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FAIRCHILD SEMICONDUCTOR®

June 2012

FSA201 — USB2.0 Full-Speed and Audio Switches with Negative Signal Capability

Features

- 3Ω Typical ON Resistance
- -3db Bandwidth: > 250MHz
- Low Power Consumption
- Packaged in Pb-free 10-pin MSOP and 10-Lead MicroPak™ (1.6 x 2.1mm)
- Power-off Protection on Common D+/R, D-/L Ports
- Automatically Detects V_{BUS} for Switch Path Selection

Applications

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

Description

The FSA201 is a Double-Pole, Double Throw (DPDT) multiplexer that combines a low-distortion audio and a USB2.0 Full-Speed (FS) 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 similar portable peripheral devices.

Since USB2.0 is an industry standard for shared data-path in portable devices, the FSA201 also incorporates a V_{BUS} detection capability. The FSA201 includes a power-off feature to minimize current consumption when V_{BUS} is not present. This power-off circuitry is available for the common D+/R, D-/L ports only. 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	Packing Description
FSA201L10X	MAC010A	10-Lead MicroPak, JEDEC MO-255, 1.6 x 2.1mm
FSA201MUX	MUA10A	10-Lead MSOP, JEDEC MO-187, 3.0mm Wide

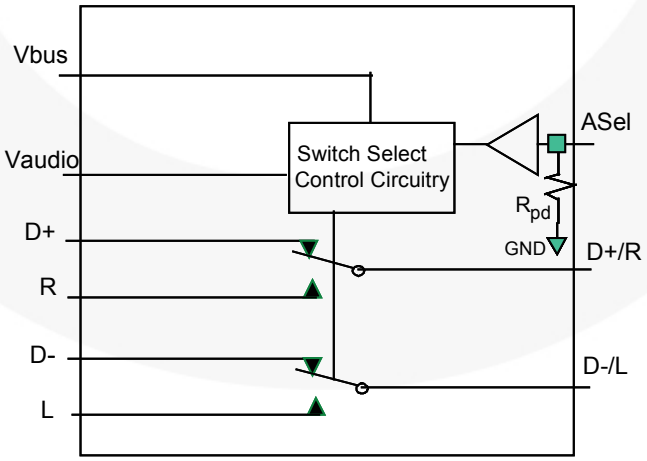


Figure 1. FSA201 Analog Symbol

Pin Assignments

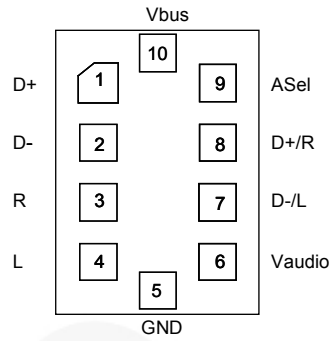


Figure 2. MicroPak™ 10-Pin

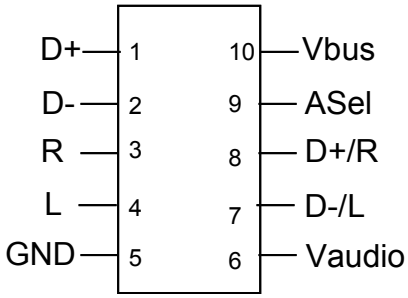


Figure 3. MSOP 10-Pin

Pin Descriptions

Pin #	Name	Description
1, 2	D+, D-	USB data bus input sources
6	V_{AUDIO}	Power supply (audio)
3, 4	R, L	Audio right and left input sources
9	A_{SEL}	Audio select to override auto USB detect when V_{AUDIO} supply is present
10	V_{BUS}	Power supply (USB) and auto USB switch-path select
8, 7	D+/R, D-/L	USB and audio common connector ports

Truth Table

A_{SEL} (1)	V_{AUDIO}	V_{BUS}	L, R	D+, D-
LOW	LOW	LOW	OFF	OFF
LOW	LOW	High (2)	OFF	ON
LOW	HIGH (2)	LOW	ON	OFF
LOW	HIGH (2)	HIGH (2)	OFF	ON
HIGH	LOW	LOW	OFF	OFF
HIGH	LOW	HIGH (2)	OFF	ON
HIGH	HIGH (2)	LOW	ON	OFF
HIGH	HIGH (2)	HIGH (2)	ON	OFF

Notes:

1. A_{SEL}- Internal resistor to GND provides auto-V_{BUS} detect if there is no external connection. Forcing A_{SEL} HIGH when V_{AUDIO} is present overrides the USB path even if V_{BUS} is present.
2. H - Value is the threshold as defined to meet USB2.0 V_{BUS} requirements and audio supply threshold in a system (see DC Tables).

Functional Description

The FSA201 is a combined USB and audio switch that enables sharing the D+/D- lines of a USB connector with stereo audio CODEC outputs. The switch is optimized for full-speed USB signals and includes an automatic V_{BUS}-detection circuit. When a USB connector, rather than a headphone, is connected to the ultra-portable device the switch is automatically configured for full-speed USB data transfer. If no V_{BUS} is detected, and yet V_{AUDIO} is present, the switch is configured for the low-distortion audio switch path. The audio switch path also handles negative signals (down to -2V), which eliminates the need for large coupling capacitors.

For those applications where the V_{BUS} is generated as a self-powered device or where V_{BUS} is not removed, the A_{SEL} pin provides the ability to switch, under software control, to the audio path. The A_{SEL} pin is internally terminated by a resistor to GND (typical value 3MΩ) and requires no connection for the standard ultra-portable (cell-phone, MP3, or Portable Media Player). In an application where the supply to the FSA201 V_{BUS} pin is not guaranteed to be removed, a GPIO pin can be used to switch out of full-speed USB mode into audio mode, using the A_{SEL} pin.

The FSA201 V_{BUS} pin must be connected directly to V_{BUS} or a supply > 3.8V, not an LDO regulated down to 3.6V or a V_{bat}-generated supply that may fall below 3.8V in normal operation (see the Application Diagram).

