FUJITSU SEMICONDUCTOR
DATA SHEET

DS05-10180-2E

MEMORY

CMOS 256K × 16 BIT HYPER PAGE MODE DYNAMIC RAM

MB814265-60/-70

CMOS 262,144 × 16 BIT Hyper Page Mode Dynamic RAM

■ DESCRIPTION

The Fujitsu MB814265 is a fully decoded CMOS Dynamic RAM (DRAM) that contains 4,194,304 memory cells accessible in 16-bit increments. The MB814265 features the "hyper page" mode of operation which provides extended valid time for data output and higher speed random access of up to 512 ×16-bits of data within the same row than the fast page mode. The MB814265-60/-70 DRAMs are ideally suited for memory applications such as embedded control, buffer, portable computers, and video imaging equipment where very low power dissipation and high bandwidth are basic requirements of the design.

The MB814265 is fabricated using silicon gate CMOS and Fujitsu's advanced four-layer polysilicon process. This process, coupled with three-dimensional stacked capacitor memory cells, reduces the possibility of soft errors and extends the time interval between memory refreshes.

■ PRODUCT LINE & FEATURES

Parameter		MB814265-60	MB814265-70
$\overline{RAS}$ Access Time		60 ns max.	70 ns max.
$\overline{CAS}$ Access Time		20 ns max.	20 ns max.
Address Access Time		30 ns max.	35 ns max.
Random Cycle Time		104 ns max.	119 ns min.
Hyper Page Mode Cycle Time		25 ns min.	30 ns min.
Low Power Dissipation	Operating current	523 mW max.	462 mW max.
	Standby current	11 mW max. (TTL level)/5.5 mW max. (CMOS level)	

- 262,144 words × 16 bit organization
- Silicon gate, CMOS, Advanced Stacked Capacitor Cell
- All input and output are TTL compatible
- 512 refresh cycles every 8.2 ms
- 9 rows × 9 columns, addressing scheme
- Early Write or $\overline{OE}$ controlled Write capability
- $\overline{RAS}$-only, $\overline{CAS}$-before-$\overline{RAS}$, or Hidden Refresh
- Hyper page mode, Read-Modify-Write capability
- On chip substrate bias generator for high performance

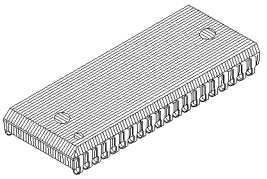
This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

■ ABSOLUTE MAXIMUM RATINGS (See WARNING)

Parameter	Symbol	Value	Unit
Voltage at any pin relative to V_{SS}	V_{IN}, V_{OUT}	–0.5 to +7.0	V
Voltage of V_{CC} supply relative to V_{SS}	V_{CC}	–0.5 to +7.0	V
Power Dissipation	P_D	1.0	W
Short Circuit Output Current	I_{OUT}	–50 to +50	mA
Storage Temperature	T_{STG}	–55 to +125	°C
Temperature under Bias	T_{BIAS}	0 to 70	°C

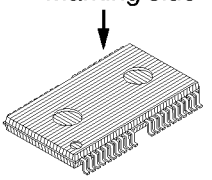
WARNING: Permanent device damage may occur if the above **Absolute Maximum Ratings** are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability

■ PACKAGE



Plastic SOJ Package
(LCC-40P-M01)

Marking side



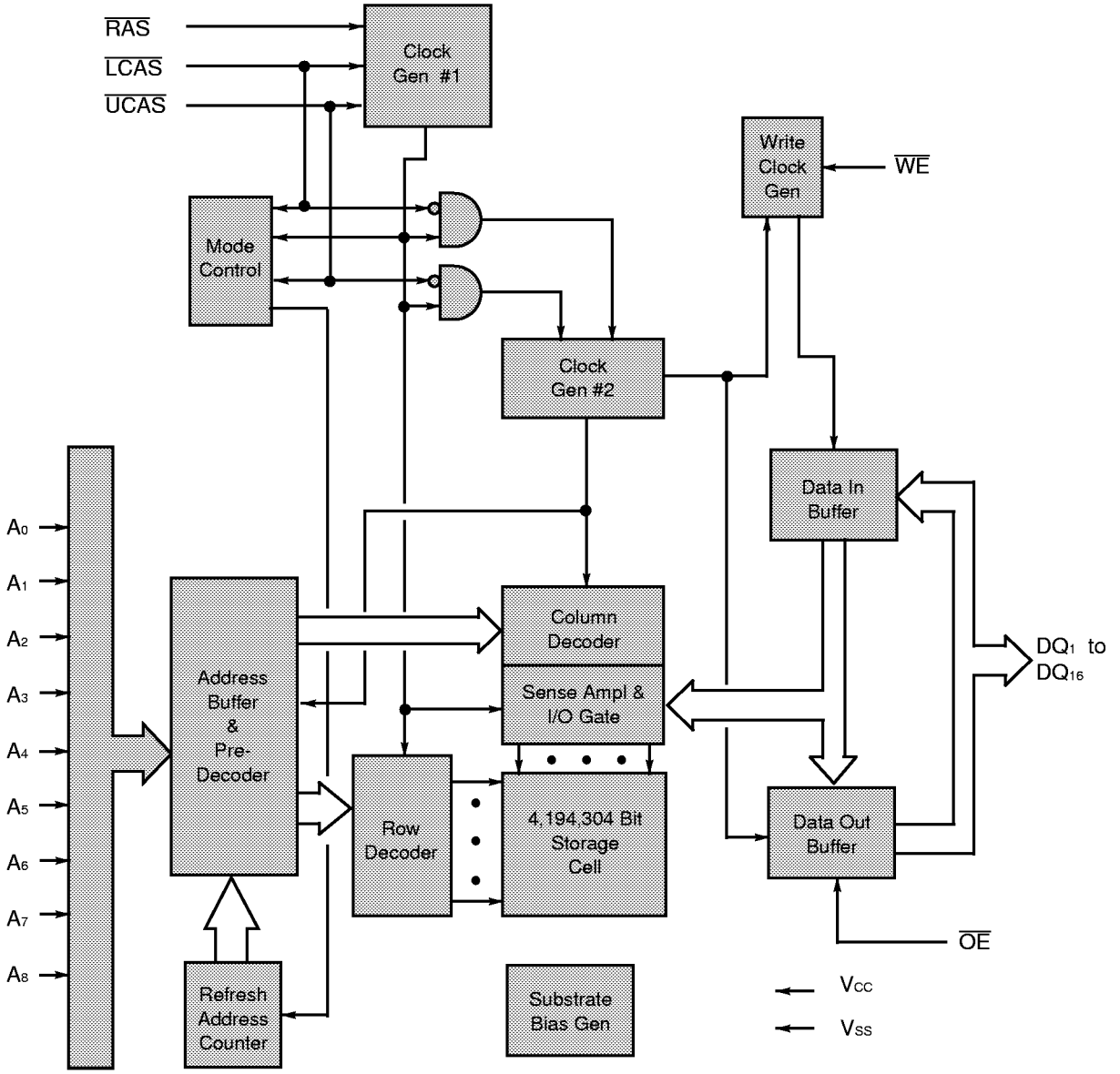
Plastic TSOP Package
(FPT-44P-M07)
(Normal Bend)

Package and Ordering Information

– 40-pin plastic (400 mil) SOJ, order as MB814265-xxPJ

– 44-pin plastic (400 mil) TSOP-II with normal bend leads, order as MB814265-xxPFTN

Fig. 1 – MB814265 DYNAMIC RAM - BLOCK DIAGRAM



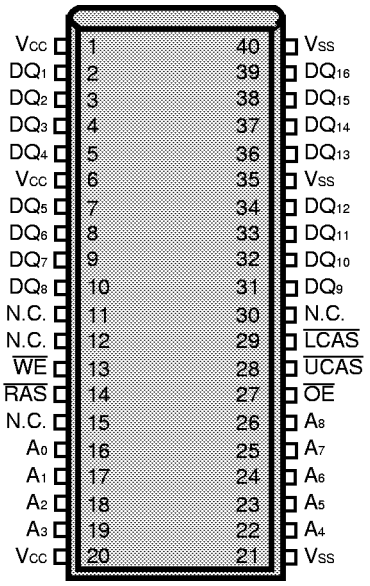
■ CAPACITANCE

(T_A = 25°C, f = 1 MHz)

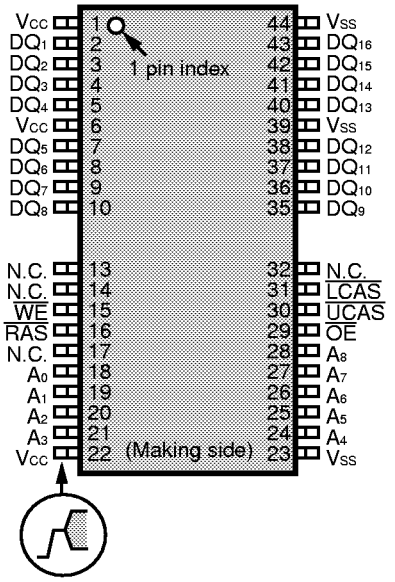
Parameter	Symbol	Typ.	Max.	Unit
Input Capacitance, A_0 to A_8	C_{IN1}	–	5	pF
Input Capacitance, $\overline{RAS}$, $\overline{LCAS}$, $\overline{UCAS}$, $\overline{WE}$, $\overline{OE}$	C_{IN2}	–	7	pF
Input/Output Capacitance, DQ_1 to DQ_{16}	C_{DQ}	–	7	pF

■ PIN ASSIGNMENTS AND DESCRIPTIONS

40-Pin SOJ:
(TOP VIEW)



44-Pin TSOP:
(TOP VIEW)
<Normal Bend>



Designator	Function
A_0 to A_8	Address inputs row : A_0 to A_8 column : A_0 to A_8 refresh : A_0 to A_8
$\overline{RAS}$	Row address strobe
$\overline{LCAS}$	Lower column address strobe
$\overline{UCAS}$	Upper column address strobe
$\overline{WE}$	Write enable
$\overline{OE}$	Output enable
DQ_1 to DQ_{16}	Data Input/Output
V_{CC}	+5.0 volt power supply
V_{SS}	Circuit ground
N.C.	No connection

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Notes	Symbol	Min.	Typ.	Max.	Unit	Ambient Operating Temp.
Supply Voltage	1	V_{CC}	4.5	5.0	5.5	V	0°C to +70°C
		V_{SS}	0	0	0		
Input High Voltage, all inputs	1	V_{IH}	2.4	—	6.5	V	
Input Low Voltage, all inputs*	1	V_{IL}	–0.3	—	0.8	V	

* : Undershoots of up to –2.0 volts with a pulse width not exceeding 20 ns are acceptable.

■ FUNCTIONAL OPERATION

ADDRESS INPUTS

Eighteen input bits are required to decode any sixteen of 4,194,304 cell addresses in the memory matrix. Since only nine address bits (A_0 to A_8) are available, the column and row inputs are separately strobed by $\overline{LCAS}$ or $\overline{UCAS}$ and $\overline{RAS}$ as shown in Figure 1. First, nine row address bits are input on pins A_0-through-A_9 and latched with the row address strobe ($\overline{RAS}$) then, nine column address bits are input and latched with the column address strobe ($\overline{LCAS}$ or $\overline{UCAS}$). Both row and column addresses must be stable on or before the falling edges of $\overline{RAS}$ and $\overline{LCAS}$ or $\overline{UCAS}$, respectively. The address latches are of the flow-through type; thus, address information appearing after t_{RAH} (min) + t_T is automatically treated as the column address.

WRITE ENABLE

The read or write mode is determined by the logic state of $\overline{WE}$. When $\overline{WE}$ is active Low, a write cycle is initiated; when $\overline{WE}$ is High, a read cycle is selected. During the read mode, input data is ignored.

DATA INPUT

Input data is written into memory in either of three basic ways : an early write cycle, an $\overline{OE}$ (delayed) write cycle, and a read-modify-write cycle. The falling edge of $\overline{WE}$ or $\overline{LCAS}$ / $\overline{UCAS}$, whichever is later, serves as the input data-latch strobe. In an early write cycle, the input data of DQ_1-DQ_8 is strobed by $\overline{LCAS}$ and DQ_9-DQ_{16} is strobed by $\overline{UCAS}$ and the setup/hold times are referenced to each $\overline{LCAS}$ and $\overline{UCAS}$ because $\overline{WE}$ goes Low before $\overline{LCAS}$/$\overline{UCAS}$. In a delayed write or a read-modify-write cycle, $\overline{WE}$ goes Low after $\overline{LCAS}$ / $\overline{UCAS}$; thus, input data is strobed by $\overline{WE}$ and all setup/hold times are referenced to the write-enable signal.

