PERICOM®

PI3USBA201

Signal Switch Solution for USB 2.0 High Speed Signals and AC Coupled Audio Signals

Features

- Icc = 150 µA max
- Voltage input tolerance down to -1.5V
- Ron = 3-ohm @±1.5V for audio channels
- THD of 0.02% with 32-ohm load
- Off-Isolation = -100dB @ 100 KHz for audio channels
- CrossTalk = -100dB @ 100 KHz for audio channels
- 2kV HBM ESD protection on I/O pins
- Con = 5pF for USB channels
- Improved switching time to eliminate pop sounds associated with charge build-up in large capacitor
- Packaging (Pb-free & Green available):
    →10-pin contact TQFN, 1.3 x 1.6, (ZL10)
   →10-pin contact UQFN, 1.4 x 1.8, (ZM10)

Description

Pericom's PI3USBA201 is a Dual SPDT 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. Combining USB and audio signals to the same port enables CE product designers to eliminate a second connector, which saves board space and BOM costs associated with connector moldings and ESD protection for the second connector.

Pericom's PI3USBA201 architecture is designed to allow audio signals to swing below ground due to AC coupling or D-Class audio amplifiers.

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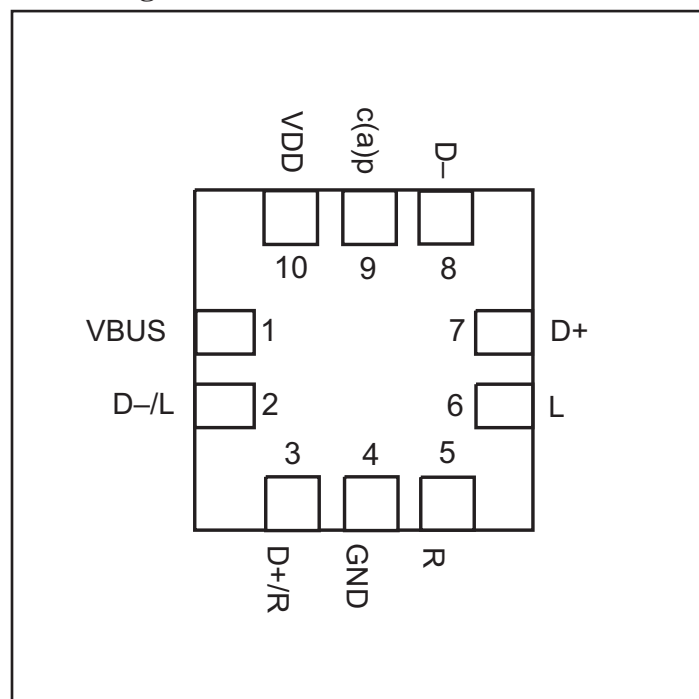
Block Diagram
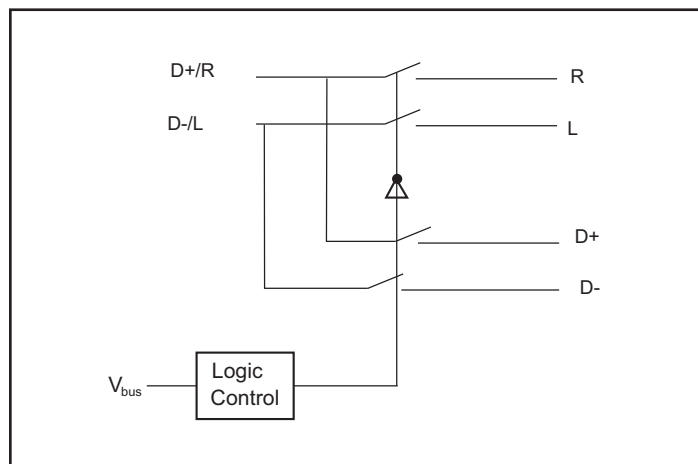
Truth Table

V_{bus}	Results	
	L/R	D+/D-
0	ON	OFF
1	OFF	ON

Pin Configuration

Maximum Ratings

(Above which useful life may be impaired. For user guidelines, not tested.)

Storage Temperature ....–65°C to +150°C
Supply Voltage (V_{DD}) ....2.5V to 2.94V
Control Input Voltage (VVbus)...0V to 5.0V
DC Input Voltage ....-1.5V to V_{DD}
Maximum Junction Temperature (T_j) .... +150°C
Lead Temperature (T_L)   Soldering, 10 seconds .... +260°C
Power Dissipation 0.5W

Note: Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended Operating Conditions

Supply Voltage (V_{DD})... 2.8V ± 5%
Control Input Voltage (V_{BUS})[1] ....0V to 5.5V
Switch Input Voltage (V_{IN}) ....-1.5V to 1.5V
Operating Temperature ....–40°C to +85°C

Notes:
1. Unused Inputs must be held HIGH or LOW. They may not float.

Pin Description

No.	Name	Function
1	V_{BUS}	Digital Control Input (Power supply from USB connector)
2	D-/L	Voice and Data Common Pin
3	D+/R	Voice and Data Common Pin
4	GND	Ground Connection
5	R	Audio Right Input
6	L	Audio Left Input
7	D+	USB Differential Input
8	D-	USB Differential Input
9	cap	External Cap (please use 0.1µF to GND)
10	V_{DD}	Power Supply

DC Electrical Characteristics

(T_A = –40°C to +85°C, V_{DD} = 2.8V ±5%)

Parameter	Test Conditions	Min.	Typ.	Max.	Units
ANALOG SWITCH CHARACTERISTICS					
Audio Signal Path (pins 2,3,5, and 6)					
Analog Signal Range, V_{ANALOG}		–1.5	–	1.5	V
R_{ON} test	V_{DD} = 2.8V and Vinput from -1.5V to 1.5V.			3.5	Ω
R_{ON} Matching Between Channels, ΔR_{ON}	V_{DD} = 2.8V, V_{BUS} = 0V, I_{COM} = 40mA, V_L or V_R = -1.5V to +1.5V	–	–	0.15	Ω
R_{ON} Flatness, $R_{FLAT(ON)}$	V_{DD} = 2.8V, V_{BUS} = 0V, I_{COM} = 40mA, V_L or V_R = -1.5V to +1.5V	–	–	1.30	Ω
OFF Leakage Current, $I_{D+/L(OFF)}$ OR $I_{D-/L(OFF)}$, $I_{com(OFF)}$	V_{DD} = 2.8V, V_{BUS} = HIGH, $V_{D+/L}$ or $V_{D+/R}$= 0V, V_L or V_R = floating, V_{D+} and V_{D-} = floating.	-5	-	5	nA
Discharge Pull Down Resistance, R_L, R_R	V_{DD} = 2.8V, V_{BUS} = 0V, $V_{D-/L}$ or $V_{D+/R}$= -0.8V, 0.8V, V_L or V_R = -0.8V, 0.8V, V_L or V_R= -0.8V, 0.8V, V_{D+} and V_{D-} = floating.		50		KW

AC Electrical Characteristics Audio Signal Path (pins 2, 3, 5, and 6)

(All typical values are at 25°C unless otherwise specified)

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
Q	Charge Injection	V_{DD} = 2.7V			10.0	pC
$Q_{IRR-audio}$	OFF Isolation	V_{DD} = 2.7V, f=100kHz		-100		dB
X_{talk_audio}	Crosstalk	V_{DD} = 2.7V, f=100kHz		-100		dB
BW_{audio}	-3db Bandwidth for Audio path	V_{DD} = 2.7V		1400		MHz
THD_{audio}	Total Harmonic Distortion for audio path	V_{DD} = 2.7V[2], Load = 32-Ohm to GND, Freq = 20Hz to 20KHz, Vinput = 0.5Vpp, Vbus = 0V		0.02		%

Notes:
1. R_L = 50-ohm, C_L = 35pF
2. R_L = 32-ohm, V_{BUS} = 0.5V P.P., f = 20 Hz to 20 kHz

Capacitance (Audio Path)

Parameters	Description	Test Conditions	Typ.	Max.	Units
C_{OFF}	Audio Path OFF Capacitance	V_{DD} = 2.7V	2.5		pF
C_{ON}	Audio Path ON Capacitance		7.5		pF

Switching Characteristics (Audio Path)[3]

Parameters	Description	Test [2] Conditions	Min.	Typ.	Max.	Units
t_{PD}	Propagation Delay[1]			0.25		ns
T_{ON}	Turn ON Time	V_{DD} = 2.7V		600		ns
T_{OFF}	Turn OFF Time	V_{DD} = 2.7V		6		ns

Notes:
1. The switch contributes no propagational delay other than the RC delay of the On-Resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.25ns for 10pF load. Since this time constant is much smaller than the rise/fall times of typical driving signals, it adds very little propagational delay to the system. Propagational delay of the bus switch when used in a system is determined by the driving circuit on the driving side of the switch and its interactions with the load on the driven side.
2. For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
3. Typical values are at V_{DD} = 2.8V, T_A = 25C ambient and maximum loading.

