

## Document Title

512Kx16 bit Low Power Full CMOS Static RAM

## Revision History

<u>Revision No.</u>	<u>History</u>	<u>Draft Date</u>	<u>Remark</u>
0.0	Initial draft	October 31, 2002	Preliminary
0.1	Revised - Deleted 44-TSOP2-400R package type.	December 11, 2002	Preliminary
1.0	Finalized - Changed Icc1 from 4mA to 3mA - Changed Icc2 from 45mA to 30mA - Changed I <sub>SB1</sub> (industrial) from 30μA to 15μA - Changed I <sub>SB1</sub> (Automotive) from 40μA to 25μA	September 16, 2003	Final

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## 512Kx16 bit Low Power Full CMOS Static RAM

### FEATURES

- Process Technology: Full CMOS
- Organization: 512K x16
- Power Supply Voltage: 2.7~3.6V
- Low Data Retention Voltage: 1.5V(Min)
- Three state outputs
- Package Type: 44-TSOP2-400F

### GENERAL DESCRIPTION

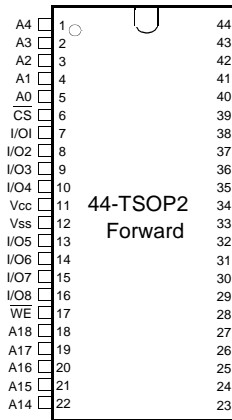
The K6X8016T3B families are fabricated by SAMSUNG's advanced full CMOS process technology. The families support various operating temperature range for user flexibility of system design. The families also support low data retention voltage for battery back-up operation with low data retention current.

### PRODUCT FAMILY

Product Family	Operating Temperature	Vcc Range	Speed	Power Dissipation		PKG Type
				Standby (I <sub>SB1</sub> , Max)	Operating (I <sub>CC2</sub> , Max)	
K6X8016T3B-F	Industrial(-40~85°C)	2.7~3.6V	55 <sup>1)</sup> /70ns	15μA	30mA	44-TSOP2-400F
K6X8016T3B-Q	Automotive(-40~125°C)		70ns	25μA		

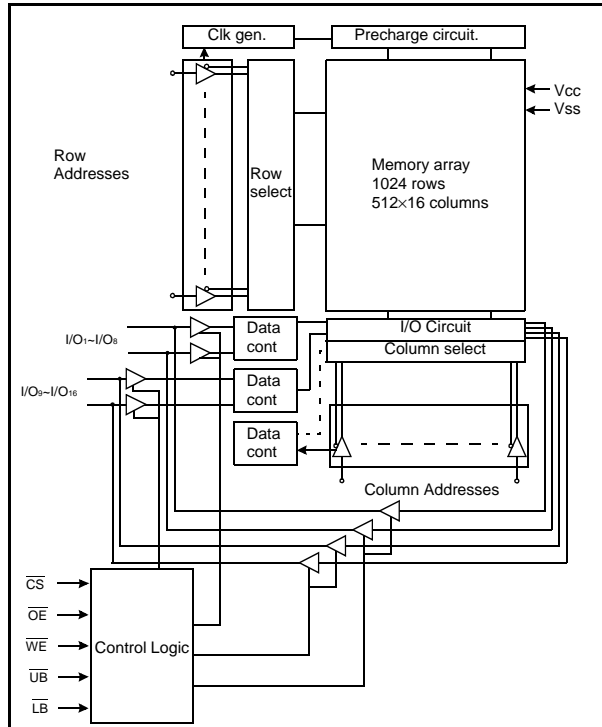
1. This parameter is measured with 50pF test load (V<sub>CC</sub>=3.0~3.6V).

