

## TS3DDR4000 12-bits 1:2 high speed DDR2/DDR3/DDR4 switch/multiplexer

### 1 Features

- Wide  $V_{DD}$  Range: 2.375 V – 3.6 V
- High Bandwidth: 5.6 GHz Typical (single-ended); 6.0 GHz Typical (differential)
- Low Switch On-Resistance ( $R_{ON}$ ): 8  $\Omega$  Typical
- Low Bit-to-Bit Skew: 3ps Typical; 6ps Max across All Channels
- Low Crosstalk: –34 dB Typical at 1067 MHz
- Low Operating Current: 40  $\mu$ A Typical
- Low-Power Mode with Low Current Consumption: 2  $\mu$ A Typical
- $I_{OFF}$  Protection Prevents Current Leakage in Powered Down State ( $V_{DD} = 0$  V)
- Supports POD\_12, SSTL\_12, SSTL\_15 and SSTL\_18 Signaling
- ESD Performance:
  - 3-kV Human Body Model (A114B, Class II)
  - 1-kV Charged Device Model (C101)
- 8 mm x 3 mm 48-balls 0.65-mm Pitch ZBA Package

### 2 Applications

- NVDIMM Modules
- Enterprise Data Systems and Servers
- Notebook/Desktop PCs
- General DDR3/DDR4 Signal Switching
- General High-Speed Signal Switching

### 3 Description

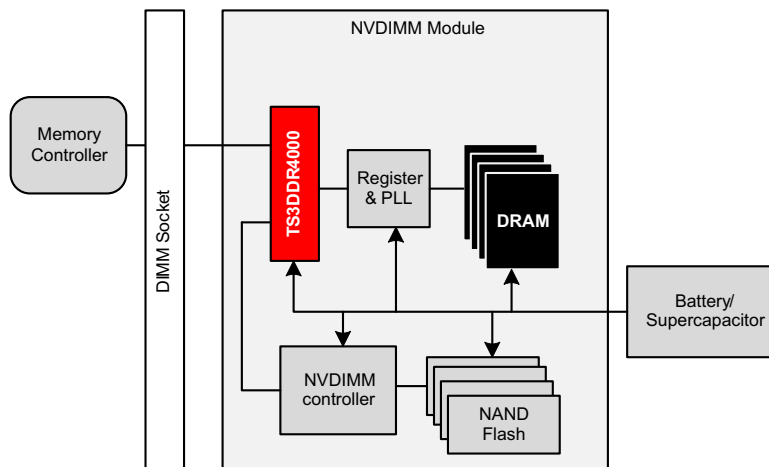
The TS3DDR4000 is 1:2 or 2:1 high speed DDR2/DDR3/DDR4 switch that offers 12-bit wide bus switching. The A port can be switched to the B or C port for all bits simultaneously. Designed for operation in DDR2, DDR3 and DDR4 memory bus systems, the TS3DDR4000 uses a proprietary architecture that delivers high bandwidth (single-ended –3dB bandwidth at 5.6 GHz), low insertion loss at low frequency, and very low propagation delay. The TS3DDR4000 is 1.8 V logic compatible, and all switches are bi-directional for added design flexibility. The TS3DDR4000 also offers a low-power mode, in which all channels become high-Z and the device consumes minimal power.

#### Device Information<sup>(1)</sup>

| PART NUMBER | PACKAGE    | BODY SIZE (NOM)   |
|-------------|------------|-------------------|
| TS3DDR4000  | NFBGA (48) | 8.00 mm x 3.00 mm |

(1) For all available packages, see the orderable addendum at the end of the datasheet.

#### Application Diagram



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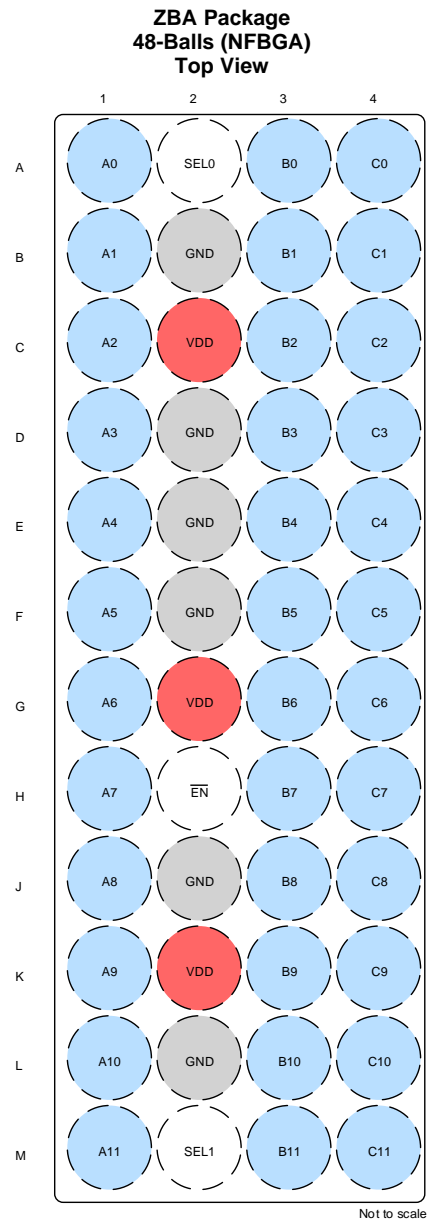
## 4 Revision History

| Changes from Revision B (May 2017) to Revision C   | Page |
|--|------|
| • Changed the <i>Pin Configuration</i> image.....  | 3    |
| • Changed $V_{IH}$ From: SEL1m and SEL2 To: SEL0 and SEL1 with a MIN value of 1 V in the <i>Recommended Operating Conditions</i> .....   | 4    |
| • Changed SEL1 To: SEL0 and SLE2 To: SEL1 in <a href="#">Figure 18</a> .....   | 11   |
| • Changed text "Standard layout technique for 0.5 mm pitch BGA package" To: "Standard layout technique for 0.65 mm pitch BGA package..." in the <i>Layout Guidelines</i> ..... | 15   |

| Changes from Revision A (March 2015) to Revision B  | Page |
|---|------|
| • Changed $V_{DD}$ Max value From: 5.5 V toTo: 4.8 V in the <i>Absolute Maximum Ratings</i> ..... | 4    |
| • Added the Note to the <i>Application and Implementation</i> section.....                        | 13   |

| Changes from Original (November 2014) to Revision A | Page |
|---|------|
| • Updated document to full version. ....            | 1    |

## 5 Pin Configuration and Functions



### Pin Functions

| PINS                   |                        | TYPE   | DESCRIPTION         |
|------------------------|------------------------|--------|---------------------|
| NAME                   | NO.                    |        |                     |
| VDD                    | C2, G2, K2             | Power  | Power supply        |
| GND                    | B2, D2, E2, F2, J2, L2 | Ground | Ground              |
| A0-A11                 | A1-M1                  | I/O    | Port A, signal 0-11 |
| B0-B11                 | A3-M3                  | I/O    | Port B, signal 0-11 |
| C0-C11                 | A4-M4                  | I/O    | Port C, signal 0-11 |
| SEL0                   | A2                     | I      | Select control 0    |
| SEL1                   | M2                     | I      | Select control 1    |
| $\overline{\text{EN}}$ | H2                     | I      | Enable              |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

|                  |  | MIN  | MAX | UNIT |
|------------------|--|------|-----|------|
| V <sub>DD</sub>  | Voltage range on V <sub>DD</sub>                 | -0.3 | 4.8 | V    |
| V <sub>IN</sub>  | Control input voltage range: SEL0, SEL1, and /EN | -0.3 | 5.5 | V    |
| V <sub>IO</sub>  | Analog voltage range: A0-A11, B0-B11, and C0-C11 | -0.3 | 3.6 | V    |
| T <sub>A</sub>   | Operating ambient temperature range              | -40  | 85  | °C   |
| T <sub>stg</sub> | Storage temperature range                        | -65  | 125 | °C   |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### 6.2 ESD Ratings

|                    |                         |   | VALUE | UNIT |
|--------------------|-------------------------|---|-------|------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Charge device model (CDM) <sup>(1)</sup>          | ±1000 | V    |
|                    |                         | Human body model (HBM) on all pins <sup>(2)</sup> | ±3000 | V    |

(1) Tested in accordance with JEDEC Standard 22, Test Method C101

(2) Tested in accordance with JEDEC Standard 22, Test Method A114

### 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|                 |   | MIN   | MAX             | UNIT |
|-----------------|---|-------|-----------------|------|
| V <sub>DD</sub> | Voltage range on V <sub>DD</sub>  | 2.375 | 3.6             | V    |
| V <sub>IO</sub> | Analog voltage range: A0-A11, B0-B11, and C0-C11                                    | 0     | 3.3             | V    |
| V <sub>IH</sub> | High-level control input voltage threshold ( $\overline{\text{EN}}$ )               | 1.4   | V <sub>DD</sub> | V    |
|                 | High-level control input voltage threshold (SEL0 and SEL1)                          | 1     | V <sub>DD</sub> | V    |
| V <sub>IL</sub> | Low-level control input voltage threshold ( $\overline{\text{EN}}$ , SEL0 and SEL1) | 0     | 0.5             | V    |
| T <sub>A</sub>  | Operating ambient temperature range   | -40   | 85              | °C   |

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | TS3DDR4000 | UNIT |
|-------------------------------|--|------------|------|
|                               |  | BGA (48)   |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 92.6       | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    | 33.4       |      |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 56.2       |      |
| ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 1.3        |      |
| ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 54.9       |      |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report .

