

V53C364405A	40	50	60
Max. $\overline{\text{RAS}}$ Access Time, (t_{RAC})	40 ns	50 ns	60 ns
Max. Column Address Access Time, (t_{CAA})	20 ns	25 ns	30 ns
Min. Extended Data Out Page Mode Cycle Time, (t_{PC})	16 ns	20 ns	25 ns
Min. Read/Write Cycle Time, (t_{RC})	69 ns	84 ns	104 ns

- 16M x 4-bit organization
- EDO Page Mode for a sustained data rate of 63 MHz
- $\overline{\text{RAS}}$ access time: 40, 50, 60 ns
- Low power dissipation
- Read-Modify-Write, $\overline{\text{RAS}}$ -Only Refresh, $\overline{\text{CAS}}$ -Before- $\overline{\text{RAS}}$ Refresh, Hidden Refresh
- Self Refresh (L-version only)
- Refresh Interval: 8192 cycles/128 ms
- Available in 32-pin 400 mil SOJ, and 32-pin 400 mil TSOP-II
- Single +3.3 V ± 0.3 V Power Supply
- LV-TTL Interface

Description

The V53C364405A is a 16,777,216 x 4 bit high-performance CMOS dynamic random access memory. The V53C364405A offers Page mode operation with Extended Data Output. The V53C364405A has an address, 13-bit row and 11-bit column.

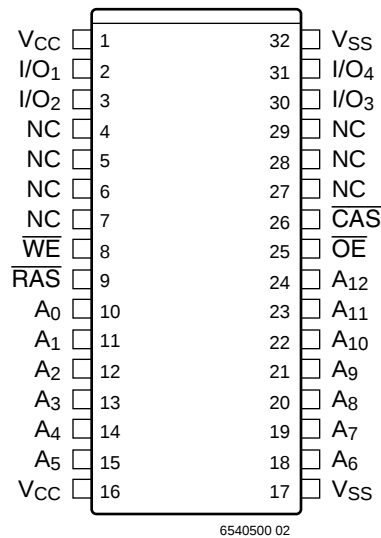
All inputs are LV-TTL compatible. EDO Page Mode operation allows random access up to 2048 x 4 bits, within a page, with cycle times as short as 16 ns.

These features make the V53C364405A ideally suited for a wide variety of high performance computer systems and peripheral applications.

Device Usage Chart

Operating Temperature Range	Package Outline		Access Time (ns)			Power		Temperature Mark
	K	T	40	50	60	Std.	L	
0°C to 70°C	•	•	•	•	•	•	•	Blank

32 Pin Plastic SOJ /TSOP-II
PIN CONFIGURATION
Top View



Pin Names

A ₀ –A ₁₂	Row, Column Address Inputs
RAS	Row Address Strobe
CAS	Column Address Strobe
WE	Write Enable
OE	Output Enable
I/O ₁ –I/O ₄	Data Input, Output
V _{CC}	+3.3V Supply
V _{SS}	0V Supply
NC	No Connect

Description	Pkg.	Pin Count
SOJ	K	32
TSOP-II	T	32

Absolute Maximum Ratings*

Operating temperature range 0 to 70 °C
 Storage temperature range -55 to 150 °C
 Soldering temperature 260 °C
 Soldering time 10 s
 Input/output voltage -0.5 to min ($V_{CC}+0.5$, 4.6) V
 Power supply voltage -0.5V to 4.6 V
 Power dissipation 1.0 W
 Data out current (short circuit) 50 mA

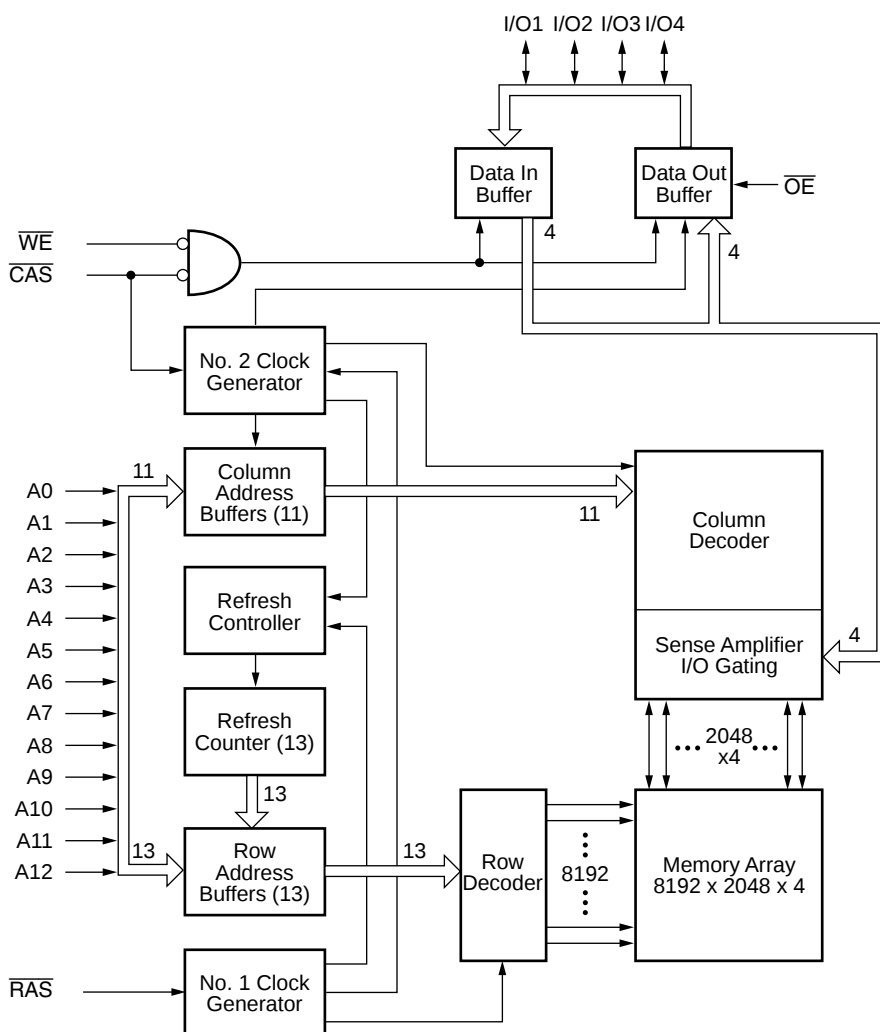
*Note: Operation above Absolute Maximum Ratings can adversely affect device reliability.

Capacitance*

$T_A = 25^\circ\text{C}$, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$, $V_{SS} = 0\text{ V}$, $f = 1\text{ Mhz}$

Symbol	Parameter	Min.	Max.	Unit
C_{IN1}	Address Input	—	5	pF
C_{IN2}	$\overline{\text{RAS}}$, CAS , $\overline{\text{WE}}$, $\overline{\text{OE}}$	—	7	pF
C_{OUT}	Data Input/Output	—	7	pF

*Note: Capacitance is sampled and not 100% tested.

Block Diagram**16M x 4**

DC and Operating Characteristics^(1, 2)

$T_A = 0^\circ\text{C}$ to 70°C , $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$, $V_{SS} = 0\text{ V}$, unless otherwise specified.

Symbol	Parameter	Access Time	V53C364405A			Unit	Test Conditions	Notes
			Min.	Typ.	Max.			
I_{LI}	Input Leakage Current (any input pin)		-2		2	μA	$V_{SS} \leq V_{IN} \leq V_{CC}$	
I_{LO}	Output Leakage Current (for High-Z State)		-2		2	μA	$V_{SS} \leq V_{OUT} \leq V_{CC}$ $\overline{\text{RAS}}, \overline{\text{CAS}}$ at V_{IH}	
I_{CC1}	V_{CC} Supply Current, Operating	40			125	mA	$t_{RC} = t_{RC}(\text{min.})$	2, 3, 4
		50			100			
		60			84			
I_{CC2}	V_{CC} Supply Current, TTL Standby				1	mA	$\overline{\text{RAS}}, \overline{\text{CAS}}$ at V_{IH} other inputs $\geq V_{SS}$	
I_{CC3}	V_{CC} Supply Current, RAS-Only Refresh	40			125	mA	$t_{RC} = t_{RC}(\text{min.})$	2, 4
		50			100			
		60			84			
I_{CC4}	V_{CC} Supply Current, EDO Page Mode Operation	40			140	mA	Minimum Cycle	2, 3, 4
		50			105			
		60			85			
I_{CC5}	V_{CC} Supply Current, CMOS Standby				500	μA	$\overline{\text{RAS}} \geq V_{CC} - 0.2\text{ V}$, $\overline{\text{CAS}} \geq V_{CC} - 0.2\text{ V}$	
I_{CC5}	V_{CC} Supply Current, CMOS Standby (L-Version)				120	μA	$\overline{\text{RAS}} \geq V_{CC} - 0.2\text{ V}$, $\overline{\text{CAS}} \geq V_{CC} - 0.2\text{ V}$	
I_{CC6}	Average Self Refresh Current CBR cycle with $t_{RAS} > t_{RASS} \text{ min.}$, (L-version) $\overline{\text{CAS}}$ held low, $\overline{\text{WE}} =$ $V_{CC} - 0.2\text{ V}$, Address and $D_{IN} = V_{CC} - 0.2\text{ V}$ or 0.2 V				400	μA		
I_{CC7}	V_{CC} Supply Current, during $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Refresh	40			170	mA		2, 4
		50			140			
		60			115			
V_{IL}	Input Low Voltage		-0.3		0.8	V		1
V_{IH}	Input High Voltage		2.0		$V_{CC} + 0.3$	V		1
V_{OL}	Output Low Voltage				0.4	V	$I_{OL} = 2\text{ mA}$	1
V_{OH}	Output High Voltage		2.4			V	$I_{OH} = -2\text{ mA}$	1

