CY7C13451G

4-Mbit (128K × 36) Flow-Through Sync SRAM

Features

- 128K × 36 common I/O
- 3.3 V core Power Supply (V_{DD})
- 2.5 V or 3.3 V I/O Supply (V_{DDQ})
- Fast Clock-to-output times
  - 8.0 ns (100 MHz version)
- Provide high performance 2-1-1-1 access rate
- User selectable burst counter supporting Intel Pentium interleaved or Linear Burst Sequences
- Separate Processor and Controller Address Strobes
- Synchronous Self Timed Write
- Asynchronous output enable
- Available in Pb-free 165-ball FBGA Package
- ZZ Sleep Mode option

Functional Description

The CY7C13451G is a 128K × 36 synchronous cache RAM designed to interface with high speed microprocessors with minimum glue logic. The maximum access delay from clock rise is 8.0 ns (100 MHz version). A 2 bit on-chip counter captures the first address in a burst and increments the address automatically for the rest of the burst access. All synchronous inputs are gated by registers controlled by a positive edge triggered Clock Input (CLK). The synchronous inputs include all addresses, all data inputs, address pipelining Chip Enable ($\overline{CE_1}$), depth expansion Chip Enables (CE_2 and $\overline{CE_3}$), Burst Control inputs (ADSC, ADSP, and ADV), Write Enables ($\overline{BW_x}$, and $\overline{BWE}$), and Global Write ($\overline{GW}$). Asynchronous inputs include the Output Enable ($\overline{OE}$) and the ZZ pin.

The CY7C13451G enables either interleaved or linear burst sequences, selected by the MODE input pin. A HIGH selects an interleaved burst sequence, while a LOW selects a linear burst sequence. Burst accesses are initiated with the Processor Address Strobe ($\overline{ADSP}$) or the cache Controller Address Strobe ($\overline{ADSC}$) inputs.

Addresses and chip enables are registered at rising edge of clock when either Address Strobe Processor ($\overline{ADSP}$) or Address Strobe Controller ($\overline{ADSC}$) is active. Subsequent burst addresses are internally generated as controlled by the Advance pin ($\overline{ADV}$).

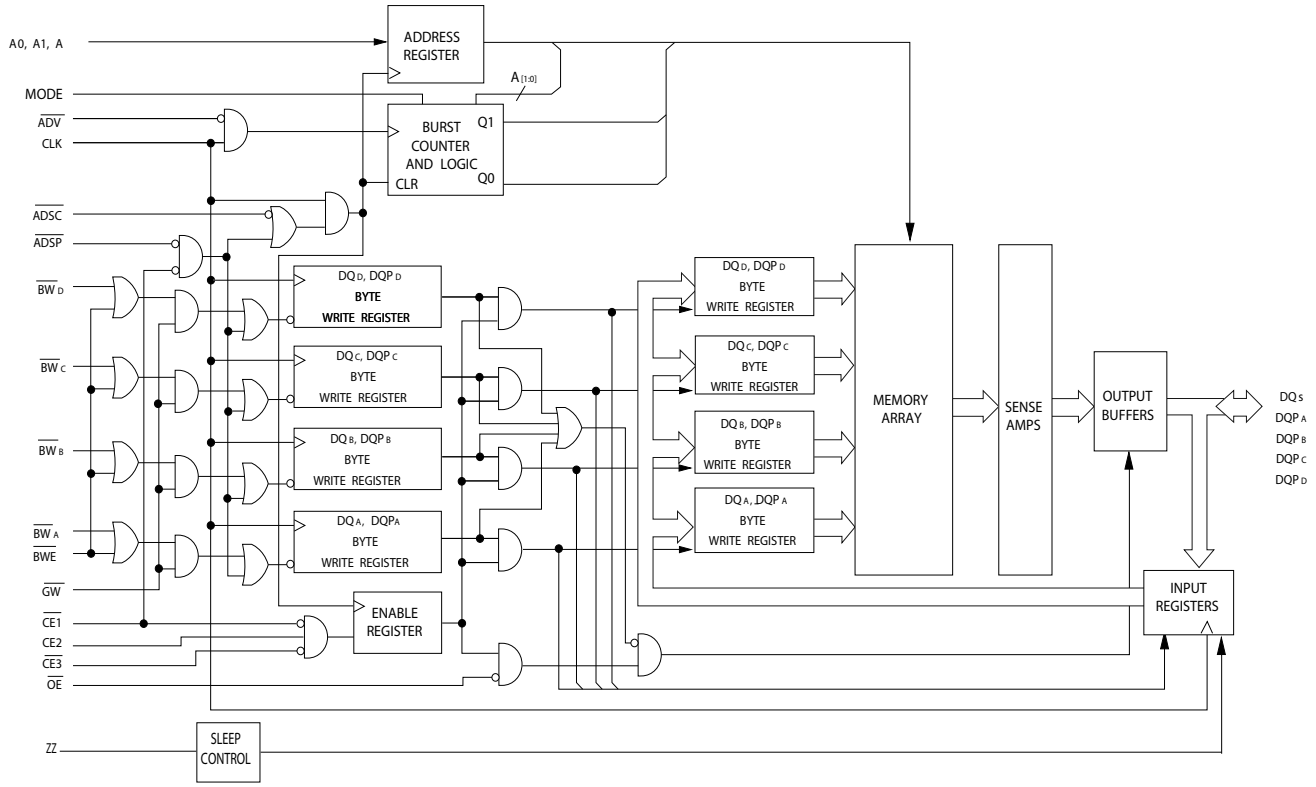
The CY7C13451G operates from a +3.3 V core power supply while all outputs operate with either a +2.5 or +3.3 V supply. All inputs and outputs are JEDEC standard JESD8-5 compatible.

For a complete list of related documentation, click here.

Selection Guide

Description	100 MHz	Unit
Maximum Access Time	8.0	ns
Maximum Operating Current	180	mA
Maximum CMOS Standby Current	60	mA

Logic Block Diagram



Contents

Pin Configurations

Figure 1. 165-ball FBGA pinout [1]

CY7C13451G (128K × 36)

	1	2	3	4	5	6	7	8	9	10	11
A	NC/288M	A	$\overline{CE_1}$	$\overline{BW_C}$	$\overline{BW_B}$	$\overline{CE_3}$	$\overline{BWE}$	$\overline{ADSC}$	$\overline{ADV}$	A	NC
B	NC/144M	A	CE_2	$\overline{BW_D}$	$\overline{BW_A}$	CLK	$\overline{GW}$	$\overline{OE}$	$\overline{ADSP}$	A	NC/576M
C	DQP_C	NC	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC/1G	DQP_B
D	DQ_C	DQ_C	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_B	DQ_B
E	DQ_C	DQ_C	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_B	DQ_B
F	DQ_C	DQ_C	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_B	DQ_B
G	DQ_C	DQ_C	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_B	DQ_B
H	NC	NC	NC	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	NC	NC	ZZ
J	DQ_D	DQ_D	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	DQ_A
K	DQ_D	DQ_D	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	DQ_A
L	DQ_D	DQ_D	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	DQ_A
M	DQ_D	DQ_D	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	DQ_A
N	DQP_D	NC	V_{DDQ}	V_{SS}	NC	NC/18M	NC	V_{SS}	V_{DDQ}	NC	DQP_A
P	NC	NC/72M	A	A	NC	A1	NC	A	A	A	NC/9M
R	MODE	NC/36M	A	A	NC	A0	NC	A	A	A	A

Note
1. Errata: The ZZ pin (Ball H11) needs to be externally connected to ground. For more information, see "Errata" on page 21.

