



**THE DATASHEET OF  
MAX20336ENT+T**



## MAX20336/MAX20337

## Ultra-Small, Low- $R_{ON}$ , Beyond-the-Rails DPST/SPDT Analog Switches

### General Description

The MAX20336/MAX20337 ultra-small, low-on-resistance ( $R_{ON}$ ) double-pole/single throw (DPST) and single-pole/double-throw (SPDT) analog switches feature Beyond-the-Rails™ capability that allows signals from -5.5V to +5.5V to pass without distortion, even when the power supply is below the signal range. The low on-resistance (0.19Ω) also makes the devices ideal for low-distortion switching applications, such as audio or video.

The MAX20336/MAX20337 are fully specified to operate from a single +1.6V to +5.5V power supply. Because of the low supply current requirement,  $V_{CCEN}$  can be provided by a GPIO. When power is not applied, the switches go to a high-impedance mode and all analog signal ports can withstand signals from -5.5V to +5.5V.

The MAX20336/MAX20337 are available in a 1.308mm x 0.828mm, 0.4mm pitch, 6-bump wafer-level package (WLP) and 1.25mm x 1.75mm 6-pin FC2QFN package, and operate over the -40°C to +85°C extended temperature range.

### Applications

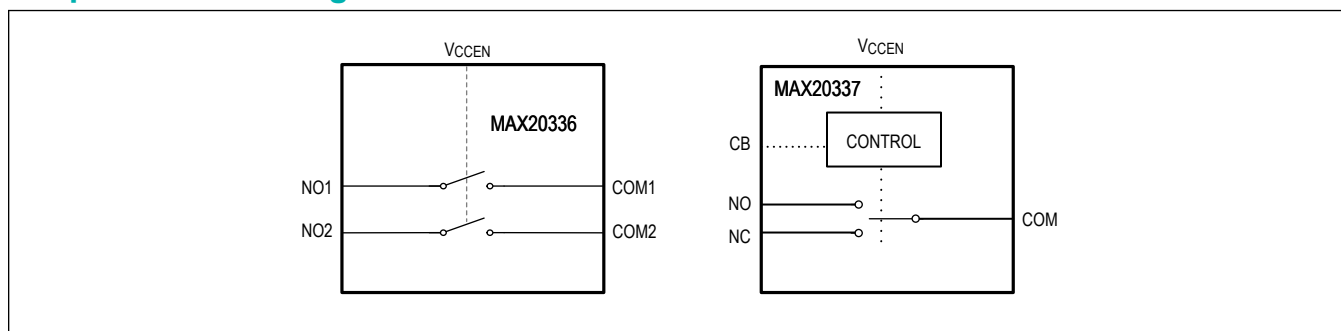
- Cell phone
- Tablet
- Portable Audio/Video Equipment
- Portable Navigation Devices

### Benefits and Features

- Distortion-Free Beyond-the-Rails Signaling
  - Negative Voltage Audio and Video Signal Capable
  - -5.5V to +5.5V Analog Signal Range Independent of  $V_{CCEN}$
  - On-Resistance 0.19Ω (typ)
  - +1.6V to +5.5V Single-Supply Range
  - Total Harmonic Distortion Plus Noise -114dB (typ)
  - On-Resistance Flatness 0.0001Ω (typ)
- Low Supply Current 65μA/70μA (typ) at 1.6V
  - Can be Powered by GPIO
  - High-Impedance Mode when  $V_{CCEN}$  Not Applied
- ESD Protection on COM\_, NO\_, NC
  - ±30kV Human Body Model
  - ±7kV IEC 61000-4-2 Air Gap
  - ±8kV IEC 61000-4-2 Contact
- Design Flexibility
  - 6-Bump WLP (1.308mm x 0.828mm) Package
  - 6-Pin FC2QFN (1.25mm x 1.75mm) Package
  - -40°C to +85°C Operating Temperature Range

Ordering Information appears at end of data sheet.

### Simplified Block Diagram



Beyond-the-Rails is a trademark of Maxim Integrated Products, Inc.

**Absolute Maximum Ratings**

V <sub>CCEN</sub> , CB to GND .....	-0.3V to +6V	FC2QFN (derate 5.83mW/°C above +70°C).....	466.2mW
NO <sub>-</sub> , COM <sub>-</sub> , NC to GND.....	-6V to +6V	Operating Temperature Range .....	-40°C to +85°C
Continuous Current NO <sub>-</sub> , COM <sub>-</sub> , NC .....	±500mA	Junction Temperature .....	+150°C
Peak Current NO <sub>-</sub> , COM <sub>-</sub> , NC (50% duty cycle, 10ms pulse).....	±850mA	Storage Temperature Range .....	-65°C to +150°C
Continuous Power Dissipation (T <sub>A</sub> = +70°C) WLP (derate 10.51mW/°C above +70°C).....	840.8mW	Soldering Temperature (reflow) .....	+260°C

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Package Information**

**6 BUMP WLP (MAX20336)**

Package Code	N60K1+1
Outline Number	<a href="#">21-100308</a>
Land Pattern Number	Refer to <a href="#">Application Note 1891</a>
<b>THERMAL RESISTANCE, FOUR-LAYER BOARD</b>	
Junction to Ambient (θ <sub>JA</sub> )	95.15°C/W

**6 BUMP WLP (MAX20337)**

Package Code	N60K1+2
Outline Number	<a href="#">21-100311</a>
Land Pattern Number	Refer to <a href="#">Application Note 1891</a>
<b>THERMAL RESISTANCE, FOUR-LAYER BOARD</b>	
Junction to Ambient (θ <sub>JA</sub> )	95.15°C/W

**6 FC2QFN (MAX20336/MAX20337)**

Package Code	F61A1F+1
Outline Number	<a href="#">21-100313</a>
Land Pattern Number	<a href="#">90-100167</a>
<b>THERMAL RESISTANCE, FOUR-LAYER BOARD</b>	
Junction to Ambient (θ <sub>JA</sub> )	171.6 °C/W
Junction to Ambient (θ <sub>JC</sub> )	58.7 °C/W

