
HM5113165F Series

128M EDO DRAM (8-Mword × 16-bit)
4k refresh

HITACHI

ADE-203-1051B(Z)

Rev. 2.0

Dec. 6, 1999

Description

The Hitachi HM5113165F Series is 128M-bit dynamic RAM organized as 8,388,608-word × 16-bit. It has realized high performance and low power by employing CMOS process technology. HM5113165F Series offers Extended Data Out (EDO) Page Mode as a high speed access mode. It is packaged in 50-pin plastic TSOPIL.

Features

- Single 3.3 V supply: $3.3\text{ V} \pm 0.3\text{ V}$
- Access time: 60 ns (max)
- Power dissipation
 - Active: 828 mW (max)
 - Standby : 3.6 mW (max) (CMOS interface)
: 1.8 mW (max) (CMOS interface) (L-version)
- EDO page mode capability
- Refresh cycles
 - $\overline{\text{RAS}}$ -only refresh
4096 cycles/64 ms
 - CBR/Hidden refresh
4096 cycles/64 ms
- 4 variations of refresh
 - $\overline{\text{RAS}}$ -only refresh
 - $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh
 - Hidden refresh
 - Self refresh (L-version)

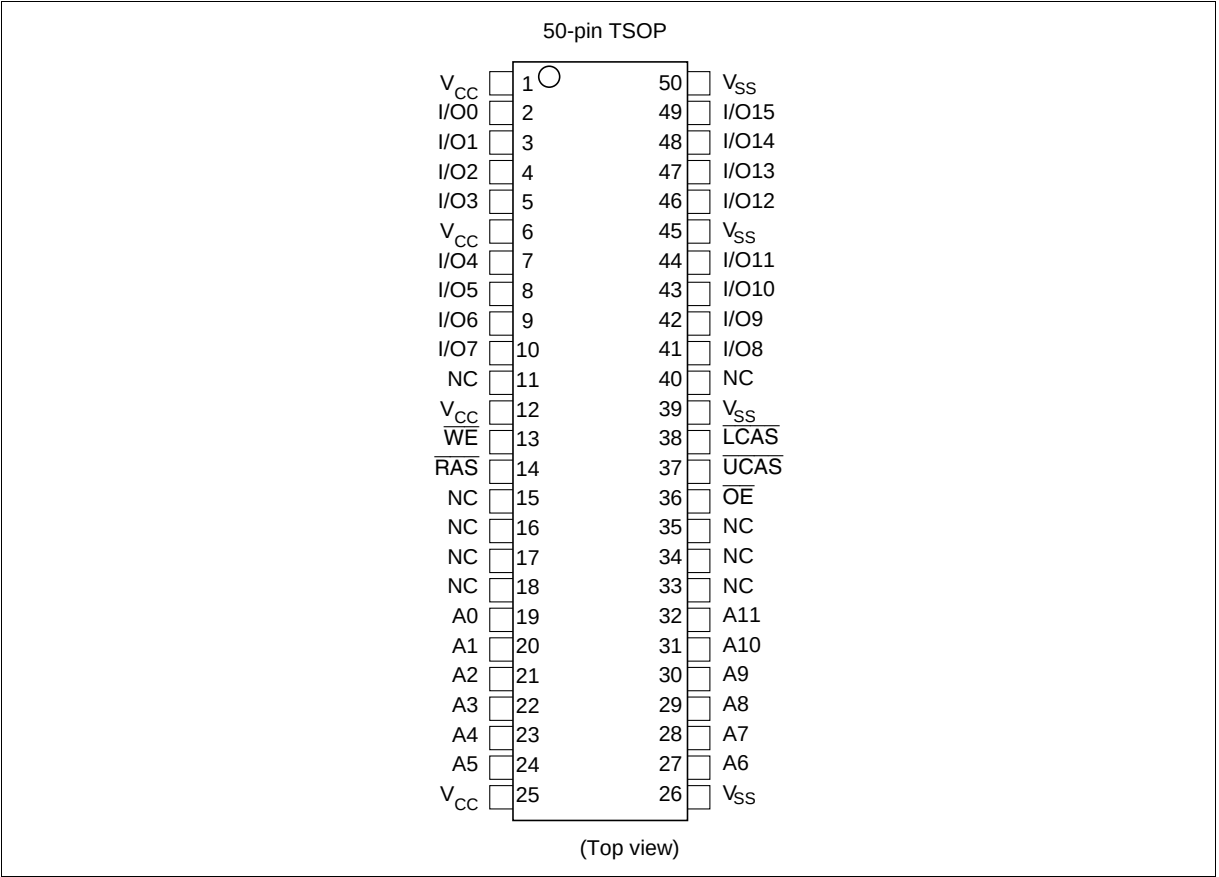
HM5113165F Series

- 2 $\overline{\text{CAS}}$ -byte control
- Battery backup operation (L-version)

Ordering Information

Type No.	Access time	Package
HM5113165FTD-6	60 ns	400-mil 50-pin plastic TSOP II (TTP-50DE)
HM5113165FLTD-6	60 ns	

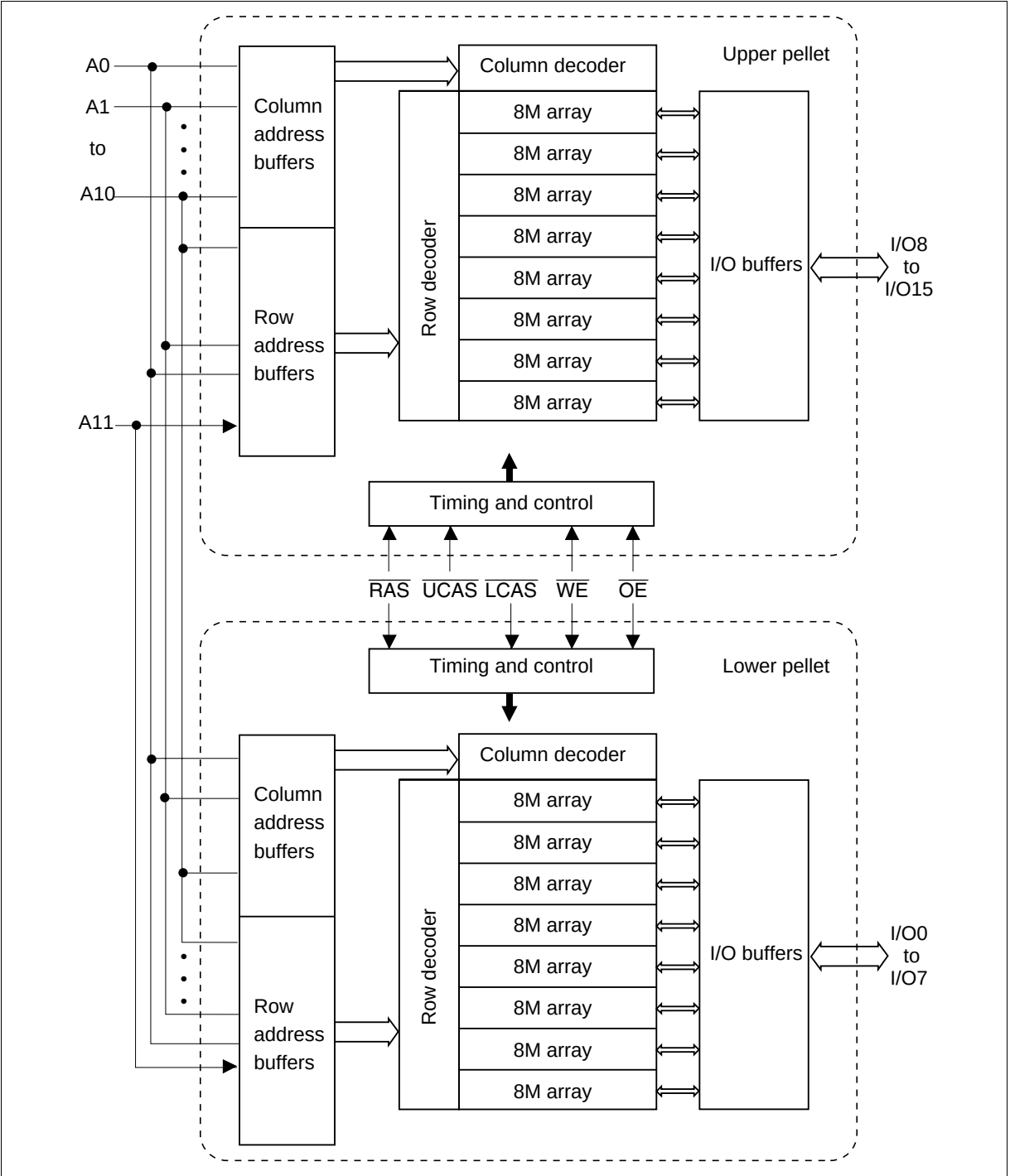
Pin Arrangement (HM5113165F Series)



Pin Description

Pin name	Function
A0 to A11	Address input — Row/Refresh address A0 to A11 — Column address A0 to A10
I/O0 to I/O15	Data input/output
RAS	Row address strobe
UCAS, LCAS	Column address strobe
WE	Write enable
OE	Output enable
V _{CC}	Power supply
V _{SS}	Ground
NC	No connection

Block Diagram



Operation Table

$\overline{\text{RAS}}$	$\overline{\text{LCAS}}$	$\overline{\text{UCAS}}$	$\overline{\text{WE}}$	$\overline{\text{OE}}$	I/O 0 to I/O 7	I/O 8 to I/O 15	Operation
H	×	×	×	×	High-Z	High-Z	Standby
L	L	H	H	L	Dout	High-Z	Read cycle
L	H	L	H	L	High-Z	Dout	
L	L	L	H	L	Dout	Dout	
L	L	H	L* ²	×	Din	×	Early write cycle
L	H	L	L* ²	×	×	Din	
L	L	L	L* ²	×	Din	Din	
L	L	H	L* ²	H	Din	×	Delayed write cycle
L	H	L	L* ²	H	×	Din	
L	L	L	L* ²	H	Din	Din	
L	L	H	H to L	L to H	Dout/Din	High-Z	Read-modify-write cycle
L	H	L	H to L	L to H	High-Z	Dout/Din	
L	L	L	H to L	L to H	Dout/Din	Dout/Din	
L	H	H	×	×	High-Z	High-Z	$\overline{\text{RAS}}$ -only refresh cycle
H to L	L	L	H	×	High-Z	High-Z	$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh cycle or Self refresh cycle (L-version)
L	L	L	H	H	High-Z	High-Z	Read cycle (Output disabled)

Notes: 1. H: V_{IH} (inactive) L: V_{IL} (active) ×: V_{IH} or V_{IL}

2. $t_{\text{WCS}} \geq 0$ ns: Early write cycle

$t_{\text{WCS}} < 0$ ns: Delayed write cycle

3. $\overline{\text{UCAS}}$ controls the upper pellet (I/O 8 to 15) only, and $\overline{\text{LCAS}}$ controls the lower pellet (I/O 0 to 7) only. Therefore, mode, read/write and High-Z control are done independently by each $\overline{\text{UCAS}}$, $\overline{\text{LCAS}}$.