Pin Definitions

Name	I/O	Description
A_0, A_1, A	Input-Synchronous	**Address Inputs Used to Select One of the 128K Address Locations**. Sampled at the rising edge of the CLK if $\overline{ADSP}$ or $\overline{ADSC}$ is active LOW, and $\overline{CE}_1$, CE_2, and $\overline{CE}_3$ are sampled active. $A_{[1:0]}$ feed the two bit counter.
$\overline{BW}_A$, $\overline{BW}_B$, $\overline{BW}_C$, $\overline{BW}_D$	Input-Synchronous	**Byte Write Select Inputs, Active LOW**. Qualified with $\overline{BWE}$ to conduct byte writes to the SRAM. Sampled on the rising edge of CLK.
$\overline{GW}$	Input-Synchronous	**Global Write Enable Input, Active LOW**. When asserted LOW on the rising edge of CLK, a global write is conducted (ALL bytes are written, regardless of the values on $\overline{BW}_{[A:D]}$ and $\overline{BWE}$).
$\overline{BWE}$	Input-Synchronous	**Byte Write Enable Input, Active LOW**. Sampled on the rising edge of CLK. This signal is asserted LOW to conduct a byte write.
CLK	Input Clock	**Clock Input**. Used to capture all synchronous inputs to the device. Also used to increment the burst counter when $\overline{ADV}$ is asserted LOW, during a burst operation.
$\overline{CE}_1$	Input-Synchronous	**Chip Enable 1 Input, Active LOW**. Sampled on the rising edge of CLK. Used in conjunction with CE_2 and $\overline{CE}_3$ to select or deselect the device. $\overline{ADSP}$ is ignored if $\overline{CE}_1$ is HIGH. $\overline{CE}_1$ is sampled only when a new external address is loaded.
CE_2	Input-Synchronous	**Chip Enable 2 Input, Active HIGH**. Sampled on the rising edge of CLK. Used in conjunction with $\overline{CE}_1$ and $\overline{CE}_3$ to select or deselect the device. CE_2 is sampled only when a new external address is loaded.
$\overline{CE}_3$	Input-Synchronous	**Chip Enable 3 Input, Active LOW**. Sampled on the rising edge of CLK. Used in conjunction with $\overline{CE}_1$ and CE_2 to select or deselect the device. $\overline{CE}_3$ is sampled only when a new external address is loaded.
$\overline{OE}$	Input-Asynchronous	**Output Enable, Asynchronous Input, Active LOW**. Controls the direction of the I/O pins. When LOW, the I/O pins act as outputs. When deasserted HIGH, I/O pins are tristated and act as input data pins. $\overline{OE}$ is masked during the first clock of a read cycle when emerging from a deselected state.
$\overline{ADV}$	Input-Synchronous	**Advance Input Signal,** Sampled on the Rising Edge of CLK. When asserted, it automatically increments the address in a burst cycle.
$\overline{ADSP}$	Input-Synchronous	**Address Strobe from Processor, Sampled on the Rising Edge of CLK, Active LOW**. When asserted LOW, addresses presented to the device are captured in the address registers. $A_{[1:0]}$ are also loaded into the burst counter. When $\overline{ADSP}$ and $\overline{ADSC}$ are both asserted, only $\overline{ADSP}$ is recognized. ASDP is ignored when $\overline{CE}_1$ is deasserted HIGH.
$\overline{ADSC}$	Input-Synchronous	**Address Strobe from Controller, Sampled on the Rising Edge of CLK, Active LOW**. When asserted LOW, addresses presented to the device are captured in the address registers. $A_{[1:0]}$ are also loaded into the burst counter. When $\overline{ADSP}$ and $\overline{ADSC}$ are both asserted, only $\overline{ADSP}$ is recognized.
ZZ [2]	Input-Asynchronous	**ZZ sleep Input, Active HIGH**. When asserted HIGH places the device in a non-time critical sleep condition with data integrity preserved. During normal operation, this pin is low or left floating. ZZ pin has an internal pull down.
DQs, DQP_A, DQP_B, DQP_C, DQP_D	I/O-Synchronous	**Bidirectional Data I/O lines**. As inputs, they feed into an on-chip data register that is triggered by the rising edge of CLK. As outputs, they deliver the data contained in the memory location specified by the addresses presented during the previous clock rise of the read cycle. The direction of the pins is controlled by $\overline{OE}$. When $\overline{OE}$ is asserted LOW, the pins act as outputs. When HIGH, DQs and $DQP_{[A:D]}$ are placed in a tristate condition.
V_{DD}	Power Supply	**Power Supply Inputs to the Core of the Device**.
V_{SS}	Ground	**Ground for the Core of the Device**.
V_{DDQ}	I/O Power Supply	**Power Supply for the I/O Circuitry**.

Note
2. Errata: The ZZ pin (Ball H11) needs to be externally connected to ground. For more information, see "Errata" on page 21.

Pin Definitions (continued)

Name	I/O	Description
MODE	Input Static	**Selects Burst Order**. When tied to GND selects linear burst sequence. When tied to V_{DD} or left floating selects interleaved burst sequence. This is a strap pin and must remain static during device operation. Mode Pin has an internal pull up.
NC	–	**No Connects**. Not Internally connected to the die.
NC/9M, NC/18M, NC/36M, NC/72M, NC/144M, NC/288M, NC/576M, NC/1G	–	**No Connects**. Not internally connected to the die. NC/9M, NC/18M, NC/36M, NC/72M, NC/144M, NC/288M, NC/576M, and NC/1G are address expansion pins and are not internally connected to the die.

Functional Overview

All synchronous inputs pass through input registers controlled by the rising edge of the clock. Maximum access delay from the clock rise (t_{CO}) is 8.0 ns (100 MHz device).

The CY7C13451G supports secondary cache in systems using either a linear or interleaved burst sequence. The interleaved burst order supports Pentium and i486™ processors. The linear burst sequence is suited for processors that use a linear burst sequence. The burst order is user selectable and is determined by sampling the MODE input. Accesses are initiated with either the Processor Address Strobe ($\overline{ADSP}$) or the Controller Address Strobe ($\overline{ADSC}$). Address advancement through the burst sequence is controlled by the $\overline{ADV}$ input. A two bit on-chip wrap around burst counter captures the first address in a burst sequence and automatically increments the address for the rest of the burst access.

Byte write operations are qualified with the Byte Write Enable ($\overline{BWE}$) and Byte Write Select ($\overline{BW}_{[A:D]}$) inputs. A Global Write Enable ($\overline{GW}$) overrides all byte write inputs and writes data to all four bytes. All writes are simplified with on-chip synchronous self timed write circuitry.

Three synchronous Chip Selects ($\overline{CE}_1$, CE_2, and $\overline{CE}_3$) and an asynchronous Output Enable ($\overline{OE}$) provide for easy bank selection and output tristate control. $\overline{ADSP}$ is ignored if $\overline{CE}_1$ is HIGH.

Single Read Accesses

A single read access is initiated when the following conditions are satisfied at clock rise:

1. $\overline{CE}_1$, CE_2, and $\overline{CE}_3$ are all asserted active.
2. $\overline{ADSP}$ or $\overline{ADSC}$ is asserted LOW (if the access is initiated by $\overline{ADSC}$, the write inputs are deasserted during this first cycle).

The address presented to the address inputs is latched into the address register and the burst counter or control logic and presented to the memory core. If the $\overline{OE}$ input is asserted LOW, the requested data is available at the data outputs a maximum to t_{CDV} after clock rise. $\overline{ADSP}$ is ignored if $\overline{CE}_1$ is HIGH.

Single Write Accesses Initiated by $\overline{ADSP}$

Single write access is initiated when the following conditions are satisfied at clock rise:

1. $\overline{CE}_1$, CE_2, and $\overline{CE}_3$ are all asserted active
2. $\overline{ADSP}$ is asserted LOW.

