

MOSEL VITELIC **V53C516405A**  
**4M X 4 EDO PAGE MODE**  
**CMOS DYNAMIC RAM**

V53C516405A	50	60
Max. $\overline{\text{RAS}}$ Access Time, (t <sub>RAC</sub> )	50 ns	60 ns
Max. Column Address Access Time, (t <sub>CAA</sub> )	25 ns	30 ns
Min. Extended Data Out Page Mode Cycle Time, (t <sub>PC</sub> )	20 ns	25 ns
Min. Read/Write Cycle Time, (t <sub>RC</sub> )	84 ns	104 ns

**Features**

- 4M x 4-bit organization
- EDO Page Mode for a sustained data rate of 50 MHz
- $\overline{\text{RAS}}$  access time: 50, 60, 70 ns
- Low power dissipation
- Read-Modify-Write,  $\overline{\text{RAS}}$ -Only Refresh,  $\overline{\text{CAS}}$ -Before- $\overline{\text{RAS}}$  Refresh, Hidden Refresh
- Refresh Interval: 4096 cycles/64 ms
- Available in 24/26-pin 300 mil SOJ, and 24/26-pin 300 mil TSOP-II
- Single +5 V  $\pm$ 10% Power Supply
- TTL Interface

**Description**

The V53C516405A is a 4,194,304 x 4 bit high-performance CMOS dynamic random access memory. The V53C516405A offers Page mode operation with Extended Data Output. The V53C516405A has a symmetric address, 12-bit row and 10-bit column.

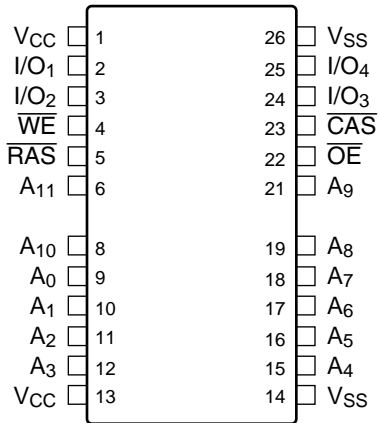
All inputs are TTL compatible. EDO Page Mode operation allows random access up to 1024 x 4 bits, within a page, with cycle times as short as 20ns.

These features make the V53C516405A 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	50	60	Std.	
0°C to 70°C	•	•	•	•	•	Blank

**24/26 Pin Plastic SOJ /TSOP-II  
PIN CONFIGURATION  
Top View**



511740502-02

**Pin Names**

A <sub>0</sub> -A <sub>11</sub>	Row, Column Address Inputs
$\overline{\text{RAS}}$	Row Address Strobe
$\overline{\text{CAS}}$	Column Address Strobe
$\overline{\text{WE}}$	Write Enable
$\overline{\text{OE}}$	Output Enable
I/O <sub>1</sub> -I/O <sub>4</sub>	Data Input, Output
V <sub>CC</sub>	+5V Supply
V <sub>SS</sub>	0V Supply
NC	No Connect

Description	Pkg.	Pin Count
SOJ	K	24/26
TSOP-II	T	24/26

**Absolute Maximum Ratings\***

Operating temperature range .....0 to 70 °C  
 Storage temperature range ..... -55 to 150 °C  
 Input/output voltage ..... -0.5 to min (V<sub>CC</sub>+0.5, 7) V  
 Power supply voltage .....-1.0V to 7V  
 Power dissipation ..... 1.0 W  
 Data out current (short circuit) ..... 50 mA

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

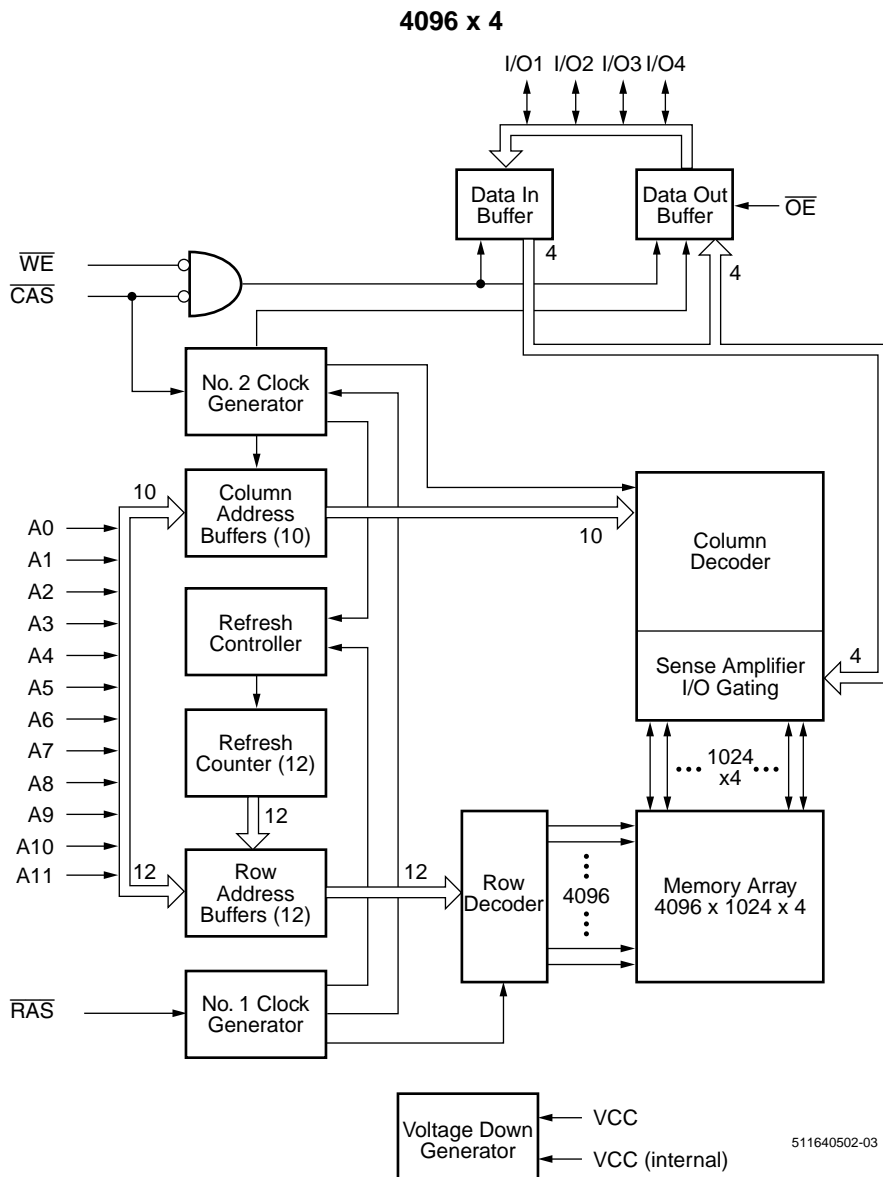
**Capacitance\***

T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5 V ± 10%, V<sub>SS</sub> = 0 V, f = 1 MHz

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

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

**Block Diagram**



511640502-03

**DC and Operating Characteristics (1-2)**

$T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ,  $V_{CC} = 5\text{ V} \pm 10\%$ ,  $V_{SS} = 0\text{ V}$ ,  $t_T = 2\text{ ns}$ , unless otherwise specified.

