TS5A22364-Q1 0.65-Ω Dual SPDT Analog Switch with Negative Signaling Capability

1 Features

- Qualified for automotive applications
- Specified Break-Before-Make (BBM) switching
- Negative signal swing capability: Maximum swing From –2.75 V to 2.75 V (V_{CC} = 2.75 V)
- Internal shunt switch prevents audible click-and-pop when switching between two sources
- Low On-state resistance (0.65 Ω typical)
- Low charge injection
- Excellent channel to channel On-state resistance matching
- 2.3-V to 5.5-V power supply (V_{CC})
- Latch-up performance meets 100 mA per AEC Q100-004
- ESD performance
  - 2500-V Human-Body Model tested per AEC Q100-002
  - 1500-V Charged-Device Model tested per AEC Q100-011

2 Applications

- Automotive infotainment
- Audio routing
- Industrial automation
- Medical imaging

3 Description

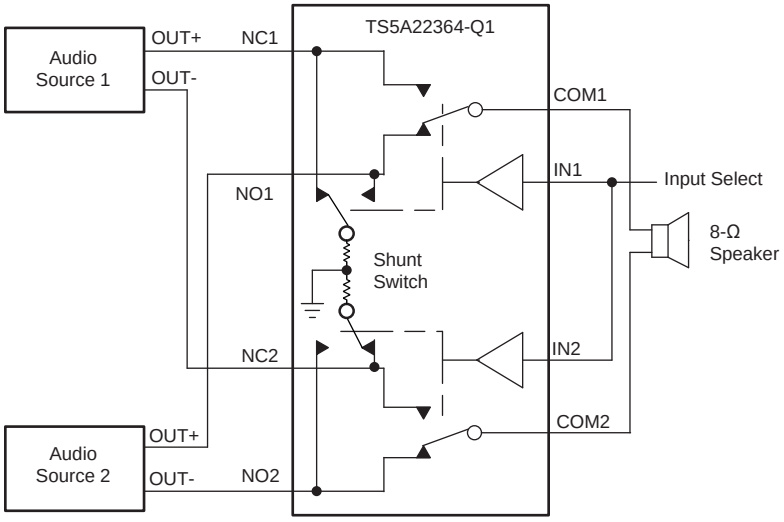
The TS5A22364-Q1 is a 2-channel single-pole double-throw (SPDT) analog switch designed to operate from 2.3 V to 5.5 V supply. The device features negative signal swing capability that allows signals below ground to pass through the switch without distortion. Additionally, the TS5A22364-Q1 includes an 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-and-pop noise when switching between two sources. The break-before-make feature prevents signal distortion during the transfer 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.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TS5A22364-Q1	VSSOP (10)	3.00 mm × 3.00 mm

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

Simplified Schematic



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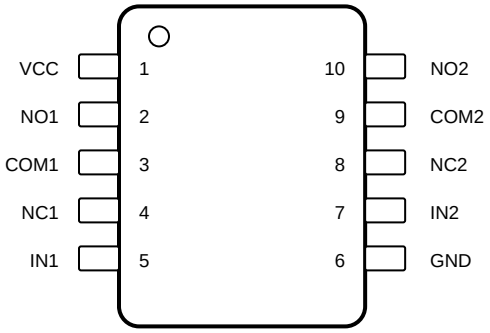
4 Revision History

Changes from Original (October 2014) to Revision A **Page**

- Changed device status from *Product Preview* to *Production Data* ... 1

5 Pin Configuration and Functions

DGS Package
10-Pin VSSOP
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
1	VCC	I	Supply power
2	NO1	I/O	Normally open (NO) signal path, switch 1
3	COM1	I/O	Common signal path, switch 1
4	NC1	I/O	Normally closed (NC) signal path, switch 1
5	IN1	I	Digital control pin to connect COM1 to NO1, switch 1
6	GND	—	Ground
7	IN2	I	Digital control pin to connect COM2 to NO2, switch 2
8	NC2	I/O	Normally closed (NC) signal path, switch 2
9	COM2	I/O	Common signal path, switch 2
10	NO2	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)(1) (2)

			MIN	MAX	UNIT
V_{CC}	Supply voltage(3)		–0.5	6	V
V_{NC}	Analog voltage on NC1-NC2 pin(3) (4) (5)		V_{CC} – 6	V_{CC} + 0.5	V
V_{NO}	Analog voltage on NO1-NO2 pin(3) (4) (5)				
V_{COM}	Analog voltage on COM1-COM2 pin(3) (4) (5)				
$I_{I/OK}$	Analog port diode input clamp 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 continuous current	V_{NC}, V_{NO}, V_{COM} = 0 to V_{CC}	–150	150	mA
	On-state switch peak current(6)		–300	300	
I_{RSH}	Off-state switch shunt resistor current		–20	20	mA
V_{IN}	Digital input voltage		–0.5	6.5	V
I_{IK}	Digital input clamp current(3) (4)	V_{IN} < 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.

6.2 ESD Ratings

				MIN	MAX	UNIT
V_{ESD}	Electrostatic discharge	Human body model (HBM), per AEC Q100-002(1)		–2500	2500	V
		Charged device model (CDM), per AEC Q100-011	all pins	–1500	1500	

(1) AEC Q100-002 indicates HBM stressing is done in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

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}	Signal path voltage	V_{CC} – 5.5	V_{CC}	V
V_{NO}				
V_{COM}				
V_{IN}	Digital control	GND	V_{CC}	V

6.4 Thermal Information

THERMAL METRIC(1) (2)		TS5A22364-Q1 DGS (VSSOP) 10 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	163.3	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	56.4	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	83.1	°C/W
ψ_{JT}	Junction-to-top characterization parameter	6.8	°C/W
ψ_{JB}	Junction-to-board characterization parameter	81.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.
(2) The package thermal impedance is calculated in accordance with JESD 51-7.

6.5 Electrical Characteristics—2.5-V Supply

V_{CC} = 2.3 V to 2.7 V, T_A = –40°C to +125°C (unless otherwise noted) (1)

PARAMETER		TEST CONDITIONS		T_A	V_{CC}	MIN	TYP	MAX	UNIT
ANALOG SWITCH									
Analog signal	V_{COM} V_{NO} V_{NC}					V_{CC} – 5.5		V_{CC}	V
On-state resistance	R_{on}	V_{NC} or V_{NO} = V_{CC}, 1.5 V, V_{CC} – 5.5 V I_{COM} = –100 mA	COM to NO or NC, See Figure 14	25°C	2.7 V		0.65	0.94	Ω
				–40°C to +125°C				1.3	
On-state resistance match between channels	ΔR_{on}	V_{NC} or V_{NO} = 1.5 V, I_{COM} = –100 mA	COM to NO or NC, See Figure 14	25°C	2.7 V		0.023	0.11	Ω
				–40°C to +125°C				0.15	
On-state resistance flatness	$R_{on(flat)}$	V_{NC} or V_{NO} = V_{CC}, 1.5 V, V_{CC} – 5.5 V I_{COM} = –100 mA	COM to NO or NC, See Figure 14	25°C	2.7 V		0.18	0.46	Ω
				–40°C to +125°C				0.56	
Shunt switch resistance	R_{SH}	I_{NO} or I_{NC} = 10 mA		–40°C to +125°C	2.7 V		25	55	Ω
On-state leakage current	$I_{COM(ON)}$	V_{NC} and V_{NO} = floating, V_{COM} = V_{CC} , V_{CC} – 5.5 V	See Figure 16	25°C	2.7 V	–200		200	nA
				–40°C to +125°C		–2500		2500	
DIGITAL CONTROL INPUTS (IN)(2)									
Input logic high	V_{IH}			–40°C to +125°C		1.4		V_{CC}	V
Input logic low	V_{IL}			–40°C to +125°C				0.4	V
Input leakage current	I_{IH}, I_{IL}	V_{IN} = V_{CC} or 0		25°C	2.7 V	–250		250	nA
				–40°C to +125°C		–250		250	
DYNAMIC									
Turnon time	t_{ON}	V_{COM} = V_{CC}, R_L = 300 Ω	C_L = 35 pF, See Figure 18	25°C	2.5 V		44	80	ns
				–40°C to +125°C	2.3 V to 2.7 V			120	
Turnoff time	t_{OFF}	V_{COM} = V_{CC}, R_L = 300 Ω	C_L = 35 pF, See Figure 18	25°C	2.5 V		22	70	ns
				–40°C to +125°C	2.3 V to 2.7 V			70	
Break-before-make time	t_{BBM}		See Figure 19	25°C	2.5 V	1	7		ns
Charge injection	Q_C	V_{GEN} = 0, R_{GEN} = 0,	C_L = 1 nF, See Figure 23	25°C	2.5 V		215		pC
On-State NC, NO, COM capacitance	$C_{COM(ON)}$	V_{COM} = V_{CC} or GND, Switch ON, f = 10 MHz	See Figure 17	25°C	2.5 V		370		pF
Digital input capacitance	C_I	V_{IN} = V_{CC} or GND	See Figure 17	25°C	2.5 V		2.6		pF
Bandwidth	BW	R_L = 50 Ω, –3 dB	See Figure 20	25°C	2.5 V		17		MHz

(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. See the *Implications of Slow or Floating CMOS Inputs* application report, SCBA004.