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

## Electrical Characteristics

( $V_{CCEN} = +1.6V$  to  $+5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CCEN} = +2.5V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
<b>POWER SUPPLY</b>							
Power-Supply Range	$V_{CCEN}$			1.6		5.5	V
Power-Supply Rejection Ratio	PSRR	$R_{COM\_} = 32\Omega$ , $f = 20kHz$			90		dB
Supply Current	$I_{CC}$	$V_{CCEN} = +1.6V$	MAX20336		65	115	$\mu A$
			MAX20337		70	115	
		$V_{CCEN} = +4.2V$	MAX20336		100	190	
			MAX20337		112	200	
<b>ANALOG SWITCH</b>							
Analog Signal Range	$V_{NC}$ , $V_{NO\_}$ , $V_{COM\_}$			-5.5		+5.5	V
On-Resistance	$R_{ON}$	$V_{CCEN} = 2.5V$ , $V_{COM\_} = 0V$ , $I_{COM\_} = 100mA$ (Note 2)			0.190	0.33	$\Omega$
		$V_{CCEN} = 1.8V$ , $V_{COM\_} = 0V$ , $I_{COM\_} = 100mA$ (Note 2)			0.225	0.40	
On-Resistance Match Between Channels	$\Delta R_{ON}$	$V_{CCEN} = 2.5V$ , $I_{COM\_} = 100mA$ , between two channels		-0.05	+0.003	+0.05	$\Omega$
On-Resistance Flatness	$R_{FLAT}$	$V_{CCEN} = 2.5V$ , $I_{COM\_} = 100mA$ , $V_{COM\_} = -5.5V$ to $+5.5V$ (Note 3, Note 4)			0.0001	0.01	$\Omega$
NO_, COM Off-Leakage Current	$I_{NO\_ (OFF)}$ , $I_{COM\_ (OFF)}$	$V_{CCEN} = 0V$ , $V_{NO\_} = -5.5$ or $+5.5V$ , $V_{COM\_} = +5.5V$ , $-5.5V$ , unconnected	MAX20336	-100		+100	nA
			MAX20337	-100		+100	
COM On-Leakage Current	$I_{COM\_ (ON)}$	$V_{CCEN} = 2.5V$ , switch closed, $V_{COM\_} = V_{NO\_} = -5.5V$ , $+5.5V$ or $V_{COM\_} = V_{NC} = -5.5V$ , $+5.5V$	MAX20336	-50		+50	nA
			MAX20337	-100		+100	
<b>DYNAMIC TIMING</b>							
Turn-On Time	$t_{ON}$	$V_{CCEN}$ from 0V to 2.5V, $V_{NO\_} = 5.5V$ , $R_L = 50\Omega$ (Figure 1)	MAX20336		1.7		ms
		$V_{CCEN} = 2.5V$ , $V_{IN} = 5V$ , $R_L = 50\Omega$ (Figure 2)	MAX20337		32.5		

**Electrical Characteristics (continued)**

( $V_{CCEN} = +1.6V$  to  $+5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CCEN} = +2.5V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Turn-Off Time	$t_{OFF}$	$V_{CCEN}$ from 2.5V to 0V, $V_{NO\_} = 5.5V$ , $R_L = 50\Omega$ (Figure 1)	MAX20336		13.5		ms
		$V_{CCEN} = 2.5V$ , $V_{IN} = 5V$ , $R_L = 50\Omega$ (Figure 2)	MAX20337		8.8		
Break-Before-Make Time	$t_{BBM}$	MAX20337 only, $V_{CCEN} = 2.5V$ , $V_{IN} = 5V$ , $R_L = 50\Omega$ . Time that both NC/NO switches are open during transition (Figure 3, Note 5)			23.7		ms
<b>AUDIO PERFORMANCE</b>							
Total Harmonic Distortion Plus Noise	THD + N	$f = 20Hz$ to $20kHz$ , $R_S = 20\Omega$ , DC bias = 0	$V_{COM\_} = 1V_{P-P}$ , $R_L = 32\Omega$		-109		dB
			$V_{COM\_} = 1V_{P-P}$ , $R_L = 600\Omega$		-109		
			$V_{COM\_} = 1V_{RMS}$ , $R_L = 32\Omega$		-114		
			$V_{COM\_} = 1V_{RMS}$ , $R_L = 600\Omega$		-114		
Off-Isolation	$V_{ISO}$	$R_S = R_L = 50\Omega$ ; $V_{COM\_} = 0.5V_{P-P}$ , $f = 100kHz$ , $V_{CCEN} = 0V$ , DC bias = 0.25V, (Figure 4)			-55		dB
Crosstalk	$V_{CT}$	$R_S = R_L = 50\Omega$ , $V_{COM\_} = 0.5V_{P-P}$ , $f = 100kHz$ (Figure 4)	MAX20336		-85		dB
			MAX20337		-55		
-3dB Bandwidth	BW	$R_S = R_L = 50\Omega$	MAX20336		270		MHz
			MAX20337		220		
NO_ Off-Capacitance	$C_{NO\_}(OFF)$	$V_{NO\_} = 0.5V_{P-P}$ , $f = 1MHz$ , COM_ unconnected	MAX20336		14		pF
			MAX20337		19		
COM_ On-Capacitance	$C_{COM\_}(ON)$	$V_{NO\_} = 0.5V_{P-P}$ , $f = 1MHz$	MAX20336		11		pF
			MAX20337		27		
<b>DIGITAL I/O (CB)</b>							
Input-Logic High Voltage	$V_{IH}$			1.4			V
Input-Logic Low Voltage	$V_{IL}$					0.4	V
Input Leakage Current	$I_{IN}$	$V_{CB} = 0V$ or $V_{CCEN}$		-1		+1	$\mu A$
<b>THERMAL PROTECTION</b>							
Thermal Shutdown	$T_{SHDN}$				+150		$^{\circ}C$
Thermal Hysteresis	$T_{HYST}$				+25		$^{\circ}C$

**Electrical Characteristics (continued)**

( $V_{CCEN} = +1.6V$  to  $+5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CCEN} = +2.5V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>ESD PROTECTION</b>						
COM_, NO_, NC		HBM			±30	kV
		IEC61000-4-2 Air-Gap Discharge			±7	
		IEC61000-4-2 Contact Discharge			±8	
All other pins		HBM			±2	kV

**Note 1:** All specifications are 100% production tested at  $T_A = +25^{\circ}C$ , unless otherwise noted. Specifications are over  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$  and are guaranteed by design.

**Note 2:** The same limits apply for  $V_{COM\_} = -5.5V$  to  $+5.5V$  and are guaranteed by design.

**Note 3:** Flatness is defined as the difference between the maximum and minimum value of on-resistance, as measured over specified analog signal ranges.