TRUTH TABLE

FUNCTION		$\overline{\text{RAS}}$	$\overline{\text{CAS}}$	$\overline{\text{WE}}$	$\overline{\text{OE}}$	ROW ADDR	COL ADDR	I/O1-I/O4
Standby		H	H $\rightarrow$ X	X	X	X	X	High Impedance
Read		L	L	H	L	ROW	COL	Data Out
Early-Write		L	L	L	X	ROW	COL	Data In
Delayed-Write		L	L	H $\rightarrow$ L	H	ROW	COL	Data In
Read-Modify-Write		L	L	H $\rightarrow$ L	L $\rightarrow$ H	ROW	COL	Data Out, Data In
EDO Page Mode Read	1st Cycle	L	H $\rightarrow$ L	H	L	ROW	COL	Data Out
	2nd Cycle	L	H $\rightarrow$ L	H	L	N/A	COL	Data Out
EDO Page Mode Write	1st Cycle	L	H $\rightarrow$ L	L	X	ROW	COL	Data In
	2nd Cycle	L	H $\rightarrow$ L	L	X	N/A	COL	Data In
EDO Page Mode RMW	1st Cycle	L	H $\rightarrow$ L	H $\rightarrow$ L	L $\rightarrow$ H	ROW	COL	Data Out, Data In
	2nd Cycle	L	H $\rightarrow$ L	H $\rightarrow$ L	L $\rightarrow$ H	N/A	COL	Data Out, Data In
$\overline{\text{RAS}}$ only refresh		L	H	X	X	ROW	N/A	High Impedance
$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh		H $\rightarrow$ L	L	H	X	X	N/A	High Impedance
Test Mode Entry		H $\rightarrow$ L	L	L	X	X	N/A	High Impedance
Hidden Refresh	READ	L $\rightarrow$ H $\rightarrow$ L	L	H	L	ROW	COL	Data Out
	WRITE	L $\rightarrow$ H $\rightarrow$ L	L	L	X	ROW	COL	Data In
Self Refresh (L-version only)		H $\rightarrow$ L	L	H	X	X	X	High Impedance

AC Characteristics ^(5,6)

$T_A = 0 \text{ to } 70^\circ\text{C}$, $V_{CC} = 3.3 \text{ V} \pm 0.3\text{V}$, $t_T = 2 \text{ ns}$

#	Symbol	Parameter	-40		- 50		- 60		Unit	Note
			min.	max.	min.	max.	min.	max.		
	Common Parameters									
1	t _{RC}	Random read or write cycle time	69	–	84	–	104	–	ns	
2	t _{RAS}	$\overline{\text{RAS}}$ pulse width	40	100k	50	100k	60	100k	ns	
3	t _{CAS}	$\overline{\text{CAS}}$ pulse width	6	10k	8	10k	10	10k	ns	
4	t _{RP}	$\overline{\text{RAS}}$ precharge time	25	–	30	–	40	–	ns	
5	t _{CP}	$\overline{\text{CAS}}$ precharge time	6	–	8	–	10	–	ns	
6	t _{ASR}	Row address setup time	0	–	0	–	0	–	ns	
7	t _{RAH}	Row address hold time	5	–	7	–	10	–	ns	
8	t _{ASC}	Column address setup time	0	–	0	–	0	–	ns	
9	t _{CAH}	Column address hold time	5	–	7	–	10	–	ns	
10	t _{RCD}	$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	9	30	11	37	14	45	ns	
11	t _{RAD}	$\overline{\text{RAS}}$ to column address delay time	7	20	9	25	12	30	ns	
12	t _{RSH}	$\overline{\text{RAS}}$ hold time	6	–	8		10	–	ns	
13	t _{CSH}	$\overline{\text{CAS}}$ hold time	32	–	40		48	–	ns	
14	t _{CRP}	$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	5	–	5	–	5	–	ns	
15	t _T	Transition time (rise and fall)	1	50	1	50	1	50	ns	7
16	t _{REF}	Refresh period	–	128	–	128	–	128	ms	
17	t _{REF}	Refresh period for L-versions	–	256	–	256	–	256	ms	

Read Cycle

18	t_{RAC}	Access time from $\overline{RAS}$	–	40	–	50	–	60	ns	8, 9
19	t_{CAC}	Access time from $\overline{CAS}$	–	10	–	13	–	15	ns	8, 9
20	t_{CAA}	Access time from column address	–	20	–	25	–	30	ns	8,10
21	t_{OEA}	$\overline{OE}$ access time	–	10	–	13	–	15	ns	
22	t_{RAL}	Column address to $\overline{RAS}$ lead time	20	–	25	–	30	–	ns	
23	t_{RCS}	Read command setup time	0	–	0	–	0	–	ns	
24	t_{RCH}	Read command hold time	0	–	0	–	0	–	ns	11
25	t_{RRH}	Read command hold time referenced to $\overline{RAS}$	0	–	0	–	0	–	ns	11
26	t_{CLZ}	$\overline{CAS}$ to output in low-Z	0	–	0	–	0	–	ns	8
27	t_{OFF}	Output buffer turn-off delay	0	10	0	13	0	15	ns	12
28	t_{DZ}	Output buffer turn-off delay from $\overline{OE}$	0	10	0	13	0	15	ns	12
29	t_{DZC}	Data to $\overline{CAS}$ low delay	0	–	0	–	0	–	ns	13
30	t_{DZO}	Data to $\overline{OE}$ low delay	0	–	0	–	0	–	ns	13

AC Characteristics ^(5,6) (Continued) $T_A = 0 \text{ to } 70^\circ\text{C}, V_{CC} = 3.3 \text{ V} \pm 0.3\text{V}, t_T = 2 \text{ ns}$

#	Symbol	Parameter	-40		- 50		- 60		Unit	Note
			min.	max.	min.	max.	min.	max.		
31	t_{CDD}	$\overline{\text{CAS}}$ high to data delay	10	–	13	–	15	–	ns	14
32	t_{ODD}	$\overline{\text{OE}}$ high to data delay	10	–	13	–	15	–	ns	14

Write Cycle

33	t_{WCH}	Write command hold time	5	–	7	–	10	–	ns	
34	t_{WP}	Write command pulse width	5	–	7	–	10	–	ns	
35	t_{WCS}	Write command setup time	0	–	0	–	0	–	ns	15
36	t_{RWL}	Write command to $\overline{\text{RAS}}$ lead time	6	–	8	–	10	–	ns	
37	t_{CWL}	Write command to $\overline{\text{CAS}}$ lead time	6	–	8	–	10	–	ns	
38	t_{DS}	Data setup time	0	–	0	–	0	–	ns	16
39	t_{DH}	Data hold time	5	–	7	–	10	–	ns	16

Read-modify-Write Cycle

40	t_{RWC}	Read-write cycle time	89	–	109	–	133	–	ns	
41	t_{RWD}	$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ delay time	52	–	65	–	77	–	ns	15
42	t_{CWD}	$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ delay time	22	–	28	–	32	–	ns	15
43	t_{AWD}	Column address to $\overline{\text{WE}}$ delay time	32	–	40	–	47	–	ns	15
44	t_{OEHL}	$\overline{\text{OE}}$ command hold time	5	–	7	–	10	–	ns	

