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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

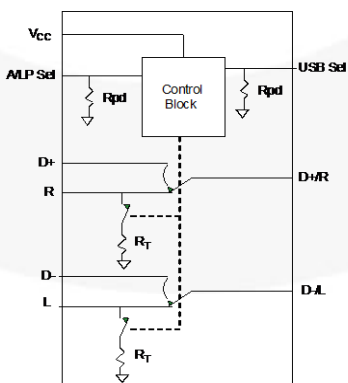


Figure 1. Analog Symbol

Pin Configuration

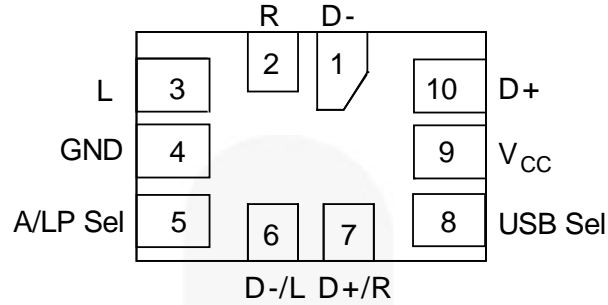


Figure 2. UMLP

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

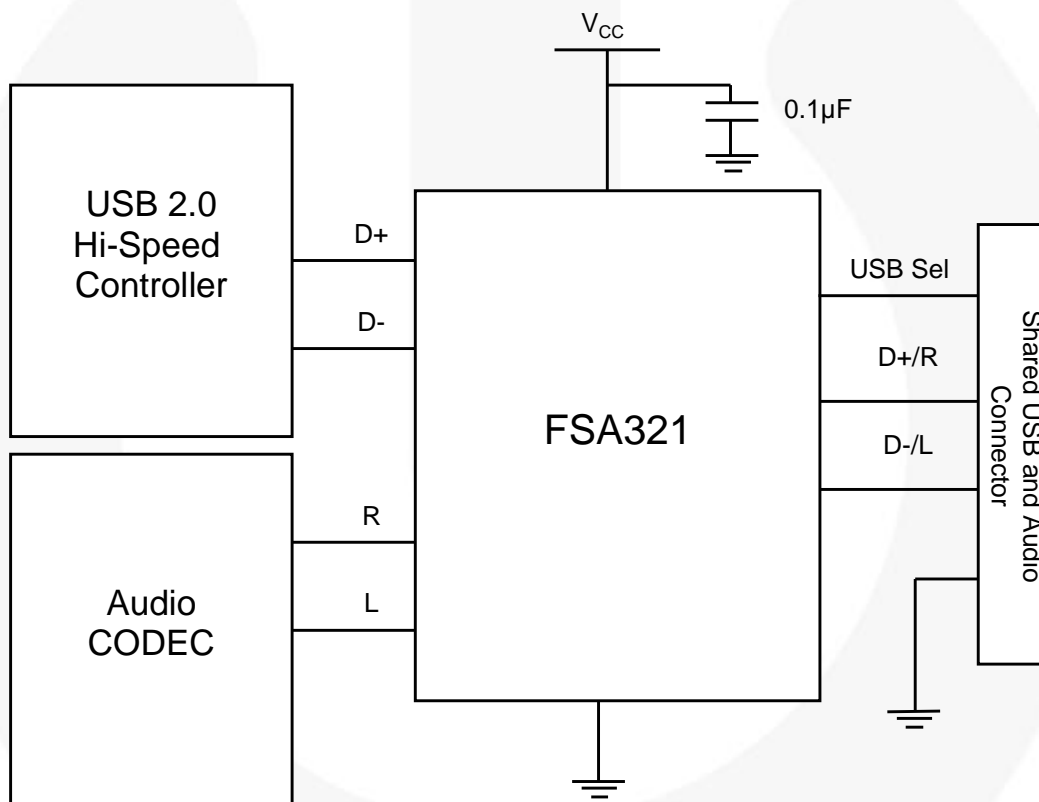


Figure 3. Typical Application Diagram

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:

- 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	°C
Θ _{JA}	Thermal Resistance (Free Air)	UMLP		284	°C/W

DC Electrical Characteristics

All typical values are at 25°C 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
ΔR _{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 _{CCCT}	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:

- On resistance is determined by the voltage drop between the A and B pins at the indicated current through the switch.
- Δ 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.
- Guaranteed by characterization, not production tested.
- 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 $25^{\circ}C$ unless otherwise specified.

