

# DDR2 SDRAM Unbuffered DIMM

**MT16HTF6464A – 512MB**

**MT16HTF12864A – 1GB**

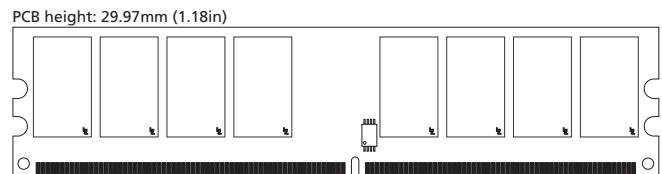
**MT16HTF25664A – 2GB**

For component specifications, refer to the Micron's Web site: [www.micron.com/ddr2](http://www.micron.com/ddr2)

## Features

- 240-pin, unbuffered, dual in-line memory module (UDIMM)
- Fast data transfer rates: PC2-3200, PC2-4200, PC2-5300, or PC2-6400
- 512MB (64 Meg x 64), 1GB (128 Meg x 64), and 2GB (256 Meg x 64)
- VDD = VDDQ = +1.8V
- VDDSPD = +1.7V to +3.6V
- JEDEC standard 1.8V I/O (SSTL\_18-compatible)
- Differential data strobe (DQS, DQS#) option
- Four-bit prefetch architecture
- DLL to align DQ and DQS transitions with CK
- Multiple internal device banks for concurrent operation
- Programmable CAS latency (CL)
- Posted CAS additive latency (AL)
- WRITE latency = READ latency - 1 t<sub>CK</sub>
- Programmable burst lengths: 4 or 8
- Adjustable data-output drive strength
- 64ms, 8,192-cycle refresh
- On-die termination (ODT)
- Serial presence-detect (SPD) with EEPROM
- Gold edge contacts
- Dual rank

**Figure 1: 240-Pin DIMM (MO-237 R/C "B")**



## Options

- Package  
240-pin DIMM (lead-free)
- Frequency/CL<sup>1</sup>  
2.5ns @ CL = 5 (DDR2-800)<sup>2</sup>  
3.0ns @ CL = 5 (DDR2-667)<sup>3</sup>  
3.75ns @ CL = 4 (DDR2-533)  
5.0ns @ CL = 3 (DDR2-400)
- PCB height  
29.97mm (1.18in)

## Marking

Y  
-80E  
-667  
-53E  
-40E

- Notes: 1. CL = CAS (READ) latency.  
2. Not available in 512MB density.  
3. Not available in 2GB density.

**Table 1: Address Table**

|                           | 512MB              | 1GB                | 2GB               |
|---------------------------|--------------------|--------------------|-------------------|
| Refresh count             | 8K                 | 8K                 | 8K                |
| Row addressing            | 8K (A0–A12)        | 16K (A0–A13)       | 16K (A0–A13)      |
| Device bank addressing    | 4 (BA0, BA1)       | 4 (BA0, BA1)       | 8 (BA0, BA1, BA2) |
| Device page size per bank | 1KB                | 1KB                | 1KB               |
| Device configuration      | 256Mb (32 Meg x 8) | 512Mb (64 Meg x 8) | 1Gb (128 Meg x 8) |
| Column addressing         | 1K (A0–A9)         | 1K (A0–A9)         | 1K (A0–A9)        |
| Module rank addressing    | 2 (S0#, S1#)       | 2 (S0#, S1#)       | 2 (S0#, S1#)      |

**Table 2: Key Timing Parameters**

| Speed Grade | Data Rate (MT/s) |        |        | $t_{RCD}$ (ns) | $t_{RP}$ (ns) | $t_{RC}$ (ns) |
|-------------|------------------|--------|--------|----------------|---------------|---------------|
|             | CL = 3           | CL = 4 | CL = 5 |                |               |               |
| -80E        | –                | 533    | 800    | 12.5           | 12.5          | 55            |
| -667        | 400              | 533    | 667    | 15             | 15            | 55            |
| -53E        | 400              | 533    | –      | 15             | 15            | 55            |
| -40E        | 400              | 400    | –      | 15             | 15            | 55            |

**Table 3: Part Numbers and Timing Parameters**

| Part Number <sup>1</sup> | Module Density | Configuration | Module Bandwidth | Memory Clock/<br>Data Rate | Latency<br>(CL- $t_{RCD}$ - $t_{RP}$ ) |
|--------------------------|----------------|---------------|------------------|----------------------------|--|
| MT16HTF6464AY-667__      | 512MB          | 64 Meg x 64   | 5.3 GB/s         | 3.0ns/667 MT/s             | 5-5-5                                  |
| MT16HTF6464AY-53E__      | 512MB          | 64 Meg x 64   | 4.3 GB/s         | 3.75ns/533 MT/s            | 4-4-4                                  |
| MT16HTF6464AY-40E__      | 512MB          | 64 Meg x 64   | 3.2 GB/s         | 5.0ns/400 MT/s             | 3-3-3                                  |
| MT16HTF12864AY-80E__     | 1GB            | 128 Meg x 64  | 6.4 GB/s         | 2.5ns/800 MT/s             | 5-5-5                                  |
| MT16HTF12864AY-667__     | 1GB            | 128 Meg x 64  | 5.3 GB/s         | 3.0ns/667 MT/s             | 5-5-5                                  |
| MT16HTF12864AY-53E__     | 1GB            | 128 Meg x 64  | 4.3 GB/s         | 3.75ns/533 MT/s            | 4-4-4                                  |
| MT16HTF12864AY-40E__     | 1GB            | 128 Meg x 64  | 3.2 GB/s         | 5.0ns/400 MT/s             | 3-3-3                                  |
| MT16HTF25664AY-80E__     | 2GB            | 256 Meg x 64  | 6.4 GB/s         | 2.5ns/800 MT/s             | 5-5-5                                  |
| MT16HTF25664AY-667__     | 2GB            | 256 Meg x 64  | 5.3 GB/s         | 3.0ns/667 MT/s             | 5-5-5                                  |
| MT16HTF25664AY-53E__     | 2GB            | 256 Meg x 64  | 4.3 GB/s         | 3.75ns/533 MT/s            | 4-4-4                                  |
| MT16HTF25664AY-40E__     | 2GB            | 256 Meg x 64  | 3.2 GB/s         | 5.0ns/400 MT/s             | 3-3-3                                  |

Notes: 1. All part numbers end with a two-place code (not shown), designating component and PCB revisions. Consult factory for current revision codes. Example: MT16HTF12864AY-80ED4.

