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CY7C1041G Automotive

4-Mbit (256K words × 16-bit) Static RAM with Error-Correcting Code (ECC)

Features

- AEC-Q100 qualified
- High speed
  - t_{AA} = 10 ns
- Temperature range
  - Automotive-E: –40 °C to 125 °C
  - Automotive-A: –40 °C to 85 °C
- Embedded ECC for single-bit error correction[1, 2]
- Low active and standby currents
  - Active current I_{CC} = 40 mA typical
  - Standby current I_{SB2} = 6 mA typical
- Operating voltage range: 2.2 V to 3.6 V
- 1.0 V data retention
- TTL- compatible inputs and outputs
- Pb-free 48-ball VFBGA and 44-pin TSOP II packages

Functional Description

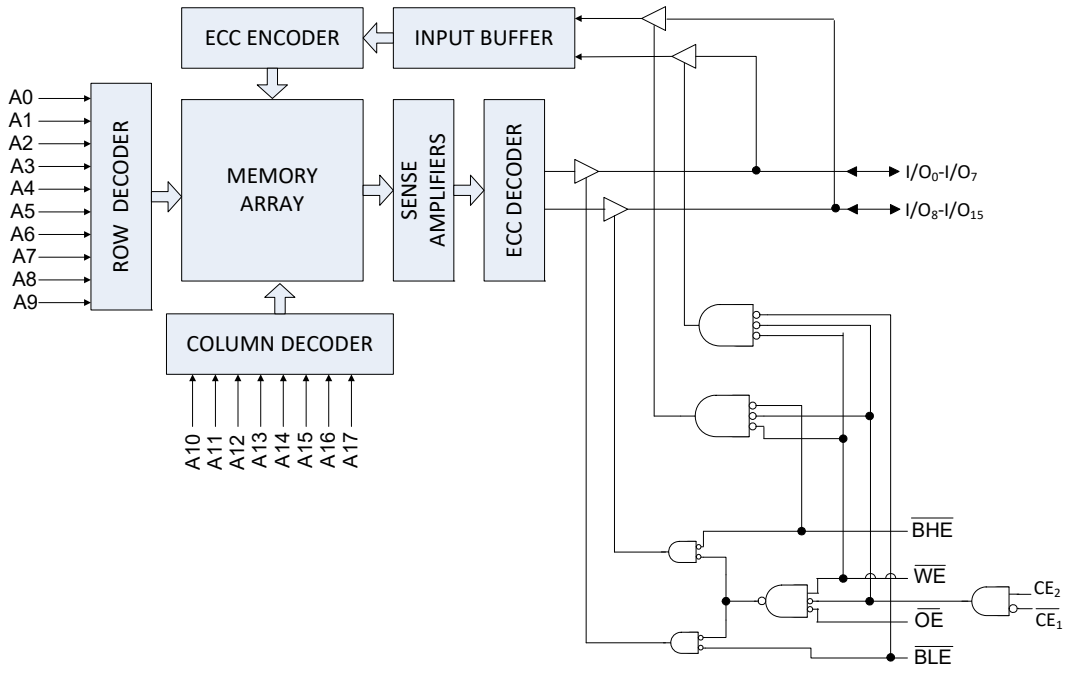
CY7C1041G is a high-performance CMOS fast static RAM automotive part with embedded ECC. This device has a single Chip Enable ($\overline{CE}$) input and is accessed by asserting it LOW.

Data writes are performed by asserting the Write Enable ($\overline{WE}$) input LOW, while providing the data on I/O_0 through I/O_{15} and the address on A_0 through A_{17} pins. The Byte High Enable ($\overline{BHE}$) and Byte Low Enable ($\overline{BLE}$) inputs control write operations to the upper and lower bytes of the specified memory location. $\overline{BHE}$ controls I/O_8 through I/O_{15} and $\overline{BLE}$ controls I/O_0 through I/O_7.

Data reads are performed by asserting the Output Enable ($\overline{OE}$) input and providing the required address on the address lines. Read data is accessible on the I/O lines (I/O_0 through I/O_{15}). Byte accesses can be performed by asserting the required byte enable signal ($\overline{BHE}$ or $\overline{BLE}$) to read either the upper byte or the lower byte of data from the specified address location.

All I/Os (I/O_0 through I/O_{15}) are placed in a HI-Z state when the device is deselected ($\overline{CE}$ LOW), or when the control signals are deasserted ($\overline{OE}$, $\overline{BLE}$, $\overline{BHE}$). Refer to the following logic block diagram.

Logic Block Diagram – CY7C1041G



Note
1. This device does not support automatic write-back on error detection.
2. SER FIT Rate <0.1 FIT/Mb. Refer AN88889 for details.

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Pin Configurations

Figure 1. 48-ball VFBGA Pinout [3]

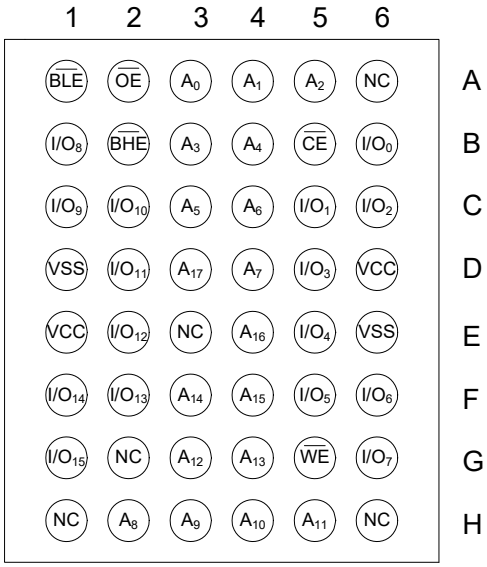
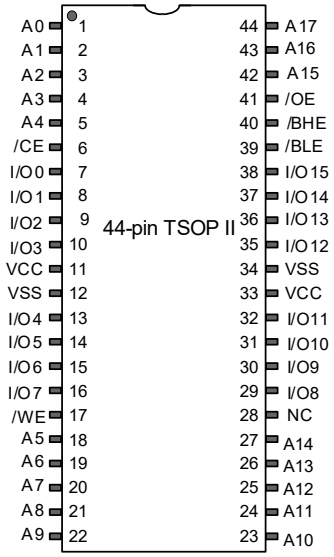


