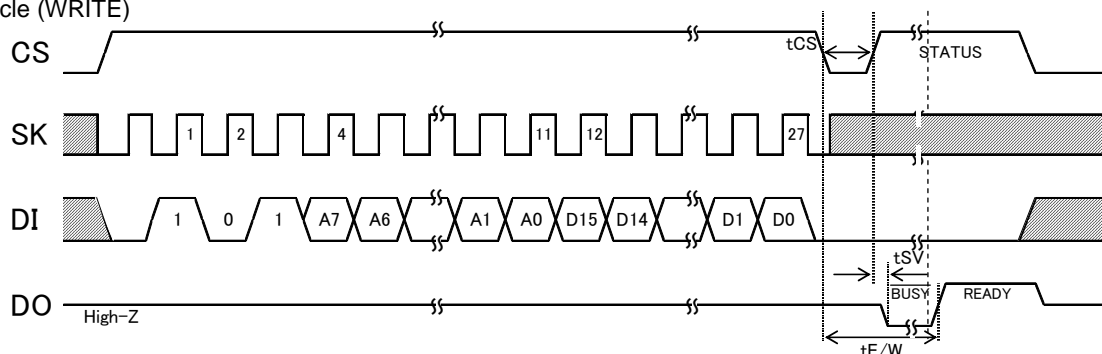


Figure 24. Write cycle

○In this command, input 16bit data (D15 to D0) are written to designated addresses (A7 to A0). The actual write starts by the fall of CS of D0 taken SK clock. When STATUS is not detected, (CS="L" fixed) Max. 2ms in conformity with tE/W, and when STATUS is detected (CS="H"), all commands are not accepted for areas where "L" (BUSY) is output from D0, therefore, do not input any command.

## 3. Write enable (WEN)

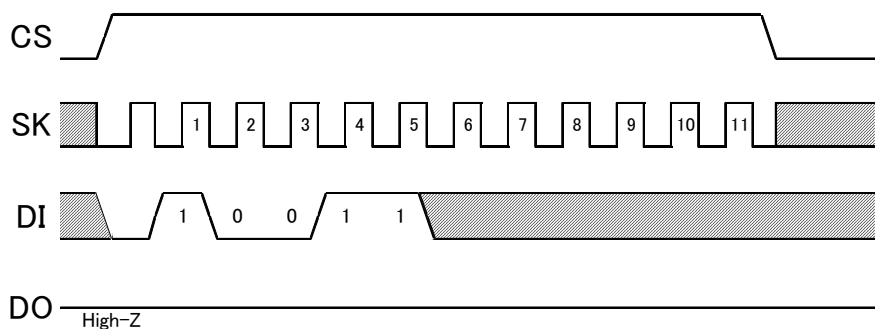


Figure 25. Write enable (WEN) cycle

○At power on, this IC is in write disable status by the internal RESET circuit. Before executing the write command, it is necessary to execute the write enable command. And, once this command is executed, it is valid until the write disable command is executed or the power is turned off. However, the read command is valid irrespective of write enable / disable command. Input to SK after 8 clocks of this command is available by either "H" or "L", but be sure to input it.

## 4. Write disable (WDS) cycle

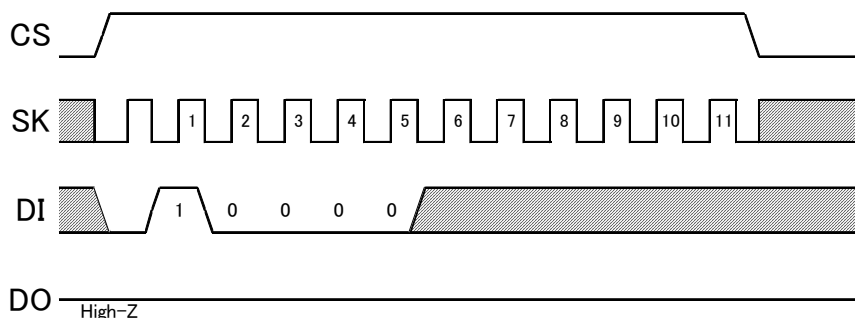


Figure 26. Write disable (WDS) cycle

○When the write enable command is executed after power on, write enable status gets in. When the write disable command is executed then, the IC gets in write disable status as same as at power on, and then the write command is canceled thereafter in software manner. However, the read command is executable. In write enable status, even when the write command is input by mistake, write is started. To prevent such a mistake, it is recommended to execute the write disable command after completion of write. Input to SK after 8 clocks of this command is available by either "H" or "L", but be sure to input it.

