

TOSHIBA MOS DIGITAL INTEGRATED CIRCUIT SILICON GATE CMOS

1,048,576-WORD BY 16-BIT/2,097,152-WORD BY 8-BIT FULL CMOS STATIC RAM

DESCRIPTION

The TC55W1600FT is a 16,777,216-bit static random access memory (SRAM) organized as 1,048,576 words by 16 bits/2,097,152 words by 8 bits. Fabricated using Toshiba's CMOS Silicon gate process technology, this device operates from a single 2.3 to 3.1 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 55 ns. It is automatically placed in low-power mode at 0.5 μ A standby current (at $V_{DD} = 3.0$ V, $T_a = 25^\circ\text{C}$, maximum) when chip enable ($\overline{CE1}$) is asserted high or ($\overline{CE2}$) is asserted low. There are three control inputs. $\overline{CE1}$ and $\overline{CE2}$ are used to select the device and for data retention control, and output enable (\overline{OE}) provides fast memory access. Data byte control pin (\overline{LB} , \overline{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 range of -40° to 85°C , the TC55W1600FT can be used in environments exhibiting extreme temperature conditions. The TC55W1600FT is available in a plastic 48-pin thin-small-outline package (TSOP).

FEATURES

- Low-power dissipation
Operating: 9.3 mW/MHz (typical)
- Single power supply voltage of 2.3 to 3.1 V
- Power down features using $\overline{CE1}$ and $\overline{CE2}$
- Data retention supply voltage of 1.5 to 3.1 V
- Direct TTL compatibility for all inputs and outputs
- Wide operating temperature range of -40° to 85°C
- Standby Current (maximum):

3.1 V	10 μ A
3.0 V	5 μ A

- Access Times (maximum):

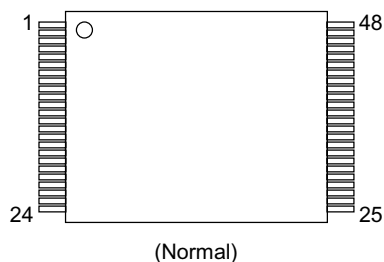
	TC55W1600FT	
	-55	-70
Access Time	55 ns	70 ns
$\overline{CE1}$ Access Time	55 ns	70 ns
$\overline{CE2}$ Access Time	55 ns	70 ns
\overline{OE} Access Time	30 ns	35 ns

- Package:

TSOP 48-P-1220-0.50 (Weight: 0.52 g typ)

PIN ASSIGNMENT (TOP VIEW)

