

# TS3A24159 0.3-Ω 2-Channel SPDT Bidirectional Analog Switch

## Dual-Channel 2:1 Multiplexer and Demultiplexer

### 1 Features

- Specified break-before-make switching
- Low ON-state resistance (0.3 Ω maximum)
- Low charge injection
- Excellent ON-state resistance matching
- Low total harmonic distortion (THD)
- 1.65-V to 3.6-V single-supply operation
- Control inputs are 1.8-V logic compatible
- 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)

### 2 Applications

- Cell phones
- Personal digital assistant (PDAs)
- Portable instrumentation
- Audio and video signal routing
- Low-voltage data-acquisition systems
- Communication circuits
- Modems
- Hard drives
- Computer peripherals
- Wireless terminals and peripherals

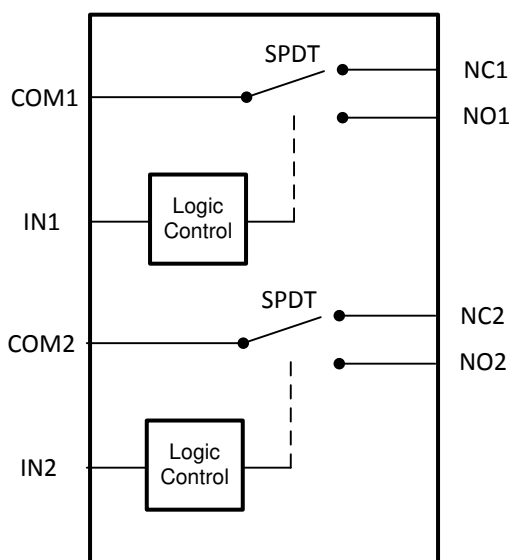
### 3 Description

The TS3A24159 is a 2-channel single-pole double-throw (SPDT) bidirectional analog switch that is designed to operate from 1.65 V to 3.6 V. It offers low ON-state resistance and excellent ON-state resistance matching with the break-before-make feature, to prevent signal distortion during the transferring of a signal from one channel to another. The device has excellent total harmonic distortion (THD) performance, low ON-state resistance, and consumes very low power. These are some of the features that make this device suitable for a variety of markets and many different applications.

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

| PART NUMBER | PACKAGE    | BODY SIZE (NOM)   |
|-------------|------------|-------------------|
| TS3A24159   | VSSOP (10) | 3.00 mm × 3.00 mm |
|             | VSON (10)  | 3.00 mm × 3.00 mm |
|             | DSBGA (10) | 1.86 mm × 1.35 mm |

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



**Functional Block Diagram**



## Table of Contents

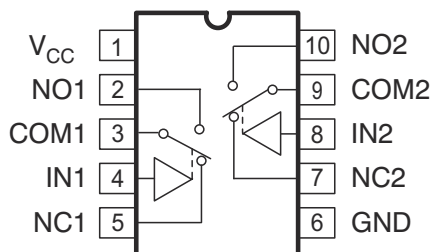
|                                                        |           |                                                                  |           |
|--------------------------------------------------------|-----------|------------------------------------------------------------------|-----------|
| <b>1 Features</b> .....                                | <b>1</b>  | 8.2 Functional Block Diagram.....                                | <b>18</b> |
| <b>2 Applications</b> .....                            | <b>1</b>  | 8.3 Feature Description.....                                     | <b>18</b> |
| <b>3 Description</b> .....                             | <b>1</b>  | 8.4 Device Functional Modes.....                                 | <b>18</b> |
| <b>4 Revision History</b> .....                        | <b>2</b>  | <b>9 Application and Implementation</b> .....                    | <b>19</b> |
| <b>5 Pin Configuration and Functions</b> .....         | <b>3</b>  | 9.1 Application Information.....                                 | <b>19</b> |
| <b>6 Specifications</b> .....                          | <b>5</b>  | 9.2 Typical Application.....                                     | <b>19</b> |
| 6.1 Absolute Maximum Ratings.....                      | <b>5</b>  | <b>10 Power Supply Recommendations</b> .....                     | <b>20</b> |
| 6.2 ESD Ratings.....                                   | <b>5</b>  | <b>11 Layout</b> .....                                           | <b>21</b> |
| 6.3 Recommended Operating Conditions.....              | <b>5</b>  | 11.1 Layout Guidelines.....                                      | <b>21</b> |
| 6.4 Thermal Information.....                           | <b>6</b>  | 11.2 Layout Example.....                                         | <b>21</b> |
| 6.5 Electrical Characteristics for 3-V Supply.....     | <b>6</b>  | <b>12 Device and Documentation Support</b> .....                 | <b>22</b> |
| 6.6 Electrical Characteristics for 2.5-V Supply.....   | <b>7</b>  | 12.1 Documentation Support.....                                  | <b>22</b> |
| 6.7 Electrical Characteristics for 1.8-V Supply.....   | <b>9</b>  | 12.2 Receiving Notification of Documentation Updates.....        | <b>22</b> |
| 6.8 Switching Characteristics for a 3-V Supply.....    | <b>10</b> | 12.3 Support Resources.....                                      | <b>22</b> |
| 6.9 Switching Characteristics for a 2.5-V Supply.....  | <b>10</b> | 12.4 Trademarks.....                                             | <b>22</b> |
| 6.10 Switching Characteristics for a 1.8-V Supply..... | <b>11</b> | 12.5 Electrostatic Discharge Caution.....                        | <b>22</b> |
| 6.11 Typical Characteristics.....                      | <b>12</b> | 12.6 Glossary.....                                               | <b>22</b> |
| <b>7 Parameter Measurement Information</b> .....       | <b>14</b> | <b>13 Mechanical, Packaging, and Orderable Information</b> ..... | <b>22</b> |
| <b>8 Detailed Description</b> .....                    | <b>18</b> |                                                                  |           |
| 8.1 Overview.....                                      | <b>18</b> |                                                                  |           |

## 4 Revision History

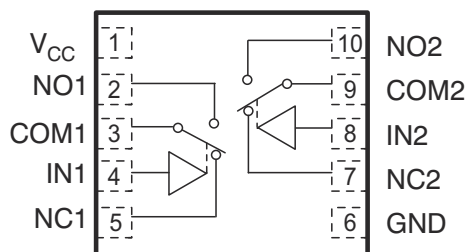
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

|                                                                                                                                                                                                                                                                                                                                                                                                      |             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>Changes from Revision G (February 2022) to Revision H (August 2022)</b> .....                                                                                                                                                                                                                                                                                                                     | <b>Page</b> |
| • Changed the maximum $V_{CC}$ from: 3.6 V to: 4 V .....                                                                                                                                                                                                                                                                                                                                             | <b>5</b>    |
| <b>Changes from Revision F (September 2019) to Revision G (February 2022)</b> .....                                                                                                                                                                                                                                                                                                                  | <b>Page</b> |
| • Updated the numbering format for tables, figures, and cross-references throughout the document.....                                                                                                                                                                                                                                                                                                | <b>1</b>    |
| • Updated the part number in the <i>Detailed Design Procedure</i> .....                                                                                                                                                                                                                                                                                                                              | <b>20</b>   |
| <b>Changes from Revision E (March 2019) to Revision F (September 2019)</b> .....                                                                                                                                                                                                                                                                                                                     | <b>Page</b> |
| • Changed the YZP package image view From: Top-Through View To: Bottom View.....                                                                                                                                                                                                                                                                                                                     | <b>3</b>    |
| <b>Changes from Revision D (July 2015) to Revision E (March 2019)</b> .....                                                                                                                                                                                                                                                                                                                          | <b>Page</b> |
| • Changed the YZP package image and deleted the <i>YZP Package, Terminal Assignments</i> table.....                                                                                                                                                                                                                                                                                                  | <b>3</b>    |
| • Changed Turnon time $V_{CC}$ (Full) value From: 2.3 V to 2.7 V To: 2.7 V to 3.6 V in <i>Switching Characteristics for a 3-V Supply</i> .....                                                                                                                                                                                                                                                       | <b>10</b>   |
| • Changed Turnon time $V_{CC}$ (Full) value From: 2.3 V to 2.7 V To: 2.7 V to 3.6 V in <i>Switching Characteristics for a 2.5-V Supply</i> .....                                                                                                                                                                                                                                                     | <b>10</b>   |
| <b>Changes from Revision C (February 2008) to Revision D (March 2015)</b> .....                                                                                                                                                                                                                                                                                                                      | <b>Page</b> |
| • Added <i>Pin Configuration and Functions</i> section, <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section ..... | <b>1</b>    |
| • Changed $V+$ to $V_{CC}$ throughout the document to meet JEDEC standards.....                                                                                                                                                                                                                                                                                                                      | <b>1</b>    |

## 5 Pin Configuration and Functions



**Figure 5-1. DGS Package, 10-Pin VSSOP (Top View)**



**Figure 5-2. DRC Package, 10-Pin VSON (Top View)**

**Table 5-1. Pin Functions – VSSOP and VSON**

| PIN |                 | TYPE <sup>(1)</sup> | DESCRIPTION                                |
|-----|-----------------|---------------------|--------------------------------------------|
| NO. | NAME            |                     |                                            |
| 1   | V <sub>CC</sub> | —                   | Power supply                               |
| 2   | NO1             | I/O                 | Normally open signal path                  |
| 3   | COM1            | I/O                 | Common signal path                         |
| 4   | IN1             | I                   | Digital control to connect COM to NO or NC |
| 5   | NC1             | I/O                 | Normally closed signal path                |
| 6   | GND             | —                   | Ground                                     |
| 7   | NC2             | I/O                 | Normally closed signal path                |
| 8   | IN2             | I                   | Digital control to connect COM to NO or NC |
| 9   | COM2            | I/O                 | Common signal path                         |
| 10  | NO2             | I/O                 | Normally open signal path                  |

(1) I = input, O = output

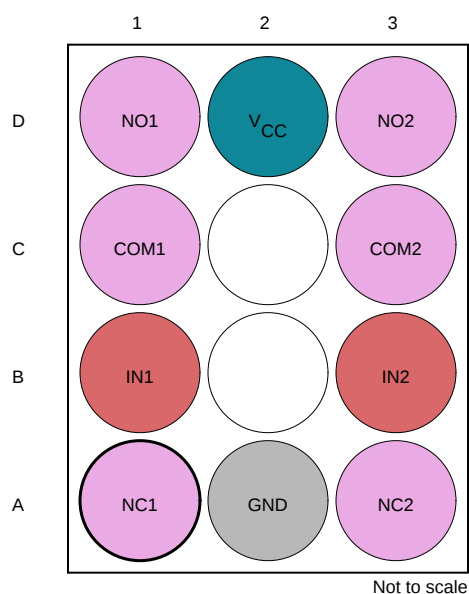


Figure 5-3. YZP Package, 10-Pin DSBGA (Bottom View)

| Legend          |       |
|-----------------|-------|
| Input or Output | Input |
| Ground          | Power |

Table 5-2. Pin Functions – DSBGA

| PIN |                 | TYPE <sup>(1)</sup> | DESCRIPTION                                |
|-----|-----------------|---------------------|--------------------------------------------|
| NO. | NAME            |                     |                                            |
| A1  | NC1             | I/O                 | Normally closed signal path                |
| A2  | GND             | —                   | Ground                                     |
| A3  | NC2             | I/O                 | Normally closed signal path                |
| B1  | IN1             | I                   | Digital control to connect COM to NO or NC |
| B3  | IN2             | I                   | Digital control to connect COM to NO or NC |
| C1  | COM1            | I/O                 | Common signal path                         |
| C3  | COM2            | I/O                 | Common signal path                         |
| D1  | NO1             | I/O                 | Normally open signal path                  |
| D2  | V <sub>CC</sub> | —                   | Power supply                               |
| D3  | NO2             | I/O                 | Normally open signal path                  |

(1) I = input, O = output

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup> <sup>(2)</sup>

|                                   |                                                                        |                                                  | MIN          | MAX            | UNIT |
|-----------------------------------|------------------------------------------------------------------------|--------------------------------------------------|--------------|----------------|------|
| $V_{CC}$                          | Supply voltage <sup>(3)</sup>                                          |                                                  | −0.5         | 4              | V    |
| $V_{NC}$<br>$V_{NO}$<br>$V_{COM}$ | Signal voltage <sup>(3)</sup> <sup>(4)</sup>                           |                                                  | −0.5         | $V_{CC} + 0.5$ | V    |
| $I_{I/O}$                         | Analog port diode current                                              | $V_{NC}, V_{NO}, V_{COM} < 0$                    | −50          | 50             | mA   |
| $I_{NC}$<br>$I_{NO}$<br>$I_{COM}$ | ON-state switch current<br>ON-state peak switch current <sup>(5)</sup> | $V_{NC}, V_{NO}, V_{COM} = 0 \text{ to } V_{CC}$ | −300<br>−500 | 300<br>500     | mA   |
| $V_{IN}$                          | Digital input voltage                                                  |                                                  | −0.5         | 3.6            | V    |
| $I_{IK}$                          | Digital input clamp current <sup>(3)</sup>                             | $V_I < 0$                                        | −50          |                | mA   |
| $I_{CC}$                          | Continuous current through $V_{CC}$                                    |                                                  |              | 100            | mA   |
| $I_{GND}$                         | Continuous current through GND                                         |                                                  | −100         |                | mA   |
| $T_{stg}$                         | Storage temperature                                                    |                                                  | −65          | 150            | °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.
- (2) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.
- (3) All voltages are with respect to ground, unless otherwise specified.
- (4) This value is limited to 5.5 V maximum.
- (5) Pulse at 1-ms duration <10% duty cycle.

