

# Approval Sheet

|                       |                              |
|-----------------------|------------------------------|
| Customer              |                              |
| Product Number        | M5R0-AGM2ACVP                |
| Data Rate             | 4800 MT/s                    |
| Pin                   | 288 pin                      |
| CI-tRCD-tRP           | 40-39-39                     |
| Operating temperature | Tc=0 to 95°C                 |
| Date                  | 7 <sup>th</sup> January 2022 |

Rev 1.1

## 1. Features

- JEDEC Standard 288-pin Registered 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
- 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 12V, VIN\_Bulk input supply range: 4.25 V to 15 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    | 4800 MT/s | 2Gx8 (16Gb)      | 2Gx80             | 10           | 1              | 2    | Y   |

### Key timing parameters

| tCK<br>(ns) | tRCD<br>(ns) | tRP<br>(ns) | tRAS<br>(ns) | tRC<br>(ns) |
|-------------|--------------|-------------|--------------|-------------|
| 0.416       | 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   |

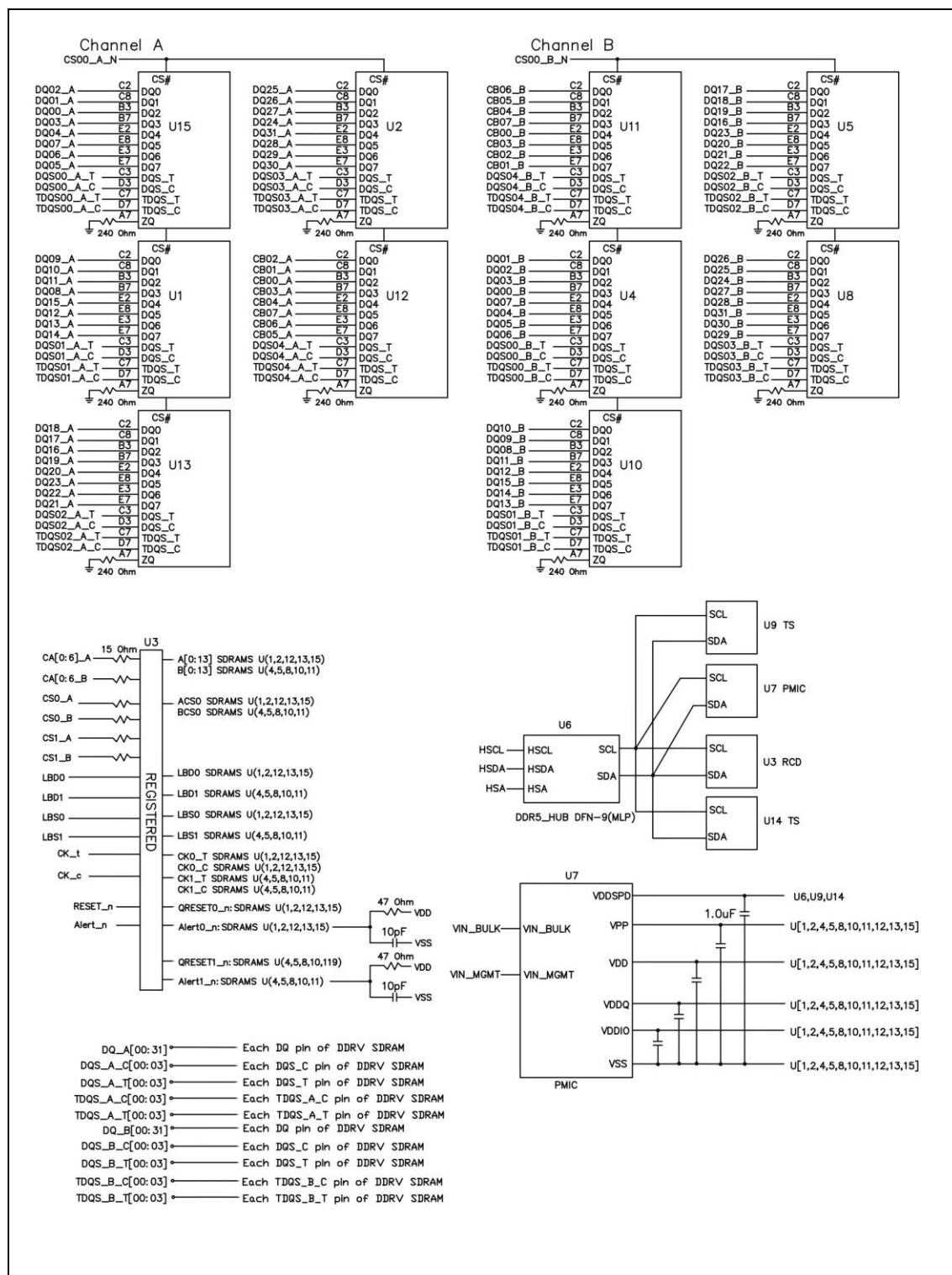
## 2. Pin Assignments

| 288-Pin DDR5 RDIMM Front |          |     |          |     |                              |     |          | 288-Pin DDR5 RDIMM Back |                                          |     |                     |     |                     |     |                     |
|--------------------------|----------|-----|----------|-----|------------------------------|-----|----------|-------------------------|------------------------------------------|-----|---------------------|-----|---------------------|-----|---------------------|
| Pin                      | Symbol   | Pin | Symbol   | Pin | Symbol                       | Pin | Symbol   | Pin                     | Symbol                                   | Pin | Symbol              | Pin | Symbol              | Pin | Symbol              |
| 1                        | VIN_BULK | 37  | Vss      | 73  | Vss                          | 109 | DQ5_B    | 145                     | VIN_BULK                                 | 181 | DQ22_A              | 217 | CK_t                | 253 | Vss                 |
| 2                        | RFU      | 38  | DQ21_A   | 74  | PAR_A                        | 110 | Vss      | 146                     | VIN_BULK                                 | 182 | Vss                 | 218 | CK_c                | 254 | DQ7_B               |
| 3                        | VIN_MGMT | 39  | Vss      | 75  | Vss                          | 111 | DQ8_B    | 147                     | PWR_GOOD_FAULT_n                         | 183 | DQ23_A              | 219 | Vss                 | 255 | Vss                 |
| 4                        | SCL      | 40  | DQ24_A   | 76  | CA0_B                        | 112 | Vss      | 148                     | SAA                                      | 184 | Vss                 | 220 | RFU                 | 256 | DQ10_B              |
| 5                        | SDA      | 41  | Vss      | 77  | Vss                          | 113 | DQ9_B    | 149                     | RFU                                      | 185 | DQ26_A              | 221 | CA1_B               | 257 | Vss                 |
| 6                        | Vss      | 42  | DQ25_A   | 78  | CA2_B                        | 114 | Vss      | 150                     | RFU                                      | 186 | Vss                 | 222 | Vss                 | 258 | DQ11_B              |
| 7                        | DQ0_A    | 43  | Vss      | 79  | Vss                          | 115 | DQS1_B_t | 151                     | Vss                                      | 187 | DQ27_A              | 223 | CA3_B               | 259 | Vss                 |
| 8                        | Vss      | 44  | DQS3_A_t | 80  | CA4_B                        | 116 | DQS1_B_c | 152                     | DQ2_A                                    | 188 | Vss                 | 224 | Vss                 | 260 | DQS6_B_c, TDQS6_B_c |
| 9                        | DQ1_A    | 45  | DQS3_A_c | 81  | Vss                          | 117 | Vss      | 153                     | Vss                                      | 189 | DQS8_A_c, TDQS8_A_c | 225 | CA5_B               | 261 | DQS6_B_t, TDQS6_B_t |
| 10                       | Vss      | 46  | Vss      | 82  | CA6_B                        | 118 | DQ12_B   | 154                     | DQ3_A                                    | 190 | DQS8_A_t, TDQS8_A_t | 226 | Vss                 | 262 | Vss                 |
| 11                       | DQS0_A_t | 47  | DQ28_A   | 83  | Vss                          | 119 | Vss      | 155                     | Vss                                      | 191 | Vss                 | 227 | PAR_B               | 263 | DQ14_B              |
| 12                       | DQS0_A_c | 48  | Vss      | 84  | CS0_B_n                      | 120 | DQ13_B   | 156                     | DQS5_A_c, TDQS5_A_c, DQS5_A_t, TDQS5_A_t | 192 | DQ30_A              | 228 | Vss                 | 264 | Vss                 |
| 13                       | Vss      | 49  | DQ29_A   | 85  | Vss                          | 121 | Vss      | 157                     | DQS5_A_t, TDQS5_A_t                      | 193 | Vss                 | 229 | CS1_B_n             | 265 | DQ15_B              |
| 14                       | DQ4_A    | 50  | Vss      | 86  | LBDRSP_A_n                   | 122 | DQ16_B   | 158                     | Vss                                      | 194 | DQ31_A              | 230 | Vss                 | 266 | Vss                 |
