

# TS5A22364 0.65-Ω Dual SPDT Analog Switches With Negative Signaling Capability

## 1 Features

- Specified Break-Before-Make Switching
- Negative Signaling Capability: Maximum Swing from  $-2.75\text{ V}$  to  $2.75\text{ V}$  ( $V_{CC} = 2.75\text{ V}$ )
- Internal Shunt Switch Prevents Audible Click-and-Pop When Switching Between Two Sources
- Low ON-State Resistance ( $0.65\text{ }\Omega$  Typical)
- Low Charge Injection
- Excellent ON-State Resistance Matching
- 2.3-V to 5.5-V Power Supply ( $V_{CC}$ )
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance Tested Per JESD 22
  - 2500-V Human-Body Model (A114-B, Class II)
  - 1500-V Charged-Device Model (C101)
  - 200-V Machine Model (A115-A)

## 2 Applications

- Cell Phones
- PDA's
- Portable Instrumentation
- Audio Routing
- Medical Imaging

## 3 Description

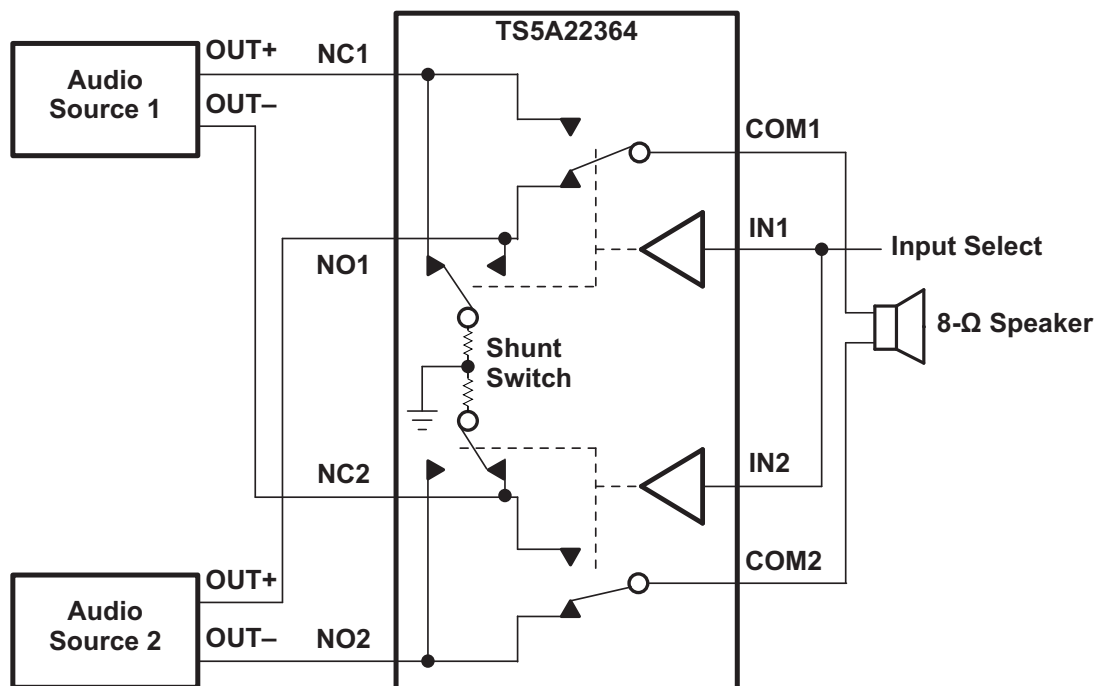
The TS5A22364 is a bidirectional, 2-channel, single-pole double-throw (SPDT) analog switch designed to operate from 2.3 V to 5.5 V. The device features negative signal capability that allows signals below ground to pass through the switch without distortion. Additionally, the TS5A22364 includes an internal shunt switch, which automatically discharges any capacitance at the NC or NO terminals when they are unconnected to COM. This reduces the audible click/pop noise when switching between two sources. The break-before-make feature prevents signal distortion during the transferring of a signal from one path to another. Low ON-state resistance, excellent channel-to-channel ON-state resistance matching, and minimal total harmonic distortion (THD) performance are ideal for audio applications. The 3.00-mm x 3.00-mm DRC package is also available as a nonmagnetic package for medical imaging applications.

### Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TS5A22364	VSON (10)	3.00 mm x 3.00 mm
	DSBGA (10)	1.90 mm x 1.40 mm
	VSSOP (10)	3.00 mm x 3.00 mm

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

### Typical Application Schematic



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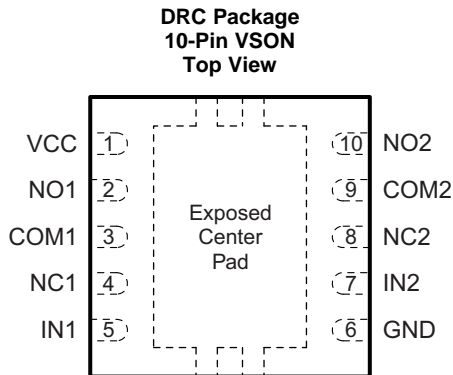
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## 4 Revision History

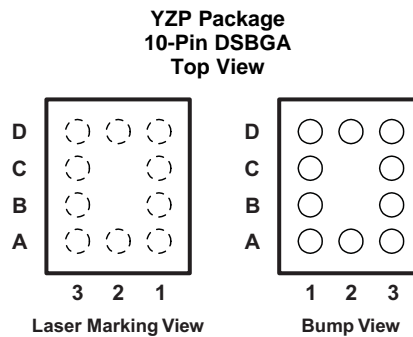
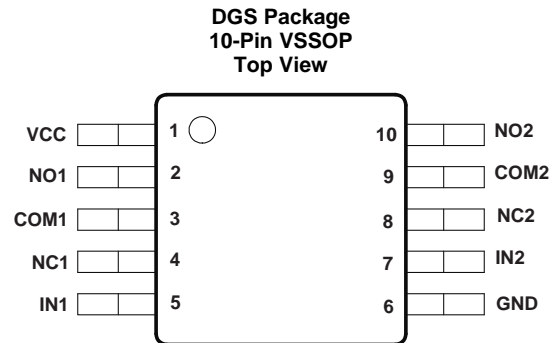
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<b>Changes from Revision G (September 2015) to Revision H</b> .....	<b>Page</b>
• Changed the $V_{IN}$ MAX value From: $V_{CC}$ To: 5.5 V in the <i>Recommended Operating Conditions</i> table .....	<b>4</b>
<b>Changes from Revision F (June 2015) to Revision G</b> .....	<b>Page</b>
• Changed $C_L$ TEST CONDITION value for all THD PARAMETERS from 15 pf to 35 pf. ....	<b>7</b>
<b>Changes from Revision E (May 2013) to Revision F</b> .....	<b>Page</b>
• Added <i>Pin Configuration and Functions</i> section, <i>ESD Ratings</i> table, <i>Recommended Operating Conditions</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section .....	<b>1</b>
• Split the TS5A22364 and TS5A22362 into separate datasheets and added verbiage to clarify the operation of the shunt resistor. ....	<b>1</b>
• Changed the max $R_{on}$ spec from 1.04 $\Omega$ to 1.30 $\Omega$ at 2.7 V $V_{CC}$ across full $T_A$ . ....	<b>5</b>
<b>Changes from Revision D (November 2011) to Revision E</b> .....	<b>Page</b>
• Added <i>Absolute Maximum Ratings</i> textnote.....	<b>4</b>
<b>Changes from Revision C (April 2010) to Revision D</b> .....	<b>Page</b>
• Added Medical Imaging to <i>Applications</i> .....	<b>1</b>

## 5 Pin Configuration and Functions



\*The exposed center pad, if used, must be connected as a secondary GND or left electrically open.



### Pin Functions

PIN			TYPE	DESCRIPTION
NAME	DRC / DGS	YZP		
VCC	1	A2	—	Power Supply
NO1	2	A3	I/O	Normally Open (NO) signal path, Switch 1
COM1	3	B3	I/O	Common signal path, Switch 1
NC1	4	C3	I/O	Normally Closed (NC) signal path, Switch 1
IN1	5	D3	I	Digital control pin to connect COM1 to NO1, Switch 1
GND	6	D2	—	Ground
IN2	7	D1	I	Digital control pin to connect COM2 to NO2, Switch 2
NC2	8	C1	I/O	Normally Closed (NC) signal path, Switch 2
COM2	9	B1	I/O	Common signal path, Switch 2
NO2	10	A1	I/O	Normally Open (NO) signal Path, Switch 2

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
$V_{CC}$	Supply voltage <sup>(3)</sup>	−0.5	6	V
$V_{NC}$ $V_{NO}$ $V_{COM}$	Analog voltage <sup>(3)</sup> <sup>(4)</sup> <sup>(5)</sup>	$V_{CC} - 6$	$V_{CC} + 0.5$	V
$I_{I/O}$	Analog port diode current $V_{NC}, V_{NO}, V_{COM} < 0$ or $V_{NC}, V_{NO}, V_{COM} > V_{CC}$	−50	50	mA
$I_{NC}$ $I_{NO}$ $I_{COM}$	ON-state switch current ON-state peak switch current <sup>(6)</sup>	−150 −300	150 300	mA
$I_{RSH}$	OFF-state switch Shunt Resistor current	−20	20	
$I_{NC}$ <sup>(3)</sup> <sup>(7)</sup> <sup>(8)</sup> $I_{NO}$ <sup>(3)</sup> <sup>(7)</sup> <sup>(8)</sup> $I_{COM}$ <sup>(3)</sup> <sup>(7)</sup> <sup>(8)</sup>	ON-state switch current ON-state peak switch current <sup>(6)</sup>	−350 −500	350 500	mA
$V_{IN}$	Digital input voltage range	−0.5	6.5	
$I_{IK}$	Digital input clamp current <sup>(3)</sup> <sup>(4)</sup> $V_I < 0$	−50	50	mA
$I_{CC}$ $I_{GND}$	Continuous current through $V_{CC}$ or GND	−100	100	mA
$T_{stg}$	Storage temperature	−65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.
- (3) All voltages are with respect to ground, unless otherwise specified.
- (4) 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.
- (7)  $V_{CC} = 3.0$  V to 5.0 V,  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .
- (8) For YZP package only.

### 6.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±2500
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±1500

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible with the necessary precautions.