### PIN DESCRIPTION



Name	Function	Name	Function
$\overline{CS}$	Chip Select Input	Vcc	Power
$\overline{OE}$	Output Enable Input	Vss	Ground
$\overline{WE}$	Write Enable Input	$\overline{UB}$	Upper Byte(I/O <sub>9</sub> ~16)
A <sub>0</sub> ~A <sub>18</sub>	Address Inputs	$\overline{LB}$	Lower Byte(I/O <sub>1</sub> ~8)
I/O <sub>1</sub> ~I/O <sub>16</sub>	Data Inputs/Outputs		

### FUNCTIONAL BLOCK DIAGRAM



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## PRODUCT LIST

Industrial Temperature Products(-40~85°C)		Automotive Temperature Products(-40~125°C)	
Part Name	Function	Part Name	Function
K6X8016T3B-TF55 <sup>1)</sup>	44-TSOP2-F, 55ns, Low Low Power	K6X8016T3B-TQ70	44-TSOP2-F, 70ns, Low Power
K6X8016T3B-TF70	44-TSOP2-F, 70ns, Low Low Power		

1. Operating voltage range is 3.0~3.6V

## FUNCTIONAL DESCRIPTION

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	$\overline{LB}$	$\overline{UB}$	I/O <sub>1-8</sub>	I/O <sub>9-16</sub>	Mode	Power
H	X	X	X	X	High-Z	High-Z	Deselected	Standby
L	H	H	X	X	High-Z	High-Z	Output Disabled	Active
L	X	X	H	H	High-Z	High-Z	Output Disabled	Active
L	L	H	L	H	Dout	High-Z	Lower Byte Read	Active
L	L	H	H	L	High-Z	Dout	Upper Byte Read	Active
L	L	H	L	L	Dout	Dout	Word Read	Active
L	X	L	L	H	Din	High-Z	Lower Byte Write	Active
L	X	L	H	L	High-Z	Din	Upper Byte Write	Active
L	X	L	L	L	Din	Din	Word Write	Active

Note: X means don't care. (Must be low or high state)

## ABSOLUTE MAXIMUM RATINGS<sup>1)</sup>

Item	Symbol	Ratings	Unit	Remark
Voltage on any pin relative to V <sub>SS</sub>	V <sub>IN</sub> , V <sub>OUT</sub>	-0.2 to V <sub>CC</sub> +0.3 (max. 3.9V)	V	-
Voltage on V <sub>CC</sub> supply relative to	V <sub>CC</sub>	-0.2 to 3.9	V	-
Power Dissipation	P <sub>D</sub>	1.0	W	-
Storage temperature	T <sub>STG</sub>	-65 to 150	°C	-
Operating Temperature	T <sub>A</sub>	-40 to 85	°C	K6X8016T3B-F
		-40 to 125	°C	K6X8016T3B-Q

1. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Functional operation should be restricted to recommended operating condition. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

## RECOMMENDED DC OPERATING CONDITIONS<sup>1)</sup>

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	V <sub>CC</sub>	2.7	3.0/3.3	3.6	V
Ground	V <sub>SS</sub>	0	0	0	V
Input high voltage	V <sub>IH</sub>	2.2	-	V <sub>CC</sub> +0.3 <sup>2)</sup>	V
Input low voltage	V <sub>IL</sub>	-0.3 <sup>3)</sup>	-	0.6	V

Note:

1. Industrial Product: T<sub>A</sub>=-40 to 85°C, otherwise specified.  
Automotive Product: T<sub>A</sub>=-40 to 125°C, otherwise specified.
2. Overshoot: V<sub>CC</sub>+3.0V in case of pulse width ≤30ns.
3. Undershoot: -3.0V in case of pulse width ≤30ns.
4. Overshoot and undershoot are sampled, not 100% tested.

## CAPACITANCE<sup>1)</sup> (f=1MHz, T<sub>A</sub>=25°C)

Item	Symbol	Test Condition	Min	Max	Unit
Input capacitance	C <sub>IN</sub>	V <sub>IN</sub> =0V	-	8	pF
Input/Output capacitance	C <sub>IO</sub>	V <sub>IO</sub> =0V	-	10	pF

