# 1-GHz BANDWIDTH, 8-CHANNEL SPST SWITCH

**Check for Samples: TS2DDR2811**

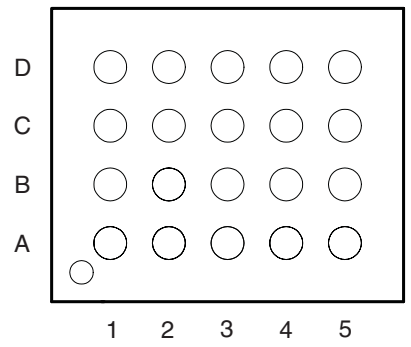
## FEATURES

- **Wide Bandwidth (BW = 1100 MHz Typ)**
- **Low Crosstalk ($X_{TALK}$ = –37 dB Typ)**
- **Low Bit-to-Bit Skew ($t_{sk(o)}$ = 100 ps Max)**
- **Low and Flat ON-State Resistance ($r_{ON}$ = 4 Ω Typ, $r_{ON(flat)}$ = 0.5 Ω Typ)**
- **Low Input/Output Capacitance ($C_{ON}$ = 8 pF Typ)**
- **Rail-to-Rail Switching on Data I/O Ports (0 V to 5 V)**
- **$V_{CC}$ Operating Range From 3 V to 3.6 V**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **ESD Performance Tested Per JESD 22**
  - **2000-V Human-Body Model (A114-B, Class II)**
  - **1000-V Charged-Device Model (C101)**

## APPLICATIONS

- **DDR2 Signal Switching**
- **GbE LAN Signal Switching**
- **Hub and Router Signal Switching**
- **Audio/Video Switching**

**ZXY PACKAGE**
**(BOTTOM VIEW)**




**TERMINAL ASSIGNMENTS**

| | | | | | |
|---|---|---|---|---|---|
| **D** | $B_6$ | $B_5$ | $B_3$ | SEL | $B_0$ |
| **C** | $B_7$ | $B_4$ | $B_2$ | $B_1$ | N.C. |
| **B** | GND | $A_5$ | $A_3$ | $A_1$ | $V_{CC}$ |
| **A** | $A_7$ | $A_6$ | $A_4$ | $A_2$ | $A_0$ |
| | **1** | **2** | **3** | **4** | **5** |

## DESCRIPTION/ORDERING INFORMATION

The TS2DDR2811 is a 8-channel single-pole single-throw (SPST) signal switch capable of switching signals with bandwidth in excess of 1 GHz. The device includes a select pin (SEL) that is used to select any 1 of the 8 channel inputs. This select pin controls the data path of the SPST switch. The device provides a low and flat ON-state resistance ($r_{ON}$) and an excellent ON-state resistance match. Low input/output capacitance, high bandwidth, low skew, and low crosstalk among channels make this device suitable for various high-bandwidth applications, such as DDR2, 10/100/1000 Base-T, audio, and video.

**Table 1. ORDERING INFORMATION**

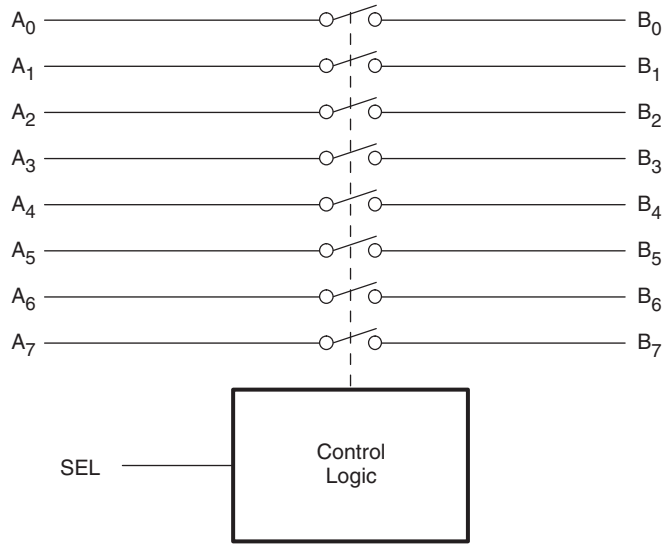
| $T_A$ | PACKAGE(1) (2) | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| –40°C to 85°C | BGA – ZXY | Tape and reel | TS2DDR2811ZXYR | SJ811 |

(1) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

## FUNCTION TABLE

| INPUT SEL | INPUT | OUTPUT | FUNCTION |
|---|---|---|---|
| H | $A_n$ | $B_n$ | $A_n = B_n$ |
| L | - | - | $A_n$ and $B_n$ are Hi-Z |

## LOGIC DIAGRAM




## TERMINAL FUNCTIONS

| BALL | | DESCRIPTION |
|---|---|---|
| NAME | NO. | |
| $A_0$, $A_1$, $A_2$, $A_3$, $A_4$, $A_5$, $A_6$, $A_7$ | A5, B4, A4 B3, A3, B2, A2, A1 | Data I/Os |
| $B_0$, $B_1$, $B_2$,$B_3$, $B_4$, $B_5$ , $B_6$, $B_7$ | D5, C4, C3, D3, C2, D2, D1, C1 | Data I/Os |
| GND | B1 | Ground |
| SEL | D4 | Select inputs |
| $V_{CC}$ | B5 | Supply voltage |

