



1M x 64 144 PIN SO DIMM

Features

- 144 Pin JEDEC Standard, 8 Byte Small Outline Dual In-line Memory Module with 8 Byte busses
- 1Mx64 Extended Data Out SO DIMM
- Performance:

		-60	-6R	-70
t _{RAC}	$\overline{\text{RAS}}$ Access Time	60ns	60ns	70ns
t _{CAC}	$\overline{\text{CAS}}$ Access Time	15ns	17ns	20ns
t _{AA}	Access Time From Address	30ns	30ns	35ns
t _{RC}	Cycle Time	104ns	104ns	124ns
t _{HPC}	EDO Mode Cycle Time	25ns	25ns	30ns

- All inputs and outputs are LVTTTL (3.3V) compatible
- Single 3.3V ± 0.3V Power Supply

- Au contacts
- Optimized for byte-write non-parity applications
- System Performance Benefits:
 - Reduced noise (18 V_{SS}/18V_{CC} pins)
 - Byte write, byte read accesses
 - Serial PDs
- Extended Data Out (EDO) Mode, Read-Modify-Write Cycles
- Refresh Modes: $\overline{\text{RAS}}$ -Only, CBR Hidden Refresh, and Self Refresh
- 1024 refresh cycles distributed across 128ms
- 10/10 (Row/Column)
- Card size: 2.66" x 1.0" x 0.149"
- DRAMS in TSOP Package

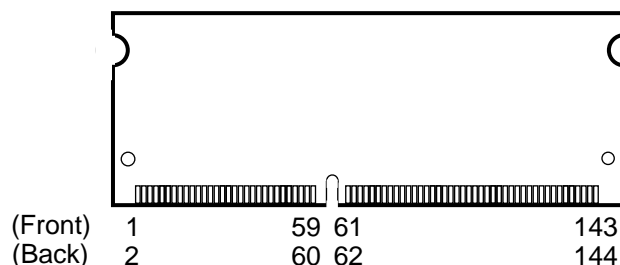
Description

IBM11T1645LP is an industry standard 144-pin 8-byte Small Outline Dual In-line Memory Module (SO DIMM) which is organized as a 1Mx64 high speed memory array designed for use in non-parity applications. The SO DIMM uses 4 1Mx16 EDO DRAMs in TSOP packages. The use of EDO DRAMs allows for a reduction in Page Mode Cycle time from 40ns (Fast Page) to 25ns for 60ns EDO modules. This card uses *serial presence detects* implemented via a serial EEPROM using the two pin I²C Protocol. This communication protocol uses

CLOCK (SCL) and DATA I/O (SDA) lines to synchronously clock data between the master (ex: The System Microprocessor) and the slave EEPROM device. The device address for the EEPROM is set to zero at the card. The first 128 bytes are utilized by the SODIMM manufacturer and the second 128 bytes are available to the end user.

All IBM 144-pin SODIMMs provide a high performance, flexible 8-byte interface in a 2.66" long space-saving footprint. Related products are the 2Mx64, 4Mx64 and the x72 (ECC) SODIMMs.

Card Outline





IBM11T1645LP

1M x 64 144 PIN SO DIMM

Pin Description

$\overline{\text{RAS0}}$	Row Address Strobe
$\overline{\text{CAS0}} - \overline{\text{CAS7}}$	Column Address Strobe
$\overline{\text{WE}}$	Read/write Input
$\overline{\text{OE}}$	Output Enable
A0 - A9	Address Inputs
DQ0 - DQ63	Data Input/Output
V _{CC}	Power (3.3V)
V _{SS}	Ground
NC	No Connect
SCL	Serial Presence Detect Clock Input
SDA	Serial Presence Detect Data Input

Pinout

Pin#	Front Side	Pin#	Back Side	Pin#	Front Side	Pin#	Back Side	
1	V _{SS}	2	V _{SS}	73	$\overline{\text{OE}}$	74	NC	
3	DQ0	4	DQ32	75	V _{SS}	76	V _{SS}	
5	DQ1	6	DQ33	77	NC	78	NC	
7	DQ2	8	DQ34	79	NC	80	NC	
9	DQ3	10	DQ35	81	V _{CC}	82	V _{CC}	
11	V _{CC}	12	V _{CC}	83	DQ16	84	DQ48	
13	DQ4	14	DQ36	85	DQ17	86	DQ49	
15	DQ5	16	DQ37	87	DQ18	88	DQ50	
17	DQ6	18	DQ38	89	DQ19	90	DQ51	
19	DQ7	20	DQ39	91	V _{SS}	92	V _{SS}	
21	V _{SS}	22	V _{SS}	93	DQ20	94	DQ52	
23	CAS0	24	CAS4	95	DQ21	96	DQ53	
25	CAS1	26	CAS5	97	DQ22	98	DQ54	
27	V _{CC}	28	V _{CC}	99	DQ23	100	DQ55	
29	A0	30	A3	101	V _{CC}	102	V _{CC}	
31	A1	32	A4	103	A6	104	A7	
33	A2	34	A5	105	A8	106	NC	
35	V _{SS}	36	V _{SS}	107	V _{SS}	108	V _{SS}	
37	DQ8	38	DQ40	109	A9	110	A12	
39	DQ9	40	DQ41	111	NC	112	A13	
41	DQ10	42	DQ42	113	V _{CC}	114	V _{CC}	
43	DQ11	44	DQ43	115	CAS2	116	CAS6	
45	V _{CC}	46	V _{CC}	117	CAS3	118	CAS7	
47	DQ12	48	DQ44	119	V _{SS}	120	V _{SS}	
49	DQ13	50	DQ45	121	DQ24	122	DQ56	
51	DQ14	52	DQ46	123	DQ25	124	DQ57	
53	DQ15	54	DQ47	125	DQ26	126	DQ58	
55	V _{SS}	56	V _{SS}	127	DQ27	128	DQ59	
57	NC	58	NC	129	V _{CC}	130	V _{CC}	
59	NC	60	NC	131	DQ28	132	DQ60	
				VOLTAGE KEY	133	DQ29	134	DQ61
61	DU	62	DU	135	DQ30	136	DQ62	
63	V _{CC}	64	V _{CC}	137	DQ31	138	DQ63	
65	DU	66	DU	139	V _{SS}	140	V _{SS}	
67	WE	68	NC	141	SDA	142	SCL	
69	RAS0	70	NC	143	V _{CC}	144	V _{CC}	
71	NC	72	NC					

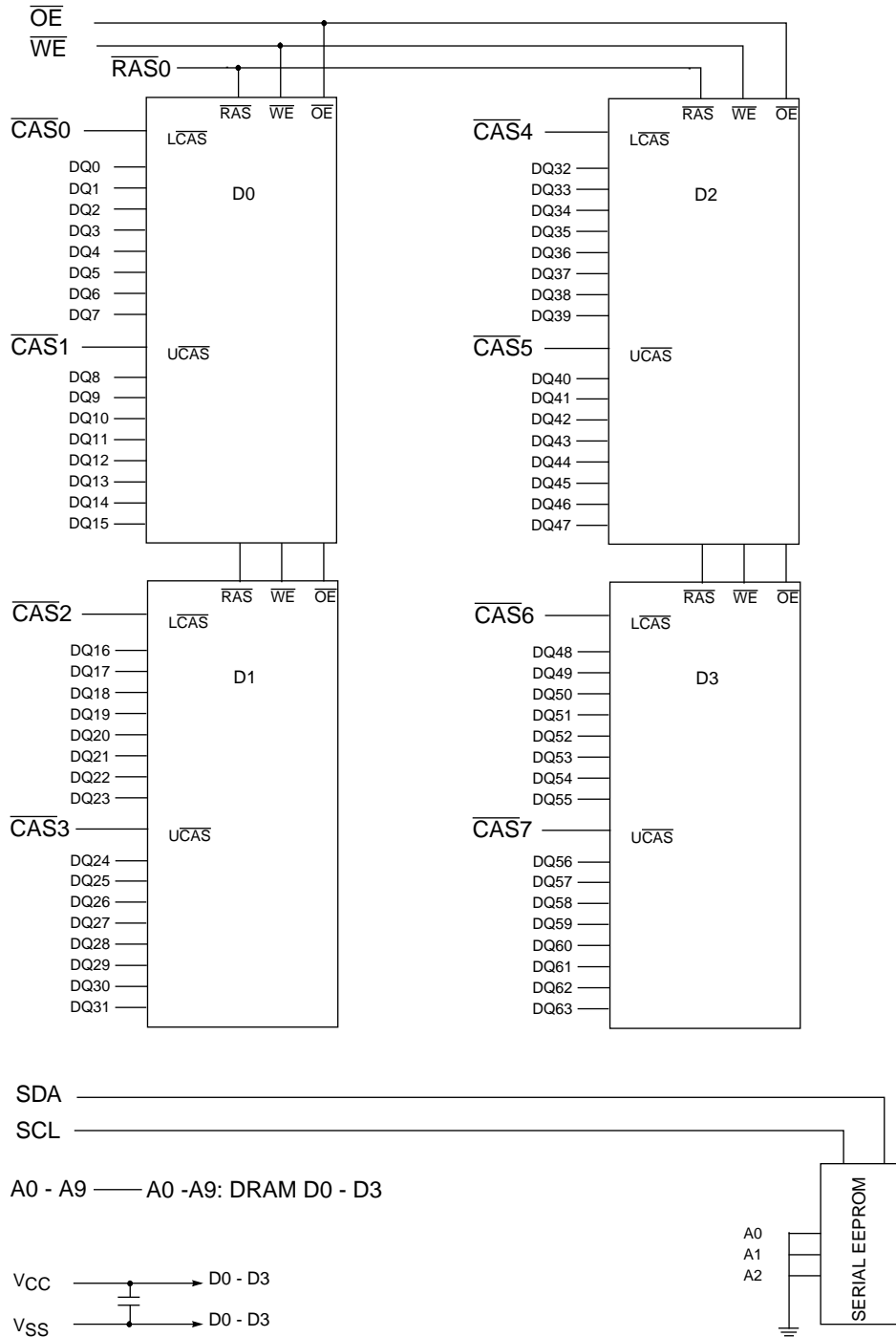
Note: All pin assignments are consistent for all 8 Byte versions.

Ordering Information

Part Number	Organization	Speed	Leads	Dimension	Power
IBM11T1645LP-60T	1Mx64	60ns	Au	2.66"x1.0"x 0.149"	3.3V
IBM11T1645LP-6RT	1Mx64	60ns	Au	2.66"x1.0"x 0.149"	3.3V
IBM11T1645LP-70T	1Mx64	70ns	Au	2.66"x1.0"x 0.149"	3.3V



Block Diagram





IBM11T1645LP

1M x 64 144 PIN SO DIMM

Truth Table

Function	RAS	$\overline{\text{CAS}}$	$\overline{\text{WE}}$	$\overline{\text{OE}}$	Row Address	Column Address	DQx	
Standby	H	X	X	X	X	X	High Impedance	
Read	L	L	H	L	Row	Col	Valid Data Out	
Early-Write	L	L	L	X	Row	Col	Valid Data In	
Late-Write	L	L	H→L	H	Row	Col	Valid Data In	
RMW	L	L	H→L	L→H	Row	Col	Valid Data In/Out	
EDO Page Mode - Read 1st Cycle	L	H→L	H	L	Row	Col	Valid Data Out	
Subsequent Cycles	L	H→L	H	L	N/A	Col	Valid Data Out	
EDO Page Mode - Write 1st Cycle	L	H→L	L	X	Row	Col	Valid Data In	
Subsequent Cycles	L	H→L	L	X	N/A	Col	Valid Data In	
EDO Page Mode - RMW 1st Cycle	L	H→L	H→L	L→H	Row	Col	Valid Data In/Out	
Subsequent Cycles	L	H→L	H→L	L→H	N/A	Col	Valid Data In/Out	
$\overline{\text{RAS}}$ -Only Refresh	L	H	X	X	Row	N/A	High Impedance	
$\overline{\text{CAS}}$ -Before- $\overline{\text{RAS}}$ Refresh	H→L	L	H	X	X	X	High Impedance	
Hidden Refresh	Read	L→H→L	L	H	L	Row	Col	Data Out
	Write	L→H→L	L	H	X	Row	Col	Data In
Self Refresh	H→L	L	H	X	X	X	High Impedance	



