
HB56SW864DBK Series

8,338,608-word × 64-bit High Density Dynamic RAM Module

HITACHI

ADE-203-777A (Z)

Rev.1.0

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Description

The HB56SW864DBK is a 8M × 64 dynamic RAM Small Outline Dual In-line Memory Module (S.O.DIMM), mounted 32 pieces of 16-Mbit DRAM (HM51W16405) sealed in TCP package and 1 piece of serial EEPROM (24C02) for Presence Detect (PD). The HB56SW864DBK offers Extended Data Out (EDO) Page Mode as a high speed access mode. An outline of the HB56SW864DBK is 144-pin Zig Zag Dual tabs socket type compact and thin package. Therefore, the HB56SW864DBK makes high density mounting possible without surface mount technology. The HB56SW864DBK provides common data inputs and outputs. Decoupling capacitors are mounted beside each TCP on the module board.

Features

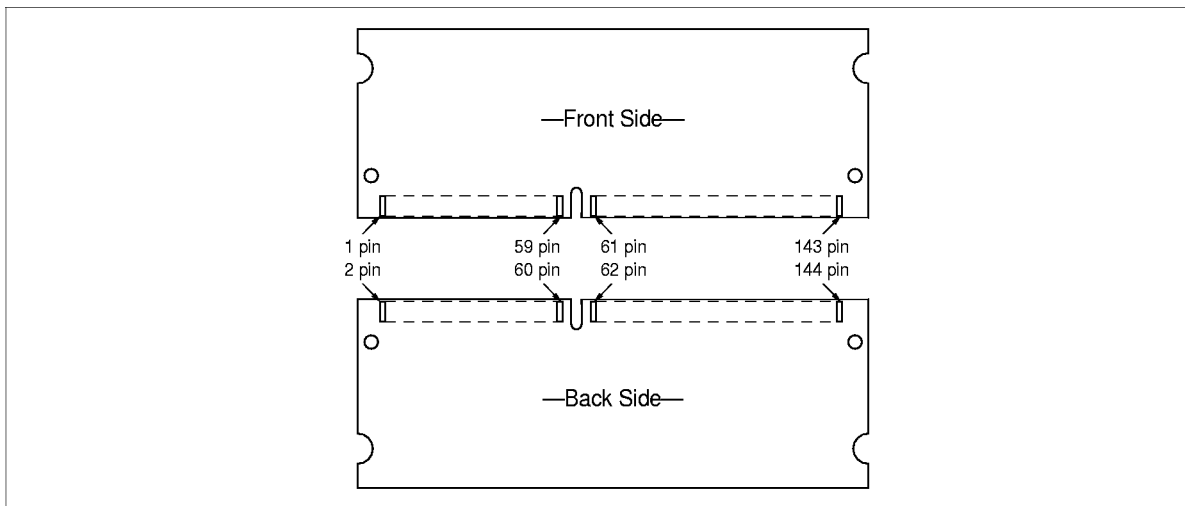
- 144-pin Zig Zag Dual tabs socket type
 - Lead pitch: 0.80 mm
- Single 3.3 V (+0.3, -0.15 V) supply
- High speed
 - Access time: $t_{RAC} = 60/70$ ns (max)
 $t_{CAC} = 15/18$ ns (max)
- Low power dissipation
 - Active mode: 4.90/4.32 W (max)
 - Standby mode (TTL): 230.4 mW (max)
(CMOS): 115.2 mW (max)
17.28 mW (max) (L/LS-version)
- EDO page mode capability
- Refresh period
 - 4096 refresh cycles: 64 ms
128 ms (L/LS-version)
- 3 variations of refresh
 - \overline{RAS} -only refresh
 - \overline{CAS} -before- \overline{RAS} refresh
 - Self refresh (LS-version)

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Ordering Information

Type No.	Access time	Package	Contact pad
HB56SW864DBK-6	60 ns	144-pin small outline DIMM	Gold
HB56SW864DBK-7	70 ns		
HB56SW864DBK-6L	60 ns		
HB56SW864DBK-7L	70 ns		
HB56SW864DBK-6LS	60 ns		
HB56SW864DBK-7LS	70 ns		

Pin Arrangement



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}	73	$\overline{\text{OE}}$	2	V _{SS}	74	NC
3	DQ0	75	V _{SS}	4	DQ32	76	V _{SS}
5	DQ1	77	NC	6	DQ33	78	NC
7	DQ2	79	NC	8	DQ34	80	NC
9	DQ3	81	V _{CC}	10	DQ35	82	V _{CC}
11	V _{CC}	83	DQ16	12	V _{CC}	84	DQ48
13	DQ4	85	DQ17	14	DQ36	86	DQ49
15	DQ5	87	DQ18	16	DQ37	88	DQ50
17	DQ6	89	DQ19	18	DQ38	90	DQ51
19	DQ7	91	V _{SS}	20	DQ39	92	V _{SS}
21	V _{SS}	93	DQ20	22	V _{SS}	94	DQ52
23	$\overline{\text{CE0}}$	95	DQ21	24	$\overline{\text{CE4}}$	96	DQ53
25	$\overline{\text{CE1}}$	97	DQ22	26	$\overline{\text{CE5}}$	98	DQ54
27	V _{CC}	99	DQ23	28	V _{CC}	100	DQ55
29	A0	101	V _{CC}	30	A3	102	V _{CC}
31	A1	103	A6	32	A4	104	A7
33	A2	105	A8	34	A5	106	A11
35	V _{SS}	107	V _{SS}	36	V _{SS}	108	V _{SS}
37	DQ8	109	A9	38	DQ40	110	NC
39	DQ9	111	A10	40	DQ41	112	NC
41	DQ10	113	V _{CC}	42	DQ42	114	V _{CC}
43	DQ11	115	$\overline{\text{CE2}}$	44	DQ43	116	$\overline{\text{CE6}}$
45	V _{CC}	117	$\overline{\text{CE3}}$	46	V _{CC}	118	$\overline{\text{CE7}}$
47	DQ12	119	V _{SS}	48	DQ44	120	V _{SS}
49	DQ13	121	DQ24	50	DQ45	122	DQ56
51	DQ14	123	DQ25	52	DQ46	124	DQ57
53	DQ15	125	DQ26	54	DQ47	126	DQ58
55	V _{SS}	127	DQ27	56	V _{SS}	128	DQ59
57	NC	129	V _{CC}	58	NC	130	V _{CC}
59	NC	131	DQ28	60	NC	132	DQ60
61	NC	133	DQ29	62	NC	134	DQ61
63	V _{CC}	135	DQ30	64	V _{CC}	136	DQ62
65	NC	137	DQ31	66	NC	138	DQ63

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Pin Arrangement (cont)

Front side				Back side			
Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name
67	\overline{WE}	139	V_{SS}	68	NC	140	V_{SS}
69	$\overline{RE0}$	141	SDA	70	NC	142	SCL
71	$\overline{RE1}$	143	V_{CC}	72	NC	144	V_{CC}

Pin Description

Pin name	Function
A0 to A11	Address inputs: <ul style="list-style-type: none">• Row address: A0 to A11• Column address: A0 to A9• Refresh address: A0 to A11
DQ0 to DQ63	Data-in/Data-out
$\overline{RE0}$, $\overline{RE1}$	Row address strobe (\overline{RAS})
$\overline{CE0}$ to $\overline{CE7}$	column address strobe (\overline{CAS})
\overline{WE}	Read/Write enable
\overline{OE}	Output enable
V_{CC}	Power supply
V_{SS}	Ground
SDA	Serial data for PD
SCL	Serial clock for PD
NC	No connection

Note: Serial PD data are not protected.

