19-5878; Rev 0; 5/11

EVALUATION KIT AVAILABLE

MAX14585/MAX14585A

Hi-Speed USB and Audio Switches with Negative Signal Capability and High-Voltage-Tolerable V_{BUS} Detection

General Description

The MAX14585/MAX14585A high-ESD-protected double-pole/double-throw (DPDT) switches multiplex Hi-Speed (480Mbps) USB and analog signals such as AC-coupled audio or video. These devices combine the low on-capacitance (C_{ON}) and low on-resistance (R_{ON}) necessary for high-performance switching applications in portable electronics and include an internal negative supply to pass audio signals that swing below ground down to -1.8V. The devices also handle USB low-/full-speed signaling and operate from a 2.7V to 5.5V supply.

The devices feature a V_{BUS} detection input (V_B) that can handle voltage up to 28V to automatically switch to the USB signal path upon detection of a valid V_{BUS} signal (V_B > V_{VBDET}). In a dead battery situation, the voltage on V_B can supply power to the part if V_B is greater than 4.5V. The MAX14585 features internal shunt resistors on the audio path to reduce clicks and pops heard at the output.

The MAX14585/MAX14585A are available in a space-saving, 10-pin, 1.4mm x 1.8mm UTQFN package and operate over the -40°C to +85°C temperature range.

Applications

Cell Phones

PDAs and Handheld Devices

Tablet PCs

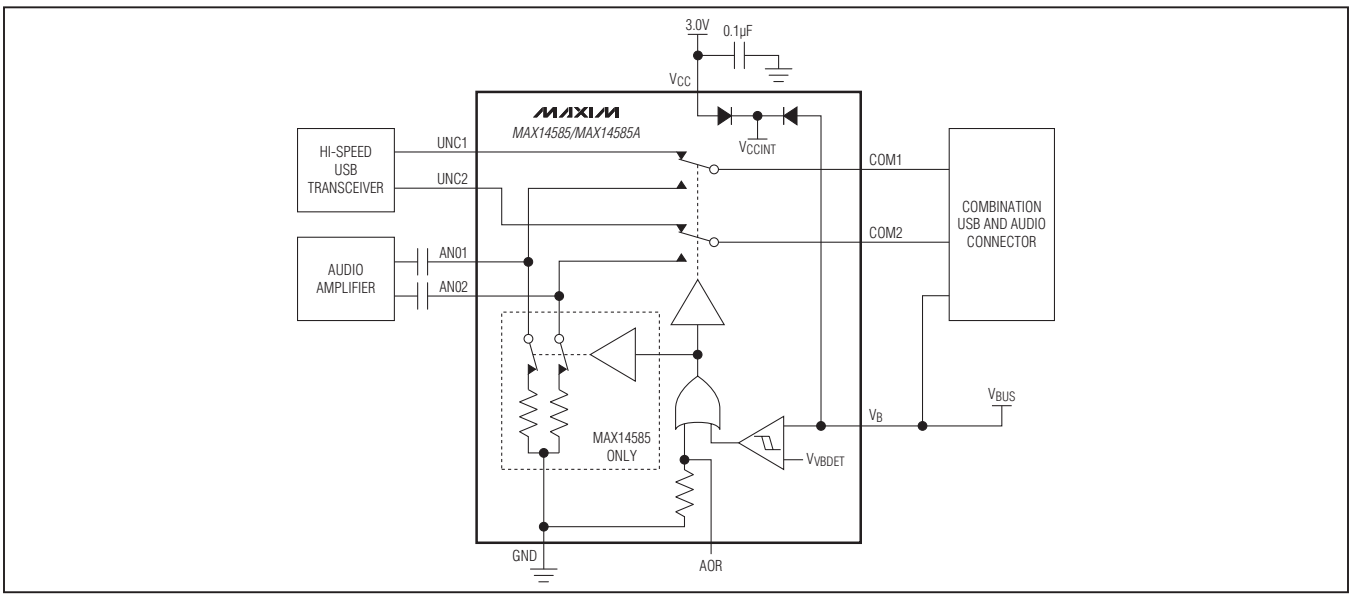
Benefits and Features

- **Low Power Consumption**
  - **Low Supply Current 7µA (typ)**
  - **Single 2.7V to 5.5V Supply Operation, V_{CC}**
- **Flexible Design**
  - **Dual Power-Supply Architecture, V_B and V_{CC}**
  - **ANO_ Channel Override Control Input**
- **High Level of Integration for Performance**
  - **28V-Capable V_B Input with Automatic UNC_ Selection by V_{BUS} Detection**
  - **Low-Capacitance Hi-Speed USB for Both Channels (UNC_ and ANO_)**
  - **Distortion-Free Negative Signal Throughput Down to -1.8V on ANO_ Channel**
  - **3Ω (typ) On-Resistance**
  - **960MHz Bandwidth**
  - **0.04% THD+N Audio Channel**
  - **±15kV Human Body Model (HBM) ESD on COM1, COM2**
- **Saves Board Space**
  - **Internal Shunt Resistor Reduces Clicks and Pops (MAX14585)**
  - **10-Pin, 1.4mm x 1.8mm UTQFN Package**

***Ordering Information* appears at end of data sheet.**

*For related parts and recommended products to use with this part, refer to **www.maxim-ic.com/MAX14585.related**.*

Typical Operating Circuit



For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

ABSOLUTE MAXIMUM RATINGS

(Voltages referenced to GND.)