## ●Application

### 1) Method to cancel each command

#### OREAD

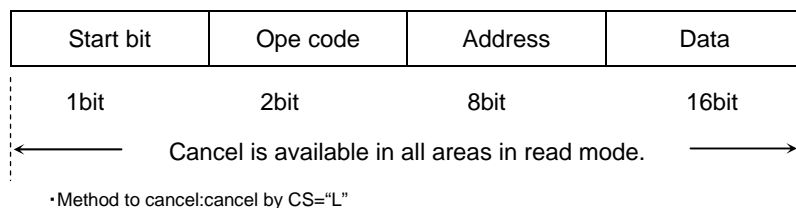


Figure 27. READ cancel available timing

#### OWRITE

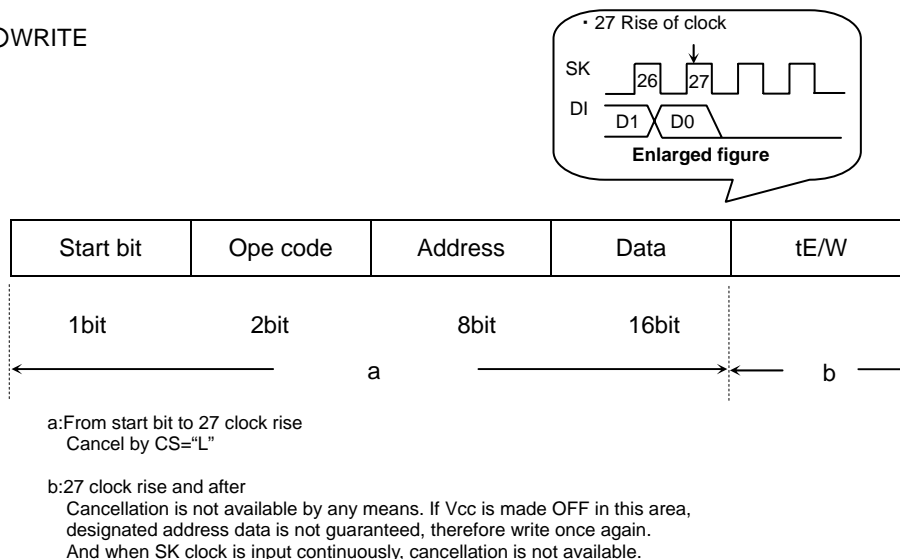


Figure 28. Write cancel available timing

### 2) At standby

#### ○Standby current

When CS is "L", SK input is "L", DI input is "H", and even with middle electric potential, current does not increase.

#### ○Timing

As shown in Figure 29, when SK at standby is "H", if CS is started, DI status may be read at the rise edge. At standby and at power ON/OFF, when to start CS, set SK input or DI input to "L" status. (Refer to Figure 30)

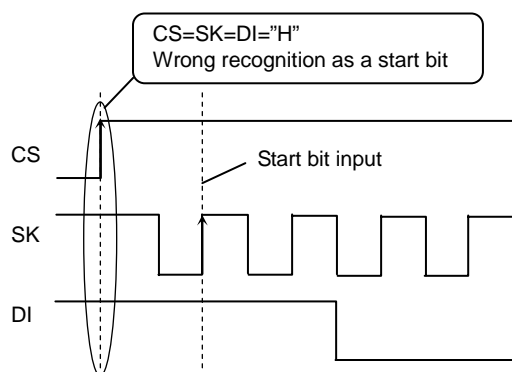


Figure 29. Wrong action timing

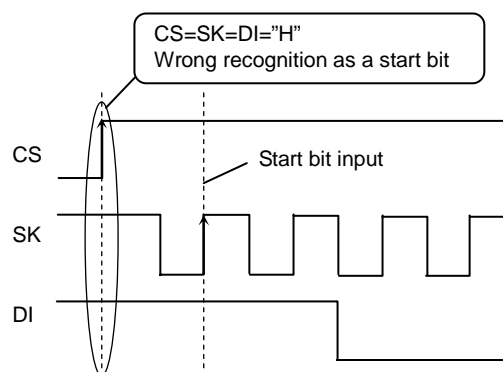


Figure 30. Normal action timing

## 3) Equivalent circuit

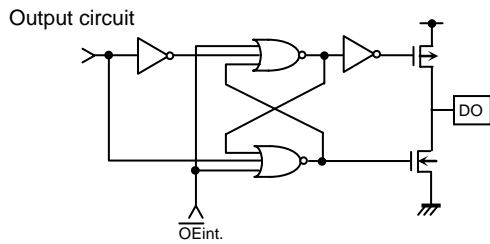


Figure 31. Output circuit (DO)

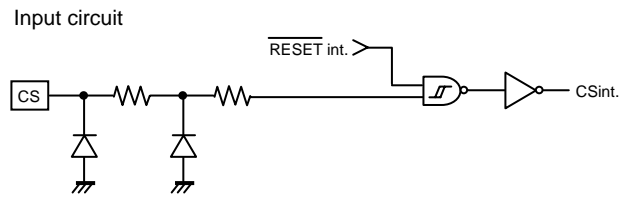


Figure 32. Input circuit (CS)

