HM511664C Series

1M FP DRAM (64-kword × 16-bit)
256 refresh

HITACHI

ADE-203-627A (Z)
Rev. 1.0
Dec. 20, 1997

Description

The Hitachi HM511664C Series is a CMOS dynamic RAM organized 65,536-word × 16-bit. HM511664C Series has realized higher density, higher performance and various functions by employing 0.8 µm CMOS process technology and some new CMOS circuit design technologies. The HM511664C Series offers Fast Page Mode as a high speed access mode. Multiplexed address input permits the HM511664C to be packaged in standard 400-mil 40-pin plastic SOJ and standard 400-mil 44-pin plastic TSOPII.

Features

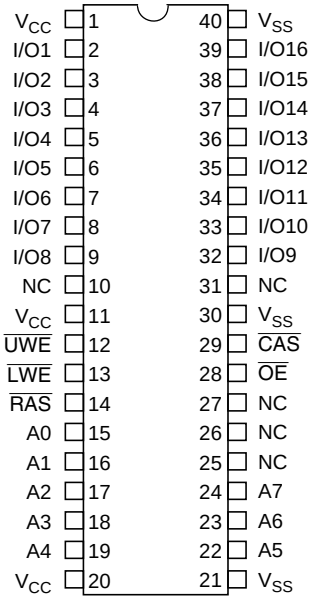
- Single 5 V supply: 5 V ± 10%
- Access time: 60 ns/70 ns/80 ns (max)
- Power dissipation
  - — Active mode: 660 mW/ 633 mW/495 mW (max)
  - — Standby mode: 11 mW (max)
- Fast page mode capability
- Refresh cycles
  - — 256 refresh cycles: 4 ms
- 2 variations of refresh
  - — $\overline{\text{RAS}}$-only refresh
  - — $\overline{\text{CAS}}$-before-$\overline{\text{RAS}}$ refresh
- 2$\overline{\text{WE}}$-byte control

Ordering Information

Type No.	Access time	Package
HM511664CJ-6	60 ns	400-mil 40-pin plastic SOJ (CP-40D)
HM511664CJ-7	70 ns	
HM511664CJ-8	80 ns	
HM511664CTT-6	60 ns	400-mil 44-pin plastic TSOPII (TTP-44/40DA)
HM511664CTT-7	70 ns	
HM511664CTT-8	80 ns	

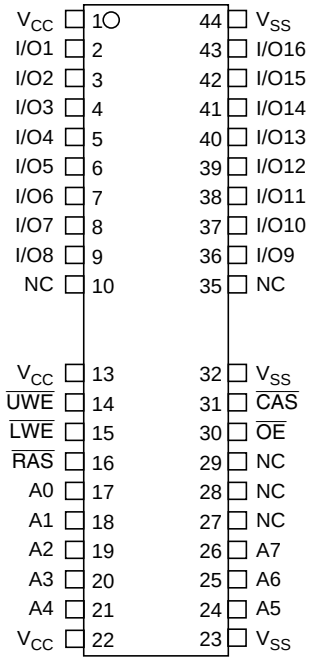
Pin Arrangement

HM511664CJ Series



(Top view)

HM511664CTT Series

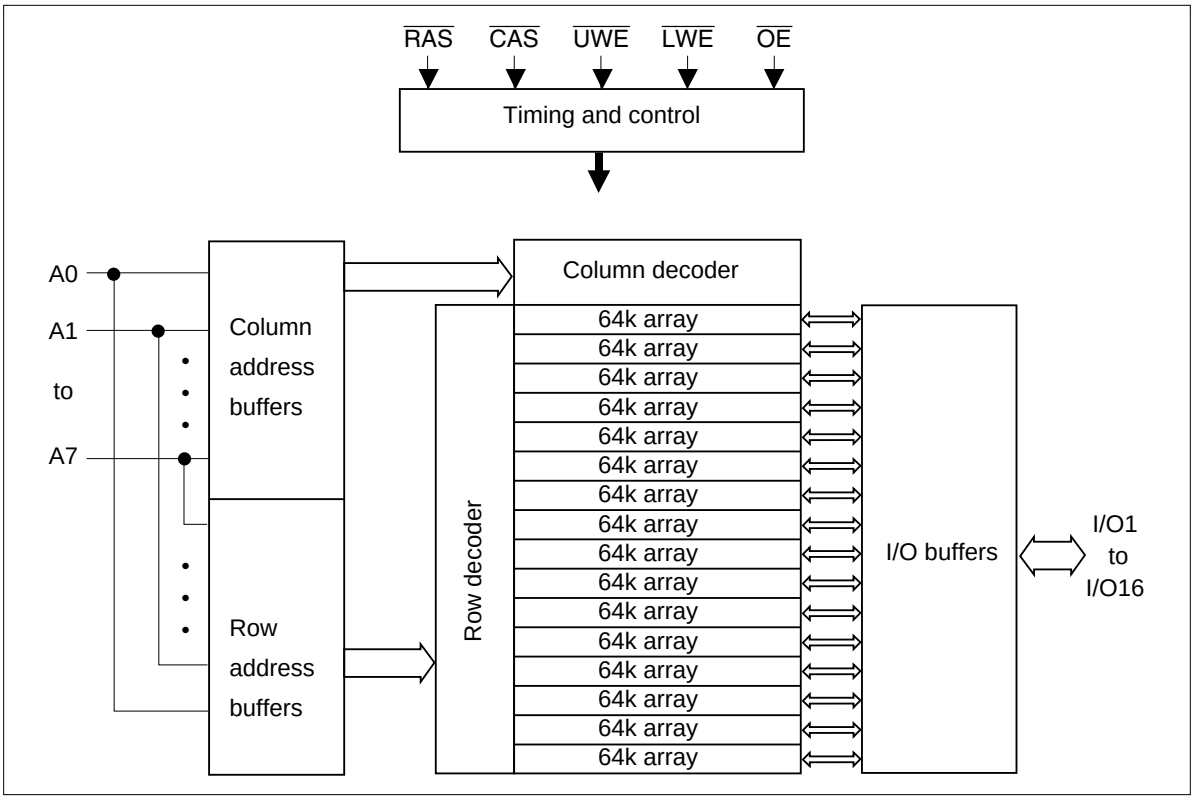


(Top view)

Pin Description

Pin name	Function
A0 to A7	Address input • Row address A0 to A7 • Refresh address A0 to A7 • Column address A0 to A7
I/O1 to I/O16	Data-in/data-out
$\overline{RAS}$	Row address strobe
$\overline{CAS}$	Column address strobe
$\overline{UWE}$, $\overline{LWE}$	Read/write enable
$\overline{OE}$	Output enable
V_{CC}	Power supply
V_{SS}	Ground
NC	No connection

Block Diagram



Operation Table

The HM511664C series has the following 10 operation modes.

1. Read cycle
2. Early write cycle
3. Delayed write cycle
4. Read-modify-write cycle
5. $\overline{RAS}$-only refresh cycle
6. $\overline{CAS}$-before-$\overline{RAS}$ refresh cycle
7. Fast page mode read cycle
8. Fast page mode early write cycle
9. Fast page mode delayed write cycle
10. Fast page mode read-modify-write cycle

Inputs

$\overline{RAS}$	$\overline{CAS}$	$\overline{UWE}$	$\overline{LWE}$	Output	Operation
H	H	D	D	Open	Standby
H	L	H	H	Valid	Standby
L	L	H	H	Valid	Read cycle
L	L	L[*2]	L[*2]	Open	Early write cycle
L	L	L[*2]	L[*2]	Undefined	Delayed write cycle
L	L	H to L	H to L	Valid	Read-modify-write cycle
L	H	D	D	Open	$\overline{RAS}$-only refresh cycle
H to L	L	D	D	Open	$\overline{CAS}$-before-$\overline{RAS}$ refresh cycle
L	H to L	H	H	Valid	Fast page mode read cycle
L	H to L	L[*2]	L[*2]	Open	Fast page mode early write cycle
L	H to L	L[*2]	L[*2]	Undefined	Fast page mode delayed write cycle
L	H to L	H to L	H to L	Valid	Fast page mode read modify-write cycle

Notes: 1. H: High (inactive) L: Low (active) D: H or L

2. $t_{WCS} \geq 0$ ns Early write cycle
   $t_{WCS} < 0$ ns Delayed write cycle
3. Mode is determined by the OR function of the $\overline{UWE}$ and $\overline{LWE}$. (Mode is set by the earliest of $\overline{UWE}$ and $\overline{LWE}$ active edge and reset by the latest of $\overline{UWE}$ and $\overline{LWE}$ inactive edge.) However write OPERATION and output High-Z control are done independently by each $\overline{UWE}$, $\overline{LWE}$.

