



LC321664AJ, AM, AT-80

1 MEG (65536 words × 16 bits) DRAM Fast Page Mode, Byte Write

Overview

The LC321664AJ, AM, AT is a CMOS dynamic RAM operating on a single 5 V power source and having a 65536-word × 16-bit configuration. Equipped with large capacity capabilities, high-speed transfer rates and low power dissipation, this series is suited for a wide variety of applications ranging from computer main memory and expansion memory to commercial equipment.

Address input utilizes a multiplexed address bus which permits it to be enclosed in compact plastic packages of SOJ 40-pin, SOP 40-pin and TSOP 44-pin. Refresh rates are within 4 ms with 256 row address (A0 to A7) selection and support $\overline{\text{RAS}}$ -only refresh, $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh and hidden refresh settings.

There are functions such as page mode, read-modify-write, and byte-write.

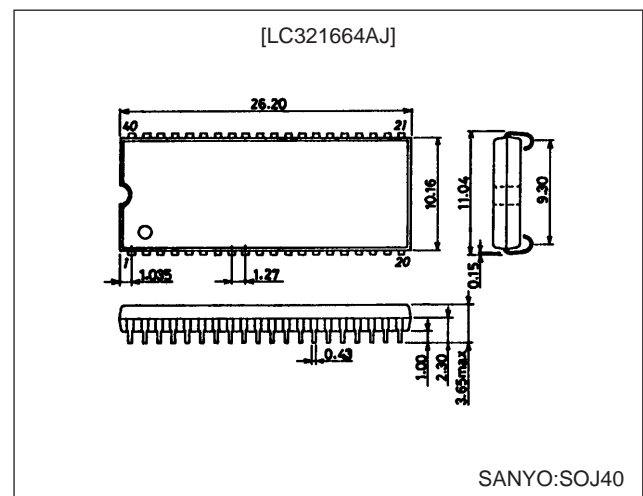
Features

- 65536-word × 16-bit configuration
- Single 5 V ±10% power supply
- All input and output (I/O) TTL compatible
- Supports fast page mode, read-modify-write, and byte-write.
- Supports output caching control using early write and Output Enable ($\overline{\text{OE}}$) control.
- 4 ms refresh using 256 refresh cycles
- Supports $\overline{\text{RAS}}$ -only refresh, $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh and hidden refresh.
- Packages
 - SOJ 40-pin (400 mil) plastic package: LC321664AJ
 - SOP 40-pin (525 mil) plastic package: LC321664AM
 - TSOP 44-pin (400 mil) plastic package: LC321664AT
- $\overline{\text{RAS}}$ access time/column address access time/ $\overline{\text{CAS}}$ access time/cycle time/power dissipation

Package Dimensions

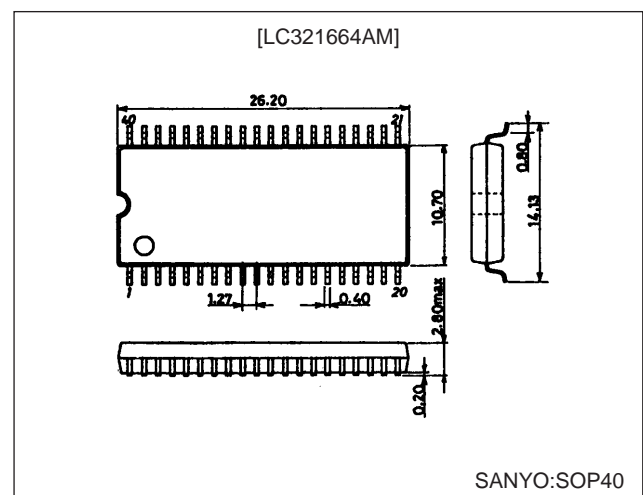
unit: mm

3200-SOJ40



unit: mm

3195-SOP40



Parameter		LC321664AJ, AM, AT-80
$\overline{\text{RAS}}$ access time		80 ns
Column address access time		45 ns
$\overline{\text{CAS}}$ access time		30 ns
Cycle time		135 ns
Power dissipation (max.)	During operation	633 mW
	During standby	5.5 mW (CMOS level)/11 mW (TTL level)

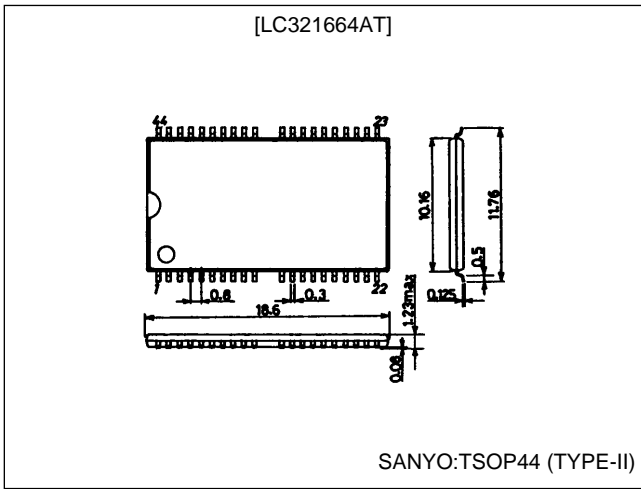
SANYO Electric Co., Ltd. Semiconductor Business Headquarters

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-0005 JAPAN

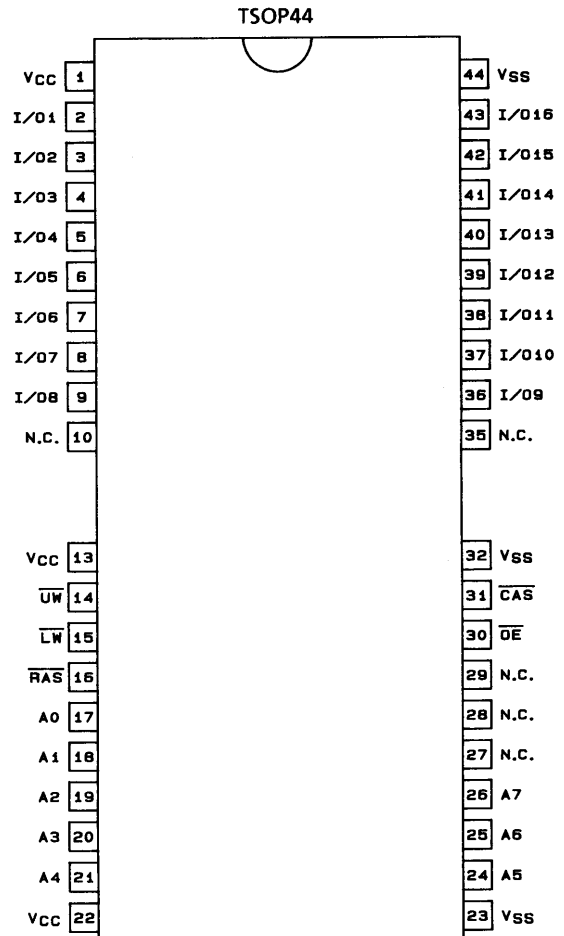
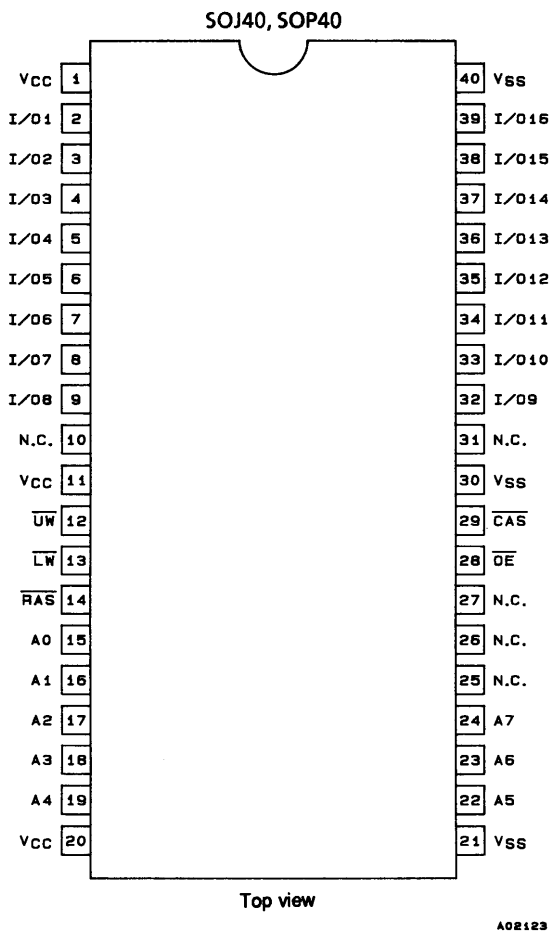
Package Dimensions

unit : mm

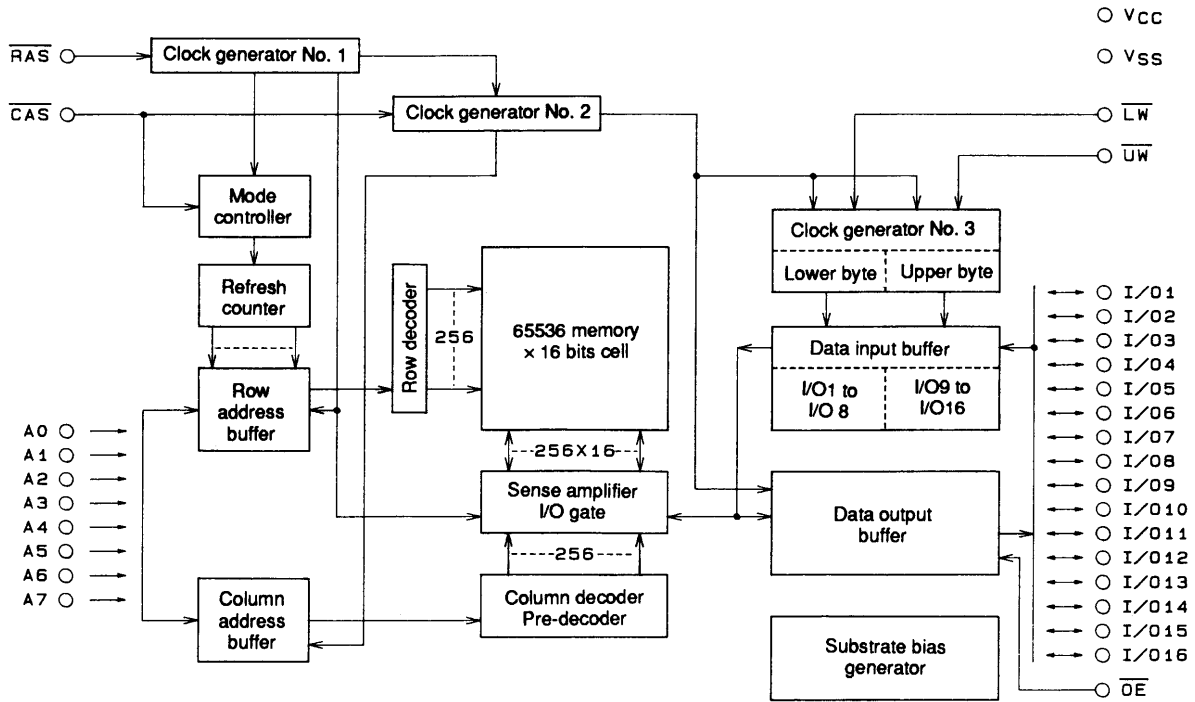
3207-TSOP44



Pin Assignments



Block Diagram



A02125

Specifications

Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Note	
Maximum supply voltage	V_{CC} max	-1.0 to +7.0	V	1	
Input voltage	V_{IN}	-1.0 to +7.0	V	1	
Output voltage	V_{OUT}	-1.0 to +7.0	V	1	
Allowable power dissipation	LC321664AJ, AM LC321664AT	Pd max	800	mW	1
			700		
Output short-circuit current	I_{OUT}	50	mA	1	
Operating temperature range	T_{opr}	0 to +70	°C	1	
Storage temperature range	T_{stg}	-55 to +150	°C	1	

Note: 1) Stresses greater than the above listed maximum values may result in damage to the device.

