

# 4-Mbit (256 K × 16) Static RAM

## Features

- Very high speed: 45 ns
- Wide voltage range: 4.5 V to 5.5 V
- Ultra low standby power
  - Typical standby current: 1 μA
  - Maximum standby current: 7 μA
- Ultra low active power
  - Typical active current: 2 mA at f = 1 MHz
- Easy memory expansion with  $\overline{CE}$  and  $\overline{OE}$  features
- Automatic power down when deselected
- Complementary metal oxide semiconductor (CMOS) for optimum speed and power
- Available in Pb-free 44-pin thin small outline package (TSOP) Type II package

## Functional Description

The CY62146E is a high performance CMOS static RAM organized as 256K words by 16 bits. This device features advanced circuit design to provide ultra low active current. It is ideal for providing More Battery Life™ (MoBL®) in portable applications. The device also has an automatic power down feature that reduces power consumption when addresses are

not toggling. Placing the device into standby mode reduces power consumption by more than 99% when deselected ( $\overline{CE}$  HIGH). The input and output pins (I/O<sub>0</sub> through I/O<sub>15</sub>) are placed in a high impedance state when the device is deselected ( $\overline{CE}$  HIGH), the outputs are disabled ( $\overline{OE}$  HIGH), both Byte High Enable and Byte Low Enable are disabled ( $\overline{BHE}$ ,  $\overline{BLE}$  HIGH) or during a write operation ( $\overline{CE}$  LOW and  $\overline{WE}$  LOW).

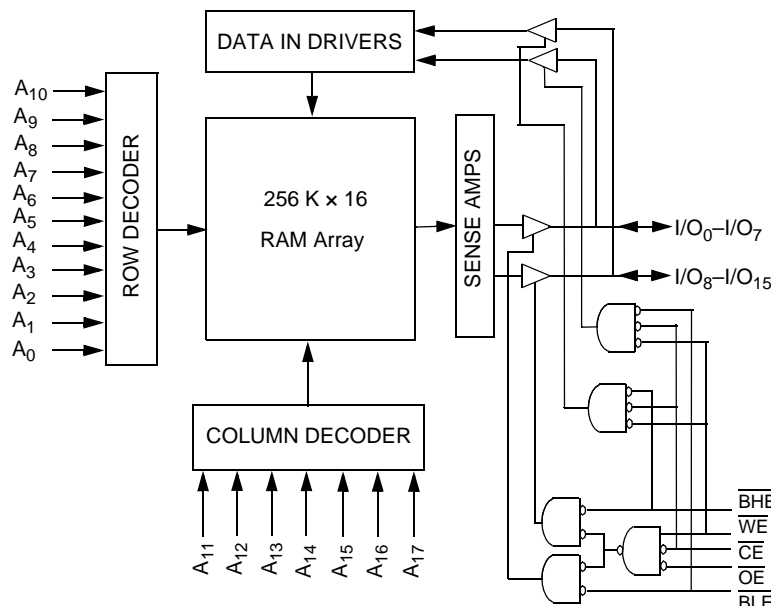
To write to the device, take Chip Enable ( $\overline{CE}$ ) and Write Enable ( $\overline{WE}$ ) inputs LOW. If Byte Low Enable ( $\overline{BLE}$ ) is LOW, then data from I/O pins (I/O<sub>0</sub> through I/O<sub>7</sub>) is written into the location specified on the address pins (A<sub>0</sub> through A<sub>17</sub>). If Byte High Enable ( $\overline{BHE}$ ) is LOW, then data from I/O pins (I/O<sub>8</sub> through I/O<sub>15</sub>) is written into the location specified on the address pins (A<sub>0</sub> through A<sub>17</sub>).

To read from the device, take Chip Enable ( $\overline{CE}$ ) 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<sub>0</sub> to I/O<sub>7</sub>. If Byte High Enable ( $\overline{BHE}$ ) is LOW, then data from memory appears on I/O<sub>8</sub> to I/O<sub>15</sub>. See Truth Table on page 11 for a complete description of read and write modes.

The CY62146E device is suitable for interfacing with processors that have TTL I/P levels. It is not suitable for processors that require CMOS I/P levels. Please Electrical Characteristics on page 4 for more details and suggested alternatives.

For a complete list of related documentation, [click here](#).

## Logic Block Diagram

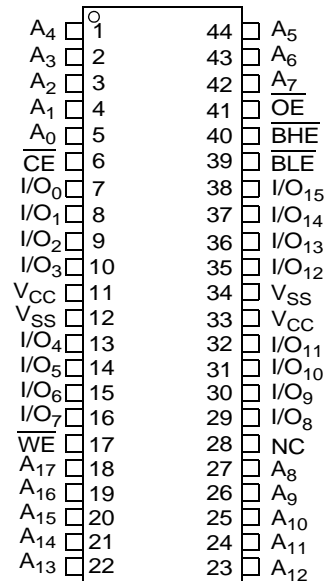


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## Pin Configurations

Figure 1. 44-pin TSOP II pinout (Top View)<sup>[1]</sup>



## Product Portfolio

Product	Range	V <sub>CC</sub> Range (V)			Speed (ns)	Power Dissipation					
						Operating I <sub>CC</sub> (mA)				Standby, I <sub>SB2</sub> (μA)	
		f = 1 MHz		f = f <sub>max</sub>							
		Min	Typ <sup>[2]</sup>	Max		Typ <sup>[2]</sup>	Max	Typ <sup>[2]</sup>	Max	Typ <sup>[2]</sup>	Max
CY62146ELL	Industrial / Automotive-A	4.5	5.0	5.5	45	2	2.5	15	20	1	7