V_{CC}, AOR ..... -0.3V to +6V
V_B ..... -0.3V to +30V
UNC_, ANO_, COM_ ($V_{CC} \geq 2.7V$) ... -1.9V to min(V_{CC} + 0.3V, 3.7V)
UNC_, COM_ ($V_B \geq 4.5V$, $V_{CC} < 2.7V$) ..... -0.3V to +3.7V
UNC_, ANO_, COM_ ($V_{CC} < 2.7V$).. -0.3V to min(V_{CC} + 0.3V, 3.7V)
UNC_, ANO_, COM_ (V_{CC} = 0V, V_B = 0V) ..... -0.3V to +6V
Continuous Current into Any Pin ..... ±100mA

Continuous Power Dissipation (T_A = +70°C)
UTQFN (derate 7mW/°C above +70°C) 559mW
Operating Temperature Range ..... -40°C to +85°C
Junction Temperature Range ..... -40°C to +150°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10s) ..... +300°C
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 THERMAL CHARACTERISTICS (Note 1)

UTQFN
Junction-to-Ambient Thermal Resistance (θ_{JA}) ..... 143.2°C/W
Junction-to-Case Thermal Resistance (θ_{JC}) ..... 20.1°C/W

Note 1: 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.maxim-ic.com/thermal-tutorial**.

ELECTRICAL CHARACTERISTICS

(T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY						
Power-Supply Range	V_{CC}		2.7		5.5	V
Supply Current	I_{SUPPLY}	V_{CC} = 4.2V, 0V < V_{AOR} < 0.4V, $V_{AOR} \geq 1.4V$		7	14	µA
Power-Supply Rejection Ratio	PSRR	f = 10kHz, V_{CC} = 3.0 ± 0.3V, $R_{COM\_}$ = 50Ω		100		dB
V_B Detect Threshold	V_{VBDET}	V_{BUS} rising, $V_{CC} \geq 2.7V$	3	3.3	3.6	V
V_B Detect Hysteresis	V_{VBDET_H}	V_{BUS} falling, $V_{CC} \geq 2.7V$		0.2		V
V_B Detect Leakage Current		V_B = 5.5V			40	µA
ANALOG SWITCH						
Analog-Signal Range	$V_{UNC\_}$	$V_{CC} \geq 2.7V$ for UNC_	0		min(3.6V, V_{CC})	V
	$V_{ANO\_}$, $V_{COM\_}$	$V_{CC} \geq 2.7V$ for ANO_, COM_	-1.8		min(3.6V, V_{CC})	
ANO_ On-Resistance	$R_{ON(NO)}$	V_{CC} = 3V, $V_{ANO\_}$ = -1.5V, +1.5V, $I_{COM\_}$ = 10mA		3	6	Ω
UNC_ On-Resistance	$R_{ON(NC)}$	V_{CC} = 3V, $V_{UNC\_}$ = 0V to V_{CC}, $I_{COM\_}$ = 10mA		3	6	Ω
		V_B = 4.5V, V_{CC} = 0V to 5.5V, $V_{UNC\_}$ = 0V to 2.5V, V_{AOR} = 0V, $I_{COM\_}$ = 10mA		3	6	
ANO_ On-Resistance Match Between Channels	$\Delta R_{ON(NO)}$	V_{CC} = 3V, $V_{ANO\_}$ = 0V, $I_{COM\_}$ = 10mA (Note 3)		0.2		Ω

ELECTRICAL CHARACTERISTICS (continued)

(T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
UNC_ On-Resistance Match Between Channels	$\Delta R_{ON(NC)}$	V_{CC} = 3V, $V_{UNC\_}$ = 0V, $I_{COM\_}$ = 10mA (Note 3)			0.2		Ω
ANO_ On-Resistance Flatness	$R_{FLAT(NO)}$	V_{CC} = 3V, $I_{COM\_}$ = 10mA, $V_{ANO\_}$ = -1.5V to +1.5V (Note 4)			0.04	0.2	Ω
UNC_ On-Resistance Flatness	$R_{FLAT(NC)}$	V_{CC} = 3V, $I_{COM\_}$ = 10mA, $V_{UNC\_}$ = 0V to V_{CC} (Note 4)			0.04	0.2	Ω
Shunt Switch Resistance	R_{SH}	$I_{ANO\_}$ = 2mA, $V_{CC} \geq$ 2.7V			700	1300	Ω
AOR Pulldown Resistor	R_{AOR}			250		1200	kΩ
UNC_ Off-Leakage Current	$I_{UNC\_(OFF)}$	Switch open, $V_{UNC\_}$ = 2.5V, 0V $V_{COM\_}$ = -1.5V, 2.5V, V_{CC} = 3V		-100		+100	nA
ANO_ Off-Leakage Current	$I_{ANO\_(OFF)}$	MAX14585A, switch open, $V_{ANO\_}$ = 2.5V, 0V, $V_{COM\_}$ = 0V, 2.5V, V_{CC} = 3V		-100		+100	nA
COM_ Off-Leakage Current	$I_{COM\_(OFF)}$	V_{CC} = 0V, $V_{COM\_}$ = 3.6V, $V_{UNC\_}$ = $V_{ANO\_}$ = unconnected		-10		+800	µA
COM_ On-Leakage Current	$I_{COM\_(ON)}$	USB mode	V_{CC} = 3V, $V_{ANO\_}$ = 0V, 2.5V, unconnected, $V_{COM\_}$ = 0V, 2.5V	-200		+200	nA
		Audio mode	V_{CC} = 3V, $V_{UNC\_}$ = 0V, 2.5V, unconnected, $V_{COM\_}$ = -1.5V, 2.5V	-200		+200	nA
Turn-On Time	t_{ON}	ANO_ to COM_, Figure 1	V_{CC} = 3V, $V_{ANO\_}$ = 1.5V, R_L = 50Ω; V_{AOR} = 0V, V_B = 0V to 5V or V_B = 5V, V_{AOR} = 0V to V_{CC}		45	120	µs
		UNC_ to COM_, Figure 1	V_{CC} = 3V, $V_{UNC\_}$ = 1.5V, R_L = 50Ω; V_{AOR} = 0V, V_B = 0V to 5V		45	120	µs
Turn-Off Time	t_{OFF}	ANO_ from COM_, Figure 1	V_{CC} = 3V, $V_{ANO\_}$ = 1.5V, R_L = 50Ω; V_{AOR} = 0V, V_B = 0V to 5V		8	40	µs
		UNC_ from COM_, Figure 1	V_{CC} = 3V, $V_{UNC\_}$ = 1.5V, R_L = 50Ω; V_{AOR} = 0V, V_B = 0V to 5V or V_B = 5V, V_{AOR} = 0V to V_{CC}		8	40	µs
Break-Before-Make Time Delay	t_D	R_L = 50Ω, time delay between one side of the switch open and the other side closed			28		µs
Output Skew (Same Switch)	$t_{SK(P)}$	Figure 2			40		ps
Output Skew Between Switches	$t_{SK(O)}$	Figure 2			40		ps
ANO_ Off-Capacitance	$C_{NO\_(OFF)}$	$V_{ANO\_}$ = 0.5V_{P-P}, DC bias = 0V, f = 1MHz			2.5		pF
UNC_ Off-Capacitance	$C_{NC\_(OFF)}$	$V_{UNC\_}$ = 0.5V_{P-P}, DC bias = 0V, f = 1MHz			2.5		pF