Serial Presence Detect

Byte #	Description	SPD Entry Value	Serial PD Data Entry (Hexadecimal)
0	Number of Serial PD Bytes Written during Production	128	80
1	Total Number of Bytes in Serial PD device	256	08
2	Fundamental Memory Type	EDO	02
3	Number of Row Addresses on Assembly	10	0A
4	Number of Column Addresses on Assembly	10	0A
5	Number of DIMM Banks	1	01
6 - 7	Data Width of Assembly	x64	4000
8	Voltage Interface Level of this Assembly	LVTTTL	01
9	$\overline{\text{RAS}}$ Access	60ns	3C
		70ns	46
10	$\overline{\text{CAS}}$ Access	15ns	0F
		17ns	11
		20ns	14
11	DIMM Configuration Type	Non-Parity	00
12	Refresh Rate/Type	SR/8X (125 us)	85
13	Primary DRAM Data Width	x16	10
14	Error Checking DRAM Data Width	N/A	00
15 - 62	Reserved	Undefined	00
63	Checksum for bytes 0 - 62	Checksum Data	cc
64 - 71	Manufacturers' JEDEC ID Code	IBM	A400000000000000
72	Module Manufacturing Location	Toronto, Canada	91
		Vimercate, Italy	53
73 - 90	Module Part Number	ASCII '11T1645LP"R"-60T'	313154313634354C50rr2D36305420202020
		ASCII '11T1645LP"R"-6RT'	313154313634354C50rr2D36525420202020
		ASCII '11T1645LP"R"-70T'	313154313634354C50rr2D37305420202020
91 - 92	Module Revision Code	"R" plus ASCII blank	rr20
93 - 94	Module Manufacturing Date	Week/Year Code	wwyy
95 - 98	Module Serial Number	Serial Number	ssssssss
99 - 127	Reserved	Undefined	00
128 - 255	Open for Customer Use	Undefined	00

cc = Checksum Data byte, 00-FF (Hex)
 "R" = Alphanumeric revision code, A-Z, 0-9
 rr = ASCII coded revision code byte "R"
 ww = Binary coded decimal week code, 01-52 (Decimal) → 01-34 (Hex)
 yy = Binary coded decimal year code, 00-99 (Decimal) → 00-63 (Hex)
 ss = Serial number data byte, 00-FF (Hex)



IBM11T1645LP

1M x 64 144 PIN SO DIMM

Absolute Maximum Ratings

Symbol	Parameter	Rating (3.3V)	Units	Notes
V _{CC}	Power Supply Voltage	-0.5 to +4.6	V	1
V _{IN}	Input Voltage	-0.5 to min (V _{CC} + 0.5, 4.6)	V	1
V _{IN/OUT(SPD)}	Input Voltage(Serial PD Device)	-0.3 to 6.5	V	1
V _{OUT}	Output Voltage	-0.5 to min (V _{CC} + 0.5, 4.6)	V	1
T _{OPR}	Operating Temperature	0 to +70	°C	1
T _{STG}	Storage Temperature	-55 to +150	°C	1
P _D	Power Dissipation	2.4	W	1
I _{OUT}	Short Circuit Output Current	50	mA	1

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

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

Symbol	Parameter	3.3V			Units	Notes
		Min	Typ	Max		
V _{CC}	Supply Voltage	3.0	3.3	3.6	V	1
V _{IH}	Input High Voltage	2.0	—	V _{CC} + 0.5	V	1, 2
V _{IH(SPD)}	Input High Voltage(Serial PD Device)	V _{CC} × 0.7	—	V _{CC} + 0.5	V	1, 2
V _{IL}	Input Low Voltage	-0.5	—	0.8	V	1, 2
V _{IL(SPD)}	Input Low Voltage(Serial PD Device)	-0.3	—	V _{CC} × 0.3	V	1, 2
V _{OL(SPD)}	Output Low Voltage(Serial PD Device) I _{OL} = 3ma	—	—	0.4	V	

1. All voltages referenced to V_{SS}.
 2. V_{IH} may overshoot to V_{CC} + 1.2V for pulse widths of ≤ 4.0ns . Additionally, V_{IL} may undershoot to -1.2V for pulse widths ≤ 4.0ns. Pulse widths measured at 50% points with amplitude measured peak to DC reference.

Capacitance (T_A = 0 to +70 °C, V_{CC} = 3.3V ± 0.3V)

Symbol	Parameter	Max	Units
C _{I1}	Input Capacitance (A0-A9)	36	pF
C _{I2}	Input Capacitance ($\overline{\text{RAS}}$, $\overline{\text{WE}}$, $\overline{\text{OE}}$)	42	pF
C _{I3}	Input Capacitance ($\overline{\text{CAS}}$)	16	pF
C _{I4}	Input Capacitance ($\overline{\text{SCL}}$)	8	pF
C _{IO1}	Input/Output Capacitance (DQ0-63)	11	pF
C _{IO2}	Input/Output Capacitance (SDA)	10	pF



DC Electrical Characteristics $T_{(A)} = 0 \text{ to } +70^{\circ}\text{C}$, $V_{CC} = 3.3\text{V} \pm 0.3\text{V}$

Symbol	Parameter	10/10 Addressing		12/8 Addressing		Units	Notes
		Min.	Max.	Min.	Max.		
I _{CC1}	Operating Current Average Power Supply Operating Current (RAS, CAS, Address Cycling: t _{RC} = t _{RC} min.)	-60/6R	—	660	—	300	mA 1, 2, 3
		-70	—	560	—	—	
I _{CC2}	Standby Current (TTL) Power Supply Standby Current (RAS = CAS = V _{IH})	—	—	—	—	—	mA
I _{CC3}	RAS Only Refresh Current Average Power Supply Current, RAS Only Mode (RAS Cycling, CAS = V _{IH} : t _{RC} = t _{RC} min)	-60/6R	—	660	—	300	mA 1, 3
		-70	—	560	—	—	
I _{CC4}	EDO Page Mode Current Average Power Supply Current, EDO Page Mode (RAS = V _{IL} , CAS, Address Cycling: t _{PC} = t _{PC} min)	-60/6R	—	360	—	260	mA 1, 2, 3
		-70	—	320	—	—	
I _{CC5}	Standby Current (CMOS) Power Supply Standby Current (RAS = CAS = V _{CC} - 0.2V)	—	.9	—	.9	—	mA
I _{CC6}	CAS Before RAS Refresh Current Average Power Supply Current during Self Refresh CBR cycle with RAS, CAS, Cycling: t _{RC} = t _{RC} min)	-60/6R	—	660	—	300	mA 1, 3
		-70	—	560	—	—	
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 0.2.	—	—	—	—	800	μA
I _{I(L)}	Input Leakage Current Input Leakage Current, any input (0.0 ≤ V _{IN} ≤ (V _{CC} + 0.3V)), All Other Pins Not Under Test = 0V x=y	RAS, WE, OE, ACC	-40	+40	-40	+40	μA
		CAS	-10	+10	-10	+10	
I _{O(L)}	Output Leakage Current (D _{OUT} is disabled, 0.0 ≤ V _{OUT} ≤ V _{CC})	—	-10	+10	-10	+10	μA
V _{OH}	Output Level (TTL) Output "H" Level Voltage (I _{OUT} = -5mA)	—	2.4	V _{CC}	2.4	V _{CC}	V
V _{OL}	Output Level (TTL) Output "L" Level Voltage (I _{OUT} = +4.2mA)	—	0.0	0.4	0.0	0.4	V

1. I_{CC1}, I_{CC3}, I_{CC4} and I_{CC6} depend on cycle rate.
2. I_{CC1} and 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}.



IBM11T1645LP

1M x 64 144 PIN SO DIMM**AC Characteristics** ($T_A = 0$ to $+70^\circ\text{C}$, $V_{CC} = 3.3\text{V} \pm 0.3\text{V}$)

1. An initial pause of $200\mu\text{s}$ 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 $t_T=2\text{ns}$.
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} .
4. Valid column addresses are A0 through A9.
5. When both $\overline{\text{CAS}}$ and $\overline{\text{UCAS}}$ (REFERENCE BLOCK DIAGRAM, PAGE 5) go low at the same time, all 16 bits of data are read/written into the device. $\overline{\text{LCAS}}$ and $\overline{\text{UCAS}}$ cannot be staggered within the same read/write cycle.

Read, Write, Read-Modify-Write and Refresh Cycles (Common Parameters)

Symbol	Parameter	-60/-6R		-70		Unit	Notes
		Min	Max	Min	Max		
t_{RC}	Random Read or Write Cycle Time	104	—	124	—	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	10	10K	12	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	14	45	14	50	ns	1
t_{RAD}	$\overline{\text{RAS}}$ to Column Address Delay Time	12	30	12	35	ns	2
t_{RSH}	$\overline{\text{RAS}}$ Hold Time	10	—	12	—	ns	
t_{CSH}	$\overline{\text{CAS}}$ Hold Time	50	—	55	—	ns	
t_{CRP}	$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time	5	—	5	—	ns	
t_{OED}	$\overline{\text{OE}}$ to D_{IN} Delay Time	15	—	15	—	ns	3
t_{DZO}	$\overline{\text{OE}}$ Delay Time from D_{IN}	0	—	0	—	ns	4
t_{DZC}	$\overline{\text{CAS}}$ Delay Time from D_{IN}	0	—	0	—	ns	4
t_T	Transition Time (Rise and Fall)	2	30	2	30	ns	

1. Operation within the $t_{RCD}(\text{max})$ limit ensures that $t_{RAC}(\text{max})$ can be met. The $t_{RCD}(\text{max})$ 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. The $t_{RAD}(\text{max})$ 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. Either t_{CDD} or t_{OED} must be satisfied.
4. Either t_{DZC} or t_{DZO} must be satisfied.



Write Cycle

Symbol	Parameter	-60/6R		-70		Unit	Notes
		Min	Max	Min	Max		
t_{WCS}	Write Command Set Up Time	0	—	0	—	ns	1
t_{WCH}	Write Command Hold Time	10	—	12	—	ns	
t_{WP}	Write Command Pulse Width	10	—	12	—	ns	
t_{RWL}	Write Command to \overline{RAS} Lead Time	10	—	12	—	ns	
t_{CWL}	Write Command to \overline{CAS} Lead Time	10	—	12	—	ns	
t_{DS}	D_{IN} Setup Time	0	—	0	—	ns	2
t_{DH}	D_{IN} Hold Time	10	—	12	—	ns	2

1. t_{WCS} , t_{RWD} , t_{CWD} , t_{AWD} , and t_{CPW} are not restrictive parameters. They are included in the data sheet as electrical characteristics only. If $t_{WCS} \geq t_{WCS}(\text{min.})$, the entire cycle is an early write cycle and the data pin will remain open circuit (high impedance) through the entire cycle; If $t_{RWD} \geq t_{RWD}(\text{min.})$, $t_{CWD} \geq t_{CWD}(\text{min.})$, $t_{AWD} \geq t_{AWD}(\text{min.})$ and $t_{CPW} \geq t_{CPW}(\text{min.})$ (Fast Page Mode), the cycle is a Read-Modify-Write cycle and the data will contain read from the selected cell: If neither of the above sets of conditions are met, the condition of the data (at access time) is indeterminate.
2. These parameters are referenced to \overline{LCAS} or \overline{UCAS} leading edge in early write cycles and to \overline{WE} leading edge in Read-Modify-Write cycles.



IBM11T1645LP

1M x 64 144 PIN SO DIMM

Read Cycle

Symbol	Parameter	-60		-6R		-70		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t_{RAC}	Access Time from \overline{RAS}	—	60	—	60	—	70	ns	1, 2, 3
t_{CAC}	Access Time from \overline{CAS}	—	15	—	17	—	20	ns	1, 3
t_{AA}	Access Time from Address	—	30	—	30	—	35	ns	2, 3
t_{OEA}	Access Time from \overline{OE}	—	15	—	17	—	20	ns	3
t_{RCS}	Read Command Setup Time	0	—	0	—	0	—	ns	
t_{RCH}	Read Command Hold Time to \overline{CAS}	0	—	0	—	0	—	ns	4
t_{RRH}	Read Command Hold Time to \overline{RAS}	0	—	0	—	0	—	ns	4
t_{RAL}	Column Address to \overline{RAS} Lead Time	30	—	30	—	35	—	ns	
t_{CLZ}	\overline{CAS} to Output in Low-Z	0	—	0	—	0	—	ns	
t_{OES}	\overline{OE} setup time prior to \overline{CAS}	5	—	5	—	5	—	ns	3
t_{ORD}	\overline{OE} setup time prior to \overline{RAS} (Hidden Refresh)	0	—	0	—	0	—	ns	
t_{CDD}	\overline{CAS} to D_{IN} Delay Time	15	—	15	—	15	—	ns	7
t_{OEZ}	Output Buffer Turn-off Delay from \overline{OE}	—	15	—	15	—	15	ns	5
t_{OFF}	Output Buffer Turn-off Delay	—	15	—	15	—	15	ns	5, 6

1. 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} .
2. 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_{AA} .
3. Measured with the specified current load and 100pF at $V_{OL} = 0.8V$ and $V_{OH} = 2.0V$.
4. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
5. $t_{OFF}(\max)$ and $t_{OEZ}(\max)$ define the time at which the output achieves the open circuit condition and are not referenced to output voltage levels.
6. t_{OFF} is referenced from the rising edge of \overline{RAS} or \overline{CAS} , which ever is last.
7. Either t_{CDD} or t_{OED} must be satisfied.