Electrical Characteristics—2.5-V Supply (continued)

V_{CC} = 2.3 V to 2.7 V, T_A = –40°C to +125°C (unless otherwise noted) (1)

PARAMETER		TEST CONDITIONS		T_A	V_{CC}	MIN	TYP	MAX	UNIT
Off-state isolation	O_{ISO}	R_L = 50 Ω	f = 100 kHz, See Figure 21	25°C	2.5 V		–66		dB
Crosstalk	X_{TALK}	R_L = 50 Ω	f = 100 kHz, See Figure 22	25°C	2.5 V		–75		dB
Total harmonic distortion	THD	R_L = 600 Ω, C_L = 35 pF	f = 20 Hz to 20 kHz, See Figure 24	25°C	2.5 V		0.01		%
SUPPLY									
Positive supply current	I_{CC}	V_{COM} and V_{IN} = V_{CC} or GND, V_{NC} and V_{NO} = floating		25°C	2.7 V		0.2	1.1	µA
				–40°C to +125°C				1.3	
		V_{COM} = V_{CC} – 5.5 V, V_{IN} = V_{CC} or GND, V_{NC} and V_{NO} = floating		–40°C to +125°C	2.7 V			3.3	µA

6.6 Electrical Characteristics—3.3-V Supply

V_{CC} = 3 V to 3.6 V, T_A = –40°C to +125°C (unless otherwise noted) (1)

PARAMETER		TEST CONDITIONS		T_A	V_{CC}	MIN	TYP	MAX	UNIT
ANALOG SWITCH									
Analog signal	V_{COM} V_{NO} V_{NC}					V_{CC} – 5.5		V_{CC}	V
On-state resistance	R_{on}	V_{NC} or V_{NO} ≤ V_{CC}, 1.5 V, V_{CC} – 5.5 V, I_{COM} = –100 mA	COM to NO or NC, See Figure 14	25°C	3 V		0.61	0.87	Ω
				–40°C to +125°C				0.97	
On-state resistance match between channels	ΔR_{on}	V_{NC} or V_{NO} = 1.5 V, I_{COM} = –100 mA	COM to NO or NC, See Figure 14	25°C	3 V		0.024	0.13	Ω
				–40°C to +125°C				0.13	
On-state resistance flatness	$R_{on(flat)}$	V_{NC} or V_{NO} ≤ V_{CC}, 1.5 V, V_{CC} – 5.5 V, I_{COM} = –100 mA	COM to NO or NC, See Figure 14	25°C	3 V		0.12	0.46	Ω
				–40°C to +125°C				0.5	
Shunt switch resistance	R_{SH}	I_{NO} or I_{NC} = 10 mA		–40°C to +125°C	3 V		25	40	Ω
On-state leakage current	$I_{COM(ON)}$	V_{NC} and V_{NO} = floating, V_{COM} = V_{CC},V_{CC} – 5.5 V	COM to NO or NC, See Figure 16	25°C	3.6 V	–200		200	nA
				–40°C to +125°C		–2500		2500	
DIGITAL CONTROL INPUTS (IN)(2)									
Input logic high	V_{IH}			–40°C to +125°C		1.4		V_{CC}	V
Input logic low	V_{IL}			–40°C to +125°C				0.6	V
Input leakage current	I_{IH}, I_{IL}	V_{IN} = V_{CC} or 0		25°C	3.6 V	–250		250	nA
				–40°C to +125°C		–250		250	
DYNAMIC									
Turnon time	t_{ON}	V_{COM} = V_{CC}, R_L = 300 Ω	C_L = 35 pF, See Figure 18	25°C	3.3 V		34	80	ns
				–40°C to +125°C	3 V to 3.6 V			80	
Turnoff time	t_{OFF}	V_{COM} = V_{CC}, R_L = 300 Ω	C_L = 35 pF, See Figure 18	25°C	3.3 V		19	70	ns
				–40°C to +125°C	3 V to 3.6 V			70	
Break-before-make time	t_{BBM}		See Figure 19	25°C	3.3 V	1	7		ns
Charge injection	Q_C	V_{GEN} = 0, R_{GEN} = 0,	C_L = 1 nF, See Figure 23	25°C	3.3 V		300		pC
On-State NC, NO, COM capacitance	$C_{COM(ON)}$	V_{COM} = V_{CC} or GND, f = 10 MHz	See Figure 17	25°C	3.3 V		370		pF

(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. See the *Implications of Slow or Floating CMOS Inputs* application report, SCBA004.

Electrical Characteristics—3.3-V Supply (continued)

V_{CC} = 3 V to 3.6 V, T_A = –40°C to +125°C (unless otherwise noted) (1)

PARAMETER		TEST CONDITIONS		T_A	V_{CC}	MIN	TYP	MAX	UNIT
Digital input capacitance	C_I	V_{IN} = V_{CC} or GND	See Figure 17	25°C	3.3 V		2.6		pF
Bandwidth	BW	R_L = 50 Ω, –3 dB	Switch ON, See Figure 20	25°C	3.3 V		17.5		MHz
Off-state isolation	O_{ISO}	R_L = 50 Ω	f = 100 kHz, See Figure 21	25°C	3.3 V		–68		dB
Crosstalk	X_{TALK}	R_L = 50 Ω	f = 100 kHz, See Figure 22	25°C	3.3 V		–76		dB
Total harmonic distortion	THD	R_L = 600 Ω, C_L = 35 pF	f = 20 Hz to 20 kHz, See Figure 24	25°C	3.3 V		0.008		%
SUPPLY									
Positive supply current	I_{CC}	V_{COM} and V_{IN} = V_{CC} or GND, V_{NC} and V_{NO} = floating		25°C	3.6 V		0.1	1.2	µA
				–40°C to +125°C				1.3	
		V_{COM} = V_{CC} – 5.5 V, V_{IN} = V_{CC} or GND, V_{NC} and V_{NO} = floating		–40°C to +125°C	3.6 V			3.4	µA

6.7 Electrical Characteristics—5-V Supply(1)

V_{CC} = 4.5 V to 5.5 V, T_A = –40°C to +125°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	V_{CC}	MIN	TYP	MAX	UNIT
ANALOG SWITCH									
Analog signal	V_{COM}, V_{NO}, V_{NC}					V_{CC} – 5.5		V_{CC}	V
On-state resistance	R_{on}	V_{NC} or V_{NO} = V_{CC}, 1.6 V, V_{CC} = –5.5 V, I_{COM} = –100 mA	COM to NO or NC, See Figure 14	25°C	4.5 V		0.52	0.74	Ω
				–40°C to +125°C				0.83	
On-state resistance match between channels	ΔR_{on}	V_{NC} or V_{NO} = 1.6 V, I_{COM} = –100 mA	COM to NO or NC, See Figure 14	25°C	4.5 V		0.04	0.23	Ω
				–40°C to +125°C				0.30	
On-state resistance flatness	$R_{on(flat)}$	V_{NC} or V_{NO} = V_{CC}, 1.6 V, V_{CC} = –5.5 V, I_{COM} = –100 mA	COM to NO or NC, See Figure 14	25°C	4.5 V		0.076	0.46	Ω
				–40°C to +125°C				0.5	
Shunt switch resistance	R_{SH}	I_{NO} or I_{NC} = 10 mA		–40°C to +125°C	4.5 V		16	36	Ω
On-state leakage current	$I_{COM(ON)}$	V_{NC} and V_{NO} = Floating, V_{COM} = VCC, V_{CC} – 5.5 V	See Figure 16	25°C	5.5 V	–200		200	nA
				–40°C to +125°C		–2500		2500	
DIGITAL CONTROL INPUTS (IN)(2)									
Input logic high	V_{IH}			–40°C to +125°C		2.4		V_{CC}	V
Input logic low	V_{IL}			–40°C to +125°C				0.8	V
Input leakage current	I_{IH}, I_{IL}	V_{IN} = V_{CC} or 0		25°C	5.5 V	–250		250	nA
				–40°C to +125°C		–250		250	
DYNAMIC									
Turnon time	t_{ON}	V_{COM} = V_{CC}, R_L = 300 Ω	C_L = 35 pF, See Figure 18	25°C	5 V		27	80	ns
				–40°C to +125°C	4.5 V to 5.5 V			80	
Turnoff time	t_{OFF}	V_{COM} = V_{CC}, R_L = 300 Ω	C_L = 35 pF, See Figure 18	25°C	5 V		13	70	ns
				–40°C to +125°C	4.5 V to 5.5 V			70	
Break-before-make time	t_{BBM}	V_{NC} = V_{NO} = V_{CC}/2 R_L = 300 Ω	C = 35 pF, See Figure 19	25°C	5 V	1	3.5		ns
Charge injection	Q_C	V_{GEN} = 0, R_{GEN} = 0	C_L = 1$_L$ nF, See Figure 23	25°C	5 V		500		pC

(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. See the *Implications of Slow or Floating CMOS Inputs* application report, SCBA004.

