



# DDR2 SDRAM Registered MiniDIMM

**MT9HTF3272(P)K – 256MB**

**MT9HTF6472(P)K – 512MB**

**MT9HTF12872(P)K – 1GB**

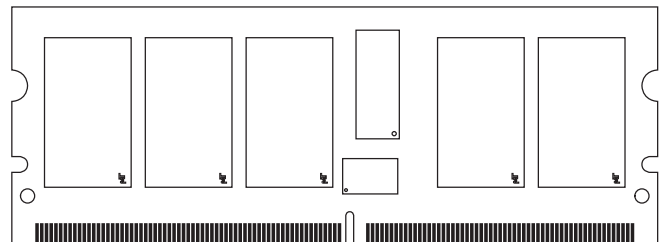
For component specifications, refer to Micron's Web site: [www.micron.com/products/dram/ddr2](http://www.micron.com/products/dram/ddr2)

## Features

- 244-pin, mini dual in-line memory module (MiniDIMM)
- Fast data transfer rates: PC2-3200, PC2-4200, or PC2-5300
- Supports ECC error detection and correction
- 256MB (32 Meg x 72), 512MB (64 Meg x 72), 1GB (128 Meg x 72)
- $V_{DD} = V_{DDQ} = +1.8V$
- $V_{DDSPD} = +1.7V$  to  $+3.6V$
- JEDEC standard 1.8V I/O (SSTL<sub>18</sub> 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
- Supports duplicate output strobe (RDQS/RDQS#)
- Programmable CAS# latency (CL)
- Posted CAS# additive latency (AL)
- WRITE latency = READ latency - 1  $t_{CK}$
- 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
- Single rank

**Figure 8: 244-Pin DIMM (MO-244 R/C "A")**

Height 30mm (1.18 in)



## Options

- Parity
- Package  
244-pin DIMM (lead-free)
- Frequency/CAS latency<sup>1</sup>  
2.5ns @ CL = 5 (DDR2-800)<sup>2</sup>  
2.5ns @ CL = 6 (DDR2-800)<sup>2</sup>  
3ns @ CL = 5 (DDR2-667)  
3.75ns @ CL = 4 (DDR2-533)  
5.0ns @ CL = 3 (DDR2-400)
- PCB height  
30mm (1.18in)

## Marking

P  
  
Y  
  
-80E  
-800  
-667  
-53E  
-40E

Notes: 1. CL = CAS (READ) latency; registered mode will add one clock cycle to CL.

2. Not available in 256MB density.

**Table 1: Address Table**

|                           | 256MB              | 512MB              | 1GB               |
|---------------------------|--------------------|--------------------|-------------------|
| 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    | 1 (S0#)            | 1 (S0#)            | 1 (S0#)           |



# 256MB, 512MB, 1GB: (x72, SR) 244-Pin DDR2 Registered MiniDIMM Features

**Table 2: Key Timing Parameters**

| Speed Grade | Industry Nomenclature | Data Rate (MT/s) |        |        |        | $t_{RCD}$ (ns) | $t_{RP}$ (ns) | $t_{RC}$ (ns) |
|-------------|-----------------------|------------------|--------|--------|--------|----------------|---------------|---------------|
|             |                       | CL = 6           | CL = 5 | CL = 4 | CL = 3 |                |               |               |
| -80E        | PC2-6400              | –                | 800    | 533    | –      | 12.5           | 12.5          | 55            |
| -800        | PC2-6400              | 800              | 667    | –      | –      | 15             | 15            | 55            |
| -667        | PC2-5300              | –                | 667    | 533    | 400    | 15             | 15            | 55            |
| -53E        | PC2-4200              | –                | –      | 533    | 400    | 15             | 15            | 55            |
| -40E        | PC2-3200              | –                | –      | 400    | 400    | 15             | 15            | 55            |

**Table 3: Part Numbers and Timing Parameters – 256MB**

Base device: MT47H32M8, 256Mb DDR2 SDRAM

| Part Number <sup>1</sup> | Module Density | Configuration | Module Bandwidth | Memory Clock/Data Rate | Latency (CL - $t_{RCD}$ - $t_{RP}$ ) |
|--------------------------|----------------|---------------|------------------|------------------------|--------------------------------------|
| MT9HTF3272(P)KY-667__    | 256MB          | 32 Meg x 72   | 5.3 GB/s         | 3.0ns/667 MT/s         | 5-5-5                                |
| MT9HTF3272(P)KY-53E__    | 256MB          | 32 Meg x 72   | 4.3 GB/s         | 3.75ns/533 MT/s        | 4-4-4                                |
| MT9HTF3272(P)KY-40E__    | 256MB          | 32 Meg x 72   | 3.2 GB/s         | 5.0ns/400 MT/s         | 3-3-3                                |

**Table 4: Part Numbers and Timing Parameters – 512MB**

Base device: MT47H64M8, 512Mb DDR2 SDRAM

| Part Number <sup>1</sup> | Module Density | Configuration | Module Bandwidth | Memory Clock/Data Rate | Latency (CL - $t_{RCD}$ - $t_{RP}$ ) |
|--------------------------|----------------|---------------|------------------|------------------------|--------------------------------------|
| MT9HTF6472(P)KY-80E__    | 512MB          | 64 Meg x 72   | 6.4 GB/s         | 2.5ns/800 MT/s         | 5-5-5                                |
| MT9HTF6472(P)KY-800__    | 512MB          | 64 Meg x 72   | 6.4 GB/s         | 2.5ns/800 MT/s         | 6-6-6                                |
| MT9HTF6472(P)KY-667__    | 512MB          | 64 Meg x 72   | 5.3 GB/s         | 3.0ns/667 MT/s         | 5-5-5                                |
| MT9HTF6472(P)KY-53E__    | 512MB          | 64 Meg x 72   | 4.3 GB/s         | 3.75ns/533 MT/s        | 4-4-4                                |
| MT9HTF6472(P)KY-40E__    | 512MB          | 64 Meg x 72   | 3.2 GB/s         | 5.0ns/400 MT/s         | 3-3-3                                |

**Table 5: Part Numbers and Timing Parameters – 1GB**

Base device: MT47H128M8, 1Gb DDR2 SDRAM

| Part Number <sup>1</sup> | Module Density | Configuration | Module Bandwidth | Memory Clock/Data Rate | Latency (CL - $t_{RCD}$ - $t_{RP}$ ) |
|--------------------------|----------------|---------------|------------------|------------------------|--------------------------------------|
| MT9HTF12872(P)KY-80E__   | 1GB            | 128 Meg x 72  | 6.4 GB/s         | 2.5ns/800 MT/s         | 5-5-5                                |
| MT9HTF12872(P)KY-800__   | 1GB            | 128 Meg x 72  | 6.4 GB/s         | 2.5ns/800 MT/s         | 6-6-6                                |
| MT9HTF12872(P)KY-667__   | 1GB            | 128 Meg x 72  | 5.3 GB/s         | 3.0ns/667 MT/s         | 5-5-5                                |
| MT9HTF12872(P)KY-53E__   | 1GB            | 128 Meg x 72  | 4.3 GB/s         | 3.75ns/533 MT/s        | 4-4-4                                |
| MT9HTF12872(P)KY-40E__   | 1GB            | 128 Meg x 72  | 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: MT9HTF6472KY-40EC2.
  2. For component data sheets, refer to Micron's web site at [www.micron.com/products/dram/ddr2](http://www.micron.com/products/dram/ddr2).



