

# 16-Mbit (1M × 16/2M × 8) Static RAM

## Features

- Ultra-low standby power
  - Typical standby current: 5.5  $\mu$ A
  - Maximum standby current: 16  $\mu$ A
- TSOP I package configurable as 1M × 16 or 2M × 8 SRAM
- Very high speed: 45 ns
- Temperature ranges
  - Industrial: -40 °C to +85 °C
- Wide voltage range: 1.65 V to 2.2 V, 2.2 V to 3.6 V, and 4.5 V to 5.5 V
- Easy memory expansion with  $\overline{CE}_1$ ,  $CE_2$ , and  $\overline{OE}$  Features
- Automatic power-down when deselected
- CMOS for optimum speed and power
- Offered in Pb-free 48-ball VFBGA and 48-pin TSOP I packages

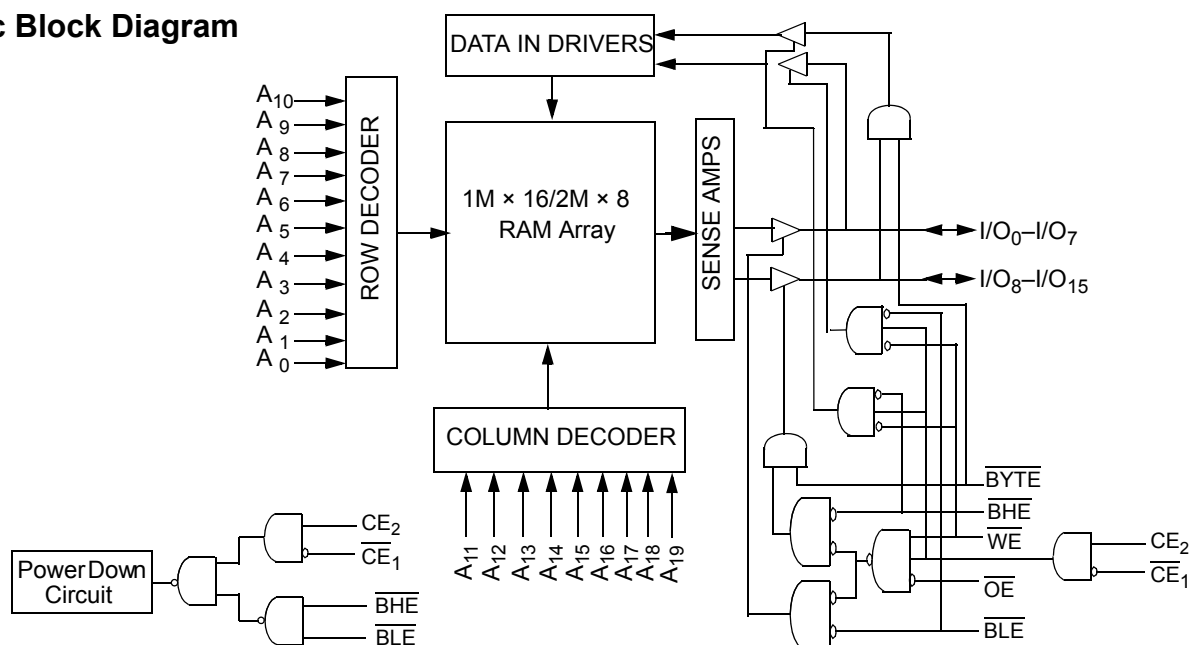
## Functional Description

The CY62167GN is a high performance CMOS static RAM organized as 1M words by 16 bits or 2M words by 8 bits. This device features an advanced circuit design that provides an ultra low active current. Ultra low active current is ideal for providing More Battery Life™ (MoBL®) in portable applications such as cellular telephones. The device also has an automatic power down feature that reduces power consumption by 99 percent when addresses are not toggling. Place the device into standby mode when deselected ( $\overline{CE}_1$  HIGH or  $CE_2$  LOW or both  $\overline{BHE}$  and  $\overline{BLE}$  are HIGH). The input and output pins ( $I/O_0$  through  $I/O_{15}$ ) are placed in a high impedance state when: the device is deselected ( $\overline{CE}_1$  HIGH or  $CE_2$  LOW), outputs are disabled ( $\overline{OE}$  HIGH), both Byte High Enable and Byte Low Enable are disabled ( $\overline{BHE}$ ,  $\overline{BLE}$  HIGH), or a write operation is in progress ( $\overline{CE}_1$  LOW,  $CE_2$  HIGH and  $\overline{WE}$  LOW).

To write to the device, take Chip Enables ( $\overline{CE}_1$  LOW and  $CE_2$  HIGH) and Write Enable ( $\overline{WE}$ ) input LOW. If Byte Low Enable ( $\overline{BLE}$ ) is LOW, then data from  $I/O$  pins ( $I/O_0$  through  $I/O_7$ ) is written into the location specified on the address pins ( $A_0$  through  $A_{19}$ ). If Byte High Enable ( $\overline{BHE}$ ) is LOW, then data from the  $I/O$  pins ( $I/O_8$  through  $I/O_{15}$ ) is written into the location specified on the address pins ( $A_0$  through  $A_{19}$ ).

To read from the device, take Chip Enables ( $\overline{CE}_1$  LOW and  $CE_2$  HIGH) and Output Enable ( $\overline{OE}$ ) LOW while forcing the Write Enable ( $\overline{WE}$ ) HIGH. If Byte Low Enable ( $\overline{BLE}$ ) is LOW, then data from the memory location specified by the address pins appears on  $I/O_0$  to  $I/O_7$ . If Byte High Enable ( $\overline{BHE}$ ) is LOW, then data from memory appears on  $I/O_8$  to  $I/O_{15}$ . See [Truth Table on page 13](#) for a complete description of read and write modes.

## Logic Block Diagram

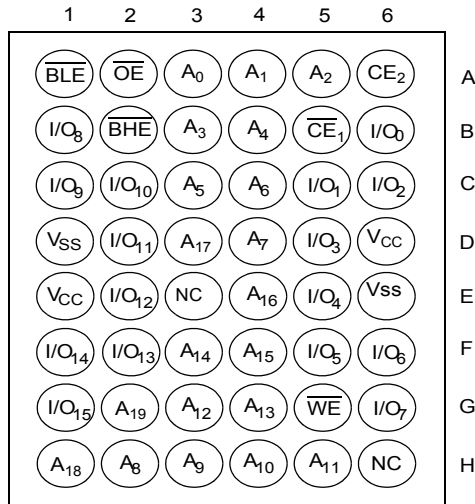


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## Pin Configuration

**Figure 1. 48-ball VFBGA pinout (Top View)** <sup>[1, 2]</sup>



**Figure 2. 48-pin TSOP I pinout (Top View)** <sup>[2, 3]</sup>



## Product Portfolio

| Product     | Range      | V <sub>CC</sub> Range (V) |                    |                      | Speed<br>(ns) | Power Dissipation              |     |                    |     |                                  |     |
|-------------|------------|---------------------------|--------------------|----------------------|---------------|--------------------------------|-----|--------------------|-----|----------------------------------|-----|
|             |            |                           |                    |                      |               | Operating I <sub>CC</sub> (mA) |     |                    |     | Standby I <sub>SB2</sub><br>(μA) |     |
|             |            | f = 1 MHz                 |                    | f = f <sub>max</sub> |               | Typ <sup>[4]</sup>             | Max | Typ <sup>[4]</sup> | Max |                                  |     |
|             |            | Min                       | Typ <sup>[4]</sup> | Max                  |               |                                |     |                    |     | Typ <sup>[4]</sup>               | Max |
| CY62167GN18 | Industrial | 1.65                      | 1.8                | 2.2                  | 55            | 7                              | 9   | 29                 | 32  | 7                                | 26  |
| CY62167GN30 |            | 2.2                       | 3.0                | 3.6                  | 45            |                                |     | 29                 | 36  | 5.5                              | 16  |
| CY62167GN   |            | 4.5                       | 5.0                | 5.5                  |               |                                |     |                    |     |                                  |     |

### Notes

- Ball H6 for the VFBGA package can be used to upgrade to a 32M density.
- NC pins are not connected on the die.
- The BYTE pin in the 48-pin TSOP I package has to be tied to V<sub>CC</sub> to use the device as a 1M × 16 SRAM. The 48-pin TSOP I package can also be used as a 2M × 8 SRAM by tying the BYTE signal to V<sub>SS</sub>. In the 2M × 8 configuration, Pin 45 is A20, while BHE, BLE and I/O<sub>8</sub> to I/O<sub>14</sub> pins are not used.
- Typical values are included for reference only and are not guaranteed or tested. Typical values are measured at V<sub>CC</sub> = V<sub>CC(typ)</sub>, T<sub>A</sub> = 25 °C.

