

Approval Sheet

| | |
|------------------------------|--------------------------------------|
| Customer | |
| Product Number | M5C0-AGS2L5ZQ |
| Data Rate | 5600 MT/s |
| Pin | 288 pin |
| CI-tRCD-tRP | 46-45-45 |
| Operating temperature | Tc=-40 to 95°C |
| Date | 24th November 2023 |

**The Total Solution For
Industrial Flash Storage**

Rev 1.0

1. Features

- JEDEC Standard 288-pin Dual In-Line Memory Module
- VDD=VDDQ= 1.1V (1.067V ~ 1.166V)
- VPP=1.8V (1.746V ~ 1.908V)
- VDDSPD= 1.8V
- On-die, internal, adjustable VREF generation for DQ,CA,CS
- 16n-bit prefetch
- Two independent I/O sub channels
- Programmable /CAS Latency: 22,26,28,30,32,36,40,42,46,50
- tREFI 3.9us for $-40^{\circ}\text{C} \leq T_{\text{case}} < 85^{\circ}\text{C}$, tREFI 1.95us for $85^{\circ}\text{C} < T_{\text{case}} \leq 95^{\circ}\text{C}$
- On-Die ECC
- PMIC on DIMM, nominal supply 5V, VIN_Bulk input supply range: 4.25 V to 5.5 V
- Fly-by topology
- I3C/I2C support
- Terminated control and C/A bus
- SPD EEPROM Hub and Integrated Thermal Sensor
- Halogen-free

Specification

| Density | Data Rate | IC Configuration | DIMM Organization | Number of IC | Number of rank | Side | ECC |
|---------|-----------|------------------|-------------------|--------------|----------------|------|-----|
| 16GB | 5600 MT/s | 2Gx8 (16Gb) | 2Gx72 | 10 | 1 | 1 | Y |

Key timing parameters

| tCK (ns) | tRCD (ns) | tRP (ns) | tRAS (ns) | tRC (ns) |
|-------------|--------------|-------------|--------------|-------------|
| 0.357 | 16.00 | 16.00 | 32 | 48.00 |

tRFC parameter by IC Configuration

| Parameter | IC Configuration | | | | Unit |
|------------|------------------|------|------|------|------|
| | 8Gb | 16Gb | 24Gb | 32Gb | |
| tRFC1,min | 195 | 295 | TBD | TBD | ns |
| tRFC2,min | 130 | 160 | TBD | TBD | ns |
| tRFCsb,min | 115 | 130 | TBD | TBD | ns |

