
HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

128 MB EDO DRAM S.O.DIMM
16-Mword $\times$ 64-bit, 8k/4k Refresh, 1-Bank Module
(16 pcs of 16 M $\times$ 4 components)

HITACHI

ADE-203-864C (Z)
Rev. 1.0
June 26, 1998

Description

The HB56SW1664DBD is a 16M $\times$ 64 dynamic RAM Small Outline Dual In-line Memory Module (S.O.DIMM), mounted 16 pieces of 64-Mbit DRAM (HM5164405) sealed in TCP package and 1 piece of serial EEPROM (2-kbit) for Presence Detect (PD). The HB56SW1664DBC is a 16M $\times$ 64 dynamic RAM Small Outline Dual In-line Memory Module (S.O.DIMM), mounted 16 pieces of 64-Mbit DRAM (HM5165405) sealed in TCP package and 1 piece of serial EEPROM (2-kbit) for Presence Detect (PD). The HB56SW1664DBD, HB56SW1664DBC offer Extended Data Out (EDO) Page Mode as a high speed access mode. An outline of the HB56SW1664DBD, HB56SW1664DBC is 144-pin Zig Zag Dual tabs socket type compact and thin package. Therefore, the HB56SW1664DBD, HB56SW1664DBC make high density mounting possible without surface mount technology. The HB56SW1664DBD, HB56SW1664DBC provide common data inputs and outputs. Decoupling capacitors are mounted on the module board.

Note: Do not push the cover or drop the modules in order to protect from mechanical defects, which would be electrical defects.

Features

- 144-pin Zig Zag Dual tabs socket type
 - Outline: 67.60 mm (Length) $\times$ 25.4 mm (Height) $\times$ 3.80 mm (Thickness)
 - Lead pitch: 0.80 mm
- Single 3.3 V (± 0.3 V) supply
- High speed
 - Access time: $t_{\text{RAC}} = 50/60$ ns (max)
 $t_{\text{CAC}} = 13/15$ ns (max)

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

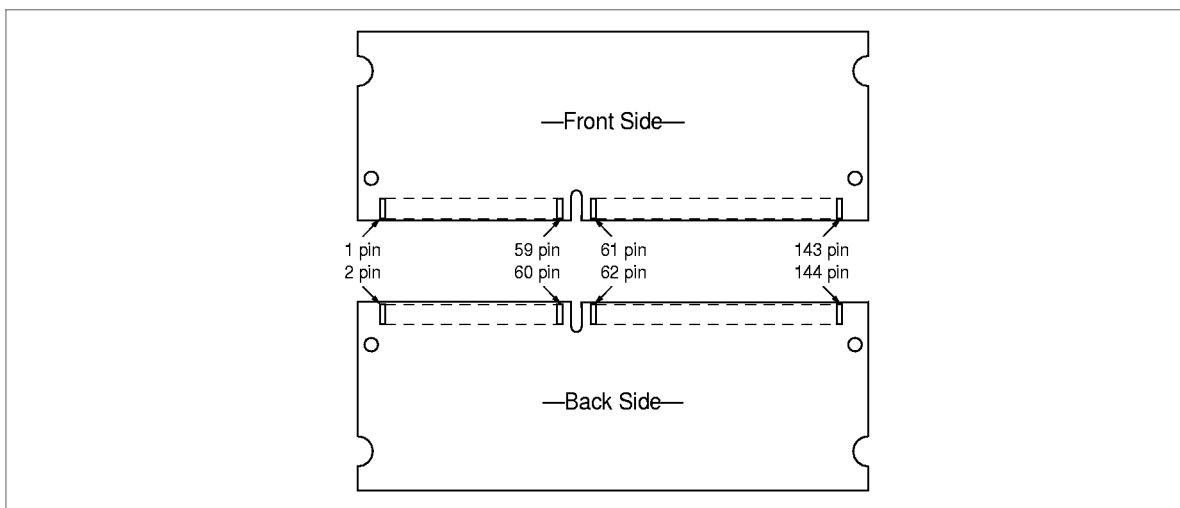
- Low power dissipation
 - Active mode: 6.34/5.76 W (max) (HB56SW1664DBD)
7.49/6.34 W (max) (HB56SW1664DBC)
 - Standby mode (TTL): 115.2 mW (max)
(CMOS): 28.8 mW (max)
(CMOS): 8.64 mW (max) (L-version)
- EDO page mode capability
- Refresh cycle
 - $\overline{\text{RAS}}$ -only refresh
 - 8192 refresh cycles/64 ms (HB56SW1664DBD)
 - 8192 refresh cycles/128 ms (HB56SW1664DBD) (L-version)
 - 4096 refresh cycles/64 ms (HB56SW1664DBC)
 - 4096 refresh cycles/128 ms (HB56SW1664DBC) (L-version)
 - CBR refresh
 - 4096 refresh cycles/64 ms
 - 4096 refresh cycles/128 ms (L-version)
- 3 variations of refresh
 - $\overline{\text{RAS}}$ -only refresh
 - $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh
 - Self refresh (L-version)

Ordering Information

Type No.	Access time	Package	Contact pad
HB56SW1664DBD-5	50 ns	144-pin small outline DIMM	Gold
HB56SW1664DBD-6	60 ns		
HB56SW1664DBD-5L	50 ns		
HB56SW1664DBD-6L	60 ns		
HB56SW1664DBC-5	50 ns		
HB56SW1664DBC-6	60 ns		
HB56SW1664DBC-5L	50 ns		
HB56SW1664DBC-6L	60 ns		

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Pin Arrangement



HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

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	A12 (NC)* ¹
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

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

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	NC	143	V_{CC}	72	NC	144	V_{CC}

Note: 1. A12: HB56SW1664DBD, NC: HB56SW1664DBC

Pin Description

Pin name	Function
A0 to A12 (HB56SW1664DBD)	Address inputs:
	Row address: A0 to A12
	Column address: A0 to A10
	Refresh address: A0 to A12
A0 to A11 (HB56SW1664DBC)	Address inputs:
	Row address: A0 to A11
	Column address: A0 to A11
	Refresh address: A0 to A11
DQ0 to DQ63	Data-in/Data-out
$\overline{RE0}$	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

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

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 byte
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 (HB56SW1664DBD)	0	0	0	0	1	1	0	1	0D	13
	(HB56SW1664DBC)	0	0	0	0	1	1	0	0	0C	12
4	Number of column addresses bits (HB56SW1664DBD)	0	0	0	0	1	0	1	1	0B	11
	(HB56SW1664DBC)	0	0	0	0	1	1	0	0	0C	12
5	Number of banks	0	0	0	0	0	0	0	1	01	1
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	LVTTL
9	RAS access time -5/5L	0	0	1	1	0	0	1	0	32	$t_{RAC} = 50$ ns
	-6/6L	0	0	1	1	1	1	0	0	3C	$t_{RAC} = 60$ ns
10	CAS access time -5/5L	0	0	0	0	1	1	0	1	0D	$t_{CAC} = 13$ ns
	-6/6L	0	0	0	0	1	1	1	1	0F	$t_{CAC} = 15$ ns
11	Module configuration type	0	0	0	0	0	0	0	0	00	Non parity
12	Refresh rate/type (HB56SW1664DBD-5/6)	0	0	0	0	0	0	1	0	02	Reduced (7.8 μ s)
	(HB56SW1664DBD-5L/6L)	1	0	0	0	0	0	0	0	80	Self refresh (15.625 μ s)
	(HB56SW1664DBC-5/6)	0	0	0	0	0	0	0	0	00	Normal (15.625 μ s)
	(HB56SW1664DBC-5L/6L)	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	16M $\times$ 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

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Byte No.	Function described	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Hex value	Comments
63	Checksum for bytes 0 to 62 (HB56SW1664DBD-5)	0	0	1	0	1	0	1	0	2A	
	(HB56SW1664DBD-6)	0	0	1	1	0	1	1	0	36	
	(HB56SW1664DBD-5L)	1	0	1	0	1	0	0	0	A8	
	(HB56SW1664DBD-6L)	1	0	1	1	0	1	0	0	B4	
	(HB56SW1664DBC-5)	0	0	1	0	1	0	0	0	28	
	(HB56SW1664DBC-6)	0	0	1	1	0	1	0	0	34	
	(HB56SW1664DBC-5L)	1	0	1	0	1	0	1	1	AB	
	(HB56SW1664DBC-6L)	1	0	1	1	0	1	1	1	B7	
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	×	×	×	×	×	×	×	×	×	*2 (ASCII-8bit code)
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	0	0	0	1	31	1
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	1	0	36	6
82	Manufacturer's part number	0	0	1	1	0	1	0	0	34	4
83	Manufacturer's part number	0	1	0	0	0	1	0	0	44	D
84	Manufacturer's part number	0	1	0	0	0	0	1	0	42	B
85	Manufacturer's part number (HB56SW1664DBD)	0	1	0	0	0	1	0	0	44	D
	(HB56SW1664DBC)	0	1	0	0	0	0	1	1	43	C
86	Manufacturer's part number	0	0	1	0	1	1	0	1	2D	—
87	Manufacturer's part number -5/5L	0	0	1	1	0	1	0	1	35	5
	-6/6L	0	0	1	1	0	1	1	0	36	6
88	Manufacturer's part number -5/6	0	0	1	0	0	0	0	0	20	(Space)
	-5L/6L	0	1	0	0	1	1	0	0	4C	L
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)