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Serial PD Matrix*1

Byte No.	Function described	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Hex value	Comments
0	Number of bytes used by module manufacturer	1	0	0	0	0	0	0	0	80	128
1	Total SPD memory size	0	0	0	0	1	0	0	0	08	256 byte
2	Memory type	0	0	0	0	0	0	1	0	02	EDO
3	Number of row addresses bits	0	0	0	0	1	1	0	0	0C	12
4	Number of column addresses bits	0	0	0	0	1	0	1	0	0A	10
5	Number of banks	0	0	0	0	0	0	1	0	02	2
6	Module data width	0	1	0	0	0	0	0	0	40	64
7	Module data width (continued)	0	0	0	0	0	0	0	0	00	0 (+)
8	Module interface signal levels	0	0	0	0	0	0	0	1	01	LVTTTL
9	RAS access time -6/-6L/-6LS	0	0	1	1	1	1	0	0	3C	$t_{RAC} = 60$ ns
	-7/-7L/-7LS	0	1	0	0	0	1	1	0	46	$t_{RAC} = 70$ ns
10	CAS access time -6/-6L/-6LS	0	0	0	0	1	1	1	1	0F	$t_{CAC} = 15$ ns
	-7/-7L/-7LS	0	0	0	1	0	0	1	0	12	$t_{CAC} = 18$ ns
11	Module configuration type	0	0	0	0	0	0	0	0	00	Non-parity
12	Refresh rate/type -6/-7	0	0	0	0	0	0	0	0	00	Normal (15.625 μ s)
	-6L/-7L (L-version)	0	0	0	0	0	0	1	1	03	(31.3 μ s)
	-6LS/-7LS (LS-version)	1	0	0	0	0	0	1	1	83	Self refresh (31.3 μ s)
13	DRAM width	0	0	0	0	0	1	0	0	04	$\times 4$
14	Error checking DRAM width	0	0	0	0	0	0	0	0	00	
15 to 31	Reserved for future offerings	0	0	0	0	0	0	0	0	00	
32 to 61	Superset information	0	0	0	0	0	0	0	0	00	Future offerings
62	SPD data revision code	0	0	0	0	0	0	0	1	01	Rev. 1
63	Checksum for bytes 0 to 62 -6	0	0	1	1	0	0	1	1	33	
	-7	0	1	0	0	0	0	0	0	40	
	-6L	0	0	1	1	0	1	1	0	36	
	-7L	0	1	0	0	0	0	1	1	43	
	-6LS	1	0	1	1	0	1	1	0	B6	
	-7LS	1	1	0	0	0	0	1	1	C3	

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Byte No.	Function described	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Hex value	Comments
64	Manufacturer's JEDEC ID code	0	0	0	0	0	1	1	1	07	Hitachi
65 to 71	Manufacturer's JEDEC ID code	0	0	0	0	0	0	0	0	00	
72	Manufacturing location	×	×	×	×	×	×	×	×	×	ASCII-8bit code*2
73	Manufacturer's part number	0	1	0	0	1	0	0	0	48	H
74	Manufacturer's part number	0	1	0	0	0	0	1	0	42	B
75	Manufacturer's part number	0	0	1	1	0	1	0	1	35	5
76	Manufacturer's part number	0	0	1	1	0	1	1	0	36	6
77	Manufacturer's part number	0	1	0	1	0	0	1	1	53	S
78	Manufacturer's part number	0	1	0	1	0	1	1	1	57	W
79	Manufacturer's part number	0	0	1	1	1	0	0	0	38	8
80	Manufacturer's part number	0	0	1	1	0	1	1	0	36	6
81	Manufacturer's part number	0	0	1	1	0	1	0	0	34	4
82	Manufacturer's part number	0	1	0	0	0	1	0	0	44	D
83	Manufacturer's part number	0	1	0	0	0	0	1	0	42	B
84	Manufacturer's part number	0	1	0	0	1	0	1	1	4B	K
85	Manufacturer's part number	0	1	0	1	1	1	1	1	5F	—
86	Manufacturer's part number -6/-6L/-6LS	0	0	1	1	0	1	1	0	36	6
	-7/-7L/-7LS	0	0	1	1	0	1	1	1	37	7
87	Manufacturer's part number -6/-7	0	0	1	0	0	0	0	0	20	(Space)
	-6L/-7L,-6LS/-7LS	0	1	0	0	1	1	0	0	4C	L
88	Manufacturer's part number -6/-7,-6L/-7L	0	0	1	0	0	0	0	0	20	(Space)
	-6LS/-7LS	0	1	0	1	0	0	1	1	53	S
89	Manufacturer's part number	0	0	1	0	0	0	0	0	20	(Space)
90	Manufacturer's part number	0	0	1	0	0	0	0	0	20	(Space)
91	Revision code	0	0	1	1	0	0	0	0	30	Initial
92	Revision code	0	0	1	0	0	0	0	0	20	(Space)
93	Manufacturing date	×	×	×	×	×	×	×	×	×	Year-code (binary)*3
94	Manufacturing date	×	×	×	×	×	×	×	×	×	Week-code (binary)*4
95 to 98	Assembly serial number	*5									
99 to 125	Manufacturer specific data	*6									
126	Reserved	0	0	0	0	0	0	0	0	00	Not use
127	Reserved	0	0	0	0	0	0	0	0	00	Not use

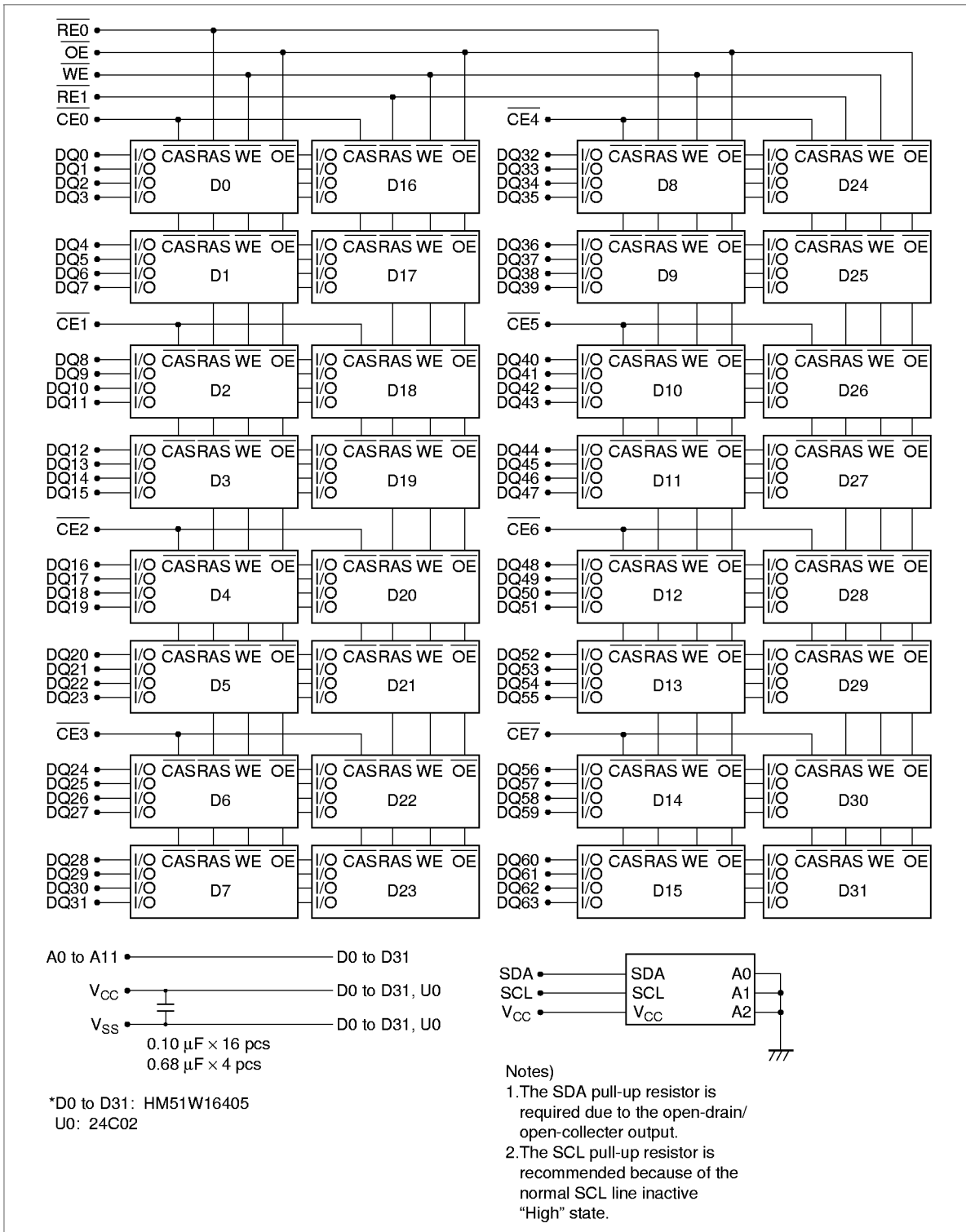
Notes: 1. All serial PD data are not protected. 0: Serial data, "Low level", 1: Serial data, "High level"

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2. Byte72 is manufacturing location code. (ex: in case of Japan, byte72 is 4Ah. 4Ah shows "J" on ASCII code.)
3. Byte 93 (Manufacturing date-year code) ex: 61h shows Year 97, 62h shows Year 98.
4. Byte 94 (Manufacturing date-week code) ex: 0Bh shows Week 11, 24h shows Week 36.
5. Bytes 95 through 98 are assembly serial number.
6. All bits of 99 through 125 are not defined ("1" or "0").

