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March 2013

FSA321 — USB2.0 Hi-Speed (480Mbps) and Audio Switches with Negative Signal Capability and Built-in Termination on Unselected Audio Paths

Features

- Audio: 1.8Ω Typical On Resistance
- HS-USB: 8Ω Typical On Resistance
- HS-USB: 5pF Typical On Capacitance
- USB Path -3db Bandwidth: > 720MHz
- Negative Swing Capable Audio Channel
- Power-off Protection on Common D+/R, D-/L Ports
- Automatic USB Detection (Configurable)
- OVT on all I/O Ports
- Flow-Through Pin Out Eliminates PCB Vias
- Built-In Termination on Unselected Audio Paths to Inhibit Audio Pop

Applications

- MP3, Cell Phone, PDA, Digital Camera, and Notebook
- LCD Monitor, TV, and Set-Top Box

Description

The FSA321 is a Double-Pole, Double Throw (DPDT) multiplexer that combines a low-distortion audio and a USB2.0 High-Speed (HS) switch path. This configuration enables audio and USB data to share a common connector port. The architecture is designed to allow audio signals to swing below ground. This means a common USB and headphone jack can be used for personal media players and portable peripheral devices.

Since USB2.0 is an industry standard for shared data-path in portable devices, FSA321 can be configured for automatic V_{BUS} detection. The FSA321 includes a power-off feature as well as over-voltage tolerance to minimize current consumption when V_{SW} exceeds V_{CC}.

Typical applications involve switching in portables and consumer applications, such as cell phones, digital cameras, and notebooks with hubs or controllers.

.

Ordering Information

Part Number	Package Number	Top Mark	Package Description
FSA321UMX	MLP010A	GL	10-Lead Quad, Ultrathin Molded Leadless Package (MLP), 1.4 x 1.8mm

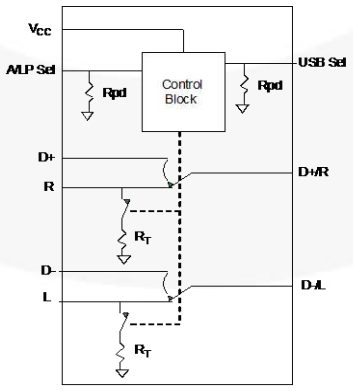


Figure 1. Analog Symbol

Pin Configuration

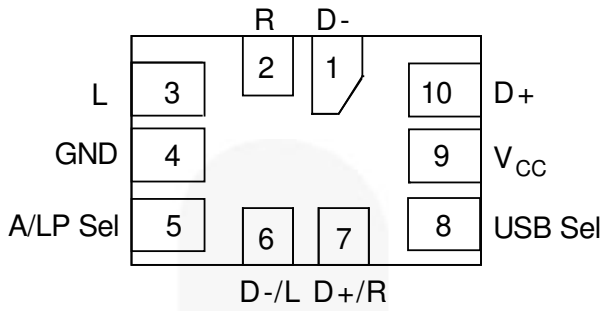


Figure 2. UMLP

Pin Definitions

Pin #	Name	Description
9	V_{CC}	Power supply
5	A/LP Sel	Audio Select Override and Power-Save Mode. This pin can be used to override USB Sel for applications where analog audio is transmitted on the USB D+, D- lines. This same select pin is used to put the FSA321 in low-power mode when USB Sel is LOW, not transmitting audio signals or USB data. The FSA321 has a weak internal pull-down, setting its default state to LOW and allowing this pin to float when not in use.
8	USB Sel	USB Path select pin. Can be connected to USB connector V_{BUS} pin for automatic USB detection.
10, 1	D+, D-	USB data bus input sources
2, 3	R, L	Audio right and left input sources
7, 6	D+/R, D-/L	USB and audio common connector ports

Truth Table

V_{CC}	USB Sel[1]	A/LP Sel	Audio Mode	USB Mode	Remarks
LOW			OFF	OFF	Disabled Inputs High-Z
HIGH[2]	HIGH[2]	LOW	OFF	ON	USB Communication
HIGH[2]	HIGH[2]	HIGH[2]	ON	OFF	Audio Override on USB
HIGH[2]	LOW	HIGH[2]	OFF	OFF	Low Power Mode
HIGH[2]	LOW	LOW	ON	OFF	Audio Out

Notes:

1. Forcing USB Sel HIGH when V_{BUS} is present allows for automatic USB detection.
2. HIGH is the threshold as defined to meet USB2.0 V_{CC} requirements and audio supply threshold in a system *(see DC Tables).*

Functional Description

The FSA321 is a combined USB and audio switch that enables sharing the D+/D- lines of a USB connector with stereo audio CODEC outputs. The USB Sel pin has an internal pull-down resistor that results in a default audio-mode configuration. The switch can be configured for auto USB detection by connecting the V_{BUS} pin to the USB Sel pin. The audio switch path also handles negative signals, eliminating the need for large coupling capacitors and greatly reducing the potential for audio pop. Termination resistors on the audio R and L ports are enabled when the switch is in USB mode, this also helps reduce audio pop when enabling the audio path.

The FSA321 allows for an audio override state by forcing A/LP Sel high when USB Sel is high. This is useful for USB car kit applications or if the device is in a cradle charger when “Send/End” is pressed.

Application Diagram

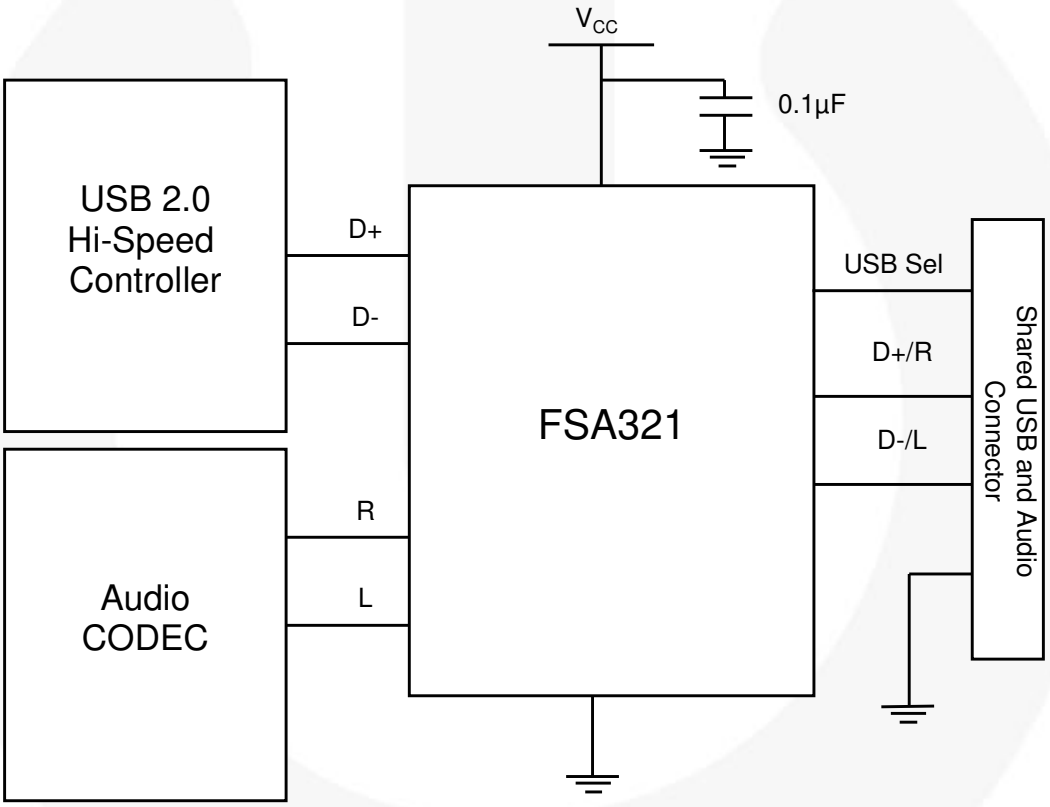


Figure 3. Typical Application Diagram

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter			Min.	Max.	Unit
V_{CC}	Supply Voltage			-0.5	4.6	V
USB Sel	USB Select Control Signal			-0.5	6.0	V
A/LP Sel	Power Save Mode Control Signal			-0.5	6.0	V
V_{SW}	Switch I/O Voltage[3]	USB Path Active		-1.0	4.6	V
		Audio Path Active		V_{CC}-4.6V	4.6	
	DC Switch I/O Voltage[3]	USB Path Active		-0.50	5.25	
		Audio Path Active				
I_{IK}	Input Clamp Diode Current				-50	mA
I_{SW}	Switch I/O Current (Continuous)	USB			50	mA
		Audio			100	mA
I_{SWPEAK}	Peak Switch Current (Pulsed at 1ms Duration, <10% Duty Cycle)	USB			100	mA
		Audio			250	mA
T_{STG}	Storage Temperature Range			-65	+150	°C
T_J	Maximum Junction Temperature				+150	°C
T_L	Lead Temperature (Soldering, 10 seconds)				+260	°C
ESD	Human Body Model, JEDEC: JESD22-A114	I/O to GND		11		kV
		All Other Pins		8		
		VCC to GND		12		
	Charged Discharge Model, JEDEC: JESD22-C101			2		
	IEC61000-4-2 System	USB Connection Pins (D+/R, D-/L, V_{BUS})	Air Gap	15		
			Contact	8		

Note:

3. The input and output negative ratings may be exceeded if the input and output diode current ratings are observed.

