

## Document Title

512Kx8 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                          | July 30, 2002     | Preliminary   |
| 0.1                 | Revised<br>- Added Commercial Product. | November 30, 2002 | Preliminary   |

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## 512Kx8 bit Low Power full CMOS Static RAM

### FEATURES

- Process Technology: Full CMOS
- Organization: 512Kx8
- Power Supply Voltage: 4.5~5.5V
- Low Data Retention Voltage: 2V(Min)
- Three state output and TTL compatible
- Package Type: 32-DIP-600, 32-SOP-525, 32-TSOP2-400F/R

### GENERAL DESCRIPTION

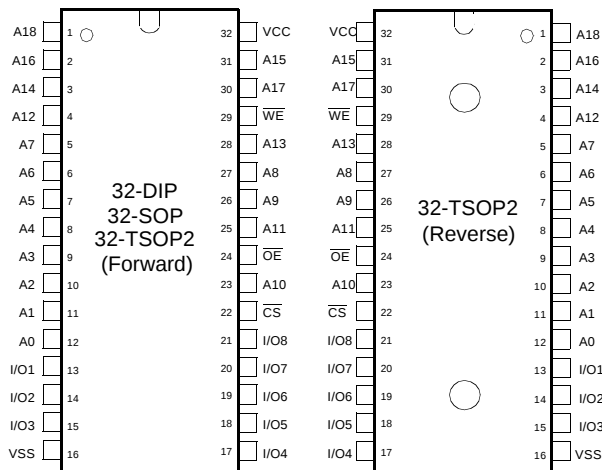
The K6X4008C1F families are fabricated by SAMSUNG's advanced full CMOS process technology. The families supports various operating temperature range and various package types for user flexibility of system design. The families also support low data retention voltage for battery back-up operation with low data retention current.

### PRODUCT FAMILY

| Product Family | Operating Temperature  | Vcc Range | Speed                  | Power Dissipation      |                          | PKG Type                                   |
|----------------|------------------------|-----------|------------------------|------------------------|--------------------------|--------------------------------------------|
|                |                        |           |                        | Standby<br>(Isb1, Max) | Operating<br>(Icc2, Max) |                                            |
| K6X4008C1F-B   | Commercial (0~70°C)    | 4.5~5.5V  | 55 <sup>1)</sup> /70ns | 20μA                   | 40mA                     | 32-DIP-600, 32-SOP-525,<br>32-TSOP2-400F/R |
| K6X4008C1F-F   | Industrial (-40~85°C)  |           |                        |                        |                          |                                            |
| K6X4008C1F-Q   | Automotive (-40~125°C) |           |                        | 30μA                   |                          | 32-SOP-525, 32-TSOP2-400F                  |

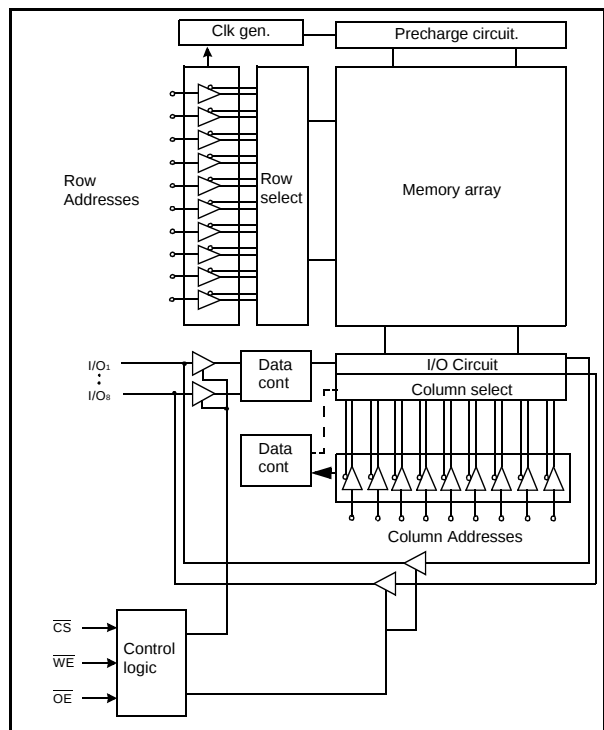
1. The parameter is measured with 50pF test load.