### 6.3 Recommended Operating Conditions

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

		MIN	MAX	UNIT
$V_{CC}$	Supply voltage	2.3	5.5	V
$V_{NC}$ $V_{NO}$ $V_{COM}$	Signal path voltage	$V_{CC} - 5.5$	$V_{CC}$	V
$V_{IN}$	Digital control	GND	5.5	V

## 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		TS5A22364			UNIT
		DGS (VSSOP)	DRC (VSON)	YZP (DSBGA)	
		10 PINS	10 PINS	10 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	163.3	44.3	90.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	56.4	70.1	0.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	83.1	19.3	8.3	°C/W
$\psi_{JT}$	Junction-to-top characterization parameter	6.8	2.0	3.2	°C/W
$\psi_{JB}$	Junction-to-board characterization parameter	81.8	19.4	8.3	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	6.2	N/A	°C/W

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

## 6.5 Electrical Characteristics for 2.5-V Supply

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	V <sub>CC</sub>	MIN	TYP	MAX	UNIT
ANALOG SWITCH									
V <sub>COM</sub> , V <sub>NO</sub> , V <sub>NC</sub>	Analog signal range					V <sub>CC</sub> – 5.5		V <sub>CC</sub>	V
R <sub>on</sub>	ON-state resistance	V <sub>NC</sub> or V <sub>NO</sub> = V <sub>CC</sub> , 1.5 V, V <sub>CC</sub> – 5.5 V I <sub>COM</sub> = –100 mA,  COM to NO or NC, see <a href="#">Figure 13</a>	25°C	2.3 V	0.65	0.94	Ω		
			Full		1.3				
			25°C	2.7 V	0.65	0.94	Ω		
			Full		1.3				
ΔR <sub>on</sub>	ON-state resistance match between channels	V <sub>NC</sub> or V <sub>NO</sub> = 1.5 V, I <sub>COM</sub> = –100 mA,  COM to NO or NC, see <a href="#">Figure 13</a>	25°C	2.7 V	0.023	0.11	Ω		
			Full		0.15				
R <sub>on(flat)</sub>	ON-state resistance flatness	V <sub>NC</sub> or V <sub>NO</sub> = V <sub>CC</sub> , 1.5 V, V <sub>CC</sub> – 5.5 V I <sub>COM</sub> = –100 mA,  COM to NO or NC, see <a href="#">Figure 13</a>	25°C	2.7 V	0.18	0.46	Ω		
			Full		0.5				
R <sub>SH</sub>	Shunt switch resistance	I <sub>NO</sub> or I <sub>NC</sub> = 10 mA	Full	2.7 V	25	50	Ω		
I <sub>COM(ON)</sub>	COM ON leakage current	V <sub>NC</sub> and V <sub>NO</sub> = Floating, V <sub>COM</sub> = V <sub>CC</sub> , V <sub>CC</sub> – 5.5 V,  See <a href="#">Figure 15</a>	25°C	2.7 V	–50	50	nA		
			Full		–375	375			
DIGITAL CONTROL INPUTS (IN) <sup>(2)</sup>									
V <sub>IH</sub>	Input logic high		Full		1.4	5.5	V		
V <sub>IL</sub>	Input logic low				0.4				
I <sub>IH</sub> , I <sub>IL</sub>	Input leakage current	V <sub>IN</sub> = V <sub>CC</sub> or 0	25°C	2.7 V	–250	250	nA		
			Full		–250	250			

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

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

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

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

PARAMETER	TEST CONDITIONS	$T_A$	$V_{CC}$	MIN	TYP	MAX	UNIT
<b>DYNAMIC</b>							
$t_{ON}$ Turnon time	$V_{COM} = V_{CC}$ , $R_L = 300 \Omega$ , $C_L = 35 \text{ pF}$ , see <a href="#">Figure 17</a>	25°C	2.5 V		44	80	ns
		Full	2.3 V to 2.7 V			120	
$t_{OFF}$ Turnoff time	$V_{COM} = V_{CC}$ , $R_L = 300 \Omega$ , $C_L = 35 \text{ pF}$ , see <a href="#">Figure 17</a>	25°C	2.5 V		22	70	ns
		Full	2.3 V to 2.7 V			70	
$t_{BBM}$ Break-before-make time	See <a href="#">Figure 18</a>	25°C	2.5 V	1	7		ns
$Q_C$ Charge injection	$V_{GEN} = 0$ , $R_{GEN} = 0$ $C_L = 1 \text{ nF}$ , see <a href="#">Figure 22</a>	25°C	2.5 V		215		pC
$C_{COM(ON)}$ NC, NO, COM ON capacitance	$V_{COM} = V_{CC}$ or GND, Switch ON, $f = 10 \text{ MHz}$ See <a href="#">Figure 16</a>	25°C	2.5 V		370		pF
$C_I$ Digital input capacitance	$V_{IN} = V_{CC}$ or GND See <a href="#">Figure 16</a>	25°C	2.5 V		2.6		pF
BW Bandwidth	$R_L = 50 \Omega$ , -3 dB	25°C	2.5 V		17		MHz
$O_{ISO}$ OFF isolation	$R_L = 50 \Omega$ $f = 100 \text{ kHz}$ , see <a href="#">Figure 20</a>	25°C	2.5 V		-66		dB
$X_{TALK}$ Crosstalk	$R_L = 50 \Omega$ $f = 100 \text{ kHz}$ , see <a href="#">Figure 21</a>	25°C	2.5 V		-75		dB
THD Total harmonic distortion	$R_L = 600 \Omega$ , $C_L = 35 \text{ pF}$ , $f = 20 \text{ Hz to } 20 \text{ kHz}$ , see <a href="#">Figure 23</a>	25°C	2.5 V		0.01%		
<b>SUPPLY</b>							
$I_{CC}$ Positive supply current	$V_{COM}$ and $V_{IN} = V_{CC}$ or GND, $V_{NC}$ and $V_{NO} = \text{Floating}$	25°C	2.7 V		0.2	1.1	$\mu\text{A}$
		Full				1.3	
	$V_{COM} = V_{CC} - 5.5$ , $V_{IN} = V_{CC}$ or GND, $V_{NC}$ and $V_{NO} = \text{Floating}$	Full	2.7 V			3.3	$\mu\text{A}$

## 6.6 Electrical Characteristics for 3.3-V Supply

 $V_{CC} = 3 \text{ V to } 3.6 \text{ V}$ ,  $T_A = -40^\circ\text{C to } 85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	V <sub>CC</sub>	MIN	TYP	MAX	UNIT
ANALOG SWITCH									
V <sub>COM</sub> , V <sub>NO</sub> , V <sub>NC</sub>	Analog signal range					V <sub>CC</sub> – 5.5		V <sub>CC</sub>	V
R <sub>on</sub>	ON-state resistance	V <sub>NC</sub> or V <sub>NO</sub> ≤ V <sub>CC</sub> , 1.5 V, V <sub>CC</sub> – 5.5 V, I <sub>COM</sub> = –100 mA, COM to NO or NC, see <a href="#">Figure 13</a>	25°C	3 V	0.61	0.87	Ω		
			Full		0.97				
ΔR <sub>on</sub>	ON-state resistance match between channels	V <sub>NC</sub> or V <sub>NO</sub> = 1.5 V, I <sub>COM</sub> = –100 mA, COM to NO or NC, see <a href="#">Figure 13</a>	25°C	3 V	0.024	0.13	Ω		
			Full		0.13				
R <sub>on(flat)</sub>	ON-state resistance flatness	V <sub>NC</sub> or V <sub>NO</sub> ≤ V <sub>CC</sub> , 1.5 V, V <sub>CC</sub> – 5.5 V, I <sub>COM</sub> = –100 mA, COM to NO or NC, see <a href="#">Figure 13</a>	25°C	3 V	0.12	0.46	Ω		
			Full		0.5				
R <sub>SH</sub>	Shunt switch resistance	I <sub>NO</sub> or I <sub>NC</sub> = 10 mA	Full	3 V	25	37	Ω		
I <sub>COM(ON)</sub>	COM ON leakage current	V <sub>NC</sub> and V <sub>NO</sub> = Open, V <sub>COM</sub> = V <sub>CC</sub> , V <sub>CC</sub> – 5.5 V, COM to NO or NC, see <a href="#">Figure 15</a>	25°C	3.6 V	–50	50	nA		
			Full		–375	375			
DIGITAL CONTROL INPUTS (IN) <sup>(2)</sup>									
V <sub>IH</sub>	Input logic high		Full		1.4	5.5	V		
V <sub>IL</sub>	Input logic low				0.6				
I <sub>IH</sub> , I <sub>IL</sub>	Input leakage current	V <sub>IN</sub> = V <sub>CC</sub> or 0	25°C	3.6 V	–250	250	nA		
			Full		–250	250			

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

(2) All digital inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Floating digital inputs will cause excessive current consumption. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, [SCBA004](#).

## Electrical Characteristics for 3.3-V Supply (continued)

 $V_{CC} = 3\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

PARAMETER	TEST CONDITIONS	$T_A$	$V_{CC}$	MIN	TYP	MAX	UNIT
<b>DYNAMIC</b>							
$t_{ON}$ Turnon time	$V_{COM} = V_{CC}$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ , see Figure 17	25°C	3.3 V	34		80	ns
		Full	3 V to 3.6 V			120	
$t_{OFF}$ Turnoff time	$V_{COM} = V_{CC}$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ , see Figure 17	25°C	3.3 V	19		70	ns
		Full	3 V to 3.6 V			70	
$t_{BBM}$ Break-before-make time	See Figure 18	25°C	3.3 V	1	7		ns
$Q_C$ Charge injection	$V_{GEN} = 0$ , $R_{GEN} = 0$ , $C_L = 1\text{ nF}$ , see Figure 22	25°C	3.3 V	300			pC
$C_{COM(ON)}$ NC, NO, COM ON capacitance	$V_{COM} = V_{CC}$ or GND, $f = 10\text{ MHz}$ See Figure 16	25°C	3.3 V	370			pF
$C_I$ Digital input capacitance	$V_{IN} = V_{CC}$ or GND See Figure 16	25°C	3.3 V	2.6			pF
BW Bandwidth	$R_L = 50\ \Omega$ , -3 dB Switch ON,	25°C	3.3 V	17.5			MHz
$O_{ISO}$ OFF isolation	$R_L = 50\ \Omega$ , $f = 100\text{ kHz}$ , see Figure 20	25°C	3.3 V	-68			dB
$X_{TALK}$ Crosstalk	$R_L = 50\ \Omega$ , $f = 100\text{ kHz}$ , see Figure 21	25°C	3.3 V	-76			dB
THD Total harmonic distortion	$R_L = 600\ \Omega$ , $C_L = 35\text{ pF}$ , $f = 20\text{ Hz to }20\text{ kHz}$ , see Figure 23	25°C	3.3 V	0.008%			
<b>SUPPLY</b>							
$I_{CC}$ Positive supply current	$V_{COM}$ and $V_{IN} = V_{CC}$ or GND, $V_{NC}$ and $V_{NO} = \text{Floating}$	25°C	3.6 V	0.1	1.2		$\mu\text{A}$
		Full			1.3		
	$V_{COM} = V_{CC} - 5.5\text{ V}$ , $V_{IN} = V_{CC}$ or GND, $V_{NC}$ and $V_{NO} = \text{Floating}$	Full	3.6 V			3.4	$\mu\text{A}$