## 6.5 Static Electrical Characteristics

Unless otherwise noted the specification applies over the  $V_{DD}$  range and operation junction temp of  $-40^{\circ}\text{C} \leq T_J \leq 85^{\circ}\text{C}$ . Typical values are for  $V_{DD} = 3.3\text{ V}$  and  $T_J = 25^{\circ}\text{C}$ .

| PARAMETER          |  | TEST CONDITION |   | MIN | TYP | MAX       | UNIT          |
|--------------------|--|----------------|---|-----|-----|-----------|---------------|
| $R_{ON}$           | On-state resistance                            | Port A to B    | $V_{DD} = 2.375\text{ V}$ , $V_{I/O} = 1.2\text{ V}$ ,<br>$I_{I/O} = 10\text{ mA}$  | –   | 8.3 | 11.2      | $\Omega$      |
|                    |  | Port A to C    |   | –   | 8.3 | 11.2      | $\Omega$      |
| $R_{ON}$<br>(FLAT) | On-state resistance flatness for all I/Os      | Port A to B    | $V_{DD} = 2.375\text{ V}$ , $V_{I/O} = 1.2\text{ V}$ , $I_{I/O} = 10\text{ mA}$   | –   | 0.6 | –         | $\Omega$      |
|                    |  | Port A to C    |   | –   | 0.6 | –         | $\Omega$      |
| $\Delta R_{ON}$    | On-state resistance match between channels     | Port A to B    | $V_{DD} = 2.375\text{ V}$ , $V_{I/O} = 1.2\text{ V}$ , $I_{I/O} = 10\text{ mA}$   | –   | 0.2 | 1.0       | $\Omega$      |
|                    |  | Port A to C    |   | –   | 0.2 | 1.0       | $\Omega$      |
| $I_{IH}$           | Control input high leakage current             | EN             | $V_{DD} = 3.6\text{ V}$ , $V_{I/EN} = 1.4\text{ V}$   | –   | –   | $\pm 1$   | $\mu\text{A}$ |
|                    |  |                | $V_{DD} = 2.375\text{ V}$ , $V_{I/EN} = 3.3\text{ V}$   | –   | –   | $\pm 1$   | $\mu\text{A}$ |
|                    |  | SEL1           | $V_{DD} = 3.6\text{ V}$ , $V_{SEL1} = 1.4\text{ V}$   | –   | –   | $\pm 1$   | $\mu\text{A}$ |
|                    |  |                | $V_{DD} = 2.375\text{ V}$ , $V_{SEL1} = 3.3\text{ V}$   | –   | –   | $\pm 1$   | $\mu\text{A}$ |
|                    |  | SEL2           | $V_{DD} = 3.6\text{ V}$ , $V_{SEL2} = 1.4\text{ V}$   | –   | –   | $\pm 1$   | $\mu\text{A}$ |
|                    |  |                | $V_{DD} = 2.375\text{ V}$ , $V_{SEL2} = 3.3\text{ V}$   | –   | –   | $\pm 1$   | $\mu\text{A}$ |
| $I_{IL}$           | Control input low leakage current              | EN             | $V_{DD} = 3.6\text{ V}$ , $V_{I/EN} = 0\text{ V}$   | –   | –   | $\pm 0.5$ | $\mu\text{A}$ |
|                    |  | SEL1           | $V_{DD} = 3.6\text{ V}$ , $V_{SEL1} = 0\text{ V}$   | –   | –   | $\pm 0.5$ | $\mu\text{A}$ |
|                    |  | SEL2           | $V_{DD} = 3.6\text{ V}$ , $V_{SEL2} = 0\text{ V}$   | –   | –   | $\pm 0.5$ | $\mu\text{A}$ |
| $I_{OFF}$          | Leakage under power off condition for all I/Os | EN             | $V_{DD} = 0\text{ V}$ , $V_{I/EN} = 0\text{ V}$ , $V_{I/O} = 0\text{ V to } 3.3\text{ V}$                                   | –   | –   | $\pm 5$   | $\mu\text{A}$ |
|                    |  |                | $V_{DD} = 0\text{ V}$ , $V_{I/EN} = 3.6\text{ V}$ , $V_{I/O} = 0\text{ V to } 3.3\text{ V}$                                 | –   | –   | $\pm 5$   | $\mu\text{A}$ |
|                    |  | SEL1           | $V_{DD} = 0\text{ V}$ , $V_{SEL1} = 0\text{ V}$ , $V_{I/O} = 0\text{ V to } 3.3\text{ V}$                                   | –   | –   | $\pm 5$   | $\mu\text{A}$ |
|                    |  |                | $V_{DD} = 0\text{ V}$ , $V_{SEL1} = 3.6\text{ V}$ , $V_{I/O} = 0\text{ V to } 3.3\text{ V}$                                 | –   | –   | $\pm 5$   | $\mu\text{A}$ |
|                    |  | SEL2           | $V_{DD} = 0\text{ V}$ , $V_{SEL2} = 0\text{ V}$ , $V_{I/O} = 0\text{ V to } 3.3\text{ V}$                                   | –   | –   | $\pm 5$   | $\mu\text{A}$ |
|                    |  |                | $V_{DD} = 0\text{ V}$ , $V_{SEL2} = 3.6\text{ V}$ , $V_{I/O} = 0\text{ V to } 3.3\text{ V}$                                 | –   | –   | $\pm 5$   | $\mu\text{A}$ |
| $I_{DD}$           | $V_{DD}$ supply current                        |                | $V_{DD} = 3.6\text{ V}$ , $I_{I/O} = 0\text{ A}$ , $/EN = 0\text{ V}$ , $V_{SEL1} = V_{SEL2} = 0\text{ V}$                  | –   | 28  | 35        | $\mu\text{A}$ |
|                    |  |                | $V_{DD} = 3.6\text{ V}$ , $I_{I/O} = 0\text{ A}$ , $/EN = 0\text{ V}$ , $V_{SEL1} = V_{SEL2} = 1.8\text{ V}$                | –   | 40  | 48        | $\mu\text{A}$ |
|                    |  |                | $V_{DD} = 3.6\text{ V}$ , $I_{I/O} = 0\text{ A}$ , $/EN = 0\text{ V}$ , $V_{SEL1} = 0\text{ V}$ , $V_{SEL2} = 1.8\text{ V}$ | –   | 40  | 44        | $\mu\text{A}$ |
|                    |  |                | $V_{DD} = 3.6\text{ V}$ , $I_{I/O} = 0\text{ A}$ , $/EN = 0\text{ V}$ , $V_{SEL1} = 1.8\text{ V}$ , $V_{SEL2} = 0\text{ V}$ | –   | 40  | 44        | $\mu\text{A}$ |
| $I_{DD, PD}$       | $V_{DD}$ supply current in power-down mode     |                | $V_{DD} = 3.6\text{ V}$ , $I_{I/O} = 0\text{ A}$ , $/EN = 1.8\text{ V}$   | –   | 2   | 5         | $\mu\text{A}$ |