### PIN DESCRIPTION



| Pin Name        | Function            |
|-----------------|---------------------|
| $\overline{WE}$ | Write Enable Input  |
| $\overline{CS}$ | Chip Select Input   |
| $\overline{OE}$ | Output Enable Input |
| A0~A18          | Address Inputs      |
| I/O1~I/O8       | Data Inputs/Outputs |
| Vcc             | Power               |
| Vss             | Ground              |

### FUNCTIONAL BLOCK DIAGRAM



SAMSUNG ELECTRONICS CO., LTD. reserves the right to change products and specifications without notice.

## PRODUCT LIST

| Commercial Products(0~70°C) |                      | Industrial Products(-40~85°C) |                      | Automotive Products(-40~125°C) |                     |
|-----------------------------|----------------------|-------------------------------|----------------------|--------------------------------|---------------------|
| Part Name                   | Function             | Part Name                     | Function             | Part Name                      | Function            |
| K6X4008C1F-DB55             | 32-DIP, 55ns, LL     | K6X4008C1F-DF55               | 32-DIP, 55ns, LL     | K6X4008C1F-GQ55                | 32-SOP, 55ns, L     |
| K6X4008C1F-DB70             | 32-DIP, 70ns, LL     | K6X4008C1F-DF70               | 32-DIP, 70ns, LL     | K6X4008C1F-GQ70                | 32-SOP, 70ns, L     |
| K6X4008C1F-GB55             | 32-SOP, 55ns, LL     | K6X4008C1F-GF55               | 32-SOP, 55ns, LL     | K6X4008C1F-VQ55                | 32-TSOP2-F, 55ns, L |
| K6X4008C1F-GB70             | 32-SOP, 70ns, LL     | K6X4008C1F-GF70               | 32-SOP, 70ns, LL     | K6X4008C1F-VQ70                | 32-TSOP2-F, 70ns, L |
| K6X4008C1F-VB55             | 32-TSOP2-F, 55ns, LL | K6X4008C1F-VF55               | 32-TSOP2-F, 55ns, LL |                                |                     |
| K6X4008C1F-VB70             | 32-TSOP2-F, 70ns, LL | K6X4008C1F-VF70               | 32-TSOP2-F, 70ns, LL |                                |                     |
| K6X4008C1F-MB55             | 32-TSOP2-R, 55ns, LL | K6X4008C1F-MF55               | 32-TSOP2-R, 55ns, LL |                                |                     |
| K6X4008C1F-MB70             | 32-TSOP2-R, 70ns, LL | K6X4008C1F-MF70               | 32-TSOP2-R, 70ns, LL |                                |                     |

## FUNCTIONAL DESCRIPTION

| $\overline{\text{CS}}$ | $\overline{\text{OE}}$ | $\overline{\text{WE}}$ | I/O Pin | Mode            | Power   |
|------------------------|------------------------|------------------------|---------|-----------------|---------|
| H                      | X <sup>1)</sup>        | X <sup>1)</sup>        | High-Z  | Deselected      | Standby |
| L                      | H                      | H                      | High-Z  | Output disbaled | Active  |
| L                      | L                      | H                      | Dout    | Read            | Active  |
| L                      | X <sup>1)</sup>        | L                      | Din     | 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> +0.5V(max. 7.0V) | V    | -            |
| Voltage on Vcc supply relative to Vss | V <sub>CC</sub>                    | -0.3 to 7.0                              | 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   | K6X4008C1F-B |
|                                       |                                    | -40 to 85                                |      | K6X4008C1F-F |
|                                       |                                    | -40 to 125                               |      | K6X4008C1F-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> | 4.5                | 5.0 | 5.5                                | V    |
| Ground             | V <sub>SS</sub> | 0                  | 0   | 0                                  | V    |
| Input high voltage | V <sub>IH</sub> | 2.2                | -   | V <sub>CC</sub> +0.5 <sup>2)</sup> | V    |
| Input low voltage  | V <sub>IL</sub> | -0.5 <sup>3)</sup> | -   | 0.8                                | V    |

