

Document Title

512K x8 bit Low Power Full CMOS Static RAM

Revision History

Revision No.	History	Draft Date	Remark
0.0	Initial Draft	Nov. 20, 2007	Preliminary
0.1	0.1 Revision $I_{DR}$ Current from 1.5 $\mu$ A to 7 $\mu$ A $t_{OE}$ from 25nsec to 30nsec with 55ns part	Dec. 5, 2007	

**Emerging Memory & Logic Solutions Inc.**

4F Korea Construction Financial Cooperative B/D, 301-1 Yeon-Dong, Jeju-Si, Jeju-Do, Rep.of Korea Zip Code : 690-719  
Tel : +82-64-740-1712 Fax : +82-64-740-1749~1750 / Homepage : www.emlsi.com

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### 512K x8 Bit Low Power CMOS Static RAM

#### FEATURES

- Very high speed : 45ns
- Process Technology : 0.15um Full CMOS
- Organization : 512K x8
- Power Supply Voltage  
=> EM641FT8S : 4.5V~5.5V
- Low Data Retention Voltage : 1.5V (MIN)
- Three state output and TTL Compatible
- Packaged product designed for 45/55/70ns
- Package Type: 32L-ST SOP

#### GENERAL DESCRIPTION

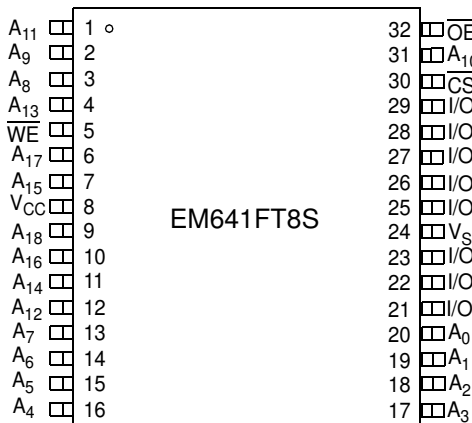
The EM641FT8S is fabricated by EMLSI's advanced full CMOS process technology. The families support industrial temperature range and Chip Scale Package for user flexibility of system design. The families also supports low data retention voltage for battery back-up operation with low data retention current.

The EM641FT8S is available in KGD, JEDEC standard 32 pin 8.0mm x 13.4mm STSOP package.

#### PRODUCT FAMILY

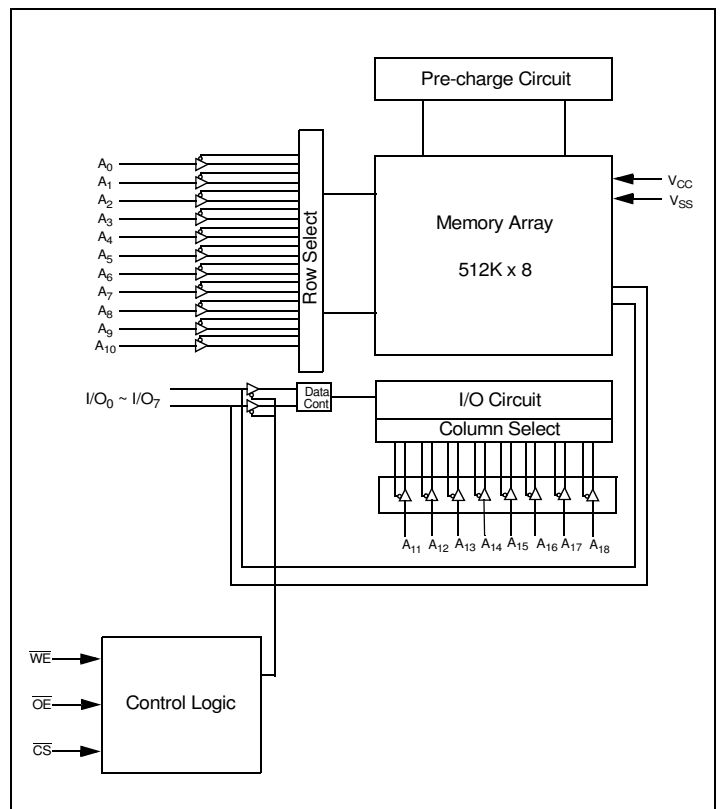
Product Family	Operating Temperature	Vcc Range	Speed	Power Dissipation		PKG Type
				Standby (I <sub>SB1</sub> , Typ.)	Operating (I <sub>CC1</sub> -Max)	
EM641FT8S-45LF	Industrial (-40 ~ 85°C)	4.5V~5.5V	45ns	1.5 μA	7mA	32-ST SOP
EM641FT8S-55LF	Industrial (-40 ~ 85°C)	4.5V~5.5V	55ns	1.5 μA	7mA	32-ST SOP
EM641FT8S-70LF	Industrial (-40 ~ 85°C)	4.5V~5.5V	70ns	1.5 μA	7mA	32-ST SOP

