

## 4M Late Write HSTL

The MCM63R736/818 is a 4M-bit synchronous late write fast static RAM designed to provide high performance in secondary cache and ATM switch, Telecom, and other high speed memory applications. The MCM63R818 (organized as 256K words by 18 bits), and the MCM63R736 (organized as 128K words by 36 bits) are fabricated in Motorola's high performance silicon gate copper CMOS technology.

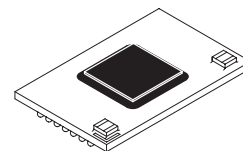
The differential clock (CK) inputs control the timing of read/write operations of the RAM. At the rising edge of CK, all addresses, write enables, and synchronous selects are registered. An internal buffer and special logic enable the memory to accept write data on the rising edge of CK, a cycle after address and control signals. Read data is also driven on the rising edge of CK.

The RAM uses HSTL inputs and outputs. The adjustable input trip-point ( $V_{ref}$ ) and output voltage ( $V_{DDQ}$ ) gives the system designer greater flexibility in optimizing system performance.

The synchronous write and byte enables allow writing to individual bytes or the entire word.

The impedance of the output buffers is programmable, allowing the outputs to match the impedance of the circuit traces which reduces signal reflections.

- Byte Write Control
- 2.5 V -5% to 3.3 V +10% Operation
- 2.375 V to 3.6 V Operation
- HSTL — I/O (JEDEC Standard JESD8-6 Class I Compatible)
- HSTL — User Selectable Input Trip-Point
- HSTL — Compatible Programmable Impedance Output Drivers
- Register to Register Synchronous Operation
- Boundary Scan (JTAG) IEEE 1149.1 Compatible
- Differential Clock Inputs
- Optional x18 or x36 Organization
- MCM63R736/818-3 = 3 ns  
MCM63R736/818-3.3 = 3.3 ns  
MCM63R736/818-3.7 = 3.7 ns  
MCM63R736/818-4 = 4 ns
- Sleep Mode Operation (ZZ pin)
- 119-Bump, 50 mil (1.27 mm) Pitch, 14mm x 22mm Flipped Chip Plastic Ball Grid Array (PBGA) Package

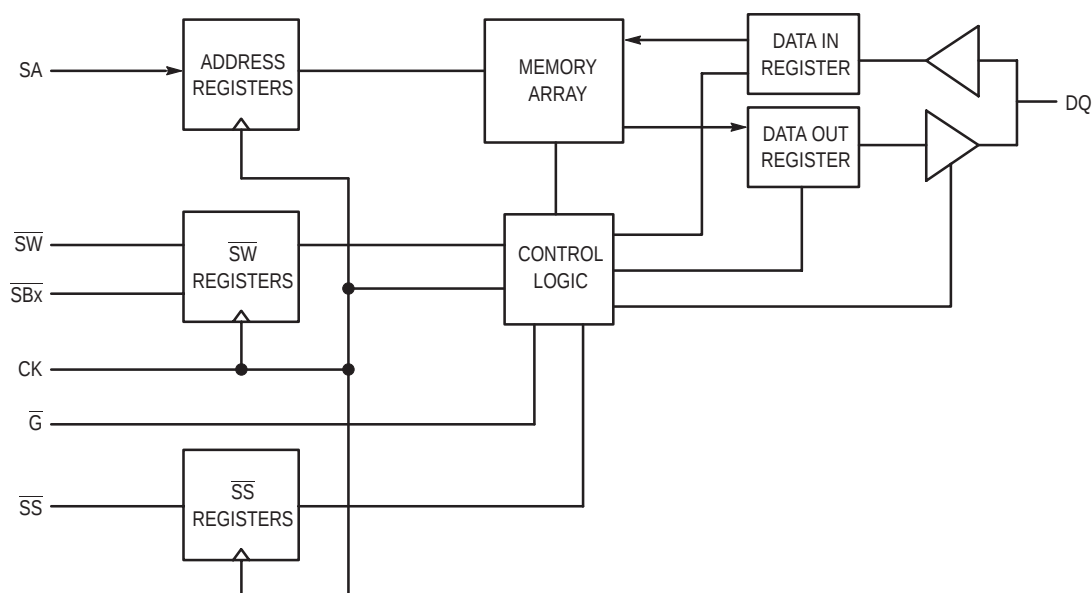
**MCM63R736**  
**MCM63R818**

FC PACKAGE  
FLIPPED CHIP PBGA  
CASE 999E-01



**Freescal Semiconductor, Inc.**

### FUNCTIONAL BLOCK DIAGRAM



## PIN ASSIGNMENTS

**TOP VIEW**

|   | 1                     | 2                    | 3                     | 4                    | 5                     | 6                    | 7                     |
|---|-----------------------|----------------------|-----------------------|----------------------|-----------------------|----------------------|-----------------------|
| A | ○<br>V <sub>DDQ</sub> | ○<br>SA              | ○<br>SA               | ○<br>NC              | ○<br>SA               | ○<br>SA              | ○<br>V <sub>DDQ</sub> |
| B | ○<br>NC               | ○<br>NC              | ○<br>SA               | ○<br>NC              | ○<br>SA               | ○<br>NC              | ○<br>NC               |
| C | ○<br>NC               | ○<br>SA              | ○<br>SA               | ○<br>V <sub>DD</sub> | ○<br>SA               | ○<br>SA              | ○<br>NC               |
| D | ○<br>DQc              | ○<br>DQc             | ○<br>V <sub>SS</sub>  | ○<br>ZQ              | ○<br>V <sub>SS</sub>  | ○<br>DQb             | ○<br>DQb              |
| E | ○<br>DQc              | ○<br>DQc             | ○<br>V <sub>SS</sub>  | ○<br>SS              | ○<br>V <sub>SS</sub>  | ○<br>DQb             | ○<br>DQb              |
| F | ○<br>V <sub>DDQ</sub> | ○<br>DQc             | ○<br>V <sub>SS</sub>  | ○<br>G               | ○<br>V <sub>SS</sub>  | ○<br>DQb             | ○<br>V <sub>DDQ</sub> |
| G | ○<br>DQc              | ○<br>DQc             | ○<br>SBc              | ○<br>NC              | ○<br>SBb              | ○<br>DQb             | ○<br>DQb              |
| H | ○<br>DQc              | ○<br>DQc             | ○<br>V <sub>SS</sub>  | ○<br>NC              | ○<br>V <sub>SS</sub>  | ○<br>DQb             | ○<br>DQb              |
| J | ○<br>V <sub>DDQ</sub> | ○<br>V <sub>DD</sub> | ○<br>V <sub>ref</sub> | ○<br>V <sub>DD</sub> | ○<br>V <sub>ref</sub> | ○<br>V <sub>DD</sub> | ○<br>V <sub>DDQ</sub> |
| K | ○<br>DQd              | ○<br>DQd             | ○<br>V <sub>SS</sub>  | ○<br>CK              | ○<br>V <sub>SS</sub>  | ○<br>DQa             | ○<br>DQa              |
| L | ○<br>DQd              | ○<br>DQd             | ○<br>SBd              | ○<br>CK              | ○<br>SBA              | ○<br>DQa             | ○<br>DQa              |
| M | ○<br>V <sub>DDQ</sub> | ○<br>DQd             | ○<br>V <sub>SS</sub>  | ○<br>SW              | ○<br>V <sub>SS</sub>  | ○<br>DQa             | ○<br>V <sub>DDQ</sub> |
| N | ○<br>DQd              | ○<br>DQd             | ○<br>V <sub>SS</sub>  | ○<br>SA              | ○<br>V <sub>SS</sub>  | ○<br>DQa             | ○<br>DQa              |
| P | ○<br>DQd              | ○<br>DQd             | ○<br>V <sub>SS</sub>  | ○<br>SA              | ○<br>V <sub>SS</sub>  | ○<br>DQa             | ○<br>DQa              |
| R | ○<br>NC               | ○<br>SA              | ○<br>V <sub>SS</sub>  | ○<br>V <sub>DD</sub> | ○<br>V <sub>DD</sub>  | ○<br>SA              | ○<br>NC               |
| T | ○<br>NC               | ○<br>NC              | ○<br>SA               | ○<br>SA              | ○<br>SA               | ○<br>NC              | ○<br>ZZ               |
| U | ○<br>V <sub>DDQ</sub> | ○<br>TMS             | ○<br>TDI              | ○<br>TCK             | ○<br>TDO              | ○<br>NC              | ○<br>V <sub>DDQ</sub> |

|   | 1                              | 2                             | 3                              | 4                              | 5                              | 6                             | 7                              |
|---|--------------------------------|-------------------------------|--------------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------|
| A | $\bigcirc$<br>V <sub>DDQ</sub> | $\bigcirc$<br>SA              | $\bigcirc$<br>SA               | $\bigcirc$<br>NC               | $\bigcirc$<br>SA               | $\bigcirc$<br>SA              | $\bigcirc$<br>V <sub>DDQ</sub> |
| B | $\bigcirc$<br>NC               | $\bigcirc$<br>NC              | $\bigcirc$<br>SA               | $\bigcirc$<br>NC               | $\bigcirc$<br>SA               | $\bigcirc$<br>NC              | $\bigcirc$<br>NC               |
| C | $\bigcirc$<br>NC               | $\bigcirc$<br>SA              | $\bigcirc$<br>SA               | $\bigcirc$<br>V <sub>DD</sub>  | $\bigcirc$<br>SA               | $\bigcirc$<br>SA              | $\bigcirc$<br>NC               |
| D | $\bigcirc$<br>DQ <sub>b</sub>  | $\bigcirc$<br>NC              | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>Z $\overline{Q}$ | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>DQ <sub>a</sub> | $\bigcirc$<br>NC               |
| E | $\bigcirc$<br>NC               | $\bigcirc$<br>DQ <sub>b</sub> | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>$\overline{SS}$  | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>NC              | $\bigcirc$<br>DQ <sub>a</sub>  |
| F | $\bigcirc$<br>V <sub>DDQ</sub> | $\bigcirc$<br>NC              | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>$\overline{G}$   | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>DQ <sub>a</sub> | $\bigcirc$<br>V <sub>DDQ</sub> |
| G | $\bigcirc$<br>NC               | $\bigcirc$<br>DQ <sub>b</sub> | $\bigcirc$<br>$\overline{SBb}$ | $\bigcirc$<br>NC               | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>NC              | $\bigcirc$<br>DQ <sub>a</sub>  |
| H | $\bigcirc$<br>DQ <sub>b</sub>  | $\bigcirc$<br>NC              | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>NC               | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>DQ <sub>a</sub> | $\bigcirc$<br>NC               |
| J | $\bigcirc$<br>V <sub>DDQ</sub> | $\bigcirc$<br>V <sub>DD</sub> | $\bigcirc$<br>V <sub>ref</sub> | $\bigcirc$<br>V <sub>DD</sub>  | $\bigcirc$<br>V <sub>ref</sub> | $\bigcirc$<br>V <sub>DD</sub> | $\bigcirc$<br>V <sub>DDQ</sub> |
| K | $\bigcirc$<br>NC               | $\bigcirc$<br>DQ <sub>b</sub> | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>CK               | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>NC              | $\bigcirc$<br>DQ <sub>a</sub>  |
| L | $\bigcirc$<br>DQ <sub>b</sub>  | $\bigcirc$<br>NC              | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>$\overline{CK}$  | $\bigcirc$<br>$\overline{SBa}$ | $\bigcirc$<br>DQ <sub>a</sub> | $\bigcirc$<br>NC               |
| M | $\bigcirc$<br>V <sub>DDQ</sub> | $\bigcirc$<br>DQ <sub>b</sub> | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>$\overline{SW}$  | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>NC              | $\bigcirc$<br>V <sub>DDQ</sub> |
| N | $\bigcirc$<br>DQ <sub>b</sub>  | $\bigcirc$<br>NC              | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>SA               | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>DQ <sub>a</sub> | $\bigcirc$<br>NC               |
| P | $\bigcirc$<br>NC               | $\bigcirc$<br>DQ <sub>b</sub> | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>SA               | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>NC              | $\bigcirc$<br>DQ <sub>a</sub>  |
| R | $\bigcirc$<br>NC               | $\bigcirc$<br>SA              | $\bigcirc$<br>V <sub>SS</sub>  | $\bigcirc$<br>V <sub>DD</sub>  | $\bigcirc$<br>V <sub>DD</sub>  | $\bigcirc$<br>SA              | $\bigcirc$<br>NC               |
| T | $\bigcirc$<br>NC               | $\bigcirc$<br>SA              | $\bigcirc$<br>SA               | $\bigcirc$<br>NC               | $\bigcirc$<br>SA               | $\bigcirc$<br>SA              | $\bigcirc$<br>ZZ               |
| U | $\bigcirc$<br>V <sub>DDQ</sub> | $\bigcirc$<br>TMS             | $\bigcirc$<br>TDI              | $\bigcirc$<br>TCK              | $\bigcirc$<br>TDO              | $\bigcirc$<br>NC              | $\bigcirc$<br>V <sub>DDQ</sub> |

