

# NLAS7222B, NLAS7222C

## High-Speed USB 2.0 (480 Mbps) DPDT Switches

ON Semiconductor's NLAS7222B and NLAS7222C are part of a series of analog switch circuits that are produced using the company's advanced sub-micron CMOS technology, achieving industry-leading performance.

Both the NLAS7222B and NLAS7222C are 2- to 1-port analog switches. Their wide bandwidth and low bit-to-bit skew allow them to pass high-speed differential signals with good signal integrity. Each switch is bidirectional and offers little or no attenuation of the high-speed signals at the outputs. Industry-leading advantages include a propagation delay of less than 250 ps, resulting from its low channel resistance and low I/O capacitance. Their high channel-to-channel crosstalk rejection results in minimal noise interference. Their bandwidth is wide enough to pass High-Speed USB 2.0 differential signals (480 Mb/s).

### Features

- $R_{ON}$  is Typically  $8.0 \Omega$  at  $V_{CC} = 3.3 V$
- Low Crosstalk:  $-30 \text{ dB @ } 250 \text{ MHz}$
- Low Current Consumption:  $1.0 \mu A$
- Channel On-Capacitance:  $8.0 \text{ pF}$  (Typical)
- $V_{CC}$  Operating Range:  $1.65 V$  to  $4.5 V$
- $> 700 \text{ MHz}$  Bandwidth (or Data Frequency)
- These are Pb-Free Devices

### Typical Applications

- Differential Signal Data Routing
- USB 2.0 Signal Routing

### Important Information

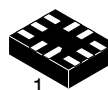
- Continuous Current Rating Through Each Switch  $\pm 300 \text{ mA}$
- $8 \text{ kV}$  I/O to GND ESD Protection



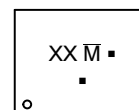
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### MARKING DIAGRAM



UQFN10  
CASE 488AT



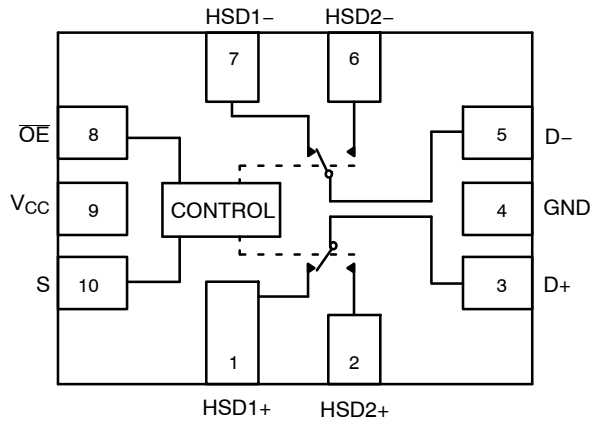
XX = Device Code  
7222B = AS  
7222C = AT  
M = Date Code  
▪ = Pb-Free Device

(Note: Microdot may be in either location)

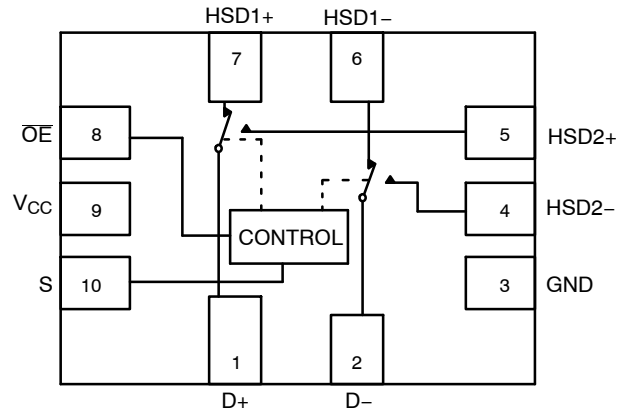
### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

# NLAS7222B, NLAS7222C



**Figure 1. Pin Connections and Logic Diagram (NLAS7222B, Top View)**



**Figure 2. Pin Connections and Logic Diagram (NLAS7222C, Top View)**

**Table 1. PIN DESCRIPTION**

Pin	Function
S	Select Input
$\overline{OE}$	Output Enable
HSD1+, HSD1-, HSD2+, HSD2-, D+, D-	Data Ports

