

Features

- 72-Pin Small Outline Dual-In-Line Memory Module
- Performance:

		-60	-70
t_{RAC}	RAS Access Time	60ns	70ns
t_{CAC}	CAS Access Time	15ns	20ns
t_{AA}	Access Time From Address	30ns	35ns
t_{RC}	Cycle Time	110ns	130ns
t_{PC}	Fast Page Mode Cycle Time	40ns	45ns

- High Performance CMOS process
- Single $3.3 \pm 0.3V$ or $5.0 \pm 0.25V$ Power Supply
- Low active current consumption
- All inputs & outputs are TTL(5V) or LVTTTL(3.3V) compatible
- Fast Page Mode access cycle
- Refresh Modes: RAS-Only, CBR, Hidden Refresh and Self Refresh
- 2048 refresh cycles distributed across 128ms
- 11/11 Addressing (Row/Column)
- Optimized for use in byte-write non-parity applications.
- Au contacts

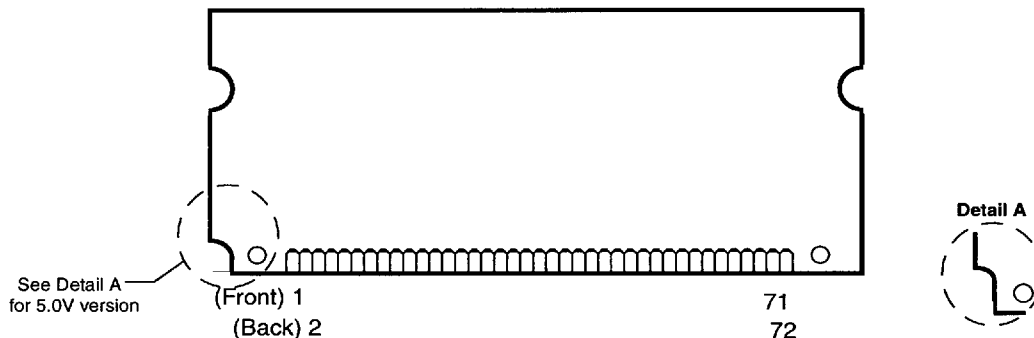
Description

The IBM11S4320BP/M are 16MB 72-pin 4-byte small outline dual in-line memory modules (SO DIMMs). The modules are organized as 4Mx32 high speed memory arrays that are intended for use in 16, 32 and 64 bit applications. They are manufactured with 8 4Mx4 TSOP devices, each in a 300mil package.

These assemblies are intended for use in space constrained and or low power applications.

The IBM 72-Pin SO DIMMs provide a high performance, flexible 4-byte interface in a 2.35" long footprint.

Card Outline





Pin Description

$\overline{RAS0}$, $\overline{RAS2}$	Row Address Strobe
$\overline{CAS0}$ - $\overline{CAS3}$	Column Address Strobe
$\overline{WE}$	Read/write Input
A0 - A10	Address Inputs
DQ0-7, 9-16, 18-25, 27-34	Data Input/output
V_{CC}	Power (+3.3V or +5V)
V_{SS}	Ground
NC	No Connect
PD1 - PD7	Presence Detects

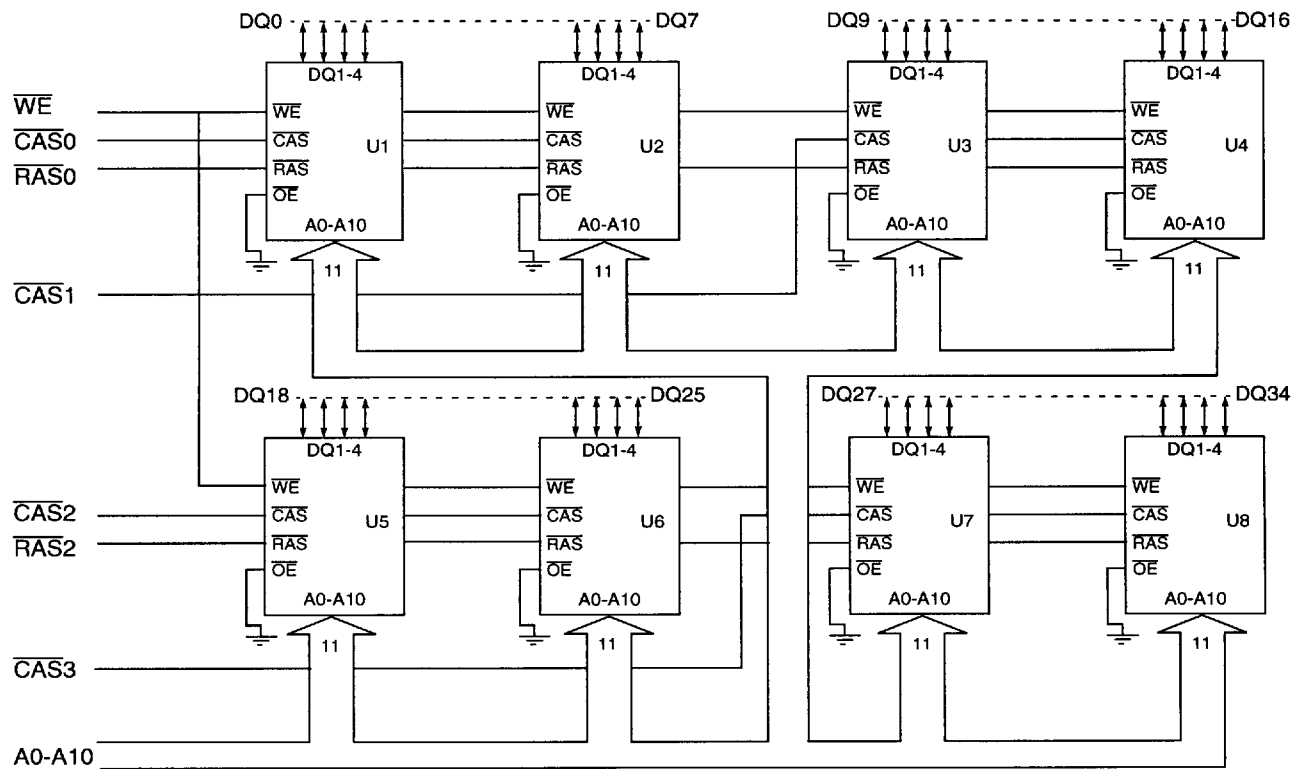
Pinout

Pin#	Name	Pin#	Name	Pin#	Name	Pin#	Name	Pin#	Name	Pin#	Name
1	V_{SS}	13	A1	25	DQ13	37	DQ18	49	DQ20	61	V_{CC}
2	DQ0	14	A2	26	DQ14	38	DQ19	50	DQ21	62	DQ32
3	DQ1	15	A3	27	DQ15	39	V_{SS}	51	DQ22	63	DQ33
4	DQ2	16	A4	28	A7	40	$\overline{CAS0}$	52	DQ23	64	DQ34
5	DQ3	17	A5	29	NC	41	$\overline{CAS2}$	53	DQ24	65	NC
6	DQ4	18	A6	30	V_{CC}	42	$\overline{CAS3}$	54	DQ25	66	PD2
7	DQ5	19	A10	31	A8	43	$\overline{CAS1}$	55	NC	67	PD3
8	DQ6	20	NC	32	A9	44	$\overline{RAS0}$	56	DQ27	68	PD4
9	DQ7	21	DQ9	33	NC	45	NC	57	DQ28	69	PD5
10	V_{CC}	22	DQ10	34	$\overline{RAS2}$	46	NC	58	DQ29	70	PD6
11	PD1	23	DQ11	35	DQ16	47	$\overline{WE}$	59	DQ31	71	PD7
12	A0	24	DQ12	36	NC	48	NC	60	DQ30	72	V_{SS}