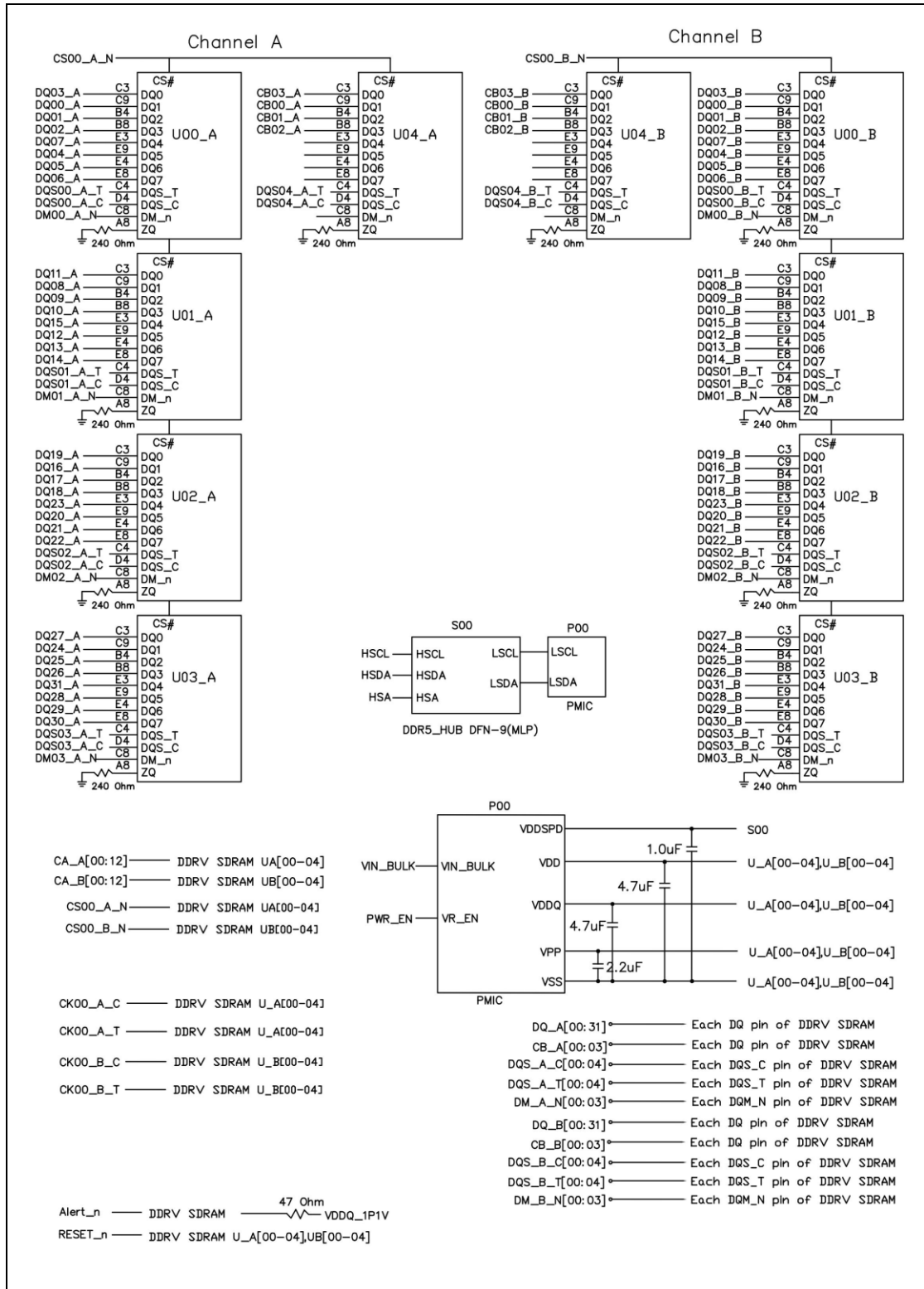
2. Pin Assignments

| 288-Pin DDR5 UDIMM Front | | | | | | | | 288-Pin DDR5 UDIMM Back | | | | | | | |
|--------------------------|----------|-----|----------|-----|----------|-----|----------|-------------------------|----------|-----|----------|-----|----------|-----|----------|
| Pin | Symbol | Pin | Symbol | Pin | Symbol | Pin | Symbol | Pin | Symbol | Pin | Symbol | Pin | Symbol | Pin | Symbol |
| 1 | VIN_BULK | 37 | DQ20_A | 73 | CK0_A_c | 109 | Vss | 145 | VIN_BULK | 181 | DQ22_A | 217 | CK1_A_c | 253 | Vss |
| 2 | RFU | 38 | Vss | 74 | Vss | 110 | DQ5_B | 146 | VIN_BULK | 182 | Vss | 218 | Vss | 254 | DQ7_B |
| 3 | RFU | 39 | DQ21_A | 75 | RFU | 111 | Vss | 147 | PWR_GOOD | 183 | DQ23_A | 219 | RFU | 255 | Vss |
| 4 | HSCL | 40 | Vss | 76 | RFU | 112 | DQ8_B | 148 | HAS | 184 | Vss | 220 | RFU | 256 | DQ10_B |
| 5 | HSDA | 41 | DQ24_A | 77 | Vss | 113 | Vss | 149 | RFU | 185 | DQ26_A | 221 | Vss | 257 | Vss |
| 6 | Vss | 42 | Vss | 78 | CK0_B_t | 114 | DQ9_B | 150 | Vss | 186 | Vss | 222 | CK1_B_t | 258 | DQ11_B |
| 7 | RFU | 43 | DQ25_A | 79 | CK0_B_c | 115 | Vss | 151 | PWR_EN | 187 | DQ27_A | 223 | CK1_B_c | 259 | Vss |
| 8 | Vss | 44 | Vss | 80 | Vss | 116 | DM1_B_n | 152 | RFU | 188 | Vss | 224 | Vss | 260 | DQS1_B_c |
| 9 | DQ0_A | 45 | DM3_A_n | 81 | RFU | 117 | Vss | 153 | Vss | 189 | DQS3_A_c | 225 | RFU | 261 | DQS1_B_t |
| 10 | Vss | 46 | Vss | 82 | CA12_B | 118 | DQ12_B | 154 | DQ2_A | 190 | DQS3_A_t | 226 | RFU | 262 | Vss |
| 11 | DQ1_A | 47 | DQ28_A | 83 | Vss | 119 | Vss | 155 | Vss | 191 | Vss | 227 | Vss | 263 | DQ14_B |
| 12 | Vss | 48 | Vss | 84 | CA10_B | 120 | DQ13_B | 156 | DQ3_A | 192 | DQ30_A | 228 | CA11_B | 264 | Vss |
| 13 | DQS0_A_c | 49 | DQ29_A | 85 | CA8_B | 121 | Vss | 157 | Vss | 193 | Vss | 229 | CA9_B | 265 | DQ15_B |
| 14 | DQS0_A_t | 50 | Vss | 86 | Vss | 122 | DQ16_B | 158 | DM0_A_n | 194 | DQ31_A | 230 | Vss | 266 | Vss |
| 15 | Vss | 51 | CB0_A | 87 | CA6_B | 123 | Vss | 159 | Vss | 195 | Vss | 231 | CA7_B | 267 | DQ18_B |
| 16 | DQ4_A | 52 | Vss | 88 | CA4_B | 124 | DQ17_B | 160 | DQ6_A | 196 | CB2_A | 232 | CA5_B | 268 | Vss |