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Voltage on any pin relative to V_{SS}	V_T	–1.0 to +7.0	V
Supply voltage relative to V_{SS}	V_{CC}	–1.0 to +7.0	V
Short circuit output current	Iout	50	mA
Power dissipation	P_T	1.0	W
Operating temperature	Topr	0 to +70	°C
Storage temperature	Tstg	–55 to +125	°C

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

Parameter		Symbol	Min	Typ	Max	Unit	Notes
Supply voltage		V_{SS}	0	0	0	V	2
		V_{CC}	4.5	5.0	5.5	V	1, 2
Input high voltage		V_{IH}	2.4	—	6.5	V	1
Input low voltage	(I/O pin)	V_{IL}	–0.5	—	0.8	V	1
	(Others)	V_{IL}	–1.0	—	0.8	V	1

Notes: 1. All voltage referred to V_{SS}.
2. The supply voltage with all V_{CC} pins must be on the same level.
The supply voltage with all V_{SS} pins must be on the same level.

DC Characteristics (Ta = 0 to +70°C, V_{CC} = 5 V ±10%, V_{SS} = 0 V) *4

		HM511664C							
		-6		-7		-8			
Parameter	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Unit**	**Test conditions**
Operating current*1, *2	I_{CC1}	—	120	—	115	—	90	mA	$\overline{RAS}$ cycling $\overline{CAS}$ cycling, t_{RC} = min
Standby current	I_{CC2}	—	2	—	2	—	2	mA	TTL interface $\overline{RAS}$, $\overline{CAS}$ = V_{IH} Dout = High-Z
		—	1	—	1	—	1	mA	CMOS interface $\overline{RAS}$, $\overline{CAS}$, $\overline{UWE}$, $\overline{LWE}$, $\overline{OE}$ ≥ V_{CC} – 0.2 V Dout = High-Z
$\overline{RAS}$-only refresh current*2	I_{CC3}	—	120	—	115	—	90	mA	t_{RC} = min
Standby current*1	I_{CC5}	—	5	—	5	—	5	mA	$\overline{RAS}$ = V_{IH}, $\overline{CAS}$ = V_{IL}, Dout = enable
$\overline{CAS}$-before-$\overline{RAS}$ refresh current*2	I_{CC6}	—	120	—	115	—	90	mA	t_{RC} = min
Fast page mode current*1, *3	I_{CC7}	—	120	—	115	—	90	mA	t_{PC} = min
Input leakage current	I_{LI}	–10	10	–10	10	–10	10	µA	0 V ≤ Vin ≤ 6.5 V
Output leakage current	I_{LO}	–10	10	–10	10	–10	10	µA	0 V ≤ Vout ≤ 6.5 V Dout = disable
Output high voltage	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	High Iout = –2.5 mA
Output low voltage	V_{OL}	0	0.4	0	0.4	0	0.4	V	Low Iout = 2.1 mA

Notes: 1. I_{CC} depends on output load condition when the device is selected. I_{CC} max is specified at the output open condition.

2. Address can be changed twice or less while $\overline{RAS}$ = V_{IL}.
3. Address can be changed twice or less while $\overline{CAS}$ = V_{IH}.
4. All the V_{CC} pins should be supplied with the same voltage. And all the V_{SS} pins should be supplied with the same voltage.

Capacitance (Ta = +25°C, V_{CC} = 5 V ±10%)

Parameter	Symbol	Typ	Max	Unit	Notes
Input capacitance (Address)	C_{I1}	—	5	pF	1
Input capacitance (Clocks)	C_{I2}	—	7	pF	1
Output capacitance (Data-in, Data-out)	$C_{I/O}$	—	10	pF	1, 2

Notes: 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$ = V_{IH} to disable Dout.

AC Characteristics (Ta = 0 to +70°C, V_{CC} = 5 V ±10%, V_{SS} = 0 V)*1, *14, *15, *17, *18

Test Conditions

- Input rise and fall time : 5 ns
- Input levels: V_{IL} = 0 V, V_{IH} = 3.0 V
- Input timing reference levels : 0.8 V, 2.4 V
- Output load : 1 TTL gate + C_L (50 pF) (Including scope and jig)

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

		HM511664C							
		-6		-7		-8			
Parameter	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Unit**	**Notes**
Random read or write cycle time	t_{RC}	105	—	125	—	145	—	ns	
$\overline{RAS}$ precharge time	t_{RP}	40	—	50	—	60	—	ns	
$\overline{RAS}$ pulse width	t_{RAS}	60	10000	70	10000	80	10000	ns	23
$\overline{CAS}$ pulse width	t_{CAS}	15	10000	20	10000	20	10000	ns	22, 24
Row address setup time	t_{ASR}	0	—	0	—	0	—	ns	
Row address hold time	t_{RAH}	10	—	10	—	10	—	ns	
Column address setup time	t_{ASC}	0	—	0	—	0	—	ns	
Column address hold time	t_{CAH}	15	—	15	—	15	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ delay time	t_{RCD}	20	45	20	50	20	60	ns	8
$\overline{RAS}$ to column address delay time	t_{RAD}	15	30	15	35	15	40	ns	9
$\overline{RAS}$ hold time	t_{RSH}	15	—	20	—	20	—	ns	
$\overline{CAS}$ hold time	t_{CSH}	60	—	70	—	80	—	ns	25
$\overline{CAS}$ to $\overline{RAS}$ precharge time	t_{CRP}	10	—	10	—	10	—	ns	
$\overline{OE}$ to Din delay time	t_{ODD}	15	—	15	—	15	—	ns	
$\overline{OE}$ delay time from Din	t_{DZO}	0	—	0	—	0	—	ns	
$\overline{CAS}$ setup time from Din	t_{DZC}	0	—	0	—	0	—	ns	
Transition time (rise and fall)	t_T	3	50	3	50	3	50	ns	7
Refresh period	t_{REF}	—	4	—	4	—	4	ms	

Read Cycle

		HM511664C							
		-6		-7		-8			
Parameter	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Unit**	**Notes**
Access time from $\overline{RAS}$	t_{RAC}	—	60	—	70	—	80	ns	2, 3
Access time from $\overline{CAS}$	t_{CAC}	—	15	—	20	—	20	ns	3, 4, 13
Access time from address	t_{AA}	—	30	—	35	—	40	ns	3, 5, 13
Access time from $\overline{OE}$	t_{OAC}	—	15	—	20	—	20	ns	22
Read command setup time	t_{RCS}	0	—	0	—	0	—	ns	20
Read command hold time to $\overline{CAS}$	t_{RCH}	0	—	0	—	0	—	ns	16, 19
Read command hold time to $\overline{RAS}$	t_{RRH}	0	—	0	—	0	—	ns	16, 19
Column address to $\overline{RAS}$ lead time	t_{RAL}	30	—	35	—	40	—	ns	
Output buffer turn-off time	t_{OFF1}	0	15	0	15	0	15	ns	6
Output buffer turn-off time to $\overline{OE}$	t_{OFF2}	0	15	0	15	0	15	ns	6
$\overline{CAS}$ to Din delay time	t_{CDD}	15	—	15	—	15	—	ns	

Write Cycle

		HM511664C							
		-6		-7		-8			
Parameter	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Unit**	**Notes**
Write command setup time	t_{WCS}	0	—	0	—	0	—	ns	10, 19
Write command hold time	t_{WCH}	10	—	13	—	15	—	ns	20
Write command pulse width	t_{WP}	10	—	13	—	15	—	ns	21
Write command to $\overline{RAS}$ lead time	t_{RWL}	20	—	20	—	20	—	ns	21
Write command to $\overline{CAS}$ lead time	t_{CWL}	10	—	13	—	15	—	ns	21
Data-in setup time	t_{DS}	0	—	0	—	0	—	ns	11, 21
Data-in hold time	t_{DH}	10	—	13	—	15	—	ns	11, 21
$\overline{CAS}$ to $\overline{OE}$ delay time	t_{COD}	—	0	—	0	—	0	ns	22