## Maximum Ratings

Exceeding maximum ratings may shorten the useful life of the device. User guidelines are not tested.

Storage temperature ..... -65 °C to + 150 °C

Ambient temperature  
with power applied ..... -55 °C to + 125 °C

Supply voltage  
to ground potential<sup>[5, 6]</sup> ..... -0.3 V to  $V_{CC(max)}$  + 0.3 V

DC voltage applied  
to outputs in High Z state<sup>[5, 6]</sup> ..... -0.3 V to  $V_{CC(max)}$  + 0.3 V

DC input voltage<sup>[5, 6]</sup> ..... -0.3 V to  $V_{CC(max)}$  + 0.3 V

Output current into outputs (LOW) ..... 20 mA

Static discharge voltage  
(MIL-STD-883, Method 3015) ..... >2001 V

Latch-up current ..... >200 mA

## Operating Range

| Device Range | Ambient Temperature | $V_{CC}^{[7]}$  |
|--------------|---------------------|---|
| Industrial   | -40 °C to +85 °C    | 1.65 V to 2.2 V,<br>2.2 V to 3.6 V,<br>4.5 V to 5.5 V |

## Electrical Characteristics

Over the Operating Range

| Parameter       | Description                              | Test Conditions  |  | 45 ns/ 55 ns                         |                    |                       | Unit |
|-----------------|--|--|--|--------------------------------------|--------------------|-----------------------|------|
|                 |  |  |  | Min                                  | Typ <sup>[8]</sup> | Max                   |      |
| V <sub>OH</sub> | Output HIGH voltage                      | 1.65 ≤ V <sub>CC</sub> ≤ 2.2                             | I <sub>OH</sub> = −0.1 mA  | 1.4                                  | –                  | –                     | V    |
|                 |  | 2.2 ≤ V <sub>CC</sub> ≤ 2.7                              | I <sub>OH</sub> = −0.1 mA  | 2.0                                  | –                  | –                     |      |
|                 |  | 2.7 ≤ V <sub>CC</sub> ≤ 3.6                              | I <sub>OH</sub> = −1.0 mA  | 2.4                                  | –                  | –                     |      |
|                 |  | 4.5 ≤ V <sub>CC</sub> ≤ 5.5                              | I <sub>OH</sub> = −1.0 mA  | 2.4                                  | –                  | –                     |      |
|                 |  | 4.5 ≤ V <sub>CC</sub> ≤ 5.5                              | I <sub>OH</sub> = −0.1 mA  | V <sub>OH</sub> − 0.5 <sup>[9]</sup> | –                  | –                     |      |
| V <sub>OL</sub> | Output LOW voltage                       | 1.65 ≤ V <sub>CC</sub> ≤ 2.2                             | I <sub>OL</sub> = 0.1 mA   | –                                    | –                  | 0.2                   | V    |
|                 |  | 2.2 ≤ V <sub>CC</sub> ≤ 2.7                              | I <sub>OL</sub> = 0.1 mA   | –                                    | –                  | 0.4                   |      |
|                 |  | 2.7 ≤ V <sub>CC</sub> ≤ 3.6                              | I <sub>OL</sub> = 2.1 mA   | –                                    | –                  | 0.4                   |      |
|                 |  | 4.5 ≤ V <sub>CC</sub> ≤ 5.5                              | I <sub>OL</sub> = 2.1 mA   | –                                    | –                  | 0.4                   |      |
| V <sub>IH</sub> | Input HIGH voltage                       | 1.65 ≤ V <sub>CC</sub> ≤ 2.2                             |  | 1.4                                  | –                  | V <sub>CC</sub> + 0.2 | V    |
|                 |  | 2.2 ≤ V <sub>CC</sub> ≤ 2.7                              |  | 1.8                                  | –                  | V <sub>CC</sub> + 0.3 |      |
|                 |  | 2.7 ≤ V <sub>CC</sub> ≤ 3.6                              |  | 2                                    | –                  | V <sub>CC</sub> + 0.3 |      |
|                 |  | 4.5 ≤ V <sub>CC</sub> ≤ 5.5                              |  | 2.2                                  | –                  | V <sub>CC</sub> + 0.5 |      |
| V <sub>IL</sub> | Input LOW voltage                        | 1.65 ≤ V <sub>CC</sub> ≤ 2.2                             |  | −0.2                                 | –                  | 0.4                   | V    |
|                 |  | 2.2 ≤ V <sub>CC</sub> ≤ 2.7                              |  | −0.3                                 | –                  | 0.6                   |      |
|                 |  | 2.7 ≤ V <sub>CC</sub> ≤ 3.6                              |  | −0.3                                 | –                  | 0.8                   |      |
|                 |  | 4.5 ≤ V <sub>CC</sub> ≤ 5.5                              |  | −0.5                                 | –                  | 0.8                   |      |
| I <sub>IX</sub> | Input leakage current                    | GND ≤ V <sub>I</sub> ≤ V <sub>CC</sub>                   |  | −1                                   | –                  | +1                    | μA   |
| I <sub>OZ</sub> | Output leakage current                   | GND ≤ V <sub>O</sub> ≤ V <sub>CC</sub> , Output disabled |  | −1                                   | –                  | +1                    | μA   |
| I <sub>CC</sub> | V <sub>CC</sub> operating supply current | f = 22.22MHz (45 ns)                                     | V <sub>CC</sub> = V <sub>CC(max)</sub><br>I <sub>OUT</sub> = 0 mA<br>CMOS levels | –                                    | 29                 | 36                    | mA   |
|                 |  | f = 18.18MHz (55 ns)                                     |  | –                                    | 29                 | 32                    | mA   |
|                 |  | f = 1 MHz  |  | –                                    | 7                  | 9                     | mA   |

### Notes

- $V_{IL(min)}$  = -2.0 V for pulse durations less than 20 ns.
- $V_{IH(max)}$  =  $V_{CC} + 2V$  for pulse durations less than 20 ns.
- Full Device AC operation assumes a 100 μs ramp time from 0 to  $V_{CC(min)}$  and 200 μs wait time after  $V_{CC}$  stabilization.
- Indicates the value for the center of distribution at 3.0 V, 25 °C and not 100% tested
- This parameter is guaranteed by design and not tested.