48 PIN TSOP



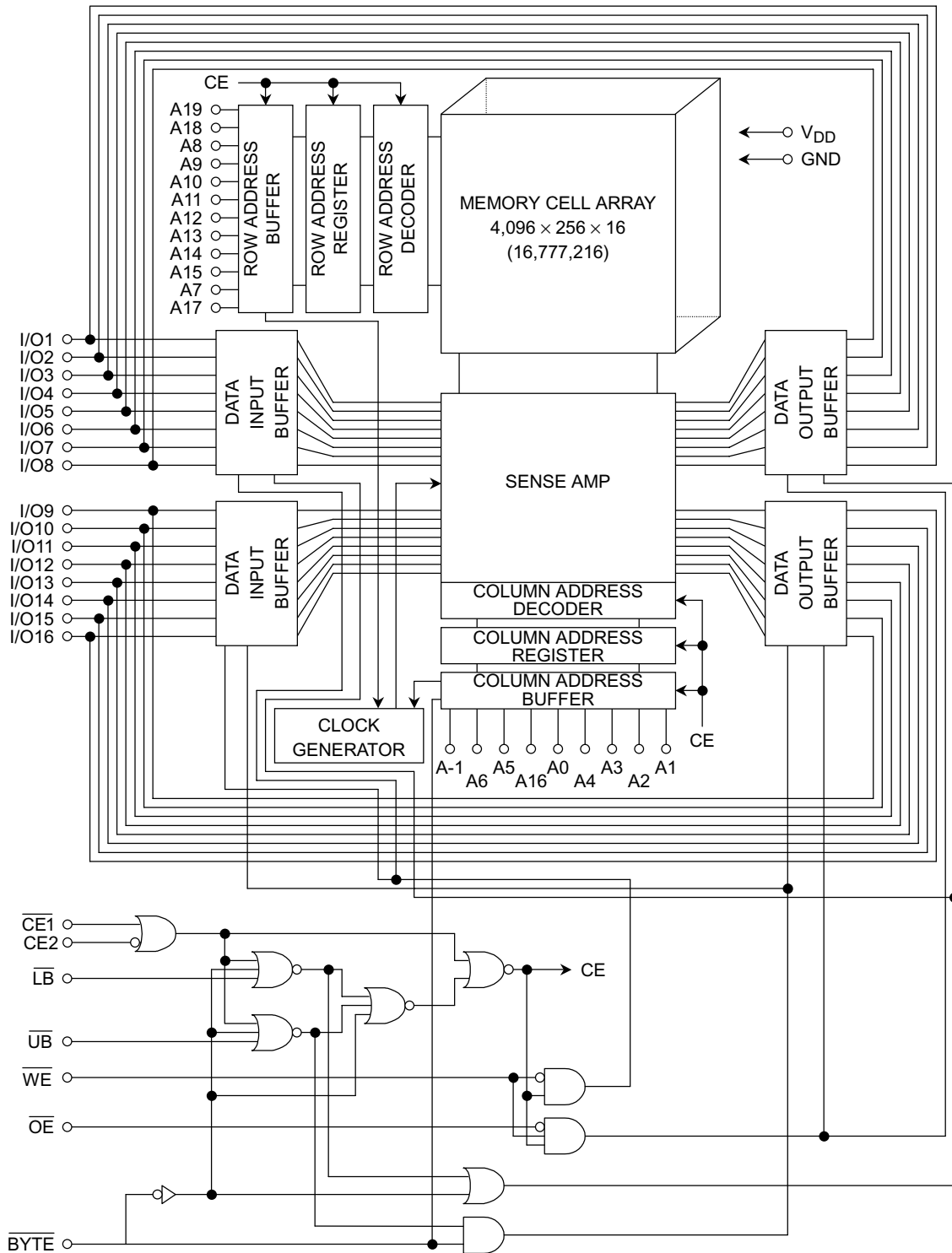
PIN NAMES

A0~A19	Address Inputs (Word Mode)
A-1~A19	Address Inputs (Byte Mode)
$\overline{CE1}$, $\overline{CE2}$	Chip Enable
R/W	Read/Write Control
\overline{OE}	Output Enable
\overline{LB} , \overline{UB}	Data Byte Control
I/O1~I/O16	Data Inputs/Outputs
\overline{BYTE}	Byte ($\times 8$ mode) Enable
V_{DD}	Power
GND	Ground
NC	No Connection
NU	Not Used (Input)

*: NU pin must be open or connected to GND.

Pin No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Pin Name	A15	A14	A13	A12	A11	A10	A9	A8	A19	NC	R/W	$\overline{CE2}$	NU	\overline{UB}	\overline{LB}	A18
Pin No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Pin Name	A17	A7	A6	A5	A4	A3	A2	A1	A0	$\overline{CE1}$	GND	\overline{OE}	I/O1	I/O9	I/O2	I/O10
Pin No.	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Pin Name	I/O3	I/O11	I/O4	I/O12	V_{DD}	I/O5	I/O13	I/O6	I/O14	I/O7	I/O15	I/O8	I/O16 /A-1	GND	\overline{BYTE}	A16

BLOCK DIAGRAM



OPERATING MODE

MODE	$\overline{CE1}$	CE2	\overline{OE}	R/W	\overline{BYTE}	\overline{LB}	\overline{UB}	I/O1~I/O8	I/O9~I/O15	I/O16	POWER
Read	L	H	L	H	L	*	*	Output	High-Z	A-1	I _{DDO}
	L	H	L	H	H	L	L	Output	Output	Output	I _{DDO}
	L	H	L	H	H	H	L	High-Z	Output	Output	I _{DDO}
	L	H	L	H	H	L	H	Output	High-Z	High-Z	I _{DDO}
Write	L	H	*	L	L	*	*	Input	High-Z	A-1	I _{DDO}
	L	H	*	L	H	L	L	Input	Input	Input	I _{DDO}
	L	H	*	L	H	H	L	High-Z	Input	Input	I _{DDO}
	L	H	*	L	H	L	H	Input	High-Z	High-Z	I _{DDO}
Output Deselect	L	H	H	H	L	*	*	High-Z	High-Z	A-1	I _{DDO}
	L	H	H	H	H	L	L	High-Z	High-Z	High-Z	I _{DDO}
	L	H	H	H	H	H	L	High-Z	High-Z	High-Z	I _{DDO}
	L	H	H	H	H	L	H	High-Z	High-Z	High-Z	I _{DDO}
Standby	H	*	*	*	H or L	*	*	High-Z	High-Z	High-Z	I _{DDS}
	*	L	*	*	H or L	*	*	High-Z	High-Z	High-Z	I _{DDS}
	*	*	*	*	H	H	H	High-Z	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	-0.3~3.9	V
V _{IN}	Input Voltage	-0.3~3.9	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	-55~150	°C
T _{opr}	Operating Temperature	-40~85	°C

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

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
V _{DD}	Power Supply Voltage	2.3	—	3.1	V
V _{IH}	Input High Voltage	2.2	—	V _{DD} + 0.3	V
V _{IL}	Input Low Voltage	-0.3	—	V _{DD} × 0.22	V
V _{DH}	Data Retention Supply Voltage	1.5	—	3.1	V