DC Recommended Operating Ranges at $T_a = 0$ to $+70^\circ\text{C}$

Parameter	Symbol	min	typ	max	Unit	Note
Power supply voltage	V_{CC}	4.5	5.0	5.5	V	2
Input high level voltage	V_{IH}	2.4		6.5	V	2
Input low level voltage (A0 to A7, RAS, CAS, UW, LW, OE)	V_{IL}	-1.0*		+0.8	V	2
Input low level voltage (I/O1 to I/O16)	V_{IL}	-0.5*		+0.8	V	2

Note: 2) All voltages are referenced to V_{SS} .

A bypass capacitor of about 0.1 μF should be connected between V_{CC} and V_{SS} of the device.

* -2.0 V when pulse width is less than 20 ns

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DC Electrical Characteristics at Ta = 0 to + 70°C, V_{CC} = 5 V ± 10%

Parameter	Symbol	Conditions	min	max	Unit	Note
Operating current (Average current during operation)	I _{CC1}	$\overline{\text{RAS}}, \overline{\text{CAS}}$, address cycling: $t_{\text{RC}} = t_{\text{RC min}}$		115	mA	3, 4, 5
Standby current	I _{CC2}	$\overline{\text{RAS}} = \overline{\text{CAS}} = V_{\text{IH}}$		2	mA	
$\overline{\text{RAS}}$ -only refresh current	I _{CC3}	$\overline{\text{RAS}}$ cycling, $\overline{\text{CAS}} = V_{\text{IH}}$: $t_{\text{RC}} = t_{\text{RC min}}$		115	mA	3, 5
Fast page mode current	I _{CC4}	$\overline{\text{RAS}} = V_{\text{IL}}$, $\overline{\text{CAS}}$ address cycling: $t_{\text{PC}} = t_{\text{PC min}}$		70	mA	3, 4, 5
Standby current	I _{CC5}	$\overline{\text{RAS}} = \overline{\text{CAS}} = V_{\text{CC}} - 0.2\text{V}$		1	mA	
$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh current	I _{CC6}	$\overline{\text{RAS}}, \overline{\text{CAS}}$ cycling: $t_{\text{RC}} = t_{\text{RC min}}$		115	mA	3
Input leakage current	I _{IL}	$0\text{V} \leq V_{\text{IN}} \leq 6.5\text{V}$, pins other than measuring pin = 0V	-10	+10	μA	
Output leakage current	I _{OL}	D _{OUT} disable, $0\text{V} \leq V_{\text{OUT}} \leq 5.5\text{V}$	-10	+10	μA	
Output high level voltage	V _{OH}	I _{OUT} = -2.5mA	2.4		V	
Output low level voltage	V _{OL}	I _{OUT} = 2.1mA		0.4	V	

Note: 3) All current values are measured at minimum cycle rate. Since current flows immoderately, if cycle time is longer than shown here value becomes smaller.

- 4) I_{CC1} and I_{CC4} are dependent on output loads. Maximum values for I_{CC1} and I_{CC4} represent values with output open.
- 5) One address change can be performed while $\overline{\text{RAS}} = V_{\text{IL}}$ (I_{CC1} and I_{CC3}).
One address change can be performed during one t_{PC} cycle (I_{CC4}).

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AC Electrical Characteristics at Ta = 0 to +70°C, V_{CC} = 5 V ± 10% (Note 6, 7, 8)

Parameter	Symbol	min	max	Unit	Note
Random read or write cycle time	t _{RC}	135		ns	
Read-write/read-modify-write cycle time	t _{RWC}	180		ns	
Fast page mode cycle time	t _{PC}	55		ns	
Fast page mode Read-write/read-modify-write cycle time	t _{PRWC}	100		ns	
$\overline{\text{RAS}}$ access time	t _{RAC}		80	ns	9, 14, 15
$\overline{\text{CAS}}$ access time	t _{CAC}		30	ns	9, 14
Column address access time	t _{AA}		45	ns	9, 15
$\overline{\text{CAS}}$ precharge access time	t _{CPA}		50	ns	9
Output low-impedance time from $\overline{\text{CAS}}$ low	t _{CLZ}	0		ns	9
Output buffer turn-off delay time	t _{OFF}	0	20	ns	10
Rise or fall time	t _T	3	50	ns	
$\overline{\text{RAS}}$ precharge time	t _{RP}	45		ns	
$\overline{\text{RAS}}$ pulse width	t _{RAS}	80	10000	ns	
$\overline{\text{RAS}}$ pulse width for fast page mode only	t _{RASP}	80	100000	ns	
$\overline{\text{RAS}}$ hold time	t _{RSH}	30		ns	
$\overline{\text{CAS}}$ hold time	t _{CSH}	80		ns	
$\overline{\text{CAS}}$ pulse width	t _{CAS}	30	10000	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	t _{RCD}	25	50	ns	14
$\overline{\text{RAS}}$ to column address delay time	t _{RAD}	17	35	ns	15
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	t _{CRP}	10		ns	
$\overline{\text{CAS}}$ precharge time	t _{CP}	10		ns	
Row address setup time	t _{ASR}	0		ns	
Row address hold time	t _{RAH}	12		ns	
Column address setup time	t _{ASC}	0		ns	
Column address hold time	t _{CAH}	20		ns	
Column address hold time referenced to $\overline{\text{RAS}}$	t _{AR}	60		ns	
Column address to $\overline{\text{RAS}}$ lead time	t _{RAL}	45		ns	
Read command setup time	t _{RCS}	0		ns	
Read command hold time referenced to $\overline{\text{CAS}}$	t _{RCH}	0		ns	11
Read command hold time referenced to $\overline{\text{RAS}}$	t _{RRH}	0		ns	11
Write command hold time	t _{WCH}	15		ns	
Write command hold time referenced to $\overline{\text{RAS}}$	t _{WCR}	60		ns	
Write command pulse width	t _{WP}	15		ns	

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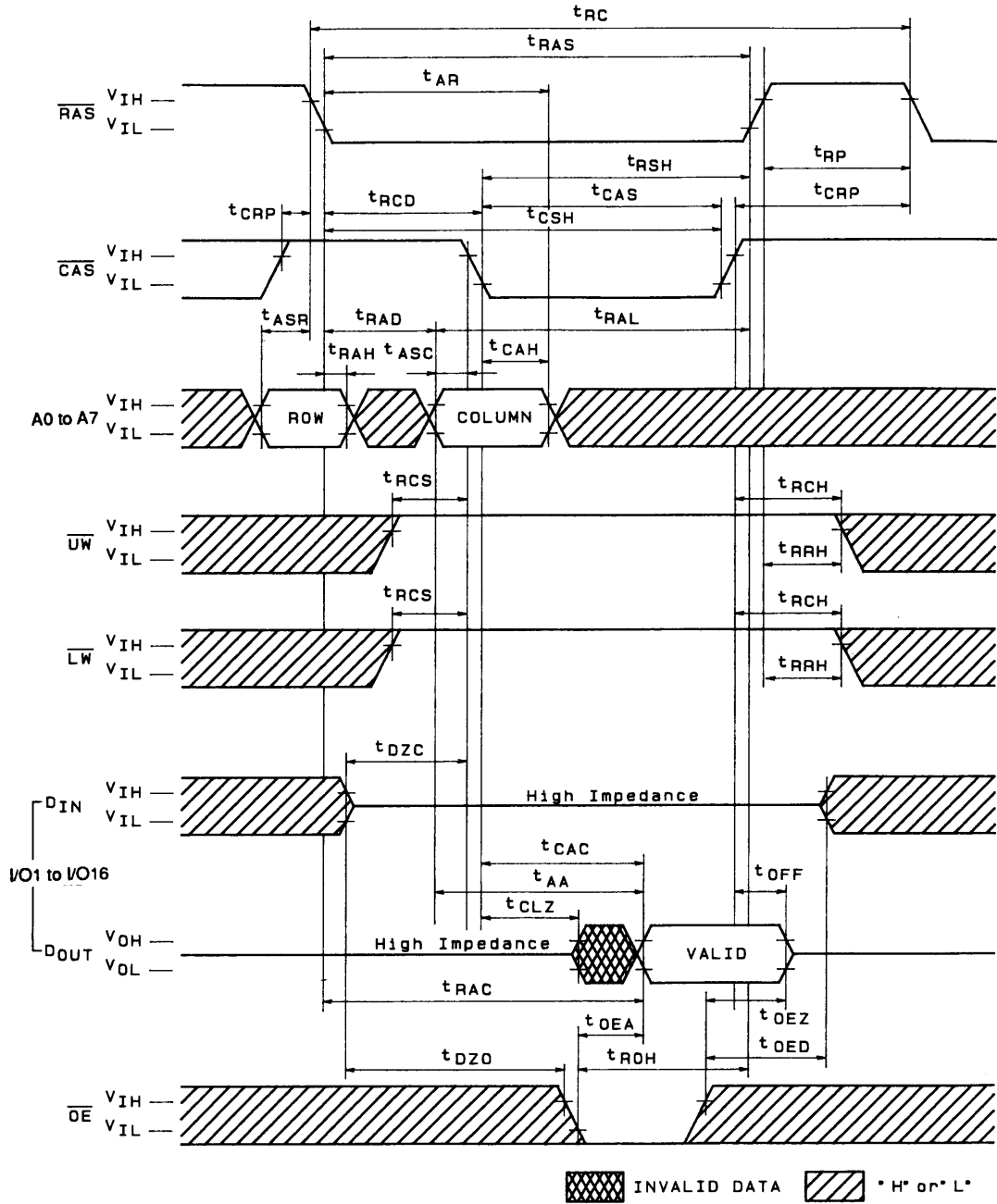
Parameter	Symbol	min	max	Unit	Note
Write command to RAS lead time	t_{RWL}	20		ns	
Write command to \overline{CAS} lead time	t_{CWL}	20		ns	
Data input setup time	t_{DS}	0		ns	12
Data input hold time	t_{DH}	20		ns	12
Data input hold time referenced to RAS	t_{DHR}	60		ns	
Refresh period	t_{REF}		4	ms	
Write command setup time	t_{WCS}	0		ns	13
\overline{CAS} to \overline{UW} , \overline{LW} delay time	t_{CWD}	50		ns	13
RAS to \overline{UW} , \overline{LW} delay time	t_{RWD}	100		ns	13
Column address to \overline{UW} , \overline{LW} delay time	t_{AWD}	65		ns	13
\overline{CAS} precharge to \overline{UW} , \overline{LW} delay time (fast page mode cycle only)	t_{CPWD}	70		ns	13
\overline{CAS} setup time for CAS-before-RAS refresh	t_{CSR}	10		ns	
\overline{CAS} hold time for CAS-before-RAS refresh	t_{CHR}	15		ns	
RAS precharge time to CAS active time	t_{RPC}	10		ns	
\overline{CAS} precharge time for CAS-before-RAS counter test	t_{CPT}	40		ns	
RAS hold time referenced to \overline{OE}	t_{ROH}	15		ns	
\overline{OE} access time	t_{OEA}		25	ns	9
\overline{OE} delay time	t_{OED}	15		ns	
\overline{OE} to output buffer turn-off delay time	$t_{O EZ}$	0	15	ns	10
\overline{OE} command hold time	$t_{OE H}$	20		ns	
Data input to \overline{CAS} delay time	t_{DZC}	0		ns	16
Data input to \overline{OE} delay time	t_{DZO}	0		ns	16
Masked write setup time	t_{MCS}	0		ns	
Masked write hold time referenced to RAS	t_{MRH}	0		ns	
Masked write hold time referenced to CAS	t_{MCH}	0		ns	