DATA OUTPUT

The three-state buffers are TTL compatible with a fanout of two TTL loads. Polarity of the output data is identical to that of the input; the output buffers remain in the high-impedance state until the column address strobe goes Low. When a read or read-modify-write cycle is executed, valid outputs and High-Z state are obtained under the following conditions:

- t_{RAC} : from the falling edge of $\overline{RAS}$ when t_{RCD} (max) is satisfied.
- t_{CAC} : from the falling edge of $\overline{LCAS}$ (for DQ_1-DQ_8) $\overline{UCAS}$ (for DQ_9-DQ_{16}) when t_{RCD} is greater than t_{RCD} (max).
- t_{AA} : from column address input when t_{RAD} is greater than t_{RAD} (max), and t_{RCD} (max) is satisfied.
- t_{OEA} : from the falling edge of $\overline{OE}$ when $\overline{OE}$ is brought Low after t_{RAC}, t_{CAC}, or t_{AA}.
- t_{OEZ} : from $\overline{OE}$ inactive.
- t_{OFF} : from $\overline{CAS}$ inactive while $\overline{RAS}$ inactive.
- t_{OFR} : from $\overline{RAS}$ inactive while $\overline{CAS}$ inactive.
- t_{WEZ} : from $\overline{WE}$ active while $\overline{CAS}$ inactive.

The data remains valid after either $\overline{OE}$ is inactive, or both $\overline{RAS}$ and $\overline{LCAS}$ (and/or $\overline{UCAS}$) are inactive, or $\overline{CAS}$ is reactived. When an early write is executed, the output buffers remain in a high-impedance state during the entire cycle.

HYPER PAGE MODE OPERATION

The hyper page mode operation provides faster memory access and lower power dissipation. The hyper page mode is implemented by keeping the same row address and strobing in successive column addresses. To satisfy these conditions, $\overline{RAS}$ is held Low for all contiguous memory cycles in which row addresses are common. For each page of memory (within column address locations), any of 512×16-bits can be accessed and, when multiple MB814265s are used, $\overline{CAS}$ is decoded to select the desired memory page. Hyper page mode operations need not be addressed sequentially and combinations of read, write, and/or read-modify-write cycles are permitted. Hyper page mode features that output remains valid when $\overline{CAS}$ is inactive until $\overline{CAS}$ is reactivated.

■ DC CHARACTERISTICS

(Recommended operating conditions unless otherwise noted.) **Notes 3**

Parameter	Notes	Symbol	Conditions	Value Min.	Value Max.	Unit
Output high voltage	1	V_{OH}	I_{OH} = –5.0 mA	2.4	—	V
Output low voltage	1	V_{OL}	I_{OL} = +4.2 mA	—	0.4	V
Input leakage current (any input)		$I_{I(L)}$	0 V ≤ V_{IN} ≤ 5.5 V; 4.5 V ≤ V_{CC} ≤ 5.5 V; V_{SS} = 0 V; All other pins not under test = 0 V	–10	10	µA
Output leakage current		$I_{DQ(L)}$	0 V ≤ V_{OUT} ≤ 5.5 V; Data out disabled	–10	10	µA
Operating current (Average power supply current)	MB814265-60	I_{CC1}	$\overline{RAS}$, $\overline{LCAS}$ & $\overline{UCAS}$ cycling; t_{RC} = min	—	95	mA
2	MB814265-70				84	mA
Standby current (Power supply current)	TTL level	I_{CC2}	$\overline{RAS}$ = $\overline{LCAS}$ = $\overline{UCAS}$ = V_{IH}	—	2.0	mA
	CMOS level		$\overline{RAS}$ = $\overline{LCAS}$ = $\overline{UCAS}$ ≥ V_{CC} –0.2 V		1.0	mA
Refresh current #1 (Average power supply current)	MB814265-60	I_{CC3}	$\overline{LCAS}$ = $\overline{UCAS}$ = V_{IH}, $\overline{RAS}$ cycling; t_{RC} = min	—	95	mA
2	MB814265-70				84	mA
Hyper page mode current	MB814265-60	I_{CC4}	$\overline{RAS}$ = V_{IL}, $\overline{LCAS}$ / $\overline{UCAS}$ cycling; t_{HPC} = min	—	95	mA
2	MB814265-70				84	mA
Refresh current #2 (Average power supply current)	MB814265-60	I_{CC5}	$\overline{RAS}$ cycling; $\overline{CAS}$-before-$\overline{RAS}$; t_{RC} = min	—	95	mA
2	MB814265-70				84	mA

■ AC CHARACTERISTICS

(At recommended operating conditions unless otherwise noted.) **Notes 3, 4, 5**

No.	Parameter	Notes	Symbol	MB814265-60		MB814265-70		Unit
				Min.	Max.	Min.	Max.	
1	Time Between Refresh		t_{REF}	—	8.2	—	8.2	ms
2	Random Read/Write Cycle Time		t_{RC}	104	—	119	—	ns
3	Read-Modify-Write Cycle Time		t_{RWC}	138	—	158	—	ns
4	Access Time from $\overline{RAS}$	6, 9	t_{RAC}	—	60	—	70	ns
5	Access Time from $\overline{CAS}$	7, 9	t_{CAC}	—	20	—	20	ns
6	Column Address Access Time	8, 9	t_{AA}	—	30	—	35	ns
7	Output Hold Time		t_{OH}	5	—	5	—	ns
8	Output Hold Time from $\overline{CAS}$		t_{OHC}	5	—	5	—	ns
9	Output Buffer Turn On Delay Time		t_{ON}	0	—	0	—	ns
10	Output Buffer Turn Off Delay Time	10	t_{OFF}	—	15	—	15	ns
11	Output Buffer Turn Off Delay Time from $\overline{RAS}$		t_{OFR}	—	15	—	15	ns
12	Output Buffer Turn Off Delay Time from $\overline{WE}$		t_{WEZ}	—	15	—	15	ns
13	Transition Time		t_T	1	50	1	50	ns
14	$\overline{RAS}$ Precharge Time		t_{RP}	40	—	45	—	ns
15	$\overline{RAS}$ Pulse Width		t_{RAS}	60	100000	70	100000	ns
16	$\overline{RAS}$ Hold Time		t_{RSH}	20	—	20	—	ns
17	$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	21	t_{CRP}	0	—	0	—	ns
18	$\overline{RAS}$ to $\overline{CAS}$ Delay Time	11, 12, 22	t_{RCD}	14	40	14	50	ns
19	$\overline{CAS}$ Pulse Width		t_{CAS}	10	—	10	—	ns
20	$\overline{CAS}$ Hold Time		t_{CSH}	40	—	50	—	ns
21	$\overline{CAS}$ Precharge Time (Normal)	19	t_{CPN}	10	—	10	—	ns
22	Row Address Set Up Time		t_{ASR}	0	—	0	—	ns
23	Row Address Hold Time		t_{RAH}	10	—	10	—	ns
24	Column Address Set Up Time		t_{ASC}	0	—	0	—	ns
25	Column Address Hold Time		t_{CAH}	10	—	10	—	ns
26	$\overline{RAS}$ to Column Address Delay Time	13	t_{RAD}	12	30	12	35	ns
27	Column Address to $\overline{RAS}$ Lead Time		t_{RAL}	30	—	35	—	ns
28	Column Address to $\overline{CAS}$ Lead Time		t_{CAL}	23	—	28	—	ns
29	Read Command Set Up Time		t_{RCS}	0	—	0	—	ns
30	Read Command Hold Time Referenced to $\overline{RAS}$	14	t_{RRH}	0	—	0	—	ns
31	Read Command Hold Time Referenced to $\overline{CAS}$	14	t_{RCH}	0	—	0	—	ns

■ AC CHARACTERISTICS (Continued)

(At recommended operating conditions unless otherwise noted.) **Notes 3, 4, 5**

No.	Parameter	Notes	Symbol	MB814265-60		MB814265-70		Unit
				Min.	Max.	Min.	Max.	
32	Write Command Set Up Time	15	t_{WCS}	0	—	0	—	ns
33	Write Command Hold Time		t_{WCH}	10	—	10	—	ns
34	$\overline{WE}$ Pulse Width		t_{WP}	10	—	10	—	ns
35	Write Command to $\overline{RAS}$ Lead Time		t_{RWL}	15	—	20	—	ns
36	Write Command to $\overline{CAS}$ Lead Time		t_{CWL}	10	—	10	—	ns
37	DIN Set Up Time		t_{DS}	0	—	0	—	ns
38	DIN Hold Time		t_{DH}	10	—	10	—	ns
39	$\overline{RAS}$ to $\overline{WE}$ Delay Time		t_{RWD}	77	—	87	—	ns
40	$\overline{CAS}$ to $\overline{WE}$ Delay Time		t_{CWD}	37	—	37	—	ns
41	Column Address to $\overline{WE}$ Delay Time		t_{AWD}	47	—	52	—	ns
42	$\overline{RAS}$ Precharge Time to $\overline{CAS}$ Active Time (Refresh Cycles)		t_{RPC}	10	—	10	—	ns
43	$\overline{CAS}$ Set Up Time for $\overline{CAS}$-before-$\overline{RAS}$ Refresh		t_{CSR}	0	—	0	—	ns
44	$\overline{CAS}$ Hold Time for $\overline{CAS}$-before-$\overline{RAS}$ Refresh		t_{CHR}	10	—	10	—	ns
45	Access Time from $\overline{OE}$	9	t_{OEA}	—	20	—	20	ns
46	Output Buffer Turn Off Delay from $\overline{OE}$	10	t_{OEZ}	—	15	—	15	ns
47	$\overline{OE}$ to $\overline{RAS}$ Lead Time for Valid Data		t_{OEL}	10	—	10	—	ns
48	$\overline{OE}$ to $\overline{CAS}$ Lead Time		t_{COL}	5	—	5	—	ns
49	$\overline{OE}$ Hold Time Referenced to $\overline{WE}$	16	t_{OEH}	0	—	0	—	ns
50	$\overline{OE}$ to Data in Delay Time		t_{OED}	15	—	15	—	ns
51	DIN to $\overline{CAS}$ Delay Time	17	t_{DZC}	0	—	0	—	ns
52	DIN to $\overline{OE}$ Delay Time	17	t_{DZO}	0	—	0	—	ns
53	$\overline{CAS}$ to Data in Delay Time		t_{CDD}	15	—	15	—	ns
54	$\overline{RAS}$ to Data in Delay Time		t_{RDD}	15	—	15	—	ns
55	Column Address Hold Time from $\overline{RAS}$		t_{AR}	26	—	26	—	ns
56	Write Command Hold Time from $\overline{RAS}$		t_{WCR}	24	—	24	—	ns
57	DIN Hold Time Referenced to $\overline{RAS}$		t_{DHR}	24	—	24	—	ns
58	$\overline{OE}$ Precharge Time		t_{OEP}	10	—	10	—	ns
59	$\overline{OE}$ Hold Time Referenced to $\overline{CAS}$		t_{OECH}	10	—	10	—	ns
60	$\overline{WE}$ Precharge Time		t_{WPZ}	10	—	10	—	ns
61	$\overline{WE}$ to Data in Delay Time		t_{WED}	15	—	15	—	ns
62	Hyper Page Mode $\overline{RAS}$ Pulse Width		t_{RASP}	60	200000	70	200000	ns

■ AC CHARACTERISTICS (Continued)

(At recommended operating conditions unless otherwise noted.) **Notes 3, 4, 5**

No.	Parameter	Notes	Symbol	MB814265-60		MB814265-70		Unit
				Min.	Max.	Min.	Max.	
63	Hyper Page Mode Read/Write Cycle Time		t_{HPC}	25	—	30	—	ns
64	Hyper Page Mode Read-Modify-Write Cycle Time		t_{HPRWC}	66	—	71	—	ns
65	Access Time from $\overline{CAS}$ Precharge	9, 18	t_{CPA}	—	35	—	40	ns
66	Hyper Page Mode $\overline{CAS}$ Pulse Width		t_{CP}	10	—	10	—	ns
67	Hyper Page Mode $\overline{RAS}$ Hold Time from $\overline{CAS}$ Precharge		t_{RHCP}	35	—	40	—	ns
68	Hyper Page Mode $\overline{CAS}$ Precharge to $\overline{WE}$ Delay Time		t_{CPWD}	52	—	57	—	