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## MCM63R736 PIN DESCRIPTIONS

| PBGA Pin Locations                                                                                                                                                   | Symbol                  | Type   | Description                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4K                                                                                                                                                                   | CK                      | Input  | Address, data in and control input register clock. Active high.                                                                                         |
| 4L                                                                                                                                                                   | $\overline{\text{CK}}$  | Input  | Address, data in and control input register clock. Active low.                                                                                          |
| (a) 6K, 7K, 6L, 7L, 6M, 6N, 7N, 6P, 7P<br>(b) 6D, 7D, 6E, 7E, 6F, 6G, 7G, 6H, 7H<br>(c) 1D, 2D, 1E, 2E, 2F, 1G, 2G, 1H, 2H<br>(d) 1K, 2K, 1L, 2L, 2M, 1N, 2N, 1P, 2P | DQx                     | I/O    | Synchronous Data I/O.                                                                                                                                   |
| 4F                                                                                                                                                                   | $\overline{\text{G}}$   | Input  | Output Enable functionality not supported. Must be tied to $V_{SS}$ or driven to $\leq V_{IL}$ max.                                                     |
| 2A, 3A, 5A, 6A, 3B, 5B, 2C, 3C, 5C, 6C,<br>4N, 4P, 2R, 6R, 3T, 4T, 5T                                                                                                | SA                      | Input  | Synchronous Address Inputs: Registered on the rising clock edge.                                                                                        |
| 5L, 5G, 3G, 3L<br>(a), (b), (c), (d)                                                                                                                                 | $\overline{\text{SBx}}$ | Input  | Synchronous Byte Write Enable: Enables writes to byte x in conjunction with the $\overline{\text{SW}}$ input. Has no effect on read cycles, active low. |
| 4E                                                                                                                                                                   | $\overline{\text{SS}}$  | Input  | Synchronous Chip Enable: Registered on the rising clock edge, active low.                                                                               |
| 4M                                                                                                                                                                   | $\overline{\text{SW}}$  | Input  | Synchronous Write: Registered on the rising clock edge, active low. Writes all enabled bytes.                                                           |
| 4U                                                                                                                                                                   | TCK                     | Input  | Test Clock (JTAG).                                                                                                                                      |
| 3U                                                                                                                                                                   | TDI                     | Input  | Test Data In (JTAG).                                                                                                                                    |
| 5U                                                                                                                                                                   | TDO                     | Output | Test Data Out (JTAG).                                                                                                                                   |
| 2U                                                                                                                                                                   | TMS                     | Input  | Test Mode Select (JTAG).                                                                                                                                |
| 4D                                                                                                                                                                   | ZQ                      | Input  | Programmable Output Impedance: Programming pin.                                                                                                         |
| 7T                                                                                                                                                                   | ZZ                      | Input  | Enables sleep mode, active high.                                                                                                                        |
| 4C, 2J, 4J, 6J, 4R, 5R                                                                                                                                               | $V_{DD}$                | Supply | Core Power Supply.                                                                                                                                      |
| 1A, 7A, 1F, 7F, 1J, 7J, 1M, 7M, 1U, 7U                                                                                                                               | $V_{DDQ}$               | Supply | Output Power Supply: Provides operating power for output buffers.                                                                                       |
| 3J, 5J                                                                                                                                                               | $V_{ref}$               | Supply | Input Reference: Provides reference voltage for input buffers.                                                                                          |
| 3D, 5D, 3E, 5E, 3F, 5F, 3H, 5H, 3K, 5K,<br>3M, 5M, 3N, 5N, 3P, 5P, 3R                                                                                                | $V_{SS}$                | Supply | Ground.                                                                                                                                                 |
| 4A, 1B, 2B, 4B, 6B, 7B, 1C, 7C, 4G, 4H,<br>1R, 7R, 1T, 2T, 6T, 6U                                                                                                    | NC                      | —      | No Connection: There is no connection to the chip.                                                                                                      |

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## MCM63R818 PIN DESCRIPTIONS

| PBGA Pin Locations                                                                                                                          | Symbol           | Type   | Description                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------|
| 4K                                                                                                                                          | CK               | Input  | Address, data in and control input register clock. Active high.                                                                     |
| 4L                                                                                                                                          | $\overline{CK}$  | Input  | Address, data in and control input register clock. Active low.                                                                      |
| (a) 6D, 7E, 6F, 7G, 6H, 7K, 6L, 6N, 7P<br>(b) 1D, 2E, 2G, 1H, 2K, 1L, 2M, 1N, 2P                                                            | DQx              | I/O    | Synchronous Data I/O.                                                                                                               |
| 4F                                                                                                                                          | $\overline{G}$   | Input  | Output Enable functionality not supported. Must be tied to $V_{SS}$ or driven to $\leq V_{IL}$ max.                                 |
| 2A, 3A, 5A, 6A, 3B, 5B, 2C, 3C, 5C, 6C,<br>4N, 4P, 2R, 6R, 2T, 3T, 5T, 6T                                                                   | SA               | Input  | Synchronous Address Inputs: Registered on the rising clock edge.                                                                    |
| 5L, 3G<br>(a), (b)                                                                                                                          | $\overline{SBx}$ | Input  | Synchronous Byte Write Enable: Enables writes to byte x in conjunction with the SW input. Has no effect on read cycles, active low. |
| 4E                                                                                                                                          | $\overline{SS}$  | Input  | Synchronous Chip Enable: Registered on the rising clock edge, active low.                                                           |
| 4M                                                                                                                                          | $\overline{SW}$  | Input  | Synchronous Write: Registered on the rising clock edge, active low. Writes all enabled bytes.                                       |
| 4U                                                                                                                                          | TCK              | Input  | Test Clock (JTAG).                                                                                                                  |
| 3U                                                                                                                                          | TDI              | Input  | Test Data In (JTAG).                                                                                                                |
| 5U                                                                                                                                          | TDO              | Output | Test Data Out (JTAG).                                                                                                               |
| 2U                                                                                                                                          | TMS              | Input  | Test Mode Select (JTAG).                                                                                                            |
| 4D                                                                                                                                          | ZQ               | Input  | Programmable Output Impedance: Programming pin.                                                                                     |
| 7T                                                                                                                                          | ZZ               | Input  | Enables sleep mode, active high.                                                                                                    |
| 4C, 2J, 4J, 6J, 4R, 5R                                                                                                                      | $V_{DD}$         | Supply | Core Power Supply.                                                                                                                  |
| 1A, 7A, 1F, 7F, 1J, 7J, 1M, 7M, 1U, 7U                                                                                                      | $V_{DDQ}$        | Supply | Output Power Supply: Provides operating power for output buffers.                                                                   |
| 3J, 5J                                                                                                                                      | $V_{ref}$        | Supply | Input Reference: Provides reference voltage for input buffers.                                                                      |
| 3D, 5D, 3E, 5E, 3F, 5F, 5G, 3H, 5H, 3K,<br>5K, 3L, 3M, 5M, 3N, 5N, 3P, 5P, 3R                                                               | $V_{SS}$         | Supply | Ground.                                                                                                                             |
| 4A, 1B, 2B, 4B, 6B, 7B, 1C, 7C, 2D, 7D,<br>1E, 6E, 2F, 1G, 4G, 6G, 2H, 4H, 7H, 1K,<br>6K, 2L, 7L, 6M, 2N, 7N, 1P, 6P, 1R,<br>7R, 1T, 4T, 6U | NC               | —      | No Connection: There is no connection to the chip.                                                                                  |

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## ABSOLUTE MAXIMUM RATINGS (Voltages Referenced to V<sub>SS</sub>, See Note)

| Rating                             | Symbol            | Value       | Unit |
|------------------------------------|-------------------|-------------|------|
| Core Supply Voltage                | V <sub>DD</sub>   | −0.5 to 3.9 | V    |
| Output Supply Voltage              | V <sub>DDQ</sub>  | −0.5 to 2.5 | V    |
| Voltage On Any Pin Other Than JTAG | V <sub>in</sub>   | −0.5 to 2.5 | V    |
| Voltage On Any JTAG Pin            | V <sub>JTAG</sub> | −0.5 to 3.9 | V    |
| Input Current (per I/O)            | I <sub>in</sub>   | ±50         | mA   |
| Output Current (per I/O)           | I <sub>out</sub>  | ±25         | mA   |
| Operating Temperature              | T <sub>A</sub>    | 0 to 70     | °C   |
| Temperature Under Bias             | T <sub>bias</sub> | −10 to 85   | °C   |
| Storage Temperature                | T <sub>stg</sub>  | −55 to 125  | °C   |

NOTE: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

This CMOS memory circuit has been designed to meet the dc and ac specifications shown in the tables, after thermal equilibrium has been established.

This device contains circuitry that will ensure the output devices are in High-Z at power up.