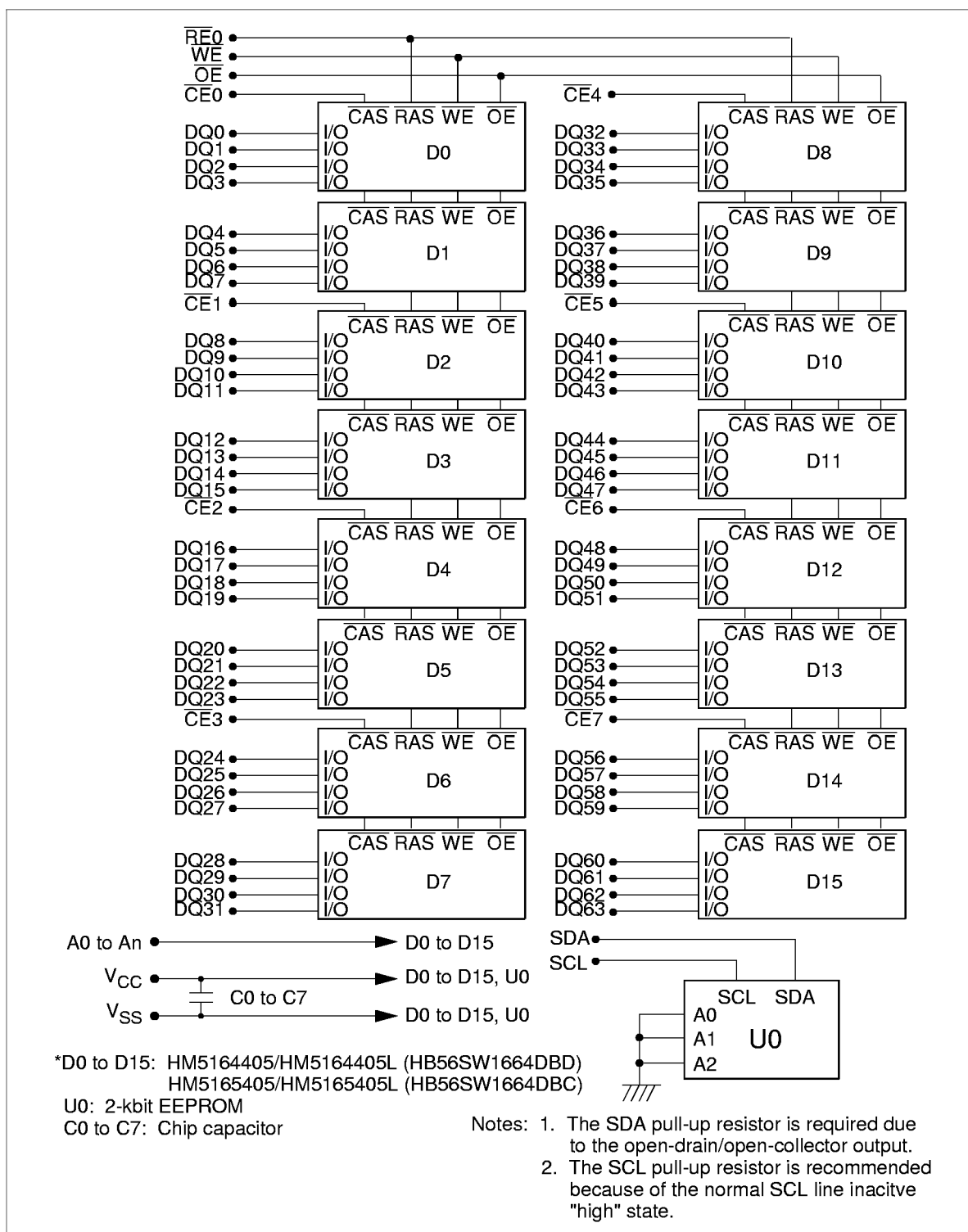
HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Byte No.	Function described	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Hex value	Comments
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, "driven Low", 1: Serial data, "driven High"
 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. Byte 95 through 98 are assembly serial number.
 6. All bits of 99 through 125 are not defined ("1" or "0").

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Block Diagram



HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Terminal voltage on any pin relative to V_{SS}	V_T	−0.5 to +4.6	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	16	W
Storage temperature range	Tstg	−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	Ta	0	—	70	°C	
Ambient illuminance	—	—	—	100	lx	

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.

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

DC Characteristics (HB56SW1664DBD)

Parameter	Symbol	50 ns		60 ns		Unit	Test conditions	Notes
		Min	Max	Min	Max			
Operating current	I_{CC1}	—	1760	—	1600	mA	$t_{RC} = \min$	1, 2
Standby current	I_{CC2}	—	32	—	32	mA	TTL interface $\overline{RAS}, \overline{CAS} = V_{IH}$ Dout = High-Z	
		—	8	—	8	mA	CMOS interface $\overline{RAS}, \overline{CAS} \geq V_{CC} - 0.2 V$ Dout = High-Z	
Standby current (L-version)	I_{CC2}	—	2.4	—	2.4	mA	CMOS interface $\overline{RAS}, \overline{CAS} \geq V_{CC} - 0.2 V$ Dout = High-Z	
$\overline{RAS}$ -only refresh current	I_{CC3}	—	1760	—	1600	mA	$t_{RC} = \min$	2
Standby current	I_{CC5}	—	80	—	80	mA	$\overline{RAS} = V_{IH}, \overline{CAS} = V_{IL}$ Dout = enable	1
$\overline{CAS}$ -before- $\overline{RAS}$ refresh current	I_{CC6}	—	1760	—	1600	mA	$t_{RC} = \min$	
EDO page mode current	I_{CC7}	—	1760	—	1600	mA	$\overline{RAS} = V_{IL}, \overline{CAS} = V_{IH}$ $t_{HPC} = t_{HPC} \min$	1, 3
Battery backup current (Standby with CBR refresh) (L-version)	I_{CC10}	—	8	—	8	mA	CMOS interface, Dout = High-Z, CBR refresh: $t_{RC} = 31.3 \mu A$, $t_{RAS} \leq 0.3 \mu A$	4
Self refresh mode current (L-version)	I_{CC11}	—	6.4	—	6.4	mA	CMOS interface $\overline{RAS}, \overline{CAS} \leq V_{CC} - 0.2 V$ Dout = High-Z	
Input leakage current	I_{LI}	-10	10	-10	10	μA	$0 V \leq V_{in} \leq V_{CC} + 0.3 V$	
Output leakage current	I_{LO}	-10	10	-10	10	μA	$0 V \leq V_{out} \leq V_{CC}$ 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 $\overline{RAS} = V_{IL}$.

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

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

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

DC Characteristics (HB56SW1664DBC)

Parameter	Symbol	50 ns		60 ns		Unit	Test conditions	Notes
		Min	Max	Min	Max			
Operating current	I_{CC1}	—	2080	—	1760	mA	$t_{RC} = \min$	1, 2
Standby current	I_{CC2}	—	32	—	32	mA	TTL interface $\overline{RAS}, \overline{CAS} = V_{IH}$ Dout = High-Z	
		—	8	—	8	mA	CMOS interface $\overline{RAS}, \overline{CAS} \geq V_{CC} - 0.2 V$ Dout = High-Z	
Standby current (L-version)	I_{CC2}	—	2.4	—	2.4	mA	CMOS interface $\overline{RAS}, \overline{CAS} \geq V_{CC} - 0.2 V$ Dout = High-Z	
$\overline{RAS}$ -only refresh current	I_{CC3}	—	2080	—	1760	mA	$t_{RC} = \min$	2
Standby current	I_{CC5}	—	80	—	80	mA	$\overline{RAS} = V_{IH}, \overline{CAS} = V_{IL}$ Dout = enable	1
$\overline{CAS}$ -before- $\overline{RAS}$ refresh current	I_{CC6}	—	2080	—	1760	mA	$t_{RC} = \min$	
EDO page mode current	I_{CC7}	—	1760	—	1600	mA	$\overline{RAS} = V_{IL}, \overline{CAS} = V_{IH}$ $t_{HPC} = t_{HPC} \min$	1, 3
Battery backup current (Standby with CBR refresh) (L-version)	I_{CC10}	—	8	—	8	mA	CMOS interface, Dout = High-Z, CBR refresh: $t_{RC} = 31.3 \mu A$, $t_{RAS} \leq 0.3 \mu A$	4
Self refresh mode current (L-version)	I_{CC11}	—	6.4	—	6.4	mA	CMOS interface $\overline{RAS}, \overline{CAS} \leq V_{CC} - 0.2 V$ Dout = High-Z	
Input leakage current	I_{LI}	-10	10	-10	10	μA	$0 V \leq V_{in} \leq V_{CC} + 0.3 V$	
Output leakage current	I_{LO}	-10	10	-10	10	μA	$0 V \leq V_{out} \leq V_{CC}$ 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 $\overline{RAS} = V_{IL}$.

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

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

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

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

Parameter	Symbol	Typ	Max	Unit	Notes
Input capacitance (Address)	C_{I1}	—	90	pF	1
Input capacitance ($\overline{\text{RAS}}$, $\overline{\text{WE}}$, $\overline{\text{OE}}$)	C_{I2}	—	120	pF	1
Input capacitance ($\overline{\text{CAS}}$)	C_{I3}	—	30	pF	1
I/O capacitance (DQ)	$C_{I/O}$	—	17	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 ($T_a = 0 \text{ to } 70^\circ\text{C}$, $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$, $V_{SS} = 0 \text{ V}$) *¹, *², *¹⁹

Test Conditions

- Input rise and fall time: 2 ns
- Input 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)
- Ambient illuminance: Under 100 lx

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

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

Parameter	Symbol	50 ns		60 ns		Unit	Notes
		Min	Max	Min	Max		
Random read or write cycle time	t_{RC}	84	—	104	—	ns	
$\overline{RAS}$ precharge time	t_{RP}	30	—	40	—	ns	
$\overline{CAS}$ precharge time	t_{CP}	8	—	10	—	ns	
$\overline{RAS}$ pulse width	t_{RAS}	50	10000	60	10000	ns	
$\overline{CAS}$ pulse width	t_{CAS}	8	10000	10	10000	ns	
Row address setup time	t_{ASR}	0	—	0	—	ns	
Row address hold time	t_{RAH}	8	—	10	—	ns	
Column address setup time	t_{ASC}	0	—	0	—	ns	
Column address hold time	t_{CAH}	8	—	10	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ delay time	t_{RCD}	12	37	14	45	ns	3
$\overline{RAS}$ to column address delay time	t_{RAD}	10	25	12	30	ns	4
$\overline{RAS}$ hold time	t_{RSH}	13	—	15	—	ns	
$\overline{CAS}$ hold time	t_{CSH}	35	—	40	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ precharge time	t_{CRP}	5	—	5	—	ns	
$\overline{OE}$ to Din delay time	t_{OED}	13	—	15	—	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

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Read Cycle

Parameter	Symbol	50 ns		60 ns		Unit	Notes
		Min	Max	Min	Max		
Access time from $\overline{\text{RAS}}$	t_{RAC}	—	50	—	60	ns	8, 9
Access time from $\overline{\text{CAS}}$	t_{CAC}	—	13	—	15	ns	9, 10, 17
Access time from address	t_{AA}	—	25	—	30	ns	9, 11, 17
Access time from $\overline{\text{OE}}$	t_{OEA}	—	13	—	15	ns	9
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}	50	—	60	—	ns	
Read command hold time to $\overline{\text{RAS}}$	t_{RRH}	0	—	0	—	ns	12
Column address to $\overline{\text{RAS}}$ lead time	t_{RAL}	25	—	30	—	ns	
Column address to $\overline{\text{CAS}}$ lead time	t_{CAL}	15	—	18	—	ns	
$\overline{\text{CAS}}$ to output in low-Z	t_{CLZ}	0	—	0	—	ns	
Output data hold time	t_{OH}	3	—	3	—	ns	21
Output data hold time from $\overline{\text{OE}}$	t_{OHO}	3	—	3	—	ns	
Output buffer turn-off time	t_{OFF}	—	13	—	15	ns	13, 21
Output buffer turn-off to $\overline{\text{OE}}$	t_{OEZ}	—	13	—	15	ns	13
$\overline{\text{CAS}}$ to Din delay time	t_{CDD}	13	—	15	—	ns	5
Output data hold time from $\overline{\text{RAS}}$	t_{OHR}	3	—	3	—	ns	21
Output buffer turn-off to $\overline{\text{RAS}}$	t_{OFR}	—	13	—	15	ns	13, 21
Output buffer turn-off to $\overline{\text{WE}}$	t_{WEZ}	—	13	—	15	ns	13
$\overline{\text{WE}}$ to Din delay time	t_{WED}	13	—	15	—	ns	
$\overline{\text{RAS}}$ to Din delay time	t_{RDD}	13	—	15	—	ns	

