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# HB56R864ES Series

8,388,608-word × 64-bit High Density Dynamic RAM Module

# HITACHI

ADE-203-779A (Z)

Rev. 1.0

May. 12, 1997

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## Description

The HB56R864ES belongs to 8 Byte DIMM (Dual In-line Memory Module) family, and has been developed as an optimized main memory solution for 4 and 8 Byte processor applications. The HB56R864ES is a 8M × 64 dynamic RAM module, mounted 32 pieces of 16-Mbit DRAM (HM5116400) sealed in TCP package, 1 piece of 16-bit BiCMOS line driver (74ABT16244) sealed in TSSOP package and 1 piece of 20-bit BiCMOS line driver (74ABT16827) sealed in TSSOP package. An outline of the HB56R864ES is 168-pin socket type package (dual lead out). Therefore, the HB56R864ES makes high density mounting possible without surface mount technology. The HB56R864ES provides common data inputs and outputs. Decoupling capacitors are mounted beside each TSOP on the module board.

## Features

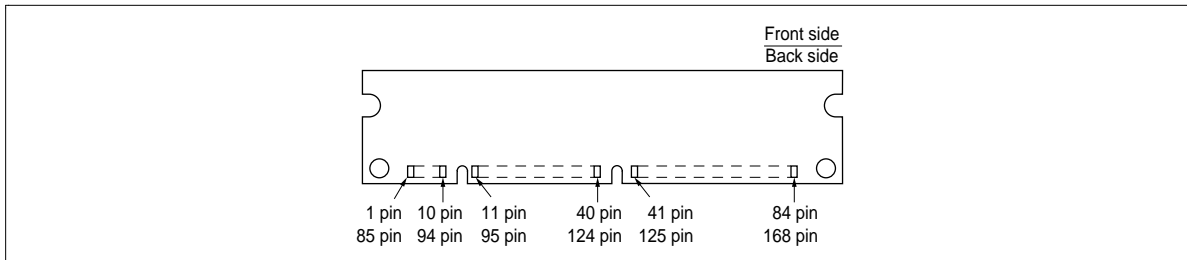
- 168-pin socket type package (Dual lead out)
  - Lead pitch: 1.27 mm
- Single 5 V (±5%) supply
- JEDEC standard outline buffered 8 byte DIMM
- High speed
  - Access time:  $t_{RAC} = 60/70$  ns (max)
  - $t_{CAC} = 20/23$  ns (max)
- Low power dissipation
  - Active mode: 7.48/6.64 W (max)
  - Standby mode (TTL): 672 mW (max)
  - (CMOS): 504 mW (max)
- Buffered input except  $\overline{RAS}$  and DQ
- 4 byte interleave enabled, dual address input (A0/B0)
- Fast page mode capability
- 4,096 refresh cycle: 64 ms
- 2 variations of refresh
  - $\overline{RAS}$ -only refresh
  - $\overline{CAS}$ -before- $\overline{RAS}$  refresh
- TTL compatible

## HB56R864ES Series

### Ordering Information

Type No.	Access time	Package	Contact pad
HB56R864ES-6	60 ns	168-pin dual lead out socket type	Gold
HB56R864ES-7	70 ns		

### Pin Arrangement



	Pin name	Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name
1	$V_{SS}$	13	DQ9	25	NC	37	A8
2	DQ0	14	DQ10	26	$V_{CC}$	38	A10
3	DQ1	15	DQ11	27	$\overline{WE0}$	39	NC
4	DQ2	16	DQ12	28	$\overline{CE0}$	40	$V_{CC}$
5	DQ3	17	DQ13	29	$\overline{CE2}$	41	NC
6	$V_{CC}$	18	$V_{CC}$	30	$\overline{RE0}$	42	NC
7	DQ4	19	DQ14	31	$\overline{OE0}$	43	$V_{SS}$
8	DQ5	20	DQ15	32	$V_{SS}$	44	$\overline{OE2}$
9	DQ6	21	DQ16	33	A0	45	$\overline{RE2}$
10	DQ7	22	NC	34	A2	46	$\overline{CE4}$
11	NC	23	$V_{SS}$	35	A4	47	$\overline{CE6}$
12	$V_{SS}$	24	NC	36	A6	48	$\overline{WE2}$

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### Pin Arrangement (cont.)

Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name
49	V <sub>CC</sub>	79	PD1	109	NC	139	DQ56
50	NC	80	PD3	110	V <sub>CC</sub>	140	DQ57
51	NC	81	PD5	111	NC	141	DQ58
52	DQ18	82	PD7	112	$\overline{\text{CE1}}$	142	DQ59
53	DQ19	83	ID0 (V <sub>SS</sub> )	113	$\overline{\text{RE3}}$	143	V <sub>CC</sub>
54	V <sub>SS</sub>	84	V <sub>CC</sub>	114	$\overline{\text{RE1}}$	144	DQ60
55	DQ20	85	V <sub>SS</sub>	115	NC	145	NC
56	DQ21	86	DQ36	116	V <sub>SS</sub>	146	NC
57	DQ22	87	DQ37	117	A1	147	NC
58	DQ23	88	DQ38	118	A3	148	NC
59	V <sub>CC</sub>	89	DQ39	119	A5	149	DQ61
60	DQ24	90	V <sub>CC</sub>	120	A7	150	NC
61	NC	91	DQ40	121	A9	151	DQ63
62	NC	92	DQ41	122	A11	152	V <sub>SS</sub>
63	NC	93	DQ42	123	NC	153	DQ64
64	NC	94	DQ43	124	V <sub>CC</sub>	154	DQ65
65	DQ25	95	NC	125	NC	155	DQ66
66	NC	96	V <sub>SS</sub>	126	B0	156	DQ67
67	DQ27	97	DQ45	127	V <sub>SS</sub>	157	V <sub>CC</sub>
68	V <sub>SS</sub>	98	DQ46	128	NC	158	DQ68
69	DQ28	99	DQ47	129	$\overline{\text{RE3}}$	159	DQ69
70	DQ29	100	DQ48	130	$\overline{\text{CE5}}$	160	DQ70
71	DQ30	101	DQ49	131	$\overline{\text{CE7}}$	161	NC
72	DQ31	102	V <sub>CC</sub>	132	$\overline{\text{PDE}}$	162	V <sub>SS</sub>
73	V <sub>CC</sub>	103	DQ50	133	V <sub>CC</sub>	163	PD2
74	DQ32	104	DQ51	134	NC	164	PD4
75	DQ33	105	DQ52	135	NC	165	PD6
76	DQ34	106	NC	136	DQ54	166	PD8
77	NC	107	V <sub>SS</sub>	137	DQ55	167	ID1 (V <sub>SS</sub> )
78	V <sub>SS</sub>	108	NC	138	V <sub>SS</sub>	168	V <sub>CC</sub>

