

TENTATIVE TOSHIBA MOS DIGITAL INTEGRATED CIRCUIT SILICON GATE CMOS

262,144-WORD BY 16-BIT FULL CMOS STATIC RAM

## DESCRIPTION

The TC55VEM216AXBN is a 4,194,304-bit static random access memory (SRAM) organized as 262,144 words by 16 bits. Fabricated using Toshiba's CMOS Silicon gate process technology, this device operates from a single 2.3 to 3.6 V power supply. Advanced circuit technology provides both high speed and low power at an operating current of 3 mA/MHz and a minimum cycle time of 40 ns. It is automatically placed in low-power mode at 0.7  $\mu$ A standby current (at  $V_{DD} = 3$  V,  $T_a = 25^\circ\text{C}$ , typical) when chip enable ( $\overline{\text{CE1}}$ ) is asserted high or ( $\text{CE2}$ ) is asserted low. There are three control inputs.  $\overline{\text{CE1}}$  and  $\text{CE2}$  are used to select the device and for data retention control, and output enable ( $\overline{\text{OE}}$ ) provides fast memory access. Data byte control pin ( $\overline{\text{LB}}$ ,  $\overline{\text{UB}}$ ) provides lower and upper byte access. This device is well suited to various microprocessor system applications where high speed, low power and battery backup are required. And, with a guaranteed operating extreme temperature range of  $-40^\circ$  to  $85^\circ\text{C}$ , the TC55VEM216AXBN can be used in environments exhibiting extreme temperature conditions. The TC55VEM216AXBN is available in a plastic 48-ball BGA.

## FEATURES

- Low-power dissipation  
Operating: 9 mW/MHz (typical)
- Single power supply voltage of 2.3 to 3.6 V
- Power down features using  $\overline{\text{CE1}}$  and  $\text{CE2}$
- Data retention supply voltage of 1.5 to 3.6 V
- Direct TTL compatibility for all inputs and outputs
- Wide operating temperature range of  $-40^\circ$  to  $85^\circ\text{C}$
- Standby Current (maximum):

3.6 V	10 $\mu$ A
3.0 V	5 $\mu$ A

- Access Times:

	TC55VEM216AXBN	
	40	55
Access Time	40 ns	55 ns
$\overline{\text{CE1}}$ Access Time	40 ns	55 ns
$\text{CE2}$ Access Time	40 ns	55 ns
$\overline{\text{OE}}$ Access Time	25 ns	30 ns

- Package:  
P-TFBGA48-0607-0.75AZ (Weight: g typ)

## PIN ASSIGNMENT (TOP VIEW)

### 48 PIN BGA

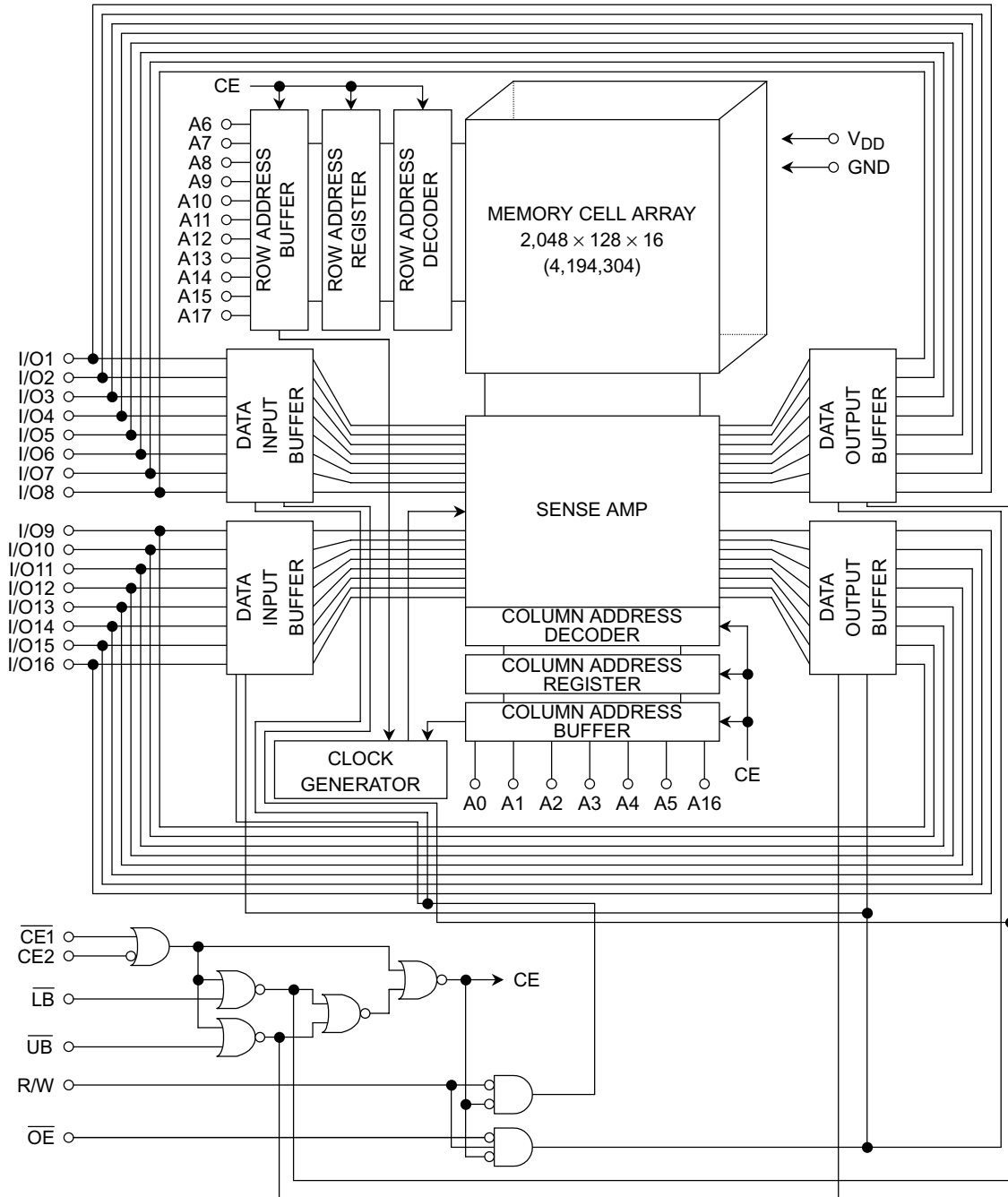
	1	2	3	4	5	6
A	$\overline{\text{LB}}$	$\overline{\text{OE}}$	A0	A1	A2	CE2
B	I/O9	$\overline{\text{UB}}$	A3	A4	$\overline{\text{CE1}}$	I/O1
C	I/O10	I/O11	A5	A6	I/O2	I/O3
D	$V_{SS}$	I/O12	A17	A7	I/O4	$V_{DD}$
E	$V_{DD}$	I/O13	OP	A16	I/O5	$V_{SS}$
F	I/O15	I/O14	A14	A15	I/O6	I/O7
G	I/O16	NC	A12	A13	R/W	I/O8
H	NC	A8	A9	A10	A11	NC

