

4-Mbit (256 K × 16) Static RAM

Features

- Very high speed: 45 ns
- Wide voltage range: 2.2 V to 3.6 V and 4.5 V to 5.5 V
- Ultra low standby power
 - Typical Standby current: 1 μ A
 - Maximum Standby current: 7 μ A
- 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) II package

Functional Description

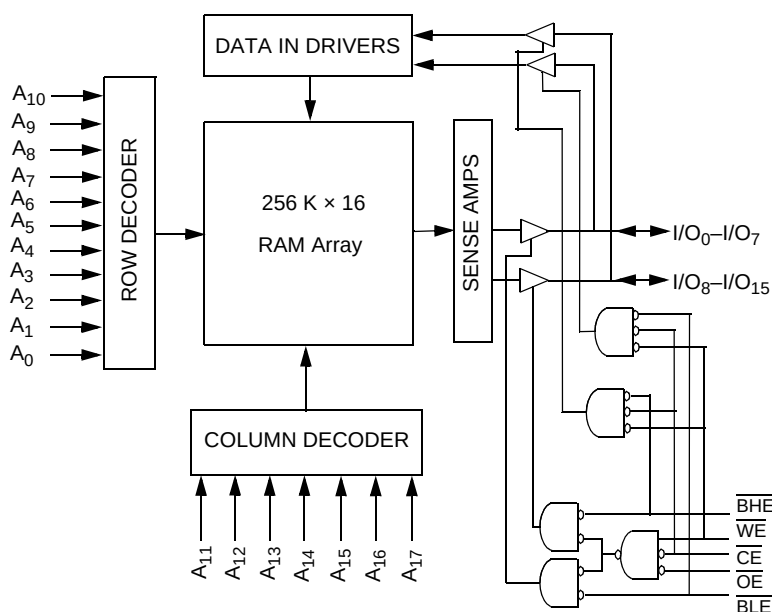
The CY62146ESL is a high performance CMOS static RAM organized as 256K words by 16 bits. This device features advanced circuit design to provide ultra low active current. This

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 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/O₀ through I/O₁₅) 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/O₀ through I/O₇) is written into the location specified on the address pins (A₀ through A₁₇). If Byte High Enable ($\overline{BHE}$) is LOW, then data from I/O pins (I/O₈ through I/O₁₅) is written into the location specified on the address pins (A₀ through A₁₇).

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/O₀ to I/O₇. If Byte High Enable ($\overline{BHE}$) is LOW, then data from memory appears on I/O₈ to I/O₁₅. See the [Truth Table on page 11](#) for a complete description of read and write modes.

Logic Block Diagram



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Pin Configurations

Figure 1. 44-pin TSOP II pinout (Top View) ^[1]

A ₄	1	44	A ₅
A ₃	2	43	A ₆
A ₂	3	42	A ₇
A ₁	4	41	$\overline{\text{OE}}$
A ₀	5	40	$\overline{\text{BHE}}$
$\overline{\text{CE}}$	6	39	$\overline{\text{BLE}}$
I/O ₀	7	38	I/O ₁₅
I/O ₁	8	37	I/O ₁₄
I/O ₂	9	36	I/O ₁₃
I/O ₃	10	35	I/O ₁₂
V _{CC}	11	34	V _{SS}
V _{SS}	12	33	V _{CC}
I/O ₄	13	32	I/O ₁₁
I/O ₅	14	31	I/O ₁₀
I/O ₆	15	30	I/O ₉
I/O ₇	16	29	I/O ₈
$\overline{\text{WE}}$	17	28	NC
A ₁₇	18	27	A ₈
A ₁₆	19	26	A ₉
A ₁₅	20	25	A ₁₀
A ₁₄	21	24	A ₁₁
A ₁₃	22	23	A ₁₂

Product Portfolio

Product	Range	V _{CC} Range (V) ^[2]	Speed (ns)	Power Dissipation					
				Operating I _{CC} , (mA)				Standby, I _{SB2} (μA)	
				f = 1MHz		f = f _{max}			
				Typ ^[3]	Max	Typ ^[3]	Max	Typ ^[3]	Max
CY62146ESL	Industrial	2.2 V–3.6 V and 4.5 V–5.5 V	45	2	2.5	15	20	1	7

Notes

- NC pins are not connected on the die.
- Datasheet specifications are not guaranteed for V_{CC} in the range of 3.6 V to 4.5 V.
- Typical values are included for reference only and are not guaranteed or tested. Typical values are measured at V_{CC} = 3 V, and V_{CC} = 5 V, T_A = 25 °C.

