Document Title

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

Revision History

Rev.No.	History	Draft Data	Remark
Rev. 0.0	Initial release with preliminary.	Aug. 5. 1998	Preliminary
Rev. 1.0	Relax DC characteristics.	Sep. 7. 1998	Preliminary
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
Rev. 2.2	Changed device ball name for FP-BGA.	Dec. 10. 1998	Final
Rev. 3.0	Added Data Retention Characteristics.	Mar. 3. 1999	Final
Rev. 3.1	Add 10ns part.	Mar. 3. 2000	Final

Rev. 1.0

Item		Previous	Changed
Icc	12ns	90mA	95mA
	15ns	88mA	93mA
	20ns	85mA	90mA

Rev. 2.1

Item	Previous	Changed
Symbol	Z	F

ex) K6R1016C1C-Z -> K6R1016C1C-F

Rev. 2.2

Previous	Changed
I/O1 ~ I/O8	I/O9 ~ I/O16
I/O9 ~ I/O16	I/O1 ~ I/O8

64K x 16 Bit High-Speed CMOS Static RAM

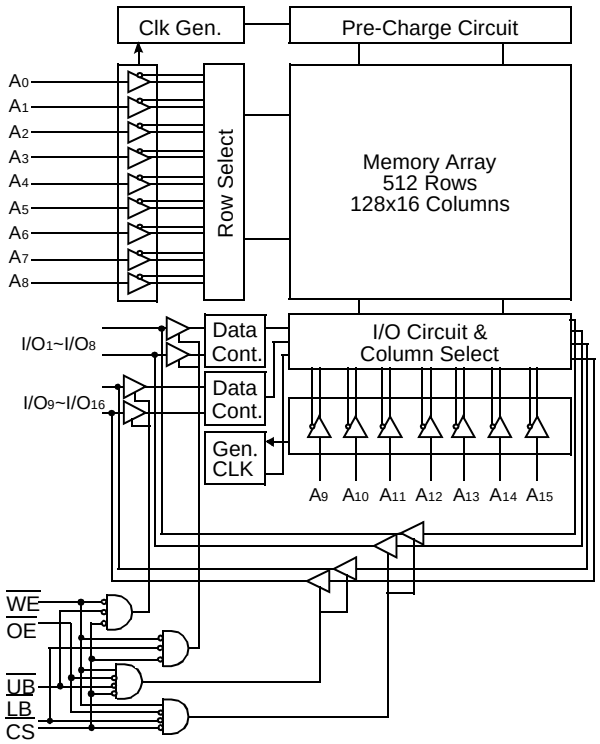
FEATURES

- Fast Access Time 10,12,15,20ns(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.)
  - K6R1016C1C-20: 90mA(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_1~ I/O_8, $\overline{UB}$: I/O_9~ I/O_{16}
- 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



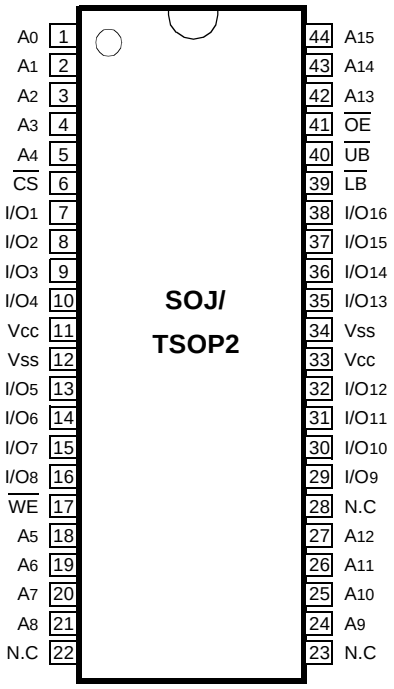
ORDERING INFORMATION

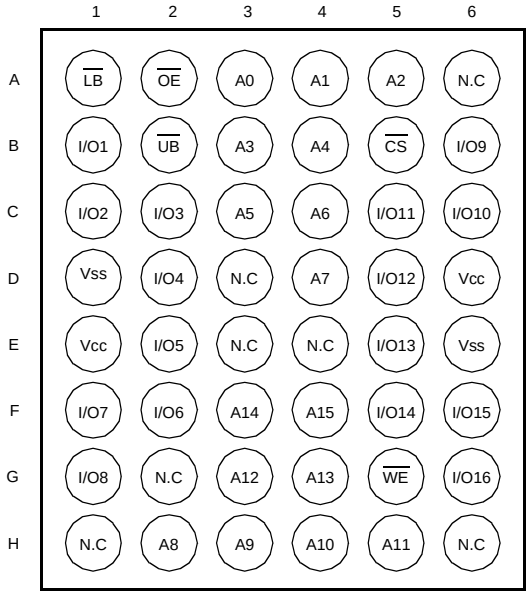
K6R1016C1C-C10/C12/C15/C20	Commercial Temp.
K6R1016C1C-I10/I12/I15/I20	Industrial Temp.

