

[Document Title](#)

128K x8 bit Super Low Power and Low Voltage Full CMOS Static RAM

[Revision History](#)

| Revision No. | History                                | Draft Date         | Remark |
|--------------|----------------------------------------|--------------------|--------|
| 0.0          | Initial Draft                          | May 9 , 2003       |        |
| 0.1          | 2' nd Draft    Add Pb-free part number | February 13 , 2004 |        |

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The attached datasheets are provided by EMLSI reserve the right to change the specifications and products. EMLSI will answer to your questions about device. If you have any questions, please contact the EMLSI office.

## FEATURES

- Process Technology : 0.18 $\mu$ m Full CMOS
- Organization : 128K x 8 bit
- Power Supply Voltage : 2.7V ~ 3.6V
- Low Data Retention Voltage : 1.5V(Min)
- Three state output and TTL Compatible
- Package Type : 32-sTSP1

## GENERAL DESCRIPTION

The EM610FV8S families are 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.

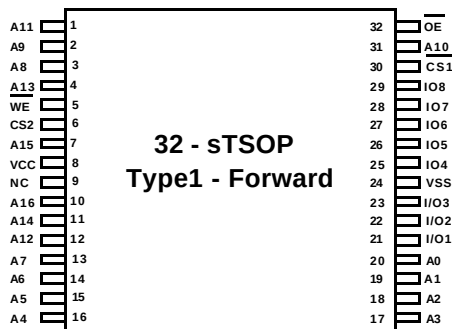
## PRODUCT FAMILY

| Product Family | Operating Temperature      | Vcc Range | Speed                   | Power Dissipation          |                             | PKG Type   |
|----------------|----------------------------|-----------|-------------------------|----------------------------|-----------------------------|------------|
|                |                            |           |                         | Standby ( $I_{SB1}$ , Typ) | Operating ( $I_{CC1}$ ·Max) |            |
| EM610FV8S      | Industrial<br>(-40 ~ 85°C) | 2.7V~3.6V | 55 <sup>1)</sup> / 70ns | 0.5 $\mu$ A <sup>2)</sup>  | 3 mA                        | 32 - sTSP1 |

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

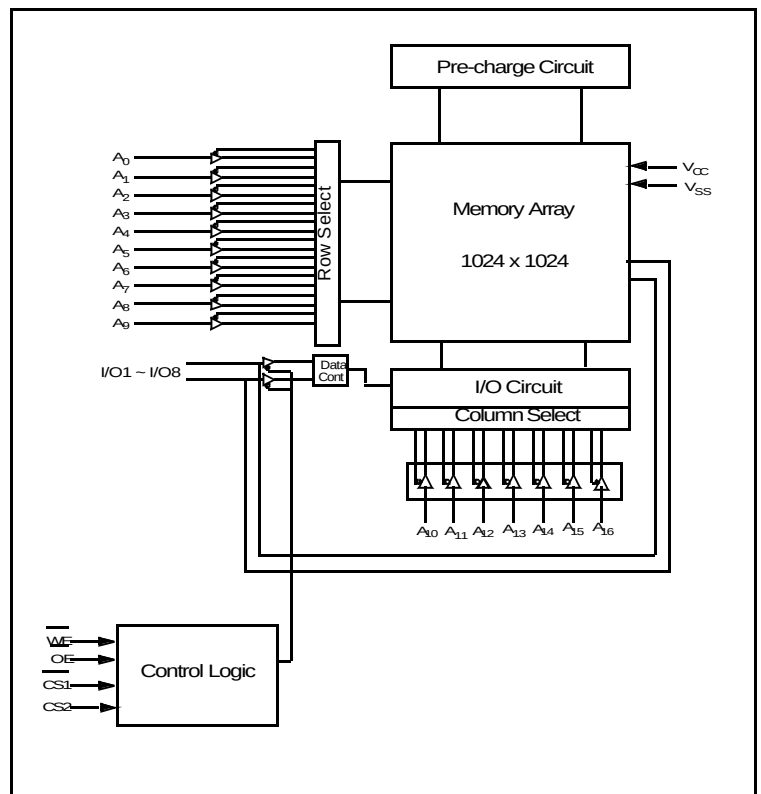
2. Typical values are measured at Vcc=3.3V, T<sub>A</sub>=25°C and not 100% tested.

