NS5S1153

USB 2.0 High Speed and Audio Switch with Negative Swing Capability

The NS5S1153 is a DPDT switch for combined true−ground audio and USB 2.0 high speed data applications. It allows portable systems to use a single port to pass either USB data or audio signals from an external headset; headset; the 2 channels being compliant to USB 2.0, USB 1.1 and USB 1.0.

The switch is capable of passing signals with negative voltages as low as 2 V below ground. The device features shunt resistors on the audio ports. These resistors are switched in when the audio channel is off and provide a safe path to ground for any charge that may build up on the audio lines. This reduces Pop & Click noise in the audio system. The NS5S1153 is also equipped with V_{BUS} detection circuitry to immediately switch to USB mode in the event that a voltage is detected on V_{BUS}.

The NS5S1153 is housed in a space saving, ultra low profile 1.4 x 1.8 x 0.5 mm 10 pin UQFN package.

Features

- 2:1 High Speed Switch
- USB 2.0, USB 1.1 & USB 1.0 Capable on all channels
- High Bandwidth of 820 MHz on D+/D−
- Capable of Passing Negative Swing Signals Down to −2 V on R/L Channel
- 1.8 V Compatible Control Pin & VBUS Detection Circuitry for Automatic Switching
- Audio Channel Shunt Resistors for Pop & Click Noise Reduction
- Ultra−Low THD in Audio Mode: 0.01% into 16 Ω Load
- 5.25 V Tolerant Common Pins
- This is a Pb−Free Device

Typical Applications

- Micro or Mini USB Applications
- Shared High Speed Data or Audio on a Single Connector
- Mobile Phones
- Tablets
- Bar Code Scanners
- Portable Devices

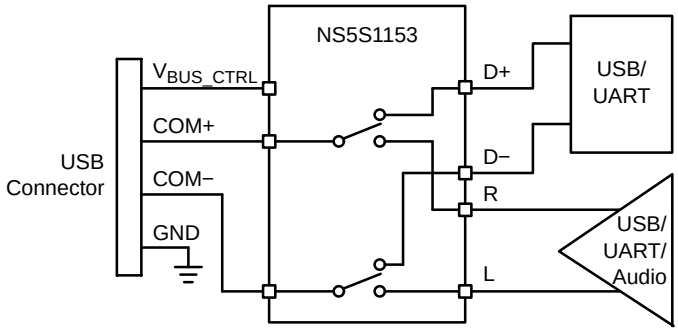
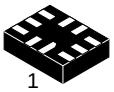


Figure 1. Application Diagram

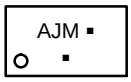
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MARKING DIAGRAMS



UQFN10
CASE 488AT



AJ = Specific Device Code
M = Date Code
▪ = Pb−Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