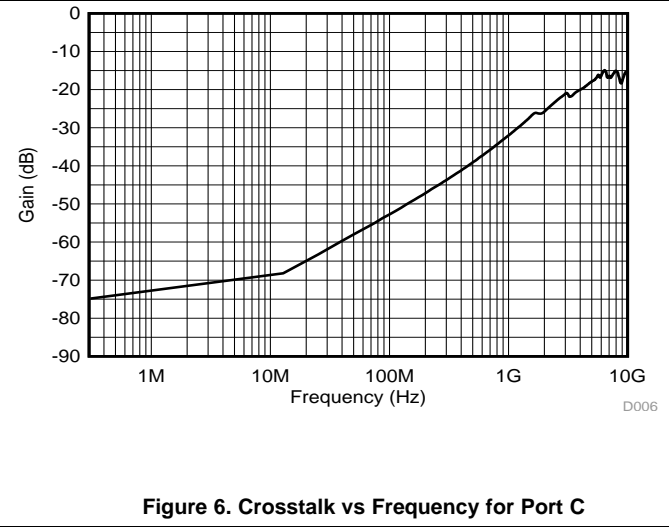
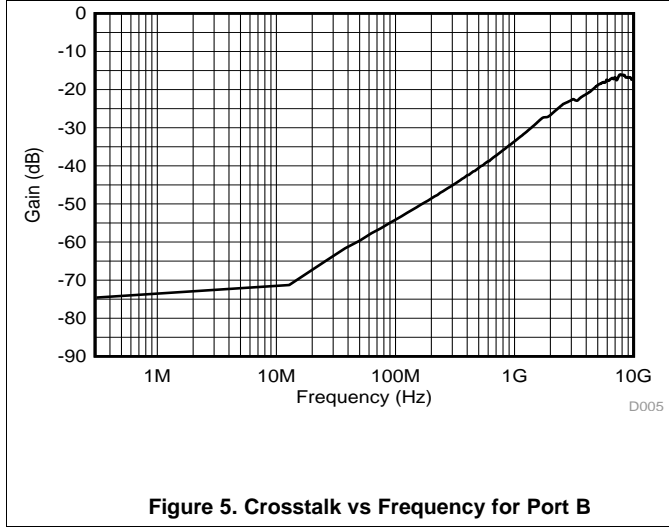
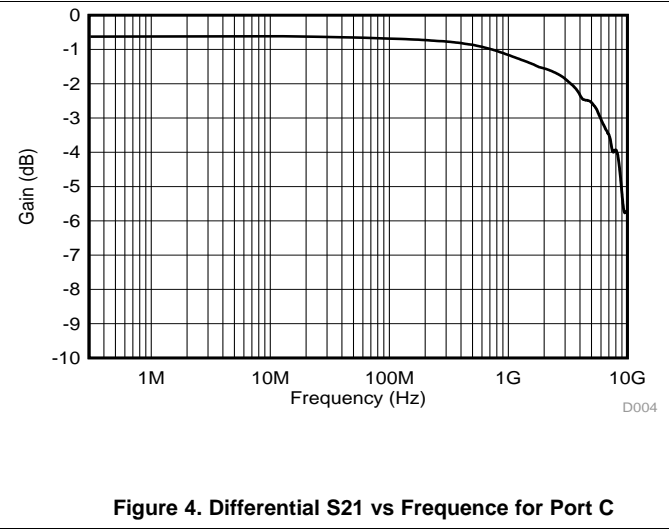
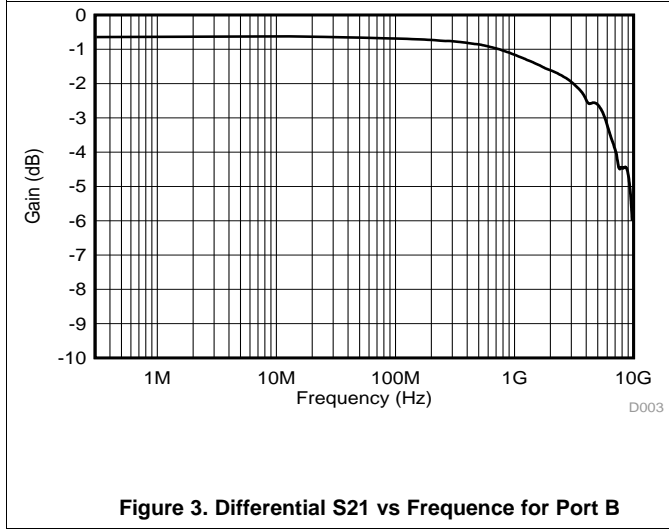
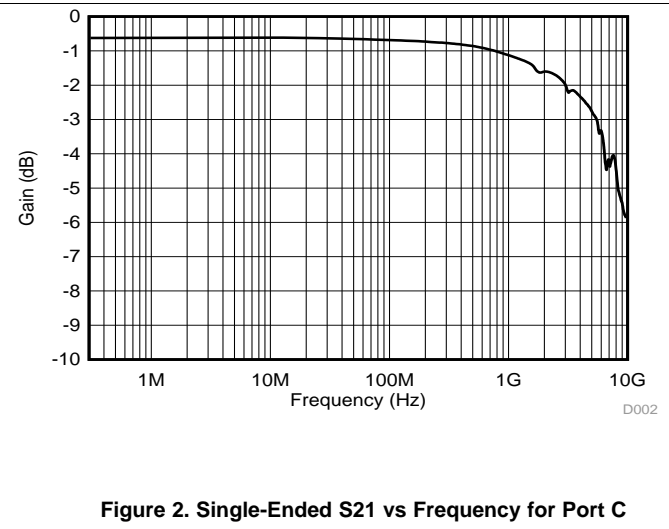
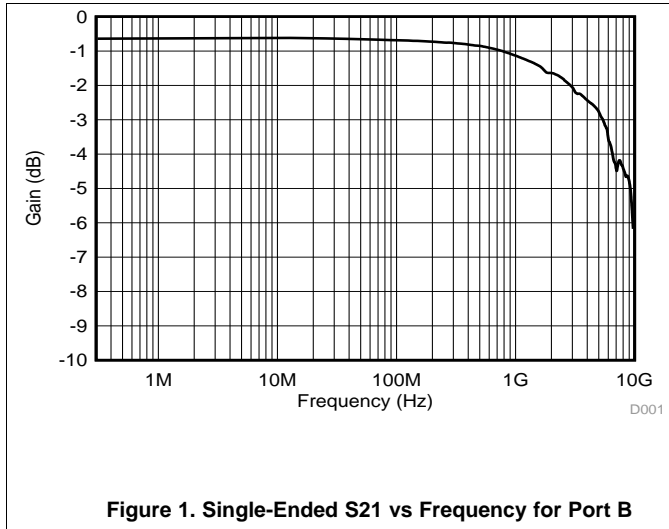
## 6.6 Dynamic Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETER        |  | TEST CONDITION |  | MIN | TYP   | MAX | UNIT          |
|------------------|--|----------------|--|-----|-------|-----|---------------|
| $t_{ON}$         | Switch turn-on time                          | EN to B        | $V_{DD} = 2.375\text{ V}$ , $R_L = 50\ \Omega$ , $V_{An} = 3.3\text{ V}$ , $V_{/EN} = 1.8\text{ V} \rightarrow 0\text{ V}$ , $V_{SEL1} = V_{SEL2} = 0\text{ V}$<br>(See Figure 12)   | –   | 65    | 140 | $\mu\text{s}$ |
|                  |  | EN to C        | $V_{DD} = 2.375\text{ V}$ , $R_L = 50\ \Omega$ , $V_{An} = 3.3\text{ V}$ , $V_{/EN} = 1.8\text{ V} \rightarrow 0\text{ V}$ , $V_{SEL1} = V_{SEL2} = 1.8\text{ V}$<br>(See Figure 12) | –   | 65    | 140 | $\mu\text{s}$ |
| $t_{SWITCH}$     | Switching time between channels for all I/Os | SEL to B       | $V_{DD} = 2.375\text{ V}$ , $V_{/EN} = 0\text{ V}$ , $R_L = 50\ \Omega$ , $V_{An} = 3.3\text{ V}$ ,<br>(See Figure 13)   | –   | 65    | –   | ns            |
|                  |  | SEL to C       | $V_{DD} = 2.375\text{ V}$ , $V_{/EN} = 0\text{ V}$ , $R_L = 50\ \Omega$ , $V_{An} = 3.3\text{ V}$ ,<br>(See Figure 13)   | –   | 50    | –   | ns            |
| $t_{PD}$         | Propagation delay                            | Port A to B    | $V_{DD} = 2.375\text{ V}$ ,<br>(See Figure 14)   | –   | 85    | –   | ps            |
|                  |  | Port A to C    | $V_{DD} = 2.375\text{ V}$ ,<br>(See Figure 14)   | –   | 85    | –   | ps            |
| $t_{SKEW}^{(1)}$ | Single-ended skew between channels           | B0 to B11      | $V_{DD} = 2.375\text{ V}$ , from any output to any other output  | –   | 3     | 8   | ps            |
|                  |  | C0 to C11      |  | –   | 3     | 6   | ps            |
| $C_{IN}$         | Control input capacitance                    | EN             | $f = 1\text{ MHz}$ , $V_{IN} = 0\text{ V}$   | –   | 6     | –   | pF            |
|                  |  | SEL1           | $f = 1\text{ MHz}$ , $V_{IN} = 0\text{ V}$   | –   | 6     | –   | pF            |
|                  |  | SEL2           | $f = 1\text{ MHz}$ , $V_{IN} = 0\text{ V}$   | –   | 6     | –   | pF            |
| $C_{OFF}$        | Switch off capacitance                       | Port A to B    | $f = 1067\text{ MHz}$ , $V_{/IO} = 0\text{ V}$ , $V_{SEL1} = V_{SEL2} = 1.8\text{ V}$  | –   | 0.5   | –   | pF            |
|                  |  | Port A to C    | $f = 1067\text{ MHz}$ , $V_{/IO} = 0\text{ V}$ , $V_{SEL1} = V_{SEL2} = 0\text{ V}$  | –   | 0.5   | –   | pF            |
| $C_{ON}$         | Switch on capacitance                        | Port A to B    | $f = 1067\text{ MHz}$ , $V_{/IO} = 1.2\text{ V}$ , $V_{SEL1} = V_{SEL2} = 0\text{ V}$  | –   | 1.0   | –   | pF            |
|                  |  | Port A to C    | $f = 1067\text{ MHz}$ , $V_{/IO} = 1.2\text{ V}$ , $V_{SEL1} = V_{SEL2} = 1.8\text{ V}$  | –   | 1.0   | –   | pF            |
| $X_{TALK}$       | Crosstalk between channels                   | B0 to B11      | $f = 1067\text{ MHz}$ , $V_{SEL1} = V_{SEL2} = 0\text{ V}$ , $R_L = 50\ \Omega$  | –   | -34   | –   | dB            |
|                  |  | C0 to C11      | $f = 1067\text{ MHz}$ , $V_{SEL1} = V_{SEL2} = 1.8\text{ V}$ , $R_L = 50\ \Omega$  | –   | -31   | –   | dB            |
| $O_{ISO}$        | Off-isolation                                | Port A to B    | $f = 1067\text{ MHz}$ , $V_{SEL1} = V_{SEL2} = 1.8\text{ V}$ , $R_L = 50\ \Omega$  | –   | -21   | –   | dB            |
|                  |  | Port A to C    | $f = 1067\text{ MHz}$ , $V_{SEL1} = V_{SEL2} = 0\text{ V}$ , $R_L = 50\ \Omega$  | –   | -21   | –   | dB            |
| $I_L$            | Insertion loss (channel on)                  | Port A to B    | $f = \text{DC}$ , $R_L = 50\ \Omega$   | –   | -0.75 | -1  | dB            |
|                  |  | Port A to C    | $f = \text{DC}$ , $R_L = 50\ \Omega$   | –   | -0.75 | -1  | dB            |
| $BW_{SE}$        | -3 dB bandwidth (Single-ended)               | Port A to B    | $R_L = 50\ \Omega$   | –   | 5.6   | –   | GHz           |
|                  |  | Port A to C    |  | –   | 5.6   | –   |               |
| $BW_{DIFF}$      | -3 dB bandwidth (Differential)               | Port A to B    | $R_L = 100\ \Omega$  | –   | 6     | –   | GHz           |
|                  |  | Port A to C    |  | –   | 6     | –   |               |