Application Diagram

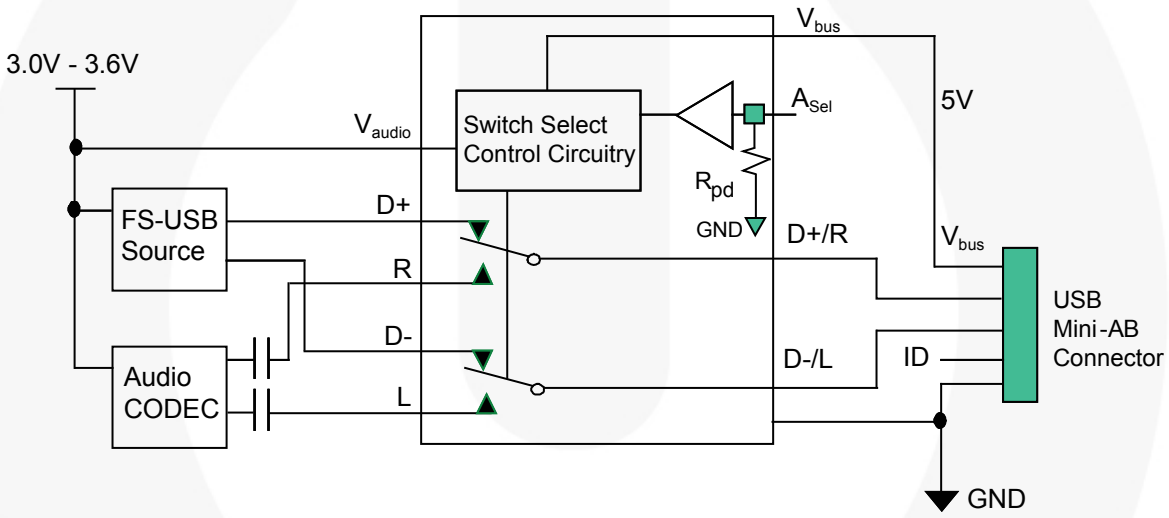


Figure 4. Application Diagram

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_{AUDIO} / V_{Bus}	Supply Voltage		-0.5	6.0	V
V_{SW}	Switch I/O Voltage[3]	D+, D-, D+/R, D-/L Pins	V_{BUS} -7.0	V_{BUS} +0.3	V
		R, L, Pins	V_{AUDIO} -7.0	V_{AUDIO} -0.3	V
A_{SEL}	Control Input Voltage		-0.5	6.0	V
I_{IK}	Input Clamp Diode Current		-50		mA
I_{SW}	Switch I/O Current (Continuous)	USB		50	mA
		Audio		250	
I_{SWPEAK}	Peak Switch Current (Pulsed at 1ms Duration, <10% Duty Cycle)	USB		100	mA
		Audio		500	
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		10	kV
		All Other Pins		8	
	Charged Discharge Model (JEDEC: JESD22-C101)			2	

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		Minimum	Maximum
V_{AUDIO}	Supply Voltage		2.7V	3.6V
V_{BUS}	Supply Voltage		4.25V	5.50V
A_{SEL}	Control Input Voltage		0V	V_{AUDIO}
V_{SW}	Switch I/O Voltage		V_{AUDIO}– 6.5V	V_{AUDIO}– 0.3V
T_A	Operating Temperature		-40°C	85°C
θ_{JA}	Thermal Resistance (free air)	MicroPak 10		330ºC / W (estimated)

DC Electrical Characteristics

All typical values are at 25ºC unless otherwise specified.

Symbol	Parameter	V_{AUDIO} (V)	Condition	T_A=- 40ºC to +85ºC			Unit
				Min.	Typ.	Max.	
Common Pins							
V_{IK}	Clamp Diode Voltage	2.7	I_{IK}=-18mA			-1.2	V
V_{IH}	Control Input Voltage HIGH	2.7 to 3.6		1.3			
V_{IL}	Control Input Voltage LOW	2.7 to 3.6				0.5	
I_{IN}	A_{SEL} Input HIGH Current	3.6	V_{CNTRL}=0V to 3.6V	-3		3	µA
I_{OFF}	Power Off Leakage Current (Common Port Only D+/R, D-/L)	V_{AUDIO}= V_{BUS}=0V	Common Port (D+/R, D-/L) V_{SW}=0V to 5.5V			1	µA
$I_{NO(0FF)}$	Off Leakage Current of Port D+, D-, R, L	3.6	V_{BUS}=0V, 5. 5V D+/R, D-/L=0.3V, V_{AUDIO} – 0.3V D+, D-, R, L=0.3V, V_{AUDIO} – 0.3V or Floating Figure 14	-50	10	50	nA
$I_{NC(0N)}$	On Leakage Current of Port D+/R or D-/L	3.6	V_{BUS}=0V, 5.5V D+/R, D-/L=0.3V, V_{AUDIO} – 0.3V, D+, D-, R, L=Floating Figure 15	-100	50	100	nA
USB Switch Path		**V_{BUS} (V)**					
	USB Analog Signal Range			0		3.6	V
R_{ONUSB}	FS Switch On Resistance(4)	4.25	$V_{D+/D-}$=0V, 3.0V, I_{ON}=-8mA Figure 6, Figure 13		3	6	Ω
ΔR_{ONUSB}	FS Delta R_{ON}(4,6)	4.25	$V_{D+/D-}$=3V, I_{ON}=-8mA		0.35		Ω
Audio Switch Path		**V_{AUDIO} (V)**					
	Audio Analog Signal Range			V_{AUDIO} – 6.5		V_{AUDIO}	V
$R_{ONAUDIO}$	Audio Switch On Resistance(7)	2.7	$V_{L/R}$=-2V, 0V, 0.7V, V_{AUDIO}-0.7V, V_{AUDIO} I_{ON}=-100mA, V_{BUS}=0V Figure 5, Figure 13		0.5	1.0	Ω
$\Delta R_{ONAudio}$	Audio Delta R_{ON}(4)	2.7	$V_{L/R}$=0.7V I_{ON}=-100mA		0.01	0.10	Ω
$R_{FLAT(Audio)}$	Audio R_{ON} Flatness(5)	2.7	$V_{L/R}$=-2V, 0V, 0.7V, 2V, 2.7V I_{ON}=-100mA			0.35	Ω

Notes:

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

DC Electrical Characteristics (Continued)

All typical values are at 25ºC unless otherwise specified.

Symbol	Parameter	V_{AUDIO} (V)	Condition	T_A=- 40ºC to +85ºC			Unit
				Min.	Typ.	Max.	
Power Supply							
V_{busth}	V_{BUS} Threshold Voltage			3.2		3.8	V
$V_{audioth}$	V_{AUDIO} Threshold			0.5		1.5	V
$I_{CC(Audio)}$	Quiescent Supply Current (Audio)	3.0	V_{ASEL}=0 to V_{AUDIO}, I_{OUT}=0			10	µA
$I_{CC(VBUS)}$	Quiescent Supply Current (V_{BUS})		V_{ASEL}=0 to V_{AUDIO}, I_{OUT}=0 V_{BUS}=5.5V			20	µA
I_{CCT}	Increase in I_{CC} Current per Control Voltage and V_{CC}	3.0	V_{ASEL}=2.6V, V_{BUS}=Floating			15	µA
			V_{ASEL}=1.8V, V_{BUS}=Floating			18	

AC Electrical Characteristics

All typical value are for V_{AUDIO}=3.3V and V_{BUS}=5.0 at 25ºC unless otherwise specified.