Symbol	Parameter	Access Time	V53C516405A			Unit	Test Conditions	Notes
			Min.	Typ.	Max.			
$I_{LI}$	Input Leakage Current (any input pin)		-10		10	$\mu\text{A}$	$V_{SS} \leq V_{IN} \leq V_{CC} + 0.5\text{V}$	1
$I_{LO}$	Output Leakage Current (for High-Z State)		-10		10	$\mu\text{A}$	$V_{SS} \leq V_{OUT} \leq V_{CC} + 0.5\text{V}$ $\overline{\text{RAS}}, \overline{\text{CAS}}$ at $V_{IH}$	1
$I_{CC1}$	$V_{CC}$ Supply Current, Operating	50			80	mA	$t_{RC} = t_{RC}(\text{min.})$	2, 3, 4
		60			70			
$I_{CC2}$	$V_{CC}$ Supply Current, TTL Standby				2	mA	$\overline{\text{RAS}}, \overline{\text{CAS}}$ at $V_{IH}$ other inputs $\geq V_{SS}$	
$I_{CC3}$	$V_{CC}$ Supply Current, RAS-Only Refresh	50			80	mA	$t_{RC} = t_{RC}(\text{min.})$	2, 4
		60			70			
$I_{CC4}$	$V_{CC}$ Supply Current, EDO Page Mode Operation	50			35	mA	Minimum Cycle	2, 3, 4
		60			30			
$I_{CC5}$	$V_{CC}$ Supply Current, during $\overline{\text{CAS}}$ -before-RAS Refresh	50			120	mA		2, 4
		60			110			
$I_{CC6}$	$V_{CC}$ Supply Current, CMOS Standby				1.0	mA	$\overline{\text{RAS}} \geq V_{CC} - 0.2\text{ V}$ , $\overline{\text{CAS}} \geq V_{CC} - 0.2\text{ V}$ other inputs $\geq V_{SS}$	1
$V_{CC}$	Power Supply Voltage		4.5	5.0	5.5	V		
$V_{IL}$	Input Low Voltage		-0.5		0.8	V		1
$V_{IH}$	Input High Voltage		2.4		$V_{CC} + 0.5$	V		1
$V_{OL}$	Output Low Voltage				0.4	V	$I_{OL} = 4.2\text{ mA}$	1
$V_{OH}$	Output High Voltage		2.4			V	$I_{OH} = -5\text{ mA}$	1

**AC Characteristics<sup>(5, 6)</sup>** $T_A = 0$  to  $70$  °C,  $V_{CC} = 5$  V  $\pm$  10 %,  $t_T = 2$  ns

#	Symbol	Parameter	-50		-60		Unit	Note
			min.	max.	min.	max.		
<b>Common Parameters</b>								
1	$t_{RC}$	Random read or write cycle time	84	–	104	–	ns	
2	$t_{RP}$	$\overline{RAS}$ precharge time	30	–	40	–	ns	
3	$t_{RAS}$	$\overline{RAS}$ pulse width	50	10k	60	10k	ns	
4	$t_{CAS}$	$\overline{CAS}$ pulse width	8	10k	10	10k	ns	
5	$t_{ASR}$	Row address setup time	0	–	0	–	ns	
6	$t_{RAH}$	Row address hold time	8	–	10	–	ns	
7	$t_{ASC}$	Column address setup time	0	–	0	–	ns	
8	$t_{CAH}$	Column address hold time	8	–	10	–	ns	
9	$t_{RCD}$	$\overline{RAS}$ to $\overline{CAS}$ delay time	12	37	14	45	ns	
10	$t_{RAD}$	$\overline{RAS}$ to column address delay	10	25	12	30	ns	
11	$t_{RSH}$	$\overline{RAS}$ hold time	13		15	–	ns	
12	$t_{CSH}$	$\overline{CAS}$ hold time	40		50	–	ns	
13	$t_{CRP}$	$\overline{CAS}$ to $\overline{RAS}$ precharge time	5	–	5	–	ns	
14	$t_T$	Transition time (rise and fall)	1	50	1	50	ns	7
15	$t_{REF}$	Refresh period	–	64	–	64	ms	
<b>Read Cycle</b>								
16	$t_{RAC}$	Access time from $\overline{RAS}$	–	50	–	60	ns	8, 9
17	$t_{CAC}$	Access time from $\overline{CAS}$	–	13	–	15	ns	8, 9
18	$t_{CAA}$	Access time from column address	–	25	–	30	ns	8,10
19	$t_{OEA}$	$\overline{OE}$ access time	–	13	–	15	ns	
20	$t_{RAL}$	Column address to $\overline{RAS}$ lead time	25	–	30	–	ns	
21	$t_{RCS}$	Read command setup time	0	–	0	–	ns	
22	$t_{RCH}$	Read command hold time	0	–	0	–	ns	11
23	$t_{RRH}$	Read command hold time referenced to $\overline{RAS}$	0	–	0	–	ns	11
24	$t_{CLZ}$	$\overline{CAS}$ to output in low-Z	0	–	0	–	ns	8
25	$t_{OFF}$	Output buffer turn-off delay	0	13	0	15	ns	12
26	$t_{O EZ}$	Output turn-off delay from $\overline{OE}$	0	13	0	15	ns	12
27	$t_{DZC}$	Data to $\overline{CAS}$ low delay	0	–	0	–	ns	13
28	$t_{DZO}$	Data to $\overline{OE}$ low delay	0	–	0	–	ns	13
29	$t_{CDD}$	$\overline{CAS}$ high to data delay	10	–	13	–	ns	14
30	$t_{ODD}$	$\overline{OE}$ high to data delay	10	–	13	–	ns	14

**AC Characteristics<sup>(5, 6)</sup>** $T_A = 0$  to  $70$  °C,  $V_{CC} = 5$  V  $\pm$  10 %,  $t_T = 2$  ns

#	Symbol	Parameter	-50		-60		Unit	Note
			min.	max.	min.	max.		
<b>Write Cycle</b>								
31	$t_{WCH}$	Write command hold time	8	–	10	–	ns	
32	$t_{WP}$	Write command pulse width	8	–	10	–	ns	
33	$t_{WCS}$	Write command setup time	0	–	0	–	ns	15
34	$t_{RWL}$	Write command to $\overline{RAS}$ lead time	8	–	10	–	ns	
35	$t_{CWL}$	Write command to $\overline{CAS}$ lead time	8	–	10	–	ns	
36	$t_{DS}$	Data setup time	0	–	0	–	ns	16
37	$t_{DH}$	Data hold time	8	–	10	–	ns	16
<b>Read-modify-Write Cycle</b>								
38	$t_{RWC}$	Read-write cycle time	113	–	138	–	ns	
39	$t_{RWD}$	$\overline{RAS}$ to $\overline{WE}$ delay time	64	–	77	–	ns	15
40	$t_{CWD}$	$\overline{CAS}$ to $\overline{WE}$ delay time	27	–	32	–	ns	15
41	$t_{AWD}$	Column address to $\overline{WE}$ delay time	39	–	47	–	ns	15
42	$t_{OEHL}$	$\overline{OE}$ command hold time	10	–	13	–	ns	
<b>EDO Page Mode Cycle</b>								
43	$t_{PC}$	EDO page mode cycle time	20	–	25	–	ns	
44	$t_{CP}$	$\overline{CAS}$ precharge time	8	–	10	–	ns	
45	$t_{CPA}$	Access time from $\overline{CAS}$ precharge	–	27	–	32	ns	7
46	$t_{COH}$	Output data hold time	5	–	5	–	ns	
47	$t_{RASP}$	$\overline{RAS}$ pulse width in EDO mode	50	200k	60	200k	ns	
48	$t_{RHPC}$	$\overline{CAS}$ precharge to $\overline{RAS}$ Delay	27	–	32	–	ns	
49	$t_{OES}$	$\overline{OE}$ setup time prior to $\overline{CAS}$	5	–	5	–	ns	
<b>EDO Page Mode Read-modify-Write Cycle</b>								
50	$t_{PRWC}$	EDO page mode read-write cycle time	58	–	68	–	ns	
51	$t_{CPWD}$	$\overline{CAS}$ precharge to $\overline{WE}$	41	–	49	–	ns	
<b><math>\overline{CAS}</math>-before-<math>\overline{RAS}</math> Refresh Cycle</b>								
52	$t_{CSR}$	$\overline{CAS}$ setup time	10	–	10	–	ns	
53	$t_{CHR}$	$\overline{CAS}$ hold time	10	–	10	–	ns	
54	$t_{RPC}$	$\overline{RAS}$ to $\overline{CAS}$ precharge time	5	–	5	–	ns	
55	$t_{WRP}$	Write to $\overline{RAS}$ precharge time	10	–	10	–	ns	
56	$t_{WRH}$	Write hold time referenced to $\overline{RAS}$	10	–	10	–	ns	