Device	Package	Shipping†
NS5S1153MUTAG	UQFN10 (Pb−Free)	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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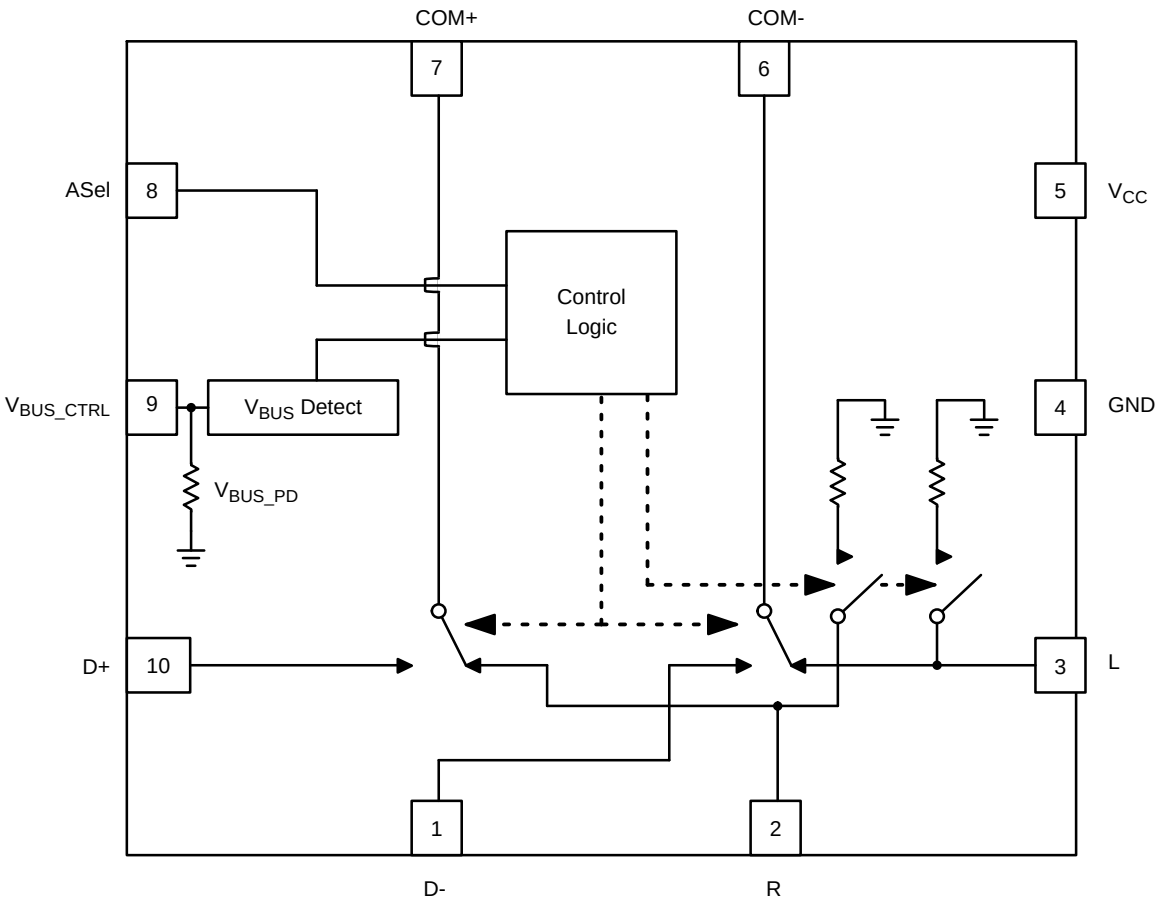


Figure 2. Functional Block Diagram
(Top View)

PIN DESCRIPTIONS

Pin #	Name	Direction	Description
1	D−	I/O	Negative Data Line for USB Signals
2	R	I/O	Right Line for Audio Signals
3	L	I/O	Left Line for Audio Signals
4	GND	Power	Ground
5	V_{CC}	Power	Power Supply
6	COM−	I/O	Left Audio / Negative Data Common Line
7	COM+	I/O	Right Audio / Positive Data Common Line
8	A_{SEL}	Input	Control Input Override Select Line
9	V_{BUS_CTRL}	Input	Control Input Select Line from V_{BUS}. If this pin is driven by an open drain I/O, we suggest maximum 100 kΩ pull up.
10	D+	I/O	Positive Data Line for USB Signals

TRUTH TABLE

A_{SEL}	V_{BUS}	L, R	D+, D−	L, R SHUNT
Low	Low	ON	OFF	OFF
Low	High	OFF	ON	ON
High	X	ON	OFF	OFF

