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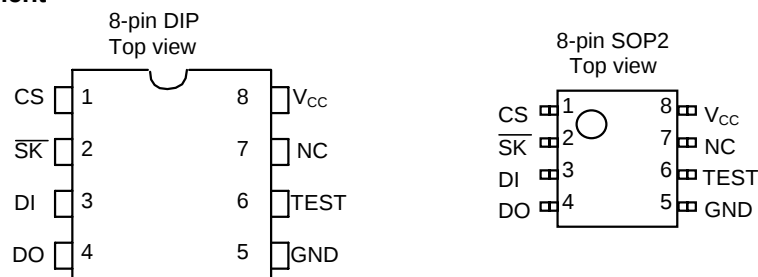
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The S-29590A / 690A series are low power 16K / 32K-bit E²PROM with a low operating voltage range. They are organized as 1024-word×16-bit and 2048-word×16bit, respectively. Each is capable of sequential read, at which time addresses are automatically incremented in 16-bit blocks. Interface is structured so that this IC can be directly connected to the CPU with serial ports. 8-bit instructions make it easy to prepare your own software.

■ Features

- Low power consumption
 - Standby : 1.0μA Max.
 - Operating : 1.2 mA Max. (VCC=5.5 V)
 - : 0.4 mA Max. (VCC=2.5 V)
- Wide operating voltage range
 - Write : 1.8 to 5.5 V
 - Read : 1.8 to 5.5 V
- Sequential read capable
- Can be easily connected to the serial port
- Endurance : 10⁶ cycles/word
- Data retention : 10 years

■ Pin Assignment



* See ■ Dimensions

Figure 1

■ Pin Functions

Table 1

Name	Pin Number		Function
	SOP2	SSOP	
CS	1	1	Chip select input
SK	2	2	Serial clock input
DI	3	3	Serial data input
DO	4	4	Serial data output
GND	5	5	Ground
TEST	6	6	Test pin (normally kept open) (can be connected to GND or Vcc)
NC	7	7	No Connection
VCC	8	8	Power supply

■ Block Diagram

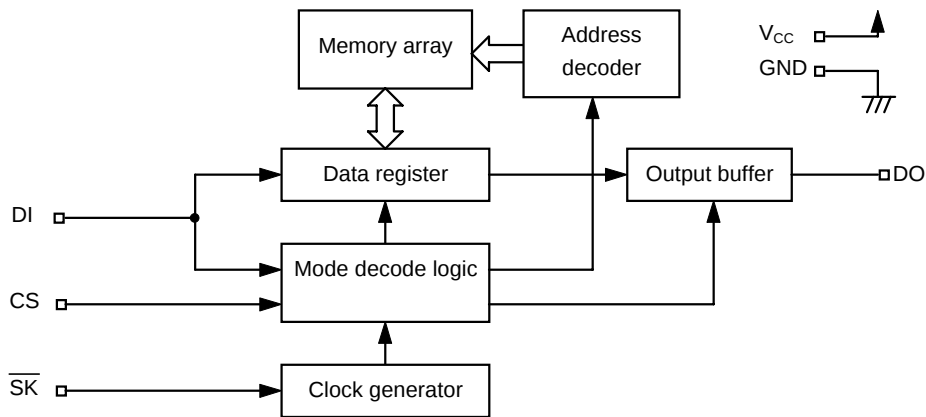


Figure 2

■ Instruction Set

Table 2

Instruction	Start Bit	Ope Code	Address		Data
			S-29530A	S-29630A	
READ (Read data)	1	1000	xA ₉ to A ₀	A ₁₀ to A ₀	D ₁₅ to D ₀ Output*
PROGRAM (Program data)	1	x100	xA ₉ to A ₀	A ₁₀ to A ₀	D ₁₅ to D ₀ Input
PEN (Program enable)	1	0011	xxxxxxxxxx	xxxxxxxxxx	—
PDS (Program disable)	1	0000	xxxxxxxxxx	xxxxxxxxxx	—

x : Doesn't matter.
* : Addresses are continuously incremented.

■ Absolute Maximum Ratings

Table 3

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 4

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V _{CC}	READ/PROGRAM EWEN/EWDS	1.8	—	5.5	V
High level input voltage	V _{IH}	V _{CC} = 2.5 to 5.5 V	0.8×V _{CC}	—	V _{CC}	V
		V _{CC} = 1.8 to 2.5 V	0.8×V _{CC}	—	V _{CC}	V
Low level input voltage	V _{IL}	V _{CC} = 2.5 to 5.5 V	0.0	—	0.2×V _{CC}	V
		V _{CC} = 1.8 to 2.5 V	0.0	—	0.15×V _{CC}	V
Operating temperature	T _{opr}		- 40	—	+ 85	°C

■ **Pin Capacitance**

Table 5

(T_a=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	—	—	8	pF
Output Capacitance	C _{OUT}	V _{OUT} =0 V	—	—	10	pF

■ **Endurance**

Table 6

Parameter	Symbol	Min.	Typ.	Max.	Unit
Endurance	N _w	10 ⁶	—	—	cycles/word

CMOS SERIAL E²PROM

S-29590A / 29690A

■ DC Electrical Characteristics

Table 7

Parameter	SmbI	Conditions	V _{CC} =4.5 V to 5.5 V			V _{CC} =2.5 V 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}	DO unloaded	—	—	1.2	—	—	0.6	—	—	0.4	mA
Current consumption (PROGRAM)	I _{CC2}	DO unloaded	—	—	5.0	—	—	2.0	—	—	1.5	mA

