◇STRUCTURE Silicon Monolithic Integrated Circuit

◇PRODUCT 4K×8 bit Electrically Erasable PROM

◇PART NUMBER BU9890GUL-W

◇PHYSICAL DIMENSION Fig.-1 (VCSP50L1)

◇BLOCK DIAGRAM Fig.-2

◇USE General purpose

◇FEATURES

- 4K words × 8 bits architecture serial EEPROM
- Wide operating voltage range (1.7V～3.6V)
- Two wire serial interface
- Self-timed write cycle with automatic erase
- 32 byte Page Write mode
- Low power consumption。
  - Write (3.3V) : 0.6mA (Typ.)
  - Read (3.6V) : 0.6mA (Typ.)
  - Standby (3.6V) : 0.1μA (Typ.)
- DATA security
  - Write protect feature (WP pin)
  - Inhibit to WRITE at low Vcc
- WLCSP 6pin package
- High reliability fine pattern CMOS technology
- Endurance : 100,000 erase/write cycles
- Data retention : 40 years
- Filtered inputs in SCL・SDA for noise suppression
- Initial data FFh in all address
- Pull-up resistor inputs in SCL・SDA

◇ABSOLUTE MAXIMUM RATING (Ta=25℃

Parameter	Symbol	Rating	Unit
Supply Voltage	Vcc	-0.3～6.5	V
Power Dissipation	Pd	220 *1	mW
Storage Temperature	Tstg	-65～125	℃
Operating Temperature	Topr	-40～85	℃
Terminal Voltage	—	-0.3～Vcc+1.0 *2	V

*1 Degradation is done at 2.2mW/℃(*1) for operation above 25℃
*2 Maximum value of Terminal Voltage is below 6.5V.

◇RECOMMENDED OPERATING CONDITION

Parameter		Symbol	Rating	Unit
Supply Voltage	Write	Vcc	2.7～3.3	V
	Read		1.7～3.6	
Input Voltage		V_{IN}	0～Vcc	V

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◇DC OPERATING CHARACTERISTICS (Unless otherwise specified Ta=−40～85℃、Vcc=1.7～3.6V)

Parameter	Symbol	Specification			Unit	test condition
		Min.	Typ.	Max.		
“H” Input Voltage1	V_{IH1}	0.7Vcc	—	Vcc+1.0	V	2.5V≦Vcc≦3.6V
“L” Input Voltage1	V_{IL1}	−0.3	—	0.3Vcc	V	2.5V≦Vcc≦3.6V
“H” Input Voltage2	V_{IH2}	0.8Vcc	—	Vcc+1.0	V	1.8V≦Vcc＜2.5V
“L” Input Voltage2	V_{IL2}	−0.3	—	0.2Vcc	V	1.8V≦Vcc＜2.5V
“H” Input Voltage3	V_{IH3}	0.9Vcc	—	Vcc+1.0	V	1.7V≦Vcc＜1.8V
“L” Input Voltage3	V_{IL3}	−0.3	—	0.1Vcc	V	1.7V≦Vcc＜1.8V
“L” Output Voltage1	V_{OL1}	—	—	0.4	V	I_{OL}=3.0mA, 2.5V≦Vcc≦3.6V(SDA)
“L” Output Voltage2	V_{OL2}	—	—	0.2	V	I_{OL}=0.7mA, 1.7V≦Vcc＜2.5V(SDA)
Input Leakage Current	I_{LI}	−1	—	1	μA	V_{IN}=0V～Vcc, (WP, TEST)
Pull-up resistor	I_{LI2}	6	10	14	kΩ	(SCL, SDA)
Output Leakage Current	I_{LO}	−1	—	1	μA	V_{OUT}=0V～Vcc(SDA)
Operating Current	I_{CC1}	—	—	4.1	mA	Vcc=3.3V,f_{SCL}=400kHz, t_{WR}=5ms Byte Write Page Write
	I_{CC2}	—	—	1.7	mA	Vcc=3.6V,f_{SCL}=400kHz Random Read Current Read Sequential Read
Standby Current	I_{SB}	—	—	2.0	μA	Vcc=3.6V,SDA,SCL=Vcc WP=GND