## PBGA PACKAGE THERMAL CHARACTERISTICS

| Rating                                               | Symbol           | Max | Unit | Notes |
|------------------------------------------------------|------------------|-----|------|-------|
| Junction to Ambient (Still Air)                      | R <sub>θJA</sub> | 50  | °C/W | 1, 2  |
| Junction to Ambient (@200 ft/min) Single-Layer Board | R <sub>θJA</sub> | 39  | °C/W | 1, 2  |
| Junction to Ambient (@200 ft/min) Four-Layer Board   | R <sub>θJA</sub> | 27  | °C/W | 3     |
| Junction to Board (Bottom)                           | R <sub>θJB</sub> | 23  | °C/W | 4     |
| Junction to Case (Top)                               | R <sub>θJC</sub> | 1   | °C/W | 5     |

### NOTES:

1. Junction temperature is a function of on-chip power dissipation, package thermal resistance, mounting site (board) temperature, ambient temperature, air flow, power dissipation of other components on the board, and board thermal resistance.
2. Per SEMI G38–87.
3. Measured using a four-layer test board with two internal planes.
4. Indicates the average thermal resistance between the die and the printed circuit board as measured by the ring cold plate method..
5. Indicates the average thermal resistance between the die and the case top surface as measured by the cold plate method (MIL SPEC–883 Method 1012.1).

## CLOCK TRUTH TABLE

| K     | ZZ | SS | SW | SBA | SBB | SBC | SBD | DQ (n) | DQ (n+1)              | Mode                  |
|-------|----|----|----|-----|-----|-----|-----|--------|-----------------------|-----------------------|
| L – H | L  | L  | H  | X   | X   | X   | X   | X      | D <sub>out</sub> 0–35 | Read Cycle All Bytes  |
| L – H | L  | L  | L  | L   | H   | H   | H   | High-Z | D <sub>in</sub> 0–8   | Write Cycle 1st Byte  |
| L – H | L  | L  | L  | H   | L   | H   | H   | High-Z | D <sub>in</sub> 9–17  | Write Cycle 2nd Byte  |
| L – H | L  | L  | L  | H   | H   | L   | H   | High-Z | D <sub>in</sub> 18–26 | Write Cycle 3rd Byte  |
| L – H | L  | L  | L  | H   | H   | H   | L   | High-Z | D <sub>in</sub> 27–35 | Write Cycle 4th Byte  |
| L – H | L  | L  | L  | L   | L   | L   | L   | High-Z | D <sub>in</sub> 0–35  | Write Cycle All Bytes |
| L – H | L  | L  | L  | H   | H   | H   | H   | High-Z | High-Z                | Abort Write Cycle     |
| L – H | L  | H  | H  | X   | X   | X   | X   | X      | High-Z                | Deselect Cycle        |
| L – H | L  | H  | L  | X   | X   | X   | X   | High-Z | High-Z                | Deselect Cycle        |
| X     | H  | X  | X  | X   | X   | X   | X   | High-Z | High-Z                | Sleep Mode            |

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## DC OPERATING CONDITIONS AND CHARACTERISTICS

(2.375 V  $\leq$  V<sub>DD</sub>  $\leq$  3.6 V, 0°C  $\leq$  T<sub>A</sub>  $\leq$  70°C, Unless Otherwise Noted)

### RECOMMENDED OPERATING CONDITIONS (See Notes 1 through 4)

| Parameter                                                                                                                                                                          | Symbol                | Min   | Typical<br>–3 | Typical<br>–3.3 | Typical<br>–3.7 | Typical<br>–4 | Max | Unit | Notes |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-------|---------------|-----------------|-----------------|---------------|-----|------|-------|
| Core Power Supply Voltage                                                                                                                                                          | V <sub>DD</sub>       | 2.375 | —             | —               | —               | —             | 3.6 | V    |       |
| Output Driver Supply Voltage                                                                                                                                                       | V <sub>DDQ</sub>      | 1.4   | —             | —               | —               | —             | 2.0 | V    |       |
| AC Supply Current (Device Selected, All Outputs Open, Freq = Max, V <sub>DD</sub> = Max, V <sub>DDQ</sub> = Max). Includes Supply Currents for V <sub>DD</sub> .                   | I <sub>DD1</sub>      | —     | 400           | 380             | 360             | 340           | —   | mA   | 5     |
| Quiescent Active Power Supply Current (Device Selected, All Outputs Open, Freq = 0, V <sub>DD</sub> = Max, V <sub>DDQ</sub> = Max). Includes Supply Currents for V <sub>DD</sub> . | I <sub>DD2</sub>      | —     | 175           | 175             | 175             | 175           | —   | mA   | 6     |
| Active Standby Power Supply Current (Device Deselected, Freq = Max, V <sub>DD</sub> = Max, V <sub>DDQ</sub> = Max).                                                                | I <sub>SB1</sub>      | —     | 200           | 195             | 190             | 185           | —   | mA   | 7     |
| CMOS Standby Supply Current (Device Deselected, Freq = 0, V <sub>DD</sub> = Max, V <sub>DDQ</sub> = Max, All Inputs Static at CMOS Levels).                                        | I <sub>SB2</sub>      | —     | 175           | 175             | 175             | 175           | —   | mA   | 6, 7  |
| Sleep Mode Current (ZZ = V <sub>IH</sub> , V <sub>DD</sub> = Max, V <sub>DDQ</sub> = Max)                                                                                          | I <sub>ZZ</sub>       | —     | 50            | 50              | 50              | 50            | —   | mA   | 6, 7  |
| Input Reference DC Voltage                                                                                                                                                         | V <sub>ref</sub> (dc) | 0.6   | —             | —               | —               | —             | 1.3 | V    | 8     |

#### NOTES:

1. All data sheet parameters specified to full range of V<sub>DD</sub> unless otherwise noted. All voltages are referenced to voltage applied to V<sub>SS</sub> bumps.
2. Supply voltage applied to V<sub>DD</sub> connections.
3. Supply voltage applied to V<sub>DDQ</sub> connections.
4. All power supply currents measured with outputs open or deselected.
5. All inputs are zero.
6. CMOS levels for I/Os are V<sub>IC</sub>  $\leq$  V<sub>SS</sub> + 0.2 V or  $\geq$  V<sub>DDQ</sub> – 0.2 V.
7. Device deselected as defined by the Clock Truth Table.
8. Although considerable latitude in the selection of the nominal dc value (i.e., rms value) of V<sub>ref</sub> is supported, the peak-to-peak ac component superimposed on V<sub>ref</sub> may not exceed 5% of the dc component of V<sub>ref</sub>.

### DC INPUT CHARACTERISTICS

| Parameter                                            | Symbol                | Min                    | Max                    | Unit | Notes |
|------------------------------------------------------|-----------------------|------------------------|------------------------|------|-------|
| DC Input Logic High                                  | V <sub>IH</sub> (dc)  | V <sub>ref</sub> + 0.1 | V <sub>DDQ</sub> + 0.3 | V    |       |
| DC Input Logic Low                                   | V <sub>IL</sub> (dc)  | –0.3                   | V <sub>ref</sub> – 0.1 | V    | 1     |
| Input Leakage Current                                | I <sub>lkg(I)</sub>   | —                      | ±5                     | μA   | 2     |
| Clock Input Signal Voltage                           | V <sub>in</sub> (dc)  | –0.3                   | 2.5                    | V    |       |
| Clock Input Differential Voltage (See Figure 3)      | V <sub>DIF</sub> (dc) | 0.2                    | 2.5                    | V    | 3     |
| Clock Input Common Mode Voltage Range (See Figure 3) | V <sub>CM</sub> (dc)  | 0.60                   | 1.1                    | V    | 4     |

#### NOTES:

1. Inputs may undershoot to –1.5 V (peak) for up to 35% t<sub>KHKH</sub> (e.g., 1.5 ns at a clock cycle time of 4.4 ns). See Figure 2.
2. 0 V  $\leq$  V<sub>in</sub>  $\leq$  V<sub>DDQ</sub> for all pins.
3. Minimum instantaneous differential input voltage required for differential input clock operation.
4. Maximum rejectable common mode input voltage variation.

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## DC OUTPUT BUFFER CHARACTERISTICS — PROGRAMMABLE IMPEDANCE PUSH-PULL OUTPUT BUFFER MODE

( $2.375\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ ,  $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ ,  $ZQ = I_{ZQ}(\text{out}) (RQ)$ ) (See Notes 1 and 2)

| Parameter                    | Symbol   | Min                             | Max                             | Unit     | Notes |
|------------------------------|----------|---------------------------------|---------------------------------|----------|-------|
| Output Logic Low             | $I_{OL}$ | $(V_{DDQ}/2) / [(RQ/5) + 10\%]$ | $(V_{DDQ}/2) / [(RQ/5) - 10\%]$ | A        | 3     |
| Output Logic High            | $I_{OH}$ | $(V_{DDQ}/2) / [(RQ/5) + 10\%]$ | $(V_{DDQ}/2) / [(RQ/5) - 10\%]$ | A        | 4     |
| Light Load Output Logic Low  | $V_{OL}$ | $V_{SS}$                        | 0.4                             | V        | 5     |
| Light Load Output Logic High | $V_{OH}$ | $V_{DDQ} - 0.4$                 | $V_{DDQ}$                       | V        | 6     |
| Programmable Impedance       | $ZQ$     | $[(RQ/5) - 10\%]$               | $[(RQ/5) + 10\%]$               | $\Omega$ | 7     |

### NOTES:

1. The impedance controlled mode is expected to be used in point-to-point applications, driving high-impedance inputs.
2. The ZQ pin is connected through RQ to  $V_{SS}$  for the controlled impedance mode.
3.  $V_{OL} = V_{DDQ}/2$ .
4.  $V_{OH} = V_{DDQ}/2$ .
5.  $I_{OL} \leq 100\text{ }\mu\text{A}$ .
6.  $|I_{OH}| \leq 100\text{ }\mu\text{A}$ .
7.  $175 \leq RQ \leq 375$ .

## DC OUTPUT BUFFER CHARACTERISTICS — MINIMUM IMPEDANCE PUSH-PULL OUTPUT BUFFER MODE

( $2.375\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ ,  $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ ) (See Notes 1 and 2)

| Parameter                    | Symbol    | Min             | Max       | Unit | Notes |
|------------------------------|-----------|-----------------|-----------|------|-------|
| Output Logic Low             | $V_{OL2}$ | $V_{SS}$        | 0.4       | V    | 3     |
| Output Logic High            | $V_{OH2}$ | $V_{DDQ} - 0.4$ | $V_{DDQ}$ | V    | 4     |
| Light Load Output Logic Low  | $V_{OL3}$ | $V_{SS}$        | 0.2       | V    | 5     |
| Light Load Output Logic High | $V_{OH3}$ | $V_{DDQ} - 0.2$ | $V_{DDQ}$ | V    | 6     |

### NOTES:

1. The push-pull output mode is expected to be used in bussed applications and may be series or parallel terminated. Conforms to the JEDEC Standard JESD8-6 Class I.
2. The ZQ pin is connected to a  $100\text{ }\Omega$  resistor to  $V_{SS}$  to enable the minimum impedance mode.
3.  $I_{OL} \geq 8\text{ mA}$ .
4.  $|I_{OH}| \geq 8\text{ mA}$ .
5.  $I_{OL} \leq 100\text{ }\mu\text{A}$ .
6.  $|I_{OH}| \leq 100\text{ }\mu\text{A}$ .

