

# Approval Sheet

|                |                            |
|----------------|----------------------------|
| Customer       |                            |
| Product Number | M4UE-AGMY2C0M-F            |
| Module speed   | PC4-3200                   |
| Pin            | 288 pin                    |
| Cl-tRCD-tRP    | 22-22-22                   |
| Operating Temp | 0℃~85℃                     |
| Date           | 15 <sup>th</sup> July 2022 |

Rev 1.0

## 1. Features

### Key Parameter

| Industry<br>Nomenclature | Speed<br>Grade | Data Rate MT/s |       |       | CL | tRCD | tRP |
|--------------------------|----------------|----------------|-------|-------|----|------|-----|
|                          |                | CL=19          | CL=21 | CL=22 |    |      |     |
| PC4-3200                 | E              | 2666           | 2933  | 3200  | 22 | 22   | 22  |

- JEDEC Standard 288-pin Dual In-Line Memory Module
- Intend for PC4-3200 applications
- Inputs and Outputs are SSTL-12 compatible
- VDD=VDDQ= 1.2 Volt (1.14V~1.26V)
- VPP=2.5 Volt (2.375V~2.75V)
- VDDSPD=2.2-3.6V
- Low-Power auto self-refresh (LPASR)
- 8 Banks (2 Bank Groups)
- Normal and Dynamic On-Die Termination for data, strobe and mask signals.
- Data bus inversion (DBI) for data bus
- Fixed burst chop (BC) of 4 and burst length (BL) of 8 via the MRS
- Selectable BC4 or BL8 on-the fly (OTF)
- Golden Connector
- Fly-By topology
- Terminated control, command and address bus
- Programmable /CAS Latency: 10,11,12,13,14,15,16,17,18,19,20,21,22,24
- On-die VREFDQ generation and Calibration
- On-Board EEPROM
- RoHS and Halogen free (Section 11)

## 2. Ordering Information

| <b>DDR4 UDIMM</b>      |         |          |                      |                   |                   |     |
|------------------------|---------|----------|----------------------|-------------------|-------------------|-----|
| Part Number            | Density | Speed    | DIMM<br>Organization | Number of<br>DRAM | Number<br>of rank | ECC |
| <b>M4UE-AGMY2C0M-F</b> | 16GB    | PC4-3200 | 2Gx64                | 8                 | 2                 | N   |

### 3. Pin Configurations (Front side/Back side)

#### DDR4 UDIMM

| Pin | Front               | Pin | Back   | Pin | Front               | Pin | Back    | Pin | Front               | Pin | Back         | Pin | Front               | Pin | Back   |
|-----|---------------------|-----|--------|-----|---------------------|-----|---------|-----|---------------------|-----|--------------|-----|---------------------|-----|--------|
| 1   | NC                  | 145 | NC     | 37  | VSS                 | 181 | DQ29    | 73  | VDD                 | 217 | VDD          | 109 | VSS                 | 253 | DQ41   |
| 2   | VSS                 | 146 | VREFCA | 38  | DQ24                | 182 | VSS     | 74  | CK0_t               | 218 | CK1_t        | 110 | DM5_n/<br>DBI5_n,NC | 254 | VSS    |
| 3   | DQ4                 | 147 | VSS    | 39  | VSS                 | 183 | DQ25    | 75  | CK0_c               | 219 | CK1_c        | 111 | NC                  | 255 | DQS5_c |
| 4   | VSS                 | 148 | DQ5    | 40  | DM3_n/<br>DBI3_n,NC | 184 | VSS     | 76  | VDD                 | 220 | VDD          | 112 | VSS                 | 256 | DQS5_t |
| 5   | DQ0                 | 149 | VSS    | 41  | NC                  | 185 | DQS3_c  | 77  | VTT                 | 221 | VTT          | 113 | DQ46                | 257 | VSS    |
| 6   | VSS                 | 150 | DQ1    | 42  | VSS                 | 186 | DQS3_t  | 78  | EVENT_n,NF          | 222 | PARITY       | 114 | VSS                 | 258 | DQ47   |
| 7   | DM0_n_t/<br>DBI0_n  | 151 | VSS    | 43  | DQ30                | 187 | VSS     | 79  | A0                  | 223 | VDD          | 115 | DQ42                | 259 | VSS    |
| 8   | NC                  | 152 | DQS0_c | 44  | VSS                 | 188 | DQ31    | 80  | VDD                 | 224 | BA1          | 116 | VSS                 | 260 | DQ43   |
| 9   | VSS                 | 153 | DQS0_t | 45  | DQ26                | 189 | VSS     | 81  | BA0                 | 225 | A10/AP       | 117 | DQ52                | 261 | VSS    |
| 10  | DQ6                 | 154 | VSS    | 46  | VSS                 | 190 | DQ27    | 82  | RAS_n<br>/A16       | 226 | VDD          | 118 | VSS                 | 262 | DQ53   |
| 11  | VSS                 | 155 | DQ7    | 47  | CB4/NC              | 191 | VSS     | 83  | VDD                 | 227 | NC           | 119 | DQ48                | 263 | VSS    |
| 12  | DQ2                 | 156 | VSS    | 48  | VSS                 | 192 | CB5,NC  | 84  | CS0_n               | 228 | WE_n/<br>A14 | 120 | VSS                 | 264 | DQ49   |
| 13  | VSS                 | 157 | DQ3    | 49  | CB0/NC              | 193 | VSS     | 85  | VDD                 | 229 | VDD          | 121 | DM6_n/<br>DBI6_n    | 265 | VSS    |
| 14  | DQ12                | 158 | VSS    | 50  | VSS                 | 194 | CB1,NC  | 86  | CAS_n/<br>A15       | 230 | NC           | 122 | NC                  | 266 | DQS6_c |
| 15  | VSS                 | 159 | DQ13   | 51  | DM8_n/<br>DBI8_n,NC | 195 | VSS     | 87  | ODT0                | 231 | VDD          | 123 | VSS                 | 267 | DQS6_t |
| 16  | DQ8                 | 160 | VSS    | 52  | NC                  | 196 | DQS8_c  | 88  | VDD                 | 232 | A13          | 124 | DQ54                | 268 | VSS    |
| 17  | VSS                 | 161 | DQ9    | 53  | VSS                 | 197 | DQS8_t  | 89  | CS1_n               | 233 | VDD          | 125 | VSS                 | 269 | DQ55   |
| 18  | DM1_n/<br>DBI1_n,NC | 162 | VSS    | 54  | CB6<br>DBI6_n,NC    | 198 | VSS     | 90  | VDD                 | 234 | NC           | 126 | DQ50                | 270 | VSS    |
| 19  | NC                  | 163 | DQS1_c | 55  | VSS                 | 199 | CB7,NC  | 91  | ODT1                | 235 | NC           | 127 | VSS                 | 271 | DQ51   |
| 20  | VSS                 | 164 | DQS1_t | 56  | CB2/NC              | 200 | VSS     | 92  | VDD                 | 236 | VDD          | 128 | DQ60                | 272 | VSS    |
| 21  | DQ14                | 165 | VSS    | 57  | VSS                 | 201 | CB3,NC  | 93  | NC                  | 237 | NC           | 129 | VSS                 | 273 | DQ61   |
| 22  | VSS                 | 166 | DQ15   | 58  | RESET_n             | 202 | VSS     | 94  | VSS                 | 238 | SA2          | 130 | DQ56                | 274 | VSS    |
| 23  | DQ10                | 167 | VSS    | 59  | VDD                 | 203 | CKE1    | 95  | DQ36                | 239 | VSS          | 131 | VSS                 | 275 | DQ57   |
| 24  | VSS                 | 168 | DQ11   | 60  | CKE0                | 204 | VDD     | 96  | VSS                 | 240 | DQ37         | 132 | DM7_n/<br>DBI7_n,NC | 276 | VSS    |
| 25  | DQ20                | 169 | VSS    | 61  | VDD                 | 205 | NC      | 97  | DQ32                | 241 | VSS          | 133 | NC                  | 277 | DQS7_c |
| 26  | VSS                 | 170 | DQ21   | 62  | ACT_n               | 206 | VDD     | 98  | VSS                 | 242 | DQ33         | 134 | VSS                 | 278 | DQS7_t |
| 27  | DQ16                | 171 | VSS    | 63  | BG0                 | 207 | BG1     | 99  | DM4_n/<br>DBI4_n,NC | 243 | VSS          | 135 | DQ62                | 279 | VSS    |
| 28  | VSS                 | 172 | DQ17   | 64  | VDD                 | 208 | ALERT_n | 100 | NC                  | 244 | DQS4_c       | 136 | VSS                 | 280 | DQ63   |
| 29  | DM2_n/<br>DBI2_n,NC | 173 | VSS    | 65  | A12/BC_n            | 209 | VDD     | 101 | VSS                 | 245 | DQS4_t       | 137 | DQ58                | 281 | VSS    |
| 30  | NC                  | 174 | DQS2_c | 66  | A9                  | 210 | A11     | 102 | DQ38                | 246 | VSS          | 138 | VSS                 | 282 | DQ59   |
| 31  | VSS                 | 175 | DQS2_t | 67  | VDD                 | 211 | A7      | 103 | VSS                 | 247 | DQ39         | 139 | SA0                 | 283 | VSS    |
| 32  | DQ22                | 176 | VSS    | 68  | A8                  | 212 | VDD     | 104 | DQ34                | 248 | VSS          | 140 | SA1                 | 284 | VSSSPD |
| 33  | VSS                 | 177 | DQ23   | 69  | A6                  | 213 | A5      | 105 | VSS                 | 249 | DQ35         | 141 | SCL                 | 285 | SDA    |
| 34  | DQ18                | 178 | VSS    | 70  | VDD                 | 214 | A4      | 106 | DQ44                | 250 | VSS          | 142 | VPP                 | 286 | VPP    |
| 35  | VSS                 | 179 | DQ19   | 71  | A3                  | 215 | VDD     | 107 | VSS                 | 251 | DQ45         | 143 | VPP                 | 287 | VPP    |
| 36  | DQ28                | 180 | VSS    | 72  | A1                  | 216 | A2      | 108 | DQ40                | 252 | VSS          | 144 | NC                  | 288 | VPP    |