ELECTRICAL CHARACTERISTICS (continued)

(T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
On-Capacitance	$C_{COM\_(ON)}$	$V_{COM\_}$ = 0.5V_{P-P}, DC bias = 0V, f = 240MHz, R_L = 50Ω		6.7		pF
AC PERFORMANCE						
ANO_ -3dB Bandwidth	BW_{NO}	R_S = R_L = 50Ω, $V_{ANO\_}$ = 0dBm, Figure 3		960		MHz
UNC_ -3dB Bandwidth	BW_{NC}	R_S = R_L = 50Ω, $V_{UNC\_}$ = 0dBm, Figure 3		960		MHz
Off-Isolation		f = 100kHz, $V_{COM\_}$ = 1V_{RMS}, R_L = 50Ω, Figure 3		-84		dB
Crosstalk		f = 100kHz, $V_{COM\_}$ = 1V_{RMS}, R_L = 50Ω, Figure 3 (Note 5)		-86		dB
Total Harmonic Distortion Plus Noise	THD+N	ANO_ to COM_, f = 20Hz to 20kHz, $V_{COM\_}$ = 0.5V_{P-P}, DC bias = 0V, R_L = 600Ω		0.042		%
LOGIC INPUT						
AOR Input Logic-High	V_{IH}	V_{CC} ≥ 2.7V	1.4			V
AOR Input Logic-Low	V_{IL}	V_{CC} ≥ 2.7V			0.4	V
AOR Input Leakage Current	I_{IN}	V_{AOR} = 0V or V_{CC}, V_{CC} ≥ 2.7V	-22		+22	µA
ESD PROTECTION						
COM1, COM2		Human Body Model		±15		kV
		IEC 61000-4-2 Air Gap Discharge		±8		
		IEC 61000-4-2 Contact Discharge		±8		
All Other Pins		Human Body Model		±2		kV

Note 2: All devices are 100% production tested at T_A = +25°C. Limits over the operating temperature range are guaranteed by design; not production tested.

Note 3: $\Delta R_{ON(MAX)} = ABS(R_{ON(CH1)} - R_{ON(CH2)})$.

Note 4: Flatness is defined as the difference between the maximum and minimum value of on-resistance, as measured over specified analog-signal ranges.

Note 5: Between two switches.

