

***RoHS Compliant***

4GB DDR4 SDRAM SO-DIMM **Halogen free**

***Product Specifications***

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*Version 0.4*



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## General Description

Apacer **78.B2GG6.4000B** is a 512M x 64 DDR4 SDRAM (Synchronous DRAM) SO-DIMM. This high-density memory module consists of 4 pieces 512M x 16 bits DDR4 synchronous DRAMs in FBGA packages and a 4K Bits EEPROM. The module is a 260-pins dual in-line memory module and is intended for mounting into a connector socket. The following provides general specifications of this module.

## Ordering Information

| Part Number    | Bandwidth   | Speed Grade | Max Frequency | CAS Latency |
|----------------|-------------|-------------|---------------|-------------|
| 78.B2GG6.4000B | 21.3 GB/sec | 2666 Mbps   | 1333 MHz      | CL19        |

| Density | Organization | Component  | Rank |
|---------|--------------|------------|------|
| 4GB     | 512M x 64    | 512M x16*4 | 1    |

## Key Parameters

| MT/s        | DDR4-1866 | DDR4-2133 | DDR4-2400       | DDR4-2666 | Unit |
|-------------|-----------|-----------|-----------------|-----------|------|
| Grade       | -CL13     | -CL15     | -CL17           | -CL19     |      |
| tCK (min)   | 1.07      | 0.93      | <b>0.83</b>     | 0.75      | ns   |
| CAS latency | 13        | 15        | <b>17</b>       | 19        | tCK  |
| tRCD (min)  | 13.92     | 14.06     | <b>14.16</b>    | 14.25     | ns   |
| tRP (min)   | 13.92     | 14.06     | <b>14.16</b>    | 14.25     | ns   |
| tRAS (min)  | 34        | 33        | <b>32</b>       | 32        | ns   |
| tRC (min)   | 47.92     | 47.05     | <b>46.16</b>    | 46.25     | ns   |
| CL-tRCD-tRP | 13-13-13  | 15-15-15  | <b>17-17-17</b> | 19-19-19  | tCK  |

## Specifications:

- ◆ On-DIMM thermal sensor : No
- ◆ Organization: 512 words x 64 bits, 1 rank
- ◆ Integrating 4 pieces of 8G bits DDR4 SDRAM sealed FBGA
- ◆ Package: 260-pin socket type small outline dual in-line memory module (SO-DIMM)
- ◆ PCB: height 30.00 mm, lead pitch 0.50 mm (pin),
- ◆ Serial Presence Detect (SPD)
- ◆ Power Supply: VDD=1.2V (1.14V to 1.26V)
- ◆ VDDQ = 1.2V (1.14V to 1.26V)
- ◆ VPP = 2.5V (2.375V to 2.75V)
- ◆ VDDSPD = 2.2V to 3.6V
- ◆ 16 internal banks
- ◆ CAS Latency (CL): 10, 11, 12, 13, 14, 15,16,17,18,19,20
- ◆ CAS Write Latency (CWL): 14,18
- ◆ Average refresh period  
7.8us at  $0^{\circ}\text{C} \leq \text{TC} \leq 85^{\circ}\text{C}$   
3.9us at  $85^{\circ}\text{C} \leq \text{TC} \leq 95^{\circ}\text{C}$
- ◆ Lead-free (RoHS compliant)
- ◆ Halogen free

## Features:

- ◆ Functionality and operations comply with the DDR4 SDRAM datasheet
- ◆ Bank Grouping is applied, and CAS to CAS latency (tCCD\_L, tCCD\_S) for the banks in the same or different bank group accesses are available
- ◆ Bi-Directional Differential Data Strobe
- ◆ 8 bit pre-fetch
- ◆ Burst Length (BL) switch on-the-fly BL8 or BC4(Burst Chop)
- ◆ Per DRAM Addressability is supported
- ◆ Internal Vref DQ level generation is available
- ◆ Write CRC is supported at all speed grades
- ◆ DBI (Data Bus Inversion) is supported(x8)
- ◆ CA parity (Command/Address Parity) mode is supported