| 15                       | Vss      | 51  | CB0_A    | 87  | LBDRSP_B_n                   | 123 | Vss      | 159                     | DQ6_A                                    | 195 | Vss                 | 231 | RFU                 | 267 | DQ18_B              |
| 16                       | DQ5_A    | 52  | Vss      | 88  | Vss                          | 124 | DQ17_B   | 160                     | Vss                                      | 196 | CB2_A               | 232 | RFU                 | 268 | Vss                 |
| 17                       | Vss      | 53  | CB1_A    | 89  | CB4_B                        | 125 | Vss      | 161                     | DQ7_A                                    | 197 | Vss                 | 233 | Vss                 | 269 | DQ19_B              |
| 18                       | DQ8_A    | 54  | Vss      | 90  | Vss                          | 126 | DQS2_B_t | 162                     | Vss                                      | 198 | CB3_A               | 234 | CB6_B               | 270 | Vss                 |
| 19                       | Vss      | 55  | DQS4_A_t | 91  | CB5_B                        | 127 | DQS2_B_c | 163                     | DQ10_A                                   | 199 | Vss                 | 235 | Vss                 | 271 | DQS7_B_c, TDQS7_B_c |
| 20                       | DQ9_A    | 56  | DQS4_A_c | 92  | Vss                          | 128 | Vss      | 164                     | Vss                                      | 200 | DQS9_A_c, TDQS9_A_c | 236 | CB7_B               | 272 | DQS7_B_t, TDQS7_B_t |
| 21                       | Vss      | 57  | Vss      | 93  | DQS9_B_t, TDQS9_B_t, DBW_B_n | 129 | DQ20_B   | 165                     | DQ11_A                                   | 201 | DQS9_A_t, TDQS9_A_t | 237 | Vss                 | 273 | Vss                 |
| 22                       | DQS1_A_t | 58  | CB4_A    | 94  | DQS9_B_c, TDQS9_B_c          | 130 | Vss      | 166                     | Vss                                      | 202 | Vss                 | 238 | DQS4_B_c            | 274 | DQ22_B              |
| 23                       | DQS1_A_c | 59  | Vss      | 95  | Vss                          | 131 | DQ21_B   | 167                     | DQS6_A_c, TDQS6_A_c, DQS6_A_t, TDQS6_A_t | 203 | CB6_A               | 239 | DQS4_B_t            | 275 | Vss                 |
| 24                       | Vss      | 60  | CB5_A    | 96  | CB0_B                        | 132 | Vss      | 168                     | DQS6_A_t, TDQS6_A_t                      | 204 | Vss                 | 240 | Vss                 | 276 | DQ23_B              |
| 25                       | DQ12_A   | 61  | Vss      | 97  | Vss                          | 133 | DQ24_B   | 169                     | Vss                                      | 205 | CB7_A               | 241 | CB2_B               | 277 | Vss                 |
| 26                       | Vss      | 62  | ALERT_n  | 98  | CB1_B                        | 134 | Vss      | 170                     | DQ14_A                                   | 206 | Vss                 | 242 | Vss                 | 278 | DQ26_B              |
| 27                       | DQ13_A   | 63  | Vss      | 99  | Vss                          | 135 | DQ25_B   | 171                     | Vss                                      | 207 | RESET_n             | 243 | CB3_B               | 279 | Vss                 |
| 28                       | Vss      | 64  | CS0_A_n  | 100 | DQ0_B                        | 136 | Vss      | 172                     | DQ15_A                                   | 208 | Vss                 | 244 | Vss                 | 280 | DQ27_B              |
| 29                       | DQ16_A   | 65  | Vss      | 101 | Vss                          | 137 | DQS3_B_t | 173                     | Vss                                      | 209 | CS1_A_n             | 245 | DQ2_B               | 281 | Vss                 |
| 30                       | Vss      | 66  | CA0_A    | 102 | DQ1_B                        | 138 | DQS3_B_c | 174                     | DQ18_A                                   | 210 | Vss                 | 246 | Vss                 | 282 | DQS8_B_c, TDQS8_B_c |
| 31                       | DQ17_A   | 67  | Vss      | 103 | Vss                          | 139 | Vss      | 175                     | Vss                                      | 211 | CA1_A               | 247 | DQ3_B               | 283 | DQS8_B_t, TDQS8_B_t |
| 32                       | Vss      | 68  | CA2_A    | 104 | DQS0_B_t                     | 140 | DQ28_B   | 176                     | DQ19_A                                   | 212 | Vss                 | 248 | Vss                 | 284 | Vss                 |
| 33                       | DQS2_A_t | 69  | Vss      | 105 | DQS0_B_c                     | 141 | Vss      | 177                     | Vss                                      | 213 | CA3_A               | 249 | DQS5_B_c, TDQS5_B_c | 285 | DQ30_B              |
| 34                       | DQS2_A_c | 70  | CA4_A    | 106 | Vss                          | 142 | DQ29_B   | 178                     | DQS7_A_c, TDQS7_A_c                      | 214 | Vss                 | 250 | DQS5_B_t, TDQS5_B_t | 286 | Vss                 |
| 35                       | Vss      | 71  | Vss      | 107 | DQ4_B                        | 143 | Vss      | 179                     | DQS7_A_t, TDQS7_A_t                      | 215 | CA5_A               | 251 | Vss                 | 287 | DQ31_B              |
| 36                       | DQ20_A   | 72  | CA6_A    | 108 | Vss                          | 144 | RFU      | 180                     | Vss                                      | 216 | Vss                 | 252 | DQ6_B               | 288 | Vss                 |