### Notes

1. NC pins are not connected on the die.
2. 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 impair the useful life of the device. These 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 .....	-0.5 V to 6.0 V
DC voltage applied to outputs in high Z state <sup>[3, 4]</sup> .....	-0.5 V to 6.0 V
DC input voltage <sup>[3, 4]</sup> .....	-0.5 V to 6.0 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 <sub>CC</sub> <sup>[5]</sup>
CY62146ELL	Industrial / Automotive-A	-40 °C to +85 °C	4.5 V–5.5 V

## Electrical Characteristics

Over the Operating Range

Parameter	Description	Test Conditions	45 ns (Industrial/Automotive-A)			Unit
			Min	Typ <sup>[6]</sup>	Max	
V <sub>OH</sub>	Output high voltage	V <sub>CC</sub> = 4.5 V, I <sub>OH</sub> = -1.0 mA	2.4	-	-	V
		V <sub>CC</sub> = 5.5 V, I <sub>OH</sub> = -0.1 mA	-	-	3.4 <sup>[7]</sup>	
V <sub>OL</sub>	Output low voltage	I <sub>OL</sub> = 2.1 mA	-	-	0.4	V
V <sub>IH</sub>	Input high voltage	4.5 ≤ V <sub>CC</sub> ≤ 5.5	2.2	-	V <sub>CC</sub> + 0.5	V
V <sub>IL</sub>	Input low voltage	4.5 ≤ V <sub>CC</sub> ≤ 5.5	-0.5	-	0.8	V
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 = f <sub>max</sub> = 1/t <sub>RC</sub> , V <sub>CC</sub> = V <sub>CCmax</sub>	-	15	20	mA
		f = 1 MHz, I <sub>OUT</sub> = 0 mA, CMOS levels	-	2	2.5	
I <sub>SB2</sub> <sup>[8]</sup>	Automatic CE power down current – CMOS inputs	$\overline{CE} \geq V_{CC} - 0.2$ V, V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V or V <sub>IN</sub> ≤ 0.2 V, f = 0, V <sub>CC</sub> = V <sub>CC(max)</sub>	-	1	7	μA

### Notes

- V<sub>IL</sub>(min) = -2.0 V for pulse durations less than 20 ns for I < 30 mA.
- V<sub>IH</sub>(max) = V<sub>CC</sub> + 0.75 V for pulse durations less than 20 ns.
- Full Device AC operation assumes a minimum of 100 μs ramp time from 0 to V<sub>CC</sub> (min) and 200 μs wait time after V<sub>CC</sub> stabilization.
- 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.
- Please note that the maximum V<sub>OH</sub> limit does not exceed minimum CMOS V<sub>IH</sub> of 3.5 V. If you are interfacing this SRAM with 5 V legacy processors that require a minimum V<sub>IH</sub> of 3.5 V, please refer to Application Note AN6081 for technical details and options you may consider.
- Chip enable (CE) and byte enables (BHE and BLE) need to be tied to CMOS levels to meet the I<sub>SB2</sub> / I<sub>CCDR</sub> spec. Other inputs are left floating.

### Capacitance

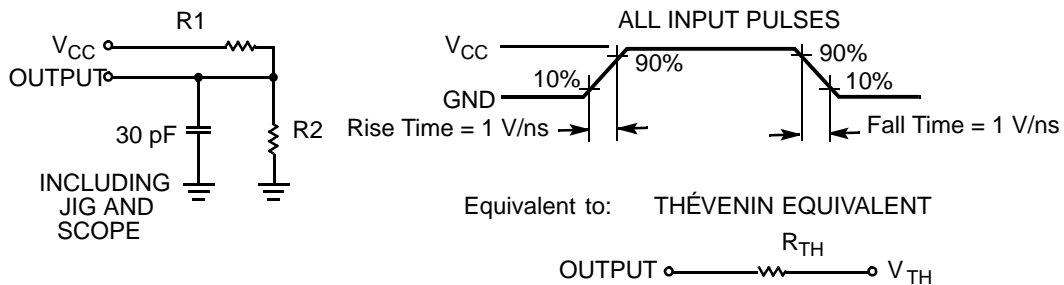
Parameter <sup>[9]</sup>	Description	Test Conditions	Max	Unit
C <sub>IN</sub>	Input capacitance	T <sub>A</sub> = 25 °C, f = 1 MHz, V <sub>CC</sub> = V <sub>CC(typ)</sub>	10	pF
C <sub>OUT</sub>	Output capacitance		10	pF

### Thermal Resistance

Parameter <sup>[9]</sup>	Description	Test Conditions	44-pin TSOP II	Unit
Θ <sub>JA</sub>	Thermal resistance (junction to ambient)	Still Air, soldered on a 3 × 4.5 inch, four layer printed circuit board	55.52	°C/W
Θ <sub>JC</sub>	Thermal resistance (junction to case)		16.03	°C/W

### AC Test Loads and Waveforms

Figure 2. AC Test Loads and Waveforms



Parameters	5.0 V	Unit
R1	1800	Ω
R2	990	Ω
R <sub>TH</sub>	639	Ω
V <sub>TH</sub>	1.77	V