## 6.7 Electrical Characteristics for 5-V Supply

 $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

PARAMETER	TEST CONDITIONS	$T_A$	$V_{CC}$	MIN	TYP	MAX	UNIT
<b>ANALOG SWITCH</b>							
$V_{COM}$ , $V_{NO}$ , $V_{NC}$	Analog signal range			$V_{CC} - 5.5$		$V_{CC}$	V
$R_{on}$	ON-state resistance	$V_{NC}$ or $V_{NO} = V_{CC}$ , 1.6 V, $V_{CC} = -5.5\text{ V}$ , $I_{COM} = -100\text{ mA}$ , COM to NO or NC, see <a href="#">Figure 13</a>	25°C Full	4.5 V	0.52 0.83	0.74	$\Omega$
$\Delta R_{on}$	ON-state resistance match between channels	$V_{NC}$ or $V_{NO} = 1.6\text{ V}$ , $I_{COM} = -100\text{ mA}$ , COM to NO or NC, see <a href="#">Figure 13</a>	25°C Full	4.5 V	0.04 0.30	0.23	$\Omega$
$R_{on(flat)}$	ON-state resistance flatness	$V_{NC}$ or $V_{NO} = V_{CC}$ , 1.6 V, $V_{CC} = -5.5\text{ V}$ , $I_{COM} = -100\text{ mA}$ , COM to NO or NC, see <a href="#">Figure 13</a>	25°C Full	4.5 V	0.076 0.5	0.46	$\Omega$
$R_{SH}$	Shunt switch resistance	$I_{NO}$ or $I_{NC} = 10\text{ mA}$	Full	4.5 V	16	36	$\Omega$
$I_{COM(ON)}$	COM ON leakage current	$V_{NC}$ and $V_{NO} = \text{Open}$ , $V_{COM} = V_{CC}$ , $V_{CC} - 5.5\text{ V}$ , See <a href="#">Figure 15</a>	25°C Full	5.5 V	-50 -375	50 375	nA
<b>DIGITAL CONTROL INPUTS (IN) <sup>(2)</sup></b>							
$V_{IH}$	Input logic high		Full		2.4	5.5	V
$V_{IL}$	Input logic low					0.8	
$I_{IH}$ , $I_{IL}$	Input leakage current	$V_{IN} = V_{CC}$ or 0	25°C Full	5.5 V	-250 -250	250 250	nA
<b>DYNAMIC</b>							
$t_{ON}$	Turnon time	$V_{COM} = V_{CC}$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ , see <a href="#">Figure 17</a>	25°C Full	5 V 4.5 V to 5.5 V	27 80	80	ns
$t_{OFF}$	Turnoff time	$V_{COM} = V_{CC}$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ , see <a href="#">Figure 17</a>	25°C Full	5 V 4.5 V to 5.5 V	13 70	70	ns
$t_{BBM}$	Break-before-make time	$V_{NC} = V_{NO} = V_{CC}/2$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$	25°C	5 V	1	3.5	ns
$Q_C$	Charge injection	$V_{GEN} = 0$ , $R_{GEN} = 0$ , $C_L = 1\text{ nF}$ , see <a href="#">Figure 22</a>	25°C	5 V	500		pC
$C_{COM(ON)}$	NC, NO, COM ON capacitance	$V_{COM} = V_{CC}$ or GND, See <a href="#">Figure 16</a>	25°C	5 V	370		pF
$C_I$	Digital input capacitance	$V_{IN} = V_{CC}$ or GND See <a href="#">Figure 16</a>	25°C	5 V	2.6		pF
BW	Bandwidth	$R_L = 50\ \Omega$	25°C	5 V	18.3		MHz
$O_{ISO}$	OFF isolation	$R_L = 50\ \Omega$ , $f = 100\text{ kHz}$ , see <a href="#">Figure 20</a>	25°C	5 V	-70		dB
$X_{TALK}$	Crosstalk	$R_L = 50\ \Omega$ , $f = 100\text{ kHz}$ , see <a href="#">Figure 21</a>	25°C	5 V	-78		dB
THD	Total harmonic distortion	$R_L = 600\ \Omega$ , $C_L = 35\text{ pF}$ , $f = 20\text{ Hz to }20\text{ kHz}$ , see <a href="#">Figure 23</a>	25°C	5 V	0.009%		
<b>SUPPLY</b>							
$I_{CC}$	Positive supply current	$V_{COM}$ and $V_{IN} = V_{CC}$ or GND, $V_{NC}$ and $V_{NO} = \text{Floating}$	25°C Full		0.2 3.5	1.3	$\mu\text{A}$
		$V_{COM} = V_{CC} - 5.5$ , $V_{IN} = V_{CC}$ or GND, $V_{NC}$ and $V_{NO} = \text{Floating}$	Full	5.5 V		5	

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

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



## 6.8 Typical Characteristics

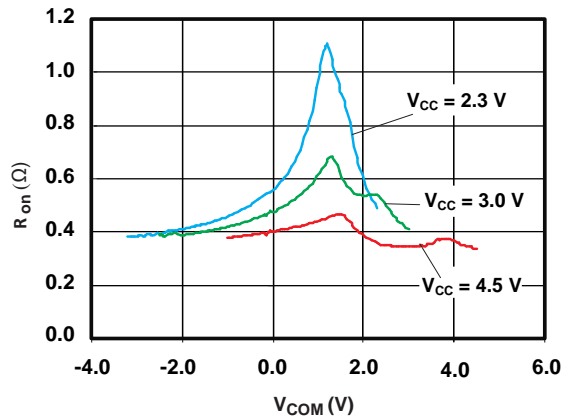


Figure 1.  $R_{on}$  vs  $V_{COM}$

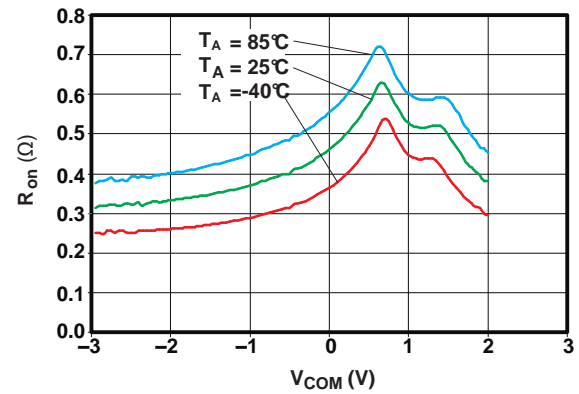


Figure 2.  $R_{on}$  vs  $V_{COM}$  ( $V_{CC} = 2.7$  V)

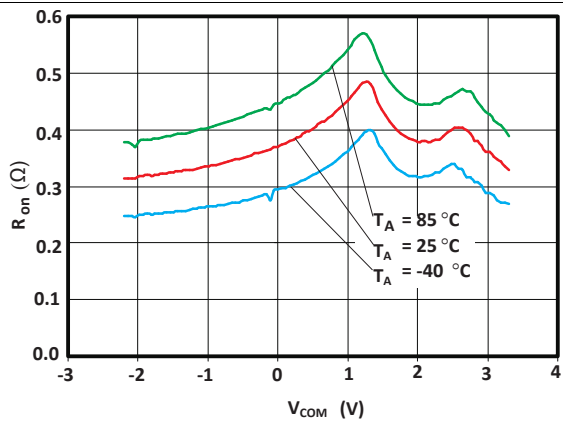


Figure 3.  $R_{on}$  vs  $V_{COM}$  ( $V_{CC} = 3.3$  V)

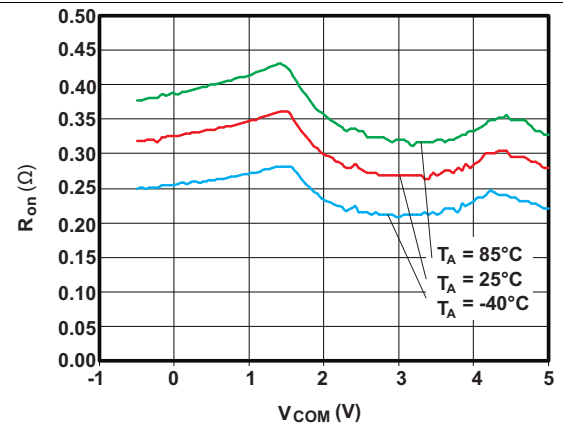


Figure 4.  $R_{on}$  vs  $V_{COM}$  ( $V_{CC} = 5$  V)