Write Cycle

Parameter	Symbol	50 ns		60 ns		Unit	Notes
		Min	Max	Min	Max		
Write command setup time	t_{WCS}	0	—	0	—	ns	14
Write command hold time	t_{WCH}	8	—	10	—	ns	
Write command pulse width	t_{WP}	8	—	10	—	ns	
Write command to $\overline{\text{RAS}}$ lead time	t_{RWL}	13	—	15	—	ns	
Write command to $\overline{\text{CAS}}$ lead time	t_{CWL}	8	—	10	—	ns	
Data-in setup time	t_{DS}	0	—	0	—	ns	15
Data-in hold time	t_{DH}	8	—	10	—	ns	15

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Read-Modify-Write Cycle

Parameter	Symbol	50 ns		60 ns		Unit	Notes
		Min	Max	Min	Max		
Read-modify-write cycle time	t_{RWC}	116	—	140	—	ns	
$\overline{RAS}$ to $\overline{WE}$ delay time	t_{RWD}	67	—	79	—	ns	14
$\overline{CAS}$ to $\overline{WE}$ delay time	t_{CWD}	30	—	34	—	ns	14
Column address to $\overline{WE}$ delay time	t_{AWD}	42	—	49	—	ns	14
$\overline{OE}$ hold time from $\overline{WE}$	t_{OEh}	13	—	15	—	ns	

Refresh Cycle

Parameter	Symbol	50 ns		60 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}	8	—	10	—	ns	
$\overline{WE}$ setup time (CBR refresh cycle)	t_{WRP}	0	—	0	—	ns	
$\overline{WE}$ hold time (CBR refresh cycle)	t_{WRH}	8	—	10	—	ns	
$\overline{RAS}$ precharge to $\overline{CAS}$ hold time	t_{RPC}	5	—	5	—	ns	

EDO Page Mode Cycle

Parameter	Symbol	50 ns		60 ns		Unit	Notes
		Min	Max	Min	Max		
EDO page mode cycle time	t_{HPC}	20	—	25	—	ns	20
EDO page mode $\overline{RAS}$ pulse width	t_{RASP}	—	100000	—	100000	ns	16
Access time from $\overline{CAS}$ precharge	t_{CPA}	—	28	—	35	ns	9, 17
$\overline{RAS}$ hold time from $\overline{CAS}$ precharge	t_{CPRH}	28	—	35	—	ns	
Output data hold time from $\overline{CAS}$ low	t_{DOH}	3	—	3	—	ns	9, 22
$\overline{CAS}$ hold time referred $\overline{OE}$	t_{COL}	8	—	10	—	ns	
$\overline{CAS}$ to $\overline{OE}$ setup time	t_{COP}	5	—	5	—	ns	
Read command hold time from $\overline{CAS}$ precharge	t_{RCHC}	28	—	35	—	ns	
Write pulse width during $\overline{CAS}$ precharge	t_{WPE}	8	—	10	—	ns	
$\overline{OE}$ precharge time	t_{OEP}	8	—	10	—	ns	

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

EDO Page Mode Read-Modify-Write Cycle

Parameter	Symbol	50 ns		60 ns		Unit	Notes
		Min	Max	Min	Max		
EDO page mode read- modify-write cycle time	t_{HPRWC}	57	—	68	—	ns	
$\overline{\text{WE}}$ delay time from $\overline{\text{CAS}}$ precharge	t_{CPW}	45	—	54	—	ns	14

Refresh (HB56SW1664DBD)

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

Refresh (HB56SW1664DBC)

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

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Self Refresh Mode (L-version)

Parameter	Symbol	50 ns		60 ns		Unit	Notes
		Min	Max	Min	Max		
$\overline{\text{RAS}}$ pulse width (self refresh)	t_{RASS}	100	—	100	—	μs	26
$\overline{\text{RAS}}$ precharge time (self refresh)	t_{RPS}	90	—	110	—	ns	26
$\overline{\text{CAS}}$ hold time (self refresh)	t_{CHS}	-50	—	-50	—	ns	

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

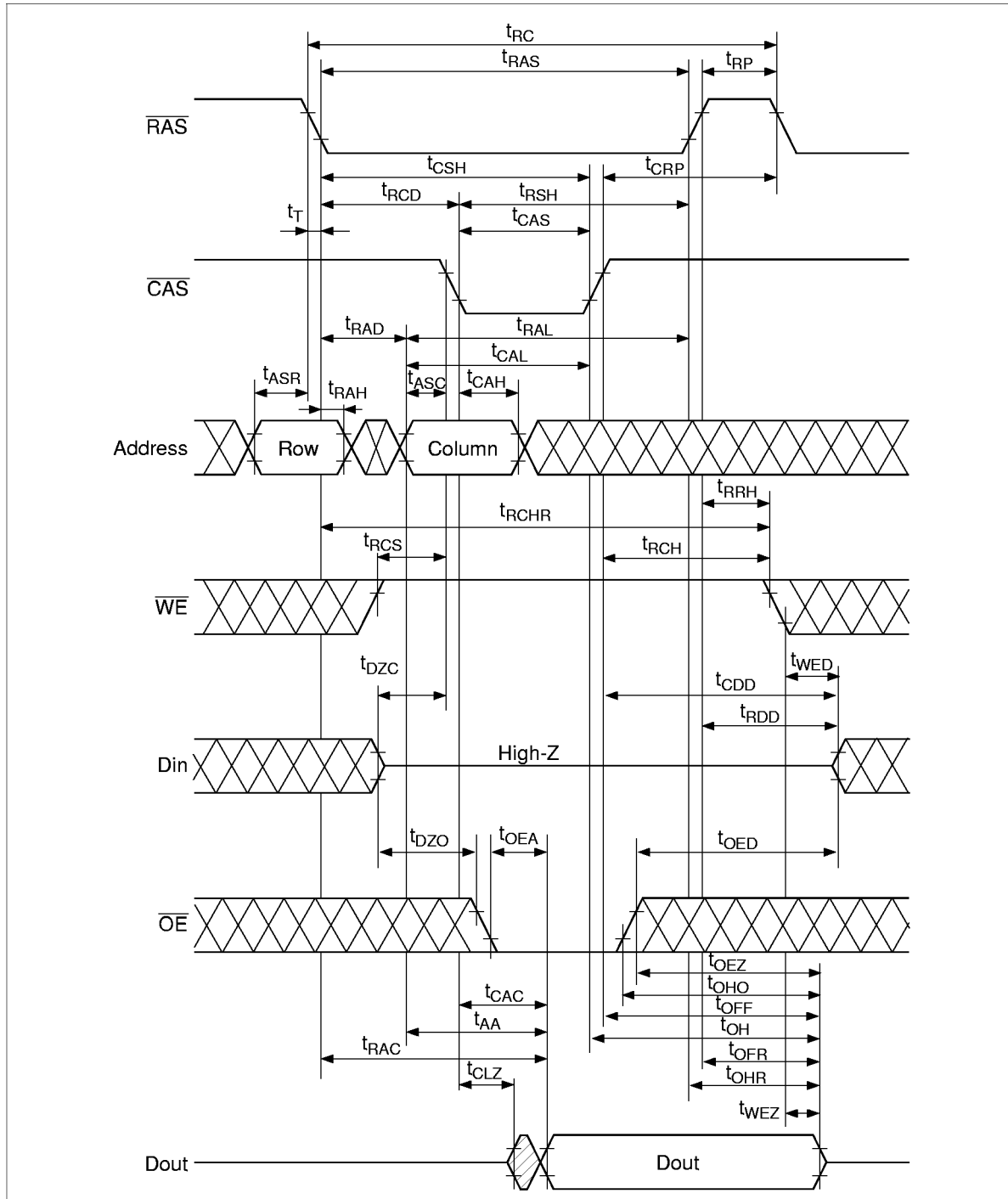
2. An initial pause of 200 μs is required after power up followed by a minimum of eight initialization cycles (any combination of cycles containing RAS-only refresh or CAS-before-RAS refresh).
3. Operation with the t_{RCD} (max) limit insures that t_{RAC} (max) can be met, t_{RCD} (max) is specified 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_{OFFR} (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 $\overline{\text{CAS}}$ 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.
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 $\overline{\text{CAS}}$ 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).