OPERATING CONDITIONS

MAXIMUM RATINGS

Symbol	Pins	Parameter	Value	Unit
V_{CC}	V_{CC}	Positive DC Supply Voltage	−0.5 to +6.0	V
V_{BUS}	V_{BUS_CTRL}	V_{BUS} Control Input Voltage	−0.5 to +6.0	V
V_{IS}	D+ to COM+ D− to COM−	Analog Signal Voltage	−0.5 to +6.0	V
	R to COM+ L to COM−		−2.5 to V_{CC} + 0.5	
V_{IS}	COM+, COM−	DC Signal Voltage Tolerance (<24 hours)	5.25	V
V_{IN}	ASel	Control Input Override Voltage	−0.5 to +6.0	V
I_{CC}	V_{CC}	Positive DC Supply Current	50	mA
T_S		Storage Temperature	−65 to +150	°C
I_{IS_CON}	COM+, COM− R, L, D+, D−	Analog Signal Continuous Current−Closed Switch	±100	mA
I_{IS_PK}	COM+, COM− R, L, D+, D−	Analog Signal Continuous Current 10% Duty Cycle	±500	mA
I_{IN}	ASel	Control Input Override Current	1	mA
	V_{BUS_CTRL}	VBUS Control Input Current	1	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

RECOMMENDED OPERATING CONDITIONS

Symbol	Pins	Parameter	Min	Max	Unit
V_{CC}	V_{CC}	Positive DC Supply Voltage	2.7	5.0	V
V_{BUS}	V_{BUS_CTRL}	V_{BUS} Control Input Voltage	GND	5.25	V
V_{IS}	D+ to COM+ D− to COM−	Analog Signal Voltage (Note 1)	GND	V_{CC}	V
	R to COM+ L to COM−		−2.0	V_{CC}	
V_{IN}	ASel	Control Input Override Voltage	GND	V_{CC}	V
T_A		Operating Temperature	−40	+85	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

1. In USB mode, any signal applied to the off−state audio inputs R, L may not swing below ground or above 1.5 V.

DC ELECTRICAL CHARACTERISTICS

CONTROL INPUT (Typical: T = 25°C, V_{CC} = 3.3 V)

Symbol	Pins	Parameter	Test Conditions	V_{CC} (V)	−40°C to +85°C			Unit
					Min	Typ	Max	
V_{IH}	A_{SEL}	Control Input HIGH Voltage		2.7 3.3 4.2	1.3 1.4 1.5	−	−	V
V_{IL}	A_{SEL}	Control Input LOW Voltage		2.7 3.3 4.2	−	−	0.4 0.4 0.4	V
I_{IN}	A_{SEL}	Current Input Leakage Current	$0 \le V_{IS} \le V_{CC}$	4.2	−	−	±50	nA
V_{IH}	V_{BUS_CTRL}	V_{BUS} Control Input HIGH Voltage		2.7 3.3 4.2	1.9 2.2 2.7	−	−	V
V_{IL}	V_{BUS_CTRL}	V_{BUS} Control Input LOW Voltage		2.7 3.3 4.2	−	−	0.8 1.1 1.6	V
I_{IN}	V_{BUS_CTRL}	V_{BUS} Current Input Leakage Current	$0 \le V_{IS} \le V_{CC}$	4.2	−	−	±25	μA

SUPPLY CURRENT AND LEAKAGE (Typical: T = 25°C, V_{CC} = 3.3 V)

Symbol	Pins	Parameter	Test Conditions	V_{CC} (V)	−40°C to +85°C			Unit
					Min	Typ	Max	
$I_{NC,NO(OFF)}$	D+, D−	OFF State Leakage	V_{BUS_CTRL} = 0 V, 4.2 V; V_{COM-}, V_{COM+} = 0 V, 4.2 V V_{D+}, V_{D-} = 4.2 V, 0 V or float V_L, V_R = float or 4.2 V, 0 V	4.2			±80	nA
$I_{COM(ON)}$	COM−, COM+	ON State Leakage	V_{BUS_CTRL} = 0 V, 4.2 V; V_{COM-}, V_{COM+} = 0 V, 4.2 V V_{D+}, V_{D-} = 4.2 V, 0 V or float V_L, V_R = float or 4.2 V, 0 V	4.2			±100	nA
I_{CC}	V_{CC}	Quiescent Supply	V_{IS} = GND to V_{CC}; I_D = 0 A	4.2		21	35	μA
I_{OFF}	COM−, COM+	Power OFF Leakage	$0 \le V_{IS} \le 4.2$ V	0			50	μA

