

# Approval Sheet

|                       |                                       |
|-----------------------|---------------------------------------|
| <b>Customer</b>       |                                       |
| <b>Product Number</b> | <b>M3U0-4GSSNCPC</b>                  |
| <b>Module speed</b>   | <b>PC3-12800</b>                      |
| <b>Pin</b>            | <b>240pin</b>                         |
| <b>CI-tRCD-tRP</b>    | <b>11-11-11</b>                       |
| <b>Operating Temp</b> | <b>0°C~85°C</b>                       |
| <b>Date</b>           | <b>14<sup>th</sup> September 2017</b> |

**The Total Solution For  
Industrial Flash Storage**

Rev 1.1

## 1. Features

### Key Parameter

| Industry<br>Nomenclature | Speed<br>Grade | Data Rate MT/s |      |       | tAA<br>(ns) | tRCD<br>(ns) | tRP<br>(ns) |
|--------------------------|----------------|----------------|------|-------|-------------|--------------|-------------|
|                          |                | CL=7           | CL=9 | CL=11 |             |              |             |
| <b>PC3-12800</b>         | <b>P</b>       | 1066           | 1333 | 1600  | 13.125      | 13.125       | 13.125      |

- JEDEC Standard 240-pin Dual In-Line Memory Module
- Intend for PC3-12800 applications
- Inputs and Outputs are SSTL-15 compatible
- VDD=VDDQ= 1.5V (-0.075/+0.075V)
- Bi-directional Differential Data Strobe
- DLL aligns DQ and DQS transition with CK transition
- SDRAMs have 8 internal banks for concurrent operation
- Normal and Dynamic On-Die Termination support.
- SDRAMs are 78-ball BGA Package
- PCB Very Low Profile
- 8 bit pre-fetch
- Two different termination values (Rtt\_Nom & Rtt\_WR)
- Auto & self refresh 7.8 $\mu$ s (Tc  $\leq$  +85°C)
- 16/10/1 Addressing (row/column/rank)-4GB
- SDRAM operating temperature range
  - 0°C  $\leq$  Tc  $\leq$  +85°C
- Programmable Device Operation:
  - Burst Type: Sequential or Interleave
  - Device CAS# Latency: 6,7,8,9,10,11
  - Burst Length: switch on-the-fly: BL=8 or BC 4
- RoHS Compliant (*Section 13*)

## 2. Environmental Requirements

DDR3 DIMMs are intended for use in standard office environments that have limited capacity for heating and air conditioning.

| Symbol   | Parameter                                 | Rating      | Units    | Notes |
|--|---|-------------|----------|-------|
| <b>TOPR</b>  | Operating Temperature (ambient)           | 0 to +55    | °C       | 3     |
| <b>TSTG</b>  | Storage Temperature                       | -50 to +100 | °C       | 1     |
| <b>HOPR</b>  | Operating Humidity (relative)             | 10 to 90    | %        |       |
| <b>HSTG</b>  | Storage Humidity (without condensation)   | 5 to 95     | %        | 1     |
| <b>PBAR</b>  | Barometric Pressure (operating & storage) | 105 to 69   | K Pascal | 1,2   |
| <p>Note 1 Stresses greater than those listed may cause permanent damage to the device. This is a stress rating only, and device functional operation at or above the conditions indicated is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.</p> <p>Note 2 Up to 9850 ft.</p> <p>Note 3 The component maximum case temperature (TCASE) shall not exceed the value specified in the DDR3 DRAM component specification. Following JEDEC specifications.</p> |   |             |          |       |

## 3. SDRAM Parameters by device density

| RTT_Nom Setting | Parameter                           |                     | 4Gb | Units |
|-----------------|-------------------------------------|---------------------|-----|-------|
| tRFC            | REF command ACT or REF command time |                     | 260 | ns    |
| tREFI           | Average periodic refresh interval   | 0°C ≤ TCASE ≤ 85°C  | 7.8 | µs    |
|                 |                                     | 85°C < TCASE ≤ 95°C | 3.9 | µs    |

#### 4. Ordering Information

| DDR3 VLP UDIMM       |         |           |                   |                |                |     |
|----------------------|---------|-----------|-------------------|----------------|----------------|-----|
| Part Number          | Density | Speed     | DIMM Organization | Number of DRAM | Number of rank | ECC |
| <b>M3U0-4GSSNCPC</b> | 4GB     | PC3-12800 | 512Mx64           | 8              | 1              | N   |

