

# 36-Mbit (1M × 36) Pipelined Sync SRAM

## Features

- Supports bus operation up to 250 MHz
- Available speed grade is 250 MHz
- Registered inputs and outputs for pipelined operation
- 2.5-V core power supply
- 2.5-V I/O power supply
- Fast clock-to-output times
  - 2.5 ns (for 250-MHz device)
- Provide high-performance 3-1-1 access rate
- User-selectable burst counter supporting interleaved or linear burst sequences
- Separate processor and controller address strobes
- Synchronous self-timed writes
- Asynchronous output enable
- Single-cycle Chip Deselect
- CY7C1440KV25 available in Pb-free 165-ball FBGA package.
- IEEE 1149.1 JTAG-Compatible Boundary Scan
- “ZZ” Sleep Mode Option

## Functional Description

The CY7C1440KV25 SRAM integrates 1M × 36 SRAM cells with advanced synchronous peripheral circuitry and a two-bit counter for internal burst operation. 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 ( $\overline{CE}_2$  and  $\overline{CE}_3$ ), Burst Control inputs ( $\overline{ADSC}$ ,  $\overline{ADSP}$ , and  $\overline{ADV}$ ), 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.

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

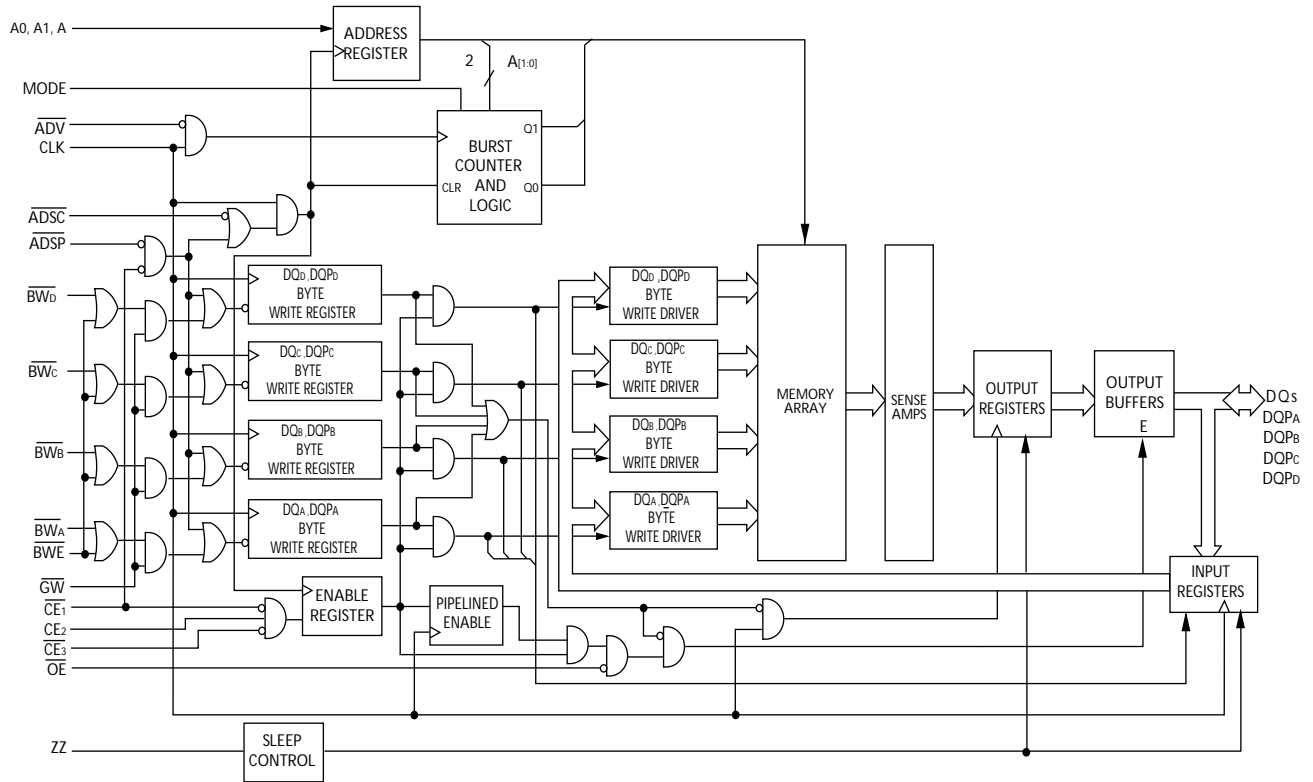
Address, data inputs, and write controls are registered on-chip to initiate a self-timed Write cycle. This part supports Byte Write operations (see Pin Descriptions and Truth Table for further details). Write cycles can be one, two or four bytes wide as controlled by the byte write control inputs.  $\overline{GW}$  when active LOW causes all bytes to be written.

The CY7C1440KV25 operates from a +2.5 V core power supply while all outputs may operate with a +2.5 V supply. All inputs and outputs are JEDEC-standard JESD8-5-compatible.

## Selection Guide

| Description               | 250 MHz  | Unit |
|---------------------------|----------|------|
| Maximum access time       | 2.5      | ns   |
| Maximum operating current | × 36 240 | mA   |

Logic Block Diagram – CY7C1440KV25



**Contents**

|  |           |  |           |
|--|-----------|--|-----------|
| <b>Pin Configurations</b> .....                      | <b>4</b>  | <b>Identification Register Definitions</b> .....     | <b>16</b> |
| <b>Pin Definitions</b> .....                         | <b>5</b>  | <b>Scan Register Sizes</b> .....                     | <b>16</b> |
| <b>Functional Overview</b> .....                     | <b>6</b>  | <b>Instruction Codes</b> .....                       | <b>16</b> |
| Single Read Accesses .....                           | 6         | <b>Boundary Scan Order</b> .....                     | <b>17</b> |
| Single Write Accesses Initiated by ADSP .....        | 6         | <b>Maximum Ratings</b> .....                         | <b>18</b> |
| Single Write Accesses Initiated by ADSC .....        | 7         | <b>Operating Range</b> .....                         | <b>18</b> |
| Burst Sequences .....                                | 7         | <b>Neutron Soft Error Immunity</b> .....             | <b>18</b> |
| Sleep Mode .....                                     | 7         | <b>Electrical Characteristics</b> .....              | <b>18</b> |
| Interleaved Burst Address Table .....                | 7         | DC Electrical Characteristics .....                  | 18        |
| Linear Burst Address Table .....                     | 7         | <b>Capacitance</b> .....                             | <b>19</b> |
| ZZ Mode Electrical Characteristics .....             | 7         | <b>Thermal Resistance</b> .....                      | <b>19</b> |
| <b>Truth Table</b> .....                             | <b>8</b>  | <b>AC Test Loads and Waveforms</b> .....             | <b>20</b> |
| <b>Truth Table for Read/Write</b> .....              | <b>9</b>  | <b>Switching Characteristics</b> .....               | <b>21</b> |
| <b>IEEE 1149.1 Serial Boundary Scan (JTAG)</b> ..... | <b>10</b> | <b>Switching Waveforms</b> .....                     | <b>22</b> |
| Disabling the JTAG Feature .....                     | 10        | <b>Ordering Information</b> .....                    | <b>26</b> |
| Test Access Port (TAP) .....                         | 10        | Ordering Code Definitions .....                      | 26        |
| PERFORMING A TAP RESET .....                         | 10        | <b>Package Diagram</b> .....                         | <b>27</b> |
| TAP REGISTERS .....                                  | 10        | <b>Acronyms</b> .....                                | <b>28</b> |
| TAP Instruction Set .....                            | 11        | <b>Document Conventions</b> .....                    | <b>28</b> |
| <b>TAP Controller State Diagram</b> .....            | <b>12</b> | Units of Measure .....                               | 28        |
| <b>TAP Controller Block Diagram</b> .....            | <b>13</b> | <b>Document History Page</b> .....                   | <b>29</b> |
| <b>TAP Timing</b> .....                              | <b>13</b> | <b>Sales, Solutions, and Legal Information</b> ..... | <b>30</b> |
| <b>TAP AC Switching Characteristics</b> .....        | <b>14</b> | Worldwide Sales and Design Support .....             | 30        |
| <b>2.5 V TAP AC Test Conditions</b> .....            | <b>15</b> | Products .....                                       | 30        |
| <b>2.5 V TAP AC Output Load Equivalent</b> .....     | <b>15</b> | PSoC@Solutions .....                                 | 30        |
| <b>TAP DC Electrical Characteristics</b>             |           | Cypress Developer Community .....                    | 30        |
| <b>and Operating Conditions</b> .....                | <b>15</b> | Technical Support .....                              | 30        |

**Pin Configurations**

**Figure 1. 165-ball FBGA (15 × 17 × 1.4 mm) Pinout**

**CY7C1440KV25 (1M × 36)**

|          | <b>1</b>         | <b>2</b>        | <b>3</b>          | <b>4</b>          | <b>5</b>          | <b>6</b>          | <b>7</b>         | <b>8</b>          | <b>9</b>          | <b>10</b>       | <b>11</b>        |
|----------|------------------|-----------------|-------------------|-------------------|-------------------|-------------------|------------------|-------------------|-------------------|-----------------|------------------|
| <b>A</b> | NC/288M          | A               | $\overline{CE}_1$ | $\overline{BW}_C$ | $\overline{BW}_B$ | $\overline{CE}_3$ | $\overline{BWE}$ | $\overline{ADSC}$ | $\overline{ADV}$  | A               | NC               |
| <b>B</b> | NC/144M          | A               | CE2               | $\overline{BW}_D$ | $\overline{BW}_A$ | CLK               | $\overline{GW}$  | $\overline{OE}$   | $\overline{ADSP}$ | A               | NC/576M          |
| <b>C</b> | DQP <sub>C</sub> | NC              | V <sub>DDQ</sub>  | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>SS</sub>   | V <sub>DDQ</sub>  | NC/1G           | DQP <sub>B</sub> |
| <b>D</b> | DQ <sub>C</sub>  | DQ <sub>C</sub> | V <sub>DDQ</sub>  | V <sub>DD</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>DD</sub>   | V <sub>DDQ</sub>  | DQ <sub>B</sub> | DQ <sub>B</sub>  |
| <b>E</b> | DQ <sub>C</sub>  | DQ <sub>C</sub> | V <sub>DDQ</sub>  | V <sub>DD</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>DD</sub>   | V <sub>DDQ</sub>  | DQ <sub>B</sub> | DQ <sub>B</sub>  |
| <b>F</b> | DQ <sub>C</sub>  | DQ <sub>C</sub> | V <sub>DDQ</sub>  | V <sub>DD</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>DD</sub>   | V <sub>DDQ</sub>  | DQ <sub>B</sub> | DQ <sub>B</sub>  |
| <b>G</b> | DQ <sub>C</sub>  | DQ <sub>C</sub> | V <sub>DDQ</sub>  | V <sub>DD</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>DD</sub>   | V <sub>DDQ</sub>  | DQ <sub>B</sub> | DQ <sub>B</sub>  |
| <b>H</b> | NC               | NC              | NC                | V <sub>DD</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>DD</sub>   | NC                | NC              | ZZ               |
| <b>J</b> | DQ <sub>D</sub>  | DQ <sub>D</sub> | V <sub>DDQ</sub>  | V <sub>DD</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>DD</sub>   | V <sub>DDQ</sub>  | DQ <sub>A</sub> | DQ <sub>A</sub>  |
| <b>K</b> | DQ <sub>D</sub>  | DQ <sub>D</sub> | V <sub>DDQ</sub>  | V <sub>DD</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>DD</sub>   | V <sub>DDQ</sub>  | DQ <sub>A</sub> | DQ <sub>A</sub>  |
| <b>L</b> | DQ <sub>D</sub>  | DQ <sub>D</sub> | V <sub>DDQ</sub>  | V <sub>DD</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>DD</sub>   | V <sub>DDQ</sub>  | DQ <sub>A</sub> | DQ <sub>A</sub>  |
| <b>M</b> | DQ <sub>D</sub>  | DQ <sub>D</sub> | V <sub>DDQ</sub>  | V <sub>DD</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>   | V <sub>SS</sub>  | V <sub>DD</sub>   | V <sub>DDQ</sub>  | DQ <sub>A</sub> | DQ <sub>A</sub>  |
| <b>N</b> | DQP <sub>D</sub> | NC              | V <sub>DDQ</sub>  | V <sub>SS</sub>   | NC                | A                 | NC               | V <sub>SS</sub>   | V <sub>DDQ</sub>  | NC              | DQP <sub>A</sub> |
| <b>P</b> | NC               | NC/72M          | A                 | A                 | TDI               | A1                | TDO              | A                 | A                 | A               | A                |
| <b>R</b> | MODE             | A               | A                 | A                 | TMS               | A0                | TCK              | A                 | A                 | A               | A                |

