

# 0.65-Ω DUAL SPDT ANALOG SWITCHES WITH NEGATIVE SIGNALING CAPABILITY

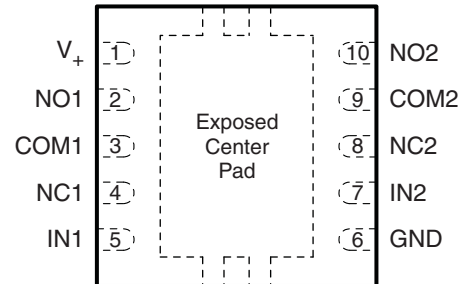
Check for Samples: [TS5A22362](#), [TS5A22364](#)

## FEATURES

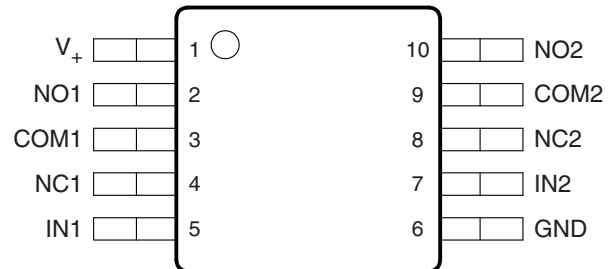
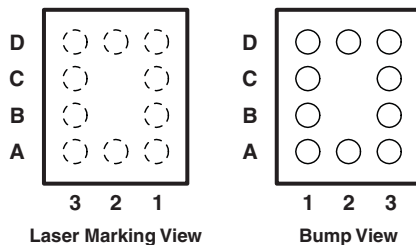
- Specified Break-Before-Make Switching
- Negative Signaling Capability: Maximum Swing From  $-2.75\text{ V}$  to  $2.75\text{ V}$  ( $V_+ = 2.75\text{ V}$ )
- Internal Shunt Switch Prevents Audible Click-and-Pop When Switching Between Two Sources (TS5A22364)
- Low ON-State Resistance ( $0.65\ \Omega$  Typical)
- Low Charge Injection
- Excellent ON-State Resistance Matching
- 2.3-V to 5.5-V Power Supply ( $V_+$ )
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance Tested Per JESD 22
  - 2500-V Human-Body Model (A114-B, Class II)
  - 1500-V Charged-Device Model (C101)
  - 200-V Machine Model (A115-A)

## APPLICATIONS

- Cell Phones
- PDAs
- Portable Instrumentation
- Audio Routing
- Medical Imaging

**DRC PACKAGE  
(TOP VIEW)**


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

**DGS PACKAGE  
(TOP VIEW)**

**YZP PACKAGE**

**YZP PACKAGE TERMINAL ASSIGNMENTS**

D	IN1	GND	IN2
C	NC1		NC2
B	COM1		COM2
A	NO1	$V_+$	NO2
	3	2	1



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.



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## DESCRIPTION

The TS5A22362 and TS5A22364 are single-pole double-throw (SPDT) analog switches designed to operate from 2.3 V to 5.5 V. The devices feature negative signal capability that allows signals below ground to pass through the switch without distortion. Additionally, the TS5A22364 includes an internal shunt switch, which automatically discharges any capacitance at the NC or NO terminals when they are unconnected to COM. This reduces the audible click/pop noise when switching between two sources. The break-before-make feature prevents signal distortion during the transferring of a signal from one path to another. Low ON-state resistance, excellent channel-to-channel ON-state resistance matching, and minimal total harmonic distortion (THD) performance are ideal for audio applications. The 3x3 mm DRC package is also available as a non-magnetic package for medical imaging application.

## ORDERING INFORMATION

For package and ordering information, see the Package Option Addendum at the end of this document.

## SUMMARY OF CHARACTERISTICS

$V_+ = 2.7 \text{ V}$ ,  $T_A = 25^\circ\text{C}$

Configuration	2:1 Multiplexer/Demultiplexer (2 x SPDT)
Number of channels	2
ON-state resistance ( $r_{on}$ )	0.65 $\Omega$
ON-state resistance match ( $\Delta r_{on}$ )	0.023 $\Omega$
ON-state resistance flatness ( $r_{on(flat)}$ )	0.18 $\Omega$
Turn-on/turn-off time ( $t_{ON}/t_{OFF}$ )	80 ns/70 ns
Break-before-make time ( $t_{BBM}$ )	7 ns
Charge injection ( $Q_C$ )	150 pC
Bandwidth (BW)	17 MHz
OFF isolation ( $O_{ISO}$ )	-66 dB at 100 kHz
Crosstalk ( $X_{TALK}$ )	-75 dB at 100 kHz
Total harmonic distortion (THD)	0.01%
Leakage current ( $I_{NO(OFF)}$ , $I_{NC(OFF)}$ )	50 nA
Package options	10-pin WCSP (YZP), 10-pin VSSOP (DGS), and 10-pin SON (DRC)

## FUNCTION TABLE

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

APPLICATION BLOCK DIAGRAMS

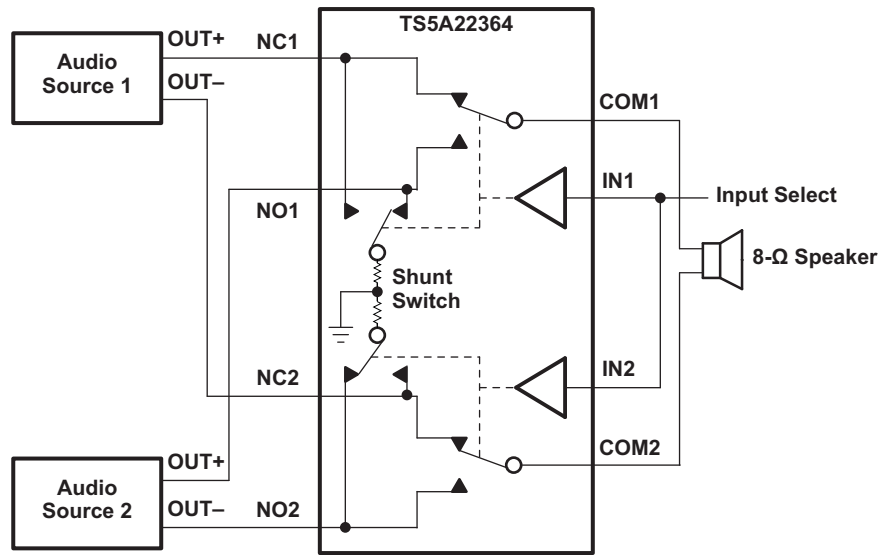


Figure 1. TS5A22364 Application Block Diagram

Shunt Switch (TS5A22364)

The 50-Ω shunt switches on the TS5A22364 automatically discharge any capacitance at the NC or NO terminals when they are unconnected to COM. This reduces audible click-and-pop sounds that occur when switching between audio sources. Audible clicks and pops are caused when a step DC voltage is switched into the speaker. By automatically discharging the side that is not connected, any residual DC voltage is removed, thereby reducing the clicks and pops.

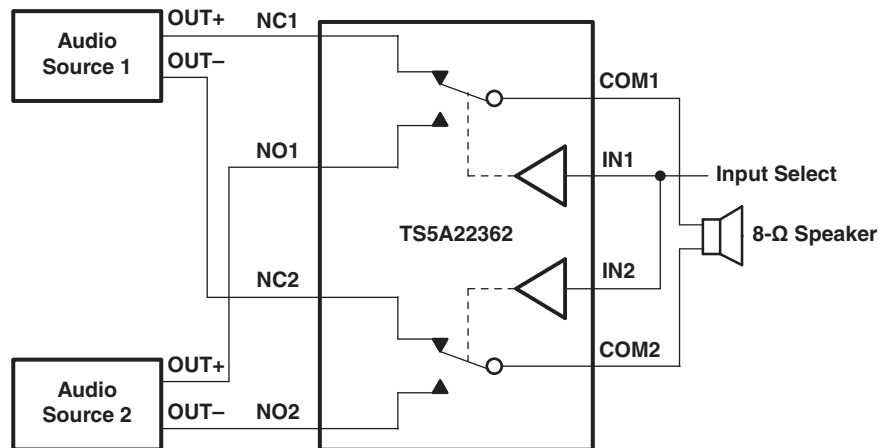


Figure 2. TS5A22362 Application Block Diagram

Negative Signaling Capacity

The TS5A22362 and TS5A22364 dual SPDT switches feature negative signal capability that allows signals below ground to pass through without distortion. These analog switches operate from a single +2.3-V to +5.5-V supply. The input/output signal swing of the device is dependant of the supply voltage  $V_+$ : the devices pass signals as high as  $V_+$  and as low as  $V_+ - 5.5$  V, including signals below ground with minimal distortion.

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

**Table 1. INPUT/OUTPUT SIGNAL SWING**

SUPPLY VOLTAGE, V <sub>+</sub>	MINIMUM (V <sub>NC</sub> , V <sub>NO</sub> , V <sub>COM</sub> ) = V <sub>+</sub> – 5.5	MAXIMUM (V <sub>NC</sub> , V <sub>NO</sub> , V <sub>COM</sub> ) = V <sub>+</sub>
5.5 V	0 V	5.5 V
4.2 V	–1.3 V	4.2 V
3.3 V	–2.2 V	3.3 V
3 V	–2.5 V	3 V
2.5 V	–3 V	2.5 V

**ABSOLUTE MINIMUM AND MAXIMUM RATINGS<sup>(1)(2)</sup>**

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

		MIN	MAX	UNIT
V <sub>+</sub>	Supply voltage range <sup>(3)</sup>	–0.5	6	V
V <sub>NC</sub> V <sub>NO</sub> V <sub>COM</sub>	Analog voltage range <sup>(3) (4) (5)</sup>	V <sub>+</sub> – 6	V <sub>+</sub> + 0.5	V
I <sub>I/O</sub> K	Analog port diode current V <sub>NC</sub> , V <sub>NO</sub> , V <sub>COM</sub> < 0 or V <sub>NC</sub> , V <sub>NO</sub> , V <sub>COM</sub> > V <sub>+</sub>	–50	50	mA
I <sub>NC</sub> I <sub>NO</sub> I <sub>COM</sub>	ON-state switch current ON-state peak switch current <sup>(6)</sup>	–150 –300	150 300	mA
I <sub>NC</sub> <sup>(3)(7)(8)</sup> I <sub>NO</sub> <sup>(3)(7)(8)</sup> I <sub>COM</sub> <sup>(3)(7)(8)</sup>	ON-state switch current ON-state peak switch current <sup>(6)</sup>	–350 –500	350 500	mA
V <sub>I</sub>	Digital input voltage range	–0.5	6.5	V
I <sub>I</sub> K	Digital input clamp current <sup>(3)(4)</sup> V <sub>I</sub> < 0	–50	50	mA
I <sub>+</sub> I <sub>GND</sub>	Continuous current through V <sub>+</sub> or GND	–100	100	mA
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) V<sub>+</sub> = 3.0 V to 5.0 V, T<sub>A</sub> = –40°C to 85°C.
- (8) For YZP package only.