## 5. Pin Configurations (Front side/Back side) X64 UDIMM

| Front |        |     |       |     |          |     |       | Back |      |     |          |     |      |     |        |
|-------|--------|-----|-------|-----|----------|-----|-------|------|------|-----|----------|-----|------|-----|--------|
| Pin   | Name   | Pin | Name  | Pin | Name     | Pin | Name  | Pin  | Name | Pin | Name     | Pin | Name | Pin | Name   |
| 1     | VREFDQ | 31  | DQ25  | 61  | A2       | 91  | DQ41  | 121  | VSS  | 151 | VSS      | 181 | A1   | 211 | VSS    |
| 2     | VSS    | 32  | VSS   | 62  | VDD      | 92  | VSS   | 122  | DQ4  | 152 | DM3      | 182 | VDD  | 212 | DM5    |
| 3     | DQ0    | 33  | /DQS3 | 63  | NC,CK1   | 93  | /DQS5 | 123  | DQ5  | 153 | NC       | 183 | VDD  | 213 | NC     |
| 4     | DQ1    | 34  | DQS3  | 64  | NC,/CK1  | 94  | DQS5  | 124  | VSS  | 154 | VSS      | 184 | CK0  | 214 | VSS    |
| 5     | VSS    | 35  | VSS   | 65  | VDD      | 95  | VSS   | 125  | DM0  | 155 | DQ30     | 185 | /CK0 | 215 | DQ46   |
| 6     | /DQS0  | 36  | DQ26  | 66  | VDD      | 96  | DQ42  | 126  | NC   | 156 | DQ31     | 186 | VDD  | 216 | DQ47   |
| 7     | DQ50   | 37  | DQ27  | 67  | VREFCA   | 97  | DQ43  | 127  | VSS  | 157 | VSS      | 187 | NC   | 217 | VSS    |
| 8     | VSS    | 38  | VSS   | 68  | NC       | 98  | VSS   | 128  | DQ6  | 158 | NC       | 188 | A0   | 218 | DQ52   |
| 9     | DQ2    | 39  | NC    | 69  | VDD      | 99  | DQ48  | 129  | DQ7  | 159 | NC       | 189 | VDD  | 219 | DQ53   |
| 10    | DQ3    | 40  | NC    | 70  | A10      | 100 | DQ49  | 130  | VSS  | 160 | VSS      | 190 | BA1  | 220 | VSS    |
| 11    | VSS    | 41  | VSS   | 71  | BA0      | 101 | VSS   | 131  | DQ12 | 161 | NC       | 191 | VDD  | 221 | DM6    |
| 12    | DQ8    | 42  | NC    | 72  | VDD      | 102 | /DQS6 | 132  | DQ13 | 162 | NC       | 192 | /RAS | 222 | NC     |
| 13    | DQ9    | 43  | NC    | 73  | /WE      | 103 | DQS6  | 133  | VSS  | 163 | VSS      | 193 | /S0  | 223 | VSS    |
| 14    | VSS    | 44  | VSS   | 74  | /CAS     | 104 | VSS   | 134  | DM1  | 164 | NC       | 194 | VDD  | 224 | DQ54   |
| 15    | /DQS1  | 45  | NC    | 75  | VDD      | 105 | DQ50  | 135  | NC   | 165 | NC       | 195 | ODT0 | 225 | DQ55   |
| 16    | DQS1   | 46  | NC    | 76  | /S1, NC  | 106 | DQ51  | 136  | VSS  | 166 | VSS      | 196 | A13  | 226 | VSS    |
| 17    | VSS    | 47  | VSS   | 77  | ODT1, NC | 107 | VSS   | 137  | DQ14 | 167 | NC       | 197 | VDD  | 227 | DQ60   |
| 18    | DQ10   | 48  | NC    | 78  | VDD      | 108 | DQ56  | 138  | DQ15 | 168 | /RESET   | 198 | NC   | 228 | DQ61   |
| 19    | DQ11   | 49  | NC    | 79  | NC       | 109 | DQ57  | 139  | VSS  | 169 | CKE1, NC | 199 | VSS  | 229 | VSS    |
| 20    | VSS    | 50  | CKE0  | 80  | VSS      | 110 | VSS   | 140  | DQ20 | 170 | VDD      | 200 | DQ36 | 230 | DM7    |
| 21    | DQ16   | 51  | VDD   | 81  | DQ32     | 111 | /DQS7 | 141  | DQ21 | 171 | A15      | 201 | DQ37 | 231 | NC     |
| 22    | DQ17   | 52  | BA2   | 82  | DQ33     | 112 | DQS7  | 142  | VSS  | 172 | A14      | 202 | VSS  | 232 | VSS    |
| 23    | VSS    | 53  | NC    | 83  | VSS      | 113 | VSS   | 143  | DM2  | 173 | VDD      | 203 | DM4  | 233 | DQ62   |
| 24    | /DQS2  | 54  | VDD   | 84  | /DQS4    | 114 | DQS8  | 144  | NC   | 174 | A12      | 204 | NC   | 234 | DQ63   |
| 25    | DQS2   | 55  | A11   | 85  | DQS4     | 115 | DQS9  | 145  | VSS  | 175 | A9       | 205 | VSS  | 235 | VSS    |
| 26    | VSS    | 56  | A7    | 86  | VSS      | 116 | VSS   | 146  | DQ22 | 176 | VDD      | 206 | DQ38 | 236 | VDDSPD |
| 27    | DQ18   | 57  | VDD   | 87  | DQ34     | 117 | SA0   | 147  | DQ23 | 177 | A8       | 207 | DQ39 | 237 | SA1    |
| 28    | DQ19   | 58  | A5    | 88  | DQ35     | 118 | SCL   | 148  | VSS  | 178 | A6       | 208 | VSS  | 238 | SDA    |
| 29    | VSS    | 59  | A4    | 89  | VSS      | 119 | SA2   | 149  | DQ28 | 179 | VDD      | 209 | DQ44 | 239 | VSS    |
| 30    | DQ24   | 60  | VDD   | 90  | DQ40     | 120 | VTT   | 150  | DQ29 | 180 | A3       | 210 | DQ45 | 240 | VTT    |