Maximum Ratings

Exceeding the 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 ^[4, 5] -0.5 V to 6.0 V

DC input voltage ^[4, 5] -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 _{CC} ^[6]
CY62146ESL	Industrial	-40 °C to +85 °C	2.2 V–3.6 V, and 4.5 V–5.5 V

Electrical Characteristics

Over the Operating Range

Parameter	Description	Test Conditions	45 ns			Unit
			Min	Typ ^[7]	Max	
V _{OH}	Output high voltage	2.2 ≤ V _{CC} ≤ 2.7 I _{OH} = -0.1 mA	2.0	—	—	V
		2.7 ≤ V _{CC} ≤ 3.6 I _{OH} = -1.0 mA	2.4	—	—	
		4.5 ≤ V _{CC} ≤ 5.5 I _{OH} = -1.0 mA	2.4	—	—	
V _{OL}	Output low voltage	2.2 ≤ V _{CC} ≤ 2.7 I _{OL} = 0.1 mA	—	—	0.4	V
		2.7 ≤ V _{CC} ≤ 3.6 I _{OL} = 2.1mA	—	—	0.4	
		4.5 ≤ V _{CC} ≤ 5.5 I _{OL} = 2.1mA	—	—	0.4	
V _{IH}	Input high voltage	2.2 ≤ V _{CC} ≤ 2.7	1.8	—	V _{CC} + 0.3	V
		2.7 ≤ V _{CC} ≤ 3.6	2.2	—	V _{CC} + 0.3	
		4.5 ≤ V _{CC} ≤ 5.5	2.2	—	V _{CC} + 0.5	
V _{IL}	Input low voltage	2.2 ≤ V _{CC} ≤ 2.7	-0.3	—	0.6	V
		2.7 ≤ V _{CC} ≤ 3.6	-0.3	—	0.8	
		4.5 ≤ V _{CC} ≤ 5.5	-0.5	—	0.8	
I _{IX}	Input Leakage Current	GND ≤ V _I ≤ V _{CC}	-1	—	+1	μA
I _{OZ}	Output Leakage Current	GND ≤ V _O ≤ V _{CC} ; Output Disabled	-1	—	+1	μA
I _{CC}	V _{CC} Operating Supply Current	f = f _{max} = 1/t _{RC} V _{CC} = V _{CCmax}	—	15	20	mA
		f = 1 MHz I _{OUT} = 0 mA, CMOS levels	—	2	2.5	
I _{SB1} ^[8]	Automatic CE Power down Current – CMOS Inputs	CE ≥ V _{CC} - 0.2 V, V _{IN} ≥ V _{CC} - 0.2 V or V _{IN} ≤ 0.2 V, f = f _{max} (Address and Data Only), f = 0 (OE, BHE, BLE and WE), V _{CC} = V _{CC(max)}	—	1	7	μA
I _{SB2} ^[8]	Automatic CE Power down Current – CMOS Inputs	CE ≥ V _{CC} - 0.2 V, V _{IN} ≥ V _{CC} - 0.2 V or V _{IN} ≤ 0.2 V, f = 0, V _{CC} = V _{CC(max)}	—	1	7	μA

Notes

4. V_{IL}(min) = -2.0V for pulse durations less than 20 ns.

5. V_{IH}(max) = V_{CC} + 0.75 V for pulse durations less than 20 ns.

6. 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.

7. Typical values are included for reference only and are not guaranteed or tested. Typical values are measured at V_{CC} = 3 V, and V_{CC} = 5 V, T_A = 25 °C.

8. Chip enable (CE) must be HIGH at CMOS level to meet the I_{SB1} / I_{SB2} / I_{CCDR} spec. Other inputs can be left floating.

Capacitance

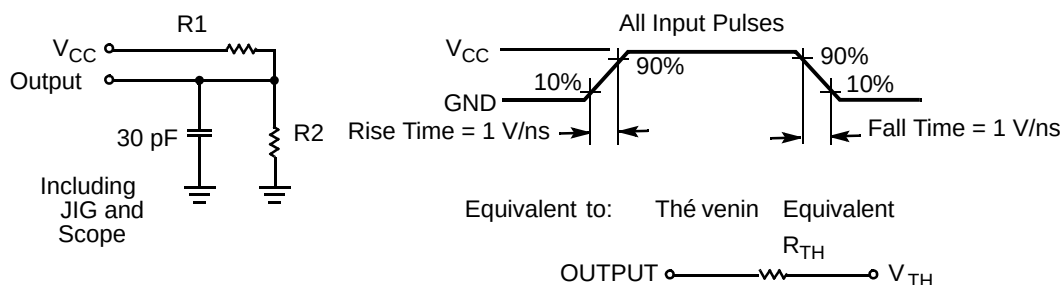
Parameter ^[9]	Description	Test Conditions	Max	Unit
C_{IN}	Input capacitance	$T_A = 25^\circ\text{C}$, $f = 1\text{ MHz}$, $V_{CC} = V_{CC(\text{typ})}$	10	pF
C_{OUT}	Output capacitance		10	pF

