

**TENTATIVE TOSHIBA MOS DIGITAL INTEGRATED CIRCUIT SILICON GATE CMOS
262,144-WORD BY 16-BIT FULL CMOS STATIC RAM**

DESCRIPTION

The TC55V400FT/TR/XB 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 2.7 to 3.6V 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 70 ns. It is automatically placed in low-power mode at 0.5µA standby current (at V_{DD}=3V, T_a=25°C, maximum) when chip enable (CE1) is asserted high or (CE2) is asserted low. There are three control inputs. CE1 and CE2 are used to select the device and for data retention control, and output enable (OE) provides fast memory access. Data byte control pin (LB, 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 TC55V400FT/TR/XB can be used in environments exhibiting extreme temperature conditions. The TC55V400FT/TR/XB is available in normal and reverse pinout plastic 48-pin thin-small-outline package (TSOP) and 48-BGA with 0.75mm ball pitch chip scale package.

FEATURES

- Low-power dissipation
Operating: 10.8 mW/MHz (typical)
- Single power supply voltage of 2.7 to 3.6V
- Power down features using CE1 and CE2
- Data retention supply voltage of 1.5 to 3.6V
- Direct TTL compatibility for all inputs and outputs
- Wide operating temperature range of -40° to 85°C
- Standby current (maximum)

3.6V	7 µA
3.0V	5 µA

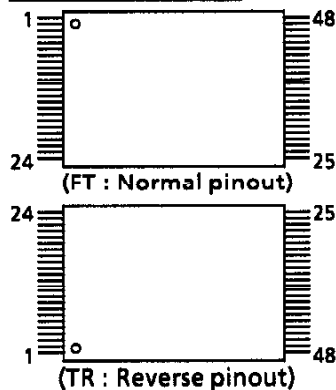
- Access Times (maximum):

	TC55V400FT/TR/XB		
	-70	-85	-10
Access Time	70 ns	85 ns	100 ns
CE1 Access Time	70 ns	85 ns	100 ns
CE2 Access Time	70 ns	85 ns	100 ns
OE Access Time	35 ns	45 ns	50 ns

- Package:

TSOP I 48-P-1214-0.50 (FT) (Weight:0.38g typ)
 TSOP I 48-P-1214-0.50A (TR) (Weight:0.38g typ)
 P-TFBGA48-0912-0.75AZ (XB) (Weight:0.24g typ)

PIN ASSIGNMENT (TOP VIEW)



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

(XB : BGA)

PIN NAMES

A0 to A17	Address Inputs
CE1, CE2	Chip Enable Input
R/W	Read / Write Control Input
OE	Output Enable Input
LB, UB	Data Byte Control Inputs
I/O1 to I/O16	Data Inputs / Outputs
V _{DD}	Power
GND	Ground
NC	No Connection

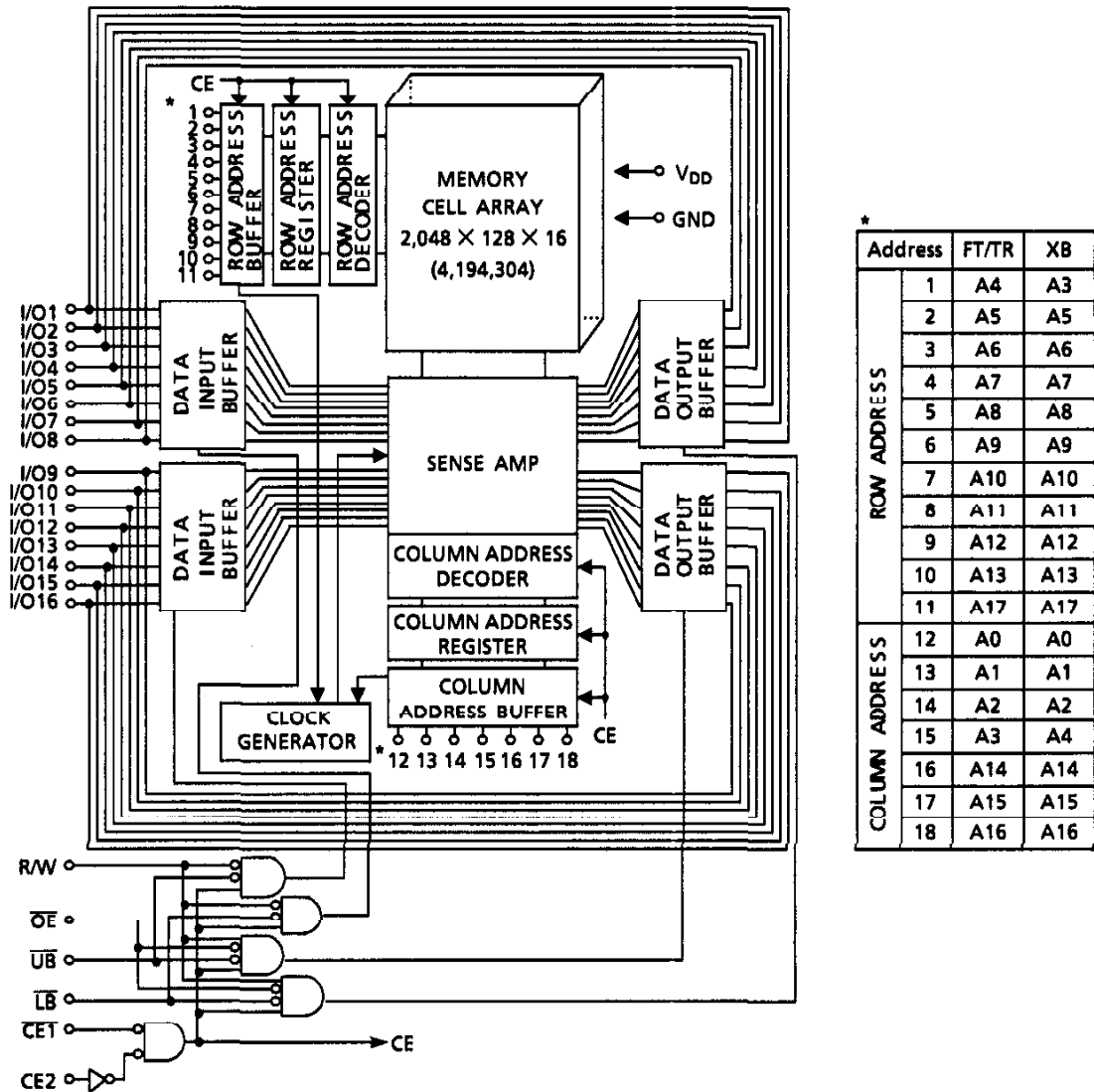
(TSOP)