## PIN DESCRIPTION



| Name                               | Function            | Name            | Function           |
|------------------------------------|---------------------|-----------------|--------------------|
| $\overline{CS}_1, CS_2$            | Chip select inputs  | $\overline{WE}$ | Write Enable input |
| $\overline{OE}$                    | Output Enable input | Vcc             | Power Supply       |
| A <sub>0</sub> ~A <sub>16</sub>    | Address Inputs      | Vss             | Ground             |
| I/O <sub>1</sub> ~I/O <sub>8</sub> | Data Inputs/outputs | NC              | No Connection      |

## FUNCTIONAL BLOCK DIAGRAM



**ABSOLUTE MAXIMUM RATINGS \***

| Parameter                             | Symbol            | Ratings                          | Unit |
|---------------------------------------|-------------------|----------------------------------|------|
| Voltage on Any Pin Relative to Vss    | $V_{IN}, V_{OUT}$ | -0.2 to $V_{CC}+0.3$ (Max. 4.0V) | V    |
| Voltage on Vcc supply relative to Vss | $V_{CC}$          | -0.2 to 4.0V                     | V    |
| Power Dissipation                     | $P_D$             | 1.0                              | W    |
| Operating Temperature                 | $T_A$             | -40 to 85                        | °C   |

\* 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.

**FUNCTIONAL DESCRIPTION**

| $\overline{CS}_1$ | $CS_2$ | $\overline{OE}$ | $\overline{WE}$ | I/O      | Mode            | Power    |
|-------------------|--------|-----------------|-----------------|----------|-----------------|----------|
| H                 | X      | X               | X               | High-Z   | Deselected      | Stand by |
| X                 | L      | X               | X               | High-Z   | Deselected      | Stand by |
| L                 | H      | H               | H               | High-Z   | Output Disabled | Active   |
| L                 | H      | L               | H               | Data Out | Read            | Active   |
| L                 | H      | X               | L               | Data In  | Write           | 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     | $V_{CC}$ | 2.7                | 3.3 | 3.6                 | V    |
| Ground             | $V_{SS}$ | 0                  | 0   | 0                   | V    |
| Input high voltage | $V_{IH}$ | 2.2                | -   | $V_{CC} + 0.2^{2)}$ | V    |
| Input low voltage  | $V_{IL}$ | -0.2 <sup>3)</sup> | -   | 0.6                 | V    |

1.  $T_A = -40$  to  $85^\circ\text{C}$ , otherwise specified
2. Overshoot:  $V_{CC} + 2.0$  V in case of pulse width  $\leq 20$ ns
3. Undershoot:  $-2.0$  V in case of pulse width  $\leq 20$ ns
4. Overshoot and undershoot are sampled, not 100% tested.

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

| 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   |

1. Capacitance is sampled, not 100% tested

**DC AND OPERATING CHARACTERISTICS**

| Parameter                 | 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>  | $\overline{CS}_1 = V_{IH}$ , CS <sub>2</sub> =V <sub>IL</sub> or $\overline{OE} = V_{IH}$ or $\overline{WE} = V_{IL}$ , V <sub>IO</sub> =V <sub>SS</sub> to V <sub>CC</sub>                                                                                                                                        |                                                                                                                                                                           | -1   | -                 | 1   | μA   |
| Operating power supply    | I <sub>CC</sub>  | I <sub>IO</sub> =0mA, $\overline{CS}_1 = V_{IL}$ , CS <sub>2</sub> = $\overline{WE} = V_{IH}$ , V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub>                                                                                                                                                                |                                                                                                                                                                           | -    | -                 | 3   | mA   |
| Average operating current | I <sub>CC1</sub> | Cycle time=1μs, 100% duty, I <sub>IO</sub> =0mA,<br>$\overline{CS}_1 \leq 0.2V$ , CS <sub>2</sub> ≥V <sub>CC</sub> -0.2V,<br>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,<br>$\overline{CS}_1 = V_{IL}$ , CS <sub>2</sub> =V <sub>IH</sub> , V <sub>IN</sub> =V <sub>IL</sub> or V <sub>IH</sub> | 55ns | -                 | -   | 25   |
|                           | 70ns             |                                                                                                                                                                                                                                                                                                                    | -                                                                                                                                                                         | -    | 20                |     |      |
| 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>  | $\overline{CS}_1 = V_{IH}$ , CS <sub>2</sub> =V <sub>IL</sub> , Other inputs=V <sub>IH</sub> or V <sub>IL</sub>                                                                                                                                                                                                    |                                                                                                                                                                           | -    | -                 | 0.3 | mA   |
| Standby Current (CMOS)    | I <sub>SB1</sub> | $\overline{CS}_1 \geq V_{CC} - 0.2V$ , CS <sub>2</sub> ≥V <sub>CC</sub> -0.2V ( $\overline{CS}_1$ controlled)<br>or 0V≤CS <sub>2</sub> ≤0.2V (CS <sub>2</sub> controlled),<br>Other inputs=0~V <sub>CC</sub><br>(Typ. condition : V <sub>CC</sub> =3.3V @ 25°C)<br>(Max. condition : V <sub>CC</sub> =3.6V @ 85°C) | LL<br>LF                                                                                                                                                                  | -    | 0.5 <sup>1)</sup> | 5   | μA   |

