

524,288-word × 9-bit Dynamic Random Access Memory

The Hitachi HM514900A are CMOS dynamic RAM organized as 524,288-word × 9-bit. HM514900A have realized higher density, higher performance and various functions by employing 0.8 μm CMOS process technology and some new CMOS circuit design technologies. The HM514900A offer Fast Page Mode as a high speed access mode.

Multiplexed address input permits the HM514900A to be packaged in standard 400-mil 28-pin plastic SOJ, standard 400-mil 28-pin plastic ZIP and standard 400-mil 28-pin plastic TSOPII.

Features

- Single 5 V (±10%)
- High speed
 - Access time: 70 ns/80 ns (max)
- Low power dissipation
 - Active mode: 605 mW/550 mW (max)
 - Standby mode: 11 mW (max)
- 1.1 mW (max) (L-version)
- Fast page mode capability
- 1,024 refresh cycles: 16 ms
- 128 ms (L-version)
- 2 variations of refresh
 - RAS-only refresh
 - CAS-before-RAS refresh
- Battery back up operation (L-version)

Ordering Information

Type No.	Access time	Package
HM514900AJ-7 HM514900AJ-8	70 ns 80 ns	400-mil 28-pin plastic SOJ (CP-28DA)
HM514900ALJ-7 HM514900ALJ-8	70 ns 80 ns	400-mil 28-pin plastic SOJ (CP-28DA)
HM514900ATT-7 HM514900ATT-8	70 ns 80 ns	400-mil 28-pin plastic TSOPII (TTP-28DA)
HM514900ALTT-7 HM514900ALTT-8	70 ns 80 ns	400 mil 28-pin plastic TSOPII (TTP-28DA)
HM514900ARR-7 HM514900ARR-8	70 ns 80 ns	400-mil 28-pin plastic TSOPII (TTP-28DA)
HM514900ALRR-7 HM514900ALRR-8	70 ns 80 ns	400 mil 28-pin plastic TSOPII (TTP-28DA)

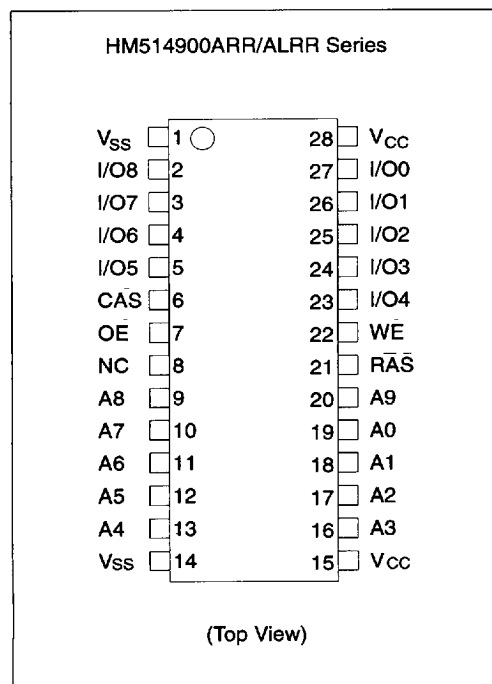
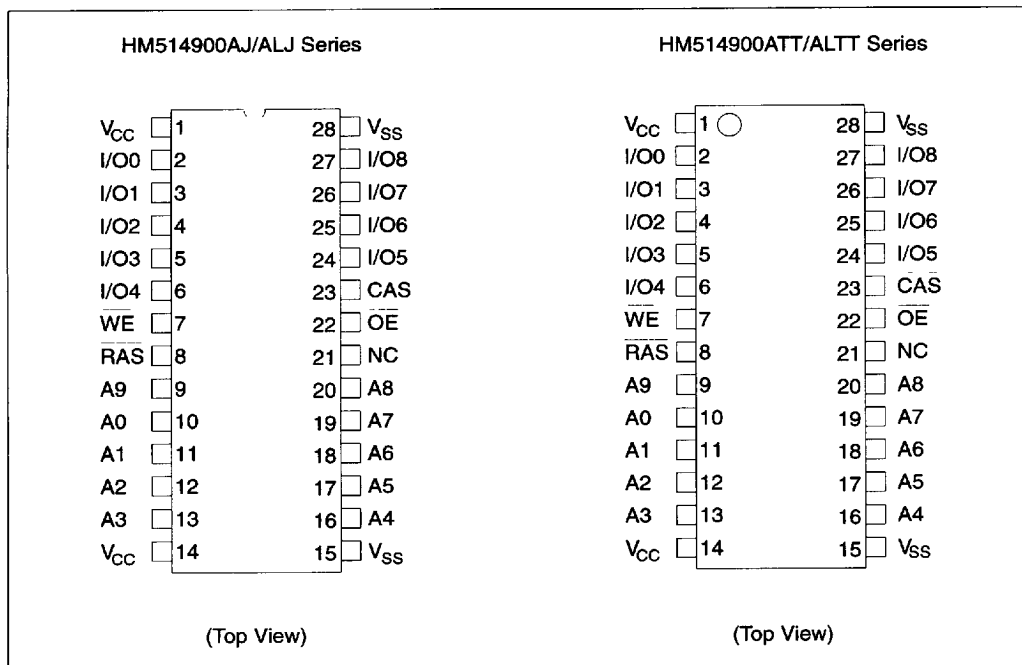
Note: The specifications of this device are subject to change without notice. Please contact your nearest Hitachi's Sales Dept. regarding specifications.