## Pin Assignments and Descriptions

**Table 6: Pin Assignments**

| 244-Pin MiniDIMM Front |        |     |         |     |        |     |           |
|------------------------|--------|-----|---------|-----|--------|-----|-----------|
| Pin                    | Symbol | Pin | Symbol  | Pin | Symbol | Pin | Symbol    |
| 1                      | VREF   | 32  | Vss     | 63  | VDDQ   | 94  | DQS5#     |
| 2                      | Vss    | 33  | DQ24    | 64  | A2     | 95  | DQS5      |
| 3                      | DQ0    | 34  | DQ25    | 65  | VDD    | 96  | Vss       |
| 4                      | DQ1    | 35  | Vss     | 66  | Vss    | 97  | DQ42      |
| 5                      | Vss    | 36  | DQS3#   | 67  | Vss    | 98  | DQ43      |
| 6                      | DQS0#  | 37  | DQS3    | 68  | PAR_IN | 99  | Vss       |
| 7                      | DQS0   | 38  | Vss     | 69  | VDD    | 100 | DQ48      |
| 8                      | Vss    | 39  | DQ26    | 70  | A10/AP | 101 | DQ49      |
| 9                      | DQ2    | 40  | DQ27    | 71  | BA0    | 102 | Vss       |
| 10                     | DQ3    | 41  | Vss     | 72  | VDD    | 103 | SA2       |
| 11                     | Vss    | 42  | CB0     | 73  | WE#    | 104 | NC (Test) |
| 12                     | DQ8    | 43  | CB1     | 74  | VDDQ   | 105 | Vss       |
| 13                     | DQ9    | 44  | Vss     | 75  | CAS#   | 106 | DQS6#     |
| 14                     | Vss    | 45  | DQS8#   | 76  | VDDQ   | 107 | DQS6      |
| 15                     | DQS1#  | 46  | DQS8    | 77  | NC     | 108 | Vss       |
| 16                     | DQS1   | 47  | Vss     | 78  | NC     | 109 | DQ50      |
| 17                     | Vss    | 48  | CB2     | 79  | VDDQ   | 110 | DQ51      |
| 18                     | RESET# | 49  | CB3     | 80  | NC     | 111 | Vss       |
| 19                     | NC     | 50  | Vss     | 81  | Vss    | 112 | DQ56      |
| 20                     | Vss    | 51  | NC      | 82  | DQ32   | 113 | DQ57      |
| 21                     | DQ10   | 52  | VDDQ    | 83  | DQ33   | 114 | Vss       |
| 22                     | DQ11   | 53  | CKE0    | 84  | Vss    | 115 | DQS7#     |
| 23                     | Vss    | 54  | VDD     | 85  | DQS4#  | 116 | DQS7      |
| 24                     | DQ16   | 55  | NC/BA2  | 86  | DQS4   | 117 | Vss       |
| 25                     | DQ17   | 56  | ERR_OUT | 87  | Vss    | 118 | DQ58      |
| 26                     | Vss    | 57  | VDDQ    | 88  | DQ34   | 119 | DQ59      |
| 27                     | DQS2#  | 58  | A11     | 89  | DQ35   | 120 | Vss       |
| 28                     | DQS2   | 59  | A7      | 90  | Vss    | 121 | SA0       |
| 29                     | Vss    | 60  | VDD     | 91  | DQ40   | 122 | SA1       |
| 30                     | DQ18   | 61  | A5      | 92  | DQ41   |     |           |
| 31                     | DQ19   | 62  | A4      | 93  | Vss    |     |           |

| 244-Pin MiniDIMM Back |               |     |               |     |               |     |               |
|-----------------------|---------------|-----|---------------|-----|---------------|-----|---------------|
| Pin                   | Symbol        | Pin | Symbol        | Pin | Symbol        | Pin | Symbol        |
| 123                   | Vss           | 154 | DQ28          | 185 | A3            | 216 | NC/<br>RDQS#5 |
| 124                   | DQ4           | 155 | DQ29          | 186 | A1            | 217 | Vss           |
| 125                   | DQ5           | 156 | Vss           | 187 | VDD           | 218 | DQ46          |
| 126                   | Vss           | 157 | DM3/<br>RDQS3 | 188 | CK0           | 219 | DQ47          |
| 127                   | DM0/<br>RDQS0 | 158 | NC/<br>RDQS#3 | 189 | CK0#          | 220 | Vss           |
| 128                   | NC/<br>RDQS#0 | 159 | Vss           | 190 | VDD           | 221 | DQ52          |
| 129                   | Vss           | 160 | DQ30          | 191 | A0            | 222 | DQ53          |
| 130                   | DQ6           | 161 | DQ31          | 192 | BA1           | 223 | Vss           |
| 131                   | DQ7           | 162 | Vss           | 193 | VDD           | 224 | RFU           |
| 132                   | Vss           | 163 | CB4           | 194 | RAS#          | 225 | RFU           |
| 133                   | DQ12          | 164 | CB5           | 195 | VDDQ          | 226 | Vss           |
| 134                   | DQ13          | 165 | Vss           | 196 | S0#           | 227 | DM6/<br>RDQS6 |
| 135                   | Vss           | 166 | DM8/<br>RDQS8 | 197 | VDDQ          | 228 | NC/<br>RDQS#6 |
| 136                   | DM1/<br>RDQS1 | 167 | NC/<br>RDQS#8 | 198 | ODT0          | 229 | Vss           |
| 137                   | NC/<br>RDQS#1 | 168 | Vss           | 199 | NC/A13        | 230 | DQ54          |
| 138                   | Vss           | 169 | CB6           | 200 | VDD           | 231 | DQ55          |
| 139                   | RFU           | 170 | CB7           | 201 | NC            | 232 | Vss           |
| 140                   | RFU           | 171 | Vss           | 202 | Vss           | 233 | DQ60          |
| 141                   | Vss           | 172 | NC            | 203 | DQ36          | 234 | DQ61          |
| 142                   | DQ14          | 173 | VDDQ          | 204 | DQ37          | 235 | Vss           |
| 143                   | DQ15          | 174 | NC/CKE1       | 205 | Vss           | 236 | DM7/<br>RDQS7 |
| 144                   | Vss           | 175 | VDD           | 206 | DM4/<br>RDQS4 | 237 | NC/<br>RDQS#7 |
| 145                   | DQ20          | 176 | NC            | 207 | NC/<br>RDQS#4 | 238 | Vss           |
| 146                   | DQ21          | 177 | NC            | 208 | Vss           | 239 | DQ62          |
| 147                   | Vss           | 178 | VDDQ          | 209 | DQ38          | 240 | DQ63          |
| 148                   | DM2/<br>RDQS2 | 179 | A12           | 210 | DQ39          | 241 | Vss           |
| 149                   | NC/<br>RDQS#2 | 180 | A9            | 211 | Vss           | 242 | SDA           |
| 150                   | Vss           | 181 | VDD           | 212 | DQ44          | 243 | SCL           |
| 151                   | DQ22          | 182 | A8            | 213 | DQ45          | 244 | VDDSPD        |
| 152                   | DQ23          | 183 | A6            | 214 | Vss           |     |               |
| 153                   | Vss           | 184 | VDDQ          | 215 | DM5/<br>RDQS5 |     |               |

- Notes: 1. Pin 55 is NC for 256MB and 512MB, and BA2 for 1GB.  
2. Pin 199 is NC for 256MB, and A13 for 512MB and 1GB.