## ABSOLUTE MAXIMUM RATINGS(1)

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

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage range | | –0.5 | 4.6 | V |
| $V_{IN}$ | Control input voltage range(2) (3) | | –0.5 | 7 | V |
| $V_{I/O}$ | Switch I/O voltage range(2) (3) (4) | | –0.5 | 7 | V |
| $I_{IK}$ | Control input clamp current | $V_{IN} < 0$ or $V_{IN} > V_{CC}$ | | –50 | mA |
| $I_{I/OK}$ | I/O port clamp current | $V_{I/O} < 0$ or $V_{I/O} > V_{CC}$ | | –50 | mA |
| $I_{I/O}$ | ON-state switch current(5) | | | ±128 | mA |
| | Continuous current through $V_{DD}$ or GND | | | ±100 | mA |
| $\theta_{JA}$ | Package thermal impedance(6) | | | 31.8 | °C/W |
| $T_{stg}$ | Storage temperature range | | –65 | 150 | °C |

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltages are with respect to ground, unless otherwise specified.
(3) The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
(4) $V_I$ and $V_O$ are used to denote specific conditions for $V_{I/O}$.
(5) $I_I$ and $I_O$ are used to denote specific conditions for $I_{I/O}$.
(6) The package thermal impedance is calculated in accordance with JESD 51-7.

## RECOMMENDED OPERATING CONDITIONS(1)

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | | 3 | 3.6 | V |
| $V_{IH}$ | High-level control input voltage | SEL | 2 | 5.5 | V |
| $V_{IL}$ | Low-level control input voltage | SEL | 0 | 0.8 | V |
| $V_I$ | Input voltage | SEL | 0 | 5.5 | V |
| $V_{I/O}$ | Input/output voltage | | 0 | $V_{CC}$ | V |
| $T_A$ | Operating free-air temperature | | –40 | 85 | °C |

(1) All unused control inputs of the device must be held at $V_{DD}$ or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

## ELECTRICAL CHARACTERISTICS

for 1000 Base-T Ethernet switching over recommended operating free-air temperature range, $V_{CC}$ = 3.3 V ± 0.3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS(1) | | | | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| $V_{IK}$ | SEL | $V_{CC}$ = 3.6 V, | $I_{IN}$ = –18 mA | | | | –0.7 | –1.2 | V |
| $I_{IH}$ | SEL | $V_{CC}$ = 3.6 V, | $V_{IN} = V_{CC}$ | | | | | ±1 | µA |
| $I_{IL}$ | SEL | $V_{CC}$ = 3.6 V, | $V_{IN}$ = GND | | | | | ±1 | µA |
| $I_{CC}$ | | $V_{CC}$ = 3.6 V, | $I_{I/O}$ = 0, | Switch ON or OFF | | | 250 | 500 | µA |
| $C_{IN}$ | SEL | f = 1 M Hz, | $V_{IN}$ = 0 | | | | 2 | 2.5 | pF |
| $C_{OFF}$ | B port | $V_I$ = 0, | f = 1 MHz, | Outputs open, | Switch OFF | | 2.5 | 4 | pF |
| $C_{ON}$ | | $V_I$ = 0, | f = 1 MHz, | Outputs open, | Switch ON | | 8 | TBD | pF |
| $r_{ON}$ | | $V_{CC}$ = 3 V, | 1.5 V ≤ $V_I$ ≤ $V_{CC}$, | $I_O$ = –40 mA | | | 4 | 6 | Ω |
| $r_{ON(flat)}$ (3) | | $V_{CC}$ = 3 V, | $V_I$ = 1.5 V and $V_{CC}$, | $I_O$ = –40 mA | | | 0.5 | | Ω |
| $\Delta r_{ON}$ (4) | | $V_{CC}$ = 3 V, | 1.5 V ≤ $V_I$ ≤ $V_{CC}$, | $I_O$ = –40 mA | | | 0.4 | 1 | Ω |

(1) $V_I$, $V_O$, $I_I$, and $I_O$ refer to I/O pins. $V_{IN}$ refers to the control inputs.
(2) All typical values are at $V_{CC}$ = 3.3 V (unless otherwise noted), $T_A$ = 25°C.
(3) $r_{ON(flat)}$ is the difference of $r_{ON}$ in a given channel at specified voltages.
(4) $\Delta r_{ON}$ is the difference of $r_{ON}$ from center ($A_4$, $A_5$) ports to any other port.

## ELECTRICAL CHARACTERISTICS

for 10/100 Base-T Ethernet switching over recommended operating free-air temperature range, $V_{CC}$ = 3.3 V ± 0.3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS[1] | | | | MIN | TYP[2] | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| $V_{IK}$ | SEL | $V_{CC}$ = 3.6 V, | $I_{IN}$ = –18 mA | | | | –0.7 | –1.2 | V |
| $I_{IH}$ | SEL | $V_{CC}$ = 3.6 V, | $V_{IN}$ = $V_{CC}$ | | | | | ±1 | µA |
| $I_{IL}$ | SEL | $V_{CC}$ = 3.6 V, | $V_{IN}$ = GND | | | | | ±1 | µA |
| $I_{CC}$ | | $V_{CC}$ = 3.6 V, | $I_{I/O}$ = 0, | Switch ON or OFF | | | 250 | 500 | µA |
| $C_{IN}$ | SEL | f = 1 MHz, | $V_{IN}$ = 0 | | | | 2 | 2.5 | pF |
| $C_{OFF}$ | B port | $V_I$ = 0, | f = 1 MHz, | Outputs open, | Switch OFF | | 2.5 | 4 | pF |
| $C_{ON}$ | | $V_I$ = 0, | f = 1 MHz, | Outputs open, | Switch ON | | 8 | | pF |
| $r_{ON}$ | | $V_{CC}$ = 3 V, | 1.25 V ≤ $V_I$ ≤ $V_{CC}$, | $I_O$ = –10 mA to –30 mA | | | 4 | 6 | Ω |
| $r_{ON(flat)}$ [3] | | $V_{CC}$ = 3 V, | $V_I$ = 1.25 V and $V_{CC}$, | $I_O$ = –10 mA to –30 mA | | | 0.5 | | Ω |
| $\Delta r_{ON}$ [4] | | $V_{CC}$ = 3 V, | 1.25 V ≤ $V_I$ ≤ $V_{CC}$, | $I_O$ = –10 mA to –30 mA | | | 0.4 | 1 | Ω |