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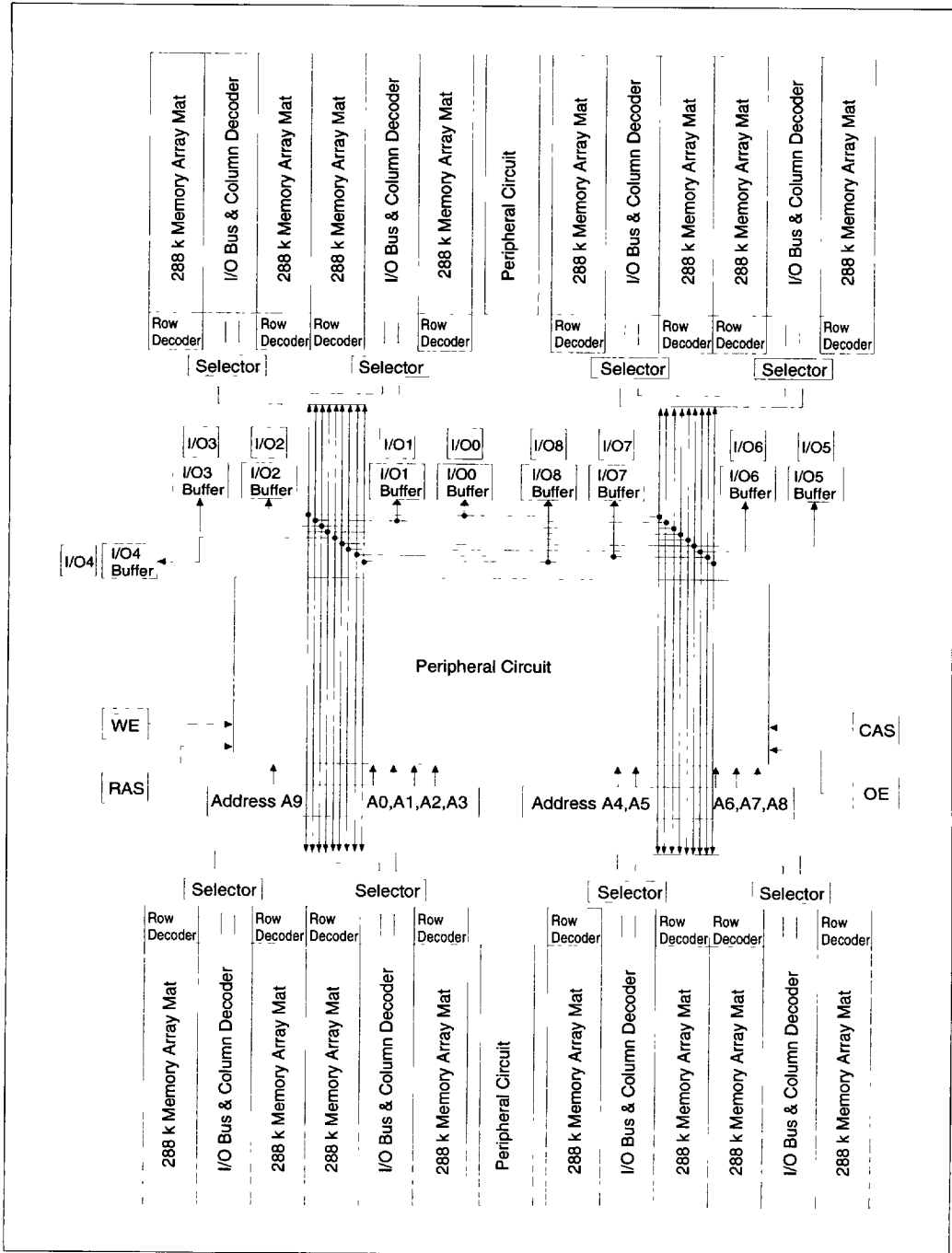
Pin Arrangement



Pin Description

Pin name	Function	
A0 – A9	Address input	
–	Row address	A0 – A9
–	Column address	A0 – A8
–	Refresh address	A0 – A9
I/O0 – I/O9	Data-in/data-out	
$\overline{\text{RAS}}$	Row address strobe	
$\overline{\text{CAS}}$	Column address strobe	
$\overline{\text{WE}}$	Read/write enable	
$\overline{\text{OE}}$	Output enable	
V_{CC}	Power (+5 V)	
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
Supply voltage relative to V_{SS}	V_{CC}	-1.0 to +7.0	V
Short circuit output current	I_{out}	50	mA
Power dissipation	P_T	1.0	W
Operating temperature	T_{opr}	0 to +70	°C
Storage temperature	T_{stg}	-55 to +125	°C

Recommended DC Operating Conditions ($T_a = 0$ to +70°C) *2

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply voltage	V_{SS}	0	0	0	V	
	V_{CC}	4.5	5.0	5.5	V	1
Input high voltage	V_{IH}	2.4	—	6.5	V	1
Input low voltage	(I/O pin) V_{IL}	-1.0	—	0.8	V	1
	(Others) V_{IL}	-2.0	—	0.8	V	1

- Notes: 1. All voltage referenced to V_{SS} .
2. The supply voltage with all V_{CC} pins must be on the same level.
The supply voltage with all V_{SS} pins must be on the same level.

DC Characteristics ($T_a = 0$ to $+70^\circ\text{C}$, $V_{CC} = 5\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$) *5

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Parameter	Symbol	-7		-8		Unit	Test conditions	Notes
		Min	Max	Min	Max			
Operating current	I_{CC1}	—	110	—	100	mA	$\overline{\text{RAS}}, \overline{\text{CAS}}$ cycling $t_{RC} = \text{min}$	1, 2
Standby current	I_{CC2}	—	2	—	2	mA	TTL interface $\overline{\text{RAS}}, \overline{\text{CAS}} = V_{IH}$ Dout = High-Z	
		—	1	—	1	mA	CMOS interface $\overline{\text{RAS}}, \overline{\text{CAS}} \geq V_{CC} - 0.2\text{ V}$ Dout = High-Z	
Standby current (L-version)		—	200	—	200	μA	CMOS interface $\overline{\text{RAS}}, \overline{\text{CAS}} \geq V_{CC} - 0.2\text{ V}$ Dout = High-Z	
$\overline{\text{RAS}}$ -only refresh current	I_{CC3}	—	110	—	100	mA	$t_{RC} = \text{min}$	2
Standby current	I_{CC5}	—	5	—	5	mA	$\overline{\text{RAS}} = V_{IH}$ $\overline{\text{CAS}} = V_{IL}$ Dout = enable	1
$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh current	I_{CC6}	—	110	—	100	mA	$t_{RC} = \text{min}$	4
Fast page mode current	I_{CC7}	—	110	—	100	mA	$t_{PC} = \text{min}$	1, 3
Battery back up current (Standby with CBR refresh) (L-version only)	I_{CC10}	—	300	—	300	μA	Standby: CMOS interface Dout = High-Z CBR refresh: $t_{RC} = 125\text{ }\mu\text{s}$ $t_{RAS} \leq 1\text{ }\mu\text{s}$, $\overline{\text{CAS}} = V_{IL}$ $\overline{\text{WE}} = V_{IH}$	4
Input leakage current	I_{LI}	-10	10	-10	10	μA	$0\text{ V} \leq V_{in} \leq 7\text{ V}$	
Output leakage current	I_{LO}	-10	10	-10	10	μA	$0\text{ V} \leq V_{out} \leq 7\text{ V}$ Dout = disable	
Output high voltage	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	V	High Iout = -5 mA	
Output low voltage	V_{OL}	0	0.4	0	0.4	V	Low Iout = 4.2 mA	