## 256MB, 512MB, 1GB: (x72, SR) 244-Pin DDR2 Registered MiniDIMM Pin Assignments and Descriptions

Table 7: Pin Descriptions

| Symbol                                         | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ODT0                                           | Input | <b>On-Die termination:</b> 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#, RDQS, RDQS#, CB, and DM. The ODT input will be ignored if disabled via the LOAD MODE (LM) command.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| CK0, CK0#                                      | Input | <b>Clock:</b> 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#.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| CKE0                                           | Input | <b>Clock enable:</b> 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 once 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. |
| S0#                                            | Input | <b>Chip select:</b> 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| RAS#, CAS#, WE#                                | Input | <b>Command inputs:</b> RAS#, CAS#, and WE# (along with S#) define the command being entered.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| BA0, BA1<br>(256MB, 512MB)<br>BA0-BA2<br>(1GB) | Input | <b>Bank address inputs:</b> 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 LM command.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| A0-A12<br>(256MB)<br>A0-A13<br>(512MB, 1GB)    | Input | <b>Address inputs:</b> 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 LM command.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| PAR_IN                                         | Input | Parity bit for the address and control bus.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| SCL                                            | Input | <b>Serial clock for presence-detect:</b> SCL is used to synchronize the presence-detect data transfer to and from the module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| SA0-SA2                                        | Input | <b>Presence-Detect address inputs:</b> These pins are used to configure the presence-detect device.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| RESET#                                         | Input | Asynchronously forces all registered outputs LOW when RESET# is LOW. This signal can be used during power up to ensure that CKE is LOW and DQs are High-Z.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| DQ0-DQ63                                       | I/O   | <b>Data Input/output:</b> Bidirectional data bus.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| DQS0-DQS8,<br>RDQS0#-RDQS8#                    | I/O   | <b>Data strobe:</b> 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 LM command. DQS9#-DQS17# are only used when RDQS# is enabled via the LM command.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| DM0-DM8                                        | I/O   | <b>Input data mask:</b> 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. If RDQS is enabled, DQS9#-DQS17# are used only during the READ command. If RDQS is disabled, DQS0-DQS17 become DM0-DM8 and DQS9#-DQS17# are not used.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| CB0-CB7                                        | I/O   | Check bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |



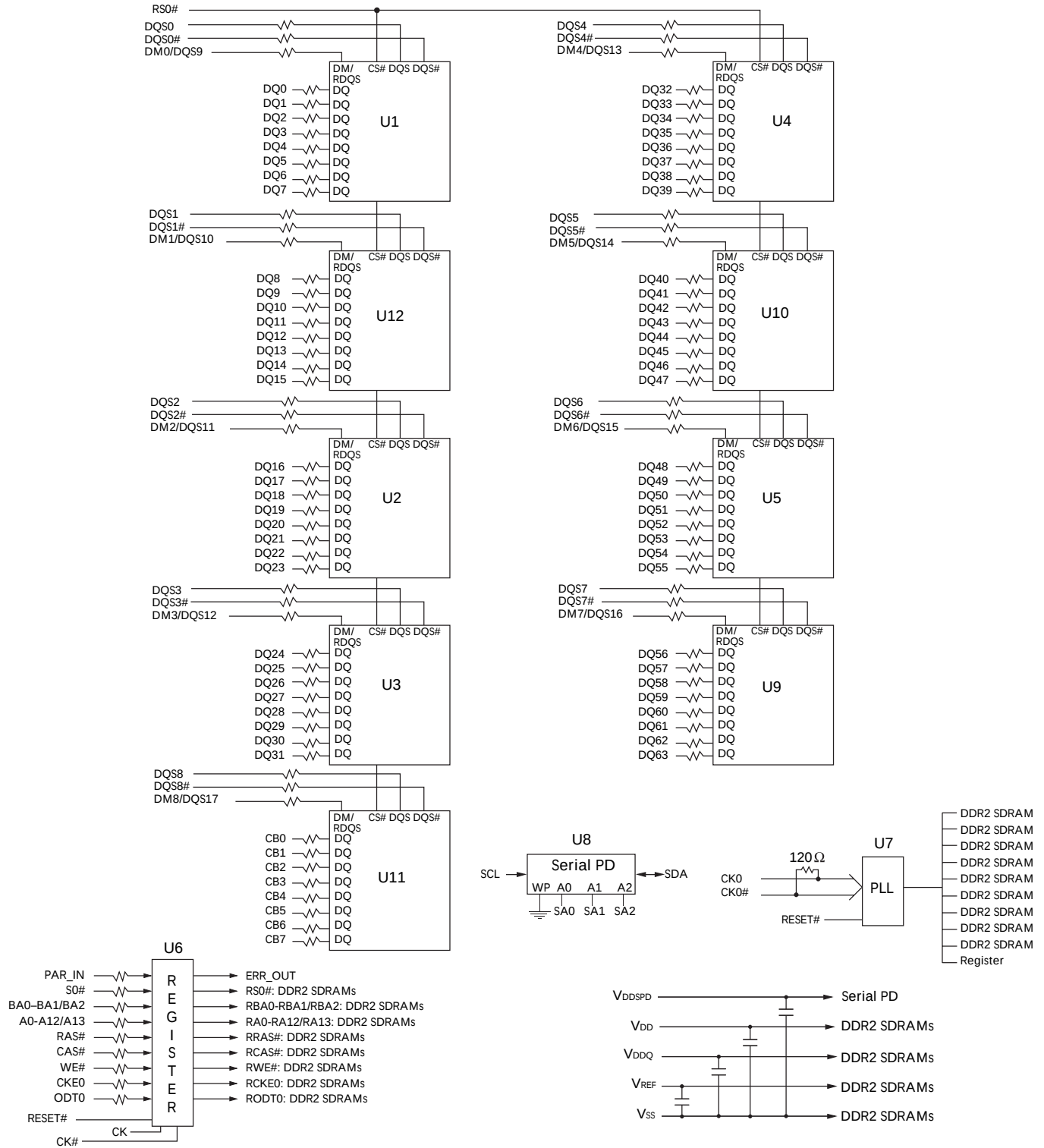
Table 7: Pin Descriptions (Continued)

| Symbol  | Type   | Description                                                                                                                                                   |
|---------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SDA     | I/O    | <b>Serial presence-detect data:</b> SDA is a bidirectional pin used to transfer addresses and data into and out of the presence-detect portion of the module. |
| ERR_OUT | Output | Parity error found on the address and control bus.                                                                                                            |
| VDD     | Supply | Power supply: 1.8V $\pm$ 0.1V.                                                                                                                                |
| VDDQ    | Supply | DQ power supply: 1.8V $\pm$ 0.1V.                                                                                                                             |
| VREF    | Supply | SSTL_18 reference voltage.                                                                                                                                    |
| VSS     | Supply | Ground.                                                                                                                                                       |
| VDDSPD  | Supply | <b>Serial EEPROM positive power supply:</b> +1.7V to +3.6V.                                                                                                   |



## Functional Block Diagram

Figure 9: Functional Block Diagram



Notes: 1. Unless otherwise noted, resistor values are 22Ω.