Pin Definitions

| Name  | I/O                | Description   |
|---|--------------------|---|
| A <sub>0</sub> , A <sub>1</sub> , A                                   | Input-Synchronous  | <b>Address Inputs used to select one of the address locations.</b> Sampled at the rising edge of the CLK if ADSP or ADSC is active LOW, and CE <sub>1</sub> , CE <sub>2</sub> , and CE <sub>3</sub> are sampled active. A1:A0 are fed to the two-bit counter.   |
| BW <sub>A</sub> , BW <sub>B</sub> , BW <sub>C</sub> , BW <sub>D</sub> | Input-Synchronous  | <b>Byte Write Select Inputs, active LOW.</b> Qualified with BWE to conduct byte writes to the SRAM. Sampled on the rising edge of CLK.  |
| GW  | Input-Synchronous  | <b>Global Write Enable Input, active LOW.</b> When asserted LOW on the rising edge of CLK, a global write is conducted (ALL bytes are written, regardless of the values on BW <sub>x</sub> and BWE).  |
| BWE   | Input-Synchronous  | <b>Byte Write Enable Input, active LOW.</b> Sampled on the rising edge of CLK. This signal must be asserted LOW to conduct a byte write.  |
| CLK   | Input-Clock        | <b>Clock Input.</b> Used to capture all synchronous inputs to the device. Also used to increment the burst counter when ADV is asserted LOW, during a burst operation.  |
| CE <sub>1</sub>   | Input-Synchronous  | <b>Chip Enable 1 Input, active LOW.</b> Sampled on the rising edge of CLK. Used in conjunction with CE <sub>2</sub> and CE <sub>3</sub> to select/deselect the device. ADSP is ignored if CE <sub>1</sub> is HIGH. CE <sub>1</sub> is sampled only when a new external address is loaded.   |
| CE <sub>2</sub>   | Input-Synchronous  | <b>Chip Enable 2 Input, active HIGH.</b> Sampled on the rising edge of CLK. Used in conjunction with CE <sub>1</sub> and CE <sub>3</sub> to select/deselect the device. CE <sub>2</sub> is sampled only when a new external address is loaded.  |
| CE <sub>3</sub>   | Input-Synchronous  | <b>Chip Enable 3 Input, active LOW.</b> Sampled on the rising edge of CLK. Used in conjunction with CE <sub>1</sub> and CE <sub>2</sub> to select/deselect the device. Not connected for BGA. Where referenced, CE <sub>3</sub> is assumed active throughout this document for BGA. CE <sub>3</sub> is sampled only when a new external address is loaded.  |
| OE  | Input-Asynchronous | <b>Output Enable, asynchronous input, active LOW.</b> Controls the direction of the I/O pins. When LOW, the I/O pins behave as outputs. When deasserted HIGH, I/O pins are tristated, and act as input data pins. OE is masked during the first clock of a read cycle when emerging from a deselected state.  |
| ADV   | Input-Synchronous  | <b>Advance Input signal, sampled on the rising edge of CLK, active LOW.</b> When asserted, it automatically increments the address in a burst cycle.  |
| ADSP  | Input-Synchronous  | <b>Address Strobe from Processor, sampled on the rising edge of CLK, active LOW.</b> When asserted LOW, addresses presented to the device are captured in the address registers. A1:A0 are also loaded into the burst counter. When ADSP and ADSC are both asserted, only ADSP is recognized. ADSP is ignored when CE <sub>1</sub> is deasserted HIGH.  |
| ADSC  | Input-Synchronous  | <b>Address Strobe from Controller, sampled on the rising edge of CLK, active LOW.</b> When asserted LOW, addresses presented to the device are captured in the address registers. A1:A0 are also loaded into the burst counter. When ADSP and ADSC are both asserted, only ADSP is recognized.  |
| ZZ  | Input-Asynchronous | <b>ZZ “sleep” Input, active HIGH.</b> When asserted HIGH places the device in a non-time-critical “sleep” condition with data integrity preserved. For normal operation, this pin has to be LOW or left floating. ZZ pin has an internal pull-down.   |
| DQs, DQPs   | I/O-Synchronous    | <b>Bidirectional Data I/O lines.</b> 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 read cycle. The direction of the pins is controlled by OE. When OE is asserted LOW, the pins behave as outputs. When HIGH, DQs and DQP <sub>x</sub> are placed in a tristate condition. |
| V <sub>DD</sub>   | Power Supply       | <b>Power supply inputs to the core of the device.</b>   |
| V <sub>SS</sub>   | Ground             | <b>Ground for the core of the device.</b>   |
| V <sub>SSQ</sub>  | I/O Ground         | <b>Ground for the I/O circuitry.</b>  |
| V <sub>DDQ</sub>  | I/O Power Supply   | <b>Power supply for the I/O circuitry.</b>  |

**Pin Definitions** (continued)

| Name                                    | I/O                            | Description  |
|---|--------------------------------|--|
| MODE                                    | Input-Static                   | <b>Selects Burst Order.</b> 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 should remain static during device operation. Mode Pin has an internal pull-up. |
| TDO                                     | JTAG serial output Synchronous | <b>Serial data-out to the JTAG circuit.</b> Delivers data on the negative edge of TCK. If the JTAG feature is not being utilized, this pin should be disconnected.   |
| TDI                                     | JTAG serial input Synchronous  | <b>Serial data-In to the JTAG circuit.</b> Sampled on the rising edge of TCK. If the JTAG feature is not being utilized, this pin can be disconnected or connected to $V_{DD}$ .   |
| TMS                                     | JTAG serial input Synchronous  | <b>Serial data-In to the JTAG circuit.</b> Sampled on the rising edge of TCK. If the JTAG feature is not being utilized, this pin can be disconnected or connected to $V_{DD}$ .   |
| TCK                                     | JTAG-Clock                     | <b>Clock input to the JTAG circuitry.</b> If the JTAG feature is not being utilized, this pin must be connected to $V_{SS}$ .  |
| NC                                      | –                              | <b>No Connects.</b> Not internally connected to the die  |
| NC/72M, NC/144M, NC/288M, NC/576, NC/1G | –                              | <b>No Connects.</b> Not internally connected to the die. 72M, 144M, 288M, 576M and 1G are address expansion pins are not internally connected to the die.  |

**Functional Overview**

All synchronous inputs pass through input registers controlled by the rising edge of the clock. All data outputs pass through output registers controlled by the rising edge of the clock. Maximum access delay from the clock rise ( $t_{CO}$ ) is 2.5 ns (250-MHz device).

The CY7C1440KV25 supports secondary cache in systems utilizing either a linear or interleaved burst sequence. The interleaved burst order supports Pentium processors. The burst order is user selectable, and is determined by sampling the MODE input. Accesses can be initiated with either the Processor Address Strobe (ADSP) or the Controller Address Strobe (ADSC). Address advancement through the burst sequence is controlled by the ADV input. A two-bit on-chip wraparound 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 (BWE) and Byte Write Select ( $BW_X$ ) inputs. A Global Write Enable (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 ( $\overline{CE}_1$ ,  $\overline{CE}_2$ ,  $\overline{CE}_3$ ) and an asynchronous Output Enable ( $\overline{OE}$ ) provide for easy bank selection and output tristate control. ADSP is ignored if  $\overline{CE}_1$  is HIGH.

**Single Read Accesses**

This access is initiated when the following conditions are satisfied at clock rise: (1) ADSP or ADSC is asserted LOW, (2)  $\overline{CE}_1$ ,  $\overline{CE}_2$ ,  $\overline{CE}_3$  are all asserted active, and (3) the Write signals (GW, BWE) are all asserted HIGH. ADSP is ignored if  $\overline{CE}_1$  is HIGH. The address presented to the address inputs (A) is stored into the address advancement logic and the Address Register while being presented to the memory array. The corresponding data is allowed to propagate to the input of the Output Registers.

At the rising edge of the next clock the data is allowed to propagate through the output register and onto the data bus within 2.5 ns (250-MHz device) if  $\overline{OE}$  is active LOW. The only exception occurs when the SRAM is emerging from a deselected state to a selected state, its outputs are always tristated during the first cycle of the access. After the first cycle of the access, the outputs are controlled by the  $\overline{OE}$  signal. Consecutive single Read cycles are supported. Once the SRAM is deselected at clock rise by the chip select and either ADSP or ADSC signals, its output will tristate immediately.

**Single Write Accesses Initiated by ADSP**

This access is initiated when both of the following conditions are satisfied at clock rise: (1) ADSP is asserted LOW, and (2)  $\overline{CE}_1$ ,  $\overline{CE}_2$ ,  $\overline{CE}_3$  are all asserted active. The address presented to A is loaded into the address register and the address advancement logic while being delivered to the memory array. The Write signals ( $\overline{GW}$ , BWE, and  $BW_X$ ) and ADV inputs are ignored during this first cycle.

ADSP-triggered Write accesses require two clock cycles to complete. If GW is asserted LOW on the second clock rise, the data presented to the DQs inputs is written into the corresponding address location in the memory array. If  $\overline{GW}$  is HIGH, then the Write operation is controlled by BWE and  $BW_X$  signals.

The CY7C1440KV25 provides Byte Write capability that is described in the Write Cycle Descriptions table. Asserting the Byte Write Enable input (BWE) with the selected Byte Write ( $BW_X$ ) input, will selectively write to only the desired bytes. Bytes not selected during a Byte Write operation will remain unaltered. A synchronous self-timed Write mechanism has been provided to simplify the Write operations.

Because CY7C1440KV25 is a common I/O device, the Output Enable ( $\overline{OE}$ ) must be deasserted HIGH before presenting data to the DQs inputs. Doing so will tristate the output drivers. As a safety precaution, DQs are automatically tristated whenever a Write cycle is detected, regardless of the state of  $\overline{OE}$ .

### Single Write Accesses Initiated by ADSC

ADSC Write accesses are initiated when the following conditions are satisfied: (1) ADSC is asserted LOW, (2) ADSP is deserted HIGH, (3)  $\overline{CE}_1$ ,  $\overline{CE}_2$ ,  $\overline{CE}_3$  are all asserted active, and (4) the appropriate combination of the Write inputs (GW, BWE, and  $BW_X$ ) are asserted active to conduct a Write to the desired byte(s). ADSC-triggered Write accesses require a single clock cycle to complete. The address presented to A is loaded into the address register and the address advancement logic while being delivered to the memory array. The ADV input is ignored during this cycle. If a global Write is conducted, the data presented to the DQs is written into the corresponding address location in the memory core. If a Byte Write is conducted, only the selected bytes are written. Bytes not selected during a Byte Write operation will remain unaltered. A synchronous self-timed Write mechanism has been provided to simplify the Write operations.

Because CY7C1440KV25 is a common I/O device, the Output Enable (OE) must be deasserted HIGH before presenting data to the DQs inputs. Doing so will tristate the output drivers. As a safety precaution, DQs are automatically tristated whenever a Write cycle is detected, regardless of the state of OE.

