

TOSHIBA MOS DIGITAL INTEGRATED CIRCUIT SILICON GATE CMOS

524,288-WORD BY 16-BIT FULL CMOS STATIC RAM

Lead-Free

DESCRIPTION

The TC55VEM316AXGN is a 8,388,608-bit static random access memory (SRAM) organized as 524,288 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 μ 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 ($\overline{\text{CE2}}$) is asserted low. There are three control inputs. $\overline{\text{CE1}}$ and $\overline{\text{CE2}}$ 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° to 85°C , the TC55VEM316AXGN can be used in environments exhibiting extreme temperature conditions. The TC55VEM316AXGN 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 $\overline{\text{CE2}}$
- 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° to 85°C
- Standby Current (maximum):

3.6 V	10 μ A
3.0 V	5 μ A

- Access Times:

	TC55VEM316AXGN	
	40	55
Access Time	40 ns	55 ns
$\overline{\text{CE1}}$ Access Time	40 ns	55 ns
$\overline{\text{CE2}}$ Access Time	40 ns	55 ns
$\overline{\text{OE}}$ Access Time	25 ns	30 ns

- Package:
P-TFBGA48-0811-0.75BZ (Weight: 0.157 g typ)
- Lead-Free

PIN ASSIGNMENT (TOP VIEW)

48 PIN BGA

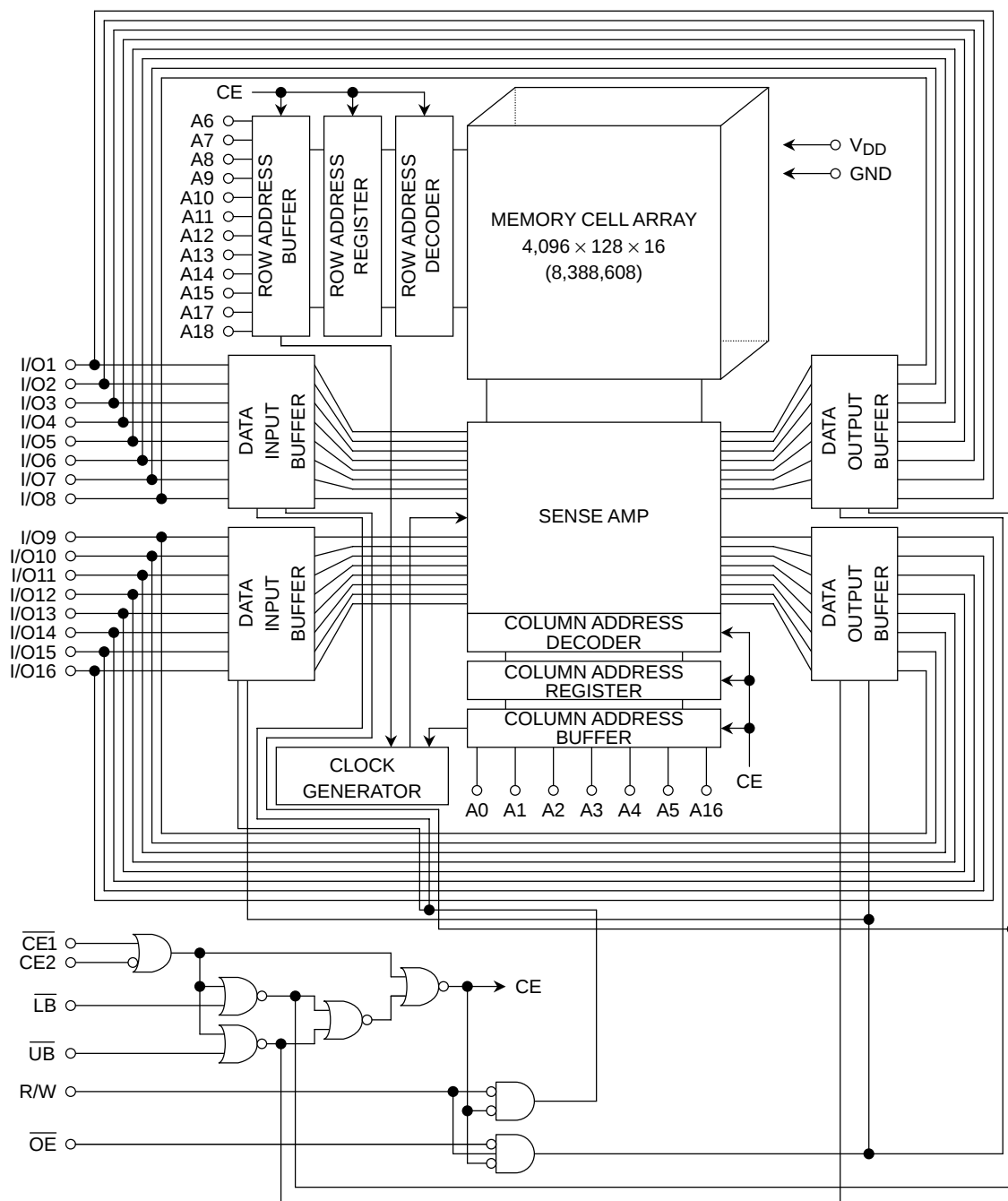
	1	2	3	4	5	6
A	$\overline{\text{LB}}$	$\overline{\text{OE}}$	A0	A1	A2	$\overline{\text{CE2}}$
B	I/O9	$\overline{\text{UB}}$	A3	A4	$\overline{\text{CE1}}$	I/O1
C	I/O10	I/O11	A5	A6	I/O2	I/O3
D	V_{SS}	I/O12	A17	A7	I/O4	V_{DD}
E	V_{DD}	I/O13	OP	A16	I/O5	V_{SS}
F	I/O15	I/O14	A14	A15	I/O6	I/O7
G	I/O16	NC	A12	A13	R/W	I/O8
H	A18	A8	A9	A10	A11	NC