Note:

1. Commercial Product: T<sub>A</sub>=0 to 70°C, otherwise specified  
 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 <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                                            | -            | -   | 10  | mA   |    |
| Average operating current      | I <sub>CC1</sub> | Cycle time=1μs, 100% duty, I <sub>IO</sub> =0mA<br>$\overline{CS}$ ≤0.2V, V <sub>IN</sub> ≥0.2V or V <sub>IN</sub> ≥V <sub>CC</sub> -0.2V                      | -            | -   | 8   | mA   |    |
|                                | 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>IH</sub> or V <sub>IL</sub>                        | -            | -   | 40  | 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>                                                                           | -            | -   | 3   | mA   |    |
| Standby Current(CMOS)          | I <sub>SB1</sub> | $\overline{CS}$ ≥V <sub>CC</sub> -0.2V, Other inputs=0~V <sub>CC</sub>                                                                                         | K6X4008C1F-B | -   | -   | 20   | μA |
|                                |                  |                                                                                                                                                                | K6X4008C1F-F | -   | -   |      |    |
|                                |                  |                                                                                                                                                                | K6X4008C1F-Q | -   | -   | 30   | μA |

## AC OPERATING CONDITIONS

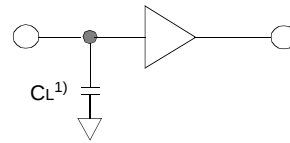
### TEST CONDITIONS (Test Load and Test Input/Output Reference)

Input pulse level: 0.8 to 2.4V

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

( $V_{CC}=4.5\sim 5.5\text{V}$ , Commercial product:  $T_A=0$  to  $70^\circ\text{C}$ , Industrial product:  $T_A=-40$  to  $85^\circ\text{C}$ , Automotive product:  $T_A=-40$  to  $125^\circ\text{C}$ )

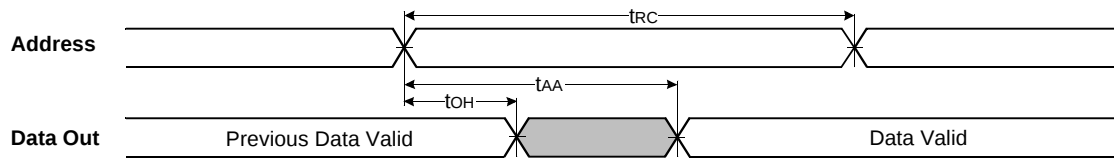
| Parameter List |                                 | Symbol           | Speed Bins |     |      |     | Units |
|----------------|---------------------------------|------------------|------------|-----|------|-----|-------|
|                |                                 |                  | 55ns       |     | 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    |
|                | 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    |
| 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         | -   | 50   | -   | 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>  | 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    |