**Note**

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

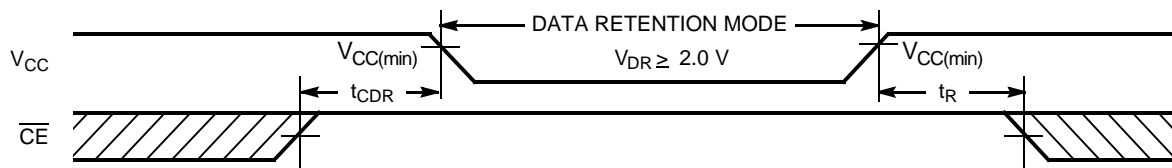
## Data Retention Characteristics

Over the Operating Range

Parameter	Description	Conditions	Min	Typ <sup>[10]</sup>	Max	Unit
$V_{DR}$	$V_{CC}$ for data retention		2	–	–	V
$I_{CCDR}^{[11]}$	Data retention current	$V_{CC} = 2\text{ V}$ , $\overline{CE} \geq V_{CC} - 0.2\text{ V}$ , $V_{IN} \geq V_{CC} - 0.2\text{ V}$ or $V_{IN} \leq 0.2\text{ V}$	–	1	7	$\mu\text{A}$
$t_{CDR}^{[12]}$	Chip deselect to data retention time		0	–	–	ns
$t_R^{[13]}$	Operation recovery time		45	–	–	ns

## Data Retention Waveform

Figure 3. Data Retention Waveform



### Notes

10. Typical values are included for reference only and are not guaranteed or tested. Typical values are measured at  $V_{CC} = V_{CC(typ)}$ ,  $T_A = 25\text{ }^\circ\text{C}$ .
11. Chip enable ( $\overline{CE}$ ) and byte enables ( $BHE$  and  $BLE$ ) need to be tied to CMOS levels to meet the  $I_{SB2} / I_{CCDR}$  spec. Other inputs are left floating.
12. Tested initially and after any design or process changes that may affect these parameters.
13. Full device operation requires linear  $V_{CC}$  ramp from  $V_{DR}$  to  $V_{CC(min)}$   $\geq 100\text{ }\mu\text{s}$  or stable at  $V_{CC(min)}$   $\geq 100\text{ }\mu\text{s}$ .

## Switching Characteristics

Over the Operating Range

Parameter <sup>[14, 15]</sup>	Description	45 ns (Industrial / Automotive-A)		Unit
		Min	Max	
<b>Read Cycle</b>				
t <sub>RC</sub>	Read cycle time	45	–	ns
t <sub>AA</sub>	Address to data valid	–	45	ns
t <sub>OHA</sub>	Data hold from address change	10	–	ns
t <sub>ACE</sub>	$\overline{CE}$ LOW to data valid	–	45	ns
t <sub>DOE</sub>	$\overline{OE}$ LOW to data valid	–	22	ns
t <sub>LZOE</sub>	$\overline{OE}$ LOW to Low Z <sup>[16]</sup>	5	–	ns
t <sub>HZOE</sub>	$\overline{OE}$ HIGH to High Z <sup>[16, 17]</sup>	–	18	ns
t <sub>LZCE</sub>	$\overline{CE}$ LOW to Low Z <sup>[16]</sup>	10	–	ns
t <sub>HZCE</sub>	$\overline{CE}$ HIGH to High Z <sup>[16, 17]</sup>	–	18	ns
t <sub>PU</sub>	$\overline{CE}$ LOW to power-up	0	–	ns
t <sub>PD</sub>	$\overline{CE}$ HIGH to power-down	–	45	ns
t <sub>DBE</sub>	$\overline{BLE}/\overline{BHE}$ LOW to data valid	–	22	ns
t <sub>LZBE</sub>	$\overline{BLE}/\overline{BHE}$ LOW to Low Z <sup>[16]</sup>	5	–	ns
t <sub>HZBE</sub>	$\overline{BLE}/\overline{BHE}$ HIGH to High Z <sup>[16, 17]</sup>	–	18	ns
<b>Write Cycle<sup>[18, 19]</sup></b>				
t <sub>WC</sub>	Write cycle time	45	–	ns
t <sub>SCE</sub>	$\overline{CE}$ LOW to write end	35	–	ns
t <sub>AW</sub>	Address setup to write end	35	–	ns
t <sub>HA</sub>	Address hold from write end	0	–	ns
t <sub>SA</sub>	Address setup to write start	0	–	ns
t <sub>PWE</sub>	$\overline{WE}$ pulse width	35	–	ns
t <sub>BW</sub>	$\overline{BLE}/\overline{BHE}$ LOW to write end	35	–	ns
t <sub>SD</sub>	Data setup to write end	25	–	ns
t <sub>HD</sub>	Data hold from write end	0	–	ns
t <sub>HZWE</sub>	$\overline{WE}$ LOW to High Z <sup>[16, 17]</sup>	–	18	ns
t <sub>LZWE</sub>	$\overline{WE}$ HIGH to Low Z <sup>[16]</sup>	10	–	ns

### Notes

- Test conditions for all parameters other than tri-state parameters assume signal transition time of 3 ns (1 V/ns) or less, timing reference levels of 1.5 V, input pulse levels of 0 to 3 V, and output loading of the specified I<sub>OL</sub>/I<sub>OH</sub> as shown in Figure 2 on page 5.
- In an earlier revision of this device, under a specific application condition, READ and WRITE operations were limited to switching of the byte enable and/or chip enable signals as described in the Application Notes AN13842 and AN66311. However, the issue has been fixed and in production now, and hence, these Application Notes are no longer applicable. They are available for download on our website as they contain information on the date code of the parts, beyond which the fix has been in production.
- At any temperature and voltage condition, t<sub>HZCE</sub> is less than t<sub>LZCE</sub>, t<sub>HZBE</sub> is less than t<sub>LZBE</sub>, t<sub>HZOE</sub> is less than t<sub>LZOE</sub>, and t<sub>HZWE</sub> is less than t<sub>LZWE</sub> for any device.
- t<sub>HZOE</sub>, t<sub>HZCE</sub>, t<sub>HZBE</sub>, and t<sub>HZWE</sub> transitions are measured when the outputs enter a high-impedance state.
- The internal write time of the memory is defined by the overlap of  $\overline{WE}$ ,  $\overline{CE} = V_{IL}$ ,  $\overline{BHE}$ ,  $\overline{BLE}$  or both = V<sub>IL</sub>. 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 be referenced to the edge of the signal that terminates the write.
- The minimum write cycle pulse width for Write Cycle No. 3 ( $\overline{WE}$  controlled,  $\overline{OE}$  LOW) should be equal to the sum of t<sub>SD</sub> and t<sub>HZWE</sub>.