### Burst Sequences

The CY7C1440KV25 provides a two-bit wraparound counter, fed by A1:A0, that implements either an interleaved or linear burst sequence. The interleaved burst sequence is designed specifically to support Intel Pentium applications. The linear burst sequence is designed to support processors that follow a linear burst sequence. The burst sequence is user selectable through the MODE input.

Asserting  $\overline{ADV}$  LOW at clock rise will automatically increment the burst counter to the next address in the burst sequence. Both Read and Write burst operations are supported.

### 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. While 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 must be deselected prior to entering the "sleep" mode.  $\overline{CE}_1$ ,  $\overline{CE}_2$ ,  $\overline{CE}_3$ , 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 A1:A0 | Second Address A1:A0 | Third Address A1:A0 | Fourth Address A1:A0 |
|---------------------|----------------------|---------------------|----------------------|
| 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        | $ZZ \geq V_{DD} - 0.2 V$  | -          | 75         | mA   |
| $t_{ZZS}$   | Device operation to ZZ            | $ZZ \geq V_{DD} - 0.2 V$  | -          | $2t_{CYC}$ | ns   |
| $t_{ZZREC}$ | ZZ recovery time                  | $ZZ \leq 0.2 V$           | $2t_{CYC}$ | -          | 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 CY7C1440KV25 follows. [1, 2, 3, 4, 5, 6]

| Operation                   | Address Used | $\overline{CE}_1$ | $CE_2$ | $\overline{CE}_3$ | ZZ | $\overline{ADSP}$ | $\overline{ADSC}$ | $\overline{ADV}$ | $\overline{WRITE}$ | $\overline{OE}$ | CLK | DQ       |
|-----------------------------|--------------|-------------------|--------|-------------------|----|-------------------|-------------------|------------------|--------------------|-----------------|-----|----------|
| Deselect Cycle, Power Down  | None         | H                 | X      | X                 | L  | X                 | L                 | X                | X                  | X               | L-H | Tristate |
| Deselect Cycle, Power Down  | None         | L                 | L      | X                 | L  | L                 | X                 | X                | X                  | X               | L-H | Tristate |
| Deselect Cycle, Power Down  | None         | L                 | X      | H                 | L  | L                 | X                 | X                | X                  | X               | L-H | Tristate |
| Deselect Cycle, Power Down  | None         | L                 | L      | X                 | L  | H                 | L                 | X                | X                  | X               | L-H | Tristate |
| Deselect Cycle, Power Down  | None         | L                 | 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**

1. X = "Don't Care." H = Logic HIGH, L = Logic LOW.
2.  $\overline{WRITE}$  = L when any one or more Byte Write enable signals and  $\overline{BWE}$  = L or  $\overline{GW}$  = L.  $\overline{WRITE}$  = H when all Byte write enable signals,  $\overline{BWE}$ ,  $\overline{GW}$  = H.
3. 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.
4. BGA package has only two chip selects  $\overline{CE}_1$  and  $CE_2$ .
5. The SRAM always initiates a read cycle when  $\overline{ADSP}$  is asserted, regardless of the state of  $\overline{GW}$ ,  $\overline{BWE}$ , or  $\overline{BW}_x$ . Writes may occur only on subsequent clocks after the  $\overline{ADSP}$  or with the assertion of  $\overline{ADSC}$ . As a result,  $\overline{OE}$  must be driven HIGH prior to the start of the write cycle to allow the outputs to tristate.  $\overline{OE}$  is a don't care for the remainder of the write cycle.
6.  $\overline{OE}$  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/Write

The Truth Table for Read/Write for CY7C1440KV25 follows. [7, 8, 9]

| Function (CY7C1440KV25)                                | $\overline{GW}$ | $\overline{BWE}$ | $\overline{BW}_D$ | $\overline{BW}_C$ | $\overline{BW}_B$ | $\overline{BW}_A$ |
|--|-----------------|------------------|-------------------|-------------------|-------------------|-------------------|
| Read   | H               | H                | X                 | X                 | X                 | X                 |
| Read   | H               | L                | H                 | H                 | H                 | H                 |
| Write Byte A – (DQ <sub>A</sub> and DQP <sub>A</sub> ) | H               | L                | H                 | H                 | H                 | L                 |
| Write Byte B – (DQ <sub>B</sub> and DQP <sub>B</sub> ) | H               | L                | H                 | H                 | L                 | H                 |
| Write Bytes B, A                                       | H               | L                | H                 | H                 | L                 | L                 |
| Write Byte C – (DQ <sub>C</sub> and DQP <sub>C</sub> ) | H               | L                | H                 | L                 | H                 | H                 |
| Write Bytes C, A                                       | H               | L                | H                 | L                 | H                 | L                 |
| Write Bytes C, B                                       | H               | L                | H                 | L                 | L                 | H                 |
| Write Bytes C, B, A                                    | H               | L                | H                 | L                 | L                 | L                 |
| Write Byte D – (DQ <sub>D</sub> and DQP <sub>D</sub> ) | H               | L                | L                 | H                 | H                 | H                 |
| Write Bytes D, A                                       | H               | L                | L                 | H                 | H                 | L                 |
| Write Bytes D, B                                       | H               | L                | L                 | H                 | L                 | H                 |
| Write Bytes D, B, A                                    | H               | L                | L                 | H                 | L                 | L                 |
| Write Bytes D, C                                       | H               | L                | L                 | L                 | H                 | H                 |
| Write Bytes D, C, A                                    | H               | L                | L                 | L                 | H                 | L                 |
| Write Bytes D, C, B                                    | 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**

7. 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.
8.  $\overline{BW}_x$  represents any byte write signal. To enable any byte write  $\overline{BW}_x$ , a Logic LOW signal should be applied at clock rise. Any number of byte writes can be enabled at the same time for any given write.
9. This table only lists a partial listing of the byte write combinations. Any combination of  $\overline{BW}_x$  is valid. Appropriate write will be done based on which byte write is active.

## IEEE 1149.1 Serial Boundary Scan (JTAG)

The CY7C1440KV25 incorporates a serial boundary scan test access port (TAP). This part is fully compliant with IEEE Standard 1149.1. The TAP operates using JEDEC-standard 2.5 V I/O logic level.

The CY7C1440KV25 contains a TAP controller, instruction register, boundary scan register, bypass register, and ID register.

### Disabling the JTAG Feature

It is possible to operate the SRAM without using the JTAG feature. To disable the TAP controller, TCK must be tied LOW ( $V_{SS}$ ) to prevent clocking of the device. TDI and TMS are internally pulled up and may be unconnected. They may alternately be connected to  $V_{DD}$  through a pull-up resistor. TDO should be left unconnected. Upon power-up, the device will come up in a reset state which will not interfere with the operation of the device.

### Test Access Port (TAP)

#### *Test Clock (TCK)*

The test clock is used only with the TAP controller. All inputs are captured on the rising edge of TCK. All outputs are driven from the falling edge of TCK.

#### *Test Mode Select (TMS)*

The TMS input is used to give commands to the TAP controller and is sampled on the rising edge of TCK. It is allowable to leave this ball unconnected if the TAP is not used. The ball is pulled up internally, resulting in a logic HIGH level.

#### *Test Data-In (TDI)*

The TDI ball is used to serially input information into the registers and can be connected to the input of any of the registers. The register between TDI and TDO is chosen by the instruction that is loaded into the TAP instruction register. For information on loading the instruction register, see [TAP Controller State Diagram on page 12](#). TDI is internally pulled up and can be unconnected if the TAP is unused in an application. TDI is connected to the most significant bit (MSB) of any register.

#### *Test Data-Out (TDO)*

The TDO output ball is used to serially clock data-out from the registers. The output is active depending upon the current state of the TAP state machine (see [Instruction Codes on page 16](#)). The output changes on the falling edge of TCK. TDO is connected to the least significant bit (LSB) of any register.

### Performing a TAP Reset

A RESET is performed by forcing TMS HIGH ( $V_{DD}$ ) for five rising edges of TCK. This RESET does not affect the operation of the SRAM and may be performed while the SRAM is operating.

At power-up, the TAP is reset internally to ensure that TDO comes up in a High Z state.

### TAP Registers

Registers are connected between the TDI and TDO balls and allow data to be scanned into and out of the SRAM test circuitry. Only one register can be selected at a time through the instruction register. Data is serially loaded into the TDI ball on the rising edge of TCK. Data is output on the TDO ball on the falling edge of TCK.

#### *Instruction Register*

Three-bit instructions can be serially loaded into the instruction register. This register is loaded when it is placed between the TDI and TDO balls as shown in the [TAP Controller Block Diagram on page 13](#). Upon power-up, the instruction register is loaded with the IDCODE instruction. It is also loaded with the IDCODE instruction if the controller is placed in a reset state as described in the previous section.

When the TAP controller is in the Capture-IR state, the two least significant bits are loaded with a binary "01" pattern to allow for fault isolation of the board-level serial test data path.

#### *Bypass Register*

To save time when serially shifting data through registers, it is sometimes advantageous to skip certain chips. The bypass register is a single-bit register that can be placed between the TDI and TDO balls. This allows data to be shifted through the SRAM with minimal delay. The bypass register is set LOW ( $V_{SS}$ ) when the BYPASS instruction is executed.

#### *Boundary Scan Register*

The boundary scan register is connected to all the input and bidirectional balls on the SRAM.

The boundary scan register is loaded with the contents of the RAM I/O ring when the TAP controller is in the Capture-DR state and is then placed between the TDI and TDO balls when the controller is moved to the Shift-DR state. The EXTEST, SAMPLE/PRELOAD and SAMPLE Z instructions can be used to capture the contents of the I/O ring.

The [Boundary Scan Order on page 17](#) shows the order in which the bits are connected. Each bit corresponds to one of the bumps on the SRAM package. The MSB of the register is connected to TDI, and the LSB is connected to TDO.

#### *Identification (ID) Register*

The ID register is loaded with a vendor-specific, 32-bit code during the Capture-DR state when the IDCODE command is loaded in the instruction register. The IDCODE is hardwired into the SRAM and can be shifted out when the TAP controller is in the Shift-DR state. The ID register has a vendor code and other information described in the [Identification Register Definitions on page 16](#).

## TAP Instruction Set

### Overview

Eight different instructions are possible with the three bit instruction register. All combinations are listed in the [Instruction Codes on page 16](#). Three of these instructions are listed as RESERVED and should not be used. The other five instructions are described in detail below.

Instructions are loaded into the TAP controller during the Shift-IR state when the instruction register is placed between TDI and TDO. During this state, instructions are shifted through the instruction register through the TDI and TDO balls. To execute the instruction once it is shifted in, the TAP controller needs to be moved into the Update-IR state.

### IDCODE

The IDCODE instruction causes a vendor-specific, 32-bit code to be loaded into the instruction register. It also places the instruction register between the TDI and TDO balls and allows the IDCODE to be shifted out of the device when the TAP controller enters the Shift-DR state.

The IDCODE instruction is loaded into the instruction register upon power-up or whenever the TAP controller is given a test logic reset state.

### SAMPLE Z

The SAMPLE Z instruction causes the boundary scan register to be connected between the TDI and TDO pins when the TAP controller is in a Shift-DR state. The SAMPLE Z command puts the output bus into a High Z state until the next command is given during the “Update IR” state.

### SAMPLE/PRELOAD

SAMPLE/PRELOAD is a 1149.1 mandatory instruction. When the SAMPLE/PRELOAD instructions are loaded into the instruction register and the TAP controller is in the Capture-DR state, a snapshot of data on the inputs and output pins is captured in the boundary scan register.

The user must be aware that the TAP controller clock can only operate at a frequency up to 20 MHz, while the SRAM clock operates more than an order of magnitude faster. Because there is a large difference in the clock frequencies, it is possible that during the Capture-DR state, an input or output will undergo a transition. The TAP may then try to capture a signal while in transition (metastable state). This will not harm the device, but there is no guarantee as to the value that will be captured. Repeatable results may not be possible.

