

## TS5A23157 Dual 10- $\Omega$ SPDT Analog Switch

### 1 Features

- Low ON-State Resistance (15  $\Omega$  at 125°C)
- 125°C Operation
- Control Inputs are 5-V Tolerant
- Specified Break-Before-Make Switching
- Low Charge Injection
- Excellent ON-Resistance Matching
- Low Total Harmonic Distortion
- 1.8-V to 5.5-V Single-Supply Operation
- 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

- Sample-and-Hold Circuits
- Battery-Powered Equipment
- Audio and Video Signal Routing
- Communication Circuits

### 3 Description

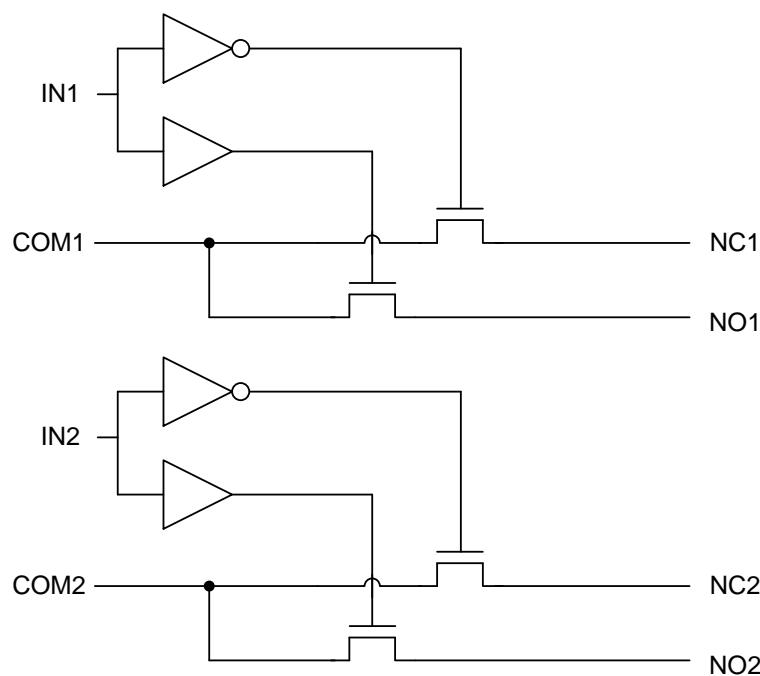
The TS5A23157 device is a dual single-pole double-throw (SPDT) analog switch designed to operate from 1.65 V to 5.5 V. This device can handle both digital and analog signals. Signals up to 5.5 V (peak) can be transmitted in either direction.

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

| PART NUMBER  | PACKAGE    | BODY SIZE (NOM)   |
|--------------|------------|-------------------|
| TS5A23157DGS | VSSOP (10) | 3.00 mm × 3.00 mm |
| TS5A23157RSE | UQFN (10)  | 2.00 mm × 1.50 mm |

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

**Block Diagram**



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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## 4 Revision History

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

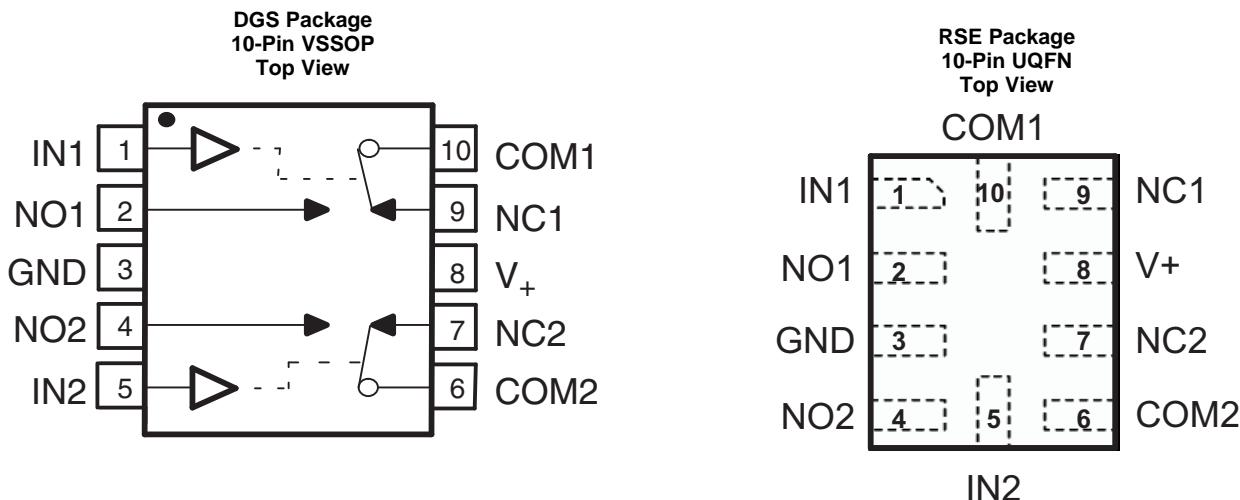
### Changes from Revision E (June 2015) to Revision F

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| • Changed <i>Feature From: Low ON-State Resistance (10 Ω) To: Low ON-State Resistance (15 Ω at 125°C)</i> .....               | 1    |
| • Added <i>Feature : 125°C Operation</i> .....  | 1    |
| • Added Junction Temperature To the <i>Absolute Maximum Ratings</i> table .....   | 4    |
| • Changed the Operating temperature MAX value From: 85°C To: 125°C in the <i>Recommended Operating Conditions</i> table ..... | 4    |
| • Changed the <i>Thermal Information</i> table .....  | 4    |
| • Changed $r_{on}$ in the <i>Electrical Characteristics for 5-V Supply</i> table.....   | 5    |
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### Changes from Revision D (October 2013) to Revision E

|  | Page |
|--|------|
| • 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 ..... | 1    |

## 5 Pin Configuration and Functions



**Pin Functions**

| <b>PIN</b> |             | <b>I/O</b> | <b>DESCRIPTION</b>               |
|------------|-------------|------------|----------------------------------|
| <b>NO.</b> | <b>NAME</b> |            |                                  |
| 1          | IN1         | I          | Select pin for switch 1          |
| 2          | NO1         | I/O        | Normally open I/O for switch 1   |
| 3          | GND         | —          | Ground                           |
| 4          | NO2         | I/O        | Normally open I/O for switch 2   |
| 5          | IN2         | I          | Select pin for switch 2          |
| 6          | COM2        | I/O        | Common I/O for switch 2          |
| 7          | NC2         | I/O        | Normally closed I/O for switch 2 |
| 8          | V+          | —          | Power supply pin                 |
| 9          | NC1         | I/O        | Normally closed I/O for switch 1 |
| 10         | COM1        | I/O        | Common I/O for switch 1          |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

|                                   |   |  | MIN  | MAX         | UNIT |
|-----------------------------------|---|--|------|-------------|------|
| $V_+$                             | Supply voltage <sup>(2)</sup>           |  | -0.5 | 6.5         | V    |
| $V_{NC}$<br>$V_{NO}$<br>$V_{COM}$ | Analog voltage <sup>(2)(3)(4)</sup>     |  | -0.5 | $V_+ + 0.5$ | V    |
| $I_{I/OK}$                        | Analog port diode current               | $V_{NC}, V_{NO}, V_{COM} < 0$ or $V_{NC}, V_{NO}, V_{COM} > V_+$ |      | $\pm 50$    | mA   |
| $I_{NC}$<br>$I_{NO}$<br>$I_{COM}$ | On-state switch current                 | $V_{NC}, V_{NO}, V_{COM} = 0$ to $V_+$                           |      | $\pm 50$    | mA   |
| $V_{IN}$                          | Digital input voltage <sup>(2)(3)</sup> |  | -0.5 | 6.5         | V    |
| $I_{IK}$                          | Digital input clamp current             | $V_{IN} < 0$   |      | -50         | mA   |
|                                   | Continuous current through $V_+$ or GND |  |      | $\pm 100$   | mA   |
| $T_J$                             | Junction Temperature                    |  |      | 150         | °C   |
| $T_{stg}$                         | 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, 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) This value is limited to 5.5 V maximum.

### 6.2 ESD Ratings

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

- (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 |
|-----------|-----------------------------|------|-------|------|
| $V_{I/O}$ | Switch input/output voltage | 0    | $V_+$ | V    |
| $V_+$     | Supply voltage              | 1.65 | 5.5   | V    |
| $V_I$     | Control input voltage       | 0    | 5.5   | V    |
| $T_A$     | Operating temperature       | -40  | 125   | °C   |

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> | TS5A23157                                    |            | UNIT |
|-------------------------------|--|------------|------|
|                               | DGS (VSSOP)                                  | RSE (UQFN) |      |
|                               | 10 PINS                                      | 10 PINS    |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 210.5      | °C/W |
| $R_{\theta JCtop}$            | Junction-to-case (top) thermal resistance    | 99.1       | °C/W |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 132.4      | °C/W |
| $\Psi_{JT}$                   | Junction-to-top characterization parameter   | 29.1       | °C/W |
| $\Psi_{JB}$                   | Junction-to-board characterization parameter | 130.5      | °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 5-V Supply

$V_+ = 4.5 \text{ V}$  to  $5.5 \text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted)

| PARAMETER                                       | TEST CONDITIONS  |  | $T_A$  | $V_+$                      | MIN              | TYP <sup>(1)</sup> | MAX           | UNIT          |
|---|--|--|--|----------------------------|------------------|--------------------|---------------|---------------|
| <b>ANALOG SWITCH</b>                            |  |  |  |                            |                  |                    |               |               |
| $V_{COM}, V_{NO}, V_{NC}$ , Analog signal range |  |  |  |                            | 0                |                    | $V_+$         | V             |
| $r_{on}$<br>ON-state resistance                 | $0 \leq V_{NO} \text{ or } V_{NC} \leq V_+, I_{COM} = -30 \text{ mA},$ | Switch ON,<br>see <a href="#">Figure 9</a>   | Full   | 4.5 V                      |                  | 10                 | $\Omega$      |               |
|   |  |  | -40 to $125^\circ\text{C}$   |                            |                  | 15                 |               |               |
| $\Delta r_{on}$                                 | ON-state resistance match between channels                             | $V_{NO} \text{ or } V_{NC} = 3.15 \text{ V}, I_{COM} = -30 \text{ mA},$                | Switch ON,<br>see <a href="#">Figure 9</a>                             | 25°C                       | 4.5 V            | 0.15               |               | $\Omega$      |
| $r_{on(\text{flat})}$                           | ON-state resistance flatness   | $0 \leq V_{NO} \text{ or } V_{NC} \leq V_+, I_{COM} = -30 \text{ mA},$                 | Switch ON,<br>see <a href="#">Figure 9</a>                             | 25°C                       | 4.5 V            | 4                  |               | $\Omega$      |
| $I_{NC(\text{OFF})}, I_{NO(\text{OFF})}$        | NC, NO OFF leakage current   | $V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+, V_{COM} = 0 \text{ to } V_+,$          | Switch OFF,<br>see <a href="#">Figure 10</a>                           | 25°C                       | 5.5 V            | -1                 | 0.05          | 1             |
|   |  |  | Full   | -1                         |                  |                    | $\mu\text{A}$ |               |
| $I_{NC(\text{ON})}, I_{NO(\text{ON})}$          | NC, NO ON leakage current  | $V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+, V_{COM} = \text{Open},$                | Switch ON,<br>see <a href="#">Figure 10</a>                            | 25°C                       | 5.5 V            | -0.1               | 0.1           | $\mu\text{A}$ |
|   |  |  | Full   | -1                         |                  | 1                  |               |               |
| $I_{COM(\text{ON})}$                            | COM ON leakage current   | $V_{NC} \text{ or } V_{NO} = \text{Open}, V_{COM} = 0 \text{ to } V_+,$                | Switch ON,<br>see <a href="#">Figure 10</a>                            | 25°C                       | 5.5 V            | -0.1               | 0.1           | $\mu\text{A}$ |
|   |  |  | Full   | -1                         |                  | 1                  |               |               |
| <b>DIGITAL INPUTS (IN12, IN2)<sup>(2)</sup></b> |  |  |  |                            |                  |                    |               |               |
| $V_{IH}$  | Input logic high   |  | Full   |                            | $V_+ \times 0.7$ |                    |               | V             |
|   |  |  | -40 to $125^\circ\text{C}$   | 4.75 V to 5.25 V           |                  | 3.1                |               |               |
| $V_{IL}$  | Input logic low  |  | Full   |                            | $V_+ \times 0.3$ |                    | V             |               |
| $I_{IH}, I_{IL}$                                | Input leakage current  | $V_{IN} = 5.5 \text{ V}$ or 0  | 25°C   | 5.5 V                      | -1               | 0.05               | 1             | $\mu\text{A}$ |
|   |  |  | Full   |                            | -1               |                    | 1             |               |
| <b>DYNAMIC</b>                                  |  |  |  |                            |                  |                    |               |               |
| $t_{ON}$  | Turnon time  | $V_{NC} = \text{GND}$ and $V_{NO} = V_+$ or $V_{NC} = V_+$ and $V_{NO} = \text{GND}$ , | $R_L = 500 \Omega, C_L = 50 \text{ pF},$ see <a href="#">Figure 12</a> | Full                       | 4.5 V to 5.5 V   | 1.7                | 5.7           | ns            |
|   |  |  |  | -40 to $125^\circ\text{C}$ | 4.75 V to 5.25 V | 1.2                | 8.7           | ns            |
| $t_{OFF}$                                       | Turnoff time   | $V_{NC} = \text{GND}$ and $V_{NO} = V_+$ or $V_{NC} = V_+$ and $V_{NO} = \text{GND}$ , | $R_L = 500 \Omega, C_L = 50 \text{ pF},$ see <a href="#">Figure 12</a> | Full                       | 4.5 V to 5.5 V   | 0.8                | 3.8           | ns            |
|   |  |  |  | -40 to $125^\circ\text{C}$ | 4.75 V to 5.25 V | 0.5                | 6.8           | ns            |
| $t_{BBM}$                                       | Break-before-make time   | $V_{NC} = V_{NO} = V_+/2, R_L = 50 \Omega,$  | $C_L = 35 \text{ pF},$ see <a href="#">Figure 13</a>                   | Full                       | 4.5 V to 5.5 V   | 0.5                |               | ns            |
| $Q_C$   | Charge injection   | $V_{NC} = V_{NO} = V_+/2, R_L = 50 \Omega,$  | See <a href="#">Figure 17</a>  | 25°C                       | 5 V              |                    | 7             | pC            |
| $C_{NC(\text{OFF})}, C_{NO(\text{OFF})}$        | NC, NO OFF capacitance   | $V_{NC} \text{ or } V_{NO} = V_+$ or GND,  | Switch OFF, see <a href="#">Figure 11</a>                              | 25°C                       | 5 V              |                    | 5.5           | pF            |
| $C_{NC(\text{ON})}, C_{NO(\text{ON})}$          | NC, NO ON capacitance  | $V_{NC} \text{ or } V_{NO} = V_+$ or GND,  | Switch ON, see <a href="#">Figure 11</a>                               | 25°C                       | 5 V              |                    | 17.5          | pF            |
| $C_{COM(\text{ON})}$                            | COM ON capacitance   | $V_{COM} = V_+$ or GND,  | Switch ON, see <a href="#">Figure 11</a>                               | 25°C                       | 5 V              |                    | 17.5          | pF            |
| $C_{IN}$  | Digital input capacitance  | $V_{IN} = V_+$ or GND,   | See <a href="#">Figure 11</a>  | 25°C                       | 5 V              |                    | 2.8           | pF            |
| BW  | Bandwidth  | $R_L = 50 \Omega,$   | Switch ON, see <a href="#">Figure 14</a>                               | 25°C                       | 4.5 V            |                    | 220           | MHz           |