| 17 | Vss | 53 | CB1_A | 89 | Vss | 125 | Vss | 161 | Vss | 197 | Vss | 233 | Vss | 269 | DQ19_B |
| 18 | DQ5_A | 54 | Vss | 90 | CA2_B | 126 | DQS2_B_c | 162 | DQ7_A | 198 | CB3_A | 234 | CA3_B | 270 | Vss |
| 19 | Vss | 55 | DQS4_A_c | 91 | CA0_B | 127 | DQS2_B_t | 163 | Vss | 199 | Vss | 235 | CA1_B | 271 | DM2_B_n |
| 20 | DQ8_A | 56 | DQS4_A_t | 92 | Vss | 128 | Vss | 164 | DQ10_A | 200 | ALERT_n | 236 | Vss | 272 | Vss |
| 21 | Vss | 57 | Vss | 93 | CS0_B_n | 129 | DQ20_B | 165 | Vss | 201 | Vss | 237 | CS1_B_n | 273 | DQ22_B |
| 22 | DQ9_A | 58 | CS0_A_n | 94 | Vss | 130 | Vss | 166 | DQ11_A | 202 | CS1_A_n | 238 | Vss | 274 | Vss |
| 23 | Vss | 59 | Vss | 95 | RESET_n | 131 | DQ21_B | 167 | Vss | 203 | Vss | 239 | DQS4_B_c | 275 | DQ23_B |
| 24 | DM1_A_n | 60 | CA0_A | 96 | Vss | 132 | Vss | 168 | DQS1_A_c | 204 | CA1_A | 240 | DQS4_B_t | 276 | Vss |
| 25 | Vss | 61 | CA2_A | 97 | CB0_B | 133 | DQ24_B | 169 | DQS1_A_t | 205 | CA3_A | 241 | Vss | 277 | DQ26_B |
| 26 | DQ12_A | 62 | Vss | 98 | Vss | 134 | Vss | 170 | Vss | 206 | Vss | 242 | CB2_B | 278 | Vss |
| 27 | Vss | 63 | CA4_A | 99 | CB1_B | 135 | DQ25_B | 171 | DQ14_A | 207 | CA5_A | 243 | Vss | 279 | DQ27_B |
| 28 | DQ13_A | 64 | CA6_A | 100 | Vss | 136 | Vss | 172 | Vss | 208 | CA7_A | 244 | CB3_B | 280 | Vss |
| 29 | Vss | 65 | Vss | 101 | DQ0_B | 137 | DM3_B_n | 173 | DQ15_A | 209 | Vss | 245 | Vss | 281 | DQS3_B_c |
| 30 | DQ16_A | 66 | CA8_A | 102 | Vss | 138 | Vss | 174 | Vss | 210 | CA9_A | 246 | DQ2_B | 282 | DQS3_B_t |
| 31 | Vss | 67 | CA10_A | 103 | DQ1_B | 139 | DQ28_B | 175 | DQ18_A | 211 | CA11_A | 247 | Vss | 283 | Vss |
| 32 | DQ17_A | 68 | Vss | 104 | Vss | 140 | Vss | 176 | Vss | 212 | Vss | 248 | DQ3_B | 284 | DQ30_B |
| 33 | Vss | 69 | CA12_A | 105 | DQS0_B_c | 141 | DQ29_B | 177 | DQ19_A | 213 | RFU | 249 | Vss | 285 | Vss |
| 34 | DQS2_A_c | 70 | RFU | 106 | DQS0_B_t | 142 | Vss | 178 | Vss | 214 | RFU | 250 | DM0_B_n | 286 | DQ31_B |
| 35 | DQS2_A_t | 71 | Vss | 107 | Vss | 143 | RFU | 179 | DM2_A_n | 215 | Vss | 251 | Vss | 287 | Vss |
| 36 | Vss | 72 | CK0_A_t | 108 | DQ4_B | 144 | RFU | 180 | Vss | 216 | CK1_A_t | 252 | DQ6_B | 288 | RFU |