(1) Verified by design.

### 6.7 Typical Characteristics



Typical Characteristics (continued)

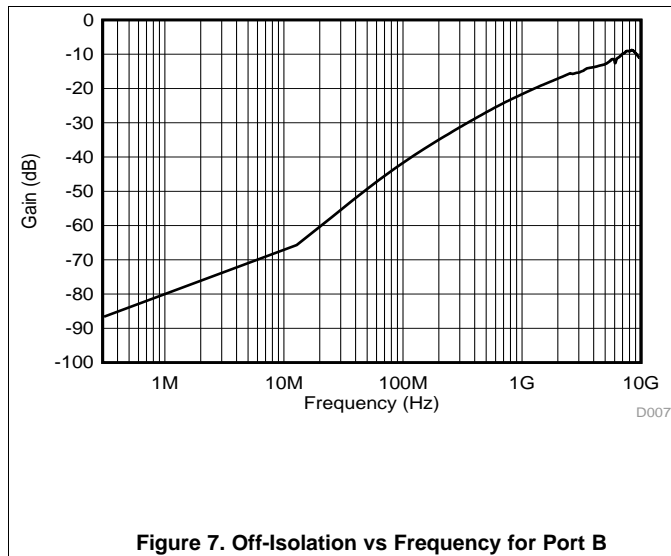


Figure 7. Off-Isolation vs Frequency for Port B

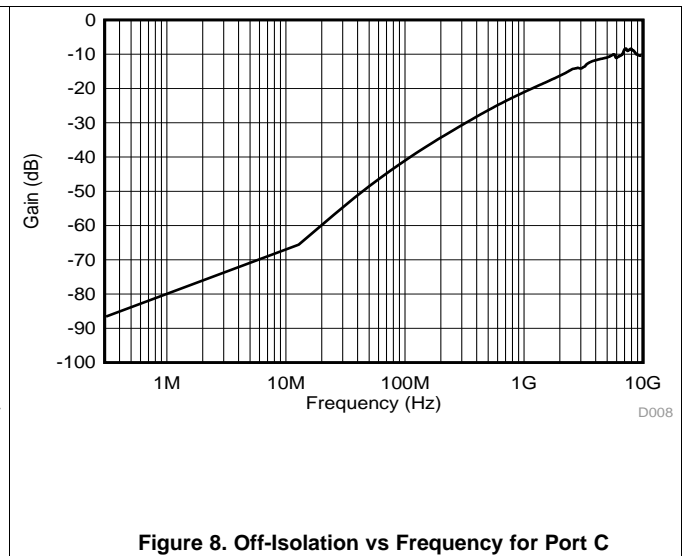


Figure 8. Off-Isolation vs Frequency for Port C

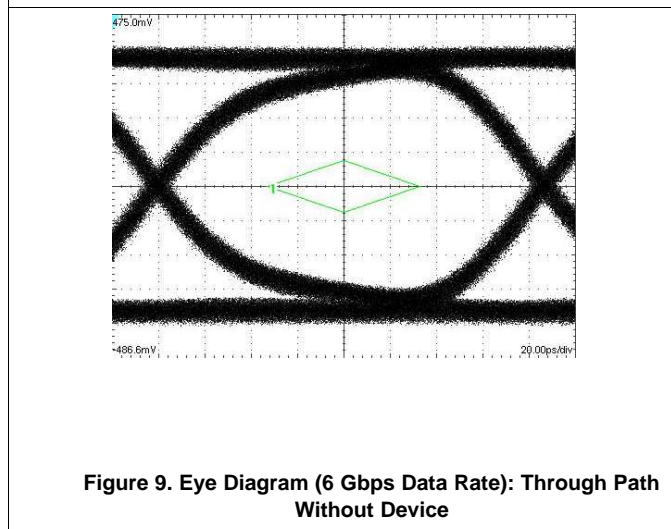


Figure 9. Eye Diagram (6 Gbps Data Rate): Through Path Without Device

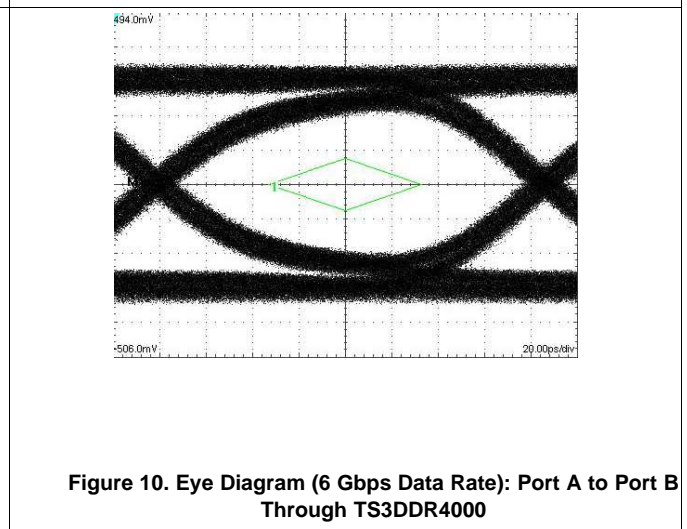


Figure 10. Eye Diagram (6 Gbps Data Rate): Port A to Port B Through TS3DDR4000

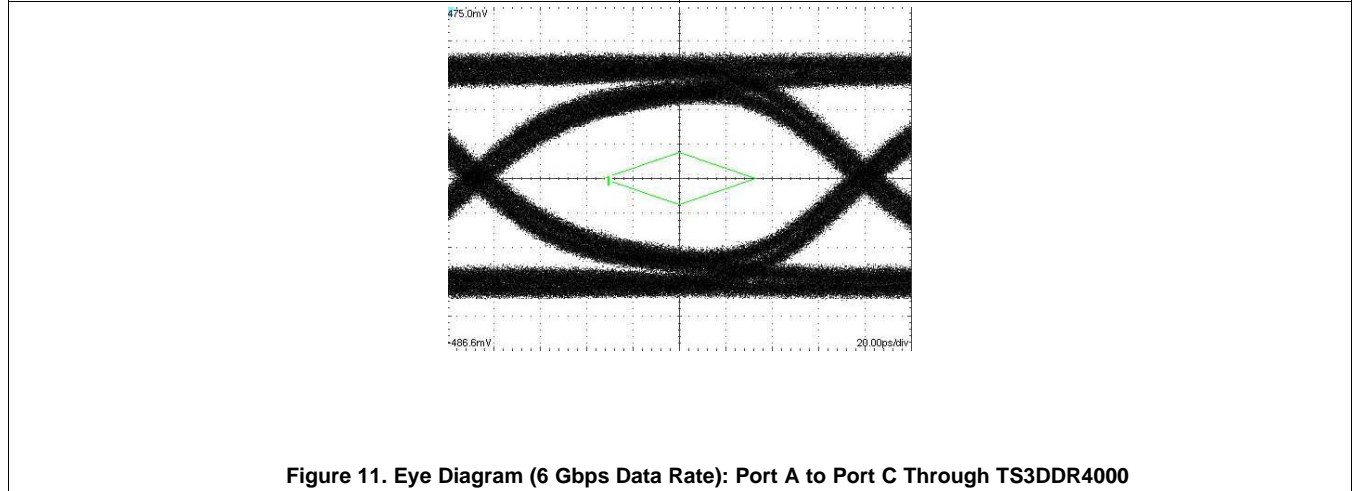


Figure 11. Eye Diagram (6 Gbps Data Rate): Port A to Port C Through TS3DDR4000



## 7 Parameter Measurement Information

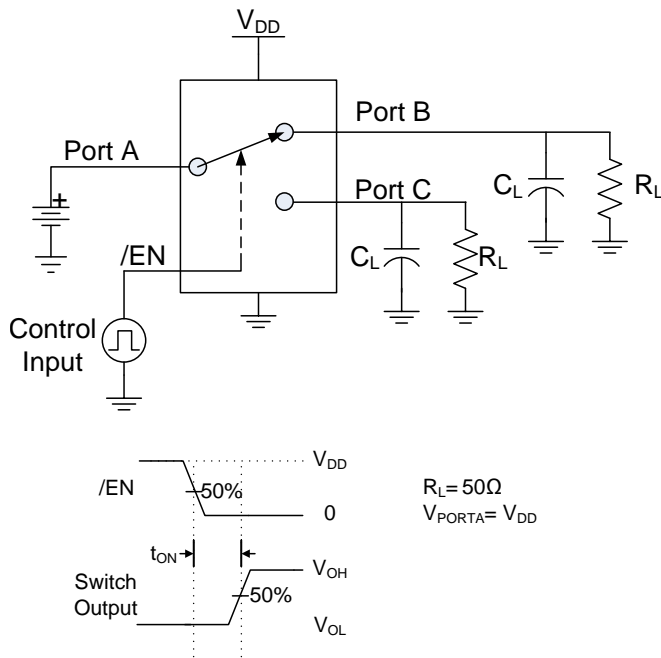


Figure 12. Switch Turn-on Time ( $t_{ON}$ ) Measurement

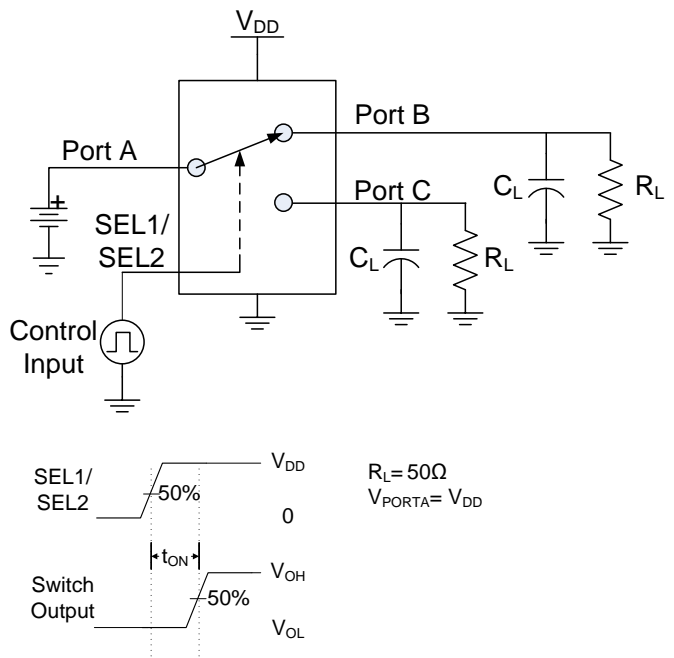


Figure 13. Switch Switching Time ( $t_{SWITCH}$ ) Measurement

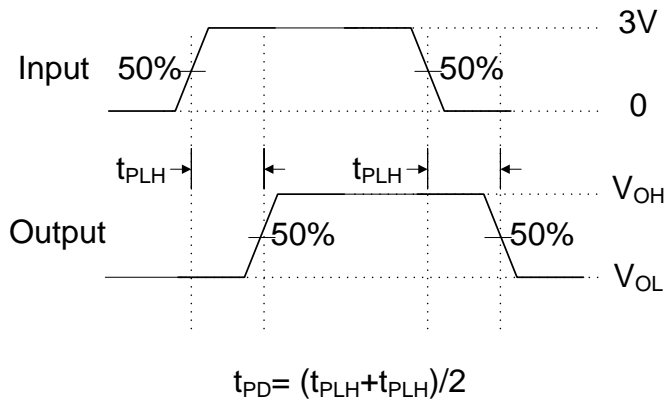


Figure 14. Propagation Delay ( $t_{PD}$ ) Measurement

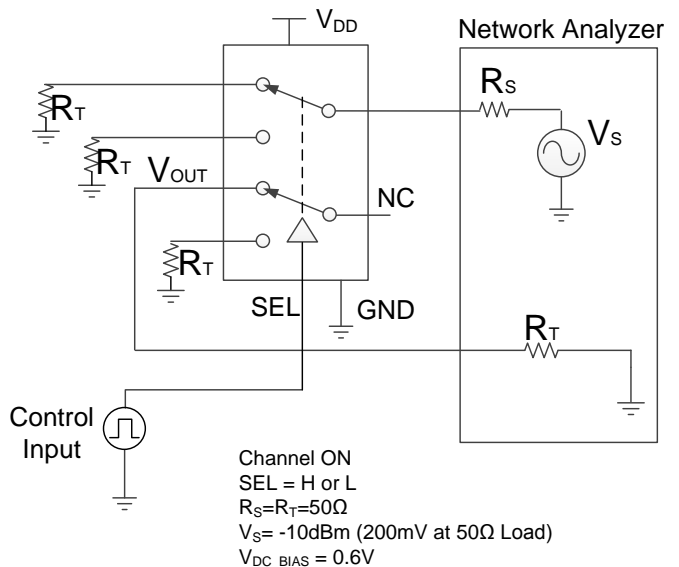


