HM514900A/AL Series

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 and standard 400-mil 28-pin plastic TSOPII.

Features

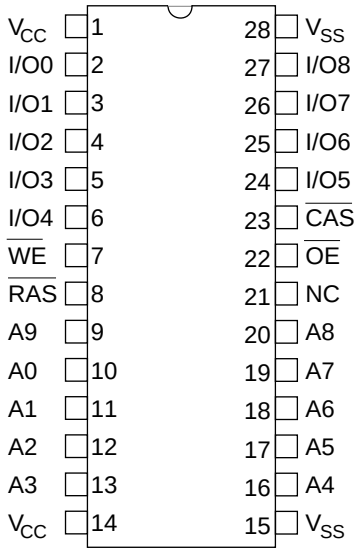
- Single 5 V (±10%)
- High speed
  - Access time: 70 ns/80 ns (max)
- Low power dissipation
  - Active mode: 605 mW/550 mW (max)
  - Standby mode: 11 mW (max)
    1.1 mW (max) (L-version)
- Fast page mode capability
- 1,024 refresh cycles: 16 ms
  128 ms (L-version)
- 2 variations of refresh
  - RAS-only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

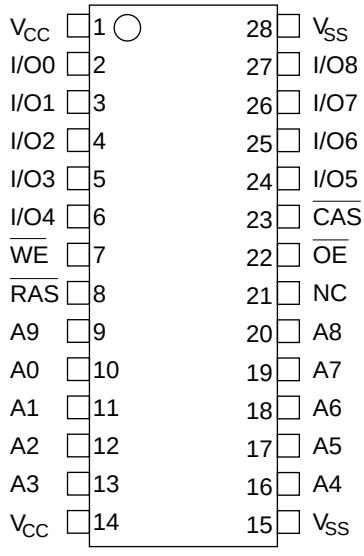
Pin Arrangement

HM514900AJ/ALJ Series



(Top View)

HM514900ATT/ALTT Series

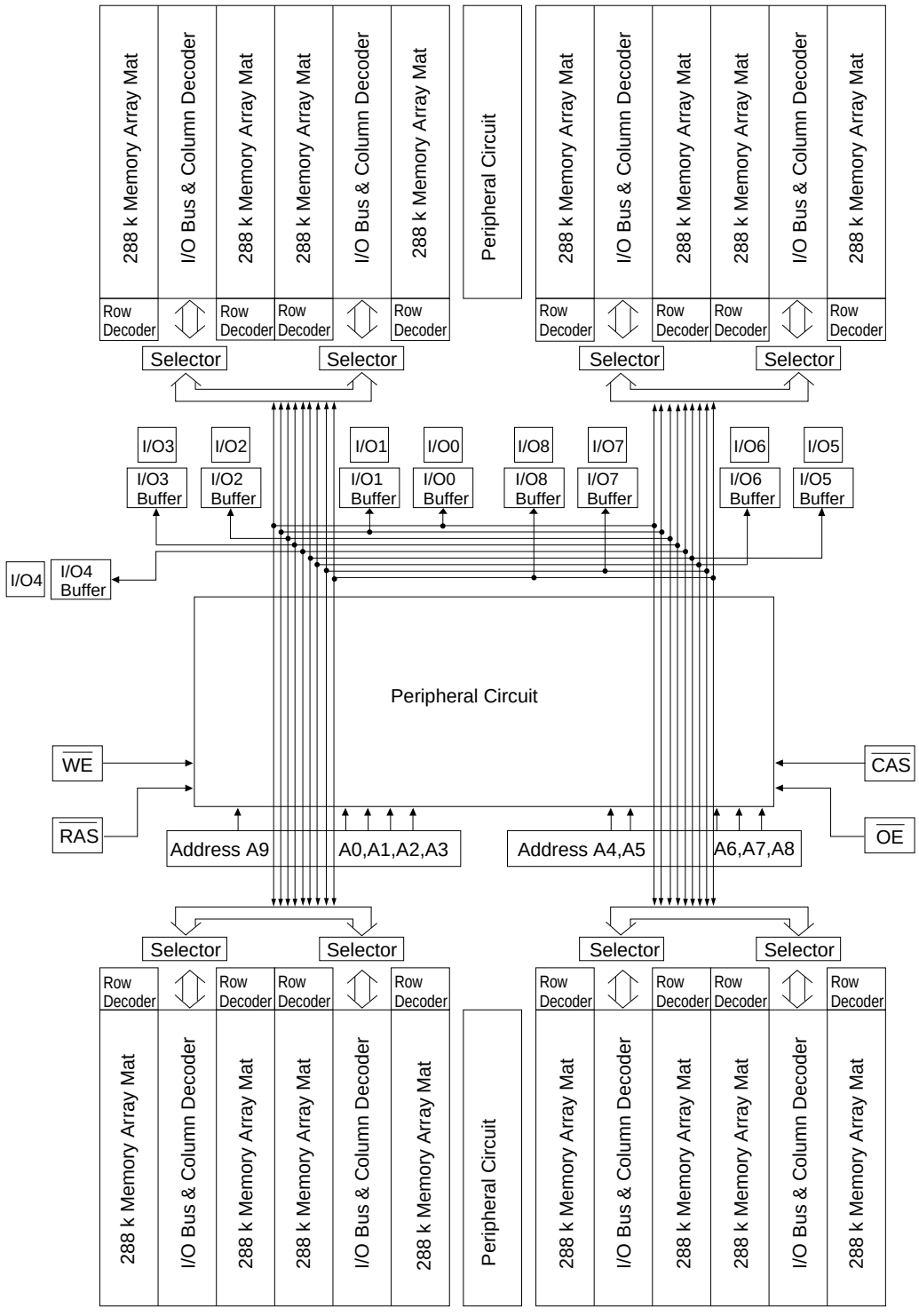


(Top View)