Read-Modify-Write Cycle

Symbol	Parameter	-60		-6R		-70		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t_{RWC}	Read-Modify-Write Cycle Time	135	—	135	—	162	—	ns	
t_{RWD}	\overline{RAS} to \overline{WE} Delay Time	79	—	79	—	94	—	ns	1
t_{CWD}	\overline{CAS} to \overline{WE} Delay Time	34	—	36	—	44	—	ns	1
t_{AWD}	Column Address to \overline{WE} Delay Time	49	—	49	—	59	—	ns	1
t_{OEH}	\overline{OE} Command Hold Time	10	—	10	—	12	—	ns	

1. t_{WCS} , t_{RWD} , t_{CWD} , t_{AWD} , and t_{CPW} are not restrictive parameters. They are included in the data sheet as electrical characteristics only. If $t_{WCS} \geq t_{WCS}(\text{min.})$, the entire cycle is an early write cycle and the data pin will remain open circuit (high impedance) through the entire cycle; If $t_{RWD} \geq t_{RWD}(\text{min.})$, $t_{CWD} \geq t_{CWD}(\text{min.})$, $t_{AWD} \geq t_{AWD}(\text{min.})$ and $t_{CPW} \geq t_{CPW}(\text{min.})$ (Fast Page Mode), the cycle is a Read-Modify-Write cycle and the data will contain read from the selected cell: If neither of the above sets of conditions are met, the condition of the data (at access time) is indeterminate.

EDO Mode Cycle

Symbol	Parameter	-60/-6R		-70		Units	Notes
		Min.	Max.	Min.	Max.		
t_{HCAS}	\overline{CAS} Pulse Width (EDO Page Mode)	10	10K	12	10K	ns	
t_{HPC}	EDO Page Mode Cycle Time (Read/Write)	25	—	30	—	ns	
t_{HPRWC}	EDO Page Mode Read Modify Write Cycle Time	60	—	72	—	ns	
t_{DOH}	Data-out Hold Time from \overline{CAS}	5	—	5	—	ns	
t_{WHZ}	Output buffer Turn-Off Delay from \overline{WE}	0	10	0	15	ns	
t_{WPZ}	\overline{WE} Pulse Width to Output Disable at \overline{CAS} High	10	—	10	—	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
t_{RASP}	EDO Page Mode \overline{RAS} Pulse Width	60	125K	70	125K	ns	
t_{OEP}	\overline{OE} High Pulse Width	10	—	10	—	ns	
t_{OEHC}	\overline{OE} High Hold Time from \overline{CAS} High	10	—	10	—	ns	

1. Measured with the specified current load and 100pF at $V_{OL} = 0.8V$ and $V_{OH} = 2.0V$.



IBM11T1645LP

1M x 64 144 PIN SO DIMM

Refresh Cycle

Symbol	Parameter	-60/-6R		-70		Unit	Notes
		Min	Max	Min	Max		
t_{CHR}	\overline{CAS} Hold Time (CAS before \overline{RAS} Refresh Cycle)	10	—	10	—	ns	
t_{CSR}	\overline{CAS} Setup Time (CAS before \overline{RAS} Refresh Cycle)	5	—	5	—	ns	
t_{WRP}	\overline{WE} Setup Time (CAS before \overline{RAS} Refresh Cycle)	10	—	10	—	ns	
t_{WRH}	\overline{WE} Hold Time (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. 1024 refreshes are required every 128ms.

Self Refresh Cycle

Symbol	Parameter	-60/-6R		-70		Unit	Notes
		Min	Max	Min	Max		
t_{RASS}	\overline{RAS} Pulse Width During Self Refresh Cycle	100	—	100	—	ns	1
t_{RPS}	\overline{RAS} Precharge Time During Self Refresh Cycle)	104	—	124	—	ns	1
t_{CHS}	\overline{CAS} Hold Time During Self Refresh Cycle)	50	—	50	—	ns	1, 2
t_{CHD}	\overline{CAS} Hold Time From RAS Falling During Self Refresh Cycle	350	—	350	—	μ s	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



Presence Detect Read and Write Cycle

Symbol	Parameter	-60/-6R/-70		Unit	Notes
		Min	Max		
f_{SCL}	SCL Clock Frequency		80	kHZ	
T_I	Noise Suppression Time Constant at SCL, SDA Inputs		100	ns	
t_{AA}	SCL Low to SDA Data Out Valid	0.3	7.0	μ s	
t_{BUF}	Time the Bus Must Be Free before a New Transmission Can Start	6.7		μ s	
$t_{HD:STA}$	Start Condition Hold Time	4.5		μ s	
t_{LOW}	Clock Low Period	6.7		μ s	
t_{HIGH}	Clock High Period	4.5		μ s	
$t_{SU:STA}$	Start Condition Setup Time(for a Repeated Start Condition)	6.7		μ s	
$t_{HD:DAT}$	Data in Hold Time	0		μ s	
$t_{SU:DAT}$	Data in Setup Time	500		ns	
t_r	SDA and SCL Rise Time		1	μ s	
t_f	SDA and SCL Fall Time		300	ns	
$t_{SU:STO}$	Stop Condition Setup Time	6.7		μ s	
t_{DH}	Data Out Hold Time	300		ns	
t_{WR}	Write Cycle Time		15	ms	1

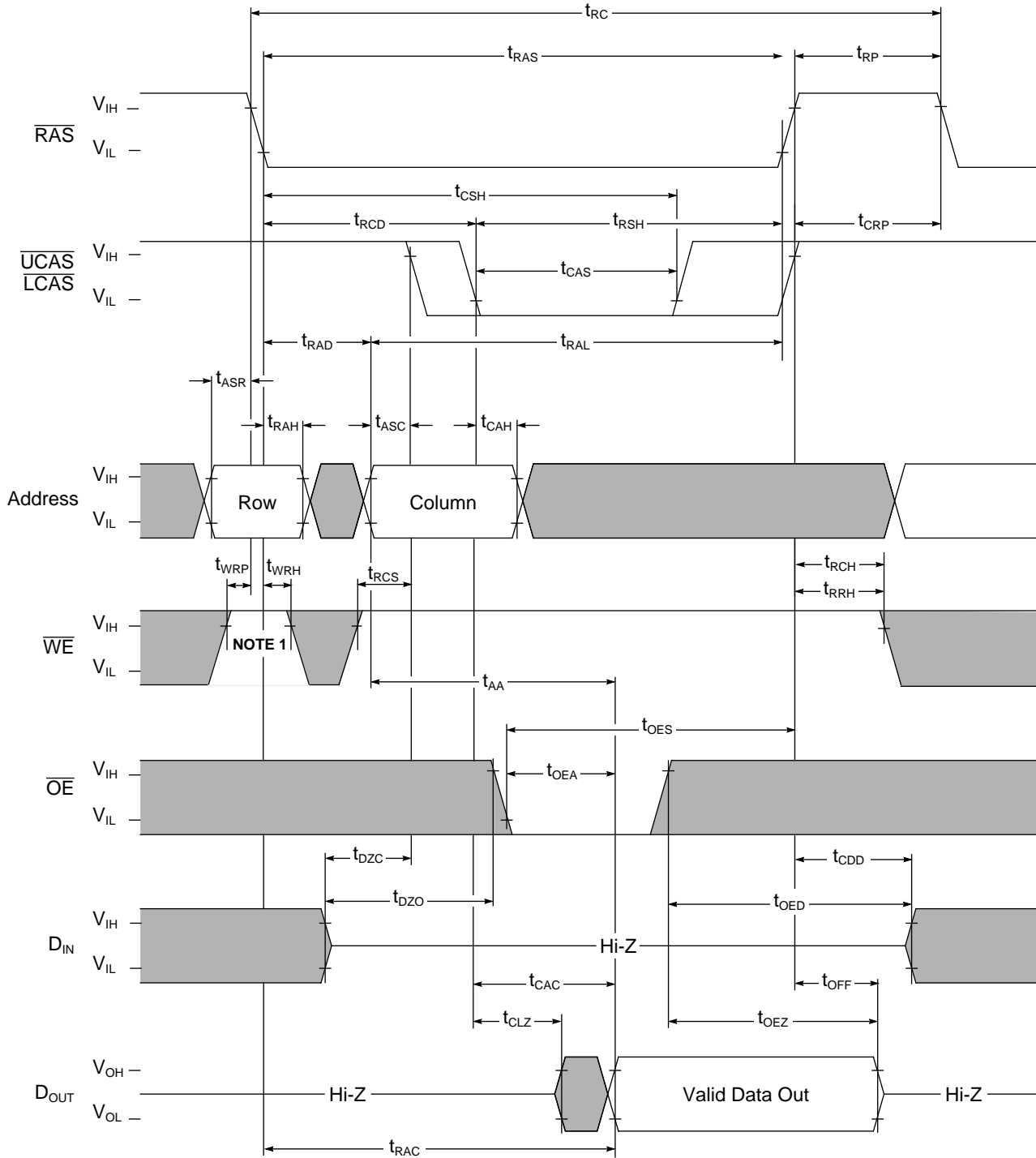
1. The write cycle time(t_{WR}) is the time from a valid stop condition of a write sequence to the end of the internal erase/program cycle. During the write cycle, the bus interface circuits are disabled, SDA is allowed to remain high per the bus-level pull-up resistor, and the device does not respond to its slave address.



IBM11T1645LP

1M x 64 144 PIN SO DIMM

Read Cycle

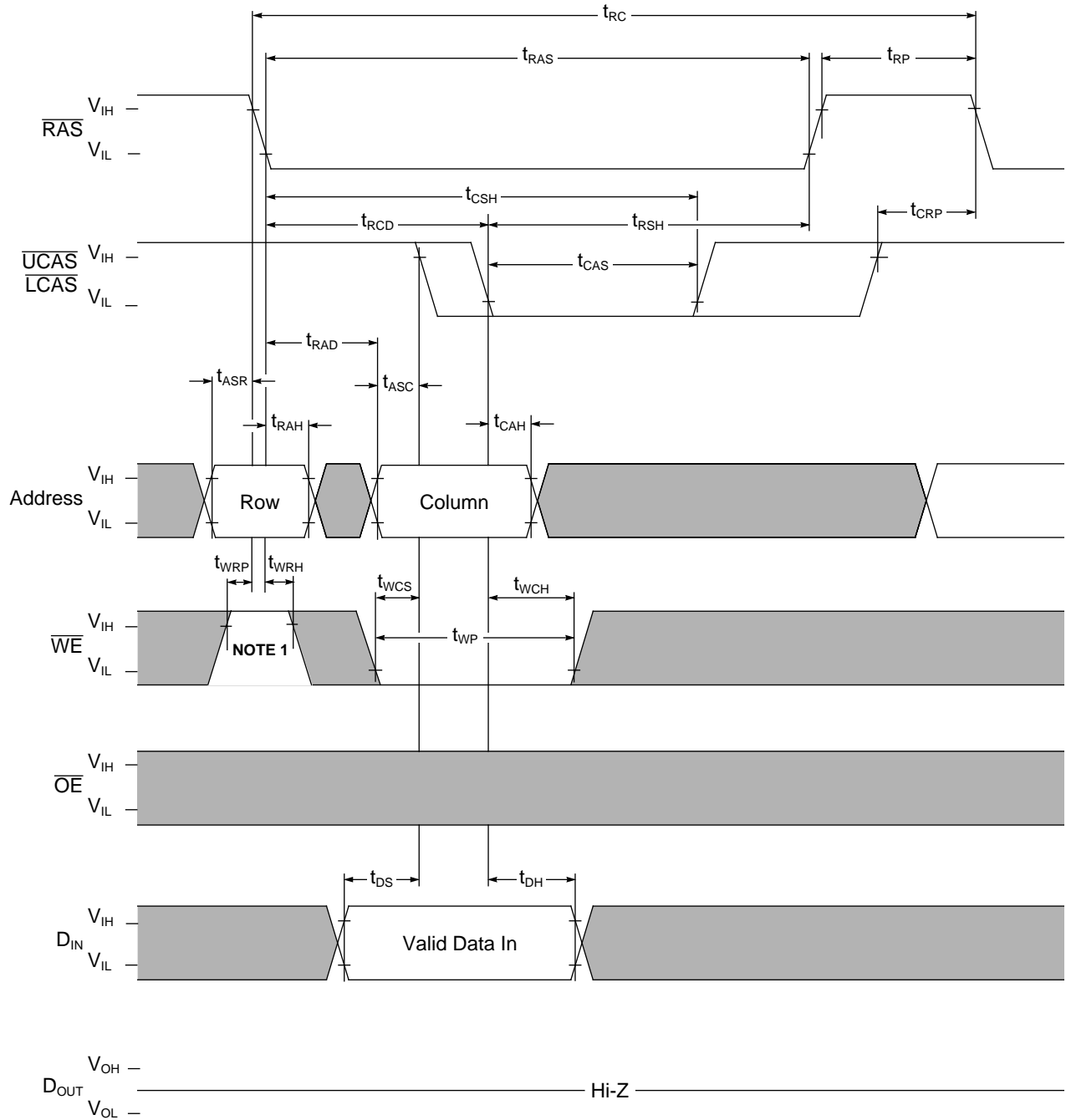


■ : "H": or "L"

NOTE 1: Implementing $\overline{\text{WE}}$ at $\overline{\text{RAS}}$ time During a Read or Write Cycle is optional. Doing so will facilitate compatibility with future EDO DRAMs.



