CY621472E30 MoBL® Automotive

4-Mbit (256K × 16) Static RAM

Features

- Very high speed: 45 ns
- Temperature range
  - Automotive-A: –40 °C to +85 °C
- Wide voltage range: 2.20 V to 3.60 V
- Ultra low standby power
  - Typical standby current: 1 µA
  - Maximum standby current: 7 µA (Automotive-A)
- Ultra low active power
  - Typical active current: 2 mA at f = 1 MHz
- Easy memory expansion with $\overline{CE}_1$, CE_2, 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
- Byte power down feature

Functional Description

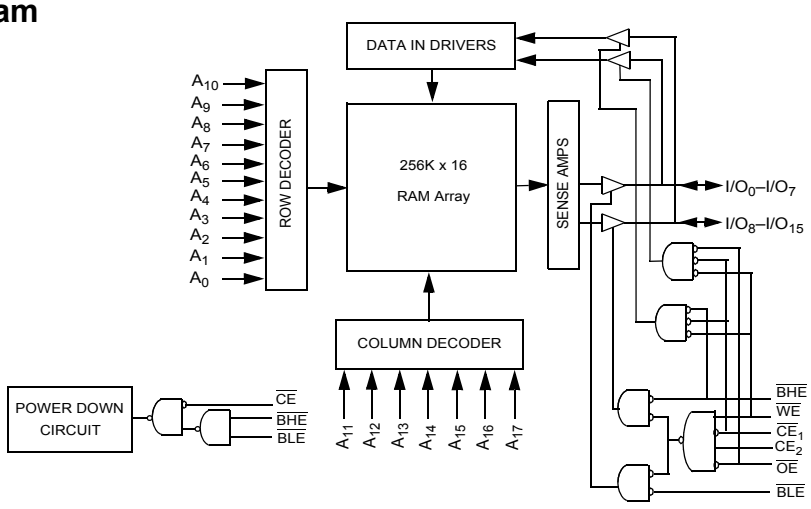
The CY621472E30 is a high-performance CMOS static RAM (SRAM) organized as 256K words by 16 bits. This device features advanced circuit design to provide ultra-low active current. It is ideal for providing More Battery Life™ (MoBL®) in portable applications such as cellular telephones. The device also has an automatic power-down feature that significantly reduces power consumption when addresses are not toggling. Placing the device into standby mode reduces power consumption by more than 99 percent when deselected ($\overline{CE}_1$ HIGH or CE_2 LOW or both $\overline{BLE}$ and $\overline{BHE}$ are HIGH). The input and output pins (I/O_0 through I/O_{15}) are placed in a high-impedance state when:

- 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)
- Write operation is active ($\overline{CE}_1$ LOW and CE_2 HIGH and $\overline{WE}$ LOW)

To write to the device, take Chip Enable ($\overline{CE}_1$ LOW and CE_2 HIGH) and Write Enable ($\overline{WE}$) inputs LOW. If Byte Low Enable ($\overline{BLE}$) is LOW, then data from the I/O pins (I/O_0 through I/O_7) is written into the location specified on the address pins (A_0 through A_{17}). 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_{17}).

To read from the device, take Chip Enable ($\overline{CE}_1$ 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 appear on I/O_0 to I/O_7. If Byte High Enable ($\overline{BHE}$) is LOW, then data from the memory appears on I/O_8 to I/O_{15}. See the Truth Table on page 11 for a complete description of read and write modes.

Logic Block Diagram



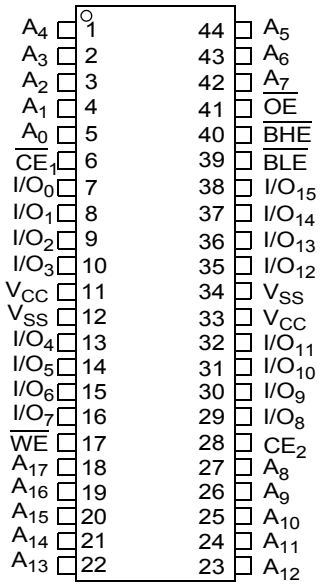
Contents

Product Portfolio

Product	Range	V_{CC} Range (V)			Speed (ns)	Power Dissipation					
						Operating I_{CC} (mA)				Standby I_{SB2} (µA)	
						f = 1 MHz		f = f_{max}			
		Min	Typ [1]	Max		Typ [1]	Max	Typ [1]	Max	Typ [1]	Max
CY621472E30LL	Automotive-A	2.2	3.0	3.6	45	2	2.5	15	20	1	7

Pin Configuration

Figure 1. 44-pin TSOP II pinout



Note
1. 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 °C.