Table 8

Parameter	SmbI	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}	CS=GND DO=Open Connected to V _{CC} or GND	—	—	1.0	—	—	1.0	—	—	1.0	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}	CMOS I _{OL} = 100μA	—	—	0.1	—	—	0.1	—	—	—	V
High level output voltage	V _{OH}	CMOS V _{CC} =2.5 to 5.5V: I _{OH} = -100μA V _{CC} =1.8 to 2.5V: I _{OH} = -10μA	V _{CC} -0.7	—	—	V _{CC} -0.7	—	—	V _{CC} -0.3	—	—	V
Write enable latch data hold voltage	V _{DH}	Only when write disable mode	1.5	—	—	1.5	—	—	1.5	—	—	V

■ AC Electrical Characteristics

Table 9

Input pulse voltage	$0.1 \times V_{CC}$ to $0.9 \times V_{CC}$
Output reference voltage	$0.5 \times V_{CC}$
Output load	100pF

Table 10

Parameter	Symble	$V_{CC}=4.5$ 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.	
CS setup time	t_{CSS}	0.2	—	—	0.4	—	—	1.0	—	—	μ s
CS hold time	t_{CSH}	0.2	—	—	0.4	—	—	1.0	—	—	μ s
CS deselect time	t_{CDS}	0.2	—	—	0.2	—	—	0.4	—	—	μ s
Data setup time	t_{DS}	0.2	—	—	0.4	—	—	0.8	—	—	μ s
Data hold time	t_{DH}	0.2	—	—	0.4	—	—	0.8	—	—	μ s
Output delay	t_{PD}	—	—	0.5	—	—	1.0	—	—	2.0	μ s
Clock frequency	f_{SK}	0	—	1.4	0	—	0.5	0	—	0.2	MHz
Clock pulse width	t_{SKH}, t_{SKL}	0.35	—	—	1.0	—	—	2.5	—	—	μ s
Output disable time	t_{HZ1}, t_{HZ2}	0	—	0.15	0	—	0.5	0	—	1.0	μ s
Output enable time	t_{SV}	0	—	0.15	0	—	0.5	0	—	1.0	μ s
Programming time	t_{PR}	—	4.0	10.0	—	4.0	10.0	—	4.0	10.0	ms

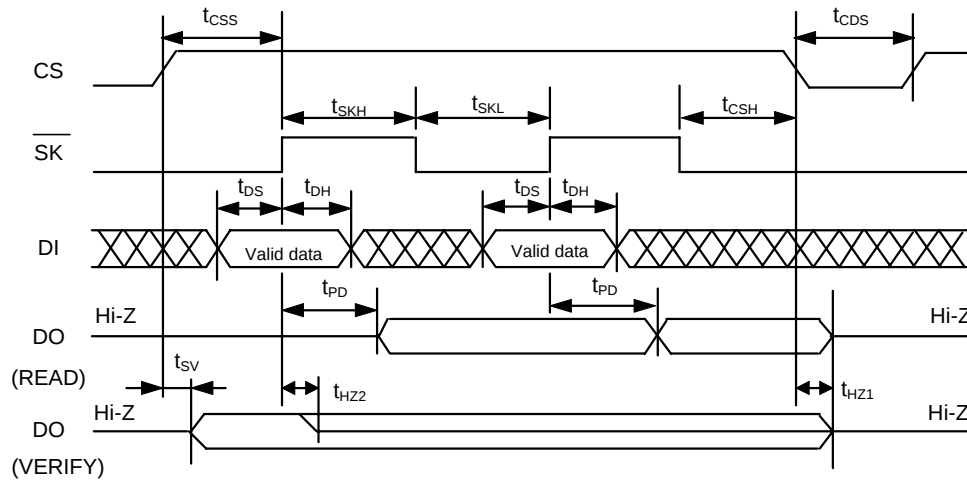


Figure 3 Timing Chart

■ Operation

Instructions (in the order of start-bit, instruction, address, and data) are latched to DI in synchronization with the rising edge of $\overline{SK}$ after CS goes high. A start-bit can only be recognized when the high of DI is latched to the rising edge of $\overline{SK}$ when CS goes from low to high, it is impossible for it to be recognized as long as DI is low, even if there are $\overline{SK}$ pulses after CS goes high. Instruction input finishes when CS goes low, where it must be low between commands during t_{CDs} .

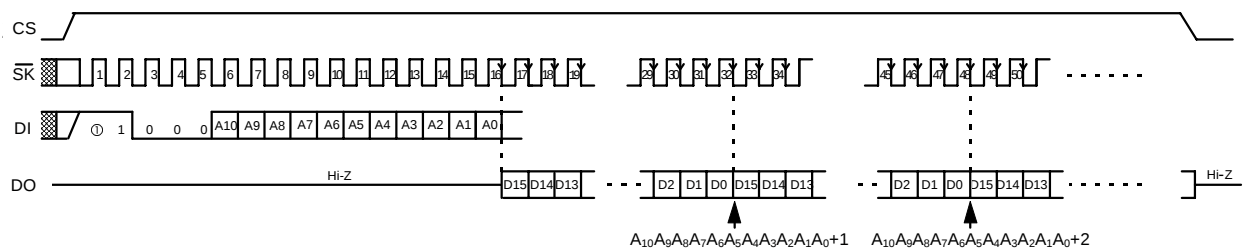
All input, including DI and $\overline{SK}$ signals, is ignored while CS is low, which is stand-by mode. The start bit + instruction, address and data are 8-bit instructions. This makes it easy to prepare your own software using a serial interface incorporated into the CPU.

