

**Document Title**

**64Kx16 Bit High-Speed CMOS Static RAM(5.0V Operating).  
Operated at Commercial and Industrial Temperature Ranges.**

**Revision History**

| <u>Rev.No.</u> | <u>History</u>  | <u>Draft Data</u> | <u>Remark</u> |             |              |              |             |      |      |      |      |  |  |
|----------------|---|-------------------|---------------|-------------|--------------|--------------|-------------|------|------|------|------|--|--|
| Rev. 0.0       | Initial release with preliminary.   | Aug. 5. 1998      | Preliminary   |             |              |              |             |      |      |      |      |  |  |
| Rev. 1.0       | Relax DC characteristics.   | Sep. 7. 1998      | Preliminary   |             |              |              |             |      |      |      |      |  |  |
|                | <table border="1"> <thead> <tr> <th>Item</th> <th>Previous</th> <th>Changed</th> </tr> </thead> <tbody> <tr> <td rowspan="3">Icc</td> <td>12ns</td> <td>90mA</td> </tr> <tr> <td>15ns</td> <td>88mA</td> </tr> <tr> <td>20ns</td> <td>85mA</td> </tr> </tbody> </table> | Item              | Previous      | Changed     | Icc          | 12ns         | 90mA        | 15ns | 88mA | 20ns | 85mA |  |  |
| Item           | Previous  | Changed           |               |             |              |              |             |      |      |      |      |  |  |
| Icc            | 12ns  | 90mA              |               |             |              |              |             |      |      |      |      |  |  |
|                | 15ns  | 88mA              |               |             |              |              |             |      |      |      |      |  |  |
|                | 20ns  | 85mA              |               |             |              |              |             |      |      |      |      |  |  |
| Rev. 2.0       | Add 48-fine pitch BGA.  | Sep. 17. 1998     | Preliminary   |             |              |              |             |      |      |      |      |  |  |
| Rev. 2.1       | Changed device part name for FP-BGA.  | Nov. 5. 1998      | Final         |             |              |              |             |      |      |      |      |  |  |
|                | <table border="1"> <thead> <tr> <th>Item</th> <th>Previous</th> <th>Changed</th> </tr> </thead> <tbody> <tr> <td>Symbol</td> <td>Z</td> <td>F</td> </tr> </tbody> </table> <p>ex) K6R1016C1C-Z -&gt; K6R1016C1C-F</p>   | Item              | Previous      | Changed     | Symbol       | Z            | F           |      |      |      |      |  |  |
| Item           | Previous  | Changed           |               |             |              |              |             |      |      |      |      |  |  |
| Symbol         | Z   | F                 |               |             |              |              |             |      |      |      |      |  |  |
| Rev. 2.2       | Changed device ball name for FP-BGA.  | Dec. 10. 1998     | Final         |             |              |              |             |      |      |      |      |  |  |
|                | <table border="1"> <thead> <tr> <th>Previous</th> <th>Changed</th> </tr> </thead> <tbody> <tr> <td>I/O1 ~ I/O8</td> <td>I/O9 ~ I/O16</td> </tr> <tr> <td>I/O9 ~ I/O16</td> <td>I/O1 ~ I/O8</td> </tr> </tbody> </table>   | Previous          | Changed       | I/O1 ~ I/O8 | I/O9 ~ I/O16 | I/O9 ~ I/O16 | I/O1 ~ I/O8 |      |      |      |      |  |  |
| Previous       | Changed   |                   |               |             |              |              |             |      |      |      |      |  |  |
| I/O1 ~ I/O8    | I/O9 ~ I/O16  |                   |               |             |              |              |             |      |      |      |      |  |  |
| I/O9 ~ I/O16   | I/O1 ~ I/O8   |                   |               |             |              |              |             |      |      |      |      |  |  |
| Rev. 3.0       | Added Data Retention Characteristics.   | Mar. 3. 1999      | Final         |             |              |              |             |      |      |      |      |  |  |
| Rev. 3.1       | Add 10ns part.  | Mar. 3. 2000      | Final         |             |              |              |             |      |      |      |      |  |  |
| Rev. 4.0       | Delete 20ns speed bin   | Sep.24. 2001      | Final         |             |              |              |             |      |      |      |      |  |  |

The attached data sheets are prepared and approved by SAMSUNG Electronics. SAMSUNG Electronics CO., LTD. reserve the right to change the specifications. SAMSUNG Electronics will evaluate and reply to your requests and questions on the parameters of this device. If you have any questions, please contact the SAMSUNG branch office near your office, call or contact Headquarters.