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
$\overline{RAS}$	Row address strobe
$\overline{CAS}$	Column address strobe
$\overline{WE}$	Read/write enable
$\overline{OE}$	Output enable
V_{CC}	Power (+5 V)
V_{SS}	Ground

Block Diagram



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	Iout	50	mA
Power dissipation	P_T	1.0	W
Operating temperature	Topr	0 to +70	°C
Storage temperature	Tstg	–55 to +125	°C

Recommended DC Operating Conditions (Ta = 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 referred 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 (Ta = 0 to +70°C, V_{CC} = 5 V ± 10%, V_{SS} = 0 V) *5

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Parameter	Symbol	Min	Max	Min	Max	Unit	Test conditions	Notes
Operating current	I_{CC1}	—	110	—	100	mA	$\overline{RAS}$, $\overline{CAS}$ cycling t_{RC} = min	1, 2
Standby current	I_{CC2}	—	2	—	2	mA	TTL interface $\overline{RAS}$, $\overline{CAS}$ = V_{IH} Dout = High-Z	
		—	1	—	1	mA	CMOS interface $\overline{RAS}$, $\overline{CAS}$ ≥ V_{CC} – 0.2 V Dout = High-Z	
Standby current (L-version)		—	200	—	200	µA	CMOS interface $\overline{RAS}$, $\overline{CAS}$ ≥ V_{CC} – 0.2 V Dout = High-Z	
$\overline{RAS}$-only refresh current	I_{CC3}	—	110	—	100	mA	t_{RC} = min	2
Standby current	I_{CC5}	—	5	—	5	mA	$\overline{RAS}$ = V_{IH} $\overline{CAS}$ = V_{IL} Dout = enable	1
$\overline{CAS}$-before-$\overline{RAS}$ refresh current	I_{CC6}	—	110	—	100	mA	t_{RC} = min	4
Fast page mode current	I_{CC7}	—	110	—	100	mA	t_{PC} = 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 µs t_{RAS} ≤ 1 µs, $\overline{CAS}$ = V_{IL} $\overline{WE}$ = V_{IH}	4
Input leakage current	I_{LI}	–10	10	–10	10	µA	0 V ≤ Vin ≤ 7 V	
Output leakage current	I_{LO}	–10	10	–10	10	µA	0 V ≤ Vout ≤ 7 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 $\overline{RAS}$ = V_{IL}.
3. Address can be changed once or less while $\overline{CAS}$ = V_{IH}.
4. V_{IH} ≥ V_{CC} – 0.2 V, V_{IL} ≤ 0.2 V; Address can be changed once or less while $\overline{CAS}$ = 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.

Capacitance (Ta = 25°C, V_{CC} = 5 V ± 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. $\overline{CAS}$ = V_{IH} to disable Dout.

AC Characteristics (Ta = 0 to +70°C, V_{CC} = 5 V ± 10%, V_{SS} = 0 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	
$\overline{RAS}$ precharge time	t_{RP}	50	—	60	—	ns	
$\overline{RAS}$ pulse width	t_{RAS}	70	10000	80	10000	ns	
$\overline{CAS}$ 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	
$\overline{RAS}$ to $\overline{CAS}$ delay time	t_{RCD}	20	50	20	60	ns	8
$\overline{RAS}$ to column address delay time	t_{RAD}	15	35	15	40	ns	9
$\overline{RAS}$ hold time	t_{RSH}	20	—	20	—	ns	
$\overline{CAS}$ 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**
$\overline{CAS}$ to $\overline{RAS}$ precharge time	t_{CRP}	10	—	10	—	ns	
$\overline{OE}$ to Din delay time	t_{ODD}	20	—	20	—	ns	
$\overline{OE}$ delay time from Din	t_{DZO}	0	—	0	—	ns	
$\overline{CAS}$ 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 $\overline{RAS}$	t_{RAC}	—	70	—	80	ns	2, 3
Access time from $\overline{CAS}$	t_{CAC}	—	20	—	20	ns	3, 4, 13
Access time from address	t_{AA}	—	35	—	40	ns	3, 5, 13
Access time from $\overline{OE}$	t_{OAC}	—	20	—	20	ns	3
Read command setup time	t_{RCS}	0	—	0	—	ns	
Read command hold time to $\overline{CAS}$	t_{RCH}	0	—	0	—	ns	
Read command hold time to $\overline{RAS}$	t_{RRH}	0	—	0	—	ns	
Column address to $\overline{RAS}$ 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 $\overline{OE}$	t_{OFF2}	0	15	0	15	ns	6
$\overline{CAS}$ to Din delay time	t_{CDD}	15	—	15	—	ns	

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 $\overline{RAS}$ lead time	t_{RWL}	20	—	20	—	ns	
Write command to $\overline{CAS}$ 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
$\overline{CAS}$ to $\overline{OE}$ 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	
$\overline{RAS}$ to $\overline{WE}$ delay time	t_{RWD}	95	—	105	—	ns	10
$\overline{CAS}$ to $\overline{WE}$ delay time	t_{CWD}	45	—	45	—	ns	10
Column address to $\overline{WE}$ delay time	t_{AWD}	60	—	65	—	ns	10
$\overline{OE}$ hold time from $\overline{WE}$	t_{OEH}	20	—	20	—	ns	