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Terminal voltage on any pin relative to V _{SS}	V _T	−0.5 to V _{CC} + 0.5 (≤ 4.6 V (max))	V
Power supply voltage relative to V _{SS}	V _{CC}	−0.5 to +4.6	V
Short circuit output current	I _{out}	50	mA
Power dissipation	P _T	1.0	W
Storage temperature	T _{stg}	−55 to +125	°C

DC Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply voltage	V _{CC}	3.0	3.3	3.6	V	1, 2
	V _{SS}	0	0	0	V	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
Ambient temperature range	T _a	0	—	70	°C	

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

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Parameter	Symbol	Min	Max	Unit	Test conditions
Operating current ^{*1, *2}	I_{CC1}	—	230	mA	$t_{RC} = \min$
Standby current	I_{CC2}	—	4	mA	TTL interface $\overline{RAS}, \overline{UCAS}, \overline{LCAS} = V_{IH}$ Dout = High-Z
		—	1	mA	CMOS interface $\overline{RAS}, \overline{UCAS},$ $\overline{LCAS} \geq V_{CC} - 0.2 \text{ V}$ Dout = High-Z
Standby current (L-version)	I_{CC2}	—	500	μA	CMOS interface $\overline{RAS}, \overline{UCAS},$ $\overline{LCAS} \geq V_{CC} - 0.2 \text{ V}$ Dout = High-Z
$\overline{RAS}$ -only refresh current ^{*2}	I_{CC3}	—	230	mA	$t_{RC} = \min$
Standby current ^{*1}	I_{CC5}	—	10	mA	$\overline{RAS} = V_{IH}$ $\overline{UCAS}, \overline{LCAS} = V_{IL}$ Dout = enable
$\overline{CAS}$ -before- $\overline{RAS}$ refresh current	I_{CC6}	—	230	mA	$t_{RC} = \min$
EDO page mode current ^{*1, *3}	I_{CC7}	—	200	mA	$\overline{RAS} = V_{IL}$, $\overline{CAS}$ cycle, $t_{HPC} = t_{HPC} \text{ min}$
Battery backup current ^{*4} (Standby with CBR refresh) (L-version)	I_{CC10}	—	2.5	mA	CMOS interface Dout = High-Z CBR refresh: $t_{RC} = 15.6 \mu\text{s}$ $t_{RAS} \leq 0.3 \mu\text{s}$
Self refresh mode current (L-version)	I_{CC11}	—	1.6	mA	CMOS interface $\overline{RAS}, \overline{UCAS}, \overline{LCAS} \leq 0.2 \text{ V}$ Dout = High-Z
Input leakage current	I_{LI}	-5	5	μA	$0 \text{ V} \leq V_{in} \leq V_{CC} + 0.3 \text{ V}$
Output leakage current	I_{LO}	-5	5	μA	$0 \text{ V} \leq V_{out} \leq V_{CC}$ Dout = disable
Output high voltage	V_{OH}	2.4	V_{CC}	V	High Iout = -2 mA
Output low voltage	V_{OL}	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 $\overline{RAS} = V_{IL}$.

3. Measured with one sequential address change per EDO cycle, t_{HPC} .

4. $V_{IH} \geq V_{CC} - 0.2 \text{ V}$, $0 \text{ V} \leq V_{IL} \leq 0.2 \text{ V}$.

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

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Input capacitance (Address)	C _{I1}	—	—	7	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. $\overline{RAS}$, $\overline{UCAS}$ and $\overline{LCAS}$ = 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, *19**Test Conditions**

- Input rise and fall time: 2 ns
- Input pulse levels: $V_{IL} = 0\text{ V}$, $V_{IH} = 3.0\text{ V}$
- 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)

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Parameter	Symbol	Min	Max	Unit	Notes
Random read or write cycle time	t _{RC}	104	—	ns	
RAS precharge time	t _{RP}	40	—	ns	
CAS precharge time	t _{CP}	10	—	ns	26
RAS pulse width	t _{RAS}	60	10000	ns	
CAS pulse width	t _{CAS}	10	10000	ns	
Row address setup time	t _{ASR}	0	—	ns	
Row address hold time	t _{RAH}	10	—	ns	
Column address setup time	t _{ASC}	0	—	ns	26
Column address hold time	t _{CAH}	10	—	ns	26
RAS to CAS delay time	t _{RCD}	14	45	ns	3
RAS to column address delay time	t _{RAD}	12	30	ns	4
RAS hold time	t _{RSH}	15	—	ns	
CAS hold time	t _{CSH}	40	—	ns	
CAS to RAS precharge time	t _{CRP}	5	—	ns	26
OE to Din delay time	t _{OED}	15	—	ns	5
OE delay time from Din	t _{DZO}	0	—	ns	6
CAS delay time from Din	t _{DZC}	0	—	ns	6
Transition time (rise and fall)	t _T	2	50	ns	7

Read Cycle

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Parameter	Symbol	Min	Max	Unit	Notes
Access time from $\overline{\text{RAS}}$	t_{RAC}	—	60	ns	8, 9
Access time from $\overline{\text{CAS}}$	t_{CAC}	—	15	ns	9, 10, 17
Access time from address	t_{AA}	—	30	ns	9, 11, 17
Access time from $\overline{\text{OE}}$	t_{OEA}	—	15	ns	9
Read command setup time	t_{RCS}	0	—	ns	26
Read command hold time to $\overline{\text{CAS}}$	t_{RCH}	0	—	ns	12, 26
Read command hold time from $\overline{\text{RAS}}$	t_{RCHR}	60	—	ns	
Read command hold time to $\overline{\text{RAS}}$	t_{RRH}	0	—	ns	12
Column address to $\overline{\text{RAS}}$ lead time	t_{RAL}	30	—	ns	
Column address to $\overline{\text{CAS}}$ lead time	t_{CAL}	18	—	ns	
$\overline{\text{CAS}}$ to output in low-Z	t_{CLZ}	0	—	ns	
Output data hold time	t_{OH}	3	—	ns	21
Output data hold time from $\overline{\text{OE}}$	t_{OHO}	3	—	ns	
Output buffer turn-off time	t_{OFF}	—	15	ns	13, 21
Output buffer turn-off to $\overline{\text{OE}}$	t_{OEZ}	—	15	ns	13
$\overline{\text{CAS}}$ to Din delay time	t_{CDD}	15	—	ns	5
Output data hold time from $\overline{\text{RAS}}$	t_{OHR}	3	—	ns	21
Output buffer turn-off to $\overline{\text{RAS}}$	t_{OFR}	—	15	ns	13, 21
Output buffer turn-off to $\overline{\text{WE}}$	t_{WEZ}	—	15	ns	13
$\overline{\text{WE}}$ to Din delay time	t_{WED}	15	—	ns	
$\overline{\text{RAS}}$ to Din delay time	t_{RDD}	15	—	ns	

Write Cycle

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Parameter	Symbol	Min	Max	Unit	Notes
Write command setup time	t_{WCS}	0	—	ns	14, 26
Write command hold time	t_{WCH}	10	—	ns	26
Write command pulse width	t_{WP}	10	—	ns	
Write command to $\overline{RAS}$ lead time	t_{RWL}	15	—	ns	
Write command to $\overline{CAS}$ lead time	t_{CWL}	10	—	ns	26
Data-in setup time	t_{DS}	0	—	ns	15, 26
Data-in hold time	t_{DH}	10	—	ns	15, 26

Read-Modify-Write Cycle

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Parameter	Symbol	Min	Max	Unit	Notes
Read-modify-write cycle time	t_{RWC}	140	—	ns	
$\overline{RAS}$ to $\overline{WE}$ delay time	t_{RWD}	79	—	ns	14
$\overline{CAS}$ to $\overline{WE}$ delay time	t_{CWD}	34	—	ns	14
Column address to $\overline{WE}$ delay time	t_{AWD}	49	—	ns	14
$\overline{OE}$ hold time from $\overline{WE}$	t_{OEh}	15	—	ns	

Refresh Cycle

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Parameter	Symbol	Min	Max	Unit	Notes
$\overline{CAS}$ setup time (CBR refresh cycle)	t_{CSR}	5	—	ns	26
$\overline{CAS}$ hold time (CBR refresh cycle)	t_{CHR}	10	—	ns	26
$\overline{WE}$ setup time (CBR refresh cycle)	t_{WRP}	0	—	ns	
$\overline{WE}$ hold time (CBR refresh cycle)	t_{WRH}	10	—	ns	
$\overline{RAS}$ precharge to $\overline{CAS}$ hold time	t_{RPC}	5	—	ns	26