**THERMAL IMPEDANCE RATINGS**

			UNIT
θ <sub>JA</sub>	Package thermal impedance <sup>(1)</sup>	DGS package	56.5
		DRC package	165.36
		YZP package	93

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

**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	$V_{COM}, V_{NO}, V_{NC}$					$V_+ - 5.5$		$V_+$	V
ON-state resistance	$r_{on}$	$V_{NC}$ or $V_{NO} = V_+, 1.5 \text{ V}$ , $V_+ - 5.5 \text{ V}$ $I_{COM} = -100 \text{ mA}$ ,	COM to NO or NC, See <a href="#">Figure 16</a>	25°C Full	2.7 V		0.65 1.04	0.94	$\Omega$
ON-state resistance match between channels	$\Delta r_{on}$	$V_{NC}$ or $V_{NO} = 1.5 \text{ V}$ , $I_{COM} = -100 \text{ mA}$ ,	COM to NO or NC, See <a href="#">Figure 16</a>	25°C Full	2.7 V		0.023 0.15	0.11	$\Omega$
ON-state resistance flatness	$r_{on(Flat)}$	$V_{NC}$ or $V_{NO} = V_+, 1.5 \text{ V}$ , $V_+ - 5.5 \text{ V}$ $I_{COM} = -100 \text{ mA}$ ,	COM to NO or NC, See <a href="#">Figure 16</a>	25°C Full	2.7 V		0.18 0.5	0.46	$\Omega$
Shunt switch resistance (TS5A22364 only)	$r_{SH}$	$I_{NO}$ or $I_{NC} = 10 \text{ mA}$		Full	2.7 V		25	50	$\Omega$
NC, NO OFF leakage current (TS5A22362 Only)	$I_{NC(OFF)}, I_{NO(OFF)}$	$V_{NC} = 2.25 \text{ V}$ , $V_+ - 5.5 \text{ V}$ $V_{COM} = V_+ - 5.5 \text{ V}$ , $2.25 \text{ V}$ $V_{NO} = \text{Open}$ COM to NO or $V_{NO} = 2.25 \text{ V}$ , $V_+ - 5.5 \text{ V}$ , $V_{COM} = V_+ - 5.5 \text{ V}$ , $2.25 \text{ V}$ $V_{NC} = \text{Open}$ COM to NC	See <a href="#">Figure 17</a>	25°C Full	2.7	-50 -375		50 375	nA
COM ON leakage current	$I_{COM(ON)}$	$V_{NC}$ and $V_{NO} = \text{Open}$ , $V_{COM} = V_+, V_+ - 5.5 \text{ V}$ ,	See <a href="#">Figure 18</a>	25°C Full	2.7 V	-50 -375		50 375	nA
<b>Digital Control Inputs (IN)<sup>(2)</sup></b>									
Input logic high	$V_{IH}$			Full		1.4		5.5	V
Input logic low	$V_{IL}$			Full				0.6	V
Input leakage current	$I_{IH}, I_{IL}$	$V_{IN} = V_+ \text{ or } 0$		25°C Full	2.7 V	-250 -250		250 250	nA

(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<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	$t_{ON}$	$V_{COM} = V_+$ , $R_L = 300 \Omega$ ,	$C_L = 35 \text{ pF}$ , See <a href="#">Figure 20</a>	25°C	2.5 V	44	80	ns
				Full	2.3 V to 2.7 V		80	
Turn-off time	$t_{OFF}$	$V_{COM} = V_+$ , $R_L = 300 \Omega$ ,	$C_L = 35 \text{ pF}$ , See <a href="#">Figure 20</a>	25°C	2.5 V	22	70	ns
				Full	2.3 V to 2.7 V		70	
Break-before-make time	$t_{BBM}$	See <a href="#">Figure 21</a> for TS5A22362 See <a href="#">Figure 22</a> for TS5A22364	25°C	2.5 V	1	7		ns
Charge injection	$Q_C$	$V_{GEN} = 0$ , $R_{GEN} = 0$ ,	$C_L = 1 \text{ nF}$ , See <a href="#">Figure 26</a>	25°C	2.5 V	150		pC
NC, NO OFF capacitance (TS5A22362 only)	$C_{NC(OFF)}$ , $C_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = V_+$ or GND,	See <a href="#">Figure 19</a>	25°C	2.5 V	70		pF
NC, NO, COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND, Switch ON, $f = 10 \text{ MHz}$	See <a href="#">Figure 19</a>	25°C	2.5 V	370		pF
Digital input capacitance	$C_I$	$V_I = V_+$ or GND	See <a href="#">Figure 19</a>	25°C	2.5 V	2.6		pF
Bandwidth	BW	$R_L = 50 \Omega$ , $-3 \text{ dB}$	See <a href="#">Figure 21</a>	25°C	2.5 V	17		MHz
OFF isolation	$O_{ISO}$	$R_L = 50 \Omega$	$f = 100 \text{ kHz}$ , See <a href="#">Figure 24</a>	25°C	2.5 V	-66		dB
Crosstalk	$X_{TALK}$	$R_L = 50 \Omega$	$f = 100 \text{ kHz}$ , See <a href="#">Figure 25</a>	25°C	2.5 V	-75		dB
Total harmonic distortion	THD	$R_L = 600 \Omega$ , $C_L = 15 \text{ pF}$ ,	$f = 20 \text{ Hz to } 20 \text{ kHz}$ , See <a href="#">Figure 27</a>	25°C	2.5 V	0.01		%
<b>Supply</b>								
Positive supply current	$I_+$	$V_I = V_+$ or GND	25°C	2.7 V	0.2	1.1		$\mu\text{A}$
			Full					
Positive supply current	$I_+$	$V_I = V_+ - 5.5 \text{ V}$	Full	2.7 V			3.3	$\mu\text{A}$

**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	$V_{COM}, V_{NO}, V_{NC}$				$V_+ - 5.5$		$V_+$	V
ON-state resistance	$r_{on}$	$V_{NC}$ or $V_{NO} \leq V_+$ , 1.5 V, $V_+ - 5.5\text{ V}$ , $I_{COM} = -100\text{ mA}$ ,	COM to NO or NC, See <a href="#">Figure 16</a>	25°C	3 V	0.61	0.87	$\Omega$
				Full		0.97		
ON-state resistance match between channels	$\Delta r_{on}$	$V_{NC}$ or $V_{NO} = 1.5\text{ V}$ , $I_{COM} = -100\text{ mA}$ ,	COM to NO or NC, See <a href="#">Figure 16</a>	25°C	3 V	0.024	0.13	$\Omega$
				Full		0.13		
ON-state resistance flatness	$r_{on(flat)}$	$V_{NC}$ or $V_{NO} \leq V_+$ , 1.5 V, $V_+ - 5.5\text{ V}$ , $I_{COM} = -100\text{ mA}$ ,	COM to NO or NC, See <a href="#">Figure 16</a>	25°C	3 V	0.12	0.46	$\Omega$
				Full		0.5		
Shunt switch resistance (TS5A22364 only)	$r_{SH}$	$I_{NO}$ or $I_{NC} = 10\text{ mA}$	Full	3 V		25	37	$\Omega$
NC, NO OFF leakage current (TS5A22362 only)	$I_{NC(OFF)}, I_{NO(OFF)}$	$V_{NC} = 3\text{ V}, V_+ - 5.5\text{ V}$ $V_{COM} = V_+ - 5.5\text{ V}, 3\text{ V}$ $V_{NO} = \text{Open}$ COM to NO or $V_{NO} = 3\text{ V}, V_+ - 5.5\text{ V}$ , $V_{COM} = V_+ - 5.5\text{ V}, 3\text{ V}$ $V_{NC} = \text{Open}$ COM to NC	See <a href="#">Figure 17</a>	25°C	3.6 V	-50	50	nA
				Full		-375	375	
COM ON leakage current	$I_{COM(ON)}$	$V_{NC}$ and $V_{NO} = \text{Open}$ , $V_{COM} = V_+, V_+ - 5.5\text{ V}$ ,	COM to NO or NC, See <a href="#">Figure 18</a>	25°C	3.6 V	-50	50	nA
				Full		-375	375	
<b>Digital Control Inputs (IN)<sup>(2)</sup></b>								
Input logic high	$V_{IH}$		Full		1.4		5.5	V
Input logic low	$V_{IL}$		Full				0.8	V
Input leakage current	$I_{IH}, I_{IL}$	$V_{IN} = V_+ \text{ or } 0$	25°C	3.6 V	-250		250	nA
			Full		-250	250		

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

(2) All 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<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	$t_{ON}$	$V_{COM} = V_+$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ , See <a href="#">Figure 20</a>	25°C	3.3 V		34	80	ns
			Full	3 V to 3.6 V			80	
Turn-off time	$t_{OFF}$	$V_{COM} = V_+$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ , See <a href="#">Figure 20</a>	25°C	3.3 V		19	70	ns
			Full	3 V to 3.6 V			70	
Break-before-make time	$t_{BBM}$	See <a href="#">Figure 21</a> for TS5A22362 See <a href="#">Figure 22</a> for TS5A22364	25°C	3.3 V	1	7		ns
Charge injection	$Q_C$	$V_{GEN} = 0$ , $R_{GEN} = 0$ , $C_L = 1\text{ nF}$ , See <a href="#">Figure 26</a>	25°C	3.3 V		150		pC
NC, NO OFF capacitance (TS5A22362 only)	$C_{NC(OFF)}$ , $C_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = V_+$ or $V_+ - 5.5\text{ V}$ , See <a href="#">Figure 19</a>	25°C	3.3 V		70		pF
NC, NO, COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND, $f = 10\text{ MHz}$ , See <a href="#">Figure 19</a>	25°C	3.3 V		370		pF
Digital input capacitance	$C_I$	$V_I = V_+$ or GND, See <a href="#">Figure 19</a>	25°C	3.3 V		2.6		pF
Bandwidth	BW	$R_L = 50\ \Omega$ , -3 dB, Switch ON, See <a href="#">Figure 21</a>	25°C	3.3 V		17.5		MHz
OFF isolation	$O_{ISO}$	$R_L = 50\ \Omega$ , $f = 100\text{ kHz}$ , See <a href="#">Figure 24</a>	25°C	3.3 V		-68		dB
Crosstalk	$X_{TALK}$	$R_L = 50\ \Omega$ , $f = 100\text{ kHz}$ , See <a href="#">Figure 25</a>	25°C	3.3 V		-76		dB
Total harmonic distortion	THD	$R_L = 600\ \Omega$ , $C_L = 15\text{ pF}$ , $f = 20\text{ Hz to }20\text{ kHz}$ , See <a href="#">Figure 27</a>	25°C	3.3 V		0.008		%
<b>Supply</b>								
Positive supply current	$I_+$	$V_I = V_+$ or GND, $V_I = V_+ - 5.5\text{ V}$	25°C	3.6 V		0.1	1.2	$\mu\text{A}$
			Full				1.3	
			Full				3.4	