Electrical Characteristics—5-V Supply[1] (continued)

V_{CC} = 4.5 V to 5.5 V, T_A = –40°C to +125°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	V_{CC}	MIN	TYP	MAX	UNIT
ON-State NC, NO, COM capacitance	$C_{COM(ON)}$	V_{COM} = V_{CC} or GND	See Figure 17	25°C	5 V		370		pF
Digital input capacitance	C_I	V_{IN} = V_{CC} or GND	See Figure 17	25°C	5 V		2.6		pF
Bandwidth	BW	R_L = 50 Ω	See Figure 20	25°C	5 V		18.3		MHz
Off-state isolation	O_{ISO}	R_L = 50 Ω	f = 100 kHz, See Figure 21	25°C	5 V		–70		dB
Crosstalk	X_{TALK}	R_L = 50 Ω	f = 100 kHz, See Figure 22	25°C	5 V		–78		dB
Total harmonic distortion	THD	R_L = 600 Ω, C_L = 35 pF	f = 20 Hz to 20 kHz, See Figure 24	25°C	5 V		0.009		%
SUPPLY									
Positive supply current	I_{CC}	V_{COM} and V_{IN} = V_{CC} or GND, V_{NC} or V_{NO} = floating		25°C	5.5 V		0.2	1.3	μA
				–40°C to +125°C				3.5	
		V_{COM} = V_{CC} – 5.5 V, V_{IN} = V_{CC} or GND, V_{NC} or V_{NO} = floating		–40°C to +125°C				5	

6.8 Typical Characteristics

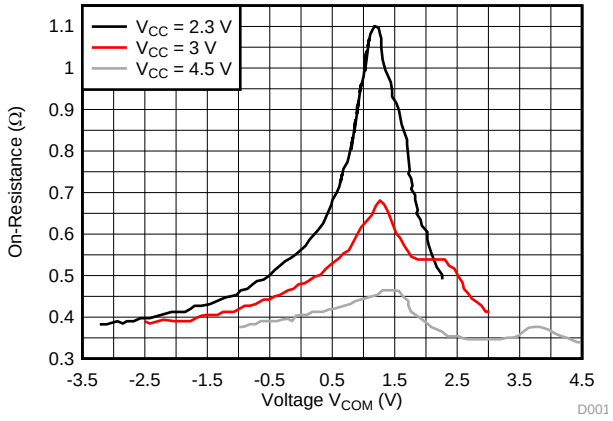


Figure 1. On-Resistance vs Voltage V_{COM}

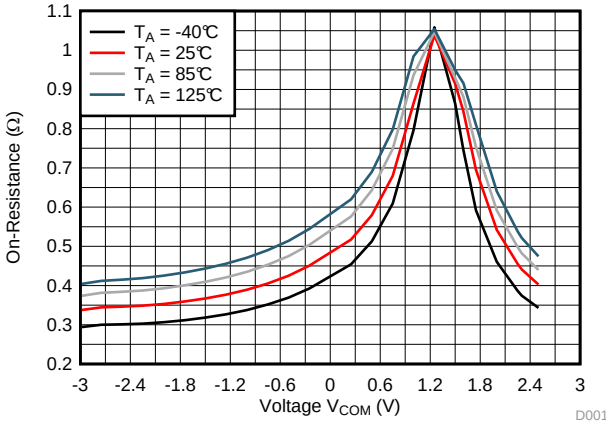


Figure 2. On-Resistance vs Voltage V_{COM} (V_{CC} = 2.3 V)

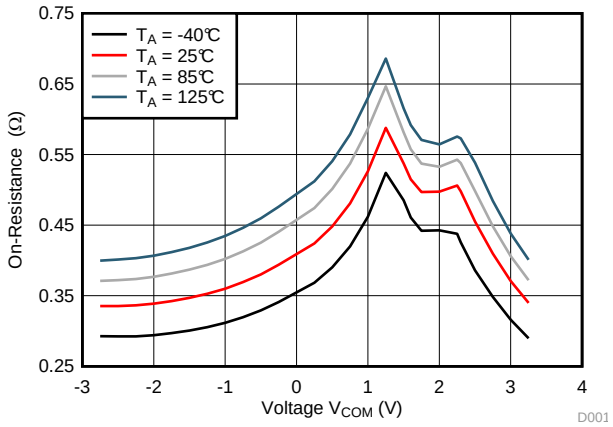


Figure 3. On-Resistance vs Voltage V_{COM} (V_{CC} = 3 V)

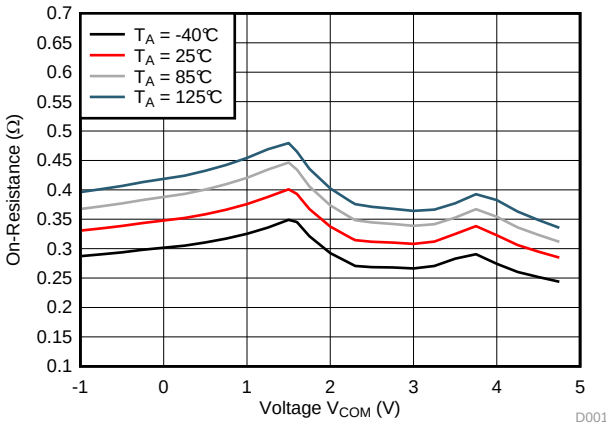


Figure 4. On-Resistance vs Voltage V_{COM} (V_{CC} = 4.5 V)

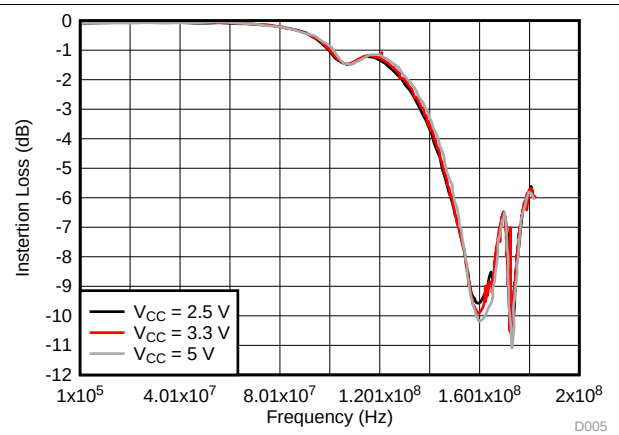


Figure 5. Insertion Loss vs Frequency for Varying V_{CC}

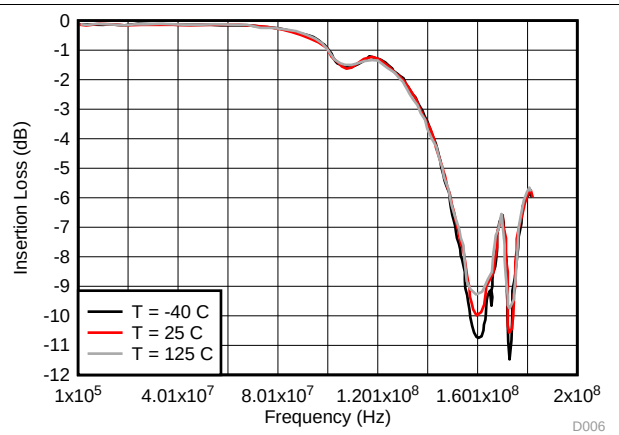


Figure 6. Insertion Loss vs Frequency for Varying Temperature

Typical Characteristics (continued)