EDO Page Mode Cycle

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Parameter	Symbol	Min	Max	Unit	Notes
EDO page mode cycle time	t _{HPC}	25	—	ns	20
EDO page mode $\overline{\text{RAS}}$ pulse width	t _{RASP}	—	100000	ns	16
Access time from $\overline{\text{CAS}}$ precharge	t _{CPA}	—	35	ns	9, 17, 26
$\overline{\text{RAS}}$ hold time from $\overline{\text{CAS}}$ precharge	t _{CPRH}	35	—	ns	
Output data hold time from $\overline{\text{CAS}}$ low	t _{DOH}	3	—	ns	9, 22
$\overline{\text{CAS}}$ hold time referred $\overline{\text{OE}}$	t _{COL}	10	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{OE}}$ setup time	t _{COP}	5	—	ns	
Read command hold time from $\overline{\text{CAS}}$ precharge	t _{RCHC}	35	—	ns	
Write pulse width during $\overline{\text{CAS}}$ precharge	t _{WPE}	10	—	ns	
$\overline{\text{OE}}$ precharge time	t _{OEP}	10	—	ns	

EDO Page Mode Read-Modify-Write Cycle

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Parameter	Symbol	Min	Max	Unit	Notes
EDO page mode read-modify-write cycle time	t _{HPRWC}	68	—	ns	
$\overline{\text{WE}}$ delay time from $\overline{\text{CAS}}$ precharge	t _{CPW}	54	—	ns	14, 26

Refresh

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

Self Refresh Mode (L-version)

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Parameter	Symbol	Min	Max	Unit	Notes
$\overline{\text{RAS}}$ pulse width (self refresh)	t_{RASS}	100	—	μs	25
$\overline{\text{RAS}}$ precharge time (self refresh)	t_{RPS}	110	—	ns	25
$\overline{\text{CAS}}$ hold time (self refresh)	t_{CHS}	−50	—	ns	26

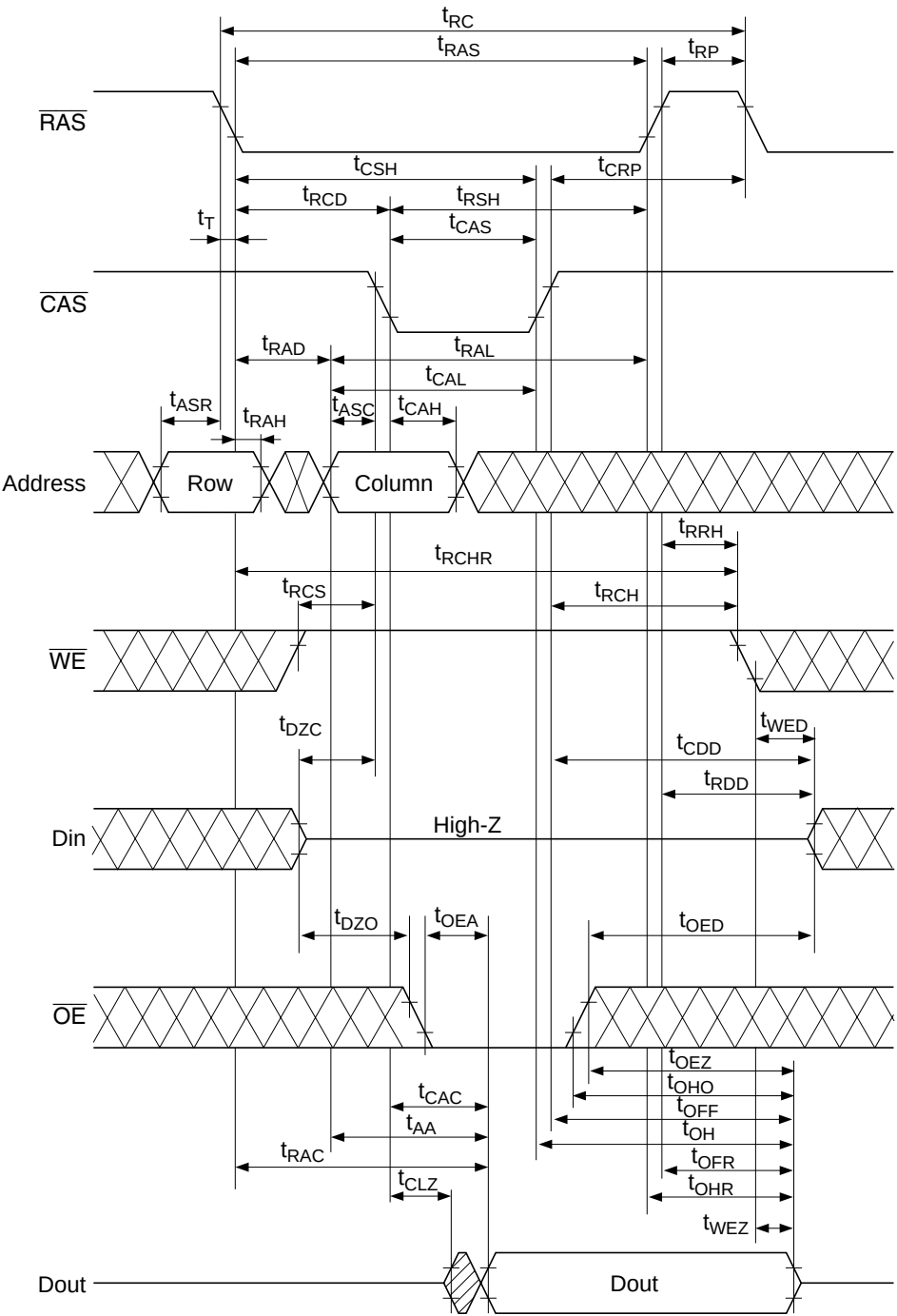
Notes: 1. AC measurements assume $t_T = 2 \text{ ns}$.

2. An initial pause of 200 μs 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).
3. 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 the access time is controlled exclusively by t_{CAC} .
4. 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} .
5. Either t_{OED} or t_{CDD} must be satisfied.
6. Either t_{DZO} or t_{DZC} must be satisfied.
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} (min) and V_{IL} (max).
8. 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.
9. Measured with a load circuit equivalent to 1 TTL loads and 100 pF.
10. 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).
11. 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).
12. Either t_{RCH} or t_{RRH} must be satisfied for a read cycles.
13. 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.
14. 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.
15. t_{DS} and t_{DH} are referred to $\overline{\text{UCAS}}$ and $\overline{\text{LCAS}}$ leading edge in early write cycles and to $\overline{\text{WE}}$ leading edge in delayed write or read-modify-write cycles.
16. t_{RASp} defines $\overline{\text{RAS}}$ pulse width in EDO page mode cycles.
17. Access time is determined by the longest among t_{AA} , t_{CAC} and t_{CPA} .
18. In delayed write or read-modify-write cycles, $\overline{\text{OE}}$ must disable output buffer prior to applying data to the device.
19. 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 $V_{\text{CC}}/V_{\text{SS}}$ line noise, which causes to degrade V_{IH} min/ V_{IL} max level.

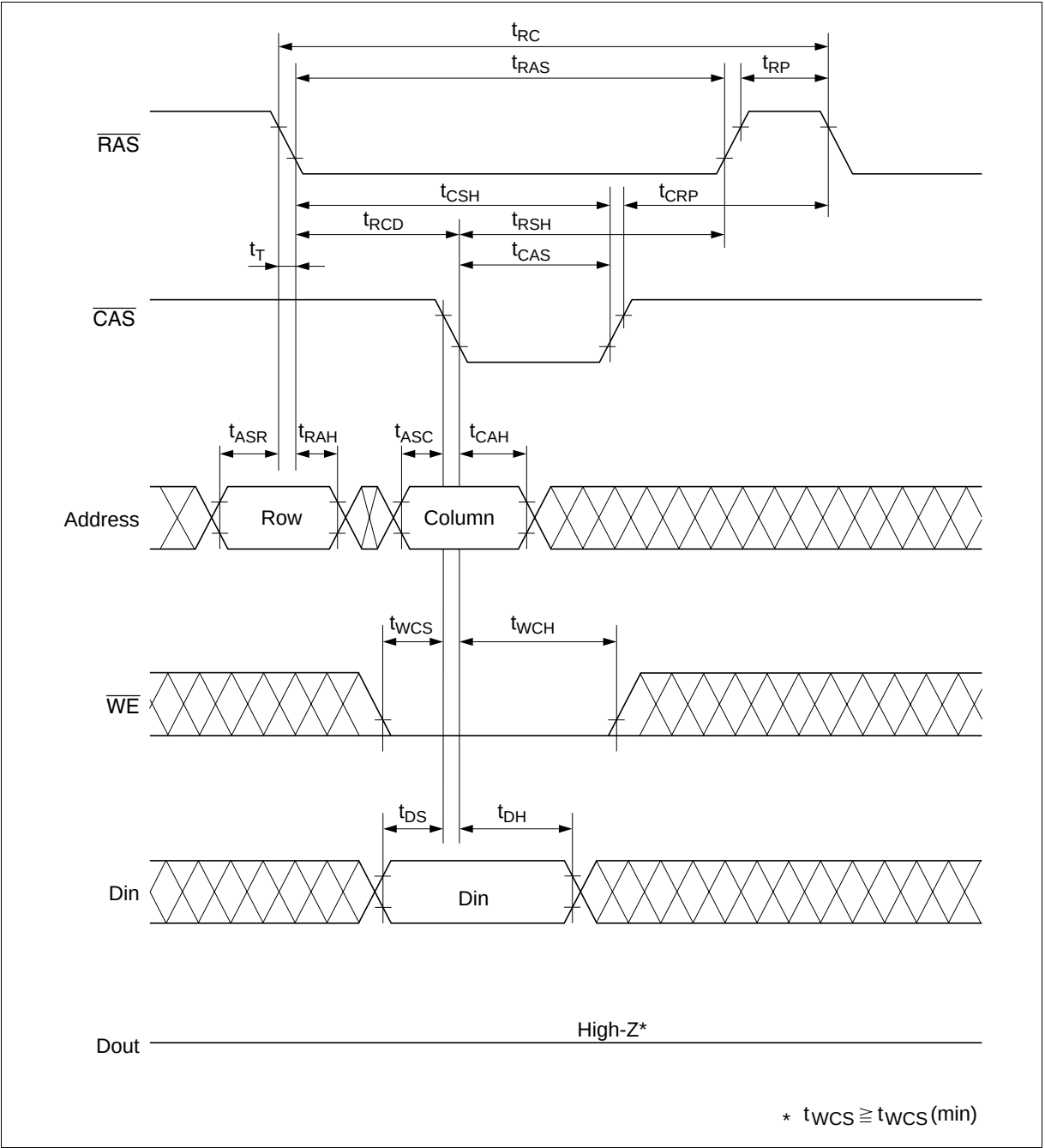
20. t_{HPC} (min) can be achieved during a series of EDO page mode write cycles or EDO page mode read cycles. If both write and read operation are mixed in a EDO page mode RAS cycle (EDO page mode mix cycle (1), (2)), minimum value of $\overline{CAS}$ cycle ($t_{CAS} + t_{CP} + 2 t_r$) becomes greater than the specified t_{HPC} (min) value. The value of $\overline{CAS}$ cycle time of mixed EDO page mode is shown in EDO page mode mix cycle (1) and (2).
21. Data output turns off and becomes high impedance from later rising edge of $\overline{RAS}$ and $\overline{CAS}$. Hold time and turn off time are specified by the timing specifications of later rising edge of $\overline{RAS}$ and $\overline{CAS}$ between t_{OHR} and t_{OH} and between t_{OFR} and t_{OFF} .
22. t_{DOH} defines the time at which the output level go cross. $V_{OL} = 0.8 V$, $V_{OH} = 2.0 V$ of output timing reference level.
23. Before and after self refresh mode, execute CBR refresh to all refresh addresses in or within 64 ms period on the condition a and b below.
- Enter self refresh mode within 15.6 μs after either burst refresh or distributed refresh at equal interval to all refresh addresses are completed.
 - Start burst refresh or distributed refresh at equal interval to all refresh addresses within 15.6 μs after exiting from self refresh mode.
24. In case of entering from $\overline{RAS}$ -only-refresh, it is necessary to execute CBR refresh before and after self refresh mode according as note 23.
25. At $t_{RASS} > 100 \mu s$, self refresh mode is activated, and not activated at $t_{RASS} < 10 \mu s$. It is undefined within the range of $10 \mu s \leq t_{RASS} \leq 100 \mu s$. For $t_{RASS} \geq 10 \mu s$, it is necessary to satisfy t_{RPS} .
26. t_{ASC} , t_{CAH} , t_{RCS} , t_{WCS} , t_{WCH} , t_{CSR} , t_{RPC} , t_{CRP} , t_{CHR} , t_{RCH} , t_{CPA} , t_{CPW} , t_{CWL} , t_{DH} , t_{DS} , t_{CHS} and t_{CP} are determined by each of UCAS /LCAS independently.
27. 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} .

