
HM5164405A Series

HM5165405A Series

16777216-word $\times$ 4-bit Dynamic Random Access Memory

HITACHI

ADE-203-459 (Z)
Preliminary
Rev. 0.3
Jan. 22, 1997

Description

The Hitachi HM5164405A Series, HM5165405A Series are CMOS dynamic RAMs organized 16,777,216-word $\times$ 4-bit. They employ the most advanced CMOS technology for high performance and low power. The HM5164405A Series, HM5165405A Series offer Extended Data Out (EDO) Page Mode as a high speed access mode. They have the package variations of standard 400-mil 32-pin plastic SOJ and standard 400-mil 32-pin plastic TSOPII.

Features

- Single 3.3 V (± 0.3 V)
- High speed
 - Access time: 50 ns/60 ns/70 ns (max)
- Low power dissipation
 - Active mode : TBD/396 mW/342 mW (max) (HM5164405A Series)
: TBD/576 mW/504 mW (max) (HM5165405A Series)
 - Standby mode : 7.2 mW (max)
: TBD (L-version)
- EDO page mode capability
- Refresh cycle
 - 8192 $\overline{\text{RAS}}$ -only refresh cycles: 64 ms (HM5164405A Series)
4096 CBR/Hidden refresh cycles: 64ms
: 128 ms (L-version)
 - 4096 $\overline{\text{RAS}}$ -only refresh cycles: 64 ms (HM5165405A Series)
4096 CBR/Hidden refresh cycles: 64ms
: 128 ms (L-version)

Preliminary: This document contains information on a new product. Specifications and information contained herein are subject to change without notice.

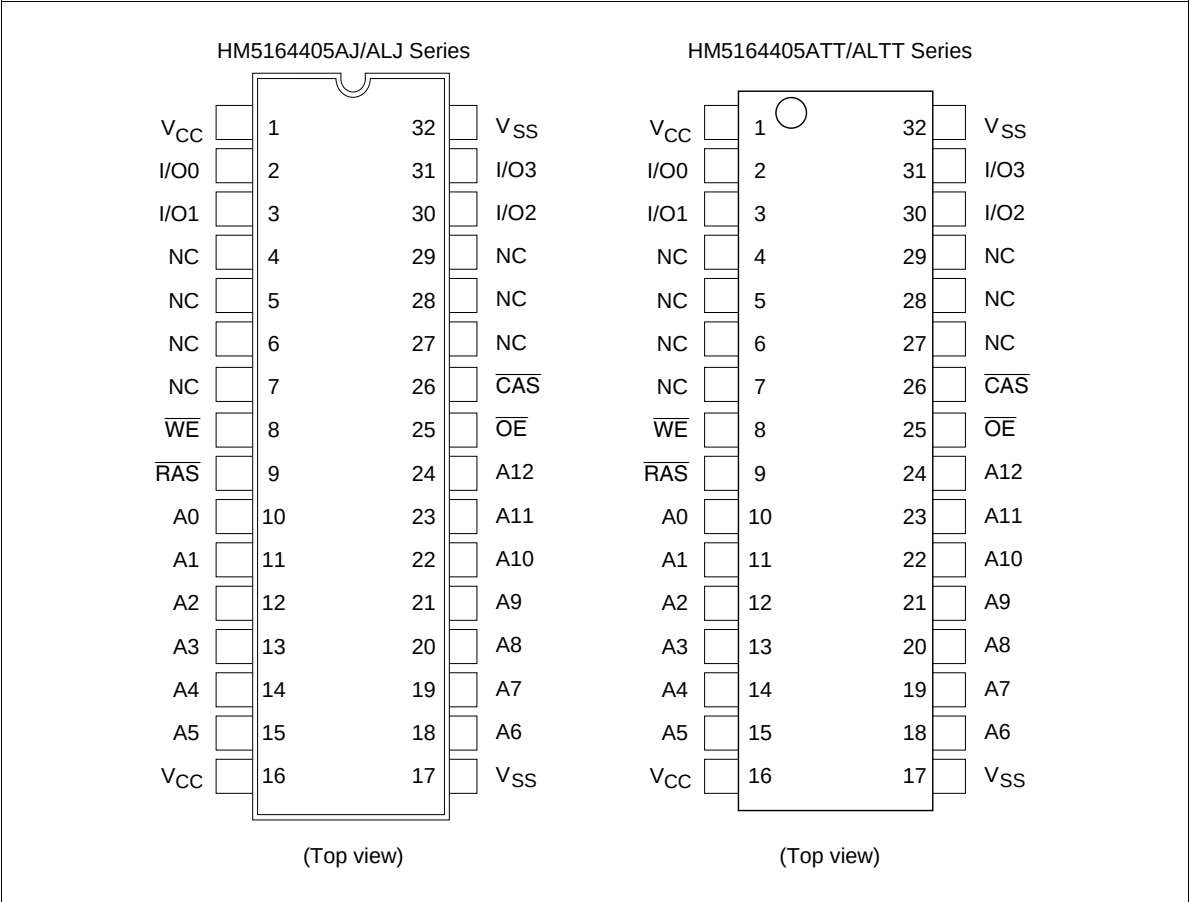
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- 4 variations of refresh
 - $\overline{\text{RAS}}$ -only refresh
 - $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh
 - Hidden refresh
 - Self refresh (L-version)
- Battery backup operation (L-version)

Ordering Information

Type No.	Access time	Package
HM5164405AJ-5	50 ns	400-mil 32-pin plastic SOJ (CP-32DC)
HM5164405AJ-6	60 ns	
HM5164405AJ-7	70 ns	
HM5164405ALJ-5	50 ns	
HM5164405ALJ-6	60 ns	
HM5164405ALJ-7	70 ns	
HM5165405AJ-5	50 ns	
HM5165405AJ-6	60 ns	
HM5165405AJ-7	70 ns	
HM5165405ALJ-5	50 ns	
HM5165405ALJ-6	60 ns	
HM5165405ALJ-7	70 ns	
HM5164405ATT-5	50 ns	400-mil 32-pin plastic TSOP II (TTP-32DC)
HM5164405ATT-6	60 ns	
HM5164405ATT-7	70 ns	
HM5164405ALTT-5	50 ns	
HM5164405ALTT-6	60 ns	
HM5164405ALTT-7	70 ns	
HM5165405ATT-5	50 ns	
HM5165405ATT-6	60 ns	
HM5165405ATT-7	70 ns	
HM5165405ALTT-5	50 ns	
HM5165405ALTT-6	60 ns	
HM5165405ALTT-7	70 ns	

Pin Arrangement

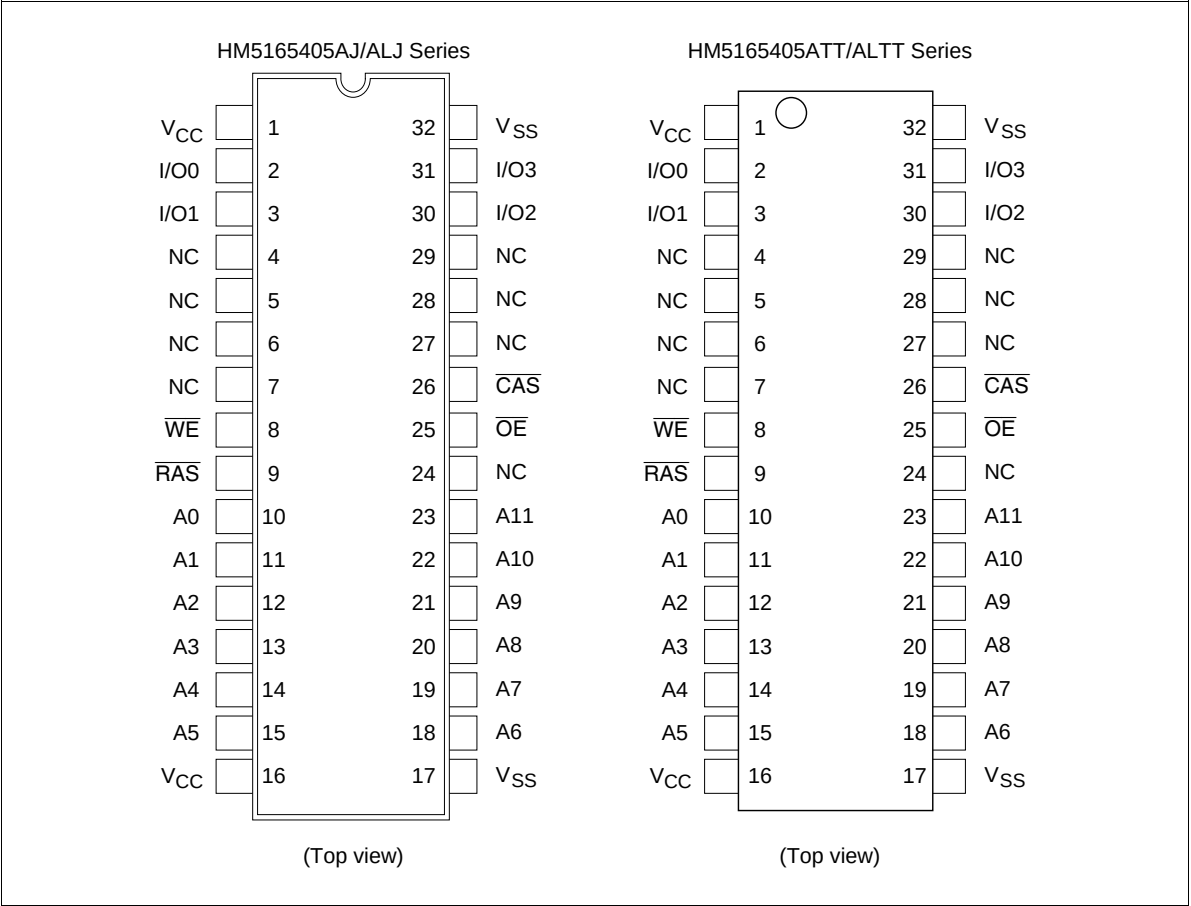


Pin Description

Pin name	Function
A0 to A12	Address input — Row/Refresh address A0 to A12 — Column address A0 to A10
I/O0 to I/O3	Data input/Data output
RAS	Row address strobe
CAS	Column address strobe
WE	Read/Write enable
OE	Output enable
V _{CC}	Power supply
V _{SS}	Ground
NC	No connection

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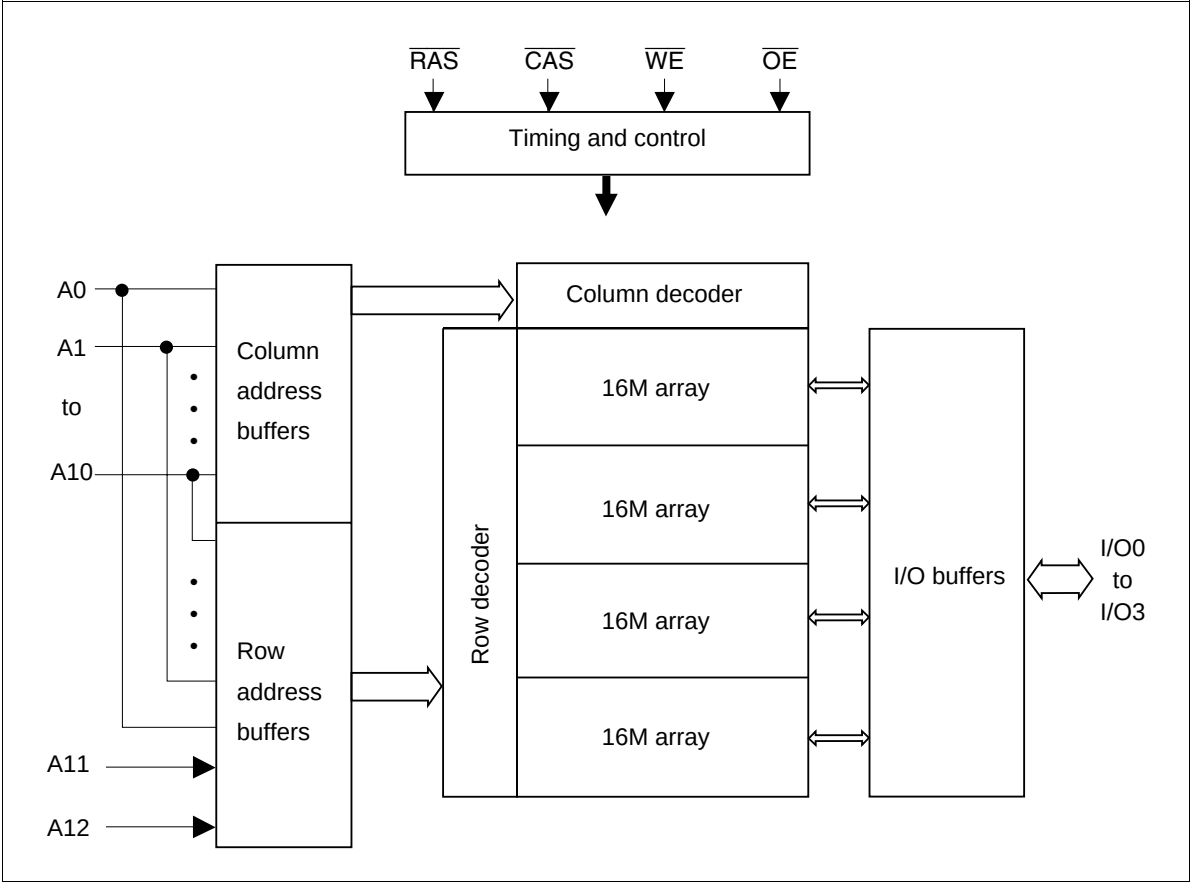
Pin Arrangement