### 6.2 ESD Ratings

|             |                         | VALUE                                                                                                                                                                         | UNIT         |
|-------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup><br>Charged-device model (CDM), per JEDEC specification JESD22-C101 or ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup> | 2000<br>1000 |
|             |                         |                                                                                                                                                                               | V            |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

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

|                                   |                       | MIN  | MAX      | UNIT |
|-----------------------------------|-----------------------|------|----------|------|
| $V_{CC}$                          | Supply Voltage        | 1.65 | 3.6      | V    |
| $V_{NC}$<br>$V_{NO}$<br>$V_{COM}$ | Signal Voltage        | 0    | $V_{CC}$ | V    |
| $V_{IN}$                          | Digital Input Voltage | 0    | $V_{CC}$ | V    |

## 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                              | TS3A24159   |            |             | UNIT |
|-------------------------------|----------------------------------------------|-------------|------------|-------------|------|
|                               |                                              | DGS (VSSOP) | DRC (VSON) | YZP (DSBGA) |      |
|                               |                                              | 10 PINS     | 10 PINS    | 10 PINS     |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 154         | 49.4       | 90.9        | °C/W |
| $R_{\theta JC(top)}$          | Junction-to-case (top) thermal resistance    | 37.9        | 71.2       | 0.3         | °C/W |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 83.6        | 23.8       | 8.3         | °C/W |
| $\Psi_{JT}$                   | Junction-to-top characterization parameter   | 1.4         | 2.2        | 3.2         | °C/W |
| $\Psi_{JB}$                   | Junction-to-board characterization parameter | 82.2        | 23.8       | 8.3         | °C/W |
| $R_{\theta JC(bot)}$          | Junction-to-case (bottom) thermal resistance | N/A         | 6.1        | N/A         | °C/W |

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

## 6.5 Electrical Characteristics for 3-V Supply

$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$ ,  $T_A = -40^\circ\text{C to } 85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                                                     | TEST CONDITIONS                                                                                                                                                                                 | $T_A$        | $V_{CC}$ | MIN | TYP  | MAX          | UNIT     |
|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------|-----|------|--------------|----------|
| <b>ANALOG SWITCH</b>                                          |                                                                                                                                                                                                 |              |          |     |      |              |          |
| Analog signal range<br>$V_{COM}, V_{NO}, V_{NC}$              |                                                                                                                                                                                                 |              |          | 0   |      | $V_{CC}$     | V        |
| Peak ON resistance<br>$r_{peak}$                              | $0 \leq (V_{NO} \text{ or } V_{NC}) \leq V_{CC}$ ,<br>$I_{COM} = -100 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                             | 25°C<br>Full | 2.7 V    |     | 0.2  | 0.3<br>0.35  | $\Omega$ |
| ON-state resistance<br>$r_{on}$                               | $V_{NO} \text{ or } V_{NC} = 2 \text{ V}$ ,<br>$I_{COM} = -100 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                                    | 25°C<br>Full | 2.7 V    |     | 0.26 | 0.3<br>0.34  | $\Omega$ |
| ON-state resistance match between channels<br>$\Delta r_{on}$ | $V_{NO} \text{ or } V_{NC} = 2 \text{ V}, 0.8 \text{ V}$ ,<br>$I_{COM} = -100 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                     | 25°C<br>Full | 2.7 V    |     | 0.01 | 0.05<br>0.05 | $\Omega$ |
| ON-state resistance flatness<br>$r_{on(flat)}$                | $0 \leq (V_{NO} \text{ or } V_{NC}) \leq V_{CC}$ ,<br>$I_{COM} = -100 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                             | 25°C         | 2.7 V    |     | 0.13 |              | $\Omega$ |
|                                                               | $V_{NO} \text{ or } V_{NC} = 2 \text{ V}, 0.8 \text{ V}$ ,<br>$I_{COM} = -100 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                     | 25°C<br>Full |          |     | 0.01 | 0.04<br>0.05 | $\Omega$ |
| NC, NO OFF leakage current<br>$I_{NC(OFF)}, I_{NO(OFF)}$      | $V_{NC} \text{ or } V_{NO} = 1 \text{ V}, V_{COM} = 3 \text{ V}$ ,<br>or<br>$V_{NC} \text{ or } V_{NO} = 3 \text{ V}, V_{COM} = 1 \text{ V}$ ,<br>Switch OFF,<br>See <a href="#">Figure 7-2</a> | 25°C<br>Full | 3.6 V    | -10 |      | 10<br>50     | nA       |
| NC, NO ON leakage current<br>$I_{NC(ON)}, I_{NO(ON)}$         | $V_{NC} \text{ or } V_{NO} = 1 \text{ V}, V_{COM} = \text{Open}$ ,<br>or<br>$V_{NC} \text{ or } V_{NO} = 3 \text{ V}, V_{COM} = \text{Open}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-3</a>  | 25°C<br>Full | 3.6 V    | -10 |      | 10<br>100    | nA       |
| COM ON leakage current<br>$I_{COM(ON)}$                       | $V_{NC} \text{ or } V_{NO} = \text{Open}, V_{COM} = 1 \text{ V}$ ,<br>or<br>$V_{NC} \text{ or } V_{NO} = \text{Open}, V_{COM} = 3 \text{ V}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-3</a>  | 25°C<br>Full | 3.6 V    | -10 |      | 10<br>100    | nA       |
| <b>DIGITAL CONTROL INPUTS (IN1, IN2)<sup>(2)</sup></b>        |                                                                                                                                                                                                 |              |          |     |      |              |          |
| Input logic high<br>$V_{IH}$                                  |                                                                                                                                                                                                 | Full         |          | 1.4 |      |              | V        |
| Input logic low<br>$V_{IL}$                                   |                                                                                                                                                                                                 | Full         |          |     |      | 0.5          | V        |
| Input leakage current<br>$I_{IH}, I_{IL}$                     | $V_I = 3.6 \text{ V or } 0$                                                                                                                                                                     | 25°C         | 3.6 V    | -40 | 5    | 40           | nA       |
|                                                               |                                                                                                                                                                                                 | Full         |          | -50 |      | 50           |          |

## 6.5 Electrical Characteristics for 3-V Supply (continued)

$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$ ,  $T_A = -40^\circ\text{C to } 85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                                                     | TEST CONDITIONS                                                                                                                | $T_A$              | $V_{CC}$ | MIN | TYP    | MAX | UNIT          |
|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------|----------|-----|--------|-----|---------------|
| <b>DYNAMIC</b>                                                |                                                                                                                                |                    |          |     |        |     |               |
| Charge injection<br>$Q_C$                                     | $V_{GEN} = 0$ ,<br>$R_{GEN} = 0$ ,<br>$C_L = 1 \text{ nF}$ ,<br>See <a href="#">Figure 7-10</a>                                | $25^\circ\text{C}$ | 3 V      |     | 9      |     | pC            |
| NC, NO<br>OFF capacitance<br>$C_{NC(OFF)}$ ,<br>$C_{NO(OFF)}$ | $V_{NC}$ or $V_{NO} = V_{CC}$ or GND,<br>Switch OFF,<br>See <a href="#">Figure 7-4</a>                                         | $25^\circ\text{C}$ | 3 V      |     | 90     |     | pF            |
| NC, NO<br>ON capacitance<br>$C_{NC(ON)}$ ,<br>$C_{NO(ON)}$    | $V_{NC}$ or $V_{NO} = V_{CC}$ or GND,<br>Switch ON,<br>See <a href="#">Figure 7-4</a>                                          | $25^\circ\text{C}$ | 3 V      |     | 224    |     | pF            |
| COM<br>ON capacitance<br>$C_{COM(ON)}$                        | $V_{COM} = V_{CC}$ or GND,<br>Switch ON,<br>See <a href="#">Figure 7-4</a>                                                     | $25^\circ\text{C}$ | 3 V      |     | 250    |     | pF            |
| Digital input<br>capacitance<br>$C_I$                         | $V_{IN} = V_{CC}$ or GND,<br>See <a href="#">Figure 7-4</a>                                                                    | $25^\circ\text{C}$ | 3 V      |     | 2      |     | pF            |
| Bandwidth<br>$BW$                                             | $R_L = 50 \Omega$ ,<br>Switch ON,<br>See <a href="#">Figure 7-7</a>                                                            | $25^\circ\text{C}$ | 3 V      |     | 23     |     | MHz           |
| OFF isolation<br>$O_{ISO}$                                    | $R_L = 50 \Omega$ ,<br>$f = 1 \text{ MHz}$ ,<br>See <a href="#">Figure 7-8</a>                                                 | $25^\circ\text{C}$ | 3 V      |     | -72    |     | dB            |
| Crosstalk<br>$X_{TALK}$                                       | $R_L = 50 \Omega$ ,<br>$f = 1 \text{ MHz}$ ,<br>See <a href="#">Figure 7-9</a>                                                 | $25^\circ\text{C}$ | 3 V      |     | -96    |     | dB            |
| Total harmonic<br>distortion<br>$THD$                         | $R_L = 600 \Omega$ ,<br>$C_L = 50 \text{ pF}$ ,<br>$f = 20 \text{ Hz to } 20 \text{ kHz}$ ,<br>See <a href="#">Figure 7-11</a> | $25^\circ\text{C}$ | 3 V      |     | 0.003% |     |               |
| <b>SUPPLY</b>                                                 |                                                                                                                                |                    |          |     |        |     |               |
| Positive supply<br>current<br>$I_{CC}$                        | $V_{IN} = V_{CC}$ or GND                                                                                                       | $25^\circ\text{C}$ | 3.6 V    |     | 15     | 100 | nA            |
|                                                               |                                                                                                                                | Full               |          |     | 1      |     | $\mu\text{A}$ |

- (1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum  
 (2) All unused digital inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application report, [Implications of Slow or Floating CMOS Inputs](#).

## 6.6 Electrical Characteristics for 2.5-V Supply

$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$ ,  $T_A = -40^\circ\text{C to } 85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                                                            | TEST CONDITIONS                                                                                                                                                                                 | $T_A$                      | $V_{CC}$ | MIN        | TYP          | MAX          | UNIT     |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------|------------|--------------|--------------|----------|
| <b>ANALOG SWITCH</b>                                                 |                                                                                                                                                                                                 |                            |          |            |              |              |          |
| Analog signal<br>range<br>$V_{COM}$ , $V_{NO}$ ,<br>$V_{NC}$         |                                                                                                                                                                                                 |                            |          | 0          |              | $V_{CC}$     | V        |
| Peak ON<br>resistance<br>$r_{peak}$                                  | $0 \leq (V_{NO} \text{ or } V_{NC}) \leq V_{CC}$ ,<br>$I_{COM} = -8 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                               | $25^\circ\text{C}$<br>Full | 2.3 V    |            | 0.35<br>0.45 |              | $\Omega$ |
| ON-state<br>resistance<br>$r_{on}$                                   | $V_{NO}$ or $V_{NC} = 1.8 \text{ V}$ ,<br>$I_{COM} = -8 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                                           | $25^\circ\text{C}$<br>Full | 2.3 V    |            |              | 0.4          | $\Omega$ |
| ON-state<br>resistance match<br>between channels<br>$\Delta r_{on}$  | $V_{NO}$ or $V_{NC} = 1.8 \text{ V}$ , $0.8 \text{ V}$ ,<br>$I_{COM} = -8 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                         | $25^\circ\text{C}$<br>Full | 2.3 V    |            | 0.01<br>0.05 | 0.05<br>0.05 | $\Omega$ |
| ON-state<br>resistance flatness<br>$r_{on(flat)}$                    | $0 \leq (V_{NO} \text{ or } V_{NC}) \leq V_{CC}$ ,<br>$I_{COM} = -8 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                               | $25^\circ\text{C}$         | 2.3 V    |            | 0.05         |              | $\Omega$ |
|                                                                      | $V_{NO}$ or $V_{NC} = 0.8 \text{ V}$ , $1.8 \text{ V}$ ,<br>$I_{COM} = -8 \text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                         | $25^\circ\text{C}$<br>Full |          |            | 0.03<br>0.1  | 0.08<br>0.1  |          |
| NC, NO<br>OFF leakage<br>current<br>$I_{NC(OFF)}$ ,<br>$I_{NO(OFF)}$ | $V_{NC}$ or $V_{NO} = 0.5 \text{ V}$ , $V_{COM} = 2.2 \text{ V}$ ,<br>or<br>$V_{NC}$ or $V_{NO} = 2.2 \text{ V}$ , $V_{COM} = 0.5 \text{ V}$ ,<br>Switch OFF,<br>See <a href="#">Figure 7-2</a> | $25^\circ\text{C}$<br>Full | 2.7 V    | -10<br>-50 |              | 10<br>50     | nA       |