**AC Characteristics<sup>(5, 6)</sup>**

$T_A = 0$  to  $70$  °C,  $V_{CC} = 5\text{ V} \pm 10\%$ ,  $t_T = 2\text{ ns}$

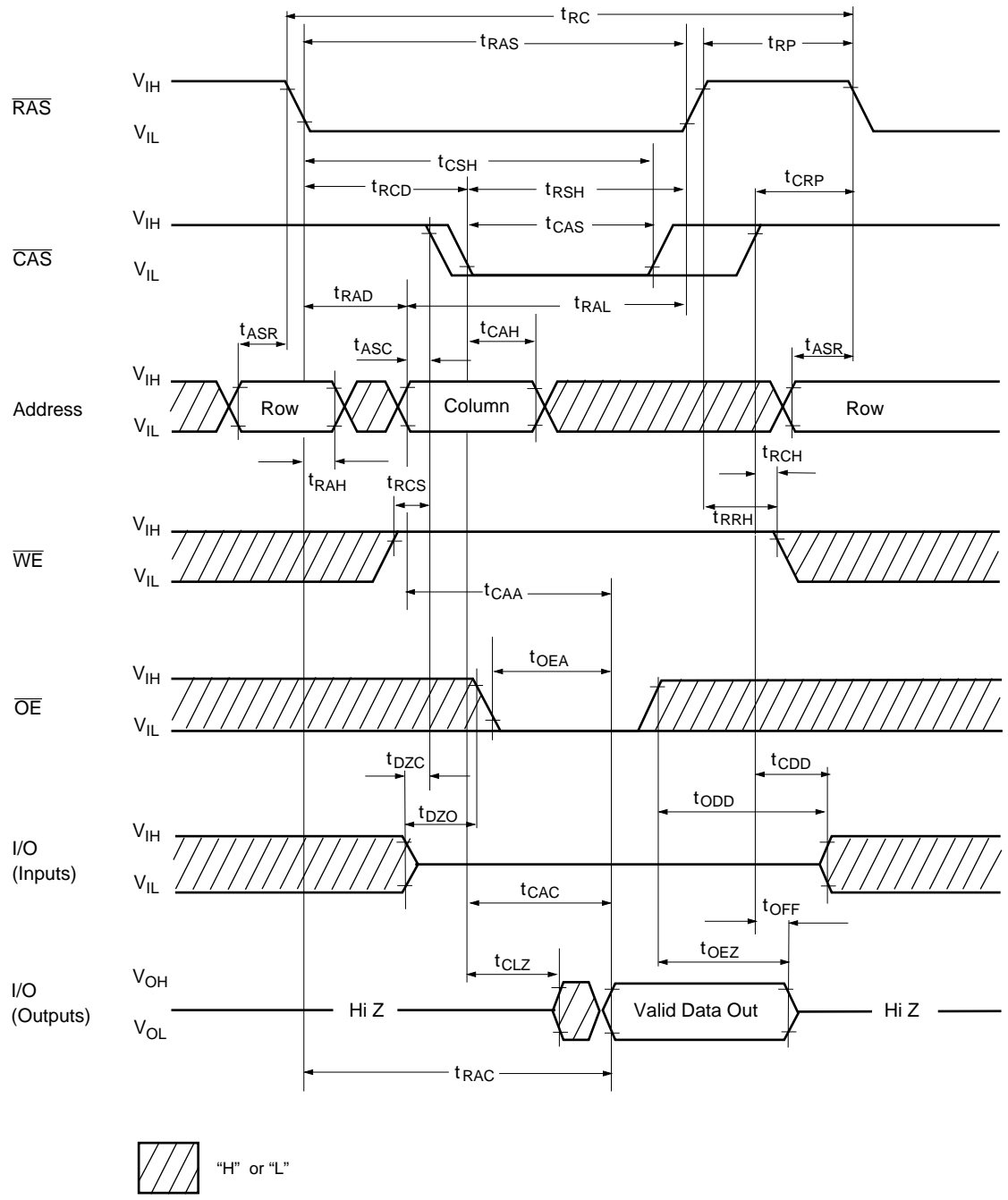
#	Symbol	Parameter	-50		-60		Unit	Note
			min.	max.	min.	max.		
<b>CAS-before-RAS Counter Test Cycle</b>								
57	$t_{CPT}$	$\overline{\text{CAS}}$ precharge time	35	–	40	–	ns	
<b>Test Mode</b>								
61	$t_{WTS}$	Write command setup time	10	–	10	–	ns	
62	$t_{WTH}$	Write command hold time	10	–	10	–	ns	
63	$t_{CHRT}$	$\overline{\text{CAS}}$ hold time	30	–	30	–	ns	
64	$t_{RAHT}$	$\overline{\text{RAS}}$ hold time in test mode	30	–	30	–	ns	

**Notes:**

- 1) All voltages are referenced to  $V_{SS}$ .
- 2)  $I_{CC1}$ ,  $I_{CC3}$ ,  $I_{CC4}$  and  $I_{CC5}$  depend on cycle rate.
- 3)  $I_{CC1}$  and  $I_{CC4}$  depend on output loading. Specified values are obtained with the output open.
- 4) Address can be changed once or less while  $\overline{RAS} = V_{IL}$ . In case of  $I_{CC4}$  it can be changed once or less during a EDO page mode cycle
- 5) An initial pause of 200  $\mu s$  is required after power-up followed by 8  $\overline{RAS}$  cycles of which at least one cycle has to be a refresh cycle, before proper device operation is achieved. In case of using the 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. Transition times are also measured between  $V_{IH}$  and  $V_{IL}$ .
- 8) Measured with the specified current load and 100 pF at  $V_{OL} = 0.8$  V and  $V_{OH} = 2.0$  V. Access time is determined by the latter of  $t_{RAC}$ ,  $t_{CAC}$ ,  $t_{CAA}$ ,  $t_{CPA}$ ,  $t_{OEA}$ .  $t_{CAC}$  is measured from tristate.
- 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)  $t_{OFF (max.)}$ ,  $t_{OEZ (max.)}$  define the time at which the output achieves the open-circuit conditions and are not referenced to output voltage levels.  $t_{OFF}$  is referenced from the rising edge of  $\overline{RAS}$  or  $\overline{CAS}$ , whichever occurs last.
- 13) Either  $t_{DZC}$  or  $t_{DZO}$  must be satisfied.
- 14) Either  $t_{CDD}$  or  $t_{ODD}$  must be satisfied.
- 15)  $t_{WCS}$ ,  $t_{RWD}$ ,  $t_{CWD}$  and  $t_{AWD}$  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 data out pin will remain open-circuit (high impedance) through the entire cycle; if  $t_{RWD} > t_{RWD (min.)}$ ,  $t_{CWD} > t_{CWD (min.)}$  and  $t_{AWD} > t_{AWD (min.)}$ , the cycle is a read-write cycle and I/O will contain data read from the selected cells. If neither of the above sets of conditions is satisfied, the condition of I/O (at access time) is indeterminate.
- 16) These parameters are referenced to the  $\overline{CAS}$  leading edge in early write cycles and to the  $\overline{WE}$  leading edge in read-write cycles.

