

# NLAS7223C

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

The NLAS7223C DPDT switch is optimized for high-speed USB 2.0 applications within portable systems. It features ultra-low on capacitance,  $C_{ON} = 7.5$  pF (typ), and a bandwidth above 900 MHz. It is optimized for applications that use a single USB interface connector to route multiple signal types. The  $C_{ON}$  and  $R_{ON}$  of both channels are suitably low to allow the NLAS7223C to pass any speed USB data or audio signals going to a moderately resistive terminal such as an external headset. It is offered in a UQFN10 1.4 mm x 1.8 mm package.

### Features

- Optimized Flow-Through Pinout on NLAS7223C
- $R_{ON}$ : 7.5  $\Omega$  Typ @  $V_{CC} = 4.2$  V
- $C_{ON}$ : 7.5 pF Typ @  $V_{CC} = 3.3$  V
- $V_{CC}$  Range: 1.65 V to 4.5 V
- Typical Bandwidth: 900 MHz
- 1.4 mm x 1.8 mm x 0.50 mm UQFN10
- OVT on Common Signal Pins D+/D- up to 5.25 V
- 8 kV ESD Protection on D+/D- to GND
- This is a Pb-Free Device

### Typical Applications

- High Speed USB 2.0 Data
- Mobile Phones
- Portable Devices

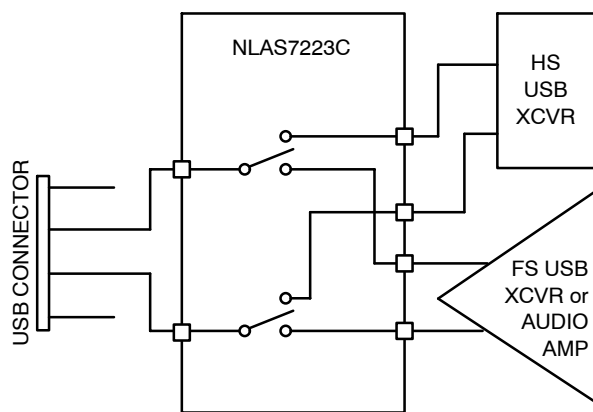


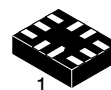
Figure 1. Application Diagram



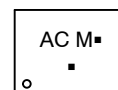
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<http://onsemi.com>

### MARKING DIAGRAM



UQFN10  
CASE 488AT



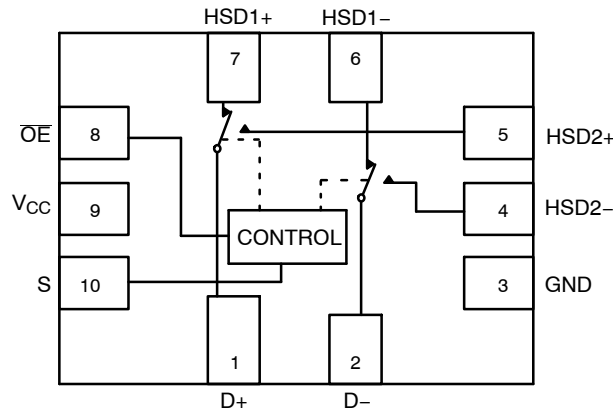
AC = Device Code  
M = Date Code  
▪ = Pb-Free Device

(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

# NLAS7223C



**Figure 2. Pin Connections and Logic Diagram**  
(NLA7223C, Top View)

**Table 1. PIN DESCRIPTION**

Pin	Function
S	Control 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
$V_{IS}$	HSDn+, HSDn-	Analog Signal Voltage	-0.5 to $V_{CC} + 0.3$	V
	D+, D-		-0.5 to +5.25	
$V_{IN}$	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
$I_{IS\_CON}$	HSDn+, HSDn-, D+, D-	Analog Signal Continuous Current-Closed Switch	$\pm 300$	mA
$I_{IS\_PK}$	HSDn+, HSDn-, 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
$V_{IS}$	HSDn+, HSDn-	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	-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.

