

# 1.35V DDR3L SDRAM SODIMM

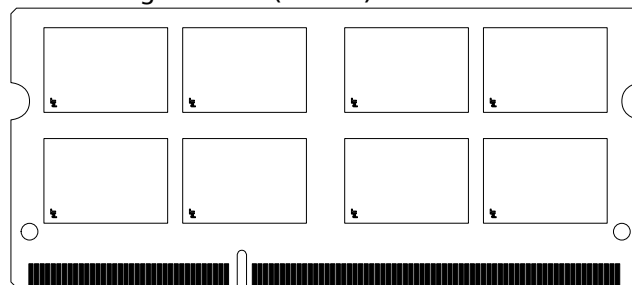
## MT16KTF2G64HZ – 16GB

### Features

- DDR3L functionality and operations supported as defined in the component data sheet
- 204-pin, small outline dual in-line memory module (SODIMM)
- Fast data transfer rates: PC3-14900 and PC3-12800
- 16GB (2 Gig x 64)
- $V_{DD} = 1.35V$  (1.283V–1.45V)
- $V_{DD} = 1.5V$  (1.425–1.575V)
- Backward compatible to  $V_{DD} = 1.5V \pm 0.075V$
- $V_{DDSPD} = 3.0\text{--}3.6V$
- Nominal and dynamic on-die termination (ODT) for data, strobe, and mask signals
- Dual rank
- Fixed burst chop (BC) of 4 and burst length (BL) of 8 via the mode register set (MRS)
- On-board I<sup>2</sup>C serial presence-detect (SPD) EEPROM
- Selectable BC4 or BL8 on-the-fly (OTF)
- Gold edge contacts
- Halogen-free
- Fly-by topology
- Terminated control, command, and address bus

**Figure 1: 204-Pin SODIMM (MO-268 R/C-F3)**

Module Height: 30mm (1.181in)



### Options

- Operating temperature
  - Commercial ( $0^{\circ}C \leq T_A \leq 70^{\circ}C$ )
- Package
  - 204-pin DIMM (halogen-free)
- Frequency/CAS latency
  - 1.07ns @ CL = 13 (DDR3-1866)
  - 1.25ns @ CL = 11 (DDR3-1600)

### Marking

None  
Z  
-1G9  
-1G6

**Table 1: Key Timing Parameters**

| Speed Grade | Industry Nomenclature | Data Rate (MT/s) |         |         |        |        |        |        |        | $t_{RCD}$ (ns) | $t_{RP}$ (ns) | $t_{RC}$ (ns) |
|-------------|-----------------------|------------------|---------|---------|--------|--------|--------|--------|--------|----------------|---------------|---------------|
|             |                       | CL = 13          | CL = 11 | CL = 10 | CL = 9 | CL = 8 | CL = 7 | CL = 6 | CL = 5 |                |               |               |
| -1G9        | PC3-14900             | 1866             | 1600    | 1333    | 1333   | 1066   | 1066   | 800    | 667    | 13.125         | 13.125        | 47.125        |
| -1G6        | PC3-12800             | –                | 1600    | 1333    | 1333   | 1066   | 1066   | 800    | 667    | 13.125         | 13.125        | 48.125        |
| -1G4        | PC3-10600             | –                | –       | 1333    | 1333   | 1066   | 1066   | 800    | 667    | 13.125         | 13.125        | 49.125        |
| -1G1        | PC3-8500              | –                | –       | –       | –      | 1066   | 1066   | 800    | 667    | 13.125         | 13.125        | 50.625        |
| -1G0        | PC3-8500              | –                | –       | –       | –      | 1066   | –      | 800    | 667    | 15             | 15            | 52.5          |
| -80B        | PC3-6400              | –                | –       | –       | –      | –      | –      | 800    | 667    | 15             | 15            | 52.5          |



## 16GB (x64, DR) 204-Pin 1.35V DDR3L SODIMM Features

**Table 2: Addressing**

| Parameter            | 16GB           |
|----------------------|----------------|
| Refresh count        | 8K             |
| Row address          | 64K A[15:0]    |
| Device bank address  | 8 BA[2:0]      |
| Device configuration | 8Gb (1 Gig x8) |
| Column address       | 2K A[11, 9:0]  |
| Module rank address  | 2 S#[1:0]      |

**Table 3: Part Numbers and Timing Parameters – 16GB Modules**

Base device: MT41K1G8,<sup>1</sup> 8Gb 1.35V DDR3L SDRAM

| Part Number <sup>2</sup> | Module Density | Configuration | Module Bandwidth | Memory Clock/<br>Data Rate | Clock Cycles<br>(CL- <sup>t</sup> RCD- <sup>t</sup> RP) |
|--------------------------|----------------|---------------|------------------|----------------------------|---------------------------------------------------------|
| MT16KTF2G64HZ-1G9__      | 16GB           | 2 Gig x 64    | 14.9 GB/s        | 1.07ns/1866 MT/s           | 13-13-13                                                |
| MT16KTF2G64HZ-1G6__      | 16GB           | 2 Gig x 64    | 12.8 GB/s        | 1.25ns/1600 MT/s           | 11-11-11                                                |

- Notes:
1. The data sheet for the base device can be found on Micron's web site.
  2. All part numbers end with a two-place code (not shown) that designates component and PCB revisions. Consult factory for current revision codes. Example: MT16KTF2G64HZ-1G9A1.