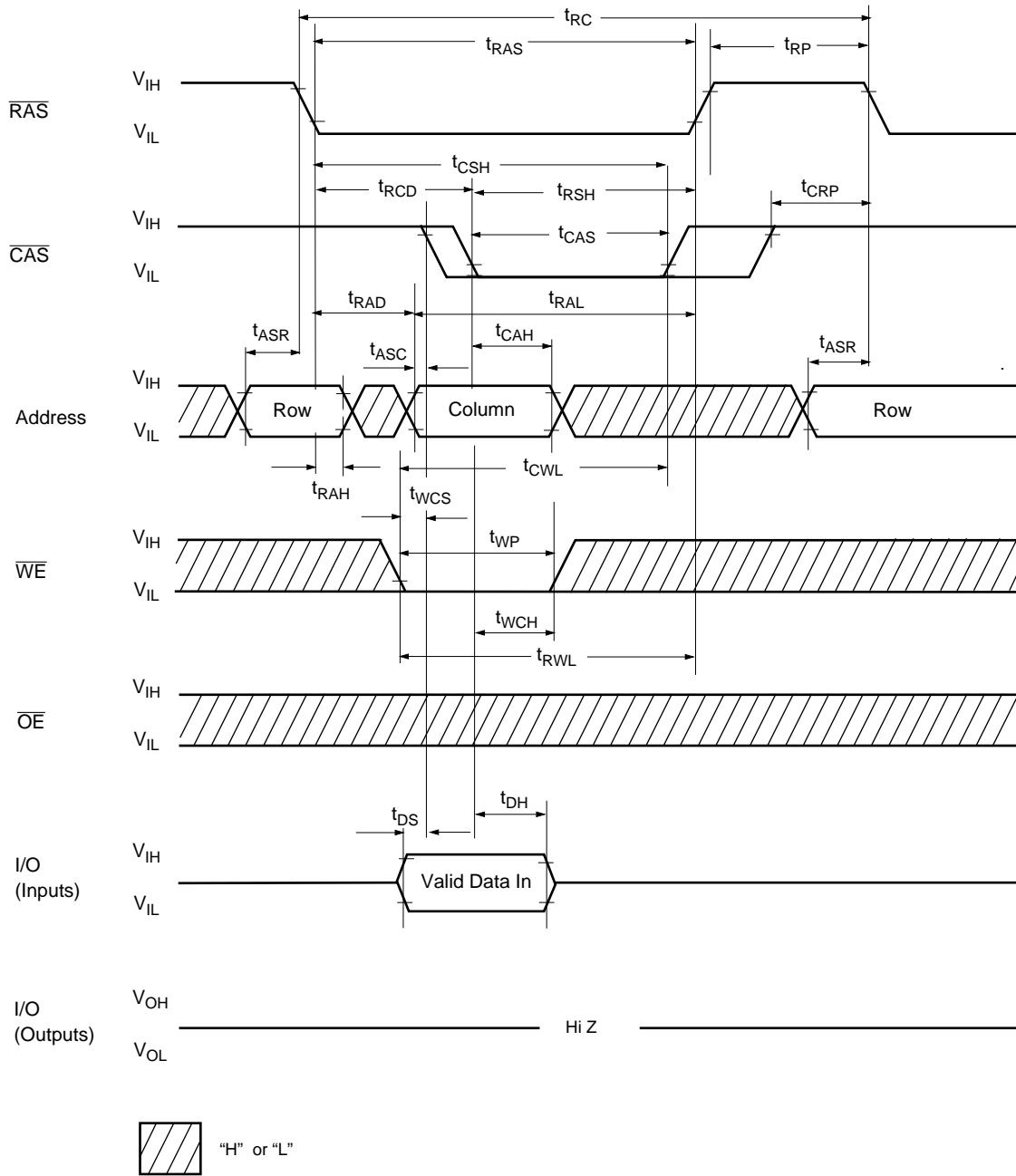


Waveforms of Read Cycle



WL1

Waveforms of Write Cycle (Early Write)