1. Read

The READ instruction reads data from a specified address. After A0 is latched at the rising edge of $\overline{SK}$, 16-bit data is continuously output in synchronization with the falling of $\overline{SK}$.

When all of the data (D15 to D0) in the specified address has been read, the data in the next address can be read with the input of another $\overline{SK}$ clock. Thus, it is possible for all of the data addresses to be read through the continuous input of $\overline{SK}$ clocks as long as CS is high.

The last address ($A_n \dots A_1 A_0 = 1 \dots 11$) rolls over to the top address ($A_n \dots A_1 A_0 = 0 \dots 00$).



*On the S-29590A, A₁₀ is optional.

Figure 4 Read Timing (S-29690A)

2. Write (PROGRAM)

The PROGRAM instruction automatically begins writing to the non-volatile memory when CS goes low at the completion of the specified clock input.

The write operation is completed in 10 ms (t_{PR} Max.), and the typical write period is less than 4 ms. In the S-29590A / 690A series, it is easy to VERIFY the completion of the write operation in order to minimize the write cycle by setting CS to high and checking the DO pin, which is low during the write operation and high after its completion. This VERIFY procedure can be executed over and over again. There are two methods to detect a change in the DO output. One is to detect a change from low to high setting CS to high, and the other is to detect a change from low to high as a result of repetitious operations of returning the CS to low after setting CS to high and checking the DO output.

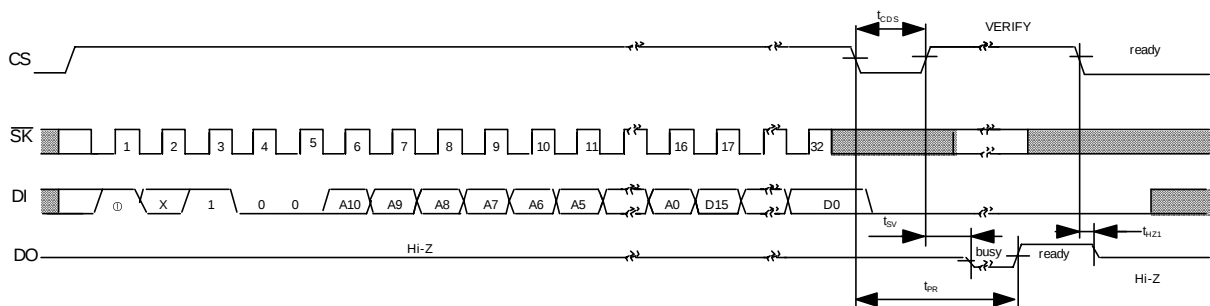
Because all $\overline{SK}$ and DI inputs are ignored during the write operation, any input of instruction will also be disregarded. When DO outputs high after completion of the write operation or if it is in the high-impedance state (Hi-Z), the input of instructions is available. Even if the DO pin remains high, it will enter the high-impedance state upon the recognition of a high of DI (start-bit) attached to the rising edge of an $\overline{SK}$ pulse. (see Figure 3).

DI input should be low during the VERIFY procedure.

2.1 PROGRAM

This instruction writes 16-bit data to a specified address.

After changing CS to high, input a start-bit, op-code (PROGRAM), address, and 16-bit data. If there is a data overflow of more than 16 bits, only the last 16-bits of the data is considered valid. Changing CS to low will start the PROGRAM operation. It is not necessary to make the data "1" before initiating the PROGRAM operation.



*On the S-29590A, A₁₀ is optional.

Figure 5 Write Timing (S-29690A)

3. Write enable (PEN) and Write disable (PDS)

The PEN instruction puts the S-29590A / 690A series into write enable mode, which accepts PROGRAM instructions. The PDS instruction puts the S-29590A / 690A series into write disable mode, which refuses PROGRAM instructions. The S-29590A / 690A series powers on in write disable mode, which protects data against unexpected, erroneous write operations caused by noise and/or CPU malfunctions. It should be kept in write disable mode except when performing write operations.

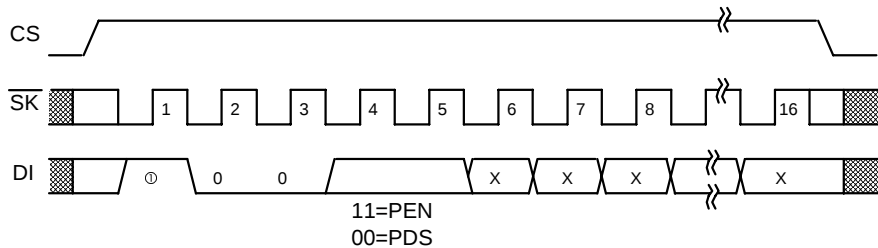


Figure 6 PEN/PDS Timing (S-29690A)

■ Receiving a Start-Bit

A start bit can be recognized by latching the high level of DI at the rising edge of $\overline{SK}$ after changing CS to high (Start-bit Recognition). The write operation begins by inputting the write instruction and setting CS to low. The DO pin then outputs low during the write operation and high at its completion by setting CS to high (Verify Operation). Therefore, only after a write operation, in order to accept the next command by having CS go high, the DO pin switch from a state of high-impedence to a state of data output; but if it recognizes a start-bit, the DO pin returns to a state of high-impedence (see Figure 3).