Figure 15. Crosstalk Measurement

Parameter Measurement Information (continued)

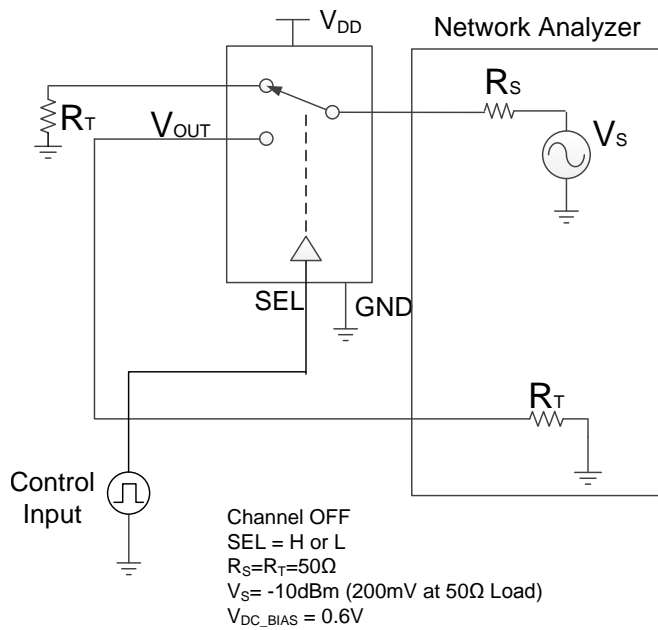


Figure 16. Off Isolation Measurement

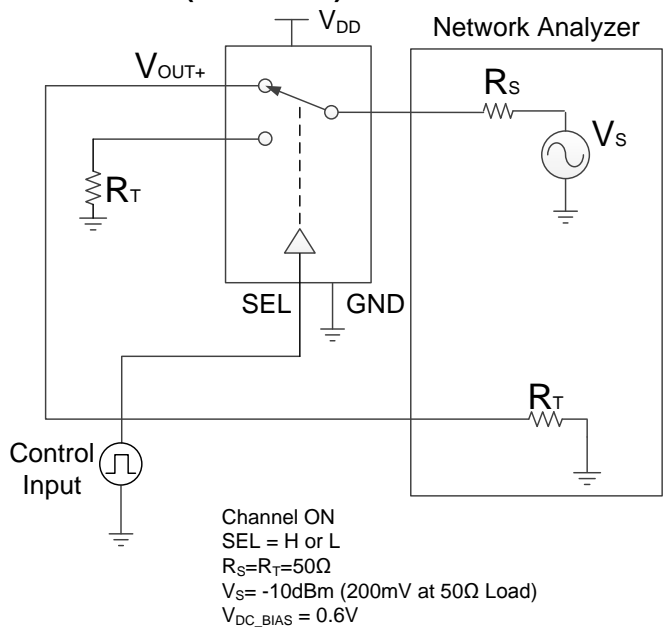


Figure 17. Bandwidth Measurement

## 8 Detailed Description

### 8.1 Overview

The TS3DDR4000 is 1:2 or 2:1 high speed DDR2/DDR3/DDR4 switch that offers 12-bit wide bus switching. The A port can be routed to the B or C port for all bits simultaneously. Designed for operation in DDR2, DDR3 and DDR4 memory bus systems that support POD\_12, SSTL\_12, SSTL\_135, SSTL\_15, or SSTL\_18 signaling, the TS3DDR4000 uses a proprietary architecture that delivers high bandwidth (differential -3dB bandwidth of up to 6 GHz), and very low propagation delay and skew across all channels. The TS3DDR4000 is 1.8 V logic compatible, and all switches are bi-directional for added design flexibility. The TS3DDR4000 also offers a low-power mode, in which all channels become high-Z and the device operates with minimal power.

