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19-5573; Rev 1; 4/11

SuperSpeed USB Passive Switch (Low/Full/Hi/SuperSpeed)

General Description

The MAX14978 high-performance, passive analog switch is ideal for switching Hi-Speed USB and SuperSpeed USB data between one source and two loads, or vice versa. The device can be used in desktop and notebook applications where SuperSpeed USB ports are in limited supply. The device consists of two sets of analog switches with one set used for USB low-speed, full-speed, and Hi-Speed signals and the second set used for USB SuperSpeed. The device operates from a single +3.3V supply.

The device features low insertion loss for all speeds. It has ±6kV Human Body Model (HBM) ESD protection on all I/O pins. In addition, the low/full/Hi-Speed COM_ ports have ESD protection to ±15kV HBM and ±8kV IEC 61000-4-2 contact.

The device is available in a small, 3.5mm x 9.0mm, 42-pin TQFN package and is specified over the extended -40°C to +85°C temperature range.

Applications

Desktop PCs

Laptop PCs

Industrial USB Switching

Features

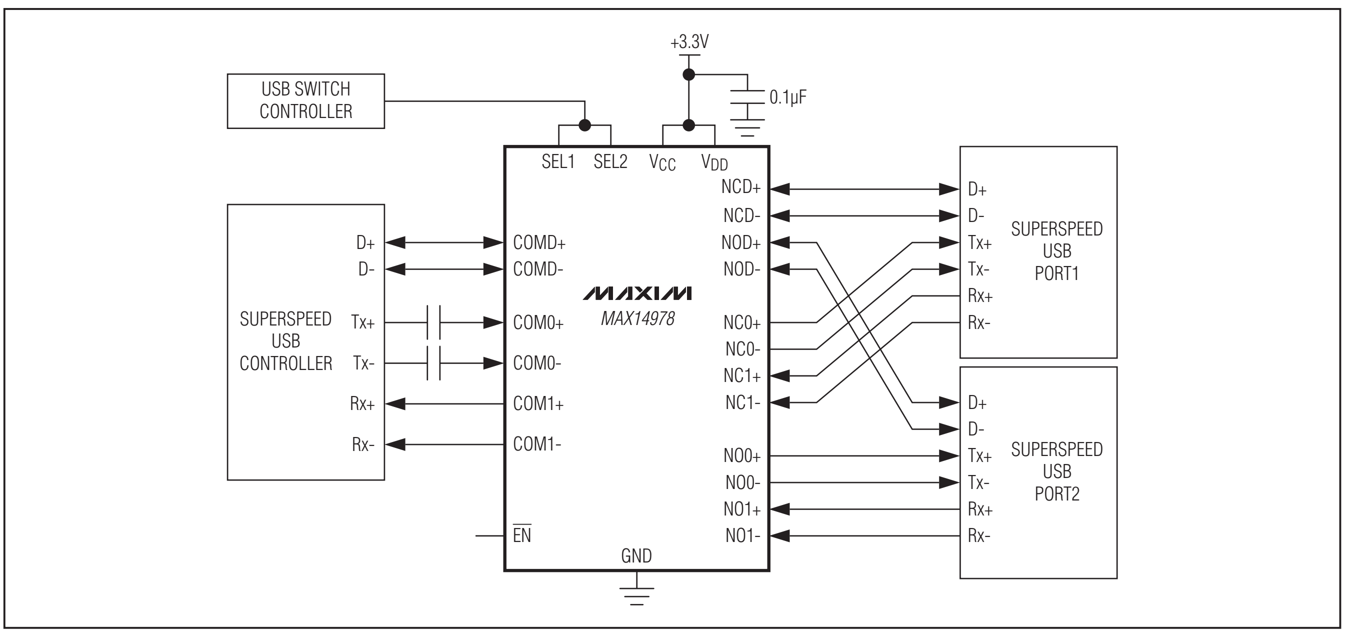
- **Designed for SuperSpeed USB Applications:**
  - **Low/Full/Hi-Speed (1.5/12/480Mbps)**
  - **SuperSpeed (5.0Gbps)**
- **Superior Return Loss and Insertion Loss for SuperSpeed Analog Switches**
- **Low Quiescent Current: 36µA (typ)**
- **All Link Training is Preserved (SuperSpeed)**
- **LVCMOS Control (1.4V ≤ V_{IH} ≤ 3.6V)**
- **Operation from a Single +3.3V Power Supply**
- **Small, 3.5mm x 9.0mm, 42-Pin TQFN Package**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX14978ETO+	-40°C to +85°C	42 TQFN-EP*

+Denotes a lead(Pb)-free/RoHS-compliant package.
**EP = Exposed pad.*

Typical Operating Circuit



ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND, unless otherwise noted.)
V_{CC} .... -0.3V to +6.0V
V_{DD} .... -0.3V to +4.0V
SEL1, $\overline{EN}$, COMD_, NOD_, NCD_ (Note 1) .... -0.3V to (V_{CC} + 0.3V)
SEL2, COM0_, COM1_, NC0_, NC1_, NO0_, NO1_ (Note 1) .... -0.3V to (V_{DD} + 0.3V)
|COM0_ - NO0_|, |COM0_ - NC0_|, |COM0 _ - NO1 _|, |COM0 _ - NC1_| (Note 1) .... 0 to +2.0V
Continuous Current (COM0_, COM1_ to NO0_, NO1_, NC0_, NC1_) .... ±70mA
Peak Current (COM0_, COM1_ to NO0_, NO1_, NC0_, NC1_) (pulsed at 1ms, 10% duty cycle) .... ±70mA
Continuous Current into Any Terminal .... ±30mA
Continuous Power Dissipation (T_A = +70°C)
TQFN (derate 35.7mW/°C above +70°C) 2857mW
Operating Temperature Range .... -40°C to +85°C
Storage Temperature Range .... -65°C to +150°C
Junction Temperature .... +150°C
Lead Temperature (soldering, 10s) .... +300°C
Soldering Temperature (reflow) .... +260°C

Note 1: Signals on SEL_, NO_, NC_, or COM_ exceeding V_{CC}, V_{DD}, or V_{GND} are clamped by internal diodes. Limit forward-diode current to maximum current rating.

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.

