
HB56UW232D Series

HB56UW432D Series

2,097,152-word $\times$ 32-bit High Density Dynamic RAM Module
4,194,304-word $\times$ 32-bit High Density Dynamic RAM Module

HITACHI

ADE-203-784A (Z)
Rev.1.0
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Description

The HB56UW232D is a $2\text{M} \times 32$ dynamic RAM Small Outline Dual In-line Memory Module (S.O.DIMM), mounted 4 pieces of 16-Mbit DRAM (HM51W17805) sealed in TSOP package. The HB56UW432D is a $4\text{M} \times 32$ dynamic RAM Small Outline Dual In-line Memory Module (S.O.DIMM), mounted 8 pieces of 16-Mbit DRAM (HM51W17805) sealed in TSOP package. The HB56UW232D, HB56UW432D offer Extended Data Out (EDO) page mode as a high speed access mode. An outline of the HB56UW232D, HB56UW432D is 72-pin Zig Zag Dual tabs socket type compact and thin package. Therefore, the HB56UW232D, HB56UW432D make high density mounting possible without surface mount technology. The HB56UW232D, HB56UW432D provide common data inputs and outputs. Decoupling capacitors are mounted on the module board.

Features

- 72-pin Zig Zag Dual tabs socket type
 - Outline: 59.69 mm (Length) $\times$ 25.40 mm (Height) $\times$ 2.42/3.80 mm (Thickness)
 - Lead pitch: 1.27 mm
- Single 3.3 V (± 0.3 V) supply
- High speed
 - Access time: $t_{\text{RAC}} = 50/60/70$ ns (max)
 $t_{\text{CAC}} = 13/15/18$ ns (max)
- Low power dissipation
 - Active mode: 1.59/1.44/1.30 W (max) (HB56UW232D Series)
1.66/1.51/1.36 W (max) (HB56UW432D Series)
 - Standby mode (TTL): 28.8/57.6 mW (max)
(CMOS): 2.16/4.32 mW (max) (L-version)
- EDO page mode capability
- Refresh period
 - 2048 refresh cycles: 32 ms
128 ms (L-version)
- 4 variations of refresh

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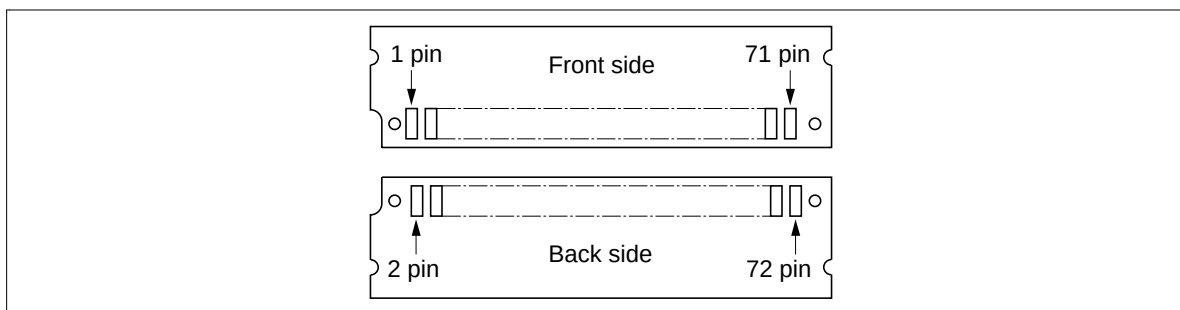
- $\overline{\text{RAS}}$ -only refresh
- $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh
- Hidden refresh
- Self refresh (L-version)

Ordering Information

Type No.	Access time	Package	Contact pad
HB56UW232D-5	50 ns	72-pin small outline DIMM	Gold
HB56UW232D -6	60 ns		
HB56UW232D -7	70 ns		
HB56UW232D -5L	50 ns		
HB56UW232D -6L	60 ns		
HB56UW232D -7L	70 ns		
HB56UW432D -5	50 ns		
HB56UW432D -6	60 ns		
HB56UW432D -7	70 ns		
HB56UW432D -5L	50 ns		
HB56UW432D -6L	60 ns		
HB56UW432D -7L	70 ns		

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Pin Arrangement



Front side				Back side			
Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name
1	V _{SS}	37	DQ18	2	DQ0	38	DQ19
3	DQ1	39	V _{SS}	4	DQ2	40	$\overline{\text{CE}}0$
5	DQ3	41	$\overline{\text{CE}}2$	6	DQ4	42	$\overline{\text{CE}}3$
7	DQ5	43	$\overline{\text{CE}}1$	8	DQ6	44	$\overline{\text{RE}}0$
9	DQ7	45	$\overline{\text{RE}}1(\text{NC})^{*2}$	10	V _{CC}	46	NC
11	PD1	47	$\overline{\text{WE}}$	12	A0	48	NC
13	A1	49	DQ20	14	A2	50	DQ21
15	A3	51	DQ22	16	A4	52	DQ23
17	A5	53	DQ24	18	A6	54	DQ25
19	A10	55	NC	20	NC	56	DQ27
21	DQ9	57	DQ28	22	DQ10	58	DQ29
23	DQ11	59	DQ31	24	DQ12	60	DQ30
25	DQ13	61	V _{CC}	26	DQ14	62	DQ32
27	DQ15	63	DQ33	28	A7	64	DQ34
29	NC	65	NC	30	V _{CC}	66	PD2
31	A8	67	PD3	32	A9	68	PD4
33	$\overline{\text{RE}}3(\text{NC})^{*1}$	69	PD5	34	$\overline{\text{RE}}2$	70	PD6
35	DQ16	71	PD7	36	NC	72	V _{SS}

Notes: 1. $\overline{\text{RE}}3$: HB56UW432D, NC: HB56UW232D

2. $\overline{\text{RE}}1$: HB56UW432D, NC: HB56UW232D

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Pin Description

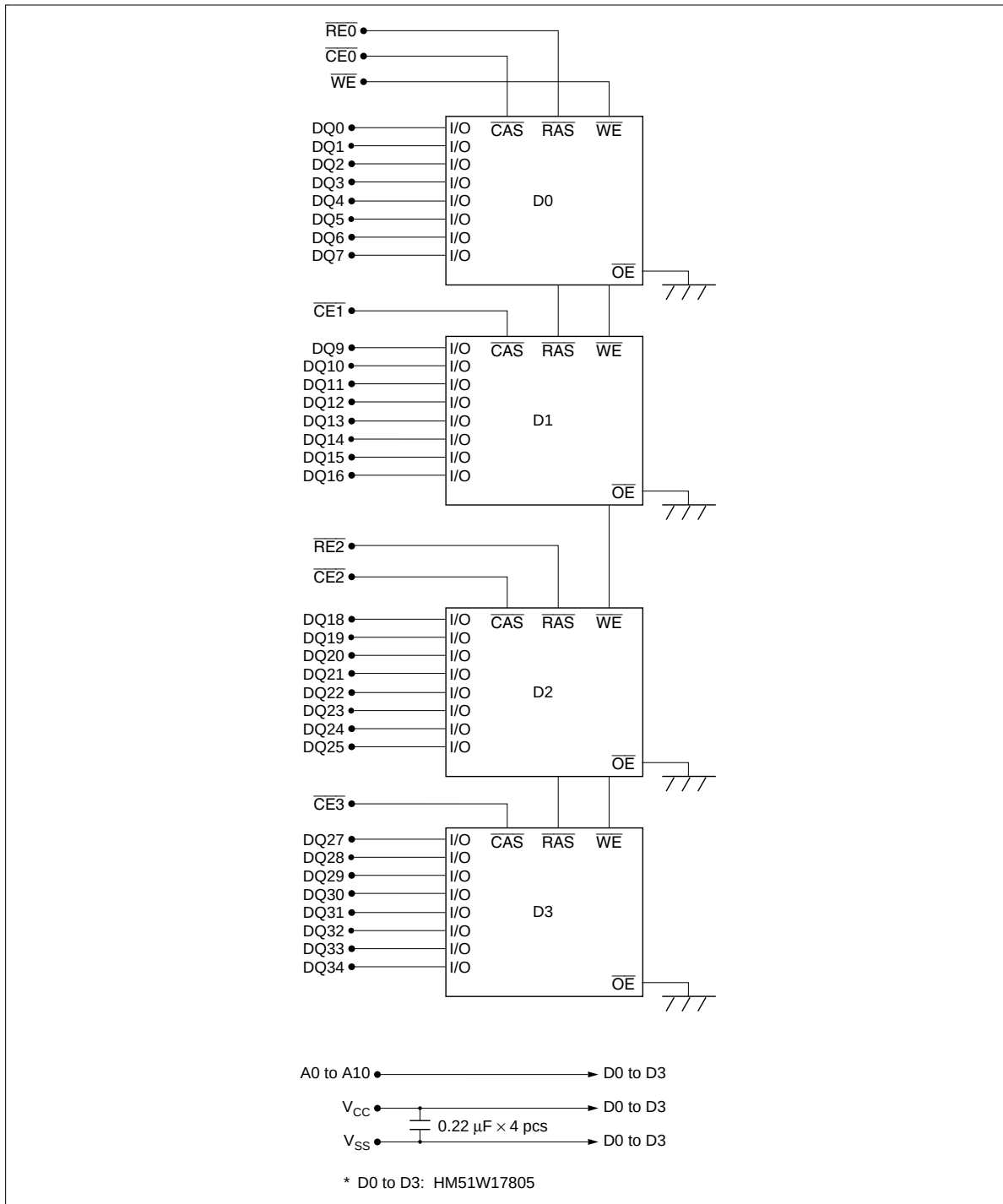
Pin name	Function
A0 to A10	Address inputs: • Row address: A0 to A10 • Column address: A0 to A9 • Refresh address: A0 to A10
DQ0 to DQ7, DQ9 to DQ16, DQ18 to DQ25, DQ27 to DQ34	Data-in/Data-out
$\overline{\text{RE0}}$ to $\overline{\text{RE3}}$	Row address strobe ($\overline{\text{RAS}}$)
$\overline{\text{CE0}}$ to $\overline{\text{CE3}}$	Column address strobe ($\overline{\text{CAS}}$)
$\overline{\text{WE}}$	Read/Write enable
V_{CC}	Power supply
V_{SS}	Ground
PD1 to PD7	Presence detect
NC	No connection