PIN NAMES

A0~A18	Address Inputs
$\overline{\text{CE1}}$, $\overline{\text{CE2}}$	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 _{DDO}
	L	H	L	H	H	L	High-Z	Output	I _{DDO}
	L	H	L	H	L	H	Output	High-Z	I _{DDO}
Write	L	H	*	L	L	L	Input	Input	I _{DDO}
	L	H	*	L	H	L	High-Z	Input	I _{DDO}
	L	H	*	L	L	H	Input	High-Z	I _{DDO}
Output Deselect	L	H	H	H	L	L	High-Z	High-Z	I _{DDO}
	L	H	H	H	H	L	High-Z	High-Z	I _{DDO}
	L	H	H	H	L	H	High-Z	High-Z	I _{DDO}
Standby	H	*	*	*	*	*	High-Z	High-Z	I _{DDS}
	*	L	*	*	*	*	High-Z	High-Z	I _{DDS}
	*	*	*	*	H	H	High-Z	High-Z	I _{DDS}

* = don't care

H = logic high

L = logic low

MAXIMUM RATINGS

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

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

DC RECOMMENDED OPERATING CONDITIONS (Ta = -40° to 85°C)

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

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

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

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

CAPACITANCE ($T_a = 25^\circ\text{C}$, $f = 1\text{ MHz}$)

SYMBOL	PARAMETER	TEST CONDITION	MAX	UNIT
C_{IN}	Input Capacitance	$V_{IN} = \text{GND}$	10	pF
C_{OUT}	Output Capacitance	$V_{OUT} = \text{GND}$	10	pF

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

AC CHARACTERISTICS AND OPERATING CONDITIONS

(Ta = -40° to 85°C, VDD = 2.7 to 3.6 V)

READ CYCLE

SYMBOL	PARAMETER	TC55VEM316AXGN				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	TC55VEM316AXGN				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