Note:  
1. NC = No Connect, RFU = Reserved for Future Use  
2. Address A17 is only valid for 16 Gb x4 based SDRAMs.  
3. RAS\_n is a multiplexed function with A16.  
4. CAS\_n is a multiplexed function with A15.  
5. WE\_n is a multiplexed function with A14.

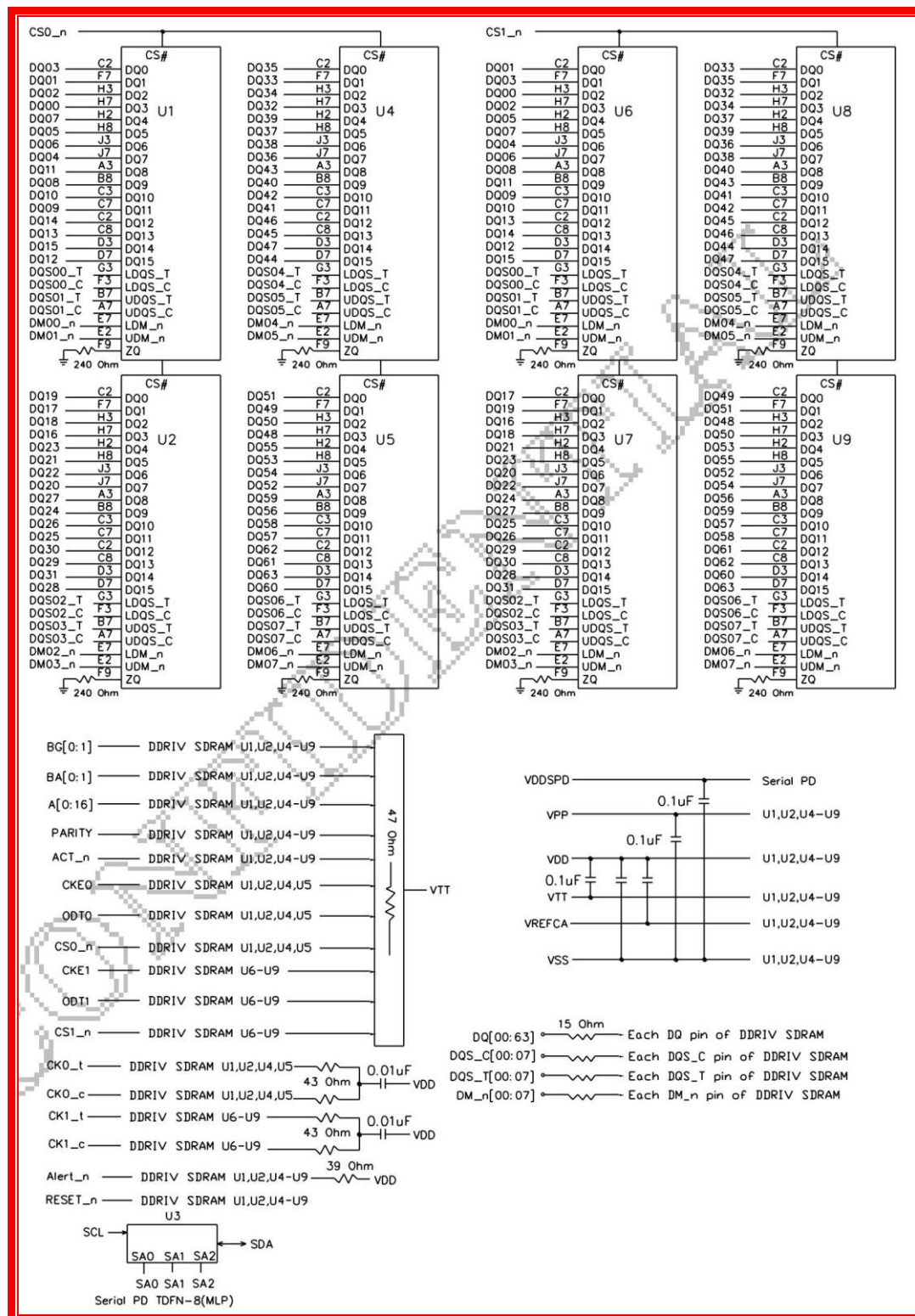
## 4. Architecture

### Pin Definition

| Pin Name                                                                                                                                                                                                                                                                                  | Description                                                                               | Pin Name   | Description                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------|-------------------------------------------------------|
| A0–A17 <sup>1</sup>                                                                                                                                                                                                                                                                       | SDRAM address bus                                                                         | SCL        | I <sup>2</sup> C serial bus clock for SPD/TSE         |
| BA0, BA1                                                                                                                                                                                                                                                                                  | SDRAM bank select                                                                         | SDA        | I <sup>2</sup> C serial bus data line for SPD/TSE     |
| BG0, BG1                                                                                                                                                                                                                                                                                  | SDRAM bank group select                                                                   | SA0–SA2    | I <sup>2</sup> C slave address select for SPD/TSE     |
| RAS_n <sup>2</sup>                                                                                                                                                                                                                                                                        | SDRAM row address strobe                                                                  | PARITY     | SDRAM parity input                                    |
| CAS_n <sup>3</sup>                                                                                                                                                                                                                                                                        | SDRAM column address strobe                                                               | VDD        | SDRAM I/O & core power supply                         |
| WE_n <sup>4</sup>                                                                                                                                                                                                                                                                         | SDRAM write enable                                                                        | C0, C1, C2 | Chip ID lines                                         |
| CS0_n, CS1_n                                                                                                                                                                                                                                                                              | DIMM Rank Select Lines                                                                    | 12 V       | Optional power Supply on socket but not used on UDIMM |
| CKE0, CKE1                                                                                                                                                                                                                                                                                | SDRAM clock enable lines                                                                  | VREFCA     | SDRAM command/address reference supply                |
| ODT0, ODT1                                                                                                                                                                                                                                                                                | SDRAM on-die termination control lines                                                    | VSS        | Power supply return (ground)                          |
| ACT_n                                                                                                                                                                                                                                                                                     | SDRAM activate                                                                            | VDDSPD     | Serial SPD-TSE positive power supply                  |
| DQ0–DQ63                                                                                                                                                                                                                                                                                  | DIMM memory data bus                                                                      | ALERT_n    | SDRAM ALERT_n                                         |
| CB0–CB7                                                                                                                                                                                                                                                                                   | DIMM ECC check bits (for x72 module)                                                      | VPP        | SDRAM Supply                                          |
| TDQS0_t–TDQS8_t<br>TDQS0_c–TDQS8_c                                                                                                                                                                                                                                                        | Dummy loads for mixed populations of x4 based and x8 based RDIMMs.<br>Not used on UDIMMs. |            |                                                       |
| DQS0_t–DQS8_t                                                                                                                                                                                                                                                                             | SDRAM data strobes<br>(positive line of differential pair)                                |            |                                                       |