### 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[6:0]_A<br>CA[6:0]_B     | Input            | VDDQ      | Command/Address Inputs           | CB[7:0]_A<br>CB[7:0]_B         | Input/<br>Output | VDDQ      | ECC Check Bits Input/Output |
| CS[1:0]_A<br>CS[1:0]_B     | Input            | VDDQ      | Chip Select                      | DQS[9:0]_A_t<br>DQS[9:0]_B_t   | Input/<br>Output | VDDQ      | Data Strobe                 |
| PAR_A<br>PAR_B             | Input            | VDDQ      | Command and Address Parity Input | DQS[9:0]_A_c<br>DQS[9:0]_B_c   | Input/<br>Output | VDDQ      | Data Strobe                 |
| ALERT_n                    | Output           | VDDQ      | Alert                            | TDQS[9:0]_A_t<br>TDQS[9:0]_B_t | Input/<br>Output | VDDQ      | Termination Data Strobe     |
| RESET_n                    | CMOS<br>Input    | VDDQ      | Active Low Asynchronous Reset    | TDQS[9:0]_A_c<br>TDQS[9:0]_B_c | Input/<br>Output | VDDQ      | Termination Data Strobe     |
| PWR_GOOD/FAI<br>L_n        | Input/<br>Output | VDDQ      | Power Good Indicator             | VIN_BULK                       | Supply           |           | External Power Supply       |
| DM[3:0]_A_n<br>DM[3:0]_B_n | Input            | VDDQ      | Input Data Mask                  | VIN_MGMT                       | Supply           |           | External Power Supply       |
| HSCL                       | Input            | VOUT      | Host Sideband Bus Clock          | LBD<br>RSP_A_n                 | Output           | VDDQ      | Loopback data output        |
| HSDA                       | Input/Output     | VOUT      | Host Sideband Bus Data           | LBS                            | Output           | VDDQ      | Loopback data strobe output |
| HSA                        | Input            | GND       | Host Sideband Bus Device ID      | VSS                            | Supply           |           | Ground                      |
| 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    | 1030     | 80       | mA    |
| IDD0F  | Operating Four Bank Active-Precharge Current   | 1420     | 100      | mA    |
| IDD2N  | Precharge Standby Current                      | 920      | 60       | mA    |
| IDD2P  | Precharge Power-Down Current                   | 880      | 60       | mA    |
| IDD3N  | Active Standby Current                         | 1420     | 70       | mA    |
| IDD3P  | Active Power-Down Current                      | 1420     | 70       | mA    |
| IDD4R  | Operating Burst Read Current                   | 3770     | 90       | mA    |
| IDD4W  | Operating Burst Write Current                  | 3490     | 370      | mA    |
| IDD5B  | Burst Refresh Current (Normal Refresh Mode)    | 2770     | 280      | mA    |
| IDD5C  | Burst Refresh Current (Same Bank Refresh Mode) | 1350     | 120      | mA    |
| IDD6N  | Self Refresh Current: Normal Temperature Range | 1020     | 150      | mA    |
| IDD7   | Operating Bank Interleave Read Current         | 5020     | 230      | mA    |
| IDD8   | Maximum Power Saving Deep Power Down Current   | 800      | 60       | 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     | 4400                    |        | 4800                    |        | 5200                    |        | Unit |
|-----------------------------------------------------------------------------------------|------------|-------------------------|--------|-------------------------|--------|-------------------------|--------|------|
|                                                                                         |            | Min                     | Max    | Min                     | Max    | Min                     | Max    |      |
| Clock Timing                                                                            |            |                         |        |                         |        |                         |        |      |
| Average clock period                                                                    | tCK,AVG    | 0.454                   | <0.500 | 0.416                   | <0.454 | 0.384                   | <0.416 | ns   |
| Command and Address Timing                                                              |            |                         |        |                         |        |                         |        |      |
| Read to Read command delay for same bank group                                          | tCCD_L     | 8nCK,5ns<br>(MAX)       |        | 8nCK,5ns<br>(MAX)       |        | 8nCK,5ns<br>(MAX)       |        | nCK  |
| WRITE to WRITE command delay for same bank group                                        | tCCD_L_WR  | 32nCK,<br>20ns<br>(MAX) |        | 32nCK,<br>20ns<br>(MAX) |        | 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) |        | 16nCK,<br>10ns<br>(MAX) |        | 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                       |        | 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<br>(MAX)       |        | 8nCK,5ns<br>(MAX)       |        | 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)       |        | 8nCK,5ns<br>(MAX)       |        | 8nCK,5ns<br>(MAX)       |        | nCK  |
| Four activate window for                                                                | tFAW,2K    | 40nCK,                  |        | 40nCK,                  |        | 40nCK,                  |        | ns   |