Notes:
1. Referenced to V_{SS}. To all V_{CC} (V_{SS}) pins, the same supply voltage should be applied.
2. I_{CC} depends on the output load conditions and cycle rates; The specified values are obtained with the output open.
   I_{CC} depends on the number of address change as $\overline{RAS}$ = V_{IL} and $\overline{UCAS}$ = V_{IH}, $\overline{LCAS}$ = V_{IH}, V_{IL} > –0.3 V.
   I_{CC1}, I_{CC3} and I_{CC5} are specified at one time of address change during $\overline{RAS}$ = V_{IL} and $\overline{UCAS}$ = V_{IH}, $\overline{LCAS}$ = V_{IH}.
   I_{CC4} is specified at one time of address change during one Page cycle.
3. An initial pause ($\overline{RAS}$ = $\overline{CAS}$ = V_{IH}) of 200 µs is required after power-up followed by any eight $\overline{RAS}$-only cycles before proper device operation is achieved. In case of using internal refresh counter, a minimum of eight $\overline{CAS}$-before-$\overline{RAS}$ initialization cycles instead of 8 $\overline{RAS}$ cycles are required.
4. AC characteristics assume t_T = 5 ns.
5. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also transition times are measured between V_{IH} (min) and V_{IL} (max).
6. Assumes that $t_{RCD} \leq t_{RCD}$ (max), $t_{RAD} \leq t_{RAD}$ (max). If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} will be increased by the amount that t_{RCD} exceeds the value shown. Refer to Fig. 2 and 3.
7. If $t_{RCD} \geq t_{RCD}$ (max), $t_{RAD} \geq t_{RAD}$ (max), and $t_{ASC} \geq t_{AA} - t_{CAC} - t_T$, access time is t_{CAC}.
8. If $t_{RAD} \geq t_{RAD}$ (max) and $t_{ASC} \leq t_{AA} - t_{CAC} - t_T$, access time is t_{AA}.
9. Measured with a load equivalent to two TTL loads and 100 pF.
10. t_{OFF} and t_{OEZ} are specified that output buffer change to high impedance state.
11. 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, access time is controlled exclusively by t_{CAC} or t_{AA}.
12. t_{RCD} (min) = t_{RAH} (min) + 2t_T + t_{ASC} (min).
13. 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, access time is controlled exclusively by t_{CAC} or t_{AA}.
14. Either t_{RRH} or t_{RCH} must be satisfied for a read cycle.
15. t_{WCS} is specified as a reference point only. If $t_{WCS} \geq t_{WCS}$ (min) the data output pin will remain High-Z state through entire cycle.
16. Assumes that $t_{WCS} < t_{WCS}$ (min).
17. Either t_{DZC} or t_{DZO} must be satisfied.
18. t_{CPA} is access time from the selection of a new column address (that is caused by changing both $\overline{UCAS}$ and $\overline{LCAS}$ from "L" to "H"). Therefore, if t_{CP} is long, t_{CPA} is longer than t_{CPA} (max).
19. Assumes that $\overline{CAS}$-before-$\overline{RAS}$ refresh.
20. The last $\overline{CAS}$ rising edge.
21. The first $\overline{CAS}$ falling edge.

Fig. 2 – t_{RAC} vs. t_{RCD}

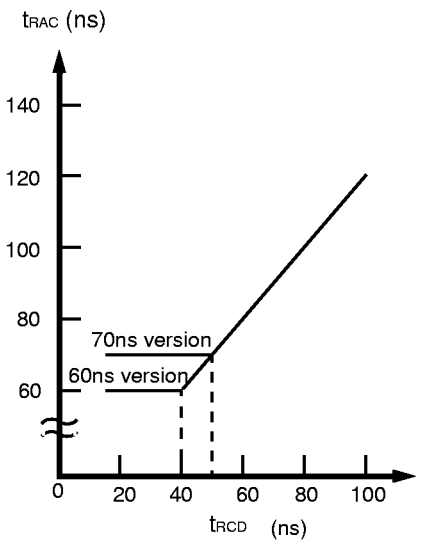


Fig. 3 – t_{RAC} vs. t_{RAD}

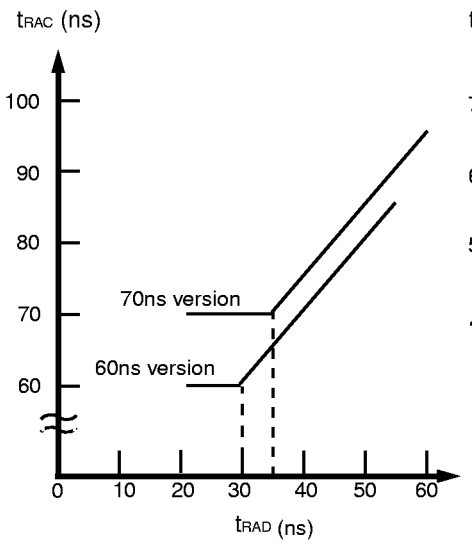
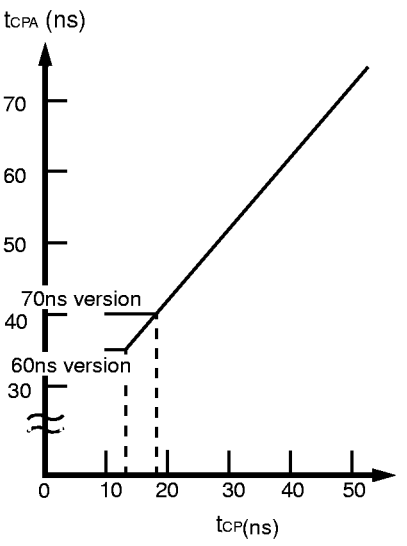


Fig. 4 – t_{CPA} vs. t_{CP}

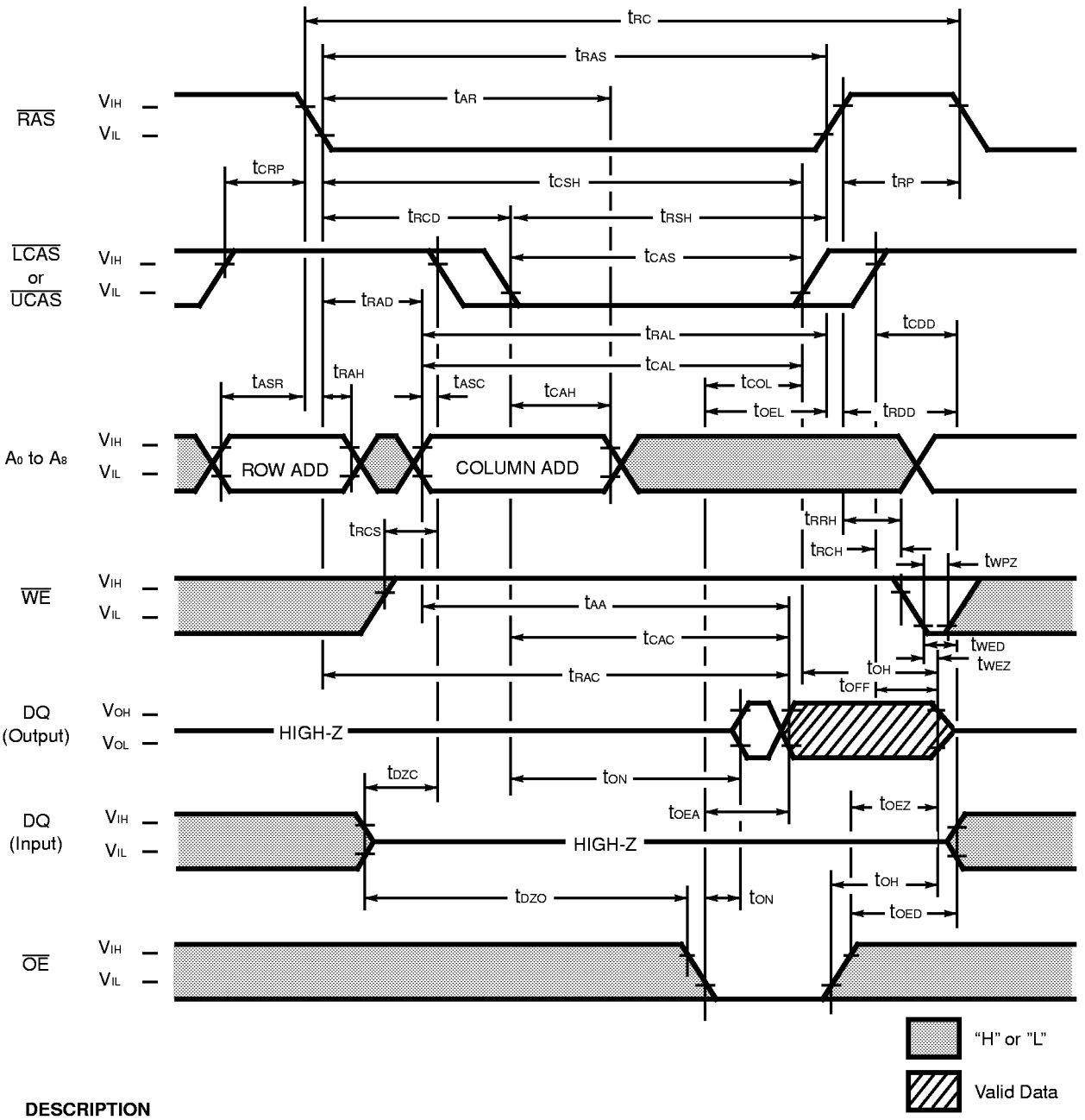


■ FUNCTIONAL TRUTH TABLE

Operation Mode	Clock Input					Address		Input/Output Data				Refresh	Note
								DQ_1 to DQ_8		DQ_9 to DQ_{16}			
	$\overline{RAS}$	$\overline{LCAS}$	$\overline{UCAS}$	$\overline{WE}$	$\overline{OE}$	Row	Column	Input	Output	Input	Output		
Standby	H	H	H	X	X	—	—	—	High-Z	—	High-Z	—	
Read Cycle	L	L H L	H L L	H	L	Valid	Valid	—	Valid High-Z Valid	—	High-Z Valid Valid	Yes*	$t_{RCS} \geq t_{RCS}$ (min)
Write Cycle (Early Write)	L	L H L	H L L	L	X	Valid	Valid	Valid — Valid	High-Z	— Valid Valid	High-Z	Yes*	$t_{WCS} \geq t_{WCS}$ (min)
Read-Modify-Write Cycle	L	L H L	H L L	H→L	L→H	Valid	Valid	Valid — Valid	Valid High-Z Valid	— Valid Valid	High-Z Valid Valid	Yes*	
$\overline{RAS}$-only Refresh Cycle	L	H	H	X	X	Valid	—	—	High-Z	—	High-Z	Yes	
$\overline{CAS}$-before-$\overline{RAS}$ Refresh Cycle	L	L	L	X	X	—	—	—	High-Z	—	High-Z	Yes	$t_{CSR} \geq t_{CSR}$ (min)
Hidden Refresh Cycle	H→L	L H L	H L L	H	L	—	—	—	Valid High-Z Valid	—	High-Z Valid Valid	Yes	Previous data is kept

Note: X ; "H" or "L"
* ; It is impossible in Hyper Page Mode.

Fig. 5 – READ CYCLE



DESCRIPTION

To implement a read operation, a valid address is latched by the $\overline{RAS}$ and $\overline{LCAS}$ or $\overline{UCAS}$ address strobes and with $\overline{WE}$ set to a High level and $\overline{OE}$ set to a Low level, the output is valid once the memory access time has elapsed. DQ_8-DQ_{16} pins is valid when $\overline{RAS}$ and $\overline{CAS}$ are High or until $\overline{OE}$ goes High. The access time is determined by $\overline{RAS}$(t_{RAC}), $\overline{LCAS}/\overline{UCAS}$($t_{CAC}$), $\overline{OE}$ (t_{OEA}) or column addresses (t_{AA}) under the following conditions:

