HM53461 SERIES

65,536-word x 4-bit Multiport CMOS Video RAM

■ DESCRIPTION

The HM53461 is a 262,144-bit multiport memory equipped with a 64k-word x 4-bit Dynamic RAM port and a 256-word x 4-bit Serial Access Memory (SAM) port. The SAM port is connected to an internal 1,024-bit data register through a 256-word x 4-bit serial read or write access control. In the read transfer cycle, the memory cell data is transferred from a selected word line of the RAM port to the data register. The RAM port has a write mask capability in addition to the conventional operation mode. Write bit selection out of 4 data bit can be achieved.
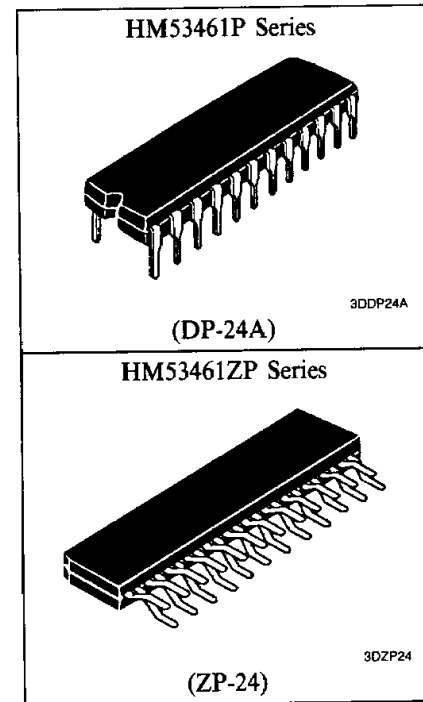
Utilizing the Hitachi 2 μm CMOS process, fast serial access operation and low power dissipation are realized. All inputs and outputs, including clocks, are TTL compatible.
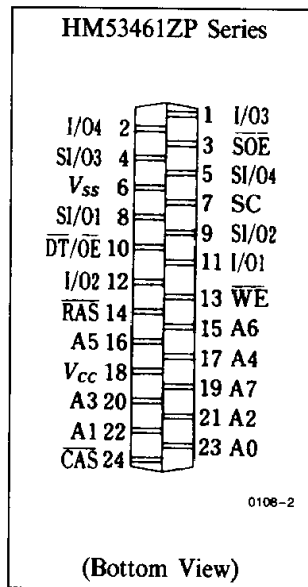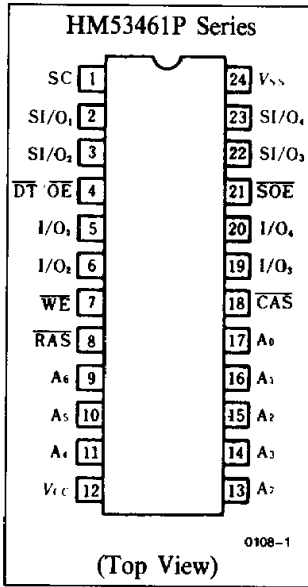
■ FEATURES

- Multiport Organization
    (RAM; 64k-word x 4-bit and SAM; 256 word x 4-bit)
- Double Layer Polysilicon/Polyicide n-Well CMOS Process
- Single 5V ($\pm$10%)
- Low Power
    Active
        RAM ....380 mW (max)
        SAM ....220 mW (max)
        Standby ....40 mW (max)
- Access Time
    RAM ....100 ns/120 ns/150 ns
    SAM ....40 ns/40 ns/60 ns
- Cycle Time Random Read or Write Cycle Time (RAM) .....190 ns/220 ns/260 ns
                    Serial Read or Write Cycle Time (SAM) ....40 ns/40 ns/60 ns
- TTL Compatible
- 256 Refresh Cycles...4 ms
- Refresh Function
    $\overline{RAS}$ Only Refresh
    $\overline{CAS}$ Before $\overline{RAS}$ Refresh
    Hidden Refresh
- Data Transfer Operation (RAM $\longleftrightarrow$ SAM)
- Fast Serial Access Operation Asynchronized with RAM Port Except Data Transfer Cycle
- Real Time Read Transfer Capability
- Write Mask Mode Capability

HM53461P Series

(DP-24A)   3DDP24A

HM53461ZP Series

(ZP-24)   3DZP24

■ ORDERING INFORMATION

Part No.	Access Time	Package
HM53461P-10	100 ns	400 mil 24-pin
HM53461P-12	120 ns	Plastic DIP
HM53461P-15	150 ns	(DP-24A)
HM53461ZP-10	100 ns	24-pin
HM53461ZP-12	120 ns	Plastic ZIP
HM53461ZP-15	150 ns	(ZP-24)

■ PIN OUT

HM53461P Series

SC	1	24	V_{SS}
SI/O$_1$	2	23	SI/O$_4$
SI/O$_2$	3	22	SI/O$_3$
$\overline{DT}/\overline{OE}$	4	21	$\overline{SOE}$
I/O$_1$	5	20	I/O$_4$
I/O$_2$	6	19	I/O$_3$
$\overline{WE}$	7	18	$\overline{CAS}$
$\overline{RAS}$	8	17	A$_0$
A$_6$	9	16	A$_1$
A$_5$	10	15	A$_2$
A$_4$	11	14	A$_3$
V_{CC}	12	13	A$_7$

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(Top View)

HM53461ZP Series

I/O4	2	1	I/O3
SI/O3	4	3	$\overline{SOE}$
V_{SS}	6	5	SI/O4
SI/O1	8	7	SC
$\overline{DT}/\overline{OE}$	10	9	SI/O2
I/O2	12	11	I/O1
$\overline{RAS}$	14	13	$\overline{WE}$
A5	16	15	A6
V_{CC}	18	17	A4
A3	20	19	A7
A1	22	21	A2
$\overline{CAS}$	24	23	A0

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(Bottom View)

■ PIN DESCRIPTION

Pin Name	Function
A$_0$–A$_7$	Address Inputs
I/O$_1$–I/O$_4$	RAM Port Data Input/Output
SI/O$_1$–SI/O$_4$	SAM Port Data Input/Output
$\overline{RAS}$	Row Address Strobe
$\overline{CAS}$	Column Address Strobe
SC	Serial Clock
$\overline{WE}$	Write Enable
$\overline{DT}/\overline{OE}$	Data Transfer/Output Enable
$\overline{SOE}$	SAM Port Enable
V_{CC}	Power Supply
V_{SS}	Ground

■ BLOCK DIAGRAM

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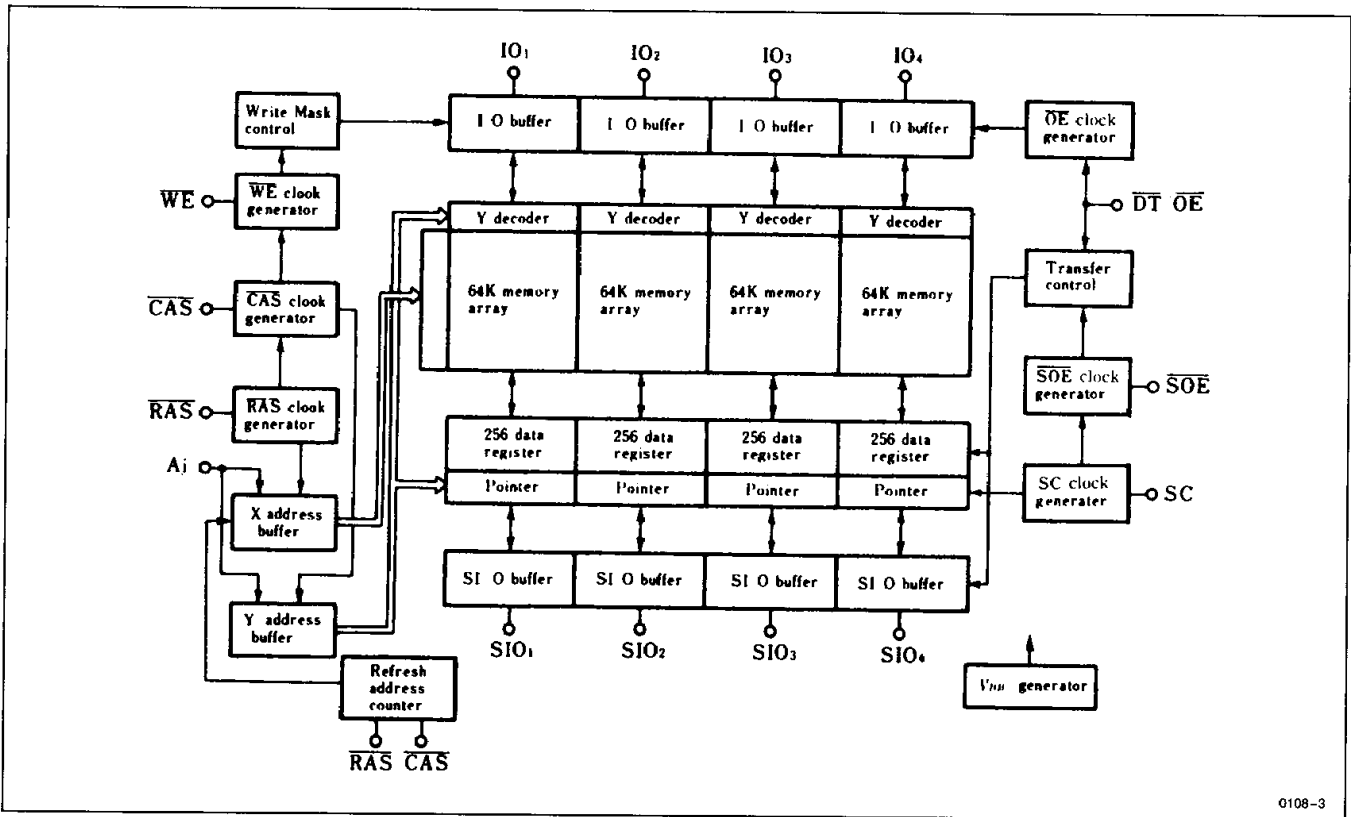
■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Voltage on Any Pin Relative to V_{SS}	V_T	−1.0 to +7.0	V
Power Supply Voltage Relative to V_{SS}	V_{CC}	−0.5 to +7.0	V
Operating Temperature, T_A (Ambient)	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Short Circuit Output Current	I_{out}	50	mA
Power Dissipation	P_T	1.0	W