PIN FUNCTION

Pin Name	Pin Function
A_0 - A_{15}	Address Inputs
$\overline{WE}$	Write Enable
$\overline{CS}$	Chip Select
$\overline{OE}$	Output Enable
$\overline{LB}$	Lower-byte Control(I/O_1~I/O_8)
$\overline{UB}$	Upper-byte Control(I/O_9~I/O_{16})
I/O_1 ~ I/O_{16}	Data Inputs/Outputs
V_{CC}	Power(+5.0V)
V_{SS}	Ground
N.C	No Connection

PIN CONFIGURATION*(TOP VIEW)*





48-CSP

ABSOLUTE MAXIMUM RATINGS*

Parameter		Symbol	Rating	Unit
Voltage on Any Pin Relative to V_{SS}		V_{IN}, V_{OUT}	-0.5 to V_{CC}+0.5	V
Voltage on V_{CC} Supply Relative to V_{SS}		V_{CC}	-0.5 to 7.0	V
Power Dissipation		P_d	1	W
Storage Temperature		T_{STG}	-65 to 150	°C
Operating Temperature	Commercial	T_A	0 to 70	°C
	Industrial	T_A	-40 to 85	°C

***** 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*(TA= to 70°C)

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
Ground	V_{SS}	0	0	0	V
Input High Voltage	V_{IH}	2.2	-	V_{CC}+0.5***	V
Input Low Voltage	V_{IL}	-0.5**	-	0.8	V

* The above parameters are also guaranteed at industrial temperature range.
****** V_{IL}(Min) = -2.0V a.c(Pulse Width ≤ 8ns) for I ≤ 20mA.
******* V_{IH}(Max) = V_{CC} + 2.0V a.c(Pulse Width ≤ 8ns) for I ≤ 20mA.

DC AND OPERATING CHARACTERISTICS*(T_A=0 to 70°C, V_{CC}=5.0V±10%, unless otherwise specified)

Parameter	Symbol	Test Conditions		Min	Max	Unit
Input Leakage Current	I_{LI}	V_{IN}=V_{SS} to V_{CC}		-2	2	µA
Output Leakage Current	I_{LO}	$\overline{CS}$=V_{IH} or $\overline{OE}$=V_{IH} or $\overline{WE}$=V_{IL} V_{OUT}=V_{SS} to V_{CC}		-2	2	µA
Operating Current	I_{CC}	Min. Cycle, 100% Duty $\overline{CS}$=V_{IL}, V_{IN} = V_{IH} or V_{IL}, I_{OUT}=0mA	10ns	-	105	mA
			12ns	-	95	
			15ns	-	93	
			20ns	-	90	
Standby Current	I_{SB}	Min. Cycle, $\overline{CS}$=V_{IH}		-	30	mA
	I_{SB1}	f=0MHz, $\overline{CS}$ ≥V_{CC}-0.2V, V_{IN}≥V_{CC}-0.2V or V_{IN} ≤0.2V	Normal	-	5	mA
			L-Ver.	-	0.5	
Output Low Voltage Level	V_{OL}	I_{OL}=8mA		-	0.4	V
Output High Voltage Level	V_{OH}	I_{OH}=-4mA		2.4	-	V
	V_{OH1}**	I_{OH1}=-0.1mA		-	3.95	V

* The above parameters are also guaranteed at industrial temperature range.
** V_{CC}=5.0V±5%, Temp.=25°C

CAPACITANCE*(T_A=25°C, f=1.0MHz)

Item	Symbol	Test Conditions	MIN	Max	Unit
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	-	8	pF
Input Capacitance	C_{IN}	V_{IN}=0V	-	6	pF

* Capacitance is sampled and not 100% tested.

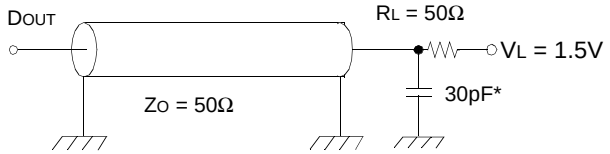
AC CHARACTERISTICS(T_A=0 to 70°C, V_{CC}=5.0V±10%, unless otherwise noted.)

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

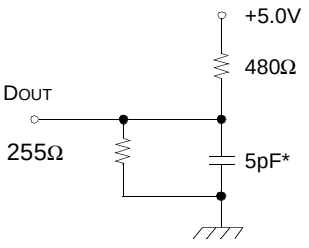
* The above test conditions are also applied at industrial temperature range.