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	NC	NC	R/W	CE2	NC	UB	LB	NC
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	CE1	GND	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	GND	NC	A16

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BLOCK DIAGRAM



* Address		
Address	FT/TR	XB
1	A4	A3
2	A5	A5
3	A6	A6
4	A7	A7
5	A8	A8
6	A9	A9
7	A10	A10
8	A11	A11
9	A12	A12
10	A13	A13
11	A17	A17
COLUMN ADDRESS		
12	A0	A0
13	A1	A1
14	A2	A2
15	A3	A4
16	A14	A14
17	A15	A15
18	A16	A16

OPERATING MODE

MODE	CE1	CE2	OE	R/W	LB	UB	I/O1 to I/O8	I/O9 to I/O16	POWER
Read	L	H	L	H	L	L	D _{OUT}	D _{OUT}	I _{DDO}
					H	L	High-Z	D _{OUT}	I _{DDO}
					L	H	D _{OUT}	High-Z	I _{DDO}
Write	L	H	X	L	L	L	D _{IN}	D _{IN}	I _{DDO}
					H	L	High-Z	D _{IN}	I _{DDO}
					L	H	D _{IN}	High-Z	I _{DDO}
Output Deselect	L	H	H	H	X	X	High-Z	High-Z	I _{DDO}
	L	H	X	X	H	H	High-Z	High-Z	I _{DDO}
Standby	H	X	X	X	X	X	High-Z	High-Z	I _{DDO}
	X	L	X	X	X	X	High-Z	High-Z	I _{DDO}

Note: X = don't care. H = logic high. L = logic low.

MAXIMUM RATINGS

SYMBOL	RATING	VALUE	UNIT
V _{DD}	Power Supply Voltage	- 0.3 to 4.6	V
V _{IN}	Input Voltage	- 0.3 * to 4.6	V
V _{IO}	Input/Output Voltage	- 0.5 to V _{DD} + 0.5	V
P _D	Power Dissipation	0.6	W
T _{solder}	Soldering Temperature (10 s)	260	°C
T _{strg}	Storage Temperature	- 55 to 150/125 **	°C
T _{opr}	Operating Temperature	- 40 to 85	°C

* - 3.0 V when measured at a pulse width of 30 ns. ** XB

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

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
V _{DD}	Power Supply Voltage	2.7	-	3.6	V
V _{IH}	Input High Voltage	2.2	-	V _{DD} + 0.3	V
V _{IL}	Input Low Voltage	- 0.3 *	-	0.6	V
V _{DH}	Data Retention Supply Voltage	1.5	-	3.6	V

* - 3.0 V when measured at a pulse width of 30 ns.