Figure 2. 44-pin TSOP II Pinout [3]



Product Portfolio

Product	Range	V_{CC} Range (V)	Speed (ns)	Power Dissipation			
				Operating I_{CC}, (mA), f = f_{max}		Standby, I_{SB2} (mA)	
				Typ[4]	Max	Typ[4]	Max
CY7C1041G	Automotive-E	2.2 V–3.6 V	10	40	50	6	14
	Automotive-A			38	45	6	8

Notes
3. NC pins are not connected internally to the die.
4. Typical values are included for reference only and are not guaranteed or tested.

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 on V_{CC} relative to GND[5] .....–0.5 V to Vcc +0.3 V

DC voltage applied to outputs in HI-Z State[5] .....–0.3 V to Vcc +0.3 V

DC input voltage[5] ..... –0.3 V to V_{CC} + 0.3 V

Current into outputs (in low state) ..... 20 mA

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

Latch-up current ..... > 140 mA

Operating Range

Grade	Ambient Temperature	V_{CC}
Automotive-E	–40 °C to +125 °C	2.2 V to 3.6 V
Automotive-A	–40 °C to +85 °C	2.2 V to 3.6 V

DC Electrical Characteristics

Over the Operating Range

Parameter	Description		Test Conditions	10 ns (Automotive-E)			10 ns (Automotive-A)			Unit
				Min	Typ	Max	Min	Typ	Max	
V_{OH}	Output HIGH voltage	2.2 V to 2.7 V	V_{CC} = Min, I_{OH} = –1.0 mA	2	–	–	2	–	–	V
		2.7 V to 3.0 V	V_{CC} = Min, I_{OH} = –4.0 mA	2.2	–	–	2.2	–	–	
		3.0 V to 3.6 V	V_{CC} = Min, I_{OH} = –4.0 mA	2.4	–	–	2.4	–	–	
V_{OL}	Output LOW voltage	2.2 V to 2.7 V	V_{CC} = Min, I_{OL} = 2 mA	–	–	0.4	–	–	0.4	V
		2.7 V to 3.6 V	V_{CC} = Min, I_{OL} = 8 mA	–	–	0.4	–	–	0.4	
V_{IH}	Input HIGH voltage	2.2 V to 2.7 V	–	2	–	V_{CC} + 0.3[5]	2	–	V_{CC} + 0.3[5]	V
		2.7 V to 3.6 V	–	2	–	V_{CC} + 0.3[5]	2	–	V_{CC} + 0.3[5]	
V_{IL}	Input LOW voltage	2.2 V to 2.7 V	–	–0.3[5]	–	0.6	–0.3[5]	–	0.6	V
		2.7 V to 3.6 V	–	–0.3[5]	–	0.8	–0.3[5]	–	0.8	
I_{IX}	Input leakage current		GND ≤ V_{IN} ≤ V_{CC}	–5	–	+5	–1	–	+1	µA
I_{OZ}	Output leakage current		GND ≤ V_{OUT} ≤ V_{CC}, Output disabled	–5	–	+5	–1	–	+1	µA
I_{CC}	Operating supply current		V_{CC} = 3.6 V, I_{OUT} = 0 mA, CMOS levels; f = f_{MAX} = $1/t_{RC}$	–	40	50	–	38	45	mA
I_{SB1}	Automatic CE power down current – TTL inputs		V_{CC} = 3.6 V, $\overline{CE}$ ≥ V_{IH}, V_{IN} ≥ V_{IH} or V_{IN} ≤ V_{IL}, f = f_{MAX}	–	–	24	–	–	15	mA
I_{SB2}	Automatic CE power down current – CMOS inputs		V_{CC} = 3.6 V, $\overline{CE}$ ≥ V_{CC} – 0.2 V, V_{IN} ≥ V_{CC} – 0.2 V or V_{IN} ≤ 0.2 V, f = 0	–	6	14	–	6	8	mA

Note

5. $V_{IL(min)}$ = –2.0 V and $V_{IH(max)}$ = V_{CC} + 2 V for pulse durations of less than 20 ns.

Capacitance

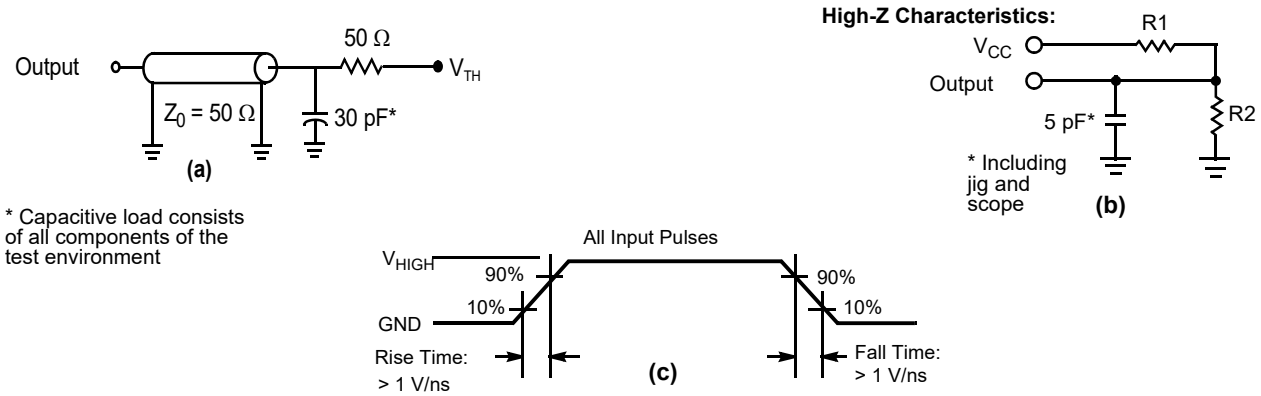
Parameter[6]	Description	Test Conditions	All Packages	Unit
C_{IN}	Input capacitance	T_A = 25 °C, f = 1 MHz, V_{CC} = $V_{CC(typ)}$	10	pF
C_{OUT}	I/O capacitance		10	pF

