

<b>V53C516400A</b>	<b>50</b>	<b>60</b>
Max. $\overline{\text{RAS}}$ Access Time, ( $t_{\text{RAC}}$ )	50 ns	60 ns
Max. Column Address Access Time, ( $t_{\text{CAA}}$ )	25 ns	30 ns
Min. Page Mode Cycle Time, ( $t_{\text{PC}}$ )	35 ns	40 ns
Min. Read/Write Cycle Time, ( $t_{\text{RC}}$ )	84 ns	104 ns

**Features**

- 4M x 4-bit organization
- Fast Page Mode for a sustained data rate of 50 MHz
- $\overline{\text{RAS}}$  access time: 50, 60 ns
- Low power dissipation
- Read-Modify-Write,  $\overline{\text{RAS}}$ -Only Refresh,  $\overline{\text{CAS}}$ -Before- $\overline{\text{RAS}}$  Refresh and 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 +5V  $\pm 10\%$  Power Supply
- TTL Interface

**Description**

The V53C516400A is a 4,194,304 x 4 bit high-performance CMOS dynamic random access memory. The V53C516400A offers Page mode operation. The V53C516400A has asymmetric address, 12-bit row and 10-bit column.

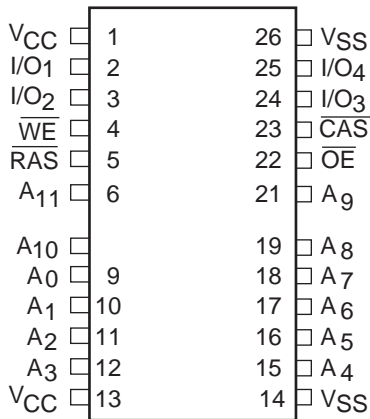
All inputs are TTL compatible. Fast Page Mode operation allows random access up to 1024 x 4 bits, within a page, with cycle times as short as 35ns.

These features make the V53C516400A 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



311640002-02

Pin Names

A <sub>0</sub> –A <sub>11</sub>	Row, Column Address Inputs
RAS	Row Address Strobe
CAS	Column Address Strobe
WE	Write Enable
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	26/24
TSOP-II	T	26/24

**Absolute Maximum Ratings\***

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

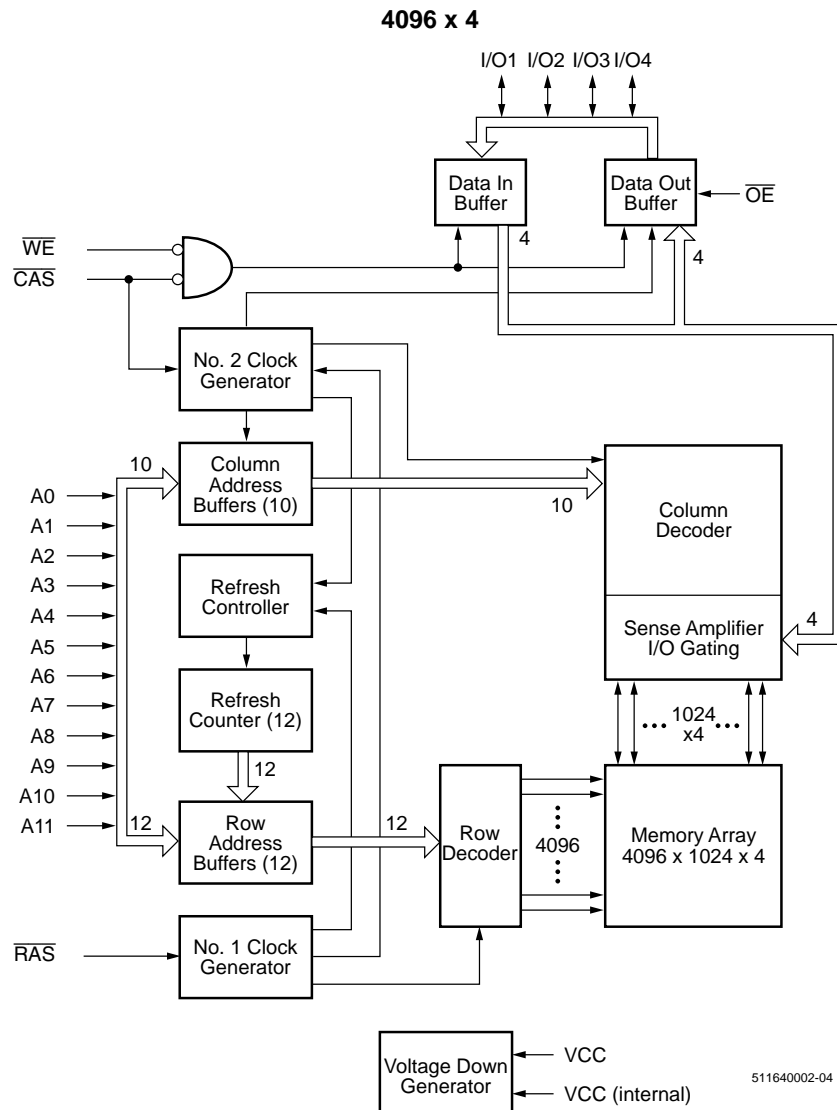
\*Note: Operation above Absolute Maximum Ratings can adversely affect device reliability.

**Capacitance\***

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V} \pm 10\%$ ,  $V_{SS} = 0\text{ V}$

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

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

**Block Diagram**

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

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

Symbol	Parameter	Access Time	V53C516400A			Unit	Test Conditions	Notes
			Min.	Typ.	Max.			
$I_{LI}$	Input Leakage Current (any input pin)		-10		10	$\mu\text{A}$	$V_{SS} \leq V_{IN} \leq V_{CC}$	1
$I_{LO}$	Output Leakage Current (for High-Z State)		-10		10	$\mu\text{A}$	$V_{SS} \leq V_{OUT} \leq V_{CC}$ RAS, CAS at $V_{IH}$	1
$I_{CC1}$	$V_{CC}$ Supply Current, Operating	50			50	mA	$t_{RC} = t_{RC}(\text{min.})$	2, 3, 4
		60			40			
$I_{CC2}$	$V_{CC}$ Supply Current, TTL Standby				2	mA	RAS, CAS at $V_{IH}$ other inputs $\geq V_{SS}$	
$I_{CC3}$	$V_{CC}$ Supply Current, RAS-Only Refresh	50			50	mA	$t_{RC} = t_{RC}(\text{min.})$	2, 4
		60			40			
$I_{CC4}$	$V_{CC}$ Supply Current, Fast Page Mode Operation	50			25	mA	Minimum Cycle	2, 3, 4
		60			20			
$I_{CC5}$	$V_{CC}$ Supply Current, during CAS-before-RAS Refresh	50			50	mA		2, 4
		60			40			
$I_{CC6}$	$V_{CC}$ Supply Current, CMOS Standby				1.0	mA	RAS $\geq V_{CC} - 0.2\text{V}$ , CAS $\geq V_{CC} - 0.2\text{V}$ other input $\geq V_{SS}$	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>** $T_A = 0 \text{ to } 70^\circ\text{C}$ ,  $V_{CC} = 5V \pm 10\%$ ,  $t_T = 2 \text{ ns}$ 

#	Symbol	Parameter	-50		-60		Unit	Note
			min.	max.	min.	max.		
Common Parameters								
1	t <sub>RC</sub>	Random read or write cycle time	90	–	110	–	ns	
2	t <sub>RP</sub>	$\overline{\text{RAS}}$ precharge time	30	–	40	–	ns	
3	t <sub>RAS</sub>	$\overline{\text{RAS}}$ pulse width	50	10k	60	10k	ns	
4	t <sub>CAS</sub>	$\overline{\text{CAS}}$ pulse width	13	10k	15	10k	ns	
5	t <sub>ASR</sub>	Row address setup time	0	–	0	–	ns	
6	t <sub>RAH</sub>	Row address hold time	8	–	10	–	ns	
7	t <sub>ASC</sub>	Column address setup time	0	–	0	–	ns	
8	t <sub>CAH</sub>	Column address hold time	10	–	15	–	ns	
9	t <sub>RCD</sub>	$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	18	37	20	45	ns	
10	t <sub>RAD</sub>	$\overline{\text{RAS}}$ to column address delay	13	25	15	30	ns	
11	t <sub>RSH</sub>	$\overline{\text{RAS}}$ hold time	13		15	–	ns	
12	t <sub>CSH</sub>	$\overline{\text{CAS}}$ hold time	50		60	–	ns	
13	t <sub>CRP</sub>	$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	5	–	5	–	ns	
14	t <sub>T</sub>	Transition time (rise and fall)	3	50	3	50	ns	7
15	t <sub>REF</sub>	Refresh period	–	64	–	64	ms	
Read Cycle								
16	t <sub>RAC</sub>	Access time from $\overline{\text{RAS}}$	–	50	–	60	ns	8, 9
17	t <sub>CAC</sub>	Access time from $\overline{\text{CAS}}$	–	13	–	15	ns	8, 9
18	t <sub>CAA</sub>	Access time from column address	–	25	–	30	ns	8,10
19	t <sub>OEA</sub>	$\overline{\text{OE}}$ access time	–	13	–	15	ns	
20	t <sub>RAL</sub>	Column address to $\overline{\text{RAS}}$ lead time	25	–	30	–	ns	
21	t <sub>RCS</sub>	Read command setup time	0	–	0	–	ns	
22	t <sub>RCH</sub>	Read command hold time	0	–	0	–	ns	11
23	t <sub>RRH</sub>	Read command hold time referenced to $\overline{\text{RAS}}$	0	–	0	–	ns	11
24	t <sub>CLZ</sub>	$\overline{\text{CAS}}$ to output in low-Z	0	–	0	–	ns	8
25	t <sub>OFF</sub>	Output buffer turn-off delay	0	13	0	15	ns	12
26	t <sub>OEZ</sub>	Output turn-off delay from $\overline{\text{OE}}$	0	13	0	15	ns	12
27	t <sub>DZC</sub>	Data to $\overline{\text{CAS}}$ low delay	0	–	0	–	ns	13
28	t <sub>DZO</sub>	Data to $\overline{\text{OE}}$ low delay	0	–	0	–	ns	13
29	t <sub>CDD</sub>	$\overline{\text{CAS}}$ high to data delay	13	–	15	–	ns	14
30	t <sub>ODD</sub>	$\overline{\text{OE}}$ high to data delay	13	–	15	–	ns	14