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

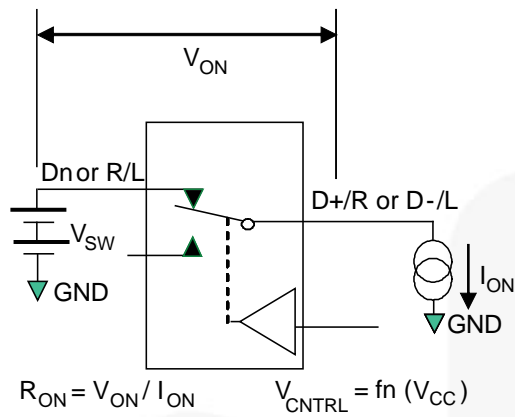


Figure 4. On Resistance

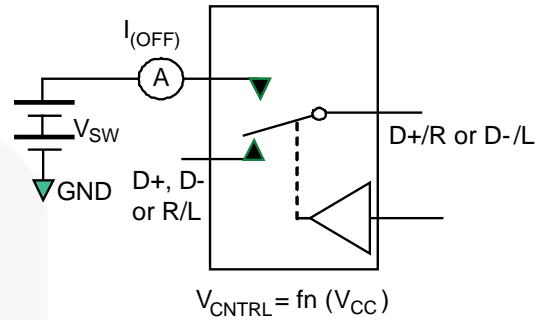


Figure 5. Off Leakage

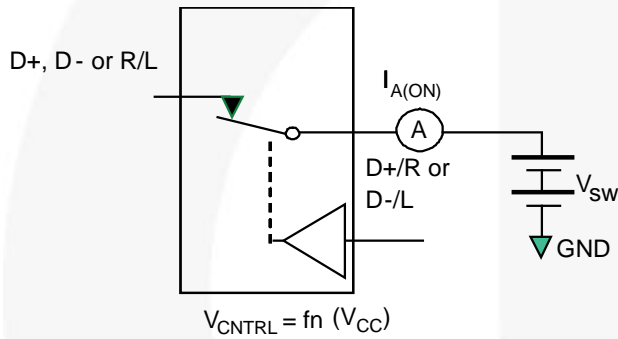


Figure 6. On Leakage

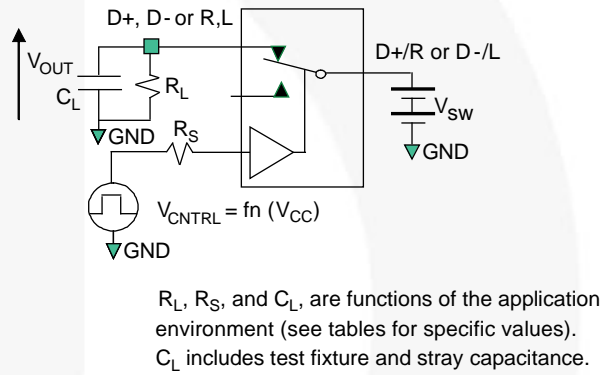


Figure 7. AC Test Circuit Load

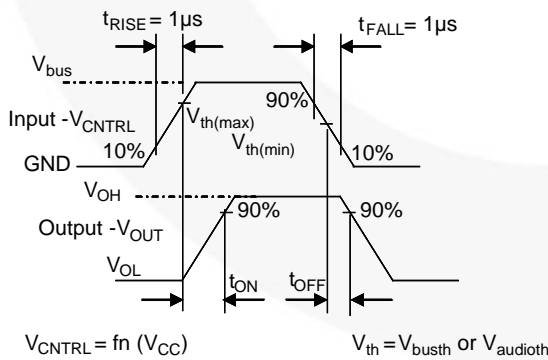


Figure 8. Turn-On / Turn-Off Waveforms (USB/Audio)

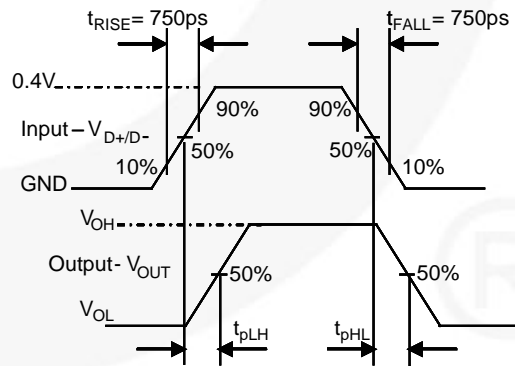


Figure 9. USB Switch Propagation Delay Waveforms

Test Diagrams (Continued)