(1)  $T_A = 25^\circ\text{C}$ .

(2) All unused digital inputs of the device must be held at  $V_+$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, SCBA004.

## Electrical Characteristics for 5-V Supply (continued)

$V_+ = 4.5 \text{ V to } 5.5 \text{ V}$ ,  $T_A = -40^\circ\text{C} \text{ to } 85^\circ\text{C}$  (unless otherwise noted)

| PARAMETER         |                           | TEST CONDITIONS   | $T_A$            | $V_+$ | MIN   | TYP <sup>(1)</sup> | MAX | UNIT |
|-------------------|---------------------------|---|------------------|-------|-------|--------------------|-----|------|
| O <sub>ISO</sub>  | OFF isolation             | $R_L = 50 \Omega$ ,<br>$f = 10 \text{ MHz}$ ,<br>Switch OFF,<br>see <a href="#">Figure 15</a>                                 | 25°C             | 4.5 V |       | -65                |     | dB   |
| X <sub>TALK</sub> | Crosstalk                 | $R_L = 50 \Omega$ ,<br>$f = 10 \text{ MHz}$ ,<br>Switch ON,<br>see <a href="#">Figure 16</a>                                  | 25°C             | 4.5 V |       | -66                |     | dB   |
| THD               | Total harmonic distortion | $R_L = 600 \Omega$ ,<br>$C_L = 50 \text{ pF}$ ,<br>$f = 600 \text{ Hz to } 20 \text{ kHz}$ ,<br>see <a href="#">Figure 18</a> | 25°C             | 4.5 V |       | 0.01%              |     |      |
| <b>SUPPLY</b>     |                           |   |                  |       |       |                    |     |      |
| I <sub>+</sub>    | Positive supply current   | $V_{IN} = V_+$ or GND,  | Switch ON or OFF | 25°C  |       |                    | 1   | μA   |
|                   |                           |   |                  | Full  | 5.5 V |                    | 10  |      |
| ΔI <sub>+</sub>   | Change in supply current  | $V_{IN} = V_+ - 0.6 \text{ V}$  | Full             | 5.5 V |       |                    | 500 | μA   |

## 6.6 Electrical Characteristics for 3.3-V Supply

$V_+ = 3$  V to 3.6 V,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS   |  | $T_A$        | $V_+$        | MIN              | TYP <sup>(1)</sup> | MAX              | UNIT          |
|--|---|--|--------------|--------------|------------------|--------------------|------------------|---------------|
| <b>ANALOG SWITCH</b>   |   |  |              |              |                  |                    |                  |               |
| $V_{\text{COM}}, V_{\text{NO}}, V_{\text{NC}}$ , Analog signal range |   |  |              |              | 0                |                    | $V_+$            | V             |
| $r_{\text{on}}$<br>ON-state resistance                               | $0 \leq V_{\text{NO}} \text{ or } V_{\text{NC}} \leq V_+$ ,<br>$I_{\text{COM}} = -24$ mA,                             | Switch ON,<br>see <a href="#">Figure 9</a>                                       | Full         | 3 V          |                  | 18                 | $\Omega$         |               |
|  |   |  | -40 to 125°C |              |                  | 23                 |                  |               |
| $\Delta r_{\text{on}}$<br>ON-state resistance match between channels | $V_{\text{NO}} \text{ or } V_{\text{NC}} = 2.1$ V,<br>$I_{\text{COM}} = -24$ mA,                                      | Switch ON,<br>see <a href="#">Figure 9</a>                                       | 25°C         | 3 V          |                  | 0.2                |                  | $\Omega$      |
| $r_{\text{on}(\text{flat})}$<br>ON-state resistance flatness         | $0 \leq V_{\text{NO}} \text{ or } V_{\text{NC}} \leq V_+$ ,<br>$I_{\text{COM}} = -24$ mA,                             | Switch ON,<br>see <a href="#">Figure 11</a>                                      | 25°C         | 3 V          |                  | 9                  |                  | $\Omega$      |
| $I_{\text{NC(OFF)}}, I_{\text{NO(OFF)}}$<br>OFF leakage current      | $V_{\text{NC}} \text{ or } V_{\text{NO}} = 0$ to $V_+$ ,<br>$V_{\text{COM}} = 0$ to $V_+$ ,                           | Switch OFF,<br>see <a href="#">Figure 10</a>                                     | 25°C         | 3.6 V        | -1               | 0.05               | 1                | $\mu\text{A}$ |
|  |   |  | Full         |              | -1               |                    | 1                |               |
| $I_{\text{NC(ON)}}, I_{\text{NO(ON)}}$<br>ON leakage current         | $V_{\text{NC}} \text{ or } V_{\text{NO}} = 0$ to $V_+$ ,<br>$V_{\text{COM}} = \text{Open}$ ,                          | Switch ON,<br>see <a href="#">Figure 10</a>                                      | 25°C         | 3.6 V        | -0.1             |                    | 0.1              | $\mu\text{A}$ |
|  |   |  | Full         |              | -1               |                    | 1                |               |
| $I_{\text{COM(ON)}}$<br>ON leakage current                           | $V_{\text{NC}} \text{ or } V_{\text{NO}} = \text{Open}$ ,<br>$V_{\text{COM}} = 0$ to $V_+$ ,                          | Switch ON,<br>see <a href="#">Figure 10</a>                                      | 25°C         | 3.6 V        | -0.1             |                    | 0.1              | $\mu\text{A}$ |
|  |   |  | Full         |              | -1               |                    | 1                |               |
| <b>DIGITAL INPUTS (IN12, IN2)<sup>(2)</sup></b>                      |   |  |              |              |                  |                    |                  |               |
| $V_{\text{IH}}$<br>Input logic high                                  |   |  | Full         |              | $V_+ \times 0.7$ |                    |                  | V             |
| $V_{\text{IL}}$<br>Input logic low                                   |   |  | Full         |              |                  |                    | $V_+ \times 0.3$ | V             |
| $I_{\text{IH}}, I_{\text{IL}}$<br>Input leakage current              | $V_{\text{IN}} = 5.5$ V or 0  |  | 25°C         | 3.6 V        | -1               | 0.05               | 1                | $\mu\text{A}$ |
|  |   |  | Full         |              | -1               |                    | 1                |               |
| <b>DYNAMIC</b>   |   |  |              |              |                  |                    |                  |               |
| $t_{\text{ON}}$<br>Turn-on time                                      | $V_{\text{NC}} = \text{GND}$ and $V_{\text{NO}} = V_+$ or<br>$V_{\text{NC}} = V_+$ and $V_{\text{NO}} = \text{GND}$ , | $R_L = 500 \Omega$ ,<br>$C_L = 50 \text{ pF}$ ,<br>see <a href="#">Figure 12</a> | Full         | 3 V to 3.6 V | 2.5              |                    | 7.6              | ns            |
|  |   |  | -40 to 125°C |              | 2.0              |                    | 10.6             | ns            |
| $t_{\text{OFF}}$<br>Turnoff time                                     | $V_{\text{NC}} = \text{GND}$ and $V_{\text{NO}} = V_+$ or<br>$V_{\text{NC}} = V_+$ and $V_{\text{NO}} = \text{GND}$ , | $R_L = 500 \Omega$ ,<br>$C_L = 50 \text{ pF}$ ,<br>see <a href="#">Figure 12</a> | Full         | 3 V to 3.6 V | 1.5              |                    | 5.3              | ns            |
|  |   |  | -40 to 125°C |              | 1.0              |                    | 8.3              | ns            |
| $t_{\text{BBM}}$<br>Break-before-make time                           | $V_{\text{NC}} = V_{\text{NO}} = V_+/2$ ,<br>$R_L = 50 \Omega$ ,  | $C_L = 35 \text{ pF}$ ,<br>see <a href="#">Figure 13</a>                         | Full         | 3 V to 3.6 V | 0.5              |                    |                  | ns            |
| $Q_C$<br>Charge injection  | $R_L = 50 \Omega$ ,<br>$C_L = 0.1 \text{ nF}$ ,   | see <a href="#">Figure 17</a>  | 25°C         | 3.3 V        |                  | 3                  |                  | pC            |
| BW<br>Bandwidth  | $R_L = 50 \Omega$ ,<br>Switch ON,   | see <a href="#">Figure 14</a>  | 25°C         | 3 V          |                  | 220                |                  | MHz           |
| $O_{\text{ISO}}$<br>OFF isolation                                    | $R_L = 50 \Omega$ ,<br>$f = 10$ MHz,  | Switch OFF,<br>see <a href="#">Figure 15</a>                                     | 25°C         | 3 V          |                  | -65                |                  | dB            |
| $X_{\text{TALK}}$<br>Crosstalk                                       | $R_L = 50 \Omega$ ,<br>$f = 10$ MHz,  | Switch ON,<br>see <a href="#">Figure 16</a>                                      | 25°C         | 3 V          |                  | -66                |                  | dB            |
| THD<br>Total harmonic distortion                                     | $R_L = 600 \Omega$ ,<br>$C_L = 50 \text{ pF}$ ,   | $f = 600$ Hz to 20 kHz,<br>see <a href="#">Figure 18</a>                         | 25°C         | 3 V          |                  | 0.015%             |                  |               |
| <b>SUPPLY</b>  |   |  |              |              |                  |                    |                  |               |
| $I_+$<br>Positive supply current                                     | $V_{\text{IN}} = V_+$ or GND,   | Switch ON or OFF   | 25°C         | 3.6 V        |                  | 1                  | $\mu\text{A}$    |               |
|  |   |  | Full         |              |                  | 10                 |                  |               |
| $\Delta I_+$<br>Change in supply current                             | $V_{\text{IN}} = V_+ - 0.6$ V   |  | Full         | 3.6 V        |                  | 500                | $\mu\text{A}$    |               |

(1)  $T_A = 25^\circ\text{C}$ .

(2) All unused digital inputs of the device must be held at  $V_+$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, SCBA004.