Write Cycle (Early Write)



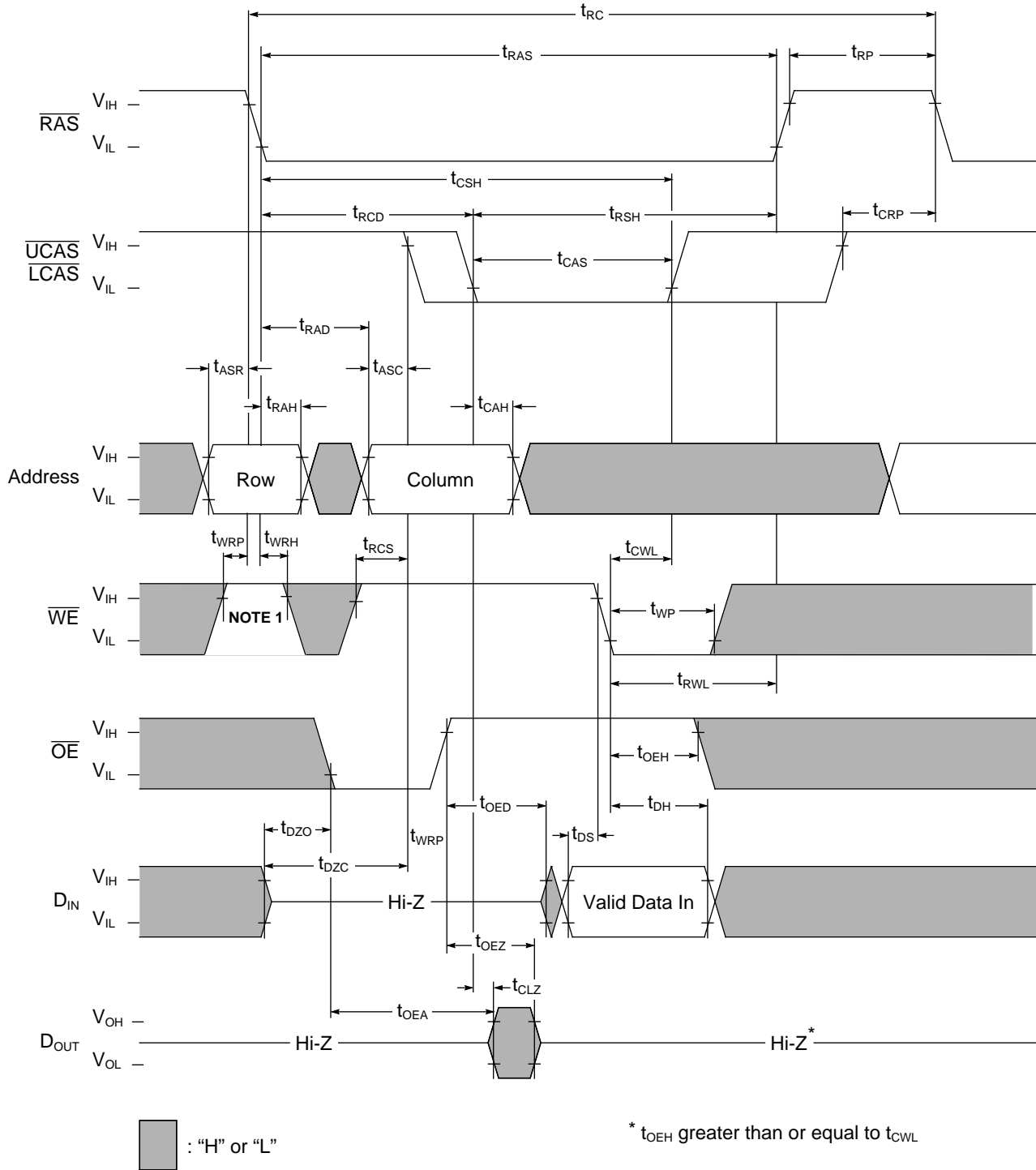
█ : "H" or "L"



IBM11T1645LP

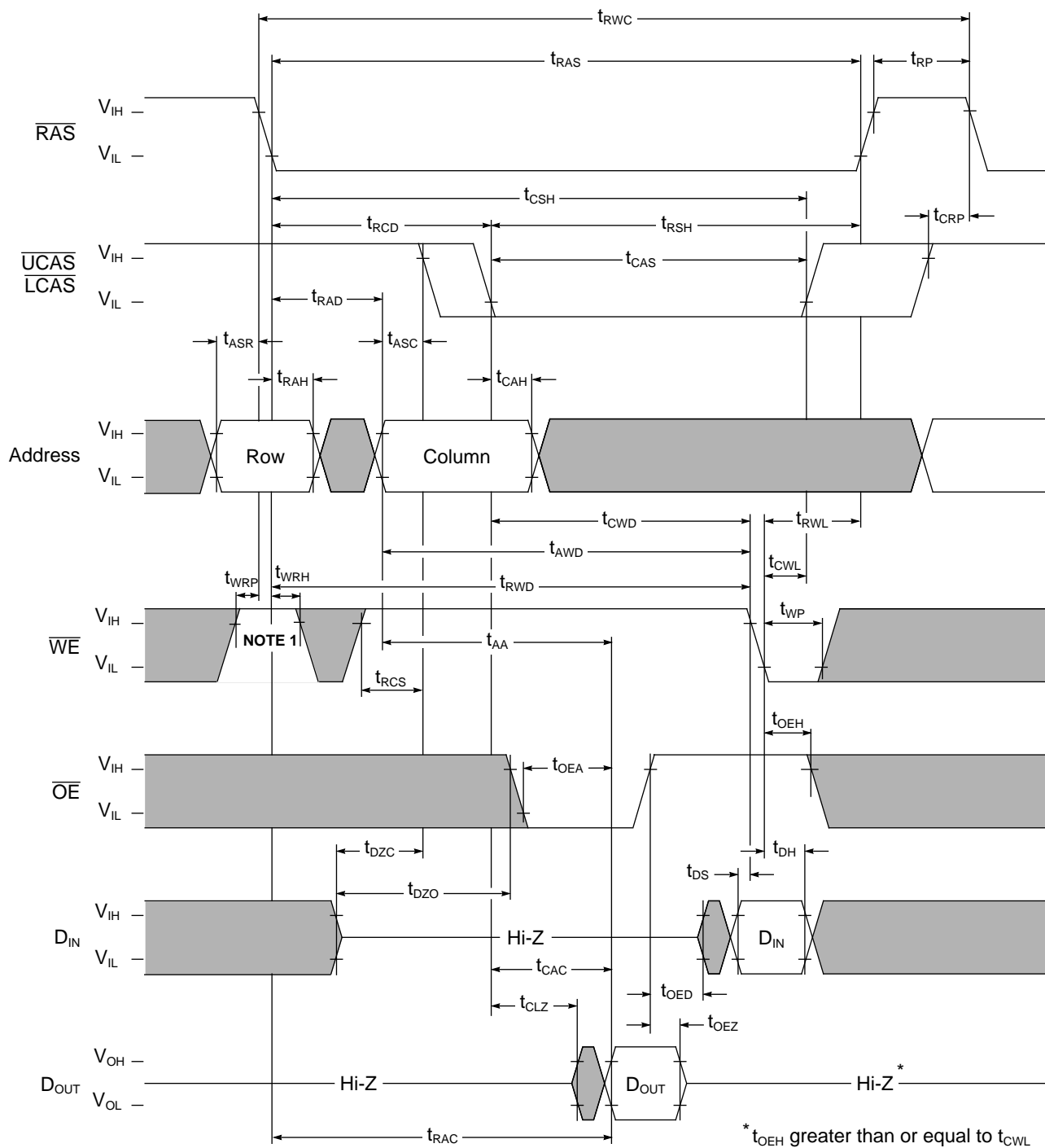
1M x 64 144 PIN SO DIMM

Write Cycle (Late Write)



NOTE 1: Implementing \overline{WE} at \overline{RAS} time During a Read or Write Cycle is optional. Doing so will facilitate compatibility with future EDO DRAMs.

Read-Modify-Write-Cycle



: "H" or "L"

NOTE 1: Implementing \overline{WE} at \overline{RAS} time During a Read or Write Cycle is optional. Doing so will facilitate compatibility with future EDO DRAMs.

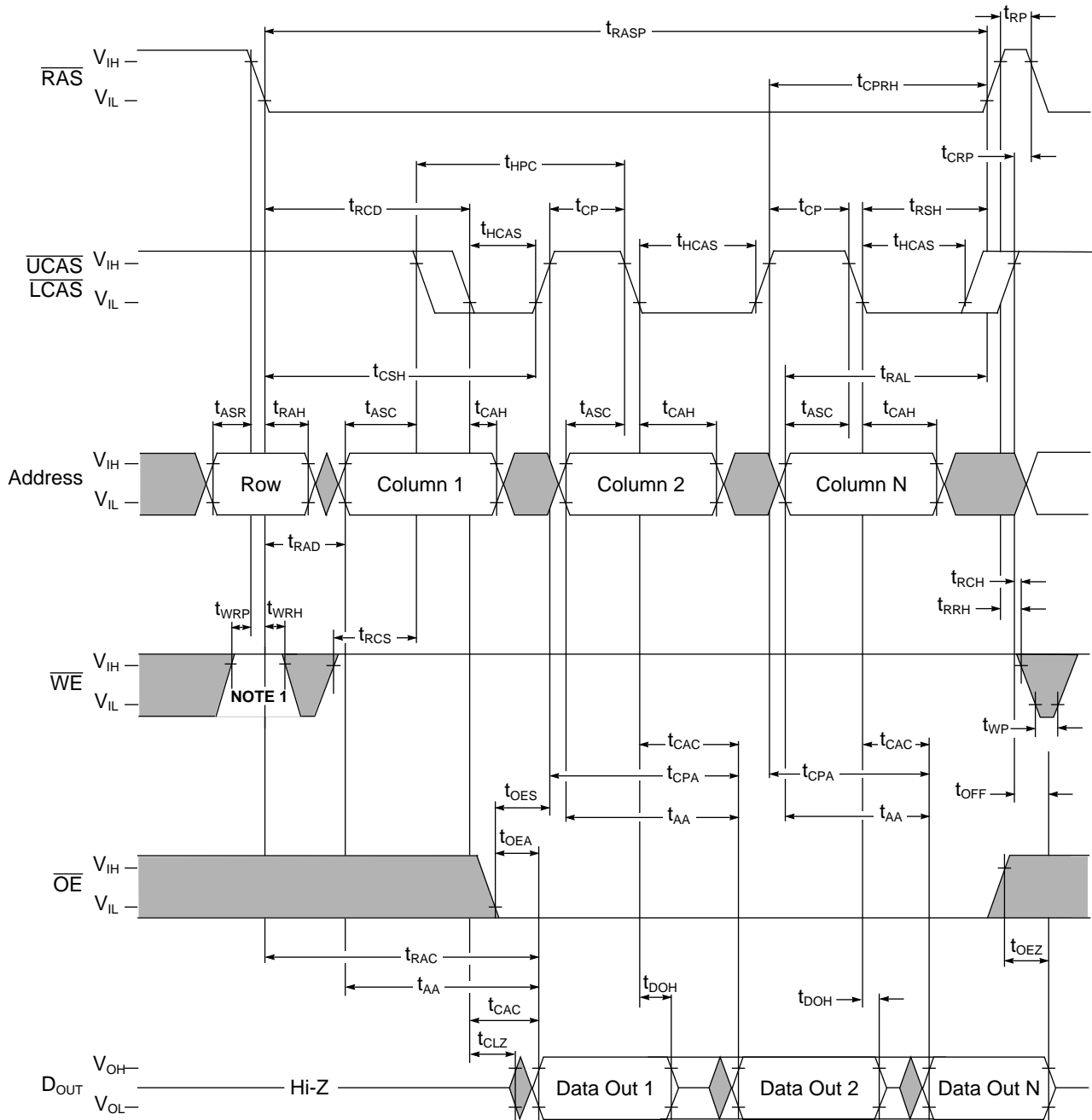
* $t_{OE H}$ greater than or equal to t_{CWL}



