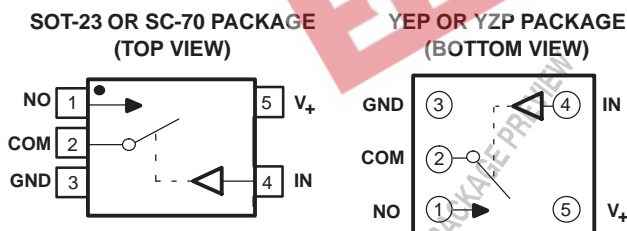


## Description

The TS5A3166 is a single-pole single-throw (SPST) analog switch that is designed to operate from 1.65 V to 5.5 V. The device offers a low ON-state resistance. The device has excellent total harmonic distortion (THD) performance and consumes very low power. These features make this device suitable for portable audio applications.

## Applications

- Cell Phones
- PDAs
- Portable Instrumentation
- Audio and Video Signal Routing
- Low-Voltage Data-Acquisition Systems
- Communication Circuits
- Modems
- Hard Drives
- Computer Peripherals
- Wireless Terminals and Peripherals
- Microphone Switching – Notebook Docking



FUNCTION TABLE

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

## Features

- Isolation in the Powered-Off Mode,  $V_+ = 0$
- Low ON-State Resistance (0.9 Ω)
- Control Inputs Are 5.5-V Tolerant
- Low Charge Injection
- Low Total Harmonic Distortion (THD)
- 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)

## Summary of Characteristics

$V_+ = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

Configuration	Single Pole Single Throw (SPST)
Number of channels	1
ON-state resistance ( $r_{ON}$ )	0.9 Ω
ON-state resistance flatness ( $r_{ON(flat)}$ )	0.15 Ω
Turn-on/turn-off time ( $t_{ON}/t_{OFF}$ )	7.5 ns/12.5 ns
Charge injection ( $Q_C$ )	1 pC
Bandwidth (BW)	200 MHz
OFF isolation ( $O_{ISO}$ )	–64 dB at 1 MHz
Total harmonic distortion (THD)	0.005%
Leakage current ( $I_{COM(OFF)}$ )	±20 nA
Power-supply current ( $I_+$ )	0.5 μA
Package option	5-pin DSBGA, SOT-23, or SC-70



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

# TS5A3166

## 0.9-Ω SPST ANALOG SWITCH



SCDS186 – FEBRUARY 2005

### ORDERING INFORMATION

T <sub>A</sub>	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING(2)
–40°C to 85°C	NanoStar™ – WCSP (DSBGA) 0.23-mm Large Bump – YEP	Tape and reel	TS5A3166YEPR	PACKAGE PREVIEW
	NanoFree™ – WCSP (DSBGA) 0.23-mm Large Bump – YZP (Pb-free)		TS5A3166YZPR	
	SOT (SOT-23) – DBV	Tape and reel	TS5A3166DBVR	JAS_
	SOT (SC-70) – DCK	Tape and reel	TS5A3166DCKR	JF_

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

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

YEP/YZP: The actual top-side marking has three preceding characters to denote year, month, and sequence code, and one following character to designate the assembly/test site. Pin 1 identifier indicates solder-bump composition (1 = SnPb, ● = Pb-free).

### Absolute Minimum and Maximum Ratings(1)(2)

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

		MIN	MAX	UNIT
V <sub>+</sub>	Supply voltage range(3)	–0.5	6.5	V
V <sub>NO</sub> V <sub>COM</sub>	Analog voltage range(3)(4)(5)	–0.5	V <sub>+</sub> + 0.5	V
I <sub>K</sub>	Analog port diode current	V <sub>NO</sub> , V <sub>COM</sub> < 0		mA
I <sub>NO</sub> I <sub>COM</sub>	On-state switch current On-state peak switch current(6)	V <sub>NO</sub> , V <sub>COM</sub> = 0 to V <sub>+</sub>		mA
V <sub>I</sub>	Digital input voltage range(3)(4)	–0.5	6.5	V
I <sub>IK</sub>	Digital input clamp current	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
θ <sub>JA</sub>	Package thermal impedance(7)	DBV package		206
		DCK package		252
		YEP/YZP package		132
T <sub>stg</sub>	Storage temperature range	–65	150	°C

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

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

(3) All voltages are with respect to ground, unless otherwise specified.

(4) The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

(5) This value is limited to 5.5 V maximum.

(6) Pulse at 1-ms duration < 10% duty cycle

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

## Electrical Characteristics for 5-V Supply<sup>(1)</sup>

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

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{COM}, V_{NO}$				0		$V_+$	V
Peak ON resistance	$r_{peak}$	$0 \leq V_{NO} \leq V_+$ , $I_{COM} = -100 \text{ mA}$ , Switch ON, See Figure 13	25°C Full	4.5 V		0.8	1.1 1.2	Ω
ON-state resistance	$r_{on}$	$V_{NO} = 2.5 \text{ V}$ , $I_{COM} = -100 \text{ mA}$ , Switch ON, See Figure 13	25°C Full	4.5 V		0.7	0.9 1	Ω
ON-state resistance flatness	$r_{on(flat)}$	$0 \leq V_{NO} \leq V_+$ , $I_{COM} = -100 \text{ mA}$ $V_{NO} = 1 \text{ V}, 1.5 \text{ V}, 2.5 \text{ V}$ , $I_{COM} = -100 \text{ mA}$ Switch ON, See Figure 13	25°C 25°C Full	4.5 V		0.15 0.09	0.15 0.15	Ω
NO OFF leakage current	$I_{NO(OFF)}$	$V_{NO} = 1 \text{ V}, V_{COM} = 4.5 \text{ V}$ , or $V_{NO} = 4.5 \text{ V}, V_{COM} = 1 \text{ V}$ Switch OFF, See Figure 14	25°C Full	5.5 V	-20 -100	4	20 100	nA
	$I_{NO(PWROFF)}$	$V_{NO} = 0 \text{ to } 5.5 \text{ V}$ , $V_{COM} = 5.5 \text{ V to } 0$	25°C Full	0 V	-5 -15	0.4	5 15	μA
COM OFF leakage current	$I_{COM(OFF)}$	$V_{COM} = 1 \text{ V}, V_{NO} = 4.5 \text{ V}$ , or $V_{COM} = 4.5 \text{ V}, V_{NO} = 1 \text{ V}$ Switch OFF, See Figure 14	25°C Full	5.5 V	-20 -100	4	20 100	nA
	$I_{COM(PWROFF)}$	$V_{NO} = 0 \text{ to } 5.5 \text{ V}$ , $V_{COM} = 5.5 \text{ V to } 0$	25°C Full	0 V	-5 -15	0.4	5 15	μA
NO ON leakage current	$I_{NO(ON)}$	$V_{NO} = 1 \text{ V}, V_{COM} = \text{Open}$ , or $V_{NO} = 4.5 \text{ V}, V_{COM} = \text{Open}$ , Switch ON, See Figure 15	25°C Full	5.5 V	-2 -20	0.3	2 20	nA
COM ON leakage current	$I_{COM(ON)}$	$V_{COM} = 1 \text{ V}, V_{NO} = \text{Open}$ , or $V_{COM} = 4.5 \text{ V}, V_{NO} = \text{Open}$ , Switch ON, See Figure 15	25°C Full	5.5 V	-2 -20	0.3	2 20	nA
<b>Digital Control Input (IN)</b>								
Input logic high	$V_{IH}$		Full		2.4		5.5	V
Input logic low	$V_{IL}$		Full		0		0.8	V
Input leakage current	$I_{IH}, I_{IL}$	$V_I = 5.5 \text{ V or } 0$	25°C	5.5 V	-2	0.3	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

# TS5A3166

## 0.9-Ω SPST ANALOG SWITCH

SCDS186 – FEBRUARY 2005

### Electrical Characteristics for 5-V Supply<sup>(1)</sup> (continued)

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

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Dynamic</b>								
Turn-on time	$t_{ON}$	$V_{COM} = V_+$ , $R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$ , See Figure 17	25°C	5 V	2.5	4.5	7	ns
			Full	4.5 V to 5.5 V	1.5		7.5	
Turn-off time	$t_{OFF}$	$V_{COM} = V_+$ , $R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$ , See Figure 17	25°C	5 V	6	9	11.5	ns
			Full	4.5 V to 5.5 V	4		12.5	
Charge injection	$Q_C$	$V_{GEN} = 0$ , $R_{GEN} = 0$ , $C_L = 1\text{ nF}$ , See Figure 20	25°C	5 V		1		pC
NO OFF capacitance	$C_{NO(OFF)}$	$V_{NO} = V_+$ or GND, Switch OFF, See Figure 16	25°C	5 V		19		pF
COM OFF capacitance	$C_{COM(OFF)}$	$V_{COM} = V_+$ or GND, Switch OFF, See Figure 16	25°C	5 V		18		pF
NO ON capacitance	$C_{NO(ON)}$	$V_{NO} = V_+$ or GND, Switch ON, See Figure 16	25°C	5 V		35.5		pF
COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND, Switch ON, See Figure 16	25°C	5 V		35.5		pF
Digital input capacitance	$C_I$	$V_I = V_+$ or GND, See Figure 16	25°C	5 V		2		pF
Bandwidth	BW	$R_L = 50\ \Omega$ , Switch ON, See Figure 18	25°C	5 V		200		MHz
OFF isolation	$O_{ISO}$	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ , Switch OFF, See Figure 19	25°C	5 V		-64		dB
Total harmonic distortion	THD	$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ , $f = 20\text{ Hz to }20\text{ kHz}$ , See Figure 21	25°C	5 V		0.005		%
<b>Supply</b>								
Positive supply current	$I_+$	$V_I = V_+$ or GND, Switch ON or OFF	25°C	5.5 V		0.01	0.1	$\mu\text{A}$
			Full				0.5	