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

#	Symbol	Parameter	-50		-60		Unit	Note
			min.	max.	min.	max.		
Write Cycle								
31	t <sub>WCH</sub>	Write command hold time	8	–	10	–	ns	
32	t <sub>WP</sub>	Write command pulse width	8	–	10	–	ns	
33	t <sub>WCS</sub>	Write command setup time	0	–	0	–	ns	15
34	t <sub>RWL</sub>	Write command to RAS lead time	13	–	15	–	ns	
35	t <sub>CWL</sub>	Write command to CAS lead time	13	–	15	–	ns	
36	t <sub>DS</sub>	Data setup time	0	–	0	–	ns	16
37	t <sub>DH</sub>	Data hold time	8	–	10	–	ns	16
Read-modify-Write Cycle								
38	t <sub>RWC</sub>	Read-write cycle time	126	–	150	–	ns	
39	t <sub>RWD</sub>	RAS to WE delay time	68	–	80	–	ns	15
40	t <sub>CWD</sub>	CAS to WE delay time	31	–	35	–	ns	15
41	t <sub>AWD</sub>	Column address to WE delay time	43	–	50	–	ns	15
42	t <sub>OEh</sub>	OE command hold time	13	–	15	–	ns	
Fast Page Mode Cycle								
43	t <sub>PC</sub>	Fast Page mode cycle time	35	–	40	–	ns	
44	t <sub>CP</sub>	CAS precharge time	10	–	10	–	ns	
45	t <sub>CPA</sub>	Access time from CAS precharge	–	30	–	35	ns	7
46	t <sub>RASP</sub>	RAS pulse width in Fast mode	50	200k	60	200k	ns	
47	t <sub>RHPC</sub>	CAS precharge to RAS Delay	30	–	35	–	ns	
Fast Page Mode Read-modify-Write Cycle								
48	t <sub>PRWC</sub>	Fast Page mode read-write cycle time	71	–	80	–	ns	
49	t <sub>CPWD</sub>	CAS precharge to WE	48	–	55	–	ns	
CAS-before-RAS Refresh Cycle								
50	t <sub>CSR</sub>	CAS setup time	10	–	10	–	ns	
51	t <sub>CHR</sub>	CAS hold time	10	–	10	–	ns	
52	t <sub>RPC</sub>	RAS to CAS precharge time	5	–	5	–	ns	
53	t <sub>WRP</sub>	Write to RAS precharge time	10	–	10	–	ns	
54	t <sub>WRH</sub>	Write hold time referenced to RAS	10	–	10	–	ns	
CAS-before-RAS Counter Test Cycle								
55	t <sub>CPT</sub>	CAS precharge time	35	–	40	–	ns	

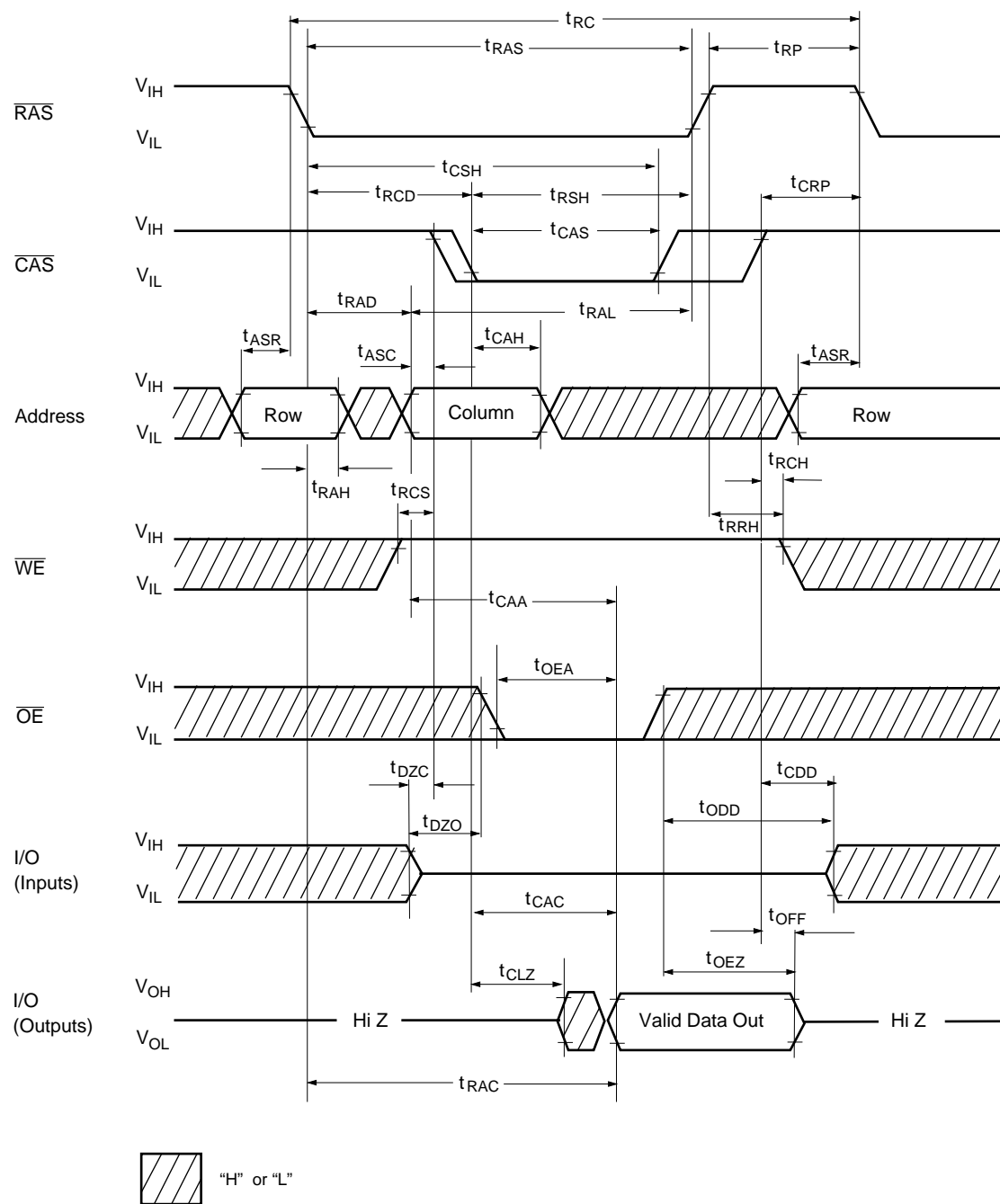
**AC Characteristics<sup>(5,6)</sup>** $T_A = 0 \text{ to } 70^\circ\text{C}$ ,  $V_{CC} = 5V \pm 10\%$ ,  $t_T = 2 \text{ ns}$ 

#	Symbol	Parameter	-50		-60		Unit	Note
			min.	max.	min.	max.		
Test Mode								
56	t <sub>WTS</sub>	Write command setup time	10	–	10	–	ns	
57	t <sub>WTH</sub>	Write command hold time	10	–	10	–	ns	
58	t <sub>CHRT</sub>	$\overline{\text{CAS}}$ hold time	30	–	30	–	ns	
59	t <sub>RAHT</sub>	$\overline{\text{RAS}}$ hold time in test mode	30	–	30	–	ns	