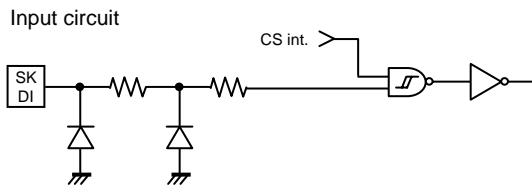


Figure 33. Input circuit (SK,DI)

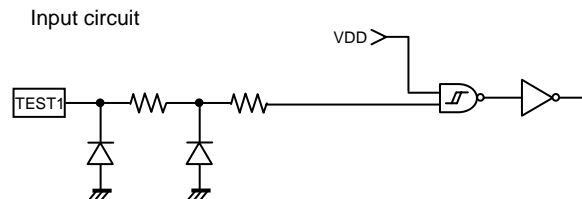


Figure 34. Input circuit (TEST1)

## 4) I/O peripheral circuit

## 4-1) Pull down CS.

By making CS="L" at power ON/OFF, mistake in operation and mistake write are prevented.

## OPull down resistance Rpd of CS pin

To prevent mistake in operation and mistake write at power ON/OFF, CS pull down resistance is necessary.

Select an appropriate value to this resistance value from microcontroller VOH, IOH, and VIL characteristics of this IC.

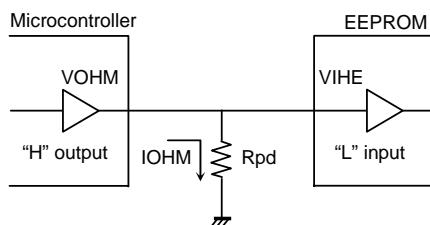


Figure 35. CS pull down resistance

$$R_{pd} \geq \frac{VO_{HM}}{IO_{HM}} \quad \dots \textcircled{1}$$

$$VO_{HM} \geq VI_{HE} \quad \dots \textcircled{2}$$

Example) When  $V_{CC}=5V$ ,  $VI_{HE}=2V$ ,  $VO_{HM}=2.4V$ ,  $IO_{HM}=2mA$ , from the equation ①,

$$R_{pd} \geq \frac{2.4}{2 \times 10^{-3}}$$

$$\therefore R_{pd} \geq 1.2 [k\Omega]$$

With the value of Rpd to satisfy the above equation, VOHM becomes 2.4V or higher, and VIHE (=2.0V), the equation ② is also satisfied.

- VIHE : EEPROM VIH specifications
- VOHM : Microcontroller VOH specifications
- IOHM : Microcontroller IOH specifications

4-2) DO is available in both pull up and pull down.

Do output become “High-Z” in other READY /  $\overline{\text{BUSY}}$  output timing than after data output at read command and write command. When malfunction occurs at “High-Z” input of the microcontroller port connected to DO, it is necessary to pull down and pull up DO. When there is no influence upon the microcontroller actions, DO may be OPEN.

If DO is OPEN, and at timing to output status READY, at timing of CS="H", SK="H", DI="H", EEPROM recognizes this as a start bit, resets READY output, and DO="High-Z", therefore, READY signal cannot be detected. To avoid such output, pull up DO pin for improvement.

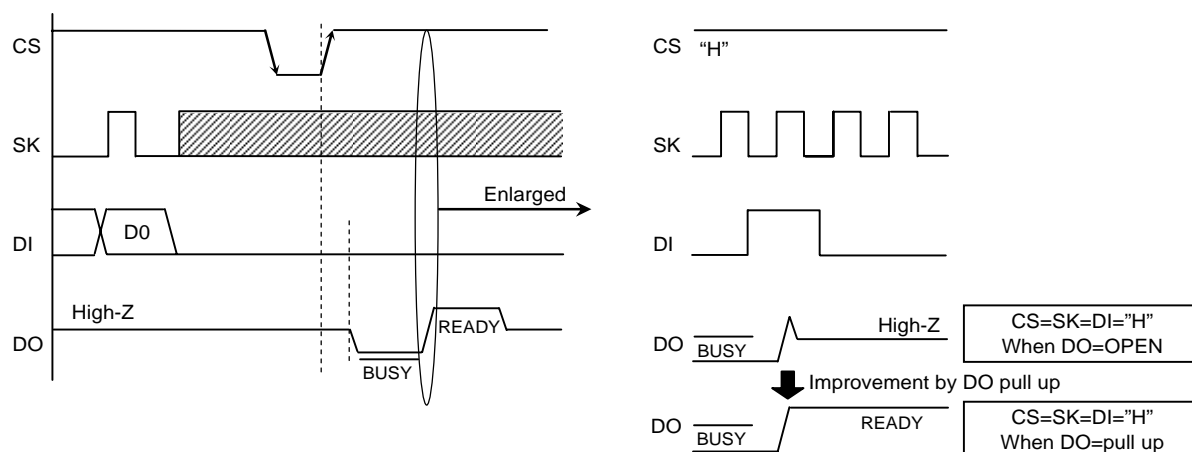


Figure 36. READY output timing at DO=OPEN

OPull up resistance  $R_{pu}$  and pull down resistance  $R_{pd}$  of DO pin

As for pull up and pull down resistance value, select an appropriate value to this resistance value from microcontroller

VIH, VIL, and VOH, IOH, VOL, IOL characteristics of this IC.