|                                                                                                                       |         |                             |  |                             |  |                             |  |     |
|-----------------------------------------------------------------------------------------------------------------------|---------|-----------------------------|--|-----------------------------|--|-----------------------------|--|-----|
| 2KB page size                                                                                                         |         | 18.160ns<br>(MAX)           |  | 16.640ns<br>(MAX)           |  | 15.360ns<br>(MAX)           |  |     |
| Four activate window for<br>1KB page size                                                                             | tFAW,1K | 32nCK,<br>14.528ns<br>(MAX) |  | 32nCK,<br>13.312ns<br>(MAX) |  | 32nCK,<br>12.288ns<br>(MAX) |  | ns  |
| Delay from start of internal<br>WRITE transaction to<br>internal READ command<br>for different bank group             | tWTR_S  | 4nCK,<br>2.5ns<br>(MAX)     |  | 4nCK,<br>2.5ns<br>(MAX)     |  | 4nCK,<br>2.5ns<br>(MAX)     |  | ns  |
| Delay from start of internal<br>WRITE transaction to<br>internal READ command<br>for same bank group                  | tWTR_L  | 16nCK,<br>10ns<br>(MAX)     |  | 16nCK,<br>10ns<br>(MAX)     |  | 16nCK,<br>10ns<br>(MAX)     |  | 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                    |  | tWR-tRTP                    |  | tWR-tRTP                    |  | ns  |
| Internal READ command<br>to PRECHARGE command<br>delay                                                                | tRTP    | 12nCK,<br>7.5ns<br>(MAX)    |  | 12nCK,<br>7.5ns<br>(MAX)    |  | 12nCK,<br>7.5ns<br>(MAX)    |  | ns  |
| PRECHARGE to PRECHARGE<br>delay                                                                                       | tPPD    | 2                           |  | 2                           |  | 2                           |  | nCK |
| WRITE recovery time                                                                                                   | tWR     | 29.964                      |  | 29.952                      |  | 29.952                      |  | ns  |
| DLL locking time                                                                                                      | tDLLK   | 1280                        |  | 1536                        |  | 1536                        |  | nCK |
| <b>Mode Register Read/Write Timing</b>                                                                                |         |                             |  |                             |  |                             |  |     |
| Mode register READ command<br>period                                                                                  | tMRR    | 14ns,<br>16nCK<br>(MAX)     |  | 14ns,<br>16nCK<br>(MAX)     |  | 14ns,<br>16nCK<br>(MAX)     |  |     |
| Mode register READ pattern<br>to mode register<br>READ pattern command<br>spacing                                     | tMRR_p  | 8                           |  | 8                           |  | 8                           |  | nCK |
| Mode register WRITE command<br>period                                                                                 | tMRW    | 5ns,8nCK<br>(MAX)           |  | 5ns,8nCK<br>(MAX)           |  | 5ns,8nCK<br>(MAX)           |  |     |
| Mode register SET command<br>delay                                                                                    | tMRD    | 14ns,<br>16nCK              |  | 14ns,<br>16nCK              |  | 14ns,<br>16nCK              |  |     |