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

## Electrical Characteristics for 3.3-V Supply<sup>(1)</sup>

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

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{COM}, V_{NO}$				0		$V_+$	V
Peak ON resistance	$r_{peak}$	$0 \leq V_{NO} \leq V_+$ , $I_{COM} = -100\text{ mA}$	Switch ON, See Figure 13	25°C Full	3 V	1.1	1.5 1.7	Ω
ON-state resistance	$r_{on}$	$V_{NO} = 2\text{ V}$ , $I_{COM} = -100\text{ mA}$	Switch ON, See Figure 13	25°C Full	3 V	1	1.4 1.5	Ω
ON-state resistance flatness	$r_{on(flat)}$	$0 \leq V_{NO} \leq V_+$ , $I_{COM} = -100\text{ mA}$ $V_{NO} = 2\text{ V}, 0.8\text{ V}$ , $I_{COM} = -100\text{ mA}$	Switch ON, See Figure 13	25°C 25°C Full	3 V	0.2 0.09	0.15 0.15	Ω
NO OFF leakage current	$I_{NO(OFF)}$	$V_{NO} = 1\text{ V}, V_{COM} = 3\text{ V}$ , or $V_{NO} = 3\text{ V}, V_{COM} = 1\text{ V}$	Switch OFF, See Figure 14	25°C Full	3.6 V	-2	0.5 2	nA
	$I_{NO(PWROFF)}$	$V_{NO} = 0\text{ to }3.6\text{ V}$ , $V_{COM} = 3.6\text{ V to }0$		25°C Full	0 V	-1	0.1 1	μA
COM OFF leakage current	$I_{COM(OFF)}$	$V_{COM} = 1\text{ V}, V_{NO} = 3\text{ V}$ , or $V_{COM} = 3\text{ V}, V_{NO} = 1\text{ V}$	Switch OFF, See Figure 14	25°C Full	3.6 V	-2	0.5 2	nA
	$I_{COM(PWROFF)}$	$V_{COM} = 0\text{ to }3.6\text{ V}$ , $V_{NO} = 3.6\text{ V to }0$		25°C Full	0 V	-1	0.1 1	μA
NO ON leakage current	$I_{NO(ON)}$	$V_{NO} = 1\text{ V}, V_{COM} = \text{Open}$ , or $V_{NO} = 3\text{ V}, V_{COM} = \text{Open}$	Switch ON, See Figure 15	25°C Full	3.6 V	-2	0.2 2	nA
COM ON leakage current	$I_{COM(ON)}$	$V_{COM} = 1\text{ V}, V_{NO} = \text{Open}$ , or $V_{COM} = 3\text{ V}, V_{NO} = \text{Open}$	Switch ON, See Figure 15	25°C Full	3.6 V	-2	0.2 2	nA
<b>Digital Control Input (IN)</b>								
Input logic high	$V_{IH}$		Full		2		5.5	V
Input logic low	$V_{IL}$		Full		0		0.8	V
Input leakage current	$I_{IH}, I_{IL}$	$V_I = 5.5\text{ V or }0$	25°C	3.6 V	-2	0.3	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

# TS5A3166

## 0.9-Ω SPST ANALOG SWITCH

SCDS186 – FEBRUARY 2005

### Electrical Characteristics for 3.3-V Supply<sup>(1)</sup> (continued)

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

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Dynamic</b>								
Turn-on time	$t_{ON}$	$V_{COM} = V_+$ , $R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$ , See Figure 17	25°C	3.3 V	2	5	10	ns
			Full	3 V to 3.6 V	1.5		11	
Turn-off time	$t_{OFF}$	$V_{COM} = V_+$ , $R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$ , See Figure 17	25°C	3.3 V	6.5	9	12	ns
			Full	3 V to 3.6 V	4		13	
Charge injection	$Q_C$	$V_{GEN} = 0$ , $R_{GEN} = 0$ , $C_L = 1\text{ nF}$ , See Figure 20	25°C	3.3 V		1		pC
NO OFF capacitance	$C_{NO(OFF)}$	$V_{NO} = V_+$ or GND, Switch OFF, See Figure 16	25°C	3.3 V		19		pF
COM OFF capacitance	$C_{COM(OFF)}$	$V_{COM} = V_+$ or GND, Switch OFF, See Figure 16	25°C	3.3 V		18		pF
NO ON capacitance	$C_{NO(ON)}$	$V_{NO} = V_+$ or GND, Switch ON, See Figure 16	25°C	3.3 V		36		pF
COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND, Switch ON, See Figure 16	25°C	3.3 V		36		pF
Digital input capacitance	$C_I$	$V_I = V_+$ or GND, See Figure 16	25°C	3.3 V		2		pF
Bandwidth	BW	$R_L = 50\ \Omega$ , Switch ON, See Figure 18	25°C	3.3 V		200		MHz
OFF isolation	$O_{ISO}$	$R_L = 50\ \Omega$ , $f = 1\text{ MHz}$ , Switch OFF, See Figure 19	25°C	3.3 V		-64		dB
Total harmonic distortion	THD	$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ , $f = 20\text{ Hz to }20\text{ kHz}$ , See Figure 21	25°C	3.3 V		0.01		%
<b>Supply</b>								
Positive supply current	$I_+$	$V_I = V_+$ or GND, Switch ON or OFF	25°C	3.6 V		0.01	0.1	$\mu\text{A}$
			Full				0.25	

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

## Electrical Characteristics for 2.5-V Supply<sup>(1)</sup>

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

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{COM}, V_{NO}$				0		$V_+$	V
Peak ON resistance	$r_{peak}$	$0 \leq V_{NO} \leq V_+$ , $I_{COM} = -8 \text{ mA}$ , Switch ON, See Figure 13	25°C Full	2.3 V		1.4	2.2 2.4	Ω
ON-state resistance	$r_{on}$	$V_{NO} = 1.8 \text{ V}$ , $I_{COM} = -8 \text{ mA}$ , Switch ON, See Figure 13	25°C Full	2.3 V		1.2	1.8 2	Ω
ON-state resistance flatness	$r_{on(flat)}$	$0 \leq V_{NO} \leq V_+$ , $I_{COM} = -8 \text{ mA}$ $V_{NO} = 0.8 \text{ V}, 1.8 \text{ V}$ , $I_{COM} = -8 \text{ mA}$ Switch ON, See Figure 13	25°C 25°C Full	2.3 V		0.5 0.2	 0.5	Ω
NO OFF leakage current	$I_{NO(OFF)}$	$V_{NO} = 0.5 \text{ V}$ , $V_{COM} = 2.3 \text{ V}$ , or $V_{NO} = 2.3 \text{ V}$ , $V_{COM} = 0.5 \text{ V}$ Switch OFF, See Figure 14	25°C Full	2.7 V	-2 -20	0.5	2 20	nA
	$I_{NO(PWROFF)}$	$V_{NO} = 0 \text{ to } 2.7 \text{ V}$ , $V_{COM} = 2.7 \text{ V to } 0$	25°C Full	0 V	-1 -5	0.1	1 5	μA
COM OFF leakage current	$I_{COM(OFF)}$	$V_{COM} = 0.5 \text{ V}$ , $V_{NO} = 2.3 \text{ V}$ , or $V_{COM} = 0.5 \text{ V}$ , $V_{NO} = 2.3 \text{ V}$ Switch OFF, See Figure 14	25°C Full	2.7 V	-2 -20	0.5	2 20	nA
	$I_{COM(PWROFF)}$	$V_{COM} = 0 \text{ to } 2.7 \text{ V}$ , $V_{NO} = 2.7 \text{ V to } 0$	25°C Full	0 V	-1 -5	0.1	1 5	μA
NO ON leakage current	$I_{NO(ON)}$	$V_{NO} = 0.5 \text{ V}$ , $V_{COM} = \text{Open}$ , or $V_{NO} = 2.3 \text{ V}$ , $V_{COM} = \text{Open}$ , Switch ON, See Figure 15	25°C Full	2.7 V	-2 -20	0.1	2 20	nA
COM ON leakage current	$I_{COM(ON)}$	$V_{COM} = 0.5 \text{ V}$ , $V_{NO} = \text{Open}$ , or $V_{COM} = 2.3 \text{ V}$ , $V_{NO} = \text{Open}$ , Switch ON, See Figure 15	25°C Full	2.7 V	-2 -20	0.1	2 20	nA
<b>Digital Control Input (IN)</b>								
Input logic high	$V_{IH}$		Full		1.8		5.5	V
Input logic low	$V_{IL}$		Full		0		0.6	V
Input leakage current	$I_{IH}, I_{IL}$	$V_I = 5.5 \text{ V or } 0$	25°C	2.7 V	-2	0.3	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