## PIN NAMES

A0~A17	Address Inputs
$\overline{\text{CE1}}$ , $\text{CE2}$	Chip Enable
R/W	Read/Write Control
$\overline{\text{OE}}$	Output Enable
$\overline{\text{LB}}$ , $\overline{\text{UB}}$	Data Byte Control
I/O1~I/O16	Data Inputs/Outputs
$V_{DD}$	Power
GND	Ground
NC	No Connection
OP*	Option

\*: OP pin must be open or connected to GND.

**BLOCK DIAGRAM**



## OPERATING MODE

MODE	$\overline{CE1}$	CE2	$\overline{OE}$	R/W	$\overline{LB}$	$\overline{UB}$	I/O1~I/O8	I/O9~I/O16	POWER
Read	L	H	L	H	L	L	Output	Output	I <sub>DDO</sub>
	L	H	L	H	H	L	High-Z	Output	I <sub>DDO</sub>
	L	H	L	H	L	H	Output	High-Z	I <sub>DDO</sub>
Write	L	H	*	L	L	L	Input	Input	I <sub>DDO</sub>
	L	H	*	L	H	L	High-Z	Input	I <sub>DDO</sub>
	L	H	*	L	L	H	Input	High-Z	I <sub>DDO</sub>
Output Deselect	L	H	H	H	L	L	High-Z	High-Z	I <sub>DDO</sub>
	L	H	H	H	H	L	High-Z	High-Z	I <sub>DDO</sub>
	L	H	H	H	L	H	High-Z	High-Z	I <sub>DDO</sub>
Standby	H	*	*	*	*	*	High-Z	High-Z	I <sub>DDS</sub>
	*	L	*	*	*	*	High-Z	High-Z	I <sub>DDS</sub>
	*	*	*	*	H	H	High-Z	High-Z	I <sub>DDS</sub>

\* = don't care  
H = logic high  
L = logic low

## MAXIMUM RATINGS

SYMBOL	RATING	VALUE	UNIT
V <sub>DD</sub>	Power Supply Voltage	-0.3~4.2	V
V <sub>IN</sub>	Input Voltage	-0.3*~4.2	V
V <sub>I/O</sub>	Input/Output Voltage	-0.5~V <sub>DD</sub> + 0.5	V
P <sub>D</sub>	Power Dissipation	0.6	W
T <sub>solder</sub>	Soldering Temperature (10s)	260	°C
T <sub>stg</sub>	Storage Temperature	-55~125	°C
T <sub>opr</sub>	Operating Temperature	-40~85	°C

\*: -2.0 V when measured at a pulse width of 20ns

## DC RECOMMENDED OPERATING CONDITIONS (T<sub>a</sub> = -40° to 85°C)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	
V <sub>DD</sub>	Power Supply Voltage	2.3	—	3.6	V	
V <sub>IH</sub>	Input High Voltage	V <sub>DD</sub> = 2.3 V~2.7 V	2.0	—	V <sub>DD</sub> + 0.3	V
		V <sub>DD</sub> = 2.7 V~3.6 V	2.2			
V <sub>IL</sub>	Input Low Voltage	-0.3*	—	V <sub>DD</sub> × 0.24	V	
V <sub>DH</sub>	Data Retention Supply Voltage	1.5	—	3.6	V	