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

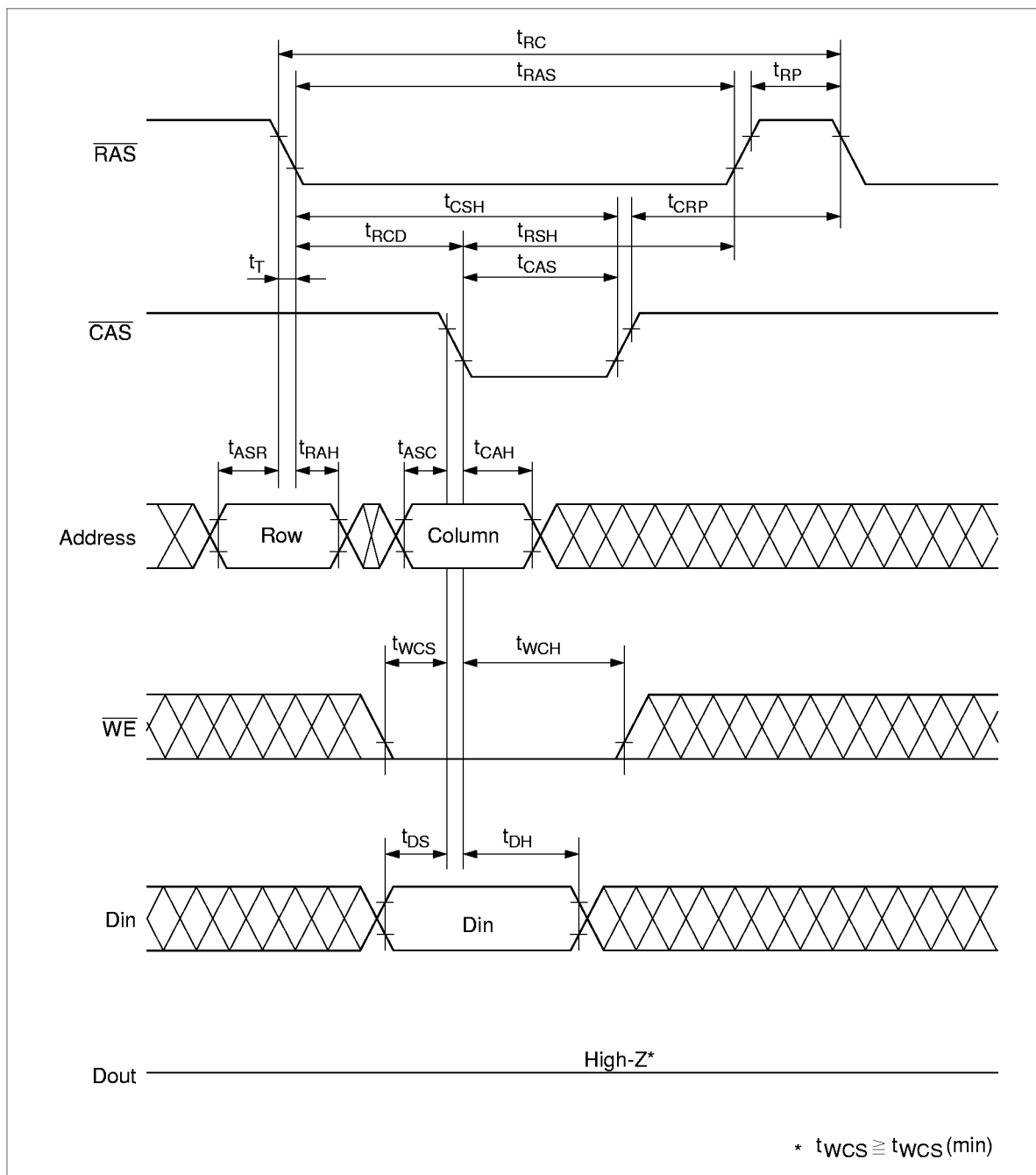
21. Data output turns off and becomes high impedance from later rising edge of $\overline{\text{RAS}}$ and $\overline{\text{CAS}}$.
Hold time and turn off time are specified by the timing specifications of later rising edge of $\overline{\text{RAS}}$ and $\overline{\text{CAS}}$ between t_{OHR} and t_{OH} and between t_{OFR} and t_{OFF} .
22. t_{DOH} defines the time at which the output level go cross. $V_{\text{OL}} = 0.8 \text{ V}$, $V_{\text{OH}} = 2.0 \text{ V}$ 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.
 - a. Enter self refresh mode within 15.6 μs after either burst refresh or distributed refresh at equal interval to all refresh addresses are completed.
 - b. 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 $\overline{\text{RAS}}$ -only-refresh, it is necessary to execute CBR refresh before and after self refresh mode according as note 23.
25. For L-version, it is available to apply each 128 ms and 31.2 μs instead of 64 ms and 15.6 μs at note 23.
26. At $t_{\text{RASS}} > 100 \mu\text{s}$, self refresh mode is activated, and not activated at $t_{\text{RASS}} < 10 \mu\text{s}$. It is undefined within the range of $10 \mu\text{s} \leq t_{\text{RASS}} \leq 100 \mu\text{s}$. For $t_{\text{RASS}} \geq 10 \mu\text{s}$, it is necessary to satisfy t_{RPS} .
27. 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*²⁷

Read Cycle

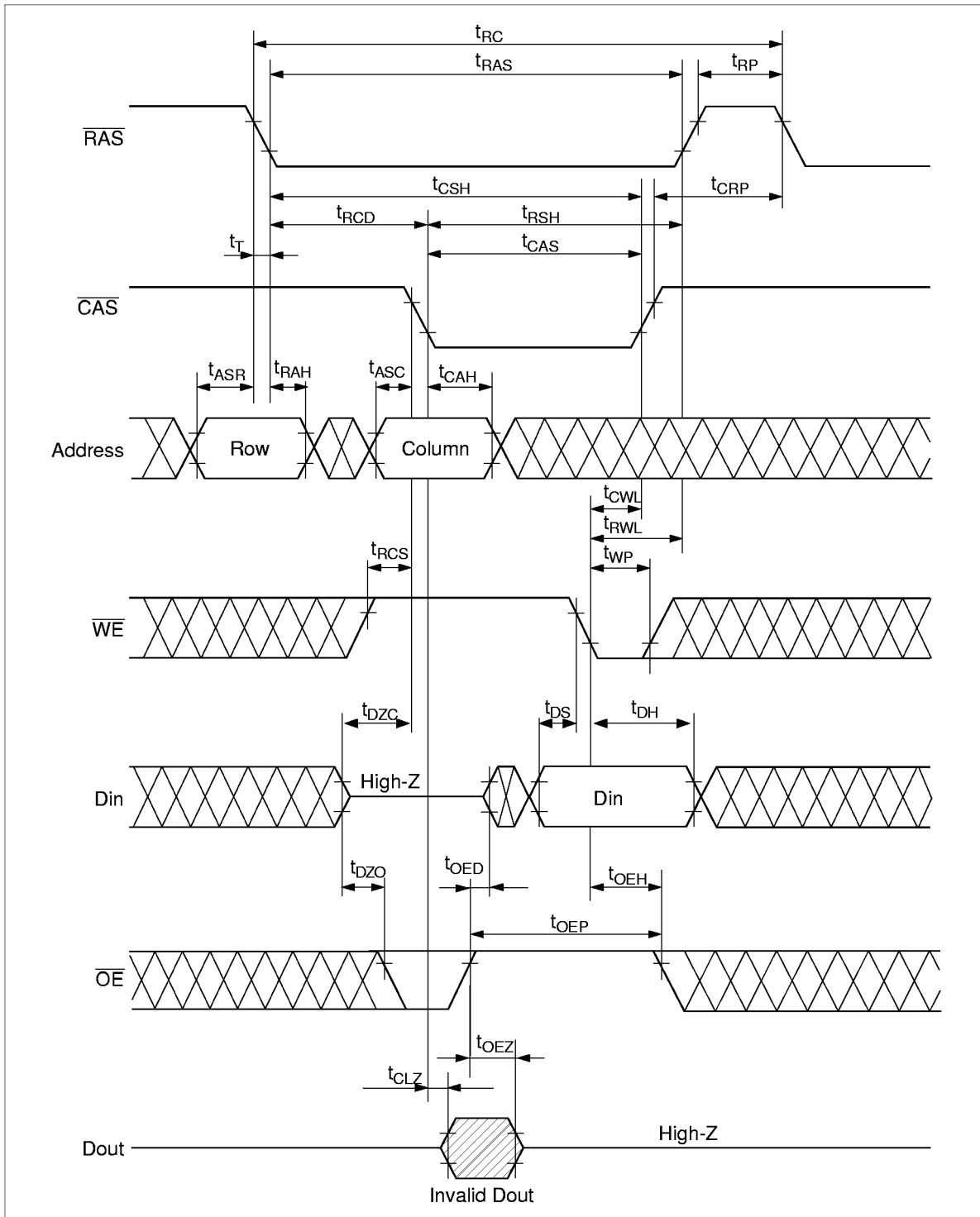


Early Write Cycle



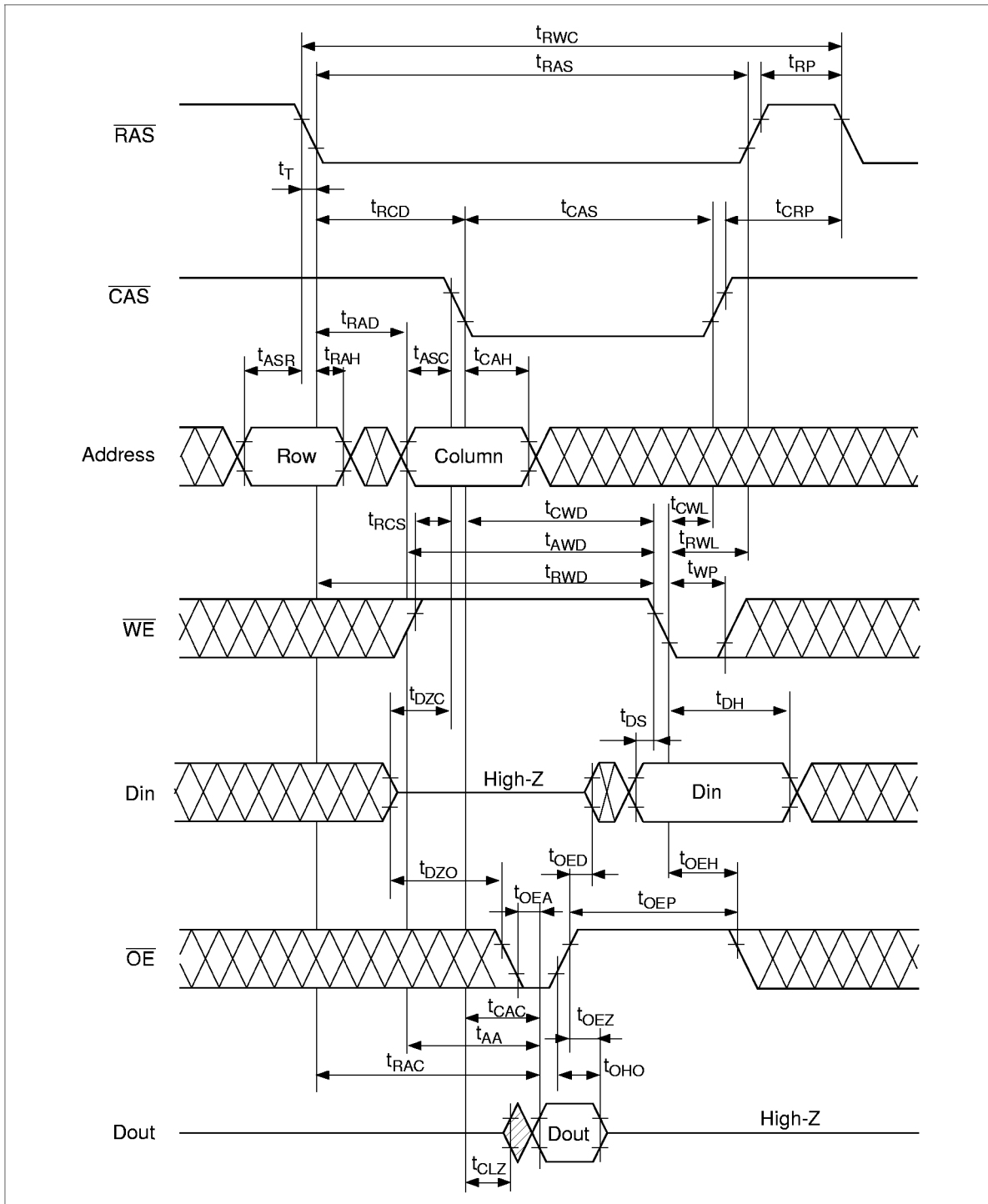
HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Delayed Write Cycle*18