| DQS0_c–DQS8_c                                                                                                                                                                                                                                                                             | SDRAM data strobes<br>(negative line of differential pair)                                | RESET_n    | Set DRAMs to a Known State                            |
| DM0_n–DM8_n,<br>DBI0_n–DBI8_n                                                                                                                                                                                                                                                             | SDRAM data masks/data bus inversion<br>(x8-based x72 DIMMs)                               | EVENT_n    | SPD signals a thermal event has occurred.             |
| CK0_t, CK1_t                                                                                                                                                                                                                                                                              | SDRAM clocks<br>(positive line of differential pair)                                      | VTT        | SDRAM I/O termination supply                          |
| CK0_c, CK1_c                                                                                                                                                                                                                                                                              | SDRAM clocks<br>(negative line of differential pair)                                      | RFU        | Reserved for future use                               |
| <b>Note 1</b> Address A17 is not valid for x8 and x16 based SDRAMs. For UDIMMs this connection pin is NC.<br><b>Note 2</b> RAS_n is a multiplexed function with A16.<br><b>Note 3</b> CAS_n is a multiplexed function with A15.<br><b>Note 4</b> WE_n is a multiplexed function with A14. |                                                                                           |            |                                                       |

## 5. Function Block Diagram:

- (16GB, 2 Ranks 1Gx16 DDR4 SDRAMs)



Note: 1. The ZQ ball on each DDR4 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.

## 6. 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.         | 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 +1.5 | V     | 4    |
| V <sub>DD</sub>                    | Voltage on VDD supply relative to V <sub>SS</sub>  |                        | -0.4 to +1.5 | V     | 4,6  |
| V <sub>DDQ</sub>                   | Voltage on VDDQ supply relative to V <sub>SS</sub> |                        | -0.4 to +1.5 | V     | 4,6  |

### Note:

- Operating Temperature T<sub>OPER</sub> is the case surface temperature on the center/top side of the DRAM.
- The Normal Temperature Range specifies the temperatures where all DRAM specifications will be supported. During operation, the DRAM case temperature must be maintained between 0-85°C under all operating conditions.
- Some applications require operation of the Extended Temperature Range between 85°C and 95°C case temperature. Full specifications are guaranteed in this range, but the following additional conditions apply:
  - Refresh commands must be doubled in frequency, therefore reducing the refresh interval tREFI to 3.9us.
  - 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), in this case IDD6 current can be increased around 10~20% than normal Temperature range.
- Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is stressing 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

## 7. Operating Condition

| Symbol                                                                                                                                                                                                                                                                                                                                                                                                                          | Parameter                                       | Min                    | Nom                   | Max                    | Units | Notes |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|------------------------|-----------------------|------------------------|-------|-------|
| V <sub>DD</sub>                                                                                                                                                                                                                                                                                                                                                                                                                 | Supply Voltage                                  | 1.14                   | 1.2                   | 1.26                   | V     | 1     |
| V <sub>PP</sub>                                                                                                                                                                                                                                                                                                                                                                                                                 | DRAM activating power supply                    | 2.375                  | 2.5                   | 2.75                   | V     | 2     |
| V <sub>REFCA(DC)</sub>                                                                                                                                                                                                                                                                                                                                                                                                          | Input reference voltage command/<br>address bus | 0.49 x V <sub>DD</sub> | 0.5 x V <sub>DD</sub> | 0.51 x V <sub>DD</sub> | V     | 3     |
| V <sub>TT</sub>                                                                                                                                                                                                                                                                                                                                                                                                                 | Termination Voltage                             | 0.49 x V <sub>DD</sub> | 0.5 x V <sub>DD</sub> | 0.51 x V <sub>DD</sub> | V     | 4     |
| <b>Note:</b><br>1. VDDQ tracks with VDD; VDDQ and VDD are tied together.<br>2. VPP must be greater than or equal to VDD at all times.<br>3. VREFCA must not be greater than 0.6 x VDD. When VDD is less than 500mV, VREF may be less than or equal to 300mV.<br>4. VTT termination voltages in excess of the specification limit adversely affect the voltage margins of command and address signals and reduce timing margins. |                                                 |                        |                       |                        |       |       |