# 16GB (x64, DR) 204-Pin 1.35V DDR3L SODIMM Pin Assignments

## Pin Assignments

Table 4: Pin Assignments

| 204-Pin DDR3 SODIMM Front |                    |     |                 |     |                 |     |                    | 204-Pin DDR3 SODIMM Back |                 |     |                 |     |                    |     |                 |
|---------------------------|--------------------|-----|-----------------|-----|-----------------|-----|--------------------|--------------------------|-----------------|-----|-----------------|-----|--------------------|-----|-----------------|
| Pin                       | Symbol             | Pin | Symbol          | Pin | Symbol          | Pin | Symbol             | Pin                      | Symbol          | Pin | Symbol          | Pin | Symbol             | Pin | Symbol          |
| 1                         | V <sub>REFDQ</sub> | 53  | DQ19            | 105 | V <sub>DD</sub> | 157 | DQ42               | 2                        | V <sub>SS</sub> | 54  | V <sub>SS</sub> | 106 | V <sub>DD</sub>    | 158 | DQ46            |
| 3                         | V <sub>SS</sub>    | 55  | V <sub>SS</sub> | 107 | A10             | 159 | DQ43               | 4                        | DQ4             | 56  | DQ28            | 108 | BA1                | 160 | DQ47            |
| 5                         | DQ0                | 57  | DQ24            | 109 | BA0             | 161 | V <sub>SS</sub>    | 6                        | DQ5             | 58  | DQ29            | 110 | RAS#               | 162 | V <sub>SS</sub> |
| 7                         | DQ1                | 59  | DQ25            | 111 | V <sub>DD</sub> | 163 | DQ48               | 8                        | V <sub>SS</sub> | 60  | V <sub>SS</sub> | 112 | V <sub>DD</sub>    | 164 | DQ52            |
| 9                         | V <sub>SS</sub>    | 61  | V <sub>SS</sub> | 113 | WE#             | 165 | DQ49               | 10                       | DQS0#           | 62  | DQS3#           | 114 | S0#                | 166 | DQ53            |
| 11                        | DM0                | 63  | DM3             | 115 | CAS#            | 167 | V <sub>SS</sub>    | 12                       | DQS0            | 64  | DQS3            | 116 | ODT0               | 168 | V <sub>SS</sub> |
| 13                        | V <sub>SS</sub>    | 65  | V <sub>SS</sub> | 117 | V <sub>DD</sub> | 169 | DQS6#              | 14                       | V <sub>SS</sub> | 66  | V <sub>SS</sub> | 118 | V <sub>DD</sub>    | 170 | DM6             |
| 15                        | DQ2                | 67  | DQ26            | 119 | A13             | 171 | DQS6               | 16                       | DQ6             | 68  | DQ30            | 120 | ODT1               | 172 | V <sub>SS</sub> |
| 17                        | DQ3                | 69  | DQ27            | 121 | S1#             | 173 | V <sub>SS</sub>    | 18                       | DQ7             | 70  | DQ31            | 122 | NC                 | 174 | DQ54            |
| 19                        | V <sub>SS</sub>    | 71  | V <sub>SS</sub> | 123 | V <sub>DD</sub> | 175 | DQ50               | 20                       | V <sub>SS</sub> | 72  | V <sub>SS</sub> | 124 | V <sub>DD</sub>    | 176 | DQ55            |
| 21                        | DQ8                | 73  | CKE0            | 125 | NC              | 177 | DQ51               | 22                       | DQ12            | 74  | CKE1            | 126 | V <sub>REFCA</sub> | 178 | V <sub>SS</sub> |
| 23                        | DQ9                | 75  | V <sub>DD</sub> | 127 | V <sub>SS</sub> | 179 | V <sub>SS</sub>    | 24                       | DQ13            | 76  | V <sub>DD</sub> | 128 | V <sub>SS</sub>    | 180 | DQ60            |
| 25                        | V <sub>SS</sub>    | 77  | NC              | 129 | DQ32            | 181 | DQ56               | 26                       | V <sub>SS</sub> | 78  | A15             | 130 | DQ36               | 182 | DQ61            |
| 27                        | DQS1#              | 79  | BA2             | 131 | DQ33            | 183 | DQ57               | 28                       | DM1             | 80  | A14             | 132 | DQ37               | 184 | V <sub>SS</sub> |
| 29                        | DQS1               | 81  | V <sub>DD</sub> | 133 | V <sub>SS</sub> | 185 | V <sub>SS</sub>    | 30                       | RESET#          | 82  | V <sub>DD</sub> | 134 | V <sub>SS</sub>    | 186 | DQS7#           |
| 31                        | V <sub>SS</sub>    | 83  | A12             | 135 | DQS4#           | 187 | DM7                | 32                       | V <sub>SS</sub> | 84  | A11             | 136 | DM4                | 188 | DQS7            |
| 33                        | DQ10               | 85  | A9              | 137 | DQS4            | 189 | V <sub>SS</sub>    | 34                       | DQ14            | 86  | A7              | 138 | V <sub>SS</sub>    | 190 | V <sub>SS</sub> |
| 35                        | DQ11               | 87  | V <sub>DD</sub> | 139 | V <sub>SS</sub> | 191 | DQ58               | 36                       | DQ15            | 88  | V <sub>DD</sub> | 140 | DQ38               | 192 | DQ62            |
| 37                        | V <sub>SS</sub>    | 89  | A8              | 141 | DQ34            | 193 | DQ59               | 38                       | V <sub>SS</sub> | 90  | A6              | 142 | DQ39               | 194 | DQ63            |
| 39                        | DQ16               | 91  | A5              | 143 | DQ35            | 195 | V <sub>SS</sub>    | 40                       | DQ20            | 92  | A4              | 144 | V <sub>SS</sub>    | 196 | V <sub>SS</sub> |
| 41                        | DQ17               | 93  | V <sub>DD</sub> | 145 | V <sub>SS</sub> | 197 | SA0                | 42                       | DQ21            | 94  | V <sub>DD</sub> | 146 | DQ44               | 198 | NF              |
| 43                        | V <sub>SS</sub>    | 95  | A3              | 147 | DQ40            | 199 | V <sub>DDSPD</sub> | 44                       | V <sub>SS</sub> | 96  | A2              | 148 | DQ45               | 200 | SDA             |
| 45                        | DQS2#              | 97  | A1              | 149 | DQ41            | 201 | SA1                | 46                       | DM2             | 98  | A0              | 150 | V <sub>SS</sub>    | 202 | SCL             |
| 47                        | DQS2               | 99  | V <sub>DD</sub> | 151 | V <sub>SS</sub> | 203 | V <sub>TT</sub>    | 48                       | V <sub>SS</sub> | 100 | V <sub>DD</sub> | 152 | DQS5#              | 204 | V <sub>TT</sub> |
| 49                        | V <sub>SS</sub>    | 101 | CK0             | 153 | DM5             | –   | –                  | 50                       | DQ22            | 102 | CK1             | 154 | DQS5               | –   | –               |
| 51                        | DQ18               | 103 | CK0#            | 155 | V <sub>SS</sub> | –   | –                  | 52                       | DQ23            | 104 | CK1#            | 156 | V <sub>SS</sub>    | –   | –               |