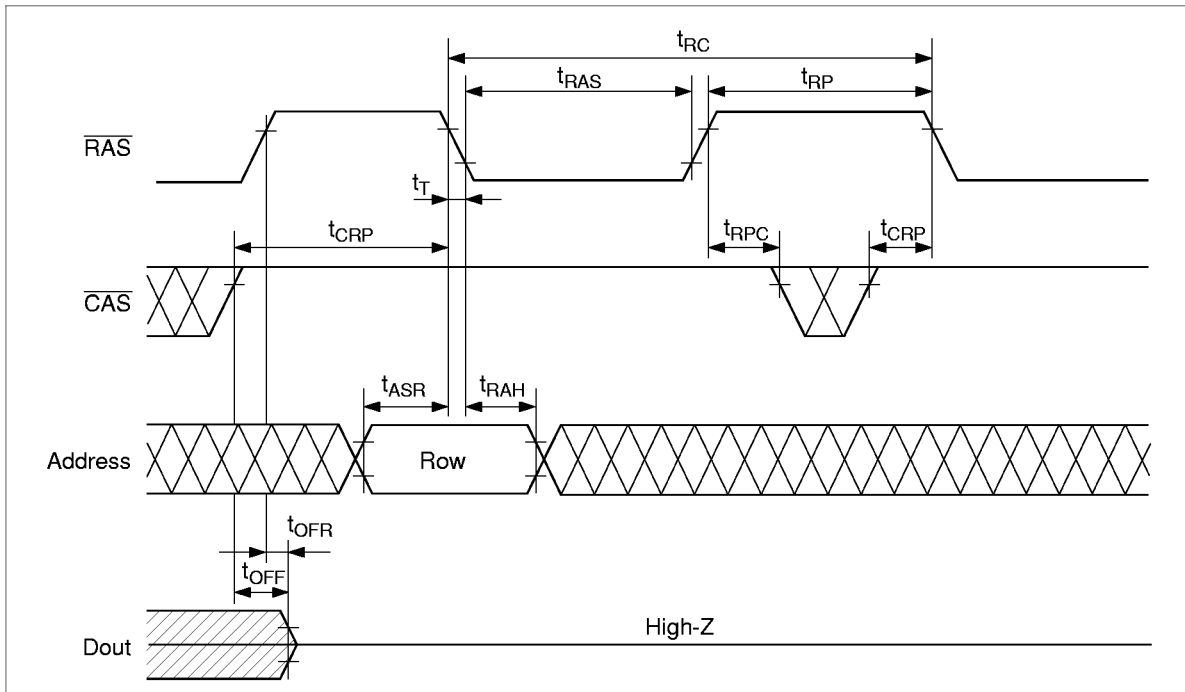
HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Read-Modify-Write Cycle*18



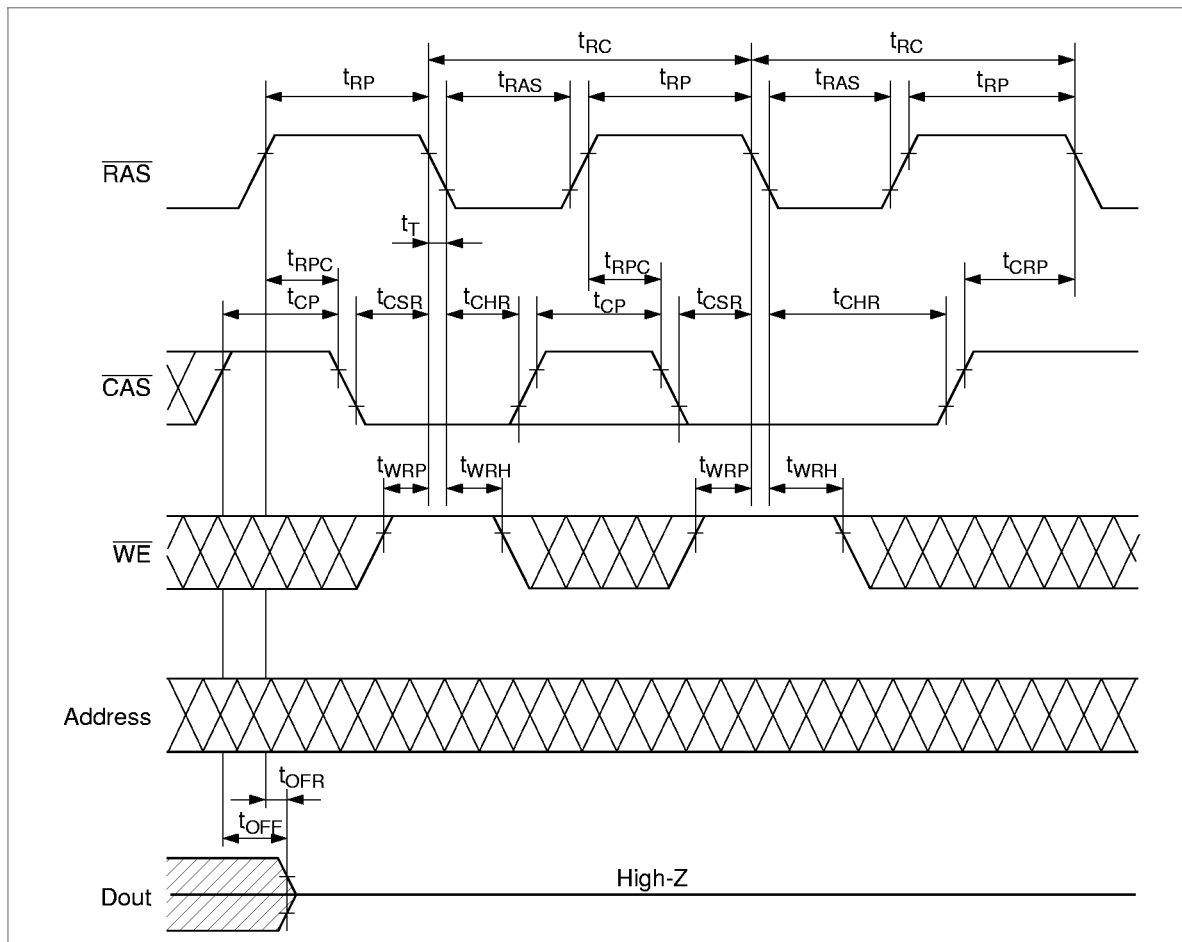
HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