Input/Output Capacitance at $T_a = 25^\circ\text{C}$, $f = 1\text{ MHz}$, $V_{CC} = 5\text{ V} \pm 10\%$

Parameter	Symbol	min	max	Unit
Input capacitance (A_0 to A_7 , RAS, \overline{CAS} , \overline{UW} , \overline{LW} , \overline{OE})	C_{IN}		7	pF
I/O capacitance (I/O_1 to I/O_{16})	$C_{I/O}$		7	pF

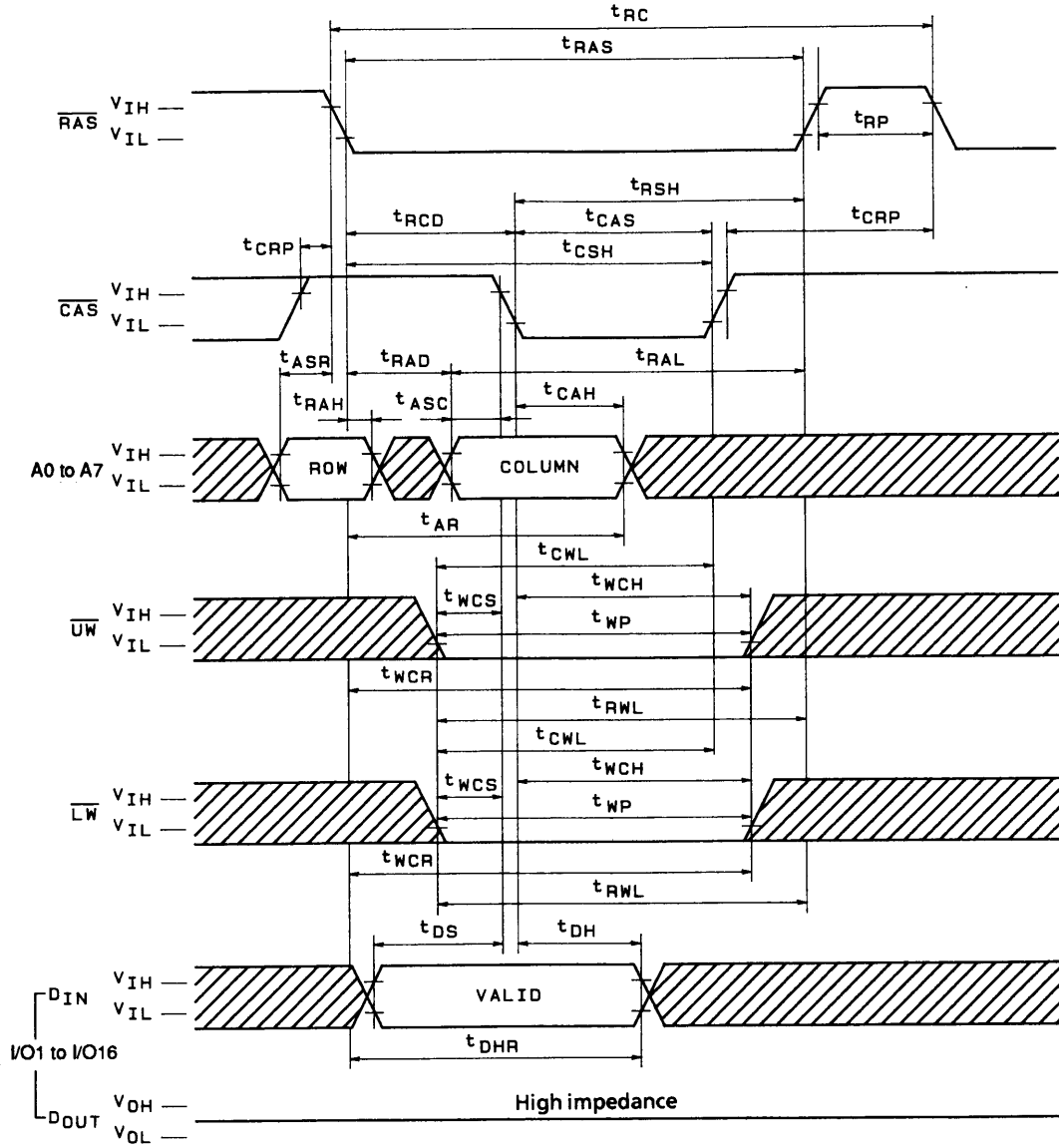
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- Notes:
- 6) After the power is turned on, 200 μ s are required after the arrival of V_{CC} stabilized current before memory is initialized and begins operation. In addition, before memory operation initializes, approximately 8 cycles worth of $\overline{\text{RAS}}$ dummy cycles are required. When the on-chip refresh counter is applied, approximately 8-cycles worth of $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ dummy cycles are required instead of the $\overline{\text{RAS}}$ dummy cycles.
 - 7) Measured at $t_T = 5$ ns.
 - 8) When measuring input signal timing, V_{IH} (min) and V_{IL} (max) are used for reference points. In addition, rise and fall time are defined between V_{IH} and V_{IL} .
 - 9) Measured using an equivalent of 50 pF and one standard TTL load.
 - 10) t_{OFF} (max) and t_{OEZ} (max) are defined as the time until output voltage can no longer be measured when output switches to a high impedance condition.
 - 11) Operation is guaranteed if either t_{RRH} or t_{RCH} are satisfied.
 - 12) These parameters are measured from the falling edge of $\overline{\text{CAS}}$ for an early-write cycle, and from the falling edge of UW and LW for a read-write/read-modify-write cycle.
 - 13) t_{WCS} , t_{CWD} , t_{RWD} , t_{AWD} and t_{CPWD} are not restrictive operating parameters for memory in that they specify the operating mode. If $t_{WCS} \geq t_{WCS}(\text{min})$, the cycle switches to an early-write cycle and output pins switch to high impedance throughout the cycle. If $t_{CWD} \geq t_{CWD}(\text{min})$, $t_{RWD} \geq t_{RWD}(\text{min})$, $t_{AWD} \geq t_{AWD}(\text{min})$ and $t_{CPWD} \geq t_{CPWD}(\text{min})$, the cycle switches to a read-write/read-modify-write cycle and data outputs equal information in the selected cells. If neither of the above conditions are satisfied, output pins are in an undefined state.
 - 14) $t_{RCD}(\text{max})$ does not indicate a restrictive operating parameter but instead represents the point at which the access time $t_{RAC}(\text{max})$ is guaranteed. If $t_{RCD} \geq t_{RCD}(\text{max})$, access time is determined according to t_{CAC} .
 - 15) $t_{RAD}(\text{max})$ does not indicate a restrictive operating parameter but instead represents the point at which the access time $t_{RAC}(\text{max})$ is guaranteed. If $t_{RAD} \geq t_{RAD}(\text{max})$, access time is determined according to t_{AA} .
 - 16) Operation is guaranteed if either t_{DZC} or t_{DZO} are satisfied.