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### Pin Description

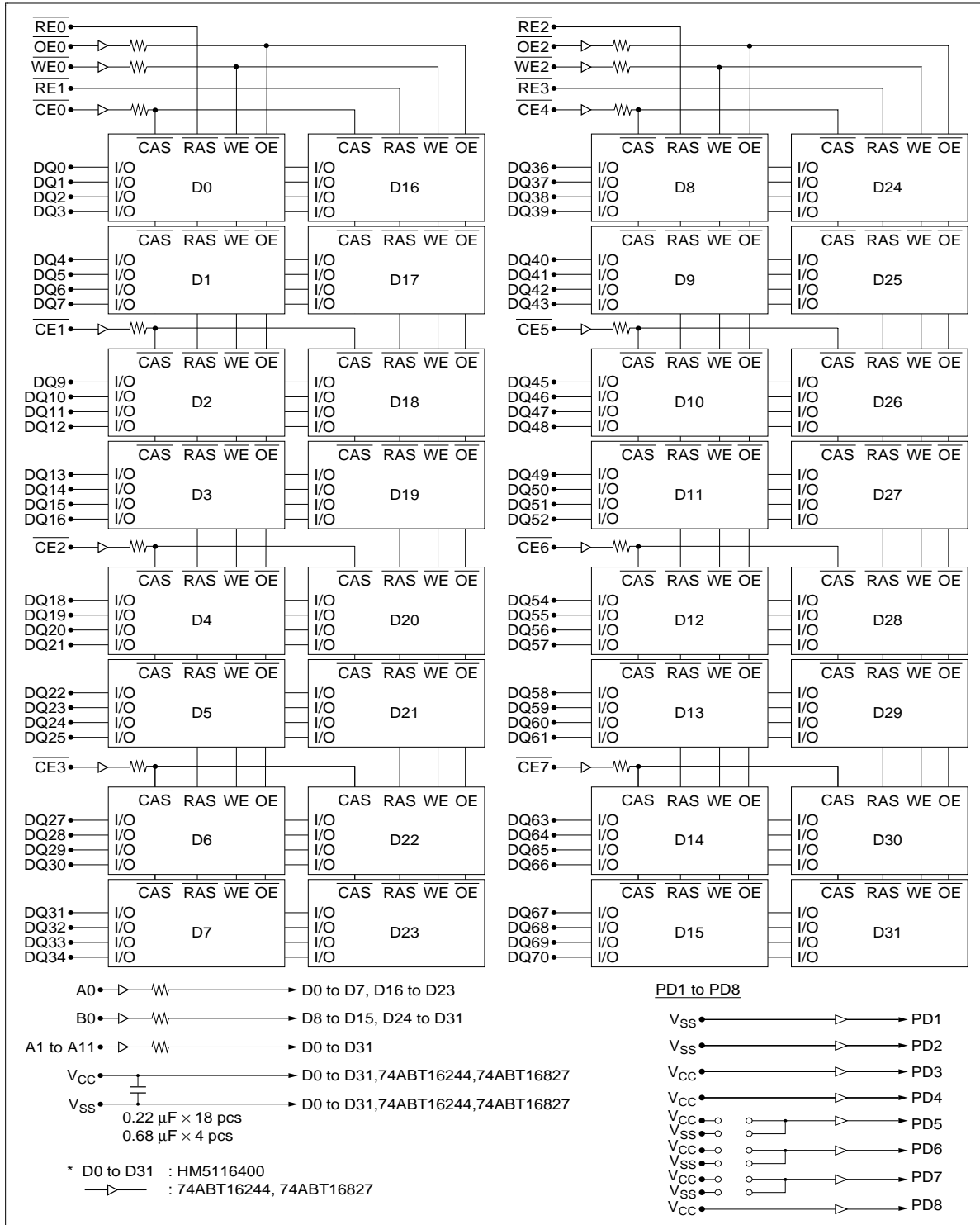
Pin name	Function
A0 to A11, B0	Address Input <ul style="list-style-type: none"> <li>• Row Address : A0 to A11, B0</li> <li>• Column Address : A0 to A9, B0</li> <li>• Refresh Address : A0 to A11, B0</li> </ul>
DQ0 to DQ7, DQ9 to DQ16, DQ18 to DQ25, Data-in/Data-out DQ27 to DQ34, DQ36 to DQ43, DQ45 to DQ52, DQ54 to DQ61, DQ63 to DQ70	
$\overline{\text{RE0}}$ to $\overline{\text{RE3}}$	Row address strobe ( $\overline{\text{RAS}}$ )
$\overline{\text{CE0}}$ to $\overline{\text{CE7}}$	Column address strobe ( $\overline{\text{CAS}}$ )
$\overline{\text{WE0}}$ , $\overline{\text{WE2}}$	Read/Write enable
$\overline{\text{OE0}}$ , $\overline{\text{OE2}}$	Output enable
$V_{\text{CC}}$	Power supply
$V_{\text{SS}}$	Ground
PD1 to PD8	Presence detect
ID0, ID1	ID bit
PDE	Presence detect enable
NC	No connection

### Presence Detect Pin Assignment

Pin name	Pin No.	$\overline{\text{PDE}} = \text{Low}$		$\overline{\text{PDE}} = \text{High}$
		60 ns	70 ns	All
PD1	79	0	0	High-Z
PD2	163	0	0	High-Z
PD3	80	1	1	High-Z
PD4	164	1	1	High-Z
PD5	81	0	0	High-Z
PD6	165	1	0	High-Z
PD7	82	1	1	High-Z
PD8	166	1	1	High-Z

Note: 1: High level (Driver output)  
0: Low level (Driver output)

## 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 +7.0	V
Supply voltage relative to $V_{SS}$	$V_{CC}$	-0.5 to +7.0	V
Short circuit output current	$I_{out}$	50	mA
Power dissipation	$P_t$	33	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 $70^\circ\text{C}$ )

Parameter	Symbol	Min	Type	Max	Unit	Note
Supply voltage	$V_{SS}$	0	0	0	V	
	$V_{CC}$	4.75	5.0	5.25	V	1
Input high voltage	$V_{IH}$	2.4	—	5.5	V	1
Input low voltage	$V_{IL}$	-0.5	—	0.8	V	1

Note: 1. All voltage referred to  $V_{SS}$ .

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### DC Characteristics (Ta = 0 to 70°C, V<sub>CC</sub> = 5 V ± 5%, V<sub>SS</sub> = 0 V)

Parameter	Symbol	60 ns		70 ns		Unit	Test conditions	Notes
		Min	Max	Min	Max			
Operating current	I <sub>CC1</sub>	—	1424	—	1264	mA	t <sub>RC</sub> = min	1, 2
Standby current	I <sub>CC2</sub>	—	128	—	128	mA	TTL interface R <sub>AS</sub> , C <sub>AS</sub> = V <sub>IH</sub> Dout = High-Z	
		—	96	—	96	mA	CMOS interface R <sub>AS</sub> , C <sub>AS</sub> ≥ V <sub>CC</sub> - 0.2 V Dout = High-Z	
R <sub>AS</sub> -only refresh current	I <sub>CC3</sub>	—	1424	—	1264	mA	t <sub>RC</sub> = min	2
Standby current	I <sub>CC5</sub>	—	224	—	224	mA	R <sub>AS</sub> = V <sub>IH</sub> , C <sub>AS</sub> = V <sub>IL</sub> Dout = enable	1
C <sub>AS</sub> -before-R <sub>AS</sub> refresh current	I <sub>CC6</sub>	—	1424	—	1264	mA	t <sub>RC</sub> = min	
Fast page mode current	I <sub>CC7</sub>	—	1264	—	1104	mA	t <sub>PC</sub> = min	1, 3
Input leakage current	I <sub>LI</sub>	-10	10	-10	10	μA	0 V ≤ Vin ≤ 5.5 V	
Output leakage current	I <sub>LO</sub>	-10	10	-10	10	μA	0 V ≤ Vout ≤ 5.5 V Dout = disable	
Output high voltage	V <sub>OH</sub>	2.4	V <sub>CC</sub>	2.4	V <sub>CC</sub>	V	High Iout = -5 mA	
Output low voltage	V <sub>OL</sub>	0	0.4	0	0.4	V	Low Iout = 4.2 mA	

- Notes: 1. I<sub>CC</sub> depends on output load condition when the device is selected, I<sub>CC</sub> max is specified at the output open condition.  
 2. Address can be changed once or less while R<sub>AS</sub> = V<sub>IL</sub>.  
 3. Address can be changed once or less while C<sub>AS</sub> = V<sub>IH</sub>.