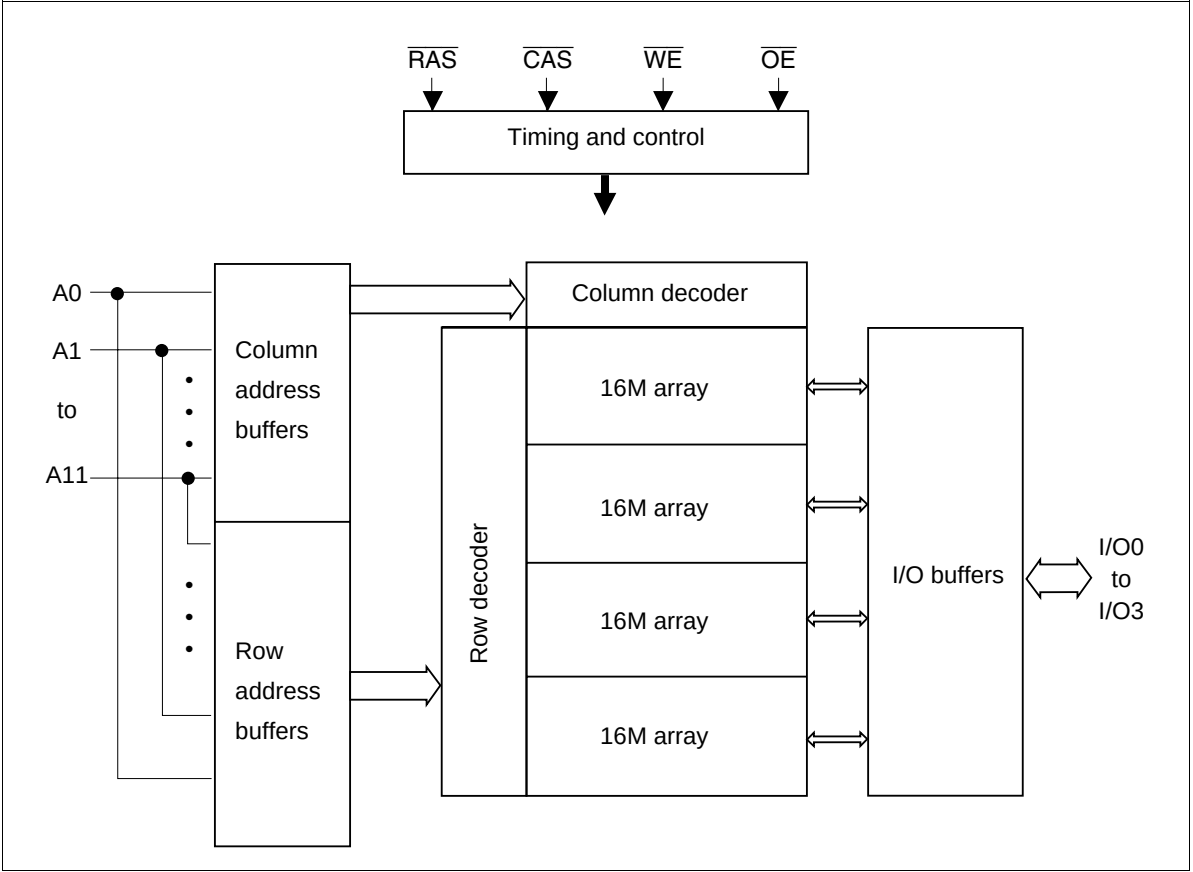
Pin Description

Pin name	Function
A0 to A11	Address input — Row/Refresh address A0 to A11 — Column address A0 to A11
I/O0 to I/O3	Data input/Data output
$\overline{\text{RAS}}$	Row address strobe
$\overline{\text{CAS}}$	Column address strobe
$\overline{\text{WE}}$	Read/Write enable
$\overline{\text{OE}}$	Output enable
V _{CC}	Power supply
V _{SS}	Ground
NC	No connection

Block Diagram (HM5164405A Series)



Block Diagram (HM5165405A Series)



Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Voltage on any pin relative to V_{SS}	V_T	$-0.5 \text{ to } V_{CC} + 0.5 (\leq 4.6 \text{ V (max)})$	V
Supply voltage relative to V_{SS}	V_{CC}	$-0.5 \text{ to } +4.6$	V
Short circuit output current	I_{out}	50	mA
Power dissipation	P_T	1.0	W
Operating temperature	T_{opr}	0 to +70	°C
Storage temperature	T_{stg}	-55 to +125	°C

Recommended DC Operating Conditions ($T_a = 0 \text{ to } +70^\circ\text{C}$)

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply voltage	V_{CC}	3.0	3.3	3.6	V	1, 2
Input high voltage	V_{IH}	2.0	—	$V_{CC} + 0.3$	V	1
Input low voltage	V_{IL}	-0.3	—	0.8	V	1

Note: 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.

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DC Characteristics

(Ta = 0 to +70°C, V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V) (HM5164405A Series)

		HM5164405A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Test conditions
Operating current* ¹ , * ²	I _{CC1}	—	TBD	—	110	—	95	mA	t _{RC} = min
Standby current	I _{CC2}	—	TBD	—	2	—	2	mA	TTL interface RAS, CAS = V _{IH} Dout = High-Z
		—	TBD	—	1	—	1	mA	CMOS interface RAS, CAS ≥ V _{CC} − 0.2 V Dout = High-Z
Standby current (L-version)	I _{CC2}	—	TBD	—	TBD	—	TBD	μA	CMOS interface RAS, CAS ≥ V _{CC} − 0.2 V Dout = High-Z
RAS-only refresh current* ²	I _{CC3}	—	TBD	—	110	—	95	mA	t _{RC} = min
Standby current* ¹	I _{CC5}	—	TBD	—	5	—	5	mA	RAS = V _{IH} , CAS = V _{IL} Dout = enable
CAS-before-RAS refresh current	I _{CC6}	—	TBD	—	140	—	120	mA	t _{RC} = min
EDO page mode current* ¹ , * ³	I _{CC7}	—	TBD	—	105	—	90	mA	t _{HPC} = min
Battery backup current* ⁴ (Standby with CBR refresh) (L-version)	I _{CC10}	—	TBD	—	TBD	—	TBD	μA	CMOS interface Dout = High-Z, CBR refresh: t _{RC} = 31.3 μs t _{RAS} ≤ 0.3 μs
Self refresh mode current (L-version)	I _{CC11}	—	TBD	—	TBD	—	TBD	μA	CMOS interface RAS, CAS ≤ 0.2 V Dout = High-Z
Input leakage current	I _{LI}	TBD	TBD	−10	10	−10	10	μA	0 V ≤ Vin ≤ V _{CC} + 0.3
Output leakage current	I _{LO}	TBD	TBD	−10	10	−10	10	μA	0 V ≤ Vin ≤ V _{CC} Dout = disable
Output high voltage	V _{OH}	TBD	TBD	2.4	V _{CC}	2.4	V _{CC}	V	High Iout = −2 mA
Output low voltage	V _{OL}	TBD	TBD	0	0.4	0	0.4	V	Low Iout = 2 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 once or less while R_{AS} = V_{IL}.
3. Address can be changed once or less within one page mode cycle t_{HPC}.
4. V_{IH} ≥ V_{CC} - 0.2 V, 0 V ≤ V_{IL} ≤ 0.2 V.

DC Characteristics

(Ta = 0 to +70°C, V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V) (HM5165405A Series)

		HM5165405A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Test conditions
Operating current* ¹ , * ²	I _{CC1}	—	TBD	—	160	—	140	mA	t _{RC} = min
Standby current	I _{CC2}	—	TBD	—	2	—	2	mA	TTL interface RAS, CAS = V _{IH} Dout = High-Z
		—	TBD	—	1	—	1	mA	CMOS interface RAS, CAS ≥ V _{CC} − 0.2 V Dout = High-Z
Standby current (L-version)	I _{CC2}	—	TBD	—	TBD	—	TBD	μA	CMOS interface RAS, CAS ≥ V _{CC} − 0.2 V Dout = High-Z
RAS-only refresh current* ²	I _{CC3}	—	TBD	—	160	—	140	mA	t _{RC} = min
Standby current* ¹	I _{CC5}	—	TBD	—	5	—	5	mA	RAS = V _{IH} , CAS = V _{IL} Dout = enable
CAS-before-RAS refresh current	I _{CC6}	—	TBD	—	140	—	120	mA	t _{RC} = min
EDO page mode current* ¹ , * ³	I _{CC7}	—	TBD	—	120	—	105	mA	t _{HPC} = min
Battery backup current* ⁴ (Standby with CBR refresh) (L-version)	I _{CC10}	—	TBD	—	TBD	—	TBD	μA	CMOS interface Dout = High-Z, CBR refresh: t _{RC} = 31.3 μs t _{RAS} ≤ 0.3 μs
Self refresh mode current (L-version)	I _{CC11}	—	TBD	—	TBD	—	TBD	μA	CMOS interface RAS, CAS ≤ 0.2 V Dout = High-Z
Input leakage current	I _{LI}	TBD	TBD	−10	10	−10	10	μA	0 V ≤ Vin ≤ V _{CC} + 0.3 V
Output leakage current	I _{LO}	TBD	TBD	−10	10	−10	10	μA	0 V ≤ Vin ≤ V _{CC} Dout = disable
Output high voltage	V _{OH}	TBD	TBD	2.4	V _{CC}	2.4	V _{CC}	V	High Iout = −2 mA
Output low voltage	V _{OL}	TBD	TBD	0	0.4	0	0.4	V	Low Iout = 2 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 once or less while RAS = V_{IL}.

