

## TS3A5017 Dual SP4T Analog Switch / Multiplexer / Demultiplexer

### 1 Features

- Isolation in the Powered-Down Mode,  $V_+ = 0$
- Low ON-State Resistance
- Low Charge Injection
- Excellent ON-State Resistance Matching
- Low Total Harmonic Distortion (THD)
- 2.3-V to 3.6-V Single-Supply Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance Tested Per JESD 22
  - 1500-V Human-Body Model (A114-B, Class II)
  - 1000-V Charged-Device Model (C101)

### 2 Applications

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

### 3 Description

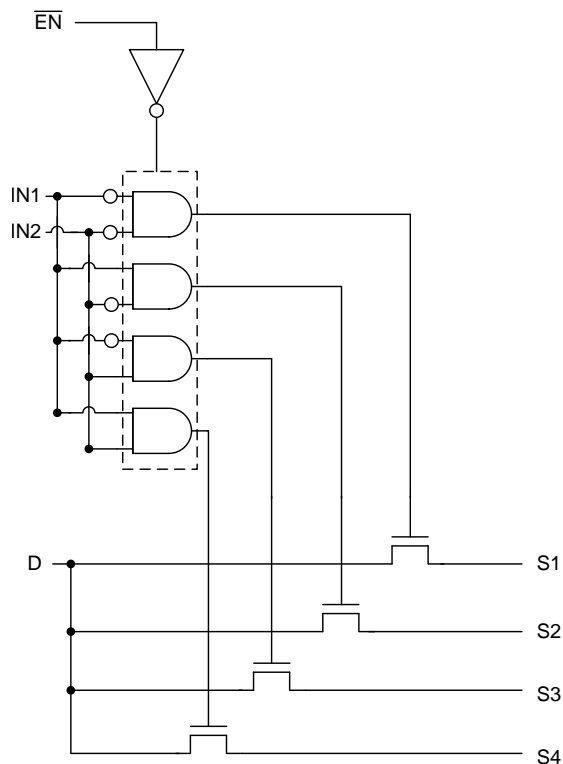
The TS3A5017 device is a dual single-pole quadruple-throw (4:1) analog switch that is designed to operate from 2.3 V to 3.6 V. This device can handle both digital and analog signals, and signals up to  $V_+$  can be transmitted in either direction.

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

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TS3A5017	SOIC (16)	9.90 mm × 3.90 mm
	SSOP (16)	4.90 mm × 3.90 mm
	TSSOP (16)	5.00 mm × 4.40 mm
	TVSOP (16)	4.40 mm × 3.60 mm
	UQFN (16)	2.50 mm × 1.80 mm
	VQFN (16)	4.00 mm × 3.50 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

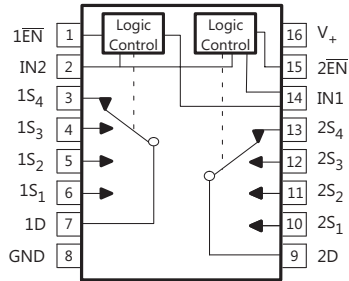
Changes from Revision F (October 2018) to Revision G	Page
• Changed <i>Feature</i> From: 2000-V Human-Body Model To: 1500-V Human-Body Model .....	1
• Changed the HBM value From: $\pm 2000$ V To: $\pm 1500$ V in the <i>ESD Ratings</i> .....	4

Changes from Revision E (April 2015) to Revision F	Page
• Changed the $X_{TALK}$ MAX value From: $-49$ dB To $-69$ dB in the <i>Electrical Characteristics for 3.3-V Supply</i> .....	6

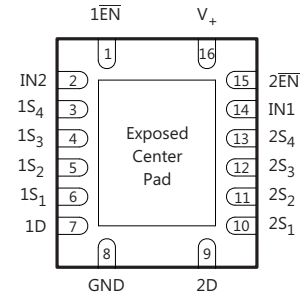
Changes from Revision D (December 2008) to Revision E	Page
• Added <i>Applications</i> , <i>Device Information</i> table, <i>Pin Functions</i> table, <i>ESD Ratings</i> table, <i>Thermal Information</i> table, <i>Typical Characteristics</i> , <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section. ....	1
• Deleted <i>Ordering Information</i> table. ....	1

## 5 Pin Configuration and Functions

**D, DBQ, DGV, and PW Package  
16-Pin SOIC, SSOP, TVSOP and TSSOP  
(Top View)**

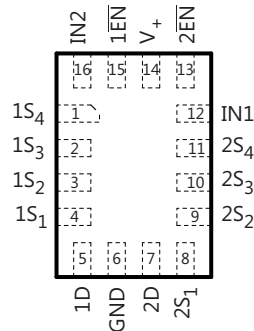


**RGY Package  
16-Pin VQFN  
(Top View)**



If exposed center pad is used, it must be connected as a secondary ground or left electrically open.

**RSV Package  
16-Pin UQFN  
(Top View)**



### Pin Functions

NAME	PIN		TYPE	DESCRIPTION
	SOIC, SSOP, TVSOP, TSSOP, VQFN NO.	UQFN NO.		
1D	7	5	I/O	Common path for switch 1
1EN	1	15	I	Active-low enable for switch 1
1S1	6	4	I/O	Switch 1 channel 1
1S2	5	3	I/O	Switch 1 channel 2
1S3	4	2	I/O	Switch 1 channel 3
1S4	3	1	I/O	Switch 1 channel 4
2D	9	7	I/O	Common path for switch 2
2EN	15	13	I	Active-low enable for switch 2
2S1	10	8	I/O	Switch 2 channel 1
2S2	11	9	I/O	Switch 2 channel 2
2S3	12	10	I/O	Switch 2 channel 3
2S4	13	11	I/O	Switch 2 channel 4
GND	8	6	–	Ground
IN1	14	12	I	Switch 1 input select
IN2	2	16	I	Switch 2 input select
V+	16	14	–	Supply voltage

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V <sub>+</sub>	Supply voltage <sup>(3)</sup>	-0.5	4.6	V
V <sub>S</sub> , V <sub>D</sub>	Analog voltage <sup>(3)(4)</sup>	-0.5	4.6	V
I <sub>SK</sub> , I <sub>DK</sub>	Analog port clamp current	V <sub>S</sub> , V <sub>D</sub> < 0		mA
I <sub>S</sub> , I <sub>D</sub>	ON-state switch current	V <sub>S</sub> , V <sub>D</sub> = 0 to 7 V		mA
V <sub>I</sub>	Digital input voltage	-0.5	4.6	V
I <sub>IK</sub>	Digital input clamp current <sup>(3)(4)</sup>	V <sub>I</sub> < 0		mA
I <sub>+</sub>	Continuous current through V <sub>+</sub>		100	mA
I <sub>GND</sub>	Continuous current through GND	-100		mA
T <sub>stg</sub>	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.

### 6.2 ESD Ratings

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

- (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 <sub>I/O</sub>	Switch input/output voltage range	0	3.6	V
V <sub>+</sub>	Supply voltage range	2.3	3.6	V
V <sub>I</sub>	Control input voltage range	0	3.6	V
T <sub>A</sub>	Operating Temperature Range	-40	85	°C

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>	TS3A5018						UNIT	
	D (SOIC)	DBQ (SSOP)	DGV (TVSOP)	PW (TSSOP)	RGY (VQFN)	RSV (UQFN)		
	16 PINS	16 PINS	16 PINS	16 PINS	16 PINS	16 PINS		
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	73	82	120	108	91.6	184	°C/W