1. Capacitance is sampled, not 100% tested

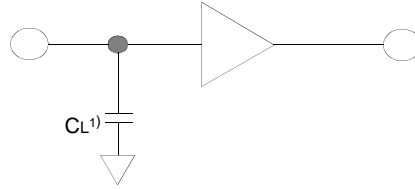
## DC AND OPERATING CHARACTERISTICS

Item	Symbol	Test Conditions	Min	Typ	Max	Unit	
Input leakage current	I <sub>LI</sub>	V <sub>IN</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	-	1	μA	
Output leakage current	I <sub>LO</sub>	$\overline{CS}=V_{IH}$ , $\overline{OE}=V_{IH}$ or $\overline{WE}=V_{IL}$ , V <sub>IO</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	-	1	μA	
Operating power supply current	I <sub>CC</sub>	I <sub>IO</sub> =0mA, $\overline{CS}=V_{IL}$ , $\overline{WE}=V_{IH}$ , V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub>	-	-	2	mA	
Average operating current	I <sub>CC1</sub>	Cycle time=1μs, 100% duty, I <sub>IO</sub> =0mA, $\overline{CS} \leq 0.2V$ , V <sub>IN</sub> ≤0.2V or V <sub>IN</sub> ≥V <sub>CC</sub> -0.2V	-	-	3	mA	
	I <sub>CC2</sub>	Cycle time=Min, I <sub>IO</sub> =0mA, 100% duty, $\overline{CS}=V_{IL}$ , V <sub>IN</sub> =V <sub>IL</sub> or V <sub>IH</sub>	-	-	30	mA	
Output low voltage	V <sub>OL</sub>	I <sub>OL</sub> = 2.1mA	-	-	0.4	V	
Output high voltage	V <sub>OH</sub>	I <sub>OH</sub> = -1.0mA	2.4	-	-	V	
Standby Current(TTL)	I <sub>SB</sub>	$\overline{CS}=V_{IH}$ , Other inputs=V <sub>IH</sub> or V <sub>IL</sub>	-	-	0.4	mA	
Standby Current(CMOS)	I <sub>SB1</sub>	$\overline{CS} \geq V_{CC}-0.2V$ , Other inputs=0~V <sub>CC</sub>	K6X8016T3B-F	-	-	15	μA
			K6X8016T3B-Q	-	-	25	

## AC OPERATING CONDITIONS

### TEST CONDITIONS (Test Load and Input/Output Reference)

Input pulse level: 0.4 to 2.2V  
 Input rising and falling time: 5ns  
 Input and output reference voltage: 1.5V  
 Output load(see right):  $C_L=100\text{pF}+1\text{TTL}$   
 $C_L=50\text{pF}+1\text{TTL}$



1. Including scope and jig capacitance

## AC CHARACTERISTICS ( $V_{CC}=2.7\sim 3.6\text{V}$ , Industrial product: $T_A=-40$ to $85^\circ\text{C}$ , Automotive product: $T_A=-40$ to $125^\circ\text{C}$ )

Parameter List		Symbol	Speed Bins				Units
			55ns <sup>1)</sup>		70ns		
			Min	Max	Min	Max	
Read	Read cycle time	t <sub>RC</sub>	55	-	70	-	ns
	Address access time	t <sub>AA</sub>	-	55	-	70	ns
	Chip select to output	t <sub>CO</sub>	-	55	-	70	ns
	Output enable to valid output	t <sub>OE</sub>	-	25	-	35	ns
	Chip select to low-Z output	t <sub>LZ</sub>	10	-	10	-	ns
	Output enable to low-Z output	t <sub>OLZ</sub>	5	-	5	-	ns
	$\overline{\text{LB}}, \overline{\text{UB}}$ enable to low-Z output	t <sub>BLZ</sub>	5	-	5	-	ns
	Chip disable to high-Z output	t <sub>HZ</sub>	0	20	0	25	ns
	Output Disable to High-Z Output	t <sub>OHZ</sub>	0	20	0	25	ns
	Output hold from address change	t <sub>OH</sub>	10	-	10	-	ns
	$\overline{\text{LB}}, \overline{\text{UB}}$ valid to data output	t <sub>BA</sub>	-	25	-	35	ns
$\overline{\text{UB}}, \overline{\text{LB}}$ disable to high-Z output	t <sub>BHZ</sub>	0	20	0	25	ns	
Write	Write cycle time	t <sub>WC</sub>	55	-	70	-	ns
	Chip select to end of write	t <sub>CW</sub>	45	-	60	-	ns
	Address set-up time	t <sub>AS</sub>	0	-	0	-	ns
	Address valid to end of write	t <sub>AW</sub>	45	-	60	-	ns
	Write pulse width	t <sub>WP</sub>	40	-	55	-	ns
	Write recovery time	t <sub>WR</sub>	0	-	0	-	ns
	Write to output high-Z	t <sub>WHZ</sub>	0	20	0	25	ns
	Data to write time overlap	t <sub>DW</sub>	20	-	30	-	ns
	Data hold from write time	t <sub>DH</sub>	0	-	0	-	ns
	End write to output low-Z	t <sub>OW</sub>	5	-	5	-	ns
$\overline{\text{LB}}, \overline{\text{UB}}$ valid to end of write	t <sub>BW</sub>	45	-	60	-	ns	