AC Electrical Characteristics - USB Signal Path (Pins 2,3,7,8)
(All typical values are at 25°C unless otherwise specified)

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
Q	Charge injection	V_{DD} = 2.7V			10	pC
$Q_{IRR\ USB}$	USB off isolation	V_{DD} = 2.7V, f=240MHz		−38		dB
X_{talk}	USB Xtalk	V_{DD} = 2.7V, f=240MHz		−33		dB
BW_{usb}	-3dB BW for USB Path	V_{DD} = 2.7V		1350		MHz
t_{PZH}/t_{PZL}	Turn on time	V_{DD} = 2.7V		12.5		ns
t_{PHZ}/t_{PLZ}	Turn off time	V_{DD} = 2.7V		4.05		ns
C_{ON}	USB port is ON			4		pF
C_{OFF}	USB port is off			1.4		pF

USB Signal Path (pins 2,3,7, and 8)					
ON Resistance, R_{ON}	V_{DD} = 2.8V, V_{BUS} = HIGH, I_{COM} = 40mA, V_{D+} or V_{D-} = -0.4V to 1.0V	-	-	7	Ω
R_{ON} Matching Between Channels, ΔR_{ON}	V_{DD} = 2.8V, V_{BUS} = HIGH I_{COM} = 40mA, V_{D+} or V_{D-} = -0.4V to +1.0V	-	-	0.25	Ω
R_{ON} Flatness, $R_{FLAT(ON)}$	V_{DD} = 2.8V, V_{BUS} = HIGH, I_{COM} = 40mA, V_{D+} or V_{D-} = -0.4V to +1.0V	-	-	2.5	Ω

Control Input (V_{bus})

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
V_{IH}	Input High Level		2.0			V
V_{IL}	Input Low Level				0.6	V
V_{IK}	Clamp Diode Voltage			−3.5		V
C_{IN}	Input Cap			1.5		pF

Power Supply

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
V_{DD}	Power Supply Range		2.8V - 5%		2.8V + 5%	V
I_{CC}	Power Supply Current	Vbus = 0V or V_{DD}, V_{DD} = 2.94V		100	150	µA

Test Circuit for Electrical Characteristics

C_L INCLUDES FIXTURE AND STRAY CAPACITANCE.
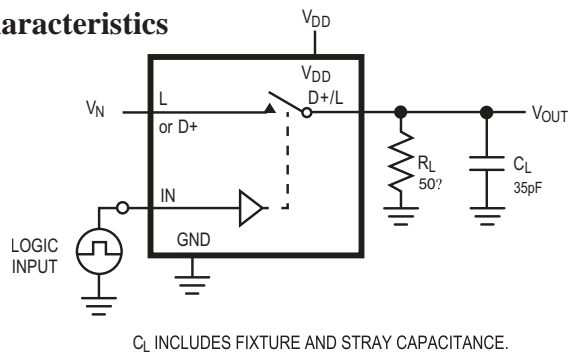
Notes:

- C_L = Load capacitance: includes jig and probe capacitance.
- R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator
- Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control.
  Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
- All input impulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50Ω, t_R ≤ 2.5ns, t_F ≤ 2.5ns.
- The outputs are measured one at a time with on transition per measurement.

Switching Waveforms

Voltage Waveforms Propagation Delay Times

Voltage Waveforms Enable and Disable Times
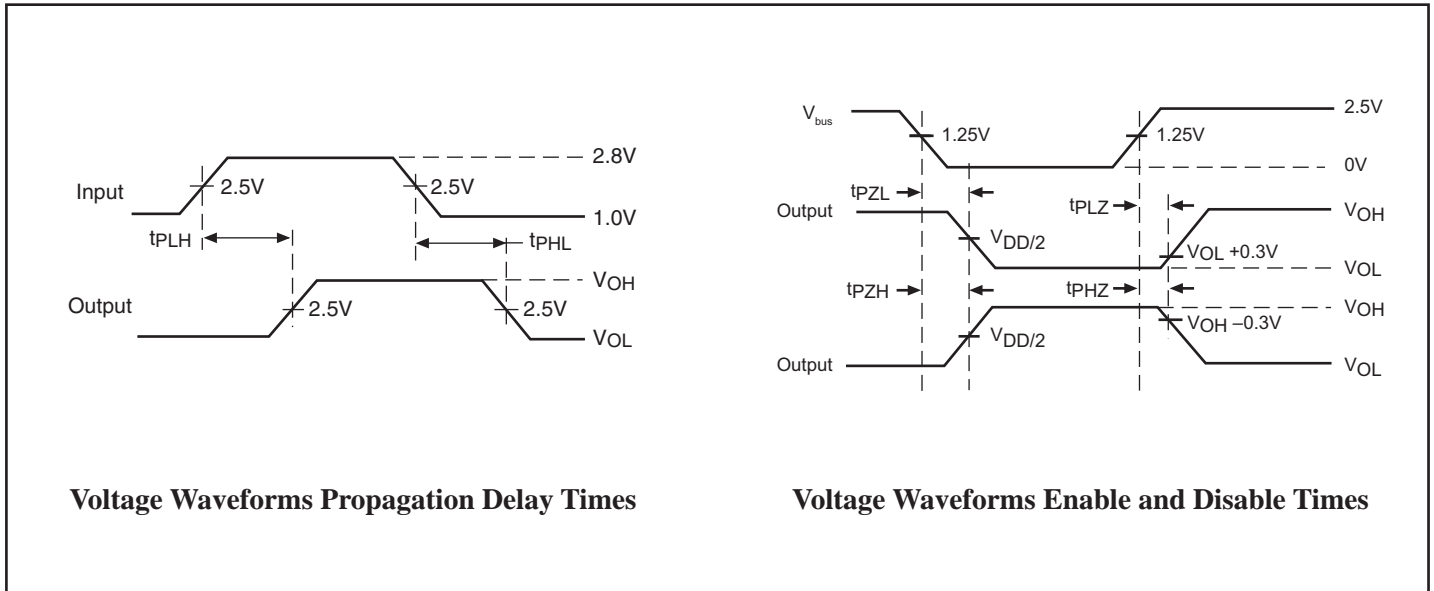
Application Section

Section 1: TDR Measurement for USB Port

• TDR passes the USB 2.0 TDR Specification. The impedance is ranging from 88-ohm to 110-ohm. Please refer to Fig 1.
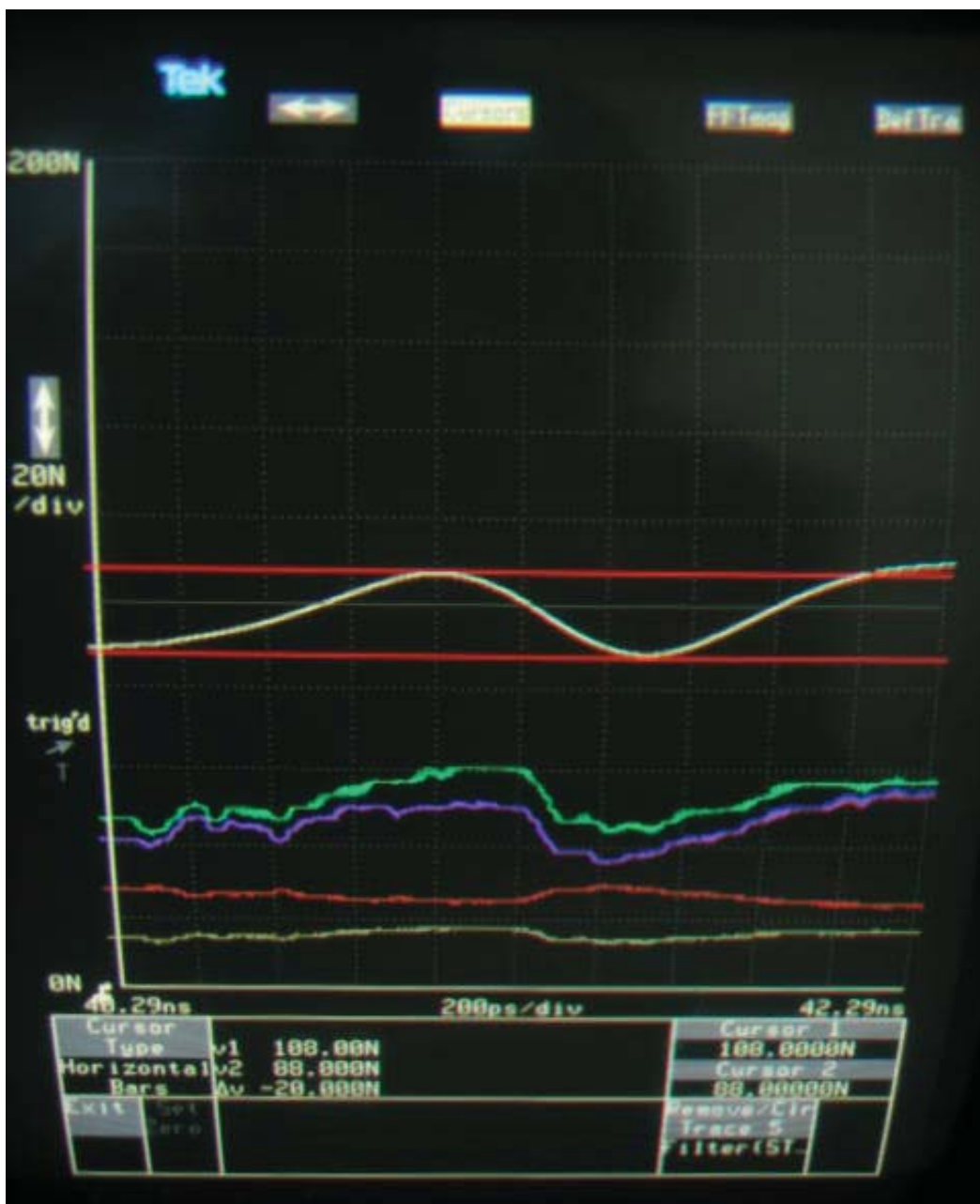
Figure 1: TDR D± to D± and L/R USB Switch Connected to Audio Switch, V_{DD}=3.3V, 25°C