## 8. Operating, Standby, and Refresh Currents

- 16GB UDIMM (2 Ranks 1Gx16 DDR4 SDRAMs)

| Symbol | Proposed Conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Value    |          | Units |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------|-------|
|        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | IDD Max. | IPP Max. |       |
| IDD0   | Operating One Bank Active-Precharge Current (AL=0)CKE: High; External clock: On; tCK, nRC, nRAS, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: Highbetween ACT and PRE; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: Cycling with one bank active at a time: 0,0,1,1,2,2,... ; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern          | 536      | 32       | mA    |
| IDD0A  | Operating One Bank Active-Precharge Current (AL=CL-1)<br>AL = CL-1, Other conditions: see IDD0                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -        | -        | mA    |
| IDD1   | Operating One Bank Active-Read-Precharge Current (AL=0)CKE: High; External clock: On; tCK, nRC, nRAS, nRCD, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: Highbetween ACT, RD and PRE; Command, Address, Bank Group Address, Bank Address Inputs, Data IO: partially toggling; DM_n: stable at 1; Bank Activity: Cycling with one bank active at a time: 0,0,1,1,2,2,... ; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern | 696      | -        | mA    |
| IDD1A  | Operating One Bank Active-Read-Precharge Current (AL=CL-1)<br>AL = CL-1, Other conditions: see IDD1                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -        | -        | mA    |
| IDD2N  | Precharge Standby Current (AL=0)CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks closed; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern                                                                                          | 376      | -        | mA    |
| IDD2NA | Precharge Standby Current (AL=CL-1)<br>AL = CL-1, Other conditions: see IDD2N                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | -        | -        | mA    |

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |    |    |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|----|
| IDD2NT    | Precharge Standby ODT Current<br>CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: VSSQ; DM_n: stable at 1; Bank Activity: all banks closed; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: toggling according ; Pattern Details: Refer to Component Datasheet for detail pattern | 440 | -  | mA |
| IDD2NL    | Precharge Standby Current with CAL enabled<br>Same definition like for IDD2N, CAL enabled3                                                                                                                                                                                                                                                                                                                                                                          | -   | -  | mA |
| IDD2NG    | Precharge Standby Current with Gear Down mode enabled<br>Same definition like for IDD2N, Gear Down mode enabled3                                                                                                                                                                                                                                                                                                                                                    | -   | -  | mA |
| IDD2ND    | Precharge Standby Current with DLL disabled<br>Same definition like for IDD2N, DLL disabled3                                                                                                                                                                                                                                                                                                                                                                        | -   | -  | mA |
| IDD2N_par | Precharge Standby Current with CA parity enabled<br>Same definition like for IDD2N, CA parity enabled3                                                                                                                                                                                                                                                                                                                                                              | -   | -  | mA |
| IDD2P     | Precharge Power-Down Current CKE: Low; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL:0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: stable at 0; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks closed; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0                                                                                         | 344 | -  | mA |
| IDD2Q     | Precharge Quiet Standby Current<br>CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: stable at 0; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks closed; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0                                                                                 | 376 | -  | mA |
| IDD3N     | Active Standby Current<br>CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks open; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern                  | 472 | 16 | mA |

|        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |   |    |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---|----|
| IDD3NA | Active Standby Current (AL=CL-1)<br>AL = CL-1, Other conditions: see IDD3N                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | -    | - | mA |
| IDD3P  | Active Power-Down Current<br>CKE: Low; External clock: On; tCK, CL: sRefer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: stable at 0; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks open; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0                                                                                                                                                                                                                             | 384  | - | mA |
| IDD4R  | Operating Burst Read Current<br>CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 82; AL: 0; CS_n: High between RD; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: seamless read data burst with different data between one burst and the next one according ; DM_n: stable at 1; Bank Activity: all banks open, RD commands cycling through banks: 0,0,1,1,2,2,... ; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern | 1104 | - | mA |
| IDD4RA | Operating Burst Read Current (AL=CL-1)<br>AL = CL-1, Other conditions: see IDD4R                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -    | - | mA |
| IDD4RB | Operating Burst Read Current with Read DBI<br>Read DBI enabled3, Other conditions: see IDD4R                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | -    | - | mA |
| IDD4W  | Operating Burst Write Current<br>CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: High between WR; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: seamless write data burst with different data between one burst and the next one ; DM_n: stable at 1; Bank Activity: all banks open, WR commands cycling through banks: 0,0,1,1,2,2,... ; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at HIGH; Pattern Details: Refer to Component Datasheet for detail pattern      | 1600 | - | mA |
| IDD4WA | Operating Burst Write Current (AL=CL-1)<br>AL = CL-1, Other conditions: see IDD4W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | -    | - | mA |
| IDD4WB | Operating Burst Write Current with Write DBI<br>Write DBI enabled3, Other conditions: see IDD4W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | -    | - | mA |

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |    |    |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|----|
| IDD4WC    | Operating Burst Write Current with Write CRC<br>Write CRC enabled <sup>3</sup> , Other conditions: see IDD4W                                                                                                                                                                                                                                                                                                                                                                                              | -   | -  | mA |
| IDD4W_par | Operating Burst Write Current with CA Parity<br>CA Parity enabled <sup>3</sup> , Other conditions: see IDD4W                                                                                                                                                                                                                                                                                                                                                                                              | -   | -  | mA |
| IDD5B     | Burst Refresh Current (1X REF)<br>CKE: High; External clock: On; tCK, CL, nRFC: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: High between REF; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: REF command every nRFC ; Output Buffer and RTT: Enabled in Mode Registers <sup>2</sup> ; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern               | 544 | 32 | mA |
| IDD5F2    | Burst Refresh Current (2X REF)<br>tRFC=tRFC_x2, Other conditions: see IDD5B                                                                                                                                                                                                                                                                                                                                                                                                                               | -   | -  | mA |
| IDD5F4    | Burst Refresh Current (4X REF)<br>tRFC=tRFC_x4, Other conditions: see IDD5B                                                                                                                                                                                                                                                                                                                                                                                                                               | -   | -  | mA |
| IDD6N     | Self Refresh Current: Normal Temperature Range<br>TCASE: 0 - 85°C; Low Power Array Self Refresh (LP ASR) : Normal <sup>4</sup> ; CKE: Low; External clock: Off; CK_t and CK_c#: LOW; CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n#, Command, Address, Bank Group Address, Bank Address, Data IO: High; DM_n: stable at 1; Bank Activity: Self-Refresh operation; Output Buffer and RTT: Enabled in Mode Registers <sup>2</sup> ; ODT Signal: MIDDLELEVEL                      | 456 | -  | mA |
| IDD6E     | Self-Refresh Current: Extended Temperature Range)<br>TCASE: 0 - 95°C; Low Power Array Self Refresh (LP ASR) : Extended <sup>4</sup> ; CKE: Low; External clock: Off; CK_t and CK_c: LOW; CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n, Command, Address, Bank Group Address, Bank Address, Data IO: High; DM_n:stable at 1; Bank Activity: Extended Temperature Self-Refresh operation; Output Buffer and RTT: Enabled in Mode Registers <sup>2</sup> ; ODT Signal: MID-LEVEL | 904 | -  | mA |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |   |    |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---|----|
| IDD6R | Self-Refresh Current: Reduced Temperature Range<br>TCASE: 0 - 45 °C; Low Power Array Self Refresh (LP ASR) : Reduced4; CKE: Low; External clock: Off; CK_t and CK_c#: LOW; CL: see Table 34 on p age 37; BL: 81; AL: 0; CS_n#, Command, Address, Bank Group Address, Bank Address, Data IO: High; DM_n:stable at 1; Bank Activity: Extended Temperature Self-Refresh operation; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: MIDLEVEL                                                                                                                                                                                                | 192  | - | mA |
| IDD6A | Auto Self-Refresh Current<br>TCASE: 0 - 95°C; Low Power Array Self Refresh (LP ASR) : Auto4;CKE: Low; External clock: Off; CK_t and CK_c#: LOW; CL: see Table 34 on p age 37; BL: 81; AL: 0; CS_n#, Command, Address, Bank Group Address, Bank Address, Data IO: High; DM_n:stable at 1; Bank Activity: Auto Self-Refresh operation; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: MID-LEVEL                                                                                                                                                                                                                                          | 192  | - | mA |
| IDD7  | Operating Bank Interleave Read Current<br>CKE: High; External clock: On; tCK, nRC, nRAS, nRCD, nRRD, nFAW, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: CL-1; CS_n: High between ACT and RDA; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; DataIO: read data bursts with different data between one burst and the next one ; DM_n: stable at 1; Bank Activity: two times interleaved cycling through banks (0, 1, ...7) with different addressing; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern | 1952 | - | mA |
| IDD8  | Maximum Power Down Current TBD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 304  | - | mA |