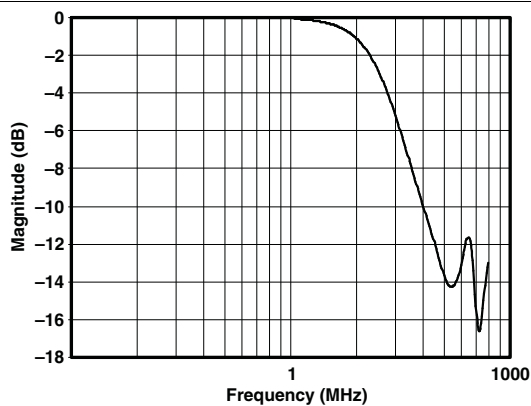


Figure 5. Insertion Loss

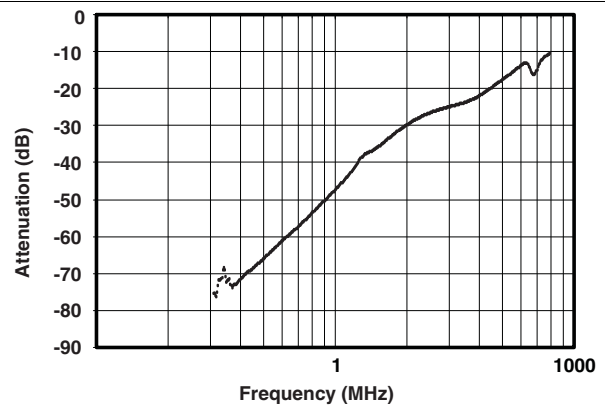


Figure 6. Off Isolation vs Frequency

## Typical Characteristics (continued)

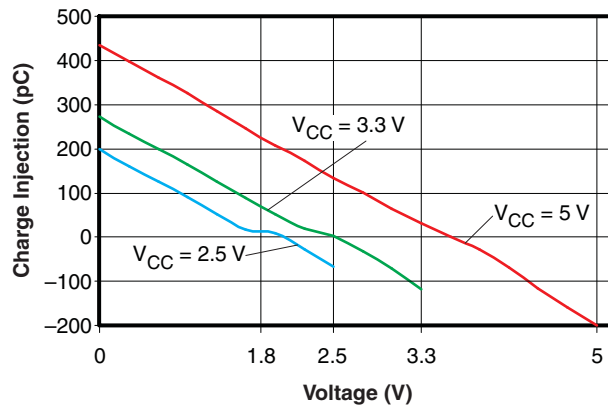


Figure 7. Charge Injection ( $Q_C$ ) vs  $V_{COM}$

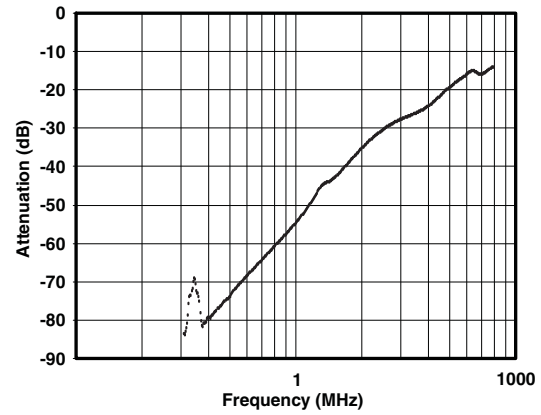


Figure 8. Crosstalk ( $V_{CC} = 3.3\text{ V}$ )

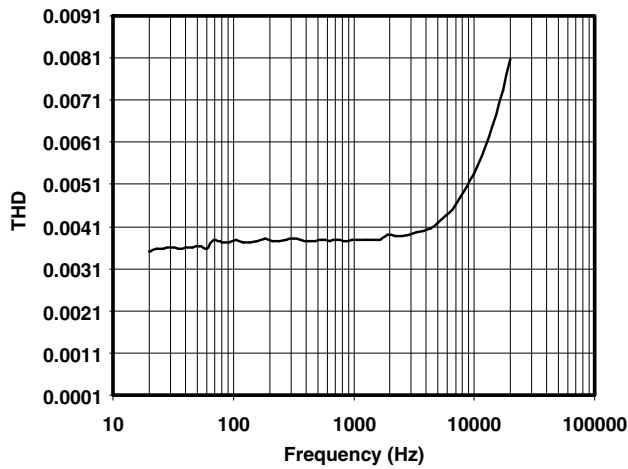


Figure 9. Total Harmonic Distortion vs Frequency

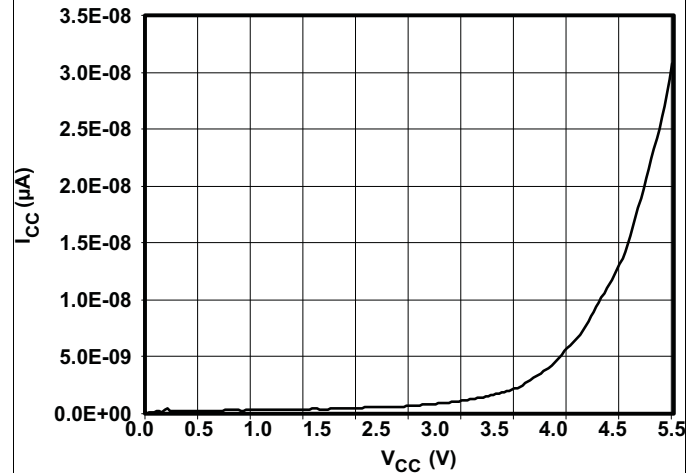


Figure 10. Power-Supply Current vs  $V_{CC}$

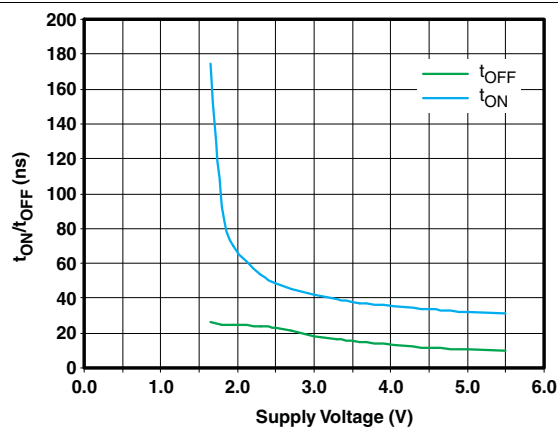


Figure 11.  $T_{ON}$  and  $T_{OFF}$  vs Supply Voltage

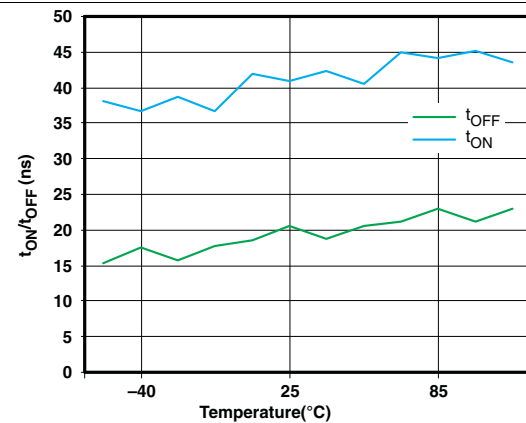
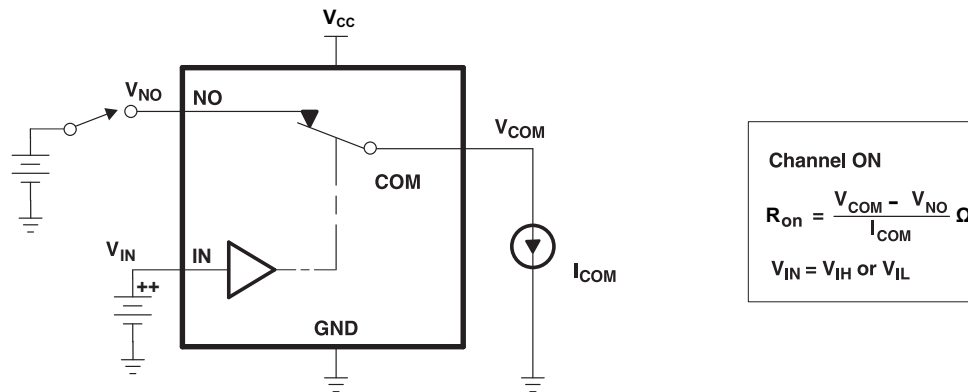
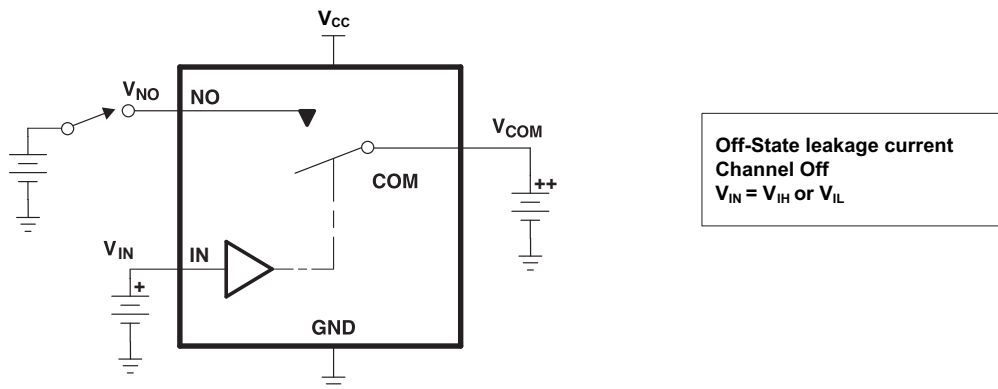


Figure 12.  $T_{ON}$  and  $T_{OFF}$  vs Temperature (2.5-V Supply)