Symbol	Parameter	V_{AUDIO}/V_{BUS} (V)	Condition	T_A=- 40°C to +85°C			Unit
				Min.	Typ.	Max.	
$t_{ONAUDIO1}$	Turn-On Time V_{AUDIO}↑ to Output	V_{BUS} = 0V	$V_{D+/R, D-/L}$=1.0V R_L=50Ω, C_L=50pF Figure 16, Figure 18			10	µs
$t_{OFFAUDIO1}$	Turn-Off Time V_{BUS}↑ to Output	V_{AUDIO}=2.7 for V_{BUS} ↑	$V_{D+/R, D-/L}$=1.0V R_L=50Ω, C_L=50pF Figure 16, Figure 18			10	µs
$t_{ONAUDIO2}$	Turn-On Time A_{SEL} to Output	V_{BUS}=4.25V V_{AUDIO}=2.7	$V_{D+/R, D-/L}$=1.0V R_L=50Ω, C_L=50pF Figure 16, Figure 17			1	µs
$t_{OFFAUDIO2}$	Turn-Off Time A_{SEL} to Output	V_{BUS} =4.25V V_{AUDIO}=2.7	$V_{D+/R, D-/L}$=1.0V R_L=50Ω, C_L=50pF Figure 16, Figure 18			1	µs
$t_{ONAUDIO3}$	Turn-On Time V_{BUS}↓ to Output	V_{AUDIO}=2.7	$V_{D+/R, D-/L}$=1.0V R_L=50Ω, C_L=50pF Figure 16, Figure 17			10	µs
t_{ONUSB}	Turn-On Time V_{USB}↑ to Output	V_{AUDIO} = 2.7	$V_{D+/R, D-/L}$=1.0V R_L=50Ω, C_L=50pF Figure 16, Figure 18			10	µs
t_{OFFUSB}	Turn-Off Time V_{USB}↓ to Output	V_{AUDIO}=2.7	$V_{D+/R, D-/L}$=1.0V R_L=50Ω, C_L=50pF Figure 16, Figure 18			10	µs
t_{PDUSB}	USB Switch Propagation Delay(8)	V_{AUDIO}=2.7 V_{BUS}=4.25V	R_L=50Ω, C_L=50pF Figure 19		0.25		ns
$OIRR_{USB}$	Off-Isolation - USB	V_{AUDIO}=2.7 V_{BUS}=4.25V	f=6MHz, R_T=50Ω, C_L=0pF Figure 8, Figure 23		-55		dB
$OIRR_A$	Off-Isolation - Audio	V_{AUDIO}=2.7 V_{BUS}=4.25V	f=6MHz, R_T=50Ω, C_L=0pF Figure 7, Figure 23		-37		dB
$Xtalk_{USB}$	Non-Adjacent Channel Crosstalk - USB	V_{AUDIO}=2.7 V_{BUS}=4.25V	f=6MHz, R_T=50Ω, C_L=0pF Figure 10, Figure 24		-49		dB
$Xtalk_A$	Non-Adjacent Channel Crosstalk - Audio	V_{AUDIO}=2.7 V_{BUS}=4.25V	f=6MHz, R_T=50Ω, C_L=0pF Figure 9, Figure 24		-39		dB
BW	-3db Bandwidth	V_{AUDIO}=2.7 V_{BUS}=4.25V	R_T=50Ω, C_L=0pF, Signal 0dBm Figure 11, Figure 12, Figure 22		400		MHz
THD	Total Harmonic Distortion	V_{AUDIO}=2.7 V_{BUS}=0V	f=20Hz to 20kHz, R_L=32Ω, $V_{R,L}$=2V_{pp} Figure 27		0.05		%
PSRR	Power Supply Rejection Ratio	V_{AUDIO}=3.3 V_{BUS}=0V	f=217Hz on V_{AUDIO} $V_{R,L}$=1.0V, R_T=32Ω, V_{Ripple}=600mV_{pp}		-56		dB

Note:

8. Guaranteed by characterization, not production tested.

USB Full-Speed Related AC Electrical Characteristics

Symbol	Parameter	V_{AUDIO} / V_{BUS}(V)	Condition	T_A=-40ºC to +85ºC			Unit
				Min.	Typ.	Max.	
$t_{SK(o)}$	Channel-to-Channel Skew[9]	V_{AUDIO}=2.7V V_{BUS}=4.25V	t_R=t_F=12ns (10-90%) at 6MHz C_L=50pF, R_L=50Ω Figure 20, Figure 21		150		ps
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output[9]	V_{AUDIO}=2.7V V_{BUS}=4.25V	t_R=t_F=12ns (10-90%) at 6MHz C_L=50pF, R_L=50Ω Figure 20, Figure 21		150		ps
t_J	Total Jitter[9]	V_{AUDIO}=2.7V V_{BUS}=4.25V	R_L=50Ω, C_L=50pF, t_R=t_F=12ns (10-90%) at 12Mbps (PRBS=2^{15} – 1)		1.6		ns

Note:

9. Guaranteed by characterization, not production tested.

Capacitance

Symbol	Parameter	V_{AUDIO} / V_{BUS}(V)	Condition	T_A=-40ºC to +85ºC			Unit
				Min.	Typ.	Max.	
$C_{IN\ (ASEL)}$	Control Pin Input Capacitance (A_{SEL})	V_{AUDIO}=2.7V V_{BUS}=4.25V	V_{Bias}=0.2V		2.5		pF
$C_{ON(D+/R,\ D-/L)}$	D+/R, D-/L (Common Port) On Capacitance	V_{AUDIO}=2.7V V_{BUS}=4.25V A_{SEL}=0V (C_{ONUSB})	V_{Bias}=0.2V, f=6MHz Figure 26		25		pF
		V_{AUDIO}=2.7V V_{BUS}=4.25V A_{SEL}=2.7V ($C_{ONAudio}$)	V_{Bias}=0.2V, f=6MHz Figure 26		29		
$C_{OFF(D+,\ D-)}$	USB Input Source Off Capacitance	V_{AUDIO}=2.7V V_{BUS}=4.25V A_{SEL}=2.7V	f=6MHz, Figure 25		5		pF
$C_{OFF(R/L)}$	Audio Input Source Off Capacitance	V_{AUDIO}=2.7V V_{BUS}=4.25V A_{SEL}=0V	f=6MHz, Figure 25		17		pF

Typical Characteristics

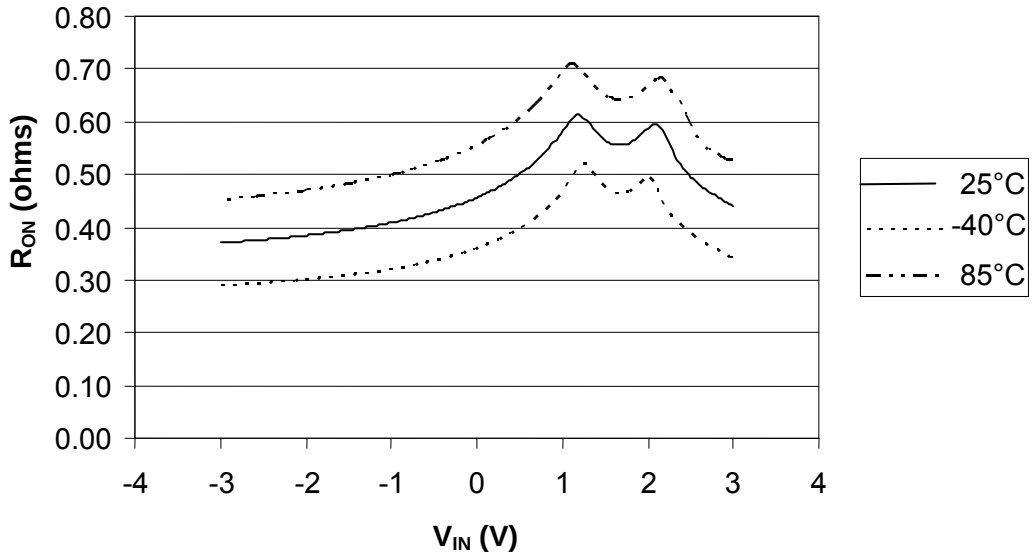


Figure 5. R_{ON} Audio Characterization (R_{ON} Audio R, V_{AUDIO}=2.7V)

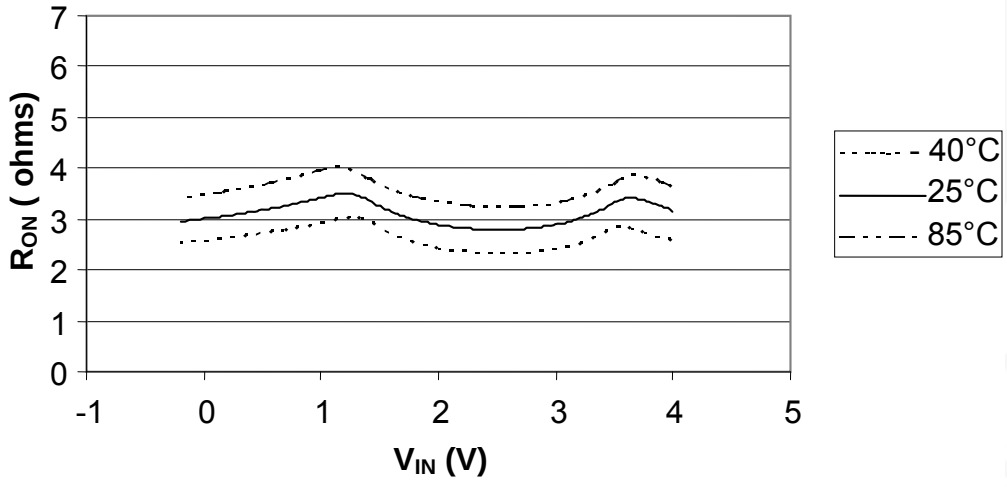


Figure 6. R_{ON} USB Characterization (R_{ON} USB D+)