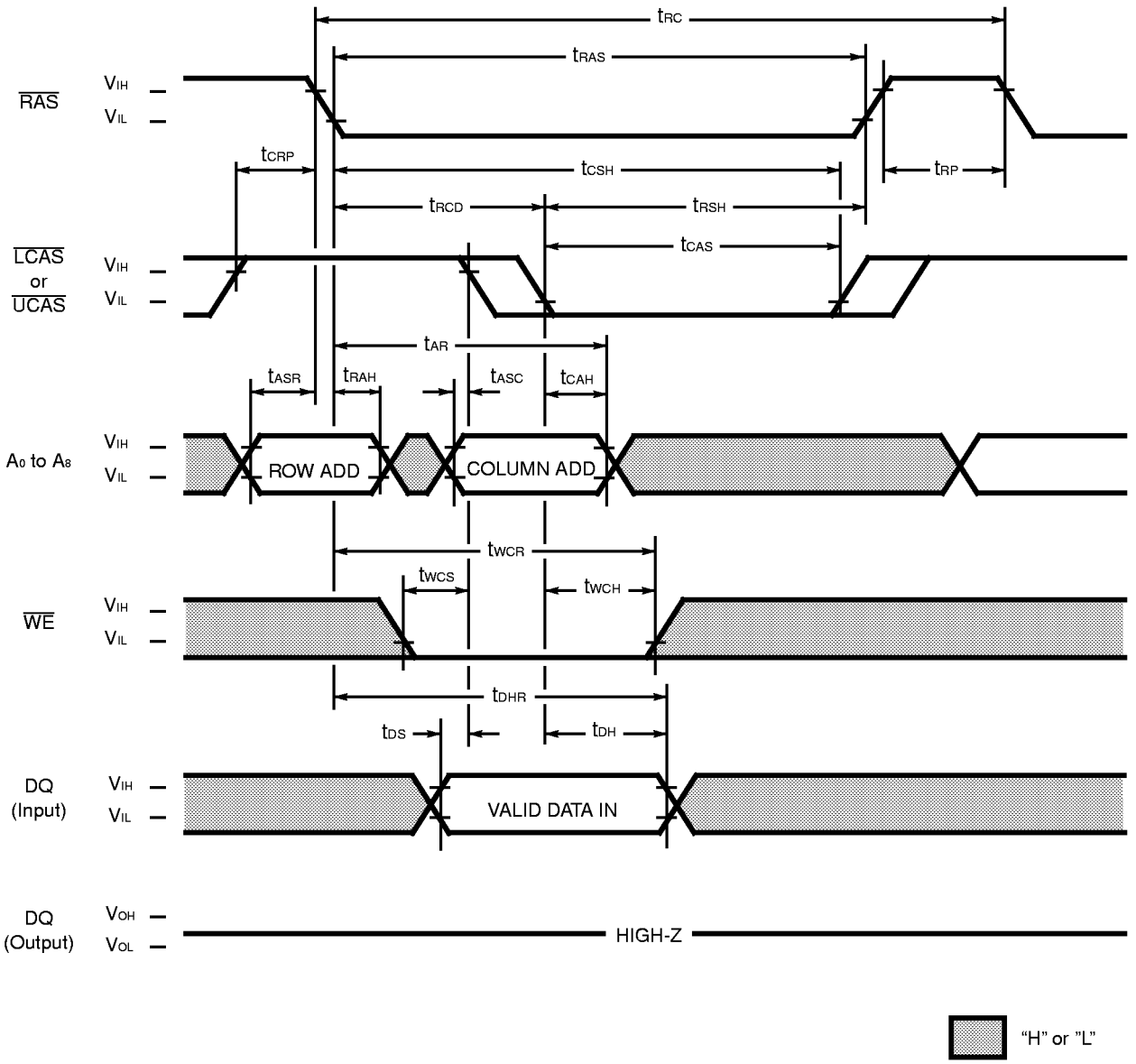
If $t_{RCD} > t_{RCD}$ (max), access time = t_{CAC}.

If $t_{RAD} > t_{RAD}$ (max), access time = t_{AA}.

If $\overline{OE}$ is brought Low after t_{RAC}, t_{CAC}, or t_{AA} (whichever occurs later), access time = t_{OEA}.

However, if either $\overline{LCAS}/\overline{UCAS}$ or $\overline{OE}$ goes High, the output returns to a high-impedance state after t_{OH} is satisfied.

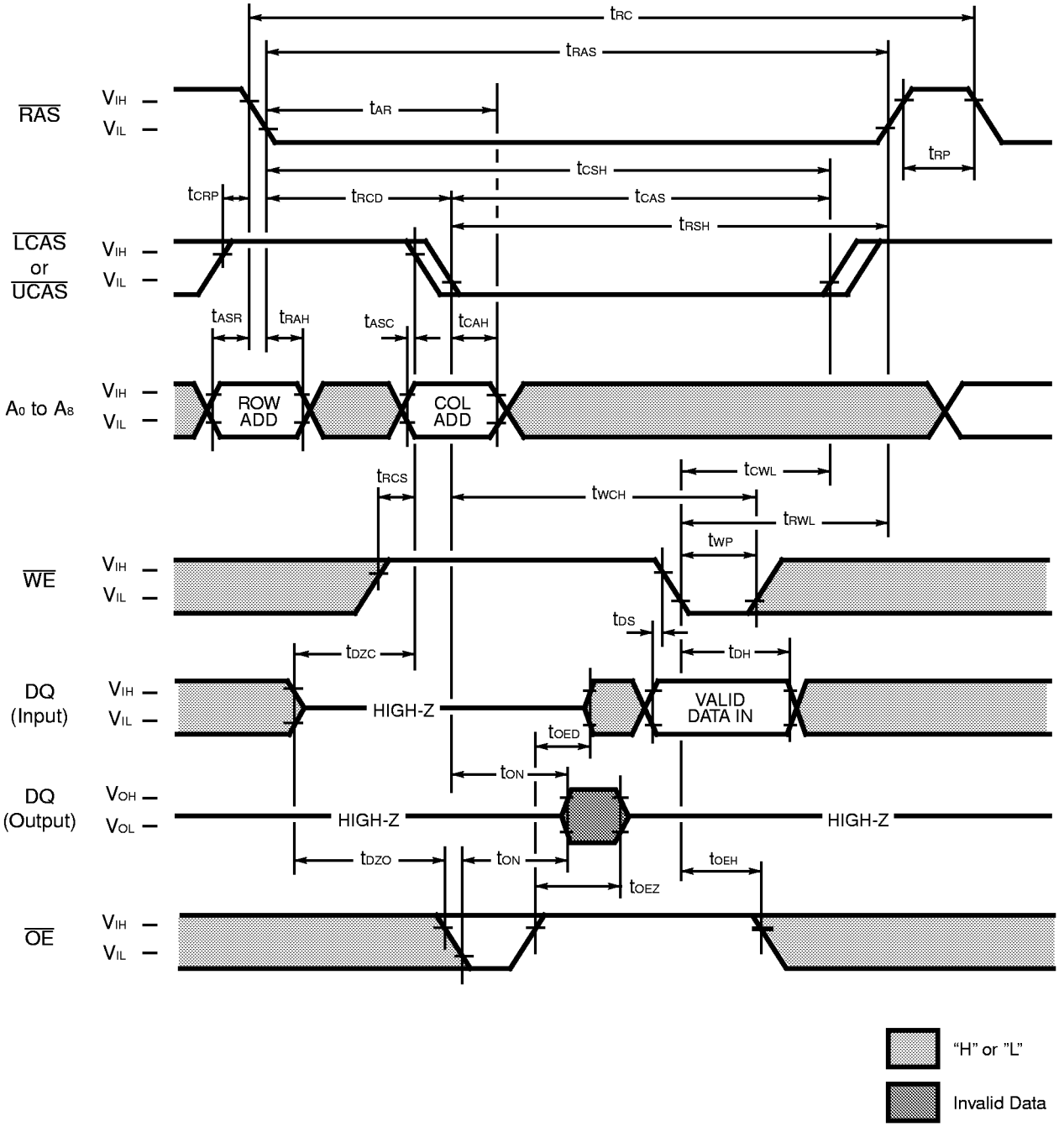
Fig. 6 – EARLY WRITE CYCLE



DESCRIPTION

A write cycle is similar to a read cycle except $\overline{WE}$ is set to a Low state and $\overline{OE}$ is a "H" or "L" signal. A write cycle can be implemented in either of three ways-early write, delayed write, or read-modify-write. During all write cycles, timing parameters t_{RWL}, t_{CWL}, t_{RAL} and t_{CAL} must be satisfied. In the early write cycle shown above t_{WCS} satisfied, data on the DQ pins are latched with the falling edge of $\overline{LCAS}$ or $\overline{UCAS}$ and written into memory.

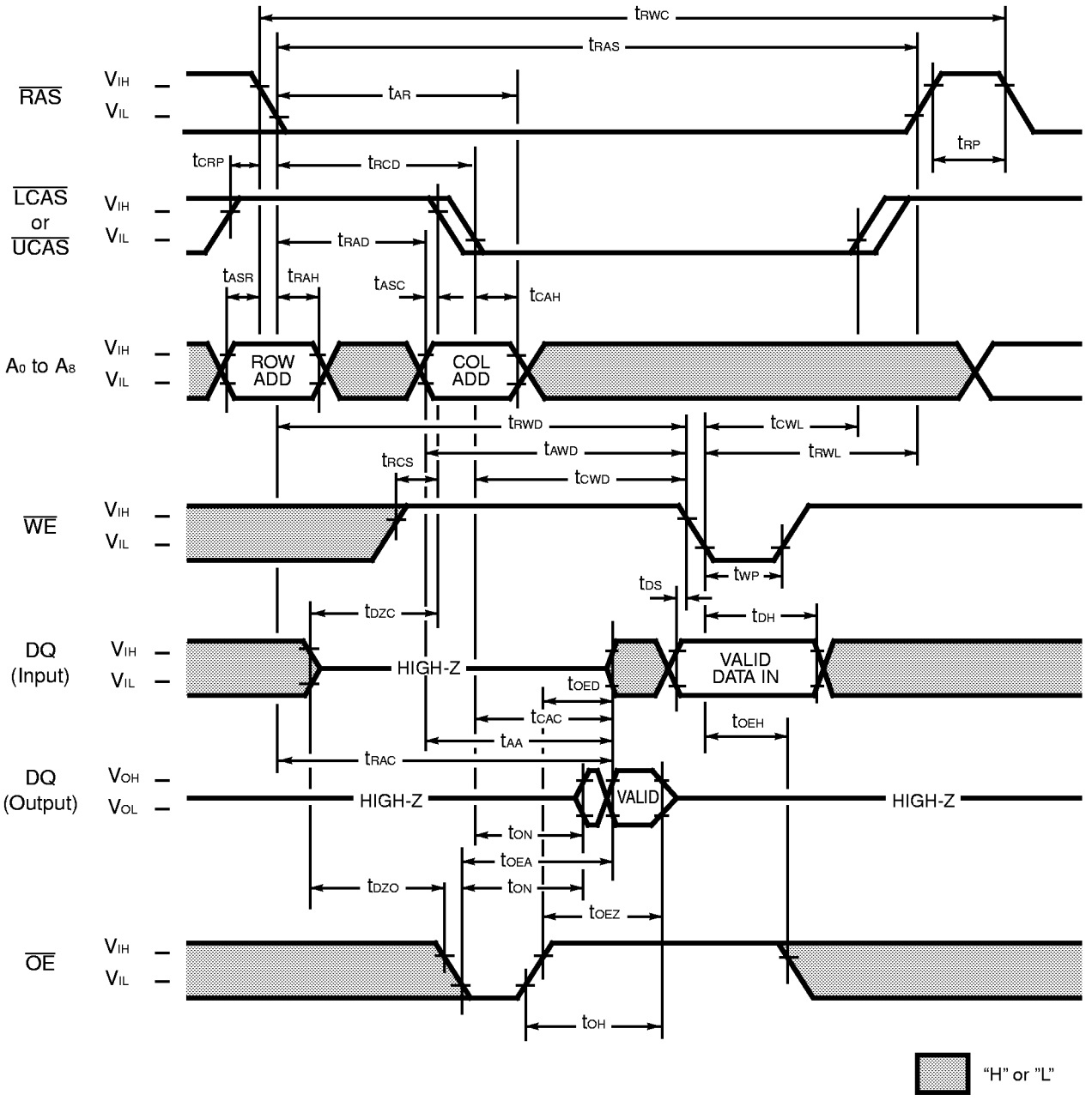
Fig. 7 – DELAYED WRITE CYCLE ($\overline{OE}$ CONTROLLED)



DESCRIPTION

In the delayed write cycle, t_{WCS} is not satisfied; thus, the data on the DQ pins are latched with the falling edge of $\overline{WE}$ and written into memory. The Output Enable ($\overline{OE}$) signal must be changed from Low to High before $\overline{WE}$ goes Low ($t_{OED} + t_T + t_{DS}$).