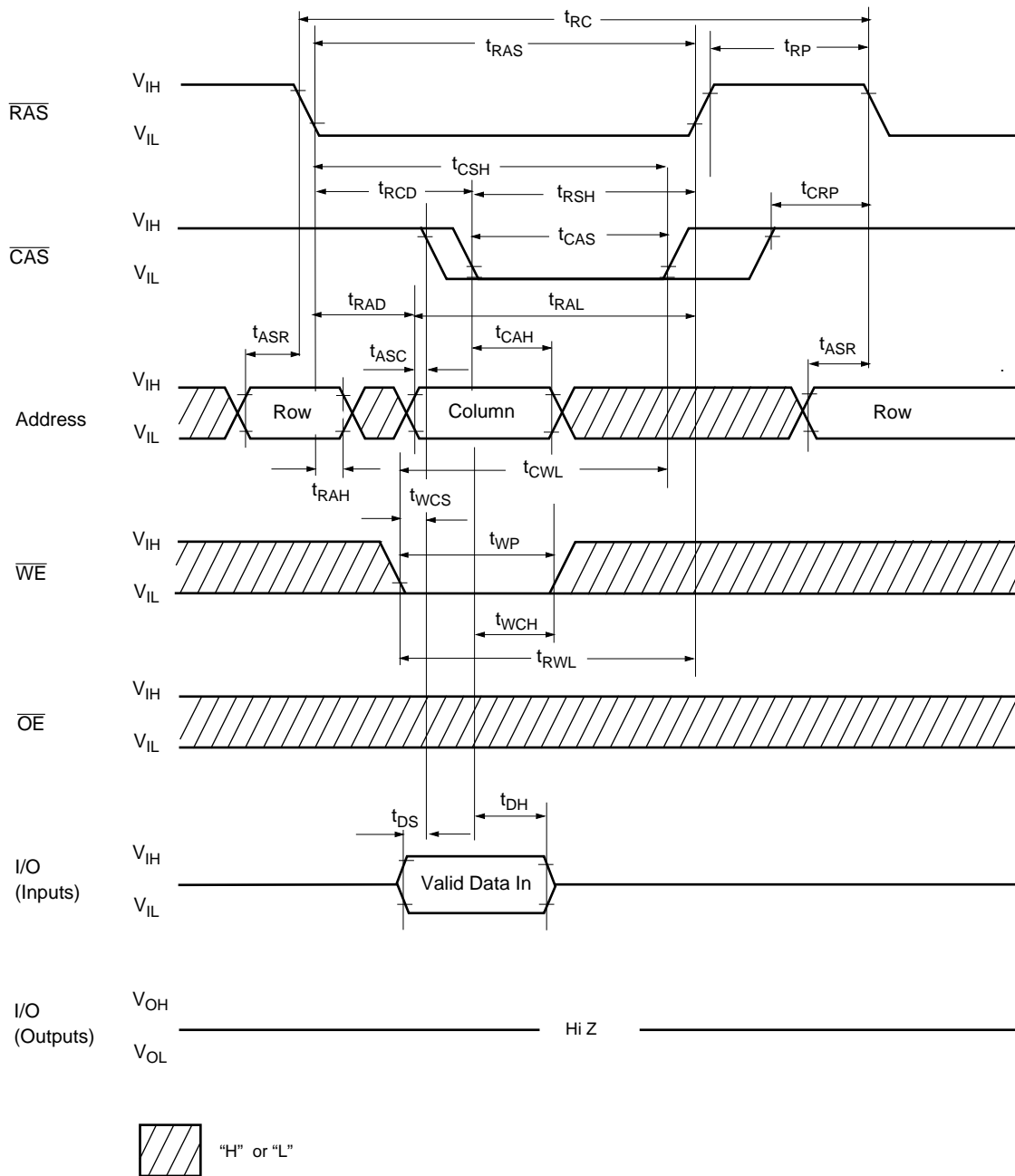
**Notes:**

- 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 Fast 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.