DC CHARACTERISTICS (Ta = -40° to 85°C, VDD = 2.3 to 3.1 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} - 0.4V		-1.0	—	—	mA	
I _{OL}	Output Low Current	V _{OL} = 0.4 V		1.0	—	—	mA	
I _{LO}	Output Leakage Current	$\overline{CE1} = V_{IH}$ or $\overline{CE2} = V_{IL}$ 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	$\overline{CE1} = V_{IL}$, $\overline{CE2} = V_{IH}$, R/W = V _{IH} , $\overline{LB} = \overline{UB} = V_{IL}$, I _{OUT} = 0 mA Other Input = V _{IH} /V _{IL}	t _{cycle}	55 ns	—	—	60	mA
				70 ns	—	—	50	
				1 μs	—	—	10	
I _{DDO2}	Operating Current	$\overline{CE1} = 0.2 V$, $\overline{CE2} = V_{DD} - 0.2 V$ 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	t _{cycle}	55 ns	—	—	55	mA
				70 ns	—	—	45	
				1 μs	—	—	5	
I _{DDS1}	Standby Current	1) $\overline{CE1} = V_{IH}$ or $\overline{CE2} = V_{IL}$ (at $\overline{BYTE} \geq V_{DD} - 0.2 V$ or $\leq 0.2 V$) 2) $\overline{LB} = \overline{UB} = V_{IH}$ (at $\overline{BYTE} \geq V_{DD} - 0.2 V$)		—	—	2	mA	
I _{DDS2}		1) $\overline{CE1} = V_{DD} - 0.2 V$, $\overline{CE2} = V_{DD} - 0.2 V$ (at $\overline{BYTE} \geq V_{DD} - 0.2 V$ or $\leq 0.2 V$) 2) $\overline{CE2} = 0.2 V$ (at $\overline{BYTE} \geq V_{DD} - 0.2 V$ or $\leq 0.2 V$) 3) $\overline{LB} = \overline{UB} = V_{DD} - 0.2 V$, $\overline{CE1} = 0.2 V$, $\overline{CE2} = V_{DD} - 0.2 V$ (at $\overline{BYTE} \geq V_{DD} - 0.2 V$)	V _{DD} = 3.1 V	Ta = 25°C	—	—	1	μA
				Ta = -40~85°C	—	—	10	
			V _{DD} = 3.0 V	Ta = 25°C	—	0.05	0.5	
				Ta = -40~40°C	—	—	1	
Ta = -40~85°C	—	—	5					

CAPACITANCE (Ta = 25°C, f = 1 MHz)

SYMBOL	PARAMETER	TEST CONDITION	MAX	UNIT
C _{IN}	Input Capacitance	V _{IN} = GND	10	pF
C _{OUT}	Output Capacitance	V _{OUT} = 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°C , $V_{DD} = 2.7$ to 3.1 V)

READ CYCLE

SYMBOL	PARAMETER	TC55W1600FT				UNIT
		-55		-70		
		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	0	—	0	—	
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	TC55W1600FT				UNIT
		-55		-70		
		MIN	MAX	MIN	MAX	
t_{WC}	Write Cycle Time	55	—	70	—	ns
t_{WP}	Write Pulse Width	45	—	50	—	
t_{CW}	Chip Enable to End of Write	50	—	60	—	
t_{BW}	Data Byte Control to End of Write	50	—	60	—	
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	25	—	30	—	
t_{DH}	Data Hold Time	0	—	0	—	

AC TEST CONDITIONS

PARAMETER	TEST CONDITION
Output load	30 pF + 1 TTL Gate
Input pulse level	$V_{DD} - 0.2\text{ V}$, 0.2 V
Timing measurements	$V_{DD} \times 0.5$
Reference level	$V_{DD} \times 0.5$
t_R , t_F	5 ns

AC CHARACTERISTICS AND OPERATING CONDITIONS

(Ta = -40° to 85°C, V_{DD} = 2.3 to 3.1 V)

READ CYCLE

SYMBOL	PARAMETER	TC55W1600FT				UNIT
		-55		-70		
		MIN	MAX	MIN	MAX	
t _{RC}	Read Cycle Time	70	—	85	—	ns
t _{ACC}	Address Access Time	—	70	—	85	
t _{CO1}	Chip Enable($\overline{CE1}$) Access Time	—	70	—	85	
t _{CO2}	Chip Enable(CE2) Access Time	—	70	—	85	
t _{OE}	Output Enable Access Time	—	35	—	45	
t _{BA}	Data Byte Control Access Time	—	70	—	85	
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	0	—	0	—	
t _{OD}	Chip Enable High to Output High-Z	—	30	—	35	
t _{ODO}	Output Enable High to Output High-Z	—	30	—	35	
t _{BD}	Data Byte Control High to Output High-Z	—	30	—	35	
t _{OH}	Output Data Hold Time	10	—	10	—	

WRITE CYCLE

SYMBOL	PARAMETER	TC55W1600FT				UNIT
		-55		-70		
		MIN	MAX	MIN	MAX	
t _{WC}	Write Cycle Time	70	—	85	—	ns
t _{WP}	Write Pulse Width	50	—	55	—	
t _{CW}	Chip Enable to End of Write	60	—	70	—	
t _{BW}	Data Byte Control to End of Write	60	—	70	—	
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	30	—	35	—	
t _{DH}	Data Hold Time	0	—	0	—	

AC TEST CONDITIONS

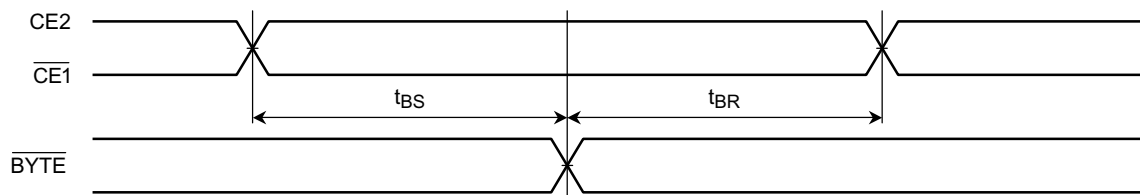
PARAMETER	TEST CONDITION
Output load	30 pF + 1 TTL Gate
Input pulse level	V _{DD} - 0.2 V, 0.2 V
Timing measurements	V _{DD} × 0.5
Reference level	V _{DD} × 0.5
t _R , t _F	5 ns