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Block Diagram



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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	16	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}	3.15	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 +0.3, -0.15 V, V_{SS} = 0 V)

Parameter	Symbol	60 ns		70 ns		Unit	Test conditions	Notes
		Min	Max	Min	Max			
Operating current	I _{CC1}	—	1360	—	1200	mA	t _{RC} = min	1, 2
Standby current	I _{CC2}	—	64	—	64	mA	TTL interface RAS, CAS = V _{IH} Dout = High-Z	
		—	32	—	32	mA	CMOS interface RAS, CAS ≥ V _{CC} - 0.2 V Dout = High-Z	
Standby current (L/LS-version)	I _{CC2}	—	4.8	—	4.8	mA	CMOS interface RAS, CAS ≥ V _{CC} - 0.2 V Dout = High-Z	
RAS-only refresh current	I _{CC3}	—	1360	—	1200	mA	t _{RC} = min	2
Standby current	I _{CC5}	—	160	—	160	mA	RAS = V _{IH} , CAS = V _{IL} Dout = enable	1
CAS-before-RAS refresh current	I _{CC6}	—	1360	—	1200	mA	t _{RC} = min	
EDO page mode current	I _{CC7}	—	1200	—	1120	mA	t _{HPC} = min	1, 3
Battery backup current (Standby with CBR refresh) (L/LS-version)	I _{CC10}	—	12.8	—	12.8	mA	CMOS interface Dout = High-Z CBR refresh: t _{RC} = 31.3 μs t _{RAS} ≤ 0.3 μs	4
Self refresh mode current (LS-version)	I _{CC11}	—	8	—	8	mA	CMOS interface RAS, CAS ≤ 0.2 V Dout = High-Z	
Input leakage current	I _{LI}	-10	10	-10	10	μA	0 V ≤ Vin ≤ 4.6 V	
Output leakage current	I _{LO}	-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}	V	High Iout = -2 mA	
Output low voltage	V _{OL}	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. V_{IH} ≥ V_{CC} - 0.2 V, 0V ≤ V_{IL} ≤ 0.2 V.

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Capacitance ($T_a = 25^\circ\text{C}$, $V_{CC} = 3.3\text{ V} + 0.3, -0.15\text{ V}$)

Parameter	Symbol	Typ	Max	Unit	Notes
Input capacitance (Address)	C_{I1}	—	180	pF	1
Input capacitance ($\overline{\text{CAS}}$)	C_{I2}	—	48	pF	1
Input capacitance ($\overline{\text{RAS}}$)	C_{I3}	—	132	pF	1
Input capacitance ($\overline{\text{WE}}$, $\overline{\text{OE}}$)	C_{I3}	—	244	pF	1
I/O capacitance (DQ)	$C_{I/O}$	—	27	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 ($T_a = 0$ to 70°C , $V_{CC} = 3.3\text{ V} + 0.3, -0.15\text{ V}$, $V_{SS} = 0\text{ V}$) *¹, *², *¹⁸, *¹⁹**Test Conditions**

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

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

Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
Random read or write cycle time	t_{RC}	104	—	124	—	ns	
\overline{RAS} precharge time	t_{RP}	40	—	50	—	ns	
\overline{CAS} precharge time	t_{CP}	10	—	13	—	ns	
\overline{RAS} pulse width	t_{RAS}	60	10000	70	10000	ns	
\overline{CAS} pulse width	t_{CAS}	10	10000	13	10000	ns	
Row address setup time	t_{ASR}	0	—	0	—	ns	
Row address hold time	t_{RAH}	10	—	10	—	ns	
Column address setup time	t_{ASC}	0	—	0	—	ns	
Column address hold time	t_{CAH}	10	—	13	—	ns	
\overline{RAS} to \overline{CAS} delay time	t_{RCD}	14	45	14	52	ns	3
\overline{RAS} to column address delay time	t_{RAD}	12	30	12	35	ns	4
\overline{RAS} hold time	t_{RSH}	13	—	13	—	ns	
\overline{CAS} hold time	t_{CSH}	40	—	45	—	ns	
\overline{CAS} to \overline{RAS} precharge time	t_{CRP}	5	—	5	—	ns	
\overline{OE} to Din delay time	t_{OED}	15	—	18	—	ns	5
\overline{OE} delay time from Din	t_{DZO}	0	—	0	—	ns	6
\overline{CAS} delay time from Din	t_{DZC}	0	—	0	—	ns	6
Transition time (rise and fall)	t_T	2	50	2	50	ns	7
Refresh period (4,096 cycles)	t_{REF}	—	64	—	64	ms	
Refresh period (4,096 cycles) (L/LS-version)	t_{REF}	—	128	—	128	ms	

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Read Cycle

Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
Access time from $\overline{\text{RAS}}$	t_{RAC}	—	60	—	70	ns	8, 9
Access time from $\overline{\text{CAS}}$	t_{CAC}	—	15	—	18	ns	9, 10, 17
Access time from address	t_{AA}	—	30	—	35	ns	9, 11, 17
Access time from $\overline{\text{OE}}$	t_{OEA}	—	15	—	18	ns	9, 21
Read command setup time	t_{RCS}	0	—	0	—	ns	
Read command hold time to $\overline{\text{CAS}}$	t_{RCH}	0	—	0	—	ns	12
Read command hold time from $\overline{\text{RAS}}$	t_{RCHR}	60	—	70	—	ns	
Read command hold time to $\overline{\text{RAS}}$	t_{RRH}	5	—	5	—	ns	12
Column address to $\overline{\text{RAS}}$ lead time	t_{RAL}	30	—	35	—	ns	
Column address to $\overline{\text{CAS}}$ lead time	t_{CAL}	18	—	23	—	ns	
$\overline{\text{CAS}}$ to output in low-Z	t_{CLZ}	0	—	0	—	ns	
Output data hold time	t_{OH}	3	—	3	—	ns	22
Output data hold time from $\overline{\text{OE}}$	t_{OHO}	3	—	3	—	ns	
Output buffer turn-off time	t_{OFF}	—	15	—	15	ns	13, 22
Output buffer turn-off to $\overline{\text{OE}}$	t_{OEZ}	—	15	—	15	ns	13
$\overline{\text{CAS}}$ to Din delay time	t_{CDD}	15	—	18	—	ns	5
Output data hold time from $\overline{\text{RAS}}$	t_{OHR}	3	—	3	—	ns	22
Output buffer turn-off time to $\overline{\text{RAS}}$	t_{OFR}	—	15	—	15	ns	22
Output buffer turn-off to $\overline{\text{WE}}$	t_{WEZ}	—	15	—	15	ns	
$\overline{\text{WE}}$ to Din delay time	t_{WED}	15	—	18	—	ns	
$\overline{\text{RAS}}$ to Din delay time	t_{RDD}	15	—	18	—	ns	
$\overline{\text{RAS}}$ next $\overline{\text{CAS}}$ delay time	t_{RNCD}	60	—	70	—	ns	

Write Cycle

Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
Write command setup time	t_{WCS}	0	—	0	—	ns	14
Write command hold time	t_{WCH}	10	—	13	—	ns	
Write command pulse width	t_{WP}	10	—	10	—	ns	
Write command to $\overline{\text{RAS}}$ lead time	t_{RWL}	10	—	13	—	ns	
Write command to $\overline{\text{CAS}}$ lead time	t_{CWL}	10	—	13	—	ns	
Data-in setup time	t_{DS}	0	—	0	—	ns	15
Data-in hold time	t_{DH}	10	—	13	—	ns	15

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Read-Modify-Write Cycle

Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
Read-modify-write cycle time	t_{RWC}	135	—	161	—	ns	
\overline{RAS} to \overline{WE} delay time	t_{RWD}	79	—	92	—	ns	14
\overline{CAS} to \overline{WE} delay time	t_{CWD}	34	—	40	—	ns	14
Column address to \overline{WE} delay time	t_{AWD}	49	—	57	—	ns	14
\overline{OE} hold time \overline{WE}	t_{OEH}	15	—	18	—	ns	

Refresh Cycle

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

EDO Page Mode Cycle

Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
EDO page mode cycle time	t_{HPC}	25	—	30	—	ns	20
EDO page mode \overline{RAS} pulse width	t_{RASP}	—	100000	—	100000	ns	16
Access time from \overline{CAS} precharge	t_{CPA}	—	35	—	40	ns	9, 17
\overline{RAS} hold time from \overline{CAS} precharge	t_{CPRH}	35	—	40	—	ns	
Output data hole time from \overline{CAS} low	t_{DOH}	3	—	3	—	ns	9, 17
\overline{CAS} hold time referred \overline{OE}	t_{COL}	10	—	13	—	ns	
\overline{CAS} to \overline{OE} setup time	t_{COP}	5	—	5	—	ns	
Read command hold time from \overline{CAS} precharge	t_{RCHC}	35	—	40	—	ns	

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EDO Page Mode Read-Modify-Write Cycle

Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
EDO page mode read-modify-write cycle time	t_{HPRWC}	68	—	79	—	ns	
$\overline{\text{WE}}$ delay time from $\overline{\text{CAS}}$ precharge	t_{CPW}	54	—	62	—	ns	14

Self Refresh Mode (LS-version)

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

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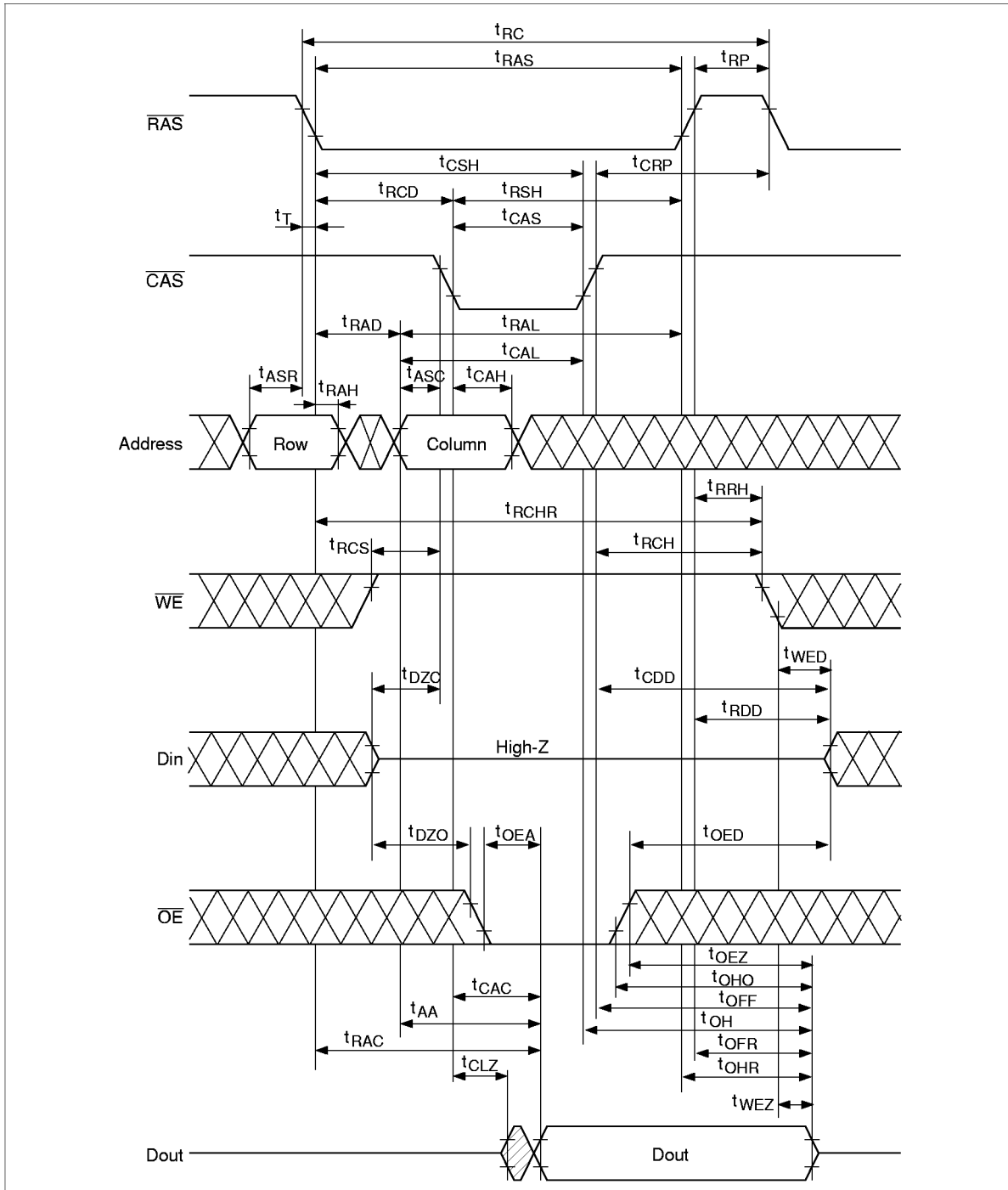
- Notes:
1. AC measurements assume $t_T = 2$ ns.
 2. An initial pause of 200 μ s is required after power up followed by a minimum of eight initialization cycles (any combination of cycles containing $\overline{\text{RAS}}$ -only refresh cycle or $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ 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 $t_{\text{RCD}} \geq t_{\text{RAD}} (\text{max}) + t_{\text{AA}} (\text{max}) - t_{\text{CAC}} (\text{max})$, 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. 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 $t_{\text{RCD}} \leq t_{\text{RCD}} (\text{max})$ 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.
 9. Measured with a load circuit equivalent to 1 TTL loads and 100 pF.
 10. Assumes that $t_{\text{RCD}} \geq t_{\text{RCD}} (\text{max})$ and $t_{\text{RCD}} + t_{\text{CAC}} (\text{max}) \geq t_{\text{RAD}} + t_{\text{AA}} (\text{max})$.
 11. Assumes that $t_{\text{RAD}} \geq t_{\text{RAD}} (\text{max})$ and $t_{\text{RCD}} + t_{\text{CAC}} (\text{max}) \leq t_{\text{RAD}} + t_{\text{AA}} (\text{max})$.
 12. Either t_{RCH} or t_{RRH} must be satisfied for a read cycles.
 13. $t_{\text{OFF}} (\text{max})$ and $t_{\text{OEZ}} (\text{max})$ 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 $t_{\text{WCS}} \geq t_{\text{WCS}} (\text{min})$, the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{\text{RWD}} \geq t_{\text{RWD}} (\text{min})$, $t_{\text{CWD}} \geq t_{\text{CWD}} (\text{min})$, and $t_{\text{AWD}} \geq t_{\text{AWD}} (\text{min})$ or $t_{\text{CWD}} \geq t_{\text{CWD}} (\text{min})$, $t_{\text{AWD}} \geq t_{\text{AWD}} (\text{min})$ and $t_{\text{CPW}} \geq t_{\text{CPW}} (\text{min})$, 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. These parameters are referred to $\overline{\text{CAS}}$ 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. After $\overline{\text{RAS}}$ is reset, if $t_{\text{OEH}} \geq t_{\text{CWL}}$, the DQ pin will remain open circuit (high impedance); $t_{\text{OEH}} < t_{\text{OEH}}$, invalid data will be out at each DQ.
 19. All the V_{CC} and V_{SS} pins shall be supplied with the same voltages.
 20. $t_{\text{HPC}} (\text{min})$ 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 ($t_{\text{CAS}} + t_{\text{CP}} + 2t_T$) becomes greater than the specified $t_{\text{HPC}} (\text{min})$ 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).
 21. 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 $V_{\text{IH}} \text{ min.} / V_{\text{IL}} \text{ max.}$ level.
 22. 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_{OFFR} and t_{OFF} .
 23. 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} .

24. 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.
25. If you use $\overline{\text{RAS}}$ only refresh or CBR burst refresh mode in normal read/write cycle, 4096 of distributed CBR refresh with 15.6 μs interval should be executed within 64 ms immediately after exiting from and before entering into the self refresh mode.
26. 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} .