Timing Chart
Read Cycle



A02139

Early Write Cycle

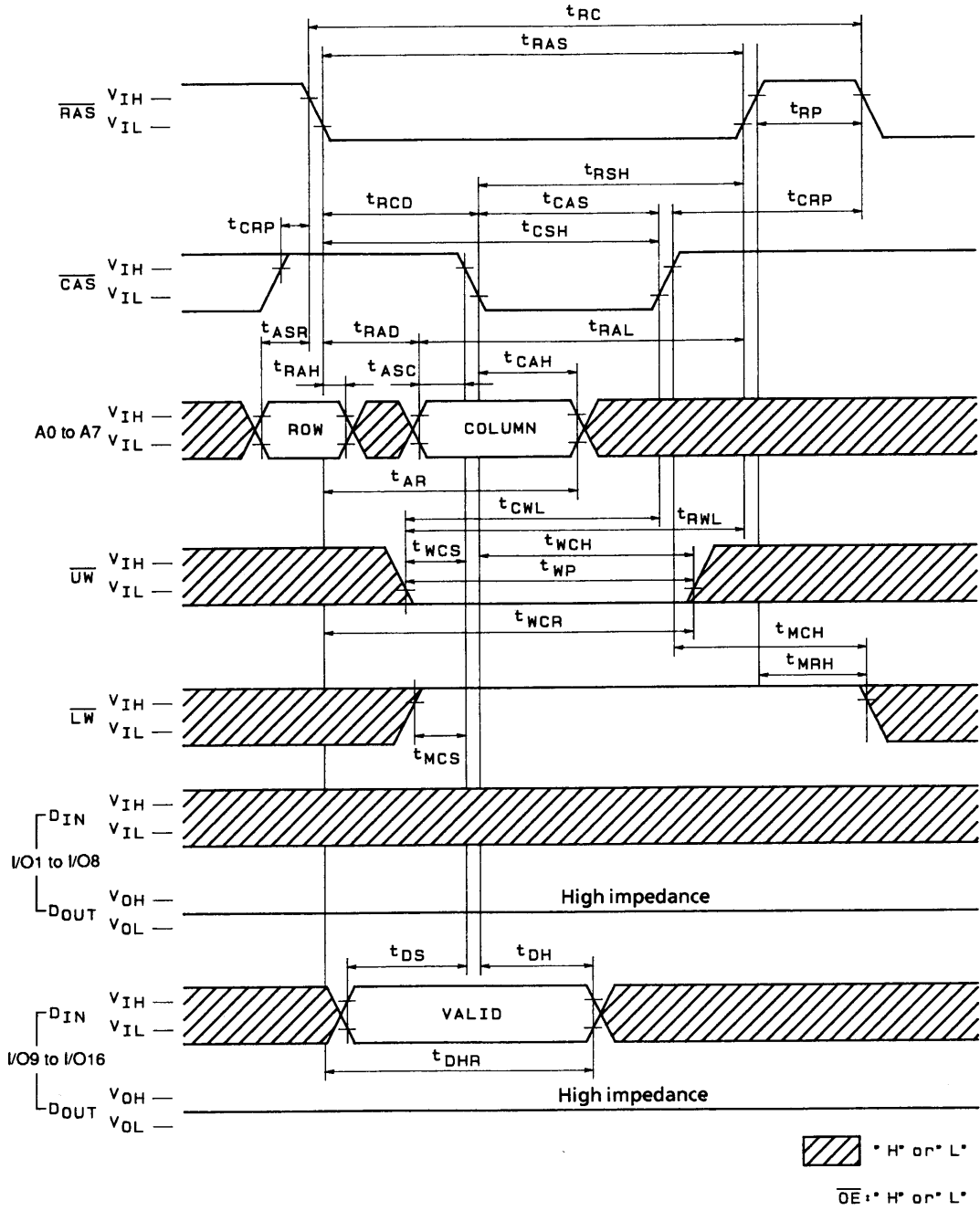


* H* or L*

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

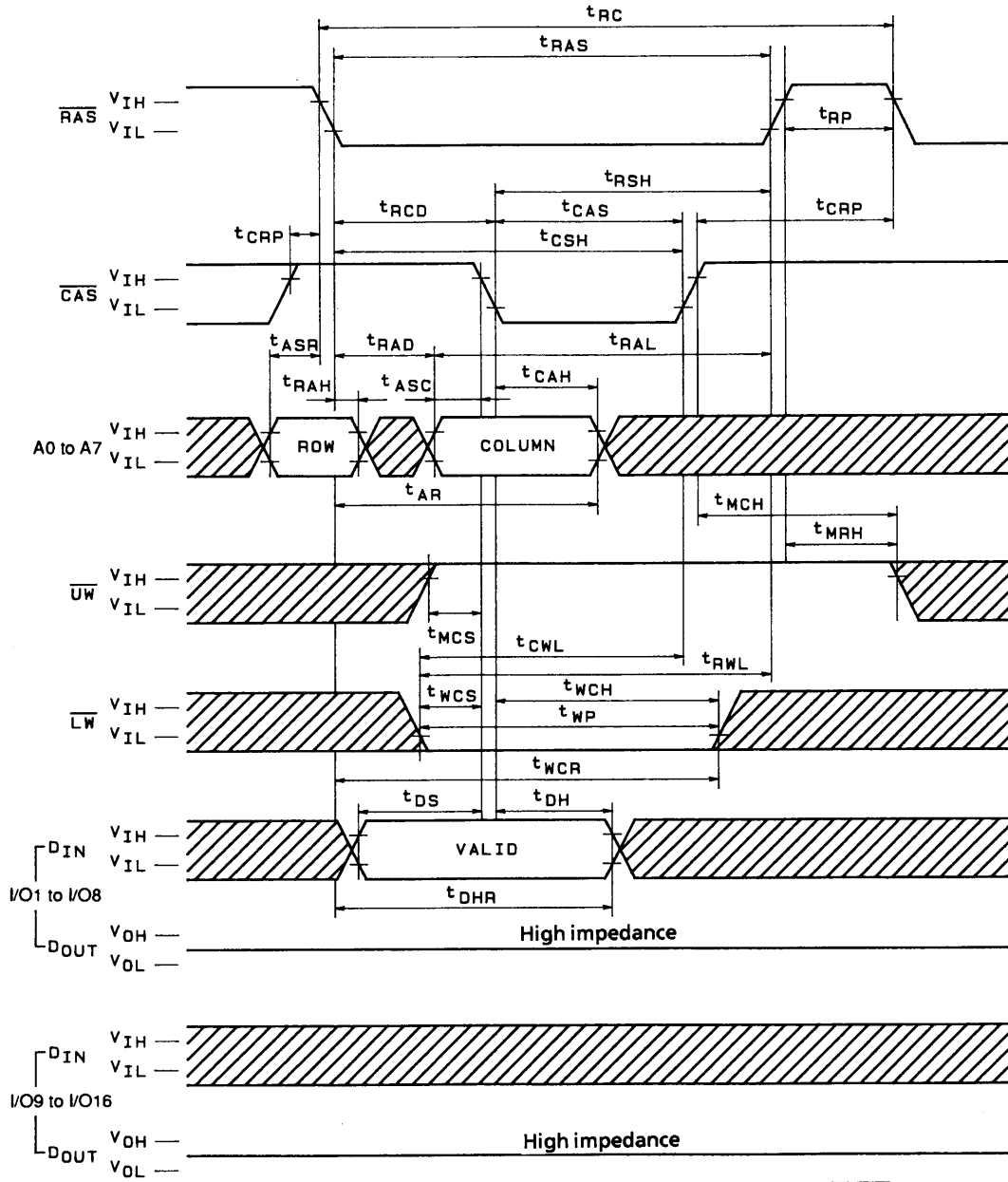
A02140

Upper Byte Early Write Cycle



A02141

Lower Byte Early Write Cycle

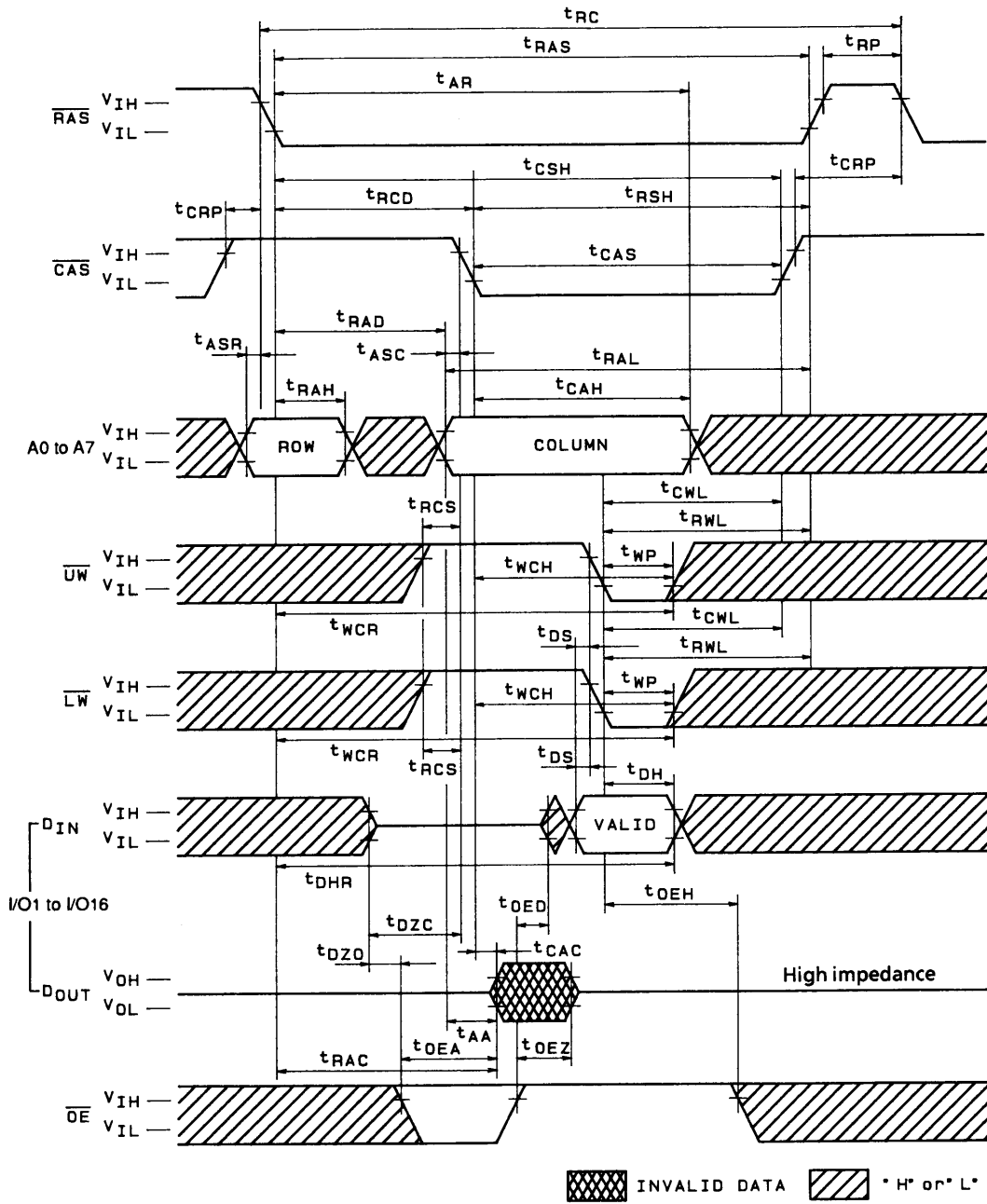


Hatched box * V_{IH} or V_{OL}