**Table 2. TRUTH TABLE**

$\overline{OE}$	S	HSD1+, HSD1-	HSD2+, HSD2-
1	X	OFF	OFF
0	0	ON	OFF
0	1	OFF	ON

## MAXIMUM RATINGS

Symbol	Pins	Parameter	Value	Unit
$V_{CC}$	$V_{CC}$	Positive DC Supply Voltage	-0.5 to +5.5	V
$V_{IS}$	HSD1+, HSD1- HSD2+, HSD2-	Analog Signal Voltage	-0.5 to $V_{CC} + 0.3$	V
	D+, D-		-0.5 to +5.5	
$V_{IN}$	S, $\overline{OE}$	Control Input Voltage, Output Enable Voltage	-0.5 to +5.5	V
$I_{CC}$	$V_{CC}$	Positive DC Supply Current	50	mA
$T_S$		Storage Temperature	-65 to +150	°C
$I_{IS\_CON}$	HSD1+, HSD1- HSD2+, HSD2- D+, D-	Analog Signal Continuous Current-Closed Switch	$\pm 300$	mA
$I_{IS\_PK}$	HSD1+, HSD1- HSD2+, HSD2- D+, D-	Analog Signal Continuous Current 10% Duty Cycle	$\pm 500$	mA
$I_{IN}$	S, $\overline{OE}$	Control Input Current, Output Enable Current	$\pm 20$	mA

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
$V_{CC}$		Positive DC Supply Voltage	1.65	4.5	V
$V_{IS}$	HSD1+, HSD1- HSD2+, HSD2-	Analog Signal Voltage	GND	$V_{CC}$	V
	D+, D-		GND	4.5	
$V_{IN}$	S, $\overline{OE}$	Control Input Voltage, Output Enable Voltage	GND	$V_{CC}$	V
$T_A$		Operating Temperature Range	-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.

# NLA57222B, NLA57222C

## ESD PROTECTION

Symbol	Parameter	Value	Unit
ESD	Human Body Model – All Pins	2.0	kV
ESD	Human Body Model – I/O to GND	8.0	kV

## DC ELECTRICAL CHARACTERISTICS

### CONTROL INPUT, OUTPUT ENABLE (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V)

Symbol	Pins	Parameter	Test Conditions	V <sub>CC</sub> (V)	–40°C to +85°C			Unit
					Min	Typ	Max	
V <sub>IH</sub>	S, $\overline{OE}$	Control Input, Output Enable HIGH Voltage (See Figure 3)		2.7	1.3	–	–	V
				3.3	1.4			
				4.2	1.6			
V <sub>IL</sub>	S, $\overline{OE}$	Control Input, Output Enable LOW Voltage (See Figure 3)		2.7	–		0.4	V
				3.3			0.4	
				4.2			0.5	
I <sub>IN</sub>	S, $\overline{OE}$	Control Input, Output Enable Leakage Current	0 ≤ V <sub>IS</sub> ≤ V <sub>CC</sub>	1.65 – 4.5	–	–	±1.0	μA

### SUPPLY AND LEAKAGE CURRENT (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V)

Symbol	Pins	Parameter	Test Conditions	V <sub>CC</sub> (V)	–40°C to +85°C			Unit
					Min	Typ	Max	
I <sub>CC</sub>	V <sub>CC</sub>	Quiescent Supply Current	V <sub>IS</sub> = V <sub>CC</sub> or GND; I <sub>OUT</sub> = 0 A	1.65 – 4.5	–	–	1.0	μA
I <sub>CC(T)</sub>	V <sub>CC</sub>	Increase in I <sub>CC</sub> per Control Voltage	V <sub>IN</sub> = 2.6 V	3.6	–	–	10	μA
I <sub>OZ</sub>	HSD1+, HSD1–, HSD2+, HSD2–	OFF State Leakage Current	0 ≤ V <sub>IS</sub> ≤ V <sub>CC</sub>	1.65 – 4.5	–	–	±1.0	μA
I <sub>OFF</sub>	D+, D–	Power OFF Leakage Current	0 ≤ V <sub>IS</sub> ≤ 4.5 V	0	–	–	±1.0	μA