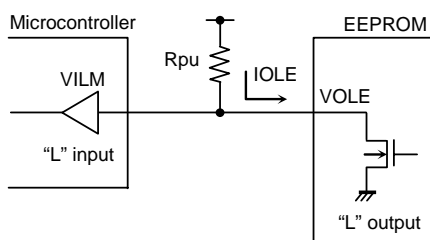


Figure 37. DO pull up resistance

$$R_{pu} \geq \frac{V_{CC}-V_{OLE}}{I_{OLE}} \quad \dots \textcircled{3}$$

$$VOLE \leq VILM \quad \dots \textcircled{4}$$

Example) When  $V_{CC}=5V$ ,  $V_{OLE}=0.4V$ ,  $I_{OLE}=2.1mA$ ,  $V_{ILM}=0.8V$ ,  
from the equation ③,

$$R_{pu} \geq \frac{5-0.4}{2.1 \times 10^{-3}}$$

$$\therefore R_{pu} \geq 2.2 \text{ [k}\Omega\text{]}$$

With the value of  $R_{pu}$  to satisfy the above equation,  $V_{OLE}$  becomes 0.4V or below, and with  $V_{ILM}(=0.8V)$ , the equation (4) is also satisfied.

- **VOLE** : EEPROM VOL specifications
- **IOLE** : EEPROM IOL specifications
- **VILM** : Microcontroller VIL specifications

$$R_{pd} \geq \frac{VOHE}{IOHE} \quad \dots \textcircled{5}$$

$$VOHE \geqslant VIHM \quad \cdot \cdot \cdot \textcircled{6}$$

Example) When  $V_{CC}=5V$ ,  $VO_{HE}=V_{CC}-0.2V$ ,  $IO_{HE}=0.1mA$ ,  
 $VI_{HM}=V_{CC} \times 0.7V$  from the equation (5),

$$R_{pd} \geq \frac{5-0.2}{0.1 \times 10^{-3}}$$

$$\therefore R_{pd} \geq 48 \text{ [k}\Omega\text{]}$$

With the value of  $R_{pd}$  to satisfy the above equation, VOHE becomes 2.4V or below, and with VIHM (=3.5V), the equation (6) is also satisfied.

- VOHE : EEPROM VOH specifications
- IOHE : EEPROM IOH specifications
- VIHm : Microcontroller VIH specifications

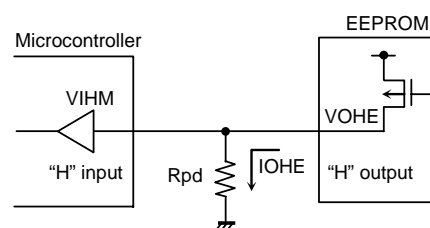


Figure 38. DO pull down resistance

5) READY /  $\overline{\text{BUSY}}$  status display (DO terminal)

(common to BR93L46-W / A46-WM, BR93L56-W / A56-WM, BR93L66-W / A66-WM, BR93L76-W / A76-WM, BR93L86-W / A86-WM)

This display outputs the internal status signal. When CS is started after  $t_{\text{CS}}$  (Min.200ns) from CS fall after write command input, "H" or "L" is output.

$R/\overline{B}$  display="L" ( $\overline{\text{BUSY}}$ ) = write under execution  
(DO status)

After the timer circuit in the IC works and creates the period of  $t_{\text{E/W}}$ , this time circuit completes automatically. And write to the memory cell is made in the period of  $t_{\text{E/W}}$ , and during this period, other command is not accepted.

$R/\overline{B}$  display = "H" (READY) = command wait status  
(DO status)

Even after  $t_{\text{E/W}}$  (max.5ms) from write of the memory cell, the following command is accepted.

Therefore, CS="H" in the period of  $t_{\text{E/W}}$ , and when input is in SK, DI, malfunction may occur, therefore, DI="L" in the area

CS="H". (Especially, in the case of shared input port, attention is required.)

\* Do not input any command while status signal is output.

Command input in  $\overline{\text{BUSY}}$  area is cancelled, but command input in READY area is accepted.

Therefore, status READY output is cancelled, and malfunction and mistake write may be made.