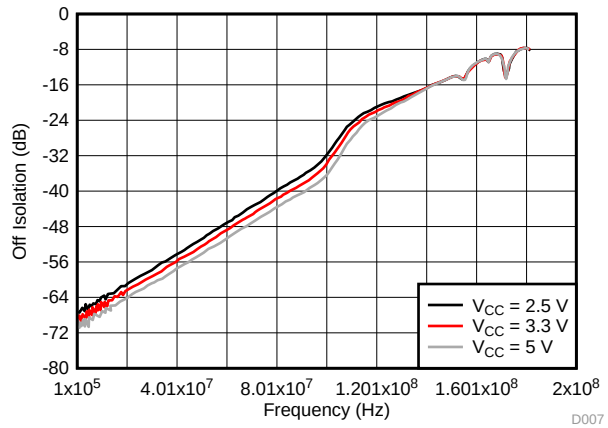


Figure 7. Off Isolation vs Frequency for Varying V_{CC}

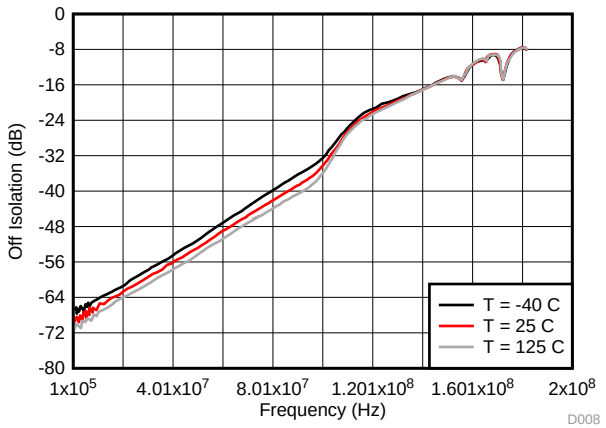


Figure 8. Off Isolation vs Frequency for Varying Temperature

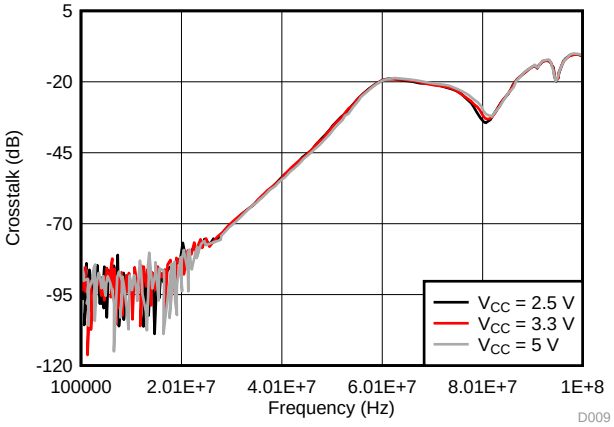


Figure 9. Crosstalk vs Frequency for Varying V_{CC}

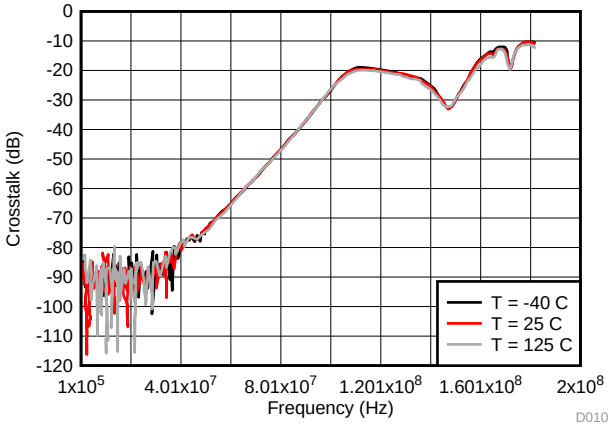


Figure 10. Crosstalk vs Frequency (V_{CC} = 3.3 V)

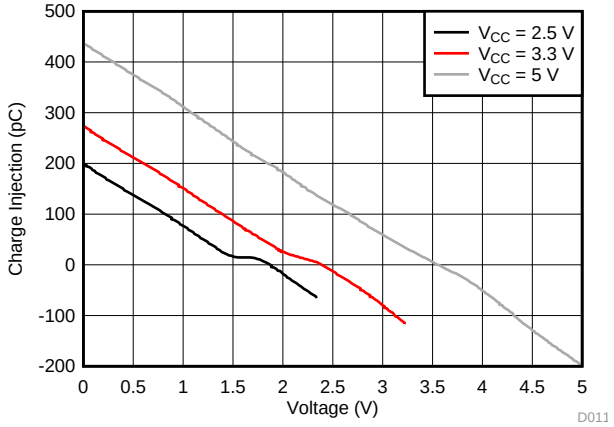


Figure 11. Charge Injection vs Voltage V_{COM}

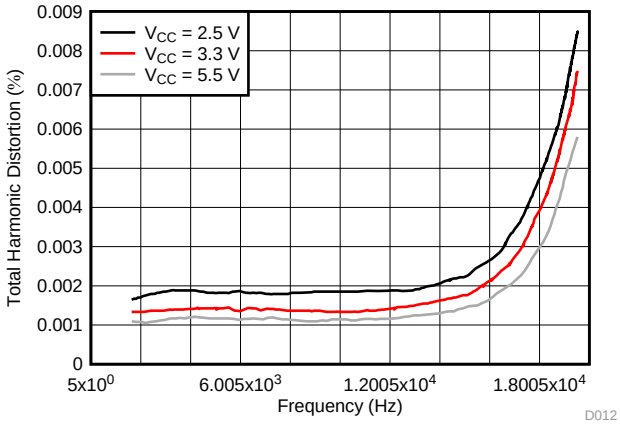
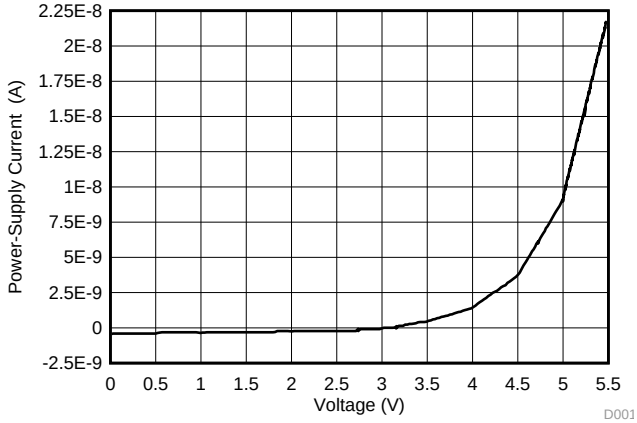


Figure 12. Total Harmonic Distortion vs Frequency

Typical Characteristics (continued)



T = 25°C V_{NC} and V_{NO} = Floating V_{COM} and V_{IN} = GND

Figure 13. Power-Supply Current vs Voltage

7 Parameter Measurement Information

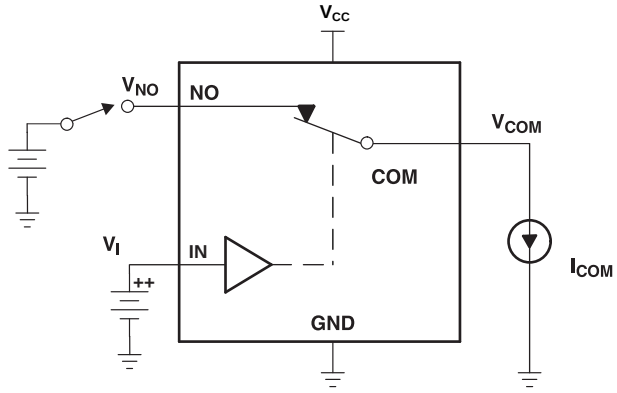


Figure 14. On-State Resistance (R_{on})

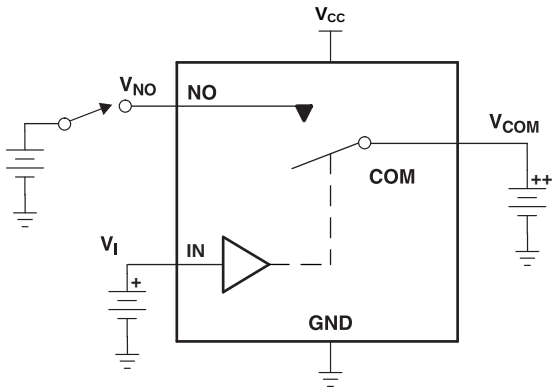


Figure 15. Off-State Leakage Current ($I_{COM(OFF)}$, $I_{NO(OFF)}$)

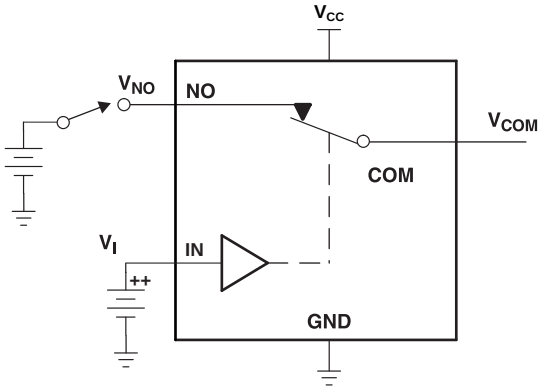


Figure 16. On-State Leakage Current ($I_{COM(ON)}$, $I_{NO(ON)}$)

Parameter Measurement Information (continued)