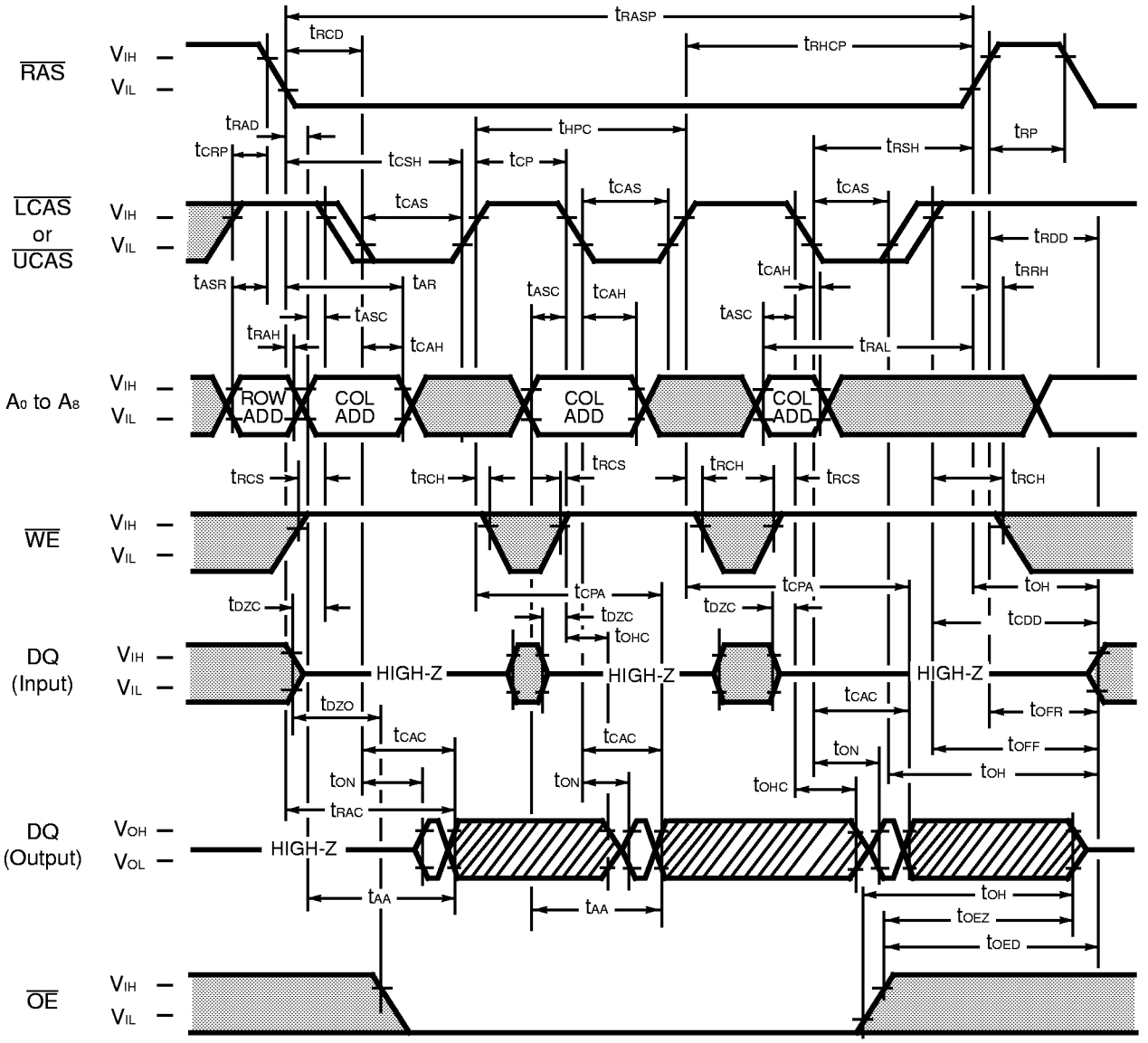
Fig. 8 – READ-MODIFY-WRITE CYCLE



DESCRIPTION

The read-modify-write cycle is executed by changing $\overline{WE}$ from High to Low after the data appears on the DQ pins. In the read-modify-write cycle, $\overline{OE}$ must be changed from Low to High after the memory access time.

Fig. 9 – HYPER PAGE MODE READ CYCLE



During one cycle is achieved, the input/output timing apply the same manner as the former cycle.

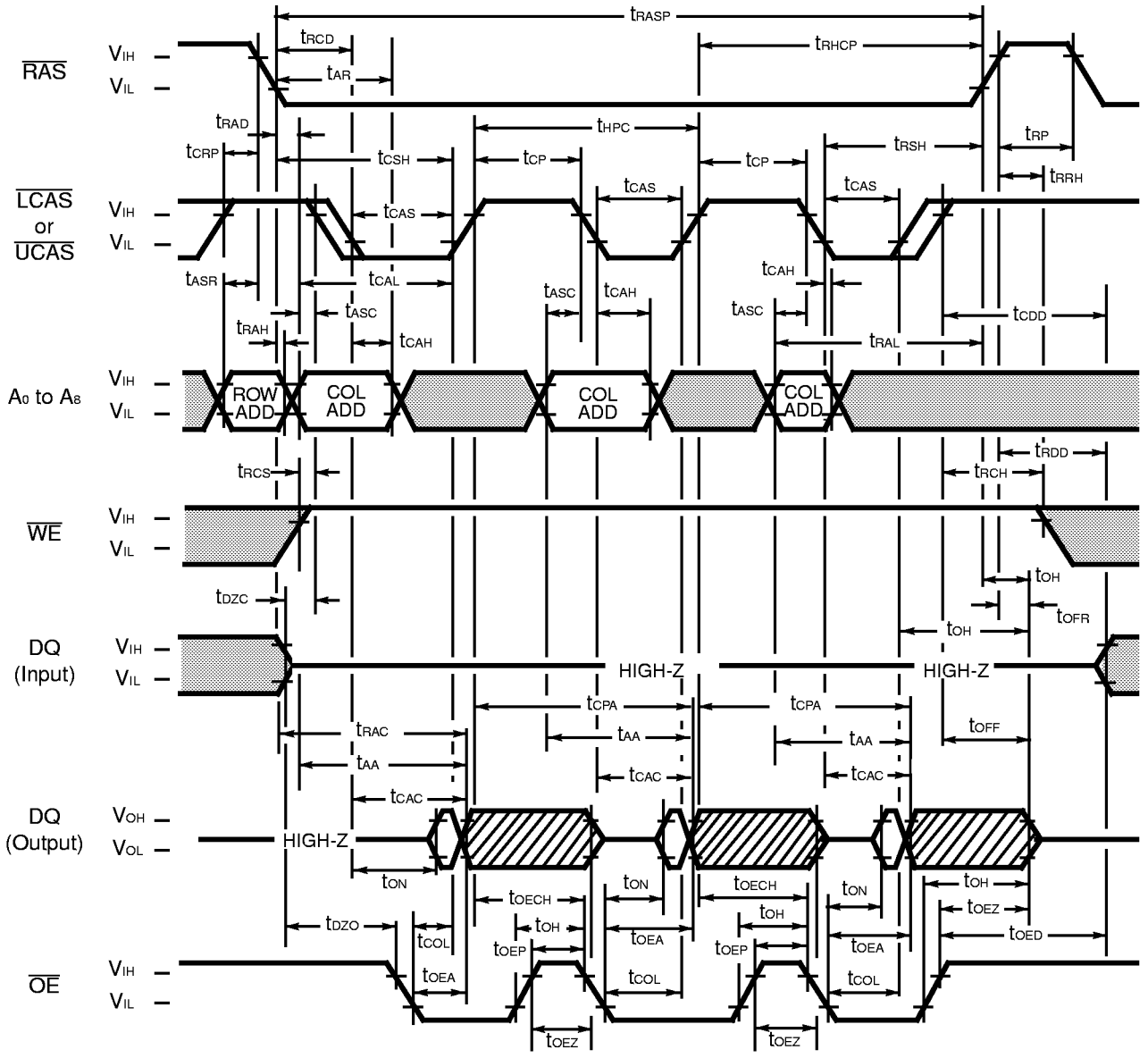
"H" or "L"

Valid Data

DESCRIPTION

The hyper page mode of operation permits faster successive memory operations at multiple column locations of the same row address. This operation is performed by strobing in the row address and maintaining $\overline{RAS}$ at a Low level and $\overline{WE}$ at a High level during all successive memory cycles in which the row address is latched. The access time is determined by t_{CAC}, t_{AA}, t_{CPA}, or t_{OEA}, whichever one is the latest in occurring.

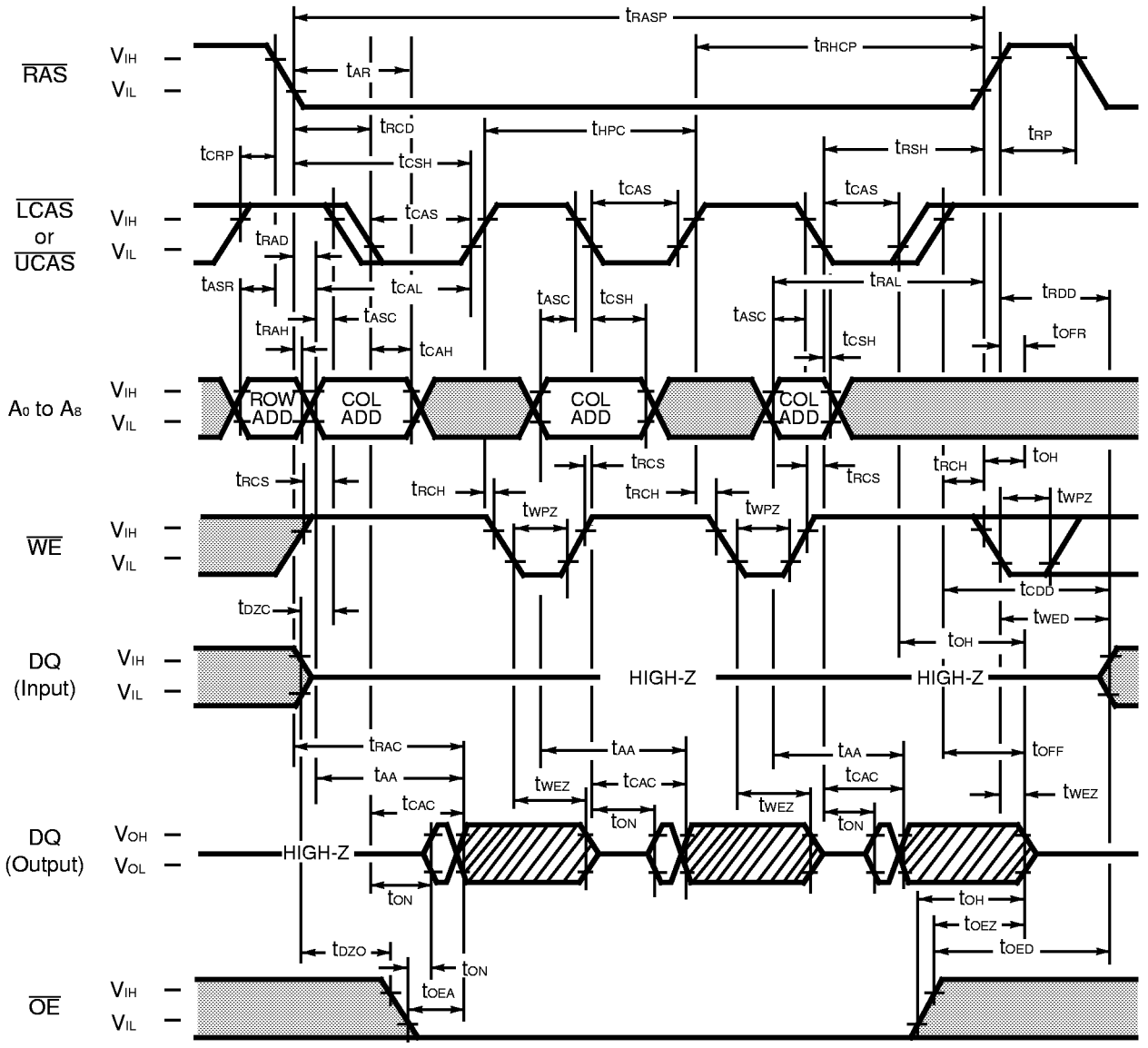
Fig. 10 – HYPER PAGE MODE READ CYCLE ($\overline{OE}$ = "H" or "L")



DESCRIPTION

The hyper page mode of operation permits faster successive memory operations at multiple column locations of the same row address. This operation is performed by strobing in the row address and maintaining $\overline{RAS}$ at a Low level and $\overline{WE}$ at a High level during all successive memory cycles in which the row address is latched. The access time is determined by t_{CAC}, t_{AA}, t_{CPA}, or t_{OEA}, whichever one is the latest in occurring.

Fig. 11 – HYPER PAGE MODE READ CYCLE ($\overline{WE}$ = "H" or "L")



During one cycle is achieved, the input/output timing apply the same manner as the former cycle.