Typical Characteristics (Continued)

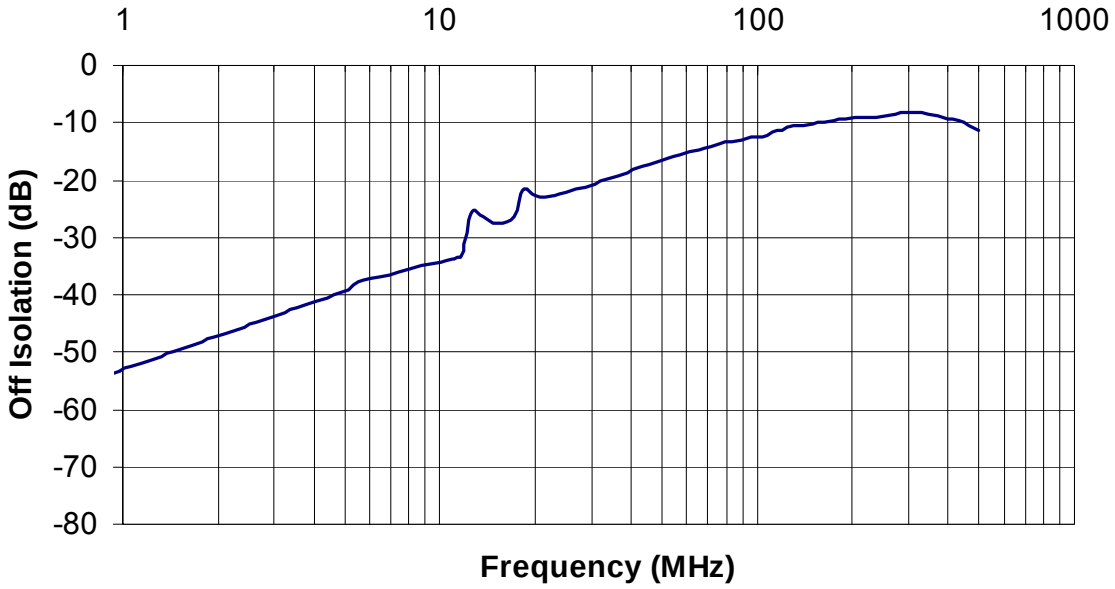


Figure 7. Off-Isolation (Audio) Characterization, Frequency Response at V_{CC} (V_{AUDIO})=2.7V

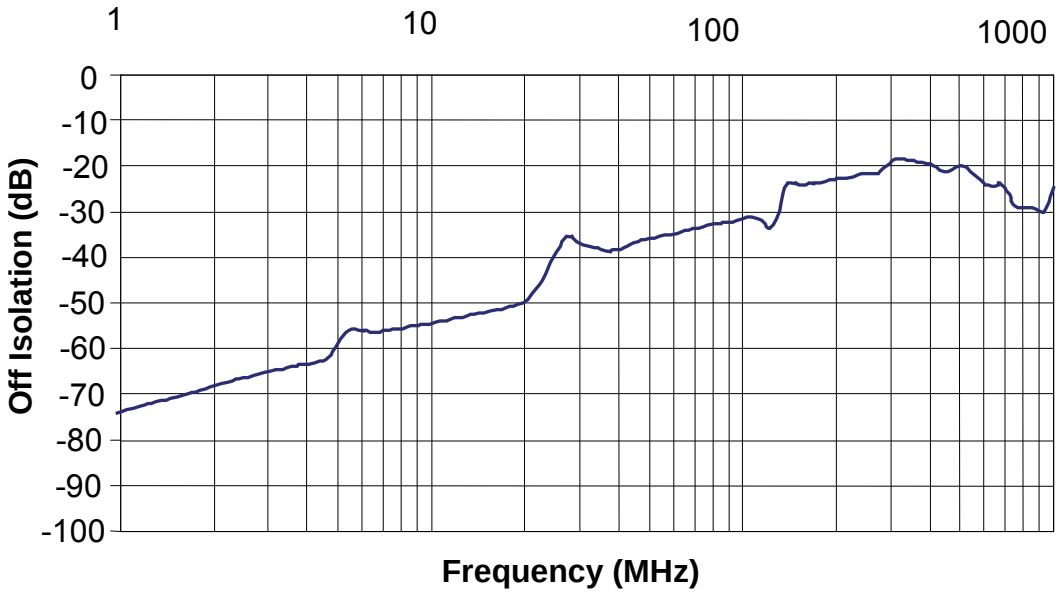


Figure 8. Off-Isolation (USB) Characterization, Frequency Response at V_{CC} (V_{BUS})=4.25V

Typical Characteristics (Continued)

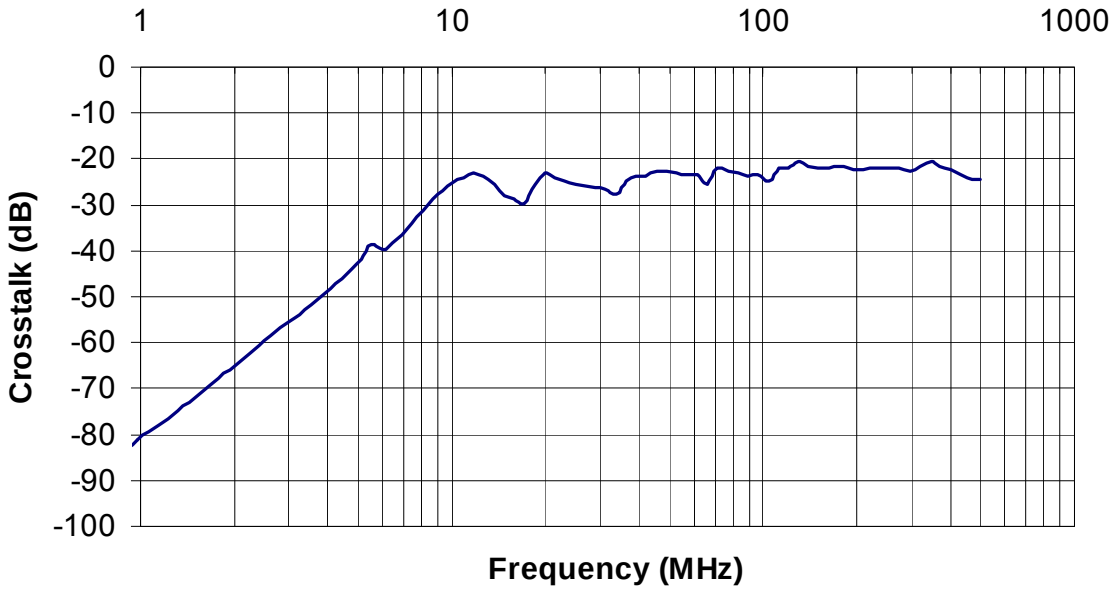


Figure 9. Non-Adjacent Channel Crosstalk (Audio) Characterization at V_{CC} (V_{AUDIO})=2.7V