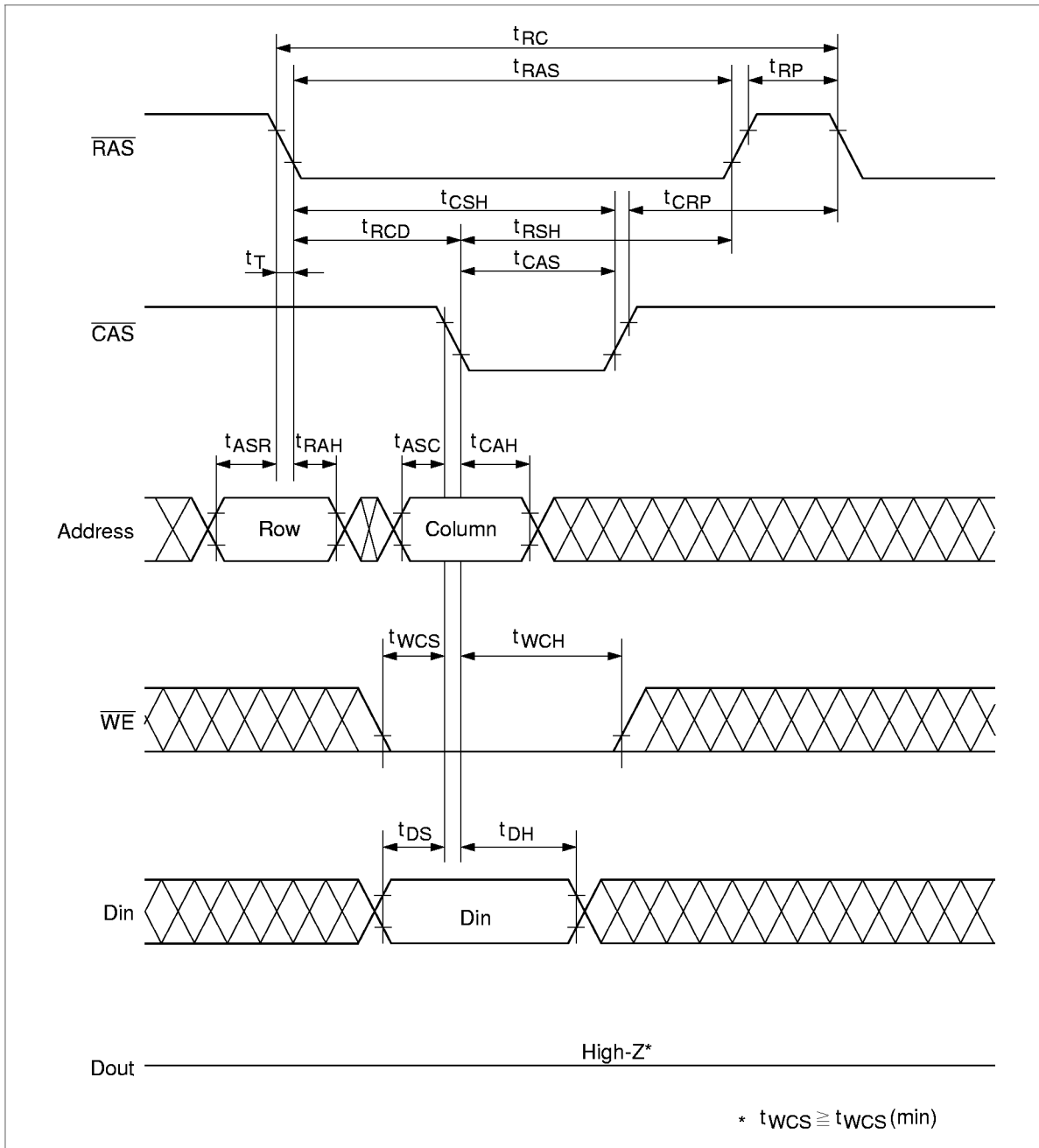
HB56SW864DBK Series

Timing Waveforms*26

Read Cycle

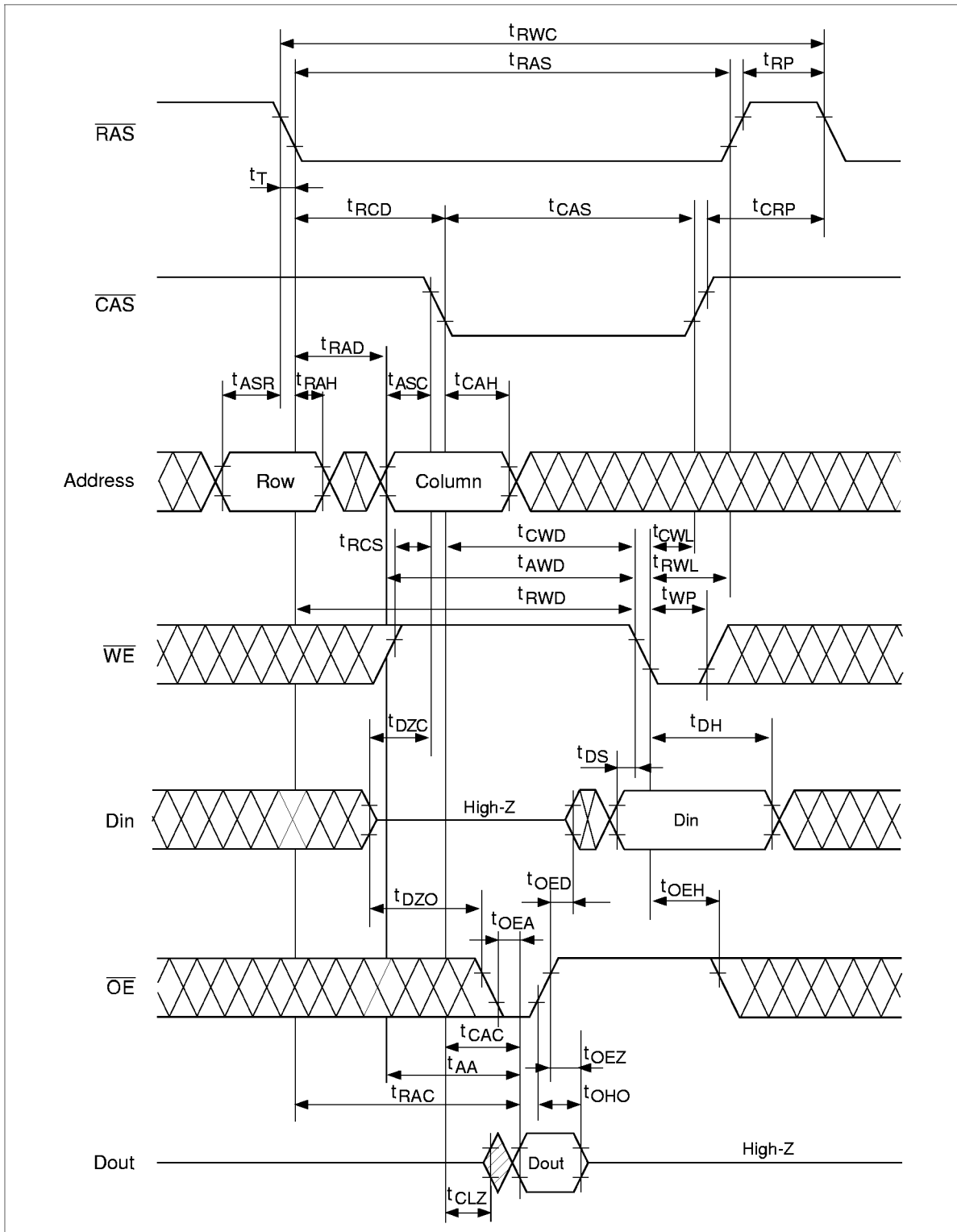


Early Write Cycle

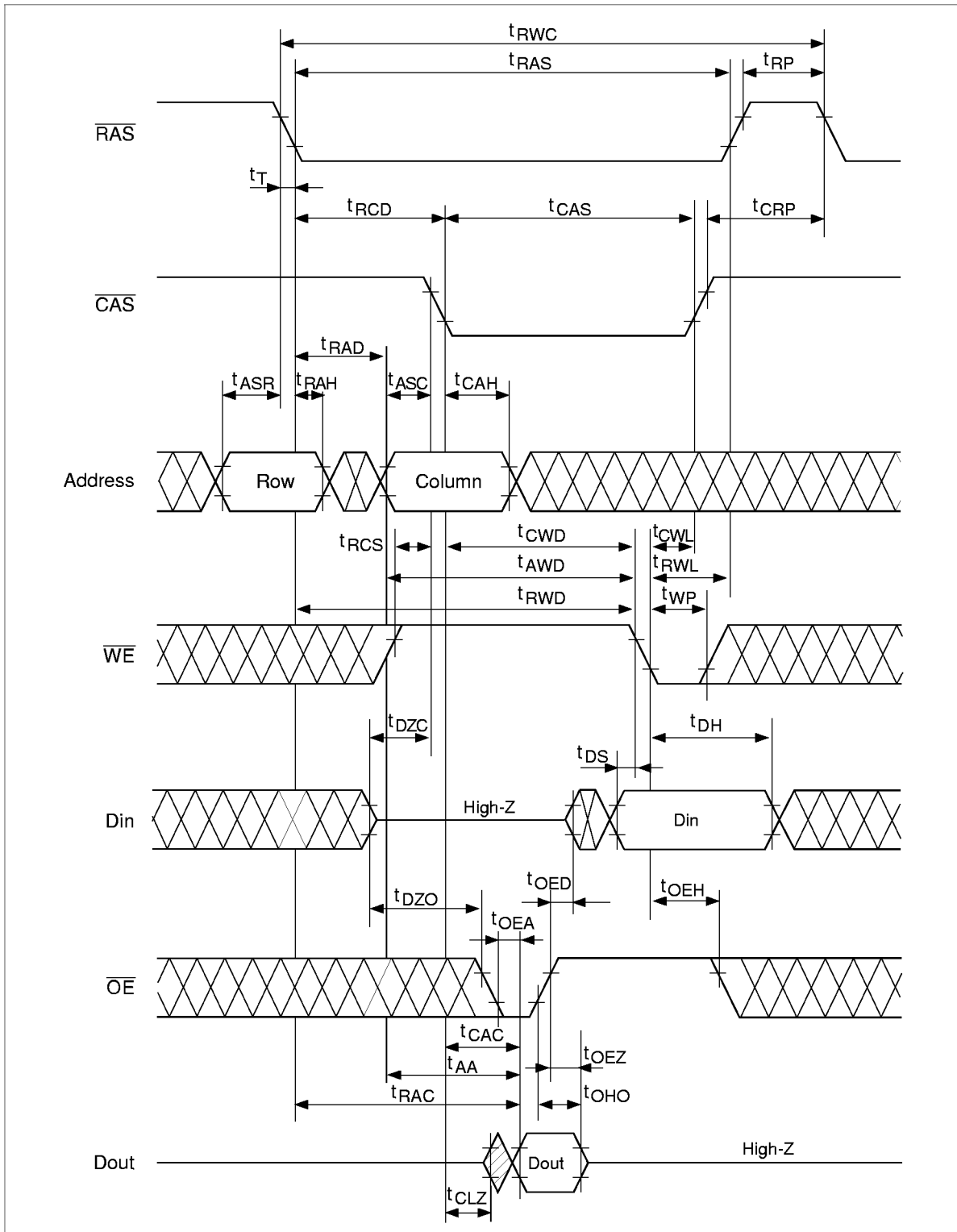


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Delayed Write Cycle*18