**Electrical Characteristics** (continued)

Over the Operating Range

| Parameter                        | Description  | Test Conditions  | 45 ns/ 55 ns          |                    |      | Unit |    |
|----------------------------------|--|--|-----------------------|--------------------|------|------|----|
|                                  |  |  | Min                   | Typ <sup>[8]</sup> | Max  |      |    |
| I <sub>SB1</sub> <sup>[10]</sup> | Automatic power down current – CMOS inputs   | $\overline{CE}_1 \geq V_{CC} - 0.2 \text{ V}$ or $CE_2 \leq 0.2 \text{ V}$<br>or $(\overline{BHE} \text{ and } \overline{BLE}) \geq V_{CC} - 0.2 \text{ V}$ ,<br>$V_{IN} \geq V_{CC} - 0.2 \text{ V}$ , $V_{IN} \leq 0.2 \text{ V}$ ,<br>$f = f_{\text{max}}$ (address and data only),<br>$f = 0$ ( $\overline{OE}$ , and $\overline{WE}$ ), $V_{CC} = V_{CC(\text{max})}$ | –                     | 5.5                | 16   | μA   |    |
| I <sub>SB2</sub> <sup>[10]</sup> | Automatic Power-down Current – CMOS Inputs<br>$V_{CC} = 2.2 \text{ V}$ to $3.6 \text{ V}$ and $4.5 \text{ V}$ to $5.5 \text{ V}$ | $\overline{CE}_1 \geq V_{CC} - 0.2 \text{ V}$ or $CE_2 \leq 0.2 \text{ V}$   | 25 °C <sup>[11]</sup> | –                  | 5.5  | 6.5  | μA |
|                                  |  |  | 40 °C <sup>[11]</sup> | –                  | 6.3  | 8.0  |    |
|                                  |  | or $(\overline{BHE} \text{ and } \overline{BLE}) \geq V_{CC} - 0.2 \text{ V}$ ,  | 70 °C <sup>[11]</sup> | –                  | 8.4  | 12.0 |    |
|                                  |  | $V_{IN} \geq V_{CC} - 0.2 \text{ V}$ or $V_{IN} \leq 0.2 \text{ V}$ ,<br>$f = 0$ , $V_{CC} = V_{CC(\text{max})}$   | 85 °C                 | –                  | 12.0 | 16.0 |    |
|                                  | Automatic Power-down Current – CMOS Inputs<br>$V_{CC} = 1.65 \text{ V}$ to $2.2 \text{ V}$                                       | $\overline{CE}_1 \geq V_{CC} - 0.2 \text{ V}$ or $CE_2 \leq 0.2 \text{ V}$<br>or $(\overline{BHE} \text{ and } \overline{BLE}) \geq V_{CC} - 0.2 \text{ V}$ ,<br>$V_{IN} \geq V_{CC} - 0.2 \text{ V}$ or $V_{IN} \leq 0.2 \text{ V}$ ,<br>$f = 0$ , $V_{CC} = V_{CC(\text{max})}$  | –                     | 7.0                | 26.0 |      |    |

**Notes**

10. Chip enables ( $\overline{CE}_1$  and  $CE_2$ ), byte enables ( $\overline{BHE}$  and  $\overline{BLE}$ ) and  $\overline{BYTE}$  must be tied to CMOS levels to meet the  $I_{SB1}/I_{SB2} / I_{CCDR}$  spec. Other inputs can be left floating.  
 11. Indicates the value for the center of distribution at 3.0 V, 25 °C and not 100% tested.

## Capacitance

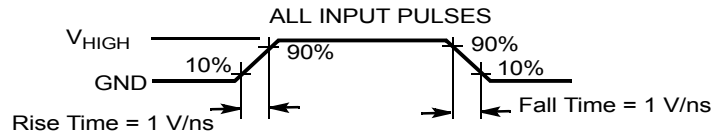
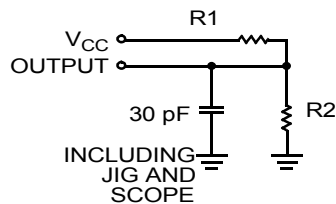
| Parameter <sup>[12]</sup> | Description        | Test Conditions  | Max | Unit |
|---------------------------|--------------------|--|-----|------|
| $C_{IN}$                  | Input capacitance  | $T_A = 25\text{ }^{\circ}\text{C}$ , $f = 1\text{ MHz}$ , $V_{CC} = V_{CC(typ)}$ | 10  | pF   |
| $C_{OUT}$                 | Output capacitance |  | 10  | pF   |

## Thermal Resistance

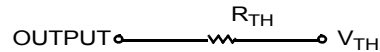
| Parameter <sup>[12]</sup> | Description                              | Test Conditions   | 48-ball VFBGA | 48-pin TSOP I | Unit                 |
|---------------------------|--|---|---------------|---------------|----------------------|
| $\Theta_{JA}$             | Thermal resistance (junction to ambient) | Still air, soldered on a 3 × 4.5 inch, four-layer printed circuit board | 31.50         | 57.99         | $^{\circ}\text{C/W}$ |
| $\Theta_{JC}$             | Thermal resistance (junction to case)    |   | 15.75         | 13.42         | $^{\circ}\text{C/W}$ |

## AC Test Loads and Waveforms

Figure 3. AC Test Loads and Waveforms



Equivalent to: THÉVENIN EQUIVALENT



| Parameters | 1.8 V | 2.5 V | 3.0 V | 5.0 V | Unit     |
|------------|-------|-------|-------|-------|----------|
| $R_1$      | 13500 | 16667 | 1103  | 1800  | $\Omega$ |
| $R_2$      | 10800 | 15385 | 1554  | 990   | $\Omega$ |
| $R_{TH}$   | 6000  | 8000  | 645   | 639   | $\Omega$ |
| $V_{TH}$   | 0.80  | 1.20  | 1.75  | 1.77  | V        |
| $V_{HIGH}$ | 1.8   | 2.5   | 3.0   | 5.0   | V        |

### Note

12. Tested initially and after any design or process changes that may affect these parameters.

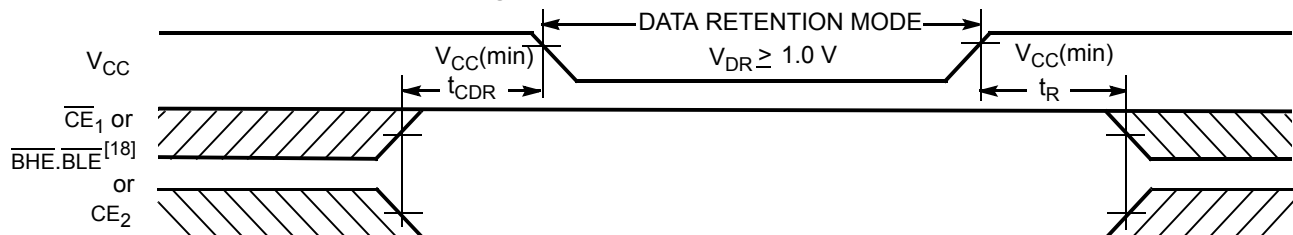
## Data Retention Characteristics

Over the Operating Range

| Parameter                      | Description                          | Conditions   | Min   | Typ <sup>[13]</sup> | Max  | Unit |
|--------------------------------|--------------------------------------|--|-------|---------------------|------|------|
| $V_{DR}$                       | $V_{CC}$ for data retention          |  | 1.0   | –                   | –    | V    |
| $I_{CCDR}$ <sup>[14, 15]</sup> | Data retention current               | $V_{CC} = 2.2 \text{ V to } 3.6 \text{ V},$<br>$\overline{CE}_1 \geq V_{CC} - 0.2 \text{ V or } CE_2 \leq 0.2 \text{ V or}$<br>$(\overline{BHE} \text{ and } \overline{BLE}) \geq V_{CC} - 0.2 \text{ V},$<br>$V_{IN} \geq V_{CC} - 0.2 \text{ V or } V_{IN} \leq 0.2 \text{ V}$     | –     | 5.5                 | 16   | μA   |
|                                |                                      | $1.2 \text{ V} \leq V_{CC} \leq 2.2 \text{ V},$<br>$\overline{CE}_1 \geq V_{CC} - 0.2 \text{ V or } CE_2 \leq 0.2 \text{ V or}$<br>$(\overline{BHE} \text{ and } \overline{BLE}) \geq V_{CC} - 0.2 \text{ V},$<br>$V_{IN} \geq V_{CC} - 0.2 \text{ V or } V_{IN} \leq 0.2 \text{ V}$ | –     | 7.0                 | 26.0 |      |
| $t_{CDR}$ <sup>[16]</sup>      | Chip deselect to data retention time |  | 0     | –                   | –    | –    |
| $t_R$ <sup>[17, 19]</sup>      | Operation recovery time              |  | 45/55 | –                   | –    | ns   |

## Data Retention Waveform

Figure 4. Data Retention Waveform



### Notes

13. Indicates the value for the center of distribution at 3.0 V, 25 °C and not 100% tested.
14. Chip enables ( $\overline{CE}_1$  and  $CE_2$ ), byte enables ( $\overline{BHE}$  and  $\overline{BLE}$ ) and  $\overline{BYTE}$  must be tied to CMOS levels to meet the  $I_{SB1} / I_{SB2} / I_{CCDR}$  spec. Other inputs can be left floating.
15.  $I_{CCDR}$  is guaranteed only after the device is first powered up to  $V_{CC(min)}$  and then brought down to  $V_{DR}$ .
16. Tested initially and after any design or process changes that may affect these parameters.
17. Full device operation requires linear  $V_{CC}$  ramp from  $V_{DR}$  to  $V_{CC(min)}$   $\geq 100 \mu\text{s}$  or stable at  $V_{CC(min)}$   $\geq 100 \mu\text{s}$ .
18.  $\overline{BHE.BLE}$  is the AND of both  $\overline{BHE}$  and  $\overline{BLE}$ . Deselect the chip by either disabling the chip enable signals or by disabling both  $\overline{BHE}$  and  $\overline{BLE}$ .
19. These parameters are guaranteed by design and are not tested.