**Note 4:** Guaranteed by design; not production tested.

**Note 5:** Between two switches.

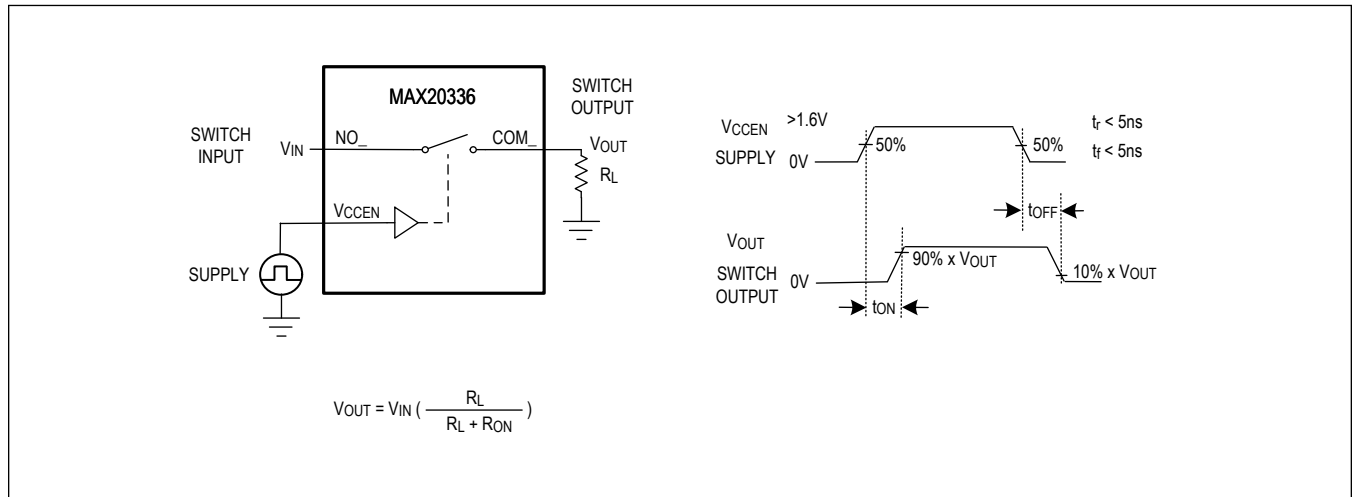


Figure 1. Switching Time (MAX20336)

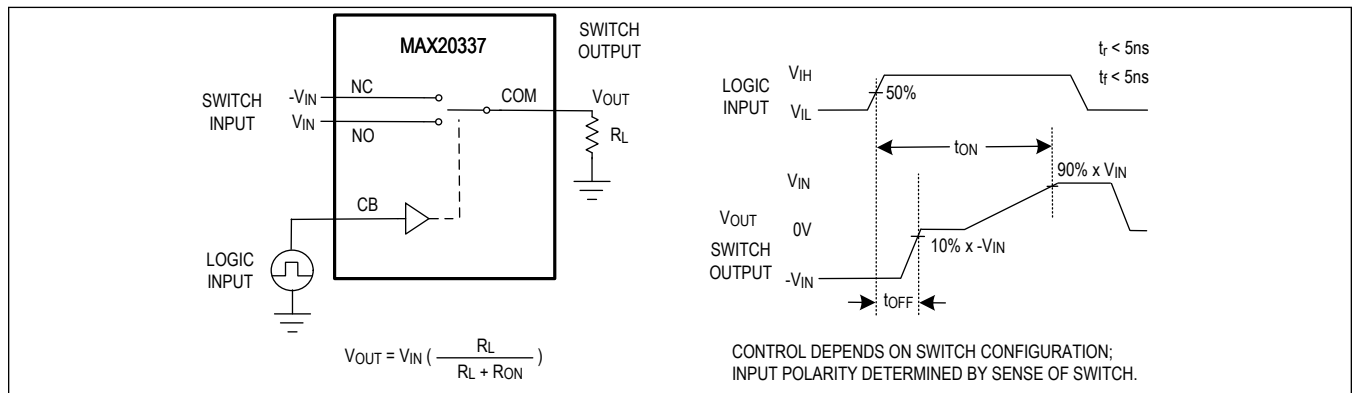


Figure 2. Switching Time (MAX20337)