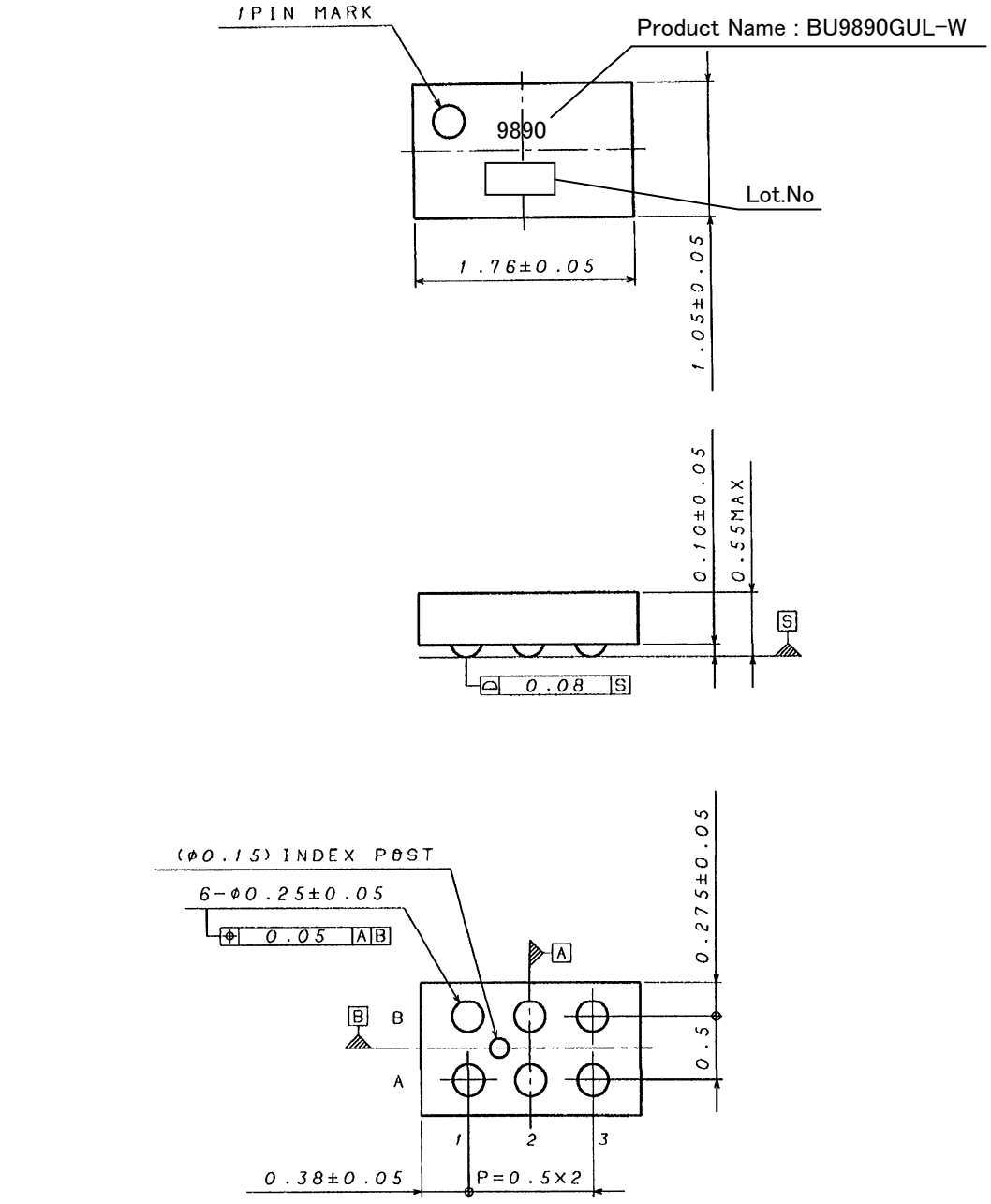
○ This product is not designed for protection against radioactive rays.