Thermal Resistance

Parameter ^[9]	Description	Test Conditions	TSOP II	Unit
Θ_{JA}	Thermal resistance (junction to ambient)	Still Air, soldered on a 3 × 4.5 inch, two-layer printed circuit board	77	$^\circ\text{C/W}$
Θ_{JC}	Thermal resistance (junction to case)		13	$^\circ\text{C/W}$

AC Test Loads and Waveforms

Figure 2. AC Test Loads and Waveforms



Parameters	2.5 V	3.0 V	5.0 V	Unit
R1	16667	1103	1800	Ω
R2	15385	1554	990	Ω
R_{TH}	8000	645	639	Ω
V_{TH}	1.20	1.75	1.77	V

Note

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

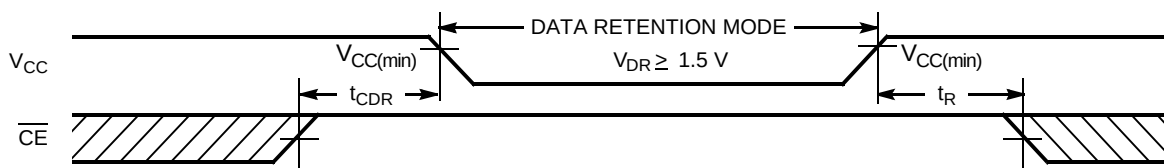
Data Retention Characteristics

Over the Operating Range

Parameter	Description	Conditions	Min	Typ ^[10]	Max	Unit
V_{DR}	V_{CC} for data retention		1.5	–	–	V
I_{CCDR} ^[11]	Data retention current	$CE \geq V_{CC} - 0.2\text{ V}$, $V_{IN} \geq V_{CC} - 0.2\text{ V}$ or $V_{IN} \leq 0.2\text{ V}$ $V_{CC} = 1.5\text{ V}$	–	1	7	μA
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 $V_{CC} = 3\text{ V}$, and $V_{CC} = 5\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$.
11. Chip enable ($\overline{CE}$) must be HIGH at CMOS level to meet the I_{SB1} / I_{SB2} / I_{CCDR} spec. Other inputs can be 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 ^[14, 15]	Description	45 ns		Unit
		Min	Max	
Read Cycle				
t _{RC}	Read cycle time	45	–	ns
t _{AA}	Address to data valid	–	45	ns
t _{OHA}	Data hold from address change	10	–	ns
t _{ACE}	$\overline{CE}$ LOW to data valid	–	45	ns
t _{DOE}	$\overline{OE}$ LOW to data valid	–	22	ns
t _{LZOE}	$\overline{OE}$ LOW to Low Z ^[16]	5	–	ns
t _{HZOE}	$\overline{OE}$ HIGH to High Z ^[16, 17]	–	18	ns
t _{LZCE}	$\overline{CE}$ LOW to Low Z ^[16]	10	–	ns
t _{HZCE}	$\overline{CE}$ HIGH to High Z ^[16, 17]	–	18	ns
t _{PU}	$\overline{CE}$ LOW to power up	0	–	ns
t _{PD}	$\overline{CE}$ HIGH to power down	–	45	ns
t _{DBE}	$\overline{BLE/BHE}$ LOW to data valid	–	22	ns
t _{LZBE}	$\overline{BLE/BHE}$ LOW to Low Z ^[16]	5	–	ns
t _{HZBE}	$\overline{BLE/BHE}$ HIGH to High Z ^[16, 17]	–	18	ns
Write Cycle ^[18]				
t _{WC}	Write cycle time	45	–	ns
t _{SCE}	$\overline{CE}$ LOW to write end	35	–	ns
t _{AW}	Address setup to write end	35	–	ns
t _{HA}	Address hold from write end	0	–	ns
t _{SA}	Address setup to Write Start	0	–	ns
t _{PWE}	$\overline{WE}$ pulse width	35	–	ns
t _{BW}	$\overline{BLE/BHE}$ LOW to write end	35	–	ns
t _{SD}	Data Setup to write end	25	–	ns
t _{HD}	Data Hold from write end	0	–	ns
t _{HZWE}	$\overline{WE}$ LOW to High Z ^[16, 17]	–	18	ns
t _{LZWE}	$\overline{WE}$ HIGH to Low Z ^[16]	10	–	ns