The addresses presented are loaded into the address register and the burst inputs ($\overline{GW}$, $\overline{BWE}$, and $\overline{BW}_x$) are ignored during this first clock cycle. If the write inputs are asserted active (see **Write Cycle Descriptions table** for appropriate states that indicate a write) on the next clock rise, the appropriate data is latched and written into the device. Byte writes are allowed. During byte writes, $\overline{BW}_A$ controls DQ_A and $\overline{BW}_B$ controls DQ_B, $\overline{BW}_C$ controls DQ_C, and $\overline{BW}_D$ controls DQ_D. All I/Os are tristated during a byte write. Since this is a common I/O device, the asynchronous $\overline{OE}$ input signal is deasserted and the I/Os are tristated prior to the presentation of data to DQ_s. As a safety precaution, the data lines are tristated after a write cycle is detected, regardless of the state of $\overline{OE}$.

Single Write Accesses Initiated by ADSC

This write access is initiated when the following conditions are satisfied at clock rise:

1. $\overline{CE}_1$, CE_2, and $\overline{CE}_3$ are all asserted active.
2. $\overline{ADSC}$ is asserted LOW.
3. $\overline{ADSP}$ is deasserted HIGH
4. The write input signals ($\overline{GW}$, $\overline{BWE}$, and $\overline{BW}_x$) indicate a write access. $\overline{ADSC}$ is ignored if $\overline{ADSP}$ is active LOW.

The addresses presented are loaded into the address register and the burst counter or control logic and delivered to the memory core. The information presented to $DQ_{[D:A]}$ is written into the specified address location. Byte writes are allowed. During byte writes, $\overline{BW}_A$ controls DQ_A, BW_B controls DQ_B, BW_C controls DQ_C, and $\overline{BW}_D$ controls DQ_D. All I/Os and even a byte write are tristated when a write is detected. Since this is a common I/O device, the asynchronous $\overline{OE}$ input signal is deasserted and the I/Os are tristated prior to the presentation of data to DQs. As a safety precaution, the data lines are tristated after a write cycle is detected, regardless of the state of $\overline{OE}$.

Burst Sequences

The CY7C13451G provides an on-chip two bit wrap around burst counter inside the SRAM. The burst counter is fed by $A_{[1:0]}$ and follows either a linear or interleaved burst order. The burst order is determined by the state of the MODE input. A LOW on MODE selects a linear burst sequence. A HIGH on MODE selects an interleaved burst order. Leaving MODE unconnected causes the device to default to a interleaved burst sequence.

Sleep Mode

The ZZ input pin is an asynchronous input. Asserting ZZ places the SRAM in a power conservation sleep mode. Two clock cycles are required to enter into or exit from this sleep mode. In this mode, data integrity is guaranteed. Accesses pending when entering the sleep mode are not considered valid nor is the completion of the operation guaranteed. The device is deselected prior to entering the sleep mode. CEs, ADSP, and ADSC must remain inactive for the duration of t_{ZZREC} after the ZZ input returns LOW.

Interleaved Burst Address Table

(MODE = Floating or V_{DD})

First Address A1, A0	Second Address A1, A0	Third Address A1, A0	Fourth Address A1, A0
00	01	10	11
01	00	11	10
10	11	00	01
11	10	01	00

Linear Burst Address Table

(MODE = GND)

First Address A_1, A_0	Second Address A_1, A_0	Third Address A_1, A_0	Fourth Address A_1, A_0
00	01	10	11
01	10	11	00
10	11	00	01
11	00	01	10

ZZ Mode Electrical Characteristics

Parameter	Description	Test Conditions	Min	Max	Unit
I_{DDZZ}	Sleep mode standby current	ZZ $\geq V_{DD} - 0.2$ V	–	40	mA
t_{ZZS}	Device operation to ZZ	ZZ $\geq V_{DD} - 0.2$ V	–	$2t_{CYC}$	ns
t_{ZZREC}	ZZ recovery time	ZZ ≤ 0.2 V	$2t_{CYC}$	–	ns
t_{ZZI}	ZZ Active to sleep current	This parameter is sampled	–	$2t_{CYC}$	ns
t_{RZZI}	ZZ Inactive to exit sleep current	This parameter is sampled	0	–	ns

Truth Table

The Truth Table for part CY7C13451G is as follows. [3, 4, 5, 6, 7]

Cycle Description	Address Used	$\overline{CE_1}$	CE_2	$\overline{CE_3}$	ZZ	$\overline{ADSP}$	$\overline{ADSC}$	$\overline{ADV}$	$\overline{WRITE}$	$\overline{OE}$	CLK	DQ
Deselected Cycle, Power down	None	H	X	X	L	X	L	X	X	X	L–H	Tristate
Deselected Cycle, Power down	None	L	L	X	L	L	X	X	X	X	L–H	Tristate
Deselected Cycle, Power down	None	L	X	H	L	L	X	X	X	X	L–H	Tristate
Deselected Cycle, Power down	None	L	L	X	L	H	L	X	X	X	L–H	Tristate
Deselected Cycle, Power down	None	X	X	H	L	H	L	X	X	X	L–H	Tristate
Sleep Mode, Power down	None	X	X	X	H	X	X	X	X	X	X	Tristate
Read Cycle, Begin Burst	External	L	H	L	L	L	X	X	X	L	L–H	Q
Read Cycle, Begin Burst	External	L	H	L	L	L	X	X	X	H	L–H	Tristate
Write Cycle, Begin Burst	External	L	H	L	L	H	L	X	L	X	L–H	D
Read Cycle, Begin Burst	External	L	H	L	L	H	L	X	H	L	L–H	Q
Read Cycle, Begin Burst	External	L	H	L	L	H	L	X	H	H	L–H	Tristate
Read Cycle, Continue Burst	Next	X	X	X	L	H	H	L	H	L	L–H	Q
Read Cycle, Continue Burst	Next	X	X	X	L	H	H	L	H	H	L–H	Tristate
Read Cycle, Continue Burst	Next	H	X	X	L	X	H	L	H	L	L–H	Q
Read Cycle, Continue Burst	Next	H	X	X	L	X	H	L	H	H	L–H	Tristate
Write Cycle, Continue Burst	Next	X	X	X	L	H	H	L	L	X	L–H	D
Write Cycle, Continue Burst	Next	H	X	X	L	X	H	L	L	X	L–H	D
Read Cycle, Suspend Burst	Current	X	X	X	L	H	H	H	H	L	L–H	Q
Read Cycle, Suspend Burst	Current	X	X	X	L	H	H	H	H	H	L–H	Tristate
Read Cycle, Suspend Burst	Current	H	X	X	L	X	H	H	H	L	L–H	Q
Read Cycle, Suspend Burst	Current	H	X	X	L	X	H	H	H	H	L–H	Tristate
Write Cycle, Suspend Burst	Current	X	X	X	L	H	H	H	L	X	L–H	D
Write Cycle, Suspend Burst	Current	H	X	X	L	X	H	H	L	X	L–H	D

Notes

3. X = "Don't Care," H = Logic HIGH, and L = Logic LOW.
4. $\overline{WRITE}$ = L when any one or more Byte Write enable signals ($\overline{BW_A}$, $\overline{BW_B}$, $\overline{BW_C}$, $\overline{BW_D}$) and $\overline{BWE}$ = L or $\overline{GW}$ = L. $\overline{WRITE}$ = H when all Byte write enable signals ($\overline{BW_A}$, $\overline{BW_B}$, $\overline{BW_C}$, $\overline{BW_D}$), $\overline{BWE}$, $\overline{GW}$ = H.
5. The DQ pins are controlled by the current cycle and the $\overline{OE}$ signal. $\overline{OE}$ is asynchronous and is not sampled with the clock.
6. The SRAM always initiates a read cycle when $\overline{ADSP}$ is asserted, regardless of the state of $\overline{GW}$, $\overline{BWE}$, or $\overline{BW_{[A:D]}}$. Writes may occur only on subsequent clocks after the $\overline{ADSP}$ or with the assertion of $\overline{ADSC}$. As a result, $\overline{OE}$ is driven HIGH prior to the start of the write cycle to enable the outputs to tristate. $\overline{OE}$ is a "Do Not Care" for the remainder of the write cycle.
7. $\overline{OE}$ is asynchronous and is not sampled with the clock rise. It is masked internally during write cycles. During a read cycle all data bits are tristate when $\overline{OE}$ is inactive or when the device is deselected, and all data bits behave as output when $\overline{OE}$ is active (LOW).

