

## TS5A3160 1-Ω SPDT Analog Switch

### 1 Features

- Low ON-State Resistance (1 Ω)
- Isolation in the Powered-Off Mode,  $V_+ = 0$
- Specified Make-Before-Break Switching
- Control Inputs are 5-V Tolerant
- Low Charge Injection
- Excellent ON-Resistance Matching
- Low Total Harmonic Distortion
- 1.65-V to 5.5-V Single-Supply Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance Tested Per JESD 22
  - 2000-V Human Body Model (A114-B, Class II)
  - 1000-V Charged-Device Model (C101)

### 2 Applications

- Mobile Phones
- Consumer and Computing
- Portable Instrumentation

### 3 Description

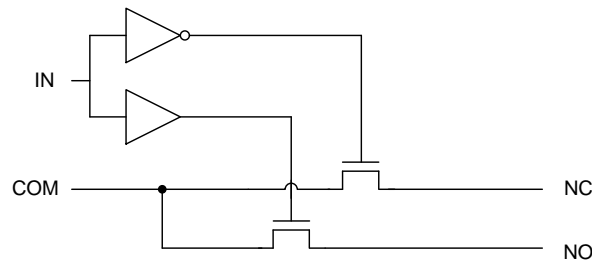
The TS5A3160 device is a single-pole double-throw (SPDT) analog switch that is designed to operate from 1.65 V to 5.5 V. The device offers a low ON-state resistance and an excellent channel-to-channel ON-state resistance matching. The device has excellent total harmonic distortion (THD) performance and consumes very low power. These features make this device suitable for portable audio applications.

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

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TS5A3160DBV	SOT-23 (6)	2.90 mm × 1.60 mm
TS5A3160DCK	SC70 (6)	2.00 mm × 1.25 mm

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

#### Block Diagram



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## 4 Revision History

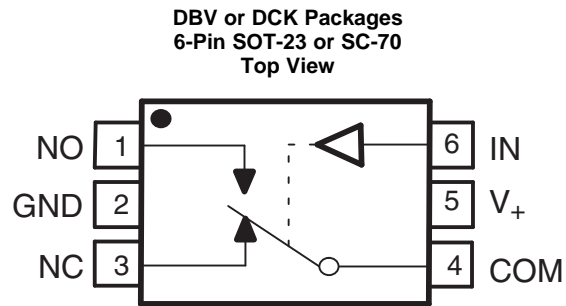
### Changes from Revision D (June 2015) to Revision E Page

- Changed Input leakage current UNIT value From:  $\mu$ A To: nA in the *Electrical Characteristics for 5-V Supply* table ..... **5**

### Changes from Revision C (March 2012) to Revision D Page

- Added *Applications*, *Device Information* table, *Pin Functions* table, *ESD Ratings* table, *Thermal Information* table, *Typical Characteristics*, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section. .... **1**

## 5 Pin Configuration and Functions



**Pin Functions**

PIN		I/O	DESCRIPTION
NO.	NAME		
1	NO	I/O	Normally open switch port
2	GND	—	Ground
3	NC	I/O	Normally closed switch port
4	COM	I/O	Common switch port
5	V+	—	Power supply
6	IN	I	Switch select. High = COM connected to NO; Low = COM connected to NC.

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
$V_+$	Supply voltage <sup>(3)</sup>	−0.5	6.5	V
$V_{NC}$ $V_{NO}$ $V_{COM}$	Analog voltage <sup>(3) (4) (5)</sup>	−0.5	$V_+ + 0.5$	V
$I_K$	Analog port diode current $V_{NC}, V_{NO}, V_{COM} < 0$	−50		mA
$I_{NC}$ $I_{NO}$ $I_{COM}$	On-state switch current On-state peak switch current <sup>(6)</sup> $V_{NC}, V_{NO}, V_{COM} = 0 \text{ to } V_+$	−200 −400	200 400	mA
$V_I$	Digital input voltage <sup>(3) (4)</sup>	−0.5	6.5	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	−65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) 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

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

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

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

		MIN	MAX	UNIT
$V_{IO}$	Switch input/output voltage	0	$V_+$	V
$V_+$	Supply voltage	1.65	5.5	V
$V_I$	Control input voltage	0	5.5	V
$T_A$	Operating temperature	−40	85	°C

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		TS5A3160		UNIT
		DBV (SOT-23)	DCK (SC-70)	
		6 PINS	6 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	165	259	°C/W

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

## 6.5 Electrical Characteristics for 5-V Supply

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	V <sub>+</sub>	MIN	TYP	MAX	UNIT
ANALOG SWITCH									
V <sub>COM</sub> , V <sub>NC</sub> , V <sub>NO</sub>	Analog signal range					0		V <sub>+</sub>	V
r <sub>peak</sub>	Peak ON resistance	0 ≤ (V <sub>NO</sub> or V <sub>NC</sub> ) ≤ V <sub>+</sub> , I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	4.5 V	0.8		1.1	Ω
				Full			1.5		
r <sub>on</sub>	ON-state resistance	V <sub>NO</sub> or V <sub>NC</sub> = 2.5 V, I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	4.5 V	0.7		0.9	Ω
				Full			1.1		
Δr <sub>on</sub>	ON-state resistance match between channels	V <sub>NO</sub> or V <sub>NC</sub> = 2.5 V, I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	4.5 V	0.05		0.1	Ω
				Full			0.1		
r <sub>on(flat)</sub>	ON-state resistance flatness	0 ≤ (V <sub>NO</sub> or V <sub>NC</sub> ) ≤ V <sub>+</sub> , I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	4.5 V	0.15			Ω
		V <sub>NO</sub> or V <sub>NC</sub> = 1 V, 1.5 V, 2.5 V, I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C		0.1	0.25		
				Full			0.25		
I <sub>NC(OFF)</sub> , I <sub>NO(OFF)</sub>	NC, NO OFF leakage current	V <sub>NC</sub> or V <sub>NO</sub> = 1 V, V <sub>COM</sub> = 4.5 V, or V <sub>NO</sub> = 4.5 V, V <sub>COM</sub> = 1 V,	Switch OFF, see <a href="#">Figure 14</a>	25°C	5.5 V	−20	2	20	nA
				Full			−100		
I <sub>NC(PWROFF)</sub> , I <sub>NO(PWROFF)</sub>		V <sub>NC</sub> or V <sub>NO</sub> = 0 to 5.5 V, V <sub>COM</sub> = 5.5 V to 0,	Switch OFF, see <a href="#">Figure 14</a>	25°C	0 V	−1	0.2	1	μA
				Full			−20		
I <sub>NC(ON)</sub> , I <sub>NO(ON)</sub>	NC, NO ON leakage current	V <sub>NC</sub> or V <sub>NO</sub> = 0 to V <sub>+</sub> , V <sub>COM</sub> = Open,	Switch ON, see <a href="#">Figure 15</a>	25°C	5.5 V	−20	2	20	nA
				Full			−100		
I <sub>COM(PWROFF)</sub>	COM OFF leakage current	V <sub>COM</sub> = 0 to 5.5 V, V <sub>NC</sub> or V <sub>NO</sub> = 5.5 V to 0,	Switch OFF, see <a href="#">Figure 14</a>	25°C	0 V	−1	0.1	1	μA
				Full			−20		
I <sub>COM(ON)</sub>	COM ON leakage current	V <sub>COM</sub> = 1 V, V <sub>NC</sub> or V <sub>NO</sub> = Open, or V <sub>COM</sub> = 4.5 V, V <sub>NC</sub> or V <sub>NO</sub> = Open,	Switch ON, see <a href="#">Figure 15</a>	25°C	5.5 V	−20	2	20	nA
				Full			−100		
DIGITAL CONTROL INPUT (IN) <sup>(2)</sup>									
V <sub>IH</sub>	Input logic high			Full		2.4		5.5	V
V <sub>IL</sub>	Input logic low			Full		0		0.8	V
I <sub>IH</sub> , I <sub>IL</sub>	Input leakage current	V <sub>I</sub> = 5.5 V or 0		25°C	5.5 V	−2		0.2	nA
				Full		100		100	

(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  $V_+$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, [SCBA004](#).