### 8.2 Functional Block Diagram

The following diagram (Figure 18) represents the switch function block diagram of the TS3DDR4000. Port A (A0-A11) can be routed to either port B (B0-B11) or port C (C0-C11) by configuring the SEL0 and SEL1 pins. The EN pin can be toggled high to put the device into the low-power mode with minimal power consumption.

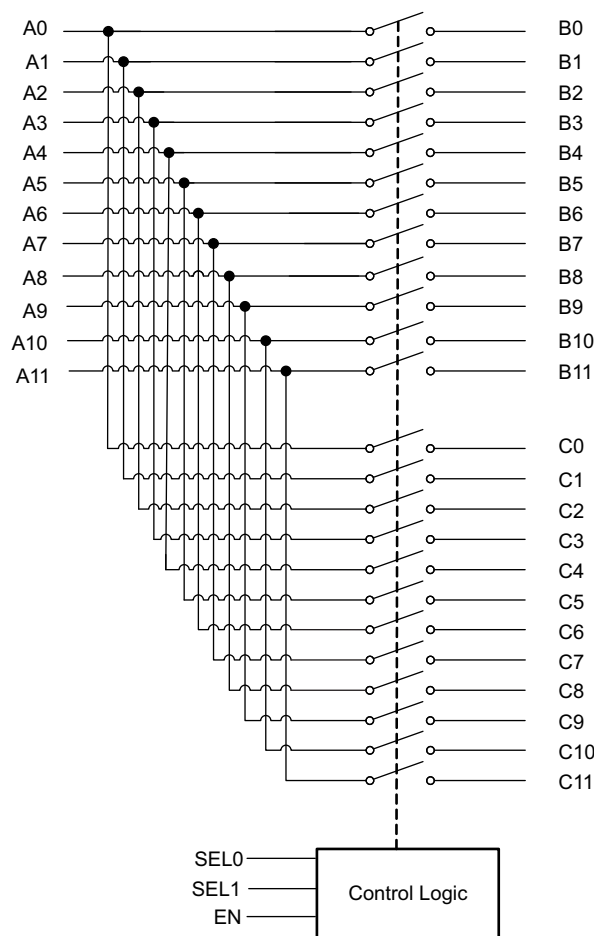


Figure 18. TS3DDR4000 Switch Function Block Diagram

### 8.3 Feature Description

- $I_{OFF}$  Protection: When no power is provided to the device ( $V_{CC} = 0\text{ V}$ ), the TS3DDR4000 prevents any I/O signals from back-powering the device. The leakage current is tightly controlled under such condition (refer to the  $I_{OFF}$  in the [Specifications](#) section) so it does not cause any system issues.
- Low-power mode: The  $\overline{EN}$  pin can be driven high to make the TS3DDR4000 enter the low-power mode. When in low power mode, all channels are isolated and the device consumes less than 5  $\mu\text{A}$  of current.

### 8.4 Device Functional Modes

When  $\overline{EN}$  pin is driven high, the TS3DDR4000 enters into the power-down mode, in which all channels are isolated and the device consumes less than 5  $\mu\text{A}$  of current. When EN pin is driven low, the A port is routed to either B port or C port depending on the configuration of SEL0 and SEL1 signals. The B and C port can also be partially turned on when SEL0 and SEL1 are not both high or both low. Refer to [Table 1](#) for the control logic details.

**Table 1. Logic Control Table**

| CONTROL PINS    |      |      | FUNCTION  |
|-----------------|------|------|---|
| $\overline{EN}$ | SEL0 | SEL1 |   |
| H               | X    | X    | Power –down mode. All channels off (isolated)   |
| L               | L    | L    | Port A to port B ON<br>Port A to port C OFF (isolated)  |
| L               | L    | H    | A [0,1,4,5,8,9] $\leftrightarrow$ B [0,1,4,5,8,9]<br>A [2,3,6,7,10,11] $\leftrightarrow$ C [2,3,6,7,10,11]<br>All other channels OFF (isolated) |
| L               | H    | L    | A [2,3,6,7,10,11] $\leftrightarrow$ B [2,3,6,7,10,11]<br>A [0,1,4,5,8,9] $\leftrightarrow$ C [0,1,4,5,8,9]<br>All other channels OFF (isolated) |
| L               | H    | H    | Port A to port B OFF (isolated)<br>Port A to port C ON  |

## 9 Application and Implementation

### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 Application Information

The TS3DDR4000 is a high-speed switch targeted for DDR memory applications that require 1:2 or 2:1 switching. The following sections describe two application scenarios that are widely used. In addition to memory applications, the TS3DDR4000 can also be used for generic high-speed switching that requires high bandwidth and minimal signal degradation.

### 9.2 Typical Application

#### 9.2.1 Non-Volatile Dual In-line Memory Module (NVDIMM) application

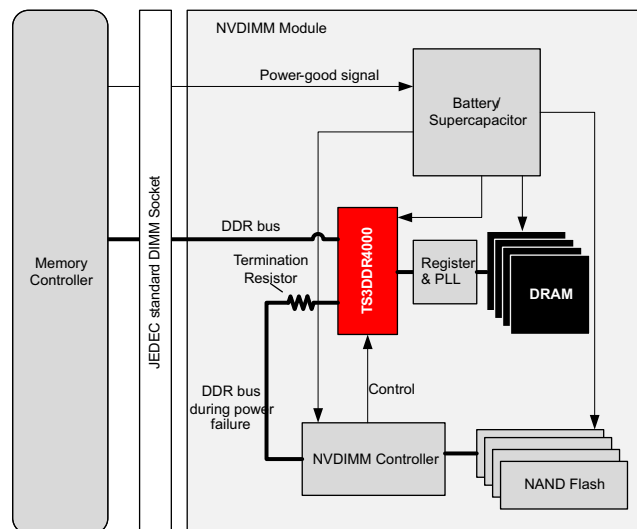


Figure 19. TS3DDR4000 Used In NVDIMM Application

##### 9.2.1.1 Design Requirements

The TS3DDR4000 can be used in the NVDIMM application to provide server systems reliable data backups when the system encounters power-failure conditions. Figure 19 depicts a typical NVDIMM design utilizing the TS3DDR4000.

In normal system operation, the TS3DDR4000 routes the DDR signals between the system and the DRAM for normal data access. When the system encounters power failure, the charge stored in the battery or the super capacitor is used to power the NVDIMM controller, which configures the TS3DDR4000 to save the data from DRAM into the NAND Flash. The NAND Flash is non-volatile in nature, so the data stored internally stays intact even when the power goes away eventually. When the system power comes back on, the NVDIMM controller can re-route the data from the NAND Flash through the TS3DDR4000 back into the DRAM and can subsequently re-start the normal system operation.

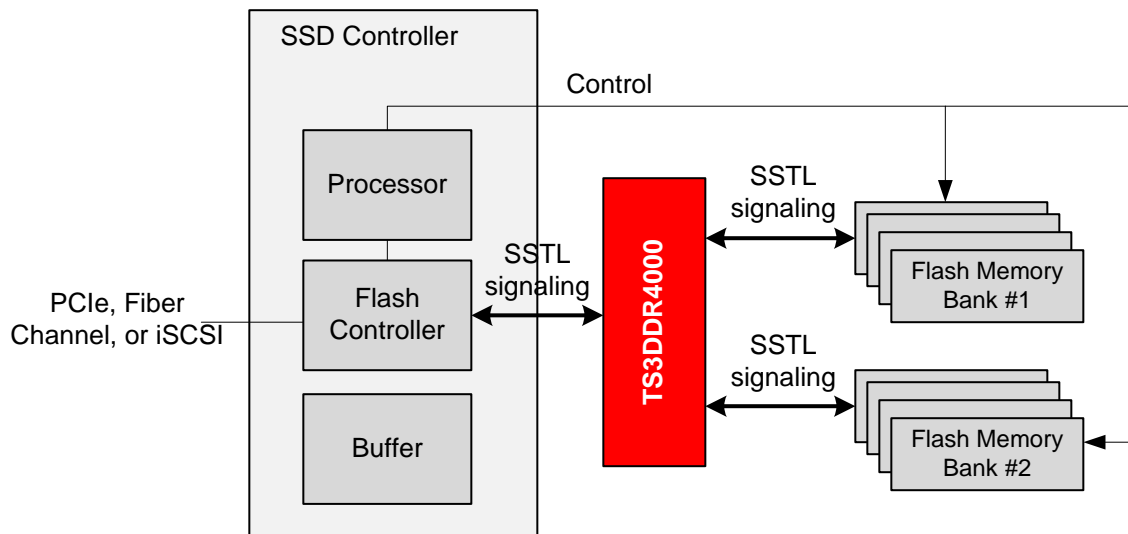
## Typical Application (continued)

### 9.2.1.2 Detailed Design Procedure

The battery or the super capacitor needs to be designed to have enough capacity to maintain the power long enough for the backup procedure to be completed. At a backup speed of 128 MB/sec, it takes about 10 seconds per 1 GB to either backup or restore the data. Typically a super capacitor is preferred for its longer life of operation. The super capacitor is usually a separate module and is connected to the NVDIMM via a cable.