## 6.6 Electrical Characteristics for 2.5-V Supply (continued)

$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$ ,  $T_A = -40^\circ\text{C to } 85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                                        | TEST CONDITIONS                                                                                                                                                                                                             | $T_A$        | $V_{CC}$ | MIN         | TYP       | MAX       | UNIT |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------|-------------|-----------|-----------|------|
| NC, NO<br>ON leakage<br>current                  | $I_{NC(ON)},$<br>$I_{NO(ON)}$<br>$V_{NC}$ or $V_{NO} = 0.5 \text{ V}$ , $V_{COM} = \text{Open}$ ,<br>or<br>$V_{NC}$ or $V_{NO} = 2.2 \text{ V}$ , $V_{COM} = \text{Open}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-3</a> | 25°C<br>Full | 2.7 V    | -10<br>-100 |           | 10<br>100 | nA   |
| ANALOG SWITCH (continued)                        |                                                                                                                                                                                                                             |              |          |             |           |           |      |
| COM<br>ON leakage<br>current                     | $I_{COM(ON)}$<br>$V_{NC}$ or $V_{NO} = \text{Open}$ , $V_{COM} = 0.5 \text{ V}$ ,<br>or<br>$V_{NC}$ or $V_{NO} = \text{Open}$ , $V_{COM} = 2.2 \text{ V}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-3</a>                 | 25°C<br>Full | 2.7 V    | -10<br>-100 |           | 10<br>100 | nA   |
| DIGITAL CONTROL INPUTS (IN1, IN2) <sup>(2)</sup> |                                                                                                                                                                                                                             |              |          |             |           |           |      |
| Input logic high                                 | $V_{IH}$                                                                                                                                                                                                                    | Full         |          | 1.25        |           |           | V    |
| Input logic low                                  | $V_{IL}$                                                                                                                                                                                                                    | Full         |          |             |           | 0.5       | V    |
| Input leakage<br>current                         | $I_{IH}, I_{IL}$<br>$V_I = 2.7 \text{ V or } 0$                                                                                                                                                                             | 25°C<br>Full | 2.7 V    | -40<br>-50  | 5         | 40<br>50  | nA   |
| DYNAMIC                                          |                                                                                                                                                                                                                             |              |          |             |           |           |      |
| Charge injection                                 | $Q_C$<br>$V_{GEN} = 0$ ,<br>$R_{GEN} = 0$ ,<br>$C_L = 1 \text{ nF}$ ,<br>See <a href="#">Figure 7-10</a>                                                                                                                    | 25°C         | 2.5 V    |             | 8         |           | pC   |
| NC, NO<br>OFF capacitance                        | $C_{NC(OFF)},$<br>$C_{NO(OFF)}$<br>$V_{NC}$ or $V_{NO} = V_{CC}$ or GND,<br>Switch OFF,<br>See <a href="#">Figure 7-4</a>                                                                                                   | 25°C         | 2.5 V    |             | 90        |           | pF   |
| NC, NO<br>ON capacitance                         | $C_{NC(ON)},$<br>$C_{NO(ON)}$<br>$V_{NC}$ or $V_{NO} = V_{CC}$ or GND,<br>Switch ON,<br>See <a href="#">Figure 7-4</a>                                                                                                      | 25°C         | 2.5 V    |             | 250       |           | pF   |
| COM<br>ON capacitance                            | $C_{COM(ON)}$<br>$V_{COM} = V_{CC}$ or GND,<br>Switch ON,<br>See <a href="#">Figure 7-4</a>                                                                                                                                 | 25°C         | 2.5 V    |             | 250       |           | pF   |
| Digital input<br>capacitance                     | $C_I$<br>$V_I = V_{CC}$ or GND,<br>See <a href="#">Figure 7-4</a>                                                                                                                                                           | 25°C         | 2.5 V    |             | 2         |           | pF   |
| Bandwidth                                        | $BW$<br>$R_L = 50 \Omega$ ,<br>Switch ON,<br>See <a href="#">Figure 7-7</a>                                                                                                                                                 | 25°C         | 2.5 V    |             | 23        |           | MHz  |
| OFF isolation                                    | $O_{ISO}$<br>$R_L = 50 \Omega$ ,<br>$f = 1 \text{ MHz}$ ,<br>See <a href="#">Figure 7-8</a>                                                                                                                                 | 25°C         | 2.5 V    |             | -72       |           | dB   |
| Crosstalk                                        | $X_{TALK}$<br>$R_L = 50 \Omega$ ,<br>$f = 1 \text{ MHz}$ ,<br>See <a href="#">Figure 7-9</a>                                                                                                                                | 25°C         | 2.5 V    |             | -96       |           | dB   |
| Total harmonic<br>distortion                     | $THD$<br>$R_L = 600 \Omega$ ,<br>$C_L = 50 \text{ pF}$ ,<br>$f = 20 \text{ Hz to } 20 \text{ kHz}$ ,<br>See <a href="#">Figure 7-11</a>                                                                                     | 25°C         | 2.5 V    |             | 0.003%    |           |      |
| SUPPLY                                           |                                                                                                                                                                                                                             |              |          |             |           |           |      |
| Positive supply<br>current                       | $I_{CC}$<br>$V_I = V_{CC}$ or GND                                                                                                                                                                                           | 25°C<br>Full | 2.7 V    |             | 10<br>700 | 100       | nA   |

(1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.

(2) All unused digital inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application report, [Implications of Slow or Floating CMOS Inputs](#).

## 6.7 Electrical Characteristics for 1.8-V Supply

$V_{CC} = 1.65\text{ V to }1.95\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                                              | TEST CONDITIONS            | $T_A$                                                                                                                                                                                                                        | $V_{CC}$     | MIN    | TYP         | MAX                 | UNIT     |
|--------------------------------------------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------|-------------|---------------------|----------|
| <b>ANALOG SWITCH</b>                                   |                            |                                                                                                                                                                                                                              |              |        |             |                     |          |
| Analog signal range                                    | $V_{COM}, V_{NO}, V_{NC}$  |                                                                                                                                                                                                                              |              | 0      |             | $V_{CC}$            | V        |
| Peak ON resistance                                     | $r_{peak}$                 | $0 \leq (V_{NO} \text{ or } V_{NC}) \leq V_{CC}$ ,<br>$I_{COM} = -2\text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                                                             | 25°C<br>Full | 1.65 V | 0.4         | 0.7<br>0.8          | $\Omega$ |
| ON-state resistance                                    | $r_{on}$                   | $V_{NO} \text{ or } V_{NC} = 1.5\text{ V}$ ,<br>$I_{COM} = -2\text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                                                                   | 25°C<br>Full | 1.65 V | 0.3         | 0.45<br>0.5         | $\Omega$ |
| <b>ANALOG SWITCH (continued)</b>                       |                            |                                                                                                                                                                                                                              |              |        |             |                     |          |
| ON-state resistance match between channels             | $\Delta r_{on}$            | $V_{NO} \text{ or } V_{NC} = 0.6\text{ V}, 1.5\text{ V}$ ,<br>$I_{COM} = -2\text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a>                                                                                     | 25°C<br>Full | 1.65 V | 0.02        | 0.04<br>0.05        | $\Omega$ |
| ON-state resistance flatness                           | $r_{on(flat)}$             | $0 \leq (V_{NO} \text{ or } V_{NC}) \leq V_{CC}$ ,<br>$I_{COM} = -2\text{ mA}$ ,<br>$V_{NO} \text{ or } V_{NC} = 0.6\text{ V}, 1.5\text{ V}$ ,<br>$I_{COM} = -8\text{ mA}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-1</a> | 25°C<br>Full | 1.65 V | 0.13        | 0.08<br>0.15<br>0.2 | $\Omega$ |
| NC, NO OFF leakage current                             | $I_{NC(OFF)}, I_{NO(OFF)}$ | $V_{NC} \text{ or } V_{NO} = 0.3\text{ V}, V_{COM} = 1.65\text{ V}$ ,<br>or<br>$V_{NC} \text{ or } V_{NO} = 1.65\text{ V}, V_{COM} = 0.3\text{ V}$ ,<br>Switch OFF,<br>See <a href="#">Figure 7-2</a>                        | 25°C<br>Full | 1.95   | -10<br>-50  | 10<br>50            | nA       |
| NC, NO ON leakage current                              | $I_{NC(ON)}, I_{NO(ON)}$   | $V_{NC} \text{ or } V_{NO} = 0.3\text{ V}, V_{COM} = \text{Open}$ ,<br>or<br>$V_{NC} \text{ or } V_{NO} = 1.65\text{ V}, V_{COM} = \text{Open}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-3</a>                            | 25°C<br>Full | 1.95 V | -10<br>-100 | 10<br>100           | nA       |
| COM ON leakage current                                 | $I_{COM(ON)}$              | $V_{NC} \text{ or } V_{NO} = \text{Open}, V_{COM} = 0.3\text{ V}$ ,<br>or<br>$V_{NC} \text{ or } V_{NO} = \text{Open}, V_{COM} = 1.65\text{ V}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-3</a>                            | 25°C<br>Full | 1.95 V | -10<br>-100 | 10<br>100           | nA       |
| <b>DIGITAL CONTROL INPUTS (IN1, IN2)<sup>(2)</sup></b> |                            |                                                                                                                                                                                                                              |              |        |             |                     |          |
| Input logic high                                       | $V_{IH}$                   |                                                                                                                                                                                                                              | Full         |        | 1           |                     | V        |
| Input logic low                                        | $V_{IL}$                   |                                                                                                                                                                                                                              | Full         |        |             | 0.4                 | V        |
| Input leakage current                                  | $I_{IH}, I_{IL}$           | $V_I = 1.95\text{ V or }0$                                                                                                                                                                                                   | 25°C<br>Full | 1.95 V | -40<br>-50  | 5<br>50             | nA       |
| <b>DYNAMIC</b>                                         |                            |                                                                                                                                                                                                                              |              |        |             |                     |          |
| Charge injection                                       | $Q_C$                      | $V_{GEN} = 0$ ,<br>$R_{GEN} = 0$ ,<br>$C_L = 1\text{ nF}$ ,<br>See <a href="#">Figure 7-10</a>                                                                                                                               | 25°C         | 1.8 V  |             | 5                   | pC       |
| NC, NO OFF capacitance                                 | $C_{NC(OFF)}, C_{NO(OFF)}$ | $V_{NC} \text{ or } V_{NO} = V_{CC} \text{ or GND}$ ,<br>Switch OFF,<br>See <a href="#">Figure 7-4</a>                                                                                                                       | 25°C         | 1.8 V  |             | 90                  | pF       |
| NC, NO ON capacitance                                  | $C_{NC(ON)}, C_{NO(ON)}$   | $V_{NC} \text{ or } V_{NO} = V_{CC} \text{ or GND}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-4</a>                                                                                                                        | 25°C         | 1.8 V  |             | 250                 | pF       |
| COM ON capacitance                                     | $C_{COM(ON)}$              | $V_{COM} = V_{CC} \text{ or GND}$ ,<br>Switch ON,<br>See <a href="#">Figure 7-4</a>                                                                                                                                          | 25°C         | 1.8 V  |             | 250                 | pF       |
| Digital input capacitance                              | $C_{IN}$                   | $V_I = V_{CC} \text{ or GND}$ ,<br>See <a href="#">Figure 7-4</a>                                                                                                                                                            | 25°C         | 1.8 V  |             | 2                   | pF       |
| Bandwidth                                              | BW                         | $R_L = 50\ \Omega$ ,<br>Switch ON,<br>See <a href="#">Figure 7-7</a>                                                                                                                                                         | 25°C         | 1.8 V  |             | 23                  | MHz      |
| OFF isolation                                          | $O_{ISO}$                  | $R_L = 50\ \Omega$ ,<br>$f = 1\text{ MHz}$ ,<br>See <a href="#">Figure 7-8</a>                                                                                                                                               | 25°C         | 1.8 V  |             | -73                 | dB       |
| Crosstalk                                              | $X_{TALK}$                 | $R_L = 50\ \Omega$ ,<br>$f = 1\text{ MHz}$ ,<br>See <a href="#">Figure 7-9</a>                                                                                                                                               | 25°C         | 1.8 V  |             | -97                 | dB       |

## 6.7 Electrical Characteristics for 1.8-V Supply (continued)

$V_{CC} = 1.65\text{ V to }1.95\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                 |                 | TEST CONDITIONS                                                                                                   | T <sub>A</sub> | V <sub>CC</sub> | MIN    | TYP | MAX | UNIT |
|---------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------|----------------|-----------------|--------|-----|-----|------|
| Total harmonic distortion | THD             | R <sub>L</sub> = 600 Ω,<br>C <sub>L</sub> = 50 pF,<br><br>f = 20 Hz to 20 kHz,<br>See <a href="#">Figure 7-11</a> | 25°C           | 1.8 V           | 0.005% |     |     |      |
| SUPPLY                    |                 |                                                                                                                   |                |                 |        |     |     |      |
| Positive supply current   | I <sub>CC</sub> | V <sub>I</sub> = V <sub>CC</sub> or GND                                                                           | 25°C           | 1.95 V          | 100    |     | 50  | nA   |
|                           |                 |                                                                                                                   | Full           |                 | 700    |     |     |      |

- (1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.  
 (2) All unused digital inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application report, [Implications of Slow or Floating CMOS Inputs](#).

## 6.8 Switching Characteristics for a 3-V Supply

$V_{CC} = 2.7\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                           | TEST CONDITIONS                                                                                                  | $T_A$              | $V_{CC}$       | MIN | TYP | MAX | UNIT |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------|--------------------|----------------|-----|-----|-----|------|
| Dynamic                             |                                                                                                                  |                    |                |     |     |     |      |
| Turnon time<br>$t_{ON}$             | $V_{COM} = V_{CC}$ ,<br>$R_L = 50\ \Omega$ ,<br>$C_L = 35\text{ pF}$ ,<br>See <a href="#">Figure 7-5</a>         | $25^\circ\text{C}$ | 3.0 V          | 20  |     | 35  | ns   |
|                                     |                                                                                                                  | Full               | 2.7 V to 3.6 V |     |     | 40  |      |
| Turnoff time<br>$t_{OFF}$           | $V_{COM} = V_{CC}$ ,<br>$R_L = 50\ \Omega$ ,<br>$C_L = 35\text{ pF}$ ,<br>See <a href="#">Figure 7-5</a>         | $25^\circ\text{C}$ | 3.0 V          | 12  |     | 25  | ns   |
|                                     |                                                                                                                  | Full               | 2.7 V to 3.6 V |     |     | 30  |      |
| Break-before-make time<br>$t_{BBM}$ | $V_{NC} = V_{NO} = V_{CC}$ ,<br>$R_L = 50\ \Omega$ ,<br>$C_L = 35\text{ pF}$ ,<br>See <a href="#">Figure 7-6</a> | $25^\circ\text{C}$ | 3.0 V          | 1   | 10  | 25  | ns   |
|                                     |                                                                                                                  | Full               | 2.7 V to 3.6 V | 0.5 |     | 30  |      |

- (1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.