## Switching Characteristics

| Parameter <sup>[20]</sup>       | Description  | 45 ns |      | 55 ns |      | Unit |
|---------------------------------|--|-------|------|-------|------|------|
|                                 |  | Min   | Max  | Min   | Max  |      |
| Read Cycle                      |  |       |      |       |      |      |
| t <sub>RC</sub>                 | Read cycle time  | 45.0  | –    | 55.0  | –    | ns   |
| t <sub>AA</sub>                 | Address to data valid  | –     | 45.0 | –     | 55.0 | ns   |
| t <sub>OHA</sub>                | Data hold from address change  | 10.0  | –    | 10.0  | –    | ns   |
| t <sub>ACE</sub>                | $\overline{CE}_1$ LOW and CE <sub>2</sub> HIGH to data valid                     | –     | 45.0 | –     | 55.0 | ns   |
| t <sub>DOE</sub>                | $\overline{OE}$ LOW to data valid  | –     | 22.0 | –     | 25.0 | ns   |
| t <sub>LZOE</sub>               | $\overline{OE}$ LOW to Low Z <sup>[21, 22]</sup>                                 | 5.0   | –    | 5.0   | –    | ns   |
| t <sub>HZOE</sub>               | $\overline{OE}$ HIGH to High Z <sup>[21, 22, 23]</sup>                           | –     | 18.0 | –     | 18.0 | ns   |
| t <sub>LZCE</sub>               | $\overline{CE}_1$ LOW and CE <sub>2</sub> HIGH to Low Z <sup>[21, 22]</sup>      | 10.0  | –    | 10.0  | –    | ns   |
| t <sub>HZCE</sub>               | $\overline{CE}_1$ HIGH and CE <sub>2</sub> LOW to High Z <sup>[21, 22, 23]</sup> | –     | 18.0 | –     | 18.0 | ns   |
| t <sub>PU</sub>                 | $\overline{CE}_1$ LOW and CE <sub>2</sub> HIGH to power-up <sup>[24]</sup>       | 0     | –    | 0     | –    | ns   |
| t <sub>PD</sub>                 | $\overline{CE}_1$ HIGH and CE <sub>2</sub> LOW to power-down <sup>[24]</sup>     | –     | 45.0 | –     | 55.0 | ns   |
| t <sub>DBE</sub>                | BLE / BHE LOW to data valid  | –     | 45.0 | –     | 55.0 | ns   |
| t <sub>LZBE</sub>               | $\overline{BLE}$ / $\overline{BHE}$ LOW to Low Z <sup>[21, 22]</sup>             | 5.0   | –    | 5.0   | –    | ns   |
| t <sub>HZBE</sub>               | $\overline{BLE}$ / $\overline{BHE}$ HIGH to High Z <sup>[21, 22, 23]</sup>       | –     | 18.0 | –     | 18.0 | ns   |
| Write Cycle <sup>[25, 26]</sup> |  |       |      |       |      |      |
| t <sub>WC</sub>                 | Write cycle time   | 45    | –    | 55    | –    | ns   |
| t <sub>SCE</sub>                | $\overline{CE}_1$ LOW and CE <sub>2</sub> HIGH to write end                      | 35    | –    | 40    | –    | ns   |
| t <sub>AW</sub>                 | Address setup to write end   | 35    | –    | 40    | –    | ns   |
| t <sub>HA</sub>                 | Address hold from write end  | 0     | –    | 0     | –    | ns   |
| t <sub>SA</sub>                 | Address setup to write start   | 0     | –    | 0     | –    | ns   |
| t <sub>PWE</sub>                | $\overline{WE}$ pulse width  | 35    | –    | 40    | –    | ns   |
| t <sub>BW</sub>                 | BLE / BHE LOW to write end   | 35    | –    | 40    | –    | ns   |
| t <sub>SD</sub>                 | Data setup to write end  | 25    | –    | 25    | –    | ns   |
| t <sub>HD</sub>                 | Data hold from write end   | 0     | –    | 0     | –    | ns   |
| t <sub>HZWE</sub>               | $\overline{WE}$ LOW to High Z <sup>[21, 22, 23]</sup>                            | –     | 18   | –     | 20   | ns   |
| t <sub>LZWE</sub>               | $\overline{WE}$ HIGH to Low Z <sup>[21, 22]</sup>                                | 10    | –    | 10    | –    | ns   |

### Notes

20. Test conditions for all parameters other than tri-state parameters assume signal transition time of 1 V/ns, timing reference levels of  $V_{CC(typ)}/2$ , input pulse levels of 0 to  $V_{CC(typ)}$ , and output loading of the specified  $I_{OL}/I_{OH}$  as shown in Figure 3 on page 6.

21. At any temperature and voltage condition,  $t_{HZCE}$  is less than  $t_{LZCE}$ ,  $t_{HZBE}$  is less than  $t_{LZBE}$ ,  $t_{HZOE}$  is less than  $t_{LZOE}$ , and  $t_{HZWE}$  is less than  $t_{LZWE}$  for any device.

22. Tested initially and after any design or process changes that may affect these parameters.

23.  $t_{HZOE}$ ,  $t_{HZCE}$ ,  $t_{HZBE}$ , and  $t_{HZWE}$  transitions are measured when the outputs enter a high impedance state.

24. These parameters are guaranteed by design and are not tested.

25. The internal write time of the memory is defined by the overlap of  $\overline{WE}$ ,  $\overline{CE}_1 = V_{IL}$ ,  $\overline{BHE}$  or  $\overline{BLE}$  or both =  $V_{IL}$ , and  $CE_2 = V_{IH}$ . All signals must be ACTIVE to initiate a write and any of these signals can terminate a write by going INACTIVE. The data input setup and hold timing must refer to the edge of the signal that terminates the write.

26. The minimum write cycle pulse width for Write Cycle No. 3 (WE Controlled, OE LOW) should be equal to the sum of  $t_{HZWE}$  and  $t_{SD}$ .