64K x 16 Bit High-Speed CMOS Static RAM

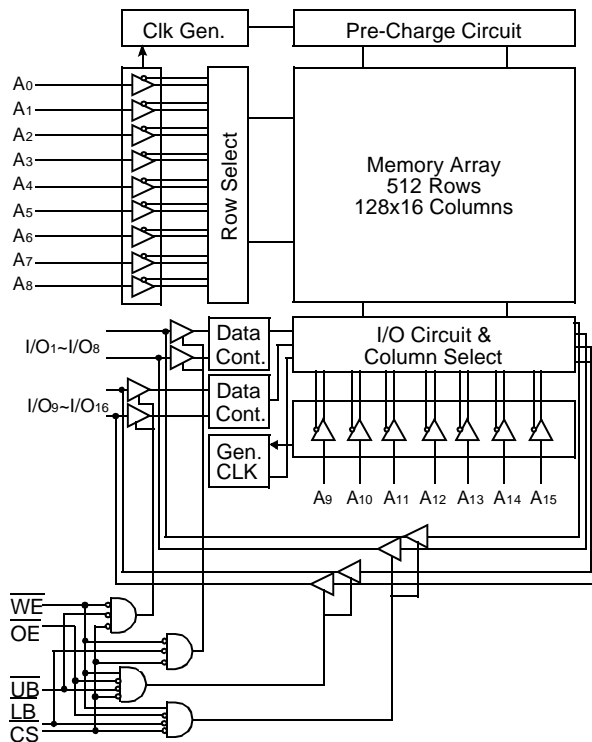
FEATURES

- Fast Access Time 10,12,15ns(Max.)
- Low Power Dissipation
  - Standby (TTL) : 30mA(Max.)
  - (CMOS) : 5mA(Max.)
  - 0.5mA(Max.) L-ver. only
- Operating K6R1016C1C-10 : 105mA(Max.)
- K6R1016C1C-12 : 95mA(Max.)
- K6R1016C1C-15 : 93mA(Max.)
- Single 5.0V±10% Power Supply
- TTL Compatible Inputs and Outputs
- I/O Compatible with 3.3V Device
- Fully Static Operation
  - No Clock or Refresh required
- Three State Outputs
- 2V Minimum Data Retention: L-ver. only
- Center Power/Ground Pin Configuration
- Data Byte Control:  $\overline{LB}$ : I/O<sub>1</sub>~ I/O<sub>8</sub>,  $\overline{UB}$ : I/O<sub>9</sub>~ I/O<sub>16</sub>
- Standard Pin Configuration:
  - K6R1016C1C-J : 44-SOJ-400
  - K6R1016C1C-T : 44-TSOP2-400BF
  - K6R1016C1C-F : 48-Fine pitch BGA with 0.75 Ball pitch

GENERAL DESCRIPTION

The K6R1016C1C is a 1,048,576-bit high-speed Static Random Access Memory organized as 65,536 words by 16 bits. The K6R1016C1C uses 16 common input and output lines and has at output enable pin which operates faster than address access time at read cycle. Also it allows that lower and upper byte access by data byte control ( $\overline{UB}$ ,  $\overline{LB}$ ). The device is fabricated using SAMSUNG's advanced CMOS process and designed for high-speed circuit technology. It is particularly well suited for use in high-density high-speed system applications. The K6R1016C1C is packaged in a 400mil 44-pin plastic SOJ or TSOP2 forward or 48-Fine pitch BGA.

FUNCTIONAL BLOCK DIAGRAM



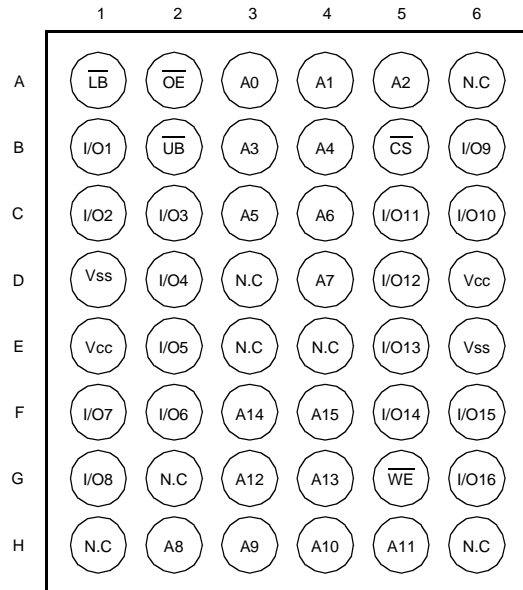
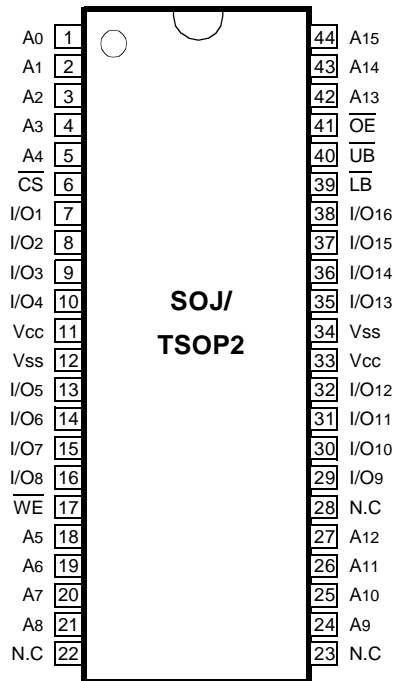
ORDERING INFORMATION

|                        |                  |
|------------------------|------------------|
| K6R1016C1C-C10/C12/C15 | Commercial Temp. |
| K6R1016C1C-I10/I12/I15 | Industrial Temp. |

PIN FUNCTION

| Pin Name                             | Pin Function   |
|--------------------------------------|--|
| A <sub>0</sub> - A <sub>15</sub>     | Address Inputs   |
| $\overline{WE}$                      | Write Enable   |
| $\overline{CS}$                      | Chip Select  |
| $\overline{OE}$                      | Output Enable  |
| $\overline{LB}$                      | Lower-byte Control(I/O <sub>1</sub> ~I/O <sub>8</sub> )  |
| $\overline{UB}$                      | Upper-byte Control(I/O <sub>9</sub> ~I/O <sub>16</sub> ) |
| I/O <sub>1</sub> ~ I/O <sub>16</sub> | Data Inputs/Outputs                                      |
| V <sub>cc</sub>                      | Power(+5.0V)   |
| V <sub>ss</sub>                      | Ground   |
| N.C                                  | No Connection  |

PIN CONFIGURATION(TOP VIEW)



ABSOLUTE MAXIMUM RATINGS\*

| Parameter   | Symbol                             | Rating                       | Unit      |
|---|------------------------------------|------------------------------|-----------|
| 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>                    | -0.5 to 7.0                  | V         |
| Power Dissipation                                 | P <sub>d</sub>                     | 1                            | W         |
| Storage Temperature                               | T <sub>STG</sub>                   | -65 to 150                   | °C        |
| Operating Temperature                             | Commercial                         | T <sub>A</sub>               | 0 to 70   |
|   | Industrial                         | T <sub>A</sub>               | -40 to 85 |

\* Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

RECOMMENDED DC OPERATING CONDITIONS\*(T<sub>A</sub>= to 70°C)

| Parameter          | 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*** | V    |
| Input Low Voltage  | V <sub>IL</sub> | -0.5** | -   | 0.8                     | V    |

\* The above parameters are also guaranteed at industrial temperature range.