# TS5A3166

## 0.9-Ω SPST ANALOG SWITCH

SCDS186 – FEBRUARY 2005

### Electrical Characteristics for 2.5-V Supply<sup>(1)</sup> (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)

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Dynamic</b>								
Turn-on time	$t_{ON}$	$V_{COM} = V_+$ , $R_L = 50 \Omega$ , $C_L = 35 \text{ pF}$ , See Figure 17	25°C	2.5 V	3	7	10	ns
			Full	2.3 V to 2.7 V	2.5		10.5	
Turn-off time	$t_{OFF}$	$V_{COM} = V_+$ , $R_L = 50 \Omega$ , $C_L = 35 \text{ pF}$ , See Figure 17	25°C	2.5 V	6.5	9.5	13	ns
			Full	2.3 V to 2.7 V	5		15	
Charge injection	$Q_C$	$V_{GEN} = 0$ , $R_{GEN} = 0$ , $C_L = 1 \text{ nF}$ , See Figure 20	25°C	2.5 V		1		pC
NO OFF capacitance	$C_{NO(OFF)}$	$V_{NO} = V_+$ or GND, Switch OFF, See Figure 16	25°C	2.5 V		19		pF
COM OFF capacitance	$C_{COM(OFF)}$	$V_{COM} = V_+$ or GND, Switch OFF, See Figure 16	25°C	2.5 V		18		pF
NO ON capacitance	$C_{NO(ON)}$	$V_{NO} = V_+$ or GND, Switch ON, See Figure 16	25°C	2.5 V		36.5		pF
COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND, Switch ON, See Figure 16	25°C	2.5 V		36.5		pF
Digital input capacitance	$C_I$	$V_I = V_+$ or GND, See Figure 16	25°C	2.5 V		2		pF
Bandwidth	BW	$R_L = 50 \Omega$ , Switch ON, See Figure 18	25°C	2.5 V		200		MHz
OFF isolation	$O_{ISO}$	$R_L = 50 \Omega$ , $f = 1 \text{ MHz}$ , Switch OFF, See Figure 19	25°C	2.5 V		-64		dB
Total harmonic distortion	THD	$R_L = 600 \Omega$ , $C_L = 50 \text{ pF}$ , $f = 20 \text{ Hz to } 20 \text{ kHz}$ , See Figure 21	25°C	2.5 V		0.02		%
<b>Supply</b>								
Positive supply current	$I_+$	$V_I = V_+$ or GND, Switch ON or OFF	25°C	2.7 V		0.01	0.1	$\mu\text{A}$
			Full				0.15	

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

## Electrical Characteristics for 1.8-V Supply<sup>(1)</sup>

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

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A$	$V_+$	MIN	TYP	MAX	UNIT
<b>Analog Switch</b>								
Analog signal range	$V_{COM}, V_{NO}$				0		$V_+$	V
Peak ON resistance	$r_{peak}$	$0 \leq V_{NO} \leq V_+$ , $I_{COM} = -2 \text{ mA}$ , Switch ON, See Figure 13	25°C Full	1.65 V		3.7	25 30	Ω
ON-state resistance	$r_{on}$	$V_{NO} = 1.5 \text{ V}$ , $I_{COM} = -2 \text{ mA}$ , Switch ON, See Figure 13	25°C Full	1.65 V		1.5	3.4 3.5	Ω
ON-state resistance flatness	$r_{on(flat)}$	$0 \leq V_{NO} \leq V_+$ , $I_{COM} = -2 \text{ mA}$ $V_{NO} = 0.6 \text{ V}, 1.5 \text{ V}$ , $I_{COM} = -2 \text{ mA}$ Switch ON, See Figure 13	25°C Full	1.65 V		1.5 2	6 6	Ω
NO OFF leakage current	$I_{NO(OFF)}$	$V_{NO} = 0.3 \text{ V}$ , $V_{COM} = 1.65 \text{ V}$ , or $V_{NO} = 1.65 \text{ V}$ , $V_{COM} = 0.3 \text{ V}$ Switch OFF, See Figure 14	25°C Full	1.95 V	-2 -20	0.5	2 20	nA
	$I_{NO(PWROFF)}$	$V_{NO} = 0 \text{ to } 1.95 \text{ V}$ , $V_{COM} = 1.95 \text{ V to } 0$	25°C Full	0 V	-1 -5	0.1	1 5	μA
COM OFF leakage current	$I_{COM(OFF)}$	$V_{COM} = 0.3 \text{ V}$ , $V_{NO} = 1.65 \text{ V}$ , or $V_{COM} = 0.3 \text{ V}$ , $V_{NO} = 1.65 \text{ V}$ Switch OFF, See Figure 14	25°C Full	1.95 V	-2 -20	0.5	2 20	nA
	$I_{COM(PWROFF)}$	$V_{COM} = 0 \text{ to } 1.95 \text{ V}$ , $V_{NO} = 1.95 \text{ V to } 0$	25°C Full	0 V	-1 -5	0.1	1 5	μA
NO ON leakage current	$I_{NO(ON)}$	$V_{NO} = 0.3 \text{ V}$ , $V_{COM} = \text{Open}$ , or $V_{NO} = 1.65 \text{ V}$ , $V_{COM} = \text{Open}$ , Switch ON, See Figure 15	25°C Full	1.95 V	-2 -20	0.1	2 20	nA
COM ON leakage current	$I_{COM(ON)}$	$V_{COM} = 0.3 \text{ V}$ , $V_{NO} = \text{Open}$ , or $V_{COM} = 1.65 \text{ V}$ , $V_{NO} = \text{Open}$ , Switch ON, See Figure 15	25°C Full	1.95 V	-2 -20	0.1	2 20	nA
<b>Digital Control Input (IN)</b>								
Input logic high	$V_{IH}$		Full		1.5		5.5	V
Input logic low	$V_{IL}$		Full		0		0.6	V
Input leakage current	$I_{IH}, I_{IL}$	$V_I = 5.5 \text{ V or } 0$	25°C	1.95 V	-2	0.3	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

# TS5A3166

## 0.9- $\Omega$ SPST ANALOG SWITCH

SCDS186 – FEBRUARY 2005

### Electrical Characteristics for 1.8-V Supply<sup>(1)</sup> (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)

PARAMETER	SYMBOL	TEST CONDITIONS		T <sub>A</sub>	V <sub>+</sub>	MIN	TYP	MAX	UNIT
Dynamic									
Turn-on time	t <sub>ON</sub>	V <sub>COM</sub> = V <sub>+</sub> , R <sub>L</sub> = 50 Ω,	C <sub>L</sub> = 35 pF, See Figure 17	25°C	1.8 V	5.5	9	19	ns
				Full	1.65 V to 1.95 V	5		20	
Turn-off time	t <sub>OFF</sub>	V <sub>COM</sub> = V <sub>+</sub> , R <sub>L</sub> = 50 Ω,	C <sub>L</sub> = 35 pF, See Figure 17	25°C	1.8 V	7.5	12	17.5	ns
				Full	1.65 V to 1.95 V	6		20	
Charge injection	Q <sub>C</sub>	V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0,	C <sub>L</sub> = 1 nF, See Figure 20	25°C	1.8 V		1		pC
NO OFF capacitance	C <sub>NO(OFF)</sub>	V <sub>NO</sub> = V <sub>+</sub> or GND, Switch OFF,	See Figure 16	25°C	1.8 V		19		pF
COM OFF capacitance	C <sub>COM(OFF)</sub>	V <sub>COM</sub> = V <sub>+</sub> or GND, Switch OFF,	See Figure 16	25°C	1.8 V		18		pF
NO ON capacitance	C <sub>NO(ON)</sub>	V <sub>NO</sub> = V <sub>+</sub> or GND, Switch ON,	See Figure 16	25°C	1.8 V		37		pF
COM ON capacitance	C <sub>COM(ON)</sub>	V <sub>COM</sub> = V <sub>+</sub> or GND, Switch ON,	See Figure 16	25°C	1.8 V		37		pF
Digital input capacitance	C <sub>I</sub>	V <sub>I</sub> = V <sub>+</sub> or GND,	See Figure 16	25°C	1.8 V		2		pF
Bandwidth	BW	R <sub>L</sub> = 50 Ω, Switch ON,	See Figure 18	25°C	1.8 V		200		MHz
OFF isolation	O <sub>ISO</sub>	R <sub>L</sub> = 50 Ω, f = 1 MHz,	Switch OFF, See Figure 19	25°C	1.8 V		−64		dB
Total harmonic distortion	THD	R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF,	f = 20 Hz to 20 kHz, See Figure 21	25°C	1.8 V		0.05		%
Supply									
Positive supply current	I <sub>+</sub>	V <sub>I</sub> = V <sub>+</sub> or GND,	Switch ON or OFF	25°C	1.95 V	0.01	0.1		μA
				Full			0.1		

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

# TYPICAL PERFORMANCE

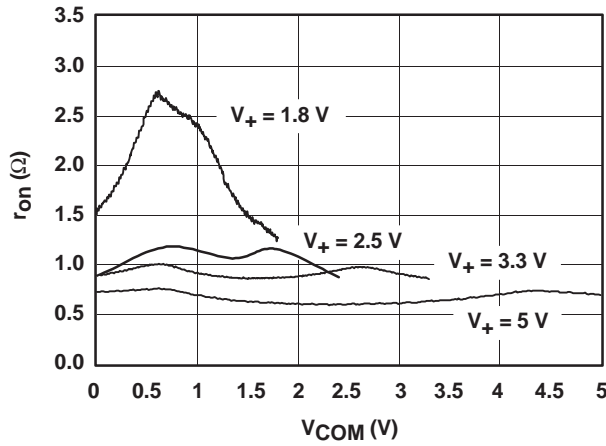


Figure 1.  $r_{on}$  vs  $V_{COM}$  ( $T_A = 25^\circ\text{C}$ )