## Pin Descriptions

The pin description table below is a comprehensive list of all possible pins for all DDR3 modules. All pins listed may not be supported on this module. See Pin Assignments for information specific to this module.

**Table 5: Pin Descriptions**

| Symbol          | Type           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ax              | 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 bank (A10 LOW, bank selected by BAx) or all banks (A10 HIGH). The address inputs also provide the op-code during a LOAD MODE command. See the Pin Assignments table for density-specific addressing information. |
| BAx             | Input          | <b>Bank address inputs:</b> Define the device bank to which an ACTIVE, READ, WRITE, or PRECHARGE command is being applied. BA define which mode register (MR0, MR1, MR2, or MR3) is loaded during the LOAD MODE command.                                                                                                                                                                                                                                                                                                        |
| CKx, CKx#       | Input          | <b>Clock:</b> Differential clock inputs. All control, command, and address input signals are sampled on the crossing of the positive edge of CK and the negative edge of CK#.                                                                                                                                                                                                                                                                                                                                                   |
| CKEx            | Input          | <b>Clock enable:</b> Enables (registered HIGH) and disables (registered LOW) internal circuitry and clocks on the DRAM.                                                                                                                                                                                                                                                                                                                                                                                                         |
| DMx             | Input          | <b>Data mask (x8 devices only):</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. Although DM pins are input-only, DM loading is designed to match that of the DQ and DQS pins.                                                                                                                                                                                                                                                   |
| ODTx            | Input          | <b>On-die termination:</b> Enables (registered HIGH) and disables (registered LOW) termination resistance internal to the DDR3 SDRAM. When enabled in normal operation, ODT is only applied to the following pins: DQ, DQS, DQS#, DM, and CB. The ODT input will be ignored if disabled via the LOAD MODE command.                                                                                                                                                                                                              |
| Par_In          | Input          | <b>Parity input:</b> Parity bit for Ax, RAS#, CAS#, and WE#.                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| RAS#, CAS#, WE# | Input          | <b>Command inputs:</b> RAS#, CAS#, and WE# (along with S#) define the command being entered.                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| RESET#          | Input (LVCMOS) | <b>Reset:</b> RESET# is an active LOW asynchronous input that is connected to each DRAM and the registering clock driver. After RESET# goes HIGH, the DRAM must be reinitialized as though a normal power-up was executed.                                                                                                                                                                                                                                                                                                      |
| Sx#             | Input          | <b>Chip select:</b> Enables (registered LOW) and disables (registered HIGH) the command decoder.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| SAx             | Input          | <b>Serial address inputs:</b> Used to configure the temperature sensor/SPD EEPROM address range on the I <sup>2</sup> C bus.                                                                                                                                                                                                                                                                                                                                                                                                    |
| SCL             | Input          | <b>Serial clock for temperature sensor/SPD EEPROM:</b> Used to synchronize communication to and from the temperature sensor/SPD EEPROM on the I <sup>2</sup> C bus.                                                                                                                                                                                                                                                                                                                                                             |
| CBx             | I/O            | <b>Check bits:</b> Used for system error detection and correction.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| DQx             | I/O            | <b>Data input/output:</b> Bidirectional data bus.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| DQSx, DQSx#     | I/O            | <b>Data strobe:</b> Differential data strobes. Output with read data; edge-aligned with read data; input with write data; center-aligned with write data.                                                                                                                                                                                                                                                                                                                                                                       |