BYTE FUNCTION

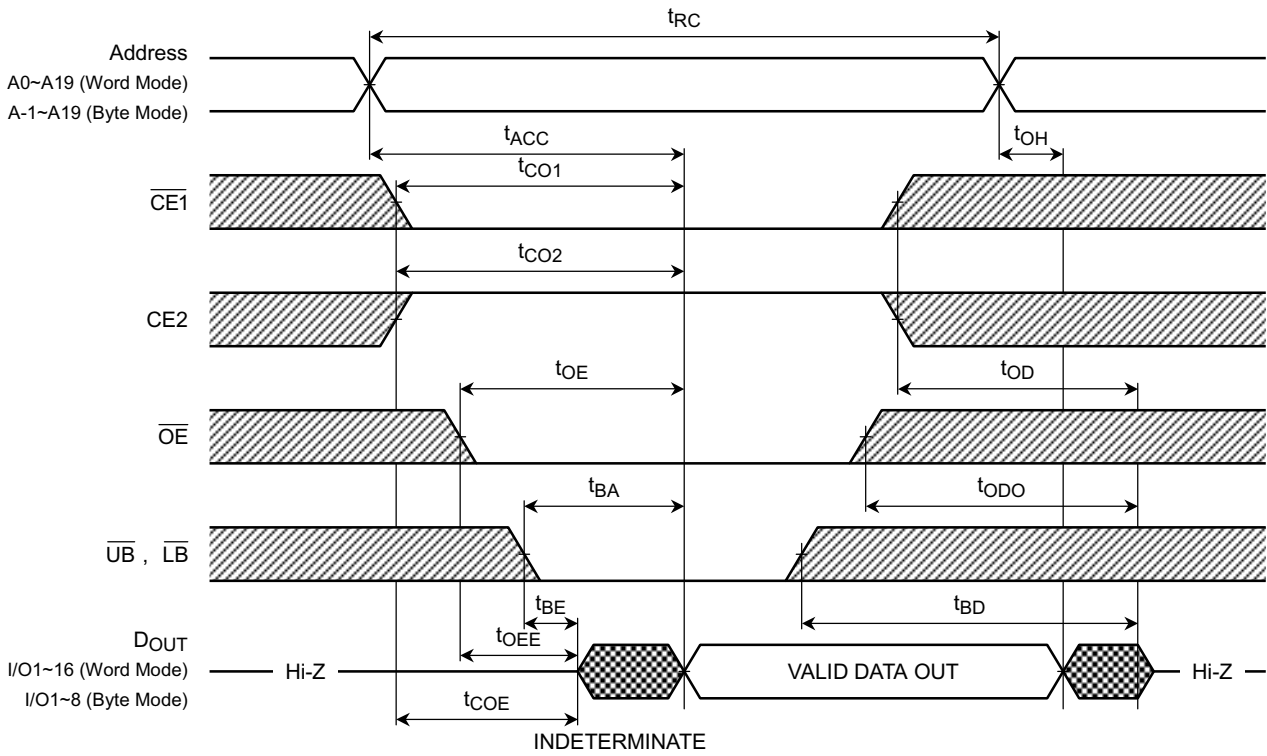
SYMBOL	PARAMETER	MIN	MAX	UNIT
t_{BS}	\overline{BYTE} Setup Time	5	—	ms
t_{BR}	\overline{BYTE} Recovery Time	5	—	ms

