

CMOS 2-WIRED SERIAL EEPROM

S-24C08A/16A

The S-24C08A/16A is a series of 2-wired, low power 8K/16K-bit EEPROMs with a wide operating range. They are organized as 1K-word \times 8-bit, 2K-word \times 8-bit respectively. Each is capable of page write, and sequential read.

The time for byte write and page write is the same, i. e., 1 msec. (max.) during operation at $5\text{ V} \pm 10\%$.

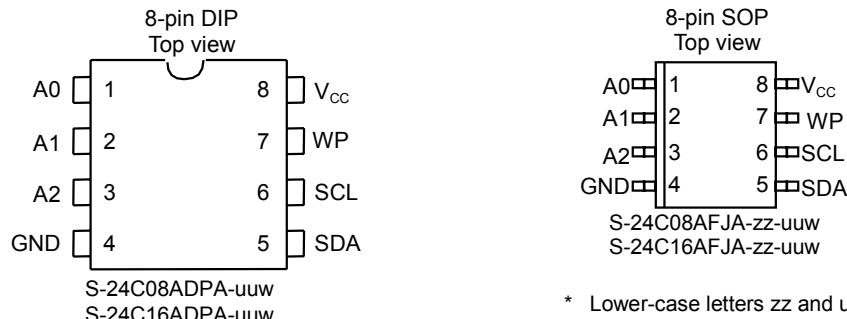
■ Features

- Low power consumption
 - Standby: $1.0\text{ }\mu\text{A}$ Max. ($V_{cc}=5.5\text{ V}$)
 - Operating: 0.8 mA Max. ($V_{cc}=5.5\text{ V}$ $f=400\text{kHz}$)
 - 0.4 mA Max. ($V_{cc}=4.5\text{ V}$ $f=100\text{kHz}$)
- Wide operating voltage range
 - Write: 2.5 to 5.5 V
 - Read: 1.8 to 5.5 V
- Page write
 - 16 bytes (S-24C08A, S-24C16A)
- Sequential read capable

- Endurance: 10^5 cycles/word
- Data retention: 10 years
- Write protection (S-24C08A, S-24C16A)
- S-24C08A: 8 kbits
- S-24C16A: 16 kbits

* The data sheet of 1K/2K/4K-bit products are available.
(S-24C0XA Series)

■ Pin Assignment



* Lower-case letters zz and uuw differ depending on the packing form.
See ■ Ordering Information and ■ Dimensions.

Figure 1

■ Pin Functions

Table 1

Name	Pin Number		Function
	DIP	SOP	
A0	1	1	NC in the S-24C08A (no connection)*, Connected to GND in the S-24C16A
A1	2	2	Connected to GND
A2	3	3	Address input in the S-24C08A Connected to GND in the S-24C16A
GND	4	4	Ground
SDA	5	5	Serial data input/output
SCL	6	6	Serial clock input
WP	7	7	WP (Write Protection) pin Connected to Vcc: Protection valid Connected to GND: Protection invalid
V _{cc}	8	8	Power supply

* When in use, connect to GND or VCC.

■ **Block Diagram**

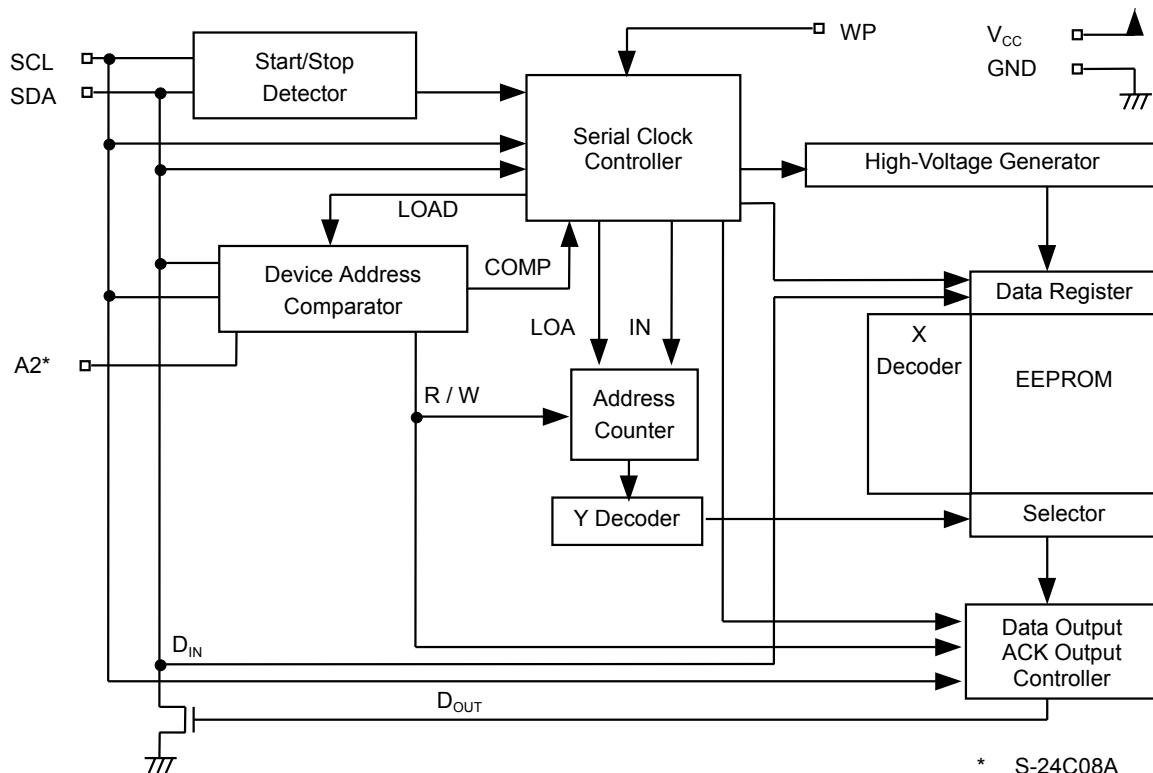


Figure 2

■ **Absolute Maximum Ratings**

Table 2

Parameter	Symbol	Ratings	Unit
Power supply voltage	V_{CC}	-0.3 to +7.0	V
Input voltage	V_{IN}	-0.3 to $V_{CC}+0.3$	V
Output voltage	V_{OUT}	-0.3 to V_{CC}	V
Storage temperature under bias	T_{bias}	-50 to +95	°C
Storage temperature	T_{stg}	-65 to +150	°C

■ Recommended Operating Conditions

Table 3

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V_{CC}	Read Operation	1.8	—	5.5	V
		Write Operation	2.5	—	5.5	V
High level input voltage	V_{IH}	$V_{CC}=2.5$ to 5.5V	$0.7 \times V_{CC}$	—	V_{CC}	V
		$V_{CC}=1.8$ to 2.5V	$0.8 \times V_{CC}$	—	V_{CC}	V
Low level input voltage	V_{IL}	$V_{CC}=2.5$ to 5.5V	0.0	—	$0.3 \times V_{CC}$	V
		$V_{CC}=1.8$ to 2.5V	0.0	—	$0.2 \times V_{CC}$	V
Operating temperature	T_{opr}	—	-40	—	+85	°C

■ Pin Capacitance

Table 4

(Ta=25°C, f=1.0 MHz, $V_{CC}=5$ V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input capacitance	C_{IN}	$V_{IN}=0$ V (SCL, A0, A1, A2, WP)	—	—	10	pF
Input/output capacitance	$C_{I/O}$	$V_{I/O}=0$ V (SDA)	—	—	10	pF

■ Endurance

Table 5

Parameter	Symbol	Min.	Typ.	Max.	Unit
Endurance	N_W	10^5	—	—	cycles/word

■ DC Electrical Characteristics

Table 6

Parameter	Symbol	V _{CC} =4.5 V to 5.5 V			V _{CC} =2.5 to 4.5 V			V _{CC} =1.8 to 2.5 V			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Current consumption (READ)	I _{CC1}	—	—	0.8 f=400kHz	—	—	0.4 f=100kHz	—	—	0.3 f=100kHz	mA
Current consumption (PROGRAM)	I _{CC2}	—	—	4.0 f=400kHz	—	—	3.5 f=100kHz	—	—	—	mA

Table 7

Parameter	Symbol	Conditions	V _{CC} =4.5 V to 5.5 V			V _{CC} =2.5 to 4.5 V			V _{CC} =1.8 to 2.5 V			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Standby current consumption	I _{SB}	V _{IN} =V _{CC} or GND	—	—	1.0	—	—	0.6	—	—	0.4	μA
Input leakage current	I _{LI}	V _{IN} =GND to V _{CC}	—	0.1	1.0	—	0.1	1.0	—	0.1	1.0	μA
Output leakage current	I _{LO}	V _{OUT} =GND to V _{CC}	—	0.1	1.0	—	0.1	1.0	—	0.1	1.0	μA
Low level output voltage	V _{OL}	I _{OL} =3.2 mA	—	—	0.4	—	—	0.4	—	—	—	V
		I _{OL} =1.5 mA	—	—	0.3	—	—	0.3	—	—	0.5	V
		I _{OL} =100 μA	—	—	0.1	—	—	0.1	—	—	0.1	V
Current address retention voltage	V _{AH}	—	1.5	—	5.5	1.5	—	4.5	1.5	—	2.5	V