Notes

14. 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 Note [AN66311](#). However, the issue has been fixed and in production now, and hence, this Application Note is no longer applicable. It is available for download on our website as it contains information on the date code of the parts, beyond which the fix has been in production.
15. Test conditions for all parameters other than tri-state parameters assume signal transition time of 3 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_{OL}/I_{OH} as shown in the [Figure 2 on page 5](#).
16. 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.
17. t_{HZOE} , t_{HZCE} , t_{HZBE} , and t_{HZWE} transitions are measured when the outputs enter a high-impedance state.
18. 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 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.

Switching Waveforms

Figure 4. Read Cycle No.1: Address Transition Controlled [19, 20]

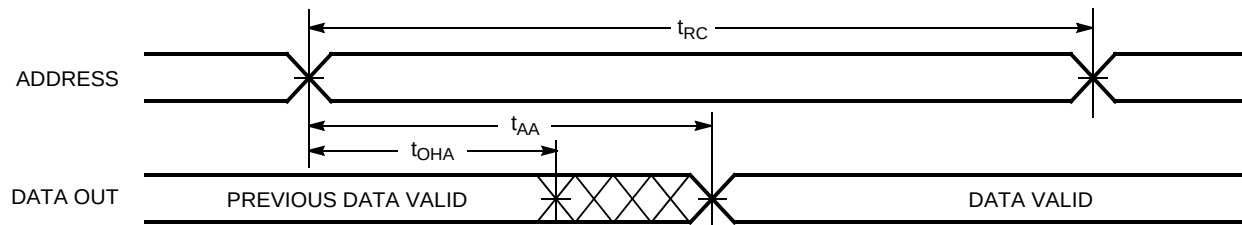
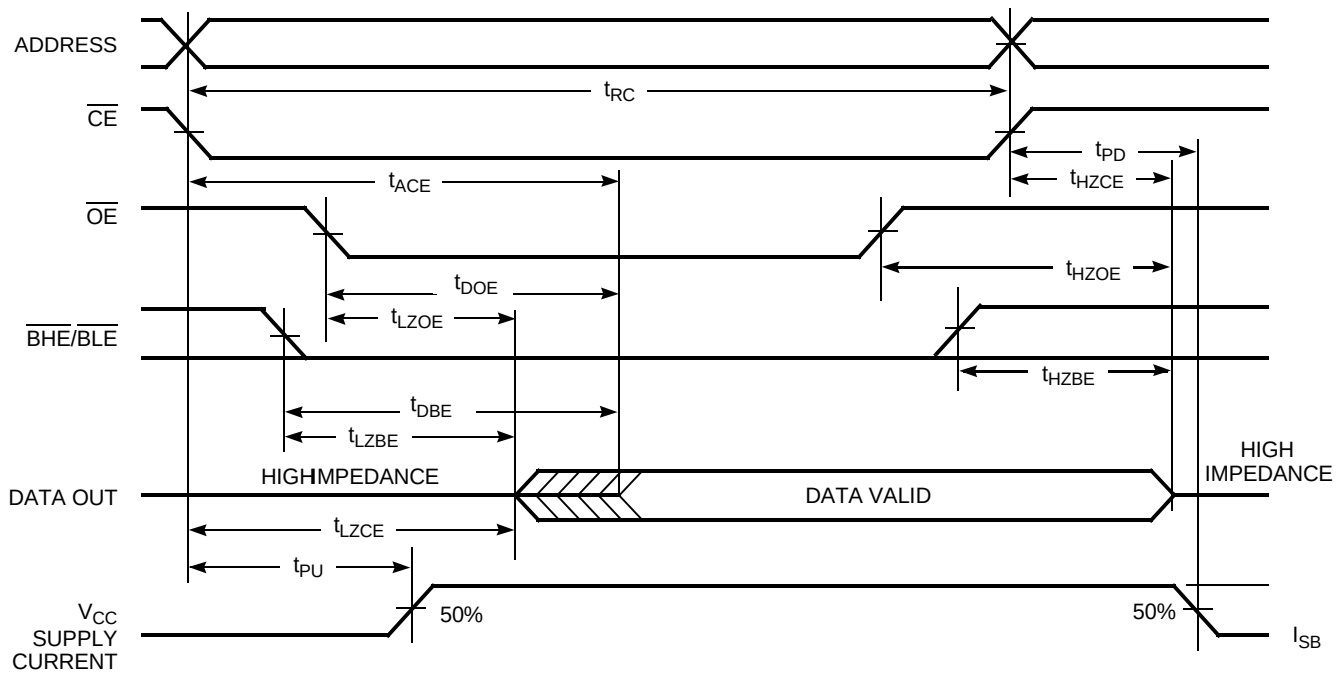