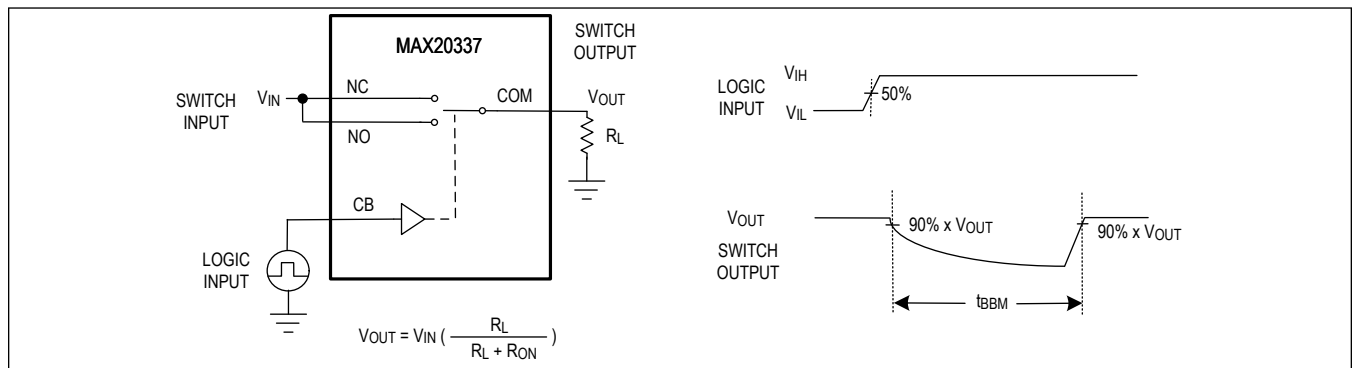


Figure 3. Break-Before-Make Interval

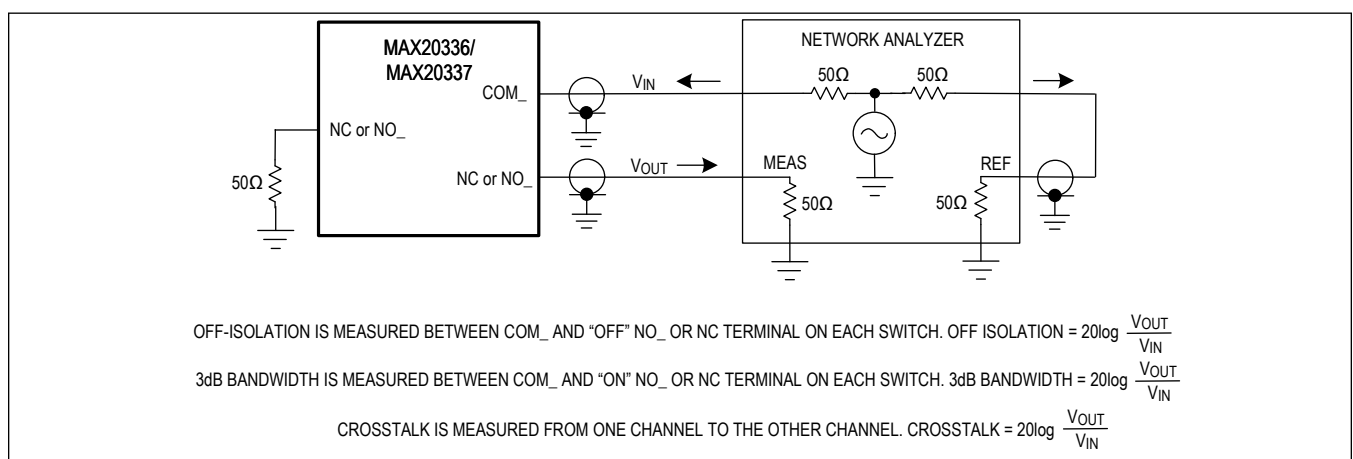
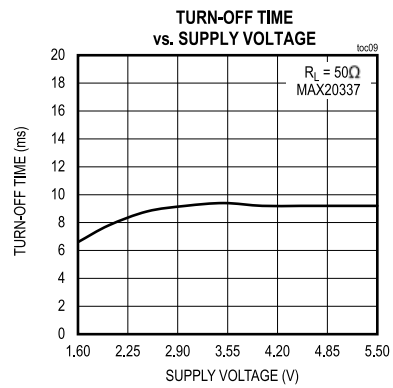
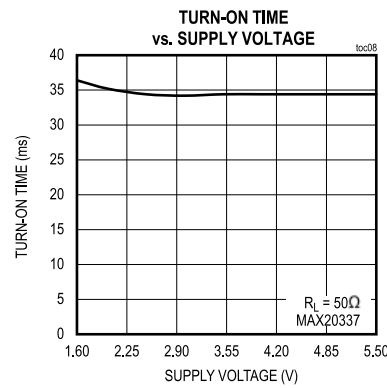
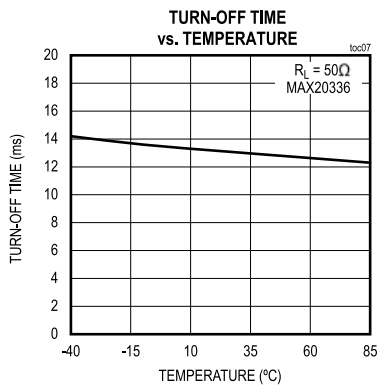
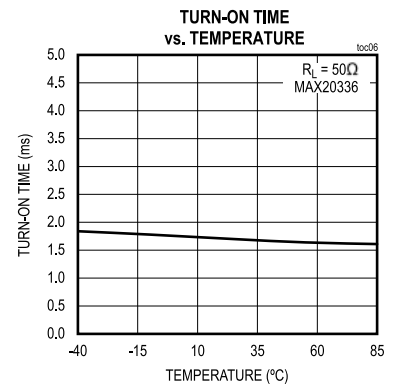
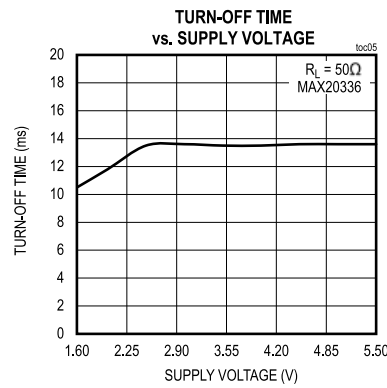
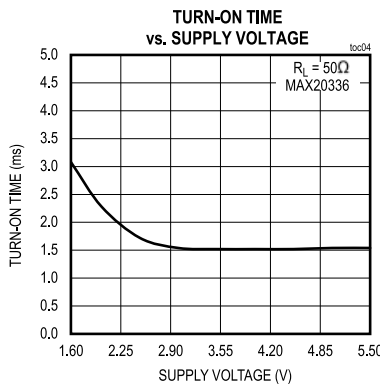
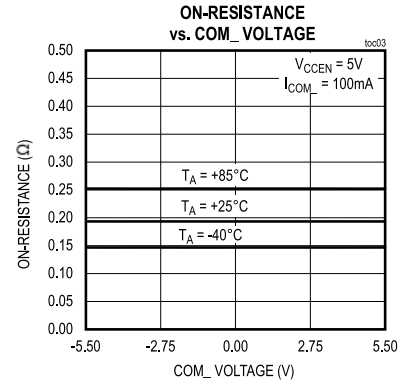
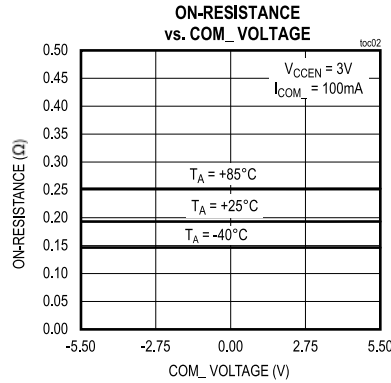
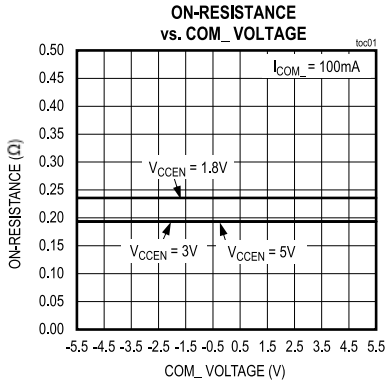