Timing Waveforms*27

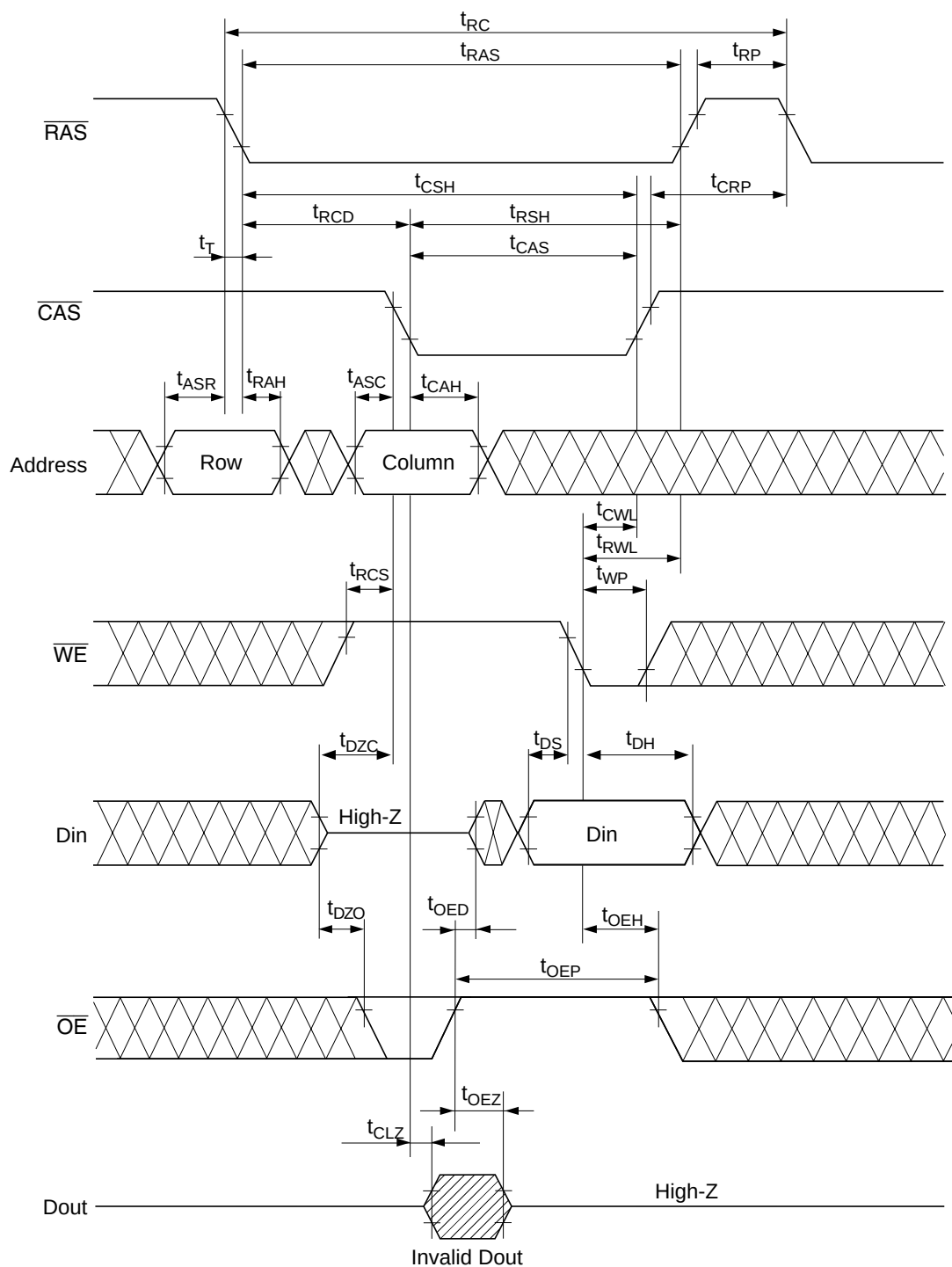
Read Cycle



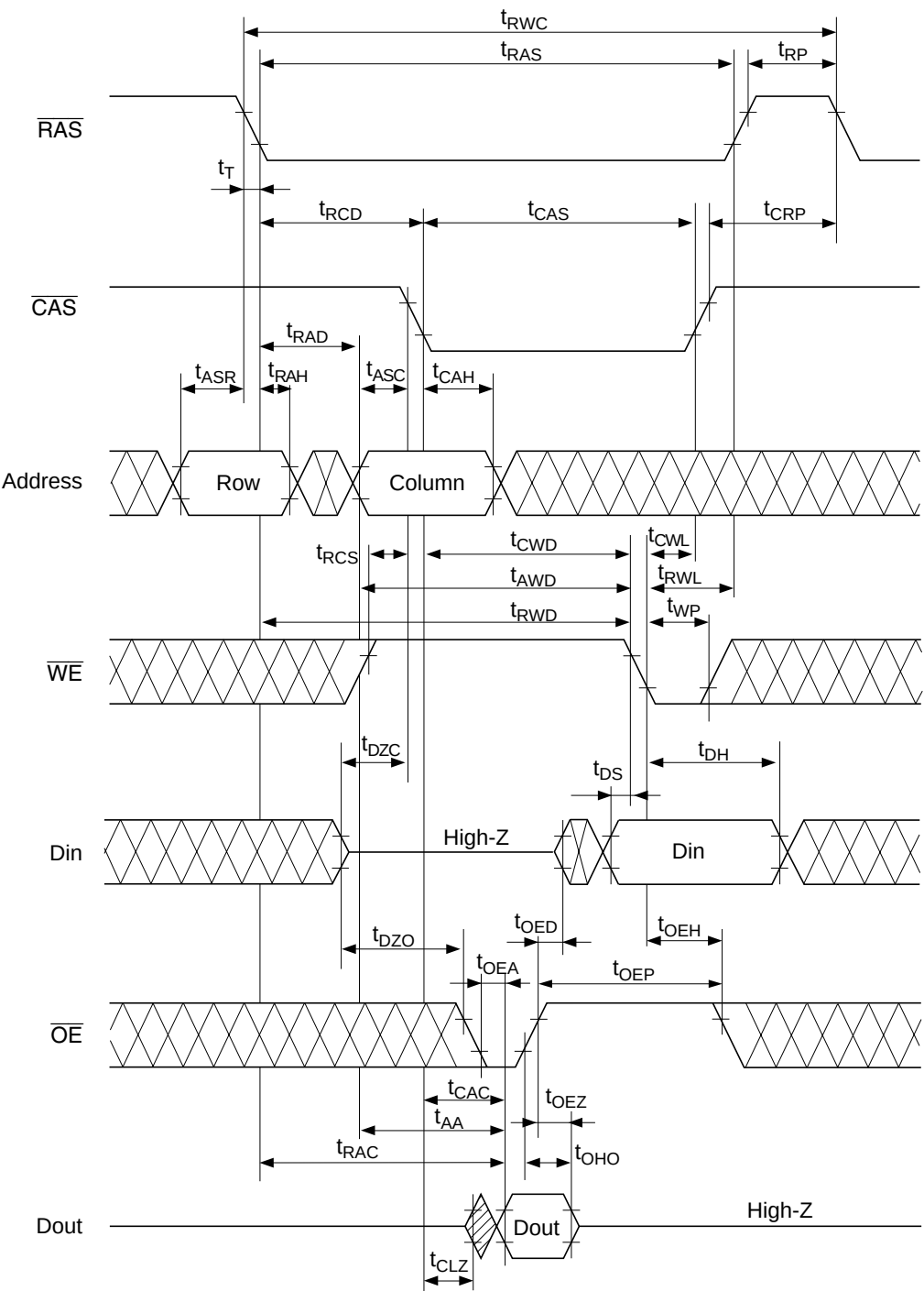
Early Write Cycle



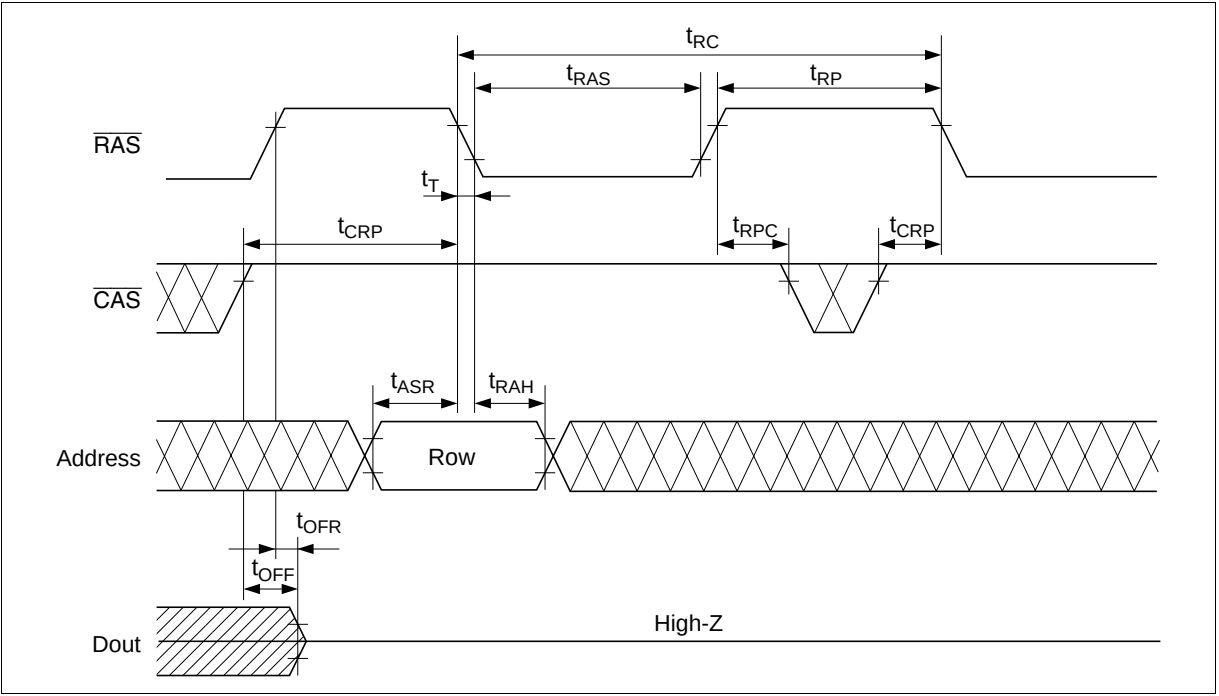