Output Loads(A)



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

Output Loads(B)
for t_{HZ}, t_{LZ}, t_{WHZ}, t_{OW}, t_{OLZ} & t_{OHZ}



* Including Scope and Jig Capacitance

READ CYCLE*

Parameter	Symbol	K6R1016C1C-10		K6R1016C1C-12		K6R1016C1C-15		K6R1016C1C-20		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
Read Cycle Time	t_{RC}	10	-	12	-	15	-	20	-	ns
Address Access Time	t_{AA}	-	10	-	12	-	15	-	20	ns
Chip Select to Output	t_{CO}	-	10	-	12	-	15	-	20	ns
Output Enable to Valid Output	t_{OE}	-	5	-	6	-	7	-	9	ns
$\overline{UB}$, $\overline{LB}$ Access Time	t_{BA}	-	5	-	6	-	7	-	9	ns
Chip Enable to Low-Z Output	t_{LZ}	3	-	3	-	3	-	3	-	ns
$\overline{UB}$, $\overline{LB}$ Enable to Low-Z Output	t_{BLZ}	0	-	0	-	0	-	0	-	ns
Output Enable to Low-Z Output	t_{OLZ}	0	-	0	-	0	-	0	-	ns
Chip Disable to High-Z Output	t_{HZ}	0	5	0	6	-	7	-	9	ns
Output Disable to High-Z Output	t_{OHZ}	0	5	0	6	-	7	-	9	ns
$\overline{UB}$, $\overline{LB}$ Disable to High-Z Output	t_{BHZ}	0	5	0	6	-	7	-	9	ns
Output Hold from Address Change	t_{OH}	3	-	3	-	3	-	3	-	ns
Chip Selection to Power Up Time	t_{PU}	0	-	0	-	0	-	0	-	ns
Chip Selection to Power DownTime	t_{PD}	-	10	-	12	-	15	-	20	ns

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

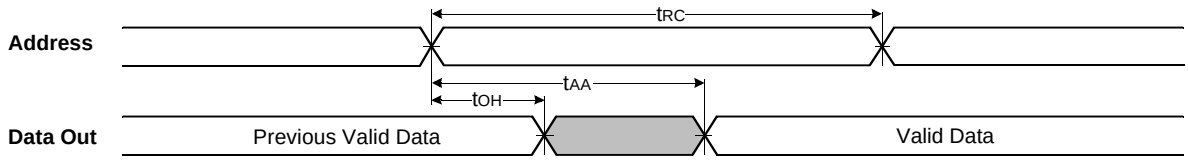
WRITE CYCLE*

Parameter	Symbol	K6R1016C10-12		K6R1016C1C-12		K6R1016C1C-15		K6R1016C1C-20		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
Write Cycle Time	t_{WC}	10	-	12	-	15	-	20	-	ns
Chip Select to End of Write	t_{CW}	7	-	8	-	9	-	10	-	ns
Address Set-up Time	t_{AS}	0	-	0	-	0	-	0	-	ns
Address Valid to End of Write	t_{AW}	7	-	8	-	9	-	10	-	ns
Write Pulse Width($\overline{OE}$ High)	t_{WP}	7	-	8	-	9	-	10	-	ns
Write Pulse Width($\overline{OE}$ Low)	t_{WP1}	10	-	12	-	15	-	20	-	ns
$\overline{UB}$, $\overline{LB}$ Valid to End of Write	t_{BW}	7	-	8	-	9	-	10	-	ns
Write Recovery Time	t_{WR}	0	-	0	-	0	-	0	-	ns
Write to Output High-Z	t_{WHZ}	0	5	0	6	0	7	0	9	ns
Data to Write Time Overlap	t_{DW}	5	-	6	-	7	-	8	-	ns
Data Hold from Write Time	t_{DH}	0	-	0	-	0	-	0	-	ns
End Write to Output Low-Z	t_{OW}	3	-	3	-	3	-	3	-	ns