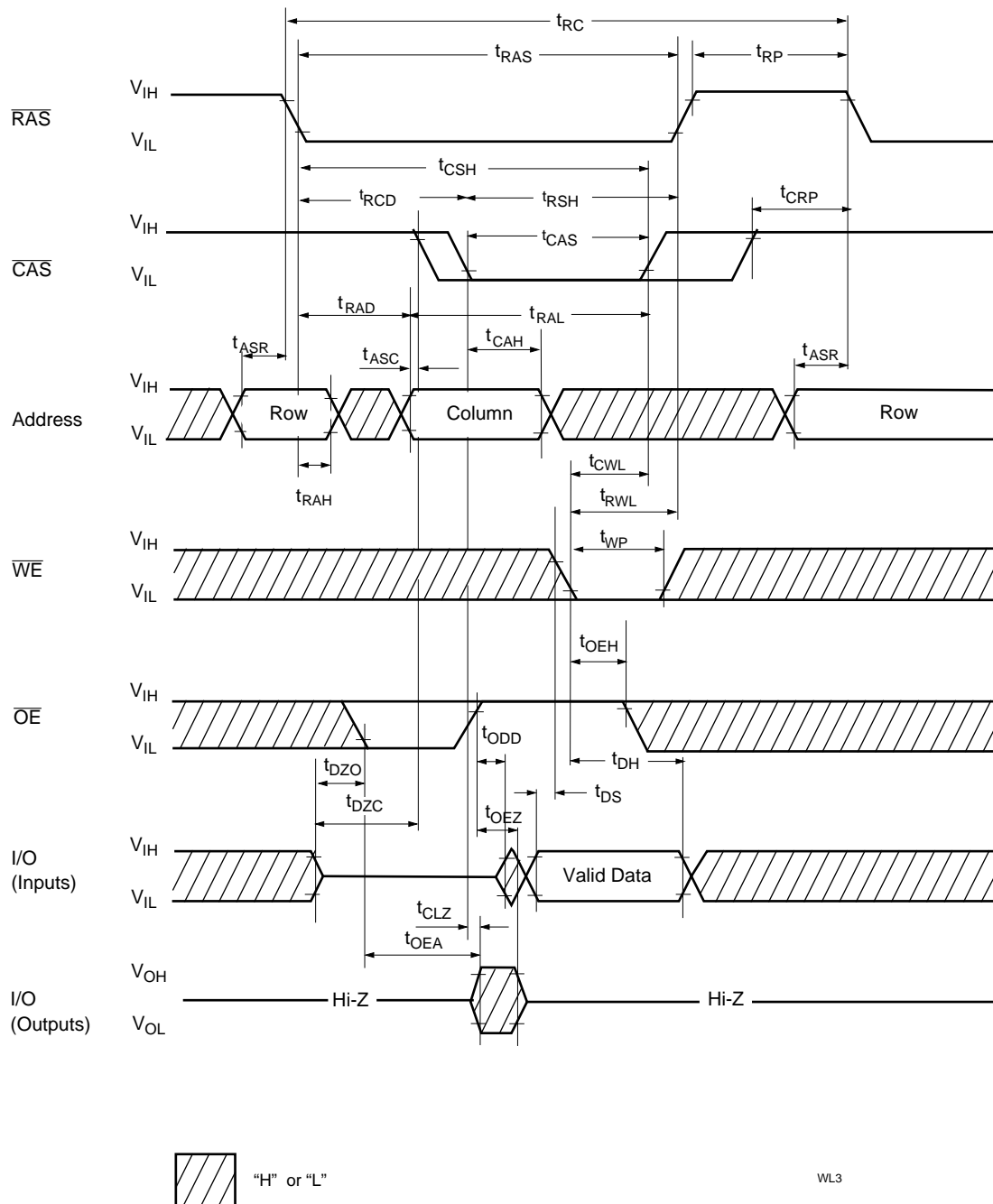


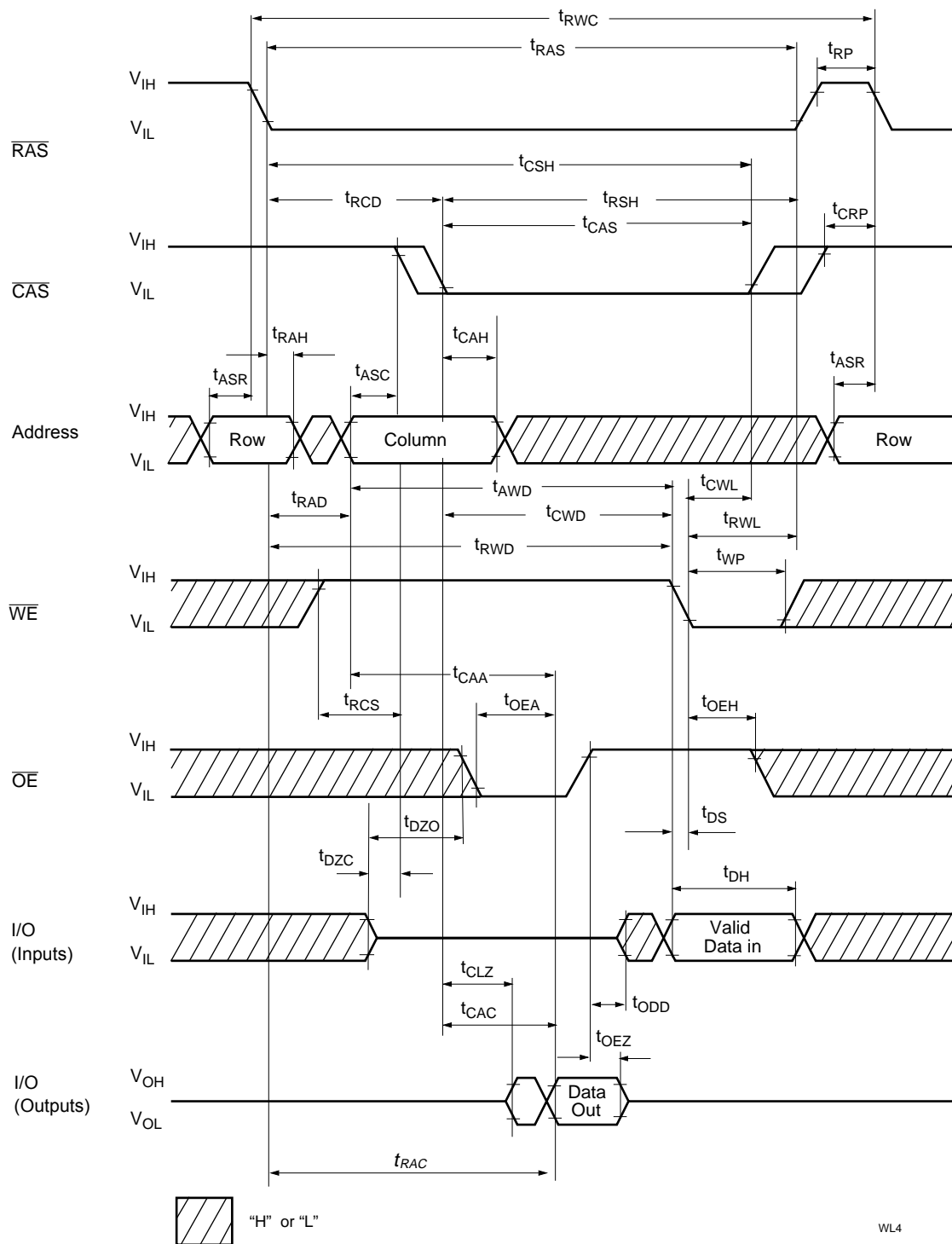
**Waveforms of Read Cycle**

WL1

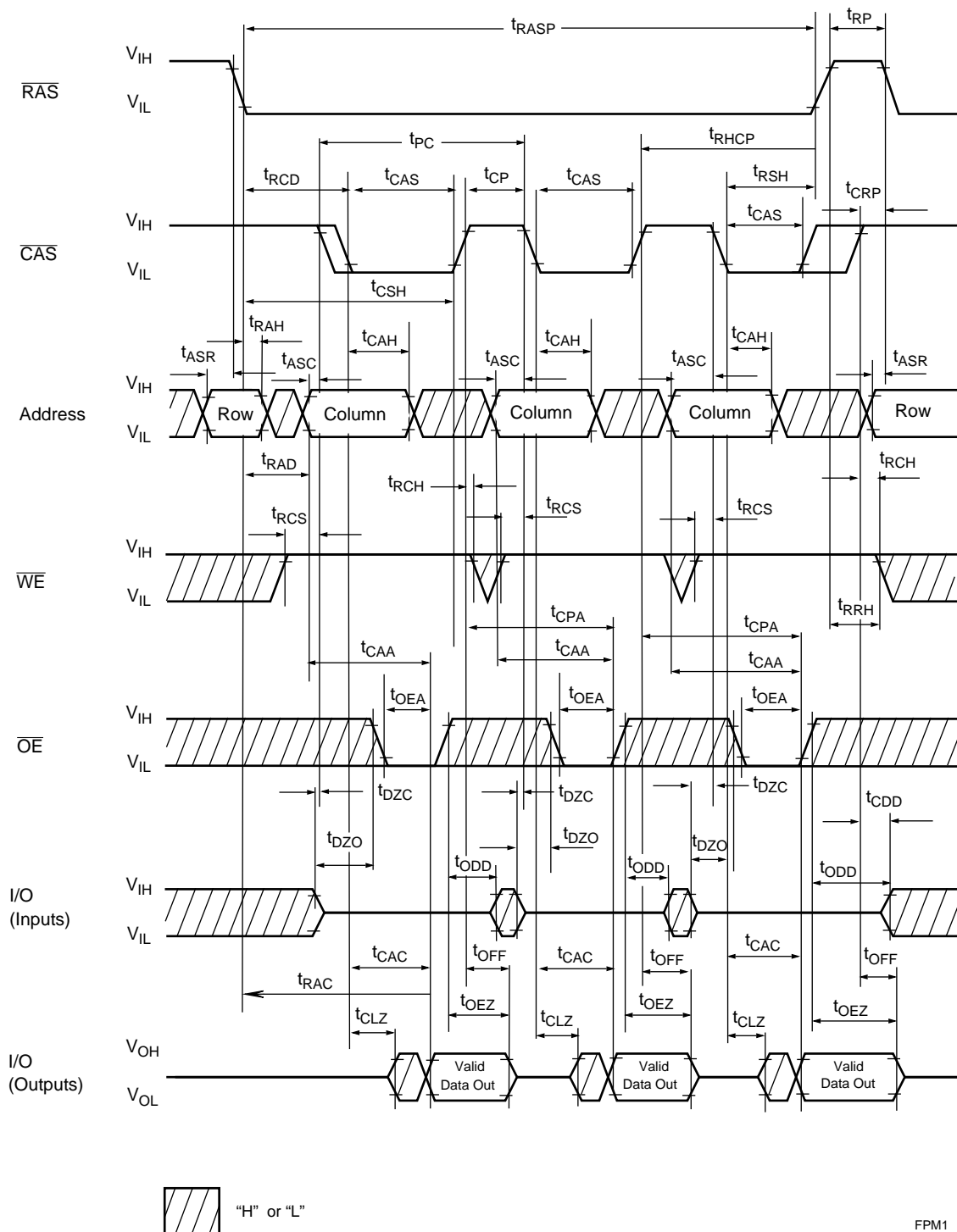
**Waveforms of Write Cycle (Early Write)**

WL2

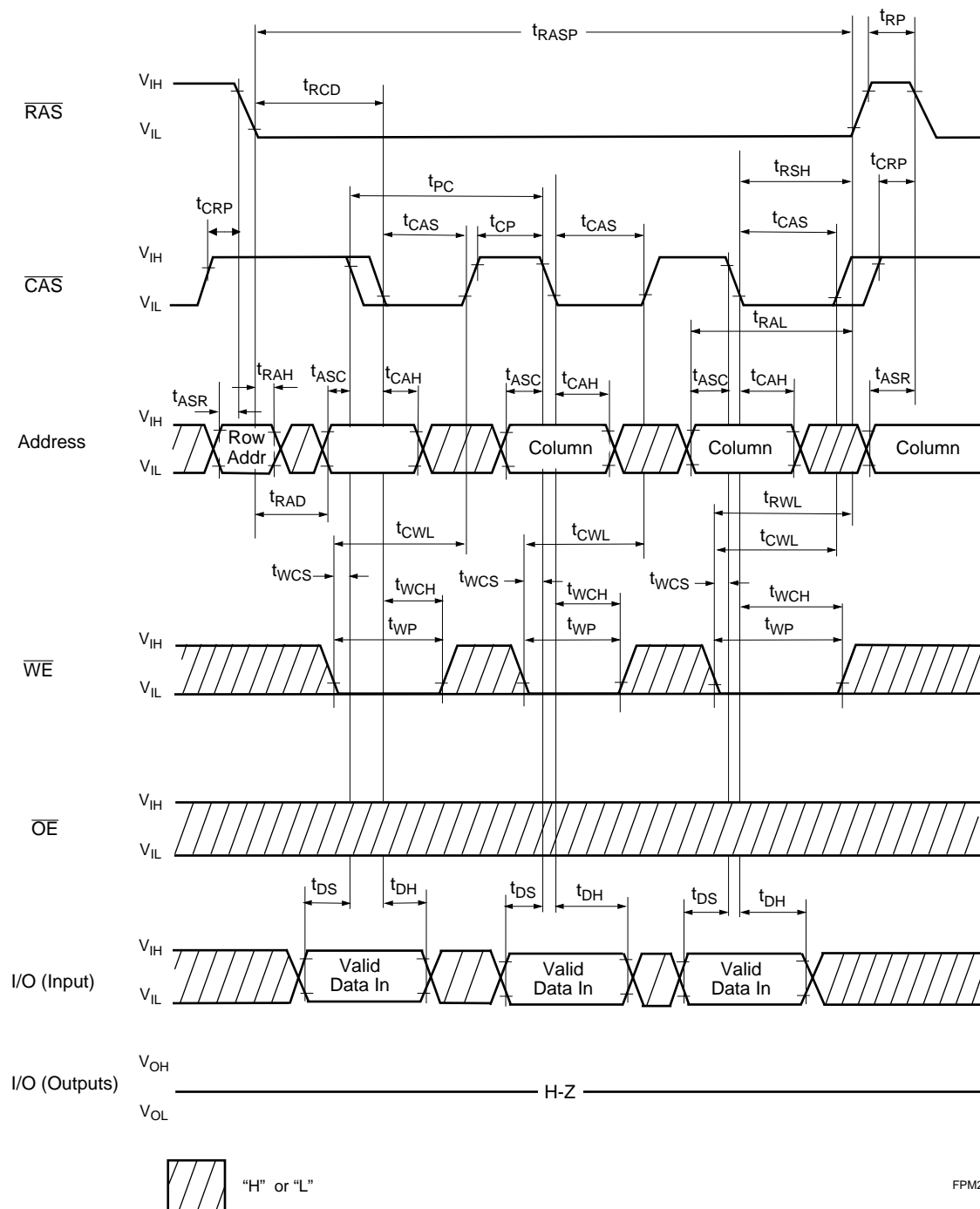
**Waveforms of Write Cycle ( $\overline{OE}$  Controlled Write)**