◇MEMORY CELL CHARACTERISTICS(Ta=25℃、Vcc=1.7～3.6V)

Parameter	Specification			Unit
	Min.	Typ.	Max.	
Write/Erase Cycle *1	100,000	—	—	cycle
Data Retention *1	40	—	—	year

*1:Not 100% TESTED

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(UNIT : mm)

Drawing No : EX912-5031

Fig.-1 PHYSICAL DIMENSION (Unit : mm)

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◇BLOCK DIAGRAM

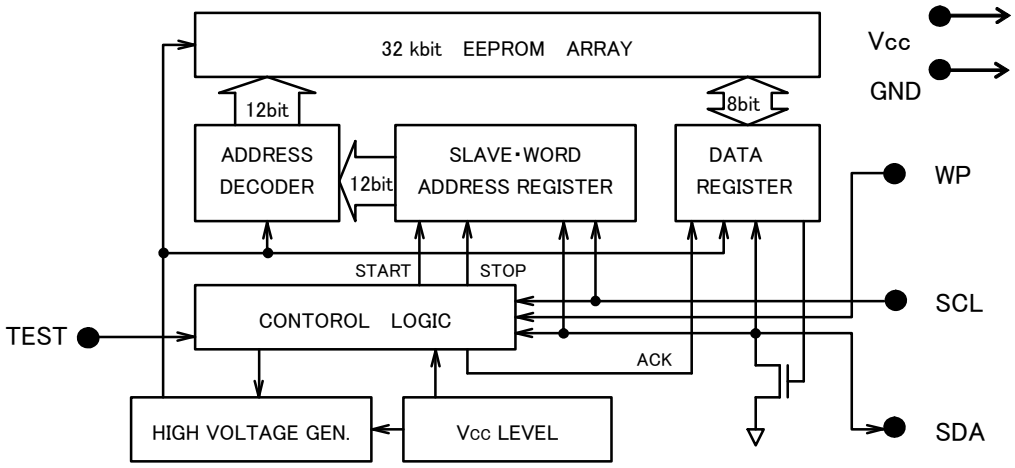
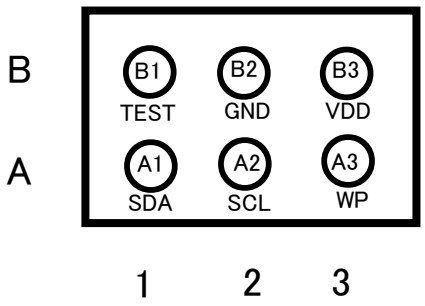


Fig.-2 BLOCK DIAGRAM

TEST Pin Connect with GND

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◇PIN CONFIGURATION



◇PIN NAME

Land No.	PIN NAME	I/O	FUNCTIONS
B3	Vcc	-	Power Supply
B2	GND	-	Ground (0V)
B1	TEST	IN	TEST Pin Connect with GND
A3	WP	IN	Write Protect Input
A2	SCL	IN	Serial Clock Input
A1	SDA	IN/OUT	Slave and Word Address, Serial Data Input, Serial Data Output

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◇AC OPERATING CHARACTERISTICS (Unless otherwise specified Ta=−40～85℃、Vcc=1.7～3.6V)

Parameter	Symbol	FAST-MODE 2.5V≦Vcc≦3.6V			STANDARD-MODE 1.7V≦Vcc≦3.6V			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	1.2	—	—	4.7	—	—	μs
SDA and SCL Rise Time *1	tR	—	—	0.3	—	—	1.0	μs
SDA and SCL Fall Time *1	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	tPD	0.1	—	0.9	0.2	—	3.5	μs
Output Data Hold Time	tDH	0.1	—	—	0.2	—	—	μs
Stop Condition Setup Time	tSU:STO	0.6	—	—	4.7	—	—	μs
Bus Free Time	tBUF	1.2	—	—	4.7	—	—	μs
Write Cycle Time	tWR	—	—	5	—	—	5	ms
Noise Spike Width (SDA and SCL)	tI	—	—	0.1	—	—	0.1	μs
WP Hold Time	tHD:WP	0	—	—	0	—	—	ns
WP Setup Time	tSU:WP	0.1	—	—	0.1	—	—	μs
WP High Period	tHIGH:WP	1.0	—	—	1.0	—	—	μs