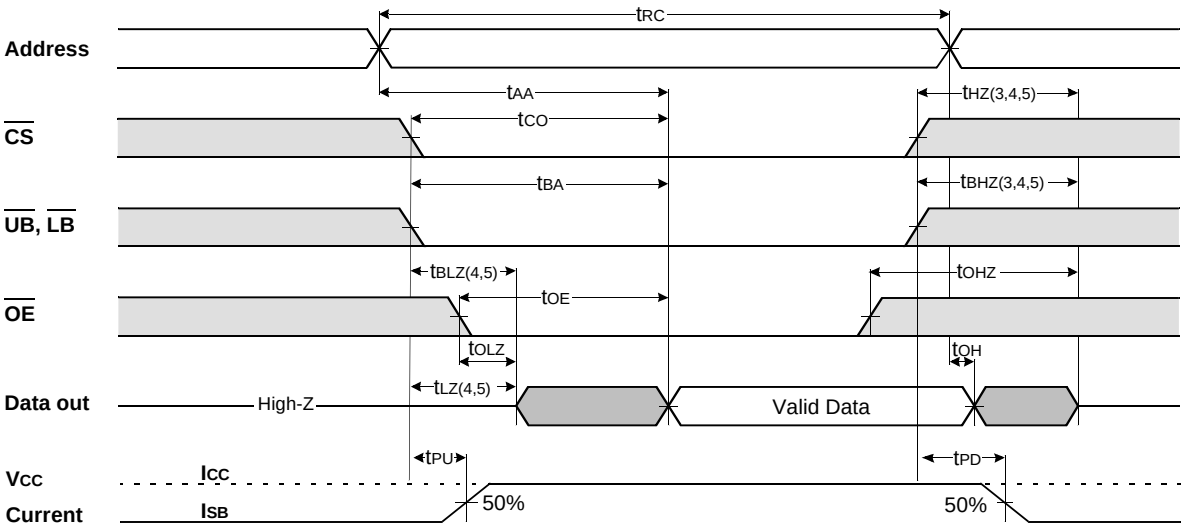
* The above parameters are also guaranteed at industrial temperature range.

TIMMING 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}



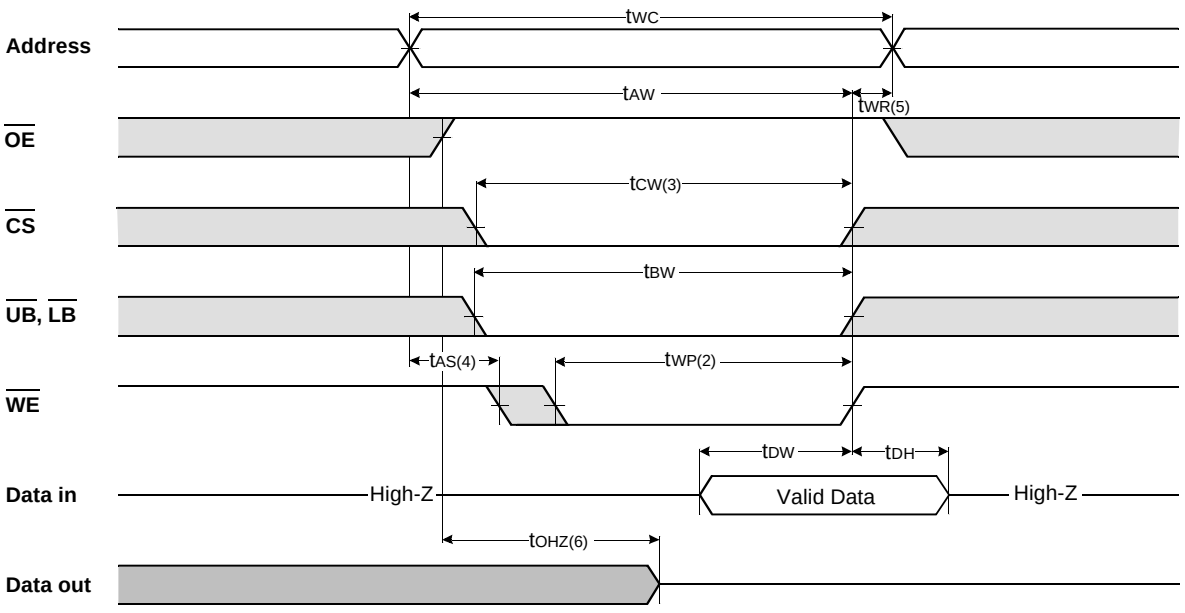
TIMING WAVEFORM OF READ CYCLE(2) ($\overline{WE}$=V_{IH})