3. Pin Descriptions

| Symbol | Type | I/O Level | Description | Symbol | Type | I/O Level | Description |
|--------------------------|------------------|-----------|-------------------------------|------------------------------|------------------|-----------|-----------------------------|
| CK_t, CK_c | Input | VDDQ | Clock | DQ[31:0]_A DQ[31:0]_B | Input/ Output | VDDQ | Data Input/Output |
| CA[12:0]_A CA[12:0]_B | Input | VDDQ | Command/Address Inputs | CB[3:0]_A CB[3:0]_B | Input/ Output | VDDQ | ECC Check Bits Input/Output |
| CS[1:0]_A CS[1:0]_B | Input | VDDQ | Chip Select | DQS[4:0]_A_t DQS[4:0]_B_t | Input/ Output | VDDQ | Data Strobe |
| ALERT_n | Output | VDDQ | Alert | DQS[4:0]_A_c DQS[4:0]_B_c | Input/ Output | VDDQ | Data Strobe |
| RESET_n | CMOS Input | VDDQ | Active Low Asynchronous Reset | DM[3:0]_A_n DM[3:0]_B_n | Input | VDDQ | Input Data Mask |
| PWR_GOOD | Input/ Output | VDDQ | Power Good Indicator | VIN_BULK | Supply | | External Power Supply |
| HSCL | Input | VOUT | Host Sideband Bus Clock | PWR_EN | Input | | PMIC Enable |
| HSDA | Input/ Output | VOUT | Host Sideband Bus Data | VSS | Supply | | Ground |
| HSA | Input | GND | Host Sideband Bus Device ID | RFU | | | Reserved for future use |

4. Function Block Diagram



5. Thermal Characteristics

| Symbol | Parameter | | Rating | Units | Note |
|------------------|-----------------------|------------------------|------------|-------|---------|
| T _c | Operation Temperature | Normal Operating Temp. | -40 to 85 | °C | 1,2,3 |
| | | Extended Temp. | 85 to 95 | °C | 1,2,3,4 |
| T _{STG} | Storage Temperature | | -55 to 100 | °C | 5 |