## 6.9 Switching Characteristics for a 2.5-V Supply

$V_{CC} = 2.3\text{ V to }2.7\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                           | TEST CONDITIONS                                                                                                  | $T_A$              | $V_{CC}$       | MIN | TYP | MAX | UNIT |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------|--------------------|----------------|-----|-----|-----|------|
| Dynamic                             |                                                                                                                  |                    |                |     |     |     |      |
| Turnon time<br>$t_{ON}$             | $V_{COM} = V_{CC}$ ,<br>$R_L = 50\ \Omega$ ,<br>$C_L = 35\text{ pF}$ ,<br>See <a href="#">Figure 7-5</a>         | $25^\circ\text{C}$ | 2.5 V          | 23  |     | 45  | ns   |
|                                     |                                                                                                                  | Full               | 2.3 V to 2.7 V |     |     | 50  |      |
| Turnoff time<br>$t_{OFF}$           | $V_{COM} = V_{CC}$ ,<br>$R_L = 50\ \Omega$ ,<br>$C_L = 35\text{ pF}$ ,<br>See <a href="#">Figure 7-5</a>         | $25^\circ\text{C}$ | 2.5 V          | 17  |     | 27  | ns   |
|                                     |                                                                                                                  | Full               | 2.3 V to 2.7 V |     |     | 30  |      |
| Break-before-make time<br>$t_{BBM}$ | $V_{NC} = V_{NO} = V_{CC}$ ,<br>$R_L = 50\ \Omega$ ,<br>$C_L = 35\text{ pF}$ ,<br>See <a href="#">Figure 7-6</a> | $25^\circ\text{C}$ | 2.5 V          | 2   | 14  | 30  | ns   |
|                                     |                                                                                                                  | Full               | 2.3 V to 2.7 V | 1   |     | 35  |      |

- (1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.

## 6.10 Switching Characteristics for a 1.8-V Supply

$V_{CC} = 1.65\text{ V to }1.95\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                               | TEST CONDITIONS                                                                                                    | $T_A$ | $V_{CC}$               | MIN | TYP | MAX | UNIT |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------|------------------------|-----|-----|-----|------|
| Dynamic                                 |                                                                                                                    |       |                        |     |     |     |      |
| Turnon time<br>$t_{ON}$                 | $V_{COM} = V_{CC}$ ,<br>$R_L = 50\ \Omega$<br><br>$C_L = 35\text{ pF}$ ,<br>See <a href="#">Figure 7-5</a>         | 25°C  | 1.8 V                  |     | 53  | 75  | ns   |
|                                         |                                                                                                                    | Full  | 1.65 V<br>to<br>1.96 V |     |     | 80  |      |
| Turnoff time<br>$t_{OFF}$               | $V_{COM} = V_{CC}$ ,<br>$R_L = 50\ \Omega$<br><br>$C_L = 35\text{ pF}$ ,<br>See <a href="#">Figure 7-5</a>         | 25°C  | 1.8 V                  |     | 24  | 35  | ns   |
|                                         |                                                                                                                    | Full  | 1.65 V<br>to<br>1.96 V |     |     | 40  |      |
| Break-before-<br>make time<br>$t_{BBM}$ | $V_{NC} = V_{NO} = V_{CC}$ ,<br>$R_L = 50\ \Omega$<br><br>$C_L = 35\text{ pF}$ ,<br>See <a href="#">Figure 7-6</a> | 25°C  | 1.8 V                  | 2   | 30  | 40  | ns   |
|                                         |                                                                                                                    | Full  | 1.65 V<br>to<br>1.96 V | 1   |     | 50  |      |

(1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.

## 6.11 Typical Characteristics

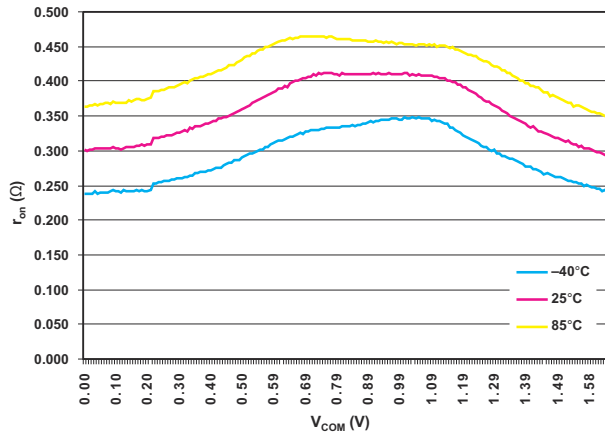
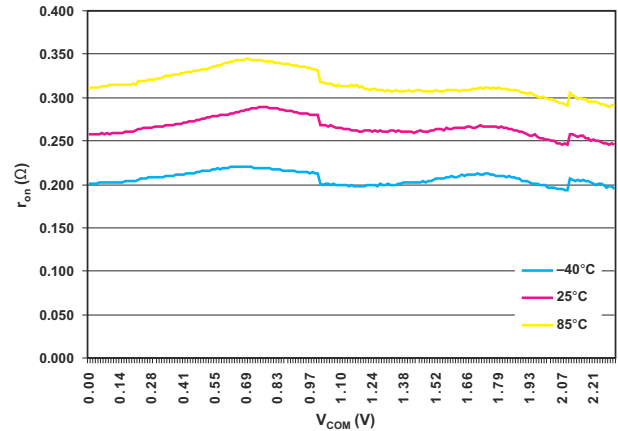
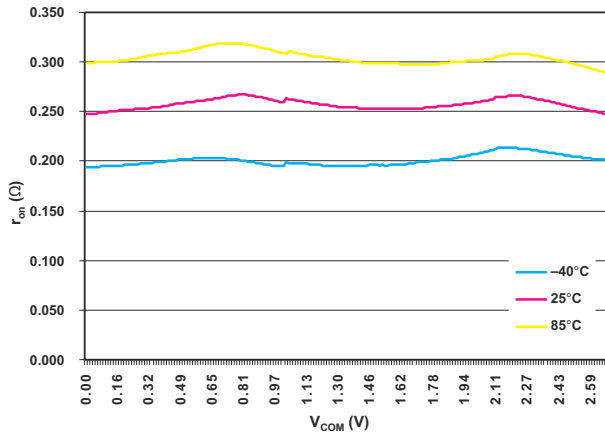
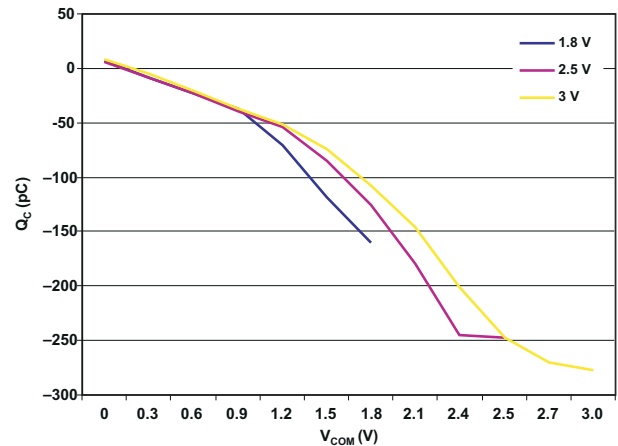
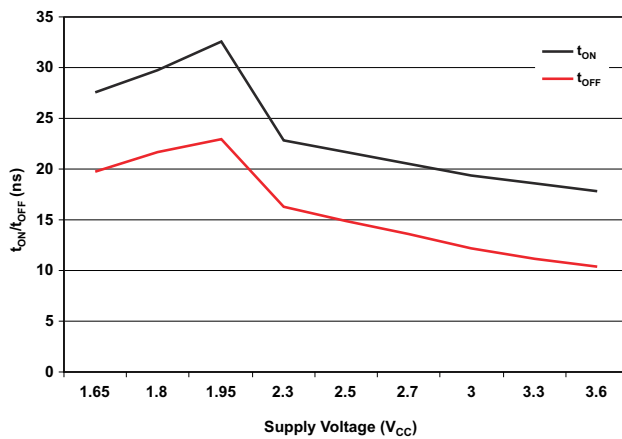
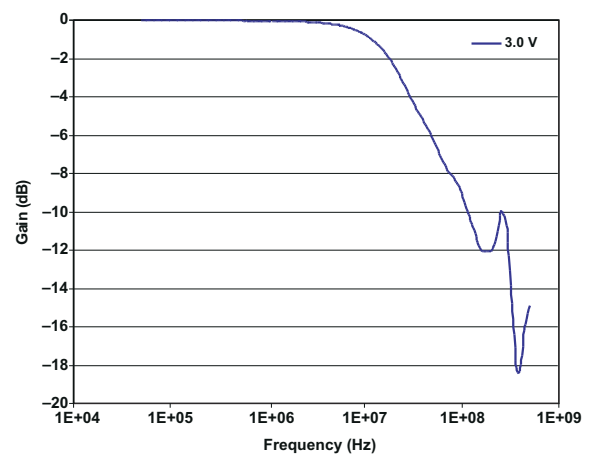
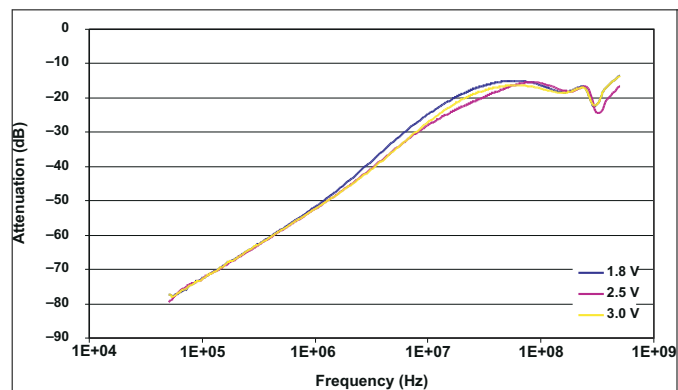
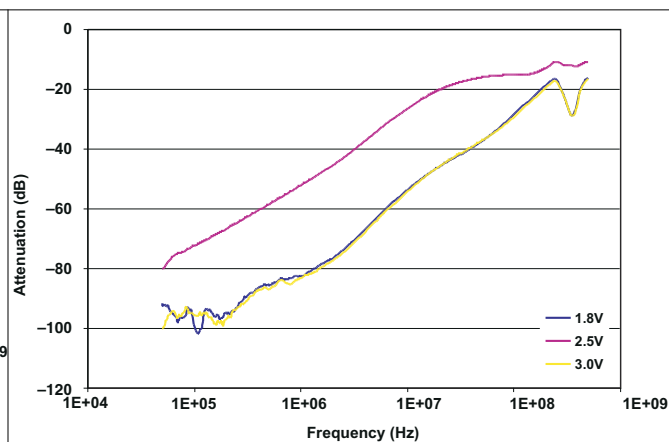
Figure 6-1.  $r_{on}$  vs  $V_{COM}$  ( $V_{CC} = 1.65$  V)Figure 6-2.  $r_{on}$  vs  $V_{COM}$  ( $V_{CC} = 2.3$  V)Figure 6-3.  $r_{on}$  vs  $V_{COM}$  ( $V_{CC} = 2.7$  V)Figure 6-4. Charge Injection ( $Q_C$ ) vs  $V_{COM}$  ( $T_A = 25^\circ\text{C}$ )Figure 6-5.  $t_{ON}$  and  $t_{OFF}$  vs Supply Voltage ( $T_A = 25^\circ\text{C}$ )

Figure 6-6. Bandwidth

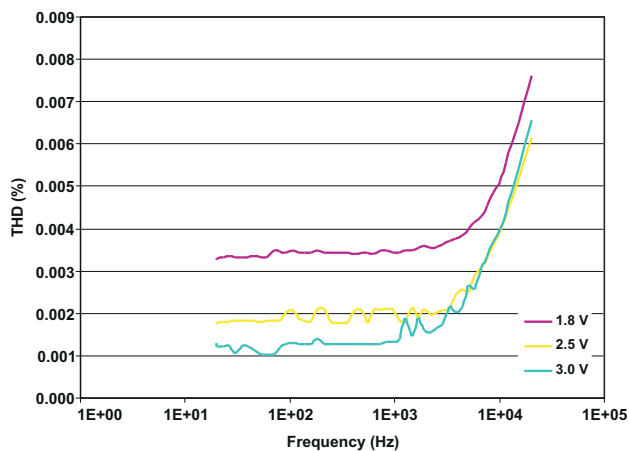
## 6.11 Typical Characteristics (continued)



**Figure 6-7. OFF Isolation**



**Figure 6-8. Crosstalk**



**Figure 6-9. Total Harmonic Distortion vs Frequency**

## 7 Parameter Measurement Information

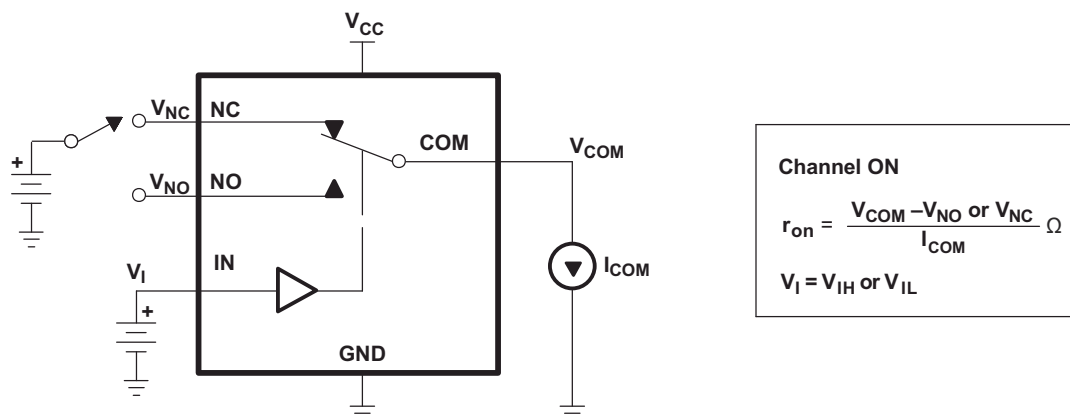


Figure 7-1. ON-State Resistance

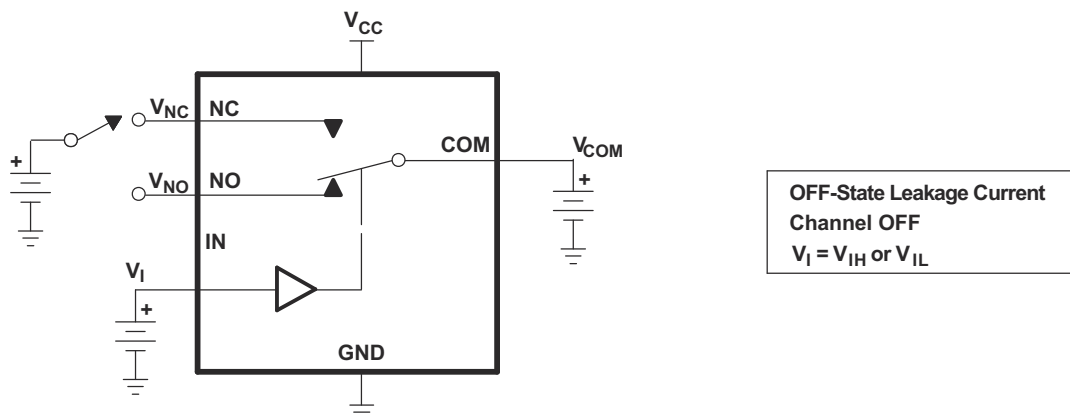


Figure 7-2. OFF-State Leakage Current ( $I_{NC(OFF)}$ ,  $I_{NC(PWROFF)}$ ,  $I_{NO(OFF)}$ ,  $I_{NO(PWROFF)}$ ,  $I_{COM(OFF)}$ ,  $I_{COM(PWROFF)}$ )