■ AC Electrical Characteristics

Table 8 Measurement Conditions	
Input pulse voltage	0.1×V _{CC} to 0.9×V _{CC}
Input pulse rising/falling time	20 ns
Output judgment voltage	0.5×V _{CC}
Output load	100 pF+ Pullup resistance 1.0 kΩ

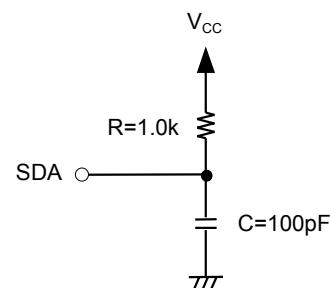


Figure 3 Output Load Circuit

Table 9

Parameter	Symbol	V _{CC} =1.8V to 5.5V			V _{CC} =4.5V to 5.5V			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
SCL clock frequency	f _{SCL}	0	—	100	0	—	400	kHz
SCL clock time "L"	t _{LOW}	4.7	—	—	1.3	—	—	μs
SCL clock time "H"	t _{HIGH}	4.0	—	—	0.6	—	—	μs
SDA output delay time	t _{AA}	0.3	—	3.5	0.3	—	1.0	μs
SDA output hold time	t _{DH}	0.3	—	—	0.3	—	—	μs
Start condition setup time	t _{SU,STA}	4.7	—	—	0.6	—	—	μs
Start condition hold time	t _{HD,STA}	4.0	—	—	0.6	—	—	μs
Data input setup time	t _{SU,DAT}	100	—	—	50	—	—	ns
Data input hold time	t _{HD,DAT}	0	—	—	0	—	—	ns
Stop condition setup time	t _{SU,STO}	4.7	—	—	0.6	—	—	μs
SCL · SDA rising time	t _R	—	—	1.0	—	—	0.3	μs
SCL · SDA falling time	t _F	—	—	0.3	—	—	0.3	μs
Bus release time	t _{BUF}	4.7	—	—	1.3	—	—	μs
Noise suppression time	t _I	—	—	100	—	—	100	ns

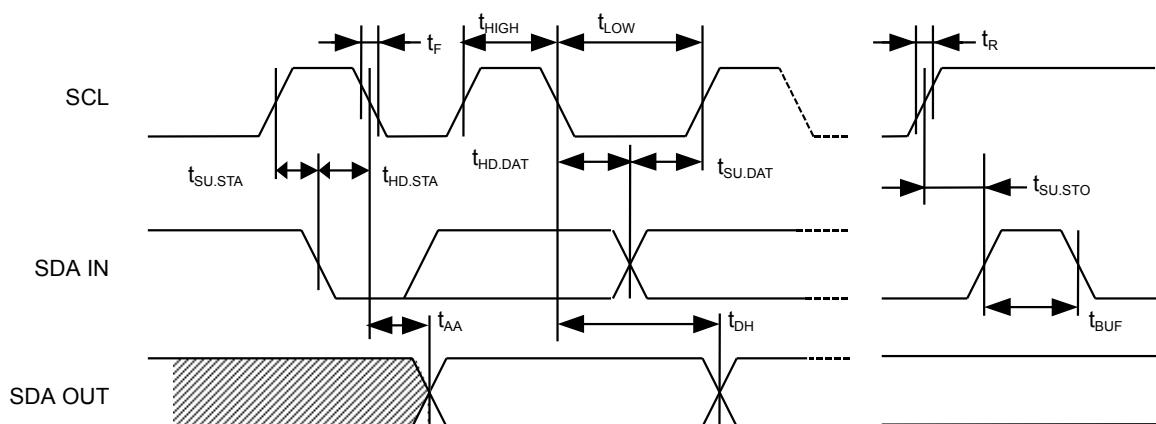


Figure 4 Bus Timing

Table 10

Item	Symbol	$V_{CC}=4.5$ to $5.5V$			$V_{CC}=2.5$ to $4.5V$			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Write time	t_{WR}	—	0.8	1.0	—	4.0	5.0	ms

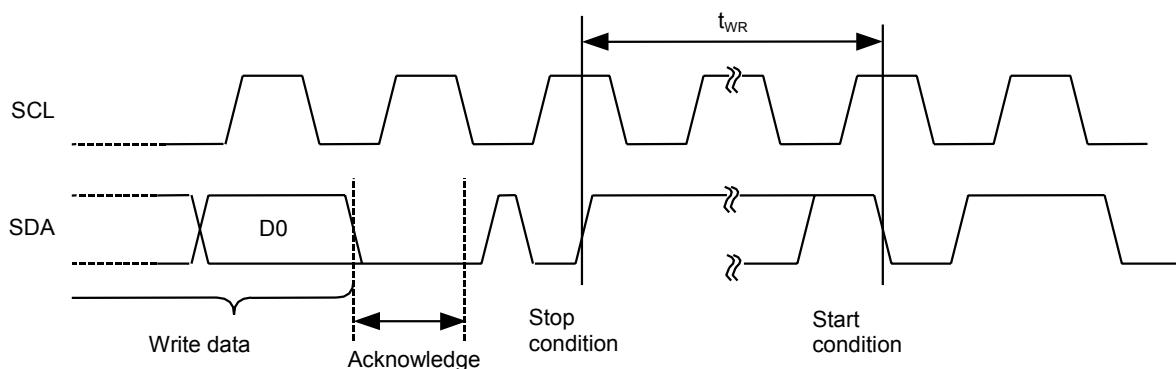


Figure 5 Write Cycle

■ Pin Functions

1. Address Input Pins (A2)

Connect pins A2 to the GND or the V_{CC} to assign slave addresses. There are 2 different ways to assign slave addresses in the S-24C08A. The S-24C16A doesn't have address input, so the slave address cannot be input. When the input slave address coincides with the slave address transmitted from the master device, 1 device can be selected from among multiple devices connected to the bus. Always connect the address input pin to GND or V_{CC} and leave it unchanged.

2. SDA (Serial Data Input/Output) Pin

The SDA pin is used for bilateral transmission of serial data. It consists of a signal input pin and an Nch open-drain transistor output pin.

Usually pull up the SDA line via resistance to the V_{CC} , and use it with other open-drain or open-collector output devices connected in a wired OR configuration.

3. SCL (Serial Clock Input) Pin

The SCL pin is used for serial clock input. It is capable of processing signals at the rising and falling edges of the SCL clock input signal. Make sure the rising time and falling time conform to the specifications.

4. WP Pin

In the S-24C08A and the S-24C16A, this pin is used for write protection. When there is no need for write protection, connect the pin to the GND; when there is a need for write protection, connect the pin to the V_{CC} .

Please refer Application Note "S-24C series EEPROMs Tips, Tricks & Traps" for equivalent circuit of each pin.

■ Operation

1. Start Condition

When the SCL line is "H," the SDA line changes from "H" to "L." This allows the device to go to the start condition.

All operations begin from the start condition.

2. Stop Condition

When the SCL line is "H," the SDA line changes from "L" to "H." This allows the device to go to the stop condition.

When the device receives the stop condition signal during a read sequence, the read operation is interrupted, and the device goes to standby mode.

When the device receives the stop condition signal during write sequence, the retrieval of write data is halted, and the EEPROM initiates rewrite.

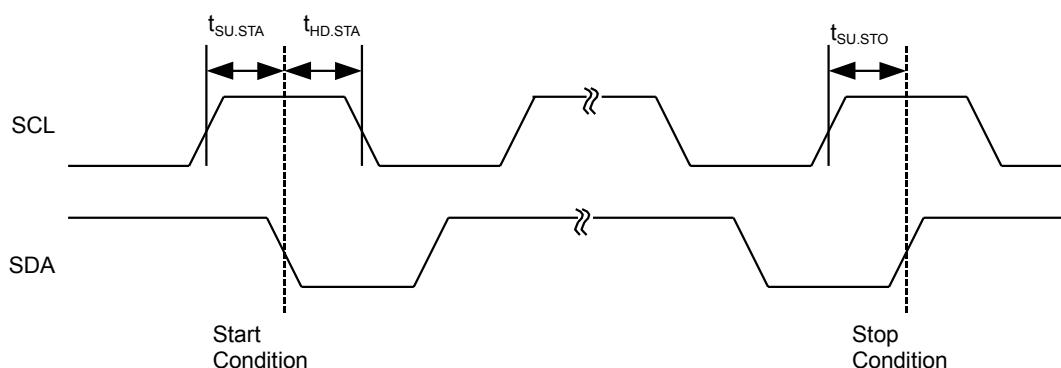


Figure 6 Start/Stop Conditions

3. Data Transmission

Changing the SDA line while the SCL line is "L" allows the data to be transmitted. A start or stop condition is recognized when the SDA line changes while the SCL line is "H."