USB ON RESISTANCE (Typical: T = 25°C, V_{CC} = 3.3 V)

Symbol	Pins	Parameter	Test Conditions	V_{CC} (V)	−40°C to +85°C			Unit
					Min	Typ	Max	
R_{ON}	D+ to COM+ D− to COM−	On−Resistance	I_{ON} = 10 mA V_{IS} = 0 V to V_{CC}	2.7 3.3 4.2		3.0 3.0 3.0	5.5 4.6 4.6	Ω
R_{FLAT}	D+ to COM+ D− to COM−	On−Resistance Flatness	I_{ON} = 10 mA V_{IS} = 0 V to V_{CC}	2.7 3.3 4.2		0.08 0.08 0.08		Ω
ΔR_{ON}	D+ to COM+ D− to COM−	On−Resistance Matching	I_{ON} = 10 mA V_{IS} = 0 V to V_{CC}	2.7 3.3 4.2		0.03 0.03 0.03		Ω

AUDIO ON RESISTANCE (Typical: T = 25°C, V_{CC} = 3.3 V)

Symbol	Pins	Parameter	Test Conditions	V_{CC} (V)	−40°C to +85°C			Unit
					Min	Typ	Max	
R_{ON}	R to COM+ L to COM−	On−Resistance	I_{ON} = 10 mA V_{IS} = −1.5 to 1.5	2.7 3.3 4.2		3.0 3.0 3.0	4.6 4.6 4.6	Ω
R_{FLAT}	R to COM+ L to COM−	On−Resistance Flatness	I_{ON} = 10 mA V_{IS} = −1.5 to 1.5	2.7 3.3 4.2		0.11 0.11 0.11		Ω
ΔR_{ON}	R to COM+ L to COM−	On−Resistance Matching	I_{ON} = 10 mA V_{IS} = −0.85 to 0.85	2.7 3.3 4.2		0.03 0.03 0.03		Ω
R_{SH}	L, R	Shunt Resistance (Resistor + Switch)	I_{ON} = 10 mA	2.7		118	160	Ω
V_{BUS_PD}	V_{BUS_CTRL}	V_{BUS_CTRL} Pull−down Resistor	I_{ON} = 10 mA			530		kΩ

AC ELECTRICAL CHARACTERISTICS

TIMING/FREQUENCY (Typical: T = 25°C, V_{CC} = 3.3 V, R_L = 50 Ω, C_L = 35 pF, f = 1 MHz)

Symbol	Pins	Parameter	Test Conditions	V_{CC} (V)	−40°C to +85°C			Unit
					Min	Typ	Max	
t_{ON}		Turn−ON Time (Closed to Open) (Figures 8 and 9)		2.7 − 4.2	−	14	−	μs
t_{OFF}		Turn−OFF Time (Closed to Open) (Figures 8 and 9)		2.7 − 4.2	−	75	−	ns
T_{BBM}		Break−Before−Make Time (Figure 7)			−	7.0	−	μs
BW	D+ to COM+ D− to COM−	−3 dB Bandwidth (Figure 10)	C_L = 5 pF R_S = 50 Ω		−	900	−	MHz

ISOLATION (Typical: T = 25°C, V_{CC} = 3.3 V, R_L = 50 Ω, C_L = 5 pF)

Symbol	Pins	Parameter	Test Conditions	V_{CC} (V)	−40°C to +85°C			Unit
					Min	Typ	Max	
O_{IRR}	Open	OFF−Isolation (Figure 10)	f = 100 kHz, R_S = 50 Ω		−	−81	−	dB
X_{TALK}	COM+ to COM−	Non−Adjacent Channel Crosstalk (Figure 10)	f = 100 kHz, R_S = 50 Ω		−	−93	−	dB
THD+N		Total Harmonic Distortion + Noise	V_{BUS_CTRL} = 0 V A_{SEL} = 3.0 V f = 20 Hz to 20 kHz V_{COM} = 0.5 V_{pp} R_L = 600 Ω	3.0	−	0.001	−	%
THD		Total Harmonic Distortion	V_{BUS_CTRL} = 0 V A_{SEL} = 0 V, 3.6 V f = 1 kHz V_{COM} = ±2.0 V_{pp} R_L = 16 Ω	3.6	−	0.01	−	%
PSRR		Power Supply Rejection Ratio	f = 10 kHz R_{COM} = 50 Ω	3.0	−	60	−	dB