## 6.7 Electrical Characteristics for 2.5-V Supply

$V_+ = 2.3\text{ V}$  to  $2.7\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted)

| PARAMETER                                       | TEST CONDITIONS                            |  | $T_A$   | $V_+$        | MIN              | TYP <sup>(1)</sup> | MAX   | UNIT          |
|---|--|--|---|--------------|------------------|--------------------|-------|---------------|
| <b>ANALOG SWITCH</b>                            |  |  |   |              |                  |                    |       |               |
| $V_{COM}, V_{NO}, V_{NC}$ , Analog signal range |  |  |   |              |                  | 0                  | $V_+$ | V             |
| $r_{on}$  | ON-state resistance                        | $0 \leq V_{NO} \text{ or } V_{NC} \leq V_+, I_{COM} = -8\text{ mA}$ ,                  | Switch ON,<br>see <a href="#">Figure 9</a>                                    | Full         | 2.3 V            | 45                 |       | $\Omega$      |
|   |  |  |   | -40 to 125°C |                  | 50                 |       |               |
| $\Delta r_{on}$                                 | ON-state resistance match between channels | $V_{NO} \text{ or } V_{NC} = 1.6\text{ V}, I_{COM} = -8\text{ mA}$ ,                   | Switch ON,<br>see <a href="#">Figure 9</a>                                    | 25°C         | 2.3 V            | 0.5                |       | $\Omega$      |
| $r_{on(\text{flat})}$                           | ON-state resistance flatness               | $0 \leq V_{NO} \text{ or } V_{NC} \leq V_+, I_{COM} = -8\text{ mA}$ ,                  | Switch ON,<br>see <a href="#">Figure 9</a>                                    | 25°C         | 2.3 V            | 27                 |       | $\Omega$      |
| $I_{NC(\text{OFF})}, I_{NO(\text{OFF})}$        | NC, NO OFF leakage current                 | $V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+, V_{COM} = 0 \text{ to } V_+$ ,         | Switch OFF,<br>see <a href="#">Figure 10</a>                                  | 25°C         | 2.7 V            | -1                 | 0.05  | $\mu\text{A}$ |
|   |  |  |   | Full         |                  | -1                 | 1     |               |
| $I_{NC(\text{ON})}, I_{NO(\text{ON})}$          | NC, NO ON leakage current                  | $V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+, V_{COM} = \text{Open}$ ,               | Switch ON,<br>see <a href="#">Figure 10</a>                                   | 25°C         | 2.7 V            | -0.1               | 0.1   | $\mu\text{A}$ |
|   |  |  |   | Full         |                  | -1                 | 1     |               |
| $I_{COM(\text{ON})}$                            | COM ON leakage current                     | $V_{NC} \text{ or } V_{NO} = \text{Open}, V_{COM} = 0 \text{ to } V_+$ ,               | Switch ON,<br>see <a href="#">Figure 10</a>                                   | 25°C         | 2.7 V            | -0.1               | 0.1   | $\mu\text{A}$ |
|   |  |  |   | Full         |                  | -1                 | 1     |               |
| <b>DIGITAL INPUTS (IN12, IN2)<sup>(2)</sup></b> |  |  |   |              |                  |                    |       |               |
| $V_{IH}$  | Input logic high                           |  |   | Full         | $V_+ \times 0.7$ |                    | V     |               |
| $V_{IL}$  | Input logic low                            |  |   | Full         | $V_+ \times 0.3$ |                    | V     |               |
| $I_{IH}, I_{IL}$                                | Input leakage current                      | $V_{IN} = 5.5\text{ V}$ or 0   | Switch ON,<br>see <a href="#">Figure 10</a>                                   | 25°C         | 2.7 V            | -1                 | 0.05  | $\mu\text{A}$ |
|   |  |  |   | Full         |                  | -1                 | 1     |               |
| <b>DYNAMIC</b>                                  |  |  |   |              |                  |                    |       |               |
| $t_{ON}$  | Turnon time                                | $V_{NC} = \text{GND}$ and $V_{NO} = V_+$ or $V_{NC} = V_+$ and $V_{NO} = \text{GND}$ , | $R_L = 500\text{ }\Omega, C_L = 50\text{ pF}$ , see <a href="#">Figure 12</a> | Full         | 2.3 V to 2.7 V   | 3.5                | 14    | ns            |
|   |  |  |   | -40 to 125°C |                  | 2.5                | 17    |               |
| $t_{OFF}$                                       | Turnoff time                               | $V_{NC} = \text{GND}$ and $V_{NO} = V_+$ or $V_{NC} = V_+$ and $V_{NO} = \text{GND}$ , | $R_L = 500\text{ }\Omega, C_L = 50\text{ pF}$ , see <a href="#">Figure 12</a> | Full         | 2.3 V to 2.7 V   | 2                  | 7.5   | ns            |
|   |  |  |   | -40 to 125°C |                  | 1.5                | 10.5  |               |
| $t_{BBM}$                                       | Break-before-make time                     | $V_{NC} = V_{NO} = V_+/2, R_L = 50\text{ }\Omega$ ,                                    | $C_L = 35\text{ pF}$ , see <a href="#">Figure 13</a>                          | Full         | 2.3 V to 2.7 V   | 0.5                |       | ns            |
| BW  | Bandwidth                                  | $R_L = 50\text{ }\Omega$ ,   | Switch ON,<br>see <a href="#">Figure 14</a>                                   | 25°C         | 2.3 V            | 220                |       | MHz           |
| $O_{ISO}$                                       | OFF isolation                              | $R_L = 50\text{ }\Omega, f = 10\text{ MHz}$ ,  | Switch OFF,<br>see <a href="#">Figure 15</a>                                  | 25°C         | 2.3 V            | -65                |       | dB            |
| $X_{TALK}$                                      | Crosstalk                                  | $R_L = 50\text{ }\Omega, f = 10\text{ MHz}$ ,  | Switch ON,<br>see <a href="#">Figure 16</a>                                   | 25°C         | 2.3 V            | -66                |       | dB            |
| THD   | Total harmonic distortion                  | $R_L = 600\text{ }\Omega, C_L = 50\text{ pF}$ ,  | $f = 600\text{ Hz}$ to $20\text{ kHz}$ , see <a href="#">Figure 18</a>        | 25°C         | 2.3 V            | 0.025%             |       |               |
| <b>SUPPLY</b>                                   |  |  |   |              |                  |                    |       |               |
| $I_+$   | Positive supply current                    | $V_{IN} = V_+$ or GND,   | Switch ON or OFF  | 25°C         | 2.7 V            | 1                  |       | $\mu\text{A}$ |
|   |  |  |   | Full         |                  | 10                 |       |               |
| $\Delta I_+$                                    | Change in supply current                   | $V_{IN} = V_+ - 0.6\text{ V}$  |   | Full         | 2.7 V            | 500                |       | $\mu\text{A}$ |

(1)  $T_A = 25^\circ\text{C}$ .

(2) All unused digital inputs of the device must be held at  $V_+$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, [SCBA004](#).

## 6.8 Electrical Characteristics for 1.8-V Supply

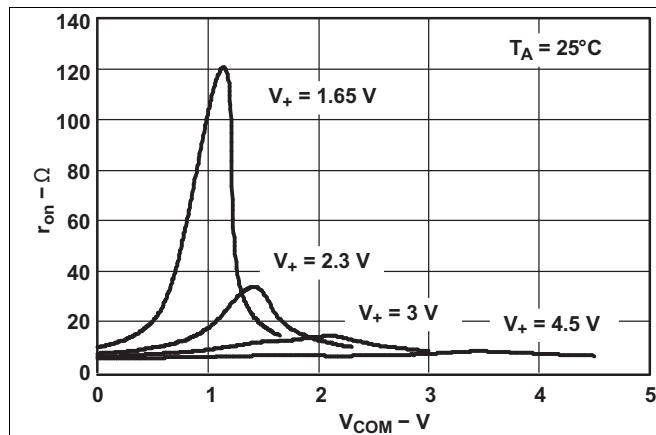
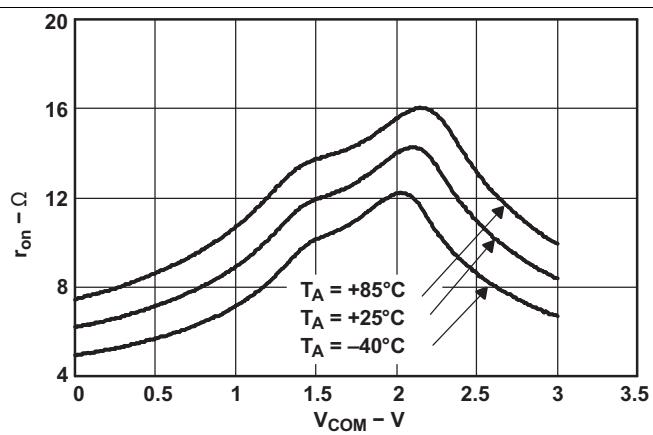
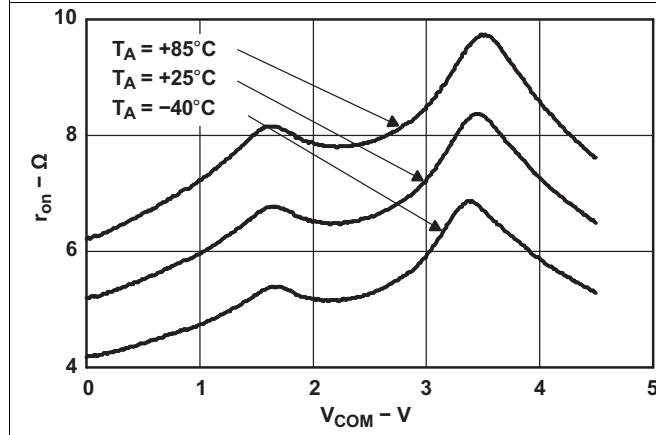
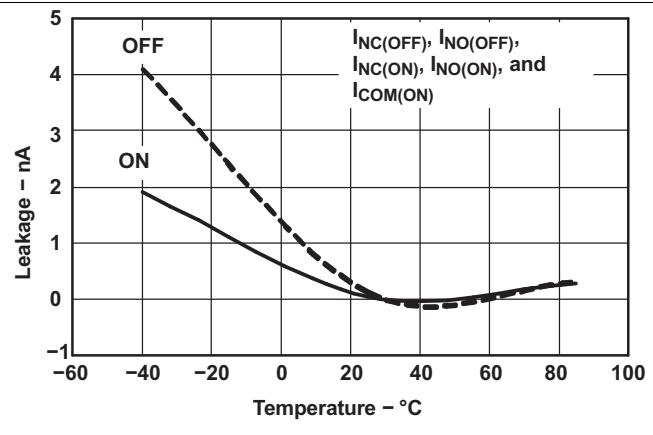
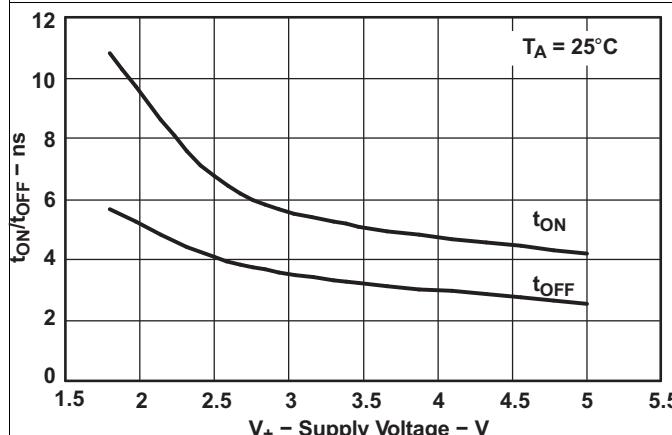
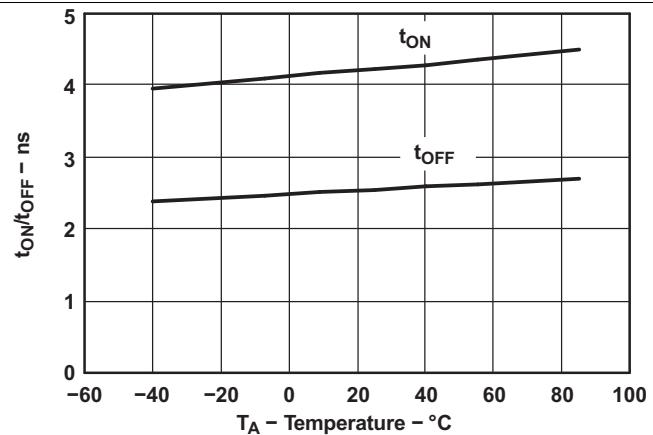
$V_+ = 1.65 \text{ V}$  to  $1.95 \text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted)