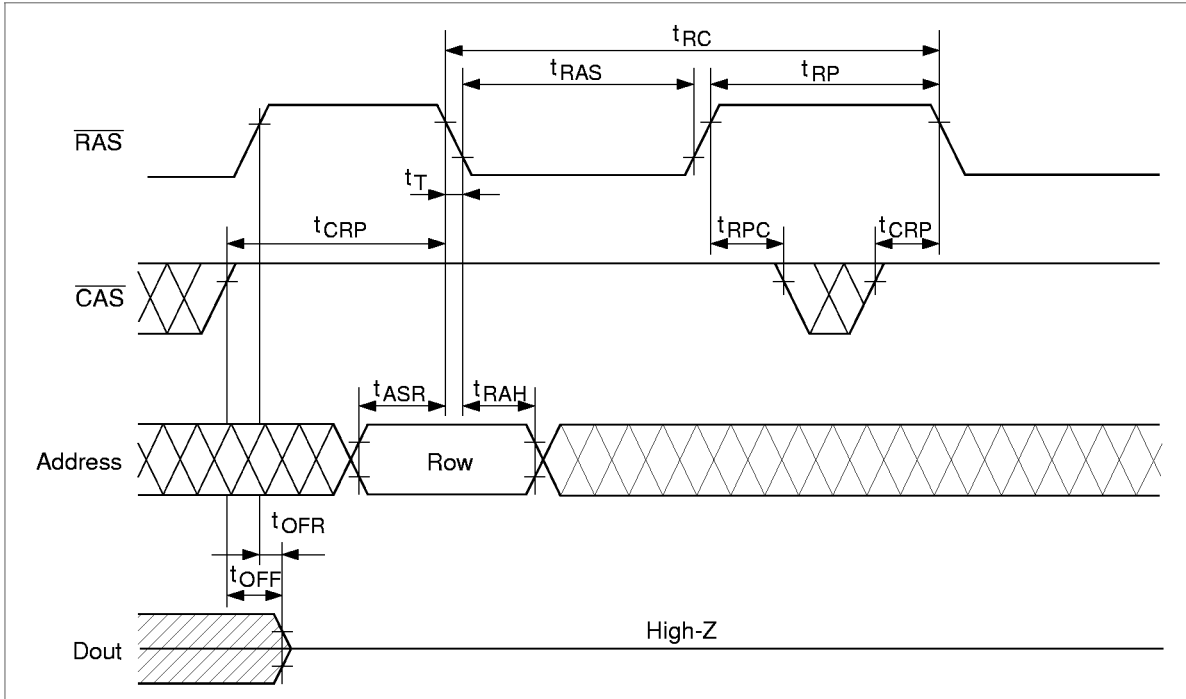


Read-Modify-Write Cycle*18

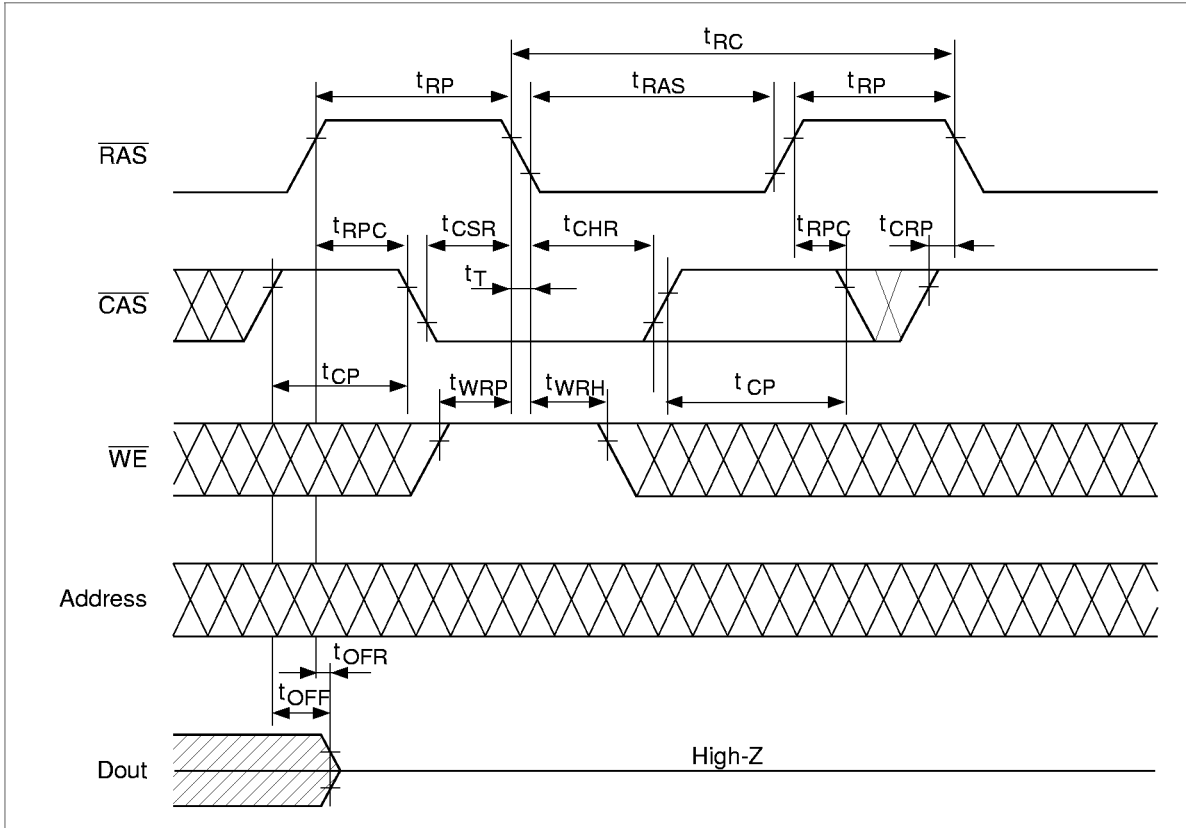


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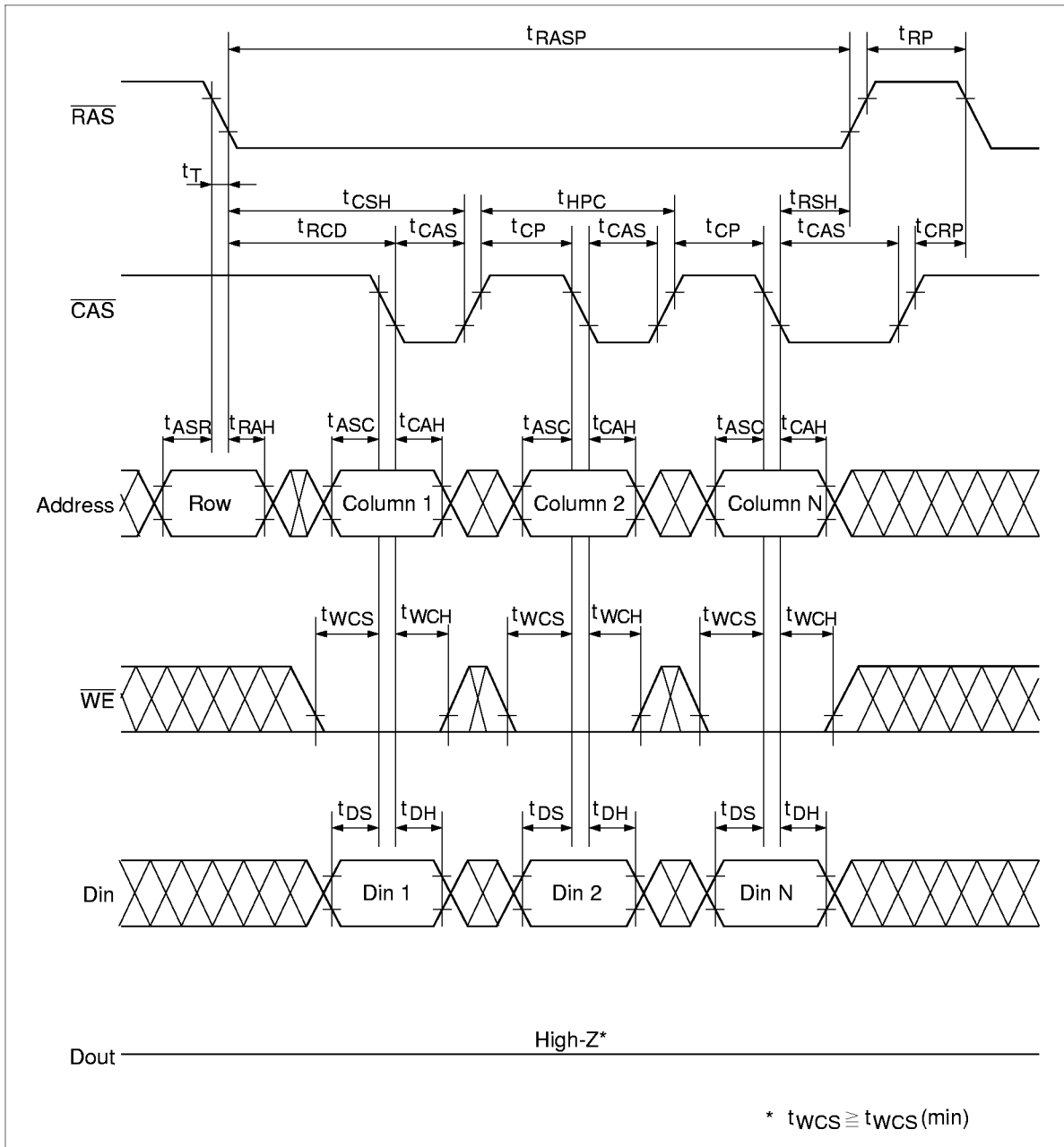
RAS-Only Refresh Cycle