Read-Modify-Write Cycle

		HM511664C							
		-6		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Read-modify-write cycle time	t_{RWC}	135	—	165	—	185	—	ns	
$\overline{RAS}$ to $\overline{WE}$ delay time	t_{RWD}	77	—	90	—	102	—	ns	10, 19
$\overline{CAS}$ to $\overline{WE}$ delay time	t_{CWD}	32	—	38	—	42	—	ns	10, 19
Column address to $\overline{WE}$ delay time	t_{AWD}	47	—	55	—	62	—	ns	10, 19
$\overline{OE}$ hold time from $\overline{WE}$	t_{OEH}	15	—	18	—	20	—	ns	21

Refresh Cycle

		HM511664C							
		-6		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
$\overline{CAS}$ setup time (CBR refresh cycle)	t_{CSR}	10	—	10	—	10	—	ns	
$\overline{CAS}$ hold time (CBR refresh cycle)	t_{CHR}	10	—	10	—	10	—	ns	
$\overline{RAS}$ precharge to $\overline{CAS}$ hold time	t_{RPC}	10	—	10	—	10	—	ns	
$\overline{CAS}$ precharge time in normal mode	t_{CPN}	10	—	10	—	10	—	ns	

Fast Page Mode Cycle

		HM511664C							
		-6		-7		-8			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Fast page mode cycle time	t_{PC}	40	—	45	—	50	—	ns	
Fast page mode $\overline{CAS}$ precharge time	t_{CP}	10	—	10	—	10	—	ns	
Fast page mode $\overline{RAS}$ pulse width	t_{RASC}	60	100000	70	100000	80	100000	ns	12
Access time from $\overline{CAS}$ precharge	t_{ACP}	—	35	—	40	—	45	ns	3, 13
$\overline{RAS}$ hold time from $\overline{CAS}$ precharge	t_{RHCP}	35	—	40	—	45	—	ns	

Fast Page Mode Read-Modify-Write Cycle

		HM511664C							
		-6		-7		-8			
Parameter	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Unit**	**Notes**
Fast page mode read-modify-write cycle time	t_{PCM}	80	—	95	—	100	—	ns	
Fast page mode read-modify-write cycle $\overline{CAS}$ precharge to $\overline{WE}$ delay time	t_{CPW}	52	—	60	—	67	—	ns	10, 21

Notes:
1. AC measurements assume t_T = 5 ns.
2. Assumes that $t_{RCD} \leq t_{RCD}$ (max) and $t_{RAD} \leq t_{RAD}$ (max). If t_{RCD} or t_{RAD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
3. Measured with a load circuit equivalent to 1 TTL loads and 50 pF.
4. Assumes that $t_{RCD} \geq t_{RCD}$ (max) and $t_{RAD} \leq t_{RAD}$ (max).
5. Assumes that $t_{RCD} \leq t_{RCD}$ (max) and $t_{RAD} \geq t_{RAD}$ (max).
6. t_{OFF1} (max), t_{OFF2} (max) define the time at which the output achieves the open circuit condition and is not referred to output voltage levels.
7. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
8. Operation with the t_{RCD} (max) limit insures 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 exclusively by t_{CAC}.
9. Operation with the t_{RAD} (max) limit insures 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 exclusively by t_{AA}.
10. 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 $t_{WCS} \geq t_{WCS}$ (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{RWD} \geq t_{RWD}$ (min), $t_{CWD} \geq t_{CWD}$ (min), $t_{AWD} \geq t_{AWD}$ (min) and $t_{CPW} \geq t_{CPW}$ (min), the cycle is a read-modify-write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
11. These parameters are referred to $\overline{CAS}$ leading edge in an early write cycle and to $\overline{WE}$ leading edge in a delayed write or a read-modify-write cycle.
12. t_{RASC} defines $\overline{RAS}$ pulse width in Fast page mode cycles.
13. Access time is determined by the longest among t_{AA}, t_{CAC} and t_{ACP}.
14. An initial pause of 100 μs is required after power up followed by a minimum of eight initialization cycles ($\overline{RAS}$-only refresh cycle or $\overline{CAS}$-before-$\overline{RAS}$ refresh cycle). If the internal refresh counter is used, a minimum of eight $\overline{CAS}$-before-$\overline{RAS}$ refresh cycles is required.
15. In delayed write or read-modify-write cycles, $\overline{OE}$ must disable output buffer prior to applying data to the device.
16. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
17. When both $\overline{UWE}$ and $\overline{LWE}$ go low at the same time, all 16-bits data are written into the device. $\overline{UWE}$ and $\overline{LWE}$ cannot be staggered within the same write/read cycles.
18. All the V_{CC} and V_{SS} pins shall be supplied with the same voltages.
19. t_{RCH}, t_{RRH}, t_{WCS}, t_{RWD}, t_{CWD} and t_{AWD} are determined by the earlier falling edge of $\overline{UWE}$ and $\overline{LWE}$.
20. t_{WCH} and t_{RCS} are determined by the later rising edge of $\overline{UWE}$ or $\overline{LWE}$.
21. t_{WP}, t_{RWL}, t_{CWL}, t_{OEH}, t_{DS}, t_{DH} and t_{CPW} should be satisfied by both $\overline{UWE}$ and $\overline{LWE}$.

22. When output buffers are enabled once, sustain the low impedance state until valid data is obtained. When output buffer is turned on and off within a very short time, generally it causes large V_{CC}/V_{SS} line noise, which causes to degrade V_{IH} min/V_{IL} max level.
23. t_{RAS} (min) = t_{RWD} (min) + t_{RWL} (min) + t_T in read-modify-write cycle.
24. t_{CAS} (min) = t_{CWD} (min) + t_{CWL} (min) + t_T in read-modify-write cycle.
25. t_{CSH}(min) can be achieved when $t_{RCD} \leq t_{CSH}$(min) – t_{CAS}(min)
26. XXX: H or L (H: V_{IH} (min) $\leq V_{IN} \leq V_{IH}$ (max), L: V_{IL} (min) $\leq V_{IN} \leq V_{IL}$ (max))

    ///////: Invalid Dout

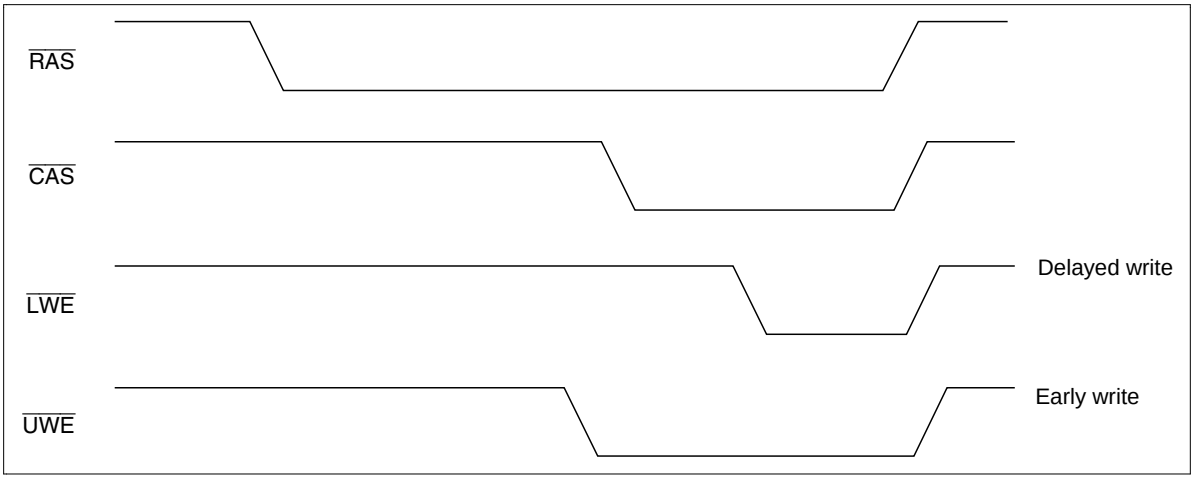
    When the address, clock and input pins are not described on timing waveforms, their pins must be applied V_{IH} or V_{IL}.

Notes concerning 2$\overline{WE}$ control

Please do not separate the $\overline{UWE}$/$\overline{LWE}$ operation timing intentionally. However skew between $\overline{UWE}$/$\overline{LWE}$ are allowed under the following conditions.