DC CHARACTERISTICS (Ta = -40° to 85°C, V_{DD} = 2.7 to 3.6V)

SYMBOL	PARAMETER	TEST CONDITION	MIN	TYP	MAX	UNIT		
I _{IL}	Input Leakage Current	V _{IN} = 0 V to 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	CE1 = V _{IH} or CE2 = V _{IL} or R/W = V _{IL} or OE = V _{IH} V _{OUT} = 0 V to V _{DD}	-	-	±1.0	μA		
I _{DDO1}	Operating Current	CE1 = V _{IL} and CE2 = V _{IH} and R/W = V _{IH} and I _{OUT} = 0 mA Other Input = V _{IH} /V _{IL}	V _{DD} = 3 V ± 10%	T _{cycle} = min	-70	-	50	mA
				T _{cycle} = 1 μs	-85,-10	-	45	
			V _{DD} = 3.3 V ± 0.3 V	T _{cycle} = min	-70	-	55	
				T _{cycle} = 1 μs	-85,-10	-	50	
I _{DDO2}	Operating Current	CE1 = 0.2 V and CE2 = V _{DD} - 0.2 V and R/W = V _{DD} - 0.2 V, I _{OUT} = 0 mA Other Inputs = V _{DD} - 0.2V/0.2V	V _{DD} = 3 V ± 10%	T _{cycle} = min	-70	-	45	
				T _{cycle} = 1 μs	-85,-10	-	40	
			V _{DD} = 3.3 V ± 0.3 V	T _{cycle} = min	-70	-	50	
				T _{cycle} = 1 μs	-85,-10	-	45	
I _{DDs1}	Standby Current	CE1 = V _{IH} or CE2 = V _{IL}	-	-	2	mA		
I _{DDs2} (Note)		CE1 = V _{DD} - 0.2 V or CE2 = 0.2 V V _{DD} = 1.5 to 3.6 V	V _{DD} = 3 V ± 10%	T _a = 25°C	-	-	0.6	
				T _a = -40 to 85°C	-	-	6	
			V _{DD} = 3.3 V ± 0.3 V	T _a = 25°C	-	-	0.7	
	T _a = -40 to 85°C			-	-	7		
V _{DD} = 3 V	T _a = 25°C	-	0.05	0.5				
	T _a = -40 to 40°C	-	-	1				
		T _a = -40 to 85°C	-	-	5			

Note: In standby mode with CE1 ≥ V_{DD} - 0.2V, these limits are assured for the condition CE2 ≥ V_{DD} - 0.2V or CE2 ≤ 0.2V.

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

READ CYCLE

SYMBOL	PARAMETER	TC55V400FT/TR/XB						UNIT
		-70		-85		-10		
		MIN	MAX	MIN	MAX	MIN	MAX	
t _{RC}	Read Cycle Time	70	—	85	—	100	—	ns
t _{ACC}	Address Access Time	—	70	—	85	—	100	
t _{CO1}	Chip Enable (CE1) Access Time	—	70	—	85	—	100	
t _{CO2}	Chip Enable (CE2) Access Time	—	70	—	85	—	100	
t _{OE}	Output Enable Access Time	—	35	—	45	—	50	
t _{BA}	Data Byte Control Access Time	—	35	—	45	—	50	
t _{COE}	Chip Enable Low to Output Active	5	—	5	—	5	—	
t _{OEE}	Output Enable Low to Output Active	0	—	0	—	0	—	
t _{BE}	Data Byte Control Low to Output Active	0	—	0	—	0	—	
t _{OD}	Chip Enable High to Output High-Z	—	30	—	35	—	40	
t _{ODO}	Output Enable High to Output High-Z	—	30	—	35	—	40	
t _{BD}	Data Byte Control High to Output High-Z	—	30	—	35	—	40	
t _{OH}	Output Data Hold Time	10	—	10	—	10	—	

WRITE CYCLE

SYMBOL	PARAMETER	TC55V400FT/TR/XB						UNIT
		-70		-85		-10		
		MIN	MAX	MIN	MAX	MIN	MAX	
t _{WC}	Write Cycle Time	70	—	85	—	100	—	ns
t _{WP}	Write Pulse Width	50	—	55	—	60	—	
t _{CW}	Chip Enable to End of Write	60	—	70	—	80	—	
t _{BW}	Data Byte Control to End of Write	50	—	55	—	60	—	
t _{AS}	Address Setup Time	0	—	0	—	0	—	
t _{WR}	Write Recovery Time	0	—	0	—	0	—	
t _{ODW}	R/W Low to Output High-Z	—	30	—	35	—	40	
t _{OEW}	R/W High to Output Active	0	—	0	—	0	—	
t _{DS}	Data Setup Time	30	—	35	—	40	—	
t _{DH}	Data Hold Time	0	—	0	—	0	—	

AC TEST CONDITIONS

Output load: 30 pF + one TTL gate (-70)
 : 100 pF + one TTL gate (-85, -10)