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter		Min.	Max.	Units
V_{CC}	Supply Voltage		1.8	4.3	V
USB Sel	USB Select Control Signal		0	5.5	V
A/LP Sel	Power-Save Mode Control Signal		0	5.5	V
V_{SW}	Switch I/O Voltage	USB Path Active	0	4.3	V
		Audio Path Active	V_{CC}-4.3V	4.3	V
T_A	Operating Temperature		-40	+85	ºC
Θ_{JA}	Thermal Resistance (Free Air)	UMLP		284	ºC/W

DC Electrical Characteristics

All typical values are at 25ºC unless otherwise specified.

Symbol	Parameter	V_{CC} (V)	Conditions	T_A = - 40 to +85°C			Unit
				Min.	Typ.[6]	Max.	
Common Pins							
V_{IK}	Clamp Diode Voltage	1.8 to 4.3	I_{IK} = -18mA			-1.2	V
V_{IH}	Control Input Voltage HIGH	1.8 to 2.7		1.0			
		2.7 to 4.3		1.2			
V_{IL}	Control Input Voltage LOW	1.8 to 2.7				0.3	
		2.7 to 4.3				0.5	
I_{IN}	USB Sel and A/LP Sel Input Current	1.8 to 4.3	V_{IN} = 0V	-1		1	µA
			V_{IN} = 5.5V	-1		10	
I_{OFF}	Power Off Leakage Current	0	D+/R, D-/L Common Ports, V_{SW} = 0V to 5.5V, All other Pins = 0V			25	µA
R_{PD}	A/LP Sel and USB Sel Internal Pull-Down Resistors	1.8 to 4.3			3		MΩ
R_T	Audio Path Termination Resistors	1.8 to 4.3			200		Ω
USB Switch Path							
	USB Analog Signal Range	1.8 to 4.3		0		4.3	V
R_{ONUSB}	HS Switch On Resistance[4]	1.8 to 4.3	$V_{D+/D-}$ = 0V, 0.4V, I_{ON} = 8mA		8	11	Ω
ΔR_{ONUSB}	HS Delta R_{ON}[5,6]	1.8 to 4.3	$V_{D+/D-}$ = 0V, I_{ON} = 8mA		0.4		Ω
Audio Switch Path							
	Audio Analog Signal Range	1.8 to 4.3		V_{CC}-4.3V		V_{CC}	V
$R_{ONAudio}$	Audio Switch On Resistance	2.7	$V_{L/R}$ = -1.0V, 0V, 1.0V I_{ON} = 60mA		1.8	2.7	Ω
$\Delta R_{ONAudio}$	Audio Delta R_{ON}[5]	2.7 to 4.3	$V_{L/R}$ = 0.7V I_{ON} = 60mA		0.4		Ω
$R_{FLAT(Audio)}$	Audio R_{ON} Flatness[7]	2.7 to 4.3	I_{ON} = 60mA		0.8	1.5	Ω
Total Switch Current Consumption							
I_{CC}	USB Active Mode Supply Current	1.8 to 4.3	A/LP Sel = LOW, USB Sel= HIGH, I_{OUT} = 0		0.5	0.8	mA
I_{CC_LPM}	USB Low Power Mode or Audio Mode Quiescent Supply Current	1.8 to 4.3	A/LP Sel = HIGH, V_{CC} = 1.8-4.3V		10	15	µA
I_{CCT}	Increase in I_{CC} current per control voltage and V_{CC} LOW POWER Mode A/LP Sel HIGH	4.3	$V_{USB\ Sel}$ = 2.6V		10	15	µA
			$V_{USB\ Sel}$ = 1.8V		15	20	
	Increase in I_{CC} current per control voltage and V_{CC} ACTIVE Mode A/LP Sel LOW		$V_{USB\ Sel}$ = 2.6V		0.6	0.9	mA
			$V_{USB\ Sel}$ = 1.8V		0.65	1.00	