|                                                                                                                             |                   |                              |                             |                              |                             |                              |                             |     |
|-----------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|-----|
|                                                                                                                             |                   | (MAX)                        |                             | (MAX)                        |                             | (MAX)                        |                             |     |
| DFE mode register WRITE<br>update delay time                                                                                | tDFE              | 80                           |                             | 80                           |                             | 80                           |                             | ns  |
| <b>Data Strobe Timing</b>                                                                                                   |                   |                              |                             |                              |                             |                              |                             |     |
| DQS_t, DQS_c differential<br>READ preamble                                                                                  | tRPRE             | TBD                          |                             | TBD                          |                             | TBD                          |                             | tCK |
| DQS_t, DQS_c differential<br>READ postamble                                                                                 | tRPST             | TBD                          |                             | TBD                          |                             | TBD                          |                             | tCK |
| DQS_t, DQS_c rising edge<br>output timing location<br>from rising CK_t, CK_c                                                | tDQSCK            | -0.286                       | 0.286                       | -0.3                         | 0.3                         | TBD                          | TBD                         | tCK |
| DQS_t, DQS_c rising edge<br>output variance window                                                                          | tDQSKI            |                              | 0.475                       |                              | 0.49                        |                              | TBD                         | tCK |
| <b>Data Strobe Timing</b>                                                                                                   |                   |                              |                             |                              |                             |                              |                             |     |
| 2-tCK WRITE preamble enable<br>window                                                                                       | tWPRE_EN_2<br>tCK | 1.5                          |                             | 1.5                          |                             | 1.5                          |                             | tCK |
| 3-tCK WRITE preamble enable<br>window                                                                                       | tWPRE_EN_3<br>tCK | 2.5                          |                             | 2.5                          |                             | 2.5                          |                             | tCK |
| 4-tCK WRITE preamble enable<br>window                                                                                       | tWPRE_EN_4<br>tCK | 2.5                          |                             | 2.5                          |                             | 2.5                          |                             | tCK |
| DQS_t, DQS_c differential<br>WRITE postamble                                                                                | tWPST             | TBD                          |                             | TBD                          |                             | TBD                          |                             | tCK |
| Final trained value of host<br>DQS_t-DQS_c timing relative<br>to CWL CK_t-CK_c<br>edge                                      | tDQSoffset        | -0.5                         | 0.5                         | -0.5                         | 0.5                         | -0.5                         | 0.5                         | tCK |
| Write leveling setup time                                                                                                   | tWLS              | -80                          | 80                          | -80                          | 80                          | -80                          | 80                          | ps  |
| Write leveling hold time                                                                                                    | tWLH              | -80                          | 80                          | -80                          | 80                          | -80                          | 80                          | ps  |
| Voltage/temperature drift<br>window of first rising<br>DQS_t preamble edge relative<br>to CWL CK_t-CK_c<br>edge (x4/x8/x16) | tDQSD             | -0.25 x<br>tWPRE_E<br>N_ntCK | 0.25 x<br>tWPRE_E<br>N_ntCK | -0.25 x<br>tWPRE_E<br>N_ntCK | 0.25 x<br>tWPRE_E<br>N_ntCK | -0.25 x<br>tWPRE_E<br>N_ntCK | 0.25 x<br>tWPRE_E<br>N_ntCK | tCK |
| Host and system voltage/<br>temperature drift window<br>of first rising DQS_t preamble<br>edge relative to                  | tDQSS             | -0.25 x tWPRE_EN_ntCK        |                             |                              |                             |                              |                             | tCK |

|                                                                    |                  |                         |      |                         |      |                         |      |     |
|--------------------------------------------------------------------|------------------|-------------------------|------|-------------------------|------|-------------------------|------|-----|
| CWL CK_t-CK_c edge<br>(x4/x8/x16)                                  |                  |                         |      |                         |      |                         |      |     |
| <b>MPSM Timing</b>                                                 |                  |                         |      |                         |      |                         |      |     |
| MPSM exit to first valid<br>command delay                          | tMPSMX           | tMRD                    |      | tMRD                    |      | tMRD                    |      | ns  |
| <b>ZQ Calibration Timing</b>                                       |                  |                         |      |                         |      |                         |      |     |
| ZQ calibration time                                                | tZQCAL           | 1                       |      | 1                       |      | 1                       |      | μs  |
| ZQ calibration latch time                                          | tZQLAT           | 30ns,<br>8nCK<br>(MIN)  |      | 30ns,<br>8nCK<br>(MIN)  |      | 30ns,<br>8nCK<br>(MIN)  |      |     |
| <b>Reset Timing</b>                                                |                  |                         |      |                         |      |                         |      |     |
| RESET_n low time for reset<br>initialization with stable<br>power  | tPW_RESET        | 1                       |      | 1                       |      | 1                       |      | μs  |
| Time after RESET_n assertion<br>to ODT off                         | tRST_ADC         |                         | 50   |                         | 50   |                         | 50   | ns  |
| <b>Self Refresh Timing</b>                                         |                  |                         |      |                         |      |                         |      |     |
| Command pass disable delay                                         | tCPDED           | 5ns,8nCK<br>(MAX)       |      | 5ns,8nCK<br>(MAX)       |      | 5ns,8nCK<br>(MAX)       |      |     |
| Self refresh CS_n low pulse<br>width                               | tCSL             | 10                      |      | 10                      |      | 10                      |      | ns  |
| Self refresh exit CS_n high<br>pulse width                         | tCSH_Srexit      | 13                      | 30   | 13                      | 30   | 13                      | 30   | ns  |
| Self refresh exit CS_n low<br>pulse width                          | tCSL_Srexit      | 3nCK                    | 30ns | 3nCK                    | 30ns | 3nCK                    | 30ns |     |
| Self refresh exit CS_n low<br>pulse width with frequency<br>change | tCSL_FreqCh<br>g | VREFCA_<br>time         |      | VREFCA_<br>time         |      | VREFCA_<br>time         |      | ns  |
| Valid clock requirement<br>before SRX                              | tCKSRX           | 3.5ns,<br>8nCK<br>(MAX) |      | 3.5ns,<br>8nCK<br>(MAX) |      | 3.5ns,<br>8nCK<br>(MAX) |      | ns  |
| Valid clock requirement after<br>SRE                               | tCKLCS           | tCPDED +<br>1nCK        |      | tCPDED +<br>1nCK        |      | tCPDED +<br>1nCK        |      | nCK |
| Self refresh exit CS_n HIGH                                        | tCASRX           | 0                       |      | 0                       |      | 0                       |      | ns  |
| Exit self refresh to commands<br>not requiring a                   | tXS              | tRFC1                   |      | tRFC1                   |      | tRFC1                   |      | ns  |