### Capacitance (Ta = 25°C, V<sub>CC</sub> = 5 V ± 5%)

Parameter	Symbol	Type	Max	Unit	Notes
Input capacitance (Address)	C <sub>I1</sub>	—	20	pF	1
Input capacitance (C <sub>E</sub> , W <sub>E</sub> , O <sub>E</sub> )	C <sub>I2</sub>	—	20	pF	1
Input capacitance (R <sub>E</sub> )	C <sub>I3</sub>	—	71	pF	1
Output capacitance (DQ)	C <sub>I/O</sub>	—	20	pF	1, 2

- Notes: 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.  
 2. C<sub>AS</sub> = V<sub>IH</sub> to disable Dout.

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AC Characteristics ( $T_a = 0$  to  $70^\circ\text{C}$ ,  $V_{CC} = 5\text{ V} \pm 5\%$ ,  $V_{SS} = 0\text{ V}$ )<sup>\*1, \*2, \*18, \*19</sup>

### Test Conditions

- Input rise and fall times: 5 ns
- Input timing reference levels: 0.8 V, 2.4 V
- Output load: 2 TTL gate +  $C_L$  (100 pF) (Including scope and jig)

### 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	$t_{RC}$	110	—	130	—	ns	
$\overline{\text{RAS}}$ precharge time	$t_{RP}$	40	—	50	—	ns	
$\overline{\text{CAS}}$ precharge time	$t_{CP}$	10	—	10	—	ns	
$\overline{\text{RAS}}$ pulse width	$t_{RAS}$	60	10000	70	10000	ns	
$\overline{\text{CAS}}$ pulse width	$t_{CAS}$	15	10000	18	10000	ns	
Row address setup time	$t_{ASR}$	5	—	5	—	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	—	15	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	$t_{RCD}$	20	40	20	47	ns	3
$\overline{\text{RAS}}$ to column address delay time	$t_{RAD}$	15	25	15	30	ns	4
$\overline{\text{RAS}}$ hold time	$t_{RSH}$	20	—	23	—	ns	
$\overline{\text{CAS}}$ hold time	$t_{CSH}$	60	—	70	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	$t_{CRP}$	10	—	10	—	ns	
$\overline{\text{OE}}$ to Din delay time	$t_{OED}$	20	—	23	—	ns	5
$\overline{\text{OE}}$ delay time from Din	$t_{DZO}$	0	—	0	—	ns	6
$\overline{\text{CAS}}$ delay time from Din	$t_{DZC}$	0	—	0	—	ns	6
Transition time (rise and fall)	$t_T$	3	50	3	50	ns	7
Refresh period (4,096 cycles)	$t_{REF}$	—	64	—	64	ms	

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### Read Cycle

Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
Access time from $\overline{\text{RAS}}$	$t_{\text{RAC}}$	—	60	—	70	ns	8, 9
Access time from $\overline{\text{CAS}}$	$t_{\text{CAC}}$	—	20	—	23	ns	9, 10, 17
Access time from address	$t_{\text{AA}}$	—	35	—	40	ns	9, 11, 17
Access time from $\overline{\text{OE}}$	$t_{\text{OEA}}$	—	20	—	23	ns	9, 20
Read command setup time	$t_{\text{RCS}}$	0	—	0	—	ns	
Read command hold time to $\overline{\text{CAS}}$	$t_{\text{RCH}}$	0	—	0	—	ns	12
Read command hold time to $\overline{\text{RAS}}$	$t_{\text{RRH}}$	5	—	5	—	ns	12
Column address to $\overline{\text{RAS}}$ lead time	$t_{\text{RAL}}$	35	—	40	—	ns	
Column address to $\overline{\text{CAS}}$ lead time	$t_{\text{CAL}}$	30	—	35	—	ns	
$\overline{\text{CAS}}$ to output in low-Z	$t_{\text{CLZ}}$	2	—	2	—	ns	
Output data hold time	$t_{\text{OH}}$	3	—	3	—	ns	
Output data hold time from $\overline{\text{OE}}$	$t_{\text{OHO}}$	3	—	3	—	ns	
Output buffer turn-off time	$t_{\text{OFF}}$	—	20	—	20	ns	13
Output buffer turn-off to $\overline{\text{OE}}$	$t_{\text{OEZ}}$	—	20	—	20	ns	13
$\overline{\text{CAS}}$ to Din delay time	$t_{\text{CDD}}$	20	—	23	—	ns	5

### Write Cycle

Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
Write command setup time	$t_{\text{WCS}}$	0	—	0	—	ns	14
Write command hold time	$t_{\text{WCH}}$	10	—	15	—	ns	
Write command pulse width	$t_{\text{WCP}}$	10	—	10	—	ns	
Write command to $\overline{\text{RAS}}$ lead time	$t_{\text{RWL}}$	20	—	23	—	ns	
Write command to $\overline{\text{CAS}}$ lead time	$t_{\text{CWL}}$	15	—	18	—	ns	
Data-in setup time	$t_{\text{DS}}$	0	—	0	—	ns	15
Data-in hold time	$t_{\text{DH}}$	15	—	20	—	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	$t_{RWC}$	155	—	181	—	ns	
$\overline{RAS}$ to $\overline{WE}$ delay time	$t_{RWD}$	85	—	98	—	ns	14
$\overline{CAS}$ to $\overline{WE}$ delay time	$t_{CWD}$	40	—	46	—	ns	14
Column address to $\overline{WE}$ delay time	$t_{AWD}$	55	—	63	—	ns	14
$\overline{OE}$ hold time from $\overline{WE}$	$t_{OEH}$	15	—	18	—	ns	

### Refresh Cycle

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

### Fast Page Mode Cycle

Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
Fast page mode cycle time	$t_{PC}$	40	—	45	—	ns	
Fast page mode $\overline{RAS}$ pulse width	$t_{RASP}$	—	100000	—	100000	ns	16
Access time from $\overline{CAS}$ precharge	$t_{CPA}$	—	40	—	45	ns	9, 17
$\overline{RAS}$ hold time from $\overline{CAS}$ precharge	$t_{CPRH}$	40	—	45	—	ns	