Truth Table for Read or Write

The Truth Table for read or write for part CY7C13451G is as follows. [8, 9]

Function	$\overline{GW}$	$\overline{BWE}$	$\overline{BW_D}$	$\overline{BW_C}$	$\overline{BW_B}$	$\overline{BW_A}$
Read	H	H	X	X	X	X
Read	H	L	H	H	H	H
Write Byte (A, DQP_A)	H	L	H	H	H	L
Write Byte (B, DQP_B)	H	L	H	H	L	H
Write Bytes (B, A, DQP_A, DQP_B)	H	L	H	H	L	L
Write Byte (C, DQP_C)	H	L	H	L	H	H
Write Bytes (C, A, DQP_C, DQP_A)	H	L	H	L	H	L
Write Bytes (C, B, DQP_C, DQP_B)	H	L	H	L	L	H
Write Bytes (C, B, A, DQP_C, DQP_B, DQP_A)	H	L	H	L	L	L
Write Byte (D, DQP_D)	H	L	L	H	H	H
Write Bytes (D, A, DQP_D, DQP_A)	H	L	L	H	H	L
Write Bytes (D, B, DQP_D, DQP_A)	H	L	L	H	L	H
Write Bytes (D, B, A, DQP_D, DQP_B, DQP_A)	H	L	L	H	L	L
Write Bytes (D, B, DQP_D, DQP_B)	H	L	L	L	H	H
Write Bytes (D, B, A, DQP_D, DQP_C, DQP_A)	H	L	L	L	H	L
Write Bytes (D, C, A, DQP_D, DQP_B, DQP_A)	H	L	L	L	L	H
Write All Bytes	H	L	L	L	L	L
Write All Bytes	L	X	X	X	X	X

Notes
8. X = “Don’t Care,” H = Logic HIGH, and L = Logic LOW.
9. This table is only a partial listing of the byte write combinations. Any combination of $\overline{BW_x}$ is valid. Appropriate write is done based on the active byte write.

Maximum Ratings

Exceeding the maximum ratings may shorten the battery 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_{DD} Relative to GND .....–0.5 V to +4.6 V

Supply Voltage on V_{DDQ} Relative to GND ..... –0.5 V to +V_{DD}

DC Voltage Applied to Outputs in tristate .....–0.5 V to V_{DDQ} + 0.5 V

DC Input Voltage .....–0.5 V to V_{DD} + 0.5 V

Current into Outputs (LOW) ..... 20 mA

Static Discharge Voltage (MIL-STD-883, Method 3015) ..... >2001 V

Latch up Current ..... >200 mA

Operating Range

Range	Ambient Temperature	V_{DD}	V_{DDQ}
Automotive	–40 °C to +125 °C	3.3 V – 5% / + 10%	2.5 V – 5% to V_{DD}

Neutron Soft Error Immunity

Parameter	Description	Test Conditions	Typ	Max*	Unit
LSBU	Logical Single-Bit Upsets	25 °C	361	394	FIT/ Mb
LMBU	Logical Multi-Bit Upsets	25 °C	0	0.01	FIT/ Mb
SEL	Single Event Latch up	85 °C	0	0.1	FIT/ Dev

** No LMBU or SEL events occurred during testing*; this column represents a statistical χ^2, 95% confidence limit calculation. For more details refer to Application Note AN54908 "Accelerated Neutron SER Testing and Calculation of Terrestrial Failure Rates"

Electrical Characteristics

Over the Operating Range

Parameter [10, 11]	Description	Test Conditions	Min	Max	Unit
V_{DD}	Power Supply Voltage		3.135	3.6	V
V_{DDQ}	I/O Supply Voltage		2.375	V_{DD}	V
V_{OH}	Output HIGH Voltage	for 3.3 V I/O, I_{OH} = –4.0 mA	2.4	–	V
		for 2.5 V I/O, I_{OH} = –1.0 mA	2.0	–	V
V_{OL}	Output LOW Voltage	for 3.3 V, I/O, I_{OL}= 8.0 mA	–	0.4	V
		for 2.5 V I/O, I_{OL} = 1.0 mA	–	0.4	V
V_{IH}	Input HIGH Voltage	for 3.3 V I/O	2.0	V_{DD} + 0.3	V
		for 2.5 V I/O	1.7	V_{DD} + 0.3	V
V_{IL}	Input LOW Voltage[10]	for 3.3 V I/O	–0.3	0.8	V
		for 2.5 V I/O	–0.3	0.7	V
I_X	Input Leakage Current except ZZ and MODE	GND ≤ V_I ≤ V_{DDQ}	–5	5	µA
	Input Current of MODE	Input = V_{SS}	–30	–	µA
		Input = V_{DD}	–	5	µA
	Input Current of ZZ	Input = V_{SS}	–5	–	µA
		Input = V_{DD}	–	30	µA
I_{OZ}	Output Leakage Current	GND ≤ V_I ≤ V_{DDQ}, Output Disabled	–5	5	µA

Notes
10. Overshoot: V_{IH}(AC) < V_{DD} +1.5V (Pulse width less than t_{CYC}/2), undershoot: V_{IL}(AC) > –2V (Pulse width less than t_{CYC}/2).
11. $T_{Power\ up}$: Assumes a linear ramp from 0 V to V_{DD}(min) within 200 ms. During this time V_{IH} < V_{DD} and V_{DDQ} ≤ V_{DD}.

Electrical Characteristics (continued)

Over the Operating Range

Parameter [10, 11]	Description	Test Conditions		Min	Max	Unit
I_{DD}	V_{DD} Operating Supply Current	V_{DD} = Max., I_{OUT} = 0 mA, f = f_{MAX} = $1/t_{CYC}$	100 MHz	–	180	mA
I_{SB1}	Automatic CE Power-down Current – TTL Inputs	Max. V_{DD}, Device Deselected, $V_{IN} \geq V_{IH}$ or $V_{IN} \leq V_{IL}$, f = f_{MAX}, inputs switching	100 MHz (Automotive)	–	150	mA
I_{SB2}	Automatic CE Power-down Current – CMOS Inputs	Max. V_{DD}, Device Deselected, $V_{IN} \geq V_{DD} - 0.3$ V or $V_{IN} \leq 0.3$ V, f = 0, inputs static	100 MHz (Automotive)	–	40	mA
I_{SB3}	Automatic CE Power-down Current – CMOS Inputs	Max. V_{DD}, Device Deselected, $V_{IN} \geq V_{DDQ} - 0.3$ V or $V_{IN} \leq 0.3$ V, f = f_{MAX}, inputs switching	100 MHz (Automotive)	–	120	mA
I_{SB4}	Automatic CE Power-down Current – TTL Inputs	Max. V_{DD}, Device Deselected, $V_{IN} \geq V_{IH}$ or $V_{IN} \leq V_{IL}$, f = 0, inputs static	100 MHz (Automotive)	–	60	mA