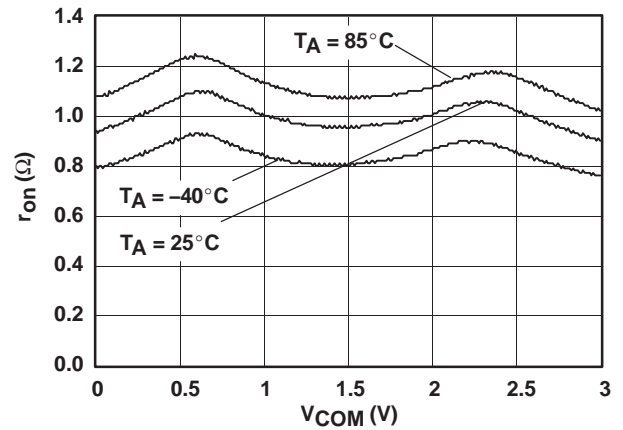


Figure 2.  $r_{on}$  vs  $V_{COM}$  ( $V_+ = 3\text{ V}$ )

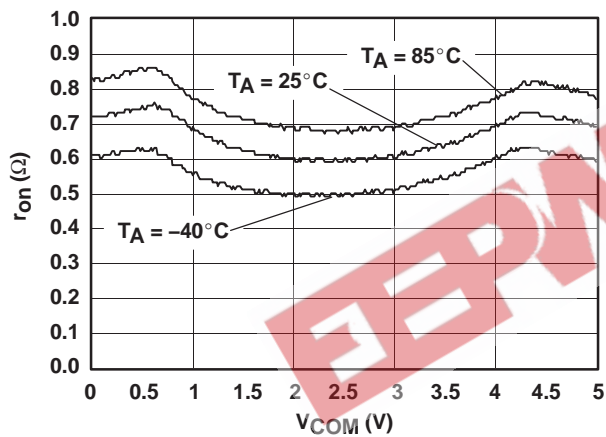


Figure 3.  $r_{on}$  vs  $V_{COM}$  ( $V_+ = 5\text{ V}$ )

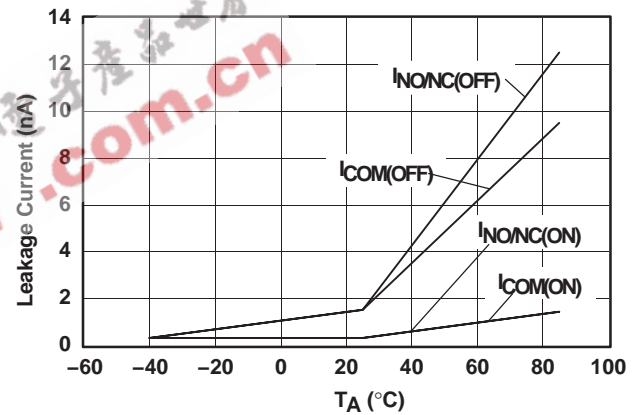


Figure 4. Leakage Current vs Temperature ( $V_+ = 5.5\text{ V}$ )

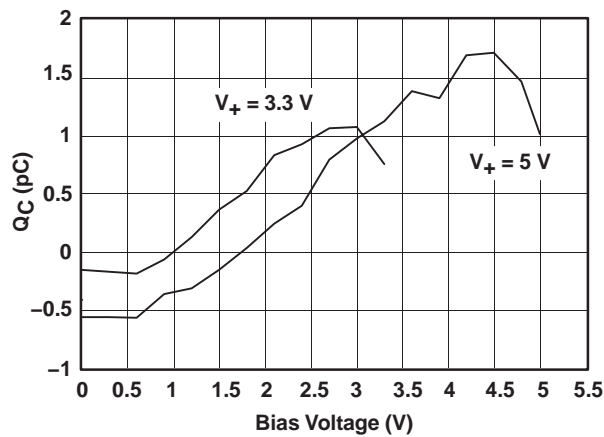


Figure 5. Charge Injection ( $Q_C$ ) vs Bias Voltage

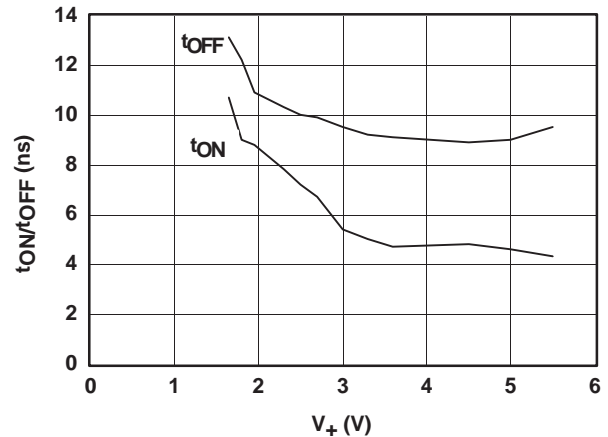


Figure 6.  $t_{ON}$  and  $t_{OFF}$  vs  $V_+$

**TYPICAL PERFORMANCE**

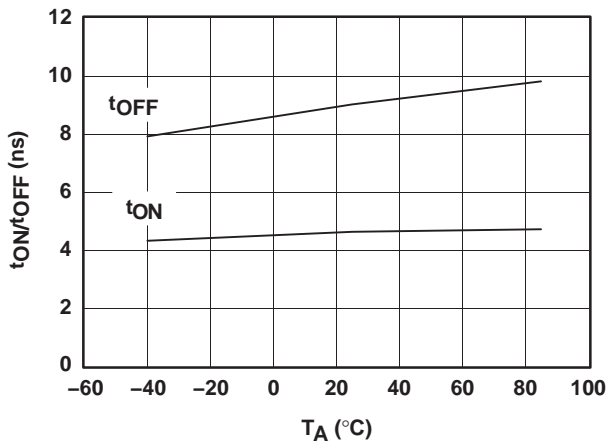


Figure 7.  $t_{ON}$  and  $t_{OFF}$  vs Temperature ( $V_+ = 5$  V)

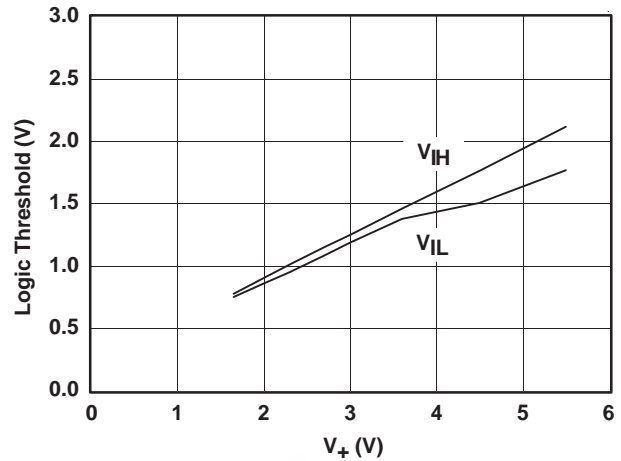


Figure 8. Logic Threshold vs  $V_+$

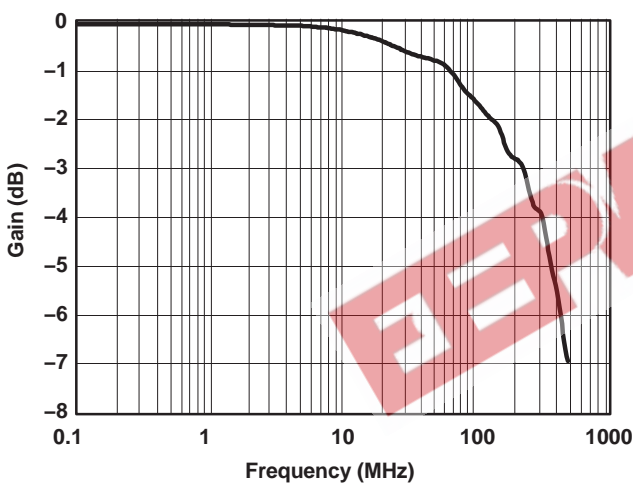


Figure 9. Gain vs Frequency ( $V_+ = 5$  V)

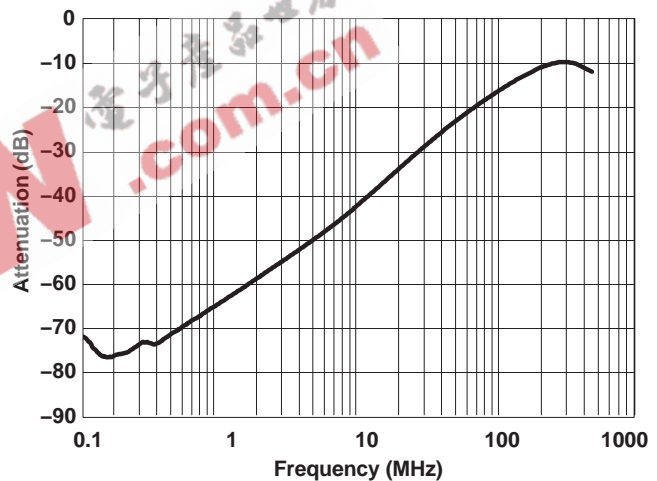


Figure 10. OFF Isolation vs Frequency ( $V_+ = 5$  V)