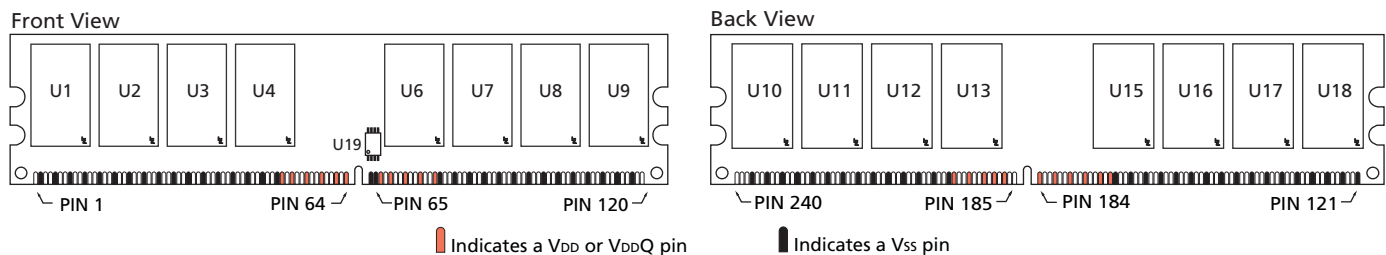
## Pin Assignments and Descriptions

**Table 4: Pin Assignment**

| 240-pin DIMM Front |        |     |        |     |        |     |        | 240-pin DIMM Back |        |     |        |     |        |     |        |
|--------------------|--------|-----|--------|-----|--------|-----|--------|-------------------|--------|-----|--------|-----|--------|-----|--------|
| Pin                | Symbol | Pin | Symbol | Pin | Symbol | Pin | Symbol | Pin               | Symbol | Pin | Symbol | Pin | Symbol | Pin | Symbol |
| 1                  | VREF   | 31  | DQ19   | 61  | A4     | 91  | Vss    | 121               | Vss    | 151 | Vss    | 181 | VDDQ   | 211 | DM5    |
| 2                  | Vss    | 32  | Vss    | 62  | VDDQ   | 92  | DQS5#  | 122               | DQ4    | 152 | DQ28   | 182 | A3     | 212 | NC     |
| 3                  | DQ0    | 33  | DQ24   | 63  | A2     | 93  | DQS5   | 123               | DQ5    | 153 | DQ29   | 183 | A1     | 213 | Vss    |
| 4                  | DQ1    | 34  | DQ25   | 64  | VDD    | 94  | Vss    | 124               | Vss    | 154 | Vss    | 184 | VDD    | 214 | DQ46   |
| 5                  | Vss    | 35  | Vss    | 65  | Vss    | 95  | DQ42   | 125               | DM0    | 155 | DM3    | 185 | CK0    | 215 | DQ47   |
| 6                  | DQS0#  | 36  | DQS3#  | 66  | Vss    | 96  | DQ43   | 126               | NC     | 156 | NC     | 186 | CK0#   | 216 | Vss    |
| 7                  | DQS0   | 37  | DQS3   | 67  | VDD    | 97  | Vss    | 127               | Vss    | 157 | Vss    | 187 | VDD    | 217 | DQ52   |
| 8                  | Vss    | 38  | Vss    | 68  | NC     | 98  | DQ48   | 128               | DQ6    | 158 | DQ30   | 188 | A0     | 218 | DQ53   |
| 9                  | DQ2    | 39  | DQ26   | 69  | VDD    | 99  | DQ49   | 129               | DQ7    | 159 | DQ31   | 189 | VDD    | 219 | Vss    |
| 10                 | DQ3    | 40  | DQ27   | 70  | A10/AP | 100 | Vss    | 130               | Vss    | 160 | Vss    | 190 | BA1    | 220 | CK2    |
| 11                 | Vss    | 41  | Vss    | 71  | BA0    | 101 | SA2    | 131               | DQ12   | 161 | NC     | 191 | VDDQ   | 221 | CK2#   |
| 12                 | DQ8    | 42  | NC     | 72  | VDDQ   | 102 | NC     | 132               | DQ13   | 162 | NC     | 192 | RAS#   | 222 | Vss    |
| 13                 | DQ9    | 43  | NC     | 73  | WE#    | 103 | Vss    | 133               | Vss    | 163 | Vss    | 193 | S0#    | 223 | DM6    |
| 14                 | Vss    | 44  | Vss    | 74  | CAS#   | 104 | DQS6#  | 134               | DM1    | 164 | DM8    | 194 | VDDQ   | 224 | NC     |
| 15                 | DQS1#  | 45  | NC     | 75  | VDDQ   | 105 | DQS6   | 135               | NC     | 165 | NC     | 195 | ODT0   | 225 | Vss    |
| 16                 | DQS1   | 46  | NC     | 76  | S1#    | 106 | Vss    | 136               | Vss    | 166 | Vss    | 196 | NC/A13 | 226 | DQ54   |
| 17                 | Vss    | 47  | Vss    | 77  | ODT1   | 107 | DQ50   | 137               | CK1    | 167 | NC     | 197 | VDD    | 227 | DQ55   |
| 18                 | NC     | 48  | NC     | 78  | VDDQ   | 108 | DQ51   | 138               | CK1#   | 168 | NC     | 198 | Vss    | 228 | Vss    |
| 19                 | NC     | 49  | NC     | 79  | Vss    | 109 | Vss    | 139               | Vss    | 169 | Vss    | 199 | DQ36   | 229 | DQ60   |
| 20                 | Vss    | 50  | Vss    | 80  | DQ32   | 110 | DQ56   | 140               | DQ14   | 170 | VDDQ   | 200 | DQ37   | 230 | DQ61   |
| 21                 | DQ10   | 51  | VDDQ   | 81  | DQ33   | 111 | DQ57   | 141               | DQ15   | 171 | CKE1   | 201 | Vss    | 231 | Vss    |
| 22                 | DQ11   | 52  | CKE0   | 82  | Vss    | 112 | Vss    | 142               | Vss    | 172 | VDD    | 202 | DM4    | 232 | DM7    |
| 23                 | Vss    | 53  | VDD    | 83  | DQS4#  | 113 | DQS7#  | 143               | DQ20   | 173 | NC     | 203 | NC     | 233 | NC     |
| 24                 | DQ16   | 54  | NC/BA2 | 84  | DQS4   | 114 | DQS7   | 144               | DQ21   | 174 | NC     | 204 | Vss    | 234 | Vss    |
| 25                 | DQ17   | 55  | NC     | 85  | Vss    | 115 | Vss    | 145               | Vss    | 175 | VDDQ   | 205 | DQ38   | 235 | DQ62   |
| 26                 | Vss    | 56  | VDDQ   | 86  | DQ34   | 116 | DQ58   | 146               | DM2    | 176 | A12    | 206 | DQ39   | 236 | DQ63   |
| 27                 | DQS2#  | 57  | A11    | 87  | DQ35   | 117 | DQ59   | 147               | NC     | 177 | A9     | 207 | Vss    | 237 | Vss    |
| 28                 | DQS2   | 58  | A7     | 88  | Vss    | 118 | Vss    | 148               | Vss    | 178 | VDD    | 208 | DQ44   | 238 | VDDSPD |
| 29                 | Vss    | 59  | VDD    | 89  | DQ40   | 119 | SDA    | 149               | DQ22   | 179 | A8     | 209 | DQ45   | 239 | SA0    |
| 30                 | DQ18   | 60  | A5     | 90  | DQ41   | 120 | SCL    | 150               | DQ23   | 180 | A6     | 210 | Vss    | 240 | SA1    |

Note: Pin 196 is NC for 512MB, or A13 for 1GB and 2GB; pin 54 is NC for 512MB and 1GB, or BA2 for 2GB.

**Figure 2: Pin Locations**



**Table 5: Pin Descriptions**

Pin numbers may not correlate with symbols; refer to Table 4 on page 3 for more information

| Pin Numbers   | Symbol                                | Type  | Description   |
|---|---------------------------------------|-------|---|
| 77, 195   | ODT0, ODT1                            | Input | On-die termination: ODT (registered HIGH) enables termination resistance internal to the DDR2 SDRAM. When enabled, ODT is only applied to each of the following pins: DQ, DQS, DQS#, and DM. The ODT input will be ignored if disabled via the LOAD MODE command.   |
| 137, 138, 185, 186, 220, 221  | CK0, CK0#,<br>CK1, CK1#,<br>CK2, CK2# | Input | Clock: CK and CK# are differential clock inputs. All address and control input signals are sampled on the crossing of the positive edge of CK and negative edge of CK#. Output data (DQs and DQS/DQS#) is referenced to the crossings of CK and CK#.  |
| 52, 171   | CKE0, CKE1                            | Input | Clock enable: CKE (registered HIGH) activates and CKE (registered LOW) deactivates clocking circuitry on the DDR2 SDRAM. The specific circuitry that is enabled/disabled is dependent on the DDR2 SDRAM configuration and operating mode. CKE LOW provides precharge power-down and SELF REFRESH operations (all device banks idle), or ACTIVE power-down (row ACTIVE in any device bank). CKE is synchronous for power-down entry, power-down exit, output disable, and for SELF REFRESH entry. CKE is asynchronous for SELF REFRESH exit. Input buffers (excluding CK, CK#, CKE, and ODT) are disabled during power-down. Input buffers (excluding CKE) are disabled during SELF REFRESH. CKE is an SSTL_18 input but will detect a LVCMOS LOW level when VDD is applied during first power-up. After VREF has become stable during the power on and initialization sequence, it must be maintained for proper operation of the CKE receiver. For proper SELF REFRESH operation, VREF must be maintained to this input. |
| 76, 193   | S0#, S1#                              | Input | Chip select: S# enables (registered LOW) and disables (registered HIGH) the command decoder. All commands are masked when S# is registered HIGH. S# provides for external rank selection on systems with multiple ranks. S# is considered part of the command code.   |
| 73, 74, 192   | RAS#, CAS#, WE#                       | Input | Command inputs: RAS#, CAS#, and WE# (along with S#) define the command being entered.   |
| 54 (2GB), 71, 190   | BA0, BA1,<br>BA2 (2GB)                | Input | Bank address inputs: BA0–BA1/BA2 define to which device bank an ACTIVE, READ, WRITE, or PRECHARGE command is being applied. BA0–BA1/BA2 define which mode register including MR, EMR, EMR(2), and EMR(3) is loaded during the LMR command.  |
| 57, 58, 60, 61, 63, 70, 176,<br>177, 179, 180, 182, 183, 188,<br>196 (1GB, 2GB) | A0–A12 (512MB)<br>A0–A13 (1GB, 2GB)   | Input | Address inputs: Provide the row address for ACTIVE commands, and the column address and auto precharge bit (A10) for READ/WRITE commands, to select one location out of the memory array in the respective bank. A10 sampled during a PRECHARGE command determines whether the precharge applies to one device bank (A10 LOW, device bank selected by BA0–BA1/BA2) or all device banks (A10 HIGH). The address inputs also provide the op-code during a LMR command.  |
| 125, 134, 146, 155, 202, 211,<br>223, 232                                       | DM0–DM7                               | Input | Input data mask: DM is an input mask signal for write data. Input data is masked when DM is sampled HIGH along with that input data during a WRITE access. DM is sampled on both edges of DQS. Although DM pins are input-only, the DM loading is designed to match that of DQ and DQS pins.  |