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## ESD PROTECTION

Symbol	Parameter	Value	Unit
ESD	Human Body Model – All Pins	3.0	kV

## DC ELECTRICAL CHARACTERISTICS

### CONTROL INPUT, OUTPUT ENABLE VOLTAGE (Typical: T = 25°C)

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 11)		2.7 3.3 4.2	1.25 1.25 1.25	–	–	V
V <sub>IL</sub>	S, $\overline{OE}$	Control Input, Output Enable LOW Voltage (See Figure 11)		2.7 3.3 4.2	–	–	0.4 0.4 0.5	V
I <sub>IN</sub>	S, $\overline{OE}$	Current Input, Output Enable Leakage Current	$0 \leq V_{IS} \leq V_{CC}$	1.65 – 4.5	–	–	±1.0	µA

### SUPPLY CURRENT AND LEAKAGE (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>D</sub> = 0 A	1.65 – 4.5	–	–	1.0	µA
I <sub>OZ</sub>		OFF State Leakage	$0 \leq V_{IS} \leq V_{CC}$	1.65 – 4.5	–	±0.1	±1.0	µA
I <sub>OFF</sub>	D+, D–	Power OFF Leakage Current	$0 \leq V_{IS} \leq V_{CC}$	0	–	–	±1.0	µA

### LIMITED V<sub>IS</sub> SWING ON RESISTANCE (Typical: T = 25°C)

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	I <sub>ON</sub> = 8 mA V <sub>IS</sub> = 0 V to 0.4 V	2.7 3.3 4.2	–	6.0 6.0 5.5	–	Ω
R <sub>FLAT</sub>		On-Resistance Flatness	I <sub>ON</sub> = 8 mA V <sub>IS</sub> = 0 V to 0.4 V	2.7 3.3 4.2	–	0.35 0.35 0.20	–	Ω
ΔR <sub>ON</sub>		On-Resistance Matching	I <sub>ON</sub> = 8 mA V <sub>IS</sub> = 0 V to 0.4 V	2.7 3.3 4.2	–	0.8 0.7 0.5	–	Ω

### FULL V<sub>IS</sub> SWING ON RESISTANCE (Typical: T = 25°C)

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	I <sub>ON</sub> = 8 mA V <sub>IS</sub> = 0 V to V <sub>CC</sub>	2.7 3.3 4.2	–	9.3 8.7 7.5	–	Ω
R <sub>FLAT</sub>		On-Resistance Flatness	I <sub>ON</sub> = 8 mA V <sub>IS</sub> = 0 V to V <sub>CC</sub>	2.7 3.3 4.2	–	3.6 3.3 2.9	–	Ω
ΔR <sub>ON</sub>		On-Resistance	I <sub>ON</sub> = 8 mA V <sub>IS</sub> = 0 V to V <sub>CC</sub>	2.7 3.3 4.2	–	0.8 0.7 0.5	–	Ω

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## 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> = 35 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 (See Figures 4 and 5)		1.65 – 4.5	–	13.0	30.0	ns
t <sub>OFF</sub>	Open to Closed	Turn-OFF Time (See Figures 4 and 5)		1.65 – 4.5	–	12.0	25.0	ns
T <sub>BMM</sub>		Break-Before-Make Time (See Figure 3)		1.65 – 4.5	2.0	–	–	ns
BW		-3 dB Bandwidth	C <sub>L</sub> = 5 pF	1.65 – 4.5	–	900	–	MHz

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

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 (See Figure 6)	f = 240 MHz	1.65 – 4.5	–	-21	–	dB
X <sub>TALK</sub>	HSD+ to HSD-	Non-Adjacent Channel Crosstalk	f = 240 MHz	1.65 – 4.5	–	-21	–	dB