**NOTES**

1. Typical values are measured at  $V_{CC} = 3.3\text{V}$ ,  $T_A = 25^\circ\text{C}$  and not 100% tested.

### AC OPERATING CONDITIONS

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

Input Pulse Level : 0.4 to 2.2V

Input Rise and Fall Time : 5ns

Input and Output reference Voltage : 1.5V

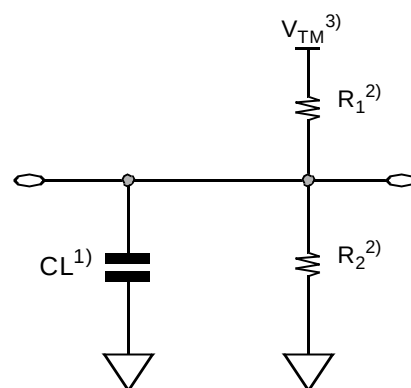
Output Load (See right) : CL = 100pF + 1 TTL

CL<sup>1)</sup> = 30pF + 1 TTL

1. Including scope and Jig capacitance

2. R<sub>1</sub>=3070Ω, R<sub>2</sub>=3150Ω

3. V<sub>TM</sub>=2.8V



**READ CYCLE** (V<sub>cc</sub> = 2.7 to 3.6V, Gnd = 0V, T<sub>A</sub> = -40°C to +85°C)

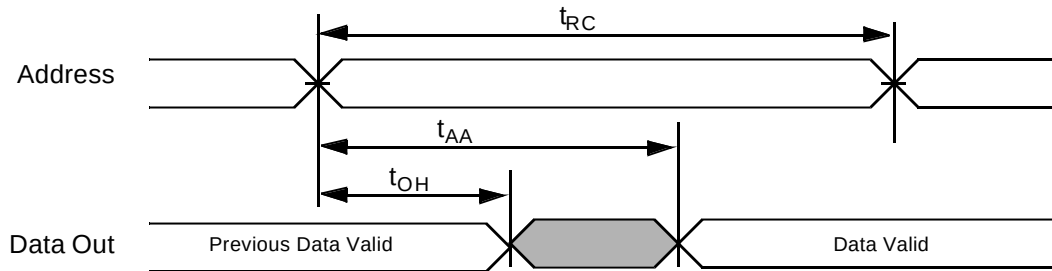
| Parameter                       | Symbol                              | 55ns |     | 70ns |     | Unit |
|---------------------------------|-------------------------------------|------|-----|------|-----|------|
|                                 |                                     | Min  | Max | Min  | Max |      |
| 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>co1</sub> , t <sub>co2</sub> | -    | 55  | -    | 70  | ns   |
| Output enable to valid output   | t <sub>OE</sub>                     | -    | 25  | -    | 35  | ns   |
| Chip select to low-Z output     | t <sub>LZ1</sub> , t <sub>LZ2</sub> | 10   | -   | 10   | -   | ns   |
| Output enable to low-Z output   | t <sub>OLZ</sub>                    | 5    | -   | 5    | -   | ns   |
| Chip disable to high-Z output   | t <sub>HZ1</sub> , t <sub>HZ2</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   |