Ordering Information

Part Number	Organization	Speed	Dimensions	Power
IBM11S4320BP-60T	4M x 32	60ns	2.35" x 1" x .1496"	3.3V
IBM11S4320BP-70T	4M x 32	70ns	2.35" x 1" x .1496"	3.3V
IBM11S4320BM-60T	4M x 32	60ns	2.35" x 1" x .1496"	5.0V
IBM11S4320BM-70T	4M x 32	70ns	2.35" x 1" x .1496"	5.0V

Block Diagram



Truth Table

Function	RAS	CAS	WE	Row Address	Column Address	All DQ bits
Standby	H	X	X	X	X	High Impedance
Read	L	L	H	Row	Col	Valid Data Out
Early-Write	L	L	L	Row	Col	Valid Data In
Fast Page Mode - Read: 1st Cycle	L	H→L	H	Row	Col	Valid Data Out
Subsequent Cycles	L	H→L	H	N/A	Col	Valid Data Out
Fast Page Mode - Write: 1st Cycle	L	H→L	L	Row	Col	Valid Data In
Subsequent Cycles	L	H→L	L	N/A	Col	Valid Data In
RAS-Only Refresh	L	H	X	Row	N/A	High Impedance
CAS-Before-RAS Refresh	H→L	L	H	X	X	High Impedance
Hidden Refresh	Read	L→H→L	H	Row	Col	Data Out
	Write	L→H→L	H	Row	Col	Data In
Self Refresh	H→L	L	H	X	X	High Impedance

Presence Detect

Pin	-60	-70
PD1	NC	NC
PD2	NC	NC
PD3	V _{SS}	V _{SS}
PD4	NC	NC
PD5	NC	V _{SS}
PD6	NC	NC
PD7	V _{SS}	V _{SS}

1. NC= OPEN, V_{SS} = GND



Absolute Maximum Ratings

Symbol	Parameter	Rating		Units	Notes
		3.3 Volt	5.0 Volt		
V_{CC}	Power Supply Voltage	-0.5 to + 4.6	-1.0 to + 7.0	V	1
V_{IN}	Input Voltage	-0.7 to min ($V_{CC} + 0.5$, 4.6)	-0.5 to min ($V_{CC} + 0.5$, 7.0)	V	1
V_{OUT}	Output Voltage	-0.5 to min ($V_{CC} + 0.5$, 4.6)	-0.5 to min ($V_{CC} + 0.5$, 7.0)	V	1
T_{OPR}	Operating Temperature	0 to +70	0 to +70	°C	1
T_{STG}	Storage Temperature	-55 to +150	-55 to +150	°C	1
P_D	Power Dissipation	3.5	5.0	W	1
I_{OUT}	Short Circuit Output Current	50	50	mA	1

1. Stresses greater than those listed may cause permanent damage to the device. This is a stress rating only, and device functional operation at or above the conditions indicated is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended DC Operating Conditions ($T_A = 0$ to 70°C)

Symbol	Parameter	3.3 Volt			5.0 Volt			Units	Notes
		Min	Typ	Max	Min	Typ	Max		
V_{CC}	Supply Voltage	3.0	3.3	3.6	4.75	5.0	5.25	V	1
V_{IH}	Input High Voltage	2.0	—	$V_{CC} + 0.5$	2.4	—	$V_{CC} + 0.5$	V	1, 2
V_{IL}	Input Low Voltage	-0.5	—	0.8	-0.5	—	0.8	V	1, 2

1. All voltages referenced to V_{SS} .
2. V_{IH} may overshoot to $V_{CC} + 1.2\text{V}$ for pulse widths of $\leq 4.0\text{ns}$ with 3.3 Volt, or $V_{CC} + 2.0\text{V}$ for pulse widths of $\leq 4.0\text{ns}$ (or $V_{CC} + 1.0\text{V}$ for $\leq 8.0\text{ns}$) with 5.0 Volt. Additionally, V_{IL} may undershoot to -2.0V for pulse widths $\leq 4.0\text{ns}$ with 3.3 Volt, or to -2.0V for pulse widths $\leq 4.0\text{ns}$ (or -1.0V for $\leq 8.0\text{ns}$) with 5.0 Volt. Pulse widths measured at 50% points with amplitude measured peak to DC reference.

Capacitance ($T_A = 0$ to $+70^\circ\text{C}$, $V_{CC} = 3.3 \pm 0.3\text{V}$ or $5.0 \pm 0.25\text{V}$)

Symbol	Parameter	Max	Units
C_{I1}	Input Capacitance (A0-A10)	53	pF
C_{I2}	Input Capacitance (RAS)	40	pF
C_{I3}	Input Capacitance (CAS)	23	pF
C_{I4}	Input Capacitance (WE)	67	pF
C_{IO}	Input - Output Capacitance (DQ0-DQ34)	15	pF

DC Electrical Characteristics (T_A = 0 to +70°C, V_{CC} = 3.3 ± 0.3V or 5.0 ± 0.25V)

