

## DUAL 10-Ω SPDT ANALOG SWITCH

### FEATURES

- Specified Break-Before-Make Switching
- Low ON-State Resistance (10 Ω)
- Control Inputs Are 5-V Tolerant
- 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)

### APPLICATIONS

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

### DESCRIPTION/ORDERING INFORMATION

The TS5A23157 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.

### ORDERING INFORMATION

T <sub>A</sub>	PACKAGE <sup>(1)(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>(3)</sup>
–40°C to 85°C	VSSOP (MSOP-10) – DGS	Tape and reel	TS5A23157DGSR	JBR
	QFN – RSE	Tape and reel	TS5A23157RSER	JB_

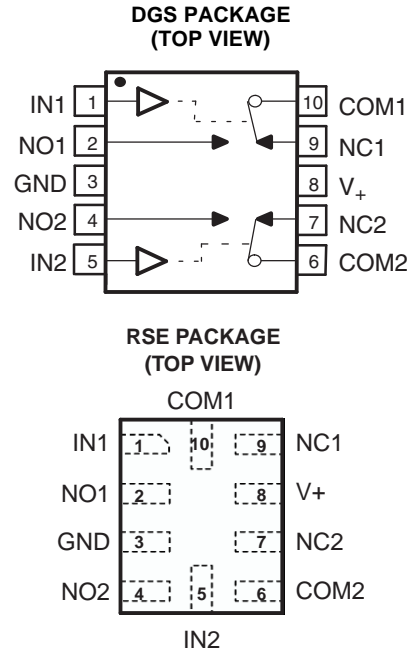
(1) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).

(3) RSE: The actual top-side marking has one additional character that designates the assembly/test site.

### FUNCTION TABLE

INPUT IN	NC TO COM, COM TO NC	NO TO COM, COM TO NO
L	ON	OFF
H	OFF	ON



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

## SUMMARY OF CHARACTERISTICS

Configuration	2:1 Multiplexer/Demultiplexer (2 × SPDT)
Number of channels	2
ON-state resistance ( $r_{on}$ )	10 $\Omega$
ON-state resistance match between channels ( $\Delta r_{on}$ )	0.15 $\Omega$
ON-state resistance flatness ( $r_{on(flat)}$ )	4 $\Omega$
Turn-on/turn-off 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 (OSIO)	–65 dB at 10 MHz
Crosstalk 9XTALK)	–66 dB at 10 MHz
Total harmonic distortion (THD)	0.01%
Leakage current ( $I_{COM(OFF)}/I_{NC(OFF)}$ )	$\pm 1 \mu A$
Package options	10-pin DGS and RSE

ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

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

		MIN	MAX	UNIT
$V_+$	Supply voltage range <sup>(2)</sup>	–0.5	6.5	V
$V_{NC}$ $V_{NO}$ $V_{COM}$	Analog voltage range <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
$I_{NC}$ $I_{NO}$ $I_{COM}$	On-state switch current $V_{NC}, V_{NO}, V_{COM} = 0$ to $V_+$		$\pm 50$	mA
$V_{IN}$	Digital input voltage range <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
$\theta_{JA}$	Package thermal impedance <sup>(5)</sup> DGS package		56.5	°C/W
	RSE package		243	
$T_{stg}$	Storage temperature range	–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltages are with respect to ground, unless otherwise specified.

(3) The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

(4) This value is limited to 5.5 V maximum.

(5) The package thermal impedance is calculated in accordance with JESD 51-7.

## 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	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP <sup>(1)</sup>	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{\text{COM}}, V_{\text{NO}}, V_{\text{NC}}$				0		$V_+$	V
ON-state resistance	$r_{\text{on}}$	$0 \leq V_{\text{NO}} \text{ or } V_{\text{NC}} \leq V_+$ , $I_{\text{COM}} = -30 \text{ mA}$ , Switch ON, See <a href="#">Figure 10</a>	Full	4.5 V			10	$\Omega$
ON-state resistance match between channels	$\Delta r_{\text{on}}$	$V_{\text{NO}} \text{ or } V_{\text{NC}} = 3.15 \text{ V}$ , $I_{\text{COM}} = -30 \text{ mA}$ , Switch ON, See <a href="#">Figure 10</a>	25°C	4.5 V		0.15		$\Omega$
ON-state resistance flatness	$r_{\text{on(flat)}}$	$0 \leq V_{\text{NO}} \text{ or } V_{\text{NC}} \leq V_+$ , $I_{\text{COM}} = -30 \text{ mA}$ , Switch ON, See <a href="#">Figure 10</a>	25°C	4.5 V		4		$\Omega$
NC, NO OFF leakage current	$I_{\text{NC(OFF)}}, I_{\text{NO(OFF)}}$	$V_{\text{NC}} \text{ or } V_{\text{NO}} = 0 \text{ to } V_+$ , $V_{\text{COM}} = 0 \text{ to } V_+$ , Switch OFF, See <a href="#">Figure 11</a>	25°C Full	5.5 V	–1	0.05	1	$\mu\text{A}$
NC, NO ON leakage current	$I_{\text{NC(ON)}}, I_{\text{NO(ON)}}$	$V_{\text{NC}} \text{ or } V_{\text{NO}} = 0 \text{ to } V_+$ , $V_{\text{COM}} = \text{Open}$ , Switch ON, See <a href="#">Figure 11</a>	25°C Full	5.5 V	–0.1		0.1	$\mu\text{A}$
COM ON leakage current	$I_{\text{COM(ON)}}$	$V_{\text{NC}} \text{ or } V_{\text{NO}} = \text{Open}$ , $V_{\text{COM}} = 0 \text{ to } V_+$ , Switch ON, See <a href="#">Figure 11</a>	25°C Full	5.5 V	–0.1		0.1	$\mu\text{A}$
<b>Digital Inputs (IN12, IN2)<sup>(2)</sup></b>								
Input logic high	$V_{\text{IH}}$		Full		$V_+ \times 0.7$			V
Input logic low	$V_{\text{IL}}$		Full				$V_+ \times 0.3$	V
Input leakage current	$I_{\text{IH}}, I_{\text{IL}}$	$V_{\text{IN}} = 5.5 \text{ V or } 0$	25°C Full	5.5 V	–1	0.05	1	$\mu\text{A}$

(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*, literature number SCBA004.

**ELECTRICAL CHARACTERISTICS FOR 5-V SUPPLY (continued)**
 $V_+ = 4.5 \text{ V to } 5.5 \text{ V}$ ,  $T_A = -40^\circ\text{C to } 85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP <sup>(1)</sup>	MAX	UNIT
<b>Dynamic</b>								
Turn-on time	$t_{ON}$	$V_{NC} = \text{GND}$ 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 13</a>	Full	4.5 V to 5.5 V	1.7		5.7	ns
Turn-off time	$t_{OFF}$	$V_{NC} = \text{GND}$ 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 13</a>	Full	4.5 V to 5.5 V	0.8		3.8	ns
Break-before-make time	$t_{BBM}$	$V_{NC} = V_{NO} = V_+/2$ , $R_L = 50 \Omega$ , $C_L = 35 \text{ pF}$ , See <a href="#">Figure 14</a>	Full	4.5 V to 5.5 V	0.5			ns
Charge injection	$Q_C$	$V_{NC} = V_{NO} = V_+/2$ , $R_L = 50 \Omega$ , See <a href="#">Figure 18</a>	25°C	5 V		7		pC
NC, NO OFF capacitance	$C_{NC(OFF)}$ , $C_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = V_+$ or GND, Switch OFF, See <a href="#">Figure 12</a>	25°C	5 V		5.5		pF
NC, NO ON capacitance	$C_{NC(ON)}$ , $C_{NO(ON)}$	$V_{NC}$ or $V_{NO} = V_+$ or GND, Switch ON, See <a href="#">Figure 12</a>	25°C	5 V		17.5		pF
COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND, Switch ON, See <a href="#">Figure 12</a>	25°C	5 V		17.5		pF
Digital input capacitance	$C_{IN}$	$V_{IN} = V_+$ or GND, See <a href="#">Figure 12</a>	25°C	5 V		2.8		pF
Bandwidth	BW	$R_L = 50 \Omega$ , Switch ON, See <a href="#">Figure 15</a>	25°C	4.5 V		220		MHz
OFF isolation	$O_{ISO}$	$R_L = 50 \Omega$ , $f = 10 \text{ MHz}$ , Switch OFF, See <a href="#">Figure 16</a>	25°C	4.5 V		–65		dB
Crosstalk	$X_{TALK}$	$R_L = 50 \Omega$ , $f = 10 \text{ MHz}$ , Switch ON, See <a href="#">Figure 17</a>	25°C	4.5 V		–66		dB
Total harmonic distortion	THD	$R_L = 600 \Omega$ , $C_L = 50 \text{ pF}$ , $f = 600 \text{ Hz to } 20 \text{ kHz}$ , See <a href="#">Figure 19</a>	25°C	4.5 V		0.01		%
<b>Supply</b>								
Positive supply current	$I_+$	$V_{IN} = V_+$ or GND, Switch ON or OFF	25°C	5.5 V			1	$\mu\text{A}$
			Full				10	
Change in supply current	$\Delta I_+$	$V_{IN} = V_+ - 0.6 \text{ V}$	Full	5.5 V			500	$\mu\text{A}$