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

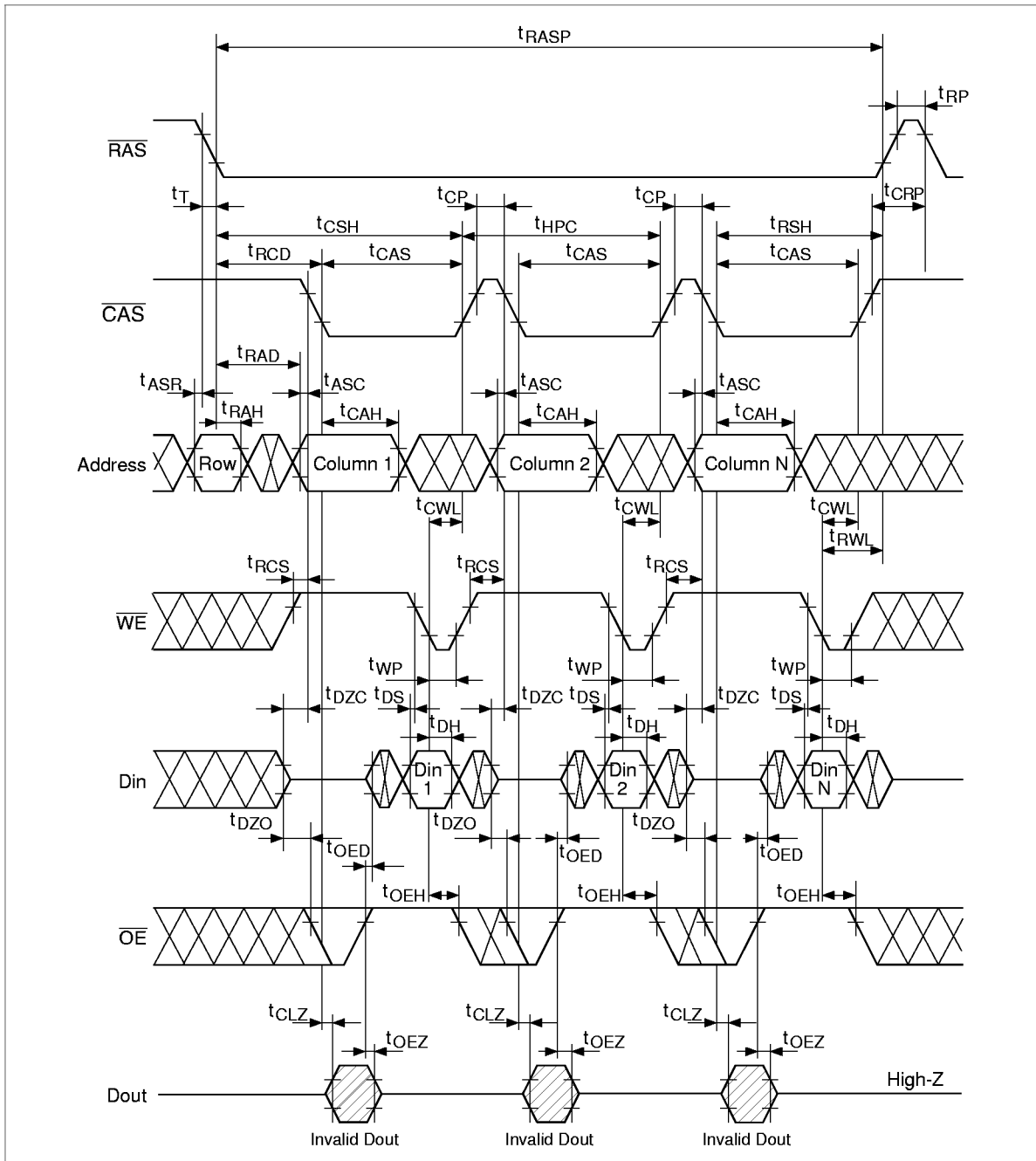


EDO Page Mode Early Write Cycle

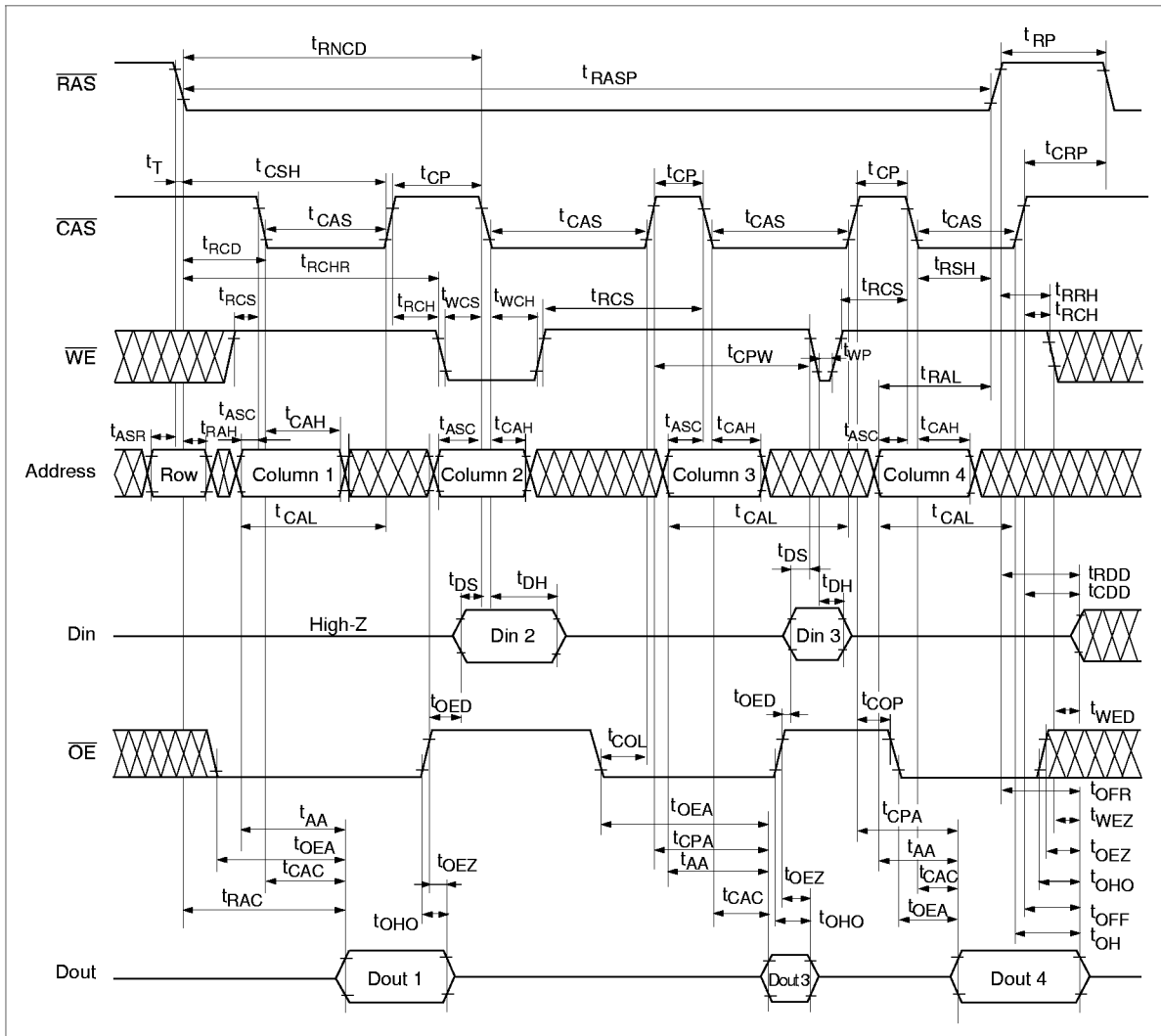


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EDO Page Mode Delayed Write Cycle*18

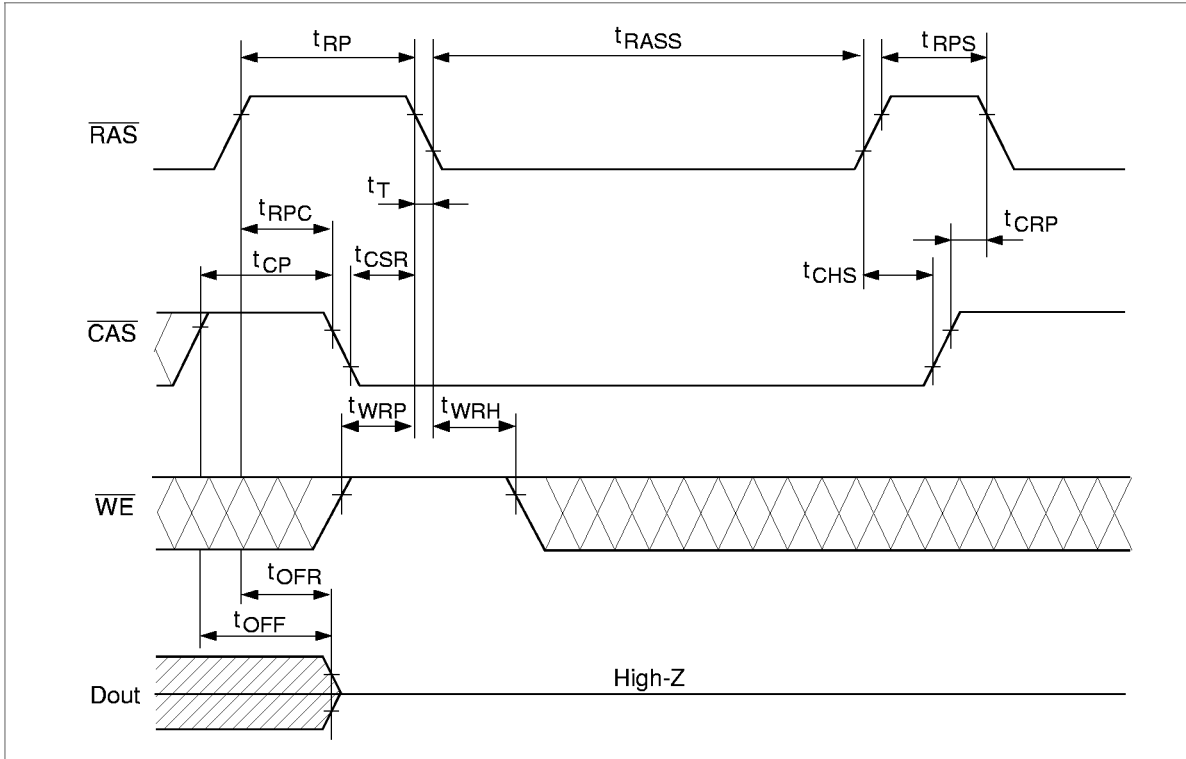


EDO Page Mode Mix Cycle (2)