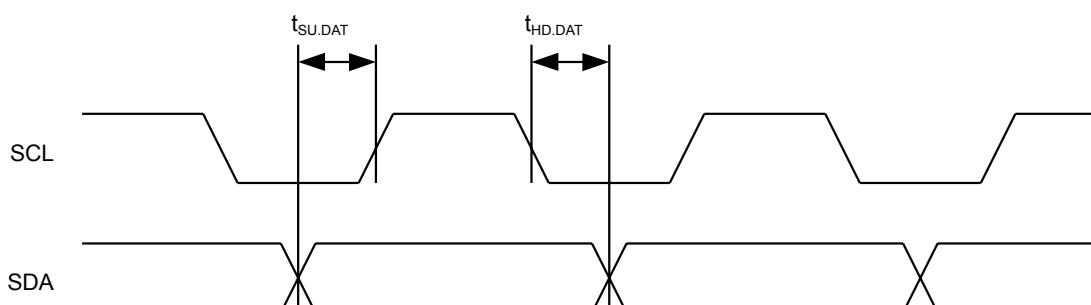


Figure 7 Data Transmission Timing

4. Acknowledgment

The unit of data transmission is 8 bits. By turning the SDA line "L," the slave device mounted on the system bus which receives the data during the 9th clock cycle outputs the acknowledgment signal verifying the data reception.

When the EEPROM is rewriting, the device does not output the acknowledgment signal.

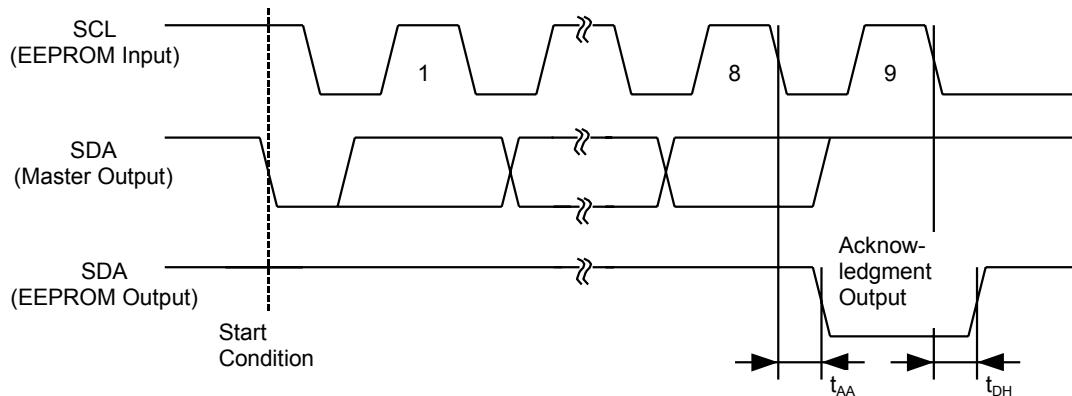


Figure 8 Acknowledgment Output Timing

5. Device Addressing

To perform data communications, the master device mounted on the system outputs the start condition signal to the slave device. Next, the master device outputs 7-bit length device address and a 1-bit length read/write instruction code onto the SDA bus.

Upper 4 bits of the device address are called the "Device Code," and set to "1010." Successive 3 bits (P2, P1, P0) are called the "Page Address." (In the S-24C08A, P2 is Slave Address A2.) Any of memory blocks (the S-24C08A has four 256-byte memory blocks and the S-24C16A has eight 256-byte memory blocks) can be selected at P2, P1, and P0.

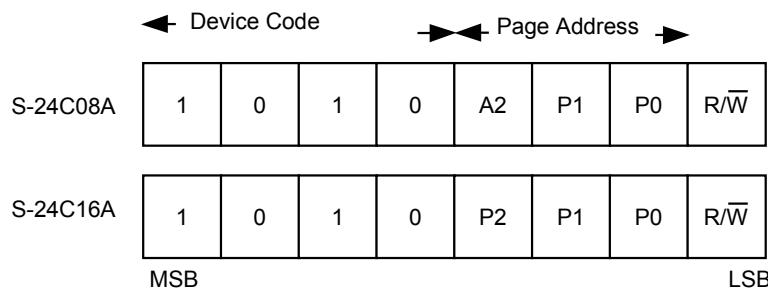


Figure 9 Device Address

6. Write

6.1 Byte Write

When the EEPROM receives a 7-bit length device address and a 1-bit read/write instruction code "0," following the start condition signal, it outputs the acknowledgment signal. Next, when the EEPROM receives an 8-bit length word address, it outputs the acknowledgment signal.

After the EEPROM receives 8-bit write data and outputs the acknowledgment signal, it receives the stop condition signal. Next, the EEPROM at the specified memory address starts to rewrite.

When the EEPROM is rewriting, all operations are prohibited and the acknowledgment signal is not output.

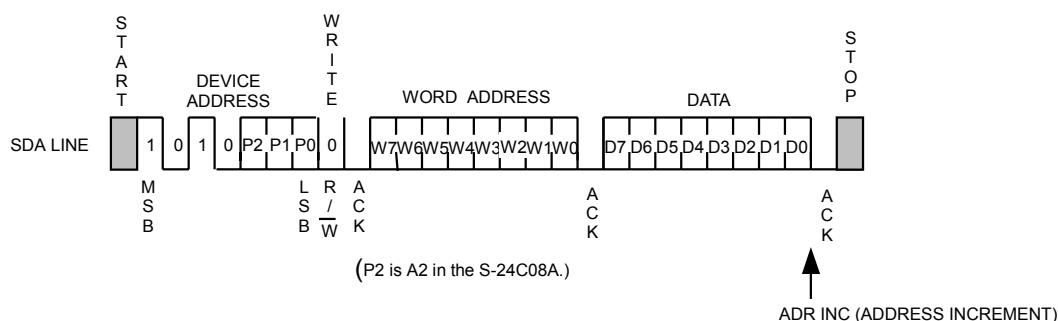


Figure 10 Byte Write

6.2 Page Write

Up to 16 bytes per page can be written in the S-24C08A and S-24C16A.

Basic data transmission procedures are the same as those in the "Byte Write." However, when the EEPROM receives 8-bit write data which corresponds to the page size, the page can be written.

When the EEPROM receives a 7-bit length device address and a 1-bit read/write instruction code "0," following the start condition signal, it outputs the acknowledgment signal. When the EEPROM receives an 8-bit length word address, it outputs the acknowledgment signal.

After the EEPROM receives 8-bit write data and outputs the acknowledgment signal, it receives 8-bit write data corresponding to the next word address, and outputs the acknowledgment signal. The EEPROM repeats reception of 8-bit write data and output of the acknowledgment signal in succession. It is capable of receiving write data corresponding to the maximum page size.

When the EEPROM receives the stop condition signal, it starts to rewrite, corresponding to the size of the page, on which write data, starting from the specified memory address, is received.

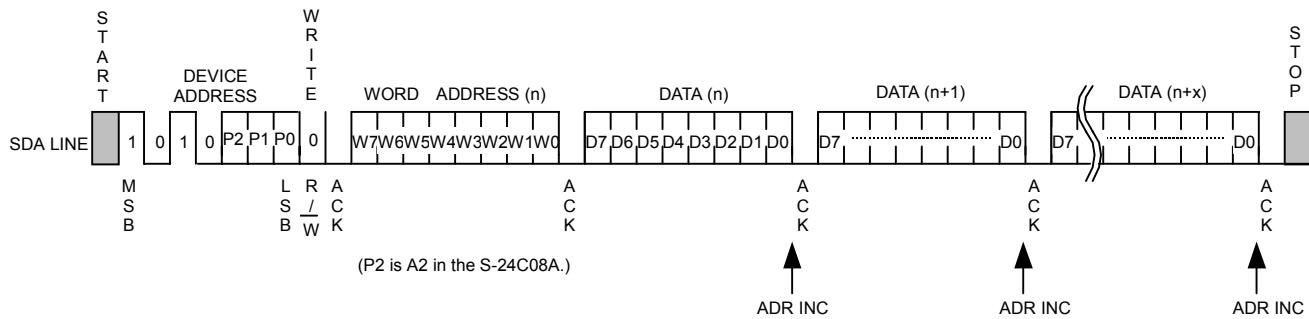


Figure 11 Page Write

In the S-24C08A or S-24C16A, the lower 4 bits at the word address are automatically incremented each when the EEPROM receives 8 bit write data.