## ELECTRICAL CHARACTERISTICS FOR 3.3-V SUPPLY

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

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP <sup>(1)</sup>	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{COM}, V_{NO}, V_{NC}$				0		$V_+$	V
ON-state resistance	$r_{on}$	$0 \leq V_{NO} \text{ or } V_{NC} \leq V_+$ , $I_{COM} = -24\text{ mA}$ , Switch ON, See Figure 10	Full	3 V			18	$\Omega$
ON-state resistance match between channels	$\Delta r_{on}$	$V_{NO} \text{ or } V_{NC} = 2.1\text{ V}$ , $I_{COM} = -24\text{ mA}$ , Switch ON, See Figure 10	$25^\circ\text{C}$	3 V		0.2		$\Omega$
ON-state resistance flatness	$r_{on(flat)}$	$0 \leq V_{NO} \text{ or } V_{NC} \leq V_+$ , $I_{COM} = -24\text{ mA}$ , Switch ON, See Figure 12	$25^\circ\text{C}$	3 V		9		$\Omega$
NC, NO OFF leakage current	$I_{NC(OFF)}, I_{NO(OFF)}$	$V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+$ , $V_{COM} = 0 \text{ to } V_+$ , Switch OFF, See Figure 11	$25^\circ\text{C}$ Full	3.6 V	-1	0.05	1	$\mu\text{A}$
NC, NO ON leakage current	$I_{NC(ON)}, I_{NO(ON)}$	$V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+$ , $V_{COM} = \text{Open}$ , Switch ON, See Figure 11	$25^\circ\text{C}$ Full	3.6 V	-0.1		0.1	$\mu\text{A}$
COM ON leakage current	$I_{COM(ON)}$	$V_{NC} \text{ or } V_{NO} = \text{Open}$ , $V_{COM} = 0 \text{ to } V_+$ , Switch ON, See Figure 11	$25^\circ\text{C}$ Full	3.6 V	-0.1		0.1	$\mu\text{A}$
<b>Digital Inputs (IN12, IN2)<sup>(2)</sup></b>								
Input logic high	$V_{IH}$		Full		$V_+ \times 0.7$			V
Input logic low	$V_{IL}$		Full			$V_+ \times 0.3$		V
Input leakage current	$I_{IH}, I_{IL}$	$V_{IN} = 5.5\text{ V or }0$	$25^\circ\text{C}$ Full	3.6 V	-1	0.05	1	$\mu\text{A}$
<b>Dynamic</b>								
Turn-on time	$t_{ON}$	$V_{NC} = \text{GND and } V_{NO} = V_+$ or $V_{NC} = V_+ \text{ and } V_{NO} = \text{GND}$ , $R_L = 500\ \Omega$ , $C_L = 50\text{ pF}$ , See Figure 13	Full	3 V to 3.6 V	2.5		7.6	ns
Turn-off time	$t_{OFF}$	$V_{NC} = \text{GND and } V_{NO} = V_+$ or $V_{NC} = V_+ \text{ and } V_{NO} = \text{GND}$ , $R_L = 500\ \Omega$ , $C_L = 50\text{ pF}$ , See Figure 13	Full	3 V to 3.6 V	1.5		5.3	ns
Break-before-make time	$t_{BBM}$	$V_{NC} = V_{NO} = V_+/2$ , $R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$ , See Figure 14	Full	3 V to 3.6 V	0.5			ns
Charge injection	$Q_C$	$R_L = 50\ \Omega$ , $C_L = 0.1\text{ nF}$ , See Figure 18	$25^\circ\text{C}$	3.3 V		3		pC
Bandwidth	BW	$R_L = 50\ \Omega$ , Switch ON, See Figure 15	$25^\circ\text{C}$	3 V		220		MHz
OFF isolation	$O_{ISO}$	$R_L = 50\ \Omega$ , $f = 10\text{ MHz}$ , Switch OFF, See Figure 16	$25^\circ\text{C}$	3 V		-65		dB
Crosstalk	$X_{TALK}$	$R_L = 50\ \Omega$ , $f = 10\text{ MHz}$ , Switch ON, See Figure 17	$25^\circ\text{C}$	3 V		-66		dB
Total harmonic distortion	THD	$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ , $f = 600\text{ Hz to }20\text{ kHz}$ , See Figure 19	$25^\circ\text{C}$	3 V		0.015		%
<b>Supply</b>								
Positive supply current	$I_+$	$V_{IN} = V_+ \text{ or GND}$ , Switch ON or OFF	$25^\circ\text{C}$ Full	3.6 V			1 10	$\mu\text{A}$
Change in supply current	$\Delta I_+$	$V_{IN} = V_+ - 0.6\text{ V}$	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*, literature number SCBA004.

**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	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP <sup>(1)</sup>	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{\text{COM}}, V_{\text{NO}}, V_{\text{NC}}$				0		$V_+$	V
ON-state resistance	$r_{\text{on}}$	$0 \leq V_{\text{NO}} \text{ or } V_{\text{NC}} \leq V_+$ , $I_{\text{COM}} = -8 \text{ mA}$ , Switch ON, See Figure 10	Full	2.3 V			45	$\Omega$
ON-state resistance match between channels	$\Delta r_{\text{on}}$	$V_{\text{NO}} \text{ or } V_{\text{NC}} = 1.6 \text{ V}$ , $I_{\text{COM}} = -8 \text{ mA}$ , Switch ON, See Figure 10	25°C	2.3 V		0.5		$\Omega$
ON-state resistance flatness	$r_{\text{on(flat)}}$	$0 \leq V_{\text{NO}} \text{ or } V_{\text{NC}} \leq V_+$ , $I_{\text{COM}} = -8 \text{ mA}$ , Switch ON, See Figure 10	25°C	2.3 V		27		$\Omega$
NC, NO OFF leakage current	$I_{\text{NC(OFF)}}, I_{\text{NO(OFF)}}$	$V_{\text{NC}} \text{ or } V_{\text{NO}} = 0 \text{ to } V_+$ , $V_{\text{COM}} = 0 \text{ to } V_+$ , Switch OFF, See Figure 11	25°C Full	2.7 V	-1	0.05	1	$\mu\text{A}$
NC, NO ON leakage current	$I_{\text{NC(ON)}}, I_{\text{NO(ON)}}$	$V_{\text{NC}} \text{ or } V_{\text{NO}} = 0 \text{ to } V_+$ , $V_{\text{COM}} = \text{Open}$ , Switch ON, See Figure 11	25°C Full	2.7 V	-0.1		0.1	$\mu\text{A}$
COM ON leakage current	$I_{\text{COM(ON)}}$	$V_{\text{NC}} \text{ or } V_{\text{NO}} = \text{Open}$ , $V_{\text{COM}} = 0 \text{ to } V_+$ , Switch ON, See Figure 11	25°C Full	2.7 V	-0.1		0.1	$\mu\text{A}$
<b>Digital Inputs (IN12, IN2)<sup>(2)</sup></b>								
Input logic high	$V_{\text{IH}}$		Full		$V_+$ $\times 0.7$			V
Input logic low	$V_{\text{IL}}$		Full				$V_+$ $\times 0.3$	V
Input leakage current	$I_{\text{IH}}, I_{\text{IL}}$	$V_{\text{IN}} = 5.5 \text{ V or } 0$	25°C Full	2.7 V	-1	0.05	1	$\mu\text{A}$
<b>Dynamic</b>								
Turn-on time	$t_{\text{ON}}$	$V_{\text{NC}} = \text{GND and } V_{\text{NO}} = V_+$ or $V_{\text{NC}} = V_+ \text{ and } V_{\text{NO}} = \text{GND}$ , $R_L = 500 \Omega$ , $C_L = 50 \text{ pF}$ , See Figure 13	Full	2.3 V to 2.7 V	3.5		14	ns
Turn-off time	$t_{\text{OFF}}$	$V_{\text{NC}} = \text{GND and } V_{\text{NO}} = V_+$ or $V_{\text{NC}} = V_+ \text{ and } V_{\text{NO}} = \text{GND}$ , $R_L = 500 \Omega$ , $C_L = 50 \text{ pF}$ , See Figure 13	Full	2.3 V to 2.7 V	2		7.5	ns
Break-before-make time	$t_{\text{BBM}}$	$V_{\text{NC}} = V_{\text{NO}} = V_+/2$ , $R_L = 50 \Omega$ , $C_L = 35 \text{ pF}$ , See Figure 14	Full	2.3 V to 2.7 V	0.5			ns
Bandwidth	BW	$R_L = 50 \Omega$ , Switch ON, See Figure 15	25°C	2.3 V		220		MHz
OFF isolation	$O_{\text{ISO}}$	$R_L = 50 \Omega$ , $f = 10 \text{ MHz}$ , Switch OFF, See Figure 16	25°C	2.3 V		-65		dB
Crosstalk	$X_{\text{TALK}}$	$R_L = 50 \Omega$ , $f = 10 \text{ MHz}$ , Switch ON, See Figure 17	25°C	2.3 V		-66		dB
Total harmonic distortion	THD	$R_L = 600 \Omega$ , $C_L = 50 \text{ pF}$ , $f = 600 \text{ Hz to } 20 \text{ kHz}$ , See Figure 19	25°C	2.3 V		0.025		%
<b>Supply</b>								
Positive supply current	$I_+$	$V_{\text{IN}} = V_+ \text{ or GND}$ , Switch ON or OFF	25°C Full	2.7 V			1 10	$\mu\text{A}$
Change in supply current	$\Delta I_+$	$V_{\text{IN}} = V_+ - 0.6 \text{ V}$	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*, literature number SCBA004.