\*: -2.0 V when measured at a pulse width of 20ns

## DC CHARACTERISTICS (Ta = -40° to 85°C, VDD = 2.3 to 3.6 V)

SYMBOL	PARAMETER	TEST CONDITION		MIN	TYP	MAX	UNIT	
I <sub>IL</sub>	Input Leakage Current	V <sub>IN</sub> = 0 V~V <sub>DD</sub>		—	—	±1.0	μA	
I <sub>OH</sub>	Output High Current	V <sub>OH</sub> = V <sub>DD</sub> - 0.5 V		-0.5	—	—	mA	
I <sub>OL</sub>	Output Low Current	V <sub>OL</sub> = 0.4 V		2.1	—	—	mA	
I <sub>LO</sub>	Output Leakage Current	$\overline{CE1} = V_{IH}$ or $CE2 = V_{IL}$ or $\overline{LB} = \overline{UB} = V_{IH}$ or $R/W = V_{IL}$ or $OE = V_{IH}$ , V <sub>OUT</sub> = 0 V~V <sub>DD</sub>		—	—	±1.0	μA	
I <sub>DDO1</sub>	Operating Current	$\overline{CE1} = V_{IL}$ and $CE2 = V_{IH}$ and $R/W = V_{IH}$ , $\overline{LB} = \overline{UB} = V_{IL}$ , I <sub>OUT</sub> = 0 mA Other Input = V <sub>IH</sub> /V <sub>IL</sub>	t <sub>cycle</sub>	MIN	—	—	35	mA
				1 μs	—	—	8	
I <sub>DDO2</sub>	Operating Current	$\overline{CE1} = 0.2 V$ and $CE2 = V_{DD} - 0.2 V$ and $R/W = V_{DD} - 0.2 V$ , $\overline{LB} = \overline{UB} = 0.2 V$ , I <sub>OUT</sub> = 0 mA Other Input = V <sub>DD</sub> - 0.2 V/0.2 V	t <sub>cycle</sub>	MIN	—	—	30	mA
				1 μs	—	—	3	
I <sub>DDS1</sub>	Standby Current	1) $\overline{CE1} = V_{IH}$ or $CE2 = V_{IL}$ 2) $\overline{LB} = \overline{UB} = V_{IH}$		—	—	1	mA	
I <sub>DDS2</sub>		1) $\overline{CE1} = V_{DD} - 0.2 V$ , $CE2 = 0.2 V$ 2) $CE2 = 0.2 V$ 3) $\overline{LB} = \overline{UB} = V_{DD} - 0.2 V$ , $\overline{CE1} = 0.2 V$ , $CE2 = V_{DD} - 0.2 V$	V <sub>DD</sub> = 3.3V±0.3 V	Ta = -40~85°C	—	—	10	μA
			V <sub>DD</sub> = 3.0 V	Ta = 25°C	—	0.7	—	
				Ta = -40~40°C	—	—	2	
Ta = -40~85°C	—	—		5				

## CAPACITANCE (Ta = 25°C, f = 1 MHz)

SYMBOL	PARAMETER	TEST CONDITION	MAX	UNIT
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = GND	10	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>OUT</sub> = GND	10	pF

Note: This parameter is periodically sampled and is not 100% tested.

## AC CHARACTERISTICS AND OPERATING CONDITIONS

( $T_a = -40^\circ$  to  $85^\circ\text{C}$ ,  $V_{DD} = 2.7$  to  $3.6\text{ V}$ )

### READ CYCLE

SYMBOL	PARAMETER	TC55VEM216AXBN				UNIT
		40		55		
		MIN	MAX	MIN	MAX	
$t_{RC}$	Read Cycle Time	40	—	55	—	ns
$t_{ACC}$	Address Access Time	—	40	—	55	
$t_{CO1}$	Chip Enable( $\overline{CE1}$ ) Access Time	—	40	—	55	
$t_{CO2}$	Chip Enable(CE2) Access Time	—	40	—	55	
$t_{OE}$	Output Enable Access Time	—	25	—	30	
$t_{BA}$	Data Byte Control Access Time	—	40	—	55	
$t_{COE}$	Chip Enable Low to Output Active	5	—	5	—	
$t_{OEE}$	Output Enable Low to Output Active	0	—	0	—	
$t_{BE}$	Data Byte Control Low to Output Active	5	—	5	—	
$t_{OD}$	Chip Enable High to Output High-Z	—	20	—	25	
$t_{ODO}$	Output Enable High to Output High-Z	—	20	—	25	
$t_{BD}$	Data Byte Control High to Output High-Z	—	20	—	25	
$t_{OH}$	Output Data Hold Time	10	—	10	—	

### WRITE CYCLE

SYMBOL	PARAMETER	TC55VEM216AXBN				UNIT
		40		55		
		MIN	MAX	MIN	MAX	
$t_{WC}$	Write Cycle Time	40	—	55	—	ns
$t_{WP}$	Write Pulse Width	30	—	40	—	
$t_{CW}$	Chip Enable to End of Write	35	—	45	—	
$t_{BW}$	Data Byte Control to End of Write	35	—	45	—	
$t_{AS}$	Address Setup Time	0	—	0	—	
$t_{WR}$	Write Recovery Time	0	—	0	—	
$t_{ODW}$	R/W Low to Output High-Z	—	20	—	25	
$t_{OEW}$	R/W High to Output Active	0	—	0	—	
$t_{DS}$	Data Setup Time	20	—	25	—	
$t_{DH}$	Data Hold Time	0	—	0	—	

Note:  $t_{OD}$ ,  $t_{ODO}$ ,  $t_{BD}$  and  $t_{ODW}$  are specified in time when an output becomes high impedance, and are not judged depending on an output voltage level.