Notes:

4. On resistance is determined by the voltage drop between the A and B pins at the indicated current through the switch.
5. $\Delta R_{ON} = R_{ON\ max} - R_{ON\ min}$ measured at identical V_{CC}, temperature, and voltage. Worst-case signal path, audio or USB channel, is characterized.
6. Guaranteed by characterization, not production tested.
7. Flatness is defined as the difference between the maximum and minimum values of on resistance over the specified range of conditions.

AC Electrical Characteristics

All typical value are for V_{CC} = 3.3V at 25ºC unless otherwise specified.

Symbol	Parameter	V_{CC} (V)	Conditions	T_A = - 40 to +85°C			Unit
				Min.	Typ.[8]	Max.	
t_{PDUSB}	USB Switch Propagation Delay[8]	3.3	R_L = 50Ω, C_L = 0pF Figure 9		0.25		ns
$Xtalk_A$	Non-Adjacent Channel Crosstalk (Audio Mode)	3.3	f = 20kHz, R_T = 32Ω, C_L = 0pF, Figure 17		-110		dB
	Non-Adjacent Channel Crosstalk (USB Mode)	3.3	f = 240MHz, R_T = 20Ω, C_L = 0pF Figure 17		-45		dB
O_{IRR}	Off Isolation (Audio Mode)	3.3	f = 20kHz, R_T = 32Ω, C_L = 0pF		-85		dB
	Off Isolation (USB Mode)	3.3	f = 240MHz, R_T = 20Ω, C_L = 0pF		-40		dB
BW	-3db Bandwidth (USB Mode)	3.3	R_T = 50Ω, C_L = 0pF, Signal 0dBm, Figure 15		720		MHz
THD	Total Harmonic Distortion (Audio Mode)	3.3	f = 20Hz to 20kHz, R_L = 32Ω, V_{IN} = $2V_{PP}$ Figure 14		0.11		%
SNR	Signal-to-Noise Ratio (Audio Mode)	3.3	f = 20Hz to 20kHz R_L = 32Ω, V_{IN} = $2V_{PP}$		-90		dB

Note:

8. Guaranteed by characterization, not production tested.

USB High-Speed-Related AC Electrical Characteristics

Symbol	Parameter	V_{CC} (V)	Conditions	T_A = - 40°C to +85°C			Unit
				Min.	Typ.	Max.	
$t_{SK(o)}$	Channel-to-Channel Skew[9] (USB Mode)	3.3	$t_R = t_F$ = 750ps (10-90%) at 240MHz C_L = 0pF, R_L = 50Ω Figure 11		35		ps
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output[9] (USB Mode)	3.3	$t_R = t_F$ = 750ps (10-90%) at 240MHz C_L = 0pF, R_L = 50Ω Figure 10		35		ps
t_J	Total Jitter[9] (USB Mode)	3.3	R_L = 50Ω, C_L = 50pF, $t_R = t_F$ = 500ps (10-90%) at 480Mbps (PRBS = $2^{15} - 1$)		130		ps

Note:
9. Guaranteed by characterization, not production tested.

Capacitance

Symbol	Parameter	V_{CC} (V)	Conditions	T_A = - 40°C to +85°C			Unit
				Min.	Typ.	Max.	
C_{IN}	Control Pin Input Capacitance	1.8 to 4.3	V_{Bias} = 0.2V		2.0		pF
$C_{ON(D+/R, D-/L)}$	D+/R, D-/L On Capacitance (USB Mode)	1.8 to 4.3	V_{Bias} = 0.2V, f = 240MHz, Figure 13		5.4		pF
		1.8 to 5.5	V_{Bias} = 0.2V, f = 1MHz, Figure 13		6.0		pF
$C_{OFF(D+, D-)}$	USB Path Off Capacitance	1.8 to 4.3	f = 1MHz, Figure 12		1.6		pF
$C_{OFF(R/L)}$	Audio Path Off Capacitance	1.8 to 4.3	f = 1MHz, Figure 12		3.5		pF

