

TOSHIBA MOS DIGITAL INTEGRATED CIRCUIT SILICON GATE CMOS

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

Lead-Free

DESCRIPTION

The TC55NEM216ASGV 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 5.5 V power supply. Advanced circuit technology provides both high speed and low power at an operating current of 3 mA/MHz (typ) and a minimum cycle time of 55 ns. It is automatically placed in low-power mode at 1.8 μ A standby current (typ) when chip enable (\overline{CE}) is asserted high or chip select (CS) is asserted low. There are three control inputs. \overline{CE} is 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 extreme temperature range of -40° to 85°C , the TC55NEM216ASGV can be used in environments exhibiting extreme temperature conditions. The TC55NEM216ASGV is available in a plastic 44-pin thin-small-outline package (TSOP).

FEATURES

- Low-power dissipation
Operating: 15 mW/MHz (typical)
- Single power supply voltage of 2.7 to 5.5 V
- Power down features using \overline{CE}
- Data retention supply voltage of 2.0 to 5.5 V
- Direct TTL compatibility for all inputs and outputs
- Wide operating temperature range of -40° to 85°C
- Standby Current (maximum): 20 μ A

- Access Times (maximum):

	5 V \pm 10%		2.7 V~5.5 V	
	55	70	55	70
Access Time	55 ns	70 ns	85 ns	100 ns
\overline{CE} Access Time	55 ns	70 ns	85 ns	100 ns
\overline{OE} Access Time	30 ns	35 ns	60 ns	70 ns

- Package:
TSOP II44-P-400-0.80 (Weight:0.47 g typ)
- Lead-Free

PIN ASSIGNMENT (TOP VIEW)

44 PIN TSOP

A4 □ 1 ○	44 □ A5
A3 □ 2	43 □ A6
A2 □ 3	42 □ A7
A1 □ 4	41 □ \overline{OE}
A0 □ 5	40 □ \overline{UB}
\overline{CE} □ 6	39 □ \overline{LB}
I/O1 □ 7	38 □ I/O16
I/O2 □ 8	37 □ I/O15
I/O3 □ 9	36 □ I/O14
I/O4 □ 10	35 □ I/O13
V _{DD} □ 11	34 □ GND
GND □ 12	33 □ V _{DD}
I/O5 □ 13	32 □ I/O12
I/O6 □ 14	31 □ I/O11
I/O7 □ 15	30 □ I/O10
I/O8 □ 16	29 □ I/O9
R/W □ 17	28 □ CS
A15 □ 18	27 □ A8
A14 □ 19	26 □ A9
A13 □ 20	25 □ A10
A12 □ 21	24 □ A11
A16 □ 22	23 □ A17

PIN NAMES

A0~A17	Address Inputs
\overline{CE}	Chip Enable
CS	Chip Select
R/W	Read/Write Control
\overline{OE}	Output Enable
\overline{LB} , \overline{UB}	Data Byte Control
I/O1~I/O16	Data Inputs/Outputs
V _{DD}	Power
GND	Ground
NC	No Connection