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

READ CYCLE

SYMBOL	PARAMETER	TC55VEM316AXGN				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	TC55VEM316AXGN				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, $V_{DD} \times 0.7 \text{ V} + 0.2 \text{ V}$
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

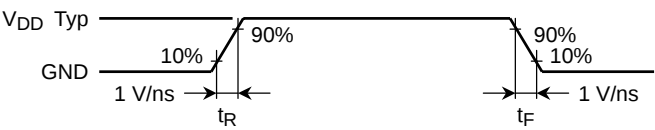
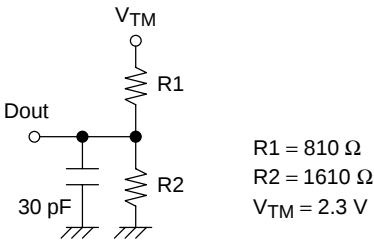
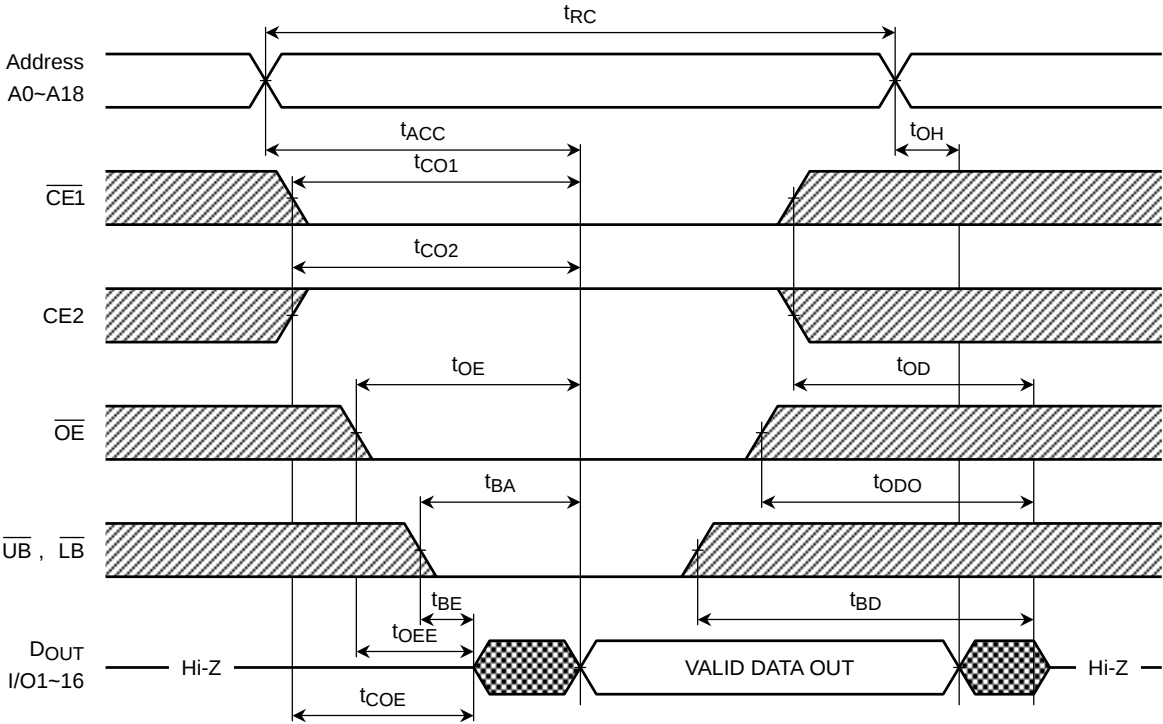