Presence Detect Pin Arrangement

Pin No.	Pin name	Function		
		50 ns	60 ns	70 ns
11	PD1	V_{SS}	V_{SS}	V_{SS}
66	PD2	NC	NC	NC
67	PD3	V_{SS}	V_{SS}	V_{SS}
68	PD4 (HB56UW232D)	NC	NC	NC
	PD4 (HB56UW432D)	V_{SS}	V_{SS}	V_{SS}
69	PD5	V_{SS}	NC	V_{SS}
70	PD6	V_{SS}	NC	NC
71	PD7	NC	NC	NC
	PD7 (L-version)	V_{SS}	V_{SS}	V_{SS}

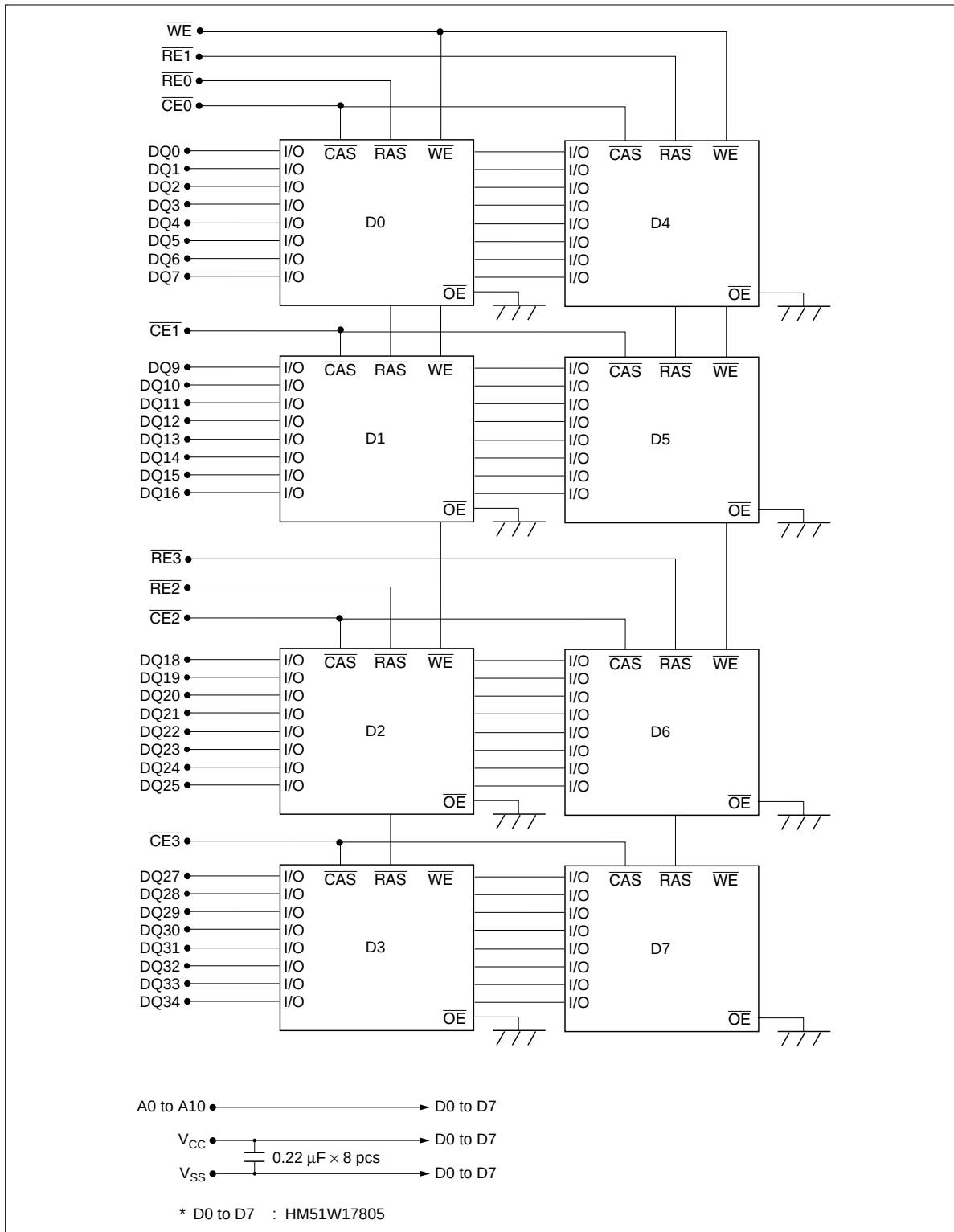
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Block Diagram (HB56UW232D)



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Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Voltage on any pin relative to V_{SS}	V_T	−0.5 to +4.6	V
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	4	W
Operating temperature	T_{opr}	0 to +70	°C
Storage temperature	T_{stg}	−55 to +125	°C

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

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply voltage	V_{SS}	0	0	0	V	
	V_{CC}	3.0	3.3	3.6	V	1
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} .

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DC Characteristics (Ta = 0 to 70°C, V_{CC} = 3.3 V ± 0.3V, V_{SS} = 0 V) (HB56UW232D)

Parameter	Symbol	50 ns		60 ns		70 ns		Unit	Test conditions	Notes
		Min	Max	Min	Max	Min	Max			
Operating current	I _{CC1}	—	440	—	400	—	360	mA	t _{RC} = min	1, 2
Standby current	I _{CC2}	—	8	—	8	—	8	mA	TTL interface RAS, CAS = V _{IH} Dout = High-Z	
		—	4	—	4	—	4	mA	CMOS interface RAS, CAS ≥ V _{CC} − 0.2 V Dout = High-Z	
Standby current (L-version)	I _{CC2}	—	0.6	—	0.6	—	0.6	mA	CMOS interface RAS, CAS ≥ V _{CC} − 0.2 V Dout = High-Z	
RAS-only refresh current	I _{CC3}	—	440	—	400	—	360	mA	t _{RC} = min	2
Standby current	I _{CC5}	—	20	—	20	—	20	mA	RAS = V _{IH} , CAS = V _{IL} Dout = enable	1
CAS-before-RAS refresh current	I _{CC6}	—	440	—	400	—	360	mA	t _{RC} = min	
EDO page mode current	I _{CC7}	—	400	—	360	—	340	mA	t _{HPC} = min	1, 3
Battery backup current (Standby with CBR refresh) (L-version)	I _{CC10}	—	1.6	—	1.6	—	1.6	mA	CMOS interface Dout = High-Z CBR refresh: t _{RC} = 62.5 μs t _{RAS} ≤ 0.3 μs	4
Self refresh mode current (L-version)	I _{CC11}	—	1	—	1	—	1	mA	CMOS interface RAS, CAS ≤ 0.2 V Dout = High-Z	
Input leakage current	I _{LI}	−10	10	−10	10	−10	10	μA	0 V ≤ Vin ≤ 4.6 V	
Output leakage current	I _{LO}	−10	10	−10	10	−10	10	μA	0 V ≤ Vout ≤ 4.6 V Dout = disable	
Output high voltage	V _{OH}	2.4	V _{CC}	2.4	V _{CC}	2.4	V _{CC}	V	High Iout = −2 mA	
Output low voltage	V _{OL}	0	0.4	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 while CAS = V_{IH}.