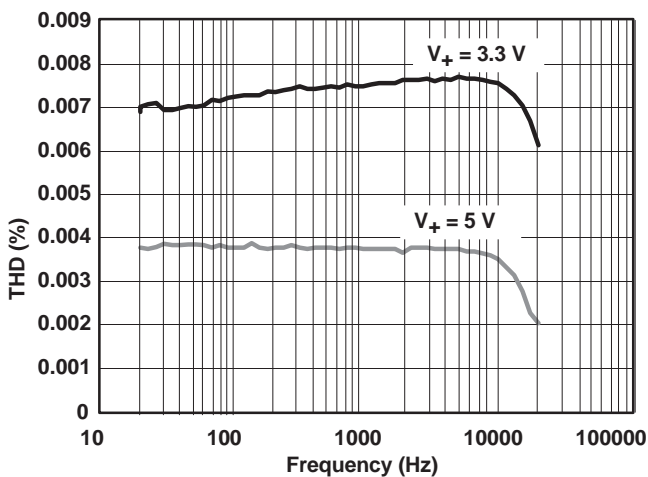


Figure 11. Total Harmonic Distortion vs Frequency ( $V_+ = 5$  V)

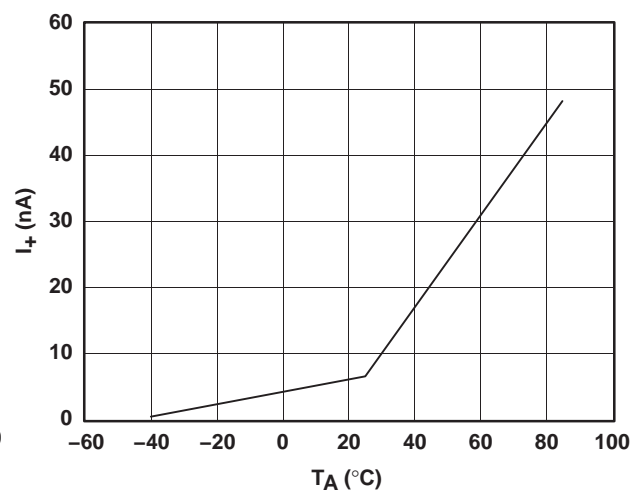


Figure 12. Power-Supply Current vs Temperature ( $V_+ = 5$  V)

### PIN DESCRIPTION

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

### PARAMETER DESCRIPTION

SYMBOL	DESCRIPTION
V <sub>COM</sub>	Voltage at COM
V <sub>NO</sub>	Voltage at NO
r <sub>on</sub>	Resistance between COM and NO ports when the channel is ON
r <sub>peak</sub>	Peak on-state resistance over a specified voltage range
r <sub>on(flat)</sub>	Difference between the maximum and minimum value of r <sub>on</sub> in a channel over the specified range of conditions
I <sub>NO(OFF)</sub>	Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the OFF state under worst-case input and output conditions
I <sub>NO(PWROFF)</sub>	Leakage current measured at the NO port during the power-down condition, V <sub>+</sub> = 0
I <sub>COM(OFF)</sub>	Leakage current measured at the COM port, with the corresponding channel (COM to NO) in the OFF state under worst-case input and output conditions
I <sub>COM(PWROFF)</sub>	Leakage current measured at the COM port during the power-down condition, V <sub>+</sub> = 0
I <sub>NO(ON)</sub>	Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the ON state and the output (COM) open
I <sub>COM(ON)</sub>	Leakage current measured at the COM port, with the corresponding channel (COM to NO) in the ON state and the output (NO) open
V <sub>IH</sub>	Minimum input voltage for logic high for the control input (IN)
V <sub>IL</sub>	Maximum input voltage for logic low for the control input (IN)
V <sub>I</sub>	Voltage at the control input (IN)
I <sub>IH</sub> , I <sub>IL</sub>	Leakage current measured at the control input (IN)
t <sub>ON</sub>	Turn-on time for the switch. This parameter is measured under the specified range of conditions and by the propagation delay between the digital control (IN) signal and analog output (COM or NO) signal when the switch is turning ON.
t <sub>OFF</sub>	Turn-off time for the switch. This parameter is measured under the specified range of conditions and by the propagation delay between the digital control (IN) signal and analog output (COM or NO) signal when the switch is turning OFF.
Q <sub>C</sub>	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 <sub>C</sub> = C <sub>L</sub> × ΔV <sub>COM</sub> . C <sub>L</sub> is the load capacitance, and ΔV <sub>COM</sub> is the change in analog output voltage.
C <sub>NO(OFF)</sub>	Capacitance at the NO port when the corresponding channel (NO to COM) is OFF
C <sub>COM(OFF)</sub>	Capacitance at the COM port when the corresponding channel (COM to NO) is OFF
C <sub>NO(ON)</sub>	Capacitance at the NO port when the corresponding channel (NO to COM) is ON
C <sub>COM(ON)</sub>	Capacitance at the COM port when the corresponding channel (COM to NO) is ON
C <sub>I</sub>	Capacitance of control input (IN)
O <sub>ISO</sub>	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.
BW	Bandwidth of the switch. This is the frequency at 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 <sub>+</sub>	Static power-supply current with the control (IN) pin at V <sub>+</sub> or GND

**PARAMETER MEASUREMENT INFORMATION**

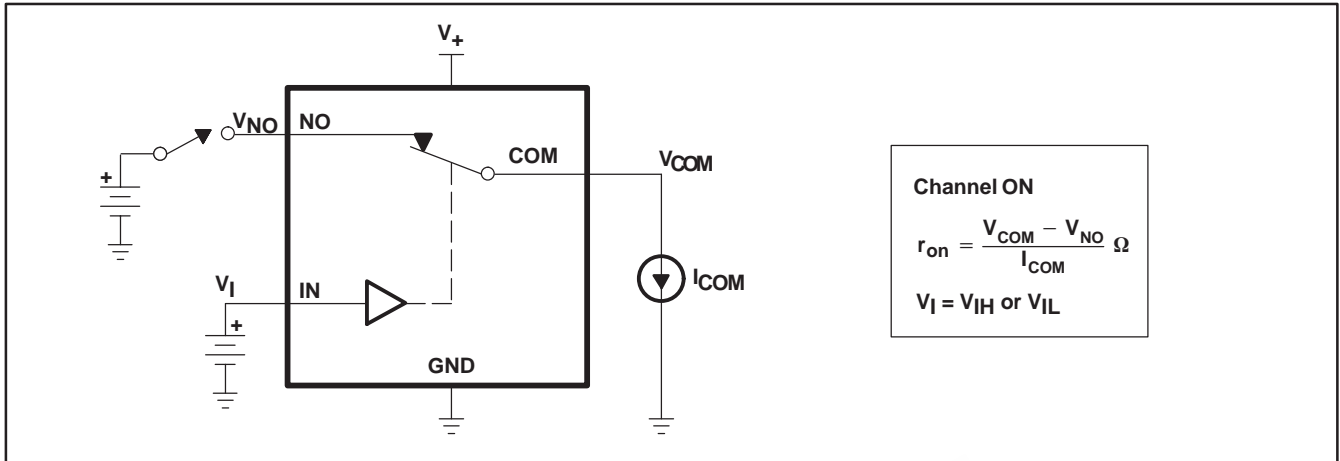


Figure 13. ON-State Resistance ( $r_{on}$ )

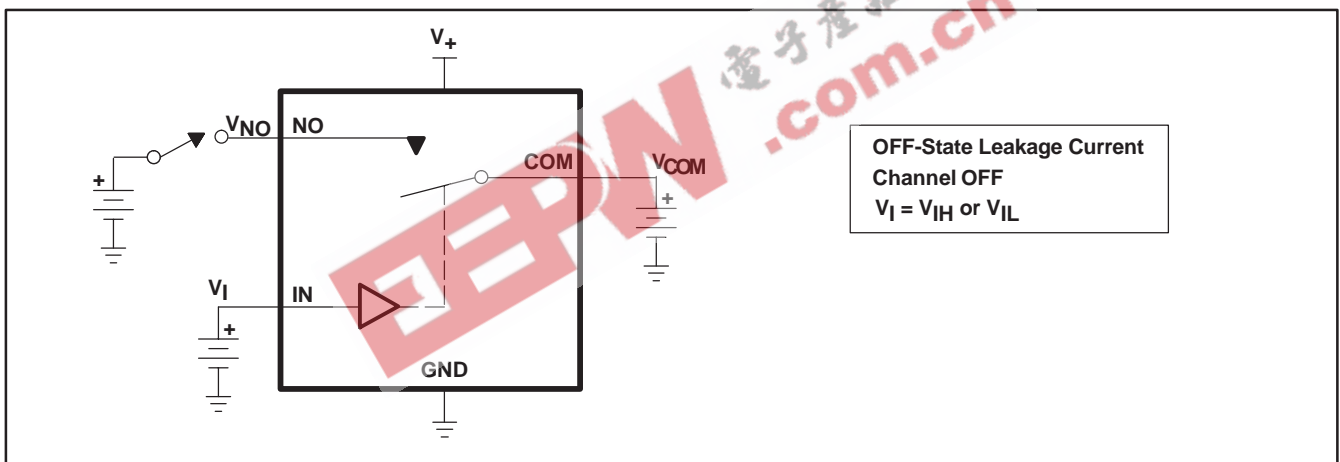


Figure 14. OFF-State Leakage Current ( $I_{COM(OFF)}$ ,  $I_{NO(OFF)}$ ,  $I_{COM(PWROFF)}$ ,  $I_{NO(PWROFF)}$ )