**TS5A3160**

SCDS216E –OCTOBER 2005–REVISED NOVEMBER 2017

[www.ti.com](http://www.ti.com)
**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)<sup>(1)</sup>

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	V <sub>+</sub>	MIN	TYP	MAX	UNIT
DYNAMIC									
t <sub>ON</sub>	Turnon time	V <sub>COM</sub> = V <sub>+</sub> , R <sub>L</sub> = 50 Ω,	C <sub>L</sub> = 35 pF, see <a href="#">Figure 17</a>	25°C	5 V	2	3.5	6	ns
				Full	4.5 V to 5.5 V	1		8	
t <sub>OFF</sub>	Turnoff time	V <sub>COM</sub> = V <sub>+</sub> , R <sub>L</sub> = 50 Ω,	C <sub>L</sub> = 35 pF, see <a href="#">Figure 17</a>	25°C	5 V	3	8.5	13	ns
				Full	4.5 V to 5.5 V	2		15	
t <sub>MBB</sub>	Make-before-break time	V <sub>COM</sub> = V <sub>+</sub> , R <sub>L</sub> = 50 Ω,	C <sub>L</sub> = 35 pF, see <a href="#">Figure 18</a>	25°C	5 V	2	7	12	ns
				Full	5 V to 5.5 V	2		15	
Q <sub>C</sub>	Charge injection	V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0,	C <sub>L</sub> = 1 nF, see <a href="#">Figure 22</a>	25°C	5 V		36.5		pC
C <sub>NC(OFF)</sub> , C <sub>NO(OFF)</sub>	NC, NO OFF capacitance	V <sub>NC</sub> or V <sub>NO</sub> = V <sub>+</sub> or GND, Switch OFF,	See <a href="#">Figure 16</a>	25°C	5 V		18		pF
C <sub>NC(ON)</sub> , C <sub>NO(ON)</sub>	NC, NO ON capacitance	V <sub>NC</sub> or V <sub>NO</sub> = V <sub>+</sub> or GND, Switch ON,	See <a href="#">Figure 16</a>	25°C	5 V		55		pF
C <sub>COM(ON)</sub>	COM ON capacitance	V <sub>COM</sub> = V <sub>+</sub> or GND, Switch ON,	See <a href="#">Figure 16</a>	25°C	5 V		55		pF
C <sub>I</sub>	Digital input capacitance	V <sub>I</sub> = V <sub>+</sub> or GND,	See <a href="#">Figure 16</a>	25°C	5 V		2		pF
BW	Bandwidth	R <sub>L</sub> = 50 Ω, Switch ON,	See <a href="#">Figure 19</a>	25°C	5 V		100		MHz
O <sub>ISO</sub>	OFF isolation	R <sub>L</sub> = 50 Ω, f = 10 MHz,	See <a href="#">Figure 20</a>	25°C	5 V		−64		dB
X <sub>TALK</sub>	Crosstalk	R <sub>L</sub> = 50 Ω, f = 1 MHz,	See <a href="#">Figure 20</a>	25°C	5 V		−64		dB
THD	Total harmonic distortion	R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF,	f = 20 Hz to 20 kHz, see <a href="#">Figure 23</a>	25°C	5 V		0.004%		
SUPPLY									
I <sub>+</sub>	Positive supply current	V <sub>I</sub> = V <sub>+</sub> or GND		25°C	5.5 V		10	50	nA
				Full				500	

## 6.6 Electrical Characteristics for 3.3-V Supply

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	V <sub>+</sub>	MIN	TYP	MAX	UNIT
ANALOG SWITCH									
V <sub>COM</sub> , V <sub>NC</sub> , V <sub>NO</sub>	Analog signal range					0		V <sub>+</sub>	V
r <sub>peak</sub>	Peak ON resistance	0 ≤ (V <sub>NO</sub> or V <sub>NC</sub> ) ≤ V <sub>+</sub> , I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	3 V	1.3		1.6	Ω
				Full				2	
r <sub>on</sub>	ON-state resistance	V <sub>NO</sub> or V <sub>NC</sub> = 2 V, I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	3 V	1.2		1.5	Ω
				Full				1.7	
Δr <sub>on</sub>	ON-state resistance match between channels	V <sub>NO</sub> or V <sub>NC</sub> = 2 V, 0.8 V, I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	3 V	0.1		0.15	Ω
				Full				0.15	
r <sub>on(flat)</sub>	ON-state resistance flatness	0 ≤ (V <sub>NO</sub> or V <sub>NC</sub> ) ≤ V <sub>+</sub> , I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	3 V	0.2			Ω
		V <sub>NO</sub> or V <sub>NC</sub> = 2 V, 0.8 V, I <sub>COM</sub> = −100 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C		0.15		0.3	
				Full				0.3	
I <sub>NC(OFF)</sub> , I <sub>NO(OFF)</sub>	NC, NO OFF leakage current	V <sub>NC</sub> or V <sub>NO</sub> = 1 V, V <sub>COM</sub> = 3 V, or V <sub>NC</sub> or V <sub>NO</sub> = 3 V, V <sub>COM</sub> = 1 V,	Switch OFF, see <a href="#">Figure 14</a>	25°C	3.6 V	−20	2	20	nA
				Full		−50		50	
I <sub>NC(PWROFF)</sub> , I <sub>NO(PWROFF)</sub>		V <sub>NC</sub> or V <sub>NO</sub> = 0 to 3.6 V, V <sub>COM</sub> = 3.6 V to 0,	Switch OFF, see <a href="#">Figure 14</a>	25°C	0 V	−1	0.2	1	μA
				Full		−15		15	
I <sub>NC(ON)</sub> , I <sub>NO(ON)</sub>	NC, NO ON leakage current	V <sub>NC</sub> or V <sub>NO</sub> = 1 V, V <sub>COM</sub> = Open, or V <sub>NC</sub> or V <sub>NO</sub> = 3 V, V <sub>COM</sub> = Open,	Switch ON, see <a href="#">Figure 15</a>	25°C	3.6 V	−10	2	10	nA
				Full		−20		20	
I <sub>COM(PWROFF)</sub>	COM OFF leakage current	V <sub>COM</sub> = 0 to 3.6 V, V <sub>NC</sub> or V <sub>NO</sub> = 3.6 V to 0,	Switch OFF, see <a href="#">Figure 14</a>	25°C	0 V	−1	0.2	1	μA
				Full		−15		15	
I <sub>COM(ON)</sub>	COM ON leakage current	V <sub>COM</sub> = 1 V, V <sub>NC</sub> or V <sub>NO</sub> = Open, or V <sub>COM</sub> = 3 V, V <sub>NC</sub> or V <sub>NO</sub> = Open,	Switch ON, see <a href="#">Figure 15</a>	25°C	3.6 V	−10	2	10	nA
				Full		−20		20	
DIGITAL CONTROL INPUT (IN) <sup>(2)</sup>									
V <sub>IH</sub>	Input logic high			Full		2		5.5	V
V <sub>IL</sub>	Input logic low			Full		0		0.8	V
I <sub>IH</sub> , I <sub>IL</sub>	Input leakage current	V <sub>I</sub> = 5.5 V or 0		25°C	3.6 V	−2		2	nA
				Full		−100		100	

(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  $V_+$  or GND to ensure proper device operation. Refer to the TI application report, [Implications of Slow or Floating CMOS Inputs, SCBA004](#).

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

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	V <sub>+</sub>	MIN	TYP	MAX	UNIT
DYNAMIC									
t <sub>ON</sub>	Turnon time	V <sub>COM</sub> = V <sub>+</sub> , R <sub>L</sub> = 50 Ω,	C <sub>L</sub> = 35 pF, see <a href="#">Figure 17</a>	25°C	3.3 V	2	4.5	13	ns
				Full	3 V to 3.6 V	1		15	
t <sub>OFF</sub>	Turnoff time	V <sub>COM</sub> = V <sub>+</sub> , R <sub>L</sub> = 50 Ω,	C <sub>L</sub> = 35 pF, see <a href="#">Figure 17</a>	25°C	3.3 V	3	9	15	ns
				Full	3 V to 3.6 V	2		20	
t <sub>MBB</sub>	Make-before-break time	V <sub>COM</sub> = V <sub>+</sub> , R <sub>L</sub> = 50 Ω,	C <sub>L</sub> = 35 pF, see <a href="#">Figure 18</a>	25°C	3.3 V	1	7	12	ns
				Full	3 V to 3.6 V	1		15	
Q <sub>C</sub>	Charge injection	V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0,	C <sub>L</sub> = 1 nF, see <a href="#">Figure 22</a>	25°C	3.3 V		20		pC
C <sub>NC(OFF)</sub> , C <sub>NO(OFF)</sub>	NC, NO OFF capacitance	V <sub>NC</sub> or V <sub>NO</sub> = V <sub>+</sub> or GND, Switch OFF,	See <a href="#">Figure 16</a>	25°C	3.3 V		18		pF
C <sub>NC(ON)</sub> , C <sub>NO(ON)</sub>	NC, NO ON capacitance	V <sub>NC</sub> or V <sub>NO</sub> = V <sub>+</sub> or GND, Switch ON,	See <a href="#">Figure 16</a>	25°C	3.3 V		55		pF
C <sub>COM(ON)</sub>	COM ON capacitance	V <sub>COM</sub> = V <sub>+</sub> or GND, Switch ON,	See <a href="#">Figure 16</a>	25°C	3.3 V		55		pF
C <sub>I</sub>	Digital input capacitance	V <sub>I</sub> = V <sub>+</sub> or GND,	See <a href="#">Figure 16</a>	25°C	3.3 V		2		pF
BW	Bandwidth	R <sub>L</sub> = 50 Ω, Switch ON,	See <a href="#">Figure 19</a>	25°C	3.3 V		100		MHz
O <sub>ISO</sub>	OFF isolation	R <sub>L</sub> = 50 Ω, f = 10 MHz,	See <a href="#">Figure 20</a>	25°C	3.3 V		−64		dB
X <sub>TALK</sub>	Crosstalk	R <sub>L</sub> = 50 Ω, f = 1 MHz,	See <a href="#">Figure 20</a>	25°C	3.3 V		−64		dB
THD	Total harmonic distortion	R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF,	f = 20 Hz to 20 kHz, see <a href="#">Figure 23</a>	25°C	3.3 V		0.01%		
SUPPLY									
I <sub>+</sub>	Positive supply current	V <sub>I</sub> = V <sub>+</sub> or GND	25°C	3.6 V		10	30	nA	
			Full				100		