Input pulse level: 0.4 V, 2.4 V

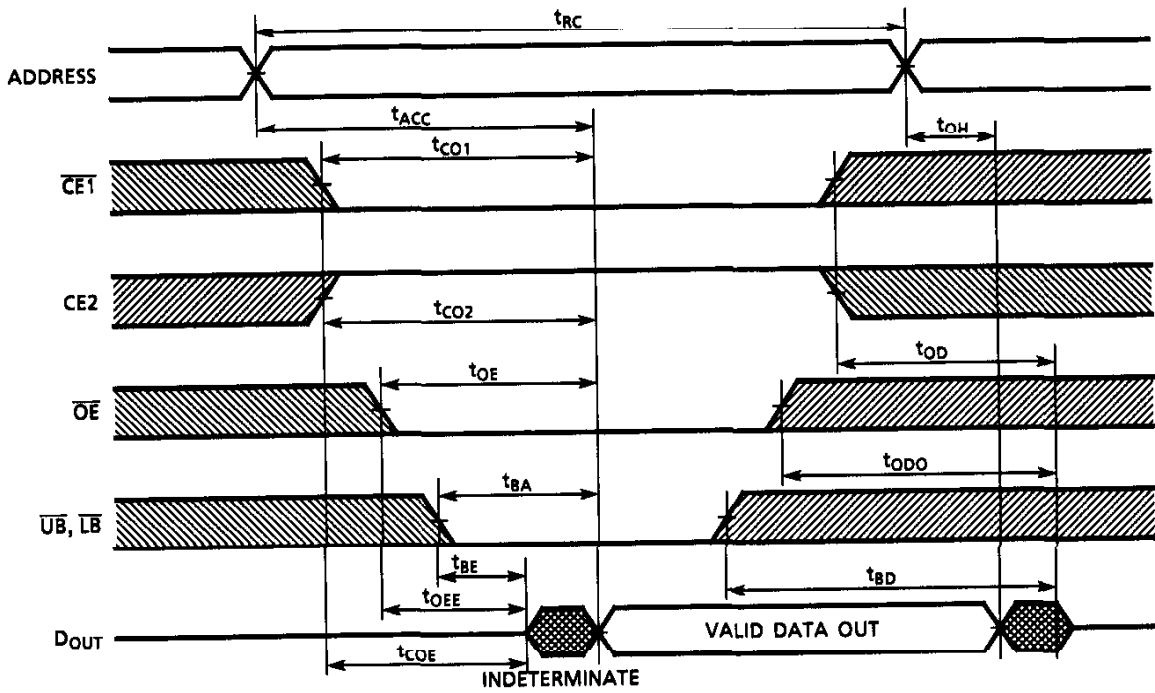
Timing measurements: 1.5 V

Reference level: V_{DD} × 0.5