**Table 5: Pin Descriptions**

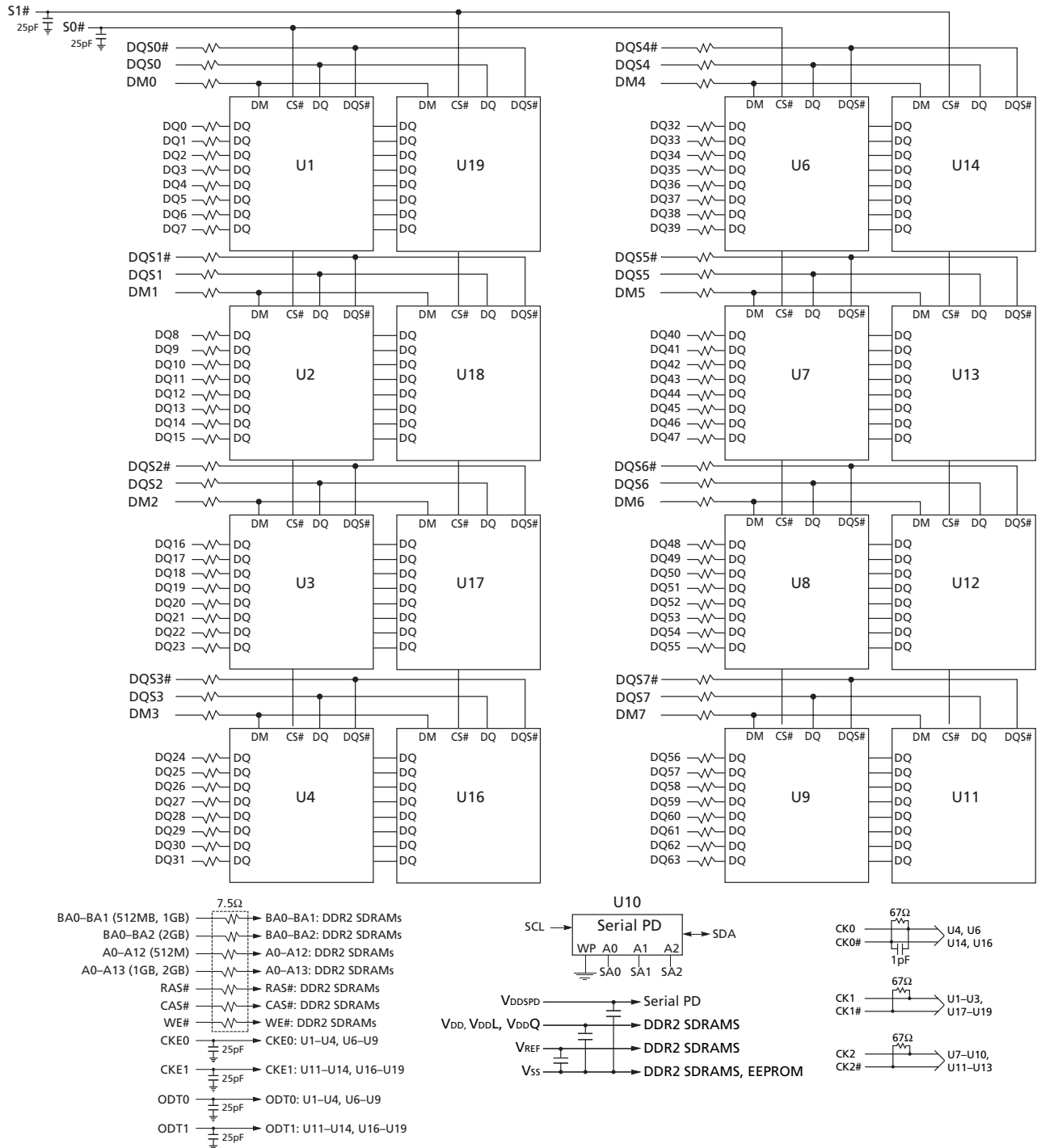
Pin numbers may not correlate with symbols; refer to Table 4 on page 3 for more information

| Pin Numbers   | Symbol                    | Type   | Description   |
|---|---------------------------|--------|---|
| 120   | SCL                       | Input  | Serial clock for presence-detect: SCL is used to synchronize the presence-detect data transfer to and from the module.  |
| 101, 239, 240   | SA0-SA2                   | Input  | Presence-detect address inputs: These pins are used to configure the presence-detect device.  |
| 3, 4, 9, 10, 12, 13, 21, 22, 24, 25, 30, 31, 33, 34, 39, 40, 80, 81, 86, 87, 89, 90, 95, 96, 98, 99, 107, 108, 110, 111, 116, 117, 122, 123, 128, 129, 131, 132, 140, 141, 143, 144, 149, 150, 152, 153, 158, 159, 199, 200, 205, 206, 208, 209, 214, 215, 217, 218, 226, 227, 229, 230, 235, 236 | DQ0-DQ63                  | I/O    | Data Input/output: Bidirectional data bus.  |
| 6, 7, 15, 16, 27, 28, 36, 37, 83, 84, 92, 93, 104, 105, 113, 114,   | DQS0-DQS7,<br>DQS0#-DQS7# | I/O    | Data strobe: Output with read data, input with write data for source synchronous operation. Edge-aligned with read data, center aligned with write data. DQS# is only used when differential data strobe mode is enabled via the LOAD MODE command. |
| 119   | SDA                       | I/O    | Serial presence-detect data: SDA is a bidirectional pin used to transfer addresses and data into and out of the presence-detect portion of the module.  |
| 53, 59, 64, 67, 69, 172, 178, 184, 187, 189, 197,   | VDD                       | Supply | Power supply: +1.8V ±0.1V.  |
| 51, 56, 62, 72, 75, 78, 170, 175, 181, 191, 194,  | VDDQ                      | Supply | DQ Power supply: +1.8V ±0.1V.   |
| 1   | VREF                      | Supply | SSTL_18 reference voltage.  |
| 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 35, 38, 41, 44, 47, 50, 65, 66, 79, 82, 85, 88, 91, 94, 97, 100, 103, 106, 109, 112, 115, 118, 121, 124, 127, 130, 133, 136, 139, 142, 145, 148, 151, 154, 157, 160, 163, 166, 169, 198, 201, 204, 207, 210, 213, 216, 219, 222, 225, 228, 231, 234, 237 | VSS                       | Supply | Ground.   |
| 238   | VDDSPD                    | Supply | Serial EEPROM positive power supply: +1.7V to +3.6V.  |
| 18, 19, 42, 43, 45, 46, 48, 49, 54 (512MB, 1GB), 55, 68, 76, 102, 125, 126, 134, 135, 146, 147, 155, 156, 161, 162, 164, 165, 167, 168, 171, 173, 174, 196 (512MB), 202, 203, 211, 212, 223, 224, 232, 233  | NC                        | -      | No connect: These pins should be left unconnected.  |

## Functional Block Diagram

Unless otherwise noted, resistor values are 22Ω. Micron module part numbers are explained in the module part numbering guide at [www.micron.com/numbering.html](http://www.micron.com/numbering.html). Modules use the following DDR2 SDRAM devices: MT47H32M8BT (512MB); MT47H64M8BT (1GB); and MT47H128M8BT (2GB).

**Figure 3: Functional Block Diagram**



## General Description

The MT16HTF6464A, MT16HTF12864A, and MT16HTF25664A DDR2 SDRAM modules are high-speed, CMOS, dynamic random-access 512MB, 1GB, and 2GB memory modules organized in x64 configuration. DDR2 modules use internally configured 4-bank (512MB, 1GB) or 8-bank (2GB) DDR2 devices.

DDR2 SDRAM modules use double data rate architecture to achieve high-speed operation. The double data rate architecture is essentially a  $4n$ -prefetch architecture with an interface designed to transfer two data words per clock cycle at the I/O pins. A single read or write access for the DDR2 SDRAM module effectively consists of a single  $4n$ -bit-wide, one-clock-cycle data transfer at the internal DDR2 device core and four corresponding  $n$ -bit-wide, one-half-clock-cycle data transfers at the I/O pins.

A bidirectional data strobe (DQS, DQS#) is transmitted externally, along with data, for use in data capture at the receiver. DQS is a strobe transmitted by the DDR2 device during READs and by the memory controller during WRITEs. DQS is edge-aligned with data for READs and center-aligned with data for WRITEs.