**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	$V_{COM}, V_{NO}, V_{NC}$				$V_+ - 5.5$		$V_+$	V
ON-state resistance	$r_{on}$	$V_{NC}$ or $V_{NO} = V_+, 1.6\text{ V}$ , $V_+ = -5.5\text{ V}$ , $I_{COM} = -100\text{ mA}$ ,	COM to NO or NC, See <a href="#">Figure 16</a>	25°C Full	4.5 V	0.52	0.74 0.83	$\Omega$
ON-state resistance match between channels	$\Delta r_{on}$	$V_{NC}$ or $V_{NO} = 1.6\text{ V}$ , $I_{COM} = -100\text{ mA}$ ,	COM to NO or NC, See <a href="#">Figure 16</a>	25°C Full	4.5 V	0.04	0.23 0.30	$\Omega$
ON-state resistance flatness	$r_{on(Flat)}$	$V_{NC}$ or $V_{NO} = V_+, 1.6\text{ V}$ , $V_+ = -5.5\text{ V}$ , $I_{COM} = -100\text{ mA}$ ,	COM to NO or NC, See <a href="#">Figure 16</a>	25°C Full	4.5 V	0.076	0.46 0.5	$\Omega$
Shunt switch resistance (TS5A22364 only)	$r_{SH}$	$I_{NO}$ or $I_{NC} = 10\text{ mA}$		Full	4.5 V	16	36	$\Omega$
NC, NO OFF leakage current	$I_{NC(OFF)}, I_{NO(OFF)}$	$V_{NC} = 4.5\text{ V}, V_+ = -5.5\text{ V}$ $V_{COM} = V_+ - 5.5\text{ V}, 4.5\text{ V}$ $V_{NO} = \text{Open}$ COM to NO or $V_{NO} = 4.5\text{ V}, V_+ = -5.5\text{ V}$ , $V_{COM} = V_+ - 5.5\text{ V}, 4.5\text{ V}$ $V_{NC} = \text{Open}$ COM to NC	See <a href="#">Figure 17</a>	25°C Full	5.5 V	-50 -375	50 375	nA
COM ON leakage current	$I_{COM(ON)}$	$V_{NC}$ and $V_{NO} = \text{Open}$ , $V_{COM} = V_+, V_+ - 5.5\text{ V}$ ,	See <a href="#">Figure 18</a>	25°C Full	5.5 V	-50 -375	50 375	nA
<b>Digital Control Inputs (IN)<sup>(2)</sup></b>								
Input logic high	$V_{IH}$			Full		2.4	5.5	V
Input logic low	$V_{IL}$			Full			0.8	V
Input leakage current	$I_{IH}, I_{IL}$	$V_{IN} = V_+ \text{ or } 0$		25°C Full	5.5 V	-250 -250	250 250	nA

(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 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	$t_{ON}$	$V_{COM} = V_+$ , $R_L = 300 \Omega$ ,	$C_L = 35 \text{ pF}$ , See <a href="#">Figure 20</a>	25°C	5 V	27	80	ns
				Full	4.5 V to 5.5 V		80	
Turn-off time	$t_{OFF}$	$V_{COM} = V_+$ , $R_L = 300 \Omega$ ,	$C_L = 35 \text{ pF}$ , See <a href="#">Figure 20</a>	25°C	5 V	13	70	ns
				Full	4.5 V to 5.5 V		70	
Break-before-make time	$t_{BBM}$	$V_{NC} = V_{NO} = V_+/2$ $R_L = 300 \Omega$ ,	$C_L = 35 \text{ pF}$ , See <a href="#">Figure 21</a>	25°C	5 V	1	3.5	ns
Charge injection	$Q_C$	$V_{GEN} = 0$ , $R_{GEN} = 0$ ,	$C_L = 1 \text{ nF}$ , See <a href="#">Figure 26</a>	25°C	5 V		10	pC
NC, NO OFF capacitance (TS5A22362 only)	$C_{NC(OFF)}$ , $C_{NO(OFF)}$	$V_{NC}$ or $V_{NO} = V_+$ or $V_+ - 5.5 \text{ V}$ ,	See <a href="#">Figure 19</a>	25°C	5 V		70	pF
NC, NO, COM ON capacitance	$C_{COM(ON)}$	$V_{COM} = V_+$ or GND,	See <a href="#">Figure 19</a>	25°C	5 V		370	pF
Digital input capacitance	$C_I$	$V_I = V_+$ or GND	See <a href="#">Figure 19</a>	25°C	5 V		2.6	pF
Bandwidth	BW	$R_L = 50 \Omega$ ,	See <a href="#">Figure 21</a>	25°C	5 V		18.3	MHz
OFF isolation	$O_{ISO}$	$R_L = 50 \Omega$ ,	$f = 100 \text{ kHz}$ , See <a href="#">Figure 24</a>	25°C	5 V		-70	dB
Crosstalk	$X_{TALK}$	$R_L = 50 \Omega$ ,	$f = 100 \text{ kHz}$ , See <a href="#">Figure 25</a>	25°C	5 V		-78	dB
Total harmonic distortion	THD	$R_L = 600 \Omega$ , $C_L = 15 \text{ pF}$ ,	$f = 20 \text{ Hz to } 20 \text{ kHz}$ , See <a href="#">Figure 27</a>	25°C	5 V		0.009	%
<b>Supply</b>								
Positive supply current	$I_+$	$V_I = V_+$ or GND	25°C	5.5 V	0.2	1.3	$\mu\text{A}$	
			Full			3.5		
			Full			5		

TYPICAL PERFORMANCE

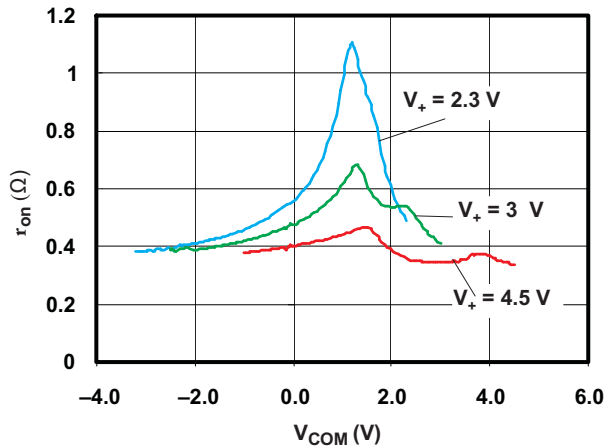


Figure 3.  $r_{on}$  vs  $V_{COM}$

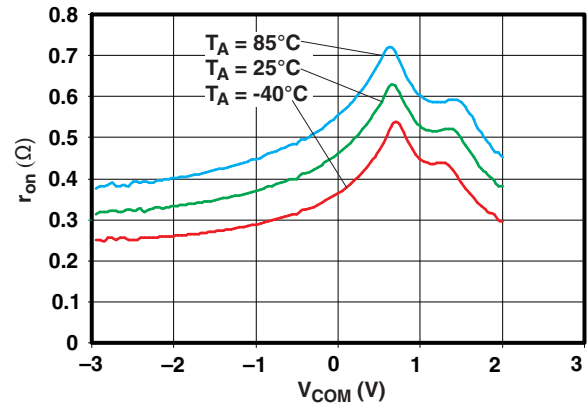


Figure 4.  $r_{on}$  vs  $V_{COM}$  ( $V_+ = 2.7$  V)

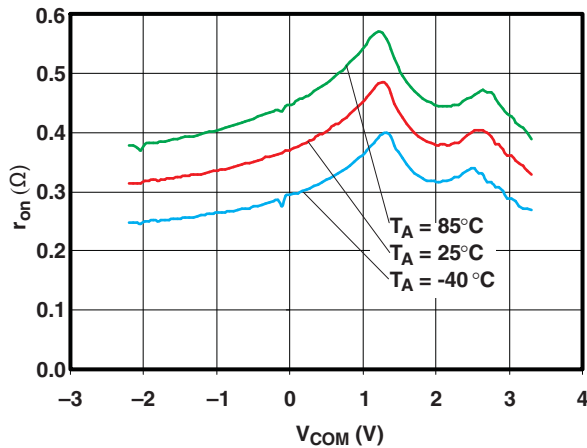


Figure 5.  $r_{on}$  vs  $V_{COM}$  ( $V_+ = 3.3$  V)

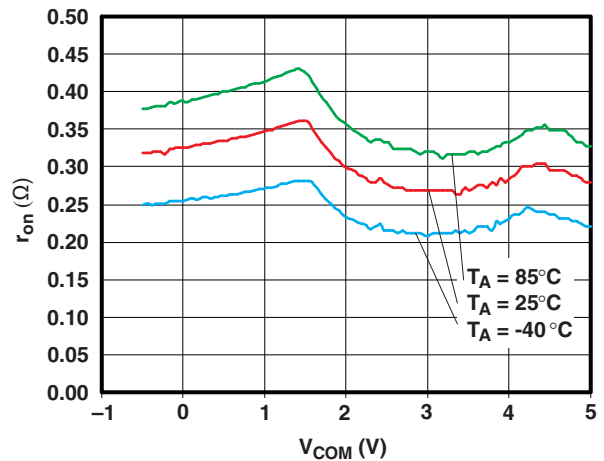


Figure 6.  $r_{on}$  vs  $V_{COM}$  ( $V_+ = 5$  V)

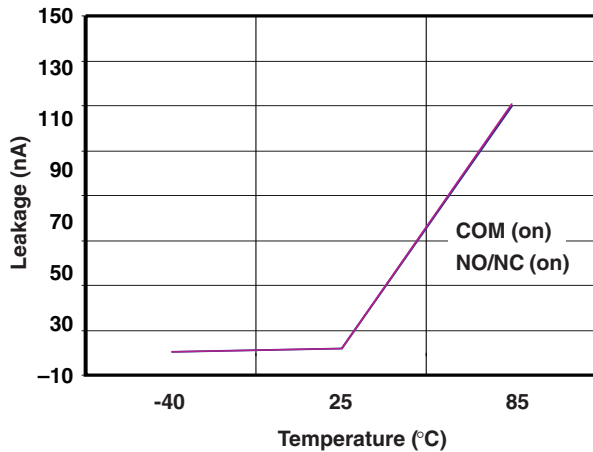


Figure 7. Leakage Current vs Temperature

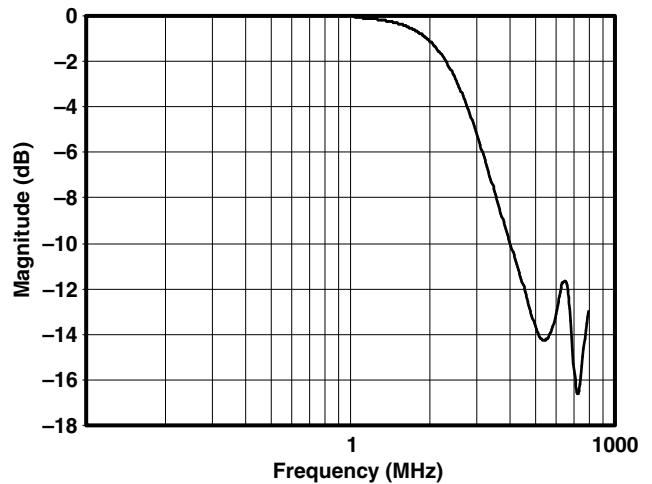


Figure 8. Insertion Loss

TYPICAL PERFORMANCE (continued)