\*\* V<sub>IL</sub>(Min) = -2.0V a.c(Pulse Width ≤ 8ns) for I ≤ 20mA.

\*\*\* V<sub>IH</sub>(Max) = V<sub>CC</sub> + 2.0V a.c(Pulse Width ≤ 8ns) for I ≤ 20mA.

## DC AND OPERATING CHARACTERISTICS\* (TA=0 to 70°C, VCC=5.0V±10%, unless otherwise specified)

| Parameter                 | Symbol | Test Conditions   | Min    | Max  | Unit |    |
|---------------------------|--------|---|--------|------|------|----|
| Input Leakage Current     | ILI    | VIN=VSS to VCC  | -2     | 2    | μA   |    |
| Output Leakage Current    | ILO    | CS=VIH or OE=VIH or WE=VIL<br>VOUT=VSS to VCC               | -2     | 2    | μA   |    |
| Operating Current         | ICC    | Min. Cycle, 100% Duty<br>CS=VIL, VIN = VIH or VIL, IOUT=0mA | 10ns   | -    | 105  | mA |
|                           |        |   | 12ns   | -    | 95   |    |
|                           |        |   | 15ns   | -    | 93   |    |
| Standby Current           | ISB    | Min. Cycle, CS=VIH  | -      | 30   | mA   |    |
|                           | ISB1   | f=0MHz, CS ≥ VCC-0.2V,<br>VIN ≥ VCC-0.2V or VIN ≤ 0.2V      | Normal | 5    |      | mA |
|                           |        |   | L-Ver. | 0.5  |      |    |
| Output Low Voltage Level  | VOL    | IOL=8mA   | -      | 0.4  | V    |    |
| Output High Voltage Level | VOH    | Ioh=-4mA  | 2.4    | -    | V    |    |
|                           | VOH1** | Ioh1=-0.1mA   | -      | 3.95 | V    |    |

\* The above parameters are also guaranteed at industrial temperature range.

\*\* VCC=5.0V±5%, Temp.=25°C

## CAPACITANCE\* (TA=25°C, f=1.0MHz)

| Item                     | Symbol           | Test Conditions      | MIN | Max | Unit |
|--------------------------|------------------|----------------------|-----|-----|------|
| Input/Output Capacitance | C <sub>I/O</sub> | V <sub>I/O</sub> =0V | -   | 8   | pF   |
| Input Capacitance        | C <sub>IN</sub>  | V <sub>IN</sub> =0V  | -   | 6   | pF   |

\* Capacitance is sampled and not 100% tested.

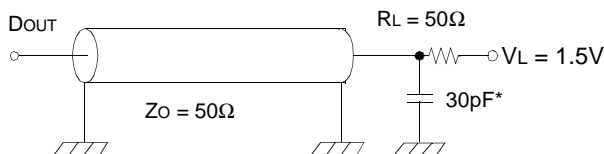
## AC CHARACTERISTICS (TA=0 to 70°C, VCC=5.0V±10%, unless otherwise noted.)

### TEST CONDITIONS\*

| Parameter                                | Value     |
|--|-----------|
| Input Pulse Levels                       | 0V to 3V  |
| Input Rise and Fall Times                | 3ns       |
| Input and Output timing Reference Levels | 1.5V      |
| Output Loads                             | See below |

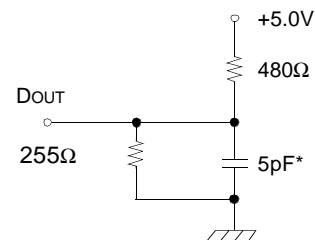
\* The above test conditions are also applied at industrial temperature range.

Output Loads(A)



Output Loads(B)

for tHZ, tLZ, tWHZ, tOW, tOLZ & tOHZ



\* Capacitive Load consists of all components of the test environment.

\* Including Scope and Jig Capacitance

READ CYCLE\*

| Parameter  | Symbol           | K6R1016C1C-10 |     | K6R1016C1C-12 |     | K6R1016C1C-15 |     | Unit |
|--|------------------|---------------|-----|---------------|-----|---------------|-----|------|
|  |                  | Min           | Max | Min           | Max | Min           | Max |      |
| Read Cycle Time  | t <sub>RC</sub>  | 10            | -   | 12            | -   | 15            | -   | ns   |
| Address Access Time  | t <sub>AA</sub>  | -             | 10  | -             | 12  | -             | 15  | ns   |
| Chip Select to Output                                      | t <sub>CO</sub>  | -             | 10  | -             | 12  | -             | 15  | ns   |
| Output Enable to Valid Output                              | t <sub>OE</sub>  | -             | 5   | -             | 6   | -             | 7   | ns   |
| $\overline{UB}$ , $\overline{LB}$ Access Time              | t <sub>BA</sub>  | -             | 5   | -             | 6   | -             | 7   | ns   |
| Chip Enable to Low-Z Output                                | t <sub>LZ</sub>  | 3             | -   | 3             | -   | 3             | -   | ns   |
| $\overline{UB}$ , $\overline{LB}$ Enable to Low-Z Output   | t <sub>BLZ</sub> | 0             | -   | 0             | -   | 0             | -   | ns   |
| Output Enable to Low-Z Output                              | t <sub>OLZ</sub> | 0             | -   | 0             | -   | 0             | -   | ns   |
| Chip Disable to High-Z Output                              | t <sub>HZ</sub>  | 0             | 5   | 0             | 6   | -             | 7   | ns   |
| Output Disable to High-Z Output                            | t <sub>OHZ</sub> | 0             | 5   | 0             | 6   | -             | 7   | ns   |
| $\overline{UB}$ , $\overline{LB}$ Disable to High-Z Output | t <sub>BHZ</sub> | 0             | 5   | 0             | 6   | -             | 7   | ns   |
| Output Hold from Address Change                            | t <sub>OH</sub>  | 3             | -   | 3             | -   | 3             | -   | ns   |
| Chip Selection to Power Up Time                            | t <sub>PU</sub>  | 0             | -   | 0             | -   | 0             | -   | ns   |
| Chip Selection to Power Down Time                          | t <sub>PD</sub>  | -             | 10  | -             | 12  | -             | 15  | ns   |

\* The above parameters are also guaranteed at industrial temperature range.