Refresh Cycle

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

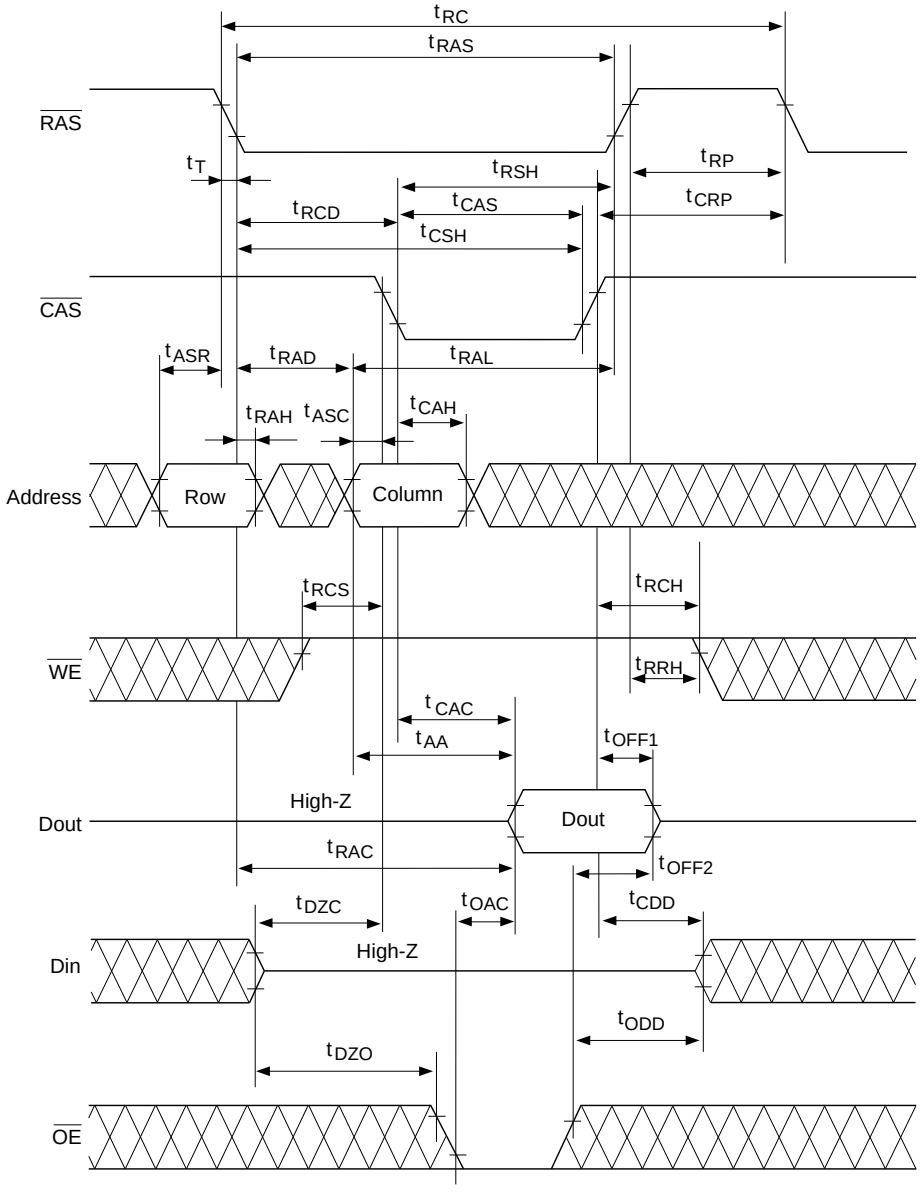
Fast Page Mode Cycle

Parameter	Symbol	HM514900A/AL -7 Min	-7 Max	-8 Min	-8 Max	Unit	Notes
Fast page mode cycle time	t_{PC}	45	—	50	—	ns	
Fast page mode $\overline{CAS}$ precharge time	t_{CP}	10	—	10	—	ns	
Fast page mode $\overline{RAS}$ pulse width	t_{RASC}	—	100000	—	100000	ns	12
Access time from $\overline{CAS}$ precharge	t_{ACP}	—	40	—	45	ns	3, 13
$\overline{RAS}$ hold time from $\overline{CAS}$ precharge	t_{RHCP}	40	—	45	—	ns	
Fast page mode read-modify-write cycle $\overline{CAS}$ precharge to $\overline{WE}$ 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 ns.
2. Assumes that $t_{RCD} \leq t_{RCD}$ (max) and $t_{RAD} \leq t_{RAD}$ (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 $t_{RCD} \geq t_{RCD}$ (max) and $t_{RAD} \leq t_{RAD}$ (max).
5. Assumes that $t_{RCD} \leq t_{RCD}$ (max) and $t_{RAD} \geq t_{RAD}$ (max).
6. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not referred to output voltage levels.
7. 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}.
8. 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}.
9. Operation with the t_{RAD} (max) limit insures that t_{RAC} (max) can be met, t_{RAD} (max) is specified as a reference point only, if t_{RAD} is greater than the specified t_{RAD} (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 $t_{WCS} \geq t_{WCS}$ (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{RWD} \geq t_{RWD}$ (min), $t_{CWD} \geq t_{CWD}$ (min), $t_{AWD} \geq t_{AWD}$ (min) and $t_{CPW} \geq t_{CPW}$ (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 $\overline{CAS}$ leading edge in an early write cycle and to $\overline{WE}$ leading edge in a delayed write or a read-modify-write cycle.
12. t_{RASC} defines $\overline{RAS}$ 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 ($\overline{RAS}$-only refresh cycle or $\overline{CAS}$-before-$\overline{RAS}$ refresh cycle). If the internal refresh counter is used, a minimum of eight $\overline{CAS}$-before-$\overline{RAS}$ refresh cycles is required.
15. In delayed write or read-modify-write cycles, $\overline{OE}$ 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.