| PARAMETER                                       | TEST CONDITIONS                               |  | $T_A$  | $V_+$           | MIN                    | TYP <sup>(1)</sup> | MAX   | UNIT            |
|---|---|--|--|-----------------|------------------------|--------------------|-------|-----------------|
| <b>ANALOG SWITCH</b>                            |   |  |  |                 |                        |                    |       |                 |
| $V_{COM}$ ,<br>$V_{NO}$ , $V_{NC}$              | Analog signal range                           |  |  |                 | 0                      |                    | $V_+$ | V               |
| $r_{on}$  | ON-state resistance                           | $0 \leq V_{NO} \text{ or } V_{NC} \leq V_+$ ,<br>$I_{COM} = -4 \text{ mA}$ ,                 | Switch ON,<br>see <a href="#">Figure 9</a>                                       | Full            | 1.65 V                 | 140                |       | $\Omega$        |
|   |   |  |  | -40 to<br>125°C |                        | 180                |       |                 |
| $\Delta r_{on}$                                 | ON-state resistance<br>match between channels | $V_{NO} \text{ or } V_{NC} = 1.15 \text{ V}$ ,<br>$I_{COM} = -4 \text{ mA}$ ,                | Switch ON,<br>see <a href="#">Figure 9</a>                                       | 25°C            | 1.65 V                 | 1                  |       | $\Omega$        |
| $r_{on(\text{flat})}$                           | ON-state resistance<br>flatness               | $0 \leq V_{NO} \text{ or } V_{NC} \leq V_+$ ,<br>$I_{COM} = -4 \text{ mA}$ ,                 | Switch ON,<br>see <a href="#">Figure 9</a>                                       | 25°C            | 1.65 V                 | 110                |       | $\Omega$        |
| $I_{NC(OFF)}$ ,<br>$I_{NO(OFF)}$                | NC, NO<br>OFF leakage current                 | $V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+$ ,<br>$V_{COM} = 0 \text{ to } V_+$ ,         | Switch OFF,<br>see <a href="#">Figure 10</a>                                     | 25°C            | 1.95 V                 | -1                 | 0.05  | 1               |
|   |   |  |  | Full            |                        | -1                 |       | 1 $\mu\text{A}$ |
| $I_{NC(ON)}$ ,<br>$I_{NO(ON)}$                  | NC, NO<br>ON leakage current                  | $V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+$ ,<br>$V_{COM} = \text{Open}$ ,               | Switch ON,<br>see <a href="#">Figure 10</a>                                      | 25°C            | 1.95 V                 | -0.1               | 0.1   | $\mu\text{A}$   |
|   |   |  |  | Full            |                        | -1                 | 1     |                 |
| $I_{COM(ON)}$                                   | COM<br>ON leakage current                     | $V_{NC} \text{ or } V_{NO} = \text{Open}$ ,<br>$V_{COM} = 0 \text{ to } V_+$ ,               | Switch ON,<br>see <a href="#">Figure 10</a>                                      | 25°C            | 1.95 V                 | -0.1               | 0.1   | $\mu\text{A}$   |
|   |   |  |  | Full            |                        | -1                 | 1     |                 |
| <b>DIGITAL INPUTS (IN12, IN2)<sup>(2)</sup></b> |   |  |  |                 |                        |                    |       |                 |
| $V_{IH}$  | Input logic high                              |  | Full   |                 | $V_+ \times 0.75$      |                    | V     |                 |
| $V_{IL}$  | Input logic low                               |  | Full   |                 | $V_+ \times 0.25$      |                    | V     |                 |
| $I_{IH}$ , $I_{IL}$                             | Input leakage current                         | $V_{IN} = 5.5 \text{ V}$ or 0  | 25°C   | 1.95 V          | -1                     | 0.05               | 1     | $\mu\text{A}$   |
|   |   |  | Full   |                 | -1                     |                    | 1     |                 |
| <b>DYNAMIC</b>                                  |   |  |  |                 |                        |                    |       |                 |
| $t_{ON}$  | Turnon time                                   | $V_{NC} = \text{GND}$ and $V_{NO} = V_+$<br>or<br>$V_{NC} = V_+$ and $V_{NO} = \text{GND}$ , | $R_L = 500 \Omega$ ,<br>$C_L = 50 \text{ pF}$ ,<br>see <a href="#">Figure 12</a> | Full            | 1.65 V<br>to<br>1.95 V | 7                  | 24    | ns              |
|   |   |  |  | -40 to<br>125°C |                        | 5.5                | 27    | ns              |
| $t_{OFF}$                                       | Turnoff time                                  | $V_{NC} = \text{GND}$ and $V_{NO} = V_+$<br>or<br>$V_{NC} = V_+$ and $V_{NO} = \text{GND}$ , | $R_L = 500 \Omega$ ,<br>$C_L = 50 \text{ pF}$ ,<br>see <a href="#">Figure 12</a> | Full            | 1.65 V<br>to<br>1.95 V | 3                  | 13    | ns              |
|   |   |  |  | -40 to<br>125°C |                        | 2                  | 16    |                 |
| $t_{BBM}$                                       | Break-before-make time                        | $V_{NC} = V_{NO} = V_+/2$ ,<br>$R_L = 50 \Omega$ ,   | $C_L = 35 \text{ pF}$ ,<br>see <a href="#">Figure 13</a>                         | Full            | 1.65 V<br>to<br>1.95 V | 0.5                |       | ns              |
| BW  | Bandwidth                                     | $R_L = 50 \Omega$ ,  | Switch ON,<br>see <a href="#">Figure 14</a>                                      | 25°C            | 1.8 V                  | 220                |       | MHz             |
| $O_{ISO}$                                       | OFF isolation                                 | $R_L = 50 \Omega$ ,<br>$f = 10 \text{ MHz}$ ,  | Switch OFF,<br>see <a href="#">Figure 15</a>                                     | 25°C            | 1.8 V                  | -60                |       | dB              |
| $X_{TALK}$                                      | Crosstalk                                     | $R_L = 50 \Omega$ ,<br>$f = 10 \text{ MHz}$ ,  | Switch ON,<br>see <a href="#">Figure 16</a>                                      | 25°C            | 1.8 V                  | -66                |       | dB              |
| THD   | Total harmonic distortion                     | $R_L = 600 \Omega$ ,<br>$C_L = 50 \text{ pF}$ ,  | $f = 600 \text{ Hz}$ to<br>20 kHz,<br>see <a href="#">Figure 18</a>              | 25°C            | 1.8 V                  | 0.015%             |       |                 |
| <b>SUPPLY</b>                                   |   |  |  |                 |                        |                    |       |                 |
| $I_+$   | Positive supply<br>current                    | $V_{IN} = V_+$ or GND,   | Switch ON or OFF   | 25°C            | 1.95 V                 | 1                  |       | $\mu\text{A}$   |
|   |   |  |  | Full            |                        | 10                 |       |                 |
| $\Delta I_+$                                    | Change in<br>supply current                   | $V_{IN} = V_+ - 0.6 \text{ V}$   |  | Full            | 1.95 V                 | 500                |       | $\mu\text{A}$   |

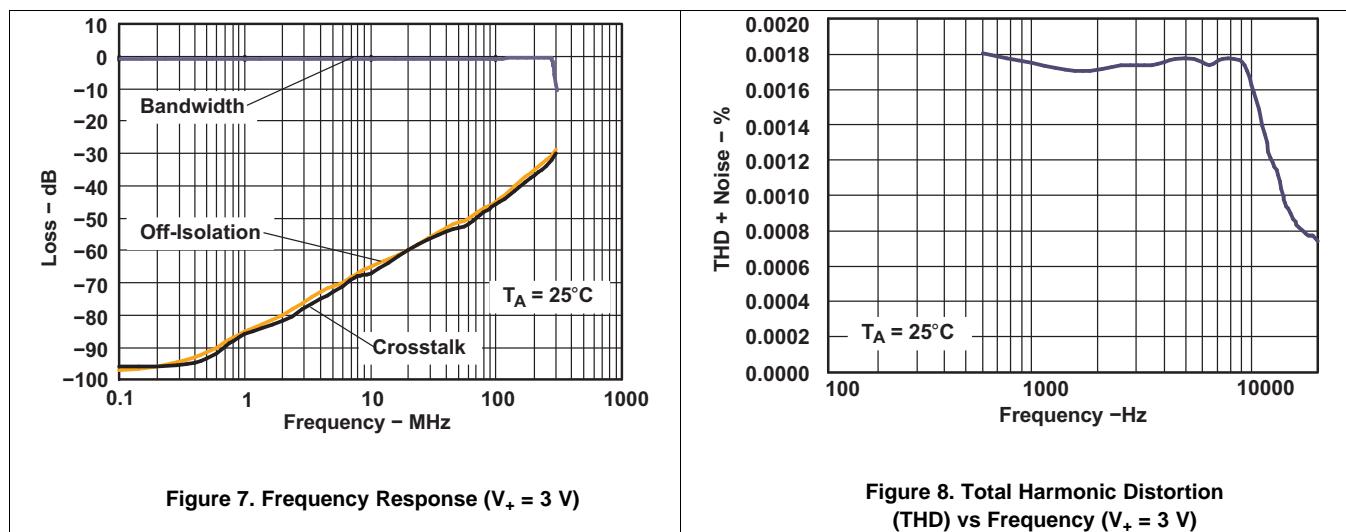
(1)  $T_A = 25^\circ\text{C}$ .

(2) All unused digital inputs of the device must be held at  $V_+$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, [SCBA004](#).

## 6.9 Typical Characteristics

Figure 1.  $r_{on}$  vs  $V_{COM}$ Figure 2.  $r_{on}$  vs  $V_{COM}$  ( $V_+ = 3\text{ V}$ )Figure 3.  $r_{on}$  vs  $V_{COM}$  ( $V_+ = 5\text{ V}$ )Figure 4. Leakage Current vs Temperature ( $V_+ = 5.5\text{ V}$ )Figure 5.  $t_{ON}$  and  $t_{OFF}$  vs  $V_+$ Figure 6.  $t_{ON}$  and  $t_{OFF}$  vs Temperature ( $V_+ = 5\text{ V}$ )

### Typical Characteristics (continued)



## 7 Parameter Measurement Information

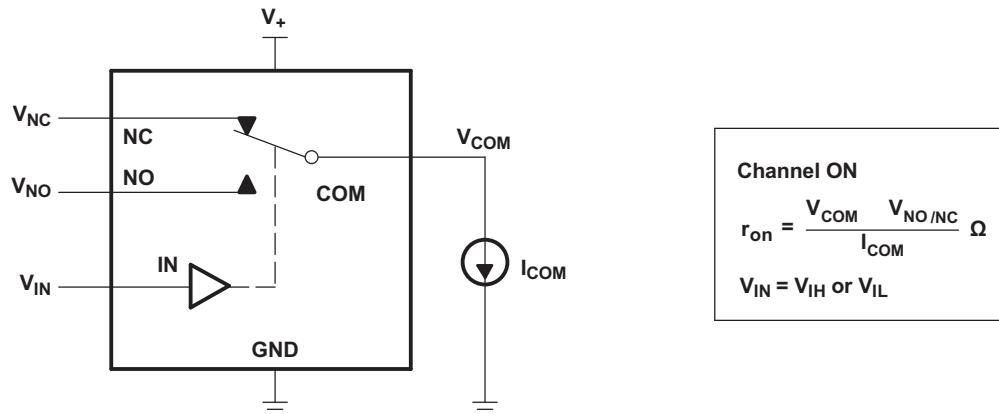


Figure 9. ON-State Resistance ( $r_{on}$ )

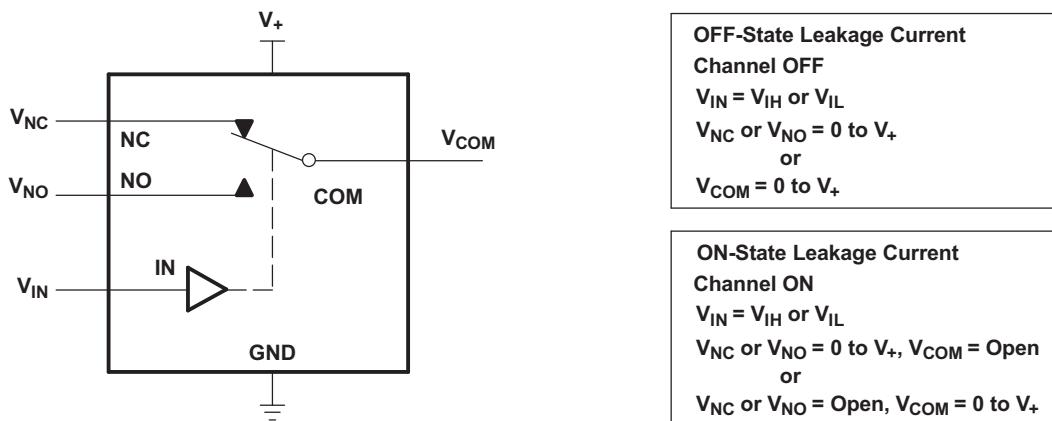


Figure 10. ON- and OFF-State Leakage Current ( $I_{COM(ON)}$ ,  $I_{NC(OFF)}$ ,  $I_{NO(OFF)}$ ,  $I_{NC(ON)}$ ,  $I_{NO(ON)}$ )