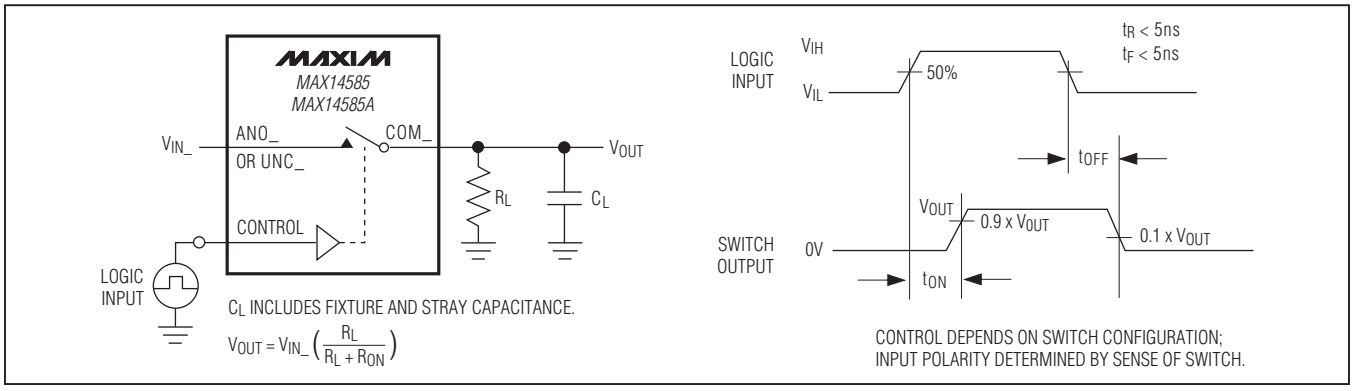


Figure 1. Switching Time

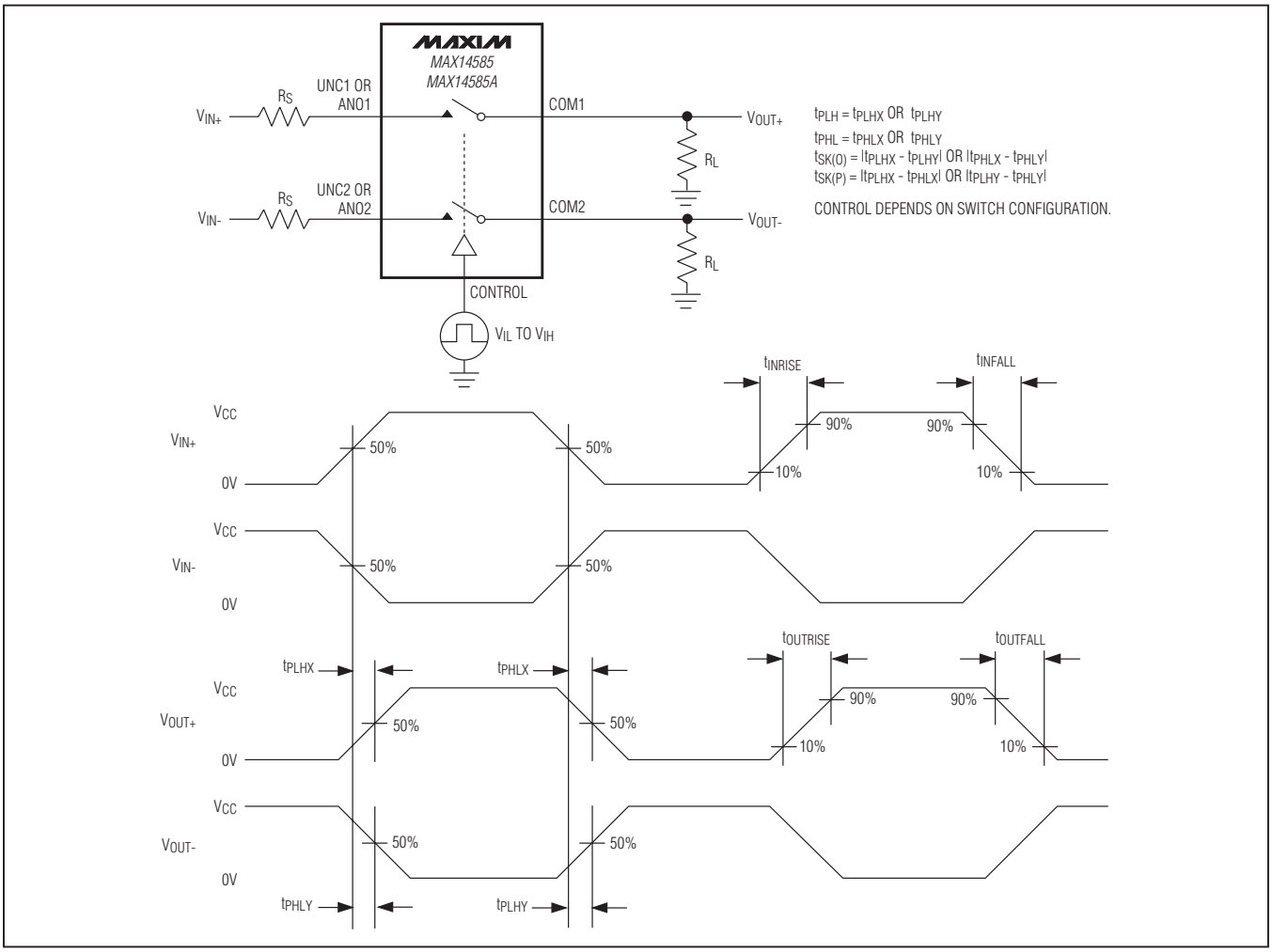


Figure 2. Output Skew

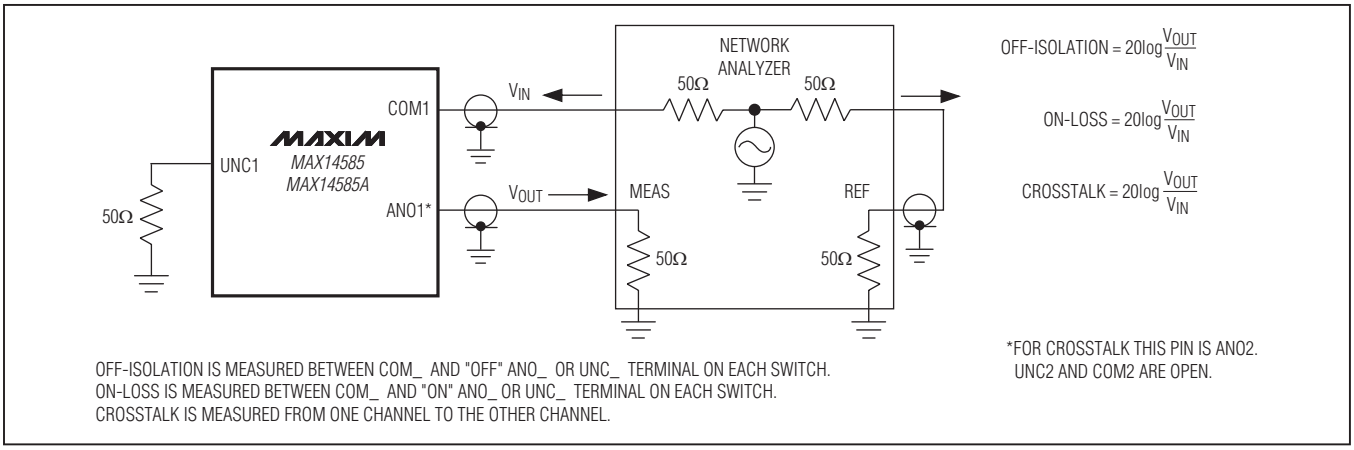


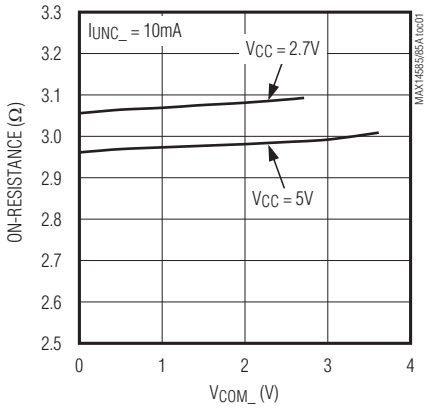
Figure 3. On-Loss, Off-Isolation, and Crosstalk