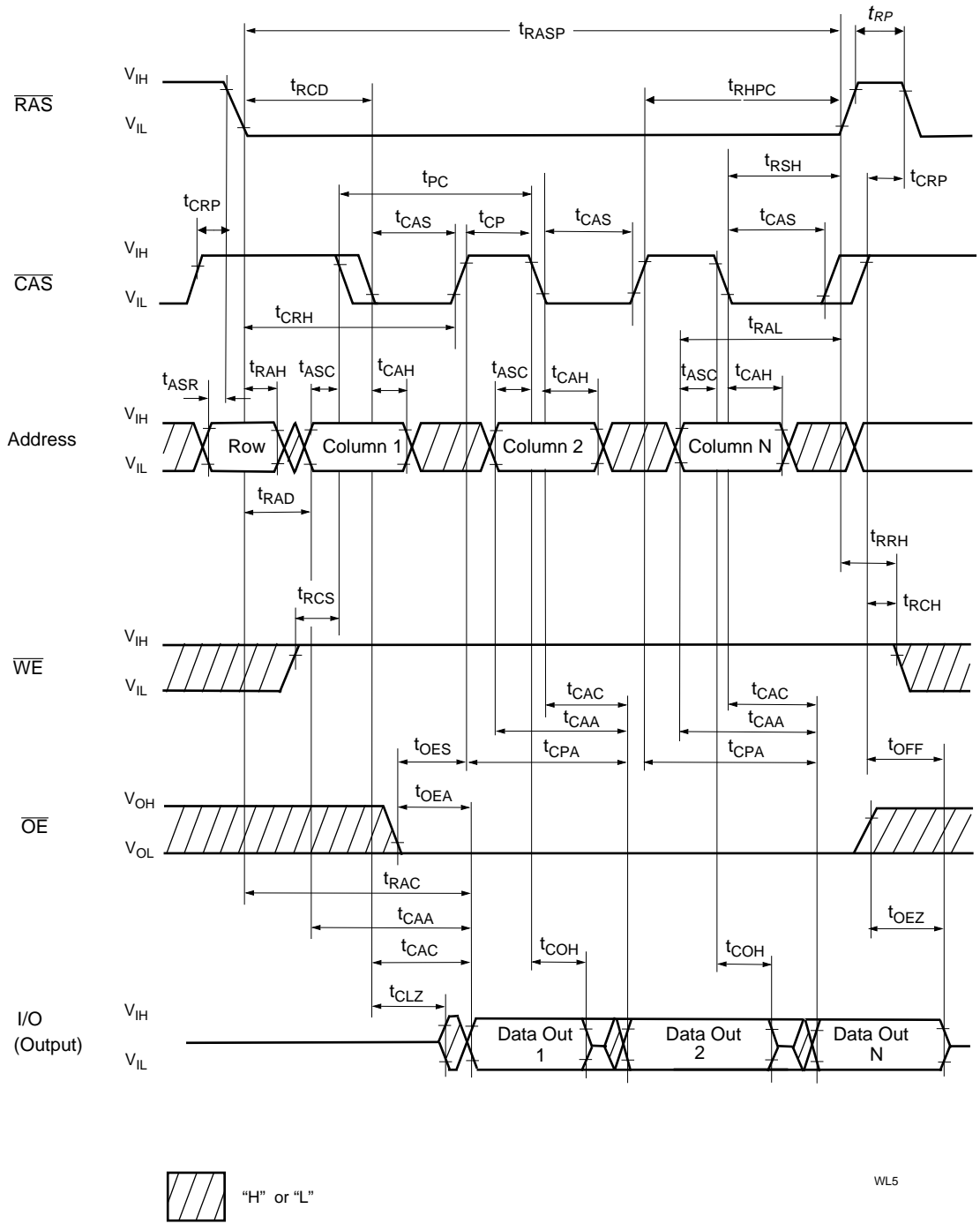


WL2

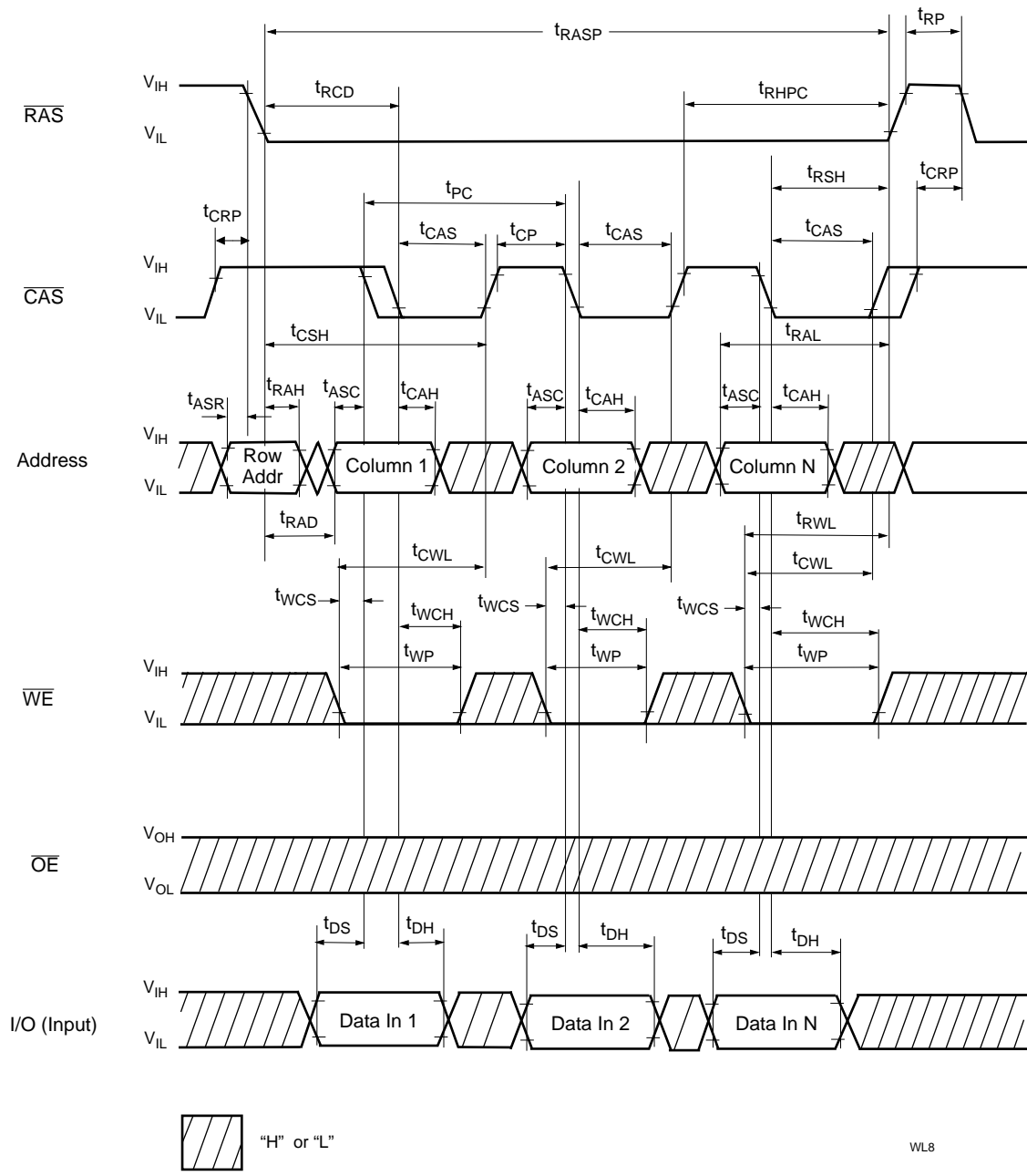




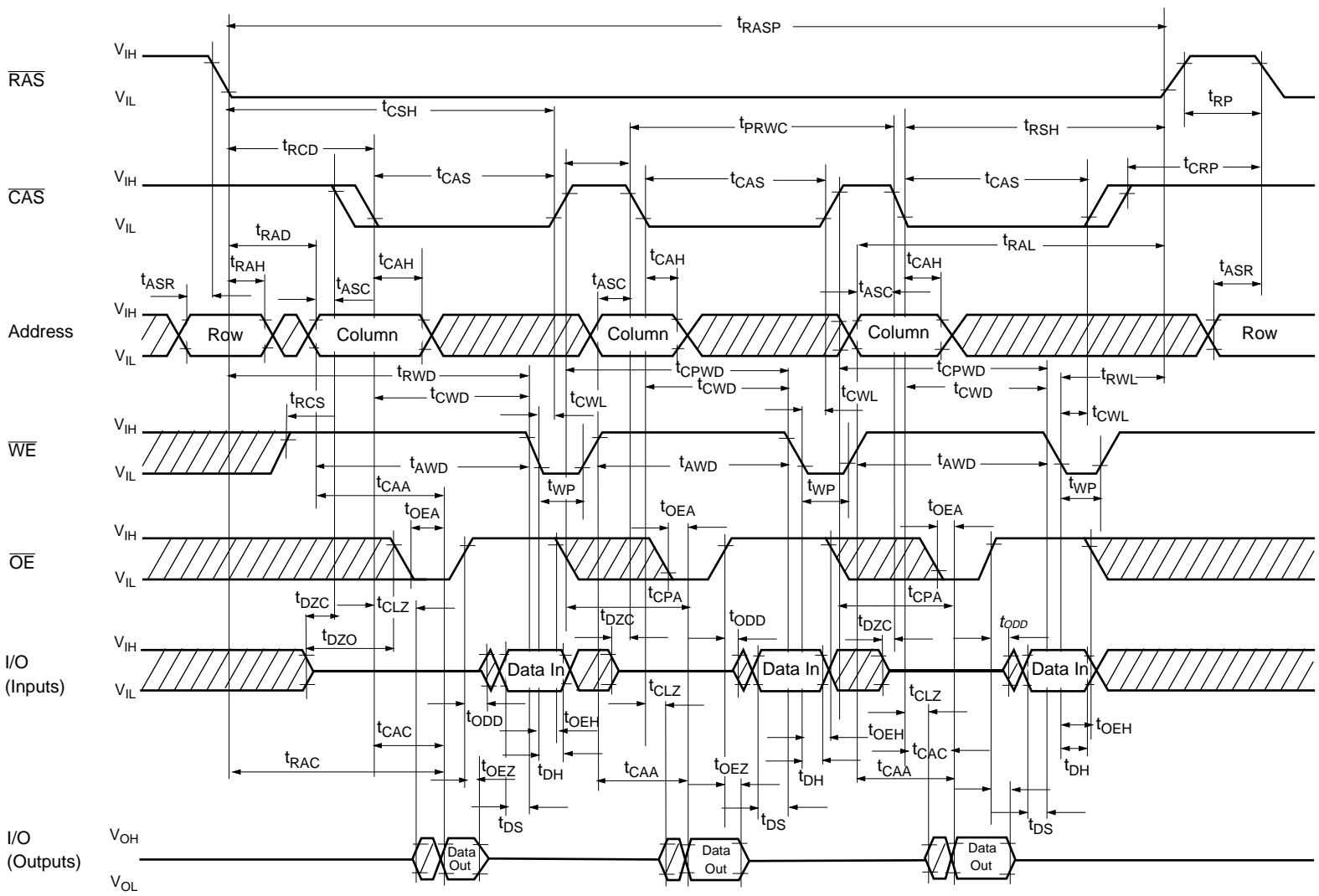
Waveforms of EDO Page Mode Read Cycle