Maximum Ratings

Exceeding the maximum ratings may impair 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 ..... –0.3 V to +3.9 V (V_{CCmax} + 0.3 V)

DC voltage applied to outputs in High Z State [2, 3] ..... –0.3 V to 3.9 V (V_{CCmax} + 0.3 V)

DC input voltage [2, 3] ..... –0.3 V to 3.9 V (V_{CCmax} + 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}[4]
CY621472E30LL	Automotive-A	–40 °C to +85 °C	2.2 V to 3.6 V

Electrical Characteristics

Over the operating range

Parameter	Description	Test Conditions	45 ns			Unit
			Min	Typ[5]	Max	
V_{OH}	Output HIGH voltage	I_{OH} = –0.1 mA	2.0	–	–	V
		I_{OH} = –1.0 mA, $V_{CC} \geq$ 2.70 V	2.4	–	–	V
V_{OL}	Output LOW voltage	I_{OL} = 0.1 mA	–	–	0.4	V
		I_{OL} = 2.1 mA, V_{CC} = 2.70 V	–	–	0.4	V
V_{IH}	Input HIGH voltage	V_{CC} = 2.2 V to 2.7 V	1.8	–	V_{CC} + 0.3	V
		V_{CC} = 2.7 V to 3.6 V	2.2	–	V_{CC} + 0.3	V
V_{IL}	Input LOW voltage	V_{CC} = 2.2 V to 2.7 V	–0.3	–	0.6	V
		V_{CC}= 2.7 V to 3.6 V	–0.3	–	0.8	V
I_{IX}	Input leakage current	GND $\leq V_I \leq V_{CC}$	–1	–	+1	µA
I_{OZ}	Output leakage current	GND $\leq V_O \leq V_{CC}$, Output disabled	–1	–	+1	µA
I_{CC}	V_{CC} operating supply current	f = f_{max} = $1/t_{RC}$; V_{CC} = $V_{CC(max)}$, I_{OUT} = 0 mA CMOS levels	–	15	20	mA
		f = 1 MHz; V_{CC} = $V_{CC(max)}$, I_{OUT} = 0 mA CMOS levels	–	2	2.5	
I_{SB1} [6]	Automatic CE power-down current — CMOS inputs	$\overline{CE_1} \geq V_{CC}$ – 0.2 V, $CE_2 \leq$ 0.2 V, $V_{IN} \geq V_{CC}$ – 0.2 V, $V_{IN} \leq$ 0.2 V, f = f_{max} (address and data only), f = 0 ($\overline{OE}$, $\overline{BHE}$, $\overline{BLE}$ and $\overline{WE}$), V_{CC} = 3.60 V	–	1	7	µA
I_{SB2} [6]	Automatic CE power-down current — CMOS inputs	$\overline{CE_1} \geq V_{CC}$ – 0.2 V or $CE_2 \leq$ 0.2 V or ($\overline{BHE}$ and $\overline{BLE}$) $\geq V_{CC}$ – 0.2 V, $V_{IN} \geq V_{CC}$ – 0.2 V or $V_{IN} \leq$ 0.2 V, f = 0, V_{CC} = 3.60 V	–	1	7	µA

Notes

2. V_{IL} (min) = –2.0 V for pulse durations less than 20 ns.
3. V_{IH} (max) = V_{CC} + 0.75 V for pulse durations less than 20 ns.
4. Full device AC operation assumes a minimum of 100-µs ramp time from 0 to V_{CC}(min) and 200 µs wait time after V_{CC} stabilization.
5. 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 °C.
6. Chip enables ($\overline{CE_1}$ and CE_2) need to be tied to CMOS levels to meet the I_{SB1} / I_{SB2} / I_{CCDR} spec. Other inputs can be left floating.

Capacitance

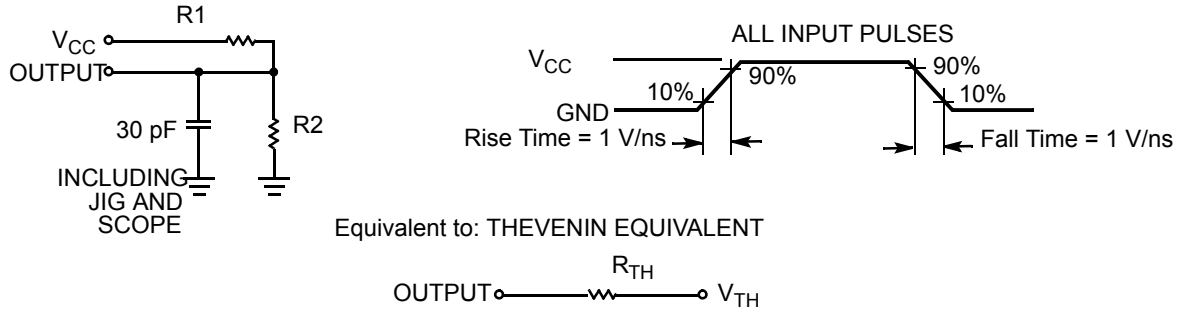
Parameter [7]	Description	Test Conditions	Max	Unit
C_{IN}	Input capacitance	T_A = 25 °C, f = 1 MHz, V_{CC} = V_{CC} (typ)	10	pF
C_{OUT}	Output capacitance		10	pF