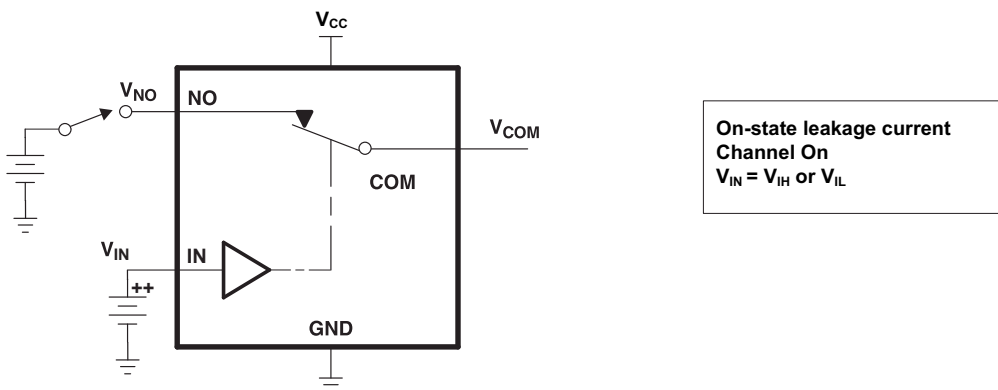
## 7 Parameter Measurement Information



**Figure 13. ON-State Resistance ( $R_{on}$ )**

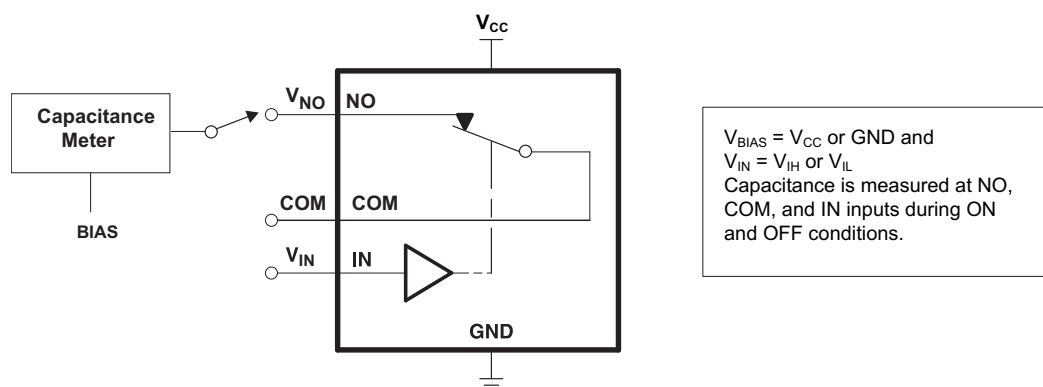


**Figure 14. OFF-State Leakage Current ( $I_{COM(OFF)}$ ,  $I_{NO(OFF)}$ )**

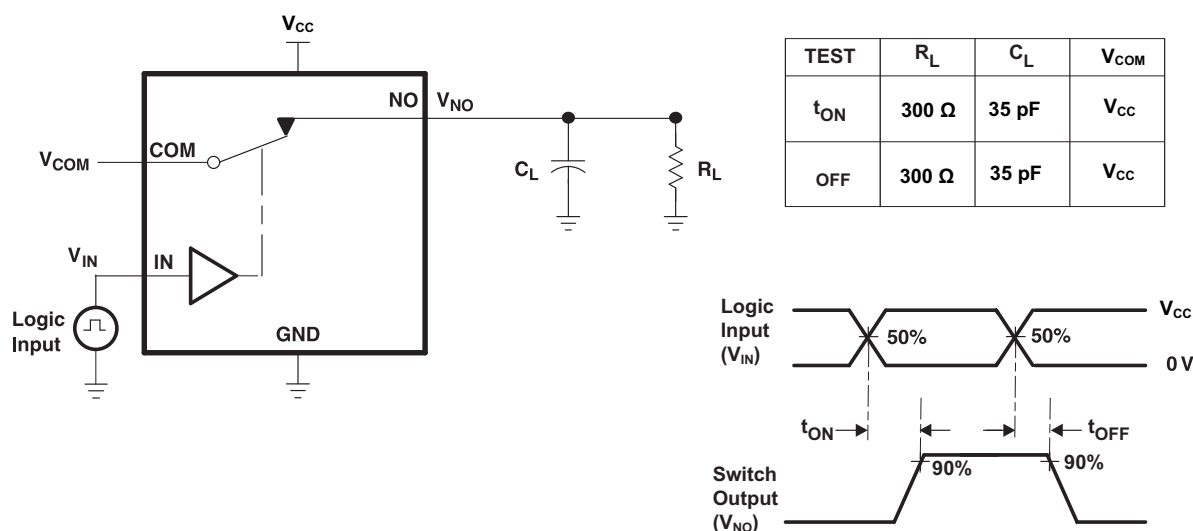


**Figure 15. ON-State Leakage Current  
( $I_{COM(ON)}$ ,  $I_{NO(ON)}$ )**

## Parameter Measurement Information (continued)



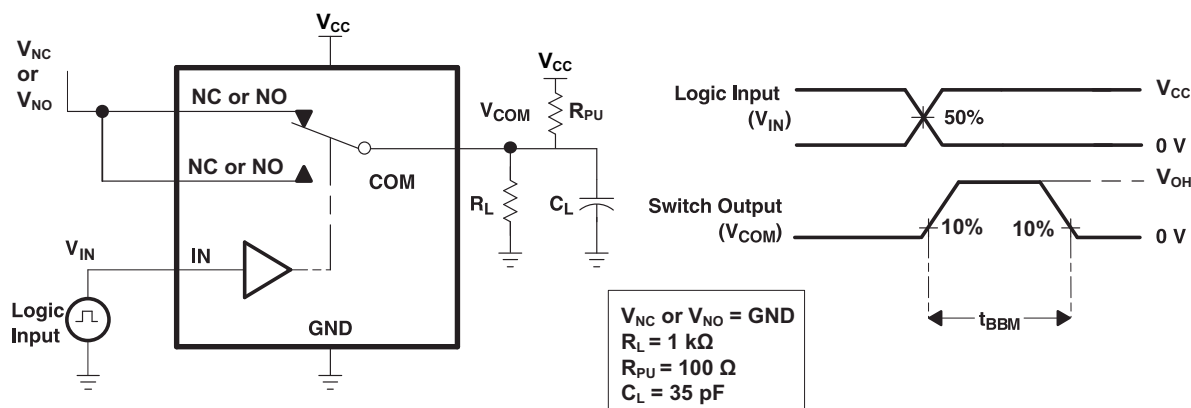
**Figure 16. Capacitance**  
( $C_I$ ,  $C_{COM(OFF)}$ ,  $C_{COM(ON)}$ ,  $C_{NO(OFF)}$ ,  $C_{NO(ON)}$ )



- 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 17. Turnon ( $t_{ON}$ ) and Turnoff Time ( $t_{OFF}$ )**

## Parameter Measurement Information (continued)



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

Figure 18. Break-Before-Make Time ( $t_{BBM}$ )

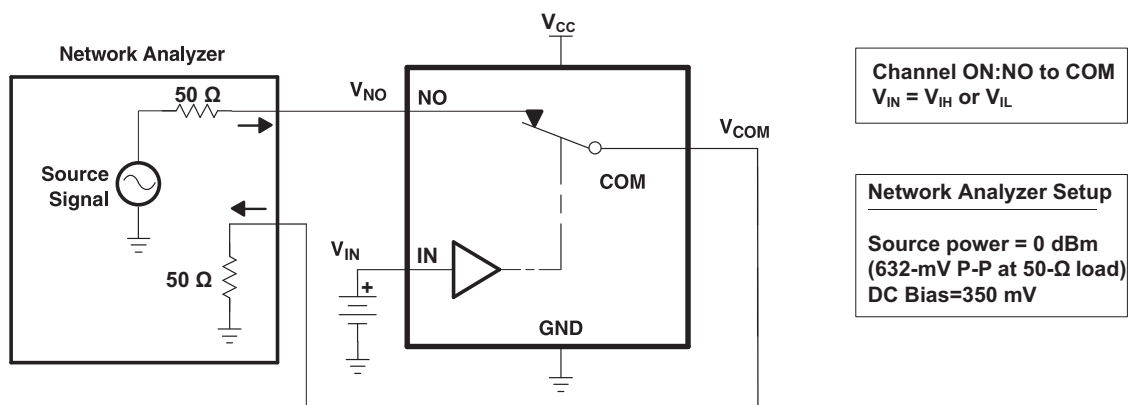


Figure 19. Bandwidth (BW)

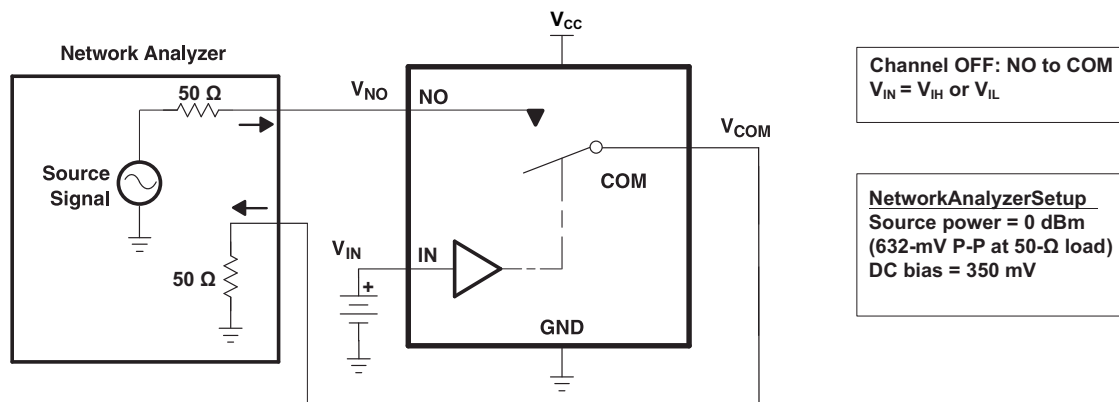
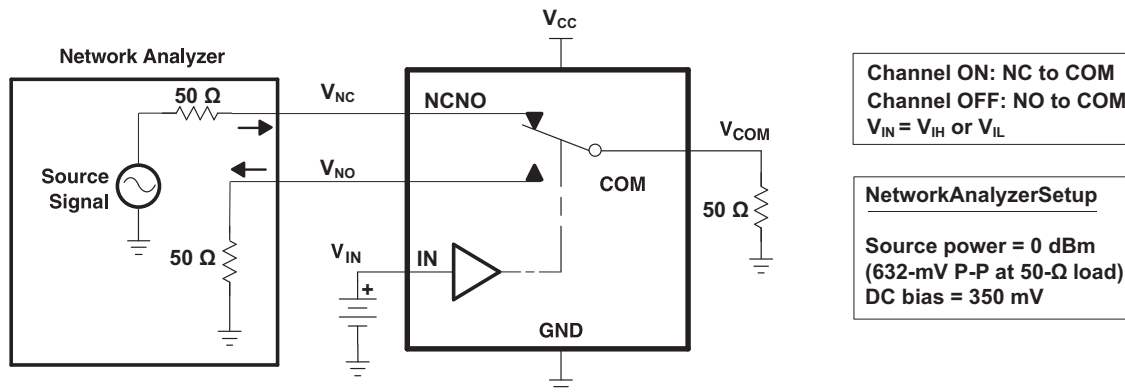
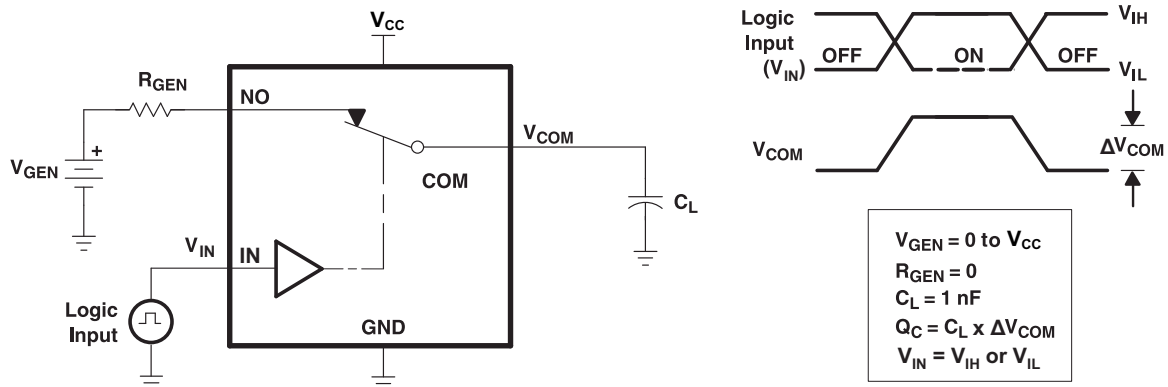