**Table 5: Pin Descriptions (Continued)**

| Symbol             | Type                   | Description                                                                                                                                                                                                                                                       |
|--------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SDA                | I/O                    | <b>Serial data:</b> Used to transfer addresses and data into and out of the temperature sensor/SPD EEPROM on the I <sup>2</sup> C bus.                                                                                                                            |
| TDQSx,<br>TDQSx#   | Output                 | <b>Redundant data strobe (x8 devices only):</b> TDQS is enabled/disabled via the LOAD MODE command to the extended mode register (EMR). When TDQS is enabled, DM is disabled and TDQS and TDQS# provide termination resistance; otherwise, TDQS# are no function. |
| Err_Out#           | Output<br>(open drain) | <b>Parity error output:</b> Parity error found on the command and address bus.                                                                                                                                                                                    |
| EVENT#             | Output<br>(open drain) | <b>Temperature event:</b> The EVENT# pin is asserted by the temperature sensor when critical temperature thresholds have been exceeded.                                                                                                                           |
| V <sub>DD</sub>    | Supply                 | <b>Power supply:</b> 1.35V (1.283–1.45V) backward-compatible to 1.5V (1.425–1.575V). The component V <sub>DD</sub> and V <sub>DDQ</sub> are connected to the module V <sub>DD</sub> .                                                                             |
| V <sub>DDSPD</sub> | Supply                 | <b>Temperature sensor/SPD EEPROM power supply:</b> 3.0–3.6V.                                                                                                                                                                                                      |
| V <sub>REFCA</sub> | Supply                 | <b>Reference voltage:</b> Control, command, and address V <sub>DD</sub> /2.                                                                                                                                                                                       |
| V <sub>REFDQ</sub> | Supply                 | <b>Reference voltage:</b> DQ, DM V <sub>DD</sub> /2.                                                                                                                                                                                                              |
| V <sub>SS</sub>    | Supply                 | Ground.                                                                                                                                                                                                                                                           |
| V <sub>TT</sub>    | Supply                 | <b>Termination voltage:</b> Used for control, command, and address V <sub>DD</sub> /2.                                                                                                                                                                            |
| NC                 | –                      | <b>No connect:</b> These pins are not connected on the module.                                                                                                                                                                                                    |
| NF                 | –                      | <b>No function:</b> These pins are connected within the module, but provide no functionality.                                                                                                                                                                     |