EDO Page Mode Cycle

45	t_{HPC}	EDO Page Mode cycle time	16	–	20	–	24	–	ns	
46	t_{CPA}	Access time from $\overline{\text{CAS}}$ precharge	–	22	–	28	–	34	ns	7
47	t_{COH}	Output data hold time	5	–	5	–	5	–	ns	
48	t_{RAS}	$\overline{\text{RAS}}$ pulse width in EDO page mode	40	200k	50	200k	60	200k	ns	
49	t_{RHPC}	$\overline{\text{CAS}}$ precharge to $\overline{\text{RAS}}$ Delay	22	–	28	–	34	–	ns	
50	t_{OEP}	$\overline{\text{OE}}$ pulse width	5	–	5	–	5	–	ns	
51	t_{OEHC}	$\overline{\text{OE}}$ hold time from $\overline{\text{CAS}}$ high	5	–	5	–	5	–	ns	
52	t_{WEZ}	Output buffer turn-off delay from $\overline{\text{WE}}$	0	10	0	13	0	15	ns	

EDO Page Mode Read-modify-Write Cycle

53	t_{PRWC}	EDO page mode read-write cycle time	42	–	54	–	63	–	ns	
54	t_{CPWD}	$\overline{\text{CAS}}$ precharge to $\overline{\text{WE}}$	32	–	41	–	49	–	ns	

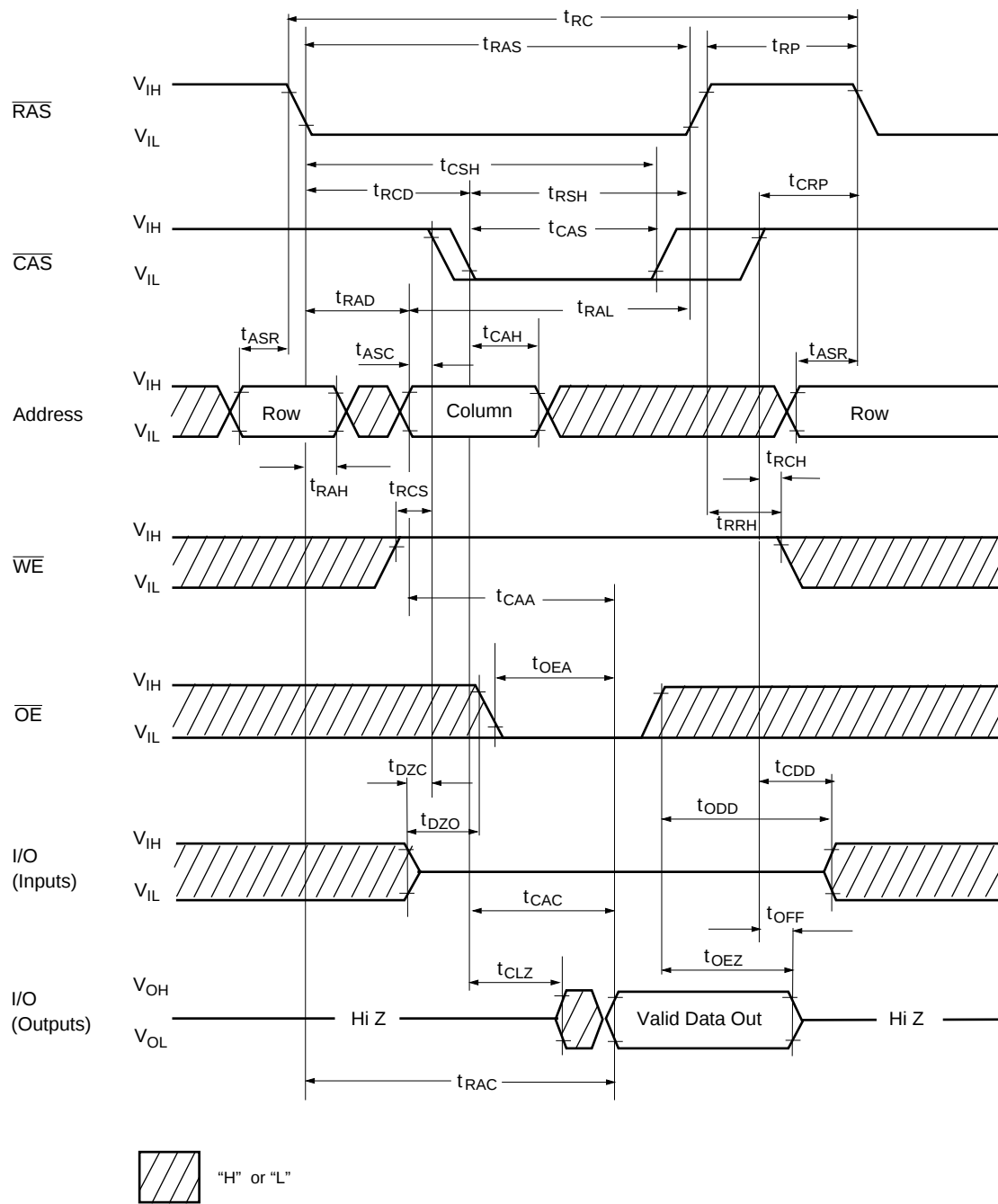
AC Characteristics ^(5,6) (Continued)

$T_A = 0 \text{ to } 70^\circ\text{C}$, $V_{CC} = 3.3 \text{ V} \pm 0.3\text{V}$, $t_T = 2 \text{ ns}$

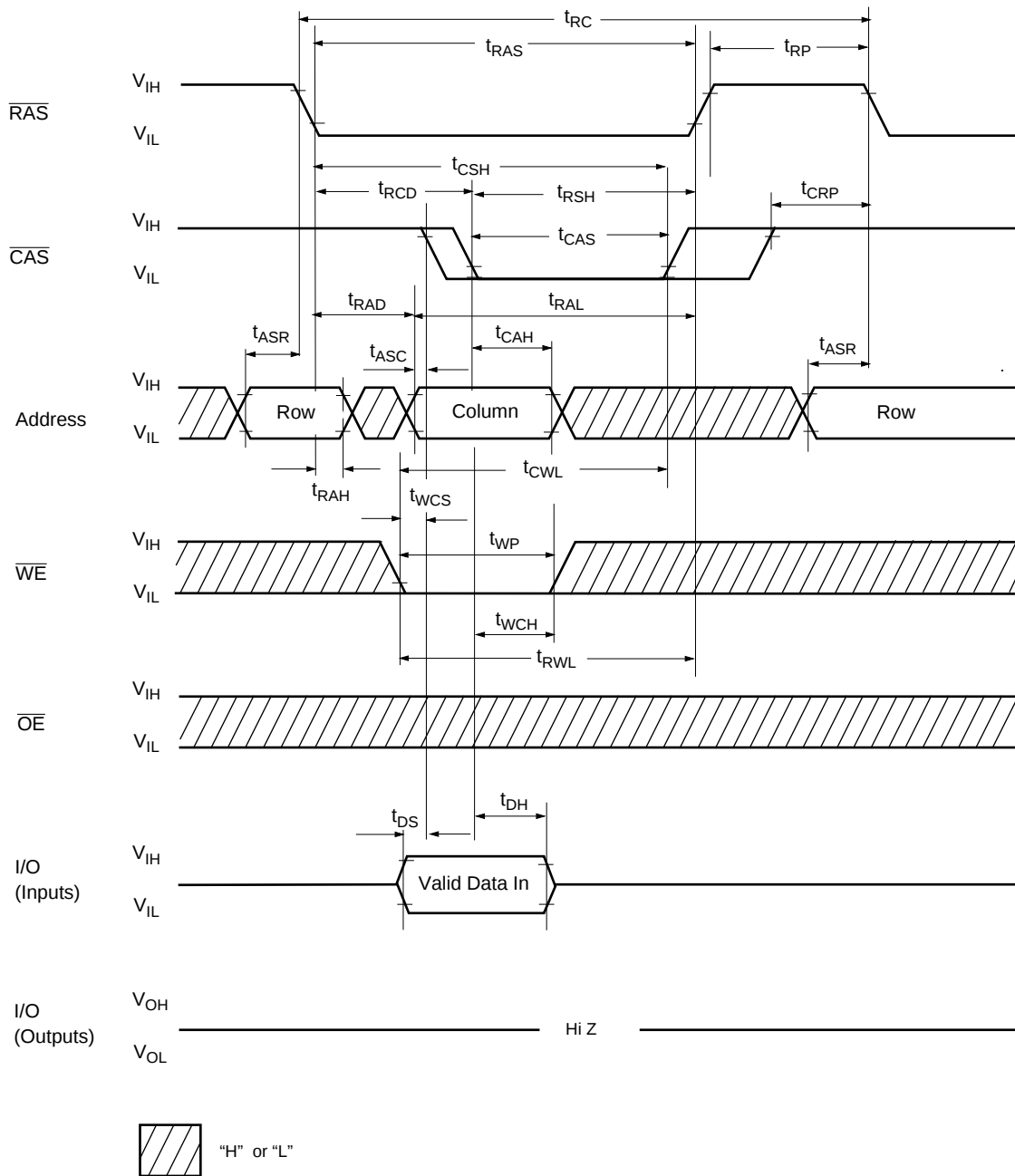
#	Symbol	Parameter	-40		- 50		- 60		Unit	Note
			min.	max.	min.	max.	min.	max.		
CAS before RAS Refresh Cycle										
55	t _{CSR}	CAS setup time	5	–	5	–	5	–	ns	
56	t _{CHR}	CAS hold time	5	–	5	–	10	–	ns	
57	t _{RPC}	RAS to CAS precharge time	5	–	5	–	5	–	ns	
58	t _{WRP}	Write to RAS precharge time	5	–	5	–	10	–	ns	
59	t _{WRH}	Write hold time referenced to RAS	5	–	5	–	10	–	ns	
Self Refresh Cycle (L-versions only)										
60	t _{RASS}	RAS pulse width	100k		100k	–	100k	–	ns	17
61	t _{RPS}	RAS precharge time	69	–	84	–	104	–	ns	17
62	t _{CHS}	CAS hold time	-50	–	-50	–	-50	–	ns	17
Test Mode Cycle										
63	t _{WTS}	Write command setup time	5	–	5	–	5	–	ns	18
64	t _{WTH}	Write command hold time	5	–	5	–	5	–	ns	18

