## Revision History

## 256K X 16 BIT LOW POWER CMOS SRAM With Error-Correcting Code (ECC)

| Revision | Details | Date |
|---|---|---|
| Rev 1.0 | Initial Release | June. 2022 |

## FEATURES

- Fast access time : 45ns
- Low power consumption:
  Operating current : 12mA (TYP.)
  Standby current : 2.5μA (TYP.)
- Single 2.7V ~ 3.6V power supply
- ECC : 1-bit error correction per byte
- All inputs and outputs TTL compatible
- Fully static operation
- Tri-state output
- Data byte control : LB# (DQ0 ~ DQ7)
  UB# (DQ8 ~ DQ15)
- Data retention voltage : 1.5V (MIN.)
- Package : 48-ball 6mm*8mm TFBGA
  44-pin 400mil TSOP II

## GENERAL DESCRIPTION

The AS6CE4016B is a 4,194,304-bit low power CMOS static random access memory organized as 262,144 words by 16 bits. It is fabricated using very high performance, high reliability CMOS technology. Its standby current is stable within the range of operating temperature.

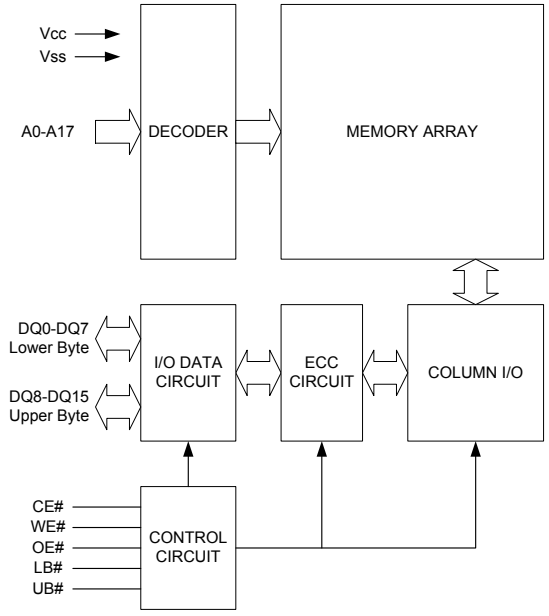
The AS6CE4016B embeds error-correcting code (ECC) which can correct single-bit error per byte. It is well designed for low power application, and particularly well suited for battery back-up nonvolatile memory application.

The AS6CE4016B operates from a single power supply of 2.7V ~ 3.6V and all inputs and outputs are fully TTL compatible

## PRODUCT FAMILY

| Product Family | Operating Temperature | $V_{CC}$ Range | Speed | Power Dissipation | |
|---|---|---|---|---|---|
| | | | | Standby($I_{SB1}$, TYP.) | Operating($I_{CC}$, TYP.) |
| AS6CE4016B | -40 ~ 85℃ | 2.7 ~ 3.6V | 45ns | 2.5μA | 12mA |

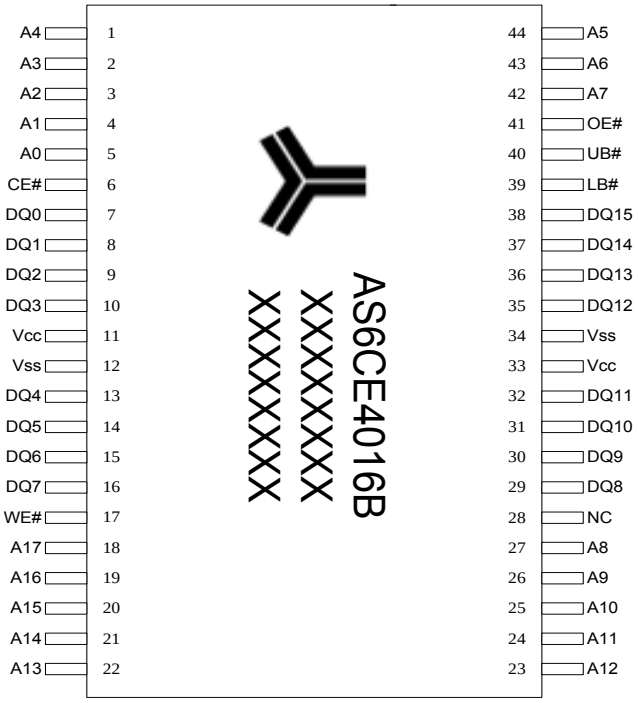
## FUNCTIONAL BLOCK DIAGRAM



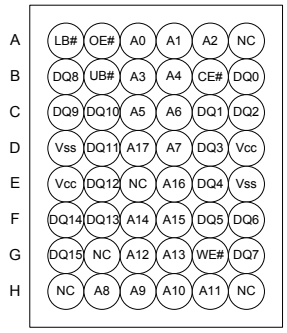

## PIN DESCRIPTION

| SYMBOL | DESCRIPTION |
|---|---|
| A0 - A17 | Address Inputs |
| DQ0 – DQ15 | Data Inputs/Outputs |
| CE# | Chip Enable Input |
| WE# | Write Enable Input |
| OE# | Output Enable Input |
| LB# | Lower Byte Control |
| UB# | Upper Byte Control |
| $V_{CC}$ | Power Supply |
| $V_{SS}$ | Ground |