- Notes: 1. I_{CC} depends on output load condition when the device is selected I_{CC} max is specified at the output open condition.
 2. Address can be changed once or less while $\overline{\text{RAS}} = V_{IL}$.
 3. Address can be changed once or less while $\overline{\text{CAS}} = V_{IH}$.
 4. $V_{IH} \geq V_{CC} - 0.2\text{ V}$, $V_{IL} \leq 0.2\text{ V}$; Address can be changed once or less while $\overline{\text{CAS}} = V_{IL}$.
 5. The supply voltage with all V_{CC} pins must be on the same level.
 The supply voltage with all V_{SS} pins must be on the same level.

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Capacitance ($T_a = 25^\circ\text{C}$, $V_{CC} = 5\text{ V} \pm 10\%$)

Parameter	Symbol	Typ	Max	Unit	Notes
Input capacitance (Address)	C_{I1}	—	5	pF	1
Input capacitance (Clocks)	C_{I2}	—	7	pF	1
Output capacitance (Data-in, Data-out)	$C_{I/O}$	—	10	pF	1, 2

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

AC Characteristics ($T_a = 0$ to $+70^\circ\text{C}$, $V_{CC} = 5\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$) *1, *14, *15

Test conditions

- Input rise and fall times: 5 ns
- Input timing reference levels: 0.8 V, 2.4 V
- Output load: 2 TTL gate + C_L (100 pF) (Including scope and jig)

Read, Write, Read-Modify-Write and Refresh Cycles (Common Parameters)

		HM514900A/AL					
		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Unit	Notes
Random read or write cycle time	t _{RC}	130	—	150	—	ns	
$\overline{\text{RAS}}$ precharge time	t _{RP}	50	—	60	—	ns	
$\overline{\text{RAS}}$ pulse width	t _{RAS}	70	10000	80	10000	ns	
$\overline{\text{CAS}}$ pulse width	t _{CAS}	20	10000	20	10000	ns	
Row address setup time	t _{ASR}	0	—	0	—	ns	
Row address hold time	t _{RAH}	10	—	10	—	ns	
Column address setup time	t _{ASC}	0	—	0	—	ns	
Column address hold time	t _{CAH}	15	—	15	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	t _{RCD}	20	50	20	60	ns	8
$\overline{\text{RAS}}$ to column address delay time	t _{RAD}	15	35	15	40	ns	9
$\overline{\text{RAS}}$ hold time	t _{RSH}	20	—	20	—	ns	
$\overline{\text{CAS}}$ hold time	t _{CSH}	70	—	80	—	ns	

Read, Write, Read-Modify-Write and Refresh Cycles (Common Parameters) (cont)

		HM514900A/AL					
		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Unit	Notes
CAS to RAS precharge time	t _{CRP}	10	—	10	—	ns	
OE to Din delay time	t _{ODD}	20	—	20	—	ns	
OE delay time from Din	t _{DZO}	0	—	0	—	ns	
CAS setup time from Din	t _{DZC}	0	—	0	—	ns	
Transition time (rise and fall)	t _T	3	50	3	50	ns	7
Refresh period	t _{REF}	—	16	—	16	ms	
Refresh period (L-version)	t _{REF}	—	128	—	128	ms	

Read Cycle

		HM514900A/AL					
		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Unit	Notes
Access time from $\overline{\text{RAS}}$	t_{RAC}	—	70	—	80	ns	2, 3
Access time from $\overline{\text{CAS}}$	t_{CAC}	—	20	—	20	ns	3, 4, 13
Access time from address	t_{AA}	—	35	—	40	ns	3, 5, 13
Access time from $\overline{\text{OE}}$	t_{OAC}	—	20	—	20	ns	3
Read command setup time	t_{RCS}	0	—	0	—	ns	
Read command hold time to $\overline{\text{CAS}}$	t_{RCH}	0	—	0	—	ns	
Read command hold time to $\overline{\text{RAS}}$	t_{RRH}	0	—	0	—	ns	
Column address to $\overline{\text{RAS}}$ lead time	t_{RAL}	35	—	40	—	ns	
Output buffer turn-off time	t_{OFF1}	0	15	0	15	ns	6
Output buffer turn-off to $\overline{\text{OE}}$	t_{OFF2}	0	15	0	15	ns	6
$\overline{\text{CAS}}$ to Din delay time	t_{CDD}	15	—	15	—	ns	

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Write Cycle

		HM514900A/AL					
		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Unit	Notes
Write command setup time	t _{WCS}	0	—	0	—	ns	10
Write command hold time	t _{WCH}	15	—	15	—	ns	
Write command pulse width	t _{WP}	10	—	10	—	ns	
Write command to $\overline{\text{RAS}}$ lead time	t _{RWL}	20	—	20	—	ns	
Write command to $\overline{\text{CAS}}$ lead time	t _{CWL}	20	—	20	—	ns	
Data-in setup time	t _{DS}	0	—	0	—	ns	11
Data-in hold time	t _{DH}	15	—	15	—	ns	11
$\overline{\text{CAS}}$ to $\overline{\text{OE}}$ delay time	t _{COD}	—	0	—	0	ns	18

Read-Modify-Write Cycle

		HM514900A/AL					
		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Unit	Notes
Read-modify-write cycle time	t _{RWC}	180	—	200	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ delay time	t _{RWD}	95	—	105	—	ns	10
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ delay time	t _{CWD}	45	—	45	—	ns	10
Column address to $\overline{\text{WE}}$ delay time	t _{AWD}	60	—	65	—	ns	10
$\overline{\text{OE}}$ hold time from $\overline{\text{WE}}$	t _{OEH}	20	—	20	—	ns	

