

# Approval Sheet

|                       |                             |
|-----------------------|-----------------------------|
| Customer              |                             |
| Product Number        | M5CZ-GGHZMC0Q-M             |
| Data Rate             | 5600 MT/s                   |
| Pin                   | 288 pin                     |
| Cl-tRCD-tRP           | 46-45-45                    |
| Operating temperature | Tc=0 to 95°C                |
| Date                  | 20 <sup>th</sup> March 2025 |

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 0°C ≤Tcase < 85°C, tREFI 1.95us for 85°C < Tcase ≤ 95°C
- On-Die ECC
- PMIC on DIMM, nominal supply 5V/2A, 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 |
|---------|-----------|------------------|-------------------|--------------|----------------|------|-----|
| 48GB    | 5600 MT/s | 3Gx8 (24Gb)      | 6Gx72             | 20           | 2              | 2    | Y   |

### Key timing parameters

| tCK<br>(ns) | tRCD<br>(ns) | tRP<br>(ns) | tRAS<br>(ns) | tRC<br>(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  | 410  | 410  | ns   |
| tRFC2,min  | 130              | 160  | 220  | 220  | ns   |
| tRFCsb,min | 115              | 130  | 190  | 190  | ns   |

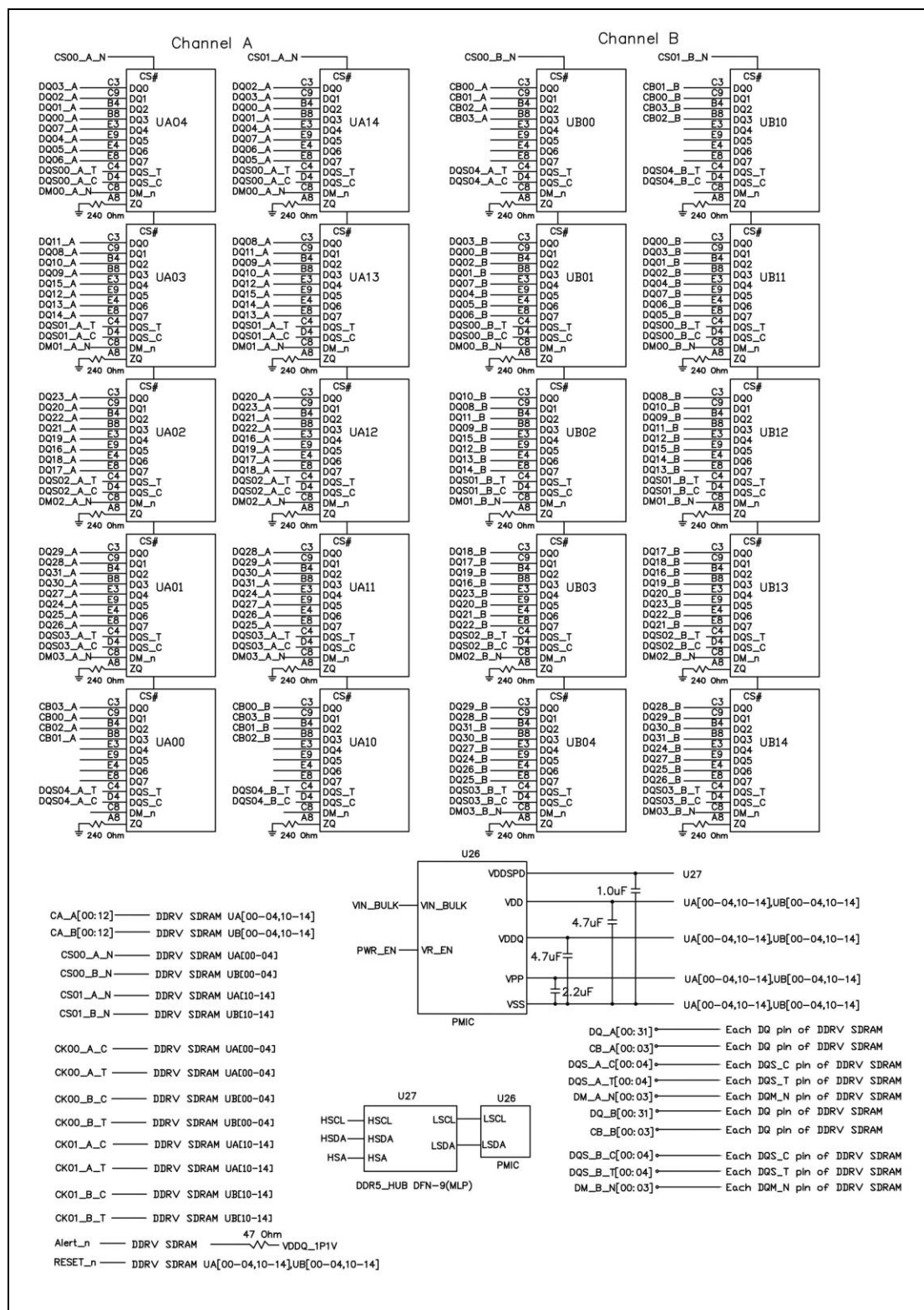
## 2. Pin Assignments

| 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<br>DQ[31:0]_B     | Input/<br>Output | VDDQ      | Data Input/Output           |
| CA[12:0]_A<br>CA[12:0]_B | Input            | VDDQ      | Command/Address Inputs        | CB[3:0]_A<br>CB[3:0]_B       | Input/<br>Output | VDDQ      | ECC Check Bits Input/Output |
| CS[1:0]_A<br>CS[1:0]_B   | Input            | VDDQ      | Chip Select                   | DQS[4:0]_A_t<br>DQS[4:0]_B_t | Input/<br>Output | VDDQ      | Data Strobe                 |
| ALERT_n                  | Output           | VDDQ      | Alert                         | DQS[4:0]_A_c<br>DQS[4:0]_B_c | Input/<br>Output | VDDQ      | Data Strobe                 |
| RESET_n                  | CMOS<br>Input    | VDDQ      | Active Low Asynchronous Reset | DM[3:0]_A_n<br>DM[3:0]_B_n   | Input            | VDDQ      | Input Data Mask             |