(1) $V_I$, $V_O$, $I_I$, and $I_O$ refer to I/O pins. $V_{IN}$ refers to the control inputs.
(2) All typical values are at $V_{CC}$ = 3.3 V (unless otherwise noted), $T_A$ = 25°C.
(3) $r_{ON(flat)}$ is the difference of $r_{ON}$ in a given channel at specified voltages.
(4) $\Delta r_{ON}$ is the difference of $r_{ON}$ from center ($A_4$, $A_5$) ports to any other port.

## SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, $V_{CC}$ = 3.3 V ± 0.3 V, $R_L$ = 200 Ω, $C_L$ = 10 pF (unless otherwise noted) (see Figure 5 and Figure 6)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | MIN | TYP[1] | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{pd}$ [2] | A or B | B or A | | 40 | | ps |
| $t_{PZH}$, $t_{PZL}$ | SEL | A or B | 0.5 | | 15 | ns |
| $t_{PHZ}$, $t_{PLZ}$ | SEL | A or B | 0.9 | | 9 | ns |
| $t_{sk(o)}$ [3] | A or B | B or A | | 50 | 100 | ps |
| $t_{sk(p)}$ [4] | | | | 50 | 150 | ps |

(1) All typical values are at $V_{CC}$ = 3.3 V (unless otherwise noted), $T_A$ = 25°C.
(2) The propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance when driven by an ideal voltage source (zero output impedance).
(3) Output skew between center port ($A_4$ to $A_5$) to any other port
(4) Skew between opposite transitions of the same output in a given device $|t_{PHL} - t_{PLH}|$

## DYNAMIC CHARACTERISTICS

over recommended operating free-air temperature range, $V_{CC}$ = 3.3 V ± 0.3 V (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | | | TYP[1] | UNIT |
|---|---|---|---|---|---|
| $X_{TALK}$ | $R_L$ = 100 Ω, | f = 250 MHz, | See Figure 8 | –37 | dB |
| $O_{IRR}$ | $R_L$ = 100 Ω, | f = 250 MHz, | See Figure 9 | –37 | dB |
| BW | $R_L$ = 50 Ω, | See Figure 7 | | 1100 | MHz |

(1) All typical values are at $V_{CC}$ = 3.3 V (unless otherwise noted), $T_A$ = 25°C.

