NS5S1153

DPDT USB 2.0 High Speed / 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. The switch is capable of passing signals with negative voltages as low as 2 V below ground. 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 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 device has an extended V_{CC} range which can operate off V_{CC} up to 4.2 V while passing true ground audio signals down to −2 V.

Features

- Low R_{ON} Audio /Data DPDT Switch
- Capable of Passing Negative Swing Signals Down to −2 V
- 1.8 V Compatible Control Pin for $2.7\ V \leq V_{CC} \leq 4.2\ V$
- High USB Path Bandwidth (>900 MHz)
- V_{BUS} Detection Circuitry for Automatic Switching Between Audio and USB Modes
- 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

- Shared USB/Audio Connector
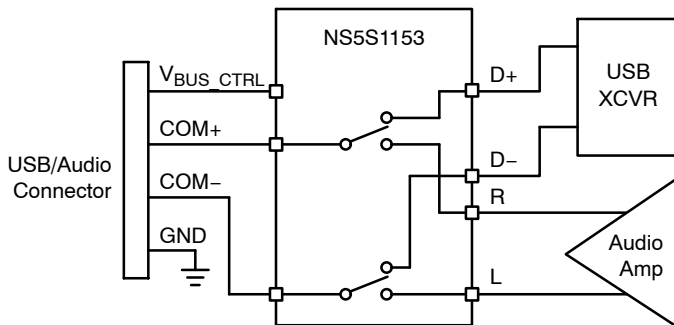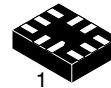- Mobile Phones
- Portable Devices

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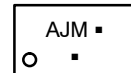**http://onsemi.com**

MARKING DIAGRAMS

UQFN10
CASE 488AT

AJM ▪
○ ▪

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.
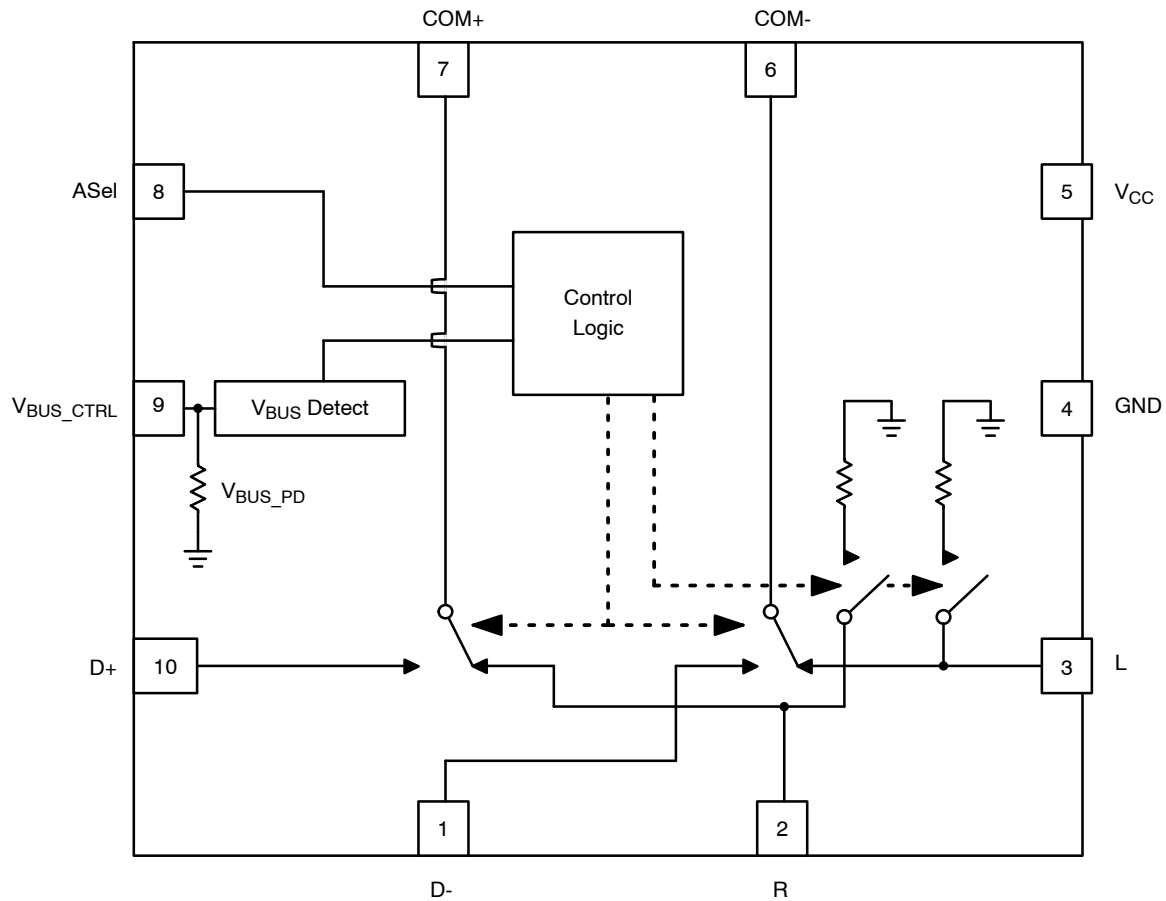