■ ELECTRICAL CHARACTERISTICS

● Recommended DC Operating Conditions (T_A = 0 to +70°C)

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	
Input High Voltage	V_{IH}	2.4	—	6.5	V	
Input Low Voltage	V_{IL}	−0.5	—	0.8	V	2

Notes: 1. All voltages referenced to V_{SS}.
       2. −3.0V for pulse width ≤ 10 ns.

● DC Electrical Characteristics (T_A = 0 to +70°C, V_{CC} = 5V ±10%, V_{SS} = 0V)

Parameter	Symbol	SAM PORT Standby	SAM PORT Active	HM53461-10	HM53461-12	HM53461-15	Unit	RAM PORT Test Conditions	Note
Operating Current	I_{CC1}	—	×	70	60	50	mA	$\overline{RAS}$, $\overline{CAS}$ Cycling t_{RC} = Min	
	I_{CC7}	×	—	110	100	80	mA		
Standby Current	I_{CC2}	—	×	7	7	7	mA	$\overline{RAS}$, $\overline{CAS}$ = V_{IH}	
	I_{CC8}	×	—	40	40	30	mA		
$\overline{RAS}$ Only Refresh Current	I_{CC3}	—	×	60	50	40	mA	$\overline{CAS}$ = V_{IH}, $\overline{RAS}$ Cycling t_{RC} = Min	
	I_{CC9}	×	—	100	90	70	mA		
Page Mode Current	I_{CC4}	—	×	50	40	35	mA	$\overline{RAS}$ = V_{IL}, $\overline{CAS}$ Cycling t_{PC} = Min	
	I_{CC10}	×	—	90	80	65	mA		
CBR Refresh Current	I_{CC5}	—	×	60	50	40	mA	$\overline{RAS}$ Cycling t_{RC} = Min	
	I_{CC11}	×	—	100	90	70	mA		
Data Transfer Current	I_{CC6}	—	×	75	65	55	mA	$\overline{RAS}$, $\overline{CAS}$ Cycling t_{RC} = Min	
	I_{CC12}	×	—	115	105	85	mA		

Parameter	Symbol	Min	Max	Unit	Test Conditions	Note
Input Leakage	I_{LI}	−10	10	μA		
Output Leakage	I_{LO}	−10	10	μA		
Output High Voltage	V_{OH}	2.4	—	V	I_{OH} = −2 mA	
Output Low Voltage	V_{OL}	—	0.4	V	I_{OL} = 4.2 mA	

■ INPUT/OUTPUT CAPACITANCE

Parameter	Symbol	Typ	Max	Unit	Note
Address	C_{I1}	—	5	pF	
Clocks	C_{I2}	—	5	pF	
I/O, SI/O	$C_{I/O}$	—	7	pF	

■ ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS
(T_A = 0 to +70°C, V_{CC} = 5V ±10%, V_{SS} = 0V)[1, 10, 11]

Parameter	Symbol	HM53461-10 Min	HM53461-10 Max	HM53461-12 Min	HM53461-12 Max	HM53461-15 Min	HM53461-15 Max	Unit	Note
Random Read or Write Cycle Time	t_{RC}	190	—	220	—	260	—	ns	
Read-Modify-Write Cycle Time	t_{RWC}	260	—	300	—	355	—	ns	
Page Mode Cycle Time	t_{PC}	70	—	85	—	105	—	ns	
Access Time from $\overline{RAS}$	t_{RAC}	—	100	—	120	—	150	ns	2, 3
Access Time from $\overline{CAS}$	t_{CAC}	—	50	—	60	—	75	ns	3, 4
Output Buffer Turn-off Delay Referenced to $\overline{CAS}$	t_{OFF1}	0	25	0	30	0	40	ns	5
Transition Time (Rise and Fall)	t_T	3	50	3	50	3	50	ns	6
$\overline{RAS}$ Precharge Time	t_{RP}	80	—	90	—	100	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	100	10000	120	10000	150	10000	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	50	10000	60	10000	75	10000	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	25	50	25	60	30	75	ns	7
$\overline{RAS}$ Hold Time	t_{RSH}	50	—	60	—	75	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	100	—	120	—	150	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	10	—	10	—	10	—	ns	
Row Address Setup Time	t_{ASR}	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	15	—	15	—	20	—	ns	
Column Address Setup Time	t_{ASC}	0	—	0	—	0	—	ns	
Column Address Hold Time	t_{CAH}	20	—	20	—	25	—	ns	
Write Command Setup Time	t_{WCS}	0	—	0	—	0	—	ns	8
Write Command Hold Time	t_{WCH}	25	—	25	—	30	—	ns	
Write Command Pulse Width	t_{WP}	15	—	20	—	25	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	35	—	40	—	45	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	35	—	40	—	45	—	ns	
Data-in Setup Time	t_{DS}	0	—	0	—	0	—	ns	9
Data-in Hold Time	t_{DH}	25	—	25	—	30	—	ns	8, 9
Read Command Setup Time	t_{RCS}	0	—	0	—	0	—	ns	
Read Command Hold Time	t_{RCH}	0	—	0	—	0	—	ns	
Read Command Hold Time Referenced to $\overline{RAS}$	t_{RRH}	10	—	10	—	10	—	ns	
Refresh Period	t_{REF}	—	4	—	4	—	4	ms	
$\overline{RAS}$ Pulse Width (Read-Modify-Write Cycle)	t_{RWS}	170	10000	200	10000	245	10000	ns	
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	85	—	100	—	125	—	ns	8
$\overline{CAS}$ Setup Time ($\overline{CAS}$ Before $\overline{RAS}$ Refresh)	t_{CSR}	10	—	10	—	10	—	ns	
$\overline{CAS}$ Hold Time ($\overline{CAS}$ Before $\overline{RAS}$ Refresh)	t_{CHR}	20	—	25	—	30	—	ns	
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	10	—	10	—	10	—	ns	
$\overline{CAS}$ Precharge Time	t_{CP}	10	—	15	—	20	—	ns	
Access Time from $\overline{OE}$	t_{OAC}	—	30	—	35	—	40	ns	
Output Buffer Turn-off Delay referenced to $\overline{OE}$	t_{OFF2}	0	25	0	30	0	40	ns	
$\overline{OE}$ to Data-in Delay Time	t_{ODD}	25	—	30	—	40	—	ns	
$\overline{OE}$ Hold Time referenced to $\overline{WE}$	t_{OEH}	10	—	15	—	20	—	ns	
Data-in to $\overline{CAS}$ Delay Time	t_{DZC}	0	—	0	—	0	—	ns	
Data-in to $\overline{OE}$ Delay Time	t_{DZO}	0	—	0	—	0	—	ns	
$\overline{OE}$ to $\overline{RAS}$ Delay Time	t_{ORD}	35	—	40	—	45	—	ns	
Serial Clock Cycle Time	t_{SCC}	40	—	40	—	60	—	ns	
Access Time from SC	t_{SCA}	—	40	—	40	—	60	ns	10
Access Time from $\overline{SOE}$	t_{SEA}	—	25	—	30	—	40	ns	10

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■ ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS

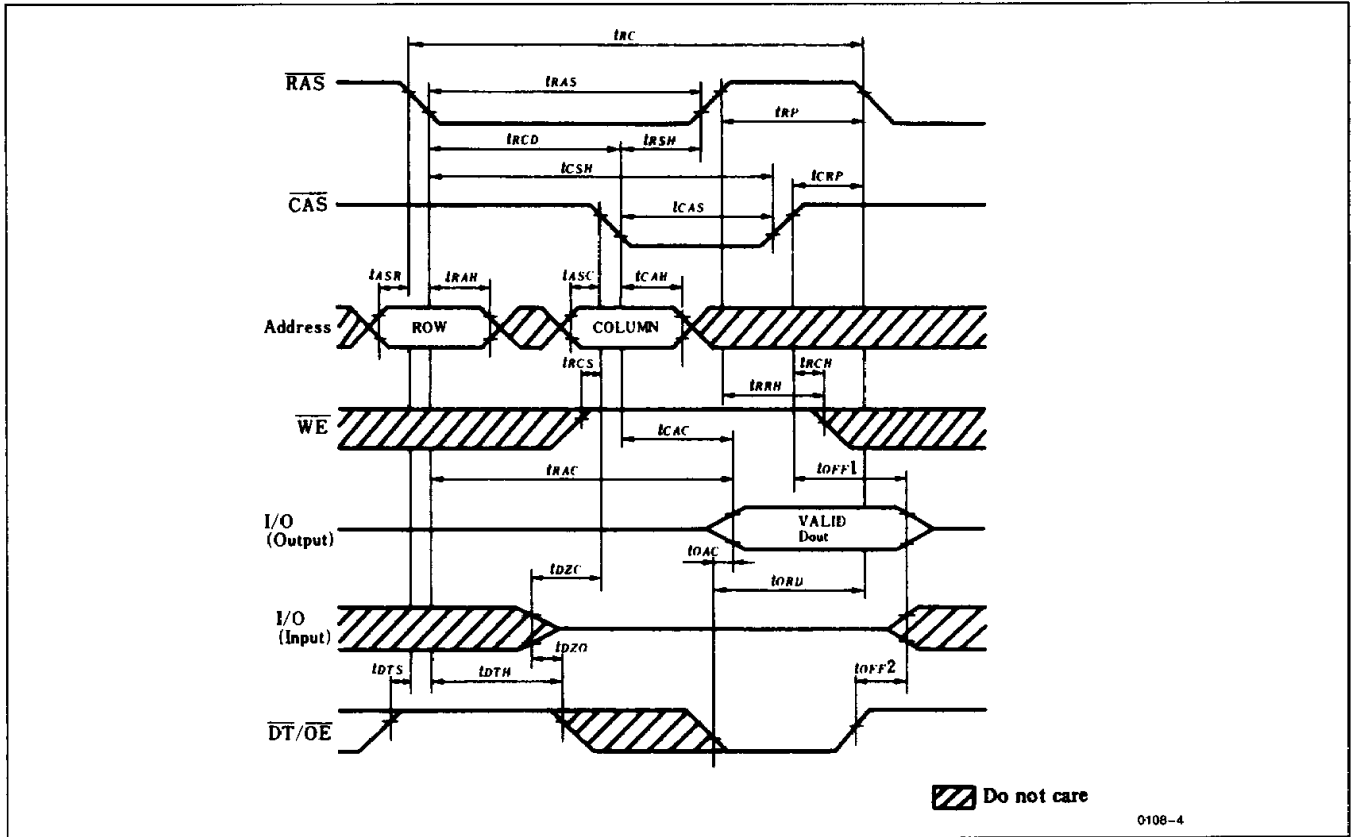$(T_A = 0$ to $+70°C$, $V_{CC} = 5V \pm 10\%$, $V_{SS} = 0V)$[1, 10, 11] (continued)

Parameter	Symbol	HM53461-10 Min	HM53461-10 Max	HM53461-12 Min	HM53461-12 Max	HM53461-15 Min	HM53461-15 Max	Unit	Note
SC Pulse Width	t_{SC}	10	—	10	—	10	—	ns	
SC Precharge Width	t_{SCP}	10	—	10	—	10	—	ns	
Serial Data-out Hold Time after SC High	t_{SOH}	10	—	10	—	10	—	ns	
Serial Output Buffer Turn-off Delay from $\overline{SOE}$	t_{SEZ}	0	25	0	25	0	30	ns	
Serial Data-in Setup TIme	t_{SIS}	0	—	0	—	0	—	ns	
Serial Data-in Hold Time	t_{SIH}	15	—	20	—	25	—	ns	
$\overline{DT}$ to $\overline{RAS}$ Setup Time	t_{DTS}	0	—	0	—	0	—	ns	
$\overline{DT}$ to $\overline{RAS}$ Hold Time (Read Transfer Cycle)	t_{RDH}	80	—	90	—	110	—	ns	
$\overline{DT}$ to $\overline{RAS}$ Hold Time	t_{DTH}	15	—	15	—	20	—	ns	
$\overline{DT}$ to $\overline{CAS}$ Hold Time	t_{CDH}	20	—	30	—	45	—	ns	
Last SC to $\overline{DT}$ Delay Time	t_{SDD}	5	—	5	—	10	—	ns	
First SC to $\overline{DT}$ Hold Time	t_{SDH}	25	—	25	—	30	—	ns	
$\overline{DT}$ to $\overline{RAS}$ Delay Time	t_{DTR}	10	—	10	—	10	—	ns	
$\overline{WE}$ to $\overline{RAS}$ Setup Time	t_{WS}	0	—	0	—	0	—	ns	
$\overline{WE}$ to $\overline{RAS}$ Hold Time	t_{WH}	15	—	15	—	20	—	ms	
I/O to $\overline{RAS}$ Setup Time	t_{MS}	0	—	0	—	0	—	ns	
I/O to $\overline{RAS}$ Hold Time	t_{MH}	15	—	15	—	20	—	ns	
Serial Output Buffer Turn-off Delay from $\overline{RAS}$	t_{SRZ}	10	50	10	60	10	75	ns	
$\overline{SC}$ to $\overline{RAS}$ Setup Time	t_{SRS}	30	—	40	—	45	—	ns	
$\overline{RAS}$ to SC Delay Time	t_{SRD}	25	—	30	—	35	—	ns	
Serial Data Input Delay Time from $\overline{RAS}$	t_{SID}	50	—	60	—	75	—	ns	
Serial Data Input to $\overline{DT}$ Delay Time	t_{SZD}	0	—	0	—	0	—	ns	
$\overline{SOE}$ to $\overline{RAS}$ Setup Time	t_{ES}	0	—	0	—	0	—	ns	
$\overline{SOE}$ to $\overline{RAS}$ Hold Time	t_{EH}	15	—	15	—	20	—	ns	
Serial Write Enable Setup Time	t_{SWS}	0	—	0	—	0	—	ns	
Serial Write Enable Hold Time	t_{SWH}	35	—	35	—	55	—	ns	
Serial Write Disable Setup Time	t_{SWIS}	0	—	0	—	0	—	ns	
Serial Write Disable Hold Time	t_{SWIH}	35	—	35	—	55	—	ns	
$\overline{DT}$ to Sout in Low-Z Delay Time	t_{DLZ}	5	—	10	—	10	—	ns	

Notes: 1. AC measurements assume $t_T = 5$ ns.

2. Assumes that $t_{RCD} \leq t_{RCD}$ (max). If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.

3. Measured with a load circuit equivalent to 2 TTL loads and 100 pF.

4. Assumes that $t_{RCD} \geq t_{RCD}$ (max).

5. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

6. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.

7. Operation with the t_{RCD} (max) limit insures that t_{RAC} (max) can be met, t_{RCD} (max) is specified as a reference point only, if t_{RCD} is greater than the specified t_{RCD} (max) limit, then access time is controlled exclusively by t_{CAC}.

8. t_{WCS} and t_{CWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if $t_{WCS} \geq t_{WCS}$ (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geq t_{CWD}$ (min), the cycle is a read/write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied; the condition of the data out (at access time) is indeterminate.

9. These parameters are referenced to $\overline{CAS}$ leading edge in an early write cycle and to $\overline{WE}$ leading edge in a delayed write or a read-modify-write cycle.