1. Pin76, 77, 169: /S1, ODT1, CKE1: Used for dual-rank UDIMMs; NC on single-rank UDIMMs

2. Pin63, 64: CK1, /CK1 Used for dual-rank UDIMMs; not used on single-rank DIMMs

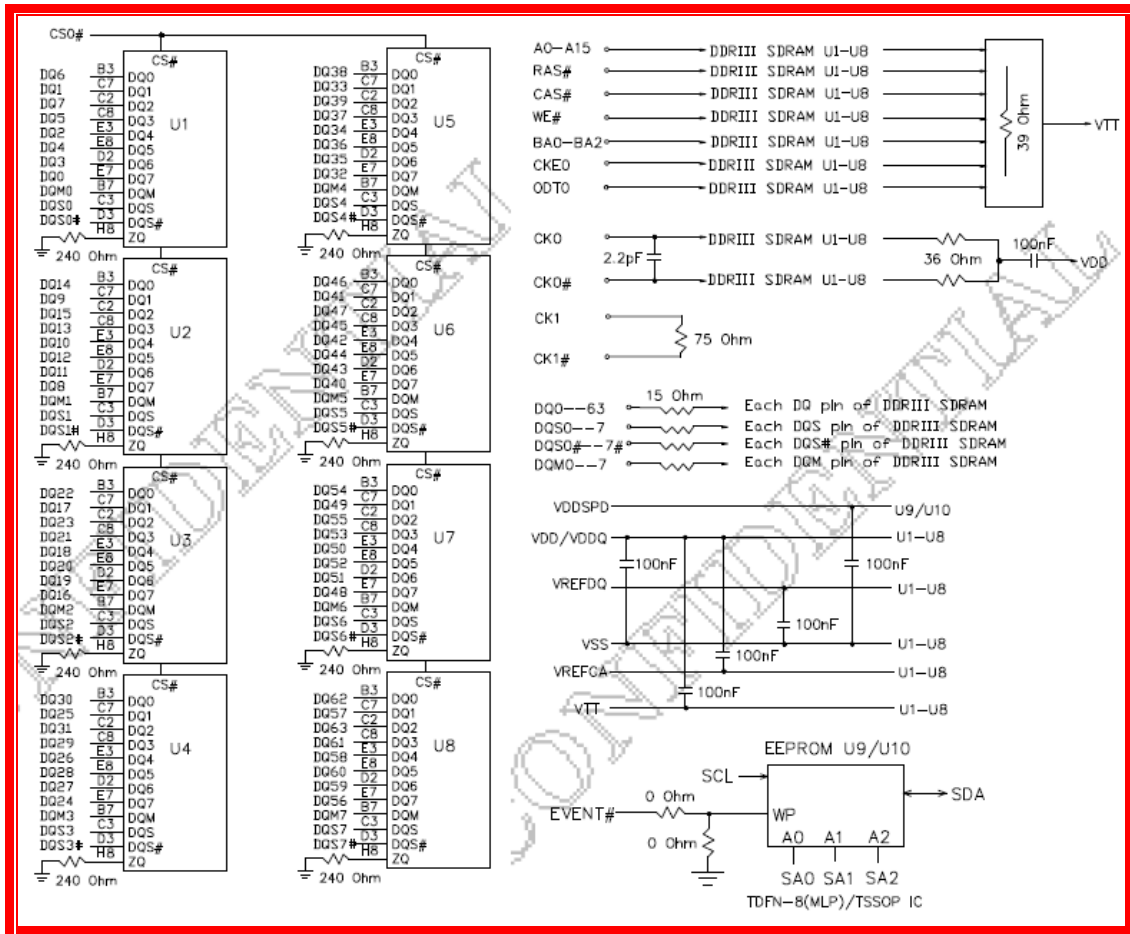
## 6. Architecture

### Pin Definition

| Pin Name    | Description   | Pin Name           | Description  |
|-------------|---|--------------------|--|
| A0–A15      | SDRAM address bus                                       | SCL                | I <sup>2</sup> C serial bus clock for EEPROM               |
| BA0–BA2     | SDRAM bank select                                       | SDA                | I <sup>2</sup> C serial bus data line for EEPROM           |
| /RAS        | SDRAM row address strobe                                | SA0-SA2            | I <sup>2</sup> C slave address select for EEPROM           |
| /CAS        | SDRAM column address strobe                             | V <sub>DD</sub> *  | SDRAM core power supply                                    |
| /WE         | SDRAM write enable                                      | V <sub>DDQ</sub> * | SDRAM I/O Driver power supply                              |
| /S0-/S1     | DIMM Rank Select Lines                                  | V <sub>REFDQ</sub> | SDRAM I/O reference supply                                 |
| CKE0–CKE1   | SDRAM clock enable lines                                | V <sub>REFCA</sub> | SDRAM command/address reference supply                     |
| ODT0–ODT1   | On-die termination control lines                        | V <sub>SS</sub>    | Power supply return (ground)                               |
| DQ0–DQ63    | DIMM memory data bus                                    | V <sub>DDSPD</sub> | Serial EEPROM positive power supply                        |
| CB0–CB7     | DIMM ECC check bits                                     | NC                 | Spare pins (no connect)                                    |
| DQS0–DQS8   | SDRAM data strobes (positive line of differential pair) | TEST               | Used by memory bus analysis tools (unused on memory DIMMs) |
| /DQS0–/DQS8 | SDRAM data strobes (negative line of differential pair) | /RESET             | Set DRAMs to Known State                                   |
| DM0–DM8     | SDRAM data masks/high data strobes (x8-based x72 DIMMs) | /EVENT             | Reserved for optional temperature-sensing hardware         |
| CK0–CK1     | SDRAM clocks (positive line of differential pair)       | V <sub>TT</sub>    | SDRAM I/O termination supply                               |
| /CK0–/CK1   | SDRAM clocks (negative line of differential pair)       | RSVD               | Reserved for future use                                    |

\*The V<sub>DD</sub> and V<sub>DDQ</sub> pins are tied common to a single power-plane on these designs.