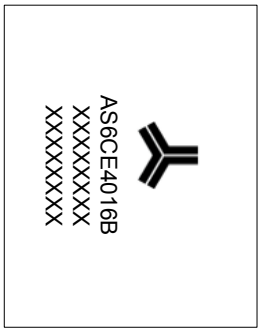
## PIN CONFIGURATION




TSOP II




TFBGA(See through with Top View)




TFBGA(Top View)

## ABSOLUTE MAXIMUM RATINGS*

| PARAMETER | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Voltage on $V_{CC}$ relative to $V_{SS}$ | $V_{T1}$ | -0.5 to 4.6 | V |
| Voltage on any other pin relative to $V_{SS}$ | $V_{T2}$ | -0.5 to $V_{CC}$+0.5 | V |
| Operating Temperature | $T_A$ | -40 to 85 | ℃ |
| Storage Temperature | $T_{STG}$ | -65 to 150 | ℃ |
| Power Dissipation | $P_D$ | 1 | W |
| DC Output Current | $I_{OUT}$ | 50 | mA |

*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 or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to the absolute maximum rating conditions for extended period may affect device reliability.

## TRUTH TABLE

| MODE | CE# | OE# | WE# | LB# | UB# | I/O OPERATION | | SUPPLY CURRENT |
|---|---|---|---|---|---|---|---|---|
| | | | | | | DQ0-DQ7 | DQ8-DQ15 | |
| Standby | H | X | X | X | X | High – Z | High – Z | $I_{SB1}$ |
| | X | X | X | H | H | High – Z | High – Z | |
| Output Disable | L | H | H | L | X | High – Z | High – Z | $I_{CC}$,$I_{CC1}$ |
| | L | H | H | X | L | High – Z | High – Z | |
| Read | L | L | H | L | H | $D_{OUT}$ | High – Z | $I_{CC}$,$I_{CC1}$ |
| | L | L | H | H | L | High – Z | $D_{OUT}$ | |
| | L | L | H | L | L | $D_{OUT}$ | $D_{OUT}$ | |
| Write | L | X | L | L | H | $D_{IN}$ | High – Z | $I_{CC}$,$I_{CC1}$ |
| | L | X | L | H | L | High – Z | $D_{IN}$ | |
| | L | X | L | L | L | $D_{IN}$ | $D_{IN}$ | |

Note: H = $V_{IH}$, L = $V_{IL}$, X = Don't care.

## DC ELECTRICAL CHARACTERISTICS

| PARAMETER | SYMBOL | TEST CONDITION | | MIN. | TYP. *4 | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | | | 2.7 | 3.0 | 3.6 | V |
| Input High Voltage | $V_{IH}$ *1 | | | 2.2 | - | $V_{CC}$+0.3 | V |
| Input Low Voltage | $V_{IL}$ *2 | | | - 0.2 | - | 0.6 | V |
| Input Leakage Current | $I_{LI}$ | $V_{CC} \geqq V_{IN} \geqq V_{SS}$ | | - 1 | - | 1 | µA |
| Output Leakage Current | $I_{LO}$ | $V_{CC} \geqq V_{OUT} \geqq V_{SS}$, Output Disabled | | - 1 | - | 1 | µA |
| Output High Voltage | $V_{OH}$ | $I_{OH}$ = -1mA | | 2.2 | 2.7 | - | V |
| Output Low Voltage | $V_{OL}$ | $I_{OL}$ = 2mA | | - | - | 0.4 | V |
| Average Operating Power supply Current | $I_{CC}$ | Cycle time = Min.<br>CE#≦0.2V, $I_{I/O}$ = 0mA<br>Other pins at 0.2V or $V_{CC}$-0.2V | | - | 12 | 20 | mA |
| | $I_{CC1}$ | Cycle time = 1µs<br>CE# = 0.2V , $I_{I/O}$ = 0mA<br>Other pins at 0.2V or $V_{CC}$ - 0.2V | | - | 3 | 5 | mA |
| Standby Power Supply Current | $I_{SB1}$ | CE# ≧$V_{CC}$ - 0.2V<br>Others at 0.2V or $V_{CC}$ - 0.2V | 40℃ | - | 2.5 | 5 | µA *5 |
| | | | | - | 2.5 | 20 | µA |