*1:Not 100% TESTED

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◇SYNCHRONOUS DATA TIMING

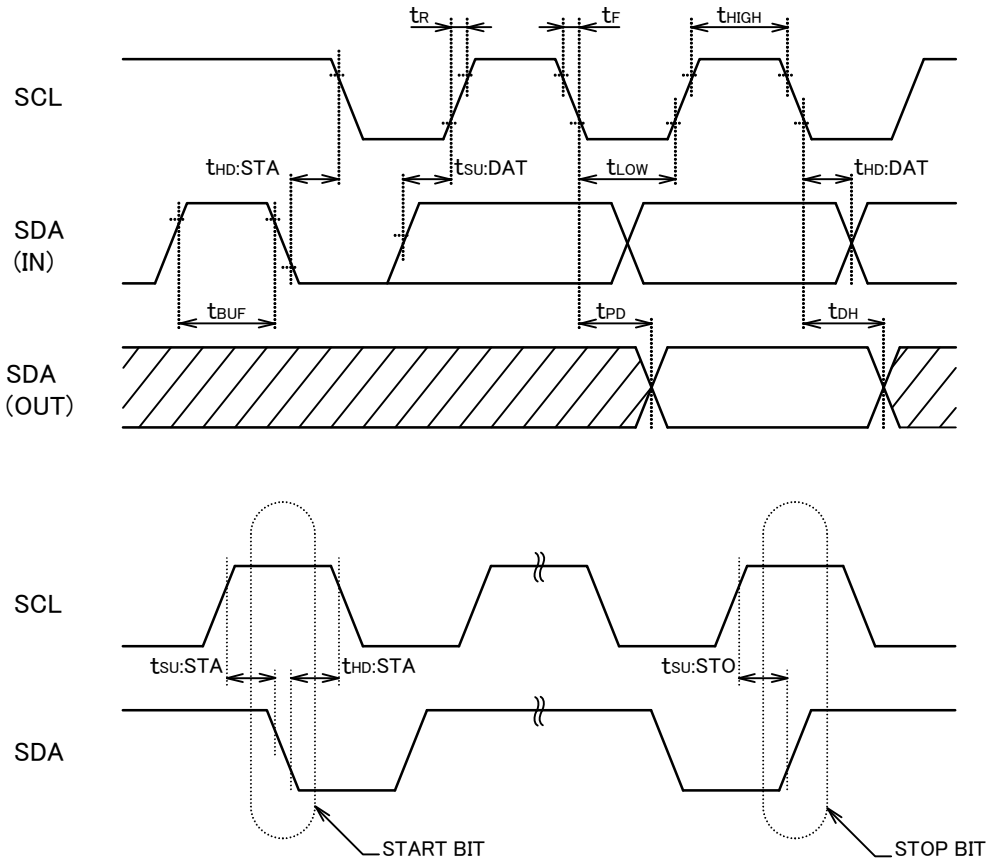


Fig.-4 SYNCHRONOUS DATA TIMING

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

◇WRITE CYCLE TIMING

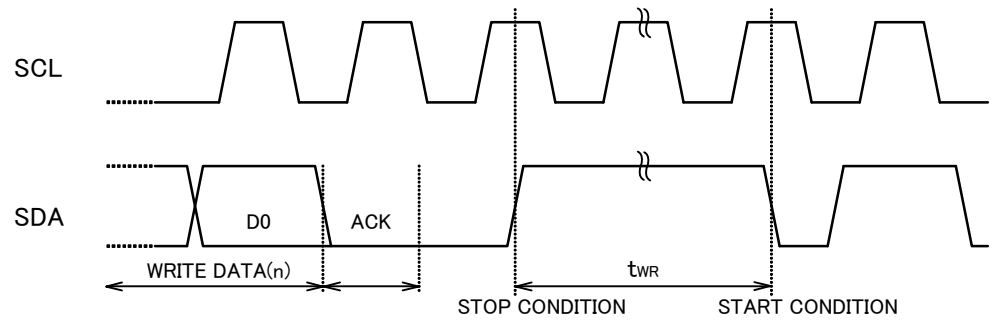


Fig.-5 WRITE CYCLE TIMING

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◇WP TIMING

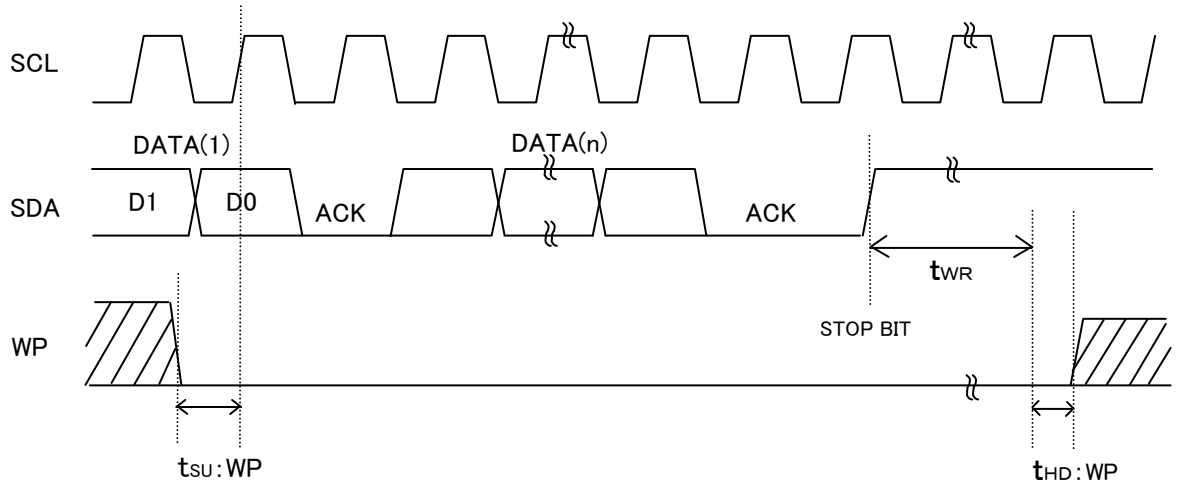


Fig.-6(a) WP TIMING OF THE WRITE OPERATION

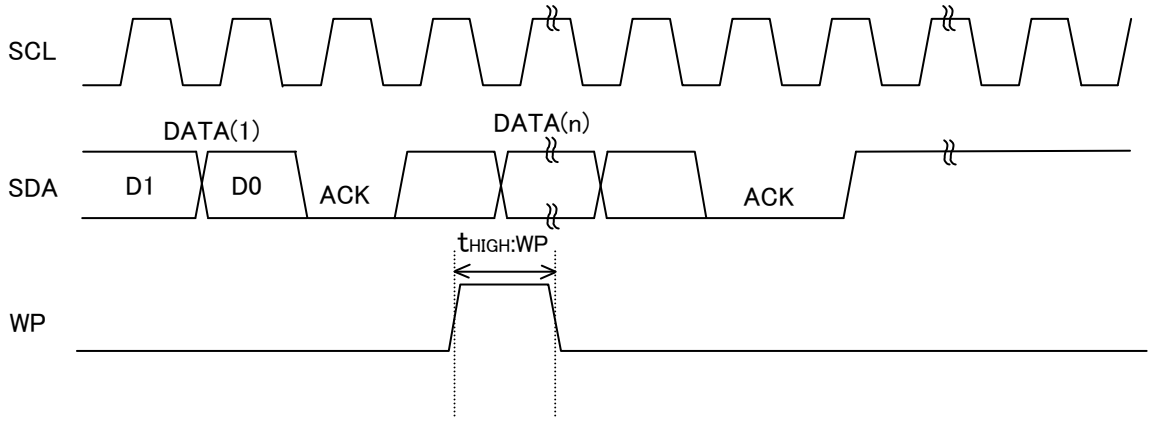


Fig.-6(b) WP TIMING OF THE WRITE CANCEL OPERATION

○For the WRITE operation, WP must be "LOW" during the period of time from the rising edge of the clock which takes in D0 of first byte until the end of t_{WR}. (See Fig.-6(a))
During this period, WRITE operation is canceled by setting WP "HIGH".(See Fig.-6(b))

○In the case of setting WP "HIGH" during t_{WR}, WRITE operation is stopped in the middle and the data of accessing address is not guaranteed. Please write correct data again in the case.

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◇DEVICE OPERATION

○START CONDITION (RECOGNITION OF START BIT)

- All commands are proceeded by the start condition, which is a HIGH to LOW transition of SDA when SCL is HIGH.
- The device continuously monitors the SDA and SCL lines for the start condition and will not respond to any command until this condition has been met.
  (See Fig.-4 SYNCHRONOUS DATA TIMING)

○STOP CONDITION (RECOGNITION OF STOP BIT)

- All commands must be terminated by a stop condition, which is a LOW to HIGH transition of SDA when SCL is HIGH.
  (See Fig.-4 SYNCHRONOUS DATA TIMING)

○NOTICE ABOUT WRITE COMMAND

- In the case that stop condition is not excuted in WRITE mode, transfered data will not be written in a memory.

○DEVICE ADDRESSING

- Following a START condition, the master output the slave address to be accessed.
- The most significant four bits of the slave address are the "device type indentifier," for this device it is fixed as "1010" and next three bit set to "000".
- The last bit of the stream (R/$\overline{W}$ ··· READ/$\overline{WRITE}$) determines the operation to be performed. When set to "1", a read operation is selected ; when set to "0", a write operation is selected.