Fig.2 : Output load

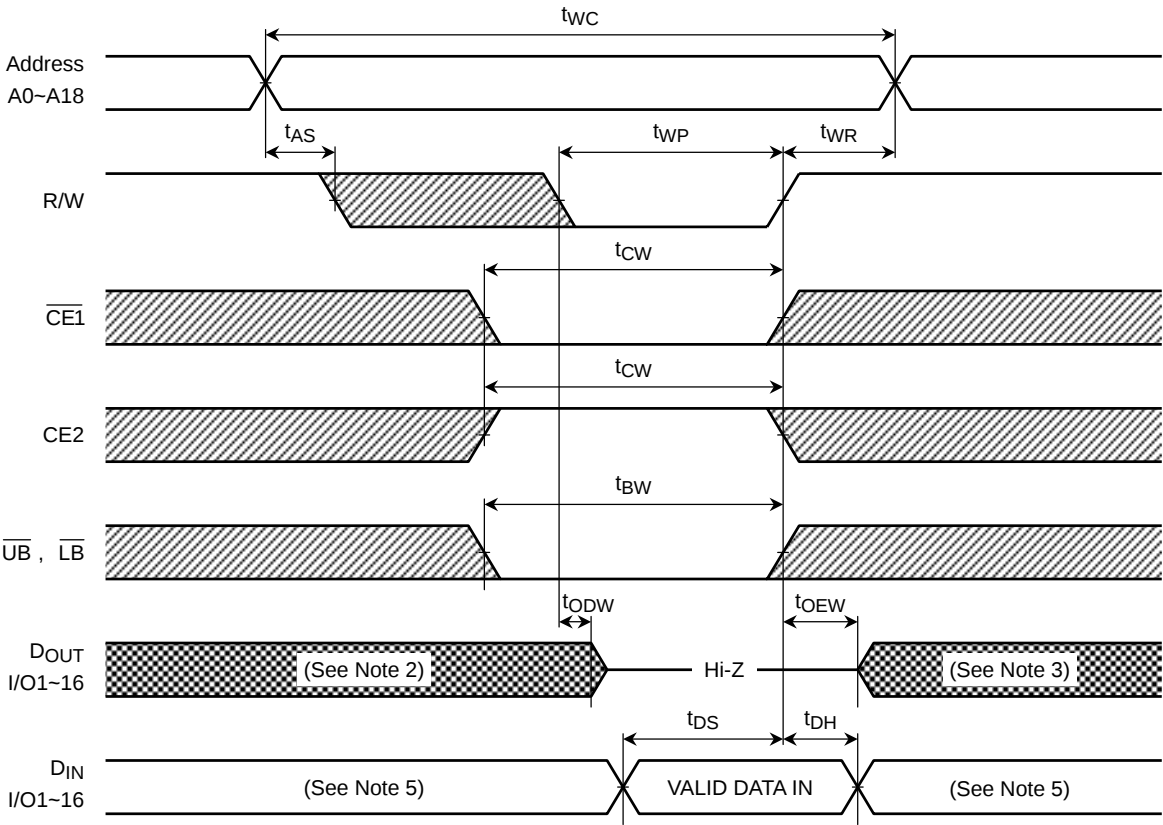


TIMING DIAGRAMS

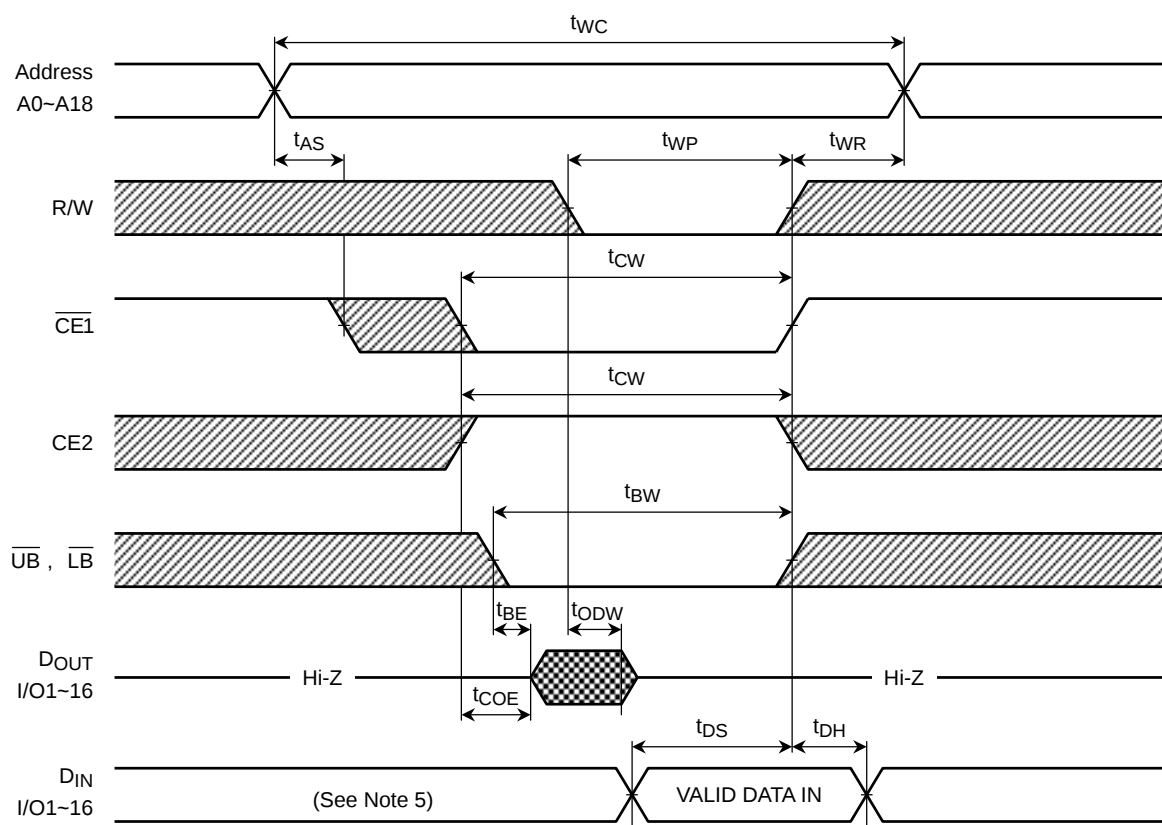