Figure 20. OFF Isolation ( $O_{ISO}$ )

## Parameter Measurement Information (continued)

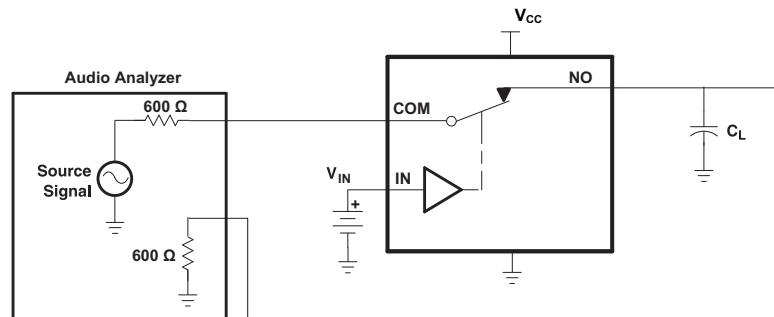
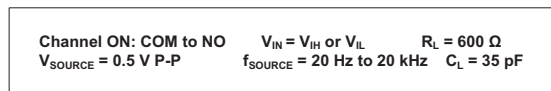


**Figure 21. Crosstalk ( $X_{TALK}$ )**



- 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 22. Charge Injection ( $Q_C$ )**



$C_L$  includes probe and jig capacitance.

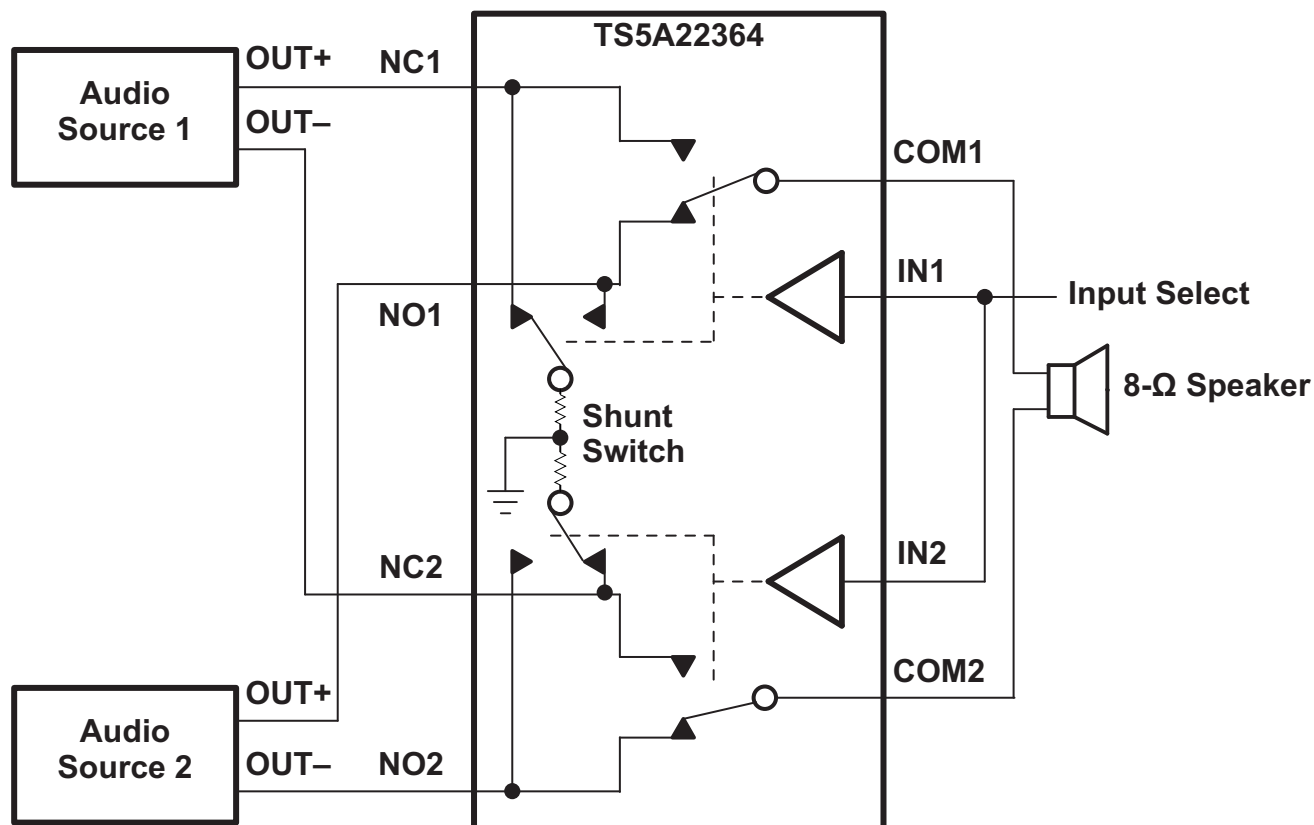
**Figure 23. Total Harmonic Distortion (THD)**

## 8 Detailed Description

### 8.1 Overview

The TS5A22364 is a bidirectional 2-channel, single-pole, double-throw (SPDT) analog switch designed to operate from 2.3-V to 5.5-V power supply. The device features negative signal swing capability that allows signals below ground to pass through the switch without distortion. Additionally, the TS5A22364 includes an internal shunt switch, which automatically discharges any capacitance at the NC or NO terminals when they are not connected to COM. Discharging the capacitance reduces the audible click and pop noise when switching between two sources. The break-before-make feature prevents signal distortion during the transferring of a signal from one path to another. Low ON-state resistance, excellent channel-to-channel ON-state resistance matching, and minimal total harmonic distortion (THD) performance are ideal for audio applications.

### 8.2 Functional Block Diagram



## 8.3 Feature Description

### 8.3.1 Click and Pop Reduction

The shunt resistors in the TS5A22364 automatically discharge any capacitance at the NC or NO terminals when they are not connected to COM. This reduces the audible click-and-pop sounds that occur when switching between audio sources. Audible clicks and pops are caused when a step DC voltage is switched into the speaker. By automatically discharging the side that is not connected, any residual DC voltage is removed, thereby reducing the clicks and pops.

### 8.3.2 Negative Signal Swing Capability

The TS5A22364 2-channel SPDT switch features negative signal capability that allows signals below ground to pass through without distortion. These analog switches operate from a single 2.3-V to 5.5-V supply. The input and output signal swing of the device is dependant of the supply voltage  $V_{CC}$ . The device passes signals as high as  $V_{CC}$  and as low as  $V_{CC} - 5.5\text{ V}$ , including signals below ground with minimal distortion. The OFF state signal path (either NC or NO) during the operation of TS5A22364 cannot handle negative DC voltage

Table 1 shows the input/output signal swing the user can get with different supply voltages.

**Table 1. Input/Output Signal Swing**

SUPPLY VOLTAGE, $V_{CC}$	MINIMUM $V_{NC}, V_{NO}, V_{COM} = V_{CC} - 5.5\text{ V}$	MAXIMUM $V_{NC}, V_{NO}, V_{COM} = V_{CC}$
	ON-STATE SIGNAL PATH	
5.5 V	0 V	5.5 V
4.5 V	–1.0 V	4.5 V
3.6 V	–1.9 V	3.6 V
3.0 V	–2.5 V	3.0 V
2.7 V	–2.8 V	2.7 V
2.3 V	–3.2 V	2.3 V

## 8.4 Device Functional Modes

The function table for TS5A22364 is shown in Table 2.

**Table 2. Function Table**

IN	NC TO COM, COM TO NC	NO TO COM, 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 shunt resistors on the TS5A22364 automatically discharge any capacitance at the NC or NO terminals when they are not connected to COM. This reduces audible click-and-pop sounds that occur when switching between audio sources. Audible clicks and pops are caused when a step DC voltage is switched into the speaker. By automatically discharging the side that is not connected, any residual DC voltage is removed, thereby reducing the clicks and pops.

### 9.2 Typical Application

The shunt resistors on the TS5A22364 are designed to automatically discharge any residual charge at the NC or NO terminals when they are not connected to COM. This reduces audible click-and-pop sounds that occur when switching between audio sources. Audible clicks and pops are caused when a step DC voltage is switched into the speaker. By automatically discharging the side that is not used for the signal path, any residual charge voltage is discharged to ground, thereby reducing the clicks and pops. The amount of power that the shunt switch can discharge from the inactive signal path is limited by the shunt resistors ( $R_{sh}$ ) power dissipation. TI recommends that during operation, the current through the shunt path should be limited to  $\pm 10$  mA.

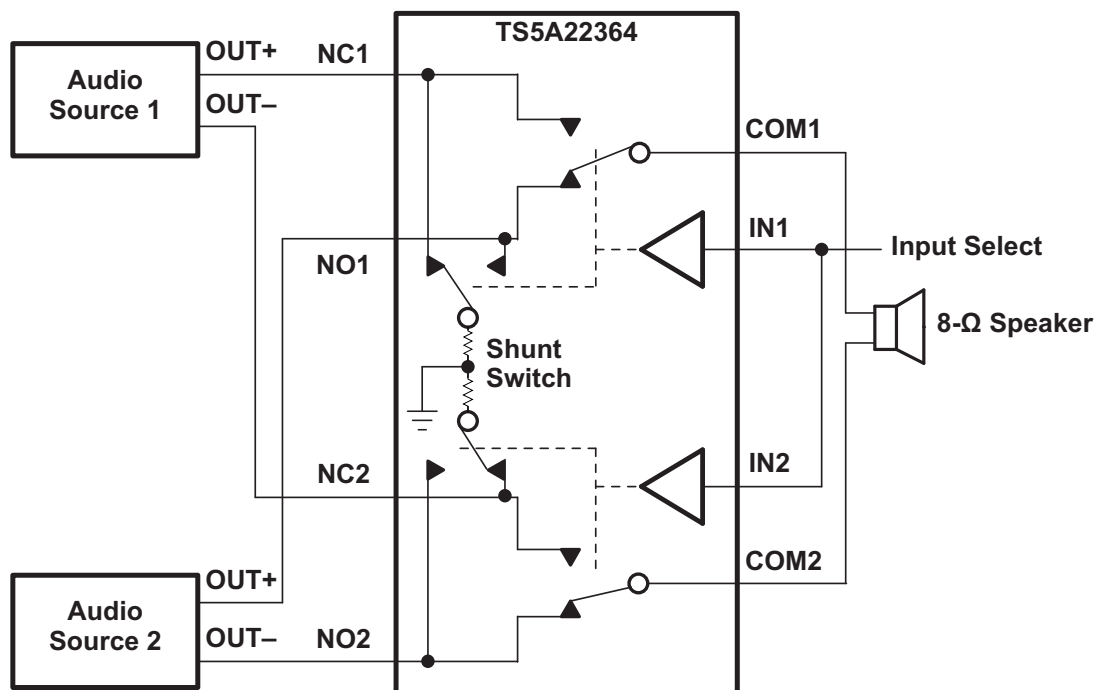


Figure 24. Shunt Switch (TS5A22364)