### HIGH SPEED ON RESISTANCE (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V)

Symbol	Pins	Parameter	Test Conditions	V <sub>CC</sub> (V)	–40°C to +85°C			Unit
					Min	Typ	Max	
R <sub>ON</sub>		On–Resistance	V <sub>IS</sub> = 0 V to 0.4 V, I <sub>ON</sub> = 8 mA	2.7	–	9.0	12	Ω
				3.3		8.0	10	
				4.2		7.0	8.0	
R <sub>FLAT</sub>		On–Resistance Flatness	V <sub>IS</sub> = 0 V to 1.0 V, I <sub>ON</sub> = 8 mA	2.7	–	1.6	–	Ω
				3.3		1.5		
				4.2		1.4		
ΔR <sub>ON</sub>		On–Resistance Matching	V <sub>IS</sub> = 0 V to 0.4 V, I <sub>ON</sub> = 8 mA	2.7	–	1.05	–	Ω
				3.3		0.85		
				4.2		0.65		

# NLAS7222B, NLAS7222C

## DC ELECTRICAL CHARACTERISTICS (continued)

### FULL SPEED ON RESISTANCE (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V)

Symbol	Pins	Parameter	Test Conditions	V <sub>CC</sub> (V)	-40°C to +85°C			Unit
					Min	Typ	Max	
R <sub>ON</sub>		On-Resistance	V <sub>IS</sub> = 0 V to V <sub>CC</sub> , I <sub>ON</sub> = 8 mA	2.7	9.0	12	Ω	
				3.3	8.5	10.5		
				4.2	7.5	8.5		
R <sub>FLAT</sub>		On-Resistance Flatness	V <sub>IS</sub> = 0 V to 1.0 V, I <sub>ON</sub> = 8 mA	2.7	1.6		Ω	
				3.3	1.5			
				4.2	1.4			
ΔR <sub>ON</sub>		On-Resistance Matching	V <sub>IS</sub> = 0 V to V <sub>CC</sub> , I <sub>ON</sub> = 8 mA	2.7	2.20		Ω	
				3.3	2.45			
				4.2	2.65			

## AC ELECTRICAL CHARACTERISTICS

### TIMING/FREQUENCY (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V, R<sub>L</sub> = 50 Ω, C<sub>L</sub> = 5 pF, f = 1 MHz)

Symbol	Pins	Parameter	Test Conditions	V <sub>CC</sub> (V)	-40°C to +85°C			Unit
					Min	Typ	Max	
t <sub>ON</sub>	Closed to Open	Turn-ON Time		1.65 - 4.5	-	14	30	ns
t <sub>OFF</sub>	Open to Closed	Turn-OFF Time		1.65 - 4.5	-	10	20	ns
t <sub>BBM</sub>		Break-Before-Make Delay		1.65 - 4.5	3.0	4.4	7.0	ns
BW		-3 dB Bandwidth	C <sub>L</sub> = 5 pF	1.65 - 4.5	-	500	-	MHz
			C <sub>L</sub> = 0 pF		-	750	-	

### ISOLATION (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V, R<sub>L</sub> = 50 Ω, C<sub>L</sub> = 5 pF, f = 1 MHz)

Symbol	Pins	Parameter	Test Conditions	V <sub>CC</sub> (V)	-40°C to +85°C			Unit
					Min	Typ	Max	
O <sub>IRR</sub>	Open	OFF-Isolation	f = 250 MHz	1.65 - 4.5	-	-22	-	dB
X <sub>TALK</sub>	HSD1+ to HSD1-	Non-Adjacent Channel Crosstalk	f = 250 MHz	1.65 - 4.5	-	-30	-	dB

### NLAS7222B CAPACITANCE (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V, R<sub>L</sub> = 50 Ω, C<sub>L</sub> = 5 pF, f = 1 MHz)