| PWR_GOOD                 | Input/<br>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/<br>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 <sub>C</sub>   | Operation Temperature | Normal Operating Temp. | 0 to 85    | °C    | 1,2,3   |
|                  |                       | Extended Temp.         | 85 to 95   | °C    | 1,2,3,4 |
| T <sub>STG</sub> | Storage Temperature   |                        | -55 to 100 | °C    | 5       |

**Note:**

- Maximum operating case temperature; T<sub>C</sub> is measured in the center of the package.
- A thermal solution must be designed to ensure the DRAM device does not exceed the maximum T<sub>C</sub> during operation.
- Device functionality is not guaranteed if the DRAM device exceeds the maximum T<sub>C</sub> during operation.
- If T<sub>C</sub> exceeds 85°C, the DRAM must be refreshed externally at 2X refresh, which is a 1.95μs interval refresh rate.
- 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    | 1440     | 150      | mA    |
| IDD0F  | Operating Four Bank Active-Precharge Current   | 1800     | 230      | mA    |
| IDD2N  | Precharge Standby Current                      | 1300     | 120      | mA    |
| IDD2P  | Precharge Power-Down Current                   | 1120     | 100      | mA    |
| IDD3N  | Active Standby Current                         | 2400     | 300      | mA    |
| IDD3P  | Active Power-Down Current                      | 2240     | 280      | mA    |
| IDD4R  | Operating Burst Read Current                   | 3520     | 240      | mA    |
| IDD4W  | Operating Burst Write Current                  | 3700     | 270      | mA    |
| IDD5B  | Burst Refresh Current (Normal Refresh Mode)    | 3380     | 560      | mA    |
| IDD5C  | Burst Refresh Current (Same Bank Refresh Mode) | 1910     | 230      | mA    |
| IDD6N  | Self Refresh Current: Normal Temperature Range | 1580     | 260      | mA    |
| IDD7   | Operating Bank Interleave Read Current         | 4110     | 590      | mA    |
| IDD8   | Maximum Power Saving Deep Power Down Current   | 840      | 100      | mA    |

The above information may be change due to the update of the device specifications and is for reference only.