Hi-Speed USB and Audio Switches with Negative Signal Capability and High-Voltage-Tolerable V_{BUS} Detection

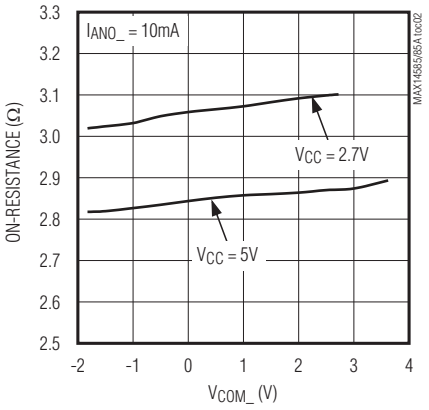
Typical Operating Characteristics

(V_{CC} = 3.0V, T_A = +25°C, unless otherwise noted.)

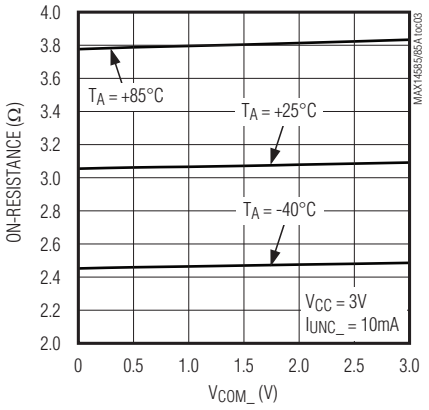
UNC_ ON-RESISTANCE vs. COM_ VOLTAGE



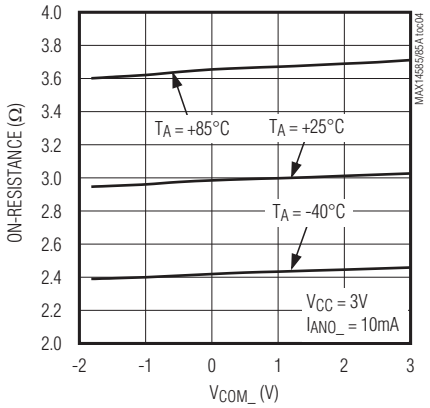
ANO_ ON-RESISTANCE vs. COM_ VOLTAGE



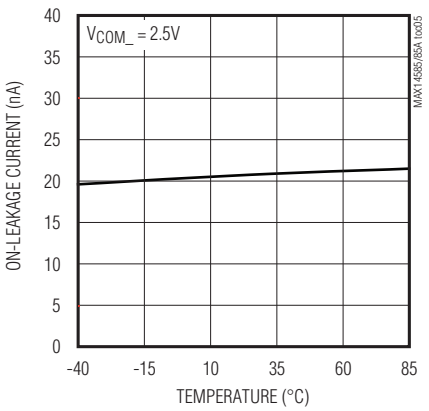
UNC_ ON-RESISTANCE vs. COM_ VOLTAGE



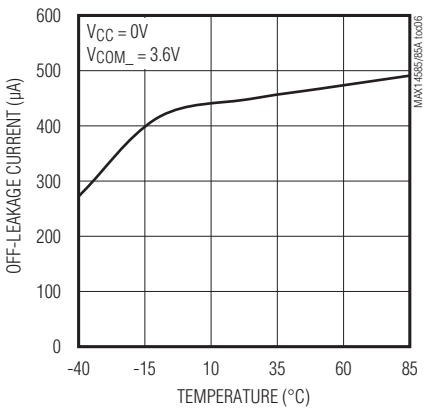
ANO_ ON-RESISTANCE vs. COM_ VOLTAGE



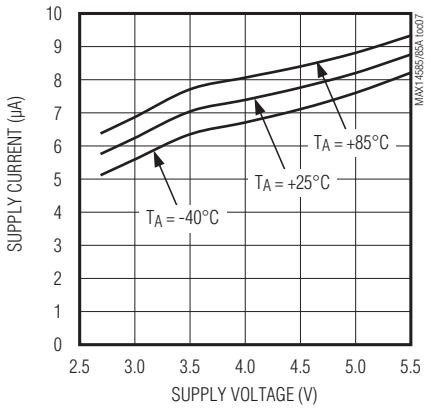
COM_ ON-LEAKAGE CURRENT vs. TEMPERATURE



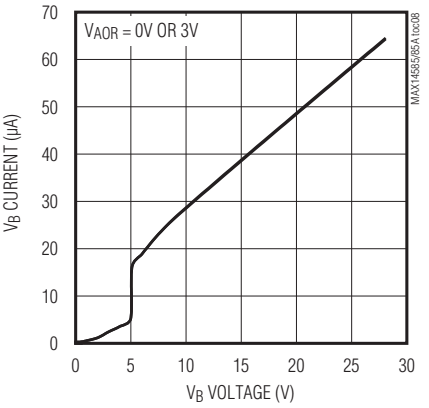
COM_ OFF-LEAKAGE CURRENT vs. TEMPERATURE