3. Address can be changed once or less within one page mode cycle t_{HPC}.

4. V_{IH} ≥ V_{CC} − 0.2 V, 0 V ≤ V_{IL} ≤ 0.2 V.

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Capacitance (Ta = 25°C, V_{CC} = 3.3 V ± 0.3 V)

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}	—	7	pF	1, 2

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

AC Characteristics ($T_a = 0$ to $+70^\circ\text{C}$, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$, $V_{SS} = 0\text{ V}$) *¹, *², *³, *¹⁸

Test Conditions

- Input rise and fall time: 2 ns
- Input levels: $V_{IL} = 0\text{ V}$, $V_{IH} = 3\text{ V}$
- Input timing reference levels: 0.8 V, 2.0 V
- Output timing reference levels: 0.8 V, 2.0 V
- Output load: 1 TTL gate + C_L (100 pF) (Including scope and jig)

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

		HM5164405A/HM5165405A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Random read or write cycle time	t _{RC}	TBD	—	104	—	124	—	ns	
RAS precharge time	t _{RP}	TBD	—	40	—	50	—	ns	
CAS precharge time	t _{CP}	TBD	—	10	—	13	—	ns	
RAS pulse width	t _{RAS}	TBD	TBD	60	10000	70	10000	ns	
CAS pulse width	t _{CAS}	TBD	TBD	10	10000	13	10000	ns	
Row address setup time	t _{ASR}	TBD	—	0	—	0	—	ns	
Row address hold time	t _{RAH}	TBD	—	10	—	10	—	ns	
Column address setup time	t _{ASC}	TBD	—	0	—	0	—	ns	
Column address hold time	t _{CAH}	TBD	—	10	—	13	—	ns	
RAS to CAS delay time	t _{RCD}	TBD	TBD	20	45	20	52	ns	3
RAS to column address delay time	t _{RAD}	TBD	TBD	15	30	15	35	ns	4
RAS hold time	t _{RSH}	TBD	—	15	—	18	—	ns	
CAS hold time	t _{CSH}	TBD	—	48	—	58	—	ns	20
CAS to RAS precharge time	t _{CRP}	TBD	—	5	—	5	—	ns	
OE to Din delay time	t _{OED}	TBD	—	15	—	18	—	ns	5
OE delay time from Din	t _{DZO}	TBD	—	0	—	0	—	ns	6
CAS delay time from Din	t _{DZC}	TBD	—	0	—	0	—	ns	6
Transition time (rise and fall)	t _T	TBD	TBD	2	50	2	50	ns	7

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Read Cycle

		HM5164405A/HM5165405A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Access time from $\overline{\text{RAS}}$	t_{RAC}	—	TBD	—	60	—	70	ns	8, 9
Access time from $\overline{\text{CAS}}$	t_{CAC}	—	TBD	—	15	—	18	ns	9, 10, 16
Access time from address	t_{AA}	—	TBD	—	30	—	35	ns	9, 11, 16
Access time from $\overline{\text{OE}}$	t_{OEA}	—	TBD	—	15	—	18	ns	9
Read command setup time	t_{RCS}	TBD	—	0	—	0	—	ns	
Read command hold time to $\overline{\text{CAS}}$	t_{RCH}	TBD	—	0	—	0	—	ns	12
Read command hold time from $\overline{\text{RAS}}$	t_{RCHR}	TBD	—	60	—	70	—	ns	
Read command hold time to $\overline{\text{RAS}}$	t_{RRH}	TBD	—	0	—	0	—	ns	12
Column address to $\overline{\text{RAS}}$ lead time	t_{RAL}	TBD	—	30	—	35	—	ns	
Column address to $\overline{\text{CAS}}$ lead time	t_{CAL}	TBD	—	18	—	23	—	ns	
$\overline{\text{CAS}}$ to output in low-Z	t_{CLZ}	TBD	—	0	—	0	—	ns	
Output data hold time	t_{OH}	TBD	—	3	—	3	—	ns	
Output data hold time from $\overline{\text{OE}}$	t_{OHO}	TBD	—	3	—	3	—	ns	
Output buffer turn-off time	t_{OFF}	—	TBD	—	15	—	15	ns	13, 19
Output buffer turn-off to $\overline{\text{OE}}$	t_{OEZ}	—	TBD	—	15	—	15	ns	13
$\overline{\text{CAS}}$ to Din delay time	t_{CDD}	TBD	—	15	—	18	—	ns	5
Output data hold time from $\overline{\text{RAS}}$	t_{OHR}	TBD	—	3	—	3	—	ns	
Output buffer turn-off to $\overline{\text{RAS}}$	t_{OFR}	—	TBD	—	15	—	15	ns	19
Output buffer turn-off to $\overline{\text{WE}}$	t_{WEZ}	—	TBD	—	15	—	15	ns	
$\overline{\text{WE}}$ to Din delay time	t_{WED}	TBD	—	15	—	18	—	ns	
$\overline{\text{RAS}}$ to Din delay time	t_{RDD}	TBD	—	15	—	18	—	ns	

Write Cycle

		HM5164405A/HM5165405A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Write command setup time	t _{WCS}	TBD	—	0	—	0	—	ns	14
Write command hold time	t _{WCH}	TBD	—	10	—	13	—	ns	
Write command pulse width	t _{WP}	TBD	—	10	—	10	—	ns	
Write command to $\overline{RAS}$ lead time	t _{RWL}	TBD	—	10	—	13	—	ns	
Write command to $\overline{CAS}$ lead time	t _{CWL}	TBD	—	10	—	13	—	ns	
Data-in setup time	t _{DS}	TBD	—	0	—	0	—	ns	
Data-in hold time	t _{DH}	TBD	—	10	—	13	—	ns	

Read-Modify-Write Cycle

		HM5164405A/HM5165405A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Read-modify-write cycle time	t _{RWC}	TBD	—	149	—	175	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ delay time	t _{RWD}	TBD	—	78	—	91	—	ns	14
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ delay time	t _{CWD}	TBD	—	33	—	39	—	ns	14
Column address to $\overline{\text{WE}}$ delay time	t _{AWD}	TBD	—	48	—	56	—	ns	14
$\overline{\text{OE}}$ hold time from $\overline{\text{WE}}$	t _{OEH}	TBD	—	15	—	18	—	ns	

Refresh Cycle

		HM5164405A/HM5165405A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
CAS setup time (CBR refresh cycle)	t _{CSR}	TBD	—	5	—	5	—	ns	
CAS hold time (CBR refresh cycle)	t _{CHR}	TBD	—	10	—	10	—	ns	
WE setup time (CBR refresh cycle)	t _{WRP}	TBD	—	0	—	0	—	ns	
WE hold time (CBR refresh cycle)	t _{WRH}	TBD	—	10	—	10	—	ns	
RAS precharge to CAS hold time	t _{RPC}	TBD	—	0	—	0	—	ns	

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EDO Page Mode Cycle

		HM5164405A/HM5165405A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
EDO page mode cycle time	t _{HPC}	TBD	—	25	—	30	—	ns	18
EDO page mode $\overline{\text{RAS}}$ pulse width	t _{RASP}	—	TBD	—	100000	—	100000	ns	15
Access time from $\overline{\text{CAS}}$ precharge	t _{CPA}	—	TBD	—	35	—	40	ns	9, 16
$\overline{\text{RAS}}$ hold time from $\overline{\text{CAS}}$ precharge	t _{CPRH}	TBD	—	35	—	40	—	ns	
Output data hold time from $\overline{\text{CAS}}$ low	t _{DOH}	TBD	—	3	—	3	—	ns	9, 16
$\overline{\text{CAS}}$ hold time referred $\overline{\text{OE}}$	t _{COL}	TBD	—	10	—	13	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{OE}}$ setup time	t _{COP}	TBD	—	10	—	10	—	ns	
Read command hold time from $\overline{\text{CAS}}$ precharge	t _{RCHC}	TBD	—	35	—	40	—	ns	
Write pulse width during $\overline{\text{CAS}}$ precharge	t _{WPE}	TBD	—	10	—	10	—	ns	
$\overline{\text{OE}}$ precharge time	t _{OEP}	TBD	—	10	—	10	—	ns	

EDO Page Mode Read-Modify-Write Cycle

		HM5164405A/HM5165405A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
EDO page mode read- modify-write cycle time	t _{HPRWC}	TBD	—	68	—	79	—	ns	
$\overline{\text{WE}}$ delay time from $\overline{\text{CAS}}$ precharge	t _{CPW}	TBD	—	54	—	62	—	ns	14

Refresh (HM5164405A Series)

Parameter	Symbol	Max	Unit	Notes
Refresh period	t _{REF}	64	ms	8192 cycles
Refresh period (L-version)	t _{REF}	128	ms	4096 cycles

Refresh (HM5165405A Series)

Parameter	Symbol	Max	Unit	Notes
Refresh period	t _{REF}	64	ms	4096 cycles
Refresh period (L-version)	t _{REF}	128	ms	4096 cycles

Self Refresh Mode (L-version)

		HM5164405AL/HM5165405AL							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
$\overline{\text{RAS}}$ pulse width (self refresh)	t_{RASS}	TBD	—	100	—	100	—	μs	
$\overline{\text{RAS}}$ precharge time (self refresh)	t_{RPS}	TBD	—	110	—	130	—	ns	
$\overline{\text{CAS}}$ hold time (self refresh)	t_{CHS}	TBD	—	−50	—	−50	—	ns	

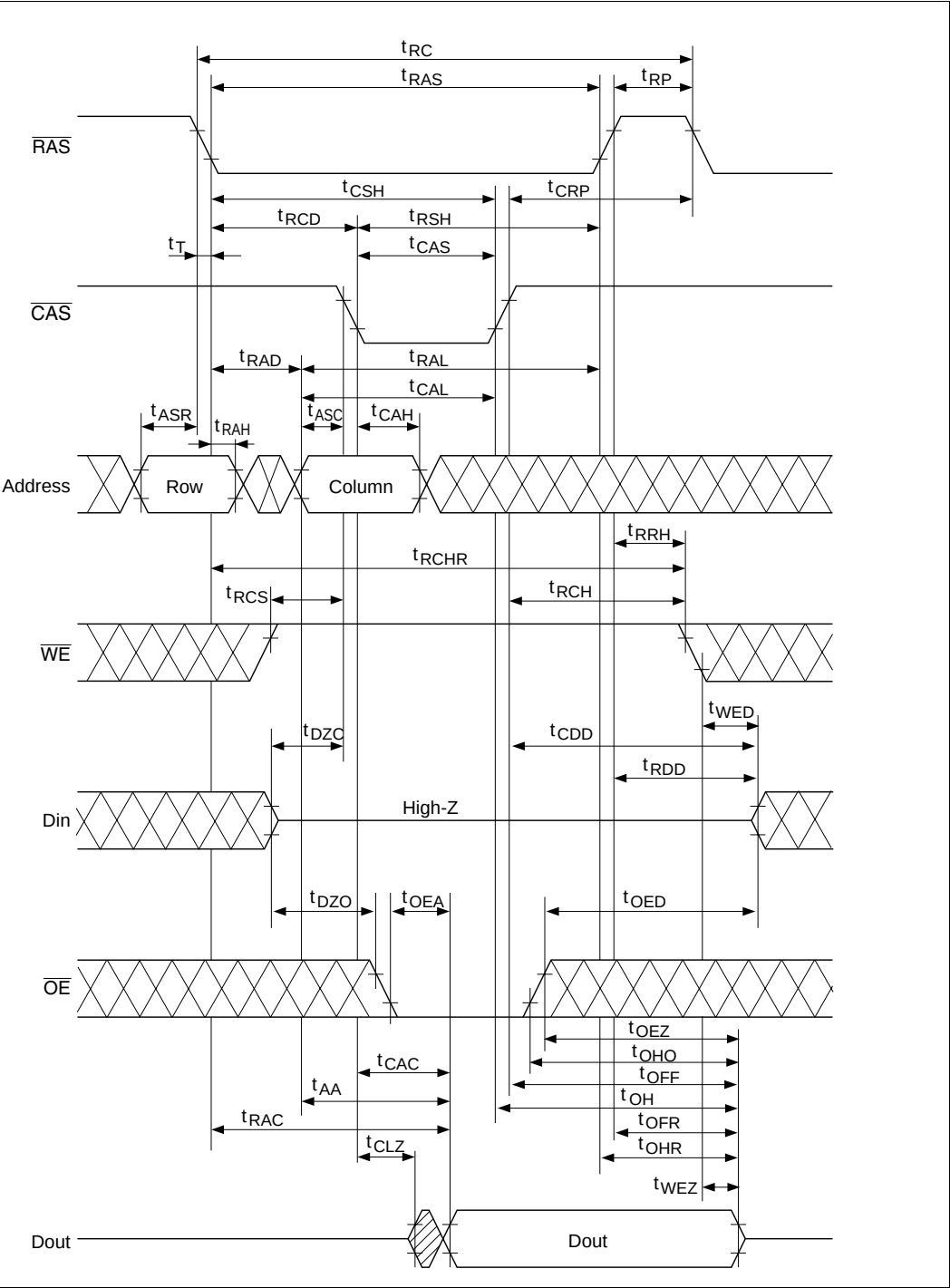
Notes: 1. AC measurements assume $t_t = 2 \text{ ns}$.