### Fast Page Mode Read-Modify-Write Cycle

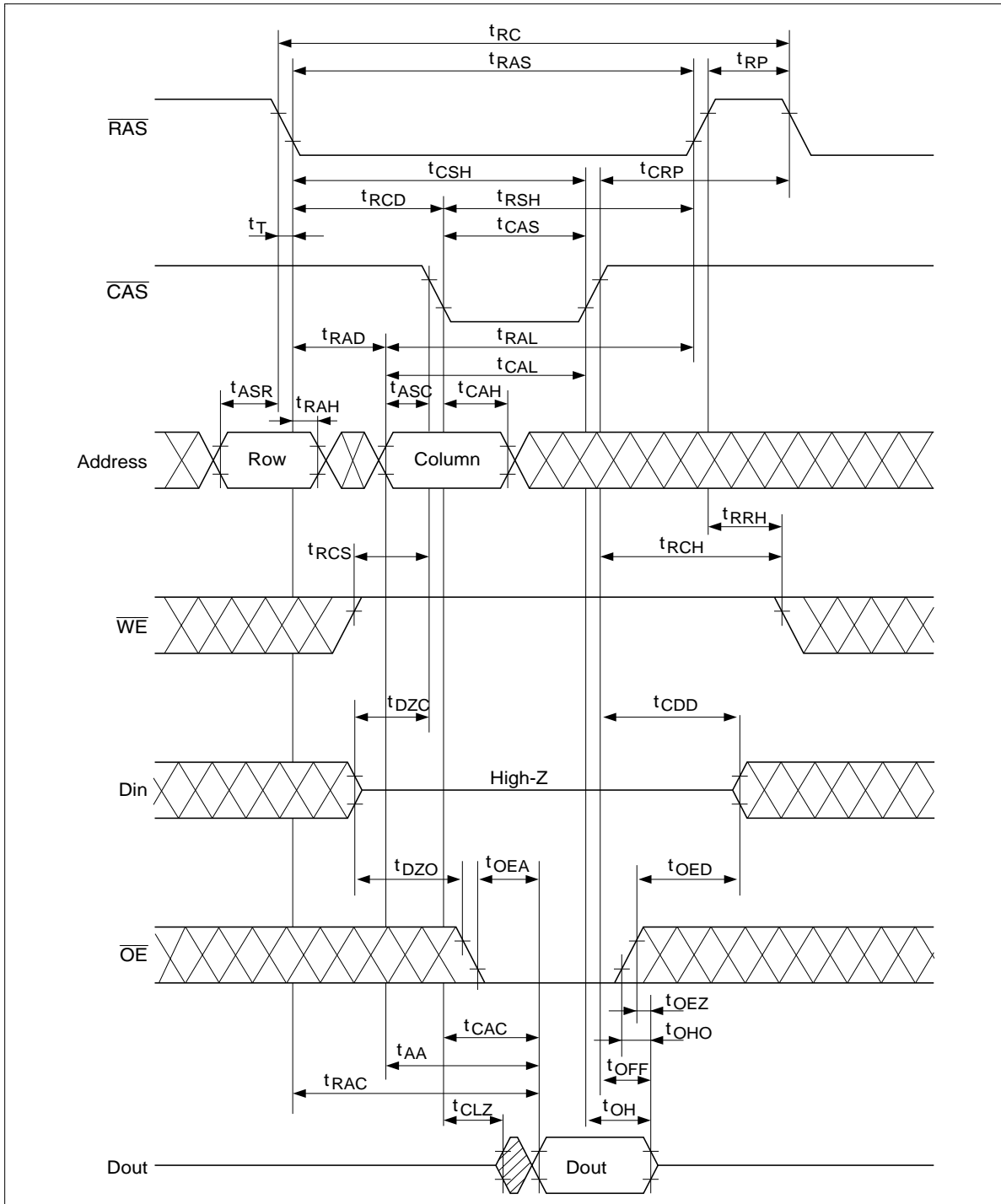
Parameter	Symbol	60 ns		70 ns		Unit	Notes
		Min	Max	Min	Max		
Fast page mode read-modify-write cycle time	$t_{PRWC}$	85	—	96	—	ns	
$\overline{WE}$ delay time from $\overline{CAS}$ precharge	$t_{CPW}$	60	—	68	—	ns	14

- Notes:
1. AC measurements assume  $t_f = 5$  ns.
  2. An initial pause of 200  $\mu$ 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  $t_{\text{RCD}}$  (max) limit insures that  $t_{\text{RAC}}$  (max) can be met,  $t_{\text{RCD}}$  (max) is specified as a reference point only; if  $t_{\text{RCD}}$  is greater than the specified  $t_{\text{RCD}}$  (max) limit, then access time is controlled exclusively by  $t_{\text{CAC}}$ .
  4. Operation with the  $t_{\text{RAD}}$  (max) limit insures that  $t_{\text{RAC}}$  (max) can be met,  $t_{\text{RAD}}$  (max) is specified as a reference point only; if  $t_{\text{RAD}}$  is greater than the specified  $t_{\text{RAD}}$  (max) limit, then access time is controlled exclusively by  $t_{\text{AA}}$ .
  5. Either  $t_{\text{OED}}$  or  $t_{\text{CDD}}$  must be satisfied.
  6. Either  $t_{\text{DZO}}$  or  $t_{\text{DZC}}$  must be satisfied.
  7.  $V_{\text{IH}}$  (min) and  $V_{\text{IL}}$  (max) are reference levels for measuring timing of input signals. Also, transition times are measured between  $V_{\text{IH}}$  (min) and  $V_{\text{IL}}$  (max).
  8. Assumes that  $t_{\text{RCD}} \leq t_{\text{RCD}}$  (max) and  $t_{\text{RAD}} \leq t_{\text{RAD}}$  (max). If  $t_{\text{RCD}}$  or  $t_{\text{RAD}}$  is greater than the maximum recommended value shown in this table,  $t_{\text{RAC}}$  exceeds the value shown.
  9. Measured with a load circuit equivalent to 2TTL 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  $t_{\text{RCH}}$  or  $t_{\text{RRH}}$  must be satisfied for a read cycles.
  13.  $t_{\text{OFF}}$  (max) and  $t_{\text{OEZ}}$  (max) is define the time at which the outputs achieve the open circuit condition and are not referred to output voltage levels.
  14.  $t_{\text{WCS}}$ ,  $t_{\text{RWD}}$ ,  $t_{\text{CWD}}$ ,  $t_{\text{CPW}}$  and  $t_{\text{AWD}}$  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. These parameters are referred to  $\overline{\text{CAS}}$  leading edge in early write cycle and to  $\overline{\text{WE}}$  leading edge in delayed write or read-modify-write cycles.
  16.  $t_{\text{RASP}}$  defines  $\overline{\text{RAS}}$  pulse width in fast page mode cycles.
  17. Access time is determined by the longest among  $t_{\text{AA}}$ ,  $t_{\text{CAC}}$  or  $t_{\text{CPA}}$ .
  18. In delayed write or read-modify-write cycle,  $\overline{\text{OE}}$  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); if  $t_{\text{OEH}} \leq t_{\text{CWL}}$ , invalid data will be out at each DQ.
  19. All the  $V_{\text{CC}}$  and  $V_{\text{SS}}$  pins shall be supplied with the same voltages.
  20. 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 causes large  $V_{\text{CC}} / V_{\text{SS}}$  line noise, which causes to degrade  $V_{\text{IH}}$  min /  $V_{\text{IL}}$  max level.
  21. XXX: H or L (H:  $V_{\text{IH}}$  (min)  $\leq V_{\text{IN}} \leq V_{\text{IH}}$  (max), L:  $V_{\text{IL}}$  (min)  $\leq V_{\text{IN}} \leq V_{\text{IL}}$  (max))  
 //////////////: Invalid Dout  
 When the address, clock and input pins are not described on timing waveforms, their pins must be applied  $V_{\text{IH}}$  or  $V_{\text{IL}}$ .