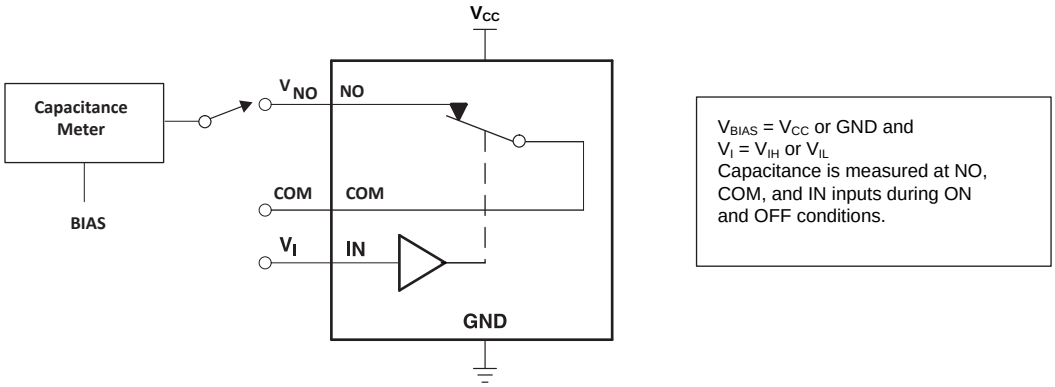
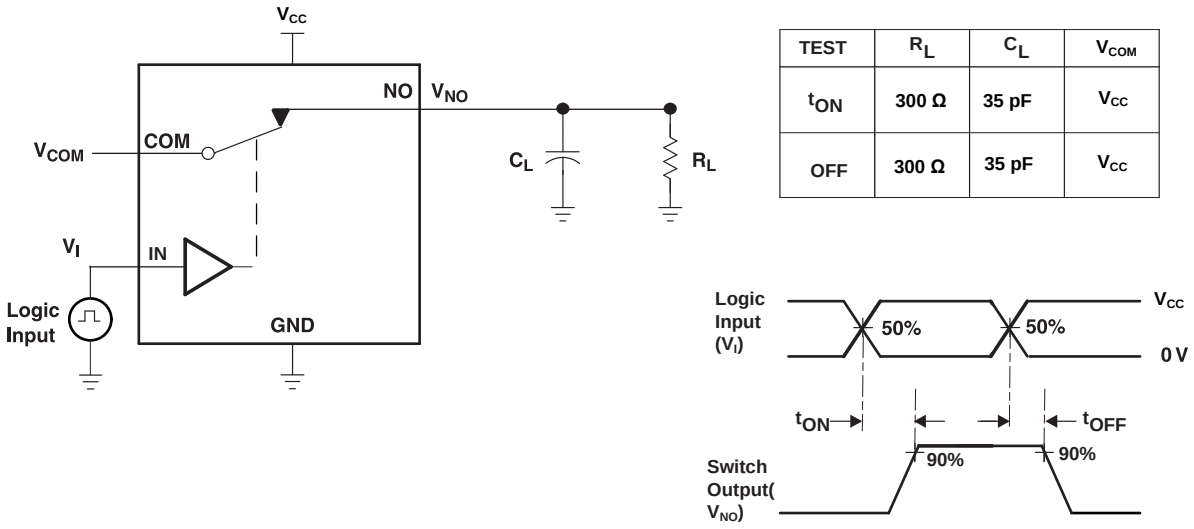


Figure 17. Capacitance
(C_I, $C_{COM(OFF)}$, $C_{COM(ON)}$, $C_{NO(OFF)}$, $C_{NO(ON)}$)



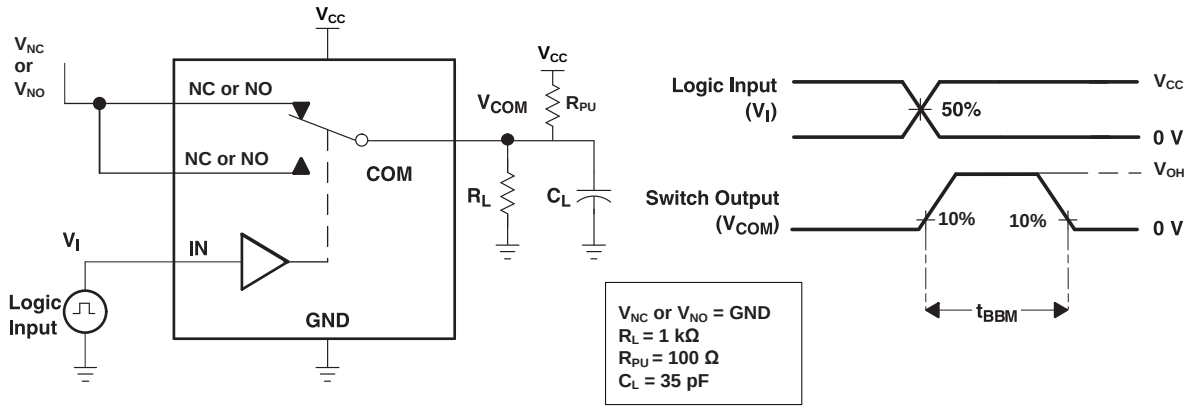
TEST	R_L	C_L	V_{COM}
t_{ON}	300 Ω	35 pF	V_{CC}
OFF	300 Ω	35 pF	V_{CC}

A. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r < 5 ns, t_f < 5 ns.

B. C_L includes probe and jig capacitance.

Figure 18. 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 ≤ 10 MHz, Z_O = 50 Ω, t_r < 5 ns, t_f < 5 ns.

Figure 19. Break-Before-Make Time (t_{BBM})

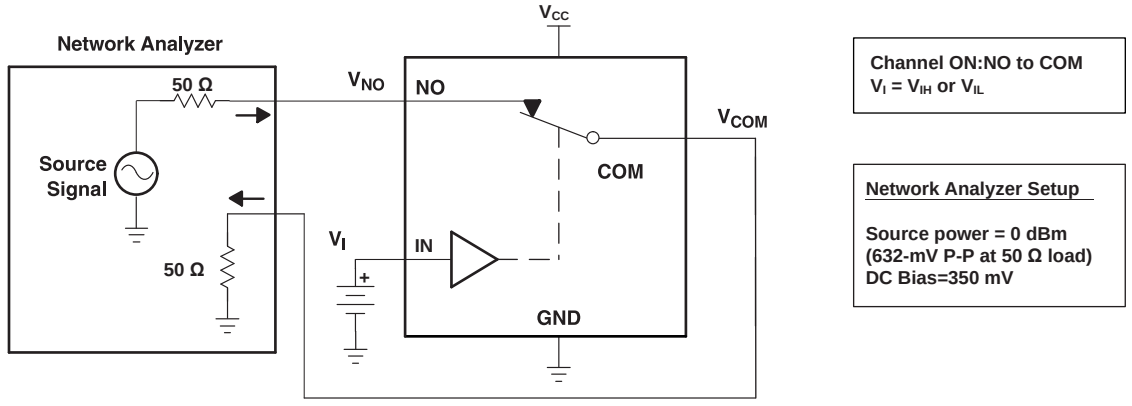


Figure 20. Bandwidth (BW)

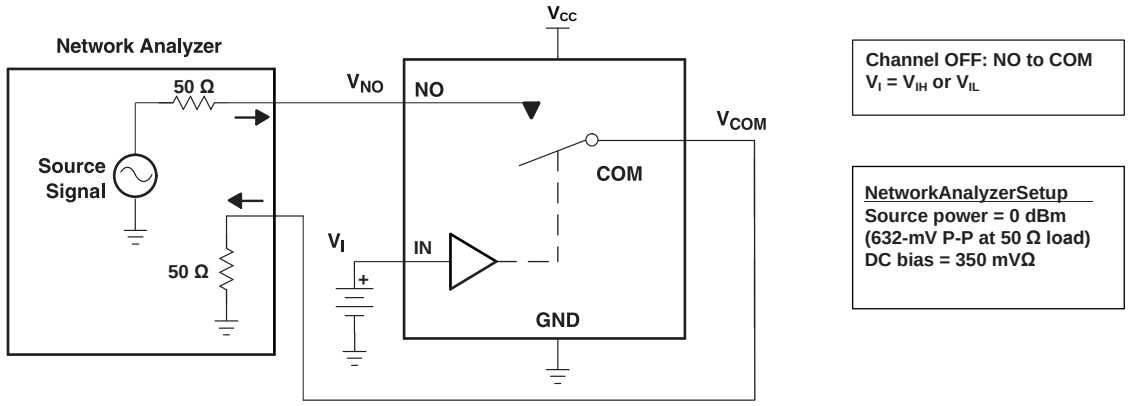


Figure 21. Off Isolation (O_{ISO})

Parameter Measurement Information (continued)