## Pin Assignments

| Pin No. | Pin name-Front | Pin No. | Pin name-Back | Pin No. | Pin name-Front | Pin No. | Pin name-Back |
|---------|----------------|---------|---------------|---------|----------------|---------|---------------|
| 1       | VSS            | 2       | VSS           | 133     | A1             | 134     | EVENT_n       |
| 3       | DQ5            | 4       | DQ4           | 135     | VDD            | 136     | VDD           |
| 5       | VSS            | 6       | VSS           | 137     | CK0_t          | 138     | CK1_t         |
| 7       | DQ1            | 8       | DQ0           | 139     | CK0_c          | 140     | CK1_c         |
| 9       | VSS            | 10      | VSS           | 141     | VDD            | 142     | VDD           |
| 11      | DQS0_c         | 12      | DM0_n, DBI0_n | 143     | PARITY         | 144     | A0            |
| 13      | DQS0_t         | 14      | VSS           | 145     | BA1            | 146     | A10/AP        |
| 15      | VSS            | 16      | DQ6           | 147     | VDD            | 148     | VDD           |
| 17      | DQ7            | 18      | VSS           | 149     | CS0_n          | 150     | BA0           |
| 19      | VSS            | 20      | DQ2           | 151     | A14/WE_n       | 152     | A16/RAS_n     |
| 21      | DQ3            | 22      | VSS           | 153     | VDD            | 154     | VDD           |
| 23      | VSS            | 24      | DQ12          | 155     | ODT0           | 156     | A15/CAS_n     |
| 25      | DQ13           | 26      | VSS           | 157     | CS1_n          | 158     | A13           |
| 27      | VSS            | 28      | DQ8           | 159     | VDD            | 160     | VDD           |
| 29      | DQ9            | 30      | VSS           | 161     | ODT1           | 162     | C0, CS2_n, NC |
| 31      | VSS            | 32      | DQS1_c        | 163     | VDD            | 164     | VREFCA        |
| 33      | DM1_n, DBI1_n  | 34      | DQS1_t        | 165     | C1, CS3_n, NC  | 166     | SA2           |
| 35      | VSS            | 36      | VSS           | 167     | VSS            | 168     | VSS           |
| 37      | DQ15           | 38      | DQ14          | 169     | DQ37           | 170     | DQ36          |
| 39      | VSS            | 40      | VSS           | 171     | VSS            | 172     | VSS           |
| 41      | DQ10           | 42      | DQ11          | 173     | DQ33           | 174     | DQ32          |
| 43      | VSS            | 44      | VSS           | 175     | VSS            | 176     | VSS           |
| 45      | DQ21           | 46      | DQ20          | 177     | DQS4_c         | 178     | DM4_n, DBI4_n |
| 47      | VSS            | 48      | VSS           | 179     | DQS4_t         | 180     | VSS           |
| 49      | DQ17           | 50      | DQ16          | 181     | VSS            | 182     | DQ39          |
| 51      | VSS            | 52      | VSS           | 183     | DQ38           | 184     | VSS           |
| 53      | DQS2_c         | 54      | DM2_n, DBI2_n | 185     | VSS            | 186     | DQ35          |
| 55      | DQS2_t         | 56      | VSS           | 187     | DQ34           | 188     | VSS           |
| 57      | VSS            | 58      | DQ22          | 189     | VSS            | 190     | DQ45          |
| 59      | DQ23           | 60      | VSS           | 191     | DQ44           | 192     | VSS           |
| 61      | VSS            | 62      | DQ18          | 193     | VSS            | 194     | DQ41          |
| 63      | DQ19           | 64      | VSS           | 195     | DQ40           | 196     | VSS           |
| 65      | VSS            | 66      | DQ28          | 197     | VSS            | 198     | DQS5_c        |
| 67      | DQ29           | 68      | VSS           | 199     | DM5_n, DBI5_n  | 200     | DQS5_t        |
| 69      | VSS            | 70      | DQ24          | 201     | VSS            | 202     | VSS           |