#### PIN DESCRIPTION



Name	Function	Name	Function
CS	Chip select input	V <sub>CC</sub>	Power Supply
OE	Output Enable input	V <sub>SS</sub>	Ground
WE	Write Enable input		
A <sub>0</sub> ~A <sub>18</sub>	Address Inputs		
I/O <sub>0</sub> ~I/O <sub>7</sub>	Data Inputs/Outputs		

#### FUNCTIONAL BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Minimum	Unit
Voltage on Any Pin Relative to $V_{SS}$	$V_{IN}, V_{OUT}$	-0.5 to 6.0V	V
Voltage on $V_{CC}$ supply relative to $V_{SS}$	$V_{CC}$	-0.5 to 6.0V	V
Power Dissipation	$P_D$	1.0	W
Operating Temperature	$T_A$	-40 to 85	°C

**Note :** Stresses greater than those listed above “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.

## FUNCTIONAL DESCRIPTION

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	I/O <sub>0-7</sub>	Mode	Power
H	X	X	High-Z	Deselected/ Power down	Stand by
L	L	H	Data Out	Read	Active
L	X	L	Data In	Write	Active
L	H	H	High-Z	Selected, Output Disabled	Active

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

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

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	$V_{CC}^{2)}$	4.5	-	5.5	V
Ground	$V_{SS}$	0	0	0	V
Input high voltage	$V_{IH}$	2.2	-	$V_{CC} + 0.5^{3)}$	V
Input low voltage	$V_{IL}$	-0.5 <sup>4)</sup>	-	0.6	V

**Notes :**

1.  $T_A = -40$  to  $85^\circ\text{C}$ , otherwise specified
2. Overshoot:  $V_{CC} + 1.0$  V in case of pulse width  $\leq 20$ ns
3. Undershoot:  $-1.0$  V in case of pulse width  $\leq 20$ ns
4. Overshoot and undershoot are sampled, not 100% tested.

**CAPACITANCE** ( $f = 1\text{MHz}$ ,  $T_A = 25^\circ\text{C}$ )

Item	Symbol	Test Condition	Min	Max	Unit
Input capacitance	$C_{IN}$	$V_{IN} = 0\text{V}$	-	8	pF
Input/Output capacitance	$C_{IO}$	$V_{IO} = 0\text{V}$	-	10	pF

**Note :** Capacitance is sampled, not 100% tested.

**DC ELECTRICAL CHARACTERISTICS** ( $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit			
Input leakage current	$I_{LI}$	$V_{IN} = V_{SS}$ to $V_{CC}$	-1	-	1	$\mu\text{A}$			
Output leakage current	$I_{LO}$	$\overline{CS} = V_{IH}$ or $\overline{OE} = V_{IH}$ or $\overline{WE} = V_{IL}$ $V_{IO} = V_{SS}$ to $V_{CC}$	-1	-	1	$\mu\text{A}$			
Operating power supply	$I_{CC}$	$I_{IO} = 0\text{mA}$ , $\overline{CS} = V_{IL}$ , $V_{IN} = V_{IH}$ or $V_{IL}$	-	-	5	mA			
Average operating current	$I_{CC1}$	Cycle time = $1\mu\text{s}$ , 100% duty, $I_{IO} = 0\text{mA}$ , $\overline{CS} \leq 0.2\text{V}$ , $V_{IN} \leq 0.2\text{V}$ or $V_{IN} \geq V_{CC} - 0.2\text{V}$	-	-	7	mA			
			$I_{CC2}$	Cycle time = Min, $I_{IO} = 0\text{mA}$ , 100% duty, $\overline{CS} = V_{IL}$ , $V_{IN} = V_{IL}$ or $V_{IH}$	45ns	-	-	65	mA
					55ns	-	-	55	
70ns	-	-	45						
Output low voltage	$V_{OL}$	$I_{OL} = 2.1\text{mA}$	-	-	0.4	V			
Output high voltage	$V_{OH}$	$I_{OH} = -1.0\text{mA}$	2.4	-	-	V			
Standby Current (TTL)	$I_{SB}$	$\overline{CS} = V_{IH}$ , Other inputs = $V_{IH}$ or $V_{IL}$	-	-	1	mA			
Standby Current (CMOS)	$I_{SB1}$	$\overline{CS} \geq V_{CC} - 0.2\text{V}$ Other inputs = $0 \sim V_{CC}$ (Typ. condition : $V_{CC} = 5\text{V}$ @ $25^\circ\text{C}$ ) (Max. condition : $V_{CC} = 5.5\text{V}$ @ $85^\circ\text{C}$ )	LF	-	1.5 <sup>1)</sup>	20	$\mu\text{A}$		