Notes:
1. $V_{IH}$(max) = $V_{CC}$ + 3.0V for pulse width less than 10ns.
2. $V_{IL}$(min) = $V_{SS}$ - 3.0V for pulse width less than 10ns.
3. Over/Undershoot specifications are characterized, not 100% tested.
4. Typical values are included for reference only and are not guaranteed or tested.
   Typical values are measured at $V_{CC}$ = $V_{CC}$(TYP.) and $T_A$ = 25℃
5. This parameter is measured at $V_{CC}$ = 3.0V

## CAPACITANCE ($T_A$ = 25℃, f = 1.0MHz)

| PARAMETER | SYMBOL | MIN. | MAX | UNIT |
|---|---|---|---|---|
| Input Capacitance | $C_{IN}$ | - | 6 | pF |
| Input/Output Capacitance | $C_{I/O}$ | - | 8 | pF |

Note : These parameters are guaranteed by device characterization, but not production tested.

## AC TEST CONDITIONS

| | |
|---|---|
| Input Pulse Levels | 0.2V to $V_{CC}$ - 0.2V |
| Input Rise and Fall Times | 3ns |
| Input and Output Timing Reference Levels | 1.5V |
| Output Load | $C_L$ = 30pF + 1TTL, $I_{OH}$/$I_{OL}$ = -1mA/2mA |

## AC ELECTRICAL CHARACTERISTICS

### (1) READ CYCLE

| PARAMETER | SYM. | AS6CE4016B-45 | | UNIT |
|---|---|---|---|---|
| | | MIN. | MAX. | |
| Read Cycle Time | $t_{RC}$ | 45 | - | ns |
| Address Access Time | $t_{AA}$ | - | 45 | ns |
| Chip Enable Access Time | $t_{ACE}$ | - | 45 | ns |
| Output Enable Access Time | $t_{OE}$ | - | 25 | ns |
| Chip Enable to Output in Low-Z | $t_{CLZ}$* | 10 | - | ns |
| Output Enable to Output in Low-Z | $t_{OLZ}$* | 5 | - | ns |
| Chip Disable to Output in High-Z | $t_{CHZ}$* | - | 15 | ns |
| Output Disable to Output in High-Z | $t_{OHZ}$* | - | 15 | ns |
| Output Hold from Address Change | $t_{OH}$ | 10 | - | ns |
| LB#, UB# Access Time | $t_{BA}$ | - | 45 | ns |
| LB#, UB# to High-Z Output | $t_{BHZ}$* | - | 20 | ns |
| LB#, UB# to Low-Z Output | $t_{BLZ}$* | 10 | - | ns |

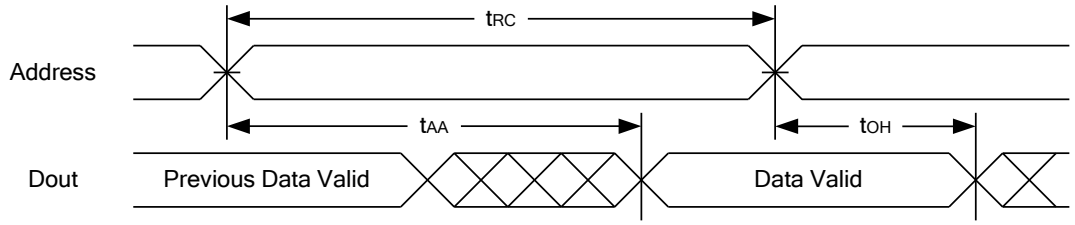
### (2) WRITE CYCLE

| PARAMETER | SYM. | AS6CE4016B-45 | | UNIT |
|---|---|---|---|---|
| | | MIN. | MAX. | |
| Write Cycle Time | $t_{WC}$ | 45 | - | ns |
| Address Valid to End of Write | $t_{AW}$ | 40 | - | ns |
| Chip Enable to End of Write | $t_{CW}$ | 40 | - | ns |
| Address Set-up Time | $t_{AS}$ | 0 | - | ns |
| Write Pulse Width | $t_{WP}$ | 35 | - | ns |
| Write Recovery Time | $t_{WR}$ | 0 | - | ns |
| Data to Write Time Overlap | $t_{DW}$ | 20 | - | ns |
| Data Hold from End of Write Time | $t_{DH}$ | 0 | - | ns |
| Output Active from End of Write | $t_{OW}$* | 5 | - | ns |
| Write to Output in High-Z | $t_{WHZ}$* | - | 15 | ns |
| LB#, UB# Valid to End of Write | $t_{BW}$ | 35 | - | ns |