■ Three-wire Interface (DI-DO direct connection)

Although the normal configuration of a serial interface is a 4-wire interface to CS, $\overline{SK}$, DI, and DO, a 3-wire interface is also a possibility by connecting DI and DO. However, since there is a possibility that the DO output from the serial memory IC will interfere with the data output from the CPU with a 3-wire interface, install a resistor between DI and DO in order to give preference to data output from the CPU to DI (See Figure 7).

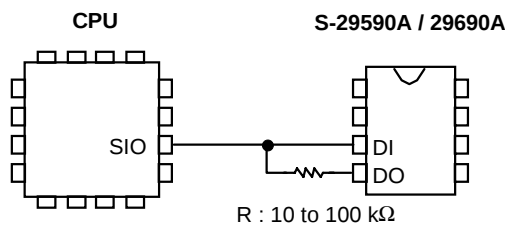


Figure 7

■ Connecting to the CPU with Serial Port

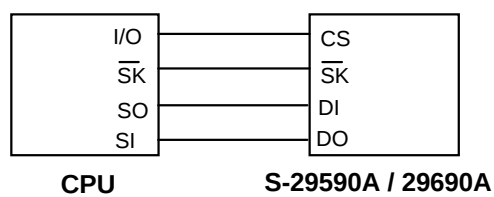


Figure 9 Connection Example

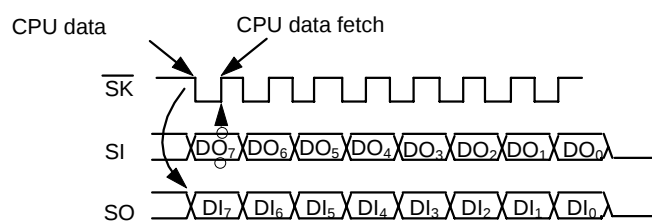


Figure 10 Serial Shift Timing

■ Dimensions (Unit : mm)