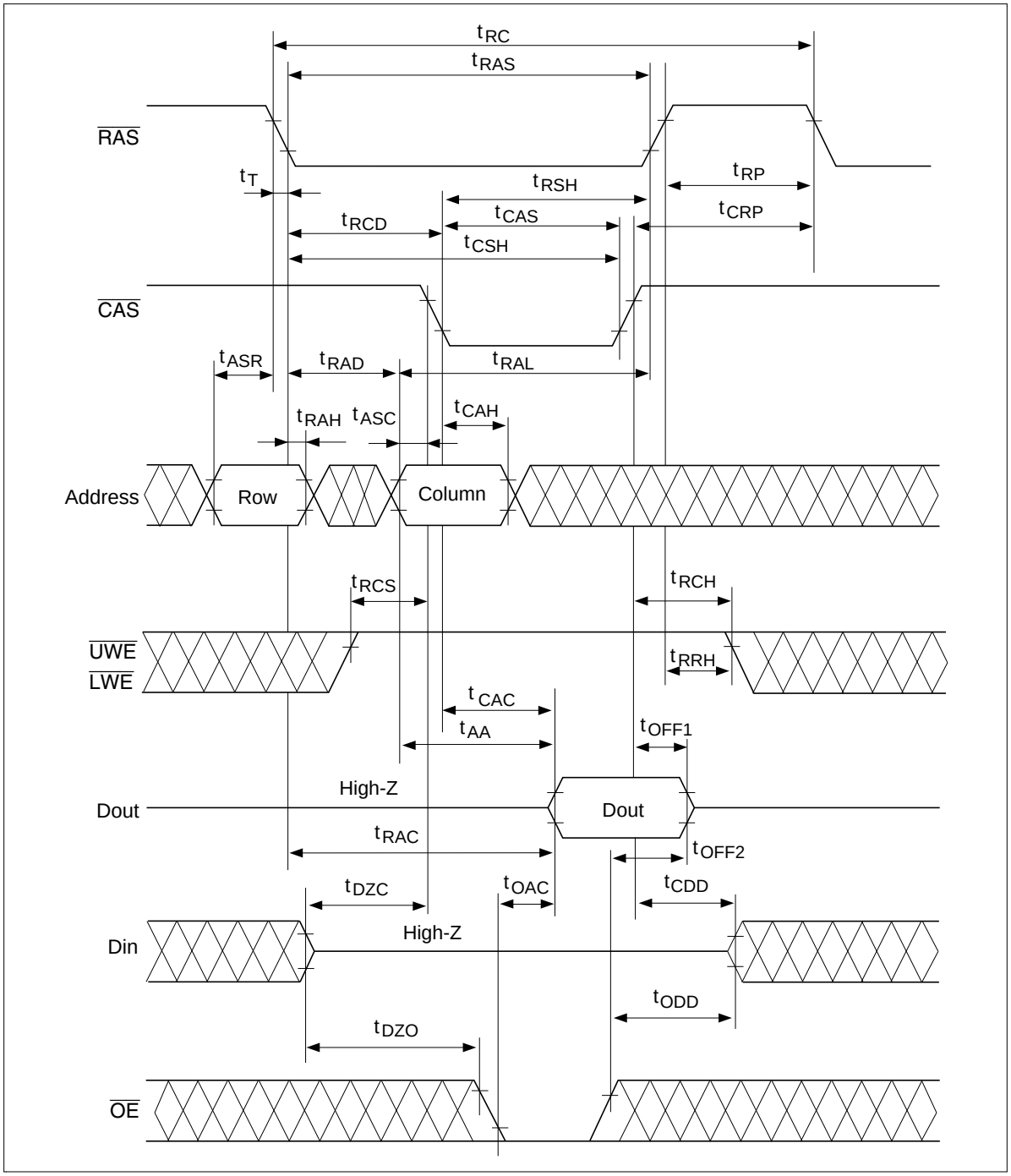
(1) Each of the $\overline{UWE}$/$\overline{LWE}$ should satisfy the timing specifications individually.

(2) Different operation mode for upper/lower byte is not allowed; such as following.

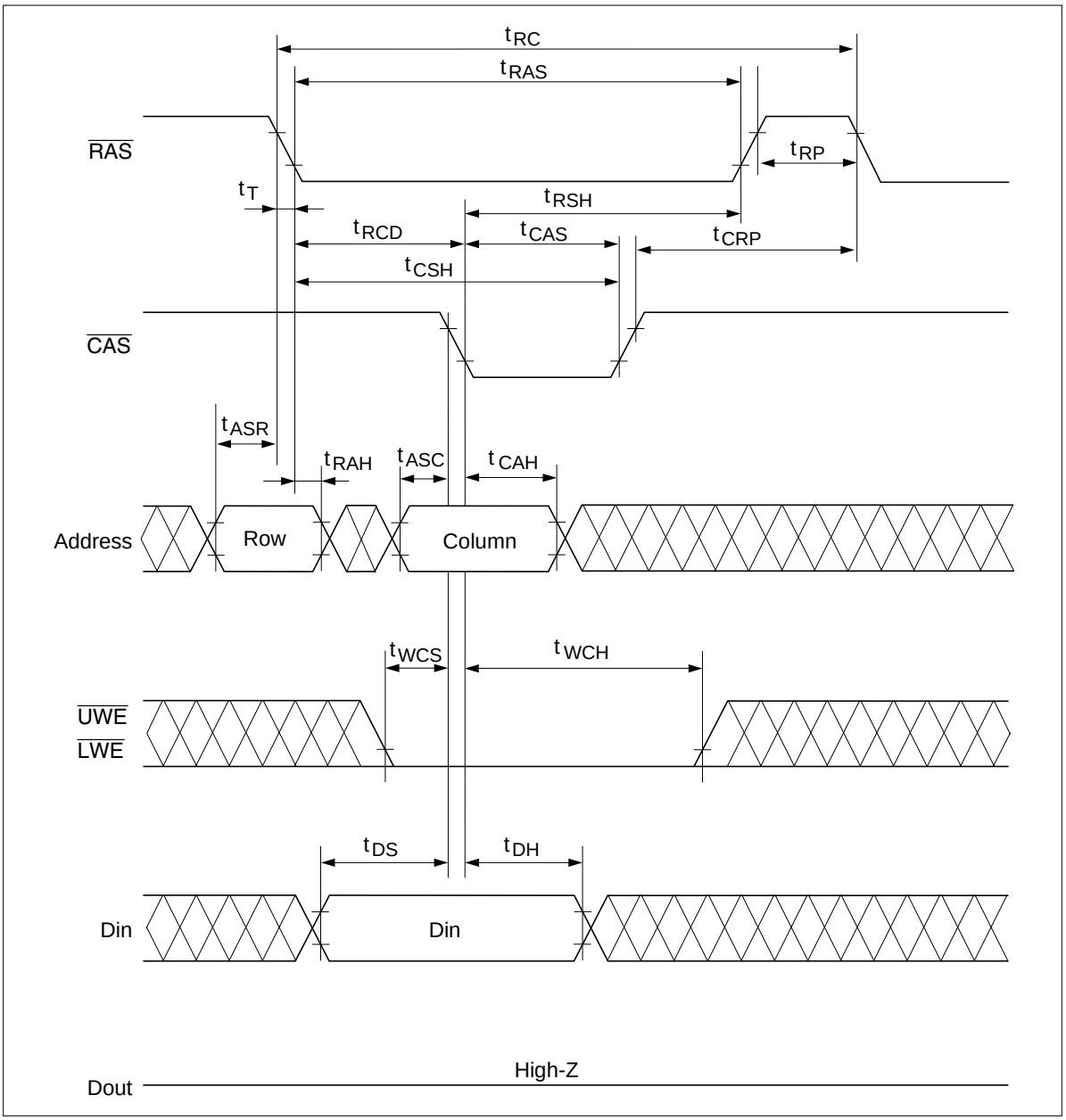


Timing Waveforms*[26]