ELECTRICAL CHARACTERISTICS

(V_{CC} = +3.0V to +5.5V, V_{DD} = +3.0V to +3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = V_{DD} = +3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Power-Supply Range	V_{CC}			3.0		5.5	V
	V_{DD}			3.0		3.6	
Supply Current	I_{CC}	V_{SEL1} = 0V or V_{CC}, $V_{\overline{EN}}$ = 0V	V_{CC} = 3.0V		0.6	1.5	µA
	I_{DD}	V_{SEL2} = 0V or V_{DD}	V_{DD} = 3.3V			60	
Shutdown Supply Current, I_{CC}	I_{SHDN}	Hi-Speed USB switches, switch disabled ($V_{\overline{EN}}$ = V_{CC})			0.1		µA
Increase in Supply Current, I_{CC}, with V_{SEL1}, $V_{\overline{EN}}$ Voltage		Hi-Speed USB switches, 0V ≤ V_{SEL1} ≤ V_{IL} or V_{IH} ≤ V_{SEL1} ≤ V_{CC} or 0V ≤ $V_{\overline{EN}}$ ≤ V_{IL} or V_{IH} ≤ $V_{\overline{EN}}$ ≤ V_{CC}				1	µA
Analog Signal Range	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$	Hi-Speed USB switches, $V_{\overline{EN}}$ = 0V (Note 3)		0		V_{CC}	V
		SuperSpeed USB switches		-0.3		V_{DD} - 1.2	
Fault-Protection Trip Threshold	V_{FP}	Hi-Speed USB switches, COMD_ only, T_A = +25°C		V_{CC} + 0.6	V_{CC} + 0.8	V_{CC} + 1	V
On-Resistance	R_{ON}	Hi-Speed USB switches, $V_{COMD\_}$ = 0V to V_{CC}			5	10	Ω
		Hi-Speed USB switches, V_{CC} = 3.0V, $V_{COMD\_}$ = 3.6V			5.5		
		SuperSpeed USB switches, V_{DD} = 3.0V, $I_{COM\_}$ = 15mA, $V_{NO\_}$ = $V_{NC\_}$ = 0V, 1.8V			7		

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +3.0V to +5.5V, V_{DD} = +3.0V to +3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = V_{DD} = +3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
On-Resistance Match Between Channels	ΔR_{ON}	Hi-Speed USB switches, V_{CC} = 3.0V, $V_{COMD\_}$ = 2.0V (Notes 4, 5)		0.1	1	Ω
		SuperSpeed USB switches, V_{DD} = 3.0V, $I_{COM\_}$ = 15mA, $V_{NO\_}$ or $V_{NC\_}$ = 0V (Notes 4, 5)		0.6	2	
On-Resistance Match Between Pairs of Same Channels	ΔR_{ON}	SuperSpeed USB switches, V_{DD} = 3.0V, $I_{COM\_}$ = 15mA, $V_{NO\_}$ or $V_{NC\_}$ = 0V (Notes 4, 5)		0.1	1	Ω
On-Resistance Flatness	R_{FLAT}	Hi-Speed USB switches, V_{CC} = 3.0V, $V_{COMD\_}$ = 0V to V_{CC} (Note 6)		0.1		Ω
		SuperSpeed USB switches, V_{DD} = 3.0V, $I_{COM\_}$ = 15mA, $V_{NO\_}$ or $V_{NC\_}$= 0V (Notes 5, 6)		0.06	2	
Off-Leakage Current	$I_{COM(OFF)}$	Hi-Speed USB switches, V_{CC} = 5.5V, $V_{COMD\_}$ = 0V or 5.5V, $V_{NOD\_}$, $V_{NCD\_}$ = 5.5V or 0V	-250		+250	nA
		SuperSpeed USB switches, V_{DD} = 3.6V, $V_{COM\_}$ = 0V, 1.8V; $V_{NO\_}$ or $V_{NC\_}$ = 1.8V, 0V	-1		+1	µA
On-Leakage Current	$I_{COM(ON)}$	Hi-Speed USB switches, V_{CC} = 5.5V, $V_{COMD\_}$ = 0V or 5.5V, $V_{NOD\_}$, $V_{NCD\_}$ = unconnected	-250		+250	nA
		SuperSpeed USB switches, V_{DD} = 3.6V, $V_{COM\_}$ = 0V, 1.8V; $V_{NO\_}$ or $V_{NC\_}$ = $V_{COM\_}$ or unconnected	-1		+1	µA
AC PERFORMANCE						
On-Channel -3dB Bandwidth	BW	Hi-Speed USB switches, R_L = R_S = 50Ω, signal = 0dBm		950		MHz
On-Loss	G_{LOSS}	SuperSpeed USB switches, R_L = R_S = 50Ω, unbalanced; 1MHz < f < 100MHz		-0.5		dB
		SuperSpeed USB switches, R_L = R_S = 50Ω, unbalanced; 500MHz < f < 1.25GHz		-1.4		
Off-Isolation	V_{ISO}	Hi-Speed USB switches, $V_{NOD\_}$, $V_{NCD\_}$ = 0dBm, R_L = R_S = 50Ω, Figure 1; f = 10MHz		-48		dB
		Hi-Speed USB switches, $V_{NOD\_}$, $V_{NCD\_}$ = 0dBm, R_L = R_S = 50Ω, Figure 1; f = 250MHz		-20		
		Hi-Speed USB switches, $V_{NOD\_}$, $V_{NCD\_}$ = 0dBm, R_L = R_S = 50Ω, Figure 1; f = 500MHz		-17		
		SuperSpeed USB switches, signal = 0dBm, R_S = R_L = 50Ω; f = 10MHz		-56		
		SuperSpeed USB switches, signal = 0dBm, R_S = R_L = 50Ω; f = 1.25GHz		-26		

SuperSpeed USB Passive Switch (Low/Full/Hi/SuperSpeed)