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

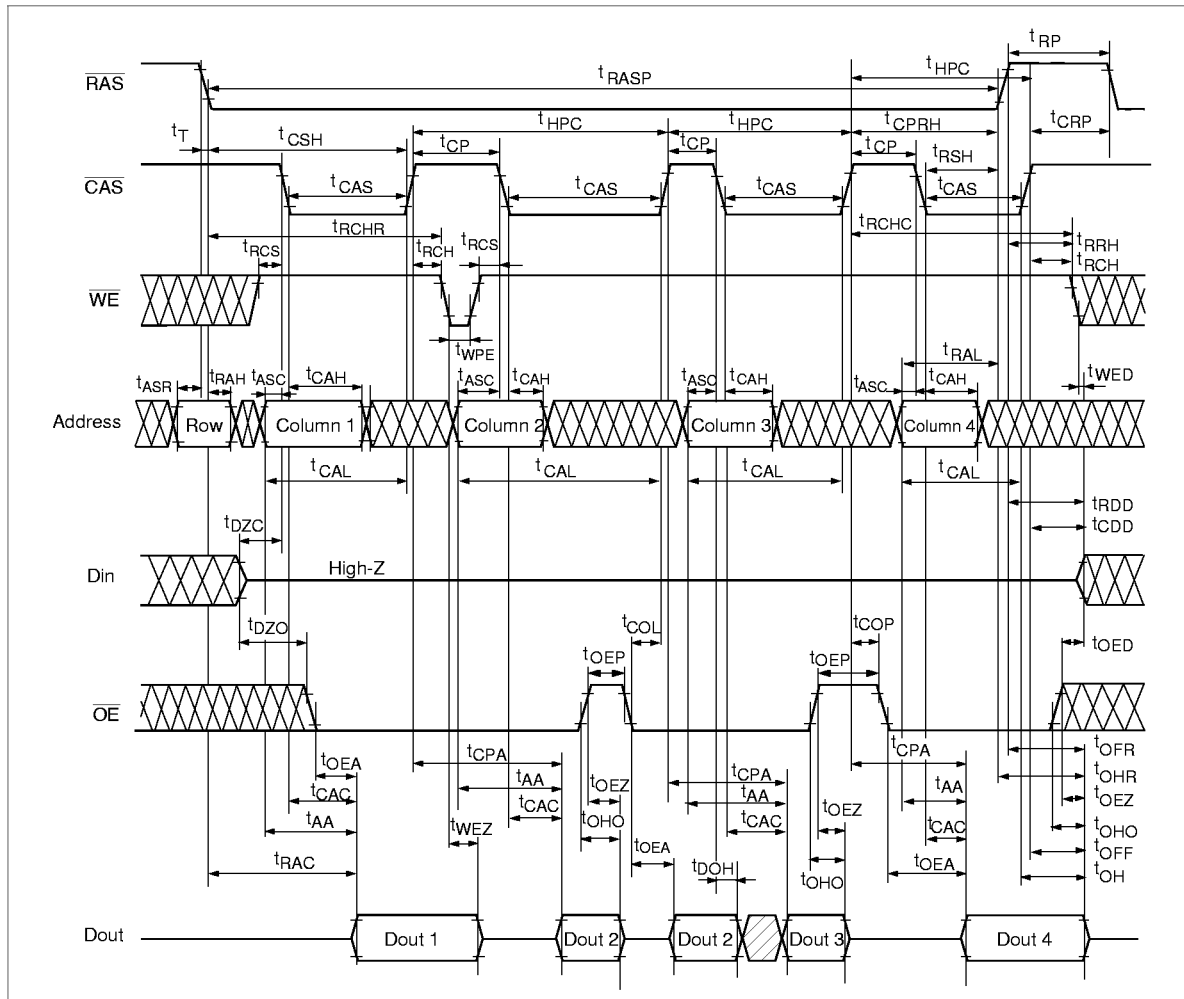


HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

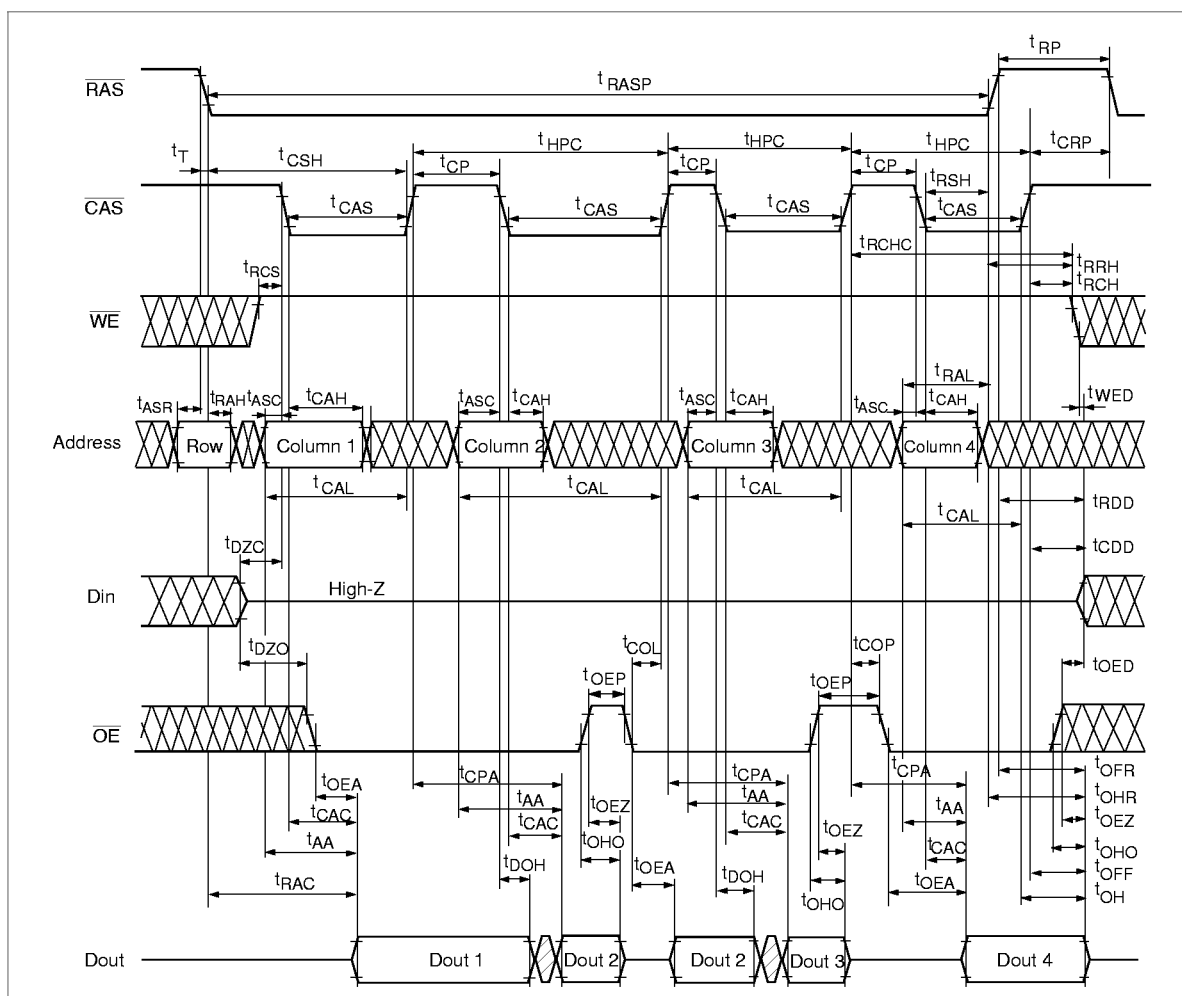
$\overline{\text{CAS}}$ -Before- $\overline{\text{RAS}}$ Refresh Cycle



EDO Page Mode Read Cycle (1)

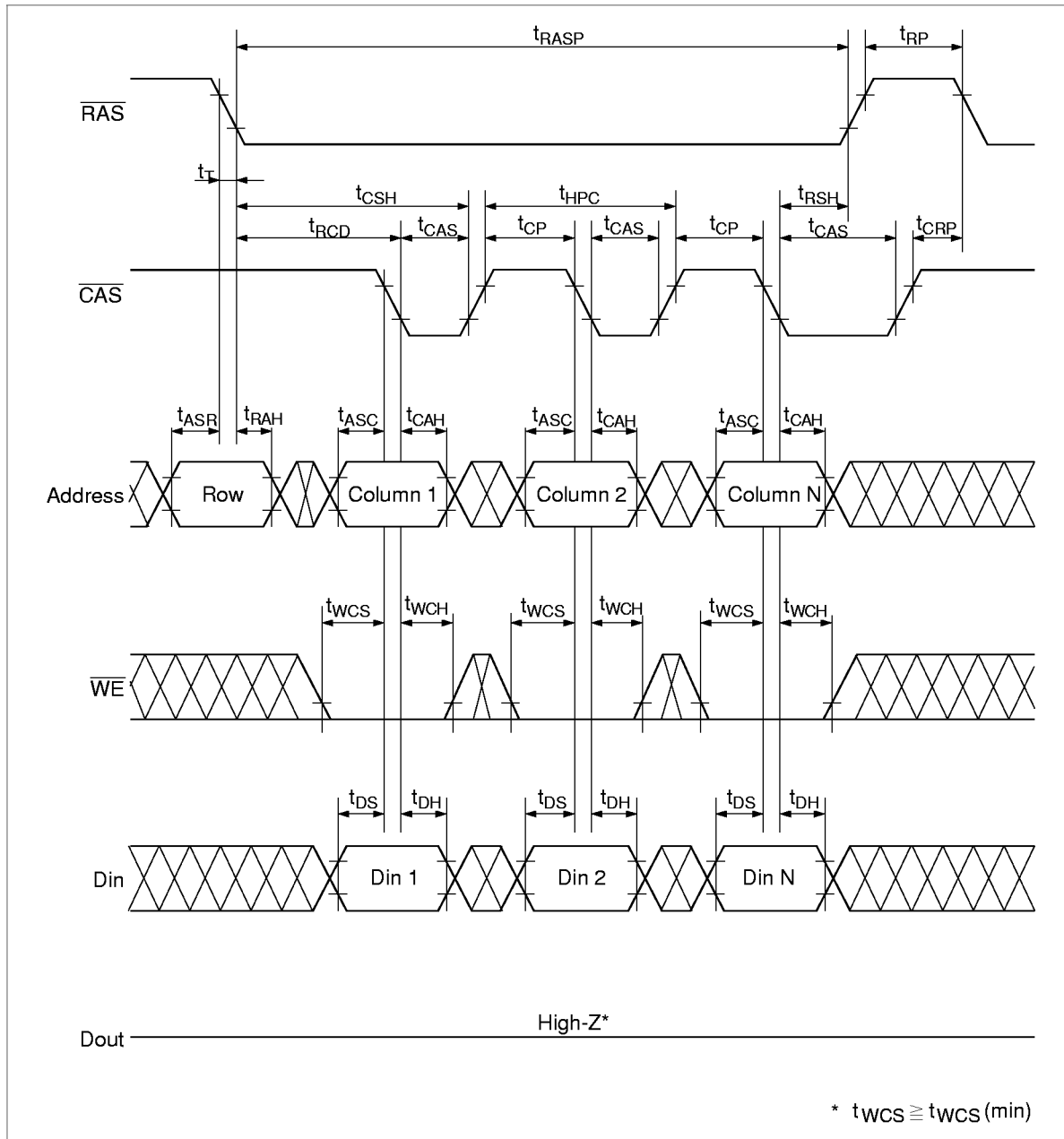


EDO Page Mode Read Cycle (2)



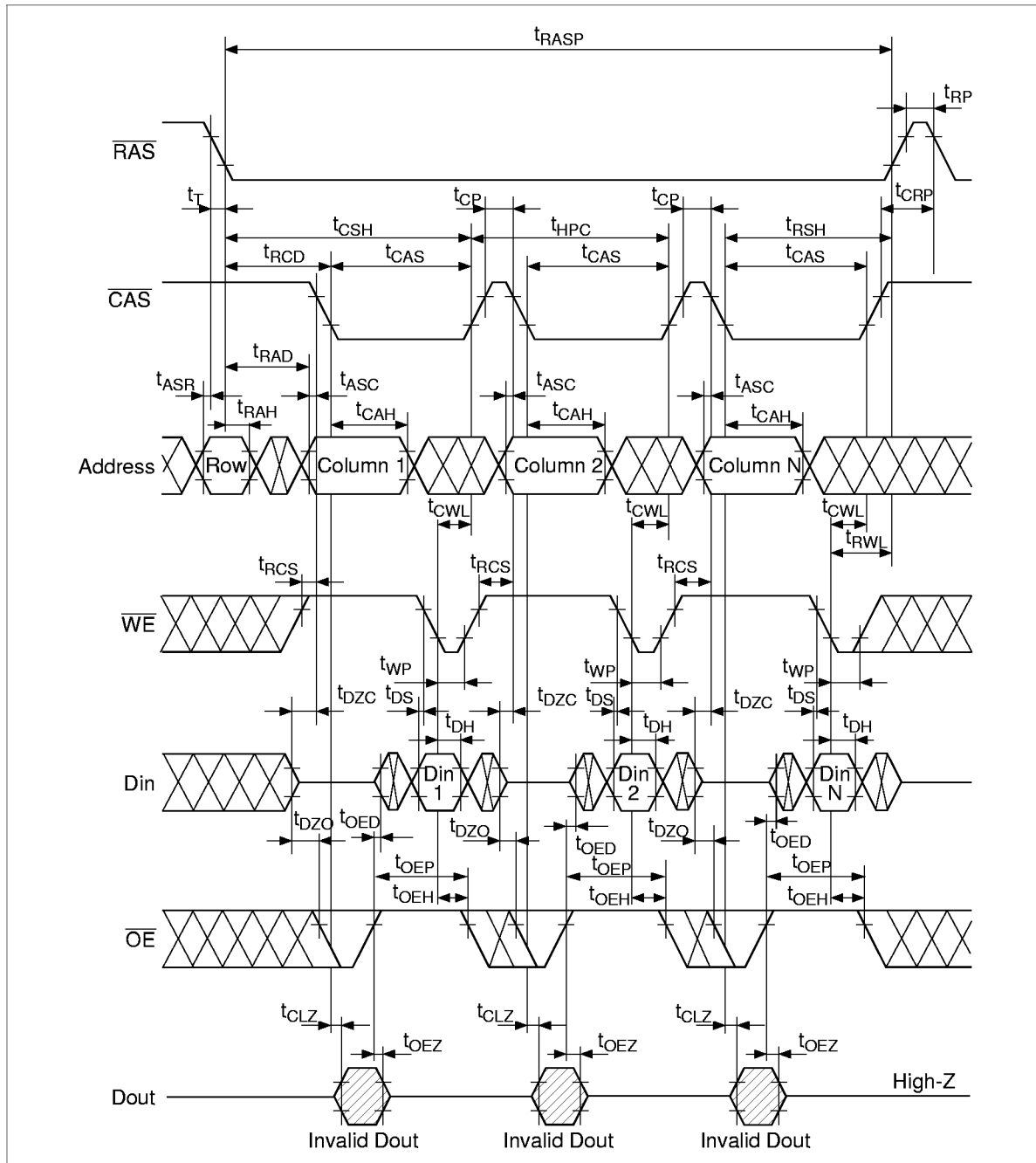
HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