Symbol	Pins	Parameter	Test Conditions	-40°C to +85°C			Unit
				Min	Typ	Max	
C <sub>IN</sub>	S, $\overline{OE}$	Control Pin Input Capacitance	V <sub>CC</sub> = 0 V	-	3.0	-	pF
C <sub>ON</sub>	D+ to HSD1+ or HSD2+	ON Capacitance	V <sub>CC</sub> = 3.3 V; $\overline{OE}$ = 0 V S = 0 V or 3.3 V	-	8.0	-	pF
C <sub>OFF</sub>	HSD1n or HSD2n	OFF Capacitance	V <sub>CC</sub> = V <sub>IS</sub> = 3.3 V; $\overline{OE}$ = 0 V S = 3.3 V or 0 V	-	4.5	-	pF

## NLAS7222B, NLAS7222C

**NLAS7222C CAPACITANCE** (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V, R<sub>L</sub> = 50 Ω, C<sub>L</sub> = 5 pF, f = 1 MHz)

Symbol	Pins	Parameter	Test Conditions	-40°C to +85°C			Unit
				Min	Typ	Max	
C <sub>IN</sub>	S, $\overline{OE}$	Control Pin, Output Enable Input Capacitance	V <sub>CC</sub> = 0 V	-	3.0	-	pF
C <sub>ON</sub>	D+ to HSD1+ or HSD2+	ON Capacitance	V <sub>CC</sub> = 3.3 V; $\overline{OE}$ = 0 V S = 0 V or 3.3 V	-	10	-	pF
C <sub>OFF</sub>	HSD1n or HSD2n	OFF Capacitance	V <sub>CC</sub> = V <sub>IS</sub> = 3.3 V; $\overline{OE}$ = 3.3 V S = 3.3 V or 0 V	-	5.5	-	pF

# NLAS7222B, NLAS7222C

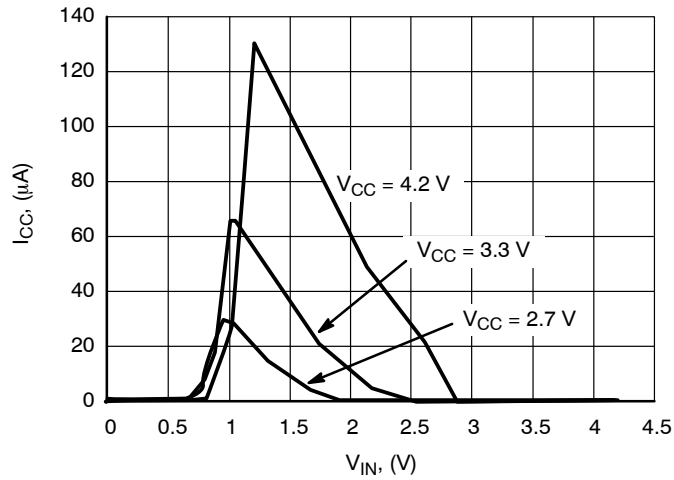


Figure 3.  $I_{CC}$  vs.  $V_{IN}$

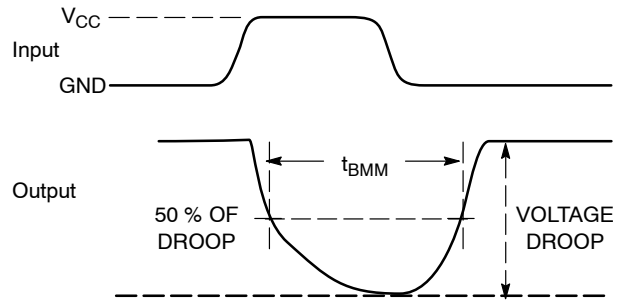
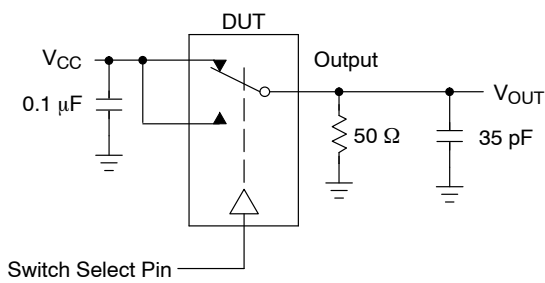