**NOTES :**

1. Typical values are measured at  $V_{CC} = 5\text{V}$ ,  $T_A = 25^\circ\text{C}$  and not 100% tested.

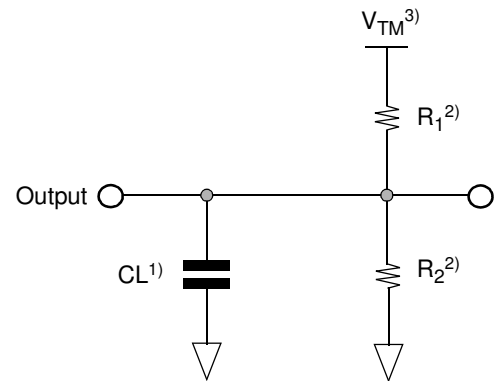
### AC OPERATING CONDITIONS

#### Test Conditions (Test Load and Test Input/Output Reference)

Input Pulse Level : 0V to  $V_{CC}$   
 Input Rise and Fall Time : 1V/ns  
 Input and Output reference Voltage :  $0.5V_{CC}$   
 Output Load (See right) :  $CL^{(1)} = 100\text{pF} + 1 \text{ TTL (70ns)}$   
 $CL^{(1)} = 30\text{pF} + 1 \text{ TTL (45ns/55ns)}$

#### Notes :

1. Including scope and Jig capacitance
2.  $R_1 = 1800 \text{ ohm}$ ,  $R_2 = 990 \text{ ohm}$
3.  $V_{TM} = V_{CC}$
4.  $CL = 5\text{pF} + 1 \text{ TTL}$  (measurement with tLZ, tOLZ, tHZ, tOHZ, tWHZ)



### READ CYCLE ( $V_{CC} = 4.5\text{V}$ to $5.5\text{V}$ , $GND = 0\text{V}$ , $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ )

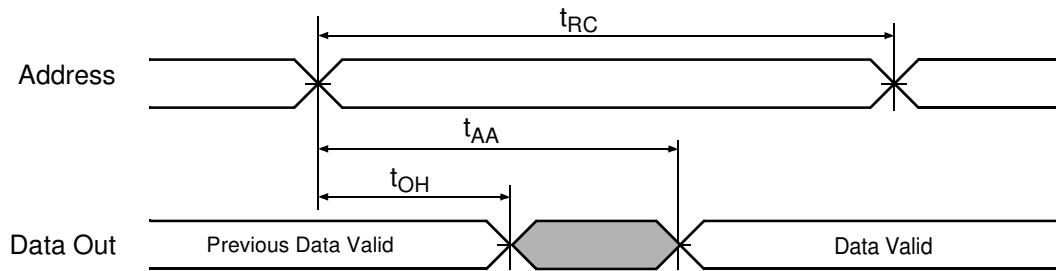
Parameter	Symbol	45ns		55ns		70ns		Unit
		Min	Max	Min	Max	Min	Max	
Read cycle time	$t_{RC}$	45	-	55	-	70	-	ns
Address access time	$t_{AA}$	-	45	-	55	-	70	ns
Chip select to output	$t_{CO}$	-	45	-	55	-	70	ns
Output enable to valid output	$t_{OE}$	-	25	-	30	-	35	ns
Chip select to low-Z output	$t_{LZ}$	10	-	10	-	10	-	ns
Output enable to low-Z output	$t_{OLZ}$	5	-	5	-	5	-	ns
Chip disable to high-Z output	$t_{HZ}$	0	20	0	20	0	25	ns
Output disable to high-Z output	$t_{OHZ}$	0	15	0	20	0	25	ns
Output hold from address change	$t_{OH}$	10	-	10	-	10	-	ns