READ CYCLE (See Note 1)



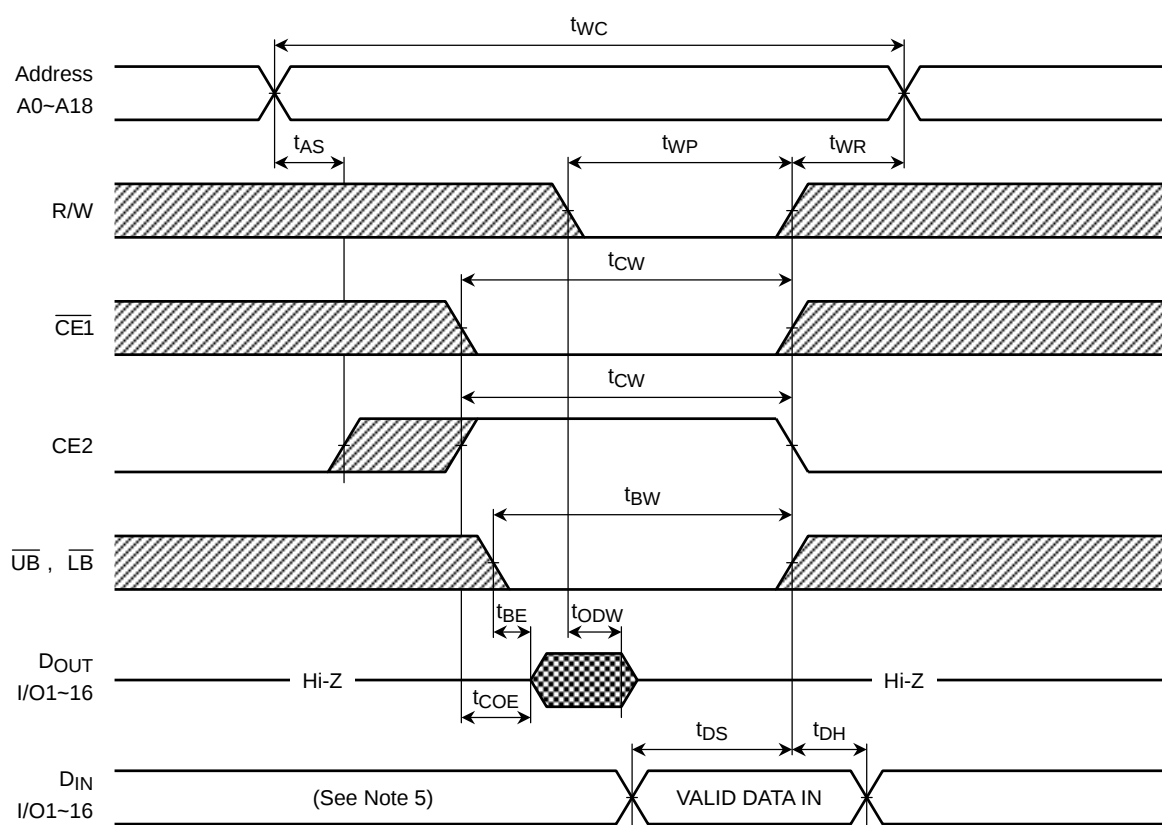
WRITE CYCLE 1 (R/W CONTROLLED) (See Note 4)