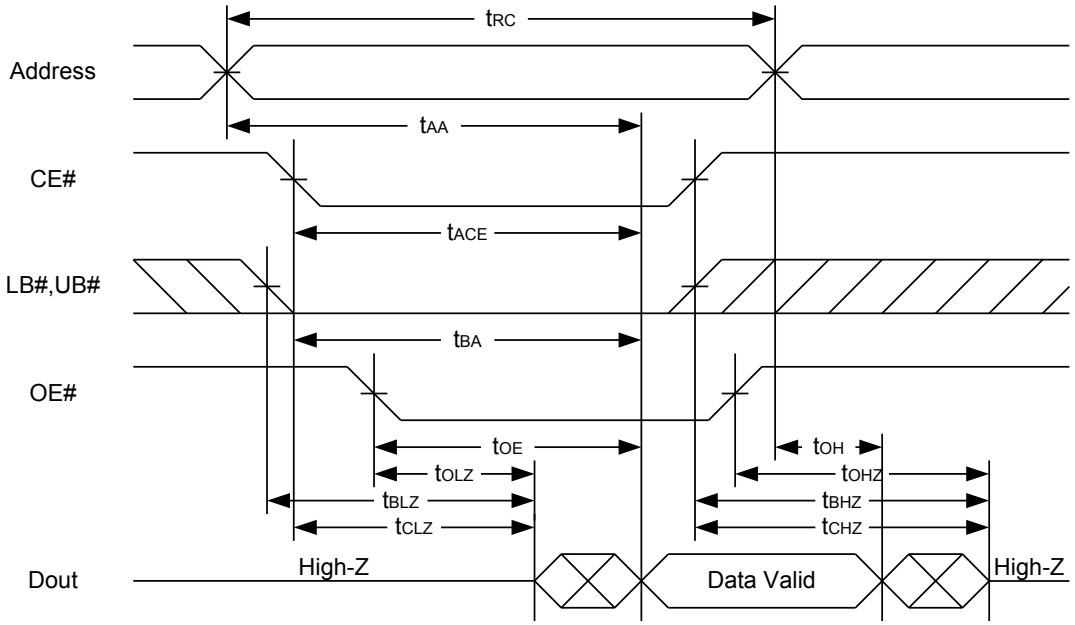
*These parameters are guaranteed by device characterization, but not production tested.