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

WL4

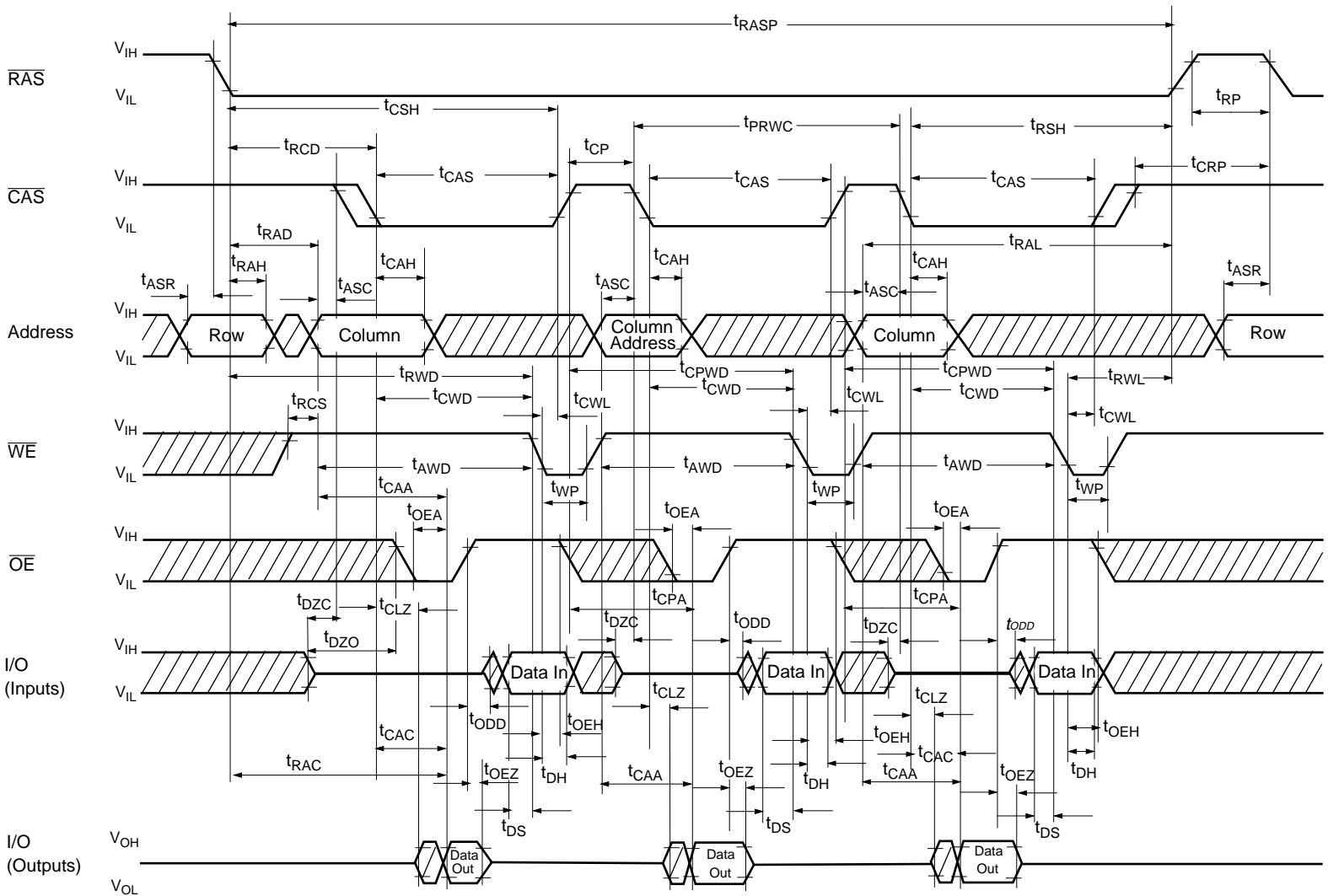
**Waveforms of Fast Page Mode Read Cycle**

FPM1

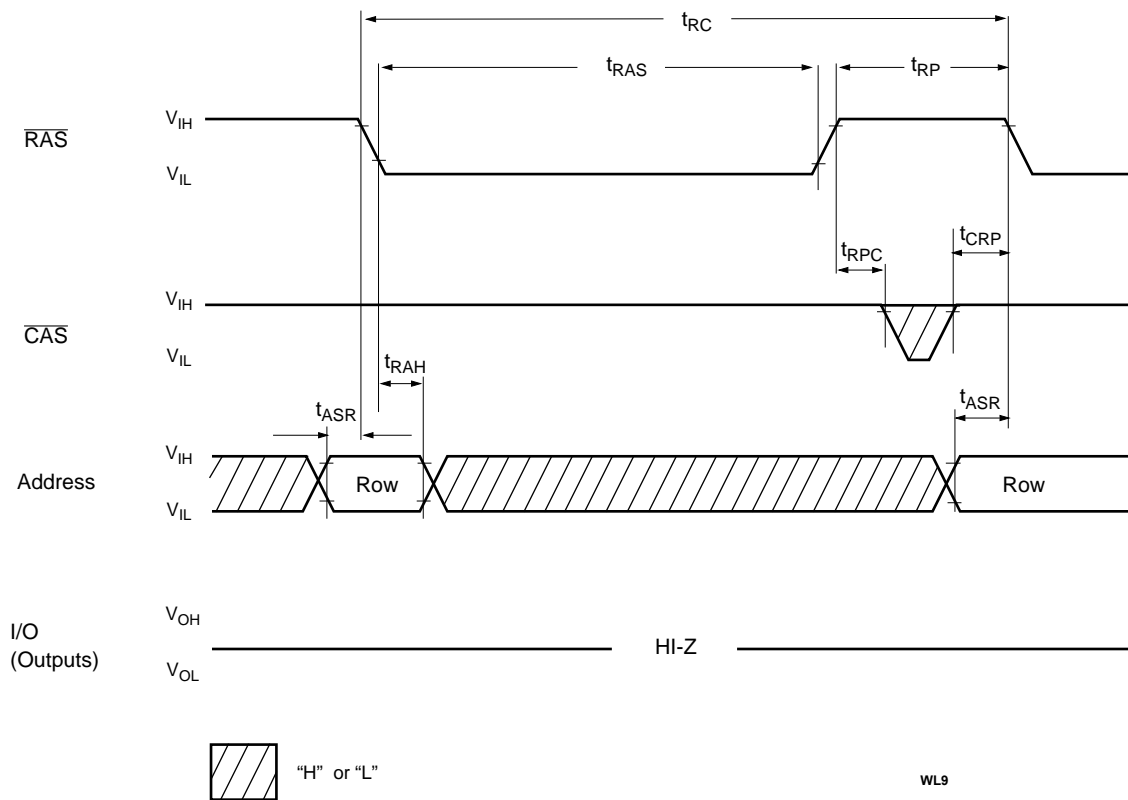
**Waveforms of Fast Page Mode Early Write Cycle**