DDR2 modules operate from a differential clock (CK and CK#); the crossing of CK going HIGH and CK# going LOW will be referred to as the positive edge of CK. Commands (address and control signals) are registered at every positive edge of CK. Input data is registered on both edges of DQS, and output data is referenced to both edges of DQS, as well as to both edges of CK.

## Serial Presence-Detect Operation

DDR2 SDRAM modules incorporate serial presence-detect (SPD). The SPD function is implemented using a 2,048-bit EEPROM. This nonvolatile storage device contains 256 bytes. The first 128 bytes can be programmed by Micron to identify the module type and various DDR2 organizations and timing parameters. The remaining 128 bytes of storage are available for use by the customer. System READ/WRITE operations between the master (system logic) and the slave EEPROM device occur via a standard I<sup>2</sup>C bus using the DIMM's SCL (clock) and SDA (data) signals, together with SA (2:0), which provide eight unique DIMM/EEPROM addresses. Write protect (WP) is tied to ground on the module, permanently disabling hardware write protect.

## Electrical Specifications

Stresses greater than those listed in Table 6 may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

**Table 6: Absolute Maximum Ratings**

| Parameter  | Symbol                              | Min             | Max | Units |    |
|--|-------------------------------------|-----------------|-----|-------|----|
| VDD supply voltage relative to VSS   | VDD                                 | -1.0            | 2.3 | V     |    |
| VDDQ supply voltage relative to VSS  | VDDQ                                | -0.5            | 2.3 | V     |    |
| VDDL supply voltage relative to VSS  | VDDL <sup>2</sup>                   | -0.5            | 2.3 | V     |    |
| Voltage on any pin relative to VSS   | VIN, VOUT                           | -0.5            | 2.3 | V     |    |
| Storage temperature  | T <sub>STG</sub>                    | -55             | 100 | °C    |    |
| DDR2 SDRAM device operating temperature (ambient)  | T <sub>case</sub>                   | 0               | 85  | °C    |    |
| Operating temperature (ambient)  | T <sub>OPR</sub>                    | 0               | 55  | °C    |    |
| Input leakage current; Any input 0V ≤ VIN ≤ VDD;<br>VREF input 0V ≤ VIN ≤ 0.95V;<br>(All other pins not under test = 0V) | Command/address,<br>RAS#, CAS#, WE# | I <sub>I</sub>  | -80 | 80    | μA |
|  | S#, CKE <sup>1</sup>                |                 | -40 | 40    |    |
|  | CK0, CK0#                           |                 | -20 | 20    |    |
|  | CK1, CK1#, CK2, CK2#                |                 | -30 | 30    |    |
|  | DM                                  |                 | -10 | 10    |    |
| Output leakage current; 0V ≤ VOUT ≤ VDDQ; DQ and<br>ODT are disabled   | DQ, DQS, DQS#                       | I <sub>oz</sub> | -10 | 10    | μA |
| VREF leakage current; VREF = valid VREF level  | -                                   | -32             | 32  | μA    |    |

- Notes: 1. S# is defined to be S0# and S1#. CKE includes both CKE0 and CKE1.  
2. VDDL is the power supply for the DDR2 devices' DLL; however, this power supply is not brought directly to a DIMM pin.

## Capacitance

At DDR2 data rates, Micron encourages designers to simulate the performance of the module to achieve optimum values. When inductance and delay parameters associated with trace lengths are used in simulations, they are significantly more accurate and realistic than a gross estimation of module capacitance. Simulations can then render a considerably more accurate result. JEDEC modules are now designed by using simulations to close timing budgets.



**Table 7: DDR2 IDD Specifications and Conditions – 512MB**  
 Values shown for DDR2 SDRAM components only

| Parameter/Condition  | Symbol             | -667                        | -53E  | -40E  | Units |    |
|--|--------------------|-----------------------------|-------|-------|-------|----|
| <b>Operating one device bank active-precharge current;</b> $t_{CK} = t_{CK} (IDD)$ , $t_{RC} = t_{RC} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MIN} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching   | IDD0 <sup>a</sup>  | 680                         | 680   | 640   | mA    |    |
| <b>Operating one device bank active-read-precharge current;</b> IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$ , $t_{RC} = t_{RC} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MIN} (IDD)$ , $t_{RCD} = t_{RCD} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W   | IDD1 <sup>a</sup>  | 760                         | 760   | 720   | mA    |    |
| <b>Precharge power-down current;</b> All device banks idle; $t_{CK} = t_{CK} (IDD)$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating  | IDD2P <sup>b</sup> | 80                          | 80    | 80    | mA    |    |
| <b>Precharge quiet standby current;</b> All device banks idle; $t_{CK} = t_{CK} (IDD)$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating  | IDD2Q <sup>b</sup> | 560                         | 560   | 400   | mA    |    |
| <b>Precharge standby current;</b> All device banks idle; $t_{CK} = t_{CK} (IDD)$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching  | IDD2N <sup>b</sup> | 640                         | 560   | 480   | mA    |    |
| <b>Active power-down current;</b> All device banks open; $t_{CK} = t_{CK} (IDD)$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating   | IDD3P <sup>b</sup> | Fast PDN exit<br>MR[12] = 0 | 480   | 400   | 320   | mA |
|  |                    | Slow PDN exit<br>MR[12] = 1 | 96    | 96    | 96    | mA |
| <b>Active standby current;</b> All device banks open; $t_{CK} = t_{CK} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$ , $t_{RP} = t_{RP} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching  | IDD3N <sup>b</sup> | 800                         | 640   | 480   | mA    |    |
| <b>Operating burst write current;</b> All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$ , $t_{RP} = t_{RP} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching   | IDD4W <sup>a</sup> | 1,560                       | 1,320 | 1,040 | mA    |    |
| <b>Operating burst read current;</b> All device banks open; Continuous burst reads, IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$ , $t_{RP} = t_{RP} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching   | IDD4R <sup>a</sup> | 1,480                       | 1,240 | 960   | mA    |    |
| <b>Burst refresh current;</b> $t_{CK} = t_{CK} (IDD)$ ; REFRESH command at every $t_{RFC} (IDD)$ interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching   | IDD5 <sup>b</sup>  | 2,880                       | 2,720 | 2,640 | mA    |    |
| <b>Self refresh current;</b> CK and CK# at 0V; CKE ≤ 0.2V; Other control and address bus inputs are floating; Data bus inputs are floating   | IDD6 <sup>b</sup>  | 80                          | 80    | 80    | mA    |    |
| <b>Operating device bank interleave read current;</b> All device banks interleaving reads, IOUT = 0mA; BL = 4, CL = CL (IDD), AL = $t_{RCD} (IDD) - 1 \times t_{CK} (IDD)$ ; $t_{CK} = t_{CK} (IDD)$ , $t_{RC} = t_{RC} (IDD)$ , $t_{RRD} = t_{RRD} (IDD)$ , $t_{RCD} = t_{RCD} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during DESELECTs; Data bus inputs are switching; See IDD7 conditions in component data sheet for detail | IDD7 <sup>a</sup>  | 2,040                       | 1,960 | 1,880 | mA    |    |

- Notes:
- a = Value calculated as one module rank in this operating condition, and all other module ranks in IDD2P (CKE LOW).
  - b = Value calculated reflects all module ranks in this operating condition.