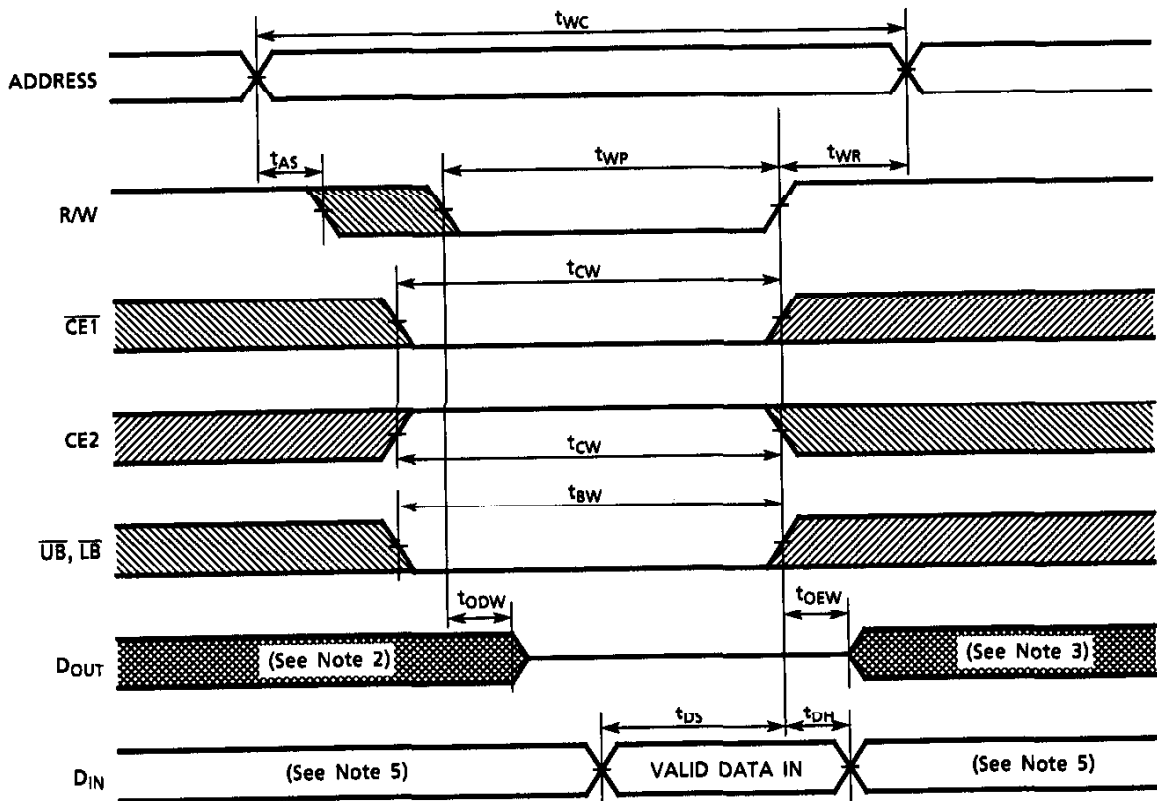
t_R, t_F: 5 ns

TIMING DIAGRAMS

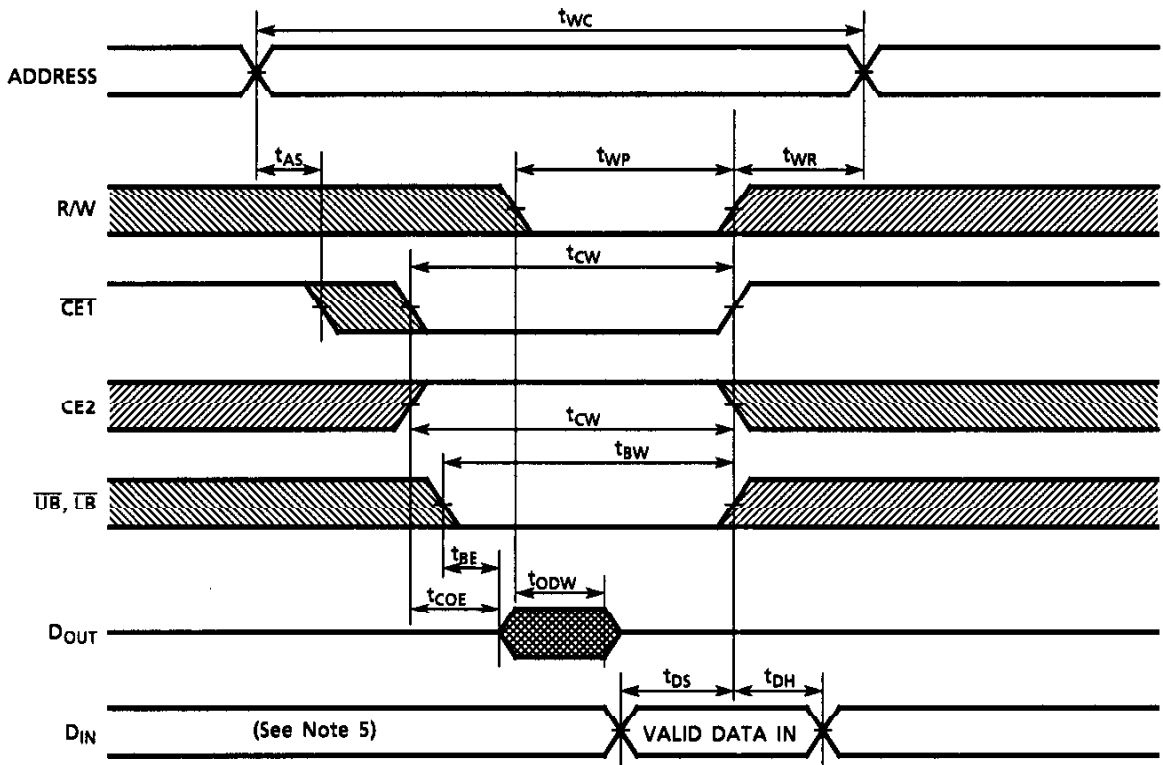
READ CYCLE (See Note 1)