## OPERATING CHARACTERISTICS

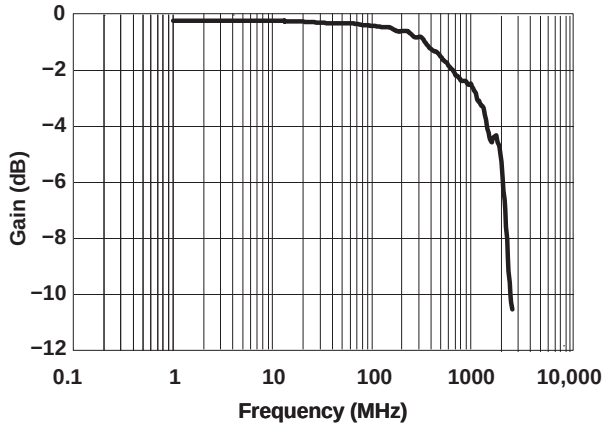



Figure 1. Gain vs Frequency

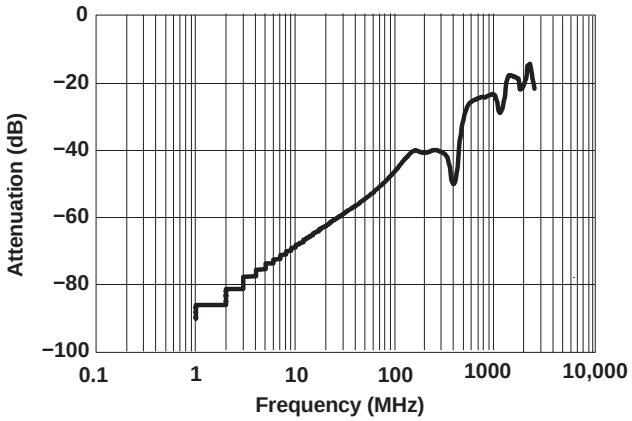



Figure 2. OFF Isolation vs Frequency

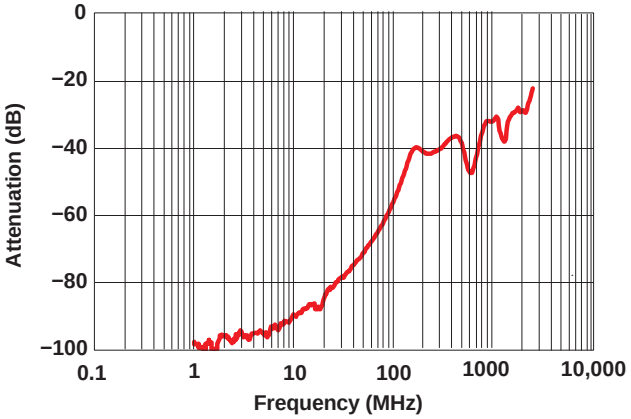



Figure 3. Crosstalk vs Frequency

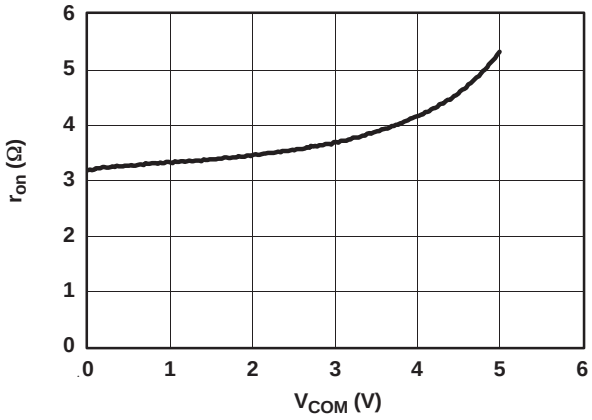
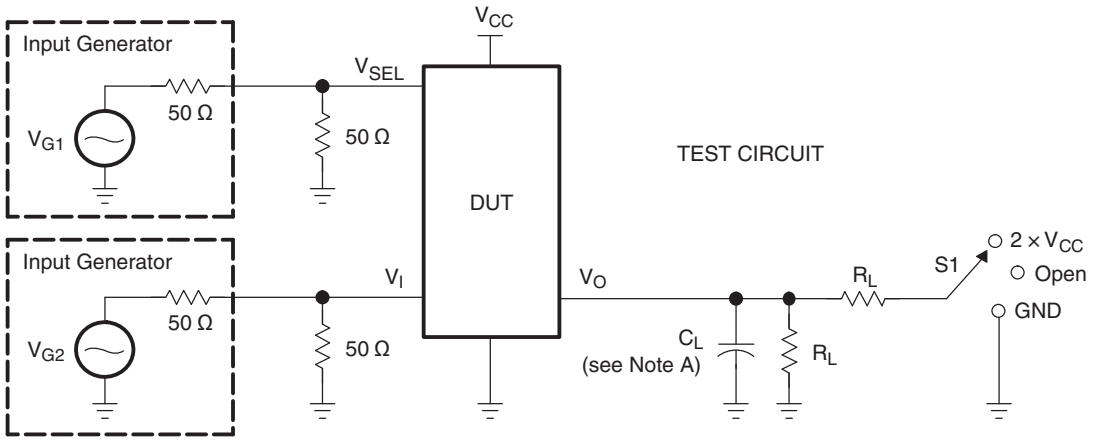
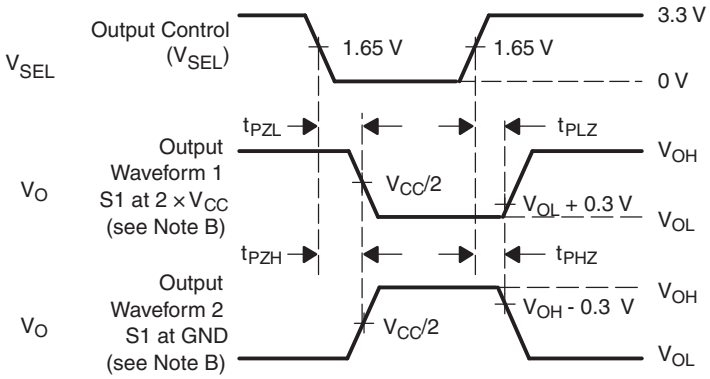



Figure 4. $r_{ON}$ (Ω) vs $V_{com}$ (V)

## PARAMETER MEASUREMENT INFORMATION
## (Enable and Disable Times)




| TEST | $V_{CC}$ | S1 | $R_L$ | $V_I$ | $C_L$ | $V_\Delta$ |
|---|---|---|---|---|---|---|
| $t_{PLZ}/t_{PZL}$ | 3.3 V ± 0.3 V | 2 × $V_{CC}$ | 200 Ω | GND | 10 pF | 0.3 V |
| $t_{PHZ}/t_{PZH}$ | 3.3 V ± 0.3 V | GND | 200 Ω | $V_{CC}$ | 10 pF | 0.3 V |




VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

A. $C_L$ includes probe and jig capacitance.

B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2is for an output with internal conditions such that the output is high, except when disabled by the output control.

C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, $Z_O$ = 50 Ω, $t_r$ ≤ 2.5 ns, $t_f$ ≤ 2.5 ns.

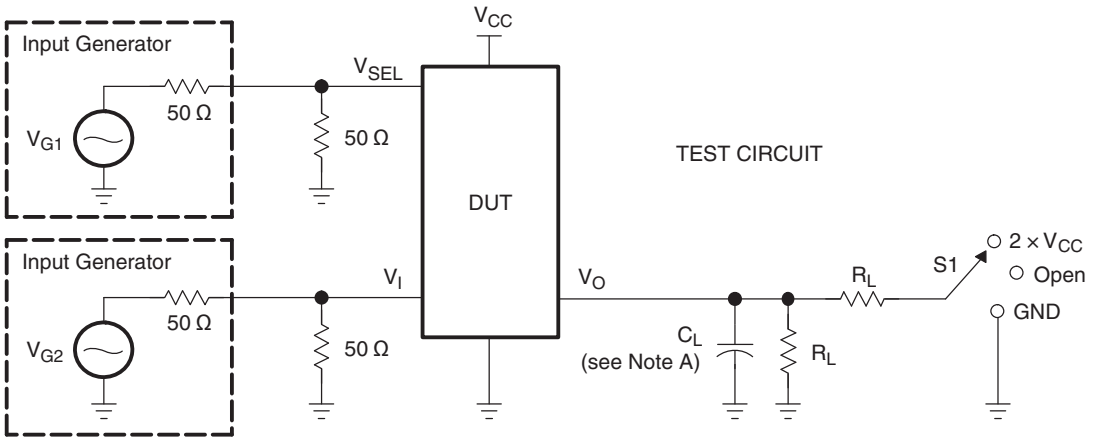
D. The outputs are measured one at a time, with one transition per measurement.