Figure 5. Read Cycle No. 2: $\overline{\text{OE}}$ Controlled [20, 21]

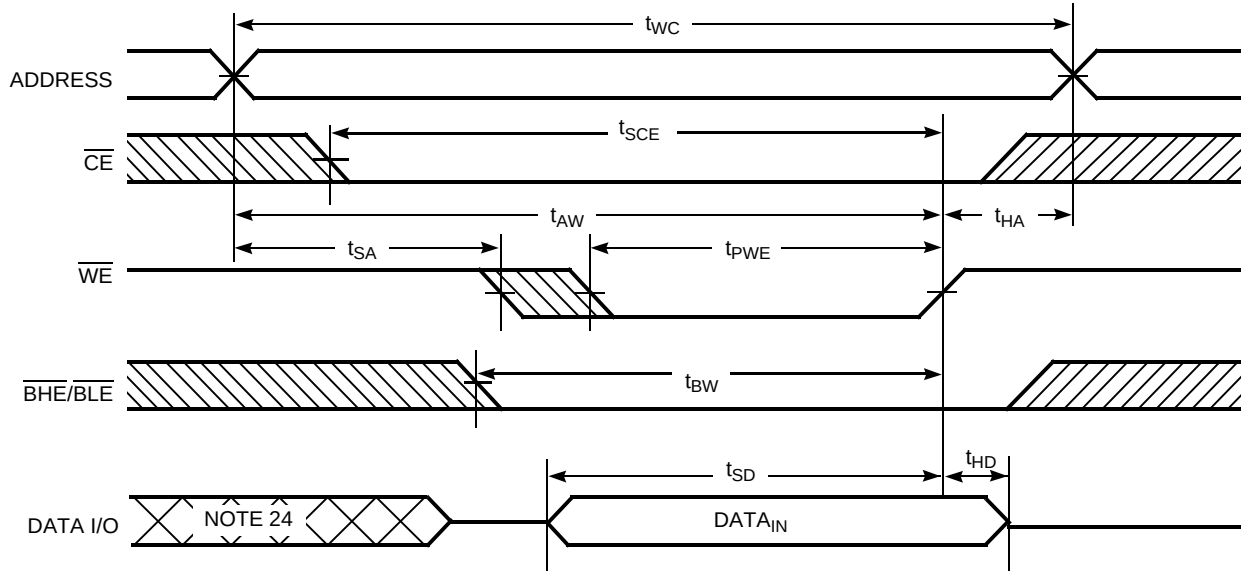
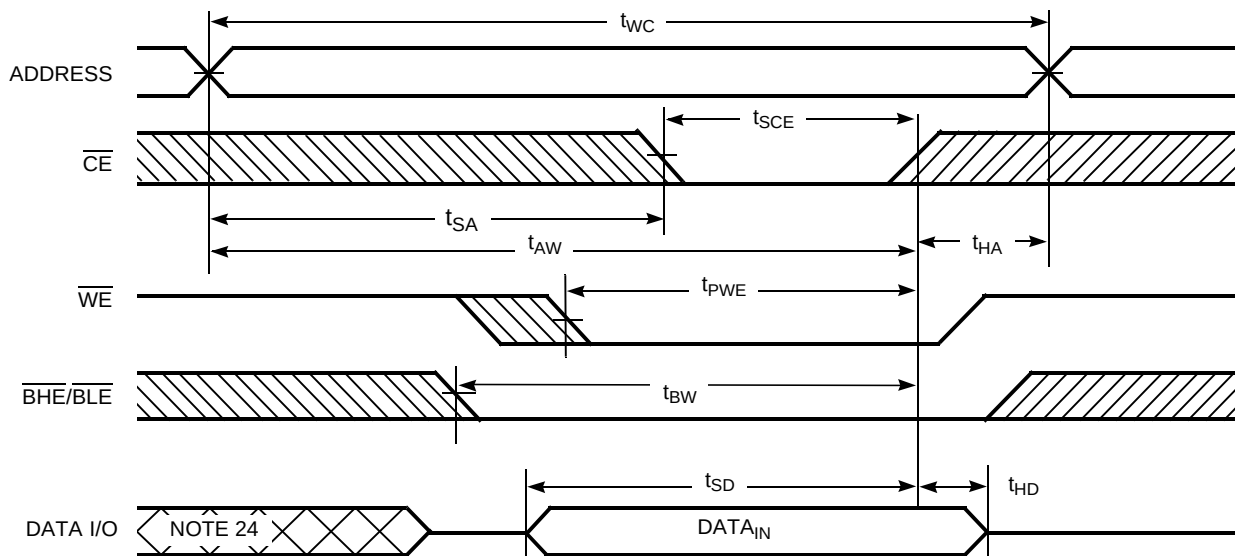