4. CAS = L (≤ 0.2 V) while RAS = L (≤ 0.2 V).

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DC Characteristics ($T_a = 0$ to 70°C , $V_{CC} = 3.3 \text{ V} \pm 0.3\text{V}$, $V_{SS} = 0 \text{ V}$) (HB56UW432D)

Parameter	Symbol	50 ns		60 ns		70 ns		Unit	Test conditions	Notes
		Min	Max	Min	Max	Min	Max			
Operating current	I_{CC1}	—	460	—	420	—	380	mA	$t_{RC} = \min$	1, 2
Standby current	I_{CC2}	—	16	—	16	—	16	mA	TTL interface $\overline{RAS}, \overline{CAS} = V_{IH}$ Dout = High-Z	
		—	8	—	8	—	8	mA	CMOS interface $\overline{RAS}, \overline{CAS} \geq V_{CC} - 0.2 \text{ V}$ Dout = High-Z	
Standby current (L-version)	I_{CC2}	—	1.2	—	1.2	—	1.2	mA	CMOS interface $\overline{RAS}, \overline{CAS} \geq V_{CC} - 0.2 \text{ V}$ Dout = High-Z	
$\overline{RAS}$ -only refresh current	I_{CC3}	—	460	—	420	—	380	mA	$t_{RC} = \min$	2
Standby current	I_{CC5}	—	40	—	40	—	40	mA	$\overline{RAS} = V_{IH}, \overline{CAS} = V_{IL}$ Dout = enable	1
$\overline{CAS}$ -before- $\overline{RAS}$ refresh current	I_{CC6}	—	460	—	420	—	380	mA	$t_{RC} = \min$	
EDO page mode current	I_{CC7}	—	420	—	380	—	360	mA	$t_{HPC} = \min$	1, 3
Battery backup current (Standby with CBR refresh) (L-version)	I_{CC10}	—	3.2	—	3.2	—	3.2	mA	CMOS interface Dout = High-Z CBR refresh: $t_{RC} = 62.5 \mu\text{s}$ $t_{RAS} \leq 0.3 \mu\text{s}$	4
Self refresh mode current (L-version)	I_{CC11}	—	2	—	2	—	2	mA	CMOS interface $\overline{RAS}, \overline{CAS} \leq 0.2 \text{ V}$ Dout = High-Z	
Input leakage current	I_{LI}	-10	10	-10	10	-10	10	μA	$0 \text{ V} \leq V_{in} \leq 4.6 \text{ V}$	
Output leakage current	I_{LO}	-10	10	-10	10	-10	10	μA	$0 \text{ V} \leq V_{out} \leq 4.6 \text{ V}$ Dout = disable	
Output high voltage	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	High Iout = -2 mA	
Output low voltage	V_{OL}	0	0.4	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 $\overline{RAS} = V_{IL}$.
 3. Address can be changed once or less while $\overline{CAS} = V_{IH}$.
 4. $\overline{CAS} = L (\leq 0.2 \text{ V})$ while $\overline{RAS} = L (\leq 0.2 \text{ V})$.

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Capacitance (Ta = 25°C, V_{CC} = 3.3 V ± 0.3 V) (HB56UW232D)

Parameter	Symbol	Typ	Max	Unit	Notes
Input capacitance (Address)	C _{II}	—	40	pF	1
Input capacitance ($\overline{\text{WE}}$)	C _{I2}	—	48	pF	1
Input capacitance ($\overline{\text{RAS}}$)	C _{I3}	—	30	pF	1
Input capacitance ($\overline{\text{CAS}}$)	C _{I4}	—	23	pF	1
I/O capacitance (DQ)	C _{I/O}	—	23	pF	1, 2

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

Capacitance (Ta = 25°C, V_{CC} = 3.3 V ± 0.3 V) (HB56UW432D)

Parameter	Symbol	Typ	Max	Unit	Notes
Input capacitance (Address)	C _{II}	—	60	pF	1
Input capacitance ($\overline{\text{WE}}$)	C _{I2}	—	76	pF	1
Input capacitance ($\overline{\text{RAS}}$)	C _{I3}	—	30	pF	1
Input capacitance ($\overline{\text{CAS}}$)	C _{I4}	—	30	pF	1
I/O capacitance (DQ)	C _{I/O}	—	30	pF	1, 2

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

AC Characteristics (Ta = 0 to 70°C, V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V) *¹, *², *¹⁸

Test Conditions

- Input rise and fall times: 2 ns
- Input level: 0 V, 3.0V
- 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)

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Read, Write, and Refresh Cycles (Common parameters)

Parameter	Symbol	50 ns		60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max	Min	Max		
Random read or write cycle time	t_{RC}	84	—	104	—	124	—	ns	
$\overline{RAS}$ precharge time	t_{RP}	30	—	40	—	50	—	ns	
$\overline{CAS}$ precharge time	t_{CP}	8	—	10	—	13	—	ns	
$\overline{RAS}$ pulse width	t_{RAS}	50	10000	60	10000	70	10000	ns	
$\overline{CAS}$ pulse width	t_{CAS}	8	10000	10	10000	13	10000	ns	
Row address setup time	t_{ASR}	0	—	0	—	0	—	ns	
Row address hold time	t_{RAH}	8	—	10	—	10	—	ns	
Column address setup time	t_{ASC}	0	—	0	—	0	—	ns	
Column address hold time	t_{CAH}	8	—	10	—	13	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ delay time	t_{RCD}	12	37	14	45	14	52	ns	3
$\overline{RAS}$ to column address delay time	t_{RAD}	10	25	12	30	12	35	ns	4
$\overline{RAS}$ hold time	t_{RSH}	10	—	13	—	13	—	ns	
$\overline{CAS}$ hold time	t_{CSH}	35	—	40	—	45	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ precharge time	t_{CRP}	5	—	5	—	5	—	ns	
$\overline{CAS}$ delay time from Din	t_{DZC}	0	—	0	—	0	—	ns	
Transition time (rise and fall)	t_T	2	50	2	50	2	50	ns	5
Refresh period (2,048 cycles)	t_{REF}	—	32	—	32	—	32	ms	
Refresh period (2,048 cycles) (L-version)	t_{REF}	—	128	—	128	—	128	ms	

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Read Cycle

Parameter	Symbol	50 ns		60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max	Min	Max		
Access time from $\overline{\text{RAS}}$	t_{RAC}	—	50	—	60	—	70	ns	6, 7
Access time from $\overline{\text{CAS}}$	t_{CAC}	—	13	—	15	—	18	ns	7, 8, 15
Access time from address	t_{AA}	—	25	—	30	—	35	ns	7, 9, 15
Read command setup time	t_{RCS}	0	—	0	—	0	—	ns	
Read command hold time to $\overline{\text{CAS}}$	t_{RCH}	0	—	0	—	0	—	ns	10
Read command hold time from $\overline{\text{RAS}}$	t_{RCHR}	50	—	60	—	70	—	ns	
Read command hold time to $\overline{\text{RAS}}$	t_{RRH}	5	—	5	—	5	—	ns	10
Column address to $\overline{\text{RAS}}$ lead time	t_{RAL}	25	—	30	—	35	—	ns	
Column address to $\overline{\text{CAS}}$ lead time	t_{CAL}	15	—	18	—	23	—	ns	
$\overline{\text{CAS}}$ to output in low-Z	t_{CLZ}	0	—	0	—	0	—	ns	
Output data hold time	t_{OH}	3	—	3	—	3	—	ns	19
Output buffer turn-off time	t_{OFF}	—	13	—	15	—	15	ns	11, 19
$\overline{\text{CAS}}$ to Din delay time	t_{CDD}	13	—	15	—	18	—	ns	
Output data hold time from $\overline{\text{RAS}}$	t_{OHR}	3	—	3	—	3	—	ns	19
Output buffer turn-off time to $\overline{\text{RAS}}$	t_{OFR}	—	13	—	15	—	15	ns	19
Output buffer turn-off to $\overline{\text{WE}}$	t_{WEZ}	—	13	—	15	—	15	ns	
$\overline{\text{WE}}$ to Din delay time	t_{WED}	13	—	15	—	18	—	ns	
$\overline{\text{RAS}}$ to Din delay time	t_{RDD}	13	—	15	—	18	—	ns	
$\overline{\text{RAS}}$ to next $\overline{\text{CAS}}$ delay time	t_{RNCD}	50	—	60	—	70	—	ns	