## 9. Timing Parameters

| Clock Timing                                              |                 |                                           |                                           |          |
|-----------------------------------------------------------|-----------------|-------------------------------------------|-------------------------------------------|----------|
| Parameter                                                 | Symbol          | MIN                                       | MAX                                       | Units    |
| Minimum Clock Cycle Time<br>(DLL off mode)                | tCK (DLL_OFF)   | 8                                         | 20                                        | ns       |
| Average Clock Period                                      | tCK(avg)        | 0.625                                     | <0.682                                    | ns       |
| Average high pulse width                                  | tCH(avg)        | 0.48                                      | 0.52                                      | tCK(avg) |
| Average low pulse width                                   | tCL(avg)        | 0.48                                      | 0.52                                      | tCK(avg) |
| Absolute Clock Period                                     | tCK(abs)        | tCK(avg)min<br>+<br>tJIT(per)min_<br>to t | tCK(avg)m<br>ax +<br>tJIT(per)m<br>ax_tot | tCK(avg) |
| Absolute clock HIGH pulse<br>width                        | tCH(abs)        | 0.45                                      | -                                         | tCK(avg) |
| Absolute clock LOW pulse<br>width                         | tCL(abs)        | 0.45                                      | -                                         | tCK(avg) |
| Clock Period Jitter- total                                | JIT(per)_tot    | -32                                       | 32                                        | ps       |
| Clock Period Jitter-<br>deterministic                     | JIT(per)_dj     | -16                                       | 16                                        | ps       |
| Clock Period Jitter during DLL<br>lock-ing period         | tJIT(per, lck)  | -25                                       | 25                                        | ps       |
| Cycle to Cycle Period Jitter                              | tJIT(cc)_to-tal | 62                                        |                                           | ps       |
| Cycle to Cycle Period Jitter<br>during DLL locking period | tJIT(cc, lck)   | 50                                        |                                           | ps       |
| Cumulative error across 2<br>cycles                       | tERR(2per)      | -46                                       | 46                                        | ps       |
| Cumulative error across 3<br>cycles                       | tERR(3per)      | -55                                       | 55                                        | ps       |
| Cumulative error across 4<br>cycles                       | tERR(4per)      | -61                                       | 61                                        | ps       |
| Cumulative error across 5<br>cycles                       | tERR(5per)      | -65                                       | 65                                        | ps       |
| Cumulative error across 6<br>cycles                       | tERR(6per)      | -69                                       | 69                                        | ps       |
| Cumulative error across 7                                 | tERR(7per)      | -73                                       | 73                                        | ps       |

|                                                                                                                                      |                        |                                                                                                                                   |    |    |
|--------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------|----|----|
| cycles                                                                                                                               |                        |                                                                                                                                   |    |    |
| Cumulative error across 8 cycles                                                                                                     | tERR(8per)             | -76                                                                                                                               | 76 | ps |
| Cumulative error across 9 cycles                                                                                                     | tERR(9per)             | -78                                                                                                                               | 78 | ps |
| Cumulative error across 10 cycles                                                                                                    | tERR(10per)            | -80                                                                                                                               | 80 | ps |
| Cumulative error across 11 cycles                                                                                                    | tERR(11per)            | -83                                                                                                                               | 83 | ps |
| Cumulative error across 12 cycles                                                                                                    | tERR(12per)            | -84                                                                                                                               | 84 | ps |
| Cumulative error across 13 cycles                                                                                                    | tERR(13per)            | -86                                                                                                                               | 86 | ps |
| Cumulative error across 14 cycles                                                                                                    | tERR(14per)            | -87                                                                                                                               | 87 | ps |
| Cumulative error across 15 cycles                                                                                                    | tERR(15per)            | -89                                                                                                                               | 89 | ps |
| Cumulative error across 16 cycles                                                                                                    | tERR(16per)            | -90                                                                                                                               | 90 | ps |
| Cumulative error across 17 cycles                                                                                                    | tERR(17per)            | -92                                                                                                                               | 92 | ps |
| Cumulative error across 18 cycles                                                                                                    | tERR(18per)            | -93                                                                                                                               | 93 | ps |
| Cumulative error across n = 13, 14 . . . 49, 50 cycles                                                                               | tERR(nper)             | $tERR(nper)_{min} = ((1 + 0.68\ln(n)) * tJIT(per)_{total\ min})$ $tERR(nper)_{max} = ((1 + 0.68\ln(n)) * tJIT(per)_{total\ max})$ |    | ps |
| Command and Address setup time to CK <sub>t</sub> , CK <sub>c</sub> referenced to V <sub>ih</sub> (ac) / V <sub>il</sub> (ac) levels | tIS(base)              | 40                                                                                                                                | -  | ps |
| Command and Address setup time to CK <sub>t</sub> , CK <sub>c</sub> referenced to V <sub>ref</sub> levels                            | tIS(V <sub>ref</sub> ) | 130                                                                                                                               | -  | ps |
| Command and Address hold time to CK <sub>t</sub> , CK <sub>c</sub> referenced to V <sub>ih</sub> (dc) / V <sub>il</sub> (dc) levels  | tIH(base)              | 65                                                                                                                                | -  | ps |
| Command and Address hold                                                                                                             | tIH(V <sub>ref</sub> ) | 130                                                                                                                               | -  | ps |

|                                                                                 |               |                  |     |       |
|---------------------------------------------------------------------------------|---------------|------------------|-----|-------|
| time to CK_t, CK_c referenced to Vref levels                                    |               |                  |     |       |
| Control and Address Input pulse width for each input                            | tIPW          | 340              | -   | ps    |
| <b>Command and Address Timing</b>                                               |               |                  |     |       |
| Parameter                                                                       | Symbol        | MIN              | MAX | Units |
| CAS_n to CAS_n command delay for same bank group                                | tCCD_L        | max(5 nCK, 5 ns) | -   | nCK   |
| CAS_n to CAS_n command delay for different bank group                           | tCCD_S        | 4                | -   | nCK   |
| ACTIVATE to ACTIVATE Command delay to different bank group for 2KB page size    | tRRD_S(2K)    | Max(4nCK, 5.3ns) | -   | nCK   |
| ACTIVATE to ACTIVATE Command delay to different bank group for 2KB page size    | tRRD_S(1K)    | Max(4nCK, 2.5ns) | -   | nCK   |
| ACTIVATE to ACTIVATE Command delay to different bank group for 1/ 2KB page size | tRRD_S(1/ 2K) | Max(4nCK, 2.5ns) | -   | nCK   |
| ACTIVATE to ACTIVATE Command delay to same bank group for 2KB page size         | tRRD_L(2K)    | Max(4nCK, 6.4ns) | -   | nCK   |
| ACTIVATE to ACTIVATE Command delay to same bank group for 1KB page size         | tRRD_L(1K)    | Max(4nCK, 4.9ns) | -   | nCK   |
| ACTIVATE to ACTIVATE Command delay to same bank group for 1/2KB page size       | tRRD_L(1/ 2K) | Max(4nCK, 4.9ns) | -   | nCK   |
| Four activate window for 2KB page size                                          | tFAW_2K       | Max(28nCK, 30ns) | -   | ns    |
| Four activate window for 1KB page size                                          | tFAW_1K       | Max(20nCK, 21ns) | -   | ns    |
| Four activate window for 1/2KB page size                                        | tFAW_1/2K     | Max(16nCK, 10ns) | -   | ns    |
| Delay from start of internal                                                    | tWTR_S        | max(2nCK, 2.5ns) | -   |       |