Thermal Resistance

Parameter [7]	Description	Test Conditions	44-pin TSOP II Package	Unit
Θ_{JA}	Thermal resistance (junction to ambient)	Still Air, soldered on a 3 × 4.5 inch, four-layer printed circuit board	55.52	°C/W
Θ_{JC}	Thermal resistance (junction to case)		16.03	°C/W

AC Test Load and Waveforms

Figure 2. AC Test Load and Waveforms



Parameters	2.50 V	3.0 V	Unit
R1	16667	1103	Ω
R2	15385	1554	Ω
R_{TH}	8000	645	Ω
V_{TH}	1.20	1.75	V

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

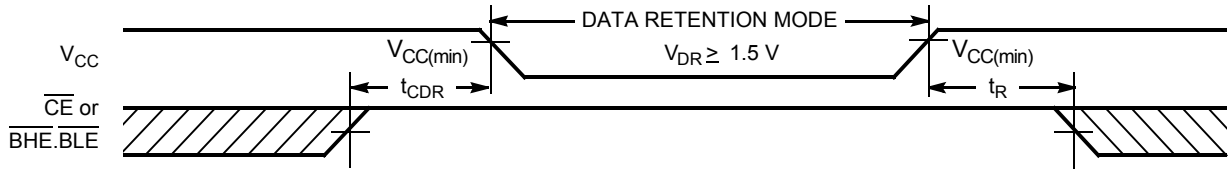
Data Retention Characteristics

Over the operating range

Parameter	Description	Conditions	Min	Typ [8]	Max	Unit
V_{DR}	V_{CC} for data retention		1.5	–	–	V
I_{CCDR}[9]	Data retention current	V_{CC} = 1.5 V, $\overline{CE_1} \geq V_{CC} - 0.2$ V or $CE_2 \leq 0.2$ V or ($\overline{BHE}$ and $\overline{BLE}$) $\geq V_{CC} - 0.2$ V, $V_{IN} \geq V_{CC} - 0.2$ V or $V_{IN} \leq 0.2$ V	–	0.8	7	µA
t_{CDR}[10]	Chip deselect to data retention time		0	–	–	ns
t_R[11]	Operation recovery time		45	–	–	ns

Data Retention Waveform

Figure 3. Data Retention Waveform [12, 13]



Notes

8. 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 °C.
9. Chip enables ($\overline{CE_1}$ and CE_2) need to be tied to CMOS levels to meet the I_{SB1} / I_{SB2} / I_{CCDR} spec. Other inputs can be left floating.
10. Tested initially and after any design or process changes that may affect these parameters.
11. Full device operation requires linear V_{CC} ramp from V_{DR} to $V_{CC(min)} \geq 100$ µs or stable at $V_{CC(min)} \geq 100$ µs.
12. $\overline{CE}$ refers to the internal logical combination of $\overline{CE_1}$ and CE_2 such that when $\overline{CE_1}$ is LOW and CE_2 is HIGH, $\overline{CE}$ is LOW. For all other cases $\overline{CE}$ is HIGH.
13. $\overline{BHE}.\overline{BLE}$ 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 $\overline{BLE}$.

Switching Characteristics

Over the Operating Range

Parameter [14]	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}	$\overline{CE}_1$ LOW/CE_2 HIGH to data valid	–	45	ns
t_{DOE}	$\overline{OE}$ LOW to data valid	–	22	ns
t_{LZOE}	$\overline{OE}$ LOW to Low-Z[15]	5	–	ns
t_{HZOE}	$\overline{OE}$ HIGH to High-Z[15, 16]	–	18	ns
t_{LZCE}	$\overline{CE}_1$ LOW/CE_2 HIGH to Low-Z[15]	10	–	ns
t_{HZCE}	$\overline{CE}_1$ HIGH/CE_2 LOW to High-Z[15, 16]	–	18	ns
t_{PU}	$\overline{CE}_1$ LOW/CE_2 HIGH to Power-up	0	–	ns
t_{PD}	$\overline{CE}_1$ HIGH/CE_2 LOW to Power-down	–	45	ns
t_{DBE}	$\overline{BLE}$/$\overline{BHE}$ LOW to data valid	–	45	ns
t_{LZBE}	$\overline{BLE}$/$\overline{BHE}$ LOW to Low-Z[15, 17]	5	–	ns
t_{HZBE}	$\overline{BLE}$/$\overline{BHE}$ HIGH to High-Z[15, 16]	–	18	ns
Write Cycle[18]				
t_{WC}	Write cycle time	45	–	ns
t_{SCE}	$\overline{CE}_1$ LOW/CE_2 HIGH 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}	$\overline{BLE}$/$\overline{BHE}$ 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[15, 16]	–	18	ns
t_{LZWE}	$\overline{WE}$ HIGH to Low-Z[15]	10	–	ns