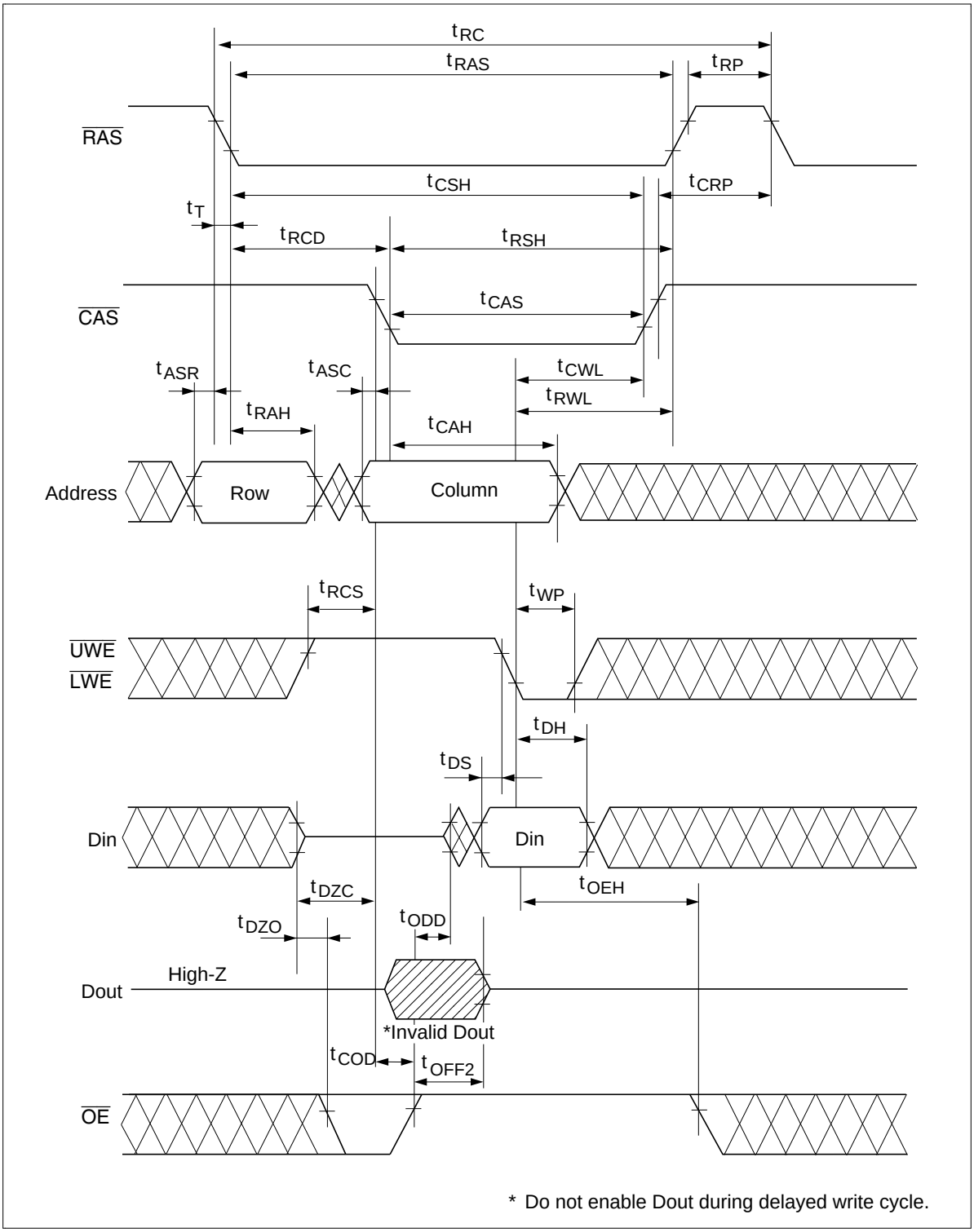
Read Cycle



Early Write Cycle

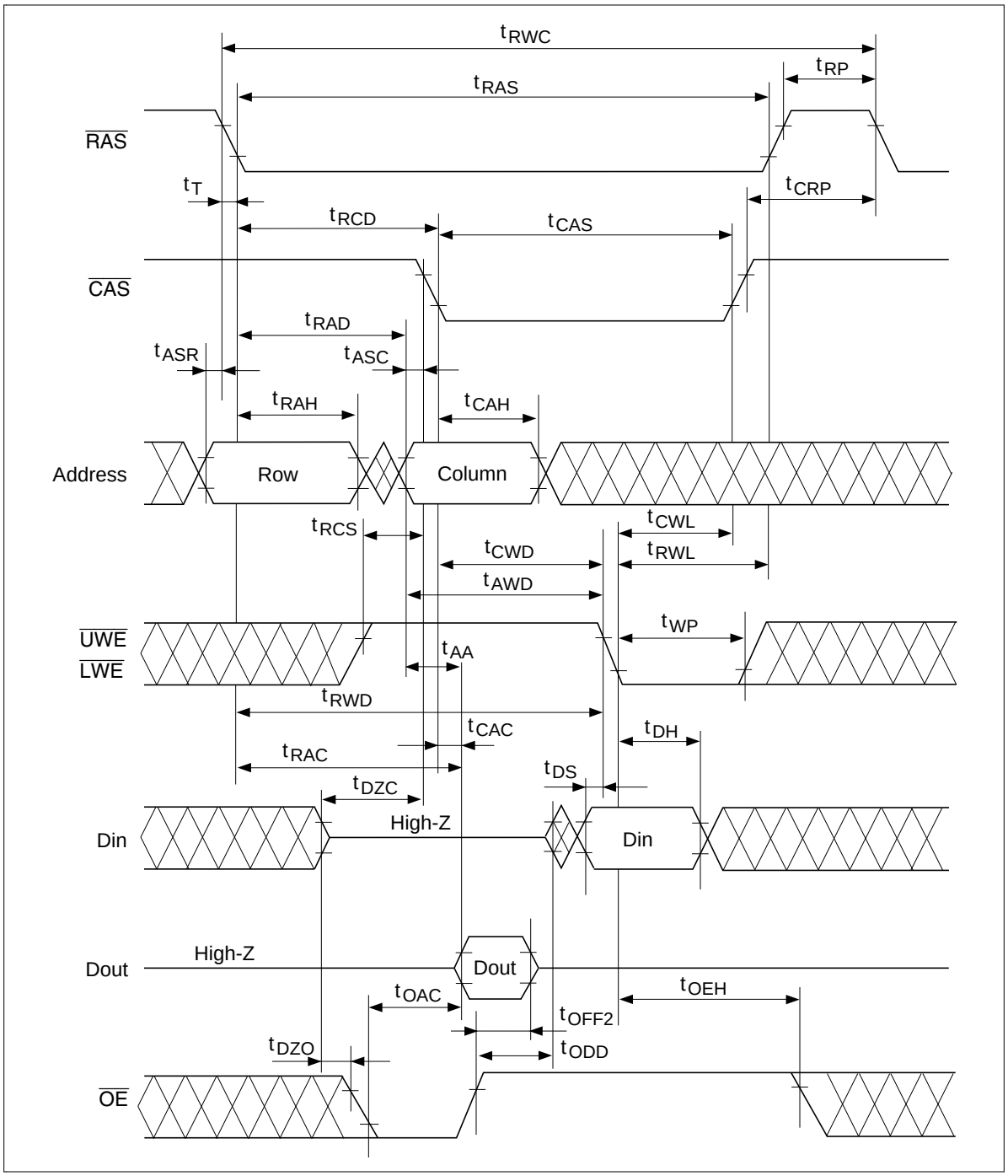


Delayed Write Cycle

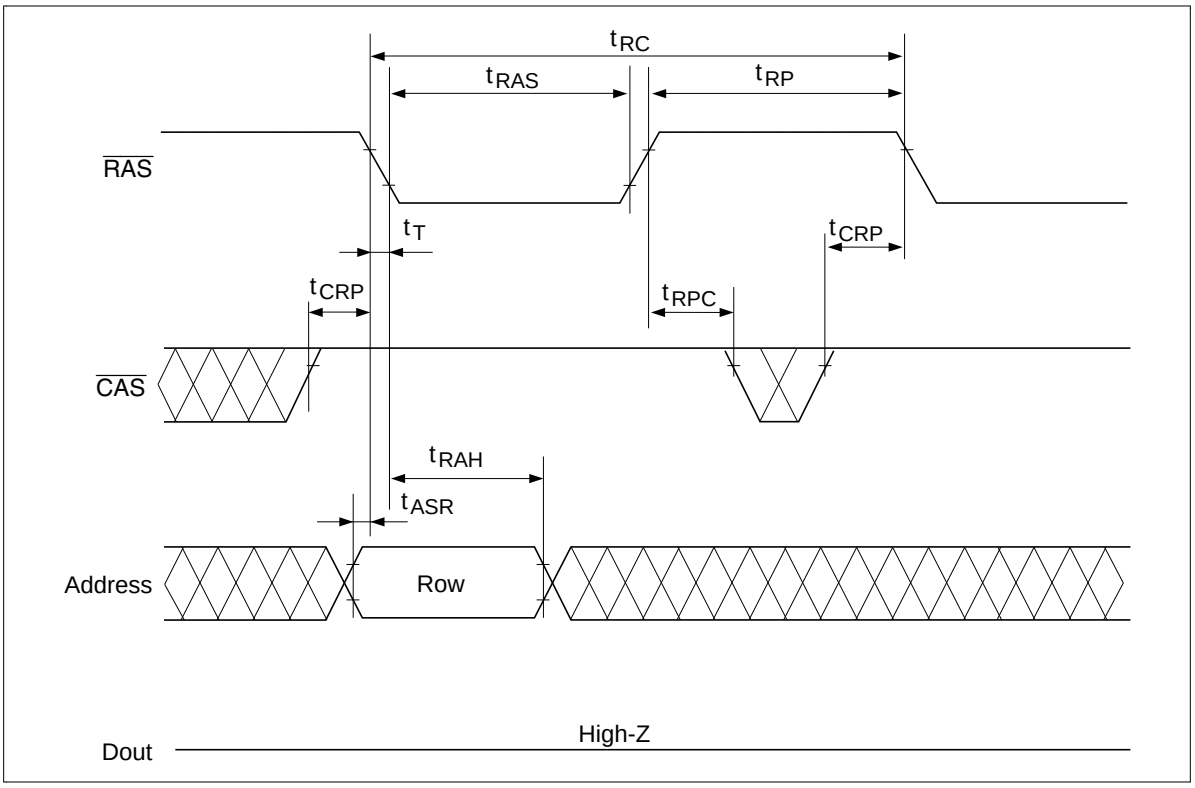