Note:

1. Maximum operating case temperature; T_c is measured in the center of the package.
2. A thermal solution must be designed to ensure the DRAM device does not exceed the maximum T_c during operation.
3. Device functionality is not guaranteed if the DRAM device exceeds the maximum T_c during operation.
4. If T_c exceeds 85°C, the DRAM must be refreshed externally at 2X refresh, which is a 1.95μs interval refresh rate.
5. Storage temperature is defined as the temperature of the top/center of the DRAM and does not reflect the storage temperatures of shipping trays.

6. IDD, IDDQ and IPP Specifications

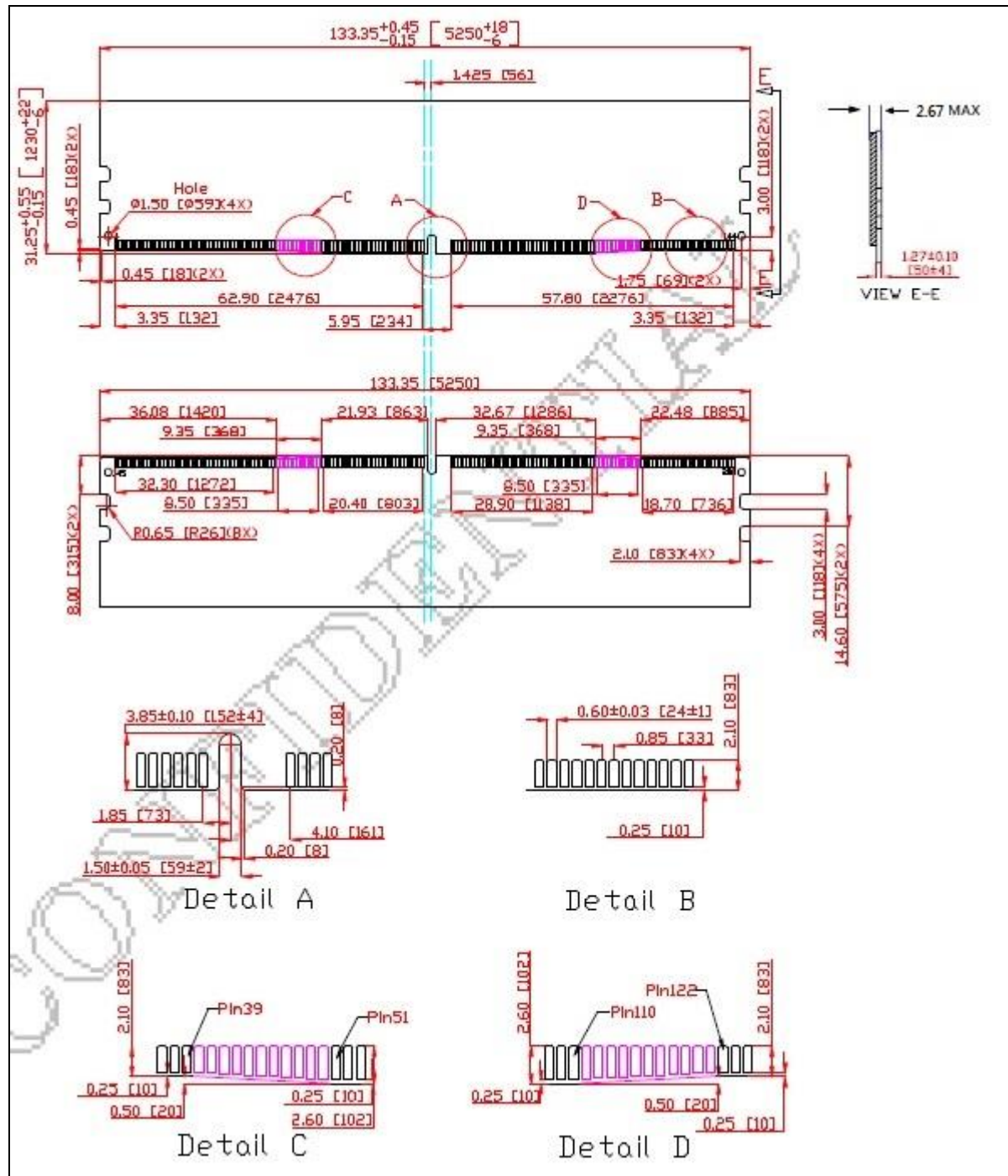
| Symbol | Description | Value | | Units |
|--------|--|----------|----------|-------|
| | | IDD Max. | IPP Max. | |
| IDD0 | Operating One Bank Active-Precharge Current | 460 | 180 | mA |
| IDD0F | Operating Four Bank Active-Precharge Current | 840 | 280 | mA |
| IDD2N | Precharge Standby Current | 280 | 140 | mA |
| IDD2P | Precharge Power-Down Current | 660 | 140 | mA |
| IDD3N | Active Standby Current | 570 | 160 | mA |
| IDD3P | Active Power-Down Current | 330 | 160 | mA |
| IDD4R | Operating Burst Read Current | 1940 | 210 | mA |
| IDD4W | Operating Burst Write Current | 2200 | 180 | mA |
| IDD5B | Burst Refresh Current (Normal Refresh Mode) | 2570 | 810 | mA |
| IDD5C | Burst Refresh Current (Same Bank Refresh Mode) | 990 | 360 | mA |
| IDD6N | Self Refresh Current: Normal Temperature Range | 640 | 270 | mA |
| IDD6E | Self Refresh Current: Extended Temperature Range | 940 | 350 | mA |
| IDD7 | Operating Bank Interleave Read Current | 3140 | 730 | mA |
| IDD8 | Maximum Power Saving Deep Power Down Current | 200 | 140 | mA |