| Pin No. | Pin name-Front | Pin No. | Pin name-Back | Pin No. | Pin name-Front | Pin No. | Pin name-Back |
|---------|----------------|---------|---------------|---------|----------------|---------|---------------|
| 71      | DQ25           | 72      | VSS           | 203     | DQ46           | 204     | DQ47          |
| 73      | VSS            | 74      | DQS3_c        | 205     | VSS            | 206     | VSS           |
| 75      | DM3_n, DBI3_n  | 76      | DQS3_t        | 207     | DQ42           | 208     | DQ43          |
| 77      | VSS            | 78      | VSS           | 209     | VSS            | 210     | VSS           |
| 79      | DQ30           | 80      | DQ31          | 211     | DQ52           | 212     | DQ53          |
| 81      | VSS            | 82      | VSS           | 213     | VSS            | 214     | VSS           |
| 83      | DQ26           | 84      | DQ27          | 215     | DQ49           | 216     | DQ48          |
| 85      | VSS            | 86      | VSS           | 217     | VSS            | 218     | VSS           |
| 87      | CB5, NC        | 88      | CB4, NC       | 219     | DQS6_c         | 220     | DM6_n, DBI6_n |
| 89      | VSS            | 90      | VSS           | 221     | DQS6_t         | 222     | VSS           |
| 91      | CB1, NC        | 92      | CB0, NC       | 223     | VSS            | 224     | DQ54          |
| 93      | VSS            | 94      | VSS           | 225     | DQ55           | 226     | VSS           |
| 95      | DQS8_c         | 96      | DM8_n, DBI8_n | 227     | VSS            | 228     | DQ50          |
| 97      | DQS8_t         | 98      | VSS           | 229     | DQ51           | 230     | VSS           |
| 99      | VSS            | 100     | CB6, NC       | 231     | VSS            | 232     | DQ60          |
| 101     | CB2, NC        | 102     | VSS           | 233     | DQ61           | 234     | VSS           |
| 103     | VSS            | 104     | CB7, NC       | 235     | VSS            | 236     | DQ57          |
| 105     | CB3, NC        | 106     | VSS           | 237     | DQ56           | 238     | VSS           |
| 107     | VSS            | 108     | RESET_n       | 239     | VSS            | 240     | DQS7_c        |
| 109     | CKE0           | 110     | CKE1          | 241     | DM7_n, DBI7_n  | 242     | DQS7_t        |
| 111     | VDD            | 112     | VDD           | 243     | VSS            | 244     | VSS           |
| 113     | BG1            | 114     | ACT_n         | 245     | DQ62           | 246     | DQ63          |
| 115     | BG0            | 116     | ALERT_n       | 247     | VSS            | 248     | VSS           |
| 117     | VDD            | 118     | VDD           | 249     | DQ58           | 250     | DQ59          |
| 119     | A12            | 120     | A11           | 251     | VSS            | 252     | VSS           |
| 121     | A9             | 122     | A7            | 253     | SCL            | 254     | SDA           |
| 123     | VDD            | 124     | VDD           | 255     | VDDSPD         | 256     | SA0           |
| 125     | A8             | 126     | A5            | 257     | VPP            | 258     | VTT           |
| 127     | A6             | 128     | A4            | 259     | VPP            | 260     | SA1           |
| 129     | VDD            | 130     | VDD           | —       | —              | —       | —             |
| 131     | A3             | 132     | A2            | —       | —              | —       | —             |

\*IC Component Composition :

|         |         |         |        |
|---------|---------|---------|--------|
| 256Mx8  | A0~A13  | 512Mx4  | A0~A14 |
| 512Mx8  | A0~A14, | 1024Mx4 | A0~A15 |
| 1024Mx8 | A0~A15, | 2048Mx4 | A0~A16 |
| 2048Mx8 | A0~A16, |         |        |