FPM2

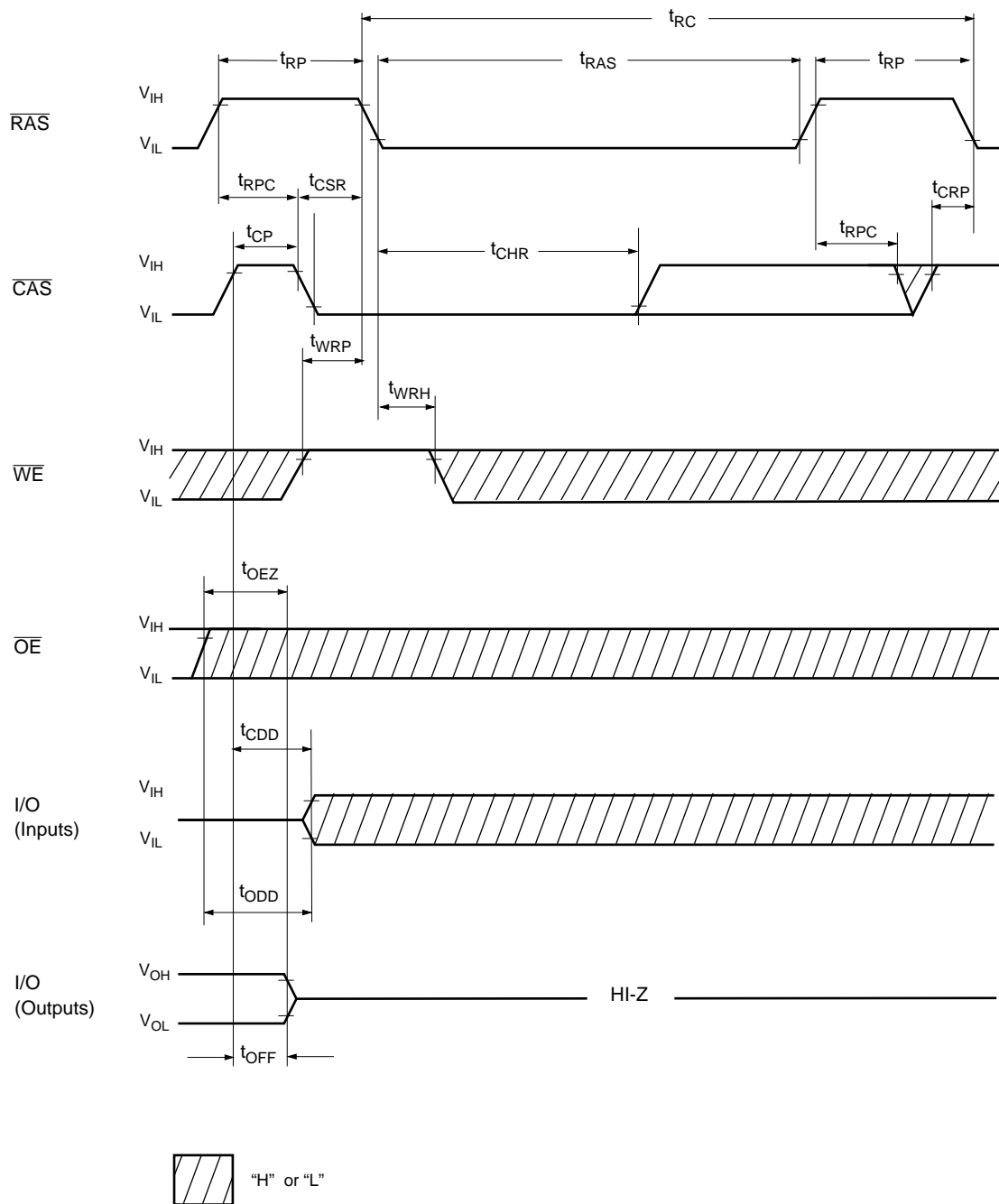
*Waveforms of Fast Page Mode Late Write and Read-Modify-Write Cycle*



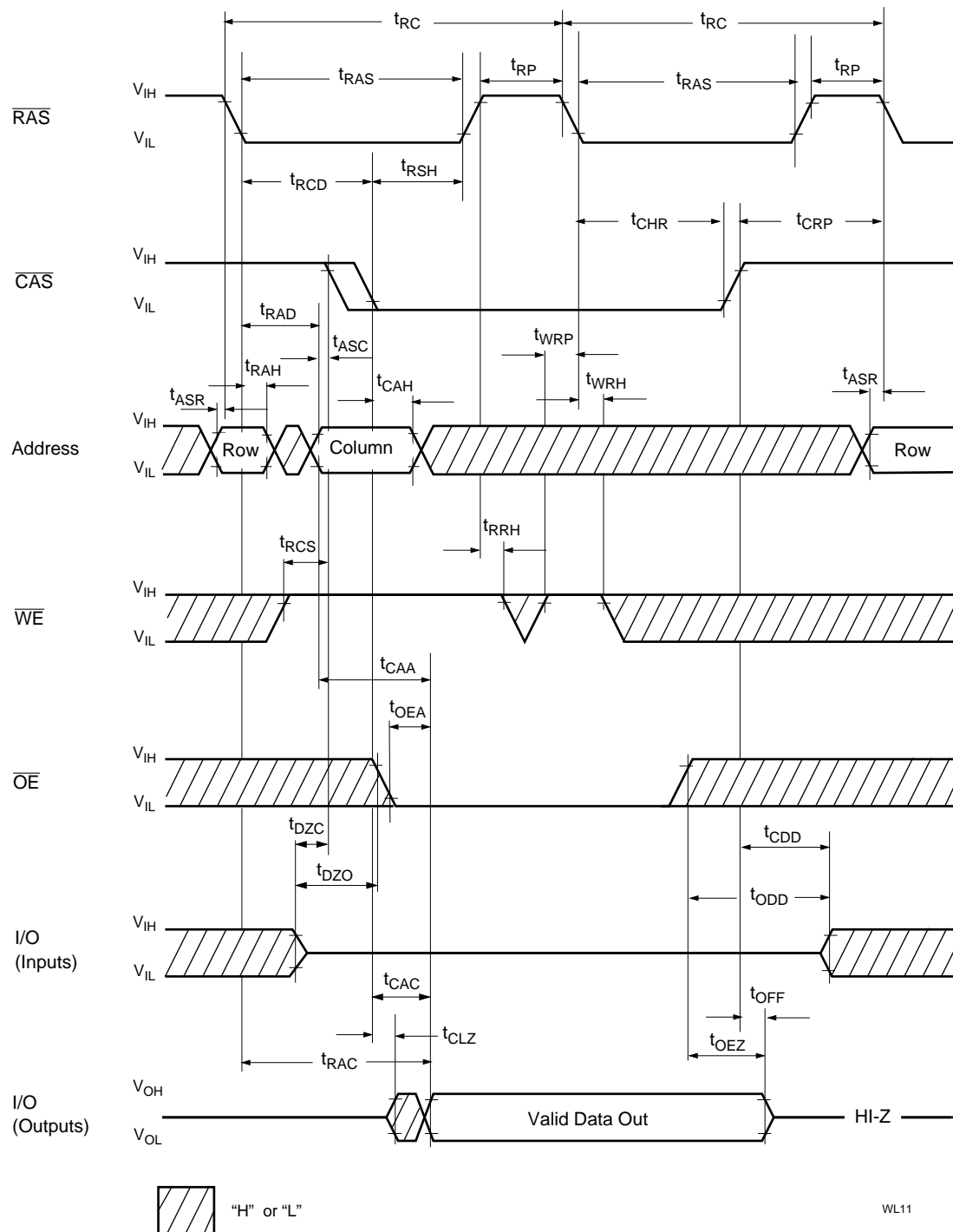
WL17

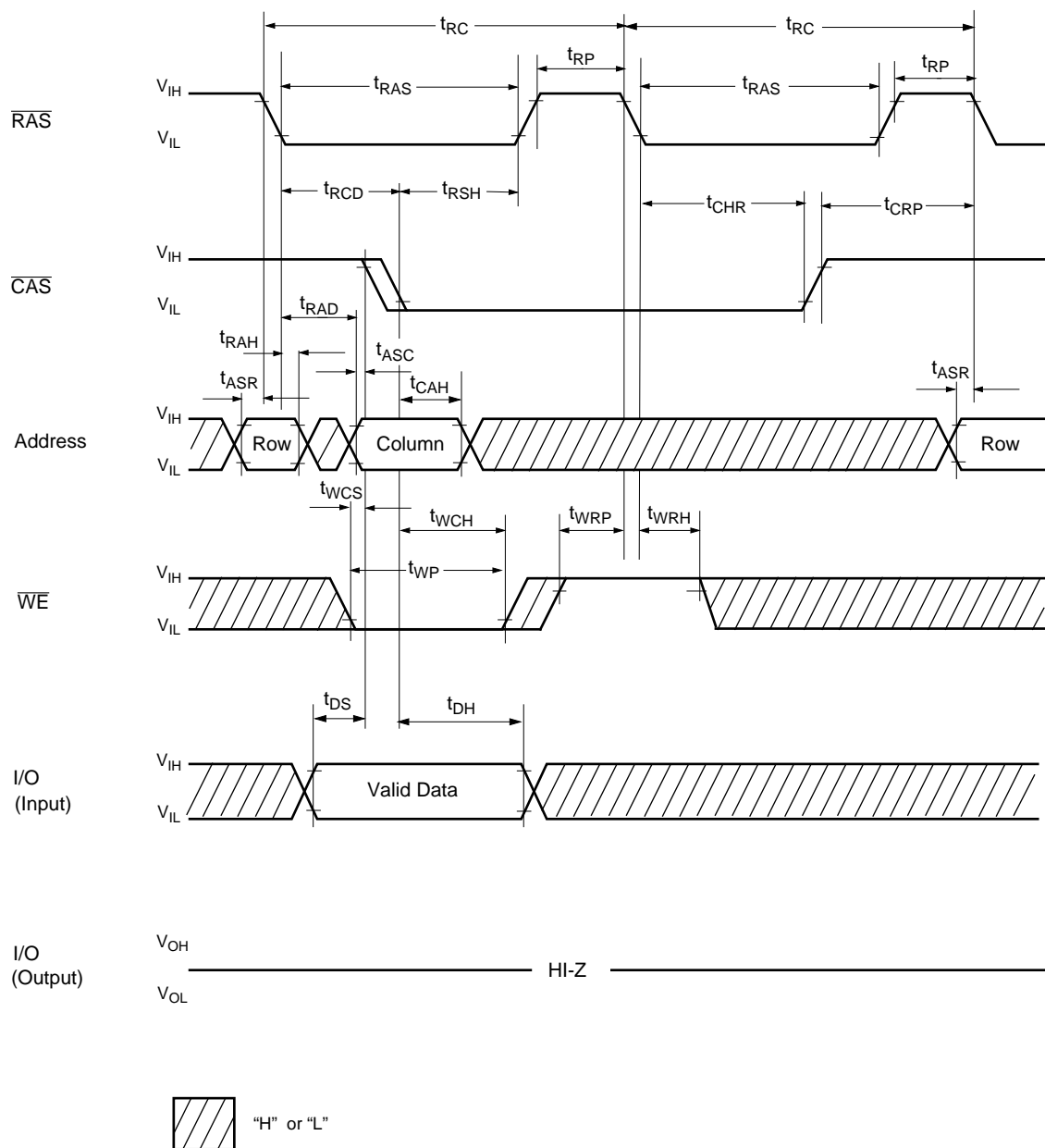
**Waveforms of  $\overline{\text{RAS}}$  Only Refresh Cycle**