R/$\overline{W}$ set to "0" · · · · · · · · · WRITE (including word address input of Random Read)
R/$\overline{W}$ set to "1" · · · · · · · · · READ

1 0 1 0	0	0	0	R/$\overline{W}$

○WRITE PROTECT (WP)

When WP pin set to Vcc(H level), write protect is set for 4,096 words (all address).
When WP pin set to GND(L level), it is enable to write 4,096 words (all address).
Either control this pin or connect to GND (or Vcc). It is inhibited from being left unconnected.

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○ACKNOWLEDGE

・Acknowledge is a software convention used to indicate successful data transfers. The transmitter device will release the bus after transmitting eight bits.
(When inputting the slave address in the write or read operation, transmitter is μ-COM. When outputting the data in the read operation, it is this device.)

・During the ninth clock cycle, the receiver will pull the SDA line LOW to acknowledge that the eight bits of data has been received.
(When inputting the slave address in the write or read operation, receiver is this device. When outputting the data in the read operation, it is μ-COM.)

・The device will respond with an Acknowledge after recognition of a START condition and its slave address (8bit).

・In the WRITE mode, the device will respond with an Acknowledge, after the receipt of each subsequent 8-bit word (word address and write data).

・In the READ mode, the device will transmit eight bit of data, release the SDA line, and monitor the line for an Acknowledge.

・If an Acknowledge is detected, and no STOP condition is generated by the master, the device will continue to transmit the data.
If an Acknowledge is not detected, the device will terminate further data transmissions and await a STOP condition before returning to the standby mode.
(See Fig.-7 ACKNOWLEDGE RESPONSE FROM RECEIVER)