CAPACITANCE (Typical: T = 25°C, V_{CC} = 3.3 V, R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, A_{SEL} = 0 V)

Symbol	Pins	Parameter	Test Conditions		−40°C to +85°C			Unit
					Min	Typ	Max	
C_{IN}	A_{SEL}	Control Pin Input Capacitance	V_{CC} = 0 V		−	2.6	−	pF
C_{ON}	D+ to COM+ D− to COM−	USB ON Capacitance	V_{BUS_CTRL} = 5 V		−	6.9	−	pF
C_{ON}	R to COM+ L to COM−	Audio ON Capacitance	V_{BUS_CTRL} = 0 V		−	9.3	−	pF
C_{OFF}	D+, D−	USB OFF Capacitance	V_{BUS_CTRL} = 0 V		−	4.8	−	pF
C_{OFF}	R, L	Audio OFF Capacitance	V_{BUS_CTRL} = 5 V		−	4.8	−	pF

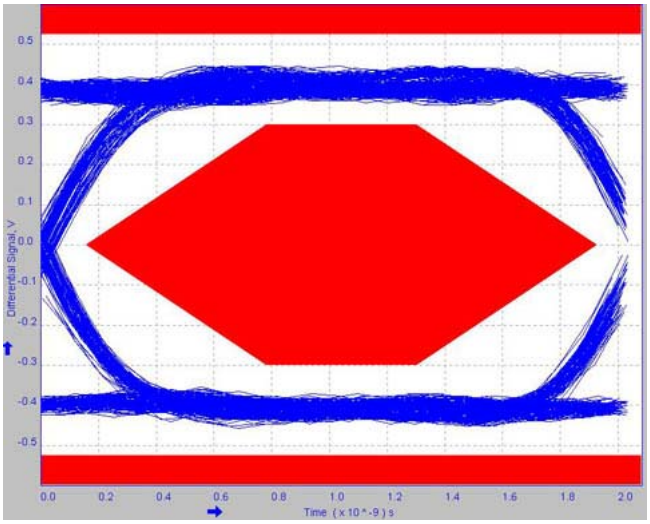


Figure 3. High Speed USB Eye Diagram of Signal Path without Switch

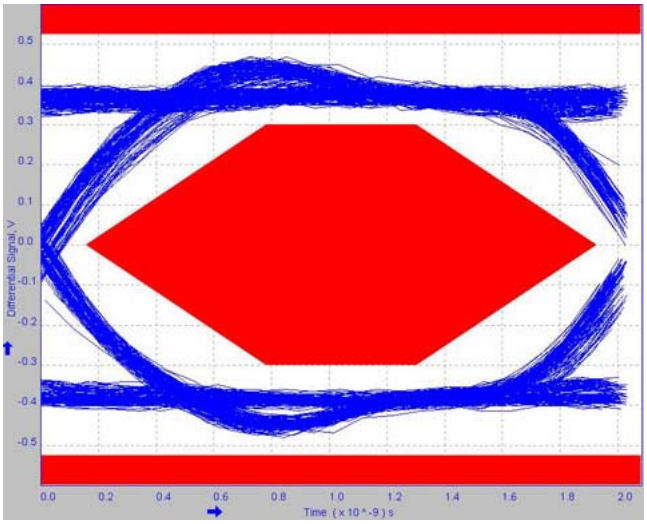


Figure 4. High Speed USB Eye Diagram of Signal Path with NS5S1153 (V_{CC} = 3.6 V)