## 6.7 Electrical Characteristics for 2.5-V Supply

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	V <sub>+</sub>	MIN	TYP	MAX	UNIT
ANALOG SWITCH									
V <sub>COM</sub> , V <sub>NC</sub> , V <sub>NO</sub>	Analog signal range					0		V <sub>+</sub>	V
r <sub>peak</sub>	Peak ON resistance	0 ≤ (V <sub>NO</sub> or V <sub>NC</sub> ) ≤ V <sub>+</sub> , I <sub>COM</sub> = −8 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	2.3 V	1.8		2.5	Ω
				Full			2.7		
r <sub>on</sub>	ON-state resistance	V <sub>NO</sub> or V <sub>NC</sub> = 1.8 V, I <sub>COM</sub> = −8 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	2.3 V	1.5		2	Ω
				Full			2.4		
Δr <sub>on</sub>	ON-state resistance match between channels	V <sub>NO</sub> or V <sub>NC</sub> = 1.8 V, I <sub>COM</sub> = −8 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	2.3 V	0.15		0.2	Ω
				Full			0.2		
r <sub>on(flat)</sub>	ON-state resistance flatness	0 ≤ (V <sub>NO</sub> or V <sub>NC</sub> ) ≤ V <sub>+</sub> , I <sub>COM</sub> = −8 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	2.3 V	2.6			Ω
		V <sub>NO</sub> or V <sub>NC</sub> = 0.8 V, 1.8 V, I <sub>COM</sub> = −8 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C		0.6	1		
				Full			1		
I <sub>NC(OFF)</sub> , I <sub>NO(OFF)</sub>	NC, NO OFF leakage current	V <sub>NC</sub> or V <sub>NO</sub> = 0.5 V, V <sub>COM</sub> = 2.2 V, or V <sub>NC</sub> or V <sub>NO</sub> = 2.2 V, V <sub>COM</sub> = 0.5 V,	Switch OFF, see <a href="#">Figure 14</a>	25°C	2.3 V	−20	2	20	nA
				Full			−50		
I <sub>NC(PWROFF)</sub> , I <sub>NO(PWROFF)</sub>		V <sub>NC</sub> or V <sub>NO</sub> = 0 to 2.7 V, V <sub>COM</sub> = 2.7 V to 0,	Switch OFF, see <a href="#">Figure 14</a>	25°C	0 V	−1	0.1	1	μA
				Full			−10		
I <sub>NC(ON)</sub> , I <sub>NO(ON)</sub>	NC, NO ON leakage current	V <sub>NC</sub> or V <sub>NO</sub> = 0.5 V, V <sub>COM</sub> = Open, or V <sub>NC</sub> or V <sub>NO</sub> = 2.2 V, V <sub>COM</sub> = Open,	Switch ON, see <a href="#">Figure 15</a>	25°C	2.7 V	−10	2	10	nA
				Full			−20		
I <sub>COM(PWROFF)</sub>	COM OFF leakage current	V <sub>COM</sub> = 0 to 2.7 V, V <sub>NC</sub> or V <sub>NO</sub> = 2.7 V to 0,	Switch OFF, see <a href="#">Figure 14</a>	25°C	0 V	−1	0.1	1	μA
				Full			−10		
I <sub>COM(ON)</sub>	COM ON leakage current	V <sub>COM</sub> = 0.5 V, V <sub>NC</sub> or V <sub>NO</sub> = Open, or V <sub>COM</sub> = 2.2 V, V <sub>NC</sub> or V <sub>NO</sub> = Open,	Switch ON, see <a href="#">Figure 15</a>	25°C	2.7 V	−10	2	10	nA
				Full			−20		
DIGITAL CONTROL INPUT (IN) <sup>(2)</sup>									
V <sub>IH</sub>	Input logic high			Full		1.8		5.5	V
V <sub>IL</sub>	Input logic low			Full		0		0.6	V
I <sub>IH</sub> , I <sub>IL</sub>	Input leakage current	V <sub>I</sub> = 5.5 V or 0		25°C	2.7 V	−2		2	nA
				Full		−20		20	

(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  $V_+$  or GND to ensure proper device operation. Refer to the TI application report, [Implications of Slow or Floating CMOS Inputs](#), [SCBA004](#).

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

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

PARAMETER	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>DYNAMIC</b>							
$t_{ON}$ Turnon time	$V_{COM} = V_+$ , $R_L = 50 \Omega$ , $C_L = 35 \text{ pF}$ , see <a href="#">Figure 17</a>	25°C	2.5 V	2	6.5	15	ns
		Full	2.3 V to 2.7 V	1		17	
$t_{OFF}$ Turnoff time	$V_{COM} = V_+$ , $R_L = 50 \Omega$ , $C_L = 35 \text{ pF}$ , see <a href="#">Figure 17</a>	25°C	2.5 V	3	11	18	ns
		Full	2.3 V to 2.7 V	2		20	
$t_{MBB}$ Make-before-break time	$V_{COM} = V_+$ , $R_L = 50 \Omega$ , $C_L = 35 \text{ pF}$ , see <a href="#">Figure 18</a>	25°C	2.5 V	1	8	12	ns
		Full	2.3 V to 2.7 V	1		15	
$Q_C$ Charge injection	$V_{GEN} = 0$ , $R_{GEN} = 0$ , $C_L = 1 \text{ nF}$ , see <a href="#">Figure 22</a>	25°C	2.5 V		12		pC
$C_{NC(OFF)}$ , $C_{NO(OFF)}$ NC, NO OFF capacitance	$V_{NC}$ or $V_{NO} = V_+$ or GND, Switch OFF, See <a href="#">Figure 16</a>	25°C	2.5 V		18		pF
$C_{NC(ON)}$ , $C_{NO(ON)}$ NC, NO ON capacitance	$V_{NC}$ or $V_{NO} = V_+$ or GND, Switch ON, See <a href="#">Figure 16</a>	25°C	2.5 V		55		pF
$C_{COM(ON)}$ COM ON capacitance	$V_{COM} = V_+$ or GND, Switch ON, See <a href="#">Figure 16</a>	25°C	2.5 V		55		pF
$C_I$ Digital input capacitance	$V_I = V_+$ or GND, See <a href="#">Figure 16</a>	25°C	2.5 V		2		pF
BW Bandwidth	$R_L = 50 \Omega$ , Switch ON, See <a href="#">Figure 19</a>	25°C	2.5 V		100		MHz
$O_{ISO}$ OFF isolation	$R_L = 50 \Omega$ , $f = 10 \text{ MHz}$ , See <a href="#">Figure 20</a>	25°C	2.5 V		-64		dB
$X_{TALK}$ Crosstalk	$R_L = 50 \Omega$ , $f = 1 \text{ MHz}$ , See <a href="#">Figure 20</a>	25°C	2.5 V		-64		dB
THD Total harmonic distortion	$R_L = 600 \Omega$ , $C_L = 50 \text{ pF}$ , $f = 20 \text{ Hz to } 20 \text{ kHz}$ , see <a href="#">Figure 23</a>	25°C	2.5 V		0.02%		
<b>SUPPLY</b>							
$I_+$ Positive supply current	$V_I = V_+$ or GND	25°C	2.7 V		10	30	nA
		Full				50	

## 6.8 Electrical Characteristics for 1.8-V Supply

 $V_+ = 1.65 \text{ V to } 1.95 \text{ V}$ ,  $T_A = -40^\circ\text{C to } 85^\circ\text{C}$  (unless otherwise noted)<sup>(1)</sup>