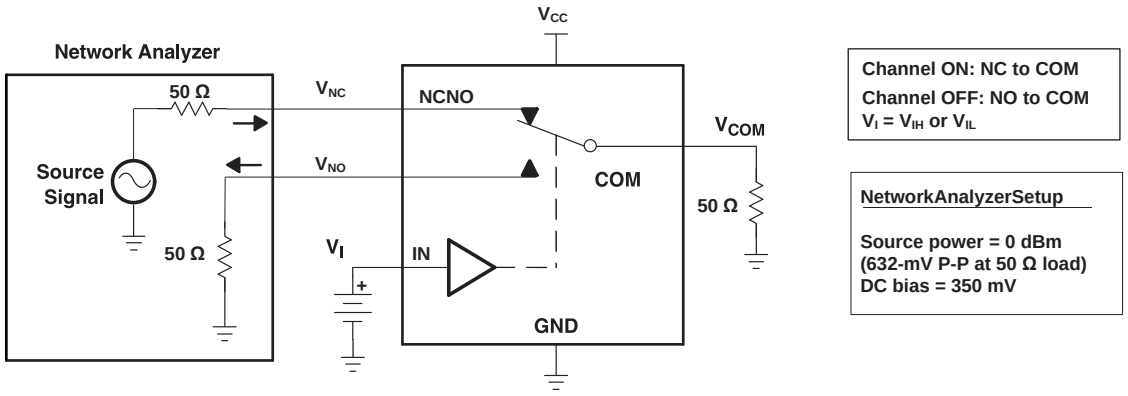
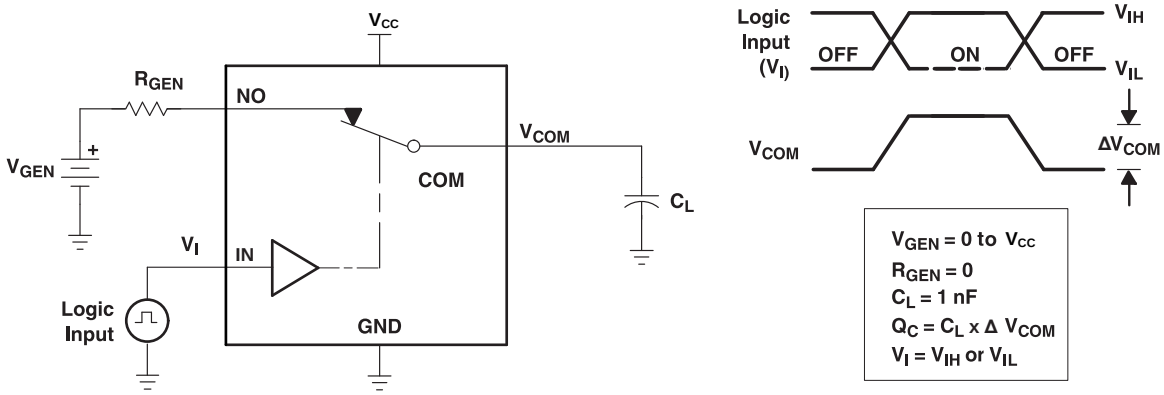


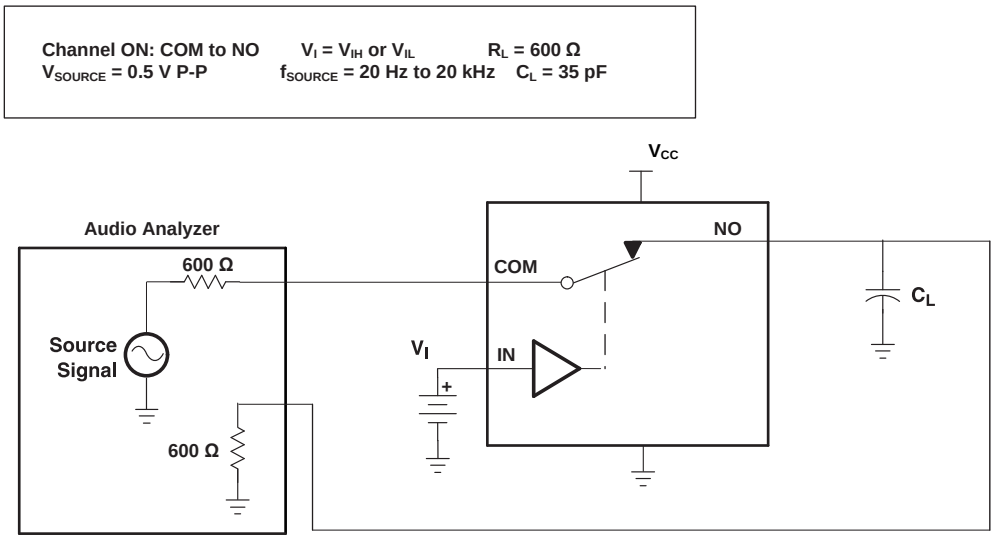
Figure 22. Crosstalk (X_{TALK})



A. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r < 5 ns, t_f < 5 ns.

B. C_L includes probe and jig capacitance.

Figure 23. Charge Injection (Q_C)



A. C_L includes probe and jig capacitance.

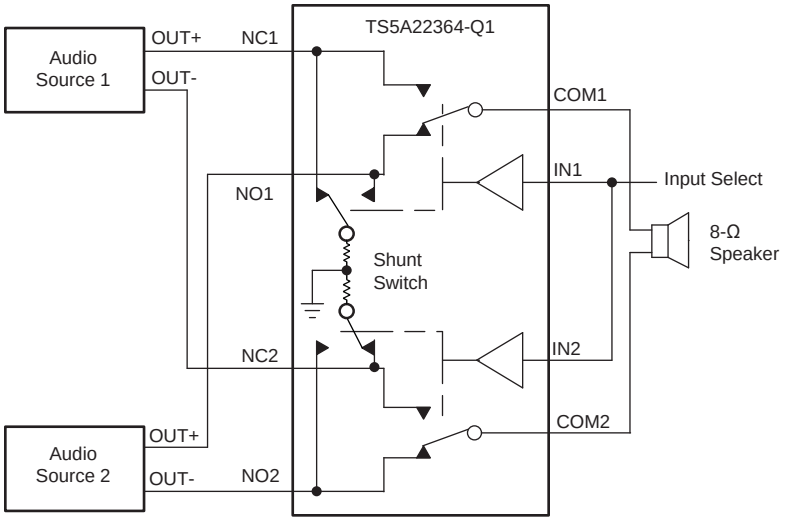
Figure 24. Total Harmonic Distortion (THD)

8 Detailed Description

8.1 Overview

The TS5A22364-Q1 is a 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-Q1 includes an internal shunt switch, which automatically discharges any capacitance at the NC or NO terminals when they are not connected to COM. This 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 50-Ω shunt switches on the TS5A22364-Q1 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.

8.4 Device Functional Modes

Table 1 shows the function table for the TS5A22364-Q1.

Table 1. 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

9.1.1 Negative Signal Swing Capability

The TS5A22364-Q1 dual SPDT switches feature 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 on the supply voltage V_{CC}: the device can pass signals as high as V_{CC} and as low as V_{CC} – 5.5 V, including signals below ground with minimal distortion. The Off state signal path (either NC or NO) during the operation of the TS5A22364-Q1 cannot handle negative DC voltage.

Table 2 shows the input-output signal swing the user can get with different supply voltages.

Table 2. Input-Output Signal Swing

SUPPLY VOLTAGE, VCC	MINIMUM (V_{NC}, V_{NO}, V_{COM}) = V_{CC} – 5.5	MAXIMUM (V_{NC}, V_{NO}, V_{COM}) = V_{CC}	MINIMUM (V_{NC}, V_{NO}, V_{COM}) = V_{CC} – 5.5	MAXIMUM (V_{NC}, V_{NO}, V_{COM}) = V_{CC}
	ON State signal path		OFF state signal path	
5.5 V	0 V	5.5 V	0 V	5.5 V
4.2 V	–1.3 V	4.2 V	0 V	4.2 V
3.3 V	–2.2 V	3.3 V	0 V	3.3 V
3 V	–2.5 V	3 V	0 V	3 V
2.5 V	–3 V	2.5 V	0 V	2.5 V

9.2 Typical Application

The 50-Ω shunt switches on the TS5A22364-Q1 automatically discharge any capacitance at the NC or NO terminals when they are unconnected 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. See Figure 25.