|                                                                                                                                |               |                                           |   |     |
|--------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------------------|---|-----|
| write transaction to internal read com-mand for different bank group                                                           |               | 5ns)                                      |   |     |
| Delay from start of internal write transaction to internal read com-mand for same bank group                                   | tWTR_L        | max(4nCK,7.5ns)                           | - |     |
| Internal READ Command to PRE-CHARGE Command delay                                                                              | tRTP          | max(4nCK,7.5ns)                           | - |     |
| WRITE recovery time                                                                                                            | tWR           | 15                                        | - | ns  |
| Write recovery time when CRC and DM are enabled                                                                                | tWR_CRC_DM    | tWR+max(5nCK,3.75ns)                      | - | ns  |
| delay from start of internal write transaction to internal read com-mand for different bank group with both CRC and DM enabled | tWTR_S_CRC_DM | tWTR_S+max(5nCK,3.75ns)                   | - | ns  |
| delay from start of internal write transaction to internal read com-mand for same bank group with both CRC and DM enabled      | tWTR_L_CRC_DM | tWTR_L+max(5nCK,3.75ns)                   | - | ns  |
| DLL locking time                                                                                                               | tDLLK         | 1024                                      | - | nCK |
| Mode Register Set command cycle time                                                                                           | tMRD          | 8                                         | - | nCK |
| Mode Register Set command up-date delay                                                                                        | tMOD          | max(24nCK,15ns)                           | - |     |
| Multi-Purpose Register Recovery Time                                                                                           | tMPRR         | 1                                         | - | nCK |
| Multi Purpose Register Write Re-covery Time                                                                                    | tWR_MPR       | tMOD (min) + AL + PL                      | - | -   |
| Auto precharge write recovery + precharge time                                                                                 | tDAL(min)     | Programmed WR + roundup ( tRP / tCK(avg)) |   | nCK |
| DQ0 or DQ10 driven to 0 set-up time to first DQS rising edge                                                                   | tPDA_S        | 0.5                                       | - | UI  |

|                                                                          |          |                      |      |             |
|--------------------------------------------------------------------------|----------|----------------------|------|-------------|
| DQ0 or DQL0 driven to 0 hold time from last DQS fall-ing edge            | tPDA_H   | 0.5                  | -    | UI          |
| CS_n to Command Address Latency                                          |          |                      |      |             |
| CS_n to Command Address Latency                                          | tCAL     | max(3 nCK, 3.748 ns) | -    | nCK         |
| DRAM Data Timing                                                         |          |                      |      |             |
| DQS_t,DQS_c to DQ skew, per group, per access                            | tDQSQ    | -                    | 0.20 | tCK(avg) /2 |
| DQ output hold time from DQS_t,DQS_c                                     | tQH      | 0.70                 | -    | tCK(avg) /2 |
| Data Valid Window per device: tQH - tDQSQ for a device                   | tDVWd    | 0.64                 | -    | UI          |
| Data Valid Window per device, per pin: tQH - tDQSQ each device's out-put | tDVWp    | 0.72                 | -    | UI          |
| DQ low impedance time from CK_t, CK_c                                    | tLZ(DQ)  | -250                 | 160  | Ps          |
| DQ high impedance time from CK_t, CK_c                                   | tHZ(DQ)  | -                    | 160  | ps          |
| Data Strobe Timing                                                       |          |                      |      |             |
| DQS_t, DQS_c differential READ Preamble                                  | tRPRE    | 0.9                  |      | tCK         |
| DQS_t, DQS_c differential READ Postamble                                 | tRPST    | 0.33                 | TBD  | tCK         |
| DQS_t,DQS_c differential output high time                                | tQSH     | 0.4                  | -    | tCK         |
| DQS_t,DQS_c differential output low time                                 | tQSL     | 0.4                  | -    | tCK         |
| DQS_t, DQS_c differential WRITE Preamble                                 | tWPRE    | 0.9                  | -    | tCK         |
| DQS_t, DQS_c differential WRITE Postamble                                | tWPST    | 0.33                 | TBD  | tCK         |
| DQS_t and DQS_c low-impedance time                                       | tLZ(DQS) | -250                 | 160  | ps          |

|                                                                             |                  |                            |      |     |
|-----------------------------------------------------------------------------|------------------|----------------------------|------|-----|
| (Referenced from RL-1)                                                      |                  |                            |      |     |
| DQS_t and DQS_c<br>high-impedance time<br>(Referenced from RL+BL/2)         | tHZ(DQS)         | -                          | 160  | ps  |
| DQS_t, DQS_c differential<br>input low pulse width                          | tDQSL            | 0.46                       | 0.54 | tCK |
| DQS_t, DQS_c differential<br>input high pulse width                         | tDQSH            | 0.46                       | 0.54 | tCK |
| DQS_t, DQS_c rising edge to<br>CK_t, CK_c rising edge (1<br>clock preamble) | tDQSS            | -0.27                      | 0.27 | tCK |
| DQS_t, DQS_c falling edge<br>setup time to CK_t, CK_c<br>rising edge        | tDSS             | 0.18                       | -    | tCK |
| DQS_t, DQS_c falling edge<br>hold time from CK_t, CK_c<br>rising edge       | tDSH             | 0.18                       | -    | tCK |
| DQS_t, DQS_c rising edge<br>output timing locatino from<br>rising           | tDQSCK (DLL On)  | -160                       | 160  | ps  |
| DQS_t, DQS_c rising edge<br>output variance window per<br>DRAM              | tDQSCKI (DLL On) |                            | 260  | ps  |
| <b>MPSM Timing</b>                                                          |                  |                            |      |     |
| Command path disable delay<br>upon MPSM entry                               | tMPED            | tMOD(min) +<br>tCPDED(min) | -    |     |
| Valid clock requirement after<br>MPSM entry                                 | tCKMPE           | tMOD(min) +<br>tCPDED(min) | -    |     |
| Valid clock requirement<br>before MPSM exit                                 | tCKMPX           | tCKSRX(min)                |      |     |
| Exit MPSM to commands not<br>requiring a locked DLL                         | tXMP             | txs(imin)                  |      |     |
| Exit MPSM to commands<br>requiring a locked DLL                             | tXMPDLL          | tXMP(min) +<br>tXSDLL(min) |      |     |
| CS setup time to CKE                                                        | tMPX_S           | tISmin + tIHmin            | -    |     |
| <b>Calibration Timing</b>                                                   |                  |                            |      |     |
| Power-up and RESET                                                          | tZQinit          | 1024                       | -    | nCK |