Notes

14. Test conditions for all parameters other than tristate parameters assume a signal transition time of 3 ns (1 V/ns) or less, 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 the Figure 2 on page 5.
15. 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.
16. t_{HZOE}, t_{HZCE}, t_{HZBE}, and t_{HZWE} transitions are measured when the outputs enter a high impedance state.
17. If both byte enables are together, this value is 10 ns.
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]

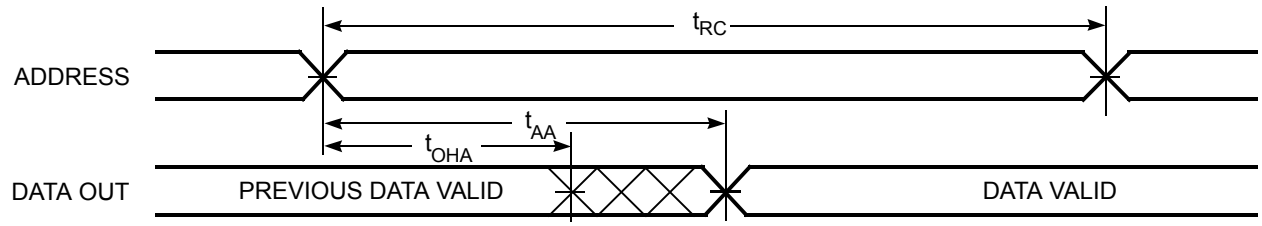
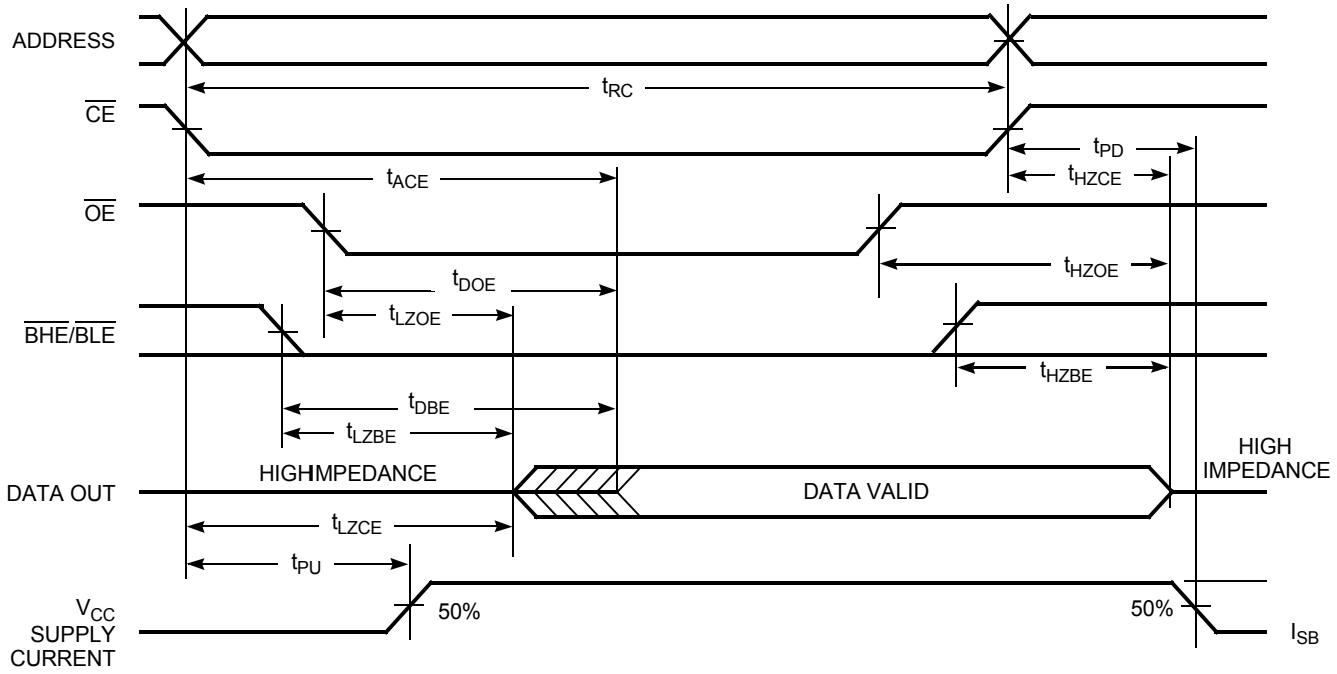


Figure 5. Read Cycle No. 2 ($\overline{OE}$ Controlled) [20, 21, 22]



Notes
19. The device is continuously selected. $\overline{OE}$, $\overline{CE}$ = V_{IL}, $\overline{BHE}$, $\overline{BLE}$, or both = V_{IL}.
20. $\overline{WE}$ is HIGH for read cycle.
21. $\overline{CE}$ refers to the internal logical combination of $\overline{CE}_1$ and CE_2 such that when $\overline{CE}_1$ is LOW and CE_2 is HIGH, $\overline{CE}$ is LOW. For all other cases $\overline{CE}$ is HIGH.
22. Address valid before or similar to $\overline{CE}$ and $\overline{BHE}$, $\overline{BLE}$ transition LOW.