### Switching Waveforms

Figure 4. Read Cycle No.1: Address Transition Controlled<sup>[20, 21]</sup>

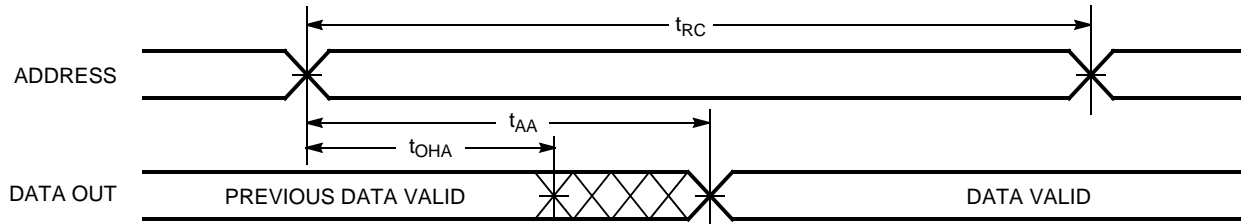
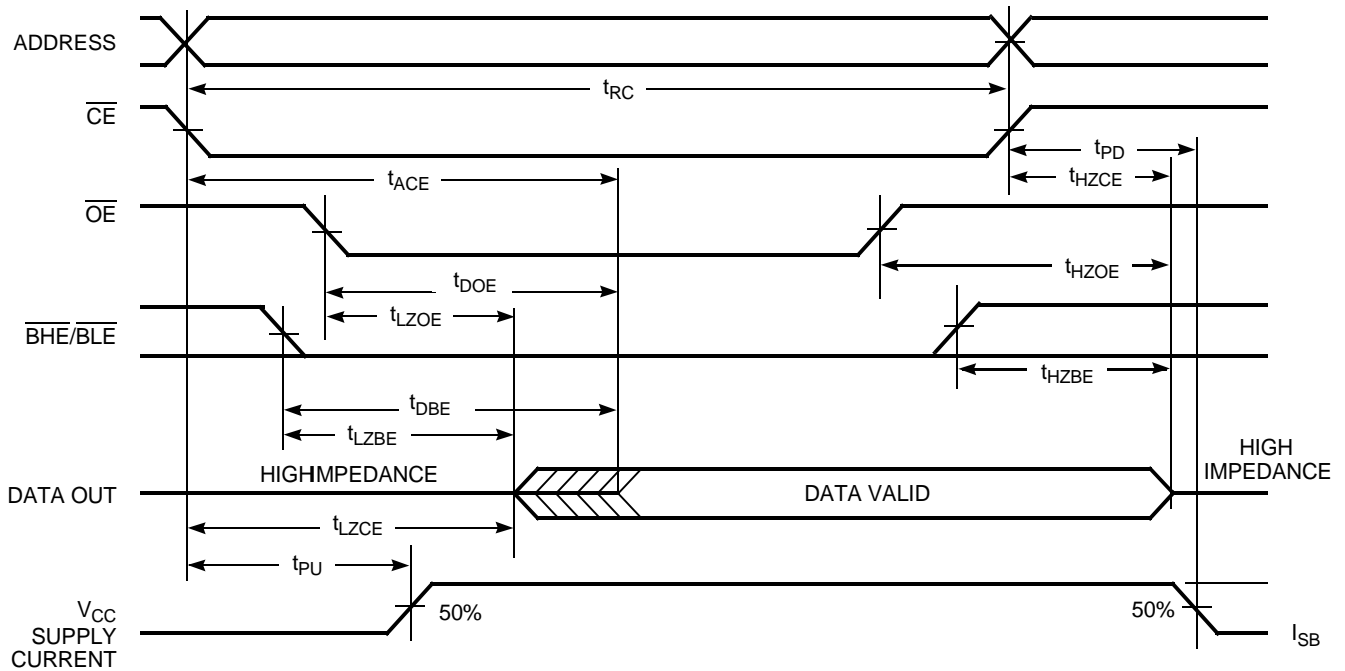


Figure 5. Read Cycle No. 2:  $\overline{OE}$  Controlled<sup>[21, 22]</sup>



**Notes**

- 20. The device is continuously selected.  $\overline{OE}$ ,  $\overline{CE}$  =  $V_{IL}$ ,  $\overline{BHE}$ ,  $\overline{BLE}$ , or both =  $V_{IL}$ .
- 21.  $\overline{WE}$  is HIGH for read cycle.
- 22. Address valid before or similar to  $\overline{CE}$ ,  $\overline{BHE}$ ,  $\overline{BLE}$  transition LOW.