The diagram illustrates the internal architecture of a 2,048 x 128 x 16 (4,194,304) memory cell array. The central component is the **MEMORY CELL ARRAY**, which is connected to a **ROW ADDRESS REGISTER** and a **ROW ADDRESS DECODER**. The **ROW ADDRESS REGISTER** receives inputs from **A6** through **A17** and is controlled by **CE**. The **ROW ADDRESS DECODER** outputs are connected to the **MEMORY CELL ARRAY**. The **MEMORY CELL ARRAY** is also connected to a **SENSE AMP** and a **COLUMN ADDRESS DECODER**. The **SENSE AMP** is connected to **DATA INPUT BUFFER** and **DATA OUTPUT BUFFER** blocks. The **COLUMN ADDRESS DECODER** is connected to a **COLUMN ADDRESS REGISTER** and a **COLUMN ADDRESS BUFFER**. The **COLUMN ADDRESS REGISTER** receives inputs from **A0** through **A5** and is controlled by **CE**. The **COLUMN ADDRESS BUFFER** outputs are connected to the **SENSE AMP**. A **CLOCK GENERATOR** is connected to the **ROW ADDRESS REGISTER**, **COLUMN ADDRESS REGISTER**, and **SENSE AMP**. The **DATA INPUT BUFFER** and **DATA OUTPUT BUFFER** blocks are connected to **I/O0** through **I/O16**. The **DATA INPUT BUFFER** is connected to **I/O0** through **I/O8**, and the **DATA OUTPUT BUFFER** is connected to **I/O0** through **I/O8**. The **DATA INPUT BUFFER** and **DATA OUTPUT BUFFER** blocks are also connected to **I/O9** through **I/O16**. The **DATA INPUT BUFFER** and **DATA OUTPUT BUFFER** blocks are connected to **VDD** and **GND**. The **DATA INPUT BUFFER** and **DATA OUTPUT BUFFER** blocks are connected to **CS**, **CE**, **LB**, **UB**, **R/W**, and **OE**. The **DATA INPUT BUFFER** and **DATA OUTPUT BUFFER** blocks are connected to **CS**, **CE**, **LB**, **UB**, **R/W**, and **OE**. The **DATA INPUT BUFFER** and **DATA OUTPUT BUFFER** blocks are connected to **CS**, **CE**, **LB**, **UB**, **R/W**, and **OE**.

OPERATING MODE

MODE	\overline{CE}	CS	\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}
CS Standby	*	L	*	*	*	*	High-Z	High-Z	I _{DDS}
Standby	H	*	*	*	*	*	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	-0.3~7.0	V
V _{IN}	Input Voltage	-0.3*~7.0	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

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

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

SYMBOL	PARAMETER	5 V ± 10%			2.7 V~5.5 V			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
V _{DD}	Power Supply Voltage	4.5	5.0	5.5	2.7	5.0	5.5	V
V _{IH}	Input High Voltage	2.4 ^{*1}	—	V _{DD} + 0.3	V _{DD} - 0.2	—	V _{DD} + 0.3	V
V _{IL}	Input Low Voltage	-0.3 ^{*2}	—	0.6	-0.3 ^{*2}	—	0.2	V
V _{DH}	Data Retention Supply Voltage	2.0	—	5.5	2.0	—	5.5	V

*1: CS pin = V_{DD} × 0.7

*2: -2.0V when measured at a pulse width of 20 ns

DC CHARACTERISTICS ($T_a = -40^\circ$ to 85°C , $V_{DD} = 5\text{ V} \pm 10\%$)

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} = 2.4 V			−1.0	—	—	mA	
I _{OL}	Output Low Current	V _{OL} = 0.4 V			2.1	—	—	mA	
I _{LO}	Output Leakage Current	$\overline{CE} = V_{IH}$ or $CS = V_{IL}$ 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	$\overline{CE} = V_{IL}$ and $CS = V_{IH}$ 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}	Operating Current	$\overline{CE} = 0.2\text{ V}$ and $CS = V_{DD} - 0.2\text{ V}$ and $R/W = V_{DD} - 0.2\text{ V}$, $\overline{LB} = \overline{UB} = 0.2\text{ V}$, I _{OUT} = 0 mA, Other Input = V _{DD} − 0.2 V/0.2 V	t _{cycle}	MIN	—	—	30	mA	
				1 μs	—	3	—		
I _{DDS1}	Standby Current	1) $\overline{CE} = V_{IH}$ 2) $CS = V_{IL}$ 3) $\overline{LB} = \overline{UB} = V_{IH}$			—	—	3	mA	
I _{DDS2}			1) $\overline{CE} = V_{DD} - 0.2\text{ V}$		Ta = 25°C	—	1.8	—	μA
			2) $CS = 0.2\text{ V}$		Ta = −40~40°C	—	—	3	
			3) $\overline{LB} = \overline{UB} = V_{DD} - 0.2\text{ V}$, $\overline{CE} = 0.2\text{ V}$, $CS = V_{DD} - 0.2\text{ V}$		Ta = −40~85°C	—	—	20	

DC CHARACTERISTICS ($T_a = -40^\circ$ to 85°C , $V_{DD} = 3\text{ V} \pm 10\%$)