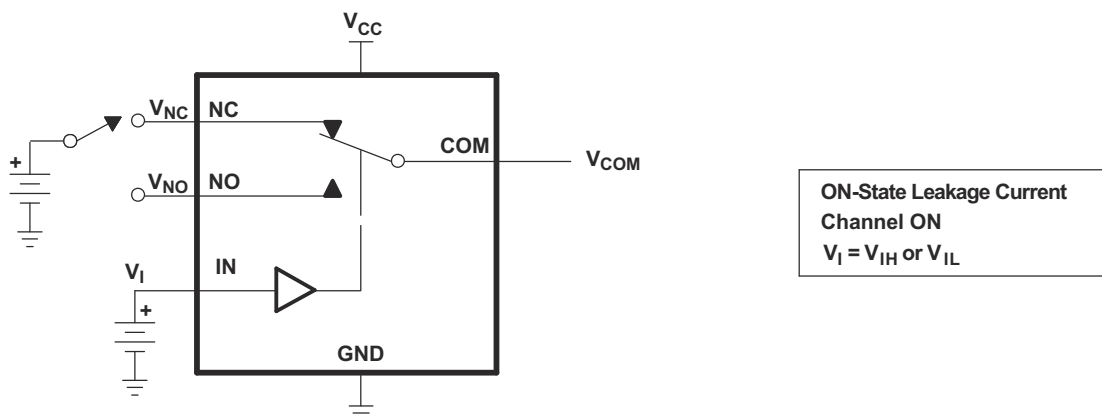
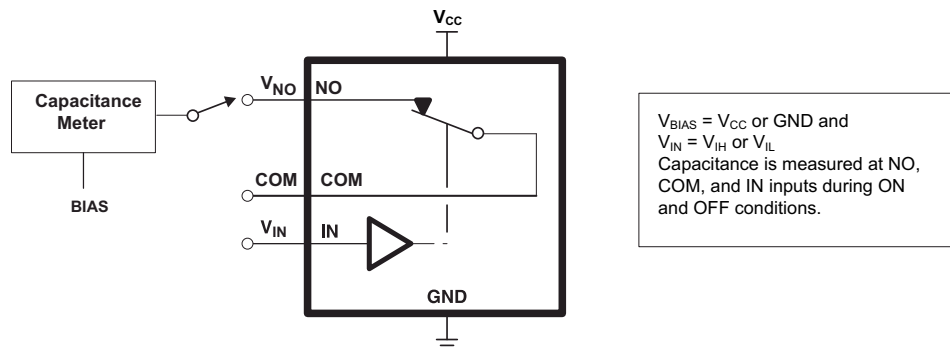
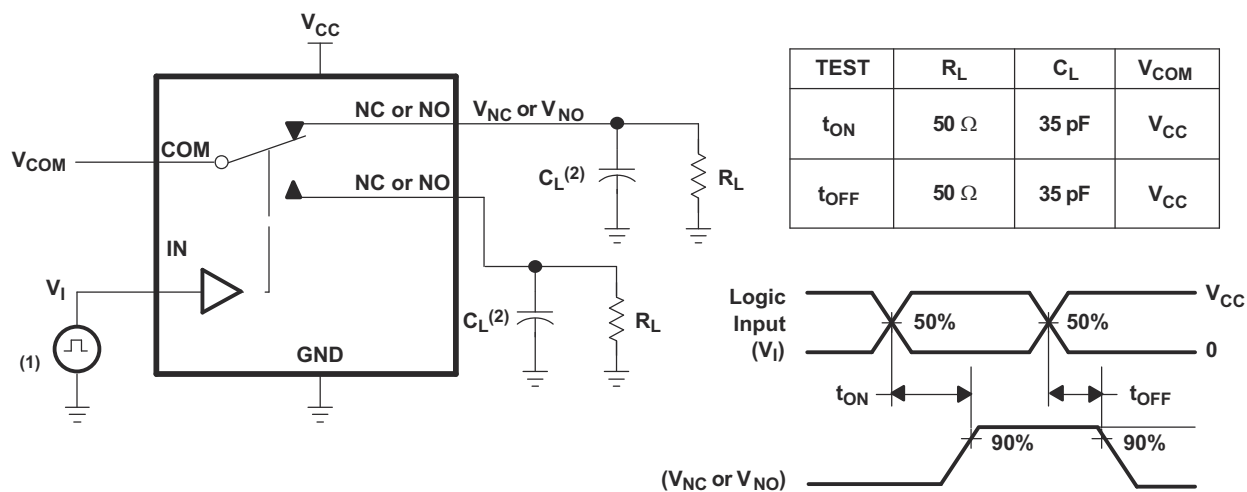


Figure 7-3. ON-State Leakage Current ( $I_{COM(ON)}$ ,  $I_{NC(ON)}$ ,  $I_{NO(ON)}$ )

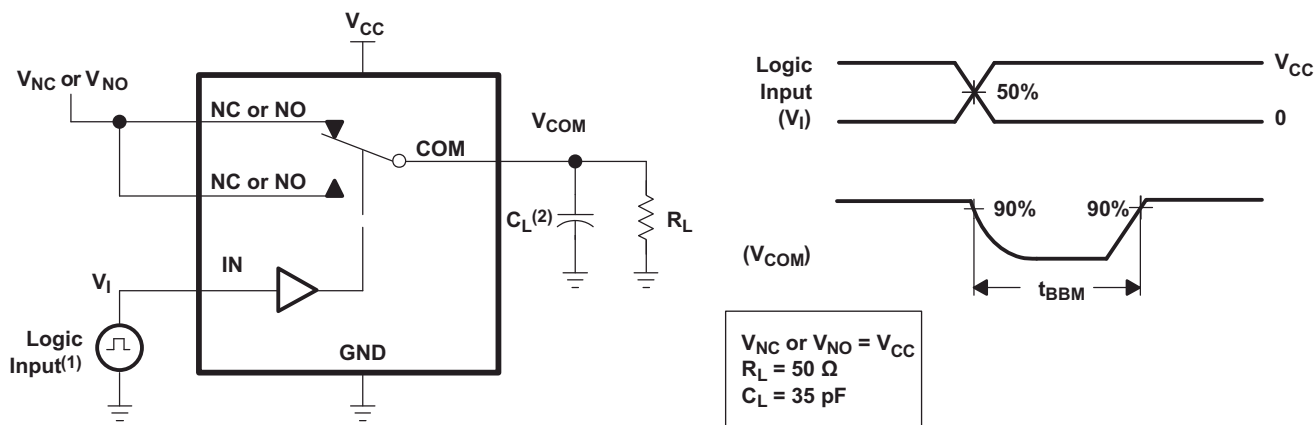


**Figure 7-4. Capacitance  $C_I$ ,  $C_{NC(OFF)}$ ,  $C_{NO(OFF)}$ ,  $C_{NC(ON)}$ ,  $C_{NO(ON)}$**



- A. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10\ \text{MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r < 5\ \text{ns}$ ,  $t_f < 5\ \text{ns}$ .  
B.  $C_L$  includes probe and jig capacitance.

**Figure 7-5. Turn-On ( $t_{ON}$ ) and Turn-Off Time ( $t_{OFF}$ )**



- A. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10\ \text{MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r < 5\ \text{ns}$ ,  $t_f < 5\ \text{ns}$ .  
B.  $C_L$  includes probe and jig capacitance.

**Figure 7-6. Break-Before-Make Time ( $t_{BBM}$ )**

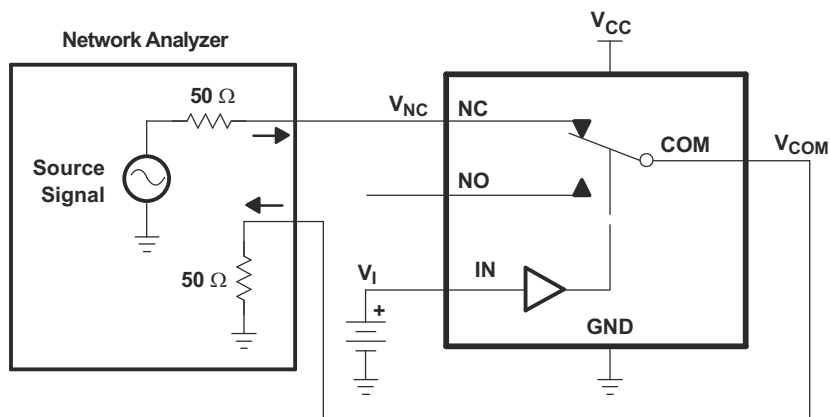
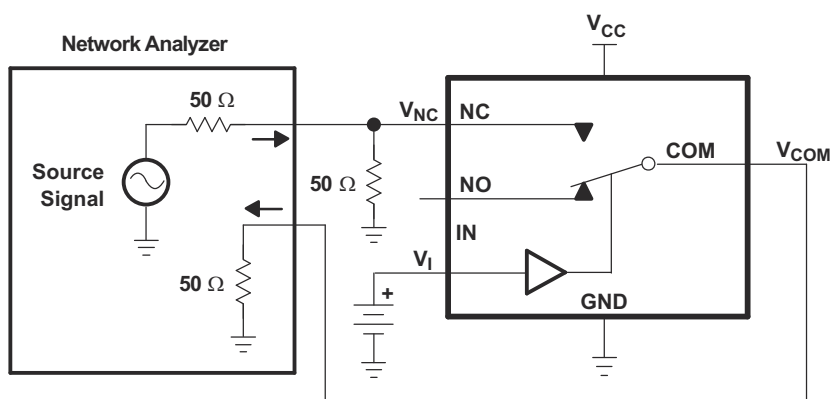


Figure 7-7. Bandwidth (BW)

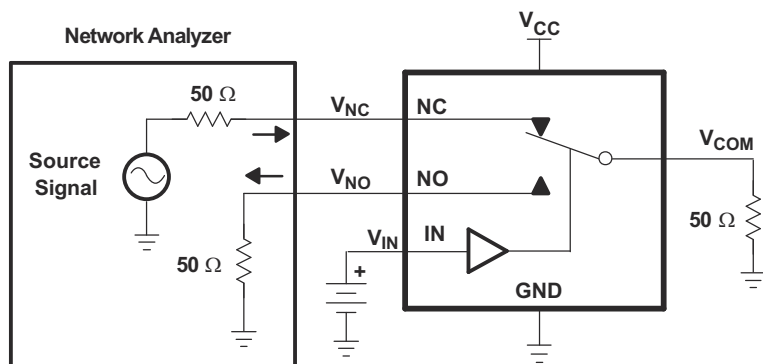
Channel ON: NC to COM  
V<sub>I</sub> = V<sub>CC</sub> or GND

**Network Analyzer Setup**  
Source Power = 0 dBm  
(632-mV P-P at 50- $\Omega$  load)  
DC Bias = 350 mV

Figure 7-8. OFF Isolation (O<sub>ISO</sub>)

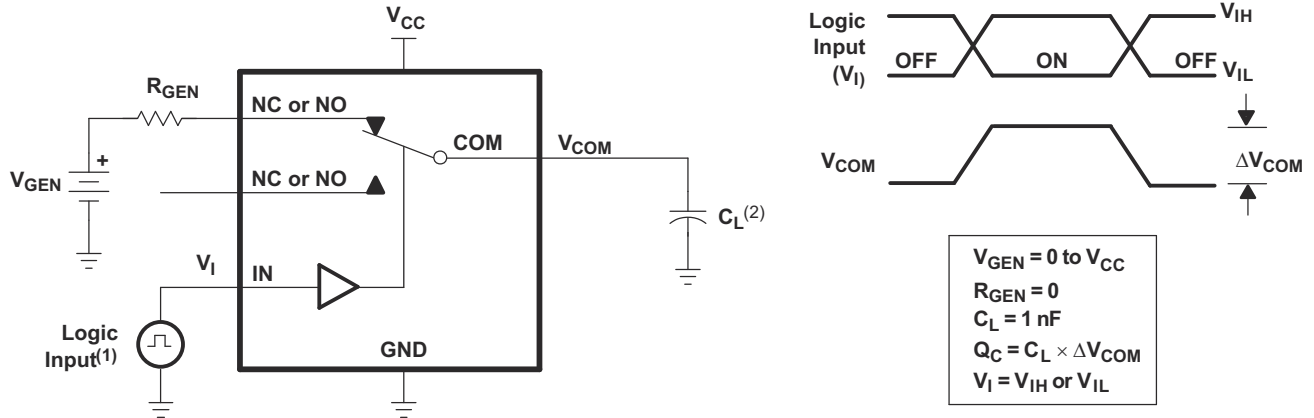
Channel OFF: NC to COM  
V<sub>I</sub> = V<sub>CC</sub> or GND

**Network Analyzer Setup**  
Source Power = 0 dBm  
(632-mV P-P at 50- $\Omega$  load)  
DC Bias = 350 mV

Figure 7-9. Crosstalk (X<sub>TALK</sub>)

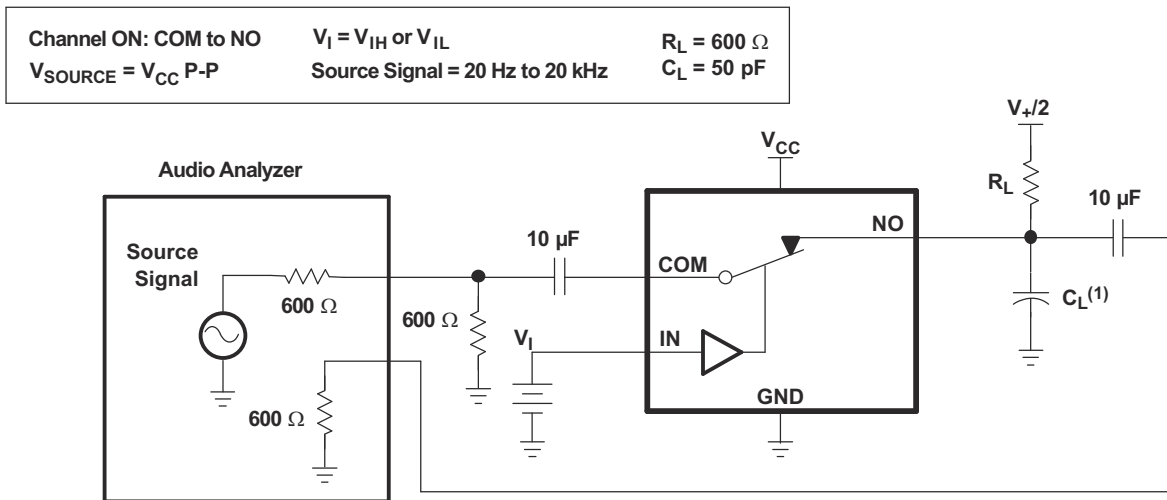
Channel ON: NC to COM  
Channel OFF: NO to COM  
V<sub>IN</sub> = V<sub>CC</sub> or GND

**Network Analyzer Setup**  
Source Power = 0 dBm  
(632-mV P-P at 50- $\Omega$  load)  
DC Bias = 350 mV



- A. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z<sub>O</sub> = 50 Ω, t<sub>r</sub> < 5 ns, t<sub>f</sub> < 5 ns.  
B. C<sub>L</sub> includes probe and jig capacitance.