NVDIMMs require support from the system motherboard. When plugged in, the BIOS must recognize the NVDIMMs. Manufacturers who control the BIOS and MRC (memory reference code) can make the necessary code changes to implement NVDIMMs into their servers.

### 9.2.2 Load Isolation Application



**Figure 20. TS3DDR4000 Used In Load Isolation Application**

#### 9.2.2.1 Design Requirements

In recent years, the size of Solid-State-Drives (SSDs) has increased rapidly, making it necessary to increase the number of flash memory devices in each drive. The flash memory devices sometimes share the same control and data channel to communicate with the controller. This causes increased loading to each communication channel as the number of flash memory devices increases. To meet the performance requirement of an SSD, the ability to isolate the loading becomes necessary.

#### 9.2.2.2 Detailed Design Procedure

As depicted in [Figure 20](#), the TS3DDR4000 can be used for load isolation purpose. Flash memory bank #1 and #2 can share the same communication channel to the flash controller without increasing the loading to each other. While the TS3DDR4000 is enabled for one channel, the other channel is fully isolated. The off-isolation specification is about -21 dB at 1067 MHz, as described in the [Specifications](#) section.

## 10 Power Supply Recommendations

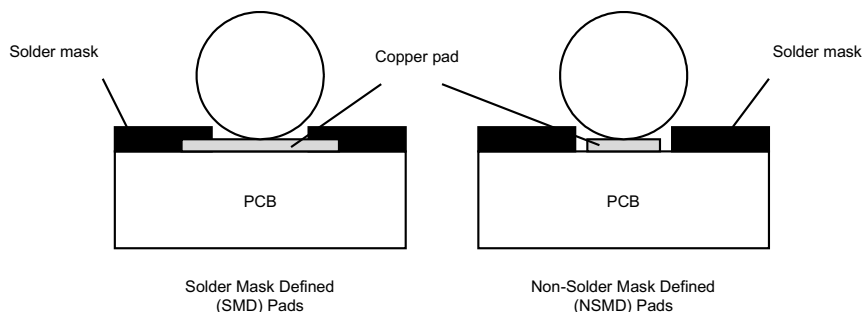
$V_{DD}$  should be in the range of 2.375 V to 3.6 V. A 0.1  $\mu$ F or higher decoupling capacitors placed as closed to the BGA pad as possible is recommended. There are no power sequence requirements for the TS3DDR4000.

## 11 Layout

### 11.1 Layout Guidelines

Standard layout technique for 0.65 mm pitch BGA package shall be employed. The following commonly-used printed-circuit-board (PCB) layout guidelines are recommended:

- Use Non-Solder-Mask-Defined (NSMD), rather than Solder-Mask-Defined (SMD) pads for the BGA solder balls to adhere if possible. For most applications, the NSMD pads provide more flexibility, fewer stress.



**Figure 21. Solder-Mask-Defined (SMD) and Non-Solder-Mask-Defined (NSMD) Pads**

- One trace can generally be routed between two solder pads of a 0.65 mm pitch BGA. This allows the outer two rows of solder pads to be routed on the same top/bottom layer. The TS3DDR4000 has 4 rows, and thus no VIAs is generally required to route all the inner balls out.
- Generally high-speed signal layout guidelines:
  - To minimize the effects of crosstalk on adjacent traces, keep the traces at least two times the trace width apart.
  - Separate high-speed signals from low-speed signals and digital from analog signals.
  - Avoid right-angle bends in a trace and try to route them at least with two 45° corners.
  - The high-speed differential signal traces should be routed parallel to each other as much as possible. The traces are recommended to be symmetrical.
  - A solid ground plane should be placed next to the high-speed signal layer. This also provides an excellent low-inductance path for the return current flow.

## 11.2 Layout Example

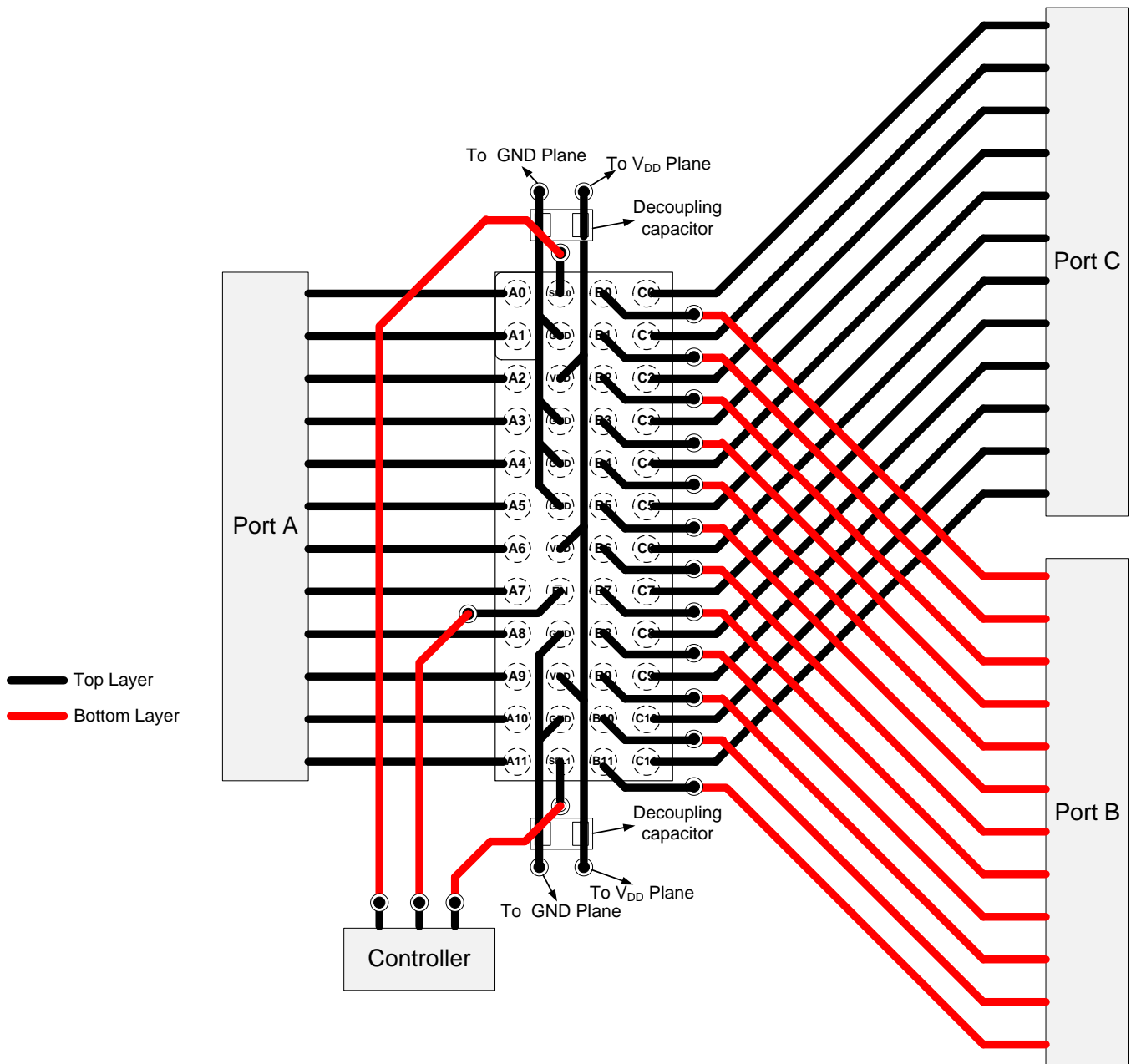


Figure 22. TS3DDR4000 Layout Example



## 12 Device and Documentation Support

### 12.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

### 12.2 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 12.3 Trademarks

E2E is a trademark of Texas Instruments.  
All other trademarks are the property of their respective owners.