### WRITE CYCLE ( $V_{CC} = 4.5\text{V}$ to $5.5\text{V}$ , $GND = 0\text{V}$ , $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ )

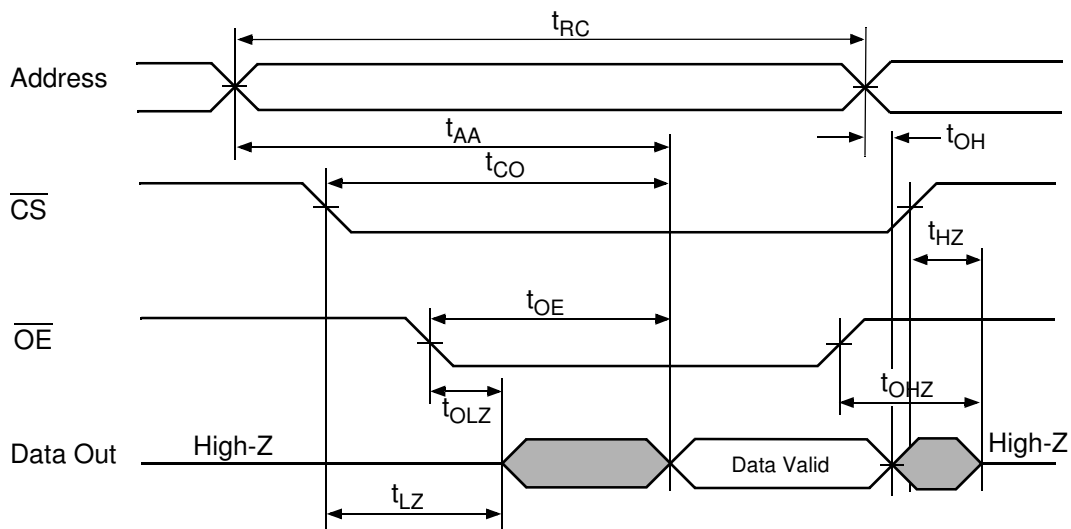
Parameter	Symbol	45ns		55ns		70ns		Unit
		Min	Max	Min	Max	Min	Max	
Write cycle time	$t_{WC}$	45	-	55	-	70	-	ns
Chip select to end of write	$t_{CW}$	45	-	45	-	60	-	ns
Address setup time	$t_{AS}$	0	-	0	-	0	-	ns
Address valid to end of write	$t_{AW}$	45	-	45	-	60	-	ns
Write pulse width	$t_{WP}$	35	-	40	-	50	-	ns
Write recovery time	$t_{WR}$	0	-	0	-	0	-	ns
Write to output high-Z	$t_{WHZ}$	0	15	0	20	0	20	ns
Data to write time overlap	$t_{DW}$	25	-	25	-	30	-	ns
Data hold from write time	$t_{DH}$	0	-	0	-	0	-	ns
End of write to output low-Z	$t_{OW}$	5	-	5	-	5	-	ns