## ELECTRICAL CHARACTERISTICS FOR 1.8-V SUPPLY

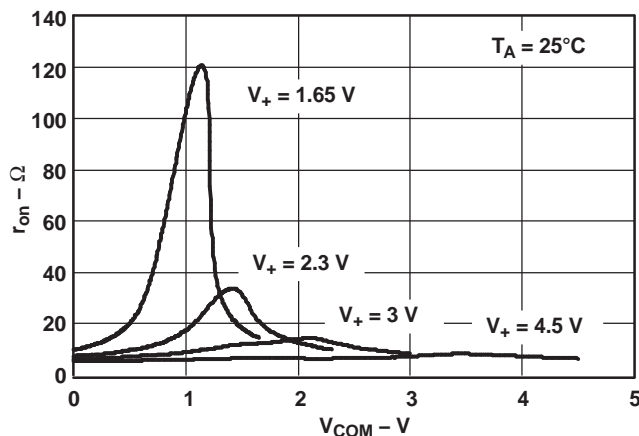
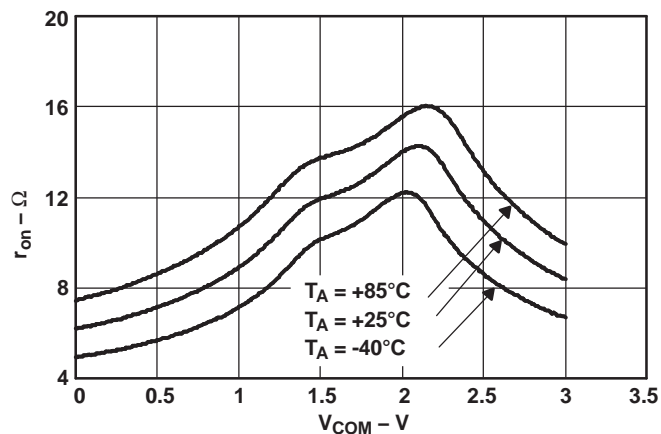
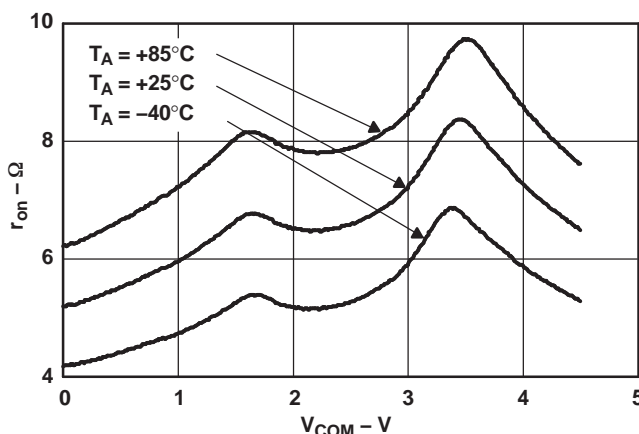
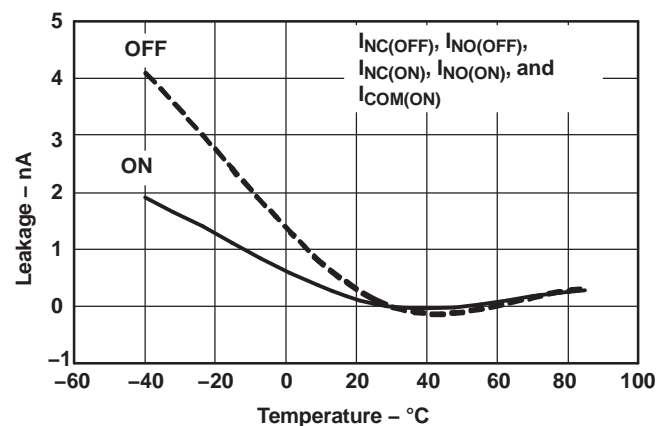
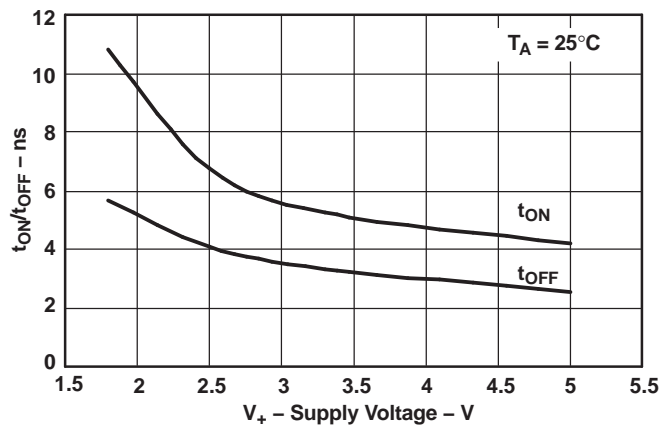
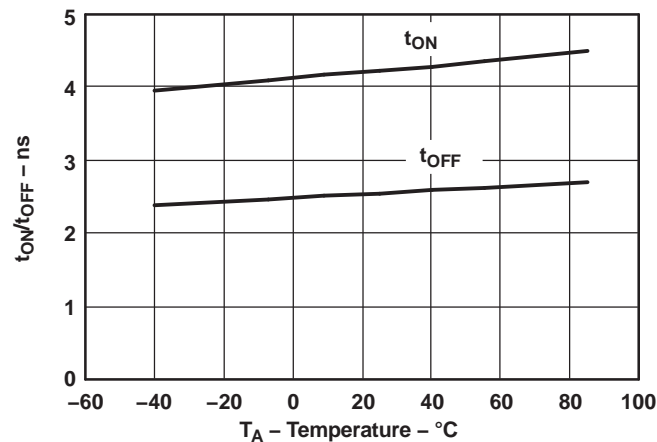
 $V_+ = 1.65\text{ V to }1.95\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP <sup>(1)</sup>	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{\text{COM}}, V_{\text{NO}}, V_{\text{NC}}$				0		$V_+$	V
ON-state resistance	$r_{\text{on}}$	$0 \leq V_{\text{NO}} \text{ or } V_{\text{NC}} \leq V_+$ , $I_{\text{COM}} = -4\text{ mA}$ , Switch ON, See <a href="#">Figure 10</a>	Full	1.65 V			140	$\Omega$
ON-state resistance match between channels	$\Delta r_{\text{on}}$	$V_{\text{NO}} \text{ or } V_{\text{NC}} = 1.15\text{ V}$ , $I_{\text{COM}} = -4\text{ mA}$ , Switch ON, See <a href="#">Figure 10</a>	25°C	1.65 V		1		$\Omega$
ON-state resistance flatness	$r_{\text{on(flat)}}$	$0 \leq V_{\text{NO}} \text{ or } V_{\text{NC}} \leq V_+$ , $I_{\text{COM}} = -4\text{ mA}$ , Switch ON, See <a href="#">Figure 10</a>	25°C	1.65 V		110		$\Omega$
NC, NO OFF leakage current	$I_{\text{NC(OFF)}}, I_{\text{NO(OFF)}}$	$V_{\text{NC}} \text{ or } V_{\text{NO}} = 0 \text{ to } V_+$ , $V_{\text{COM}} = 0 \text{ to } V_+$ , Switch OFF, See <a href="#">Figure 11</a>	25°C Full	1.95 V	–1	0.05	1	$\mu\text{A}$
NC, NO ON leakage current	$I_{\text{NC(ON)}}, I_{\text{NO(ON)}}$	$V_{\text{NC}} \text{ or } V_{\text{NO}} = 0 \text{ to } V_+$ , $V_{\text{COM}} = \text{Open}$ , Switch ON, See <a href="#">Figure 11</a>	25°C Full	1.95 V	–0.1		0.1	$\mu\text{A}$
COM ON leakage current	$I_{\text{COM(ON)}}$	$V_{\text{NC}} \text{ or } V_{\text{NO}} = \text{Open}$ , $V_{\text{COM}} = 0 \text{ to } V_+$ , Switch ON, See <a href="#">Figure 11</a>	25°C Full	1.95 V	–0.1		0.1	$\mu\text{A}$
<b>Digital Inputs (IN12, IN2)<sup>(2)</sup></b>								
Input logic high	$V_{\text{IH}}$		Full		$V_+ \times 0.75$			V
Input logic low	$V_{\text{IL}}$		Full			$V_+ \times 0.25$		V
Input leakage current	$I_{\text{IH}}, I_{\text{IL}}$	$V_{\text{IN}} = 5.5\text{ V or }0$	25°C Full	1.95 V	–1	0.05	1	$\mu\text{A}$
<b>Dynamic</b>								
Turn-on time	$t_{\text{ON}}$	$V_{\text{NC}} = \text{GND and } V_{\text{NO}} = V_+$ or $V_{\text{NC}} = V_+ \text{ and } V_{\text{NO}} = \text{GND}$ , $R_L = 500\text{ }\Omega$ , $C_L = 50\text{ pF}$ , See <a href="#">Figure 13</a>	Full	1.65 V to 1.95 V	7		24	ns
Turn-off time	$t_{\text{OFF}}$	$V_{\text{NC}} = \text{GND and } V_{\text{NO}} = V_+$ or $V_{\text{NC}} = V_+ \text{ and } V_{\text{NO}} = \text{GND}$ , $R_L = 500\text{ }\Omega$ , $C_L = 50\text{ pF}$ , See <a href="#">Figure 13</a>	Full	1.65 V to 1.95 V	3		13	ns
Break-before-make time	$t_{\text{BBM}}$	$V_{\text{NC}} = V_{\text{NO}} = V_+/2$ , $R_L = 50\text{ }\Omega$ , $C_L = 35\text{ pF}$ , See <a href="#">Figure 14</a>	Full	1.65 V to 1.95 V	0.5			ns
Bandwidth	BW	$R_L = 50\text{ }\Omega$ , Switch ON, See <a href="#">Figure 15</a>	25°C	1.8 V		220		MHz
OFF isolation	$O_{\text{ISO}}$	$R_L = 50\text{ }\Omega$ , $f = 10\text{ MHz}$ , Switch OFF, See <a href="#">Figure 16</a>	25°C	1.8 V		–60		dB
Crosstalk	$X_{\text{TALK}}$	$R_L = 50\text{ }\Omega$ , $f = 10\text{ MHz}$ , Switch ON, See <a href="#">Figure 17</a>	25°C	1.8 V		–66		dB
Total harmonic distortion	THD	$R_L = 600\text{ }\Omega$ , $C_L = 50\text{ pF}$ , $f = 600\text{ Hz to }20\text{ kHz}$ , See <a href="#">Figure 19</a>	25°C	1.8 V		0.015		%
<b>Supply</b>								
Positive supply current	$I_+$	$V_{\text{IN}} = V_+ \text{ or GND}$ , Switch ON or OFF	25°C Full	1.95 V			1 10	$\mu\text{A}$
Change in supply current	$\Delta I_+$	$V_{\text{IN}} = V_+ - 0.6\text{ V}$	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*, literature number SCBA004.