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} – 0.2 V			–0.1	—	—	mA
I _{OL}	Output Low Current	V _{OL} = 0.2 V			0.1	—	—	mA
I _{LO}	Output Leakage Current	$\overline{CE} = V_{IH}$ or CS = 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 _{DDO2}	Operating Current	$\overline{CE} = 0.2\text{ V}$ and CS = V _{DD} – 0.2 V and R/W = V _{DD} – 0.2 V, $\overline{LB} = \overline{UB} = 0.2\text{ V}$, I _{OUT} = 0 mA, Other Input = V _{DD} – 0.2 V/0.2 V	t _{cycle}	MIN	—	—	30	mA
				1 μs	—	3	—	
I _{DDS2}	Standby Current	1) $\overline{CE} = V_{DD} - 0.2\text{ V}$ 2) CS = 0.2 V 3) $\overline{LB} = \overline{UB} = V_{DD} - 0.2\text{ V}$, $\overline{CE} = 0.2\text{ V}$, CS = V _{DD} – 0.2 V	Ta = 25°C		—	1.6	—	μA
			Ta = –40~40°C		—	—	3	
			Ta = –40~85°C		—	—	20	

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 = 5 V ± 10%)

READ CYCLE

SYMBOL	PARAMETER	TC55NEM216ASGV				UNIT
		55		70		
		MIN	MAX	MIN	MAX	
t _{RC}	Read Cycle Time	55	—	70	—	ns
t _{ACC}	Address Access Time	—	55	—	70	
t _{CO}	Chip Enable 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 _{OOE}	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	TC55NEM216ASGV				UNIT
		55		70		
		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	0.4 V, 2.6 V
t _R , t _F	5 ns
Timing measurements	1.5 V
Reference level	1.5 V
Output load	30 pF + 1 TTL Gate (55) 100 pF + 1 TTL Gate (70)

AC CHARACTERISTICS AND OPERATING CONDITIONS

(Ta = -40° to 85°C, V_{DD} = 2.7 to 5.5 V)

READ CYCLE

SYMBOL	PARAMETER	TC55NEM216ASGV				UNIT
		55		70		
		MIN	MAX	MIN	MAX	
t _{RC}	Read Cycle Time	85	—	100	—	ns
t _{ACC}	Address Access Time	—	85	—	100	
t _{CO}	Chip Enable Access Time	—	85	—	100	
t _{OE}	Output Enable Access Time	—	60	—	70	
t _{BA}	Data Byte Control Access Time	—	85	—	100	
t _{COE}	Chip Enable Low to Output Active	5	—	5	—	
t _{OOE}	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	—	35	—	40	
t _{ODO}	Output Enable High to Output High-Z	—	35	—	40	
t _{BD}	Data Byte Control High to Output High-Z	—	35	—	40	
t _{OH}	Output Data Hold Time	10	—	10	—	

WRITE CYCLE

SYMBOL	PARAMETER	TC55NEM216ASGV				UNIT
		55		70		
		MIN	MAX	MIN	MAX	
t _{WC}	Write Cycle Time	85	—	100	—	ns
t _{WP}	Write Pulse Width	55	—	60	—	
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	—	35	—	40	
t _{OEW}	R/W High to Output Active	0	—	0	—	
t _{DS}	Data Setup Time	35	—	40	—	
t _{DH}	Data Hold Time	0	—	0	—	