Notes

19. The device is continuously selected. $\overline{\text{OE}}$, $\overline{\text{CE}} = V_{\text{IL}}$, $\overline{\text{BHE}}$, $\overline{\text{BLE}}$, or both = V_{IL} .

20. WE is HIGH for read cycle.

21. Address valid before or similar to $\overline{\text{CE}}$, $\overline{\text{BHE}}$, $\overline{\text{BLE}}$ transition LOW.

Switching Waveforms (continued)
Figure 6. Write Cycle No 1: $\overline{\text{WE}}$ Controlled [22, 23]

Figure 7. Write Cycle 2: $\overline{\text{CE}}$ Controlled [22, 23]

Notes

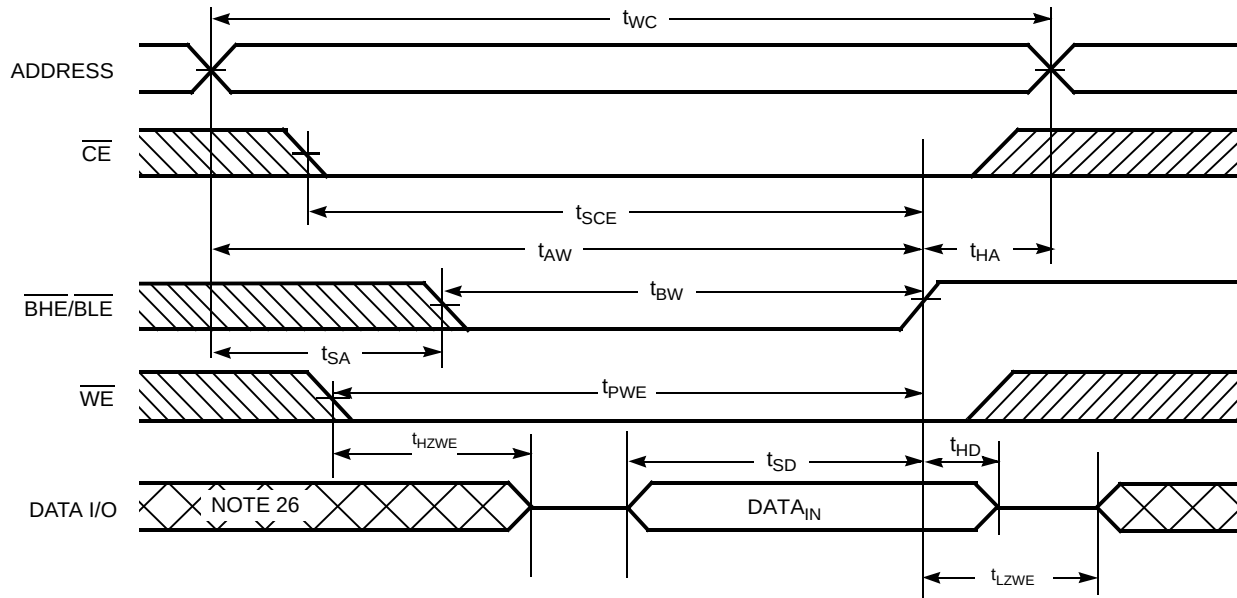
22. The internal write time of the memory is defined by the overlap of $\overline{\text{WE}}$, $\overline{\text{CE}} = V_{\text{IL}}$, $\overline{\text{BHE}}$, $\overline{\text{BLE}}$ or both = V_{IL} . All signals must be active to initiate a write and any of these signals can terminate a write by going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

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

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

Switching Waveforms (continued)

Figure 8. Write Cycle 3: BHE/BL $\overline{E}$ Controlled ^[25]



Notes

25. If $\overline{CE}$ goes HIGH simultaneously with $\overline{WE} = V_{IH}$, the output remains in a high impedance state.
 26. During this period, the I/Os are in output state. Do not apply input signals.

