

## 10-Ω SPDT ANALOG SWITCH SINGLE-CHANNEL 2:1 MULTIPLEXER/DEMULTIPLEXER

### FEATURES

- 2.25-V to 5.5-V Single-Supply Operation
- Low ON-State Resistance (10 Ω Max at  $V_+ = 5V$ )
- Specified Break-Before-Make Switching
- Low Power Consumption
- TTL/CMOS Compatible Control Input
- Low Input/Output Capacitance
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance Tested Per JESD
  - 2000-V Human-Body Model (A114-B, Class II)
  - 1000-V Charged-Device Model (C101)
- Control Inputs Are 5.5-V Tolerant
- Excellent ON-State Resistance Matching
- Low Total Harmonic Distortion (THD)

### APPLICATIONS

- Cell Phones
- Communication Systems
- Portable Test Equipment
- Battery Operated Systems
- Sample-and-Hold Circuits

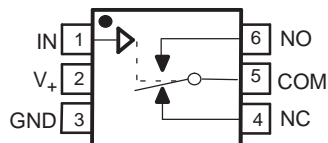
### DESCRIPTION

The TS5A9411 is a single-pole double-throw (SPDT) analog switch that is designed to operate from 2.25 V to 5.5 V. The device offers low ON-state resistance, low leakage, and low power with a break-before-make feature. These features make this device suitable for portable and battery-powered applications.

### FUNCTION TABLE

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

**DCK PACKAGE  
(TOP VIEW)**



### ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)(2)</sup>	ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>(3)</sup>
–40°C to 85°C	SOT (SC-70) – DCK Tape and reel	TS5A9411DCKR	32_

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



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<sup>(1)</sup>**

Configuration	2:1 Multiplexer/ Demultiplexer (1 × SPDT)
Number of channels	1
ON-state resistance ( $r_{ON}$ )	5.3 $\Omega$
ON-state resistance match ( $\Delta r_{ON}$ )	0.03 $\Omega$
ON-state resistance flatness $r_{ON(flat)}$	2 $\Omega$
Turn-on/turn-off time ( $t_{ON/OFF}$ )	9 ns/7 ns
Break-before-make time ( $t_{BBM}$ )	1 ns
Charge injection ( $Q_C$ )	12.5 pC
Bandwidth (BW)	100 MHz
OFF isolation ( $O_{ISO}$ )	–84 dB at 1 MHz
Crosstalk ( $X_{TALK}$ )	–85 dB at 1 MHz
Total harmonic distortion (THD)	0.03%
Leakage current ( $I_{NO(OFF)}/I_{NC(OFF)}$ )	$\pm 3$ nA
Power-supply current ( $I_+$ )	0.01 $\mu$ A
Package options	6-pin DCK

(1)  $V_+ = 5$  V,  $T_A = 25^\circ\text{C}$ **ABSOLUTE MINIMUM AND MAXIMUM RATINGS<sup>(1)(2)</sup>**

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

		MIN	MAX	UNIT
$V_+$	Supply voltage range <sup>(3)</sup>	–0.3	6	V
$V_{NO}$ $V_{NC}$ $V_{COM}$	Analog voltage range <sup>(3)(4)(5)</sup>	–0.3	$V_+ + 0.3$	V
$I_K$	Analog port diode current $V_{NC}, V_{NO}, V_{COM} < 0$	–50		mA
$I_{NO}$ $I_{NC}$ $I_{COM}$	On-state switch current On-state peak switch current <sup>(6)</sup> $V_{NO}, V_{NC}, V_{COM} = 0$ to $V_+$	–50 –200	50 200	mA
$V_I$	Digital input voltage range <sup>(3)(4)</sup>	–0.5	$V_+ + 0.3$	V
$I_{IK}$	Digital input clamp current $V_I < 0$	–50		mA
$I_+$	Continuous current through $V_+$		100	mA
$I_{GND}$	Continuous current through GND	–100		mA
$T_{stg}$	Storage temperature range	–65	150	$^\circ\text{C}$

- (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) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum
- (3) All voltages are with respect to ground, unless otherwise specified.
- (4) The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- (5) This value is limited to 5.5 V maximum.
- (6) Pulse at 1-ms duration < 10% duty cycle

**THERMAL IMPEDANCE RATINGS**

			UNIT
$\theta_{JA}$	Package thermal impedance <sup>(1)</sup>	DCK package	259 $^\circ\text{C}/\text{W}$

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

**ELECTRICAL CHARACTERISTICS FOR 5-V SUPPLY<sup>(1)</sup>**
 $V_+ = 4.5\text{ V to }5.5\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{COM}, V_{NO}, V_{NC}$				0		$V_+$	V
ON-state resistance	$r_{ON}$	$V_{NO}$ or $V_{NC} = 3\text{ V}$ , $I_{COM} = -10\text{ mA}$ ,	Switch ON, See <a href="#">Figure 6</a>	25°C	4.5 V	5.3	9	$\Omega$
				Full		10		
ON-state resistance match between channels	$\Delta r_{ON}$	$V_{NO}$ or $V_{NC} = 3\text{ V}$ , $I_{COM} = -10\text{ mA}$ ,	Switch ON, See <a href="#">Figure 6</a>	25°C	4.5 V	0.03	0.3	$\Omega$
				Full		0.3		
ON-state resistance flatness	$r_{ON(flat)}$	$0 \leq (V_{NO} \text{ or } V_{NC}) \leq V_+$ , $I_{COM} = -10\text{ mA}$ ,	Switch ON, See <a href="#">Figure 6</a>	25°C	4.5 V	2		$\Omega$
NC, NO OFF leakage current	$I_{NC(OFF)}, I_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = 1\text{ V}$ , $V_{COM} = 1\text{ V to }4.5\text{ V}$ , or $V_{NC}$ or $V_{NO} = 4.5\text{ V}$ , $V_{COM} = 1\text{ V}$ ,	Switch OFF, See <a href="#">Figure 7</a>	25°C	5.5 V	-500	500	pA
				Full		-3	3	nA
NC, NO ON leakage current	$I_{NC(ON)}, I_{NO(ON)}$	$V_{NC}$ or $V_{NO} = 1\text{ V}$ , $V_{COM} = 1\text{ V}$ $V_{NC}$ or $V_{NO} = 4.5\text{ V}$ , $V_{COM} = 4.5\text{ V}$ ,	Switch ON, See <a href="#">Figure 8</a>	25°C	5.5 V	-500	500	pA
				Full		-3	3	nA
COM ON leakage current	$I_{COM(ON)}$	$V_{NC}$ or $V_{NO} = \text{Open}$ , $V_{COM} = 1\text{ V}$ , or $V_{NC}$ or $V_{NO} = \text{Open}$ , $V_{COM} = 4.5\text{ V}$ ,	Switch ON, See <a href="#">Figure 8</a>	25°C	5.5 V	-500	500	pA
				Full		-3	3	nA
<b>Digital Input (IN)</b>								
Input logic high	$V_{IH}$			Full	4.5 V to 5.5 V	2.4	5.5	V
					4.5 V	2	5.5	
Input logic low	$V_{IL}$			Full	4.5 V to 5.5 V	0	0.8	V
Input leakage current	$I_{IH}, I_{IL}$	$V_I = 5.5\text{ V or }0$		25°C	5.5 V	-0.05	0.05	$\mu\text{A}$
				Full		-0.05	0.05	