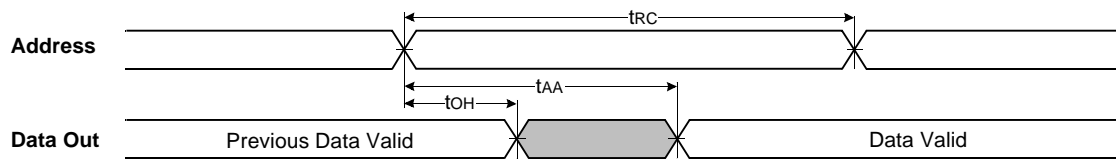
1. Voltage range is 3.0V~3.6V for industrial product.

## DATA RETENTION CHARACTERISTICS

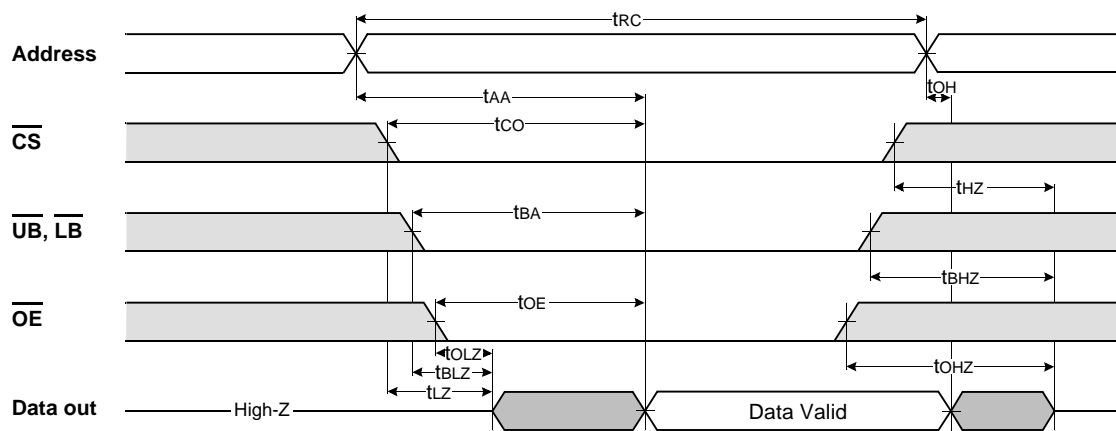
Item	Symbol	Test Condition	Min	Typ	Max	Unit	
V <sub>CC</sub> for data retention	V <sub>DR</sub>	$\overline{\text{CS}} \geq V_{CC}-0.2\text{V}$	1.5	-	3.6	V	
Data retention current	I <sub>DR</sub>	$V_{CC}=1.5\text{V}, \overline{\text{CS}} \geq V_{CC}-0.2\text{V}$	K6X8016T3B-F	-	-	6	$\mu\text{A}$
			K6X8016T3B-Q	-	-	10	
Data retention set-up time	t <sub>SDR</sub>	See data retention waveform	0	-	-	ms	
Recovery time	t <sub>RDR</sub>		5	-	-		

## TIMING DIAGRAMS

**TIMING WAVEFORM OF READ CYCLE(1)** (Address Controlled,  $\overline{CS}=\overline{OE}=V_{IL}$ ,  $\overline{WE}=V_{IH}$ ,  $\overline{UB}$  or/and  $\overline{LB}=V_{IL}$ )