IBM11T1645LP

1M x 64 144 PIN SO DIMM

EDO Page Mode Read Cycle

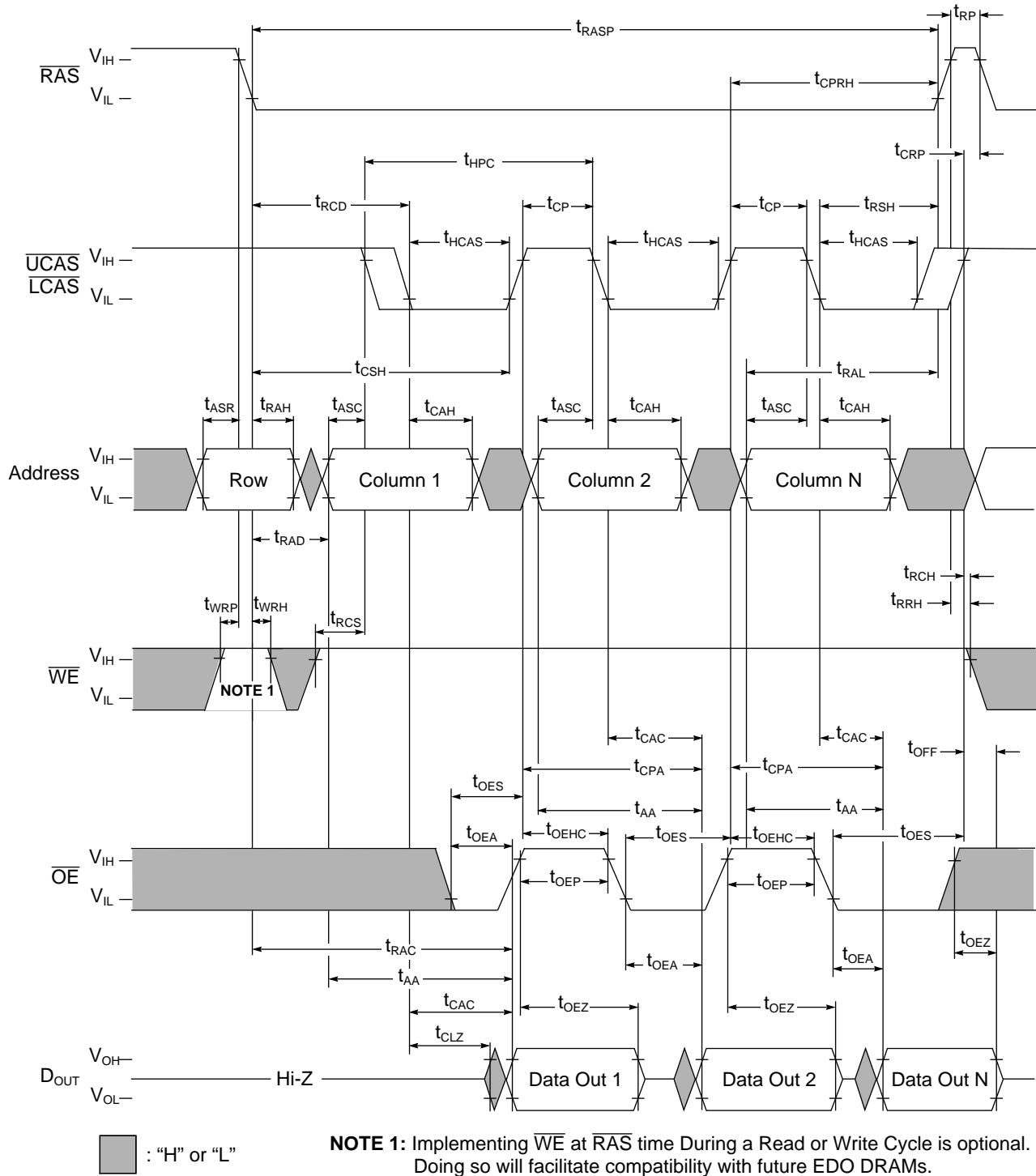


■ : "H" or "L"

NOTE 1: Implementing \overline{WE} at \overline{RAS} time During a Read or Write Cycle is optional. Doing so will facilitate compatibility with future EDO DRAMs.



EDO Page Mode Read Cycle (\overline{OE} Control)

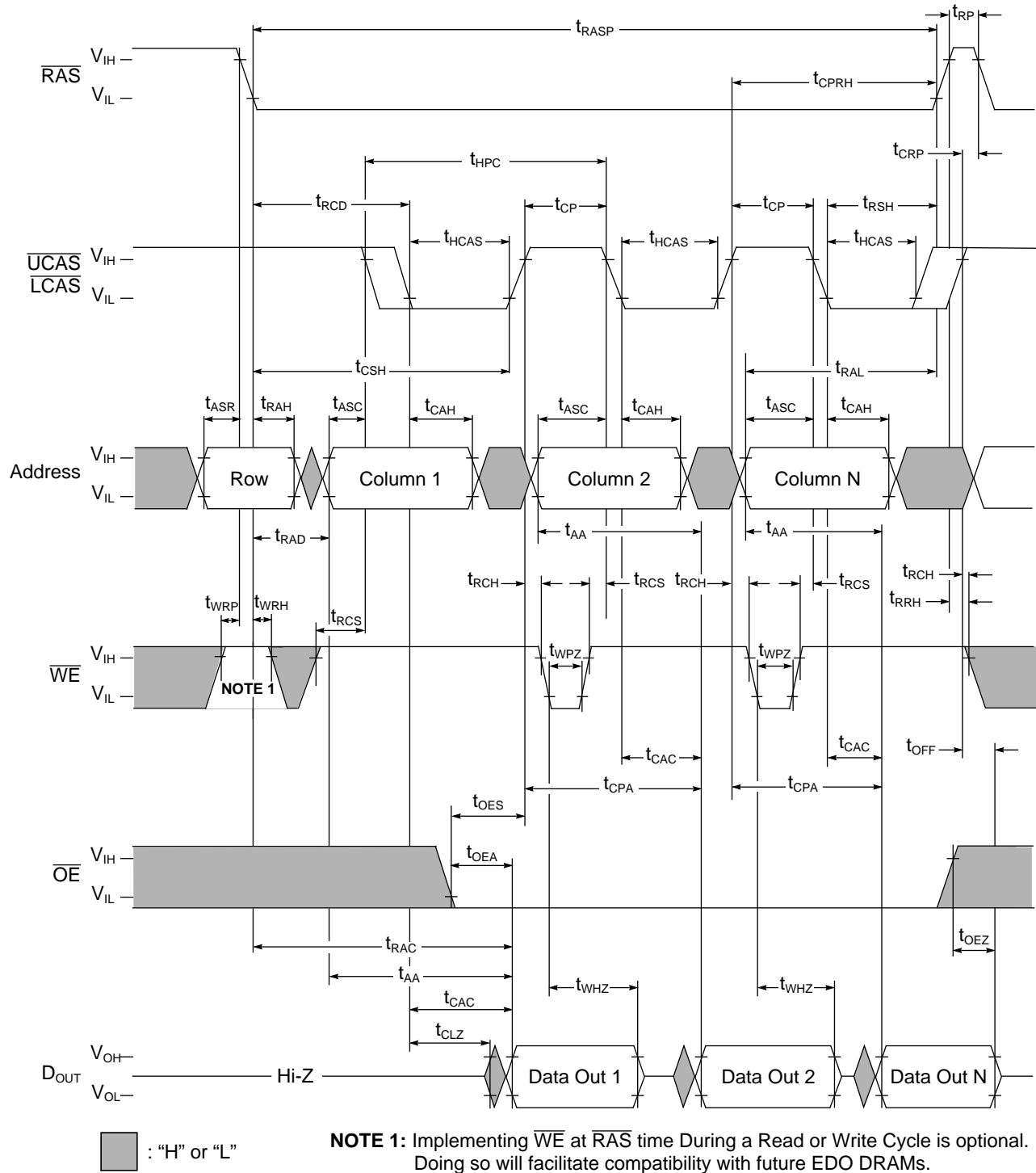




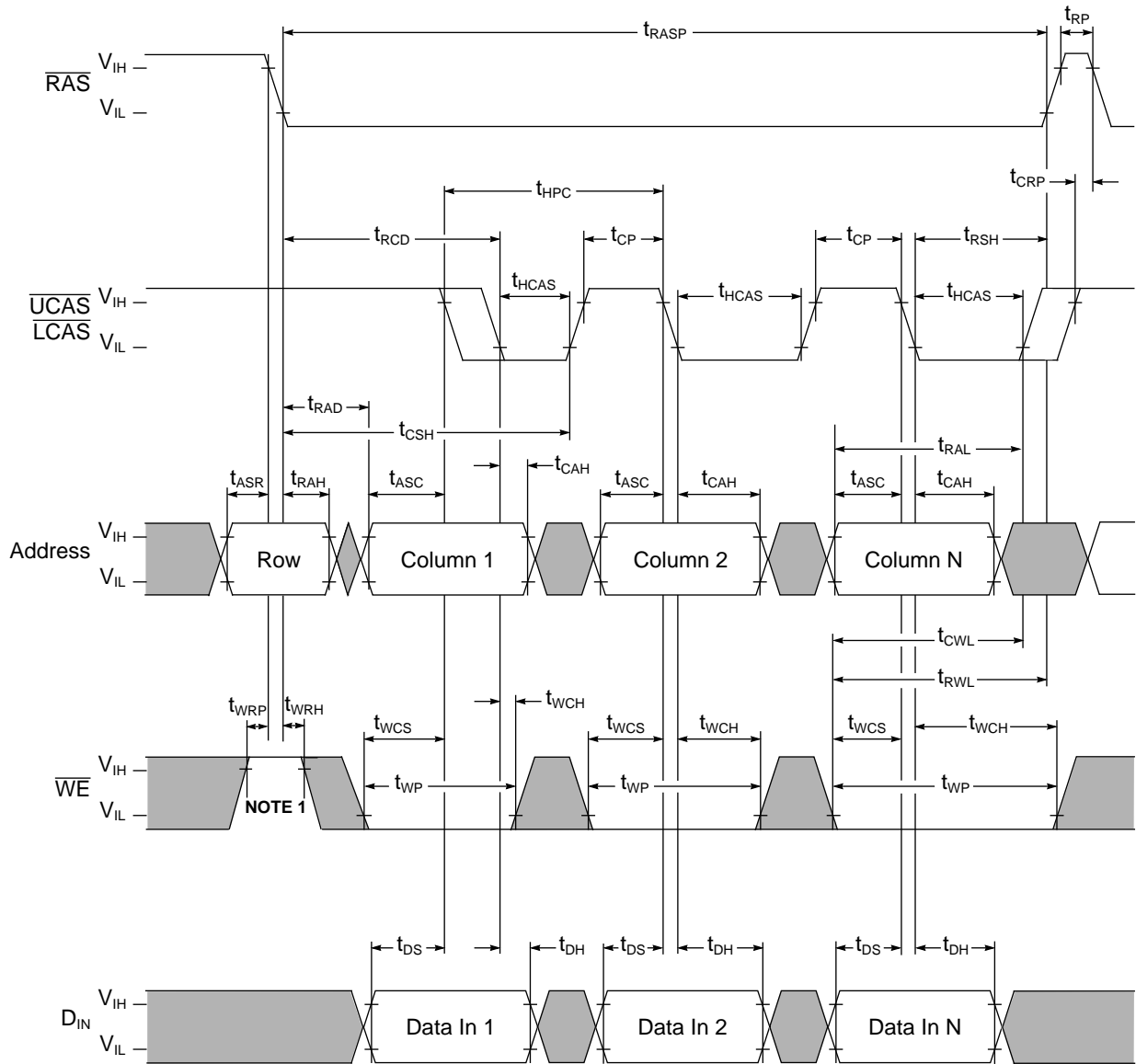
IBM11T1645LP

1M x 64 144 PIN SO DIMM

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



EDO Page Mode Early Write Cycle



□ : "H" or "L"

NOTE 1: Implementing \overline{WE} at \overline{RAS} time During a Read or Write Cycle is optional. Doing so will facilitate compatibility with future EDO DRAMs.