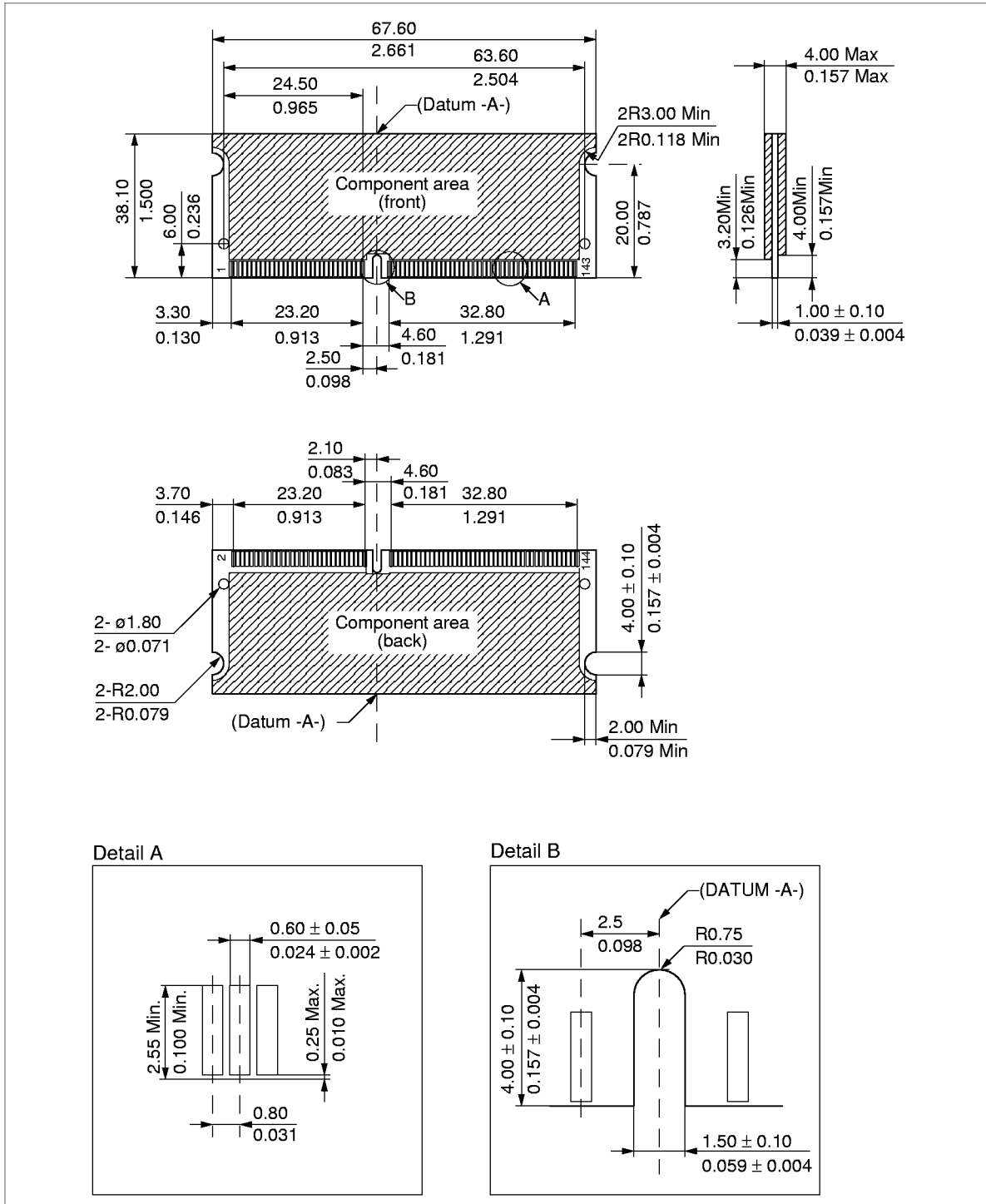


HB56SW864DBK Series

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



Physical Outline (Unit: mm/inch)



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HB56SW864DBK Series

Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
1.0	Jun. 18, 1997	Initial issue (referred to HM51W16405/HM51W17405 rev. 3.0)		