7. Timing Parameters

| Parameter | Symbol | 5600 | | 6000 | | 6400 | | Unit |
|---|------------|-------------------------|-----|-------------------------|-----|-------------------------|-----|------|
| | | Min | Max | Min | Max | Min | Max | |
| Clock Timing | | | | | | | | |
| Average clock period | tCK,AVG | 0.357 | | 0.333 | | 0.312 | | ns |
| Command and Address Timing | | | | | | | | |
| Read to Read command delay for same bank group | tCCD_L | 8nCK,5ns (MAX) | | 8nCK,5ns (MAX) | | 8nCK,5ns (MAX) | | nCK |
| WRITE to WRITE command delay for same bank group | tCCD_L_WR | 32nCK, 20ns (MAX) | | 32nCK, 20ns (MAX) | | 32nCK, 20ns (MAX) | | nCK |
| WRITE to WRITE command delay for same bank group, second WRITE not RMW | tCCD_L_WR2 | 16nCK, 10ns (MAX) | | 16nCK, 10ns (MAX) | | 16nCK, 10ns (MAX) | | nCK |
| Read to Read or Write to Write command delay for different bank group for BL16, BC8 OTF | tCCD_S | 8 | | 8 | | 8 | | nCK |
| ACTIVATE to ACTIVATE command delay to different bank group for 2KB page size | tRRD_S,2K | 8 | | 8 | | 8 | | nCK |
| ACTIVATE to ACTIVATE command delay to different bank group for 1KB page size | tRRD_S,1K | 8 | | 8 | | 8 | | nCK |
| ACTIVATE to ACTIVATE command delay to same bank group for 2KB page size | tRRD_L,2K | 8nCK,5ns (MAX) | | 8nCK,5ns (MAX) | | 8nCK,5ns (MAX) | | nCK |
| ACTIVATE to ACTIVATE command delay to same bank group for 1KB page size | tRRD_L,1K | 8nCK,5ns (MAX) | | 8nCK,5ns (MAX) | | 8nCK,5ns (MAX) | | nCK |
| Four activate window for | tFAW,2K | 40nCK, | | 40nCK, | | 40nCK, | | ns |