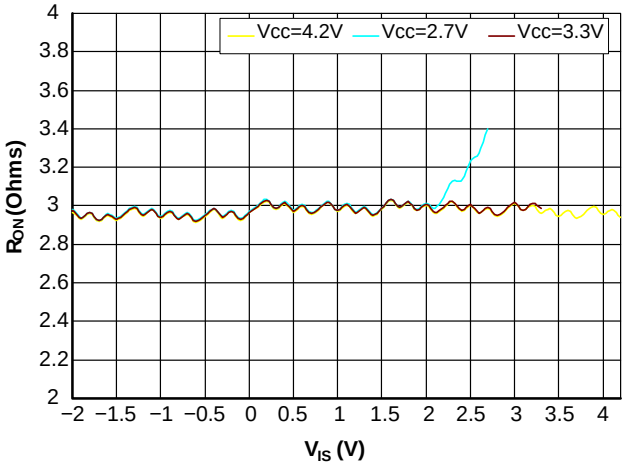


Figure 5. Audio ON Resistance vs. Signal Voltage @ T = 25°C, 2.7 V ≤ V_{CC} ≤ 4.2 V

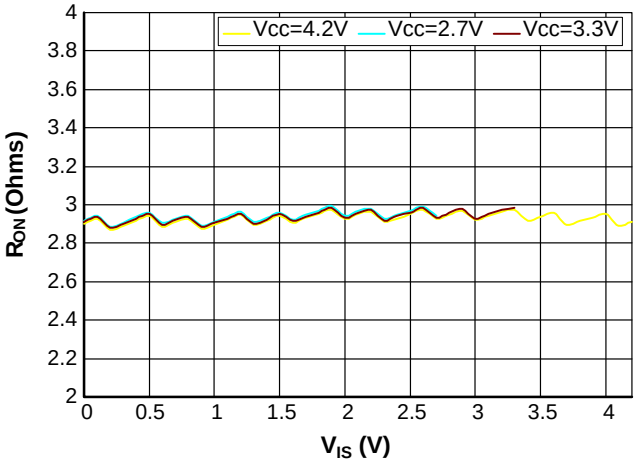


Figure 6. USB ON Resistance vs. Signal Voltage @ T = 25°C, 2.7 V ≤ V_{CC} ≤ 4.2 V

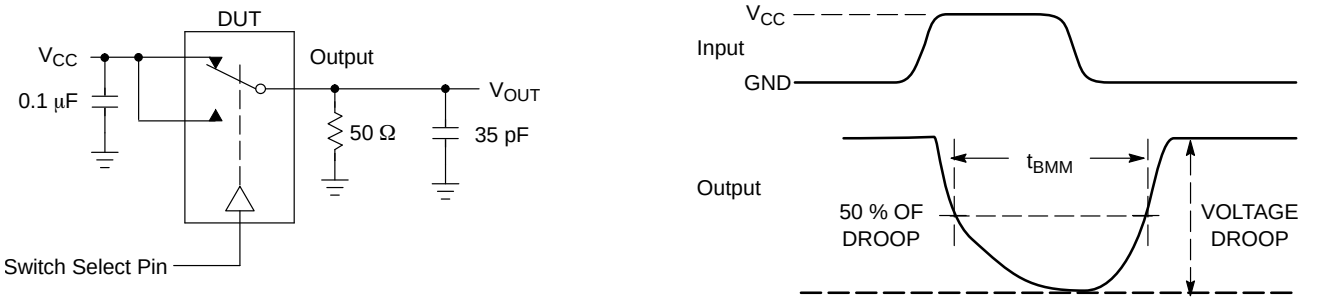


Figure 7. t_{BBM} (Time Break−Before−Make)