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	V <sub>+</sub>	MIN	TYP	MAX	UNIT
ANALOG SWITCH									
V <sub>COM</sub> , V <sub>NC</sub> , V <sub>NO</sub>	Analog signal range					0		V <sub>+</sub>	V
r <sub>peak</sub>	Peak ON resistance	0 ≤ (V <sub>NO</sub> or V <sub>NC</sub> ) ≤ V <sub>+</sub> , I <sub>COM</sub> = −2 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	1.65 V	5		15	Ω
				Full					
r <sub>on</sub>	ON-state resistance	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V, I <sub>COM</sub> = −2 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	1.65 V	2	2.5	3.5	Ω
				Full					
Δr <sub>on</sub>	ON-state resistance match between channels	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V, I <sub>COM</sub> = −2 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	1.65 V	0.15		0.4	Ω
				Full		0.4			
r <sub>on(flat)</sub>	ON-state resistance flatness	0 ≤ (V <sub>NO</sub> or V <sub>NC</sub> ) ≤ V <sub>+</sub> , I <sub>COM</sub> = −2 mA,	Switch ON, see <a href="#">Figure 13</a>	25°C	1.65 V	5		Ω	
				25°C		4.5			
				Full					
I <sub>NC(OFF)</sub> , I <sub>NO(OFF)</sub>	NC, NO OFF leakage current	V <sub>NC</sub> or V <sub>NO</sub> = 0.3 V, V <sub>COM</sub> = 1.65 V, or V <sub>NC</sub> or V <sub>NO</sub> = 1.65 V, V <sub>COM</sub> = 0.3 V,	Switch OFF, see <a href="#">Figure 14</a>	25°C	1.95 V	−5	2	5	nA
Full		−20		20					
I <sub>NC(PWROFF)</sub> , I <sub>NO(PWROFF)</sub>		V <sub>NC</sub> or V <sub>NO</sub> = 0 to 1.95 V, V <sub>COM</sub> = 1.95 V to 0,	Switch OFF, see <a href="#">Figure 14</a>	25°C	0 V	−1	0.1	1	μA
Full				−5		5			
I <sub>NC(ON)</sub> , I <sub>NO(ON)</sub>	NC, NO ON leakage current	V <sub>NC</sub> or V <sub>NO</sub> = 0.3 V, V <sub>COM</sub> = Open, or V <sub>NC</sub> or V <sub>NO</sub> = 1.65 V, V <sub>COM</sub> = Open,	Switch ON, see <a href="#">Figure 15</a>	25°C	1.95 V	−5	2	5	nA
				Full		−20		20	
I <sub>COM(PWROFF)</sub>	COM OFF leakage current	V <sub>COM</sub> = 0 to 1.95 V, V <sub>NC</sub> or V <sub>NO</sub> =1.95 V to 0,	Switch OFF, see <a href="#">Figure 14</a>	25°C	0 V	−1	0.1	1	μA
				Full		−5		5	
I <sub>COM(ON)</sub>	COM ON leakage current	V <sub>COM</sub> = 0.3 V, V <sub>NC</sub> or V <sub>NO</sub> = Open, or V <sub>COM</sub> = 1.65 V, V <sub>NC</sub> or V <sub>NO</sub> = Open,	Switch ON, see <a href="#">Figure 15</a>	25°C	1.95 V	−5	2	5	nA
				Full		−20		20	
DIGITAL CONTROL INPUT (IN) <sup>(2)</sup>									
V <sub>IH</sub>	Input logic high			Full		1.5		5.5	V
V <sub>IL</sub>	Input logic low			Full		0		0.6	V
I <sub>IH</sub> , I <sub>IL</sub>	Input leakage current	V <sub>I</sub> = 5.5 V or 0		25°C	1.95 V	−2		2	nA
				Full		−20		20	

(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  $V_+$  or GND to ensure proper device operation. Refer to the TI application report, [Implications of Slow or Floating CMOS Inputs](#), [SCBA004](#).

## Electrical Characteristics for 1.8-V Supply (continued)

 $V_+ = 1.65\text{ V to }1.95\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)<sup>(1)</sup>

PARAMETER		TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>DYNAMIC</b>								
$t_{ON}$	Turnon time	$V_{COM} = V_+$ , $R_L = 50\ \Omega$ ,  $C_L = 35\text{ pF}$ , see <a href="#">Figure 17</a>	25°C	1.8 V	6	13	24	ns
			Full	2.3 V to 2.7 V	5		27	
$t_{OFF}$	Turnoff time	$V_{COM} = V_+$ , $R_L = 50\ \Omega$ ,  $C_L = 35\text{ pF}$ , see <a href="#">Figure 17</a>	25°C	1.8 V	6	15	27	ns
			Full	2.3 V to 2.7 V	5		30	
$t_{MBB}$	Make-before-break time	$V_{COM} = V_+$ , $R_L = 50\ \Omega$ ,  $C_L = 35\text{ pF}$ , see <a href="#">Figure 18</a>	25°C	1.8 V	2	7	12	ns
			Full	2.3 V to 2.7 V	2		15	
$Q_C$	Charge injection	$V_{GEN} = 0$ , $R_{GEN} = 0$ ,  $C_L = 1\text{ nF}$ , see <a href="#">Figure 22</a>	25°C	1.8 V		5.5		pC
$C_{NC(OFF)}$ , $C_{NO(OFF)}$	NC, NO OFF capacitance	$V_{NC}$ or $V_{NO} = V_+$ or GND, Switch OFF,  See <a href="#">Figure 16</a>	25°C	1.8 V		18		pF
$C_{NC(ON)}$ , $C_{NO(ON)}$	NC, NO ON capacitance	$V_{NC}$ or $V_{NO} = V_+$ or GND, Switch ON,  See <a href="#">Figure 16</a>	25°C	1.8 V		55		pF
$C_{COM(ON)}$	COM ON capacitance	$V_{COM} = V_+$ or GND, Switch ON,  See <a href="#">Figure 16</a>	25°C	1.8 V		55		pF
$C_I$	Digital input capacitance	$V_I = V_+$ or GND,  See <a href="#">Figure 16</a>	25°C	1.8 V		2		pF
BW	Bandwidth	$R_L = 50\ \Omega$ , Switch ON,  See <a href="#">Figure 19</a>	25°C	1.8 V		105		MHz
$O_{ISO}$	OFF isolation	$R_L = 50\ \Omega$ , $f = 10\text{ MHz}$ ,  See <a href="#">Figure 20</a>	25°C	1.8 V		-64		dB
$X_{TALK}$	Crosstalk	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ ,  See <a href="#">Figure 20</a>	25°C	1.8 V		-64		dB
THD	Total harmonic distortion	$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ ,  $f = 20\text{ Hz to }20\text{ kHz}$ , see <a href="#">Figure 23</a>	25°C	1.8 V		0.06%		
<b>SUPPLY</b>								
$I_+$	Positive supply current	$V_I = V_+$ or GND	25°C	1.95 V		5	15	nA
			Full				50	

## 6.9 Typical Characteristics

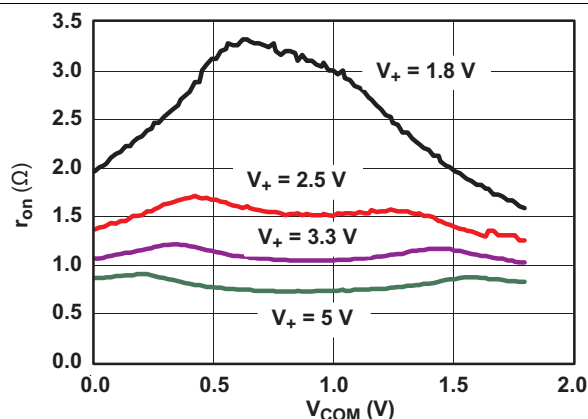


Figure 1.  $r_{on}$  vs  $V_{COM}$

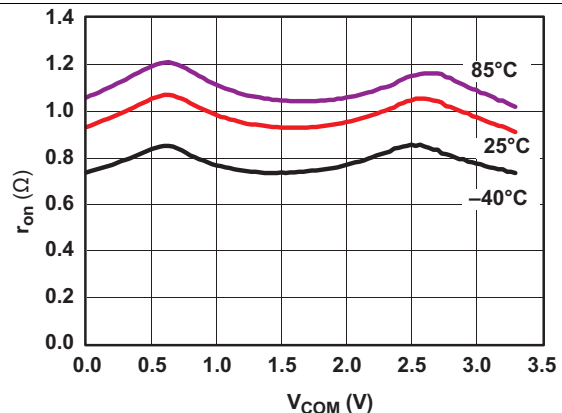


Figure 2.  $r_{on}$  vs  $V_{COM}$  ( $V_+ = 3.3$  V)

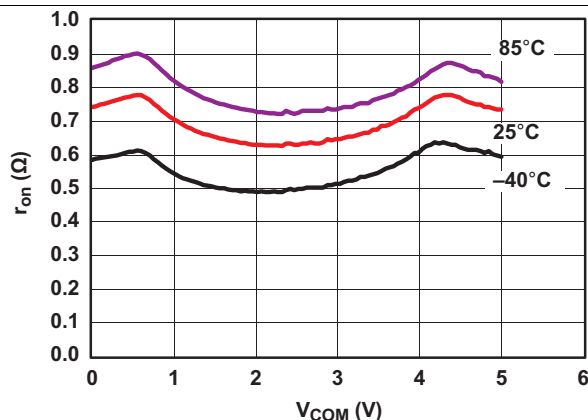


Figure 3.  $r_{on}$  vs  $V_{COM}$  ( $V_+ = 5$  V)

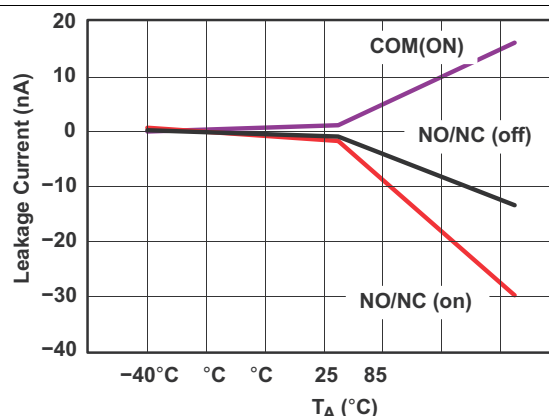


Figure 4. Leakage Current vs Temperature ( $V_+ = 5.5$  V)