White box * V_{IL} or V_{OH}

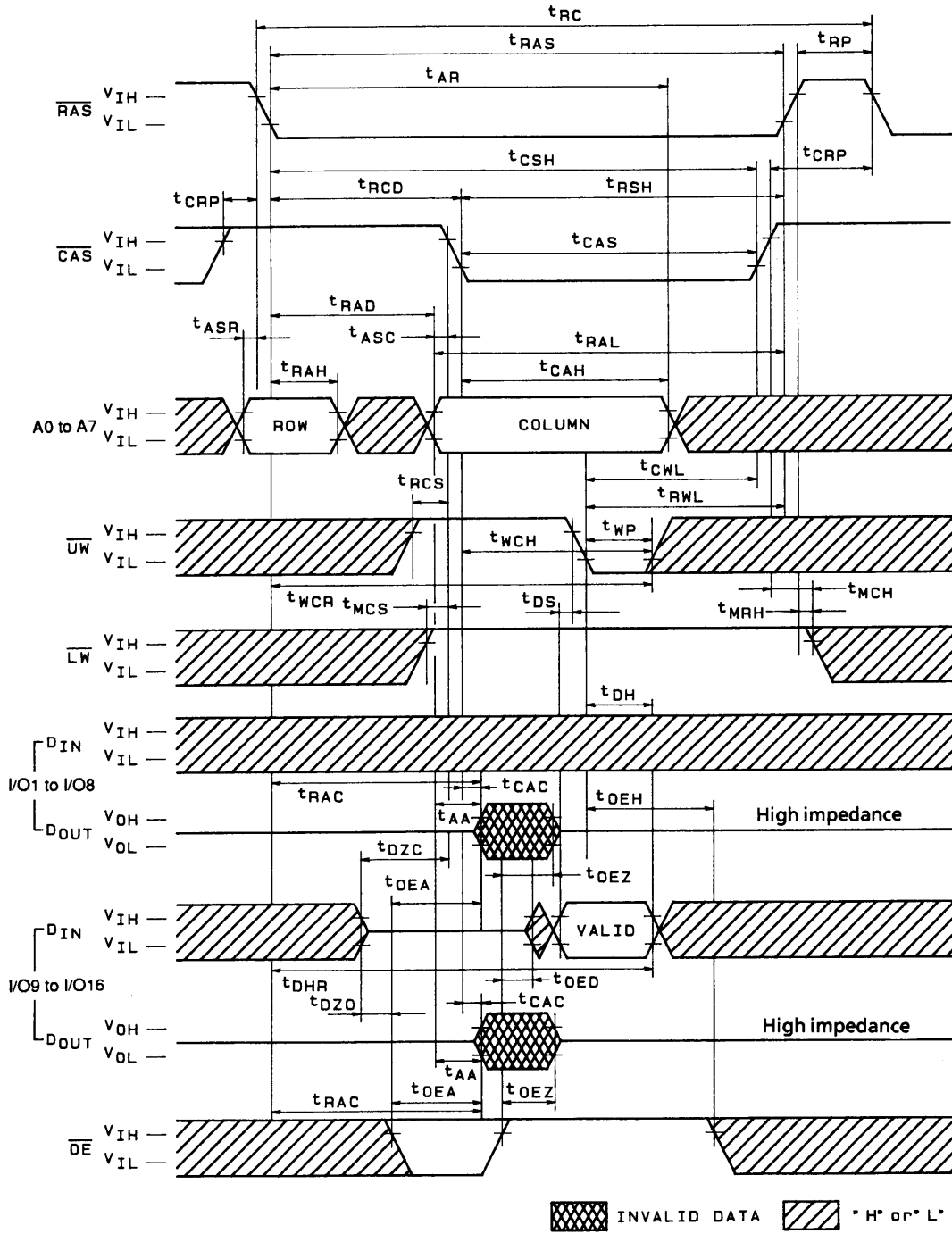
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Write Cycle (OE Control)



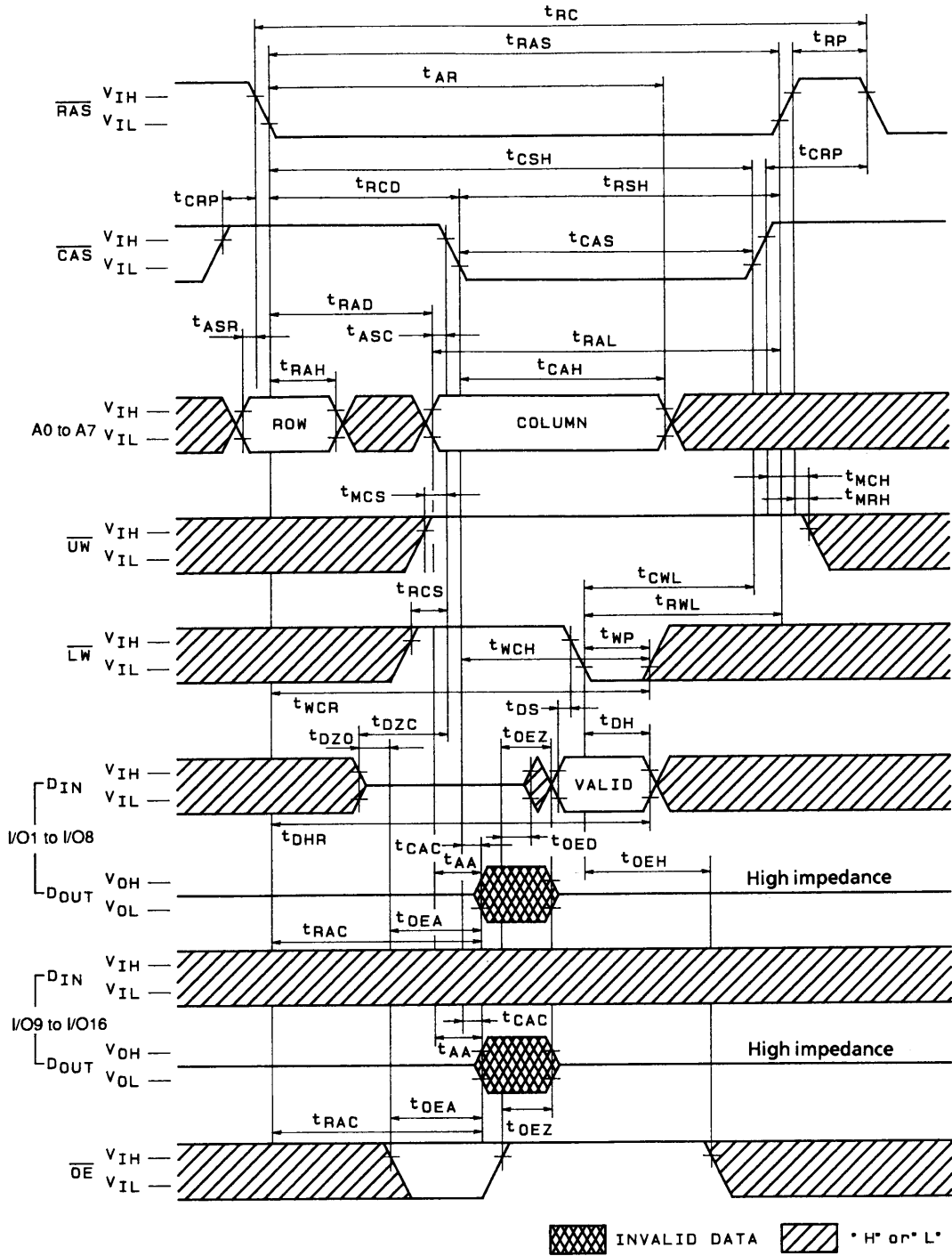
A02143

Upper Byte Write Cycle ($\overline{\text{OE}}$ Control)



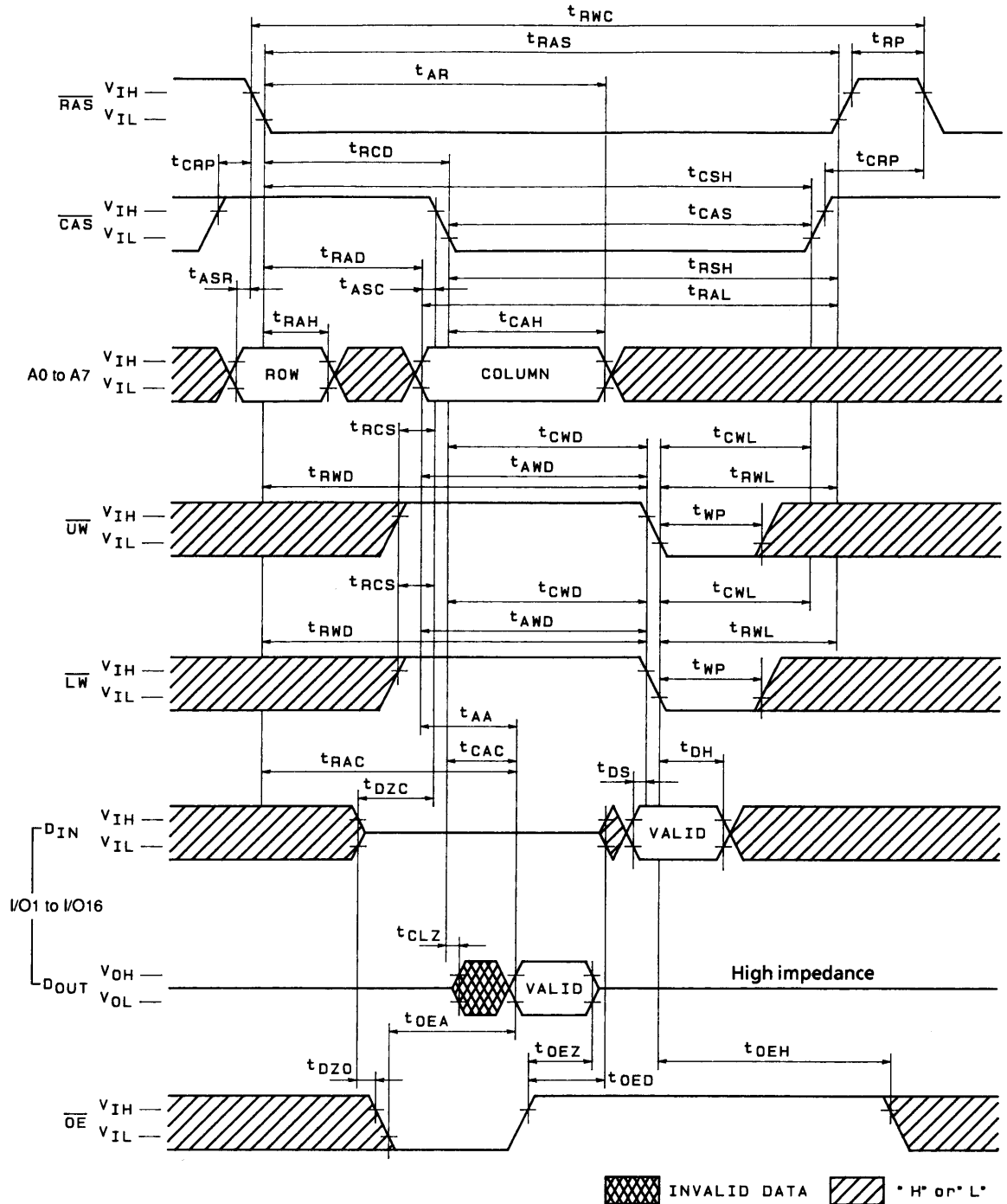
A02144

Lower Byte Write Cycle ($\overline{\text{OE}}$ Control)