## DATA RETENTION CHARACTERISTICS

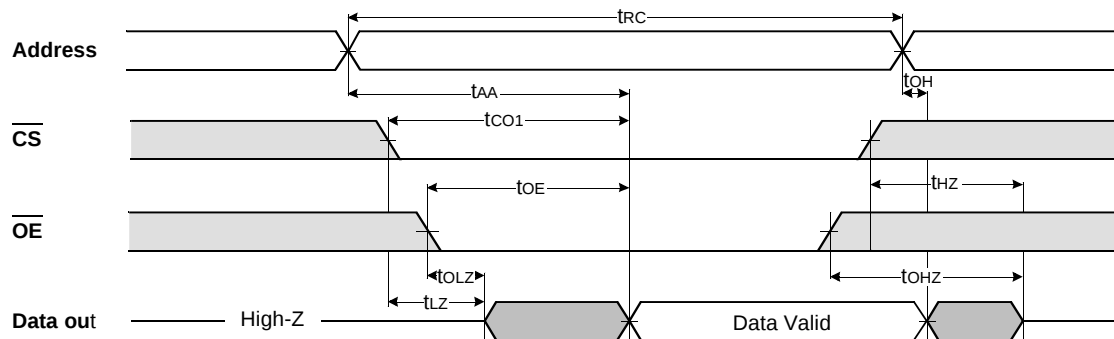
| Item                               | Symbol           | Test Condition                                              | Min | Typ | Max | Unit          |
|------------------------------------|------------------|-------------------------------------------------------------|-----|-----|-----|---------------|
| V <sub>CC</sub> for data retention | V <sub>DR</sub>  | $\overline{CS} \geq V_{CC}-0.2\text{V}$                     | 2.0 | -   | 5.5 | V             |
| Data retention current             | I <sub>DR</sub>  | $V_{CC}=3.0\text{V}, \overline{CS} \geq V_{CC}-0.2\text{V}$ | -   | -   | 15  | $\mu\text{A}$ |
|                                    |                  |                                                             |     |     | 20  |               |
|                                    |                  |                                                             |     |     | 30  |               |
| 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,  $\overline{CS}=\overline{OE}=V_{IL}$ ,  $\overline{WE}=V_{IH}$ )



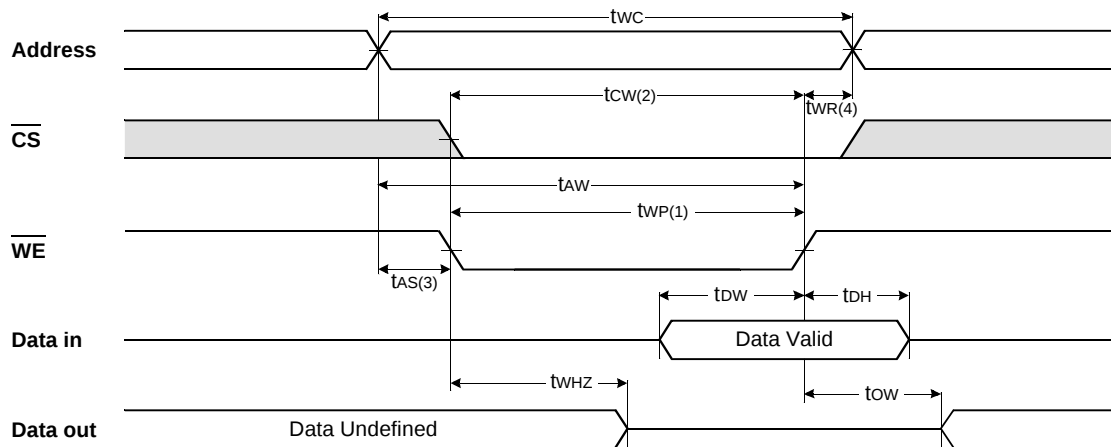
**TIMING WAVEFORM OF READ CYCLE(2)** ( $\overline{WE}=V_{IH}$ )



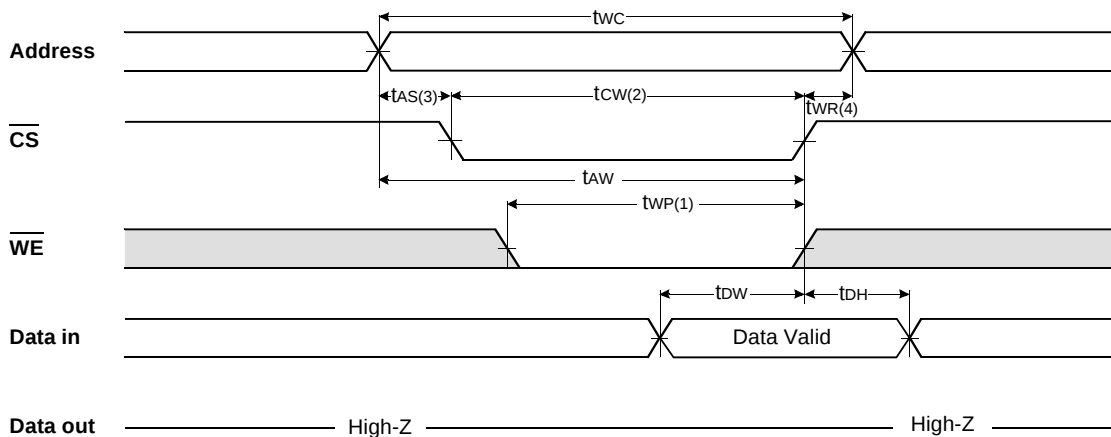
### NOTES (READ CYCLE)