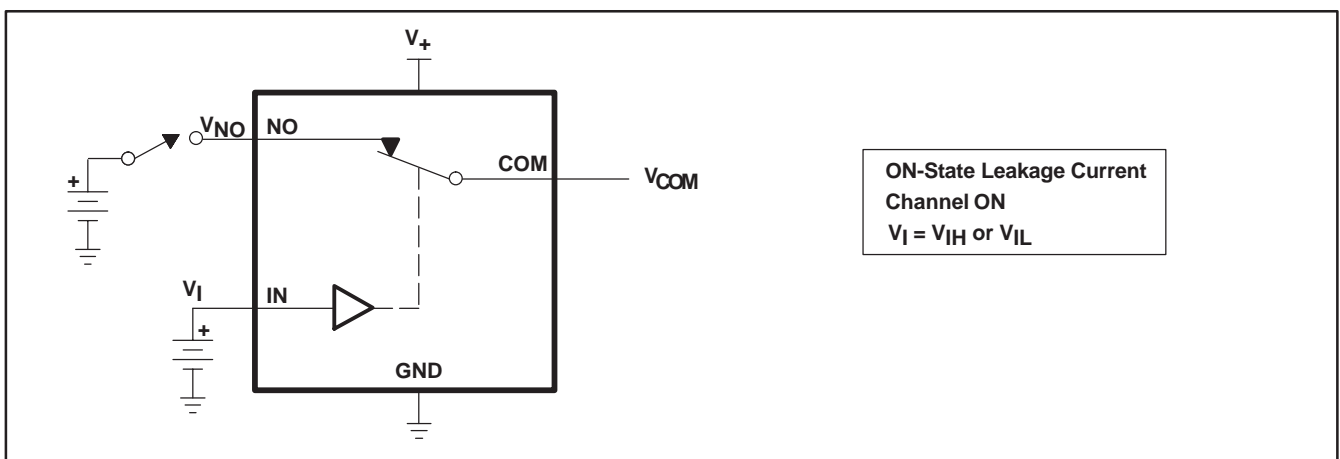
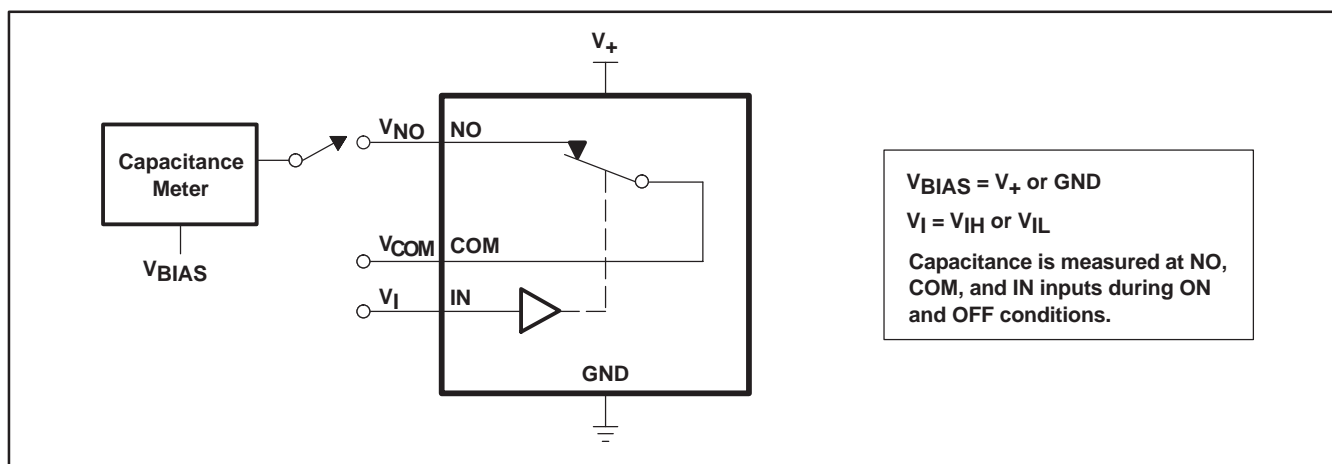
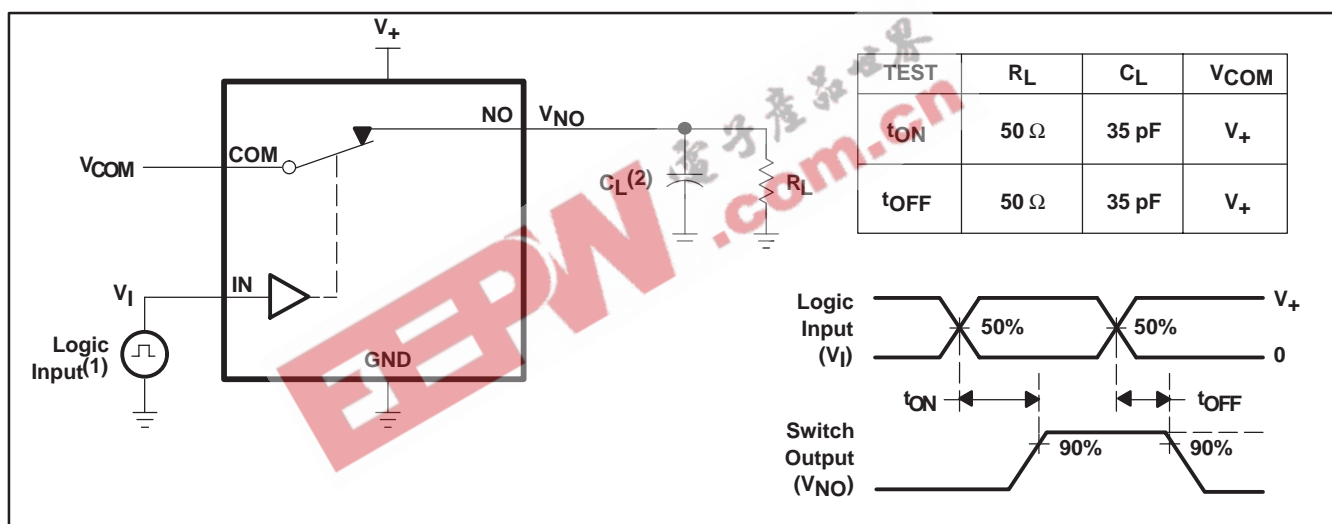


Figure 15. ON-State Leakage Current ( $I_{COM(ON)}$ ,  $I_{NO(ON)}$ )