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

**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	MAX	UNIT
<b>Dynamic</b>								
Turn-on time	$t_{ON}$	$V_{COM} = 3\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , See <a href="#">Figure 10</a>	25°C	5 V			9
				Full				4.5 V to 5.5 V
Turn-off time	$t_{OFF}$	$V_{COM} = 3\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , See <a href="#">Figure 10</a>	25°C	5 V			7
				Full				4.5 V to 5.5 V
Break-before-make time	$t_{BBM}$	$V_{NC} = V_{NO} = 3\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , See <a href="#">Figure 11</a>	25°C	5 V			1
				Full				0.9
Charge injection	$Q_C$	$V_{GEN} = 0$ , $R_{GEN} = 0$ ,	$C_L = 1\text{ nF}$ , See <a href="#">Figure 15</a>	25°C	5 V		12.5	pC
NC, NO OFF capacitance	$C_{NC(OFF)}$ , $C_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = V_+$ or GND, $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 9</a>	25°C	5 V		3.5	pF
NC, NO ON capacitance	$C_{NC(ON)}$ , $C_{NO(ON)}$	$V_{NC}$ or $V_{NO} = V_+$ or GND, $f = 1\text{ MHz}$ ,	See <a href="#">Figure 9</a>	25°C	5 V		8.5	pF
COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND, $f = 1\text{ MHz}$ ,	Switch ON, See <a href="#">Figure 9</a>	25°C	5 V		8.5	pF
Digital input capacitance	$C_I$	$V_I = V_+$ or GND, $f = 1\text{ MHz}$ ,	See <a href="#">Figure 9</a>	25°C	5 V		25	pF
Bandwidth	BW	$R_L = 50\ \Omega$ , Switch ON,	See <a href="#">Figure 12</a>	25°C	5 V		100	MHz
OFF isolation	$O_{ISO}$	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 13</a>	25°C	5 V		-84	dB
Crosstalk	$X_{TALK}$	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ,	Switch ON, See <a href="#">Figure 14</a>	25°C	5 V		-85	dB
Total harmonic distortion	THD	$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ ,	$f = 20\text{ Hz to }20\text{ kHz}$ , See <a href="#">Figure 16</a>	25°C	5 V		0.03	%
<b>Supply</b>								
Positive supply current	$I_+$	$V_I = V_+$ or GND,	Switch ON or OFF	25°C	5.5 V			0.01
				Full				0.5

**ELECTRICAL CHARACTERISTICS FOR 3-V SUPPLY<sup>(1)</sup>**
 $V_+ = 2.7\text{ V to }3.3\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{COM}, V_{NO}, V_{NC}$				0		$V_+$	V
ON-state resistance	$r_{ON}$	$V_{NO}$ or $V_{NC} = 1.5\text{ V}$ , $I_{COM} = -10\text{ mA}$ ,	Switch ON, See <a href="#">Figure 6</a>	25°C	2.7 V	11.5	15	$\Omega$
				Full		20		
ON-state resistance match between channels	$\Delta r_{ON}$	$V_{NO}$ or $V_{NC} = 1.5\text{ V}$ , $I_{COM} = -10\text{ mA}$ ,	Switch ON, See <a href="#">Figure 6</a>	25°C	2.7 V	0.05	0.3	$\Omega$
				Full		0.3		
ON-state resistance flatness	$r_{ON(Flat)}$	$0 \leq (V_{NO} \text{ or } V_{NC}) \leq V_+$ , $I_{COM} = -10\text{ mA}$ ,	Switch ON, See <a href="#">Figure 6</a>	25°C	3 V	2		$\Omega$
NC, NO OFF leakage current	$I_{NC(OFF)}, I_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = 1\text{ V}$ , $V_{COM} = 1\text{ V to }3\text{ V}$ , or $V_{NC}$ or $V_{NO} = 3\text{ V}$ , $V_{COM} = 1\text{ V}$ ,	Switch OFF, See <a href="#">Figure 7</a>	25°C	3.3V	-400	400	pA
				Full		-2	2	nA
NC, NO ON leakage current	$I_{NC(ON)}, I_{NO(ON)}$	$V_{NC}$ or $V_{NO} = 1\text{ V}$ , $V_{COM} = 1\text{ V}$ $V_{NC}$ or $V_{NO} = 3\text{ V}$ , $V_{COM} = 3\text{ V}$ ,	Switch ON, See <a href="#">Figure 8</a>	25°C	3.3 V	-400	400	pA
				Full		-2	2	nA
COM ON leakage current	$I_{COM(ON)}$	$V_{NC}$ or $V_{NO} = \text{Open}$ , $V_{COM} = 1\text{ V}$ , or $V_{NC}$ or $V_{NO} = \text{Open}$ , $V_{COM} = 3\text{ V}$ ,	Switch ON, See <a href="#">Figure 8</a>	25°C	3.3 V	-400	400	pA
				Full		-2	2	nA
<b>Digital Input (IN)</b>								
Input logic high	$V_{IH}$		Full		2		5.5	V
Input logic low	$V_{IL}$		Full		0		0.8	V
Input leakage current	$I_{IH}, I_{IL}$	$V_I = 5.5\text{ V or }0$	25°C	3.6 V	-0.05		0.05	$\mu\text{A}$
			Full		-0.05	0.05		