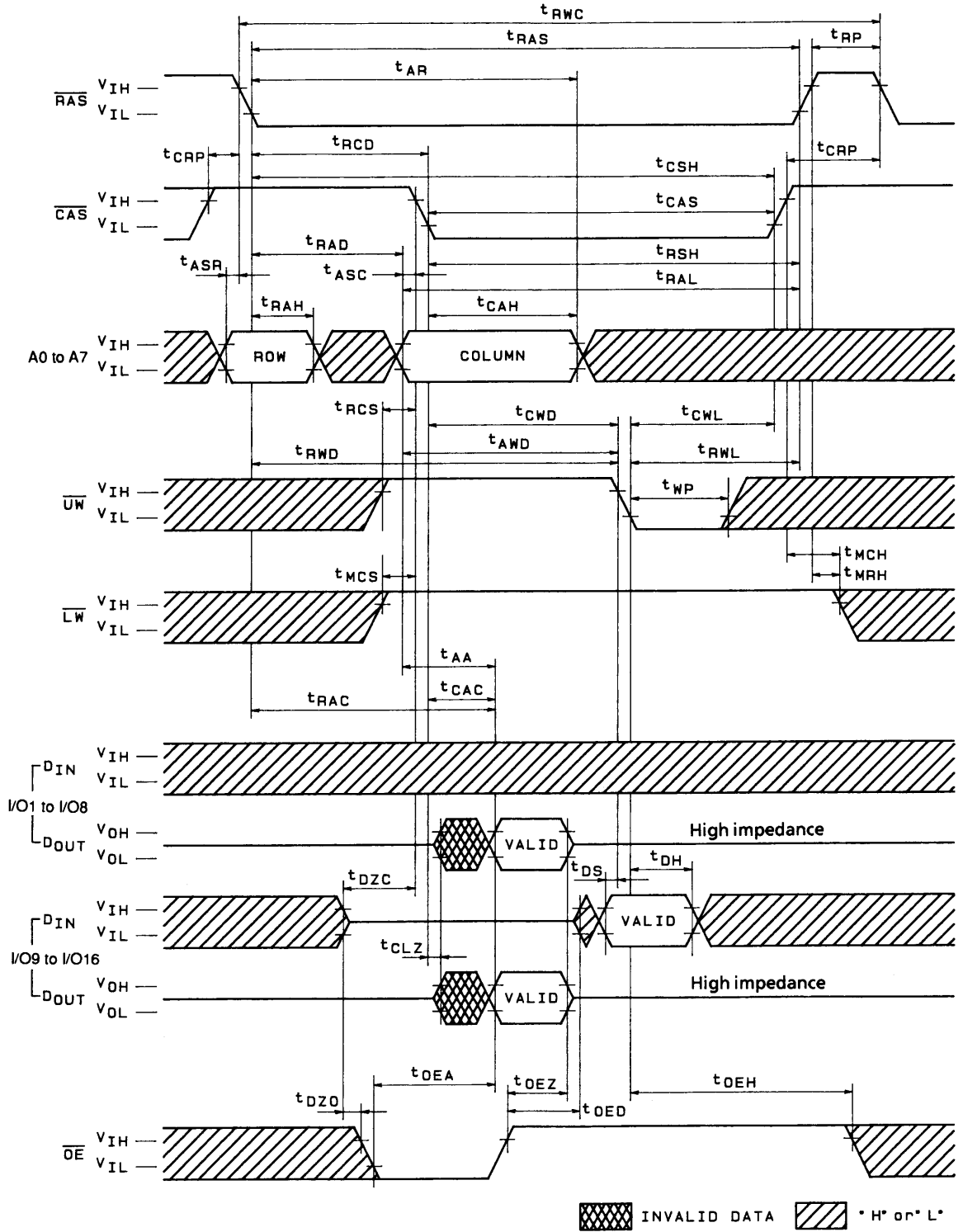
A02145

Read-Modify-Write Cycle



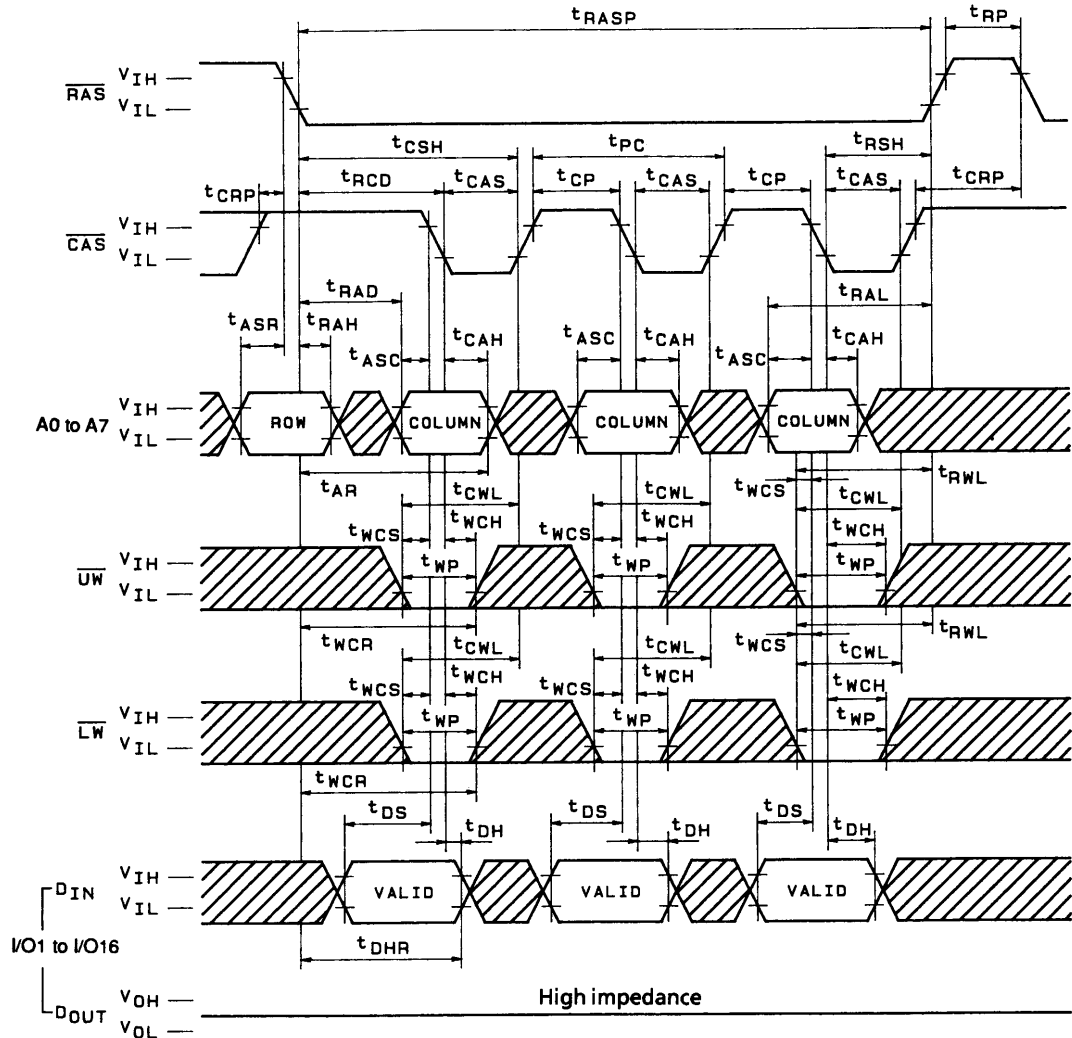
A02146

Read-Modify Upper Byte Write Cycle



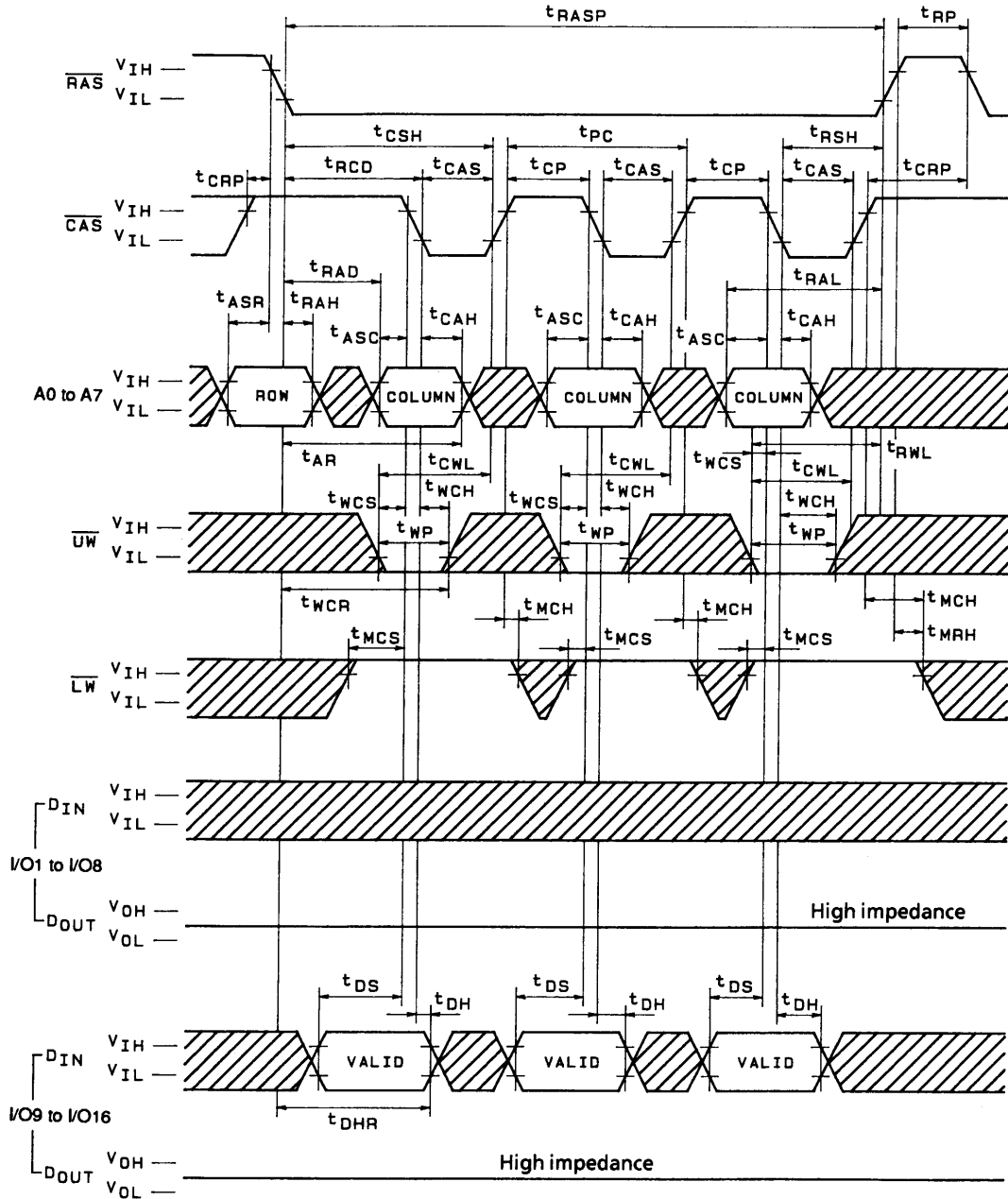
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Fast Page Mode Early Write Cycle