**Table 8: DDR2 IDD Specifications and Conditions – 1GB**  
 Values shown for DDR2 SDRAM components only

| Parameter/Condition   | Symbol             | -80E                        | -667  | -53E   | -40E  | Units |    |
|---|--------------------|-----------------------------|-------|--------|-------|-------|----|
| <b>Operating one device bank active-precharge current;</b> $t_{CK} = t_{CK} (IDD)$ , $t_{RC} = t_{RC} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MIN} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching  | IDD0 <sup>a</sup>  | 856                         | 776   | 696    | 696   | mA    |    |
| <b>Operating one device bank active-read-precharge current;</b> $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$ , $t_{RC} = t_{RC} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MIN} (IDD)$ , $t_{RCD} = t_{RCD} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W   | IDD1 <sup>a</sup>  | 976                         | 896   | 816    | 776   | mA    |    |
| <b>Precharge power-down current;</b> All device banks idle; $t_{CK} = t_{CK} (IDD)$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating   | IDD2P <sup>b</sup> | 112                         | 112   | 112    | 112   | mA    |    |
| <b>Precharge quiet standby current;</b> All device banks idle; $t_{CK} = t_{CK} (IDD)$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating   | IDD2Q <sup>b</sup> | 800                         | 720   | 640    | 560   | mA    |    |
| <b>Precharge standby current;</b> All device banks idle; $t_{CK} = t_{CK} (IDD)$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching   | IDD2N <sup>b</sup> | 880                         | 800   | 720    | 640   | mA    |    |
| <b>Active power-down current;</b> All device banks open; $t_{CK} = t_{CK} (IDD)$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating  | IDD3P <sup>b</sup> | Fast PDN exit<br>MR[12] = 0 | 640   | 560    | 480   | 400   | mA |
|   |                    | Slow PDN exit<br>MR[12] = 1 | 192   | 192    | 192   | 192   | mA |
| <b>Active standby current;</b> All device banks open; $t_{CK} = t_{CK} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$ , $t_{RP} = t_{RP} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching   | IDD3N <sup>b</sup> | 1,120                       | 1,040 | 880    | 720   | mA    |    |
| <b>Operating burst write current;</b> All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$ , $t_{RP} = t_{RP} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching  | IDD4W <sup>a</sup> | 1,616                       | 1,416 | 1,1176 | 976   | mA    |    |
| <b>Operating burst read current;</b> All device banks open; Continuous burst reads, $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$ , $t_{RP} = t_{RP} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching   | IDD4R <sup>a</sup> | 1,696                       | 1,496 | 1,216  | 976   | mA    |    |
| <b>Burst refresh current;</b> $t_{CK} = t_{CK} (IDD)$ ; REFRESH command at every $t_{RFC} (IDD)$ interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching  | IDD5 <sup>b</sup>  | 3,680                       | 2,880 | 2,720  | 2,640 | mA    |    |
| <b>Self refresh current;</b> CK and CK# at 0V; CKE $\leq 0.2\text{V}$ ; Other control and address bus inputs are floating; Data bus inputs are floating   | IDD6 <sup>b</sup>  | 112                         | 112   | 112    | 112   | mA    |    |
| <b>Operating device bank interleave read current;</b> All device banks interleaving reads, $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = $t_{RCD} (IDD) - 1 \times t_{CK} (IDD)$ ; $t_{CK} = t_{CK} (IDD)$ , $t_{RC} = t_{RC} (IDD)$ , $t_{RRD} = t_{RRD} (IDD)$ , $t_{RCD} = t_{RCD} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during DESELECTs; Data bus inputs are switching; See IDD7 conditions in component data sheet for detail | IDD7 <sup>a</sup>  | 2,456                       | 1,976 | 1,856  | 1,816 | mA    |    |

- Notes: 1. a = Value calculated as one module rank in this operating condition, and all other module ranks in IDD2P (CKE LOW).  
 2. b = Value calculated reflects all module ranks in this operating condition.

**Table 9: DDR2 IDD Specifications and Conditions – 2GB**  
 Values shown for DDR2 SDRAM components only

| Parameter/Condition  | Symbol       | -80E                        | -667  | -53E  | -40E  | Units |    |
|--|--------------|-----------------------------|-------|-------|-------|-------|----|
| <b>Operating one device bank active-precharge current;</b> $t_{CK} = t_{CK} (IDD)$ , $t_{RC} = t_{RC} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MIN} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching   | $I_{DD0}^a$  | 856                         | 776   | 696   | 616   | mA    |    |
| <b>Operating one device bank active-read-precharge current;</b> $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$ , $t_{RC} = t_{RC} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MIN} (IDD)$ , $t_{RCD} = t_{RCD} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as $I_{DD4W}$   | $I_{DD1}^a$  | 936                         | 856   | 816   | 696   | mA    |    |
| <b>Precharge power-down current;</b> All device banks idle; $t_{CK} = t_{CK} (IDD)$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating  | $I_{DD2P}^b$ | 112                         | 112   | 112   | 112   | mA    |    |
| <b>Precharge quiet standby current;</b> All device banks idle; $t_{CK} = t_{CK} (IDD)$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating  | $I_{DD2Q}^b$ | 1,040                       | 880   | 656   | 560   | mA    |    |
| <b>Precharge standby current;</b> All device banks idle; $t_{CK} = t_{CK} (IDD)$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching  | $I_{DD2N}^b$ | 1,120                       | 960   | 720   | 640   | mA    |    |
| <b>Active power-down current;</b> All device banks open; $t_{CK} = t_{CK} (IDD)$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating   | $I_{DD3P}^b$ | Fast PDN exit<br>MR[12] = 0 | 720   | 640   | 480   | 400   | mA |
|  |              | Slow PDN exit<br>MR[12] = 1 | 160   | 160   | 160   | 160   | mA |
| <b>Active standby current;</b> All device banks open; $t_{CK} = t_{CK} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$ , $t_{RP} = t_{RP} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching  | $I_{DD3N}^b$ | 1,200                       | 1,120 | 880   | 720   | mA    |    |
| <b>Operating burst write current;</b> All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$ , $t_{RP} = t_{RP} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching   | $I_{DD4W}^a$ | 1,536                       | 1,336 | 1,096 | 936   | mA    |    |
| <b>Operating burst read current;</b> All device banks open; Continuous burst reads, $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$ , $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$ , $t_{RP} = t_{RP} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching  | $I_{DD4R}^a$ | 1,576                       | 1,336 | 1,216 | 936   | mA    |    |
| <b>Burst refresh current;</b> $t_{CK} = t_{CK} (IDD)$ ; REFRESH command at every $t_{RFC} (IDD)$ interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching   | $I_{DD5}^b$  | 4,480                       | 4,160 | 4,000 | 3,520 | mA    |    |
| <b>Self refresh current;</b> CK and CK# at 0V; $CKE \leq 0.2V$ ; Other control and address bus inputs are floating; Data bus inputs are floating   | $I_{DD6}^b$  | 112                         | 112   | 112   | 112   | mA    |    |
| <b>Operating device bank interleave read current;</b> All device banks interleaving reads, $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = $t_{RCD} (IDD) - 1 \times t_{CK} (IDD)$ ; $t_{CK} = t_{CK} (IDD)$ , $t_{RC} = t_{RC} (IDD)$ , $t_{RRD} = t_{RRD} (IDD)$ , $t_{RCD} = t_{RCD} (IDD)$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during DESELECTs; Data bus inputs are switching; See $I_{DD7}$ conditions in component data sheet for detail | $I_{DD7}^a$  | 2,736                       | 2,456 | 2,376 | 2,136 | mA    |    |

- Notes: 1. a = Value calculated as one module rank in this operating condition, and all other module ranks in  $I_{DD2P}$  (CKE LOW).  
 2. b = Value calculated reflects all module ranks in this operating condition.

## AC Timing and Operating Conditions

Recommended AC operating conditions are given in the DDR2 component data sheets. Component specifications are available on Micron's Web site: [www.micron.com/ddr2](http://www.micron.com/ddr2). Module speed grades correlate with component speed grades as shown in the following table:

**Table 10: Module and Component Speed Grade Table**

| Module Speed Grade | Component Speed Grade |
|--------------------|-----------------------|
| -80E               | -25E                  |
| -667               | -3                    |
| -53E               | -37E                  |
| -40E               | -5E                   |

## Serial Presence-Detect

### SPD Clock and Data Conventions

Data states on the SDA line can change only during SCL LOW. SDA state changes during SCL HIGH are reserved for indicating start and stop conditions (Figures 4 and 5 on page 14).

### SPD Start Condition

All commands are preceded by the start condition, which is a HIGH-to-LOW transition of SDA when SCL is HIGH. The SPD device continuously monitors the SDA and SCL lines for the start condition and will not respond to any command until this condition has been met.

### SPD Stop Condition

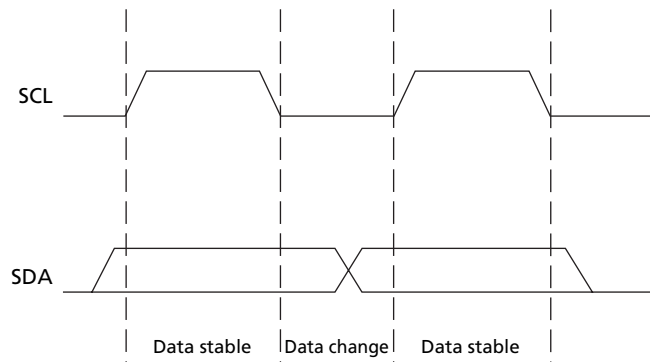
All communications are terminated by a stop condition, which is a LOW-to-HIGH transition of SDA when SCL is HIGH. The stop condition is also used to place the SPD device into standby power mode.