## TIMING DIAGRAMS

### TIMING WAVEFORM OF READ CYCLE(1) (Address Transition Controlled)



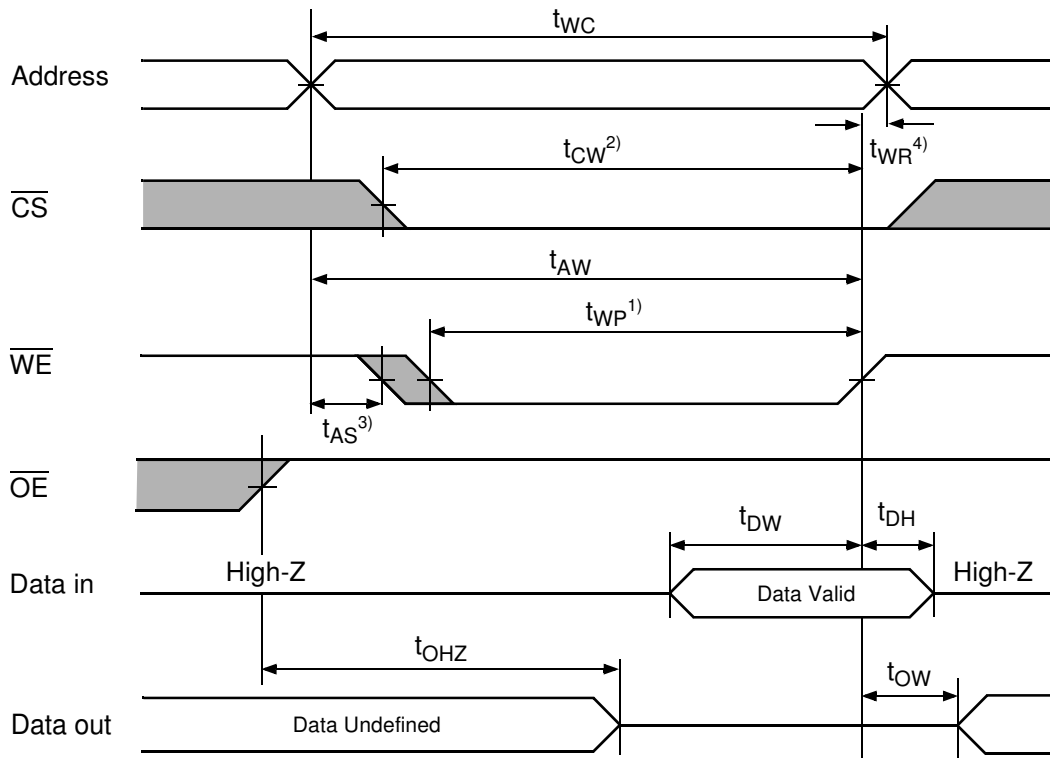
### TIMING WAVEFORM OF READ CYCLE(2) ( $\overline{OE}$ Controlled)



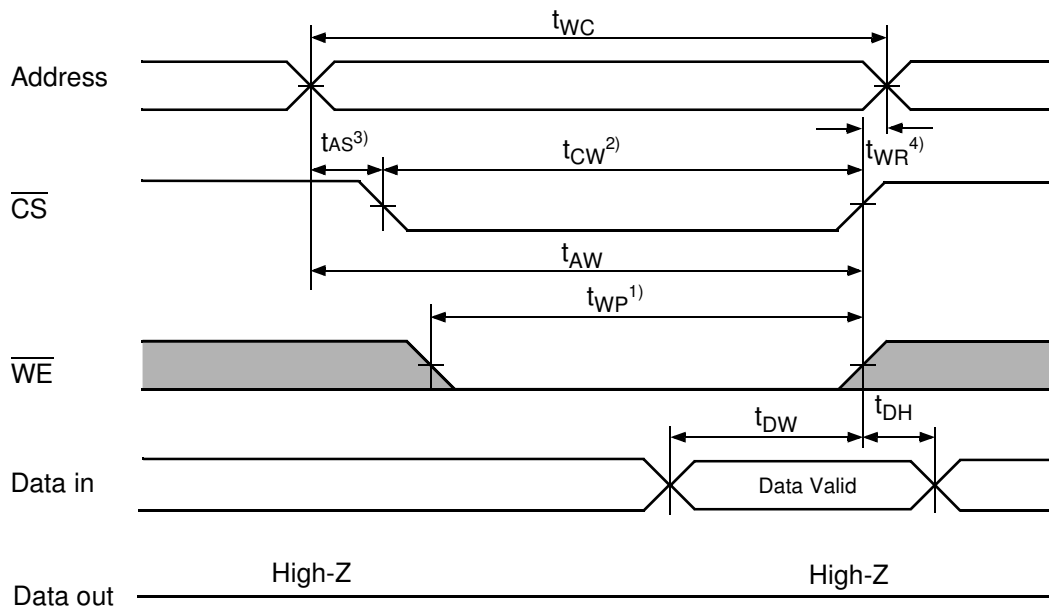
#### NOTES (READ CYCLE)

- $t_{HZ}$  and  $t_{OHZ}$  are defined as the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
- 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.