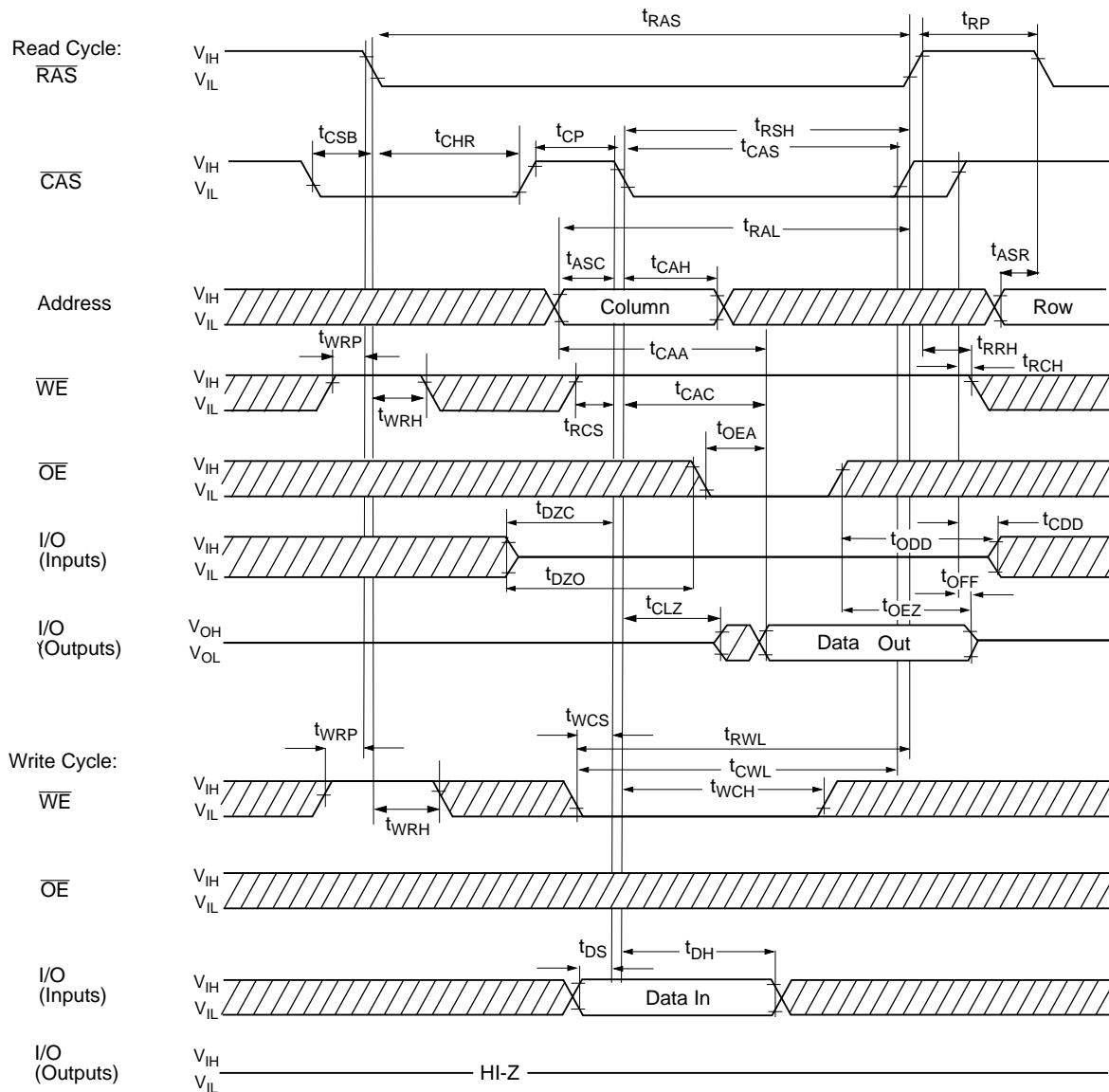
**Waveforms of  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  Refresh Cycle**