## DQ Map

**Table 6: Component-to-Module DQ Map, R/C-F3 (Front)**

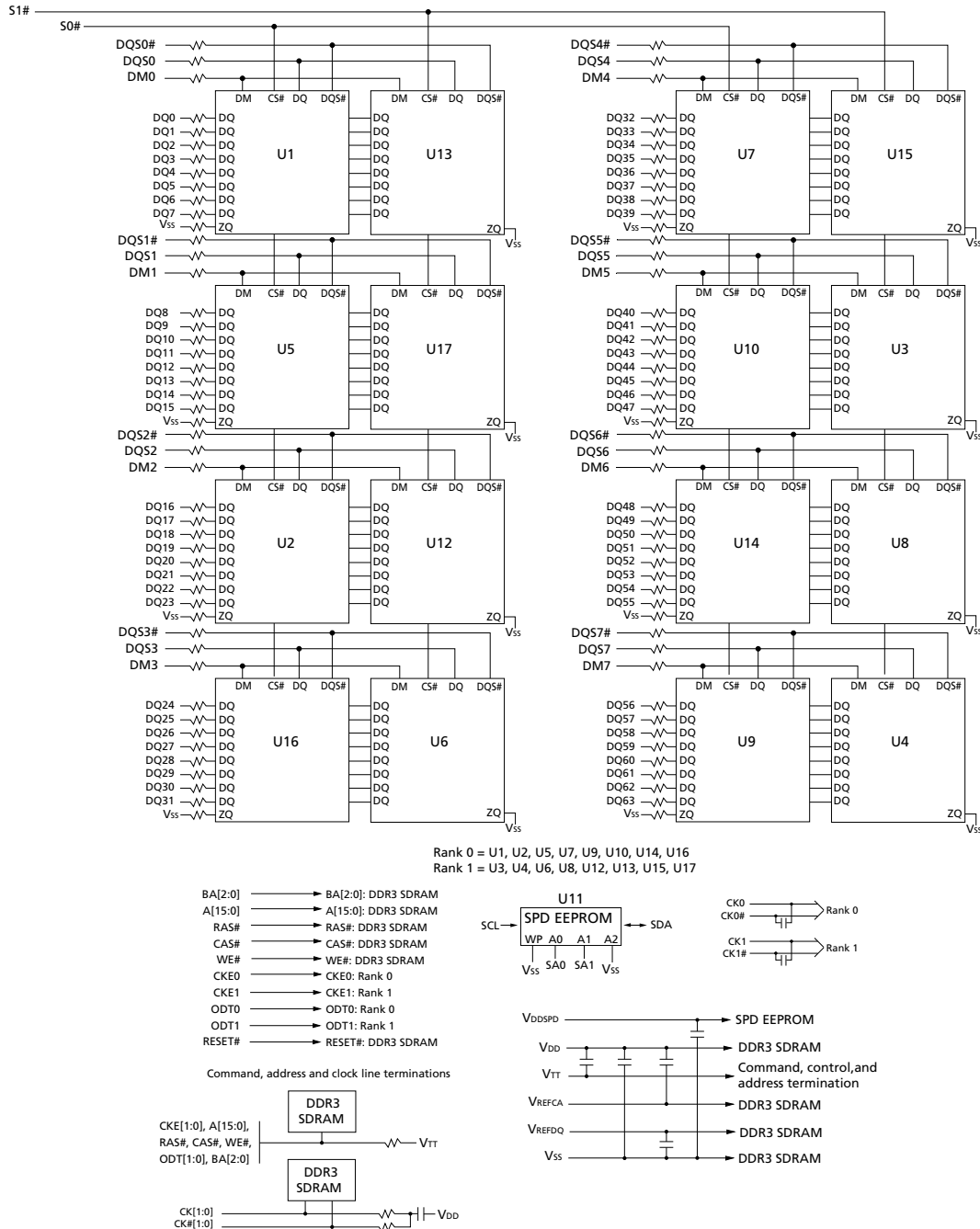
| Component Reference Number | Component DQ | Module DQ | Module Pin Number | Component Reference Number | Component DQ | Module DQ | Module Pin Number |
|----------------------------|--------------|-----------|-------------------|----------------------------|--------------|-----------|-------------------|
| U1                         | 0            | 2         | 13                | U2                         | 0            | 18        | 49                |
|                            | 1            | 5         | 6                 |                            | 1            | 21        | 42                |
|                            | 2            | 3         | 15                |                            | 2            | 19        | 51                |
|                            | 3            | 0         | 5                 |                            | 3            | 16        | 37                |
|                            | 4            | 6         | 16                |                            | 4            | 22        | 48                |
|                            | 5            | 4         | 4                 |                            | 5            | 20        | 40                |
|                            | 6            | 7         | 18                |                            | 6            | 23        | 50                |
|                            | 7            | 1         | 7                 |                            | 7            | 17        | 39                |
| U3                         | 0            | 42        | 159               | U4                         | 0            | 58        | 191               |
|                            | 1            | 45        | 150               |                            | 1            | 61        | 182               |
|                            | 2            | 43        | 161               |                            | 2            | 59        | 193               |
|                            | 3            | 40        | 151               |                            | 3            | 56        | 183               |
|                            | 4            | 46        | 160               |                            | 4            | 62        | 192               |
|                            | 5            | 44        | 148               |                            | 5            | 60        | 180               |
|                            | 6            | 47        | 162               |                            | 6            | 63        | 194               |
|                            | 7            | 41        | 153               |                            | 7            | 57        | 185               |
| U5                         | 0            | 13        | 24                | U6                         | 0            | 26        | 63                |
|                            | 1            | 10        | 31                |                            | 1            | 29        | 56                |
|                            | 2            | 8         | 19                |                            | 2            | 27        | 65                |
|                            | 3            | 11        | 33                |                            | 3            | 24        | 55                |
|                            | 4            | 9         | 21                |                            | 4            | 30        | 66                |
|                            | 5            | 15        | 36                |                            | 5            | 28        | 54                |
|                            | 6            | 12        | 22                |                            | 6            | 31        | 68                |
|                            | 7            | 14        | 34                |                            | 7            | 25        | 57                |
| U7                         | 0            | 34        | 145               | U8                         | 0            | 53        | 168               |
|                            | 1            | 37        | 136               |                            | 1            | 50        | 177               |
|                            | 2            | 35        | 147               |                            | 2            | 48        | 165               |
|                            | 3            | 32        | 133               |                            | 3            | 51        | 179               |
|                            | 4            | 38        | 142               |                            | 4            | 49        | 167               |
|                            | 5            | 36        | 134               |                            | 5            | 55        | 176               |
|                            | 6            | 39        | 144               |                            | 6            | 52        | 166               |
|                            | 7            | 33        | 135               |                            | 7            | 54        | 174               |

