

## Document Title

128K x16 bit Low Power and Low Voltage CMOS Static RAM

## Revision History

<u>Revision No.</u>	<u>History</u>	<u>Draft Data</u>	<u>Remark</u>
0.0	Initial Draft	October 1, 1997	Preliminary
0.1	Revise - Increased operating current(Icc1):20mA → 25mA	December 9, 1997	Preliminary
1.0	Finalize	August 27, 1998	Final

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Revision 1.0  
August 1998

## 128K x16 bit Low Power and Low Voltage CMOS Static RAM

### FEATURES

- Process Technology: TFT
- Organization: 128Kx16
- Power Supply Voltage: 2.7~3.3V
- Low Data Retention Voltage: 2V(Min)
- Three state output and TTL Compatible
- Package Type: 44-TSOP2 -400F

### GENERAL DESCRIPTION

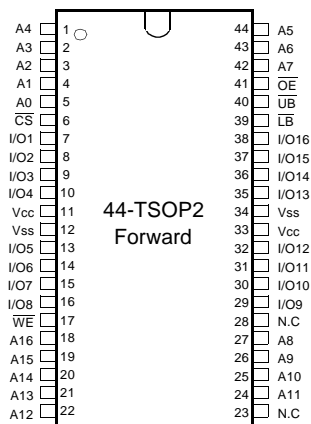
The K6T2016U3M families are fabricated by SAMSUNG's advanced CMOS process technology. The families support various operating temperature ranges and small package for user flexibility of system design. The families also support low data retention voltage for battery back-up operation with low data retention 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)	
K6T2016U3M-B	Commercial(0~70°C)	2.7~3.3V	85 <sup>1)</sup> /100ns	10μA	55mA	44-TSOP2-F
K6T2016U3M-F	Industrial(-40~85°C)			15μA		

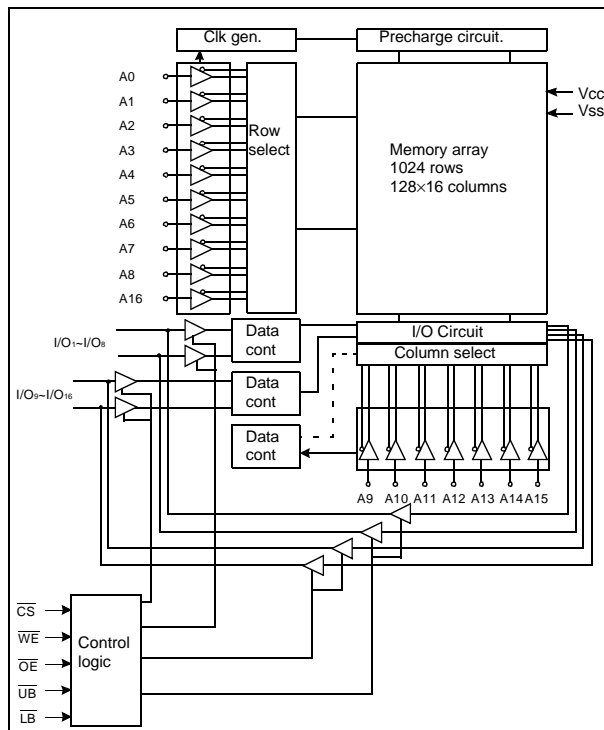
1. The parameter is measured with 30pF test load.

### PIN DESCRIPTION



Name	Function	Name	Function
CS	Chip Select Input	I/O <sub>1</sub> ~I/O <sub>16</sub>	Data Inputs/Outputs
OE	Output Enable Input	A <sub>0</sub> ~A <sub>16</sub>	Address Inputs
WE	Write Enable Input	Vcc	Power
UB	Upper Block Select Input	Vss	Ground
LB	Lower Block Select Input	N.C	No Connection

### FUNCTIONAL BLOCK DIAGRAM



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## PRODUCT LIST

Commercial Temperature Products(0~70°C)		Industrial Temperature Products(-40~85°C)	
Part Name	Function	Part Name	Function
K6T2016U3M-TB85	44-TSOP2, 85ns, 3.0V, LL	K6T2016U3M-TF85	44-TSOP2, 85ns, 3.0V, LL
K6T2016U3M-TB10	44-TSOP2, 100ns, 3.0V, LL	K6T2016U3M-TF10	44-TSOP2, 100ns, 3.0V, LL