Section 2: Tektronics Compliance Test for USB Port

Part A: USB 2.0 Full Speed Compliance Test Result

Signal Quality Test Results in Tektronix format
Device Description: Full Speed, Far End Device, Down Stream Testing, Tier 6, Dummy Device.
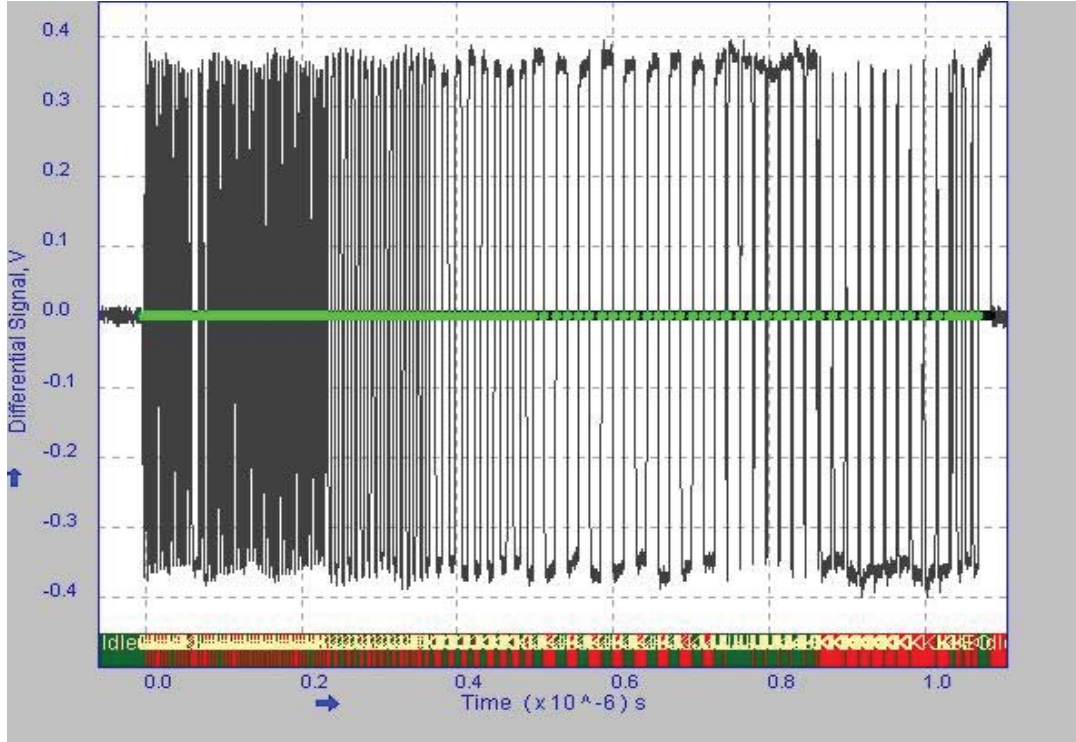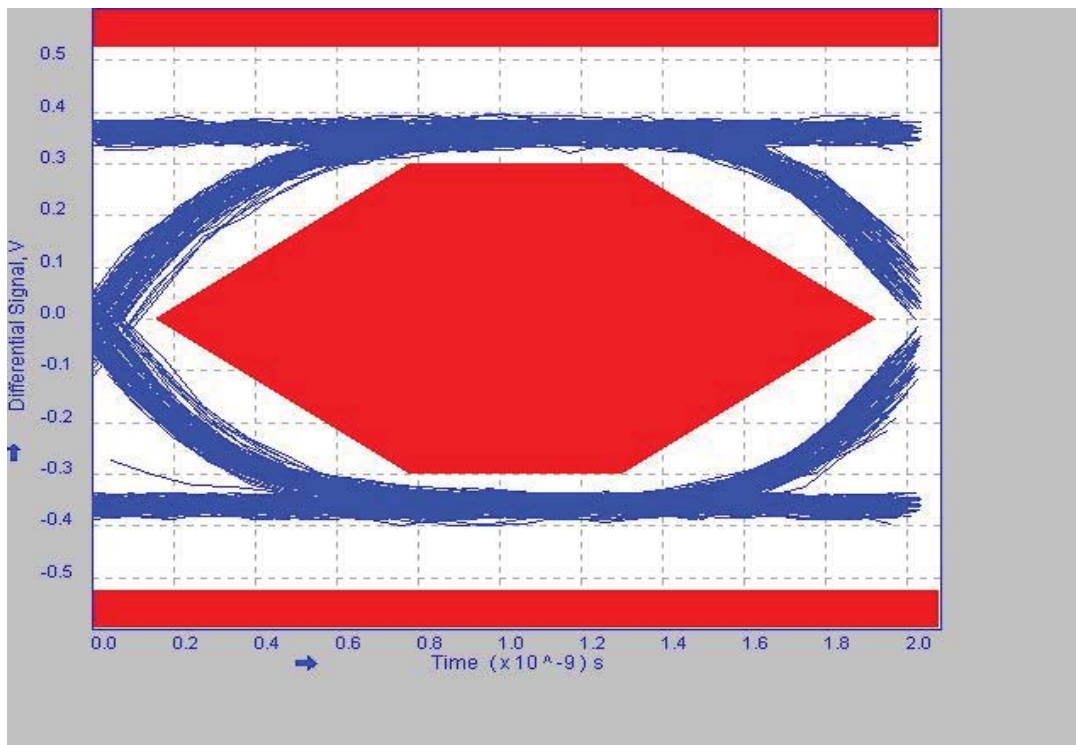Overall Result: Pass*
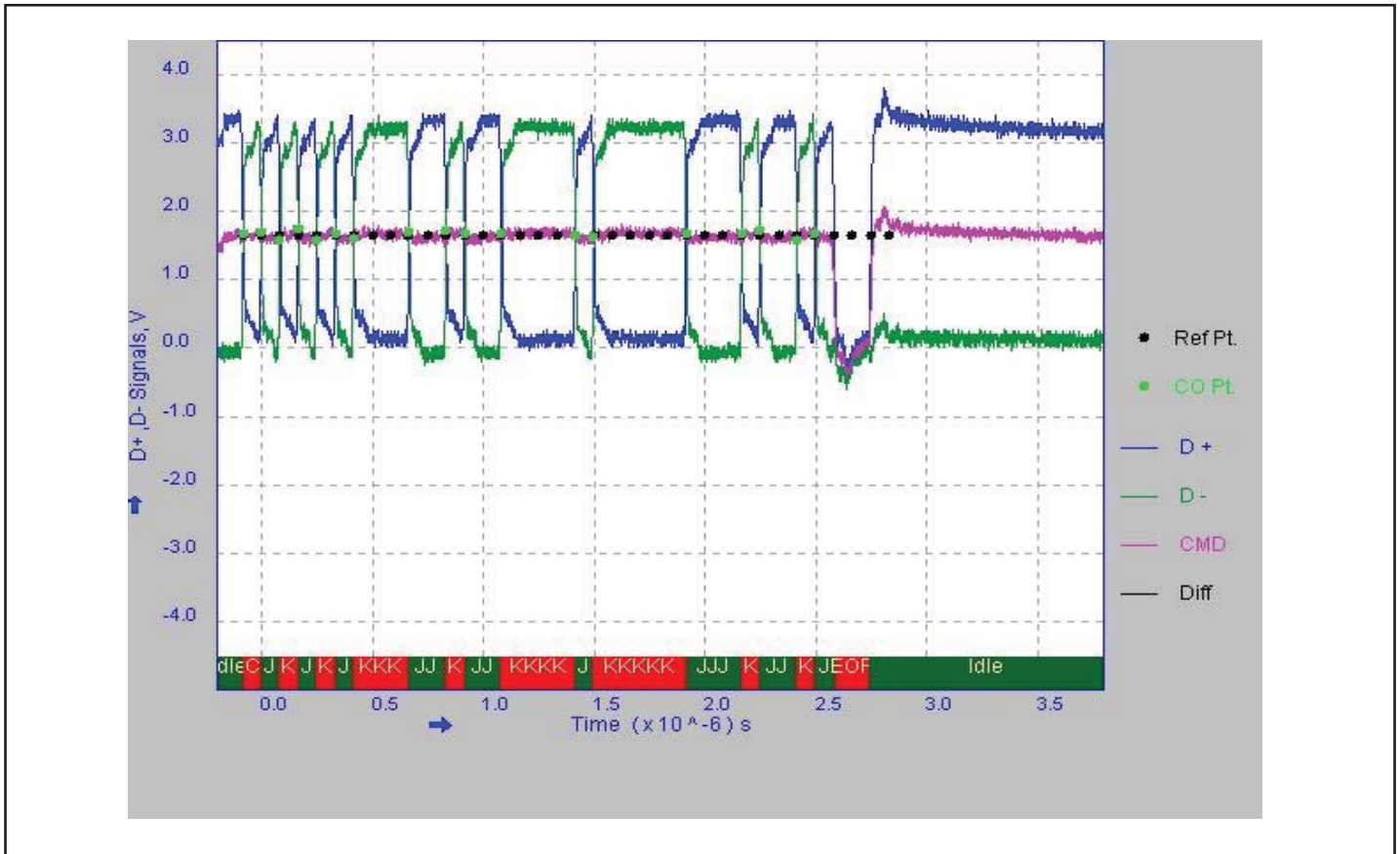
Figure 4. Waveform Plot
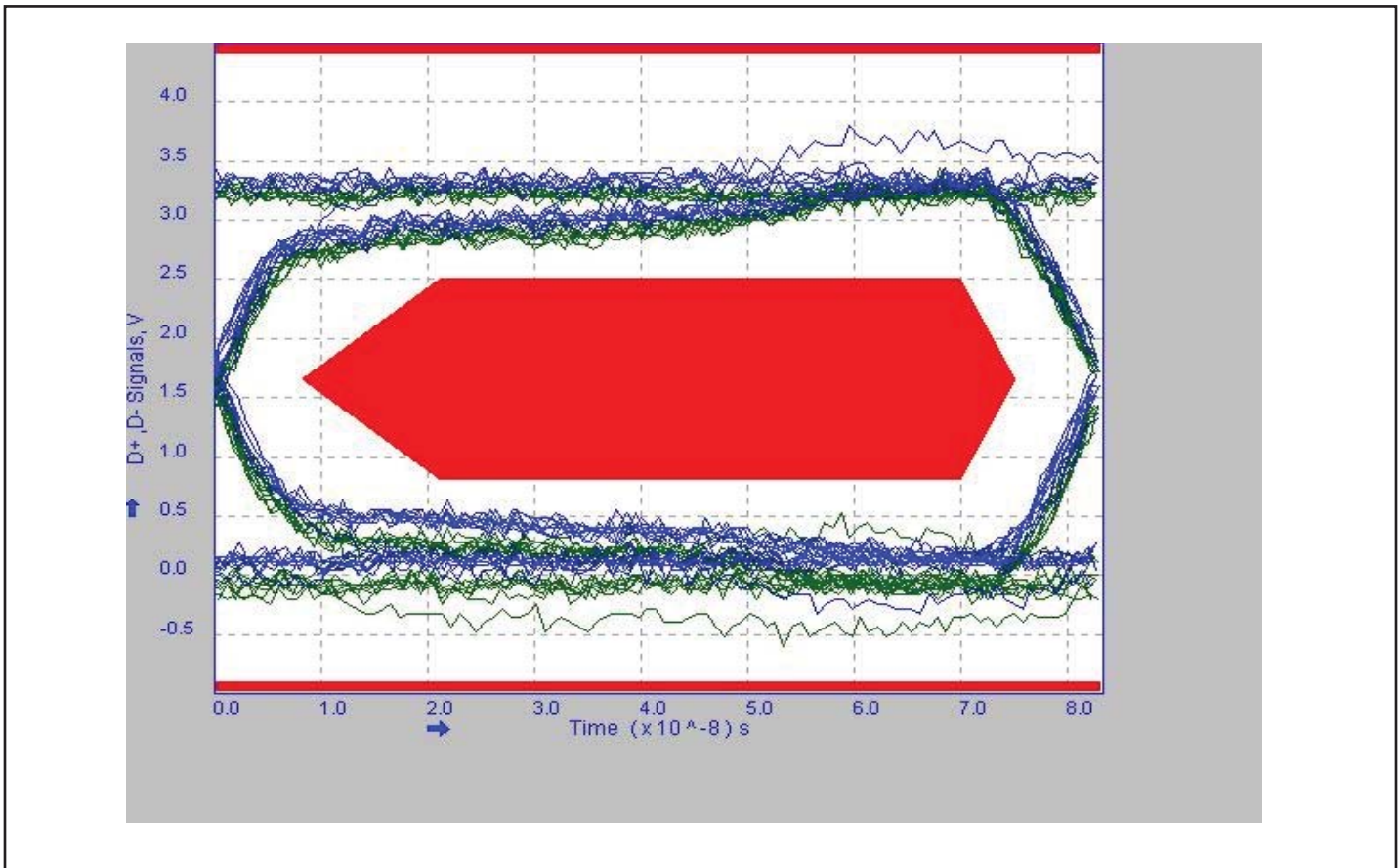
Figure 5. Eye Diagram