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)

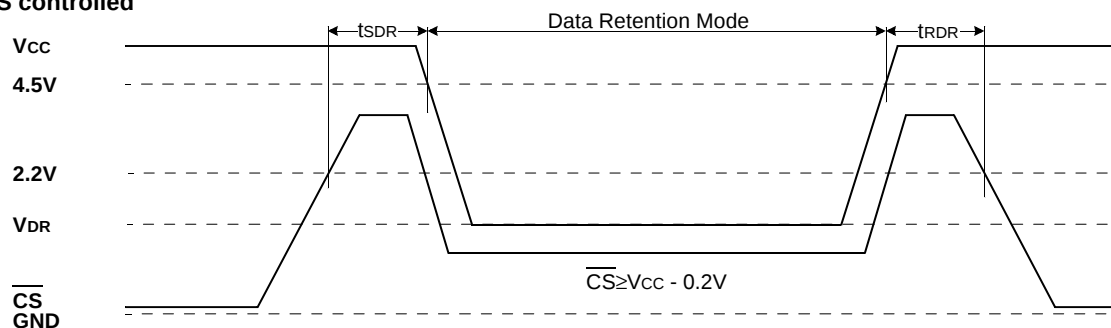


### NOTES (WRITE CYCLE)

1. A write occurs during the overlap of a low  $\overline{CS}$  and a low  $\overline{WE}$ . A write begins at the latest transition among  $\overline{CS}$  going Low and  $\overline{WE}$  going low : A write end at the earliest transition among  $\overline{CS}$  going high and  $\overline{WE}$  going high,  $t_{WP}$  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.  $t_{WR}$  is applied in case a write ends with  $\overline{CS}$  or  $\overline{WE}$  going high.