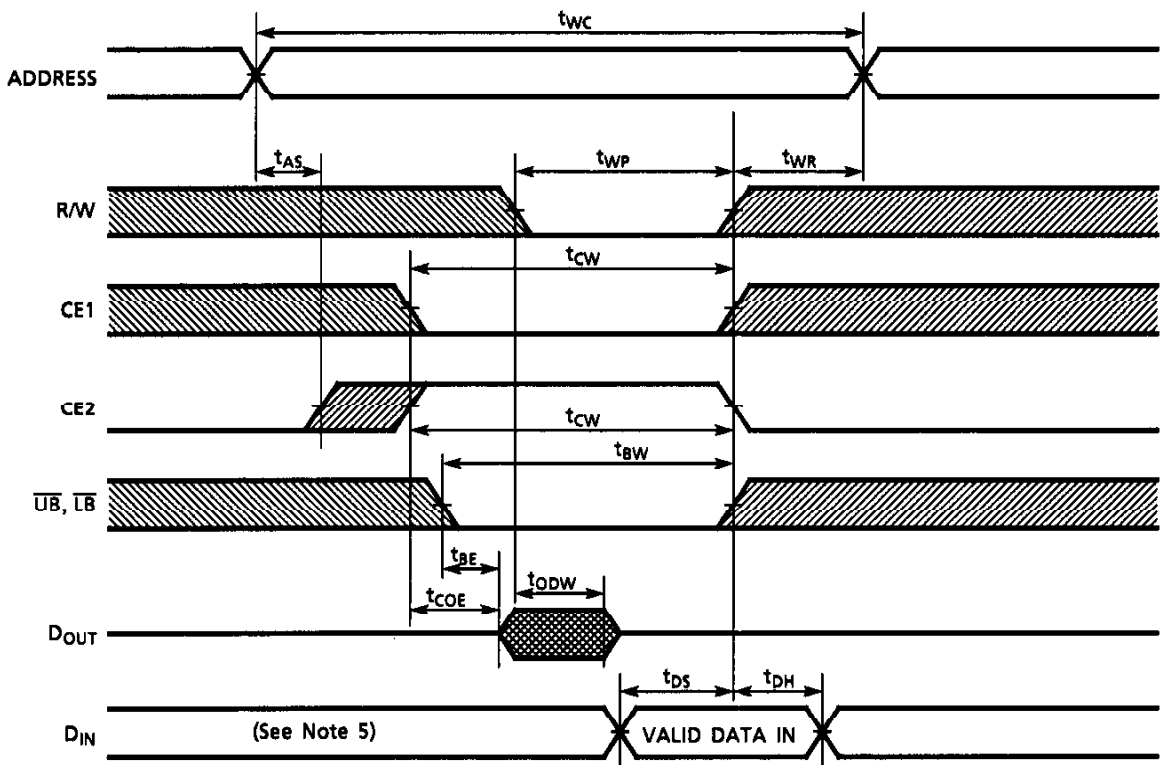
WRITE CYCLE 1 (R/W CONTROLLED) (See Note 4)



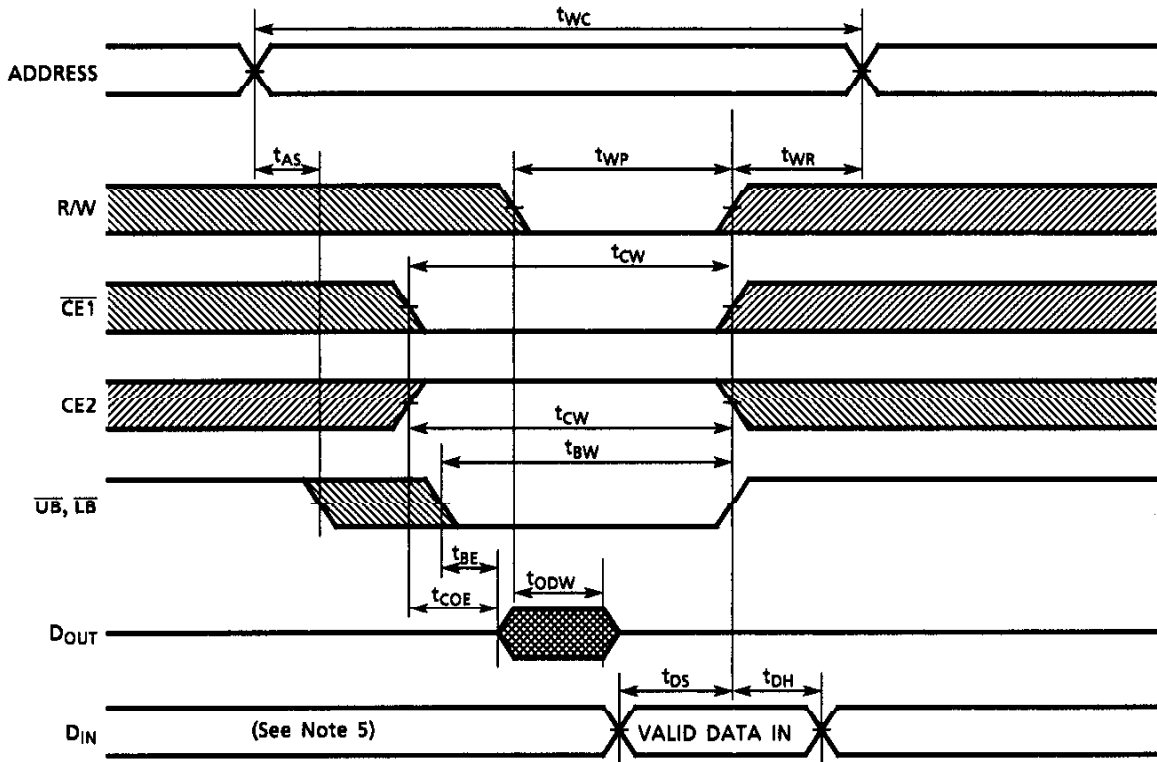
WRITE CYCLE 2 (CE1 CONTROLLED) (See Note 4)