Note : LL - Low Low Standby Current

## FUNCTIONAL DESCRIPTION

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	$\overline{LB}$	$\overline{UB}$	I/O1-8	I/O9-16	Mode	Power
H	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	High-Z	High-Z	Deselected	Standby
L	H	H	X <sup>1)</sup>	X <sup>1)</sup>	High-Z	High-Z	Output Disabled	Active
L	X <sup>1)</sup>	X <sup>1)</sup>	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 <sup>1)</sup>	L	L	H	Din	High-Z	Lower Byte Write	Active
L	X <sup>1)</sup>	L	H	L	High-Z	Din	Upper Byte Write	Active
L	X <sup>1)</sup>	L	L	L	Din	Din	Word Write	Active

1. X means don't care. (Must be in low or high state)

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

Item	Symbol	Ratings	Unit	Remark
Voltage on any pin relative to Vss	V <sub>IN</sub> , V <sub>OUT</sub>	-0.5 to V <sub>CC</sub> +0.5	V	-
Voltage on V <sub>CC</sub> supply relative to Vss	V <sub>CC</sub>	-0.3 to 4.6	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>	0 to 70	°C	K6T2016U3M-L
		-40 to 85	°C	K6T2016U3M-P
Soldering temperature and time	T <sub>SOLDER</sub>	260°C, 10sec (Lead Only)	-	-

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	Product	Min	Typ	Max	Unit
Supply voltage	V <sub>CC</sub>	K6T2016U3M Family	2.7	3.0	3.3	V
Ground	V <sub>SS</sub>	All Family	0	0	0	V
Input high voltage	V <sub>IH</sub>	K6T2016U3M Family	2.2	-	V <sub>CC</sub> +0.3	V
Input low voltage	V <sub>IL</sub>	K6T2016U3M Family	-0.3 <sup>3)</sup>	-	0.6	V

Note:

- Commercial Product : T<sub>A</sub>=0 to 70°C, otherwise specified  
Industrial Product : T<sub>A</sub>=-40 to 85°C, otherwise specified
- Overshoot : V<sub>CC</sub>+2.0V in case of pulse width ≤ 20ns
- Undershoot : -2.0V in case of pulse width ≤ 20ns
- 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

- Capacitance is sampled, not 100% tested

## DC AND OPERATING CHARACTERISTICS

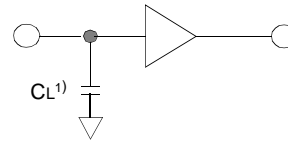
Item	Symbol	Test Conditions	Min	Typ	Max	Unit	
Input leakage current	I <sub>LI</sub>	V <sub>IN</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	-	1	μA	
Output leakage current	I <sub>LO</sub>	$\overline{CS}$ =V <sub>IH</sub> or $\overline{OE}$ =V <sub>IH</sub> or $\overline{WE}$ =V <sub>IL</sub> , V <sub>IO</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 <sub>IL</sub> , V <sub>IN</sub> =V <sub>IL</sub> or V <sub>IH</sub> , Read	-	-	5	mA	
Average operating current	I <sub>CC1</sub>	Cycle time=1μs, 100% duty, I <sub>IO</sub> =0mA $\overline{CS}$ ≤0.2V V <sub>IN</sub> ≤0.2V or V <sub>IN</sub> ≥V <sub>CC</sub> -0.2V	Read	-	-	5	mA
			Write	-	-	25	
	I <sub>CC2</sub>	Cycle time=Min, 100% duty, I <sub>IO</sub> =0mA, $\overline{CS}$ =V <sub>IL</sub> , V <sub>IN</sub> =V <sub>IL</sub> or V <sub>IH</sub>	-	-	55	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 <sub>IH</sub> , Other inputs=V <sub>IL</sub> or V <sub>IH</sub>	-	-	0.3	mA	
Standby Current (CMOS)	I <sub>SB1</sub>	$\overline{CS}$ ≥V <sub>CC</sub> -0.2V, Other inputs=0~V <sub>CC</sub>	-	-	10 <sup>1)</sup>	μA	