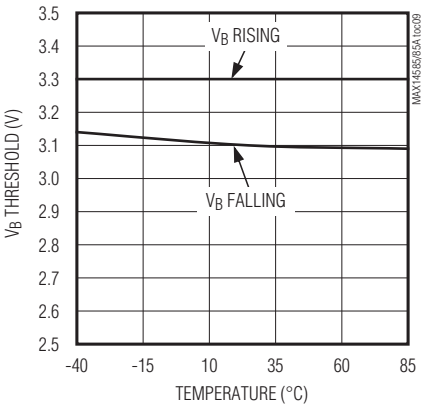
SUPPLY CURRENT vs. SUPPLY VOLTAGE



V_B SUPPLY CURRENT vs. SUPPLY VOLTAGE



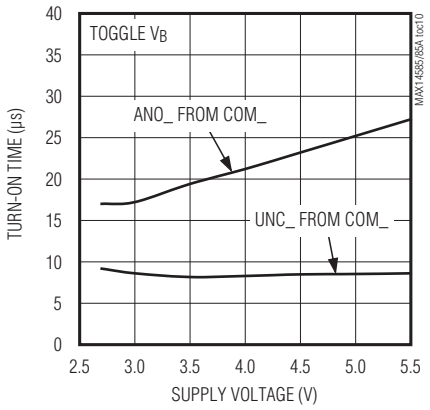
V_B DETECT THRESHOLD vs. TEMPERATURE



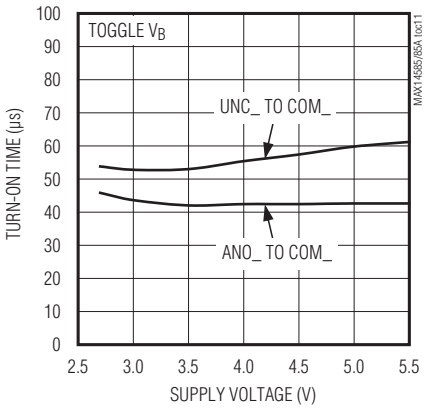
Typical Operating Characteristics (continued)

(V_{CC} = 3.0V, T_A = +25°C, unless otherwise noted.)

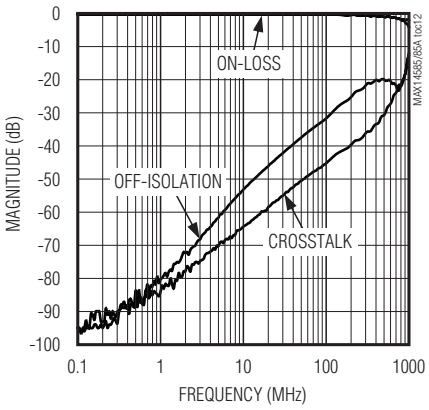
TURN-OFF TIME vs. SUPPLY VOLTAGE



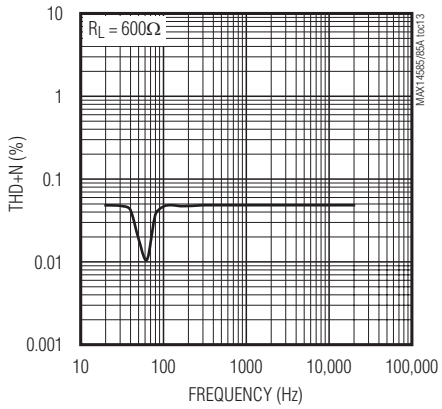
TURN-ON TIME vs. SUPPLY VOLTAGE



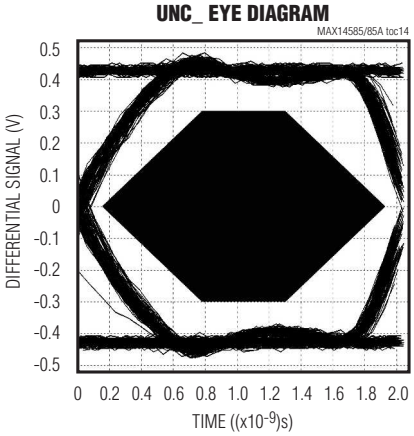
FREQUENCY RESPONSE



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY

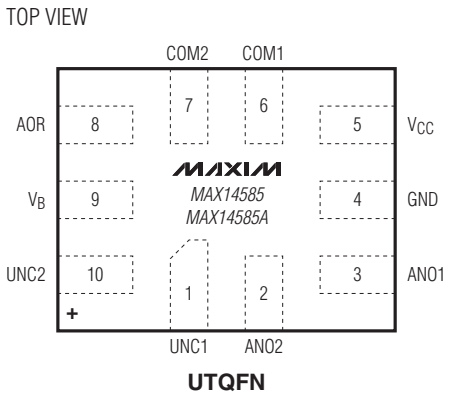


UNC_ EYE DIAGRAM



Hi-Speed USB and Audio Switches with Negative Signal Capability and High-Voltage-Tolerable V_{BUS} Detection