Even when the write data exceeds 16 bytes, the upper 4 bits of the word address and page address (P2, P1, P0) remain unchanged, and the lower 4 bits are rolled over and overwritten.

6.3 Acknowledgment Polling

Acknowledgment polling is used to know when the rewriting of the EEPROM is finished.

After the EEPROM receives the stop condition signal and once it starts to rewrite, all operations are prohibited. Also, the EEPROM cannot respond to the signal transmitted by the master device.

Accordingly, the master device transmits the start condition signal and the device address read/write instruction code to the EEPROM (namely, the slave device) to detect the response of the slave device. This allows users to know when the rewriting of the EEPROM is finished.

That is, if the slave device does not output the acknowledgment signal, it means that the EEPROM is rewriting; when the slave device outputs the acknowledgment signal, you can know that rewriting has been completed. It is recommended to use read instruction "1" for the read/write instruction code transmitted by the master device.

6.4 Write Protection

The S-24C08A and the S-24C16A are capable of protecting the memory. When the WP pin is connected to V_{CC} , writing to all memory area is prohibited.

When the WP pin is connected to GND, the write protection becomes invalid, and writing in all memory area becomes available. However, when there is no need for using write protection, always connect the WP pin to GND.

7. Read

7.1 Current Address Read

The EEPROM is capable of storing the last accessed memory address during both writing and reading. The memory address is stored as long as the power voltage is more than the retention voltage V_{AH} .

Accordingly, when the master device recognizes the position of the address pointer inside the EEPROM, data can be read from the memory address of the current address pointer without assigning a word address. This is called "Current Address Read".

"Current Address Read" is explained for when the address counter inside the EEPROM is an "n" address.

When the EEPROM receives a 7-bit length device address and a 1-bit read/write instruction code "1," following the start condition signal, it outputs the acknowledgment signal. However, in the S-24C08A/16A, page address (P1, P0)/(P2, P1, P0) becomes invalid, and the memory address of the current address pointer becomes valid.

Next, 8-bit length data at an "n" address is output from the EEPROM, in synchronization with the SCL clock.

The address counter is incremented at the falling edge of the SCL clock by which the 8th bit of data is output, and the address counter goes to address n+1.

The master device does not output the acknowledgment signal and transmits the stop condition signal to finish reading.

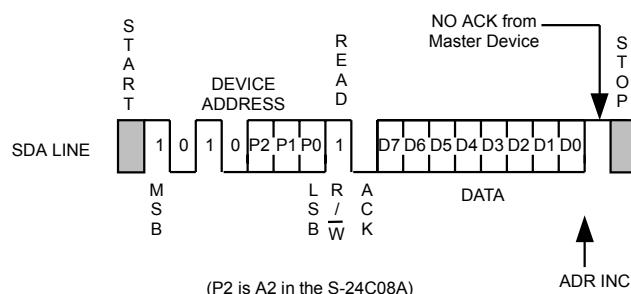


Figure 12 Current Address Read

For recognition of the address pointer inside the EEPROM, take into consideration the following:
The memory address counter inside the EEPROM is automatically incremented for every falling edge of the SCL clock by which the 8th bit of data is output during the time of reading. During the time of writing, upper bits of the memory address (upper 4 bits of the word address and page address) are left unchanged and are not incremented.

7.2 Random Read

Random read is a mode used when the data is read from arbitrary memory addresses.

To load a memory address into the address counter inside the EEPROM, first perform a dummy write according to the following procedures:

When the EEPROM receives a 7-bit length device address and a 1-bit read/write instruction code "0," following the start condition signal, it outputs the acknowledgment signal.

Next, the EEPROM receives an 8-bit length word address and outputs the acknowledgment signal.

Last, the memory address is loaded into the address counter of the EEPROM.

the EEPROM receives the write data during byte or page writing. However, data reception is not performed during dummy write.

The memory address is loaded into the memory address counter inside the EEPROM during dummy write. After that, the master device can read the data starting from the arbitrary memory address by transmitting a new start condition signal and performing the same operation as that in the "Current Read."

That is, when the EEPROM receives a 7-bit length device address and a 1-bit read/write instruction code "1," following the start condition signal, it outputs the acknowledgment signal.

Next, 8-bit length data is output from the EEPROM, in synchronization with the SCL clock. The master device does not output an acknowledgment signal and transmits the stop condition signal to finish reading.

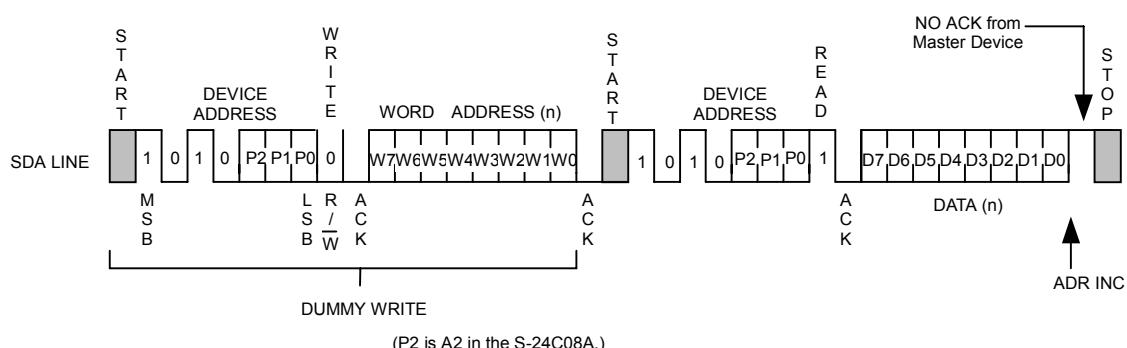


Figure 13 Random Read

7.3 Sequential Read

When the EEPROM receives a 7-bit length device address and a 1-bit read/write instruction code "1" in both current and random read operations, following the start condition signal, it outputs the acknowledgment signal

When 8-bit length data is output from the EEPROM, in synchronization with the SCL clock, the memory address counter inside the EEPROM is automatically incremented at the falling edge of the SCL clock, by which the 8th data is output.

When the master device transmits the acknowledgment signal, the next memory address data is output.

When the master device transmits the acknowledgment signal, the memory address counter inside the EEPROM is incremented and read data in succession. This is called "Sequential Read."

When the master device does not output an acknowledgement signal and transmits the stop condition signal, the read operation is finished.

Data can be read in the "Sequential Read" mode in succession. When the memory address counter reaches the last word address, it rolls over to the first memory address.

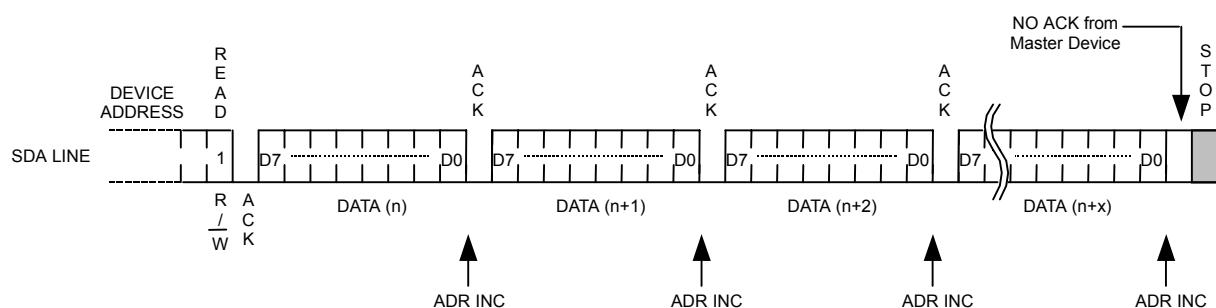


Figure 14 Sequential Read

8. Address Increment Timing

The address increment timing is as follows. See Figures 15 and 16. During reading operation, the memory address counter is automatically incremented at the falling edge of the SCL clock (the 8th read data is output).

During writing operation, the memory address counter is also automatically incremented at the falling edge of the SCL clock when the 8th bit write data is fetched.