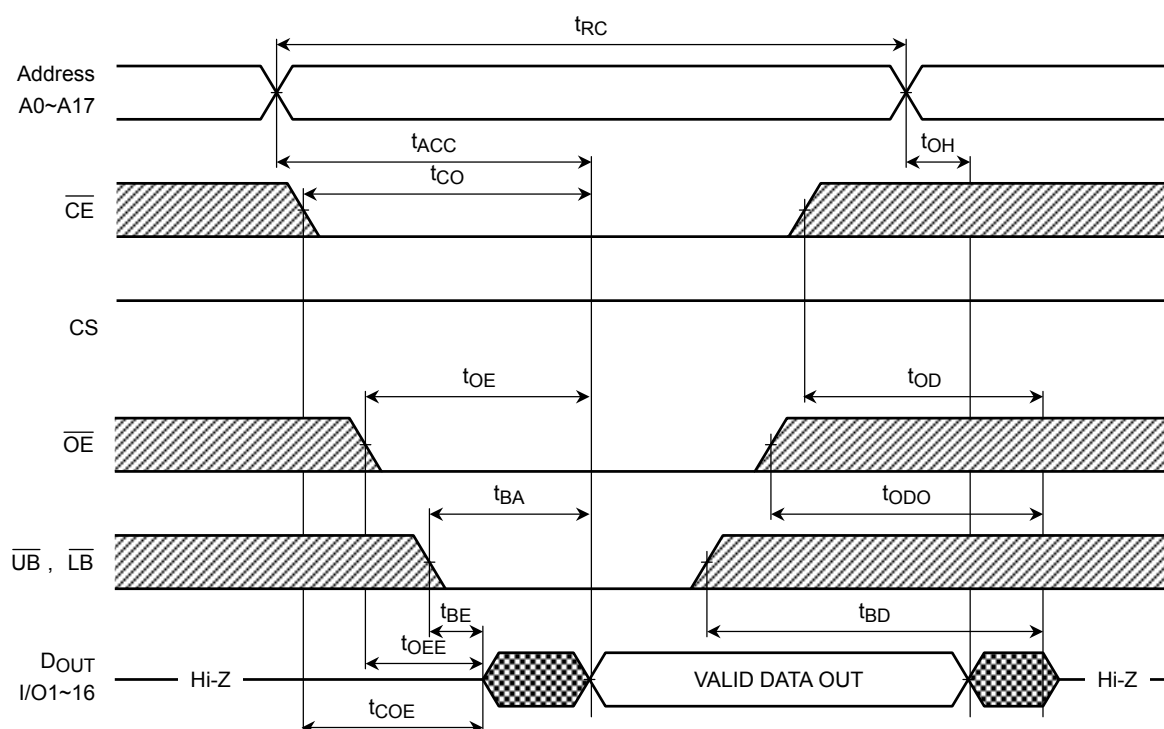
Note: t_{OD}, t_{ODO}, t_{BD} and t_{ODW} are specified in time when an output becomes high impedance, and are not judged depending on an output voltage level.

AC TEST CONDITIONS

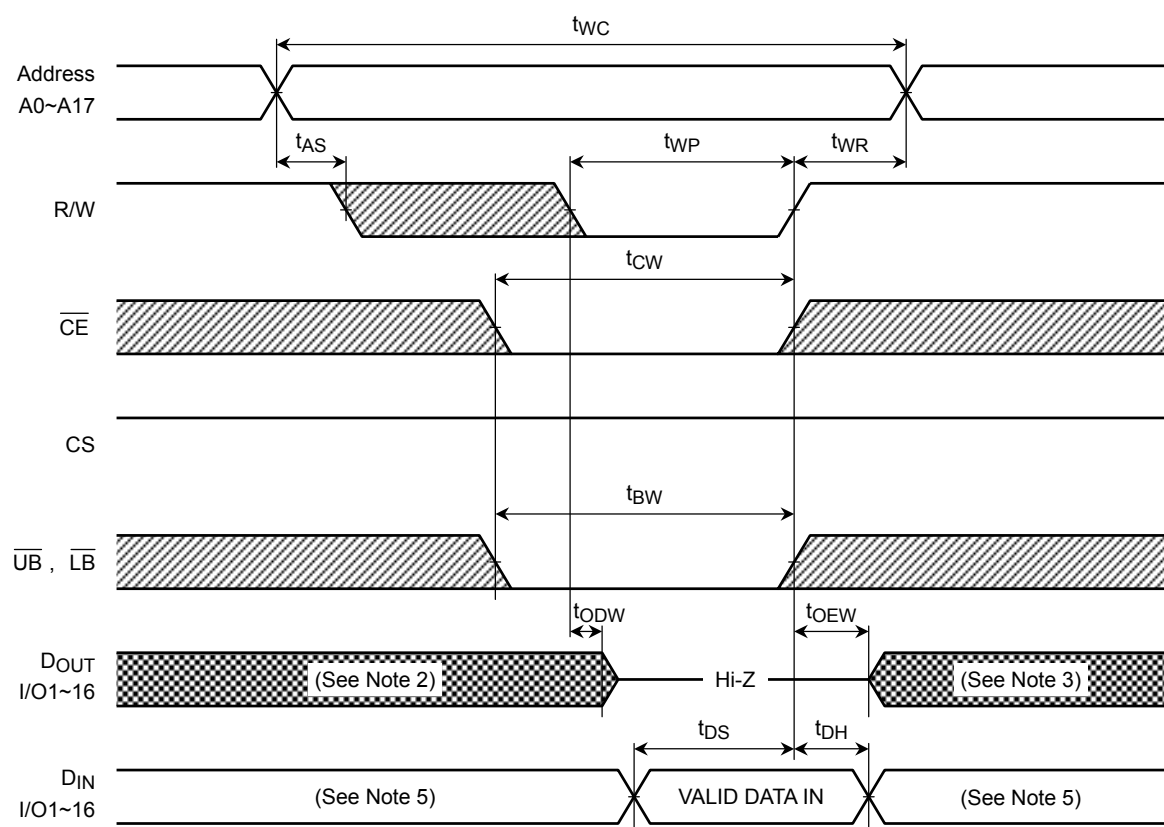
PARAMETER	TEST CONDITION
Input pulse level	0.2 V, V _{DD} - 0.2 V
t _R , t _F	5 ns
Timing measurements	1.5 V
Reference level	1.5 V
Output load	30 pF (Include Jig) (55) 100 pF (Include Jig) (70)