Switching Waveforms (continued)

Figure 6. Write Cycle 1:  $\overline{WE}$  Controlled<sup>[23, 24, 25]</sup>

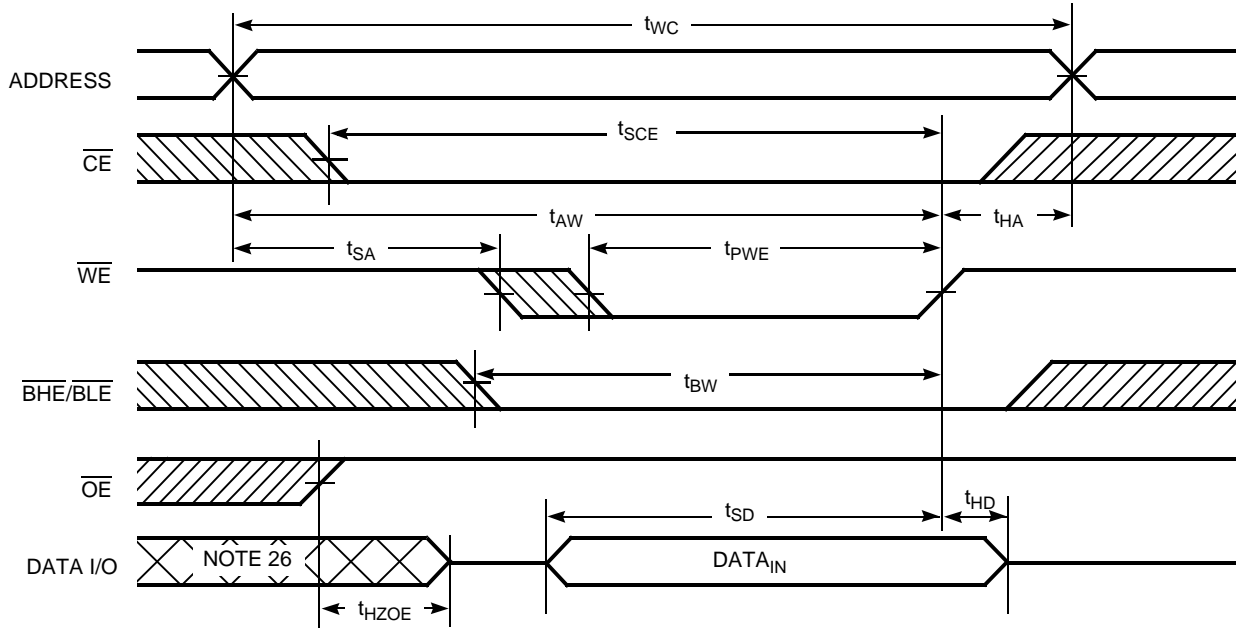
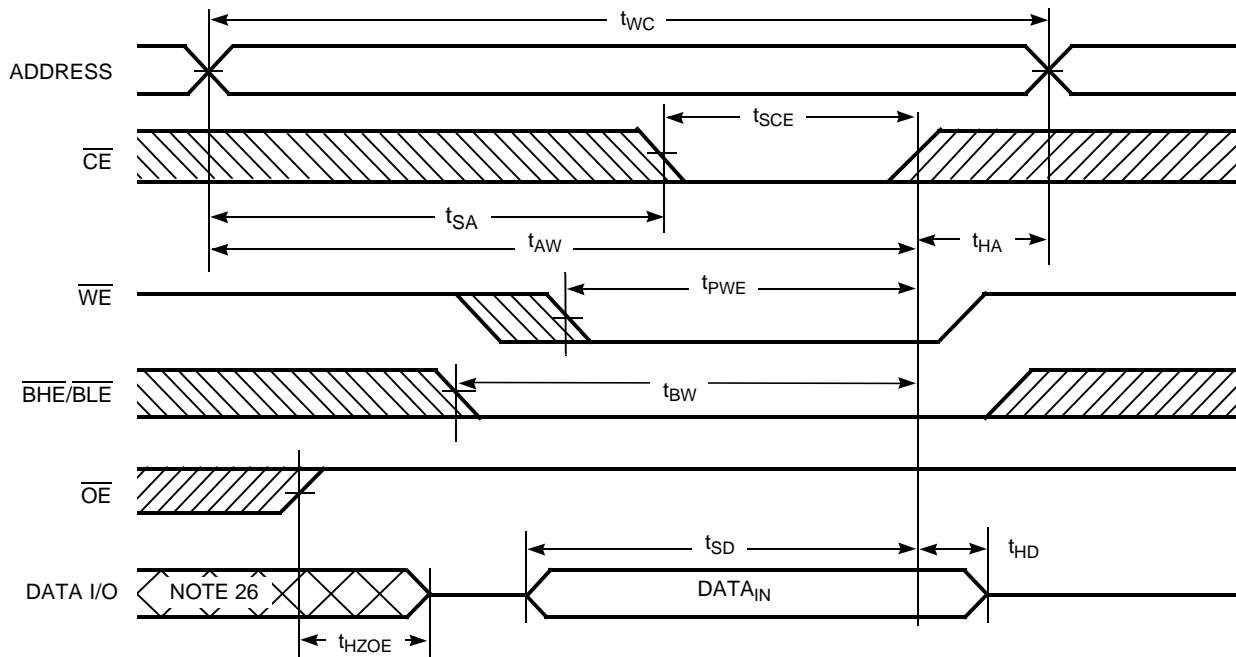