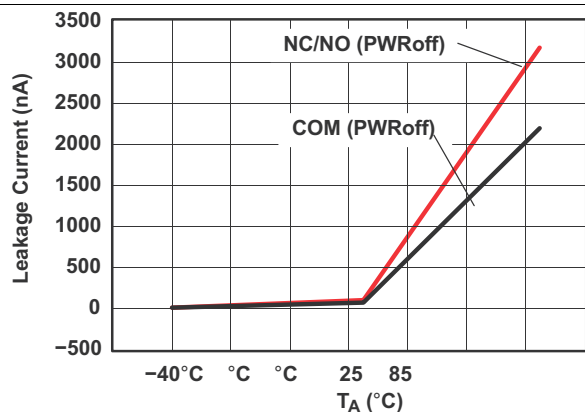


Figure 5. Leakage Current vs Temperature ( $V_+ = 5$  V)

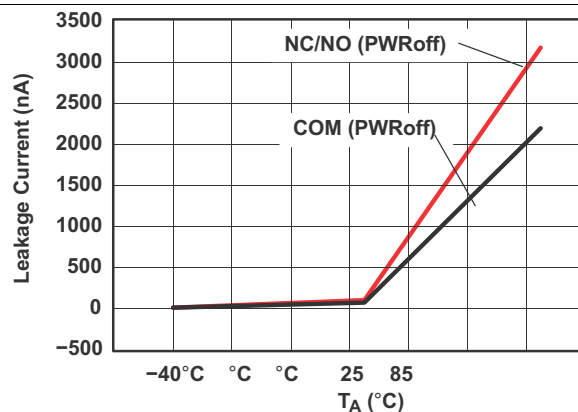


Figure 6. Charge Injection ( $Q_C$ ) vs  $V_{COM}$

## Typical Characteristics (continued)

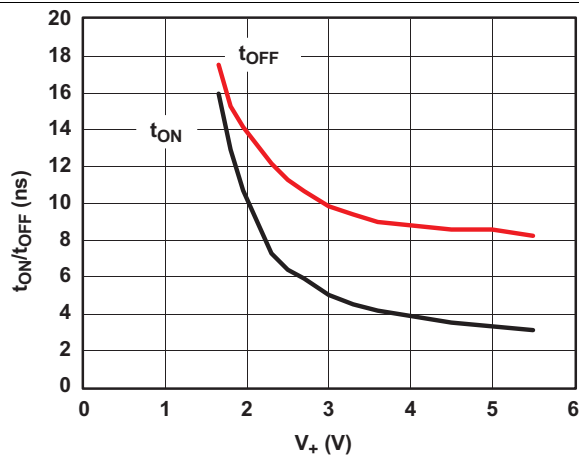
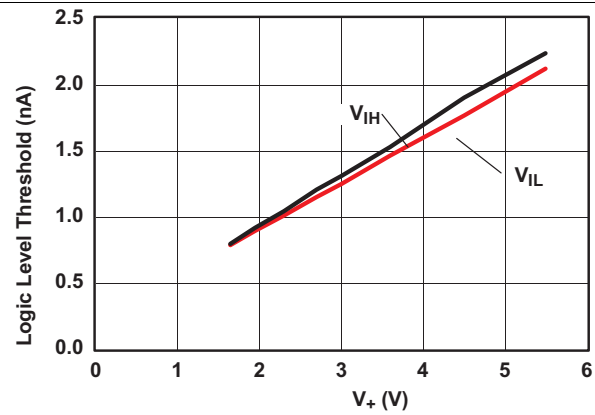
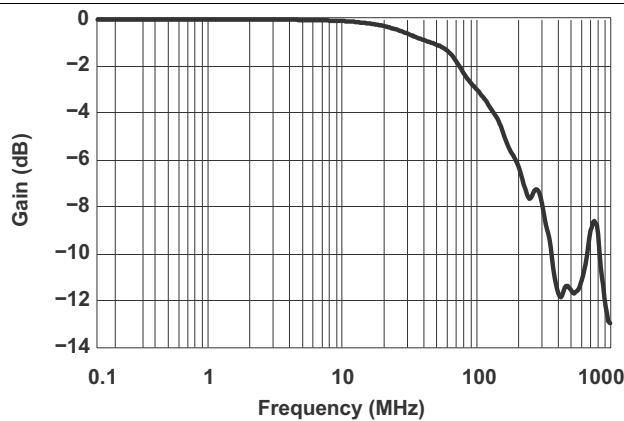
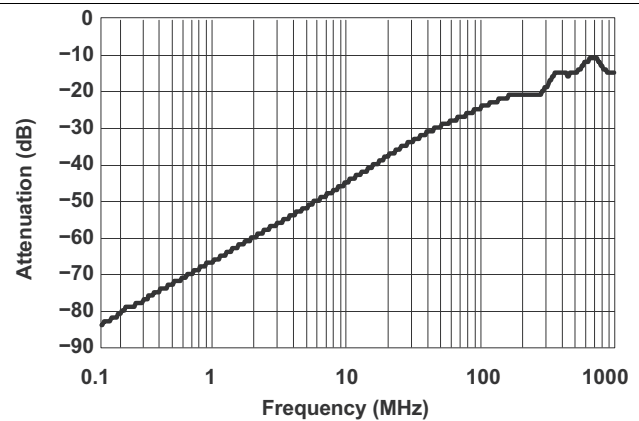
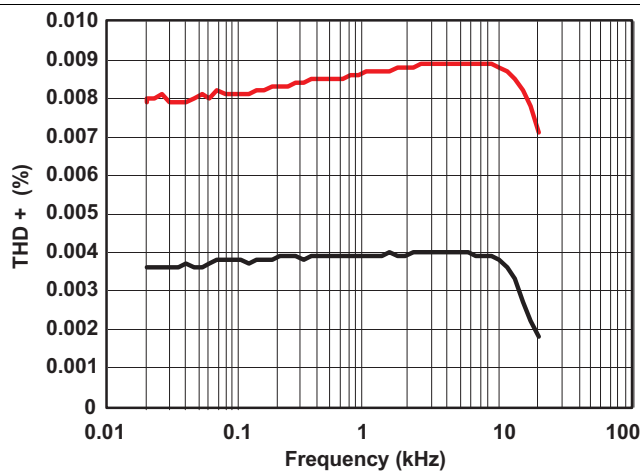
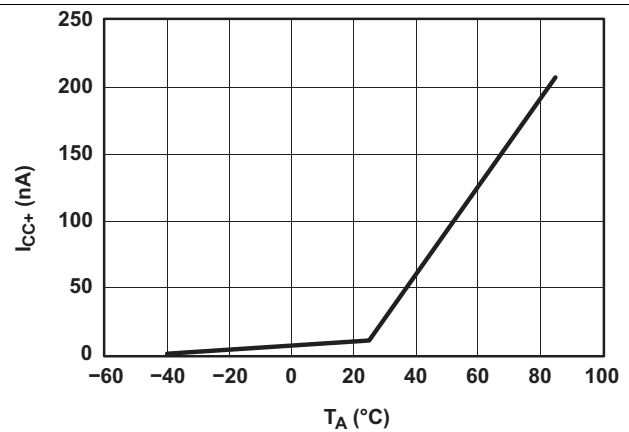
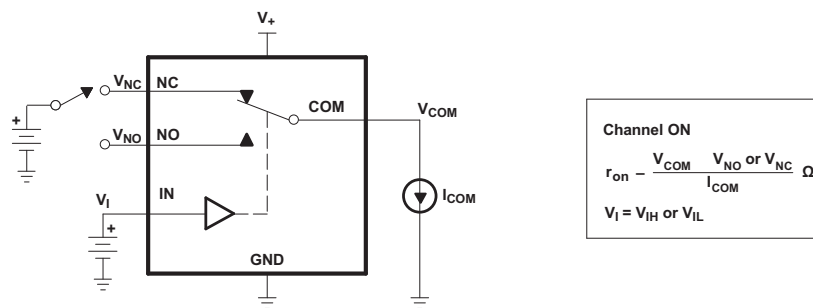

Figure 7.  $t_{ON}$  and  $t_{OFF}$  vs Supply Voltage

Figure 8. Logic-Level Threshold vs V<sub>+</sub>

Figure 9. Bandwidth (Gain vs Frequency) (V<sub>+</sub> = 5 V)

Figure 10. OFF Isolation vs Crosstalk (V<sub>+</sub> = 5 V)


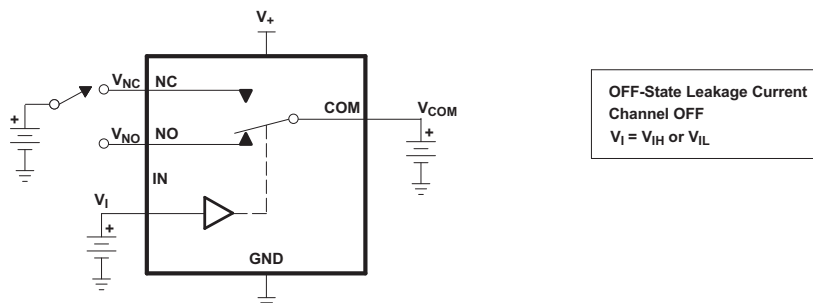
Figure 11. Total Harmonic Distortion vs Frequency