Pin Configuration



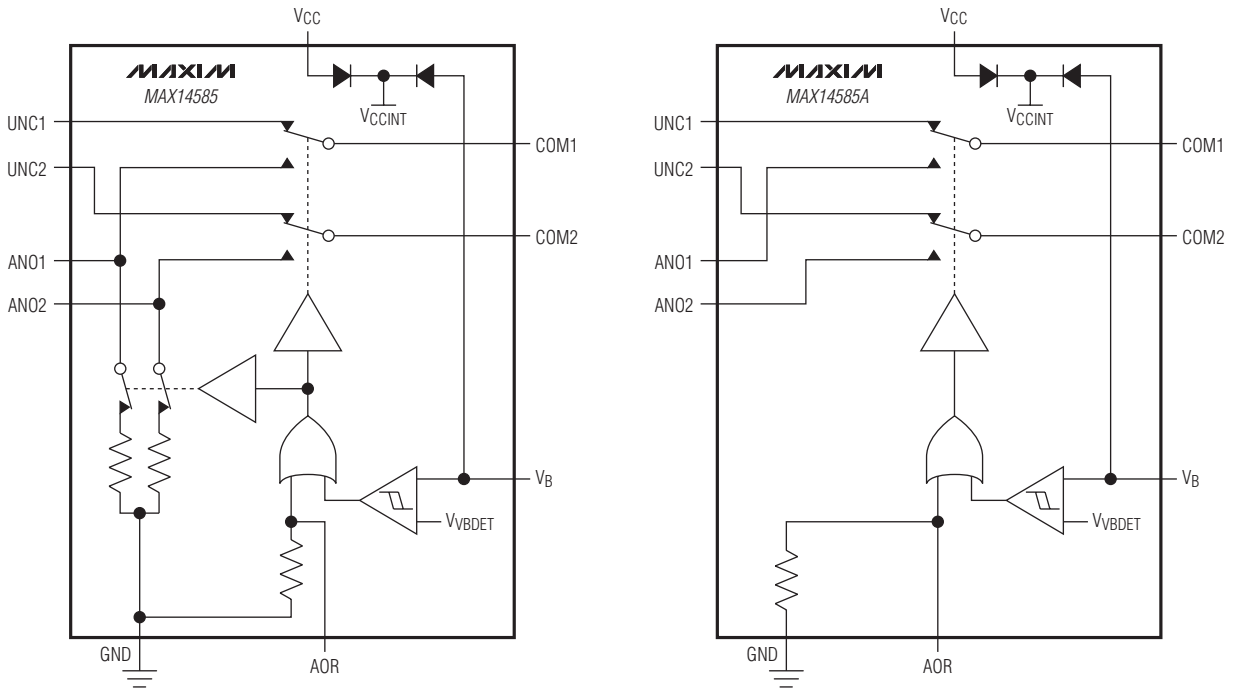
UTQFN

Pin Description

PIN	NAME	FUNCTION
1	UNC1	USB Input 1. Normally closed terminal for switch 1.
2	ANO2	Audio Input 2. Normally open terminal for switch 2.
3	ANO1	Audio Input 1. Normally open terminal for switch 1.
4	GND	Ground
5	V_{CC}	Positive Supply-Voltage Input. Bypass V_{CC} to GND with a 0.1µF capacitor as close as possible to the device.
6	COM1	Common Terminal for Switch 1
7	COM2	Common Terminal for Switch 2
8	AOR	Audio Override Input. Drive AOR low to have V_B control the switch. Drive AOR high to connect COM_ to ANO_. AOR has an internal pulldown resistor to GND.
9	V_B	V_{BUS} Detection Input. If $V_B \geq V_{VBDET}$, COM_ connects to UNC_. Otherwise, COM_ connects to ANO_.
10	UNC2	USB Input 2. Normally closed terminal for switch 2.

Hi-Speed USB and Audio Switches with Negative Signal Capability and High-Voltage-Tolerable V_{BUS} Detection

Functional Diagrams/Truth Table



MAX14585/MAX14585A				MAX14585
V_B	AOR	UNC_	ANO_	ANO_SHUNT
> V_{VBDET}	0	ON	OFF	ON
< V_{VBDET}	0	OFF	ON	OFF
X	1	OFF	ON	OFF

X = DON'T CARE

Detailed Description

The MAX14585/MAX14585A are high-ESD-protected single DPDT switches that operate from a 2.7V to 5.5V supply and are designed to multiplex Hi-Speed USB signals and AC-coupled analog signals. These switches combine the low on-capacitance (C_{ON}) and low on-resistance (R_{ON}) necessary for high-performance switching applications. These devices meet the requirements for USB low-speed and full-speed signaling. The negative signal capability of the analog channel allows signals below ground to pass through without distortion.

Analog-Signal Levels

The devices are bidirectional, allowing ANO_, UNC_, and COM_ to be configured as either inputs or outputs. Note that UNC_ and ANO_ are only protected against ESD up to ±2kV (HBM) and could require additional ESD protection if used as outputs. These devices feature a charge pump that generates a negative supply to allow analog signals as low as -1.8V to pass through ANO_ when V_{CC} supply is greater than 2.7V. This allows AC-coupled signals that drop below ground to pass when operating from a single power supply.

When V_{CC} is below 2.7V and V_B is less than 4.5V, the switches accept signals from 0 to 3.6V but do not switch according to the *Functional Diagrams/Truth Table*.

V_{BUS} Detection Input

The devices feature a V_{BUS} detection input (V_B) that connects COM_ to UNC_ when V_B exceeds the V_{BUS} detection threshold (V_{VBDET}). For applications where V_{BUS} is always present, drive the audio override input (AOR) high to connect ANO_ to COM_ (see the *Functional Diagrams/Truth Table*). Drive AOR low to have V_B control the switch position. Drive AOR rail-to-rail to minimize power consumption.

The V_B input is capable of handling voltage up to 28V for higher V_{BUS} application. In the case where the main power V_{CC} is lost due to an event such as a dead battery, V_B becomes the power supply if V_B is greater than 4.5V.

Click-and-Pop Suppression (MAX14585)

The switched 700Ω (typ) shunt resistors on the MAX14585 automatically discharge any capacitance at the ANO_ terminals when they are unconnected from COM_. This reduces audio click-and-pop sounds that can occur when switching between USB and audio sources.