Waveforms of EDO Page Mode Early Write Cycle

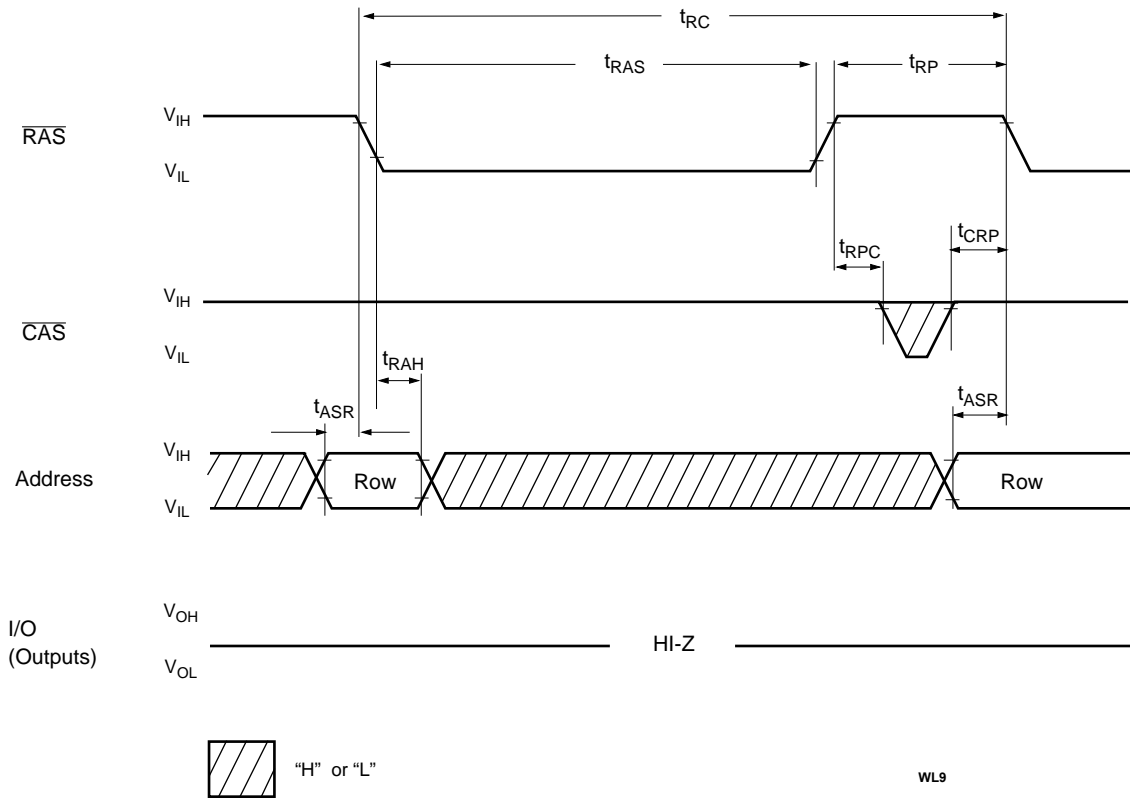


Waveforms of EDO Page Mode Late Write and Read-Modify-Write Cycle



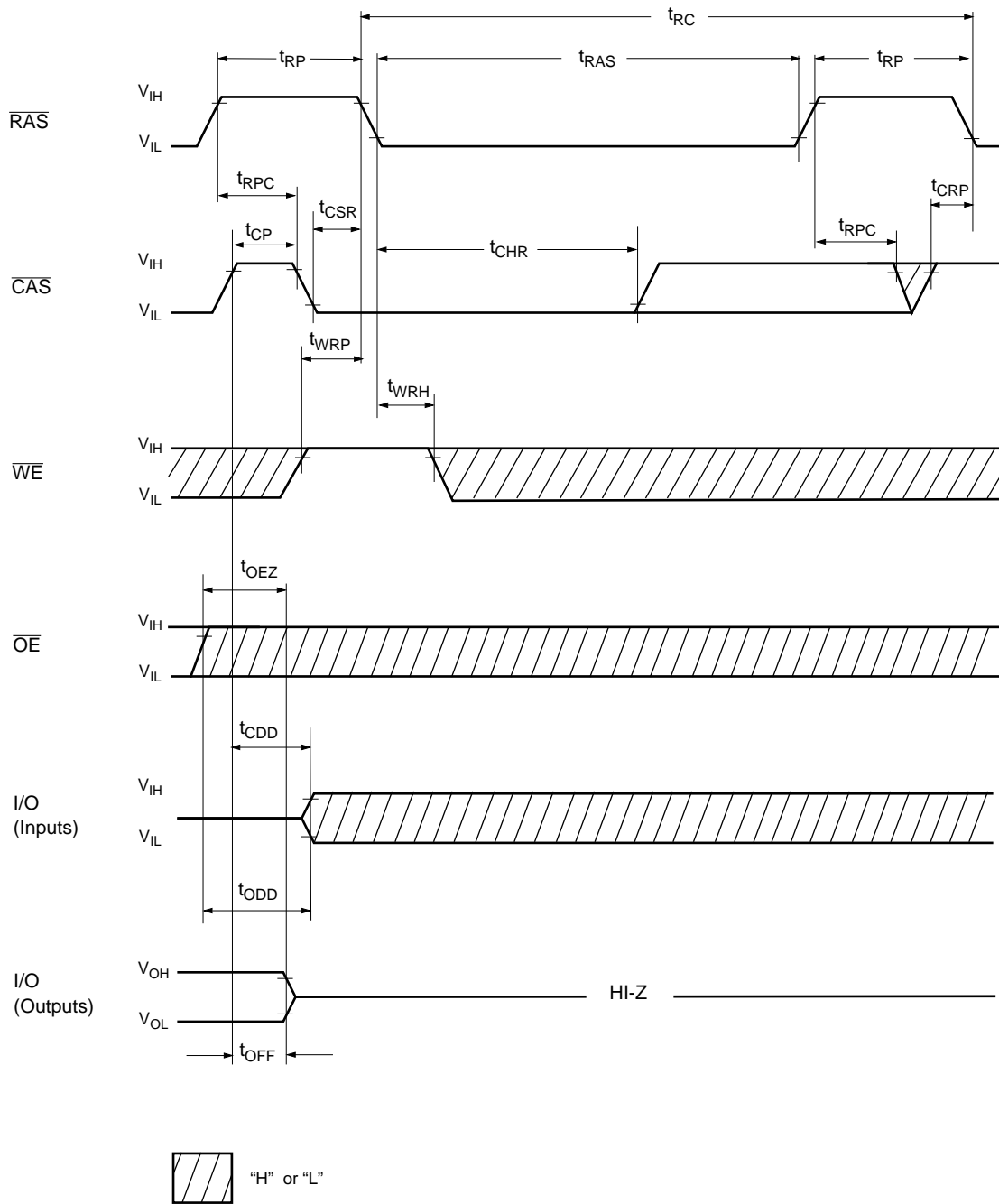
WL17