Switching Waveforms (continued)

Figure 6. Write Cycle No. 1 (WE Controlled) [23, 24, 25, 26]

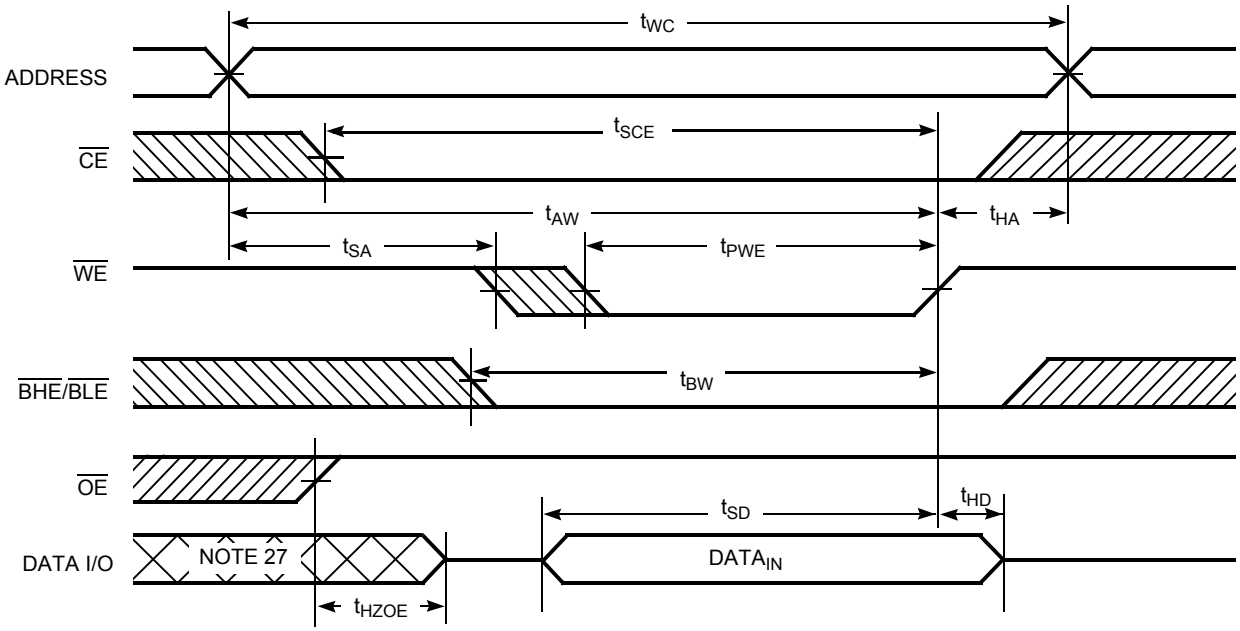
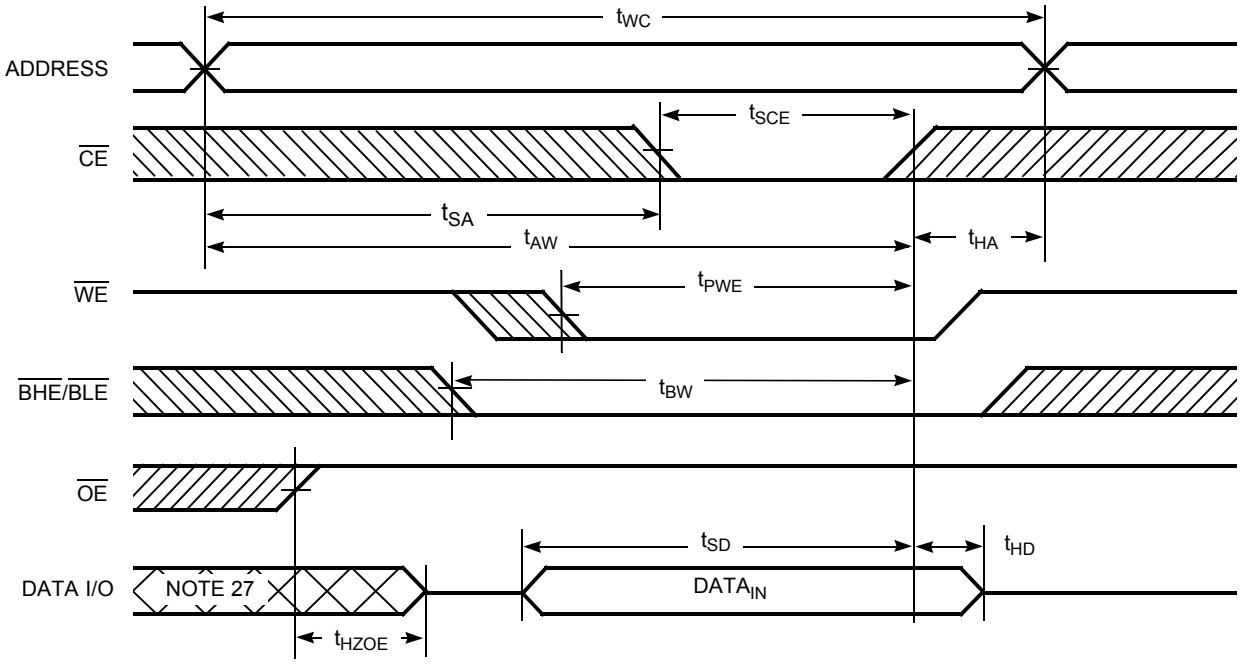