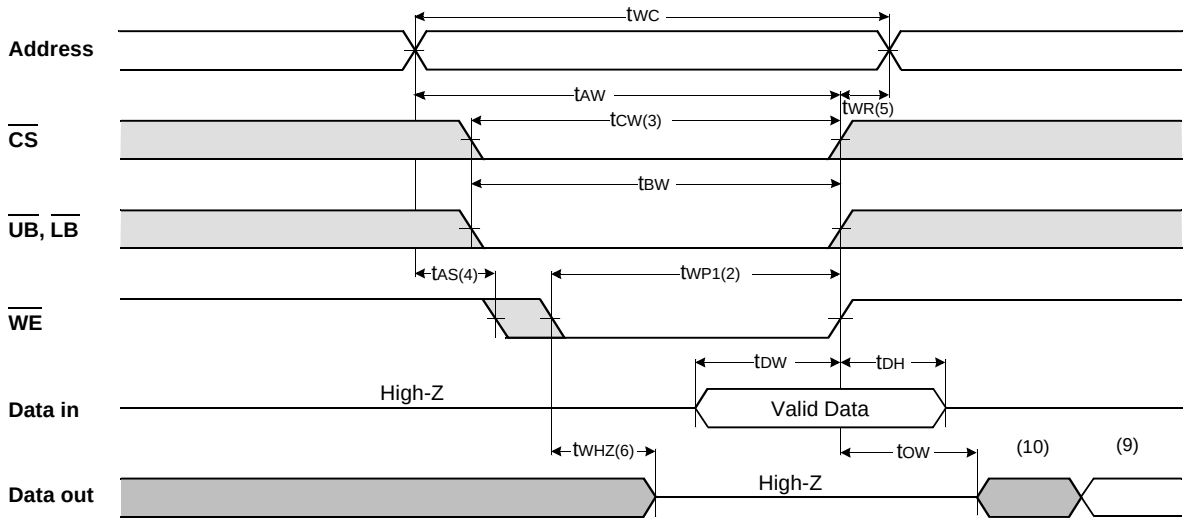
NOTES(READ CYCLE)

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}(Max.) is less than t_{LZ}(Min.) both for a given device and from device to device.
5. Transition is measured ±200mV 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.

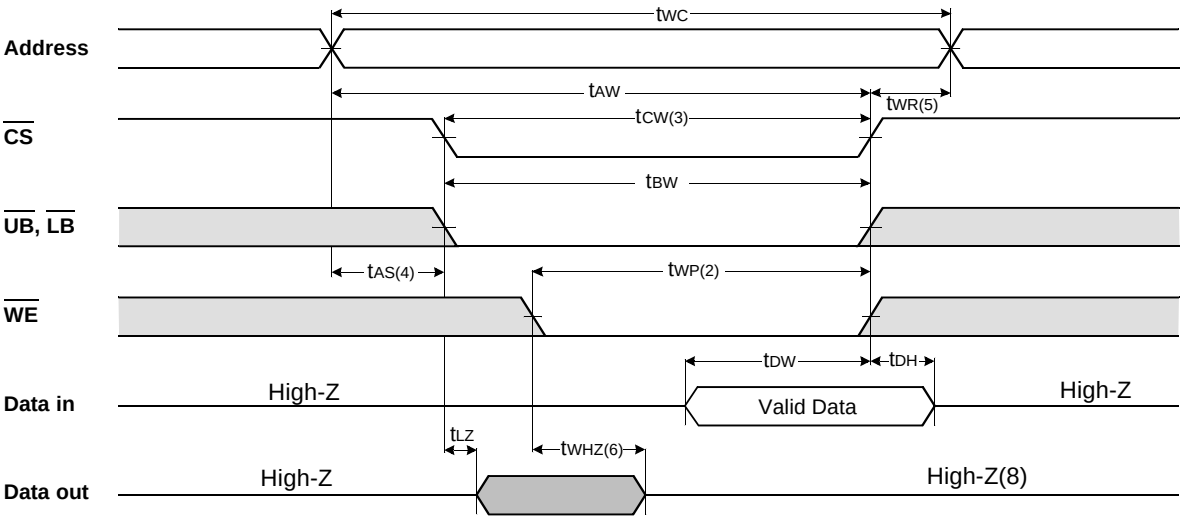
TIMING WAVEFORM OF WRITE CYCLE(1) ($\overline{OE}$ =Clock)