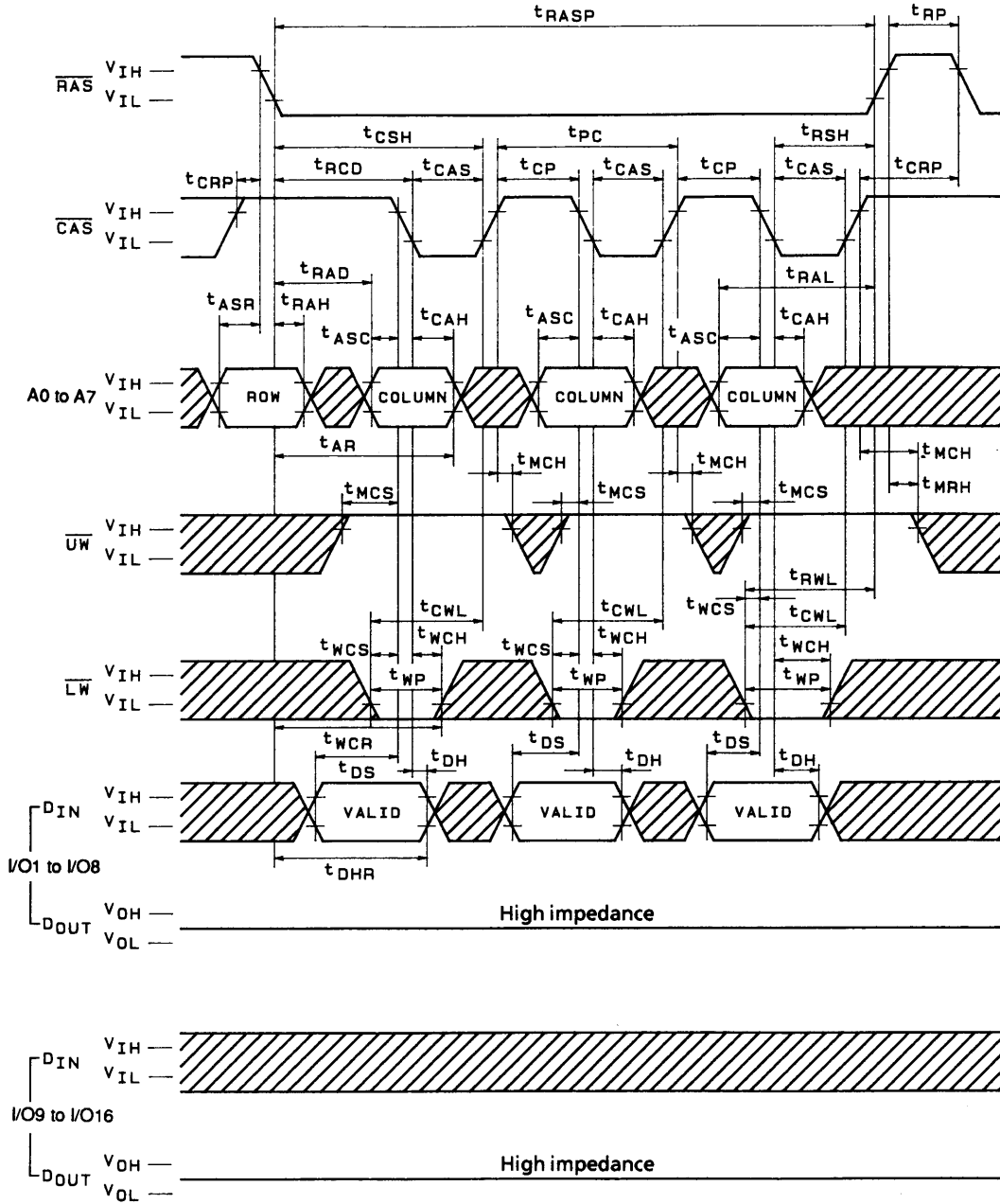
A02150

Fast Page Mode Upper Byte Early Write Cycle



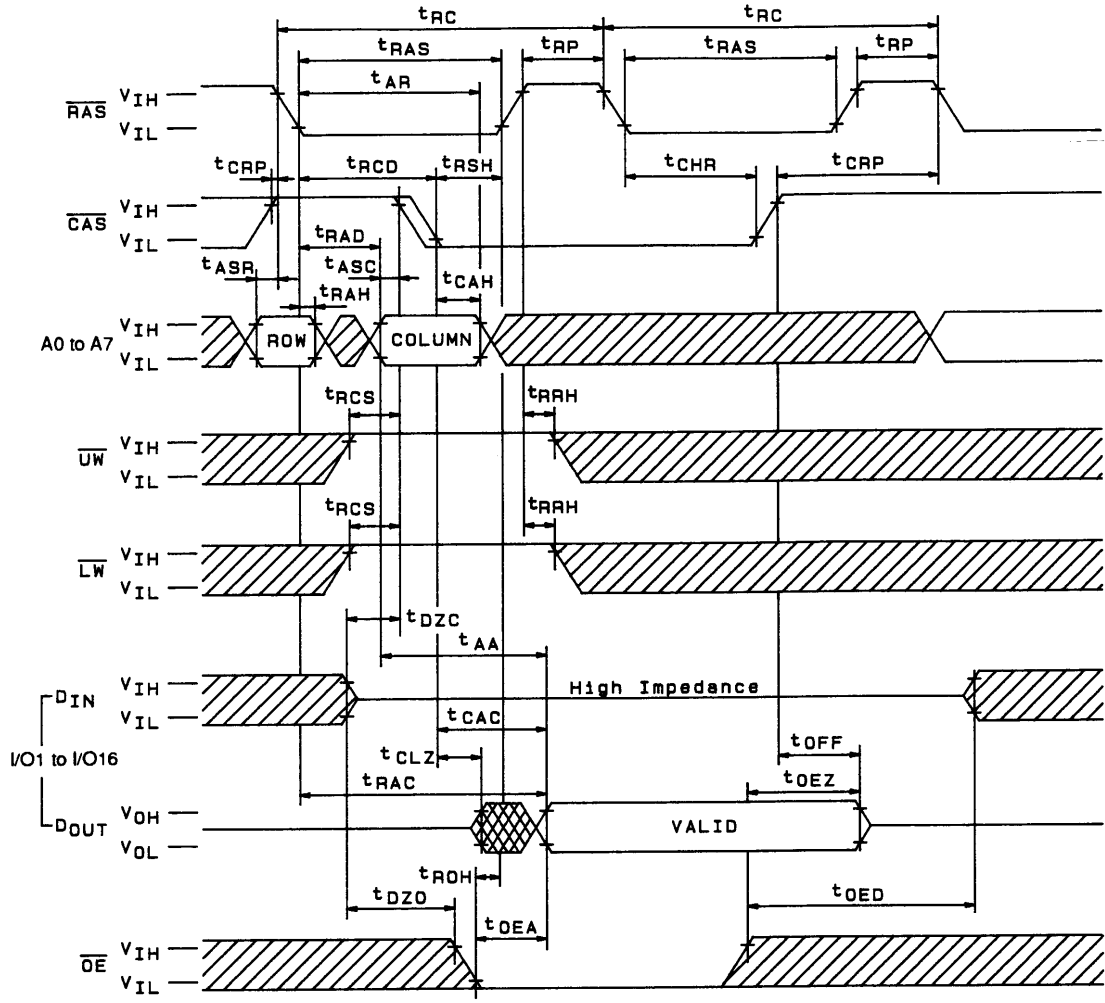
A02151

Fast Page Mode Lower Byte Early Write Cycle



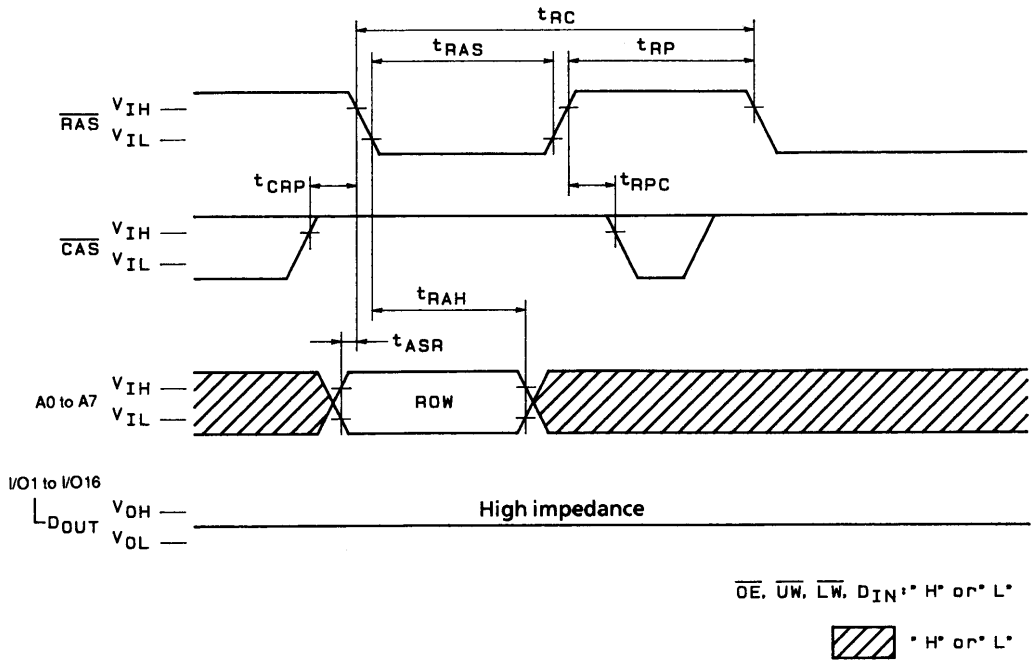
A02152

Hidden Refresh Cycle



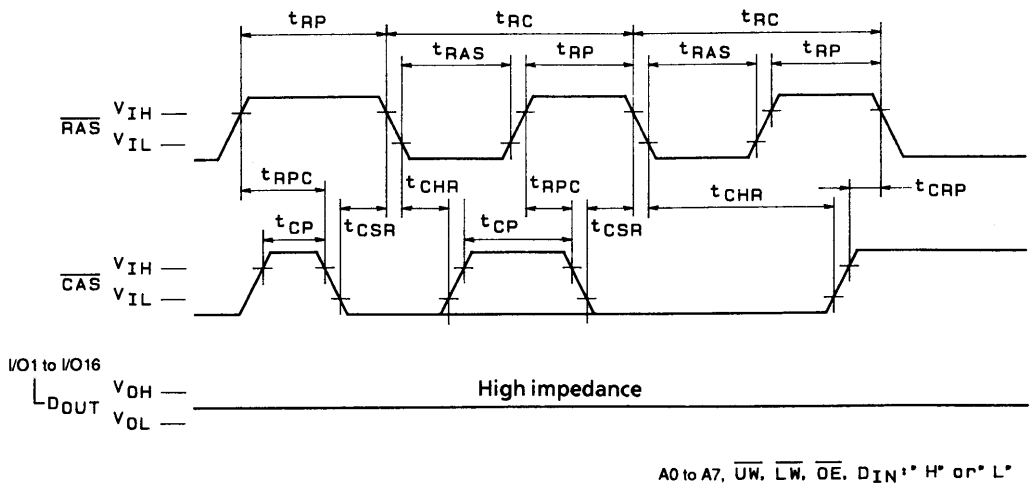
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RAS-Only Refresh Cycle