Figure 7. Write Cycle 2:  $\overline{CE}$  Controlled<sup>[23, 24, 25]</sup>



Notes

23. Data I/O is high impedance if  $\overline{OE} = V_{IH}$ .

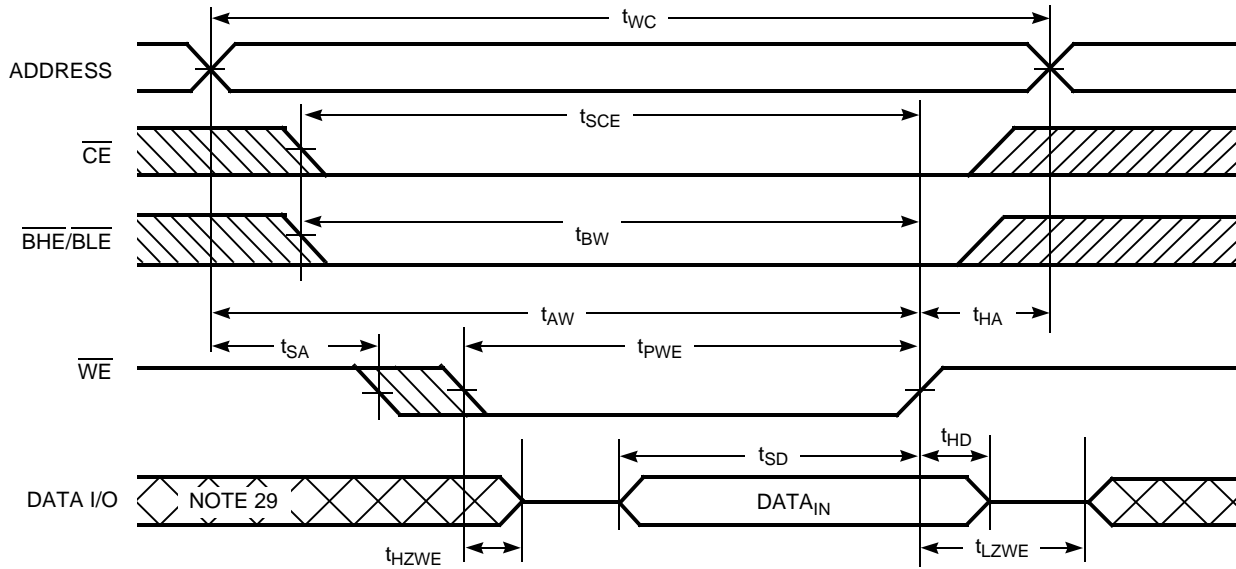
24. If  $\overline{CE}$  goes HIGH simultaneously with  $\overline{WE} = V_{IH}$ , the output remains in a high impedance state.

25. The internal write time of the memory is defined by the overlap of  $\overline{WE}$ ,  $\overline{CE} = V_{IL}$ ,  $\overline{BHE}$ ,  $\overline{BLE}$  or both =  $V_{IL}$ . All signals must be active to initiate a write and any of these signals can terminate the write by going inactive. The input setup and hold timing must be referenced to the dge of the signal that terminate the write.

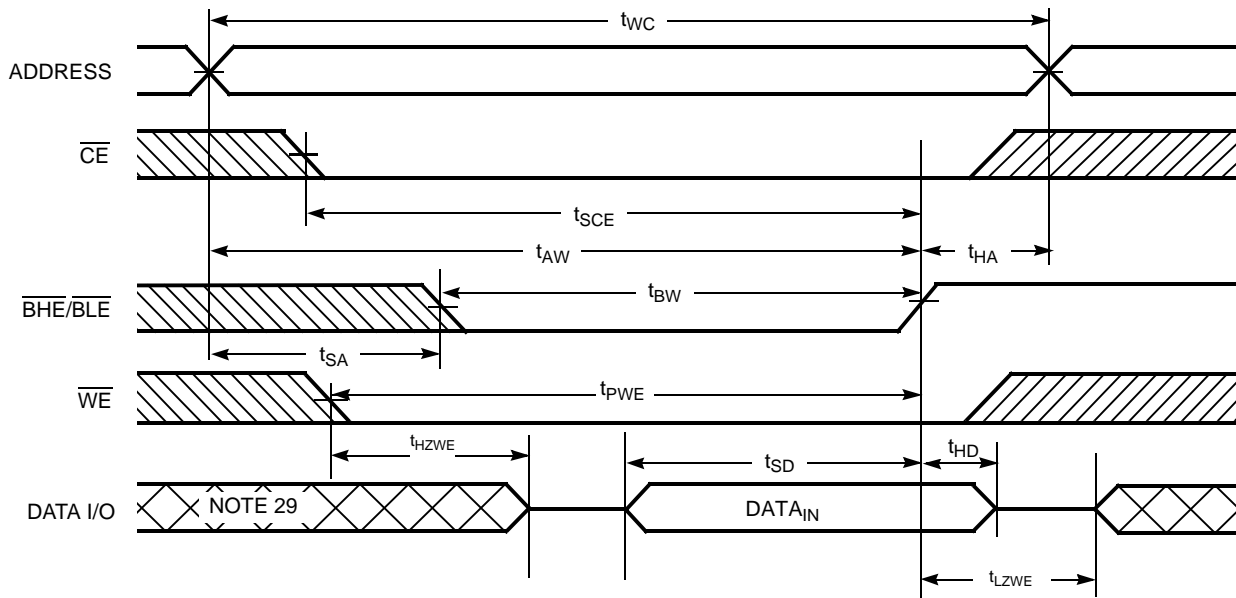
26. During this period, the I/Os are in output state. Do not apply input signals.

**Switching Waveforms** (continued)

**Figure 8. Write Cycle 3:  $\overline{WE}$  controlled,  $\overline{OE}$  LOW<sup>[27, 28, 30]</sup>**



**Figure 9. Write Cycle 4:  $\overline{BHE}/\overline{BLE}$  Controlled,  $\overline{OE}$  LOW<sup>[27, 28]</sup>**



**Notes**

- 27. If  $\overline{CE}$  goes HIGH simultaneously with  $\overline{WE} = V_{IH}$ , the output remains in a high impedance state.
- 28. The internal write time of the memory is defined by the overlap of  $\overline{WE}$ ,  $\overline{CE} = V_{IL}$ ,  $\overline{BHE}$ ,  $\overline{BLE}$  or both =  $V_{IL}$ . All signals must be active to initiate a write and any of these signals can terminate the write by going inactive. The input setup and hold timing must be referenced to the dge of the signal that terminate the write.
- 29. During this period, the I/Os are in output state. Do not apply input signals.
- 30. The minimum write cycle pulse width should be equal to the sum of  $t_{SD}$  and  $t_{HZWE}$ .