Results based on USB-IF / Waiver Limits :

Measurement Name	Minimum	Maximum	Mean	pk-pk	Standard Deviation	RMS	Popu-lation	Status
Eye Diagram Test	-	-	-	-	-	-	-	Pass
Signal Rate	11.90476Mbps	12.12471Mbps	12.00434Mbps	0.0000bps	79.88911kbps	12.00837Mbps	31	Pass
Crossover Voltage	1.588571 V	1.746667 V	1.661607 V	158.0952mV	47.16220mV	1.662239 V	18	Pass
EOP Width	-	-	166.5854ns	-	-	-	1	Pass
Consecutive Jitter	-706.6734ps	871.2068ps	0.0000s	1.577880ns	471.7937ps	457.7071ps	17	Pass
Paired JK Jitter	-432.8111ps	203.0108ps	-103.3794ps	635.8218ps	194.7113ps	209.4296ps	8	Pass
Paired KJ Jitter	-391.2876ps	349.0961ps	-125.8723ps	740.3836ps	254.9465ps	267.4998ps	7	Pass

Additional Information :
 Rise Time: Min: 30.890ns Max: 540.81ns Mean: 217.87ns Std: 230.23ns RMS: 306.35ns Population: 8
 Fall Time: Min: 28.568ns Max: 620.31ns Mean: 182.20ns Std: 200.98ns RMS: 262.87ns Population: 9

* The Overall Result for this test is Pass, because individual status of the measurements is Pass and it is performed on Tier 6 (as per USB-IF).

Part B: USB 2.0 High Speed Compliance Test Result
Signal Quality Test Results in Tektronix format
Device Description: High Speed, Near End Device, Up Stream Testing, Tier 1, Dummy Device.
Overall Result: Pass*

Figure 6. Waveform Plot

Figure 7. Eye Diagram

Results based on USB-IF / Waiver Limits

Measurement Name	Minimum	Maximum	Mean	pk-pk	Standard Deviation	RMS	Popu-lation	Status
Monotonic Property	-	-	-	-	-	-	0	Pass
Eye Diagram Test	-	-	-	-	-	-	-	Pass
Signal Rate	470.3833Mbps	491.3558Mbps	480.0858Mbps	0.0000bps	4.946610Mbps	480.2564Mbps	513	Pass
EOP Width	-	-	16.32403ns	-	-	-	1	Pass
EOP Width (Bits)	-	-	7.836932	-	-	-	1	Pass
Rise Time	771.4486ps	1.081520ns	910.3355ps	310.0716ps	62.09212ps	912.4309ps	107	Pass
Fall Time	757.9116ps	1.046563ns	889.0831ps	288.6509ps	61.68317ps	891.2003ps	7	Pass

Monotonicity test is performed on the test limits of 15.0% and 85.0%.

Additional Information :
  Consecutive Jitter range : -71.64ps to 118.7ps RMS Jitter 37.48ps
  KJ Paired Jitter range : -79.45ps to 86.69ps RMS Jitter 33.26ps
  JK Paired Jitter range : -70.36ps to 77.29ps RMS Jitter 25.08ps

*The Overall Result for this test is Pass, because one or more individual status of the measurements is Pass.
For this test, the recommended configuration for USB2 testing (as per USB-IF) is on Tier 1
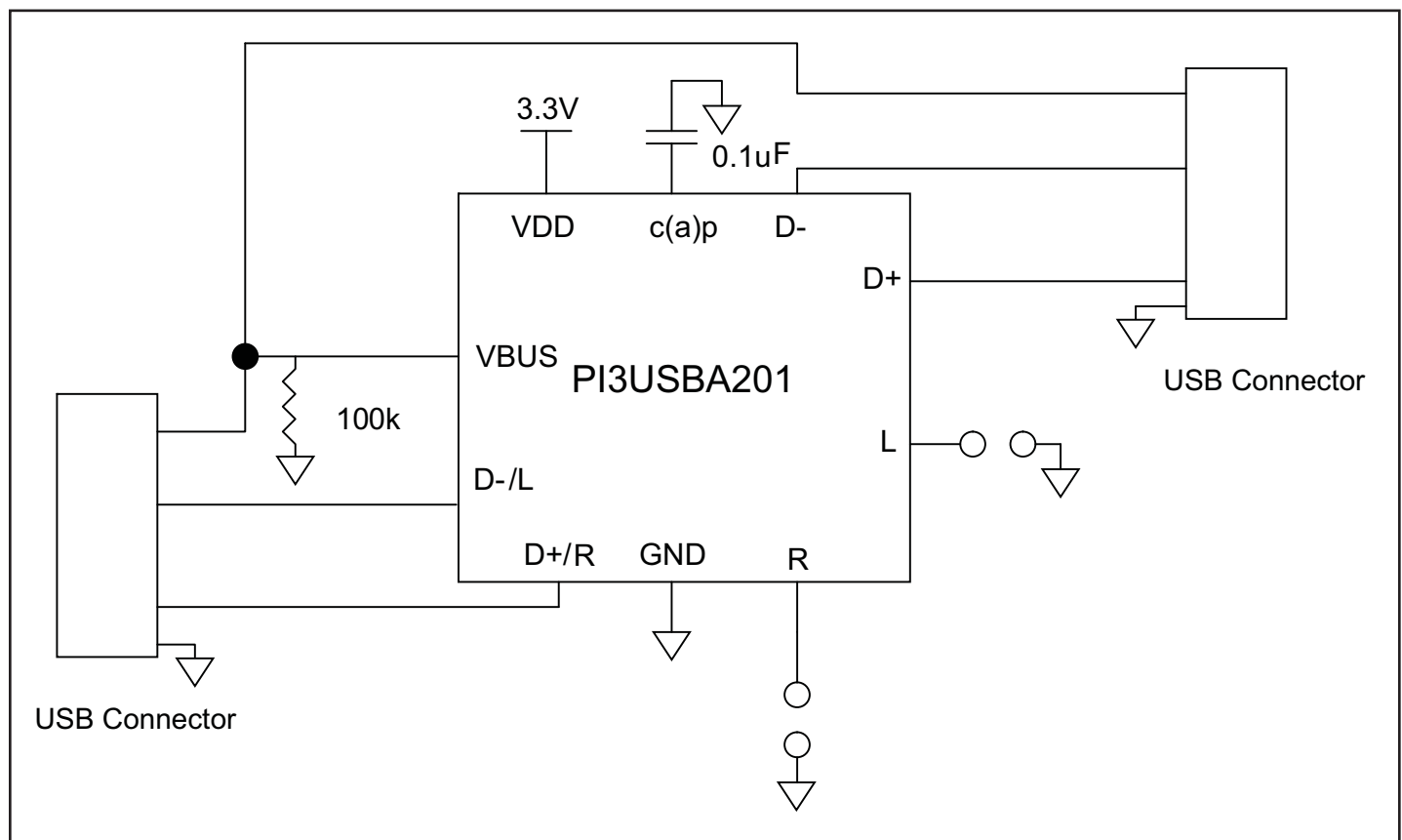
Figure 8. PI3USBA201 USB Compliance Test Schematic

Section 3. Pop Sound Elimination Evaluation

Pop sound elimination is evaluated with long switch time feature. Moreover, pop sound is evaluated with AC coupling capacitor placed before PI3USBA201 and after PI3USBA201. A MP3 player is used as a source and Philips headset is used to confirm the pop sound occurs or not.