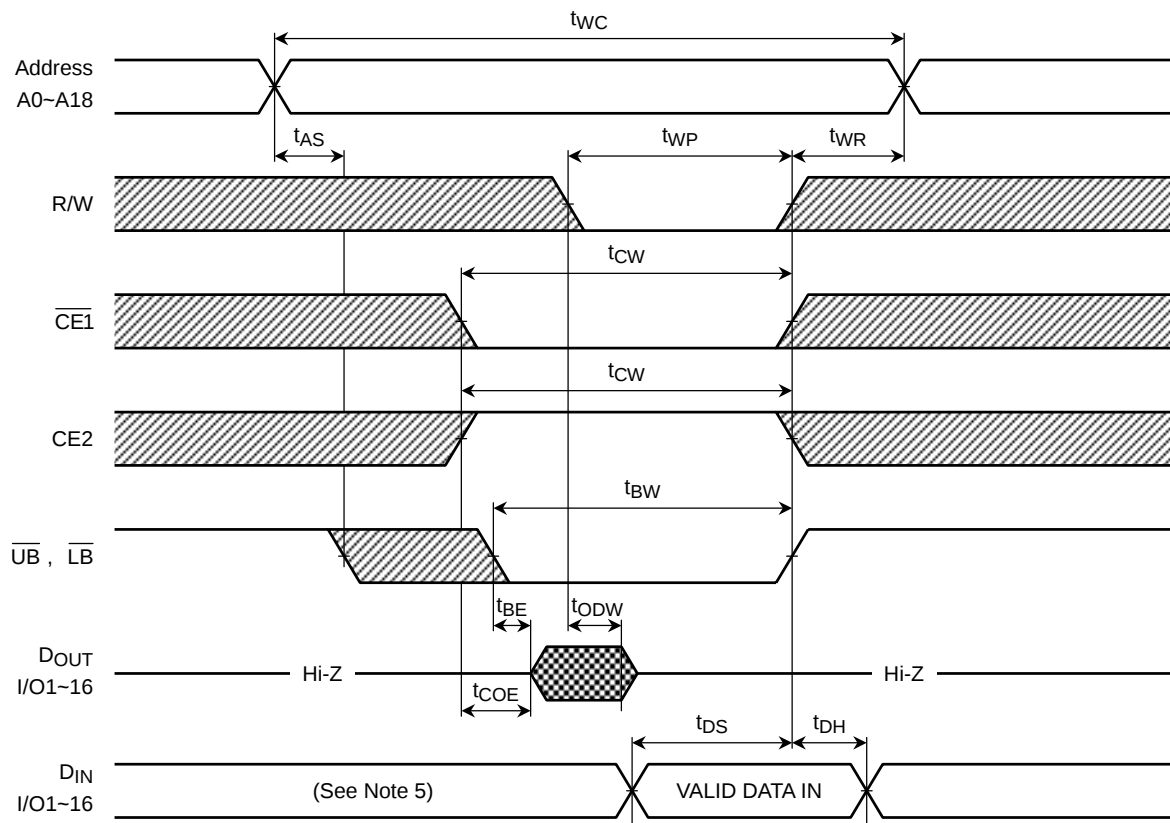
WRITE CYCLE 2 ($\overline{\text{CE1}}$ CONTROLLED) (See Note 4)