## AC CHARACTERISTICS AND OPERATING CONDITIONS

( $T_a = -40^\circ$  to  $85^\circ\text{C}$ ,  $V_{DD} = 2.3$  to  $3.6\text{ V}$ )

### READ CYCLE

SYMBOL	PARAMETER	TC55VEM216AXBN				UNIT
		40		55		
		MIN	MAX	MIN	MAX	
$t_{RC}$	Read Cycle Time	55	—	70	—	ns
$t_{ACC}$	Address Access Time	—	55	—	70	
$t_{CO1}$	Chip Enable( $\overline{CE1}$ ) Access Time	—	55	—	70	
$t_{CO2}$	Chip Enable(CE2) Access Time	—	55	—	70	
$t_{OE}$	Output Enable Access Time	—	30	—	35	
$t_{BA}$	Data Byte Control Access Time	—	55	—	70	
$t_{COE}$	Chip Enable Low to Output Active	5	—	5	—	
$t_{OEE}$	Output Enable Low to Output Active	0	—	0	—	
$t_{BE}$	Data Byte Control Low to Output Active	5	—	5	—	
$t_{OD}$	Chip Enable High to Output High-Z	—	25	—	30	
$t_{ODO}$	Output Enable High to Output High-Z	—	25	—	30	
$t_{BD}$	Data Byte Control High to Output High-Z	—	25	—	30	
$t_{OH}$	Output Data Hold Time	10	—	10	—	

### WRITE CYCLE

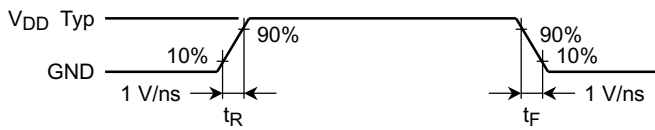
SYMBOL	PARAMETER	TC55VEM216AXBN				UNIT
		40		55		
		MIN	MAX	MIN	MAX	
$t_{WC}$	Write Cycle Time	55	—	70	—	ns
$t_{WP}$	Write Pulse Width	40	—	50	—	
$t_{CW}$	Chip Enable to End of Write	45	—	55	—	
$t_{BW}$	Data Byte Control to End of Write	45	—	55	—	
$t_{AS}$	Address Setup Time	0	—	0	—	
$t_{WR}$	Write Recovery Time	0	—	0	—	
$t_{ODW}$	R/W Low to Output High-Z	—	25	—	30	
$t_{OEW}$	R/W High to Output Active	0	—	0	—	
$t_{DS}$	Data Setup Time	25	—	30	—	
$t_{DH}$	Data Hold Time	0	—	0	—	

Note:  $t_{OD}$ ,  $t_{ODO}$ ,  $t_{BD}$  and  $t_{ODW}$  are specified in time when an output becomes high impedance, and are not judged depending on an output voltage level.

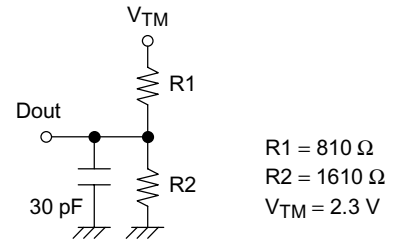
## AC TEST CONDITIONS

PARAMETER	TEST CONDITION
Input pulse level	0.2 V, $V_{DD} \times 0.7 V + 0.2 V$
$t_R, t_F$	1V / ns(Fig.1)
Timing measurements	$V_{DD} \times 0.5$
Reference level	$V_{DD} \times 0.5$
Output load	30 pF + 1 TTL Gate(Fig.2)