- An initial pause of $200 \mu\text{s}$ is required after power up followed by a minimum of eight initialization cycles (any combination of cycles containing $\overline{\text{RAS}}$ -only refresh or $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh).
- 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} .
- 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} .
- Either t_{OED} or t_{CDD} must be satisfied.
- Either t_{DZO} or t_{DZC} must be satisfied.
- 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).
- Assumes that $t_{\text{RCD}} \leq t_{\text{RCD}}$ (max) and $t_{\text{RAD}} \leq t_{\text{RAD}}$ (max). If t_{RCD} or t_{RAD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
- Measured with a load circuit equivalent to 1 TTL loads and 100 pF .
- Assumes that $t_{\text{RCD}} \geq t_{\text{RCD}}$ (max) and $t_{\text{RCD}} + t_{\text{CAC}}$ (max) $\geq t_{\text{RAD}} + t_{\text{AA}}$ (max).
- Assumes that $t_{\text{RAD}} \geq t_{\text{RAD}}$ (max) and $t_{\text{RCD}} + t_{\text{CAC}}$ (max) $\leq t_{\text{RAD}} + t_{\text{AA}}$ (max).
- Either t_{RCH} or t_{RRH} must be satisfied for a read cycles.
- t_{OFF} (max), t_{OEZ} (max), t_{WEZ} (max) and t_{OFR} (max) define the time at which the outputs achieve the open circuit condition and are not referred to output voltage levels.
- t_{WCS} , t_{RWD} , t_{CWD} , t_{AWD} and t_{CPW} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only; if $t_{\text{WCS}} \geq t_{\text{WCS}}$ (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{\text{RWD}} \geq t_{\text{RWD}}$ (min), $t_{\text{CWD}} \geq t_{\text{CWD}}$ (min), and $t_{\text{AWD}} \geq t_{\text{AWD}}$ (min), or $t_{\text{CWD}} \geq t_{\text{CWD}}$ (min), $t_{\text{AWD}} \geq t_{\text{AWD}}$ (min) and $t_{\text{CPW}} \geq t_{\text{CPW}}$ (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.
- t_{RASP} defines $\overline{\text{RAS}}$ pulse width in EDO page mode cycles.
- Access time is determined by the longest among t_{AA} , t_{CAC} and t_{CPA} .
- All the V_{CC} and V_{SS} pins shall be supplied with the same voltages.
- In delayed write or read-modify-write cycles, $\overline{\text{OE}}$ must disable output buffer prior to applying data to the device.
- t_{HPC} (min) can be achieved during a series of EDO page mode write cycles or EDO page mode read cycles. If both write and read operation are mixed in a EDO page mode $\overline{\text{RAS}}$ cycle (EDO page mode mix cycle (1), (2)), minimum value of $\overline{\text{CAS}}$ cycle ($t_{\text{CAS}} + t_{\text{CP}} + 2 t_t$) becomes greater than the specified t_{HPC} (min) value. The value of $\overline{\text{CAS}}$ cycle time of mixed EDO page mode is shown in EDO page mode mix cycle (1) and (2).

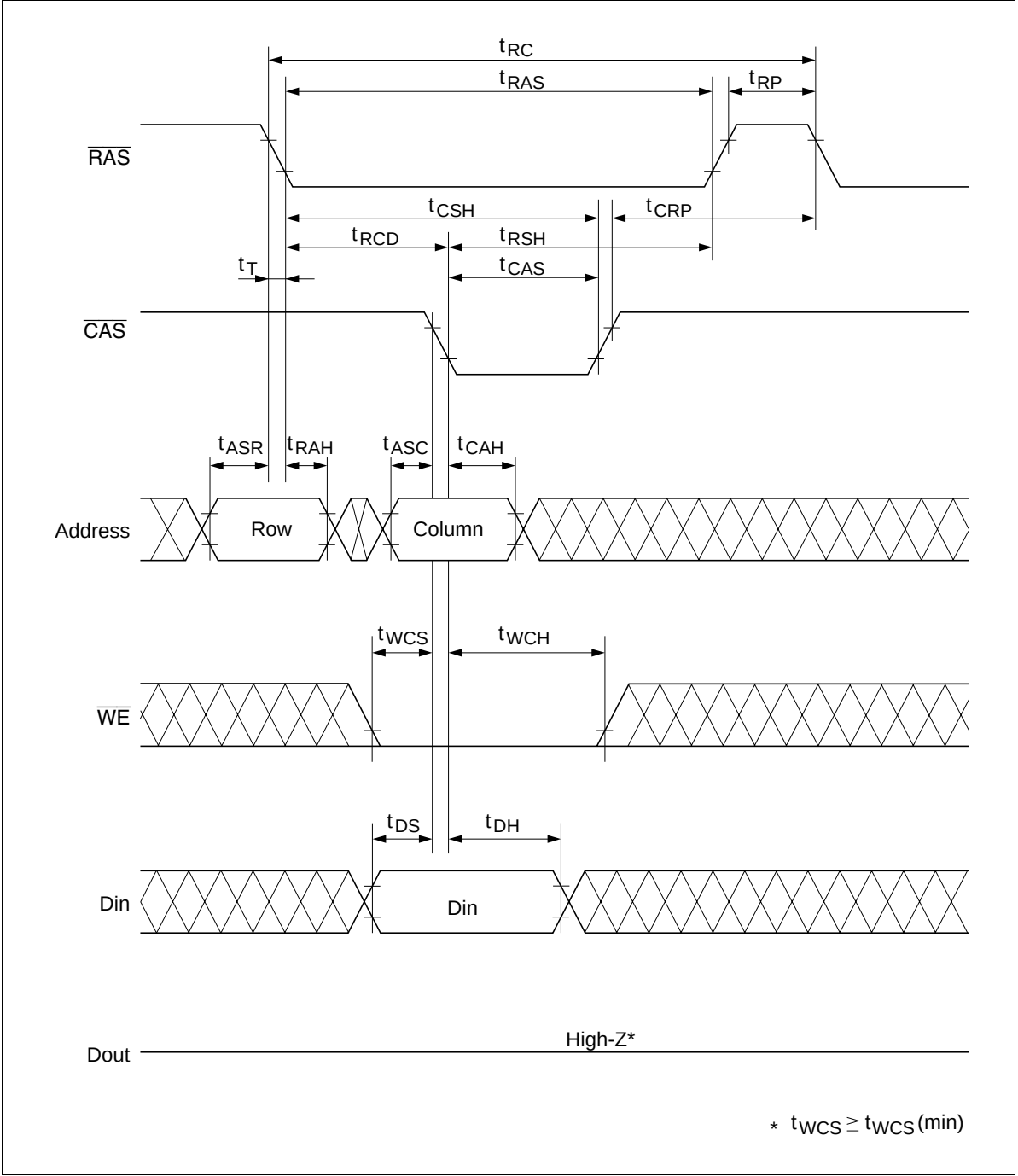
20. Data output turns off and becomes high impedance from later rising edge of $\overline{\text{RAS}}$ and $\overline{\text{CAS}}$.
Hold time and turn off time are specified by the timing specifications of later rising edge of $\overline{\text{RAS}}$ and $\overline{\text{CAS}}$ between t_{OHR} and t_{OH} and between t_{OFR} and t_{OFF} .
21. t_{CSH} (min) can be achieved when $t_{\text{RCD}} \leq t_{\text{CSH}}$ (min) - t_{CAS} (min).
22. Please do not use t_{RASS} timing, $10 \mu\text{s} \leq t_{\text{RASS}} \leq 100 \mu\text{s}$. During this period, the device is in transition state from normal operation mode to self refresh mode. If $t_{\text{RASS}} > 100 \mu\text{s}$, then $\overline{\text{RAS}}$ precharge time should use t_{RPS} instead of t_{RP} .
23. CBR burst refresh or 4096 cycles of distributed CBR refresh with $15.6 \mu\text{s}$ interval should be executed within 64 ms immediately after exiting from and before entering into the self refresh mode.
24. Repetitive self refresh mode without refreshing all memory is not allowed. Once you exit from self refresh mode, all memory cells need to be refreshed before re-entering the self refresh mode again.
25. XXX: H or L (H: V_{IH} (min) $\leq V_{\text{IN}} \leq V_{\text{IH}}$ (max), L: V_{IL} (min) $\leq V_{\text{IN}} \leq V_{\text{IL}}$ (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} .