Refresh Cycle

		HM514900A/AL					
		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Unit	Notes
CAS setup time (CAS-before-RAS refresh cycle)	t _{CSR}	10	—	10	—	ns	
CAS hold time (CAS-before-RAS refresh cycle)	t _{CHR}	10	—	10	—	ns	
RAS precharge to CAS hold time	t _{RPC}	10	—	10	—	ns	
CAS precharge time in normal mode	t _{CPN}	10	—	10	—	ns	

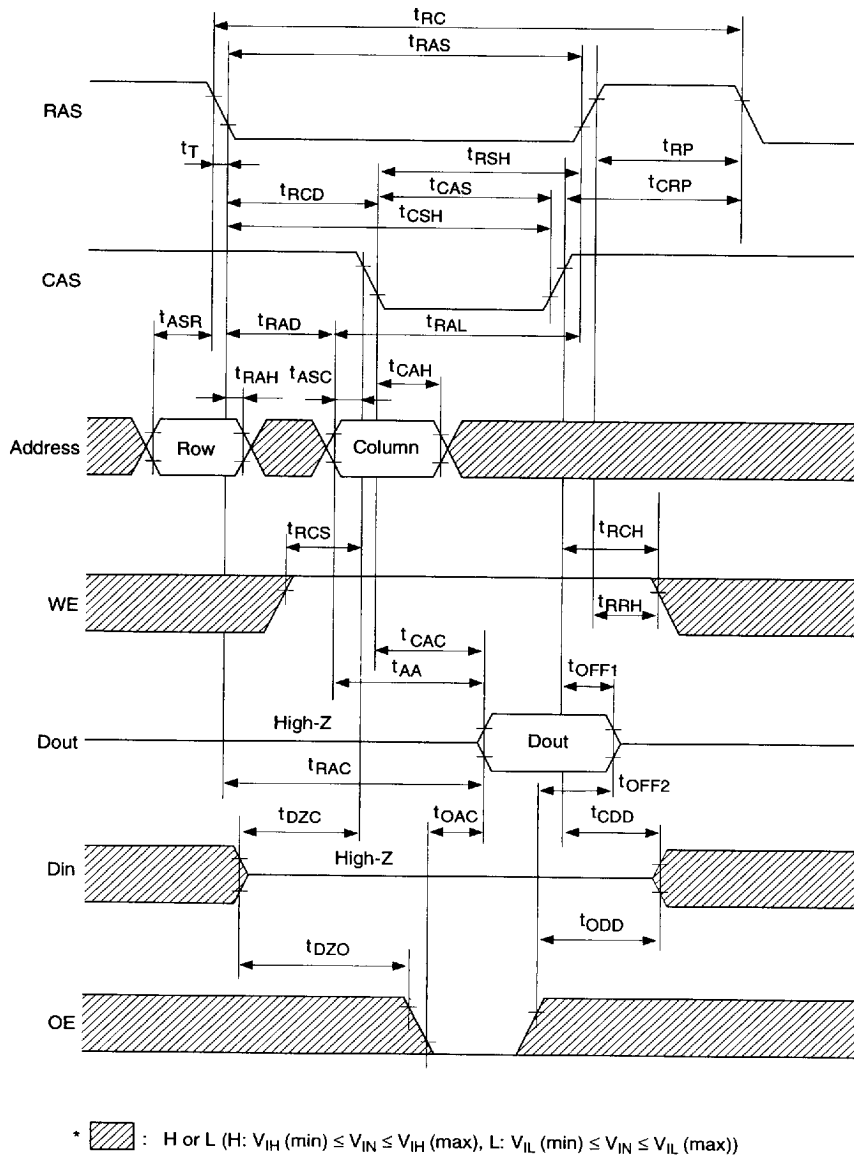
Fast Page Mode Cycle

		HM514900A/AL					
		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Unit	Notes
Fast page mode cycle time	t _{PC}	45	—	50	—	ns	
Fast page mode $\overline{\text{CAS}}$ precharge time	t _{CP}	10	—	10	—	ns	
Fast page mode $\overline{\text{RAS}}$ pulse width	t _{RASC}	—	100000	—	100000	ns	12
Access time from $\overline{\text{CAS}}$ precharge	t _{ACP}	—	40	—	45	ns	3, 13
$\overline{\text{RAS}}$ hold time from $\overline{\text{CAS}}$ precharge	t _{RHCP}	40	—	45	—	ns	
Fast page mode read-modify-write cycle $\overline{\text{CAS}}$ precharge to $\overline{\text{WE}}$ delay time	t _{CPW}	65	—	70	—	ns	
Fast page mode read-modify-write cycle time	t _{PCM}	95	—	100	—	ns	