Figure 4.  $t_{BMM}$  (Time Break-Before-Make)

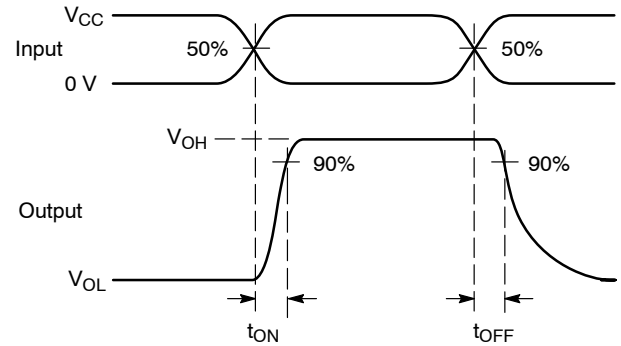
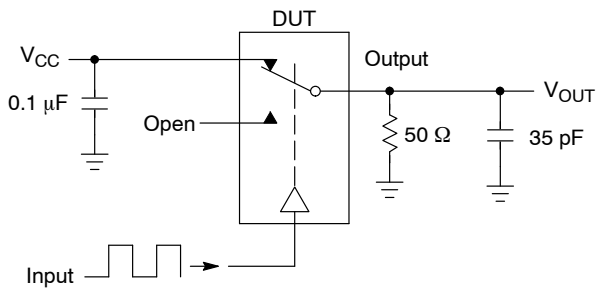


Figure 5.  $t_{ON}/t_{OFF}$

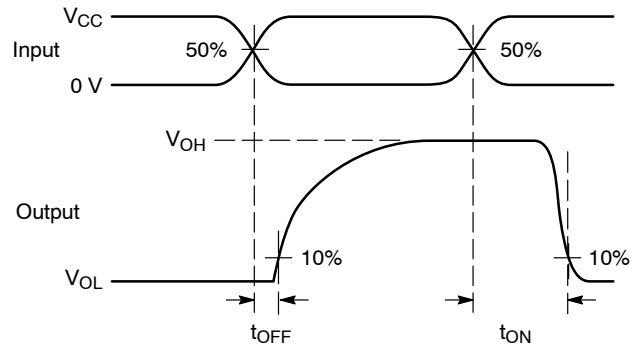
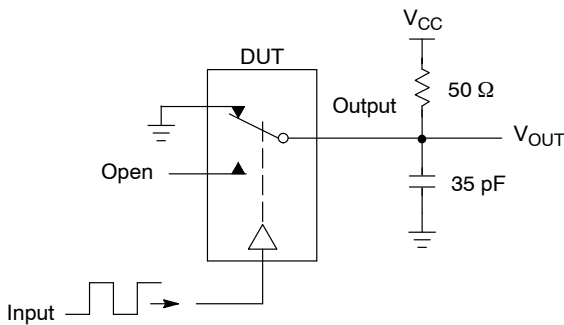
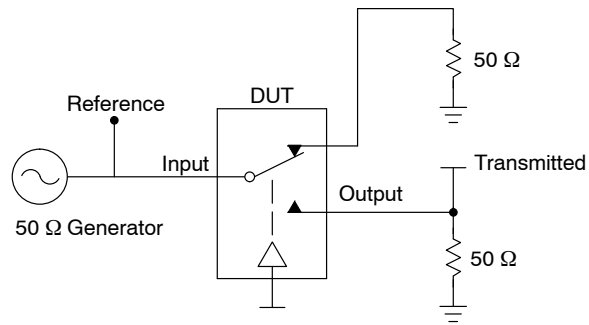


Figure 6.  $t_{ON}/t_{OFF}$

## NLAS7222B, NLAS7222C



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.