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +3.0V to +5.5V, V_{DD} = +3.0V to +3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = V_{DD} = +3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Crosstalk (Note 7)	V_{CT}	Hi-Speed USB switches, $V_{NOD\_}$, $V_{NCD\_}$= 0dBm, R_L = R_S = 50Ω, Figure 1	f = 10MHz		-73		dB
			f = 250MHz		-54		
			f = 500MHz		-33		
		SuperSpeed USB switches, crosstalk between any two pairs, R_S = R_L = 50Ω, unbalanced, Figure 1	f = 50MHz		-53		
			f = 1.25GHz		-32		
Signaling Data Rate	BR	SuperSpeed USB switches, R_S = R_L = 50Ω			5.0		Gbps
LOGIC INPUT							
Input Logic-High	V_{IH}			1.4			V
Input Logic-Low	V_{IL}					0.5	V
Input Leakage Current	I_{IN}	Hi-Speed USB switches		-250		+250	nA
		SuperSpeed USB switches, V_{SEL2} = 0V or V_{DD}		-1		+1	µA
Input Logic Hysteresis	V_{HYST}	SuperSpeed USB switches			100		mV
DYNAMIC PERFORMANCE							
Turn-On Time	t_{ON}	Hi-Speed USB switches, $V_{NOD\_}$ or $V_{NCD\_}$ = 1.5V, R_L = 300Ω, C_L = 35pF, $V_{\overline{EN}}$ = V_{CC} to 0V, Figure 2			20	100	µs
		SuperSpeed USB switches, $V_{NO\_}$ or $V_{NC\_}$ = 1.0V, R_L = 50Ω, Figure 2			90	250	ns
Turn-Off Time	t_{OFF}	$V_{NOD\_}$ or $V_{NCD\_}$ = 1.5V, R_L = 300Ω, C_L = 35pF, $V_{\overline{EN}}$ = 0V to V_{CC}, Figure 2			1	5	µs
		SuperSpeed USB switches, $V_{NO\_}$ or $V_{NC\_}$ = 1.0V, R_L = 50Ω, Figure 2			10	50	ns
Propagation Delay	t_{PLH}, t_{PHL}	Hi-Speed USB switches, R_L = R_S = 50Ω, Figure 3			100		ps
		SuperSpeed USB switches, R_L = R_S = 50Ω			50		
Output Skew Between Switches	t_{SK}	Hi-Speed USB switches, skew between switch 1 and 2, R_L = R_S = 50Ω, Figure 3			40		ps
Output Skew Between Pairs	t_{SK1}	SuperSpeed USB switches, R_S = R_L = 50Ω, unbalanced; skew between any two pairs, Figure 3			50		ps
Output Skew Between Same Pair	t_{SK2}	SuperSpeed USB switches, R_S = R_L = 50Ω, unbalanced; skew between two lines on same pair, Figure 3			10		ps
Fault-Protection Response Time	t_{FP}	Hi-Speed USB switches, $V_{COMD\_}$ = 0V to 5V step, R_L = R_S = 50Ω, V_{CC} = 3.3V, Figure 4		0.5		5.0	µs

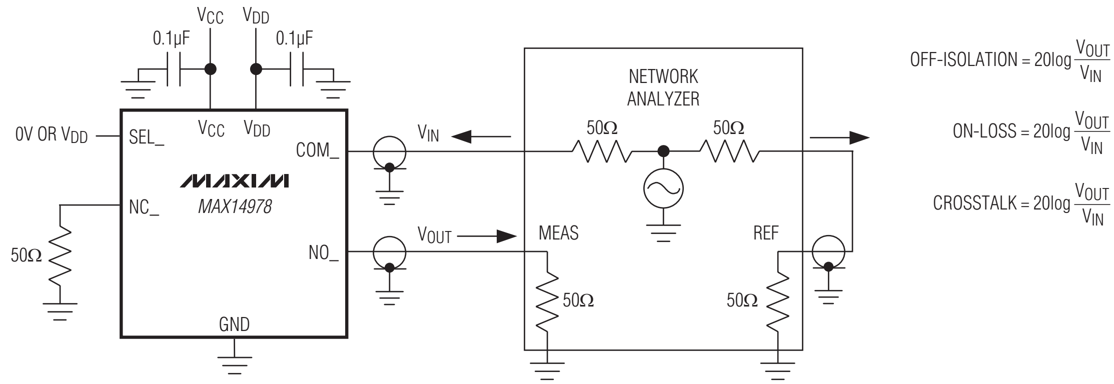
ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +3.0V to +5.5V, V_{DD} = +3.0V to +3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = V_{DD} = +3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Fault-Protection Recovery Time	t_{FPR}	Hi-Speed USB switches, $V_{COMD\_}$ = 5V to 0V step, R_L = R_S = 50Ω, V_{CC} = 3.3V, Figure 4			100	µs
NO_ or NC_ Off-Capacitance	$C_{NO(OFF)}$ or $C_{NC(OFF)}$	Hi-Speed USB switches, f = 1MHz, Figure 5		2		pF
		SuperSpeed USB switches, Figure 5		1		
COM_ Off-Capacitance	$C_{COM(OFF)}$	Hi-Speed USB switches, f = 1MHz, Figure 5		5.5		pF
		Hi-Speed USB switches, f = 240MHz, Figure 5		4.8		
COM_ On-Capacitance	$C_{COM(ON)}$	Hi-Speed USB switches, f = 1MHz, Figure 5		6.5		pF
		Hi-Speed USB switches, f = 240MHz, Figure 5		5.5		
		SuperSpeed USB switches, Figure 5		2		
Total Harmonic Distortion Plus Noise	THD+N	Hi-Speed USB switches, $V_{COMD\_}$ = $1V_{P-P}$, V_{BIAS} = 1V, R_L = R_S = 50Ω, f = 20Hz to 20kHz		0.03		%
ESD PROTECTION						
COMD+, COMD-		Human Body Model		±15		kV
		IEC 61000-4-2 Air Gap Discharge		±15		
		IEC 61000-4-2 Contact Discharge		±8		
COM0_, COM1_		Human Body Model		±6		kV
All Pins		Human Body Model		±2		kV