## CAPACITANCE ( $f = 1.0\text{ MHz}$ , $dV = 30\text{ mV}$ , $2.375\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ , $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ , Periodically Sampled Rather Than 100% Tested)

| Characteristic                  | Symbol    | Typ | Max | Unit |
|---------------------------------|-----------|-----|-----|------|
| Input Capacitance               | $C_{in}$  | 3.2 | 5   | pF   |
| Input/Output Capacitance        | $C_{I/O}$ | 3.8 | 6   | pF   |
| CK, $\overline{CK}$ Capacitance | $C_{CK}$  | 3.7 | 5   | pF   |

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## AC OPERATING CONDITIONS AND CHARACTERISTICS

(2.375 V ≤ V<sub>DD</sub> ≤ 3.6 V, 0°C ≤ T<sub>A</sub> ≤ 70°C, Unless Otherwise Noted)

Input Pulse Levels ..... 0.25 to 1.25 V  
 Input Rise/Fall Time ..... 1 V/ns (20% to 80%)  
 Input Timing Measurement Reference Level ..... 0.75 V  
 Output Timing Reference Level ..... 0.75 V

Clock Input Timing Reference Level ..... Differential Cross-Point  
 ZQ for 50 Ω Impedance ..... 250 Ω  
 R<sub>θJA</sub> Device ..... 22°C/W

### READ/WRITE CYCLE TIMING (See Note 1)

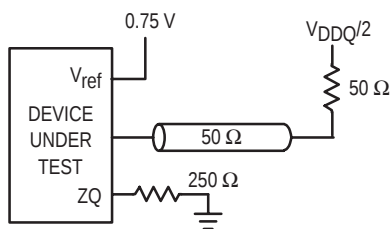
| Parameter                                                         | Symbol                                                                           | 63R736-3<br>63R818-3 |     | 63R736-3.3<br>63R818-3.3 |      | 63R736-3.7<br>63R818-3.7 |      | 63R736-4<br>63R818-4 |     | Unit | Notes |
|-------------------------------------------------------------------|----------------------------------------------------------------------------------|----------------------|-----|--------------------------|------|--------------------------|------|----------------------|-----|------|-------|
|                                                                   |                                                                                  | Min                  | Max | Min                      | Max  | Min                      | Max  | Min                  | Max |      |       |
| Cycle Time                                                        | t <sub>KHKH</sub>                                                                | 3                    | —   | 3.3                      | —    | 3.7                      | —    | 4                    | —   | ns   |       |
| Clock High Pulse Width                                            | t <sub>KHKL</sub>                                                                | 1.2                  | —   | 1.2                      | —    | 1.5                      | —    | 1.5                  | —   | ns   |       |
| Clock Low Pulse Width                                             | t <sub>KLKH</sub>                                                                | 1.2                  | —   | 1.2                      | —    | 1.5                      | —    | 1.5                  | —   | ns   |       |
| Clock High to Output Low-Z                                        | t <sub>KHQX1</sub>                                                               | 0.5                  | —   | 0.5                      | —    | 0.5                      | —    | 0.5                  | —   | ns   | 1, 2  |
| Clock High to Output Valid                                        | t <sub>KHQV</sub>                                                                | —                    | 1.5 | —                        | 1.65 | —                        | 1.85 | —                    | 2   | ns   |       |
| Clock High to Output Hold                                         | t <sub>KHQX</sub>                                                                | 0.5                  | —   | 0.5                      | —    | 0.5                      | —    | 0.5                  | —   | ns   | 1     |
| Clock High to Output High-Z                                       | t <sub>KHQZ</sub>                                                                | —                    | 1.5 | —                        | 1.65 | —                        | 1.85 | —                    | 2   | ns   | 1, 3  |
| ZZ High to Sleep Mode                                             | t <sub>ZZE</sub>                                                                 | 3                    | —   | 3.3                      | —    | 3.7                      | —    | 4                    | —   | ns   |       |
| ZZ Low to Recovery                                                | t <sub>ZZR</sub>                                                                 | —                    | 10  | —                        | 10   | —                        | 10   | —                    | 10  | ns   |       |
| Setup Times:<br>Address<br>Data In<br>Chip Select<br>Write Enable | t <sub>AVKH</sub><br>t <sub>DVKH</sub><br>t <sub>SVKH</sub><br>t <sub>WVKH</sub> | 0.5                  | —   | 0.5                      | —    | 0.5                      | —    | 0.5                  | —   | ns   |       |
| Hold Times:<br>Address<br>Data In<br>Chip Select<br>Write Enable  | t <sub>KHAX</sub><br>t <sub>KHDX</sub><br>t <sub>KHSX</sub><br>t <sub>KHWX</sub> | 0.5                  | —   | 0.5                      | —    | 0.5                      | —    | 0.5                  | —   | ns   |       |

#### NOTES:

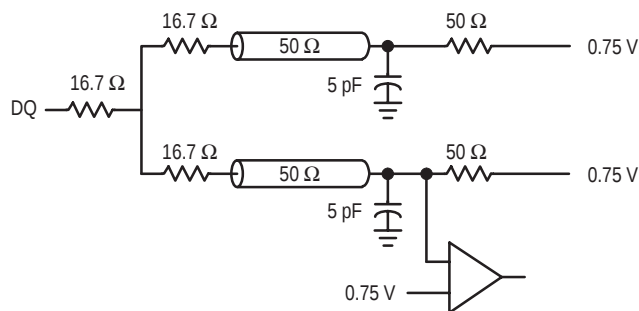
1. This parameter is sampled and not 100% tested.
2. Measured at ±200 mV from steady state.
3. Measured at ±200 mV from steady state. See Test Load Figure 1b.

## TIMING LIMITS

The table of timing values shows either a minimum or a maximum limit for each parameter. Input requirements are specified from the external system point of view. Thus, address setup time is shown as a minimum since the system must supply at least that much time. On the other hand, responses from the memory are specified from the device point of view. Thus, the access time is shown as a maximum since the device never provides data later than that time.



a. Test Load



b. Test Load

Figure 1. Test Loads

### AC INPUT CHARACTERISTICS (See Note 1)

| Parameter                                | Symbol         | Min                        | Max                        | Notes |
|------------------------------------------|----------------|----------------------------|----------------------------|-------|
| AC Input Logic High (See Figure 4)       | $V_{IH} (ac)$  | $V_{ref} + 200 \text{ mV}$ | —                          |       |
| AC Input Logic Low (See Figures 2 and 4) | $V_{IL} (ac)$  | —                          | $V_{ref} - 200 \text{ mV}$ | 2     |
| Input Reference Peak-to-Peak AC Voltage  | $V_{ref} (ac)$ | —                          | 5% $V_{ref} (dc)$          | 3     |
| Clock Input Differential Voltage         | $V_{dif} (ac)$ | 400 mV                     | $V_{DDQ} + 500 \text{ mV}$ | 4     |

#### NOTES:

- Inputs may overshoot to  $V_{DDQ} + 1.5 \text{ V}$  (peak) for up to 35%  $t_{KHKH}$  (e.g., 1.5 ns at a clock cycle time of 4.4 ns). See Figure 2.
- Inputs may undershoot to  $-1.5 \text{ V}$  (peak) for up to 35%  $t_{KHKH}$  (e.g., 1.5 ns at a clock cycle time of 4.4 ns). See Figure 2.
- Although considerable latitude in the selection of the nominal dc value (i.e., rms value) of  $V_{ref}$  is supported, the peak-to-peak ac component superimposed on  $V_{ref}$  may not exceed 5% of the dc component of  $V_{ref}$ .
- Minimum instantaneous differential input voltage required for differential input clock operation.

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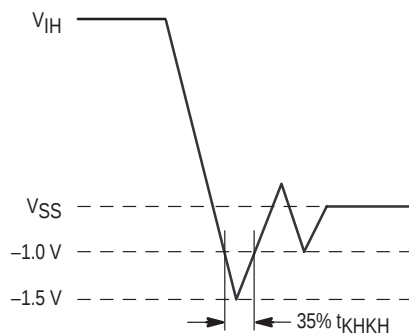


Figure 2. Undershoot Voltage

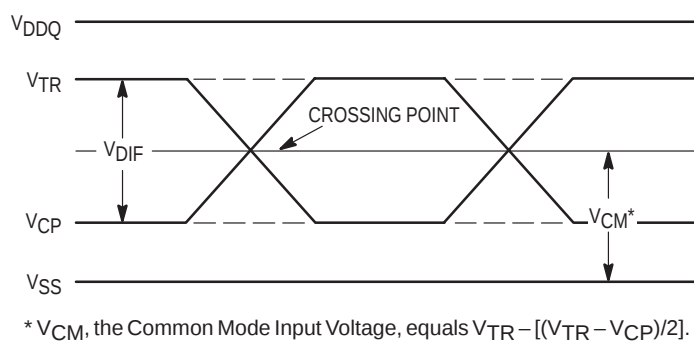


Figure 3. Differential Inputs/Common Mode Input Voltage

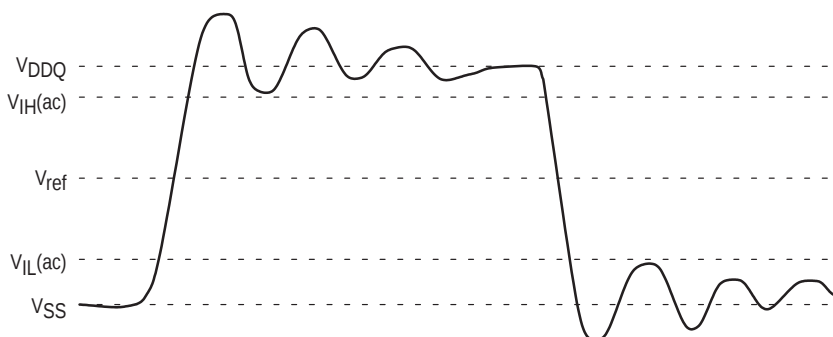
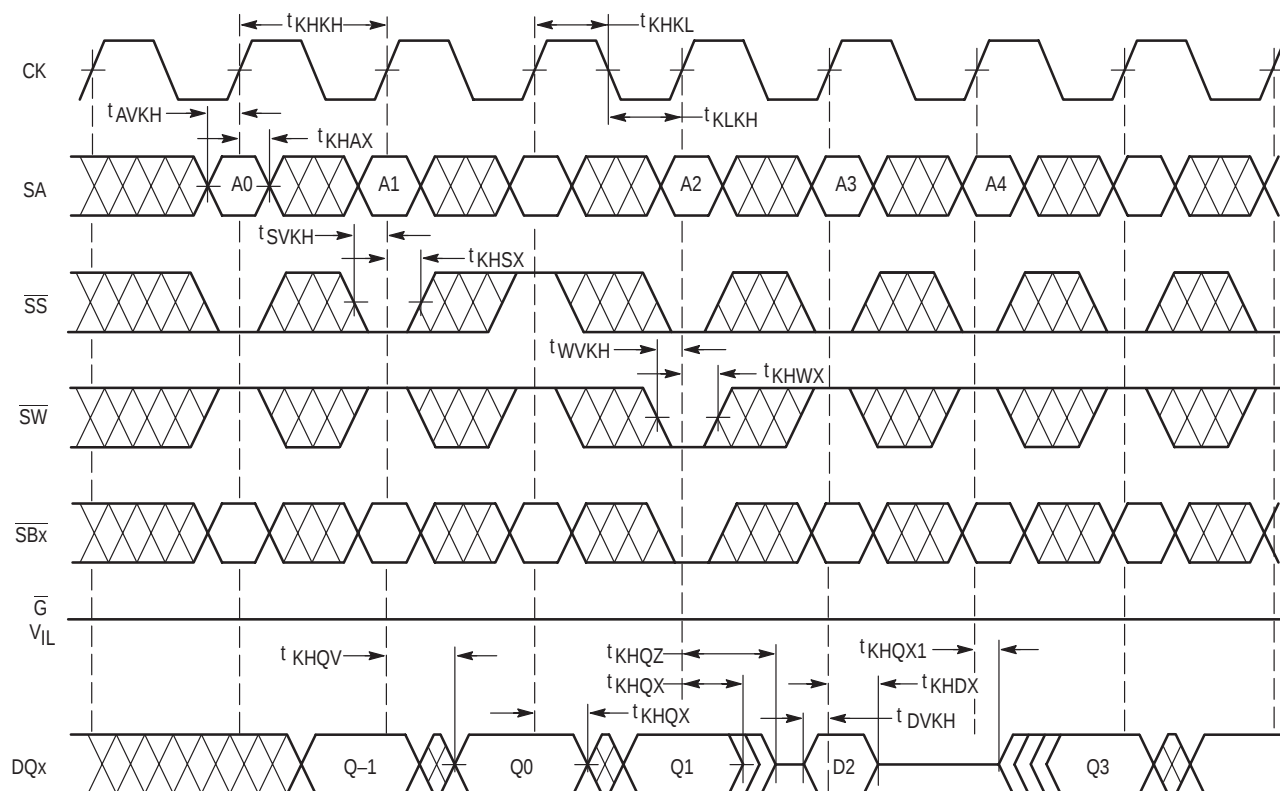