**Fig.1** : Input rise and fall time

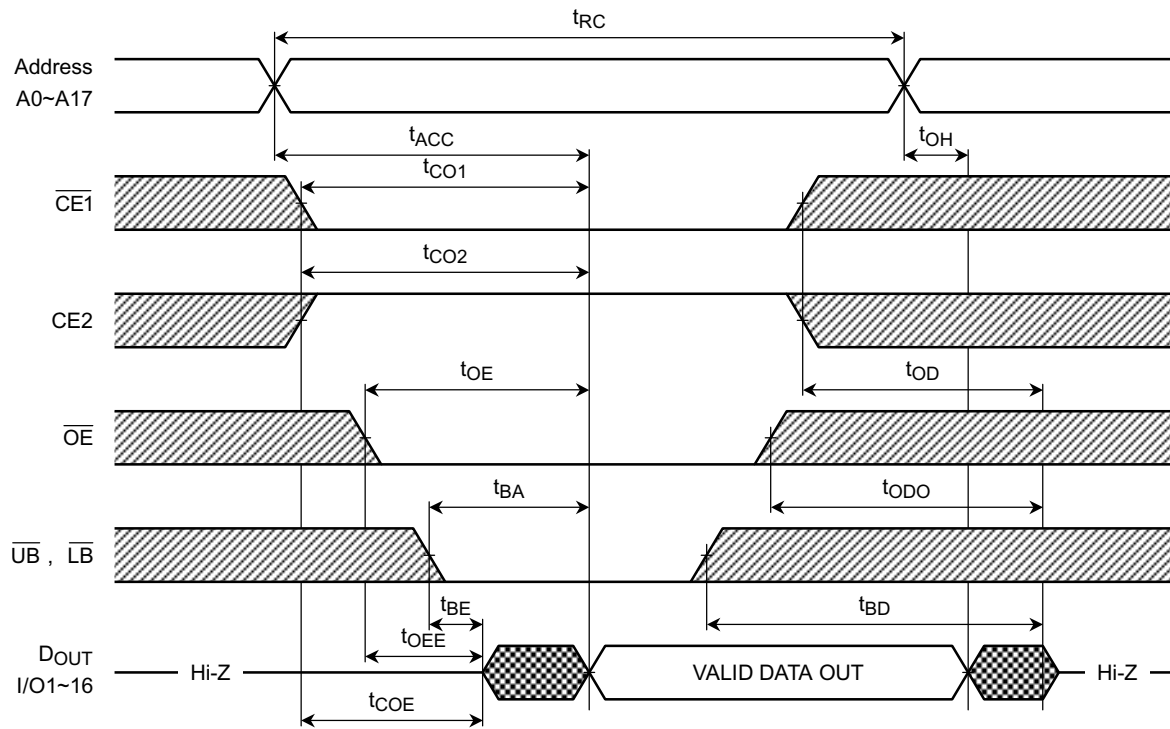


**Fig.2** : Output load

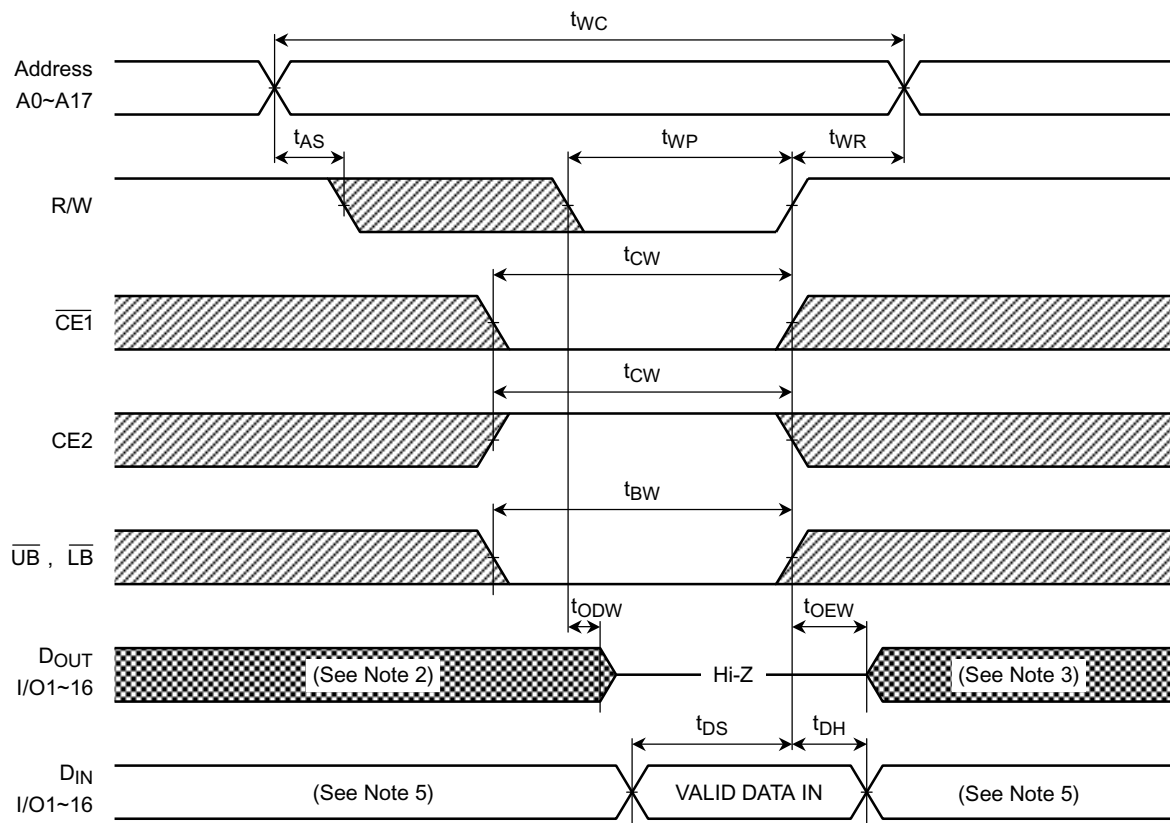


## TIMING DIAGRAMS

### READ CYCLE (See Note 1)

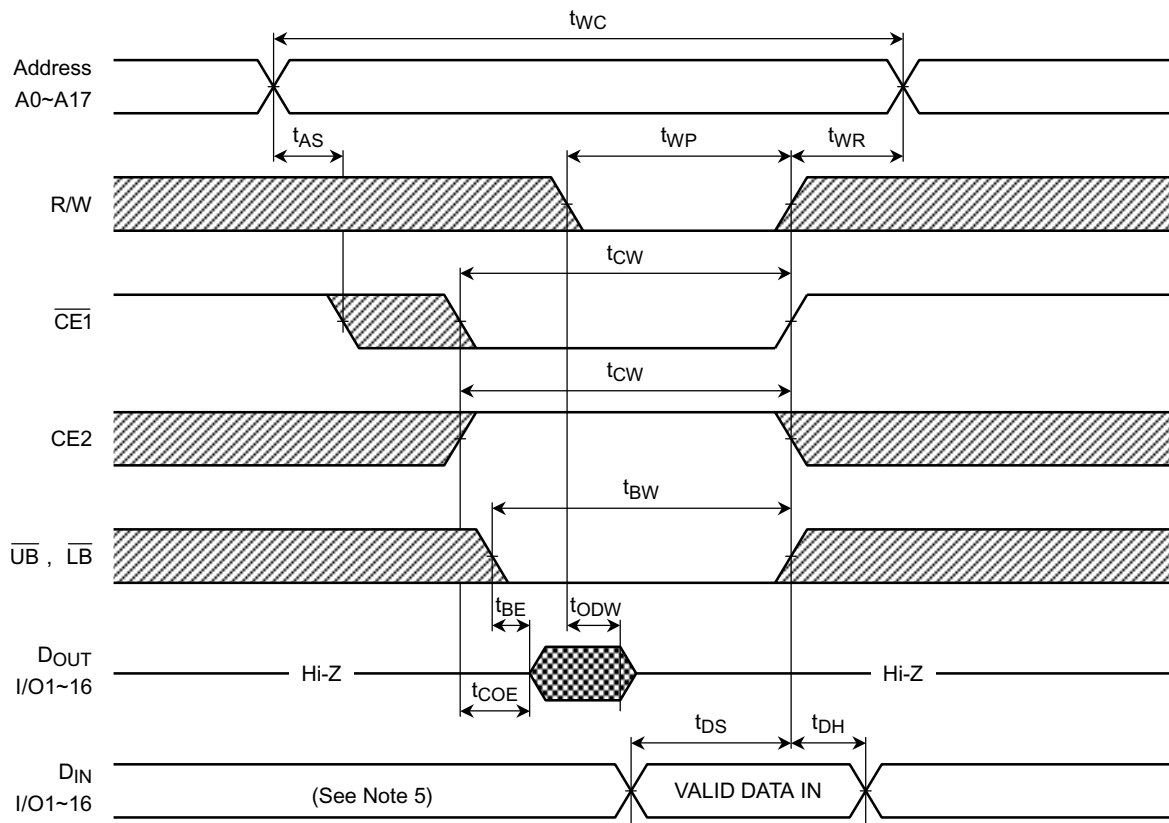


### WRITE CYCLE 1 (R/W CONTROLLED) (See Note 4)

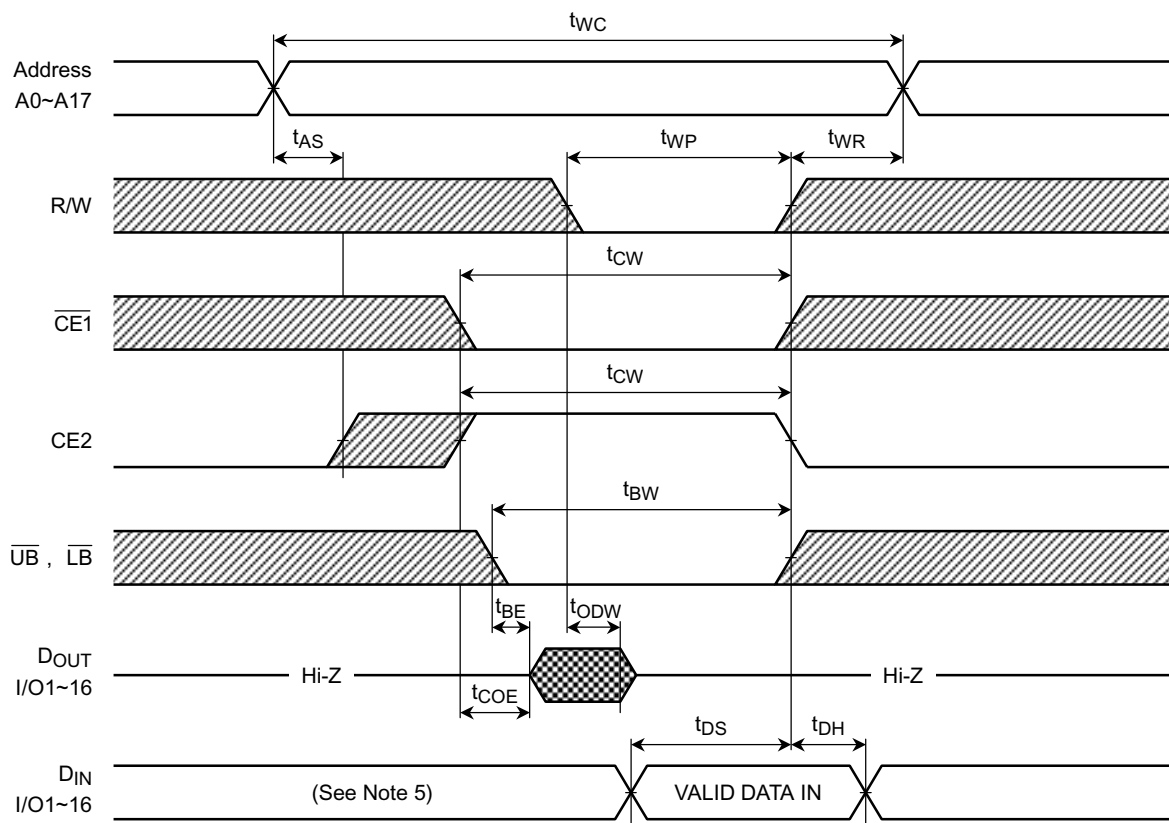




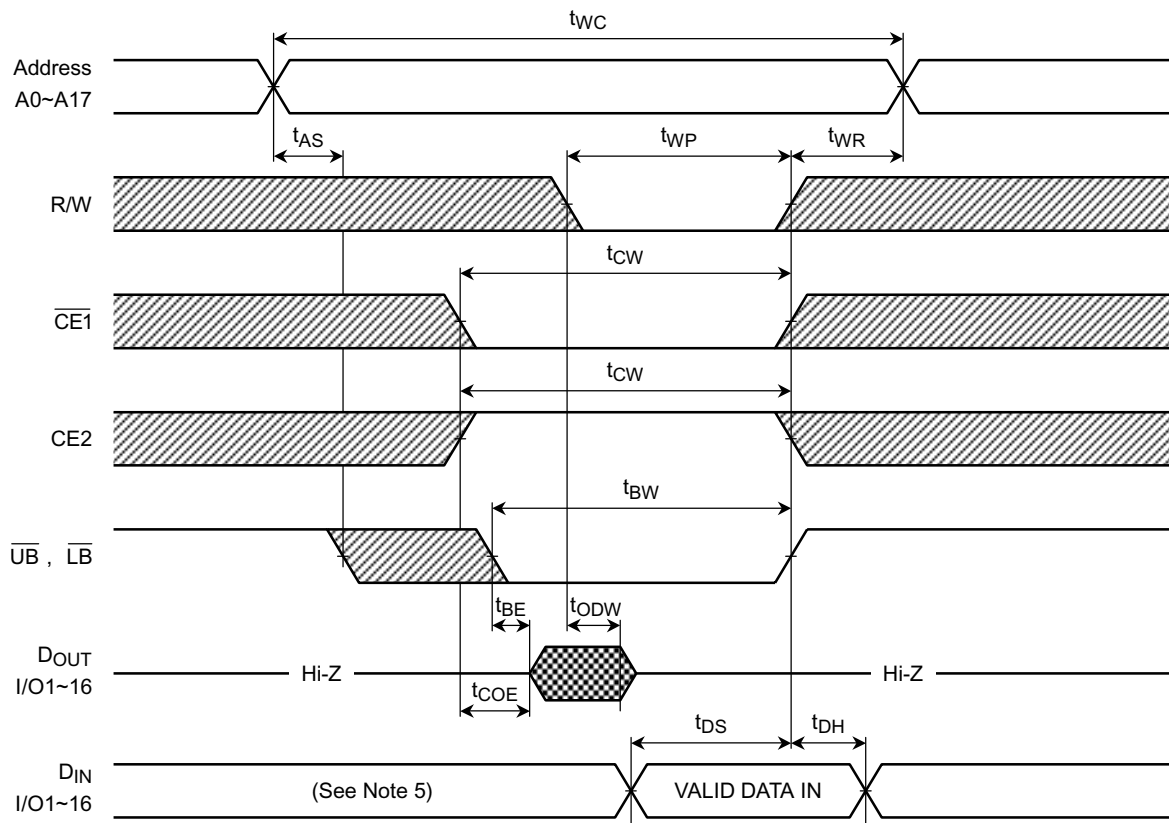
WRITE CYCLE 2 (CE1 CONTROLLED) (See Note 4)