## TYPICAL CHARACTERISTICS

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



## TYPICAL CHARACTERISTICS (continued)

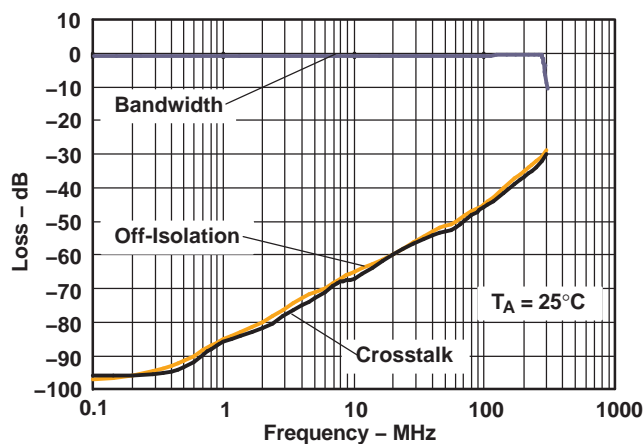


Figure 7. Frequency Response ( $V_+ = 3\text{ V}$ )

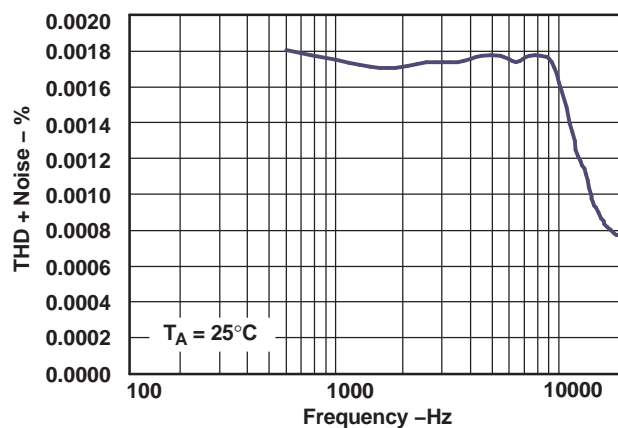


Figure 8. Total Harmonic Distortion (THD) vs Frequency ( $V_+ = 3\text{ V}$ )

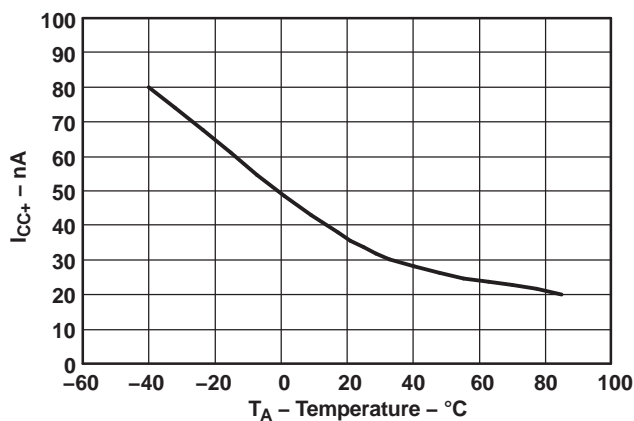


Figure 9. Power-Supply Current vs Temperature ( $V_+ = 5\text{ V}$ )

**PIN DESCRIPTION**

PIN NO.	NAME	DESCRIPTION
1	IN1	Digital control to connect COM to NO or NC
2	NO1	Normally open
3	GND	Digital ground
4	NO2	Normally open
5	IN2	Digital control to connect COM to NO or NC
6	COM2	Common
7	NC2	Normally closed
8	V <sub>+</sub>	Power supply
9	NC1	Normally closed
10	COM1	Common