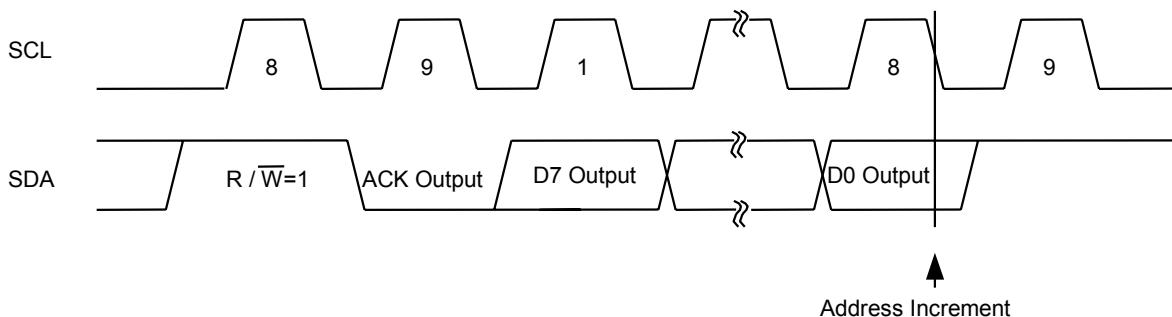


Figure 15 Address Increment Timing During Reading

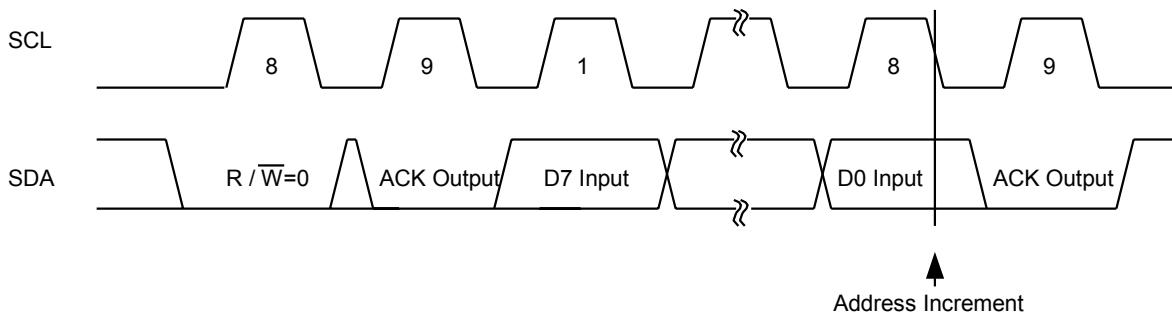


Figure 16 Address Increment Timing During Writing

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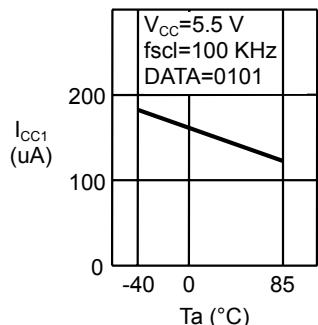
Please note that any product or system incorporating this IC may infringe upon the Philips I²C Bus Patent Rights depending upon its configuration.

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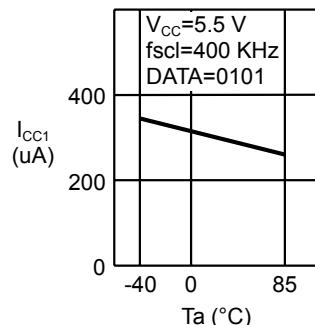
■ Characteristics

1. DC Characteristics

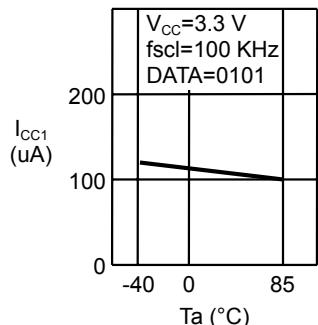
1.1 Current consumption (READ) I_{CC1} — Ambient temperature T_a



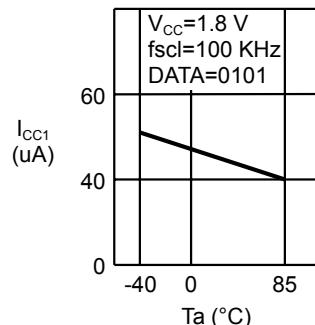
1.2 Current consumption (READ) I_{CC1} — Ambient temperature T_a



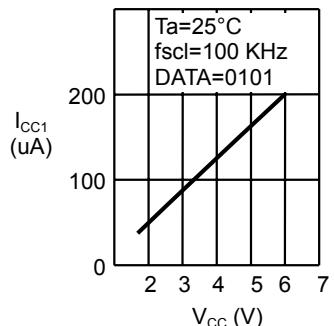
1.3 Current consumption (READ) I_{CC1} — Ambient temperature T_a



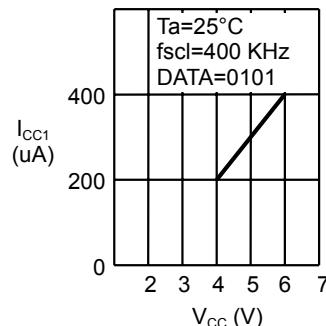
1.4 Current consumption (READ) I_{CC1} — Ambient temperature T_a



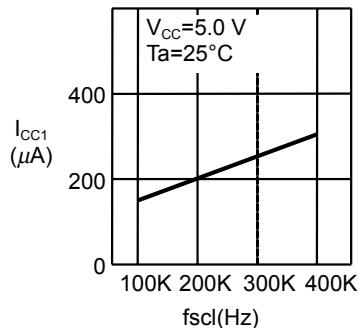
1.5 Current consumption (READ) I_{CC1} — Power supply voltage V_{CC}



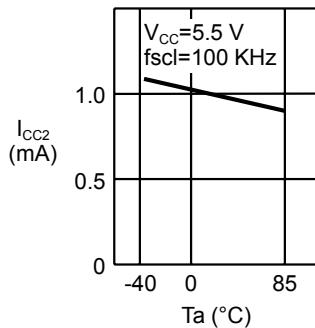
1.6 Current consumption (READ) I_{CC1} — Power supply voltage V_{CC}



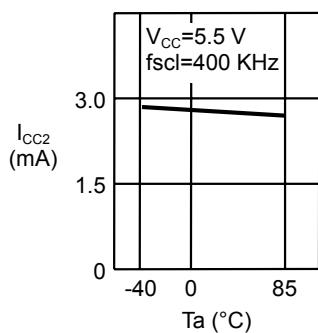
1.7 Current consumption (READ) I_{CC1} — Clock frequency $fscl$



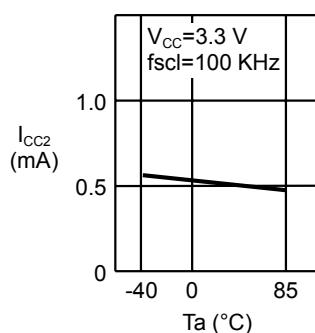
1.8 Current consumption (PROGRAM) I_{CC2} — Ambient temperature T_a



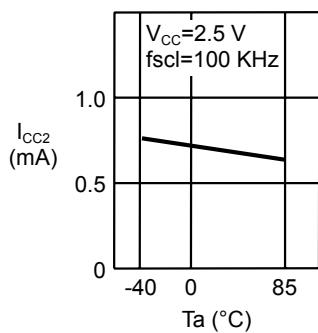
1.9 Current consumption (PROGRAM) I_{CC2} —
 Ambient temperature T_a



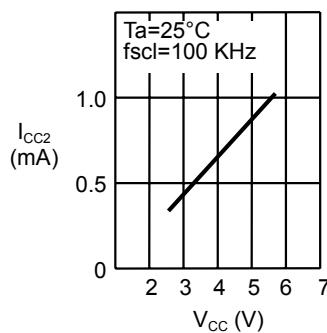
1.10 Current consumption (PROGRAM) I_{CC2} —
 Ambient temperature T_a



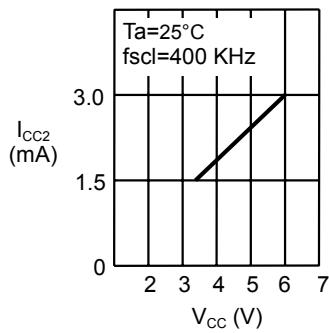
1.11 Current consumption (PROGRAM) I_{CC2} —
 Ambient temperature T_a



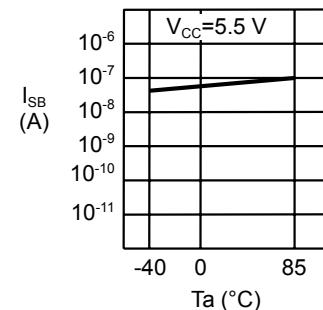
1.12 Current consumption (PROGRAM) I_{CC2} —
 Power supply voltage V_{CC}



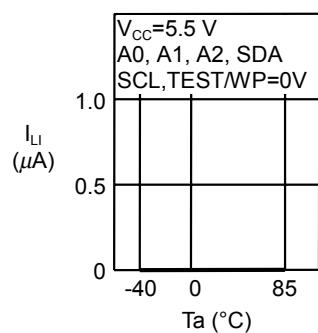
1.13 Current consumption (PROGRAM) I_{CC2} —
 Power supply voltage V_{CC}



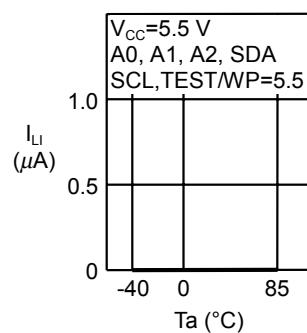
1.14 Standby current consumption I_{SB} —
 Ambient temperature T_a