Long switch time evaluation:
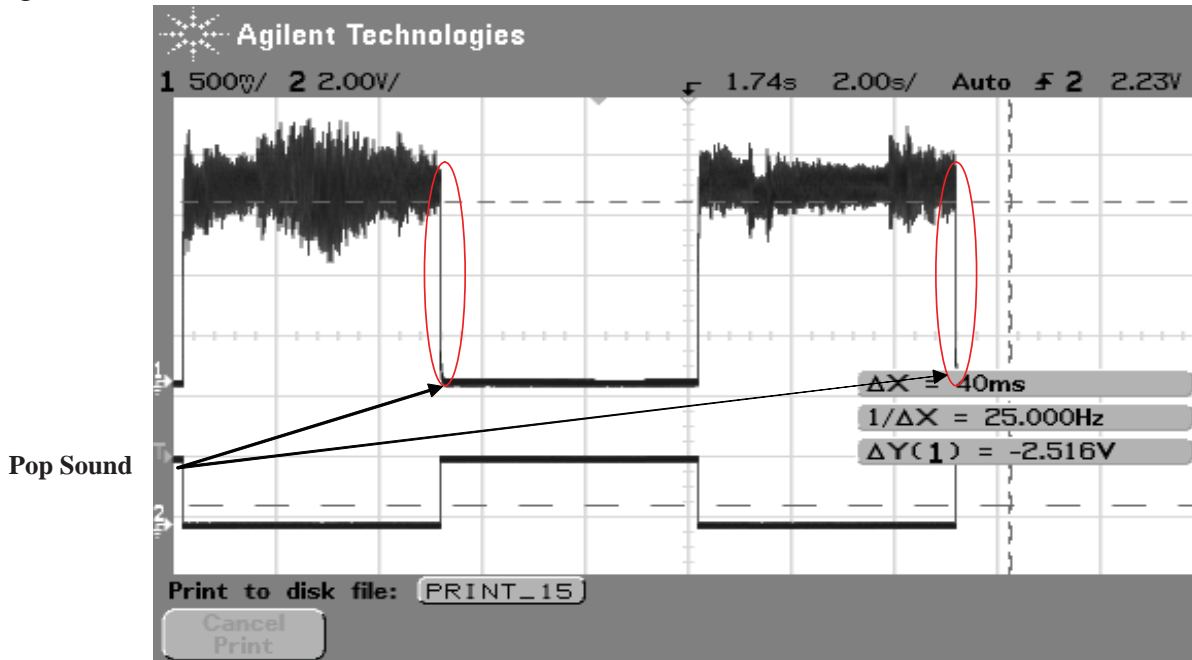
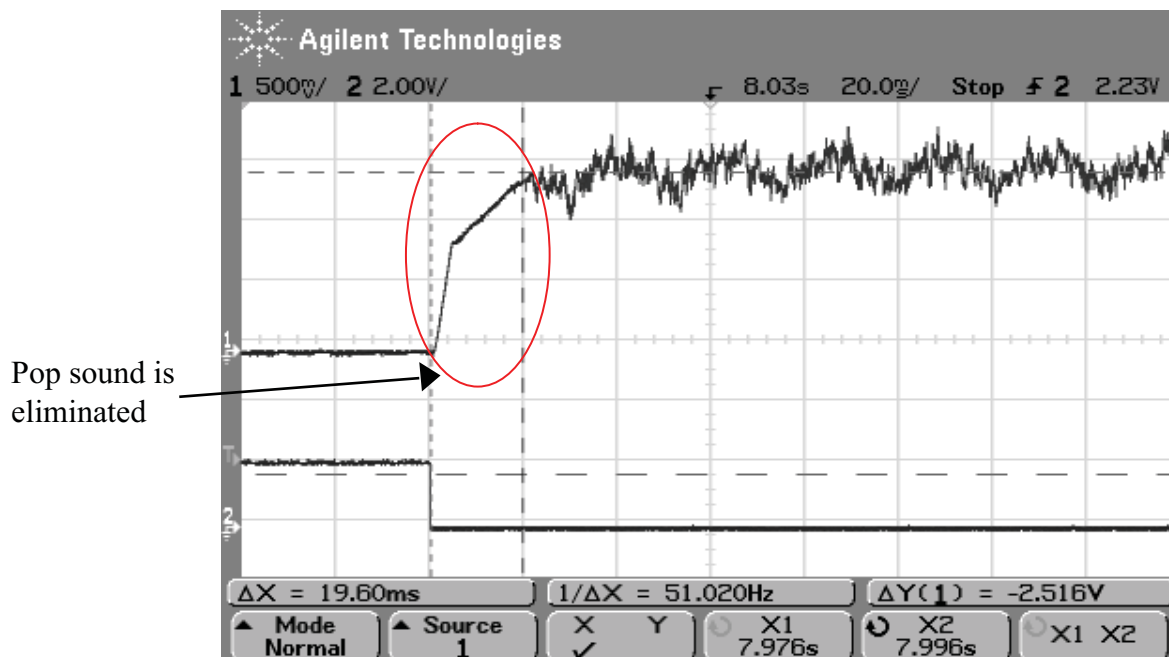**Figure 9: Pop sound with 0.1µF cap at the c(a)p pin**