### SPD Acknowledge

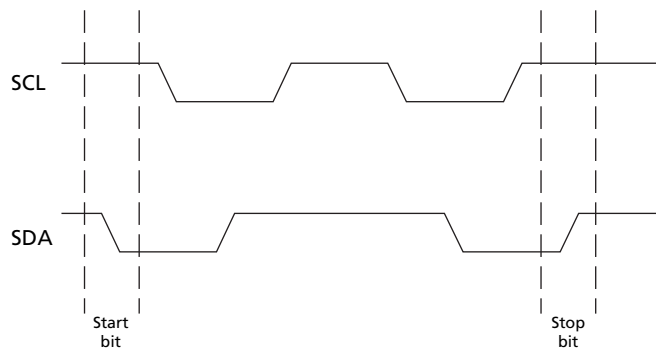
Acknowledge is a software convention used to indicate successful data transfers. The transmitting device, either master or slave, will release the bus after transmitting 8 bits. During the ninth clock cycle, the receiver will pull the SDA line LOW to acknowledge that it received the 8 bits of data (Figure 6 on page 14).

The SPD device will always respond with an acknowledge after recognition of a start condition and its slave address. If both the device and a WRITE operation have been selected, the SPD device will respond with an acknowledge after the receipt of each subsequent 8-bit word. In the read mode the SPD device will transmit 8 bits of data, release the SDA line and monitor the line for an acknowledge. If an acknowledge is detected and no stop condition is generated by the master, the slave will continue to transmit data. If an acknowledge is not detected, the slave will terminate further data transmissions and await the stop condition to return to standby power mode.

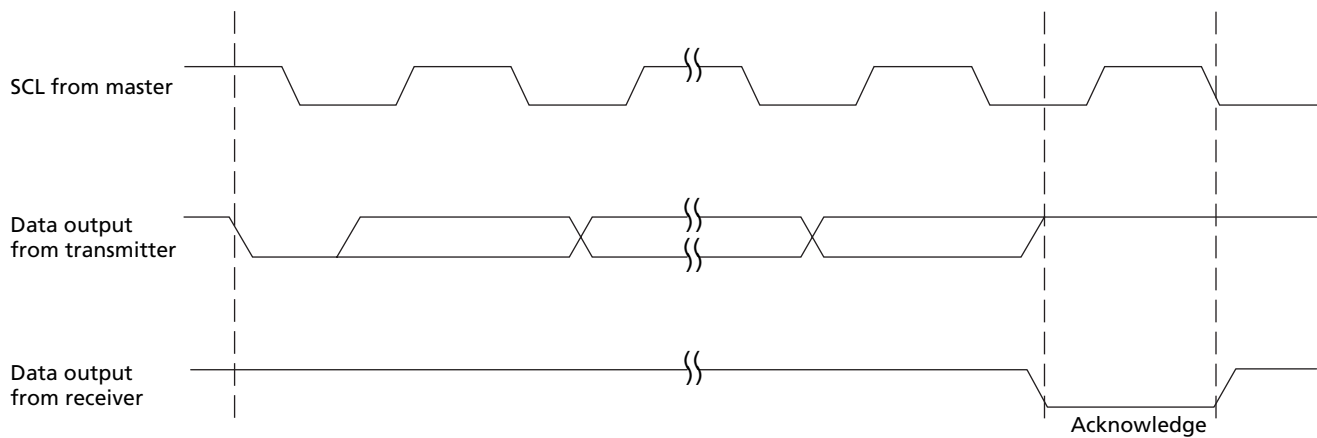
**Figure 4: Data Validity**



**Figure 5: Definition of Start and Stop**



**Figure 6: Acknowledge Response From Receiver**



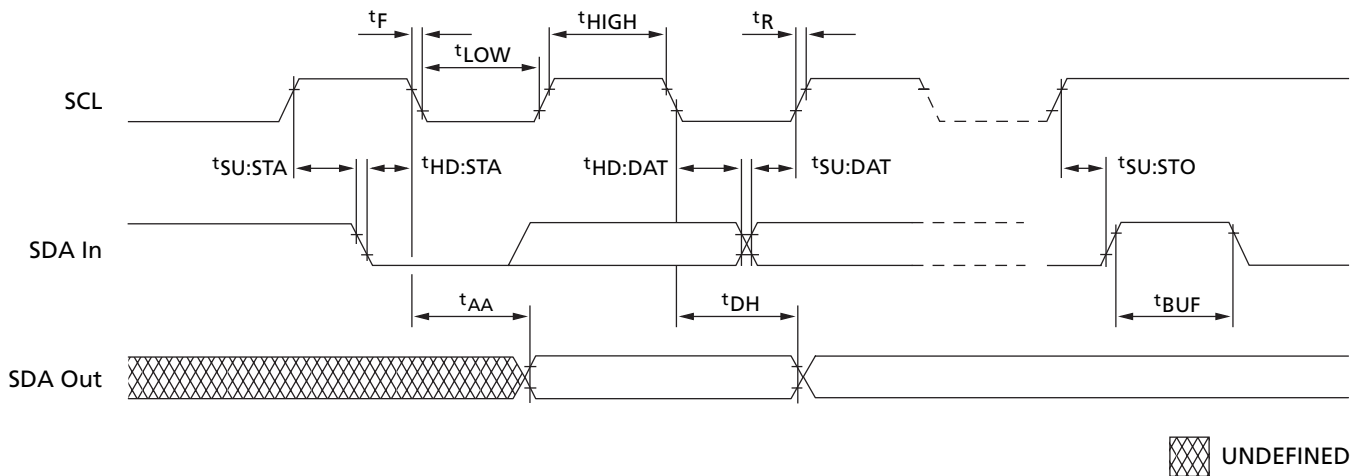
**Table 11: EEPROM Device Select Code**  
The most significant bit (b7) is sent first

| Select Code                          | Device Type Identifier |    |    |    | Chip Enable |     |     | R $\bar{W}$ |
|--------------------------------------|------------------------|----|----|----|-------------|-----|-----|-------------|
|                                      | b7                     | b6 | b5 | b4 | b3          | b2  | b1  | b0          |
| Memory area select code (two arrays) | 1                      | 0  | 1  | 0  | SA2         | SA1 | SA0 | R $\bar{W}$ |
| Protection register select code      | 0                      | 1  | 1  | 0  | SA2         | SA1 | SA0 | R $\bar{W}$ |

**Table 12: EEPROM Operating Modes**

| Mode                 | R $\bar{W}$ Bit | $\bar{W}C$                         | Bytes | Initial Sequence                               |
|----------------------|-----------------|------------------------------------|-------|--|
| Current address READ | 1               | V <sub>IH</sub> or V <sub>IL</sub> | 1     | Start, device select, R $\bar{W}$ = 1          |
| Random address READ  | 0               | V <sub>IH</sub> or V <sub>IL</sub> | 1     | Start, device select, R $\bar{W}$ = 0, address |
|                      | 1               | V <sub>IH</sub> or V <sub>IL</sub> | 1     | Restart, device select, R $\bar{W}$ = 1        |
| Sequential READ      | 1               | V <sub>IH</sub> or V <sub>IL</sub> | ≥ 1   | Similar to current or random address READ      |
| Byte WRITE           | 0               | V <sub>IL</sub>                    | 1     | Start, device select, R $\bar{W}$ = 0          |
| Page WRITE           | 0               | V <sub>IL</sub>                    | ≤ 16  | Start, device select, R $\bar{W}$ = 0          |

**Figure 7: SPD EEPROM Timing Diagram**



**Table 13: Serial Presence-Detect EEPROM DC Operating Conditions**

All voltages referenced to VSS; VDDSPD = +1.7V to +3.6V

| Parameter/Condition  | Symbol                      | Min          | Max          | Units |
|--|-----------------------------|--------------|--------------|-------|
| Supply voltage   | VDDSPD                      | 1.7          | 3.6          | V     |
| Input high voltage: Logic 1; All inputs                    | V <sub>IH</sub>             | VDDSPD × 0.7 | VDDSPD + 0.5 | V     |
| Input low voltage: Logic 0; All inputs                     | V <sub>IL</sub>             | -0.6         | VDDSPD × 0.3 | V     |
| Output low voltage: I <sub>OUT</sub> = 3mA                 | V <sub>OL</sub>             | -            | 0.4          | V     |
| Input leakage current: V <sub>IN</sub> = GND to VDD        | I <sub>LI</sub>             | 0.10         | 3            | μA    |
| Output leakage current: V <sub>OUT</sub> = GND to VDD      | I <sub>LO</sub>             | 0.05         | 3            | μA    |
| Standby current:   | I <sub>SB</sub>             | 1.6          | 4            | μA    |
| Power supply current, READ: SCL clock frequency = 100 KHz  | I <sub>CC<sub>R</sub></sub> | 0.4          | 1            | mA    |
| Power supply current, WRITE: SCL clock frequency = 100 KHz | I <sub>CC<sub>W</sub></sub> | 2            | 3            | mA    |