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

## 6.5 Electrical Characteristics for 3.3-V Supply

 $V_+ = 2.7\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)<sup>(1)</sup>

PARAMETER		TEST CONDITIONS		$T_A$	$V_+$	MIN	TYP	MAX	UNIT	
<b>Analog Switch</b>										
$V_D, V_S$	Analog signal range					0		$V_+$	V	
$r_{on}$	ON-state resistance	$0 \leq V_S \leq V_+$ , $I_D = -32\text{ mA}$ ,	Switch ON, see <a href="#">Figure 12</a>	25°C	3 V		11	12	$\Omega$	
				Full			14			
$\Delta r_{on}$	ON-state resistance match between channels	$V_S = 2.1\text{ V}$ , $I_D = -32\text{ mA}$ ,	Switch ON, see <a href="#">Figure 12</a>	25°C	3 V		1	2	$\Omega$	
				Full			3			
$r_{on(Flat)}$	ON-state resistance flatness	$0 \leq V_S \leq V_+$ , $I_D = -32\text{ mA}$ ,	Switch ON, see <a href="#">Figure 12</a>	25°C	3 V		7	9	$\Omega$	
				Full			10			
$I_{S(OFF)}$	S OFF leakage current	$V_S = 1\text{ V}, V_D = 3\text{ V}$ , or $V_S = 3\text{ V}, V_D = 1\text{ V}$ ,	Switch OFF, see <a href="#">Figure 13</a>	25°C	3.6 V		-0.1	0.05	0.1	$\mu\text{A}$
				Full			-0.2	0.2		
$I_{SPWR(OFF)}$		$V_S = 0\text{ to }3.6\text{ V}$ , $V_D = 3.6\text{ V to }0$ ,		25°C	0 V		-1	0.5	1	$\mu\text{A}$
				Full			-5	5		
$I_{D(OFF)}$	D OFF leakage current	$V_S = 1\text{ V}, V_D = 3\text{ V}$ , or $V_S = 3\text{ V}, V_D = 1\text{ V}$ ,	Switch OFF, see <a href="#">Figure 13</a>	25°C	3.6 V		-0.1	0.05	0.1	$\mu\text{A}$
				Full			-0.2	0.2		
$I_{DPWR(OFF)}$		$V_D = 0\text{ to }3.6\text{ V}$ , $V_S = 3.6\text{ V to }0$ ,		25°C	0 V		-1	0.5	1	$\mu\text{A}$
				Full			-5	5		
$I_{S(ON)}$	S ON leakage current	$V_S = 1\text{ V}, V_D = \text{Open}$ , or $V_S = 3\text{ V}, V_D = \text{Open}$ ,	Switch ON, see <a href="#">Figure 14</a>	25°C	3.6 V		-0.1	0.05	0.1	$\mu\text{A}$
				Full			-0.2	0.2		
$I_{D(ON)}$	D ON leakage current	$V_D = 1\text{ V}, V_S = \text{Open}$ , or $V_D = 3\text{ V}, V_S = \text{Open}$ ,	Switch ON, see <a href="#">Figure 14</a>	25°C	3.6 V		-0.1	0.05	0.1	$\mu\text{A}$
				Full			-0.2	0.2		
<b>Digital Control Inputs (IN1, IN2, EN)<sup>(2)</sup></b>										
$V_{IH}$	Input logic high			Full		2		$V_+$	V	
$V_{IL}$	Input logic low			Full		0		0.8	V	
$I_{IH}, I_{IL}$	Input leakage current	$V_I = V_+$ or 0		25°C	3.6 V		-1	0.05	1	$\mu\text{A}$
				Full			-1	1		
$Q_C$	Charge injection	$V_{GEN} = 0, R_{GEN} = 0$ , $C_L = 0.1\text{ nF}$ ,	See <a href="#">Figure 21</a>	25°C	3.3 V		5		pC	
$C_{S(OFF)}$	S OFF capacitance	$V_S = V_+$ or GND, Switch OFF,	See <a href="#">Figure 15</a>	25°C	3.3 V		4.5		pF	
$C_{D(OFF)}$	D OFF capacitance	$V_D = V_+$ or GND, Switch OFF,	See <a href="#">Figure 15</a>	25°C	3.3 V		19		pF	
$C_{S(ON)}$	S ON capacitance	$V_S = V_+$ or GND, Switch ON,	See <a href="#">Figure 15</a>	25°C	3.3 V		25		pF	
$C_{D(ON)}$	D ON capacitance	$V_D = V_+$ or GND, Switch ON,	See <a href="#">Figure 15</a>	25°C	3.3 V		25		pF	
$C_I$	Digital input capacitance	$V_I = V_+$ or GND,	See <a href="#">Figure 15</a>	25°C	3.3 V		2		pF	
BW	Bandwidth	$R_L = 50\ \Omega$ , Switch ON,	See <a href="#">Figure 17</a>	25°C	3.3 V		165		MHz	
$O_{ISO}$	OFF isolation	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ ,	See <a href="#">Figure 18</a>	25°C	3.3 V		-69		dB	

(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*, literature number SCBA004.

**Electrical Characteristics for 3.3-V Supply (continued)**
 $V_+ = 2.7\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)<sup>(1)</sup>

PARAMETER		TEST CONDITIONS		$T_A$	$V_+$	MIN	TYP	MAX	UNIT
$X_{\text{TALK}}$	Crosstalk	$R_L = 50\ \Omega$ , $f = 1\ \text{MHz}$ ,	See <a href="#">Figure 19</a>	25°C	3.3 V		-69		dB
$X_{\text{TALK(ADJ)}}$	Crosstalk adjacent	$R_L = 50\ \Omega$ , $f = 1\ \text{MHz}$ ,	See <a href="#">Figure 20</a>	25°C	3.3 V		-74		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 22</a>	25°C	3.3 V		0.21%		
<b>Supply</b>									
$I_+$	Positive supply current	$V_I = V_+$ or GND,	Switch ON or OFF	25°C	3.6 V		2.5	7	$\mu\text{A}$
				Full				10	

**6.6 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		$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Analog Switch</b>									
$V_D, V_S$	Analog signal range					0		$V_+$	V
$r_{\text{on}}$	ON-state resistance	$0 \leq V_S \leq V_+$ , $I_D = -24\ \text{mA}$ ,	Switch ON, see <a href="#">Figure 12</a>	25°C	2.3 V		20.5	22	$\Omega$
				Full				24	
$\Delta r_{\text{on}}$	ON-state resistance match between channels	$V_S = 1.6\ \text{V}$ , $I_D = -24\ \text{mA}$ ,	Switch ON, see <a href="#">Figure 12</a>	25°C	2.3 V		1	2	$\Omega$
				Full				3	
$r_{\text{on(Flat)}}$	ON-state resistance flatness	$0 \leq V_S \leq V_+$ , $I_D = -24\ \text{mA}$ ,	Switch ON, see <a href="#">Figure 12</a>	25°C	2.3 V		16	18	$\Omega$
				Full				20	
$I_{\text{S(OFF)}}$	S OFF leakage current	$V_S = 0.5\ \text{V}$ , $V_D = 2.2\ \text{V}$ , or $V_S = 2.2\ \text{V}$ , $V_D = 0.5\ \text{V}$ ,	Switch OFF, see <a href="#">Figure 13</a>	25°C	2.7 V	-0.1	0.05	0.1	$\mu\text{A}$
$I_{\text{SPWR(OFF)}}$		$V_S = 0\ \text{to }2.7\ \text{V}$ , $V_D = 2.7\ \text{V to }0$ ,		Full		0 V	-0.2		
$I_{\text{D(OFF)}}$	D OFF leakage current	$V_S = 0.5\ \text{V}$ , $V_D = 2.2\ \text{V}$ , or $V_S = 2.2\ \text{V}$ , $V_D = 0.5\ \text{V}$ ,	Switch OFF, see <a href="#">Figure 13</a>	25°C	2.7 V	-0.1	0.05	0.1	$\mu\text{A}$
$I_{\text{DPWR(OFF)}}$		$V_D = 0\ \text{to }2.7\ \text{V}$ , $V_S = 2.7\ \text{V to }0$ ,		Full		0 V	-0.2		
$I_{\text{S(ON)}}$	S ON leakage current	$V_S = 0.5\ \text{V}$ , $V_D = \text{Open}$ , or $V_S = 2.2\ \text{V}$ , $V_D = \text{Open}$ ,	Switch ON, see <a href="#">Figure 14</a>	25°C	2.7 V	-0.1	0.05	0.1	$\mu\text{A}$
$I_{\text{D(ON)}}$	D ON leakage current	$V_D = 0.5\ \text{V}$ , $V_S = \text{Open}$ , or $V_D = 2.2\ \text{V}$ , $V_S = \text{Open}$ ,	Switch ON, see <a href="#">Figure 14</a>	Full		2.7 V	-0.2		
<b>Digital Control Inputs (IN1, IN2, EN)<sup>(2)</sup></b>									
$V_{\text{IH}}$	Input logic high			Full		1.7		$V_+$	V
$V_{\text{IL}}$	Input logic low			Full		0		0.7	V
$I_{\text{IH}}, I_{\text{IL}}$	Input leakage current	$V_I = V_+$ or 0		25°C	2.7 V	-1	0.05	1	$\mu\text{A}$
				Full			-1		
$Q_C$	Charge injection	$V_{\text{GEN}} = 0$ , $R_{\text{GEN}} = 0$ , $C_L = 0.1\ \text{nF}$ ,	See <a href="#">Figure 21</a>	25°C	2.5 V				pC
$C_{\text{S(OFF)}}$	S OFF capacitance	$V_S = V_+$ or GND, Switch OFF,	See <a href="#">Figure 15</a>	25°C	2.5 V		4.5		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  $V_+$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