* Do not enable Dout during delayed write cycle.

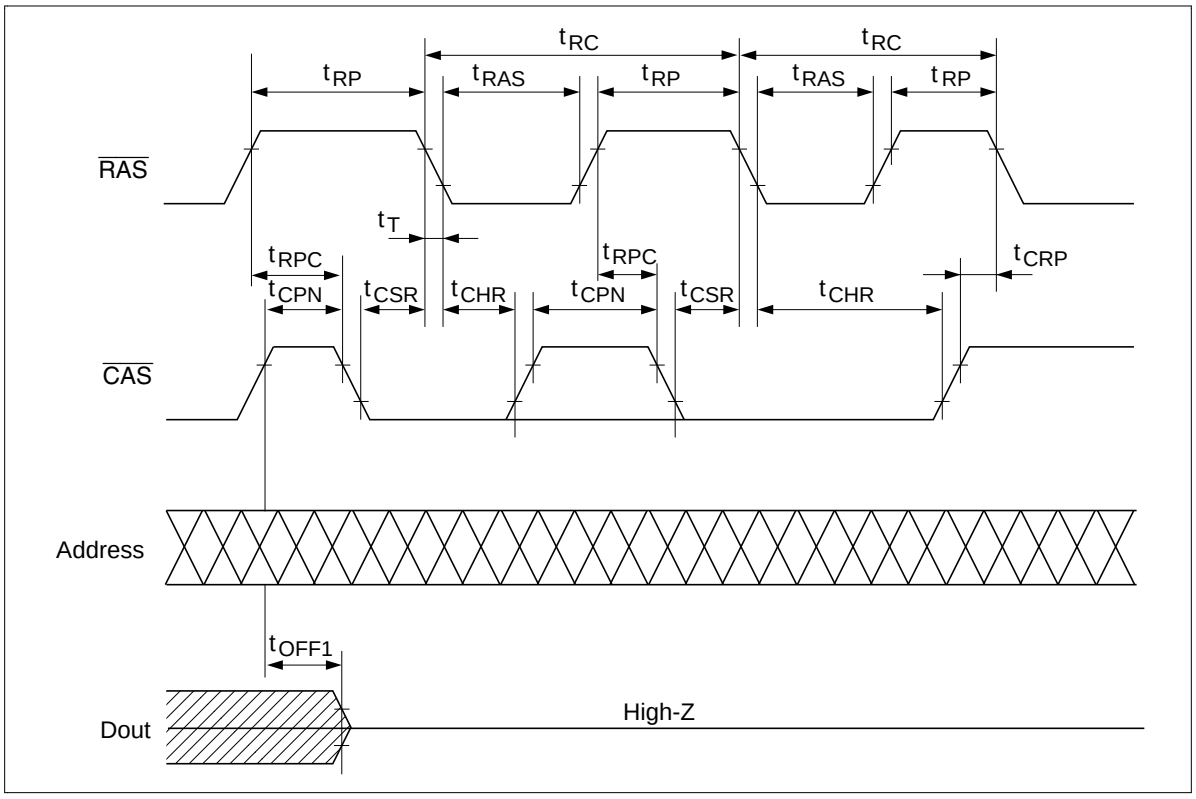
Read-Modify-Write Cycle



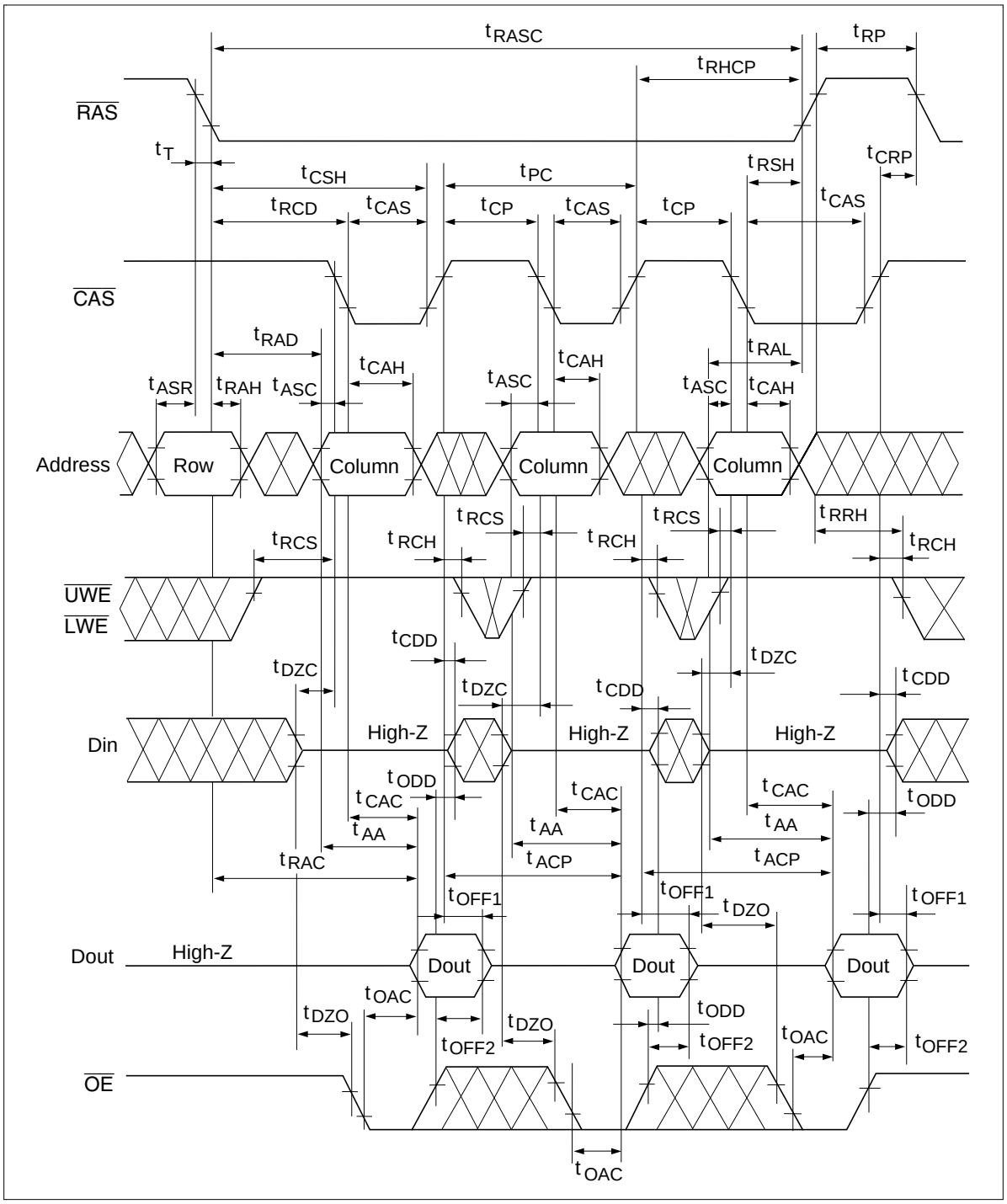
$\overline{\text{RAS}}$-Only Refresh Cycle