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

**ELECTRICAL CHARACTERISTICS FOR 3-V SUPPLY (continued)**
 $V_+ = 2.7\text{ V to }3.3\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Dynamic</b>								
Turn-on time	$t_{ON}$	$V_{COM} = 3\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , See <a href="#">Figure 10</a>	25°C	3 V		13	ns
				Full	2.7 V to 3.3 V		15	
Turn-off time	$t_{OFF}$	$V_{COM} = 3\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , See <a href="#">Figure 10</a>	25°C	3.3 V		7.5	ns
				Full	2.7 V to 3.3 V		8.5	
Break-before-make time	$t_{BBM}$	$V_{NC} = V_{NO} = 3\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , See <a href="#">Figure 11</a>	25°C	3.3 V		1	ns
				Full		0.9		
Charge injection	$Q_C$	$V_{GEN} = 0$ , $R_{GEN} = 0$ ,	$C_L = 1\text{ nF}$ , See <a href="#">Figure 15</a>	25°C	3 V		6	pC
NC, NO OFF capacitance	$C_{NC(OFF)}$ , $C_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = V_+$ or GND, $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 9</a>	25°C	3 V		3.5	pF
NC, NO ON capacitance	$C_{NC(ON)}$ , $C_{NO(ON)}$	$V_{NC}$ or $V_{NO} = V_+$ or GND, $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 9</a>	25°C	3 V		8.5	pF
COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND, $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 9</a>	25°C	3 V		8.5	pF
Digital input capacitance	$C_I$	$V_I = V_+$ or GND, $f = 1\text{ MHz}$ ,	See <a href="#">Figure 9</a>	25°C	3 V		2.5	pF
Bandwidth	BW	$R_L = 50\ \Omega$ , Switch ON,	See <a href="#">Figure 12</a>	25°C	3 V		100	MHz
OFF isolation	$O_{ISO}$	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 13</a>	25°C	3 V		-84	dB
Crosstalk	$X_{TALK}$	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ ,	Switch ON, See <a href="#">Figure 14</a>	25°C	3 V		-85	dB
Total harmonic distortion	THD	$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ ,	$f = 20\text{ Hz to }20\text{ kHz}$ , See <a href="#">Figure 16</a>	25°C	3 V		0.09	%
<b>Supply</b>								
Positive supply current	$I_+$	$V_I = V_+$ or GND,	Switch ON or OFF	25°C	3.6 V		0.01	$\mu\text{A}$
				Full		0.5		

**ELECTRICAL CHARACTERISTICS FOR 2.5-V SUPPLY<sup>(1)</sup>**
 $V_+ = 2.25\text{ V to }2.75\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{COM}, V_{NO}, V_{NC}$				0		$V_+$	V
ON-state resistance	$r_{ON}$	$V_{NO}$ or $V_{NC} = 1\text{ V}$ , $I_{COM} = -10\text{ mA}$ ,	Switch ON, See <a href="#">Figure 6</a>	25°C	2.25 V	15	25	$\Omega$
				Full		28		
ON-state resistance match between channels	$\Delta r_{ON}$	$V_{NO}$ or $V_{NC} = 1\text{ V}$ , $I_{COM} = -10\text{ mA}$ ,	Switch ON, See <a href="#">Figure 6</a>	25°C	2.25 V	0.06	0.3	$\Omega$
				Full		0.3		
ON-state resistance flatness	$r_{ON(Flat)}$	$0 \leq (V_{NO} \text{ or } V_{NC}) \leq V_+$ , $I_{COM} = -10\text{ mA}$ ,	Switch ON, See <a href="#">Figure 6</a>	25°C	2.25 V	4		$\Omega$
NC, NO OFF leakage current	$I_{NC(OFF)}, I_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = 1.5\text{ V}$ , $V_{COM} = 0.5\text{ V to }1.5\text{ V}$ , or $V_{NC}$ or $V_{NO} = 1.5\text{ V}$ , $V_{COM} = 1.5\text{ V}$ ,	Switch OFF, See <a href="#">Figure 7</a>	25°C	2.75 V	-300	300	pA
				Full		-1	1	nA
NC, NO ON leakage current	$I_{NC(ON)}, I_{NO(ON)}$	$V_{NC}$ or $V_{NO} = 1.5\text{ V}$ , $V_{COM} = 0.5\text{ V to }1.5\text{ V}$ , $V_{NC}$ or $V_{NO} = 1.5\text{ V}$ , $V_{COM} = 1.5\text{ V}$ ,	Switch ON, See <a href="#">Figure 8</a>	25°C	2.75 V	-300	300	pA
				Full		-1	1	nA
COM ON leakage current	$I_{COM(ON)}$	$V_{NC}$ or $V_{NO} = \text{Open}$ , $V_{COM} = 0.5\text{ V}$ , or $V_{NC}$ or $V_{NO} = \text{Open}$ , $V_{COM} = 1.5\text{ V}$ ,	Switch ON, See <a href="#">Figure 8</a>	25°C	2.75 V	-300	300	pA
				Full		-1	1	nA
<b>Digital Input (IN)</b>								
Input logic high	$V_{IH}$		Full		2		5.5	V
Input logic low	$V_{IL}$		Full		0		0.4	V
Input leakage current	$I_{IH}, I_{IL}$	$V_I = 5.5\text{ V or }0\text{ V}$	25°C	2.75 V	-0.05		0.05	$\mu\text{A}$
			Full		-0.05	0.05		

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

**ELECTRICAL CHARACTERISTICS FOR 2.5-V SUPPLY (continued)**
 $V_+ = 2.25\text{ V to }2.75\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Dynamic</b>								
Turn-on time	$t_{ON}$	$V_{COM} = 2\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , See <a href="#">Figure 10</a>	25°C	2.5 V		18	ns
				Full	2.25 V to 2.75 V		20	
Turn-off time	$t_{OFF}$	$V_{COM} = 2\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , See <a href="#">Figure 10</a>	25°C	2.5 V		8	ns
				Full	2.25 V to 2.75 V		9.5	
Break-before-make time	$t_{BBM}$	$V_{NC} = V_{NO} = 2\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , See <a href="#">Figure 11</a>	25°C	2.5 V		1	ns
				Full			0.9	
Charge injection	$Q_C$	$V_{GEN} = 0$ , $R_{GEN} = 0$ ,	$C_L = 1\text{ nF}$ , See <a href="#">Figure 15</a>	25°C	2.5 V		4.5	pC
NC, NO OFF capacitance	$C_{NC(OFF)}$ , $C_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = V_+$ or GND, $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 9</a>	25°C	2.5 V		3.5	pF
NC, NO ON capacitance	$C_{NC(ON)}$ , $C_{NO(ON)}$	$V_{NC}$ or $V_{NO} = V_+$ or GND, $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 9</a>	25°C	2.5 V		8.5	pF
COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND, $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 9</a>	25°C	2.5 V		8.5	pF
Digital input capacitance	$C_i$	$V_i = V_+$ or GND, $f = 1\text{ MHz}$ ,	See <a href="#">Figure 9</a>	25°C	2.5 V		2.5	pF
Bandwidth	BW	$R_L = 50\ \Omega$ , Switch ON,	See <a href="#">Figure 12</a>	25°C	2.5 V		100	MHz
OFF isolation	$O_{ISO}$	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ ,	Switch OFF, See <a href="#">Figure 13</a>	25°C	2.5 V		-84	dB
Crosstalk	$X_{TALK}$	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ ,	Switch ON, See <a href="#">Figure 14</a>	25°C	2.5 V		-84	dB
Total harmonic distortion	THD	$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ ,	$f = 20\text{ Hz to }20\text{ kHz}$ , See <a href="#">Figure 16</a>	25°C	2.5 V		0.15	%
Positive supply current	$I_+$	$V_i = V_+$ or GND,	Switch ON or OFF	25°C	2.75 V		0.01	$\mu\text{A}$
				Full			0.5	