Notes:

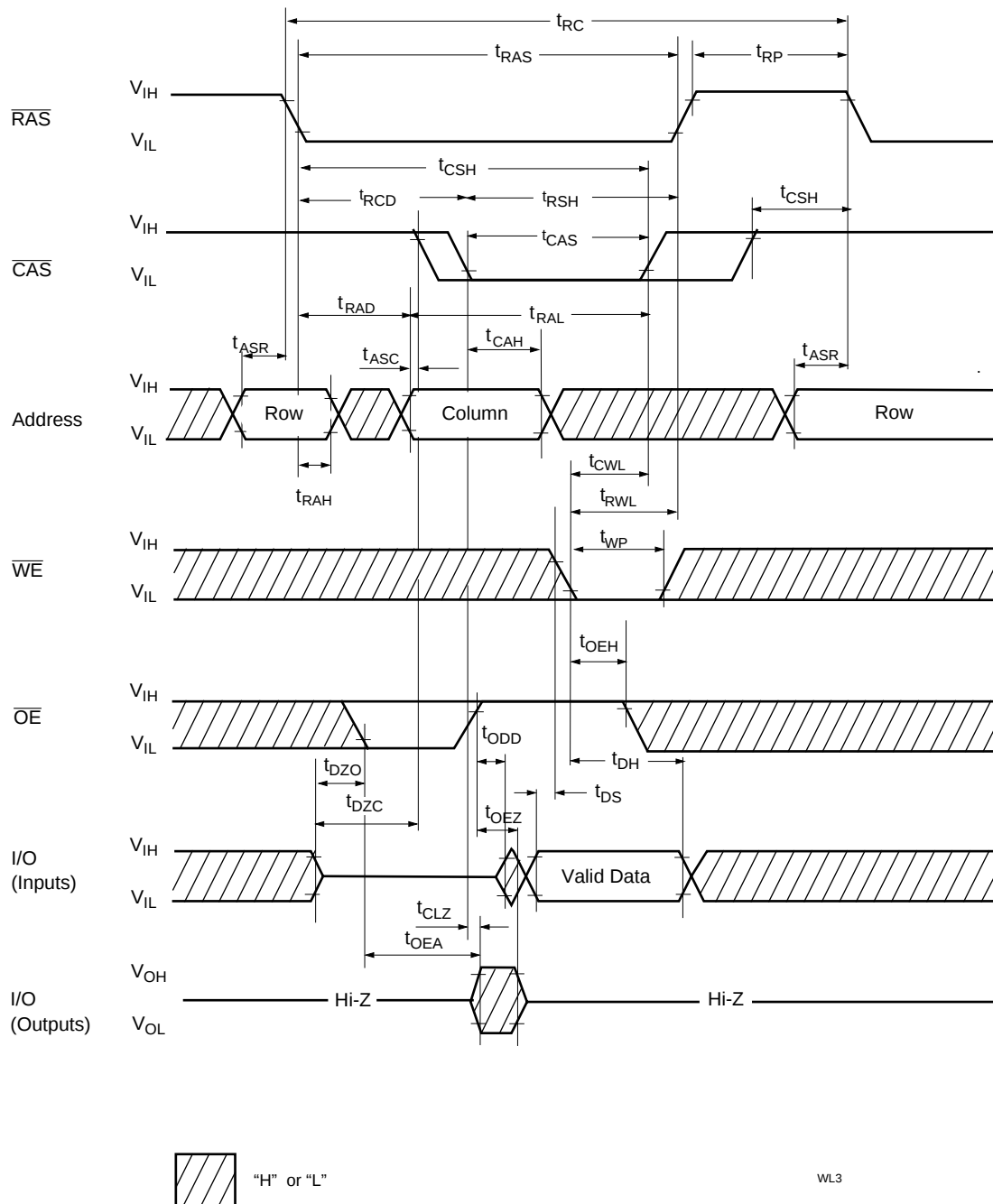
- 1) All voltages are referenced to VSS.
 V_{IH} may overshoot to $V_{CC} + 0.2V$ for pulse widths of $< 4ns$ with 3.3V. V_{IL} may undershoot to $-2.0V$ for pulse width $< 4.0 ns$ with 3.3V. Pulse width measured at 50% points with amplitude measured peak to DC reference.
- 2) I_{CC1} , I_{CC3} , I_{CC4} and I_{CC6} and I_{CC7} depend on cycle rate.
- 3) I_{CC1} and I_{CC4} depend on output loading. Specified values are measured with the output open.
- 4) Address can be changed once or less while $\overline{RAS} = V_{IL}$. In the case of I_{CC4} it can be changed once or less during a EDO page mode cycle (t_{PC}).
- 5) An initial pause of 100 μs is required after power-up followed by 8 $\overline{RAS}$ -only-refresh cycles, before proper device operation is achieved. In case of using internal refresh counter, a minimum of 8 $\overline{CAS}$ -before- $\overline{RAS}$ initialization cycles instead of 8 $\overline{RAS}$ cycles are required.
- 6) AC measurements assume $t_T = 2 ns$.
- 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) Measured with the specified current load and 100 pF at $V_{OH} = 2.0 V$ and $V_{OL} = 0.8 V$.
- 9) Operation within the $t_{RCD(max.)}$ limit ensures 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 by t_{CAC} .
- 10) Operation within the $t_{RAD(max.)}$ limit ensures 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 by t_{CAA} .
- 11) Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
- 12) $t_{OFF(max.)}$ and $t_{OEZ(max.)}$ define the time at which the outputs achieve the open-circuit condition and are not referenced to output voltage levels.
- 13) Either t_{DZC} or t_{DZO} must be satisfied.
- 14) Either t_{CDD} or t_{ODD} must be satisfied.
- 15) t_{WCS} , t_{RWD} , t_{CWD} , t_{AWD} and t_{CPWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If $t_{WCS} > t_{WCS(min.)}$, the cycle is an early write cycle and the I/O pin will remain open-circuit (high impedance) through the entire cycle; if $t_{RWD} > t_{RWD(min.)}$, $t_{CWD} > t_{CWD(min.)}$, $t_{AWD} > t_{AWD(min.)}$ and $t_{CPWD} > t_{CPWD(min.)}$, the cycle is a read-write cycle and I/O pins will contain data read from the selected cells. If neither of the above sets of conditions is satisfied, the condition of the I/O pins (at access time) is indeterminate.
- 16) These parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WRITE}$ leading edge in Read-Modify-Write cycles.
- 17) When using Self Refresh mode, the following refresh operations must be performed to ensure proper DRAM operation:
 If row addresses are being refresh in an evenly distributed manner over the refresh interval using CBR refresh cycles, then only one CBR cycle must be performed immediately after exit from Self Refresh.
 If row addresses are being refresh in any other manner (ROR - Distributed/Burst or CBR-Burst) over the refresh interval, then a full set of row refreshed must be performed immediately before entry to and immediately after exit from Self Refresh
- 18) In a Test Mode Read Cycle, the value of t_{rac} , t_{RAC} , t_{CAC} and t_{CPA} are delayed by 5 ns from the specified value. These parameters must be adjusted in Test Mode cycles by adding 5ns to the specified value. Associated timings must be adjusted by 5 ns.