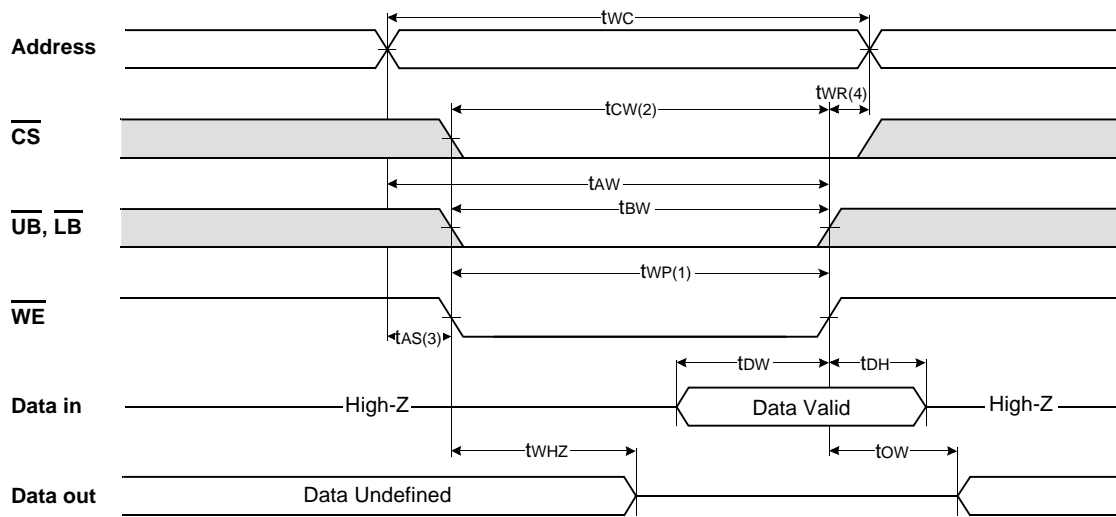
**TIMING WAVEFORM OF READ CYCLE(2)** ( $\overline{WE}=V_{IH}$ )



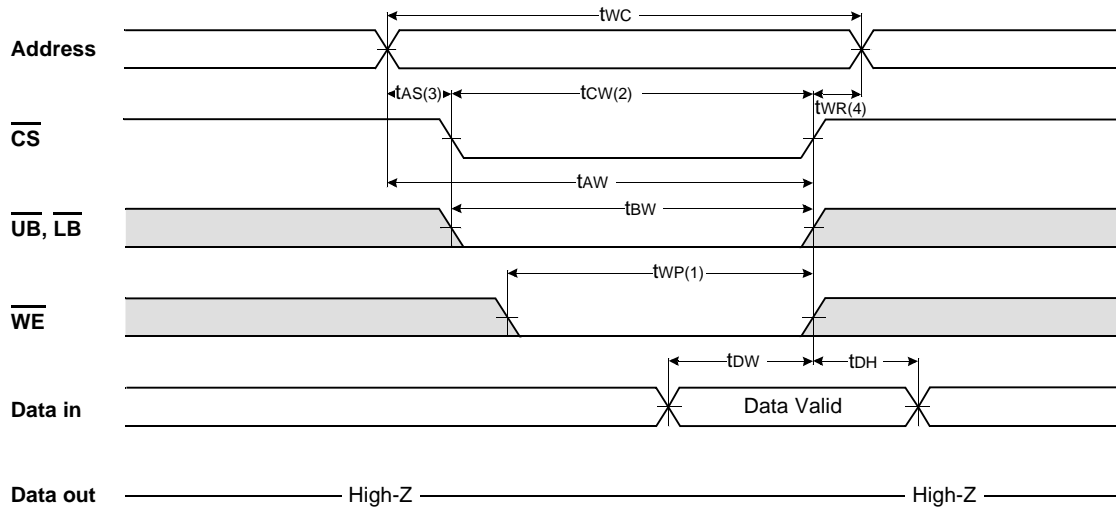
### NOTES (READ CYCLE)

1.  $t_{HZ}$  and  $t_{OHZ}$  are defined as the time at which the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. At any given temperature and voltage condition,  $t_{HZ}(\text{Max.})$  is less than  $t_{LZ}(\text{Min.})$  both for a given device and from device to device interconnection.