## TIMING WAVEFORMS

**READ CYCLE 1** (Address Controlled) (1,2)

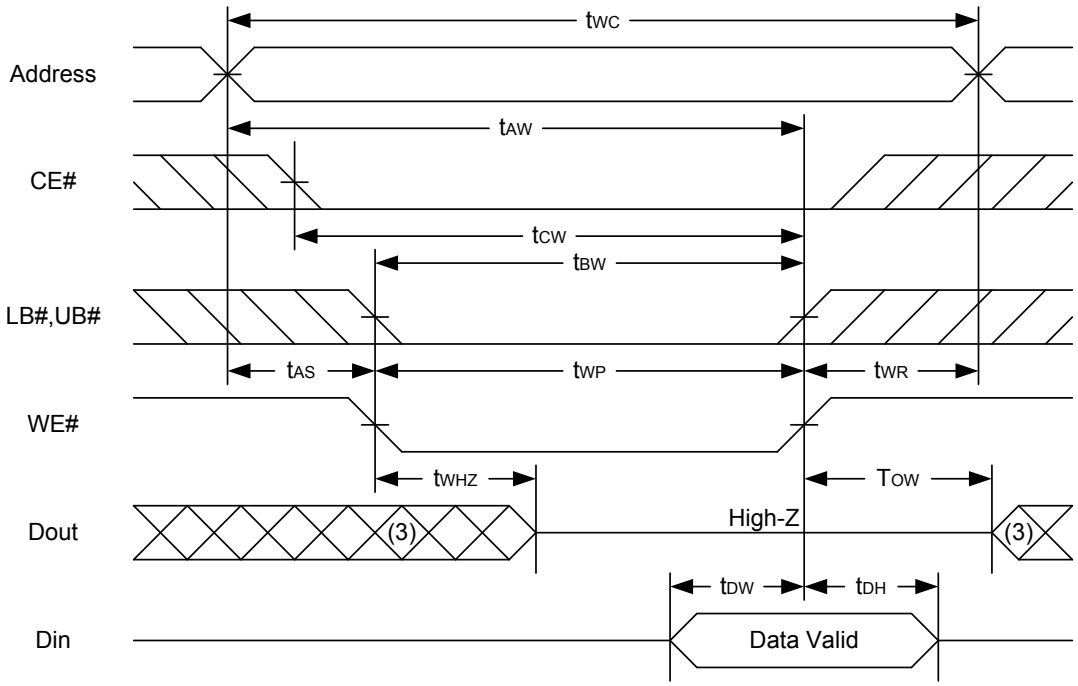



**READ CYCLE 2** (CE# and OE# Controlled) (1,3,4,5)

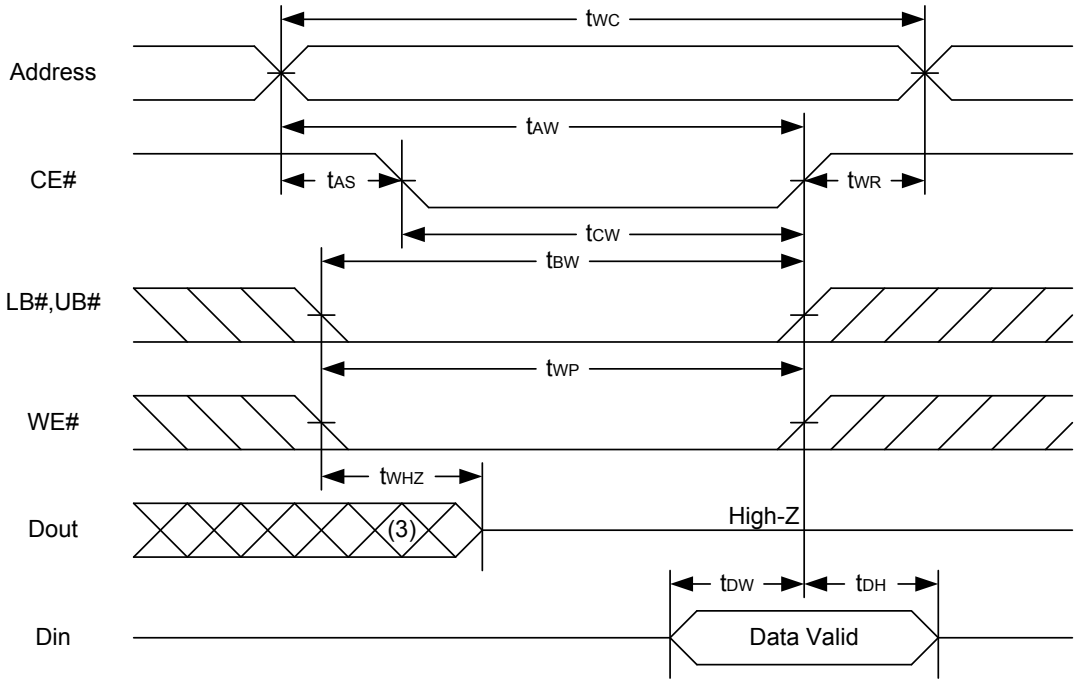



Notes :
1.WE# is high for read cycle.
2.Device is continuously selected OE# = low, CE# = low, LB# or UB# = low.
3.Address must be valid prior to or coincident with CE# = low, LB# or UB# = low transition; otherwise $t_{AA}$ is the limiting parameter.
4.$t_{CLZ}$, $t_{BLZ}$, $t_{OLZ}$, $t_{CHZ}$, $t_{BHZ}$ and $t_{OHZ}$ are specified with $C_L$ = 5pF. Transition is measured ±500mV from steady state.
5.At any given temperature and voltage condition, $t_{CHZ}$ is less than $t_{CLZ}$ , $t_{BHZ}$ is less than $t_{BLZ}$, $t_{OHZ}$ is less than $t_{OLZ}$.

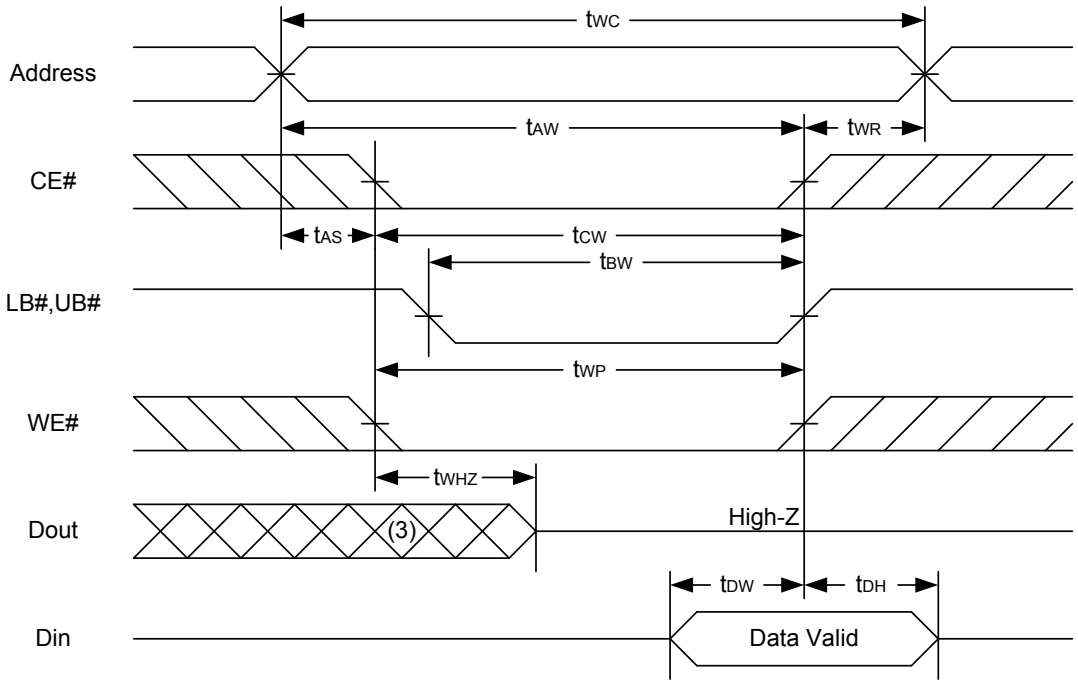
**WRITE CYCLE 1** (WE# Controlled) (1,2,4,5)