Symbol	Parameter		Min	Max	Units	Notes
I _{CC1}	Operating Current Average Power Supply Operating Current (RAS, CAS, Address Cycling: t _{RC} = t _{RC} min)	-60	—	680	mA	1, 2, 3
		-70	—	600		
I _{CC2}	Standby Current (TTL) Power Supply Standby Current (RAS = CAS ≥ V _{IH})	—	—	16	mA	
I _{CC3}	RAS Only Refresh Current Average Power Supply Current, RAS Only Mode (RAS Cycling, CAS ≥ V _{IH} : t _{RC} = t _{RC} min)	-60	—	680	mA	1, 3
		-70	—	600		
I _{CC4}	Fast Page Mode Current Average Power Supply Current, Fast Page Mode (RAS = V _{IL} , CAS, Address Cycling: t _{PC} = t _{PC} min)	-60	—	520	mA	1, 2, 3
		-70	—	440		
I _{CC5}	Standby Current (CMOS) Power Supply Standby Current (RAS = CAS = V _{CC} - 0.2V)	—	—	1.6	mA	
I _{CC6}	CAS Before RAS Refresh Current Average Power Supply Current, CAS Before RAS Mode (RAS, CAS, Cycling: t _{RC} = t _{RC} min)	-60	—	680	mA	1, 3
		-70	—	600		
I _{CC7}	Self Refresh Current Average Power Supply Current during Self Refresh CBR cycle with RAS ≥ t _{RASS} (min); CAS held low; WE = V _{CC} - 0.2V; Addresses and D _{IN} = V _{CC} - 0.2V or 0.2V.	3.3V	—	1600	μA	
		5.0V	—	2400		
I _{IL}	Input Leakage Current Input Leakage Current, any input (0.0 ≤ V _{IN} ≤ (V _{CC} - 6.0V)) All Other Pins Not Under Test = 0V	RAS	-40	+40	μA	
		CAS	-20	+20		
		All others	-80	+80		
I _{OL}	Output Leakage Current (D _{OUT} is disabled, 0.0 ≤ V _{OUT} ≤ V _{CC})	—	-10	+10	μA	
V _{OH}	Output High Level Output "H" Level Voltage (I _{OUT} = -5mA @ 2.4V)	—	2.4	V _{CC}	V	
V _{OL}	Output Low Level Output "L" Level Voltage (I _{OUT} = +4.2mA @ 0.4V)	—	0.0	0.4	V	
1. I _{CC1} , I _{CC3} , I _{CC4} and I _{CC6} depend on cycle rate. 2. I _{CC1} , I _{CC4} depend on output loading. Specified values are obtained with the output open. 3. Address can be changed once or less while RAS = V _{IL} . In the case of I _{CC4} , it can be changed once or less when CAS = V _{IH} .						

AC Characteristics ($T_A = 0$ to $+70^\circ\text{C}$, $V_{CC} = 3.3$ 0.3V or 5.0 0.25V)

1. An initial pause of 200 μs is required after power-up followed by 8 $\overline{\text{RAS}}$ only refresh cycles before proper device operation is achieved. In case of using the internal refresh counter, a minimum of 8 $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh cycles instead of 8 $\overline{\text{RAS}}$ only refresh cycles is required.
2. AC measurements assume $t_f=5\text{ns}$.
3. $V_{IH}(\text{min.})$ and $V_{IL}(\text{max.})$ are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL} .

Read, Write, and Refresh Cycles (Common Parameters)

Symbol	Parameter	-60		-70		Units	Notes
		Min	Max	Min	Max		
t_{RC}	Random Read or Write Cycle Time	110	—	130	—	ns	
t_{RP}	$\overline{\text{RAS}}$ Precharge Time	40	—	50	—	ns	
t_{CP}	$\overline{\text{CAS}}$ Precharge Time	10	—	10	—	ns	
t_{RAS}	$\overline{\text{RAS}}$ Pulse Width	60	10K	70	10K	ns	
t_{CAS}	$\overline{\text{CAS}}$ Pulse Width	15	10K	20	10K	ns	
t_{ASR}	Row Address Setup Time	0	—	0	—	ns	
t_{RAH}	Row Address Hold Time	10	—	10	—	ns	
t_{ASC}	Column Address Setup Time	0	—	0	—	ns	
t_{CAH}	Column Address Hold Time	10	—	10	—	ns	
t_{RCD}	$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Delay Time	20	45	20	50	ns	1
t_{RAD}	$\overline{\text{RAS}}$ to Column Address Delay Time	15	30	15	35	35	2
t_{RSH}	$\overline{\text{RAS}}$ Hold Time	15	—	20	—	ns	
t_{CSH}	$\overline{\text{CAS}}$ Hold Time	60	—	70	—	ns	
t_{CRP}	$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time	5	—	5	—	ns	
t_{DZC}	$\overline{\text{CAS}}$ Delay Time from D_{IN}	0	—	0	—	ns	
t_T	Transition Time (Rise and Fall)	3	30	3	30	ns	

1. Operation within the $t_{RCD}(\text{max})$ limit ensures that $t_{RAC}(\text{max})$ can be met. $t_{RCD}(\text{max})$ is specified as a reference point only: if t_{RCD} is greater than the specified $t_{RCD}(\text{max})$ limit, then access time is controlled by t_{CAC} .

2. Operation within the $t_{RAD}(\text{max})$ limit ensures that $t_{RAC}(\text{max})$ can be met. $t_{RAD}(\text{max})$ is specified as a reference point only: If t_{RAD} is greater than the specified $t_{RAD}(\text{max})$ limit, then access time is controlled by t_{AA} .

Write Cycle

Symbol	Parameter	-60		-70		Units	Notes
		Min	Max	Min	Max		
t_{WCS}	Write Command Set Up Time	0	—	0	—	ns	1
t_{WCH}	Write Command Hold Time	15	—	15	—	ns	
t_{WP}	Write Command Pulse Width	15	—	15	—	ns	
t_{RWL}	Write Command to $\overline{RAS}$ Lead Time	15	—	20	—	ns	
t_{CWL}	Write Command to $\overline{CAS}$ Lead Time	15	—	20	—	ns	
t_{DS}	D_{IN} Setup Time	0	—	0	—	ns	
t_{DH}	D_{IN} Hold Time	12	—	15	—	ns	

1. t_{WCS} is not a restrictive operating parameter. It is included in the data sheet as an electrical characteristic only. If $t_{WCS} \geq t_{WCS}(\text{min})$, the cycle is an early write cycle and the data pin will remain open circuit (high impedance) through the entire cycle. If the above condition is not satisfied, the condition of the data out (at access time) is indeterminate.

Read Cycle

Symbol	Parameter	-60		-70		Units	Notes
		Min	Max	Min	Max		
t_{RAC}	Access Time from $\overline{RAS}$	—	60	—	70	ns	1, 2, 3
t_{CAC}	Access Time from $\overline{CAS}$	—	15	—	20	ns	1, 3
t_{AA}	Access Time from Address	—	30	—	35	ns	2, 3
t_{RCS}	Read Command Setup Time	0	—	0	—	ns	
t_{RCH}	Read Command Hold Time to $\overline{CAS}$	0	—	0	—	ns	4
t_{RRH}	Read Command Hold Time to $\overline{RAS}$	0	—	0	—	ns	4
t_{RAL}	Column Address to $\overline{RAS}$ Lead Time	30	—	35	—	ns	
t_{CAL}	Column Address to $\overline{CAS}$ Lead Time	30	—	35	—	ns	
t_{CLZ}	$\overline{CAS}$ to Output in Low-Z	0	—	0	—	ns	3
t_{OH}	Output Data Hold Time	3	—	3	—	ns	
t_{CDD}	$\overline{CAS}$ to D_{IN} Delay Time	15	—	15	—	ns	
t_{OFF}	Output Buffer Turn-off Delay	—	15	—	15	ns	5

1. Operation within the $t_{RCD}(\text{max.})$ limit ensures that $t_{RAC}(\text{max.})$ can be met. $t_{RCD}(\text{max.})$ is specified as a reference point only. If t_{RCD} is greater than the specified $t_{RCD}(\text{max.})$ limit, then access time is controlled by t_{CAC} .

2. Operation within the $t_{RAD}(\text{max.})$ limit ensures that $t_{RAC}(\text{max.})$ can be met. $t_{RAD}(\text{max.})$ is specified as a reference point only. If t_{RAD} is greater than the specified $t_{RAD}(\text{max.})$ limit, then access time is controlled by t_{AA} .