## Electrical Characteristics for 2.5-V Supply (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
$C_{D(OFF)}$	D OFF capacitance	$V_D = V_+$ or GND, Switch OFF,	See Figure 15	25°C	2.5 V		18.5		pF
$C_{S(ON)}$	S ON capacitance	$V_S = V_+$ or GND, Switch ON,	See Figure 15	25°C	2.5 V		24		pF
$C_{D(ON)}$	D ON capacitance	$V_D = V_+$ or GND, Switch ON,	See Figure 15	25°C	2.5 V		24		pF
$C_I$	Digital input capacitance	$V_I = V_+$ or GND,	See Figure 15	25°C	2.5 V		2		pF
BW	Bandwidth	$R_L = 50\ \Omega$ , Switch ON,	See Figure 17	25°C	2.5 V		165		MHz
$O_{ISO}$	OFF isolation	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ ,	See Figure 18	25°C	2.5 V		-69		dB
$X_{TALK}$	Crosstalk	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ ,	See Figure 19	25°C	2.5 V		-69		dB
$X_{TALK(ADJ)}$	Crosstalk adjacent	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ ,	See Figure 20	25°C	2.5 V		-74		dB
THD	Total harmonic distortion	$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ ,	$f = 20\text{ Hz to }20\text{ kHz}$ , see Figure 22	25°C	2.5 V		0.29%		
<b>Supply</b>									
$I_+$	Positive supply current	$V_I = V_+$ or GND,	Switch ON or OFF	25°C	2.7 V		2.5	7	$\mu\text{A}$
				Full					

## 6.7 Switching Characteristics for 3.3-V supply

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

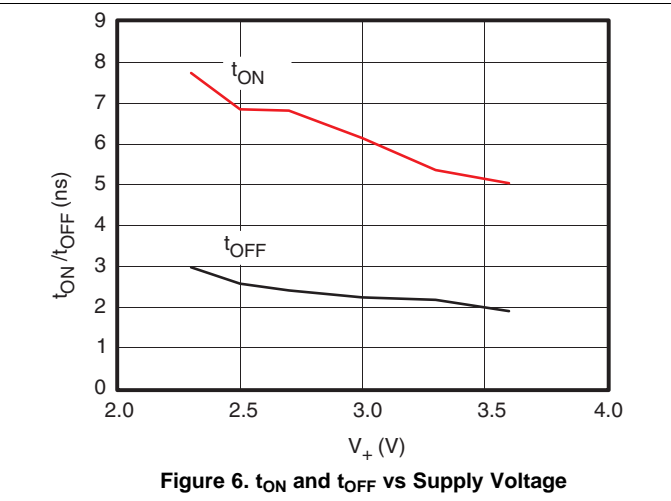
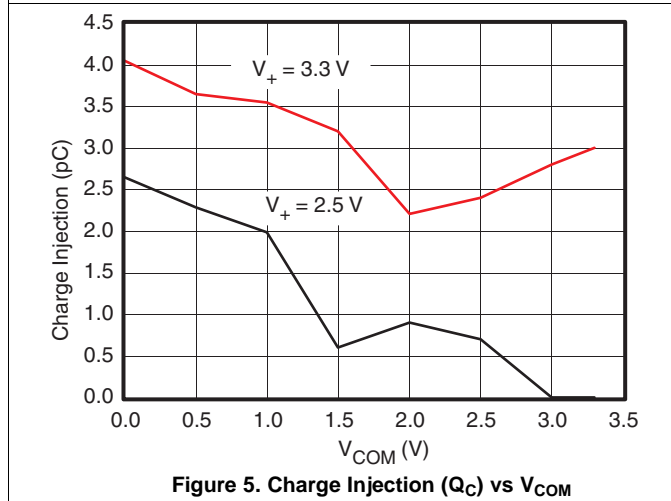
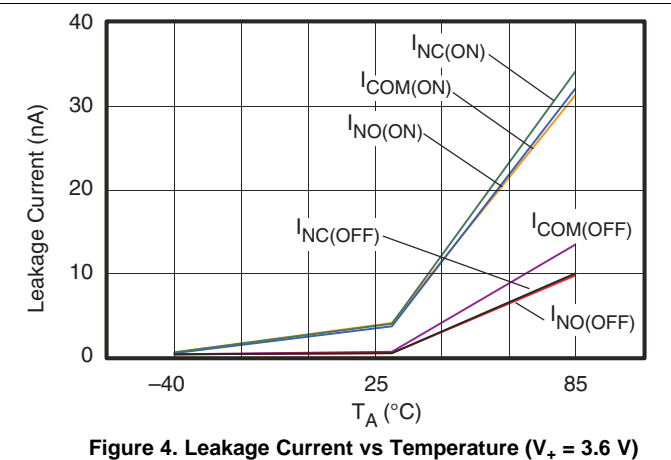
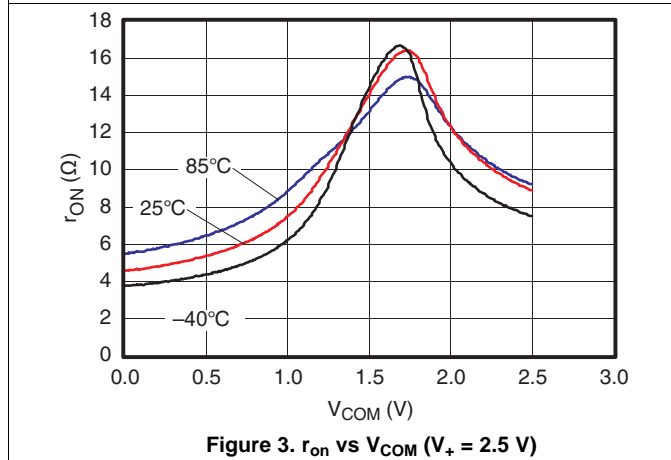
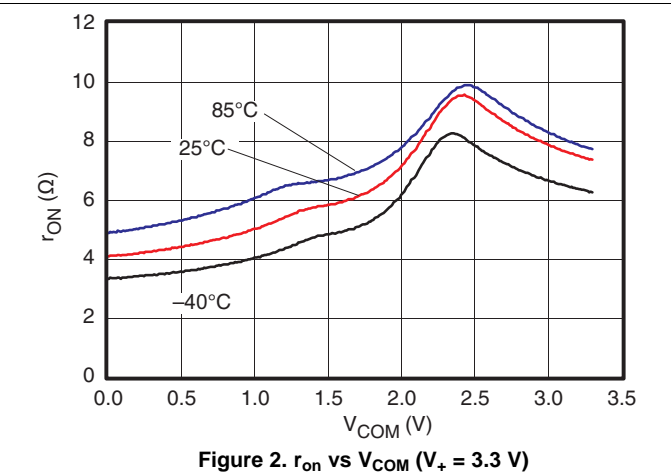
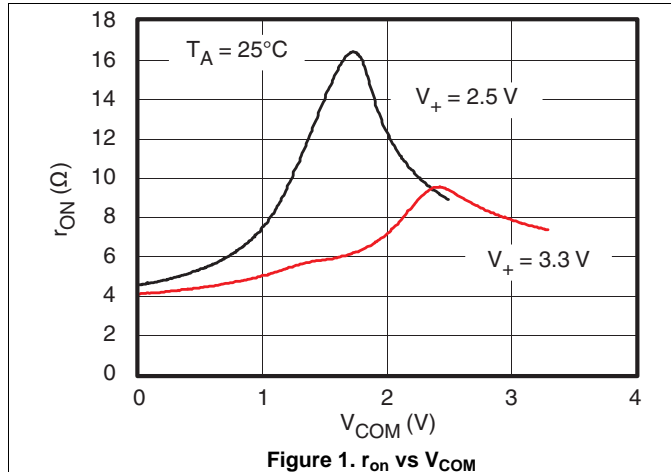
PARAMETER		TEST CONDITIONS		$T_A$	$V_+$	MIN	TYP	MAX	UNIT
$t_{ON}$	Turnon time	$V_D = 2\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , see Figure 16	25°C	3.3 V	1	5	9.5	ns
				Full	3 V to 3.6 V	1		10.5	
$t_{OFF}$	Turnoff time	$V_D = 2\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , see Figure 16	25°C	3.3 V	0.5	1.5	3.5	ns
				Full	3 V to 3.6 V	0.5		4.5	

## 6.8 Switching Characteristics for 2.5-V supply

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

PARAMETER		TEST CONDITIONS		$T_A$	$V_+$	MIN	TYP	MAX	UNIT
$t_{ON}$	Turnon time	$V_{COM} = 2\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , see Figure 16	25°C	2.5 V	1.5	5	8	ns
				Full	2.3 V to 2.7 V	1		10	
$t_{OFF}$	Turnoff time	$V_{COM} = 2\text{ V}$ , $R_L = 300\ \Omega$ ,	$C_L = 35\text{ pF}$ , see Figure 16	25°C	2.5 V	0.3	2	4.5	ns
				Full	2.3 V to 2.7 V	0.3		6	