Typical Application (continued)

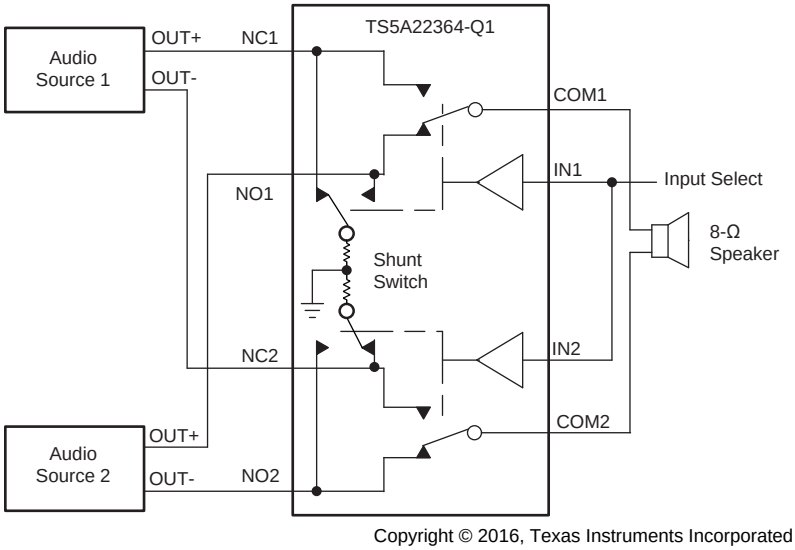


Figure 25. Shunt Switch Block Diagram

9.2.1 Design Requirements

Tie the digitally controlled input select pins IN1 and IN2 to V_{CC} or GND to avoid unwanted switch states 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-Q1 operates from a single 2.3-V to 5.5-V supply and the input-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 V. Use Table 2 as a guide for selecting supply voltage based on the signal passing through the switch.

Limit the current through the shunt resistor so as not to exceed the ±20 mA.

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

9.2.3 Application Curve

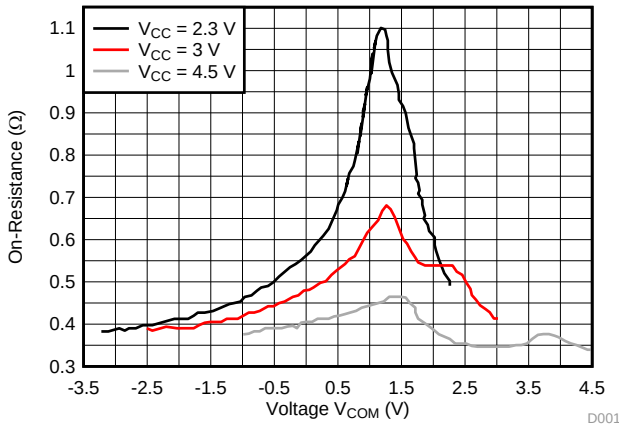


Figure 26. On-Resistance vs Voltage V_{COM}

10 Power Supply Recommendations

The TS5A22364-Q1 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. It is recommended to include a 100 μs 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-μF 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

It is recommended to place 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

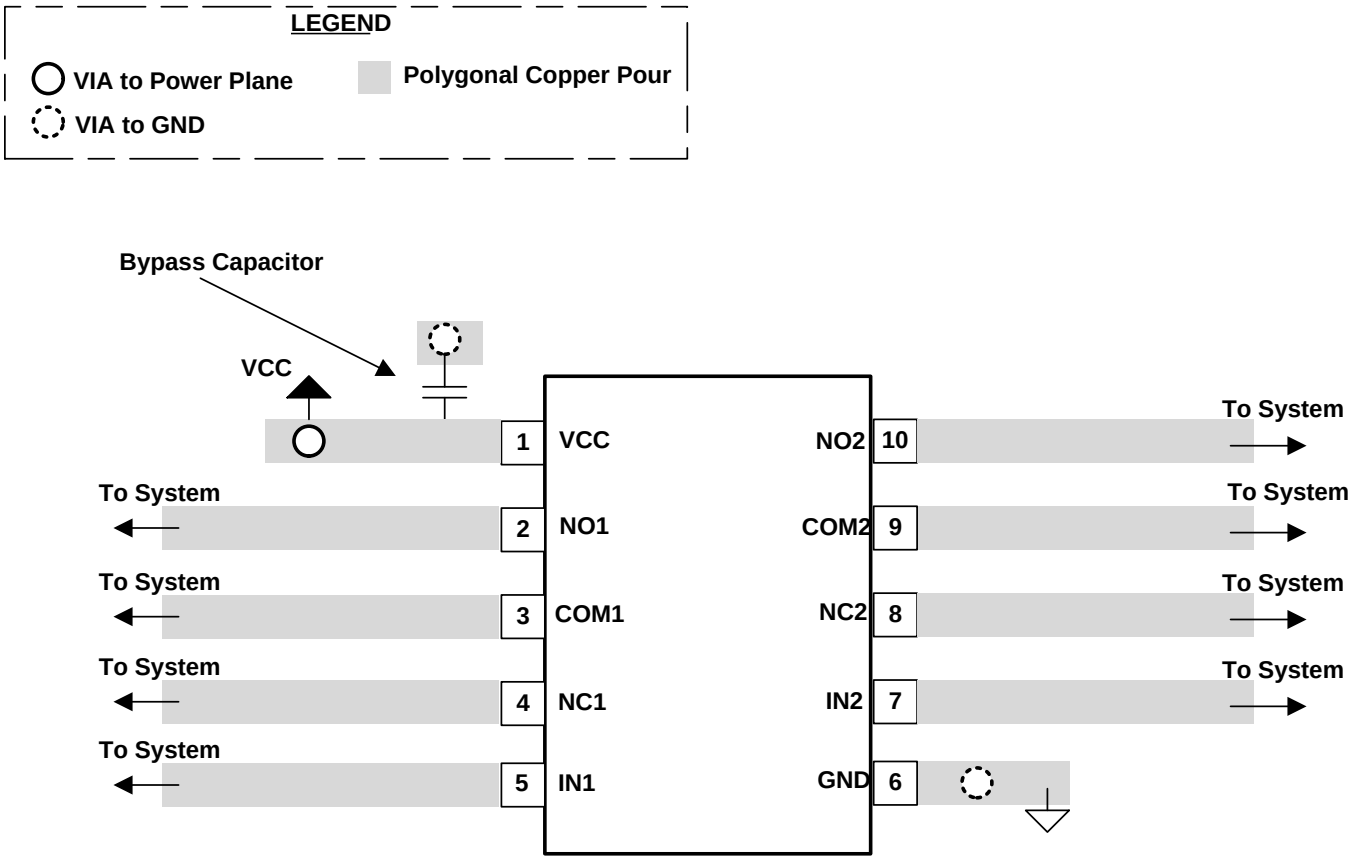


Figure 27. Layout Example of TS5A22364-Q1

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.
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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.

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 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
TS5A22364QDGSRQ1	ACTIVE	VSSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	SJN	Samples

(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.

OTHER QUALIFIED VERSIONS OF TS5A22364-Q1 :

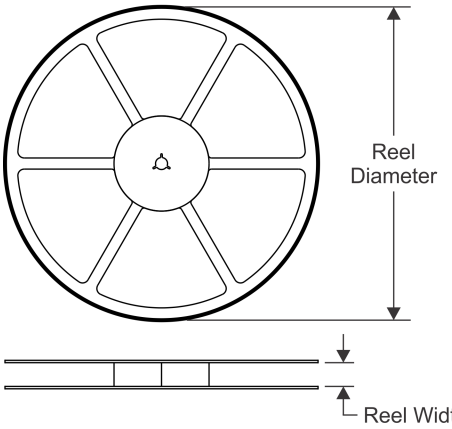
- Catalog: TS5A22364

NOTE: Qualified Version Definitions:

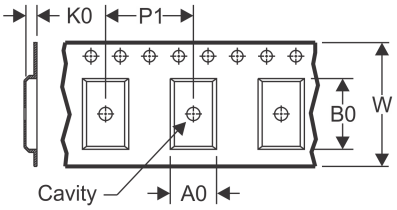
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