**7. Function Block Diagram:**  
 - (4GB, 1 Rank 512Mx8 DDR3 SDRAMs)



## 8. SDRAM Absolute Maximum Ratings

| Symbol                             | Parameter  | Rating                   | Units    | Note |     |
|------------------------------------|--|--------------------------|----------|------|-----|
| T <sub>OPER</sub>                  | Operation Temperature                              | Normal Operating Temp.   | 0 to 85  | °C   | 1,2 |
|                                    |  | Extended Temp.(optional) | 85 to 95 | °C   | 1,3 |
| T <sub>STG</sub>                   | Storage Temperature                                | -55 to 100               | °C       | 4,5  |     |
| V <sub>IN</sub> , V <sub>OUT</sub> | Voltage on any pins relative to V <sub>ss</sub>    | -0.4 to +1.80            | V        | 4    |     |
| V <sub>DD</sub>                    | Voltage on VDD supply relative to V <sub>ss</sub>  | -0.4 to +1.80            | V        | 4,6  |     |
| V <sub>DDQ</sub>                   | Voltage on VDDQ supply relative to V <sub>ss</sub> | -0.4 to +1.80            | V        | 4,6  |     |

**Note:**

- Operating Temperature T<sub>OPER</sub> is the case surface temperature on the center / top side of the DRAM.  
For measurement conditions, please refer to the JEDEC document JESD51-2.
- The Normal Temperature Range specifies the temperatures where all DRAM specifications will be supported. During operation, the DRAM case temperature must be maintained between 0 to 85 °C under all operating conditions.
- Some applications require operation of the DRAM in the Extended Temperature Range between 85 °C and 95 °C case temperature. Full specifications are supported in this range, but the following additional conditions apply:
  - Refresh commands must be doubled in frequency, therefore reducing the Refresh interval tREFI to 3.9 μs. It is also possible to specify a component with 1X refresh (tREFI to 7.8μs) in the Extended Temperature Range. Please refer to supplier data sheet and/or the DIMM SPD for option availability.
  - If Self-Refresh operation is required in the Extended Temperature Range, then it is mandatory to either use the Manual Self-Refresh mode with Extended Temperature Range capability (MR2 A6 =0b and MR2 A7 = 1b) or enable the optional Auto Self-Refresh mode (MR2 A6 = 1b and MR2 A7 =0b). Please refer to the supplier data sheet and/or the DIMM SPD for Auto Self-Refresh option availability, Extended Temperature Range support and tREFI requirements in the Extended Temperature Range.
- Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is 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.
- Storage Temperature is the case surface temperature on the center/top side of the DRAM. For the measurement conditions, please refer to JESD51-2 standard.
- V<sub>DD</sub> and V<sub>DDQ</sub> must be within 300 mV of each other at all times;and VREF must be not greater than 0.6 x V<sub>DDQ</sub>, When V<sub>DD</sub> and V<sub>DDQ</sub> are less than 500 mV; VREF may be equal to or less than 300 mV



## 9. DRAM AC & DC Operating

| Symbol   | Parameter  | Min        | Typ.                | Max        | Units | Notes |
|--|--|------------|---------------------|------------|-------|-------|
| <b>Recommended DC Operating Conditions</b>                         |  |            |                     |            |       |       |
| <b>Recommended DC Operating Conditions - DDR3 (1.5V) operation</b> |  |            |                     |            |       |       |
| <b>VDD</b>   | Supply Voltage   | 1.425      | 1.5                 | 1.575      | V     | 1,2   |
| <b>VDDSPD</b>  | Supply Voltage   | 3          | 3.3                 | 3.6        | V     |       |
| <b>VDDQ</b>  | Supply Voltage   | 1.425      | 1.5                 | 1.575      | V     | 1,2   |
| <b>Single Ended AC/DC Input Levels</b>                             |  |            |                     |            |       |       |
| <b>VIH (DC) DDR3</b>   | DC Input High (Logic1) Voltage                               | VREF + 100 |                     | VDD        | V     | 3     |
| <b>VIL (DC) DDR3</b>   | DC Input Low (Logic 0) Voltage                               | VSS        |                     | VREF - 100 | V     | 3     |
| <b>VIH (AC) DDR3</b>   | AC Input High (Logic1) Voltage                               | VREF+ 150  |                     |            | V     | 3     |
| <b>VIL (AC) DDR3</b>   | AC Input Low (Logic 0) Voltage                               |            |                     | VREF - 150 | V     | 3     |
| <b>VREFDQ (DC)</b>   | Reference Voltage for DQ, DM inputs                          | 0.49VDDQ   | 0.5VDDQ             | 0.51VDDQ   | V     | 4,5   |
| <b>VREFCA (DC)</b>   | Reference Voltage for ADD,CMD inputs                         | 0.49VDDQ   | 0.5VDDQ             | 0.51VDDQ   | V     | 4,5   |
| <b>Single Ended AC/DC Output Levels</b>                            |  |            |                     |            |       |       |
| <b>VOH (DC)</b>  | DC output high measurement level<br>(for IV curve linearity) | -          | 0.8 x VDDQ          | -          | V     |       |
| <b>VOH (DC)</b>  | DC output mid measurement level<br>(for IV curve linearity)  | -          | 0.5 x VDDQ          | -          | V     |       |
| <b>VOL (DC)</b>  | DC output low measurement level<br>(for IV curve linearity)  | -          | 0.2 x VDDQ          | -          | V     |       |
| <b>VOH (AC)</b>  | AC output high measurement level<br>(for output SR)          | -          | VTT + 0.1 x<br>VDDQ | -          | V     | 6     |
| <b>VOL (AC)</b>  | AC output low measurement level<br>(for output SR)           |            | VTT - 0.1 x<br>VDDQ | -          | V     | 6     |