Capacitance

Parameter [12]	Description	Test Conditions	165-ball FBGA Max.	Unit
C_{IN}	Input capacitance	T_A = 25 °C, f = 1 MHz, V_{DD} = 3.3 V, V_{DDQ} = 2.5 V	5	pF
C_{CLK}	Clock input capacitance		5	pF
$C_{I/O}$	Input/Output capacitance		7	pF

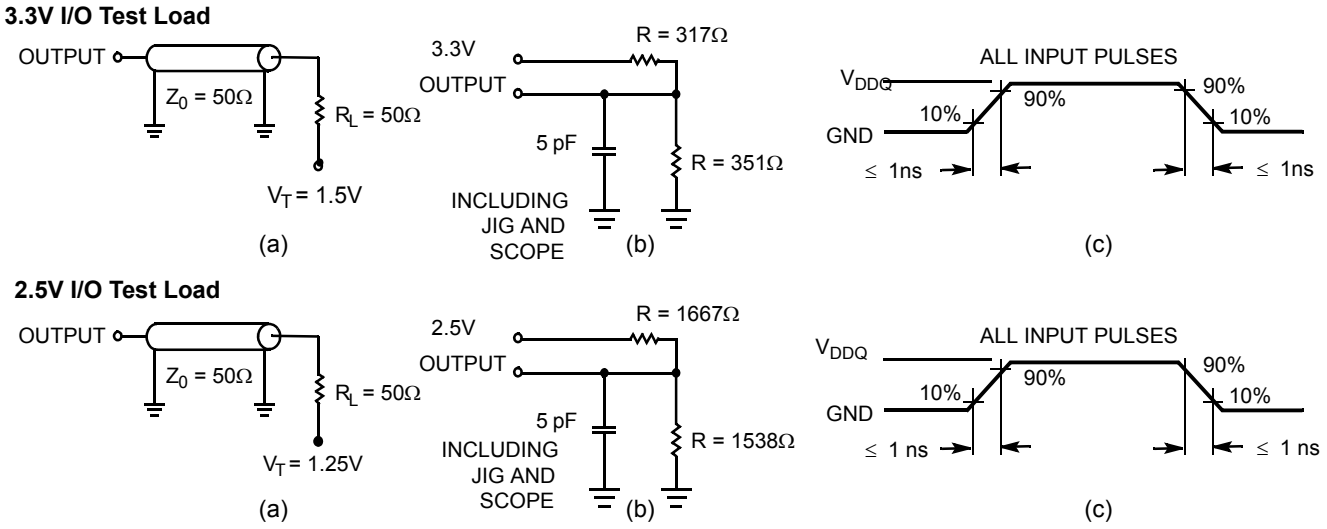
Thermal Resistance

Parameter [12]	Description	Test Conditions	165-ball FBGA Package	Unit
Θ_{JA}	Thermal resistance (junction to ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, per EIA/JESD51.	16.8	°C/W
Θ_{JC}	Thermal resistance (junction to case)		3.0	°C/W

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

AC Test Loads and Waveforms

Figure 2. AC Test Loads and Waveforms



Switching Characteristics

Over the Operating Range

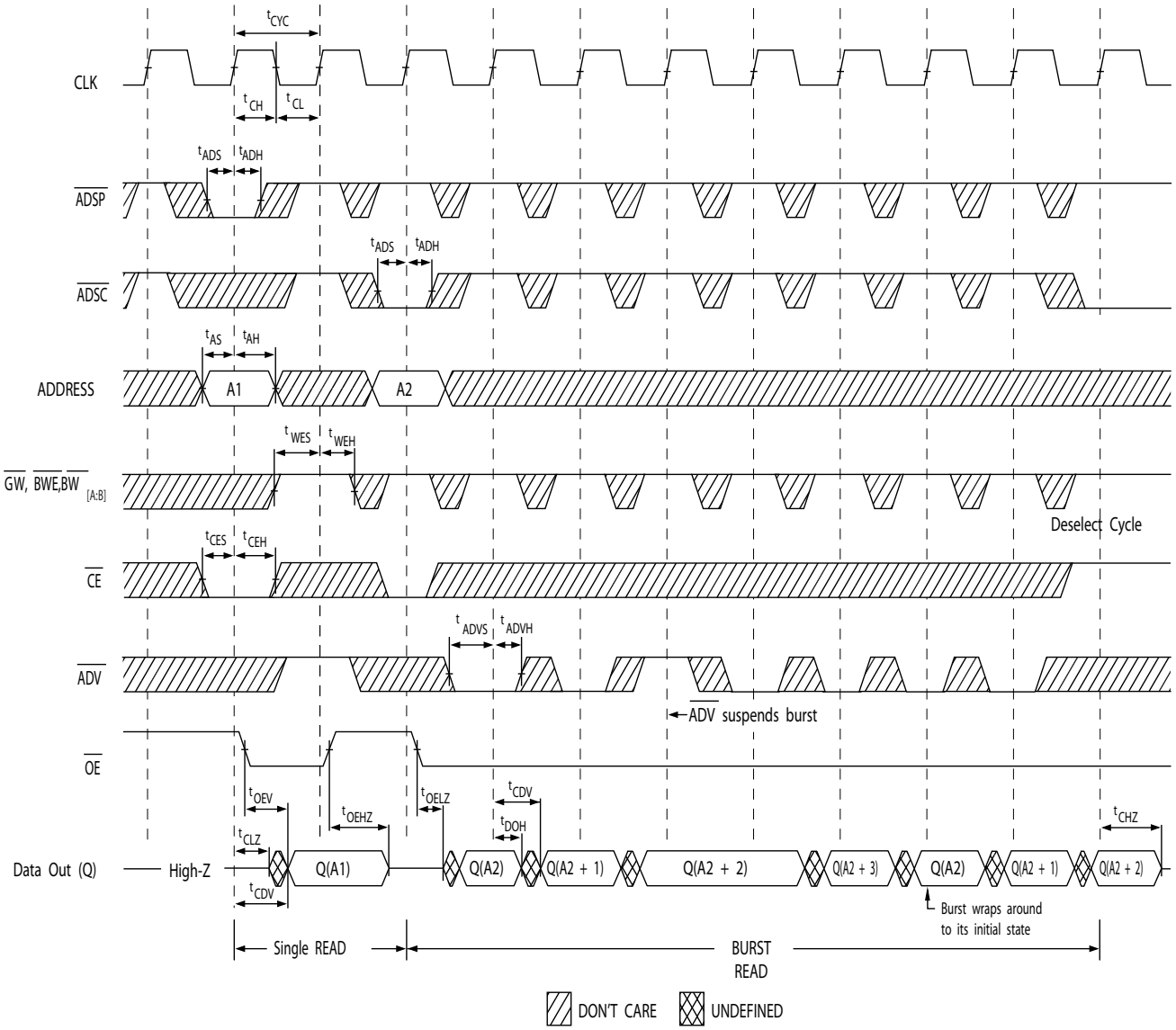
Parameter [13, 14]	Description	-100		Unit
		Min	Max	
t_{POWER}	V_{DD}(Typical) to the first Access [15]	1	–	ms
Clock				
t_{CYC}	Clock Cycle Time	10	–	ns
t_{CH}	Clock HIGH	4.0	–	ns
t_{CL}	Clock LOW	4.0	–	ns
Output Times				
t_{CDV}	Data Output Valid After CLK Rise	–	8.0	ns
t_{DOH}	Data Output Hold After CLK Rise	2.0	–	ns
t_{CLZ}	Clock to Low Z [16, 17, 18]	0	–	ns
t_{CHZ}	Clock to High Z [16, 17, 18]	–	3.5	ns
t_{OEV}	$\overline{OE}$ LOW to Output Valid	–	3.5	ns
t_{OELZ}	$\overline{OE}$ LOW to Output Low Z [16, 17, 18]	0	–	ns
t_{OEHZ}	$\overline{OE}$ HIGH to Output High Z [16, 17, 18]	–	3.5	ns
Setup Times				
t_{AS}	Address Setup Before CLK Rise	2.0	–	ns
t_{ADS}	$\overline{ADSP}$, $\overline{ADSC}$ Setup Before CLK Rise	2.0	–	ns
t_{ADVS}	$\overline{ADV}$ Setup Before CLK Rise	2.0	–	ns
t_{WES}	$\overline{GW}$, $\overline{BWE}$, $\overline{BW_x}$ Setup Before CLK Rise	2.0	–	ns
t_{DS}	Data Input Setup Before CLK Rise	2.0	–	ns
t_{CES}	Chip Enable Setup	2.0	–	ns
Hold Times				
t_{AH}	Address Hold After CLK Rise	0.5	–	ns
t_{ADH}	$\overline{ADSP}$, $\overline{ADSC}$ Hold After CLK Rise	0.5	–	ns
t_{WEH}	$\overline{GW}$, $\overline{BWE}$, $\overline{BW_x}$ Hold After CLK Rise	0.5	–	ns
t_{ADVH}	$\overline{ADV}$ Hold After CLK Rise	0.5	–	ns
t_{DH}	Data Input Hold After CLK Rise	0.5	–	ns
t_{CEH}	Chip Enable Hold After CLK Rise	0.5	–	ns