Test Diagrams

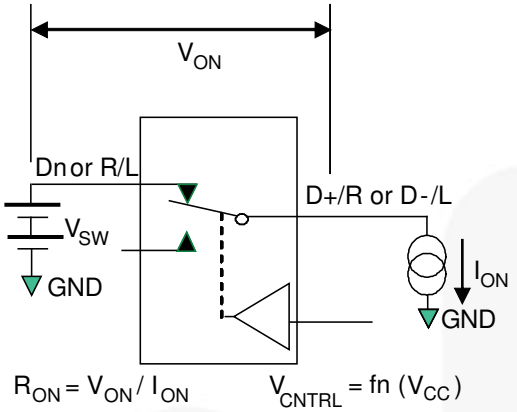


Figure 4. On Resistance

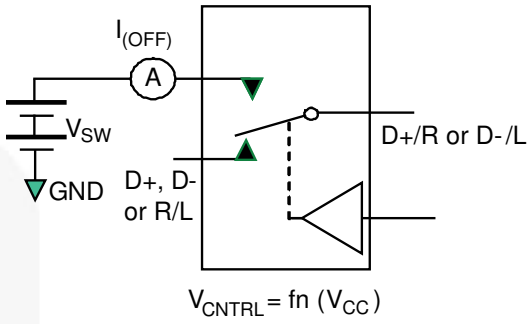


Figure 5. Off Leakage

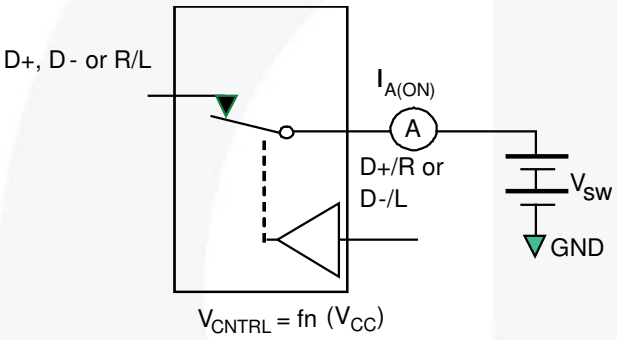
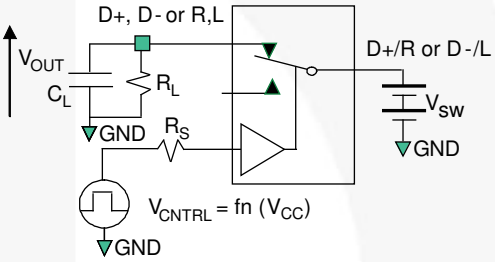


Figure 6. On Leakage



R_L, R_S, and C_L, are functions of the application environment (see tables for specific values). C_L includes test fixture and stray capacitance.

Figure 7. AC Test Circuit Load

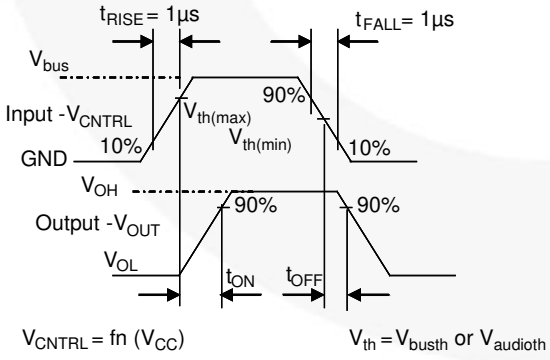


Figure 8. Turn-On / Turn-Off Waveforms (USB/Audio)

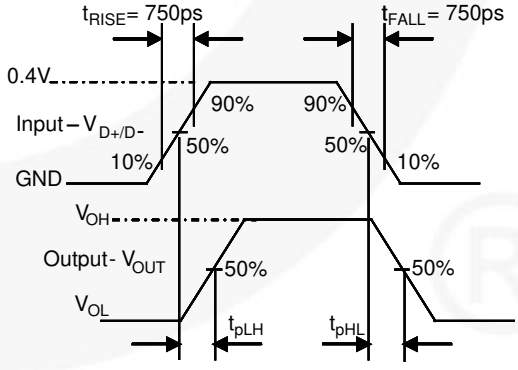


Figure 9. USB Switch Propagation Delay Waveforms

Test Diagrams (Continued)