## Pin Descriptions

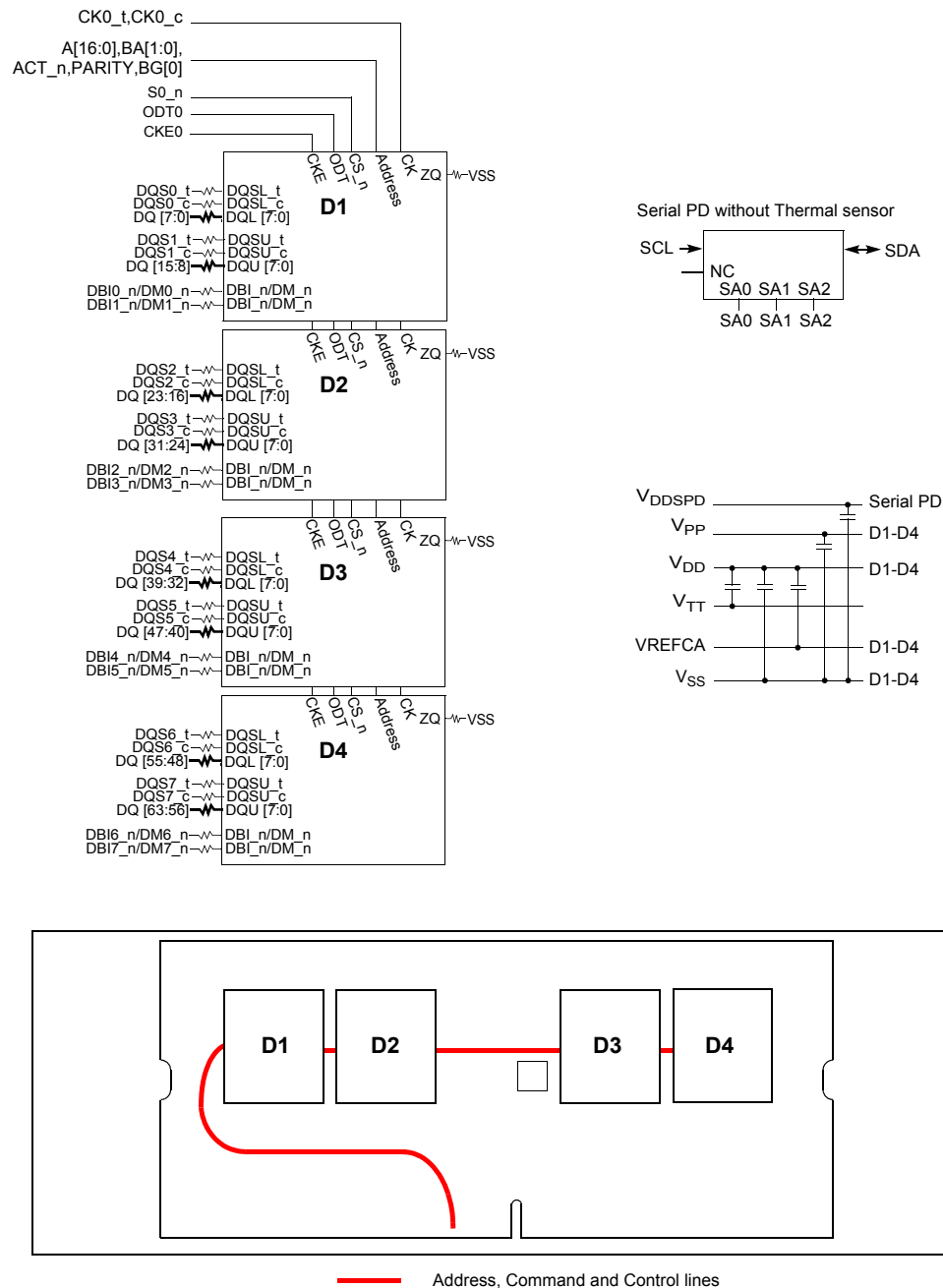
| Pin Name            | Description                                                                           |
|---------------------|---------------------------------------------------------------------------------------|
| Ax <sup>1*</sup>    | SDRAM address bus                                                                     |
| BAx                 | SDRAM bank select                                                                     |
| BGx                 | SDRAM bank group select                                                               |
| RAS_n <sup>2*</sup> | SDRAM row address strobe                                                              |
| CAS_n <sup>3*</sup> | SDRAM column address strobe                                                           |
| WE_n <sup>4*</sup>  | SDRAM write enable                                                                    |
| CSx_n               | DIMM Rank Select Lines                                                                |
| CKEx                | SDRAM clock enable lines                                                              |
| ODTx                | SDRAM on-die termination control lines                                                |
| ACT_n               | SDRAM input for activate input                                                        |
| DQx                 | DIMM memory data bus                                                                  |
| CBx                 | DIMM ECC check bits                                                                   |
| TDQSx_t ; TDQSx_c   | Dummy loads for mixed populations of x4 based and x8 based RDIMMs. Not used on UDIMMs |
| DQSx_t              | Data Buffer data strobes (positive line of differential pair)                         |
| DQSx_c              | Data Buffer data strobes (negative line of differential pair)                         |
| DMx_n,<br>DBlx_n    | SDRAM data masks/data bus inversion(x8-based x72 DIMMs)                               |
| CKx_t               | SDRAM clock input (positive line of differential pair)                                |
| CKx_c               | SDRAM clocks input (negative line of differential pair)                               |
| SCL                 | I <sup>2</sup> C serial bus clock for SPD-TSE and register                            |
| SDA                 | I <sup>2</sup> C serial bus data line for SPD-TSE and register                        |
| SAx                 | I <sup>2</sup> C slave address select for SPD-TSE and register                        |
| PARITY              | SDRAM parity input                                                                    |
| VDD                 | SDRAM core power supply                                                               |
| 12 V                | Optional Power Supply on socket but not used on DIMM                                  |
| VREFCA              | SDRAM command/address reference supply                                                |
| VSS                 | Power supply return (ground)                                                          |
| VDDSPD              | Serial SPD-TSE positive power supply                                                  |
| ALERT_n             | SDRAM ALERT_n output                                                                  |
| VPP                 | SDRAM Supply                                                                          |
| RESET_n             | Set Register and SDRAMs to a Known State                                              |
| EVENT_n             | SPD signals a thermal event has occurred                                              |
| VTT                 | SDRAM I/O termination supply                                                          |
| RFU                 | Reserved for future use                                                               |