### 6.9 Typical Characteristics





Typical Characteristics (continued)

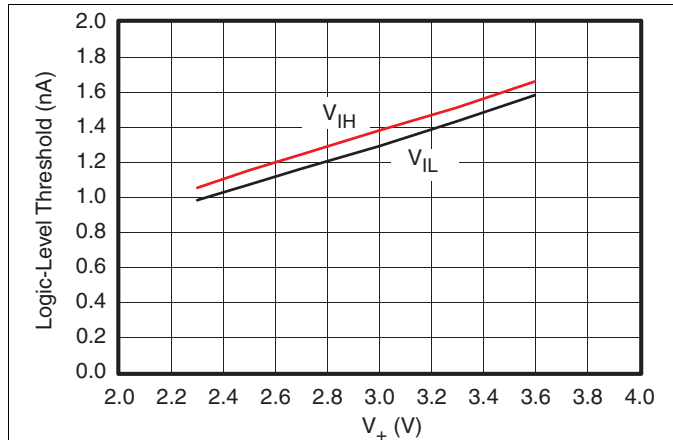


Figure 7. Logic-Level Threshold vs  $V_+$

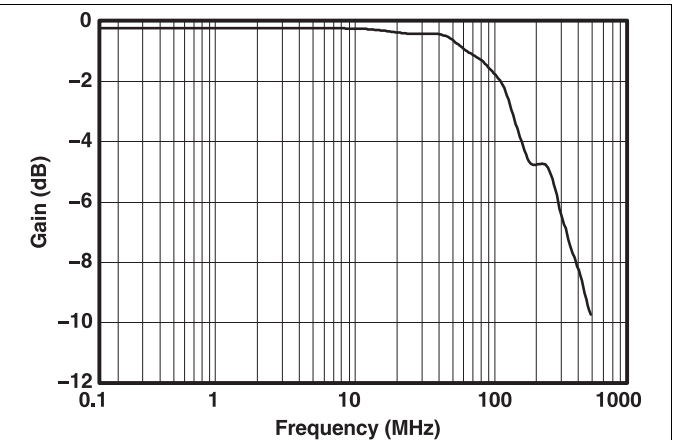


Figure 8. Bandwidth (Gain vs Frequency) ( $V_+ = 3.3$  V)

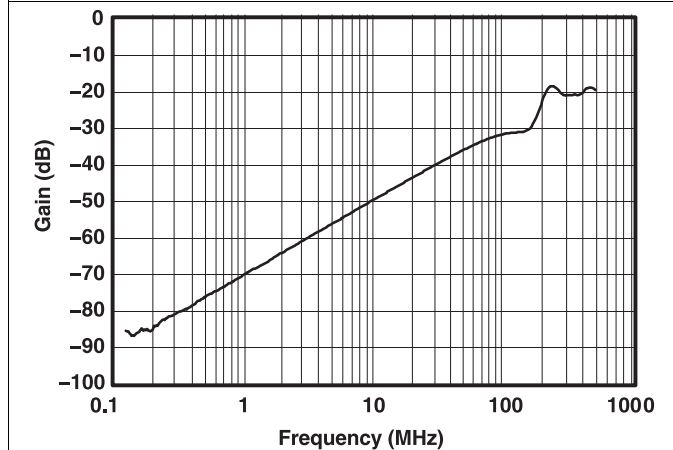


Figure 9. OFF Isolation and Crosstalk vs Frequency ( $V_+ = 3.3$  V)

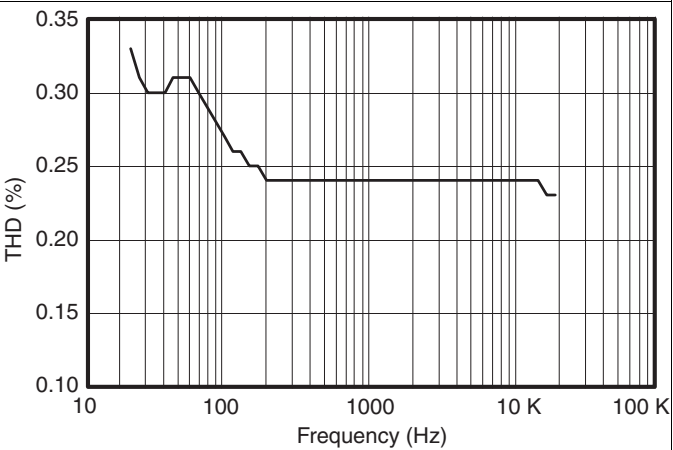


Figure 10. Total Harmonic Distortion vs Frequency

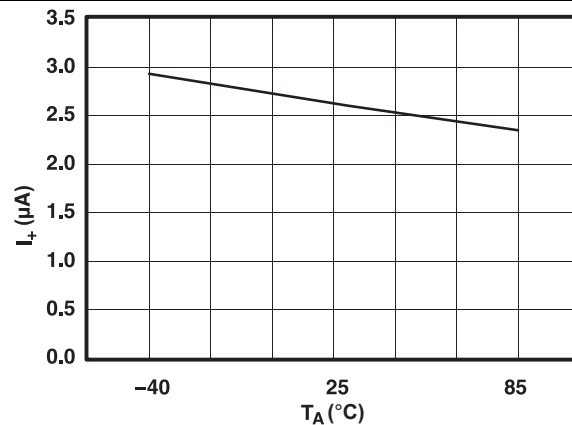
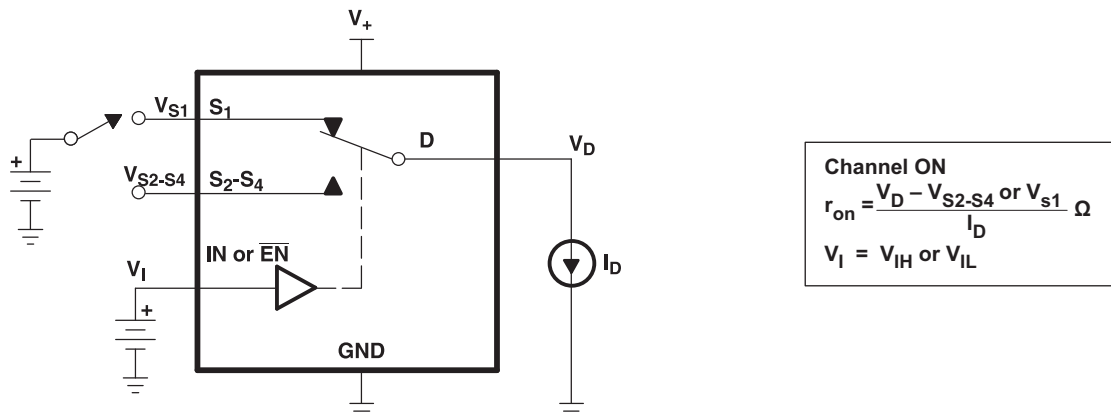
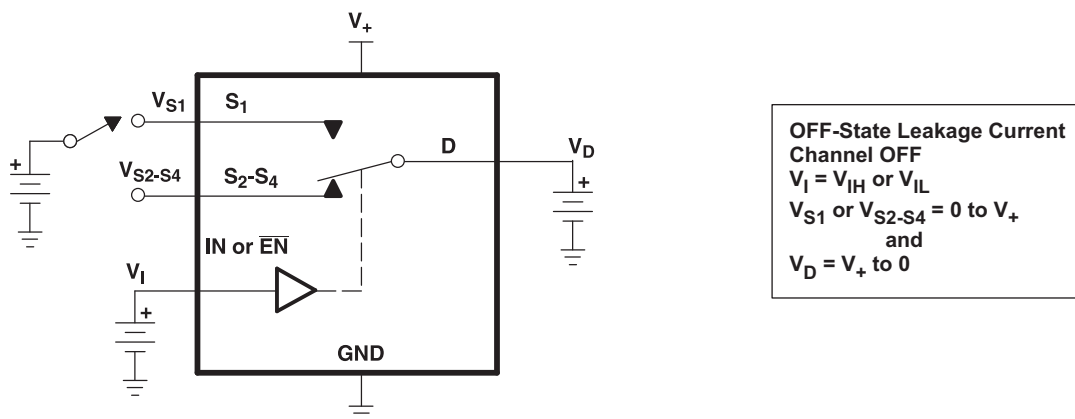


Figure 11. Power-Supply Current vs Temperature ( $V_+ = 3.6$  V)