Figure 10: Pop sound with 0.1µF cap at the c(a)p pin (switching from USB path to Audio path)
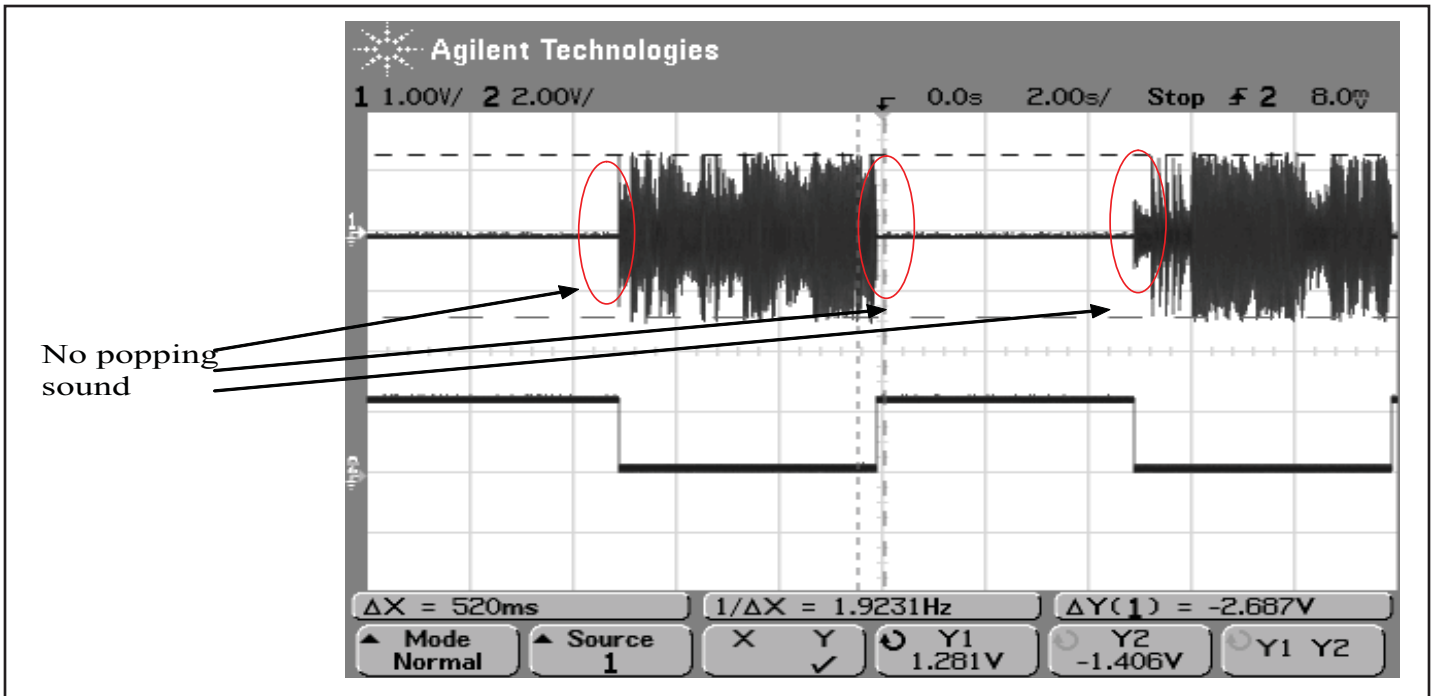
Figure 11: Pop sound elimination with AC coupling capacitor placed before PI3USBA201
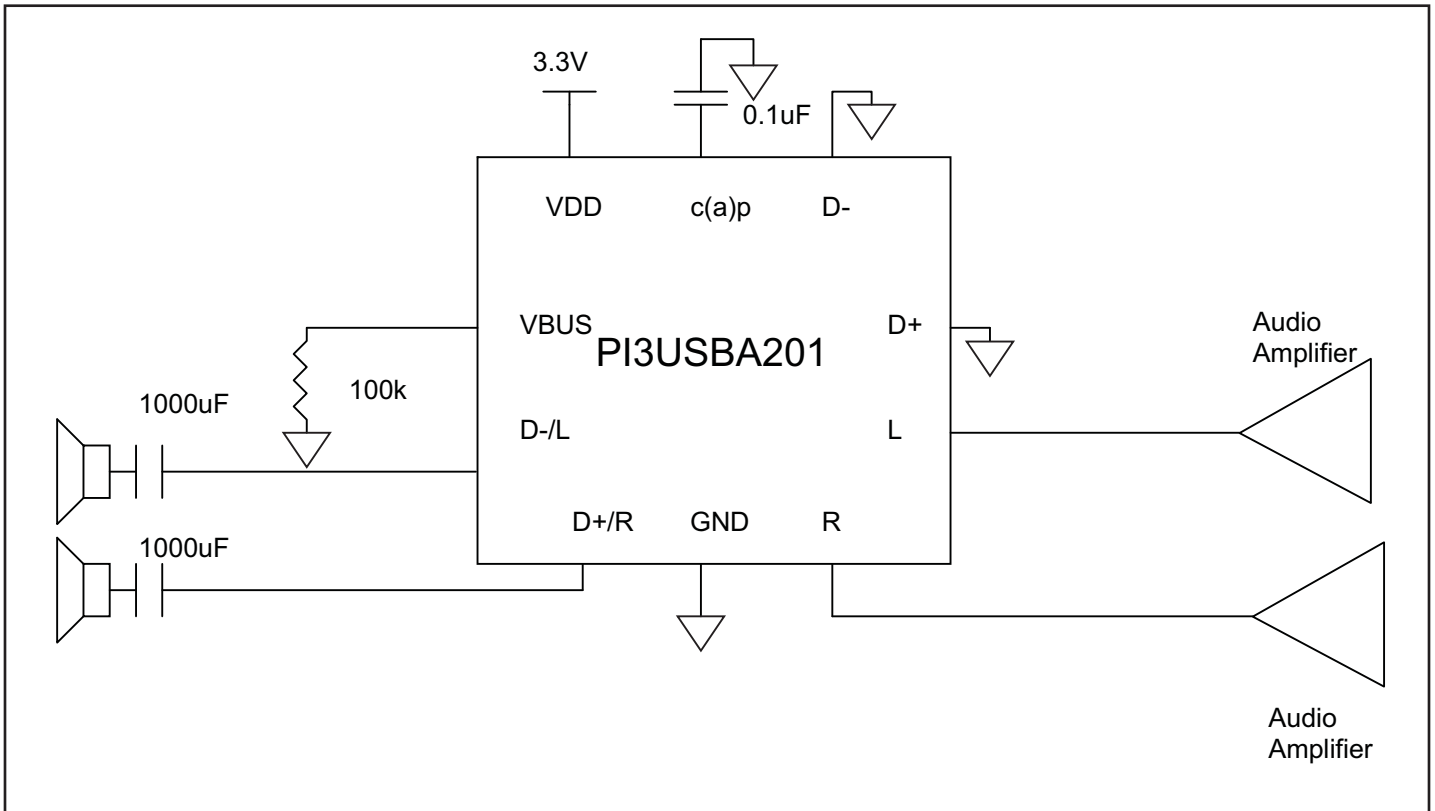
Figure 12: Schematic of Testing Pop sound elimination with Long Switching Time
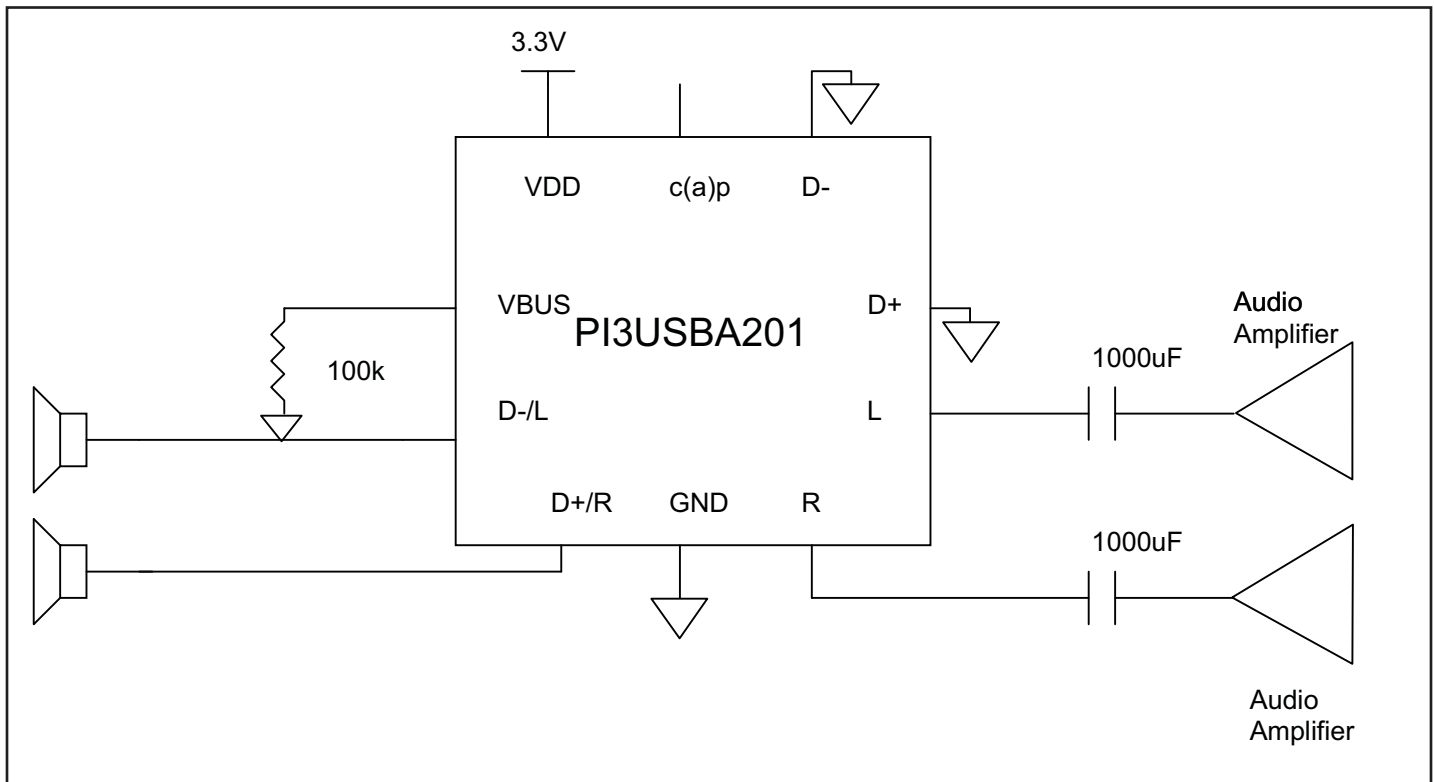
Figure 13: Schematic of Testing Pop sound elimination with AC coupling capacitor placed before PI3USBA201

Conclusion

1. Pop sound evaluation:

   a. Using long switch time, pop sound still occurs when PI3USBA201 switches to USB port. Pop sound is eliminated when PI3USBA201 switches to Audio port. Please refer to Figure 9 to 10.

   b. When placing AC coupling capacitor, pop sound is eliminated. Please refer to Figure 11.

Test Circuits and Timing Diagrams

C_L INCLUDES FIXTURE AND STRAY CAPACITANCE.

Figure 1. AC Test Circuit
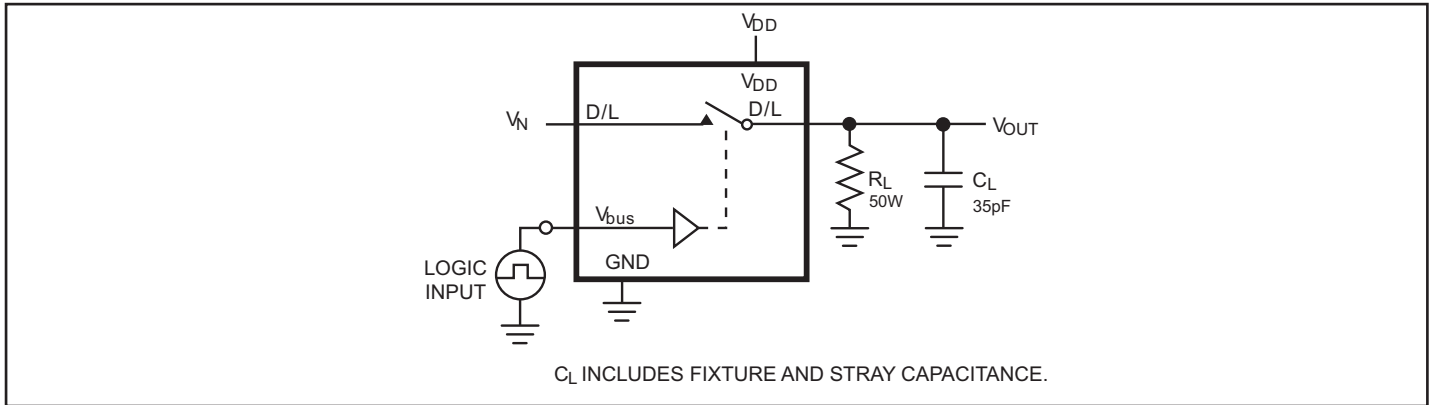
Note:
1. Unused input (NC or NO) must be grounded.