Notes

13. Timing reference level is 1.5V when V_{DDQ} = 3.3V and is 1.25V when V_{DDQ} = 2.5V.
14. Test conditions shown in (a) of unless otherwise noted.
15. This part has a voltage regulator internally; t_{POWER} is the time that the power needs to be supplied above V_{DD}(minimum) initially before a read or write operation is initiated.
16. t_{CHLZ}, t_{CLZ},t_{OELZ}, and t_{OEHZ} are specified with AC test conditions shown in (b) of Figure 2 on page 12. Transition is measured ± 200 mV from steady state voltage.
17. At any voltage and temperature, t_{OEHZ} is less than t_{OELZ} and t_{CHZ} is less than t_{CLZ} to eliminate bus contention between SRAMs when sharing the same data bus. These specifications do not imply a bus contention condition, but reflect parameters guaranteed over worst case user conditions. Device is designed to achieve High Z prior to Low Z under the same system conditions.
18. This parameter is sampled and not 100% tested.

Timing Diagrams

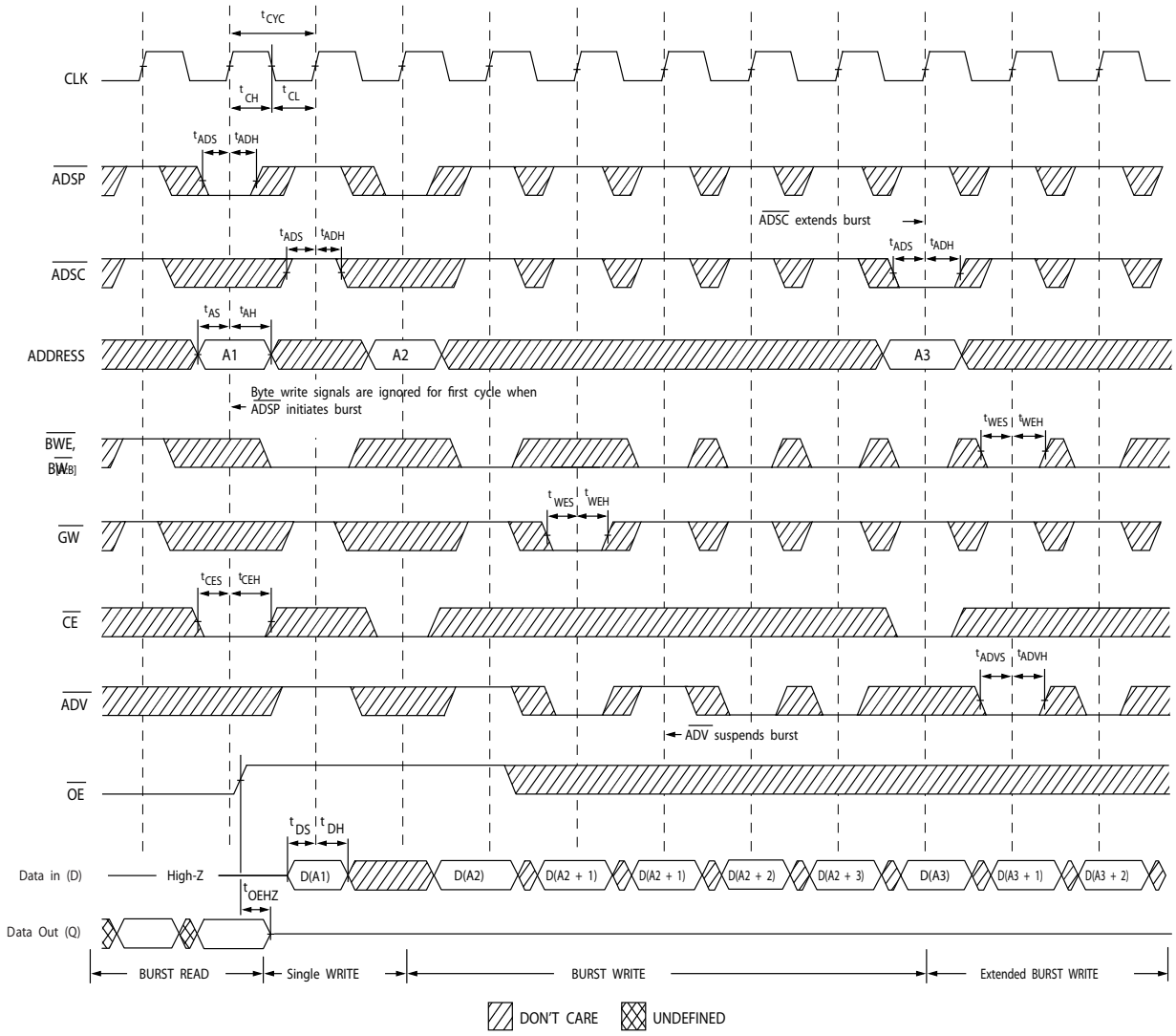
Figure 3. Read Cycle Timing [19]



Note
19. On this diagram, when $\overline{CE}$ is LOW: $\overline{CE}_1$ is LOW, CE_2 is HIGH and $\overline{CE}_3$ is LOW. When $\overline{CE}$ is HIGH: $\overline{CE}_1$ is HIGH or CE_2 is LOW or $\overline{CE}_3$ is HIGH.