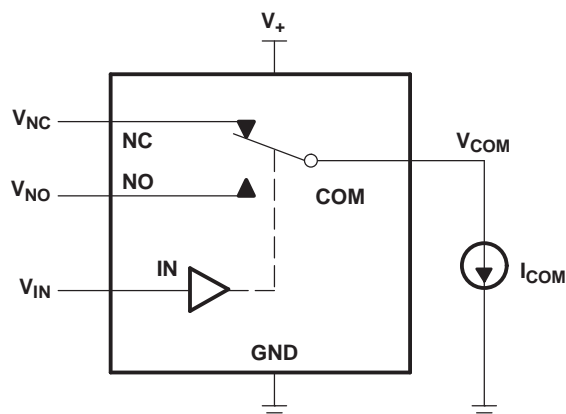
**PARAMETER DESCRIPTION**

SYMBOL	DESCRIPTION
V <sub>COM</sub>	Voltage at COM
V <sub>NC</sub>	Voltage at NC
V <sub>NO</sub>	Voltage at NO
r <sub>on</sub>	Resistance between COM and NC or COM and NO ports when the channel is ON
Δr <sub>on</sub>	Difference of r <sub>on</sub> between channels
r <sub>on(flat)</sub>	Difference between the maximum and minimum value of r <sub>on</sub> in a channel over the specified range of conditions
I <sub>NC(OFF)</sub>	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 <sub>NO(OFF)</sub>	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 <sub>NC(ON)</sub>	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 <sub>NO(ON)</sub>	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 <sub>COM(ON)</sub>	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 <sub>IH</sub>	Minimum input voltage for logic high for the control input (IN)
V <sub>IL</sub>	Minimum input voltage for logic low for the control input (IN)
V <sub>IN</sub>	Voltage at IN
I <sub>IH</sub> , I <sub>IL</sub>	Leakage current measured at IN
t <sub>ON</sub>	Turn-on 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 <sub>OFF</sub>	Turn-off 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 <sub>BBM</sub>	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 <sub>C</sub>	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 ) and measured by the total charge induced due to switching of the control input. Charge injection, Q <sub>C</sub> = C <sub>L</sub> × ΔV <sub>O</sub> , C <sub>L</sub> is the load capacitance and ΔV <sub>O</sub> is the change in analog output voltage.
C <sub>NC(OFF)</sub>	Capacitance at the NC port when the corresponding channel (NC to COM) is OFF
C <sub>NO(OFF)</sub>	Capacitance at the NO port when the corresponding channel (NC to COM) is OFF
C <sub>NC(ON)</sub>	Capacitance at the NC port when the corresponding channel (NC to COM) is ON
C <sub>NO(ON)</sub>	Capacitance at the NO port when the corresponding channel (NC to COM) is ON
C <sub>COM(ON)</sub>	Capacitance at the COM port when the corresponding channel (COM to NC or COM to NO) is ON
C <sub>IN</sub>	Capacitance of IN
O <sub>ISO</sub>	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 <sub>ISO</sub> = 20 LOG (V <sub>NC</sub> /V <sub>COM</sub> ) dB, V <sub>COM</sub> is the input and V <sub>NC</sub> is the output.

**PARAMETER DESCRIPTION (continued)**

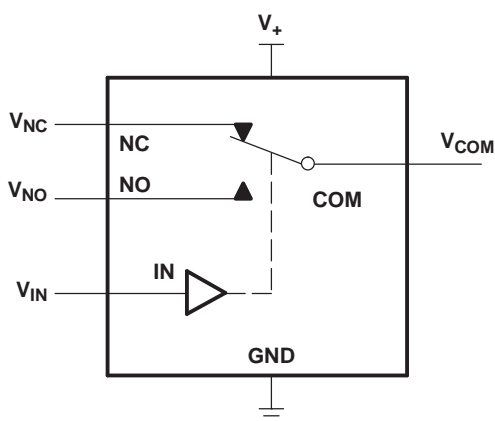
SYMBOL	DESCRIPTION
$X_{\text{TALK}}$	Crosstalk is a measurement of unwanted signal coupling from an ON channel to an OFF channel (NC to NO or NO to NC). This is measured at a specific frequency and in dB. Crosstalk, $X_{\text{TALK}} = 20 \log (V_{\text{NC1}}/V_{\text{NO1}})$ , $V_{\text{NO1}}$ is the input and $V_{\text{NC1}}$ 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, $20 \log (V_{\text{NC}}/V_{\text{COM}})$ dB, where $V_{\text{NC}}$ is the output and $V_{\text{COM}}$ 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.

## PARAMETER MEASUREMENT INFORMATION



Channel ON

$$r_{on} = \frac{V_{COM} - V_{NO/NC}}{I_{COM}} \Omega$$

 $V_{IN} = V_{IH} \text{ or } V_{IL}$ Figure 10. ON-State Resistance ( $r_{on}$ )

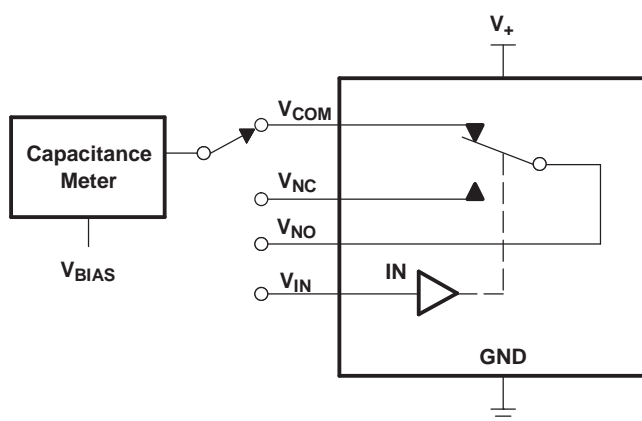
OFF-State Leakage Current

Channel OFF

 $V_{IN} = V_{IH} \text{ or } V_{IL}$  $V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+$ or  
 $V_{COM} = 0 \text{ to } V_+$ 

ON-State Leakage Current

Channel ON

 $V_{IN} = V_{IH} \text{ or } V_{IL}$  $V_{NC} \text{ or } V_{NO} = 0 \text{ to } V_+, V_{COM} = \text{Open}$ or  
 $V_{NC} \text{ or } V_{NO} = \text{Open}, V_{COM} = 0 \text{ to } V_+$ Figure 11. ON- and OFF-State Leakage Current ( $I_{COM(ON)}$ ,  $I_{NC(OFF)}$ ,  $I_{NO(OFF)}$ ,  $I_{NC(ON)}$ ,  $I_{NO(ON)}$ ) $V_{BIAS} = V_+ \text{ or } GND$  $V_{IN} = V_{IH} \text{ or } V_{IL}$ Capacitance is measured at NC,  
NO, COM, and IN inputs during  
ON and OFF conditions.Figure 12. Capacitance  $C_{IN}$ ,  $C_{COM(ON)}$ ,  $C_{NC(OFF)}$ ,  $C_{NO(OFF)}$ ,  $C_{NC(ON)}$ ,  $C_{NO(ON)}$