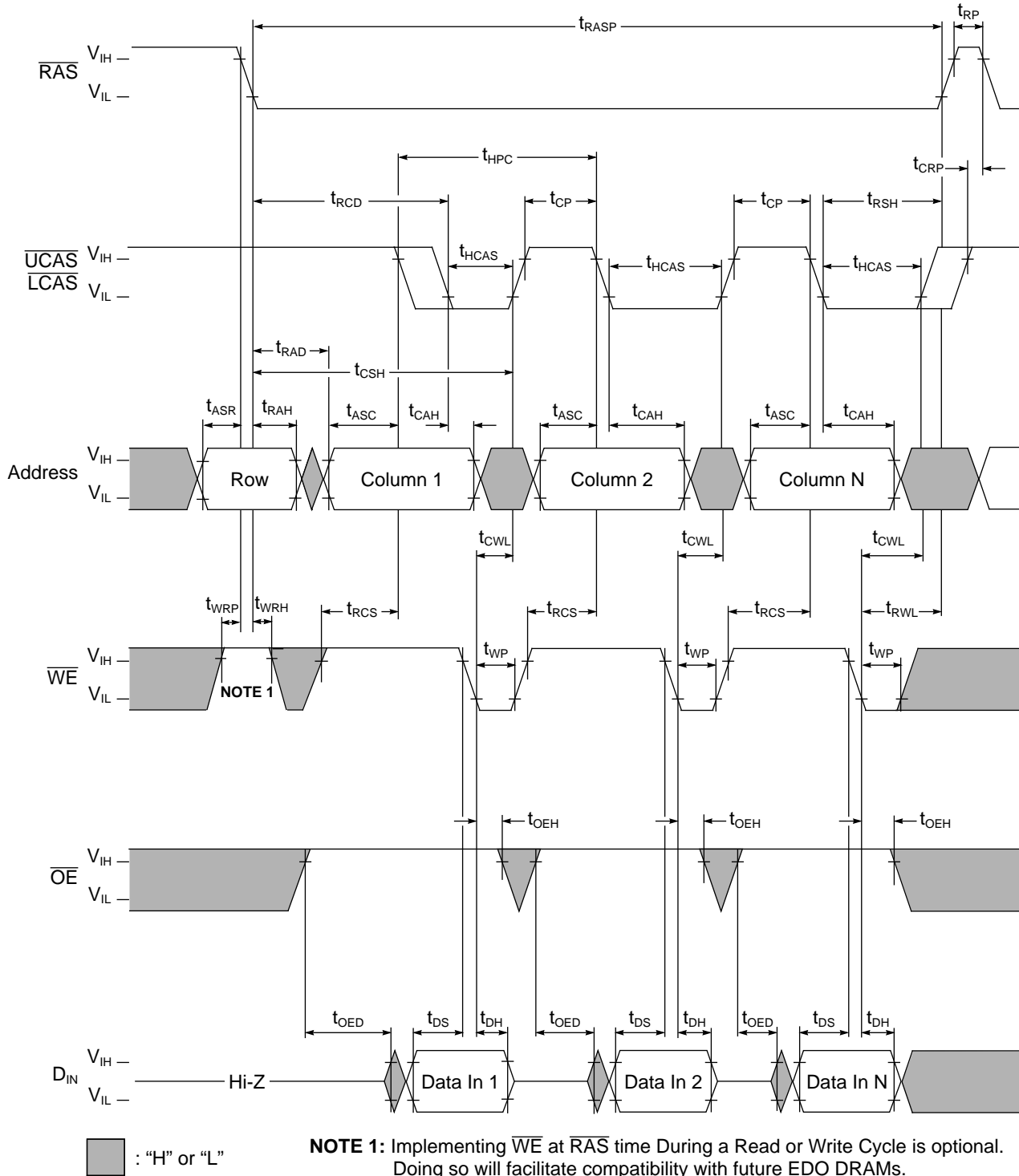
\overline{OE} = Don't care



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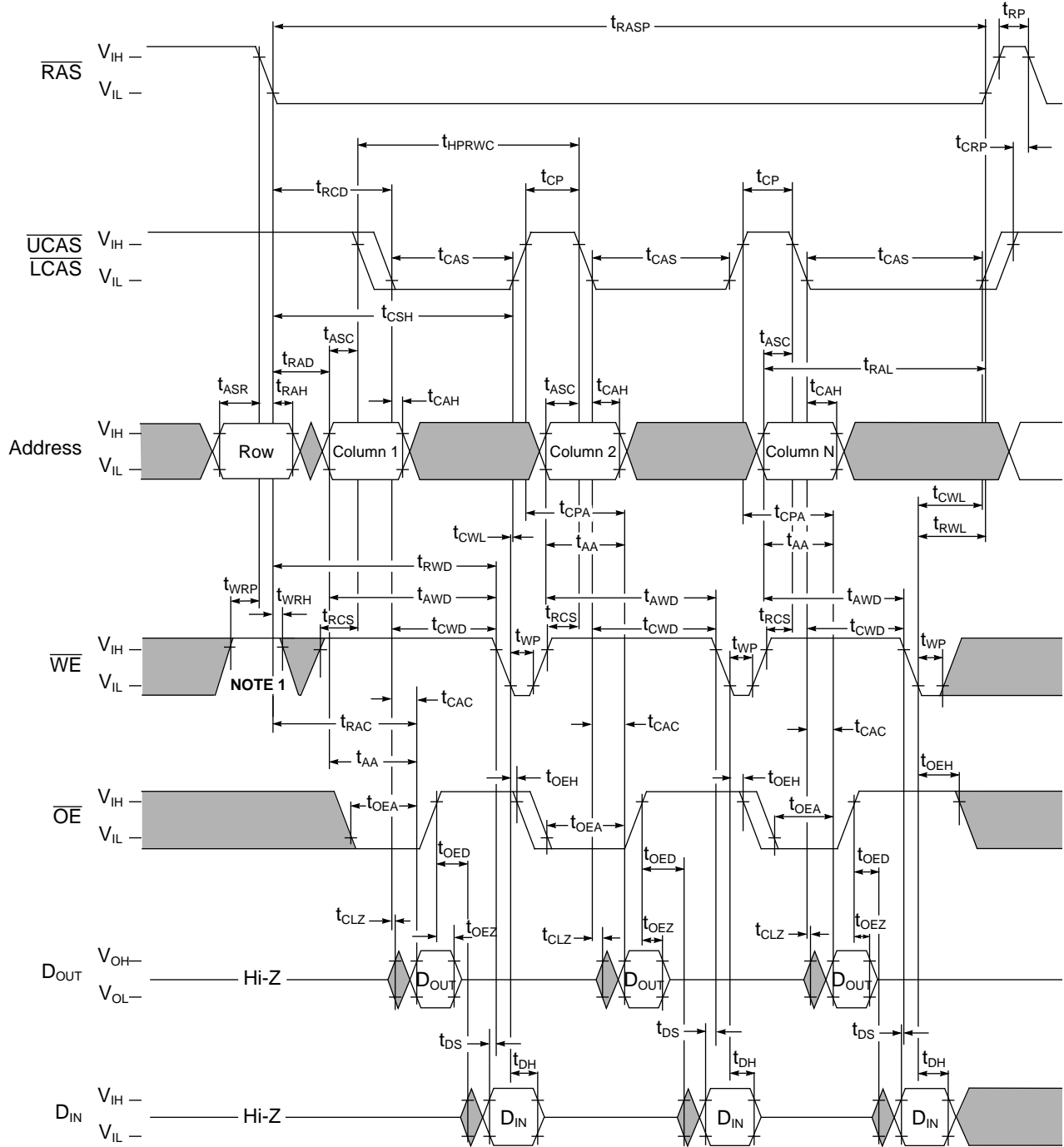
1M x 64 144 PIN SO DIMM

EDO Page Mode Late Write Cycle





EDO Page Mode Read Modify Write Cycle



■ : "H" or "L"

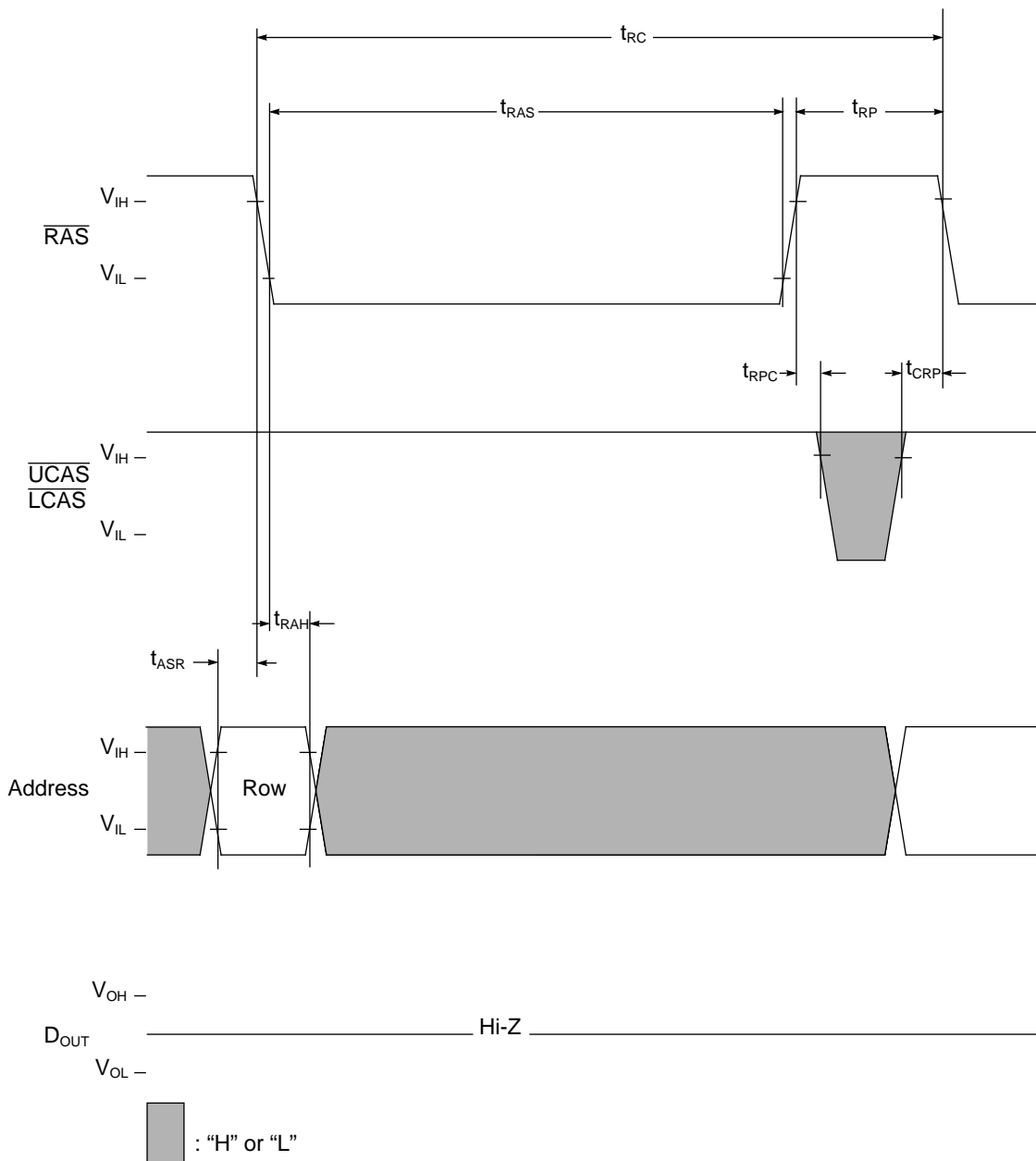
NOTE 1: Implementing \overline{WE} at \overline{RAS} time During a Read or Write Cycle is optional. Doing so will facilitate compatibility with future EDO DRAMs.