Logic Input Waveforms inverted for
Switches that have opposite logic
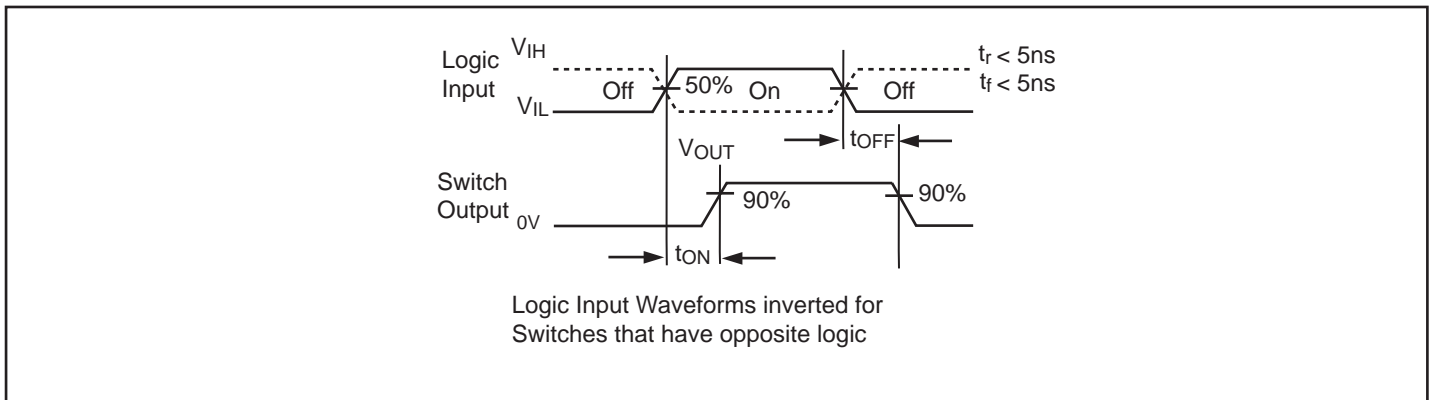
Figure 2. AC Waveforms
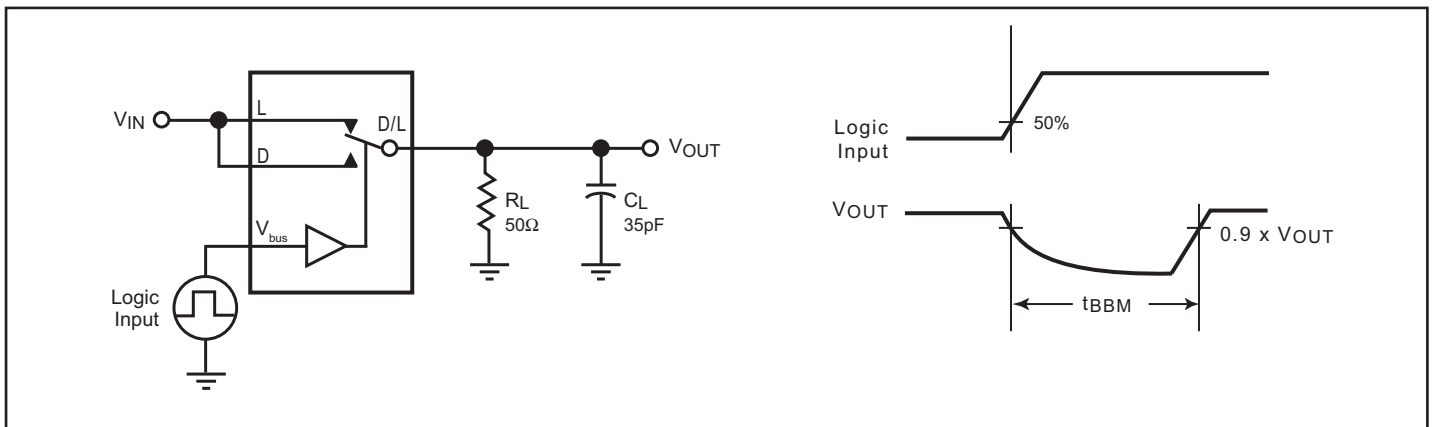
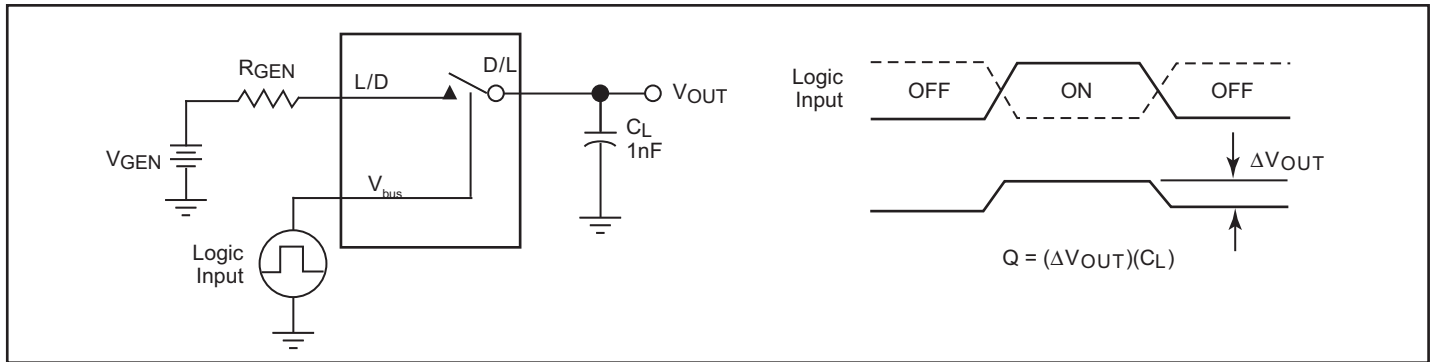**Figure 3. Break Before Make Interval Timing**
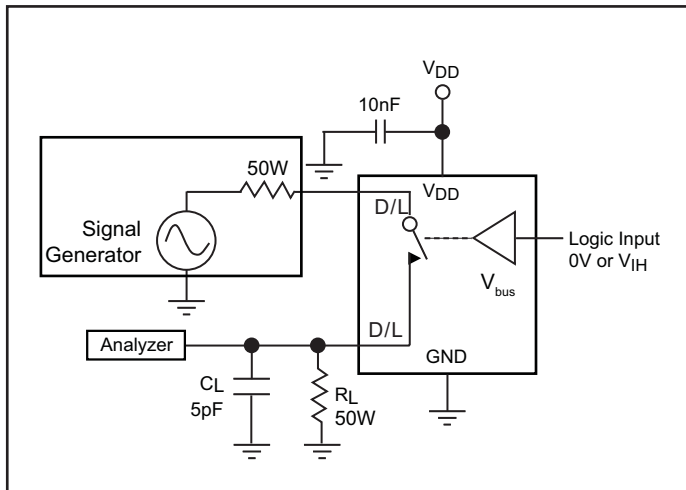
Figure 4. Charge Injection Test
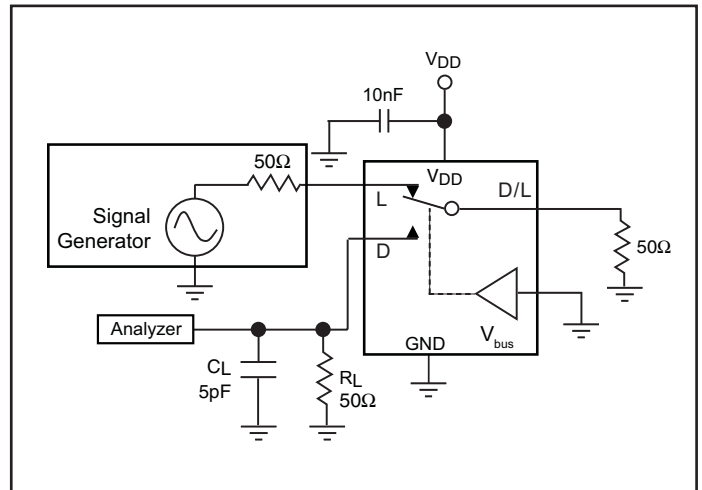