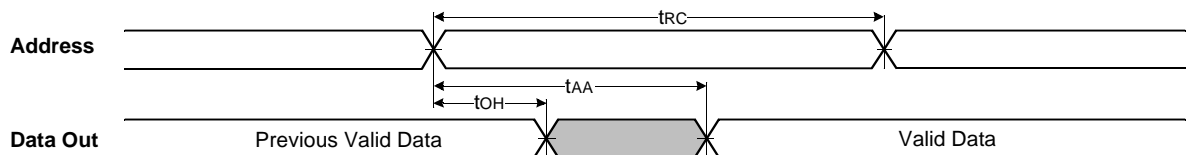
WRITE CYCLE\*

| Parameter   | Symbol           | K6R1016C10-12 |     | K6R1016C1C-12 |     | K6R1016C1C-15 |     | Unit |
|---|------------------|---------------|-----|---------------|-----|---------------|-----|------|
|   |                  | Min           | Max | Min           | Max | Min           | Max |      |
| Write Cycle Time  | t <sub>WC</sub>  | 10            | -   | 12            | -   | 15            | -   | ns   |
| Chip Select to End of Write                             | t <sub>CW</sub>  | 7             | -   | 8             | -   | 9             | -   | ns   |
| Address Set-up Time                                     | t <sub>AS</sub>  | 0             | -   | 0             | -   | 0             | -   | ns   |
| Address Valid to End of Write                           | t <sub>AW</sub>  | 7             | -   | 8             | -   | 9             | -   | ns   |
| Write Pulse Width( $\overline{OE}$ High)                | t <sub>WP</sub>  | 7             | -   | 8             | -   | 9             | -   | ns   |
| Write Pulse Width( $\overline{OE}$ Low)                 | t <sub>WP1</sub> | 10            | -   | 12            | -   | 15            | -   | ns   |
| $\overline{UB}$ , $\overline{LB}$ Valid to End of Write | t <sub>BW</sub>  | 7             | -   | 8             | -   | 9             | -   | ns   |
| Write Recovery Time                                     | t <sub>WR</sub>  | 0             | -   | 0             | -   | 0             | -   | ns   |
| Write to Output High-Z                                  | t <sub>WHZ</sub> | 0             | 5   | 0             | 6   | 0             | 7   | ns   |
| Data to Write Time Overlap                              | t <sub>DW</sub>  | 5             | -   | 6             | -   | 7             | -   | ns   |
| Data Hold from Write Time                               | t <sub>DH</sub>  | 0             | -   | 0             | -   | 0             | -   | ns   |
| End Write to Output Low-Z                               | t <sub>OW</sub>  | 3             | -   | 3             | -   | 3             | -   | ns   |

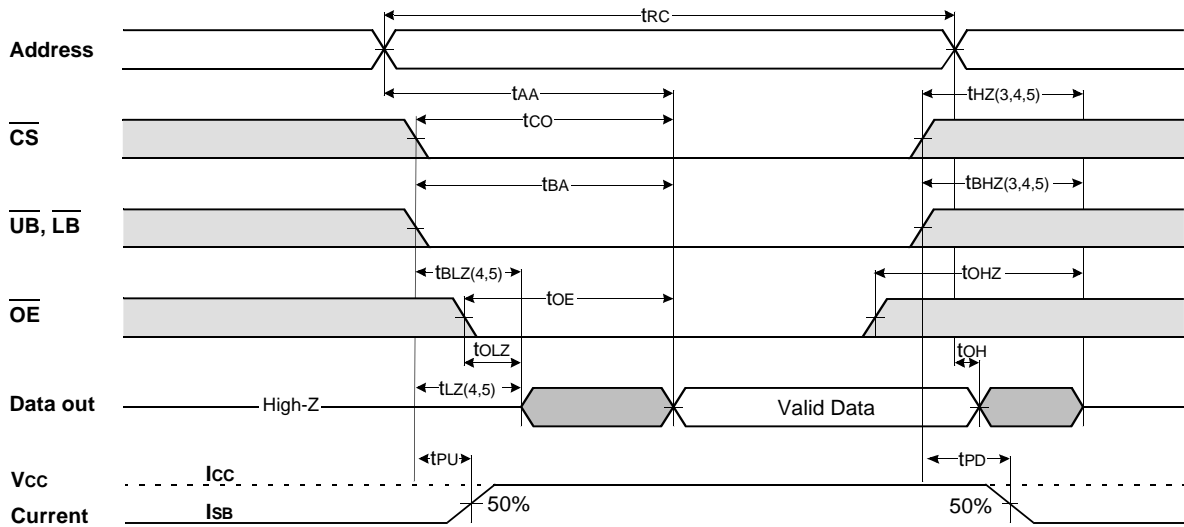
\* The above parameters are also guaranteed at industrial temperature range.