Figure 12. Power-Supply Current vs Temperature (V<sub>+</sub> = 5 V)

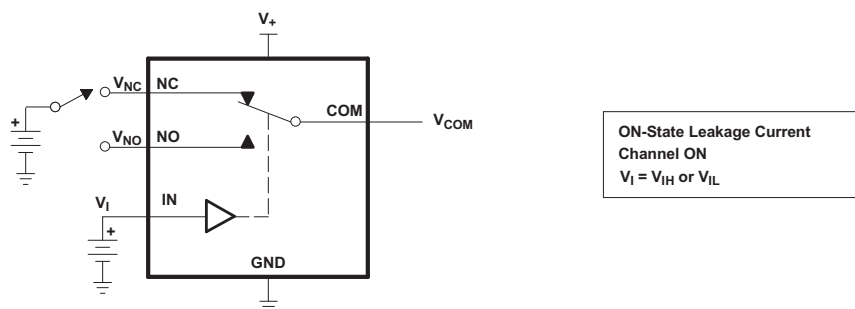
## 7 Parameter Measurement Information



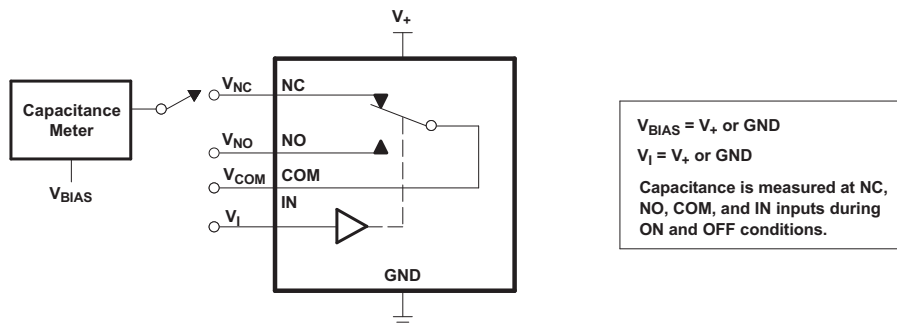
**Figure 13. ON-State Resistance ( $r_{on}$ )**



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

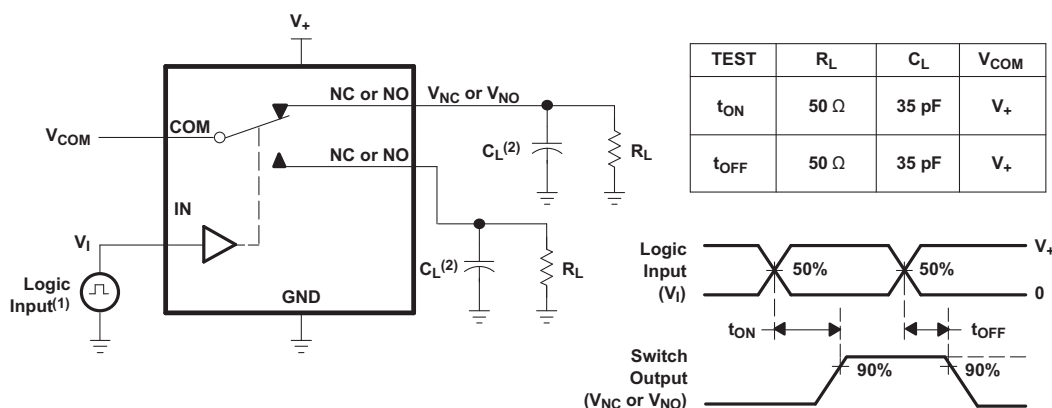


**Figure 15. ON-State Leakage Current ( $I_{COM(ON)}$ ,  $I_{NC(ON)}$ ,  $I_{NO(ON)}$ )**



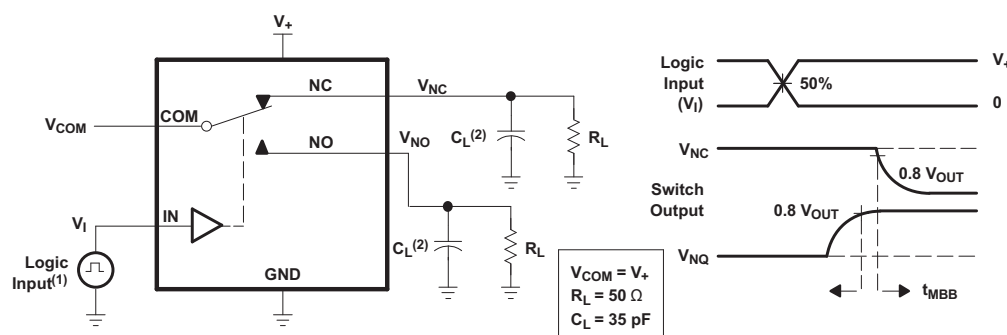
**Figure 16. Capacitance ( $C_I$ ,  $C_{COM(ON)}$ ,  $C_{NC(OFF)}$ ,  $C_{NO(OFF)}$ ,  $C_{NC(ON)}$ ,  $C_{NO(ON)}$ )**

## Parameter Measurement Information (continued)



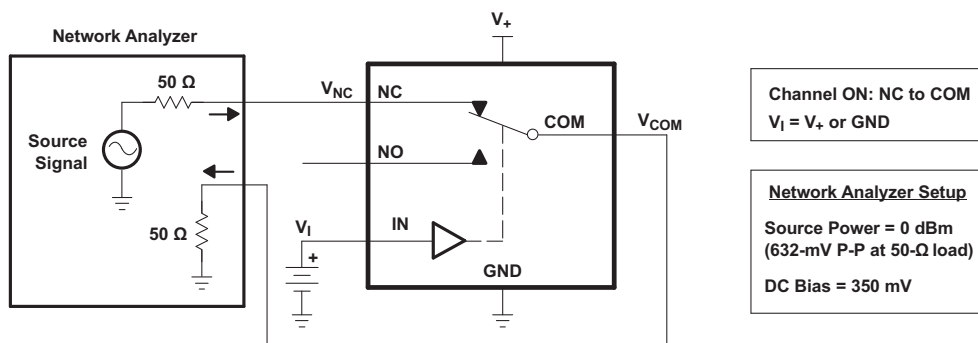
- A. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10$  MHz,  $Z_O = 50 \Omega$ ,  $t_r < 5$  ns,  $t_f < 5$  ns.
- B.  $C_L$  includes probe and jig capacitance.

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



- 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 18. Make-Before-Break Time ( $t_{MBB}$ )**



**Figure 19. Bandwidth (BW)**



**Network Analyzer**

Source Signal

50  $\Omega$

50  $\Omega$

50  $\Omega$

$V_{NC}$

50  $\Omega$

$V_{IN}$

$V_{+}$

NC

NO

IN

COM

$V_{COM}$

GND

Channel OFF: NC to COM  
 $V_I = V_{+}$  or GND

**Network Analyzer Setup**

Source Power = 0 dBm  
 (632-mV P-P at 50- $\Omega$  load)

DC Bias = 350 mV

**Network Analyzer**

Source Signal

50  $\Omega$

50  $\Omega$

V<sub>NC</sub>

V<sub>NO</sub>

V<sub>I</sub>

V<sub>+</sub>

V<sub>COM</sub>

50  $\Omega$

Channel ON: NC to COM  
Channel OFF: NO to COM  
V<sub>I</sub> = V<sub>+</sub> or GND

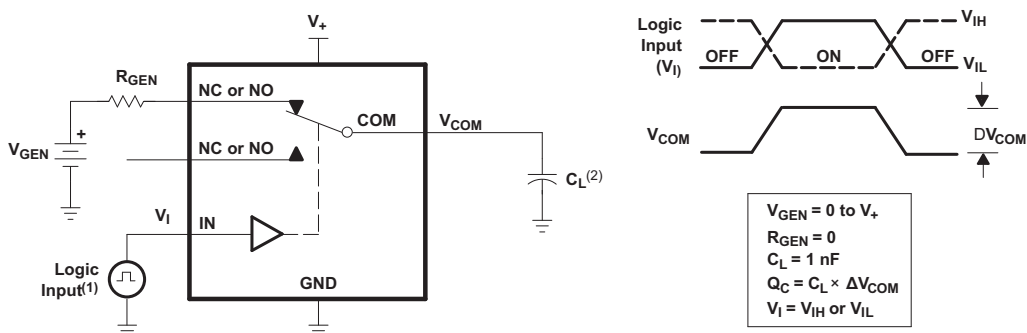
**Network Analyzer Setup**

Source Power = 0 dBm  
(632-mV P-P at 50- $\Omega$  load)

DC Bias = 350 mV

Figure 1: Test circuit and waveforms for the 74VHC14. The circuit diagram shows a 74VHC14 inverter with its input (IN) connected to a logic input source ( $V_I$ ) through a resistor ( $R_{GEN}$ ). The output (COM) is connected to a load capacitor ( $C_L^{(2)}$ ) and a common mode voltage source ( $V_{COM}$ ). The supply voltage is  $V_+$ . The waveforms show the Logic Input ( $V_I$ ) switching between  $V_{IH}$  and  $V_{IL}$ , and the output voltage ( $V_{COM}$ ) switching between  $V_{IH}$  and  $V_{IL}$ . The output voltage ( $V_{COM}$ ) is labeled as  $V_{COM}$  and the load capacitor is labeled as  $C_L^{(2)}$ . A box contains the test conditions:  $V_{GEN} = 0$  to  $V_+$ ,  $R_{GEN} = 0$ ,  $C_L = 1 \text{ nF}$ ,  $Q_C = C_L \times \Delta V_{COM}$ , and  $V_I = V_{IH}$  or  $V_{IL}$ .