E. $t_{PLZ}$ and $t_{PHZ}$ are the same as $t_{dis}$.

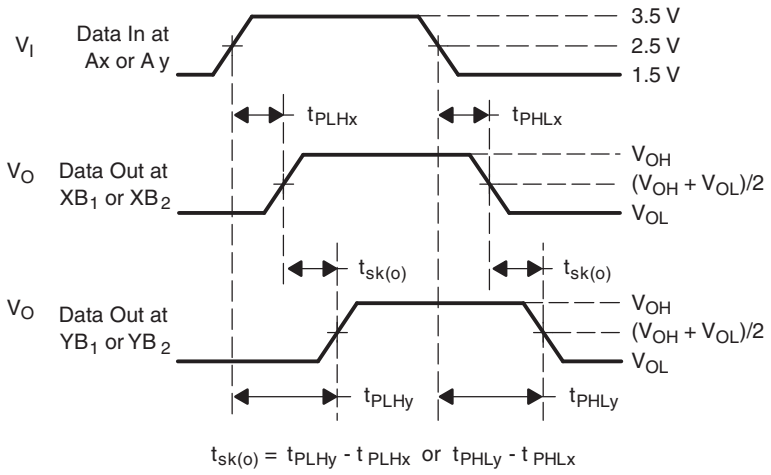
F. $t_{PZL}$ and $t_{PZH}$ are the same as $t_{en}$.

**Figure 5. Test Circuit and Voltage Waveforms**

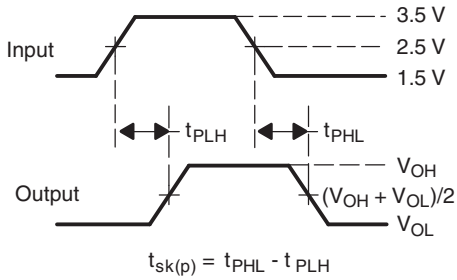
## PARAMETER MEASUREMENT INFORMATION (Skew)




| TEST | $V_{CC}$ | S1 | $R_L$ | $V_{in}$ | $C_L$ |
|---|---|---|---|---|---|
| $t_{sk(o)}$ | 3.3 V ± 0.3 V | Open | 200 Ω | $V_{CC}$ or GND | 10 pF |
| $t_{sk(p)}$ | 3.3 V ± 0.3 V | Open | 200 Ω | $V_{CC}$ or GND | 10 pF |




VOLTAGE WAVEFORMS
OUTPUT SKEW ($t_{sk(o)}$)




VOLTAGE WAVEFORMS
PULSE SKEW [$t_{sk(p)}$]

A. $C_L$ includes probe and jig capacitance.

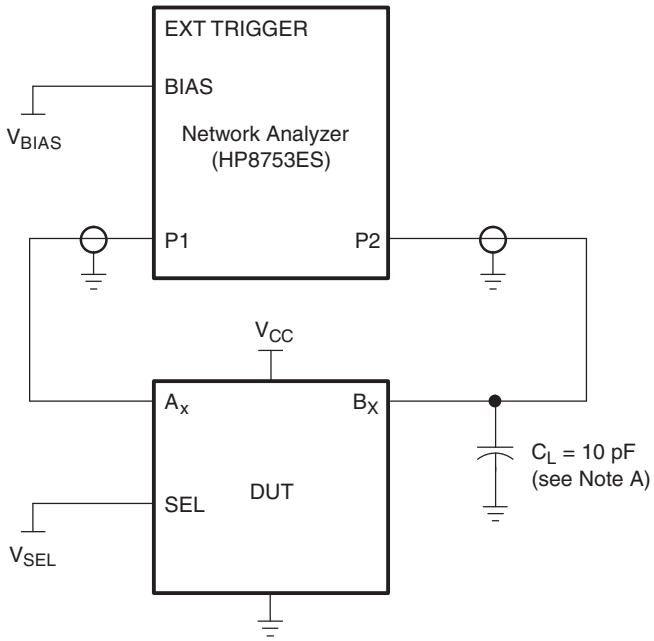
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2is for an output with internal conditions such that the output is high, except when disabled by the output control.

C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, $Z_O$ = 50 Ω, $t_r$ ≤ 2.5 ns, $t_f$ ≤ 2.5 ns.

D. The outputs are measured one at a time, with one transition per measurement.

**Figure 6. Test Circuit and Voltage Waveforms**

## PARAMETER MEASUREMENT INFORMATION




A. $C_L$ includes probe and jig capacitance.

**Figure 7. Test Circuit for Frequency Response (BW)**

Frequency response is measured at the output of the ON channel. For example, when $V_{SEL}$ = 0 and $A_0$ is the input, the output is measured at B0. All unused analog I/O ports are left open.