Delayed Write Cycle*¹⁸



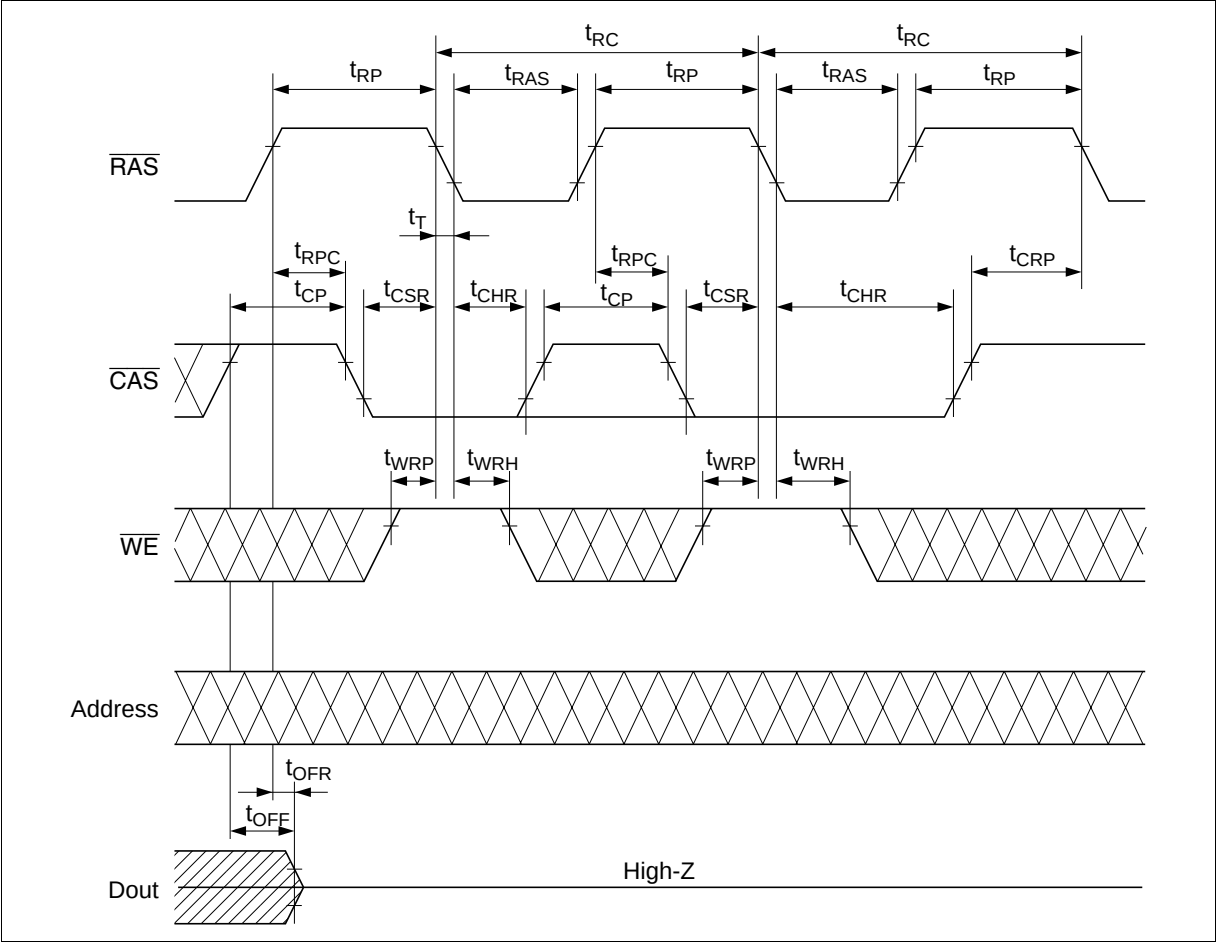
Read-Modify-Write Cycle*18



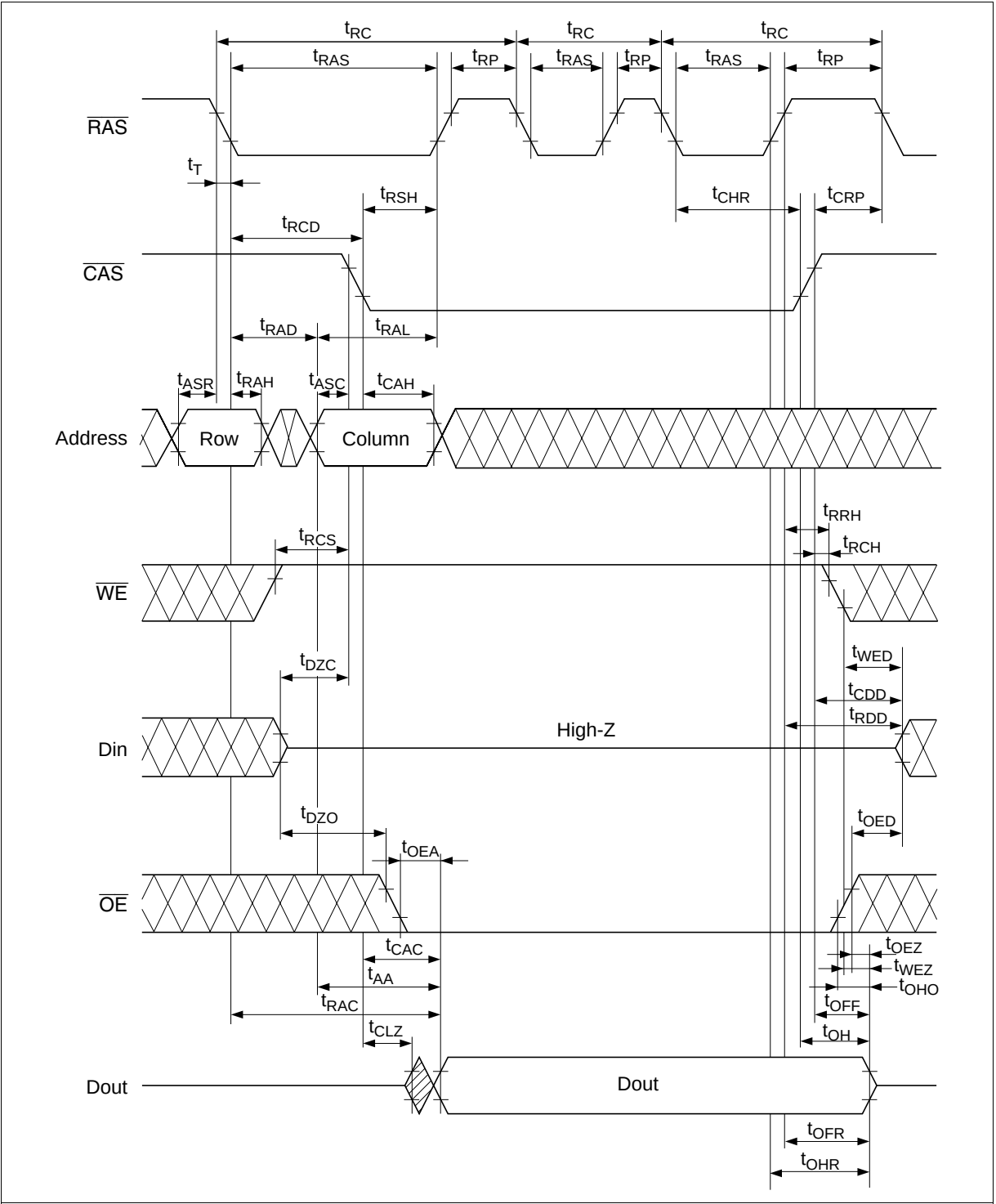
RAS-Only Refresh Cycle



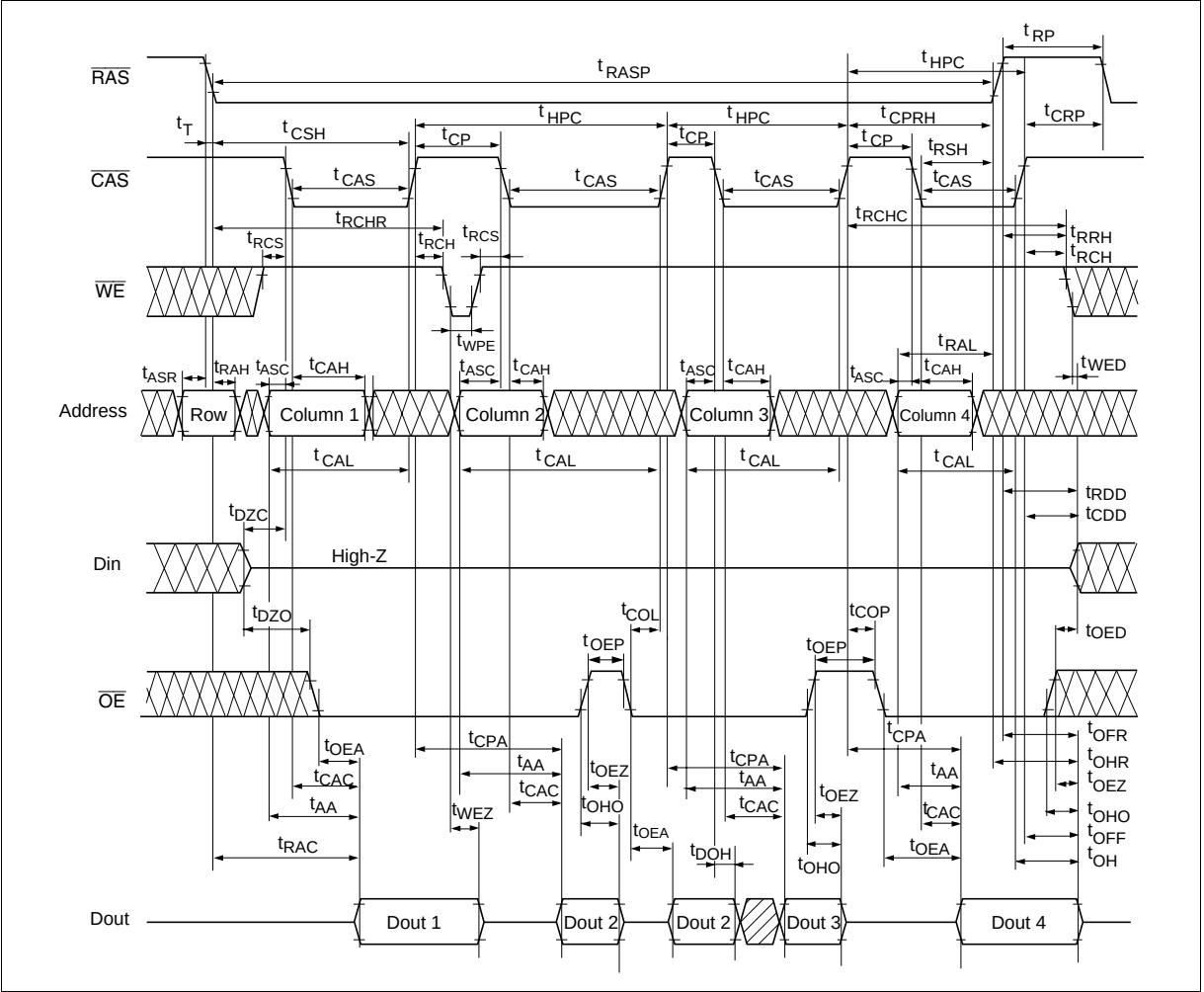