10. Measured with a load circuit equivalent to 2 TTL and 50 pF.

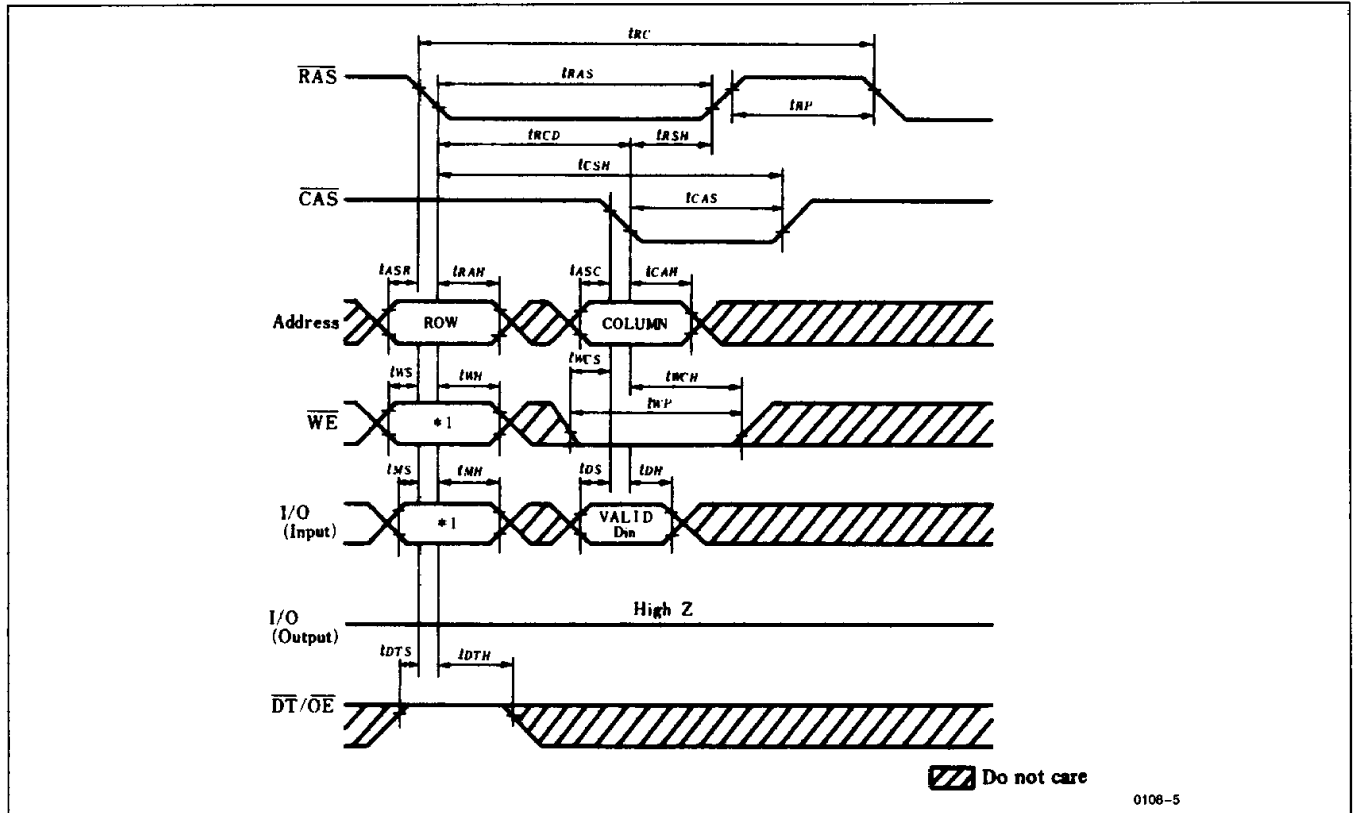11. An initial pause of 100 μs is required after power-up. Then execute at least 8 initialization cycles.