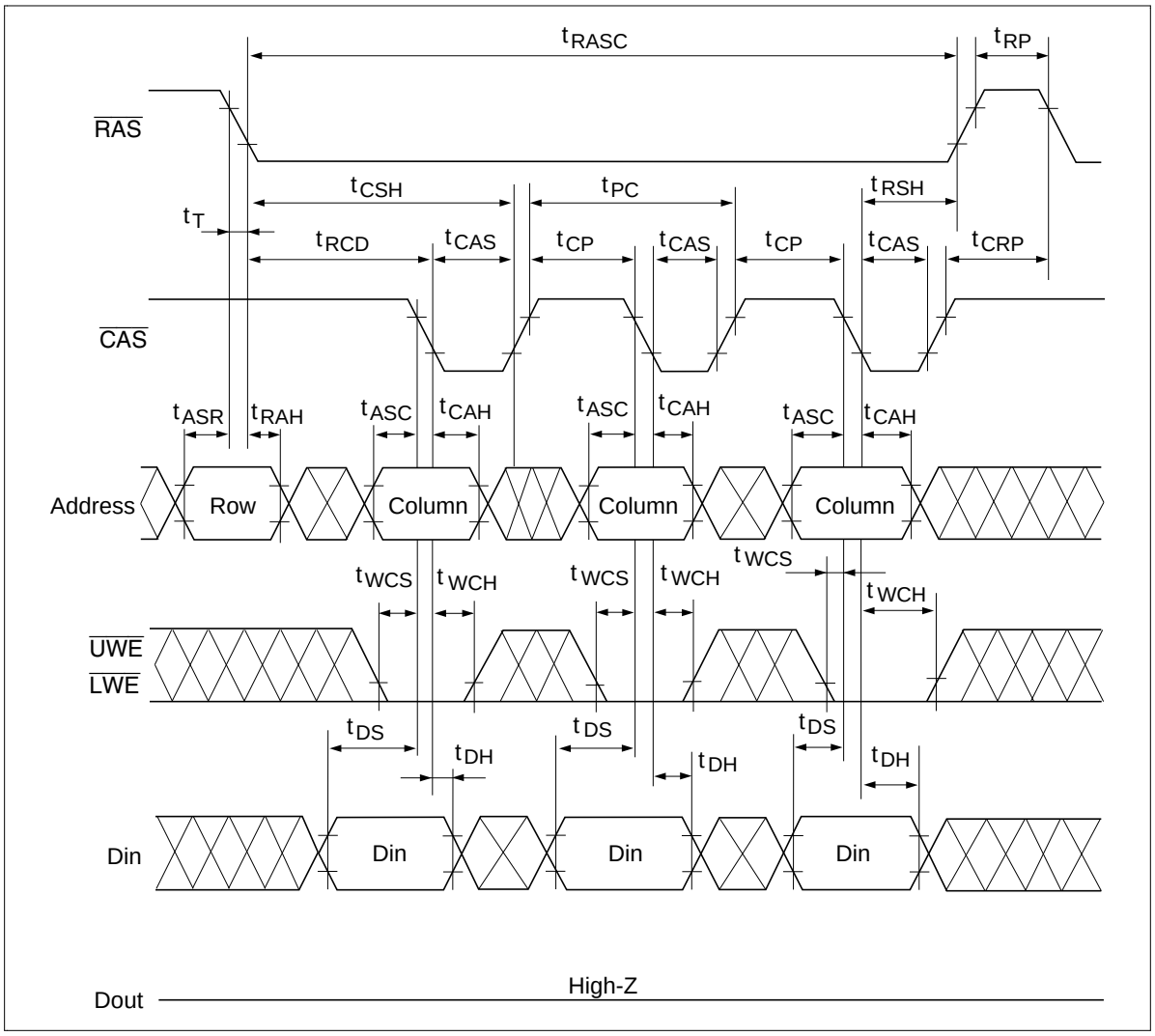
$\overline{\text{CAS}}$-Before-$\overline{\text{RAS}}$ Refresh Cycle