To guarantee that the boundary scan register will capture the correct value of a signal, the SRAM signal must be stabilized long enough to meet the TAP controller’s capture setup plus hold times ( $t_{CS}$  and  $t_{CH}$ ). The SRAM clock input might not be captured

correctly if there is no way in a design to stop (or slow) the clock during a SAMPLE/PRELOAD instruction. If this is an issue, it is still possible to capture all other signals and simply ignore the value of the clock captured in the boundary scan register.

Once the data is captured, it is possible to shift out the data by putting the TAP into the Shift-DR state. This places the boundary scan register between the TDI and TDO pins.

PRELOAD allows an initial data pattern to be placed at the latched parallel outputs of the boundary scan register prior to the selection of another boundary scan test operation.

The shifting of data for the SAMPLE and PRELOAD phases can occur concurrently when required — that is, while data captured is shifted out, the preloaded data can be shifted in.

### BYPASS

When the BYPASS instruction is loaded in the instruction register and the TAP is placed in a Shift-DR state, the bypass register is placed between the TDI and TDO pins. The advantage of the BYPASS instruction is that it shortens the boundary scan path when multiple devices are connected together on a board.

### EXTEST

The EXTEST instruction enables the preloaded data to be driven out through the system output pins. This instruction also selects the boundary scan register to be connected for serial access between the TDI and TDO in the shift-DR controller state.

### EXTEST OUTPUT BUS TRISTATE

IEEE Standard 1149.1 mandates that the TAP controller be able to put the output bus into a tristate mode.

The boundary scan register has a special bit located at bit #89 (for 165-ball FBGA package). When this scan cell, called the “extest output bus tristate”, is latched into the preload register during the “Update-DR” state in the TAP controller, it will directly control the state of the output (Q-bus) pins, when the EXTEST is entered as the current instruction. When HIGH, it will enable the output buffers to drive the output bus. When LOW, this bit will place the output bus into a High Z condition.

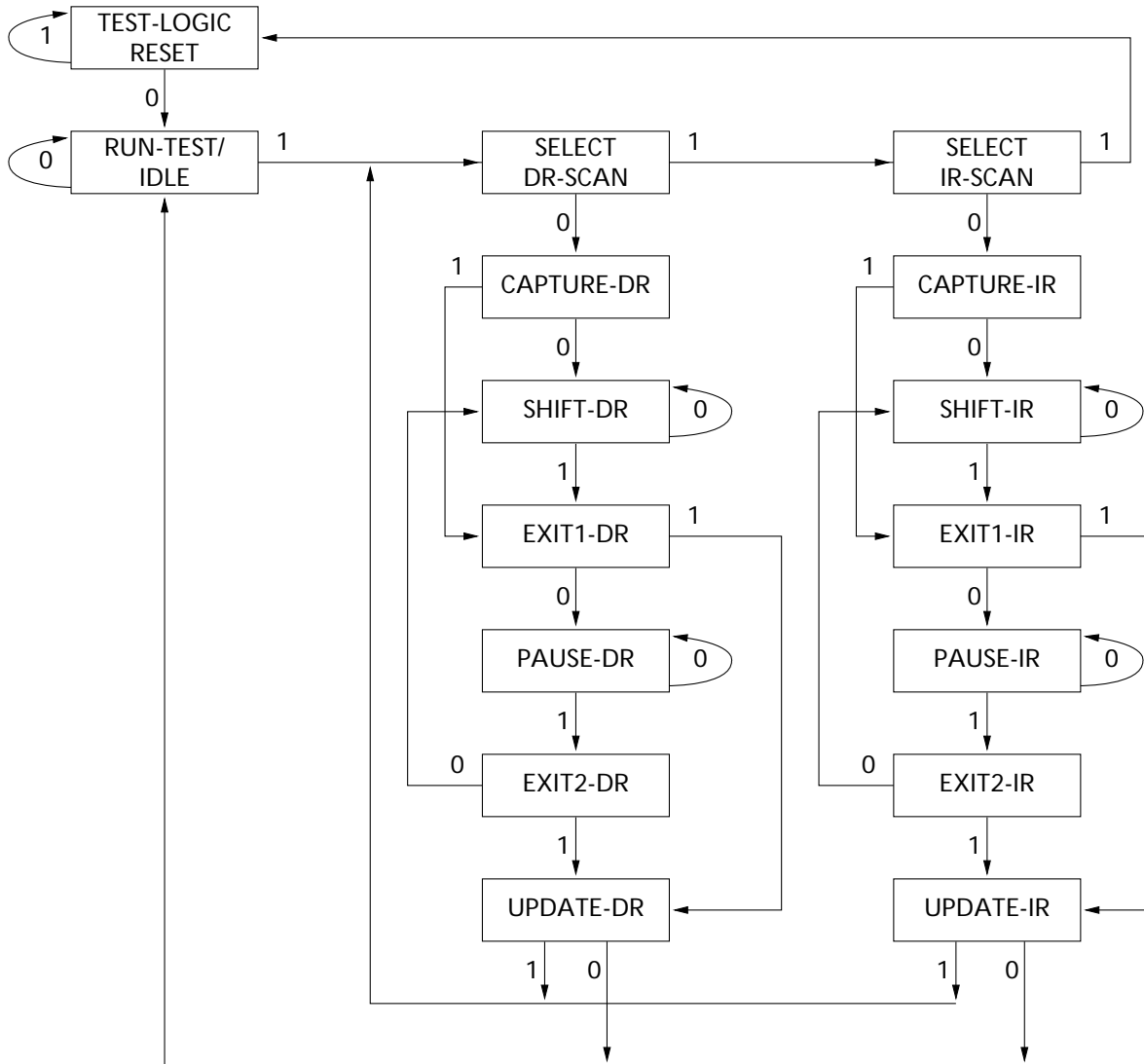
This bit can be set by entering the SAMPLE/PRELOAD or EXTEST command, and then shifting the desired bit into that cell, during the “Shift-DR” state. During “Update-DR”, the value loaded into that shift-register cell will latch into the preload register. When the EXTEST instruction is entered, this bit will directly control the output Q-bus pins. Note that this bit is pre-set HIGH to enable the output when the device is powered-up, and also when the TAP controller is in the “Test-Logic-Reset” state.

### Reserved

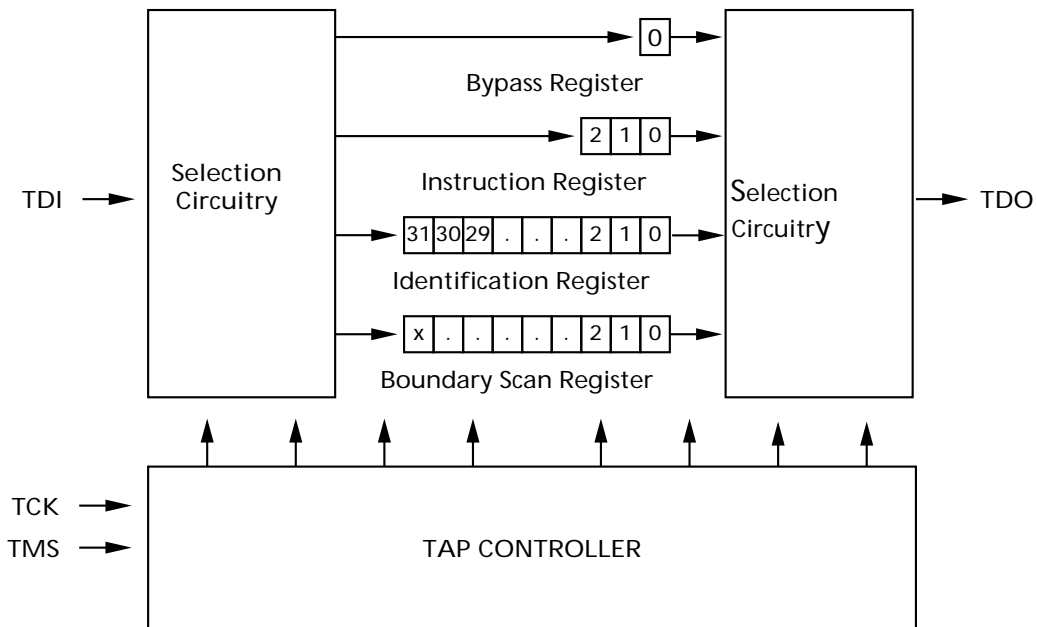
These instructions are not implemented but are reserved for future use. Do not use these instructions.

### TAP Controller State Diagram

The 0/1 next to each state represents the value of TMS at the rising edge of TCK.

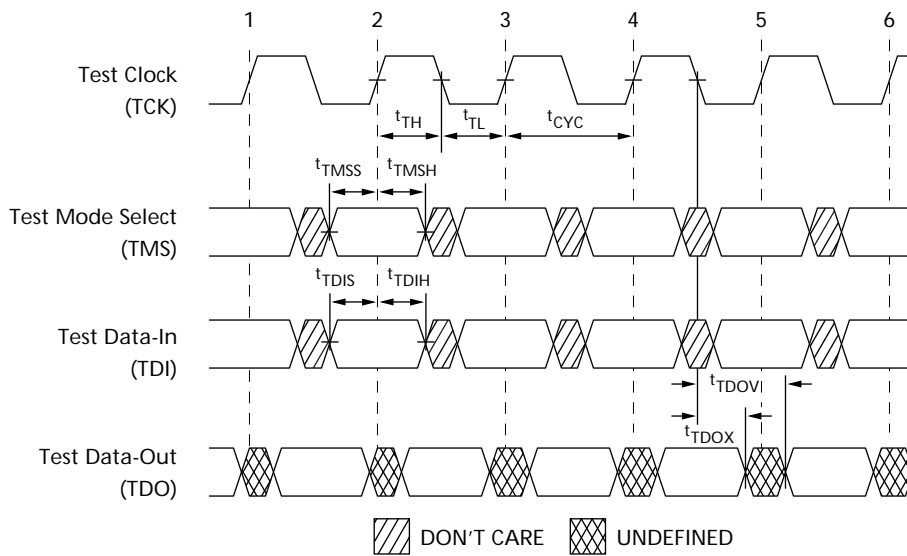


### TAP Controller Block Diagram



### TAP Timing

Figure 2. TAP Timing



## TAP AC Switching Characteristics

Over the Operating Range

| Parameter <sup>[10, 11]</sup> | Description                   | Min | Max | Unit |
|-------------------------------|-------------------------------|-----|-----|------|
| <b>Clock</b>                  |                               |     |     |      |
| $t_{TCYC}$                    | TCK Clock Cycle Time          | 50  | –   | ns   |
| $t_{TF}$                      | TCK Clock Frequency           | –   | 20  | MHz  |
| $t_{TH}$                      | TCK Clock HIGH time           | 20  | –   | ns   |
| $t_{TL}$                      | TCK Clock LOW time            | 20  | –   | ns   |
| <b>Output Times</b>           |                               |     |     |      |
| $t_{TDOV}$                    | TCK Clock LOW to TDO Valid    | –   | 10  | ns   |
| $t_{TDOX}$                    | TCK Clock LOW to TDO Invalid  | 0   | –   | ns   |
| <b>Setup Times</b>            |                               |     |     |      |
| $t_{TMSS}$                    | TMS Setup to TCK Clock Rise   | 5   | –   | ns   |
| $t_{TDIS}$                    | TDI Setup to TCK Clock Rise   | 5   | –   | ns   |
| $t_{CS}$                      | Capture Setup to TCK Rise     | 5   | –   | ns   |
| <b>Hold Times</b>             |                               |     |     |      |
| $t_{TMSh}$                    | TMS Hold after TCK Clock Rise | 5   | –   | ns   |
| $t_{TDIH}$                    | TDI Hold after Clock Rise     | 5   | –   | ns   |
| $t_{CH}$                      | Capture Hold after Clock Rise | 5   | –   | ns   |

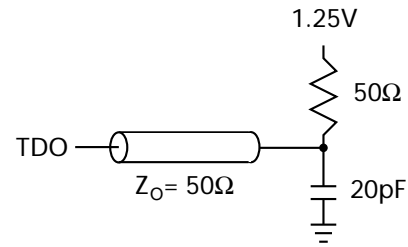
### Notes

10.  $t_{CS}$  and  $t_{CH}$  refer to the setup and hold time requirements of latching data from the boundary scan register.  
 11. Test conditions are specified using the load in TAP AC test Conditions.  $t_R/t_F = 2$  V/ns (Slew Rate).