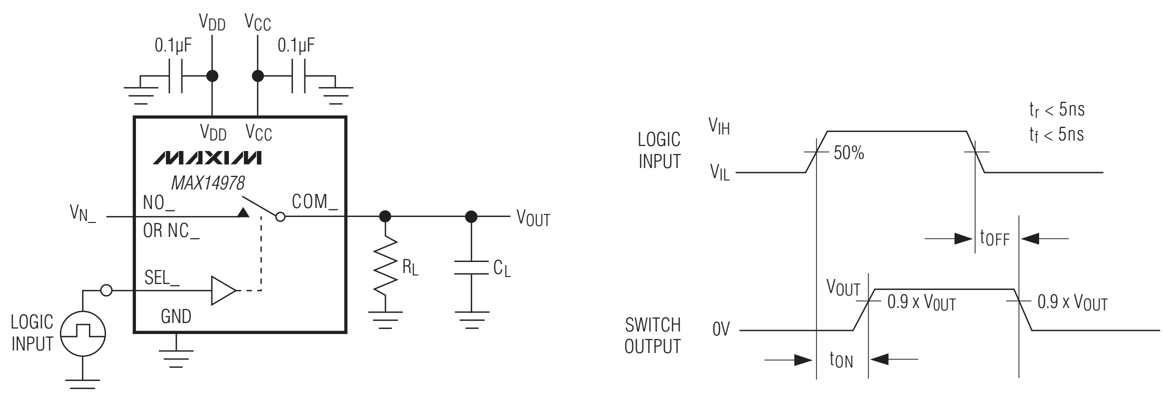
Note 2: All devices are 100% production tested at T_A = +25°C. All temperature limits are guaranteed by design.
Note 3: The switch turns off for voltages above V_{FP}, protecting downstream circuits in case of a fault condition.
Note 4: $\Delta R_{ON(MAX)} = |R_{ON(CH1)} - R_{ON(CH2)}|$.
Note 5: Guaranteed by design. Not production tested.
Note 6: Flatness is defined as the difference between the maximum and minimum value of on-resistance, as measured over specified analog-signal ranges.
Note 7: Between any two switches.

Test Circuits/Timing Diagrams



MEASUREMENTS ARE STANDARDIZED AGAINST SHORTS AT IC TERMINALS.
OFF-ISOLATION IS MEASURED BETWEEN COM_ AND "OFF" NO_ OR NC_ TERMINAL ON EACH SWITCH.
ON-LOSS IS MEASURED BETWEEN COM_ AND "ON" NO_ OR NC_ TERMINAL ON EACH SWITCH.
CROSSTALK IS MEASURED BETWEEN ANY TWO PAIRS.
SIGNAL DIRECTION THROUGH SWITCH IS REVERSED; WORST VALUES ARE RECORDED.

Figure 1. Off-Isolation, On-Loss, and Crosstalk



C_L INCLUDES FIXTURE AND STRAY CAPACITANCE.

$$V_{OUT} = V_{N\_}\left(\frac{R_L}{R_L + R_{ON}}\right)$$

$V_{N\_} = V_{NO\_}$ OR $V_{NC\_}$

Figure 2. Switching Time

Test Circuits/Timing Diagrams (continued)

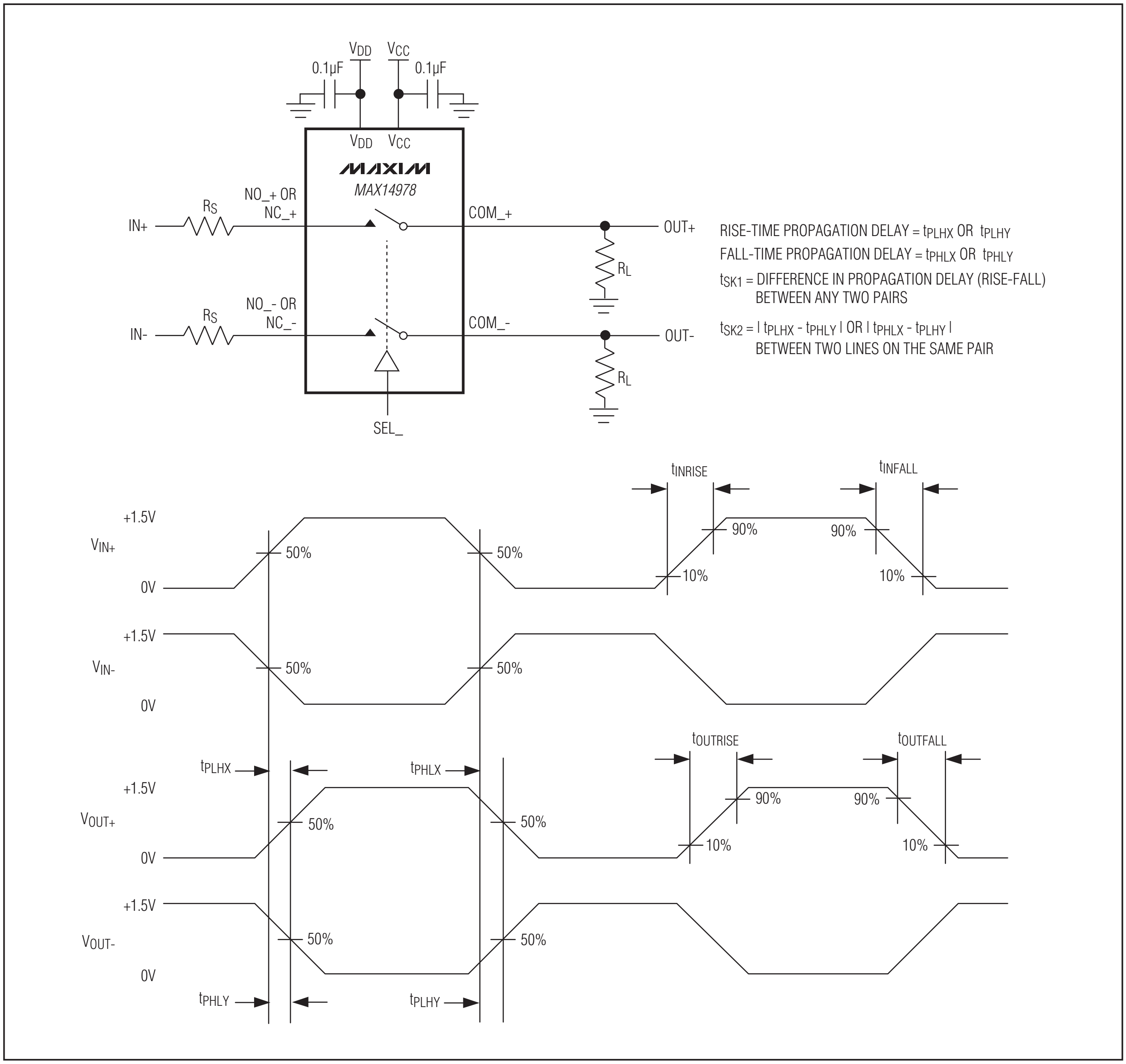


Figure 3. Propagation Delay, Output Skew

SuperSpeed USB Passive Switch (Low/Full/Hi/SuperSpeed)

Test Circuits/Timing Diagrams (continued)