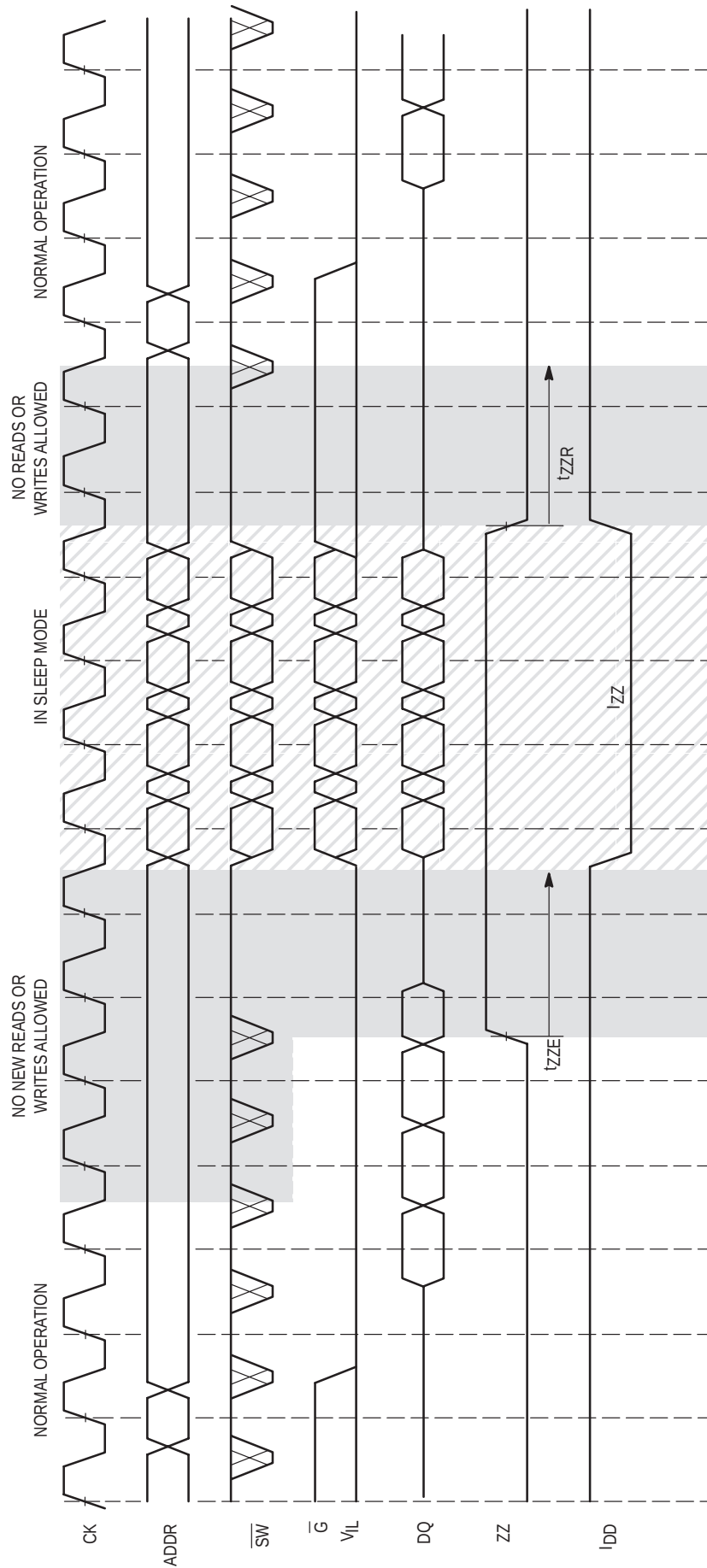
Figure 4. AC Input Conditions

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## REGISTER/REGISTER READ-WRITE-READ CYCLES



SLEEP MODE TIMING



## FUNCTIONAL OPERATION

### READ AND WRITE OPERATIONS

All control signals are registered on the rising edge of the CK clock. These signals must meet the setup and hold times shown in the AC Characteristics table. On the rising edge of the following clock, read data is clocked into the output register and available at the outputs at  $t_{KHQV}$ . During this same cycle a new read address can be applied to the address pins.

A deselect cycle (dead cycle) must occur prior to a write cycle. Read cycles may follow write cycles immediately.

$\overline{SS}$  and  $\overline{SW}$  control output drive. Chip deselect via a high on  $\overline{SS}$  at the rising edge of the CK clock has its effect on the output drivers after the next rising edge of the CK clock.  $\overline{SW}$  low deselects the output drivers immediately (on the same cycle).

Output data will be available at  $t_{KHQV}$ . Outputs will begin driving at  $t_{KHQX1}$ . Outputs will hold previous data until  $t_{KHQX}$  or  $t_{GHQX}$ .

### WRITE AND BYTE WRITE FUNCTIONS

Note that in the following discussion the term "byte" refers to nine bits of the RAM I/O bus. In all cases, the timing parameters described for synchronous write input ( $\overline{SW}$ ) apply to each of the byte write enable inputs ( $\overline{SBa}$ ,  $\overline{SBb}$ , etc.).

Byte write enable inputs have no effect on read cycles. This allows the system designer not interested in performing byte writes to connect the byte enable inputs to active low ( $V_{SS}$ ). Reads of all bytes proceed normally and write cycles, activated via a low on  $\overline{SW}$ , and the rising edge of the CK clock, write the entire RAM I/O width. This way the designer is spared having to drive multiple write input buffer loads.

Byte writes are performed using the byte write enable inputs in conjunction with the synchronous write input ( $\overline{SW}$ ). It is important to note that writing any one byte will inhibit a read of all bytes at the current address. The RAM can not simultaneously read one byte and write another at the same address. A write cycle initiated with none of the byte write enable inputs active is neither a read or a write. No write will

occur, but the outputs will be deselected as in a normal write cycle.

### LATE WRITE

The write address is sampled on the first rising edge of clock, and write data is sampled on the following rising edge.

The late write feature is implemented with single stage write buffering. Write buffering is transparent to the user. A comparator monitors the address bus and, when necessary, routes buffer contents to the outputs to assure coherent operation. This occurs in all cases, whether there is a byte write or a full word is written.

### PROGRAMMABLE IMPEDANCE OPERATION

The designer can program the RAMs output buffer impedance by terminating the  $\overline{ZQ}$  pin to  $V_{SS}$  through a precision resistor ( $RQ$ ). The value of  $RQ$  is five times the output impedance desired. For example, 250  $\Omega$  resistor will give an output impedance of 50  $\Omega$ .

Impedance updates occur during write and deselect cycles.

The actual change in the impedance occurs in small increments and is binary. The binary impedance has 256 values and therefore, there are no significant disturbances that occur on the output because of this smooth update method.

At power up, the output impedance will take up to 65,000 cycles for the impedance to be completely updated. At recovery from sleep mode, the previously programmed value will be recovered.

### POWER UP AND INITIALIZATION

The following supply voltage application sequence is recommended:  $V_{SS}$ ,  $V_{DD}$ , then  $V_{DDQ}$ . Please note, per the Absolute Maximum Ratings table,  $V_{DDQ}$  is not to exceed  $V_{DDQ} + 0.5$  V or 2.5 V max, whatever the instantaneous value of  $V_{DD}$ . Once supplies have reached specification levels, a minimum dwell of 1.0 ms with CK clock inputs cycling is required before beginning normal operations. At power up the output impedance will be set at approximately 50  $\Omega$  as stated above.

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## SLEEP MODE

This device is equipped with an optional sleep or low power mode. The sleep mode pin is asynchronous and active high. During normal operation, the ZZ pin is pulled low. When ZZ is pulled high, the chip will enter sleep mode where the device will meet the lowest possible power conditions. The Sleep Mode Timing diagram shows the modes of operation: Normal Operation, No Read/Write Allowed, and Sleep Mode.

### Normal Operation

All inputs must meet setup and hold times prior to sleep and  $t_{ZZR}$  nanoseconds after recovering from sleep. Clock (CK) must also meet cycle high and low times during these periods. Two cycles prior to sleep, initiation of either a read or write operation is not allowed.

### No Read/Write Allowed

During the period of time just prior to sleep and during recovery from sleep, the assertion of any write or read signal is not allowed. If a write or read operation occurs during these periods, the memory array may be corrupted. Validity of data out from the RAM can not be guaranteed immediately after ZZ is asserted (prior to being in sleep). During sleep mode recovery, the output impedance must be given additional time above and beyond  $t_{ZZR}$  in order to match desired impedance (see explanation in **Output Impedance Circuitry** paragraph).

### Sleep Mode

The RAM automatically deselects itself. The RAM disconnects its internal clock buffer. The external clock may continue to run without impacting the RAMs sleep current ( $I_{ZZ}$ ). All outputs will remain in a High-Z state while in sleep mode. All inputs are allowed to toggle. The RAM will not be selected, and will not perform any reads or writes.