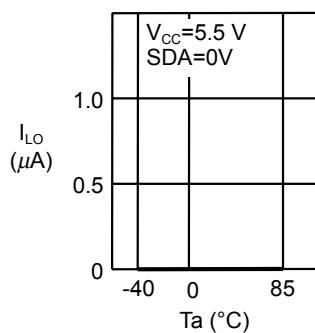
1.15 Input leakage current I_{LI} —
 Ambient temperature T_a



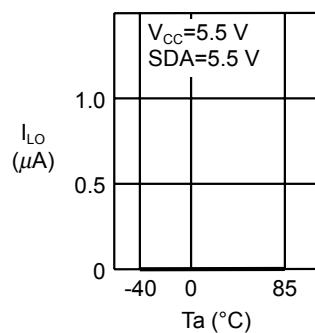
1.16 Input leakage current I_{LI} —
 Ambient temperature T_a



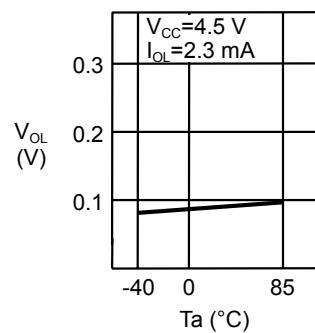
1.17 Output leakage current I_{LO} —
Ambient temperature T_a



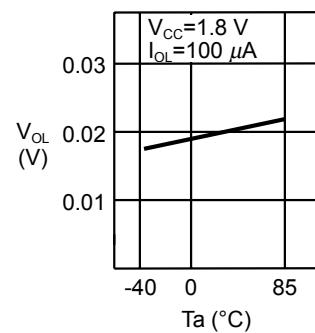
1.18 Output leakage current I_{LO} —
Ambient temperature T_a



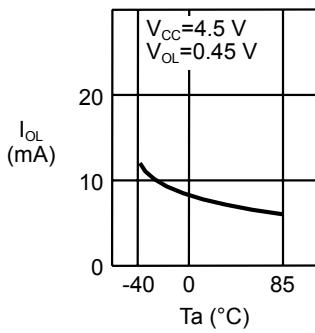
1.19 Low level output voltage V_{OL} —
Ambient temperature T_a



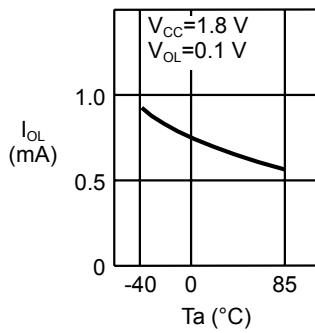
1.20 Low level output voltage V_{OL} —
Ambient temperature T_a



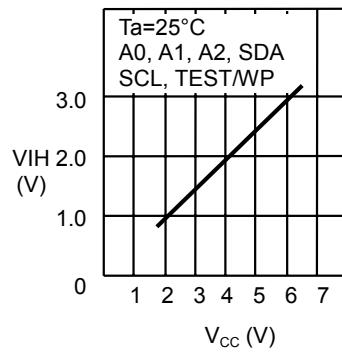
1.21 Low level output current I_{OL} —
Ambient temperature T_a



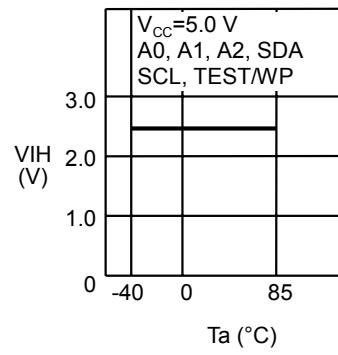
1.22 Low level output current I_{OL} —
Ambient temperature T_a



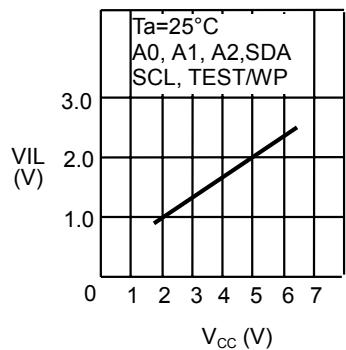
1.23 High input inversion voltage VIH —
Power supply voltage V_{CC}



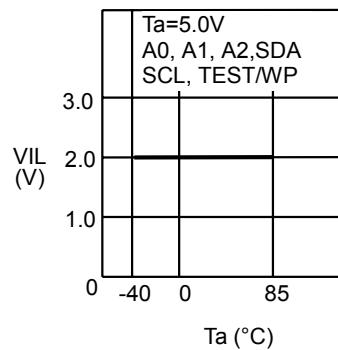
1.24 High input inversion voltage VIH —
Ambient temperature T_a



1.25 Low input inversion voltage V_{IL} —
Power supply voltage V_{CC}

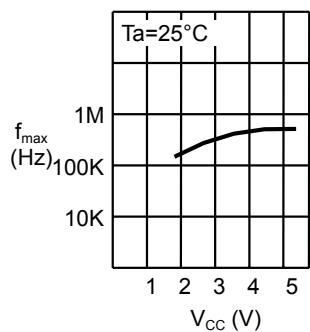


1.26 Low input inversion voltage V_{IL} —
Ambient temperature T_a

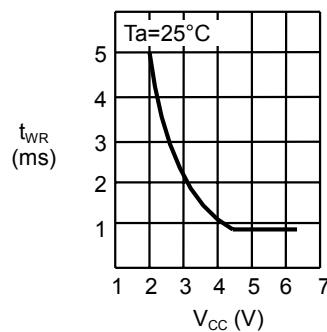


2. AC Characteristics

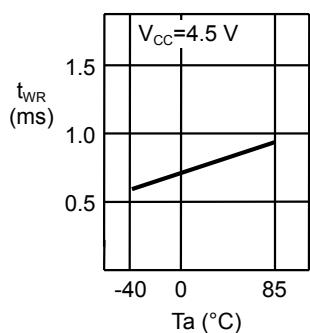
2.1 Maximum operating frequency f_{max} —
Power supply voltage V_{CC}



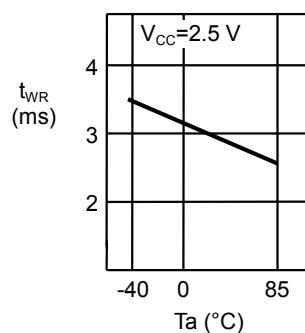
2.2 Write time t_{WR} —
Power supply voltage V_{CC}



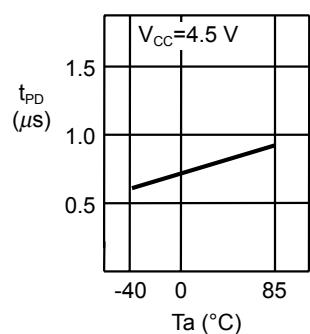
2.3 Write time t_{WR} —
Ambient temperature T_a



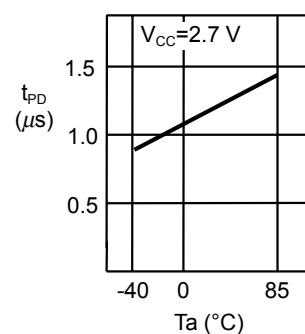
2.4 Write time t_{WR} —
Ambient temperature T_a



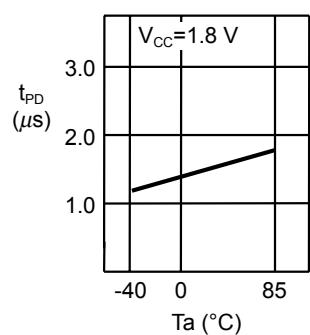
2.5 SDA output delay time t_{PD} —
Ambient temperature T_a



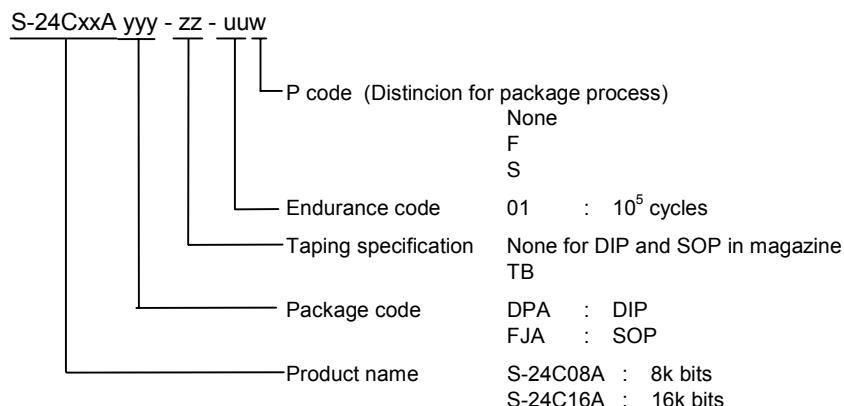
2.6 SDA output delay time t_{PD} —
Ambient temperature T_a



2.7 SDA output delay time t_{PD} —
Ambient temperature T_a



■ Ordering Information



Product name	Package code	Endurance code	Taping specification	P code	Package/Tape/Reel drawings
S-24C08A	DPA	-01	None	None	DP008-A
				-F	DP008-E
				-S	DP008-A DP008-E
	FJA	-01	-TB (None for magazine)	None	FJ008-D
				-F	FJ008-E
				-S	FJ008-D FJ008-E
S-24C16A	DPA	-01	None	None	DP008-A
	FJA	-01	-TB (None for magazine)	None	FJ008-D

Note

- 1) Package dimensions of SOPs whose package code is FJA are the same in the range of deviation.
- 2) Please contact an SII local office or a local representative for details.