- K6T2016U3M-I Family =15μA

## AC OPERATING CONDITIONS

### TEST CONDITIONS (Test Load and Test 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) :  $C_L=100\text{pF}+1\text{TTL}$   
 $C_L=30\text{pF}+1\text{TTL}$



1. Including scope and jig capacitance

## AC CHARACTERISTICS ( $V_{CC}=2.7\sim 3.3\text{V}$ , K6T2016U3M-L Family: $T_A=0$ to $70^\circ\text{C}$ , K6T2016U3M-I Family: $T_A=-40$ to $85^\circ\text{C}$ )

Parameter List	Symbol	Speed Bins				Units	
		85 <sup>1)</sup> ns		100ns			
		Min	Max	Min	Max		
Read	Read cycle time	tRC	85	-	100	-	ns
	Address access time	tAA	-	85	-	100	ns
	Chip select to output	tCO	-	85	-	100	ns
	Output enable to valid output	tOE	-	45	-	55	ns
	Byte enable to valid output	tBA	-	45	-	55	ns
	Chip select to low-Z output	tLZ	10	-	10	-	ns
	Output enable to low-Z output	tOLZ	5	-	5	-	ns
	$\overline{UB}$ , $\overline{LB}$ enable to low-Z output	tBLZ	5	-	5	-	ns
	Chip disable to high-Z output	tHZ	0	25	0	30	ns
	$\overline{UB}$ , $\overline{LB}$ disable to high-Z output	tBHZ	0	25	0	30	ns
	Output disable to high-Z output	tOHZ	0	25	0	30	ns
	Output hold from address change	tOH	15	-	15	-	ns
Write	Write cycle time	tWC	85	-	100	-	ns
	Chip select to end of write	tCW	70	-	80	-	ns
	Address set-up time	tAS	0	-	0	-	ns
	Address valid to end of write	tAW	75	-	80	-	ns
	$\overline{UB}$ , $\overline{LB}$ valid to end of write	tBW	75	-	80	-	ns
	Write pulse width	tWP	60	-	70	-	ns
	Write recovery time	tWR	0	-	0	-	ns
	Write to output high-Z	tWHZ	0	30	0	30	ns
	Data to write time overlap	tDW	35	-	40	-	ns
	Data hold from write time	tDH	0	-	0	-	ns
End write to output low-Z	tOW	5	-	5	-	ns	

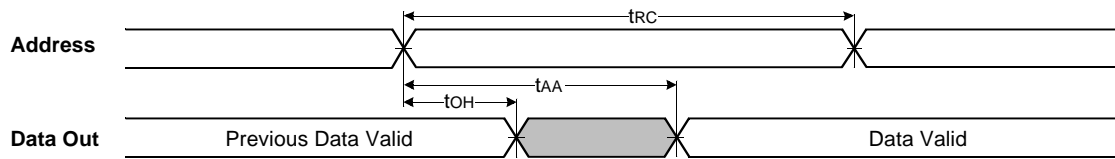
1. The parameter is measured with 30pF test load.

## DATA RETENTION CHARACTERISTICS

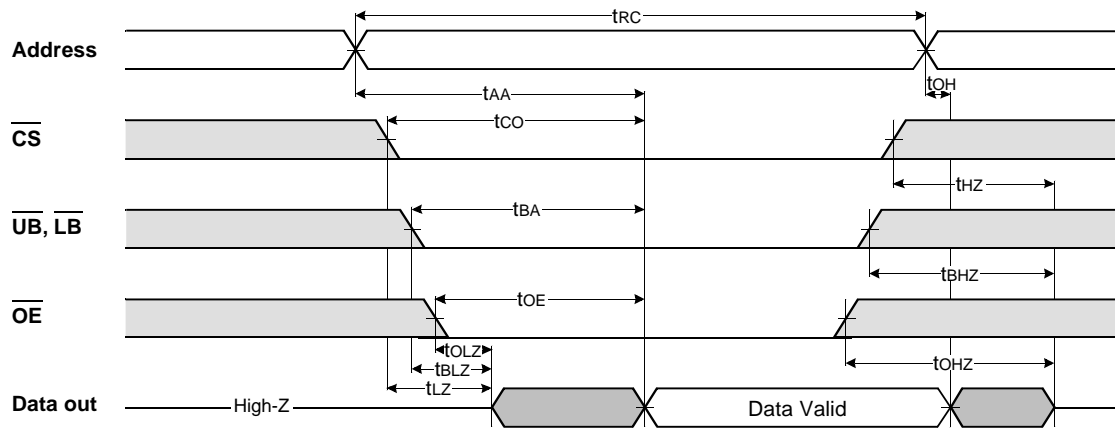
Item	Symbol	Test Condition	Min	Typ	Max	Unit
Vcc for data retention	VDR	$\overline{CS} \geq V_{CC}-0.2\text{V}$	2.0	-	3.3	V
Data retention current	IDR	$V_{CC}=3.0\text{V}$ , $\overline{CS} \geq V_{CC}-0.2\text{V}$	-	-	10	$\mu\text{A}$
Data retention set-up time	tSDR	See data retention waveform	0	-	-	ms
Recovery time	tRDR		5	-	-	