TIMING DIAGRAMS

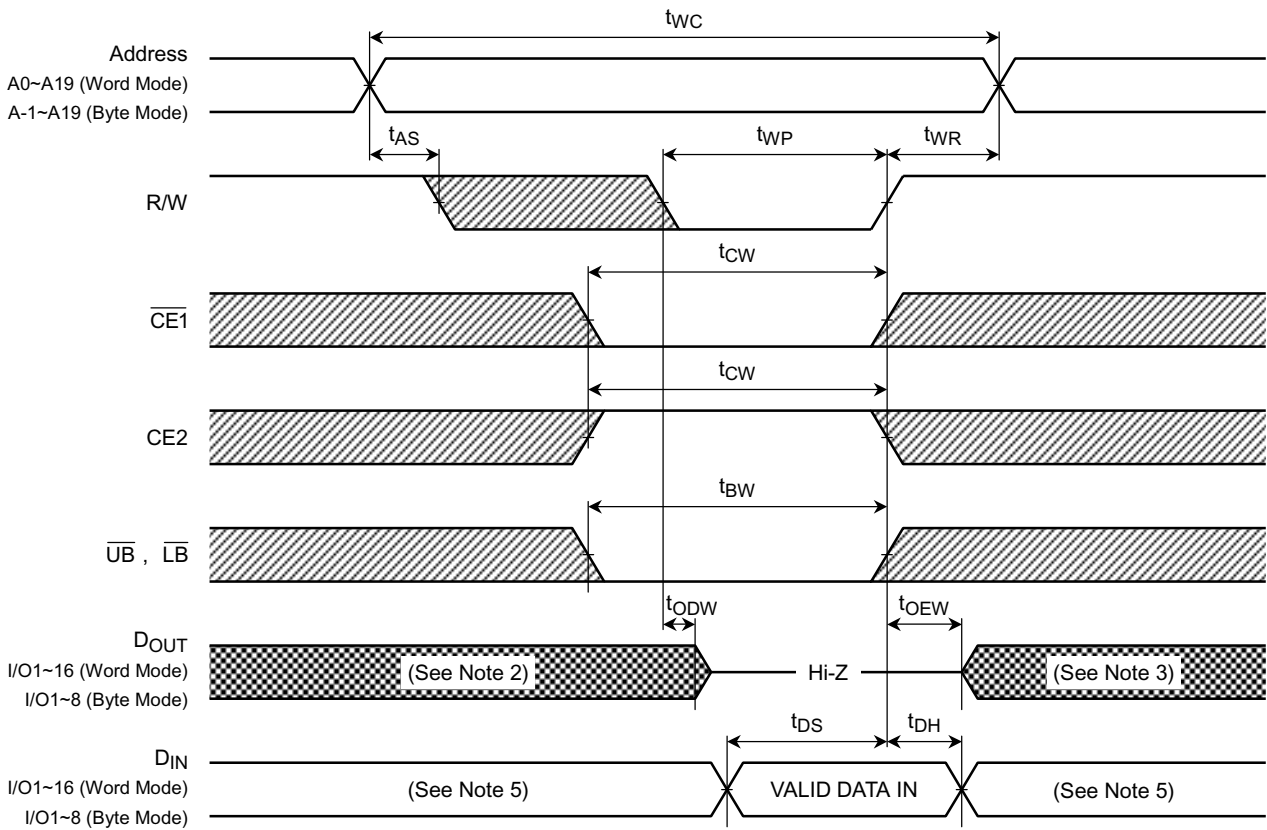
BYTE



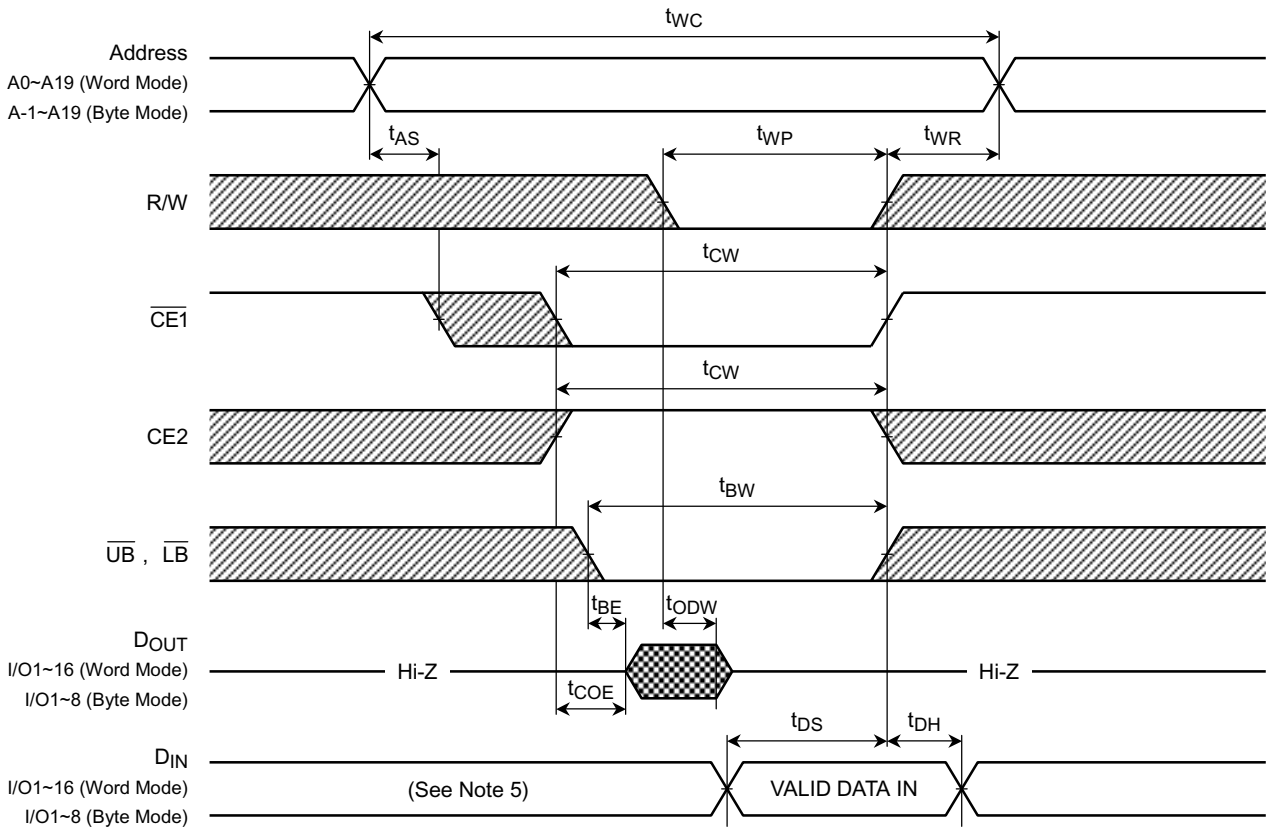
READ CYCLE (See Note 1)