# PARAMETER MEASUREMENT INFORMATION (continued)

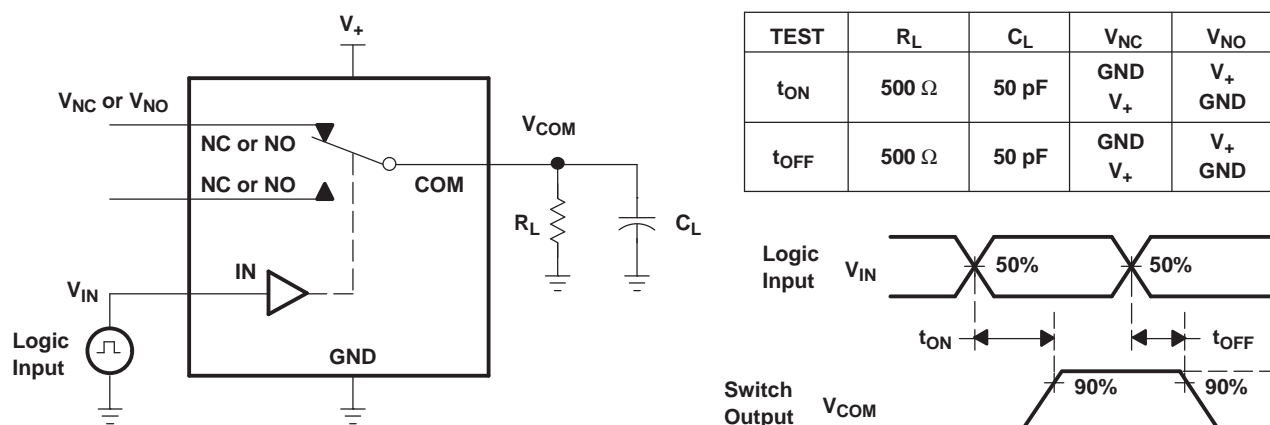


Figure 13. Turn-On ( $t_{ON}$ ) and Turn-Off ( $t_{OFF}$ ) Time

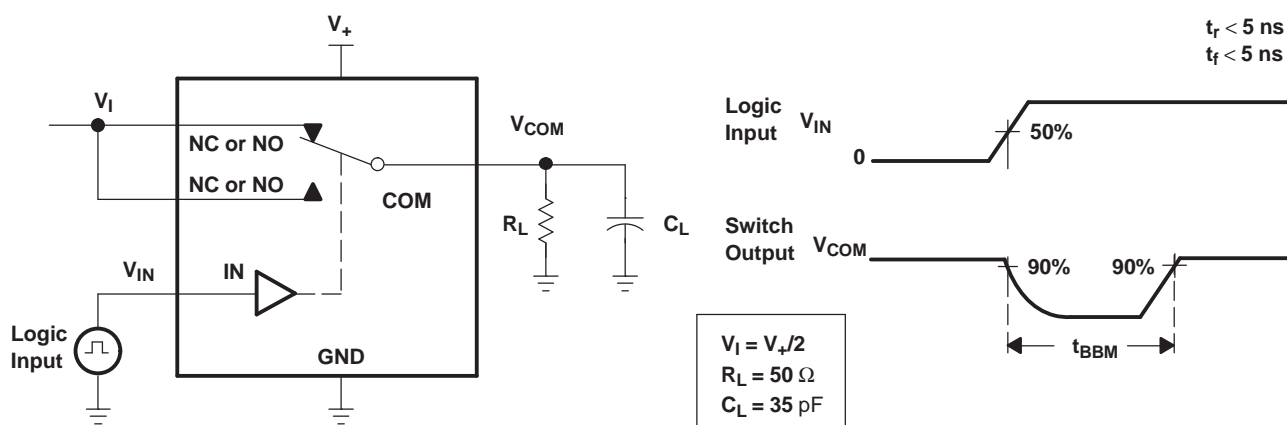


Figure 14. Break-Before-Make ( $t_{BBM}$ ) Time

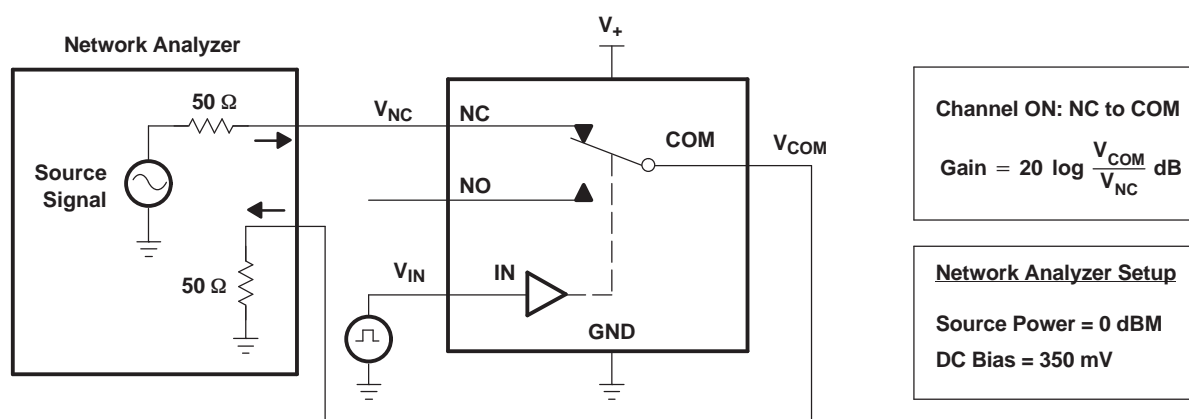
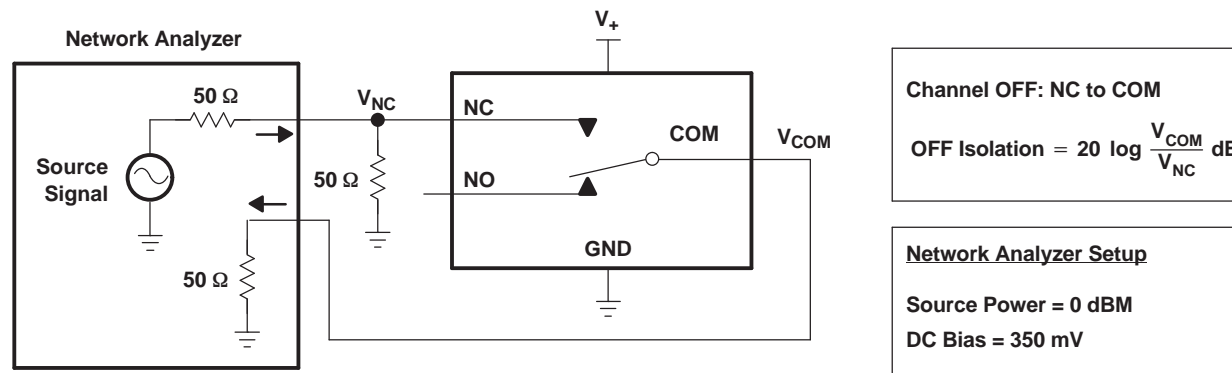
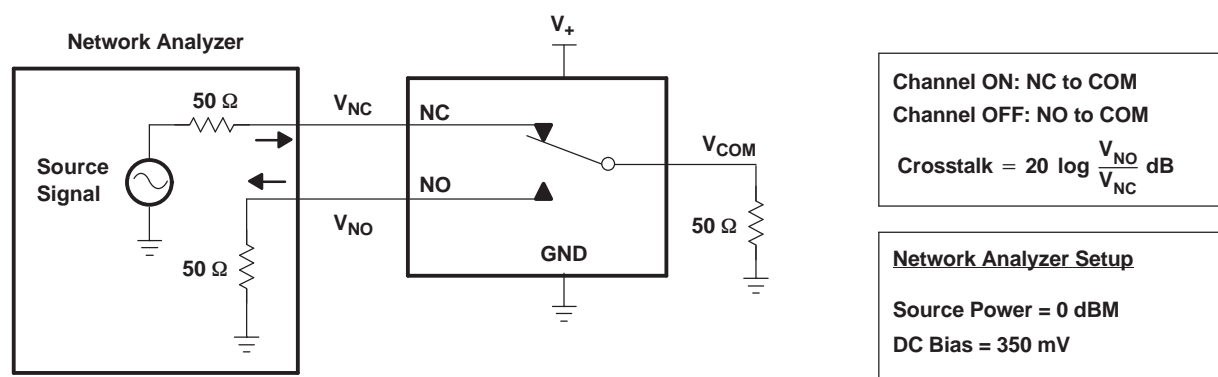
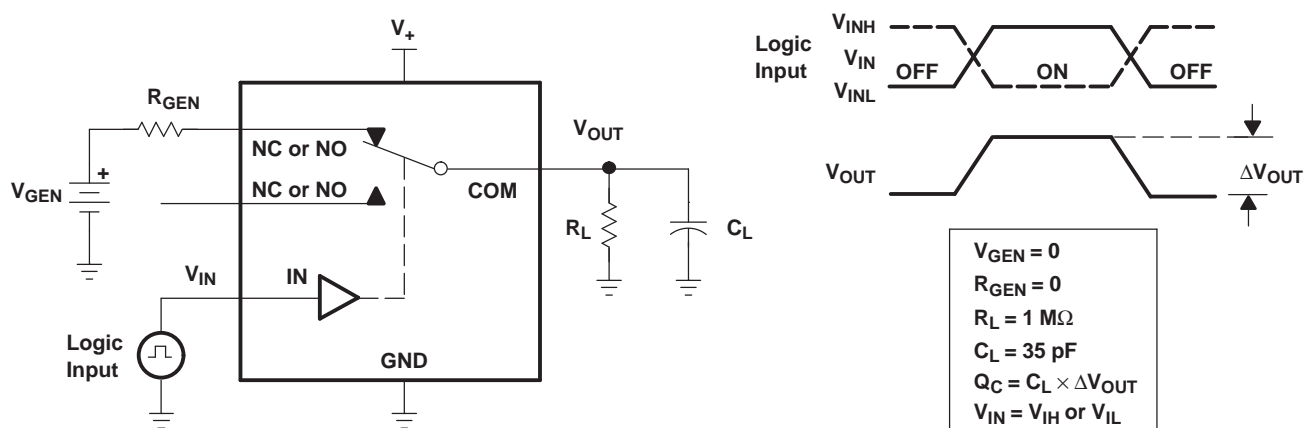
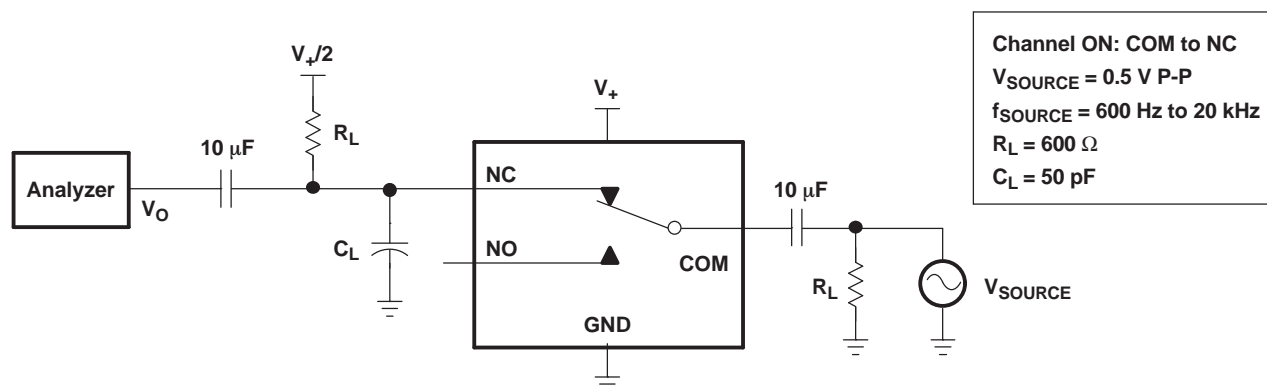


Figure 15. Frequency Response (BW)

## PARAMETER MEASUREMENT INFORMATION (continued)

Figure 16. OFF Isolation ( $O_{\text{ISO}}$ )Figure 17. Crosstalk ( $X_{\text{TALK}}$ )Figure 18. Charge Injection ( $Q_{\text{C}}$ )