### 2.5 V TAP AC Test Conditions

Input pulse levels .....  $V_{SS}$  to 2.5 V  
 Input rise and fall times (Slew Rate) ..... 2 V/ns  
 Input timing reference levels ..... 1.25 V  
 Output reference levels ..... 1.25 V  
 Test load termination supply voltage ..... 1.25 V

### 2.5 V TAP AC Output Load Equivalent



### TAP DC Electrical Characteristics and Operating Conditions

(0 °C <  $T_A$  < +70 °C;  $V_{DD} = 2.5 \text{ V} \pm 0.125 \text{ V}$  unless otherwise noted)

| Parameter <sup>[12]</sup> | Description         | Test Conditions                |                           | Min  | Max            | Unit          |
|---------------------------|---------------------|--------------------------------|---------------------------|------|----------------|---------------|
| $V_{OH1}$                 | Output HIGH Voltage | $I_{OH} = -1.0 \text{ mA}$     | $V_{DDQ} = 2.5 \text{ V}$ | 1.7  | –              | V             |
| $V_{OH2}$                 | Output HIGH Voltage | $I_{OH} = -100 \mu\text{A}$    | $V_{DDQ} = 2.5 \text{ V}$ | 2.1  | –              | V             |
| $V_{OL1}$                 | Output LOW Voltage  | $I_{OL} = 1.0 \text{ mA}$      | $V_{DDQ} = 2.5 \text{ V}$ | –    | 0.4            | V             |
| $V_{OL2}$                 | Output LOW Voltage  | $I_{OL} = 100 \mu\text{A}$     | $V_{DDQ} = 2.5 \text{ V}$ | –    | 0.2            | V             |
| $V_{IH}$                  | Input HIGH Voltage  | –                              | $V_{DDQ} = 2.5 \text{ V}$ | 1.7  | $V_{DD} + 0.3$ | V             |
| $V_{IL}$                  | Input LOW Voltage   | –                              | $V_{DDQ} = 2.5 \text{ V}$ | –0.3 | 0.7            | V             |
| $I_X$                     | Input Load Current  | $GND \leq V_{IN} \leq V_{DDQ}$ |                           | –5   | 5              | $\mu\text{A}$ |

**Note**

12. All voltages referenced to  $V_{SS}$  (GND).

### Identification Register Definitions

| Instruction Field                  | CY7C1440KV25<br>(1M × 36) | Description                                  |
|------------------------------------|---------------------------|--|
| Revision Number (31:29)            | 000                       | Describes the version number.                |
| Device Depth (28:24)               | 01011                     | Reserved for Internal Use                    |
| Architecture/Memory Type (23:18)   | 000000                    | Defines memory type and architecture         |
| Bus Width/Density (17:12)          | 100111                    | Defines width and density                    |
| Cypress JEDEC ID Code (11:1)       | 00000110100               | Allows unique identification of SRAM vendor. |
| ID Register Presence Indicator (0) | 1                         | Indicates the presence of an ID register.    |

### Scan Register Sizes

| Register Name                               | Bit Size (× 36) |
|---|-----------------|
| Instruction                                 | 3               |
| Bypass                                      | 1               |
| ID  | 32              |
| Boundary Scan Order (165-ball FBGA package) | 89              |

### Instruction Codes

| Instruction    | Code | Description  |
|----------------|------|--|
| EXTEST         | 000  | Captures I/O ring contents.  |
| IDCODE         | 001  | Loads the ID register with the vendor ID code and places the register between TDI and TDO. This operation does not affect SRAM operations. |
| SAMPLE Z       | 010  | Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Forces all SRAM output drivers to a High Z state.       |
| RESERVED       | 011  | Do Not Use: This instruction is reserved for future use.   |
| SAMPLE/PRELOAD | 100  | Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Does not affect SRAM operation.                         |
| RESERVED       | 101  | Do Not Use: This instruction is reserved for future use.   |
| RESERVED       | 110  | Do Not Use: This instruction is reserved for future use.   |
| BYPASS         | 111  | Places the bypass register between TDI and TDO. This operation does not affect SRAM operations.  |



**Boundary Scan Order**

165-ball FBGA [13, 14]

**CY7C1440KV25 (1M × 36)**

| Bit # | Ball ID |
|-------|---------|
| 1     | N6      |
| 2     | N7      |
| 3     | N10     |
| 4     | P11     |
| 5     | P8      |
| 6     | R8      |
| 7     | R9      |
| 8     | P9      |
| 9     | P10     |
| 10    | R10     |
| 11    | R11     |
| 12    | H11     |
| 13    | N11     |
| 14    | M11     |
| 15    | L11     |
| 16    | K11     |
| 17    | J11     |
| 18    | M10     |
| 19    | L10     |
| 20    | K10     |
| 21    | J10     |
| 22    | H9      |
| 23    | H10     |
| 24    | G11     |
| 25    | F11     |

| Bit # | Ball ID |
|-------|---------|
| 26    | E11     |
| 27    | D11     |
| 28    | G10     |
| 29    | F10     |
| 30    | E10     |
| 31    | D10     |
| 32    | C11     |
| 33    | A11     |
| 34    | B11     |
| 35    | A10     |
| 36    | B10     |
| 37    | A9      |
| 38    | B9      |
| 39    | C10     |
| 40    | A8      |
| 41    | B8      |
| 42    | A7      |
| 43    | B7      |
| 44    | B6      |
| 45    | A6      |
| 46    | B5      |
| 47    | A5      |
| 48    | A4      |
| 49    | B4      |
| 50    | B3      |

| Bit # | Ball ID |
|-------|---------|
| 51    | A3      |
| 52    | A2      |
| 53    | B2      |
| 54    | C2      |
| 55    | B1      |
| 56    | A1      |
| 57    | C1      |
| 58    | D1      |
| 59    | E1      |
| 60    | F1      |
| 61    | G1      |
| 62    | D2      |
| 63    | E2      |
| 64    | F2      |
| 65    | G2      |
| 66    | H1      |
| 67    | H3      |
| 68    | J1      |
| 69    | K1      |
| 70    | L1      |
| 71    | M1      |
| 72    | J2      |
| 73    | K2      |
| 74    | L2      |
| 75    | M2      |

| Bit # | Ball ID  |
|-------|----------|
| 76    | N1       |
| 77    | N2       |
| 78    | P1       |
| 79    | R1       |
| 80    | R2       |
| 81    | P3       |
| 82    | R3       |
| 83    | P2       |
| 84    | R4       |
| 85    | P4       |
| 86    | N5       |
| 87    | P6       |
| 88    | R6       |
| 89    | Internal |

**Notes**

- 13. Balls which are NC (No Connect) are Pre-Set LOW.
- 14. Bit# 89 is Pre-Set HIGH.

### 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<sub>DD</sub> Relative to GND ..... -0.5 V to +3.6 V
- Supply Voltage on V<sub>DDQ</sub> Relative to GND ..... -0.5 V to +V<sub>DD</sub>
- DC Voltage Applied to Outputs in Tristate ..... -0.5 V to V<sub>DDQ</sub> + 0.5 V
- DC Input Voltage ..... -0.5 V to V<sub>DD</sub> + 0.5 V
- Current into Outputs (LOW) ..... 20 mA
- Static Discharge Voltage (per MIL-STD-883, Method 3015) ..... > 2001 V
- Latch-up Current ..... > 200 mA

### Operating Range

| Range      | Ambient Temperature | V <sub>DD</sub> | V <sub>DDQ</sub>              |
|------------|---------------------|-----------------|-------------------------------|
| Industrial | -40 °C to +85 °C    | 2.5 V ± 5%      | 2.5 V - 5% to V <sub>DD</sub> |

### Neutron Soft Error Immunity

| Parameter | Description               | Test Conditions | Typ | Max* | Unit    |
|-----------|---------------------------|-----------------|-----|------|---------|
| LSBU      | Logical Single-Bit Upsets | 25 °C           | <5  | 5    | 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  $\chi^2$ , 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

#### DC Electrical Characteristics

Over the Operating Range

| Parameter <sup>[15, 16]</sup> | Description                              | Test Conditions   | Min   | Max                     | Unit |
|-------------------------------|--|---|-------|-------------------------|------|
| V <sub>DD</sub>               | Power Supply Voltage                     |   | 2.375 | 2.625                   | V    |
| V <sub>DDQ</sub>              | I/O Supply Voltage                       | for 2.5 V I/O   | 2.375 | V <sub>DD</sub>         | V    |
| V <sub>OH</sub>               | Output HIGH Voltage                      | for 2.5 V I/O, I <sub>OH</sub> = -1.0 mA                  | 2.0   | -                       | V    |
| V <sub>OL</sub>               | Output LOW Voltage                       | for 2.5 V I/O, I <sub>OL</sub> = 1.0 mA                   | -     | 0.4                     | V    |
| V <sub>IH</sub>               | Input HIGH Voltage <sup>[15]</sup>       | for 2.5 V I/O   | 1.7   | V <sub>DD</sub> + 0.3 V | V    |
| V <sub>IL</sub>               | Input LOW Voltage <sup>[15]</sup>        | for 2.5 V I/O   | -0.3  | 0.7                     | V    |
| I <sub>X</sub>                | Input Leakage Current except ZZ and MODE | GND ≤ V <sub>I</sub> ≤ V <sub>DDQ</sub>                   | -5    | 5                       | μA   |
|                               | Input Current of MODE                    | Input = V <sub>SS</sub>                                   | -30   | -                       | μA   |
|                               |  | Input = V <sub>DD</sub>                                   | -     | 5                       | μA   |
|                               | Input Current of ZZ                      | Input = V <sub>SS</sub>                                   | -5    | -                       | μA   |
| Input = V <sub>DD</sub>       |  | -   | 30    | μA                      |      |
| I <sub>OZ</sub>               | Output Leakage Current                   | GND ≤ V <sub>I</sub> ≤ V <sub>DDQ</sub> , Output Disabled | -5    | 5                       | μA   |

**Notes**

- 15. Overshoot: V<sub>IH(AC)</sub> < V<sub>DD</sub> + 1.5 V (Pulse width less than t<sub>CYC/2</sub>), undershoot: V<sub>IL(AC)</sub> > -2 V (Pulse width less than t<sub>CYC/2</sub>).
- 16. TPower-up: Assumes a linear ramp from 0 V to V<sub>DD(min)</sub> within 200 ms. During this time V<sub>IH</sub> < V<sub>DD</sub> and V<sub>DDQ</sub> ≤ V<sub>DD</sub>.