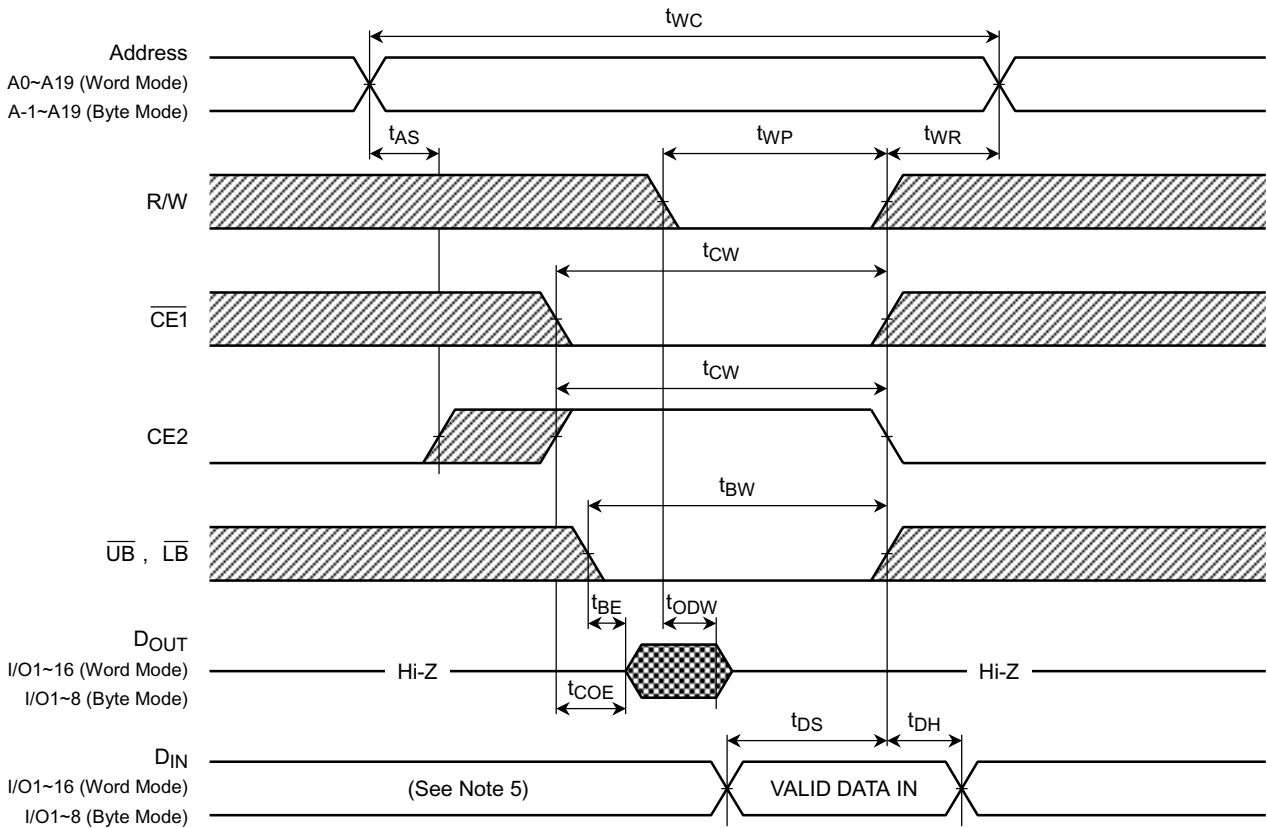
WRITE CYCLE 1 (R/W CONTROLLED) (See Note 4)