TIMING DIAGRAMS

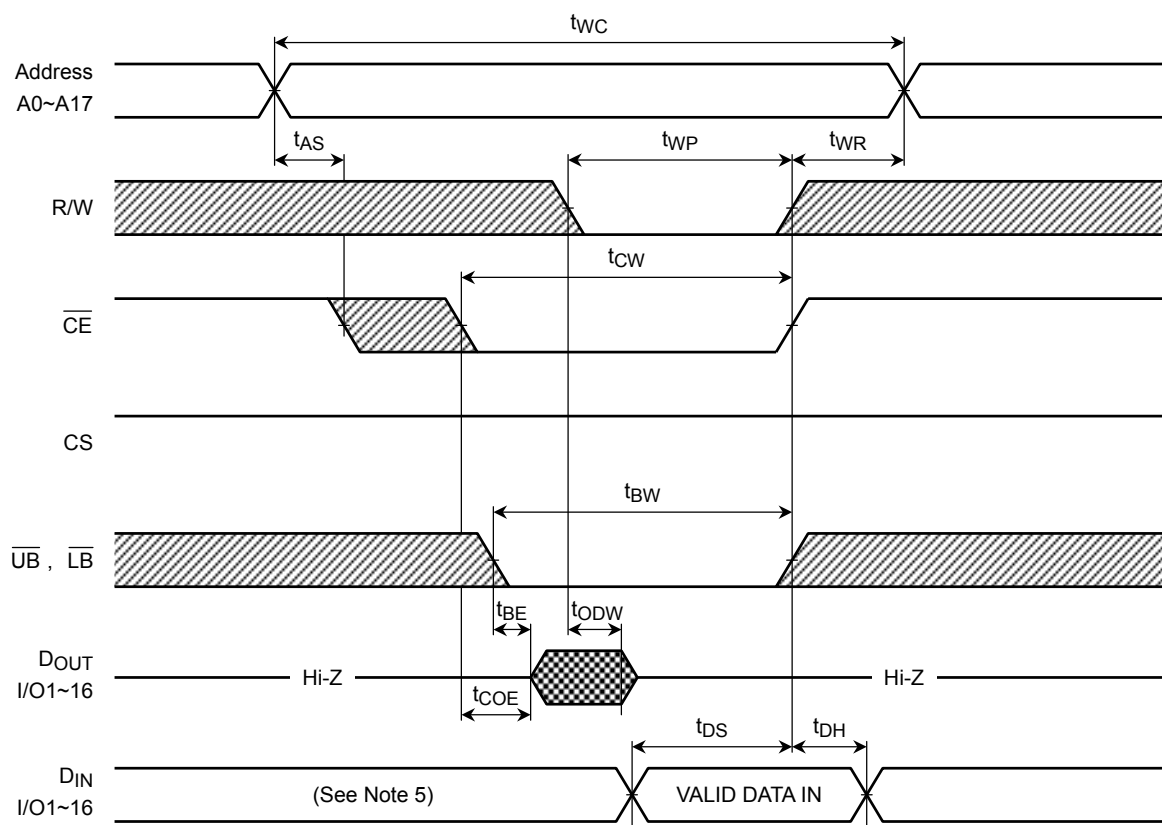
READ CYCLE (See Note 1)