TIMING DIAGRAMS

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



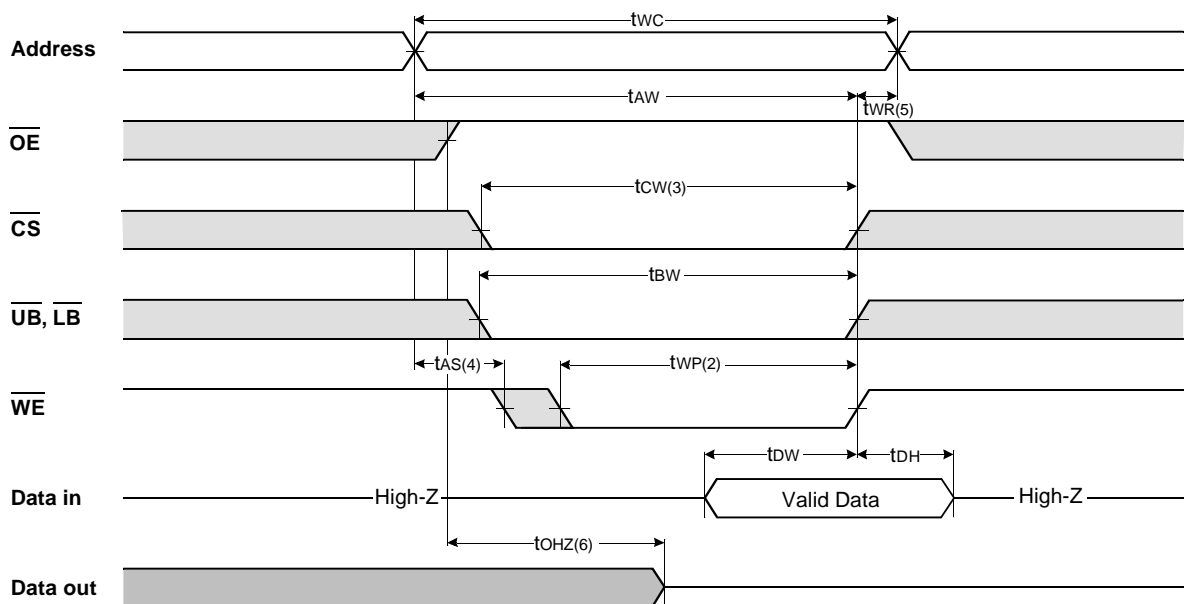
TIMING WAVEFORM OF READ CYCLE(2) ( $\overline{WE}=V_{IH}$ )



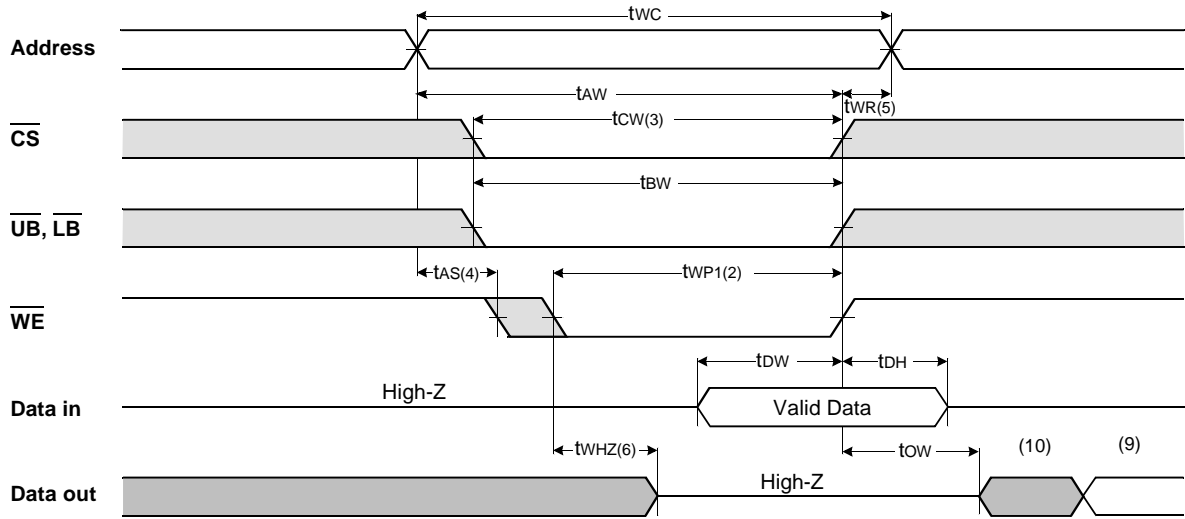
NOTES(READ CYCLE)

1.  $\overline{WE}$  is high for read cycle.
2. All read cycle timing is referenced from the last valid address to the first transition address.
3.  $t_{HZ}$  and  $t_{OHZ}$  are defined as the time at which the outputs achieve the open circuit condition and are not referenced to  $V_{OH}$  or  $V_{OL}$  levels.
4. 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.
5. Transition is measured  $\pm 200\text{mV}$  from steady state voltage with Load(B). This parameter is sampled and not 100% tested.
6. Device is continuously selected with  $\overline{CS}=V_{IL}$ .
7. Address valid prior to coincident with  $\overline{CS}$  transition low.
8. For common I/O applications, minimization or elimination of bus contention conditions is necessary during read and write cycle.

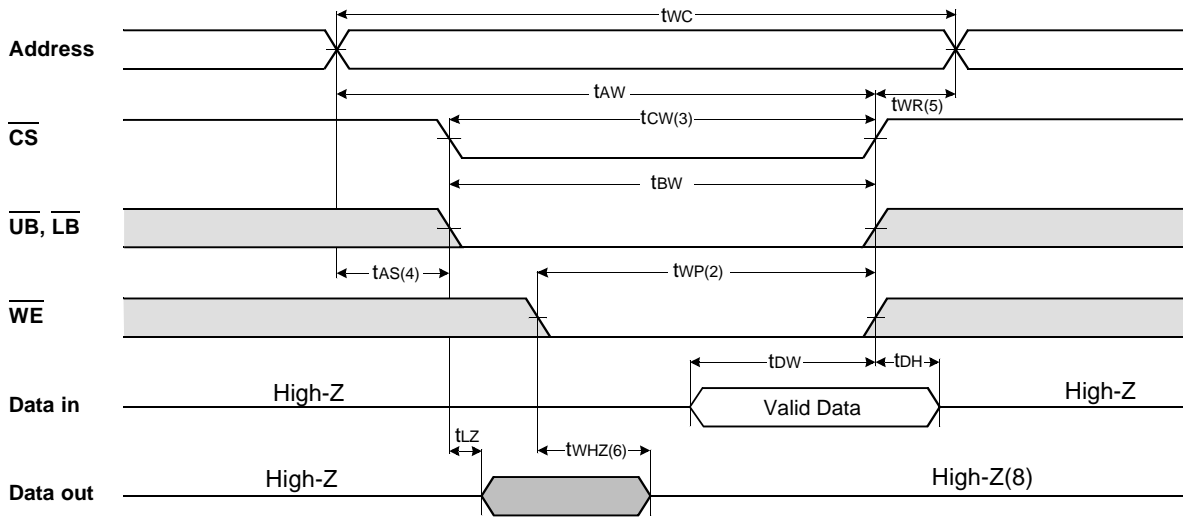
TIMING WAVEFORM OF WRITE CYCLE(1) ( $\overline{OE}=\text{Clock}$ )