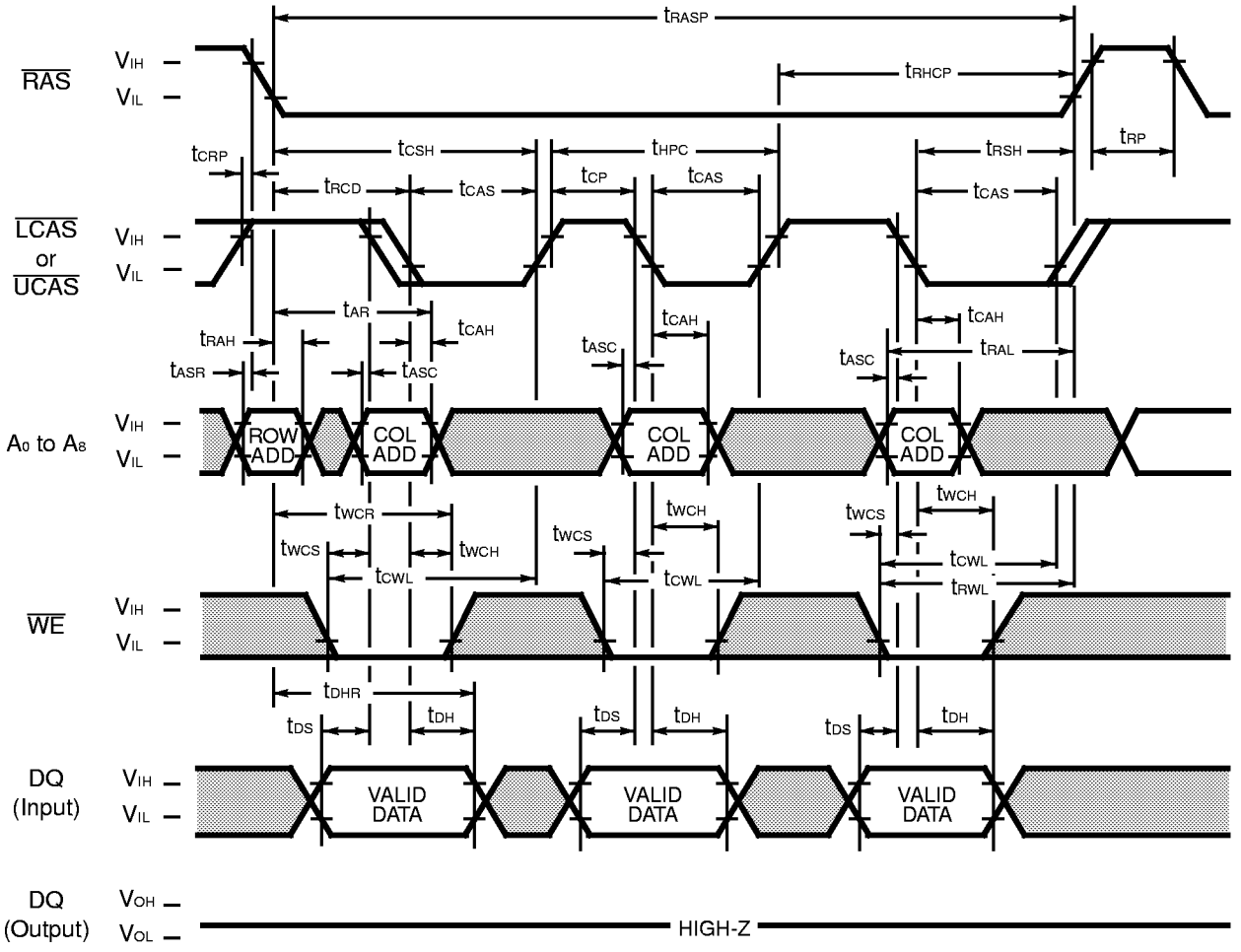
"H" or "L"

Valid Data

DESCRIPTION

The hyper page mode of operation permits faster successive memory operations at multiple column locations of the same row address. This operation is performed by strobing in the row address and maintaining $\overline{RAS}$ at a Low level and $\overline{WE}$ at a High level during all successive memory cycles in which the row address is latched. The access time is determined by t_{CAC}, t_{AA}, t_{CPA}, or t_{OEA}, whichever one is the latest in occurring.

Fig. 12 – HYPER PAGE MODE EARLY WRITE CYCLE



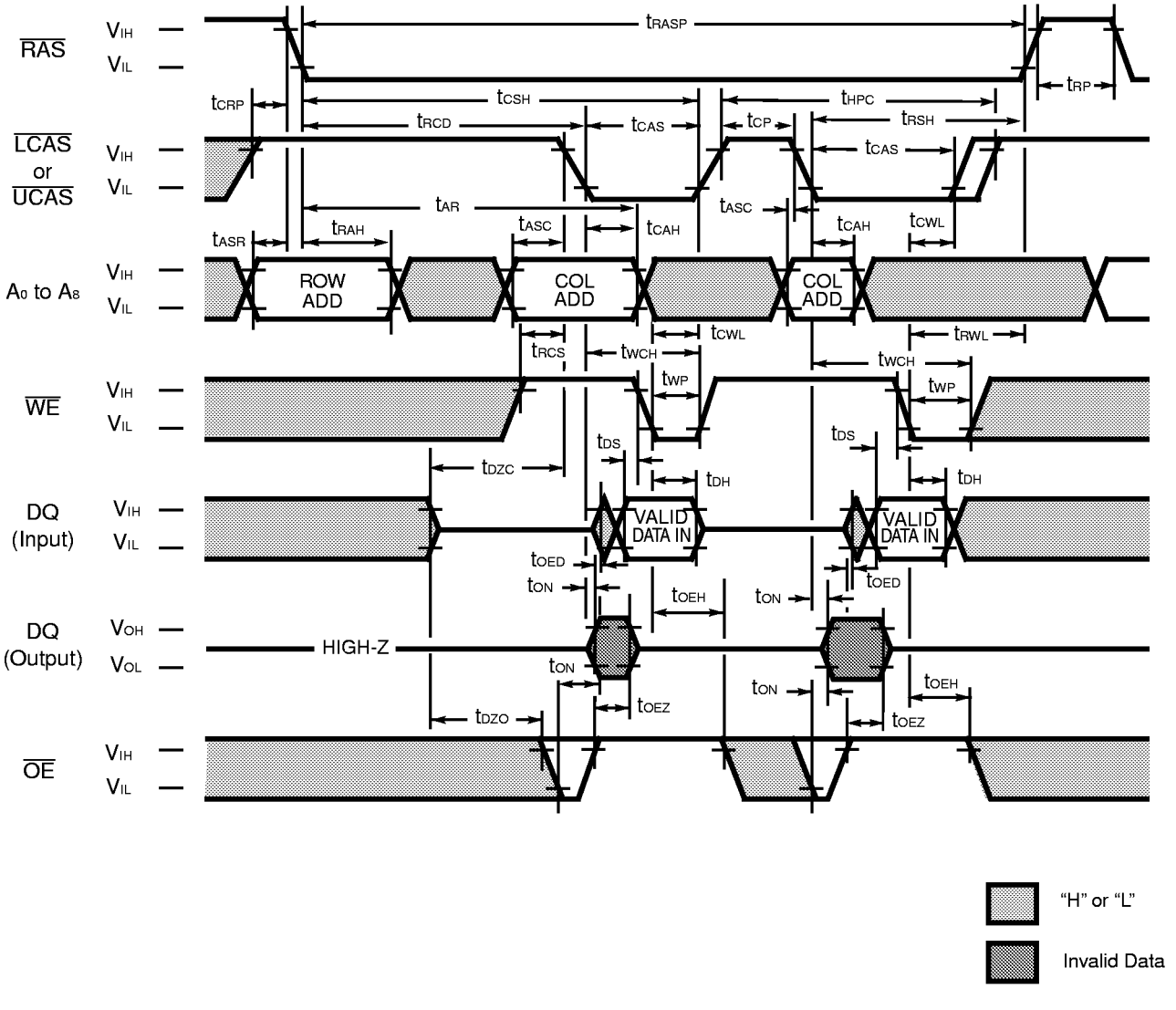
During one cycle is achieved, the input/output timing apply the same manner as the former cycle.

"H" or "L"

DESCRIPTION

The hyper page mode early write cycle is executed in the same manner as the hyper page mode read cycle except the states of $\overline{WE}$ and $\overline{OE}$ are reversed. Data appearing on the DQ_1 to DQ_8 is latched on the falling edge of $\overline{LCAS}$ and one appearing on the DQ_9 to DQ_{16} is latched on the falling edge of $\overline{UCAS}$ and the data is written into the memory. During the hyper page mode early write cycle, including the delayed ($\overline{OE}$) write and read-modify-write cycles, t_{CWL} must be satisfied.

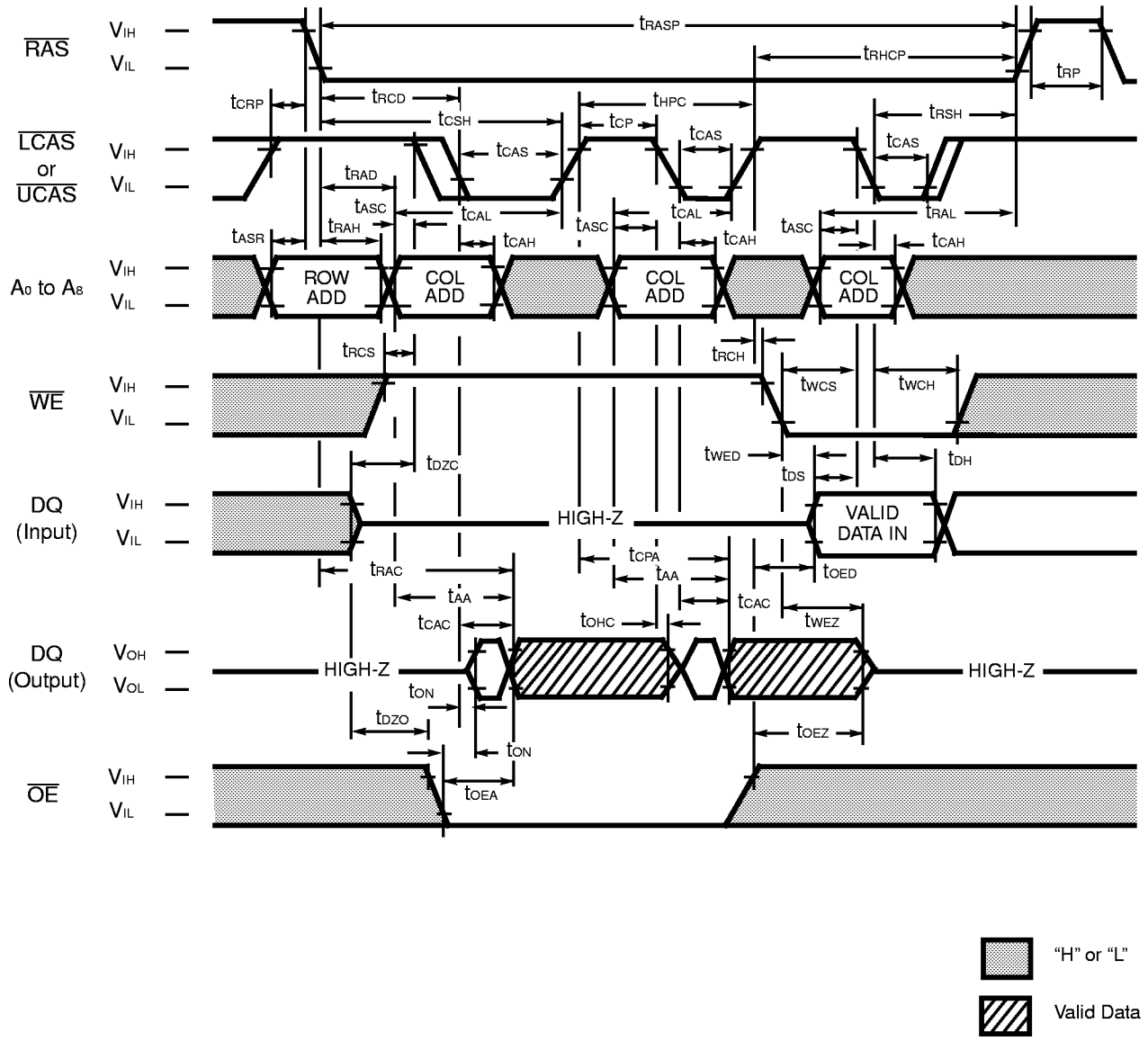
Fig. 13 – HYPER PAGE MODE DELAYED WRITE CYCLE



DESCRIPTION

The hyper page mode delayed write cycle is executed in the same manner as the hyper page mode early write cycle except for the states of $\overline{WE}$ and $\overline{OE}$. Input data on the DQ pins are latched on the falling edge of $\overline{WE}$ and written into memory. In the hyper page mode delayed write cycle, $\overline{OE}$ must be changed from Low to High before $\overline{WE}$ goes Low ($t_{OED} + t_T + t_{DS}$).