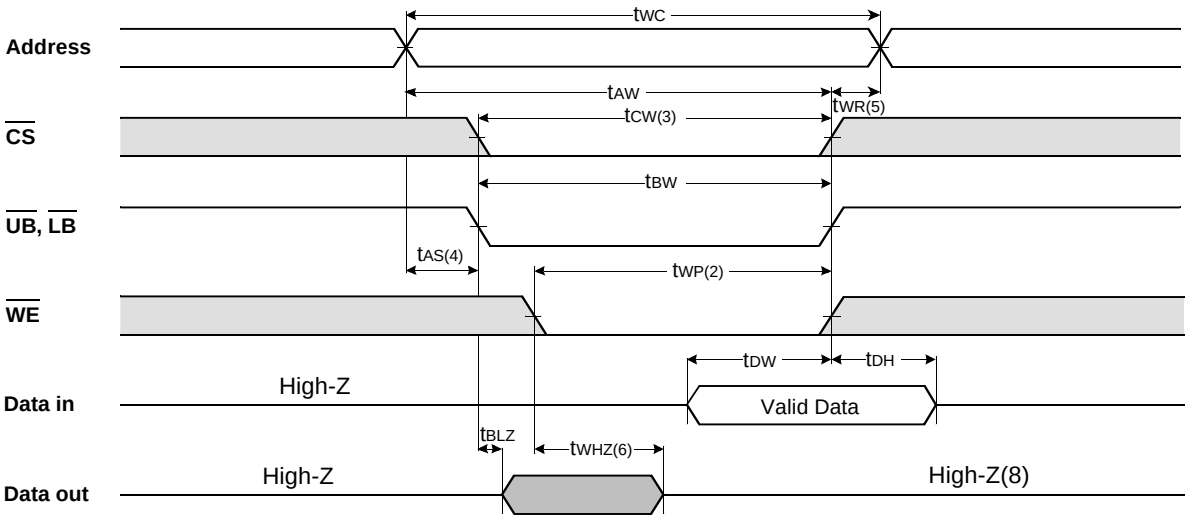
TIMING WAVEFORM OF WRITE CYCLE(2) ($\overline{OE}$ =Low fixed)



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 $\overline{CS}$, $\overline{WE}$, LB and UB. A write begins at the latest transition $\overline{CS}$ going low and $\overline{WE}$ going low; A write ends at the earliest transition $\overline{CS}$ going high or $\overline{WE}$ going high. t_{WP} is measured from the beginning of write to the end of write.
3. t_{CW} is measured from the later of $\overline{CS}$ going low to end of write.
4. t_{AS} is measured from the address valid to the beginning of write.
5. 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.
6. If $\overline{OE}$, $\overline{CS}$ and $\overline{WE}$ 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 $\overline{CS}$ goes low simultaneously with $\overline{WE}$ going or after $\overline{WE}$ going low, the outputs remain high impedance state.
9. Dout is the read data of the new address.
10. When $\overline{CS}$ 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/O_1~I/O_8	I/O_9~I/O_{16}	
H	X	X*	X	X	Not Select	High-Z	High-Z	I_{SB}, I_{SB1}
L	H	H	X	X	Output Disable	High-Z	High-Z	I_{CC}
L	X	X	H	H				
L	H	L	L	H	Read	D_{OUT}	High-Z	I_{CC}
			H	L		High-Z	D_{OUT}	
			L	L		D_{OUT}	D_{OUT}	
L	L	X	L	H	Write	D_{IN}	High-Z	I_{CC}
			H	L		High-Z	D_{IN}	
			L	L		D_{IN}	D_{IN}	

* X means Don't Care.

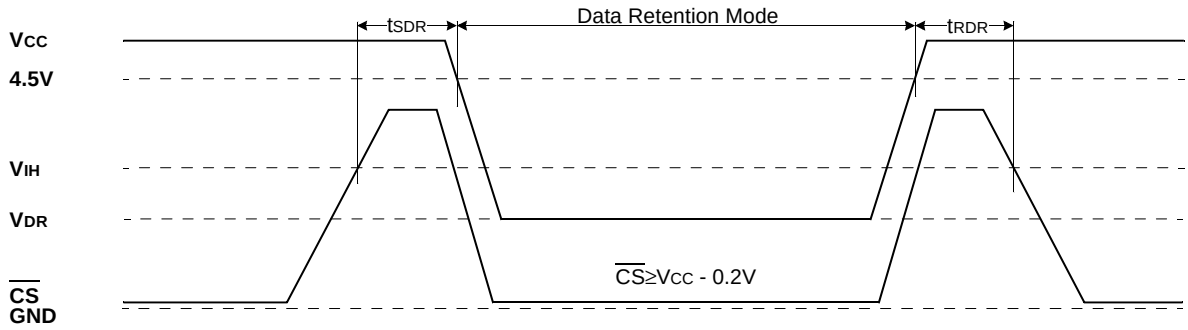
DATA RETENTION CHARACTERISTICS*(T_A=0 to 70°C)

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geq V_{CC}$-0.2V	2.0	-	5.5	V
Data Retention Current	I_{DR}	V_{CC}=3.0V, $\overline{CS} \geq V_{CC}$-0.2V $V_{IN} \geq V_{CC}$-0.2V or $V_{IN} \leq 0.2V$	-	-	0.4	mA
		V_{CC}=2.0V, $\overline{CS} \geq V_{CC}$-0.2V $V_{IN} \geq V_{CC}$-0.2V or $V_{IN} \leq 0.2V$	-	-	0.3	
Data Retention Set-Up Time	t_{SDR}	See Data Retention Wave form(below)	0	-	-	ns
Recovery Time	t_{RDR}		5	-	-	ms