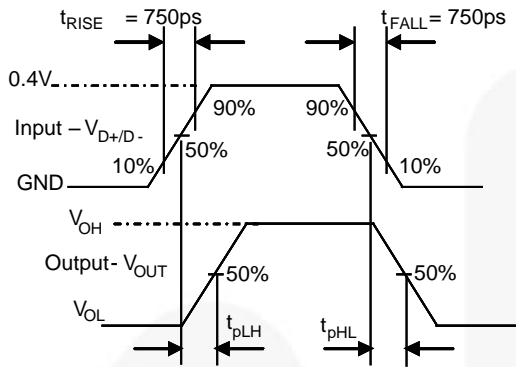


Figure 10. Pulse Skew: $t_{SK(P)} = |t_{pHL} - t_{pLH}|$

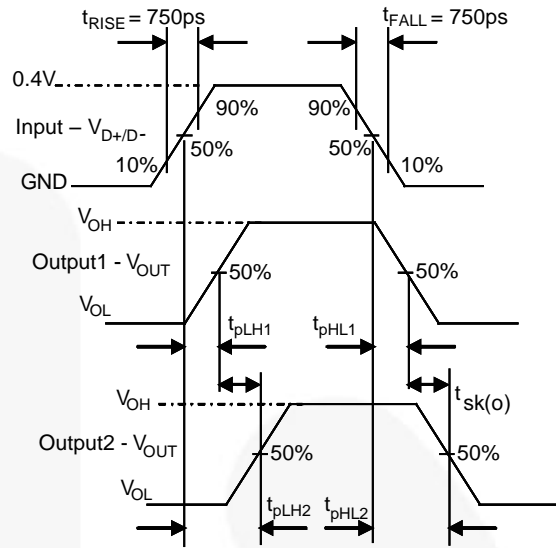


Figure 11. Output Skew: $t_{SK(O)} = |t_{pLH1} - t_{pLH2}|$
or $|t_{pHL1} - t_{pHL2}|$

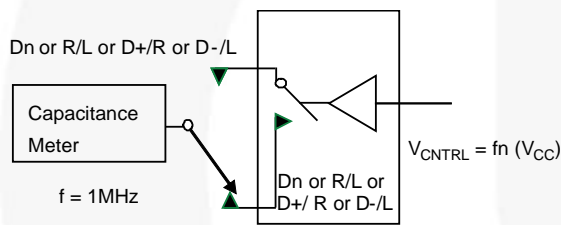


Figure 12. Channel Off Capacitance

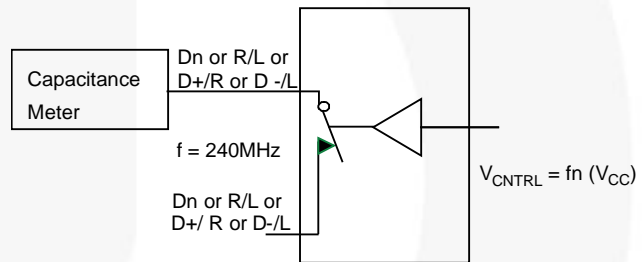


Figure 13. Channel On Capacitance

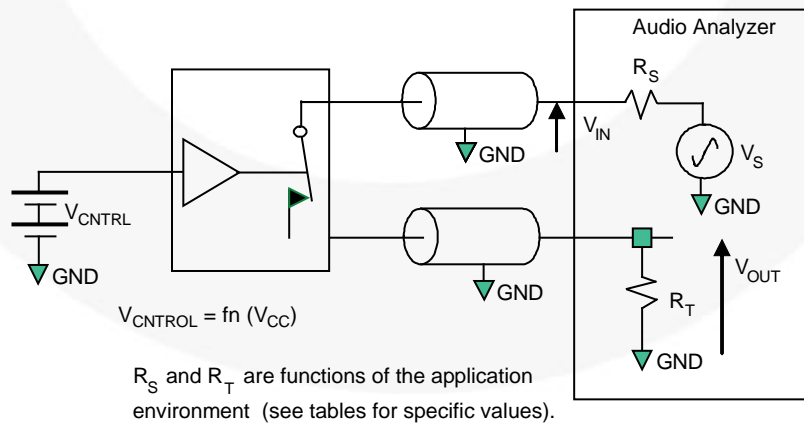


Figure 14. Total Harmonic Distortion

Test Diagrams (Continued)