Write Cycle

Parameter	Symbol	50 ns		60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max	Min	Max		
Write command setup time	t_{WCS}	0	—	0	—	0	—	ns	12
Write command hold time	t_{WCH}	8	—	10	—	13	—	ns	
Write command pulse width	t_{WP}	8	—	10	—	10	—	ns	
Data-in setup time	t_{DS}	0	—	0	—	0	—	ns	13
Data-in hold time	t_{DH}	8	—	10	—	13	—	ns	13

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Refresh Cycle

Parameter	Symbol	50 ns		60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max	Min	Max		
CAS setup time (CBR refresh cycle)	t_{CSR}	5	—	5	—	5	—	ns	
CAS hold time (CBR refresh cycle)	t_{CHR}	8	—	10	—	10	—	ns	
WE setup time (CBR refresh cycle)	t_{WRP}	0	—	0	—	0	—	ns	
WE hold time (CBR refresh cycle)	t_{WRH}	8	—	10	—	10	—	ns	
RAS precharge to CAS hold time	t_{RPC}	5	—	5	—	5	—	ns	

EDO Page Mode Cycle

Parameter	Symbol	50 ns		60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max	Min	Max		
EDO page mode cycle time	t_{HPC}	20	—	25	—	30	—	ns	16
EDO page mode RAS pulse width	t_{RASP}	—	100000	—	100000	—	100000	ns	14
Access time from CAS precharge	t_{CPA}	—	30	—	35	—	40	ns	7, 15
RAS hold time from CAS precharge	t_{CPRH}	30	—	35	—	40	—	ns	
Output data hold time from CAS low	t_{DOH}	3	—	3	—	3	—	ns	7, 15
Read command hold time from CAS precharge	t_{RCHC}	30	—	35	—	40	—	ns	

Self Refresh Mode (L-version)

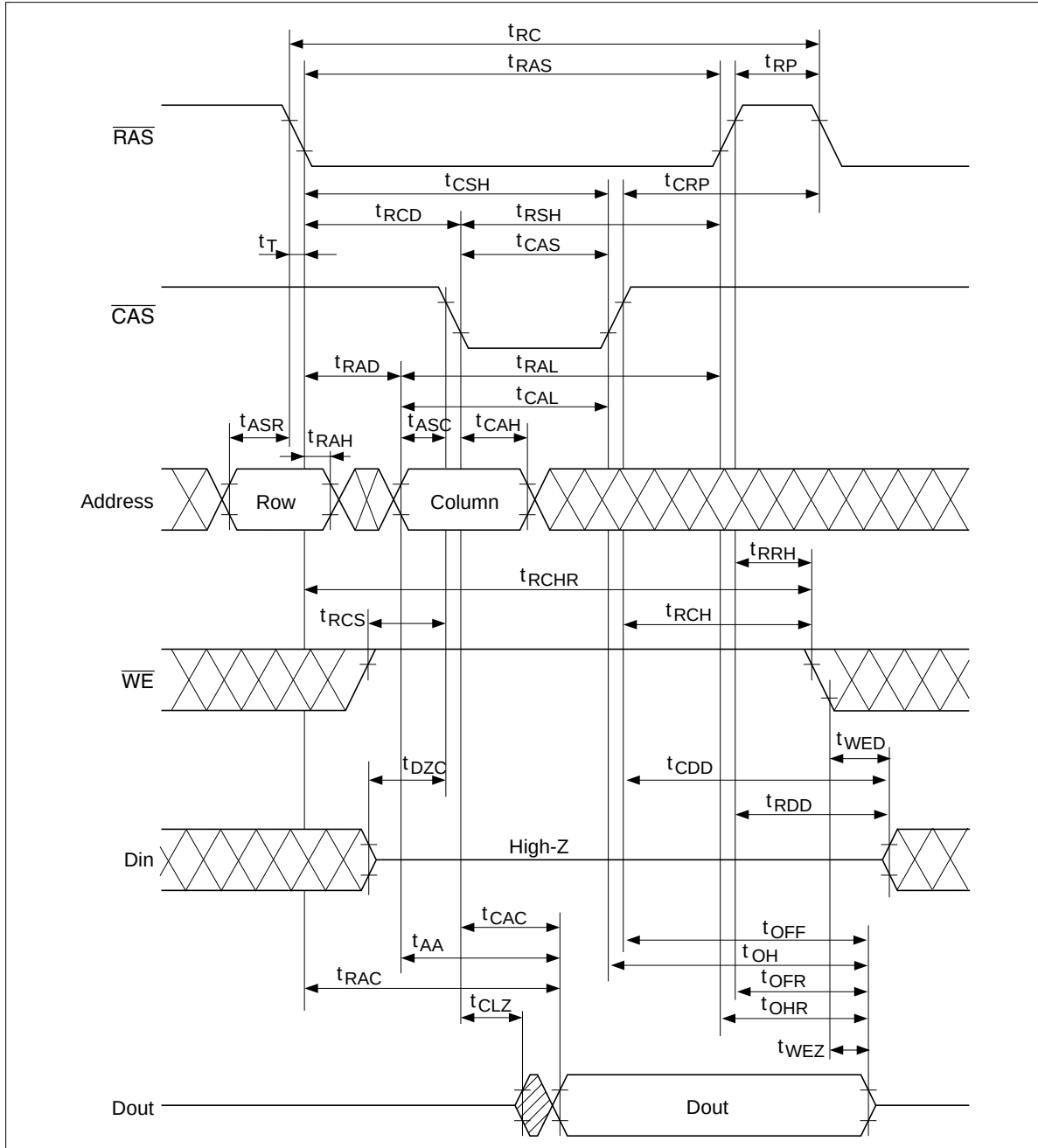
Parameter	Symbol	50 ns		60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max	Min	Max		
RAS pulse width (Self refresh)	t_{RASS}	100	—	100	—	100	—	μs	
RAS precharge time (Self refresh)	t_{RPS}	90	—	110	—	130	—	ns	
CAS hold time (Self refresh)	t_{CHS}	−50	—	−50	—	−50	—	ns	

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- Notes:
1. AC measurements assume $t_r = 2$ ns.
 2. An initial pause of 200 μ s is required after power up followed by a minimum of eight initialization cycles (any combination of cycles containing $\overline{\text{RAS}}$ -only refresh cycle or $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh). If the internal refresh counter is used, a minimum of eight $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh cycles are required.
 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 $t_{\text{RCD}} \geq t_{\text{RCD}} (\text{max}) + t_{\text{AA}} (\text{max}) - t_{\text{CAC}} (\text{max})$, then 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. 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 $t_{\text{RCD}} \leq t_{\text{RCD}} (\text{max})$ and $t_{\text{RAD}} \leq t_{\text{RAD}} (\text{max})$. If t_{RCD} or t_{RAD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
 7. Measured with a load circuit equivalent to 1 TTL loads and 100 pF.
 8. Assumes that $t_{\text{RCD}} \geq t_{\text{RCD}} (\text{max})$ and $t_{\text{RCD}} + t_{\text{CAC}} (\text{max}) \geq t_{\text{RAD}} + t_{\text{AA}} (\text{max})$.
 9. Assumes that $t_{\text{RAD}} \geq t_{\text{RAD}} (\text{max})$ and $t_{\text{RCD}} + t_{\text{CAC}} (\text{max}) \leq t_{\text{RAD}} + t_{\text{AA}} (\text{max})$.
 10. Either t_{RCH} or t_{RRH} must be satisfied for a read cycles.
 11. t_{OFF} (max) defines the time at which the outputs achieve the open circuit condition and are not referred to output voltage levels.
 12. Early write cycle only ($t_{\text{WCS}} \geq t_{\text{WCS}} (\text{min})$).
 13. These parameters are referred to $\overline{\text{CAS}}$ leading edge in early write cycles.
 14. t_{RASp} defines $\overline{\text{RAS}}$ pulse width in EDO page mode cycles.
 15. Access time is determined by the longest among t_{AA} , t_{CAC} and t_{CPA} .
 16. t_{HPC} (min) can be achieved during a series of EDO page mode write cycles or EDO page mode read cycles.
 17. 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.
 18. All the V_{CC} and V_{SS} pins shall be supplied with the same voltages.
 19. 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} .
 20. 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 $t_{\text{RASS}} \geq 100 \mu\text{s}$, then $\overline{\text{RAS}}$ precharge time should use t_{RPS} instead of t_{RP} .
 21. If you use distributed CBR refresh mode with 15.6 μs interval in normal read/write cycle, CBR refresh should be executed within 15.6 μs immediately after exiting from and before entering into self refresh mode.
 22. If you use $\overline{\text{RAS}}$ only refresh or CBR burst refresh mode in normal read/write cycle, 2048 cycles of distributed CBR refresh with 15.6 μs interval should be executed within 32 ms immediately after exiting from and before entering into the self refresh mode.
 23. Repetitive self refresh mode without refreshing all memory is not allowed. Once you exit from self fresh mode, all memory cells need to be refreshed before re-entering the self refresh mode again.
 24. XXX: H or L (H: $V_{\text{IH}} (\text{min}) \leq V_{\text{IN}} \leq V_{\text{IH}} (\text{max})$, L: $V_{\text{IL}} (\text{min}) \leq V_{\text{IN}} \leq V_{\text{IL}} (\text{max})$)
/////: 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} .