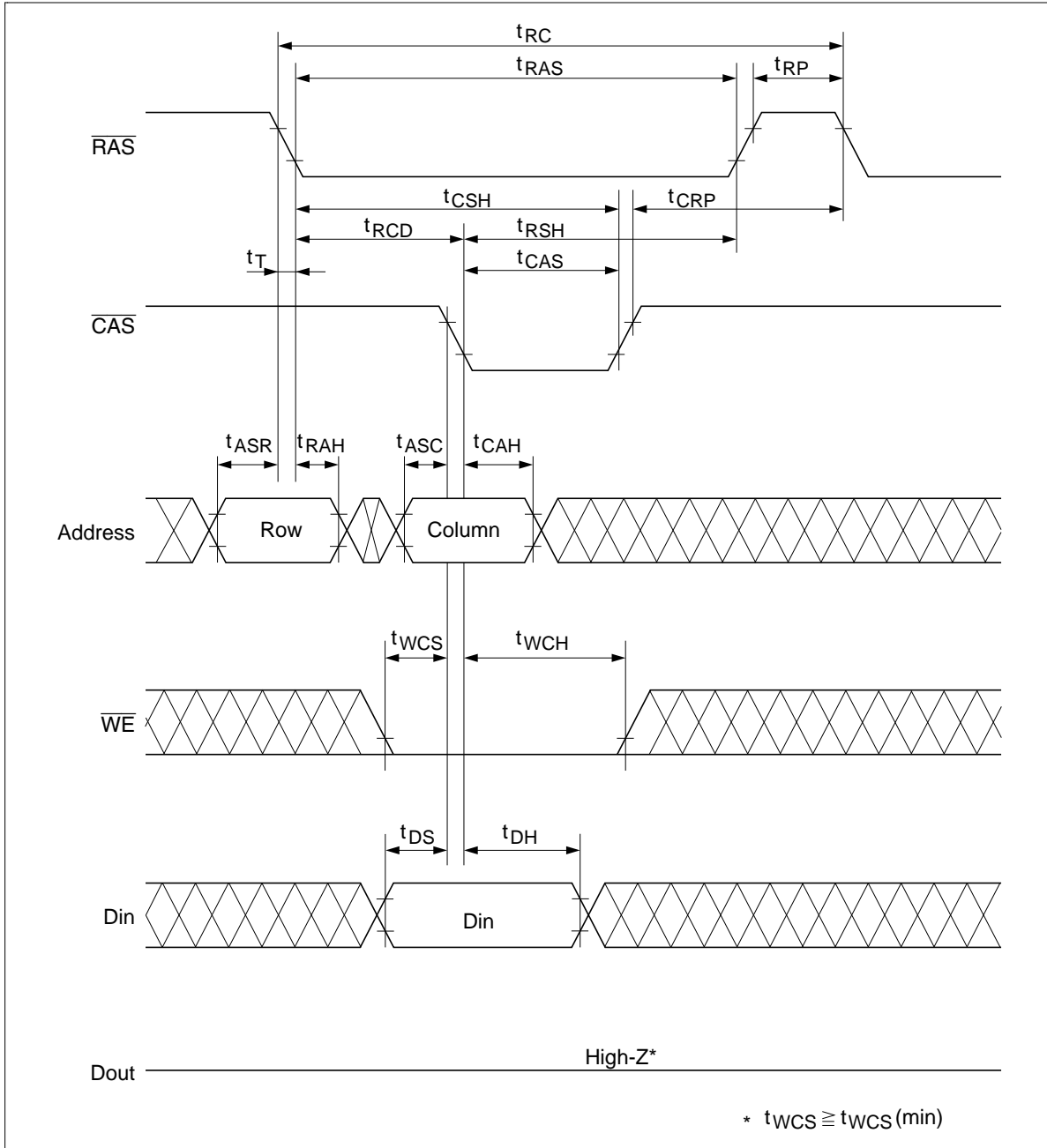
# HB56R864ES Series

## Timing Waveform\*21

### Read Cycle

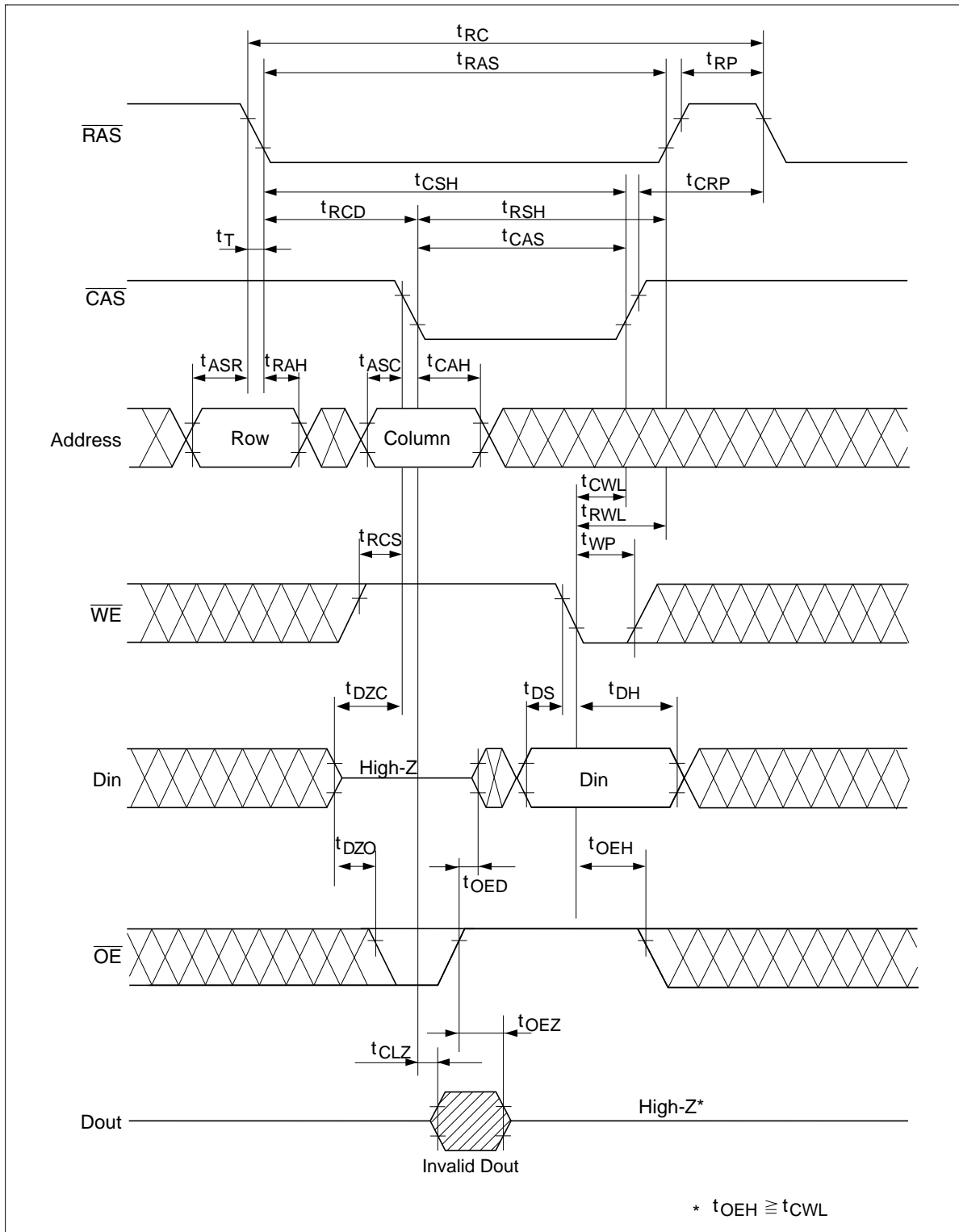


Early Write Cycle



# HB56R864ES Series

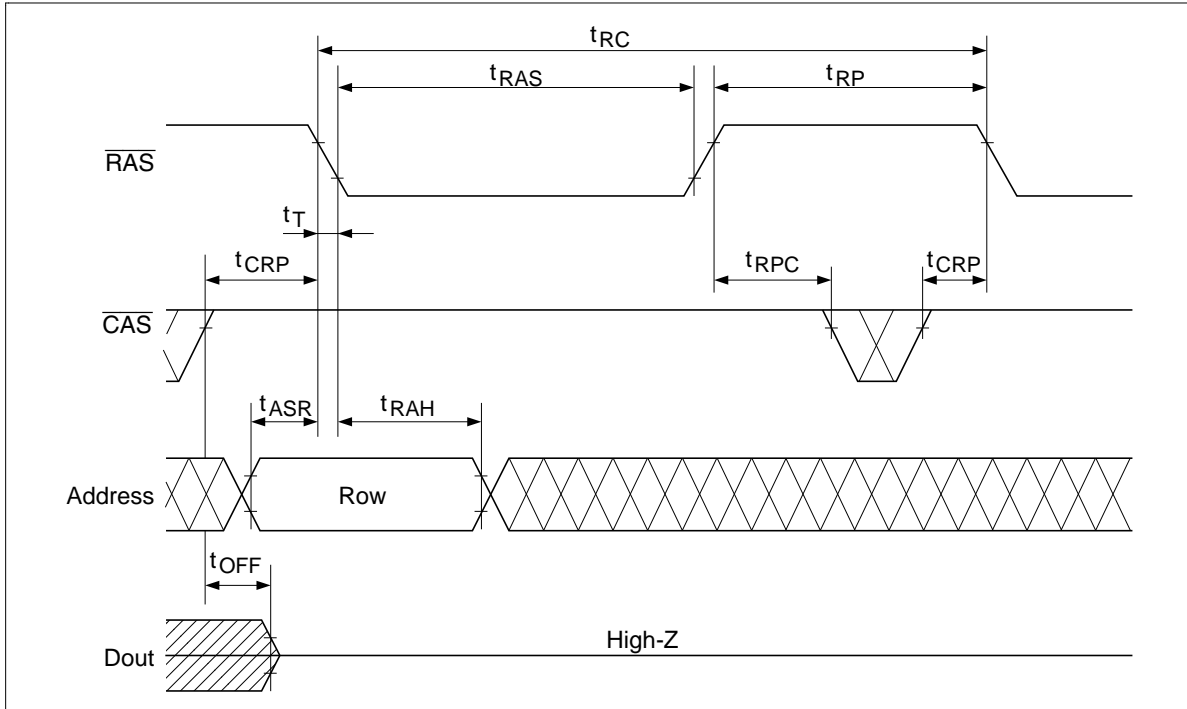
## Delayed Write Cycle<sup>\*18</sup>



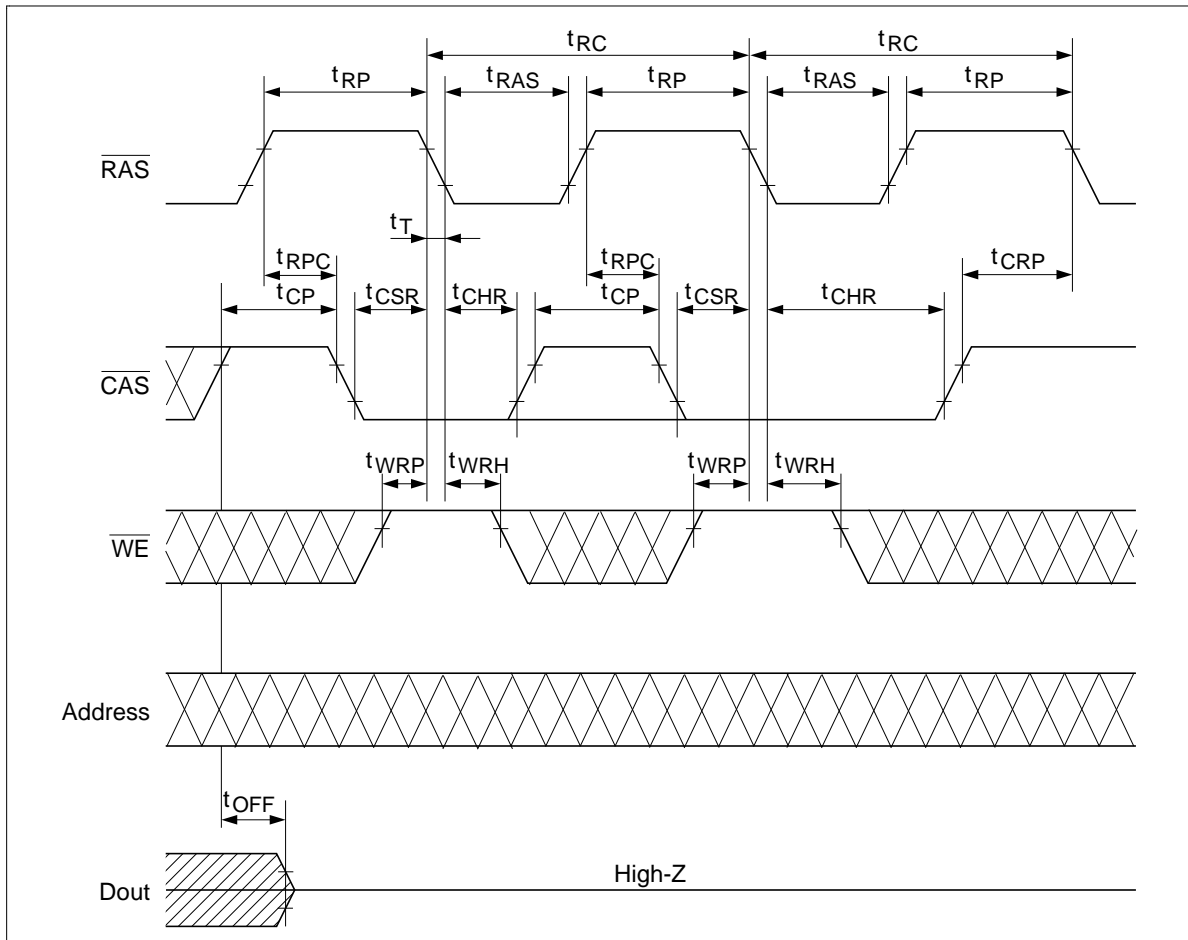