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

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

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 7. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/ $V_{ONL}$**

# NLAS7222B, NLAS7222C

## APPLICATIONS INFORMATION

The low on resistance and capacitance of the NLAS7222B provides for a high bandwidth analog switch suitable for applications such as USB data switching. Results for the USB 2.0 signal quality tests will be shown in this section, along with a description of the evaluation test board. The data for the eye diagram signal quality and jitter tests verifies that the NLAS7222B can be used as a data switch in low, full and high speed USB 2.0 systems.

Figures 8, 9 and 10 provide a description of the test evaluation board. The USB tests were conducted per the procedures provided by the USB Implementers Forum

([www.usb.org](http://www.usb.org)), the industry group responsible for defining the USB certification requirements. The test patterns were generated by a PC and MATLAB software, and were inputted to the analog switch through USB connectors J1 (HSD1) or J2 (HSD2). A USB certified device was plugged into connector J4 to function as a data transceiver. The high speed and full speed tests used a flash memory device, while the low speed tests used a mouse. Test connectors J3 and J5 provide a direct connection of the USB device and were used to verify that the analog switch does not distort the data signals.

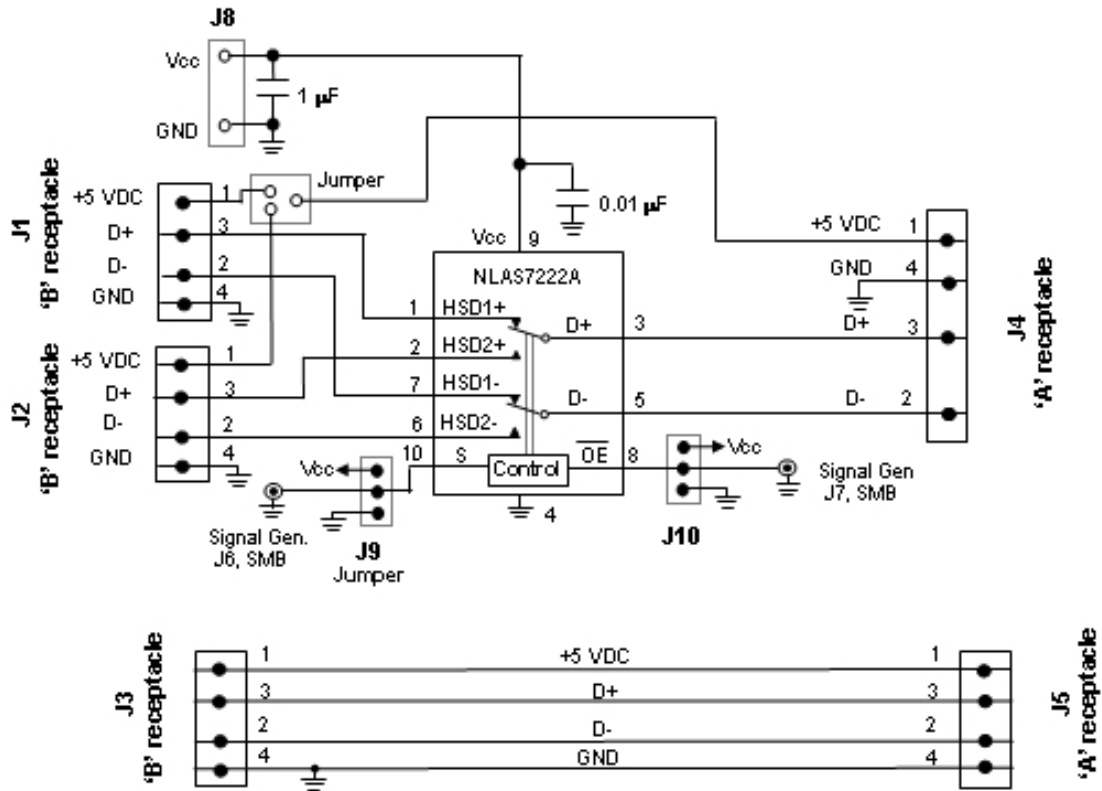


Figure 8. Schematic of the NLAS7222B USB Demo Board



## NLAS7222B, NLAS7222C

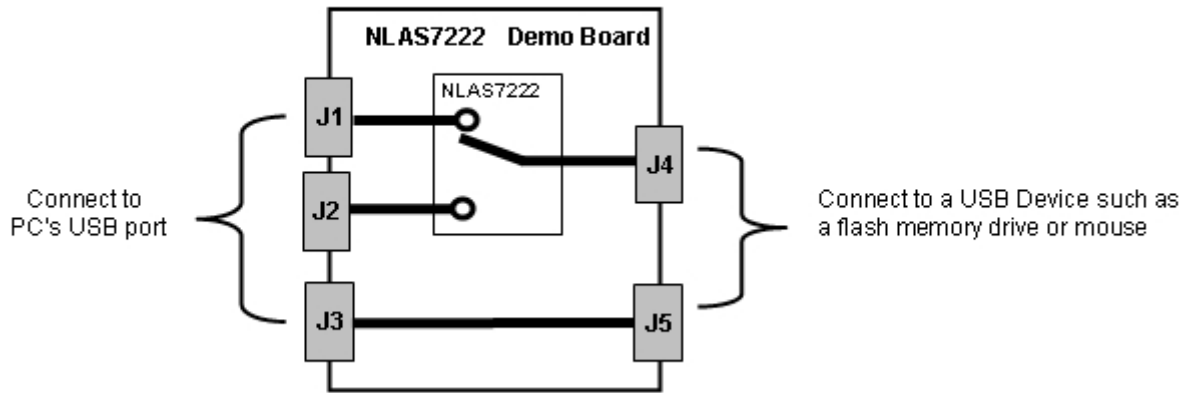


Figure 9. Block Diagram of the NLAS7222B USB Demo Board

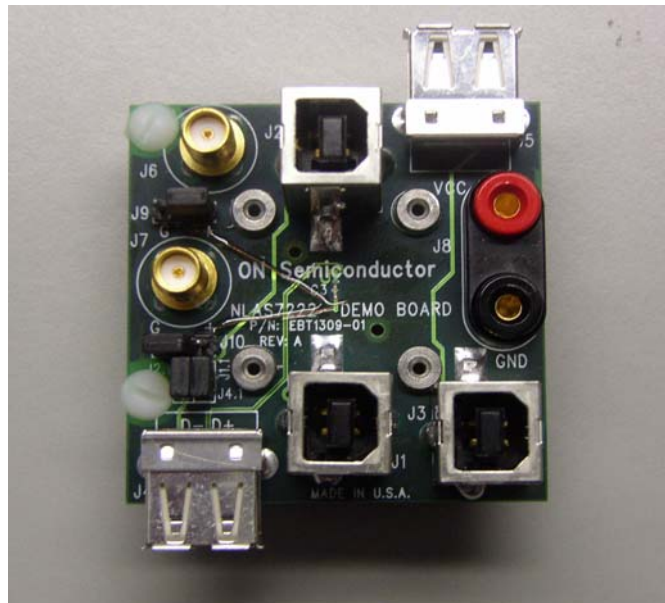


Figure 10. Photograph of the NLAS7222B USB Demo Board

### ORDERING INFORMATION

Device	Marking	Package	Shipping <sup>†</sup>
NLAS7222BMUTAG	AS	UQFN10 (Pb-Free)	3000 / Tape & Reel
NLAS7222BMUTBG	AS	UQFN10 (Pb-Free)	3000 / Tape & Reel
NLAS7222CMUTBG	AT	UQFN10 (Pb-Free)	3000 / Tape & Reel

<sup>†</sup>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.