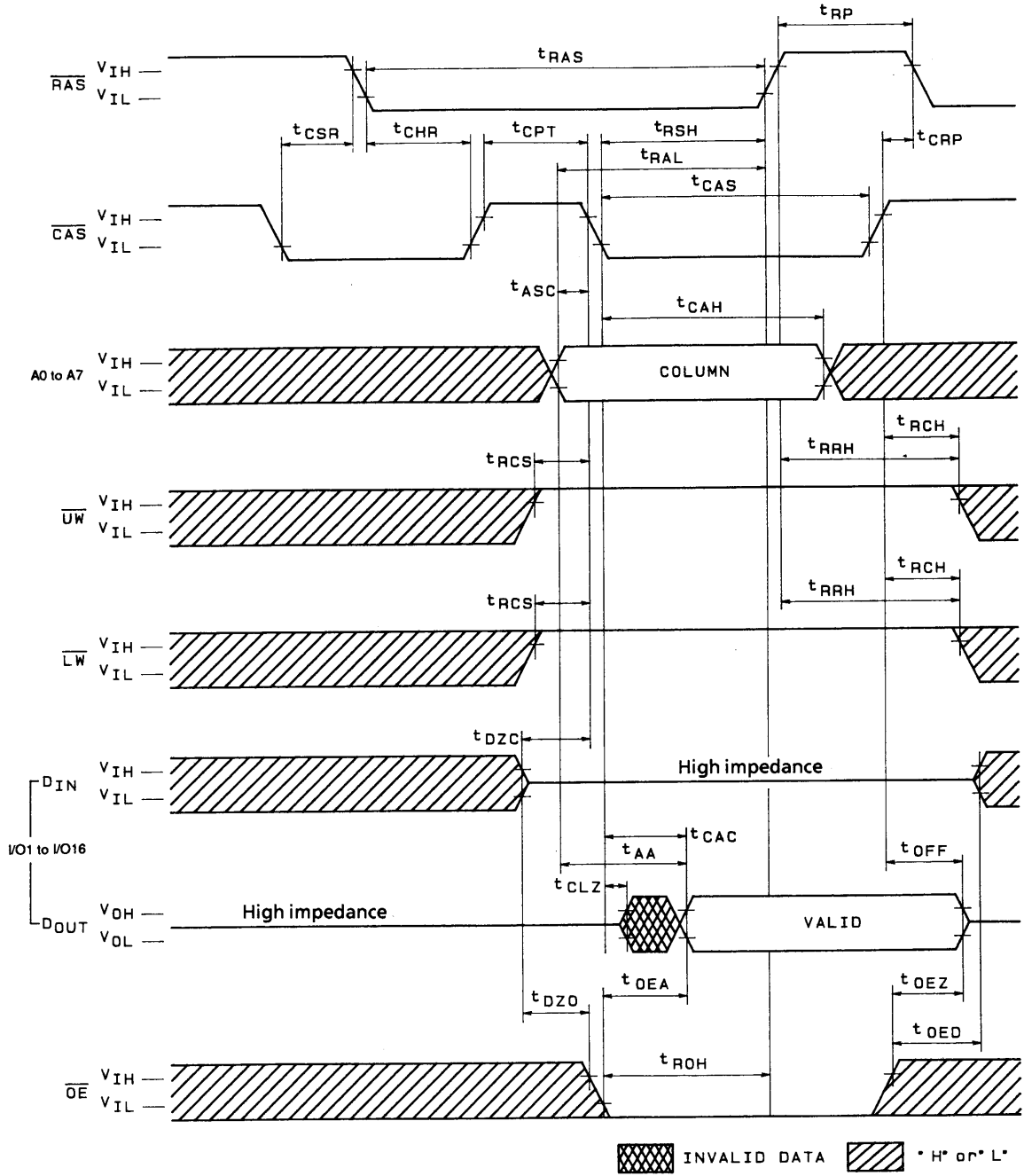
A02157

CAS-Before-RAS Refresh Cycle



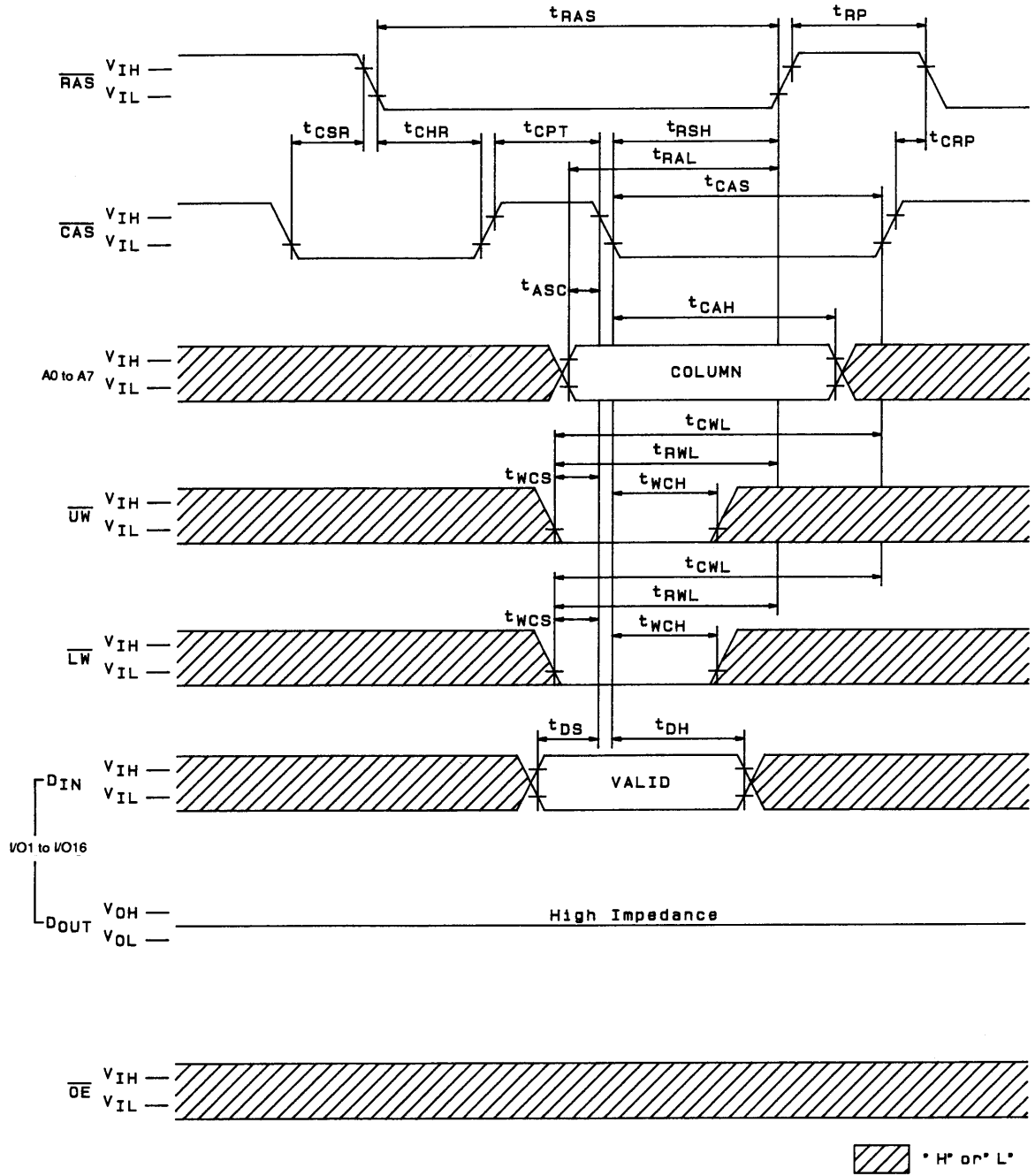
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CAS-Before-RAS Refresh Counter Test Cycle (read)



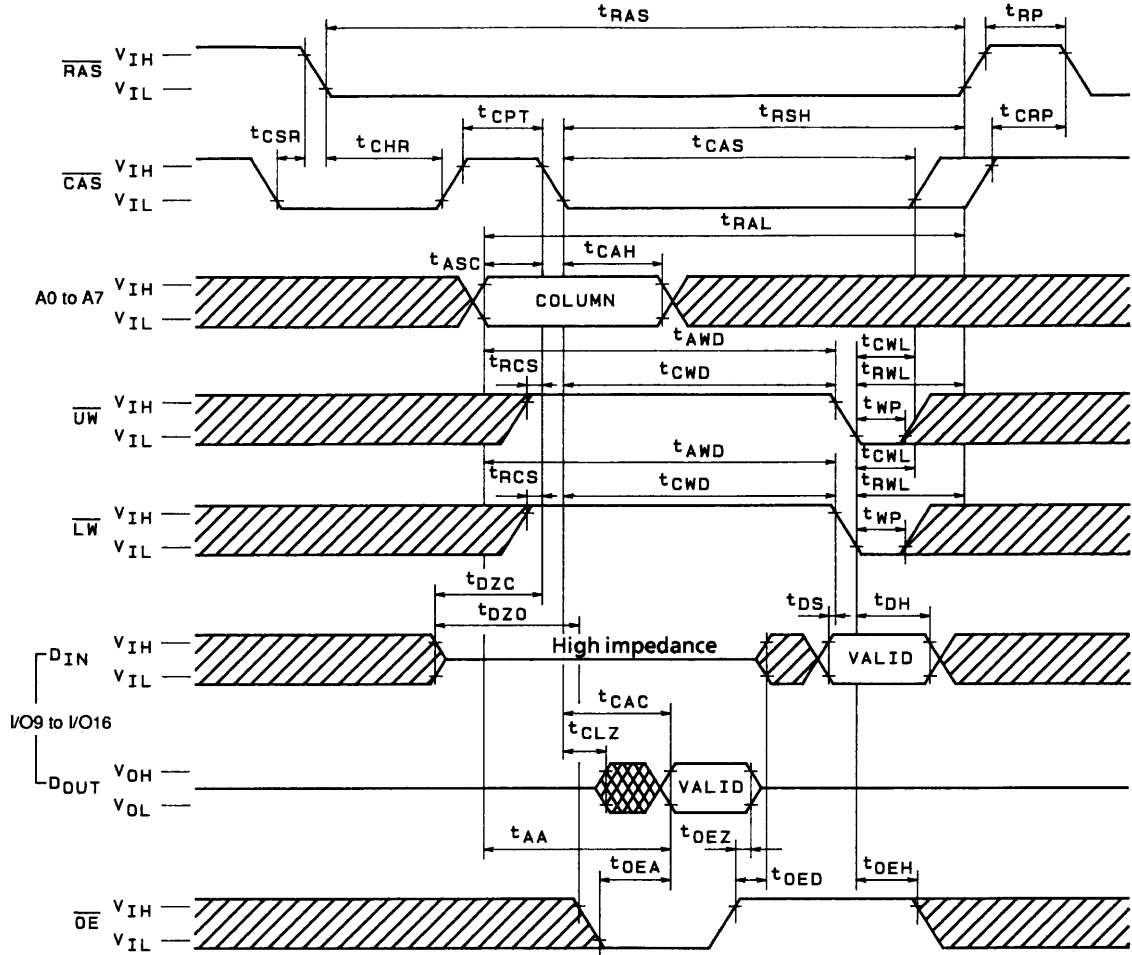
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CAS-Before-RAS Refresh Counter Test Cycle (write)



A02160
A03477

CAS-Before-RAS Refresh Counter Test Cycle (read-modify-write)



INVALID DATA *H* or *L*

A02161

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