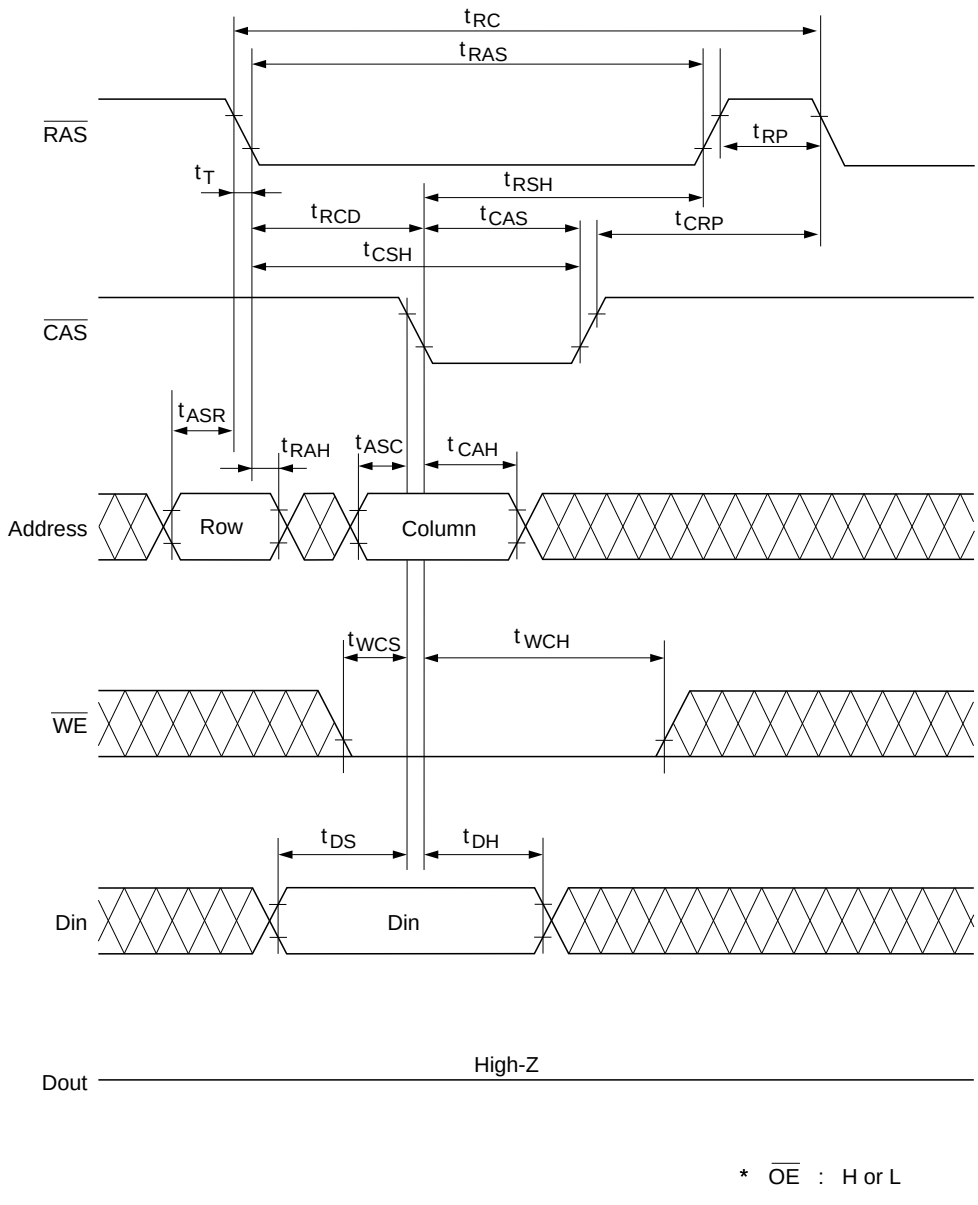
Timing Waveforms *19

Read Cycle

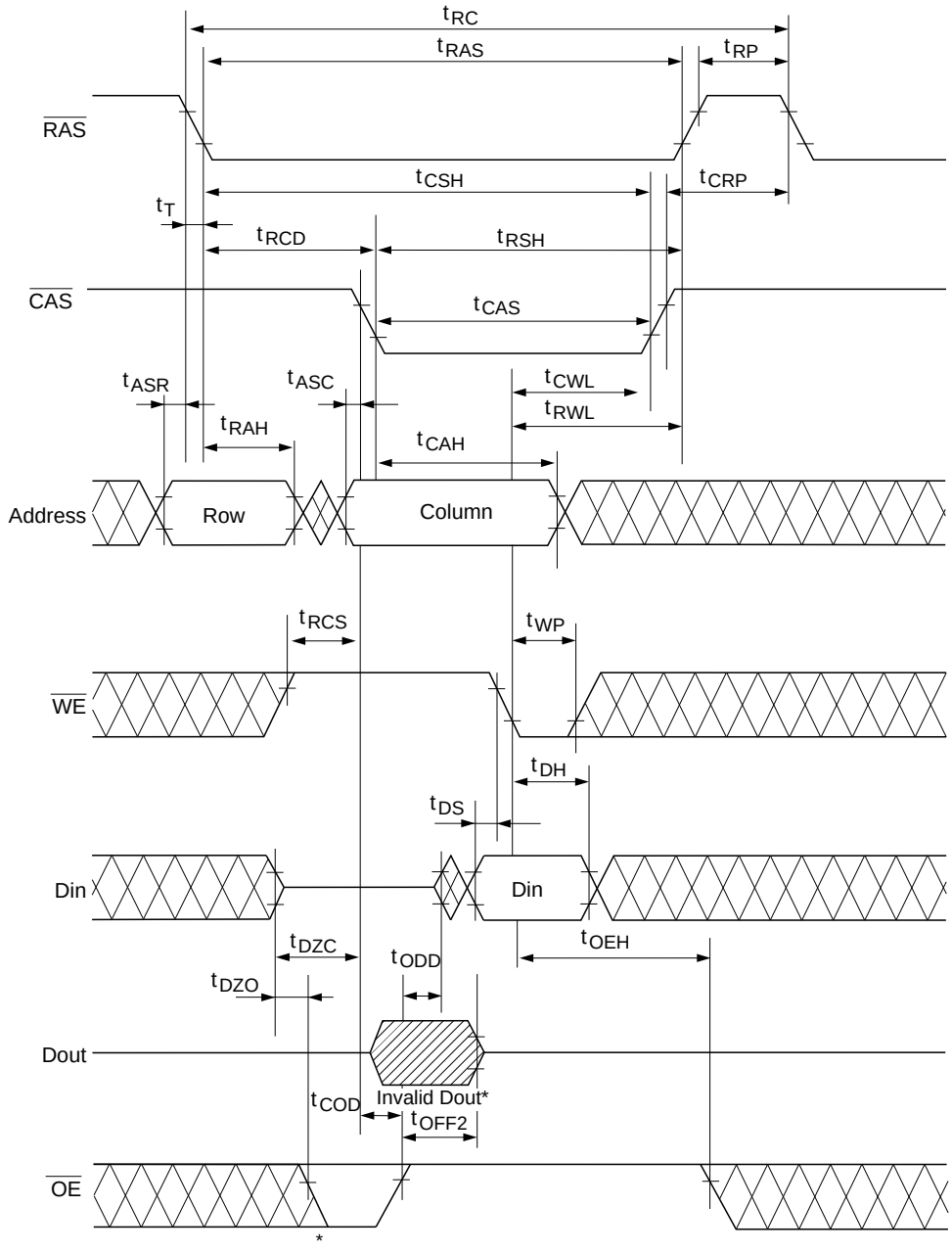


Note: 19 H or L (H: V_{IH} (min) ≤ V_{IN} ≤ V_{IH} (max), L: V_{IL} (min) ≤ V_{IN} ≤ V_{IL} (max))
Invalid Dout