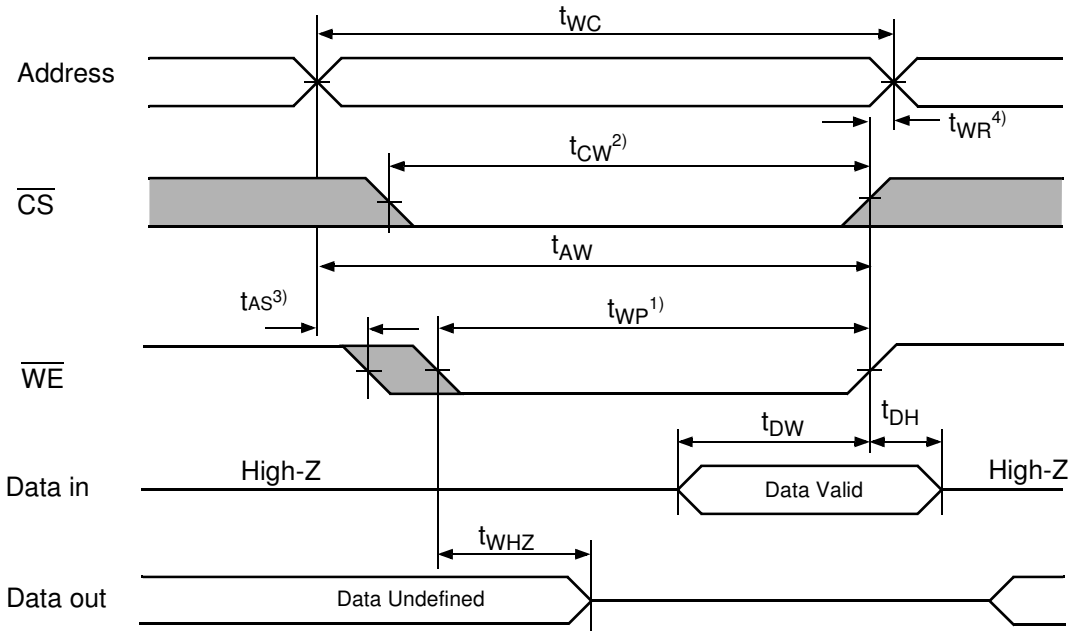
**TIMING WAVEFORM OF WRITE CYCLE(1) ( $\overline{WE}$  Controlled,  $\overline{OE}$  High During WRITE)**



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



**TIMING WAVEFORM OF WRITE CYCLE(3) ( $\overline{WE}$  Controlled,  $\overline{OE}$  LOW)**



**NOTES (WRITE CYCLE)**

1. A write occurs during the overlap( $t_{WP}$ ) of low  $\overline{CS}$  and low  $\overline{WE}$ . A write begins at the latest transition among  $\overline{CS}$  goes low and  $\overline{WE}$  goes low. 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.



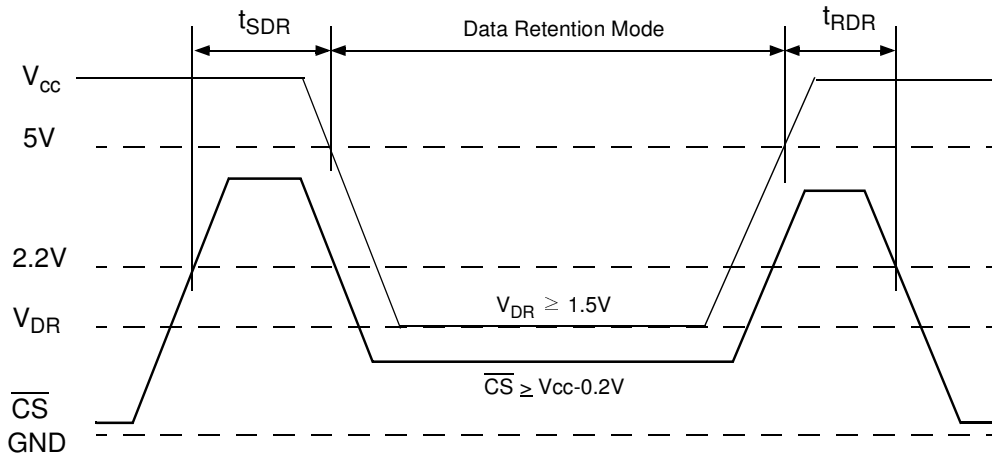
**DATA RETENTION CHARACTERISTICS**

Parameter	Symbol	Test Condition	Min	Typ <sup>2)</sup>	Max	Unit
V <sub>CC</sub> for Data Retention	V <sub>DR</sub>	I <sub>SB1</sub> Test Condition (Chip Disabled) <sup>1)</sup>	1.5	-	-	V
Data Retention Current	I <sub>DR</sub>	I <sub>SB1</sub> Test Condition (Chip Disabled) <sup>1)</sup>	-	1	7	μA
Chip Deselect to Data Retention Time	t <sub>SDR</sub>	See data retention wave form	0	-	-	ns
Operation Recovery Time	t <sub>RDR</sub>		t <sub>RC</sub>	-	-	