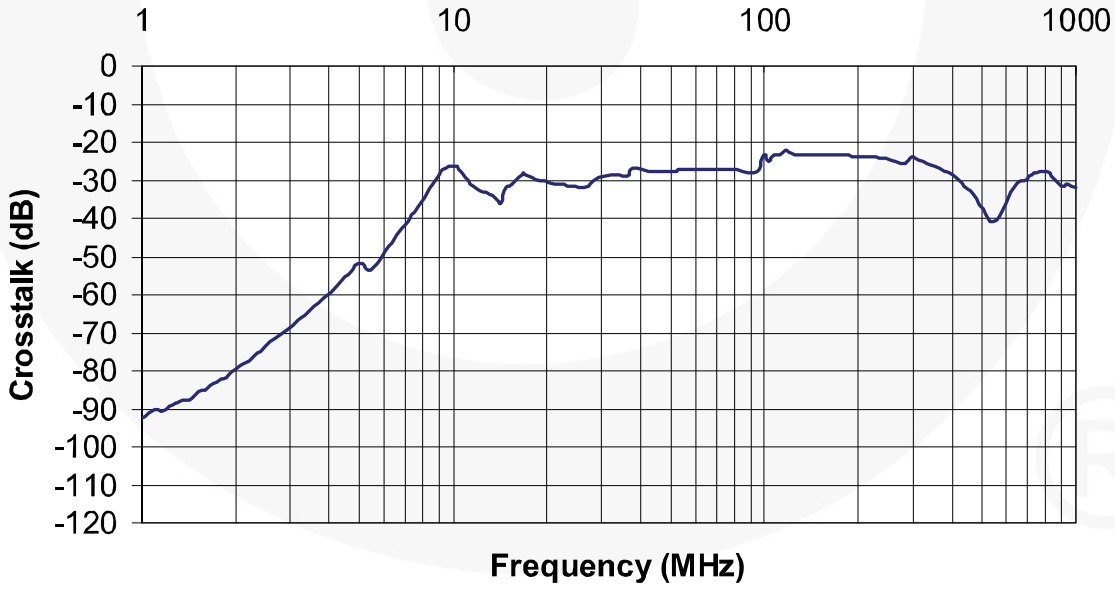


Figure 10. Non-Adjacent Channel Crosstalk (USB) Characterization at V_{CC} (V_{BUS})=4.25V

Typical Characteristics (Continued)

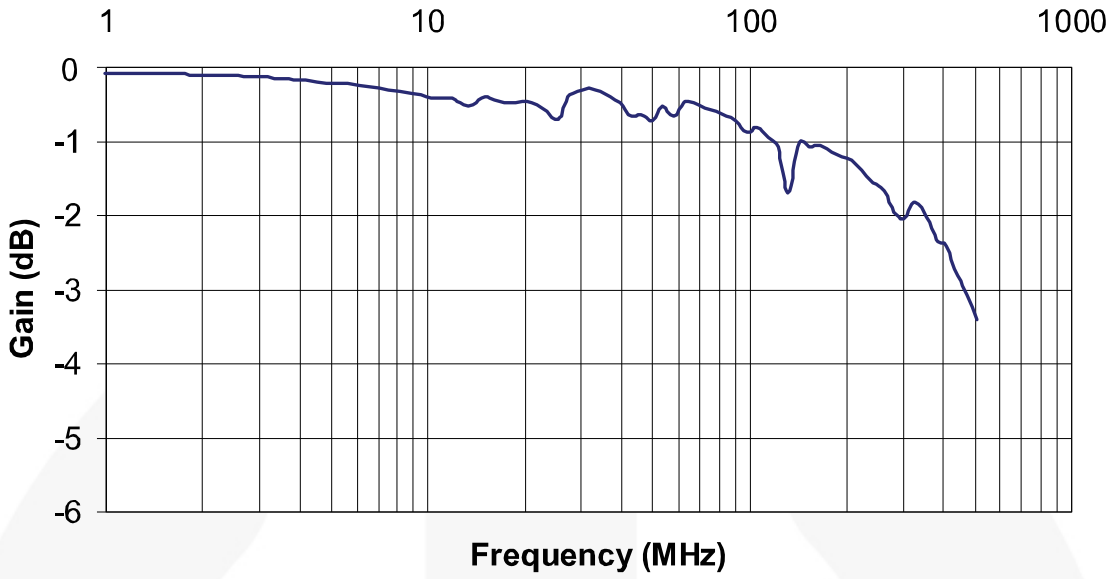


Figure 11. Bandwidth Characterization, Frequency Response at C_L=0pF, V_{CC} (V_{AUDIO})=2.7V

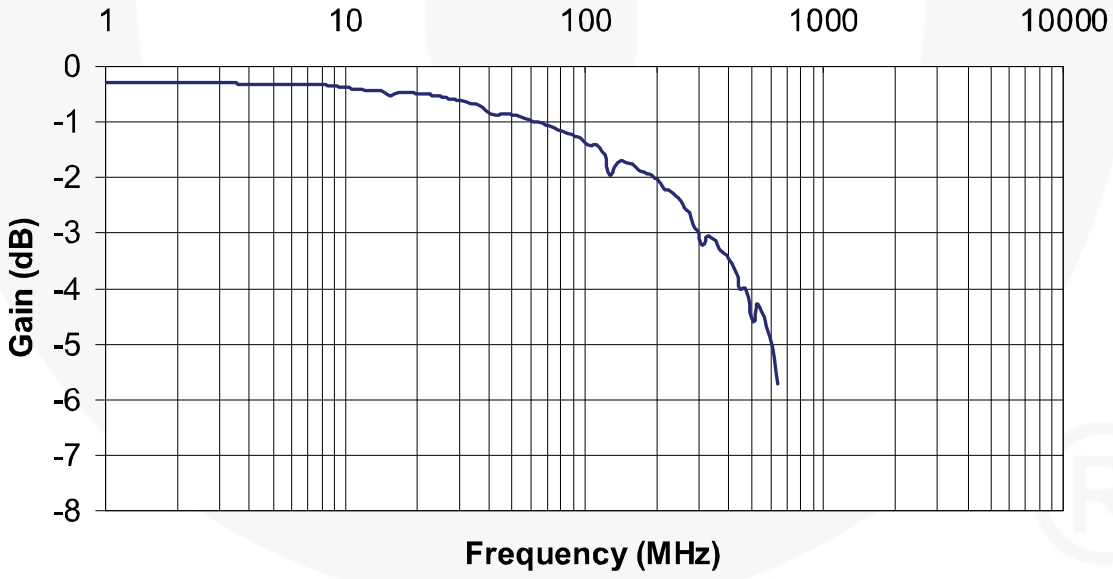


Figure 12. Bandwidth Characterization, Frequency Response at C_L=0pF, V_{CC} (V_{BUS})=4.25V