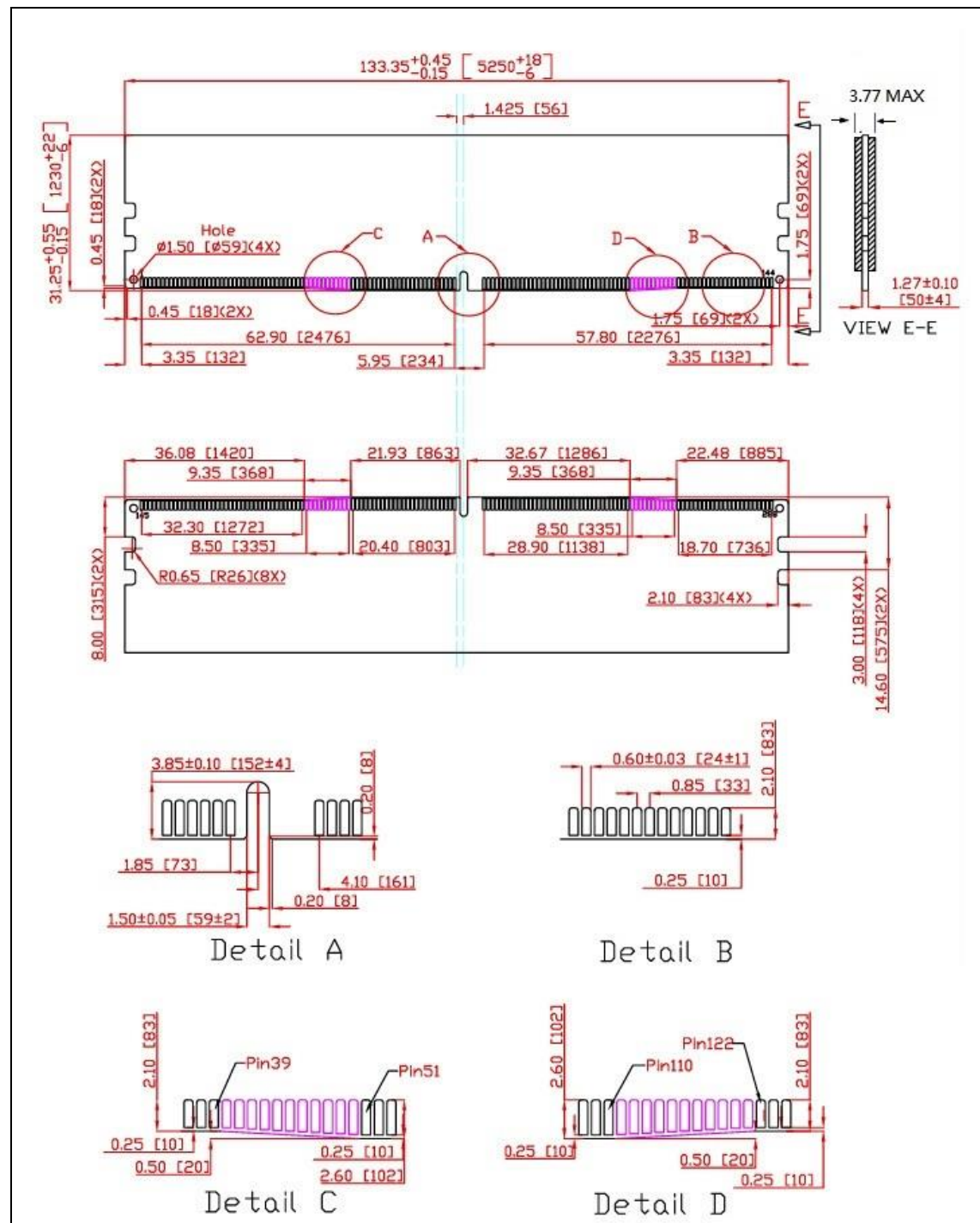
## 7. Timing Parameters

| Parameter                                                                               | Symbol     | 5600                        |     | Unit |
|-----------------------------------------------------------------------------------------|------------|-----------------------------|-----|------|
|                                                                                         |            | Min                         | Max |      |
| Average clock period                                                                    | tCK_AVG    | 0.357                       |     | ns   |
| Read to Read command delay for same bank group                                          | tCCD_L     | 8nCK,5ns<br>(MAX)           |     | nCK  |
| WRITE to WRITE command delay for same bank group                                        | tCCD_L_WR  | 32nCK,<br>20ns<br>(MAX)     |     | nCK  |
| WRITE to WRITE command delay for same bank group, second WRITE not RMW                  | tCCD_L_WR2 | 16nCK,<br>10ns<br>(MAX)     |     | nCK  |
| Read to Read or Write to Write command delay for different bank group for BL16, BC8 OTF | tCCD_S     | 8                           |     | nCK  |
| ACTIVATE to ACTIVATE command delay to different bank group for 2KB page size            | tRRD_S,2K  | 8                           |     | nCK  |
| ACTIVATE to ACTIVATE command delay to different bank group for 1KB page size            | tRRD_S,1K  | 8                           |     | nCK  |
| ACTIVATE to ACTIVATE command delay to same bank group for 2KB page size                 | tRRD_L,2K  | 8nCK,5ns<br>(MAX)           |     | nCK  |
| ACTIVATE to ACTIVATE command delay to same bank group for 1KB page size                 | tRRD_L,1K  | 8nCK,5ns<br>(MAX)           |     | nCK  |
| Four activate window for 2KB page size                                                  | tFAW,2K    | 40nCK,<br>14.280ns<br>(MAX) |     | ns   |



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

## 8. Module Dimensions



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

## 9. RoHS Declaration

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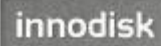
Tel: (02) 7703-3000 Internet: <https://www.innodisk.com/>