Timing Waveforms*25

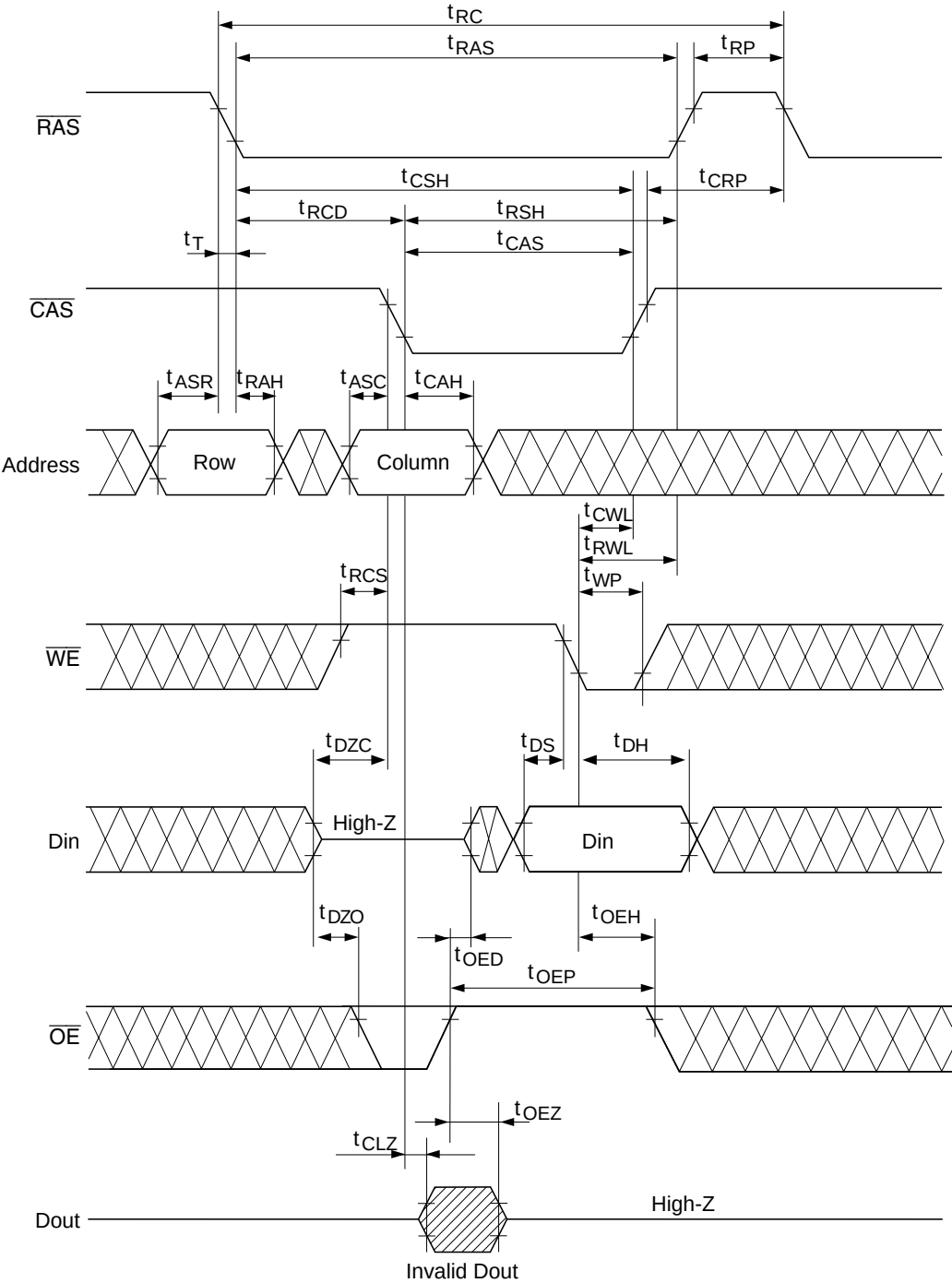
Read Cycle

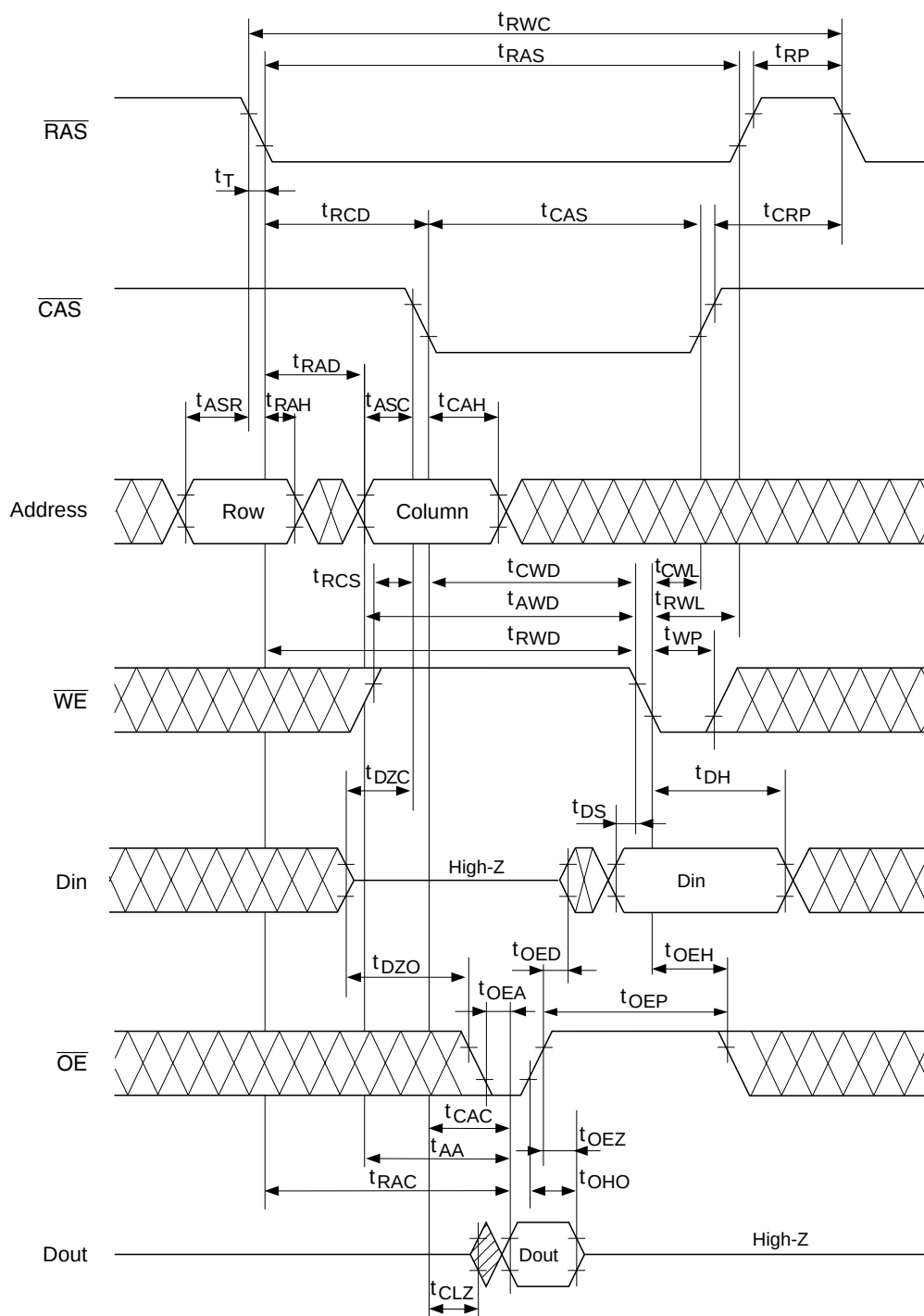


Early Write Cycle

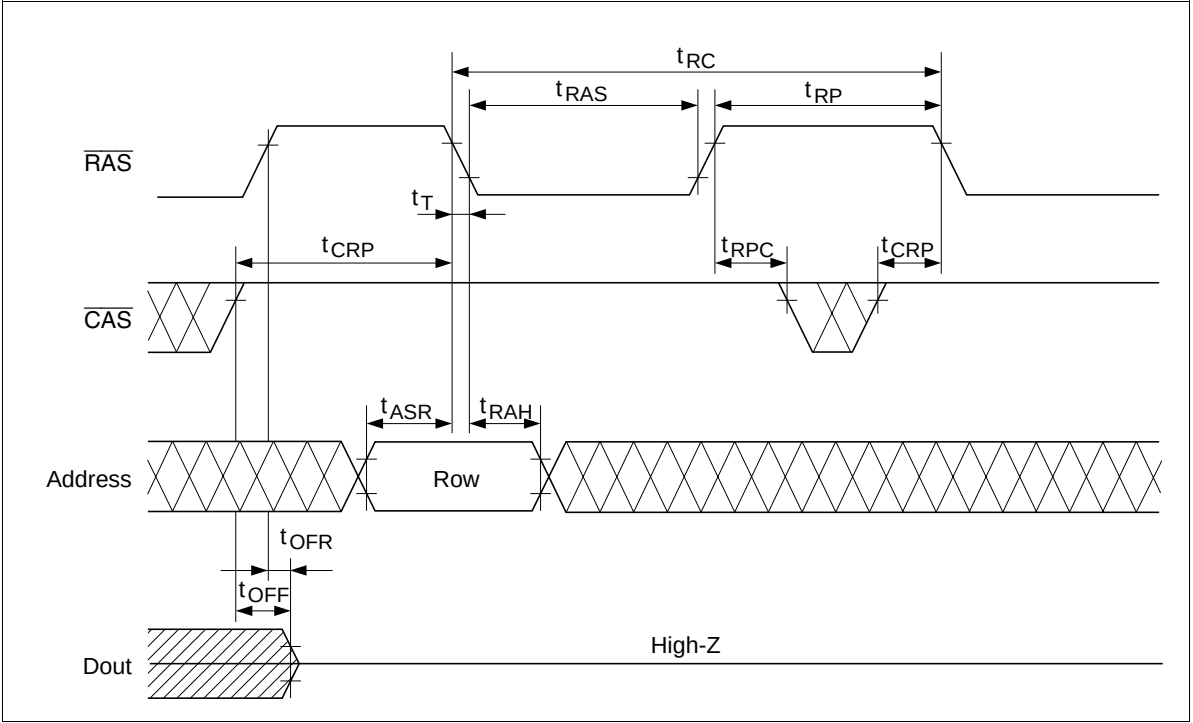


Delayed Write Cycle*18

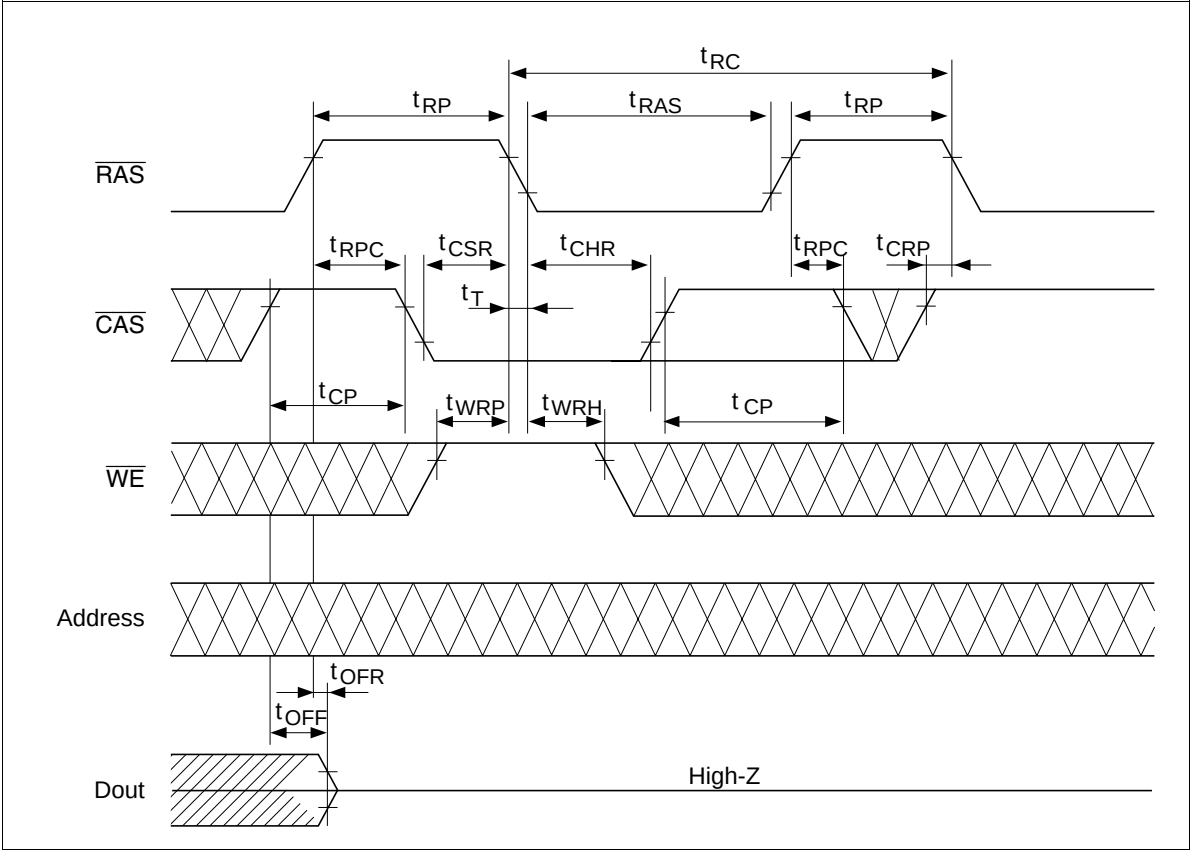




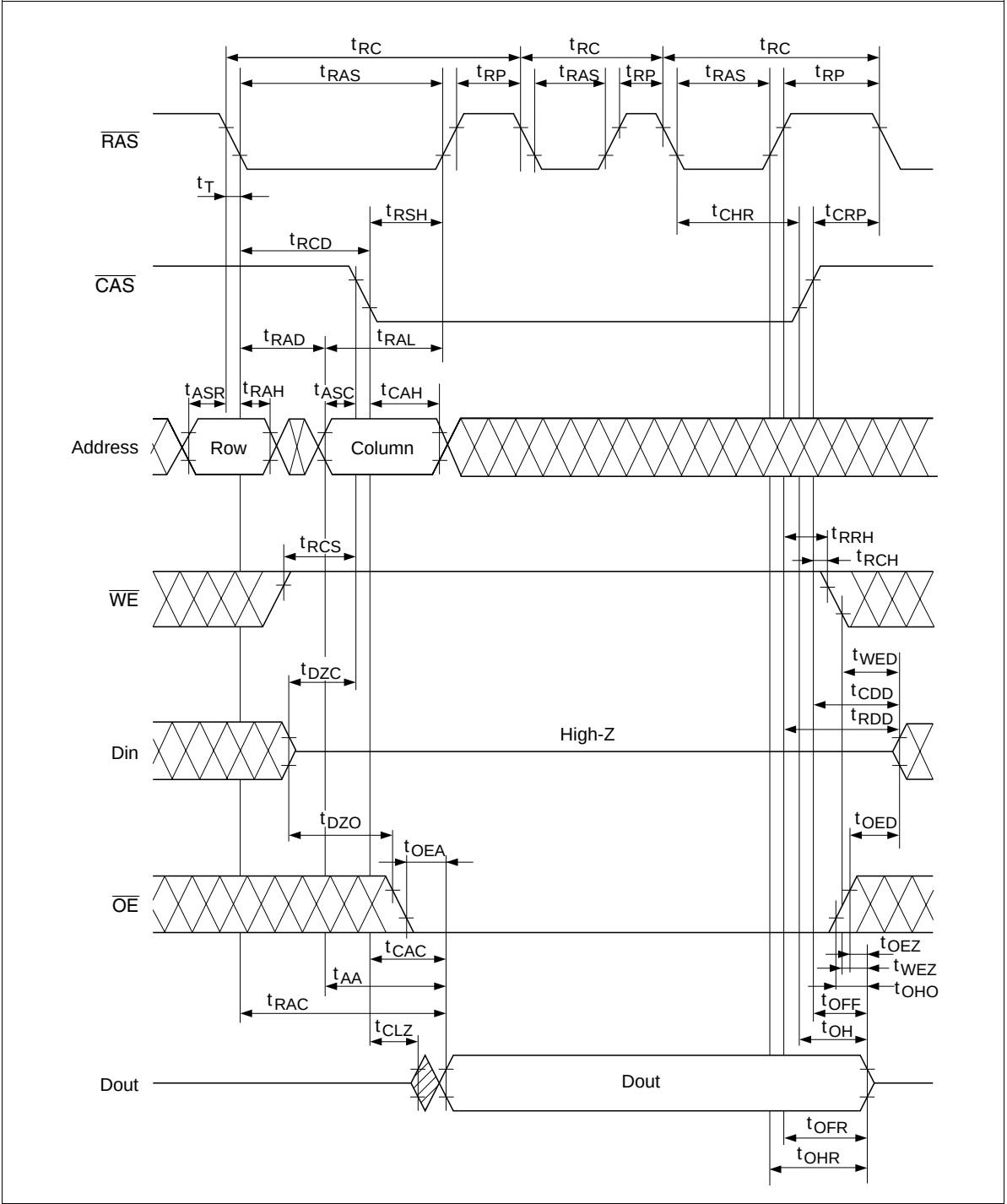