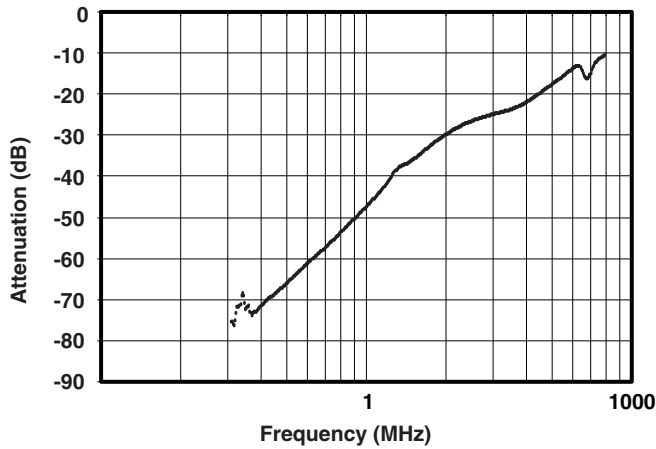


Figure 9. OFF Isolation vs Frequency

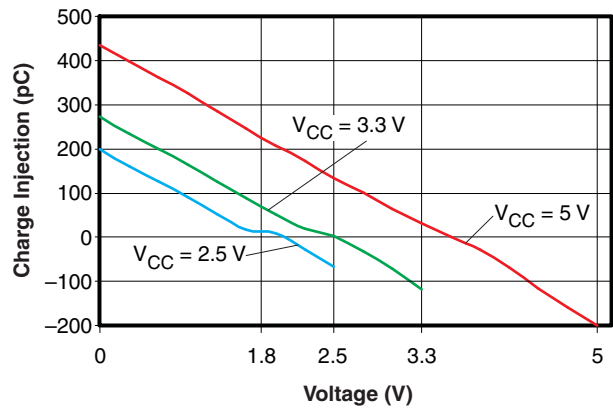


Figure 10. Charge Injection ( $Q_C$ ) vs  $V_{COM}$

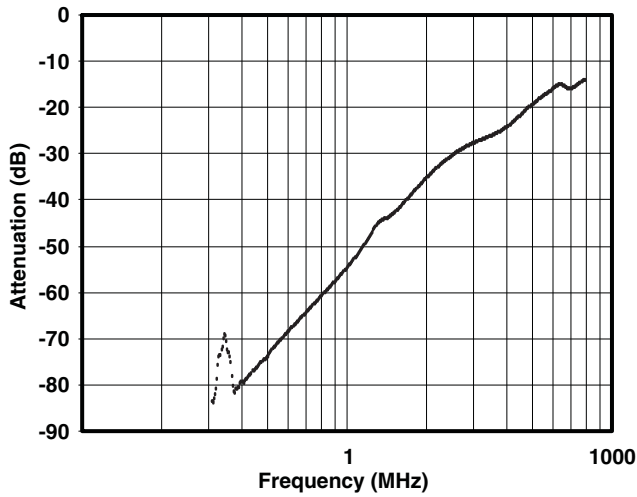


Figure 11. Crosstalk ( $V_+ = 3.3$  V)

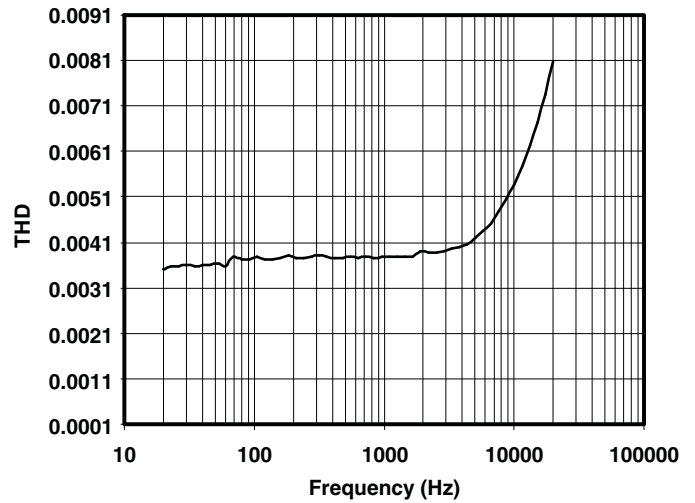


Figure 12. Total Harmonic Distortion vs Frequency

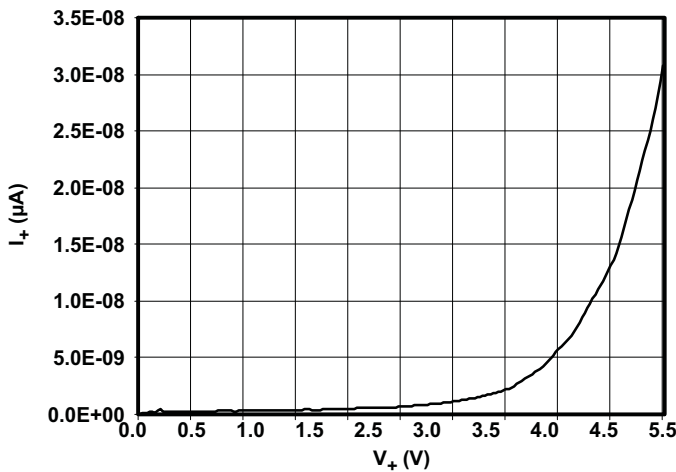


Figure 13. Power-Supply Current vs  $V_+$

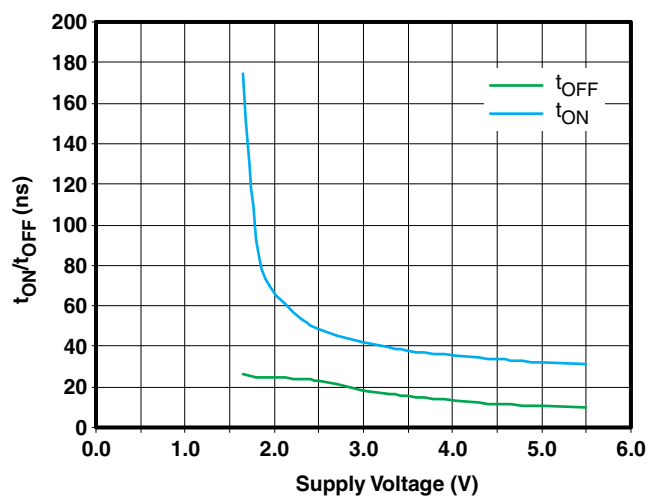


Figure 14.  $t_{ON}$  and  $t_{OFF}$  vs Supply Voltage

TYPICAL PERFORMANCE (continued)

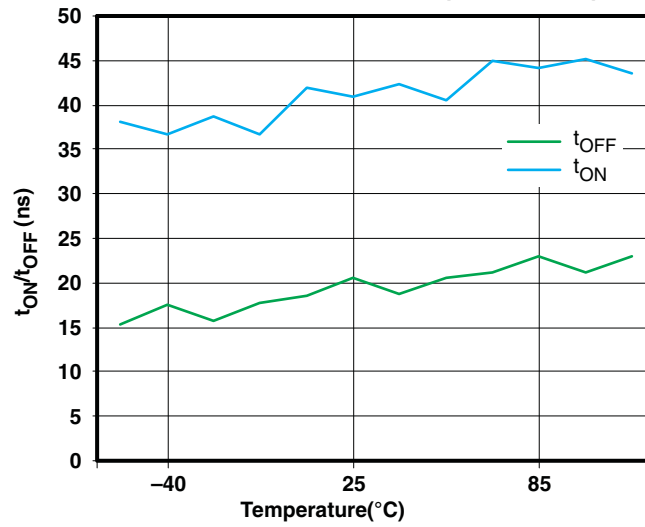


Figure 15. t<sub>ON</sub> and t<sub>OFF</sub> vs Temperature (2.5-V Supply)

PARAMETER MEASUREMENT INFORMATION

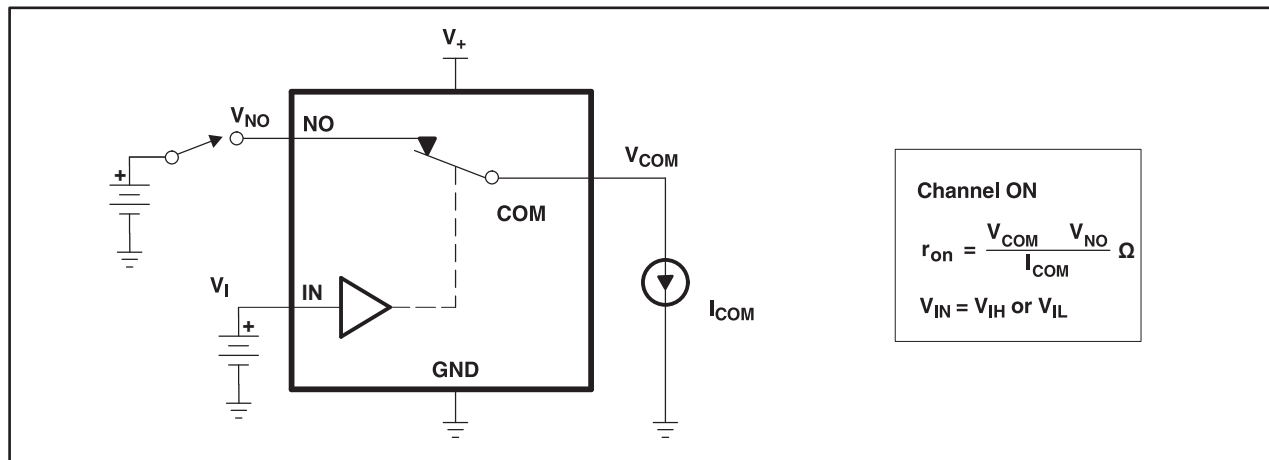


Figure 16. ON-State Resistance ( $r_{ON}$ )

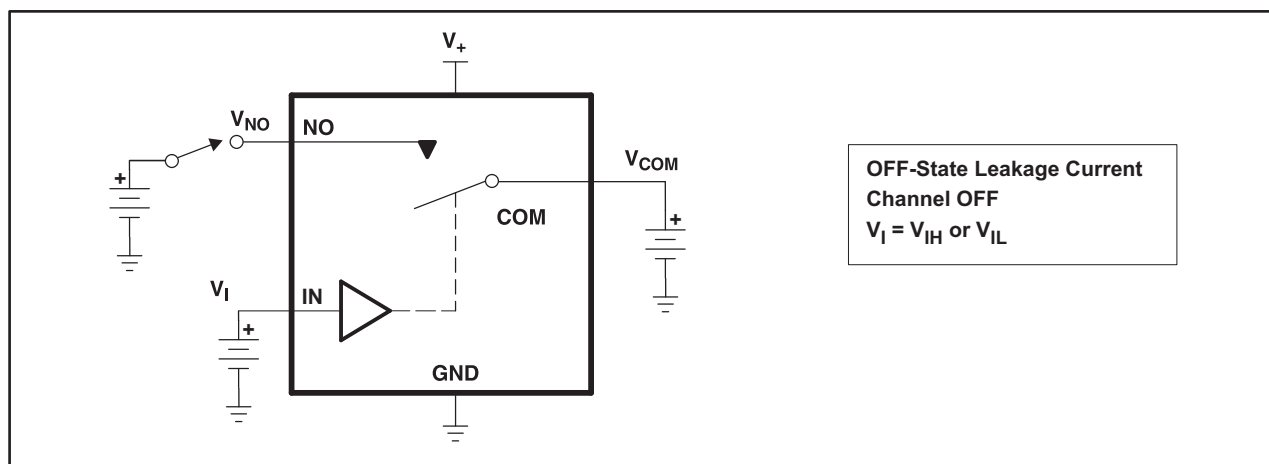


Figure 17. OFF-State Leakage Current ( $I_{COM(OFF)}$ ,  $I_{NO(OFF)}$ )