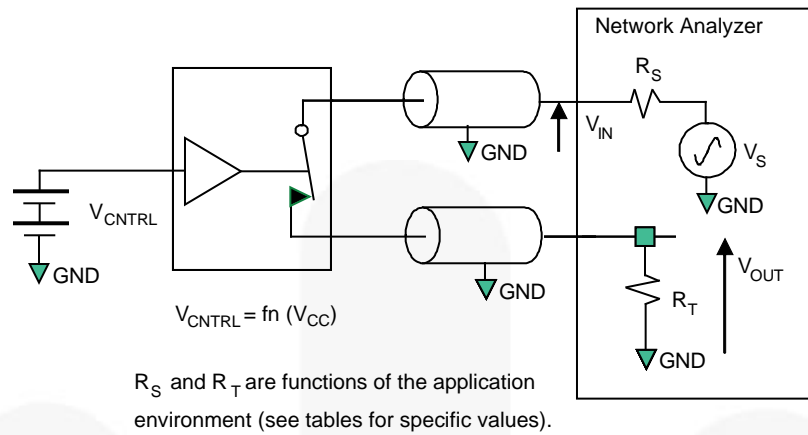


Figure 15. USB Bandwidth

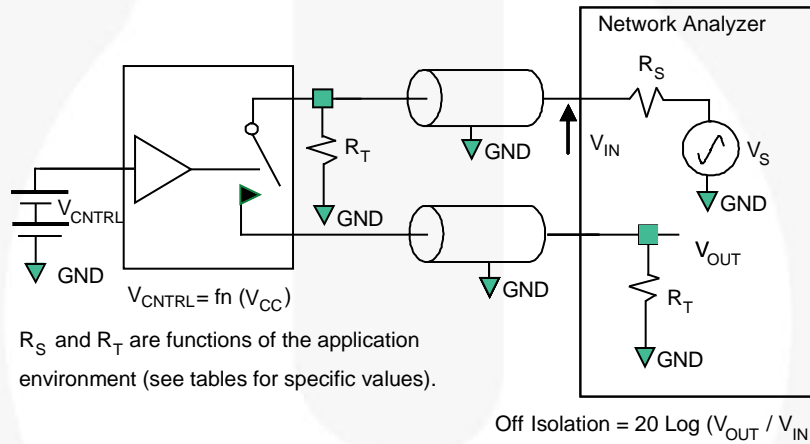


Figure 16. Channel Off Isolation

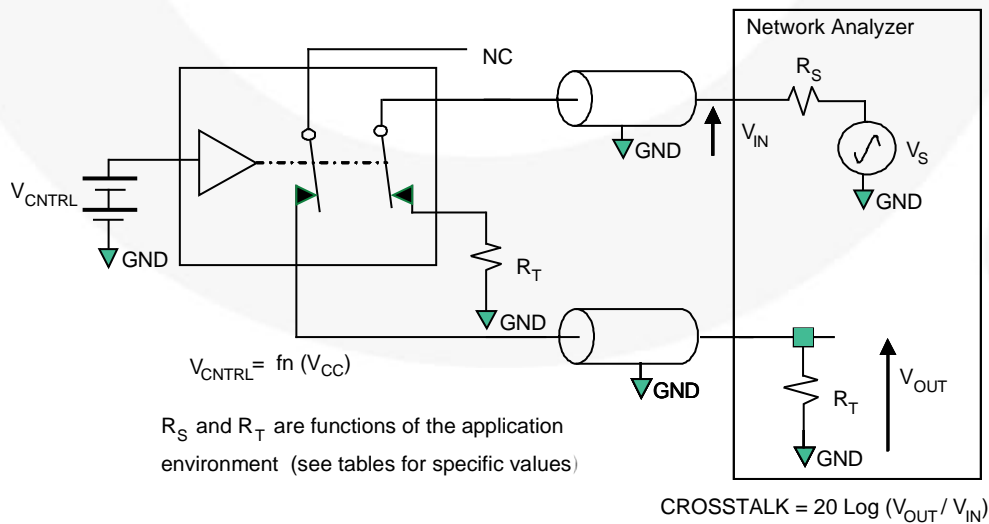