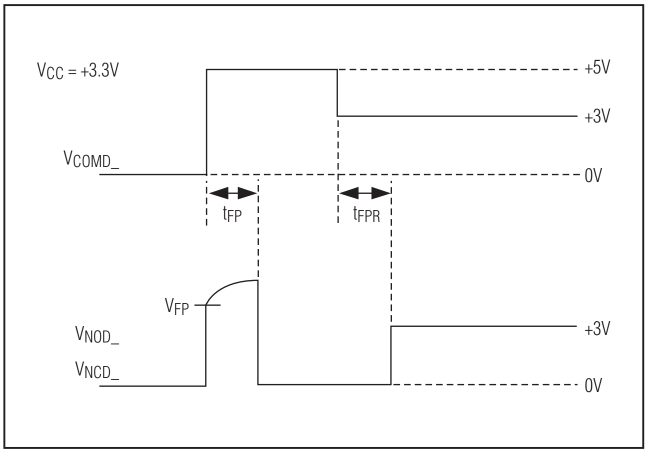


Figure 4. Fault Protection Response/Recovery Time

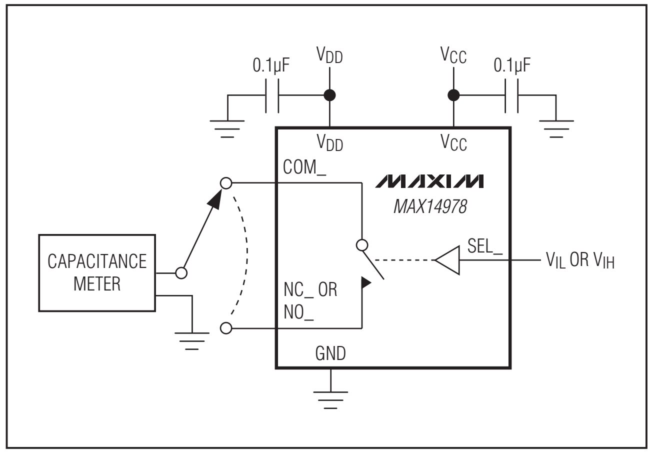
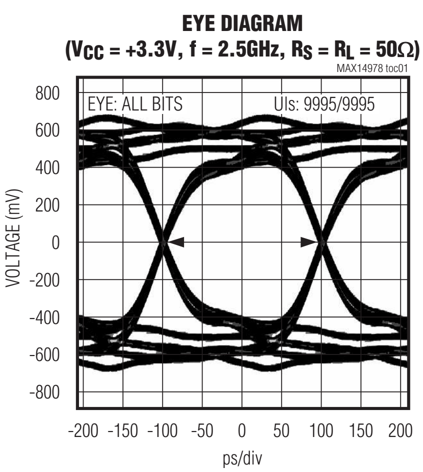
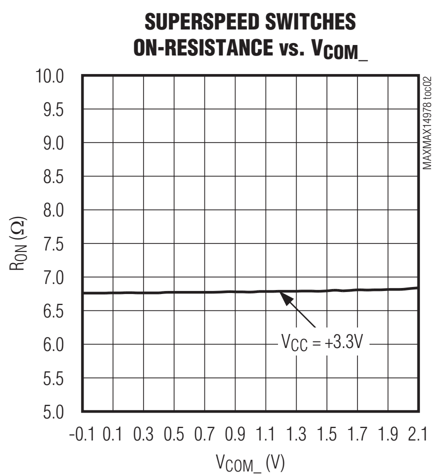


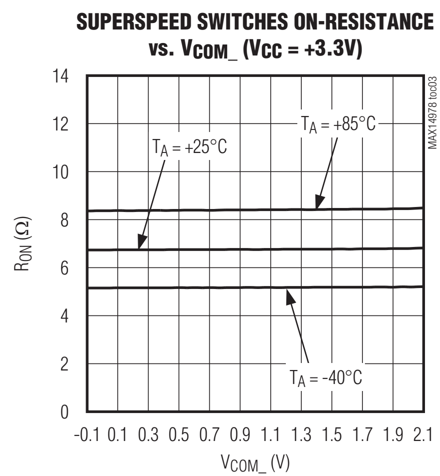
Figure 5. Channel Off-/On-Capacitance

Typical Operating Characteristics

(V_{CC} = V_{DD} = 3.3V, T_A = +25°C, unless otherwise noted.)



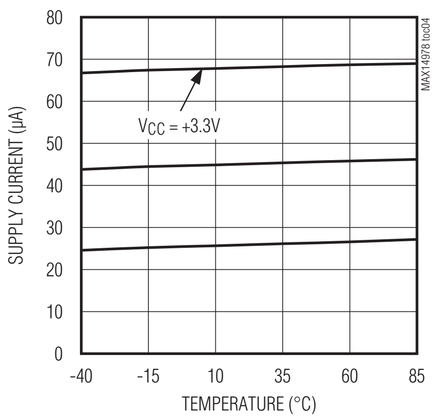




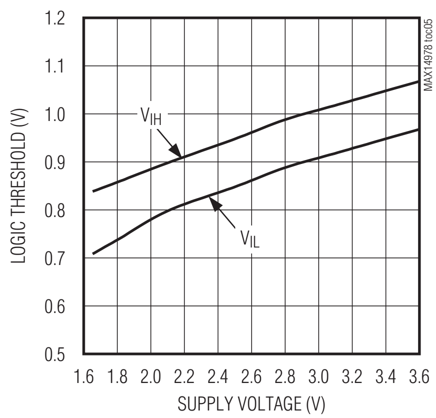
Typical Operating Characteristics (continued)

(V_{CC} = V_{DD} = 3.3V, T_A = +25°C, unless otherwise noted.)