## Typical Application (continued)

### 9.2.1 Design Requirements

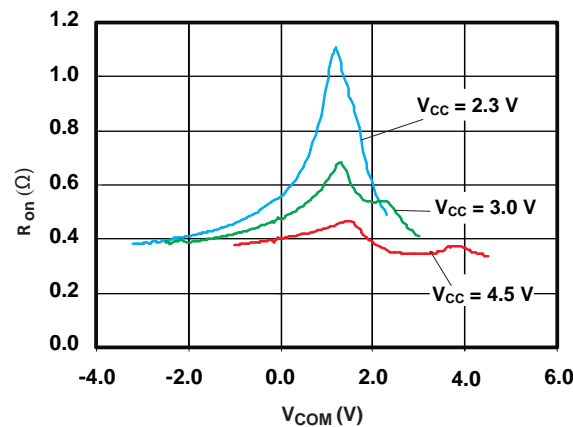
Tie the digitally controlled inputs select pins IN1 and IN2 to  $V_{CC}$  or GND to avoid unwanted switch states and high current consumption that could result if the logic control pins are left floating.

### 9.2.2 Detailed Design Procedure

Select the appropriate supply voltage to cover the entire voltage swing of the signal passing through the switch because the TS5A22364 operates from a single 2.3-V to 5.5-V supply and the input and output signal swing of the device is dependant of the supply voltage,  $V_{CC}$ . The device will pass signals as high as  $V_{CC}$  and as low as  $V_{CC} - 5.5$  V. Use [Table 1](#) as a guide for selecting supply voltage based on the signal passing through the ON-state switch path.

Ensure that the device is powered up with a valid supply voltage on VCC before a voltage can be applied to the signal paths NC and NO.

### 9.2.3 Application Curve



**Figure 25.  $R_{on}$  vs  $V_{COM}$**

## 10 Power Supply Recommendations

The TS5A22364 operates from a single 2.3-V to 5.5-V supply. The device must be powered up with a supply voltage on VCC before a voltage can be applied to the signal paths NC and NO. TI recommends to include a 100- $\mu$ s delay after VCC is at voltage before applying a signal on NC and NO paths

It is also good practice to place a 0.1- $\mu$ F bypass capacitor on the supply pin VCC to GND to smooth out lower frequency noise to provide better load regulation across the frequency spectrum.

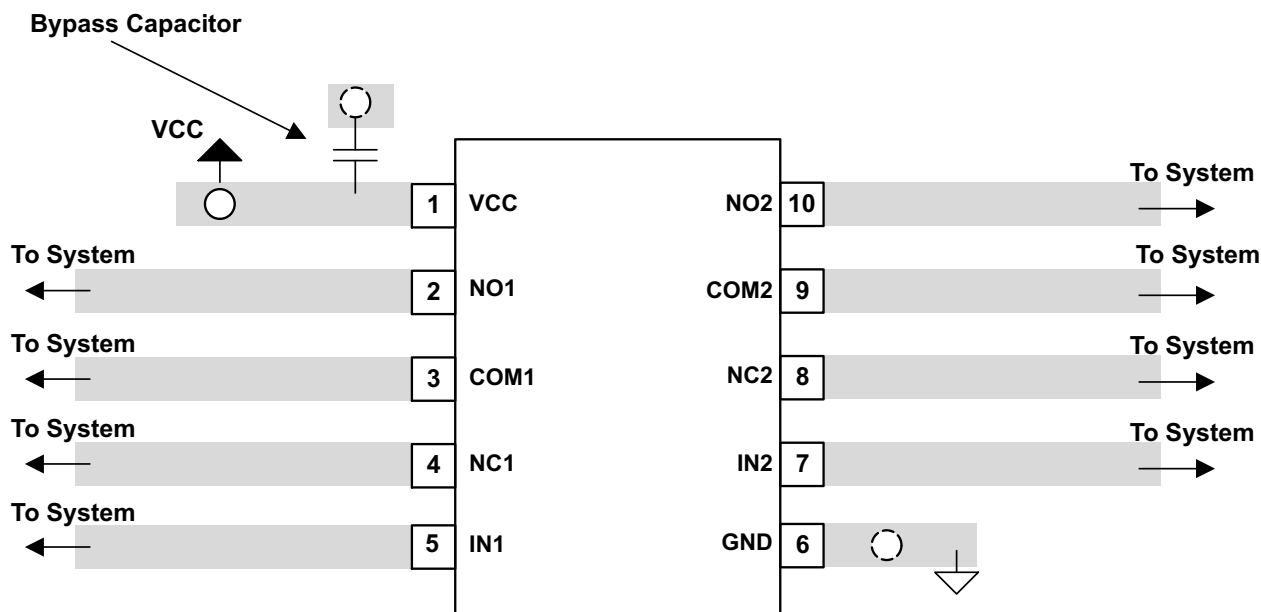
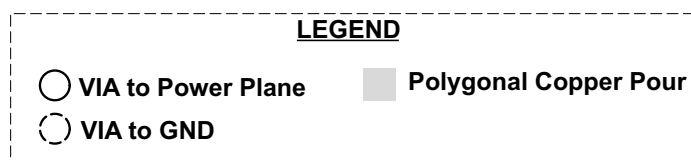
## 11 Layout

### 11.1 Layout Guidelines

TI recommends placing a bypass capacitor as close to the supply pin VCC as possible to help smooth out lower frequency noise to provide better load regulation across the frequency spectrum.

Minimize trace lengths and vias on the signal paths in order to preserve signal integrity.

### 11.2 Layout Example



## 12 Device and Documentation Support

### 12.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

### 12.2 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, 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.

### 12.3 Trademarks

E2E is a trademark of Texas Instruments.  
All other trademarks are the property of their respective owners.

### 12.4 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.

### 12.5 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 (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">TS5A22364DGSR</a>	Active	Production	VSSOP (DGS)   10	2500   LARGE T&R	Yes	NIPDAU   SN	Level-1-260C-UNLIM	-40 to 85	(38Q, 38R)
TS5A22364DGSR.B	Active	Production	VSSOP (DGS)   10	2500   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	(38Q, 38R)
TS5A22364DGSRG4	Active	Production	VSSOP (DGS)   10	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	38R
TS5A22364DGSRG4.B	Active	Production	VSSOP (DGS)   10	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	38R
<a href="#">TS5A22364DRCR</a>	Active	Production	VSON (DRC)   10	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZVF
TS5A22364DRCR.B	Active	Production	VSON (DRC)   10	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZVF
TS5A22364DRCRG4	Active	Production	VSON (DRC)   10	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZVF
TS5A22364DRCRG4.B	Active	Production	VSON (DRC)   10	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZVF
<a href="#">TS5A22364YZPR</a>	Active	Production	DSBGA (YZP)   10	3000   LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	(38, 382)
TS5A22364YZPR.B	Active	Production	DSBGA (YZP)   10	3000   LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	(38, 382)

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

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

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

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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

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

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

**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.

**OTHER QUALIFIED VERSIONS OF TS5A22364 :**

- Automotive : [TS5A22364-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
TS5A22364DGSR	VSSOP	DGS	10	2500	330.0	12.4	5.25	3.35	1.25	8.0	12.0	Q1
TS5A22364DGSRG4	VSSOP	DGS	10	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
TS5A22364DRCR	VSON	DRC	10	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TS5A22364DRCRG4	VSON	DRC	10	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TS5A22364YZPR	DSBGA	YZP	10	3000	178.0	9.2	1.49	1.99	0.63	4.0	8.0	Q2

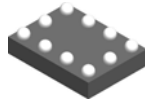
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS5A22364DGSR	VSSOP	DGS	10	2500	366.0	364.0	50.0
TS5A22364DGSRG4	VSSOP	DGS	10	2500	358.0	335.0	35.0
TS5A22364DRCR	VSON	DRC	10	3000	353.0	353.0	32.0
TS5A22364DRCRG4	VSON	DRC	10	3000	353.0	353.0	32.0
TS5A22364YZPR	DSBGA	YZP	10	3000	220.0	220.0	35.0