## TIMMING DIAGRAMS

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



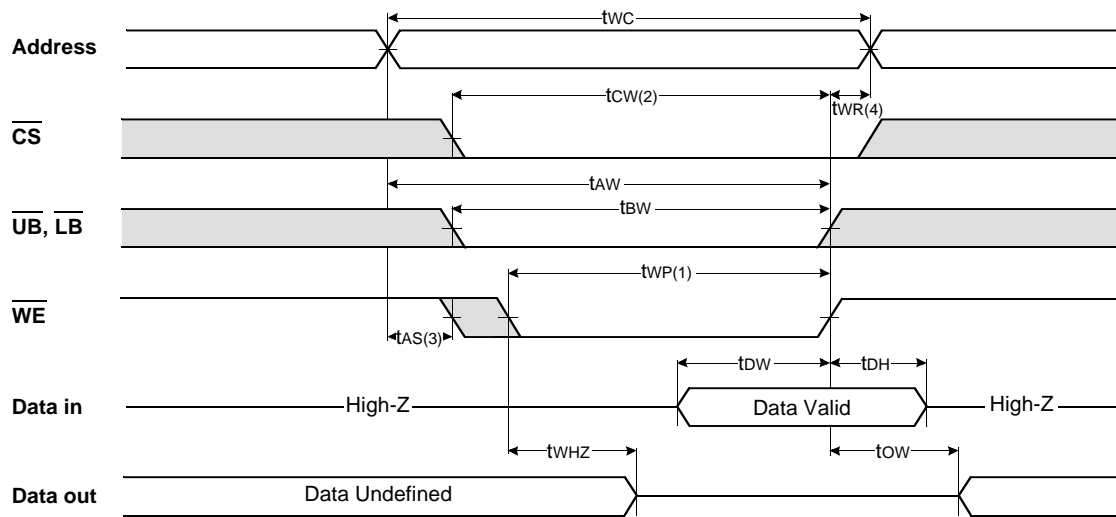
**TIMING WAVEFORM OF READ CYCLE(2)** ( $\overline{WE}=V_{IH}$ )



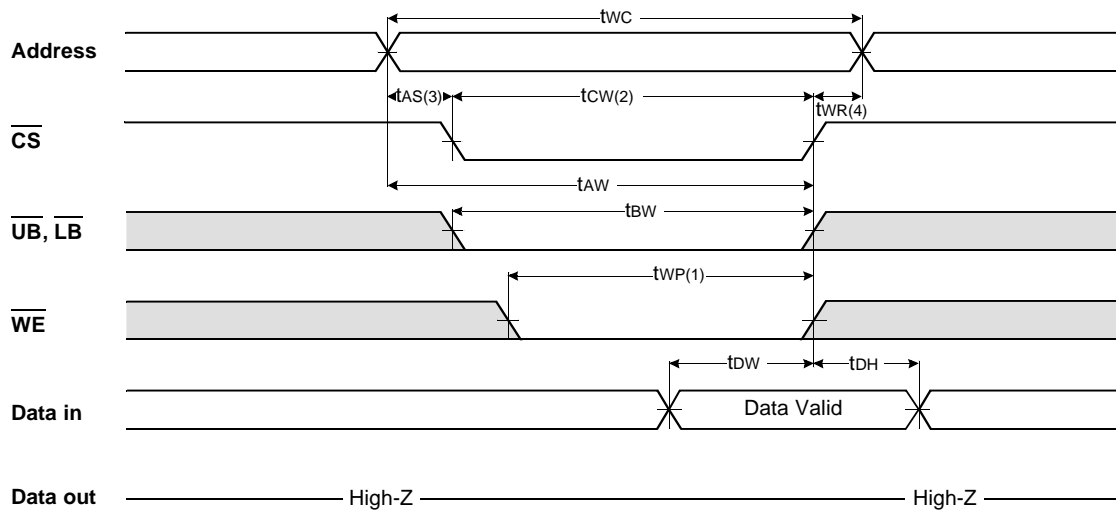
### NOTES (READ CYCLE)