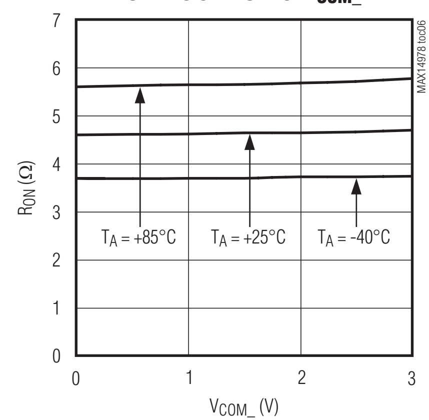
SUPERSPEED HI-SPEED SWITCHES SUPPLY CURRENT vs. TEMPERATURE



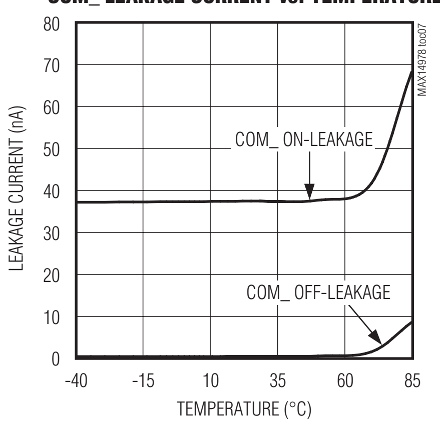
SUPERSPEED SWITCHES LOGIC-INPUT THRESHOLD vs. SUPPLY VOLTAGE



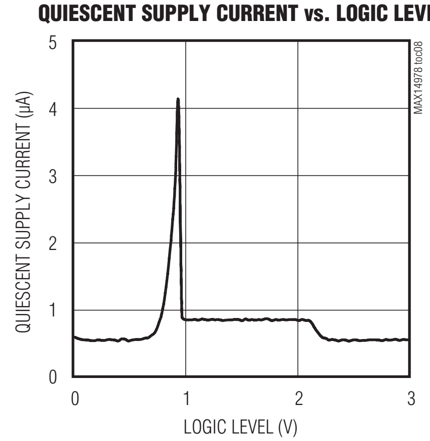
LOW/FULL/HI-SPEED SWITCHES ON-RESISTANCE vs. $V_{COM\_}$



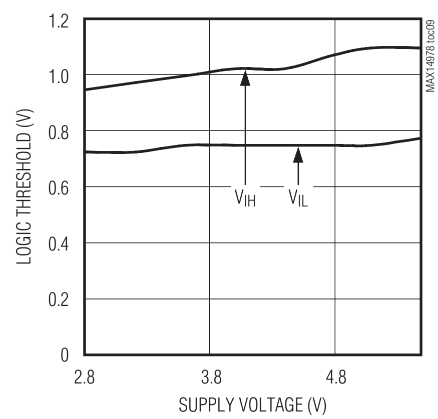
LOW/FULL/HI-SPEED SWITCHES COM_ LEAKAGE CURRENT vs. TEMPERATURE



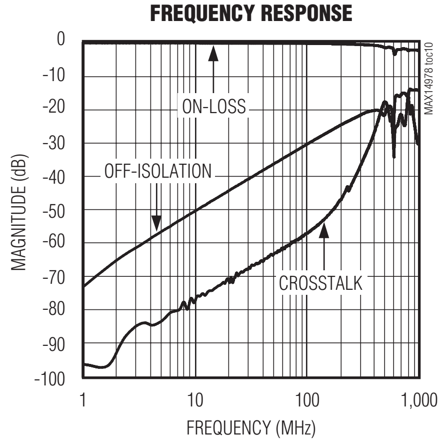
LOW/FULL/HI-SPEED SWITCHES QUIESCENT SUPPLY CURRENT vs. LOGIC LEVEL



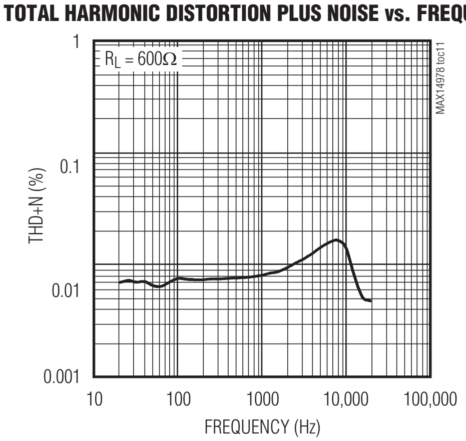
LOW/FULL/HI-SPEED SWITCHES LOGIC-INPUT THRESHOLD vs. SUPPLY VOLTAGE



LOW/FULL/HI-SPEED SWITCHES FREQUENCY RESPONSE

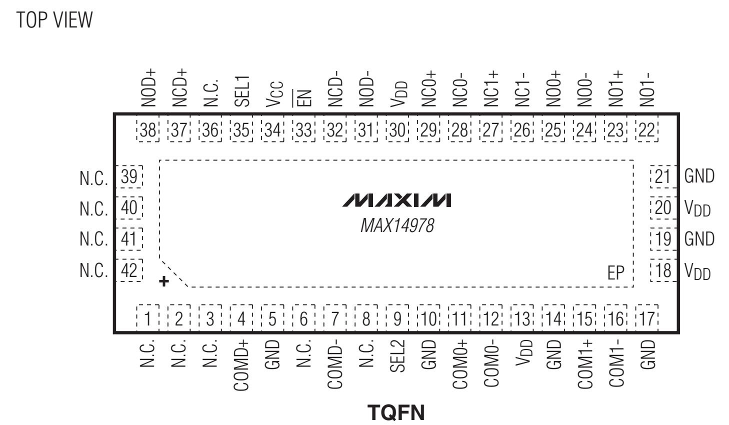


LOW/FULL/HI-SPEED SWITCHES TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



SuperSpeed USB Passive Switch (Low/Full/Hi/SuperSpeed)