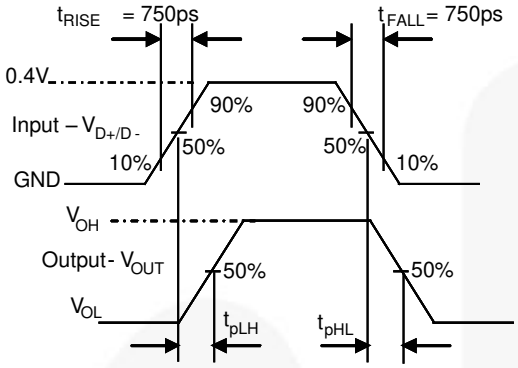


Figure 10. Pulse Skew: $t_{SK(P)} = | t_{PHL} - t_{PLH} |$

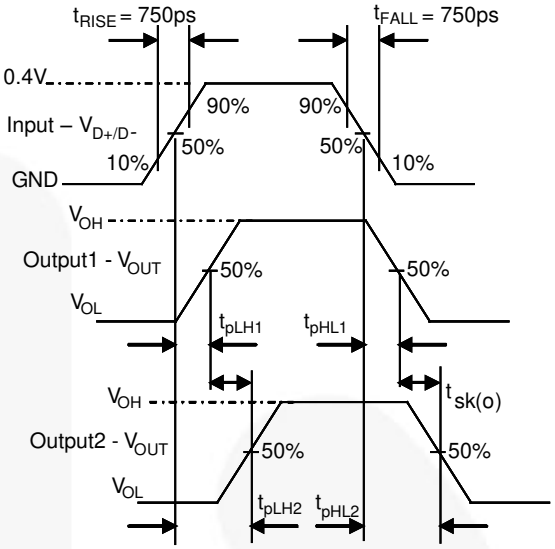


Figure 11. Output Skew: $t_{SK(O)} = | t_{PLH1} - t_{PLH2} |$ or $| t_{PHL1} - t_{PHL2} |$

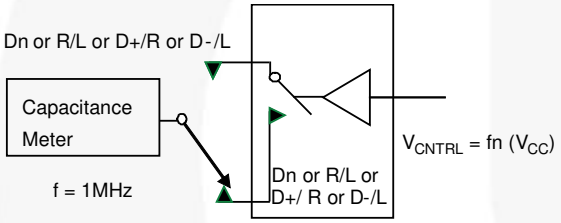


Figure 12. Channel Off Capacitance

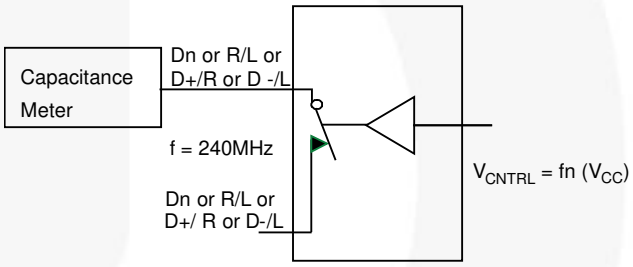
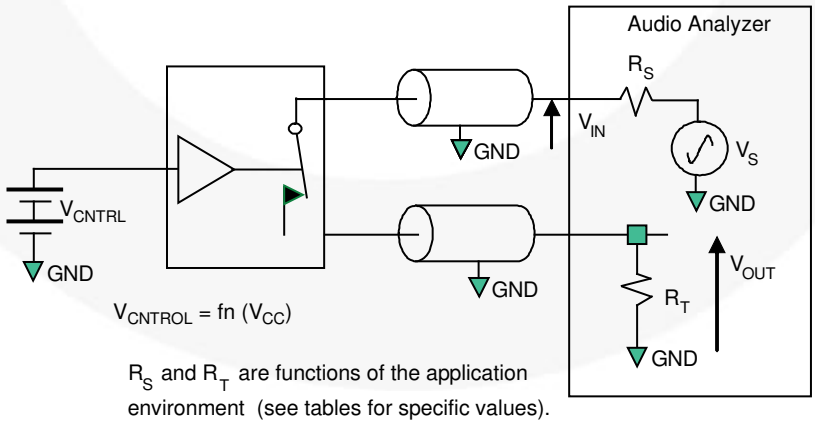


Figure 13. Channel On Capacitance



R_S and R_T are functions of the application environment (see tables for specific values).