## SERIAL BOUNDARY SCAN TEST ACCESS PORT OPERATION

### OVERVIEW

The serial boundary scan test access port (TAP) on this RAM is designed to operate in a manner consistent with IEEE Standard 1149.1–1990 (commonly referred to as JTAG), but does not implement all of the functions required for IEEE 1149.1 compliance. Certain functions have been modified or eliminated because their implementation places extra delays in the RAMs critical speed path. Nevertheless, the RAM supports the standard TAP controller architecture. The TAP controller is the state machine that controls the TAPs operation and can be expected to function in a manner that does not conflict with the operation of devices with IEEE

1149.1 compliant TAPs. The TAP operates using conventional JEDEC Standard 8–1B low voltage (3.3 V) TTL/CMOS logic level signaling.

### DISABLING THE TEST ACCESS PORT

It is possible to use this device without utilizing the TAP. To disable the TAP controller without interfering with normal operation of the device, TCK must be tied to  $V_{SS}$  to preclude mid-level inputs. TDI and TMS are designed so an undriven input will produce a response identical to the application of a logic 1, and may be left unconnected. But they may also be tied to  $V_{DD}$  through a 1 k resistor. TDO should be left unconnected.

### TAP DC OPERATING CHARACTERISTICS

(2.375 V  $\leq V_{DD} \leq 3.6$  V, 0°C  $\leq T_A \leq 70$ °C, Unless Otherwise Noted)

| Parameter                   | Symbol    | Min            | Max            | Unit    | Notes |
|-----------------------------|-----------|----------------|----------------|---------|-------|
| Logic Input Logic High      | $V_{IH1}$ | 1.2            | $V_{DD} + 0.3$ | V       |       |
| Logic Input Logic Low       | $V_{IL1}$ | –0.3           | 0.4            | V       |       |
| Logic Input Leakage Current | $I_{lkg}$ | —              | $\pm 5$        | $\mu A$ | 1     |
| CMOS Output Logic Low       | $V_{OL1}$ | —              | 0.2            | V       | 2     |
| CMOS Output Logic High      | $V_{OH1}$ | $V_{DD} - 0.2$ | —              | V       | 3     |
| TTL Output Logic Low        | $V_{OL2}$ | —              | 0.4            | V       | 4     |
| TTL Output Logic High       | $V_{OH2}$ | 2.4            | —              | V       | 5     |

#### NOTES:

1. 0 V  $\leq V_{in} \leq V_{DD}$  for all logic input pins.
2.  $I_{OL1} \leq 100 \mu A$  @  $V_{OL} = 0.2$  V. Sampled, not 100% tested.
3.  $|I_{OH1}| \leq 100 \mu A$  @  $V_{DDQ} - 0.2$  V. Sampled, not 100% tested.
4.  $I_{OL2} \leq 8$  mA @  $V_{OL} = 0.4$  V.
5.  $|I_{OH2}| \leq 8$  mA @  $V_{OH} = 2.4$  V.

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## TAP AC OPERATING CONDITIONS AND CHARACTERISTICS

(2.375 V ≤ V<sub>DD</sub> ≤ 3.6 V, 0°C ≤ T<sub>A</sub> ≤ 70°C, Unless Otherwise Noted)

Input Pulse Levels ..... 0 to 3.0 V  
 Input Rise/Fall Time ..... 1 V/ns (20% to 80%)  
 Input Timing Measurement Reference Level ..... 1.5 V  
 Output Timing Reference Level ..... 1.5 V

Output Test Load ..... 50 Ω Parallel Terminated T-Line with 20 pF Receiver Input Capacitance  
 Test Load Termination Supply Voltage (V<sub>T</sub>) ..... 1.5 V

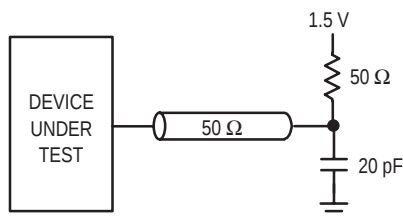
### TAP CONTROLLER TIMING

| Parameter                  | Symbol            | Min | Max | Unit | Notes |
|----------------------------|-------------------|-----|-----|------|-------|
| Cycle Time                 | t <sub>THTH</sub> | 100 | —   | ns   |       |
| Clock High Time            | t <sub>THTL</sub> | 40  | —   | ns   |       |
| Clock Low Time             | t <sub>TLTH</sub> | 40  | —   | ns   |       |
| TMS Setup                  | t <sub>MVTH</sub> | 10  | —   | ns   |       |
| TMS Hold                   | t <sub>THMX</sub> | 10  | —   | ns   |       |
| TDI Valid to TCK High      | t <sub>DVTH</sub> | 10  | —   | ns   |       |
| TCK High to TDI Don't Care | t <sub>THDX</sub> | 10  | —   | ns   |       |
| Capture Setup              | t <sub>CS</sub>   | 10  | —   | ns   | 1     |
| Capture Hold               | t <sub>CH</sub>   | 10  | —   | ns   | 1     |
| TCK Low to TDO Unknown     | t <sub>TLQX</sub> | 0   | —   | ns   |       |
| TCK Low to TDO Valid       | t <sub>TLOV</sub> | —   | 20  | ns   |       |

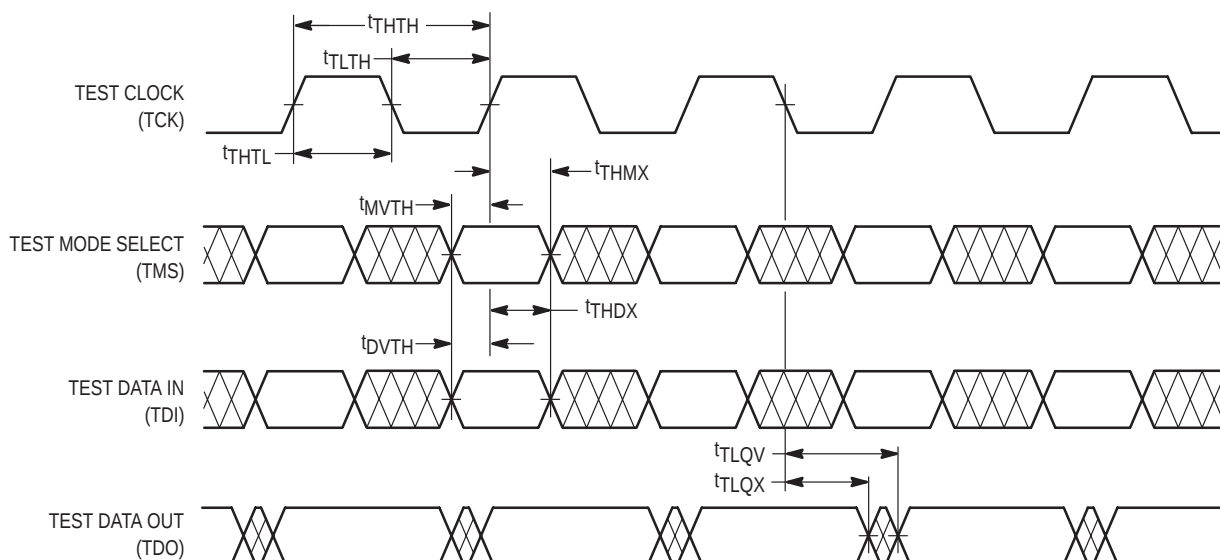
NOTE:

1. t<sub>CS</sub> + t<sub>CH</sub> defines the minimum pause in RAM I/O pad transitions to assure accurate pad data capture.

### AC TEST LOAD



### TAP CONTROLLER TIMING DIAGRAM



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## TEST ACCESS PORT PINS

### TCK — TEST CLOCK (INPUT)

Clocks all TAP events. All inputs are captured on the rising edge of TCK and all outputs propagate from the falling edge of TCK.

### TMS — TEST MODE SELECT (INPUT)

The TMS input is sampled on the rising edge of TCK. This is the command input for the TAP controller state machine. An undriven TMS input will produce the same result as a logic 1 input level (not IEEE 1149.1 compliant).

### TDI — TEST DATA IN (INPUT)

The TDI input is sampled on the rising edge of TCK. This is the input side of the serial registers placed between TDI and TDO. The register placed between TDI and TDO is determined by the state of the TAP controller state machine and the instruction that is currently loaded in the TAP instruction register (refer to Figure 6). An undriven TDI pin will produce the same result as a logic 1 input level (not IEEE 1149.1 compliant).

### TDO — TEST DATA OUT (OUTPUT)

Output that is active depending on the state of the TAP state machine (refer to Figure 6). Output changes in response to the falling edge of TCK. This is the output side of the serial registers placed between TDI and TDO.

### $\overline{\text{TRST}}$ — TAP RESET

This device does not have a  $\overline{\text{TRST}}$  pin.  $\overline{\text{TRST}}$  is optional in IEEE 1149.1. The test-logic-reset state is entered while TMS is held high for five rising edges of TCK. Power-on reset circuitry is included internally. This type of reset does not affect the operation of the system logic. The reset affects test logic only.

## TEST ACCESS PORT REGISTERS

### OVERVIEW

The various TAP registers are selected (one at a time) via the sequences of 1s and 0s input to the TMS pin as the TCK is strobed. Each of the TAPs registers are serial shift registers that capture serial input data on the rising edge of TCK and push serial data out on subsequent falling edge of TCK. When a register is selected it is “placed” between the TDI and TDO pins.

### INSTRUCTION REGISTER

The instruction register holds the instructions that are executed by the TAP controller when it is moved into the run test/idle or the various data register states. The instructions are 3 bits long. The register can be loaded when it is placed between the TDI and TDO pins. The instruction register is automatically preloaded with the IDCODE instruction at power up or whenever the controller is placed in test-logic-reset state.

### BYPASS REGISTER

The bypass register is a single bit register that can be placed between TDI and TDO. It allows serial test data to be passed through the RAMs TAP to another device in the scan chain with as little delay as possible.

## BOUNDARY SCAN REGISTER

The boundary scan register is identical in length to the number of active input and I/O connections on the RAM (not counting the TAP pins). This also includes a number of place holder locations (always set to a logic 1) reserved for density upgrade address pins. There are a total of 70 bits in the case of the x36 device and 51 bits in the case of the x18 device. The boundary scan register, under the control of the TAP controller, is loaded with the contents of the RAMs I/O ring when the controller is in capture-DR state and then is placed between the TDI and TDO pins when the controller is moved to shift-DR state. Several TAP instructions can be used to activate the boundary scan register.

The Bump/Bit Scan Order tables describe which device bump connects to each boundary scan register location. The first column defines the bit's position in the boundary scan register. The shift register bit nearest TDO (i.e., first to be shifted out) is defined as bit 1. The second column is the name of the input or I/O at the bump and the third column is the bump number.

## IDENTIFICATION (ID) REGISTER

The ID register is a 32-bit register that is loaded with a device and vendor specific 32-bit code when the controller is put in capture-DR state with the IDCODE command loaded in the instruction register. The code is loaded from a 32-bit on-chip ROM. It describes various attributes of the RAM as indicated below. The register is then placed between the TDI and TDO pins when the controller is moved into shift-DR state. Bit 0 in the register is the LSB and the first to reach TDO when shifting begins.