EDO Page Mode Early Write Cycle



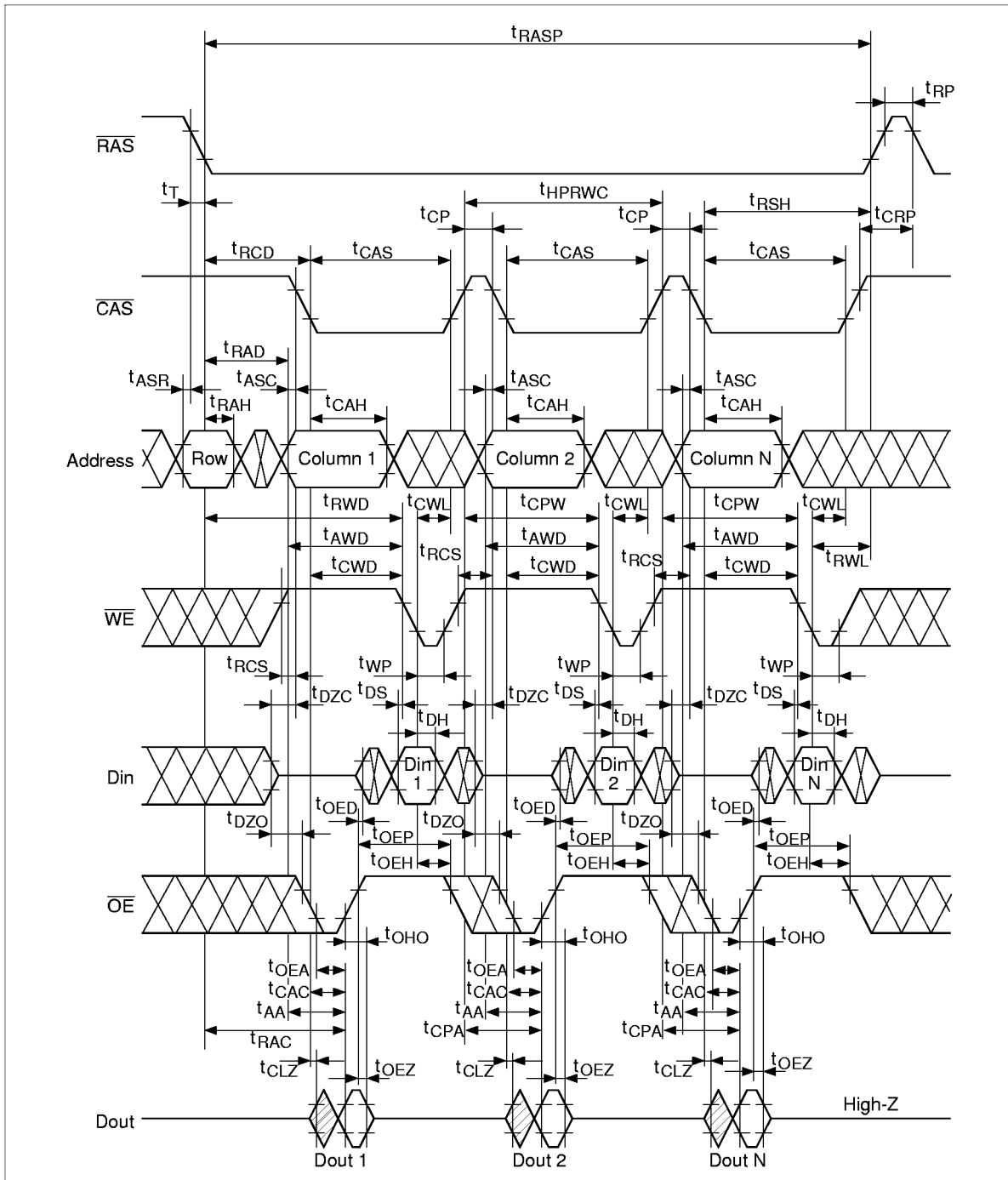
HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