## General Description

The MT9HTF3272(P)K, MT9HTF6472(P)K, and MT9HTF12872(P)K DDR2 SDRAM modules are high-speed, CMOS, dynamic random-access 256MB, 512MB, and 1GB memory modules organized in x72 configuration. DDR2 SDRAM modules use internally configured quad-bank (256Mb, 512Mb) or eight-bank (1Gb) DDR2 SDRAM 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 DRAM 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 SDRAM 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 SDRAM 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.

## PLL and Register Operation

DDR2 SDRAM modules operate in registered mode, where the command/address input signals are latched in the registers on the rising clock edge and sent to the DDR2 SDRAM devices on the following rising clock edge (data access is delayed by one clock cycle). A phase-lock loop (PLL) on the module receives and redrives the differential clock signals (CK, CK#) to the DDR2 SDRAM devices. The registers and PLL minimize system and clock loading. Registered mode will add one clock cycle to CL.

## 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 SDRAM 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 8 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 8: Absolute Maximum DC Ratings**

| Symbol            | Parameter                                                                                                                                     |                                                   | Min  | Max  | Units |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|------|------|-------|
| VDD               | VDD supply voltage relative to Vss                                                                                                            |                                                   | −1.0 | +2.3 | V     |
| VDDQ              | VDDQ supply voltage relative to Vss                                                                                                           |                                                   | −0.5 | +2.3 | V     |
| VDDL              | VDDL supply voltage relative to Vss                                                                                                           |                                                   | −0.5 | +2.3 | V     |
| VIN, VOUT         | Voltage on any pin relative to Vss                                                                                                            |                                                   | −0.5 | +2.3 | V     |
| T <sub>STG</sub>  | Storage temperature                                                                                                                           |                                                   | −55  | +100 | °C    |
| T <sub>CASE</sub> | DDR2 SDRAM device operating temperature                                                                                                       |                                                   | 0    | +85  | °C    |
| T <sub>OPR</sub>  | Operating temperature                                                                                                                         |                                                   | 0    | +55  | °C    |
| I <sub>I</sub>    | Input leakage current; Any input $0V \leq V_{IN} \leq V_{DD}$ ; VREF input $0V \leq V_{IN} \leq 0.95V$ ; (All other pins not under test = 0V) | Command/Address, RAS#, CAS#, WE# S#, CKE, ODT, DM | −5   | +5   | μA    |
|                   |                                                                                                                                               | CK, CK#                                           | −10  | +10  |       |
| I <sub>OZ</sub>   | Output leakage current; $0V \leq V_{OUT} \leq V_{DDQ}$ ; DQs and ODT are disabled                                                             | DQ, DQS, DQS#                                     | −5   | +5   | μA    |
| I <sub>VREF</sub> | VREF leakage current; VREF = Valid VREF level                                                                                                 |                                                   | −18  | +18  | μA    |

## 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.





# 256MB, 512MB, 1GB: (x72, SR) 244-Pin DDR2 Registered MiniDIMM Electrical Specifications

**Table 9: IDD Specifications and Conditions – 256MB**

Values shown for DDR2 SDRAM components only

| Parameter/Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Symbol | -667  | -53E  | -40E  | Units |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------|-------|-------|-------|
| <b>Operating one bank active-precharge current;</b> $t_{CK} = t_{CK} (I_{DD})$ , $t_{RC} = t_{RC} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MIN} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                                       | IDD0   | 810   | 720   | 675   | mA    |
| <b>Operating one bank active-read-precharge current;</b> $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RC} = t_{RC} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MIN} (I_{DD})$ , $t_{RCD} = t_{RCD} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W                                                                                                           | IDD1   | 900   | 810   | 765   | mA    |
| <b>Precharge power-down current;</b> All device banks idle; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating                                                                                                                                                                                                                                                                                             | IDD2P  | 45    | 45    | 45    | mA    |
| <b>Precharge quiet standby current;</b> All device banks idle; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are STABLE; Data bus inputs are floating                                                                                                                                                                                                                                                                             | IDD2Q  | 360   | 315   | 225   | mA    |
| <b>Precharge standby current;</b> All device banks idle; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                                                                                                               | IDD2N  | 360   | 315   | 270   | mA    |
| <b>Active power-down current;</b> All device banks open; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating                                                                                                                                                                                                                                                                                                | IDD3P  | 270   | 225   | 180   | mA    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        | 54    | 54    | 54    | mA    |
| <b>Active standby current;</b> All device banks open; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$ , $t_{RP} = t_{RP} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                   | IDD3N  | 450   | 360   | 270   | mA    |
| <b>Operating burst write current;</b> All device banks open, continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$ , $t_{RP} = t_{RP} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching                                                                                                                                      | IDD4W  | 1,710 | 1,440 | 1,125 | 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; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$ , $t_{RP} = t_{RP} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching                                                                                                               | IDD4R  | 1,620 | 1,350 | 1,035 | mA    |
| <b>Burst refresh current;</b> $t_{CK} = t_{CK} (I_{DD})$ ; REFRESH command at every $t_{RFC} (I_{DD})$ interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                                                             | IDD5   | 1,620 | 1,530 | 1,485 | 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   | 45    | 45    | 45    | mA    |
| <b>Operating bank interleave read current;</b> All device banks interleaving reads, $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = $t_{RCD} (I_{DD}) - 1 \times t_{CK} (I_{DD})$ ; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RC} = t_{RC} (I_{DD})$ , $t_{RRD} = t_{RRD} (I_{DD})$ , $t_{RCD} = t_{RCD} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching; See IDD7 Conditions for detail | IDD7   | 2250  | 2,160 | 2,070 | mA    |