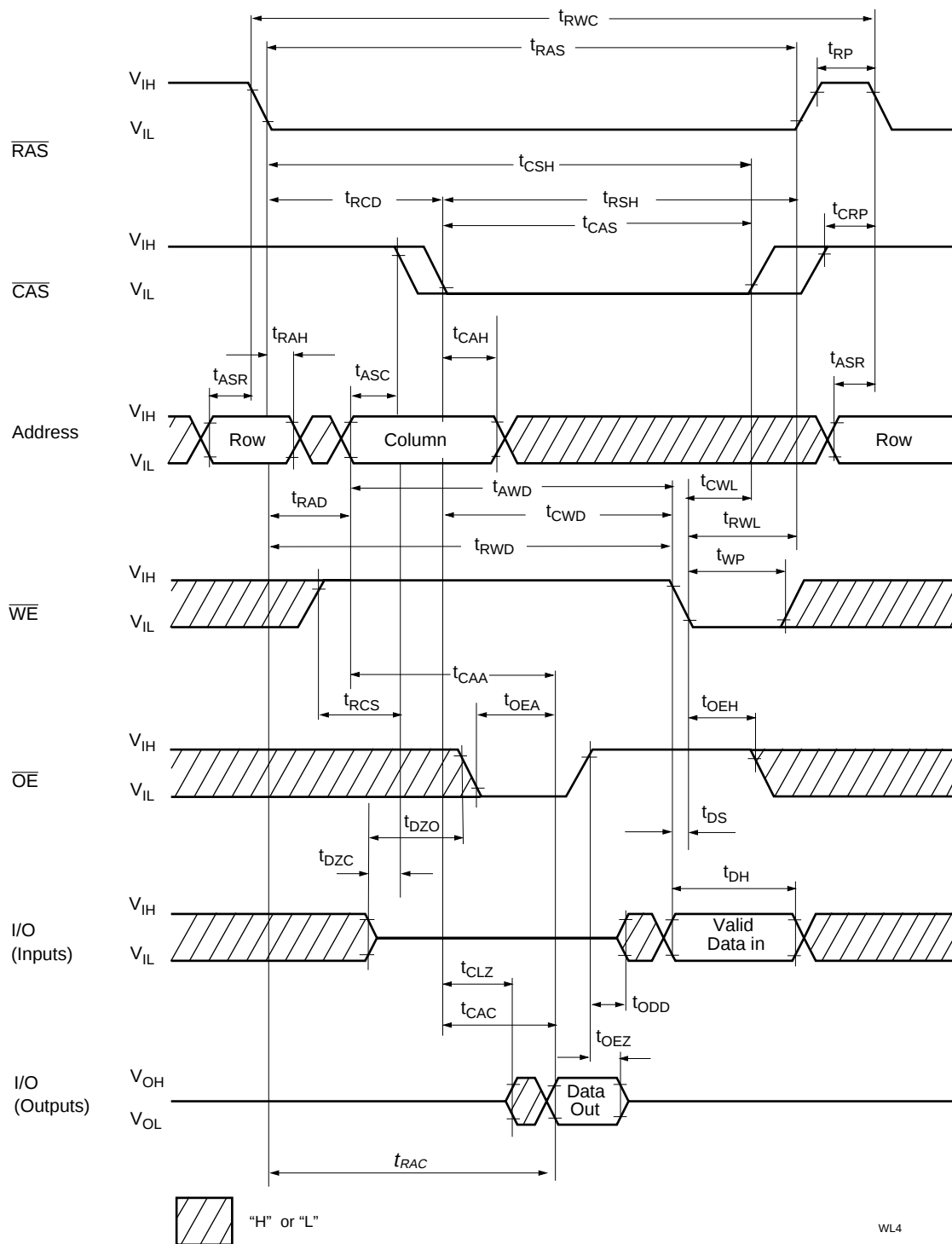
Waveforms of Read Cycle

WL1

Waveforms of Write Cycle (Early Write)

WL2

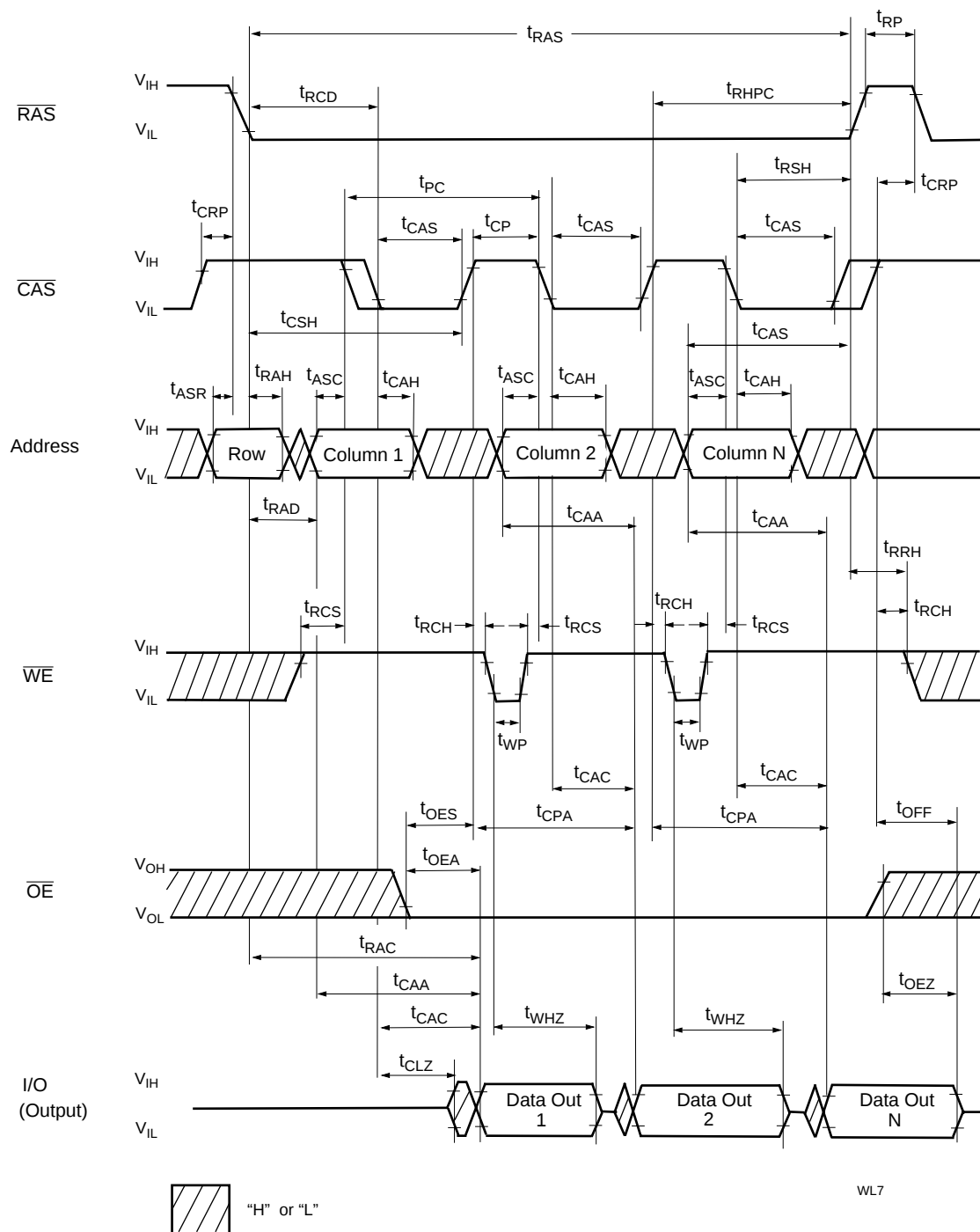
Waveforms of Write Cycle ($\overline{OE}$ Controlled Write)