Thermal Resistance

Parameter[6]	Description	Test Conditions	48-ball VFBGA	44-pin TSOPII	Unit
Θ_{JA}	Thermal resistance (junction to ambient)	Still air, soldered on a 3 × 4.5 inch, four-layer printed circuit board	30.68	66.82	°C/W
Θ_{JC}	Thermal resistance (junction to case)		14.83	15.97	°C/W

AC Test Loads and Waveforms

Figure 3. AC Test Loads and Waveforms [7]



Parameters	3.0 V	Unit
R1	317	Ω
R2	351	Ω
V_{TH}	1.5	V
V_{HIGH}	3	V

Notes
6. Tested initially and after any design or process change that may affect these parameters.
7. Full-device AC operation assumes a 100 µs ramp time from 0 to $V_{CC(min)}$ and a 100 µs wait time after V_{CC} stabilization.

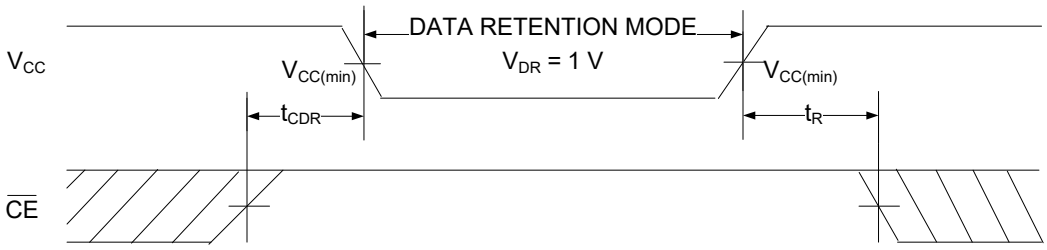
Data Retention Characteristics

Over the Operating Range

Parameter	Description	Conditions	Automotive-E		Automotive-A		Unit
			Min	Max	Min	Max	
V_{DR}	V_{CC} for data retention	–	1	–	1	–	V
I_{CCDR}	Data retention current	V_{CC} = 1.2 V, $\overline{CE} \geq V_{CC} - 0.2$ V, $V_{IN} \geq V_{CC} - 0.2$ V or $V_{IN} \leq 0.2$ V	–	14	–	8	mA
t_{CDR}[8]	Chip deselect to data retention time	–	0	–	0	–	ns
t_R[8, 9]	Operation recovery time	$V_{CC} \geq 2.2$ V	10	–	10	–	ns

Data Retention Waveform

Figure 4. Data Retention Waveform [9]



Notes
8. These parameters are guaranteed by design.
9. 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.

AC Switching Characteristics

Over the Operating Range

Parameter[10]	Description	10 ns (Automotive-A/Automotive-E)		Unit
		Min	Max	
Read Cycle				
t_{RC}	Read cycle time	10	–	ns
t_{AA}	Address to data	–	10	ns
t_{OHA}	Data	3	–	ns
t_{ACE}	$\overline{CE}$ LOW to data[11]	–	10	ns
t_{DOE}	$\overline{OE}$ LOW to data	–	4.5	ns
t_{LZOE}	$\overline{OE}$ LOW to low impedance[12, 13]	0	–	ns
t_{HZOE}	$\overline{OE}$ HIGH to HI-Z[12, 13]	–	5	ns
t_{LZCE}	$\overline{CE}$ LOW to low impedance[11, 12, 13]	3	–	ns
t_{HZCE}	$\overline{CE}$ HIGH to HI-Z[11, 12, 13]	–	5	ns
t_{PU}	$\overline{CE}$ LOW to power up[11, 13]	0	–	ns
t_{PD}	$\overline{CE}$ HIGH to power down[11, 13]	–	10	ns
t_{DBE}	Byte enable to data valid	–	4.5	ns
t_{LZBE}	Byte enable to low impedance[13]	0	–	ns
t_{HZBE}	Byte disable to HI-Z[13]	–	6	ns
Write Cycle[14, 15]				
t_{WC}	Write cycle time	10	–	ns
t_{SCE}	$\overline{CE}$ LOW to write end[10]	7	–	ns
t_{AW}	Address setup to write end	7	–	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	7	–	ns
t_{SD}	Data setup to write end	5	–	ns
t_{HD}	Data hold from write end	0	–	ns
t_{LZWE}	$\overline{WE}$ HIGH to low impedance[12, 13]	3	–	ns
t_{HZWE}	$\overline{WE}$ LOW to HI-Z[12, 13]	–	5	ns
t_{BW}	Byte Enable to write end	7	–	ns