PARAMETER MEASUREMENT INFORMATION (continued)

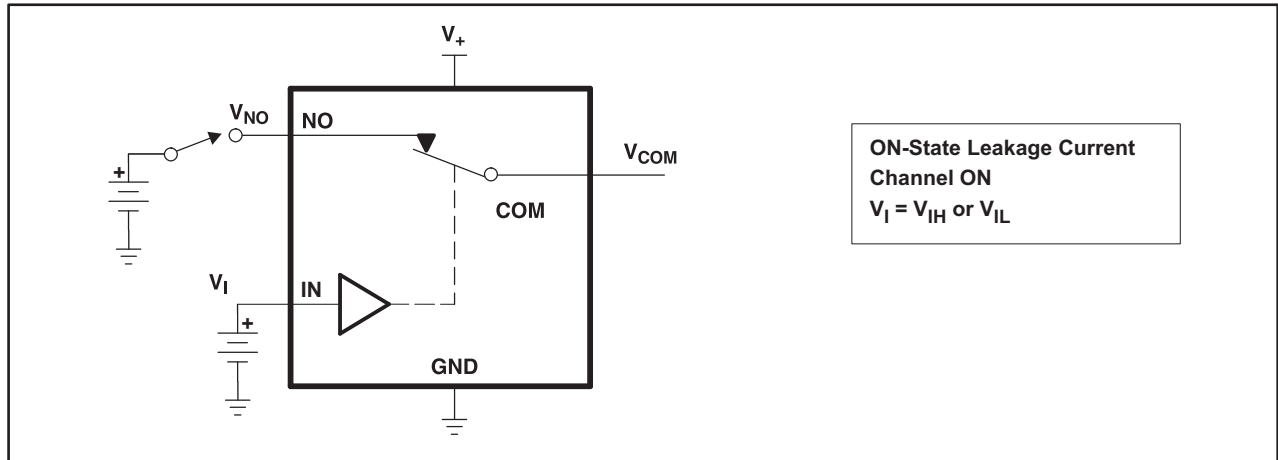


Figure 18. ON-State Leakage Current  
( $I_{COM(ON)}$ ,  $I_{NO(ON)}$ )

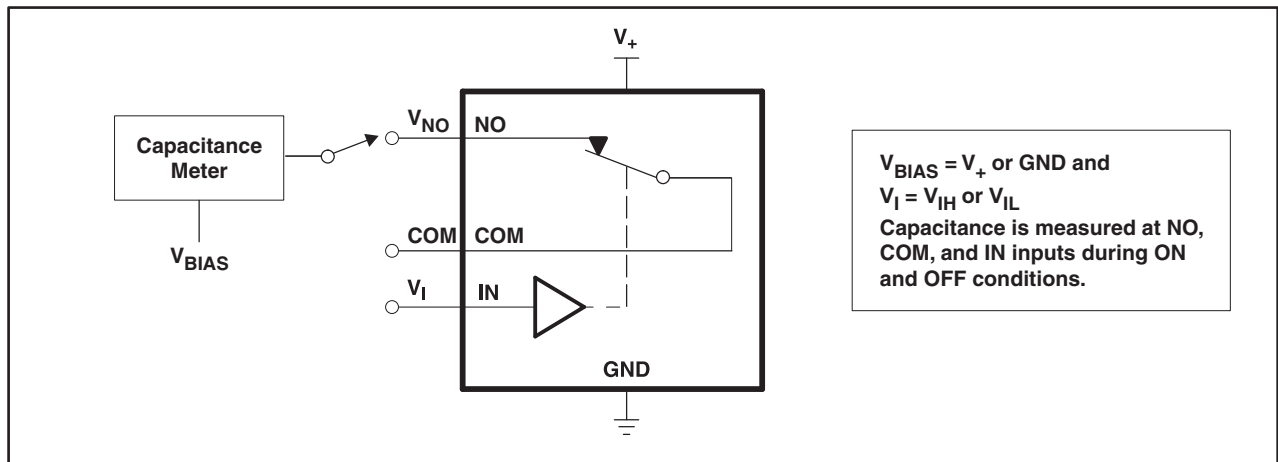


Figure 19. Capacitance  
( $C_I$ ,  $C_{COM(OFF)}$ ,  $C_{COM(ON)}$ ,  $C_{NO(OFF)}$ ,  $C_{NO(ON)}$ )

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

PARAMETER MEASUREMENT INFORMATION (continued)

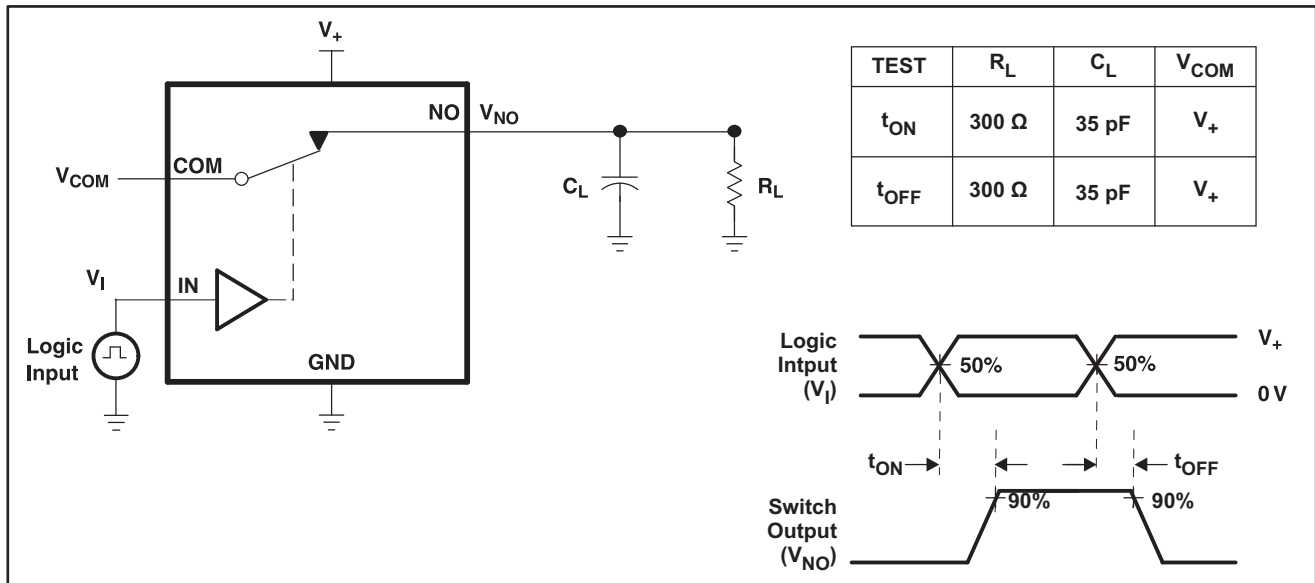


Figure 20. Turn-On ( $t_{ON}$ ) and Turn-Off Time ( $t_{OFF}$ )

- A.  $C_L$  includes probe and jig capacitance.
- B. 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.

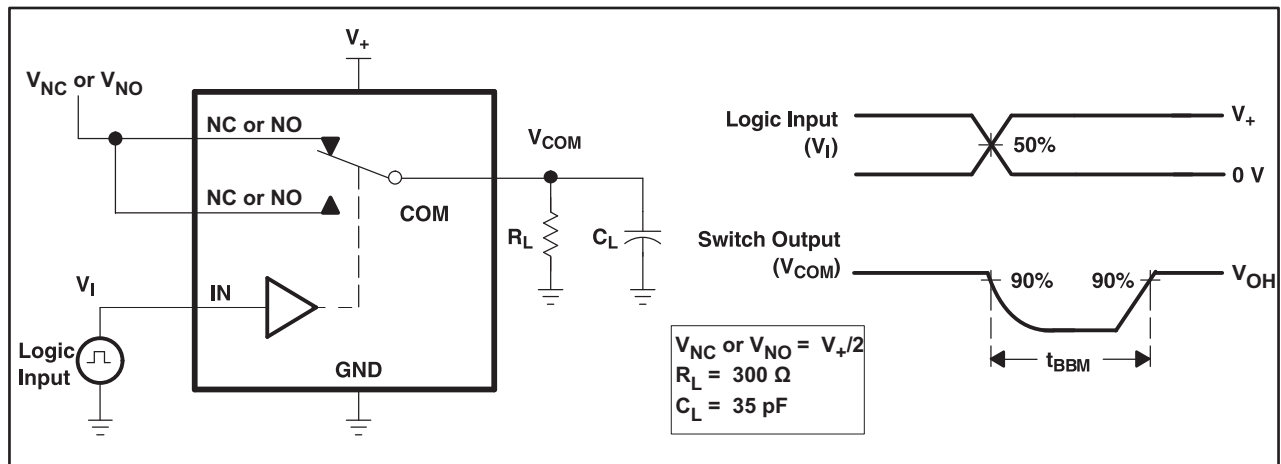


Figure 21. Break-Before-Make Time ( $t_{BBM}$ ) (TS5A22362 Only)



PARAMETER MEASUREMENT INFORMATION (continued)

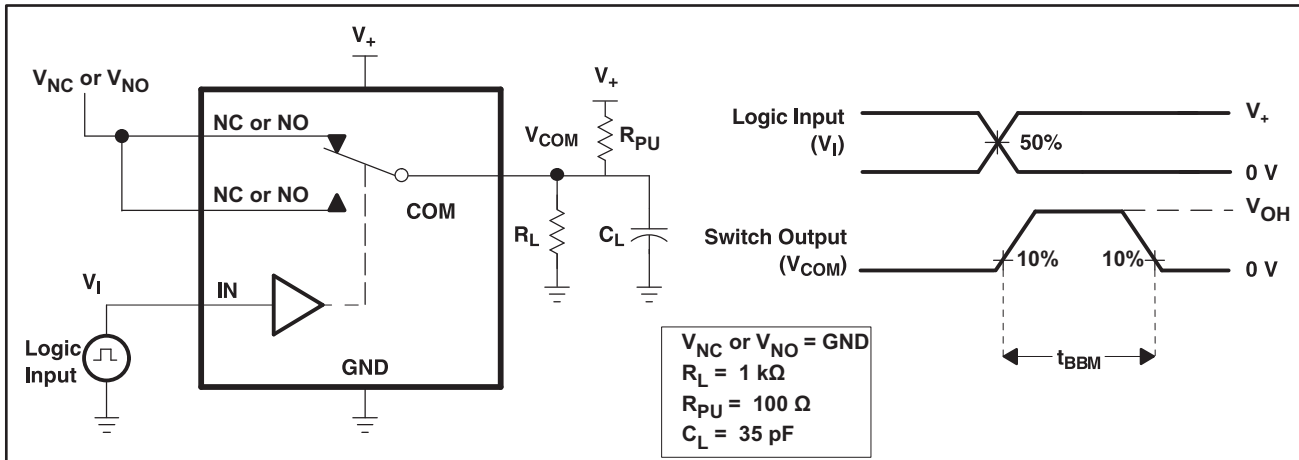


Figure 22. Break-Before-Make Time ( $t_{BBM}$ ) (TS5A22364 Only)

- A.  $C_L$  includes probe and jig capacitance.
- B. 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.