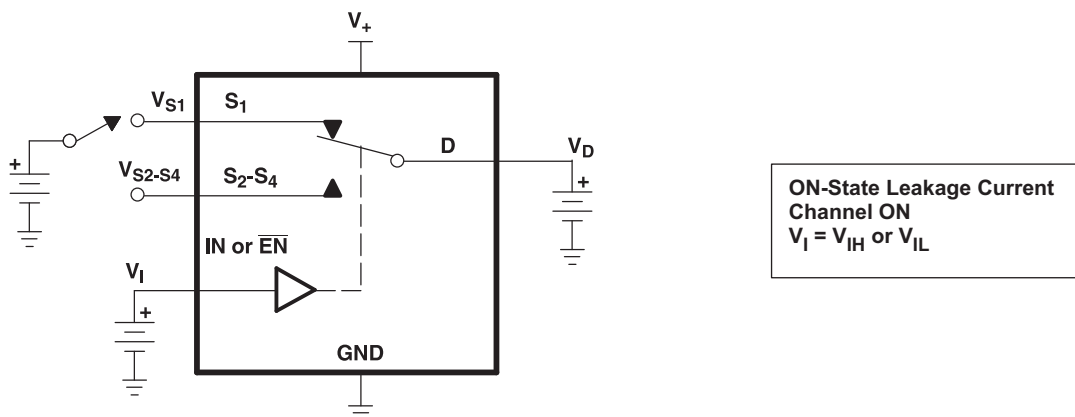
## 7 Parameter Measurement Information



**Figure 12. ON-State Resistance ( $r_{on}$ )**



**Figure 13. OFF-State Leakage Current ( $I_{D(OFF)}$ ,  $I_{S(OFF)}$ )**



**Figure 14. ON-State Leakage Current ( $I_{D(ON)}$ ,  $I_{S(ON)}$ )**

Parameter Measurement Information (continued)

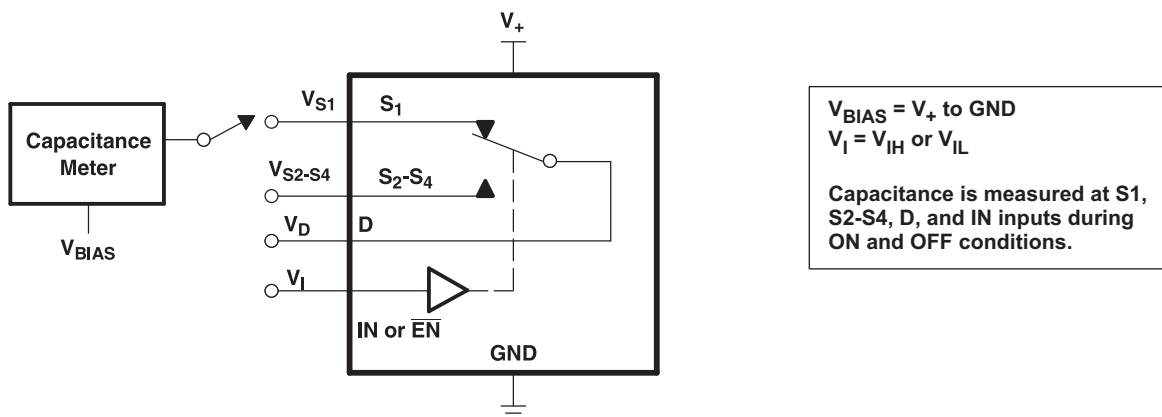
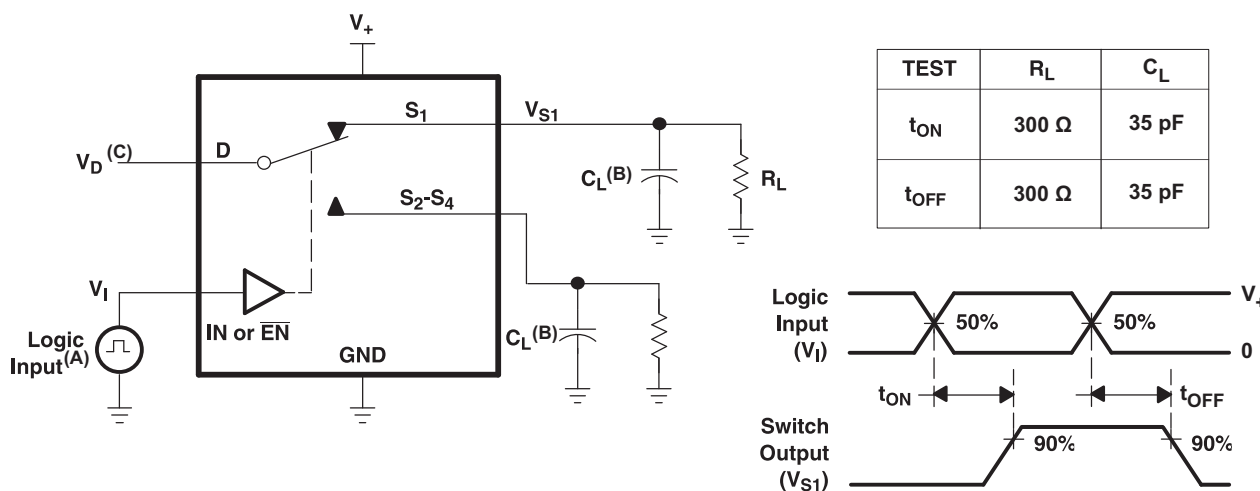


Figure 15. Capacitance ( $C_I$ ,  $C_{D(OFF)}$ ,  $C_{D(ON)}$ ,  $C_{S(OFF)}$ ,  $C_{S(ON)}$ )



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

Figure 16. Turnon ( $t_{ON}$ ) and Turnoff Time ( $t_{OFF}$ )