TYPICAL PERFORMANCE

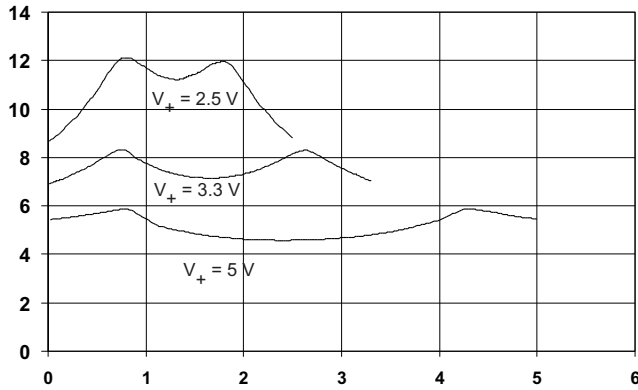


Figure 1. r<sub>ON</sub> vs V<sub>IN</sub>

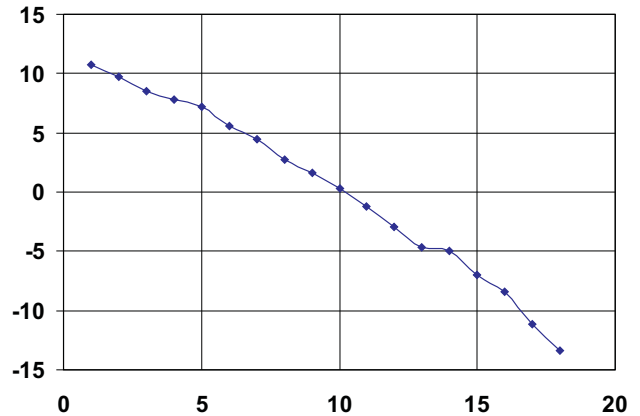


Figure 2. Charge Injection (Q<sub>C</sub>) vs V<sub>COM</sub>

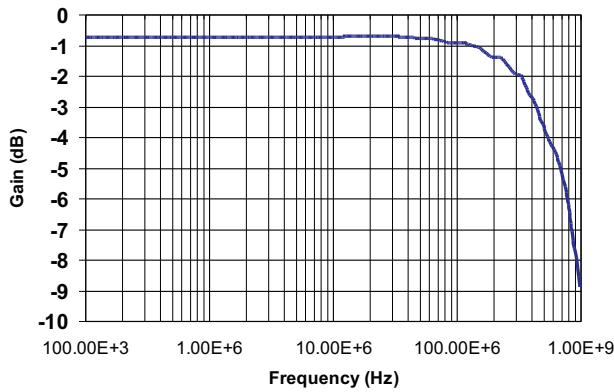


Figure 3. Bandwidth (V<sub>+</sub> = 3 V)

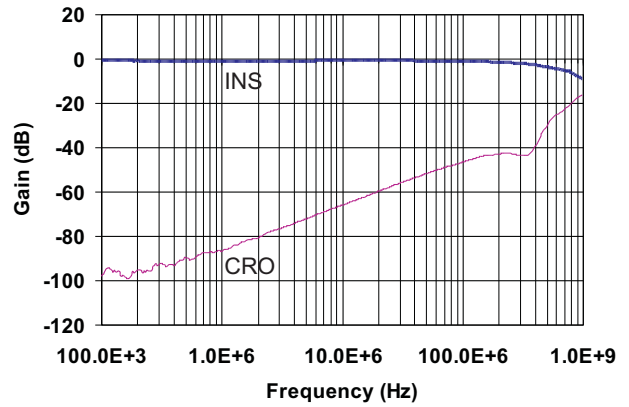


Figure 4. OFF Isolation vs Crosstalk (V<sub>+</sub> = 3 V)

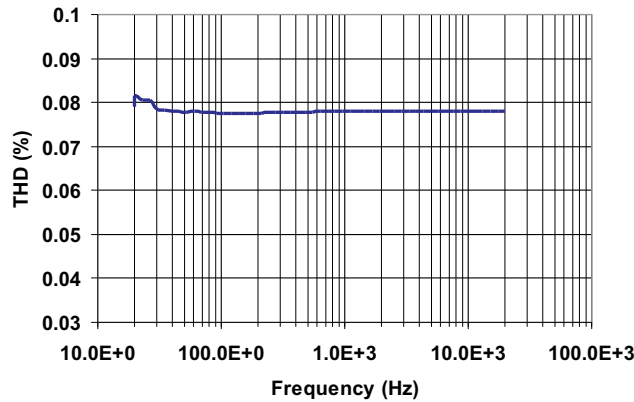


Figure 5. Total Harmonic Distortion vs Frequency

**PIN DESCRIPTION**

PIN NO.	NAME	DESCRIPTION
1	IN	Digital control to connect COM to NO
2	V <sub>+</sub>	Power supply
3	GND	Digital ground
4	NC	Normally closed
5	COM	Common
6	NO	Normally open

**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 (COM to NO or COM to NC) in the ON state and the output (NC or NO) being open
I <sub>COM(PWROFF)</sub>	Leakage current measured at the COM port during the power-down condition, V <sub>+</sub> = 0
V <sub>IH</sub>	Minimum input voltage for logic high for the control input (IN)
V <sub>IL</sub>	Maximum input voltage for logic low for the control input (IN)
V <sub>I</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, or 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, or 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 coulomb (C) 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.