## Switching Waveforms

Figure 5. Read Cycle No. 1 (Address Transition Controlled)<sup>[27, 28]</sup>

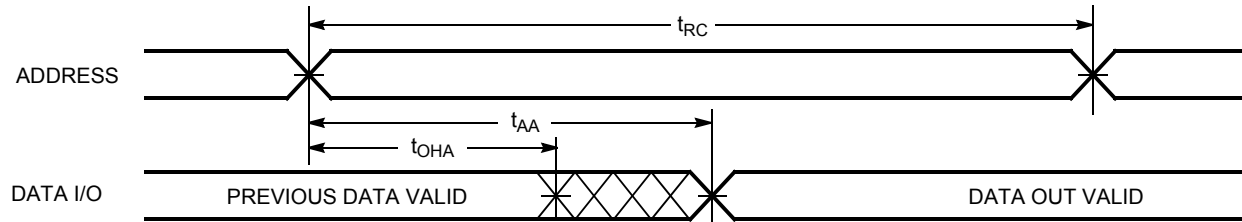
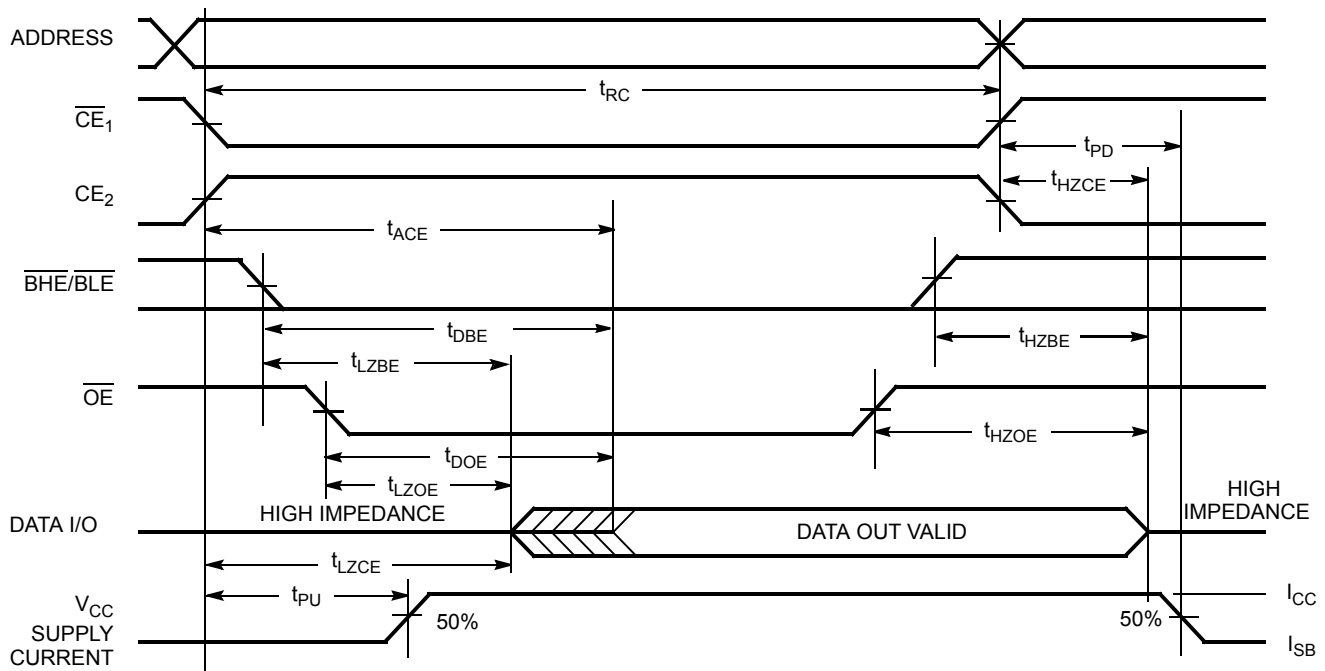


Figure 6. Read Cycle No. 2 ( $\overline{OE}$  Controlled)<sup>[28, 29]</sup>

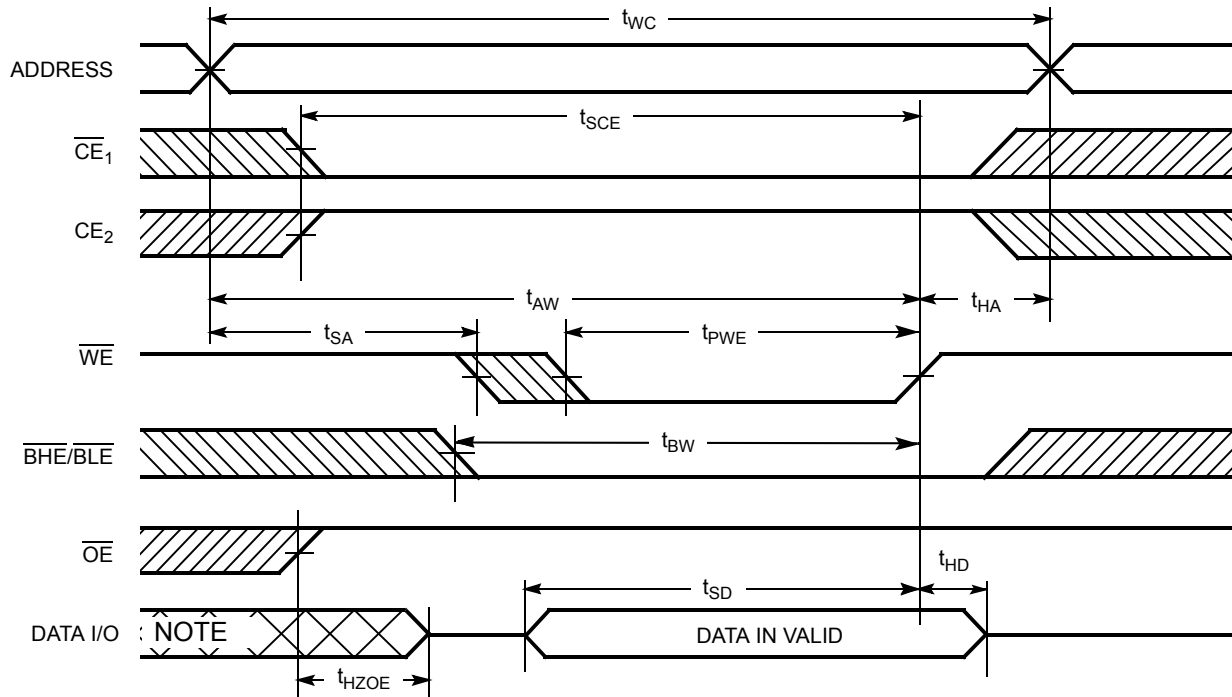


### Notes

27. The device is continuously selected.  $\overline{OE}$ ,  $\overline{CE}_1 = V_{IL}$ ,  $\overline{BHE}$ ,  $\overline{BLE}$  or both =  $V_{IL}$ , and  $CE_2 = V_{IH}$ .

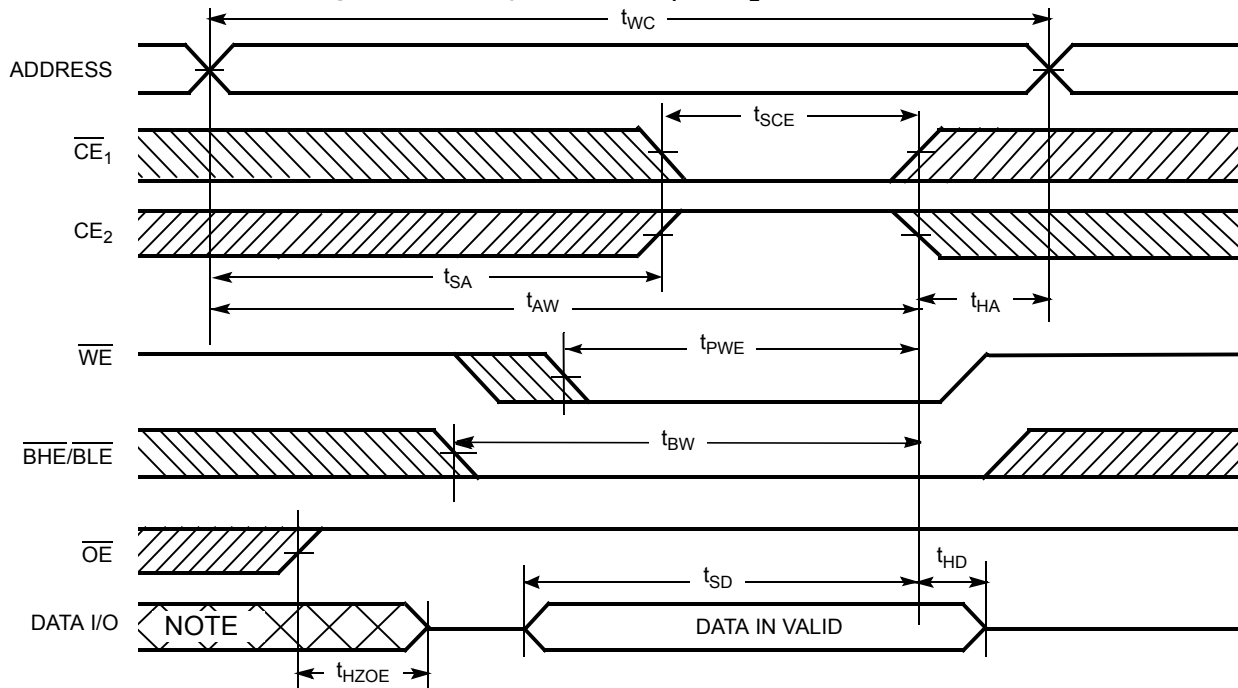
28.  $\overline{WE}$  is HIGH for read cycle.