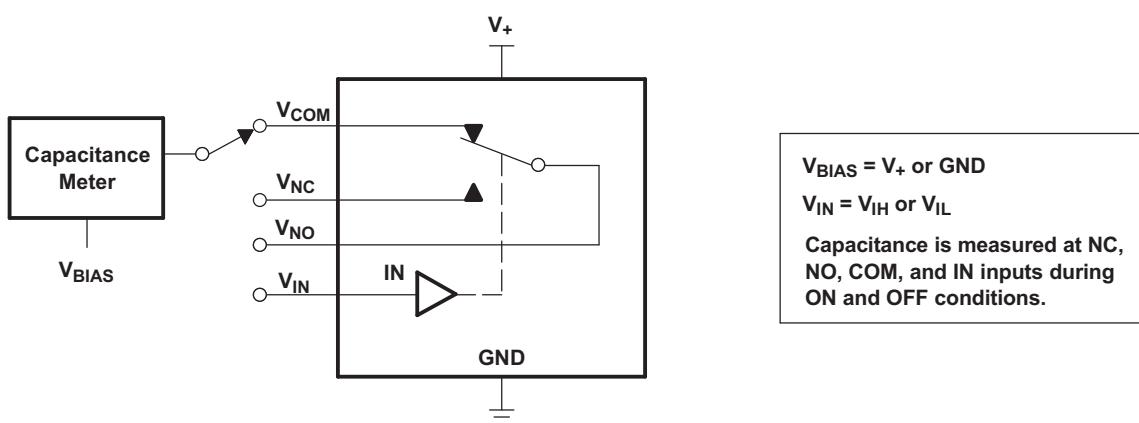


Figure 11. Capacitance ( $C_{IN}$ ,  $C_{COM(ON)}$ ,  $C_{NC(OFF)}$ ,  $C_{NO(OFF)}$ ,  $C_{NC(ON)}$ ,  $C_{NO(ON)}$ )

### Parameter Measurement Information (continued)

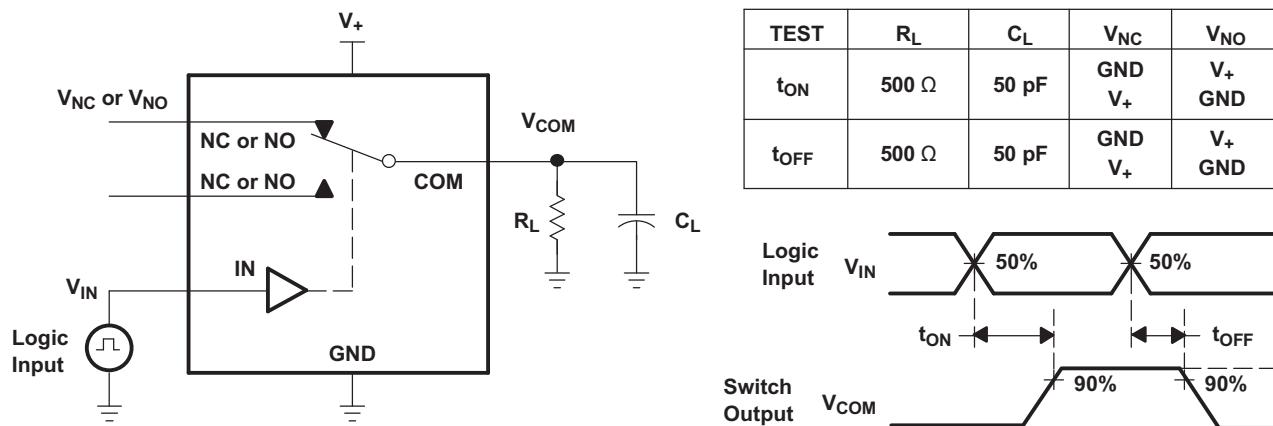


Figure 12. Turnon ( $t_{ON}$ ) and Turnoff ( $t_{OFF}$ ) Time

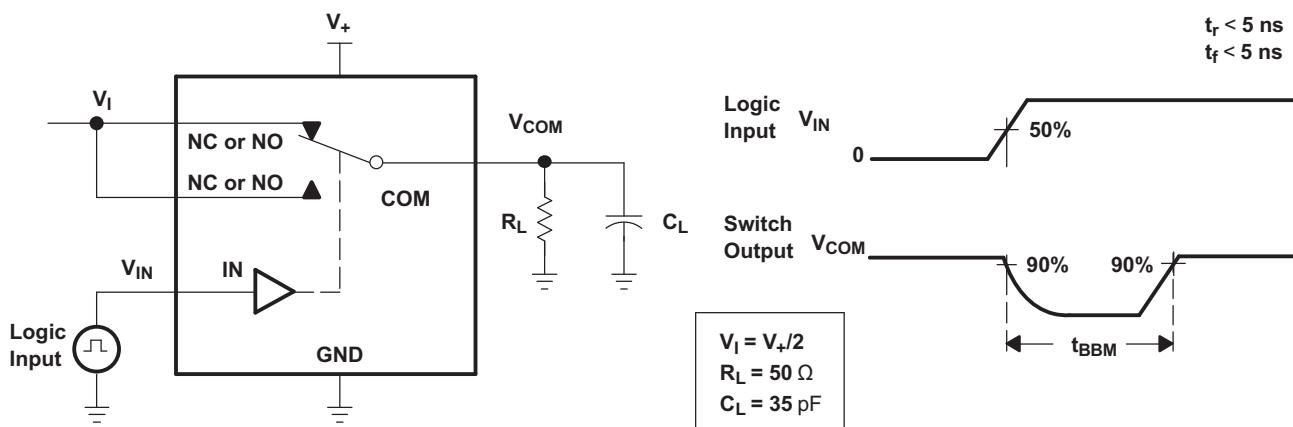


Figure 13. Break-Before-Make ( $t_{BBM}$ ) Time

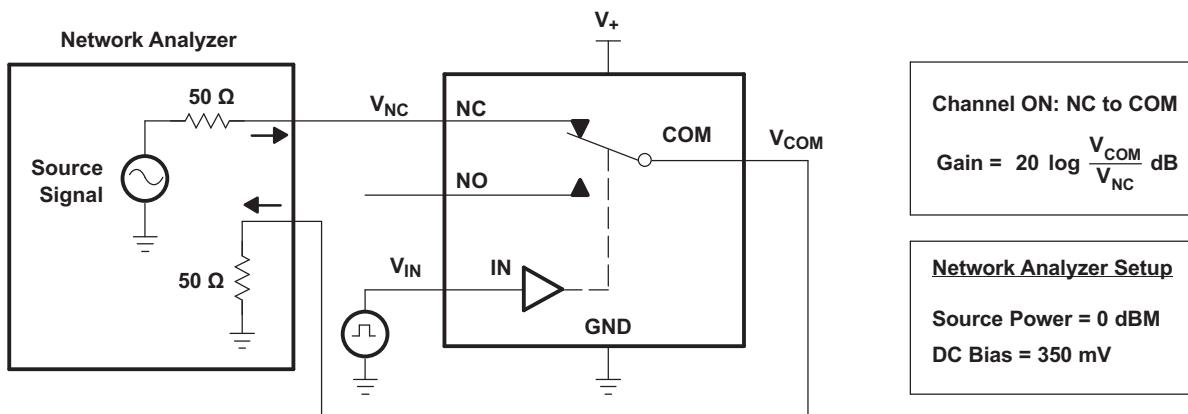


Figure 14. Frequency Response (BW)

### Parameter Measurement Information (continued)

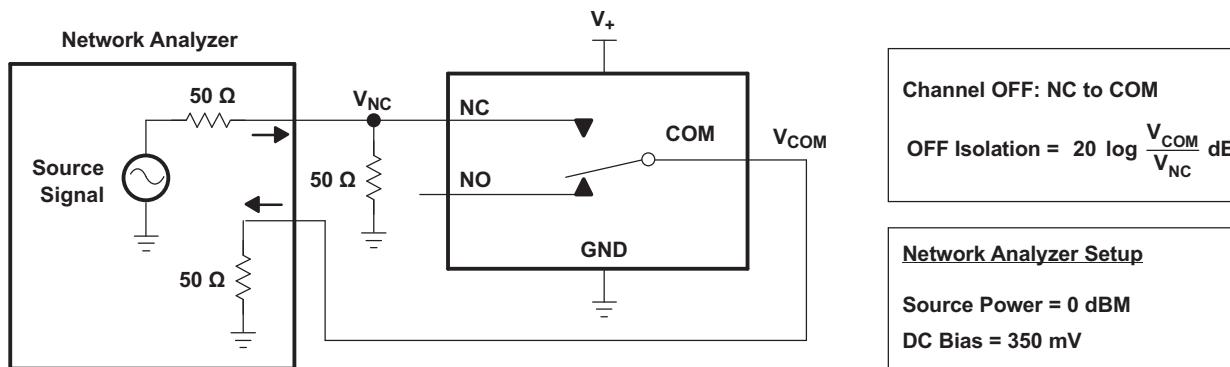


Figure 15. OFF Isolation ( $O_{\text{ISO}}$ )

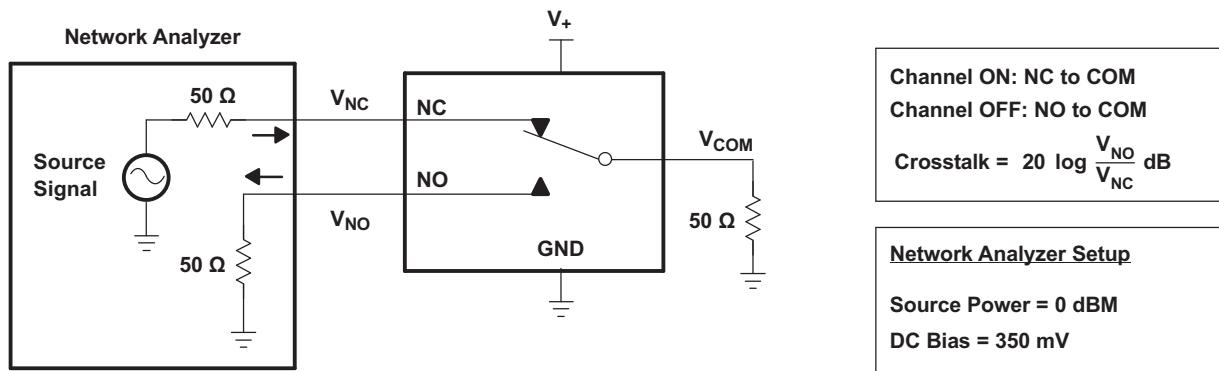


Figure 16. Crosstalk ( $X_{\text{TALK}}$ )

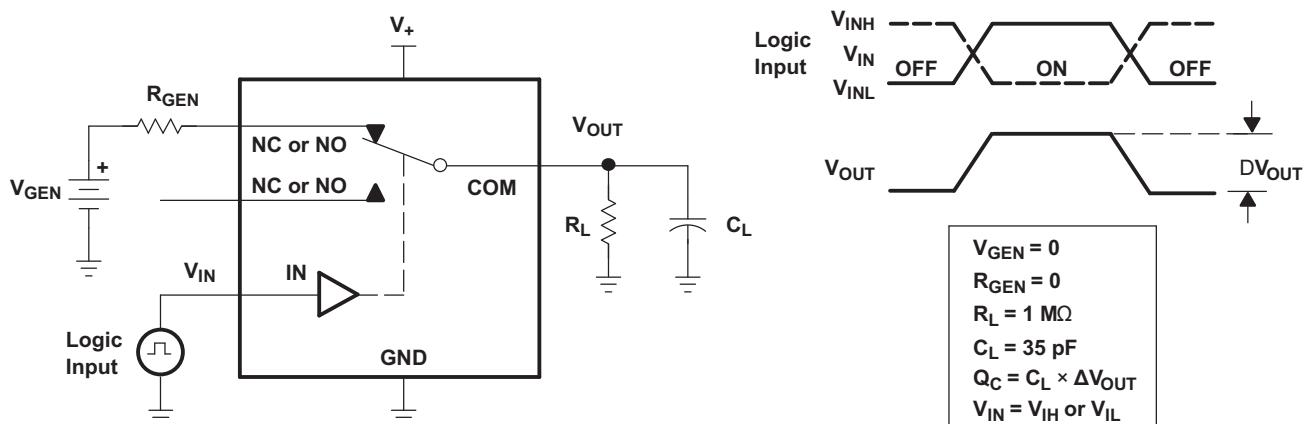


Figure 17. Charge Injection ( $Q_{\text{C}}$ )