# HB56R864ES Series

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

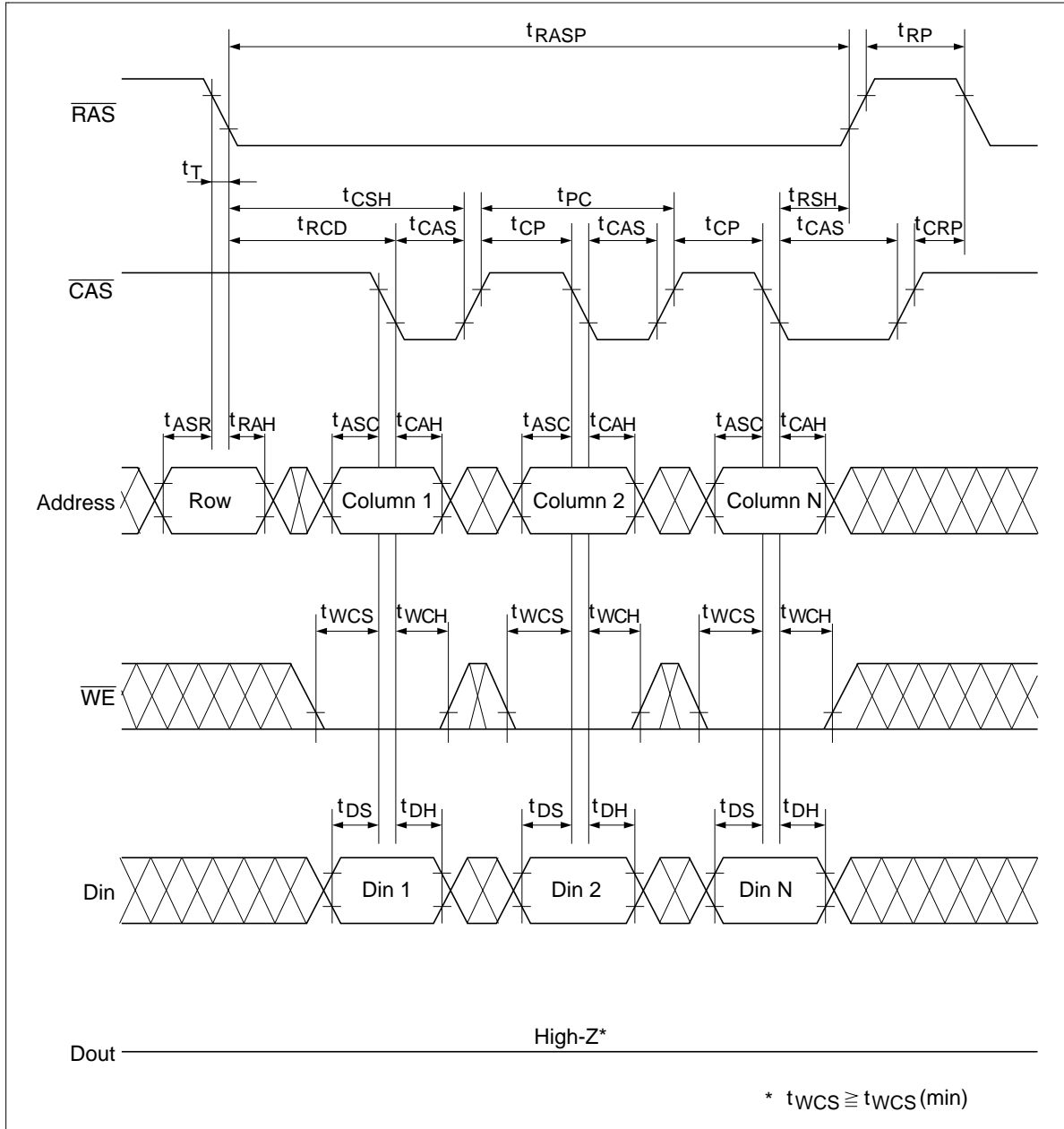


$\overline{\text{CAS}}$ -Before- $\overline{\text{RAS}}$  Refresh Cycle



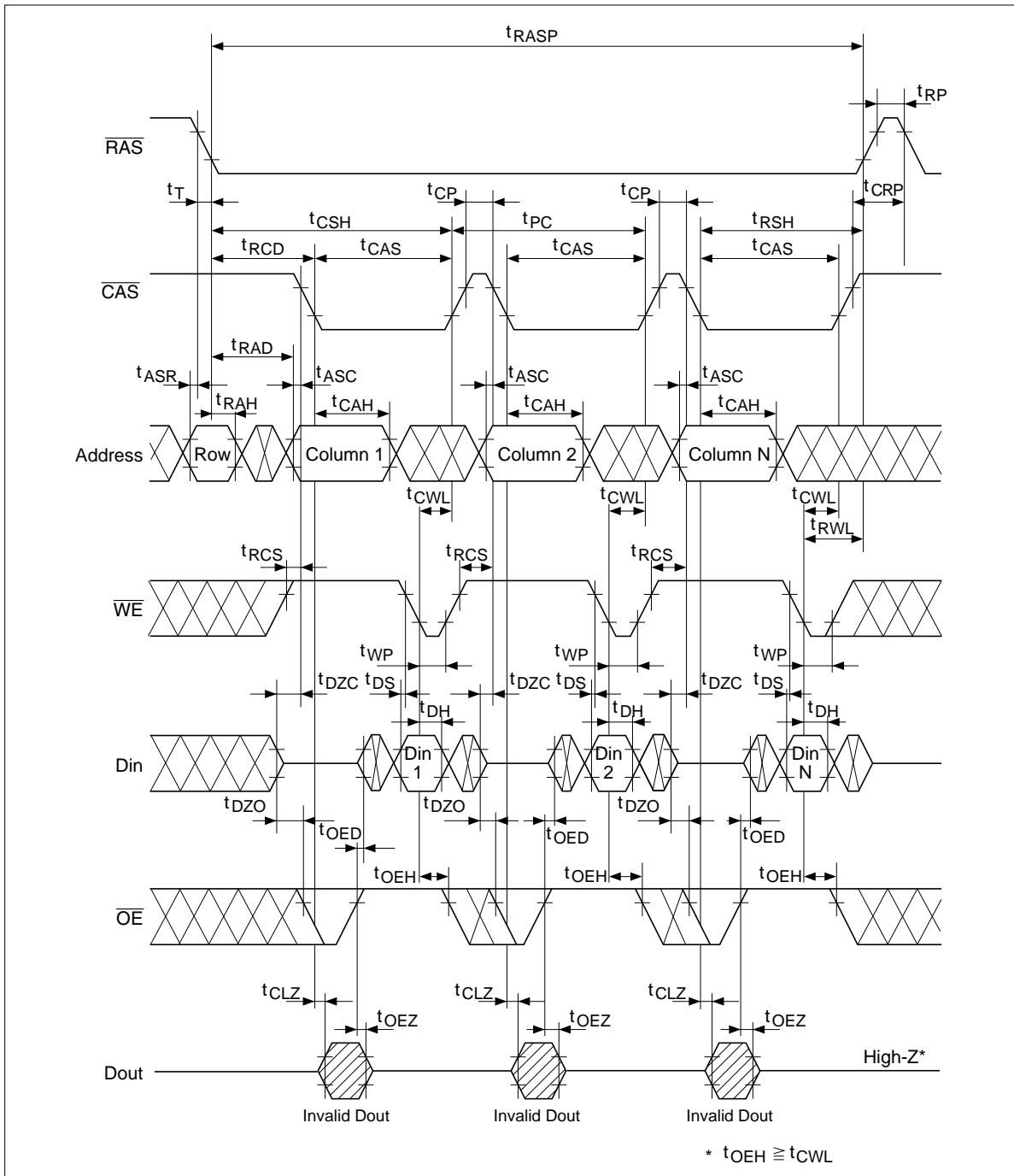


Fast Page Mode Early Write Cycle

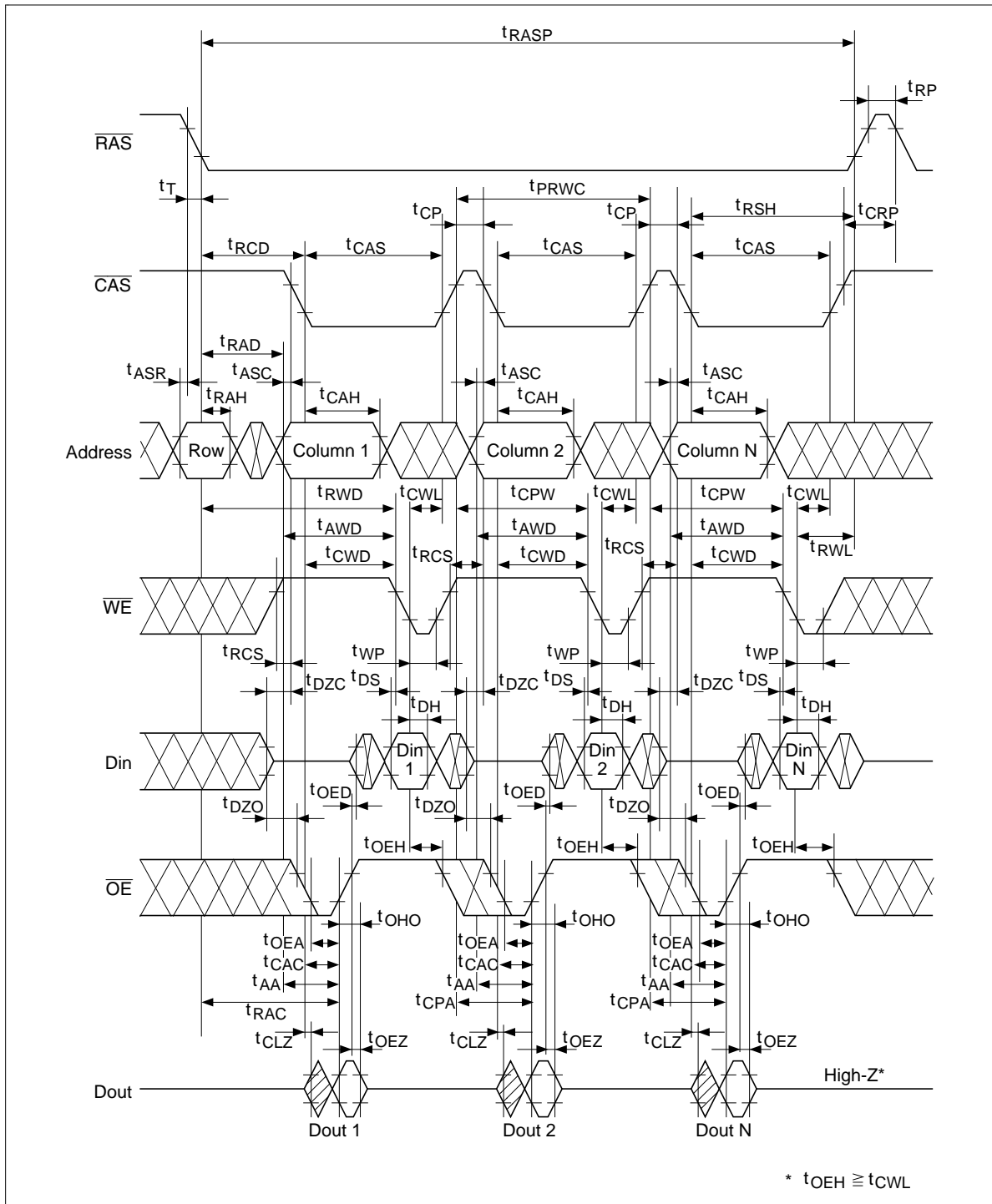