### HP8753ES Setup

Average = 4
RBW = 3 kHz
$V_{BIAS}$ = 0.35 V
ST = 2 s
P1 = 0 dBM

## PARAMETER MEASUREMENT INFORMATION (continued)

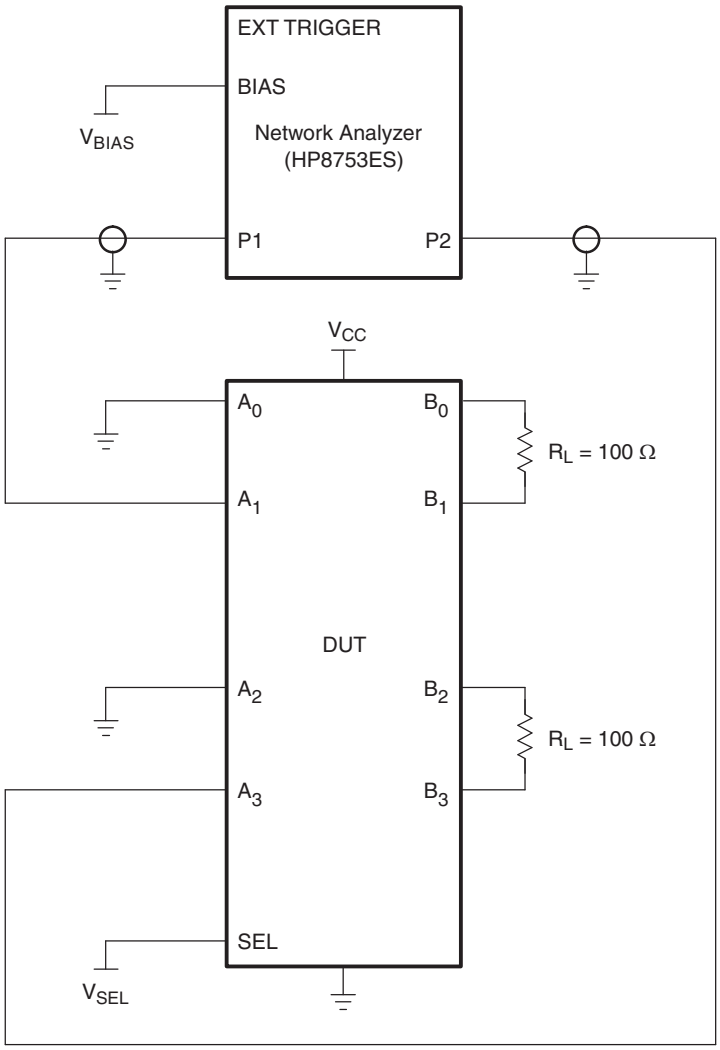


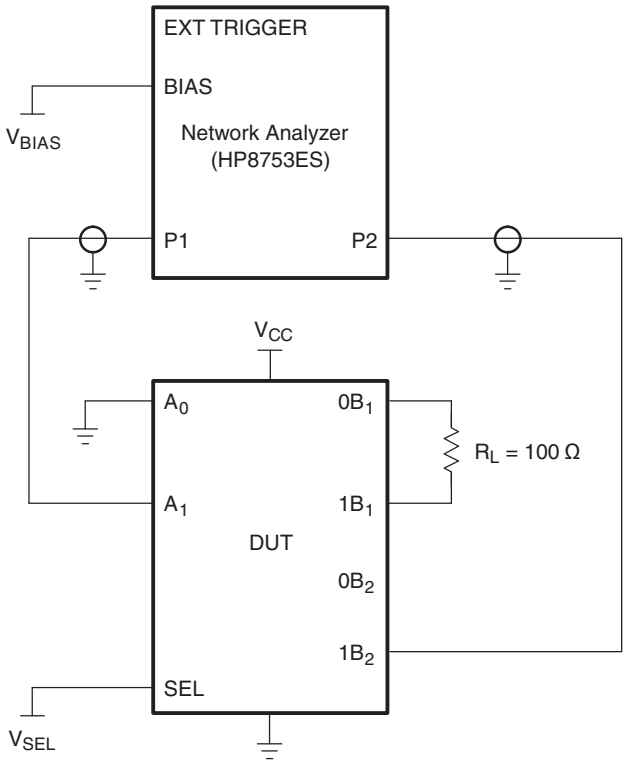

**Figure 8. Test Circuit for Crosstalk ($X_{TALK}$)**

Crosstalk is measured at the output of the nonadjacent ON channel. For example, when $V_{SELn}$ = 0 and $A_0$ is the input, the output is measured at B0. All unused analog input (A) ports are connected to GND, and output (B) ports are connected to GND through 50-Ω pulldown resistors.

### HP8753ES Setup

Average = 4
RBW = 3 kHz
$V_{BIAS}$ = 0.35 V
ST = 2 s
P1 = 0 dBM

## PARAMETER MEASUREMENT INFORMATION (continued)




A. $C_L$ includes probe and jig capacitance.

B. A 50-Ω termination resistor is needed to match the loading of the network analyzer.

**Figure 9. Test Circuit for Off Isolation ($O_{IRR}$)**

OFF isolation is measured at the output of the OFF channel. For example, when $V_{SELn} = V_{CC}$ and $A_0$ is the input, the output is measured at B0. All unused analog input (A) ports are left open, and output (B) ports are connected to GND through 50-Ω pulldown resistors.