**Truth Table**

CE <sup>[31]</sup>	WE	OE	BHE	BLE	Inputs/Outputs	Mode	Power
H	X	X	X <sup>[31]</sup>	X <sup>[31]</sup>	High Z	Deselect/power down	Standby (I <sub>SB</sub> )
L	X	X	H	H	High Z	Output disabled	Active (I <sub>CC</sub> )
L	H	L	L	L	Data out (I/O <sub>0</sub> –I/O <sub>15</sub> )	Read	Active (I <sub>CC</sub> )
L	H	L	H	L	Data out (I/O <sub>0</sub> –I/O <sub>7</sub> ); I/O <sub>8</sub> –I/O <sub>15</sub> in High-Z	Read	Active (I <sub>CC</sub> )
L	H	L	L	H	Data out (I/O <sub>8</sub> –I/O <sub>15</sub> ); I/O <sub>0</sub> –I/O <sub>7</sub> in High-Z	Read	Active (I <sub>CC</sub> )
L	H	H	L	L	High Z	Output disabled	Active (I <sub>CC</sub> )
L	H	H	H	L	High Z	Output disabled	Active (I <sub>CC</sub> )
L	H	H	L	H	High Z	Output disabled	Active (I <sub>CC</sub> )
L	L	X	L	L	Data in (I/O <sub>0</sub> –I/O <sub>15</sub> )	Write	Active (I <sub>CC</sub> )
L	L	X	H	L	Data in (I/O <sub>0</sub> –I/O <sub>7</sub> ); I/O <sub>8</sub> –I/O <sub>15</sub> in High Z	Write	Active (I <sub>CC</sub> )
L	L	X	L	H	Data in (I/O <sub>8</sub> –I/O <sub>15</sub> ); I/O <sub>0</sub> –I/O <sub>7</sub> in High Z	Write	Active (I <sub>CC</sub> )

**Note**

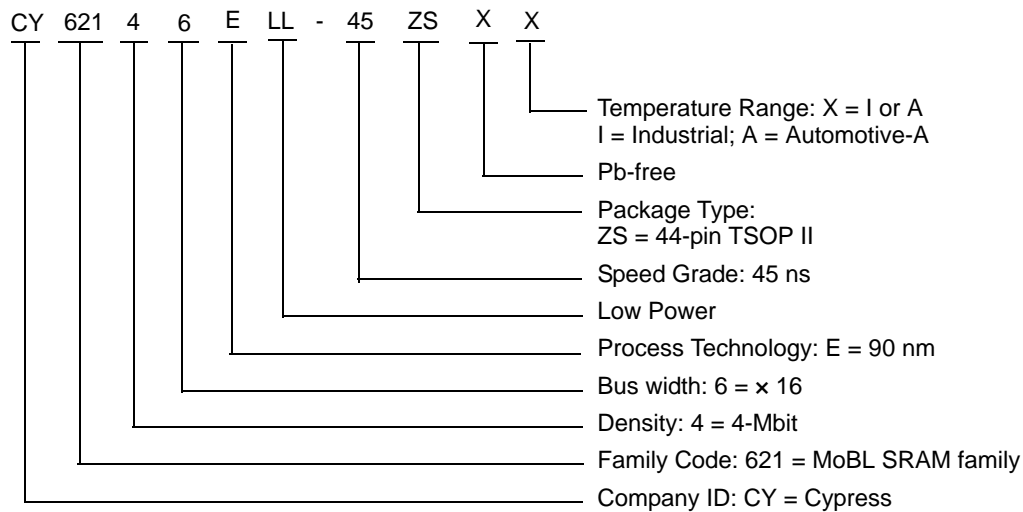
31. Chip enable ( $\overline{CE}$ ) and byte enables ( $\overline{BHE}$  and  $\overline{BLE}$ ) must be at CMOS levels (not floating) to meet the I<sub>SB2</sub> / I<sub>CCDR</sub> spec. Intermediate voltage levels on these pins is not permitted.

## Ordering Information

Speed (ns)	Ordering Code	Package Diagram	Package Type	Operating Range
45	CY62146ELL-45ZSXI	51-85087	44-pin TSOP II (Pb-free)	Industrial
	CY62146ELL-45ZSXA	51-85087	44-pin TSOP II (Pb-free)	Automotive-A