IBM11T1645LP

1M x 64 144 PIN SO DIMM

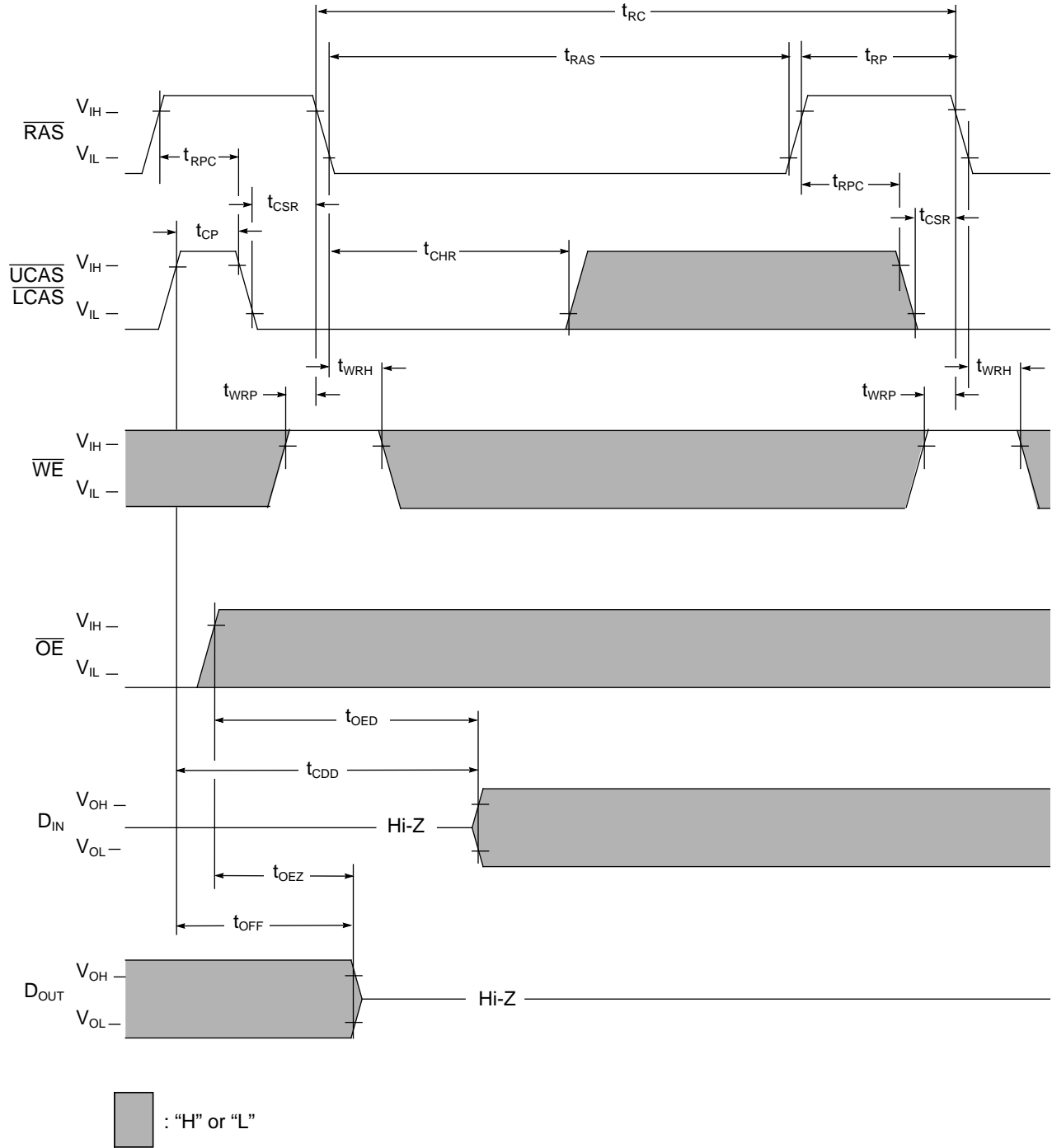
RAS Only Refresh Cycle



Note: $\overline{\text{WE}}$, $\overline{\text{OE}}$, D_{IN} are "H" or "L"



CAS Before RAS Refresh Cycle



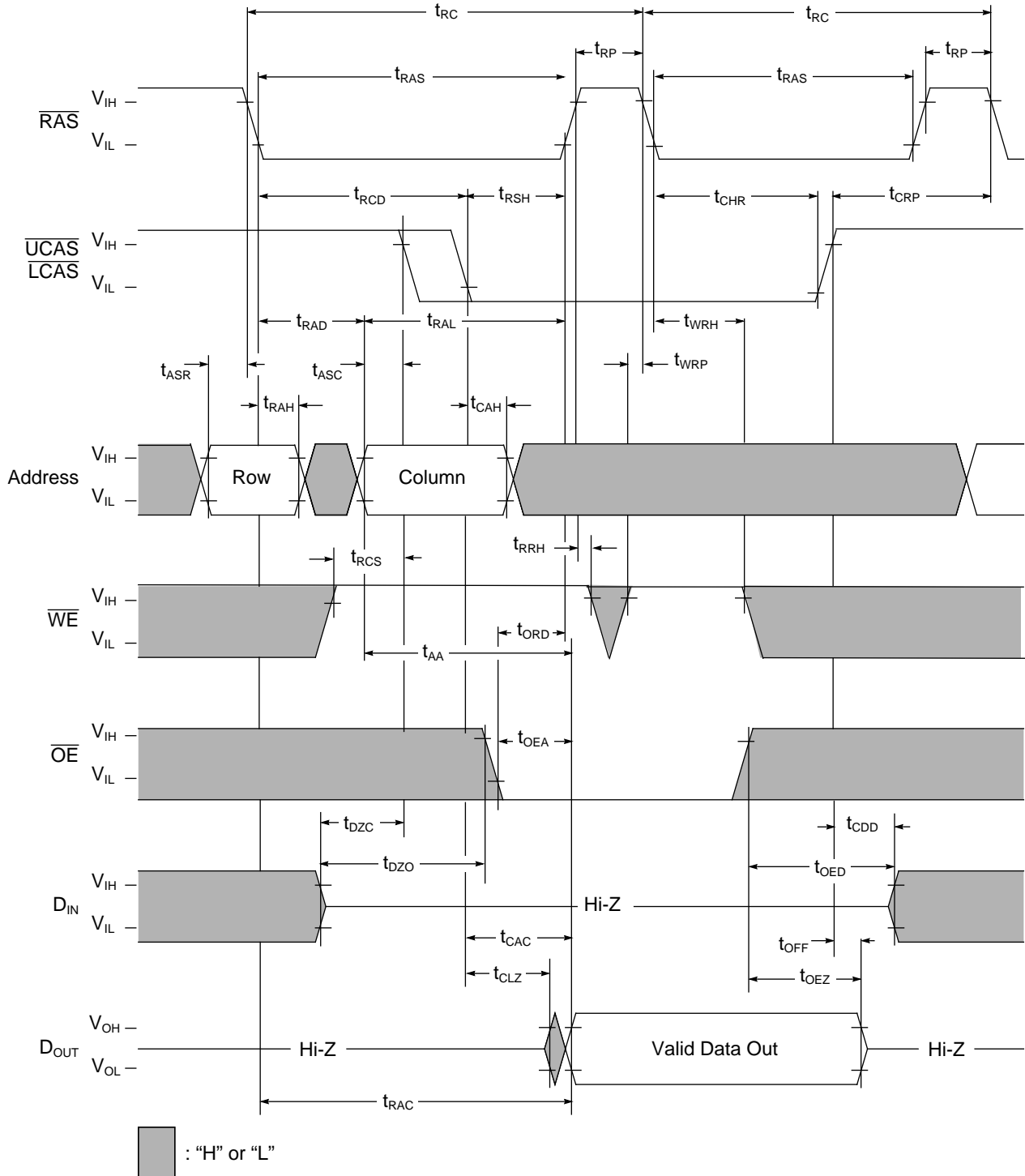
NOTE: Address is "H" or "L"



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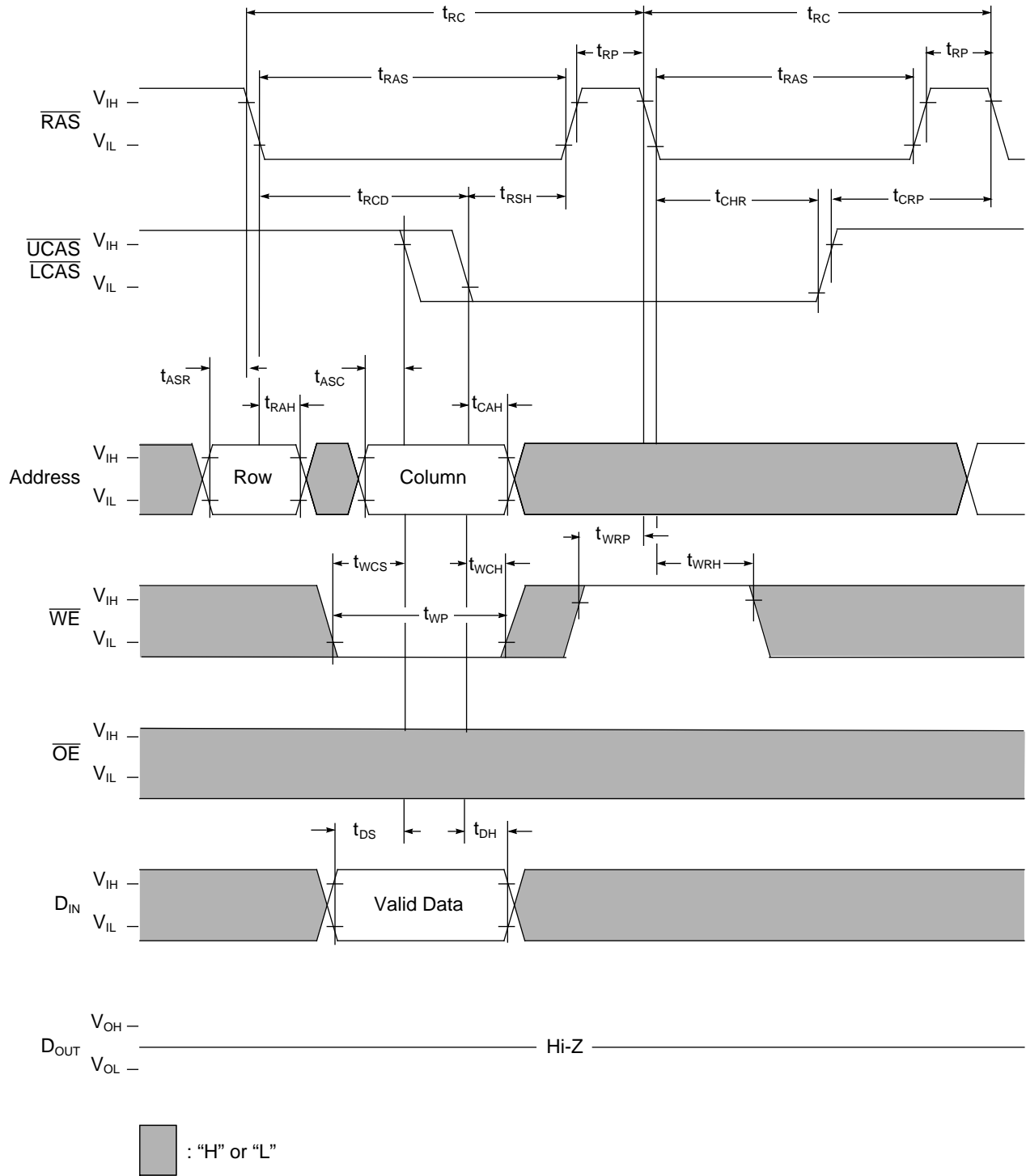
1M x 64 144 PIN SO DIMM

Hidden Refresh Cycle (Read)





Hidden Refresh Cycle (Write)