- Notes:
1. AC measurements assume $t_T = 5 \text{ ns}$.
 2. Assumes that $t_{RCD} \leq t_{RCD}(\text{max})$ and $t_{RAD} \leq t_{RAD}(\text{max})$. If t_{RCD} or t_{RAD} 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 $t_{RCD} \geq t_{RCD}(\text{max})$ and $t_{RAD} \leq t_{RAD}(\text{max})$.
 5. Assumes that $t_{RCD} \leq t_{RCD}(\text{max})$ and $t_{RAD} \geq t_{RAD}(\text{max})$.
 6. $t_{OFF}(\text{max})$ defines the time at which the output achieves the open circuit condition and is not referred to output voltage levels.
 7. $V_{IH}(\text{min})$ and $V_{IL}(\text{max})$ are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL} .
 8. Operation with the $t_{RCD}(\text{max})$ limit insures that $t_{RAC}(\text{max})$ can be met, $t_{RCD}(\text{max})$ is specified as a reference point only, if t_{RCD} is greater than the specified $t_{RCD}(\text{max})$ limit, then access time is controlled exclusively by t_{CAC} .
 9. Operation with the $t_{RAD}(\text{max})$ limit insures that $t_{RAC}(\text{max})$ can be met, $t_{RAD}(\text{max})$ is specified as a reference point only, if t_{RAD} is greater than the specified $t_{RAD}(\text{max})$ limit, then access time is controlled exclusively by t_{AA} .
 10. t_{WCS} , t_{RWD} , t_{CWD} and t_{AWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if $t_{WCS} \geq t_{WCS}(\text{min})$, the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{RWD} \geq t_{RWD}(\text{min})$, $t_{CWD} \geq t_{CWD}(\text{min})$, $t_{AWD} \geq t_{AWD}(\text{min})$ and $t_{CPW} \geq t_{CPW}(\text{min})$, the cycle is a read-modify-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.
 11. These parameters are referred to $\overline{\text{CAS}}$ leading edge in an early write cycle and to $\overline{\text{WE}}$ leading edge in a delayed write or a read-modify-write cycle.
 12. t_{RASC} defines $\overline{\text{RAS}}$ pulse width in fast page mode cycles.
 13. Access time is determined by the longer of t_{AA} or t_{CAC} or t_{ACP} .
 14. An initial pause of 100 μs is required after power up followed by a minimum of eight initialization cycles ($\overline{\text{RAS}}$ -only refresh cycle or $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh cycle). If the internal refresh counter is used, a minimum of eight $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh cycles is required.
 15. In delayed write or read-modify-write cycles, $\overline{\text{OE}}$ must disable output buffer prior to applying data to the device.
 16. Either t_{RCH} or T_{RRH} must be satisfied for a read cycle.
 17. The supply voltage with all V_{CC} pins must be on the same level.
The supply voltage with all V_{SS} pins must be on the same level.
 18. Do not enable Dout buffer when using delayed write timing.