Test Diagrams

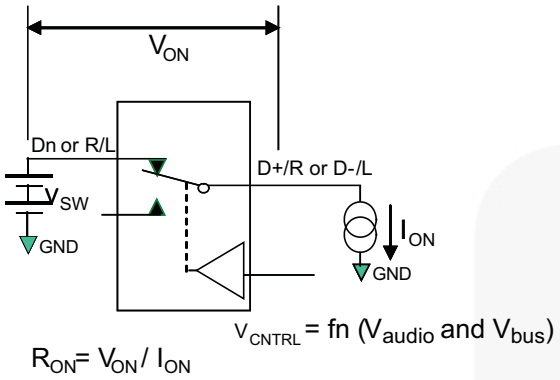


Figure 13. On Resistance

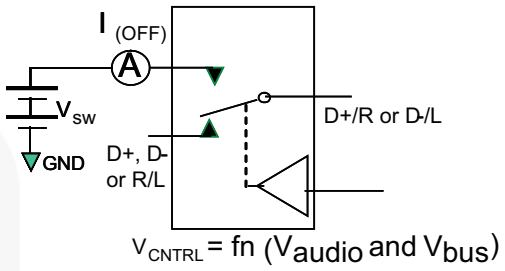


Figure 14. Off Leakage

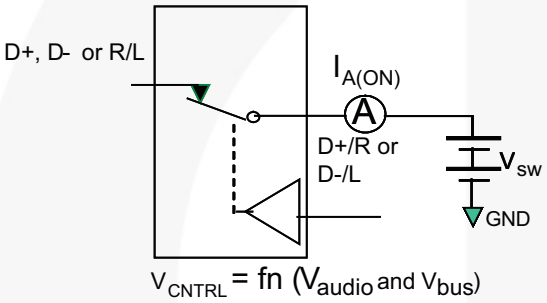
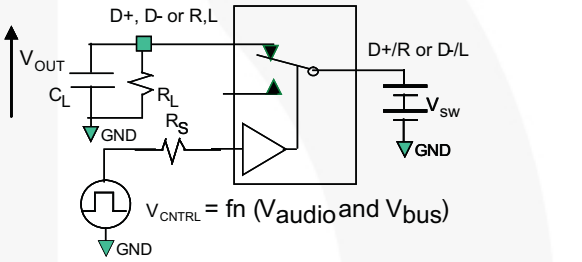


Figure 15. On Leakage



R_L , R_S and C_L are function of application environment (see AC Tables for specific values)
C_L includes test fixture and stray capacitance

Figure 16. AC Test Circuit Load

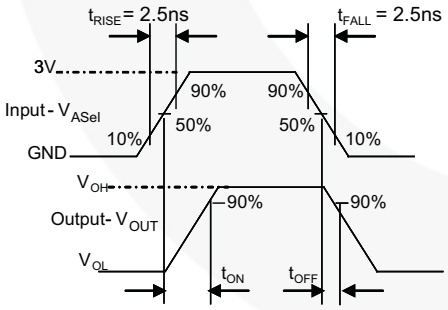


Figure 17. Turn-On / Turn-Off Waveforms (A_{SEL})

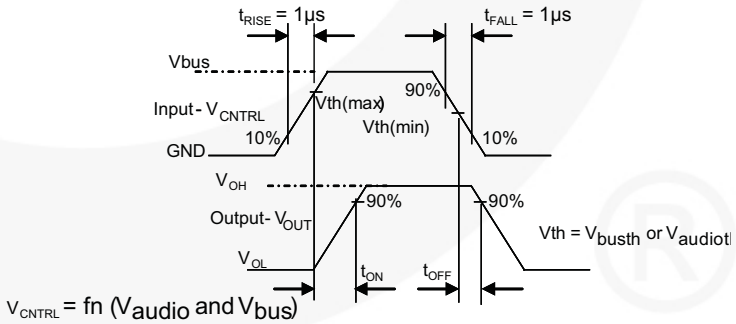


Figure 18. Turn-On / Turn-Off Waveforms (USB/Audio)

Test Diagrams (Continued)

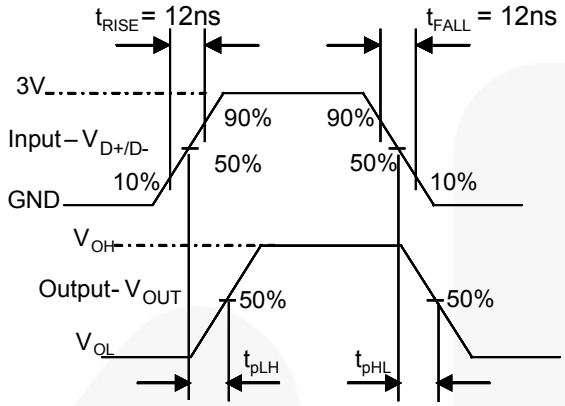


Figure 19. USB Switch Propagation Delay Waveforms

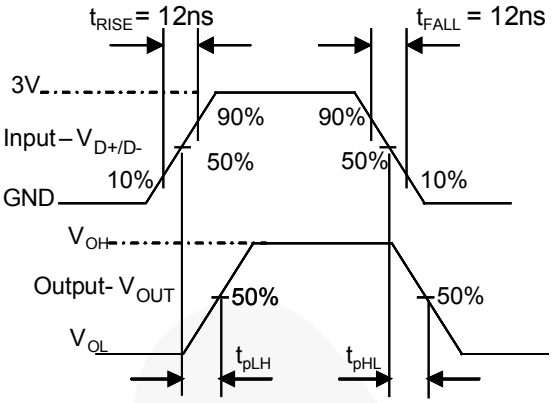


Figure 20. Pulse Skew: $t_{SK(P)}$= | t_{PHL} – t_{PLH} |

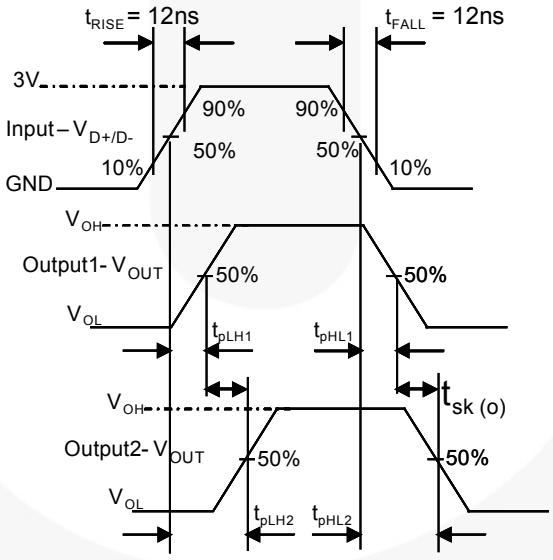


Figure 21. Output Skew: $t_{SK(O)}$= | t_{PLH1} – t_{PLH2} | or | t_{PHL1} – t_{PHL2} |

Test Diagrams (Continued)