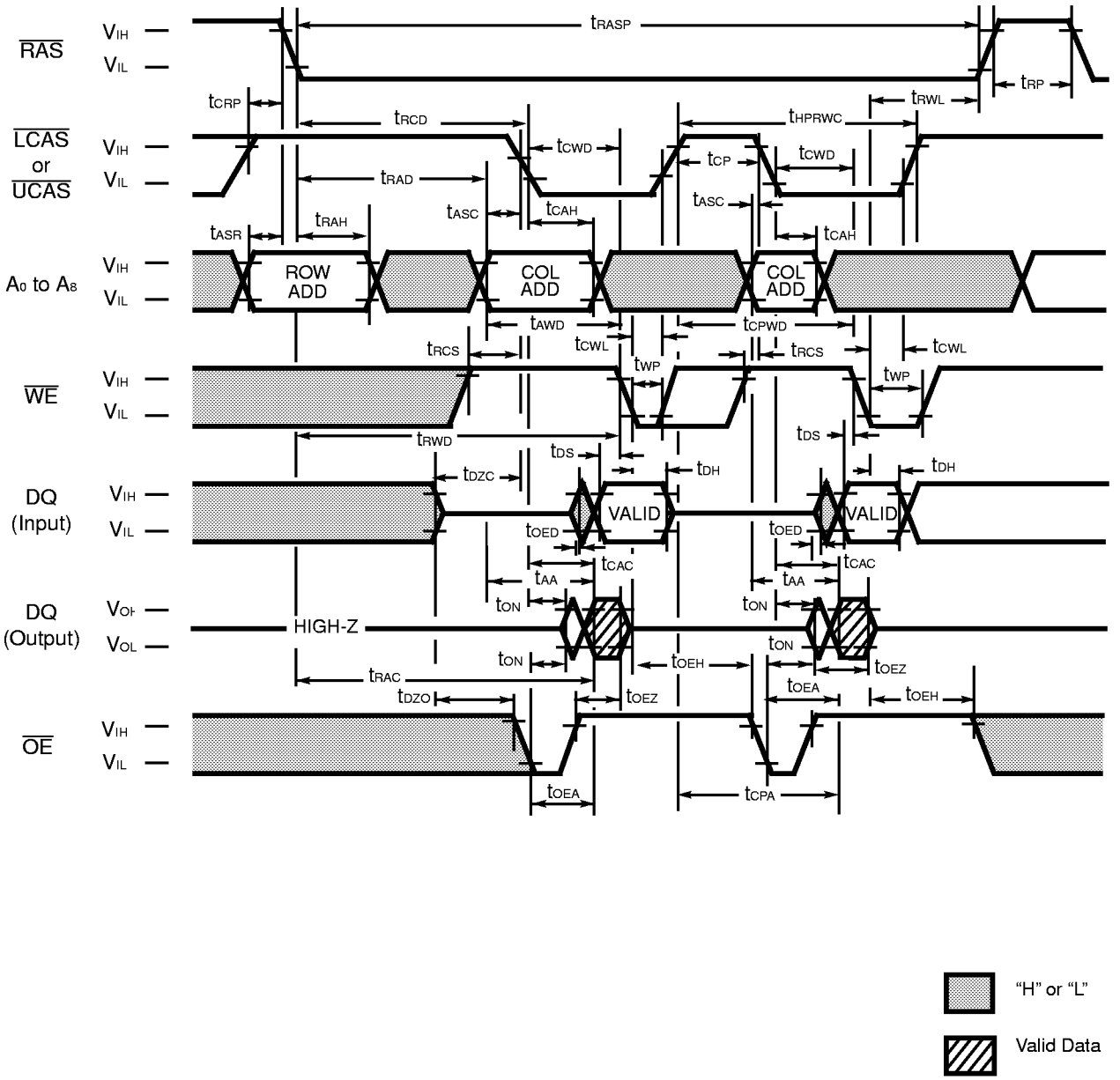
Fig. 14 – HYPER PAGE MODE READ/WRITE MIXED CYCLE



DESCRIPTION

The hyper page mode performs read/write operations repetitively during one $\overline{RAS}$ cycle. At this time, t_{HPC} (min) is invalid.

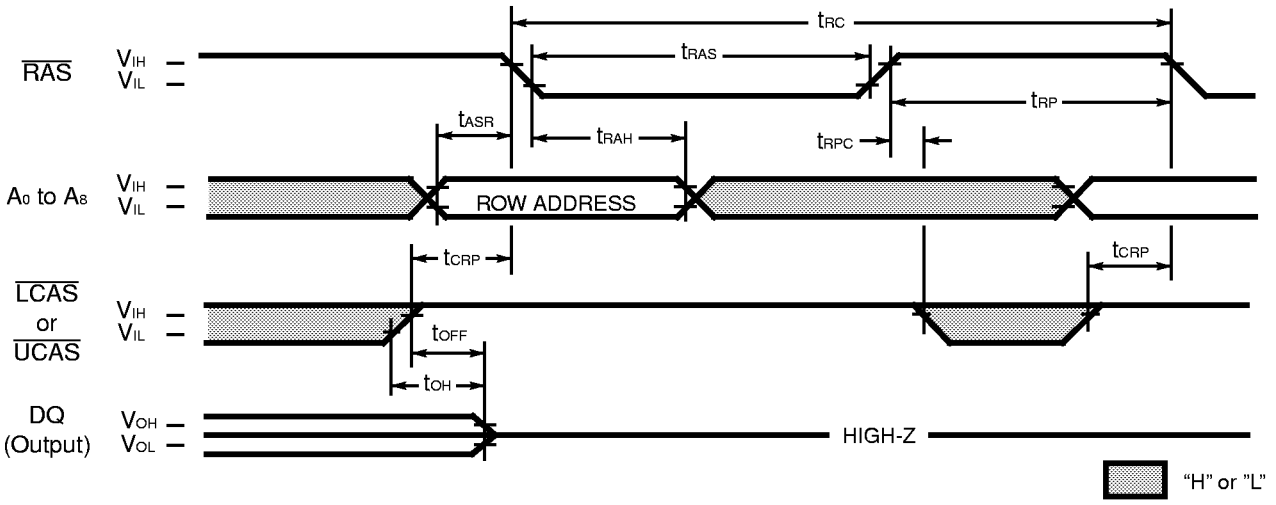
Fig. 15 – HYPER PAGE MODE READ-MODIFY-WRITE CYCLE



DESCRIPTION

During the hyper page mode of operation, the read-modify-write cycle can be executed by switching $\overline{WE}$ from High to Low after input data appears at the DQ pins during a normal cycle.

Fig. 16 – $\overline{RAS}$-ONLY REFRESH ($\overline{WE}$ = $\overline{OE}$ = "H" or "L")

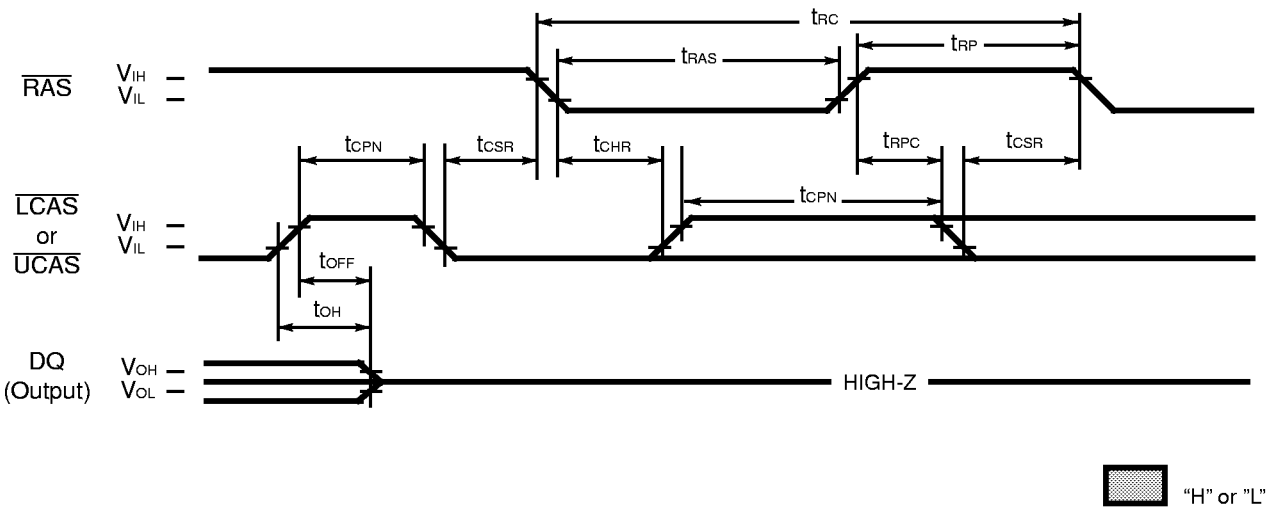


DESCRIPTION

Refresh of RAM memory cells is accomplished by performing a read, a write, or a read-modify-write cycle at each of 512 row addresses every 8.2-milliseconds. Three refresh modes are available: $\overline{RAS}$-only refresh, $\overline{CAS}$-before-$\overline{RAS}$ refresh, and hidden refresh.

$\overline{RAS}$-only refresh is performed by keeping $\overline{RAS}$ Low and $\overline{LCAS}$ and $\overline{UCAS}$ High throughout the cycle; the row address to be refreshed is latched on the falling edge of $\overline{RAS}$. During $\overline{RAS}$-only refresh, DQ pins are kept in a high-impedance state.

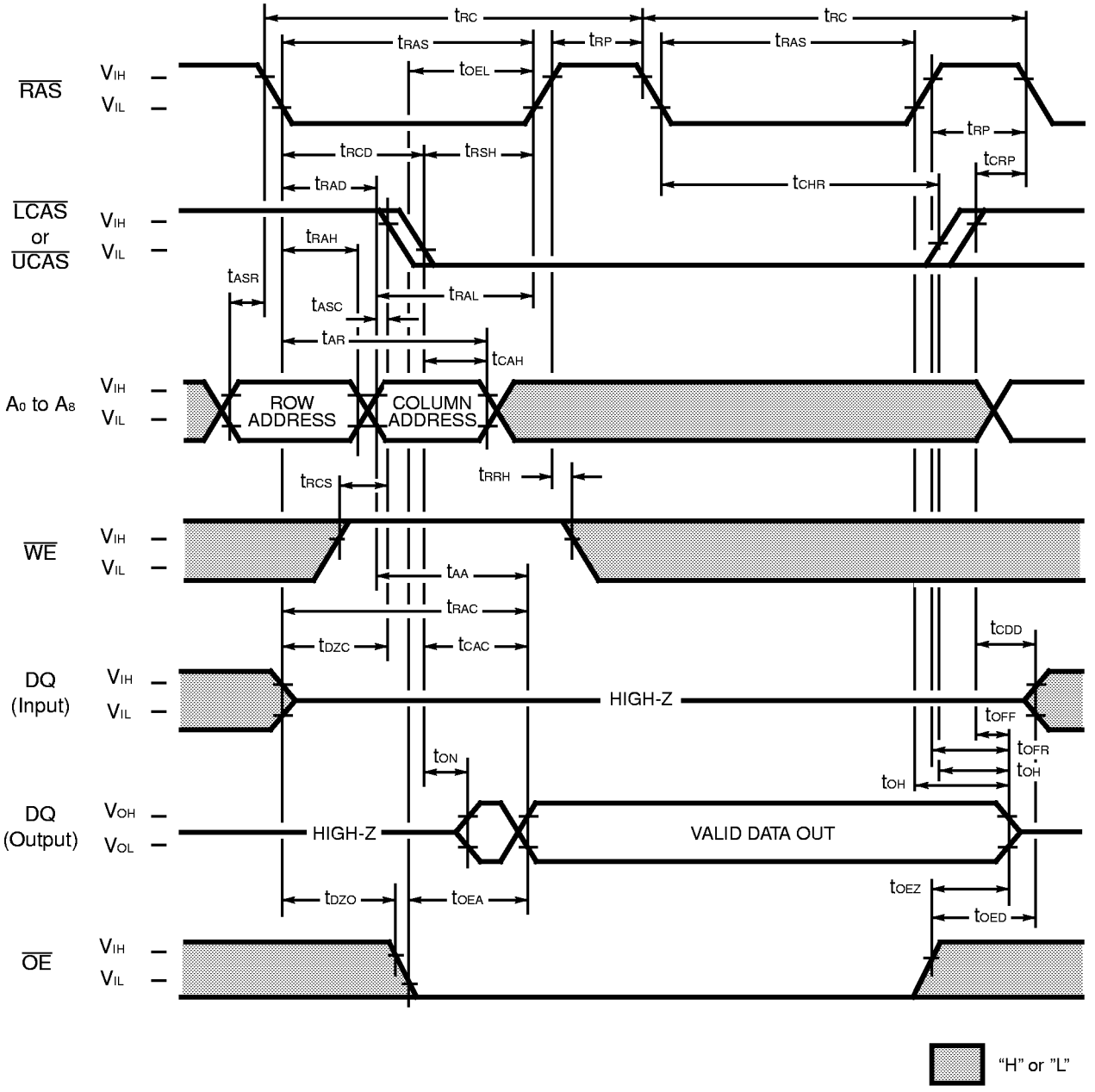
Fig. 17 $\overline{CAS}$-BEFORE-$\overline{RAS}$ REFRESH (ADDRESSES = WE = OE = "H" or "L")



DESCRIPTION

$\overline{CAS}$-before-$\overline{RAS}$ refresh is an on-chip refresh capability that eliminates the need for external refresh addresses. If $\overline{LCAS}$ or $\overline{UCAS}$ is held Low for the specified setup time (t_{CSR}) before $\overline{RAS}$ goes Low, the on-chip refresh control clock generators and refresh address counter are enabled. An internal refresh operation automatically occurs and the refresh address counter is internally incremented in preparation for the next $\overline{CAS}$-before-$\overline{RAS}$ refresh operation.