Pin Configuration



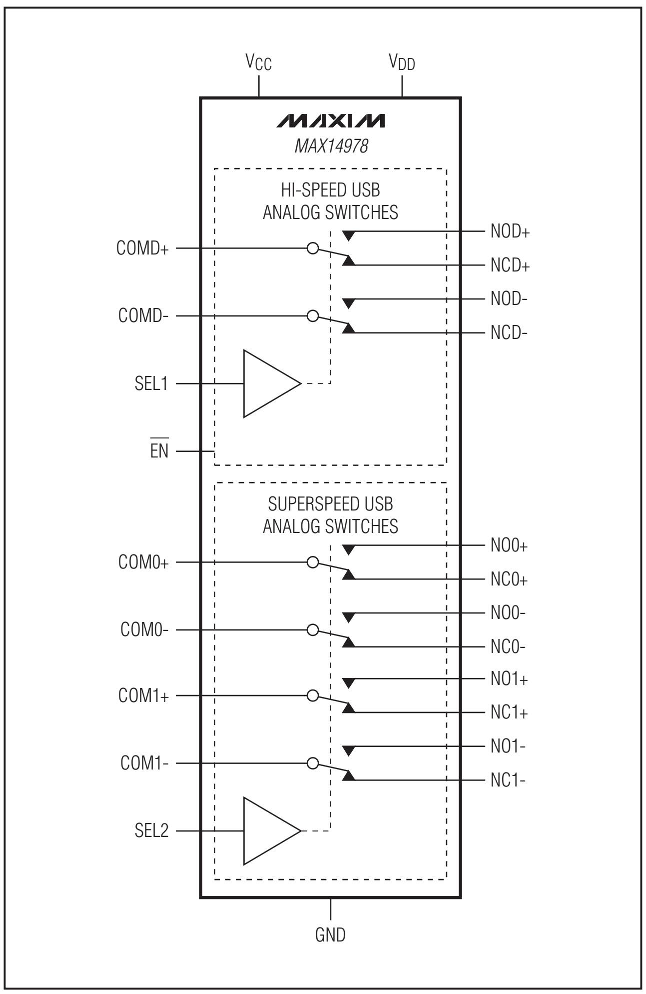
Pin Description

PIN	NAME	FUNCTION
1, 2, 3, 6, 8, 36, 39–42	N.C.	No Connection. Not internally connected.
4	COMD+	Hi-Speed USB Analog Switch, Common D+ Terminal
5, 10, 14, 17, 19, 21	GND	Ground
7	COMD-	Hi-Speed USB Analog Switch, Common D- Terminal
9	SEL2	Digital Control Input for SuperSpeed USB Analog Switches
11	COM0+	SuperSpeed USB Analog Switch 0, Common Positive Terminal
12	COM0-	SuperSpeed USB Analog Switch 0, Common Negative Terminal
13, 18, 20, 30	V_{DD}	Positive Supply Voltage Input for SuperSpeed USB Switches. Bypass V_{DD} to GND with a 0.1µF ceramic capacitor as close as possible to the device.
15	COM1+	SuperSpeed USB Analog Switch 1, Common Positive Terminal
16	COM1-	SuperSpeed USB Analog Switch 1, Common Negative Terminal
22	NO1-	SuperSpeed USB Analog Switch 1, Normally Open Negative Terminal
23	NO1+	SuperSpeed USB Analog Switch 1, Normally Open Positive Terminal
24	NO0-	SuperSpeed USB Analog Switch 0, Normally Open Negative Terminal
25	NO0+	SuperSpeed USB Analog Switch 0, Normally Open Positive Terminal
26	NC1-	SuperSpeed USB Analog Switch 1, Normally Closed Negative Terminal
27	NC1+	SuperSpeed USB Analog Switch 1, Normally Closed Positive Terminal
28	NC0-	SuperSpeed USB Analog Switch 0, Normally Closed Negative Terminal
29	NC0+	SuperSpeed USB Analog Switch 0, Normally Closed Positive Terminal
31	NOD-	Hi-Speed USB Analog Switch, Normally Open D- Terminal
32	NCD-	Hi-Speed USB Analog Switch, Normally Closed D- Terminal

Pin Description (continued)

PIN	NAME	FUNCTION
33	$\overline{EN}$	Active-Low Enable Input for Hi-Speed USB Switches. Drive $\overline{EN}$ high to put Hi-Speed USB switches in high impedance. Drive $\overline{EN}$ low for normal operation.
34	V_{CC}	Positive-Supply Voltage Input for Hi-Speed USB Switches. Bypass V_{CC} to GND with a 0.1µF ceramic capacitor as close as possible to the device.
35	SEL1	Digital Control Input for Hi-Speed USB Analog Switches
37	NCD+	Hi-Speed USB Analog Switch, Normally Closed D+ Terminal
38	NOD+	Hi-Speed USB Analog Switch, Normally Open D+ Terminal
—	EP	Exposed Pad. EP is internally connected to GND. Connect EP to a large ground plane to maximize thermal performance. EP is not intended as an electrical connection point.

Functional Diagram/Truth Table



HI-SPEED USB SWITCHES				
$\overline{EN}$	SEL1	NOD_	NCD_	COMD_
0	0	OFF	ON	—
0	1	ON	OFF	—
1	X	OFF	OFF	HIGH-Z

SUPERSPEED USB SWITCHES		
SEL2	NO_	NC_
0	OFF	ON
1	ON	OFF

SuperSpeed USB Passive Switch (Low/Full/Hi/SuperSpeed)

Detailed Description

The MAX14978 is ideal for SuperSpeed USB and low/full/Hi-Speed (1.5/12/480Mbps) USB switching applications. The low V_{IH} threshold of the device permits it to be used with logic levels as low as 1.4V. The device's Hi-Speed USB analog switches are based on a charge-pump-assisted n-channel architecture and operate with 36μA (typ) quiescent current. The device features dual digital control inputs (SEL_) to switch Hi-Speed USB and SuperSpeed USB signal paths separately.

Digital Control Inputs (SEL1, SEL2)

The device's provides dual digital control inputs (SEL1, SEL2) to select the signal path between the COM_ and NO_ or NC_ channels. Drive SEL1 and SEL2 rail-to-rail to minimize power consumption. See the *Functional Diagram/Truth Table*.

Analog-Signal Levels

The device's switches are bidirectional, allowing NO_, NC_, and COM_ to be configured as either inputs or outputs.

The Hi-Speed USB switches are equipped with a charge-pump-assisted n-channel architecture that allows the switch to pass analog signals that exceed V_{CC} up to the overvoltage fault-protection threshold. This allows USB signals that exceed V_{CC} to pass, allowing compliance with USB requirements for voltage levels.

The SuperSpeed USB switches accept signals on the COM_, NO_, and NC_ channels within a range of -0.1V to (V_{DD} - 1.2V). Signals on the COM_+ channels are routed to either the NO_+ or NC_+ channels, and signals on the COM_- channels are routed to either the NO_- or NC_- channels.

Overvoltage Fault Protection

The device features overvoltage fault protection on COMD_. Fault protection prevents these switches from being damaged due to shorts to the USB VBUS voltage rail. Fault protection protects the switch and USB transceiver from damaging voltage levels. When voltages on COMD_ exceed the fault-protection threshold (V_{FP}), COMD_, NCD_ and NOD_ are high impedance.

Enable Input

The device features a shutdown mode for the Hi-Speed USB analog switches that reduces the V_{CC} quiescent current to 0.1μA (typ) and places COMD+ and COMD- in high impedance. Drive $\overline{EN}$ high to place the Hi-Speed USB analog switches in shutdown mode, and drive $\overline{EN}$ low for normal operation.