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





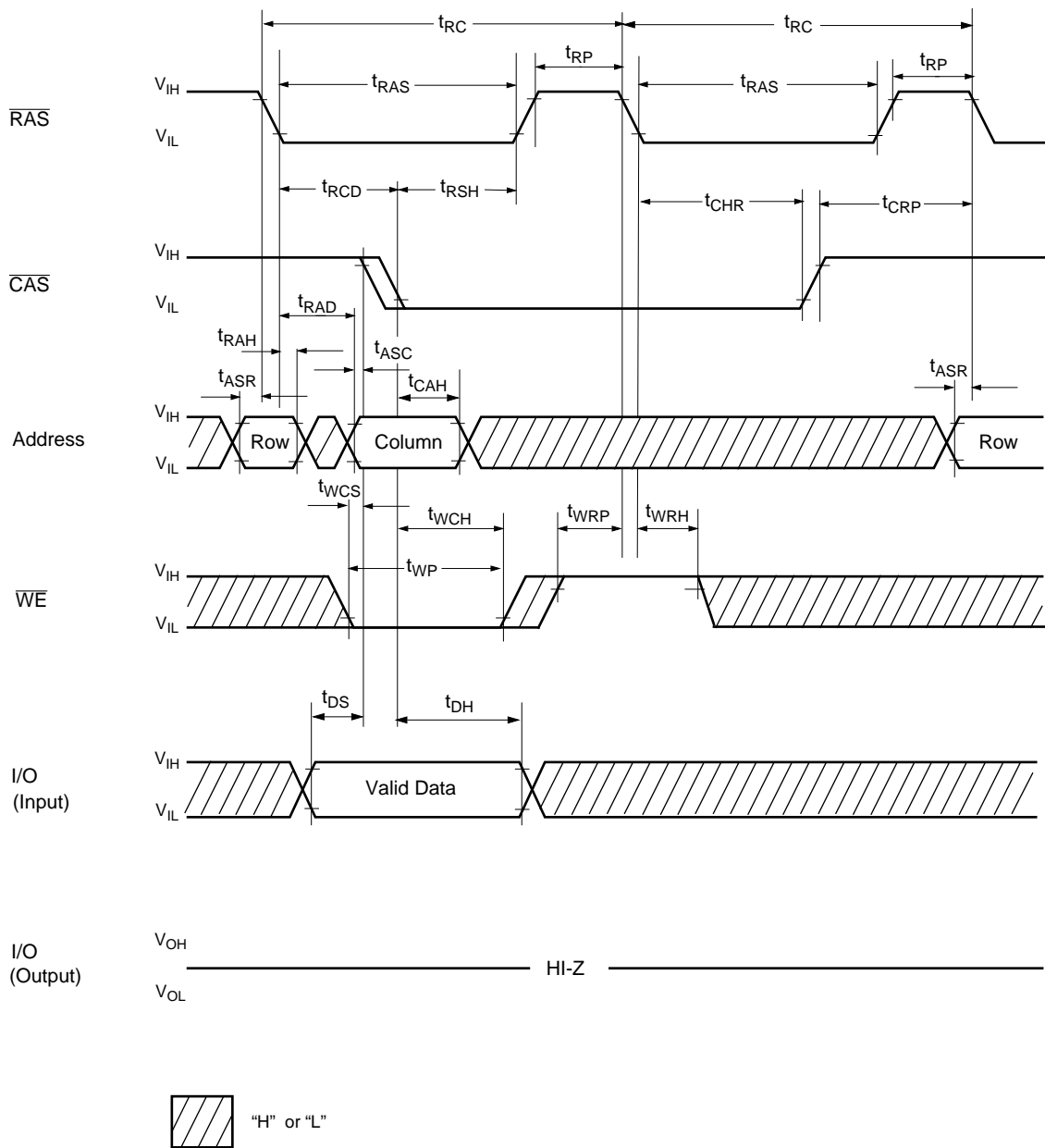
Waveforms of  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  Refresh Cycle