\*Notes:

1. Address A17 is only valid for 16 Gb x4 based SDRAMs. For UDIMMs this connection pin is NC.
2. RAS\_n is a multiplexed function with A16.
3. CAS\_n is a multiplexed function with A15.
4. WE\_n is a multiplexed function with A14.



# Functional Block Diagram



**Note 1:** Unless otherwise noted, resistor values are  $15\ \Omega \pm 5\%$ .

**Note 2:** ZQ resistors are  $240\ \Omega \pm 1\%$ . For all other resistor values refer to the appropriate wiring diagram.

**Note 3:** CK1\_t, CK1\_c terminated with  $75\ \Omega \pm 5\%$  resistor.

## Absolute Maximum Ratings

| Parameter                           | Symbol                             | Description     | Units | Notes |
|-------------------------------------|------------------------------------|-----------------|-------|-------|
| Voltage on VDD pin relative to Vss  | V <sub>DD</sub>                    | - 0.3 V ~ 1.5 V | V     | 1,2   |
| Voltage on VDDQ pin relative to Vss | V <sub>DDQ</sub>                   | - 0.3 V ~ 1.5 V | V     | 1,2   |
| Voltage on VPP pin relative to Vss  | V <sub>PP</sub>                    | - 0.3 V ~ 3.0 V | V     | 3     |
| Voltage on any pin relative to Vss  | V <sub>IN</sub> , V <sub>OUT</sub> | - 0.3 V ~ 1.5 V | V     | 1,2   |