Notes

10. Test conditions assume a signal transition time (rise/fall) of 3 ns or less, timing reference levels of 1.5 V (for $V_{CC} \geq 3$ V) and $V_{CC}/2$ (for $V_{CC} < 3$ V), and input pulse levels of 0 to 3 V (for $V_{CC} \geq 3$ V) and 0 to V_{CC} (for $V_{CC} < 3$ V). Test conditions for the read cycle use output loading shown in part (a) of Figure 3 on page 5, unless specified otherwise.
11. For all dual chip enable devices, $\overline{CE}$ is the logical combination of $\overline{CE_1}$ and CE_2. When $\overline{CE_1}$ is LOW and CE_2 is HIGH, $\overline{CE}$ is LOW; when $\overline{CE_1}$ is HIGH or CE_2 is LOW, $\overline{CE}$ is HIGH.
12. t_{HZOE}, t_{HZCE}, t_{HZWE}, t_{HZBE}, t_{LZOE}, t_{LZCE}, t_{LZWE}, and t_{LZBE} are specified with a load capacitance of 5 pF as in (b) of Figure 3 on page 5. Transition is measured ±200 mV from steady state voltage.
13. These parameters are guaranteed by design and are not tested.
14. The internal write time of the memory is defined by the overlap of $\overline{WE}$ = V_{IL}, $\overline{CE}$ = V_{IL} and $\overline{BHE}$ or $\overline{BLE}$ = V_{IL}. These signals must be LOW to initiate a write, and the HIGH transition of any of these signals can terminate the operation. The input data setup and hold timing should be referenced to the edge of the signal that terminates the write.
15. The minimum write cycle pulse width for Write Cycle No. 2 ($\overline{WE}$ Controlled, $\overline{OE}$ LOW) should be equal to sum of t_{SD} and t_{HZWE}.

Switching Waveforms

Figure 5. Read Cycle No. 1 of CY7C1041G (Address Transition Controlled) [16, 17]

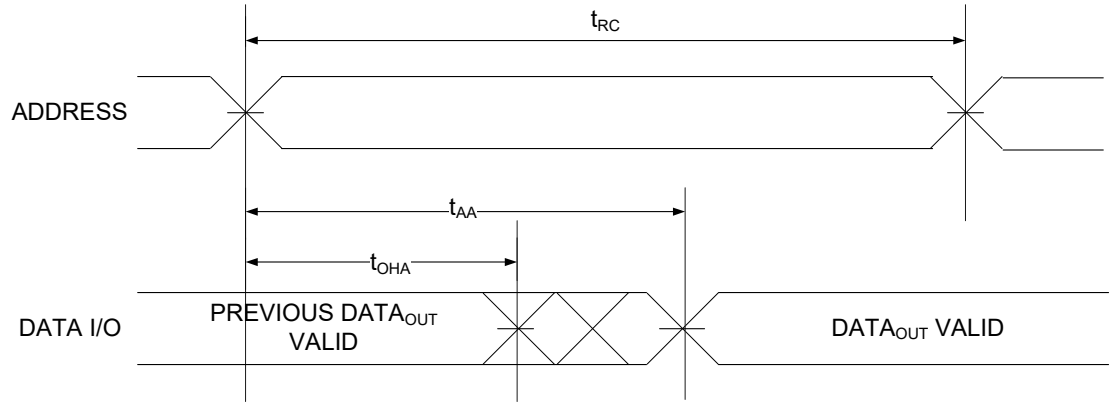
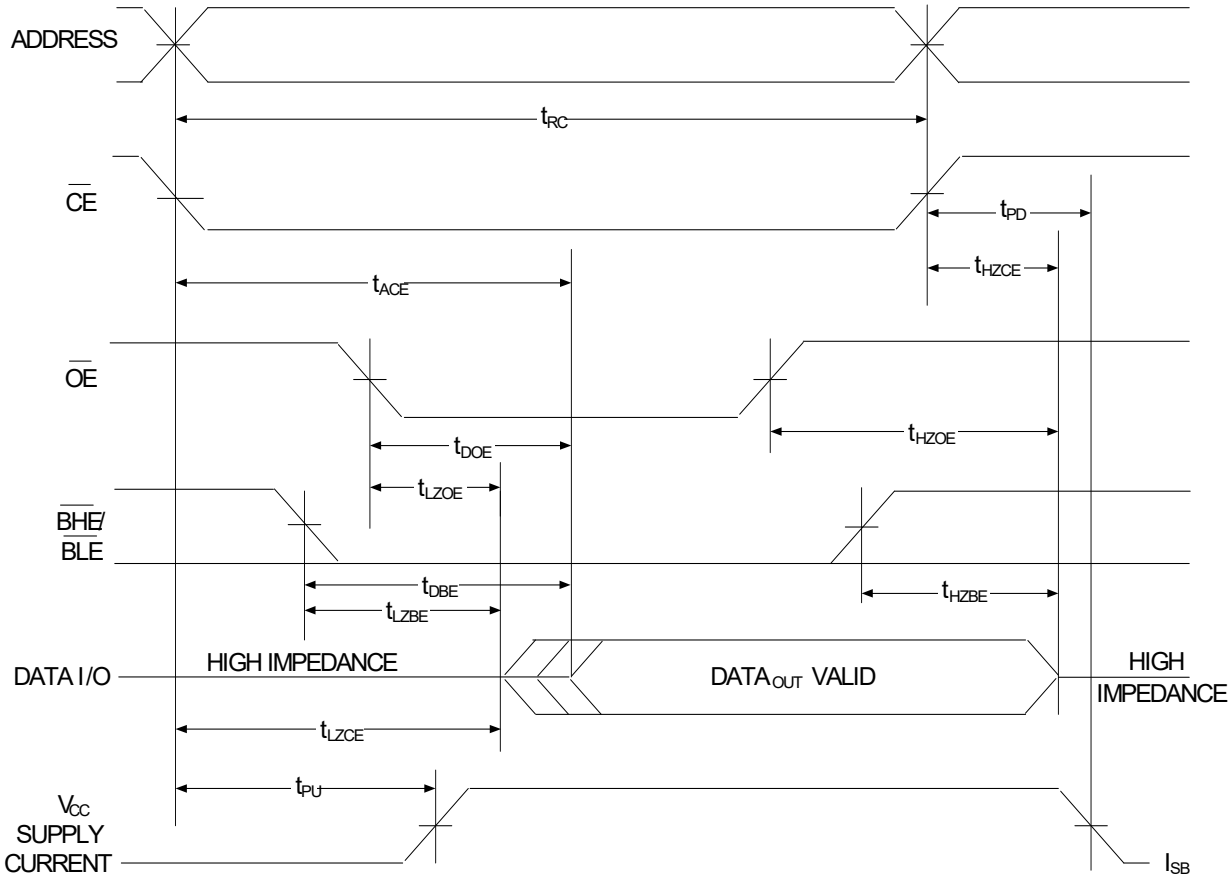