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

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, f = 1 MHz	–	1.5	–	pF
			V <sub>CC</sub> = 0 V, f = 10 MHz	–	1.0	–	
C <sub>ON</sub>	D+ to HSD1+ or HSD2+	ON Capacitance	V <sub>CC</sub> = 3.3 V; $\overline{OE}$ = 0 V, S = 0V or 3.3 V f = 1 MHz	–	7.5	–	
			V <sub>CC</sub> = 3.3 V; $\overline{OE}$ = 0 V, S = 0V or 3.3 V f = 10 MHz	–	6.5	–	
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, f = 1 MHz	–	3.8	–	
			V <sub>CC</sub> = V <sub>IS</sub> = 3.3 V; $\overline{OE}$ = 0 V, S = 3.3 V or 0 V, f = 10 MHz	–	2.0	–	

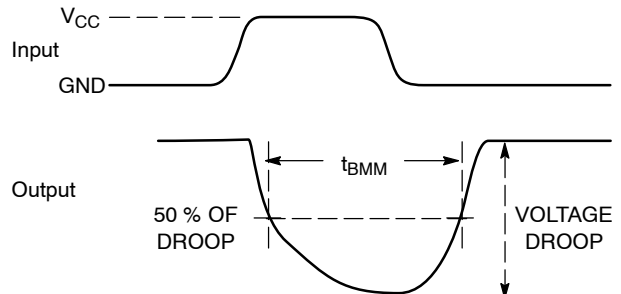
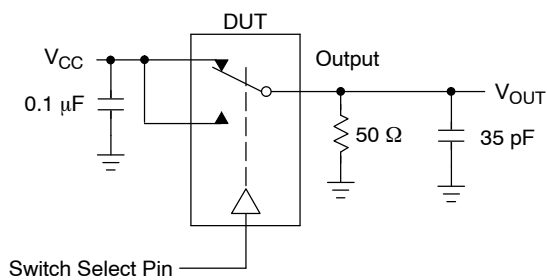


Figure 3. t<sub>BMM</sub> (Time Break-Before-Make)

# NLAS7223C

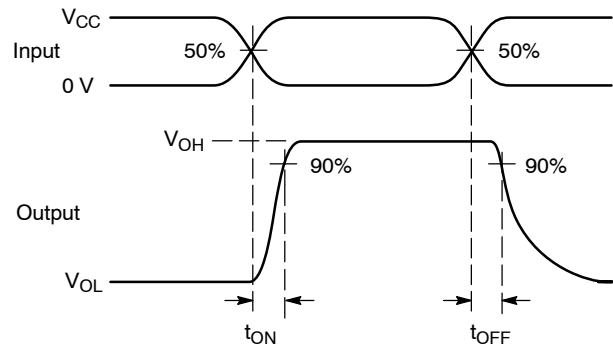
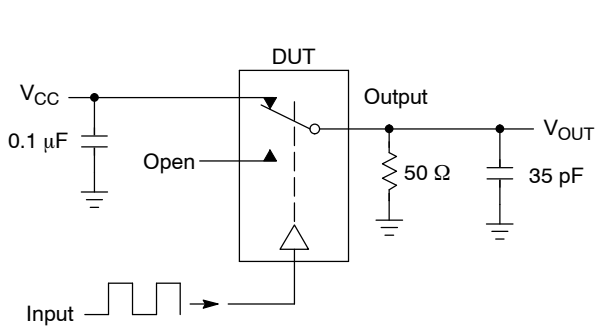