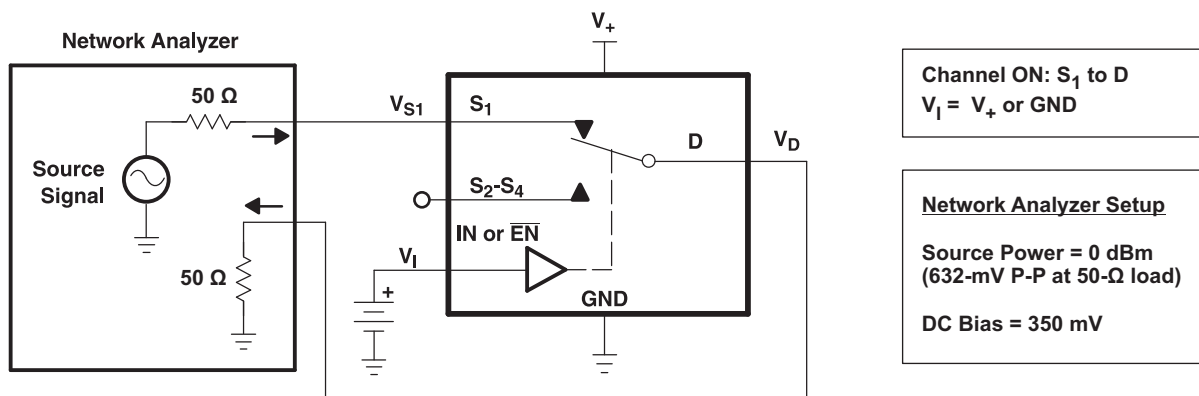
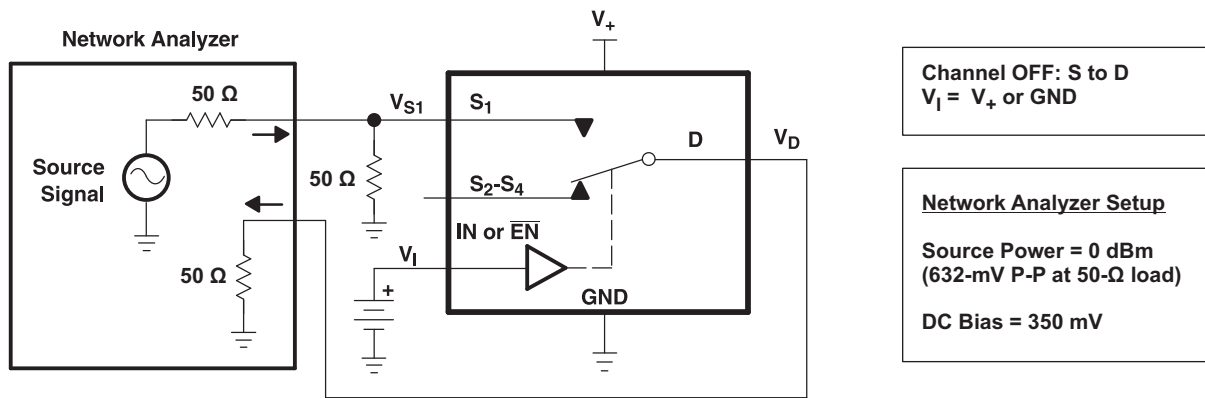
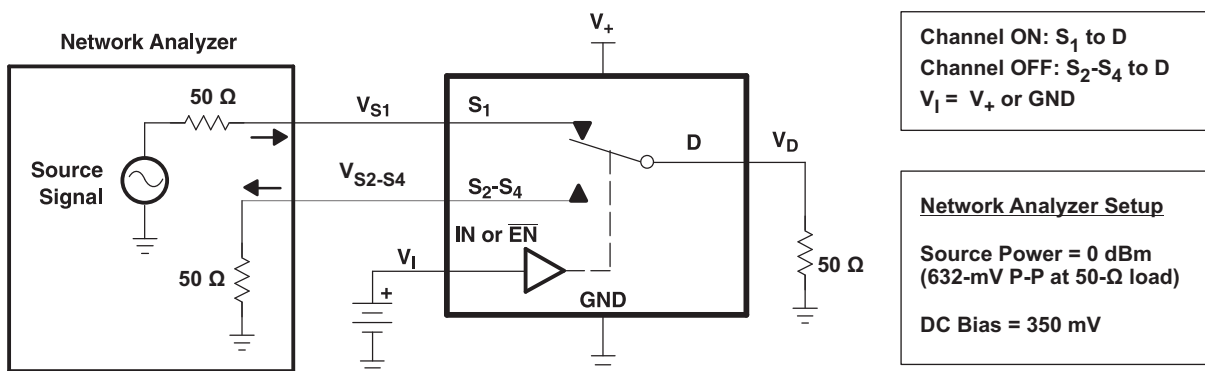
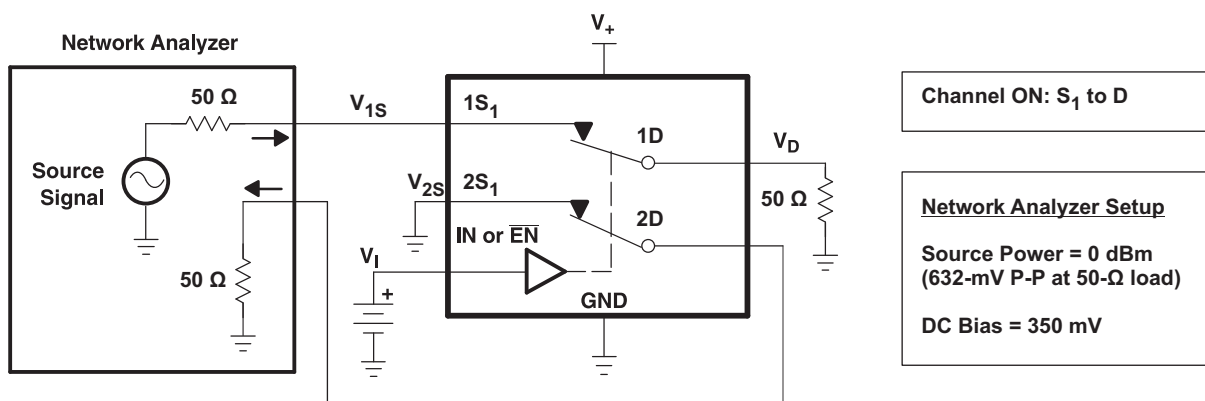
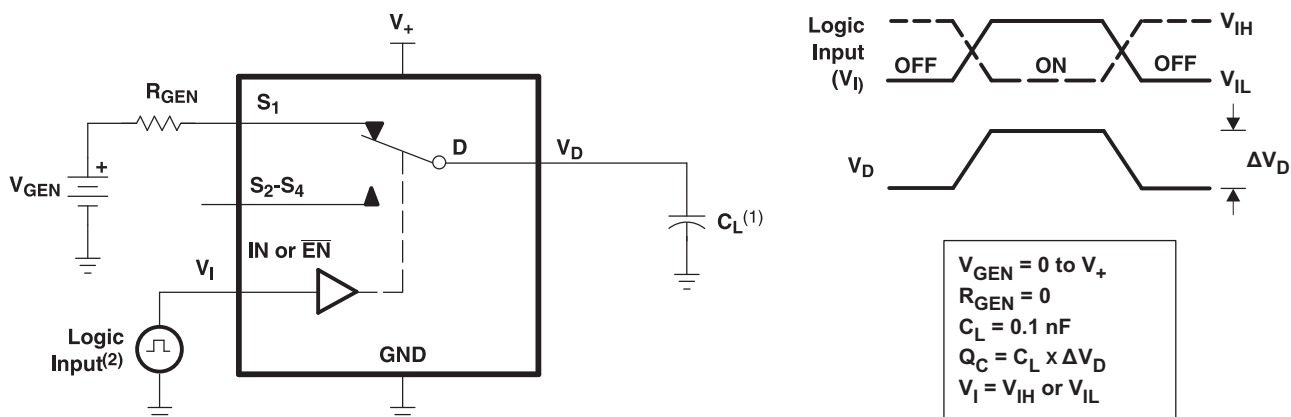


Figure 17. Bandwidth (BW)

**Parameter Measurement Information (continued)**

**Figure 18. OFF Isolation ( $O_{ISO}$ )**

**Figure 19. Crosstalk ( $X_{TALK}$ )**

**Figure 20. Adjacent Crosstalk ( $X_{TALK}$ )**

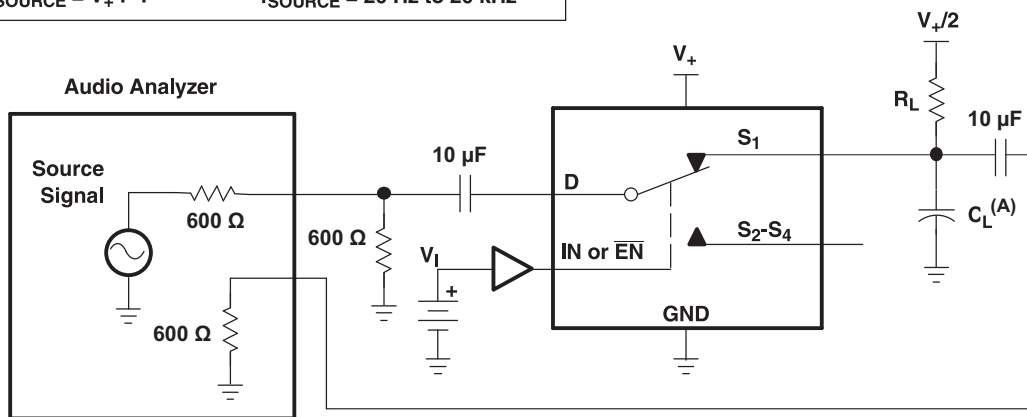
Parameter Measurement Information (continued)



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

Figure 21. Charge Injection (Q<sub>C</sub>)

Channel ON: D to S	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>
V <sub>SOURCE</sub> = V <sub>+</sub> P-P	f <sub>SOURCE</sub> = 20 Hz to 20 kHz



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

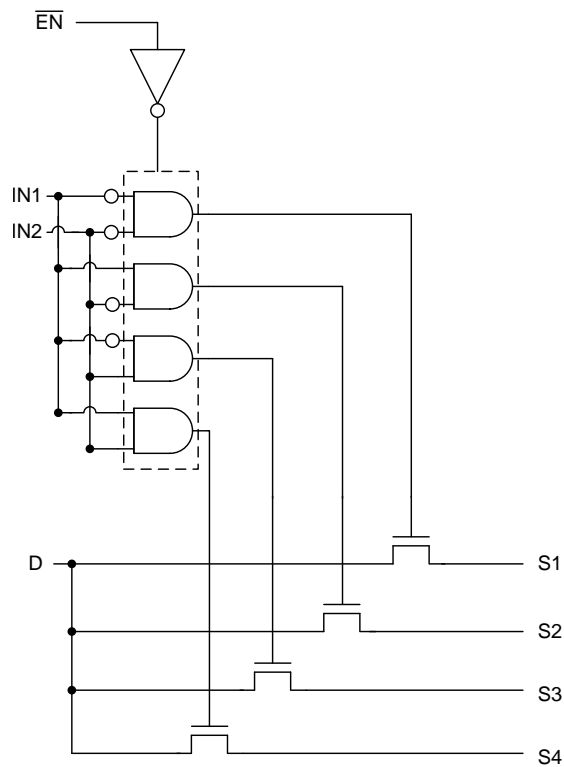
Figure 22. Total Harmonic Distortion (THD)

## 8 Detailed Description

### 8.1 Overview

The TS3A5017 is a dual Single-Pole-4-Throw (SP4T) solid-state analog switch. The TS3A5017, like all analog switches, is bidirectional. Each D pin connects to its four respective S pins, with the switch connection dependent on the status of  $\overline{\text{EN}}$ , IN2, and IN1. See [Table 1](#) for the switch configuration truth table.