### HP8753ES Setup

Average = 4
RBW = 3 kHz
$V_{BIAS}$ = 0.35 V
ST = 2 s
P1 = 0 dBM

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TS2DDR2811ZXYR | LIFEBUY | BGA MICROSTAR JUNIOR | ZXY | 20 | 2500 | Green (RoHS & no Sb/Br) | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | SJ811 | |

**(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.

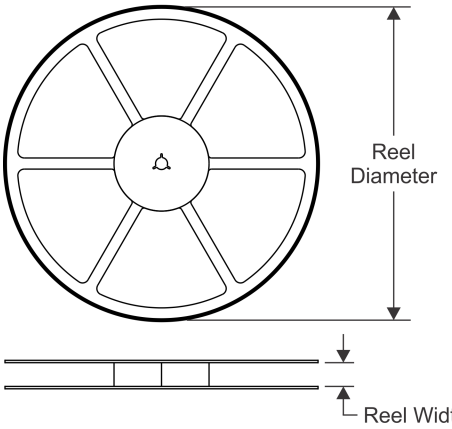
**(4)** There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

**(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.

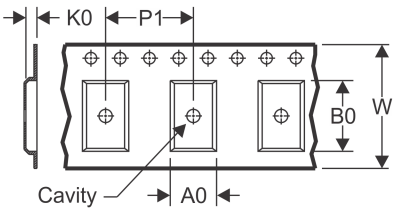
**(6)** Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

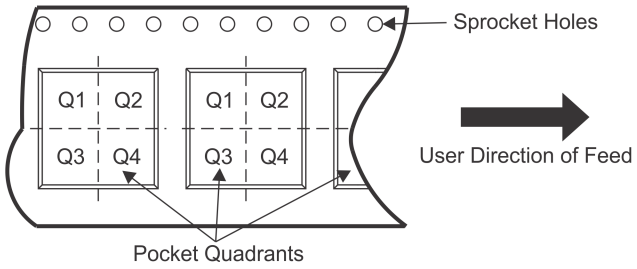



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

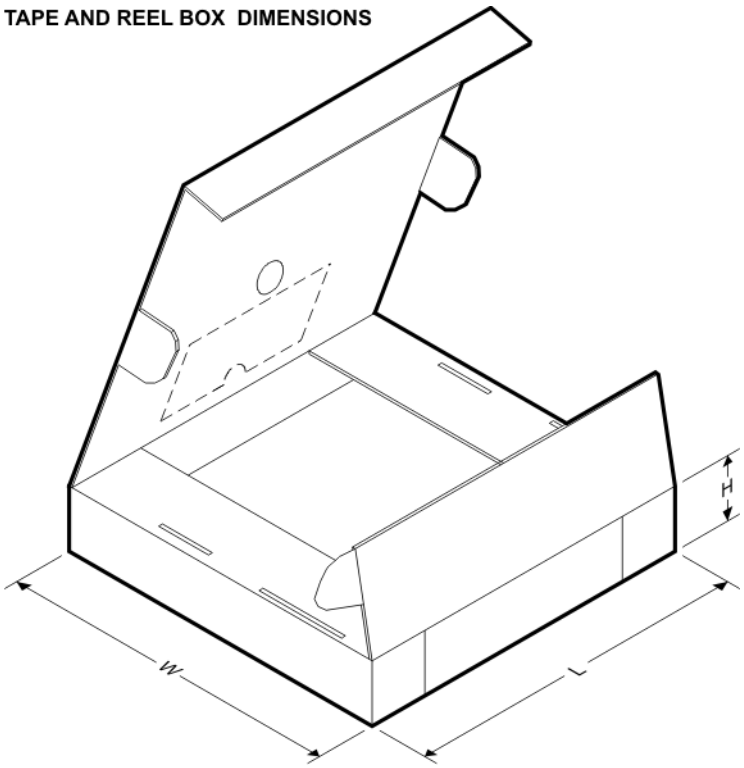
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TS2DDR2811ZXYR | BGA MICROSTAR JUNIOR | ZXY | 20 | 2500 | 330.0 | 12.4 | 2.75 | 3.45 | 1.05 | 4.0 | 12.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

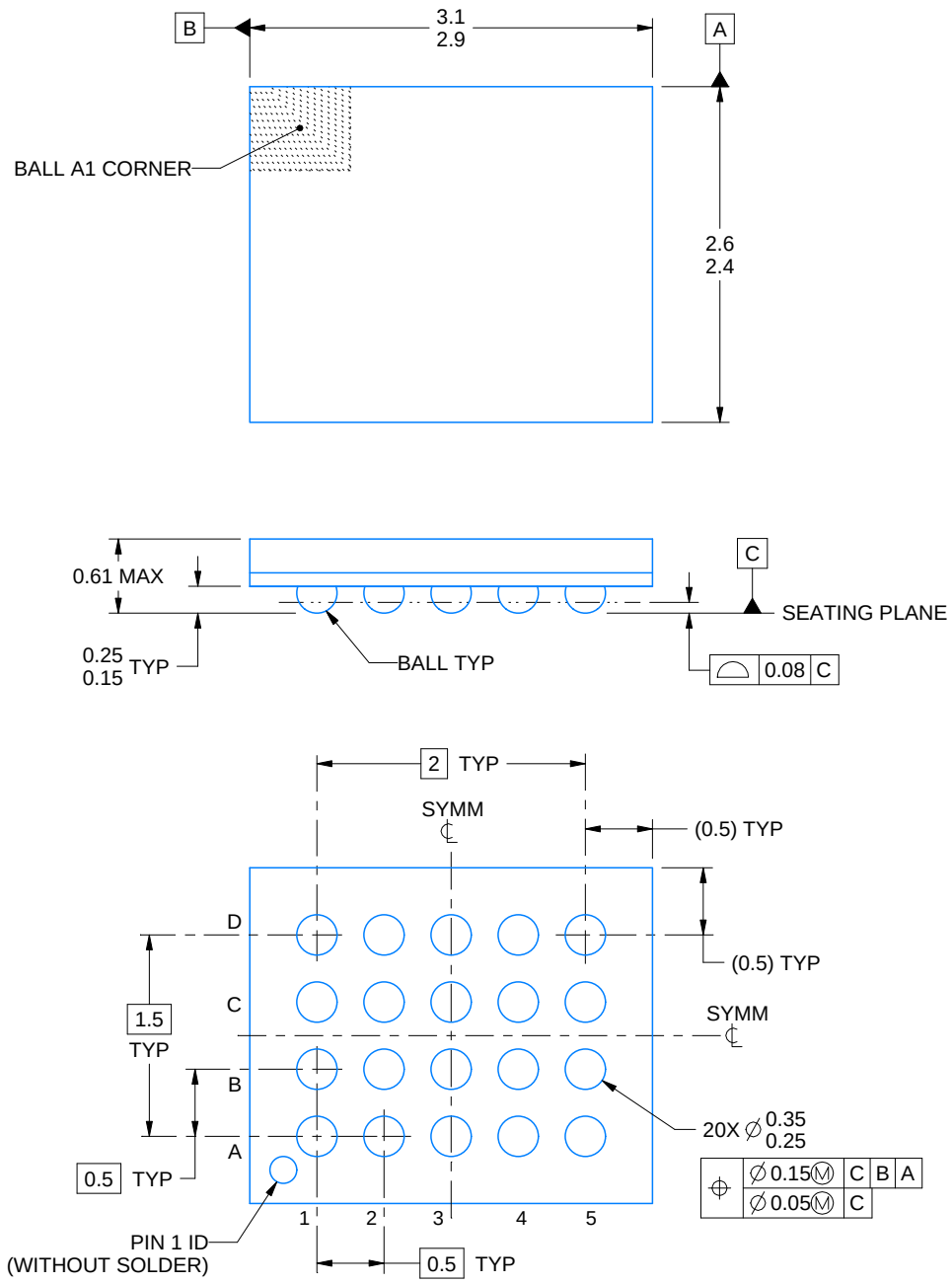
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TS2DDR2811ZXYR | BGA MICROSTAR JUNIOR | ZXY | 20 | 2500 | 350.0 | 350.0 | 43.0 |