# MECHANICAL CASE OUTLINE

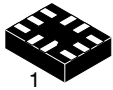
## PACKAGE DIMENSIONS

ON Semiconductor®

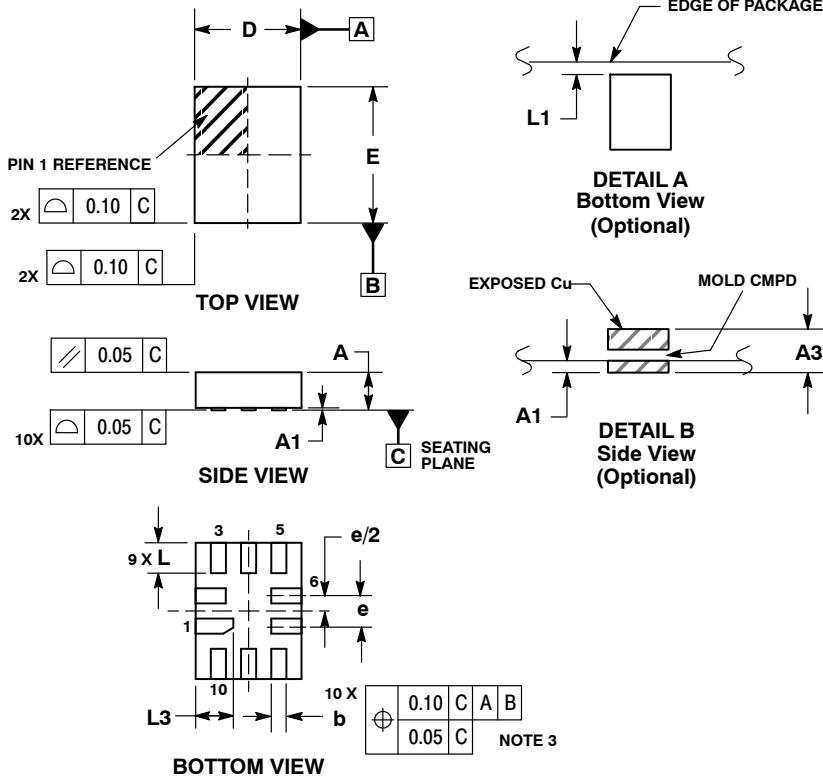


### UQFN10 1.4x1.8, 0.4P CASE 488AT-01 ISSUE A

DATE 01 AUG 2007



SCALE 5:1

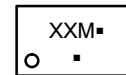


NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- CONTROLLING DIMENSION: MILLIMETERS
- DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
- 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

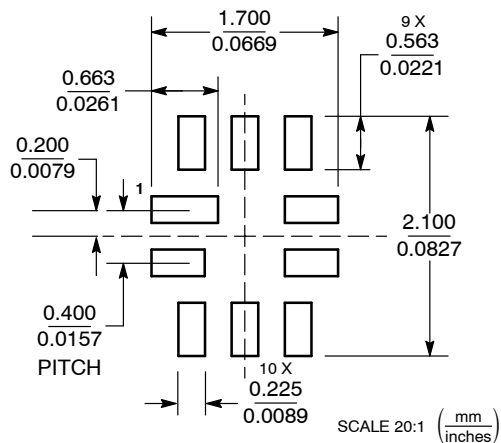
### GENERIC MARKING DIAGRAM\*



- 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



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<b>DESCRIPTION:</b>	<b>10 PIN UQFN, 1.4 X 1.8, 0.4P</b>	<b>PAGE 1 OF 1</b>

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[NS5S1153MUTAG](#) [FSUSB11MTCX](#) [FSUSB42MUX](#) [PI3USB102GZLEX](#) [P6KE110A](#) [SMAJ200A](#) [SMAJ70CA](#) [SMAJ11A](#) [SMAJ140CA](#)  
[SMAJ14A](#) [SMAJ160CA](#) [SMAJ250A](#) [SMAJ51CA](#) [SMAJ5.0CA](#) [30KP400CA](#) [1SMB5.0AT3G](#) [MAX4717ETB+T](#) [MAX4989ETD+T](#)  
[MAX4717EBCT](#) [MAX4717EUB+](#) [MAX4906ELB+T](#) [MAX4899EETE+](#) [MAX4906EFELB+T](#) [MAX4907FELA+T](#) [MAX4907ELA+T](#)  
[MAX4983EEVB+T](#) [MAX4984EEVB+T](#) [MAX4899AEETE+T](#) [MAX14618ETA+T](#) [MAX14651ETA+T](#)