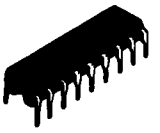
HM50464 Series

65536-word x 4-bit Dynamic Random Access Memory

■ FEATURES

- Page mode capability
- Single 5V (±10%)
- On chip substrate bias generator
- Low power: 350 mW active, 20 mW standby
- High speed: Access Time 120ns/150ns/200ns
- Output data controlled by $\overline{CAS}$ or $\overline{OE}$
- TTL compatible
- 256 refresh cycles . . . . . 4 ms
- 3 variations of refresh . . . . . $\overline{RAS}$ only refresh
  $\overline{CAS}$ before $\overline{RAS}$ refresh
  Hidden refresh

HM50464P Series



(DP-18B)

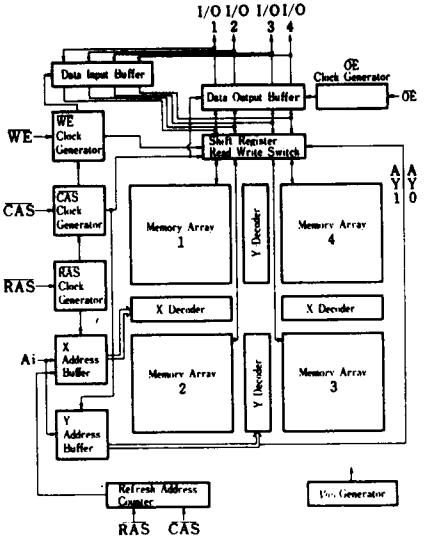
HM50464CP Series

(CP-18)

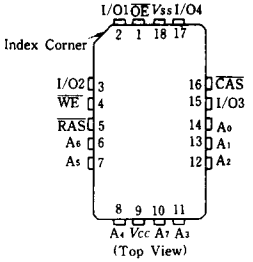
■ ORDERING INFORMATION

Type No.	Access Time	Package
HM50464P-12	120ns	300 mil 18 pin Plastic DIP
HM50464P-15	150ns	
HM50464P-20	200ns	
HM50464CP-12	120ns	18 pin PLCC
HM50464CP-15	150ns	
HM50464CP-20	200ns	

■ BLOCK DIAGRAM



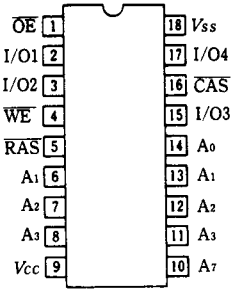
● HM50464CP Series



(Top View)

■ PIN ARRANGEMENT

● HM50464P Series



(Top View)

$A_0 - A_7$	Address Inputs
$\overline{CAS}$	Column Address Strobe
I/O1 – I/O4	Data In/Data Out
$\overline{OE}$	Output Enable
$\overline{RAS}$	Row Address Strobe
$\overline{WE}$	Read/Write Input
V_{CC}	Power (+5V)
V_{SS}	Ground
$A_0 - A_7$ (Row)	Refresh Address Inputs

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on any pin relative to V_{SS}	V_T	−1 to +7	V
Supply Voltage relative to V_{SS}	V_{CC}	−1 to +7	V
Operating Temperature (Ambient)	$Topr$	0 to +70	°C
Storage Temperature (Ambient)	$Tstg$	−55 to +125	°C
Power Dissipation	P_T	1.0	W
Short Circuit Output Current	$Iout$	50	mA

■ RECOMMENDED DC OPERATING CONDITION (Ta = 0 to +70°C)

Parameter	Symbol	min.	typ.	max.	unit
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}	−1.0	–	0.8	V

Note) All voltage referenced to V_{SS}.