**Table 14: Serial Presence-Detect EEPROM AC Operating Conditions**

All voltages referenced to VSS; VDDSPD = +1.7V to +3.6V

| Parameter/Condition   | Symbol              | Min | Max | Units | Notes |
|---|---------------------|-----|-----|-------|-------|
| SCL LOW to SDA data-out valid                               | t <sup>AA</sup>     | 0.2 | 0.9 | μs    | 1     |
| Time the bus must be free before a new transition can start | t <sup>BUF</sup>    | 1.3 | -   | μs    |       |
| Data-out hold time  | t <sup>DH</sup>     | 200 | -   | ns    |       |
| SDA and SCL fall time                                       | t <sup>F</sup>      | -   | 300 | ns    | 2     |
| Data-in hold time   | t <sup>HD:DAT</sup> | 0   | -   | μs    |       |
| Start condition hold time                                   | t <sup>HD:STA</sup> | 0.6 | -   | μs    |       |
| Clock HIGH period   | t <sup>HIGH</sup>   | 0.6 | -   | μs    |       |
| Noise suppression time constant at SCL, SDA inputs          | t <sub>I</sub>      | -   | 50  | ns    |       |
| Clock LOW period  | t <sup>LOW</sup>    | 1.3 | -   | μs    |       |
| SDA and SCL rise time                                       | t <sup>R</sup>      | -   | 0.3 | μs    | 2     |
| SCL clock frequency   | f <sup>SCL</sup>    | -   | 400 | KHz   |       |
| Data-in setup time  | t <sup>SU:DAT</sup> | 100 | -   | ns    |       |
| Start condition setup time                                  | t <sup>SU:STA</sup> | 0.6 | -   | μs    | 3     |
| Stop condition setup time                                   | t <sup>SU:STO</sup> | 0.6 | -   | μs    |       |
| WRITE cycle time  | t <sup>WRC</sup>    | -   | 10  | ms    | 4     |

- Notes:
1. To avoid spurious start and stop conditions, a minimum delay is placed between SCL = 1 and the falling or rising edge of SDA.
  2. This parameter is sampled.
  3. For a restart condition, or following a WRITE cycle.
  4. The SPD EEPROM WRITE cycle time (t<sup>WRC</sup>) is the time from a valid stop condition of a write sequence to the end of the EEPROM internal erase/program cycle. During the WRITE cycle, the EEPROM bus interface circuit is disabled, SDA remains HIGH due to pull-up resistor, and the EEPROM does not respond to its slave address.



**Table 15: Serial Presence-Detect Matrix**

"1"/"0": Serial Data, "driven to HIGH"/"driven to LOW"; table notes located on page 19

| Byte | Description  | Entry (Version)                                      | MT16HTF6464A        | MT16HTF12864A        | MT16HTF25664A        |
|------|--|--|---------------------|----------------------|----------------------|
| 0    | Number of SPD bytes used by Micron                               | 128  | 80                  | 80                   | 80                   |
| 1    | Total number of bytes in SPD device                              | 256  | 08                  | 08                   | 08                   |
| 2    | Fundamental memory type  | DDR2 SDRAM   | 08                  | 08                   | 08                   |
| 3    | Number of row addresses on assembly                              | 13, 14   | 0D                  | 0E                   | 0E                   |
| 4    | Number of column addresses on assembly                           | 10   | 0A                  | 0A                   | 0A                   |
| 5    | DIMM height and module ranks                                     | 1.18in, dual rank                                    | 61                  | 61                   | 61                   |
| 6    | Module data width  | 64   | 40                  | 40                   | 40                   |
| 7    | Reserved   | 0  | 00                  | 00                   | 00                   |
| 8    | Module voltage interface levels                                  | SSTL 1.8V  | 05                  | 05                   | 05                   |
| 9    | DDR2 cycle time, $t_{CK}$ (CL = MAX value, see byte 18)          | -80E<br>-667<br>-53E<br>-40E                         | -<br>30<br>3D<br>50 | 25<br>30<br>3D<br>50 | 25<br>30<br>3D<br>50 |
| 10   | DDR2 access from clock, $t_{AC}$ (CL = MAX value, see byte 18)   | -80E<br>-667<br>-53E<br>-40E                         | -<br>45<br>50<br>60 | 40<br>45<br>50<br>60 | 40<br>45<br>50<br>60 |
| 11   | Module configuration type  |  | 00                  | 00                   | 00                   |
| 12   | Refresh rate/type  | 7.81 $\mu$ s/self                                    | 82                  | 82                   | 82                   |
| 13   | DDR2 SDRAM device width (primary device)                         | 8  | 08                  | 08                   | 08                   |
| 14   | Error-checking DDR2 data width                                   | N/A  | 00                  | 00                   | 00                   |
| 15   | Reserved   | 1 clock  | 00                  | 00                   | 00                   |
| 16   | Burst lengths supported  | 4, 8   | 0C                  | 0C                   | 0C                   |
| 17   | Number of banks on DDR2 device                                   | 4 or 8   | 04                  | 04                   | 08                   |
| 18   | CAS latencies supported  | -80E (6, 5, 4)<br>-667 (5, 4, 3)<br>-53E/-40E (4, 3) | -<br>38<br>18       | 30<br>38<br>18       | 30<br>38<br>18       |
| 19   | Module thickness   |  | 01                  | 01                   | 01                   |
| 20   | DDR2 DIMM type   | Unbuffered   | 02                  | 02                   | 02                   |
| 21   | DDR2 module attributes   |  | 00                  | 00                   | 00                   |
| 22   | DDR2 device attributes: weak driver (01) or 50 $\Omega$ ODT (03) | -80E/-667<br>-53E/-40E                               | 03<br>01            | 03<br>01             | 03<br>01             |
| 23   | DDR2 cycle time, $t_{CK}$ , MAX CL - 1                           | -80E/-667<br>-53E<br>-40E                            | 3D<br>50<br>50      | 3D<br>50<br>50       | 3D<br>50<br>50       |
| 24   | SDRAM access from CK, $t_{AC}$ , MAX CL - 1                      | -80E<br>-667<br>-53E<br>-40E                         | -<br>45<br>50<br>60 | 40<br>45<br>50<br>60 | 40<br>45<br>50<br>60 |
| 25   | SDRAM cycle time, $t_{CK}$ , MAX CL - 2                          | -80E<br>-667<br>-53E/-40E(N/A)                       | -<br>50<br>00       | 00<br>50<br>00       | 00<br>50<br>00       |
| 26   | SDRAM access from CK, $t_{AC}$ , MAX CL - 2                      | -80E<br>-667<br>-53E/-40E(N/A)                       | -<br>45<br>00       | 00<br>45<br>00       | 00<br>45<br>00       |
| 27   | MIN row precharge time, $t_{RP}$                                 | -80E<br>-667/-53E/-40E                               | -<br>3C             | 32<br>3C             | 32<br>3C             |

**Table 15: Serial Presence-Detect Matrix**

"1"/"0": Serial Data, "driven to HIGH"/"driven to LOW"; table notes located on page 19

| Byte  | Description   | Entry (Version)              | MT16HTF6464A        | MT16HTF12864A        | MT16HTF25664A        |
|-------|---|------------------------------|---------------------|----------------------|----------------------|
| 28    | MIN row active to row active, $t_{RRD}$                               |                              | 1E                  | 1E                   | 1E                   |
| 29    | MIN RAS#-to-CAS# delay, $t_{RCD}$                                     | -80E<br>-667/-53E/-40E       | -<br>3C             | 32<br>3C             | 32<br>3C             |
| 30    | MIN RAS# pulse width, $t_{RAS}$                                       | -80E/-667/-53E<br>-40E       | 2D<br>28            | 2D<br>28             | 2D<br>28             |
| 31    | Module rank density   | 256MB, 512MB, 1GB            | 40                  | 80                   | 01                   |
| 32    | Address and command setup time, $t_{IS_b}$                            | -80E<br>-667<br>-53E<br>-40E | -<br>20<br>25<br>35 | 17<br>20<br>25<br>35 | 17<br>20<br>25<br>35 |
| 33    | Address and command hold time, $t_{IH_b}$                             | -80E<br>-667<br>-53E<br>-40E | -<br>27<br>37<br>47 | 25<br>27<br>37<br>47 | 25<br>27<br>37<br>47 |
| 34    | Data/data mask input setup time, $t_{DS_b}$                           | -80E<br>-667/-53E<br>-40E    | -<br>10<br>15       | 05<br>10<br>15       | 05<br>10<br>15       |
| 35    | Data/data mask input hold time, $t_{DH_b}$                            | -80E<br>-667<br>-53E<br>-40E | -<br>17<br>22<br>27 | 12<br>17<br>22<br>27 | 12<br>17<br>22<br>27 |
| 36    | Write recovery time, $t_{WR}$   |                              | 3C                  | 3C                   | 3C                   |
| 37    | WRITE-to-READ command delay, $t_{WTR}$                                | -80E/-667/-53E<br>-40E       | 1E<br>28            | 1E<br>28             | 1E<br>28             |
| 38    | READ-to-PRECHARGE command delay, $t_{RTP}$                            |                              | 1E                  | 1E                   | 1E                   |
| 39    | Mem analysis probe  |                              | 00                  | 00                   | 00                   |
| 40    | Extension for bytes 41 and 42   | -80E<br>-667/-53E/-40E       | -<br>00             | 30<br>00             | 36<br>06             |
| 41    | MIN active auto refresh time, $t_{RC}$                                | -80E<br>-667/-53E<br>-40E    | -<br>3C<br>37       | 39<br>3C<br>37       | 39<br>3C<br>37       |
| 42    | MIN AUTO REFRESH-to-ACTIVE/<br>AUTO REFRESH command period, $t_{RFC}$ |                              | 69                  | 69                   | 7F                   |
| 43    | DDR2 device MAX cycle time, $t_{CKMAX}$                               |                              | 80                  | 80                   | 80                   |
| 44    | DDR2 device MAX DQS-DQ skew time,<br>$t_{DQSQ}$                       | -80E<br>-667<br>-53E<br>-40E | -<br>18<br>1E<br>23 | 14<br>18<br>1E<br>23 | 14<br>18<br>1E<br>23 |
| 45    | DDR2 device MAX read data hold skew<br>factor, $t_{QHS}$              | -80E<br>-667<br>-53E<br>-40E | -<br>22<br>28<br>2D | 1E<br>22<br>28<br>2D | 1E<br>22<br>28<br>2D |
| 46    | PLL relock time   |                              | 00                  | 00                   | 00                   |
| 47–61 | Optional features, not supported                                      |                              | 00                  | 00                   | 00                   |
| 62    | SPD revision  | Release 1.2                  | 12                  | 12                   | 12                   |
| 63    | Checksum for bytes 0–62   | -80E<br>-667<br>-53E<br>-40E | -<br>ED<br>98<br>FF | 90<br>4C<br>F7<br>5E | 31<br>ED<br>98<br>FF |