Applications Information

Extended ESD Protection

ESD protection structures are incorporated on all pins to protect against electrostatic discharges up to ±2kV (HBM) encountered during handling and assembly. COM1 and COM2 are further protected against ESD up to ±15kV (HBM) without damage. **The ESD structures withstand high ESD in both normal operation and when the devices are 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 setup, test methodology, and test results.

Human Body Model

Figure 4 shows the HBM. Figure 5 shows the current waveform it generates when discharged into a low-impedance state. This model consists of a 100pF capacitor charged to the ESD voltage of interest that is then discharged into the device through a 1.5kΩ resistor.

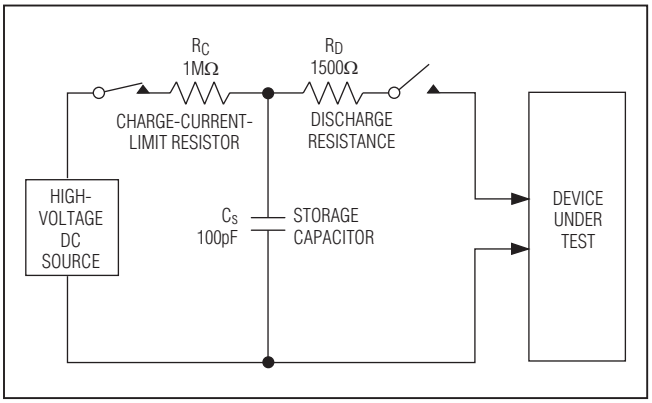


Figure 4. Human Body ESD Test Model

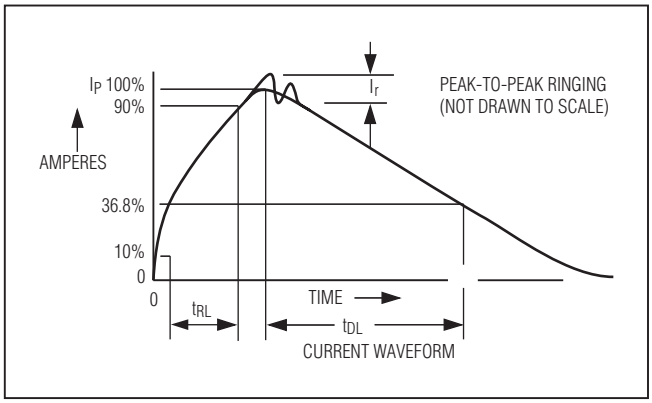


Figure 5. Human Body Current Waveform

Hi-Speed USB and Audio Switches with Negative Signal Capability and High-Voltage-Tolerable V_{BUS} Detection

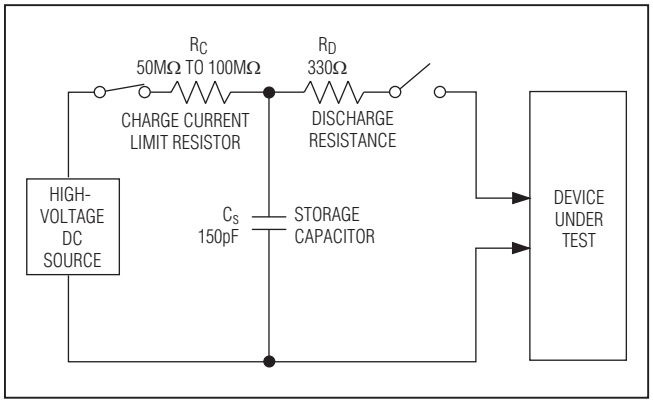


Figure 6. IEC 61000-4-2 ESD Test Model

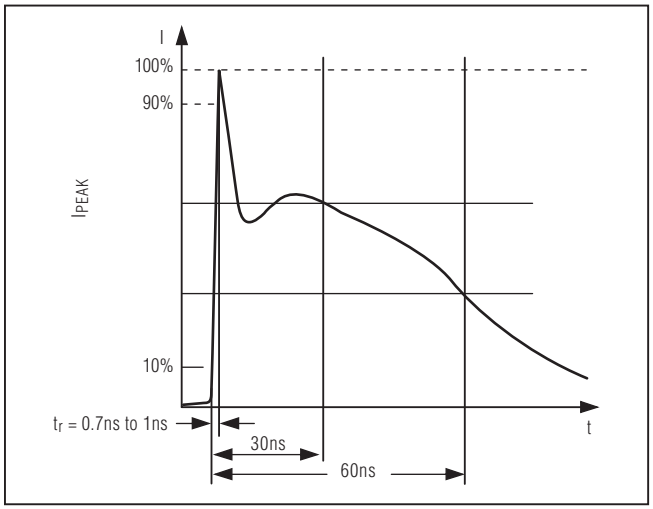


Figure 7. IEC 61000-4-2 ESD Generator Current Waveform

Chip Information

PROCESS: BiCMOS

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 6 shows the IEC 61000-4-2 model and Figure 7 shows the current waveform for the ±8kV, IEC 61000-4-2, Level 4, ESD Contact-Discharge Method.

Layout

Hi-Speed USB requires careful PCB layout with 45Ω single-ended/90Ω differential controlled-impedance matched traces of equal lengths. Ensure that bypass capacitors are as close to the device as possible. Use large ground planes where possible.

Ordering Information/ Selector Guide

PART	TOP MARK	SHUNT RESISTOR	PIN-PACKAGE
MAX14585EVB+T	AAY	Yes	10 UTQFN
MAX14585AEVB+T	AAZ	No	10 UTQFN

Note: *All devices are specified over the -40°C to +85°C temperature range.*
+Denotes a lead(Pb)-free/RoHS-compliant package.
T = Tape and reel.

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maxim-ic.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 TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
10 UTQFN	V101A1CN+1	21-0028	90-0287

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Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	5/11	Initial release	—