## Electrical Characteristics

Over the Operating Range

### DC Electrical Characteristics (continued)

Over the Operating Range

| Parameter <sup>[15, 16]</sup> | Description                                   | Test Conditions  | Min                    | Max | Unit |    |
|-------------------------------|---|--|------------------------|-----|------|----|
| I <sub>DD</sub>               | V <sub>DD</sub> Operating Supply Current      | V <sub>DD</sub> = Max, I <sub>OUT</sub> = 0 mA,<br>f = f <sub>MAX</sub> = 1/t <sub>CYC</sub>   | 4-ns cycle,<br>250 MHz | –   | 240  | mA |
| I <sub>SB1</sub>              | Automatic CE Power-down Current – TTL Inputs  | V <sub>DD</sub> = Max, Device Deselected,<br>V <sub>IN</sub> ≥ V <sub>IH</sub> or V <sub>IN</sub> ≤ V <sub>IL</sub> ,<br>f = f <sub>MAX</sub> = 1/t <sub>CYC</sub> | All speeds             | –   | 90   | mA |
| I <sub>SB2</sub>              | Automatic CE Power-down Current – CMOS Inputs | V <sub>DD</sub> = Max, Device Deselected,<br>V <sub>IN</sub> ≤ 0.3 V or V <sub>IN</sub> ≥ V <sub>DDQ</sub> – 0.3 V,<br>f = 0                                       | All speeds             | –   | 80   | mA |
| I <sub>SB3</sub>              | Automatic CE Power-down Current – CMOS Inputs | V <sub>DD</sub> = Max, Device Deselected,<br>V <sub>IN</sub> ≤ 0.3 V or V <sub>IN</sub> ≥ V <sub>DDQ</sub> – 0.3 V,<br>f = f <sub>MAX</sub> = 1/t <sub>CYC</sub>   | All speeds             | –   | 90   | mA |
| I <sub>SB4</sub>              | Automatic CE Power-down Current – TTL Inputs  | V <sub>DD</sub> = Max, Device Deselected,<br>V <sub>IN</sub> ≥ V <sub>IH</sub> or V <sub>IN</sub> ≤ V <sub>IL</sub> , f = 0  | All speeds             | –   | 80   | mA |

## Capacitance

| Parameter <sup>[17]</sup> | Description              | Test Conditions  | 165-ball FBGA Max | Unit |
|---------------------------|--------------------------|--|-------------------|------|
| C <sub>IN</sub>           | Input capacitance        | T <sub>A</sub> = 25 °C, f = 1 MHz, V <sub>DD</sub> /V <sub>DDQ</sub> = 2.5 V | 5                 | pF   |
| C <sub>CLK</sub>          | Clock input capacitance  |  | 5                 | pF   |
| C <sub>I/O</sub>          | Input/Output capacitance |  | 5                 | pF   |

## Thermal Resistance

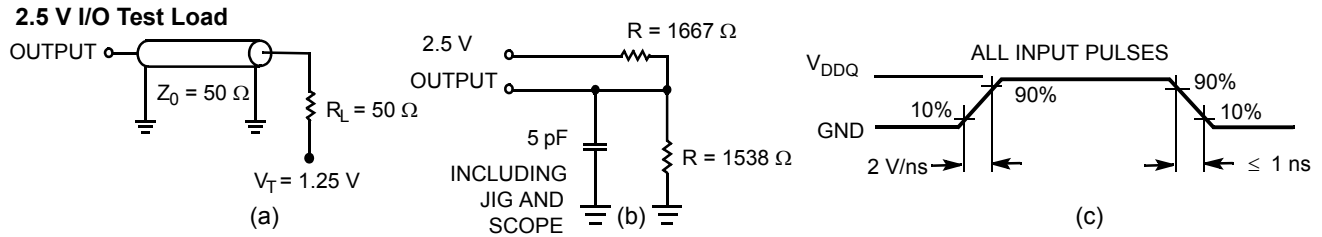
| Parameter <sup>[17]</sup> | Description                              | Test Conditions  | 165-ball FBGA Package  | Unit  |      |
|---------------------------|--|--|------------------------|-------|------|
| Θ <sub>JA</sub>           | Thermal resistance (junction to ambient) | Test conditions follow standard test methods and procedures for measuring thermal impedance, per EIA/JESD51. | With Still Air (0 m/s) | 14.24 | °C/W |
|                           |  | With Air Flow (1 m/s)  | 12.47                  | °C/W  |      |
|                           |  | With Air Flow (3 m/s)  | 11.40                  | °C/W  |      |
| Θ <sub>JC</sub>           | Thermal resistance (junction to case)    |  | 3.92                   | °C/W  |      |
| Θ <sub>JB</sub>           | Thermal resistance (junction to board)   |  | 7.19                   | °C/W  |      |

**Note**

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

## AC Test Loads and Waveforms

Figure 3. AC Test Loads and Waveforms



## Switching Characteristics

Over the Operating Range

| Parameter <sup>[18, 19]</sup> | Description   | -250 |     | Unit |
|-------------------------------|---|------|-----|------|
|                               |   | Min  | Max |      |
| t <sub>POWER</sub>            | V <sub>DD</sub> (typical) to the first Access <sup>[20]</sup>                                     | 1    | –   | ms   |
| <b>Clock</b>                  |   |      |     |      |
| t <sub>CYC</sub>              | Clock Cycle Time  | 4.0  | –   | ns   |
| t <sub>CH</sub>               | Clock HIGH  | 1.5  | –   | ns   |
| t <sub>CL</sub>               | Clock LOW   | 1.5  | –   | ns   |
| <b>Output Times</b>           |   |      |     |      |
| t <sub>CO</sub>               | Data Output Valid After CLK Rise  | –    | 2.5 | ns   |
| t <sub>DOH</sub>              | Data Output Hold After CLK Rise   | 1.0  | –   | ns   |
| t <sub>CLZ</sub>              | Clock to Low Z <sup>[21, 22, 23]</sup>  | 1.0  | –   | ns   |
| t <sub>CHZ</sub>              | Clock to High Z <sup>[21, 22, 23]</sup>   | –    | 2.6 | ns   |
| t <sub>OEV</sub>              | $\overline{\text{OE}}$ LOW to Output Valid  | –    | 2.6 | ns   |
| t <sub>OELZ</sub>             | $\overline{\text{OE}}$ LOW to Output Low Z <sup>[21, 22, 23]</sup>                                | 0    | –   | ns   |
| t <sub>OEHZ</sub>             | $\overline{\text{OE}}$ HIGH to Output High Z <sup>[21, 22, 23]</sup>                              | –    | 2.6 | ns   |
| <b>Setup Times</b>            |   |      |     |      |
| t <sub>AS</sub>               | Address Setup Before CLK Rise   | 1.2  | –   | ns   |
| t <sub>ADS</sub>              | ADSC, ADSP Setup Before CLK Rise  | 1.2  | –   | ns   |
| t <sub>ADVS</sub>             | ADV Setup Before CLK Rise   | 1.2  | –   | ns   |
| t <sub>WES</sub>              | $\overline{\text{GW}}$ , $\overline{\text{BWE}}$ , $\overline{\text{BW}}_x$ Setup Before CLK Rise | 1.2  | –   | ns   |
| t <sub>DS</sub>               | Data Input Setup Before CLK Rise  | 1.2  | –   | ns   |
| t <sub>CES</sub>              | Chip Enable Setup Before CLK Rise   | 1.2  | –   | ns   |
| <b>Hold Times</b>             |   |      |     |      |
| t <sub>AH</sub>               | Address Hold After CLK Rise   | 0.3  | –   | ns   |
| t <sub>ADH</sub>              | ADSP, ADSC Hold After CLK Rise  | 0.3  | –   | ns   |
| t <sub>ADVH</sub>             | ADV Hold After CLK Rise   | 0.3  | –   | ns   |
| t <sub>WEH</sub>              | $\overline{\text{GW}}$ , $\overline{\text{BWE}}$ , $\overline{\text{BW}}_x$ Hold After CLK Rise   | 0.3  | –   | ns   |
| t <sub>DH</sub>               | Data Input Hold After CLK Rise  | 0.3  | –   | ns   |
| t <sub>CEH</sub>              | Chip Enable Hold After CLK Rise   | 0.3  | –   | ns   |

### Notes

18. Timing reference level is 1.25 V when V<sub>DDQ</sub> = 2.5 V.

19. Test conditions shown in (a) of [Figure 3 on page 20](#) unless otherwise noted.

20. This part has a voltage regulator internally; t<sub>POWER</sub> is the time that the power needs to be supplied above V<sub>DD(minimum)</sub> initially before a read or write operation can be initiated.

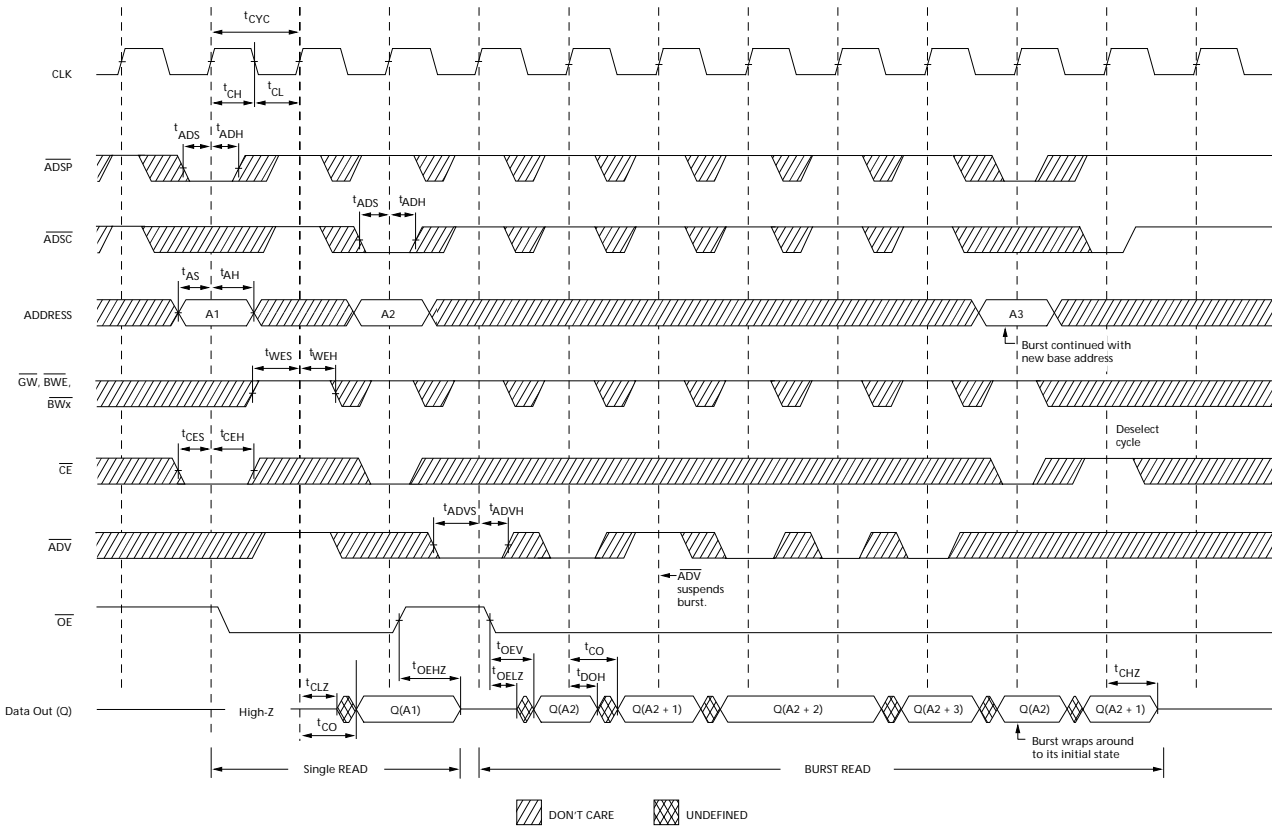
21. t<sub>CHZ</sub>, t<sub>CLZ</sub>, t<sub>OELZ</sub>, and t<sub>OEHZ</sub> are specified with AC test conditions shown in part (b) of [Figure 3 on page 20](#). Transition is measured ± 200 mV from steady-state voltage.

22. At any given voltage and temperature, t<sub>OEHZ</sub> is less than t<sub>OELZ</sub> and t<sub>CHZ</sub> is less than t<sub>CLZ</sub> 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.