## 256MB, 512MB, 1GB: (x72, SR) 244-Pin DDR2 Registered MiniDIMM Electrical Specifications

**Table 10: IDD Specifications and Conditions – 512MB**

Values shown for DDR2 SDRAM components only

| Parameter/Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Symbol | -80E/-800                   | -667  | -53E  | -40E  | Units |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------------|-------|-------|-------|-------|----|
| <b>Operating one bank active-precharge current;</b> $t_{CK} = t_{CK} (I_{DD})$ , $t_{RC} = t_{RC} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MIN} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                                       | IDD0   | 900                         | 810   | 720   | 720   | mA    |    |
| <b>Operating one bank active-read-precharge current;</b> $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RC} = t_{RC} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MIN} (I_{DD})$ , $t_{RCD} = t_{RCD} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W                                                                                                           | IDD1   | 1,035                       | 945   | 855   | 810   | mA    |    |
| <b>Precharge power-down current;</b> All device banks idle; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is LOW; Other control and address bus inputs are STABLE; Data bus inputs are floating                                                                                                                                                                                                                                                                                             | IDD2P  | 63                          | 63    | 63    | 63    | mA    |    |
| <b>Precharge quiet standby current;</b> All device banks idle; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating                                                                                                                                                                                                                                                                             | IDD2Q  | 450                         | 405   | 360   | 315   | mA    |    |
| <b>Precharge standby current;</b> All device banks idle; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                                                                                                               | IDD2N  | 495                         | 450   | 405   | 360   | mA    |    |
| <b>Active power-down current;</b> All device banks open; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating                                                                                                                                                                                                                                                                                                | IDD3P  | Fast PDN Exit<br>MR[12] = 0 | 360   | 315   | 270   | 225   | mA |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        | Slow PDN Exit<br>MR[12] = 1 | 108   | 108   | 108   | 108   | mA |
| <b>Active standby current;</b> All device banks open; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$ , $t_{RP} = t_{RP} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                   | IDD3N  | 630                         | 585   | 495   | 405   | mA    |    |
| <b>Operating burst write current;</b> All device banks open, continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$ , $t_{RP} = t_{RP} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching                                                                                                                                      | IDD4W  | 1,755                       | 1,530 | 1,260 | 1,035 | 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; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$ , $t_{RP} = t_{RP} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching                                                                                                               | IDD4R  | 1,845                       | 1,620 | 1,305 | 1,035 | mA    |    |
| <b>Burst refresh current;</b> $t_{CK} = t_{CK} (I_{DD})$ ; REFRESH command at every $t_{RFC} (I_{DD})$ interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                                                             | IDD5   | 2,070                       | 1,620 | 1,530 | 1,485 | 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   | 63                          | 63    | 63    | 63    | mA    |    |
| <b>Operating bank interleave read current;</b> All device banks interleaving reads, $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = $t_{RCD} (I_{DD}) - 1 \times t_{CK} (I_{DD})$ ; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RC} = t_{RC} (I_{DD})$ , $t_{RRD} = t_{RRD} (I_{DD})$ , $t_{RCD} = t_{RCD} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching; See IDD7 Conditions for detail | IDD7   | 2,700                       | 2,160 | 2,025 | 1,980 | mA    |    |



# 256MB, 512MB, 1GB: (x72, SR) 244-Pin DDR2 Registered MiniDIMM Electrical Specifications

**Table 11: IDD Specifications and Conditions – 1GB**

Values shown for DDR2 SDRAM components only

| Parameter/Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Symbol | -80E/-800                   | -667  | -53E  | -40E  | Units |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------------|-------|-------|-------|-------|
| <b>Operating one bank active-precharge current;</b> $t_{CK} = t_{CK} (I_{DD})$ , $t_{RC} = t_{RC} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MIN} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                                       | IDD0   | 810                         | 765   | 630   | 630   | mA    |
| <b>Operating one bank active-read-precharge current;</b> $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RC} = t_{RC} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MIN} (I_{DD})$ , $t_{RCD} = t_{RCD} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W                                                                                                           | IDD1   | 990                         | 900   | 855   | 810   | mA    |
| <b>Precharge power-down current;</b> All device banks idle; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating                                                                                                                                                                                                                                                                                             | IDD2P  | 63                          | 63    | 63    | 63    | mA    |
| <b>Precharge quiet standby current;</b> All device banks idle; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating                                                                                                                                                                                                                                                                             | IDD2Q  | 450                         | 360   | 360   | 315   | mA    |
| <b>Precharge standby current;</b> All device banks idle; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                                                                                                               | IDD2N  | 450                         | 360   | 360   | 315   | mA    |
| <b>Active power-down current;</b> All device banks open; $t_{CK} = t_{CK} (I_{DD})$ ; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating                                                                                                                                                                                                                                                                                                | IDD3P  | Fast PDN Exit<br>MR[12] = 0 | 360   | 270   | 270   | mA    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        | Slow PDN Exit<br>MR[12] = 1 | 90    | 90    | 90    | mA    |
| <b>Active standby current;</b> All device banks open; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$ , $t_{RP} = t_{RP} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                   | IDD3N  | 540                         | 495   | 405   | 360   | mA    |
| <b>Operating burst write current;</b> All device banks open, continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$ , $t_{RP} = t_{RP} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching                                                                                                                                      | IDD4W  | 1,440                       | 1,215 | 1,125 | 945   | 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; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$ , $t_{RP} = t_{RP} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching                                                                                                               | IDD4R  | 1,440                       | 1,215 | 1,125 | 945   | mA    |
| <b>Burst refresh current;</b> $t_{CK} = t_{CK} (I_{DD})$ ; REFRESH command at every $t_{RFC} (I_{DD})$ interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching                                                                                                                                                                                                                             | IDD5   | 2,115                       | 1,935 | 1,890 | 1,845 | 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   | 63                          | 63    | 63    | 63    | mA    |
| <b>Operating bank interleave read current;</b> All device banks interleaving reads, $I_{OUT} = 0\text{mA}$ ; BL = 4, CL = CL (IDD), AL = $t_{RCD} (I_{DD}) - 1 \times t_{CK} (I_{DD})$ ; $t_{CK} = t_{CK} (I_{DD})$ , $t_{RC} = t_{RC} (I_{DD})$ , $t_{RRD} = t_{RRD} (I_{DD})$ , $t_{RCD} = t_{RCD} (I_{DD})$ ; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching; See IDD7 Conditions for detail | IDD7   | 3,015                       | 2,520 | 2,430 | 2,340 | mA    |



## AC Operating Specifications

Recommended AC operating conditions are given in the DDR2 component data sheets, available at [www.micron.com/products/dram/ddr2](http://www.micron.com/products/dram/ddr2). Module speed grades correlate with component speed grades as shown in Figure 12:

**Table 12: Module and Component Speed Grade Table**

| Module Speed Grade | Component Speed Grade |
|--------------------|-----------------------|
| -80E               | -25E                  |
| -800               | -25                   |
| -667               | -3                    |
| -53E               | -37E                  |
| -40E               | -5E                   |