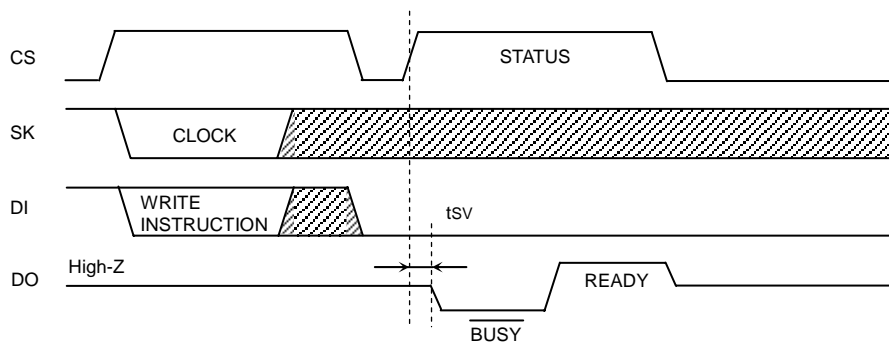


Figure 39.  $R/\overline{B}$  status output timing chart

## 6) When to directly connect DI and DO

This IC has independent input terminal DI and output terminal DO, and separate signals are handled on timing chart, meanwhile, by inserting a resistance R between these DI and DO terminals, it is possible to carry out control by 1 control line.

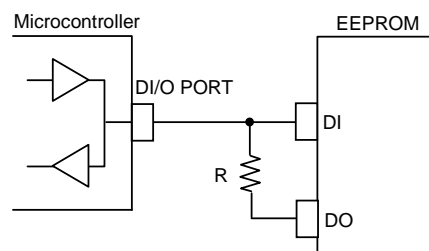


Figure 40. DI, DO control line common connection

○Data collision of microcontroller DI/O output and DO output and feedback of DO output to DI input.

Drive from the microcontroller DI/O output to DI input on I/O timing, and signal output from DO output occur at the same time in the following points.

- (1) 1 clock cycle to take in A0 address data at read command

Dummy bit "0" is output to DO terminal.

→When address data A0 = "1" input, through current route occurs.

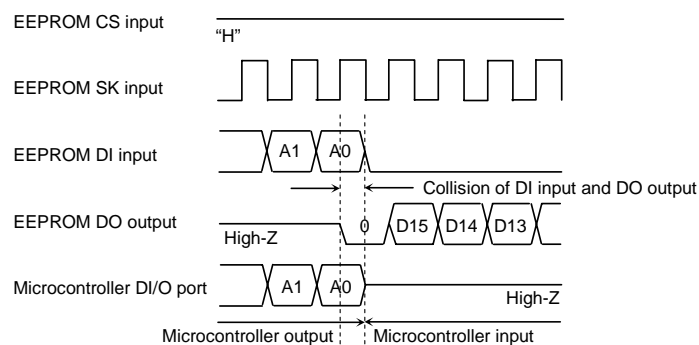


Figure 41. Collision timing at read data output at DI, DO direct connection

- (2) Timing of CS = "H" after write command. DO terminal in READY /  $\overline{\text{BUSY}}$  function output.

When the next start bit input is recognized, "HIGH-Z" gets in.

→Especially, at command input after write, when CS input is started with microcontroller DI/O output "L", READY output "H" is output from DO terminal, and through current route occurs.

Feedback input at timing of these (1) and (2) does not cause disorder in basic operations, if resistance R is inserted.

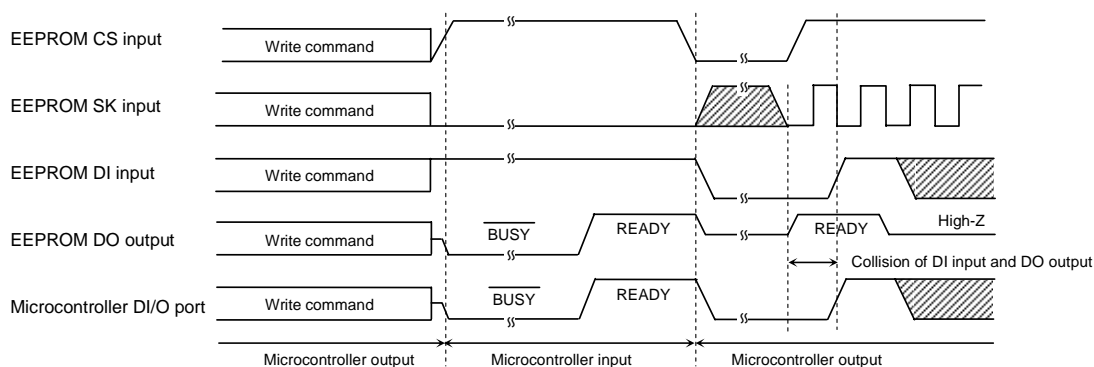


Figure 42. Collision timing at DI, DO direct connection

Note) As for the case (2), attention must be paid to the following.