Early Write Cycle

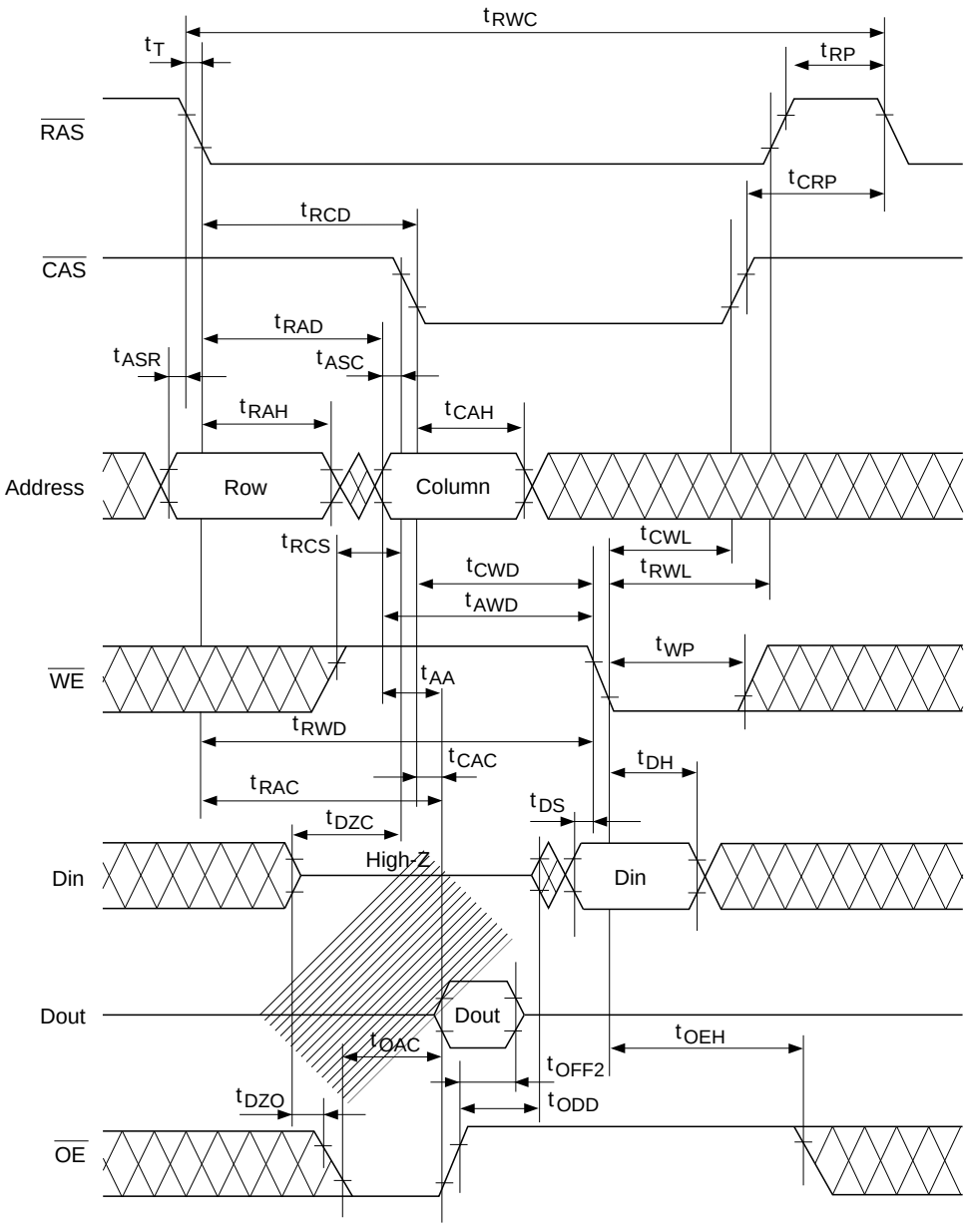


Delayed Write Cycle

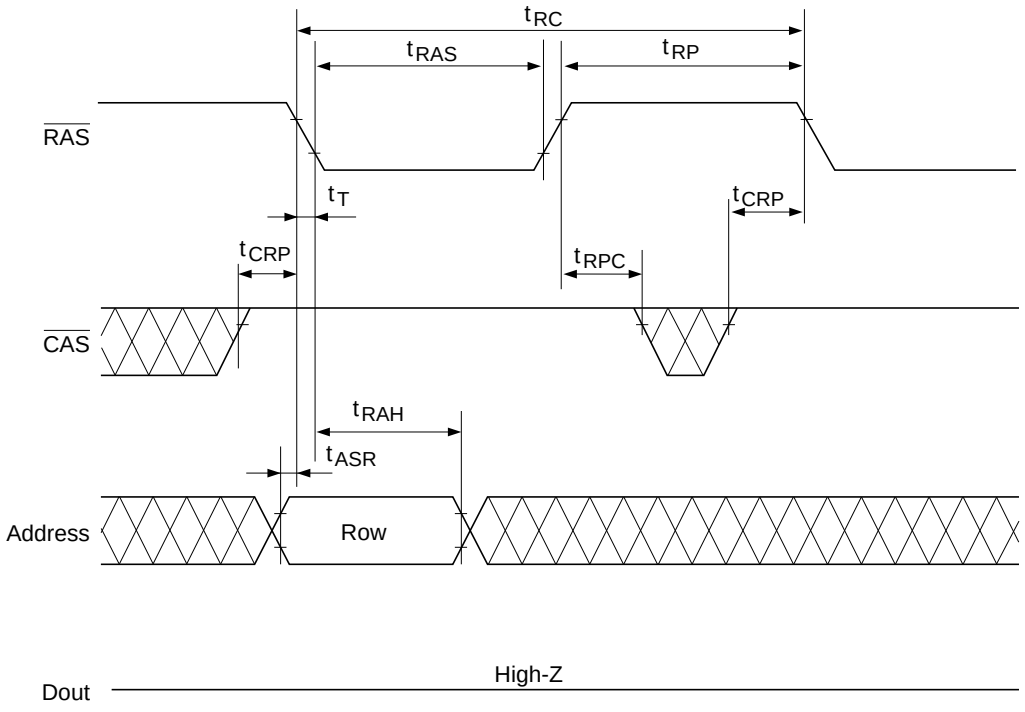