**WRITE CYCLE** (V<sub>cc</sub> = 2.7 to 3.6V, Gnd = 0V, T<sub>A</sub> = -40°C to +85°C)

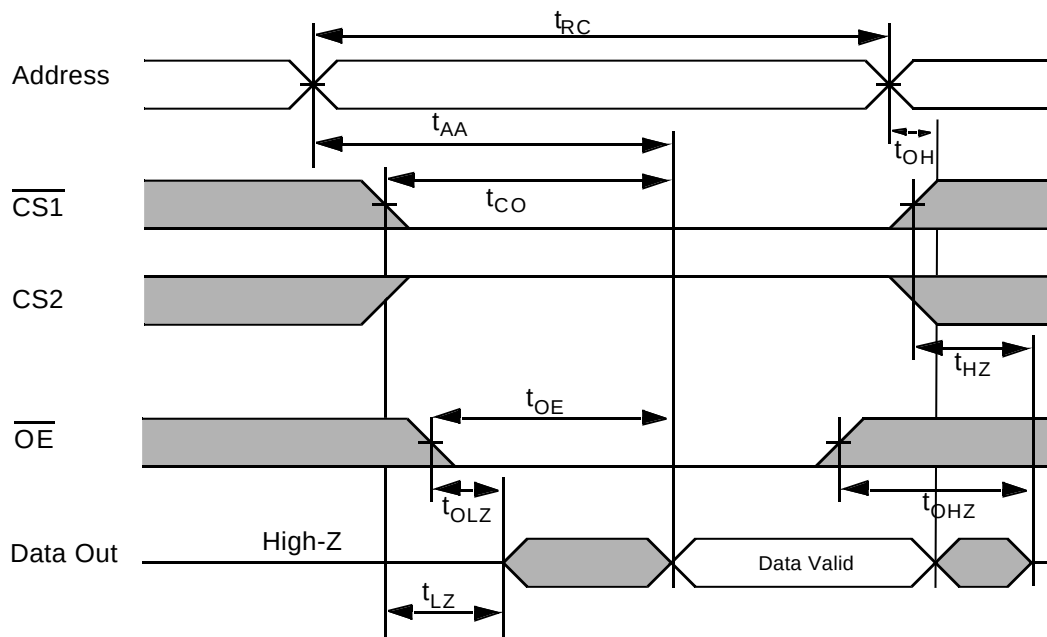
| Parameter                     | Symbol                              | 55ns |     | 70ns |     | Unit |
|-------------------------------|-------------------------------------|------|-----|------|-----|------|
|                               |                                     | Min  | Max | Min  | Max |      |
| Write cycle time              | t <sub>WC</sub>                     | 55   | -   | 70   | -   | ns   |
| Chip select to end of write   | t <sub>CW1</sub> , t <sub>CW2</sub> | 45   | -   | 60   | -   | ns   |
| Address setup 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   | -   | 50   | -   | ns   |
| Write recovery time           | t <sub>WR</sub>                     | 0    | -   | 0    | -   | ns   |
| Write to output high-Z        | t <sub>WHZ</sub>                    | 0    | 20  | 0    | 20  | ns   |
| Data to write time overlap    | t <sub>DW</sub>                     | 25   |     | 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   |

## TIMING DIAGRAMS

**TIMING WAVEFORM OF READ CYCLE(1).** (Address Controlled,  $\overline{CS1}=\overline{OE}=V_{IL}$ ,  $CS2=\overline{WE}=V_{IH}$ )



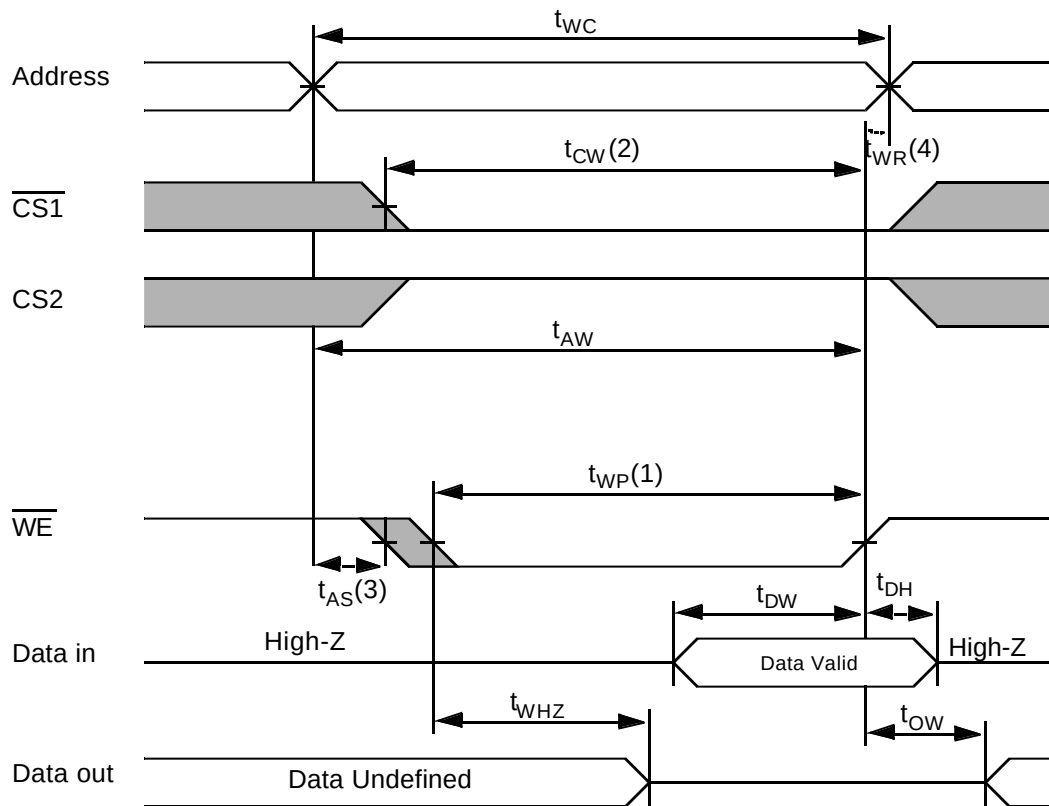
**TIMING WAVEFORM OF READ CYCLE(2)** ( $\overline{WE} = V_{IH}$ )