Figure 4.  $t_{ON}/t_{OFF}$

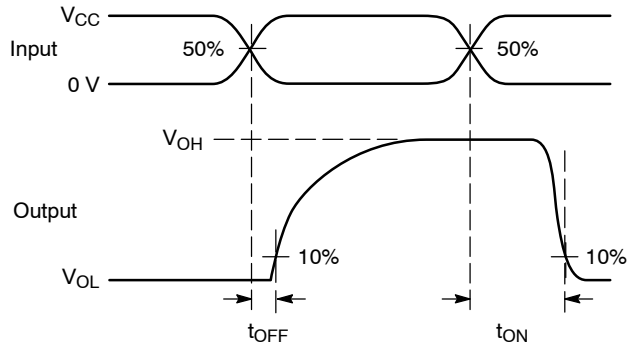
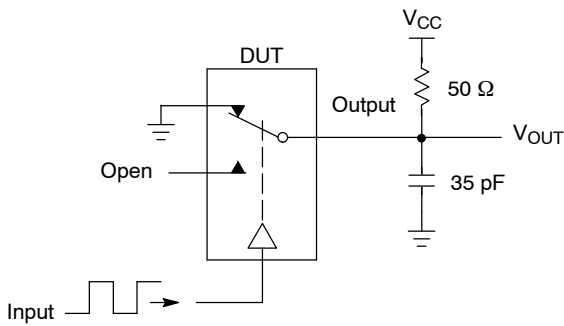
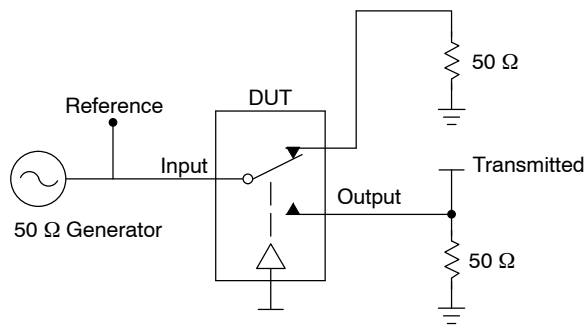


Figure 5.  $t_{ON}/t_{OFF}$



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.

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

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

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  $\Omega$

Figure 6. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/ $V_{ONL}$

# NLAS7223C

## DETAILED DESCRIPTION

### High Speed (480Mbps) USB 2.0 Optimized

The NLAS7223C is a DPDT switch designed for USB applications within portable systems. The  $R_{ON}$  and  $C_{ON}$  of both switches are maintained at industry-leading low levels in order to ensure maximum signal integrity for USB 2.0 high speed data communication. The NLAS7223C switch can be used to switch between high speed (480Mbps) USB signals and a variety of audio or data signals such as full speed USB, UART or even a moderately resistive audio terminal.

### Over Voltage Tolerant

The NLAS7223C features over voltage tolerant I/O protection on the common signal pins D+/D-. This allows the switch to interface directly with a USB connector. The D+/D- pins can withstand a short to  $V_{BUS}$ , up to 5.25 V, continuous DC current for up to 24 hours as specified in the USB 2.0 specification. This protection is achieved without the need for any external resistors or protection devices.