**Figure 7-10. Charge Injection (Q<sub>C</sub>)**



- A. C<sub>L</sub> includes probe and jig capacitance.

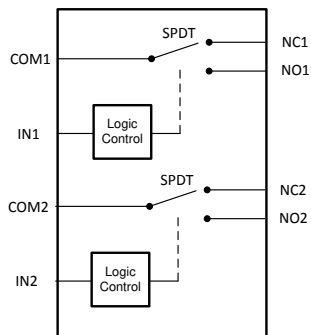
**Figure 7-11. Total Harmonic Distortion (THD)**

## 8 Detailed Description

### 8.1 Overview

The TS3A24159 is a 2-channel single-pole double-throw (SPDT) bidirectional analog switch that is designed to operate from 1.65 V to 3.6 V. It offers low ON-state resistance and excellent ON-state resistance matching with the break-before-make feature, to prevent signal distortion during the transferring of a signal from one channel to another. The device has excellent total harmonic distortion (THD) performance, low ON-state resistance, and consumes very low power. These are some of the features that make this device suitable for a variety of markets and many different applications.

### 8.2 Functional Block Diagram



### 8.3 Feature Description

The TS3A24159 device is bidirectional with two single-pole, double-throw switches. Each of the two switches are controlled independently by two digital signals.

### 8.4 Device Functional Modes

**Table 8-1. Function Table**

| IN | NC TO COM,<br>COM TO NC | NO TO COM,<br>COM TO NO |
|----|-------------------------|-------------------------|
| L  | ON                      | OFF                     |
| H  | OFF                     | ON                      |

## 9 Application and Implementation

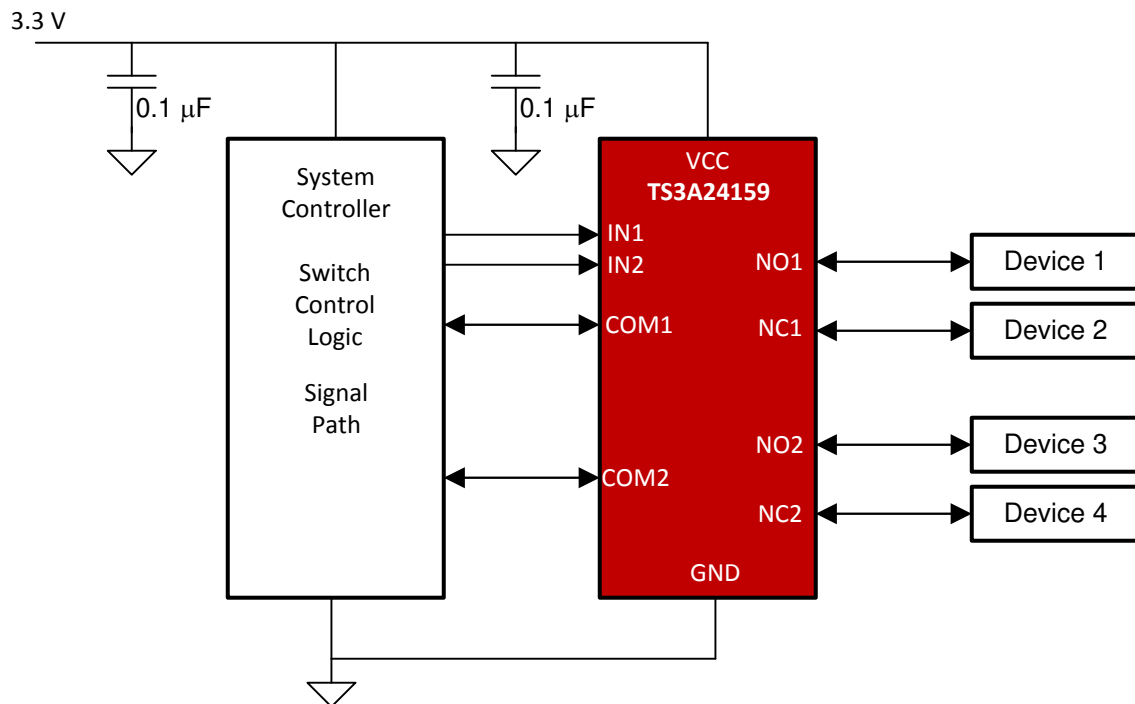
### Note

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, as well as validating and testing their design implementation to confirm system functionality.

### 9.1 Application Information

The switch of the TS3A24159 device is bidirectional. Hence, NO, NC, and COM pins can be used as both inputs or outputs.

### 9.2 Typical Application



#### 9.2.1 Design Requirements

Ensure that all of the signals passing through the switch are within the specified ranges to ensure proper performance.

**Table 9-1. Design Parameters**

|                                   |                       | MIN  | MAX      | UNIT |
|-----------------------------------|-----------------------|------|----------|------|
| $V_{CC}$                          | Supply Voltage        | 1.65 | 3.6      | V    |
| $V_{NC}$<br>$V_{NO}$<br>$V_{COM}$ | Signal Voltage        | 0    | $V_{CC}$ | V    |
| $V_{IN}$                          | Digital Input Voltage | 0    | $V_{CC}$ | V    |

### 9.2.2 Detailed Design Procedure

The TS3A24159 device can be properly operated without any external components. However, it is recommended to connect the unused pins to ground through a 50- $\Omega$  resistor to prevent signal reflections back into the device. It is also recommended that the digital control pins (IN1 and IN2) be pulled up to  $V_{CC}$  or down to GND to avoid undesired switch positions that could result from the floating pin.

Select the appropriate supply voltage to cover the entire voltage swing of the signal passing through the switch because the TS3A24159 input/output signal swing through NO and COM are dependant of the supply voltage  $V_{CC}$ .

### 9.2.3 Application Curve

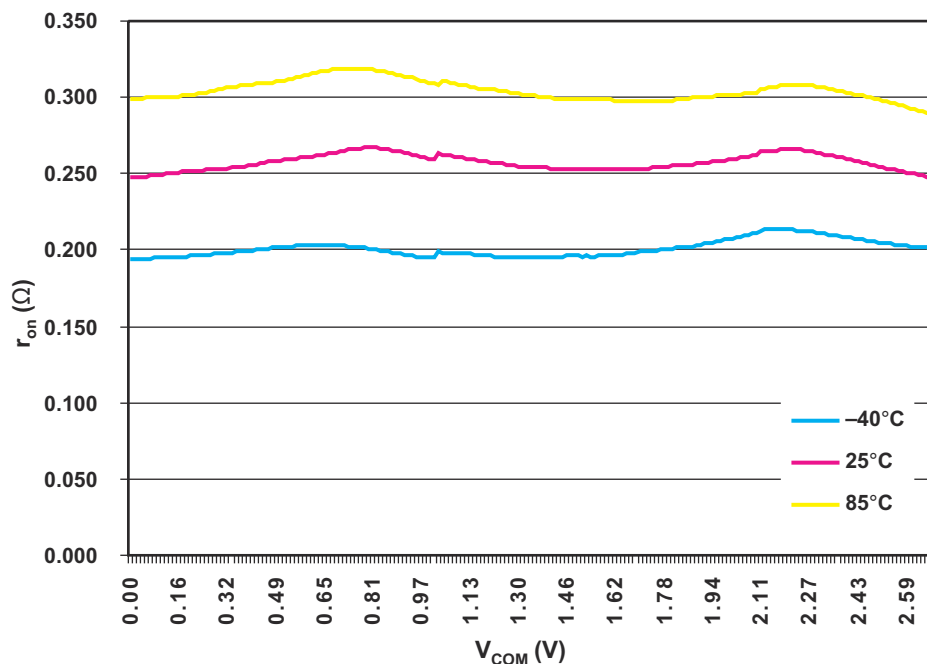


Figure 9-1.  $r_{ON}$  vs  $V_{COM}$

## 10 Power Supply Recommendations

- Proper power-supply sequencing is recommended for all CMOS devices.
- Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings can cause permanent damage to the device.
- Always sequence  $V_{CC}$  on first, followed by NO or COM.
- Although it is not required, power-supply bypassing improves noise margin and prevents switching noise propagation from the  $V_{CC}$  supply to other components.
- A 0.1- $\mu$ F capacitor, connected from  $V_{CC}$  to GND, is adequate for most applications.

## 11 Layout

### 11.1 Layout Guidelines

To ensure reliability of the device, following common printed-circuit board layout guidelines is recommended. Bypass capacitors must be used on power supplies. Short trace lengths should be used to avoid excessive loading.

### 11.2 Layout Example

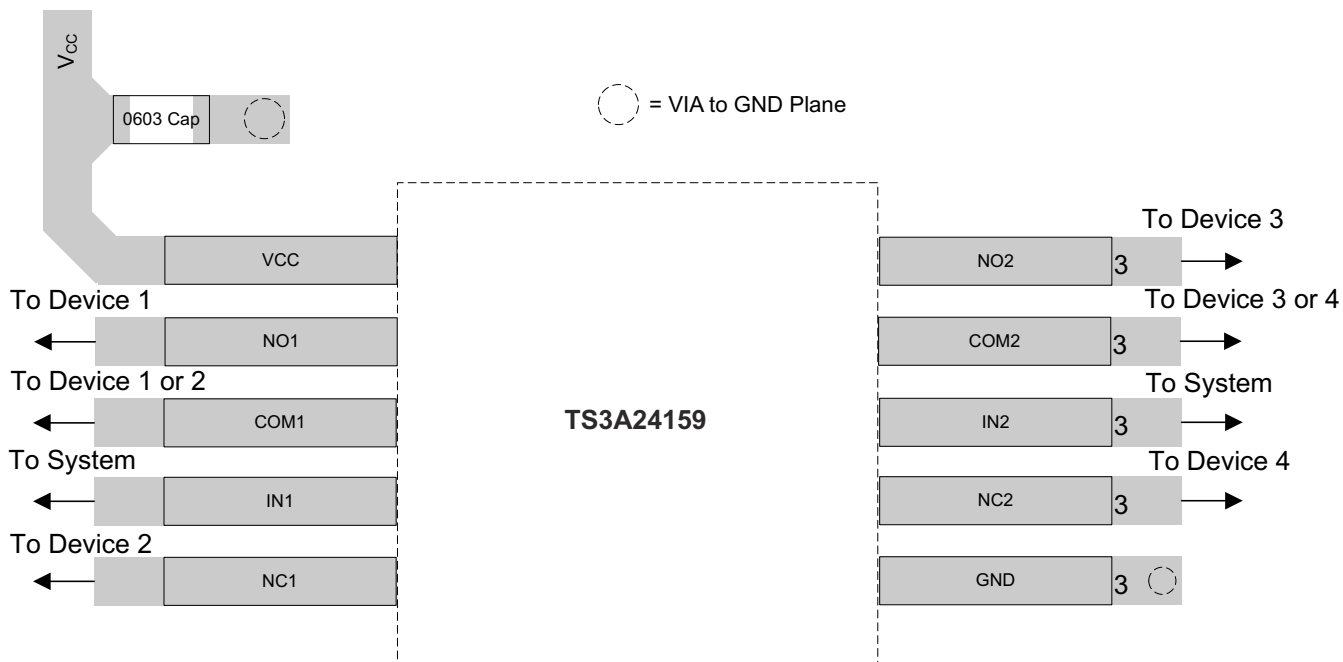


Figure 11-1. Layout Example

## 12 Device and Documentation Support

### 12.1 Documentation Support

#### 12.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, [Implications of Slow or Floating CMOS Inputs application note](#)

### 12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](#). Click on *Subscribe to updates* 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.