WRITE CYCLE 3 (CE2 CONTROLLED) (See Note 4)



## WRITE CYCLE 4 ( $\overline{UB}$ , $\overline{LB}$ CONTROLLED) (See Note 4)



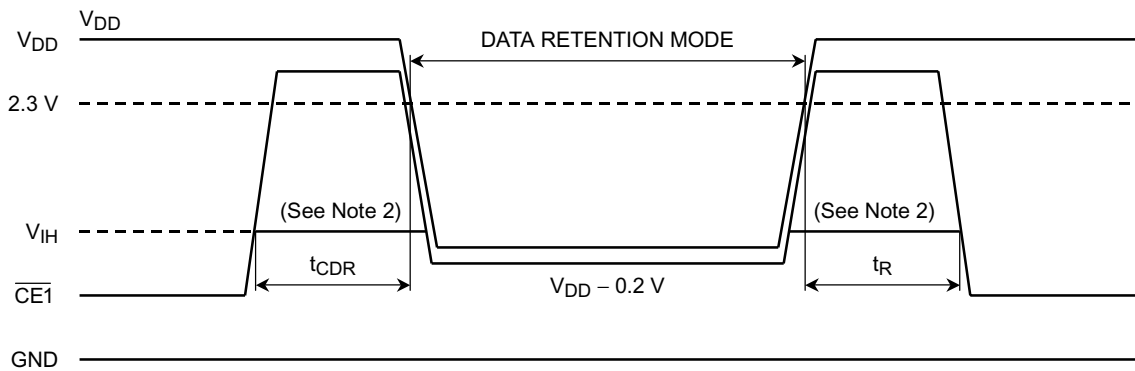
### Note:

- (1) R/W remains HIGH for the read cycle.
- (2) If  $\overline{CE1}$  (or  $\overline{UB}$  or  $\overline{LB}$ ) goes LOW (or CE2 goes HIGH) coincident with or after R/W goes LOW, the outputs will remain at high impedance.