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



WRITE CYCLE 4 (UB, LB CONTROLLED) (See Note 4)



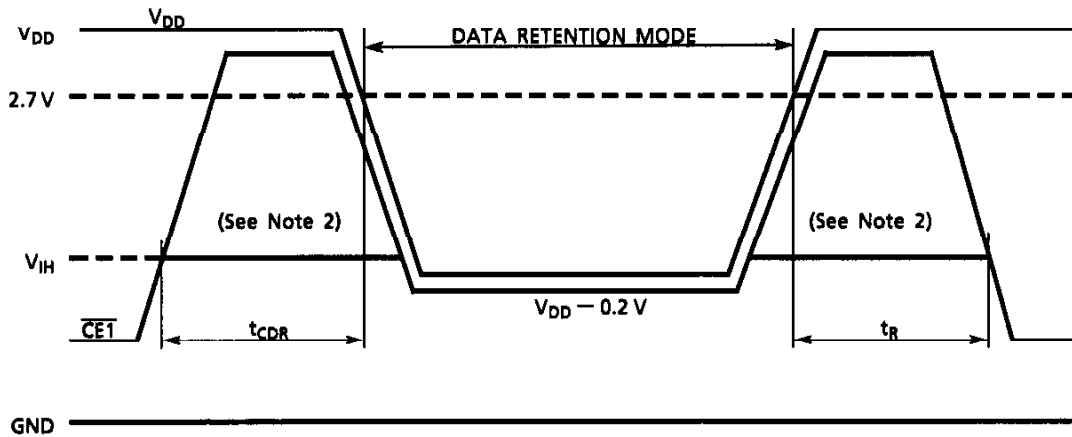
- Note:
- (1) R/W remains HIGH for the read cycle.
 - (2) If $\overline{CE1}$ goes LOW (or CE2 goes HIGH) coincident with or after R/W goes LOW, the outputs will remain at high impedance.
 - (3) If $\overline{CE1}$ goes HIGH (or CE2 goes LOW) coincident with or before R/W goes HIGH, the outputs will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

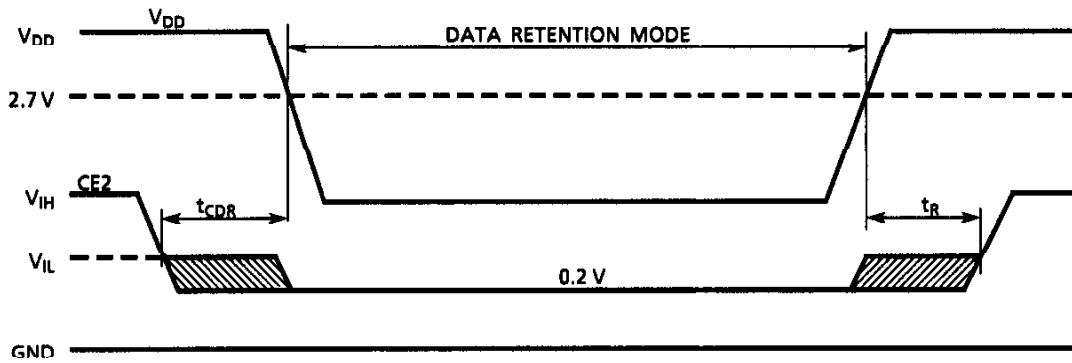
SYMBOL	PARAMETER		MIN	TYP	MAX	UNIT
V _{DH}	Data Retention Supply Voltage		1.5	—	3.6	V
I _{DD52}	Standby Current	V _{DH} = 3.0 V	Ta = -40° to 40°C	—	1	μA
			Ta = -40° to 85°C	—	5	
		V _{DH} = 3.6 V	Ta = -40° to 85°C	—	7	
t _{CDR}	Chip Deselect to Data Retention Mode Time		0	—	—	nS
t _R	Recovery Time		t _{RC} (See Note)	—	—	nS

Note: Read cycle time

CE1 CONTROLLED DATA RETENTION MODE (See Note 1)



CE2 CONTROLLED DATA RETENTION MODE (See Note 3)