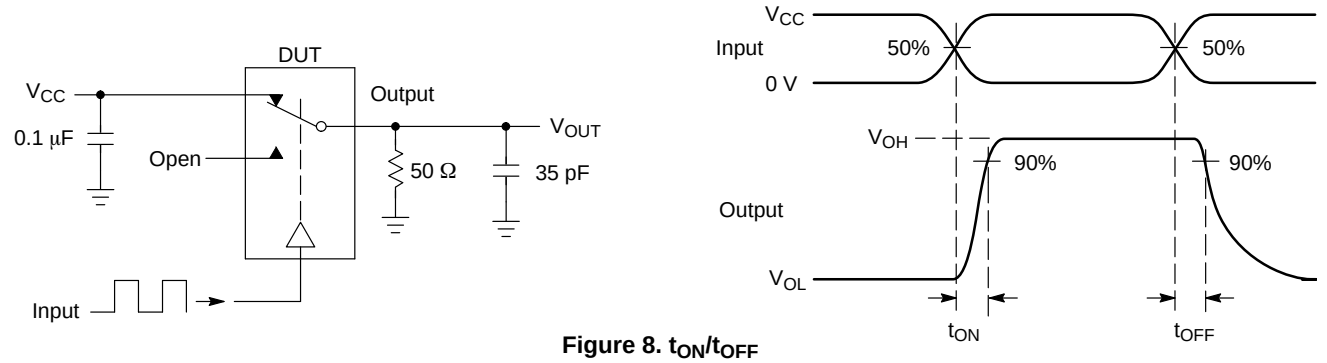


Figure 8. t_{ON}/t_{OFF}

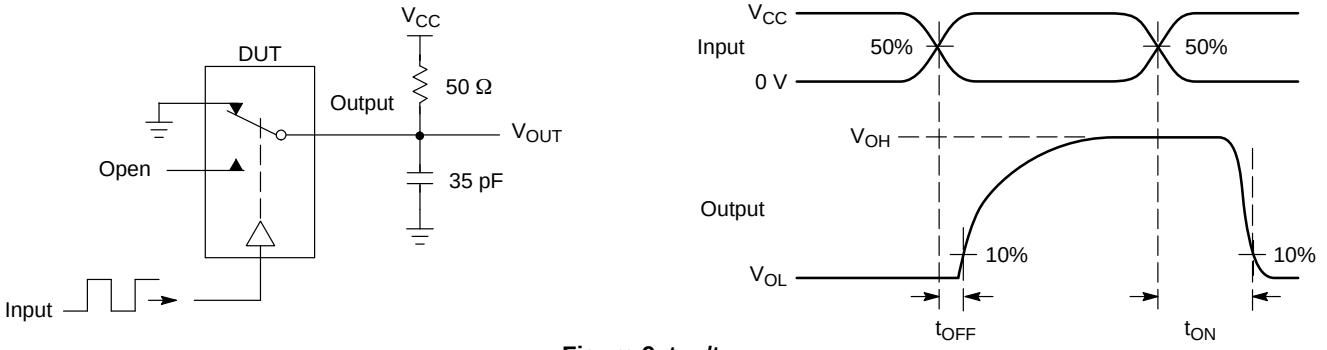
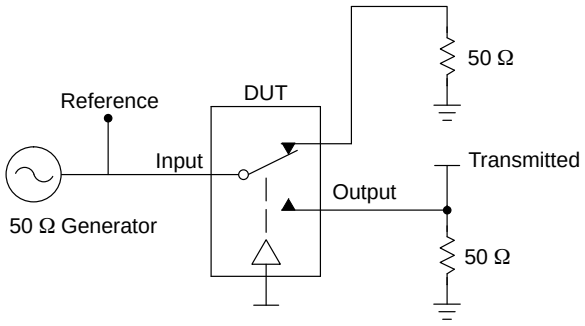


Figure 9. t_{ON}/t_{OFF}



Channel switch control/s test socket is normalized. Off isolation is measured across an off channel. On loss is the bandwidth of an On switch. V_{ISO}, Bandwidth and V_{ONL} are independent of the input signal direction.