| Symbol                                 | Parameter                    | Min    | Typ. | Max    | Units | Notes |
|--|------------------------------|--------|------|--------|-------|-------|
| <b>Differential AC/DC Input Levels</b> |                              |        |      |        |       |       |
| <b>VIHdiff DDR3</b>                    | Differential Input high      | +0.2   |      | Note 9 | V     | 7     |
| <b>VILdiff DDR3</b>                    | Differential Input logic Low | Note 9 | -    | -0.2   | V     | 7     |

|   |   |                               |                        |                               |   |    |
|---|---|-------------------------------|------------------------|-------------------------------|---|----|
| <b>VIHdiff(ac) DDR3</b>   | Differential Input high ac                                    | $2^* (V_{IH} (AC) - V_{REF})$ | -                      | Note 9                        | V | 8  |
| <b>VILdiff(ac) DDR3</b>   | Differential Input logic Low ac                               | Note 9                        | -                      | $2^* (V_{REF} - V_{IL} (AC))$ | V | 8  |
| <b>Differential AC and DC Output Levels</b>   |   |                               |                        |                               |   |    |
| <b>VOHdiff(AC)</b>  | AC differential output high measurement level (for output SR) | -                             | $+ 0.2 \times V_{DDQ}$ | -                             | V | 10 |
| <b>VOLDiff(AC)</b>  | AC differential output low measurement level (for output SR)  | -                             | $- 0.2 \times V_{DDQ}$ | -                             | V | 10 |
| <b>Note:</b>  |   |                               |                        |                               |   |    |
| <ol style="list-style-type: none"> <li>Under all conditions VDDQ must be less than or equal to VDD.</li> <li>VDDQ tracks with VDD. AC parameters are measured with VDD and VDDQ tied together.</li> <li>For DQ and DM, Vref = VrefDQ. For input only pins except RESET#, Vref = VrefCA.</li> <li>Recommended DC Operating Conditions - DDR3 (1.5V) operation : The ac peak noise on VRef may not allow VRef to deviate from VRef(DC) by more than +/-1% VDD (for reference: approx. +/- 15 mV); Recommended DC Operating Conditions - DDR3L (1.35V) operation: The ac peak noise on VRef may not allow VRef to deviate from VRef(DC) by more than +/-1% VDD (for reference: approx. +/- 13.5 mV)</li> <li>For reference: approx. VDD/2.</li> <li>The swing of <math>\pm 0.1 \times V_{DDQ}</math> is based on approximately 50% of the static single-ended output high or low swing with a driver impedance of <math>40 \Omega</math> and an effective test load of <math>25 \Omega</math> to <math>V_{TT} = V_{DDQ}/2</math></li> <li>Used to define a differential signal slew-rate.</li> <li>For CK - CK# use VIH/VIL(ac) of ADD/CMD and VREFCA; for DQS - DQS#, DQSL, DQSL#, DQSU, DQSU# use VIH/VIL(ac) of DQs and VREFDQ; if a reduced ac-high or ac-low level is used for a signal group, then the reduced level applies also here.</li> <li>These values are not defined, however the single-ended signals CK, CK#, DQS, DQS#, DQSL, DQSL#, DQSU, DQSU# need to be within the respective limits (VIH(dc) max, VIL(dc)min) for single-ended signals as well as the limitations for overshoot and undershoot.</li> <li>The swing of <math>\pm 0.2 \times V_{DDQ}</math> is based on approximately 50% of the static single-ended output high or low swing with a driver impedance of <math>40 \Omega</math> and an effective test load of <math>25 \Omega</math> to <math>V_{TT} = V_{DDQ}/2</math> at each of the differential outputs.</li> </ol> |   |                               |                        |                               |   |    |

## 10. Operating, Standby, and Refresh Currents

- 4GB UDIMM (1 Rank, 512Mx8 DDR3 SDRAMs)

| Symbol | Parameter/Condition                            |           | PC3-12800 | Unit |
|--------|--|-----------|-----------|------|
| I DD0  | One bank; Active - Precharge                   |           | 232       | mA   |
| I DD1  | One bank; Active - Read - Precharge            |           | 320       | mA   |
| I DD2N | Precharge Standby Current                      |           | 104       | mA   |
| I DD2P | Precharge Power Down Current                   | Fast Mode | 88        | mA   |
|        | Precharge Power Down Current                   | Slow Mode | 88        | mA   |
| I DD2Q | Precharge Quiet Standby Current                |           | 96        | mA   |
| I DD3N | Active Standby Current                         |           | 184       | mA   |
| I DD3P | Active Power-Down Current                      |           | 88        | mA   |
| I DD4R | Operating Current Burst Read                   |           | 568       | mA   |
| I DD4W | Operating Current Burst Write                  |           | 568       | mA   |
| I DD5B | Burst Refresh Current                          |           | 1600      | mA   |
| I DD6  | Self-Refresh Current: Normal Temperature Range |           | 120       | mA   |
| I DD7  | Operating Bank Interleave Read Current         |           | 1040      | mA   |
| I DD8  | Reset Low Current                              |           | 120       | mA   |