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■ TIMING WAVEFORMS
● Read Cycle


```
                                                    ☑☑ Do not care
                                                         0108-4
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● Early Write Cycle


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                                                    ☑☑ Do not care
                                                         0108-5
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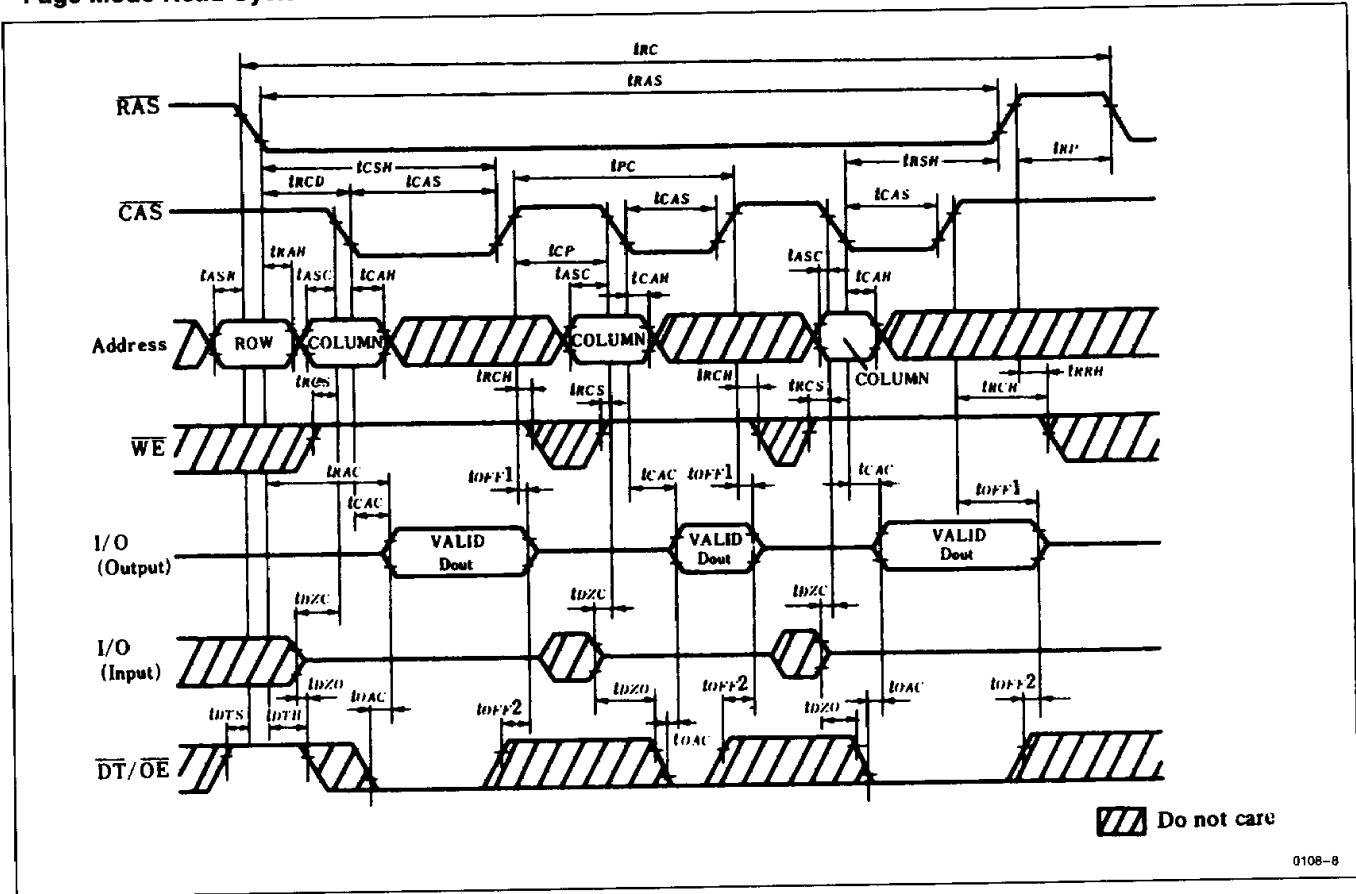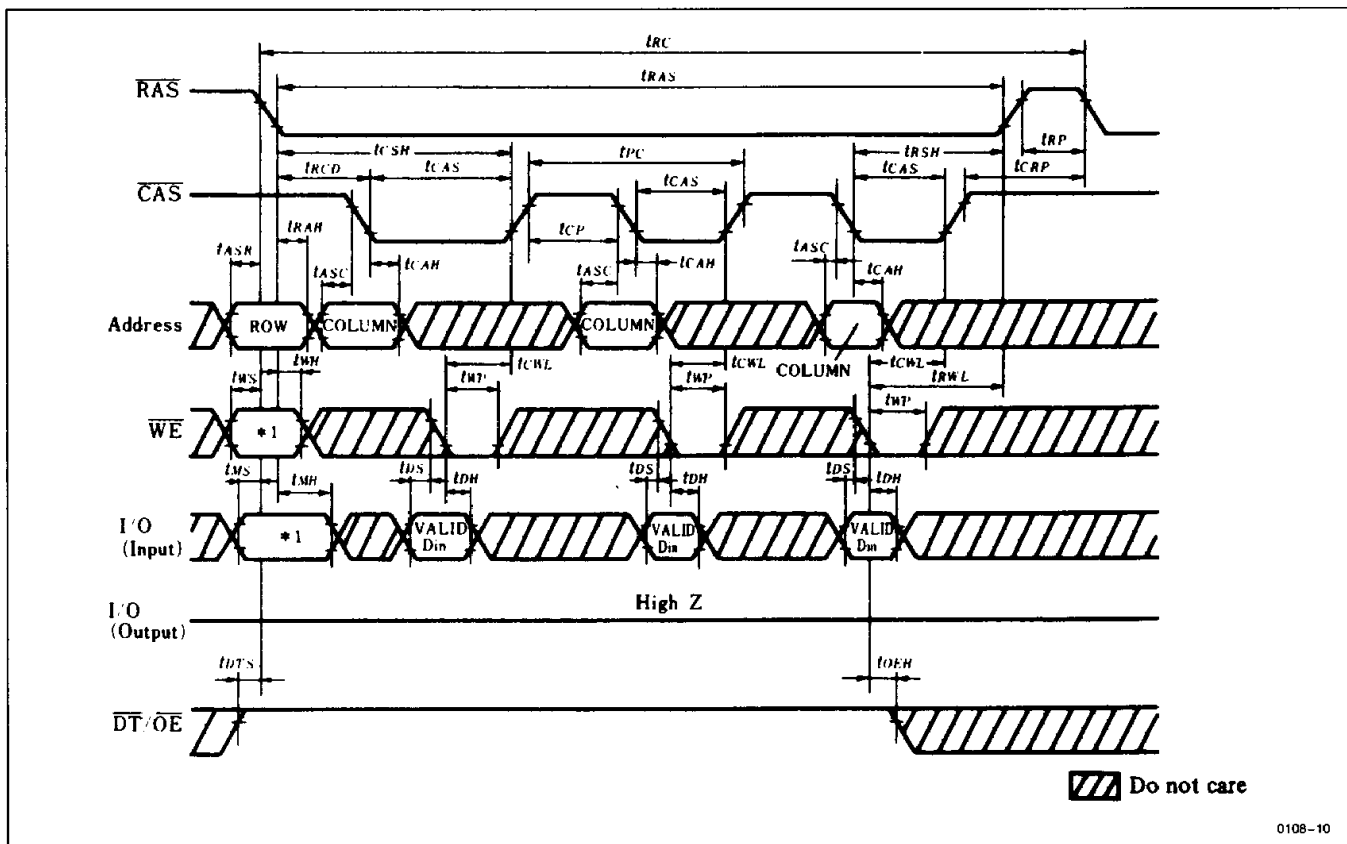
Note: *1. When $\overline{WE}$ is "H" level, all the data on the I/O can be written into the cell.
When $\overline{WE}$ is "L" level, the data on the I/O are not written except for when I/O is "high" at the falling edge of $\overline{RAS}$.

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• **Delayed Write Cycle**