* Do not enable Dout during delayed write cycle.

Read-Modify-Write Cycle



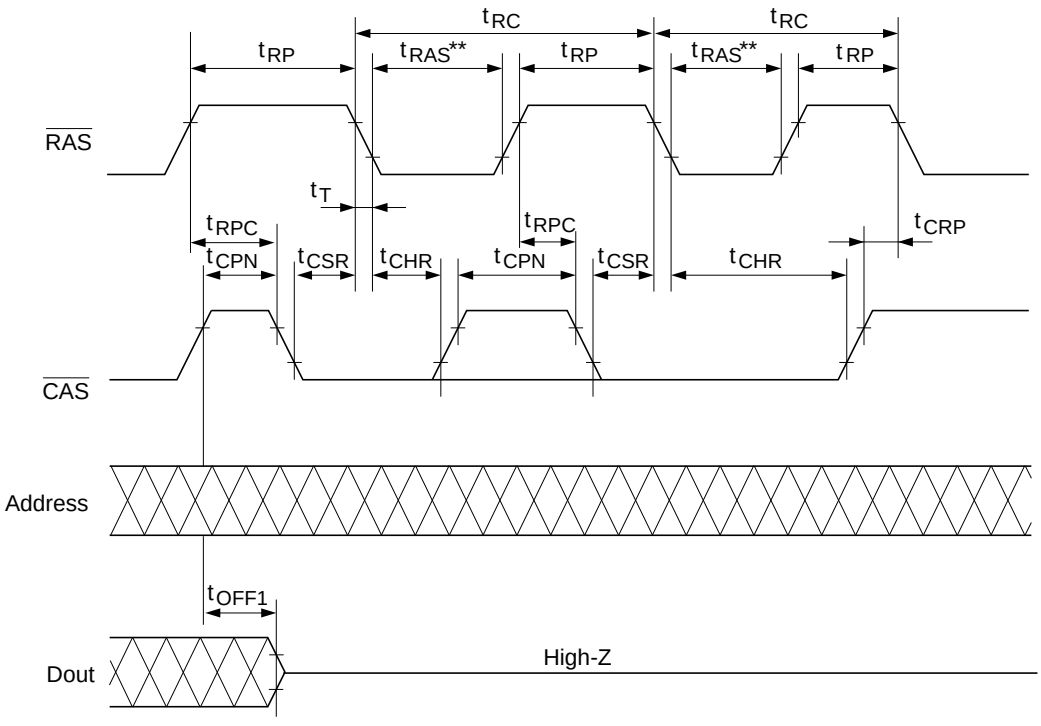
$\overline{\text{RAS}}$-Only Refresh Cycle