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



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

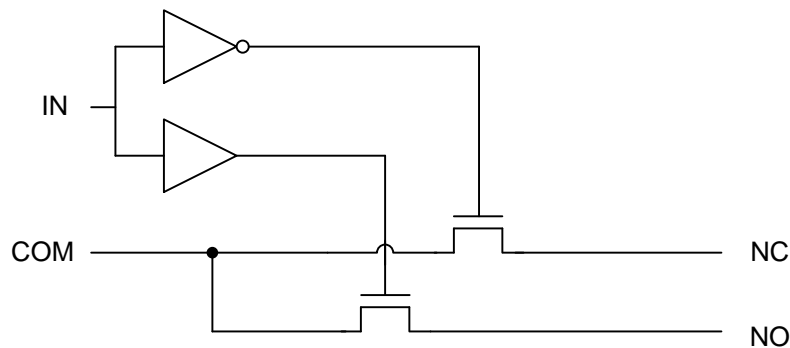
## 8 Detailed Description

### 8.1 Overview

The TS5A3160 is a single-pole-double-throw (SPDT) solid-state analog switch. The TS5A3160, like all analog switches, is bidirectional. When powered on, each COM pin is connected to the NC pin. For this device, NC stands for *normally closed* and NO stands for *normally open*. If IN is low, COM is connected to NC. If IN is high, COM is connected to NO.

The TS5A3160 is a make-before-break switch. This means that during switching, a connection is made before the existing connection is broken. During this brief period, the NC and NO pins are connected to each other.

### 8.2 Functional Block Diagram



### 8.3 Feature Description

The low ON-state resistance, ON-state resistance matching, and charge injection in the TS5A3160 make this switch an excellent choice for analog signals that require minimal distortion. In addition, the low THD allows audio signals to be preserved more clearly as they pass through the device.

The 1.65-V to 5.5-V operation allows compatibility with more logic levels, and the bidirectional I/Os can pass analog signals from 0 V to  $V_+$  with low distortion.

### 8.4 Device Functional Modes

[Table 1](#) lists the functional modes for the TS5A3160.

**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

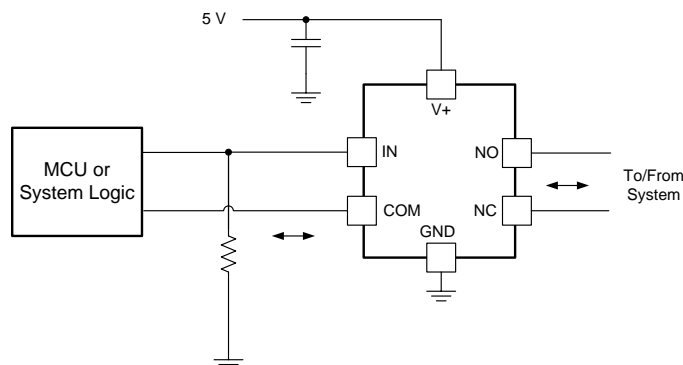
### NOTE

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

The TS5A3160 can be used in a variety of customer systems. The TS5A3160 can be used anywhere multiple analog or digital signals must be selected to pass across a single line.

### 9.2 Typical Application



**Figure 24. System Schematic for TS5A3160**

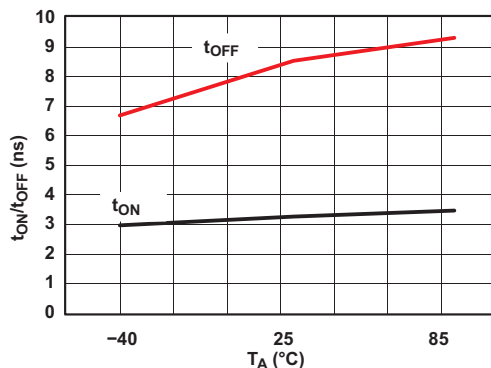
#### 9.2.1 Design Requirements

In this particular application,  $V_+$  was 1.8 V, although  $V_+$  is allowed to be any voltage specified in [Recommended Operating Conditions](#). A decoupling capacitor is recommended on the  $V_+$  pin. See [Power Supply Recommendations](#) for more details.

#### 9.2.2 Detailed Design Procedure

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

#### 9.2.3 Application Curve



**Figure 25.  $t_{ON}$  and  $t_{OFF}$  vs Temperature ( $V_+ = 5\text{ V}$ )**

## 10 Power Supply Recommendations

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

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

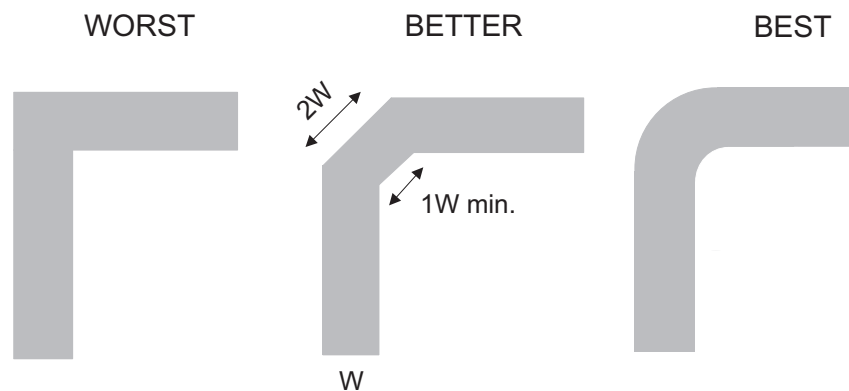
## 11 Layout

### 11.1 Layout Guidelines

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

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

### 11.2 Layout Example



**Figure 26. Trace Example**

## 12 Device and Documentation Support

### 12.1 Device Support

#### 12.1.1 Device Nomenclature

**Table 2. Parameter Description**

SYMBOL	DESCRIPTION
$V_{COM}$	Voltage at COM
$V_{NC}$	Voltage at NC
$V_{NO}$	Voltage at NO
$r_{on}$	Resistance between COM and NO ports when the channel is ON
$r_{peak}$	Peak on-state resistance over a specified voltage range
$\Delta r_{on}$	Difference of $r_{on}$ between channels in a specific device
$r_{on(flat)}$	Difference between the maximum and minimum value of $r_{on}$ in a channel over the specified range of conditions
$I_{NC(OFF)}$	Leakage current measured at the NC port, with the corresponding channel (NC to COM) in the OFF state under worst-case input and output conditions
$I_{NC(PWROFF)}$	Leakage current measured at the NC port during the power-off condition, $V_+ = 0$
$I_{NO(OFF)}$	Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the OFF state
$I_{NO(PWROFF)}$	Leakage current measured at the NO port during the power-off condition, $V_+ = 0$
$I_{NC(ON)}$	Leakage current measured at the NC port, with the corresponding channel (NC to COM) in the ON state and the output (COM) open
$I_{NO(ON)}$	Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the ON state and the output (COM) open
$I_{NO(OFF)}$	Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the OFF state and the output (COM) open
$I_{NO(ON)}$	Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the ON state and the output (COM) open
$I_{COM(OFF)}$	Leakage current measured at the COM port, with the corresponding channel (COM to NO) in the OFF state
$I_{COM(PWROFF)}$	Leakage current measured at the COM port during the power-off condition, $V_+ = 0$
$I_{COM(ON)}$	Leakage current measured at the COM port, with the corresponding channel (COM to NO) in the ON state and the output (NO) open
$V_{IH}$	Minimum input voltage for logic high for the control input (IN)
$V_{IL}$	Maximum input voltage for logic low for the control input (IN)
$V_I$	Voltage at the control input (IN)
$I_{IH}, I_{IL}$	Leakage current measured at the control input (IN)
$t_{ON}$	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 output (COM or NO) signal when the switch is turning ON.
$t_{OFF}$	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 output (COM or NO) signal when the switch is turning OFF.
$t_{MBB}$	Make-before-break time. This parameter is measured under the specified range of conditions and by the propagation delay between the output of two adjacent analog channels (NC and NO) when the control signal changes state.
$Q_C$	Charge injection is a measurement of unwanted signal coupling from the control (IN) input to the analog (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, $Q_C = C_L \times \Delta V_{COM}$ . $C_L$ is the load capacitance and $\Delta V_{COM}$ is the change in analog output voltage.
$C_{NC(OFF)}$	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 NO) is ON
$C_I$	Capacitance of IN
$O_{ISO}$	OFF isolation of the switch is a measurement of OFF-state switch impedance. This is measured in dB in a specific frequency, with the corresponding channel (NO to COM) in the OFF state.