Note: *1. When $\overline{WE}$ is "H" level, all the data on I/O_1–I/O_4 can be written into the memory cell.
When $\overline{WE}$ is "L" level, the data on I/Os are not written except for when I/O = "H" at the falling edge of $\overline{RAS}$.
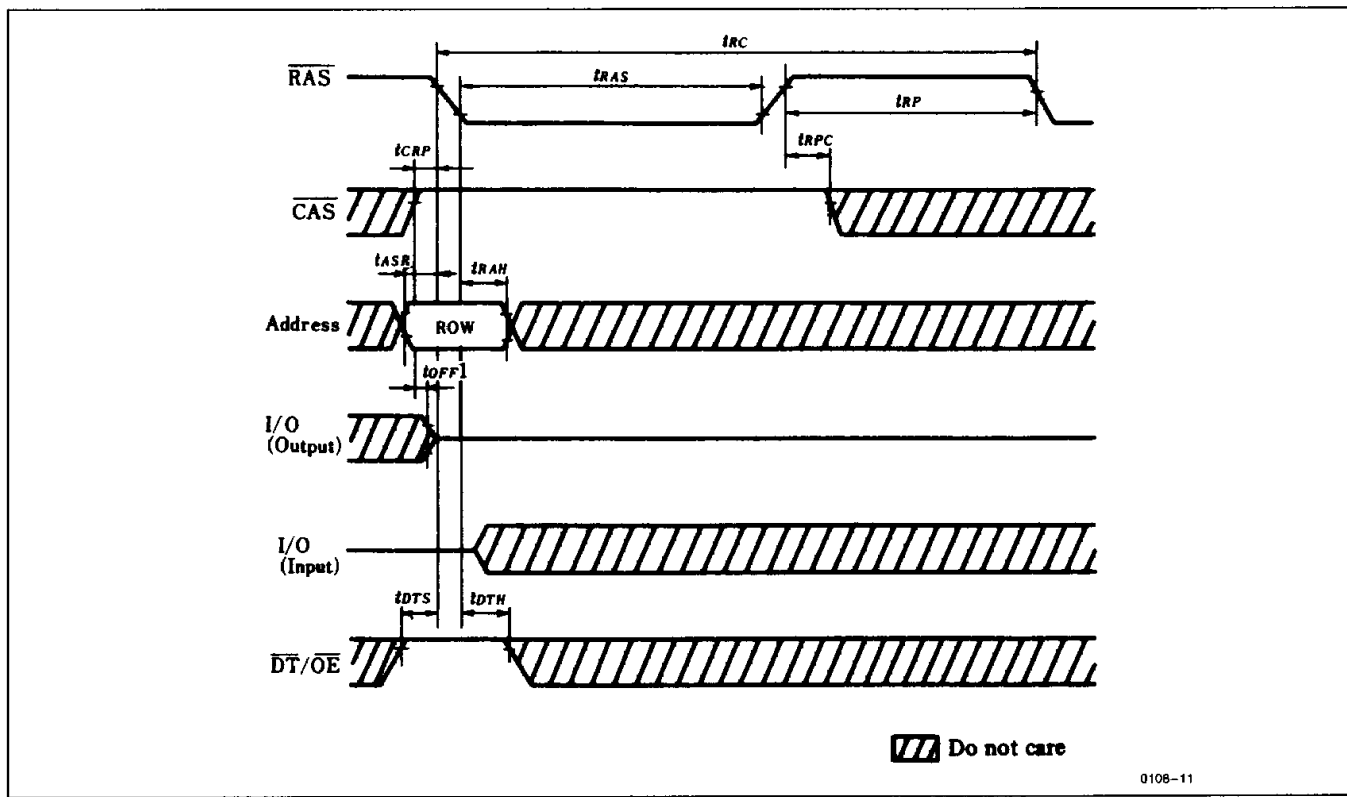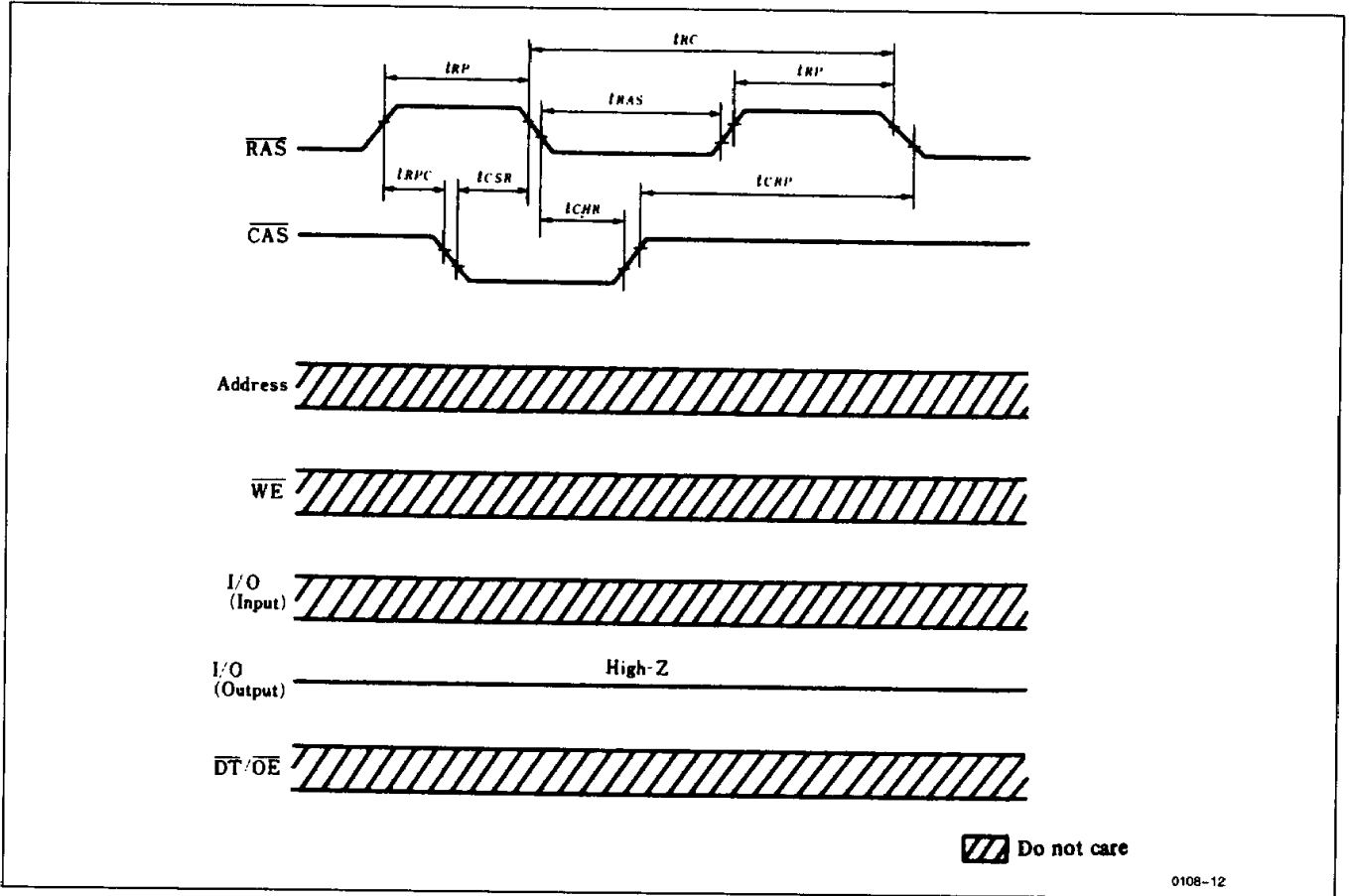
• **Read-Modify-Write Cycle**

Note: *1. When $\overline{WE}$ is "H" level, all the data on I/O_1–I/O_4 can be written into the memory cell.
When $\overline{WE}$ is "L" level, the data on I/Os are not written except for when I/O = "H" at the falling edge of $\overline{RAS}$.
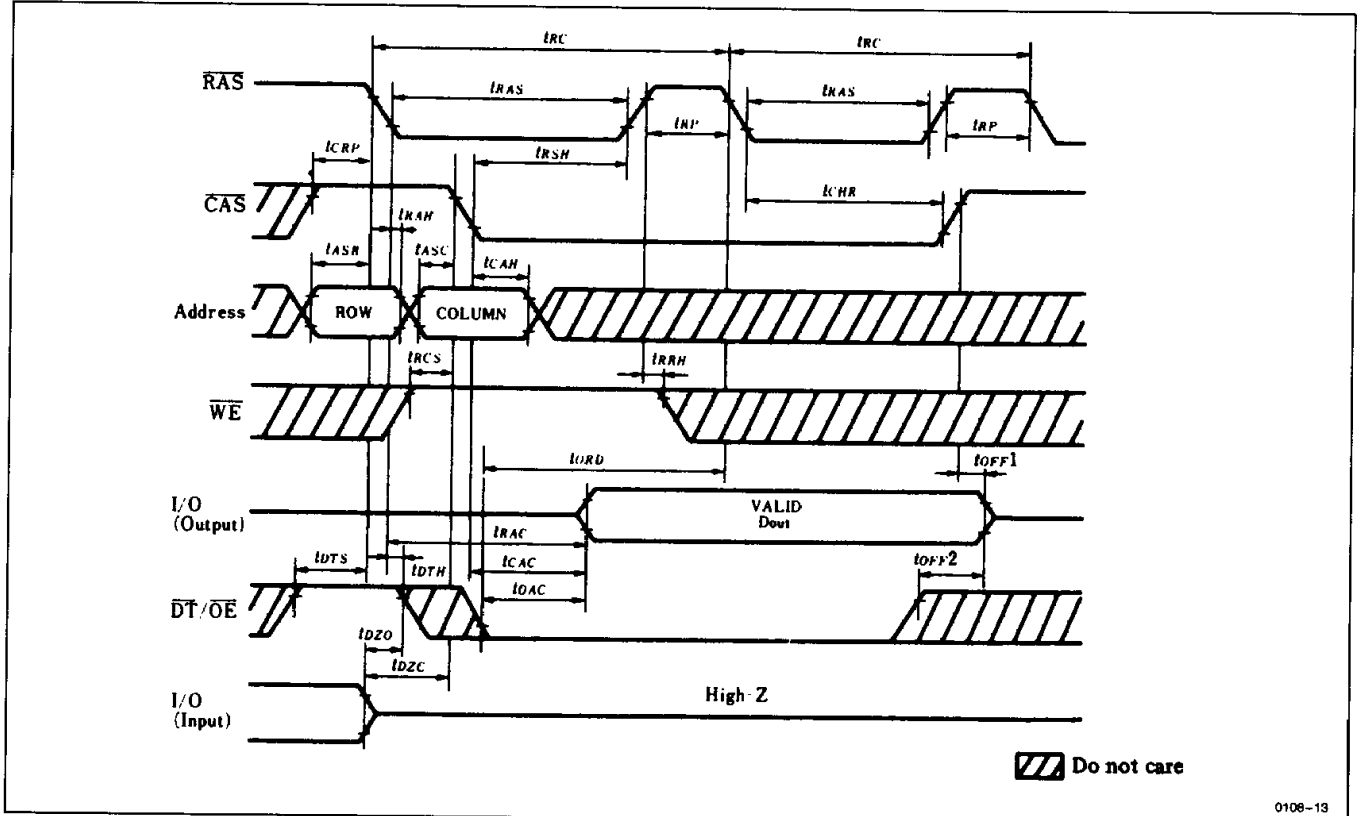
977

• **Page Mode Read Cycle**

• **Page Mode Write Cycle (Early Write)**
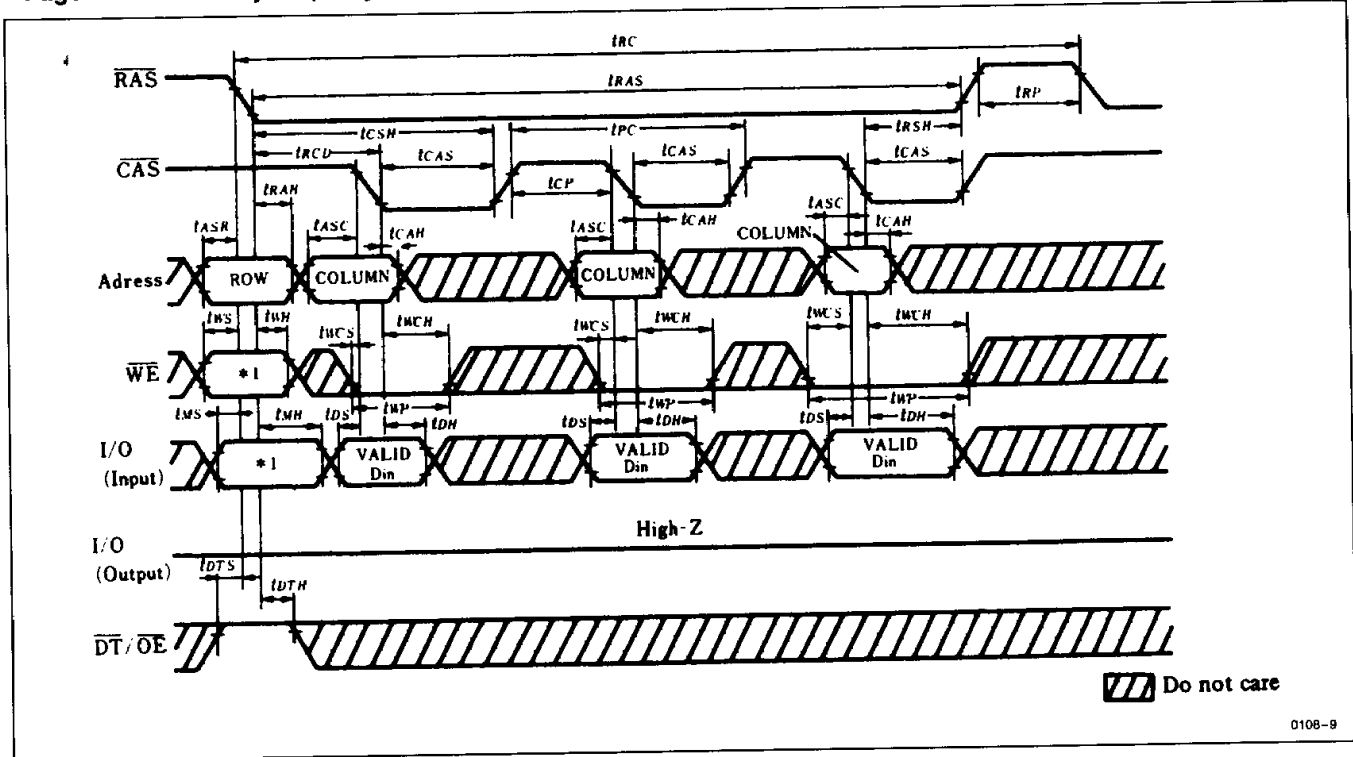
Note: *1. When $\overline{WE}$ is "H" level, all the data on $I/O_1 - I/O_4$ can be written into the memory cell.
When $\overline{WE}$ is "L" level, the data on I/Os are not written except for when I/O = "H" at the falling edge of $\overline{RAS}$.