Figure 4. 3dB Bandwidth, Off-Isolation, and Crosstalk

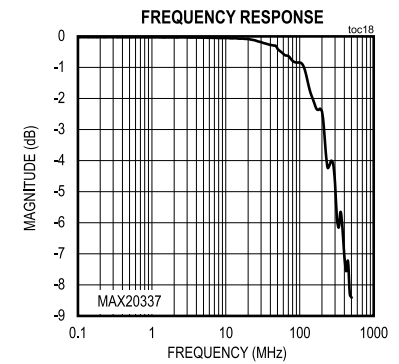
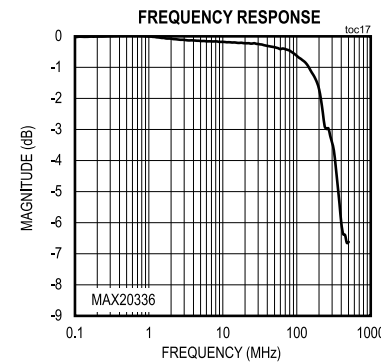
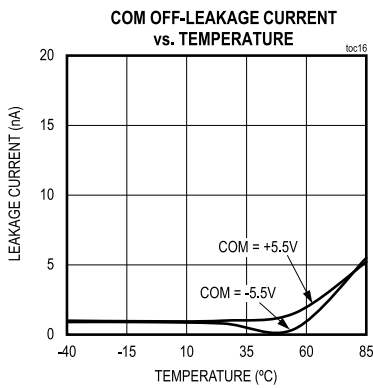
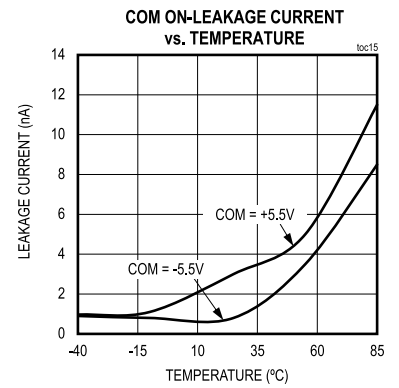
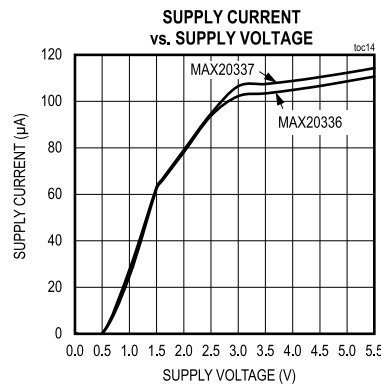
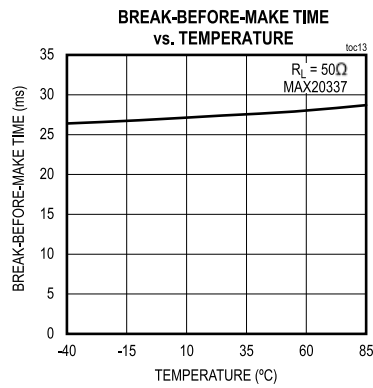
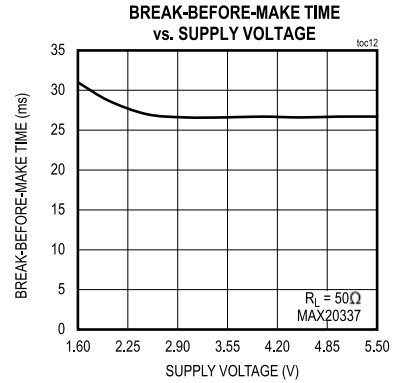
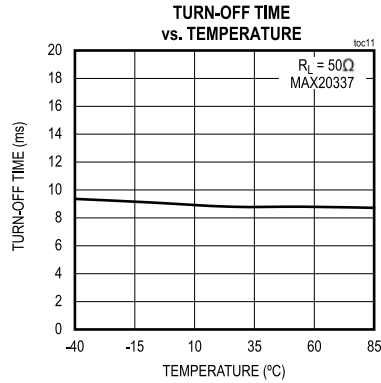
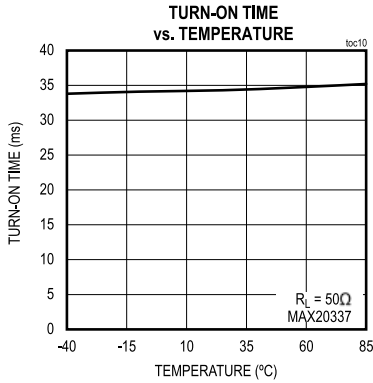
Typical Operating Characteristics

( $V_{CCEN} = +2.5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



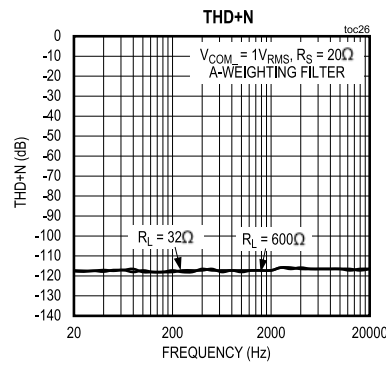
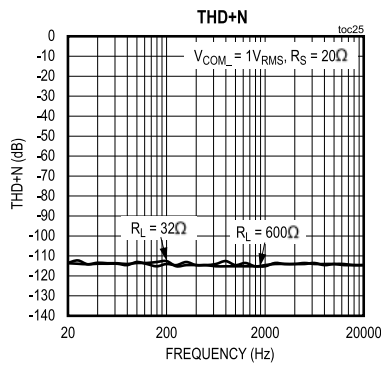
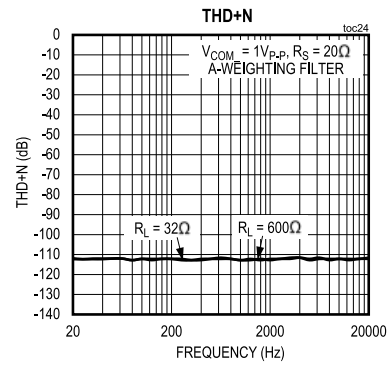
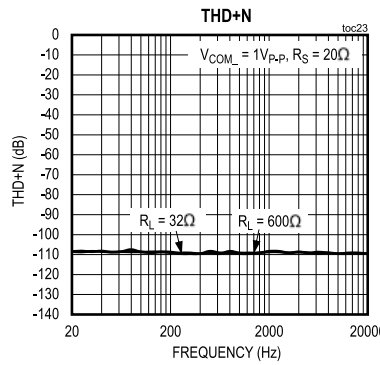
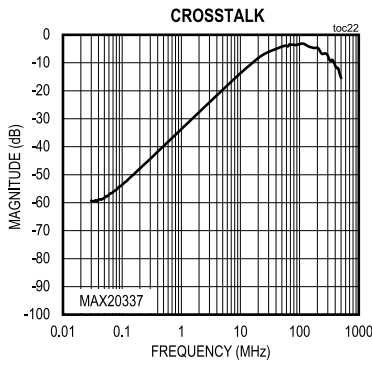
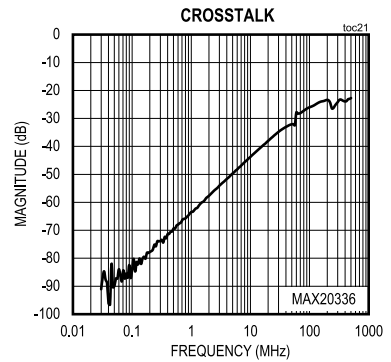
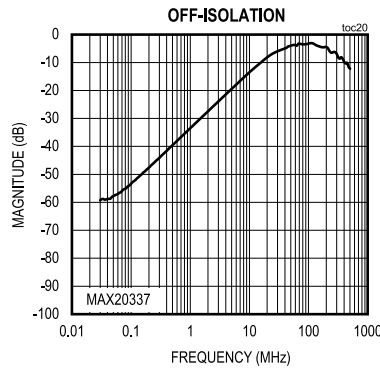
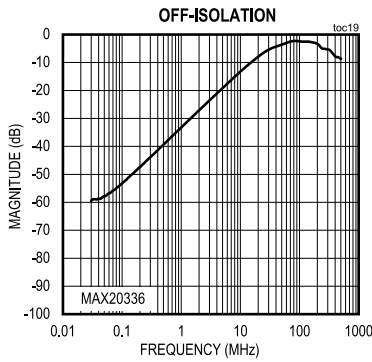
Typical Operating Characteristics (continued)