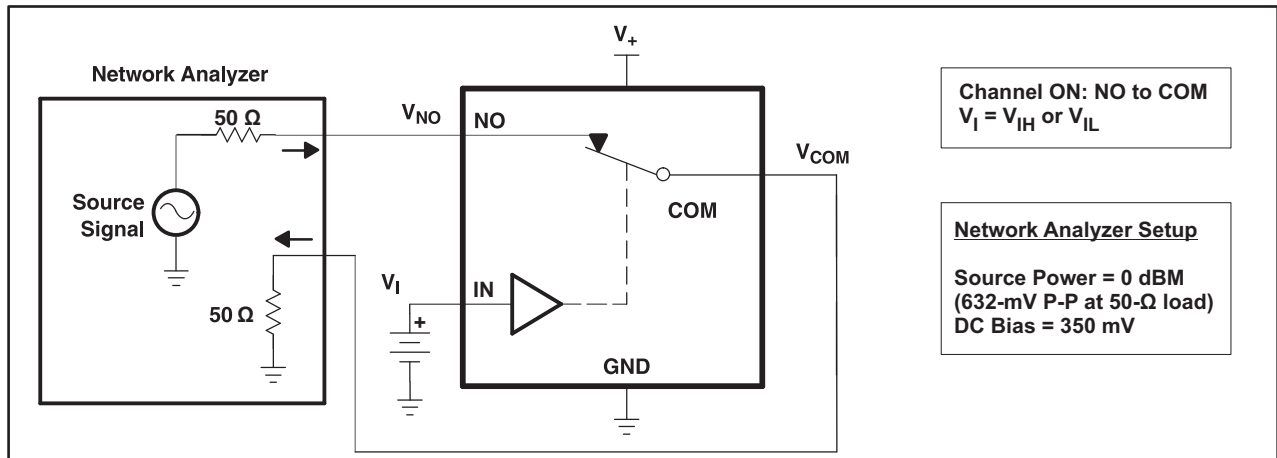
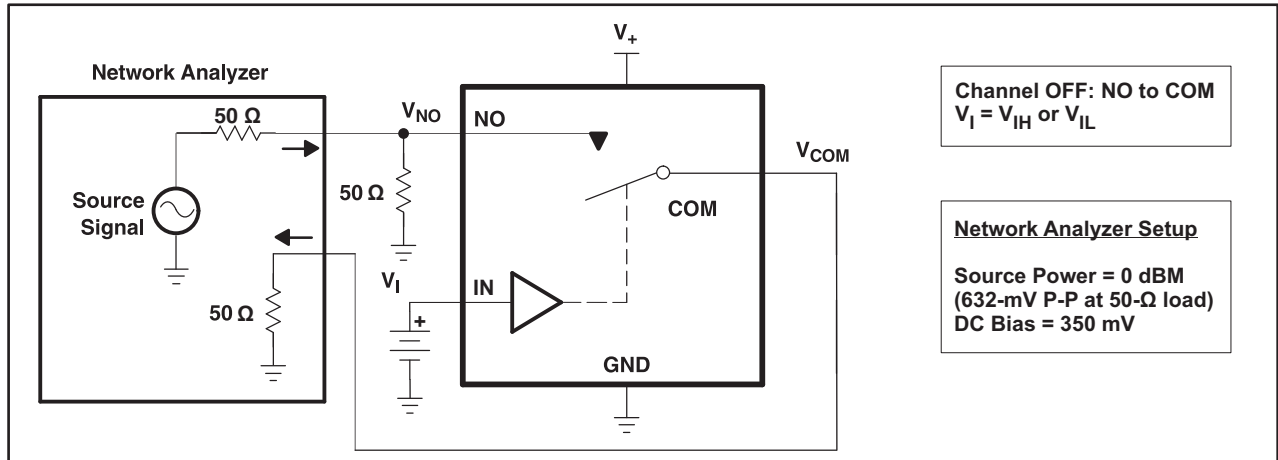
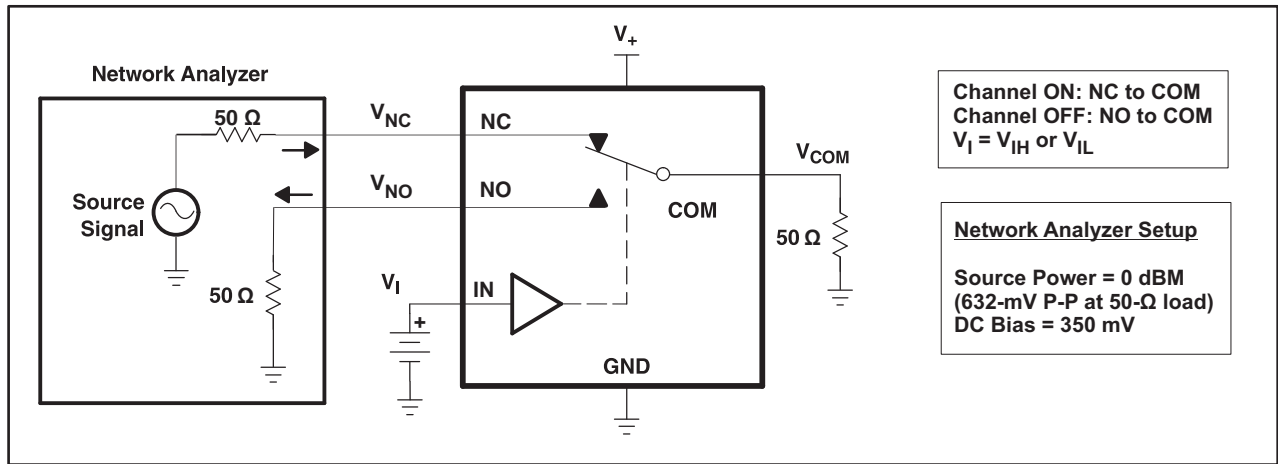


Figure 23. Bandwidth (BW)

**PARAMETER MEASUREMENT INFORMATION (continued)**

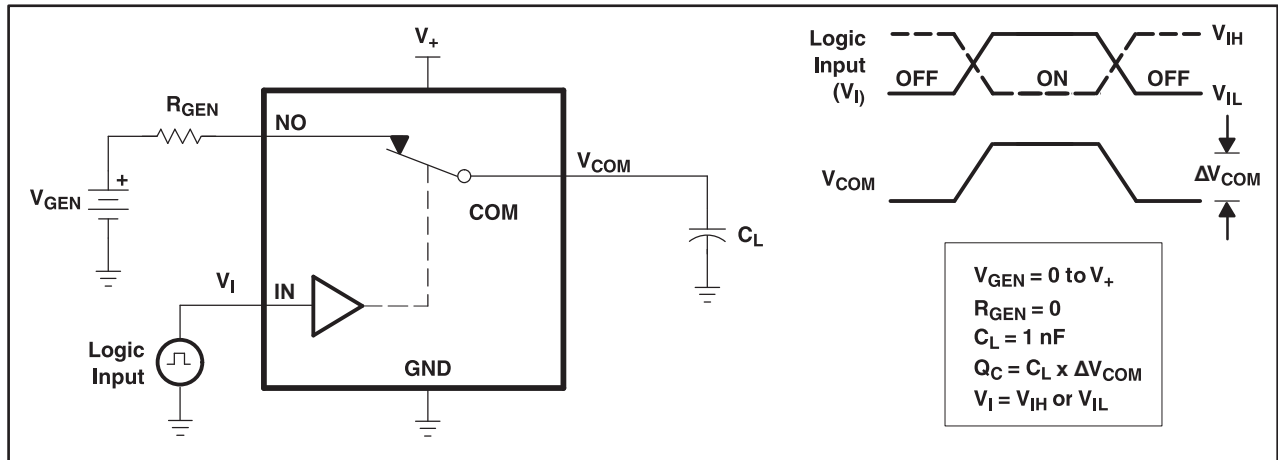


**Figure 24. OFF Isolation ( $O_{ISO}$ )**



**Figure 25. Crosstalk ( $X_{TALK}$ )**

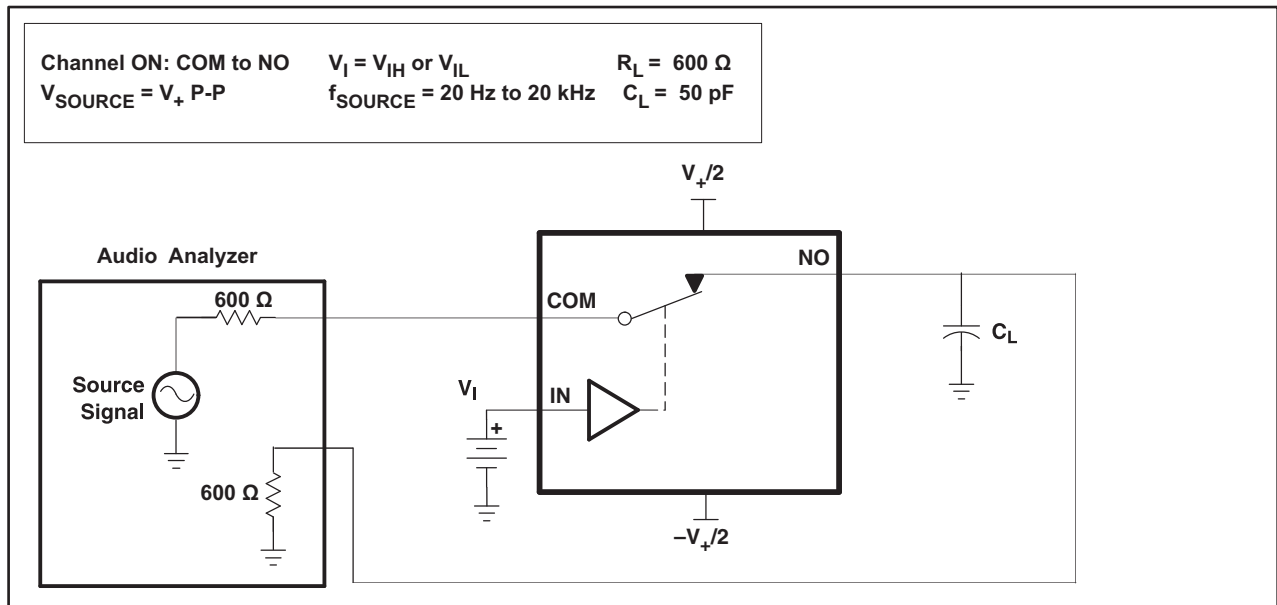
- A. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10$  MHz,  $Z_O = 50 \Omega$ ,  $t_r < 5$  ns,  $t_f < 5$  ns.
- B.  $C_L$  includes probe and jig capacitance.