## 11. Timing Parameters

| Symbol              | Parameter   | PC3-12800                             |   | Unit      |
|---------------------|---|---------------------------------------|---|-----------|
|                     |   | Min.                                  | Max.                                    |           |
| <b>Clock Timing</b> |   |                                       |   |           |
| tCK (DLL-Off)       | Minimum Clock Cycle Time                                | 8                                     | -                                       | ns        |
| tCK (avg)           | Average Clock Period                                    | 1.5                                   | 3.3                                     | ns        |
| tCH (avg)           | Average high pulse width                                | 0.47                                  | 0.53                                    | tCK (avg) |
| tCL (avg)           | Average low pulse width                                 | 0.47                                  | 0.53                                    | tCK (avg) |
| tCK (abs)           | Absolute Clock Period                                   | tCK(avg)<br>min +<br>tJIT(per)<br>min | tCK(avg)<br>max +<br>tJIT(per)<br>max - | Ps        |
| tCH (abs)           | Absolute high pulse width                               | 0.43                                  | -                                       | tCK (avg) |
| tCL (abs)           | Absolute low pulse width                                | 0.43                                  | -                                       | tCK (avg) |
| JIT (per)           | Clock Period Jitter                                     | -70                                   | 70                                      | Ps        |
| TJIT (per, lck)     | Clock Period Jitter during DLL locking period.          | -60                                   | 60                                      | Ps        |
| JIT (CC)            | Cycle to Cycle Period Jitter                            | 140                                   |   | Ps        |
| TJIT (CC, lck)      | Cycle to Cycle Period Jitter during DLL locking period. | 120                                   |   | Ps        |
| TJIT (duty)         |   | -                                     | -                                       | Ps        |
| TERR (2per)         | Cumulative error across 2 cycle                         | -103                                  | 103                                     | Ps        |
| TERR (3per)         | Cumulative error across 3 cycle                         | -122                                  | 122                                     | Ps        |
| TERR (4per)         | Cumulative error across 4 cycle                         | -136                                  | 136                                     | Ps        |
| TERR (5per)         | Cumulative error across 5 cycle                         | -147                                  | 147                                     | Ps        |
| TERR (6per)         | Cumulative error across 6 cycle                         | -155                                  | 155                                     | Ps        |
| TERR (7per)         | Cumulative error across 7 cycle                         | -163                                  | 163                                     | Ps        |
| TERR (8per)         | Cumulative error across 3 cycle                         | -169                                  | 169                                     | Ps        |
| TERR (9per)         | Cumulative error across 4 cycle                         | -175                                  | 175                                     | Ps        |
| TERR (10per)        | Cumulative error across 5 cycle                         | -180                                  | 180                                     | Ps        |

| TERR (11per)        | Cumulative error across 6 cycle   | -184   | 184  | Ps       |
|---------------------|---|--|------|----------|
| TERR (12per)        | Cumulative error across 7 cycle   | -188   | 188  | Ps       |
| TERR (nper)         | Cumulative error across 13~50 cycle                                       | $tERR(nper)min = (1 + 0.68ln(n)) *$<br>$tJIT(per)min$<br>$tERR(nper)max = (1 + 0.68ln(n)) *$<br>$tJIT(per)max$ |      | Ps       |
| Data Timing         |   |  |      |          |
| Symbol              | Parameter   | Min.   | Max. | Unit     |
| tDSQ                | DQS, DQS# to DQ skew, per group, per access                               | -  | 100  | Ps       |
| tQH                 | DQ output hold time from DQS, DQS#  | 0.38   | -    | tCK(avg) |
| tLZ (DQ)            | DQ low-impedance time from CK, CK#  | -450   | 225  | Ps       |
| tHZ(DQ)             | DQ high impedance time from CK, CK#                                       | -  | 225  | Ps       |
| tDS(base)<br>AC150  | Data setup time to DQS, DQS#<br>referenced to<br>Vih(ac) / Vil(ac) levels | 10   | -    | Ps       |
| tDH(base)<br>DC 100 | Data hold time from DQS, DQS#<br>referenced to Vih(dc) / Vil(dc) levels   | 45   | -    | Ps       |
| Data Strobe Timing  |   |  |      |          |
| Symbol              | Parameter   | Min.   | Max. | Unit     |
| tRPRE               | DQS,DQS# differential READ Preamble                                       | 0.9  |      | tCK(avg) |
| tRPST               | DQS, DQS# differential READ Postamble                                     | 0.3  |      | tCK(avg) |
| tQSH                | DQS, DQS# differential output high time                                   | 0.4  |      | tCK(avg) |
| tQSL                | DQS, DQS# differential output low time                                    | 0.4  |      | tCK(avg) |
| tWPRE               | DQS, DQS# differential WRITE Preamble                                     | 0.9  |      | tCK(avg) |
| tWPST               | DQS, DQS# differential WRITE Postamble                                    | 0.3  |      | tCK(avg) |
| tDQSK               | DQS, DQS# rising edge output access time<br>from rising CK, CK#           | -225   | 225  | Ps       |