3. Measured with the specified current load and 100pF.

4. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.

5. $t_{OFF}(\text{max})$ defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.



Fast Page Mode Cycle

Symbol	Parameter	-60		-70		Units	Notes
		Min	Max	Min	Max		
t_{PC}	Fast Page Mode Cycle Time	40	—	45	—	ns	
t_{RASP}	Fast Page Mode $\overline{RAS}$ Pulse Width	60	100K	70	100K	ns	
t_{CPRH}	$\overline{RAS}$ Hold Time from $\overline{CAS}$ Precharge	35	—	40	—	ns	
t_{CPA}	Access Time from $\overline{CAS}$ Precharge	—	35	—	40	ns	1, 2
1. Measured with the specified current load and 100pF. 2. Access Time is determined by the latter of t_{CAC}, t_{CPA}.							

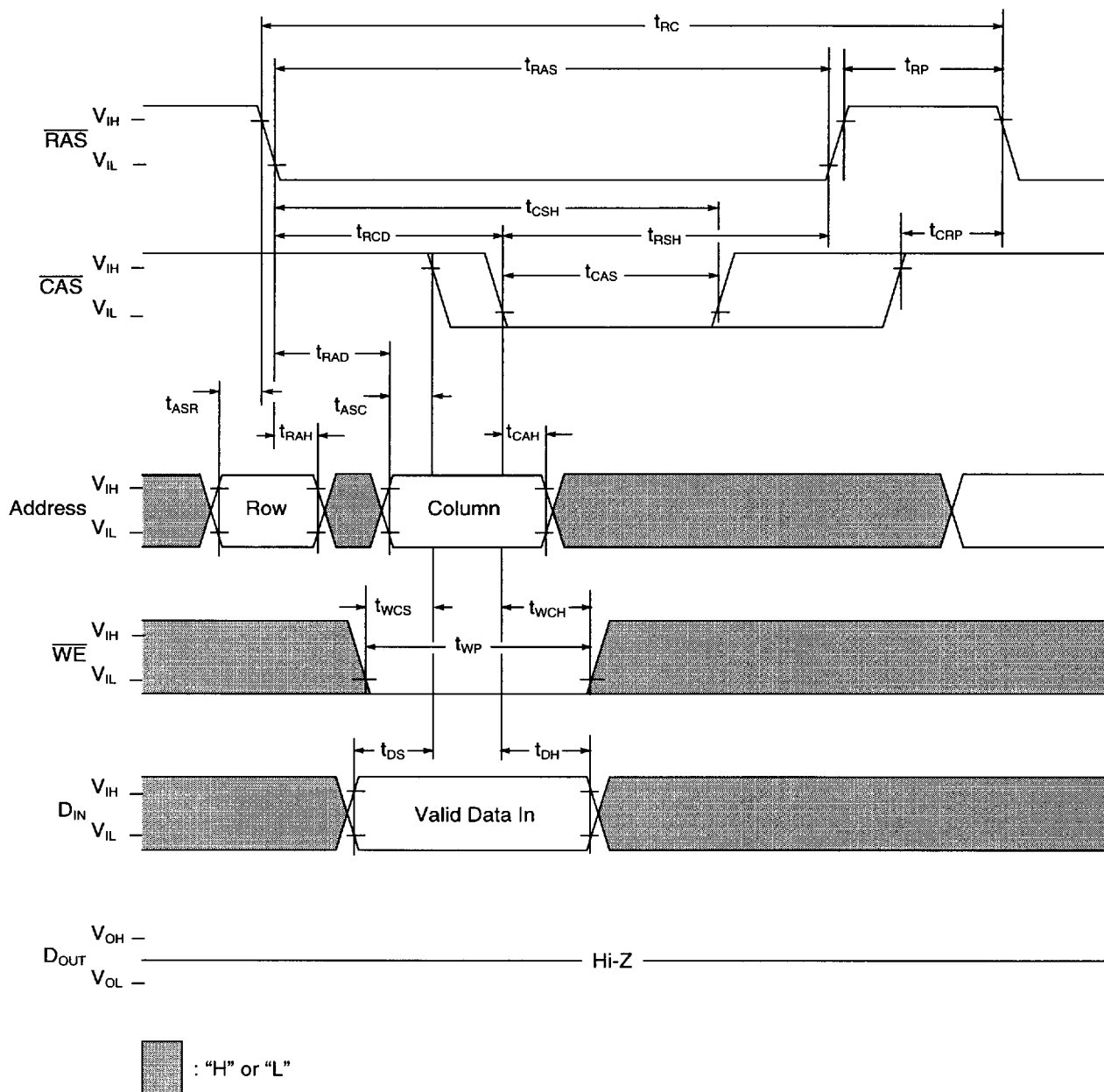
Refresh Cycle

Symbol	Parameter	-60		-70		Units	Notes
		Min	Max	Min	Max		
t_{CHR}	$\overline{CAS}$ Hold Time ($\overline{CAS}$ before $\overline{RAS}$ Refresh Cycle)	10	—	10	—	ns	
t_{CSR}	$\overline{CAS}$ Setup Time ($\overline{CAS}$ before $\overline{RAS}$ Refresh Cycle)	5	—	5	—	ns	
t_{WRP}	$\overline{WE}$ Setup Time ($\overline{CAS}$ before $\overline{RAS}$ Refresh Cycle)	10	—	10	—	ns	
t_{WRH}	$\overline{WE}$ Hold Time ($\overline{CAS}$ before $\overline{RAS}$ Refresh Cycle)	10	—	10	—	ns	
t_{RPC}	$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	5	—	5	—	ns	
t_{REF}	Refresh Period	—	128	—	128	ms	1
1. 2048 refreshes are required every 128ms.							

Self Refresh Cycle

Symbol	Parameter	-60		-70		Units	Notes
		Min.	Max.	Min.	Max.		
t_{RASS}	RAS Pulse Width During Self Refresh Cycle	100	—	100	—	μs	1
t_{RPS}	RAS Precharge Time During Self Refresh Cycle	104	—	124	—	ns	1
t_{CHS}	CAS Hold Time During Self Refresh Cycle	-50	—	-50	—	ns	1, 2
t_{CHD}	CAS Hold Time From RAS Falling During Self Refresh Cycle	350	—	350	—	μs	1, 2
1. When using Self Refresh mode, the following refresh operations must be performed to ensure proper DRAM operation: If row addresses are being refreshed 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 refreshed in any other manner (ROR - Distributed/Burst; or CBR-Burst) over the refresh interval, then a full set of row refreshes must be performed immediately before entry to and immediately after exit from Self Refresh. 2. If $t_{RASS} > t_{CHD}$ (min) then t_{CHD} applies. If $t_{RASS} \leq t_{CHD}$ (min) then t_{CHS} applies.							