**Table 7: Component-to-Module DQ Map, R/C-F3 (Back)**

| Component Reference Number | Component DQ | Module DQ | Module Pin Number | Component Reference Number | Component DQ | Module DQ | Module Pin Number |
|----------------------------|--------------|-----------|-------------------|----------------------------|--------------|-----------|-------------------|
| U9                         | 0            | 61        | 182               | U10                        | 0            | 45        | 150               |
|                            | 1            | 58        | 191               |                            | 1            | 42        | 159               |
|                            | 2            | 56        | 183               |                            | 2            | 40        | 151               |
|                            | 3            | 59        | 193               |                            | 3            | 43        | 161               |
|                            | 4            | 57        | 185               |                            | 4            | 41        | 153               |
|                            | 5            | 63        | 194               |                            | 5            | 47        | 162               |
|                            | 6            | 60        | 180               |                            | 6            | 44        | 148               |
|                            | 7            | 62        | 192               |                            | 7            | 46        | 160               |
| U12                        | 0            | 21        | 42                | U13                        | 0            | 5         | 6                 |
|                            | 1            | 18        | 49                |                            | 1            | 2         | 13                |
|                            | 2            | 16        | 37                |                            | 2            | 0         | 5                 |
|                            | 3            | 19        | 51                |                            | 3            | 3         | 15                |
|                            | 4            | 17        | 39                |                            | 4            | 1         | 7                 |
|                            | 5            | 23        | 50                |                            | 5            | 7         | 18                |
|                            | 6            | 20        | 40                |                            | 6            | 4         | 4                 |
|                            | 7            | 22        | 48                |                            | 7            | 6         | 16                |
| U14                        | 0            | 50        | 177               | U15                        | 0            | 37        | 136               |
|                            | 1            | 53        | 168               |                            | 1            | 34        | 145               |
|                            | 2            | 51        | 179               |                            | 2            | 32        | 133               |
|                            | 3            | 48        | 165               |                            | 3            | 35        | 147               |
|                            | 4            | 54        | 174               |                            | 4            | 33        | 135               |
|                            | 5            | 52        | 166               |                            | 5            | 39        | 144               |
|                            | 6            | 55        | 176               |                            | 6            | 36        | 134               |
|                            | 7            | 49        | 167               |                            | 7            | 38        | 142               |
| U16                        | 0            | 29        | 56                | U17                        | 0            | 10        | 31                |
|                            | 1            | 26        | 63                |                            | 1            | 13        | 24                |
|                            | 2            | 24        | 55                |                            | 2            | 11        | 33                |
|                            | 3            | 27        | 65                |                            | 3            | 8         | 19                |
|                            | 4            | 25        | 57                |                            | 4            | 14        | 34                |
|                            | 5            | 31        | 68                |                            | 5            | 12        | 22                |
|                            | 6            | 28        | 54                |                            | 6            | 15        | 36                |
|                            | 7            | 30        | 66                |                            | 7            | 9         | 21                |

### Functional Block Diagram

Figure 2: Functional Block Diagram



Note: 1. The ZQ ball on each DDR3 component is connected to an external  $240\Omega \pm 1\%$  resistor that is tied to ground. It is used for the calibration of the component's ODT and output driver.

## General Description

DDR3 SDRAM modules are high-speed, CMOS dynamic random access memory modules that use internally configured 8-bank DDR3 SDRAM devices. DDR3 SDRAM modules use DDR architecture to achieve high-speed operation. DDR3 architecture is essentially an  $8n$ -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 DDR3 SDRAM module effectively consists of a single  $8n$ -bit-wide, one-clock-cycle data transfer at the internal DRAM core and eight corresponding  $n$ -bit-wide, one-half-clock-cycle data transfers at the I/O pins.

DDR3 modules use two sets of differential signals: DQS, DQS# to capture data and CK and CK# to capture commands, addresses, and control signals. Differential clocks and data strobes ensure exceptional noise immunity for these signals and provide precise crossing points to capture input signals.

## Fly-By Topology

DDR3 modules use faster clock speeds than earlier DDR technologies, making signal quality more important than ever. For improved signal quality, the clock, control, command, and address buses have been routed in a fly-by topology, where each clock, control, command, and address pin on each DRAM is connected to a single trace and terminated (rather than a tree structure, where the termination is off the module near the connector). Inherent to fly-by topology, the timing skew between the clock and DQS signals can be easily accounted for by using the write-leveling feature of DDR3.

## Serial Presence-Detect EEPROM Operation

DDR3 SDRAM modules incorporate serial presence-detect. The SPD data is stored in a 256-byte EEPROM. The first 128 bytes are programmed by Micron to comply with JEDEC standard JC-45, "Appendix X: Serial Presence Detect (SPD) for DDR3 SDRAM Modules." These bytes identify module-specific timing parameters, configuration information, and physical attributes. 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) SDA (data), and SA (address) pins. Write protect (WP) is connected to V<sub>SS</sub>, permanently disabling hardware write protection. For further information refer to Micron technical note TN-04-42, "Memory Module Serial Presence-Detect."

## Electrical Specifications

Stresses greater than those listed may cause permanent damage to the module. This is a stress rating only, and functional operation of the module at these or any other conditions outside those indicated in each device's data sheet is not implied. Exposure to absolute maximum rating conditions for extended periods may adversely affect reliability.

**Table 8: Absolute Maximum Ratings**

| Symbol            | Parameter                                    | Min  | Max   | Units |
|-------------------|----------------------------------------------|------|-------|-------|
| $V_{DD}$          | $V_{DD}$ supply voltage relative to $V_{SS}$ | -0.4 | 1.975 | V     |
| $V_{IN}, V_{OUT}$ | Voltage on any pin relative to $V_{SS}$      | -0.4 | 1.975 | V     |