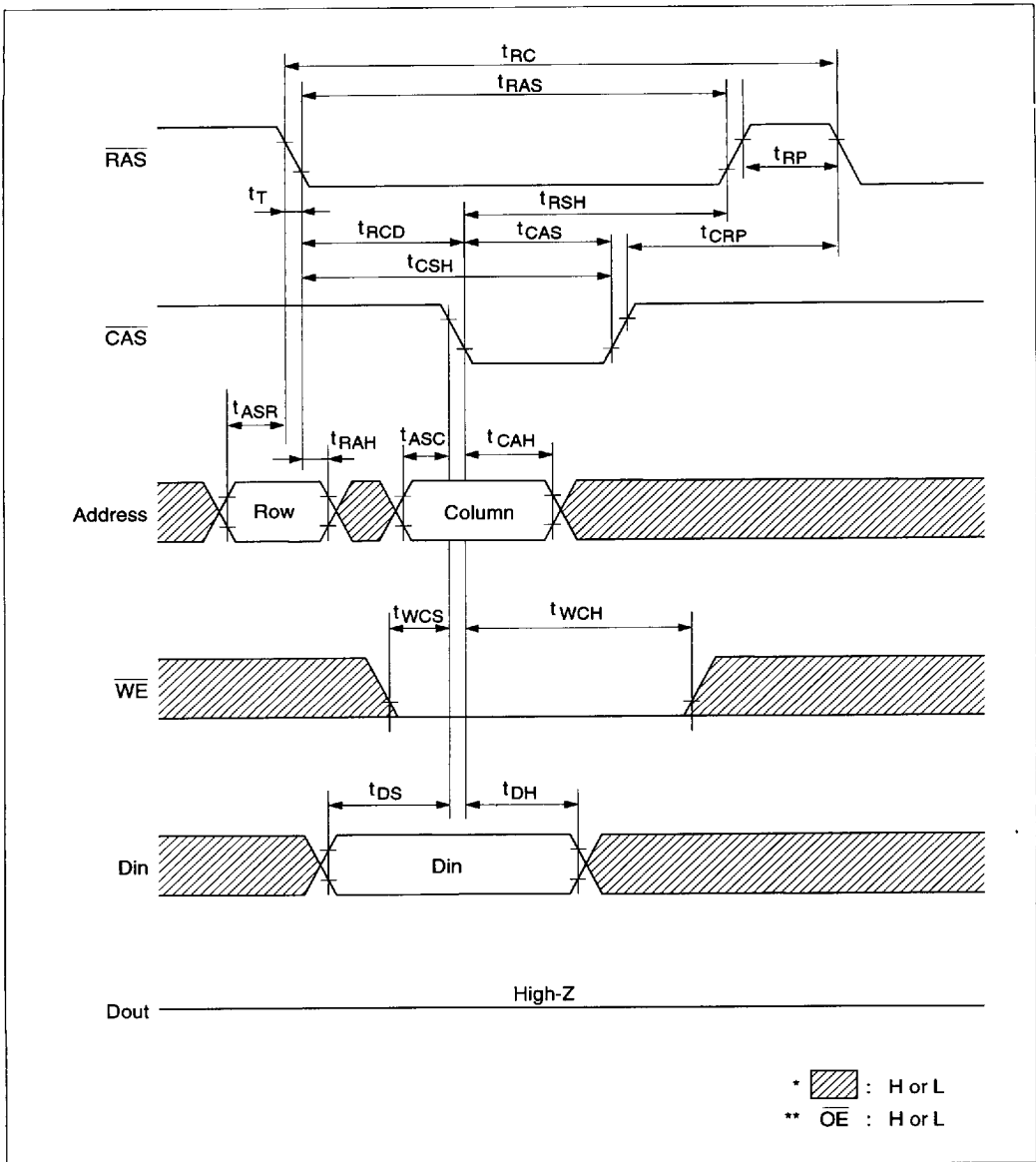
Timing Waveforms

Read Cycle

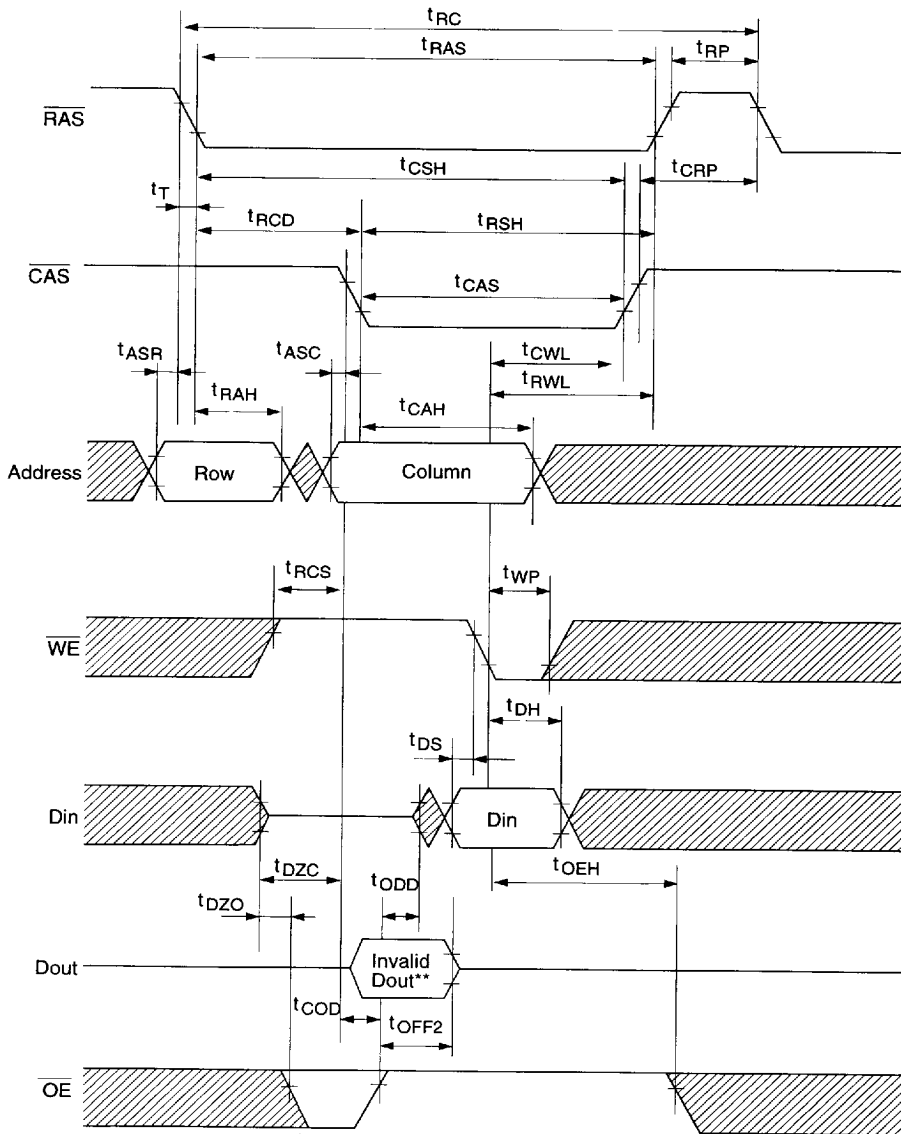


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Early Write Cycle



Delayed Write Cycle

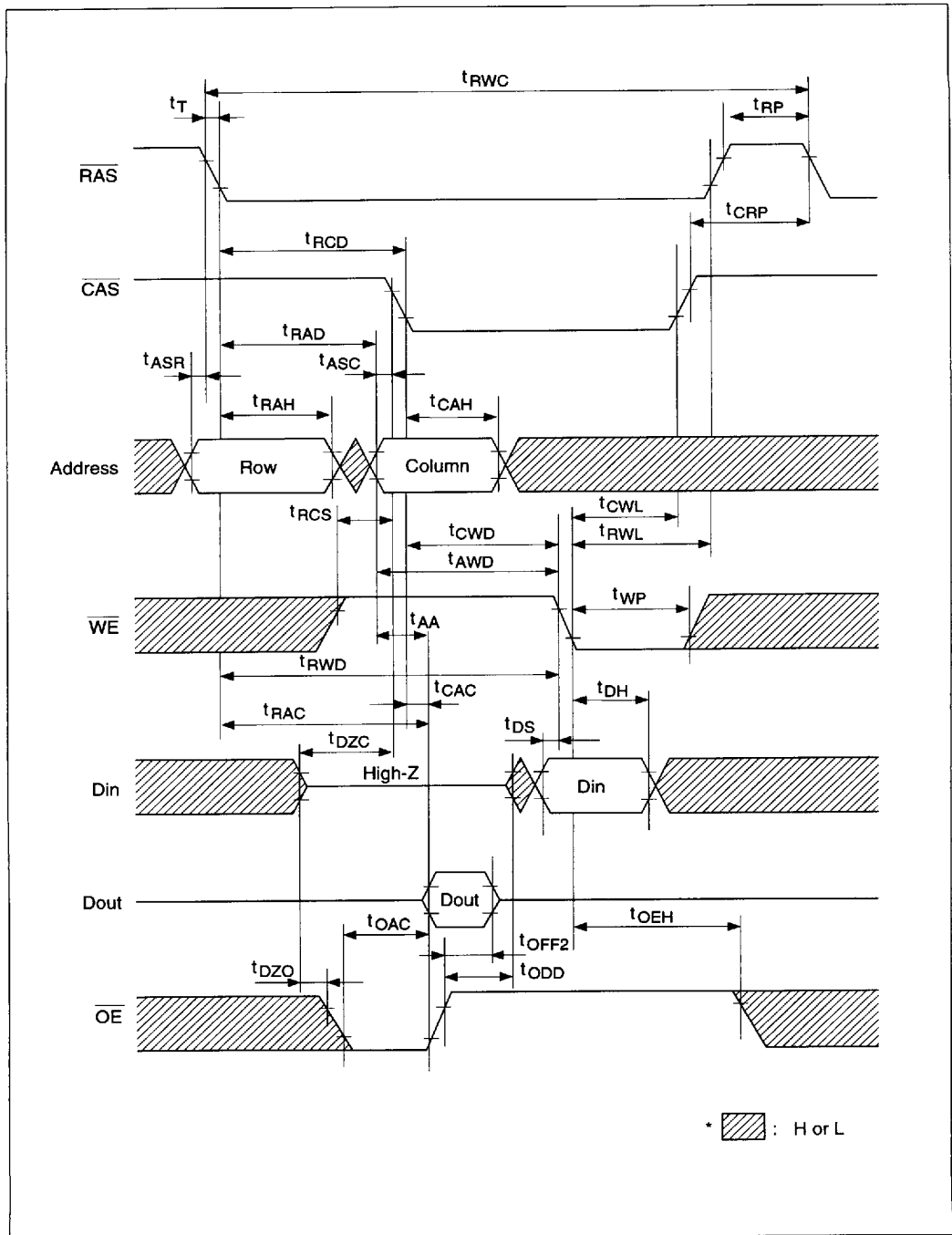


* : H or L

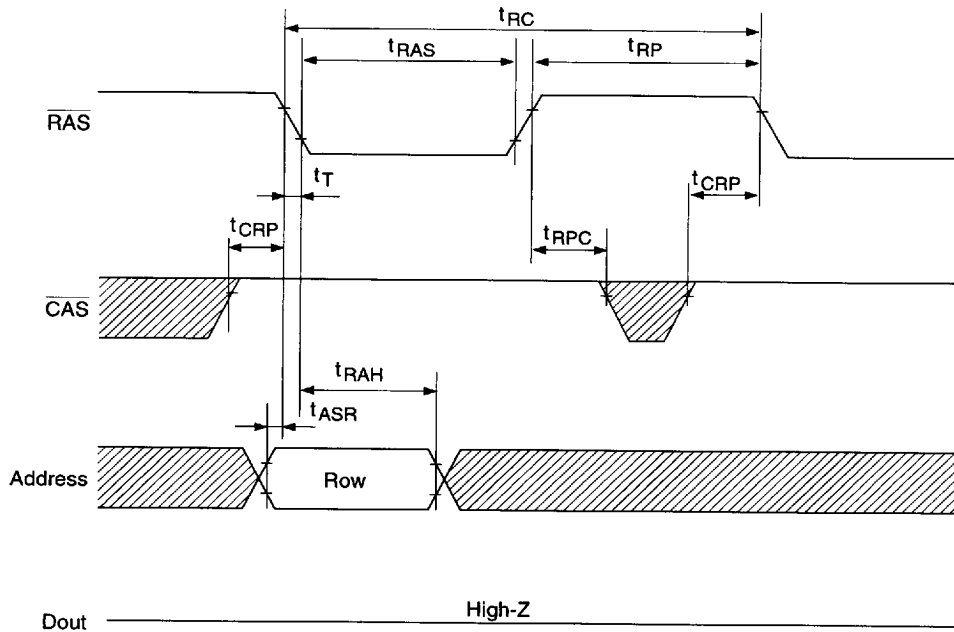