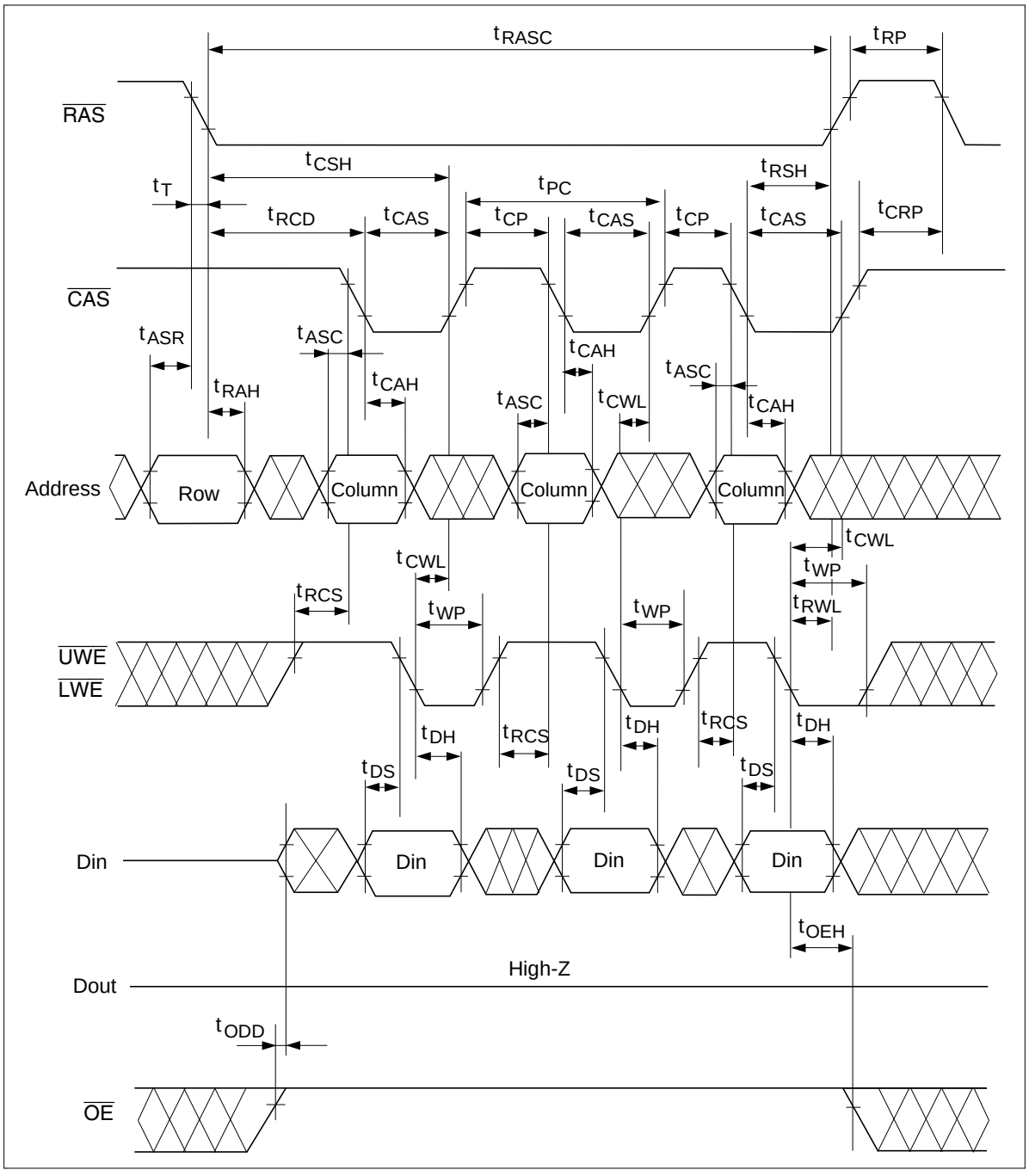
Fast Page Mode Read Cycle



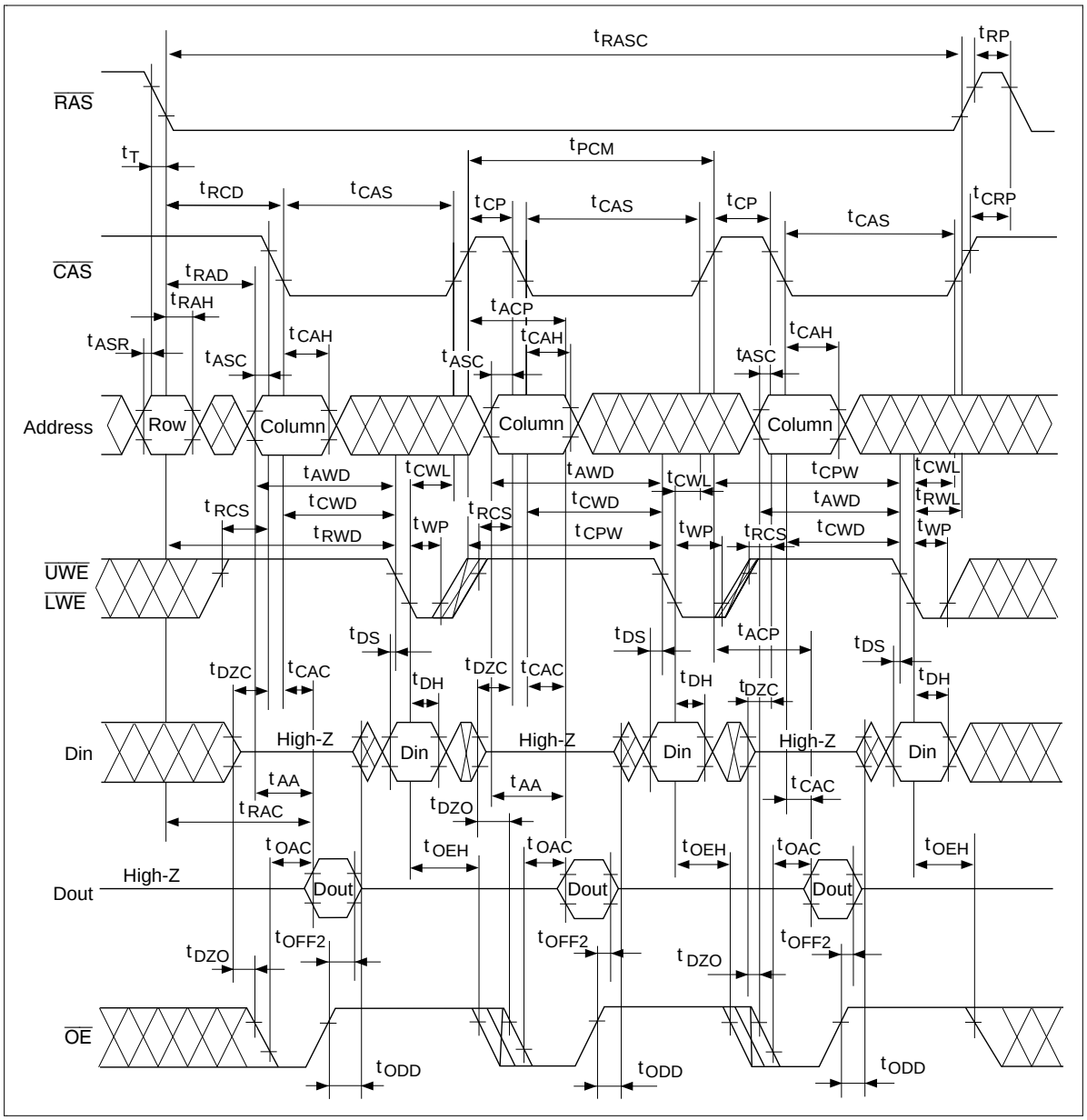
Fast Page Mode Early Write Cycle



Fast Page Mode Delayed Write Cycle



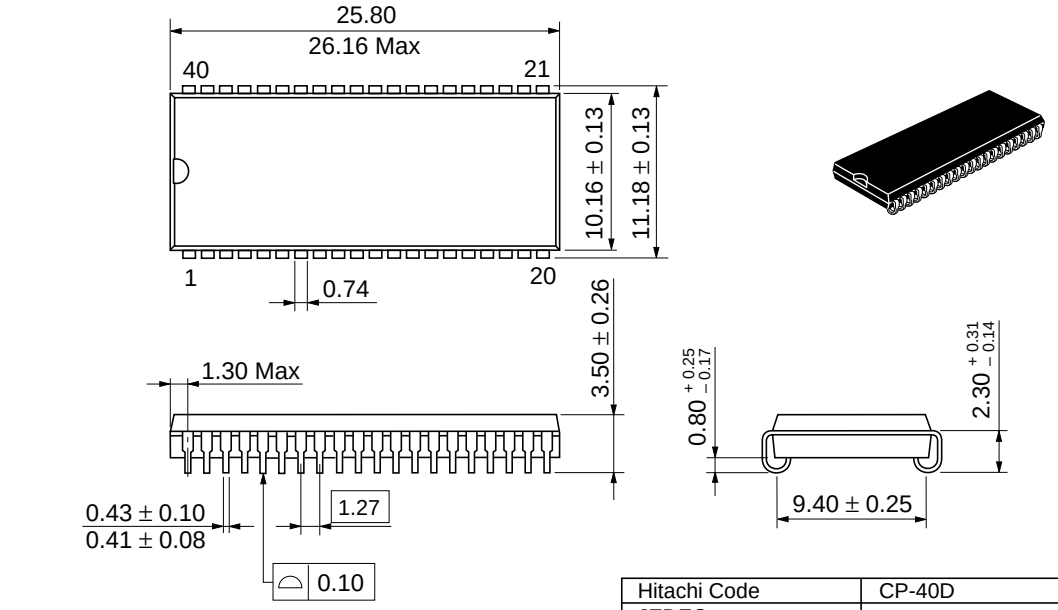
Fast Page Mode Read-Modify-Write Cycle



Package Dimension

HM511664CJ Series (CP-40D)

Unit: mm



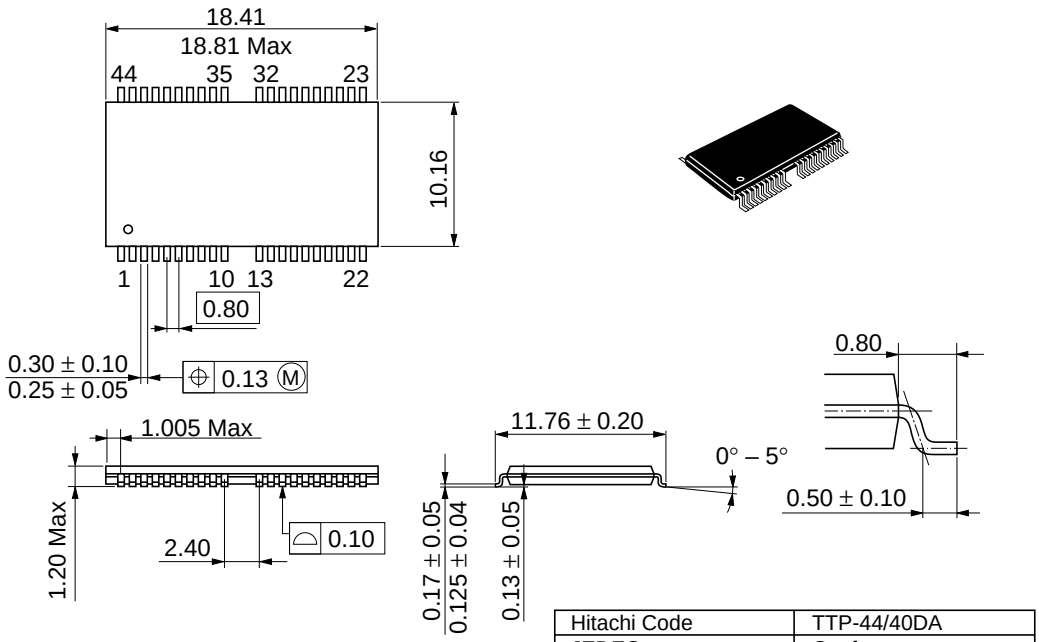
Dimension including the plating thickness
Base material dimension

Hitachi Code	CP-40D
JEDEC	—
EIAJ	Conforms
Weight (reference value)	1.73 g

Package Dimension (cont.)

HM511664CTT Series (TTP-44/40DA)

Unit: mm



Dimension including the plating thickness
Base material dimension

Hitachi Code	TTP-44/40DA
JEDEC	Conforms
EIAJ	—
Weight (reference value)	0.43 g

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Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
0.0	Sep. 10, 1996	Initial issue	I. Ogiwara	S. Suzuki
0.1	Dec. 20, 1996	Correct errors of AC Characteristics t_T (min): 2/2/2 ns to 3/3/3 ns Deletion of note 23	T. Oono	S. Suzuki
1.0	Dec. 20, 1997	Change of Subtitle		