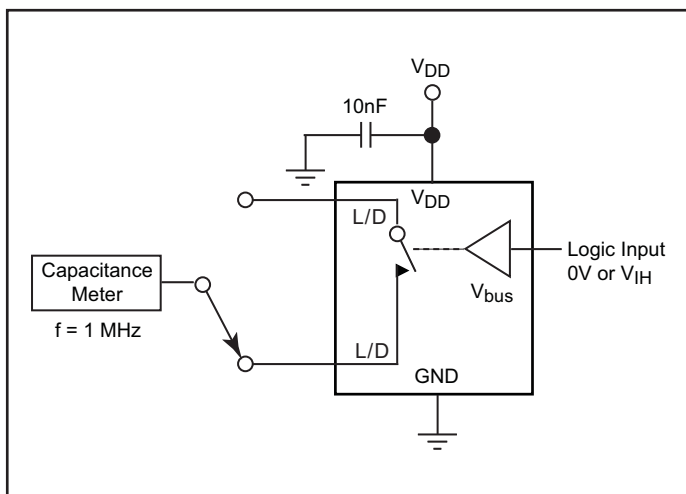**Figure 5. Off Isolation**

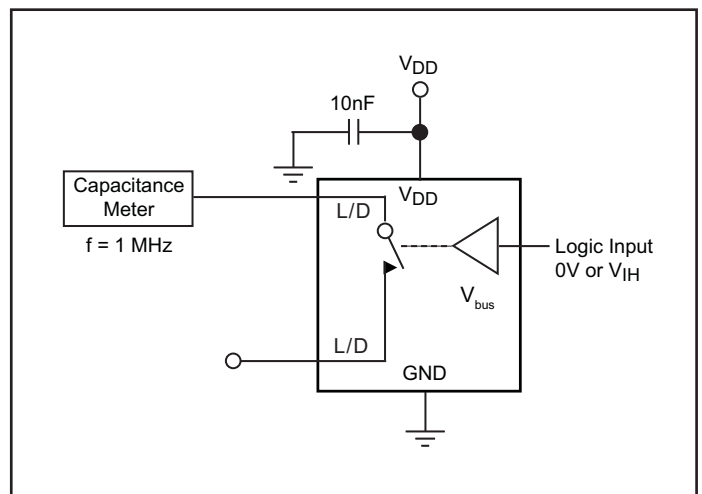**Figure 6. Crosstalk**

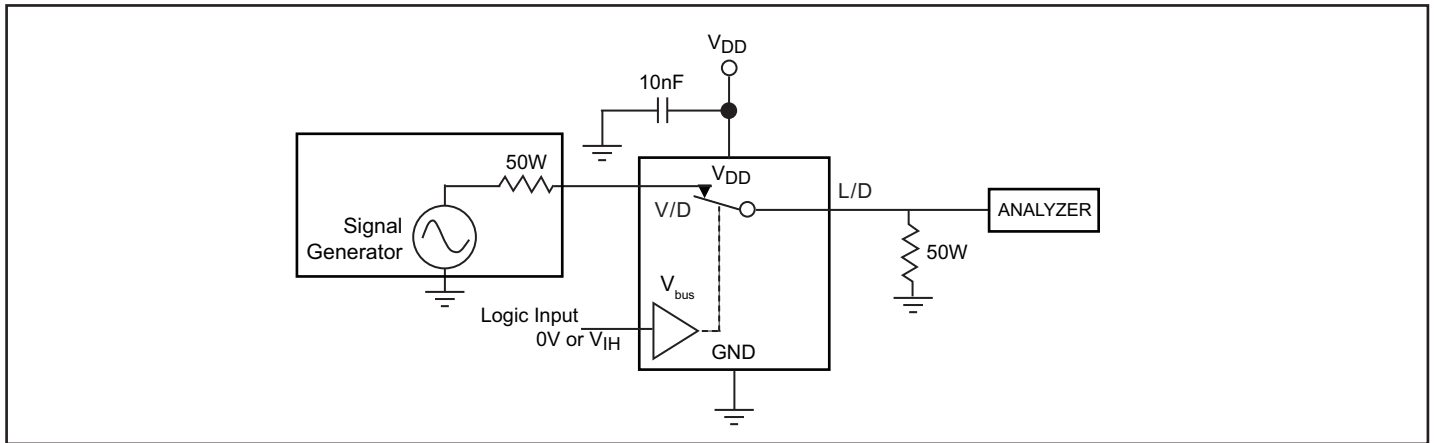**Figure 7. Channel Off Capacitance**

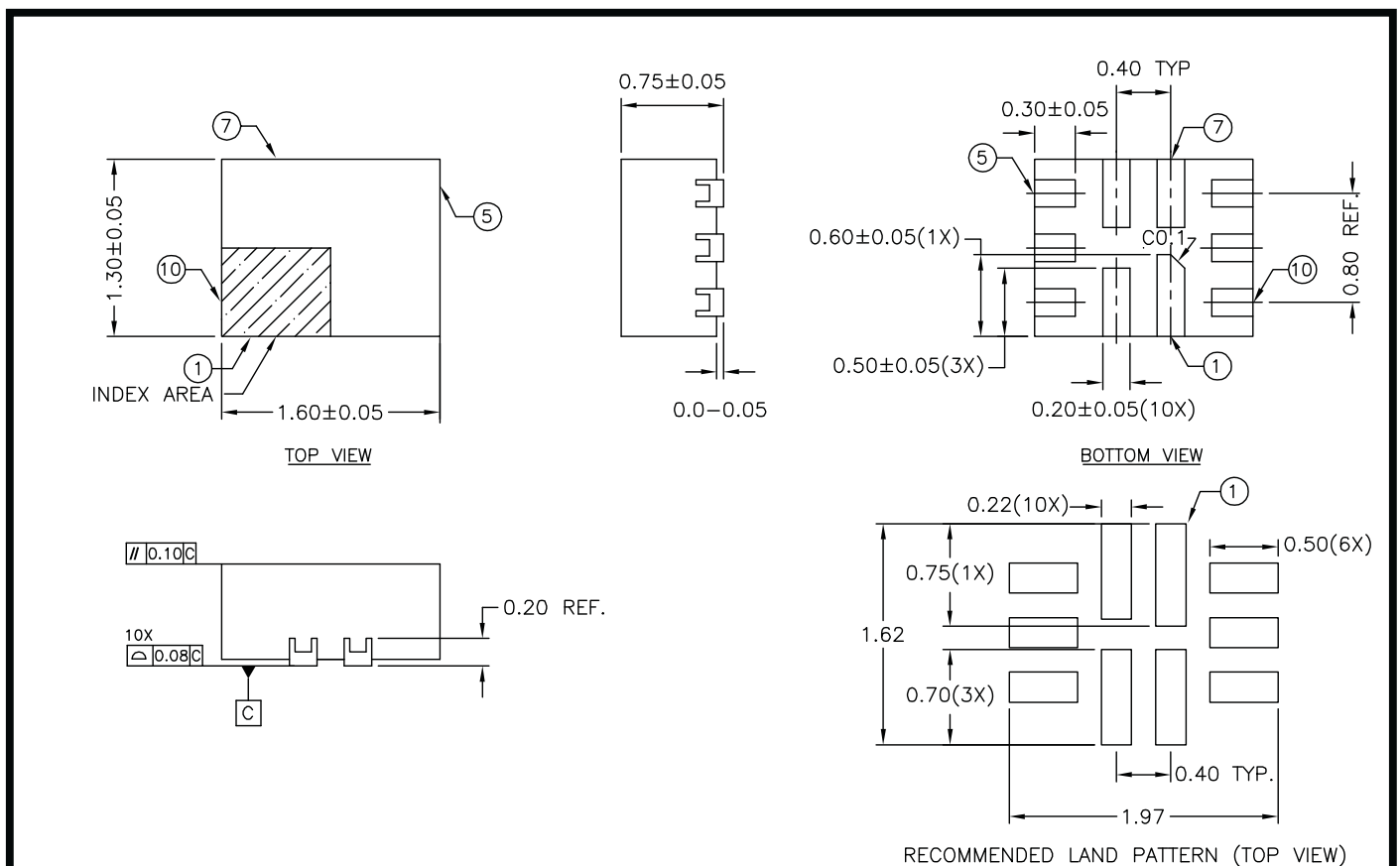
Figure 8. Channel On Capacitance

Figure 9. Bandwidth

Packaging Mechanical: 10-Contact TQFN (ZL)
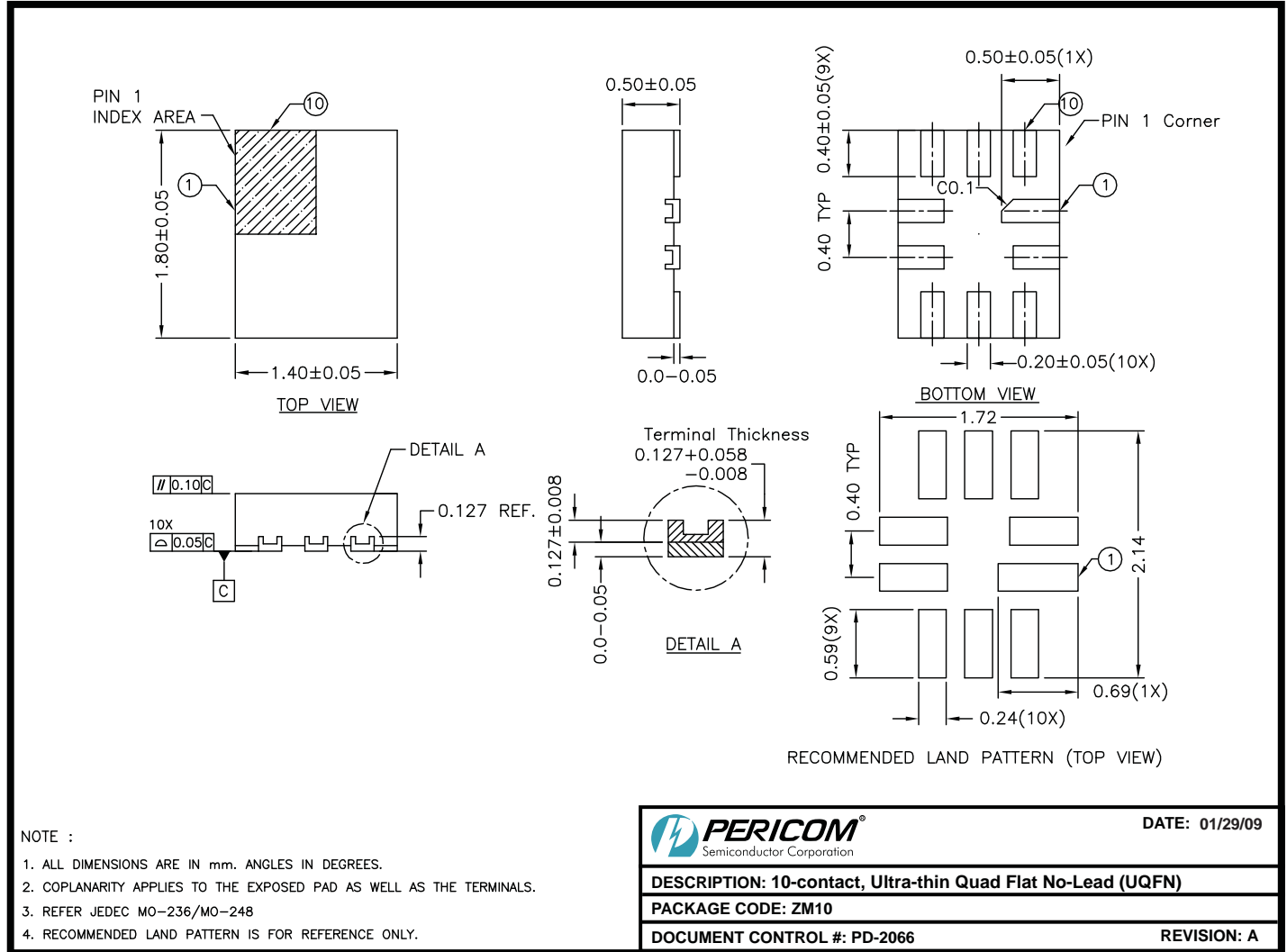

NOTE :

1. ALL DIMENSIONS ARE IN MILLIMETERS.

2. REFER MO-220.

3. RECOMMENDED LAND PATTERN IS FOR REFERENCE ONLY.

	DATE: 01/12/09
Semiconductor Corporation	
DESCRIPTION: 10-Contact, Thin Fine Pitch Quad Flat No-Lead (TQFN)	
PACKAGE CODE: ZL (ZL10)	
DOCUMENT CONTROL #: PD-2052	**REVISION: C**

09-0031

Packaging Mechanical: 10-Contact UQFN (ZM)

	DATE: 01/29/09
DESCRIPTION: 10-contact, Ultra-thin Quad Flat No-Lead (UQFN)	
PACKAGE CODE: ZM10	
DOCUMENT CONTROL #: PD-2066	**REVISION: A**

NOTE :

1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
3. REFER JEDEC MO-236/MO-248
4. RECOMMENDED LAND PATTERN IS FOR REFERENCE ONLY.

09-0072

Ordering Information

Ordering Code	Package Code	Package Description	Top Mark
PI3USBA201ZLE	ZL	Pb-free & Green, 10-contact TQFN	FG
PI3USBA201ZME	ZM	Pb-free & Green, 10-contact UQFN	FG

Notes:
• Thermal characteristics can be found on the company web site at www.pericom.com/packaging/
• E = Pb-free and Green
• X suffix = Tape/Reel

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