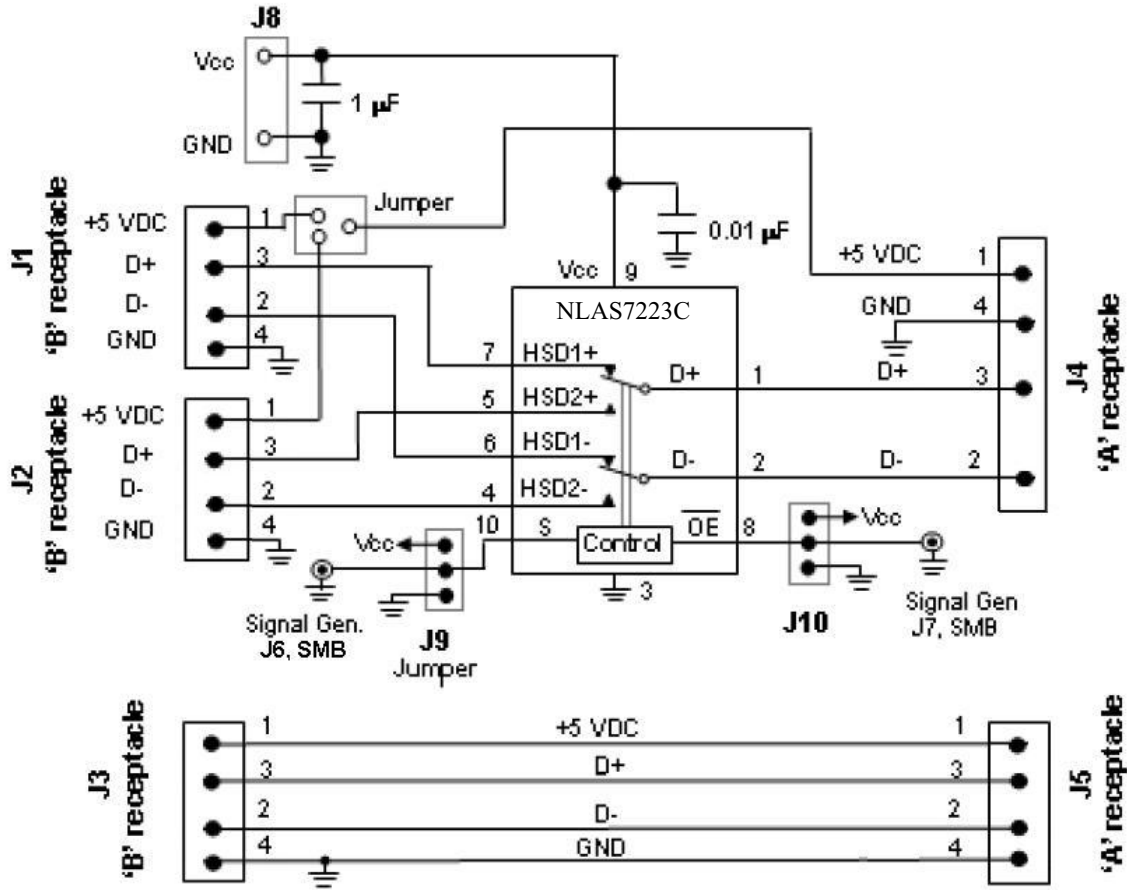


Figure 7. Board Schematic

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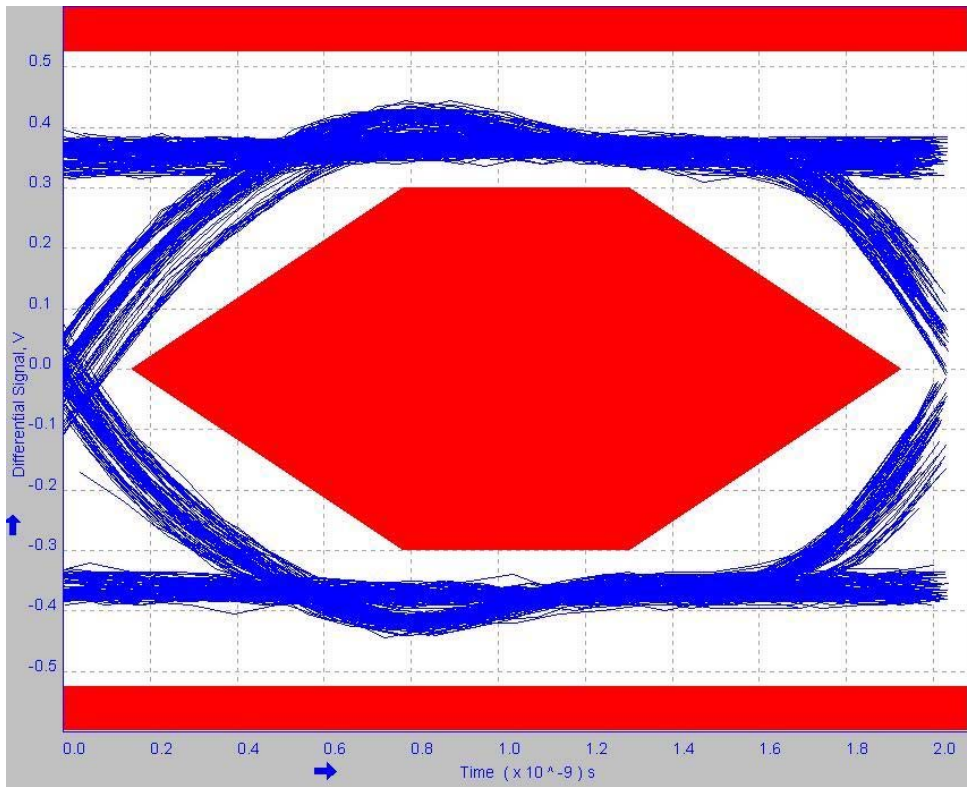