( $V_{CCEN} = +2.5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

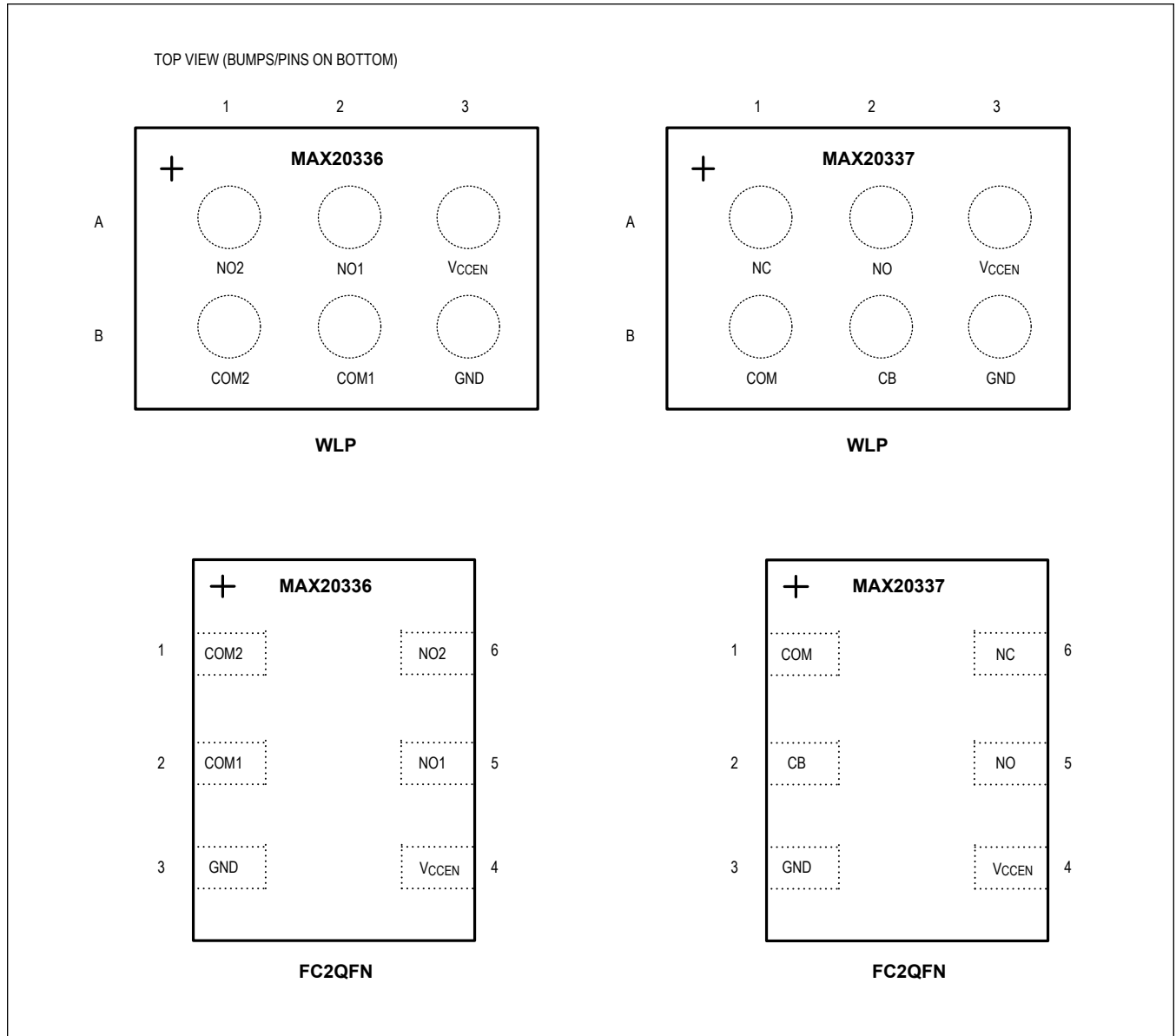


Typical Operating Characteristics (continued)

( $V_{CCEN} = +2.5V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.)



Pin Configuration



## Pin Description

PIN				NAME	FUNCTION
MAX20336 WLP	MAX20336 FC2QFN	MAX20337 WLP	MAX20337 FC2QFN		
A1	6	-	-	NO2	Normally Open Terminal for Switch 2
-	-	A1	6	NC	Normally Closed Terminal
A2	5	-	-	NO1	Normally Open Terminal for Switch 1
-	-	A2	5	NO	Normally Open Terminal
A3	4	A3	4	V <sub>CCEN</sub>	Supply Voltage Enable Input. Bypass V <sub>CCEN</sub> to GND with a 0.1 $\mu$ F capacitor as close to the device as possible.
B1	1	-	-	COM2	Common Terminal for Switch 2
-	-	B1	1	COM	Common Terminal
B2	2	-	-	COM1	Common Terminal for Switch 1
-	-	B2	2	CB	Digital Control Input. Drive CB low to connect COM to NC. Drive CB high to connect COM to NO.
B3	3	B3	3	GND	Ground

## Detailed Description

The MAX20336/MAX20337 are ultra-small, low on-resistance, high ESD-protected DPST/SPDT switches that operate from a +1.6V to +5.5V supply, and are designed to pass analog signals, such as AC-biased or DC-biased audio and video signals. These switches feature the low on-resistance ( $R_{ON}$ ) necessary for high-performance switching applications. The Beyond-the-Rails signal capability of the MAX20336/MAX20337 allows signals below ground and above  $V_{CCEN}$  to pass without distortion.

### Analog Signal Levels

The MAX20336/MAX20337 are bidirectional, allowing NO\_, NC and COM\_ to be configured as either inputs or outputs. The topology of the switches allows the signal to drop below ground without the need of an external negative voltage supply.

### Digital Control Input

The MAX20336 combines enable and supply pins. The switches are on when the device is powered. Connect  $V_{CCEN}$  to GND to turn off the switches.

The MAX20337 has a control bit (CB). COM is connected to NC when CB is low, and connected to NO when CB is high. Connect  $V_{CCEN}$  to GND to turn off the switches.