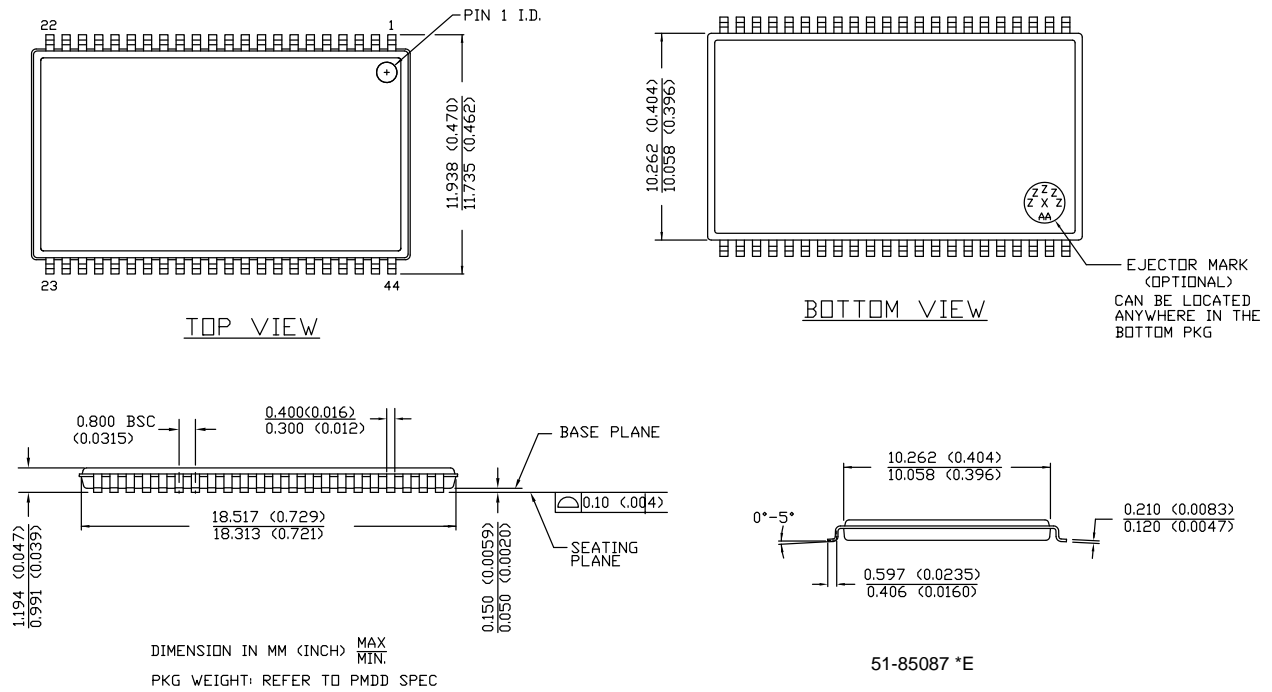
contact your local Cypress sales representative for availability of these parts.

## Ordering Code Definitions



Package Diagram

Figure 10. 44-pin TSOP Z44-II Package Outline, 51-85087



## Acronyms

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

## Document Conventions

### Units of Measure

Symbol	Unit of Measure
°C	degree Celsius
MHz	megahertz
μA	microampere
mA	milliampere
ns	nanosecond
Ω	ohm
pF	picofarad
V	volt
W	watt

Document History Page

Document Title: CY62146E MoBL <sup>®</sup> , 4-Mbit (256 K × 16) Static RAM				
Document Number: 001-07970				
Rev.	ECN No.	Issue Date	Orig. of Change	Description of Change
**	463213	See ECN	NXR	New data sheet.
*A	684343	See ECN	VKN	Added Preliminary Automotive-A Information Updated Ordering Information Table
*B	925501	See ECN	VKN	Added footnote #8 related to I <sub>SB2</sub> and I <sub>CCDR</sub> Added footnote #13 related AC timing parameters
*C	1045260	See ECN	VKN	Converted Automotive-A specs from preliminary to final
*D	2073548	See ECN	VKN / AESA	Corrected typo in the Data Retention Waveform and removed its irrelevant footnote
*E	2943752	06/03/2010	VKN	Added <a href="#">Contents</a> Added footnote related to chip enable in <a href="#">Truth Table</a> Updated <a href="#">Package Diagram</a> Added <a href="#">Sales, Solutions, and Legal Information</a>
*F	3109050	12/13/2010	PRAS	Changed Table Footnotes to Footnotes. Added Ordering Code Definitions.
*G	3149059	01/20/2011	RAME	Updated as per latest template Corrected Errors in Ordering Code Definitions Added <a href="#">Acronyms</a> and <a href="#">Units of Measure</a> .
*H	3296704	06/29/11	RAME	Removed reference to AN1064 SRAM system guidelines
*I	3921993	03/05/2013	MEMJ	Updated <a href="#">Switching Waveforms</a> : Added Note 25 and referred the same note in <a href="#">Figure 6</a> , <a href="#">Figure 7</a> . Removed Note "WE is HIGH for read cycle." and its references in <a href="#">Figure 6</a> , <a href="#">Figure 7</a> . Added Note 28 and referred the same note in <a href="#">Figure 8</a> , <a href="#">Figure 9</a> . Updated <a href="#">Package Diagram</a> : spec 51-85087 – Changed revision from *C to *E.
*J	4013949	06/04/2013	MEMJ	Updated <a href="#">Functional Description</a> . Updated <a href="#">Electrical Characteristics</a> : Added one more Test Condition "V <sub>CC</sub> = 5.5 V, I <sub>OH</sub> = -0.1 mA" for V <sub>OH</sub> parameter and added maximum value corresponding to that Test Condition. Added Note 7 and referred the same note in maximum value for V <sub>OH</sub> parameter corresponding to Test Condition "V <sub>CC</sub> = 5.5 V, I <sub>OH</sub> = -0.1 mA".
*K	4102022	08/14/2013	VINI	Updated <a href="#">Switching Characteristics</a> : Updated Note 15. Updated in new template.
*L	4576478	11/21/2014	VINI	Added related documentation hyperlink in page 1. Added Note 19 in <a href="#">Switching Characteristics</a> . Added note reference 19 in the Switching Characteristics table. Added Note 30 in <a href="#">Switching Waveforms</a> . Added note reference 30 in <a href="#">Figure 8</a> .
*M	5196888	04/14/2016	VINI	Updated <a href="#">Thermal Resistance</a> . Updated CY logo and Sales page.

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