■ DC ELECTRICAL CHARACTERISTICS (V_{CC} = 5V ±10%, V_{SS} = 0V, Ta = 0 to +70°C)

Parameter	Symbol	HM50464-12		HM50464-15		HM50464-20		Unit	Note
		min.	max.	min.	max.	min.	max.		
Operating Current (t_{RC} = min.)	I_{CC1}	–	83	–	70	–	55	mA	1
Standby Current ($\overline{RAS}$ = V_{IH}, Dout = Disable)	I_{CC2}	–	4.5	–	4.5	–	4.5	mA	
Refresh Current ($\overline{RAS}$ only refresh, t_{RC} = min.)	I_{CC3}	–	62	–	53	–	42	mA	
Standby Current ($\overline{RAS}$ = V_{IH}, Dout = Enable)	I_{CC5}	–	10	–	10	–	10	mA	1
Refresh Current ($\overline{CAS}$ before $\overline{RAS}$ refresh, t_{RC} = min.)	I_{CC6}	–	69	–	58	–	45	mA	1
Operating Current (Page mode, t_{PC} = min.)	I_{CC7}	–	57	–	48	–	37	mA	1
Input Leakage Current (0 < Vin < 7V)	I_{LI}	−10	10	−10	10	−10	10	μA	
Output Leakage Current (0 < $Vout$ < 7V, Dout = Disable)	I_{LO}	−10	10	−10	10	−10	10	μA	
Output High Voltage ($Iout$ = −5 mA)	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	
Output Low Voltage ($Iout$ = 4.2 mA)	V_{OL}	0	0.4	0	0.4	0	0.4	V	

Note) 1. I_{CC} depends on output loading condition when the device is selected, I_{CC} max. is specified at the output open condition.

■ CAPACITANCE (V_{CC} = 5V ±10%, Ta = 25°C)

Parameter		Symbol	typ.	max.	Unit	Note
Input Capacitance	Address	$CI1$	–	5	pF	1
	$\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$, $\overline{OE}$	$CI2$	–	10	pF	1
Output Capacitance	Data In/Data Out	CI/O	–	10	pF	1, 2

Notes) 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$ = V_{IH} to disable Dout.

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

Parameter	Symbol	HM50464-12		HM50464-15		HM50464-20		Unit	Note
		min.	max.	min.	max.	min.	max.		
Access Time from $\overline{RAS}$	t_{RAC}	–	120	–	150	–	200	ns	2, 3
Access Time from $\overline{CAS}$	t_{CAC}	–	60	–	75	–	100	ns	3, 4
Output Buffer Turn-off Delay referenced to $\overline{CAS}$	t_{OFF1}	–	30	–	40	–	50	ns	5
Transition Time (Rise and Fall)	t_T	3	50	3	50	3	50	ns	6
Random Read or Write Cycle Time	t_{RC}	220	–	260	–	330	–	ns	
$\overline{RAS}$ Precharge Time	t_{RP}	90	–	100	–	120	–	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	120	10000	150	10000	200	10000	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	60	10000	75	10000	100	10000	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	25	60	25	75	30	100	ns	7
$\overline{RAS}$ Hold Time	t_{RSH}	60	–	75	–	100	–	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	120	–	150	–	200	–	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	10	–	10	–	10	–	ns	
Row Address Set-up Time	t_{ASR}	0	–	0	–	0	–	ns	
Row Address Hold Time	t_{RAH}	15	–	15	–	20	–	ns	

(to be continued)