Figure 1. Application Diagram

Publication Order Number:
NS5S1153/D

NS5S1153

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}
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 Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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

Minimum and maximum values are guaranteed through test or design across the Recommended Operating Conditions, where applicable. Typical values are listed for guidance only and are based on the particular conditions listed for section, where applicable. These conditions are valid for all values found in the characteristics tables unless otherwise specified in the test conditions.

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	4.4 4.4 4.4	– 	– 	V
V_{IL}	V_{BUS_CTRL}	V_{BUS} Control Input LOW Voltage		2.7 3.3 4.2	– 	– 	0.8 0.8 0.8	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
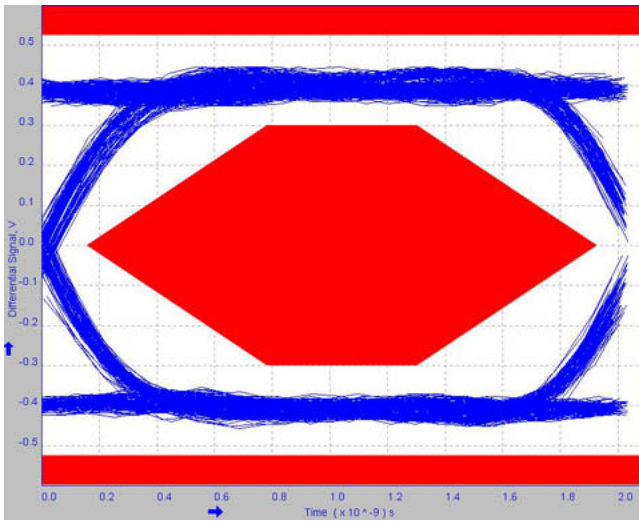
Figure 3. High Speed USB Eye Diagram of Signal Path without Switch