29. Address valid before or similar to  $\overline{CE}_1$ ,  $\overline{BHE}$ ,  $\overline{BLE}$  transition LOW and  $CE_2$  transition HIGH.

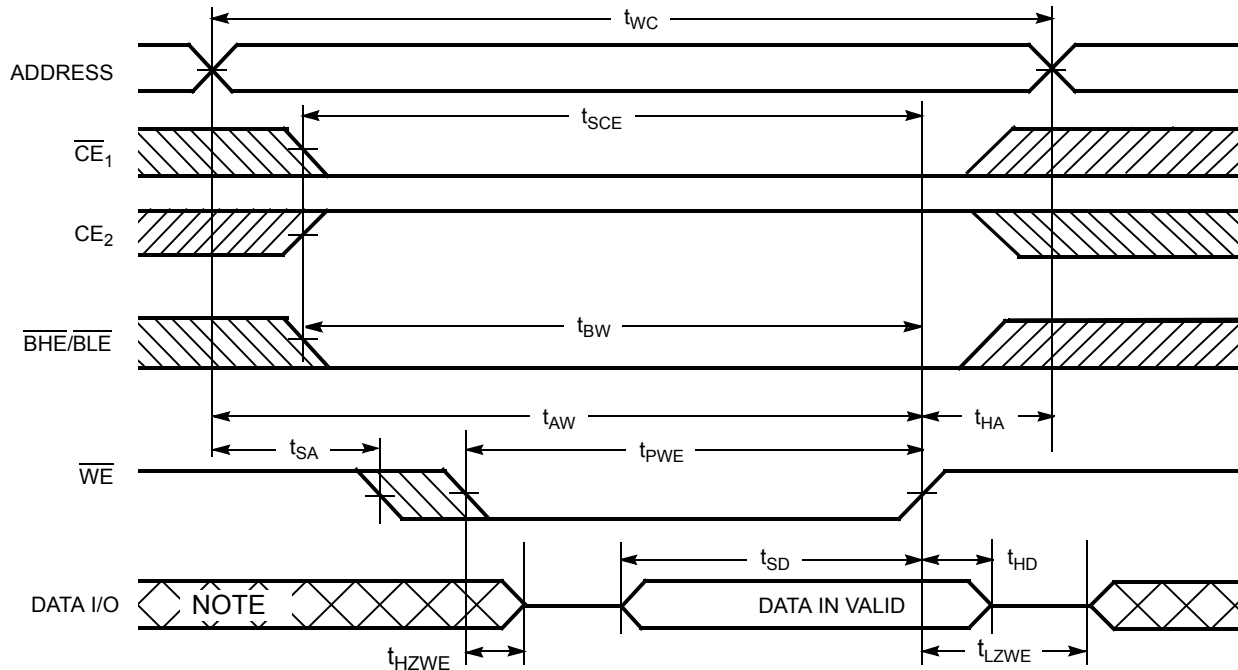
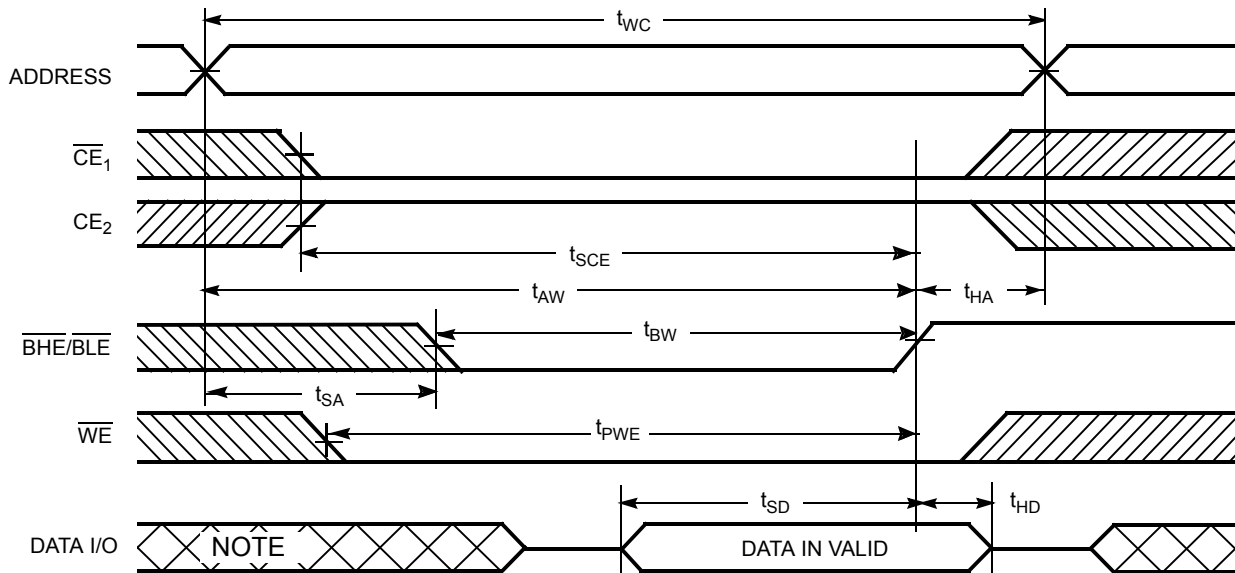
**Switching Waveforms (continued)**
**Figure 7. Write Cycle No. 1 ( $\overline{WE}$  Controlled)**<sup>[30, 31, 32]</sup>

**Notes**

30. The internal write time of the memory is defined by the overlap of  $\overline{WE}$ ,  $\overline{CE}_1 = V_{IL}$ ,  $\overline{BHE}$  or  $\overline{BLE}$  or both =  $V_{IL}$ , and  $\overline{CE}_2 = V_{IH}$ . All signals must be ACTIVE to initiate a write and any of these signals can terminate a write by going INACTIVE. The data input setup and hold timing must refer to the edge of the signal that terminates the write.
31. Data I/O is high impedance if  $\overline{OE} = V_{IH}$ .
32. If  $\overline{CE}_1$  goes HIGH and  $\overline{CE}_2$  goes LOW simultaneously with  $\overline{WE} = V_{IH}$ , the output remains in a high impedance state.
33. During this period the I/Os are in output state. Do not apply input signals.

**Switching Waveforms** (continued)

**Figure 8. Write Cycle No. 2 ( $\overline{CE_1}$  or  $CE_2$  Controlled)**<sup>[34, 35]</sup>

**Notes**

34. The internal write time of the memory is defined by the overlap of  $\overline{WE}$ ,  $\overline{CE_1} = V_{IL}$ ,  $\overline{BHE}$  or  $\overline{BLE}$  or both =  $V_{IL}$ , and  $CE_2 = V_{IH}$ . All signals must be ACTIVE to initiate a write and any of these signals can terminate a write by going INACTIVE. The data input setup and hold timing must refer to the edge of the signal that terminates the write.
35. If  $\overline{CE_1}$  goes HIGH and  $CE_2$  goes LOW simultaneously with  $\overline{WE} = V_{IH}$ , the output remains in a high impedance state.
36. During this period the I/Os are in output state. Do not apply input signals.

**Switching Waveforms (continued)**
**Figure 9. Write Cycle No. 3 ( $\overline{WE}$  Controlled,  $\overline{OE}$  LOW)<sup>[37, 38]</sup>**

**Figure 10. Write Cycle No. 4 ( $\overline{BHE/BLER}$  Controlled,  $\overline{OE}$  LOW)<sup>[37, 38]</sup>**

**Notes**

37. If  $\overline{CE_1}$  goes HIGH and  $\overline{CE_2}$  goes LOW simultaneously with  $\overline{WE} = V_{IH}$ , the output remains in a high impedance state.
38. The minimum write cycle pulse width should be equal to the sum of  $t_{HZWE}$  and  $t_{SD}$ .
39. During this period the I/Os are in output state. Do not apply input signals.