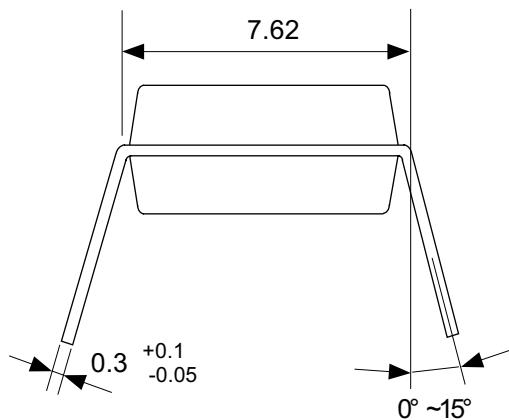
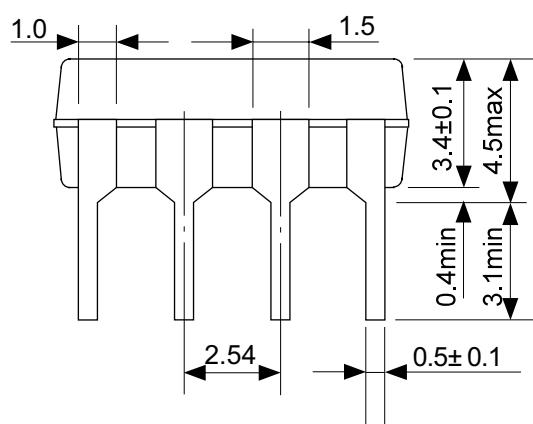
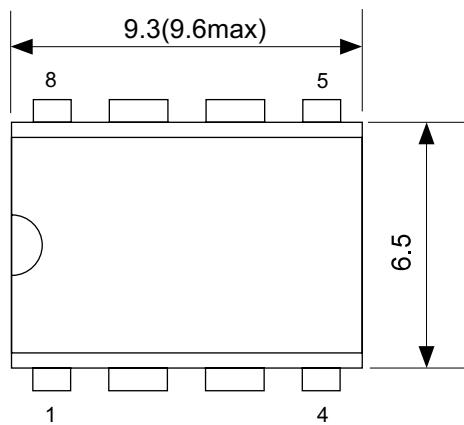
■ 8-pin DIP

DP008-A

011022

● Dimensions

Unit:mm

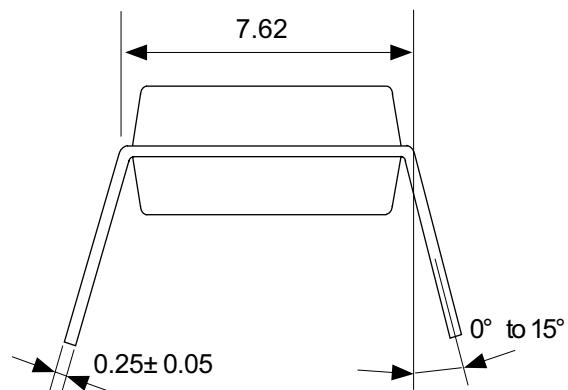
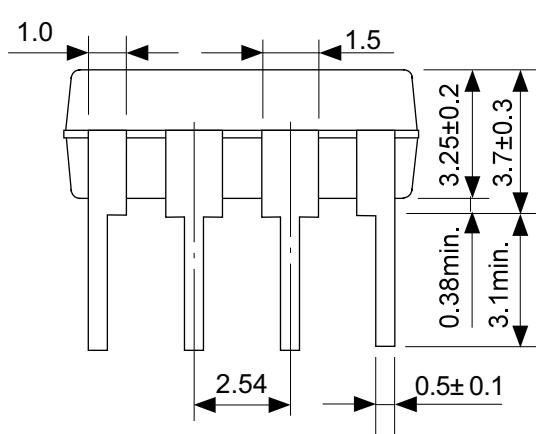
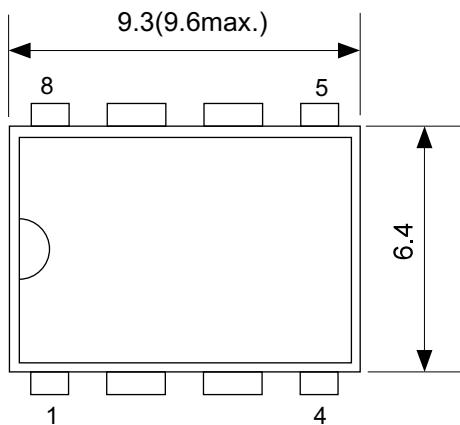