# PACKAGE OUTLINE

## ZXY0020A

## VFBGA - 0.61 mm max height

PLASTIC BALL GRID ARRAY

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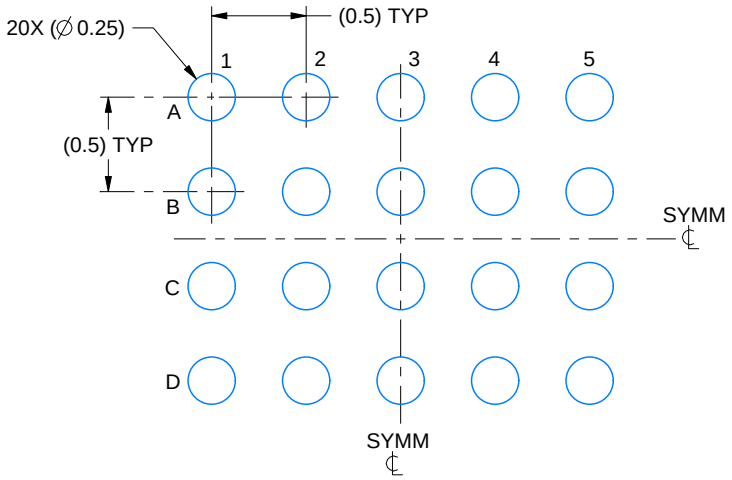
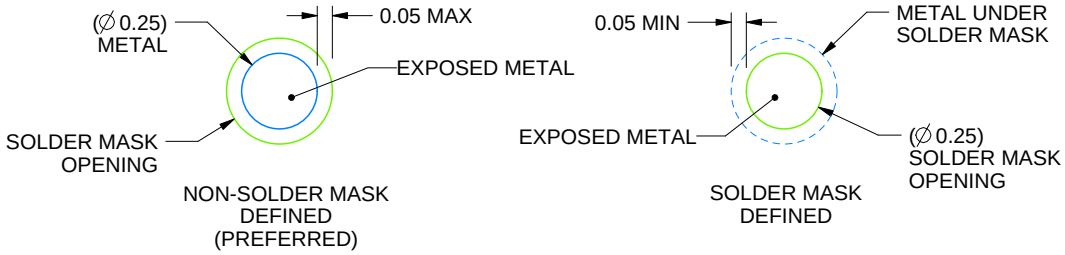
NOTES:

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.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:25X




SOLDER MASK DETAILS
NOT TO SCALE

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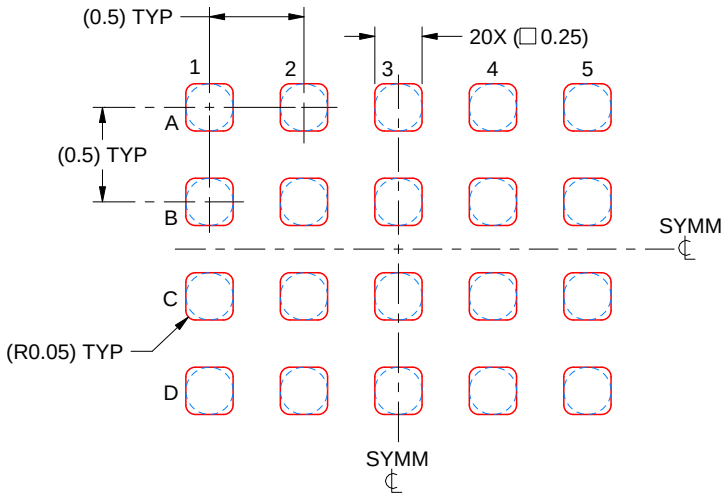
NOTES: (continued)

3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
For information, see Texas Instruments literature number SPRAA99 (www.ti.com/lit/spraa99).




SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE: 25X

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NOTES: (continued)

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

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