**WRITE CYCLE 2** (CE# Controlled) (1,4,5)



**WRITE CYCLE 3** (LB#,UB# Controlled) (1,4,5)




Notes :
1.A write occurs during the overlap of a low CE#, low WE#, LB# or UB# = low.
2.During a WE# controlled write cycle with OE# low, $t_{WP}$ must be greater than $t_{WHZ} + t_{DW}$ to allow the drivers to turn off and data to be placed on the bus.
3.During this period, I/O pins are in the output state, and input signals must not be applied.
4.If the CE#, LB#, UB# low transition occurs simultaneously with or after WE# low transition, the outputs remain in a high impedance state.
5.$t_{OW}$ and $t_{WHZ}$ are specified with $C_L$ = 5pF. Transition is measured ±500mV from steady state.

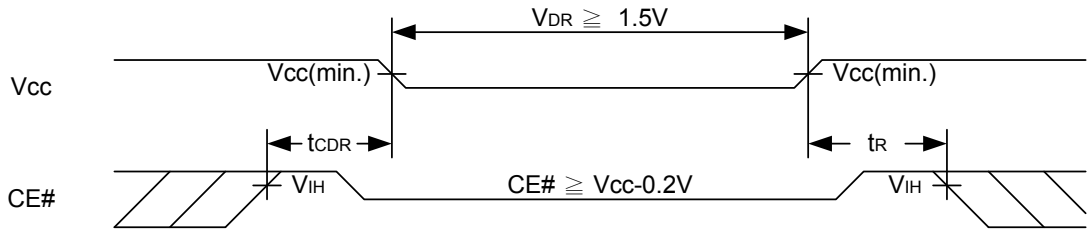
## DATA RETENTION CHARACTERISTICS

| PARAMETER | SYMBOL | TEST CONDITION | | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| $V_{CC}$ for Data Retention | $V_{DR}$ | CE# ≧ $V_{CC}$ - 0.2V | | 1.5 | - | 3.6 | V |
| Data Retention Current | $I_{DR}$ | $V_{CC}$ = 1.5V<br>CE# ≧ $V_{CC}$ - 0.2V<br>Other pins at 0.2V or $V_{CC}$-0.2V | 40℃ | - | 2 | 5 | µA |
| | | | | - | 2 | 20 | µA |
| Chip Disable to Data Retention Time | $t_{CDR}$ | See Data Retention Waveforms (below) | | 0 | - | - | ns |
| Recovery Time | $t_R$ | | | $t_{RC*}$ | - | - | ns |