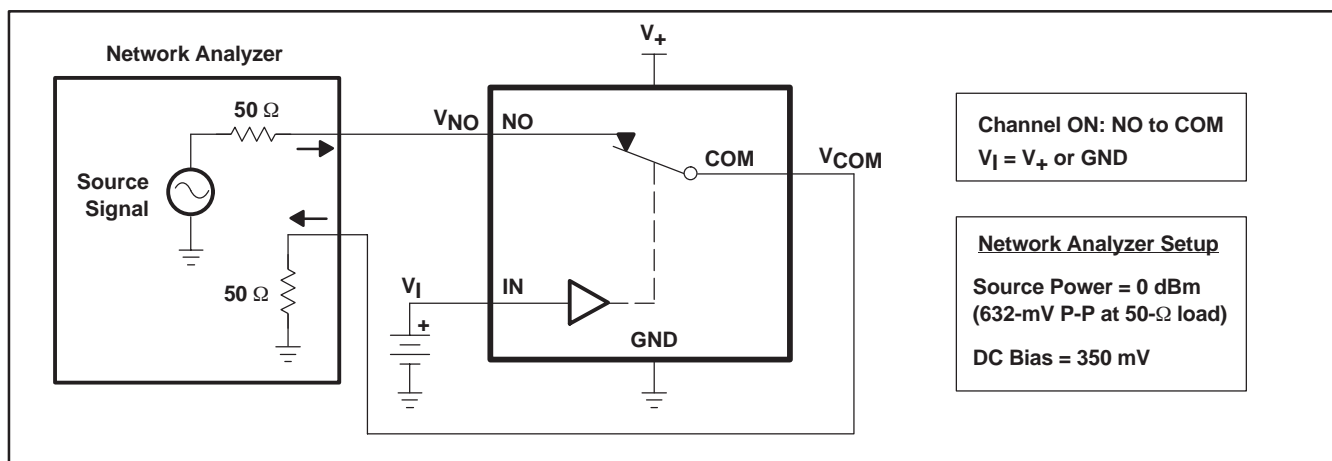


**Figure 16. Capacitance ( $C_I$ ,  $C_{COM(OFF)}$ ,  $C_{COM(ON)}$ ,  $C_{NO(OFF)}$ ,  $C_{NO(ON)}$ )**

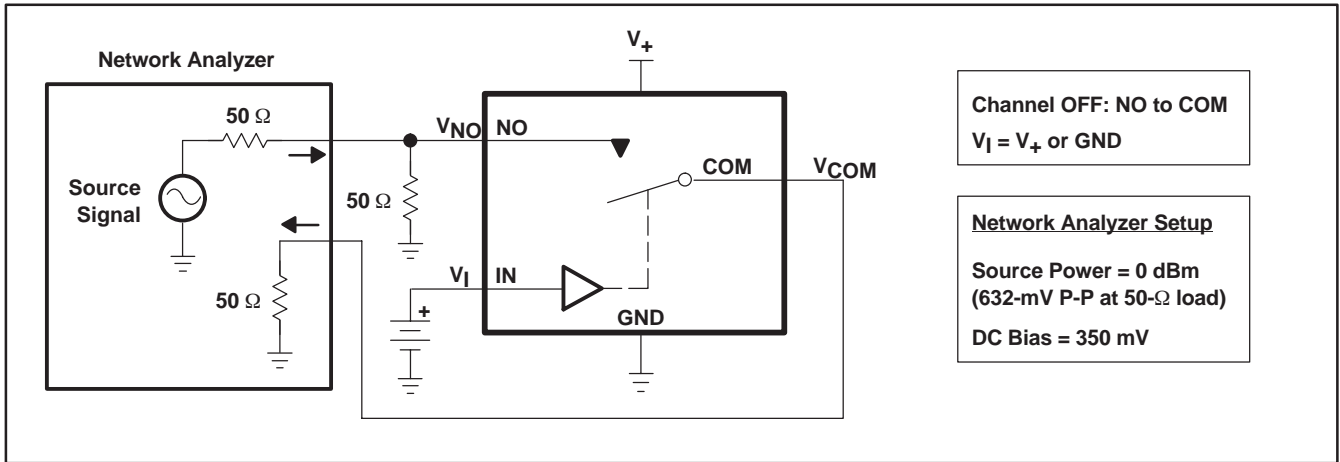


- (1) All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z<sub>O</sub> = 50 Ω, t<sub>r</sub> < 5 ns, t<sub>f</sub> < 5 ns.  
(2) C<sub>L</sub> includes probe and jig capacitance.

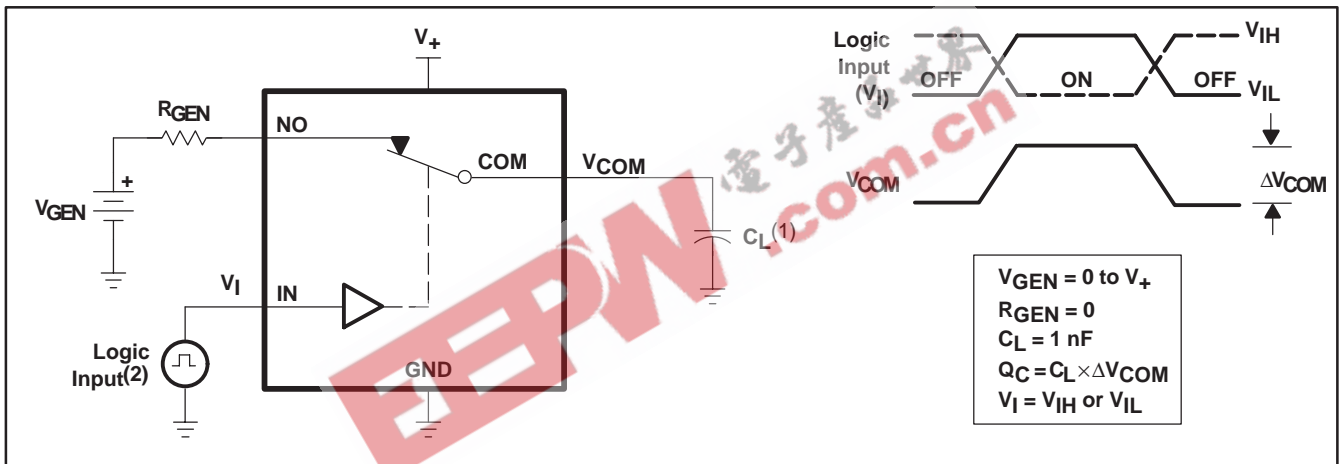
**Figure 17. Turn-On (t<sub>ON</sub>) and Turn-Off Time (t<sub>OFF</sub>)**



**Figure 18. Bandwidth (BW)**



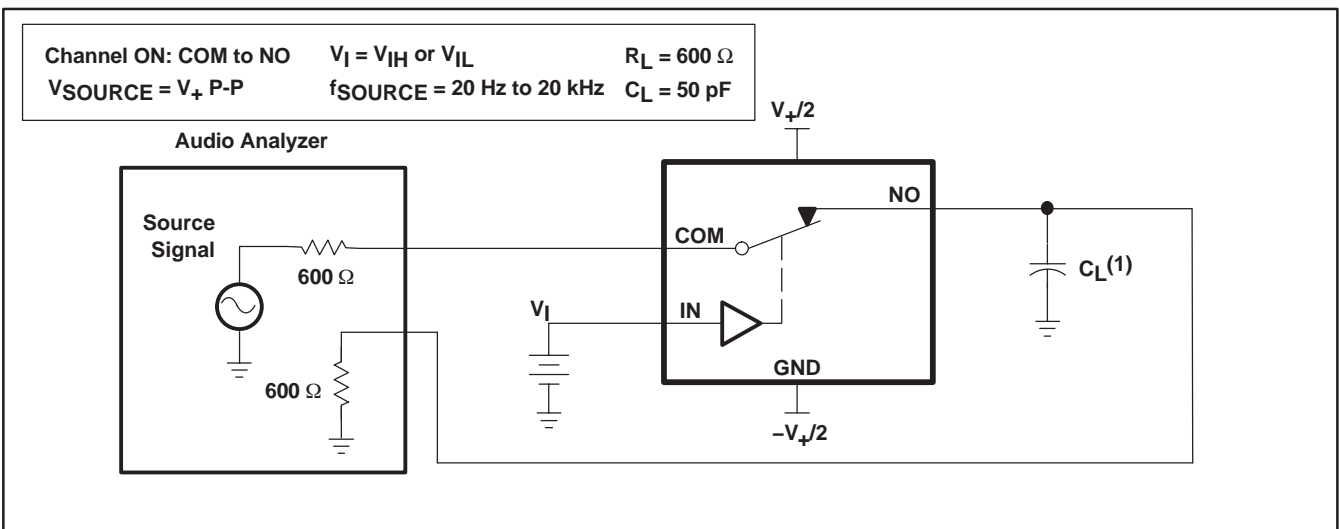
**Figure 19. OFF Isolation ( $O_{ISO}$ )**



(1) C<sub>L</sub> includes probe and jig capacitance.

(2) 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.

**Figure 20. Charge Injection (Q<sub>C</sub>)**



(1) C<sub>L</sub> includes probe and jig capacitance.

**Figure 21. Total Harmonic Distortion (THD)**

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TS5A3166DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS5A3166DBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS5A3166DCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS5A3166DCKRE4	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS5A3166YZPR	ACTIVE	WCSP	YZP	5	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

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

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

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

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

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

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

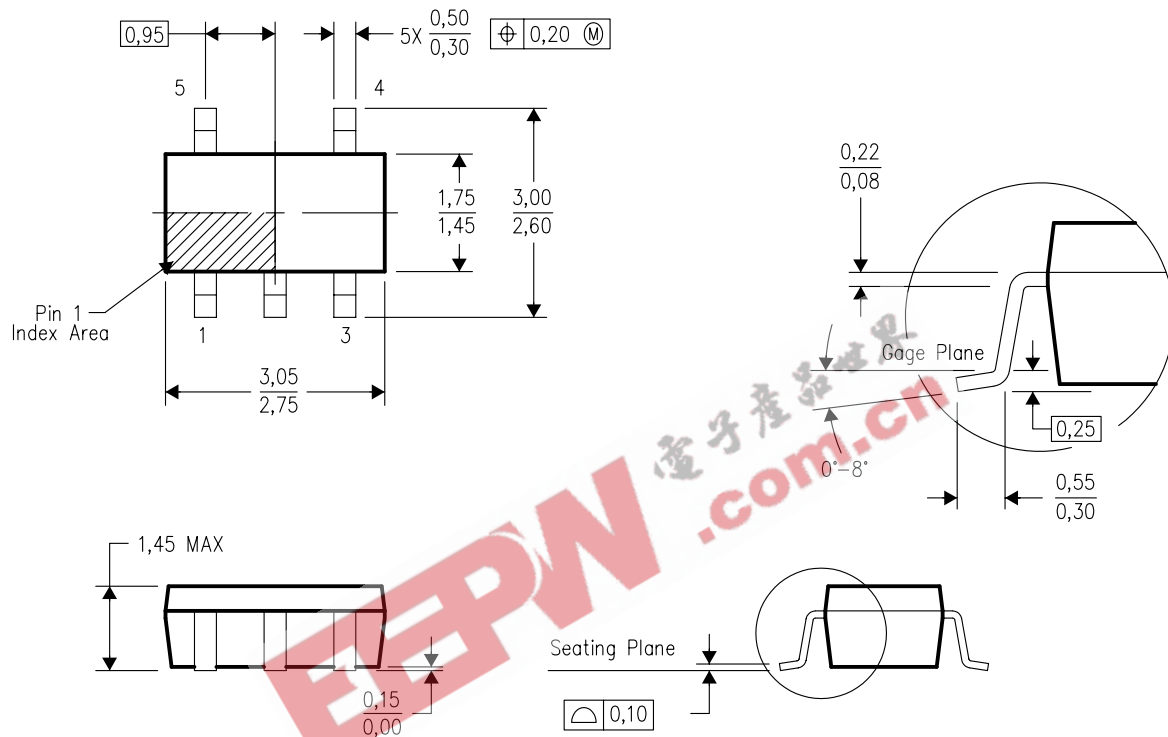
**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information.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