Figure 6. Read Cycle No. 2 ($\overline{OE}$ Controlled) [17]



Notes
16. The device is continuously selected, $\overline{OE}$ = V_{IL}, $\overline{CE}$ = V_{IL}, $\overline{BHE}$ or $\overline{BLE}$ or both = V_{IL}.
17. $\overline{WE}$ is HIGH for read cycle.

Switching Waveforms (continued)

Figure 7. Write Cycle No. 1 ($\overline{CE}$ Controlled) [18, 19, 20]

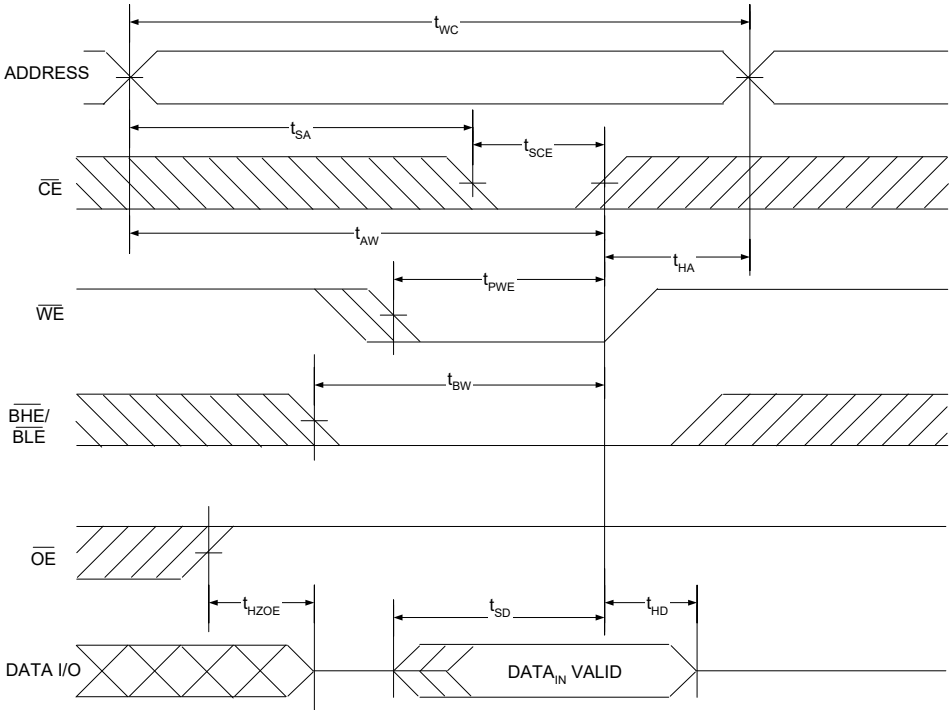
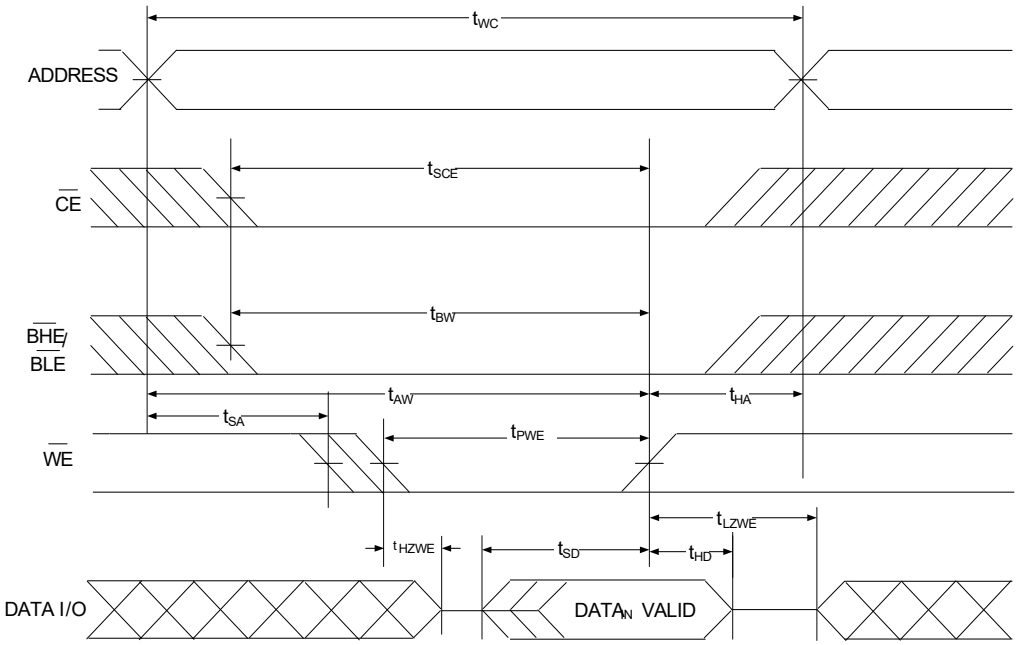


Figure 8. Write Cycle No. 2 ($\overline{WE}$ Controlled, $\overline{OE}$ LOW) [18, 19, 20, 21]



Notes

18. Address valid prior to or coincident with $\overline{CE}$ LOW transition.
19. The internal write time of the memory is defined by the overlap of $\overline{WE}$ = V_{IL}, $\overline{CE}$ = V_{IL} and $\overline{BHE}$ or $\overline{BLE}$ = V_{IL}. These signals must be LOW to initiate a write, and the HIGH transition of any of these signals can terminate the operation. The input data setup and hold timing should be referenced to the edge of the signal that terminates the write.
20. Data I/O is in HI-Z state if $\overline{CE}$ = V_{IH}, or $\overline{OE}$ = V_{IH} or $\overline{BHE}$, and/or $\overline{BLE}$ = V_{IH}.
21. The minimum write cycle pulse width should be equal to sum of t_{SD} and t_{HZWE}.