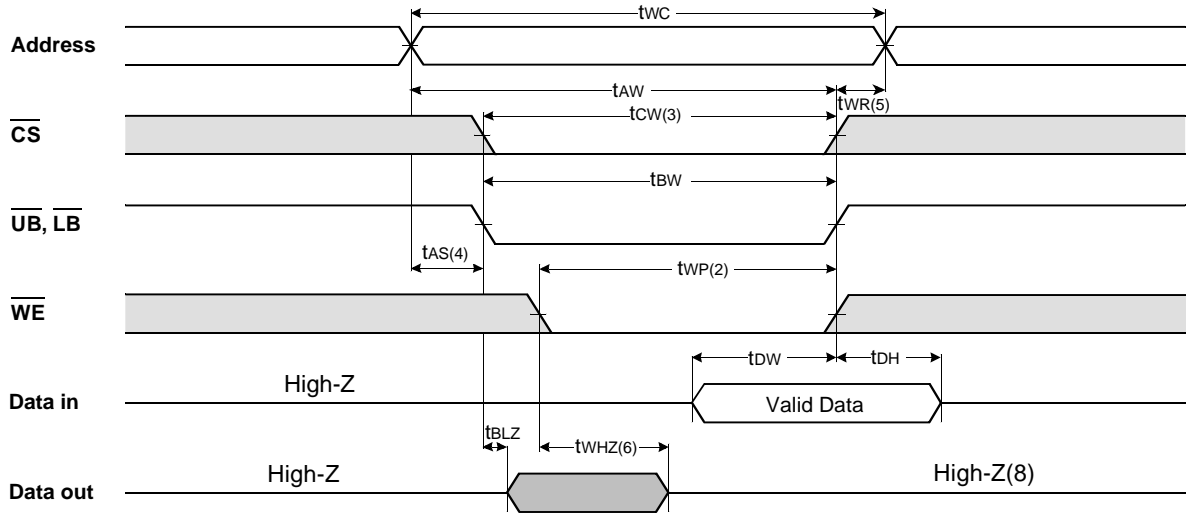
TIMING WAVEFORM OF WRITE CYCLE(2) ( $\overline{OE}$  =Low fixed)



TIMING WAVEFORM OF WRITE CYCLE(3) ( $\overline{CS}$ =Controlled)



TIMING WAVEFORM OF WRITE CYCLE(4) ( $\overline{UB}$ ,  $\overline{LB}$  Controlled)



NOTES(WRITE CYCLE)

1. All write cycle timing is referenced from the last valid address to the first transition address.
2. A write occurs during the overlap of a low CS, WE, LB and UB. A write begins at the latest transition CS going low and WE going low; A write ends at the earliest transition CS going high or WE going high. tWP is measured from the beginning of write to the end of write.
3. tcw is measured from the later of CS going low to end of write.
4. tAS is measured from the address valid to the beginning of write.
5. tWR is measured from the end of write to the address change. tWR applied in case a write ends as CS or WE going high.
6. If OE, CS and WE are in the Read Mode during this period, the I/O pins are in the output low-Z state. Inputs of opposite phase of the output must not be applied because bus contention can occur.
7. For common I/O applications, minimization or elimination of bus contention conditions is necessary during read and write cycle.
8. If CS goes low simultaneously with WE going or after WE going low, the outputs remain high impedance state.
9. Dout is the read data of the new address.
10. When CS is low: I/O pins are in the output state. The input signals in the opposite phase leading to the output should not be applied.

FUNCTIONAL DESCRIPTION

| $\overline{CS}$ | $\overline{WE}$ | $\overline{OE}$ | $\overline{LB}$ | $\overline{UB}$ | Mode           | I/O Pin   |            | Supply Current |
|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|-----------|------------|----------------|
|                 |                 |                 |                 |                 |                | I/O1~I/O8 | I/O9~I/O16 |                |
| H               | X               | X*              | X               | X               | Not Select     | High-Z    | High-Z     | ISB, ISB1      |
| L               | H               | H               | X               | X               | Output Disable | High-Z    | High-Z     | Icc            |
| L               | X               | X               | H               | H               | Read           | DOUT      | High-Z     | Icc            |
| L               | H               | L               | L               | H               |                | High-Z    | DOUT       |                |
| L               | H               | L               | L               | L               |                | DOUT      | DOUT       |                |
| L               | L               | X               | L               | H               | Write          | DIN       | High-Z     | Icc            |
| L               | L               | X               | H               | L               |                | High-Z    | DIN        |                |
| L               | L               | X               | L               | L               |                | DIN       | DIN        |                |

\* X means Don't Care.

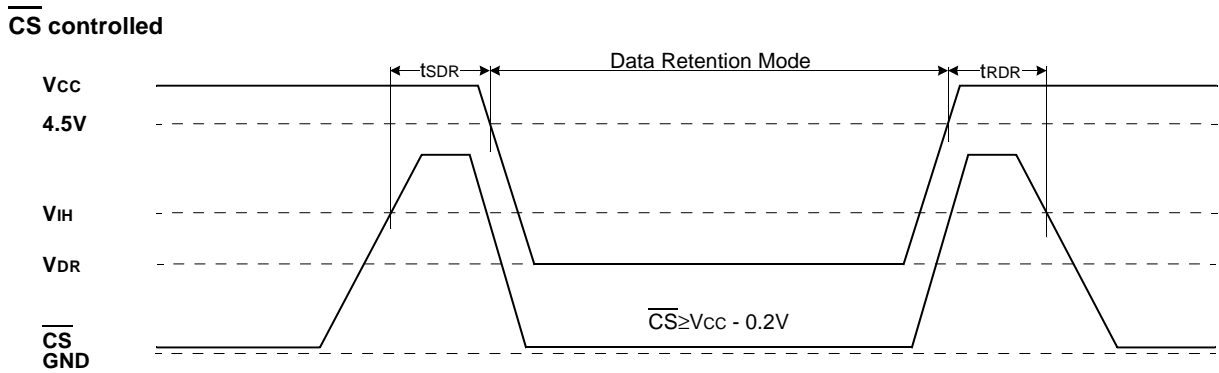


DATA RETENTION CHARACTERISTICS\*(TA=0 to 70°C)