EDO Page Mode Delayed Write Cycle*18

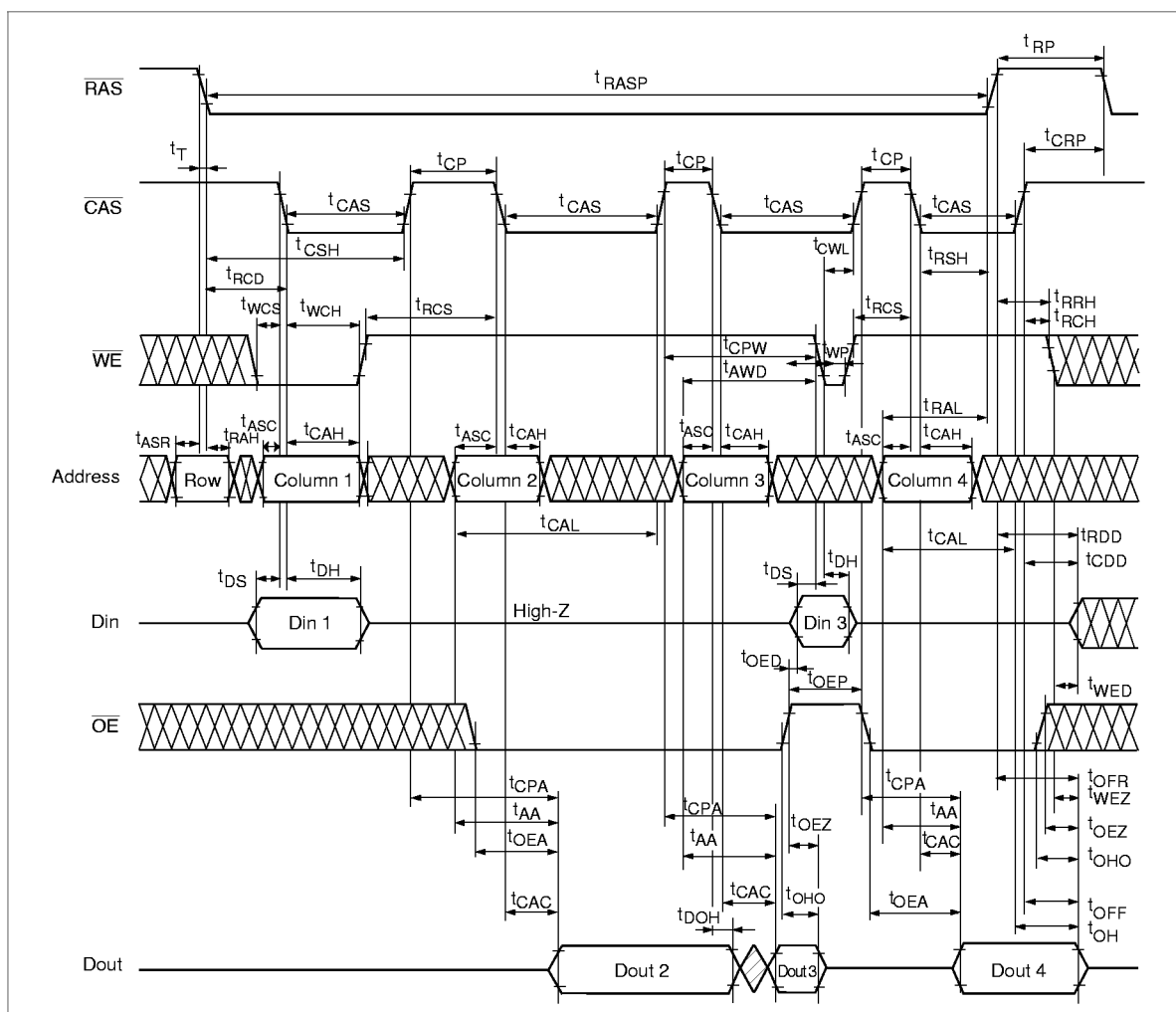


HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

EDO Page Mode Read-Modify-Write Cycle*18

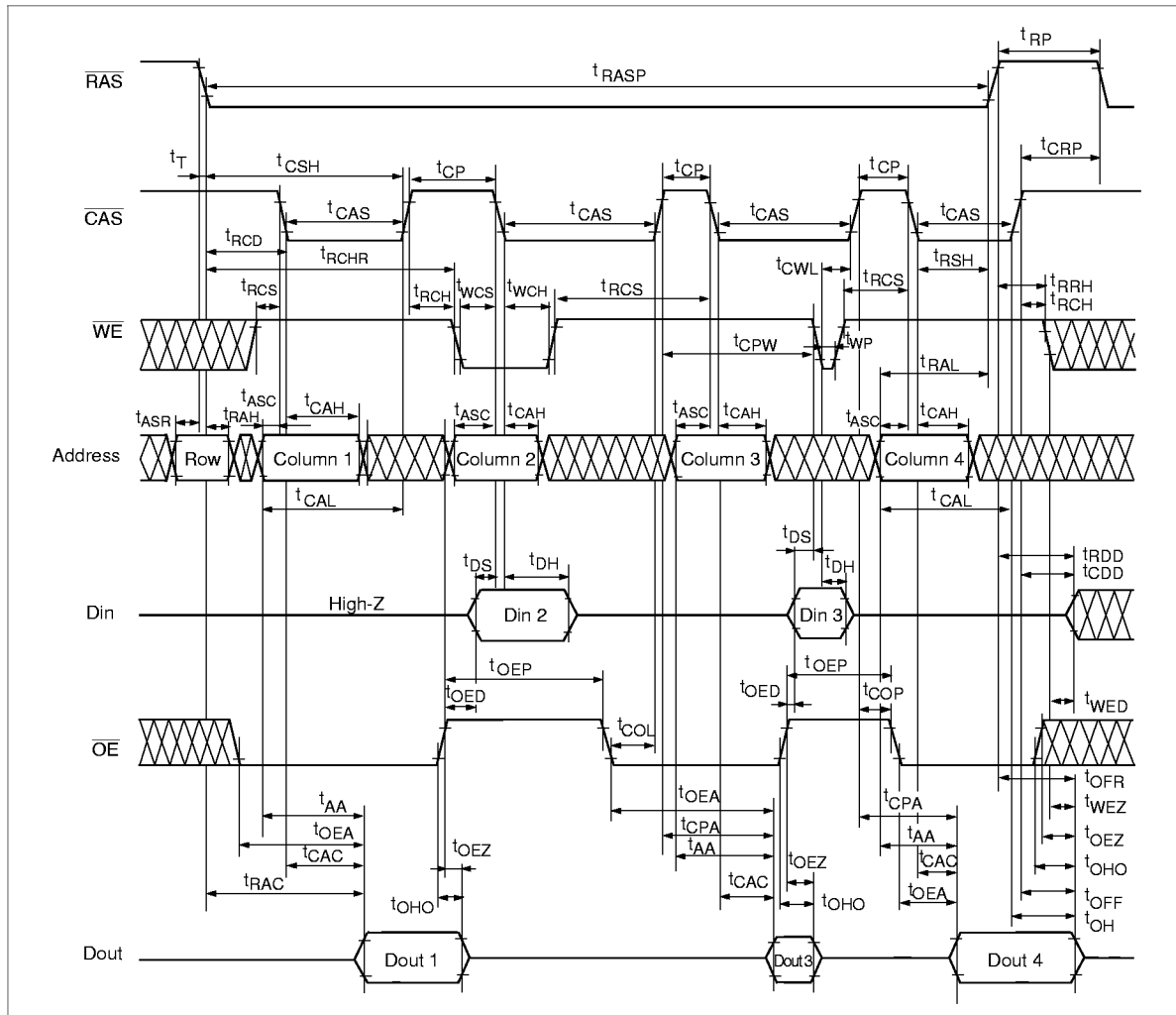


EDO Page Mode Mix Cycle (1) *²⁰



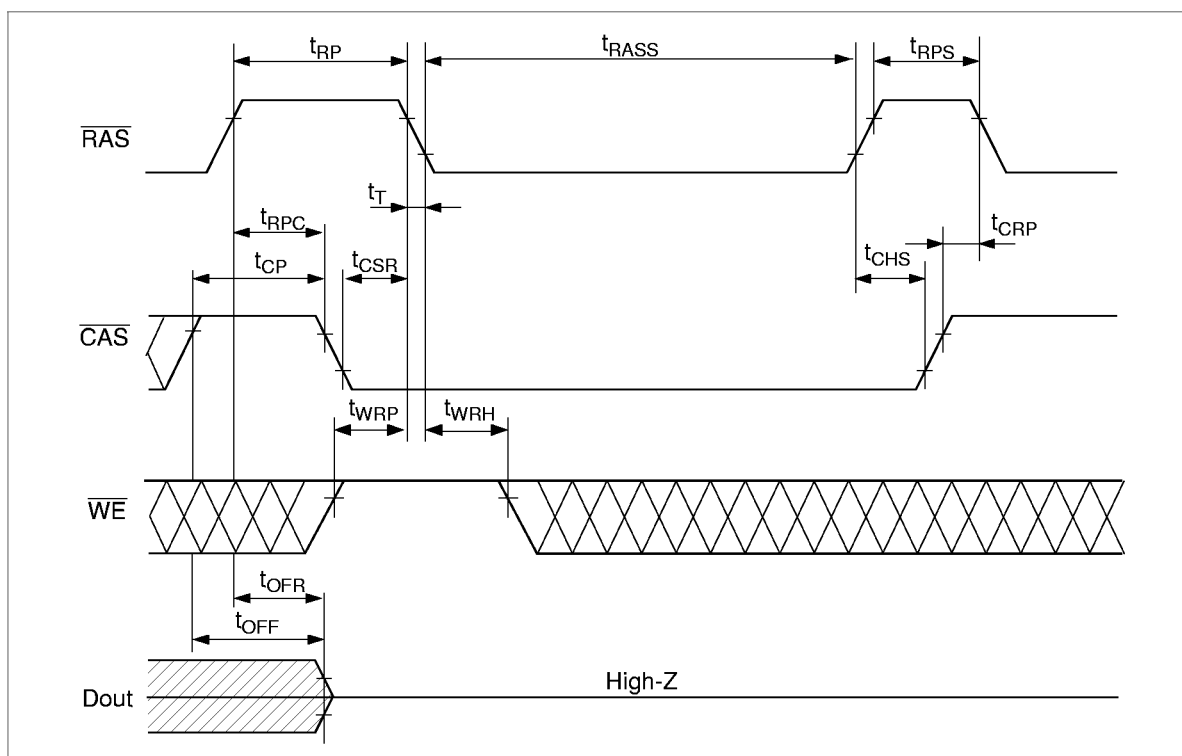
HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

EDO Page Mode Mix Cycle (2) *20



HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Self Refresh Cycle (L-version)* 23, 24, 25, 26

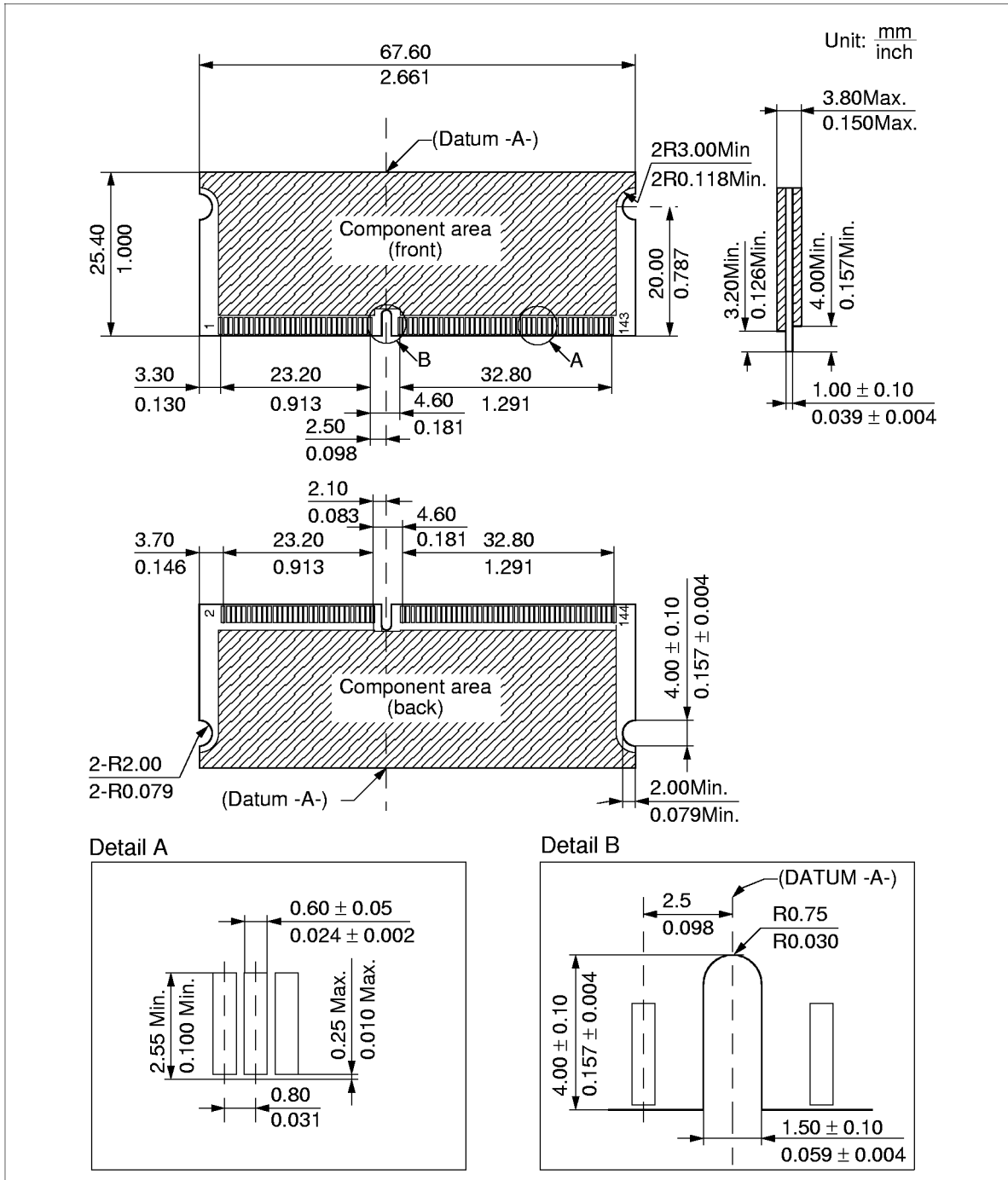


HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Physical Outline

HB56SW1664DBD Series

HB56SW1664DBC Series



Cautions

1. Hitachi neither warrants nor grants licenses of any rights of Hitachi's or any third party's patent, copyright, trademark, or other intellectual property rights for information contained in this document. Hitachi bears no responsibility for problems that may arise with third party's rights, including intellectual property rights, in connection with use of the information contained in this document.
2. Products and product specifications may be subject to change without notice. Confirm that you have received the latest product standards or specifications before final design, purchase or use.
3. Hitachi makes every attempt to ensure that its products are of high quality and reliability. However, contact Hitachi's sales office before using the product in an application that demands especially high quality and reliability or where its failure or malfunction may directly threaten human life or cause risk of bodily injury, such as aerospace, aeronautics, nuclear power, combustion control, transportation, traffic, safety equipment or medical equipment for life support.
4. Design your application so that the product is used within the ranges guaranteed by Hitachi particularly for maximum rating, operating supply voltage range, heat radiation characteristics, installation conditions and other characteristics. Hitachi bears no responsibility for failure or damage when used beyond the guaranteed ranges. Even within the guaranteed ranges, consider normally foreseeable failure rates or failure modes in semiconductor devices and employ systemic measures such as fail-safes, so that the equipment incorporating Hitachi product does not cause bodily injury, fire or other consequential damage due to operation of the Hitachi product.
5. This product is not designed to be radiation resistant.
6. No one is permitted to reproduce or duplicate, in any form, the whole or part of this document without written approval from Hitachi.
7. Contact Hitachi's sales office for any questions regarding this document or Hitachi semiconductor products.

HITACHI

Hitachi, Ltd.

Semiconductor & IC Div.

Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan

Tel: Tokyo (03) 3270-2111

Fax: (03) 3270-5109

For further information write to:

Hitachi Semiconductor
(America) Inc.
2000 Sierra Point Parkway
Brisbane, CA. 94005-1897
U S A
Tel: 800-285-1601
Fax: 303-297-0447

Hitachi Europe GmbH
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: 01628-585000
Fax: 01628-585160

Hitachi Asia Pte. Ltd.
16 Collyer Quay #20-00
Hitachi Tower
Singapore 049318
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

Copyright © Hitachi, Ltd., 1998. All rights reserved. Printed in Japan.

HB56SW1664DBD-5/5L/6/6L, HB56SW1664DBC-5/5L/6/6L

Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
0.0	Dec. 5, 1997	Initial issue (referred to HM5164405/HM5165405 Series rev 0.0)	S. Tsukui	K. Tsuneda
0.1	Jan. 30, 1998	Change of V_{CC} :3.3V+0.3V/-0.15V to 3.3V±0.3V	S. Tsukui	K. Tsuneda
0.2	Mar. 16, 1998	Change of Block Diagram Change of Physical Outline	S. Tsukui	K. Tsuneda
1.0	Jun. 26, 1998	(referred to HM5164405/HM5165405 Series rev. 1.0) General Description Addition of Notes about protection from mechanical defects AC Test condition Addition of Ambient illuminance		