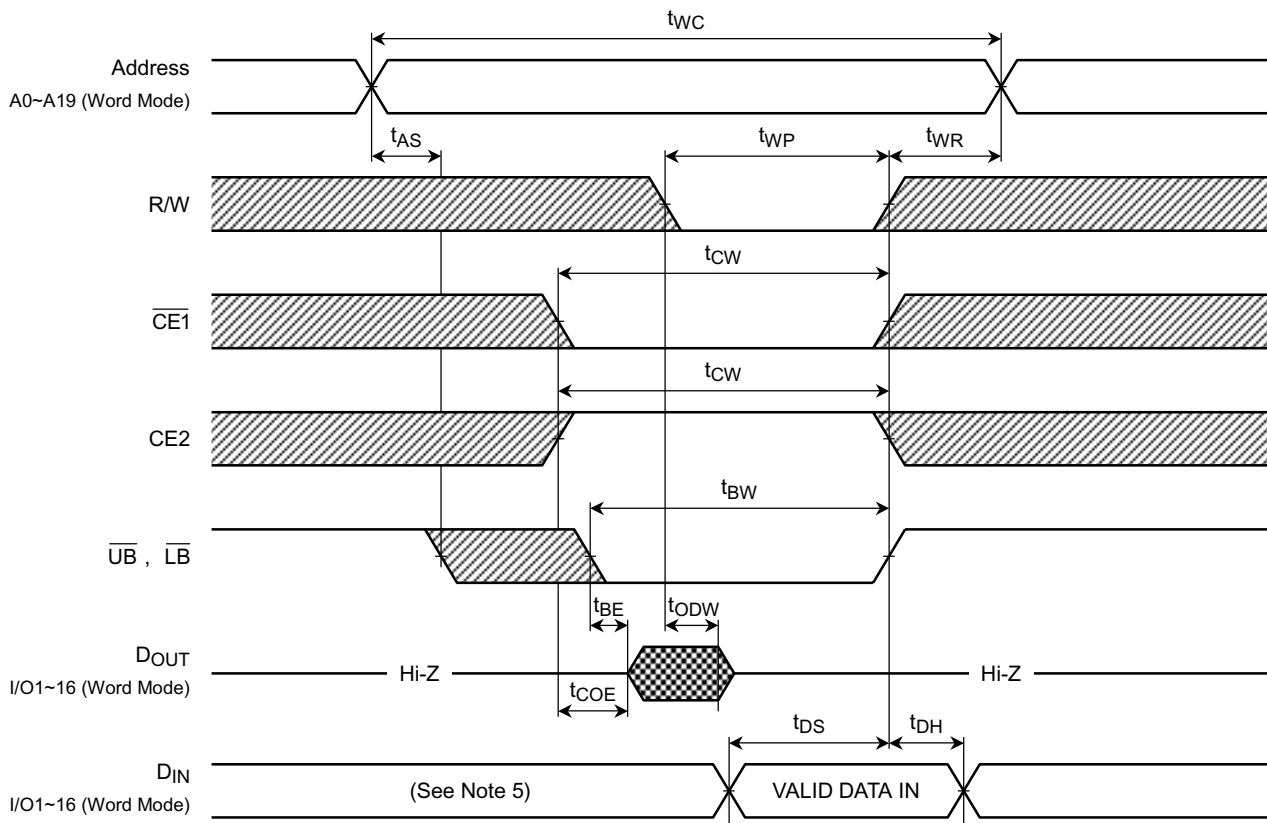
WRITE CYCLE 2 ($\overline{CE1}$ CONTROLLED) (See Note 4)



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



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



Note:

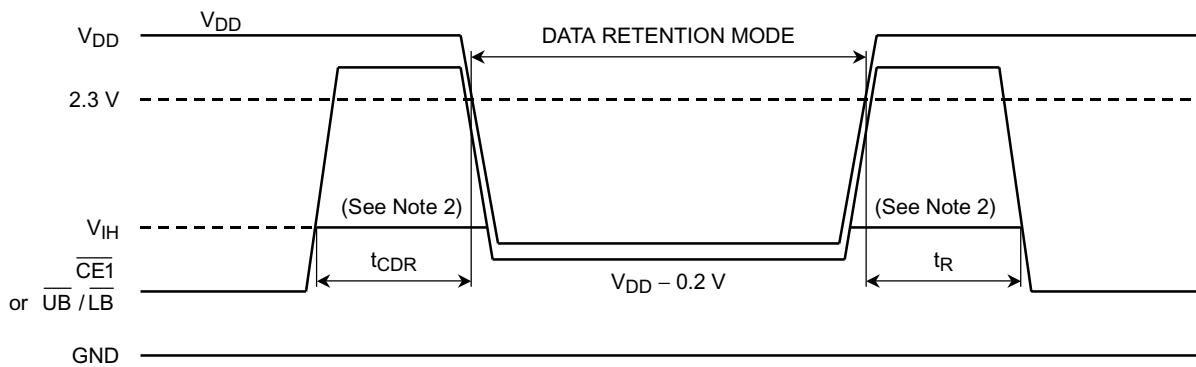
- (1) R/W remains HIGH for the read cycle.
- (2) If $\overline{CE1}$ or $\overline{UB}/\overline{LB}$ goes LOW (or CE2 goes HIGH) coincident with or after R/W goes LOW, the outputs will remain at high impedance.
- (3) If $\overline{CE1}$ or $\overline{UB}/\overline{LB}$ goes HIGH (or CE2 goes LOW) coincident 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)

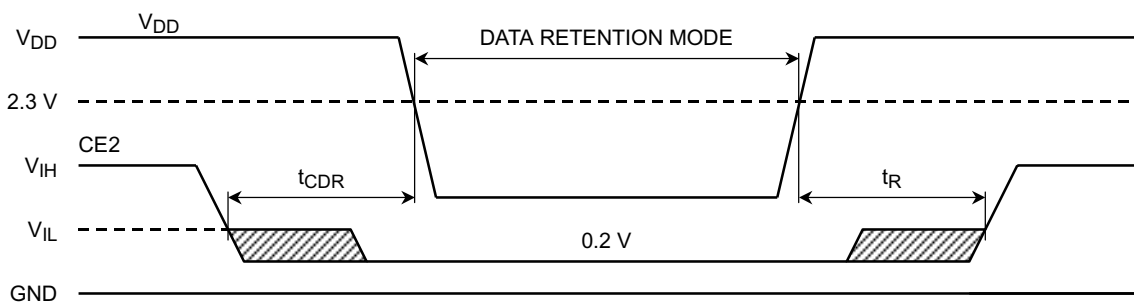
SYMBOL	PARAMETER		MIN	TYP	MAX	UNIT	
V _{DH}	Data Retention Supply Voltage		1.5	—	3.1	V	
I _{DD} S2	Standby Current	V _{DH} = 3.1 V	Ta = -40~85°C	—	—	10	μA
		V _{DH} = 3.0 V	Ta = -40~40°C	—	—	1	
			Ta = -40~85°C	—	—	5	
t _{CDR}	Chip Deselect to Data Retention Mode Time		0	—	—	ns	
t _R	Recovery Time		t _{RC} (See Note)	—	—	ns	