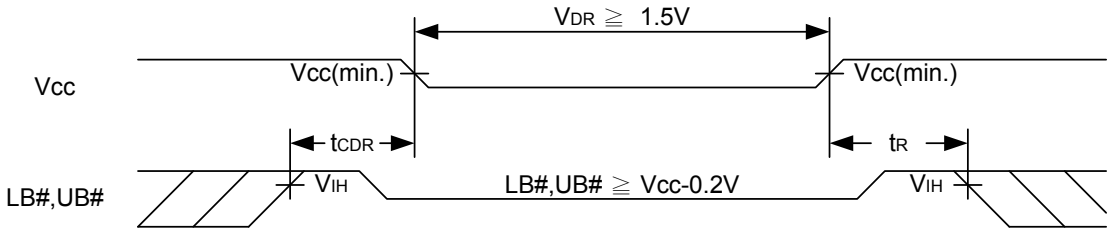
$t_{RC*}$ = Read Cycle Time

## DATA RETENTION WAVEFORM

**Low Vcc Data Retention Waveform (1)** (CE# controlled)

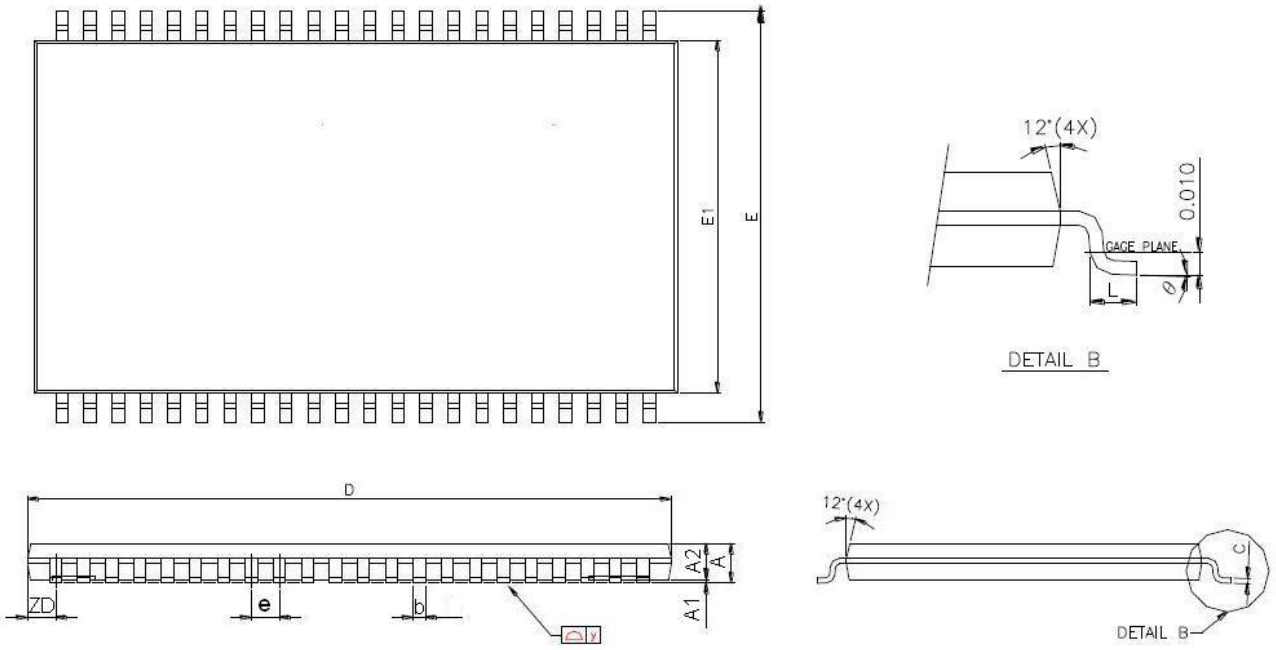



**Low Vcc Data Retention Waveform (2)** (LB#, UB# controlled)



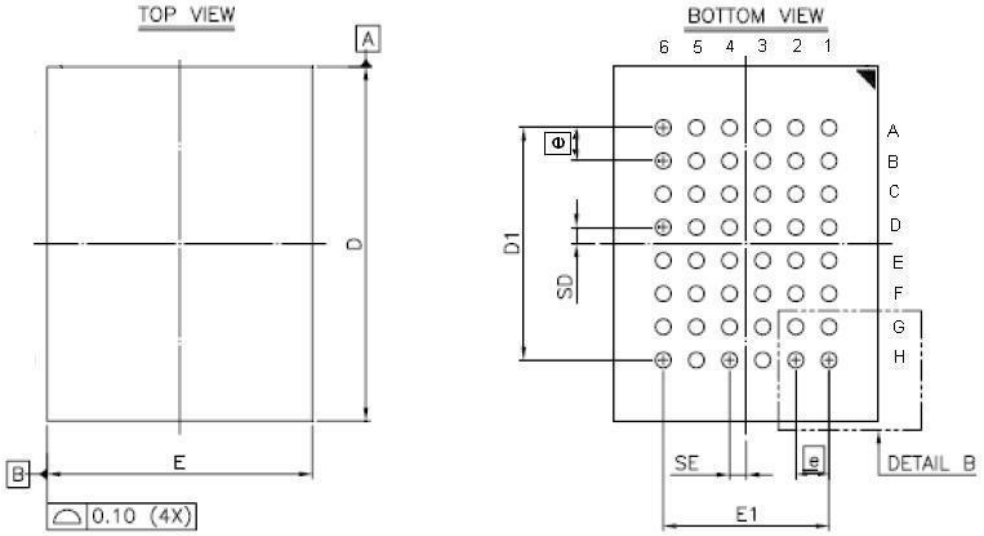
## PACKAGE OUTLINE DIMENSION

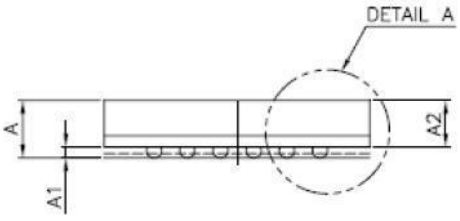
**44-pin 400mil TSOP II Package Outline Dimension**