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



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



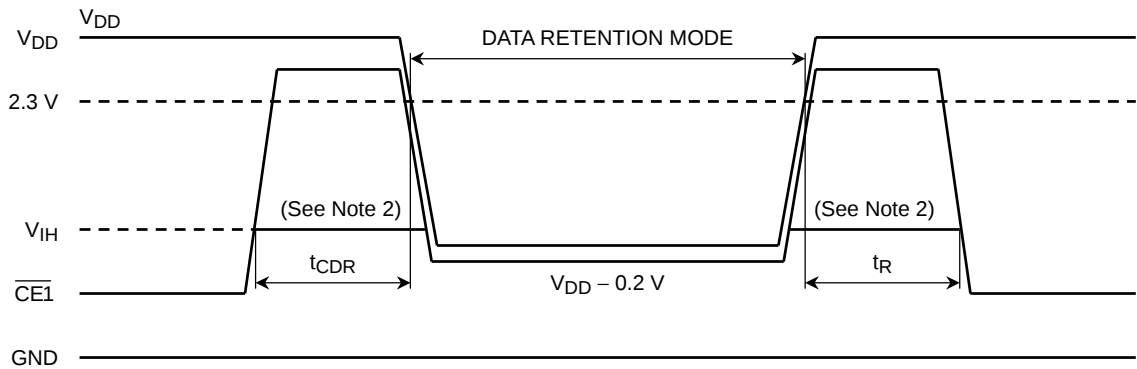
Note:

- (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.

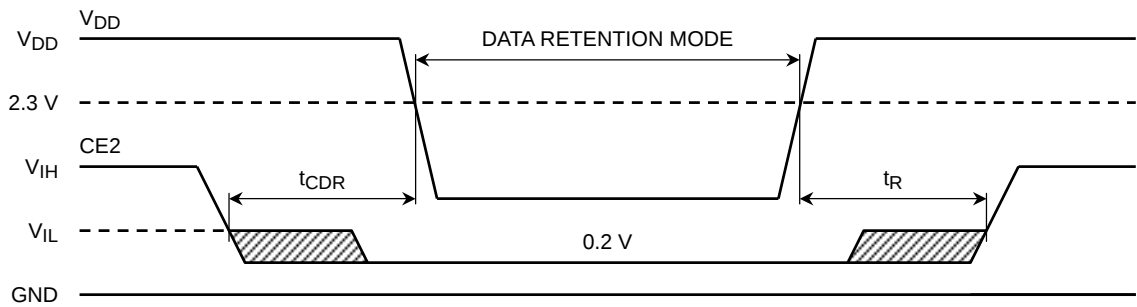
DATA RETENTION CHARACTERISTICS (Ta = -40° to 85°C)

SYMBOL	PARAMETER			MIN	TYP	MAX	UNIT
V _{DH}	Data Retention Supply Voltage			1.5	—	3.6	V
I _{DDS2}	Standby Current	V _{DH} = 3.6 V	Ta = −40~85°C	—	—	10	μA
		V _{DH} = 3.0 V	Ta = −40~40°C	—	—	2	
			Ta = −40~85°C	—	—	5	
t _{CDR}	Chip Deselect to Data Retention Mode Time			0	—	—	ns
t _R	Recovery Time			5	—	—	ms