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

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

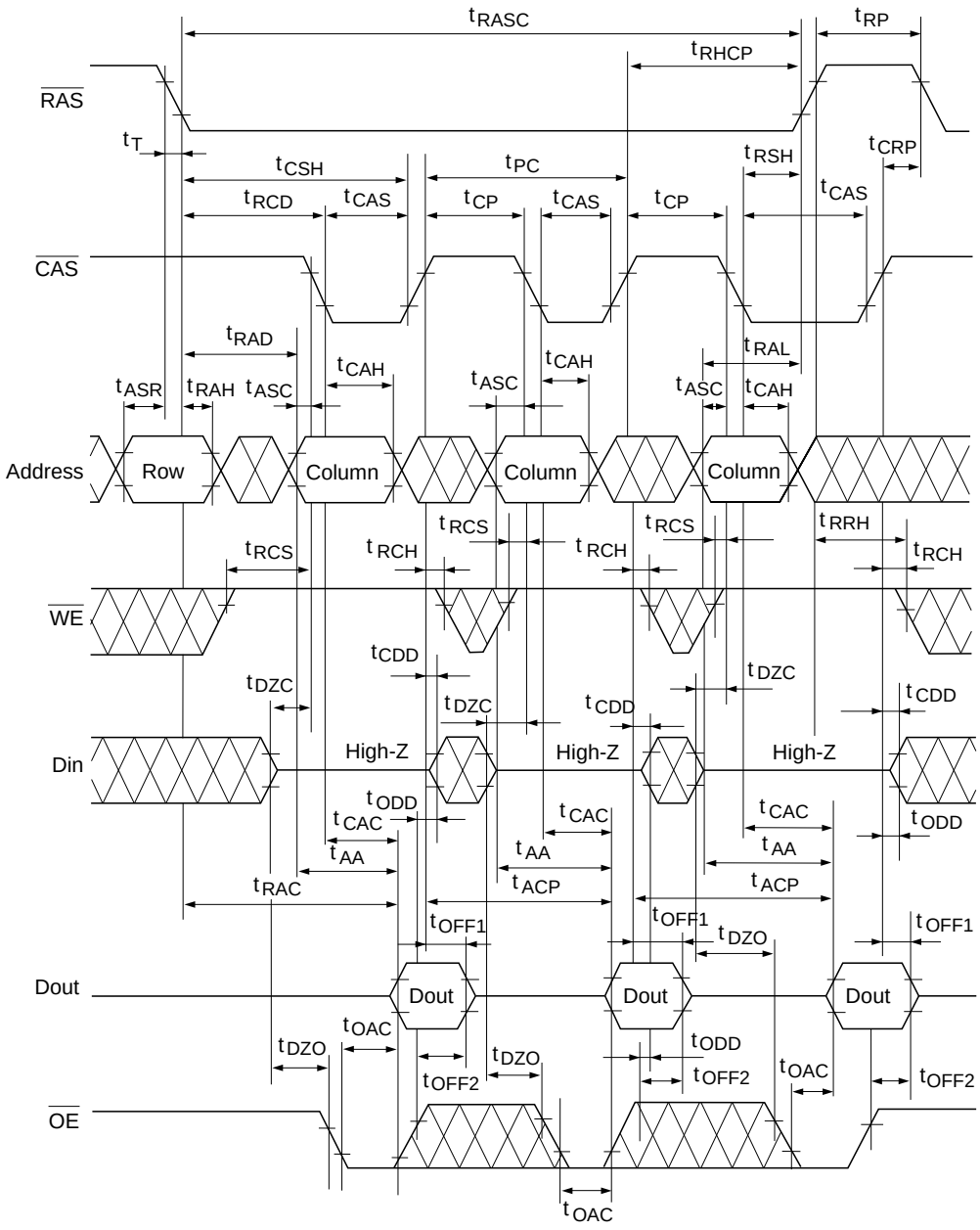
$\overline{CAS}$-Before-$\overline{RAS}$ Refresh Cycle