|                                   |   |                  |             |             |
|-----------------------------------|---|------------------|-------------|-------------|
| tLZ(DQS)                          | DQS and DQS# low-impedance time<br>(Referenced from RL - 1)             | -450             | 225         | Ps          |
| tHZ(DQS)                          | DQS and DQS# high-impedance time<br>(Referenced from RL + BL/2)         | -                | 225         | Ps          |
| tDQSL                             | DQS, DQS# differential input low pulse width                            | 0.45             | 0.55        | tCK(avg)    |
| tDQSH                             | DQS, DQS# differential input high pulse width                           | 0.45             | 0.55        | tCK(avg)    |
| tDQSS                             | DQS, DQS# rising edge to CK, CK# rising edge                            | -0.27            | 0.27        | tCK(avg)    |
| tDSS                              | DQS, DQS# falling edge setup time to CK, CK# rising edge                | 0.18             | -           | tCK(avg)    |
| tDSH                              | DQS, DQS# falling edge hold time from CK, CK# rising edge               | 0.18             | -           | tCK(avg)    |
| <b>Command and Address Timing</b> |   |                  |             |             |
| <b>Symbol</b>                     | <b>Parameter</b>  | <b>Min.</b>      | <b>Max.</b> | <b>Unit</b> |
| tDLLK                             | DLL locking time  | 512              | -           | nCK         |
| tRTP                              | Internal READ Command to PRECHARGE Command delay                        | max(4nCK, 7.5ns) | -           |             |
| tWTR                              | Delay from start of internal write transaction to Internal read command | max(4nCK, 7.5ns) | -           |             |
| tWR                               | WRITE recovery time   | 15               | -           | ns          |
| tMRD                              | Mode Register Set command cycle time                                    | 4                | -           | nCK         |
| tMOD                              | Mode Register Set command update delay                                  | max(12nCK, 15ns) | -           |             |
| tRCD                              | Refer to Section 1 Feature  |                  |             |             |
| tRP                               | Refer to Section 1 Feature  |                  |             |             |
| tRC                               | Refer to Section 1 Feature  |                  |             |             |
| tCCD                              |   | 4                | -           | nCK         |

|                           |  |  |             |             |
|---------------------------|--|--|-------------|-------------|
| tDAL (min)                | Auto precharge write recovery + precharge time                                     | WR + roundup( $t_{RP} / t_{CK(ave)}$ ) |             | nCK         |
| tMPRR                     | Multi-Purpose Register Recovery Time   | 1                                      | -           | nCK         |
| tRAS                      | ACTIVE to PRECHARGE command period   | 35                                     | 9 tREFI     | ns          |
| tRRD                      | ACTIVE to ACTIVE command period for 1KB page size                                  | max(4nCK, 6ns)                         | -           |             |
| tRRD                      | ACTIVE to ACTIVE command period for 2KB page size                                  | max(4nCK, 7.5ns)                       | -           |             |
| tFAW                      | Four activate window for 1KB page size   | 30                                     | -           | ns          |
| tFAW                      | Four activate window for 2KB page size   | 40                                     | -           | ns          |
| tIS (base)                | Command and Address setup time to CK, CK#, referenced to Vih(ac) / Vil(ac) levels. | 45                                     |             | ns          |
| tIH(base)                 | Command and Address hold time from CK, CK# referenced to Vih(dc) / Vil(dc) levels  | 170                                    |             | ps          |
| tIS(base)<br>AC150        | Command and Address setup time to CK, CK# referenced to Vih(ac) / Vil(ac) levels   | 120                                    |             | ps          |
| <b>Calibration Timing</b> |  |  |             |             |
| <b>Symbol</b>             | <b>Parameter</b>   | <b>Min.</b>                            | <b>Max.</b> | <b>Unit</b> |
| tZQinit                   | Power-up and RESET calibration time  | Max.<br>(512nCK,<br>640ns)             | -           | nCK         |
| tZQoper                   | Normal operation Full calibration time   | Max.<br>(256nCK,<br>320ns)             | -           | nCK         |
| tZQCS                     | Normal operation Short calibration time  | Max.<br>(64nCK,<br>80ns)               | -           | nCK         |

| Reset Timing         |  |                              |      |      |
|----------------------|--|------------------------------|------|------|
| Symbol               | Parameter  | Min.                         | Max. | Unit |
| tXPR                 | Exit Reset from CKE HIGH to a valid command  | max(5nCK, tRFC(min) + 10ns)  | -    |      |
| Self Refresh Timings |  |                              |      |      |
| Symbol               | Parameter  | Min.                         | Max. | Unit |
| tXS                  | Exit Self Refresh to commands not requiring a locked DLL   | Max(5nCK), tRFC(min) + 10ns) |      |      |
| tXSDLL               | Exit Self Refresh to commands requiring a locked DLL.  | tDLL(min)                    | -    | nCK  |
| tCKESR               | Minimum CKE low width for Self Refresh entry to exit timing.   | tCKE9min) + 1nCK             | -    |      |
| tCKSRE               | Valid Clock Requirement after Self Refresh Entry (SRE) or Power-Down Entry (PDE)   | Max(5nCK, 10ns)              | -    |      |
| tCKSRX               | Valid Clock Requirement before Self Refresh Exit (SRX) or Power-Down Exit (PDX) or Reset Exit                                      | Max(5nCK, 10ns)              | -    |      |
| Power Down Timings   |  |                              |      |      |
| Symbol               | Parameter  | Min.                         | Max. | Unit |
| tXP                  | Exit Power Down with DLL on to any valid command; Exit Precharge Power Down with DLL frozen to commands not requiring a locked DLL | max(3nCK, 6ns)               | -    |      |
| tXPDLL               | Exit Precharge Power Down with DLL frozen to commands requiring a locked DLL   | max(10nCK, 24ns)             | -    |      |