Switching Waveforms (continued)

Figure 9. Write Cycle No. 3 ($\overline{BLE}$ or $\overline{BHE}$ Controlled) [22, 23]

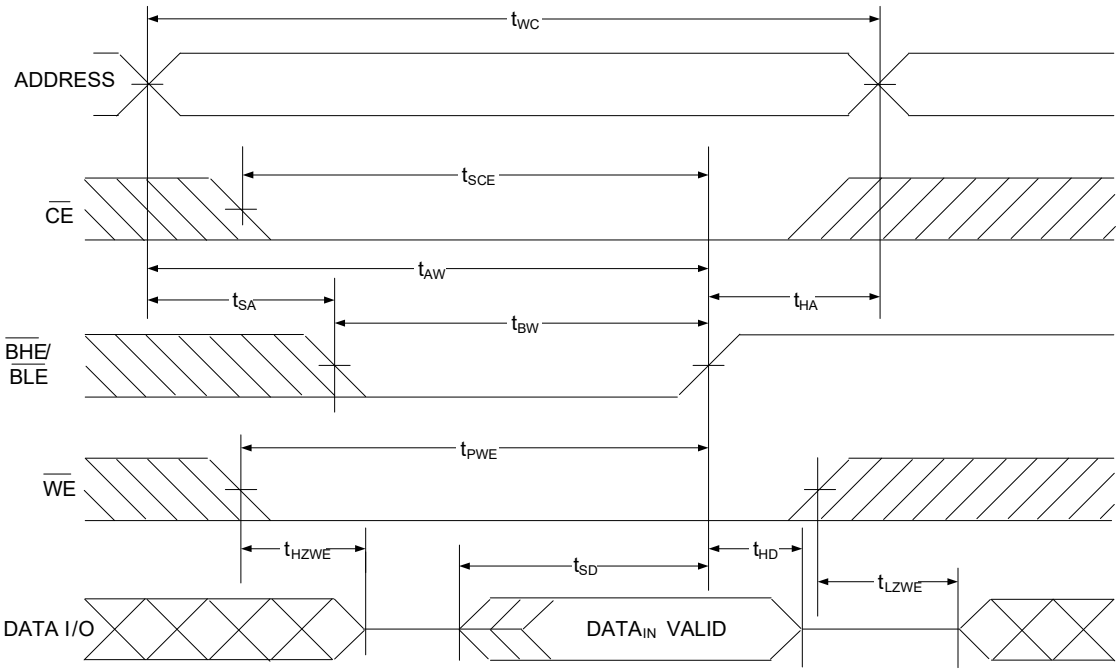
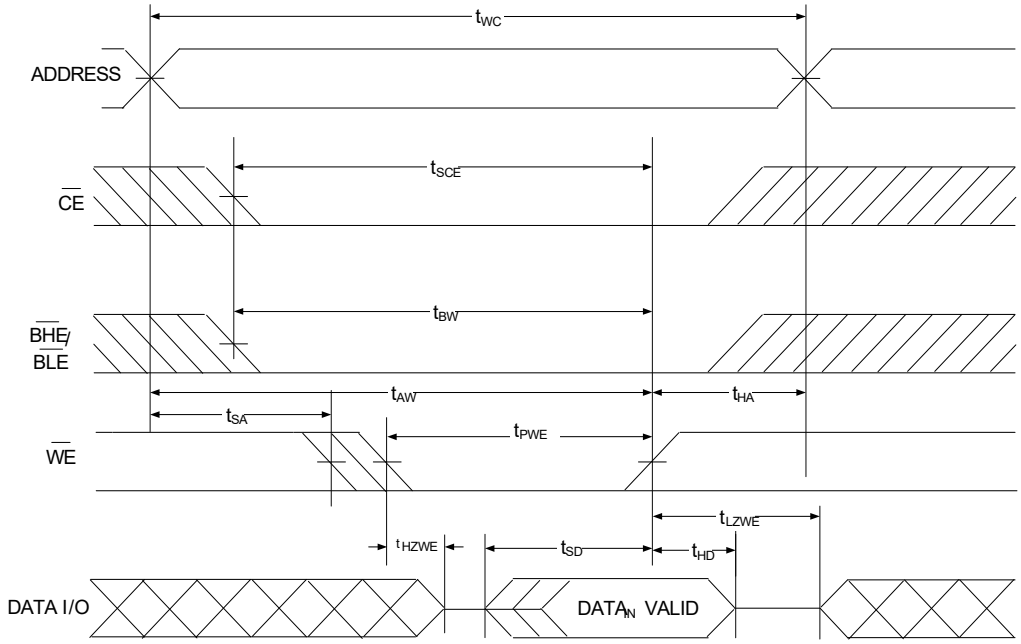


Figure 10. Write Cycle No. 4 ($\overline{WE}$ Controlled) [22, 23, 24]



Notes

22. The internal write time of the memory is defined by the overlap of $\overline{WE}$ = V_{IL}, $\overline{CE}$ = V_{IL} and $\overline{BHE}$ or $\overline{BLE}$ = V_{IL}. These signals must be LOW to initiate a write, and the HIGH transition of any of these signals can terminate the operation. The input data setup and hold timing should be referenced to the edge of the signal that terminates the write.
23. Data I/O is in HI-Z state if $\overline{CE}$ = V_{IH}, or $\overline{OE}$ = V_{IH} or $\overline{BHE}$, and/or $\overline{BLE}$ = V_{IH}.
24. Data I/O is high impedance if $\overline{OE}$ = V_{IH}.
25. During this period the I/Os are in output state. Do not apply input signals.