## Register and PLL Specifications

**Table 13: Register (SSTUB3287A or Equivalent)**

| Parameter                               | Symbol               | Pins                      | Condition                                                                                                                                                                                              | Min                         | Max                         | Units |
|-----------------------------------------|----------------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------------|-------|
| DC high-level input voltage             | V <sub>IH</sub> (DC) | Address, Control, Command | SSTL_18                                                                                                                                                                                                | V <sub>REF</sub> (DC) + 125 | V <sub>DDQ</sub> + 250      | mV    |
| DC low-level input voltage              | V <sub>IL</sub> (DC) | Address, Control, Command | SSTL_18                                                                                                                                                                                                | 0                           | V <sub>REF</sub> (DC) - 125 | mV    |
| AC high-level input voltage             | V <sub>IH</sub> (AC) | Address, Control, Command | SSTL_18                                                                                                                                                                                                | V <sub>REF</sub> (DC) + 250 | V <sub>DD</sub>             | mV    |
| AC low-level input voltage              | V <sub>IL</sub> (AC) | Address, Control, Command | SSTL_18                                                                                                                                                                                                | 0                           | V <sub>REF</sub> (DC) - 250 | mV    |
| Output high voltage                     | V <sub>OH</sub>      | Parity output             | LVC MOS                                                                                                                                                                                                | 1.2                         | –                           | mV    |
| Output low voltage                      | V <sub>OL</sub>      | Parity output             | LVC MOS                                                                                                                                                                                                | –                           | 0.5                         | mV    |
| Input current                           | I <sub>I</sub>       | All pins                  | V <sub>I</sub> = V <sub>DDQ</sub> or V <sub>SSQ</sub>                                                                                                                                                  | –5                          | 5                           | μA    |
| Static standby                          | I <sub>DD</sub>      | All pins                  | RESET# = V <sub>SSQ</sub> (I/O = 0)                                                                                                                                                                    | –                           | 100                         | μA    |
| Static operating                        | I <sub>DD</sub>      | All pins                  | RESET# = V <sub>SSQ</sub> ;<br>V <sub>I</sub> = V <sub>IH</sub> (AC) or V <sub>IL</sub> (DC)<br>I/O = 0                                                                                                | –                           | 80mA                        | μA    |
| Dynamic operating – clock tree          | I <sub>DDD</sub>     | N/A                       | RESET# = V <sub>DD</sub> , V <sub>I</sub> = V <sub>IH</sub> (AC) or V <sub>IL</sub> (AC), I/O = 0; CK and CK# switching 50% duty cycle                                                                 | –                           | Varies by manufacturer      | μA    |
| Dynamic operating (per each input)      | I <sub>DDD</sub>     | N/A                       | RESET# = V <sub>DD</sub> , V <sub>I</sub> = V <sub>IH</sub> (AC) or V <sub>IL</sub> (AC), I/O = 0; CK and CK# switching 50% duty cycle; One data input switching at t <sub>CK/2</sub> , 50% duty cycle | –                           | Varies by manufacturer      | μA    |
| Input capacitance (per device, per pin) | C <sub>I</sub>       | All inputs except RESET#  | V <sub>I</sub> = V <sub>REF</sub> ±250mV;<br>V <sub>DDQ</sub> = 1.8V                                                                                                                                   | 2.5                         | 3.5                         | pF    |
| Input capacitance (per device, per pin) |                      | RESET#                    | V <sub>I</sub> = V <sub>DDQ</sub> or V <sub>SSQ</sub>                                                                                                                                                  | –                           | Varies by manufacturer      | pF    |

## PLL

**Table 14: PLL (CU877 device or Equivalent JESD82-8.01)**

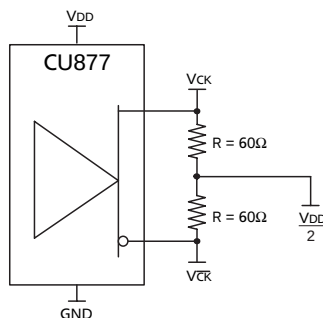
| Parameter                             | Symbol               | Pins            | Condition                                                                                 | Min                          | Max                          | Units |
|---------------------------------------|----------------------|-----------------|-------------------------------------------------------------------------------------------|------------------------------|------------------------------|-------|
| DC high-level input voltage           | V <sub>IH</sub>      | RESET#          | LVC MOS                                                                                   | 0.65 × V <sub>DD</sub>       | –                            | mV    |
| DC low-level input voltage            | V <sub>IL</sub>      | RESET#          | LVC MOS                                                                                   | –                            | 0.35 × V <sub>DD</sub>       | mV    |
| Input voltage (limits)                | V <sub>IN</sub>      | RESET#, CK, CK# |                                                                                           | –0.3                         | V <sub>DDQ</sub> + 0.3       | mV    |
| DC high-level input voltage           | V <sub>IH</sub>      | CK, CK#         | Differential input                                                                        | 0.65 × V <sub>DD</sub>       | –                            | mV    |
| DC low-level input voltage            | V <sub>IL</sub>      | CK, CK#         | Differential input                                                                        | –                            | 0.35 × V <sub>DD</sub>       | mV    |
| Input differential-pair cross voltage | V <sub>IX</sub>      | CK, CK#         | Differential input                                                                        | (V <sub>DDQ</sub> /2) - 0.15 | (V <sub>DDQ</sub> /2) + 0.15 | V     |
| Input differential voltage            | V <sub>ID</sub> (DC) | CK, CK#         | Differential input                                                                        | 0.3                          | V <sub>DDQ</sub> + 0.4       | V     |
| Input differential voltage            | V <sub>ID</sub> (AC) | CK, CK#         | Differential input                                                                        | 0.6                          | V <sub>DDQ</sub> + 0.4       | V     |
| Input current                         | I <sub>I</sub>       | RESET#          | V <sub>I</sub> = V <sub>DDQ</sub> or V <sub>SSQ</sub>                                     | –10                          | 10                           | μA    |
|                                       |                      | CK, CK#         | V <sub>I</sub> = V <sub>DDQ</sub> or V <sub>SSQ</sub>                                     | –250                         | 250                          | μA    |
| Output disabled current               | I <sub>ODL</sub>     |                 | RESET# = V <sub>SSQ</sub> ; V <sub>I</sub> = V <sub>IH</sub> (AC) or V <sub>IL</sub> (DC) | 100                          | –                            | μA    |
| Static supply current                 | I <sub>DDLD</sub>    |                 | CK = CK# = LOW                                                                            | –                            | 500                          | μA    |
| Dynamic supply                        | I <sub>DD</sub>      | N/A             | CK, CK# = 270 MHz, all outputs open (not connected to PCB)                                | –                            | 300                          | mA    |
| Input capacitance                     | C <sub>IN</sub>      | Each input      | V <sub>I</sub> = V <sub>DDQ</sub> or V <sub>SSQ</sub>                                     | 2                            | 3                            | pF    |

**Table 15: PLL Clock Driver Timing Requirements and Switching Characteristics**

Note: 1

| Parameter                                 | Symbol           | 0°C ≤ T <sub>OPR</sub> ≤ +55°C<br>V <sub>DD</sub> = +1.8V ±0.1V |       | Units |
|-------------------------------------------|------------------|-----------------------------------------------------------------|-------|-------|
|                                           |                  | Min                                                             | Max   |       |
| Stabilization time                        | t <sub>L</sub>   | –                                                               | 15    | μs    |
| Input clock slew rate                     | t <sub>LSI</sub> | 1.0                                                             | 4     | V/ns  |
| SSC modulation frequency                  |                  | 30                                                              | 33    | KHz   |
| SSC clock input frequency deviation       |                  | 0.0                                                             | –0.50 | %     |
| PLL loop bandwidth (–3dB from unity gain) |                  | 2.0                                                             | –     | MHz   |

- Notes: 1. PLL timing and switching specifications are critical for proper operation of the DDR2 DIMM. This is a subset of parameters for the specific PLL used. Detailed PLL information is available in JEDEC Standard JESD82.
2. The output slew rate is determined from the IBIS model:





**Table 16: Serial Presence-Detect EEPROM DC Operating Conditions**

All voltages referenced to V<sub>SS</sub>; V<sub>DDSPD</sub> = +1.7V to +3.6V

| Parameter/Condition                                                  | Symbol                      | Min                      | Max                      | Units |
|----------------------------------------------------------------------|-----------------------------|--------------------------|--------------------------|-------|
| Supply voltage                                                       | V <sub>DDSPD</sub>          | 1.7                      | 3.6                      | V     |
| Input high voltage: Logic 1; All inputs                              | V <sub>IH</sub>             | V <sub>DDSPD</sub> × 0.7 | V <sub>DDSPD</sub> + 0.5 | V     |
| Input low voltage: Logic 0; All inputs                               | V <sub>IL</sub>             | −0.6                     | V <sub>DDSPD</sub> × 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 V <sub>DDSPD</sub>   | I <sub>LI</sub>             | 0.10                     | 3                        | μA    |
| Output leakage current: V <sub>OUT</sub> = GND to V <sub>DDSPD</sub> | 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 17: Serial Presence-Detect EEPROM AC Operating Conditions**

All voltages referenced to V<sub>SS</sub>; V<sub>DDSPD</sub> = +1.7V to +3.6V

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



# 256MB, 512MB, 1GB: (x72, SR) 244-Pin DDR2 Registered MiniDIMM Register and PLL Specifications

**Table 18: Serial Presence-Detect Matrix**

"1"/"0": Serial Data, "driven to HIGH"/"driven to LOW"; table notes located on page 17

| Byte | Description                                                                | Entry (Version)                                                  | MT9HTF3272K/<br>MT9HTF3272(P)K | MT9HTF6472K/<br>MT9HTF6472(P)K | MT9HTF12872K/<br>MT9HTF12872K(P)K |
|------|----------------------------------------------------------------------------|------------------------------------------------------------------|--------------------------------|--------------------------------|-----------------------------------|
| 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                                               | 30mm, single rank                                                | 60                             | 60                             | 60                                |
| 6    | Module data width                                                          | 72                                                               | 48                             | 48                             | 48                                |
| 7    | Module data width (continued)                                              | 0                                                                | 00                             | 00                             | 00                                |
| 8    | Module voltage interface levels                                            | SSTL 1.8V                                                        | 05                             | 05                             | 05                                |
| 9    | SDRAM cycle time, <sup>t</sup> CK (CL = maximum value, see byte 18)        | -80E/-800<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   | SDRAM access from Clock, <sup>t</sup> AC (CL = maximum value, see byte 18) | -80E/-800<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                                                  | ECC<br>ECC and parity                                            | 02<br>06                       | 02<br>06                       | 02<br>06                          |
| 12   | Refresh rate/type                                                          | 7.81μs/SELF                                                      | 82                             | 82                             | 82                                |
| 13   | SDRAM device width (primary SDRAM)                                         | 8                                                                | 08                             | 08                             | 08                                |
| 14   | Error-checking SDRAM data width                                            | 8                                                                | 08                             | 08                             | 08                                |
| 15   | Minimum clock delay, back-to-back random column access                     | 1 clock                                                          | 00                             | 00                             | 00                                |
| 16   | Burst lengths supported                                                    | 4, 8                                                             | 0C                             | 0C                             | 0C                                |
| 17   | Number of banks on SDRAM device                                            | 4 or 8                                                           | 04                             | 04                             | 08                                |
| 18   | CAS latencies supported                                                    | -80E (5, 4)<br>-800 (6, 5)<br>-667 (5, 4, 3)<br>-53E/-40E (4, 3) | –<br>–<br>38<br>18             | 30<br>60<br>38<br>18           | 60<br>60<br>38<br>18              |
| 19   | Module thickness                                                           |                                                                  | 01                             | 01                             | 01                                |
| 20   | DDR2 DIMM type                                                             | Registered MiniDIMM                                              | 10                             | 10                             | 10                                |
| 21   | SDRAM module attributes                                                    |                                                                  | 04                             | 04                             | 04                                |
| 22   | SDRAM device attributes: weak driver (01) and 50Ω ODT (03)                 | -80E/-800/-667<br>-53E/-40E                                      | –/03<br>01                     | 03<br>01                       | 03<br>01                          |
| 23   | SDRAM cycle time, <sup>t</sup> CK, MAX CL - 1                              | -80E/-667<br>-800<br>-53E/-40E                                   | –/3D<br>–<br>50                | 3D<br>30<br>50                 | 3D<br>30<br>50                    |





# 256MB, 512MB, 1GB: (x72, SR) 244-Pin DDR2 Registered MiniDIMM Register and PLL Specifications

**Table 18: Serial Presence-Detect Matrix**

"1"/"0": Serial Data, "driven to HIGH"/"driven to LOW"; table notes located on page 17

| Byte | Description                                     | Entry (Version)                     | MT9HTF3272K/<br>MT9HTF3272(P)K | MT9HTF6472K/<br>MT9HTF6472(P)K | MT9HTF12872K/<br>MT9HTF12872K(P)K |
|------|-------------------------------------------------|-------------------------------------|--------------------------------|--------------------------------|-----------------------------------|
| 24   | SDRAM access from CK, $t_{AC}$ ,<br>MAX CL - 1  | -80E/-800<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, $t_{CK}$ ,<br>MAX CL - 2      | -80E/-800<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, $t_{AC}$ ,<br>MAX CL - 2  | -80E/-800<br>-667<br>-53E/-40E(N/A) | –<br>45<br>00                  | 00<br>45<br>00                 | 00<br>45<br>00                    |
| 27   | Minimum row precharge time,<br>$t_{RP}$         | -80E<br>-800/-667/-53E/<br>-40E     | –<br>–/3C                      | 32<br>3C                       | 32<br>3C                          |
| 28   | Minimum row active-to-row<br>active, $t_{RRD}$  |                                     | 1E                             | 1E                             | 1E                                |
| 29   | Minimum RAS#-to-CAS# delay,<br>$t_{RCD}$        | -80E<br>-800/-667/-53E/<br>-40E     | –<br>–/3C                      | 32<br>3C                       | 32<br>3C                          |
| 30   | Minimum RAS# pulse width, $t_{RAS}$             | -80E/-800/<br>-667/-53E<br>-40E     | 2D<br>2D<br>28                 | 2D<br>2D<br>28                 | 2D<br>2D<br>28                    |
| 31   | Module rank density                             | 256MB, 512MB<br>1GB                 | 40                             | 80                             | 01                                |
| 32   | Address and command setup<br>time, $t_{IS_b}$   | -80E/-800<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,<br>$t_{IH_b}$    | -80E/-800<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,<br>$t_{DS_b}$ | -80E/-800<br>-667/-53E<br>-40E      | –<br>10<br>15                  | 5<br>10<br>15                  | 5<br>10<br>15                     |
| 35   | Data/ Data mask input hold time,<br>$t_{DH_b}$  | -80E/-800<br>-667<br>-53E<br>-40E   | –<br>17<br>22<br>27            | 12<br>17<br>22<br>27           | 12<br>35<br>22<br>27              |
| 36   | Write recovery time, $t_{WR}$                   |                                     | 3C                             | 3C                             | 3C                                |
| 37   | WRITE-to-READ command delay,<br>$t_{WTR}$       | -80E<br>-800/-40E<br>-667/-53E      | –<br>28<br>1E                  | 1E<br>28<br>1E                 | 28<br>28<br>1E                    |
| 38   | READ-to-PRECHARGE command<br>delay, $t_{RTP}$   |                                     | 1E                             | 1E                             | 1E                                |
| 39   | Memory analysis probe                           |                                     | 00                             | 00                             | 00                                |
| 40   | Extension for bytes 41 and 42                   | -80E<br>-800<br>-667/-53E/-40E      | –<br>–<br>00                   | 30<br>00<br>00                 | 06<br>06<br>06                    |