Truth Table

CE ^[27]	WE	OE	BHE	BLE	Inputs/Outputs	Mode	Power
H	X	X	X	X	High-Z	Deselect/Power down	Standby (I _{SB})
L	X	X	H	H	High-Z	Output disabled	Active (I _{CC})
L	H	L	L	L	Data Out (I/O ₀ –I/O ₁₅)	Read	Active (I _{CC})
L	H	L	H	L	Data Out (I/O ₀ –I/O ₇); I/O ₈ –I/O ₁₅ in High-Z	Read	Active (I _{CC})
L	H	L	L	H	Data Out (I/O ₈ –I/O ₁₅); I/O ₀ –I/O ₇ in High-Z	Read	Active (I _{CC})
L	H	H	L	L	High-Z	Output disabled	Active (I _{CC})
L	H	H	H	L	High-Z	Output disabled	Active (I _{CC})
L	H	H	L	H	High-Z	Output disabled	Active (I _{CC})
L	L	X	L	L	Data In (I/O ₀ –I/O ₁₅)	Write	Active (I _{CC})
L	L	X	H	L	Data In (I/O ₀ –I/O ₇); I/O ₈ –I/O ₁₅ in High-Z	Write	Active (I _{CC})
L	L	X	L	H	Data In (I/O ₈ –I/O ₁₅); I/O ₀ –I/O ₇ in High-Z	Write	Active (I _{CC})