Figure 17. Non-Adjacent Channel-to-Channel Crosstalk

Physical Dimensions

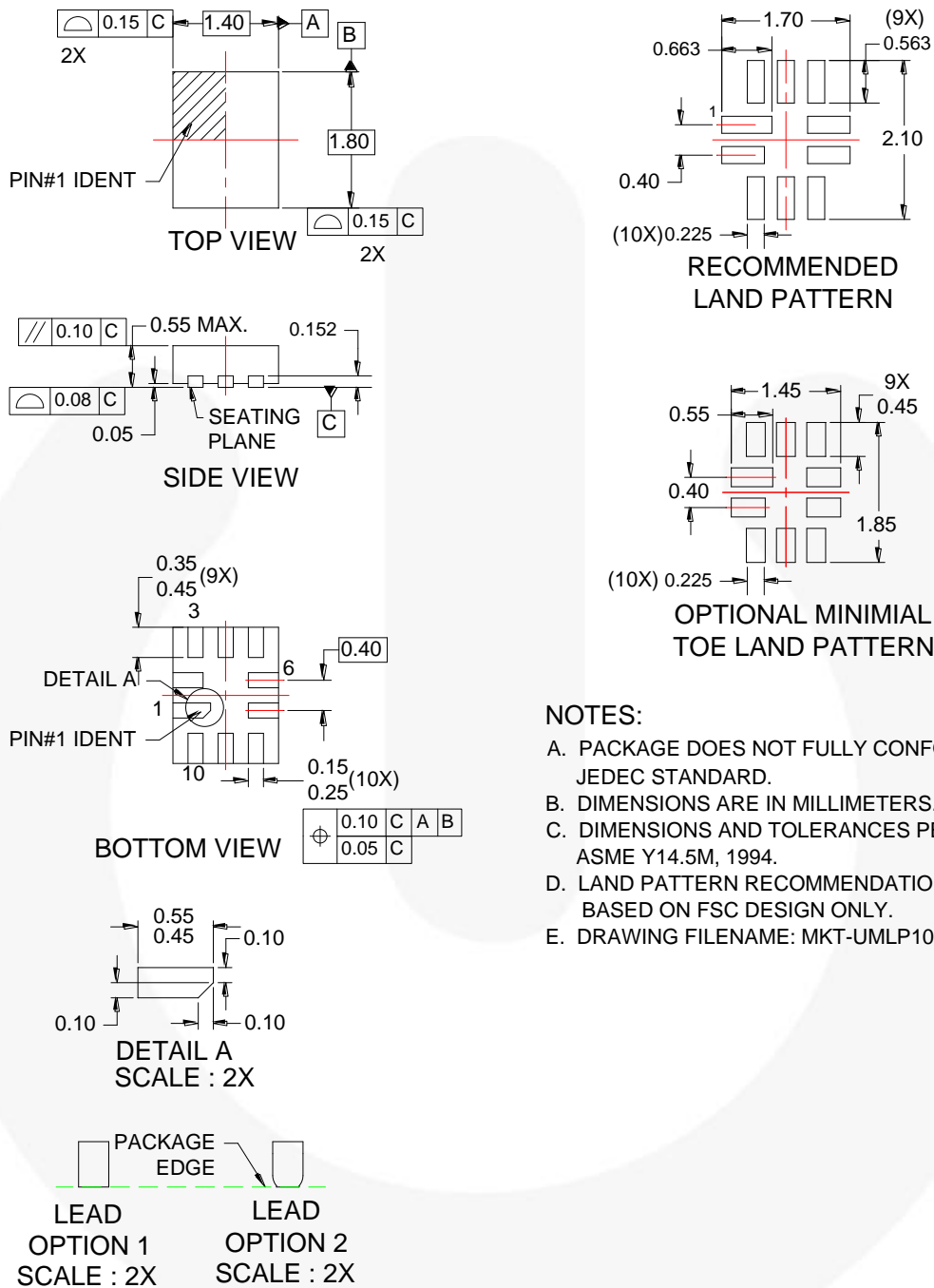


Figure 18. 10-Lead, Quad Ultrathin Molded Leadless Package (UMLP)

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