**Figure 26. Charge Injection ( $Q_C$ )**

**PARAMETER MEASUREMENT INFORMATION (continued)**

A.  $C_L$  includes probe and jig capacitance.



**Figure 27. Total Harmonic Distortion (THD)**

## REVISION HISTORY

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Changes from Revision C (April 2010) to Revision D	Page
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- Added Medical Imaging to Application. .... 1
- 

Changes from Revision D (November 2011) to Revision E	Page
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- Updated  $I_{NC}$ ,  $I_{NO}$ ,  $I_{COM}$  MIN and MAX values in the ABSOLUTE RATINGS table.. .... 4
-

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TS5A22362DGSR	ACTIVE	VSSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	39R	<a href="#">Samples</a>
TS5A22362DGSRG4	ACTIVE	VSSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	39R	<a href="#">Samples</a>
TS5A22362DRCR	ACTIVE	VSON	DRC	10	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZVG	<a href="#">Samples</a>
TS5A22362DRCT-NM	ACTIVE	VSON	DRC	10	250	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR	-40 to 85	ZVGNM	<a href="#">Samples</a>
TS5A22362YZPR	ACTIVE	DSBGA	YZP	10	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	(39 ~ 392)	<a href="#">Samples</a>
TS5A22364DGSR	ACTIVE	VSSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	(38Q ~ 38R)	<a href="#">Samples</a>
TS5A22364DGSRG4	ACTIVE	VSSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	(38Q ~ 38R)	<a href="#">Samples</a>
TS5A22364DRCR	ACTIVE	VSON	DRC	10	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZVF	<a href="#">Samples</a>
TS5A22364YZPR	ACTIVE	DSBGA	YZP	10	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	(38 ~ 382)	<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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

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

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

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

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

- (3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.
- (4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.
- (5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.
- (6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**OTHER QUALIFIED VERSIONS OF TS5A22364 :**

- Automotive: [TS5A22364-Q1](#)

NOTE: Qualified Version Definitions:

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

**TAPE AND REEL INFORMATION**

**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
TS5A22362DGSR	VSSOP	DGS	10	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
TS5A22362DRCR	VSON	DRC	10	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TS5A22362DRCT-NM	VSON	DRC	10	250	180.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TS5A22362YZPR	DSBGA	YZP	10	3000	178.0	9.2	1.49	1.99	0.63	4.0	8.0	Q2
TS5A22364DGSR	VSSOP	DGS	10	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
TS5A22364DRCR	VSON	DRC	10	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TS5A22364YZPR	DSBGA	YZP	10	3000	178.0	9.2	1.49	1.99	0.63	4.0	8.0	Q2

**TAPE AND REEL BOX DIMENSIONS**

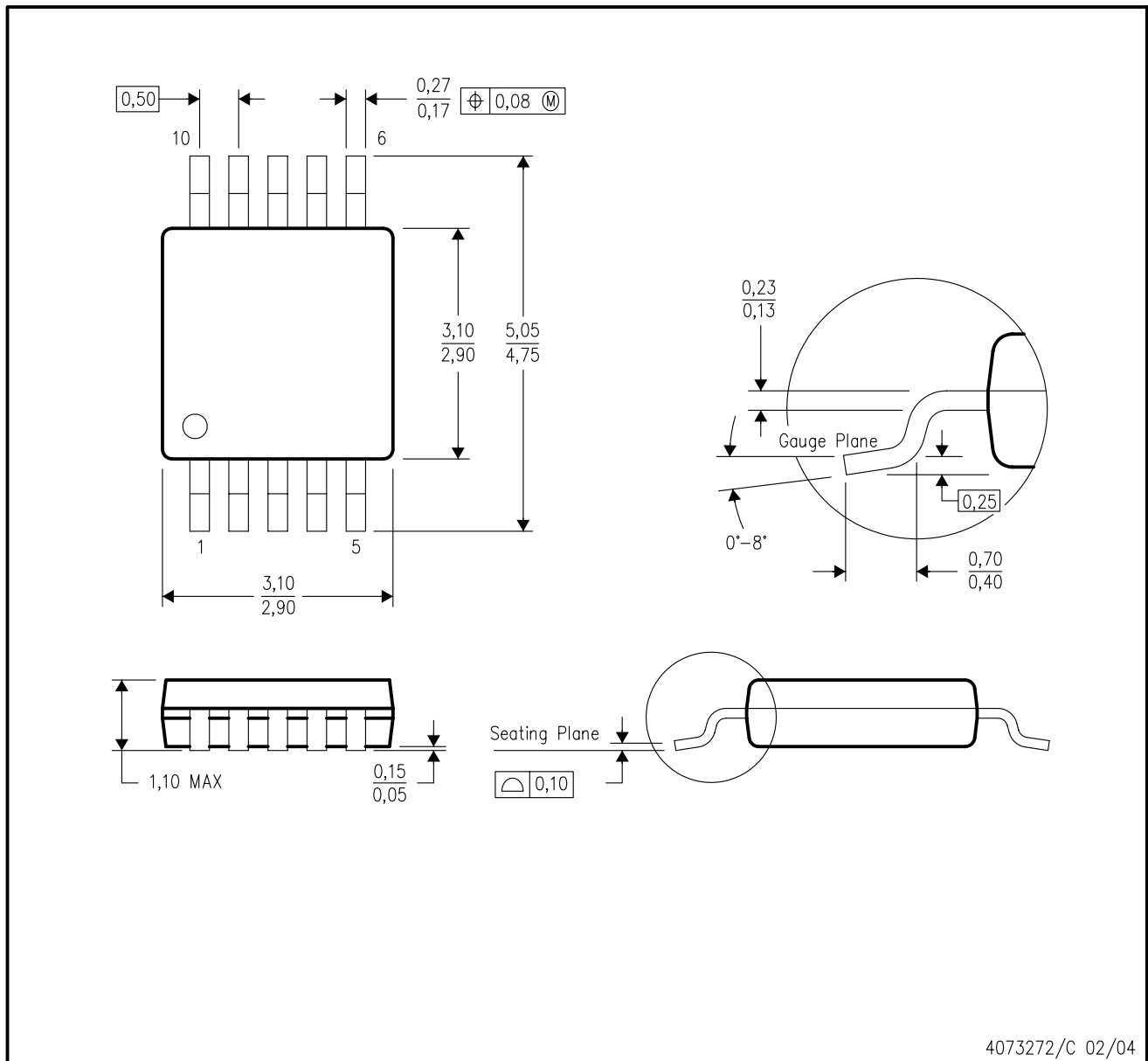

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS5A22362DGSR	VSSOP	DGS	10	2500	358.0	335.0	35.0
TS5A22362DRCR	VSON	DRC	10	3000	367.0	367.0	35.0
TS5A22362DRCT-NM	VSON	DRC	10	250	210.0	185.0	35.0
TS5A22362YZPR	DSBGA	YZP	10	3000	220.0	220.0	35.0
TS5A22364DGSR	VSSOP	DGS	10	2500	358.0	335.0	35.0
TS5A22364DRCR	VSON	DRC	10	3000	367.0	367.0	35.0
TS5A22364YZPR	DSBGA	YZP	10	3000	220.0	220.0	35.0



DGS (S-PDSO-G10)

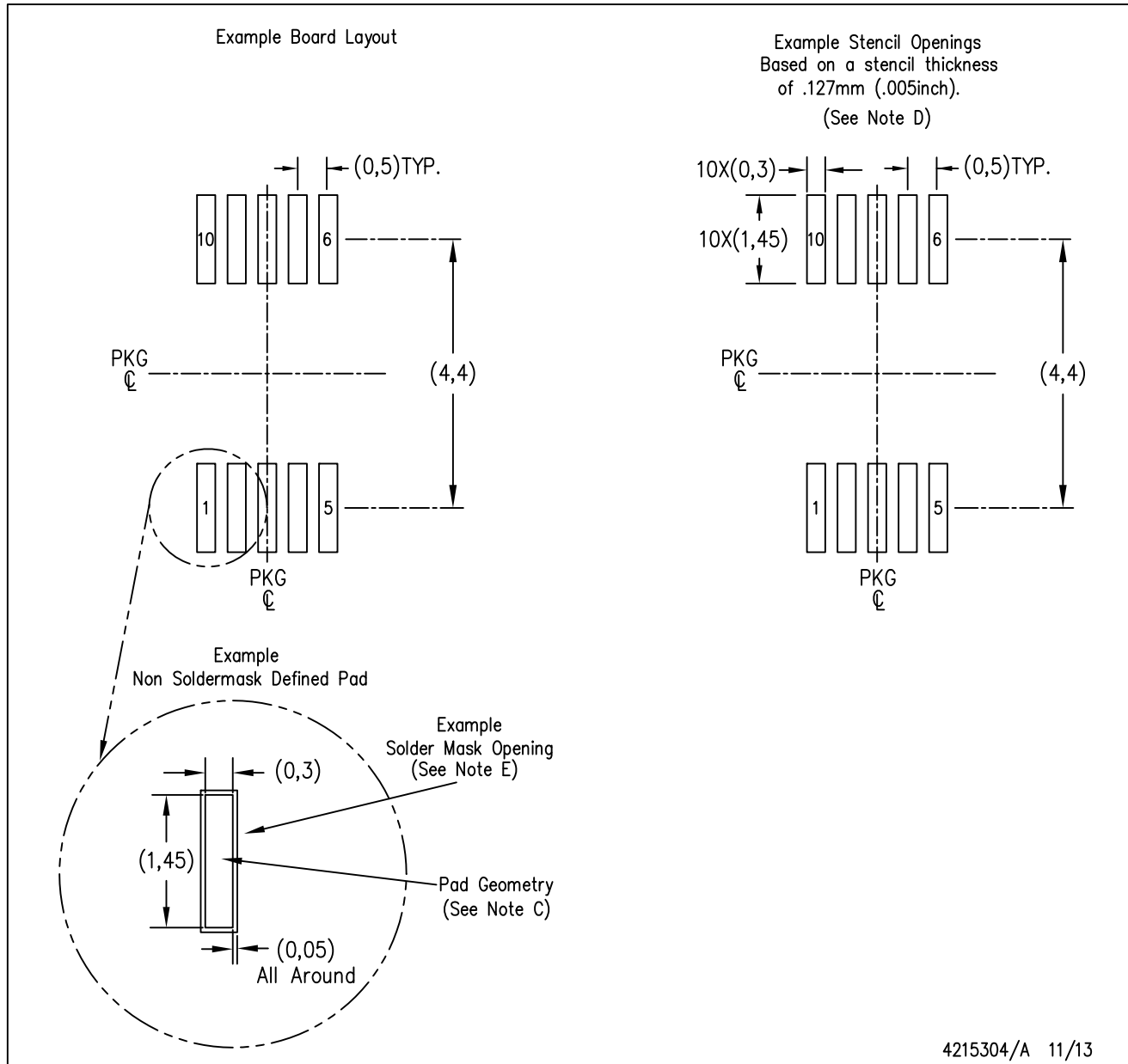
PLASTIC SMALL-OUTLINE PACKAGE



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

DGS (S-PDSO-G10)

PLASTIC SMALL OUTLINE PACKAGE



- NOTES:
- 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.