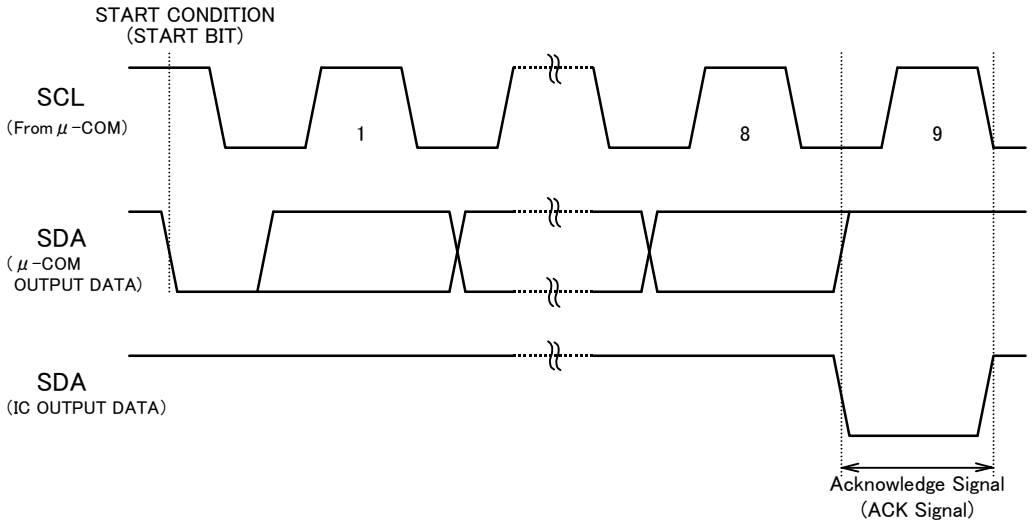


Fig.-7 ACKNOWLEDGE RESPONSE FROM RECEIVER

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◇BYTE WRITE

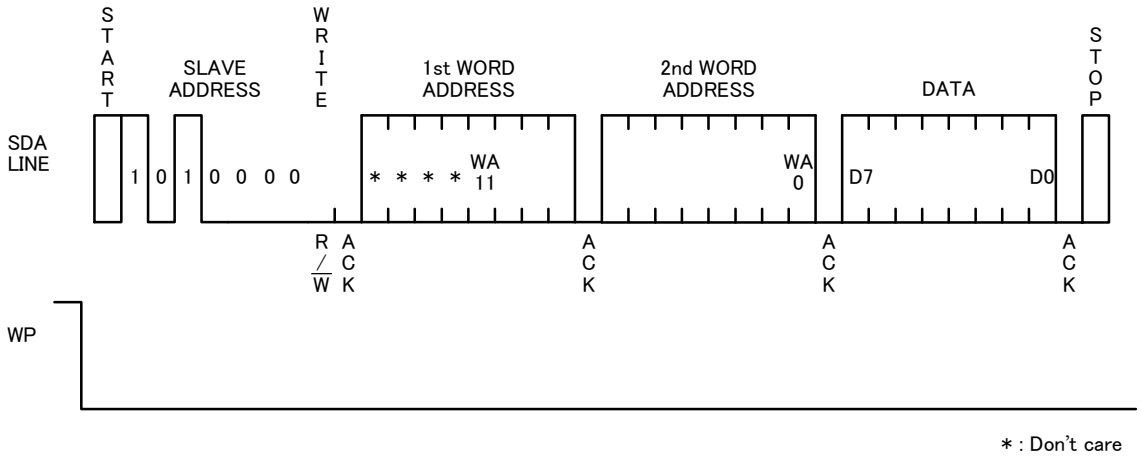


Fig.-8 BYTE WRITE CYCLE TIMING

○By using this command, the data is programed into the indicated word address.
○When the master generates a STOP condition, the device begins the internal write cycle to the nonvolatile memory array.

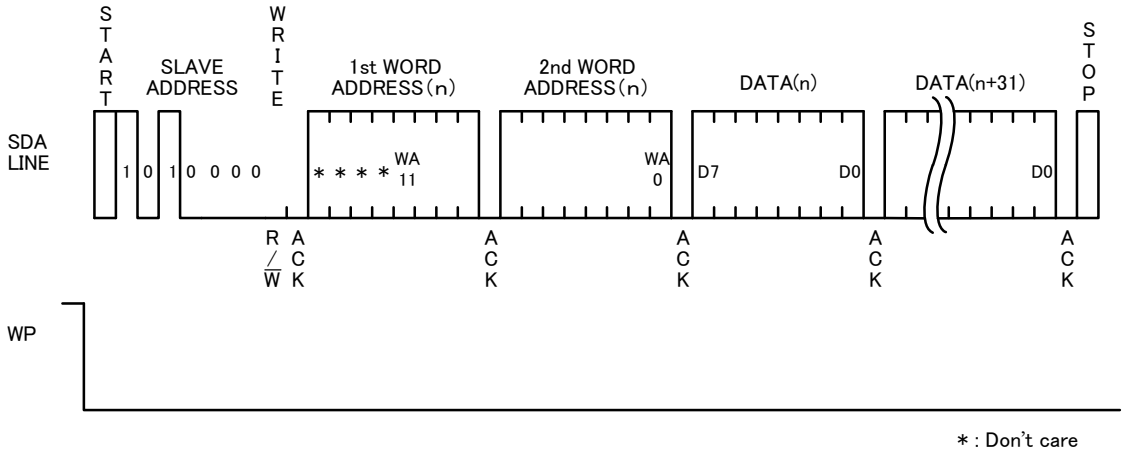


Fig.-9 PAGE WRITE CYCLE TIMING

○This device is capable of thirty-two byte Page Write operation.
○When two or more byte data are inputted, the five low order address(WA4～WA0) bits are internally incremented by one after the receipt of each word. The seven higher order bits of the address(WA4～WA0) remain constant.

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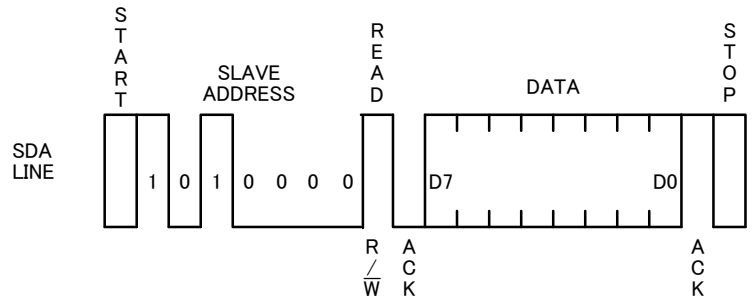


Fig.-10 CURRENT READ CYCLE TIMING

○ In case that the previous operation is Random or Current Read (which includes Sequential Read respectively), the internal address counter is increased by one from the last accessed address (n). Thus Current Read outputs the data of the next word address (n+1).
If the last command is Byte or Page Write, the internal address counter stays at the last address (n). Thus Current Read outputs the data of the word address (n).