Waveforms of Read-Write (Read-Modify-Write) Cycle

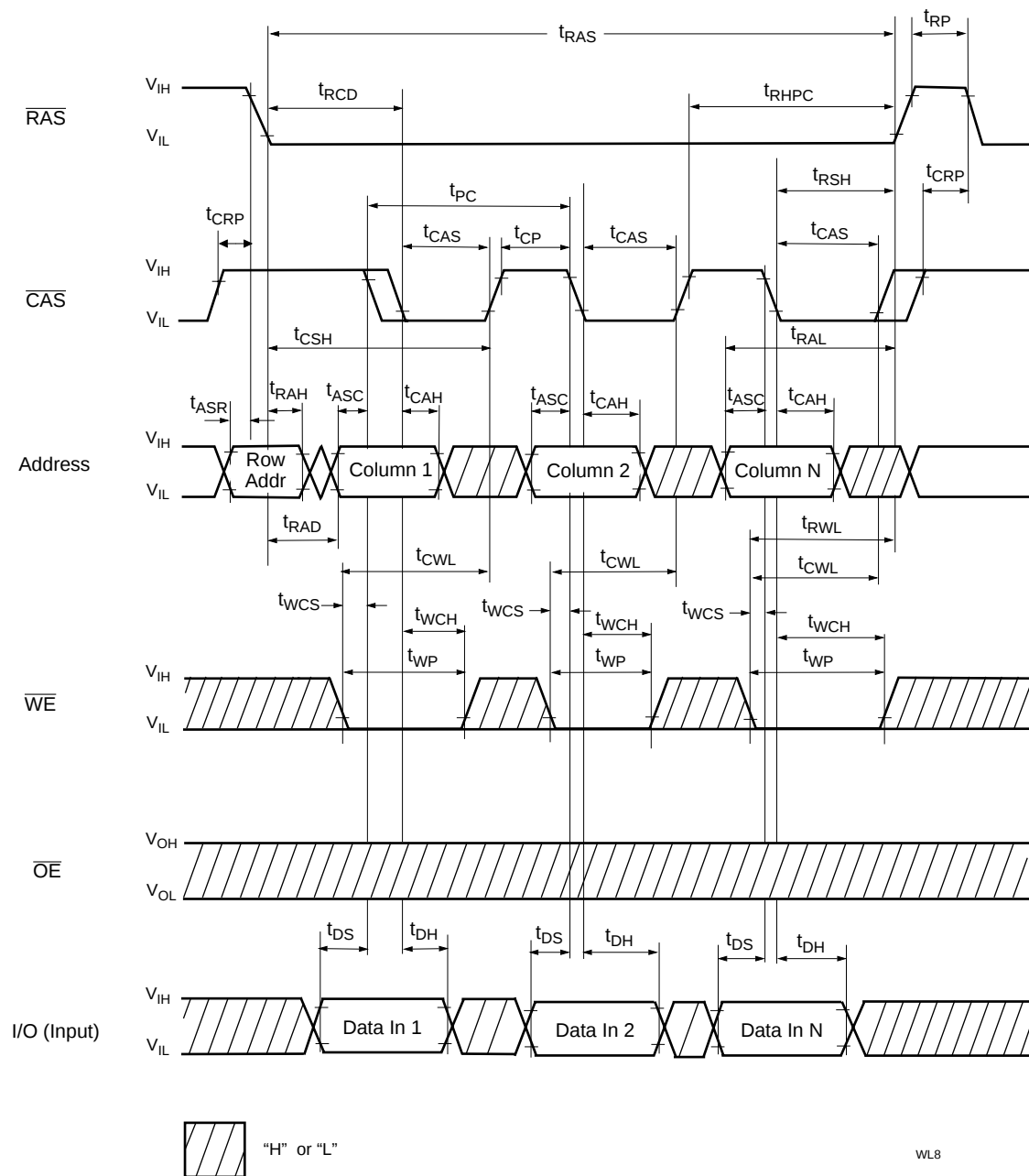
[illegible]

Waveforms of EDO Page Mode Read Cycle ($\overline{\text{OE}}$ Control)



Waveforms of EDO Page Mode Read Cycle ($\overline{WE}$ Control)

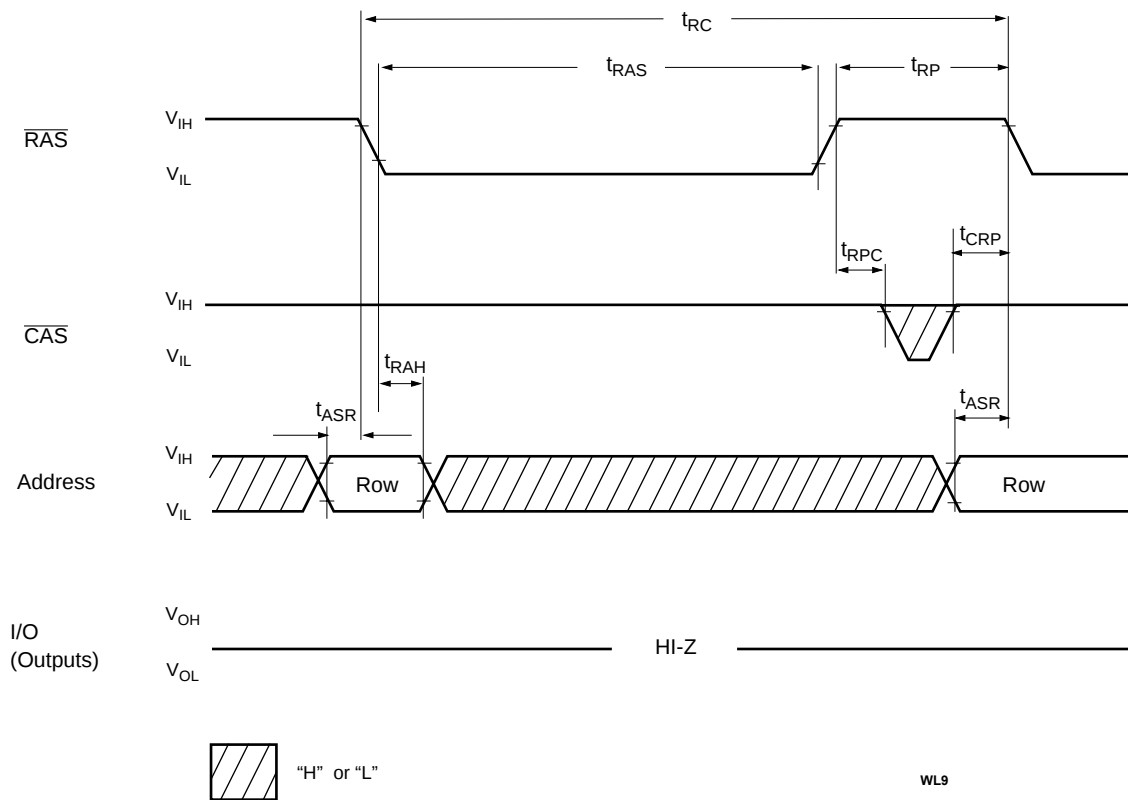
WL7

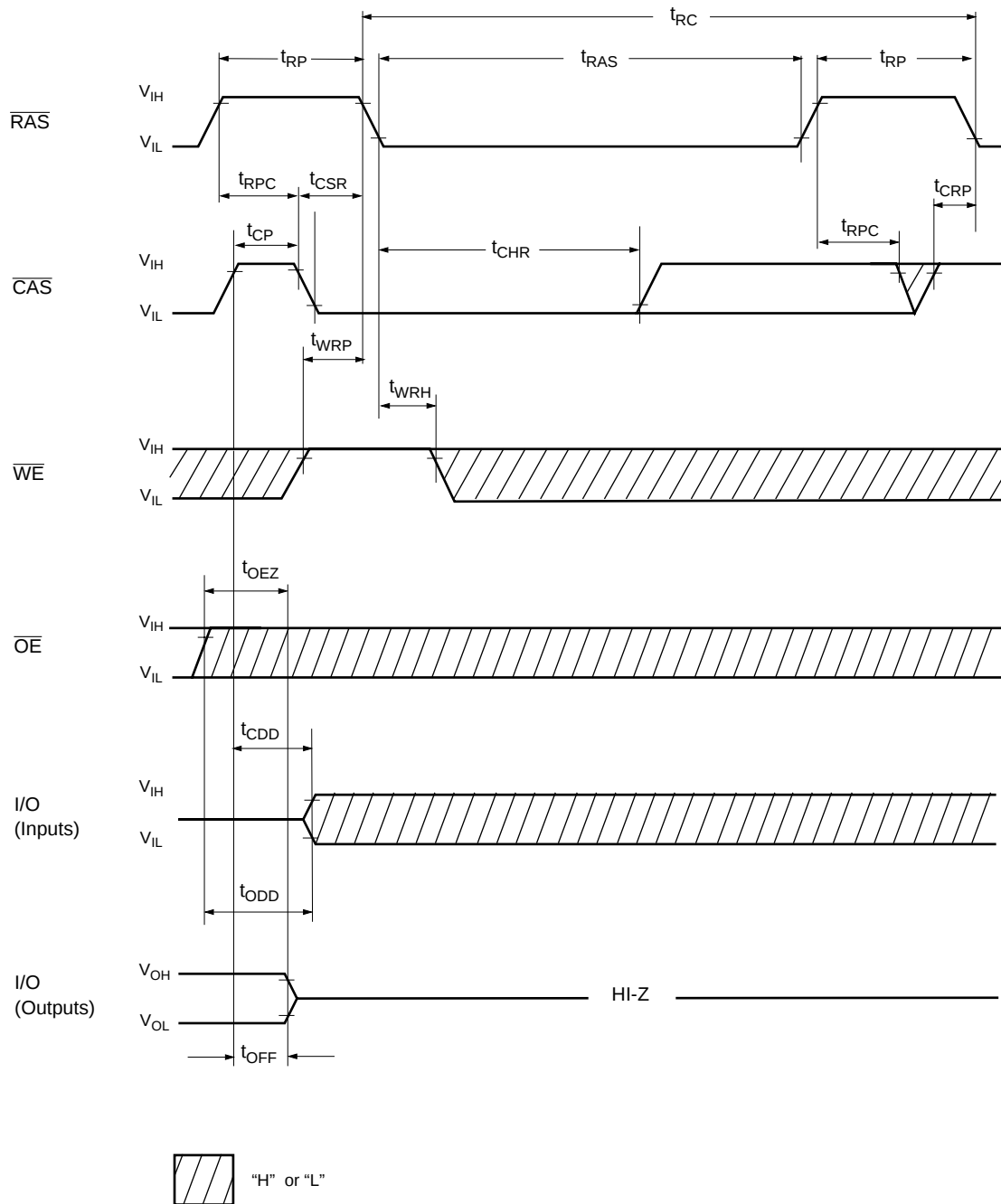
Waveforms of EDO Page Mode Early Write Cycle