### Parameter Measurement Information (continued)

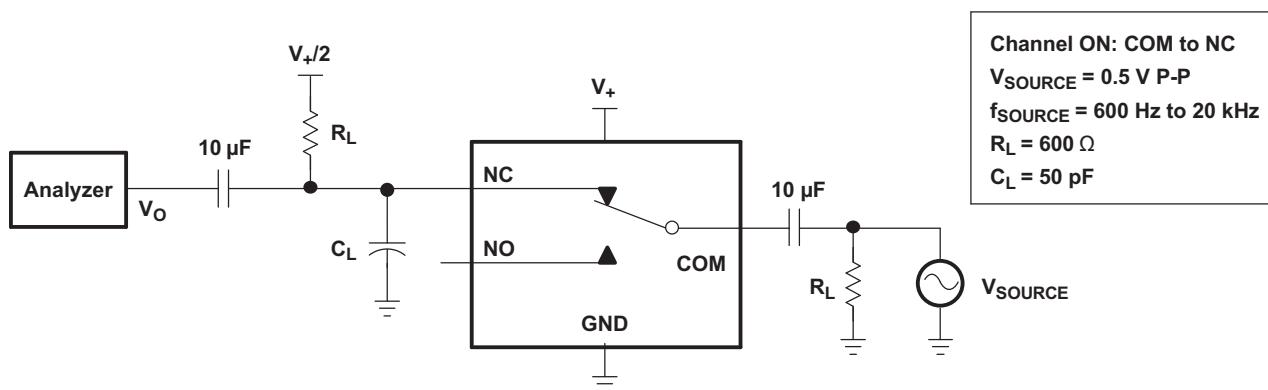


Figure 18. Total Harmonic Distortion (THD)

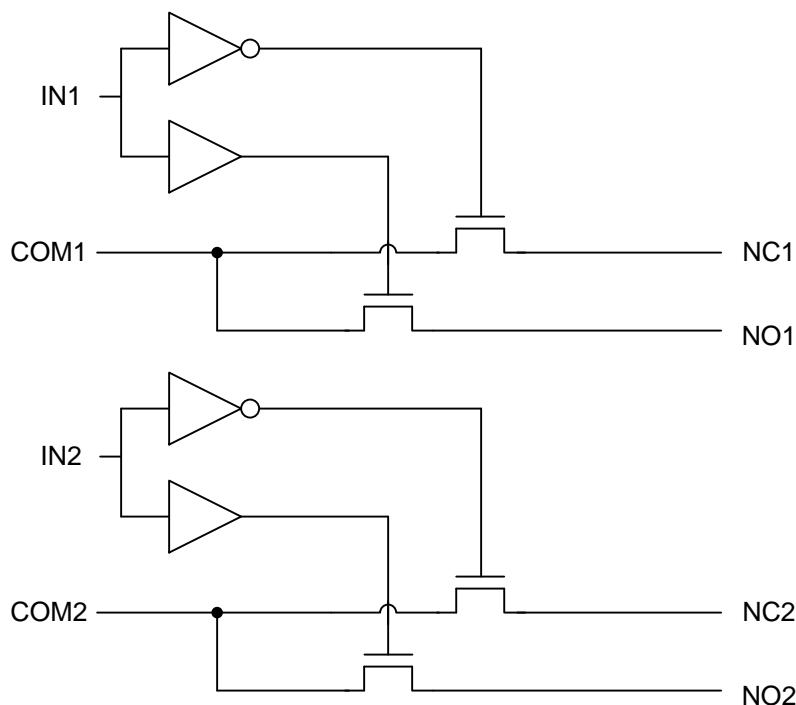
## 8 Detailed Description

### 8.1 Overview

The TS5A23157 is a dual single-pole-double-throw (SPDT) solid-state analog switch. The TS5A23157, like all analog switches, is bidirectional. When powered on, each COM pin is connected to its respective NC pin when the IN pin is low. For this device, NC stands for *normally closed* and NO stands for *normally open*. If IN is low, COM is connected to NC. If IN is high, COM is connected to NO.

The TS5A23157 is a break-before-make switch. This means that during switching, a connection is broken before a new connection is established. The NC and NO pins are never connected to each other.

### 8.2 Functional Block Diagram



### 8.3 Feature Description

The low ON-state resistance, ON-state resistance matching, and charge injection in the TS5A23157 make this switch an excellent choice for analog signals that require minimal distortion. In addition, the low THD allows audio signals to be preserved more clearly as they pass through the device.

The 1.65-V to 5.5-V operation allows compatibility with more logic levels, and the bidirectional I/Os can pass analog signals from 0 V to  $V_+$  with low distortion. The control inputs are 5-V tolerant, allowing control signals to be present without  $V_{CC}$ .

### 8.4 Device Functional Modes

Table 1 lists the functional modes for TS5A23157.

Table 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

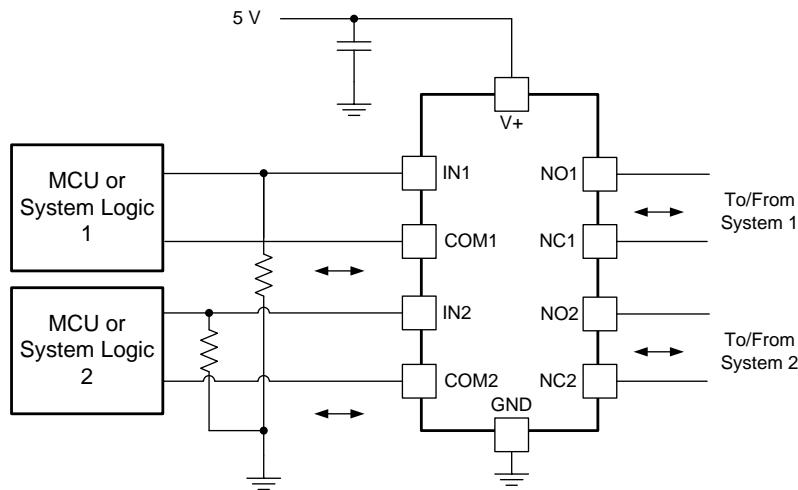
### NOTE

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. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 Application Information

The TS5A3157 can be used in a variety of customer systems. The TS5A3157 can be used anywhere multiple analog or digital signals must be selected to pass across a single line.

### 9.2 Typical Application



**Figure 19. System Schematic for TS5A23157**

#### 9.2.1 Design Requirements

In this particular application,  $V_+$  was 5 V, although  $V_+$  is allowed to be any voltage specified in [Recommended Operating Conditions](#). A decoupling capacitor is recommended on the  $V_+$  pin. See [Power Supply Recommendations](#) for more details.

#### 9.2.2 Detailed Design Procedure

In this application, IN is, by default, pulled low to GND. Choose the resistor size based on the current driving strength of the GPIO, the desired power consumption, and the switching frequency (if applicable). If the GPIO is open-drain, use pullup resistors instead.

## Typical Application (continued)

### 9.2.3 Application Curve

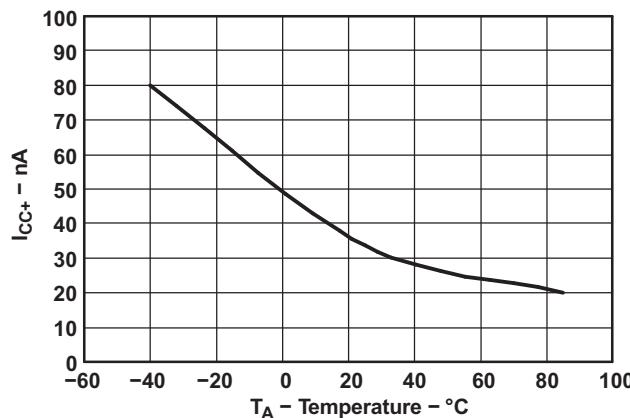


Figure 20. Power-Supply Current vs Temperature ( $V_+ = 5$  V)

## 10 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the [Recommended Operating Conditions](#).

Each  $V_{CC}$  terminal should have a good bypass capacitor to prevent power disturbance. For devices with a single supply, a  $0.1\text{-}\mu\text{F}$  bypass capacitor is recommended. If there are multiple pins labeled  $V_{CC}$ , then a  $0.01\text{-}\mu\text{F}$  or  $0.022\text{-}\mu\text{F}$  capacitor is recommended for each  $V_{CC}$  because the  $V_{CC}$  pins will be tied together internally. For devices with dual supply pins operating at different voltages, for example  $V_{CC}$  and  $V_{DD}$ , a  $0.1\text{-}\mu\text{F}$  bypass capacitor is recommended for each supply pin. It is acceptable to parallel multiple bypass capacitors to reject different frequencies of noise.  $0.1\text{-}\mu\text{F}$  and  $1\text{-}\mu\text{F}$  capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results.

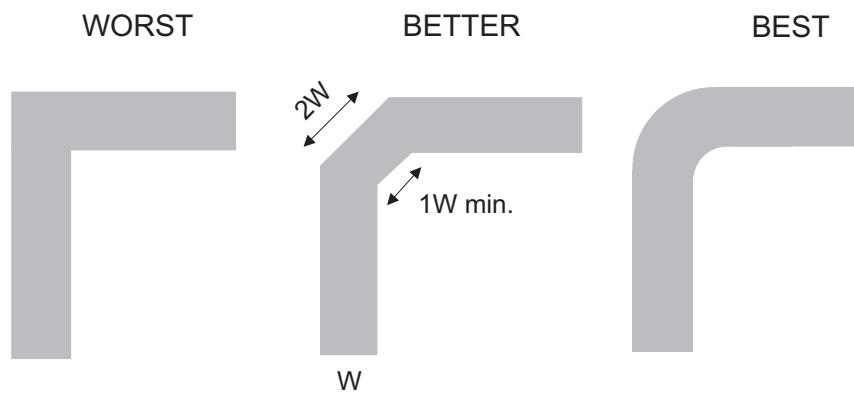
## 11 Layout

### 11.1 Layout Guidelines

Reflections and matching are closely related to loop antenna theory, but different enough to warrant their own discussion. When a PCB trace turns a corner at a 90° angle, a reflection can occur. This is primarily due to the change of width of the trace. At the apex of the turn, the trace width is increased to 1.414 times its width. This upsets the transmission line characteristics, especially the distributed capacitance and self-inductance of the trace — resulting in the reflection. It is a given that not all PCB traces can be straight, and so they will have to turn corners. Below figure shows progressively better techniques of rounding corners. Only the last example maintains constant trace width and minimizes reflections.

Unused switch I/Os, such as NO, NC, and COM, can be left floating or tied to GND. However, the IN pin must be driven high or low. Due to partial transistor turnon when control inputs are at threshold levels, floating control inputs can cause increased  $I_{CC}$  or unknown switch selection states.

### 11.2 Layout Example



**Figure 21. Trace Example**

## 12 Device and Documentation Support

### 12.1 Device Support

#### 12.1.1 Device Nomenclature

**Table 2. Parameter Description**

| SYMBOL                | DESCRIPTION  |
|-----------------------|--|
| $V_{COM}$             | Voltage at COM   |
| $V_{NC}$              | Voltage at NC  |
| $V_{NO}$              | Voltage at NO  |
| $r_{on}$              | Resistance between COM and NC or COM and NO ports when the channel is ON   |
| $\Delta r_{on}$       | Difference of $r_{on}$ between channels  |
| $r_{on(\text{flat})}$ | Difference between the maximum and minimum value of $r_{on}$ in a channel over the specified range of conditions   |
| $I_{NC(\text{OFF})}$  | Leakage current measured at the NC port, with the corresponding channel (NC to COM) in the OFF state under worst-case input and output conditions  |
| $I_{NO(\text{OFF})}$  | Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the OFF state under worst-case input and output conditions  |
| $I_{NC(\text{ON})}$   | Leakage current measured at the NC port, with the corresponding channel (NC to COM) in the ON state and the output (COM) being open  |
| $I_{NO(\text{ON})}$   | Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the ON state and the output (COM) being open  |
| $I_{COM(\text{ON})}$  | Leakage current measured at the COM port, with the corresponding channel (NO to COM or NC to COM) in the ON state and the output (NC or NO) being open   |
| $V_{IH}$              | Minimum input voltage for logic high for the control input (IN)  |
| $V_{IL}$              | Minimum input voltage for logic low for the control input (IN)   |
| $V_{IN}$              | Voltage at IN  |
| $I_{IH}, I_{IL}$      | Leakage current measured at IN   |
| $t_{ON}$              | Turnon time for the switch. This parameter is measured under the specified range of conditions and by the propagation delay between the digital control (IN) signal and analog outputs (COM/NC/NO) signal when the switch is turning ON.   |
| $t_{OFF}$             | Turnoff time for the switch. This parameter is measured under the specified range of conditions and by the propagation delay between the digital control (IN) signal and analog outputs (COM/NC/NO) signal when the switch is turning OFF.   |
| $t_{BBM}$             | Break-before-make time. This parameter is measured under the specified range of conditions and by the propagation delay between the output of two adjacent analog channels (NC and NO) when the control signal changes state.  |
| $Q_C$                 | Charge injection is a measurement of unwanted signal coupling from the control (IN) input to the analog (NC, NO, or COM) output. This is measured in coulombs (C) and measured by the total charge induced due to switching of the control input. Charge injection, $Q_C = C_L \times \Delta V_O$ , $C_L$ is the load capacitance and $\Delta V_O$ is the change in analog output voltage. |
| $C_{NC(\text{OFF})}$  | Capacitance at the NC port when the corresponding channel (NC to COM) is OFF   |
| $C_{NO(\text{OFF})}$  | Capacitance at the NO port when the corresponding channel (NC to COM) is OFF   |
| $C_{NC(\text{ON})}$   | Capacitance at the NC port when the corresponding channel (NC to COM) is ON  |
| $C_{NO(\text{ON})}$   | Capacitance at the NO port when the corresponding channel (NC to COM) is ON  |
| $C_{COM(\text{ON})}$  | Capacitance at the COM port when the corresponding channel (COM to NC or COM to NO) is ON  |
| $C_{IN}$              | Capacitance of IN  |
| $O_{ISO}$             | OFF isolation of the switch is a measurement of OFF-state switch impedance. This is measured in dB in a specific frequency, with the corresponding channel (NC to COM or NO to COM) in the OFF state. OFF isolation, $O_{ISO} = 20 \log (V_{NC}/V_{COM})$ dB, $V_{COM}$ is the input and $V_{NC}$ is the output.   |
| $X_{TALK}$            | Crosstalk is a measurement of unwanted signal coupling from an ON channel to an OFF channel (NC to NO or NO to NC). This is measured at a specific frequency and in dB. Crosstalk, $X_{TALK} = 20 \log (V_{NC1}/V_{NO1})$ , $V_{NO1}$ is the input and $V_{NC1}$ is the output.  |
| $BW$                  | Bandwidth of the switch. This is the frequency where the gain of an ON channel is -3 dB below the dc gain. Gain is measured from the equation, $20 \log (V_{NC}/V_{COM})$ dB, where $V_{NC}$ is the output and $V_{COM}$ is the input.   |
| $I_+$                 | Static power-supply current with the control (IN) pin at $V_+$ or GND  |
| $\Delta I_+$          | This is the increase in $I_+$ for each control (IN) input that is at the specified voltage, rather than at $V_+$ or GND.   |