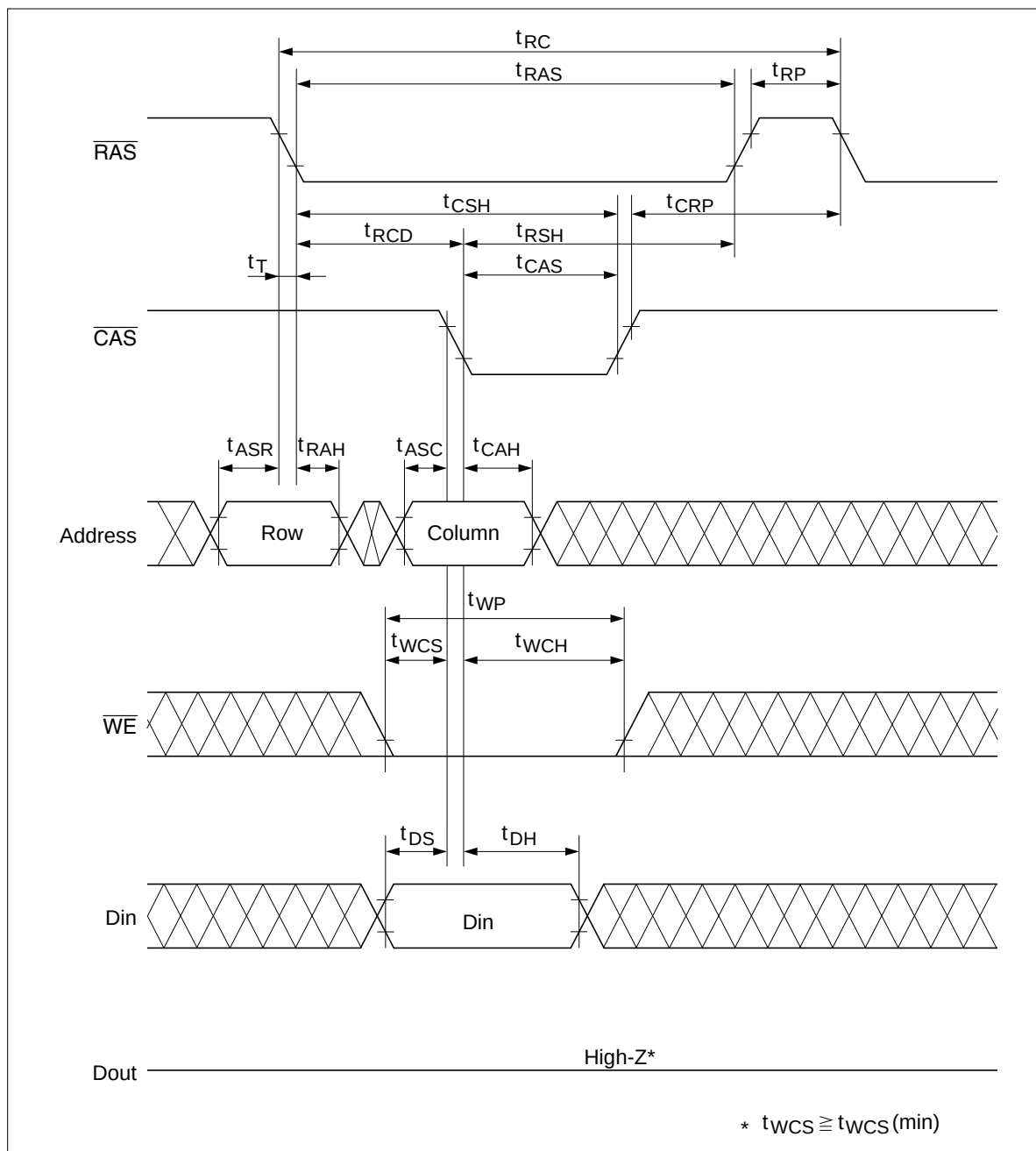
Timing Waveforms*24

Read Cycle



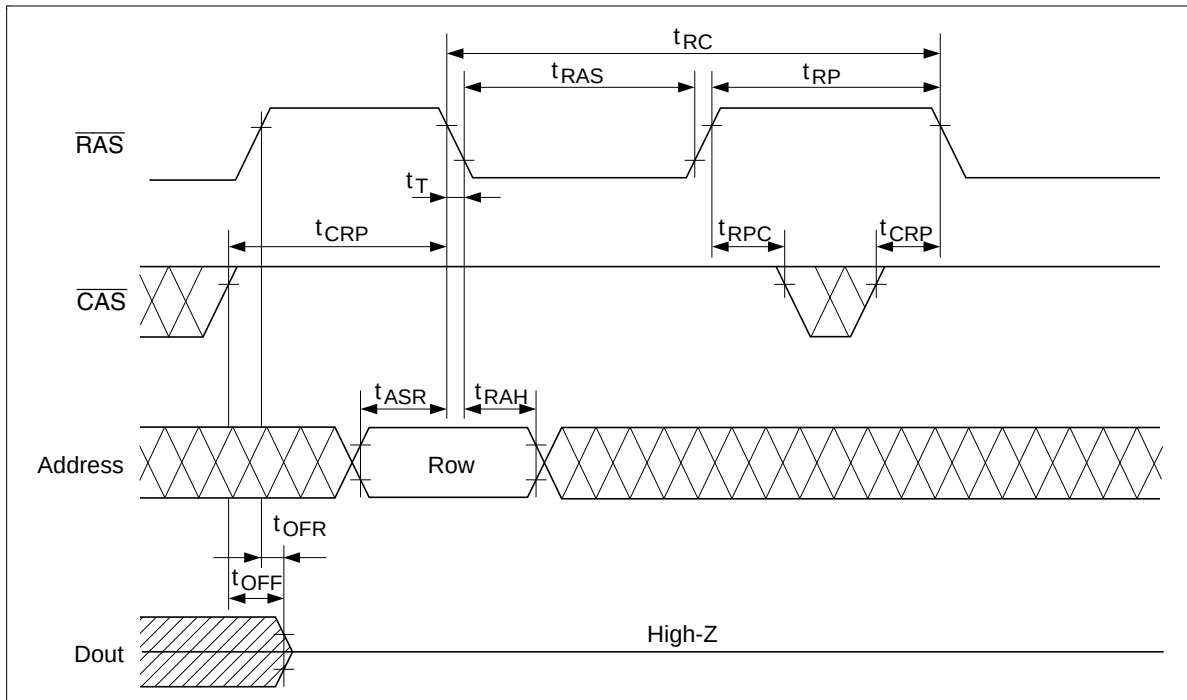
HB56UW232D Series, HB56UW432D Series

Early Write Cycle



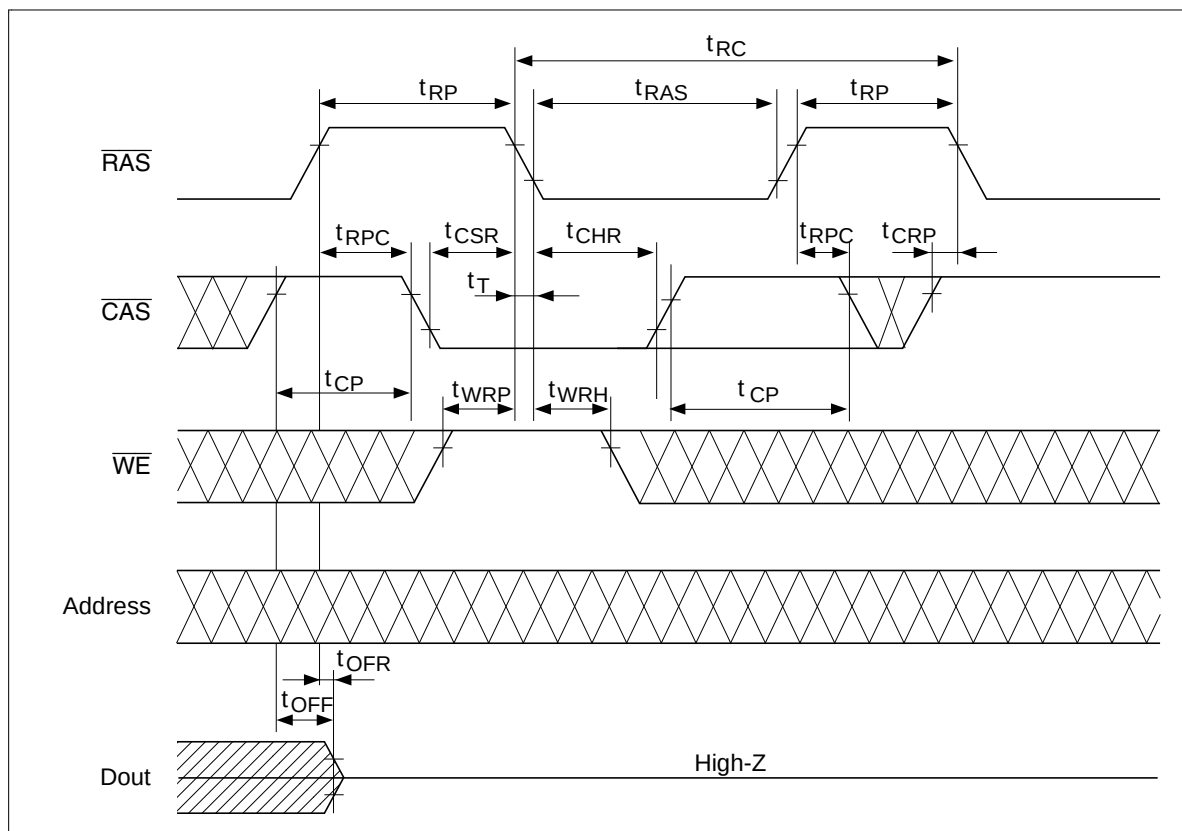
HB56UW232D Series, HB56UW432D Series

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



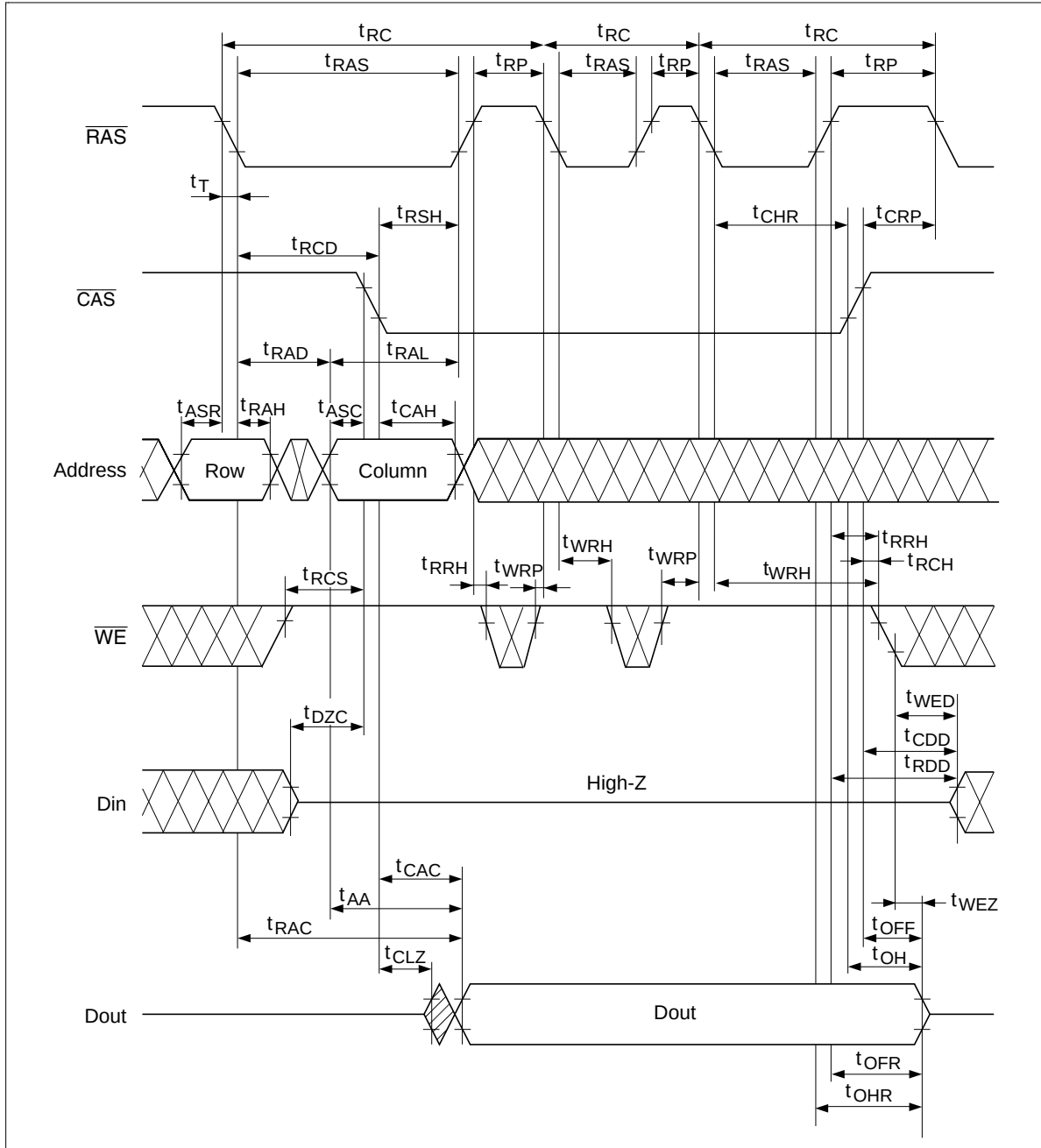