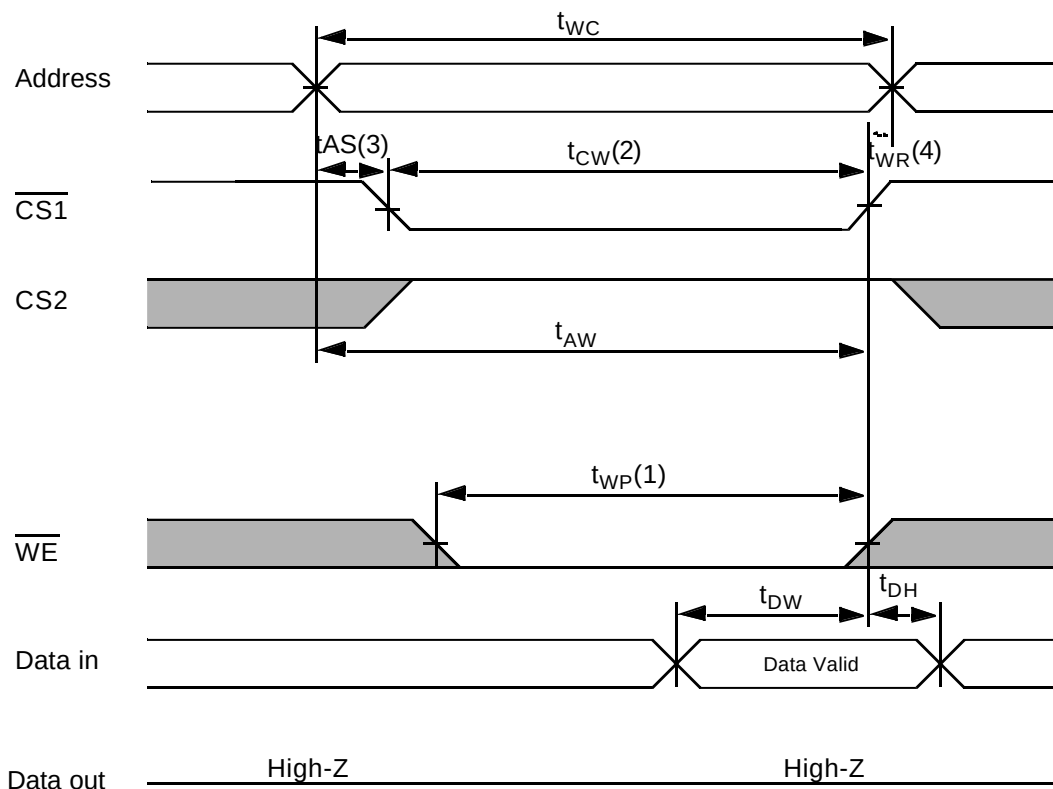
### NOTES (READ CYCLE)