** Do not enable Dout during delayed write cycle.

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Read-Modify-Write Cycle



RAS-Only Refresh Cycle



* $\overline{\text{OE}}$, $\overline{\text{WE}}$: H or L

**  : H or L

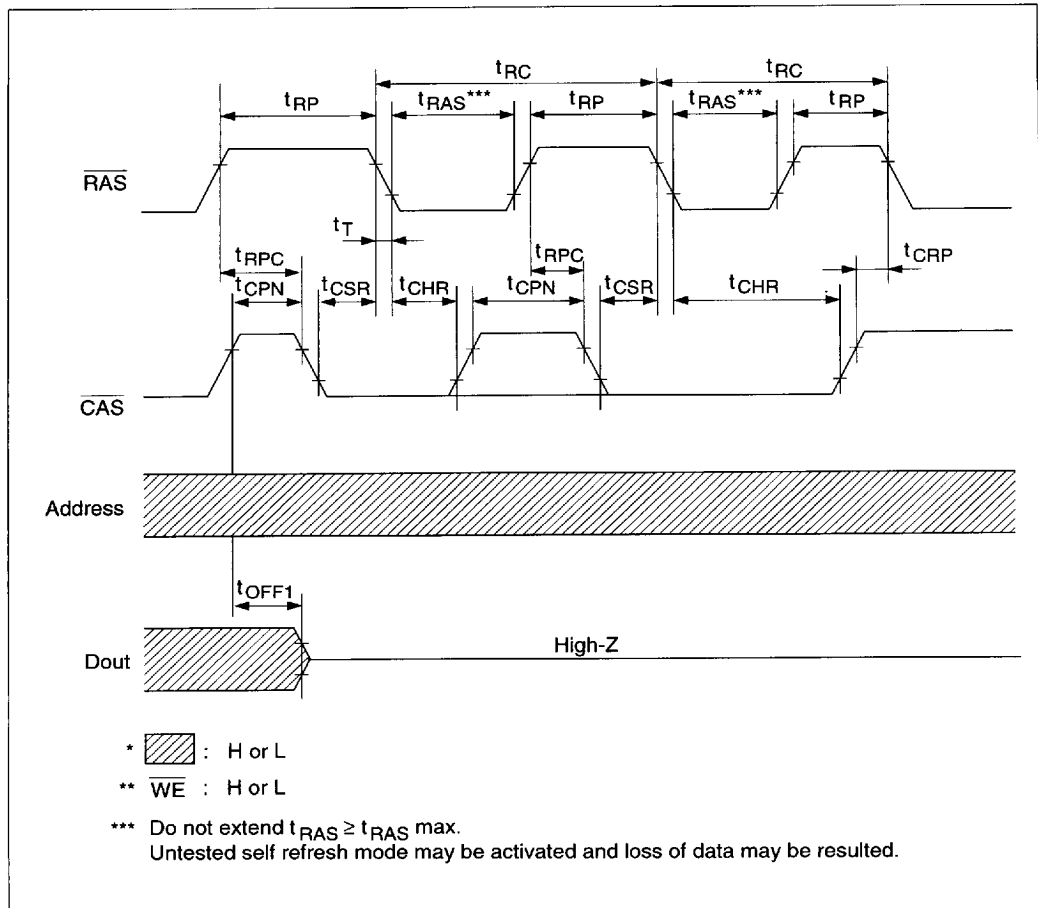
*** Refresh address : A0 – A9 (AX0 – AX9)