Applications Information

USB Switching

The device's analog switches are fully compliant with the USB 2.0 and USB 3.0 specifications. The low on-resistance and low on-capacitance of these switches make them ideal for high-performance switching applications. The device is ideal for routing USB data lines and for applications that require switching between multiple USB hosts or devices. The device's Hi-Speed USB analog switches also feature overvoltage fault protection to guard systems against shorts to the USB VBUS voltage rail that is required for all Hi-Speed USB applications.

Extended ESD Protection

As with all Maxim devices, ESD protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. COMD+ and COMD- are further protected against static electricity. Maxim's engineers have developed state-of-the-art structures to protect these pins against ESD up to ±15kV without damage. The ESD structures withstand high ESD in normal operation and when the device is powered down. After an ESD event, the device continues to function without latchup.

The device is characterized for protection to the following limits:

- ±15kV using Human Body Model
- ±15kV using IEC 61000-4-2 Air Gap Discharge method
- ±8kV using IEC 61000-4-2 Contact Discharge method

Note: High ESD performance is only applicable to the Hi-Speed USB section of the switch. The SuperSpeed USB section is rated to ±6kV HBM.

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 6a shows the Human Body Model, and Figure 6b 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, which is then discharged into the test device through a 1.5kΩ resistor.

IEC 61000-4-2

The main difference between tests done using the Human Body Model 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 ESD test model (Figure 7a) the ESD-withstand voltage measured to this standard is generally lower than that measured using the Human Body Model. Figure 7b shows the current waveform for the ±8kV IEC 61000-4-2 Level 4 ESD Contact Discharge test.

The Air Gap Discharge test involves approaching the device with a charged probe. The Contact Discharge method connects the probe to the device before the probe is energized.

Layout

High-speed switches require proper layout and design procedures for optimum performance. Keep design-controlled impedance PCB traces as short as possible or follow impedance layouts per the SuperSpeed USB specification. Ensure that power-supply bypass capacitors are placed as close as possible to the device. Multiple bypass capacitors are recommended. Connect all grounds and the exposed pad to large ground planes where possible.

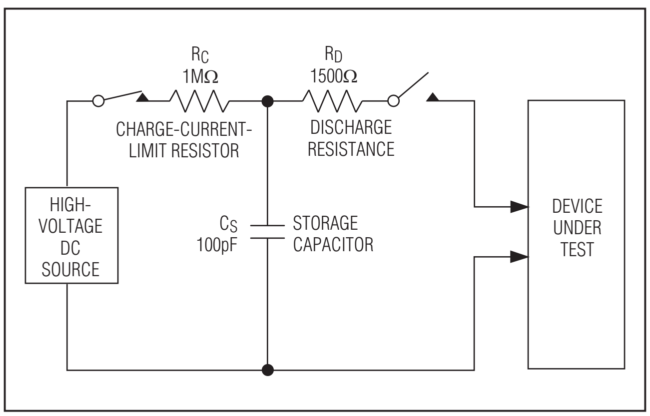


Figure 6a. Human Body ESD Test Model

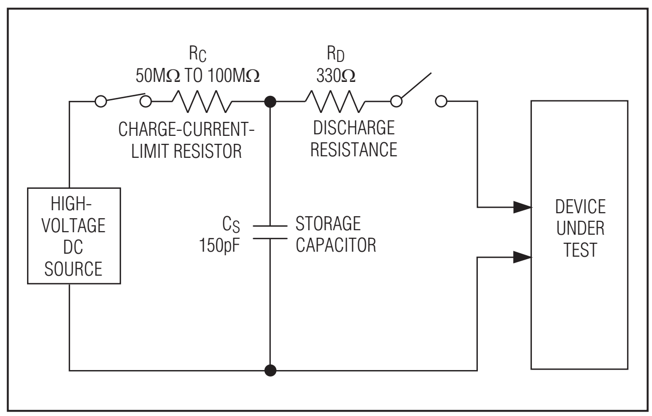


Figure 7a. IEC 61000-4-2 ESD Test Model

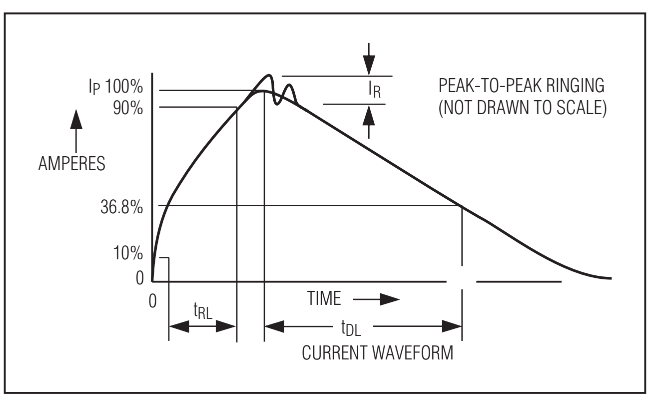


Figure 6b. Human Body Current Waveform

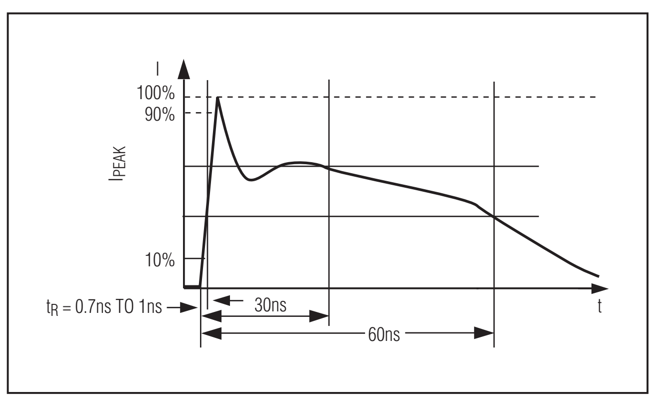


Figure 7b. IEC 61000-4-2 ESD Generator Current Waveform

SuperSpeed USB Passive Switch (Low/Full/Hi/SuperSpeed)

Power-Supply Sequencing

Caution: Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the device.

Proper power-supply sequencing is recommended for all CMOS devices. Always apply V_{CC} and V_{DD} before applying analog signals, especially if the analog signals are not current limited.

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.
42 TQFN-EP	T423590M+1	21-0181	90-0079

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/10	Initial release	—
1	4/11	Updated analog signal range specification in *Electrical Characteristics*	2