## 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 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                  |
| 鄰苯二甲酸二異丁酯 (DIBP)            | < 1000 ppm                  |



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Innodisk Corporation

立 保 證 書 人 (Guarantor)

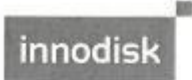
Company name 公司名稱： Innodisk Corporation 宜鼎國際股份有限公司

Company Representative 公司代表人： 簡川勝

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

Date 日期： 2023 / 06 / 14

## 10. REACH Declaration

|                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>宜鼎國際股份有限公司<br/>Innodisk Corporation<br/>REACH Declaration</p> <p>Tel:(02)7703-3000 Fax:(02) 7703-3555 Internet: <a href="https://www.innodisk.com/">https://www.innodisk.com/</a></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). We hereby confirm that the product(s),</p> <p><b>Scope: Flash Memory, DRAM Module and Embedded Peripherals Products.</b></p> <p>■ The standard products of <b>not listed in the <u>Appendix2</u></b> meet the requirements of REACH SVHC regulations(SVHCs &lt; 0.1% in Article), as described in the candidate list table currently including 240 substances (release date: 23-JAN-2024) and shown on the ECHA website. <a href="https://echa.europa.eu/candidate-list-table">https://echa.europa.eu/candidate-list-table</a></p> <p>■ The standard products listed in the <b><u>Appendix2</u></b> contain(s) one or more hazardous substances or constituents exceeding 0.1 % by weight in article if not otherwise specified in candidate list table.</p> <p>Where the threshold value is exceeded, the substances in question are to be declared in accompanying. (SVHCs &gt; 0.1% in Article).</p> <p>■ Comply with REACH Annex XVII.</p> <p><b>Guarantor</b></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> Yichuan Chen 陳怡全</u></p> <p>Company Representative Title 公司代表人職稱: <u>Quality Assurance Div. SR. Manager 品質處經理</u></p> <p>Date 日期: <u>2024 / 02 / 19</u></p> |
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## Revision Log

| Rev | Date                        | Modification        |
|-----|-----------------------------|---------------------|
| 0.1 | 20 <sup>th</sup> March 2025 | Preliminary Edition |
| 1.0 | 20 <sup>th</sup> March 2025 | Official Released   |