Write Cycle (Early Write)

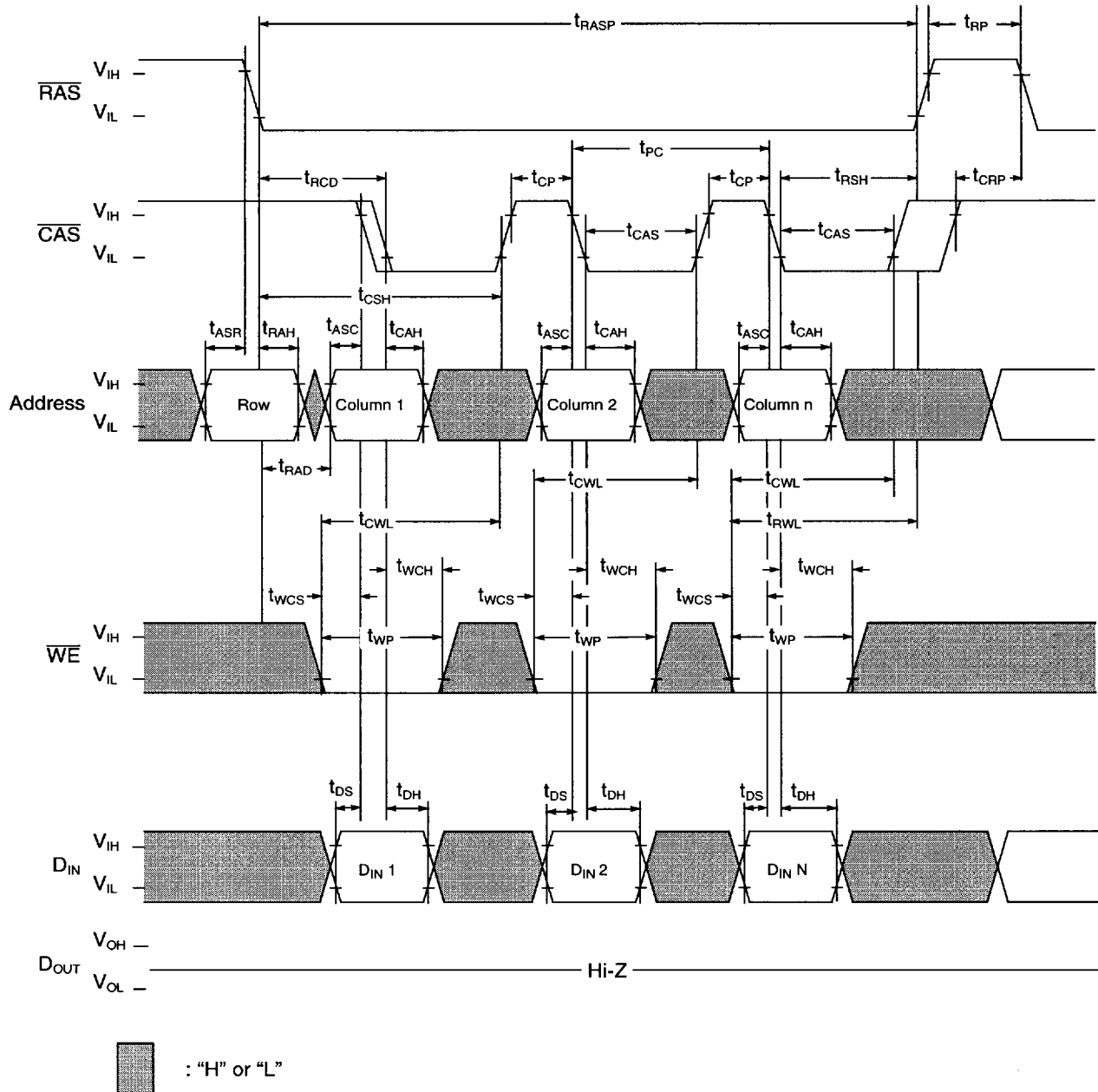


The diagram illustrates the timing relationships for a 2D array memory device. The signals shown are:

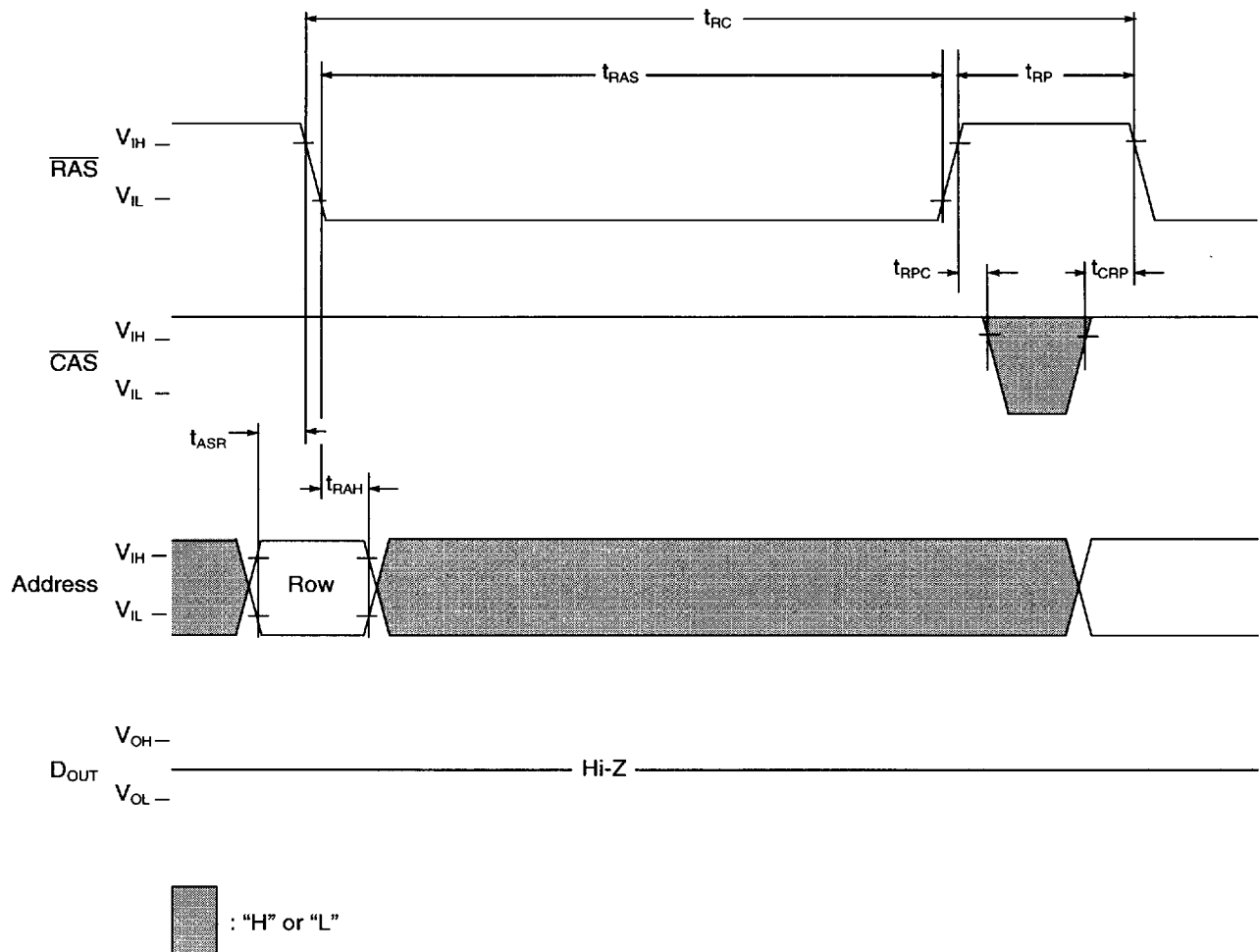
- RAS**: Row Address Strobe, with high level V_{IH} and low level V_{IL} . Timing parameters include t_{RASP} (pulse width), t_{CPRH} (time from RAS high to CAS high), and t_{RP} (time from RAS high to RAS low).
- CAS**: Column Address Strobe, with high level V_{IH} and low level V_{IL} . Timing parameters include t_{RCD} (time from RAS low to CAS low), t_{CAS} (pulse width), t_{CP} (time from CAS low to data output), t_{RSH} (time from RAS high to CAS high), t_{CRP} (time from CAS high to RAS high), t_{CSH} (time from CAS high to data output), t_{CAL} (time from CAS low to data output), and t_{RAL} (time from RAS low to data output).
- Address**: Row and Column addresses, with high level V_{IH} and low level V_{IL} . Timing parameters include t_{ASR} (time from RAS low to row address high), t_{RAH} (time from row address high to row address low), t_{ASC} (time from row address low to column address high), t_{CAH} (time from column address high to column address low), t_{RAD} (time from RAS low to row address low), t_{RCH} (time from RAS high to row address high), t_{RCS} (time from RAS low to row address low), t_{AA} (time from row address low to data output), t_{CPA} (time from column address low to data output), t_{OH} (time from data output high to data output low), t_{DZC} (time from data output low to data output high), t_{CAC} (time from data output high to data output low), t_{OFF} (time from data output low to data output high), and t_{CLZ} (time from data output high to data output low).
- WE**: Write Enable, with high level V_{IH} and low level V_{IL} . Timing parameters include t_{RRH} (time from RAS high to WE high), t_{RRL} (time from RAS low to WE low), t_{DZC} (time from data output low to data output high), t_{CAC} (time from data output high to data output low), t_{OFF} (time from data output low to data output high), and t_{CLZ} (time from data output high to data output low).
- DIN**: Data Input, with high level V_{IH} and low level V_{IL} . Timing parameters include t_{DZC} (time from data output low to data output high), t_{CAC} (time from data output high to data output low), t_{OFF} (time from data output low to data output high), and t_{CLZ} (time from data output high to data output low).
- DOUT**: Data Output, with high level V_{OH} and low level V_{OL} . Timing parameters include t_{DZC} (time from data output low to data output high), t_{CAC} (time from data output high to data output low), t_{OFF} (time from data output low to data output high), and t_{CLZ} (time from data output high to data output low).