### 8.2 Functional Block Diagram



**Figure 23. Functional Block Diagram (Each Switch)**

### 8.3 Feature Description

Isolation in powered-down mode allows signals to be present at the inputs while the switch is powered off without causing damage to the device. The low ON-state resistance and low charge injection give the TS3A5017 better performance at higher speeds.

## 8.4 Device Functional Modes

**Table 1. Function Table**

$\overline{\text{EN}}$	IN2	IN1	D TO S, S TO D
L	L	L	D = S <sub>1</sub>
L	L	H	D = S <sub>2</sub>
L	H	L	D = S <sub>3</sub>
L	H	H	D = S <sub>4</sub>
H	X	X	OFF

## 9 Application and Implementation

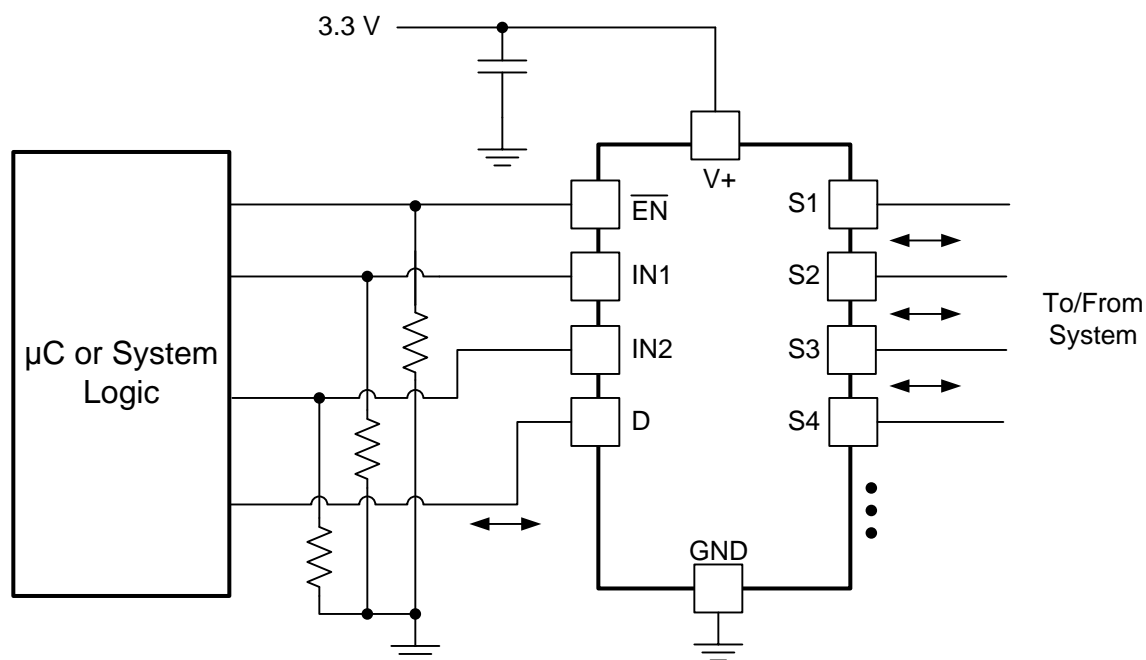
### NOTE

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 TS3A5018 can be used in a variety of customer systems. The TS3A5018 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 TS3A5017**

#### 9.2.1 Design Requirements

In this particular application, V+ was 3.3 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,  $\overline{\text{EN}}$ , IN1, and IN2 are, by default, pulled low to GND. Choose these resistor sizes 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.



## Typical Application (continued)

### 9.2.3 Application Curve

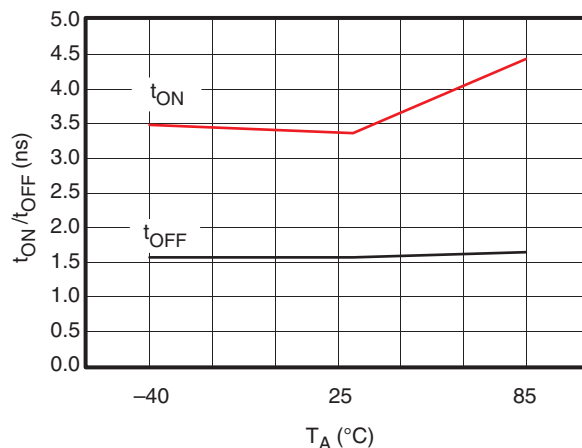


Figure 25. t<sub>ON</sub> and t<sub>OFF</sub> vs Temperature (V<sub>+</sub> = 3.3 V)

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

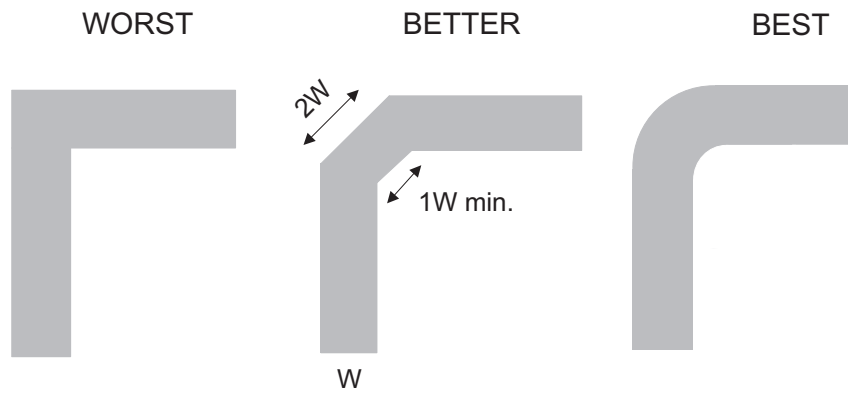
## 11 Layout

### 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 IN1, IN2, and EN pins 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<sub>CC</sub> or unknown switch selection states. See *Implications of Slow or Floating CMOS Inputs*, [SCBA004](#) for more details.

**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 NC or NO ports when the channel is ON
$\Delta r_{on}$	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
$I_{NC(ON)}$	Leakage current measured at the NC port, with the corresponding channel (NC to COM) in the ON state and the output (COM) open
$I_{NO(OFF)}$	Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the OFF state
$I_{NO(ON)}$	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 NC or NO) in the OFF state
$I_{COM(ON)}$	Leakage current measured at the COM port, with the corresponding channel (COM to NC or NO) in the ON state and the output (NC or NO) open
$V_{IH}$	Minimum input voltage for logic high for the control input (IN, $\overline{EN}$ )
$V_{IL}$	Maximum input voltage for logic low for the control input (IN, $\overline{EN}$ )
$V_I$	Voltage at the control input (IN, $\overline{EN}$ )
$I_{IH}, I_{IL}$	Leakage current measured at the control input (IN, $\overline{EN}$ )
$t_{ON}$	Turnon 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 (NC or NO) signal when the switch is turning ON.
$t_{OFF}$	Turnoff 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 (NC or NO) signal when the switch is turning OFF.
$Q_C$	Charge injection is a measurement of unwanted signal coupling from the control (IN) input to the analog (NC or NO) 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
$C_{NC(ON)}$	Capacitance at the NC port when the corresponding channel (NC to COM) is ON
$C_{NO(OFF)}$	Capacitance at the NC port when the corresponding channel (NO to COM) is OFF
$C_{NO(ON)}$	Capacitance at the NC port when the corresponding channel (NO to COM) is ON
$C_{COM(OFF)}$	Capacitance at the COM port when the corresponding channel (COM to NC) is OFF
$C_{COM(ON)}$	Capacitance at the COM port when the corresponding channel (COM to NC) is ON
$C_I$	Capacitance of control input (IN, $\overline{EN}$ )
$O_{ISO}$	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 (NC to COM) in the OFF state.
$X_{TALK}$	Crosstalk is a measurement of unwanted signal coupling from an ON channel to an OFF channel (NC1 to NO1). Adjacent crosstalk is a measure 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 describes the signal distortion caused by the analog switch. This is defined as the ratio of root mean square (RMS) value of the second, third, and higher harmonic to the absolute magnitude of the fundamental harmonic.
$I_+$	Static power-supply current with the control (IN) pin at $V_+$ or GND

## 12.2 Documentation Support

### 12.2.1 Related Documentation

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

## 12.3 Trademarks

All trademarks are the property of their respective owners.

## 12.4 Electrostatic Discharge Caution



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

## 12.5 Glossary

[SLYZ022](#) — *TI Glossary*.