| | | | | | | | | |
|---|---------|-----------------------------|--|-----------------------------|--|-----------------------------|--|-----|
| 2KB page size | | 14.280ns (MAX) | | 13.333ns (MAX) | | 12.500ns (MAX) | | |
| Four activate window for 1KB page size | tFAW,1K | 32nCK, 11.428ns (MAX) | | 32nCK, 10.666ns (MAX) | | 32nCK, 10.000ns (MAX) | | ns |
| Delay from start of internal WRITE transaction to internal READ command for different bank group | tWTR_S | 2.5 | | 2.5 | | 2.5 | | ns |
| Delay from start of internal WRITE transaction to internal READ command for same bank group | tWTR_L | 10 | | 10 | | 10 | | ns |
| Delay from start of internal WRITE transaction to internal READ with AUTO PRECHARGE command for same bank | tWTRA | tWR-tRTP | | tWR-tRTP | | tWR-tRTP | | ns |
| Internal READ command to PRECHARGE command delay | tRTP | 7.5 | | 7.5 | | 7.5 | | ns |
| PRECHARGE to PRECHARGE delay | tPPD | 2 | | 2 | | 2 | | nCK |
| WRITE recovery time | tWR | 30 | | 30 | | 30 | | ns |

8. Module Dimensions



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

9. RoHS Declaration

| | | |
|---|---|----------|
| innodisk | 宜鼎國際股份有限公司 Innodisk Corporation | Page 1/2 |
| 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 7(a)、7(c)-I、6(c) 允許豁免。 We declare, our products permitted by the following exemptions specified in the Annex of the RoHS directive. | | |
| ※ 7(a) Lead in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead). | | |
| ※ 7(c)-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. | | |
| ※ 6(c) Copper alloy containing up to 4% lead by weight. (This exemption applies to products that use antennas) | | |
| 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 | |




宜鼎國際股份有限公司
Innodisk Corporation

| | |
|------------------|------------|
| 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 Ohira 簡川勝Company Representative Title 公司代表人職稱： Chairman 董事長Date 日期： 2021 / 06 / 09

10. REACH Declaration

| | |
|--|--|
|  | <p style="text-align: center;">宜鼎國際股份有限公司 Innodisk Corporation REACH Declaration</p> |
| <p style="text-align: right;">Tel:(02)7703-3000 Fax:(02) 7703-3555 Internet: https://www.innodisk.com/</p> | |
| <p>Innodisk Corporation pursues its social responsibility for global environmental preservation by committing to be compliant with REACH regulation (REGULATION (EC) No 1907/2006).</p> | |
| <p>We hereby confirm that the product(s),</p> | |
| <p>Scope: Flash Memory, DRAM Module and Embedded Peripherals Products.</p> | |
| <p>■ The standard products of not listed in the <u>Appendix2</u> meet the requirements of REACH SVHC regulations(SVHCs < 0.1% in Article), as described in the candidate list table currently including 224 substances and shown on the ECHA website. (http://echa.europa.eu/de/candidate-list-table).</p> | |
| <p>■ The standard products listed in the <u>Appendix2</u> 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).</p> | |
| <p>■ Comply with REACH Annex XVII.</p> | |
| <p>Guarantor</p> | |
| <p>Company name 公司名稱： <u>Innodisk Corporation 宜鼎國際股份有限公司</u></p> | |
| <p>Company Representative 公司代表人： <u> 陳怡全</u></p> | |
| <p>Company Representative Title 公司代表人職稱： <u>QA Manager 品保經理</u></p> | |
| <p>Date 日期： <u>2022 / 06 / 14</u></p> | |
|  | |

Revision Log

| Rev | Date | Modification |
|-----|--------------------------------|---------------------|
| 0.1 | 24 th November 2023 | Preliminary Edition |
| 1.0 | 24 th November 2023 | Official Released |