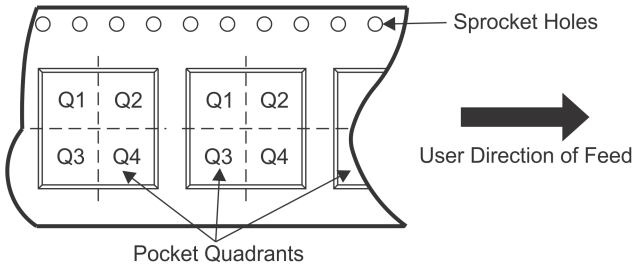


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

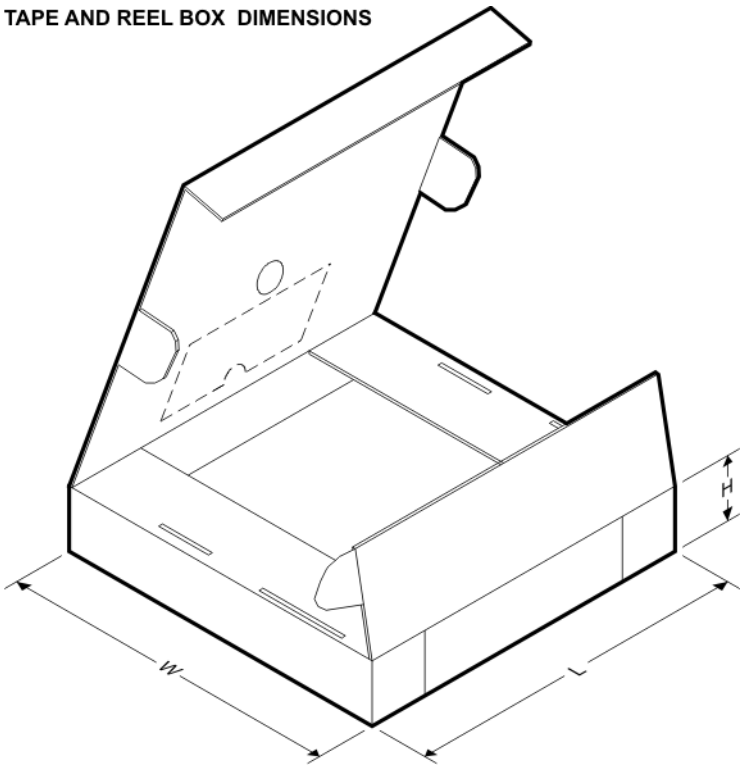
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TS5A22364QDGSRQ1	VSSOP	DGS	10	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1

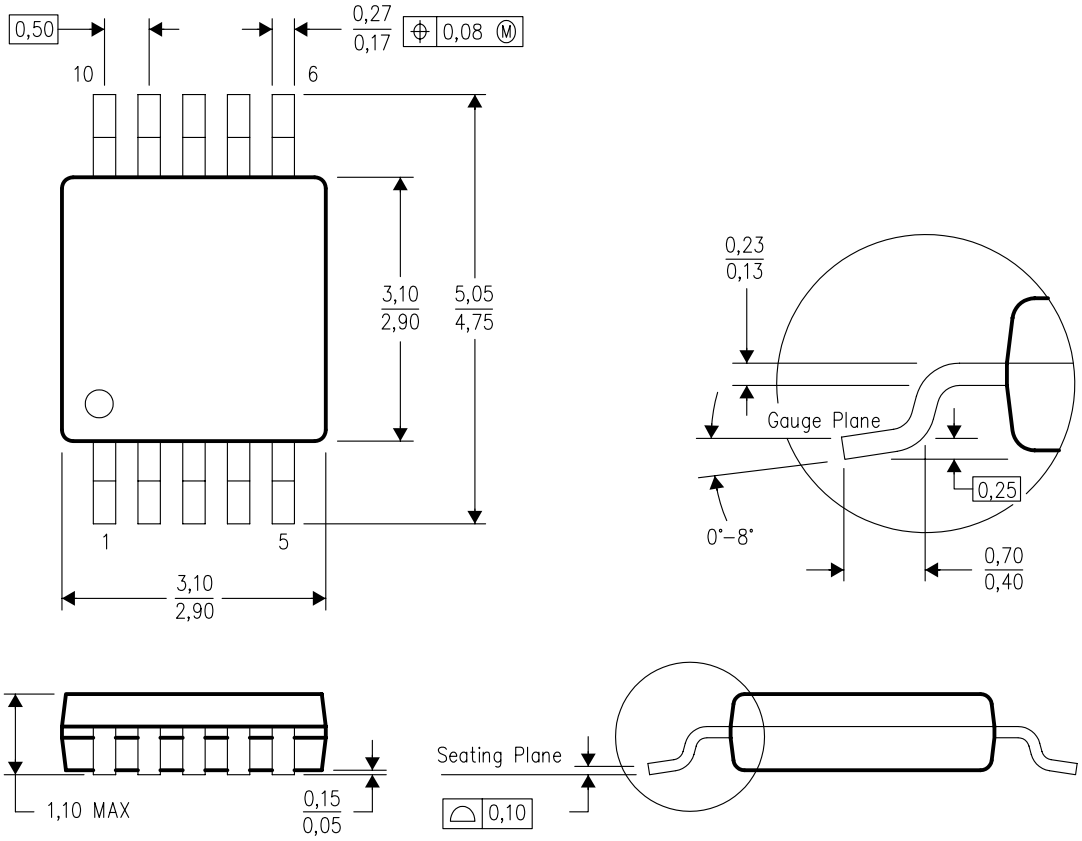
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS5A22364QDGSRQ1	VSSOP	DGS	10	2500	366.0	364.0	50.0

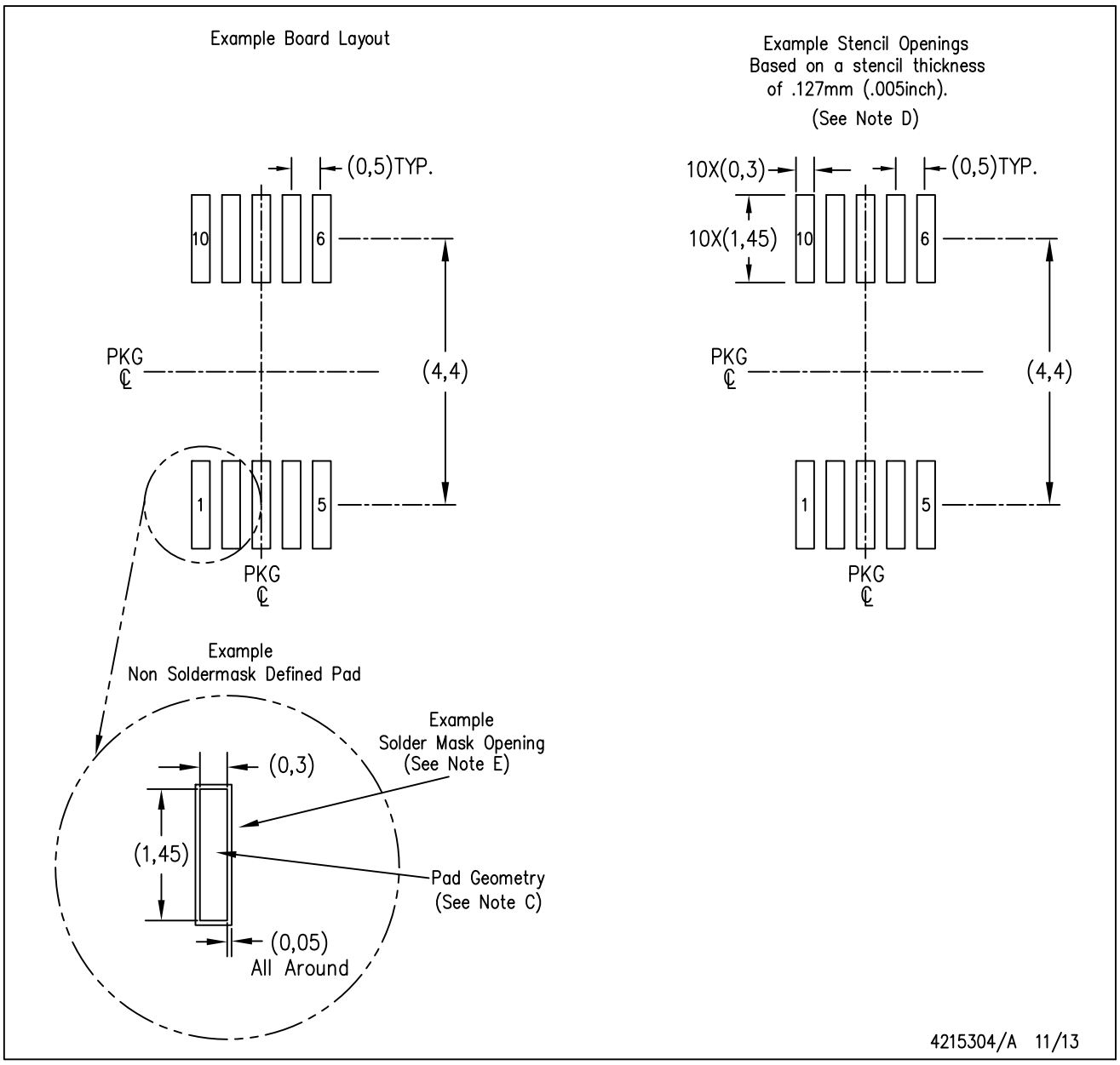
DGS (S–PDSO–G10) PLASTIC SMALL–OUTLINE PACKAGE



4073272/C 02/04

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

DGS (S–PDSO–G10) PLASTIC SMALL OUTLINE PACKAGE



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. 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.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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