Timing Diagrams (continued)

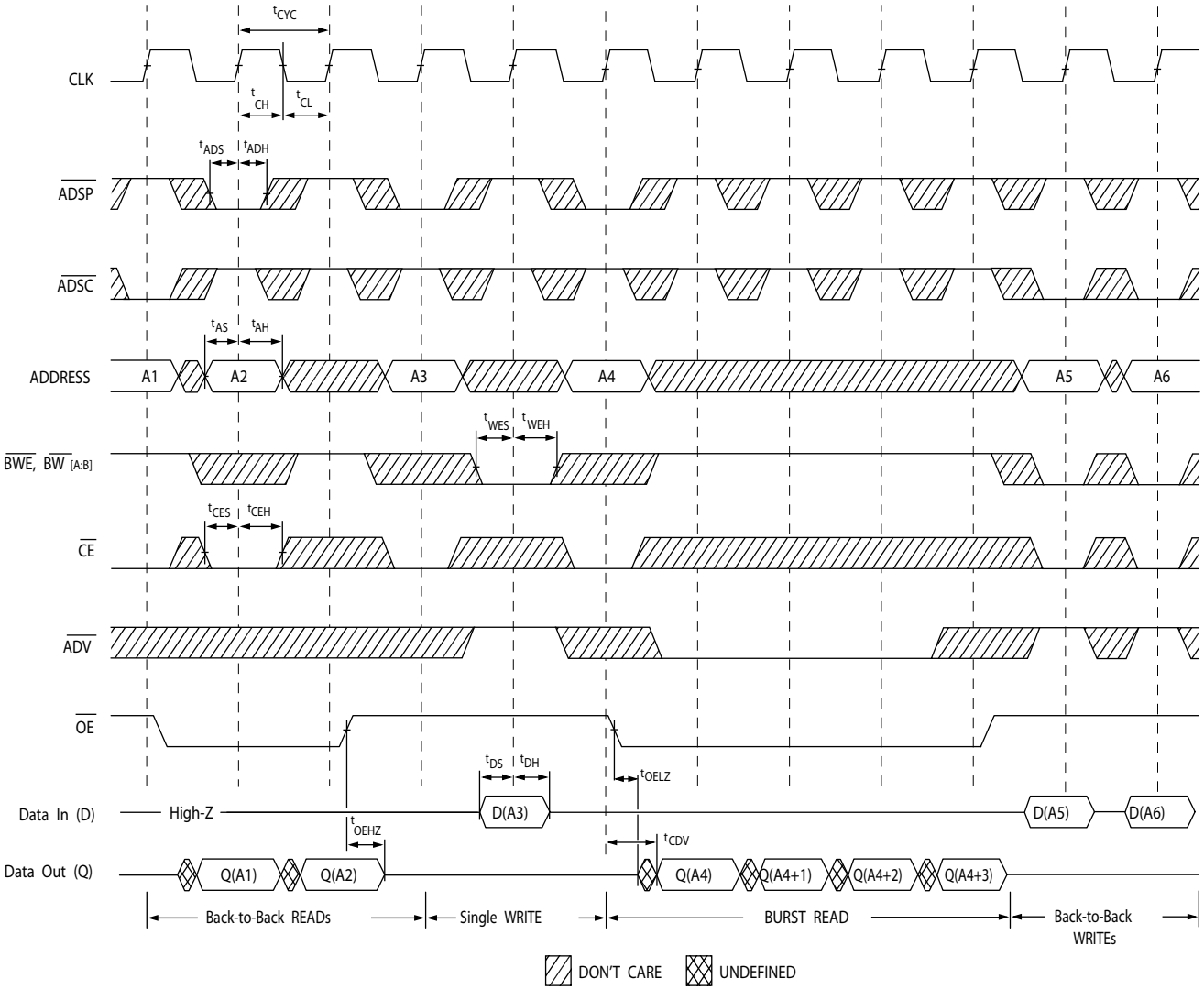
Figure 4. Write Cycle Timing [20, 21]



Notes
20. On this diagram, when $\overline{CE}$ is LOW: $\overline{CE}_1$ is LOW, CE_2 is HIGH and $\overline{CE}_3$ is LOW. When $\overline{CE}$ is HIGH: $\overline{CE}_1$ is HIGH or CE_2 is LOW or $\overline{CE}_3$ is HIGH.
21. Full width write can be initiated by either $\overline{GW}$ LOW; or by $\overline{GW}$ HIGH, $\overline{BWE}$ LOW and $\overline{BW}_x$ LOW.

Timing Diagrams (continued)

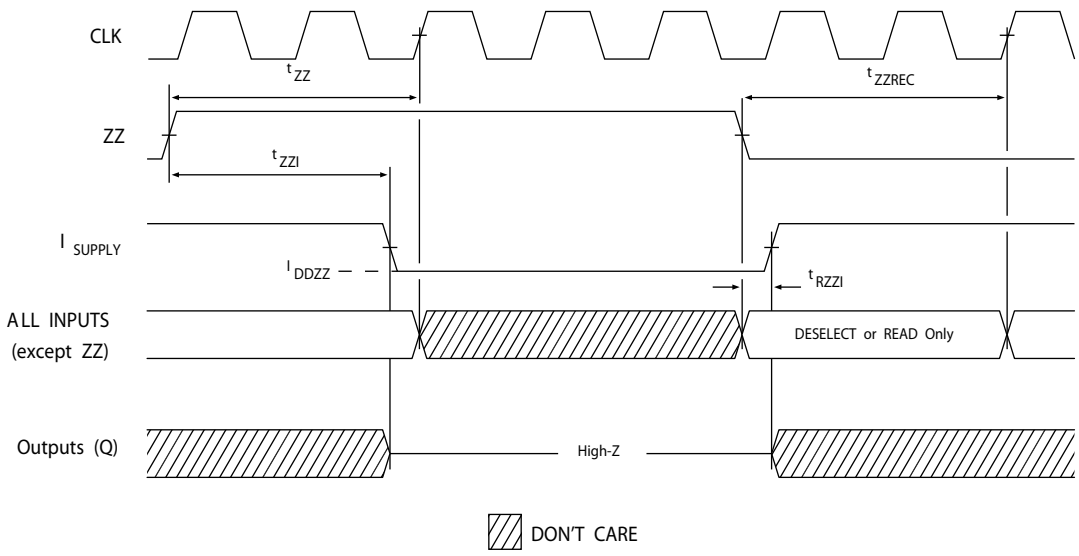
Figure 5. Read/Write Timing [22, 23, 24]



Notes
22. Full width write can be initiated by either $\overline{GW}$ LOW; or by $\overline{GW}$ HIGH, $\overline{BWE}$ LOW and $\overline{BW}_x$ LOW.
23. The data bus (Q) remains in High Z following a WRITE cycle, unless a new read access is initiated by $\overline{ADSP}$ or $\overline{ADSC}$.
24. $\overline{GW}$ is HIGH.

Timing Diagrams (continued)

Figure 6. ZZ Mode Timing [25, 26]



Notes
25. Device must be deselected when entering ZZ mode. See Truth Table on page 8 for all possible signal conditions to deselect the device.
26. DQs are in High Z when exiting ZZ sleep mode.

Ordering Information

The table below contains only the parts that are currently available. If you don't see what you are looking for, please contact your local sales representative. For more information, visit the Cypress website at www.cypress.com and refer to the product summary page at http://www.cypress.com/products

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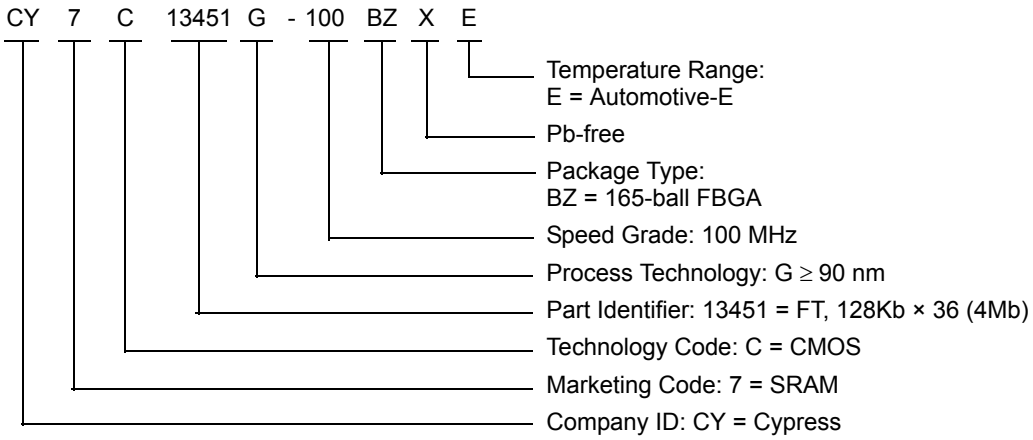
Table 1. Ordering Information