Waveforms of EDO Page Mode Late Write Cycle

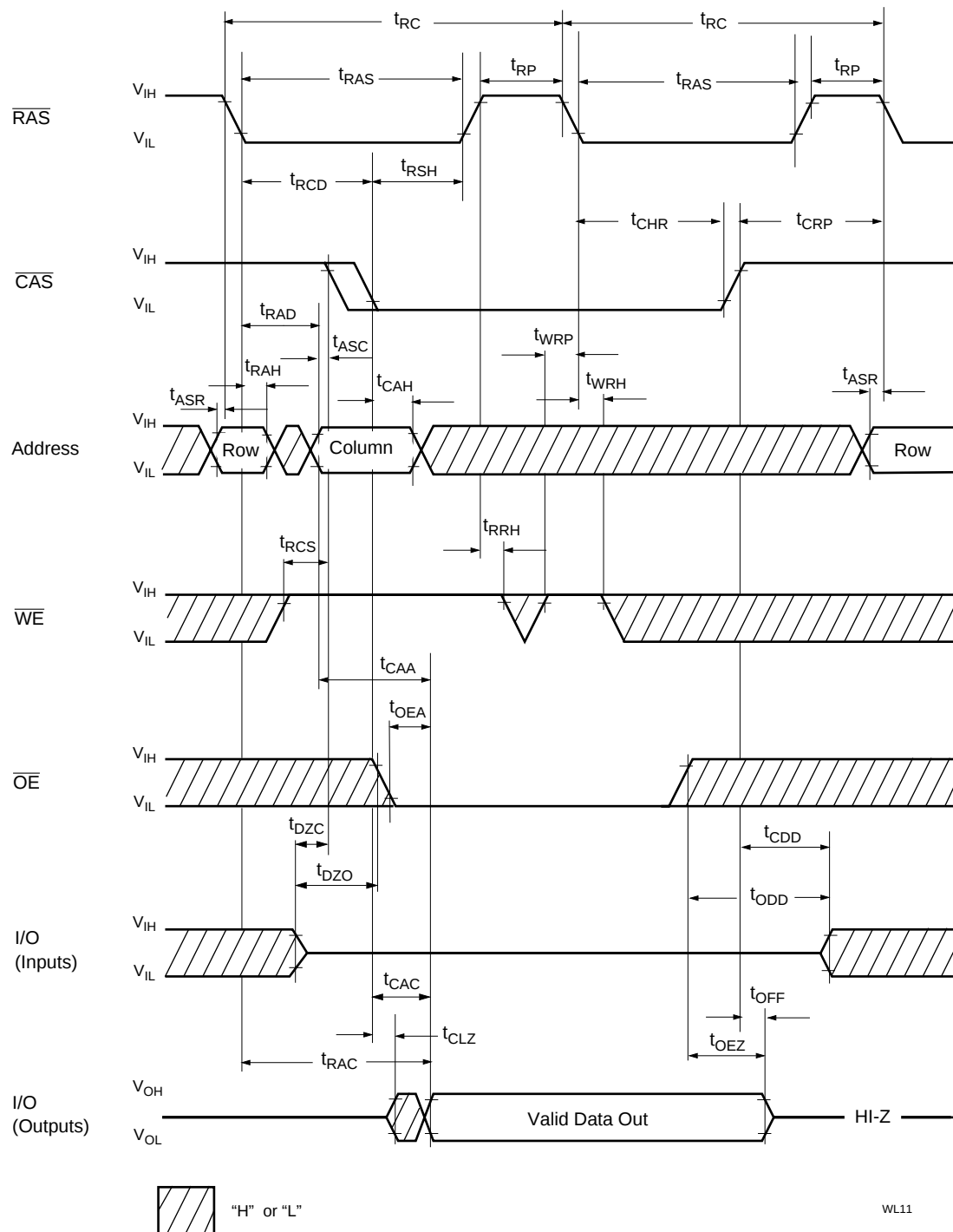


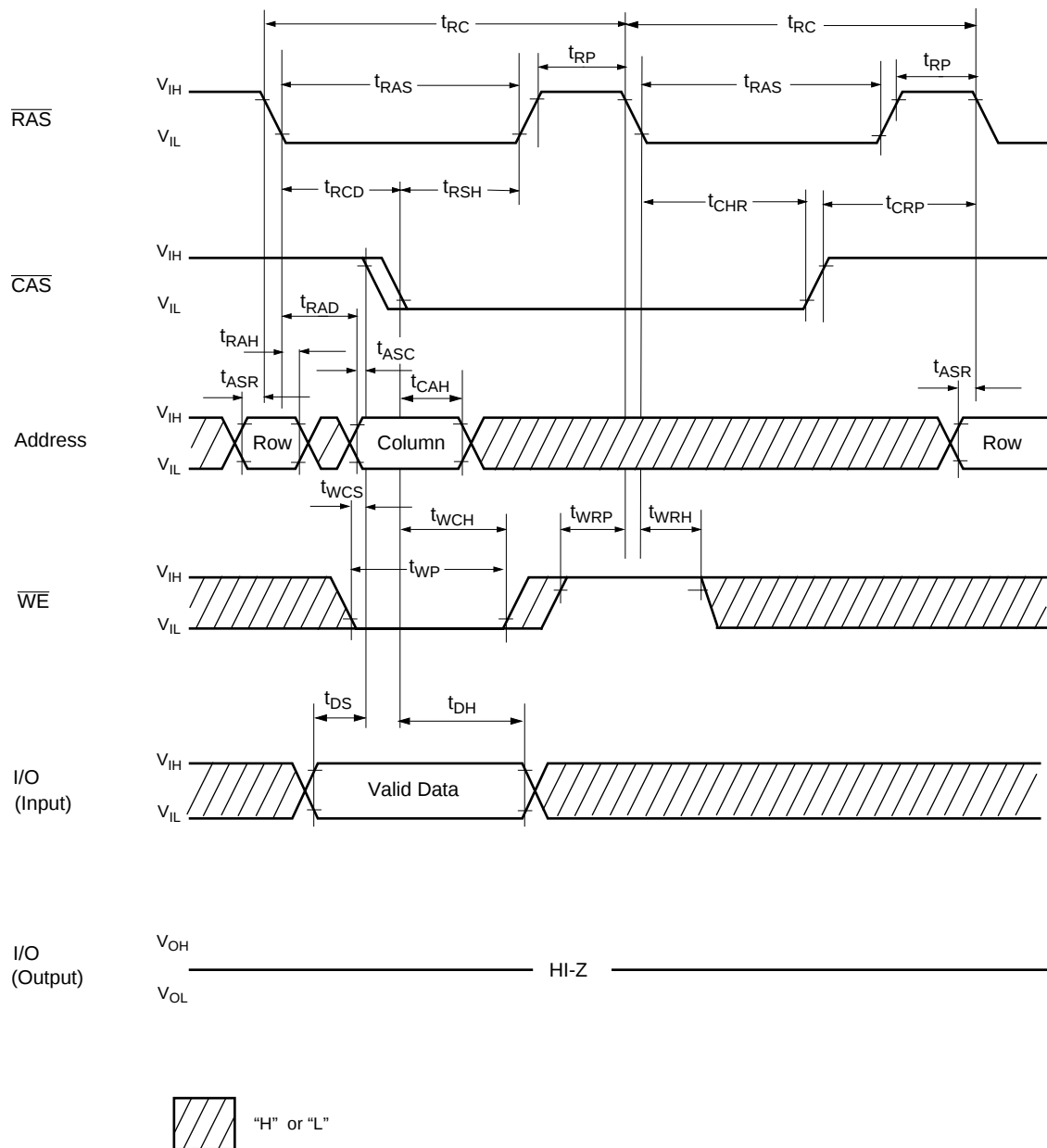
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Waveforms of $\overline{\text{RAS}}$ Only Refresh Cycle