Legend: $\square$: "H" or "L"

Fast Page Mode Write Cycle

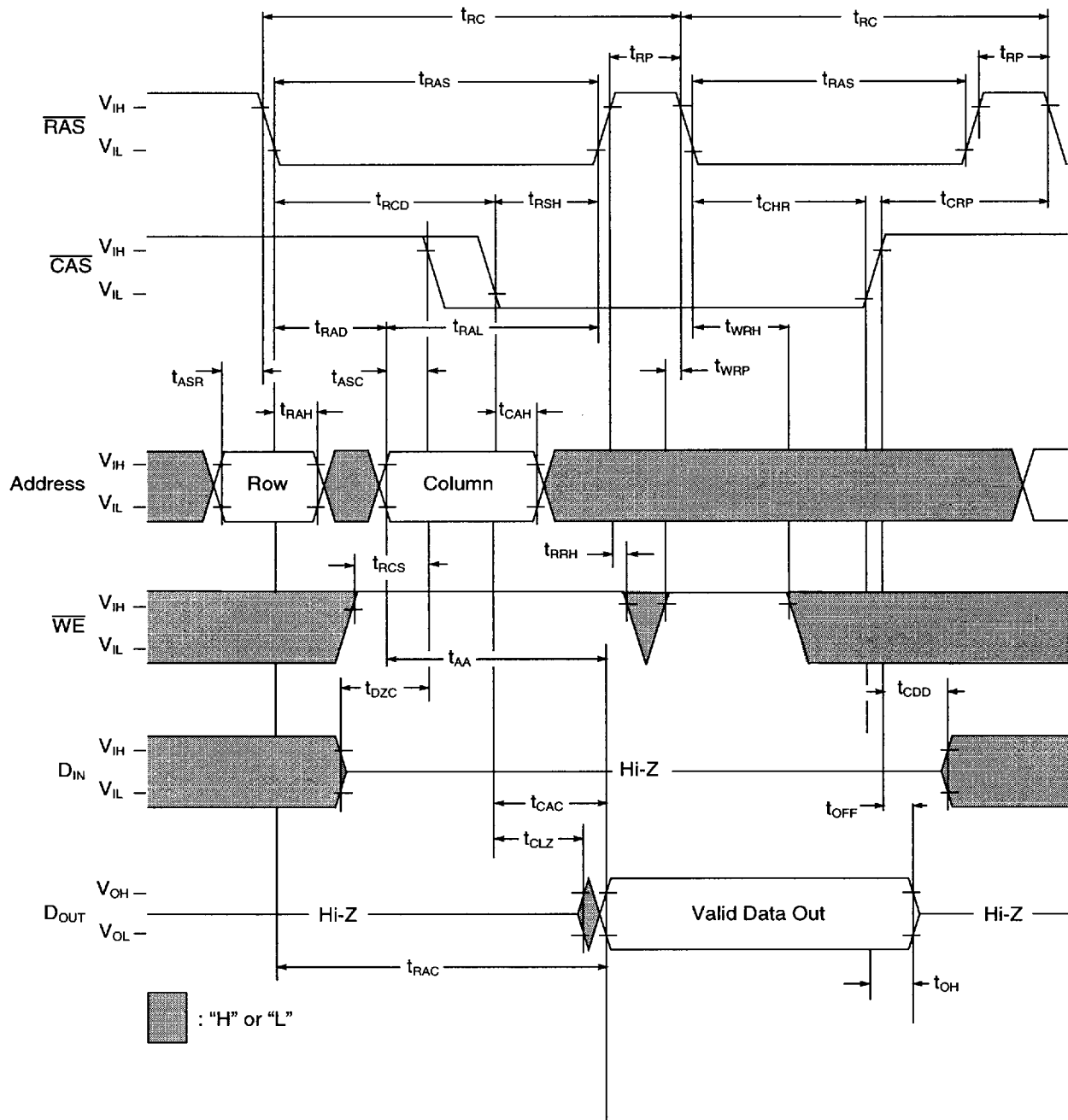


RAS Only Refresh Cycle

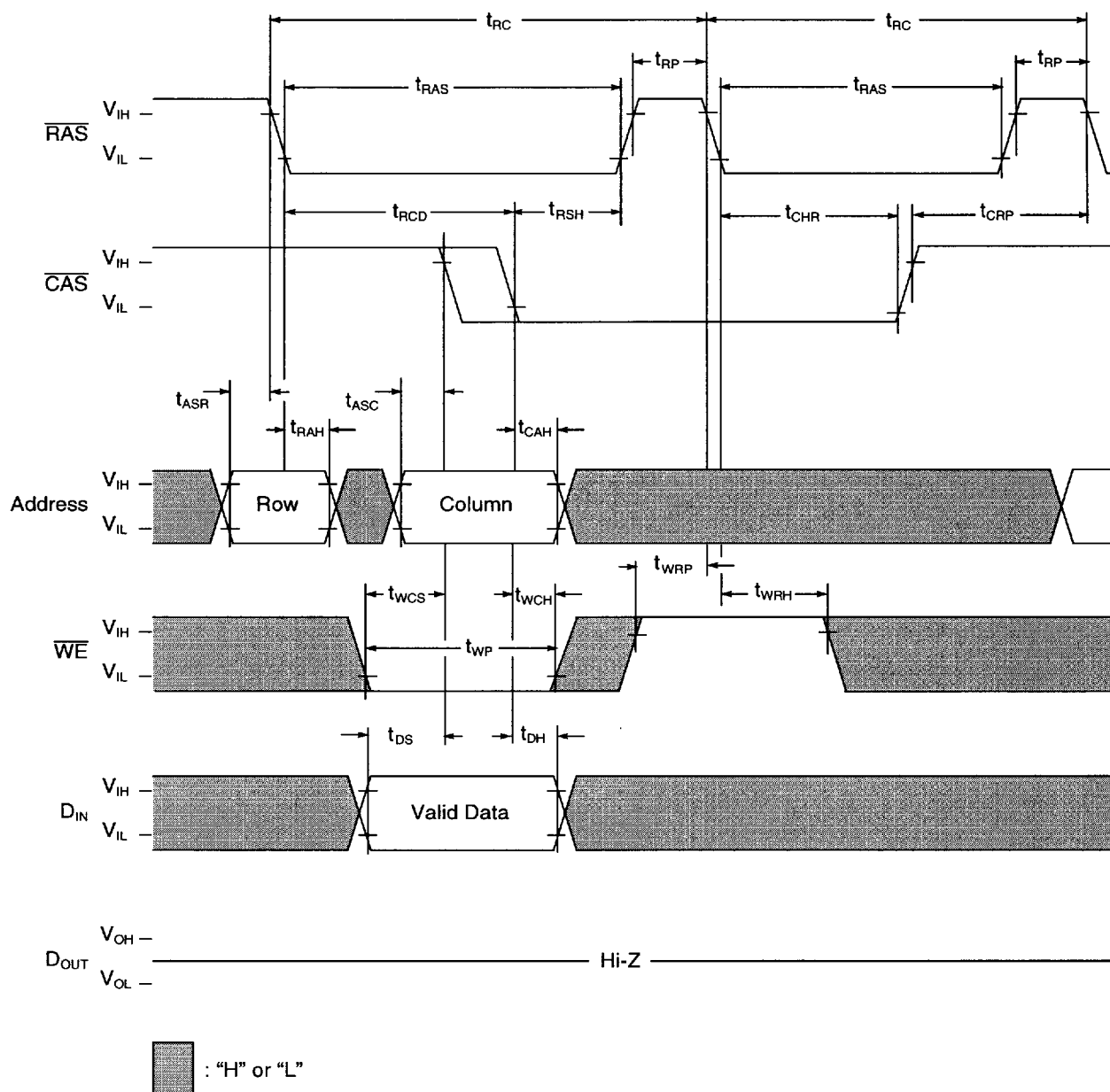