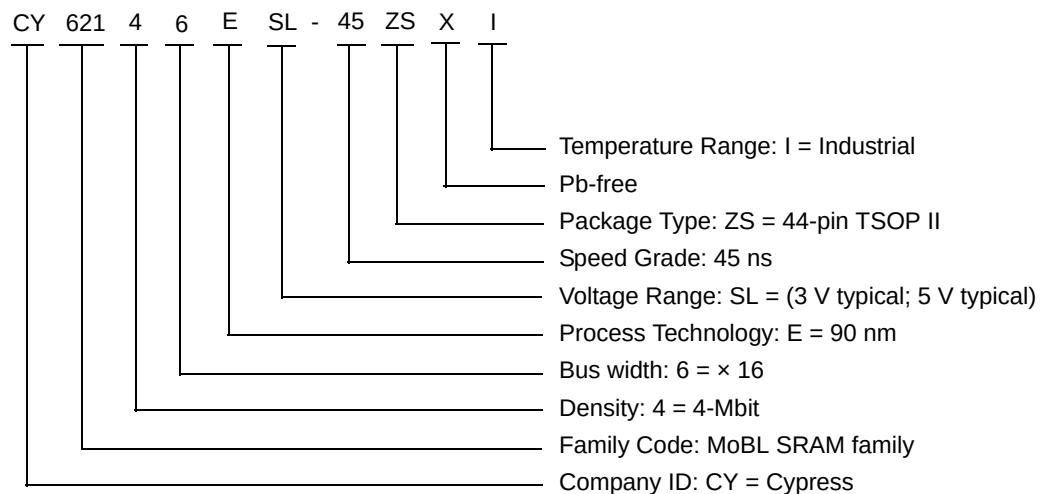
Note

27. Chip enable must be at CMOS levels (not floating). Intermediate voltage levels on this pin is not permitted.

Ordering Information

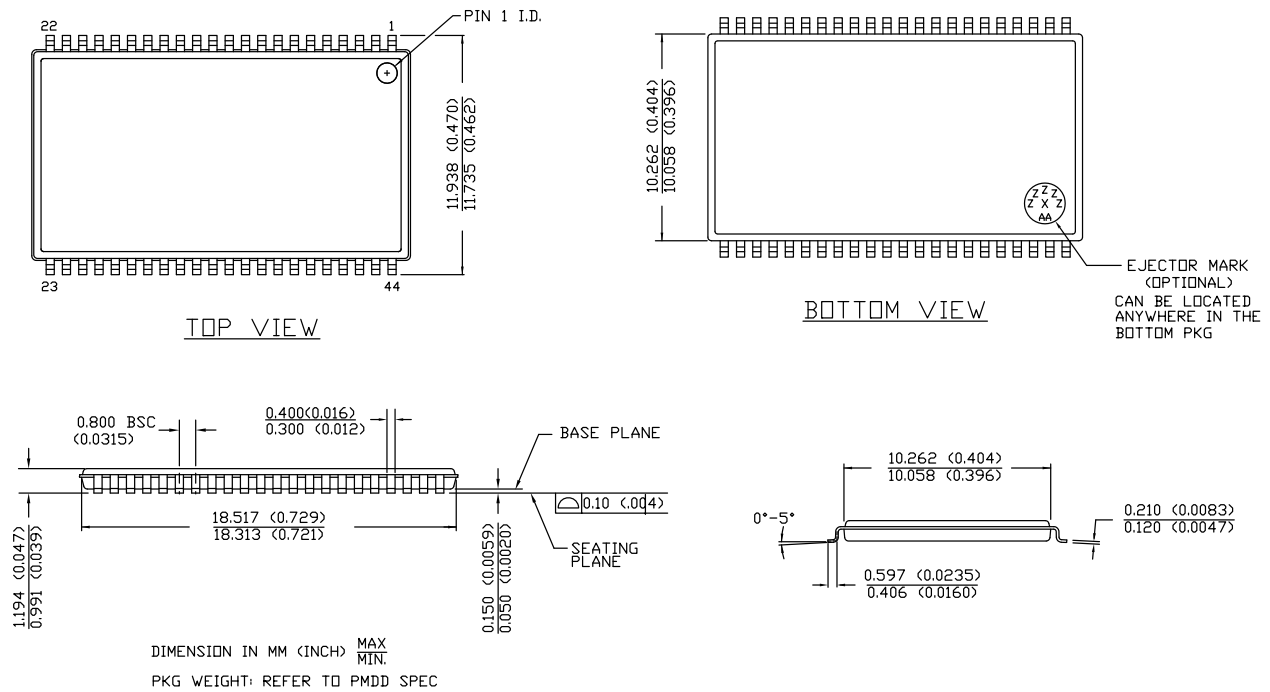
Speed (ns)	Ordering Code	Package Diagram	Package Type	Operating Range
45	CY62146ESL-45ZSXI	51-85087	44-pin TSOP Type II (Pb-free)	Industrial

Ordering Code Definitions



Package Diagram

Figure 9. 44-pin TSOP Z44-II Package Outline, 51-85087



51-85087 *E

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: CY62146ESL MoBL®, 4-Mbit (256 K × 16) Static RAM Document Number: 001-43142				
Rev.	ECN No.	Issue Date	Orig. of Change	Description of Change
**	1875228	See ECN	VKN / AESA	New data sheet.
*A	2944332	06/04/2010	VKN	Added Contents Updated Electrical Characteristics : Added Note 8 and referred the same note in I _{SB2} parameter. Updated Truth Table : Added Note 27 and referred the same note in $\overline{CE}$ column. Updated Package Diagram . Added Sales, Solutions, and Legal Information .
*B	3109186	12/13/2010	PRAS	Changed Table Footnotes to Footnotes. Added Ordering Code Definitions .
*C	3296704	06/29/2011	RAME	Updated Functional Description : Removed reference to AN1064 SRAM system guidelines. Updated Electrical Characteristics : Updated Note 8 (Added I _{SB1}) and referred the same note in I _{SB1} parameter. Updated Capacitance : Added Note 9 and referred the same note in parameter column. Updated Thermal Resistance : Added Note 9 and referred the same note in parameter column. Updated Data Retention Characteristics : Added Note 11 and referred the same note in I _{CCDR} parameter. Changed minimum value of t _R parameter from t _{RC} to 45 ns. Updated Switching Characteristics : Moved Note 14 to parameter column. Added Units of Measure .
*D	3903350	02/13/2013	MEMJ	Updated Switching Waveforms : Updated Figure 6 (Removed $\overline{OE}$ signal). Updated Figure 7 (Removed $\overline{OE}$ signal). Removed the Note "Data I/O is high impedance if $\overline{OE} = V_{IH}$." and its reference in Figure 6 , Figure 7 . Removed the figure "Write Cycle 3: $\overline{WE}$ controlled, $\overline{OE}$ LOW". Updated Figure 8 (Removed "OE LOW" in caption only). Updated Package Diagram : spec 51-85087 – Changed revision from *C to *E.
*E	4100920	08/21/2013	VINI	Updated Switching Characteristics : Added Note 14 and referred the same note in "Parameter" column. Updated in new template.

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