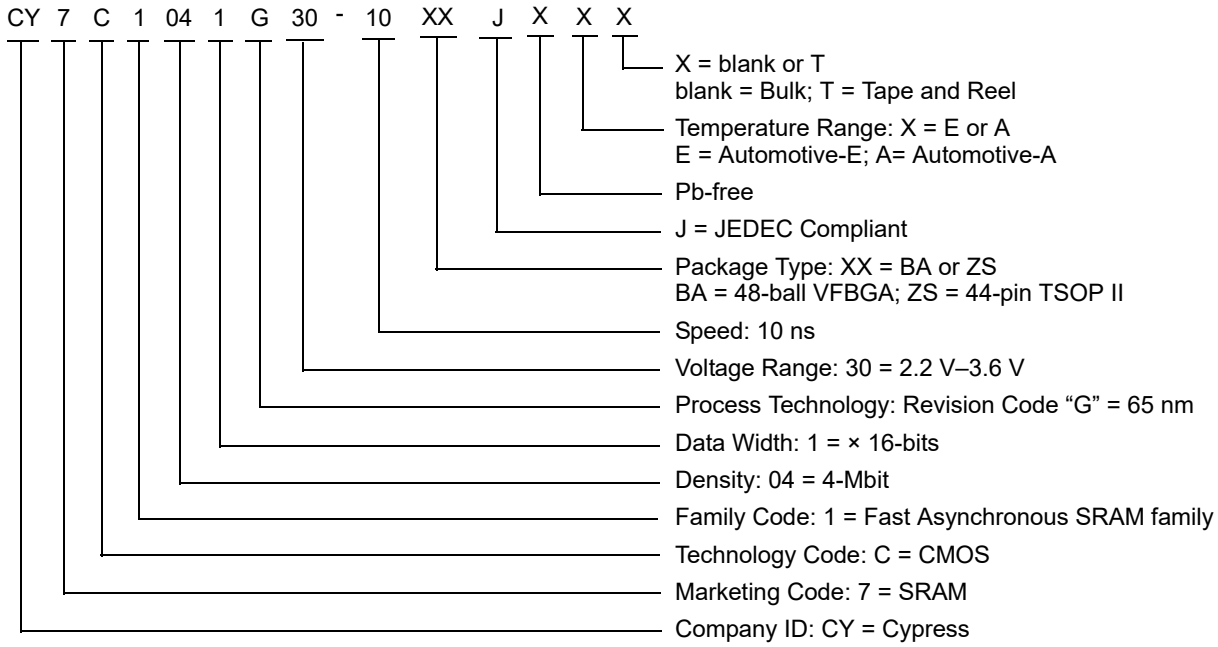
Truth Table

$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	$\overline{BLE}$	$\overline{BHE}$	$I/O_0–I/O_7$	$I/O_8–I/O_{15}$	Mode	Power
H	X	X	X	X	HI-Z	HI-Z	Power down	Standby (I_{SB})
L	L	H	L	L	Data out	Data out	Read all bits	Active (I_{CC})
L	L	H	L	H	Data out	HI-Z	Read lower bits only	Active (I_{CC})
L	L	H	H	L	HI-Z	Data out	Read upper bits only	Active (I_{CC})
L	X	L	L	L	Data in	Data in	Write all bits	Active (I_{CC})
L	X	L	L	H	Data in	HI-Z	Write lower bits only	Active (I_{CC})
L	X	L	H	L	HI-Z	Data in	Write upper bits only	Active (I_{CC})
L	H	H	X	X	HI-Z	HI-Z	Selected, outputs disabled	Active (I_{CC})

Ordering Information

Speed (ns)	Voltage Range	Ordering Code	Package Diagram	Package Type (all Pb-free)	Operating Range
10	2.2 V–3.6 V	CY7C1041G30-10BAJXE	001-85259	48-ball VFBGA	Automotive-E
		CY7C1041G30-10BAJXET	001-85259	48-ball VFBGA, Tape and Reel	
		CY7C1041G30-10ZSXE	51-85087	44-pin TSOP II	
		CY7C1041G30-10ZSXET	51-85087	44-pin TSOP II, Tape and Reel	
		CY7C1041G30-10ZSXA	51-85087	44-pin TSOP II	Automotive-A
		CY7C1041G30-10ZSXAT	51-85087	44-pin TSOP II, Tape and Reel	

Ordering Code Definitions



Package Diagrams

Figure 11. 48-ball VFBGA (6 × 8 × 1.2 mm) BA48M/BK48M (0.35 mm Ball Diameter) Package Outline, 001-85259