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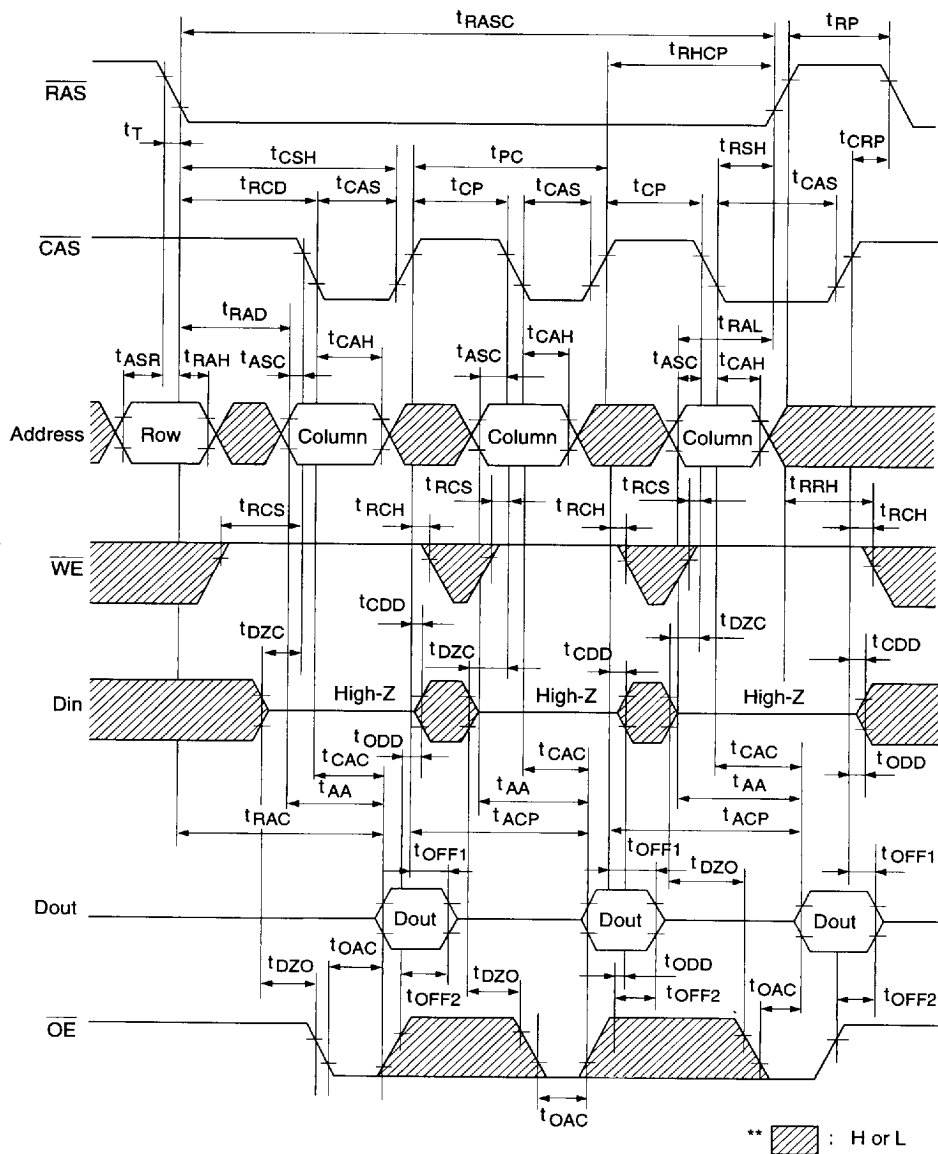
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CAS-Before-RAS Refresh Cycle

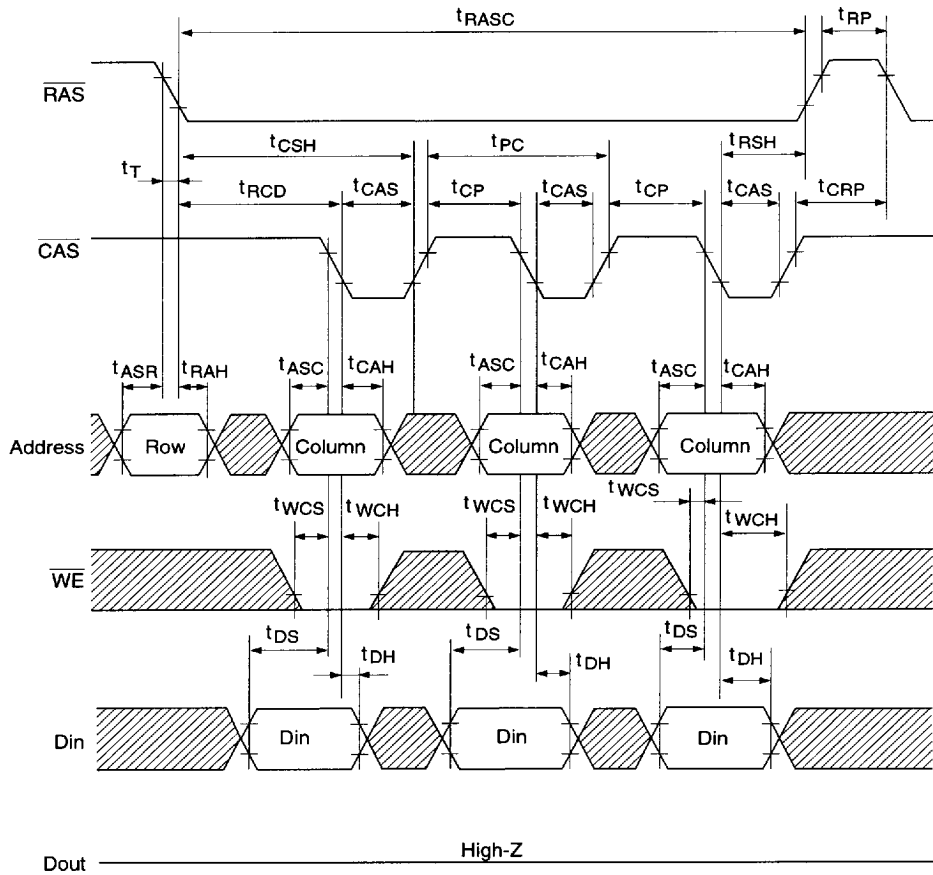


Fast Page Mode Read Cycle



HM514900A/AL Series

Fast Page Mode Early Write Cycle



* $\overline{OE}$: H or L

**  : H or L

Fast Page Mode Delayed Write Cycle