HB56UW232D Series, HB56UW432D Series

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



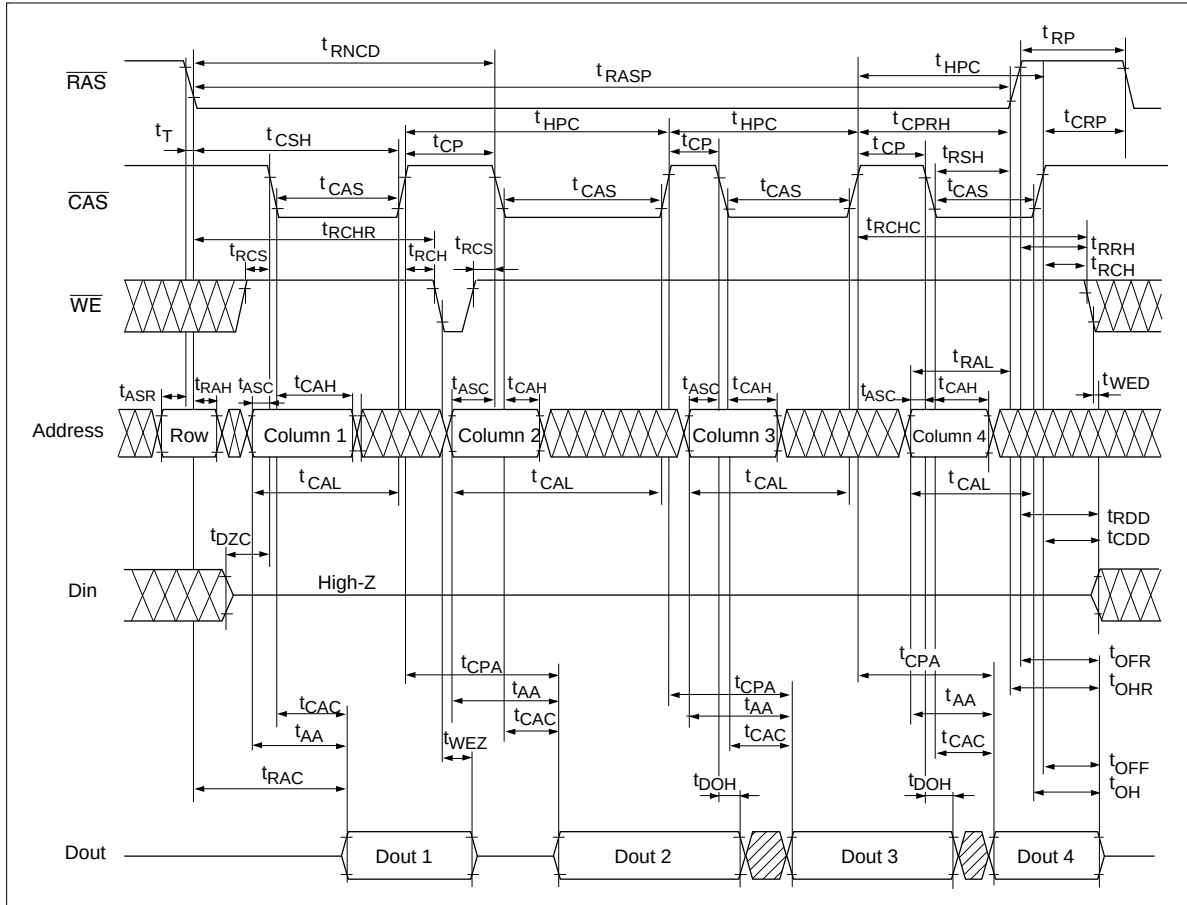
HB56UW232D Series, HB56UW432D Series

Hidden Refresh Cycle



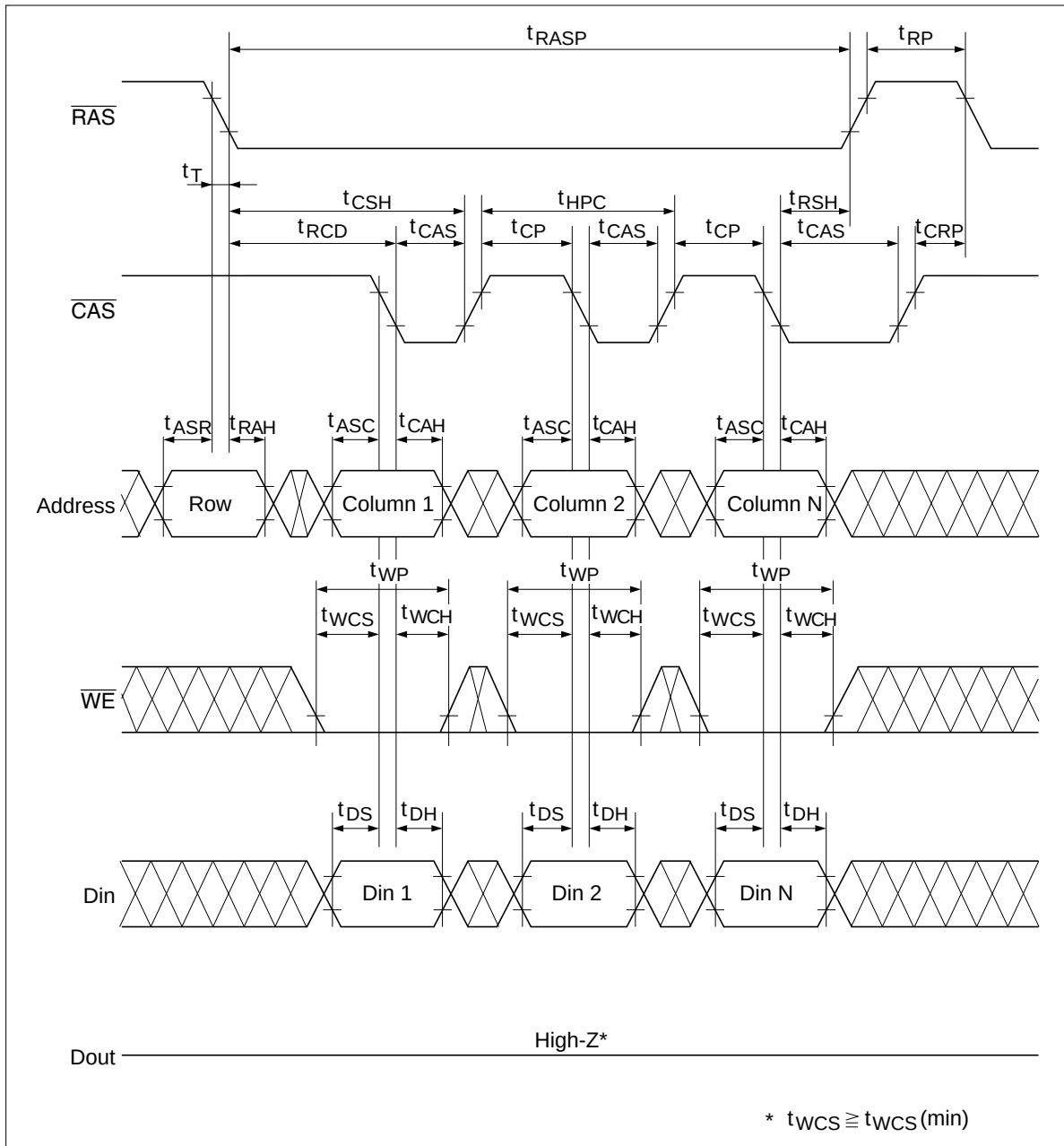
HB56UW232D Series, HB56UW432D Series

EDO Page Mode Read Cycle