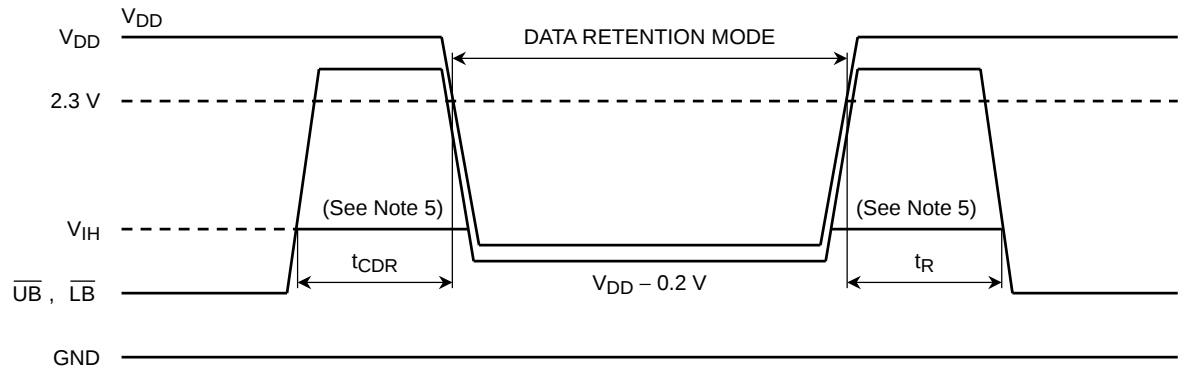
CE1 CONTROLLED DATA RETENTION MODE (See Note 1)



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 $\text{CE2} \geq \text{V}_{\text{DD}} - 0.2 \text{ V}$.
- (2) When $\overline{\text{CE1}}$ is operating at the $\text{V}_{\text{IH}}(\text{min.})$ level, the operating current is given by I_{DDS1} during the transition of V_{DD} from 2.3(2.7) to 2.2V(2.4 V).
- (3) In 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 $\overline{\text{CE1}} \geq \text{V}_{\text{DD}} - 0.2 \text{ V}$, $\text{CE2} \leq 0.2 \text{ V}$ or $\text{CE2} \geq \text{V}_{\text{DD}} - 0.2 \text{ V}$.
- (5) When $\overline{\text{CE1}}$ is operating at the $\text{V}_{\text{IH}}(\text{min.})$ level, the operating current is given by I_{DDS1} during the transition of V_{DD} from 2.3(2.7) to 2.2V(2.4 V).

Unit:mm

Technical drawing of a mechanical part showing three views: front, top, and side.

Front View: A rectangle with overall dimensions 11.0 (width) and 8.0 (height). A circular feature is located in the lower-left corner. A tolerance of $\phi 0.2$ SB is indicated on the left edge. A surface finish symbol $\sqrt{\text{0.15}}$ is shown on the bottom edge, with a note $\times 4$ indicating its application to four surfaces.

Top View: A rectangle with overall dimensions 5.25 (width) and 3.75 (height). A grid of 24 holes is arranged in 4 rows and 6 columns. The center-to-center distance between columns is 0.75, and between rows is 0.375. The distance from the left edge to the first column of holes is 2.875, and from the right edge to the last column is 0.375. A tolerance of $\phi 0.08$ M SAB is indicated on the left edge. A surface finish symbol $\sqrt{\text{0.1S}}$ is shown on the top edge.

Side View: A cross-section showing a total thickness of 0.28 ± 0.05 and a maximum height of 1.2 max. A tolerance of $\phi 0.1$ S is indicated on the bottom edge. A surface finish symbol $\sqrt{\text{0.1S}}$ is shown on the top edge.

Section Lines: The section line for the front view is labeled 'S' and for the top view is labeled 'B'.

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