|                                                                                                 |                  |                                   |   |     |
|-------------------------------------------------------------------------------------------------|------------------|-----------------------------------|---|-----|
| calibration time                                                                                |                  |                                   |   |     |
| Normal operation Full calibration time                                                          | tZQoper          | 512                               | - | nCK |
| Normal operation Short calibration time                                                         | tZQCS            | 128                               | - | nCK |
| Reset/Self Refresh Timing                                                                       |                  |                                   |   |     |
| Exit Reset from CKE HIGH to a valid command                                                     | command tXPR     | max<br>(5nCK,tRFC(min))+<br>10ns) | - |     |
| Exit Self Refresh to commands not requiring a locked DLL                                        | tXS              | tRFC(min)+1<br>0ns                | - |     |
| SRX to commands not requiring a locked DLL in Self Refresh ABORT                                | tX-S_ABORT( min) | tRFC4(min)+<br>10ns               | - |     |
| Exit Self Refresh to ZQCL,ZQCS and MRS (CL,CWL,WR,RTP and Gear Down)                            | tXS_FAST (min)   | tRFC4(min)+<br>10ns               | - |     |
| Exit Self Refresh to commands re-quiring a locked DLL                                           | tXSDLL           | tDLLK(min)                        | - |     |
| Minimum CKE low width for Self re-fresh entry to exit timing                                    | tCKESR           | tCKE(min)+1<br>nCK                | - |     |
| Minimum CKE low width for Self re-fresh entry to exit timing with CA Parity enabled             | tCKESR_ PAR      | tCKE(min)+<br>1nCK+PL             | - |     |
| Valid Clock Requirement after Self Refresh Entry (SRE) or Power- Down Entry (PDE)               | tCKSRE           | max(5nCK,10<br>ns)                | - |     |
| Valid Clock Requirement after Self Refresh Entry (SRE) or Power- Down when CA Parity is enabled | tCKS-RE_ PAR     | max<br>(5nCK,10ns)<br>+PL         | - |     |
| Valid Clock Requirement                                                                         | tCKSRX           | max(5nCK,10                       | - |     |

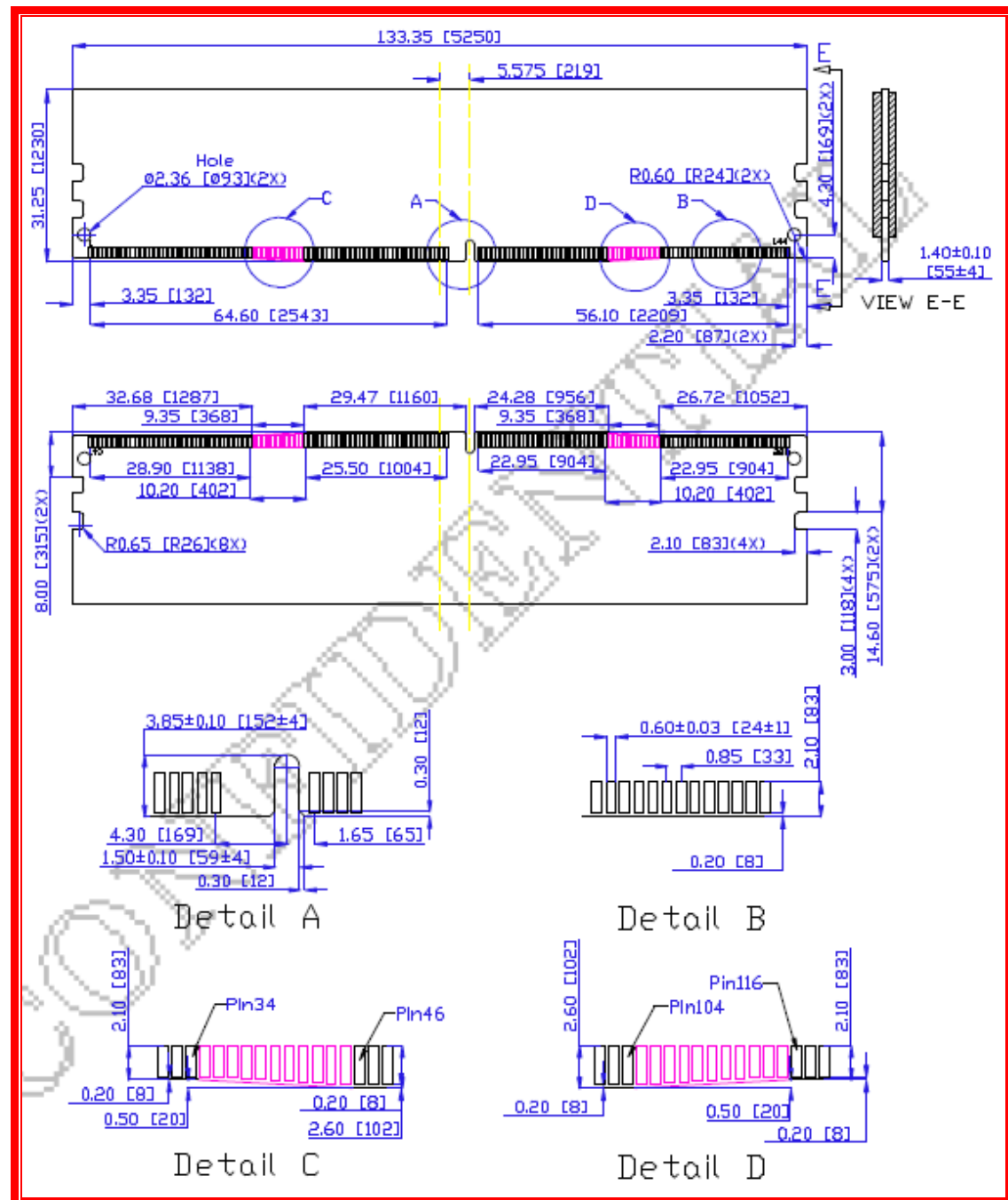
|                                                                                                                                               |              |                         |         |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------|---------|-----|
| before Self Refresh Exit (SRX)<br>or Power-Down Exit (PDX) or<br>Reset Exit                                                                   |              | ns)                     |         |     |
| Power Down Timing                                                                                                                             |              |                         |         |     |
| Exit Power Down with DLL on<br>to any valid command;Exit<br>Precharge Power Down with<br>DLL frozen to commands not<br>requiring a locked DLL | tXP          | (4nCK,6ns)              | -       |     |
| CKE minimum pulse width                                                                                                                       | tCKE         | max (3nCK,<br>5ns)      | -       |     |
| Command pass disable delay                                                                                                                    | tCPDED       | 4                       | -       | nCK |
| Power Down Entry to Exit<br>Timing                                                                                                            | tPD          | tCKE(min)               | 9*tREFI |     |
| Timing of ACT command to<br>Power Down entry                                                                                                  | tACTPDEN     | 2                       | -       | nCK |
| Timing of PRE or PREA<br>command to Power Down<br>entry                                                                                       | tPRPDEN      | 2                       | -       | nCK |
| Timing of RD/RDA command<br>to Power Down entry                                                                                               | tRDPDEN      | RL+4+1                  | -       | nCK |
| Timing of WR command to<br>Power Down entry (BL8OTF,<br>BL8MRS, BC4OTF)                                                                       | tWRPDEN      | WL+4+(tWR/<br>tCK(avg)) | -       | nCK |
| Timing of WRA command to<br>Power Down entry (BL8OTF,<br>BL8MRS, BC4OTF)                                                                      | tWRAPDEN     | WL+4+WR+1               | -       | nCK |
| Timing of WR command to<br>Power Down entry (BC4MRS)                                                                                          | tWRP-BC4DEN  | WL+2+(tWR/<br>tCK(avg)) | -       | nCK |
| Timing of WRA command to<br>Power Down entry (BC4MRS)                                                                                         | tWRAP-BC4DEN | WL+2+WR+1               | -       | nCK |
| Timing of REF command to<br>Power Down entry                                                                                                  | tREFPDEN     | 2                       | -       | nCK |
| Timing of MRS command to<br>Power Down entry                                                                                                  | tMRSPDEN     | tMOD(min)               | -       |     |
| PDA Timing                                                                                                                                    |              |                         |         |     |
| Mode Register Set command                                                                                                                     | tMRD_PDA     | max(16nCK,1             |         |     |