When status READY is output, DO and DI are shared, DI="H" and the microcontroller DI/O="High-Z" or the microcontroller DI/O="H", if SK clock is input, DO output is input to DI and is recognized as a start bit, and malfunction may occur. As a method to avoid malfunction, at status READY output, set SK="L", or start CS within 4 clocks after "H" of READY signal is output.

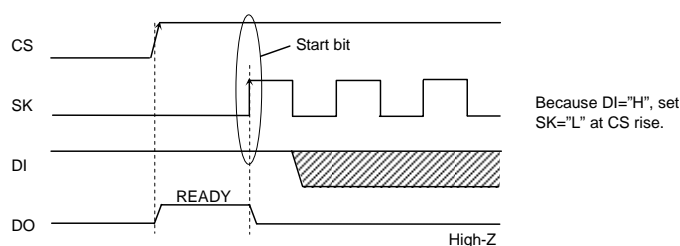


Figure 43. Start bit input timing at DI, DO direct connection



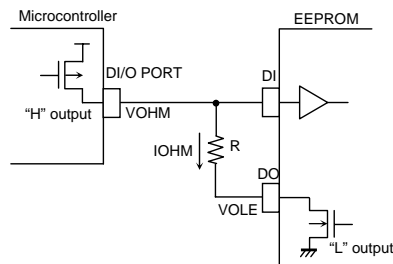
## ○ Selection of resistance value R

The resistance R becomes through current limit resistance at data collision. When through current flows, noises of power source line and instantaneous stop of power source may occur. When allowable through current is defined as I, the following relation should be satisfied. Determine allowable current amount in consideration of impedance and so forth of power source line in set. And insert resistance R, and set the value R to satisfy EEPROM input level  $V_{IH}/V_{IL}$  even under influence of voltage decline owing to leak current and so forth. Insertion of R will not cause any influence upon basic operations.

## (1) Address data A0 = "1" input, dummy bit "0" output timing

(When microcontroller DI/O output is "H", EEPROM DO outputs "L", and "H" is input to DI)

- Make the through current to EEPROM 10mA or below.
- See to it that the level  $V_{IH}$  of EEPROM should satisfy the following.



## Conditions

$$V_{OHM} \leq V_{IHE}$$

$$V_{OHM} \leq I_{OHM} \times R + V_{OLE}$$

At this moment, if  $V_{OLE}=0V$ ,

$$V_{OHM} \leq I_{OHM} \times R$$

$$\therefore R \geq \frac{V_{OHM}}{I_{OHM}} \quad \dots \textcircled{7}$$

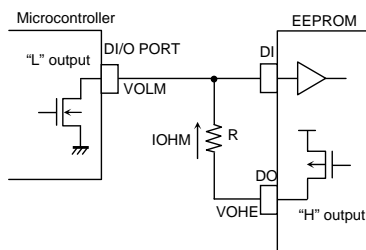
- $V_{IHE}$  : EEPROM  $V_{IH}$  specifications
- $V_{OLE}$  : EEPROM  $V_{OL}$  specifications
- $V_{OHM}$  : Microcontroller  $V_{OH}$  specifications
- $I_{OHM}$  : Microcontroller  $I_{OH}$  specifications

Figure 44. Circuit at DI, DO direct connection (Microcontroller DI/O "H" output, EEPROM "L" output)

## (2) DO status READY output timing

(When the microcontroller DI/O is "L", EEPROM DO output "H", and "L" is input to DI)

- Set the EEPROM input level  $V_{IL}$  so as to satisfy the following.



## Conditions

$$V_{OLM} \geq V_{ILE}$$

$$V_{OLM} \geq V_{OHE} - I_{OLM} \times R$$

As this moment,  $V_{OHE}=V_{CC}$

$$V_{OLM} \geq V_{CC} - I_{OLM} \times R$$

$$\therefore R \geq \frac{V_{CC} - V_{OLM}}{I_{OLM}} \quad \dots \textcircled{8}$$

- $V_{ILE}$  : EEPROM  $V_{IL}$  specifications
- $V_{OHE}$  : EEPROM  $V_{OH}$  specifications
- $V_{OLM}$  : Microcontroller  $V_{OL}$  specifications
- $I_{OLM}$  : Microcontroller  $I_{OL}$  specifications

Figure 45. Circuit at DI, DO direct connection (Microcontroller DI/O "L" output, EEPROM "H" output)

Example) When  $V_{CC}=5V$ ,  $V_{OHM}=5V$ ,  $I_{OHM}=0.4mA$ ,  $V_{OLM}=5V$ ,  $I_{OLM}=0.4mA$ ,