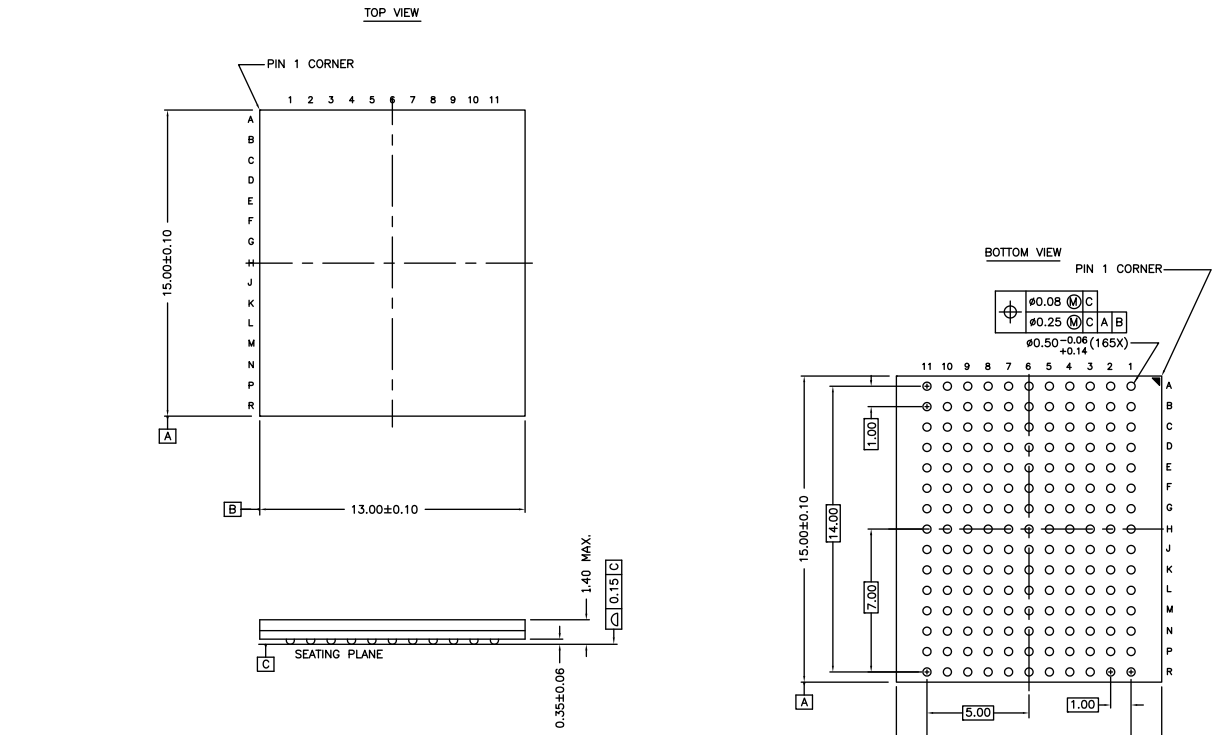
Speed (MHz)	Ordering Code	Package Diagram	Part and Package Type	Operating Range
100	CY7C13451G-100BZXE	51-85180	165-ball FBGA (13 × 15 × 1.4 mm) Pb-free	Automotive

Ordering Code Definitions



Package Diagrams

Figure 7. 165-ball FBGA (13 × 15 × 1.4 mm) BB165D/BW165D (0.5 Ball Diameter) Package Outline, 51-85180



NOTES :
SOLDER PAD TYPE : NON-SOLDER MASK DEFINED (NSMD)
JEDEC REFERENCE : MO-216 / ISSUE E
PACKAGE CODE : BB0AC/BW0AC
PACKAGE WEIGHT : SEE CYPRESS PACKAGE MATERIAL DECLARATION DATASHEET (PMDD) POSTED ON THE CYPRESS WEB.

51-85180 *G

Acronyms

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
$\overline{CE}$	Chip Enable
CEN	Clock Enable
GW	Global Write
I/O	Input/Output
$\overline{OE}$	Output Enable
SRAM	Static Random Access Memory
TQFP	Thin Quad Flat Pack
WE	Write Enable

Document Conventions

Units of Measure

Symbol	Unit of Measure
°C	degree Celsius
MHz	megahertz
µA	microampere
mA	milliampere
mm	millimeter
ms	millisecond
MHz	megahertz
ns	nanosecond
pF	picofarad
V	volt
W	watt

Errata

This section describes the Ram9 Sync SRAM ZZ pin issues. Details include trigger conditions, the devices affected, proposed workaround and silicon revision applicability. Please contact your local Cypress sales representative if you have further questions.

Part Numbers Affected

Density & Revision	Package Type	Operating Range
4Mb-Ram9 Synchronous SRAMs: CY7C134**G	165-ball FBGA	Automotive

Product Status

All of the devices in the Ram9 4Mb Sync family are qualified and available in production quantities.

Ram9 Sync ZZ Pin Issues Errata Summary

The following table defines the errata applicable to available Ram9 4Mb Sync family devices.

Item	Issues	Description	Device	Fix Status
1.	ZZ Pin	When asserted HIGH, the ZZ pin places device in a “sleep” condition with data integrity preserved.The ZZ pin currently does not have an internal pull-down resistor and hence cannot be left floating externally by the user during normal mode of operation.	4M-Ram9 (90nm)	For the 4M Ram9 (90 nm) devices, there is no plan to fix this issue.

1. ZZ Pin Issue

- PROBLEM DEFINITION
  The problem occurs only when the device is operated in the normal mode with ZZ pin left floating. The ZZ pin on the SRAM device does not have an internal pull-down resistor. Switching noise in the system may cause the SRAM to recognize a HIGH on the ZZ input, which may cause the SRAM to enter sleep mode. This could result in incorrect or undesirable operation of the SRAM.

- TRIGGER CONDITIONS
  Device operated with ZZ pin left floating.

- SCOPE OF IMPACT
  When the ZZ pin is left floating, the device delivers incorrect data.

- WORKAROUND
  Tie the ZZ pin externally to ground.

- FIX STATUS
  For the 4M Ram9 (90 nm) devices, there is no plan to fix this issue

Document History Page

Document Title: CY7C13451G, 4-Mbit (128K × 36) Flow-Through Sync SRAM Document Number: 001-88572				
Revision	**ECN**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	4077242	PRIT	09/12/2013	New data sheet.
*A	4287129	PRIT	02/20/2014	Updated Electrical Characteristics: Changed maximum value of I_{DD} parameter from 205 mA to 180 mA. Changed maximum value of I_{SB1} parameter from 80 mA to 150 mA. Changed maximum value of I_{SB3} parameter from 65 mA to 120 mA. Changed maximum value of I_{SB4} parameter from 45 mA to 60 mA.
*B	4419347	PRIT	06/25/2014	Included 100-pin TQFP package related information in all instances across the document. Updated Pin Configurations: Updated Figure 1. Updated Ordering Information (Updated part numbers). Updated Package Diagrams: Added spec 51-85050 *E.
*C	4430376	PRIT	07/04/2014	Changed status from Preliminary to Final. Removed 100-pin TQFP package related information across the document. Updated Ordering Information (Updated part numbers). Updated Package Diagrams: Removed spec 51-85050 *E.
*D	4598640	PRIT	12/16/2014	Updated Functional Description: Added “For a complete list of related documentation, click here.” at the end. Updated to new template.
*E	5099908	PRIT	01/22/2016	Updated Package Diagrams: spec 51-85180 – Changed revision from *F to *G. Completing Sunset Review.
*F	5329574	PRIT	06/29/2016	Updated Truth Table. Updated to new template.
*G	5974265	AESATMP9	11/22/2017	Updated logo and copyright.

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