|                                                                                                   |                 |      |        |          |
|---------------------------------------------------------------------------------------------------|-----------------|------|--------|----------|
| cycle time in PDA mode                                                                            |                 | 0ns) |        |          |
| Mode Register Set command<br>up-date delay in PDA mode                                            | tMOD_PDA        | tMOD |        |          |
| ODT Timing                                                                                        |                 |      |        |          |
| Asynchronous RTT turn-on<br>delay (Power-Down with DLL<br>frozen)                                 | tAONAS          | 1.0  | 9.0    | ns       |
| Asynchronous RTT turn-off<br>delay (Power-Down with DLL<br>frozen)                                | tAOFAS          | 1.0  | 9.0    | ns       |
| RTT dynamic change skew                                                                           | tADC            | 0.26 | 0.74   | tCK(avg) |
| Write Leveling Timing                                                                             |                 |      |        |          |
| First DQS_t/DQS_n rising<br>edge af-ter write leveling<br>mode is pro-grammed                     | tWLMRD          | 40   | -      | nCK      |
| DQS_t/DQS_n delay after<br>write lev-eling mode is<br>programmed                                  | tWLDQSEN        | 25   | -      | nCK      |
| Write leveling setup time<br>from rising CK_t, CK_c<br>crossing to rising<br>DQS_t/DQS_n crossing | tWLS            | 0.13 | -      | tCK(avg) |
| Write leveling hold time from<br>rising DQS_t/DQS_n crossing<br>to rising CK_t, CK_ crossing      | tWLH            | 0.13 | -      | tCK(avg) |
| Write leveling output delay                                                                       | tWLO            | 0    | 9.5    | ns       |
| Write leveling output error                                                                       | tWLOE           |      | 2      | ns       |
| CA Parity Timing                                                                                  |                 |      |        |          |
| Commands not guaranteed to<br>be executed during this time                                        | tPAR_UN-KNOWN   | -    | PL     |          |
| Delay from errant command<br>to ALERT_n assertion                                                 | tPAR_ALER T_ON  | -    | PL+6ns |          |
| Pulse width of ALERT_n signal<br>when asserted                                                    | tPAR_ALER T_PW  | 96   | 192    | nCK      |
| Time from when Alert is<br>asserted till controller must<br>start providing DES                   | tPAR_ALER T_RSP | -    | 85     | nCK      |

|                                       |               |     |     |     |
|---------------------------------------|---------------|-----|-----|-----|
| commands in Persistent CA parity mode |               |     |     |     |
| Parity Latency                        | PL            | 6   | nCK |     |
| CRC Error Reporting                   |               |     |     |     |
| CRC error to ALERT_n latency          | tCRC_ALER T   | 3   | 13  | ns  |
| CRC ALERT_n pulse width               | CRC_ALER T_PW | 6   | 10  | nCK |
| tREFI                                 |               |     |     |     |
| tRFC1 (min)                           | 2Gb           | 160 | -   | ns  |
|                                       | 4Gb           | 260 | -   | ns  |
|                                       | 8Gb           | 350 | -   | ns  |
|                                       | 16Gb          | 550 | -   | ns  |
| tRFC2 (min)                           | 2Gb           | 110 | -   | ns  |
|                                       | 4Gb           | 160 | -   | ns  |
|                                       | 8Gb           | 260 | -   | ns  |
|                                       | 16Gb          | 350 | -   | ns  |
| tRFC3 (min)                           | 2Gb           | 90  | -   | ns  |
|                                       | 4Gb           | 110 | -   | ns  |
|                                       | 8Gb           | 160 | -   | ns  |
|                                       | 16Gb          | 260 | -   | ns  |

## 10. PACKAGE DIMENSION

- (16GB, 2 Ranks 1Gx16 DDR4 base UDIMM)



Note: All dimensions are in millimeters (mils) and should be kept within a tolerance of  $\pm 0.15$  (6), unless otherwise specified



## 11. RoHS Declaration

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宜鼎國際股份有限公司  
Innodisk Corporation

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

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

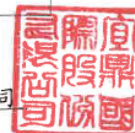
Manufacturer Products: All Innodisk EM FLASH, DRAM and EP products

- 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.
- 三、本公司聲明我們的產品符合 RoHS 指令的附件中 (7a)、(7c-I) 允許豁免。  
We declare, our products permitted by the following exemptions specified in the Annex of the RoHS directive.
- ※ (7a) Lead in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead).
- ※ (7C-I) Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectric devices, or in a glass or ceramic matrix compound.

| 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: 2020 / 03 / 03

## 12. REACH Declaration

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宜鼎國際股份有限公司  
Innodisk Corporation  
REACH DeclarationTel: (02) 7703-3000 Fax: (02) 7703-3555 Internet: <https://www.innodisk.com/>

Innodisk Corporation pursues its social responsibility for global environmental preservation by committing to be compliant with REACH regulation (REGULATION (EC) No 1907/2006). We hereby confirm that the product(s),

**Scope: Flash Memory, DRAM Module and Embedded Peripherals Products.**

- The standard products of **not listed in the Appendix2** meet the requirements of REACH SVHC regulations (SVHCs < 0.1% in Article), as described in the candidate list table currently including 219 substances and shown on the ECHA website. (<http://echa.europa.eu/de/candidate-list-table>).
- Contain(s) one or more hazardous substances or constituents exceeding 0.1 % by weight in article if not otherwise specified in candidate list table.  
Where the threshold value is exceeded, the substances in question are to be declared in accompanying. (SVHCs > 0.1% in Article).
- Comply with REACH Annex XVII.

## 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:  陳柏華

Company Representative Title 公司代表人職稱: QA Manager 品保經理

Date 日期: 2021 / 07 / 12



## Revision Log

| Rev | Date                       | Modification        |
|-----|----------------------------|---------------------|
| 0.1 | 15 <sup>th</sup> July 2022 | Preliminary Edition |
| 1.0 | 15 <sup>th</sup> July 2022 | Official Released   |