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.

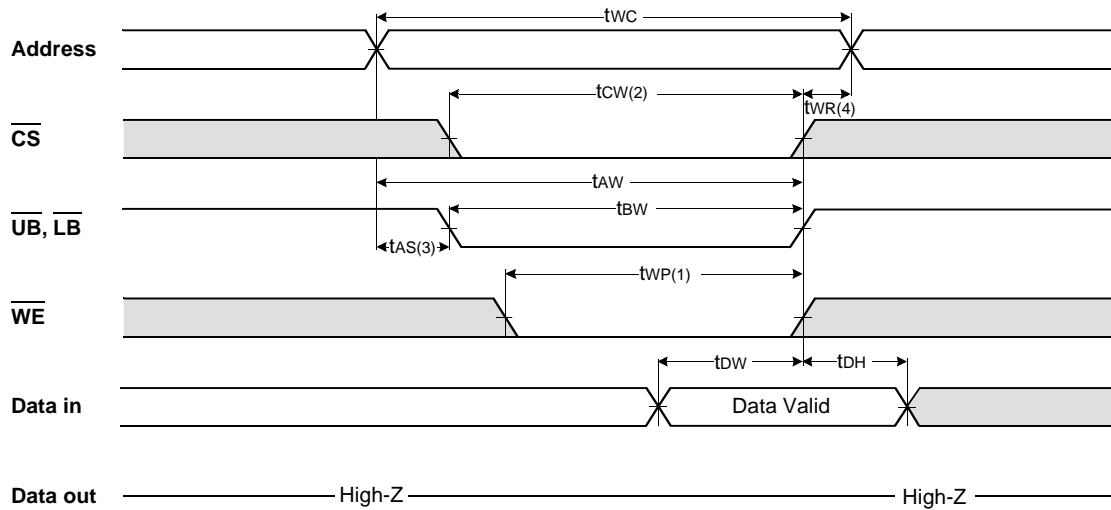
TIMING WAVEFORM OF WRITE CYCLE(1) ( $\overline{WE}$  Controlled)



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



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

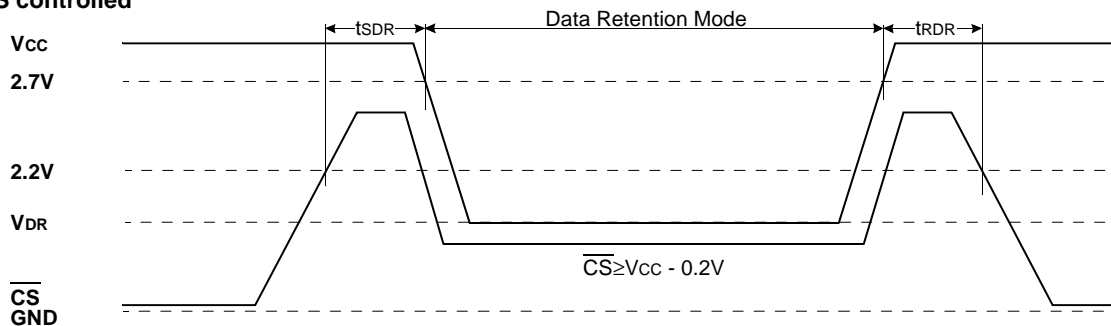


### NOTES (WRITE CYCLE)

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 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)