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

DATA RETENTION WAVE FORM

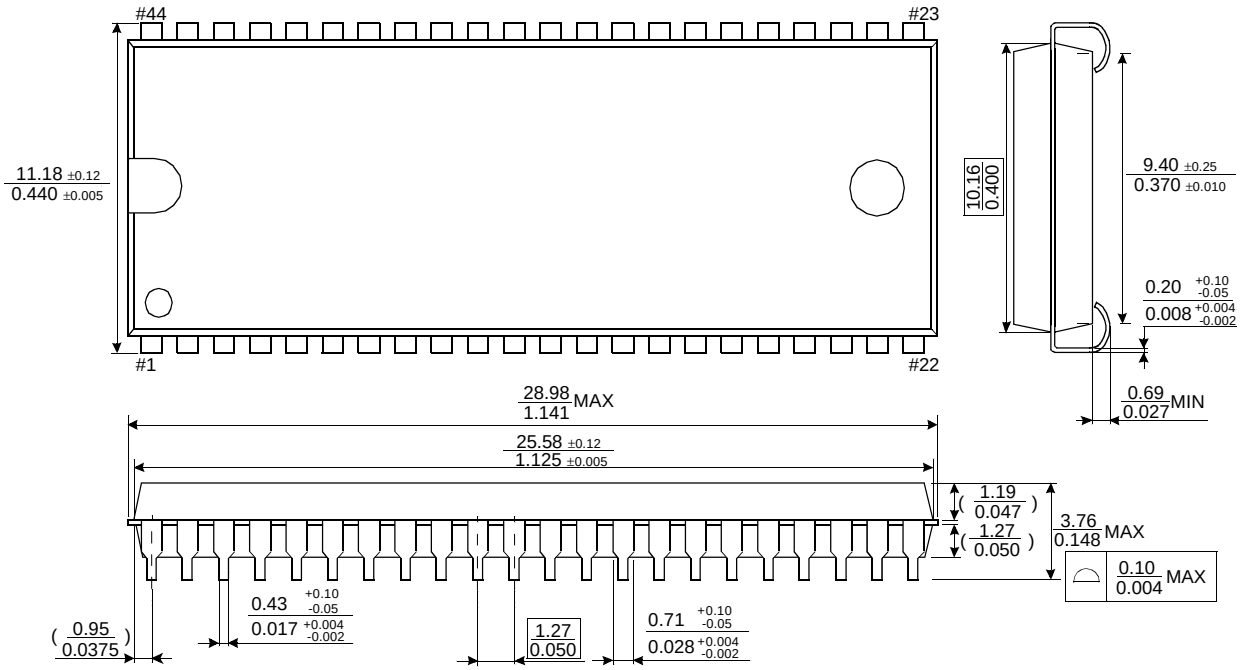
$\overline{CS}$ controlled



PACKAGE DIMENSIONS

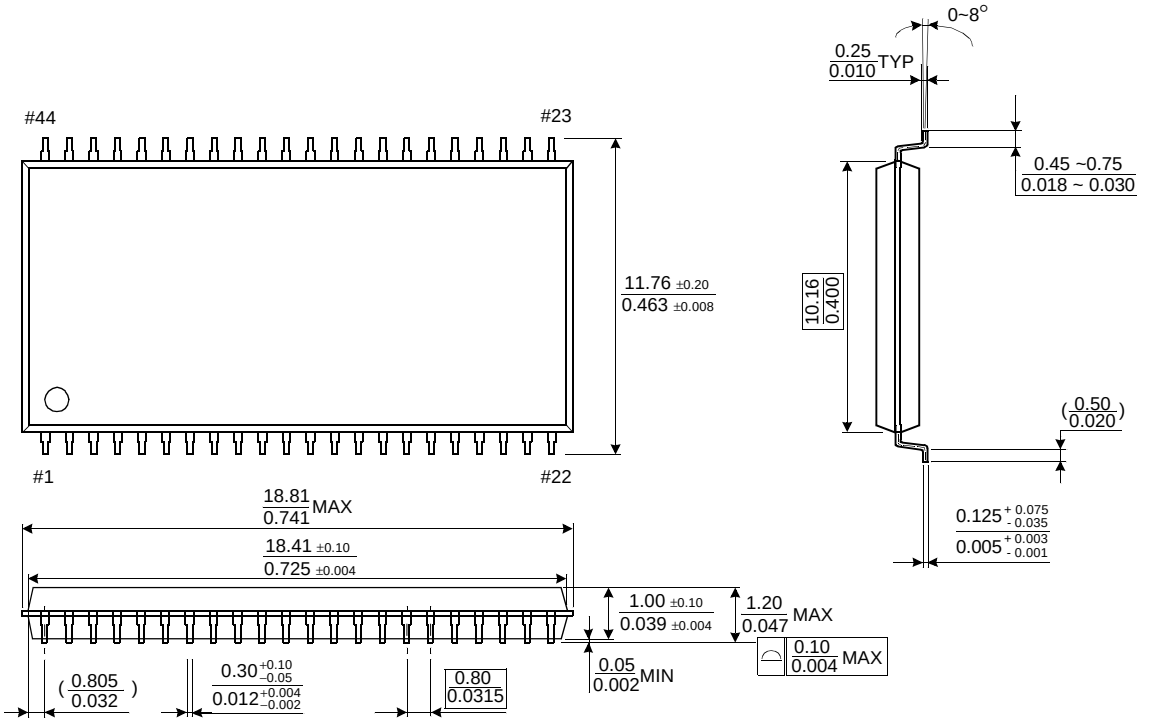
Units:millimeters/Inches

44-SOJ-400



44-TSOP2-400BF

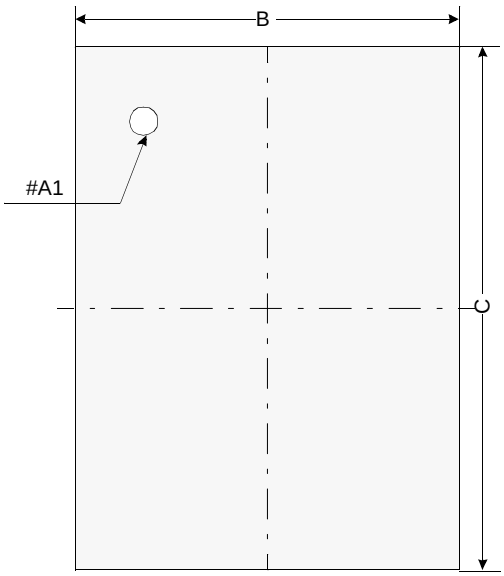
Units:millimeters/Inches