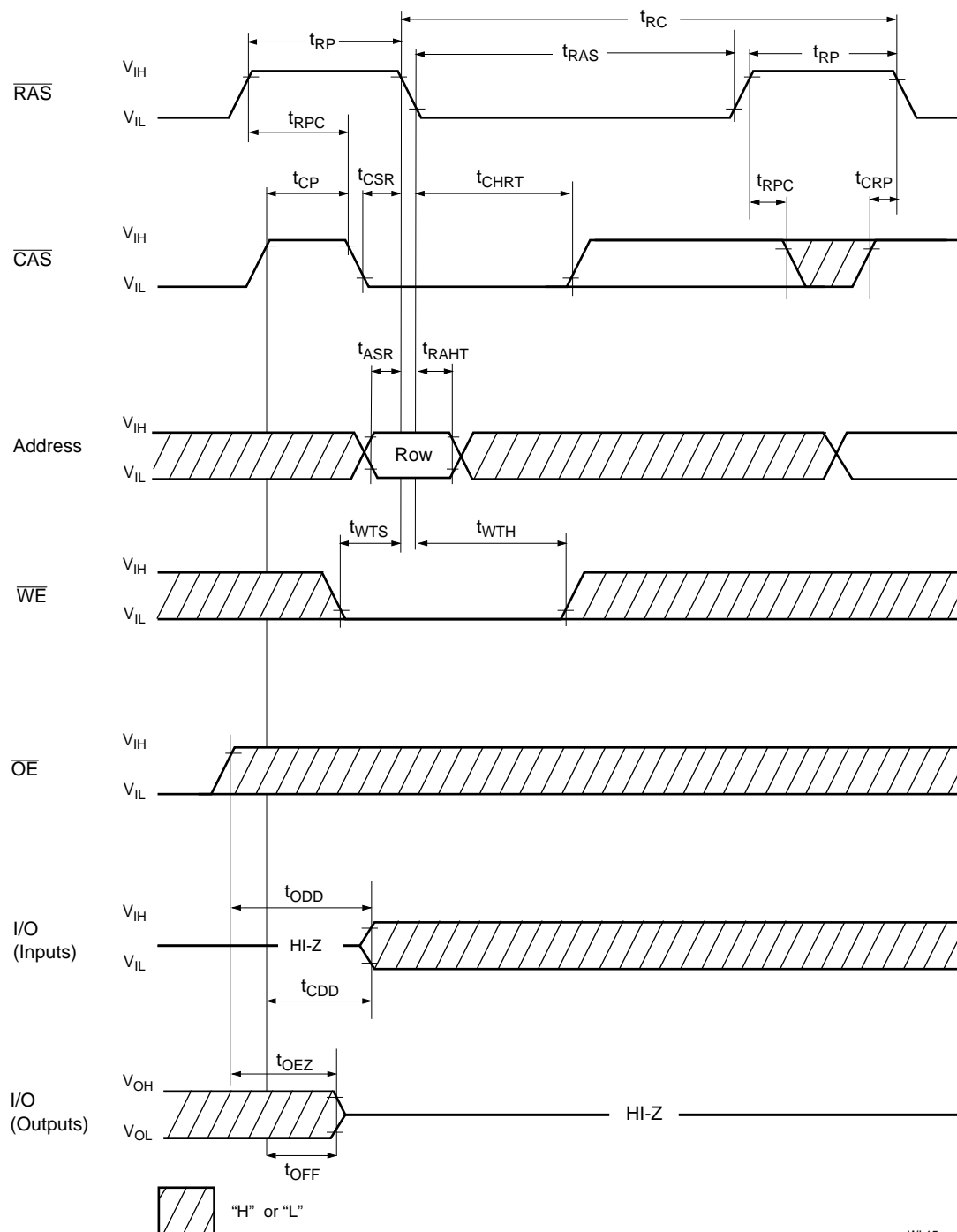
WL10

**Waveforms of Hidden Refresh Read Cycle**

**Waveforms of Hidden Refresh Early Write Cycle**

WL12

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

**Waveforms of Test Mode Entry**

WL15

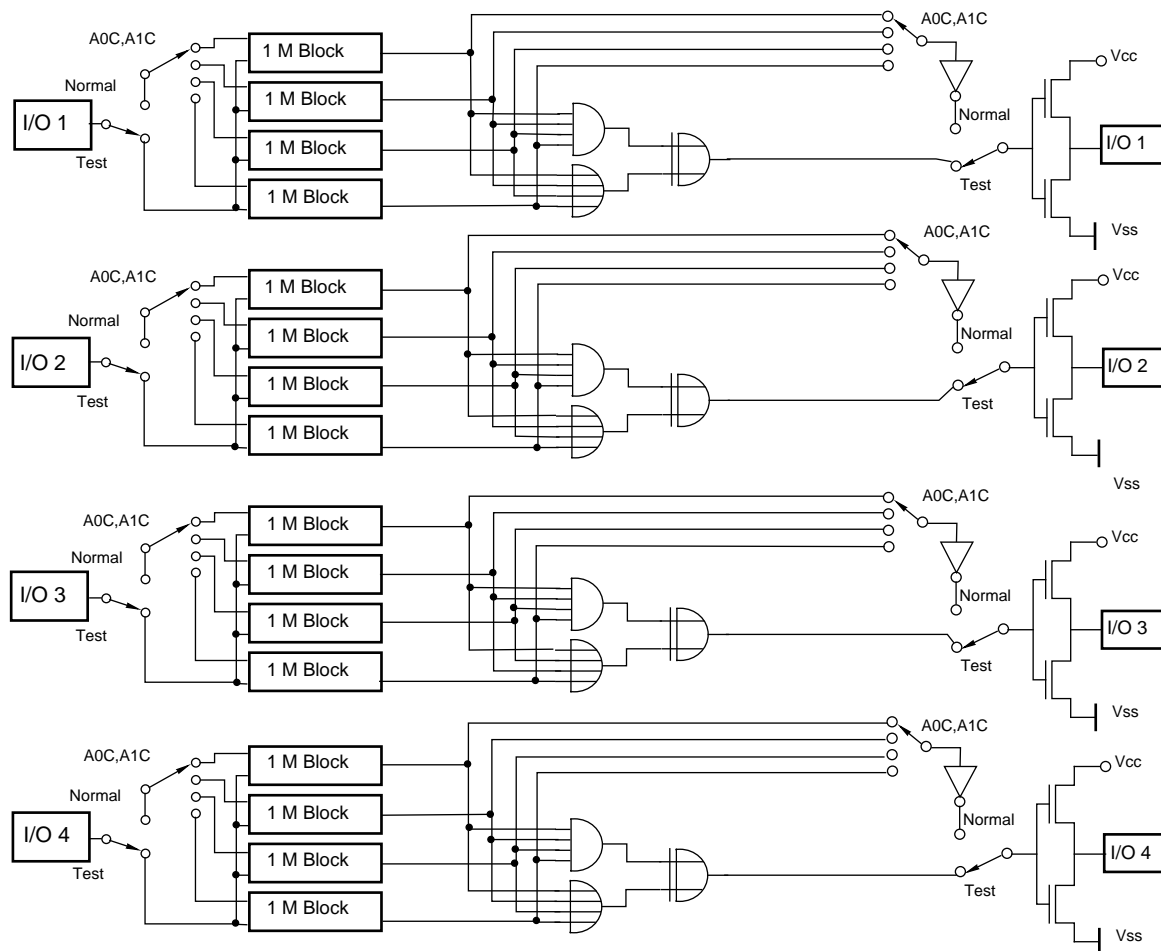
**Test Mode**

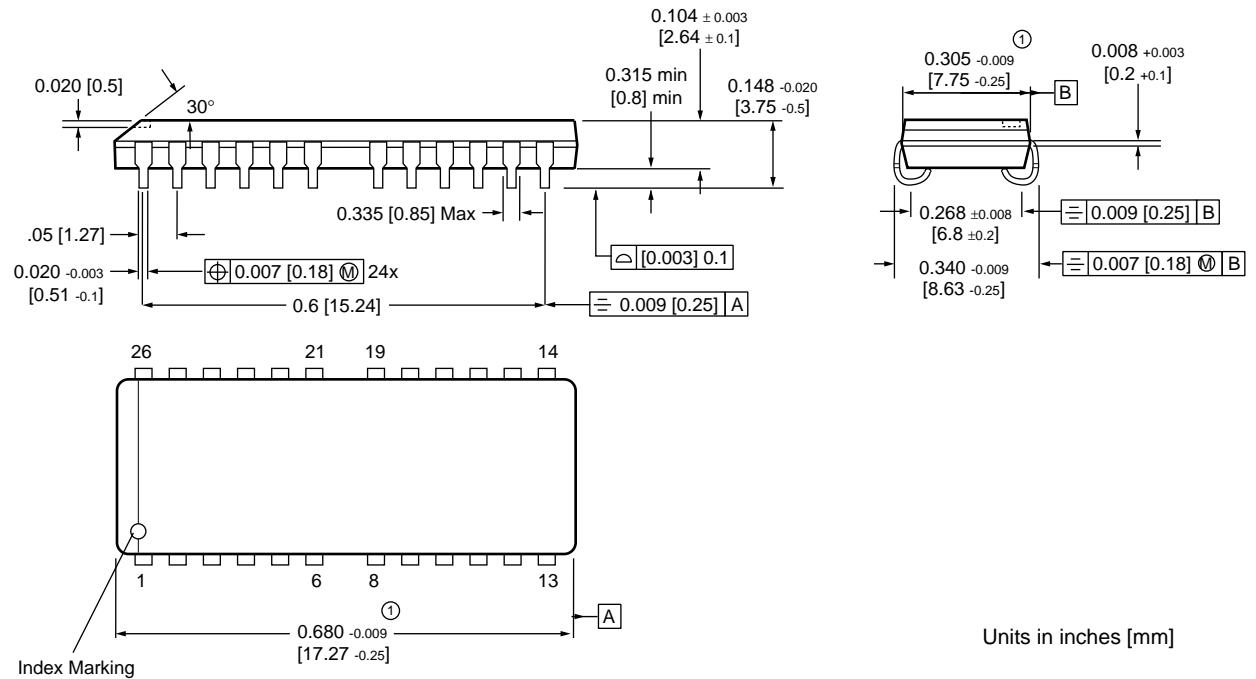
As the V53C516400A is organized internally as 1M x 16-bits, a test mode cycle using 4:1 compression can be used to improve test time. Note that in the 4M x 4 version the test time is reduced by 1/4 for a N test pattern.

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

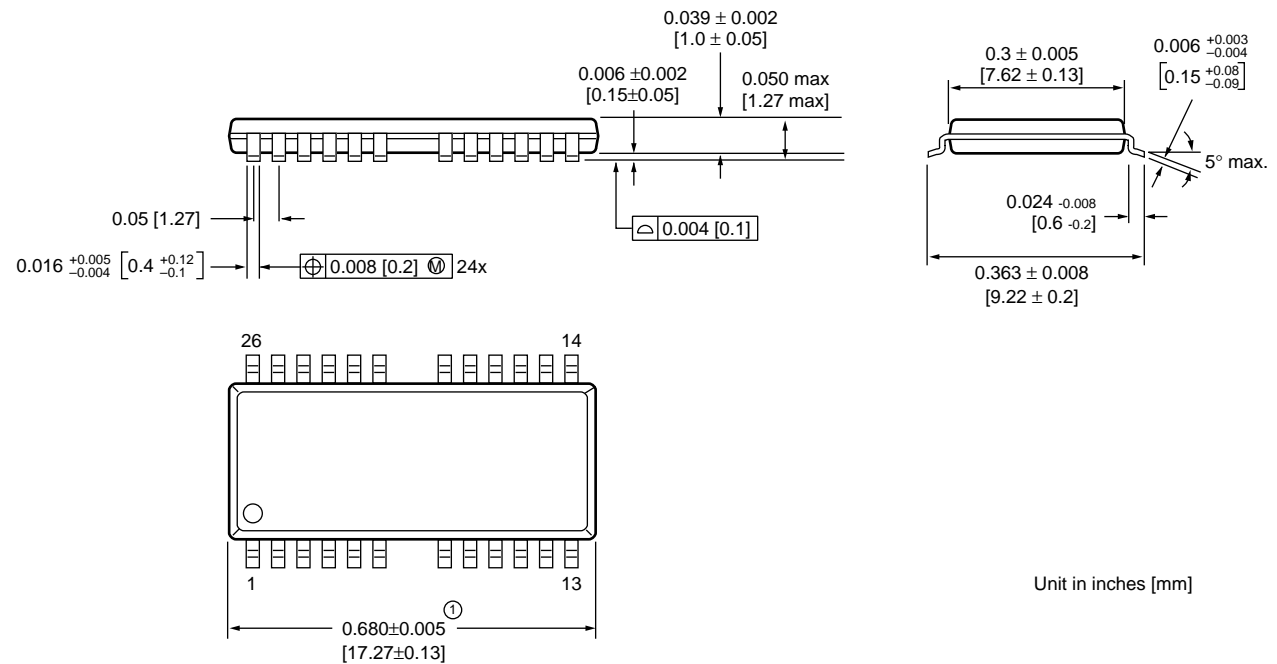
they were not equal, the I/O would indicate a "0". The WCBR cycle (WE, CAS before RAS) puts the device into test mode. To exit from test mode, a "CAS before RAS refresh", "RAS only refresh" or "Hidden refresh" can be used. Refresh during test mode operation can be performed by normal read cycles or by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

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

**Block Diagram in Test Mode**

**Package Diagrams****24/26-pin 300 mil SOJ**

① Does not include plastic or metal protrusion of 0.15 max. per side

**24/26-pin 300 mil TSOP-II**

① Does not include plastic or metal protrusion of 0.15 max. per side

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