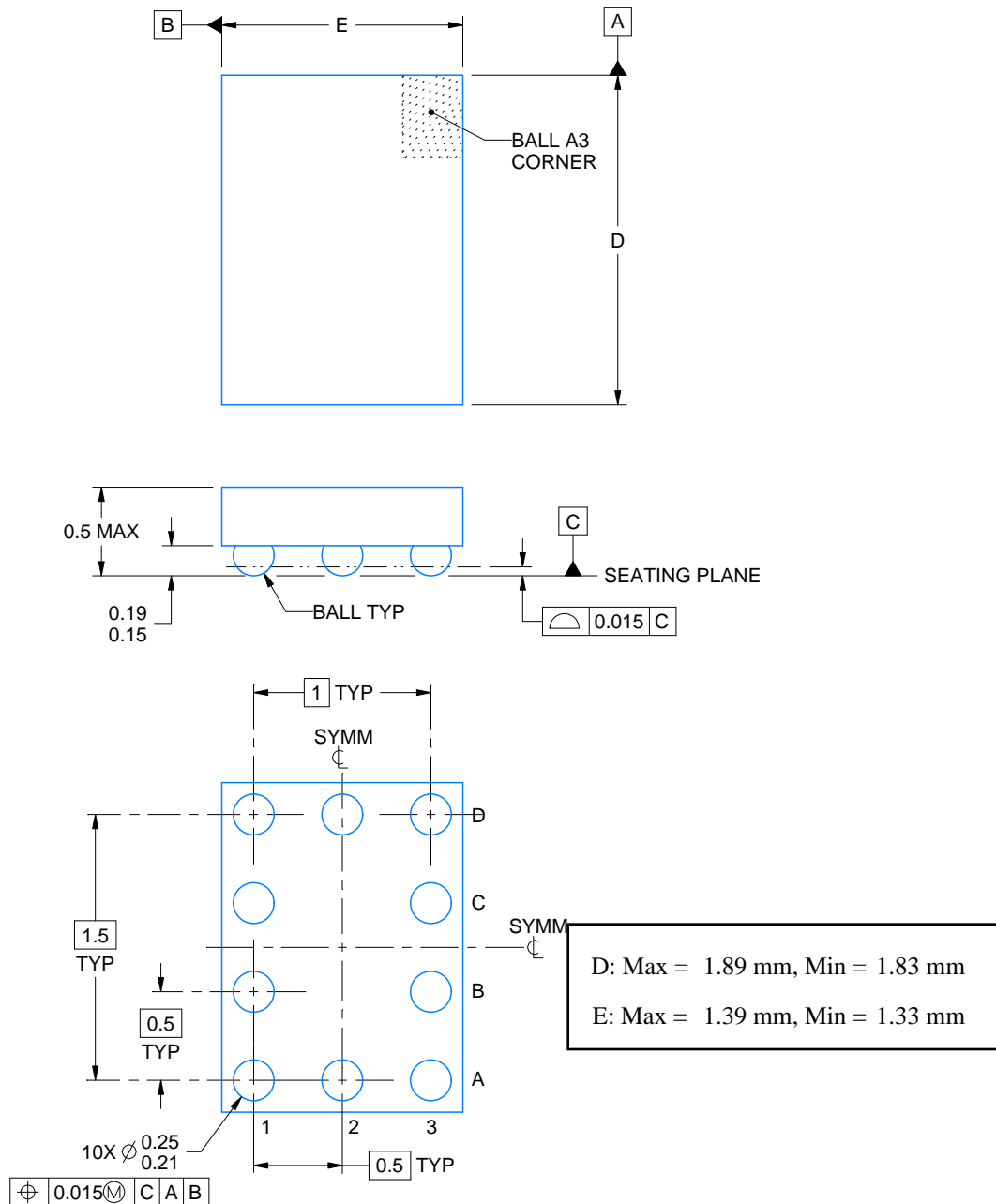


YZP0010

# PACKAGE OUTLINE

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



4219350/B 11/2017

## NOTES:

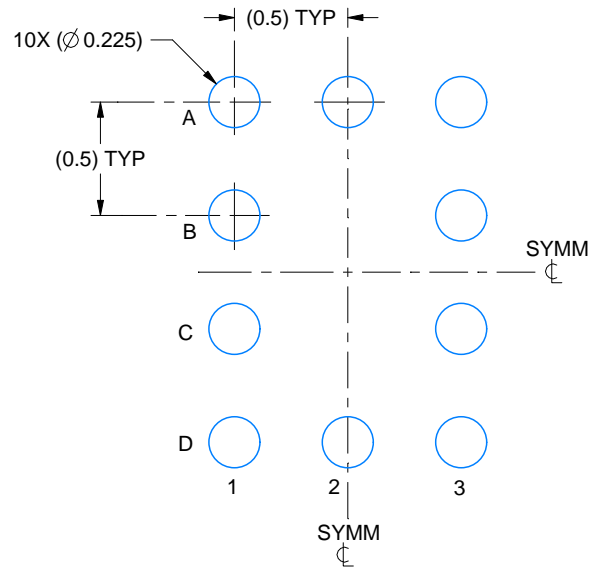
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

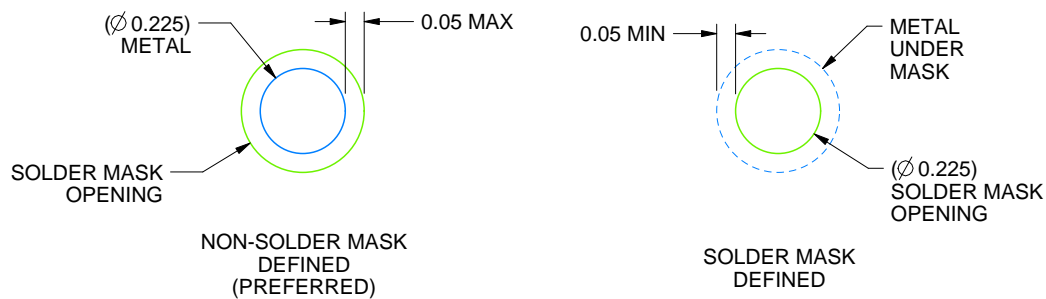
YZP0010

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE  
SCALE:30X



SOLDER MASK DETAILS  
NOT TO SCALE

4219350/B 11/2017

NOTES: (continued)

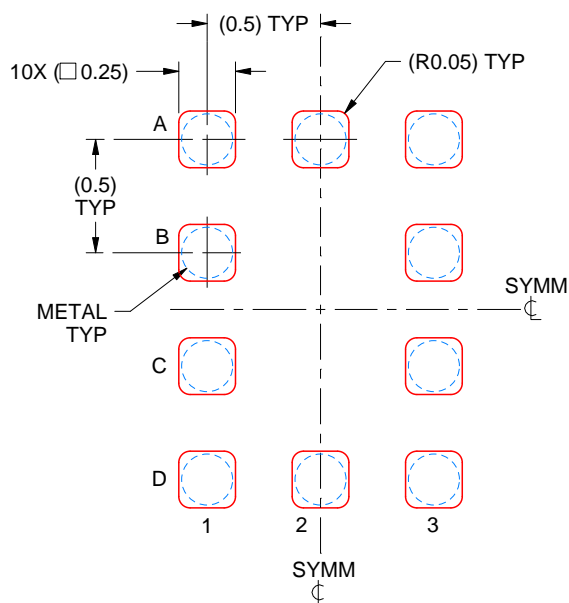
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For more information, see Texas Instruments literature number SBVA017 ([www.ti.com/lit/sbva017](http://www.ti.com/lit/sbva017)).

## EXAMPLE STENCIL DESIGN

YZP0010

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



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

4219350/B 11/2017

NOTES: (continued)

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



4221984/A 05/2015

**NOTES:**

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

# EXAMPLE BOARD LAYOUT

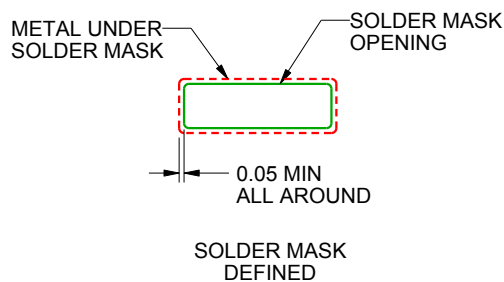
DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221984/A 05/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

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

## EXAMPLE STENCIL DESIGN

DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



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

4221984/A 05/2015

NOTES: (continued)

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

## GENERIC PACKAGE VIEW

**DRC 10**

**VSON - 1 mm max height**

3 x 3, 0.5 mm pitch

PLASTIC SMALL OUTLINE - NO LEAD

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





4218878/B 07/2018

## NOTES:

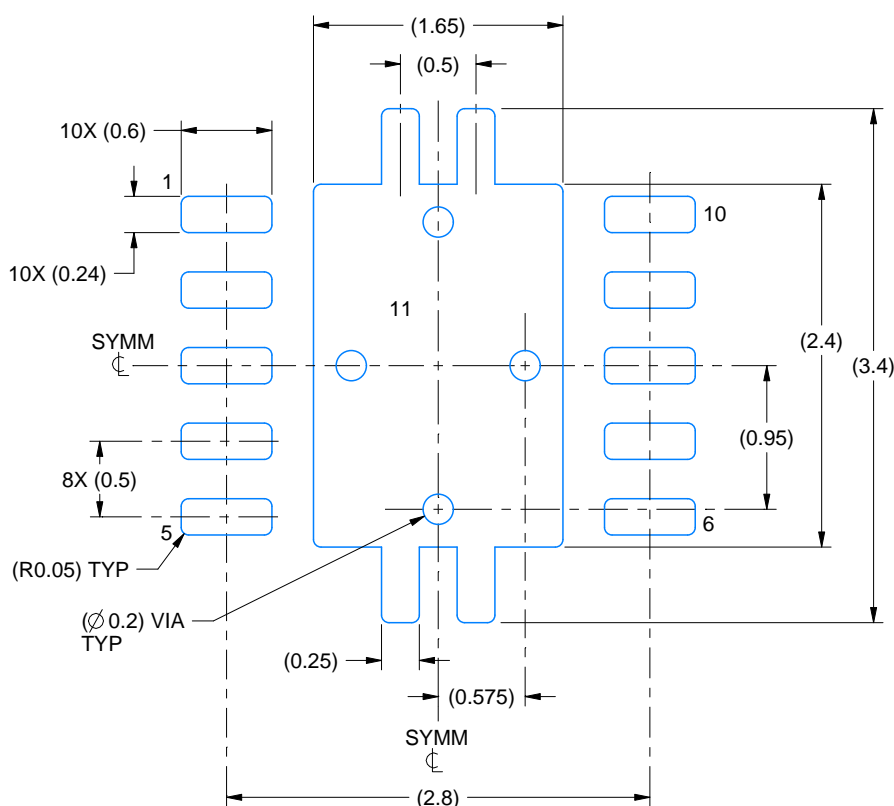
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical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



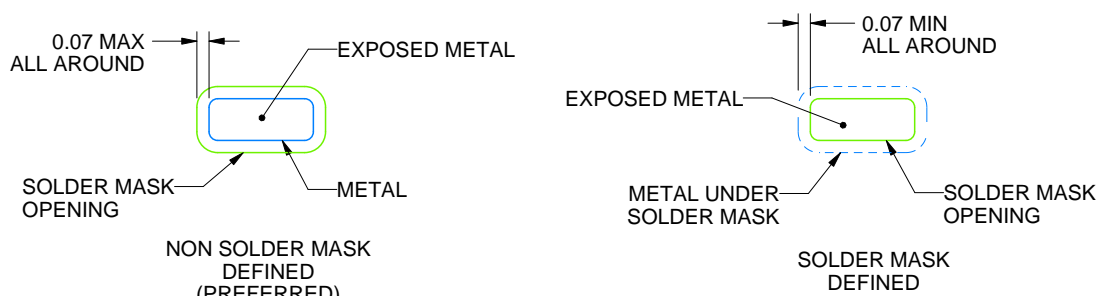
**DRC0010J**

**VSON - 1 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:20X



## SOLDER MASK DETAILS

4218878/B 07/2018

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

**DRC0010J**

**VSON - 1 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL

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

4218878/B 07/2018

NOTES: (continued)

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

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