**Table 2. Parameter Description (continued)**

SYMBOL	DESCRIPTION
$X_{TALK}$	Crosstalk is a measurement of unwanted signal coupling from an ON channel to an adjacent ON channel (NC1 to NC2). 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 is defined as the ratio of the root mean square (RMS) value of the second, third, and higher harmonics to the magnitude of fundamental harmonic.
$I_+$	Static power-supply current with the control (IN) pin at $V_+$ or GND

## 12.2 Documentation Support

### 12.2.1 Related Documentation

For related documentation, see the following:

- *Implications of Slow or Floating CMOS Inputs*, [SCBA004](#)

## 12.3 Community Resources

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

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

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

## 12.4 Trademarks

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

## 12.5 Electrostatic Discharge Caution



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

## 12.6 Glossary

[SLYZ022](#) — *TI Glossary*.

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

## 13 Mechanical, Packaging, and Orderable Information

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

## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TS5A3160DBVR	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	JAKR JAKH	<a href="#">Samples</a>
TS5A3160DBVT	ACTIVE	SOT-23	DBV	6	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	JAKR JAKH	<a href="#">Samples</a>
TS5A3160DCKJ	ACTIVE	SC70	DCK	6	10000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(JKK, JKR) JKH	<a href="#">Samples</a>
TS5A3160DCKR	ACTIVE	SC70	DCK	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(JKK, JKR) JKH	<a href="#">Samples</a>
TS5A3160DCKRG4	ACTIVE	SC70	DCK	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(JKK, JKR) JKH	<a href="#">Samples</a>
TS5A3160DCKT	ACTIVE	SC70	DCK	6	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(JKK, JKR) JKH	<a href="#">Samples</a>
TS5A3160DCKTG4	ACTIVE	SC70	DCK	6	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(JKK, JKR) JKH	<a href="#">Samples</a>

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

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

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

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

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

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

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

<sup>(6)</sup> Lead finish/Ball material - Orderable Devices 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.

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**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
TS5A3160DBVR	SOT-23	DBV	6	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
TS5A3160DBVT	SOT-23	DBV	6	250	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
TS5A3160DCKJ	SC70	DCK	6	10000	330.0	8.4	2.3	2.55	1.2	4.0	8.0	Q3
TS5A3160DCKJ	SC70	DCK	6	10000	330.0	8.4	2.41	2.41	1.2	4.0	8.0	Q3
TS5A3160DCKR	SC70	DCK	6	3000	180.0	9.2	2.3	2.55	1.2	4.0	8.0	Q3
TS5A3160DCKR	SC70	DCK	6	3000	180.0	8.4	2.41	2.41	1.2	4.0	8.0	Q3
TS5A3160DCKT	SC70	DCK	6	250	180.0	8.4	2.41	2.41	1.2	4.0	8.0	Q3
TS5A3160DCKT	SC70	DCK	6	250	180.0	9.2	2.3	2.55	1.2	4.0	8.0	Q3

## TAPE AND REEL BOX DIMENSIONS



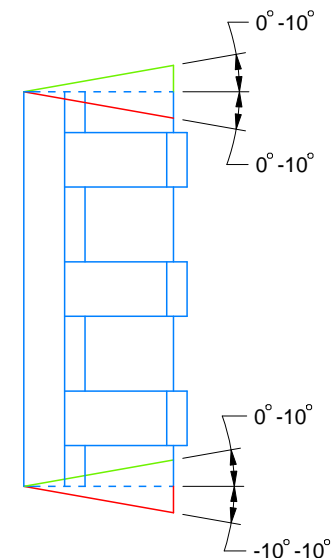
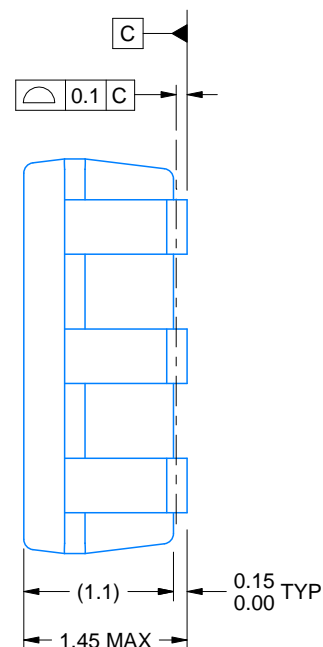
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS5A3160DBVR	SOT-23	DBV	6	3000	202.0	201.0	28.0
TS5A3160DBVT	SOT-23	DBV	6	250	202.0	201.0	28.0
TS5A3160DCKJ	SC70	DCK	6	10000	182.0	182.0	20.0
TS5A3160DCKJ	SC70	DCK	6	10000	358.0	335.0	35.0
TS5A3160DCKR	SC70	DCK	6	3000	205.0	200.0	33.0
TS5A3160DCKR	SC70	DCK	6	3000	202.0	201.0	28.0
TS5A3160DCKT	SC70	DCK	6	250	202.0	201.0	28.0
TS5A3160DCKT	SC70	DCK	6	250	205.0	200.0	33.0



## SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



### ALTERNATIVE PACKAGE SINGULATION VIEW

4214840/D 09/2023

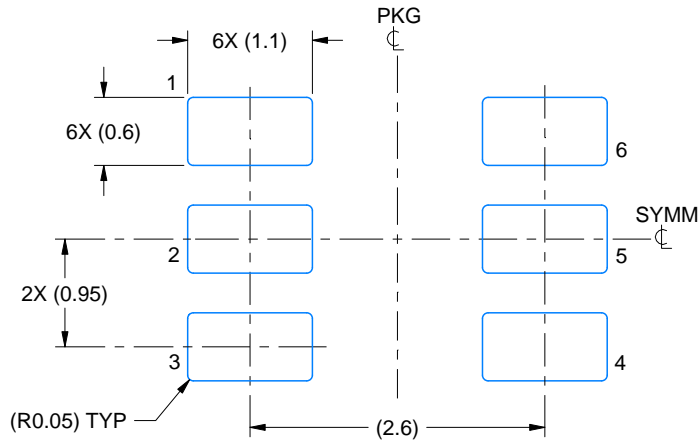
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.25 per side.
4. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
5. Reference JEDEC MO-178.

# EXAMPLE BOARD LAYOUT

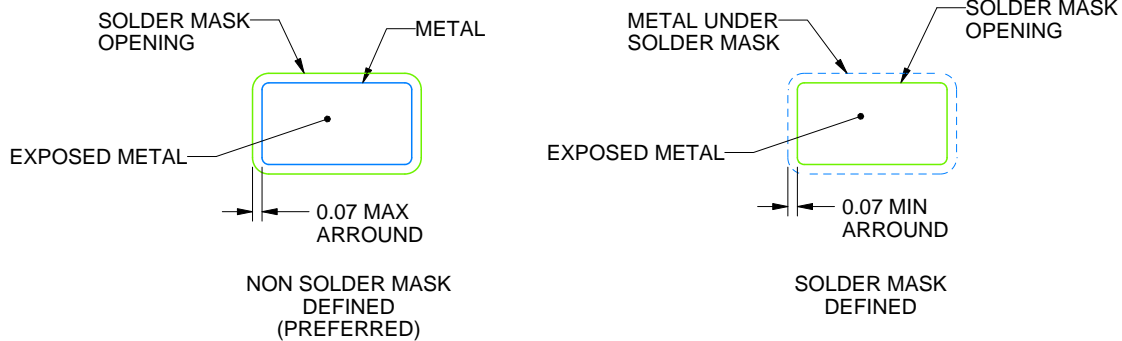
DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4214840/D 09/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

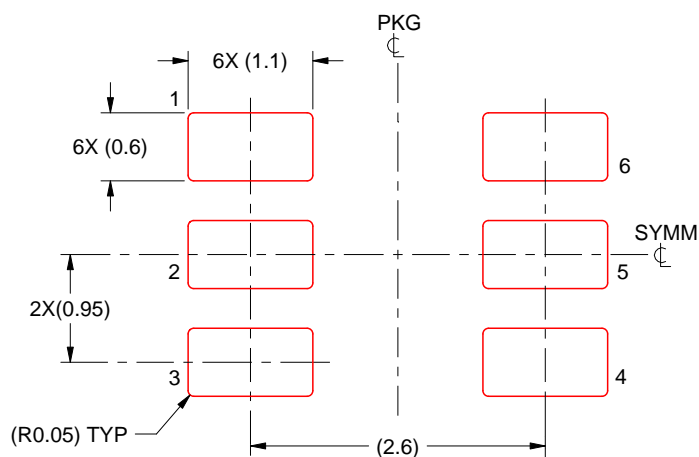
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

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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.

## DCK (R-PDSO-G6)

## PLASTIC SMALL-OUTLINE PACKAGE



4093553-4/G 01/2007

- 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.

DCK (R-PDSO-G6)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - E. 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

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