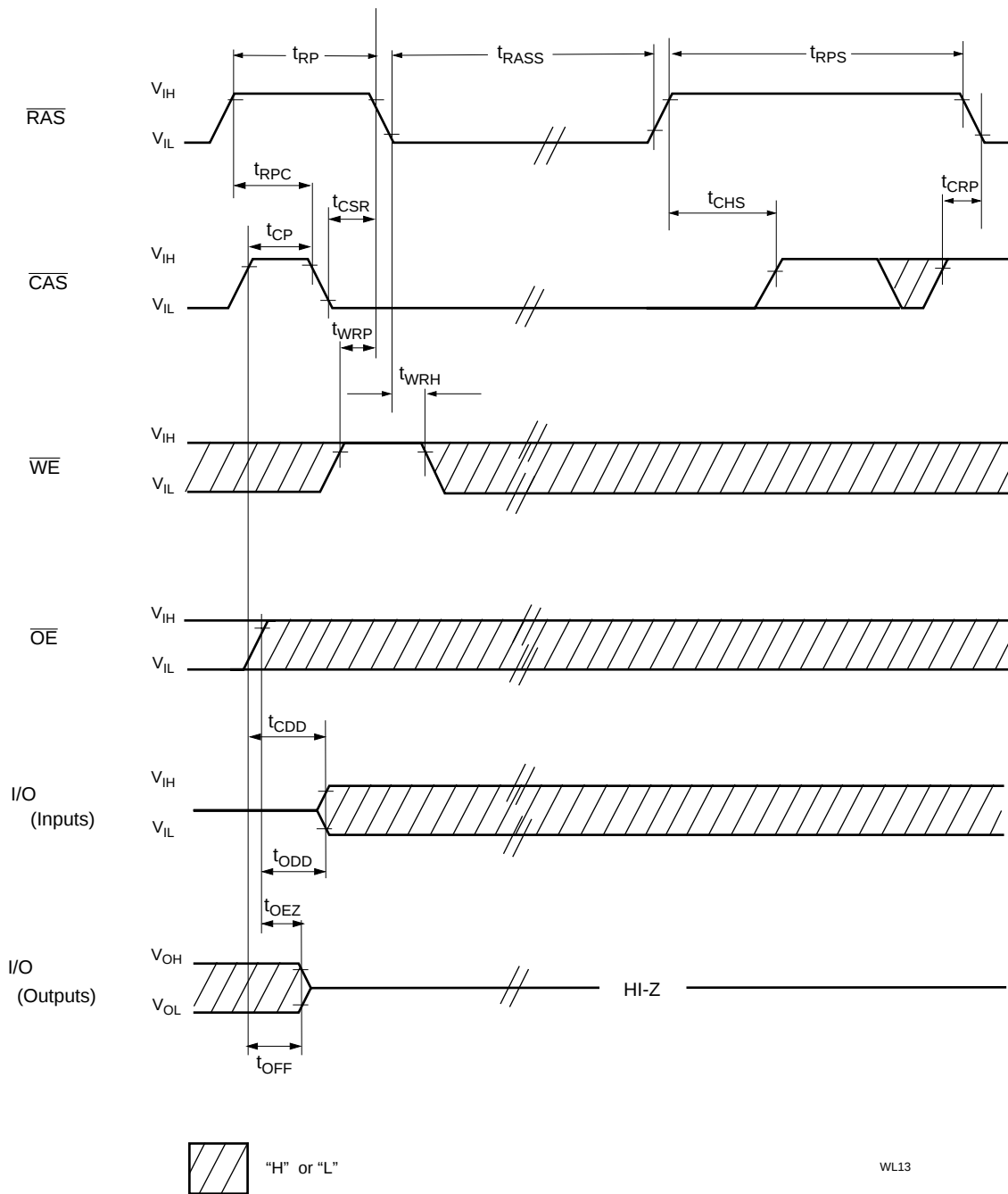
Waveforms of $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Refresh Cycle

WL10

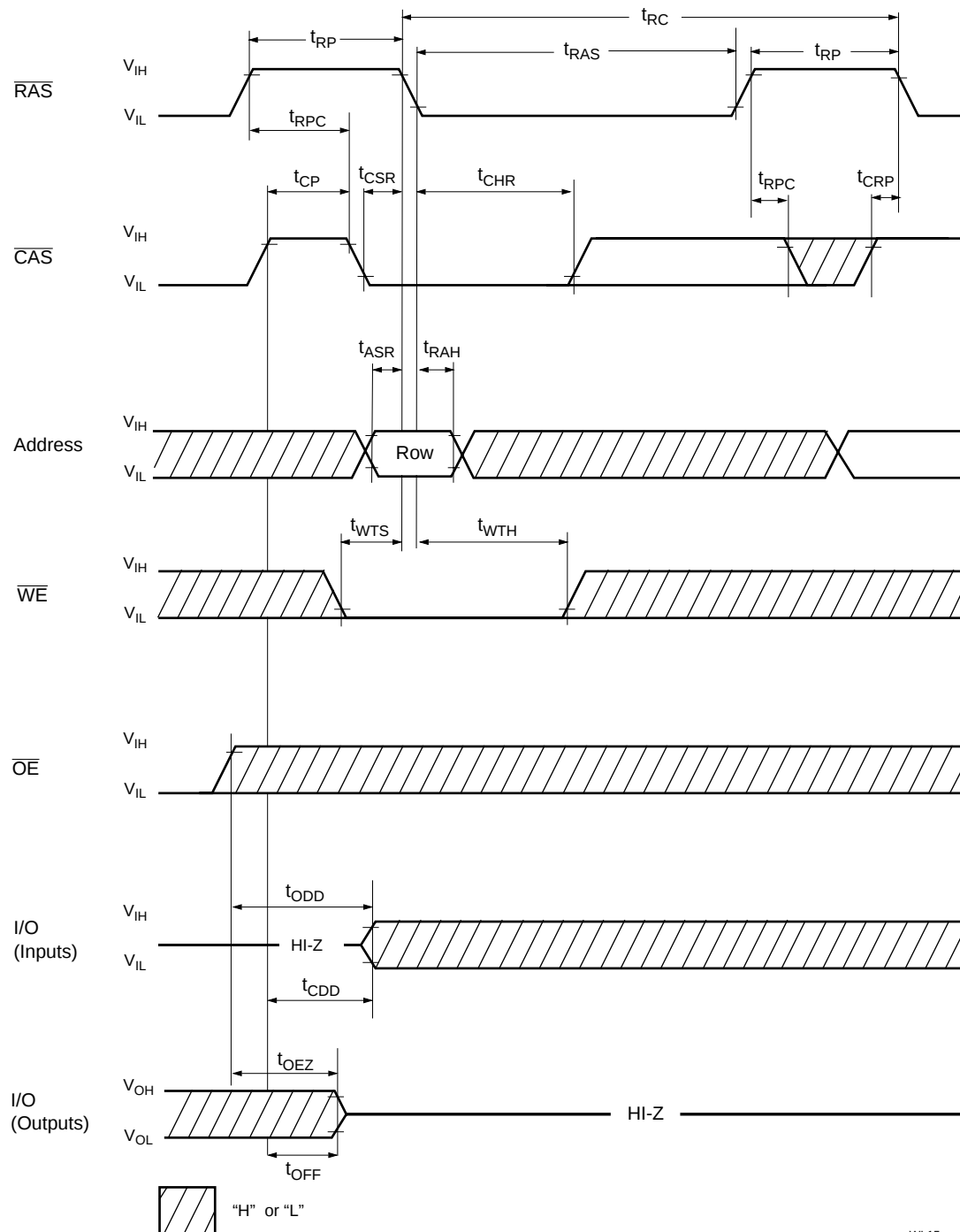
Waveforms of Hidden Refresh Read Cycle

Waveforms of Hidden Refresh Early Write Cycle

WL12

Waveforms of Self Refresh (Sleep Mode)

WL13

Waveforms of Test Mode Entry Cycle

WL15

32-pin 400 mil SOJ



① Does not include plastic or metal protrusion of 0.010 [0.25] max. per side

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