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

# MECHANICAL DATA

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



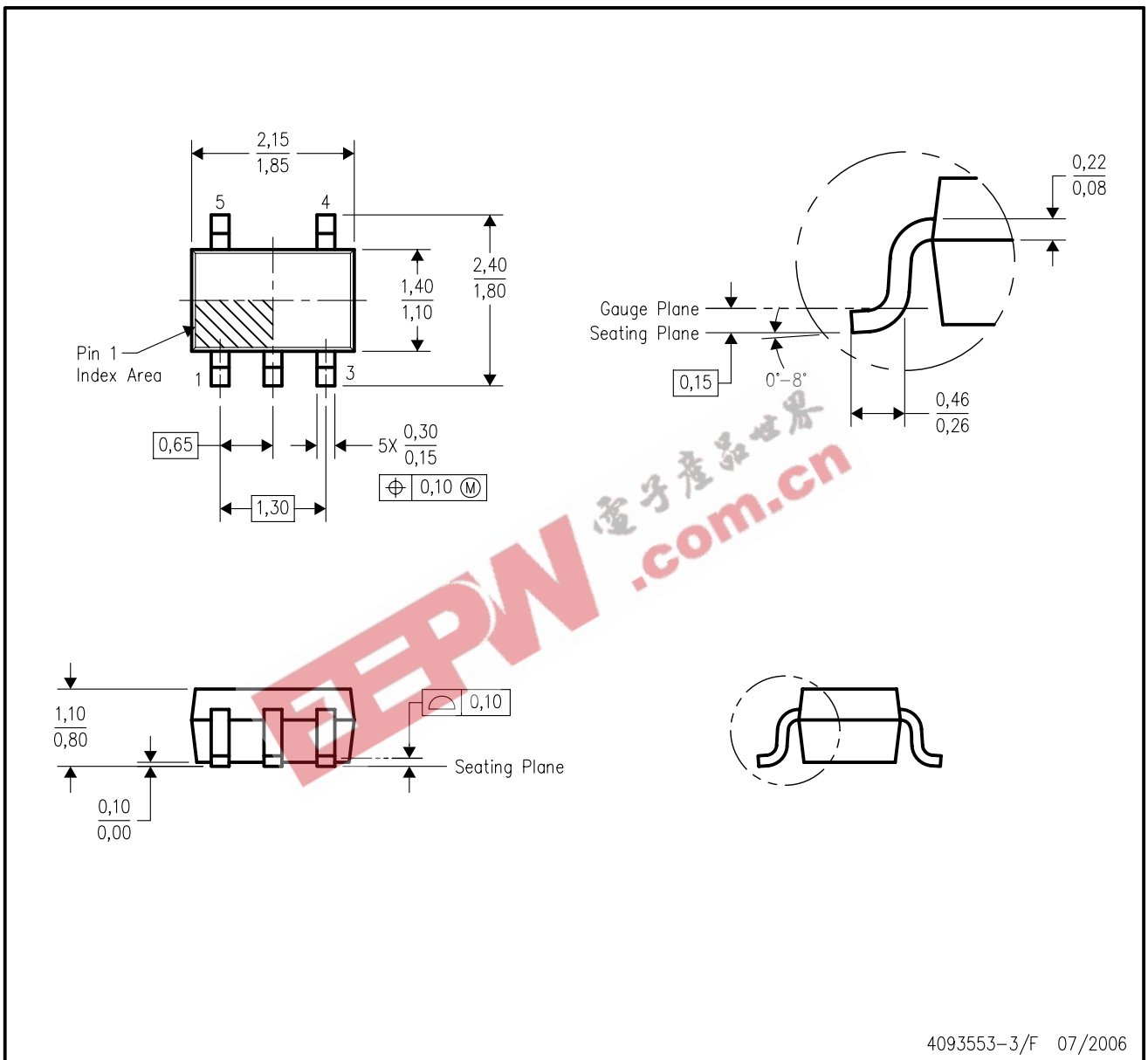
4073253-4/K 03/2006

- 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. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Falls within JEDEC MO-178 Variation AA.

## MECHANICAL DATA

DCK (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE

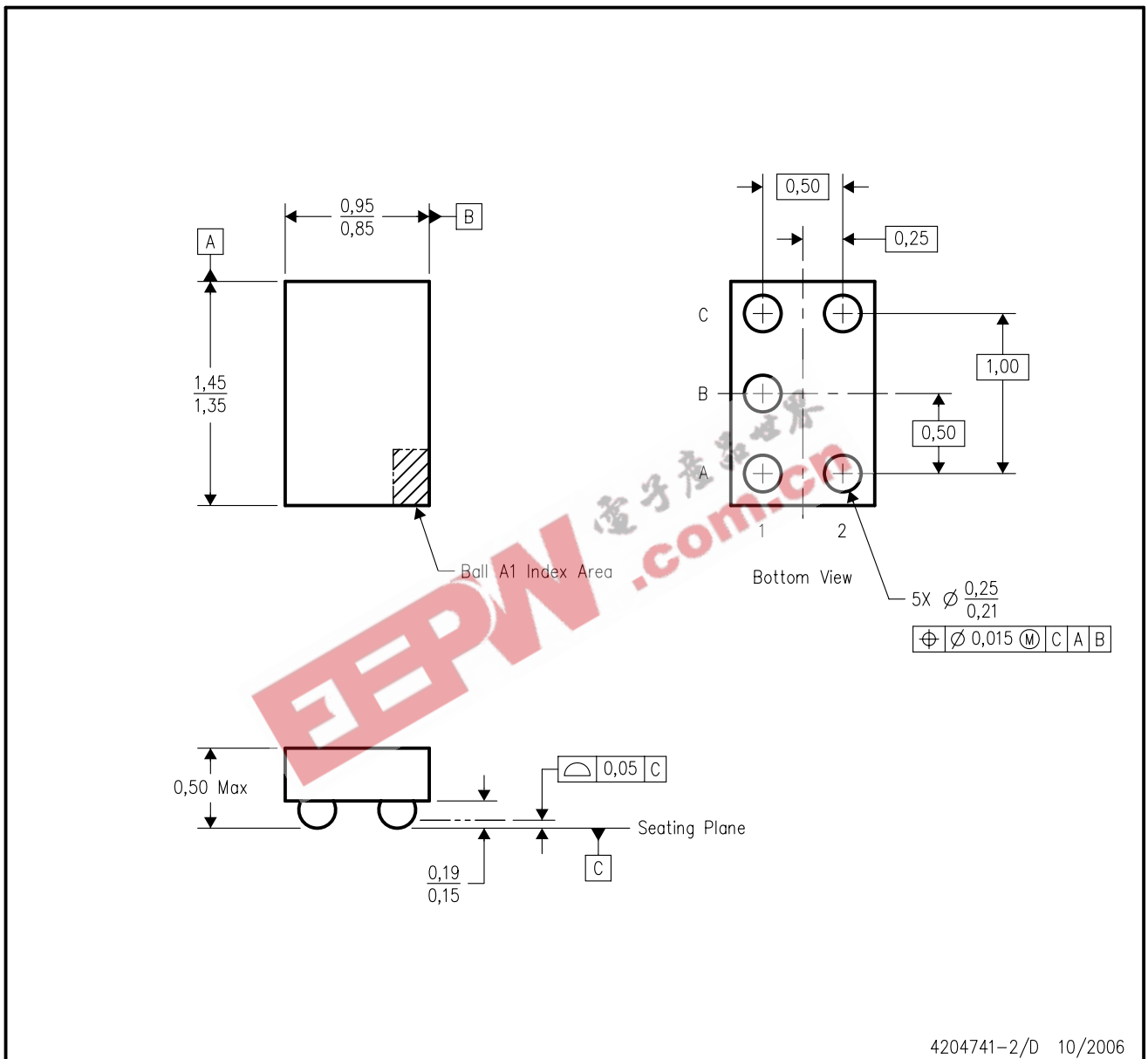


- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - Falls within JEDEC MO-203 variation AA.

# MECHANICAL DATA

YZP (R-XBGA-N5)

DIE-SIZE BALL GRID ARRAY



4204741-2/D 10/2006

- 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. NanoFree™ package configuration.
  - D. This package is lead-free. Refer to the 5 YEP package (drawing 4204725) for tin-lead (SnPb).

NanoFree is a trademark of Texas Instruments.

## IMPORTANT NOTICE

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

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

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

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

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

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

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

### Products

Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
Low Power Wireless	<a href="http://www.ti.com/lpw">www.ti.com/lpw</a>

### Applications

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

Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265