### 12.3 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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### 12.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### 12.6 Glossary

[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 part number         | Status<br>(1) | Material type<br>(2) | Package   Pins   | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|-------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">TS3A24159DGSR</a> | Active        | Production           | VSSOP (DGS)   10 | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 85    | (L8Q, L8R)          |
| TS3A24159DGSR.B               | Active        | Production           | VSSOP (DGS)   10 | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 85    | (L8Q, L8R)          |
| <a href="#">TS3A24159DRCR</a> | Active        | Production           | VSON (DRC)   10  | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | ZWS                 |
| TS3A24159DRCR.B               | Active        | Production           | VSON (DRC)   10  | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | ZWS                 |
| <a href="#">TS3A24159YZPR</a> | Active        | Production           | DSBGA (YZP)   10 | 3000   LARGE T&R      | Yes         | SNAGCU                               | Level-1-260C-UNLIM                | -40 to 85    | L87                 |
| TS3A24159YZPR.B               | Active        | Production           | DSBGA (YZP)   10 | 3000   LARGE T&R      | Yes         | SNAGCU                               | Level-1-260C-UNLIM                | -40 to 85    | L87                 |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts 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.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## TAPE AND REEL INFORMATION



\*All dimensions are nominal

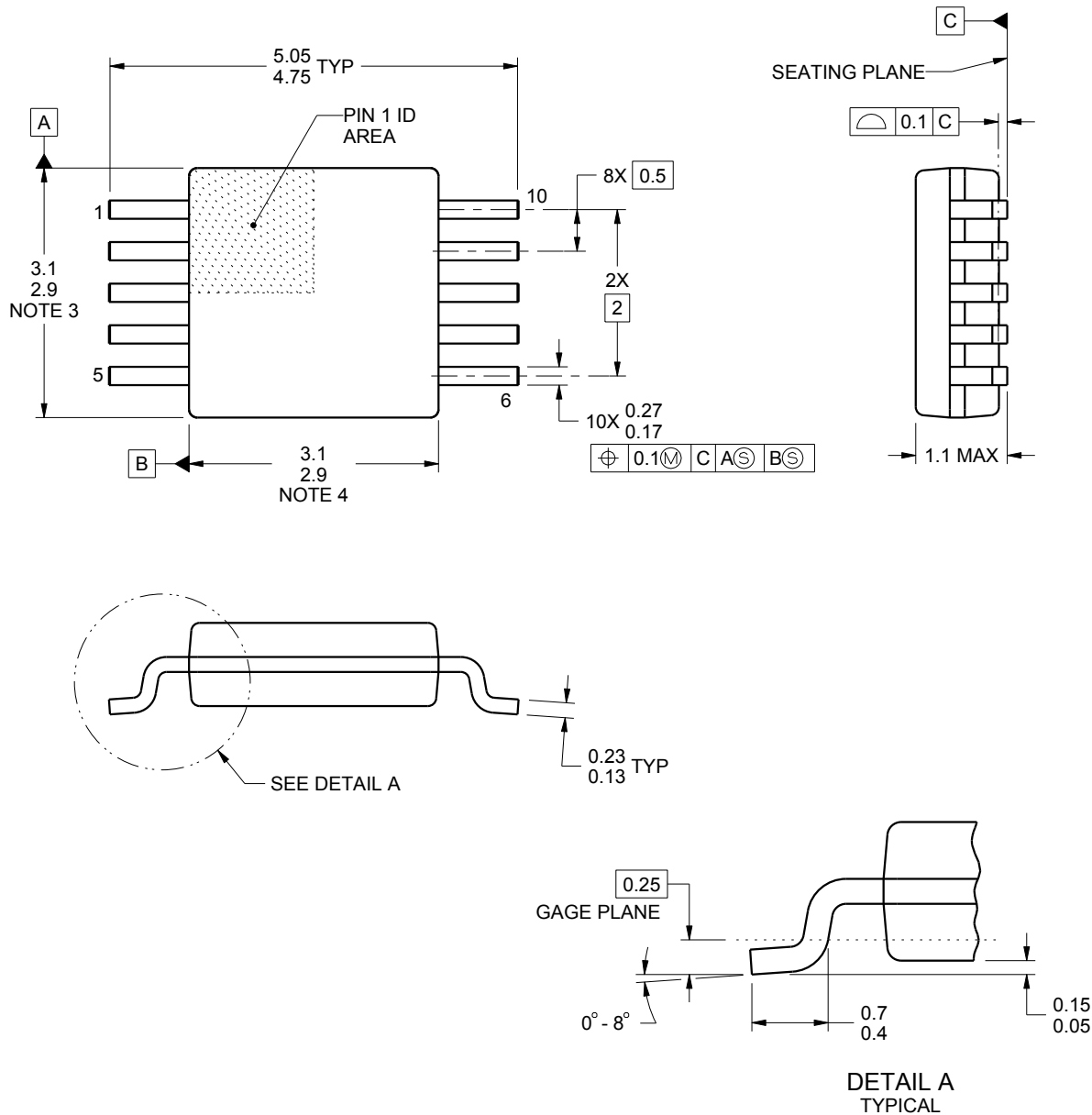
| Device        | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TS3A24159DGSR | VSSOP        | DGS             | 10   | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TS3A24159DRCR | VSON         | DRC             | 10   | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TS3A24159YZPR | DSBGA        | YZP             | 10   | 3000 | 178.0              | 9.2                | 1.49    | 1.99    | 0.63    | 4.0     | 8.0    | Q2            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TS3A24159DGSR | VSSOP        | DGS             | 10   | 2500 | 358.0       | 335.0      | 35.0        |
| TS3A24159DRCR | VSON         | DRC             | 10   | 3000 | 353.0       | 353.0      | 32.0        |
| TS3A24159YZPR | DSBGA        | YZP             | 10   | 3000 | 220.0       | 220.0      | 35.0        |



4221984/A 05/2015

**NOTES:**

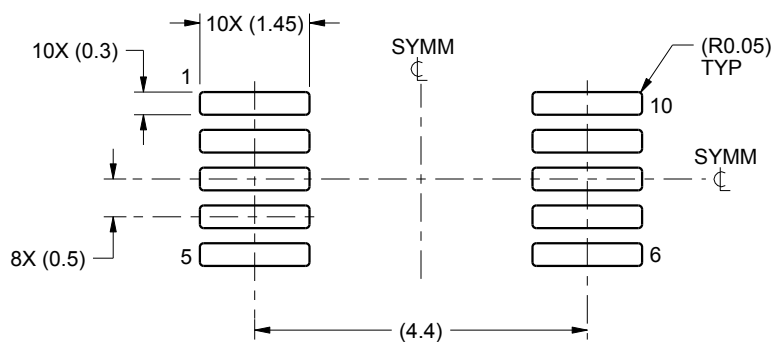
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187, variation BA.

# EXAMPLE BOARD LAYOUT

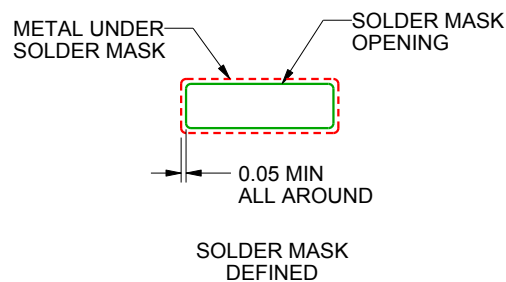
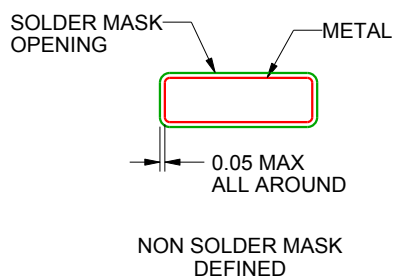
DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221984/A 05/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

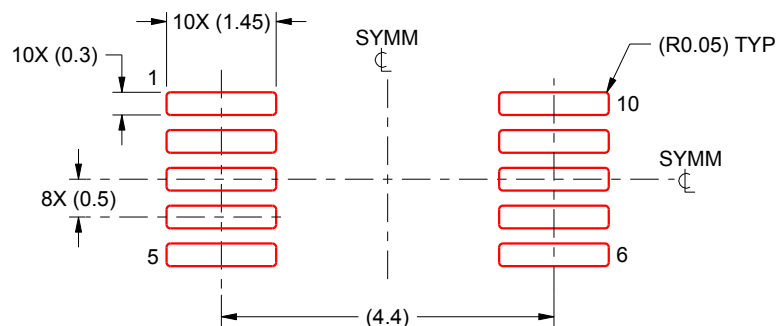
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:10X

4221984/A 05/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

## GENERIC PACKAGE VIEW

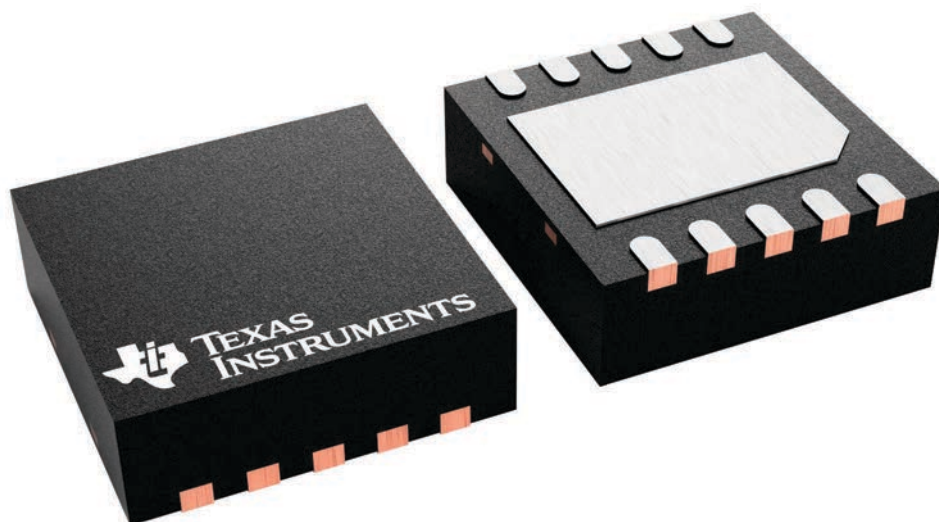
**DRC 10**

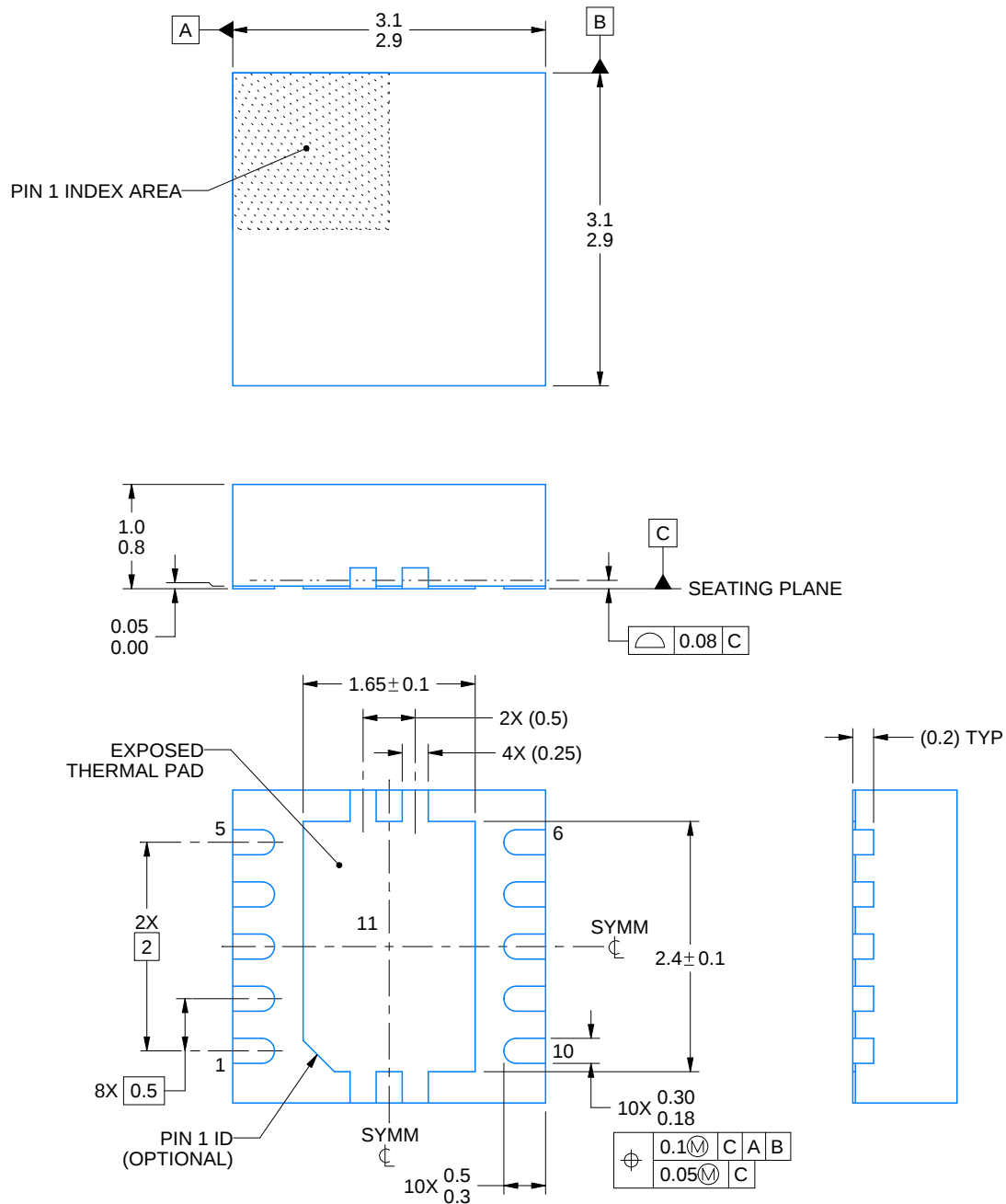
**VSON - 1 mm max height**

3 x 3, 0.5 mm pitch

PLASTIC SMALL OUTLINE - NO LEAD

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.