■ 8-pin DIP

● Dimensions

DP008-E 011022

Unit : mm

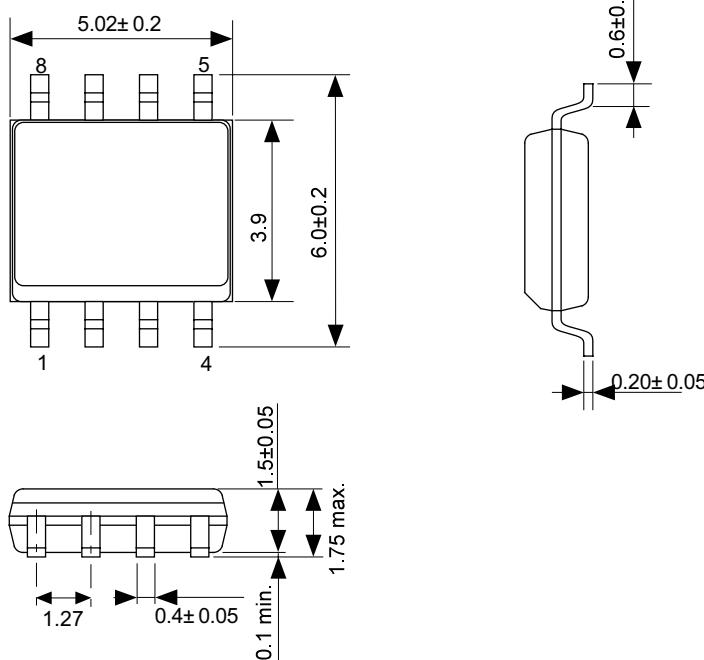


■ 8-pin SOP

FJ008-D

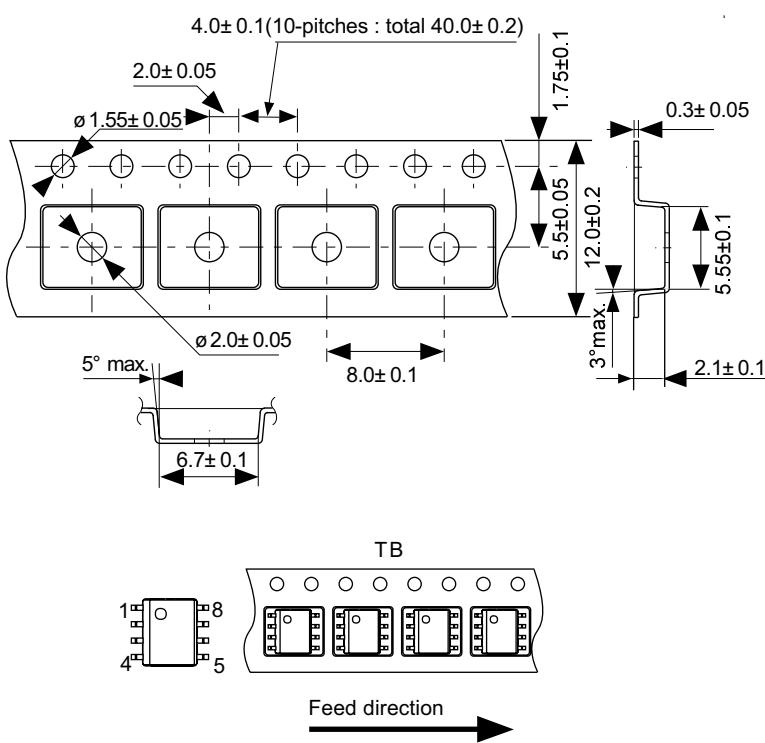
011022

● Dimensions



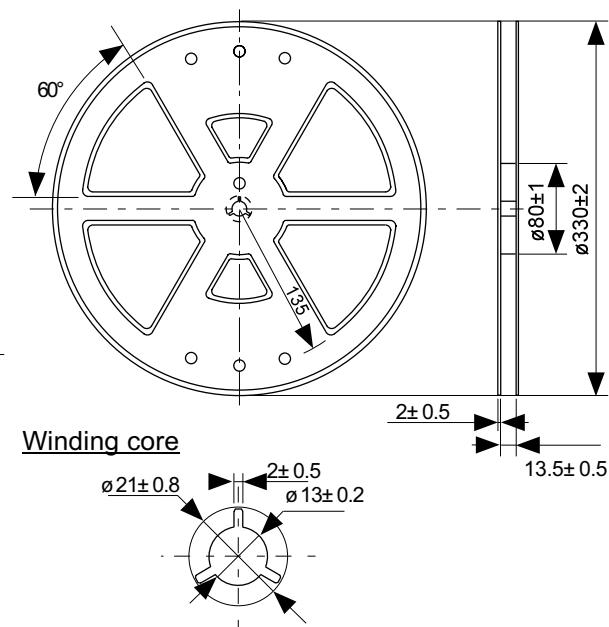
Unit : mm

● Tape Specifications



● Reel Specifications

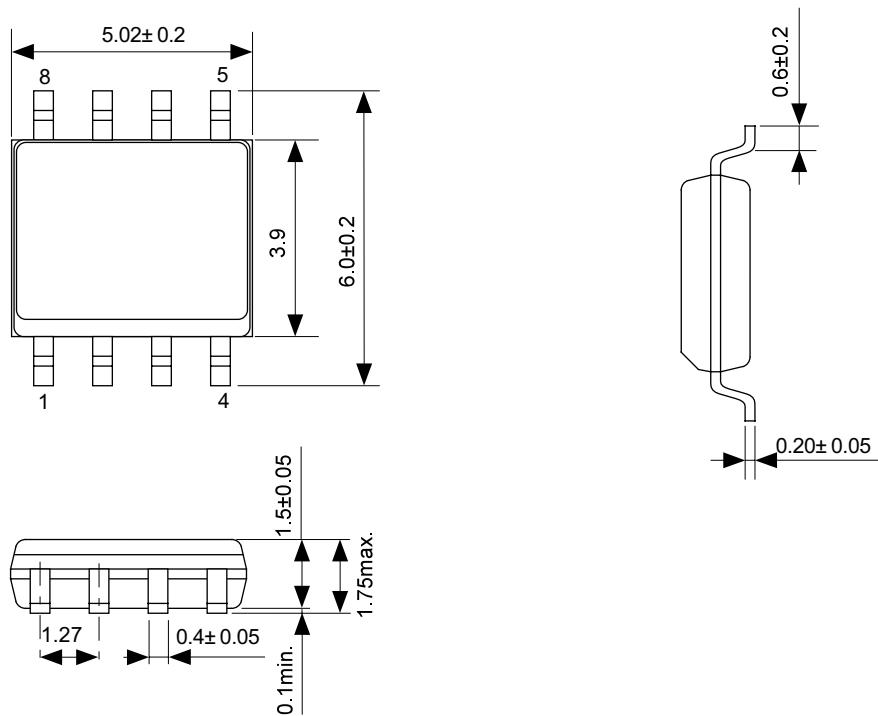
2000 pcs./reel



■ 8-pin SOP

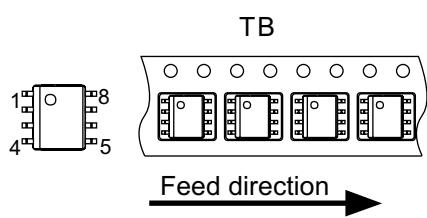
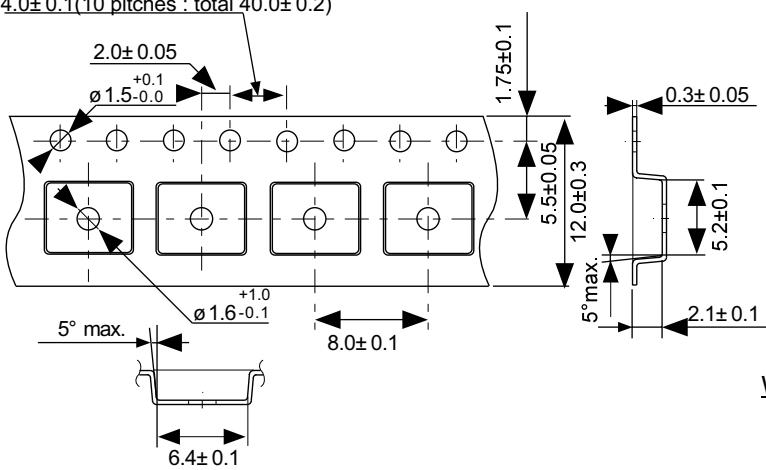
FJ008-E 011022

● Dimensions



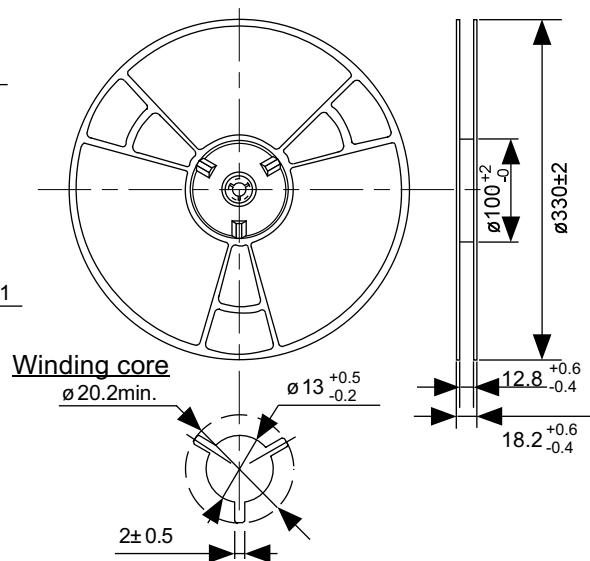
● Tape Specifications

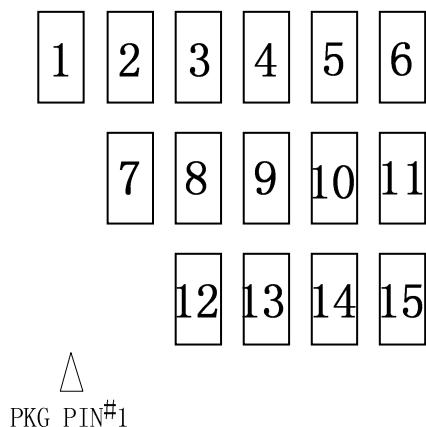
4.0 ± 0.1 (10 pitches : total 40.0 ± 0.2)



● Reel Specifications

2000 pcs./reel



● 8-pin DIP

1 to 8 : Product code

9 : Assembly mark

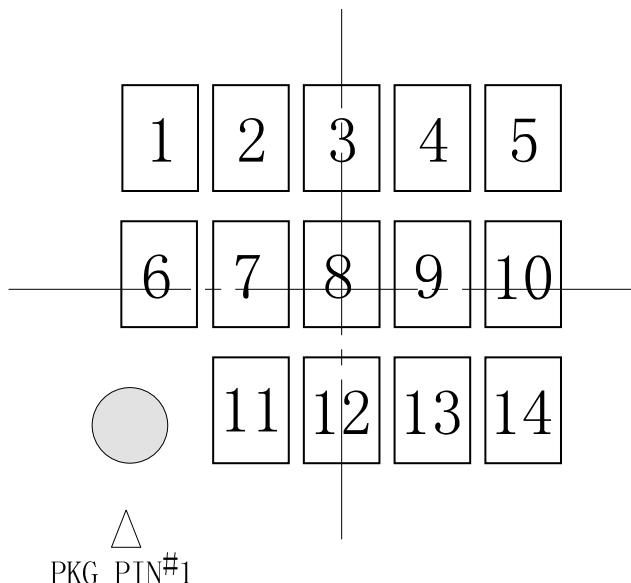
10 : Year of assembly

11 : Month of assembly

12 to 15 : Lot No.

Numbers 1, 2, 7, 8, and/or 12 include blanks depending on product type.

No. : D P 0 0 8 - A - M - S D - 1 . 0

● 8-pin SOP

1 to 7 : Product code

8 : Assembly mark

9 : Year of assembly

10 : Month of assembly

11 to 14 : Lot No.

Numbers 1, 6, 7, and/or 11 include blanks depending on product type.

No. : F J 0 0 8 - A - M - S D - 1 . 0

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