**Table 9: Operating Conditions**

| Symbol     | Parameter                                                                                                                                                 | Min                                       | Nom                 | Max                                | Units | Notes                      |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------|------------------------------------|-------|----------------------------|
| $V_{DD}$   | $V_{DD}$ supply voltage                                                                                                                                   | 1.283                                     | 1.35                | 1.45                               | V     |                            |
|            |                                                                                                                                                           | 1.425                                     | 1.5                 | 1.575                              | V     | 1                          |
| $I_{VT}$   | Termination reference current from $V_{TT}$                                                                                                               | -600                                      | -                   | 600                                | mA    |                            |
| $V_{TT}$   | Termination reference voltage (DC) – command/address bus                                                                                                  | $0.49 \times V_{DD} - 20\text{mV}$        | $0.5 \times V_{DD}$ | $0.51 \times V_{DD} + 20\text{mV}$ | V     | 2                          |
| $I_I$      | Input leakage current;<br>Any input $0V \leq V_{IN} \leq V_{DD}$ ;<br>$V_{REF}$ input $0V \leq V_{IN} \leq 0.95V$<br>(All other pins not under test = 0V) | Address inputs,<br>RAS#, CAS#,<br>WE#, BA | -32                 | 0                                  | 32    | $\mu\text{A}$              |
|            |                                                                                                                                                           | S#, CKE, ODT,<br>CK, CK#                  | -16                 | 0                                  | 16    |                            |
|            |                                                                                                                                                           | DM                                        | -4                  | 0                                  | 4     |                            |
| $I_{OZ}$   | Output leakage current;<br>$0V \leq V_{OUT} \leq V_{DD}$ ;<br>DQ and ODT are disabled; ODT is HIGH                                                        | DQ, DQS, DQS#                             | -10                 | 0                                  | 10    | $\mu\text{A}$              |
| $I_{VREF}$ | $V_{REF}$ supply leakage current;<br>$V_{REFDQ} = V_{DD}/2$ or $V_{REFCA} = V_{DD}/2$<br>(All other pins not under test = 0V)                             |                                           | -16                 | 0                                  | 16    | $\mu\text{A}$              |
| $T_A$      | Module ambient operating temperature                                                                                                                      | Commercial                                | 0                   | -                                  | 70    | $^{\circ}\text{C}$ 3, 4    |
| $T_C$      | DDR3 SDRAM component case operating temperature                                                                                                           | Commercial                                | 0                   | -                                  | 95    | $^{\circ}\text{C}$ 3, 4, 5 |

- Notes:
- Module is backward-compatible with 1.5V operation. Refer to device specification for details and operation guidance.
  - $V_{TT}$  termination voltage in excess of the stated limit will adversely affect the command and address signals' voltage margin and will reduce timing margins.
  - $T_A$  and  $T_C$  are simultaneous requirements.
  - For further information, refer to technical note TN-00-08: "Thermal Applications," available on Micron's web site.
  - The refresh rate is required to double when  $85^{\circ}\text{C} < T_C \leq 95^{\circ}\text{C}$ .

## DRAM Operating Conditions

Recommended AC operating conditions are given in the DDR3 component data sheets. Component specifications are available at [micron.com](http://micron.com). Module speed grades correlate with component speed grades, as shown below.

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

DDR3 components may exceed the listed module speed grades; module may not be available in all listed speed grades

| Module Speed Grade | Component Speed Grade |
|--------------------|-----------------------|
| -2G1               | -093                  |
| -1G9               | -107                  |
| -1G6               | -125                  |
| -1G4               | -15E                  |
| -1G1               | -187E                 |
| -1G0               | -187                  |
| -80C               | -25E                  |
| -80B               | -25                   |

## Design Considerations

### Simulations

Micron memory modules are designed to optimize signal integrity through carefully designed terminations, controlled board impedances, routing topologies, trace length matching, and decoupling. However, good signal integrity starts at the system level. Micron encourages designers to simulate the signal characteristics of the system's memory bus to ensure adequate signal integrity of the entire memory system.

### Power

Operating voltages are specified at the DRAM, not at the edge connector of the module. Designers must account for any system voltage drops at anticipated power levels to ensure the required supply voltage is maintained.

## I<sub>DD</sub> Specifications

**Table 11: DDR3 I<sub>DD</sub> Specifications and Conditions – 16GB (Die Revision A)**

Values are for the MT41K1G8 DDR3L SDRAM only and are computed from values specified in the 1.35V 8Gb (1 Gig x 8) component data sheet

| Parameter                                                                 | Symbol                          | 1866 | 1600 | Units |
|---------------------------------------------------------------------------|---------------------------------|------|------|-------|
| Operating current 0: One bank ACTIVATE-to-PRECHARGE                       | I <sub>DD0</sub> <sup>1</sup>   | 640  | 624  | mA    |
| Operating current 1: One bank ACTIVATE-to-READ-to-PRECHARGE               | I <sub>DD1</sub> <sup>1</sup>   | 736  | 712  | mA    |
| Precharge power-down current: Slow exit                                   | I <sub>DD2P0</sub> <sup>2</sup> | 176  | 176  | mA    |
| Precharge power-down current: Fast exit                                   | I <sub>DD2P1</sub> <sup>2</sup> | 256  | 224  | mA    |
| Precharge quiet standby current                                           | I <sub>DD2Q</sub> <sup>2</sup>  | 576  | 544  | mA    |
| Precharge standby current                                                 | I <sub>DD2N</sub> <sup>2</sup>  | 608  | 576  | mA    |
| Precharge standby ODT current                                             | I <sub>DD2NT</sub> <sup>1</sup> | 424  | 408  | mA    |
| Active power-down current                                                 | I <sub>DD3P</sub> <sup>2</sup>  | 608  | 576  | mA    |
| Active standby current                                                    | I <sub>DD3N</sub> <sup>2</sup>  | 848  | 816  | mA    |
| Burst read operating current                                              | I <sub>DD4R</sub> <sup>1</sup>  | 1168 | 1088 | mA    |
| Burst write operating current                                             | I <sub>DD4W</sub> <sup>1</sup>  | 1168 | 1088 | mA    |
| Refresh current                                                           | I <sub>DD5B</sub> <sup>1</sup>  | 2088 | 2048 | mA    |
| Self refresh temperature current: MAX T <sub>C</sub> = 85°C               | I <sub>DD6</sub> <sup>2</sup>   | 384  | 384  | mA    |
| Self refresh temperature current (SRT-enabled): MAX T <sub>C</sub> = 95°C | I <sub>DD6ET</sub> <sup>2</sup> | 544  | 544  | mA    |
| All banks interleaved read current                                        | I <sub>DD7</sub> <sup>1</sup>   | 1688 | 1608 | mA    |
| Reset current                                                             | I <sub>DD8</sub> <sup>2</sup>   | 208  | 208  | mA    |