WL10

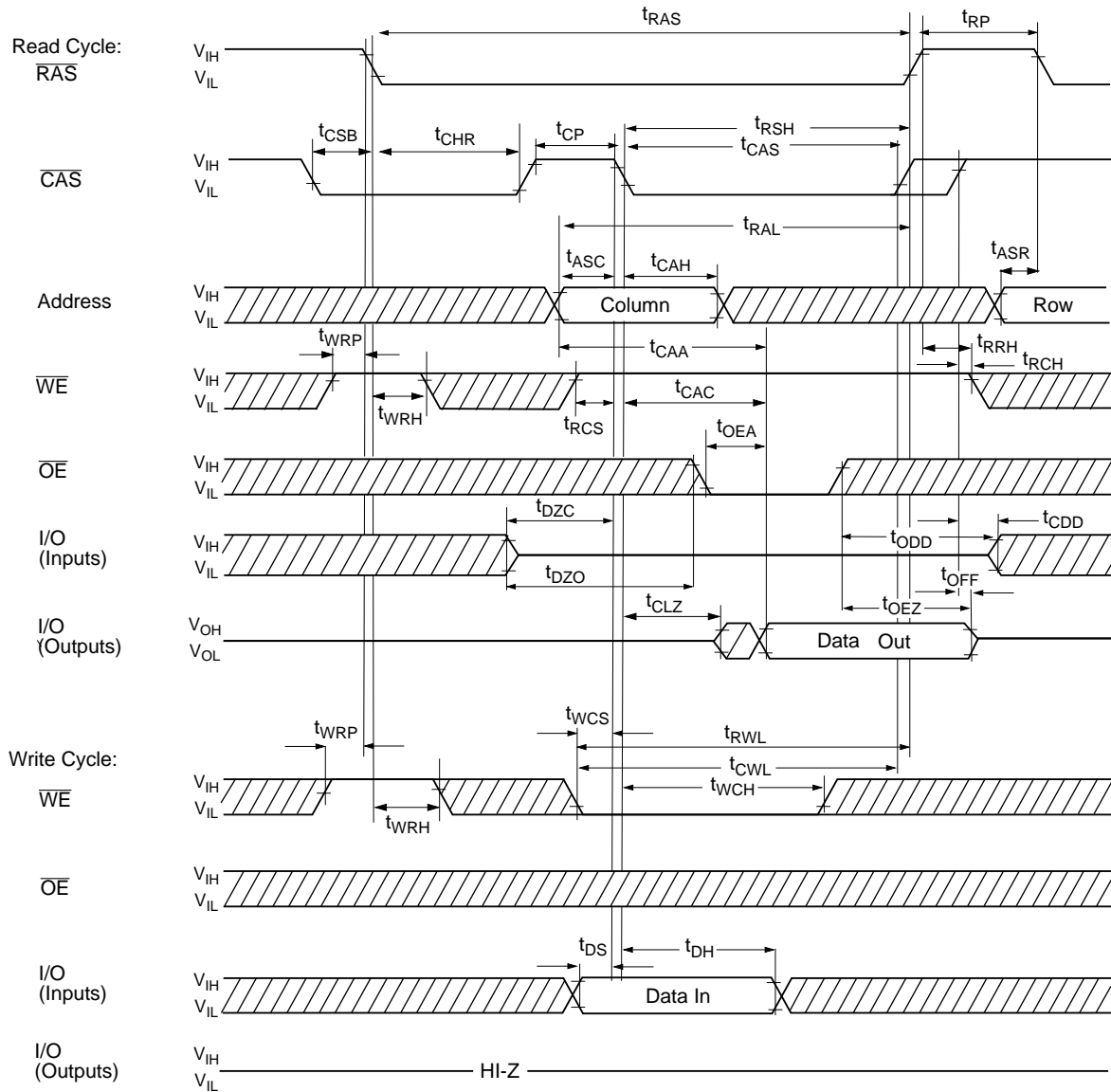


Waveforms of Hidden Refresh Early Write Cycle

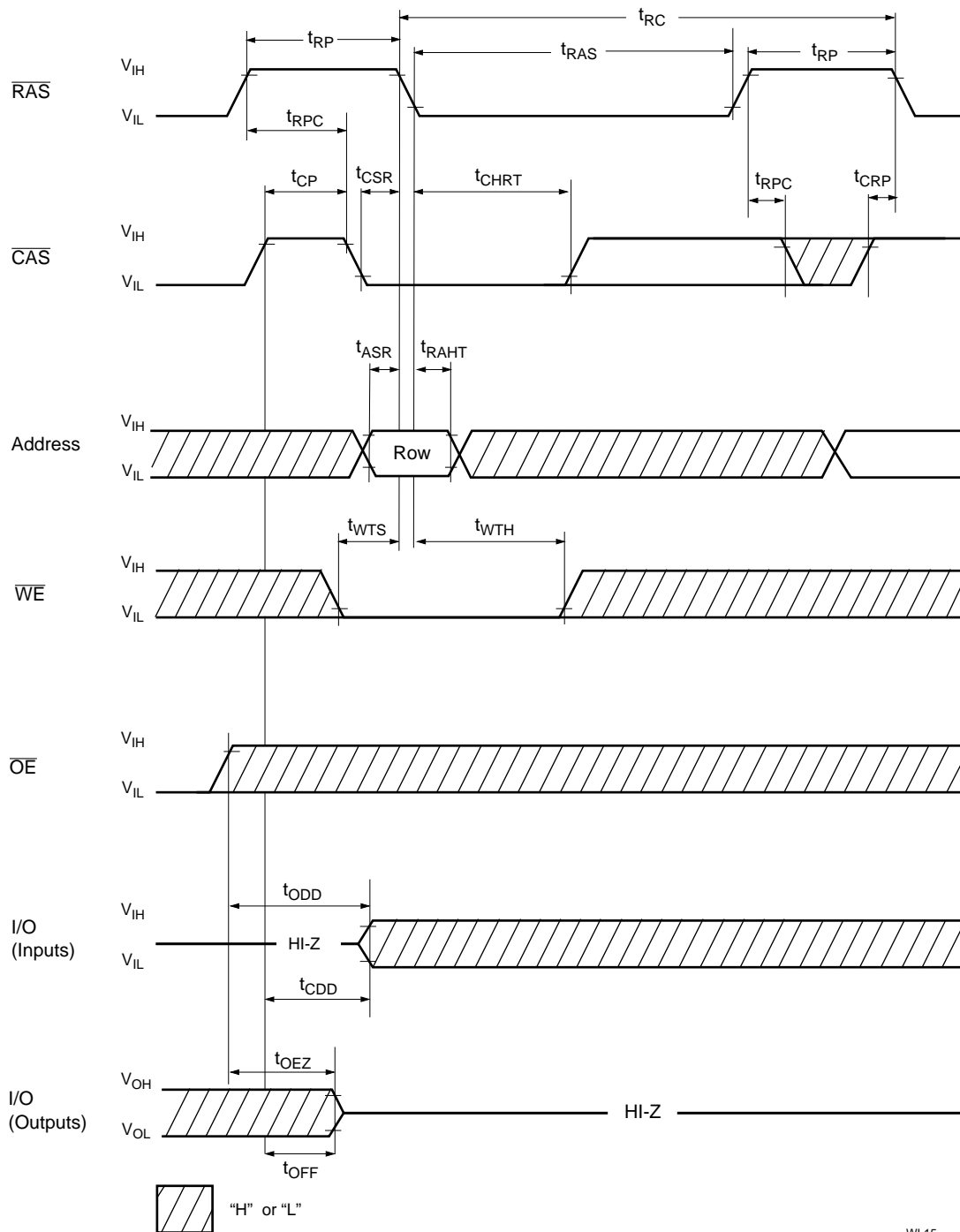


WL12

**Waveforms of CAS-before-RAS Refresh Counter Test Cycle**



**Waveforms of Test Mode Entry**



WL15

**Test Mode**

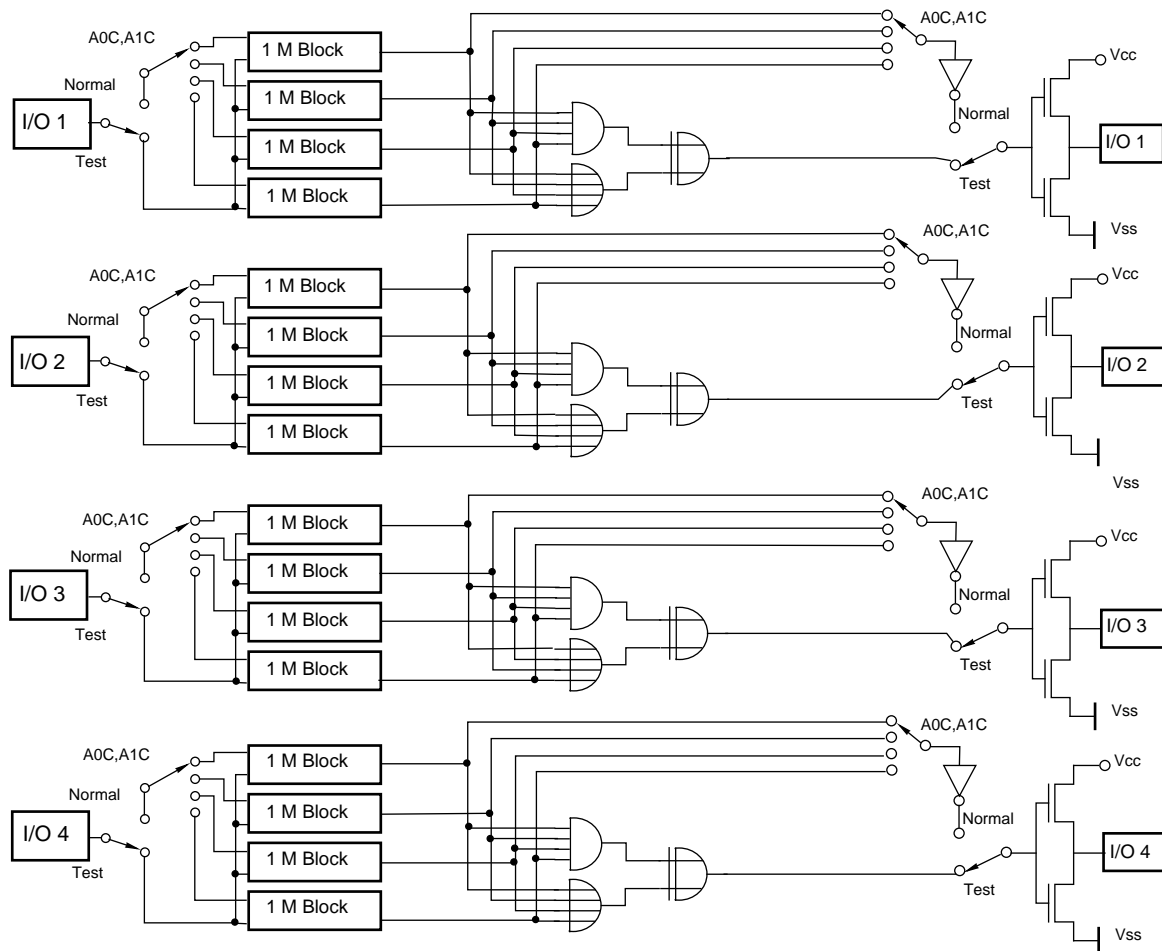
As the V53C516405A is organized internally as 1M x 16-bits, a test mode cycle using 4:1 compression can be used to improve test time. Note that in the 4M x 4 version the test time is reduced by 1/4 for a N test pattern.

In a test mode "write" the data from each I/O pin is written into four 1M blocks simultaneously (all "1" s or all "0" s). In test mode "read" each I/O output is used for indicating the test mode result. If the internal four bits are equal, the I/O would indicate a "1".

If they were not equal, the I/O would indicate a "0". The WCBR cycle ( $\overline{WE}$ , CAS before  $\overline{RAS}$ ) puts the device into test mode. To exit from test mode, a "CAS before  $\overline{RAS}$  refresh", "RAS only refresh" or "Hidden refresh" can be used. Refresh during test mode operation can be performed by normal read cycles or by WCBR refresh cycles.

Row addresses A0 through A9 have to kept high to perform a testmode entry cycle. All other addresses are don't care.

**Block Diagram in Test Mode**





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