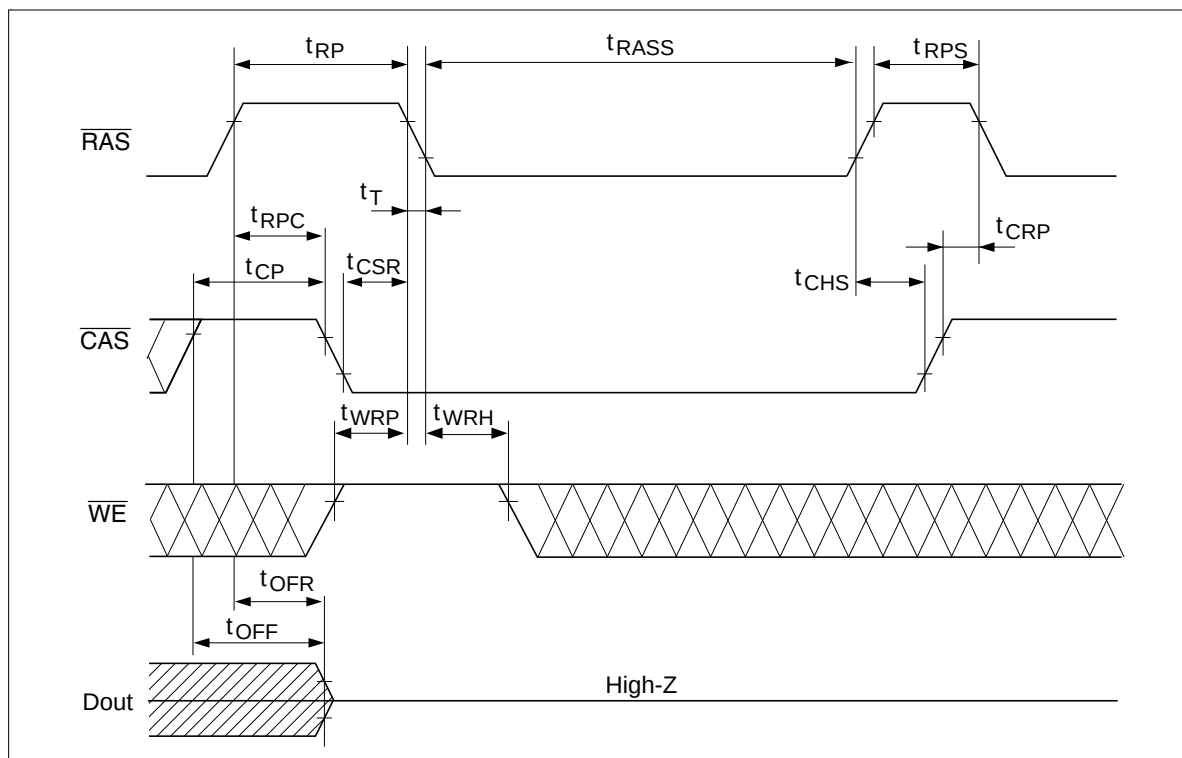
HB56UW232D Series, HB56UW432D Series

EDO Page Mode Early Write Cycle



HB56UW232D Series, HB56UW432D Series

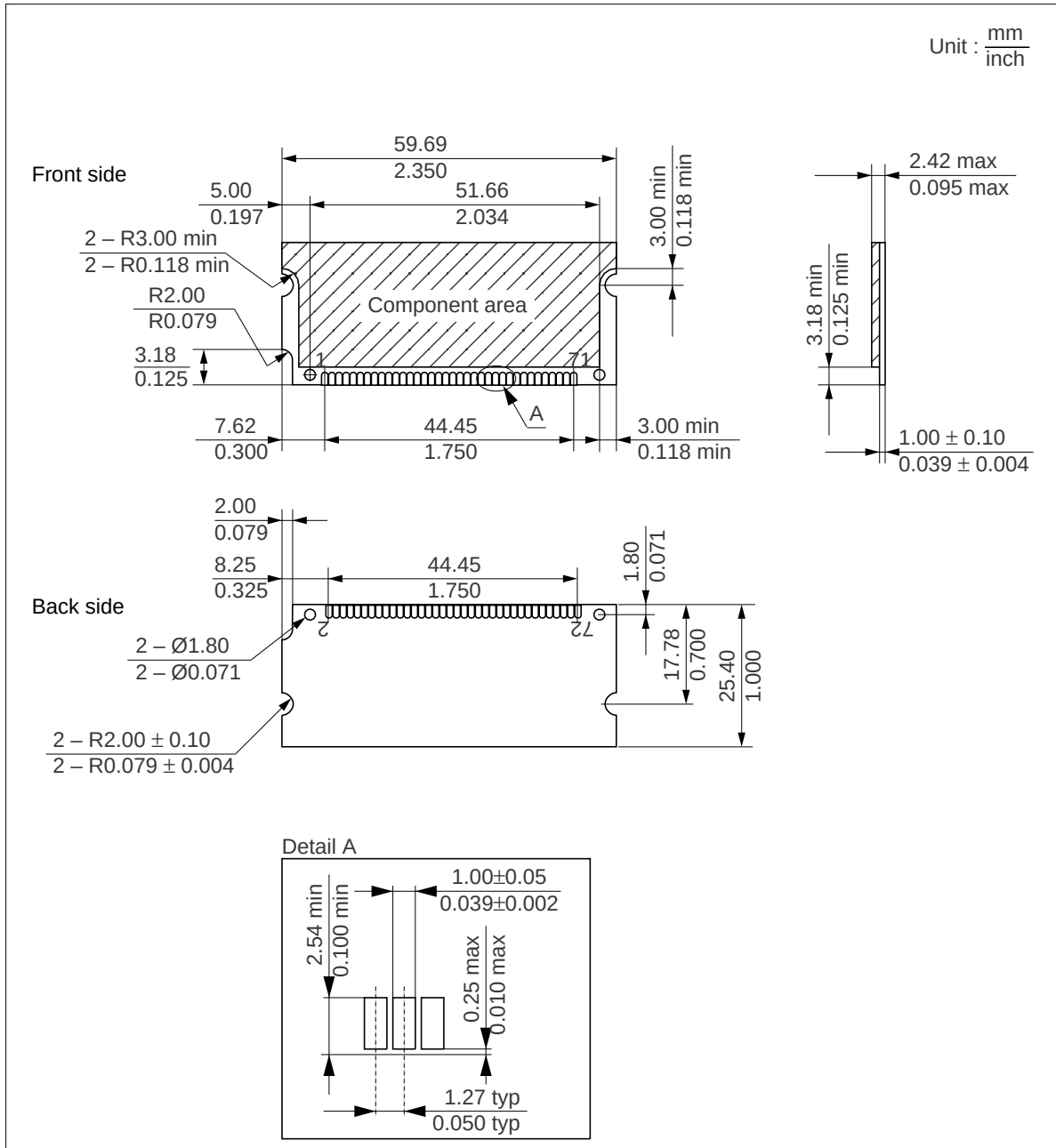
Self Refresh Cycle (L-version)* 20, 21, 22, 23



HB56UW232D Series, HB56UW432D Series

Physical Outline

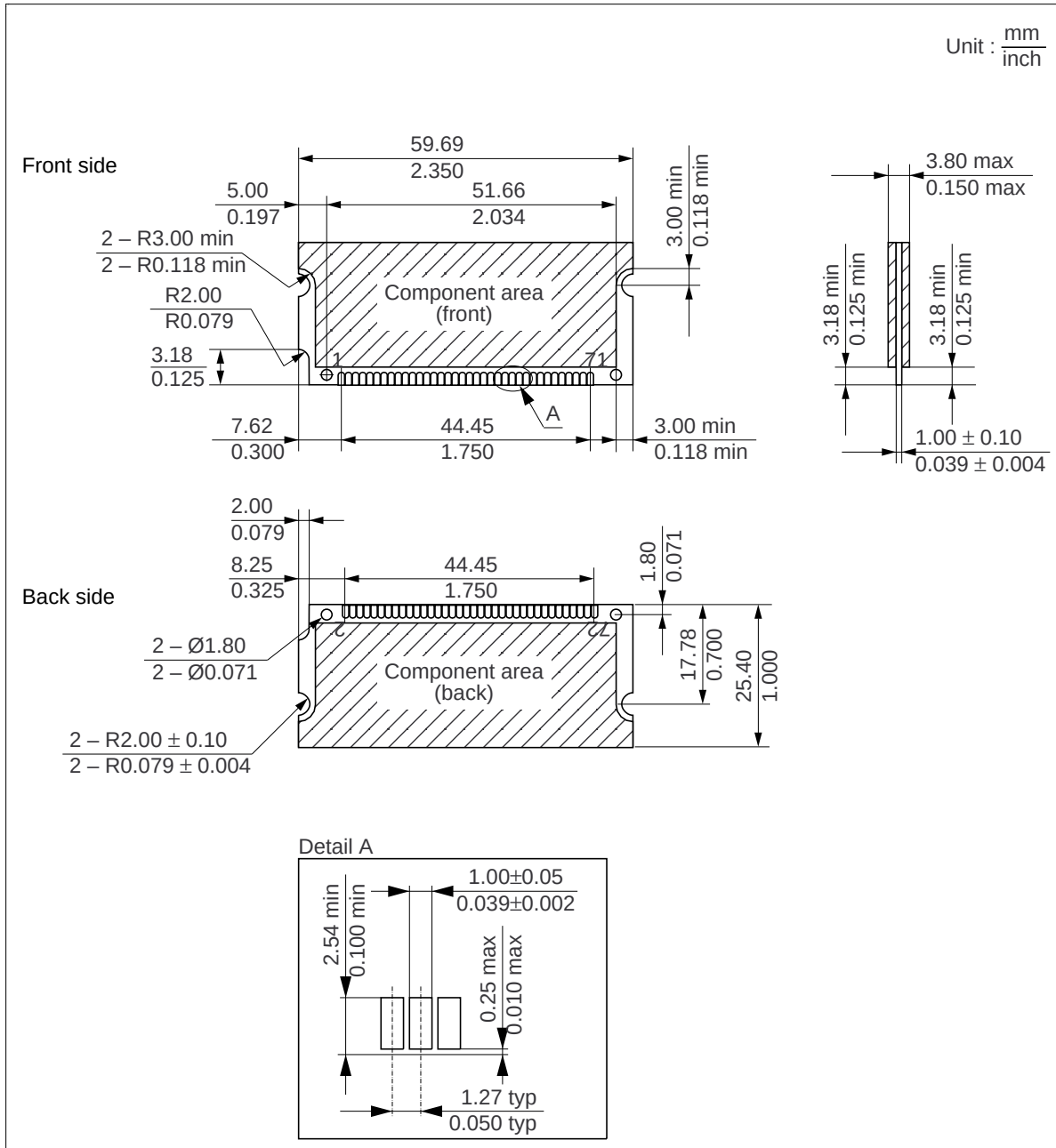
HB56UW232D Series



HB56UW232D Series, HB56UW432D Series

Physical Outline

HB56UW432D Series



HB56UW232D Series, HB56UW432D Series

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HB56UW232D Series, HB56UW432D Series

Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
1.0	May. 20, 1997	(referred to HM51W17805 rev 3.0) Initial issue		