## DATA RETENTION WAVE FORM

### $\overline{CS}$ controlled



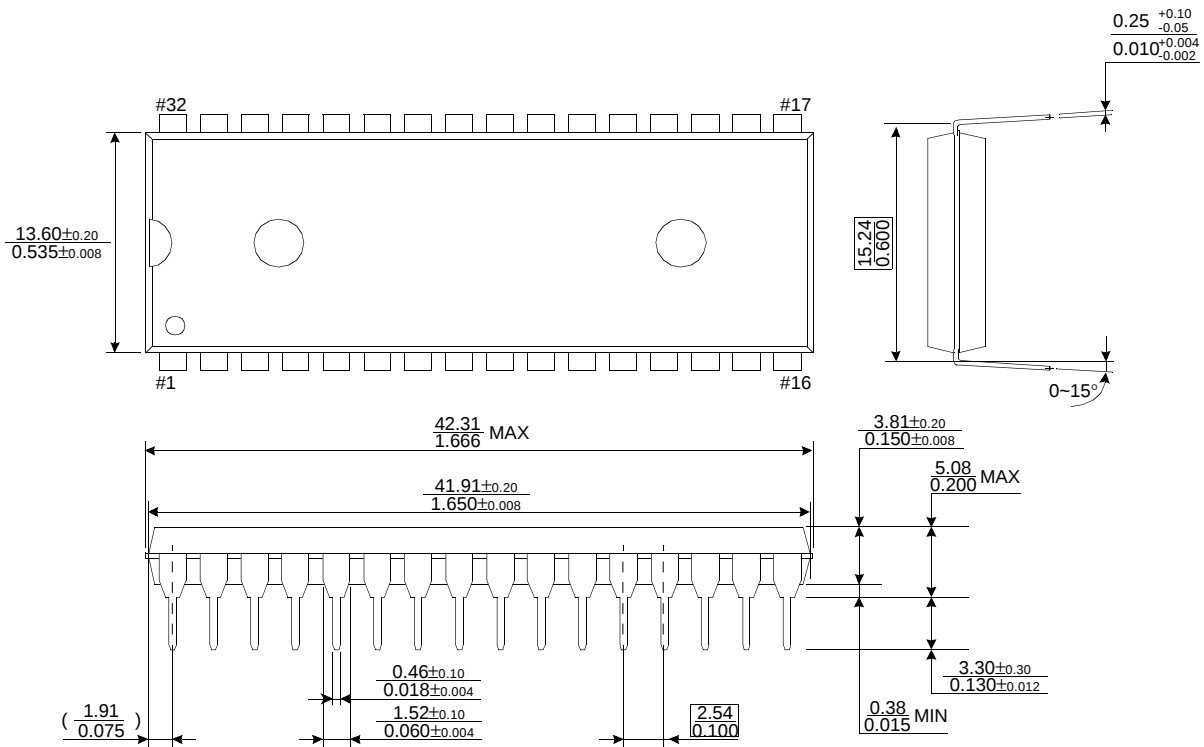
# K6X4008C1F Family

**Preliminary**  
**CMOS SRAM**

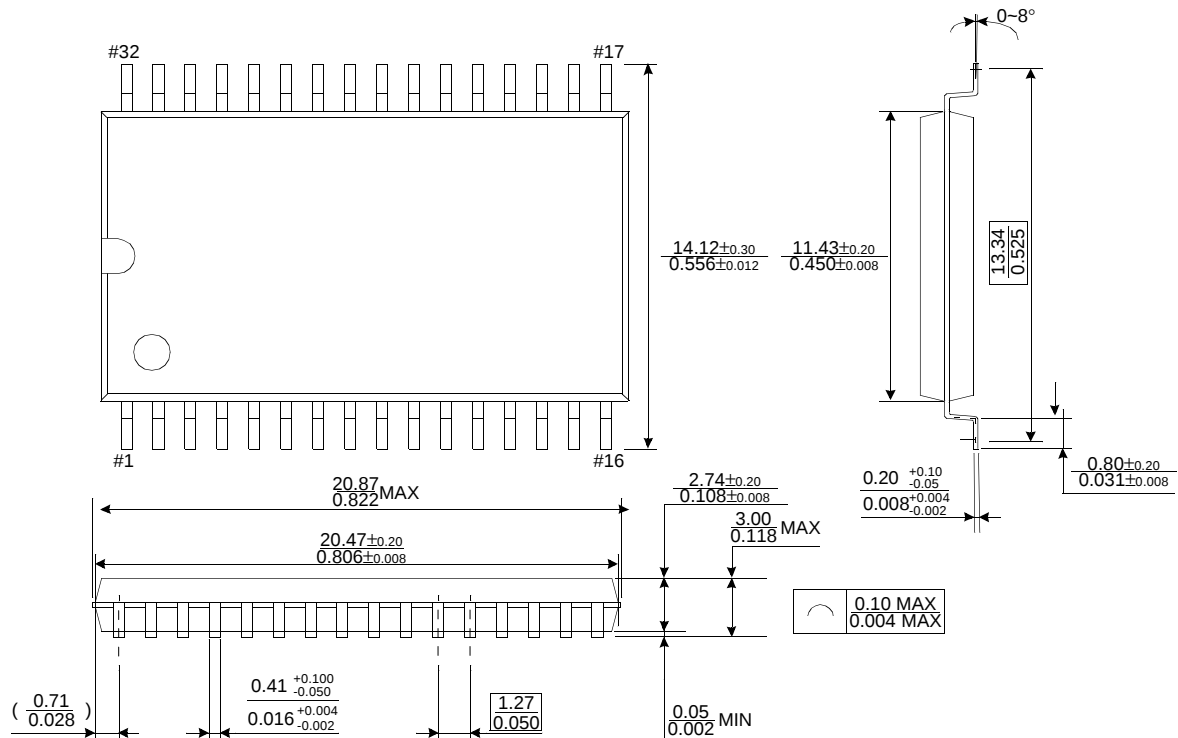
## PACKAGE DIMENSIONS

Units : millimeter(Inch)