### 12.4 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 12.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples        |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|----------------|
| TS3DDR4000ZBAR   | ACTIVE        | NFBGA        | ZBA                | 48   | 3000           | RoHS & Green    | SNAGCU                               | Level-3-260C-168 HR  | -40 to 85    | DDR4000                 | <b>Samples</b> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

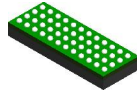
| Device         | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TS3DDR4000ZBAR | NFBGA        | ZBA             | 48   | 3000 | 330.0              | 16.4               | 3.4     | 8.4     | 1.65    | 8.0     | 16.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TS3DDR4000ZBAR | NFBGA        | ZBA             | 48   | 3000 | 336.6       | 336.6      | 31.8        |

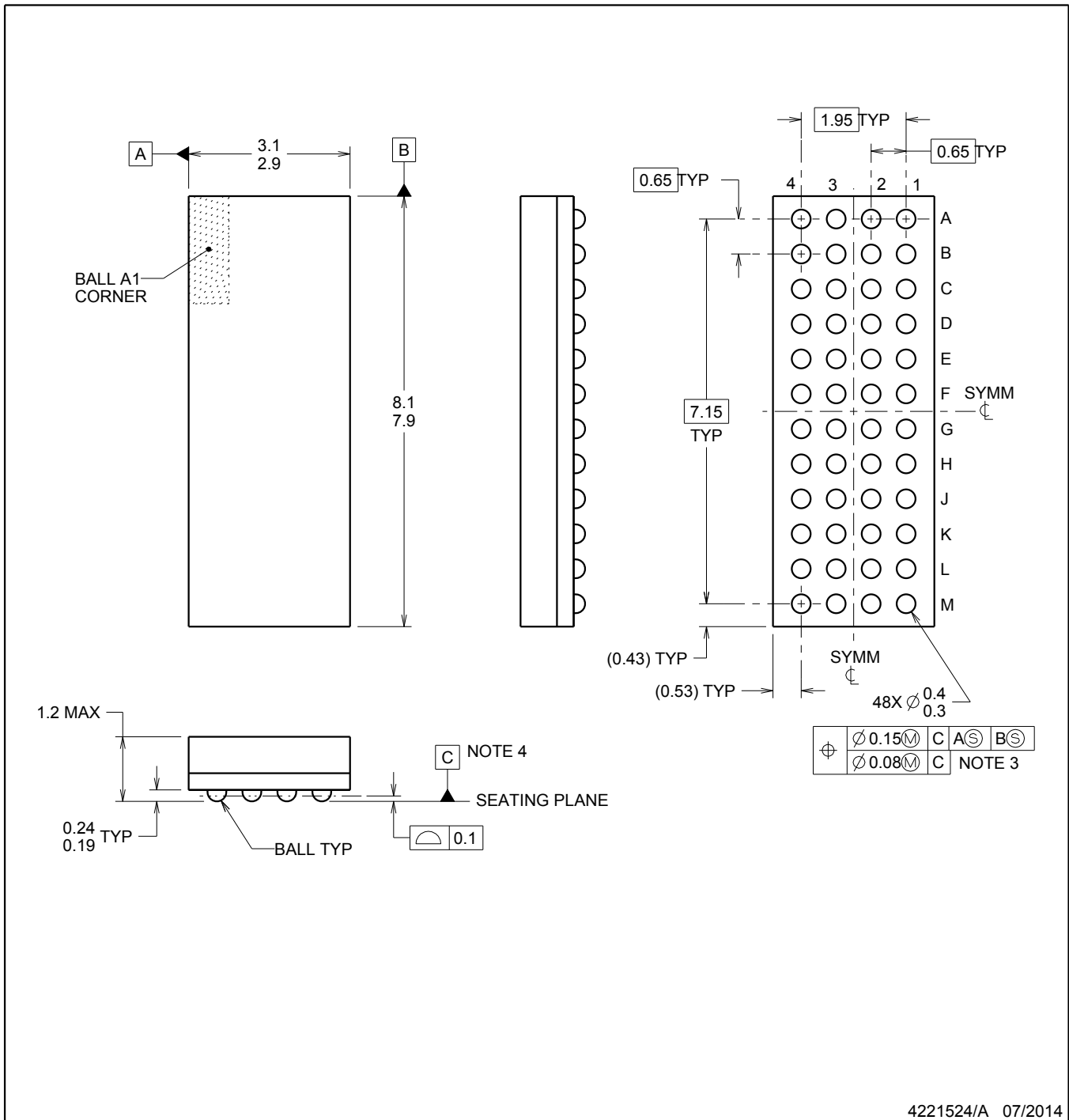
# ZBA0048A



# PACKAGE OUTLINE

## NFBGA - 1.2 mm max height

BALL GRID ARRAY



### NOTES:

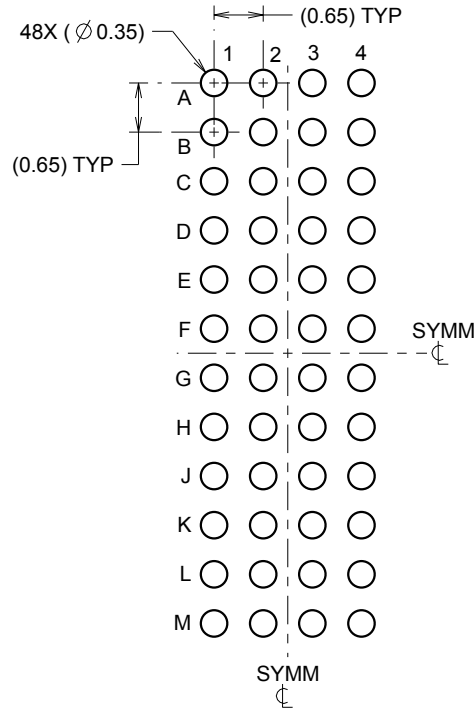
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Dimension is measured at the maximum solder ball diameter, parallel to primary datum C.
4. Primary datum C and seating plane are defined by the spherical crowns of the solder balls.

# EXAMPLE BOARD LAYOUT

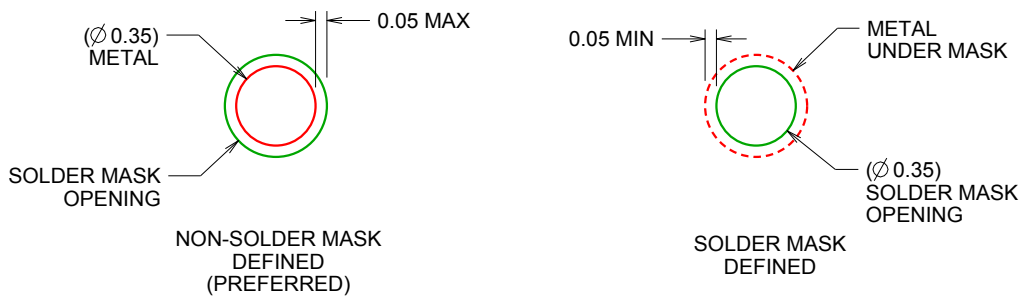
ZBA0048A

NFBGA - 1.2 mm max height

BALL GRID ARRAY



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221524/A 07/2014

NOTES: (continued)

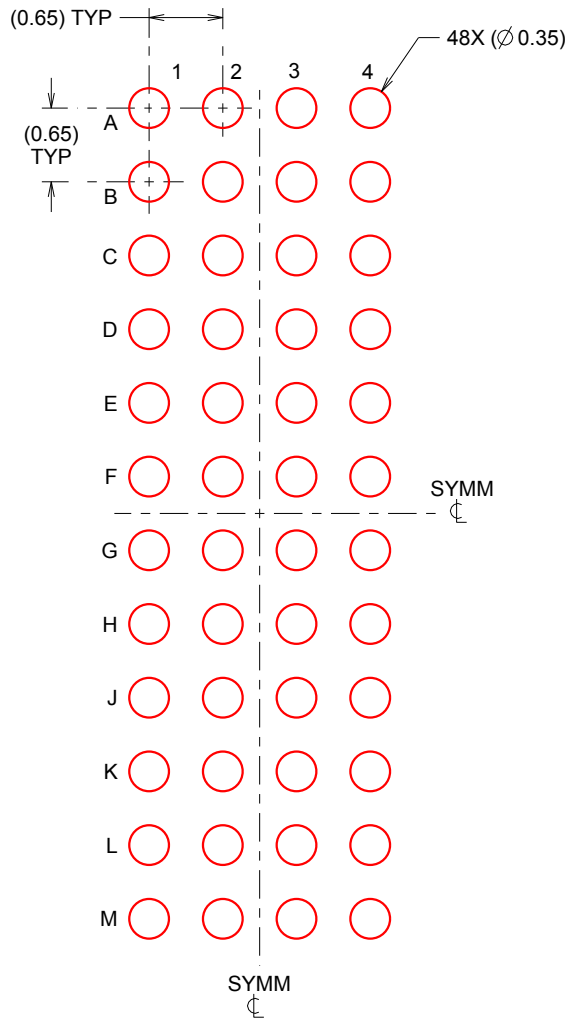
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For more information, see Texas Instruments Literature number SPRAA99 ([www.ti.com/lit/spraa99](http://www.ti.com/lit/spraa99)).

# EXAMPLE STENCIL DESIGN

ZBA0048A

NFBGA - 1.2 mm max height

BALL GRID ARRAY



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4221524/A 07/2014

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

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