Note: Read cycle time

CE1, UB/LB CONTROLLED DATA RETENTION MODE (See Note 1,4)



CE2 CONTROLLED DATA RETENTION MODE (See Note 3)



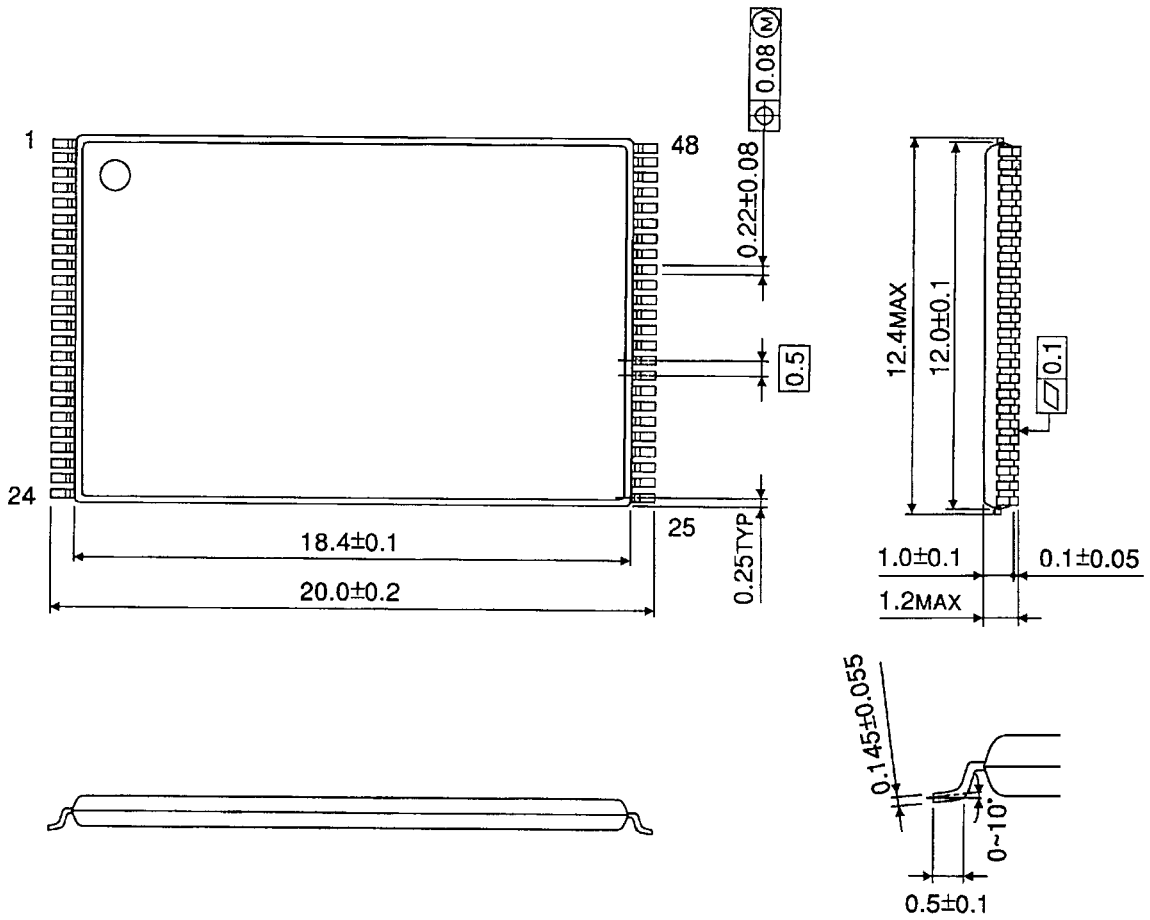
Note:

- (1) In $\overline{CE1}$ or $\overline{UB}/\overline{LB}$ controlled data retention mode, minimum standby current mode is entered when $CE2 \leq 0.2\text{ V}$ or $CE2 \geq V_{DD} - 0.2\text{ V}$.
- (2) When $\overline{CE1}$ or $\overline{UB}/\overline{LB}$ is operating at the V_{IH} minimum level, the operating current is given by $I_{DD}S1$ during the transition of V_{DD} from 3.1 V to 2.4 V.
- (3) In CE2 controlled data retention mode, minimum standby current mode is entered when $CE2 \leq 0.2\text{ V}$.
- (4) In $\overline{UB}/\overline{LB}$ controlled data retention mode, minimum standby current mode is entered when $\overline{CE1}/CE2 \leq 0.2\text{ V}$ or $\overline{CE1}/CE2 \geq V_{DD} - 0.2\text{ V}$.

PACKAGE DIMENSIONS

TSOP I 48-P-1220-0.50

Unit : mm



Weight: 0.52 g (typ)

RESTRICTIONS ON PRODUCT USE

000707EBA

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