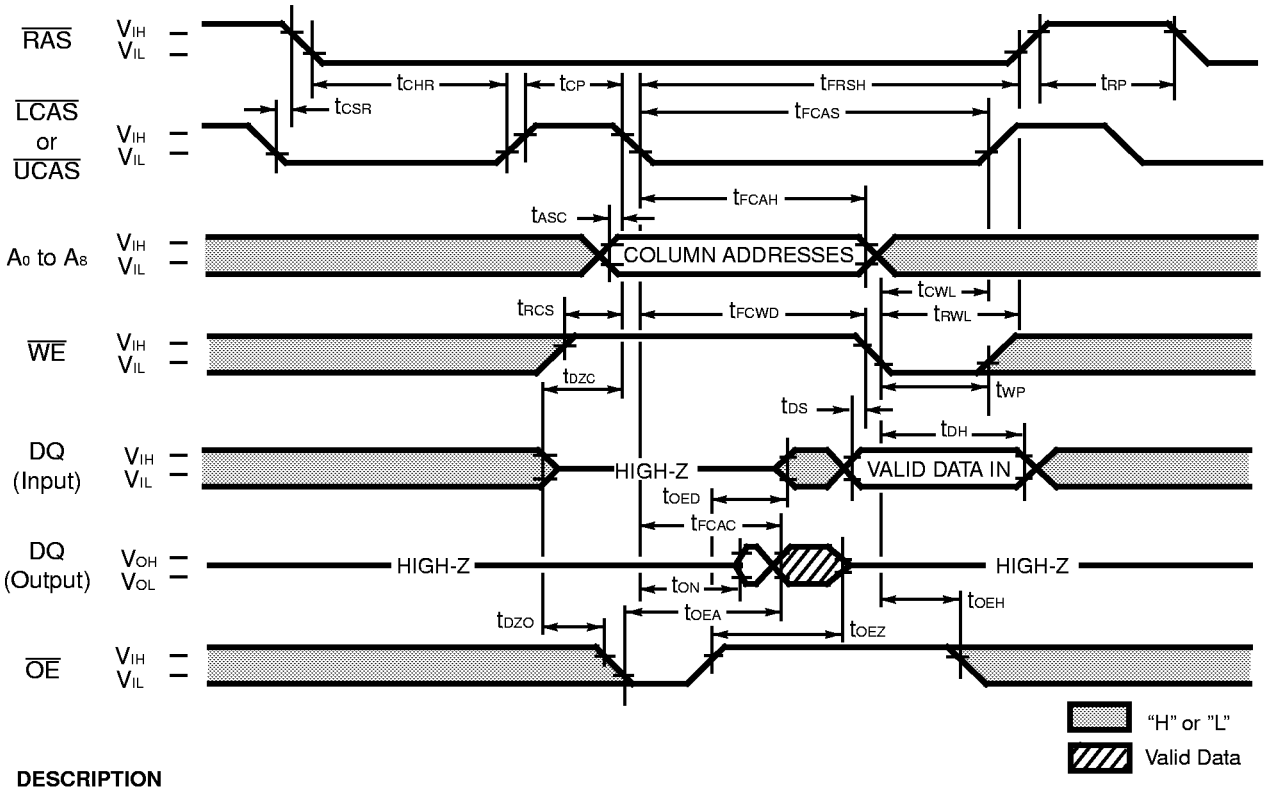
Fig. 18 – HIDDEN REFRESH CYCLE



DESCRIPTION

A hidden refresh cycle may be performed while maintaining the latest valid data at the output by extending the active time of $\overline{LCAS}$ or $\overline{UCAS}$ and cycling $\overline{RAS}$. The refresh row address is provided by the on-chip refresh address counter. This eliminates the need for the external row address that is required by DRAMs that do not have $\overline{CAS}$-before-$\overline{RAS}$ refresh capability.

Fig. 19 – $\overline{CAS}$-BEFORE-$\overline{RAS}$ REFRESH COUNTER TEST CYCLE



DESCRIPTION

A special timing sequence using the $\overline{CAS}$-before-$\overline{RAS}$ refresh counter test cycle provides a convenient method to verify the functionality of $\overline{CAS}$-before-$\overline{RAS}$ refresh circuitry. After a $\overline{CAS}$-before-$\overline{RAS}$ refresh cycle, if $\overline{LCAS}$ or $\overline{UCAS}$ makes a transition from High to Low while $\overline{RAS}$ is held Low, read and write operations are enabled as shown above. Row and column addresses are defined as follows:

Row Address: Bits A_0 through A_8 are defined by the on-chip refresh counter.

Column Address: Bits A_0 through A_8 are defined by latching levels on A_0-A_8 at the second falling edge of $\overline{LCAS}$ or $\overline{UCAS}$.

The $\overline{CAS}$-before-$\overline{RAS}$ Counter Test procedure is as follows ;

1) Normalize the internal refresh address counter by using 8 $\overline{RAS}$-only refresh cycles.
2) Use the same column address throughout the test.
3) Write "0" to all 512 row addresses at the same column address by using CBR refresh counter test cycles.
4) Read "0" written in procedure 3) by using normal read cycle and check; After reading "0" and check are completed (or simultaneously), write "1" to the same addresses by using normal write cycle (or read-modify-write cycle).
5) Read and check data "1" written in procedure 4) by using CBR refresh counter test cycle for all 512 memory locations.
6) Reverse test data and repeat procedures 3), 4), and 5).

(At recommended operating conditions unless otherwise noted.)

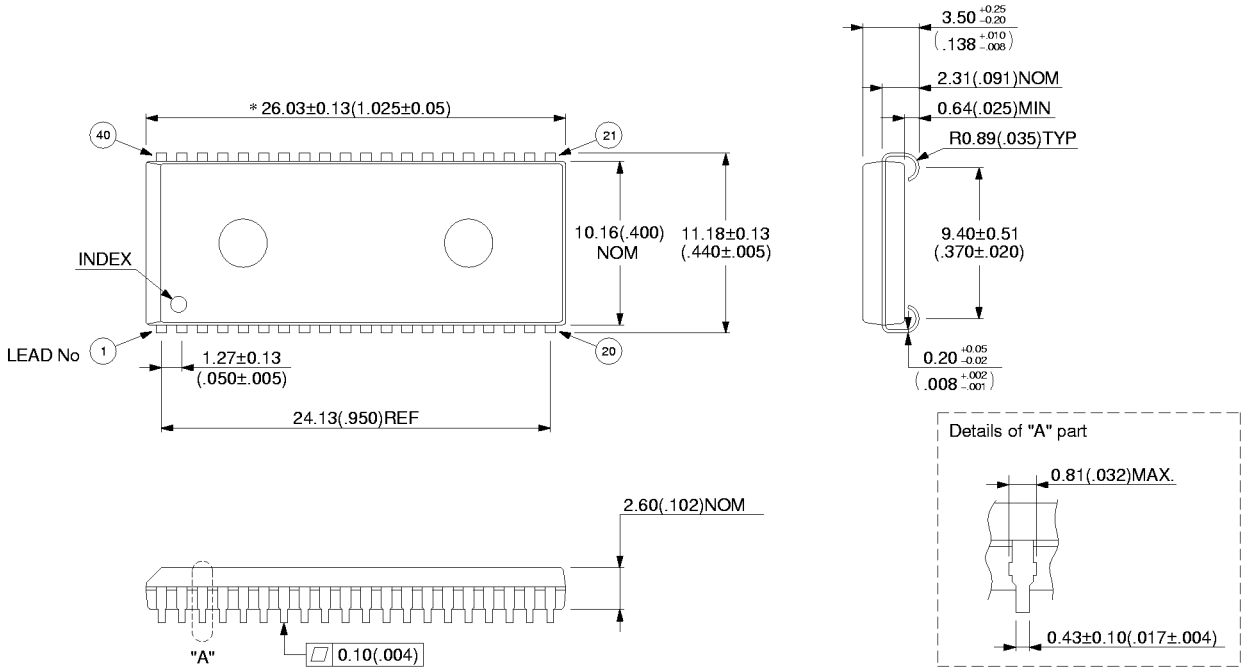
No.	Parameter	Symbol	MB814265-60		MB814265-70		Unit
			Min.	Max.	Min.	Max.	
90	Access Time from $\overline{CAS}$	t_{FCAC}	—	55	—	55	µs
91	Column Adress Hold Time	t_{FCAH}	30	—	30	—	ns
92	$\overline{CAS}$ to $\overline{WE}$ Delay Time	t_{FCWD}	80	—	80	—	ns
93	$\overline{CAS}$ Pulse Width	t_{FCAS}	55	—	55	—	µs
94	$\overline{RAS}$ Hold Time	t_{FRSH}	55	—	55	—	ns
95	$\overline{CAS}$ Hold Time	t_{FCSH}	85	—	85	—	ns

Note: Assumes that $\overline{CAS}$-before-$\overline{RAS}$ refresh counter test cycle only.

■ PACKAGE DIMENSIONS

(Suffix : –PJ)

40 pin, Plastic SOJ
(LCC-40P-M01)

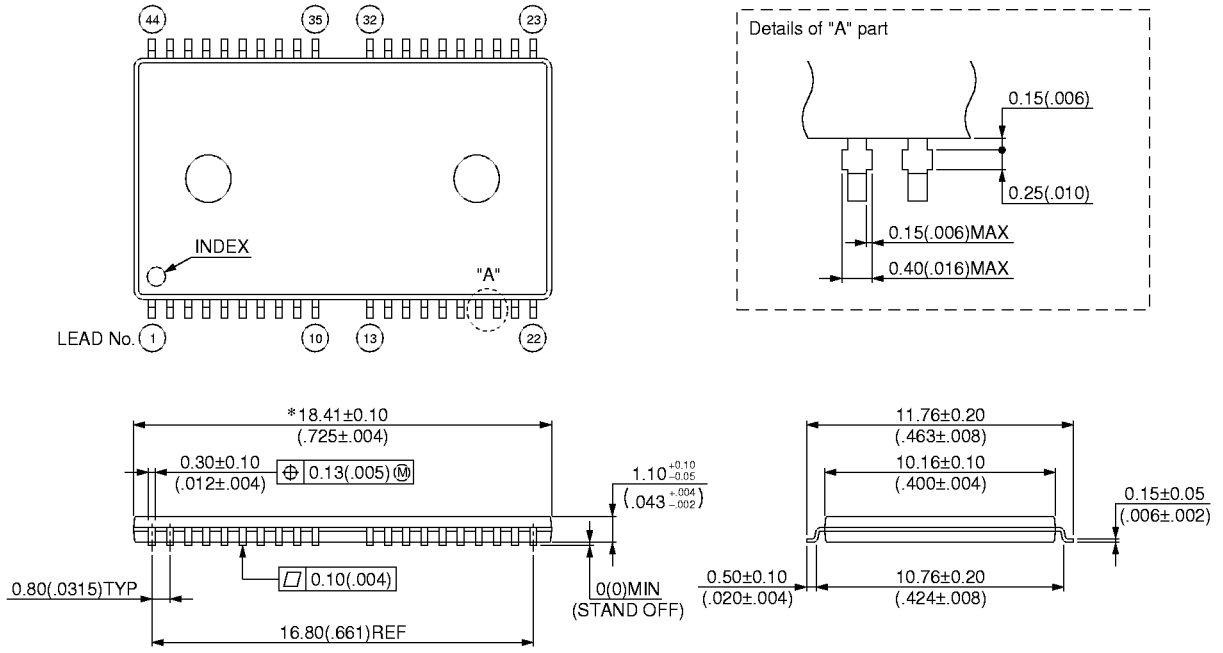


Dimensions in mm(inches).

■ PACKAGE DIMENSIONS (Continued)

(Suffix : –PFTN)

44 pin, Plastic TSOP(II)
(FPT-44P-M07)



Dimensions in mm(inches).