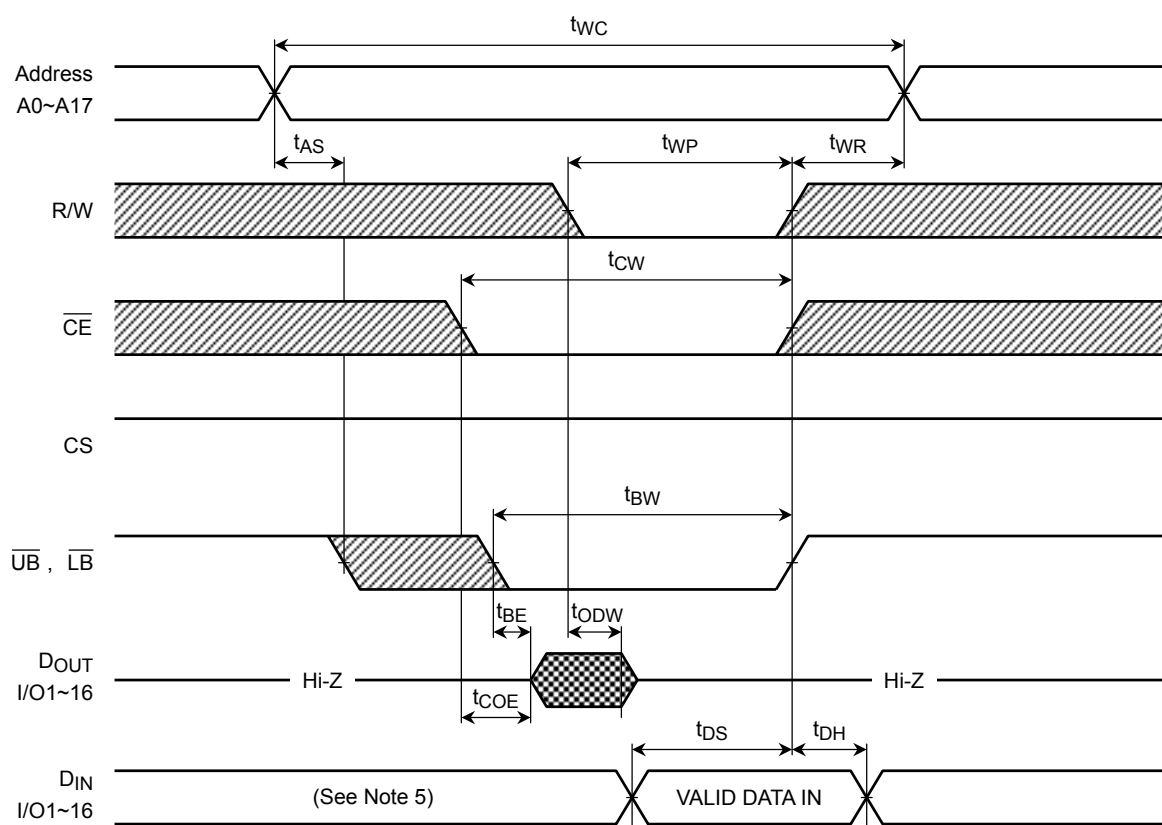
WRITE CYCLE 1 (R/W CONTROLLED) (See Note 4)



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



WRITE CYCLE 3 ($\overline{UB}, \overline{LB}$ CONTROLLED) (See Note 4)