V_{ISO} = Off Channel Isolation = 20 Log $\left(\frac{V_{OUT}}{V_{IN}}\right)$ for V_{IN} at 100 kHz

V_{ONL} = On Channel Loss = 20 Log $\left(\frac{V_{OUT}}{V_{IN}}\right)$ for V_{IN} at 100 kHz to 50 MHz

Bandwidth (BW) = the frequency 3 dB below V_{ONL}
V_{CT} = Use V_{ISO} setup and test to all other switch analog input/outputs terminated with 50 Ω

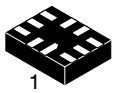
Figure 10. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/V_{ONL}

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

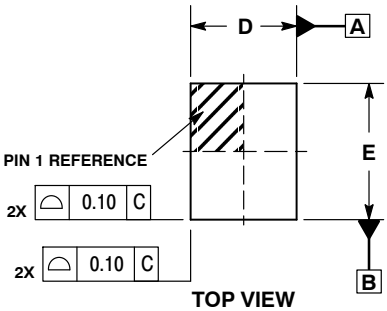
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UQFN10 1.4x1.8, 0.4P
CASE 488AT−01
ISSUE A

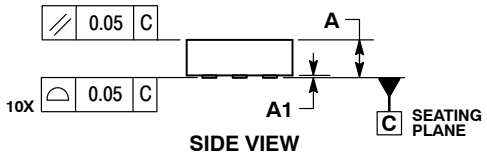
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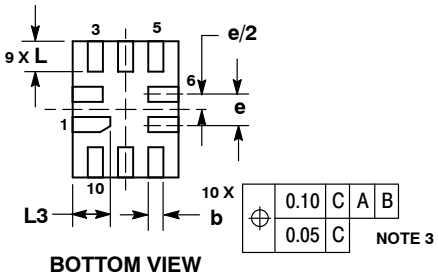
SCALE 5:1



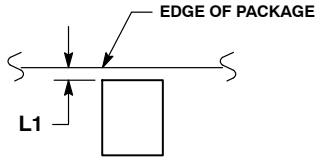
TOP VIEW



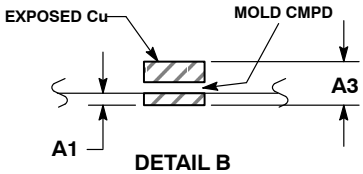
SIDE VIEW



BOTTOM VIEW



DETAIL A
Bottom View
(Optional)

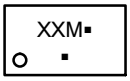


DETAIL B
Side View
(Optional)

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	MILLIMETERS	
DIM	MIN	MAX
A	0.45	0.60
A1	0.00	0.05
A3	0.127 REF	
b	0.15	0.25
D	1.40 BSC	
E	1.80 BSC	
e	0.40 BSC	
L	0.30	0.50
L1	0.00	0.15
L3	0.40	0.60

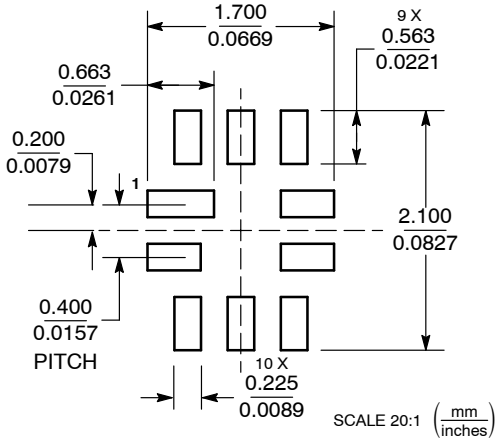
GENERIC MARKING DIAGRAM*



XX = Specific Device Code
M = Date Code
▪ = Pb−Free Package
(Note: Microdot may be in either location)

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

MOUNTING FOOTPRINT



SCALE 20:1 $\left(\frac{\text{mm}}{\text{inches}}\right)$

DOCUMENT NUMBER:	**98AON22493D**	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red.
DESCRIPTION:	**10 PIN UQFN, 1.4 X 1.8, 0.4P**	**PAGE 1 OF 1**

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