|                                                                           |          |                                                     |                                           |                                                     |                                           |                                                     |                                           |     |
|---------------------------------------------------------------------------|----------|-----------------------------------------------------|-------------------------------------------|-----------------------------------------------------|-------------------------------------------|-----------------------------------------------------|-------------------------------------------|-----|
| locked DLL                                                                |          |                                                     |                                           |                                                     |                                           |                                                     |                                           |     |
| Exit self refresh to commands<br>requiring a locked<br>DLL                | tXS_DLL  | tDLLK                                               |                                           | tDLLK                                               |                                           | tDLLK                                               |                                           | ns  |
| <b>Power-Down Timing</b>                                                  |          |                                                     |                                           |                                                     |                                           |                                                     |                                           |     |
| Command pass disable delay                                                | tCPDED   | 5ns,8nCK<br>(MAX)                                   |                                           | 5ns,8nCK<br>(MAX)                                   |                                           | 5ns,8nCK<br>(MAX)                                   |                                           | ns  |
| Power-down time                                                           | tPD      | 7.5ns,<br>8nCK<br>(MAX)                             | 5*tREFI1<br>(normal)<br>9*tREFI2<br>(FGR) | 7.5ns,<br>8nCK<br>(MAX)                             | 5*tREFI1<br>(normal)<br>9*tREFI2<br>(FGR) | 7.5ns,<br>8nCK<br>(MAX)                             | 5*tREFI1<br>(normal)<br>9*tREFI2<br>(FGR) | ns  |
| Exit power-down to next<br>valid command                                  | tXP      | 7.5ns,<br>8nCK<br>(MAX)                             |                                           | 7.5ns,<br>8nCK<br>(MAX)                             |                                           | 7.5ns,<br>8nCK<br>(MAX)                             |                                           | ns  |
| Timing of ACT command<br>to POWER DOWN ENTRY<br>command                   | tACTPDEN | 2                                                   |                                           | 2                                                   |                                           | 2                                                   |                                           | nCK |
| Timing of PREab, PREsb or<br>PREpb command to POWER<br>DOWN ENTRY command | tPRPDEN  | 2                                                   |                                           | 2                                                   |                                           | 2                                                   |                                           | nCK |
| Timing of READ or READ<br>w/ AP command to POWER<br>DOWN ENTRY command    | tRDPDEN  | CL<br>+RBL/2+1                                      |                                           | CL<br>+RBL/2+1                                      |                                           | CL<br>+RBL/2+1                                      |                                           | nCK |
| Timing of WRITE command<br>to POWER DOWN ENTRY<br>command                 | tWRPDEN  | CWL<br>+WBL/ 2+<br>(tWR/<br>tCK(avg))<br>+1         |                                           | CWL<br>+WBL/ 2+<br>(tWR/<br>tCK(avg))<br>+1         |                                           | CWL<br>+WBL/ 2+<br>(tWR/<br>tCK(avg))<br>+1         |                                           | nCK |
| Timing of WRITE w/ AP<br>command to POWER<br>DOWN ENTRY command           | tWRAPDEN | CWL<br>+WBL/<br>2+-0.25 x<br>tWPRES_EN_n<br>tCKWR+1 |                                           | CWL<br>+WBL/<br>2+-0.25 x<br>tWPRES_EN_n<br>tCKWR+1 |                                           | CWL<br>+WBL/<br>2+-0.25 x<br>tWPRES_EN_n<br>tCKWR+1 |                                           | nCK |
| Timing of REFab or REFSb<br>command to POWER<br>DOWN ENTRY command        | tREFPDEN | 2                                                   |                                           | 2                                                   |                                           | 2                                                   |                                           | nCK |
| Timing of MRR command                                                     | tMRPDEN  | CL+8+1                                              |                                           | CL+8+1                                              |                                           | CL+8+1                                              |                                           | nCK |

|                                                                                  |                      |                                                 |                         |                                                 |                         |               |                         |     |
|----------------------------------------------------------------------------------|----------------------|-------------------------------------------------|-------------------------|-------------------------------------------------|-------------------------|---------------|-------------------------|-----|
| to POWER DOWN ENTRY<br>command                                                   |                      |                                                 |                         |                                                 |                         |               |                         |     |
| Timing of MRW command<br>to POWER DOWN ENTRY<br>command                          | tMRWPDEN             | tMRD<br>(MIN)                                   |                         | tMRD<br>(MIN)                                   |                         | tMRD<br>(MIN) |                         | nCK |
| Timing of MPC command<br>to POWER DOWN ENTRY<br>command                          | tMPCPDEN             | tMPC_delay                                      |                         | tMPC_delay                                      |                         | tMPC_delay    |                         | nCK |
| <b>MPC Command Timing</b>                                                        |                      |                                                 |                         |                                                 |                         |               |                         |     |
| MPC to any other valid<br>command                                                | tMPC_Delay           | tMRD                                            |                         | tMRD                                            |                         | tMRD          |                         | nCK |
| Time between stable MPC<br>command and first falling<br>CS edge (setup)          | tMC_MPC_Setup        | 3                                               |                         | 3                                               |                         | 3             |                         | nCK |
| Time between first rising<br>CS edge and stable MPC<br>command (HOLD)            | tMC_MPC_Hold         | 3                                               |                         | 3                                               |                         | 3             |                         | nCK |
| Time CS_n is held LOW to<br>register MPC command                                 | tMPC_CS              | 3.5                                             | 8                       | 3.5                                             | 8                       | 3.5           | 8                       | nCK |
| <b>PDA Timing</b>                                                                |                      |                                                 |                         |                                                 |                         |               |                         |     |
| PDA ENUMERATE ID command<br>to any other command<br>cycle                        | tPDA_DELAY           | tPDA_DQ<br>S_DELAY<br>(MAX) +<br>BL/2 +<br>19ns |                         | tPDA_DQ<br>S_DELAY<br>(MAX) +<br>BL/2 +<br>19ns |                         | TBD           |                         | ns  |
| Delay to rising strobe edge<br>used for sampling DQ during<br>PDA operation      | tPDA_DQS_DELAY       | 5                                               | 18                      | 5                                               | 18                      | TBD           | TBD                     | ns  |
| DQS setup time during<br>PDA operation                                           | tPDA_S               | 3                                               |                         | 3                                               |                         | TBD           |                         | nCK |
| DQS hold time during PDA<br>operation                                            | tPDA_H               | 3                                               |                         | 3                                               |                         | TBD           |                         | nCK |
| <b>Read Training Timing</b>                                                      |                      |                                                 |                         |                                                 |                         |               |                         |     |
| Registration of MRW continuous<br>burst mode exit to<br>next valid command delay | tCont_Exit_<br>Delay |                                                 | tCont_Exit<br>+<br>tMRW |                                                 | tCont_Exit<br>+<br>tMRW |               | tCont_Exit<br>+<br>tMRW | ns  |
| Registration of MRW continuous                                                   | tCont_Exit           |                                                 | CL+BL/                  |                                                 | CL+BL/                  |               | CL+BL/                  | ns  |