## Truth Table

| $\overline{CE}_1$ | $CE_2$            | $\overline{WE}$ | $\overline{OE}$ | $\overline{BHE}$  | $\overline{BLE}$  | Inputs/Outputs   | Mode                | Power                |
|-------------------|-------------------|-----------------|-----------------|-------------------|-------------------|--|---------------------|----------------------|
| H                 | X <sup>[40]</sup> | X               | X               | X <sup>[40]</sup> | X <sup>[40]</sup> | High Z   | Deselect/Power-down | Standby ( $I_{SB}$ ) |
| X <sup>[40]</sup> | L                 | X               | X               | X <sup>[40]</sup> | X <sup>[40]</sup> | High Z   | Deselect/Power-down | Standby ( $I_{SB}$ ) |
| X <sup>[40]</sup> | X <sup>[40]</sup> | X               | X               | H                 | H                 | High Z   | Deselect/Power-down | Standby ( $I_{SB}$ ) |
| L                 | H                 | H               | L               | L                 | L                 | Data Out ( $I/O_0$ – $I/O_{15}$ )                                  | Read                | Active ( $I_{CC}$ )  |
| L                 | H                 | H               | L               | H                 | L                 | Data Out ( $I/O_0$ – $I/O_7$ );<br>High Z ( $I/O_8$ – $I/O_{15}$ ) | Read                | Active ( $I_{CC}$ )  |
| L                 | H                 | H               | L               | L                 | H                 | High Z ( $I/O_0$ – $I/O_7$ );<br>Data Out ( $I/O_8$ – $I/O_{15}$ ) | Read                | Active ( $I_{CC}$ )  |
| L                 | H                 | H               | H               | X                 | X                 | High Z   | Output disabled     | Active ( $I_{CC}$ )  |
| L                 | H                 | L               | X               | L                 | L                 | Data In ( $I/O_0$ – $I/O_{15}$ )                                   | Write               | Active ( $I_{CC}$ )  |
| L                 | H                 | L               | X               | H                 | L                 | Data In ( $I/O_0$ – $I/O_7$ );<br>High Z ( $I/O_8$ – $I/O_{15}$ )  | Write               | Active ( $I_{CC}$ )  |
| L                 | H                 | L               | X               | L                 | H                 | High Z ( $I/O_0$ – $I/O_7$ );<br>Data In ( $I/O_8$ – $I/O_{15}$ )  | Write               | Active ( $I_{CC}$ )  |

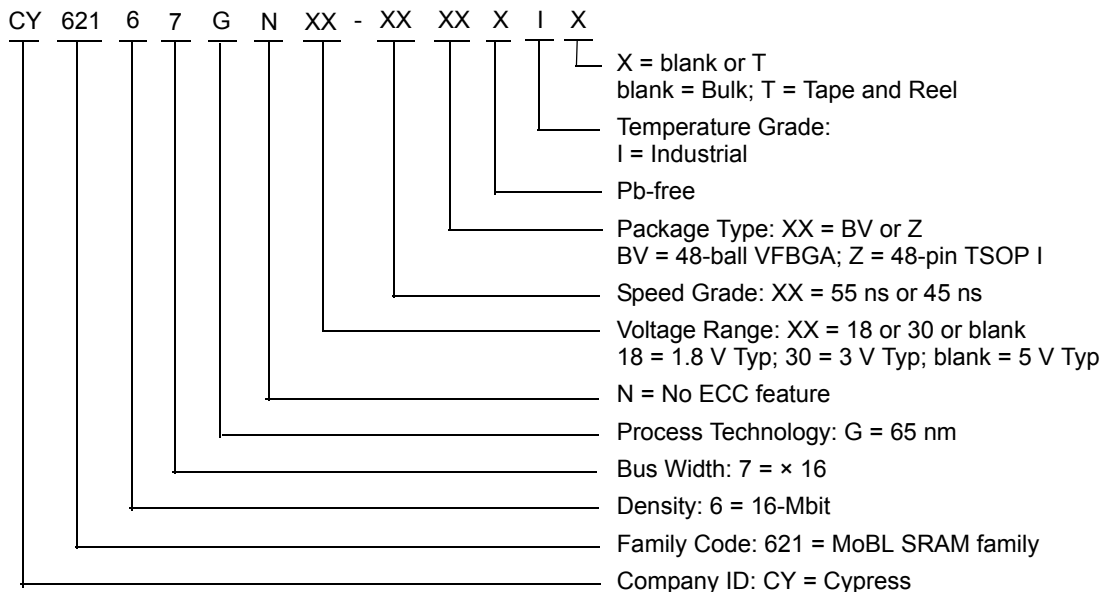
### Note

40. The 'X' (Don't care) state for the chip enables and Byte enables in the truth table refer to the logic state (either HIGH or LOW). Intermediate voltage levels on these pins is not permitted.

## Ordering Information

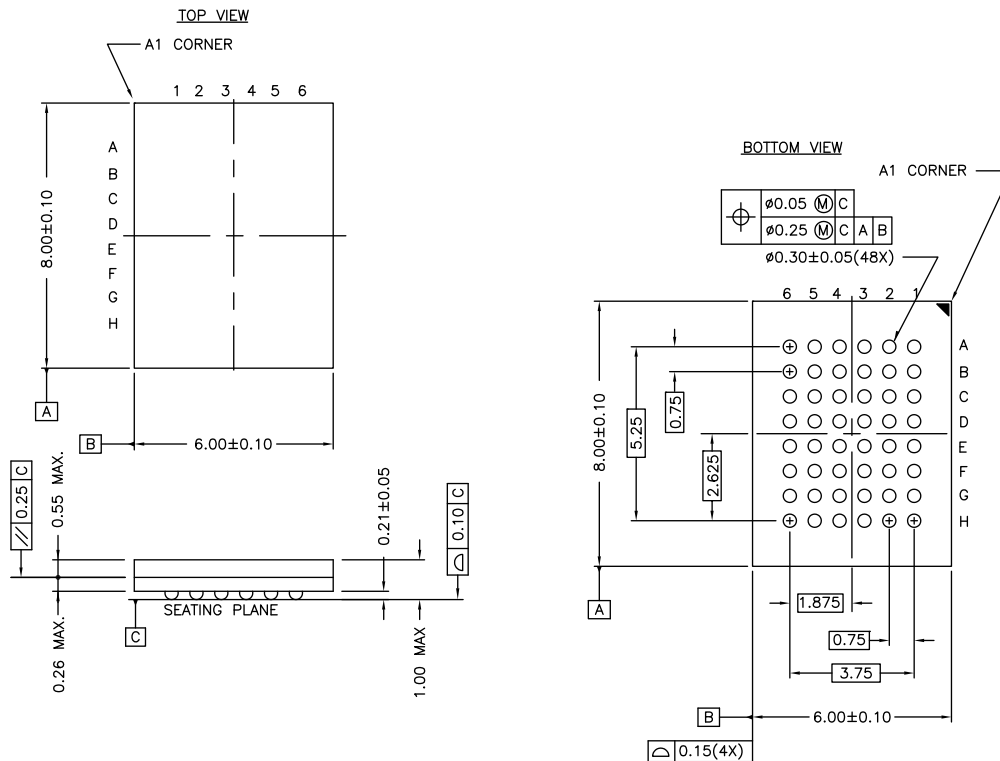
| Speed (ns) | Voltage Range | Ordering Code       | Package Diagram | Package Type  | Operating Range |
|------------|---------------|---------------------|-----------------|---|-----------------|
| 55         | 1.65 V–2.2 V  | CY62167GN18-55BVXI  | 51-85150        | 48-ball VFBGA (6 × 8 × 1 mm),<br>Package Code: BV48 | Industrial      |
|            |               | CY62167GN18-55BVXIT |                 |   |                 |
| 45         | 2.2 V–3.6 V   | CY62167GN30-45BVXI  | 51-85150        | 48-ball VFBGA (6 × 8 × 1 mm),<br>Package Code: BV48 |                 |
|            |               | CY62167GN30-45BVXIT |                 |   |                 |
|            |               | CY62167GN30-45ZXI   | 51-85183        | 48-pin TSOP I (Pb-free)                             |                 |
|            |               | CY62167GN30-45ZXIT  |                 |   |                 |
|            | 4.5 V–5.5 V   | CY62167GN-45ZXI     | 51-85183        | 48-pin TSOP I (Pb-free)                             |                 |
|            |               | CY62167GN-45ZXIT    |                 |   |                 |