# HB56R864ES Series

## Fast Page Mode Delayed Write Cycle\*18



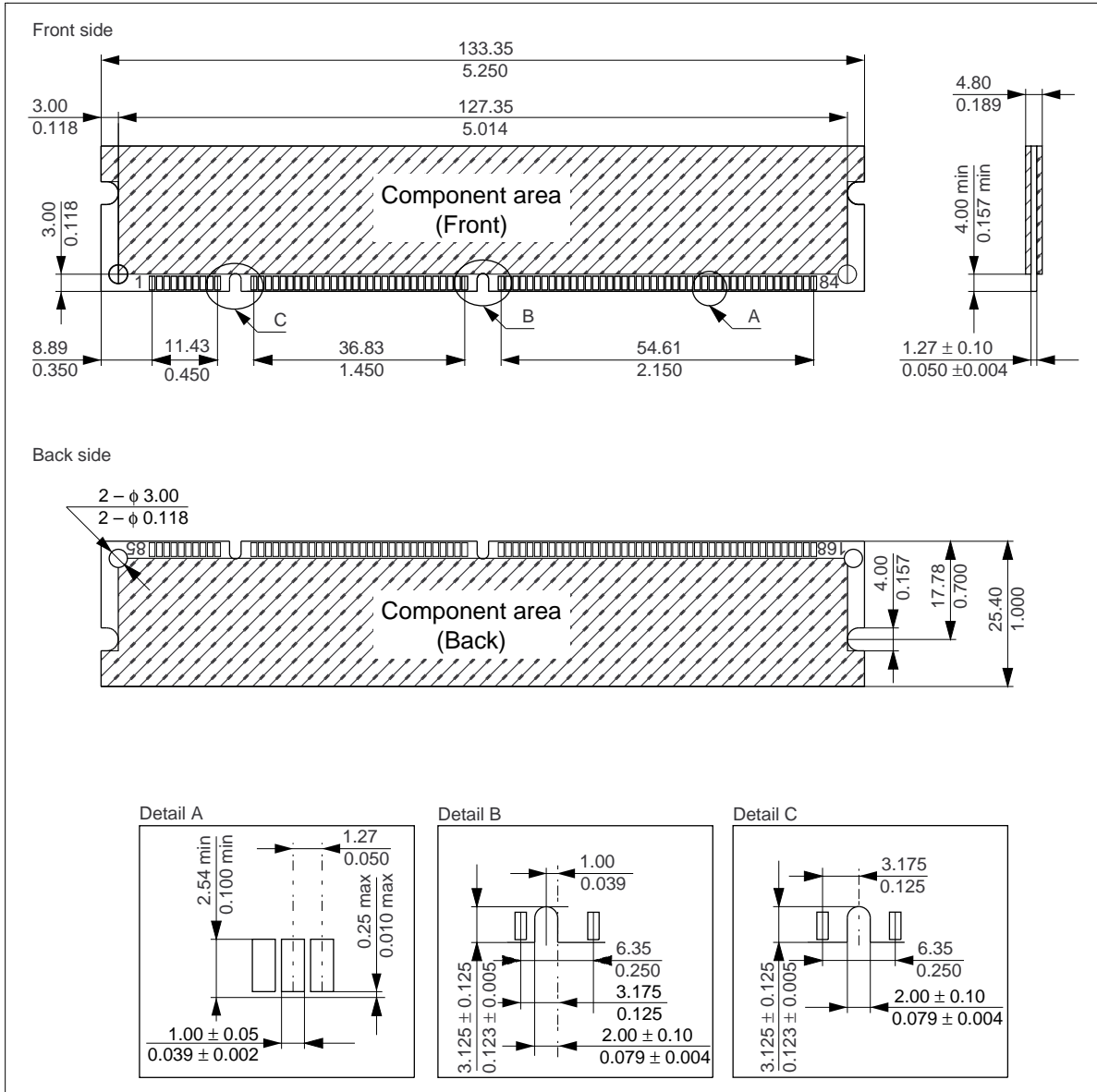
Fast Page Mode Read-Modify-Write Cycle\*<sup>18</sup>



# HB56R864ES Series

## Physical Outline

Unit: mm/inch



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## **HB56R864ES Series**

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### **Revision Record**

<b>Rev.</b>	<b>Date</b>	<b>Contents of Modification</b>	<b>Drawn by</b>	<b>Approved by</b>
1.0	May. 12, 1997	Initial issue (referred to HM5116400/HM5117400 rev. 2.0)		

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