### 32 PIN DUAL INLINE PACKAGE (600mil)



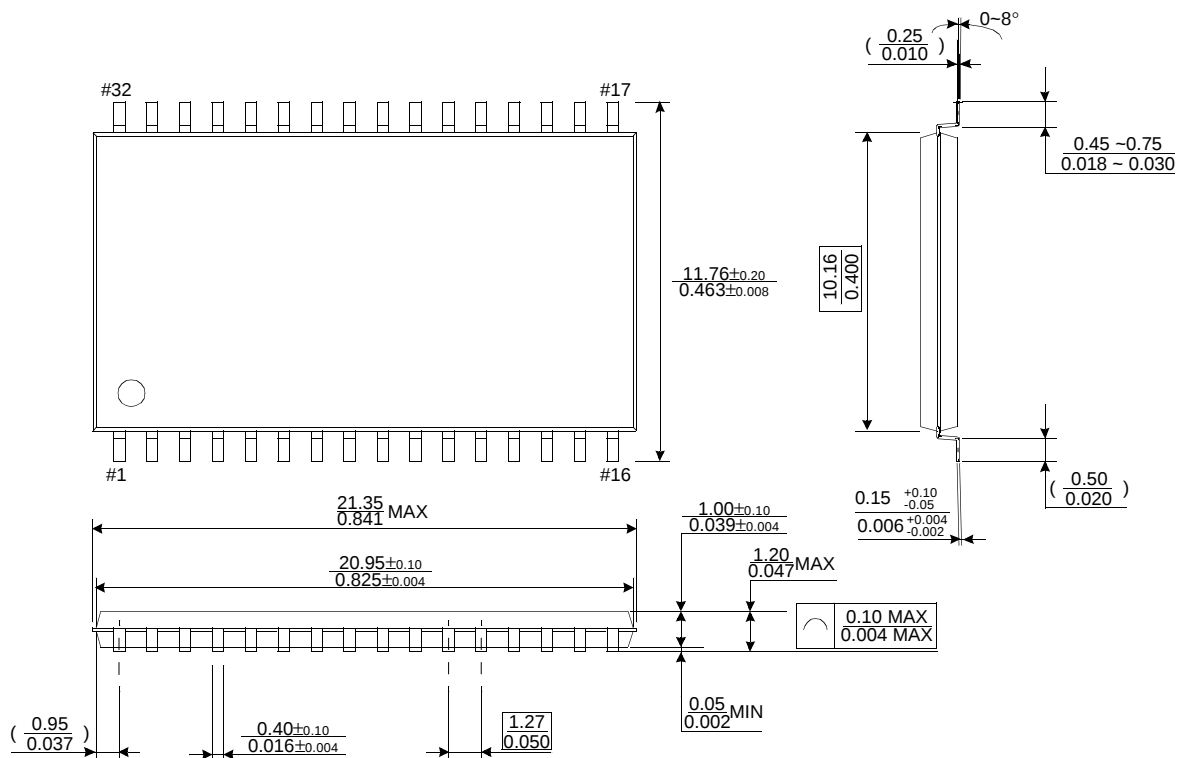
### 32 PIN PLASTIC SMALL OUTLINE PACKAGE (525mil)



## PACKAGE DIMENSIONS

Units : millimeter(Inch)

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



### 32 PIN THIN SMALL OUTLINE PACKAGE TYPE II (400R)