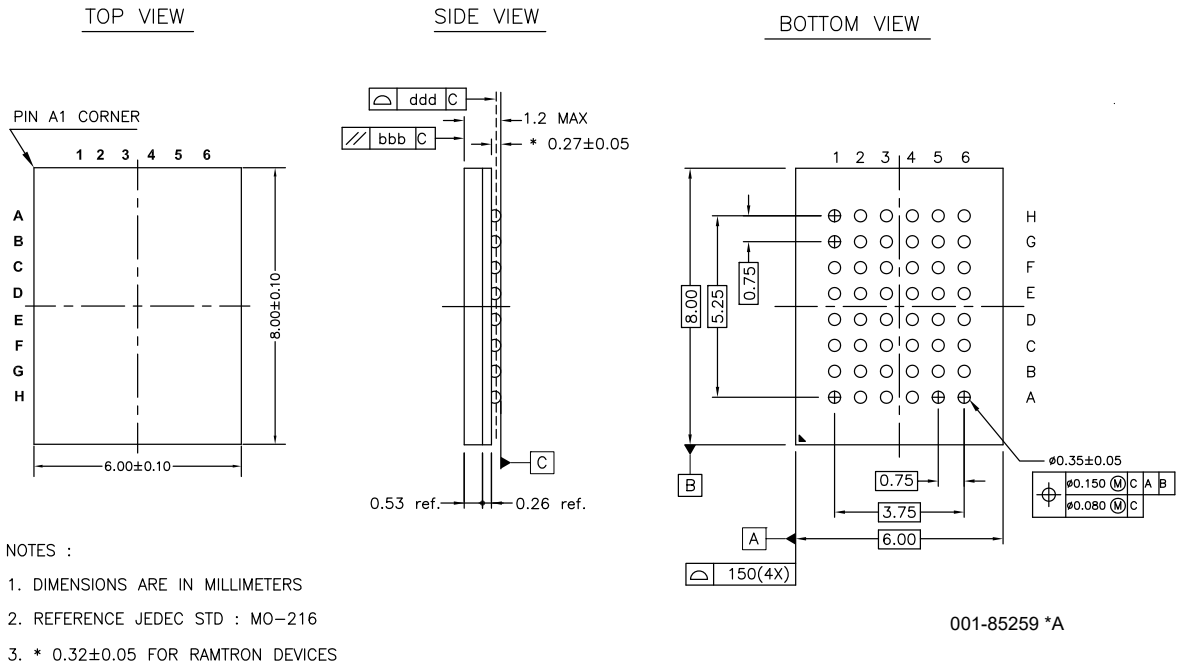
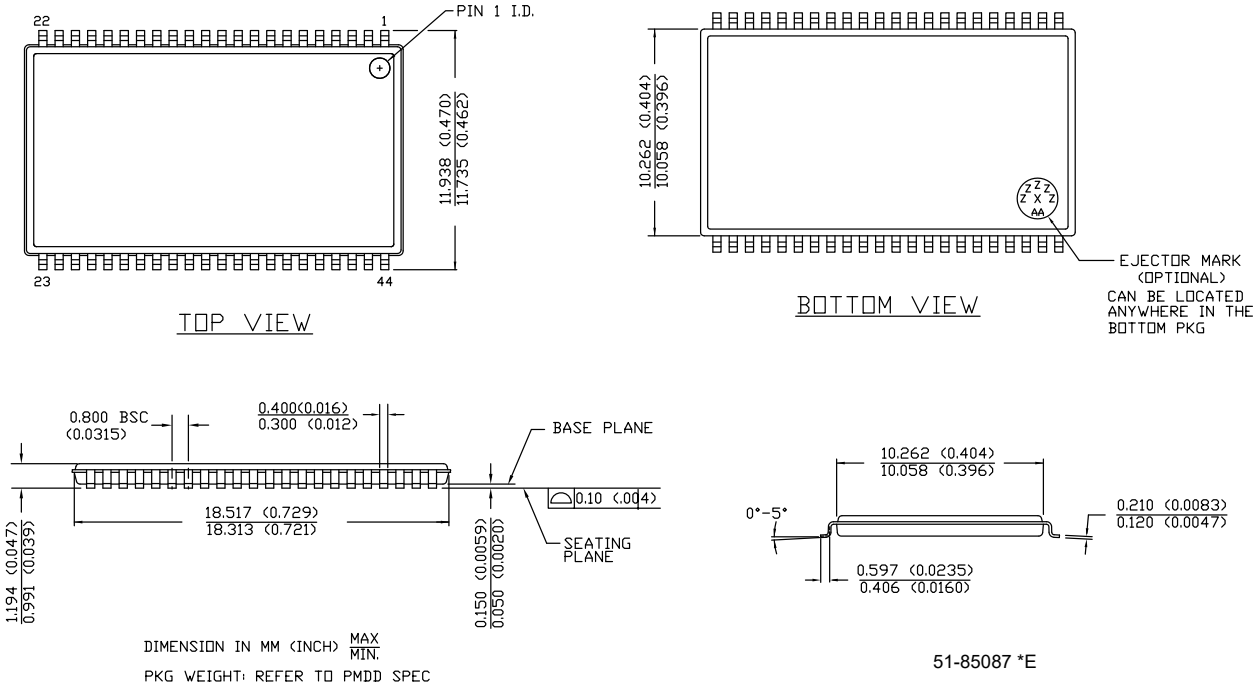


Figure 12. 44-pin TSOP Z44-II Package Outline, 51-85087



Acronyms

Table 1. Acronyms Used in this Document

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

Document Conventions

Units of Measure

Table 2. 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: CY7C1041G Automotive, 4-Mbit (256K words × 16-bit) Static RAM with Error-Correcting Code (ECC) Document Number: 001-91255				
Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
*F	4996293	NILE	10/30/2015	Changed status from Preliminary to Final.
*G	5026902	NILE	11/25/2015	Added Automotive-A Temperature Range related information in all instances across the document. Updated Ordering Information: Updated part numbers.
*H	5427560	NILE	09/07/2016	Updated Maximum Ratings: Updated Note 5 (Replaced “2 ns” with “20 ns”). Updated DC Electrical Characteristics: Removed details of V_{OH} parameter corresponding to Test Condition “2.7 V to 3.6 V”. Added details of V_{OH} parameter corresponding to Test Conditions “2.7 V to 3.0 V” and “3.0 V to 3.6 V”. Updated Ordering Information: Updated part numbers. Updated to new template.
*I	5787756	NILE	06/27/2017	Updated to new template. Completing Sunset Review.
*J	6249178	NILE	07/16/2018	Updated Features: Added “AEC-Q100 qualified”. Added Note 2 and referred the same note in “Embedded ECC for single-bit error correction”. Updated to new template. Completing Sunset Review.

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