CAS-Before-RAS Refresh Cycle

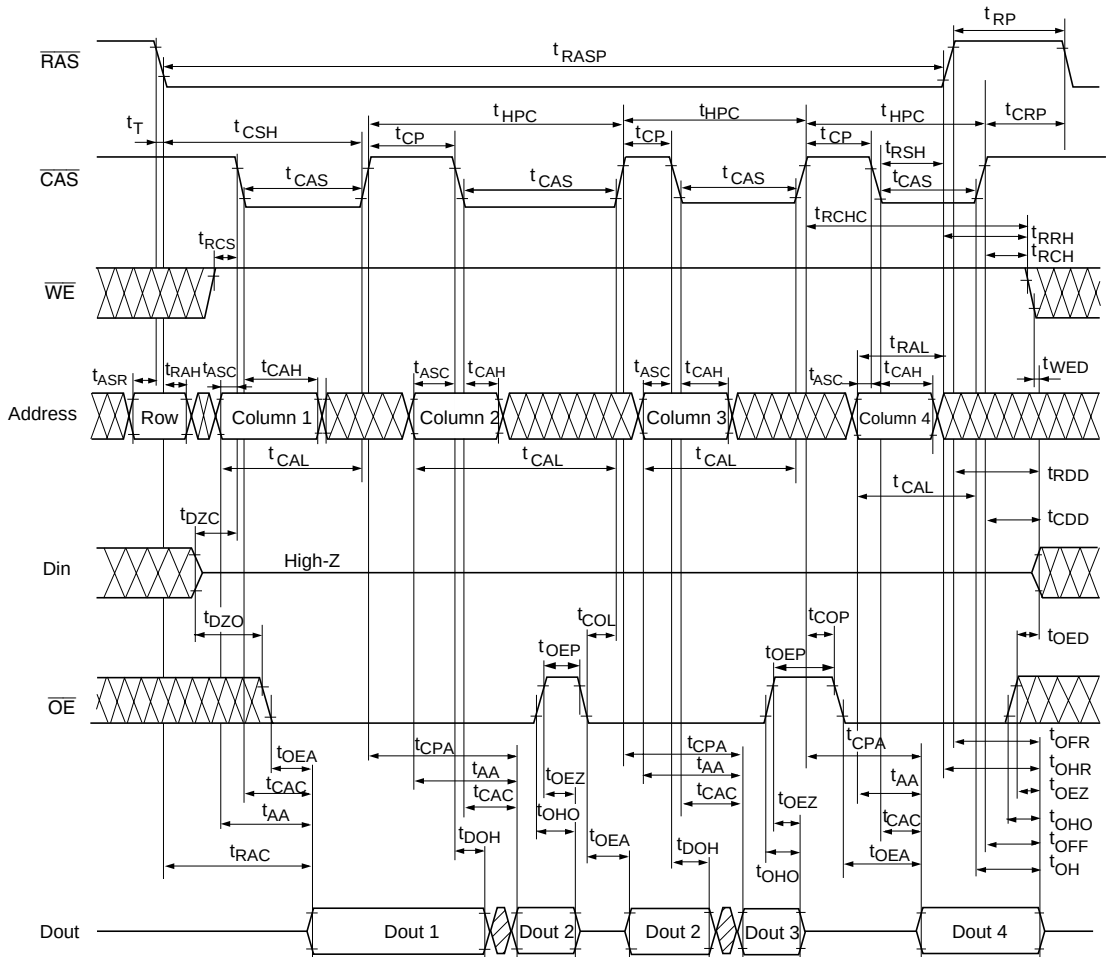


Hidden Refresh Cycle

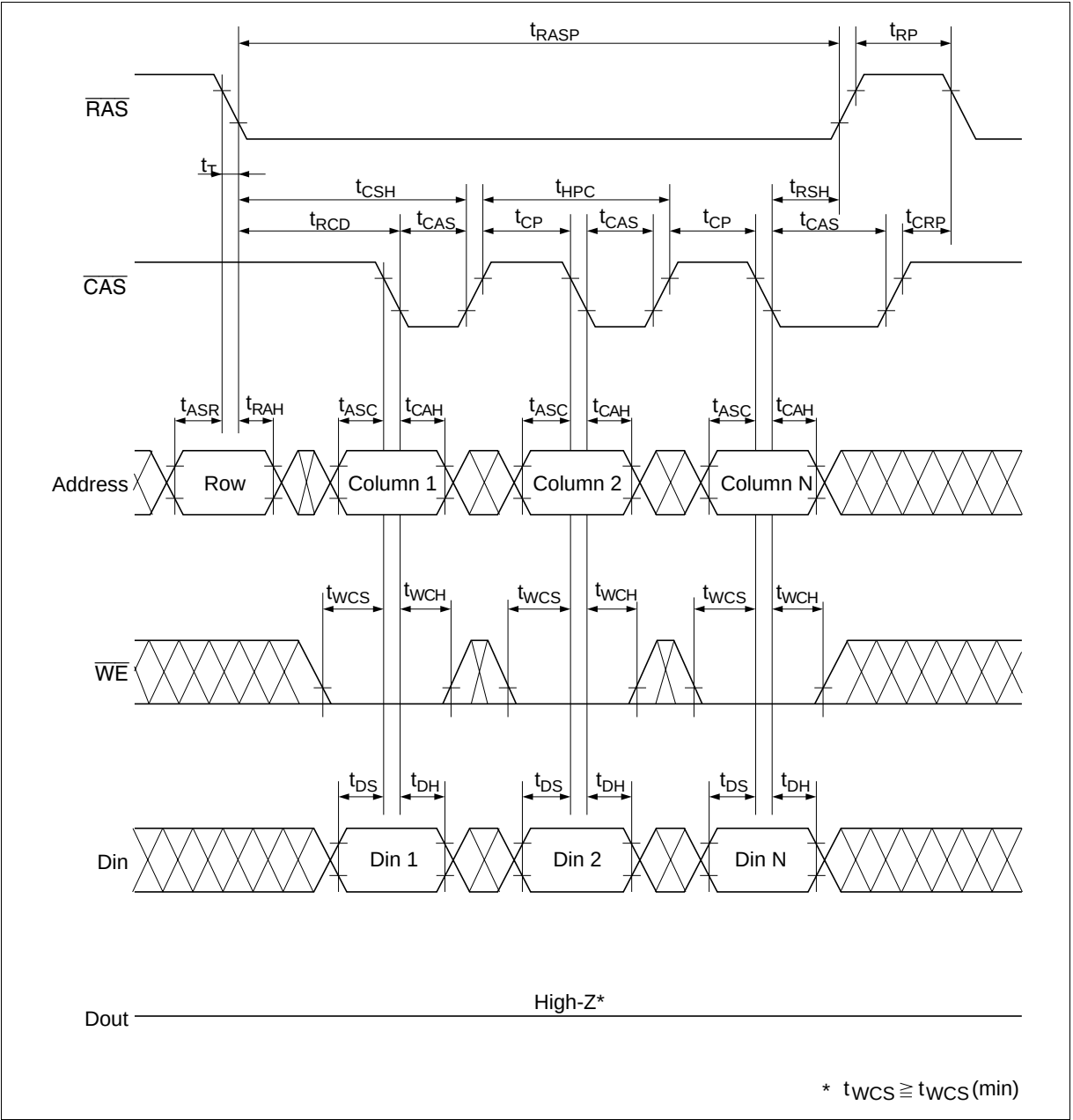


EDO Page Mode Read Cycle (1)