**Table 3. Summary of Characteristics**

| CONFIGURATION  | <b>2:1 MULTIPLEXER/DEMULTIPLEXER<br/>(2 × SPDT)</b> |
|--|---|
| Number of channels   | 2   |
| ON-state resistance ( $r_{on}$ )                               | 10 Ω  |
| ON-state resistance match between channels ( $\Delta r_{on}$ ) | 0.15 Ω  |
| ON-state resistance flatness ( $r_{on(flat)}$ )                | 4 Ω   |
| Turnon/turnoff time ( $t_{ON}/t_{OFF}$ )                       | 5.7 ns/3.8 ns                                       |
| Break-before-make time ( $t_{BBM}$ )                           | 0.5 ns  |
| Charge injection ( $Q_C$ )                                     | 7 pC  |
| Bandwidth (BW)   | 220 MHz   |
| OFF isolation ( $O_{SIO}$ )                                    | -65 dB at 10 MHz                                    |
| Crosstalk 9XTALK)  | -66 dB at 10 MHz                                    |
| Total harmonic distortion (THD)                                | 0.01%   |
| Leakage current ( $I_{COM(OFF)}/I_{NC(OFF)}$ )                 | ±1 μA   |
| Package options  | 10-pin DGS and RSE                                  |

## 12.2 Documentation Support

### 12.2.1 Related Documentation

For related documentation, see the following:

- *Implications of Slow or Floating CMOS Inputs*, SCBA004

## 12.3 Community Resources

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

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

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

## 12.4 Trademarks

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

## 12.5 Electrostatic Discharge Caution



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

## 12.6 Glossary

[SLYZ022 — TI Glossary](#).

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

## 13 Mechanical, Packaging, and Orderable Information

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

**PACKAGING INFORMATION**

| Orderable 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) |
|-----------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| TS5A23157DGSR         | Active        | Production           | VSSOP (DGS)   10 | 2500   LARGE T&R      | Yes         | NIPDAU   SN                          | Level-1-260C-UNLIM                | -40 to 125   | (3BR, JBR)          |
| TS5A23157DGSR.Z       | Active        | Production           | VSSOP (DGS)   10 | 2500   LARGE T&R      | Yes         | SN                                   | Level-1-260C-UNLIM                | -40 to 125   | (3BR, JBR)          |
| TS5A23157DGSRG4       | Active        | Production           | VSSOP (DGS)   10 | 2500   null           | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | JBR                 |
| TS5A23157DGSRG4.Z     | Active        | Production           | VSSOP (DGS)   10 | 2500   null           | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | JBR                 |
| TS5A23157DGST.Z       | Obsolete      | Production           | VSSOP (DGS)   10 | -                     | -           | Call TI                              | Call TI                           | -40 to 125   | JBR                 |
| TS5A23157RSER         | Active        | Production           | UQFN (RSE)   10  | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | JBO                 |
| TS5A23157RSER.Z       | Active        | Production           | UQFN (RSE)   10  | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | JBO                 |
| TS5A23157RSERG4.Z     | Active        | Production           | UQFN (RSE)   10  | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | JBO                 |

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

(2) **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.

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

(4) **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.

(5) **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.

(6) **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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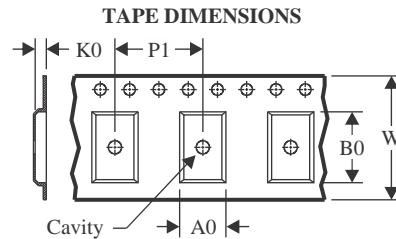
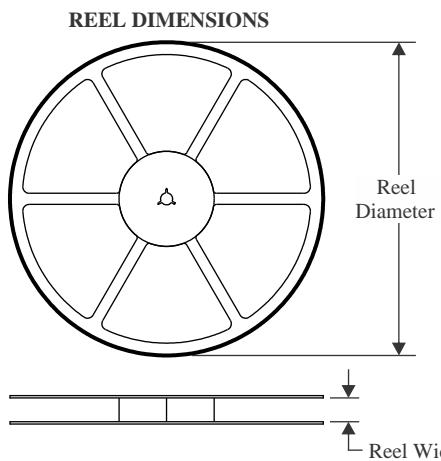
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TS5A23157 :**

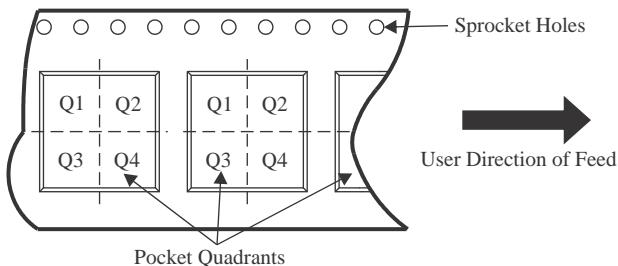
- Automotive : [TS5A23157-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

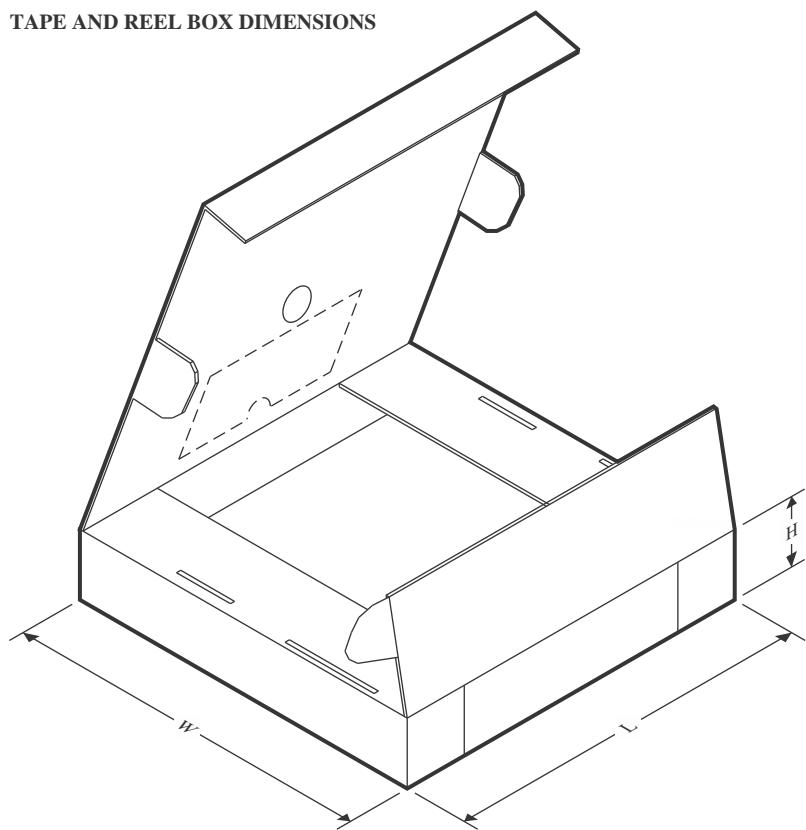
**TAPE AND REEL INFORMATION**

|    |   |
|----|---|
| 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 |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TS5A23157DGSR | VSSOP        | DGS             | 10   | 2500 | 330.0              | 12.4               | 5.25    | 3.35    | 1.25    | 8.0     | 12.0   | Q1            |
| TS5A23157RSER | UQFN         | RSE             | 10   | 3000 | 180.0              | 9.5                | 1.7     | 2.2     | 0.75    | 4.0     | 8.0    | Q1            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TS5A23157DGSR | VSSOP        | DGS             | 10   | 2500 | 366.0       | 364.0      | 50.0        |
| TS5A23157RSER | UQFN         | RSE             | 10   | 3000 | 189.0       | 185.0      | 36.0        |

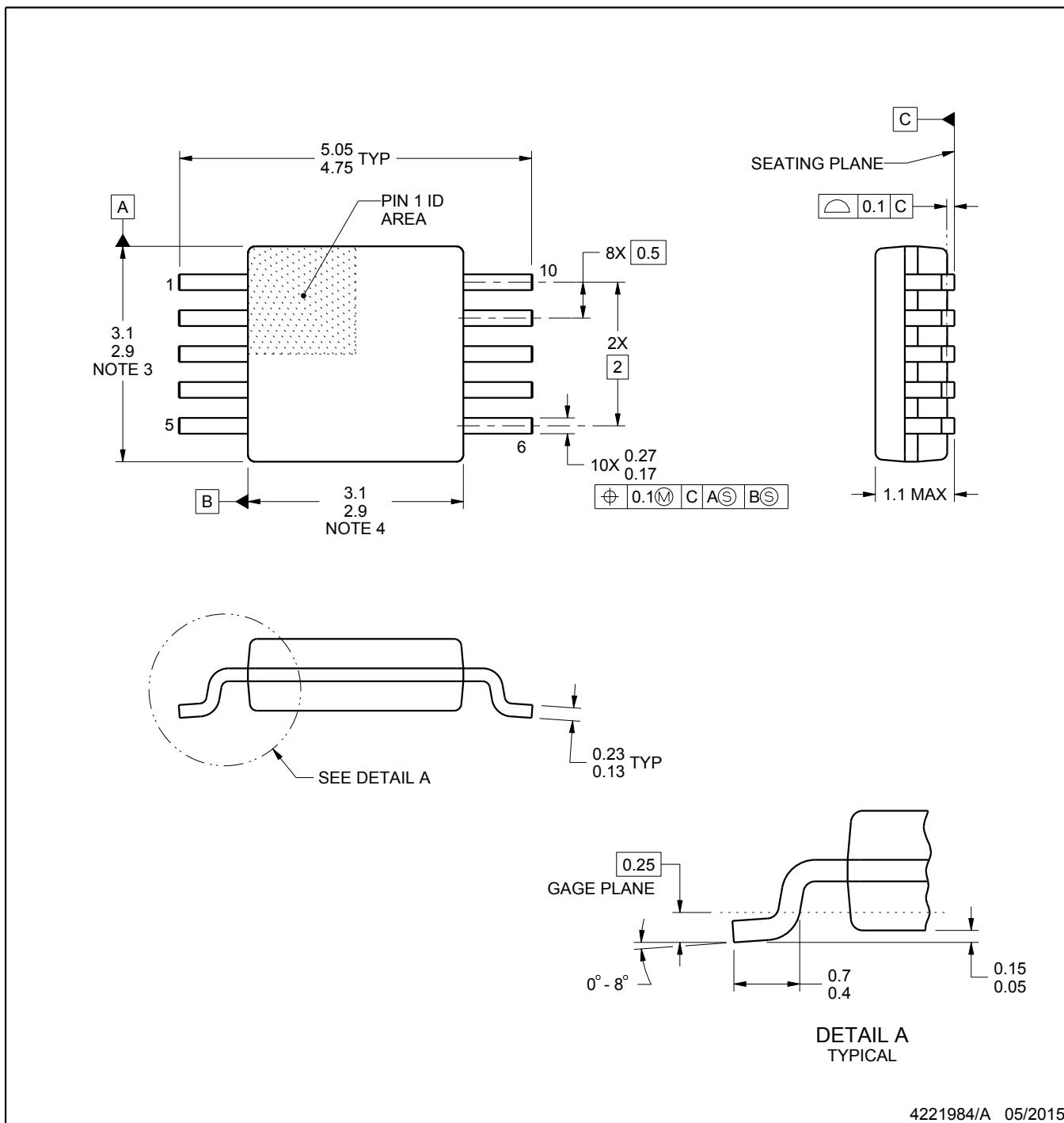
# PACKAGE OUTLINE

DGS0010A



VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



NOTES:

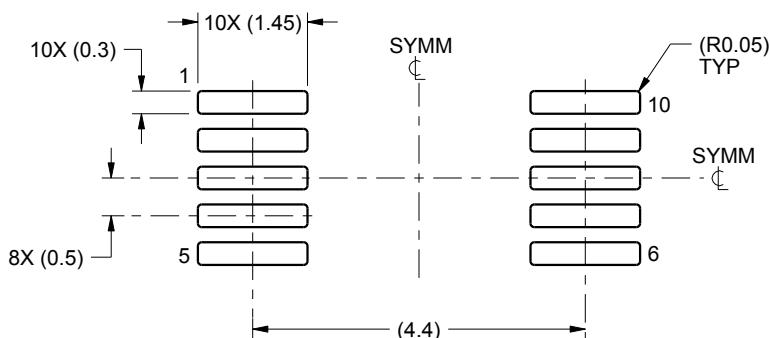
- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate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

# EXAMPLE BOARD LAYOUT

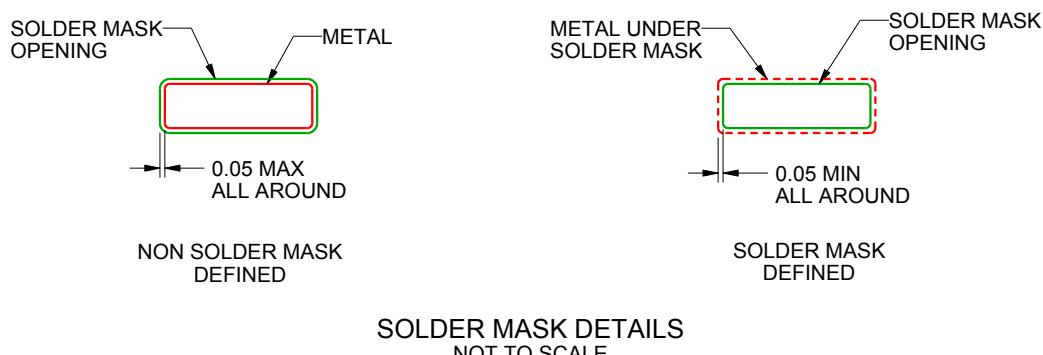
DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



4221984/A 05/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

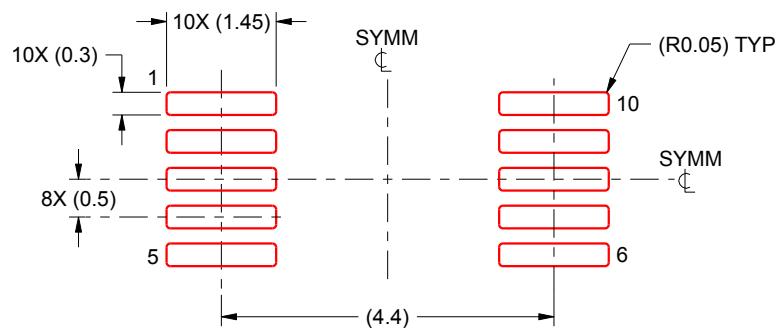
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# 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

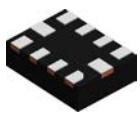
4221984/A 05/2015

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.

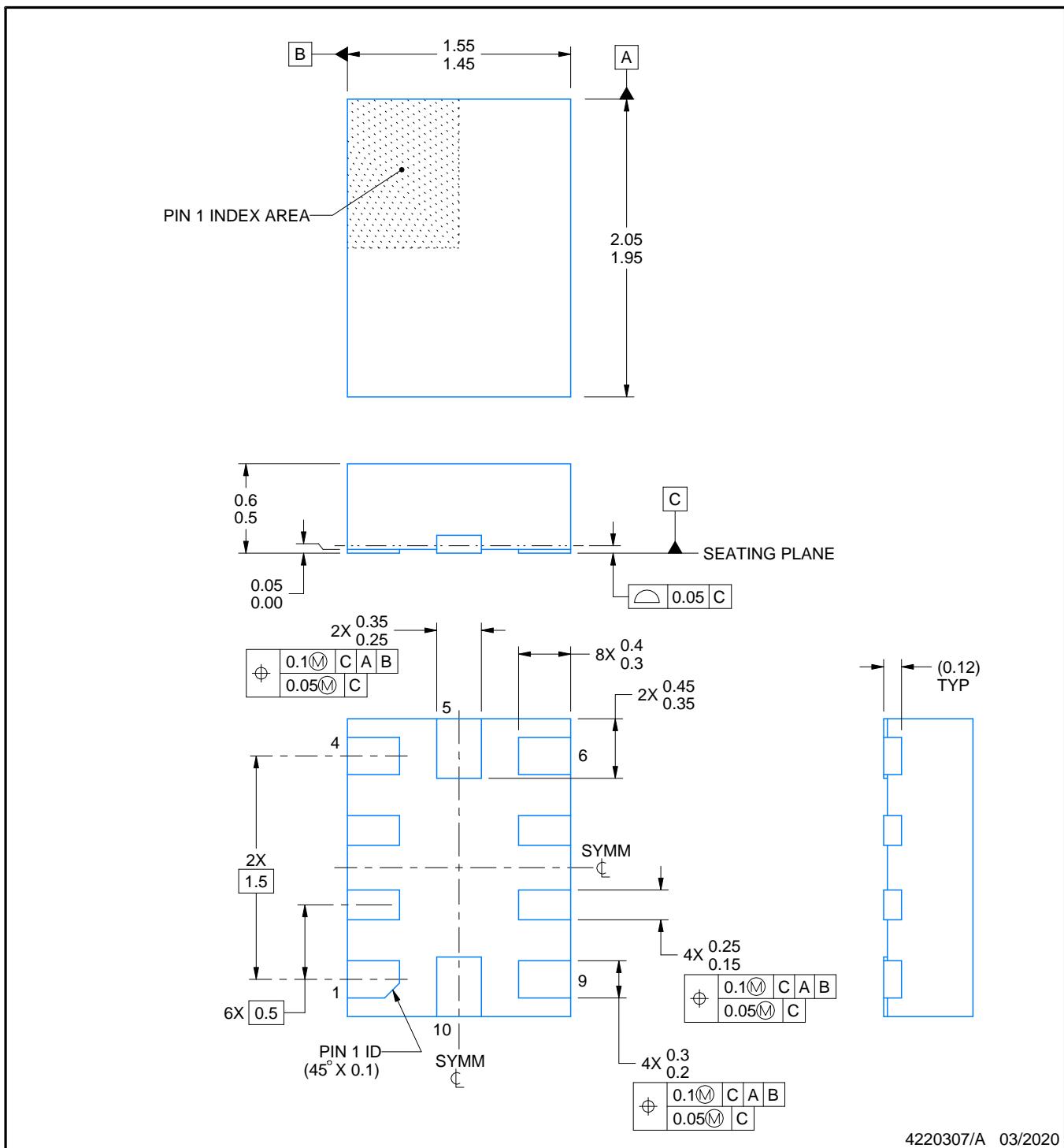
## **PACKAGE OUTLINE**

RSE0010A



## **UQFN - 0.6 mm max height**

## PLASTIC QUAD FLATPACK - NO LEAD



4220307/A 03/2020

## **NOTES:**

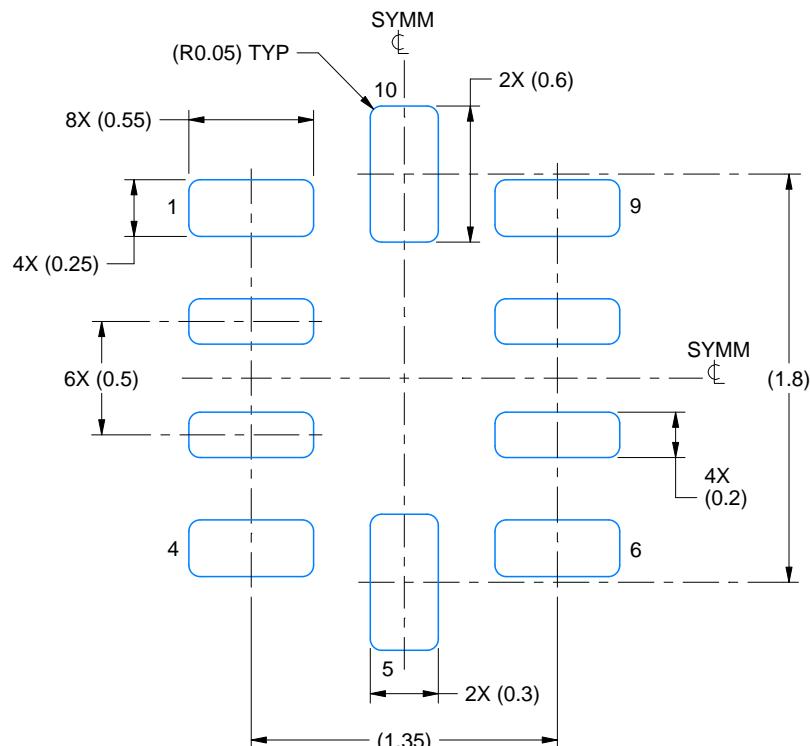
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
  2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

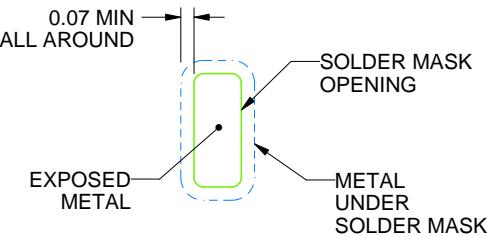
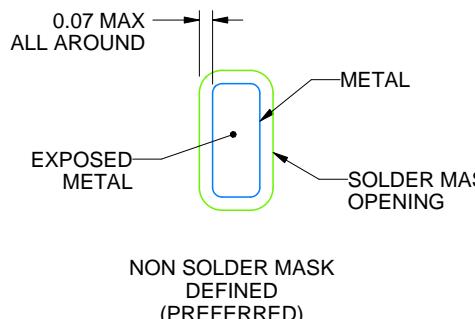
RSE0010A

UQFN - 0.6 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:30X



SOLDER MASK DETAILS  
NOT TO SCALE

4220307/A 03/2020

NOTES: (continued)

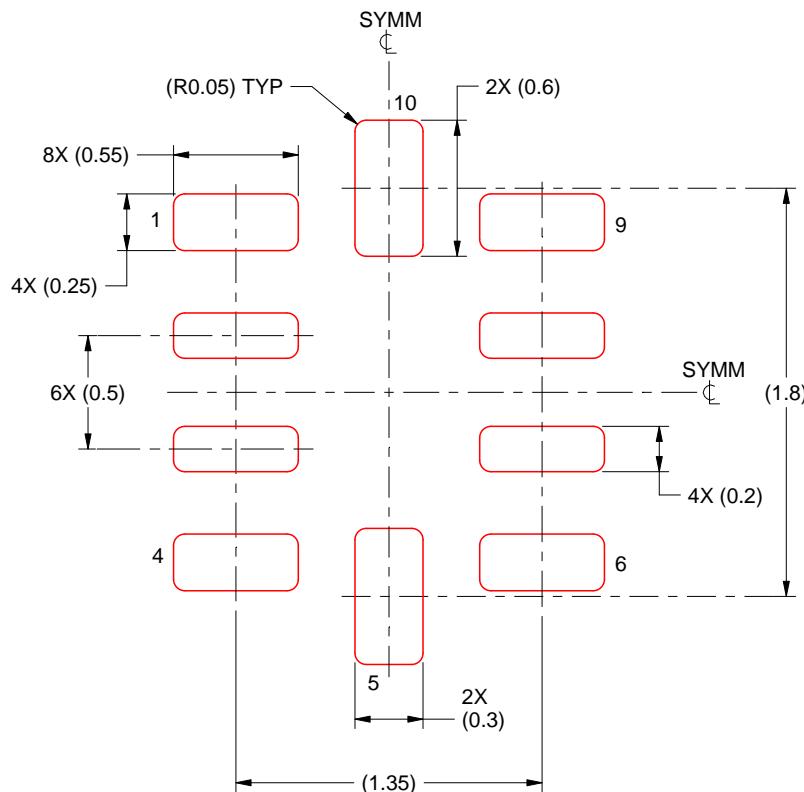
3. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).

# EXAMPLE STENCIL DESIGN

RSE0010A

UQFN - 0.6 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICKNESS  
SCALE: 30X

4220307/A 03/2020

NOTES: (continued)

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

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