From the equation  $\textcircled{7}$ ,

$$R \geq \frac{V_{OHM}}{I_{OHM}}$$

$$R \geq \frac{5}{0.4 \times 10^{-3}}$$

$$\therefore R \geq 12.5 \text{ [k}\Omega\text{]} \quad \dots \textcircled{9}$$

From the equation  $\textcircled{8}$ ,

$$R \geq \frac{V_{CC} - V_{OLM}}{I_{OLM}}$$

$$R \geq \frac{5 - 0.4}{2.1 \times 10^{-3}}$$

$$\therefore R \geq 2.2 \text{ [k}\Omega\text{]} \quad \dots \textcircled{10}$$

Therefore, from the equations  $\textcircled{9}$  and  $\textcircled{10}$ ,

$$\therefore R \geq 12.5 \text{ [k}\Omega\text{]}$$

## 7) Notes on power ON/OFF

- At power ON/OFF, set CS "L".

When CS is "H", this IC gets in input accept status (active). If power is turned on in this status, noises and the likes may cause malfunction, mistake write or so. To prevent these, at power ON, set CS "L". (When CS is in "L" status, all inputs are cancelled.) And at power decline, owing to power line capacity and so forth, low power status may continue long. At this case too, owing to the same reason, malfunction, mistake write may occur, therefore, at power OFF too, set CS "L".

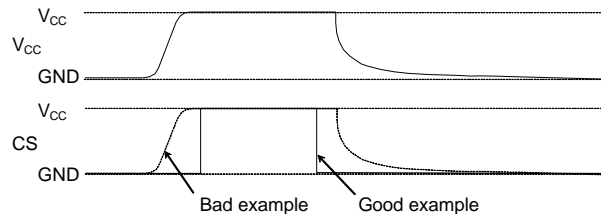


Figure 46. Timing at power ON/OFF

(Bad example) CS pin is pulled up to Vcc.

In this case, CS becomes "H" (active status), and EEPROM may have malfunction, mistake write owing to noise and the likes.  
Even when CS input is High-Z, the status becomes like this case, which please note.

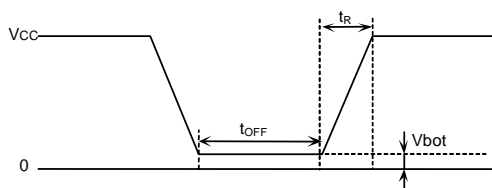
(Good example) It is "L" at power ON/OFF.

Set 10ms or higher to recharge at power OFF.  
When power is turned on without observing this condition, IC internal circuit may not be reset, which please note.

## OPOR circuit

This IC has a POR (Power On Reset) circuit as a mistake write countermeasure. After POR action, it gets in write disable status. The POR circuit is valid only when power is ON, and does not work when power is OFF. However, if CS is "H" at power ON/OFF, it may become write enable status owing to noises and the likes. For secure actions, observe the following conditions.

- Set CS="L"
- Turn on power so as to satisfy the recommended conditions of  $t_R$ ,  $t_{OFF}$ ,  $V_{bot}$  for POR circuit action.

Recommended conditions of  $t_R$ ,  $t_{OFF}$ ,  $V_{bot}$ 

| $t_R$          | $t_{OFF}$      | $V_{bot}$     |
|----------------|----------------|---------------|
| 10ms or below  | 10ms or higher | 0.3V or below |
| 100ms or below | 10ms or higher | 0.2V or below |

Figure 47. Rise waveform diagram

## OLVCC circuit

LVCC ( $V_{CC}$ -Lockout) circuit prevents data rewrite action at low power, and prevents wrong write.  
At LVCC voltage (Typ.=1.2V) or below, it prevent data rewrite.

## 8) Noise countermeasures

## ○VCC noise (bypass capacitor)

When noise or surge gets in the power source line, malfunction may occur, therefore, for removing these, it is recommended to attach a bypass capacitor (0.1 $\mu$ F) between IC  $V_{CC}$  and GND, At that moment, attach it as close to IC as possible. And, it is also recommended to attach a bypass capacitor between board  $V_{CC}$  and GND.

## ○SK noise

When the rise time ( $t_R$ ) of SK is long, and a certain degree or more of noise exists, malfunction may occur owing to clock bit displacement. To avoid this, a Schmitt trigger circuit is built in SK input. The hysteresis width of this circuit is set about 0.2V, if noises exist at SK input, set the noise amplitude 0.2Vp-p or below. And it is recommended to set the rise time ( $t_R$ ) of SK 100ns or below. In the case when the rise time is 100ns or higher, take sufficient noise countermeasures. Make the clock rise, fall time as small as possible.