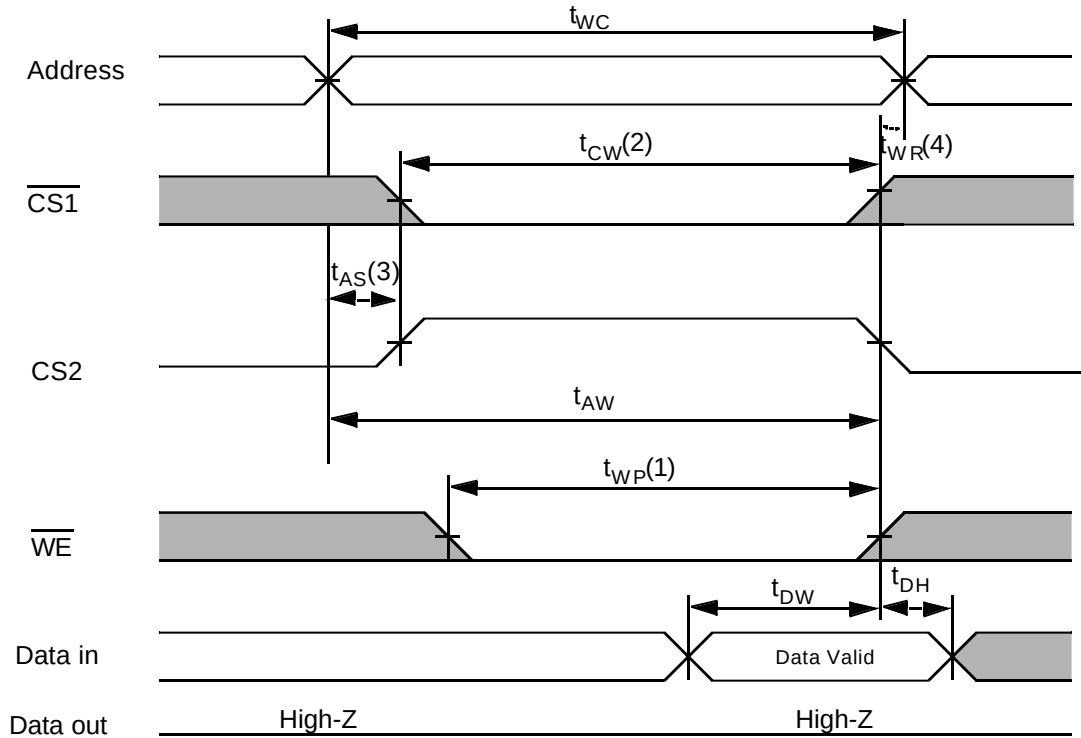
1.  $t_{HZ}$  and  $t_{OHZ}$  are defined as the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. At any given temperature and voltage condition,  $t_{HZ}(\text{Max.})$  is less than  $t_{LZ}(\text{Min.})$  both for a given device and from device to device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

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



**TIMING WAVEFORM OF WRITE CYCLE(2) ( $\overline{CS1}$  CONTROLLED)**



**TIMING WAVEFORM OF WRITE CYCLE(3) ( CS<sub>2</sub> CONTROLLED)**

**NOTES (WRITE CYCLE)**

1. A write occurs during the overlap(t<sub>WP</sub>) of low  $\overline{CS_1}$ , a high CS<sub>2</sub> and low  $\overline{WE}$ . A write begins at the latest transition among  $\overline{CS_1}$  goes low, CS<sub>2</sub> goes high and  $\overline{WE}$  goes low. A write ends at the earliest transition when  $\overline{CS_1}$  goes high, CS<sub>2</sub> goes high and  $\overline{WE}$  goes high. The t<sub>WP</sub> is measured from the beginning of write to the end of write.
2. t<sub>CW</sub> is measured from the  $\overline{CS_1}$  going low to end of write.
3. t<sub>AS</sub> is measured from the address valid to the beginning of write.
4. t<sub>WR</sub> is measured from the end of write to the address change. t<sub>WR</sub> applied in case a write ends as  $\overline{CS_1}$  or  $\overline{WE}$  going high.



## DATA RETENTION CHARACTERISTICS

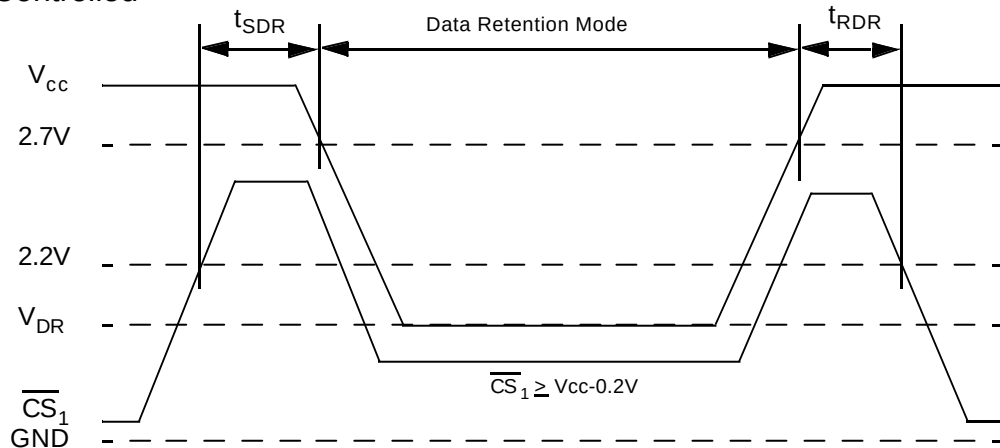
| Parameter                            | Symbol           | Test Condition                                                                          | Min             | Typ <sup>2)</sup> | Max | Unit |
|--------------------------------------|------------------|-----------------------------------------------------------------------------------------|-----------------|-------------------|-----|------|
| V <sub>CC</sub> for Data Retention   | V <sub>DR</sub>  | I <sub>SB1</sub> Test Condition<br>(Chip Disabled) <sup>1)</sup>                        | 1.5             | -                 | 3.6 | V    |
| Data Retention Current               | I <sub>DR</sub>  | V <sub>CC</sub> =1.5V, I <sub>SB1</sub> Test Condition<br>(Chip Disabled) <sup>1)</sup> | -               | 0.25              | -   | 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