1. 8-pin DIP

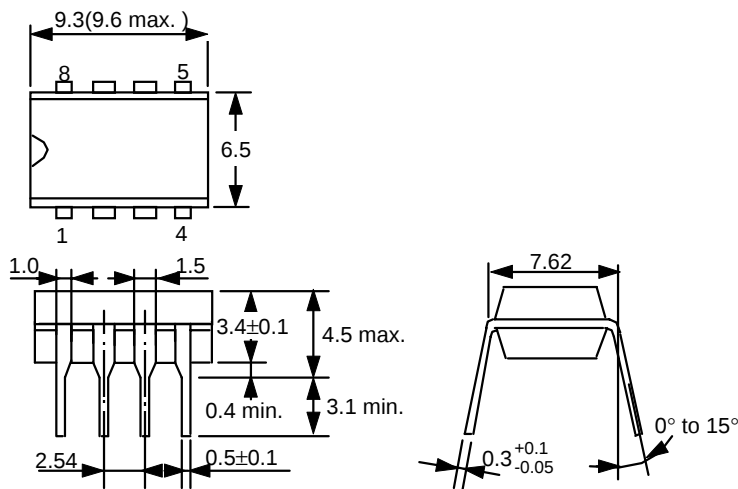


Figure 10

Markings

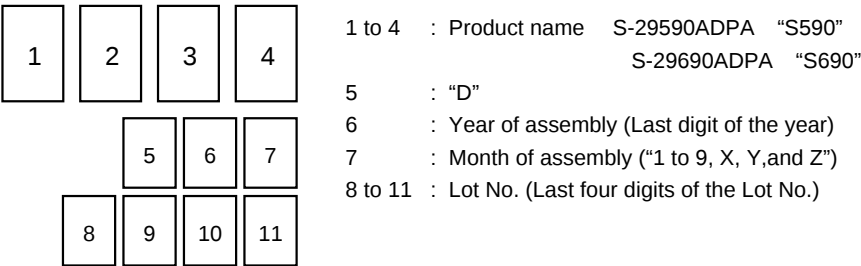


Figure 11

2. 8-pin SOP

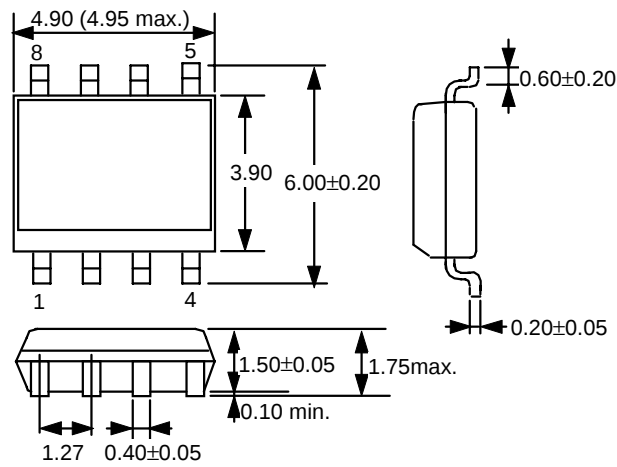


Figure 12

Markings

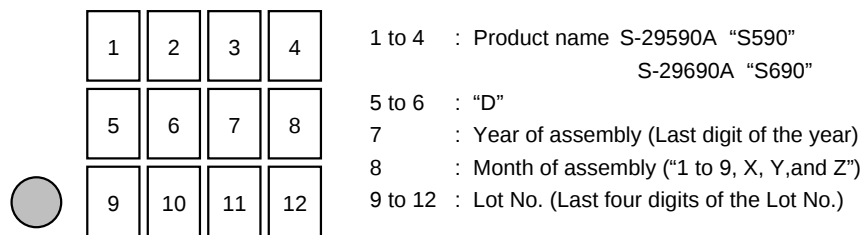


Figure 13

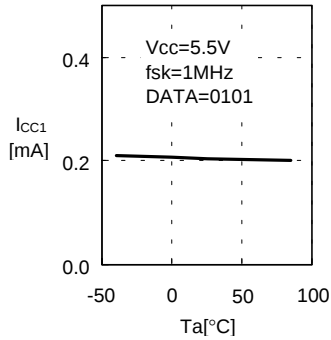
Ordering Information

S-29X90A	XXXX	Package	DPA	:	DIP
			DFJA	:	SOP
		Product	S-29590A	:	16Kbit
			S-29690A	:	32Kbit

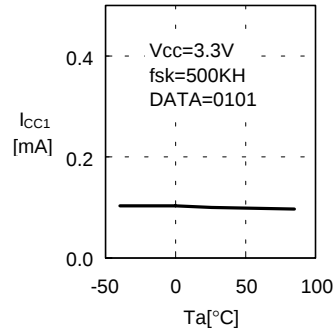
■ Characteristics

1.DC Characteristics

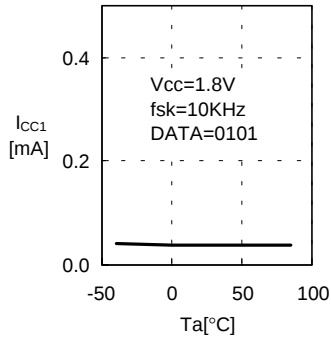
1.1 Current consumption (READ) I_{CC1} – Ambient temperature T_a



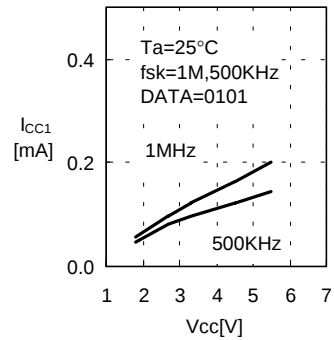
1.2 Current consumption (READ) I_{CC1} – Ambient temperature T_a



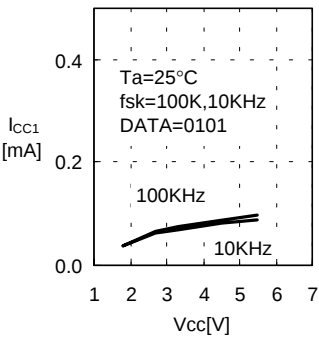
1.3 Current consumption (READ) I_{CC1} – Ambient temperature T_a



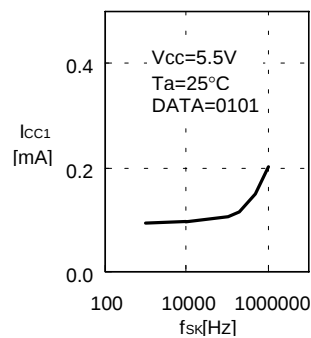
1.4 Current consumption (READ) I_{CC1} – Power supply voltage V_{CC}



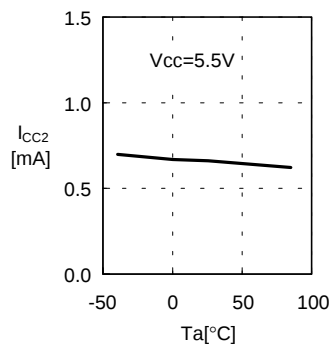
1.5 Current consumption (READ) I_{CC1} – Power supply voltage V_{CC}



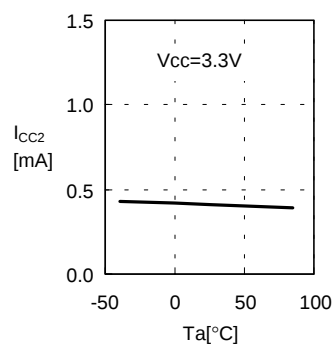
1.6 Current consumption (READ) I_{CC1} – Clock frequency f_{SK}



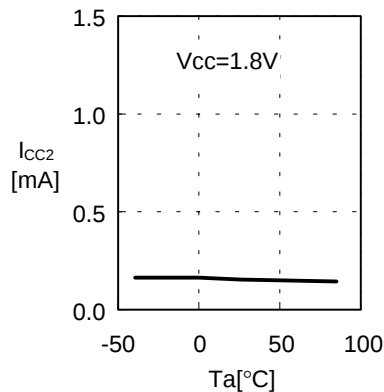
1.7 Current consumption (PROGRAM) I_{CC2} – Ambient temperature T_a



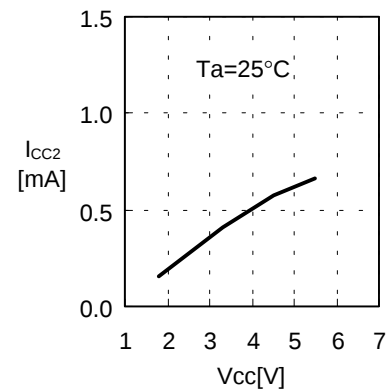
1.8 Current consumption (PROGRAM) I_{CC2} – Ambient temperature T_a