**●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.
- (3) Absolute Maximum Ratings  
If the absolute maximum ratings such as impressed voltage and action 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 voltage is not lower than that of GND terminal in consideration of transition status.
- (5) Heat design  
In consideration of allowable loss in actual use condition, carry out heat design with sufficient margin.
- (6) Terminal to terminal short-circuit 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 short-circuit 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, evaluate design sufficient.

## 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.

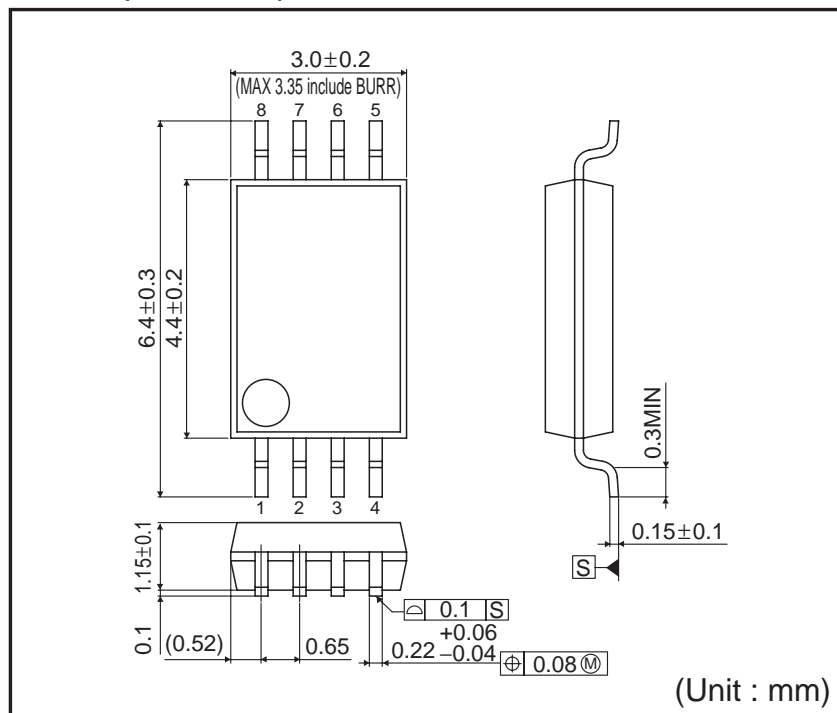
If there are any differences in translation version of this document formal version takes priority.

## ●Ordering Information

|                     |  |  |  |  |  |  |  |  |  |   |
|---------------------|--|--|--|--|--|--|--|--|--|---|
| B U 9 8 8 8 F V - W |  |  |  |  |  |  |  |  |  | E 2   |
| Part Number         |  |  |  |  |  |  |  |  |  | Package<br>FV: SSOP-B8  |
|                     |  |  |  |  |  |  |  |  |  | Packaging and forming specification<br>E2: Embossed tape and reel |

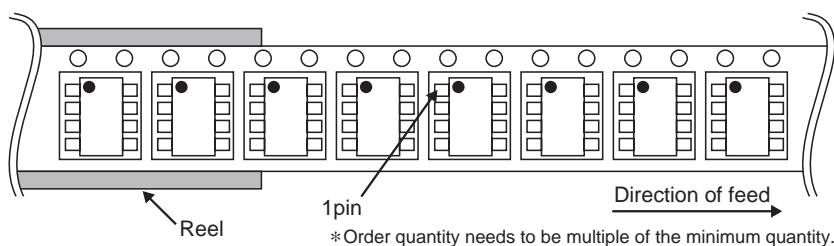
### ●Physical Dimension Tape and Reel Information

## SSOP-B8 (BU9888FV-W)



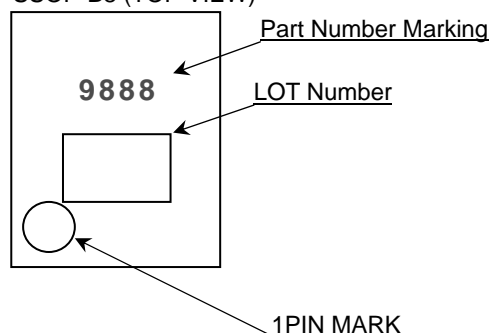
<Tape and Reel information>

|                   |   |
|-------------------|---|
| Tape              | Embossed carrier tape   |
| Quantity          | 2500pcs   |
| Direction of feed | E2<br>( 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 ) |



### ● Marking Diagram

### SSOP-B8 (TOP VIEW)



●Revision History

| Date        | Revision | Changes     |
|-------------|----------|-------------|
| 10.Sep.2012 | 001      | New Release |

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|-----------|-----------|------------|-----------|
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| CLASS IV  |           | CLASS III  |           |

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  - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
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- 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.
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- Confirm that operation temperature is within the specified range described in the product specification.
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## Precaution for Mounting / Circuit board design

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

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