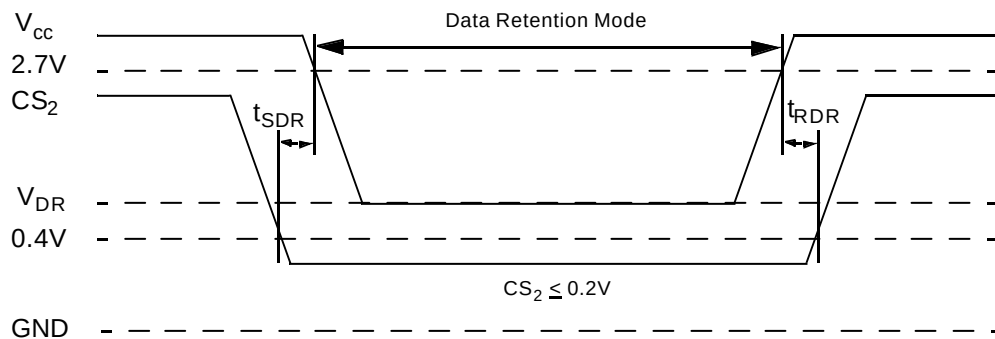
1. See the I<sub>SB1</sub> measurement condition of datasheet page 4.
2. Typical values are measured at T<sub>A</sub>=25°C and not 100% tested.