23. This parameter is sampled and not 100% tested.

## Switching Waveforms

Figure 4. Read Cycle Timing [24]

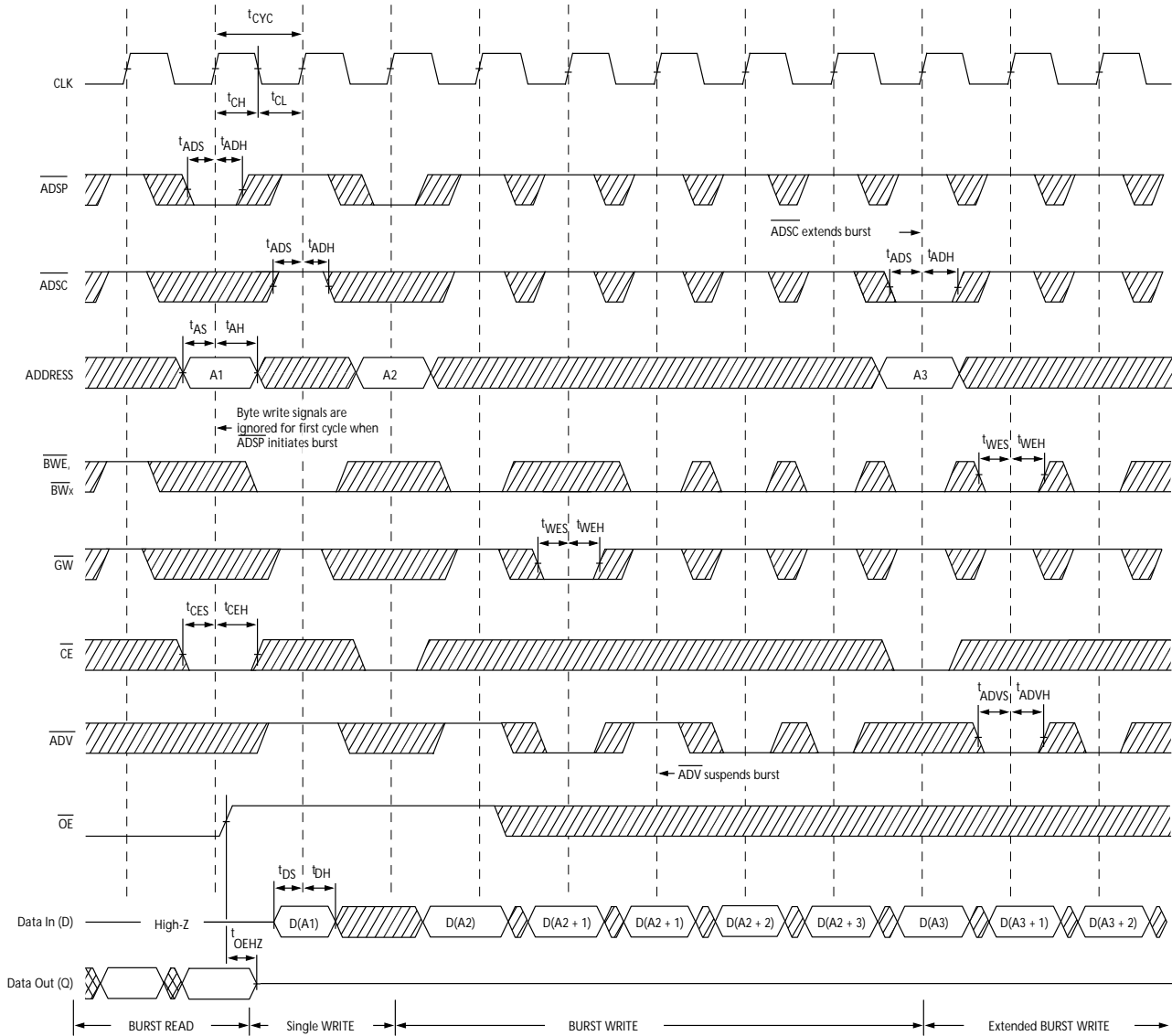


**Note**

24. 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.

Switching Waveforms (continued)

Figure 5. Write Cycle Timing [25, 26]



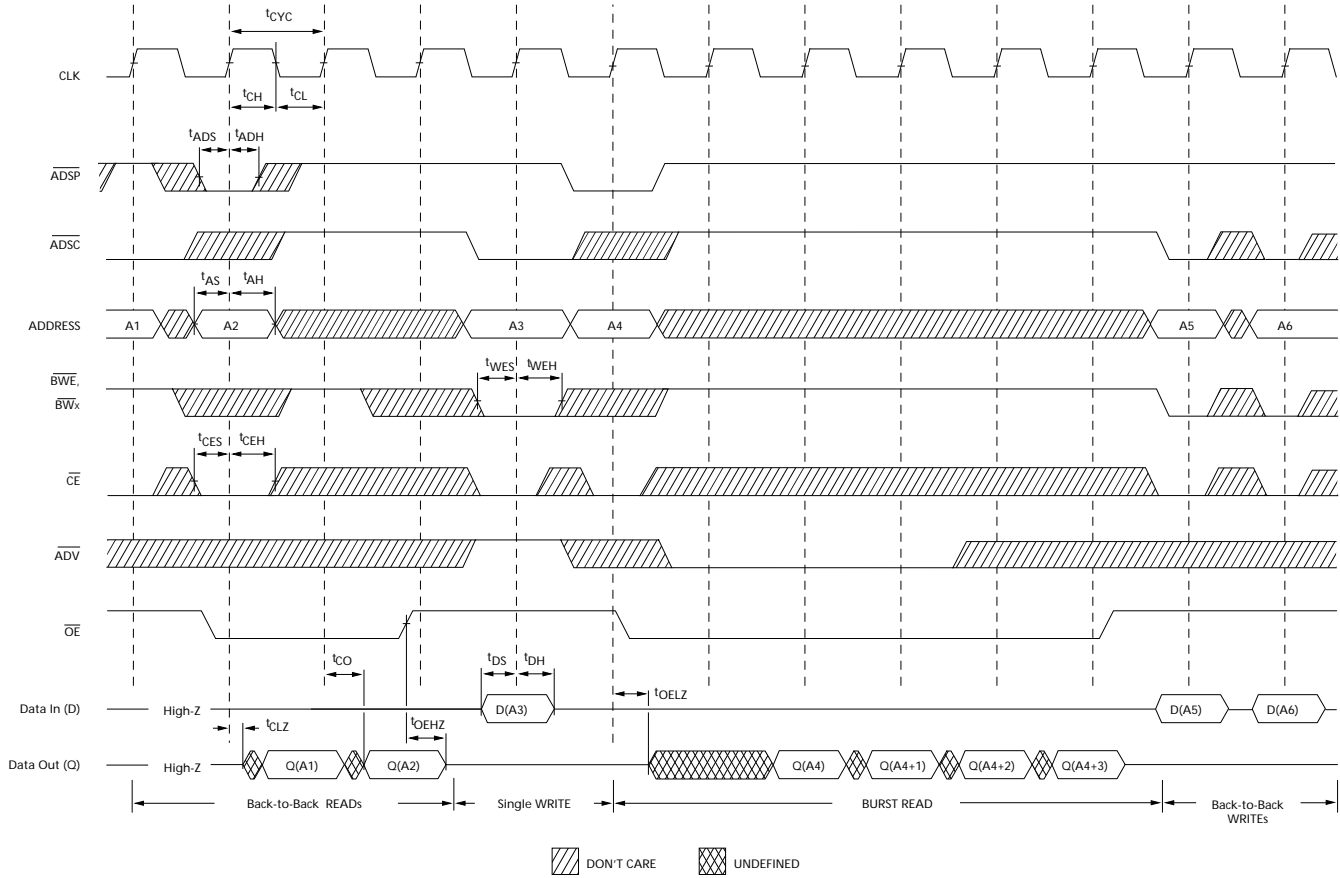
Notes

25. 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.

26. Full width write can be initiated by either  $\overline{GW}$  LOW; or by  $\overline{GW}$  HIGH,  $\overline{BWE}$  LOW and  $\overline{BW}_X$  LOW.

Switching Waveforms (continued)

Figure 6. Read/Write Cycle Timing [27, 28, 29]



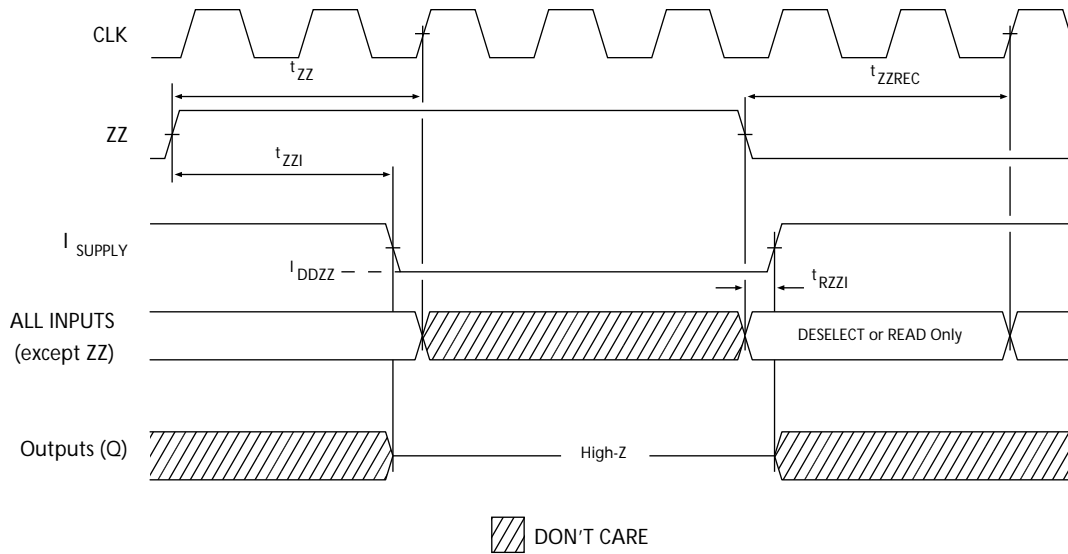
Notes

- 27. On this diagram, when  $\overline{CE}$  is LOW:  $\overline{CE}_1$  is LOW,  $\overline{CE}_2$  is HIGH and  $\overline{CE}_3$  is LOW. When  $\overline{CE}$  is HIGH:  $\overline{CE}_1$  is HIGH or  $\overline{CE}_2$  is LOW or  $\overline{CE}_3$  is HIGH.
- 28. The data bus (Q) remains in high Z following a WRITE cycle, unless a new read access is initiated by ADSP or ADSC.
- 29.  $\overline{GW}$  is HIGH.



**Switching Waveforms** (continued)

**Figure 7. ZZ Mode Timing** [30, 31]



**Notes**

- 30. Device must be deselected when entering ZZ mode. See Cycle Descriptions table for all possible signal conditions to deselect the device.
- 31. DQs are in high Z when exiting ZZ sleep mode.