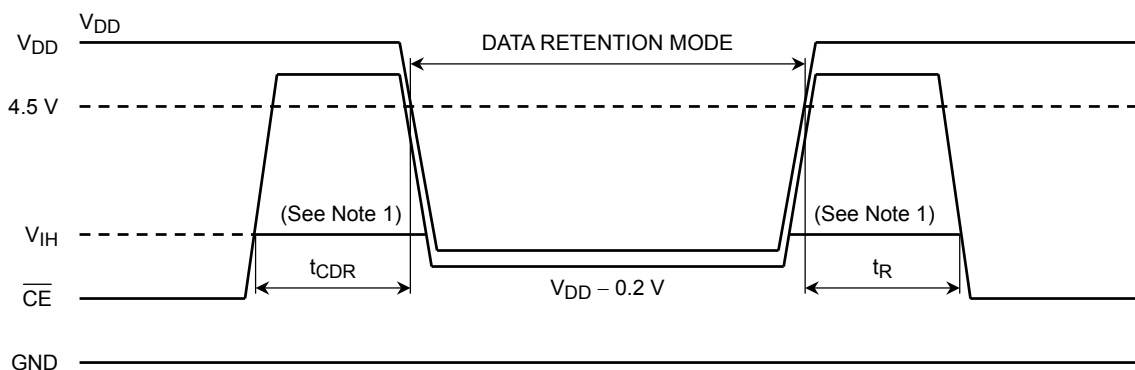
Note:

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

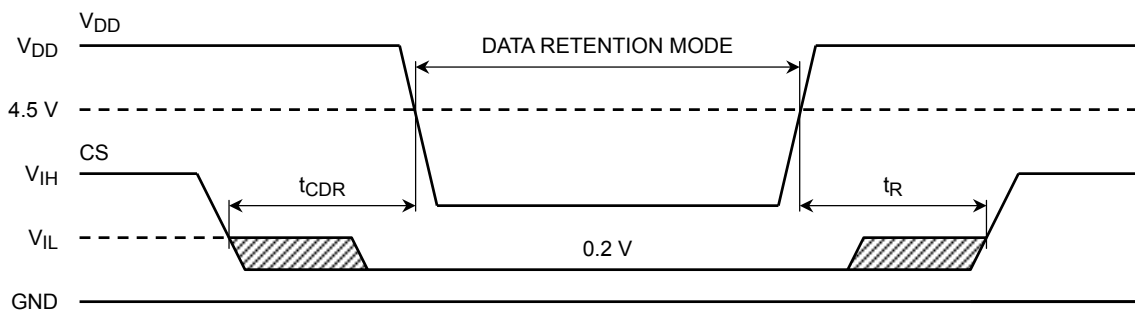
DATA RETENTION CHARACTERISTICS (Ta = -40° to 85°C)

SYMBOL	PARAMETER		MIN	TYP	MAX	UNIT
V _{DH}	Data Retention Supply Voltage		2.0	—	5.5	V
I _{DDS2}	Standby Current	Ta = -40~40°C	—	—	3	μA
		Ta = -40~85°C	—	—	20	
t _{CDR}	Chip Deselect to Data Retention Mode Time		0	—	—	ns
t _R	Recovery Time		5	—	—	ms

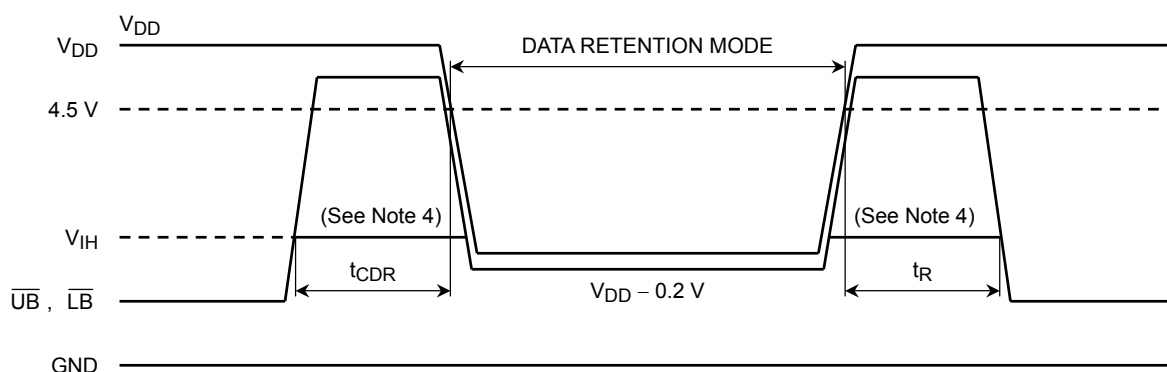
\overline{CE} CONTROLLED DATA RETENTION MODE