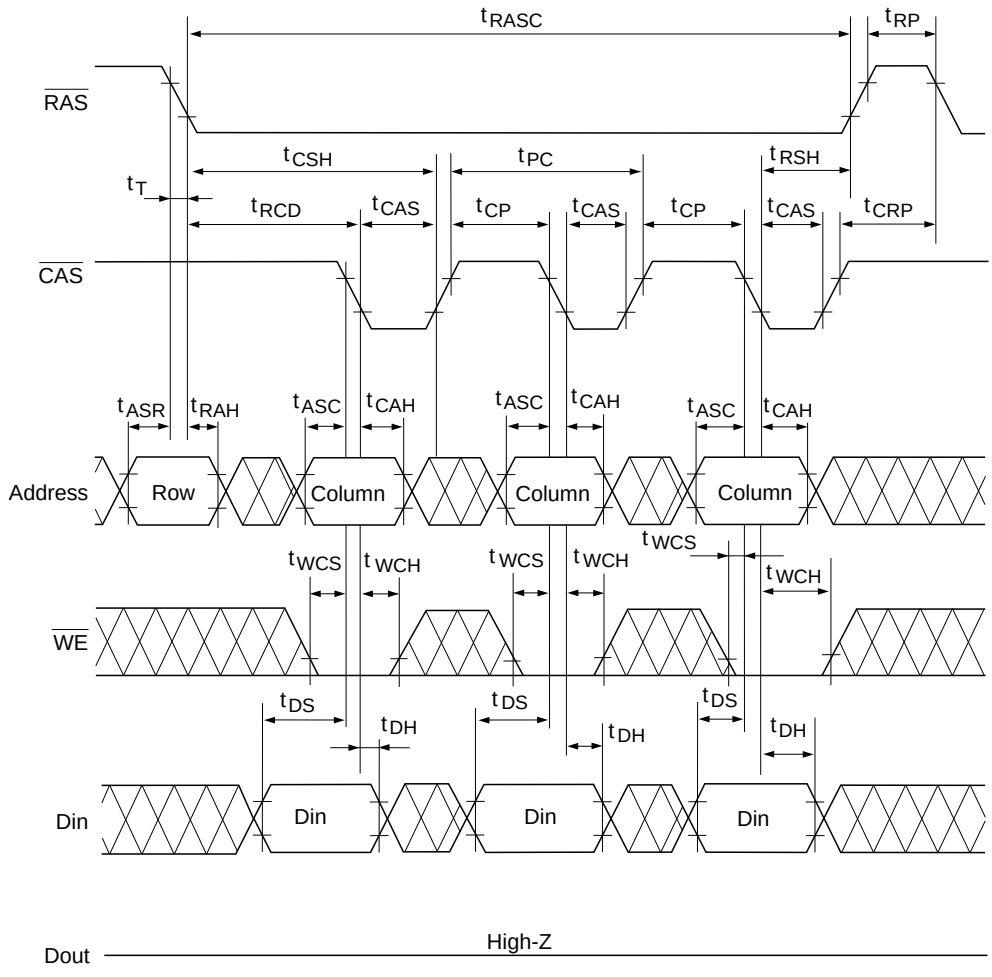
* $\overline{WE}$: H or L

** : Do not extend $t_{RAS} \geq t_{RAS}$ max.
Untested self refresh mode may be activated and loss of data may be resulted. (HM514900A/AL)

Fast Page Mode Read Cycle

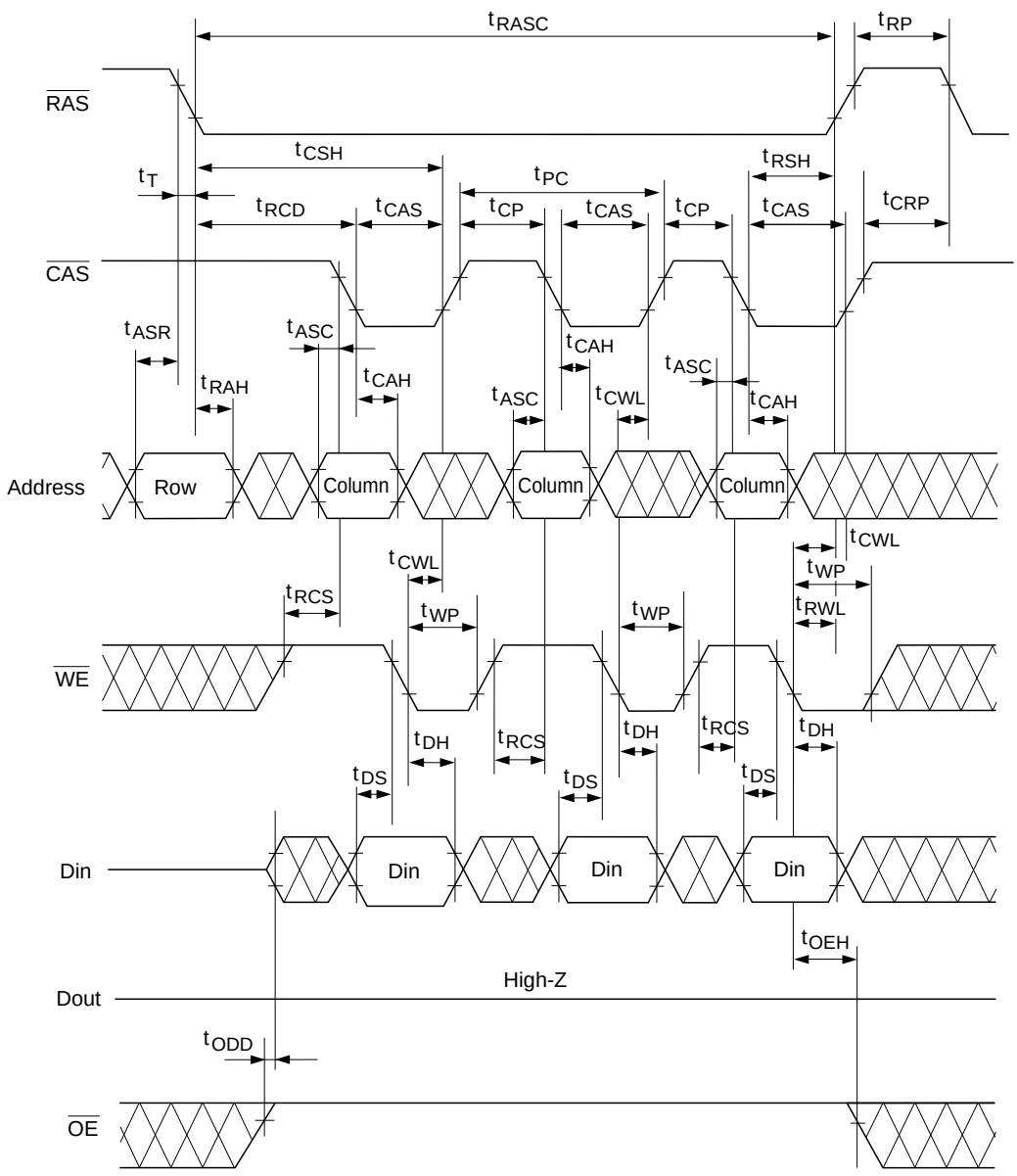


Fast Page Mode Early Write Cycle



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

Fast Page Mode Delayed Write Cycle



Fast Page Mode Read-Modify-Write Cycle