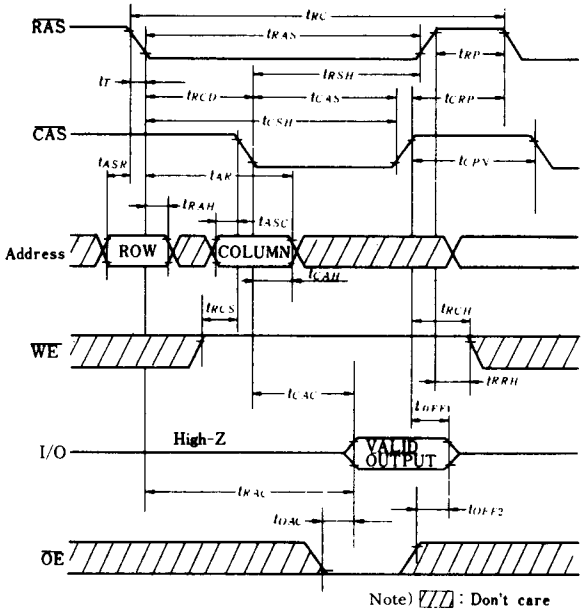
Parameter	Symbol	HM50464-12		HM50464-15		HM50464-20		Unit	Note
		min.	max.	min.	max.	min.	max.		
Column Address Set-up Time	t_{ASC}	0	–	0	–	0	–	ns	
Column Address Hold Time	t_{CAH}	20	–	25	–	30	–	ns	
Column Address Hold Time referenced to $\overline{RAS}$	t_{AR}	80	–	100	–	130	–	ns	
Write Command Set-up Time	t_{WCS}	0	–	0	–	0	–	ns	8
Write Command Hold Time	t_{WCH}	40	–	45	–	55	–	ns	
Write Command Hold Time referenced to $\overline{RAS}$	t_{WCR}	100	–	120	–	155	–	ns	
Write Command Pulse Width	t_{WP}	40	–	45	–	55	–	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	40	–	45	–	55	–	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	40	–	45	–	55	–	ns	
Data-in Set-up Time	t_{DS}	0	–	0	–	0	–	ns	9
Data-in Hold Time	t_{DH}	40	–	45	–	55	–	ns	9
Data-in Hold Time referenced to $\overline{RAS}$	t_{DHR}	100	–	120	–	155	–	ns	
Read Command Set-up Time	t_{RCS}	0	–	0	–	0	–	ns	
Read Command Hold Time referenced to $\overline{CAS}$	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	
Read-Write Cycle Time	t_{RWC}	305	–	360	–	450	–	ns	
$\overline{CAS}$ to $\overline{WE}$ Delay Time	t_{CWD}	100	–	125	–	160	–	ns	8
$\overline{RAS}$ to $\overline{WE}$ Delay Time	t_{RWD}	160	–	200	–	260	–	ns	8
$\overline{CAS}$ Precharge Time	t_{CPN}	50	–	60	–	80	–	ns	
$\overline{CAS}$ Set-up 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}	120	–	150	–	200	–	ns	
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	–	0	–	0	–	ns	
Access Time from $\overline{OE}$	t_{OAC}	–	30	–	35	–	45	ns	
Output Buffer Turn-off Delay referenced to $\overline{OE}$	t_{OFF2}	–	30	–	40	–	50	ns	
$\overline{OE}$ to Data-in Delay Time	t_{ODD}	30	–	40	–	50	–	ns	
$\overline{OE}$ Hold Time referenced to $\overline{WE}$	t_{OEH}	25	–	30	–	40	–	ns	
Page Mode Cycle Time	t_{PC}	120	–	145	–	190	–	ns	
$\overline{CAS}$ Precharge Time (for Page-mode Cycle Only)	t_{CP}	50	–	60	–	80	–	ns	
$\overline{CAS}$ Read-modify-write Cycle Time (Page-mode)	t_{PCM}	205	–	245	–	310	–	ns	

Notes)

1. AC measurements assume t_T = 5ns.
2. Assume that $t_{RCD} \leqq t_{RCD}$ (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 2TTL loads and 100pF.
4. Assumes that $t_{RCD} \geqq t_{RCD}$ (max).
5. t_{OFF} (max) is defined as 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 be t_{CAC}.
8. t_{WCS}, t_{CWD} and t_{RWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if $t_{WCS} \geqq t_{WCS}$ (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geqq t_{CWD}$ (min) and $t_{RWD} \geqq t_{RWD}$ (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 early write cycles and to $\overline{WE}$ leading edge in delayed write or read-modify-write cycles.
10. An initial pause of 100 μs is required after power-up followed by a minimum of 8 initialization of cycles.
11. Minimum of 8 $\overline{CAS}$ before $\overline{RAS}$ refresh is required before using internal refresh counter.
12. In delayed write or read-modify-write cycles, $\overline{OE}$ must disable output buffers prior to applying data to the device.