DRC (S-PVSON-N10)

PLASTIC SMALL OUTLINE NO-LEAD



4204102-3/L 09/11

- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - This drawing is subject to change without notice.
  - Small Outline No-Lead (SON) package configuration.
  - The package thermal pad must be soldered to the board for thermal and mechanical performance, if present.
  - See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions, if present

# THERMAL PAD MECHANICAL DATA

DRC (S-PVSON-N10)

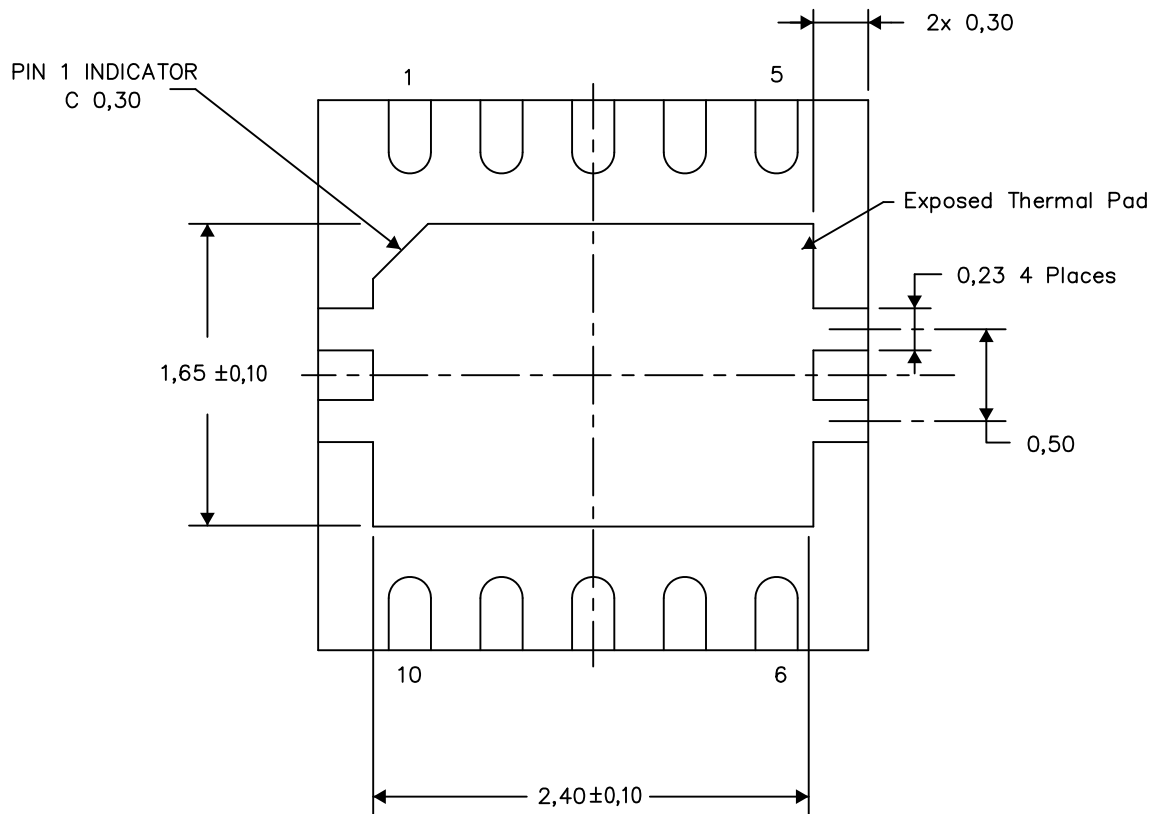
PLASTIC SMALL OUTLINE NO-LEAD

## 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

4206565-3/U 04/14

NOTE: A. All linear dimensions are in millimeters



# THERMAL PAD MECHANICAL DATA

DRC (S-PVSON-N10)

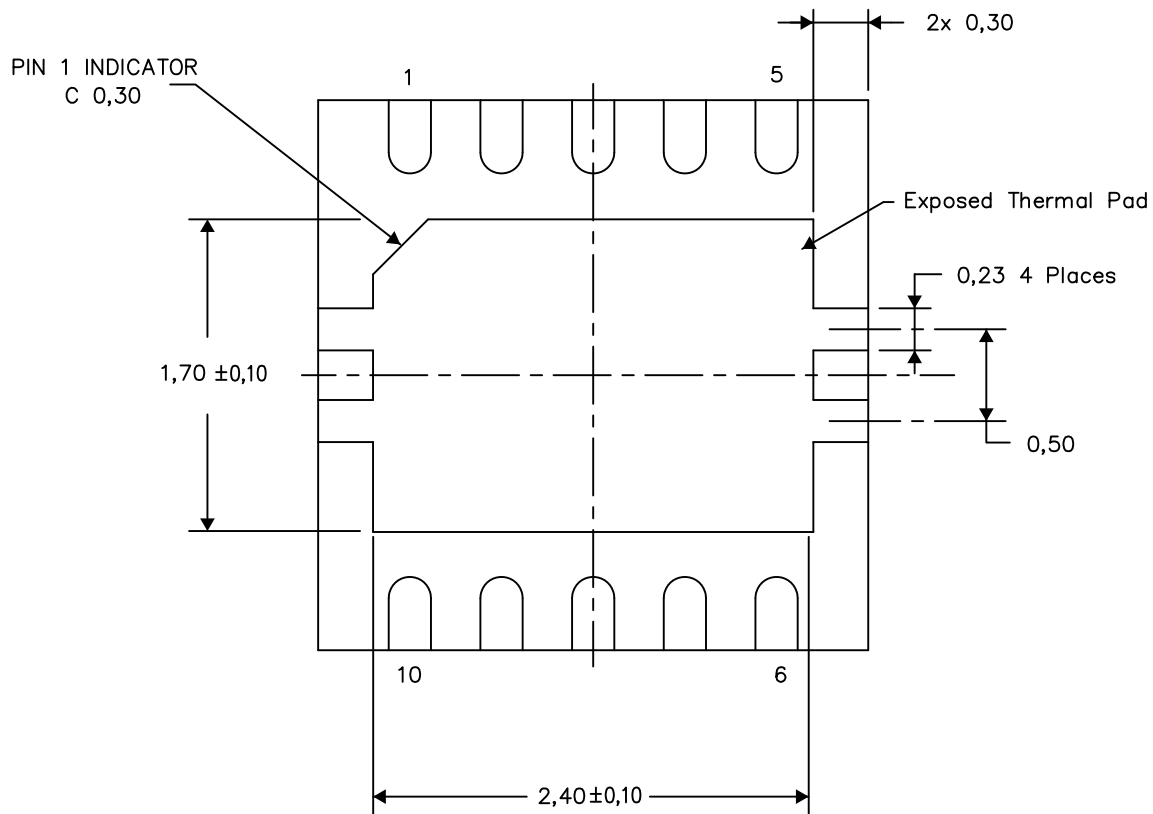
PLASTIC SMALL OUTLINE NO-LEAD

## 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).

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



Bottom View

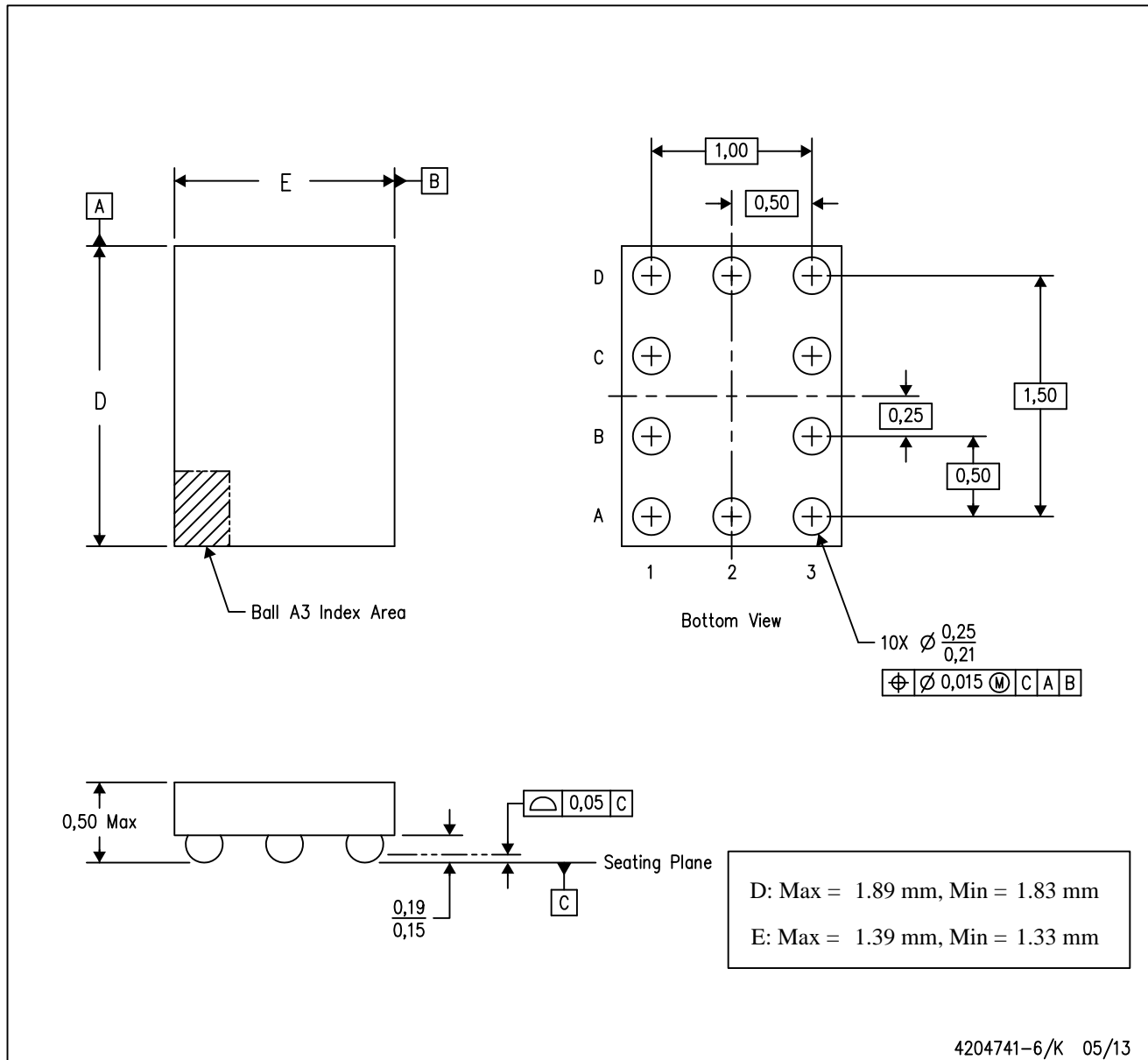
Exposed Thermal Pad Dimensions

4206565-8/U 04/14

NOTE: A. All linear dimensions are in millimeters

YZP (R-XBGA-N10)

(CUSTOM) DIE-SIZE BALL GRID ARRAY



- 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.

NanoFree is a trademark of Texas Instruments.

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