CS CONTROLLED DATA RETENTION MODE (See Note 2)



\overline{UB} , \overline{LB} CONTROLLED DATA RETENTION MODE (See Note 3)



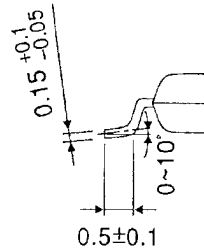
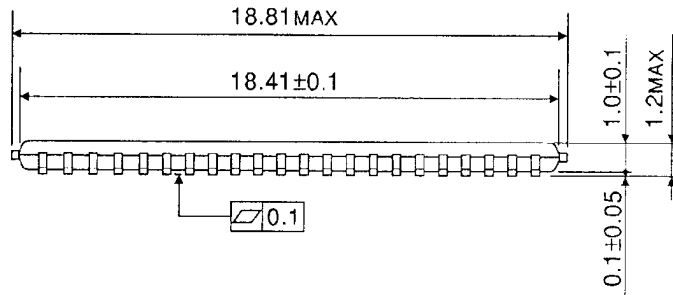
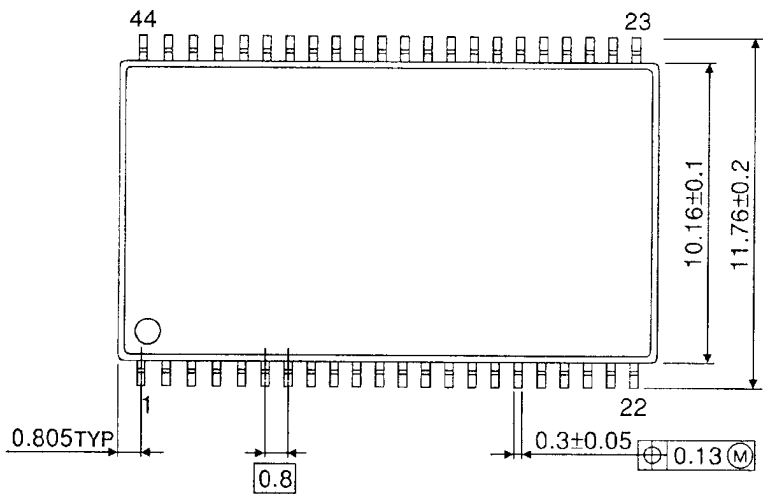
Note:

- (1) In \overline{CE} controlled data retention mode, minimum standby current mode is entered when $CS \leq 0.2$ V or $CS \geq V_{DD} - 0.2$ V.
- (2) When \overline{CE} is operating at the $V_{IH}(\text{min.})$ level(2.4 V), the operating current is given by I_{DDs1} during the transition of V_{DD} from 4.5 to 2.6 V.
- (3) In CS controlled data retention mode, minimum standby current mode is entered when $CS \leq 0.2$ V.
- (4) In \overline{UB} (or \overline{LB}) controlled data retention mode, minimum standby current mode is entered when $\overline{CE}, CS \leq 0.2$ V or $\overline{CE}, CS \geq V_{DD} - 0.2$ V.
- (5) When \overline{UB} (or \overline{LB}) is operating at the $V_{IH}(\text{min.})$ level(2.4 V), the operating current is given by I_{DDs1} during the transition of V_{DD} from 4.5 to 2.6 V.

PACKAGE DIMENSIONS

TSOPII 44-P-400-0.80

Unit : mm



Weight:0.47 g (typ)

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