## DATA RETENTION WAVE FORM

$\overline{CS}_1$  Controlled



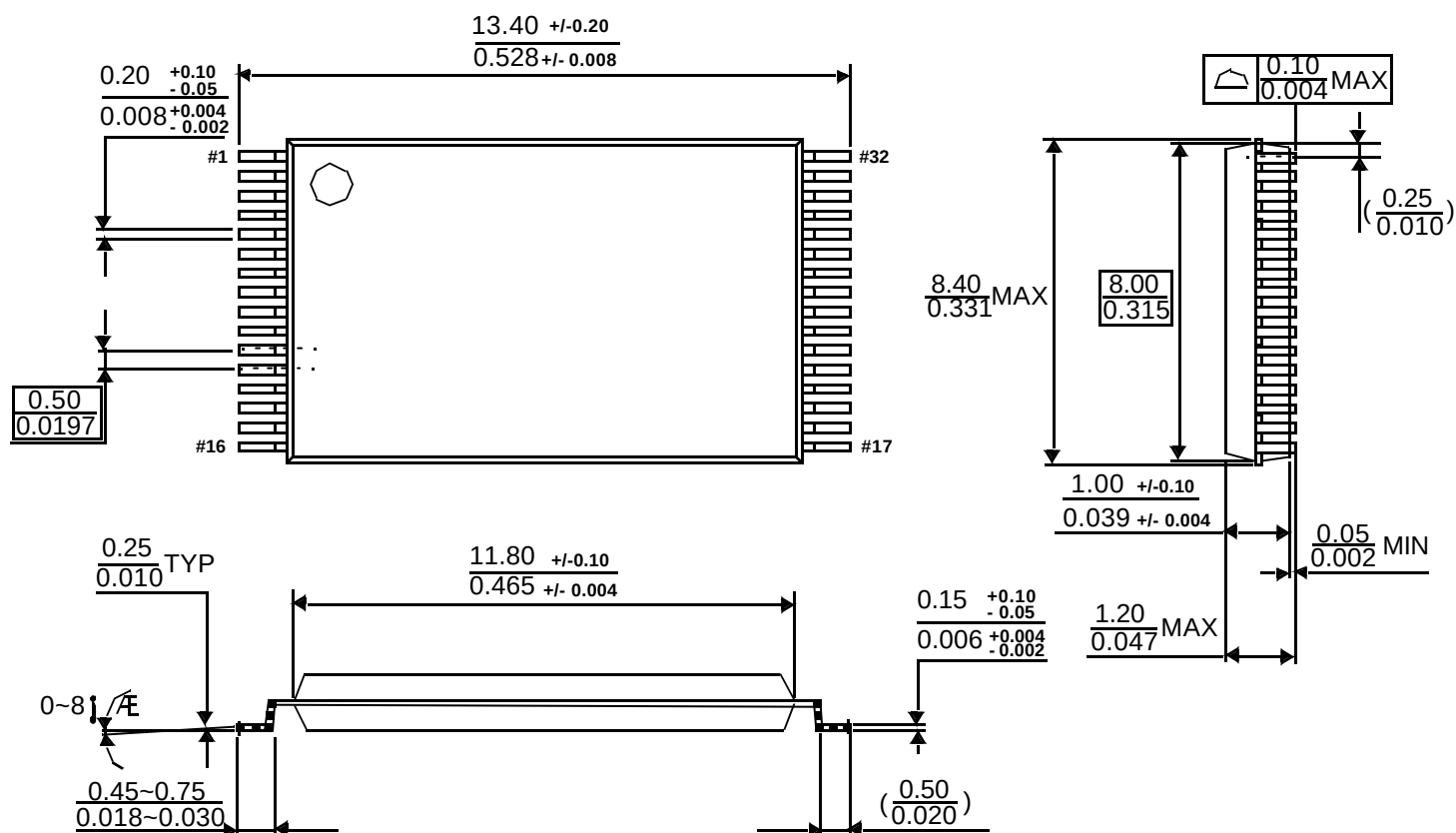
CS<sub>2</sub> Controlled



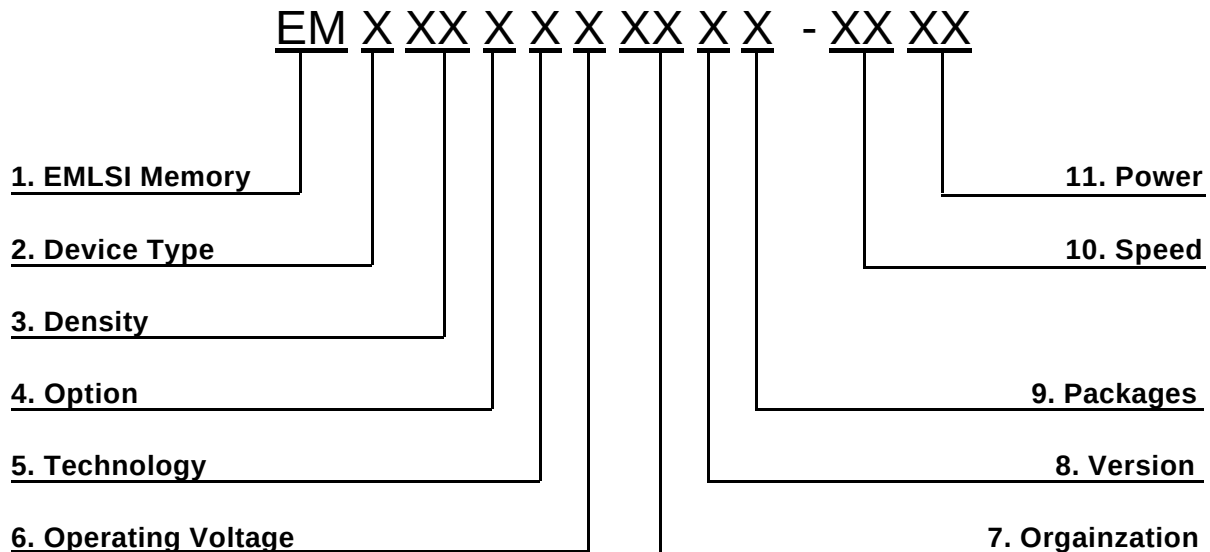
**PACKAGE DIMENSIONS**

Unit : millimeters/Inches

( 32-sTSOP1-0813.4F )



## MEMORY FUNCTION GUIDE



### 1. Memory Component

#### 2. Device Type

- 6 ----- Low Power SRAM
- 7 ----- STRAM

#### 3. Density

- 1 ----- 1M
- 2 ----- 2M
- 4 ----- 4M
- 8 ----- 8M
- 16 ----- 16M
- 32 ----- 32M
- 64 ----- 64M

#### 4. Option

- 0 ----- Dual CS
- 1 ----- Single CS

#### 5. Technology

- Blank ----- CMOS
- F ----- Full CMOS

#### 6. Operating Voltage

- Blank ----- 5.0V
- V ----- 2.7V~3.6V
- U ----- 3.0V
- S ----- 2.5V
- R ----- 2.0V
- P ----- 1.8V

#### 7. Organization

- 8 ----- x8 bit
- 16 ----- x16 bit
- 32 ----- x32 bit

### 8. Version

- Blank ----- Mother Die
- A ----- First revision
- B ----- Second revision
- C ----- Third revision
- D ----- Fourth revision
- E ----- Fifth revision
- F ----- Sixth revision

### 9. Package

- Blank ----- FPBGA
- S ----- 32 sTSOP1
- T ----- 32 TSOP1
- U ----- 44 TSOP2
- W ----- Wafer

### 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)
- L ----- Low Power
- S ----- Standard Power