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• **Page Mode Write Cycle (Delayed Write)**

0108-10

Note: *1. When $\overline{WE}$ is "H" level, all the data on $I/O_1-I/O_4$ can be written into the memory cell.
When $\overline{WE}$ is "L" level, the data on I/Os are not written except for when I/O = "H" at the falling edge of $\overline{RAS}$.

• **$\overline{RAS}$ Only Refresh Cycle**

0108-11

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• CAS Before RAS Refresh Cycle

0108-12

• Hidden Refresh Cycle

0108-13

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• Read Transfer Cycle (1)*1, *2
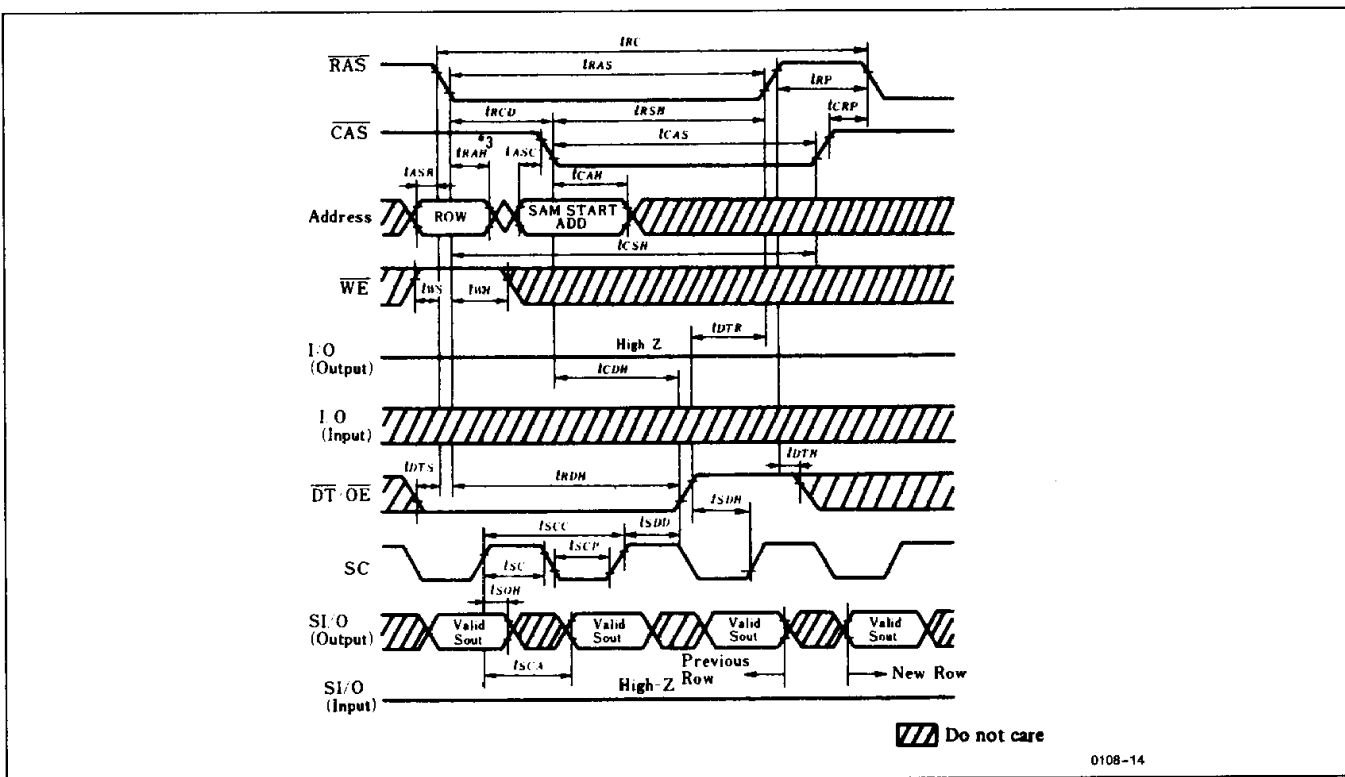
Notes: *1. In the case that the previous data transfer cycle was read transfer.
*2. Assume that $\overline{SOE}$ is "L" level.
*3. $\overline{CAS}$ and SAM start address need not be supplied every cycle, only when it is desired to change to a new SAM start address.
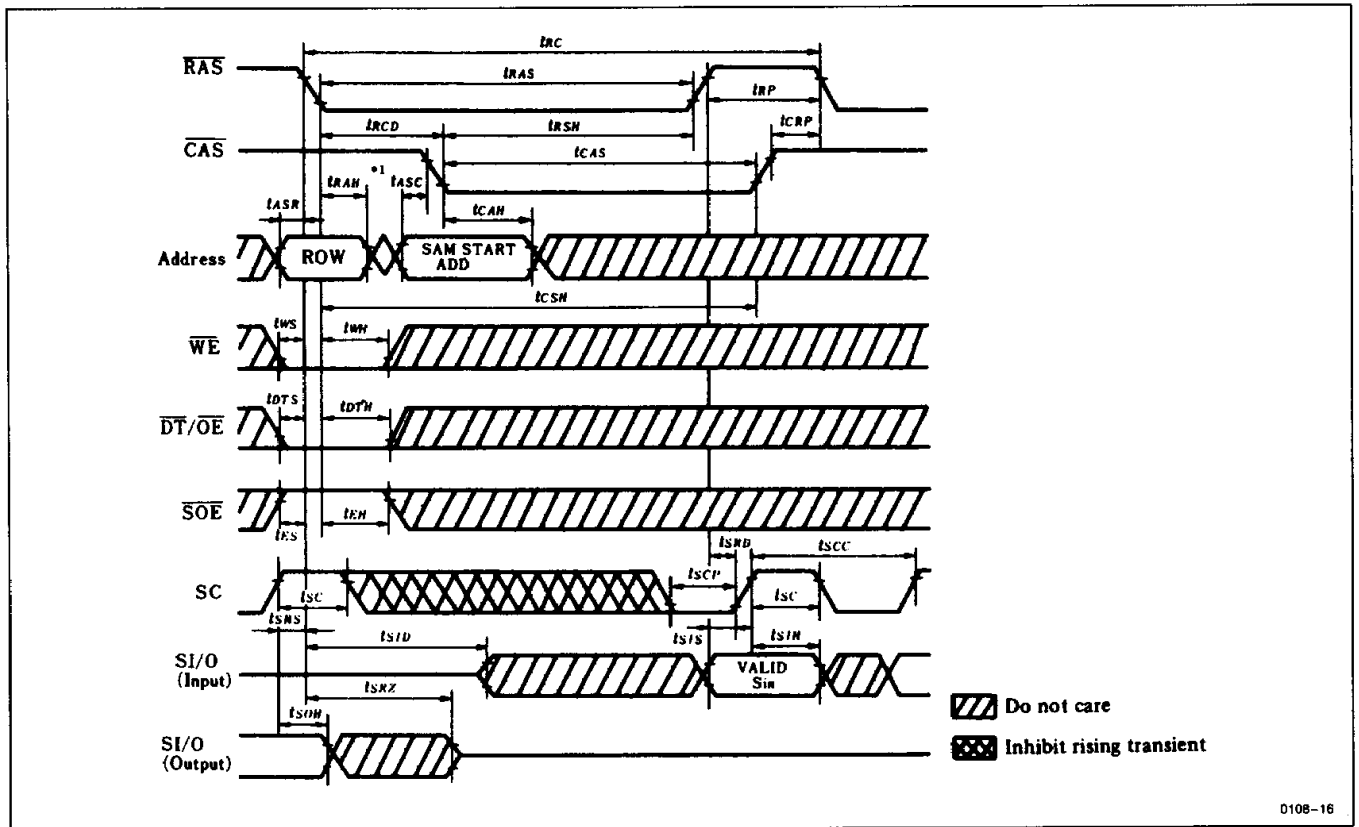