4218878/B 07/2018

## NOTES:

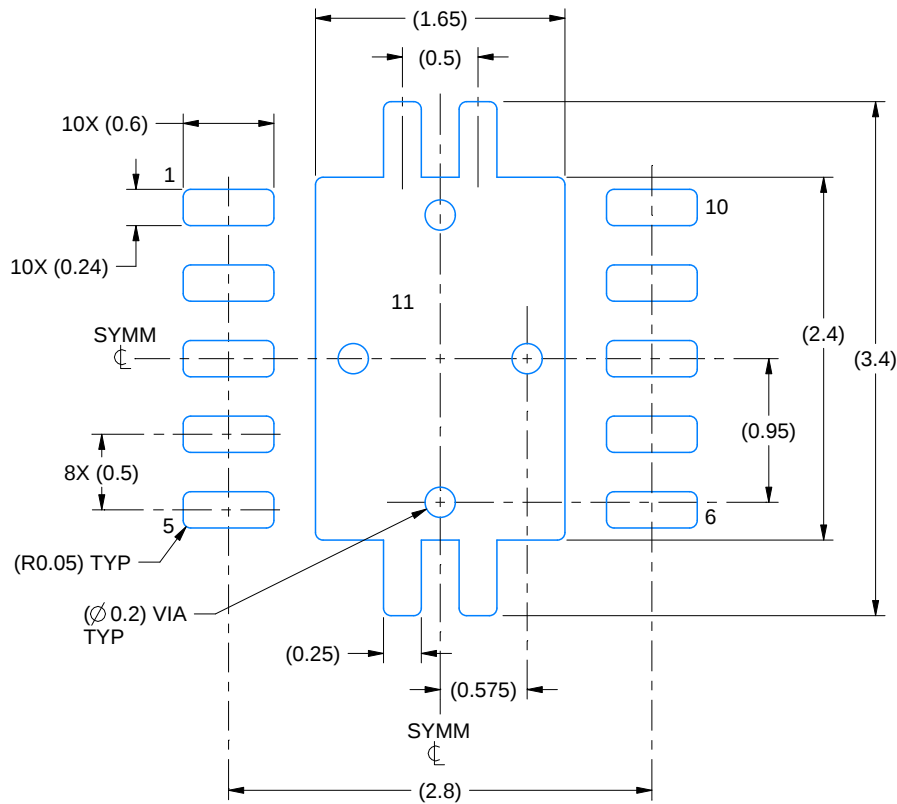
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

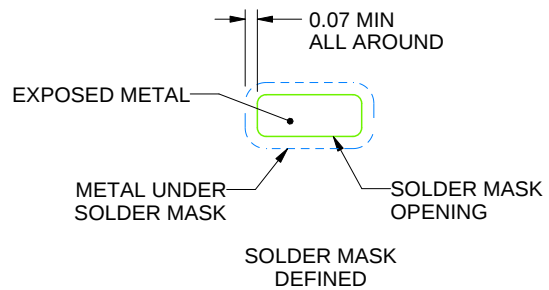
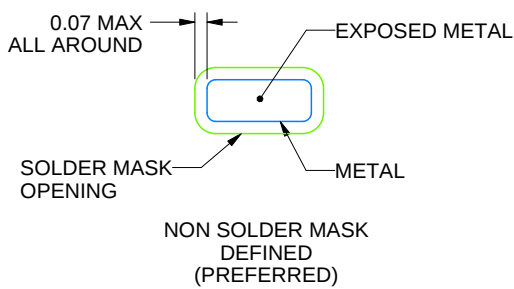
DRC0010J

VSON - 1 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:20X



SOLDER MASK DETAILS

4218878/B 07/2018

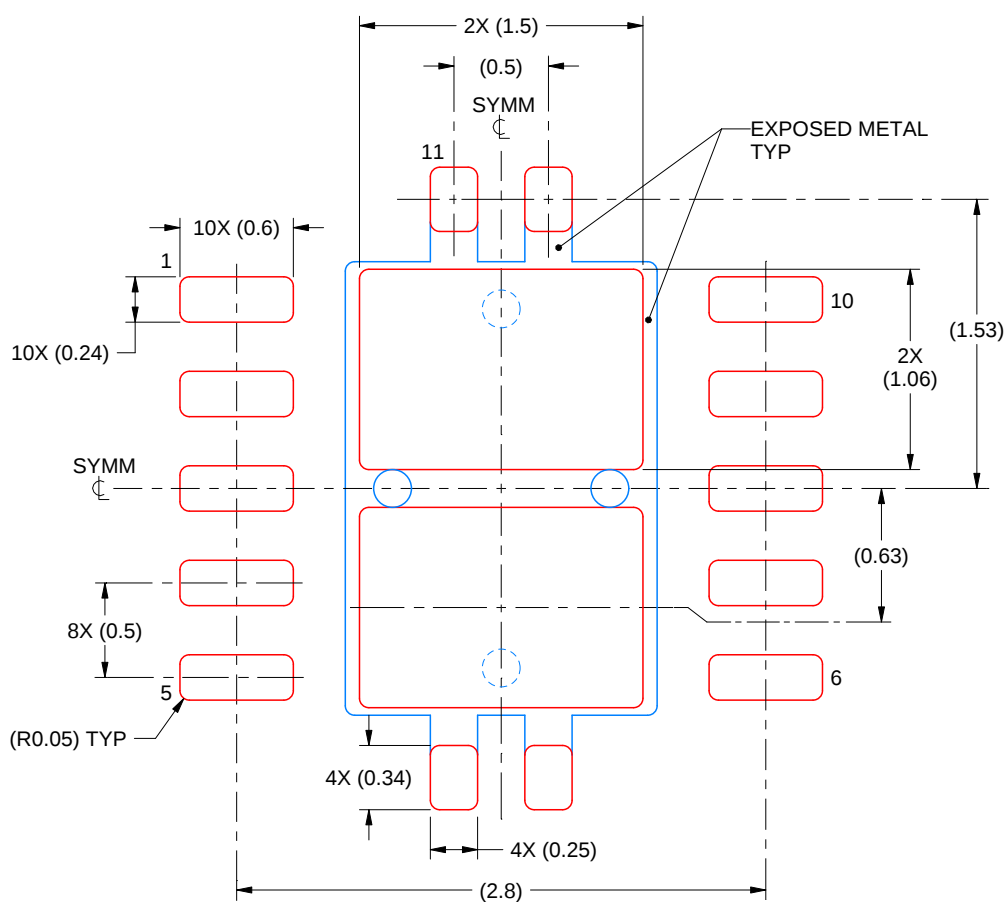
NOTES: (continued)

- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

**DRC0010J**

**VSON - 1 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 11:  
80% PRINTED SOLDER COVERAGE BY AREA  
SCALE:25X

4218878/B 07/2018

NOTES: (continued)

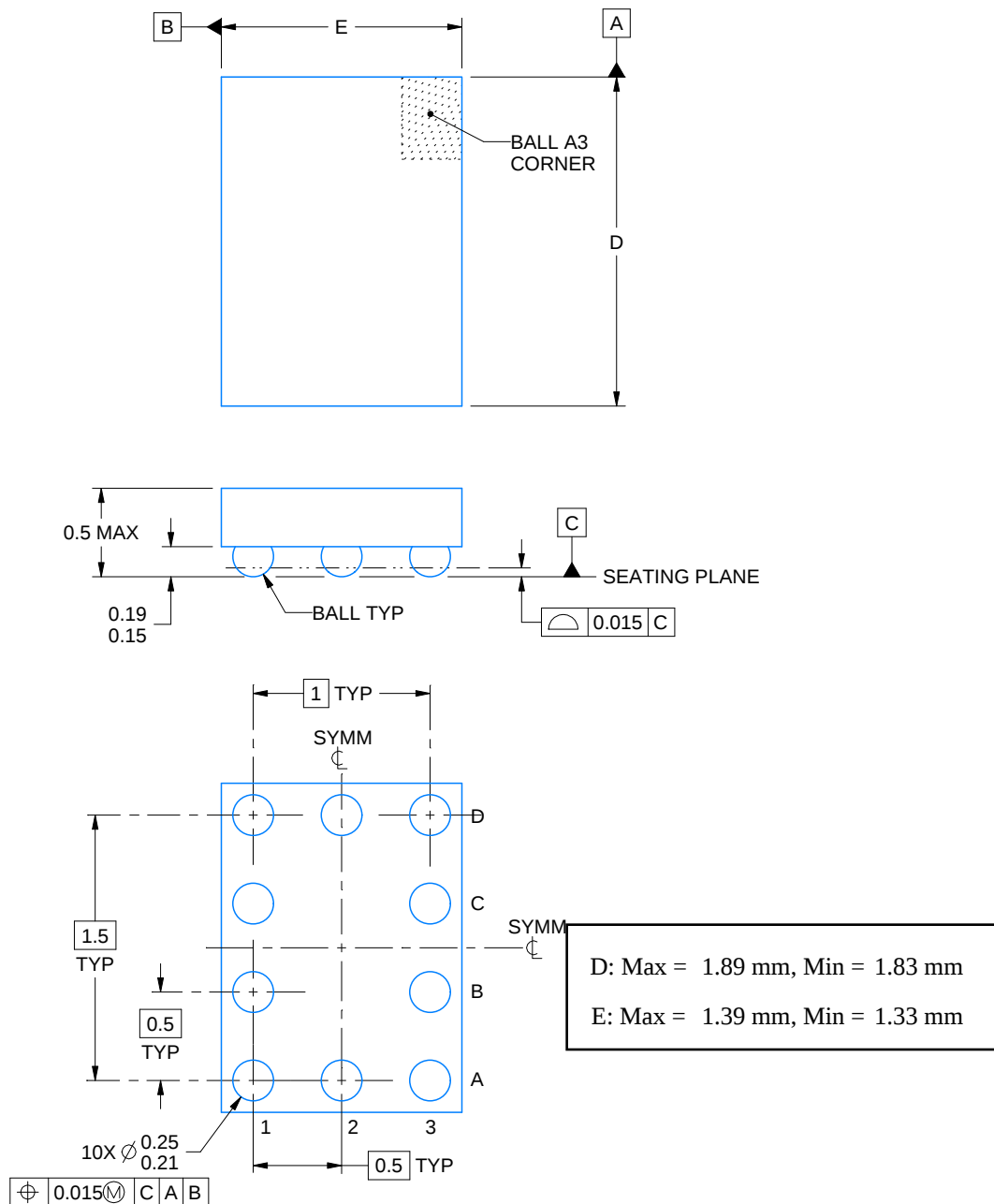
6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

## PACKAGE OUTLINE

**YZP0010**

**DSBGA - 0.5 mm max height**

## DIE SIZE BALL GRID ARRAY



4219350/B 11/2017

NOTES:

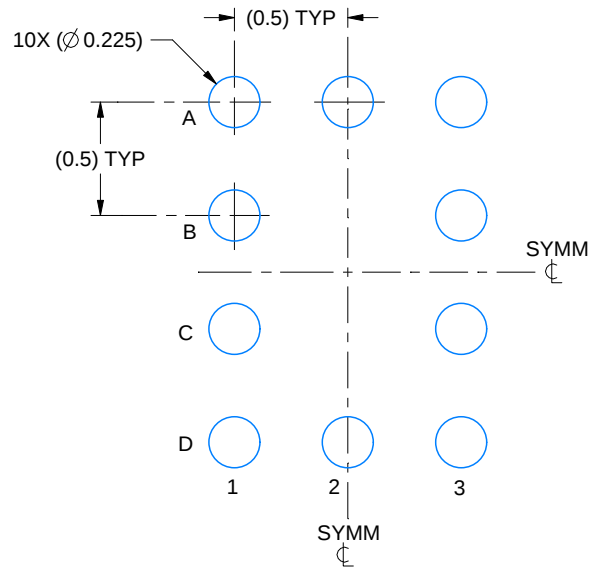
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

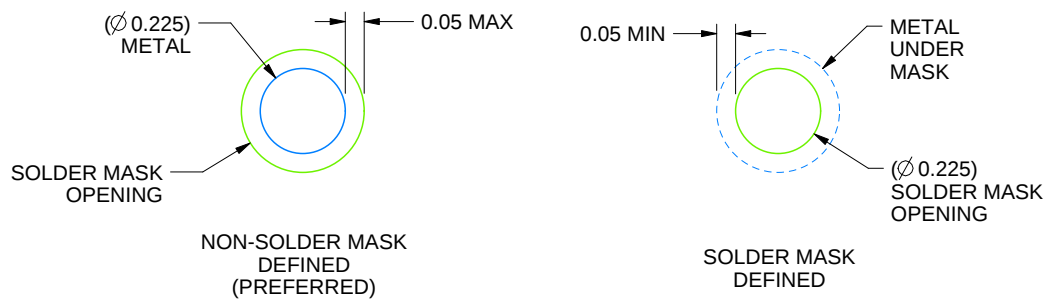
YZP0010

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE  
SCALE:30X



SOLDER MASK DETAILS  
NOT TO SCALE

4219350/B 11/2017

NOTES: (continued)

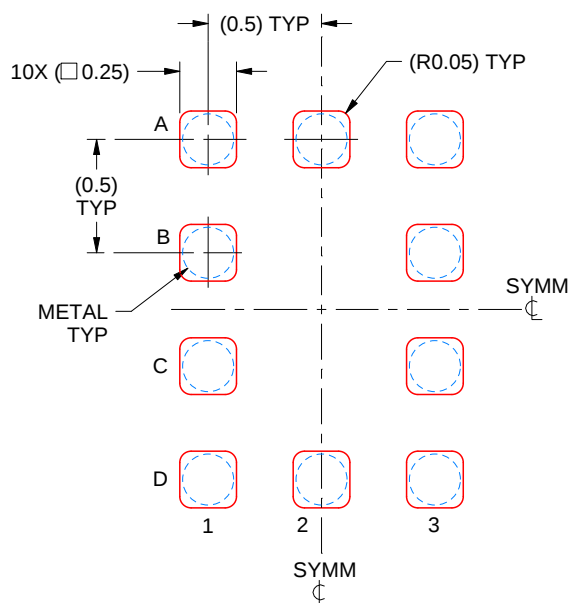
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For more information, see Texas Instruments literature number SBVA017 ([www.ti.com/lit/sbva017](http://www.ti.com/lit/sbva017)).

## EXAMPLE STENCIL DESIGN

YZP0010

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL  
SCALE:30X

4219350/B 11/2017

NOTES: (continued)

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

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