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

### 13 Mechanical, Packaging, and Orderable Information

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

**PACKAGING INFORMATION**

Orderable 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
TS3A5017D	LIFEBUY	SOIC	D	16	40	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TS3A5017	
TS3A5017DBQR	ACTIVE	SSOP	DBQ	16	2500	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	YA017	Samples
TS3A5017DGVR	ACTIVE	TVSOP	DGV	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	YA017	Samples
TS3A5017DR	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TS3A5017	Samples
TS3A5017PW	LIFEBUY	TSSOP	PW	16	90	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	YA017	
TS3A5017PWR	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	YA017	Samples
TS3A5017PWRG4	LIFEBUY	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	YA017	
TS3A5017RGYR	ACTIVE	VQFN	RGY	16	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	YA017	Samples
TS3A5017RGYRG4	LIFEBUY	VQFN	RGY	16	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	YA017	
TS3A5017RSVR	ACTIVE	UQFN	RSV	16	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ZVL	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) **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.

(6) 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.

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

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TS3A5017 :**

- Automotive : [TS3A5017-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

**TAPE AND REEL INFORMATION**

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


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TS3A5017DBQR	SSOP	DBQ	16	2500	330.0	12.5	6.4	5.2	2.1	8.0	12.0	Q1
TS3A5017DGVR	TVSOP	DGV	16	2000	330.0	12.4	6.8	4.0	1.6	8.0	12.0	Q1
TS3A5017DR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TS3A5017PWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TS3A5017RGYR	VQFN	RGY	16	3000	330.0	12.4	3.8	4.3	1.5	8.0	12.0	Q1
TS3A5017RSVR	UQFN	RSV	16	3000	180.0	12.4	2.1	2.9	0.75	4.0	12.0	Q1



**TAPE AND REEL BOX DIMENSIONS**

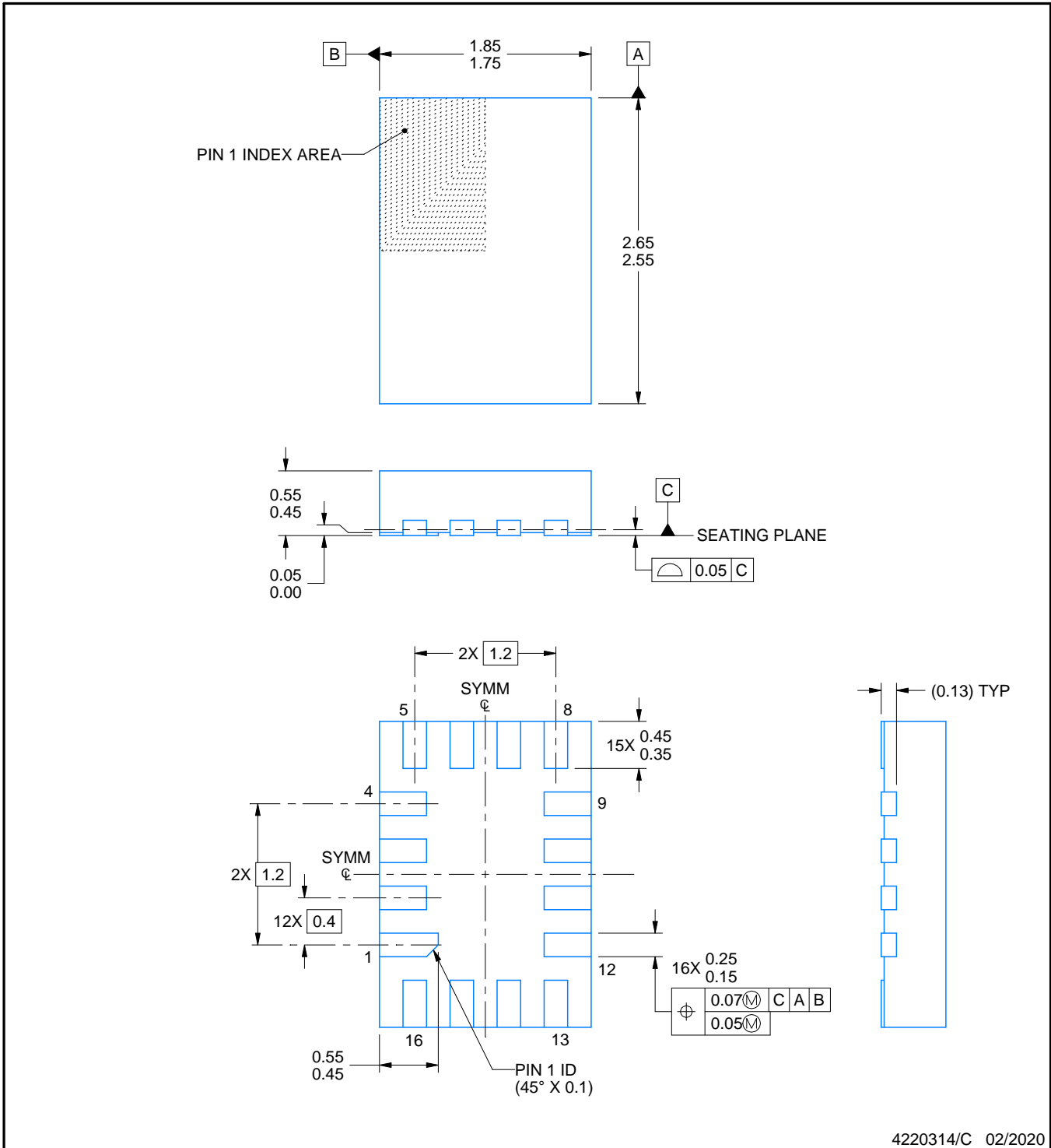
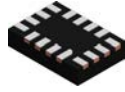

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS3A5017DBQR	SSOP	DBQ	16	2500	340.5	338.1	20.6
TS3A5017DGVR	TVSOP	DGV	16	2000	356.0	356.0	35.0
TS3A5017DR	SOIC	D	16	2500	340.5	336.1	32.0
TS3A5017PWR	TSSOP	PW	16	2000	356.0	356.0	35.0
TS3A5017RGYR	VQFN	RGY	16	3000	356.0	356.0	35.0
TS3A5017RSVR	UQFN	RSV	16	3000	200.0	183.0	25.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
TS3A5017D	D	SOIC	16	40	507	8	3940	4.32
TS3A5017PW	PW	TSSOP	16	90	530	10.2	3600	3.5



NOTES:

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

# EXAMPLE BOARD LAYOUT

RSV0016A

UQFN - 0.55 mm max height

ULTRA THIN QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 25X



4220314/C 02/2020

NOTES: (continued)

3. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).

# EXAMPLE STENCIL DESIGN

RSV0016A

UQFN - 0.55 mm max height

ULTRA THIN QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.125 MM THICK STENCIL  
SCALE: 25X

4220314/C 02/2020

NOTES: (continued)

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

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AC.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



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



4220204/A 02/2017

**NOTES:**

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



# EXAMPLE BOARD LAYOUT

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



4220204/A 02/2017

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

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4220204/A 02/2017

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.

DGV (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE

24 PINS SHOWN



4073251/E 08/00

- 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, not to exceed 0,15 per side.  
 D. Falls within JEDEC: 24/48 Pins – MO-153  
 14/16/20/56 Pins – MO-194



# DBQ0016A

# PACKAGE OUTLINE

SSOP - 1.75 mm max height

SHRINK SMALL-OUTLINE PACKAGE



## NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 inch, per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MO-137, variation AB.

# EXAMPLE BOARD LAYOUT

DBQ0016A

SSOP - 1.75 mm max height

SHRINK SMALL-OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:8X



SOLDER MASK DETAILS

4214846/A 03/2014

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

DBQ0016A

SSOP - 1.75 mm max height

SHRINK SMALL-OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.127 MM] THICK STENCIL  
SCALE:8X

4214846/A 03/2014

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.

RGY (R-PVQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. QFN (Quad Flatpack No-Lead) package configuration.
  - D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
  - E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
  - F. Pin 1 identifiers are located on both top and bottom of the package and within the zone indicated. The Pin 1 identifiers are either a molded, marked, or metal feature.
  - G. Package complies to JEDEC MO-241 variation BA.

RGY (R-PVQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD

**THERMAL INFORMATION**

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at [www.ti.com](http://www.ti.com).

The exposed thermal pad dimensions for this package are shown in the following illustration.



Bottom View

Exposed Thermal Pad Dimensions

4206353-3/P 03/14

NOTE: All linear dimensions are in millimeters



RGY (R-PVQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD



4208122-3/P 03/14

- 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. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - 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. Refer to IPC 7525 for stencil design considerations.
  - F. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.

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