- Notes: 1. One module rank in the active I<sub>DD</sub>; the other rank in I<sub>DD2P0</sub> (slow exit).  
2. All ranks in this I<sub>DD</sub> condition.

## Serial Presence-Detect EEPROM

For the latest SPD data, refer to Micron's SPD page: [micron.com/spd](http://micron.com/spd).

**Table 12: Serial Presence-Detect EEPROM DC Operating Conditions**

All voltages referenced to  $V_{DDSPD}$

| Parameter/Condition                                       | Symbol      | Min                    | Max                    | Units         |
|-----------------------------------------------------------|-------------|------------------------|------------------------|---------------|
| Supply voltage                                            | $V_{DDSPD}$ | 3.0                    | 3.6                    | V             |
| Input low voltage: Logic 0; All inputs                    | $V_{IL}$    | -0.45                  | $V_{DDSPD} \times 0.3$ | V             |
| Input high voltage: Logic 1; All inputs                   | $V_{IH}$    | $V_{DDSPD} \times 0.7$ | $V_{DDSPD} + 1.0$      | V             |
| Output low voltage: $I_{OUT} = 3\text{mA}$                | $V_{OL}$    | –                      | 0.4                    | V             |
| Input leakage current: $V_{IN} = \text{GND to } V_{DD}$   | $I_{LI}$    | 0.1                    | 2.0                    | $\mu\text{A}$ |
| Output leakage current: $V_{OUT} = \text{GND to } V_{DD}$ | $I_{LO}$    | 0.05                   | 2.0                    | $\mu\text{A}$ |

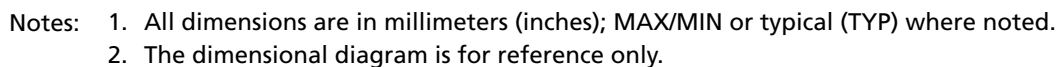
**Table 13: Serial Presence-Detect EEPROM AC Operating Conditions**

| Parameter/Condition                                         | Symbol       | Min | Max | Units         | Notes |
|-------------------------------------------------------------|--------------|-----|-----|---------------|-------|
| Clock frequency                                             | $t_{SCL}$    | 10  | 400 | kHz           |       |
| Clock pulse width HIGH time                                 | $t_{HIGH}$   | 0.6 | –   | $\mu\text{s}$ |       |
| Clock pulse width LOW time                                  | $t_{LOW}$    | 1.3 | –   | $\mu\text{s}$ |       |
| SDA rise time                                               | $t_R$        | –   | 300 | $\mu\text{s}$ | 1     |
| SDA fall time                                               | $t_F$        | 20  | 300 | ns            | 1     |
| Data-in setup time                                          | $t_{SU:DAT}$ | 100 | –   | ns            |       |
| Data-in hold time                                           | $t_{HD:DI}$  | 0   | –   | $\mu\text{s}$ |       |
| Data-out hold time                                          | $t_{HD:DAT}$ | 200 | 900 | ns            |       |
| Data out access time from SCL LOW                           | $t_{AA:DAT}$ | 0.2 | 0.9 | $\mu\text{s}$ | 2     |
| Start condition setup time                                  | $t_{SU:STA}$ | 0.6 | –   | $\mu\text{s}$ | 3     |
| Start condition hold time                                   | $t_{HD:STA}$ | 0.6 | –   | $\mu\text{s}$ |       |
| Stop condition setup time                                   | $t_{SU:STO}$ | 0.6 | –   | $\mu\text{s}$ |       |
| Time the bus must be free before a new transition can start | $t_{BUF}$    | 1.3 | –   | $\mu\text{s}$ |       |
| WRITE time                                                  | $t_W$        | –   | 10  | ms            |       |

- Notes:
1. Guaranteed by design and characterization, not necessarily tested.
  2. To avoid spurious start and stop conditions, a minimum delay is placed between the falling edge of SCL and the falling or rising edge of SDA.
  3. For a restart condition, or following a WRITE cycle.

### Figure 3: 204-Pin DDR3 SODIMM

### Figure 3: 204-Pin DDR3 SODIMM





## **Revision History**

### **Rev. B – 02/15**

- Removed -1G4 and -1G1 speed grades
- Added -1G9 (1866) and -1G6 (1600) IDDs

### **Rev. A – 09/14**

- Initial release; PCB 1777referenced, 16GB die rev A (V91A) IDDs all set to "TBD"

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This data sheet contains minimum and maximum limits specified over the power supply and temperature range set forth herein.  
Although considered final, these specifications are subject to change, as further product development and data characterization some-  
times occur.