PARAMETER DESCRIPTION (continued)

SYMBOL	DESCRIPTION
$C_{NC(OFF)}$	Capacitance at the NC port when the corresponding channel (NC to COM) is OFF
$C_{NO(OFF)}$	Capacitance at the NO port when the corresponding channel (NO to COM) is OFF
$C_{NC(ON)}$	Capacitance at the NC port when the corresponding channel (NC to COM) is ON
$C_{NO(ON)}$	Capacitance at the NO port when the corresponding channel (NO to COM) is ON
$C_{COM(ON)}$	Capacitance at the COM port when the corresponding channel (COM to NC or COM to NO) is ON
$C_I$	Capacitance of control input (IN)
$O_{ISO}$	OFF isolation of the switch is a measurement 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.
$X_{TALK}$	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 in a specific frequency and in dB.
BW	Bandwidth of the switch. This is the frequency in which the gain of an ON channel is –3 dB below the DC gain.
THD	Total harmonic distortion describes the signal distortion caused by the analog switch. This is defined as the ratio or root mean square (RMS) value of the second, third, and higher harmonic to the absolute magnitude of the fundamental harmonic.
$I_+$	Static power-supply current with the control (IN) pin at $V_+$ or GND

PARAMETER MEASUREMENT INFORMATION

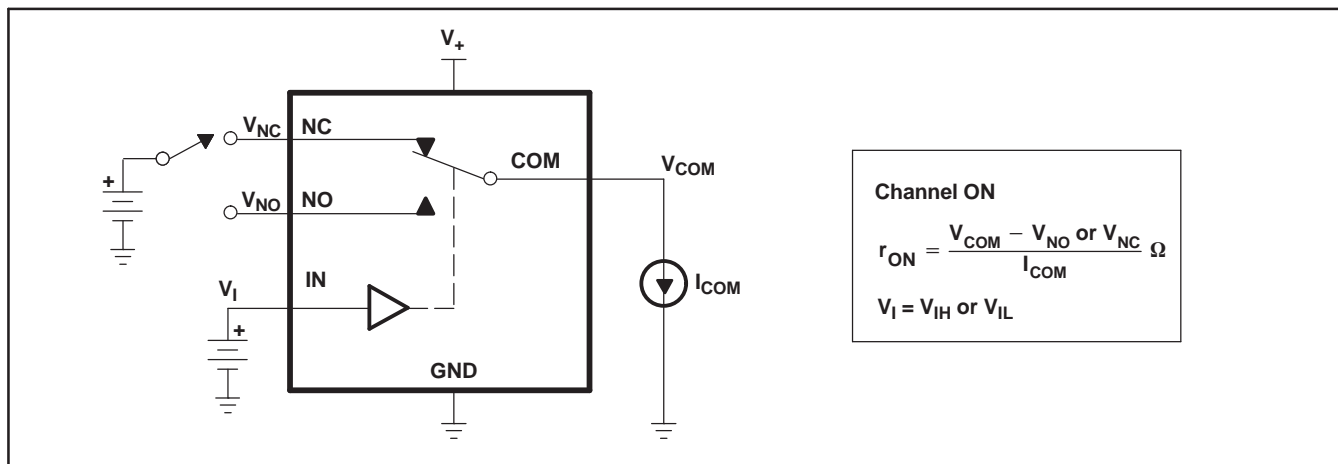


Figure 6. ON-State Resistance ( $r_{ON}$ )

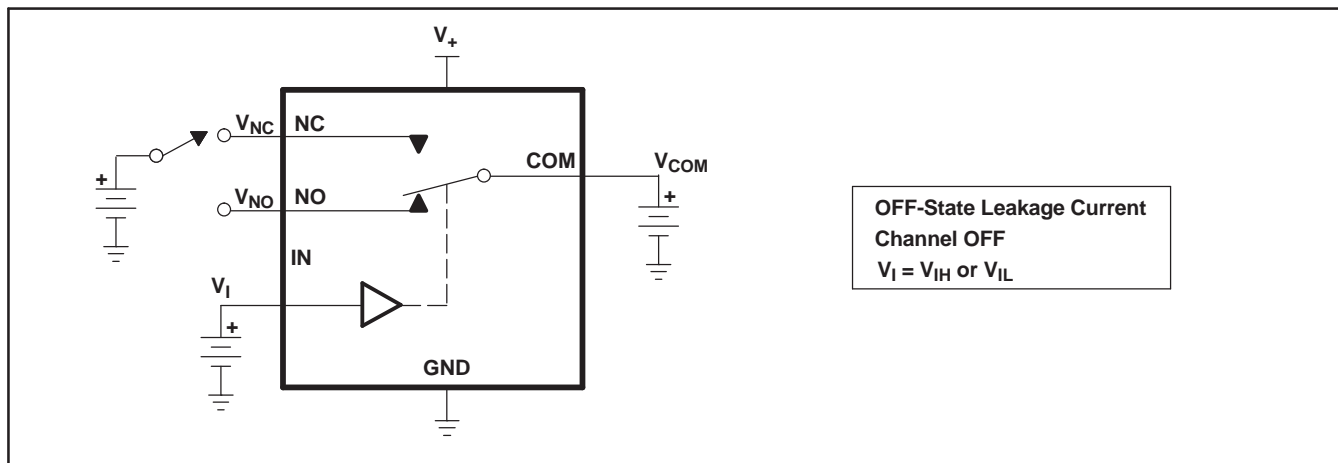


Figure 7. OFF-State Leakage Current ( $I_{NC(OFF)}$ ,  $I_{NC(PWROFF)}$ ,  $I_{NO(OFF)}$ ,  $I_{NO(PWROFF)}$ ,  $I_{COM(OFF)}$ ,  $I_{COM(PWROFF)}$ )

PARAMETER MEASUREMENT INFORMATION (continued)