Figure 7. Write Cycle No. 2 (CE Controlled) [23, 24, 25, 26]



Notes

23. CE refers to the internal logical combination of $\overline{CE}_1$ and CE_2 such that when $\overline{CE}_1$ is LOW and CE_2 is HIGH, CE is LOW. For all other cases CE is HIGH.
24. The internal write time of the memory is defined by the overlap of WE, CE = V_{IL}, BHE, 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.
25. Data I/O is high-impedance if OE = V_{IH}.
26. If CE goes HIGH simultaneously with WE = V_{IH}, the output remains in a high-impedance state.
27. During this period, the I/Os are in output state. Do not apply input signals.

Switching Waveforms (continued)

Figure 8. Write Cycle No. 3 (WE Controlled, OE LOW) [28, 29]

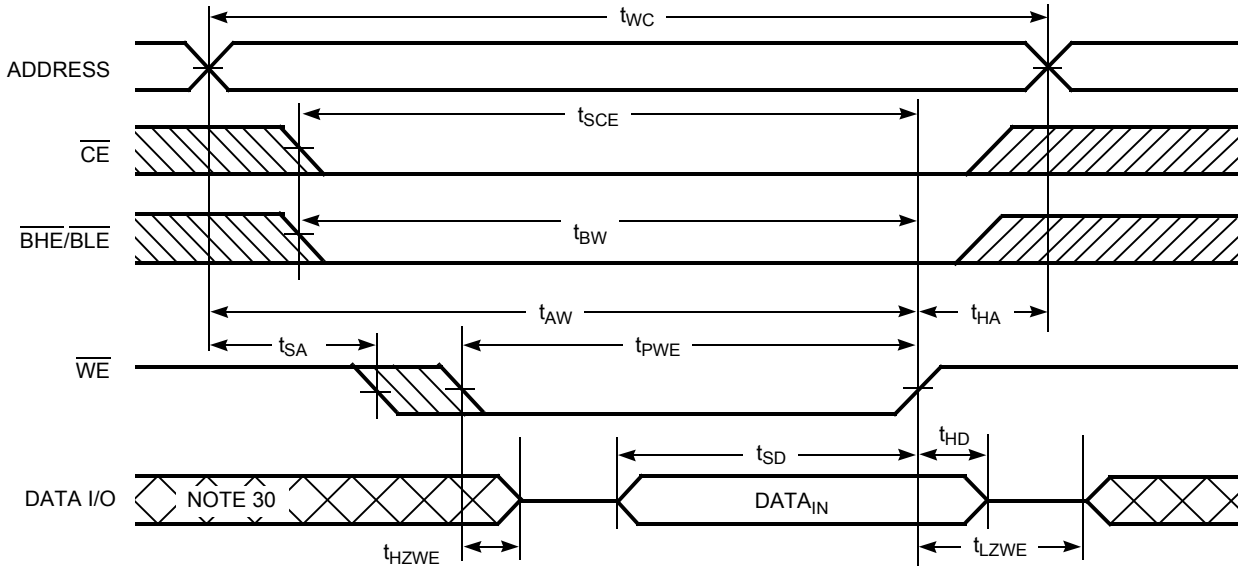
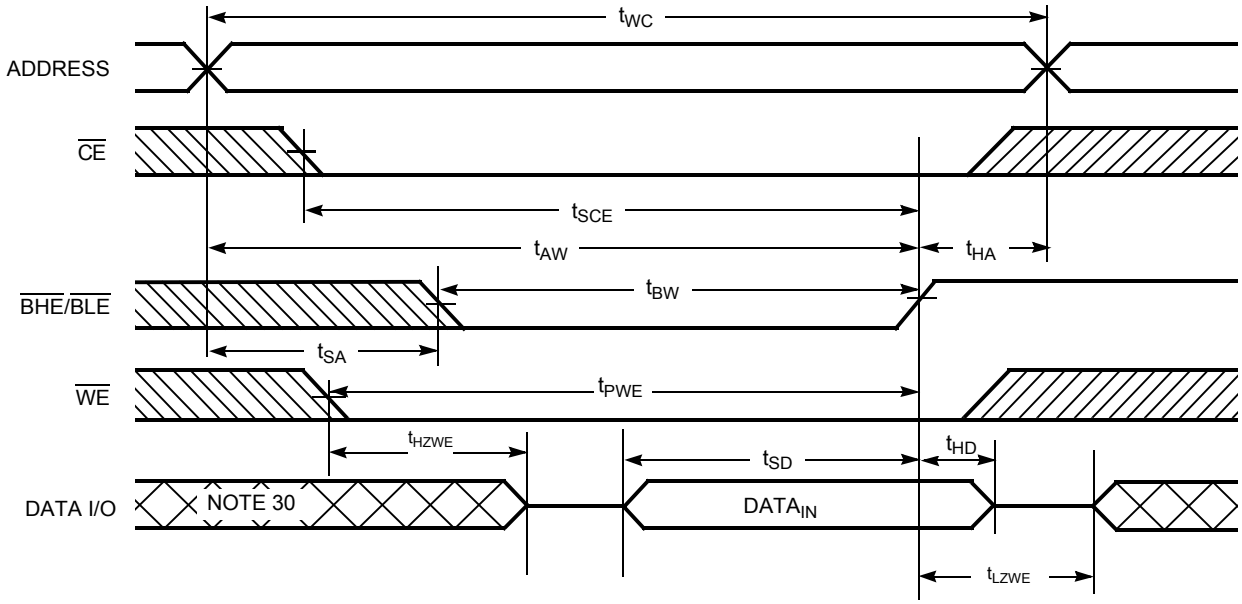