• Read Transfer Cycle (2)*1, *2
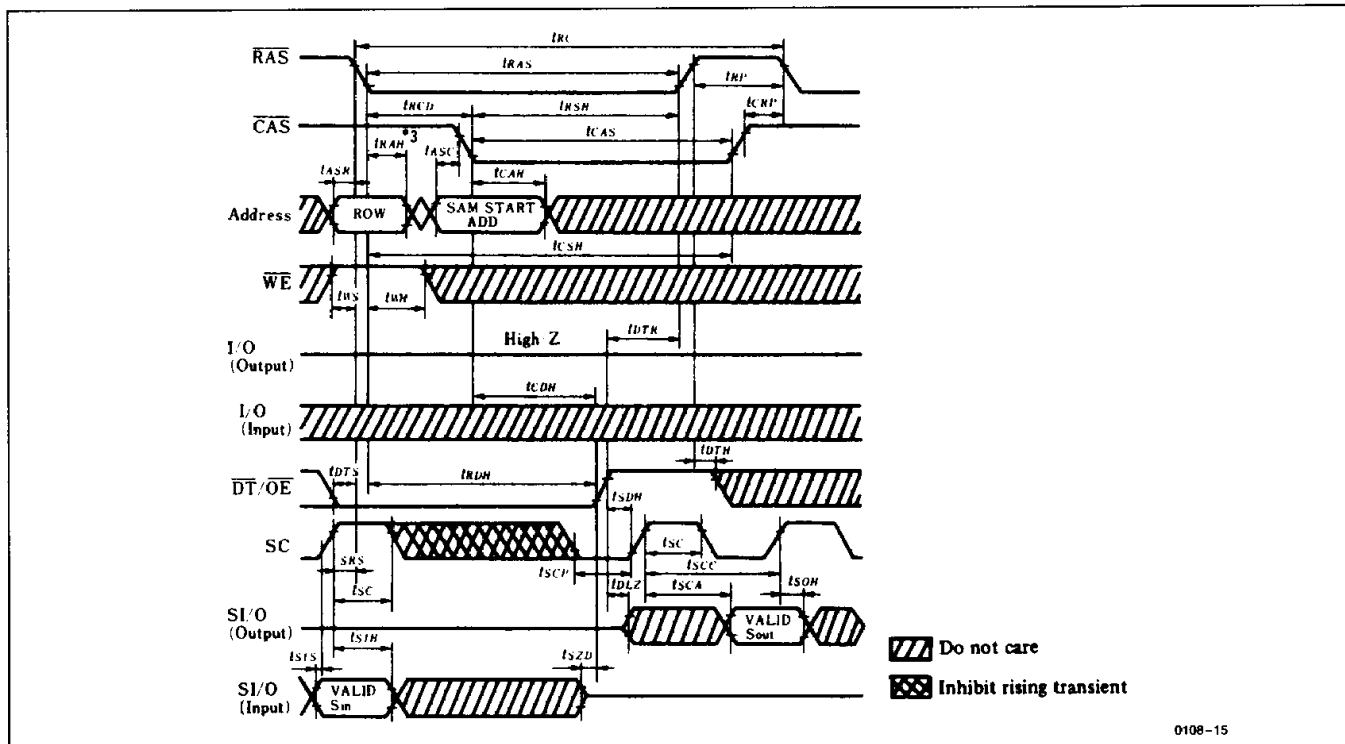
Notes: *1. In the case that the previous data transfer cycle was write transfer or pseudo transfer.
*2. Assume that $\overline{SOE}$ is "L" level.
*3. $\overline{CAS}$ and SAM start address need not be supplied every cycle, only when it is desired to change to a new SAM start address.
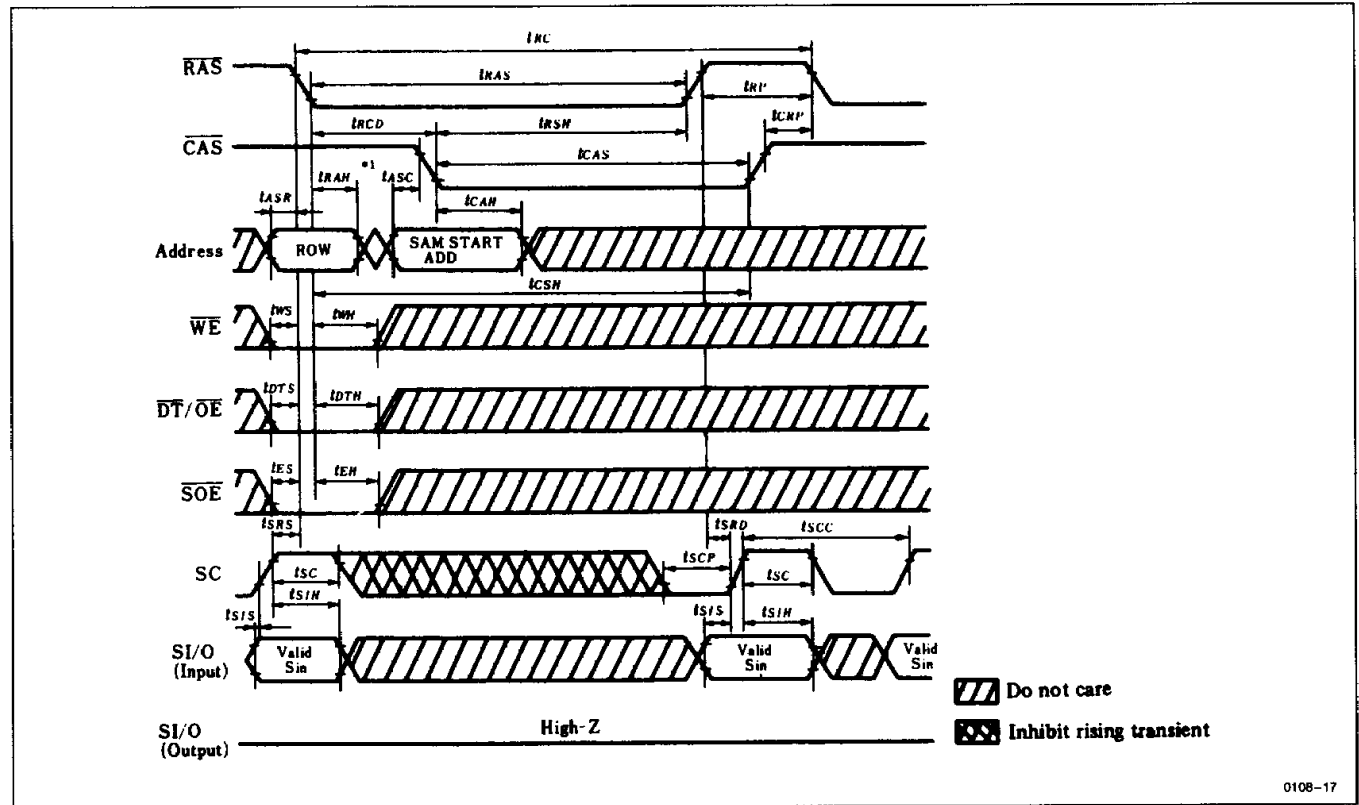

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● **Pseudo Transfer Cycle**

0108-16

Note: *1. $\overline{CAS}$ and SAM start address need not be supplied every cycle, only when it is desired to change to a new SAM start address.
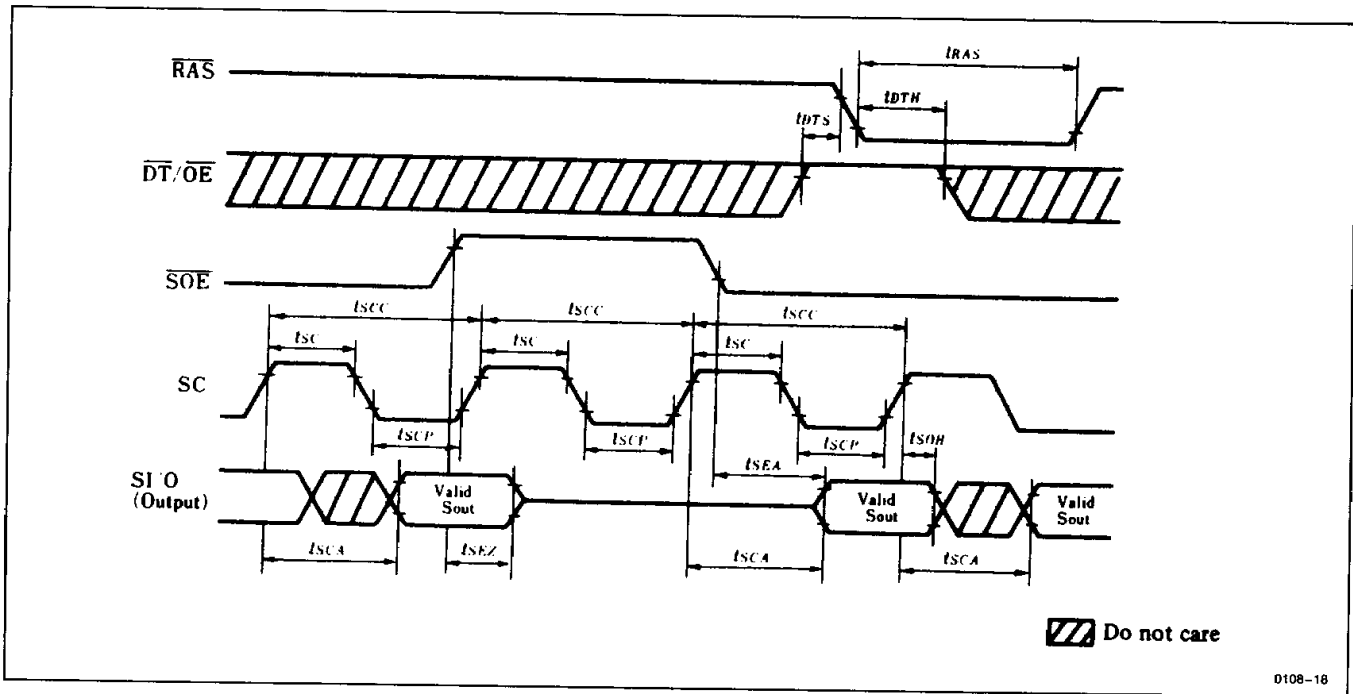
● **Write Transfer Cycle**

0108-17

Note: *1. $\overline{CAS}$ and SAM start address need not be supplied every cycle, only when it is desired to change to a new SAM start address.

• Serial Read Cycle

Do not care

0108-18

• Serial Write Cycle

Do not care

0108-19