NOTE: $\overline{\text{WE}}$ and D_{IN} are "H" or "L"

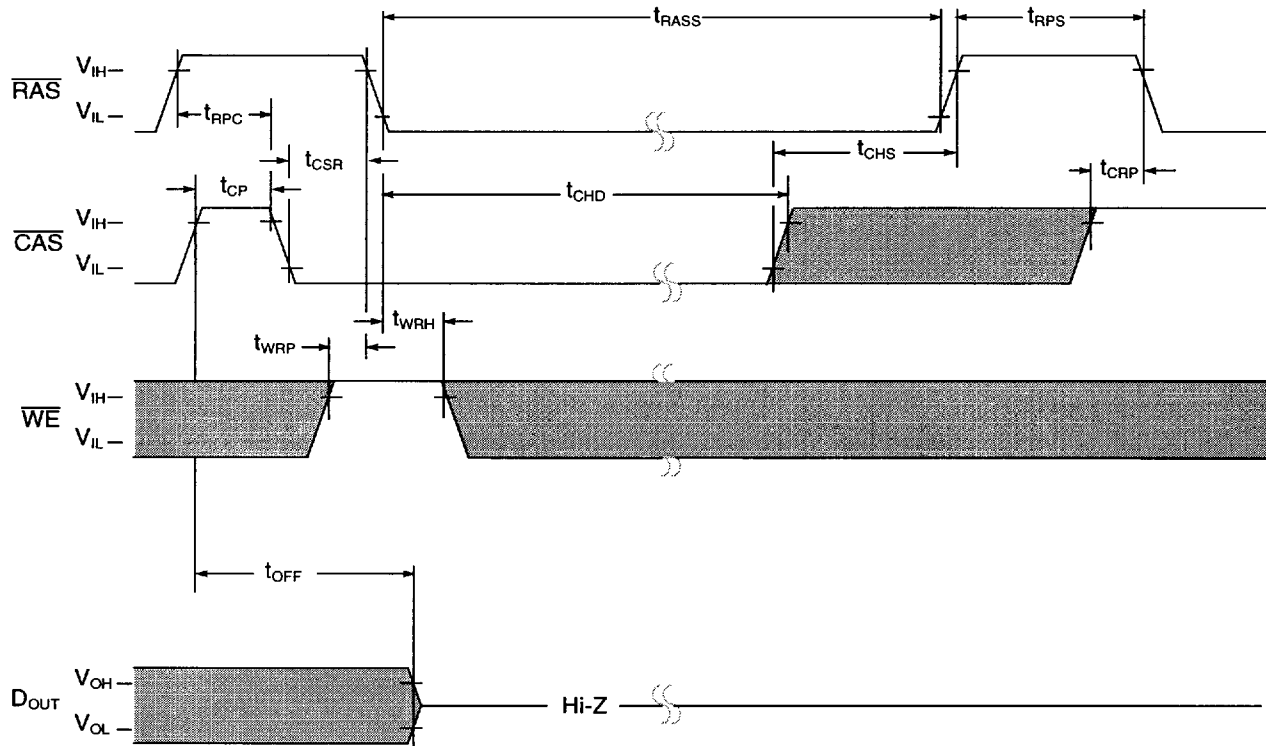
Hidden Refresh Cycle (Read)



Hidden Refresh Cycle (Write)