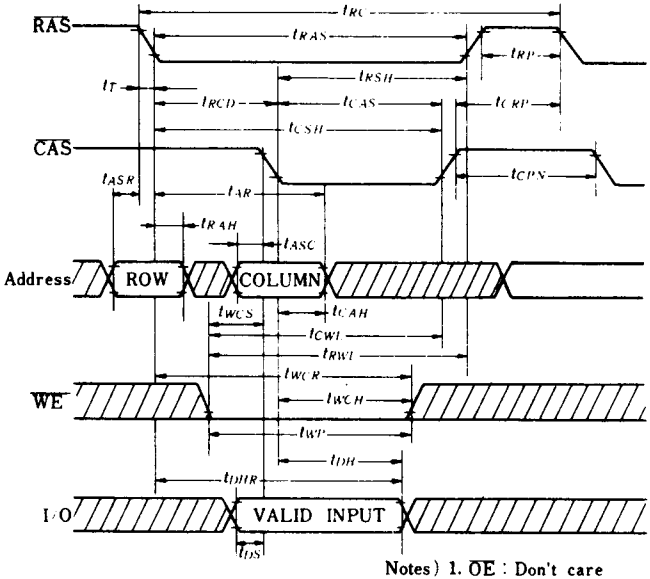
■ TIMING WAVEFORMS

• READ CYCLE



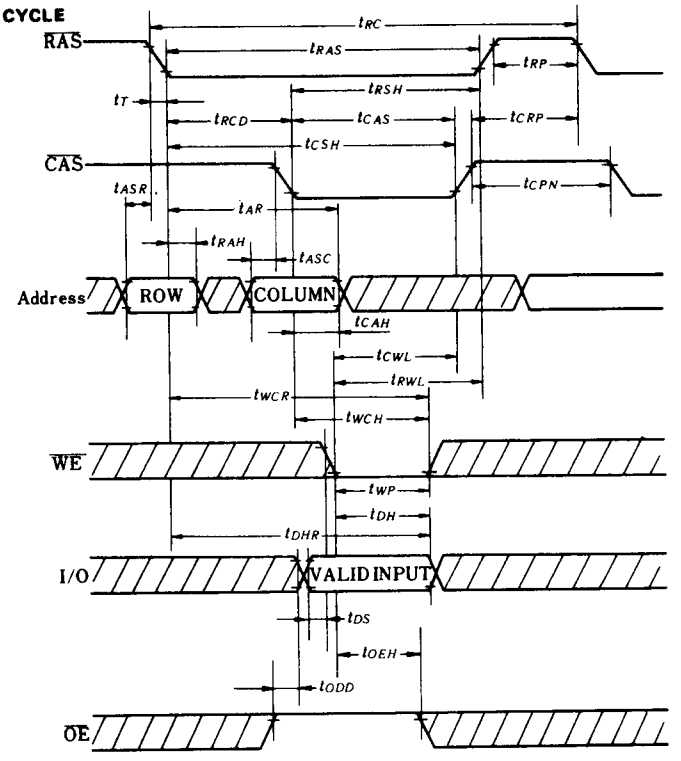
Note) ▨ : Don't care

• EARLY WRITE CYCLE



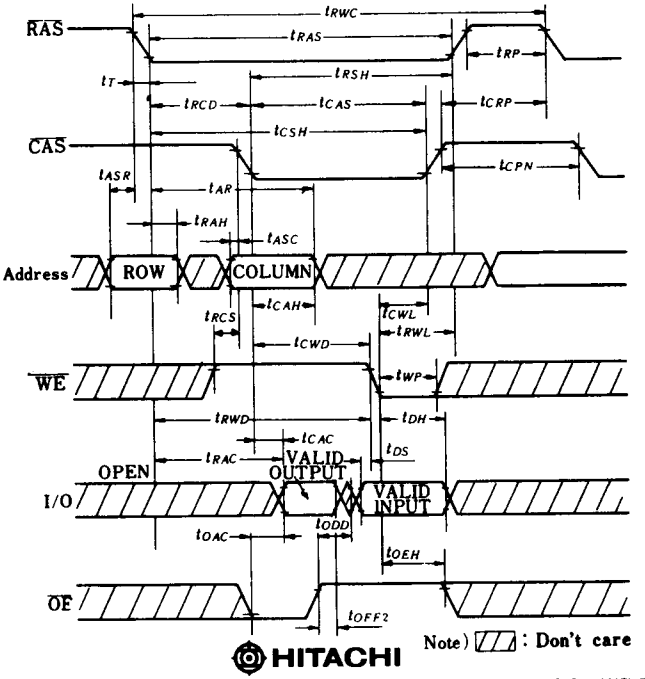
Notes) 1. $\overline{OE}$: Don't care
2. ▨ : Don't care

- **DELAYED WRITE CYCLE**