## PARAMETER MEASUREMENT INFORMATION (continued)



**Figure 19. Total Harmonic Distortion (THD)**

## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TS5A23157DGSR	ACTIVE	VSSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	JBR	<a href="#">Samples</a>
TS5A23157DGSRE4	ACTIVE	VSSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	JBR	<a href="#">Samples</a>
TS5A23157DGSRG4	ACTIVE	VSSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	JBR	<a href="#">Samples</a>
TS5A23157DGST	ACTIVE	VSSOP	DGS	10	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	JBR	<a href="#">Samples</a>
TS5A23157DGSTE4	ACTIVE	VSSOP	DGS	10		TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
TS5A23157DGSTG4	ACTIVE	VSSOP	DGS	10	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	JBR	<a href="#">Samples</a>
TS5A23157RSER	ACTIVE	UQFN	RSE	10	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	JBO	<a href="#">Samples</a>
TS5A23157RSERG4	ACTIVE	UQFN	RSE	10	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	JBO	<a href="#">Samples</a>

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

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

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

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

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

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

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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



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

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

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

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**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**


\*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	5.3	3.4	1.4	8.0	12.0	Q1
TS5A23157DGST	VSSOP	DGS	10	250	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
TS5A23157RSER	UQFN	RSE	10	3000	179.0	8.4	1.75	2.25	0.65	4.0	8.0	Q1

## TAPE AND REEL BOX DIMENSIONS

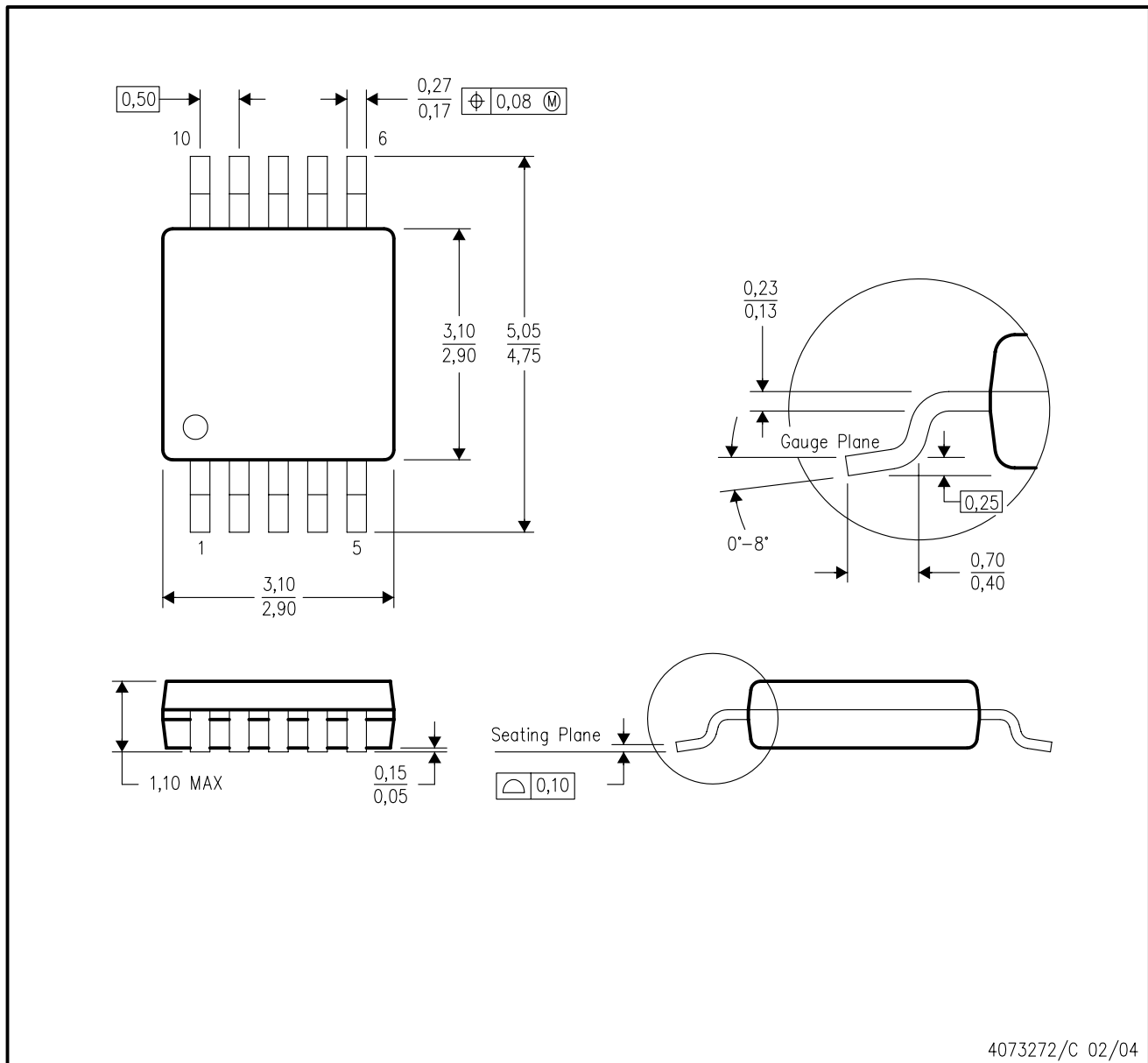


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS5A23157DGSR	VSSOP	DGS	10	2500	358.0	335.0	35.0
TS5A23157DGST	VSSOP	DGS	10	250	358.0	335.0	35.0
TS5A23157RSER	UQFN	RSE	10	3000	203.0	203.0	35.0

## DGS (S-PDSO-G10)

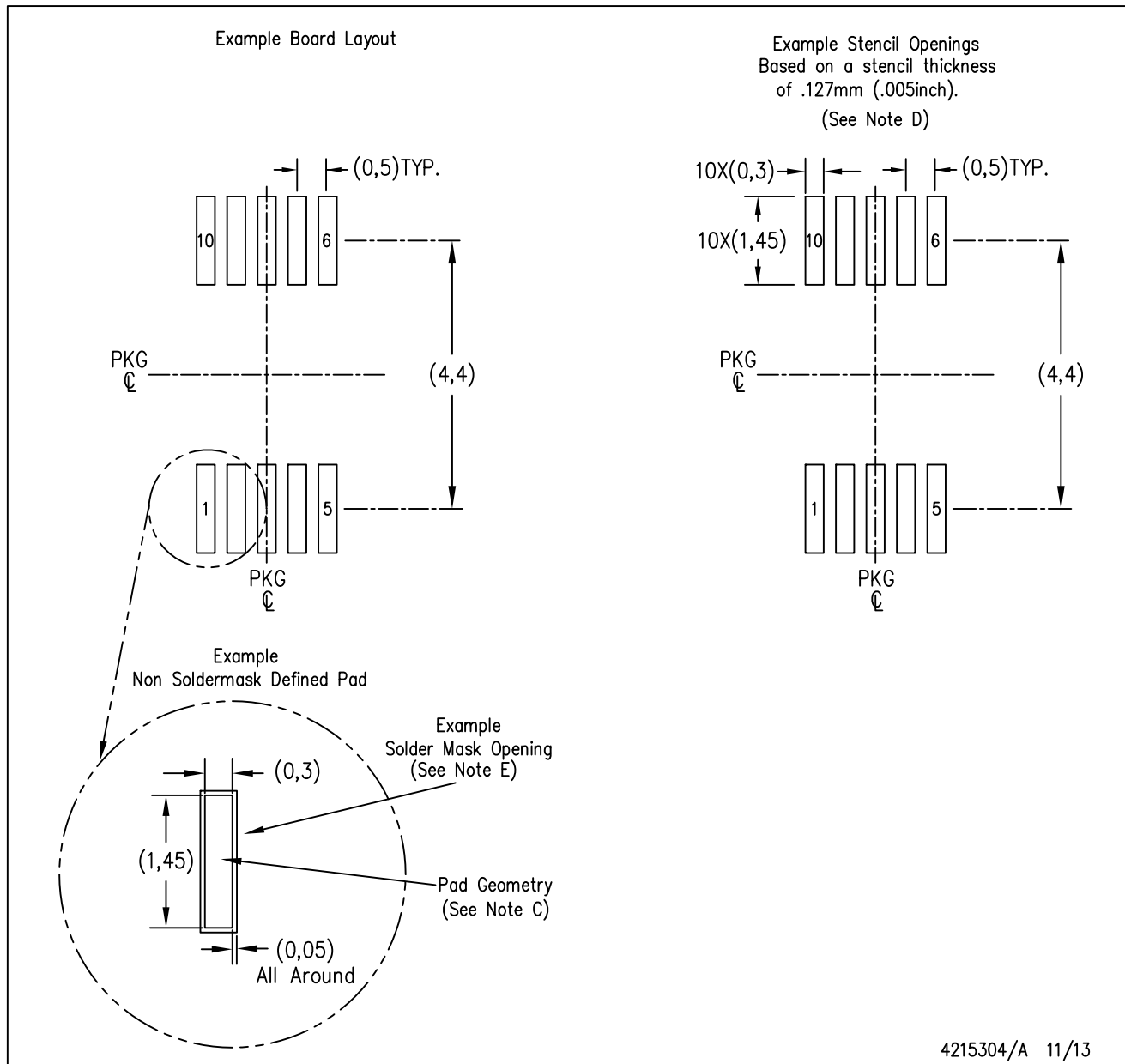
## PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion.
  - Falls within JEDEC MO-187 variation BA.