Figure 9. Write Cycle No. 4 (BHE/BLE Controlled, OE LOW) [28, 29]



Notes
28. CE refers to the internal logical combination of $\overline{CE}_1$ and CE_2 such that when $\overline{CE}_1$ is LOW and CE_2 is HIGH, CE is LOW. For all other cases CE is HIGH.
29. If CE goes HIGH simultaneously with WE = V_{IH}, the output remains in a high-impedance state.
30. During this period, the I/Os are in output state. Do not apply input signals.

Truth Table

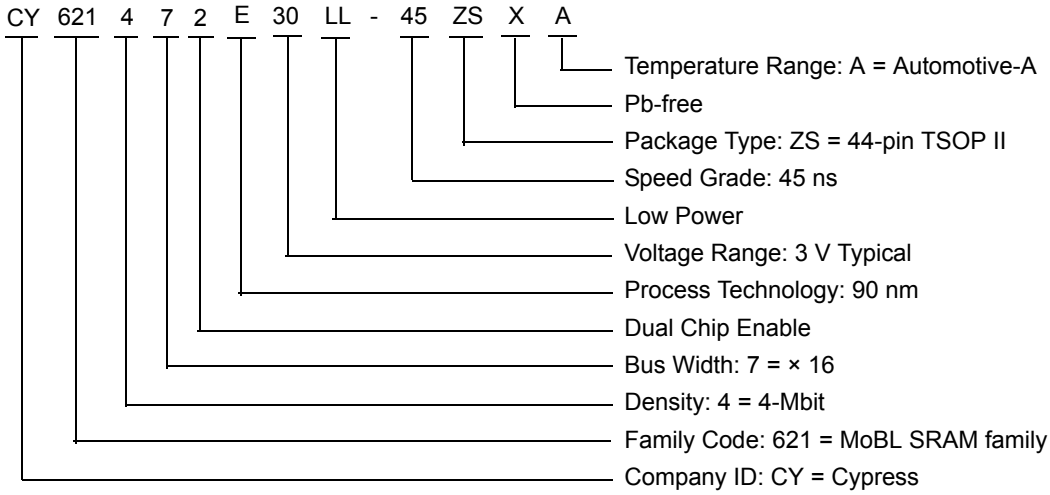
$\overline{CE_1}$	CE_2	$\overline{WE}$	$\overline{OE}$	$\overline{BHE}$	$\overline{BLE}$	I/Os	Mode	Power
H	X[31]	X	X	X	X	High-Z	Deselect/Power-down	Standby (I_{SB})
X[31]	L	X	X	X	X	High-Z	Deselect/Power-down	Standby (I_{SB})
X[31]	X[31]	X	X	H	H	High-Z	Deselect/Power-down	Standby (I_{SB})
L	H	H	L	L	L	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); I/O_8–I/O_{15} in High Z	Read	Active (I_{CC})
L	H	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	H	L	L	High-Z	Output disabled	Active (I_{CC})
L	H	H	H	H	L	High-Z	Output disabled	Active (I_{CC})
L	H	H	H	L	H	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); I/O_8–I/O_{15} in High-Z	Write	Active (I_{CC})
L	H	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
31. The 'X' (Don't care) state for the chip enables ($\overline{CE_1}$ and CE_2) in the Truth Table refer to the logic state (either HIGH or LOW). Intermediate voltage levels on these pins is not permitted.