| Parameter                  | Symbol | Test Condition   | Min. | Typ. | Max. | Unit |
|----------------------------|--------|--|------|------|------|------|
| Vcc for Data Retention     | VDR    | $\overline{CS} \geq V_{CC} - 0.2V$   | 2.0  | -    | 5.5  | V    |
| Data Retention Current     | IDR    | $V_{CC} = 3.0V, \overline{CS} \geq V_{CC} - 0.2V$<br>$V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} \leq 0.2V$ | -    | -    | 0.4  | mA   |
|                            |        | $V_{CC} = 2.0V, \overline{CS} \geq V_{CC} - 0.2V$<br>$V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} \leq 0.2V$ | -    | -    | 0.3  |      |
| Data Retention Set-Up Time | tSDR   | See Data Retention Wave form(below)  | 0    | -    | -    | ns   |
| Recovery Time              | tRDR   | See Data Retention Wave form(below)  | 5    | -    | -    | ms   |

\* The above parameters are also guaranteed at industrial temperature range.  
Data Retention Characteristic is for L-ver only.

DATA RETENTION WAVE FORM



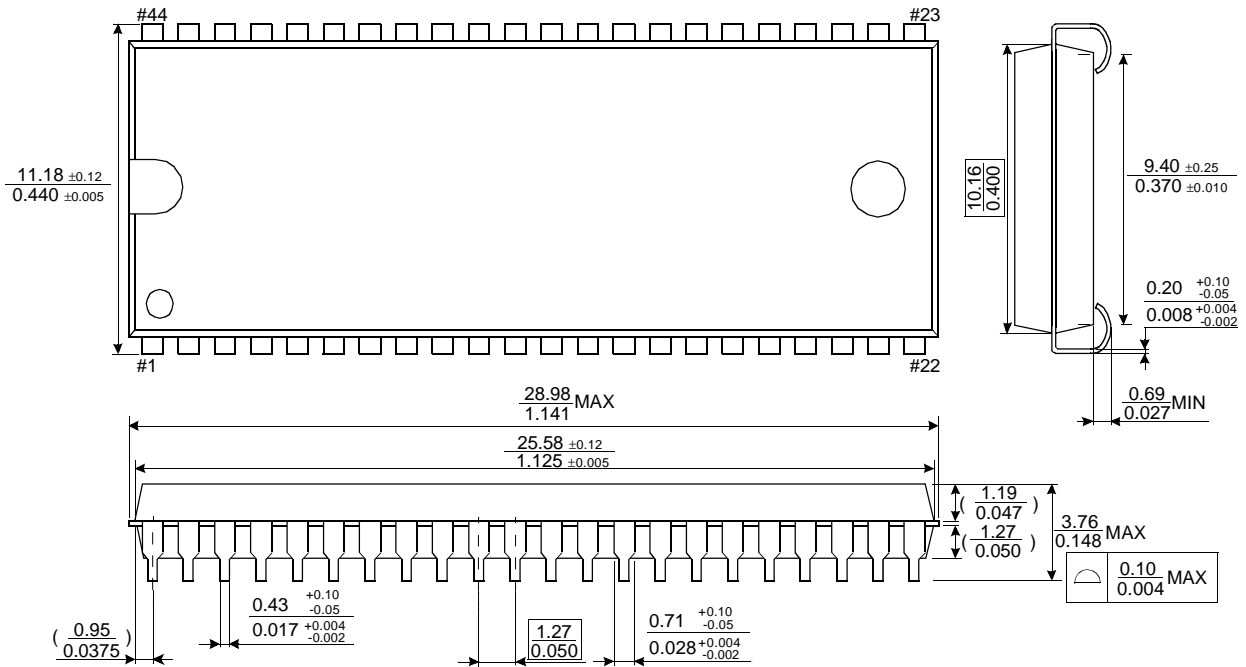
# K6R1016C1C-C/C-L, K6R1016C1C-I/C-P

# CMOS SRAM

## PACKAGE DIMENSIONS

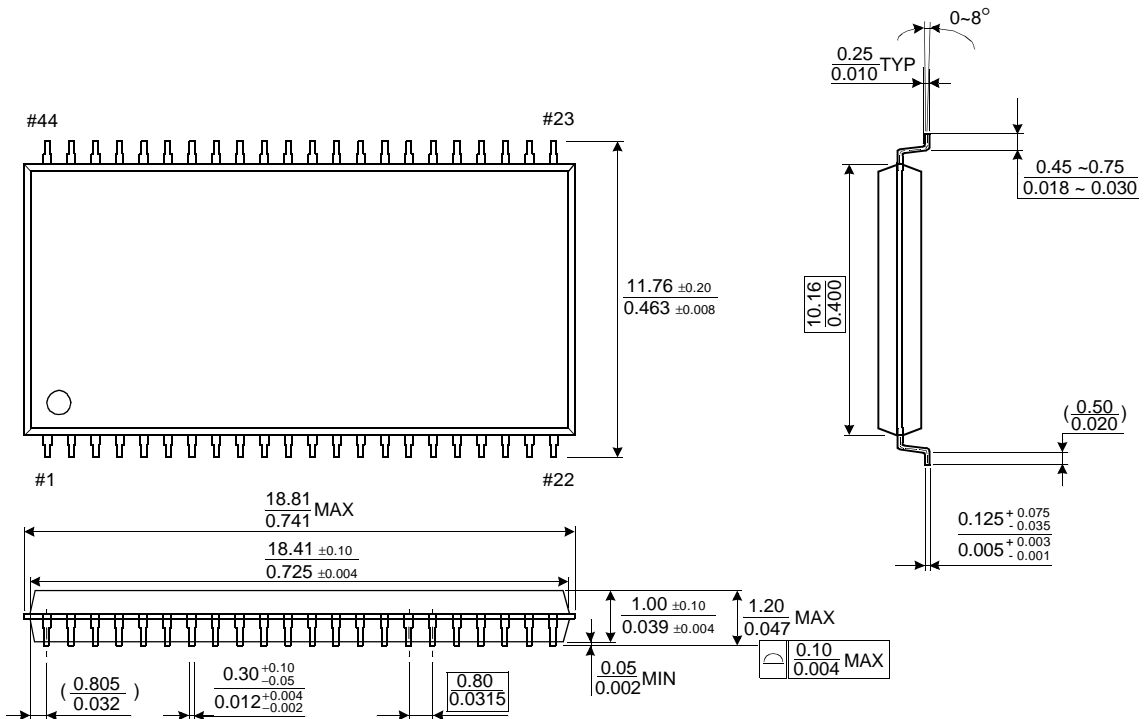
Units: millimeters/Inches

### 44-SOJ-400



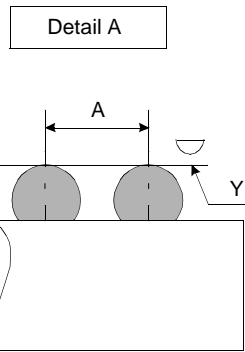
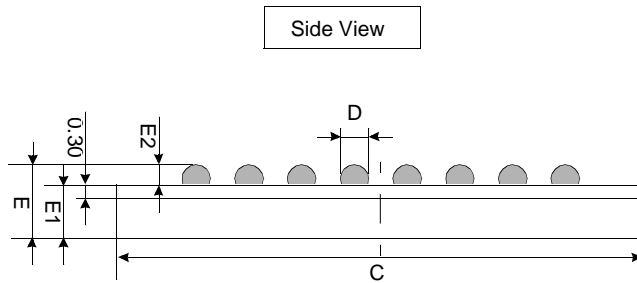
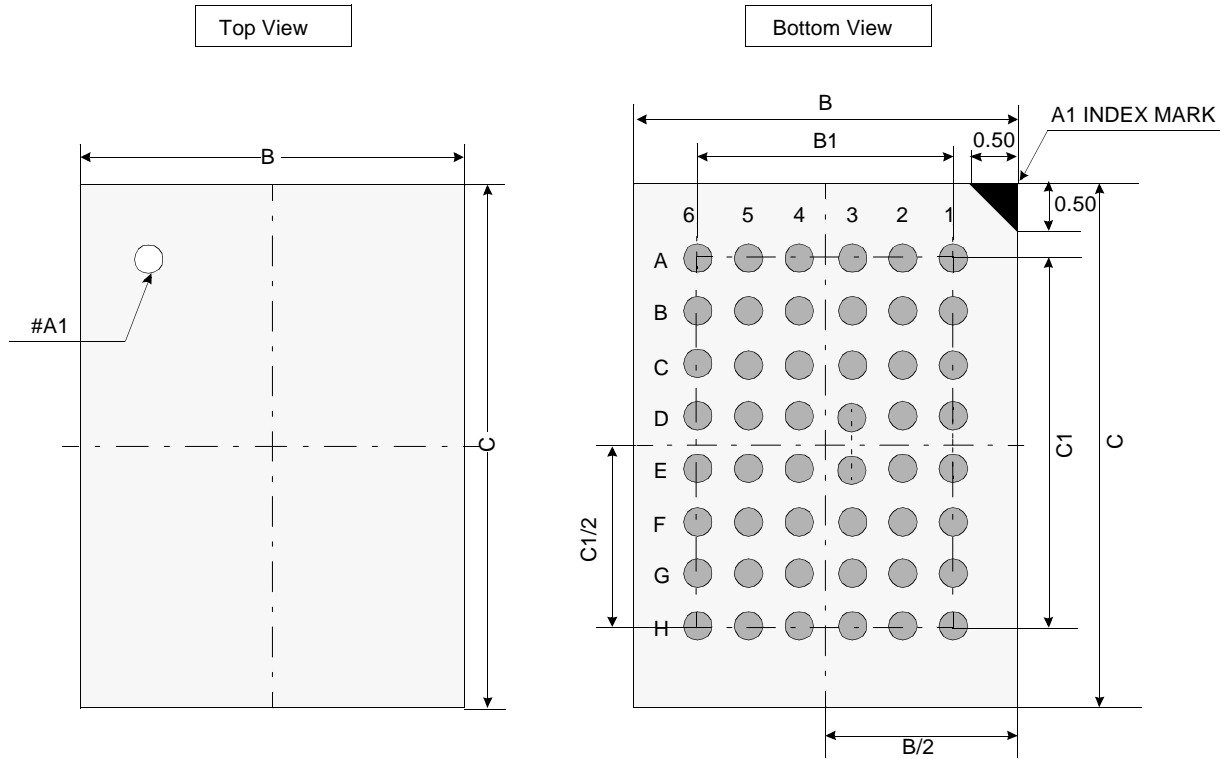
### 44-TSOP2-400BF

Units: millimeters/Inches



PACKAGE OUTLINE

(Units : millimeter)



|    | Min  | Typ  | Max  |
|----|------|------|------|
| A  | -    | 0.75 | -    |
| B  | 5.90 | 6.00 | 6.10 |
| B1 | -    | 3.75 | -    |
| C  | 6.90 | 7.00 | 7.10 |
| C1 | -    | 5.25 | -    |
| D  | 0.30 | 0.35 | 0.40 |
| E  | -    | 1.05 | 1.20 |
| E1 | -    | 0.80 | -    |
| E2 | 0.20 | 0.25 | 0.30 |
| Y  | -    | -    | 0.08 |

- Notes.**
1. Bump counts: 48(8row x 6column)
  2. Bump pitch : (x,y)=(0.75 x 0.75)(typ.)
  3. All tolerance are +/-0.050 unless otherwise specified.
  4. Typ : Typical
  5. Y is coplanarity: 0.08(Max)