RAS-Only Refresh Cycle

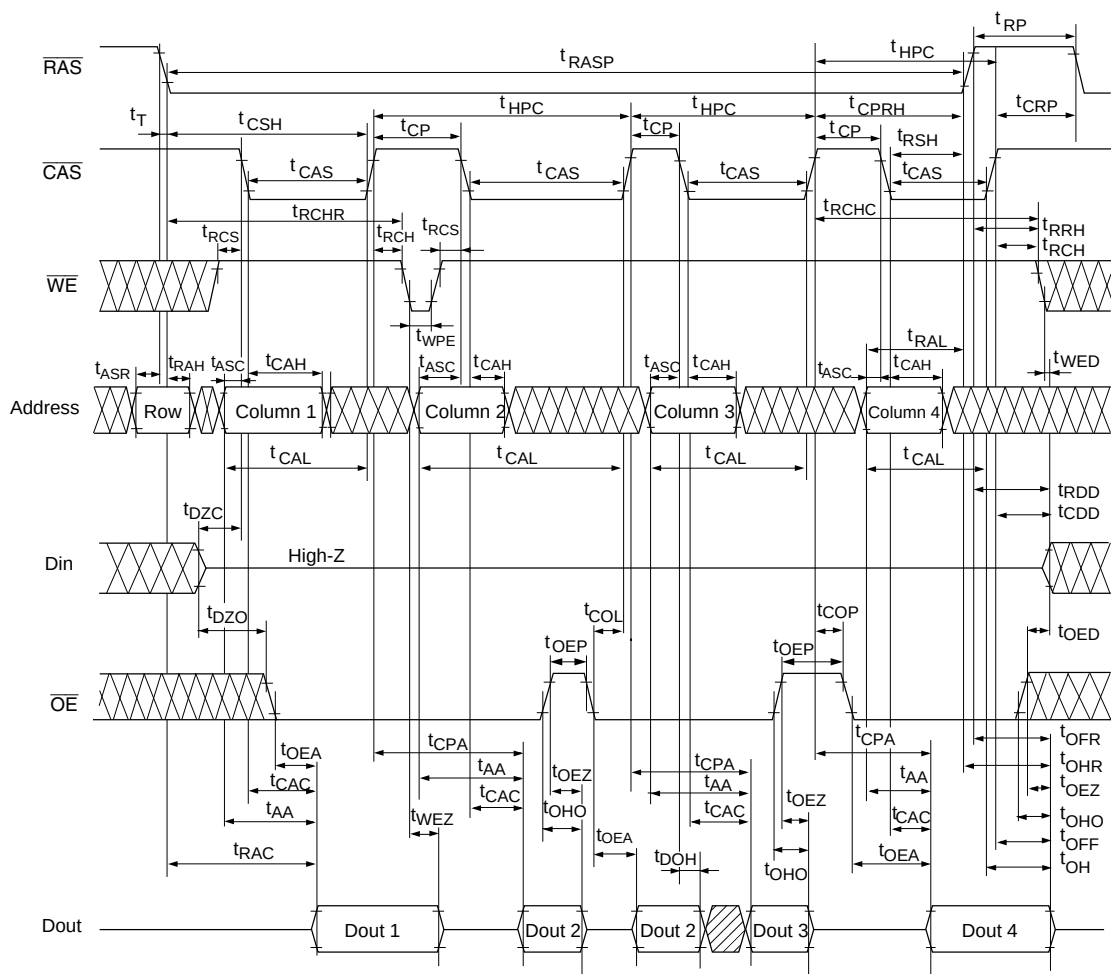


CAS-Before-RAS Refresh Cycle

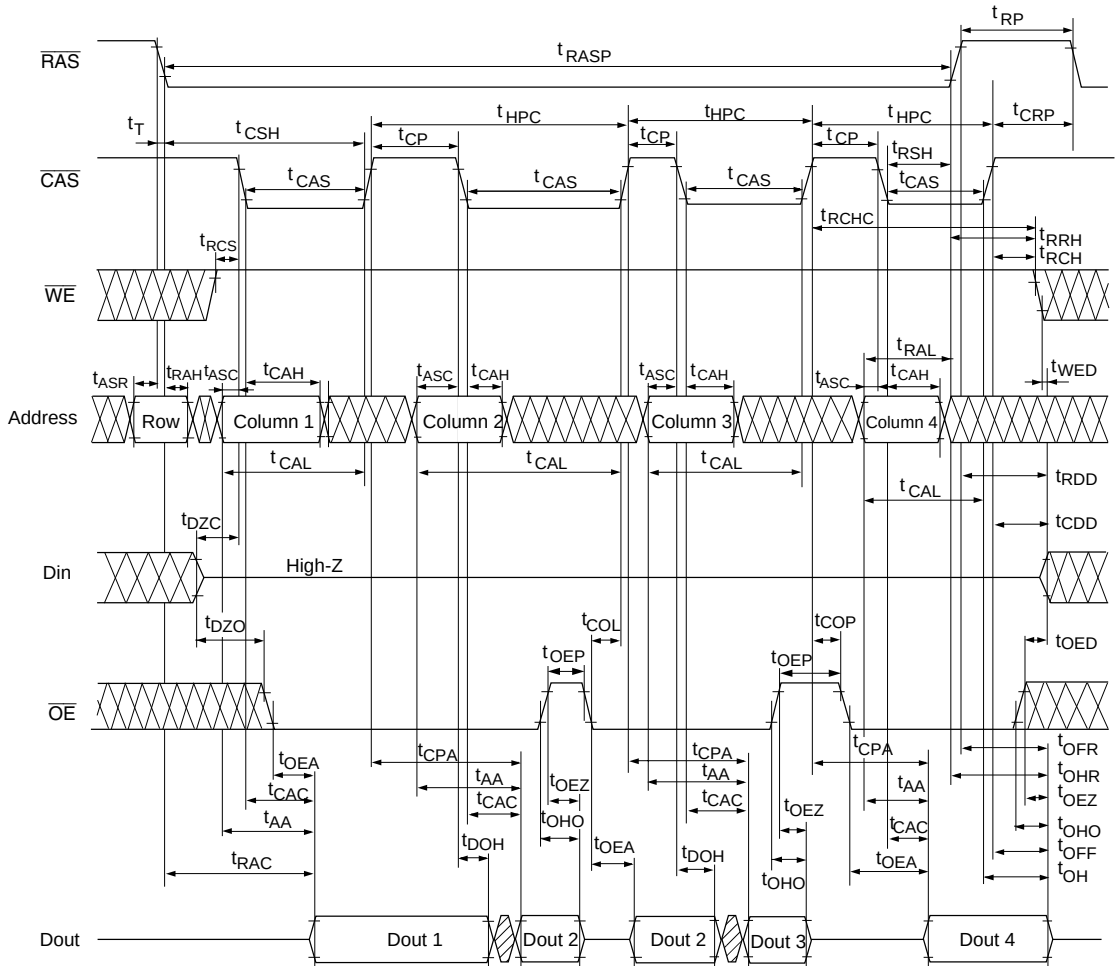


Hidden Refresh Cycle

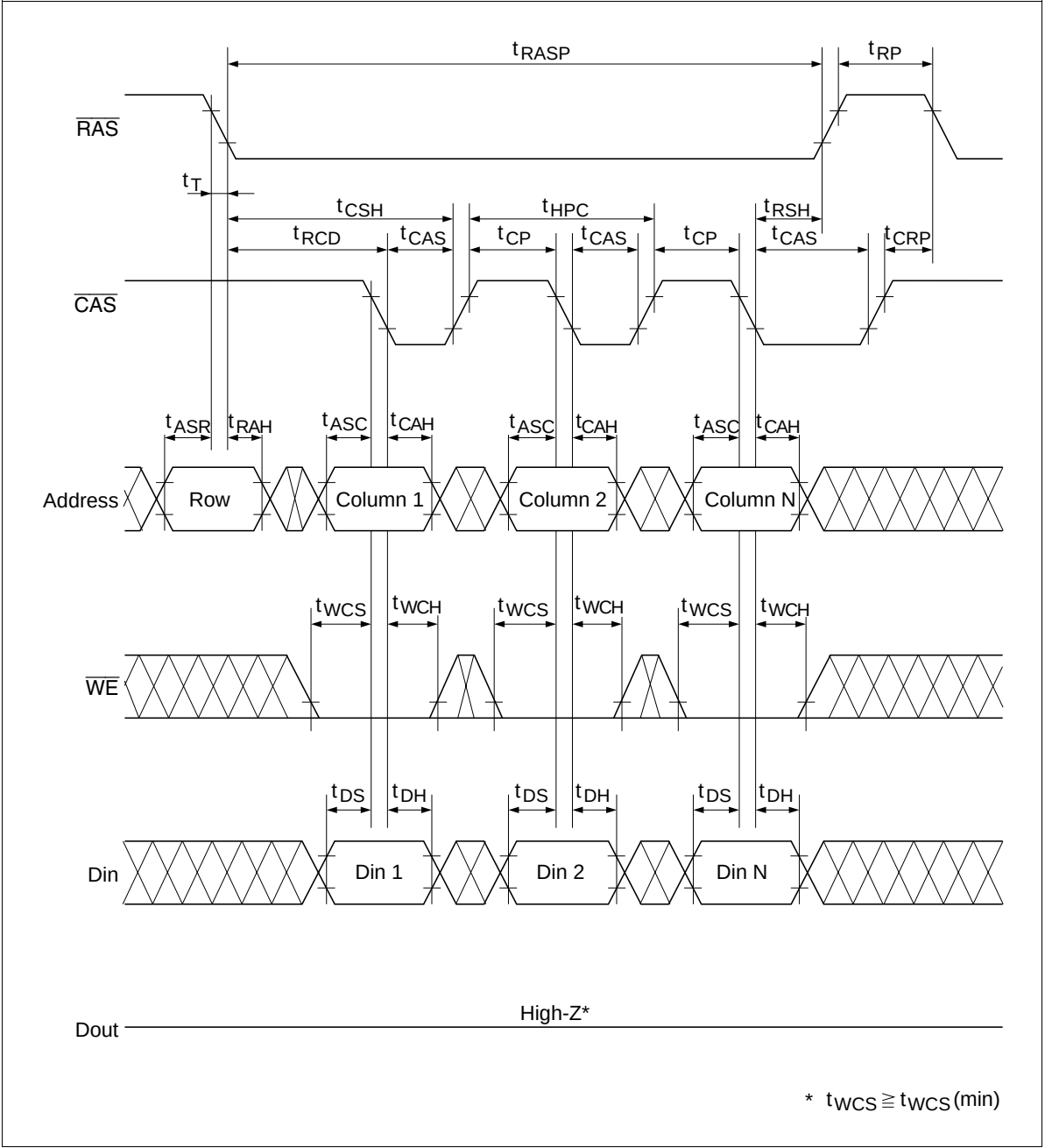




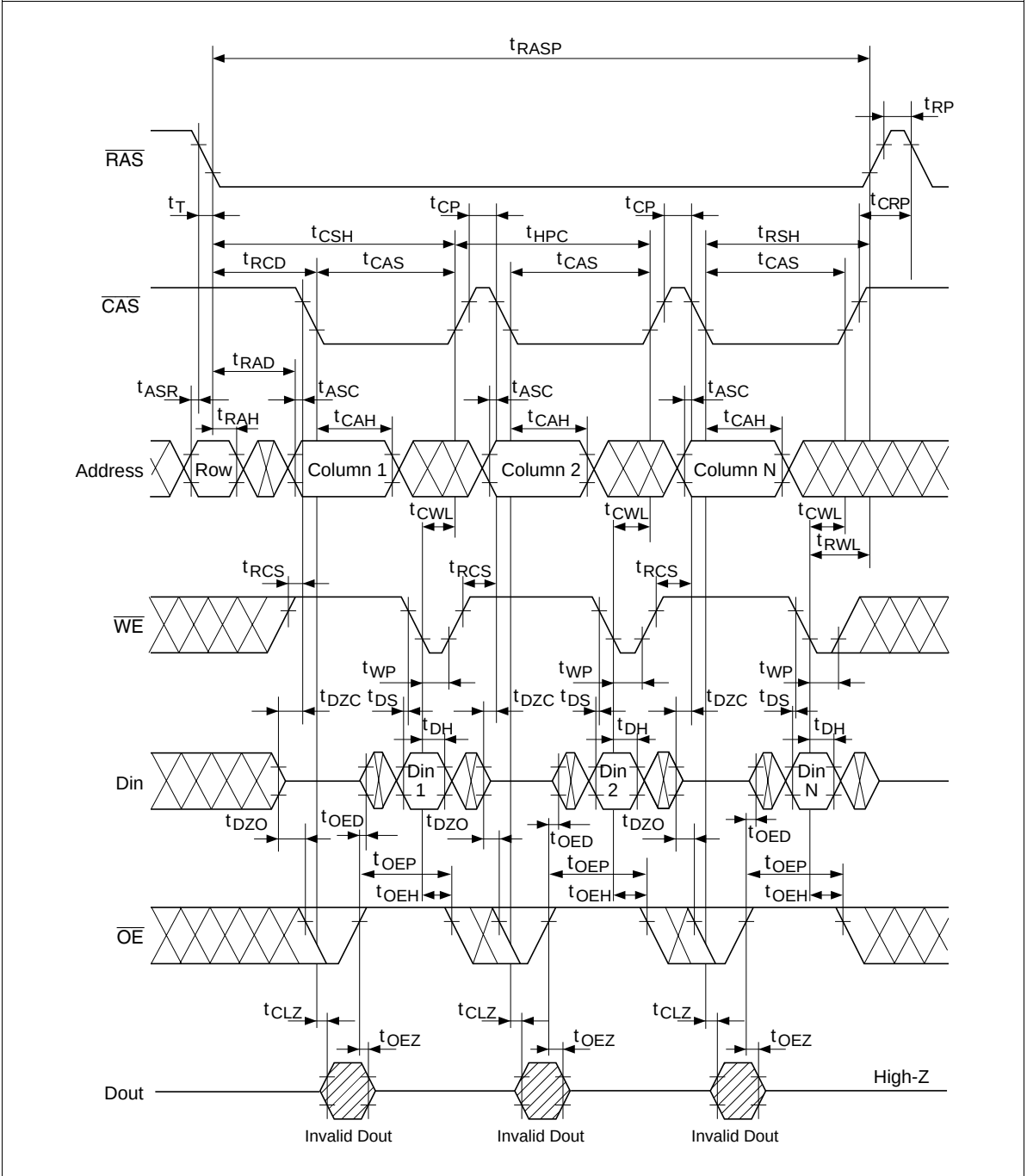
EDO Page Mode Read Cycle (2)