Self Refresh Cycle (Sleep Mode)

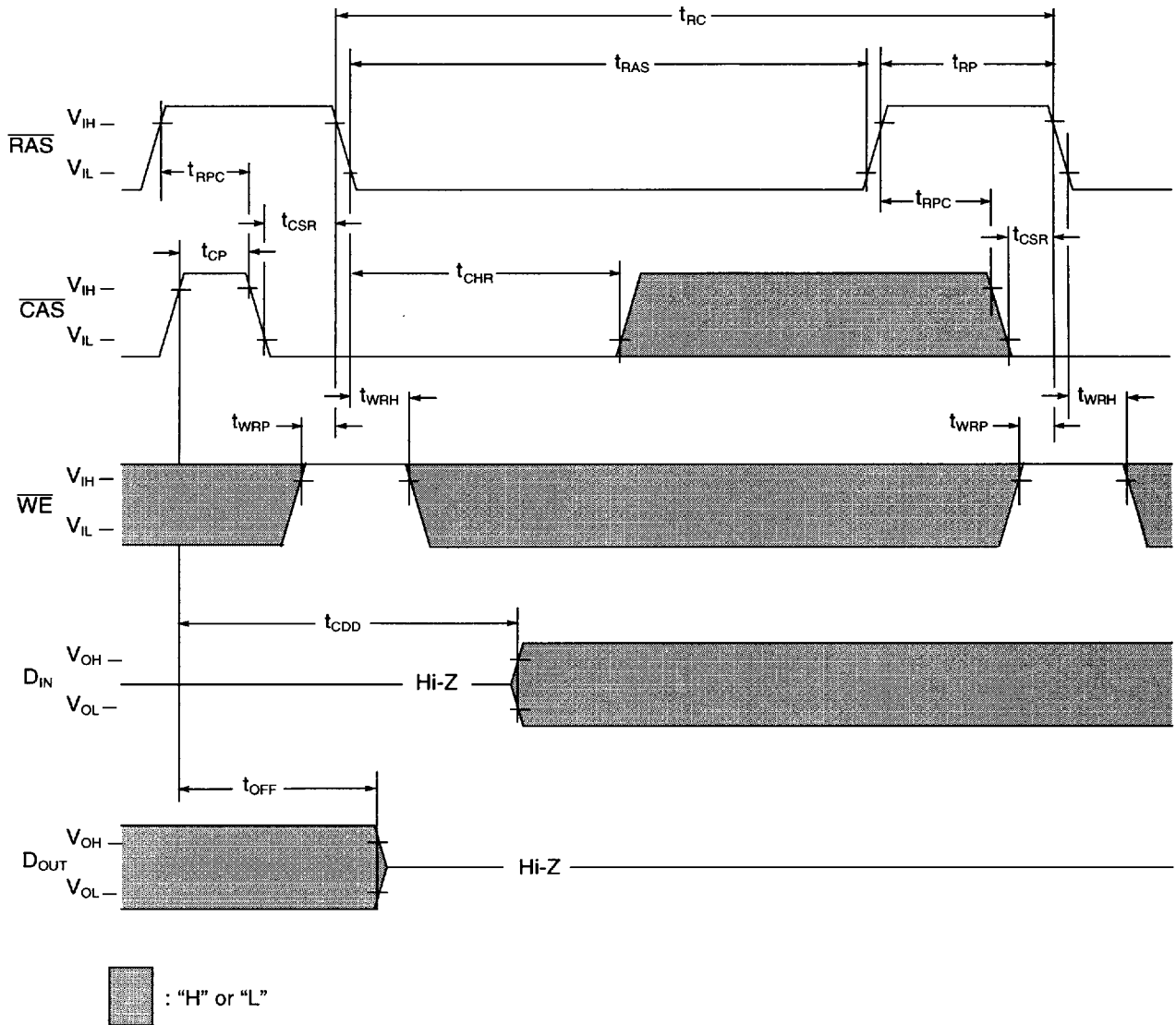


■ : "H" or "L"

NOTES:

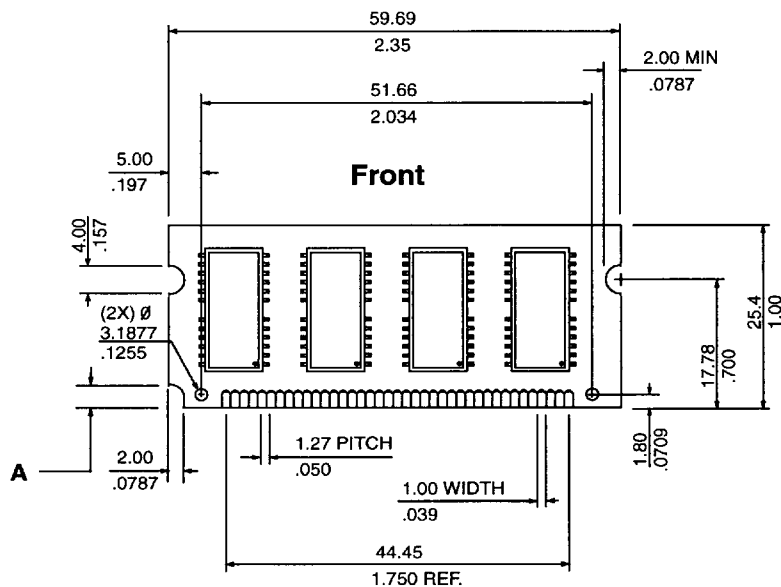
1. Address is "H" or "L"
2. Once $\overline{\text{RAS}}$ (min) is provided and $\overline{\text{RAS}}$ remains low, the DRAM will be in Self Refresh, commonly known as "Sleep Mode."
3. If $t_{\text{RASS}} > t_{\text{CHD}}$ (min) then t_{CHD} applies.
 If $t_{\text{RASS}} \leq t_{\text{CHD}}$ (min) then t_{CHS} applies.

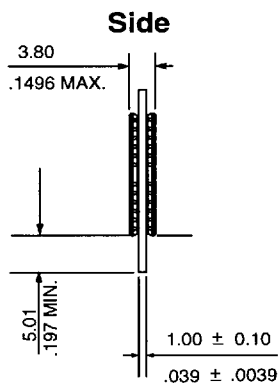
CAS Before RAS Refresh Cycle



NOTE: Address is "H" or "L"

Layout Drawing



$$A = \begin{array}{c|c} 3.3V & 5.0V \\ \hline 3.175 & 6.35 \\ .125 & .246 \end{array}$$


Note: All dimensions are typical unless otherwise stated.

Millimeters
Inches



Revision Log

Rev	Contents of Modification
12/94	Initial release of 4Mx32 specification using 4Mx4 11/11 Addressing
7/95	Update specification information; Changed tRPC, tRC, tRPC, tCP, tRAS, tRSH; Added Hidden Refresh and Self Refresh; Corrected currents ICC1, ICC3, ICC4, ICC6; Added ICC7 ; Added Undershoot/Overshoot note to Recommended DC Operating Condition Table.
4/96	Corrected typo's
8/96	Changed DRAM retention time