- (3) If  $\overline{CE1}$  (or  $\overline{UB}$  or  $\overline{LB}$ ) goes HIGH (or CE2 goes LOW) coincident with or before R/W goes HIGH, the outputs will remain at high impedance.
- (4) If  $\overline{OE}$  is HIGH during the write cycle, the outputs will remain at high impedance.
- (5) Because I/O signals may be in the output state at this time, input signals of reverse polarity must not be applied.

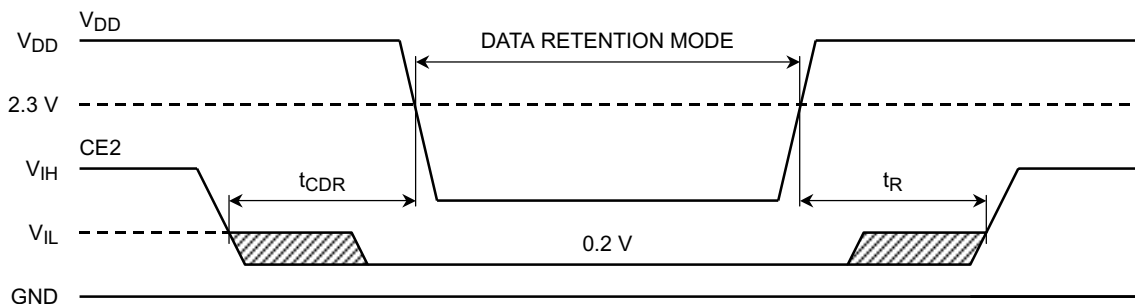
## DATA RETENTION CHARACTERISTICS (Ta = -40° to 85°C)