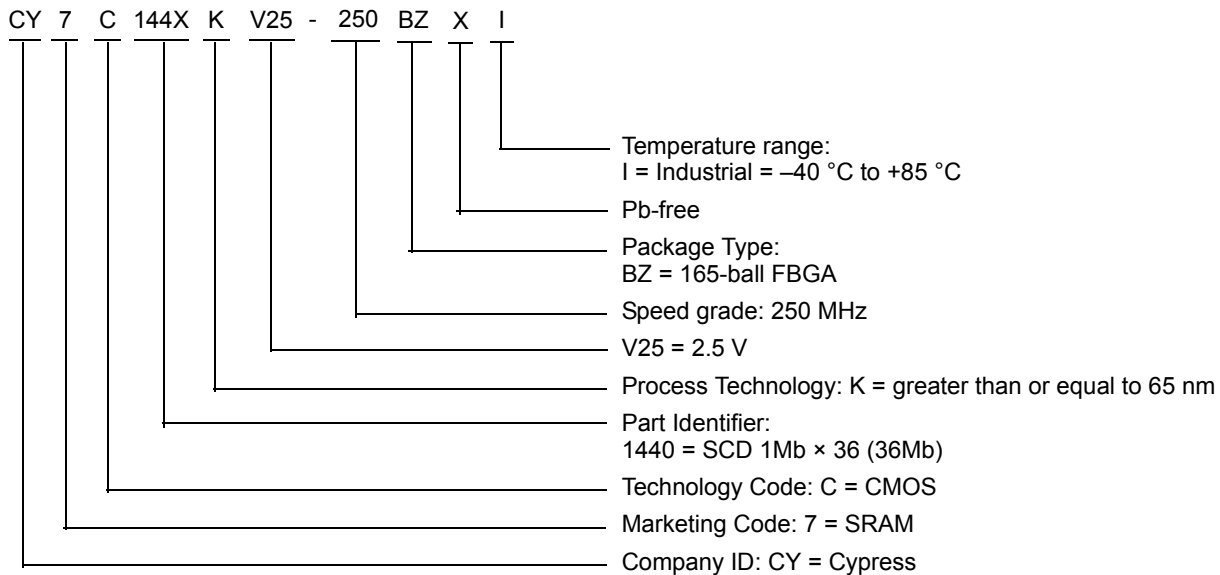
## Ordering Information

Table 1 lists the ordering codes. The table contains only the parts that are currently available. If you do not see what you are looking for, contact your local sales representative. For more information, visit the Cypress website at [www.cypress.com](http://www.cypress.com) and refer to the product summary page at <http://www.cypress.com/products>.

**Table 1. Ordering Information**

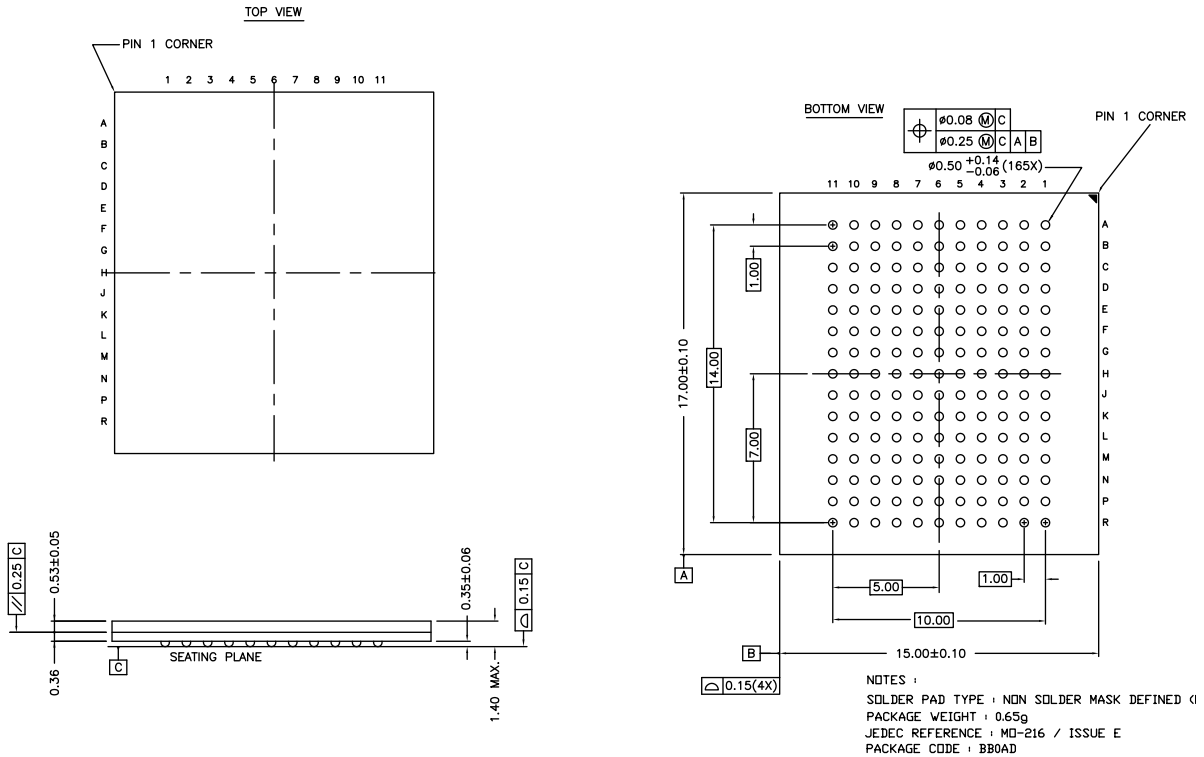
| Speed (MHz) | Ordering Code        | Package Diagram | Part and Package Type                   | Operating Range |
|-------------|----------------------|-----------------|---|-----------------|
| 250         | CY7C1440KV25-250BZXI | 51-85195        | 165-ball FBGA (15 × 17 × 1.4mm) Pb-free | Industrial      |

### Ordering Code Definitions



### Package Diagram

Figure 8. 165-ball FBGA ((15 × 17 × 1.40 mm) 0.50 Ball Diameter) Package Outline, 51-85195



51-85195 \*D

## Acronyms

Table 2. Acronyms Used in this Document

| Acronym         | Description                             |
|-----------------|---|
| CMOS            | Complementary Metal Oxide Semiconductor |
| $\overline{CE}$ | Chip Enable                             |
| FBGA            | Fine-Pitch Ball Grid Array              |
| I/O             | Input/Output                            |
| JTAG            | Joint Test Action Group                 |
| LSB             | Least Significant Bit                   |
| MSB             | Most Significant Bit                    |
| $\overline{OE}$ | Output Enable                           |
| SRAM            | Static Random Access Memory             |
| TCK             | Test Clock                              |
| TDI             | Test Data-In                            |
| TDO             | Test Data-Out                           |
| TMS             | Test Mode Select                        |
| TTL             | Transistor-Transistor Logic             |
| $\overline{WE}$ | Write Enable                            |

## Document Conventions

### Units of Measure

Table 3. Units of Measure

| Symbol | Unit of Measure |
|--------|-----------------|
| °C     | degree Celsius  |
| MHz    | megahertz       |
| μA     | microampere     |
| μs     | microsecond     |
| mA     | milliampere     |
| mm     | millimeter      |
| ms     | millisecond     |
| mV     | millivolt       |
| ns     | nanosecond      |
| %      | percent         |
| pF     | picofarad       |
| V      | volt            |
| W      | watt            |

## Document History Page

| Document Title: CY7C1440KV25, 36-Mbit (1M × 36) Pipelined Sync SRAM<br>Document Number: 001-94719 |         |                 |                 |  |
|---|---------|-----------------|-----------------|--|
| Revision  | ECN     | Orig. of Change | Submission Date | Description of Change  |
| *B  | 4680529 | PRIT            | 04/10/2015      | Changed status from Preliminary to Final.  |
| *C  | 4757974 | DEVM            | 05/07/2015      | Updated <a href="#">Functional Overview</a> :<br>Updated <a href="#">ZZ Mode Electrical Characteristics</a> :<br>Changed maximum value of I <sub>DDZZ</sub> parameter from 89 mA to 75 mA. |
| *D  | 5331734 | PRIT            | 06/30/2016      | Updated <a href="#">Neutron Soft Error Immunity</a> :<br>Updated values in "Typ" and "Max" columns corresponding to LSBU parameter.<br>Updated to new template.                            |

## Sales, Solutions, and Legal Information

### Worldwide Sales and Design Support

Cypress maintains a worldwide network of offices, solution centers, manufacturer's representatives, and distributors. To find the office closest to you, visit us at [Cypress Locations](#).

#### Products

|                               |  |
|-------------------------------|--|
| ARM® Cortex® Microcontrollers | <a href="http://cypress.com/arm">cypress.com/arm</a>               |
| Automotive                    | <a href="http://cypress.com/automotive">cypress.com/automotive</a> |
| Clocks & Buffers              | <a href="http://cypress.com/clocks">cypress.com/clocks</a>         |
| Interface                     | <a href="http://cypress.com/interface">cypress.com/interface</a>   |
| Lighting & Power Control      | <a href="http://cypress.com/powerpsoc">cypress.com/powerpsoc</a>   |
| Memory                        | <a href="http://cypress.com/memory">cypress.com/memory</a>         |
| PSoC                          | <a href="http://cypress.com/psoc">cypress.com/psoc</a>             |
| Touch Sensing                 | <a href="http://cypress.com/touch">cypress.com/touch</a>           |
| USB Controllers               | <a href="http://cypress.com/usb">cypress.com/usb</a>               |
| Wireless/RF                   | <a href="http://cypress.com/wireless">cypress.com/wireless</a>     |

#### PSoC® Solutions

[PSoC 1](#) | [PSoC 3](#) | [PSoC 4](#) | [PSoC 5LP](#)

#### Cypress Developer Community

[Forums](#) | [Projects](#) | [Video](#) | [Blogs](#) | [Training](#) | [Components](#)

#### Technical Support

[cypress.com/support](http://cypress.com/support)

© Cypress Semiconductor Corporation, 2014-2016. This document is the property of Cypress Semiconductor Corporation and its subsidiaries, including Spansion LLC ("Cypress"). This document, including any software or firmware included or referenced in this document ("Software"), is owned by Cypress under the intellectual property laws and treaties of the United States and other countries worldwide. Cypress reserves all rights under such laws and treaties and does not, except as specifically stated in this paragraph, grant any license under its patents, copyrights, trademarks, or other intellectual property rights. If the Software is not accompanied by a license agreement and you do not otherwise have a written agreement with Cypress governing the use of the Software, then Cypress hereby grants you a personal, non-exclusive, nontransferable license (without the right to sublicense) (1) under its copyright rights in the Software (a) for Software provided in source code form, to modify and reproduce the Software solely for use with Cypress hardware products, only internally within your organization, and (b) to distribute the Software in binary code form externally to end users (either directly or indirectly through resellers and distributors), solely for use on Cypress hardware product units, and (2) under those claims of Cypress's patents that are infringed by the Software (as provided by Cypress, unmodified) to make, use, distribute, and import the Software solely for use with Cypress hardware products. Any other use, reproduction, modification, translation, or compilation of the Software is prohibited.

TO THE EXTENT PERMITTED BY APPLICABLE LAW, CYPRESS MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARD TO THIS DOCUMENT OR ANY SOFTWARE OR ACCOMPANYING HARDWARE, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. To the extent permitted by applicable law, Cypress reserves the right to make changes to this document without further notice. Cypress does not assume any liability arising out of the application or use of any product or circuit described in this document. Any information provided in this document, including any sample design information or programming code, is provided only for reference purposes. It is the responsibility of the user of this document to properly design, program, and test the functionality and safety of any application made of this information and any resulting product. Cypress products are not designed, intended, or authorized for use as critical components in systems designed or intended for the operation of weapons, weapons systems, nuclear installations, life-support devices or systems, other medical devices or systems (including resuscitation equipment and surgical implants), pollution control or hazardous substances management, or other uses where the failure of the device or system could cause personal injury, death, or property damage ("Unintended Uses"). A critical component is any component of a device or system whose failure to perform can be reasonably expected to cause the failure of the device or system, or to affect its safety or effectiveness. Cypress is not liable, in whole or in part, and you shall and hereby do release Cypress from any claim, damage, or other liability arising from or related to all Unintended Uses of Cypress products. You shall indemnify and hold Cypress harmless from and against all claims, costs, damages, and other liabilities, including claims for personal injury or death, arising from or related to any Unintended Uses of Cypress products.

Cypress, the Cypress logo, Spansion, the Spansion logo, and combinations thereof, PSoC, CapSense, EZ-USB, F-RAM, and Traveo are trademarks or registered trademarks of Cypress in the United States and other countries. For a more complete list of Cypress trademarks, visit [cypress.com](http://cypress.com). Other names and brands may be claimed as property of their respective owners.