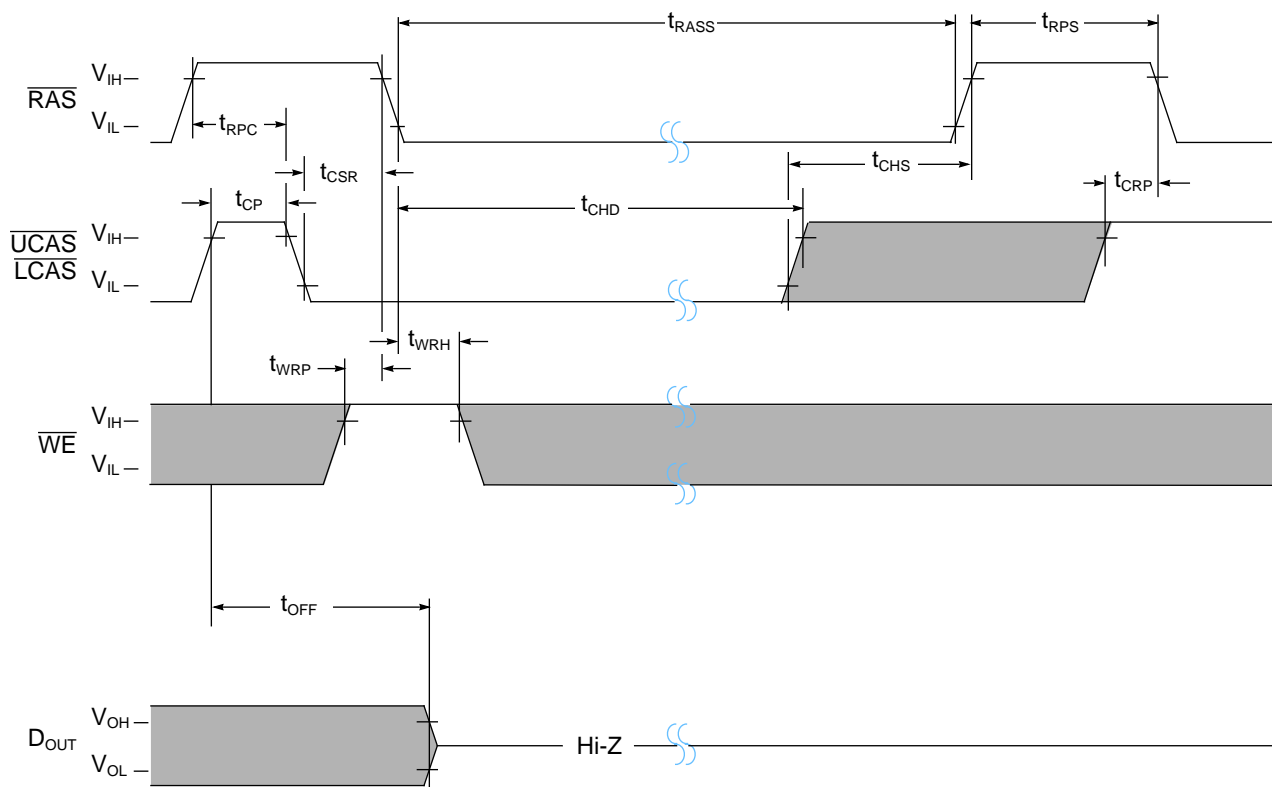





IBM11T1645LP

1M x 64 144 PIN SO DIMM

Self Refresh Cycle (Sleep Mode) - Low Power version only



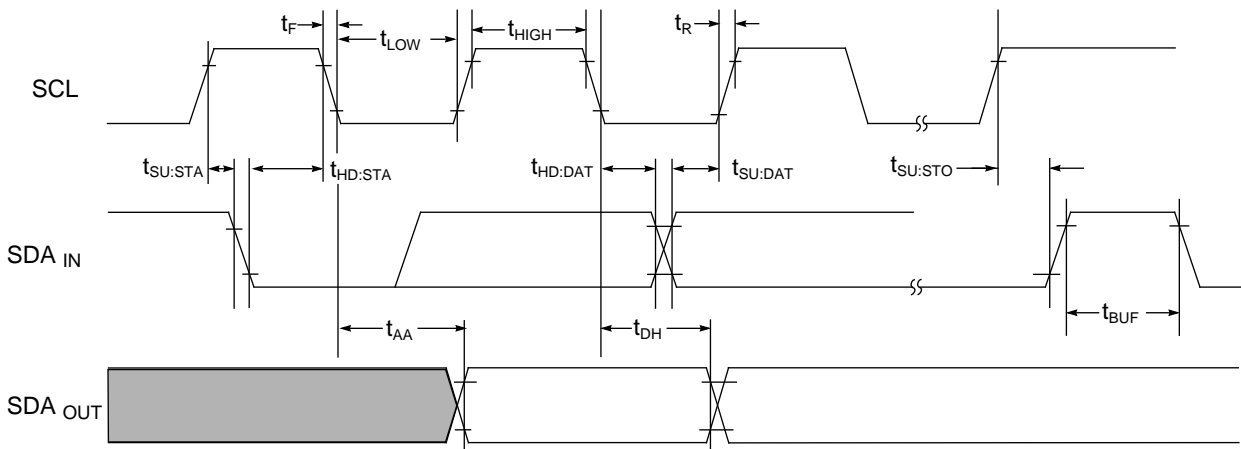
 : "H" or "L"

NOTES:

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



Presence Detect (EEPROM) Bus Timing



Presence Detect Operation

Clock and Data Conventions: Data states on the SDA line can change only during SCL low. SDA state changes during SCL HIGH are reserved for indicating start and stop conditions (Figure 1 & Figure 3).

Start Condition: All commands are preceded by the start condition, which is a HIGH to LOW transition of SDA when SCL is high. The serial PD device continuously monitors the SDA and SCL lines for the start condition and will not respond to any command until this condition has been met.

Stop Condition: All communications are terminated by a stop condition, which is a LOW to HIGH transition of SDA when SCL is HIGH. The stop condition is also used to place the serial PD device into standby power mode.

Acknowledge: Acknowledge is a software convention used to indicate successful data transfers. The transmitting device, either master or slave, will release the bus after transmitting eight bits. During the ninth clock cycle the receiver will pull the SDA line LOW to acknowledge that it received the eight bits of data (Figure 3).

The PD device will always respond with an acknowledge after recognition of a start condition and its slave address. If both the device and a write operation have been selected, The PD device, will respond with an acknowledge after the receipt of each subsequent eight bit word. In the read mode the PD device will transmit eight bits of data, release the SDA line and monitor the line for an acknowl-

edge. If an acknowledge is detected and no stop condition is generated by the master, the slave will continue to transmit data. If an acknowledge is not detected, the slave will terminate further data transmissions and await the stop condition to return to standby power mode.

Figure 1. Data Window

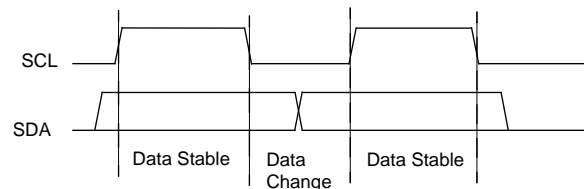


Figure 2. Definition of Start & Stop

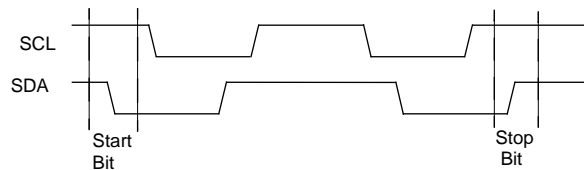
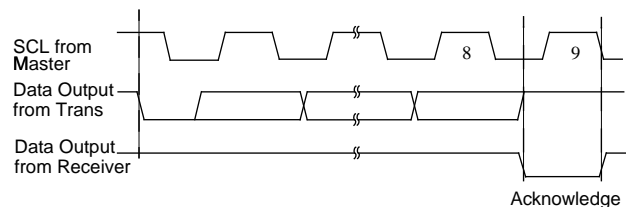


Figure 3. Acknowledge Response From Receiver

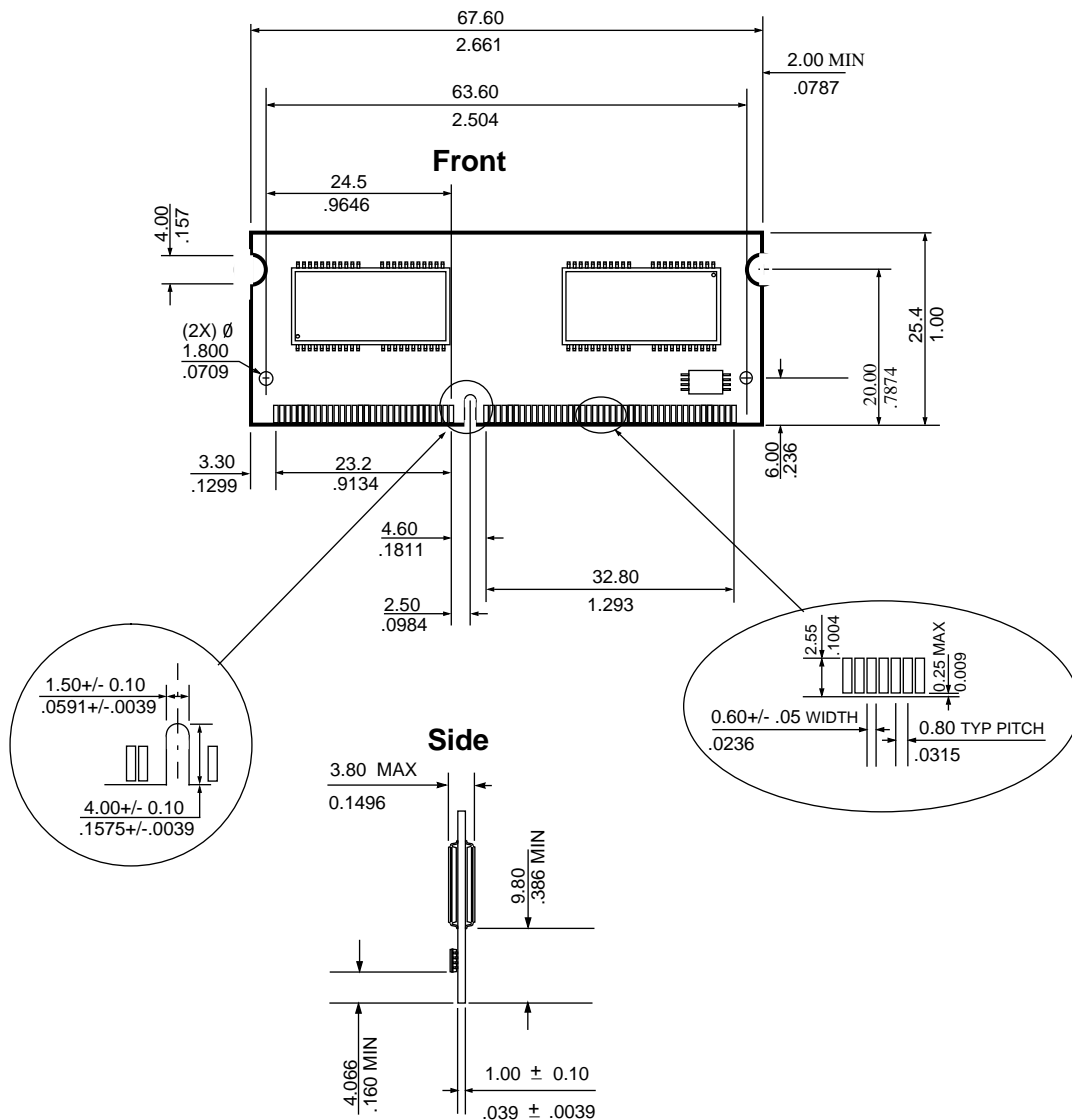




IBM11T1645LP

1M x 64 144 PIN SO DIMM

Layout Drawing



Note: All dimensions are typical unless otherwise stated. MILLIMETERS
INCHES



Revision Log

Rev	Contents of Modification
1/96	Initial Release.
4/96	Add Self Refresh and -6R timings
11/96	Add 12/10 Address part, Correct typos: <ol style="list-style-type: none">1. Corrected Serial PD part drawing, Page 5.2. Corrected note on Read-Modify, Write, and Refresh Cycle tables.3. Changed t_{ODD} to t_{OED}
4/97	Update Serial Presence Detect table Remove 12/8 addressing option. See application spec #75H5939 Update power



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