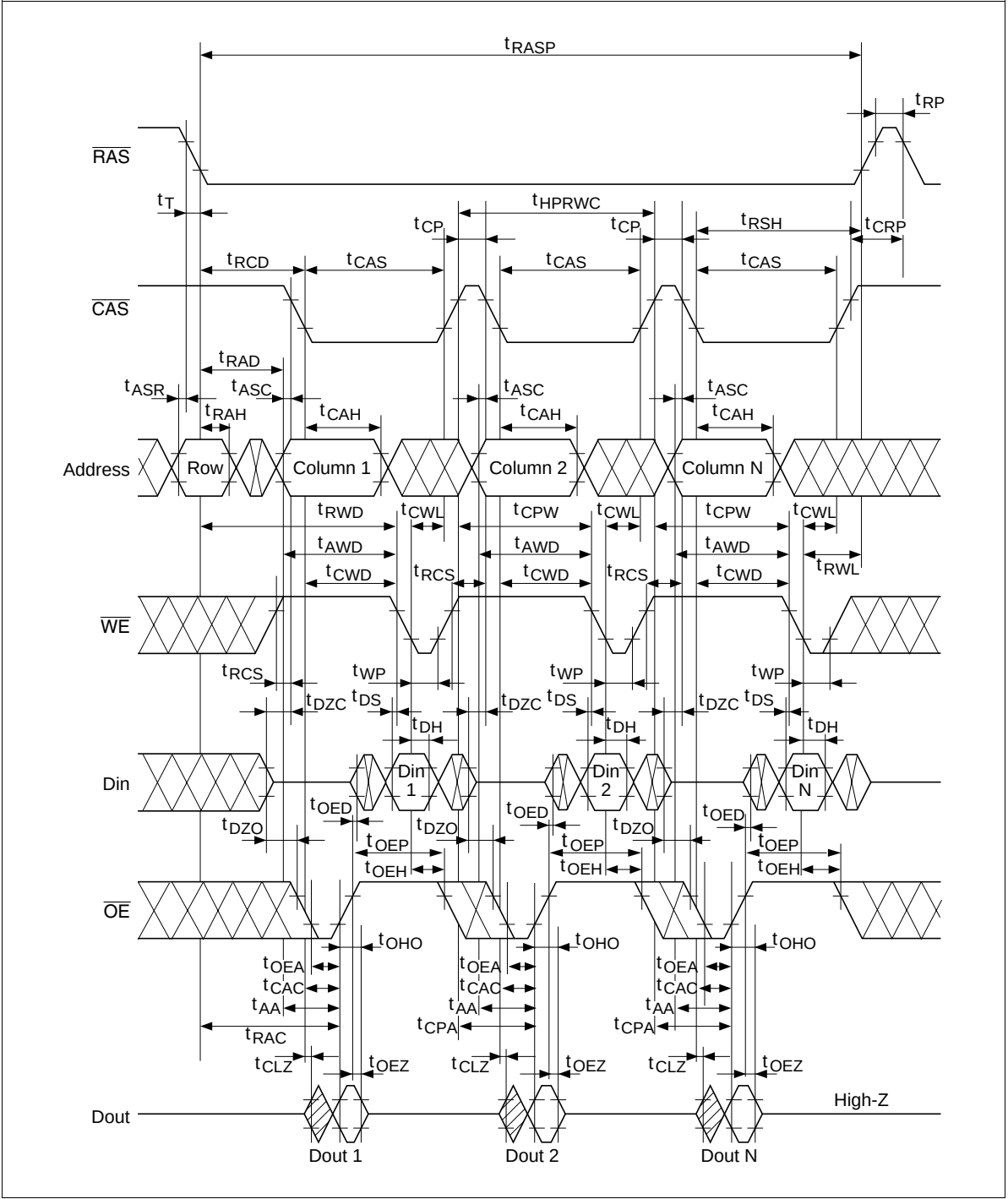
EDO Page Mode Early Write Cycle



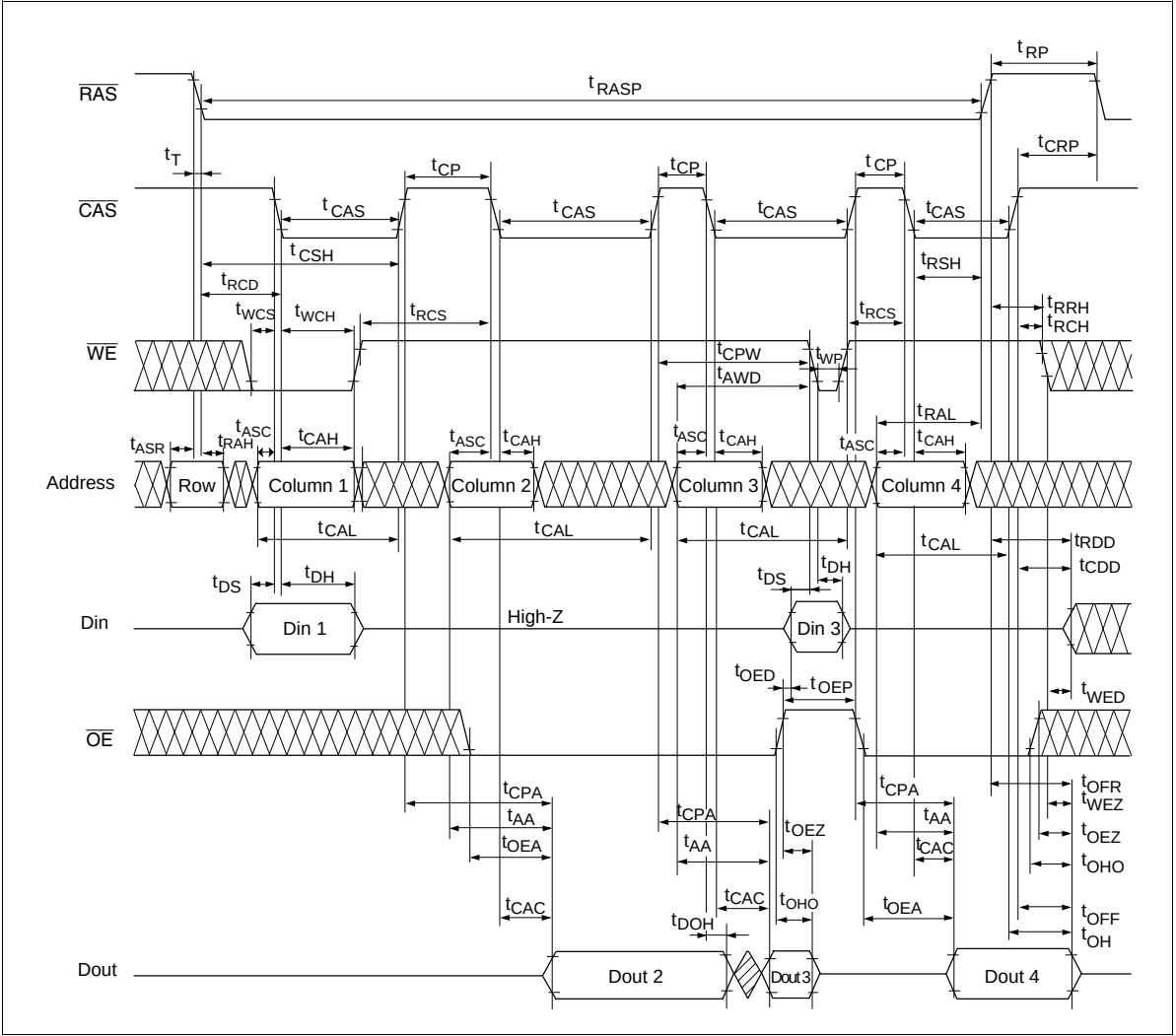
EDO Page Mode Delayed Write Cycle*18



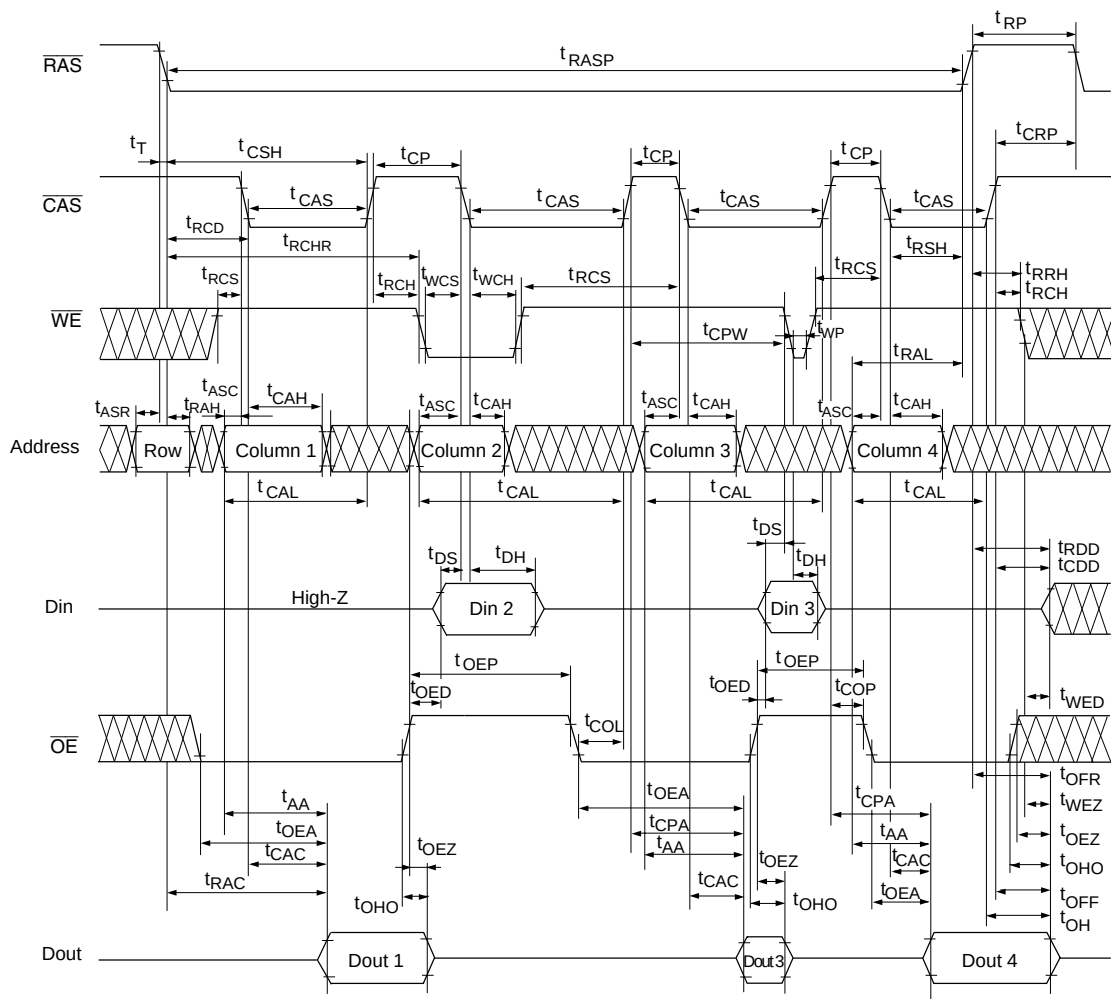
EDO Page Mode Read-Modify-Write Cycle*18



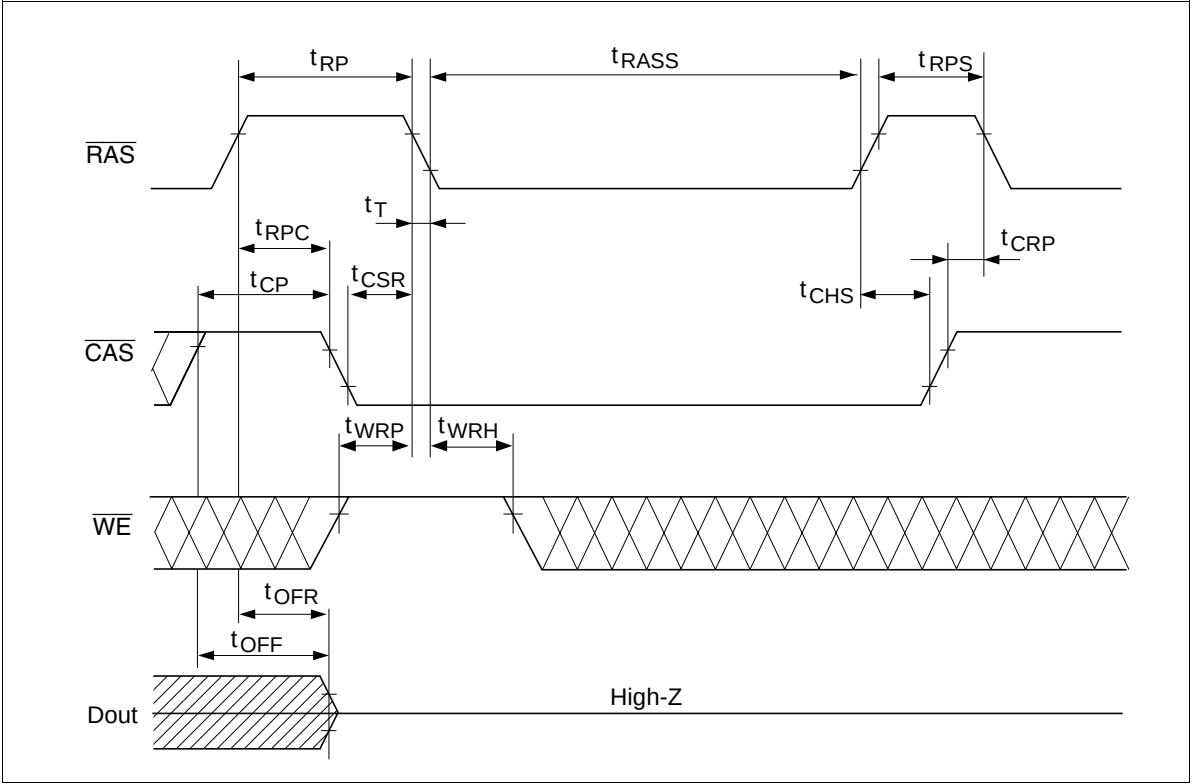
EDO Page Mode Mix Cycle (1)



EDO Page Mode Mix Cycle (2)



Self Refresh Cycle (L-version)* 22, 23, 24



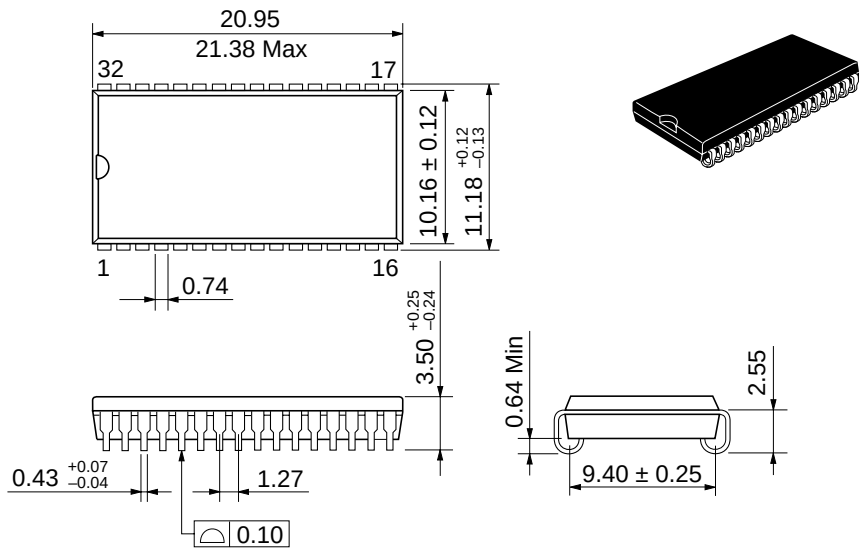
HM5164405A Series, HM5165405A Series

Package Dimensions

HM5164405AJ/ ALJ Series

HM5165405AJ/ ALJ Series (CP-32DC)

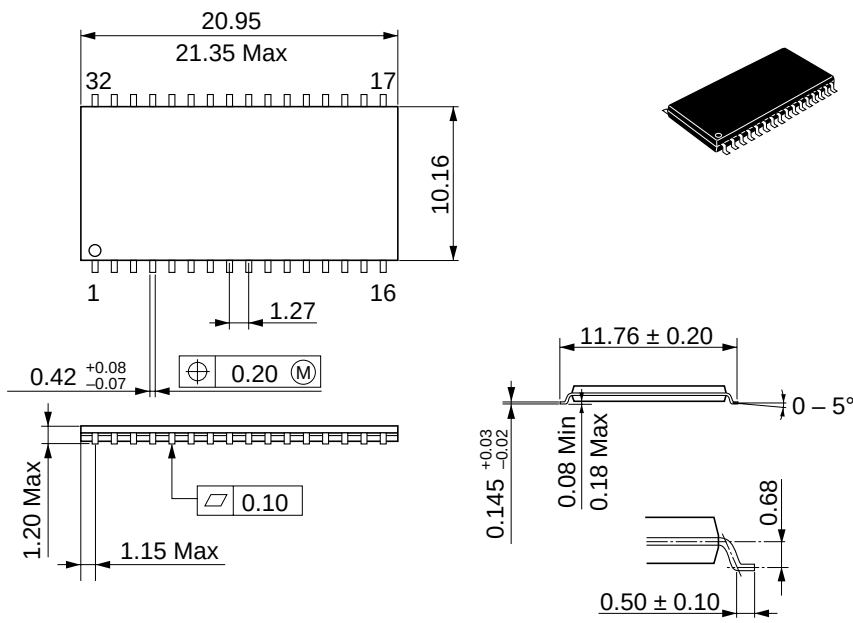
Unit: mm



HM5164405ATT/ALTT Series

HM5165405ATT/ALTT Series (TTP-32DC)

Unit: mm



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HITACHI

Hitachi, Ltd.

Semiconductor & IC Div.
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100, Japan
Tel: Tokyo (03) 3270-2111
Fax: (03) 3270-5109

For further information write to:

Hitachi America, Ltd.
Semiconductor & IC Div.
2000 Sierra Point Parkway
Brisbane, CA. 94005-1835
U S A
Tel: 415-589-8300
Fax: 415-583-4207

Hitachi Europe GmbH
Electronic Components Group
Continental Europe
Dornacher Straße 3
D-85622 Feldkirchen
München
Tel: 089-9 91 80-0
Fax: 089-9 29 30 00

Hitachi Europe Ltd.
Electronic Components Div.
Northern Europe Headquarters
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA
United Kingdom
Tel: 0628-585000