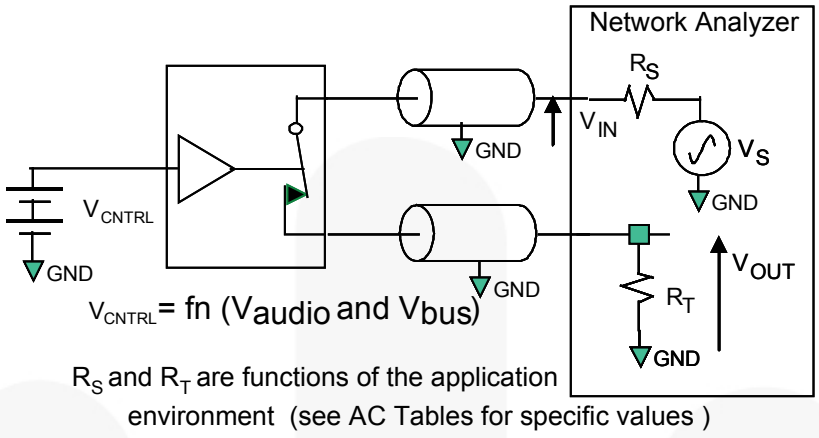


Figure 22. USB Bandwidth

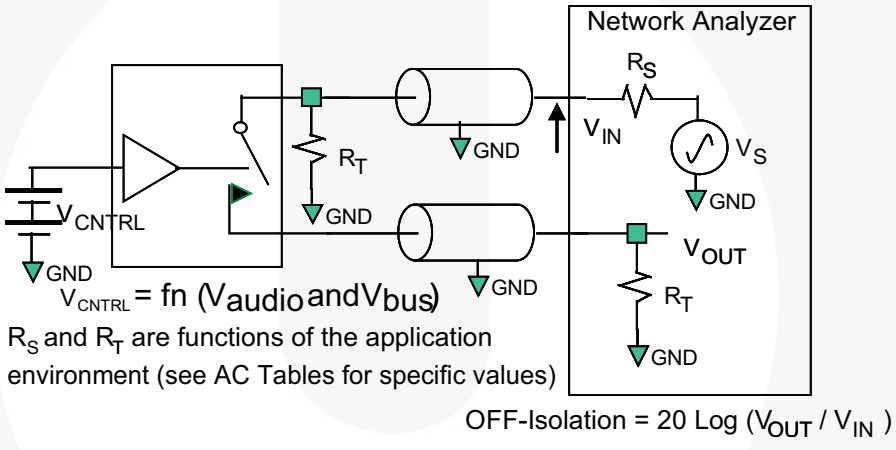


Figure 23. Channel Off Isolation

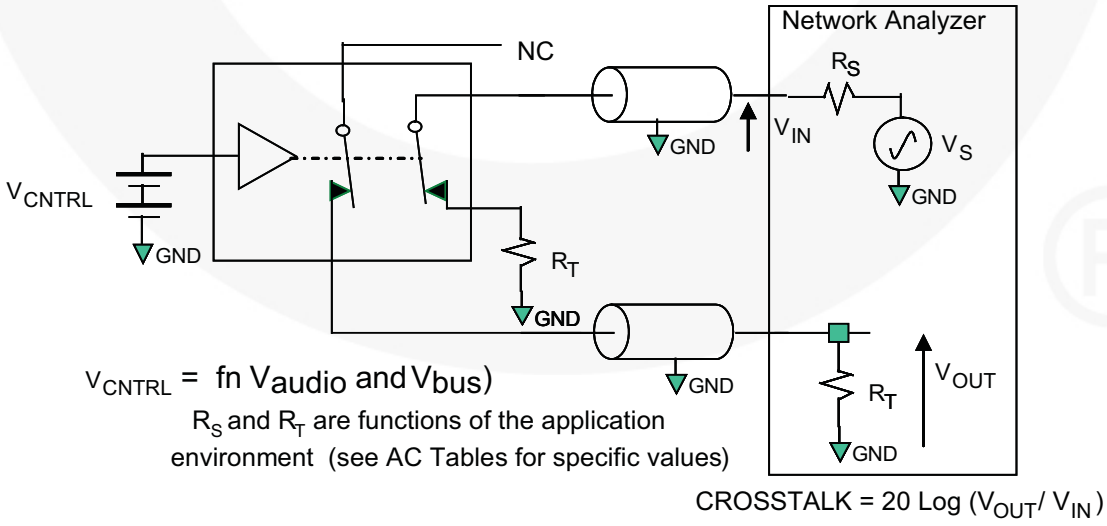


Figure 24. Non-Adjacent Channel-to-Channel Crosstalk

Test Diagrams (Continued)