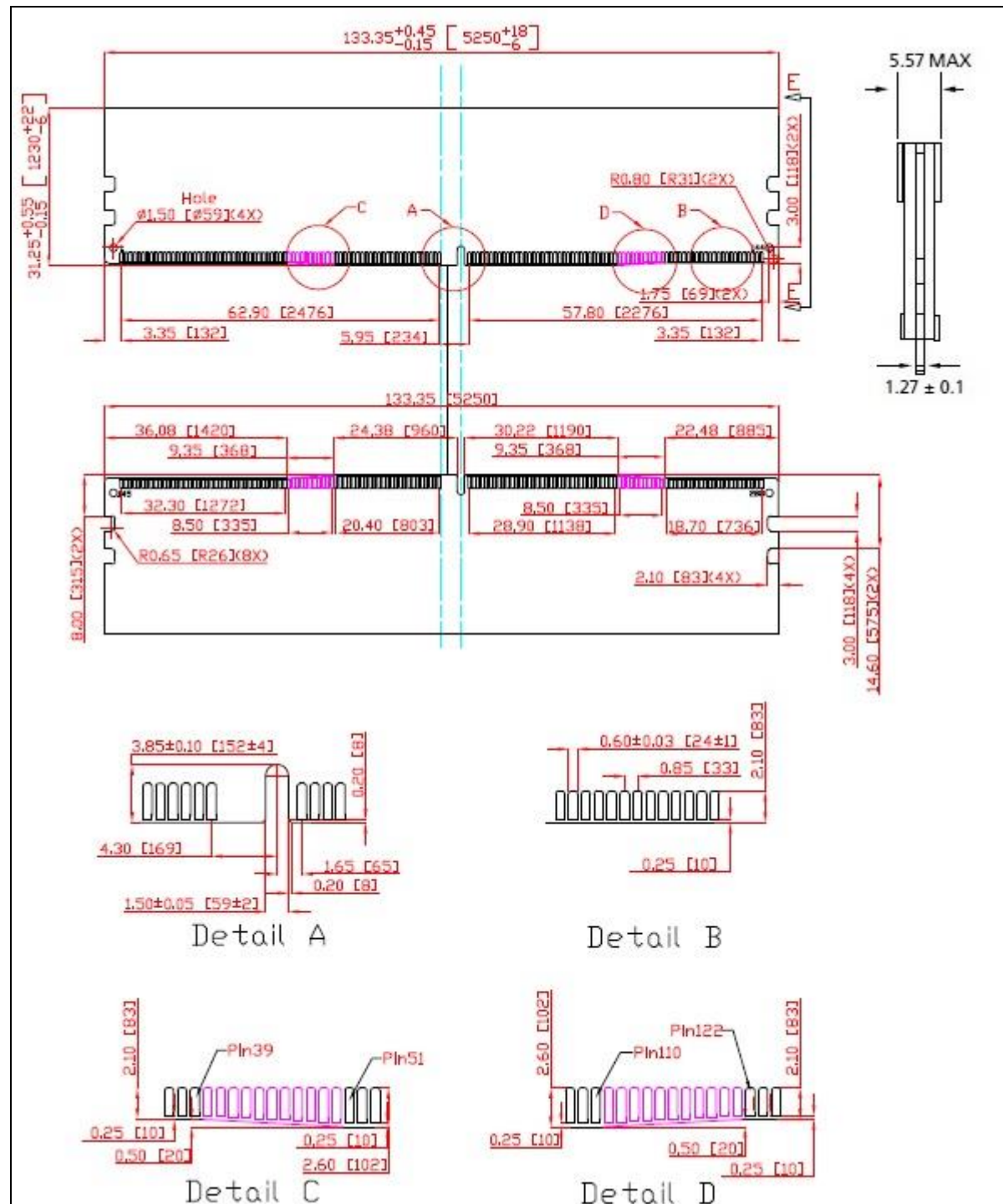
|                                                                                                                           |                           |    |                         |    |                         |    |                         |     |
|---------------------------------------------------------------------------------------------------------------------------|---------------------------|----|-------------------------|----|-------------------------|----|-------------------------|-----|
| burst mode exit to                                                                                                        |                           |    | 2+10nCK                 |    | 2+10nCK                 |    | 2+10nCK                 |     |
| end of training mode                                                                                                      |                           |    |                         |    |                         |    |                         |     |
| <b>Read Preamble Timing</b>                                                                                               |                           |    |                         |    |                         |    |                         |     |
| Delay from MRW command<br>to DQS driven                                                                                   | tSDOn                     |    | 12nCK,<br>20ns<br>(MAX) |    | 12nCK,<br>20ns<br>(MAX) |    | 12nCK,<br>20ns<br>(MAX) |     |
| Delay from MRW command<br>to DQS disabled                                                                                 | tSDOff                    |    | 12nCK,<br>20ns<br>(MAX) |    | 12nCK,<br>20ns<br>(MAX) |    | 12nCK,<br>20ns<br>(MAX) |     |
| <b>CA Training Mode Timing</b>                                                                                            |                           |    |                         |    |                         |    |                         |     |
| Registration of CATM entry<br>command to start of<br>training samples time                                                | tCATM_Entry               | 20 |                         | 20 |                         | 20 |                         | ns  |
| Registration of CATM exit<br>CS_n assertion to end of<br>training mode (when DQ is<br>no longer driven by the<br>device). | tCATM_Exit                |    | 14                      |    | 14                      |    | 14                      | ns  |
| Registration of CATM exit<br>to next valid command delay                                                                  | tCATM_Exit_<br>Delay      | 20 |                         | 20 |                         | 20 |                         | ns  |
| Time from sample evaluation<br>to output on DQ bus                                                                        | tCATM_Valid               |    | 20                      |    | 20                      |    | 20                      | ns  |
| Time output is available on<br>DQ bus                                                                                     | tCATM_DQ_<br>Window       | 2  |                         | 2  |                         | 2  |                         | nCK |
| CS_n assertion duration to<br>exit CATM                                                                                   | tCATM_CS_E<br>xit         | 2  | 8                       | 2  | 8                       | 2  | 8                       | nCK |
| Registration of CSTM entry<br>command to start of training<br>samples time                                                | tCSTM_Entry               | 20 |                         | 20 |                         | 20 |                         | ns  |
| Min time between last<br>CS_n pulse and first pulse<br>of MPC command to exit<br>CSTM                                     | tCSTM_Min_<br>to_MPC_exit | 4  |                         | 4  |                         | 4  |                         | nCK |
| Registration of CSTM exit<br>command to end of training<br>mode                                                           | tCSTM_Exit                |    | 20                      |    | 20                      |    | 20                      | ns  |
| Time from sample evaluation                                                                                               | tCSTM_Valid               |    | 20                      |    | 20                      |    | 20                      | ns  |