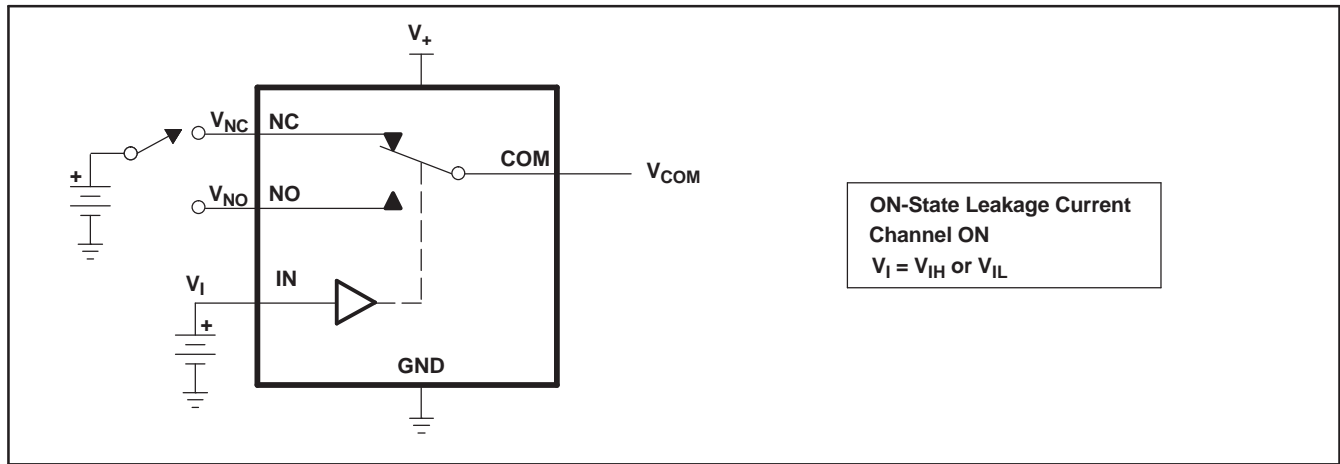


Figure 8. ON-State Leakage Current ( $I_{COM(ON)}$ ,  $I_{NC(ON)}$ ,  $I_{NO(ON)}$ )

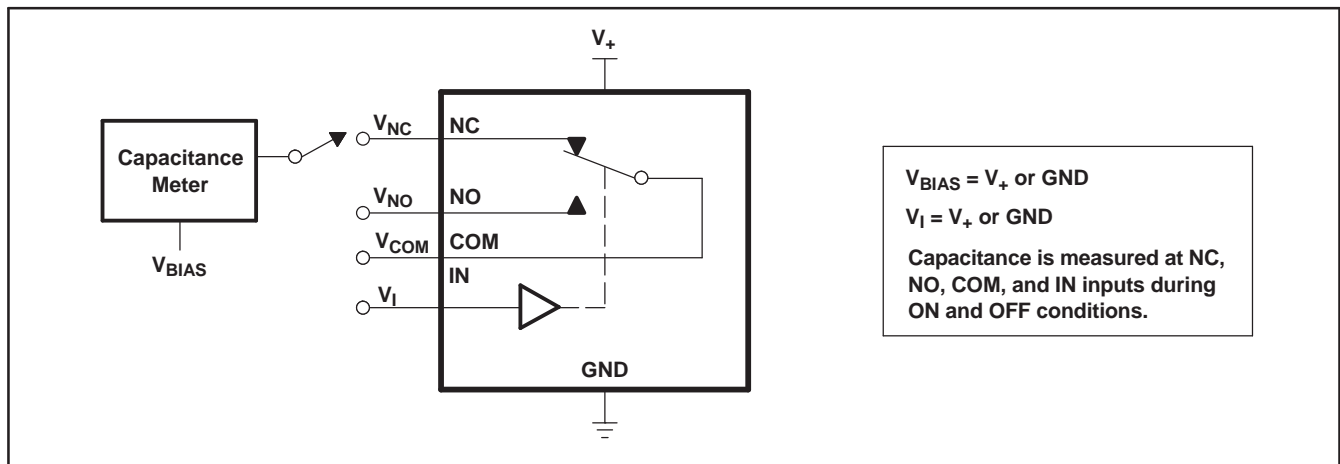
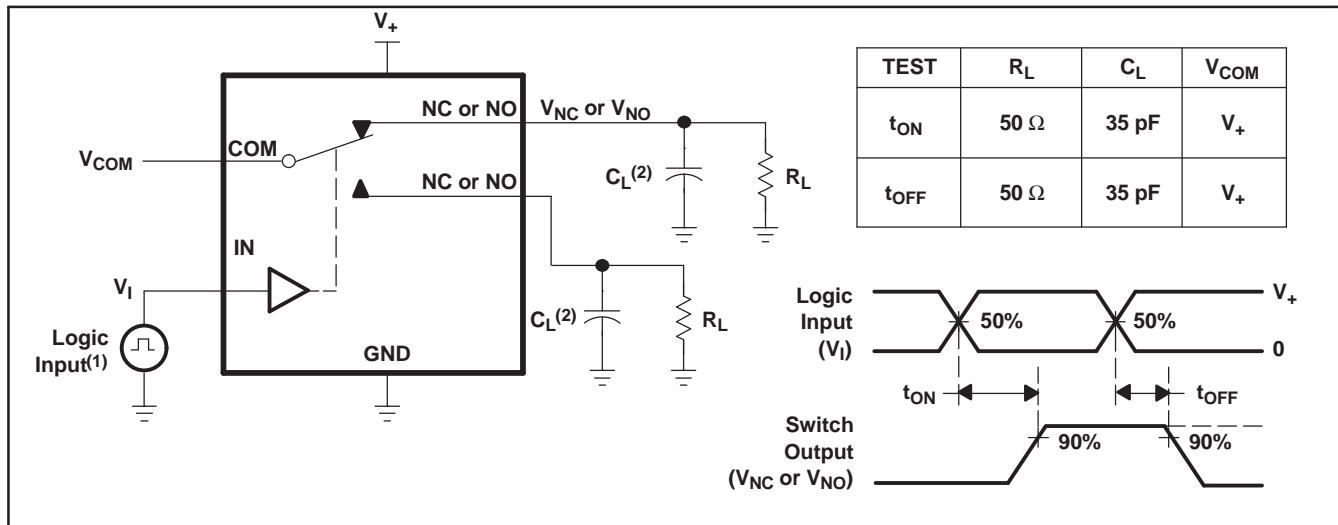
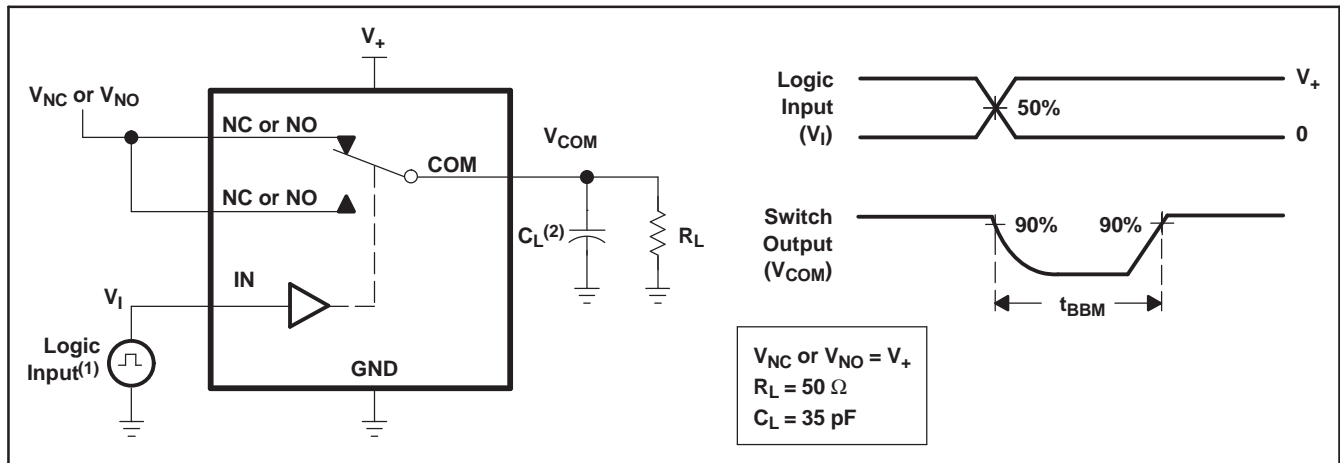