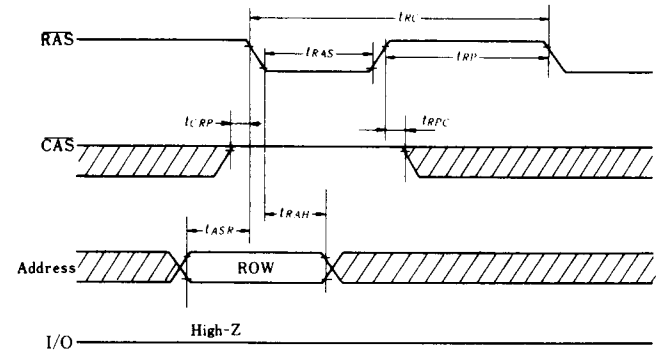
Note) ▨ : Don't care

- **READ MODIFY WRITE CYCLE**



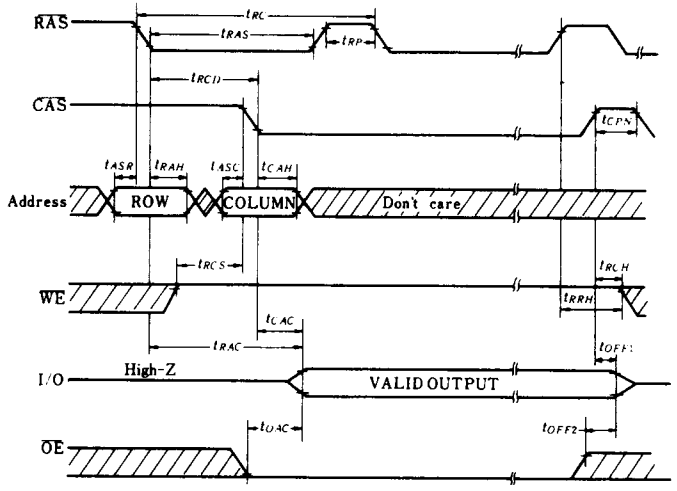
Note) ▨ : Don't care

- **$\overline{RAS}$ ONLY REFRESH CYCLE**



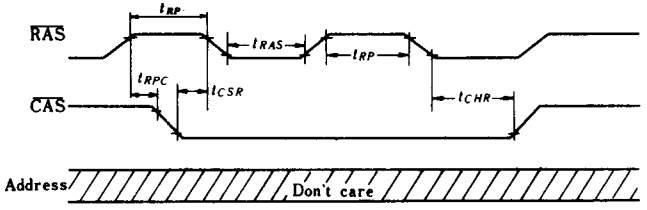
Notes) 1. $\overline{OE}$, $\overline{WE}$: Don't care
2. ▨ : Don't care