## Applications Information

### Extended ESD Protection

ESD-protection structures are incorporated on all pins to protect against electrostatic discharges up to  $\pm 2\text{kV}$  (HBM) encountered during handling and assembly. COM\_, NC and NO\_ are further protected against ESD up to  $\pm 30\text{kV}$  (HBM),  $\pm 7\text{kV}$  (Air-Gap Discharge), and  $\pm 8\text{kV}$  (Contact Discharge) without damage. The ESD structures withstand high ESD both in normal operation and when the device is powered down. After an ESD event, the devices continue to function without latchup.

### ESD Test Conditions

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test methodology and test results.

### Human Body Model

Figure 5 shows the Human Body Model. Figure 6 shows the current waveform it generates when discharged into a low impedance. This model consists of a  $100\text{pF}$  capacitor charged to the ESD voltage of interest that is then discharged into the device through a  $1.5\text{k}\Omega$  resistor.

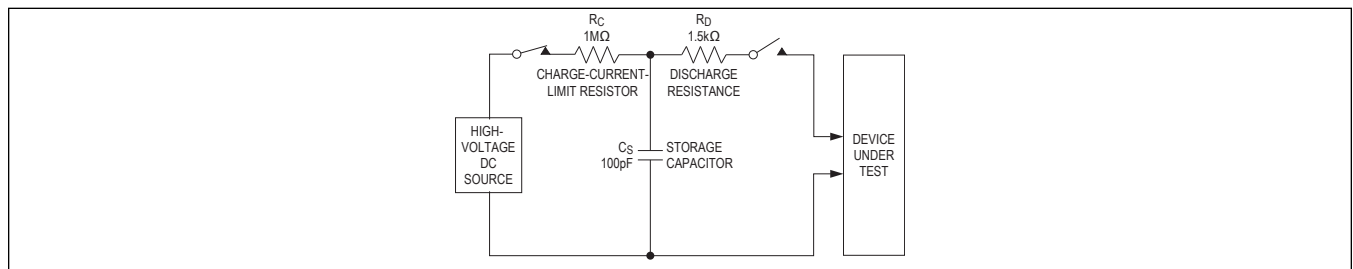


Figure 5. Human Body ESD Test Model

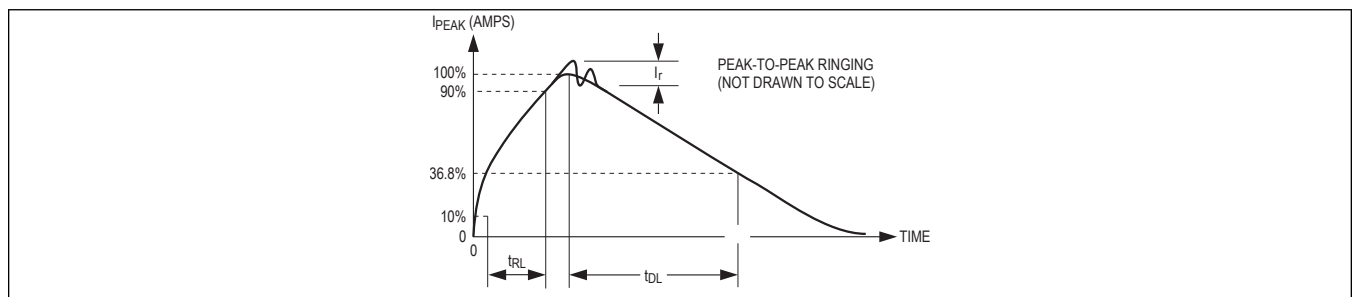


Figure 6. Human Body Current Waveform

### IEC 61000-4-2

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment. It does not specifically refer to integrated circuits. The major difference between tests done using the HBM and IEC 61000-4-2 is higher peak current in IEC 61000-4-2, because series resistance is lower in the IEC 61000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the HBM. Figure 7 shows the IEC 61000-4-2 model and Figure 8 shows the current waveform for the  $\pm 8\text{kV}$ , IEC 61000-4-2, Level 4, ESD Contact-Discharge Method.