|                                                                                                                                      |                            |                |     |                |     |                |     |     |
|--------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------|-----|----------------|-----|----------------|-----|-----|
| to output on DQ bus                                                                                                                  |                            |                |     |                |     |                |     |     |
| Time output is available on DQ bus                                                                                                   | tCSTM_DQ_ Window           | 2              |     | 2              |     | 2              |     | nCK |
| Registration of CSTM exit to next valid command delay                                                                                | tCSTM_Exit_ Delay          | 20             |     | 20             |     | 20             |     | ns  |
| <b>Write Leveling Timing</b>                                                                                                         |                            |                |     |                |     |                |     |     |
| Write leveling pulse enable: time from write leveling training enable MRW to when internal write leveling pulse logic level is valid | tWLPEN                     | 0              | 15  | 0              | 15  | 0              | 15  | ns  |
| Write leveling output delay                                                                                                          | tWLO                       | 0              | 9.5 | 0              | 9.5 | 0              | 9.5 | ns  |
| Write leveling output error                                                                                                          | tWLOE                      | 0              | 2   | 0              | 2   | 0              | 2   | ns  |
| Width of write leveling internal pulse                                                                                               | tWL_Pulse_ Width           | 2              |     | 2              |     | 2              |     | tCK |
| <b>VREFC/VREFC Timing</b>                                                                                                            |                            |                |     |                |     |                |     |     |
| VREFC/VREFC command to any other valid command delay                                                                                 | tVREFC_Delay/ tVREFC_Delay | tMRD           |     | tMRD           |     | tMRD           |     | nCK |
| Time CS_n is held LOW to register VREFC/VREFC command                                                                                | tVREFC_CS/ tVREFC_CS       | 3.5            | 8   | 3.5            | 8   | 3.5            | 8   | nCK |
| <b>hPPR/sPPR Timing</b>                                                                                                              |                            |                |     |                |     |                |     |     |
| hPPR programming time (x4/x8)                                                                                                        | tPGMa                      | 1000           |     | 1000           |     | 1000           |     | ms  |
| hPPR programming time (x16)                                                                                                          | tPGMb                      | 2000           |     | 2000           |     | 2000           |     | ms  |
| sPPR programming time                                                                                                                | tPGM_sPPR                  | CWL +8tCK +tWR |     | CWL +8tCK +tWR |     | CWL +8tCK +tWR |     | tCK |
| hPPR/sPPR recognition time                                                                                                           | tPGM_Exit                  | tRP            |     | tRP            |     | tRP            |     | ns  |
| hPPR program exit and new address setting time                                                                                       | tPGMPST                    | 50             |     | 50             |     | 50             |     | μs  |
| sPPR program exit and new address setting time                                                                                       | tPGMPST_sP PR              | tMRD           |     | tMRD           |     | tMRD           |     | ns  |

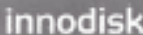
| DQS Interval Oscillator Readout Timing                                |                  |                                         |    |                           |    |                           |    |     |
|-----------------------------------------------------------------------|------------------|-----------------------------------------|----|---------------------------|----|---------------------------|----|-----|
| Delay time from DQS interval oscillator stop to mode register readout | tOSCO            | tMPC_De<br>lay                          |    | tMPC_De<br>lay            |    | tMPC_De<br>lay            |    | nCK |
| DQS interval oscillator start gap in automatic stop mode              | tOSCS            | tMPC_Delay + DQS interval timer runtime |    |                           |    |                           |    | nCK |
| ECS Timing                                                            |                  |                                         |    |                           |    |                           |    |     |
| ECS operation time                                                    | tECSc            | 176nCK,<br>110ns<br>(MAX)               |    | 176nCK,<br>110ns<br>(MAX) |    | 176nCK,<br>110ns<br>(MAX) |    |     |
| CRC Error Reporting Timing                                            |                  |                                         |    |                           |    |                           |    |     |
| CRC error to ALERT_n_latency                                          | tCRC_ALERT       | 3                                       | 13 | 3                         | 13 | 3                         | 13 | ns  |
| CRC ALERT_n pulse width                                               | CRC_ALERT_<br>PW | 12                                      | 20 | 12                        | 20 | 12                        | 20 | nCK |



## 8. Module Dimensions



## 9. RoHS Declaration



**宜鼎國際股份有限公司**  
**Innodisk Corporation**

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**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 (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




## 10. REACH Declaration

innodisk

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).

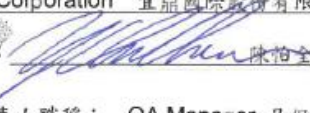
We hereby confirm that the product(s),

**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:  陳柏全

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 | 22 <sup>th</sup> November 2021 | Preliminary Edition                                    |
| 1.0 | 22 <sup>th</sup> November 2021 | Official released                                      |
| 1.1 | 7 <sup>th</sup> January 2022   | Added PMIC VIN_Bulk input supply range: 4.25 V to 15 V |