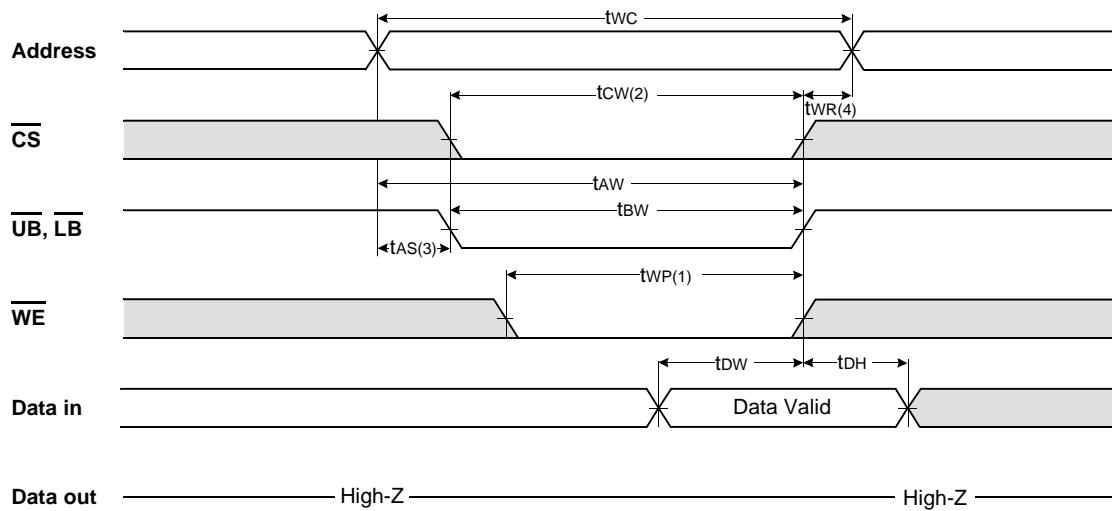
TIMING WAVEFORM OF WRITE CYCLE(1) ( $\overline{WE}$  Controlled)



TIMING WAVEFORM OF WRITE CYCLE(2) ( $\overline{CS}$  Controlled)



## TIMING WAVEFORM OF WRITE CYCLE(3) ( $\overline{UB}$ , $\overline{LB}$ Controlled)

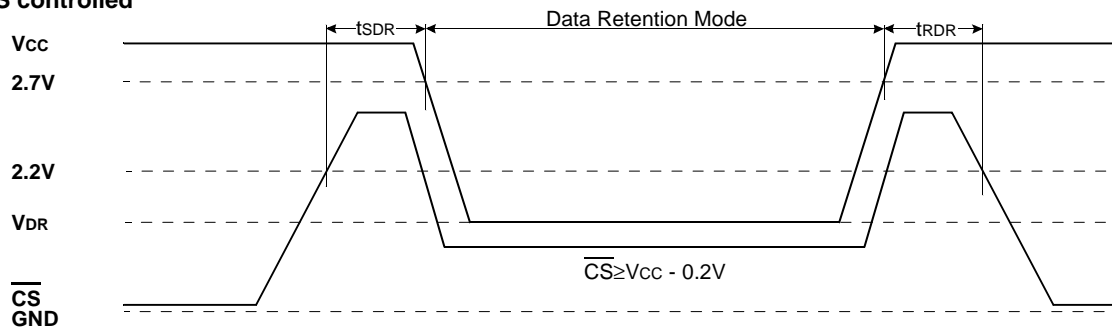


### NOTES (WRITE CYCLE)

1. A write occurs during the overlap( $t_{WP}$ ) of low  $\overline{CS}$  and low  $\overline{WE}$ . A write begins when  $\overline{CS}$  goes low and  $\overline{WE}$  goes low with asserting  $\overline{UB}$  or  $\overline{LB}$  for single byte operation or simultaneously asserting  $\overline{UB}$  and  $\overline{LB}$  for double byte operation. A write ends at the earliest transition when  $\overline{CS}$  goes high and  $\overline{WE}$  goes high. The  $t_{WP}$  is measured from the beginning of write to the end of write.
2.  $t_{CW}$  is measured from the  $\overline{CS}$  going low to the end of write.
3.  $t_{AS}$  is measured from the address valid to the beginning of write.
4.  $t_{WR}$  is measured from the end of write to the address change.  $t_{WR}$  applied in case a write ends as  $\overline{CS}$  or  $\overline{WE}$  going high.

## DATA RETENTION WAVE FORM

### $\overline{CS}$ controlled





## PACKAGE DIMENSIONS

Unit: millimeters(inches)

### 44 PIN THIN SMALL OUTLINE PACKAGE TYPE II (400F)