### ID Register Presence Indicator

|         |   |
|---------|---|
| Bit No. | 0 |
| Value   | 1 |

### Motorola JEDEC ID Code (Compressed Format, per IEEE Standard 1149.1 – 1990)

|         |    |    |   |   |   |   |   |   |   |   |   |
|---------|----|----|---|---|---|---|---|---|---|---|---|
| Bit No. | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Value   | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |

### Reserved For Future Use

|         |    |    |    |    |    |    |
|---------|----|----|----|----|----|----|
| Bit No. | 17 | 16 | 15 | 14 | 13 | 12 |
| Value   | x  | x  | x  | x  | x  | x  |

### Device Width

| Configuration | Bit No. | 22 | 21 | 20 | 19 | 18 |
|---------------|---------|----|----|----|----|----|
| 128K x 36     | Value   | 0  | 0  | 1  | 0  | 0  |
| 256K x 18     | Value   | 0  | 0  | 0  | 1  | 1  |

### Device Depth

| Configuration | Bit No. | 27 | 26 | 25 | 24 | 23 |
|---------------|---------|----|----|----|----|----|
| 128K x 36     | Value   | 0  | 0  | 1  | 0  | 1  |
| 256K x 18     | Value   | 0  | 0  | 1  | 1  | 0  |

### Revision Number

|         |    |    |    |    |
|---------|----|----|----|----|
| Bit No. | 31 | 30 | 29 | 28 |
| Value   | x  | x  | x  | x  |

Figure 5. ID Register Bit Meanings

## Freescale Semiconductor, Inc.

MCM63R736 Bump/Bit Scan Order

| Bit No. | Signal Name      | Bump ID | Bit No. | Signal Name      | Bump ID |
|---------|------------------|---------|---------|------------------|---------|
| 1       | M2               | 5R      | 36      | SA               | 3B      |
| 2       | SA               | 4P      | 37      | NC               | 2B      |
| 3       | SA               | 4T      | 38      | SA               | 3A      |
| 4       | SA               | 6R      | 39      | SA               | 3C      |
| 5       | SA               | 5T      | 40      | SA               | 2C      |
| 6       | ZZ               | 7T      | 41      | SA               | 2A      |
| 7       | DQa              | 6P      | 42      | DQc              | 2D      |
| 8       | DQa              | 7P      | 43      | DQc              | 1D      |
| 9       | DQa              | 6N      | 44      | DQc              | 2E      |
| 10      | DQa              | 7N      | 45      | DQc              | 1E      |
| 11      | DQa              | 6M      | 46      | DQc              | 2F      |
| 12      | DQa              | 6L      | 47      | DQc              | 2G      |
| 13      | DQa              | 7L      | 48      | DQc              | 1G      |
| 14      | DQa              | 6K      | 49      | DQc              | 2H      |
| 15      | DQa              | 7K      | 50      | DQc              | 1H      |
| 16      | $\overline{SBa}$ | 5L      | 51      | $\overline{SBc}$ | 3G      |
| 17      | $\overline{CK}$  | 4L      | 52      | ZQ               | 4D      |
| 18      | CK               | 4K      | 53      | $\overline{SS}$  | 4E      |
| 19      | $\overline{G}$   | 4F      | 54      | NC               | 4G      |
| 20      | $\overline{SBb}$ | 5G      | 55      | NC               | 4H      |
| 21      | DQb              | 7H      | 56      | $\overline{SW}$  | 4M      |
| 22      | DQb              | 6H      | 57      | $\overline{SBd}$ | 3L      |
| 23      | DQb              | 7G      | 58      | DQd              | 1K      |
| 24      | DQb              | 6G      | 59      | DQd              | 2K      |
| 25      | DQb              | 6F      | 60      | DQd              | 1L      |
| 26      | DQb              | 7E      | 61      | DQd              | 2L      |
| 27      | DQb              | 6E      | 62      | DQd              | 2M      |
| 28      | DQb              | 7D      | 63      | DQd              | 1N      |
| 29      | DQb              | 6D      | 64      | DQd              | 2N      |
| 30      | SA               | 6A      | 65      | DQd              | 1P      |
| 31      | SA               | 6C      | 66      | DQd              | 2P      |
| 32      | SA               | 5C      | 67      | SA               | 3T      |
| 33      | SA               | 5A      | 68      | SA               | 2R      |
| 34      | NC               | 6B      | 69      | SA               | 4N      |
| 35      | SA               | 5B      | 70      | M1               | 3R      |

MCM63R818 Bump/Bit Scan Order

| Bit No. | Signal Name      | Bump ID | Bit No. | Signal Name      | Bump ID |
|---------|------------------|---------|---------|------------------|---------|
| 1       | M2               | 5R      | 36      | $\overline{SBb}$ | 3G      |
| 2       | SA               | 6T      | 37      | ZQ               | 4D      |
| 3       | SA               | 4P      | 38      | $\overline{SS}$  | 4E      |
| 4       | SA               | 6R      | 39      | NC               | 4G      |
| 5       | SA               | 5T      | 40      | NC               | 4H      |
| 6       | ZZ               | 7T      | 41      | $\overline{SW}$  | 4M      |
| 7       | DQa              | 7P      | 42      | DQb              | 2K      |
| 8       | DQa              | 6N      | 43      | DQb              | 1L      |
| 9       | DQa              | 6L      | 44      | DQb              | 2M      |
| 10      | DQa              | 7K      | 45      | DQb              | 1N      |
| 11      | $\overline{SBa}$ | 5L      | 46      | DQb              | 2P      |
| 12      | $\overline{CK}$  | 4L      | 47      | SA               | 3T      |
| 13      | CK               | 4K      | 48      | SA               | 2R      |
| 14      | $\overline{G}$   | 4F      | 49      | SA               | 4N      |
| 15      | DQa              | 6H      | 50      | SA               | 2T      |
| 16      | DQa              | 7G      | 51      | M1               | 3R      |
| 17      | DQa              | 6F      |         |                  |         |
| 18      | DQa              | 7E      |         |                  |         |
| 19      | DQa              | 6D      |         |                  |         |
| 20      | SA               | 6A      |         |                  |         |
| 21      | SA               | 6C      |         |                  |         |
| 22      | SA               | 5C      |         |                  |         |
| 23      | SA               | 5A      |         |                  |         |
| 24      | NC               | 6B      |         |                  |         |
| 25      | SA               | 5B      |         |                  |         |
| 26      | SA               | 3B      |         |                  |         |
| 27      | NC               | 2B      |         |                  |         |
| 28      | SA               | 3A      |         |                  |         |
| 29      | SA               | 3C      |         |                  |         |
| 30      | SA               | 2C      |         |                  |         |
| 31      | SA               | 2A      |         |                  |         |
| 32      | DQb              | 1D      |         |                  |         |
| 33      | DQb              | 2E      |         |                  |         |
| 34      | DQb              | 2G      |         |                  |         |
| 35      | DQb              | 1H      |         |                  |         |

## NOTES:

1. The NC pads listed in this table are indeed no connects, but are represented in the boundary scan register by a "place holder" bit that is forced to logic 1. These pads are reserved for use as address inputs on higher density RAMs that follow this pad out and scan order standard.
2. In scan mode, differential inputs CK and  $\overline{CK}$  are referenced to each other and must be at opposite logic levels for reliable operation.
3. ZQ, M1, and M2 are not ordinary inputs and may not respond to standard I/O logic levels. ZQ, M1, and M2 must be driven to within 100 mV of a  $V_{DD}$  or  $V_{SS}$  supply rail to ensure consistent results.
4. ZZ must remain at  $V_{IL}$  during boundary scan to ensure consistent results.

**TAP CONTROLLER INSTRUCTION SET****OVERVIEW**

There are two classes of instructions defined in the IEEE Standard 1149.1–1990; the standard (public) instructions and device specific (private) instructions. Some public instructions, are mandatory for IEEE 1149.1 compliance. Optional public instructions must be implemented in prescribed ways.

Although the TAP controller in this device follows the IEEE 1149.1 conventions, it is not IEEE 1149.1 compliant because some of the mandatory instructions are not fully implemented. The TAP on this device may be used to monitor all input and I/O pads, but can not be used to load address, data, or control signals into the RAM or to preload the I/O buffers. In other words, the device will not perform IEEE 1149.1 EXTEST, INTEST, or the preload portion of the SAMPLE/PRELOAD command.

When the TAP controller is placed in capture–IR state, the two least significant bits of the instruction register are loaded with 01. When the controller is moved to the shift–IR state the instruction register is placed between TDI and TDO. In this state, the desired instruction is serially loaded through the TDI input (while the previous contents are shifted out at TDO). For all instructions, the TAP executes newly loaded instructions only when the controller is moved to update–IR state. The TAP instruction sets for this device are listed in the following tables.

**STANDARD (PUBLIC) INSTRUCTIONS****BYPASS**

The BYPASS instruction is loaded in the instruction register when the bypass register is placed between TDI and TDO. This occurs when the TAP controller is moved to the shift–DR state. This allows the board level scan path to be shortened to facilitate testing of other devices in the scan path.

**SAMPLE/PRELOAD**

SAMPLE/PRELOAD is an IEEE 1149.1 mandatory public instruction. When the SAMPLE/PRELOAD instruction is loaded in the instruction register, moving the TAP controller into the capture–DR state loads the data in the RAMs input and I/O buffers into the boundary scan register. Because the RAM clock(s) are independent from the TAP clock (TCK), it is possible for the TAP to attempt to capture the I/O ring contents while the input buffers are in transition (i.e., in a metastable state). Although allowing the TAP to sample metastable inputs will not harm the device, repeatable results can not be

expected. RAM input signals must be stabilized for long enough to meet the TAPs input data capture setup plus hold time ( $t_{CS}$  plus  $t_{CH}$ ). The RAMs clock inputs need not be paused for any other TAP operation except capturing the I/O ring contents into the boundary scan register.

Moving the controller to shift–DR state then places the boundary scan register between the TDI and TDO pins. Because the PRELOAD portion of the command is not implemented in this device, moving the controller to the update–DR state with the SAMPLE/PRELOAD instruction loaded in the instruction register has the same effect as the pause–DR command. This functionality is not IEEE 1149.1 compliant.

**EXTEST**

EXTEST is an IEEE 1149.1 mandatory public instruction. It is to be executed whenever the instruction register, whatever length it may be in the device, is loaded with all logic 0s. EXTEST is not implemented in this device. Therefore, this device is not IEEE 1149.1 compliant. Nevertheless, this RAMs TAP does respond to an all 0s instruction, as follows. With the EXTEST (000) instruction loaded in the instruction register, the RAM responds just as it does in response to the SAMPLE/PRELOAD instruction described above, except the DQ pins are forced to High–Z any time the instruction is loaded.

**IDCODE**

The IDCODE instruction causes the ID ROM to be loaded into the ID register when the controller is in capture–DR mode and places the ID register between the TDI and TDO pins in shift–DR mode. The IDCODE instruction is the default instruction loaded in at power up and any time the controller is placed in the test–logic–reset state.