DGS (S-PDSO-G10)

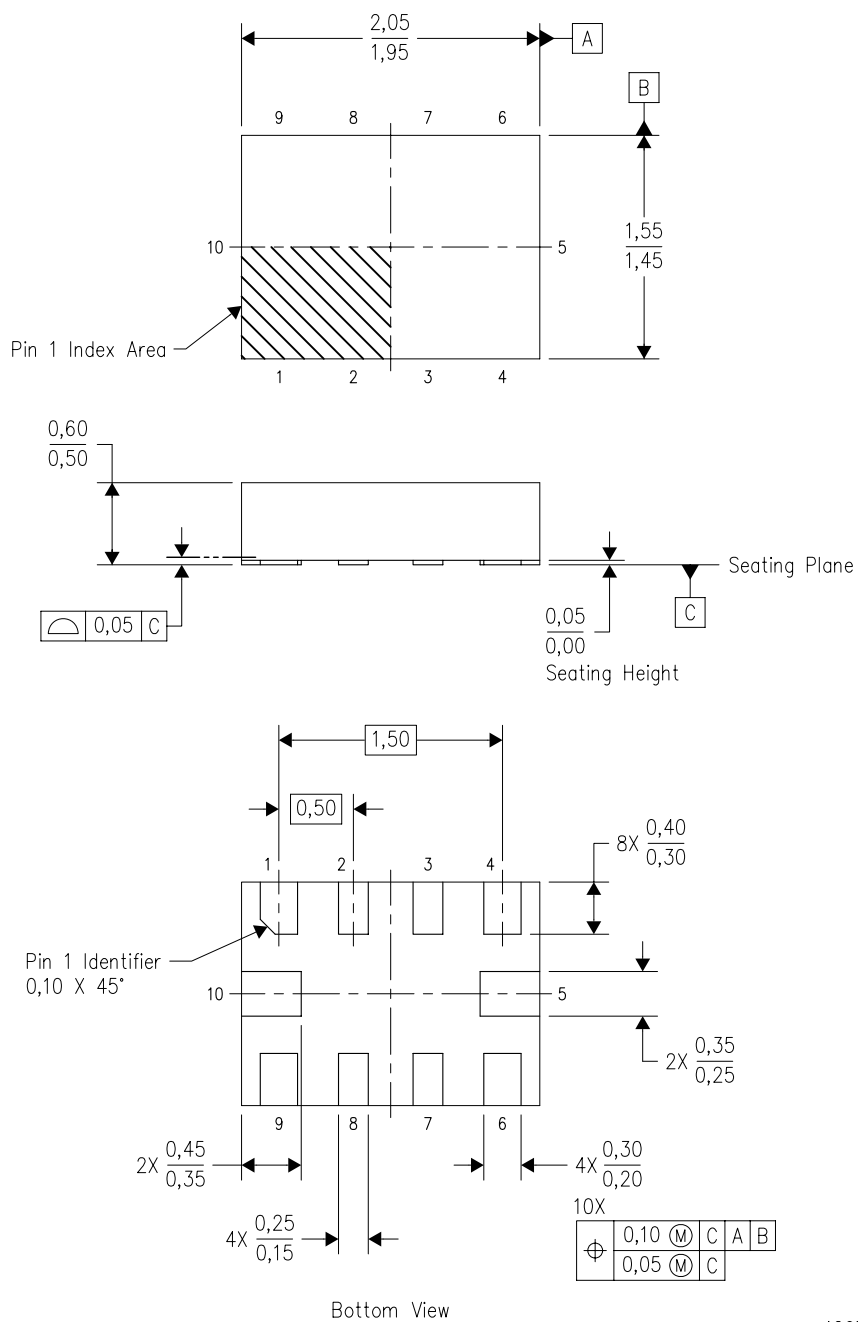
PLASTIC SMALL OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

RSE (R-PUQFN-N10)

PLASTIC QUAD FLATPACK NO-LEAD

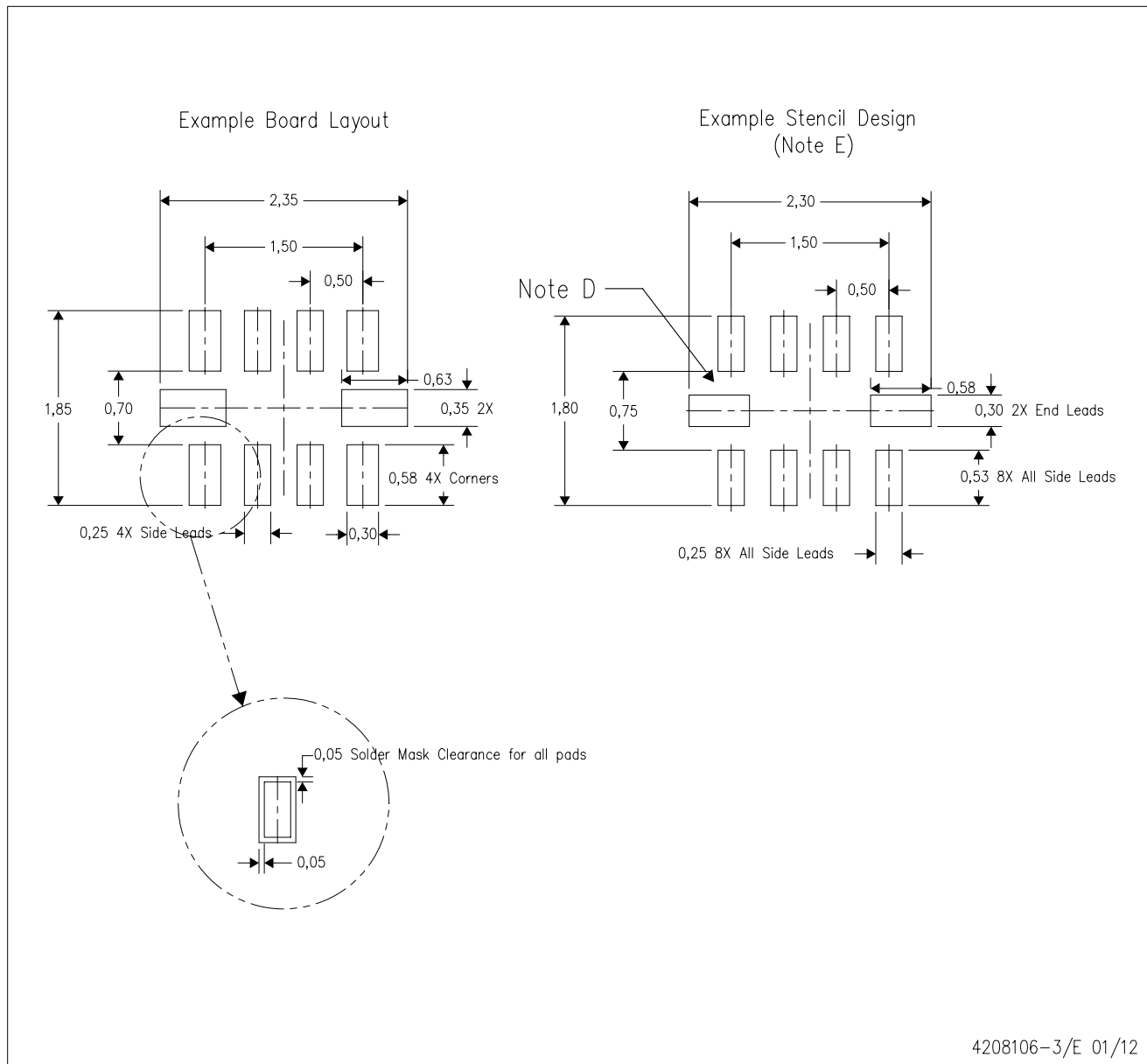


4207268-3/D 01/11

- NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.  
B. This drawing is subject to change without notice.  
C. QFN (Quad Flatpack No-Lead) package configuration.  
D. This package complies to JEDEC MO-288 variation UEFD.

RSE (R-PUQFN-N10)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
  - E. Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
  - F. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
  - G. Side aperture dimensions over-print land for acceptable area ratio > 0.66. Customer may reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.

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