Notes:

1. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. VDD and VDDQ must be within 300 mV of each other at all times; and VREFCA must be not greater than 0.6 x VDDQ, When VDD and VDDQ are less than 500 mV; VREF may be equal to or less than 300 mV
3. VPP must be equal or greater than VDD/VDDQ at all times

# DRAM Component Operating Temperature Range

| Symbol            | Parameter                          | Rating   | Units | Notes |
|-------------------|------------------------------------|----------|-------|-------|
| T <sub>OPER</sub> | Normal Operating Temperature Range | 0 to 85  | °C    | 1,2   |
|                   | Extended Temperature Range         | 85 to 95 | °C    | 1,3   |

## Notes:

- Operating Temperature T<sub>OPER</sub> is the case surface temperature on the center / top side of the DRAM. For measurement conditions please refer to the JEDEC document JESD51-2.
- The Normal Temperature Range specifies the temperatures where all DRAM specifications will be supported. During operation, the DRAM case temperature must be maintained between 0°C - 85°C under all operating conditions.
- Some applications require operation of the DRAM in the Extended Temperature Range between 85°C and 95°C case temperature. Full specifications are guaranteed in this range, but the following additional conditions apply:
  - Refresh commands must be doubled in frequency, therefore reducing the Refresh interval tREFI to 3.9 μs. It is also possible to specify a component with 1X refresh (tREFI to 7.8μs) in the Extended Temperature Range. Please refer to the DIMM SPD for option availability
  - If Self-Refresh operation is required in the Extended Temperature Range, then it is mandatory to either use the Manual Self-Refresh mode with Extended Temperature Range capability (MR2 A6 = 0b and MR2 A7 = 1b), in this case IDD6 current can be increased around 10~20% than normal Temperature range.

# Operating Conditions

## Recommended DC Operating Conditions – DDR4 (1.2V) operation

| Symbol | Parameter                 | Rating |      |      | Units | Notes |
|--------|---------------------------|--------|------|------|-------|-------|
|        |                           | Min.   | Typ. | Max. |       |       |
| VDD    | Supply Voltage            | 1.14   | 1.2  | 1.26 | V     | 1,2,3 |
| VDDQ   | Supply Voltage for Output | 1.14   | 1.2  | 1.26 | V     | 1,2,3 |
| VPP    | Activation Supply Voltage | 2.375  | 2.5  | 2.75 | V     | 3     |

Notes:

1. Under all conditions VDDQ must be less than or equal to VDD..
2. VDDQ tracks with VDD. AC parameters are measured with VDD and VDDQ tied together.
3. DC bandwidth is limited to 20MHz.

## Environmental Requirements

| Symbol | Parameter                                 | Rating      | Units | Notes |
|--------|-------------------------------------------|-------------|-------|-------|
| HOPR   | Operating Humidity (relative)             | 10 to 90    | %     |       |
| TSTG   | Storage Temperature                       | -50 to +100 | °C    | 1     |
| HSTG   | Storage Humidity (without condensation)   | 5 to 95     | %     | 1     |
| PBAR   | Barometric Pressure (operating & storage) | 105 to 69   | kPa   | 1,2   |

Notes:

1. Stresses greater than those listed may cause permanent damage to the device. This is a stress rating only. and device functional operation at or above the conditions indicated is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. Up to 9850 ft.



## Revision History

| Revision | Date       | Description                                   | Remark |
|----------|------------|-----------------------------------------------|--------|
| 0.1      | 5/5/2014   | Initial release                               |        |
| 0.2      | 11/2/2015  | Updated VDDSPD                                |        |
| 0.3      | 03/15/2017 | Add Environmental Requirements                |        |
| 0.4      | 09/04/2017 | Remove TOPR (Operating Temperature (ambient)) |        |

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