Figure 9. Capacitance ( $C_I$ ,  $C_{COM(ON)}$ ,  $C_{NC(OFF)}$ ,  $C_{NO(OFF)}$ ,  $C_{NC(ON)}$ ,  $C_{NO(ON)}$ )



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

**Figure 10. Turn-On ( $t_{ON}$ ) and Turn-Off Time ( $t_{OFF}$ )**



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

Figure 11. Break-Before-Make Time ( $t_{BBM}$ )

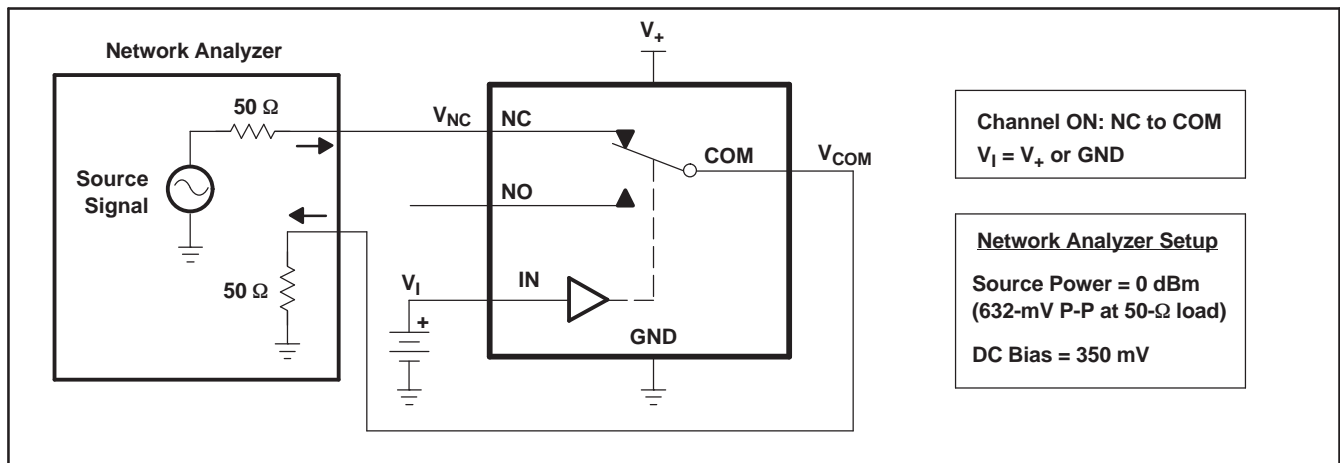


Figure 12. Bandwidth (BW)

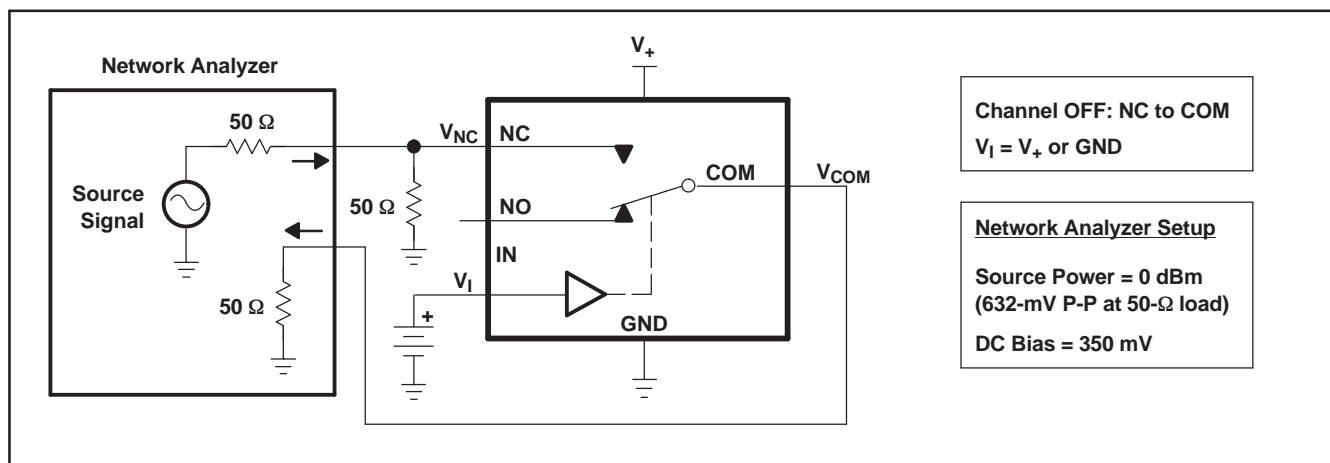


Figure 13. OFF Isolation ( $O_{ISO}$ )