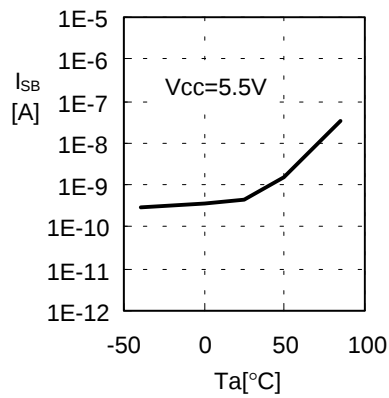
1.9 Current consumption (PROGRAM) I_{CC2} – Ambient temperature T_a



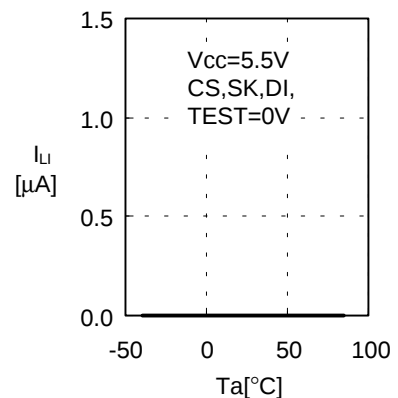
1.10 Current consumption (PROGRAM) I_{CC2} – Power supply voltage V_{CC}



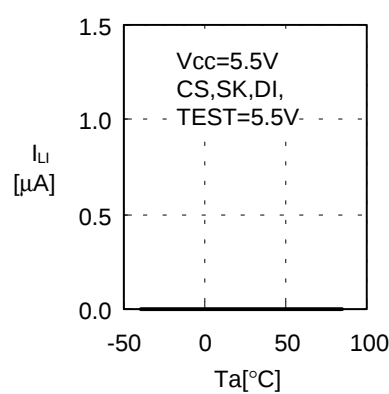
1.11 Standby current consumption I_{SB} – Ambient temperature T_a



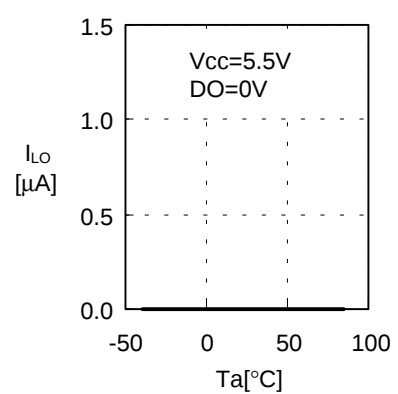
1.12 Input leakage current I_{LI} – Ambient temperature T_a



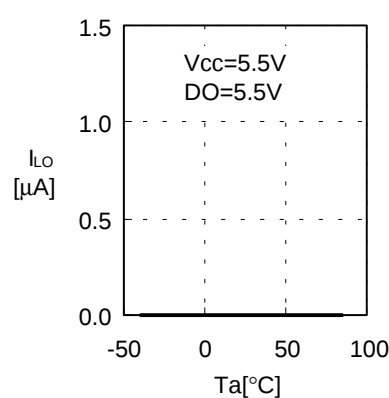
1.13 Input leakage current I_{LI} – Ambient temperature T_a



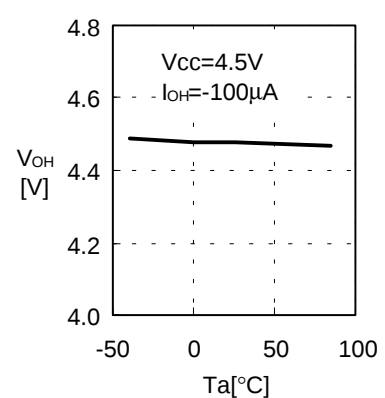
1.14 Output leakage current I_{LO} – Ambient temperature T_a



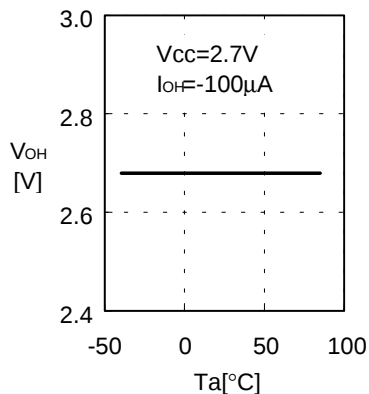
1.15 Output leakage current I_{LO} – Ambient temperature T_a



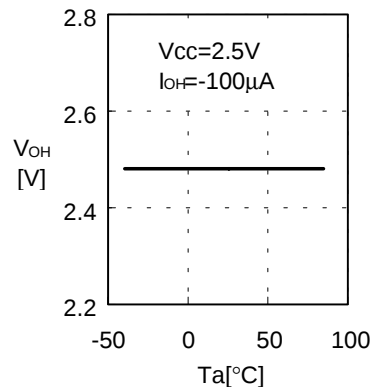
1.16 High level output voltage V_{OH} – Ambient temperature T_a