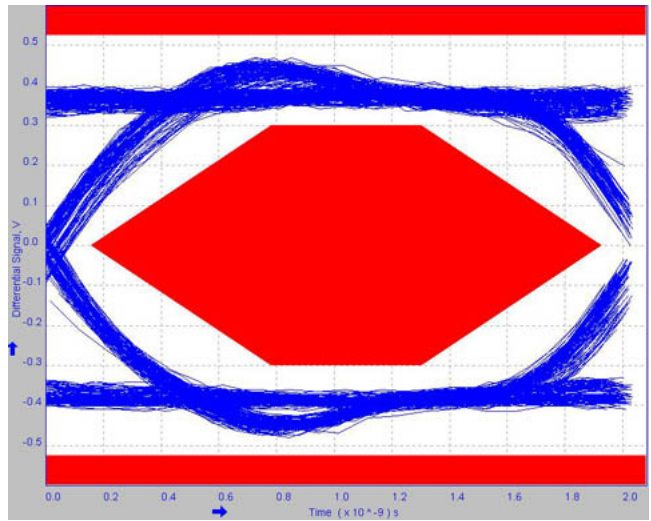
Figure 4. High Speed USB Eye Diagram of Signal Path with NS5S1153 (V$_{CC}$ = 3.6 V)
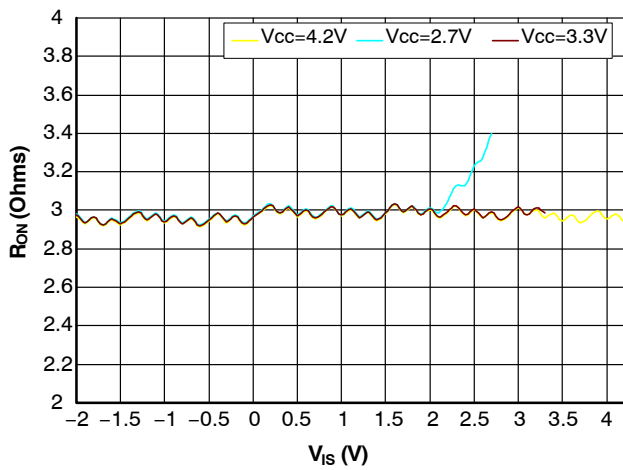
Figure 5. Audio ON Resistance vs. Signal Voltage @ T = 25°C, 2.7 V ≤ V$_{CC}$ ≤ 4.2 V
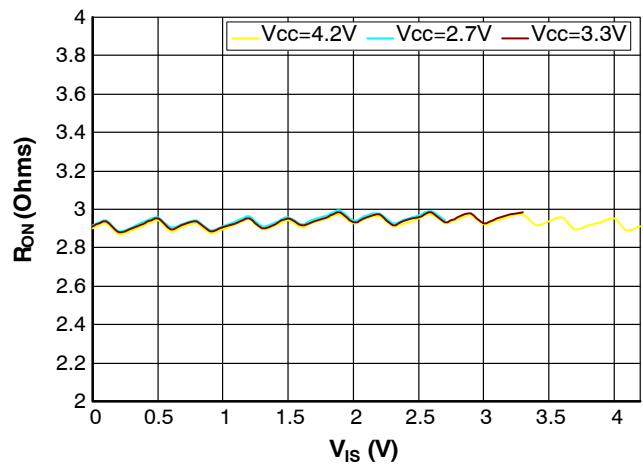
Figure 6. USB ON Resistance vs. Signal Voltage @ T = 25°C, 2.7 V ≤ V$_{CC}$ ≤ 4.2 V
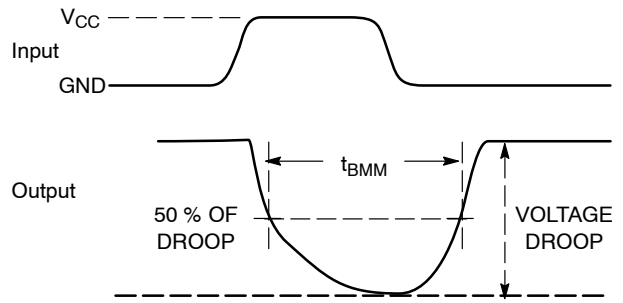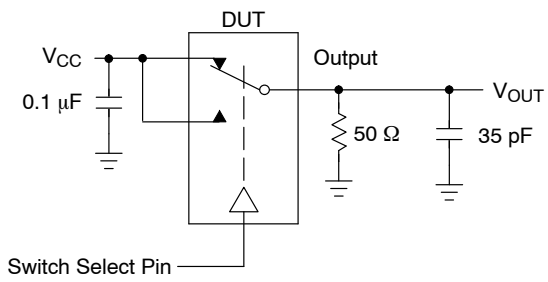
Figure 7. t$_{BBM}$ (Time Break−Before−Make)
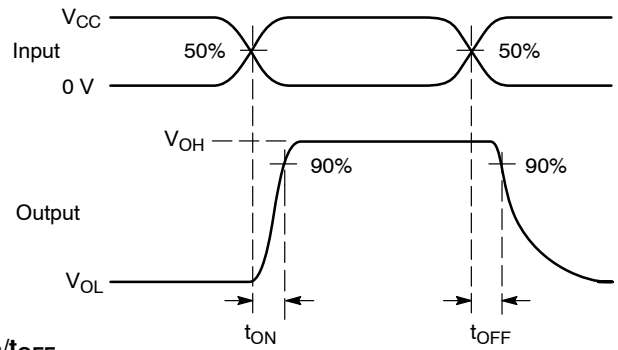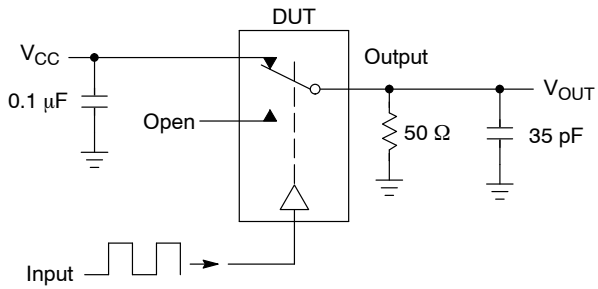
Figure 8. t$_{ON}$/t$_{OFF}$
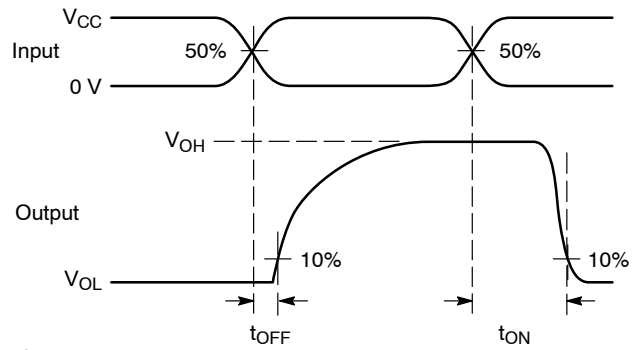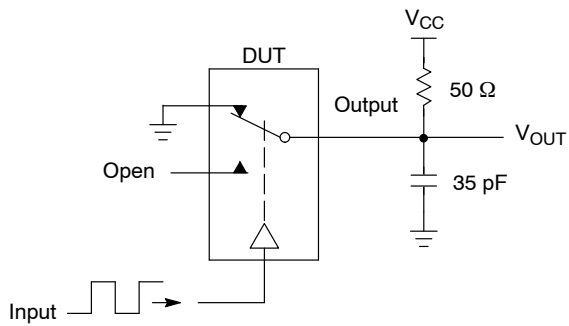
Figure 9. t$_{ON}$/t$_{OFF}$
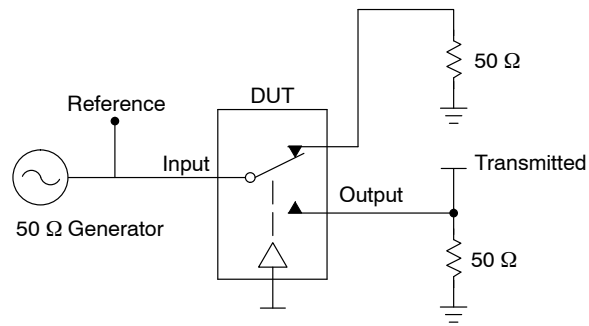
Channel switch control/s test socket is normalized. Off isolation is measured across an off channel. On loss is the bandwidth of an On switch. V_{ISO}, Bandwidth and V_{ONL} are independent of the input signal direction.