○If an Acknowledge is detected, and no STOP condition is generated by the master (μ-COM), the device will continue to transmit the data. [It can transmit all data (32kbit 4096word)]

○If an Acknowledge is not detected, the device will terminate further data transmissions and await a STOP condition before returning to the standby mode.

NOTE) If an Acknowledge is detected with "Low" level, not "High" level, command will become Sequential Read. So the device transmits the next data, Read is not terminated. In the case of terminating Read, input Acknowledge with "High" always, then input stop condition.

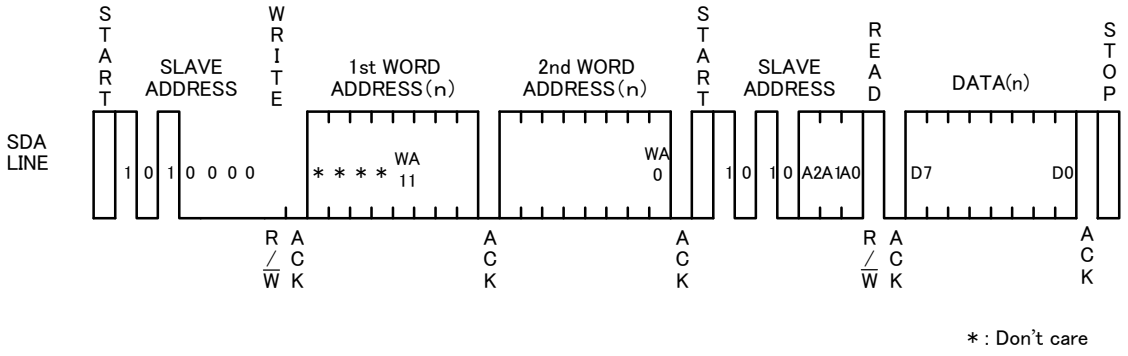


Fig.-11 RANDOM READ CYCLE TIMING

○Random Read operation allows the master to access any memory location indicated word address.

○If an Acknowledge is detected, and no STOP condition is generated by the master (μ-COM), the device will continue to transmit the data. [It can transmit all data (32kbit 4096word)]

○If an Acknowledge is not detected, the device will terminate further data transmissions and await a STOP condition before returning to the standby mode.

NOTE) If an Acknowledge is detected with "Low" level, not "High" level, command will become Sequential Read. So the device transmits the next data, Read is not terminated. In the case of terminating Read, input Acknowledge with "High" always, then input stop condition.

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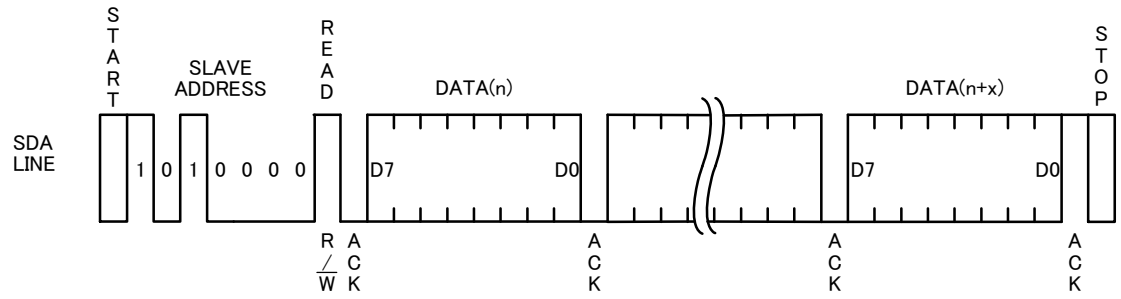


Fig.-12 SEQUENTIAL READ CYCLE TIMING
(Current Read)

○○If an Acknowledge is detected, and no STOP condition is generated by the master (μ-COM), the device will continue to transmit the data. [It can transmit all data (32kbit 4096word)]

○If an Acknowledge is not detected, the device will terminate further data transmissions and await a STOP condition before returning to the standby mode.

○The Sequential Read operation can be performed with both Current Read and Random Read.

NOTE) If an Acknowledge is detected with "Low" level, not "High" level, command will become Sequential Read. So the device transmits the next data, Read is not terminated. In the case of terminating Read, input Acknowledge with "High" always, then input stop condition.

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