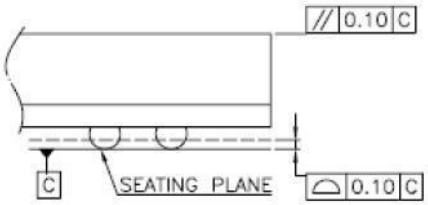

| SYMBOLS | DIMENSIONS IN MILLMETERS | | | DIMENSIONS IN MILS | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | - | - | 1.20 | - | - | 47.2 |
| A1 | 0.05 | 0.10 | 0.15 | 2.0 | 3.9 | 5.9 |
| A2 | 0.95 | 1.00 | 1.05 | 37.4 | 39.4 | 41.3 |
| b | 0.30 | - | 0.45 | 11.8 | - | 17.7 |
| c | 0.12 | - | 0.21 | 4.7 | - | 8.3 |
| D | 18.212 | 18.415 | 18.618 | 717 | 725 | 733 |
| E | 11.506 | 11.760 | 12.014 | 453 | 463 | 473 |
| E1 | 9.957 | 10.160 | 10.363 | 392 | 400 | 408 |
| e | - | 0.800 | - | - | 31.5 | - |
| L | 0.40 | 0.50 | 0.60 | 15.7 | 19.7 | 23.6 |
| ZD | - | 0.805 | - | - | 31.7 | - |
| y | - | - | 0.076 | - | - | 3 |
| θ | $0^o$ | $3^o$ | $6^o$ | $0^o$ | $3^o$ | $6^o$ |

**48-ball 6mm × 8mm TFBGA Package Outline Dimension**

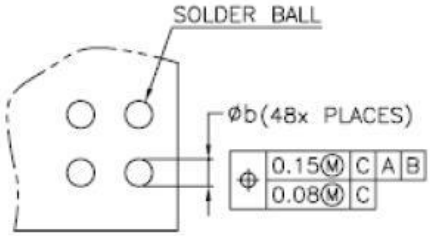



SIDE VIEW




DETAIL A




DETAIL B

| SYM. | DIMENSION (mm) | | | DIMENSION (inch) | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | — | — | 1.40 | — | — | 0.055 |
| A1 | 0.20 | 0.25 | 0.30 | 0.008 | 0.010 | 0.012 |
| A2 | — | — | 1.05 | — | — | 0.041 |
| b | 0.30 | 0.35 | 0.40 | 0.012 | 0.014 | 0.016 |
| D | 7.95 | 8.00 | 8.05 | 0.313 | 0.315 | 0.317 |
| D1 | 5.25 BSC | | | 0.207 BSC | | |
| E | 5.95 | 6.00 | 6.05 | 0.234 | 0.236 | 0.238 |
| E1 | 3.75 BSC | | | 0.148 BSC | | |
| SE | 0.375 TYP | | | 0.015 TYP | | |
| SD | 0.375 TYP | | | 0.015 TYP | | |
| e | 0.75 BSC | | | 0.030 BSC | | |

NOTE:
1. CONTROLLING DIMENSION : MILLIMETER.
2. REFERENCE DOCUMENT : JEDEC MO-207.

## ORDERING INFORMATION

| Alliance Part Number | Organization | VCC Range | Package | Operating Temp | Speed ns |
|---|---|---|---|---|---|
| AS6CE4016B-45ZIN | 256K x 16 | 2.7 ~ 3.6V | 44-pin 400 mil TSOP II | Industrial -40°C ~ 85°C | 45 |
| AS6CE4016B-45BIN | 256K x 16 | 2.7 ~ 3.6V | 48-ball 6mm × 8mm FBGA | Industrial -40°C ~ 85°C | 45 |

## PART NUMBERING SYSTEM

| AS6C | E4016B | -45 | Z/B | I | N | XX |
|---|---|---|---|---|---|---|
| **AS6C** = Low Power SRAM | Device Number<br>**E**=With ECC<br>**40** = 4Meg<br>**16** = x 16 bit<br>**B** = B die version | Access Time<br>**45** = 45ns | **Z**=TSOPII<br>**B**=FBGA | **I** = Industrial Temp<br>-40°C~ 85°C | Indicates Pb and Halogen Free | Packing Type<br>**None** : Tray<br>**TR** : Reel |

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