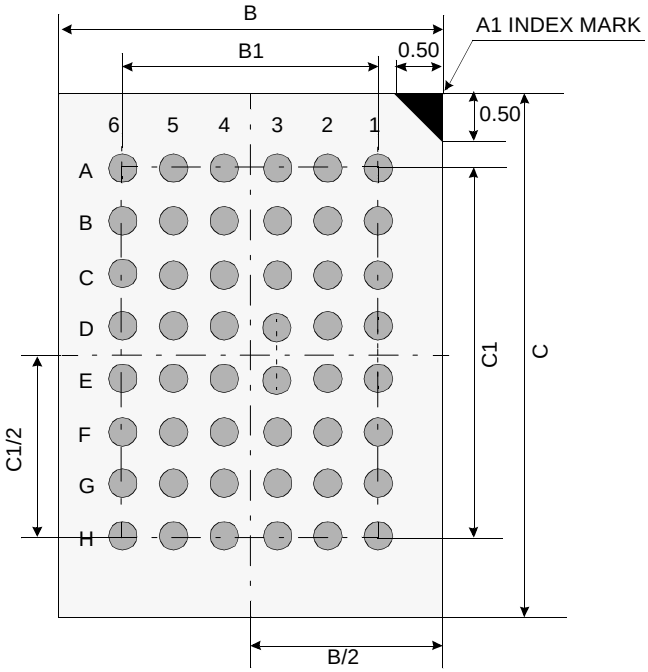
PACKAGE OUTLINE

(Units : millimeter)

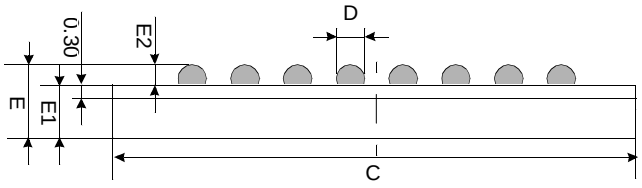
Top View



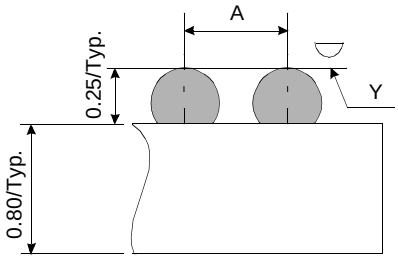
Bottom View



Side View



Detail A



	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 tolerence are +/-0.050 unless otherwise specified.
4. Typ : Typical
5. Y is coplanarity: 0.08(Max)