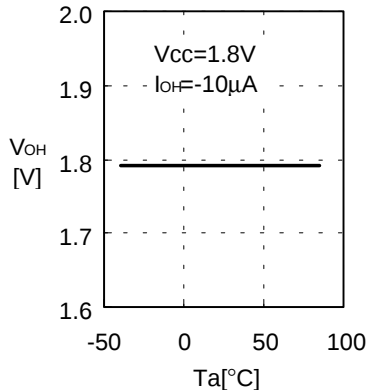
1.17 High level output voltage V_{OH} – Ambient temperature T_a



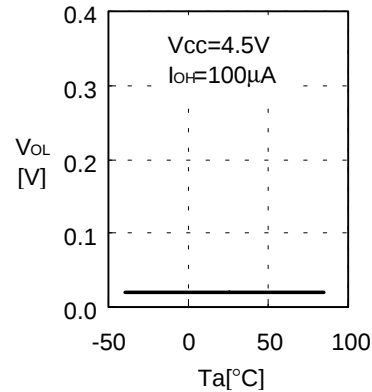
1.18 High level output voltage V_{OH} – Ambient temperature T_a



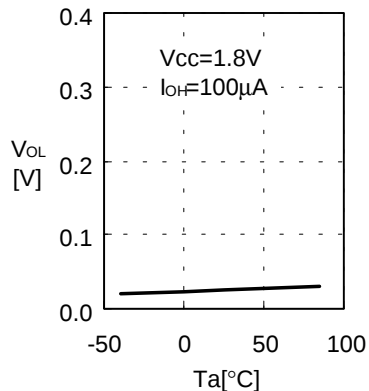
1.19 High level output voltage V_{OH} – Ambient temperature T_a



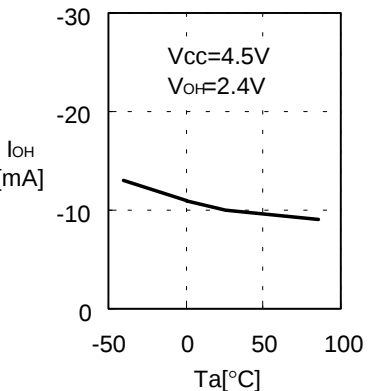
1.20 Low level output voltage V_{OL} – Ambient temperature T_a



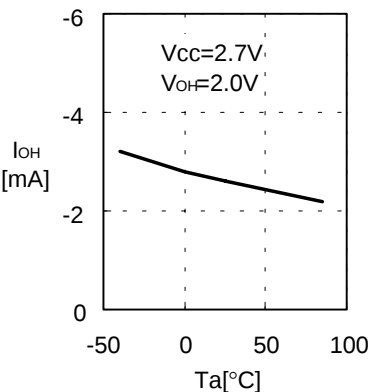
1.21 Low level output voltage V_{OL} – Ambient temperature T_a



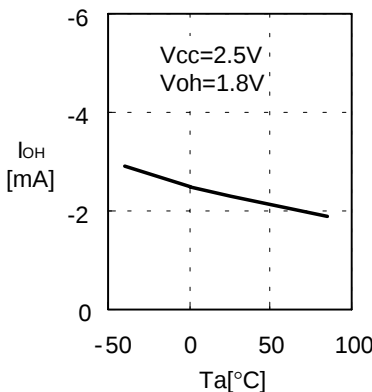
1.22 High level output current I_{OH} – Ambient temperature T_a



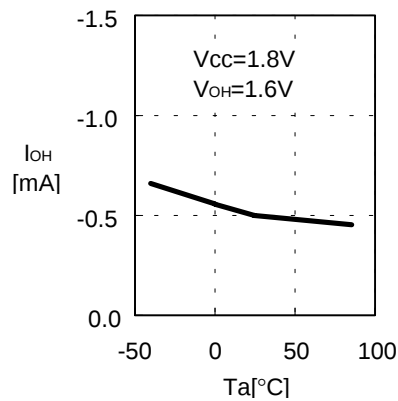
1.23 High level output current I_{OH} – Ambient temperature T_a



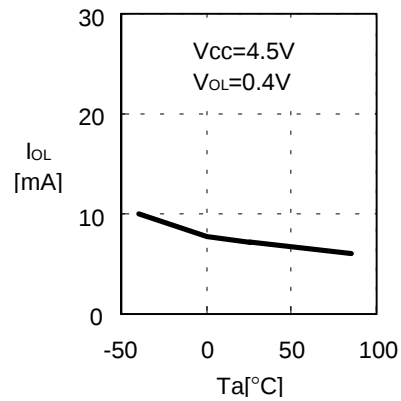
1.24 High level output current I_{OH} – Ambient temperature T_a



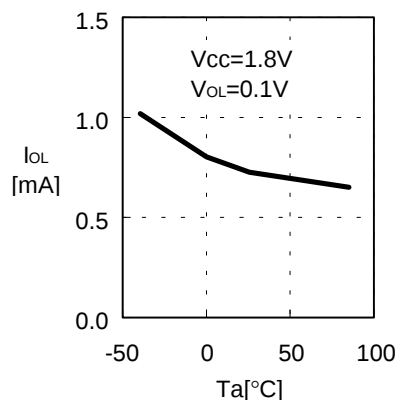
1.25 High level output current I_{OH} – Ambient temperature T_a