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

V_{ONL} = On Channel Loss = $20 \, Log\left(\dfrac{V_{OUT}}{V_{IN}}\right)$ 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}

NS5S1153

PACKAGE DIMENSIONS

UQFN10 1.4x1.8, 0.4P
CASE 488AT–01
ISSUE A
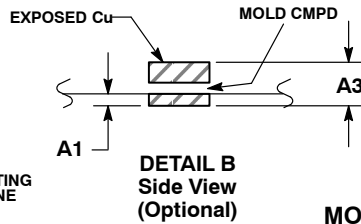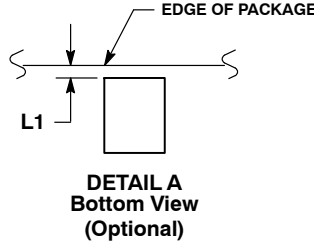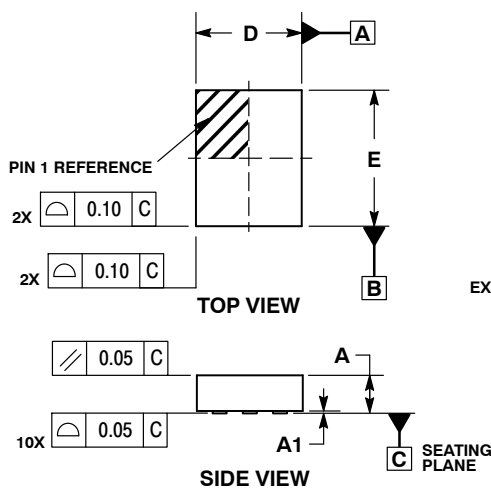
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

DIM	MILLIMETERS	
	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

TOP VIEW

DETAIL A Bottom View (Optional)

SIDE VIEW

DETAIL B Side View (Optional)

BOTTOM VIEW

MOUNTING FOOTPRINT

1.700 / 0.0669
9 X 0.563 / 0.0221
0.663 / 0.0261
0.200 / 0.0079
2.100 / 0.0827
0.400 / 0.0157 PITCH
10 X 0.225 / 0.0089
SCALE 20:1 $\left(\frac{mm}{inches}\right)$
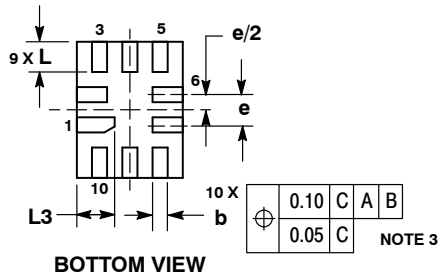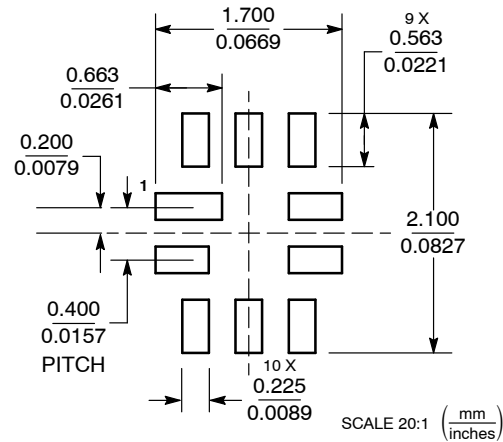
*For additional information on our Pb–Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

NS5S1153/D