**NOTES :**

1. See the ISB1 measurement condition of data sheet page 4.
2. Typical value is measured at TA=25°C and not 100% tested.

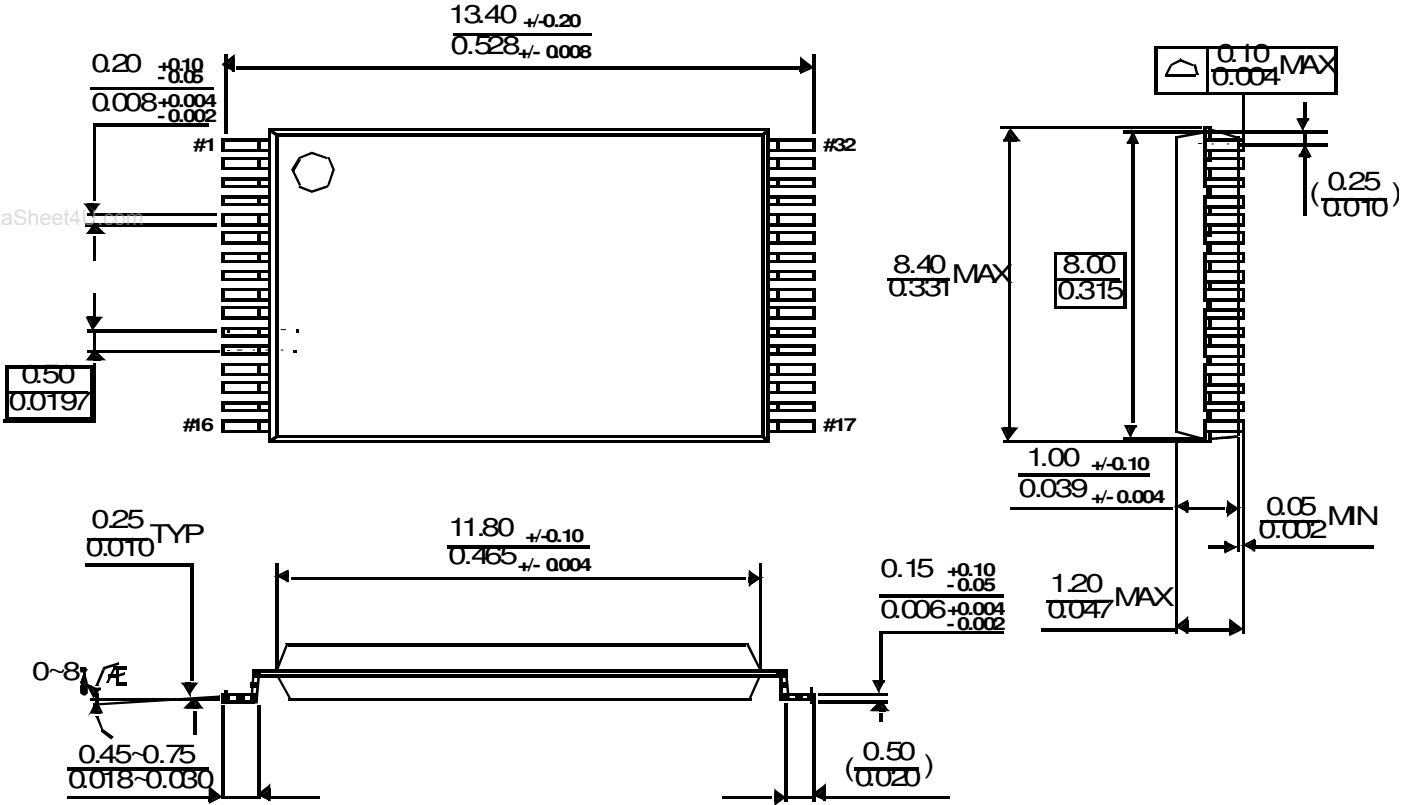
**DATA RETENTION WAVE FORM**



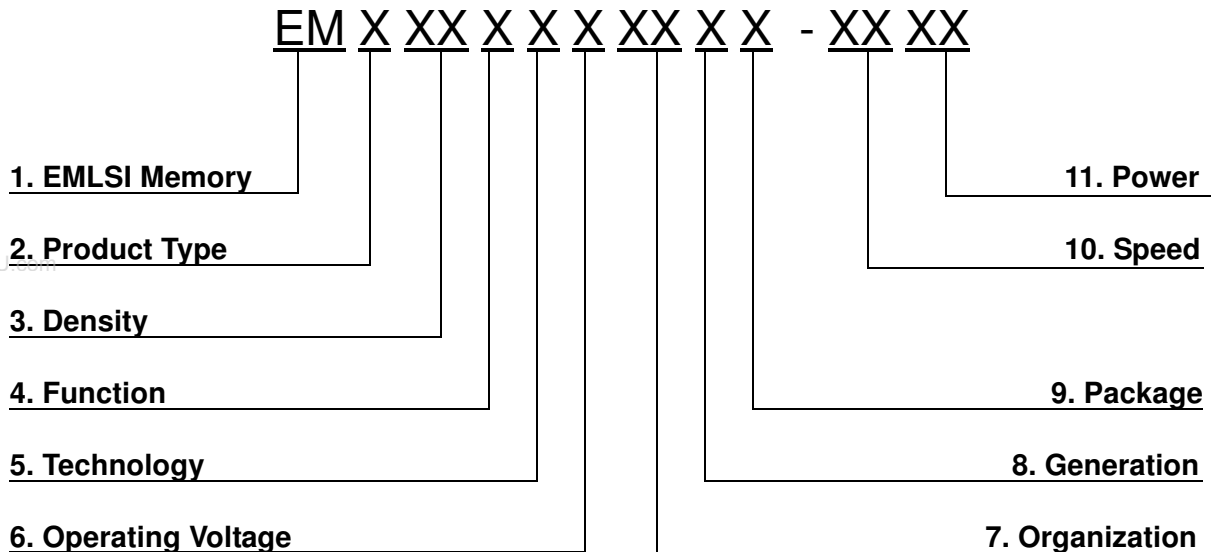
**PACKAGE DIMENSIONS**

32Pin - sTSOP Type1

Unit : millimeters/Inches



**SRAM PART CODING SYSTEM**



**1. Memory Component**  
EM ----- Memory

**2. Product Type**  
6 ----- SRAM

**3. Density**  
1 ----- 1M  
2 ----- 2M  
4 ----- 4M  
8 ----- 8M

**4. Function**  
0 ----- Dual CS  
1 ----- Single CS  
2 ----- Multiplexed  
3 ----- Single CS / LBB, UBB(tBA=tOE)  
4 ----- Single CS / LBB, UBB(tBA=tCO)  
5 ----- Dual CS / LBB, UBB(tBA=tOE)  
6 ----- Dual CS / LBB, UBB(tBA=tCO)

**5. Technology**  
F ----- Full CMOS

**6. Operating Voltage**  
T ----- 5.0V  
V ----- 3.3V  
U ----- 3.0V  
S ----- 2.5V  
R ----- 2.0V  
P ----- 1.8V

**7. Organization**  
8 ----- x8 bit  
16 ----- x16 bit

**8. Generation**  
Blank ----- 1st generation  
A ----- 2nd generation  
B ----- 3rd generation  
C ----- 4th generation  
D ----- 5th generation  
E ----- 6th generation  
F ----- 7th generation  
G ----- 8th generation

**9. Package**  
Blank ----- KGD, 48&36FpBGA  
S ----- 32 sTSOP1  
T ----- 32 TSOP1  
U ----- 44 TSOP2  
V ----- 32 SOP

**10. Speed**  
45 ----- 45ns  
55 ----- 55ns  
70 ----- 70ns  
85 ----- 85ns  
10 ----- 100ns  
12 ----- 120ns

**11. Power**  
LL ----- Low Low Power  
LF ----- Low Low Power(Pb-Free & Green)  
L ----- Low Power  
S ----- Standard Power