**Table 15: Serial Presence-Detect Matrix**

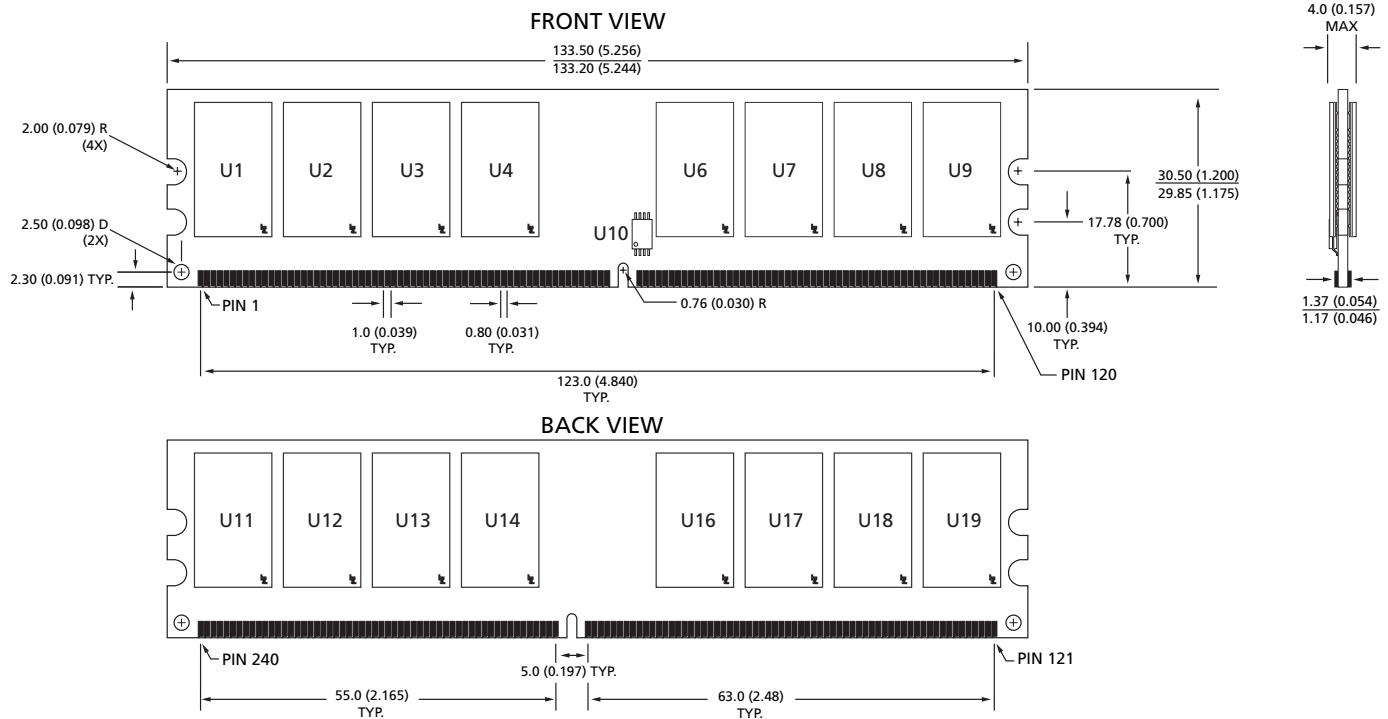
"1"/"0": Serial Data, "driven to HIGH"/"driven to LOW"; table notes located on page 19

| Byte   | Description                       | Entry (Version) | MT16HTF6464A  | MT16HTF12864A | MT16HTF25664A |
|--------|-----------------------------------|-----------------|---------------|---------------|---------------|
| 64     | Manufacturer's JEDEC ID code      | MICRON          | 2C            | 2C            | 2C            |
| 65-71  | Manufacturer's JEDEC ID code      | (Continued)     | FF            | FF            | FF            |
| 72     | Manufacturing location            | 01-12           | 01-0C         | 01-0C         | 01-0C         |
| 73-90  | Module part number (ASCII)        |                 | Variable data | Variable data | Variable data |
| 91     | PCB identification code           | 1-9             | 01-09         | 01-09         | 01-09         |
| 92     | Identification code (continued)   | 0               | 00            | 00            | 00            |
| 93     | Year of manufacture in BCD        |                 | Variable data | Variable data | Variable data |
| 94     | Week of manufacture in BCD        |                 | Variable data | Variable data | Variable data |
| 95-98  | Module serial number              |                 | Variable data | Variable data | Variable data |
| 99-127 | Manufacturer-specific data (RSVD) |                 | -             | -             | -             |

Notes: 1. The <sup>t</sup>RAS SPD value shown is based on the JEDEC standard value of 45ns; the actual device specification is <sup>t</sup>RAS = 40ns.

## Module Dimensions

**Figure 8: 240-pin DIMM DDR2 Module Dimensions**



- Notes: 1. All dimensions are in millimeters (inches);  $\frac{\text{MAX}}{\text{MIN}}$  or typical where noted.
2. The dimensional diagram is for reference only. Refer to the MO document for complete design dimensions.



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**This data sheet contains minimum and maximum limits specified over the complete power supply and temperature range for production devices. Although considered final, these specifications are subject to change, as further product development and data characterization sometimes occur.**

## Revision History

|  |              |
|--|--------------|
| <b>Rev. D, Released (No Mark)</b> .....  | <b>4/06</b>  |
| <ul style="list-style-type: none"><li>• Added -80E speed grade to 1GB and 2GB densities</li><li>• Removed component data</li><li>• Updated format, style</li></ul>   |              |
| <b>Rev. C, Released (No Mark)</b> .....  | <b>5/05</b>  |
| <ul style="list-style-type: none"><li>• Corrected 1GB -53E SPD</li></ul>   |              |
| <b>Rev. C, Released (No Mark)</b> .....  | <b>3/05</b>  |
| <ul style="list-style-type: none"><li>• Added -667 speed grade</li><li>• Updated Initialization process</li><li>• Updated Idds</li></ul>   |              |
| <b>Rev. B, Released (No Mark) (MT16HTF6464A), Preliminary (MT16HTF12864A, MT16HTF25664A)</b> .....   | <b>8/04</b>  |
| <ul style="list-style-type: none"><li>• Updated features list</li><li>• Updated part numbers</li><li>• Removed OCD, updated General Description</li><li>• Updated Initialization diagram, EMR diagrams</li><li>• Updated Table 15, AC Operating Conditions</li><li>• Updated SPD</li></ul> |              |
| <b>Rev. A, Pub. 11/03, Preliminary (MT16HTF6464A), Advance (MT16HTF12864A and MT16HTF25664A)</b> .....   | <b>11/03</b> |
| <ul style="list-style-type: none"><li>• New Datasheet, lvg'd from HTF8C32_64_128x72AG</li></ul>  |              |