**THE DEVICE SPECIFIC (PUBLIC) INSTRUCTION****SAMPLE–Z**

If the SAMPLE–Z instruction is loaded in the instruction register, all DQ pins are forced to an inactive drive state (High–Z) and the boundary scan register is connected between TDI and TDO when the TAP controller is moved to the shift–DR state.

**THE DEVICE SPECIFIC (PRIVATE) INSTRUCTION****NO OP**

Do not use these instructions; they are reserved for future use.

# Freescale Semiconductor, Inc.

## STANDARD (PUBLIC) INSTRUCTION CODES

| Instruction    | Code* | Description                                                                                                                                                                                          |
|----------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EXTEST         | 000   | Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Forces all DQ pins to High-Z state. <b>NOT IEEE 1149.1 COMPLIANT.</b>                                             |
| IDCODE         | 001** | Preloads ID register and places it between TDI and TDO. Does not affect RAM operation.                                                                                                               |
| SAMPLE/PRELOAD | 100   | Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Does not affect RAM operation. Does not implement IEEE 1149.1 PRELOAD function. <b>NOT IEEE 1149.1 COMPLIANT.</b> |
| BYPASS         | 111   | Places bypass register between TDI and TDO. Does not affect RAM operation.                                                                                                                           |
| SAMPLE-Z       | 010   | Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Forces all DQ pins to High-Z state.                                                                               |

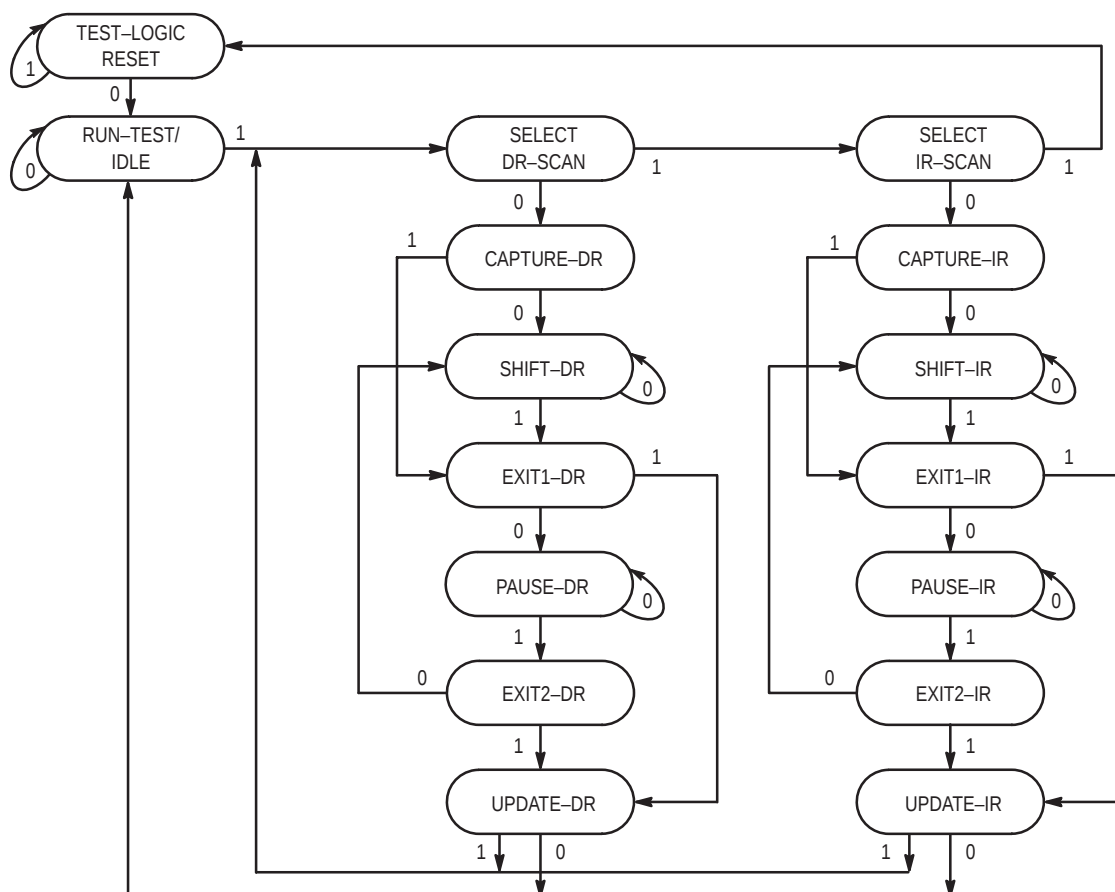
\* Instruction codes expressed in binary; MSB on left, LSB on right.

\*\* Default instruction automatically loaded at power up and in test-logic-reset state.

## STANDARD (PRIVATE) INSTRUCTION CODES

| Instruction | Code* | Description                                                      |
|-------------|-------|------------------------------------------------------------------|
| NO OP       | 011   | Do not use these instructions; they are reserved for future use. |
| NO OP       | 101   | Do not use these instructions; they are reserved for future use. |
| NO OP       | 110   | Do not use these instructions; they are reserved for future use. |

\* Instruction codes expressed in binary, MSB on left, LSB on right.



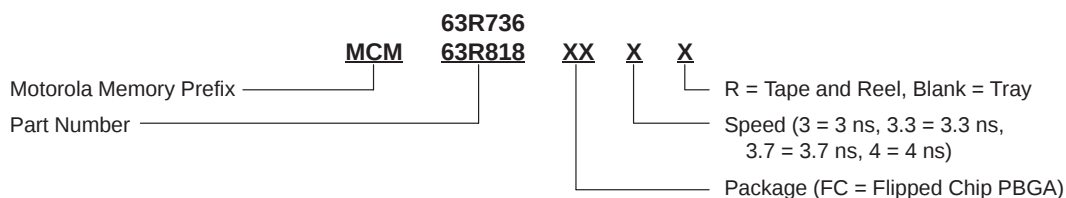
NOTE: The value adjacent to each state transition represents the signal present at TMS at the rising edge of TCK.

Figure 6. TAP Controller State Diagram

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## ORDERING INFORMATION

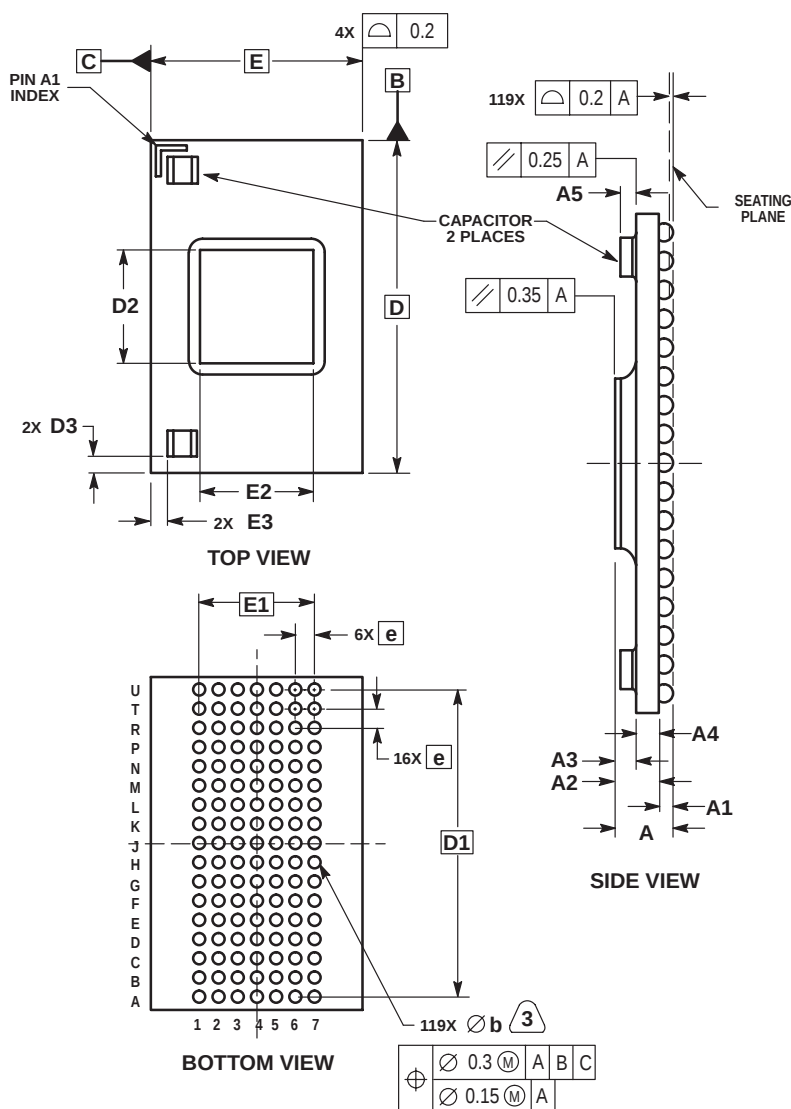
(Order by Full Part Number)



|                     |                |                |                 |                 |
|---------------------|----------------|----------------|-----------------|-----------------|
| Full Part Numbers — | MCM63R736FC3   | MCM63R818FC3   | MCM63R736FC3R   | MCM63R818FC3R   |
|                     | MCM63R736FC3.3 | MCM63R818FC3.3 | MCM63R736FC3.3R | MCM63R818FC3.3R |
|                     | MCM63R736FC3.7 | MCM63R818FC3.7 | MCM63R736FC3.7R | MCM63R818FC3.7R |
|                     | MCM63R736FC4   | MCM63R818FC4   | MCM63R736FC4R   | MCM63R818FC4R   |

## PACKAGE DIMENSIONS

### FC PACKAGE 119-BUMP FLIP CHIP PBGA CASE 999E-01



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M,1992.
  2. ALL DIMENSIONS IN MILLIMETERS.
  3. DIMENSION b IS THE MAXIMUM SOLDER BALL DIAMETER MEASURED PARALLEL TO DATUM PLANE A.
  4. DATUM A, THE SEATING PLANE, IS DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
  5. D2 AND E2 DEFINE THE AREA OCCUPIED BY THE DIE. D3 AND E3 ARE THE MINIMUM CLEARANCE FROM THE PACKAGE EDGE TO THE CHIP CAPACITORS.
  6. CAPACITORS MAY NOT BE PRESENT ON ALL DEVICES.
  7. CAUTION MUST BE TAKEN NOT TO SHORT EXPOSED METAL CAPACITOR PADS ON PACKAGE TOP.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | —           | 2.77 |
| A1  | 0.50        | 0.70 |
| A2  | 1.75        | 2.07 |
| A3  | 0.80        | 0.92 |
| A4  | 0.92        | 1.15 |
| A5  | —           | 0.70 |
| D   | 22.00 BSC   |      |
| D1  | 20.32 BSC   |      |
| D2  | 7.12        | 7.69 |
| D3  | 1.10        | —    |
| E   | 14.00 BSC   |      |
| E1  | 7.62 BSC    |      |
| E2  | 7.21        | 7.51 |
| E3  | 1.10        | —    |
| b   | 0.60        | 0.90 |
| e   | 1.27 BSC    |      |

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