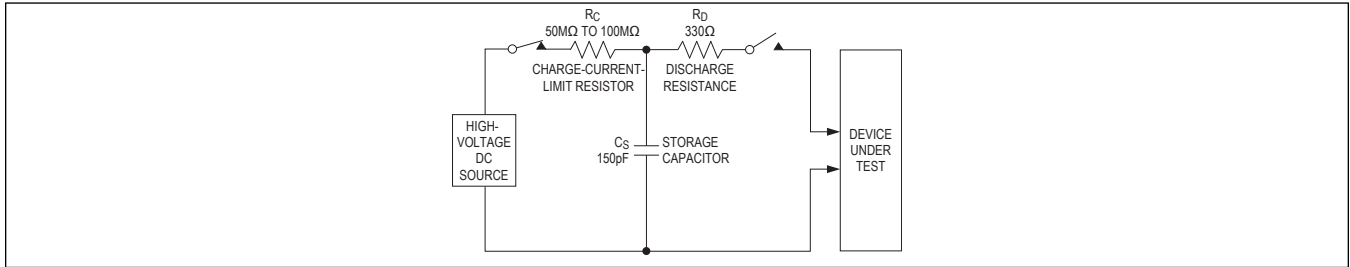


Figure 7. IEC 61000-4-2 ESD Test Model

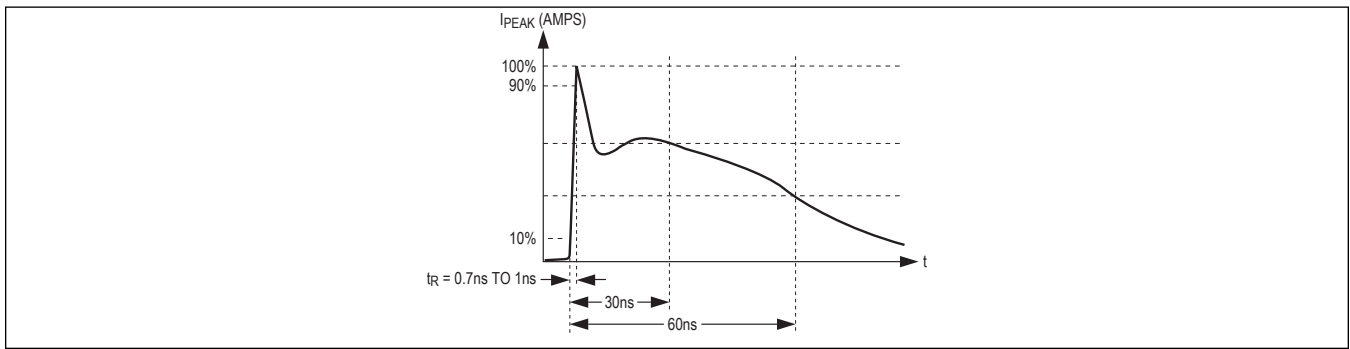
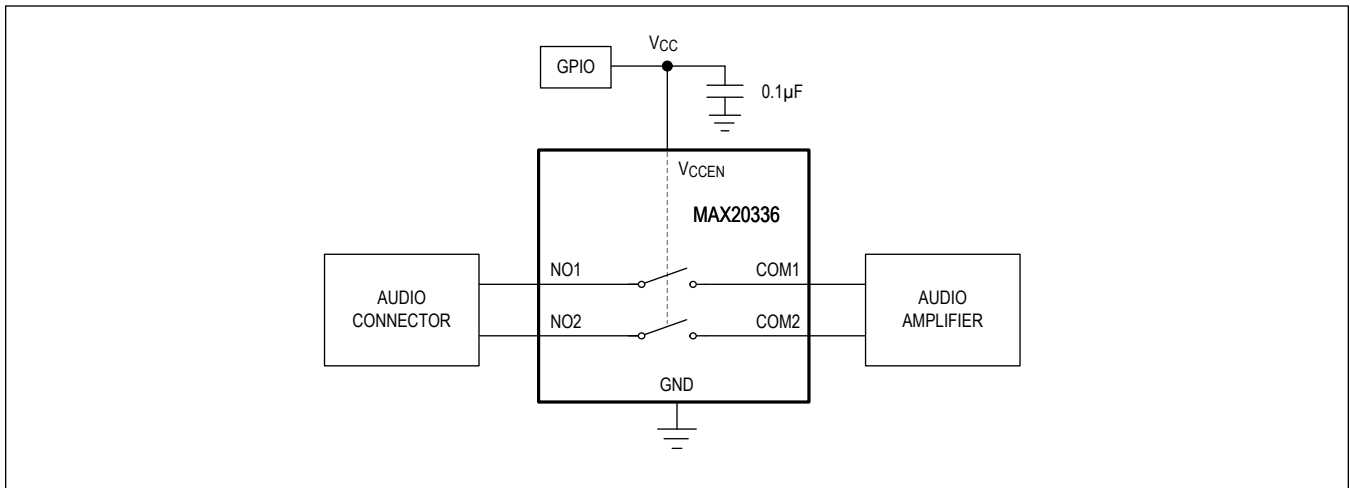


Figure 8. IEC 61000-4-2 ESD Generator Current Waveform

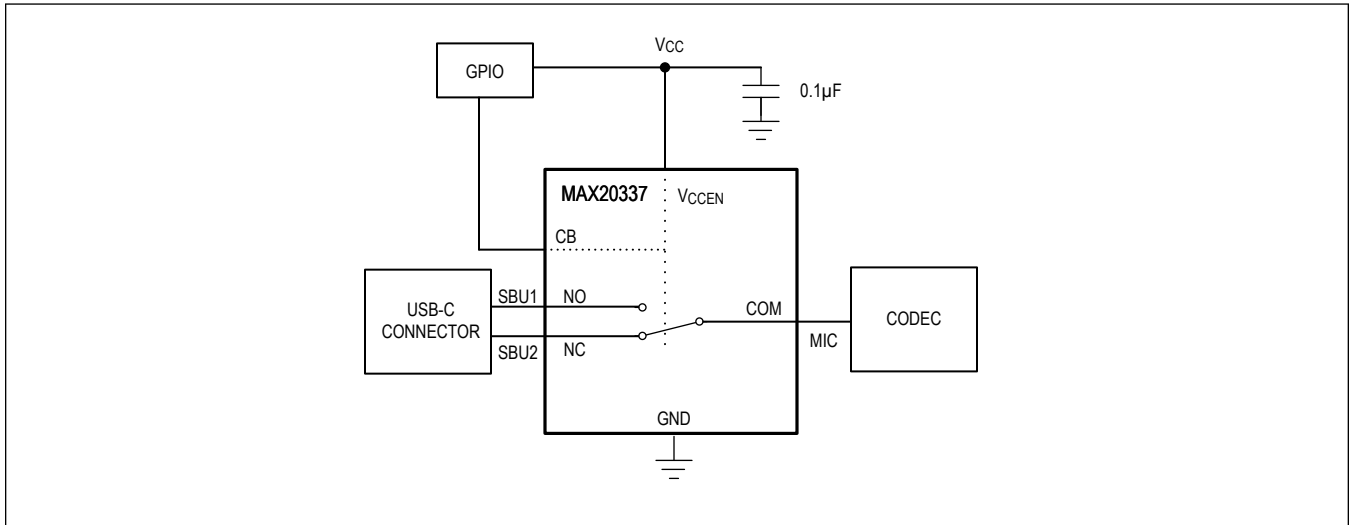
### Typical Application Circuit

#### MAX20336



Typical Application Circuit (continued)

MAX20337



Ordering Information

PART NUMBER	PIN-PACKAGE	TOP MARKING	PACKAGE CODE	PACKAGE OUTLINE DRAWING
MAX20336ENT+	6 WLP	AM	N60K1+1	<a href="#">21-100308</a>
MAX20336ENT+T	6 WLP	AM	N60K1+1	<a href="#">21-100308</a>
MAX20336AEFT+	6 FC2QFN	AAA	F61A1F+1	<a href="#">21-100313</a>
MAX20336AEFT+T	6 FC2QFN	AAA	F61A1F+1	<a href="#">21-100313</a>
MAX20337ENT+	6 WLP	AL	N60K1+2	<a href="#">21-100311</a>
MAX20337ENT+T	6 WLP	AL	N60K1+2	<a href="#">21-100311</a>
MAX20337AEFT+	6 FC2QFN	AAB	F61A1F+1	<a href="#">21-100313</a>
MAX20337AEFT+T	6 FC2QFN	AAB	F61A1F+1	<a href="#">21-100313</a>

+ Denotes lead(Pb)-free/RoHS compliance.

T = Tape-and-reel.

## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/19	Initial release	—
1	1/21	Updated the title, <i>General Description, Benefits and Features, Absolute Maximum Ratings, Package Information, Electrical Characteristics, Pin Configuration, Pin Description, Detailed Description, Analog Signal Levels, Digital Control Input, and Extended ESD Protection</i> ; added new Figure 2 and Figure 3, renumbered subsequent figures added new MAX20337 <i>Typical Application Circuit</i> ; replaced all TOCs and added new TOCs; added MAX20337ENT+, MAX20337ENT+T, MAX20337AEFT+ and MAX20337EFT+T, and removed future product designation from MAX20336AEFT+ and MAX20336AEFT+T from the <i>Ordering Information</i> table	1–11

For pricing, delivery, and ordering information, please visit Maxim Integrated's online storefront at <https://www.maximintegrated.com/en/storefront/storefront.html>.

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