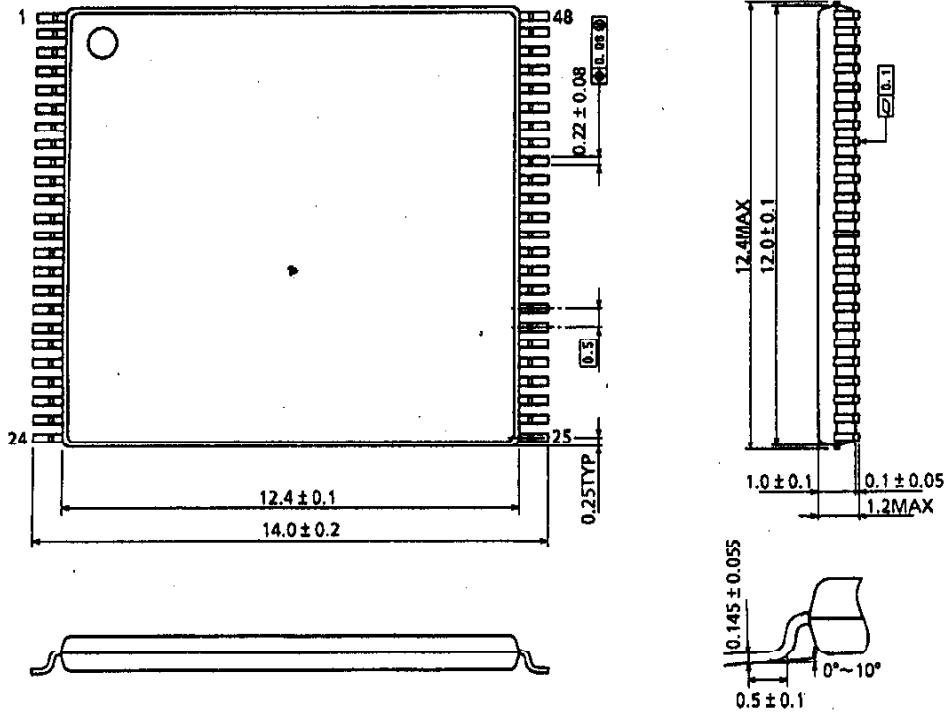
Note: (1) In $\overline{CE1}$ controlled data retention mode, minimum standby current mode is entered when $CE2 \leq 0.2\text{ V}$ or $CE2 \geq V_{DD} - 0.2\text{ V}$.

(2) When $\overline{CE1}$ is operating at the V_{IH} level (2.2 V), the operating current is given by I_{DD51} during the transition of V_{DD} from 3.6 to 2.4 V.

(3) In CE2 controlled data retention mode, minimum standby current mode is entered when $CE2 \leq 0.2\text{ V}$.

PACKAGE DIMENSIONS (TSOP I 48-P-1214-0.50)

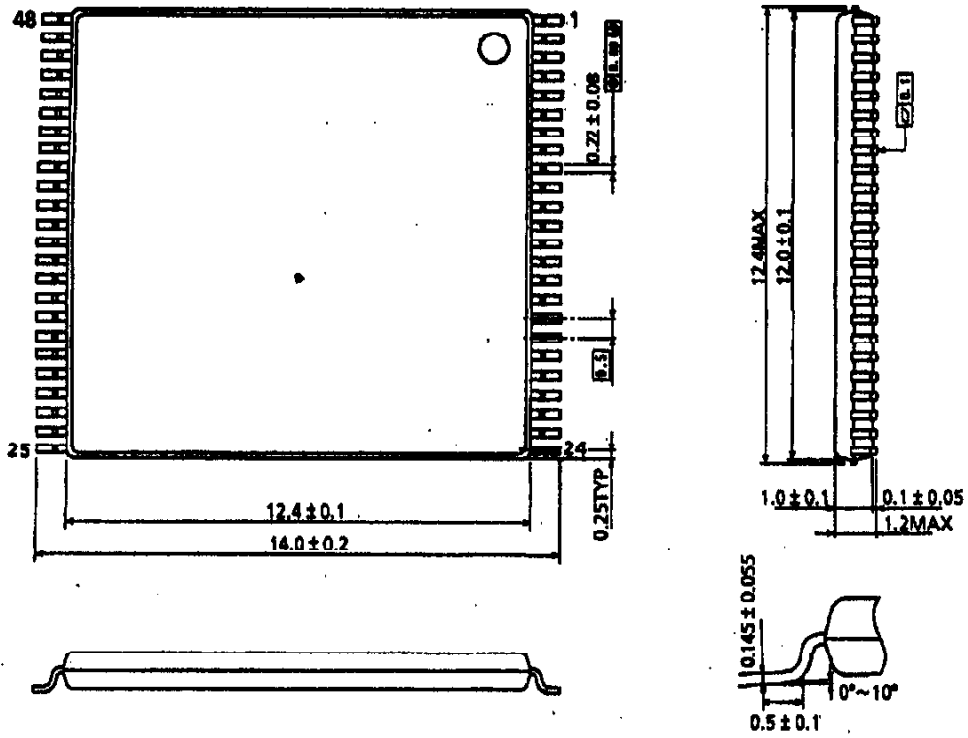
Units in mm



Weight: 0.38 g (typ)

PACKAGE DIMENSIONS (TSOP I 48-P-1214-0.5A)

Units in mm



Weight: 0.38 g (typ)