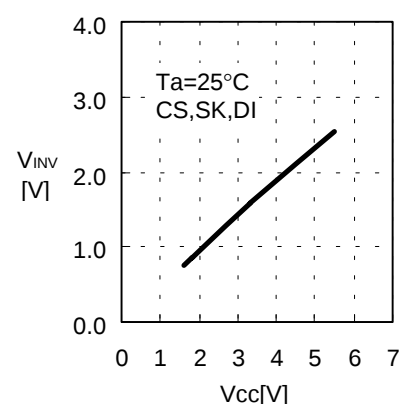
1.26 Low level output current I_{OL} – Ambient temperature T_a



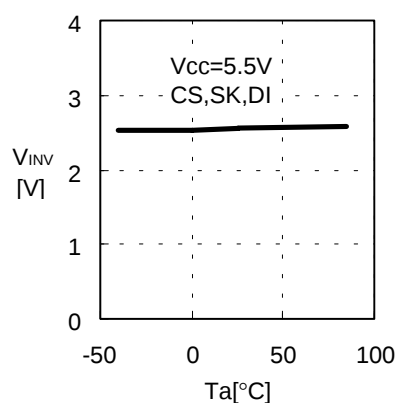
1.27 Low level output current I_{OL} – Ambient temperature T_a



1.28 Input inversion voltage V_{INV} – Power supply voltage V_{CC}

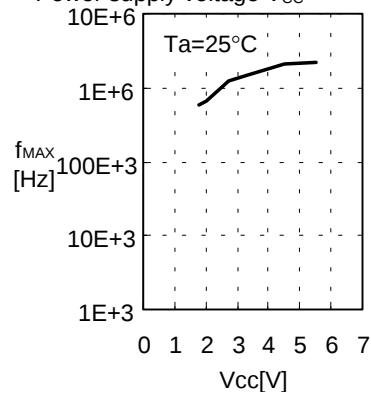


1.29 Input inversion voltage V_{INV} – Ambient temperature T_a

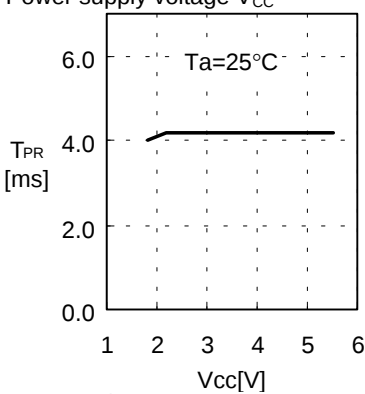


2.AC Characteristics

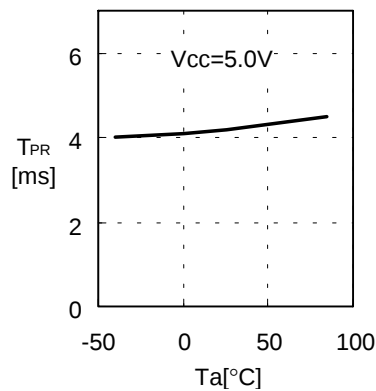
2.1 Maximum operation frequency f_{MAX} –
Power supply voltage V_{CC}



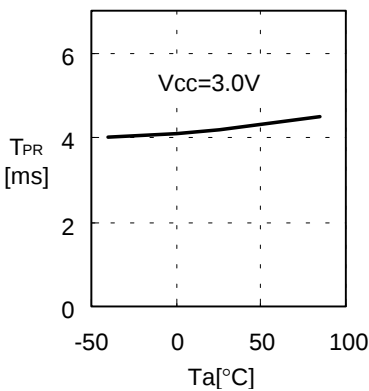
2.2 Program time T_{PR} –
Power supply voltage V_{CC}



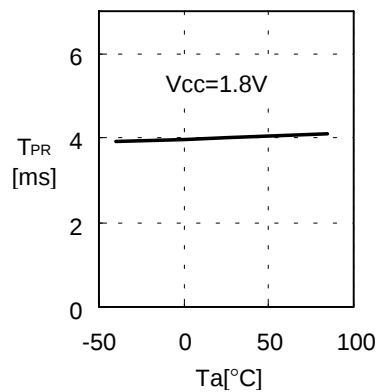
2.3 Program time T_{PR} –
Ambient temperature T_a



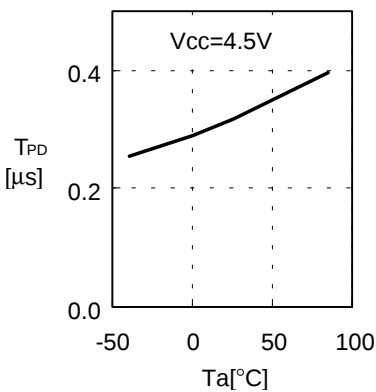
2.4 Program time T_{PR} –
Ambient temperature T_a



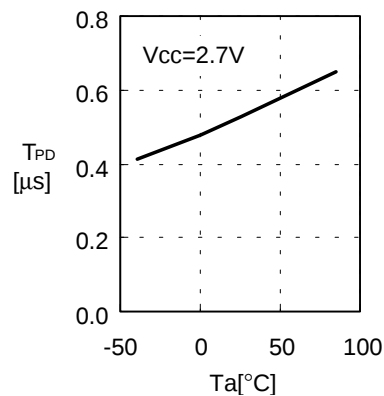
2.5 Program time T_{PR} –
Ambient temperature T_a



2.6 Data output delay time T_{PD} –
Ambient temperature T_a



2.7 Data output delay time T_{PD} –
Ambient temperature T_a



2.8 Data output delay time T_{PD} –
Ambient temperature T_a