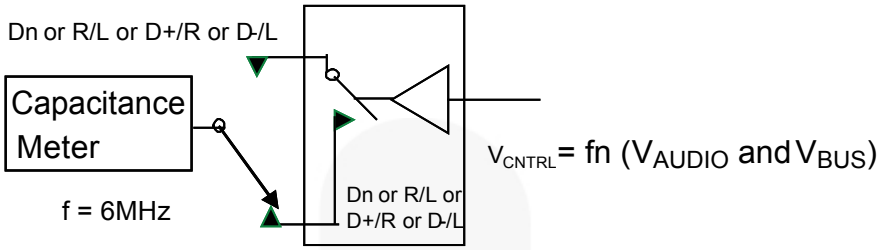


Figure 25. Channel Off Capacitance

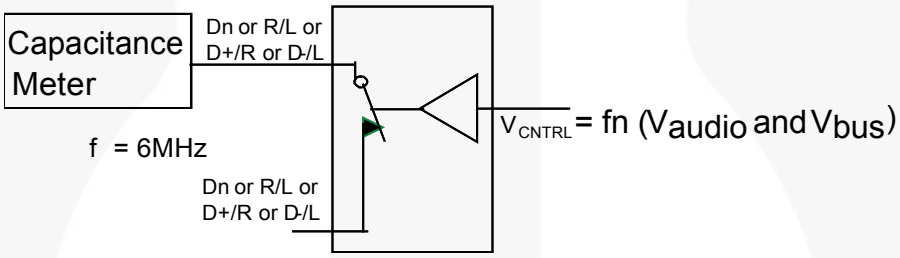


Figure 26. Channel On Capacitance

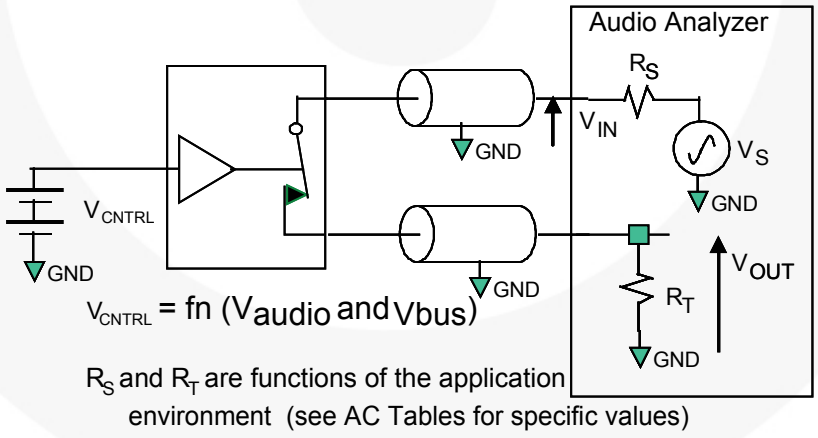
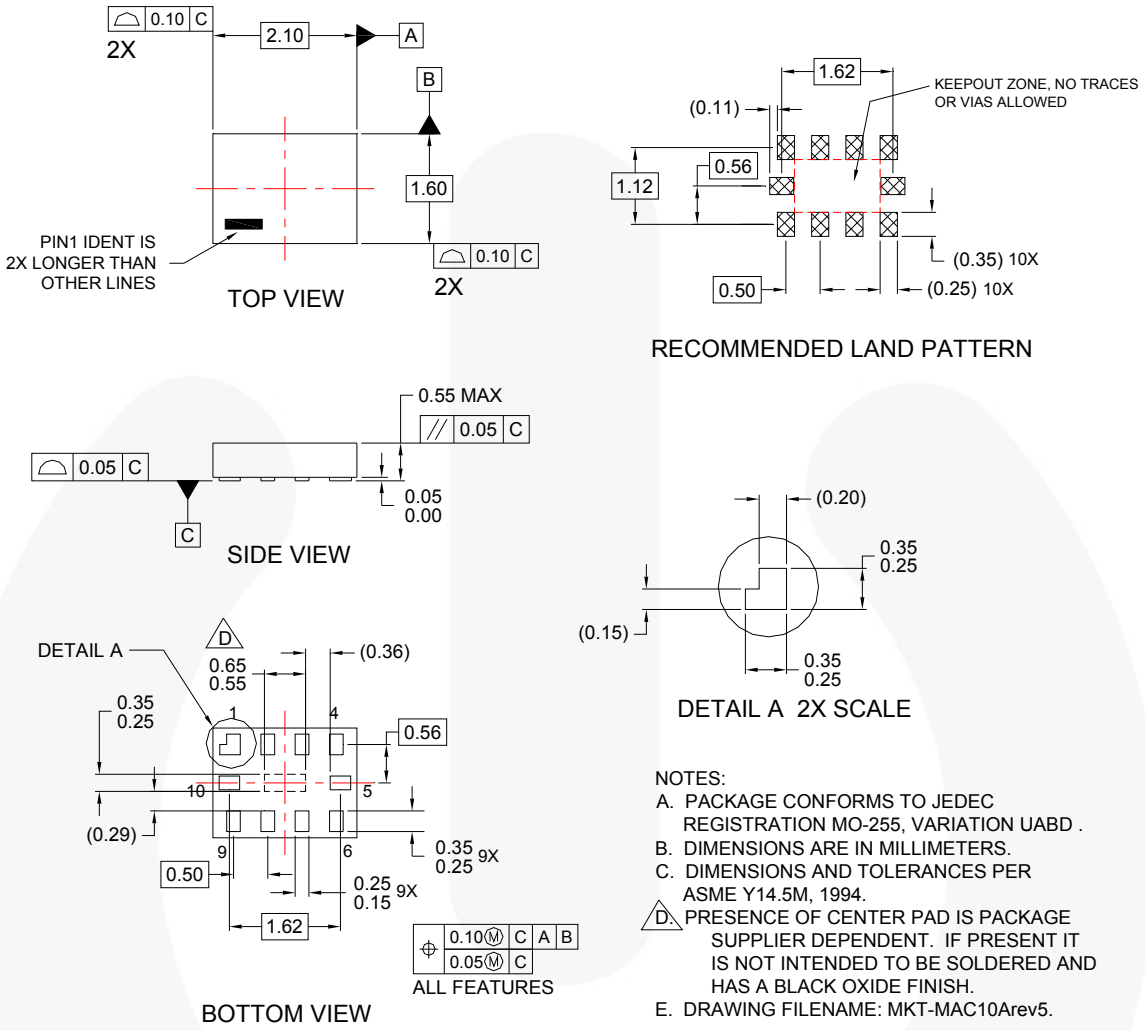


Figure 27. Total Harmonic Distortion

Physical Dimensions



NOTES:

A. PACKAGE CONFORMS TO JEDEC REGISTRATION MO-255, VARIATION UABD .

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.

D. PRESENCE OF CENTER PAD IS PACKAGE SUPPLIER DEPENDENT. IF PRESENT IT IS NOT INTENDED TO BE SOLDERED AND HAS A BLACK OXIDE FINISH.

E. DRAWING FILENAME: MKT-MAC10Arev5.

Figure 28. 10-Lead MicroPak™

Package Designator	Tape Section	Number Cavity	Cavity Status	Cover Tape Status
L10X	Leader (Start End)	125 (typical)	Empty	Sealed
	Carrier	5000	Filled	Sealed
	Trailer (Hub End)	75 (typical)	Empty	Sealed

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Physical Dimensions

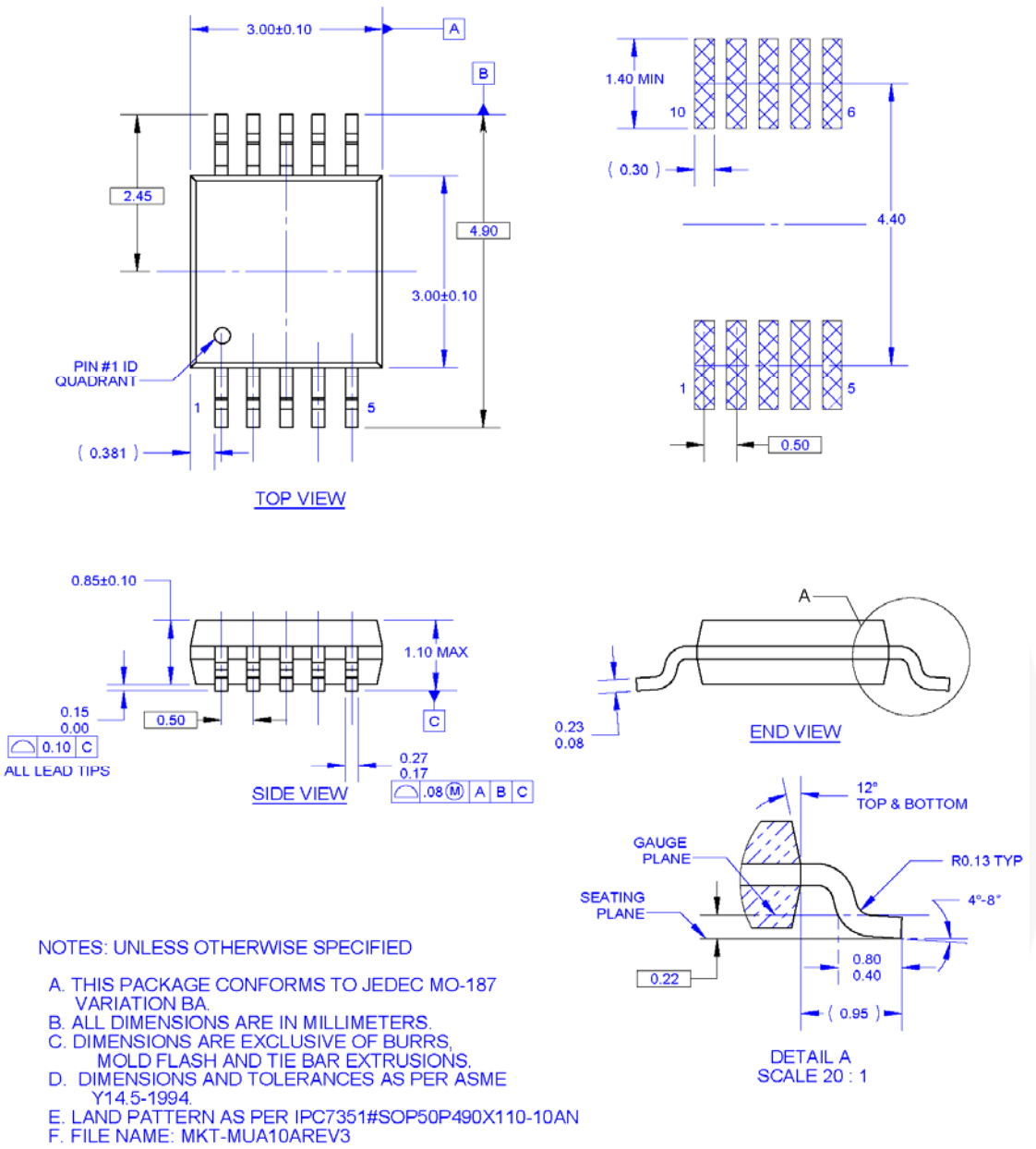

Figure 29. 10-Lead Molded Small Outline Package (MSOP)

Tape Size	A	B	C	D	N	W1	W2	W3
	13	0.059	0.512	0.795	7.008	0.448	0.724	0.486-0.606
(12mm)	(330)	(1.5)	(13)	(20.2)	(178)	(12.4)	(18.4)	(11.9-15.4)

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