Figure 14. Total Harmonic Distortion

Test Diagrams (Continued)

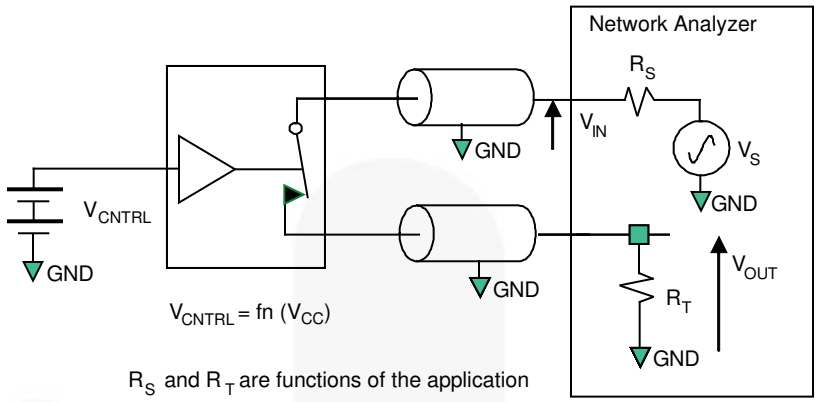


Figure 15. USB Bandwidth

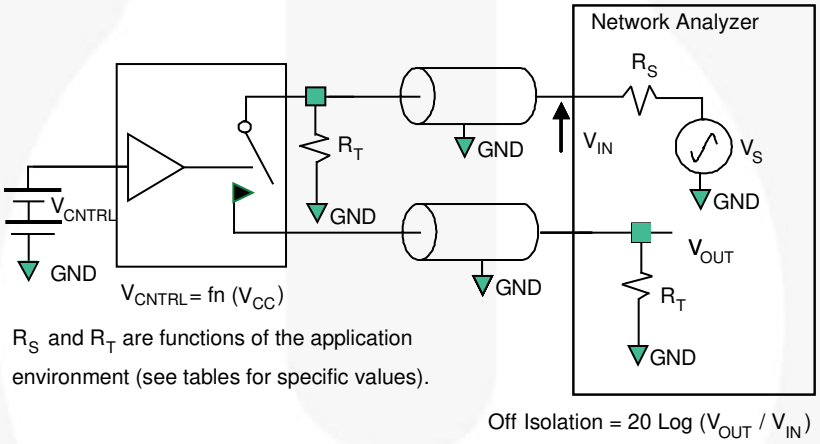


Figure 16. Channel Off Isolation

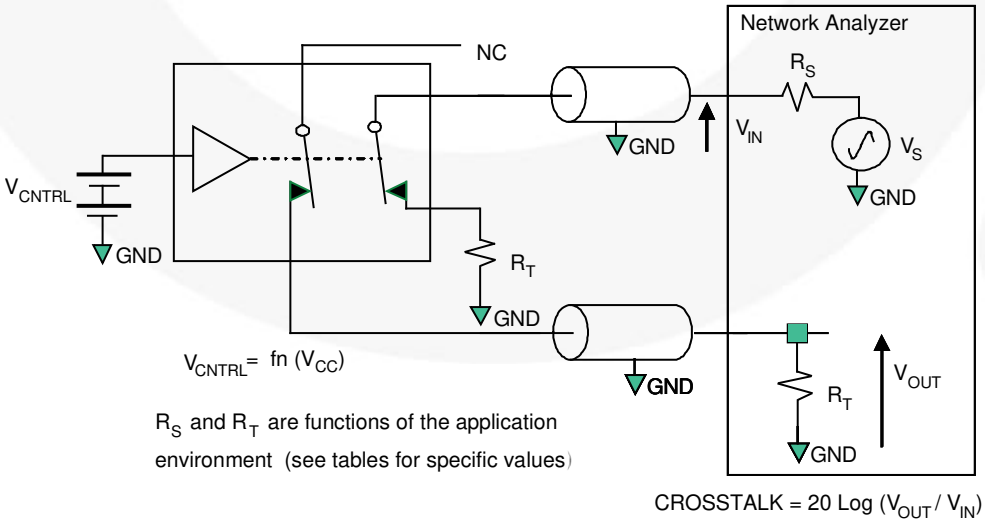
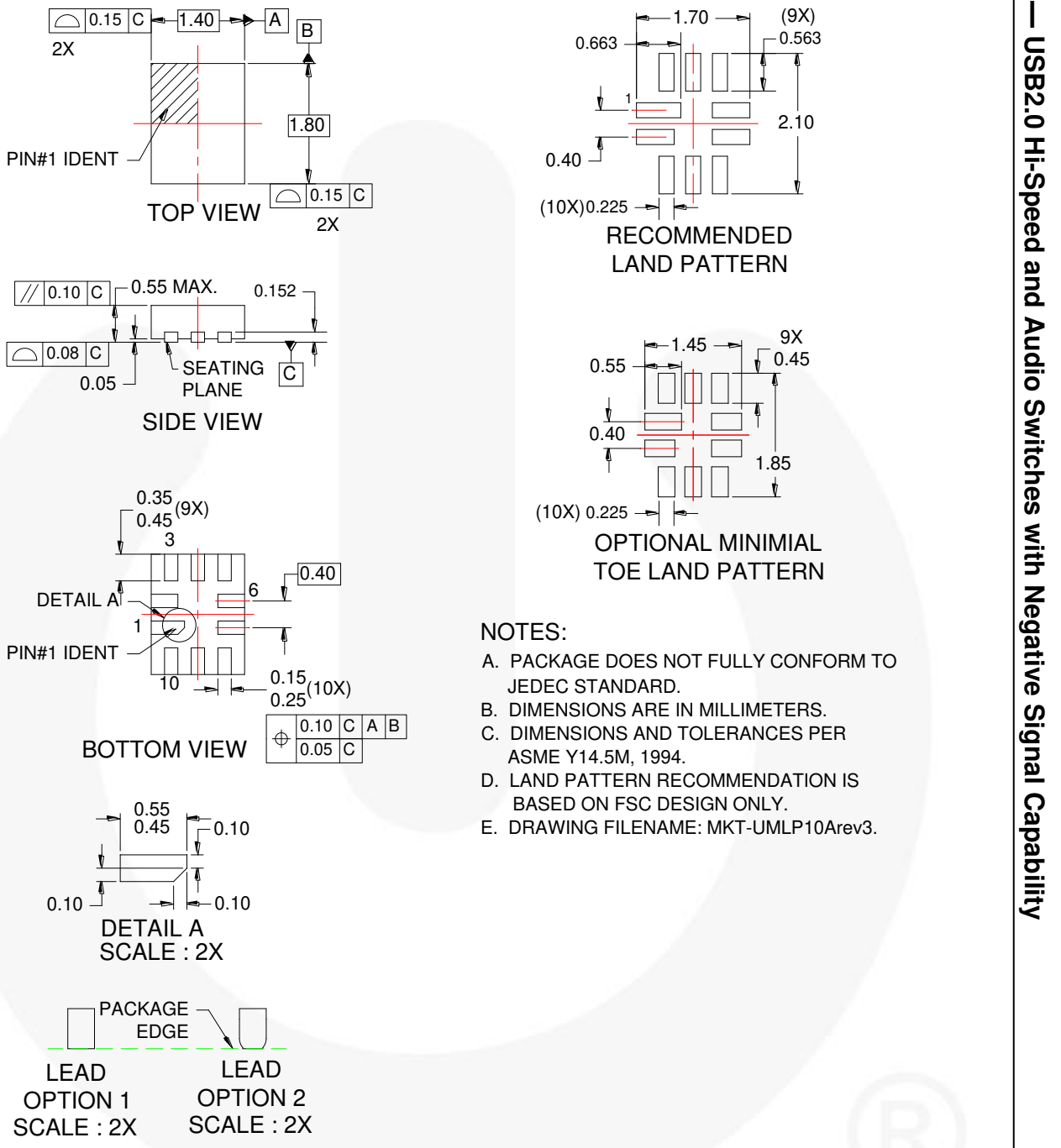


Figure 17. Non-Adjacent Channel-to-Channel Crosstalk

Physical Dimensions



NOTES:

A. PACKAGE DOES NOT FULLY CONFORM TO JEDEC STANDARD.
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
D. LAND PATTERN RECOMMENDATION IS BASED ON FSC DESIGN ONLY.
E. DRAWING FILENAME: MKT-UMLP10Arev3.

Figure 18. 10-Lead, Quad Ultrathin Molded Leadless Package (UMLP)

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TinyCalc™
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As used herein:

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PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

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