Fax: 0628-778322

Hitachi Asia Pte. Ltd.
16 Collyer Quay #20-00
Hitachi Tower
Singapore 0104
Tel: 535-2100
Fax: 535-1533

Hitachi Asia (Hong Kong) Ltd.
Unit 706, North Tower,
World Finance Centre,
Harbour City, Canton Road
Tsim Sha Tsui, Kowloon
Hong Kong
Tel: 27359218
Fax: 27306071

Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
0.0	Oct. 13, 1995	Initial issue	S. Ikenaga	J. Kitano
0.1	Apr. 30, 1996	Change format Unification of HM5164405A Series and HM5165405A Series Addition of HM5164405A/HM5165405A-5 Series Addition of HM5164405AJ/ALJ Series, HM5165405AJ/ALJ Series (CP-32DC) Pin Descriptions Addition of Row/Refresh address and Column address to address input Addition of Block Diagrams DC Characteristics (HM5165405A) I_{CC1} max: 140/130 mA to TBD/180/160 mA I_{CC3} max: 120/105 mA to TBD/180/160 mA I_{CC6} max: 120/105 mA to TBD/150/130 mA I_{CC7} max: 120/105 mA to TBD/140/120 mA Addition of note 4 AC Characteristics t_{RCD} max: 38/45 ns to TBD/45/52 ns t_{COP} min: 5/5 ns to TBD/10/10 ns Addition of t_{WPE} and t_{OEP} t_{HPRWC} min: 79/90 ns to TBD/68/79 ns Addition of notes 20 to 24 Change of notes 3 and 13 Timing waveforms Addition of t_{WPE} and t_{OEP} timings Deletion of note: $t_{OE H} \geq t_{CWL}$	S. Ikenaga	J. Kitano
0.2	Jun. 12, 1996	AC Characteristics Change of notes 18 and 25 Timing waveforms Deletion of notes about undefined pins		