SYMBOL	PARAMETER		MIN	TYP	MAX	UNIT	
V <sub>DH</sub>	Data Retention Supply Voltage		1.5	—	3.6	V	
I <sub>DDS2</sub>	Standby Current	V <sub>DH</sub> = 3.6 V	Ta = -40~85°C	—	—	10	μA
		V <sub>DH</sub> = 3.0 V	Ta = -40~40°C	—	—	2	
			Ta = -40~85°C	—	—	5	
t <sub>CDR</sub>	Chip Deselect to Data Retention Mode Time		0	—	—	ns	
t <sub>R</sub>	Recovery Time		5	—	—	ms	

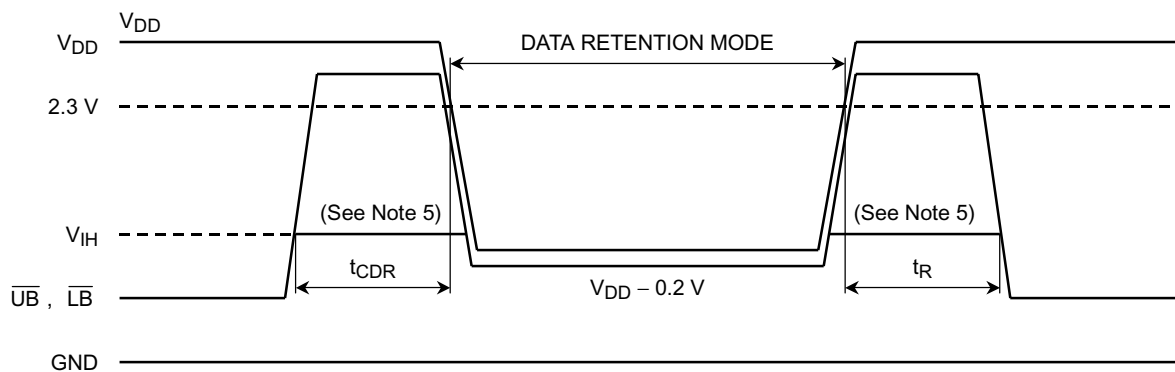
### CE1 CONTROLLED DATA RETENTION MODE (See Note 1)



### CE2 CONTROLLED DATA RETENTION MODE (See Note 3)



### UB, LB CONTROLLED DATA RETENTION MODE (See Note 4)



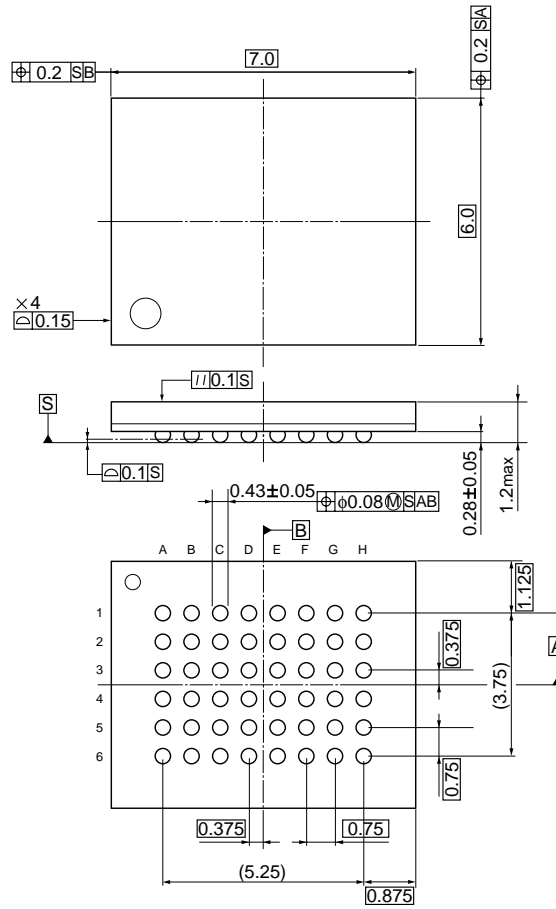
Note:

- (1) In  $\overline{\text{CE1}}$  controlled data retention mode, minimum standby current mode is entered when  $\text{CE2} \leq 0.2 \text{ V}$  or  $\text{CE2} \geq \text{VDD} - 0.2 \text{ V}$ .
- (2) When  $\overline{\text{CE1}}$  is operating at the  $\text{VIH}(\text{min.})$  level, the operating current is given by  $\text{I}_{\text{DDS1}}$  during the transition of  $\text{VDD}$  from 2.3(2.7) to 2.2V(2.4 V).
- (3) In  $\text{CE2}$  controlled data retention mode, minimum standby current mode is entered when  $\text{CE2} \leq 0.2 \text{ V}$ .
- (4) In  $\overline{\text{UB}}$  (or  $\overline{\text{LB}}$ ) controlled data retention mode, minimum standby current mode is entered when  $\overline{\text{CE1}} \leq 0.2 \text{ V}$  or  $\overline{\text{CE1}} \geq \text{VDD} - 0.2 \text{ V}$ ,  $\text{CE2} \leq 0.2 \text{ V}$  or  $\text{CE2} \geq \text{VDD} - 0.2 \text{ V}$ .
- (5) When  $\overline{\text{CE1}}$  is operating at the  $\text{VIH}(\text{min.})$  level, the operating current is given by  $\text{I}_{\text{DDS1}}$  during the transition of  $\text{VDD}$  from 2.3(2.7) to 2.2V(2.4 V).

## PACKAGE DIMENSIONS

P-TFBGA48-0607-0.75AZ

Unit:mm



Weight: g (typ)

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000707EBA

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