|                    |  |                           |             |             |
|--------------------|--|---------------------------|-------------|-------------|
| tCKE               | CKE minimum pulse width  | max(3nCK, 5ns)            | -           |             |
| tCPDED             | Command pass disable delay   | 1                         | -           | nCK         |
| tPD                | Power Down Entry to Exit Timing                                    | tCK(min)                  | 9*tREFI     |             |
| tACTPDEN           | Timing of ACT command to Power Down entry                          | 1                         | -           | nCK         |
| tPRPDEN            | Timing of PRE or PREA command to Power Down entry                  | 1                         | -           | nCK         |
| tRDPDEN            | Timing of RD/RDA command to Power Down entry                       | RL+4+1                    | -           | nCK         |
| tWRPDEN            | Timing of WR command to Power Down entry (BL8OTF, BL8MRS, BC4OTF)  | WL + 4 + (tWR / tCK(avg)) | -           | nCK         |
| tWRAPDEN           | Timing of WRA command to Power Down entry (BL8OTF, BL8MRS, BC4OTF) | WL + 4 + WR + 1           | -           | nCK         |
| tWRPDEN            | Timing of WR command to Power Down entry (BC4MRS)                  | WL + 2 + (tWR / tCK(avg)) | -           | nCK         |
| tWRAPDEN           | Timing of WRA command to Power Down entry (BC4MRS)                 | WL + 2 + WR + 1           | -           | nCK         |
| tREFPDEN           | Timing of REF command to Power Down entry                          | 1                         | -           | nCK         |
| tMRSPDEN           | Timing of MRS command to Power Down entry                          | tMOD(min)                 | -           | nCK         |
| <b>ODT Timings</b> |  |                           |             |             |
| <b>Symbol</b>      | <b>Parameter</b>   | <b>Min.</b>               | <b>Max.</b> | <b>Unit</b> |
| ODTH4              | ODT high time without write command or with write command and BC4  | 4                         | -           | nCK         |
| ODTH8              | ODT high time with Write command and BL8                           | 6                         | -           | nCK         |

|                              |   |             |             |             |
|------------------------------|---|-------------|-------------|-------------|
| tAONPD                       | Asynchronous RTT turn-on delay (Power-Down with DLL frozen)                         | 2           | 8.5         | ns          |
| tAOFPD                       | Asynchronous RTT turn-off delay (Power-Down with DLL frozen)                        | 2           | 8.5         | ns          |
| tAON                         | RTT-turn-on   | -225        | 225         | ps          |
| tAOF                         | RTT_Nom and RTT_WR turn-off time from ODTLoff reference                             | 0.3         | 0.7         | tCK(avg)    |
| tADC                         | RTT dynamic change skew   | 0.3         | 0.7         | tCK(avg)    |
| <b>Write Leveling Timing</b> |   |             |             |             |
| <b>Symbol</b>                | <b>Parameter</b>  | <b>Min.</b> | <b>Max.</b> | <b>Unit</b> |
| tWLMRD                       | First DQS/DQS# rising edge after write leveling mode is programmed                  | 40          | -           | nCK         |
| tWLDQSEN                     | DQS/DQS# delay after write leveling mode is programmed                              | 25          | -           | nCK         |
| tWLS                         | Write leveling setup time from rising CK, CK# crossing to rising DQS, DQS# crossing | 195         | -           | ps          |
| tWLH                         | Write leveling hold time from rising DQS, DQS# crossing to rising CK, CK# crossing  | 195         | -           | ps          |
| tWLO                         | Write leveling output delay   | 0           | 9           | ns          |
| tWLOE                        | Write leveling output error   | 0           | 2           | ns          |



## 13. RoHS Declaration

innodisk

宜鼎國際股份有限公司  
Innodisk Corporation

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Tel: (02) 7703-3000 Fax: (02) 7703-3555 Internet: <http://www.innodisk.com/>

## RoHS 自我宣告書 (RoHS Declaration of Conformity)

**Manufacturer Product: All Innodisk EM Flash and Dram products**

- 一、宜鼎國際股份有限公司（以下稱本公司）特此保證售予貴公司之所有產品，皆符合歐盟 2011/65/EU 及 (EU) 2015/863 關於 RoHS 之規範要求。

Innodisk Corporation declares that all products sold to the company, are complied with European Union RoHS Directive (2011/65/EU) and (EU) 2015/863 requirement.

- 二、本公司同意因本保證書或與本保證書相關事宜有所爭議時，雙方宜友好協商，達成協議。

Innodisk Corporation agrees that both parties shall settle any dispute arising from or in connection with this Declaration of Conformity by friendly negotiations.

| Name of hazardous substance | Limited of RoHS ppm (mg/kg) |
|-----------------------------|-----------------------------|
| 鉛 (Pb)                      | < 1000 ppm                  |
| 汞 (Hg)                      | < 1000 ppm                  |
| 鎘 (Cd)                      | < 100 ppm                   |
| 六價鉻 (Cr 6+)                 | < 1000 ppm                  |
| 多溴聯苯 (PBBs)                 | < 1000 ppm                  |
| 多溴二苯醚 (PBDEs)               | < 1000 ppm                  |
| 鄰苯二甲酸二(2-乙基己基)酯 (DEHP)      | < 1000 ppm                  |
| 鄰苯二甲酸丁酯苯甲酯 (BBP)            | < 1000 ppm                  |
| 鄰苯二甲酸二丁酯 (DBP)              | < 1000 ppm                  |
| 鄰苯二甲酸二異丁酯 (DIBP)            | < 1000 ppm                  |

**立保證書人 (Guarantor)**

Company name 公司名稱： Innodisk Corporation 宜鼎國際股份有限公司

Company Representative 公司代表人： Randy Chien 簡川勝

Company Representative Title 公司代表人職稱： Chairman 董事長

Date 日期： 2017 / 01 / 18



## Revision Log

| Rev | Date                            | Modification        |
|-----|---------------------------------|---------------------|
| 0.1 | 28 <sup>th</sup> July 2016      | Preliminary Edition |
| 1.0 | 28 <sup>th</sup> July 2016      | Official released.  |
| 1.1 | 14 <sup>th</sup> September 2017 | Modified typo       |