Ordering Information

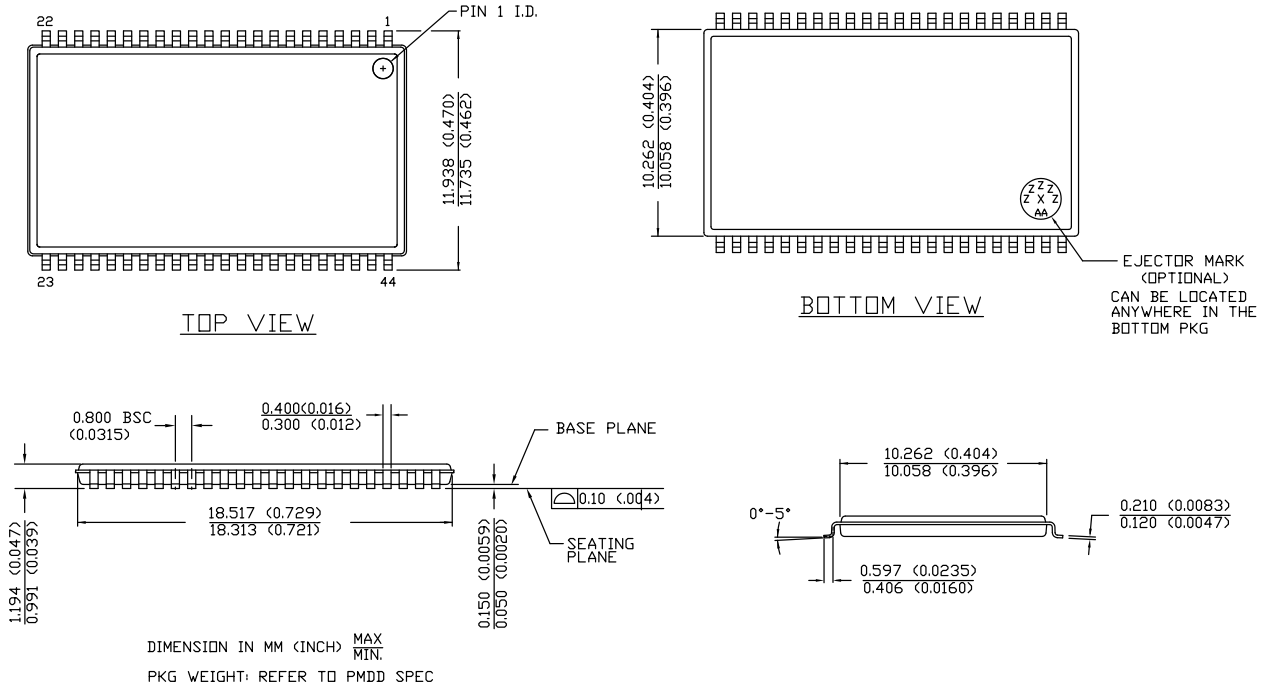
Speed (ns)	Ordering Code	Package Diagram	Package Type	Operating Range
45	CY621472E30LL-45ZSXA	51-85087	44-pin TSOP II (Pb-free)	Automotive-A

Ordering Code Definitions



Package Diagram

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



51-85087 *E

Acronyms

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
I/O	Input/Output
$\overline{OE}$	Output Enable
SRAM	Static Random Access Memory
TSOP	Thin Small Outline Package
$\overline{WE}$	Write Enable

Document Conventions

Units of Measure

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

Document History Page

Document Title: CY621472E30 MoBL® Automotive, 4-Mbit (256K × 16) Static RAM Document Number: 001-89978				
Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
*A	4316520	VINI	03/21/2014	Changed status from Preliminary to Final.
*B	5545167	VINI	12/07/2016	Updated Thermal Resistance: Replaced “two-layer” with “four-layer” in “Test Conditions” column. Changed value of Θ_{JA} parameter corresponding to 44-pin TSOP II Package from 77 °C/W to 55.52 °C/W. Changed value of Θ_{JC} parameter corresponding to 44-pin TSOP II Package from 13 °C/W to 16.03 °C/W. Updated to new template. Completing Sunset Review.

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