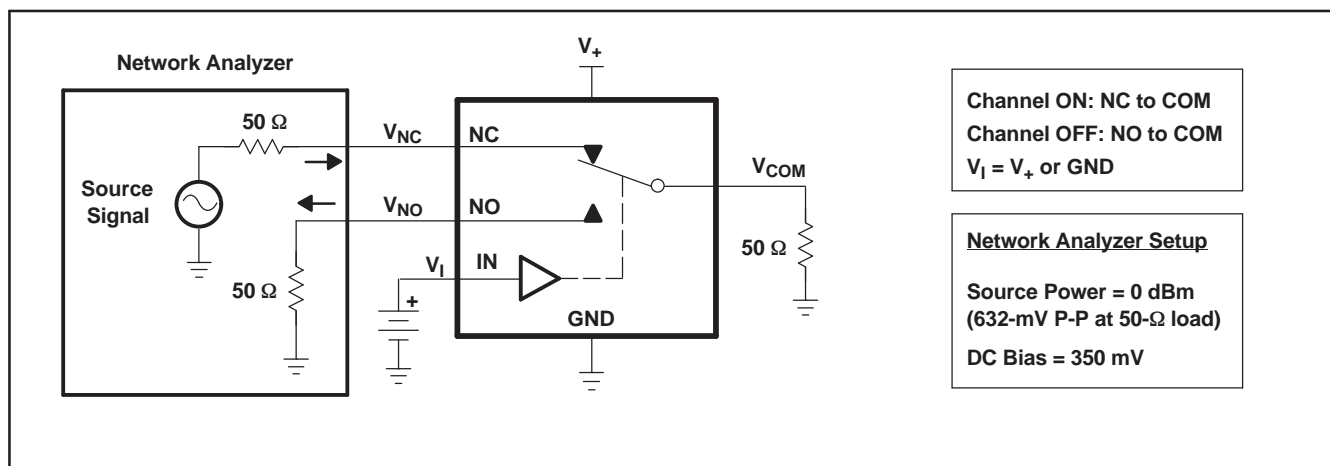
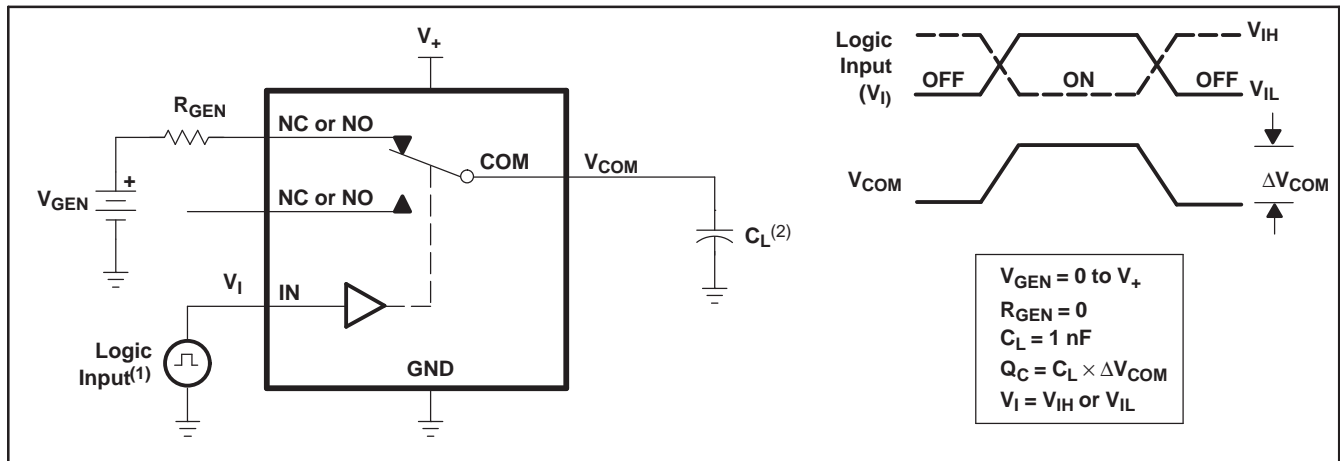
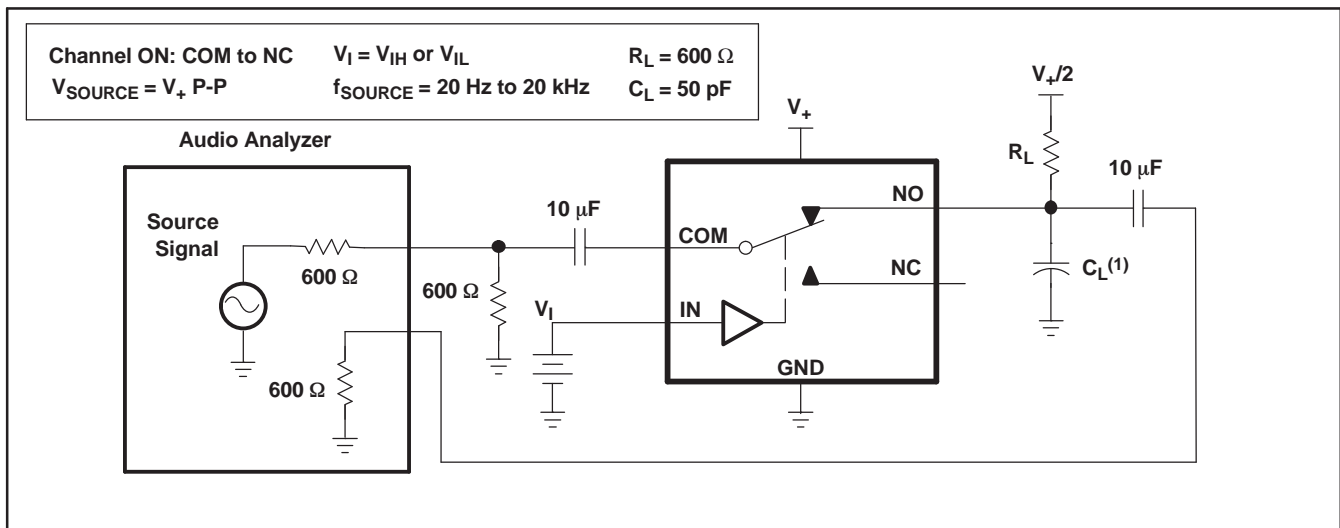


Figure 14. Crosstalk ( $X_{TALK}$ )



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

Figure 15. Charge Injection (Q<sub>C</sub>)



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

Figure 16. Total Harmonic Distortion (THD)



**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TS5A9411DCKR	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS5A9411DCKRG4	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS5A9411DCKT	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS5A9411DCKTG4	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

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

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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.

**TAPE AND REEL INFORMATION**



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



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TS5A9411DCKR	SC70	DCK	6	3000	180.0	9.2	2.24	2.34	1.22	4.0	8.0	Q3
TS5A9411DCKT	SC70	DCK	6	250	180.0	9.2	2.24	2.34	1.22	4.0	8.0	Q3

**TAPE AND REEL BOX DIMENSIONS**



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS5A9411DCKR	SC70	DCK	6	3000	202.0	201.0	28.0
TS5A9411DCKT	SC70	DCK	6	250	202.0	201.0	28.0

DCK (R-PDSO-G6)

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. Mold flash and protrusion shall not exceed 0.15 per side.
  - Falls within JEDEC MO-203 variation AB.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2008, Texas Instruments Incorporated