- **HIDDEN REFRESH CYCLE**

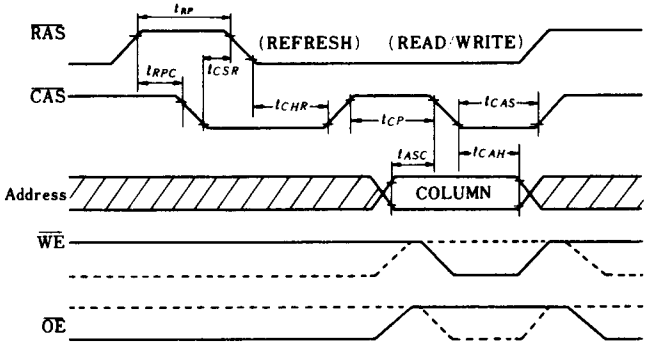


Note) ▨ : Don't care

- **$\overline{CAS}$ BEFORE $\overline{RAS}$ REFRESH CYCLE**

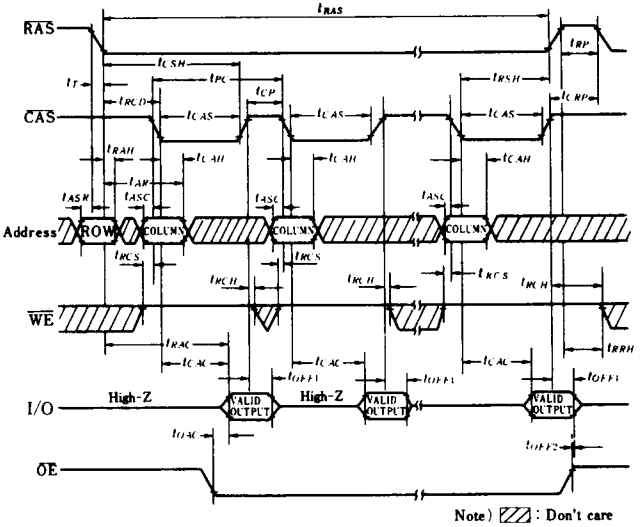


- **COUNTER TEST**



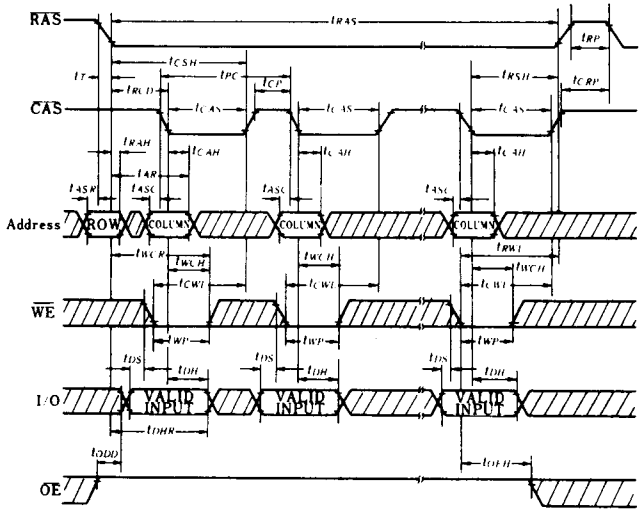
Notes) 1. Dotted-line Means Read Cycle. 2. ▨ : Don't care

- **PAGE MODE READ CYCLE**



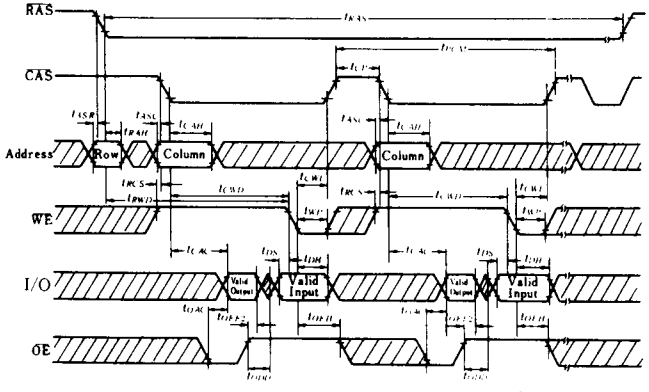
Note) ▨ : Don't care

- **PAGE MODE WRITE CYCLE**



Note) ▨ : Don't care

- **PAGE MODE READ MODIFY WRITE CYCLE**



Note) ▨ : Don't care