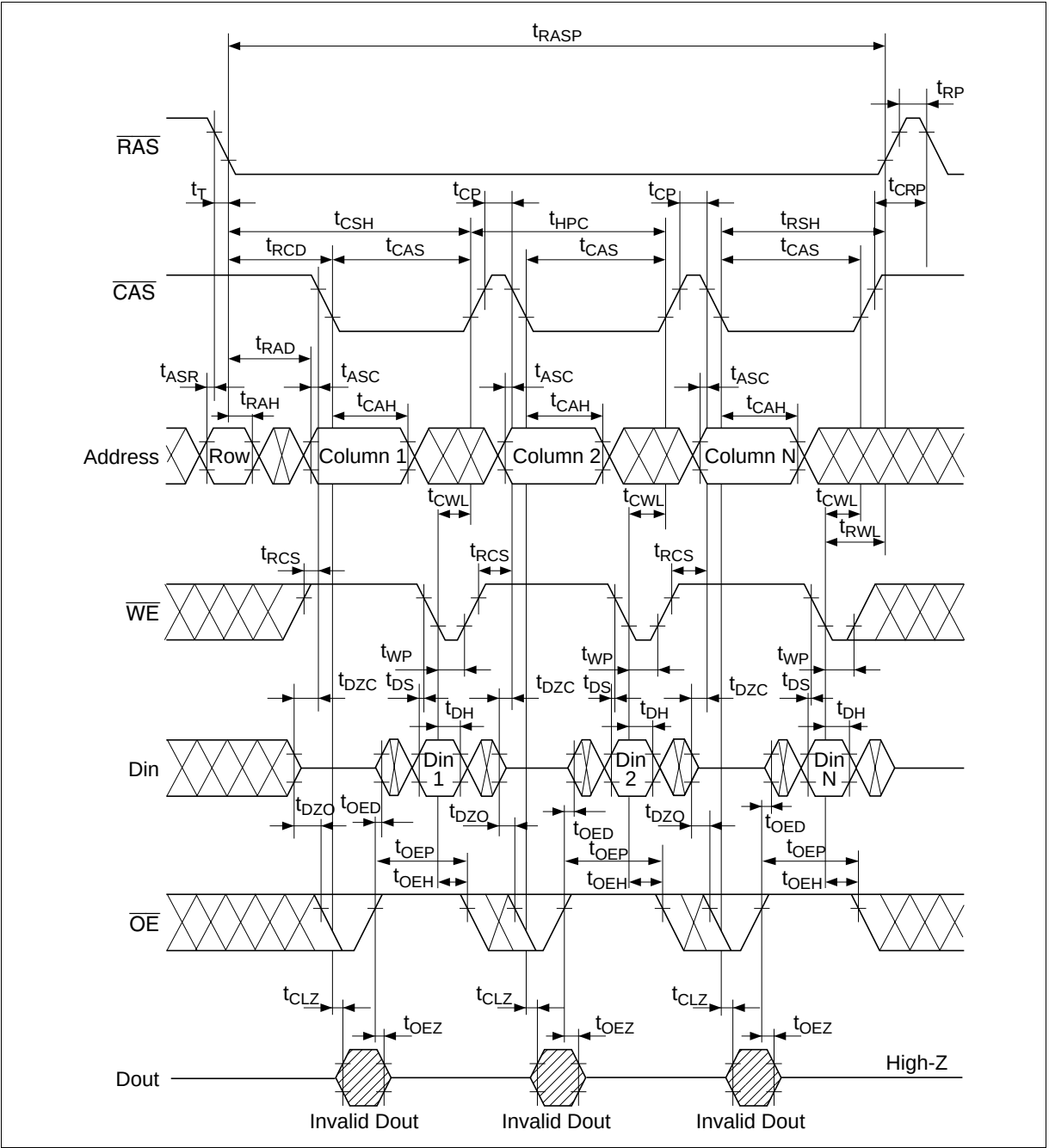




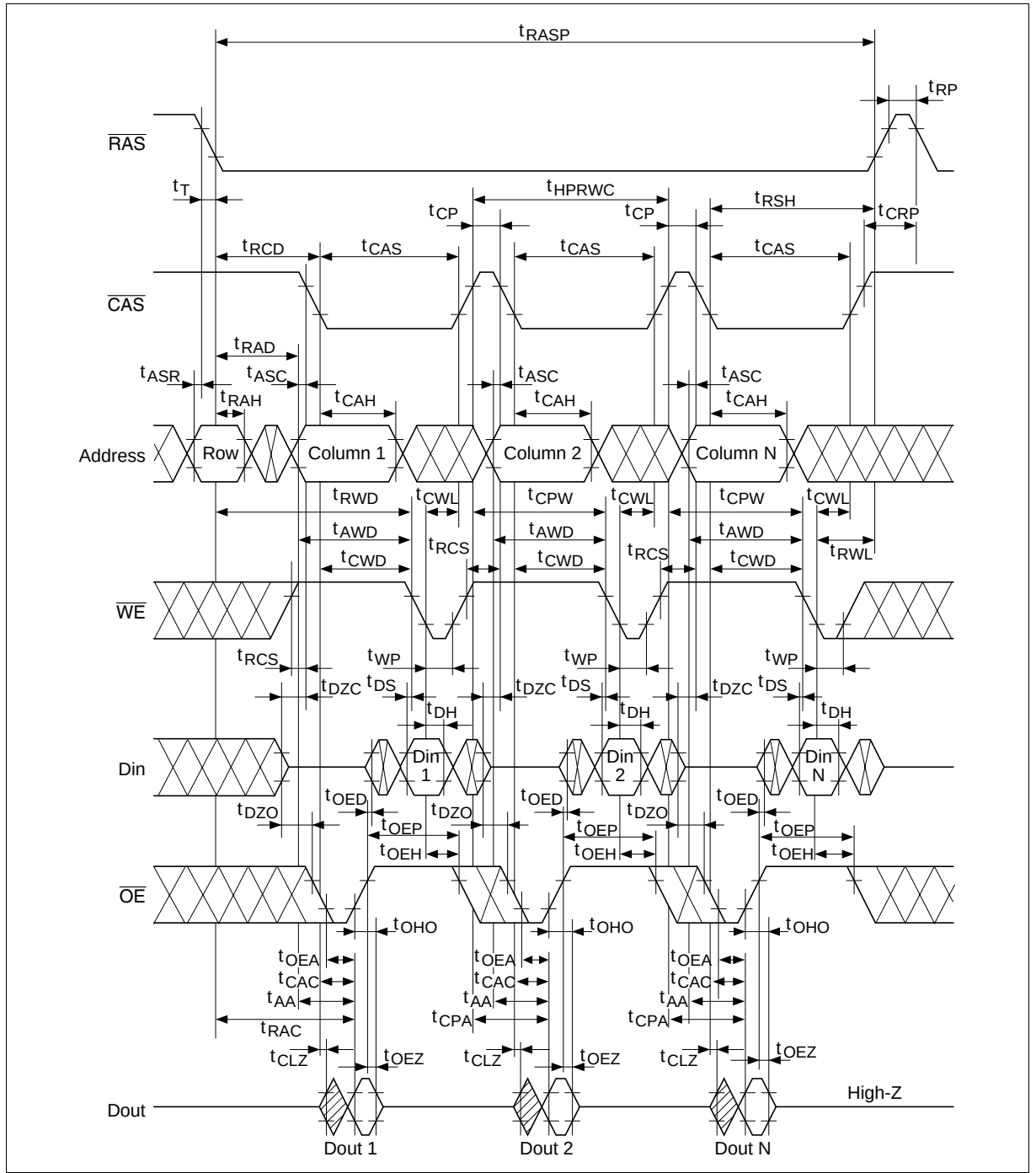
EDO Page Mode Early Write Cycle



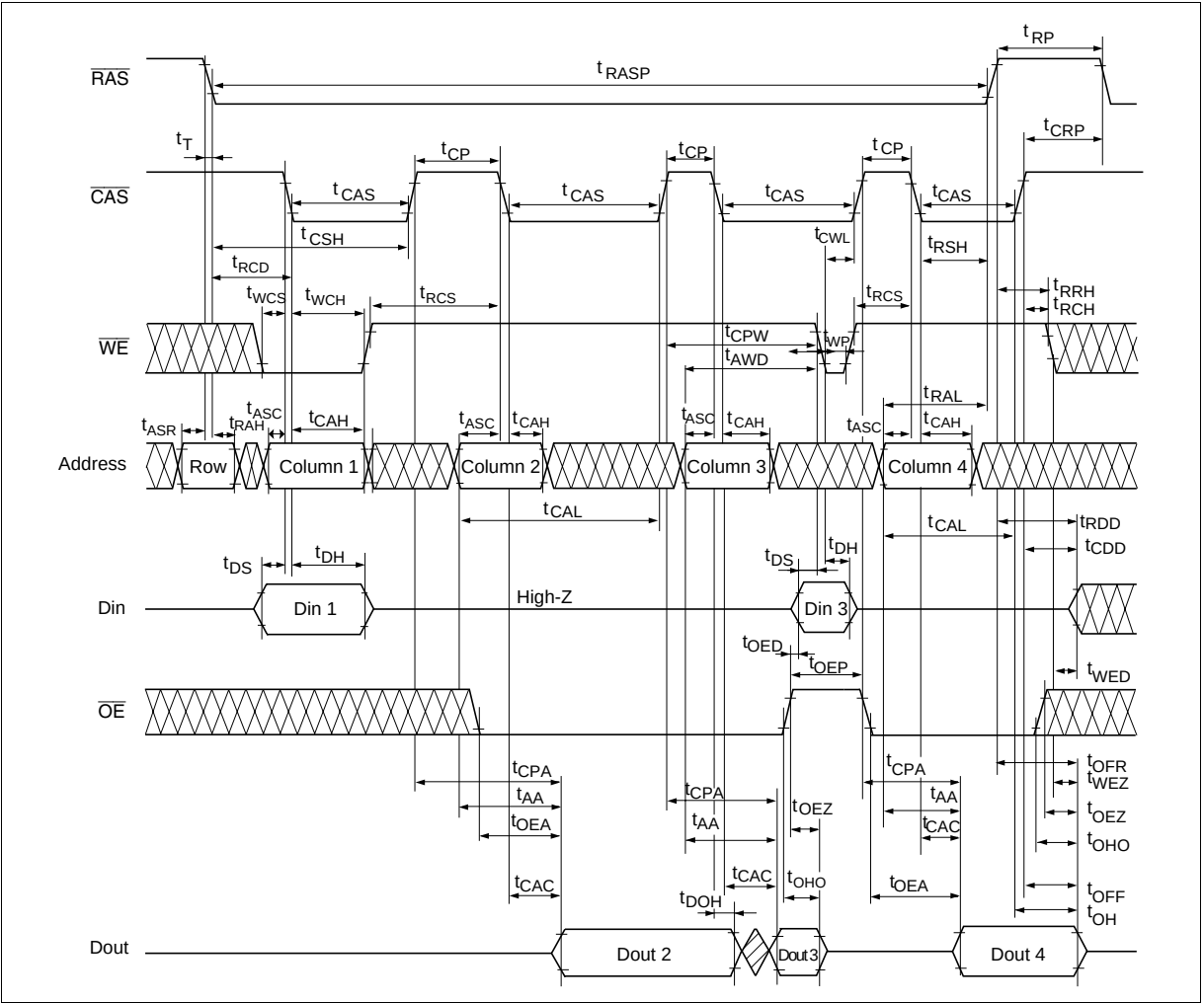
EDO Page Mode Delayed Write Cycle*18



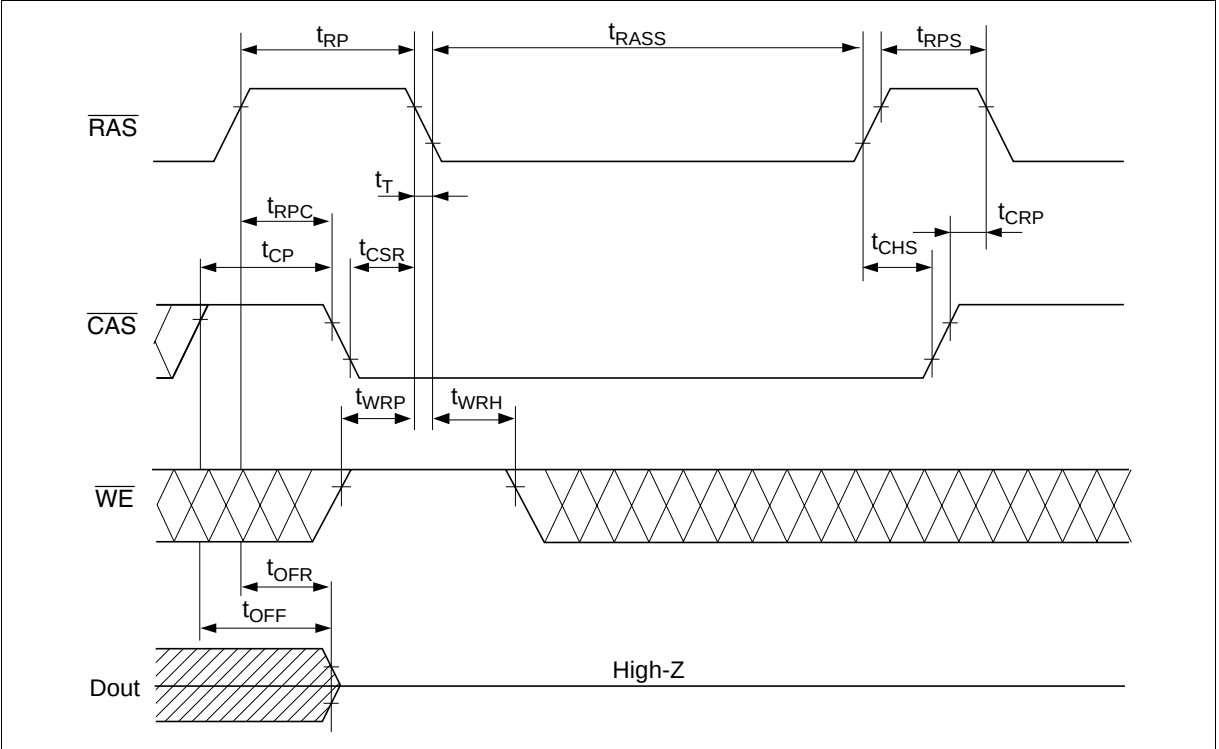
EDO Page Mode Read-Modify-Write Cycle*18



EDO Page Mode Mix Cycle (1) *20



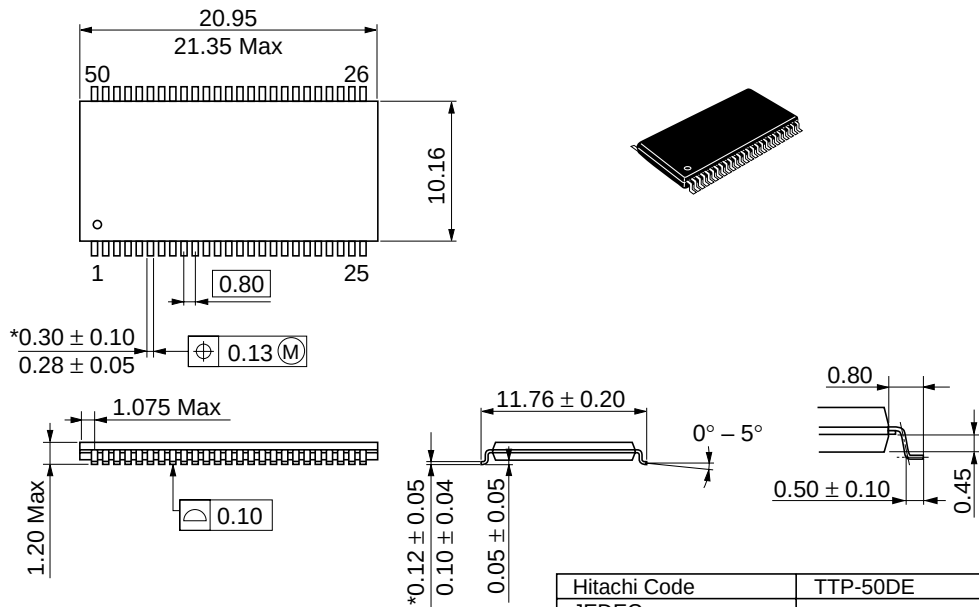
Self Refresh Cycle (L-version)*23, 24, 25



Package Dimensions

HM5113165FTD/FLTD Series (TTP-50DE)

Unit: mm



*Dimension including the plating thickness
Base material dimension

Hitachi Code	TTP-50DE
JEDEC	—
EIAJ	—
Weight (reference value)	0.56 g

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Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
0.0	May. 19, 1999	Initial issue	M. Kawamura	M. Mishima
1.0	Nov. 8, 1999	Deletion of Preliminary	M. Kawamura	Y. Kasama
2.0	Dec. 6, 1999	DC Characteristics I_{CC10} (L-version) max: 2 mA to 2.5 mA		