## Ordering Code Definitions



## Package Diagrams

**Figure 11. 48-ball VFBGA (6 × 8 × 1.0 mm) Package Outline, 51-85150**

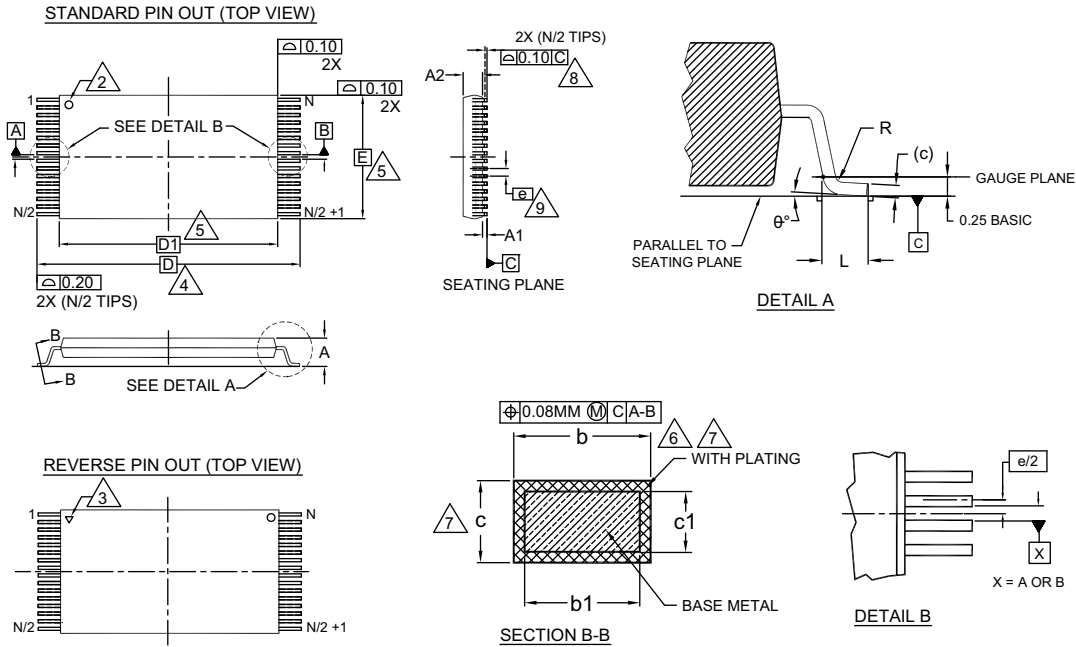


NOTE:  
 PACKAGE WEIGHT: See Cypress Package Material Declaration Datasheet (PMDD)  
 posted on the Cypress web.

51-85150 \*H

## Package Diagrams (continued)

**Figure 12. 48-pin TSOP I (12 × 18.4 × 1.0 mm) Package Outline, 51-85183**



| SYMBOL | DIMENSIONS  |      |      |
|--------|-------------|------|------|
|        | MIN.        | NOM. | MAX. |
| A      | —           | —    | 1.20 |
| A1     | 0.05        | —    | 0.15 |
| A2     | 0.95        | 1.00 | 1.05 |
| b1     | 0.17        | 0.20 | 0.23 |
| b      | 0.17        | 0.22 | 0.27 |
| c1     | 0.10        | —    | 0.16 |
| c      | 0.10        | —    | 0.21 |
| D      | 20.00 BASIC |      |      |
| D1     | 18.40 BASIC |      |      |
| E      | 12.00 BASIC |      |      |
| e      | 0.50 BASIC  |      |      |
| L      | 0.50        | 0.60 | 0.70 |
| θ      | 0°          | —    | 8    |
| R      | 0.08        | —    | 0.20 |
| N      | 48          |      |      |

### NOTES:

1. DIMENSIONS ARE IN MILLIMETERS (mm).
2. PIN 1 IDENTIFIER FOR STANDARD PIN OUT (DIE UP).
3. PIN 1 IDENTIFIER FOR REVERSE PIN OUT (DIE DOWN); INK OR LASER MARK.
4. TO BE DETERMINED AT THE SEATING PLANE  $\square C$ . THE SEATING PLANE IS DEFINED AS THE PLANE OF CONTACT THAT IS MADE WHEN THE PACKAGE LEADS ARE ALLOWED TO REST FREELY ON A FLAT HORIZONTAL SURFACE.
5. DIMENSIONS D1 AND E DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE MOLD PROTRUSION ON E IS 0.15mm PER SIDE AND ON D1 IS 0.25mm PER SIDE.
6. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08mm TOTAL IN EXCESS OF b DIMENSION AT MAX. MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.07mm.
7. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.10mm AND 0.25mm FROM THE LEAD TIP.
8. LEAD COPLANARITY SHALL BE WITHIN 0.10mm AS MEASURED FROM THE SEATING PLANE.
9. DIMENSION "e" IS MEASURED AT THE CENTERLINE OF THE LEADS.
10. JEDEC SPECIFICATION NO. REF: MO-142(D)DD.

51-85183 \*F



## Acronyms

| Acronym                 | Description                             |
|-------------------------|---|
| $\overline{\text{BHE}}$ | Byte High Enable                        |
| $\overline{\text{BLE}}$ | Byte Low Enable                         |
| $\overline{\text{CE}}$  | Chip Enable                             |
| CMOS                    | Complementary Metal Oxide Semiconductor |
| I/O                     | Input/Output                            |
| $\overline{\text{OE}}$  | Output Enable                           |
| SRAM                    | Static Random Access Memory             |
| TSOP                    | Thin Small Outline Package              |
| VFBGA                   | Very Fine-Pitch Ball Grid Array         |
| $\overline{\text{WE}}$  | Write Enable                            |

## Document Conventions

### Units of Measure

| Symbol | Unit of Measure |
|--------|-----------------|
| °C     | degree Celsius  |
| MHz    | megahertz       |
| μA     | microampere     |
| μs     | microsecond     |
| mA     | milliampere     |
| mm     | millimeter      |
| ns     | nanosecond      |
| Ω      | ohm             |
| %      | percent         |
| pF     | picofarad       |
| V      | volt            |
| W      | watt            |

## Document History Page

| Document Title: CY62167GN MoBL®, 16-Mbit (1M × 16/2M × 8) Static RAM<br>Document Number: 001-93628 |         |                 |                 |   |
|--|---------|-----------------|-----------------|---|
| Rev.   | ECN No. | Orig. of Change | Submission Date | Description of Change   |
| *B   | 5210733 | NILE            | 07/04/2016      | Changed status from Preliminary to Final.   |
| *C   | 5420388 | VINI            | 09/08/2016      | Updated <a href="#">Electrical Characteristics</a> :<br>Changed minimum value of $V_{OH}$ parameter corresponding to Test Condition " $2.7 \leq V_{CC} \leq 3.6$ , $I_{OH} = -1.0$ mA" from 2.2 V to 2.4 V.<br>Changed minimum value of $V_{IH}$ parameter corresponding to Test Condition " $2.2 \leq V_{CC} \leq 2.7$ " from 2 V to 1.8 V.<br>Updated Note 5 (Replaced 2 ns with 20 ns).<br>Updated Note 6 (Replaced 2 ns with 20 ns).<br>Updated <a href="#">Ordering Information</a> :<br>Updated part numbers.<br>Added Tape and Reel parts.<br>Updated to new template. |
| *D   | 5783985 | NILE            | 06/23/2017      | Updated <a href="#">Data Retention Characteristics</a> :<br>Changed typical value of $I_{CCDR}$ parameter corresponding to Condition " $1.2 \text{ V} \leq V_{CC} \leq 2.2 \text{ V}$ " from 5.5 $\mu\text{A}$ to 7.0 $\mu\text{A}$ .<br>Changed maximum value of $I_{CCDR}$ parameter corresponding to Condition " $1.2 \text{ V} \leq V_{CC} \leq 2.2 \text{ V}$ " from 16.0 $\mu\text{A}$ to 26.0 $\mu\text{A}$ .<br>Updated <a href="#">Package Diagrams</a> :<br>spec 51-85183 – Changed revision from *D to *F.<br>Updated to new template.                             |

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