# 256MB, 512MB, 1GB: (x72, SR) 244-Pin DDR2 Registered MiniDIMM Register and PLL Specifications

**Table 18: Serial Presence-Detect Matrix**

"1"/"0": Serial Data, "driven to HIGH"/"driven to LOW"; table notes located on page 17

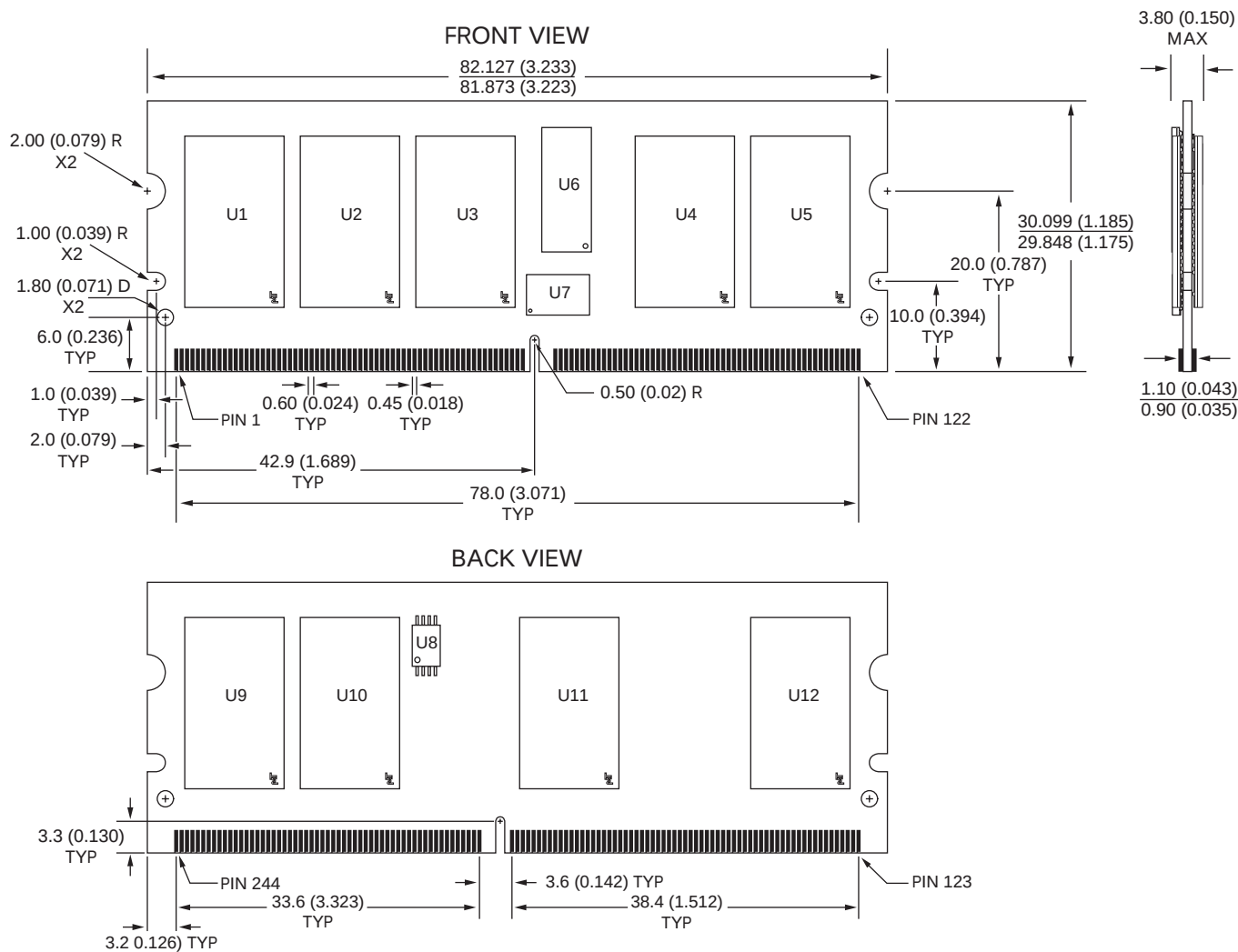
| Byte    | Description                                                           | Entry (Version)                      | MT9HTF3272K/<br>MT9HTF3272(P)K    | MT9HTF6472K/<br>MT9HTF6472(P)K      | MT9HTF12872K/<br>MT9HTF12872(P)K    |
|---------|-----------------------------------------------------------------------|--------------------------------------|-----------------------------------|-------------------------------------|-------------------------------------|
| 41      | MIN active auto refresh time, $t_{RC}$ (see note 1)                   | -80E<br>-800/-667/-53E<br>-40E       | 39<br>3C<br>37                    | 39<br>3C<br>37                      | 3C<br>3C<br>37                      |
| 42      | Minimum AUTO REFRESH to ACTIVE/AUTO REFRESH command period, $t_{RFC}$ |                                      | 4B                                | 69                                  | 7F                                  |
| 43      | SDRAM device MAX cycle time, $t_{CK}$ (MAX)                           |                                      | 80                                | 80                                  | 80                                  |
| 44      | SDRAM device MAX DQS-DQ skew time, $t_{DQSQ}$                         | -80E/-800<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      | SDRAM device MAX read data hold skew factor, $t_{QHS}$                | -80E/-800<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                                                       |                                      | 0F                                | 0F                                  | 0F                                  |
| 47–61   | Optional features, not supported                                      |                                      | 00                                | 00                                  | 00                                  |
| 62      | SPD revision                                                          | Release 1.2                          | 12                                | 12                                  | 12                                  |
| 63      | Checksum for bytes 0–62 ECC/ECC and parity                            | -80E<br>-800<br>-667<br>-53E<br>-40E | –<br>–<br>1F/23<br>CA/CE<br>31/35 | C6<br>DA<br>7E/82<br>29/2D<br>90/94 | 7B<br>7B<br>1F/23<br>CA/CE<br>31/35 |
| 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)                                     |                                      | 00                                | 00                                  | 00                                  |
| 128–255 | Customer reserved                                                     |                                      | FF                                | FF                                  | FF                                  |

Notes: 1. The  $t_{RC}$  SPD values shown are JEDEC DDR2 device specification values. The actual Micron DDR2 device specification is  $t_{RC} = 55ns$  for all speed grades.



## Module Dimensions

Figure 10: 244-pin DIMM DDR2 Module Dimensions



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



8000 S. Federal Way, P.O. Box 6, Boise, ID 83707-0006, Tel: 208-368-3900

prodmtg@micron.com www.micron.com Customer Comment Line: 800-932-4992

Micron, the M logo, and the Micron logo are trademarks of Micron Technology, Inc. All other trademarks are the property of their respective owners.

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.