Figure 8. Signal Quality

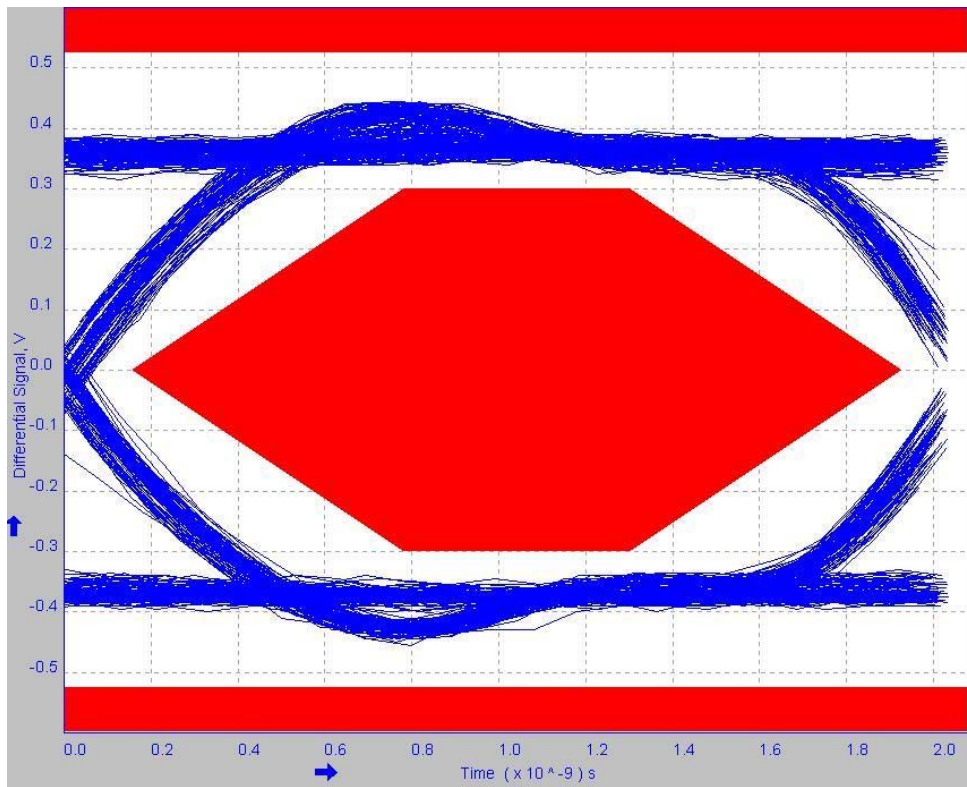


Figure 9. Near End Eye Diagram

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Near End Test Data:				Min	Max
Std.	Consecutive jitter range	-61.64	113.30	ps	-200 ps +200 ps
	Paired JK jitter range	-58.36	46.47	ps	
	Paired KJ jitter range	-62.00	81.30	ps	
NO	Consecutive jitter range	-66.69	69.37	ps	-200 ps +200 ps
	Paired JK jitter range	-74.71	60.06	ps	
	Paired KJ jitter range	-58.86	70.90	ps	

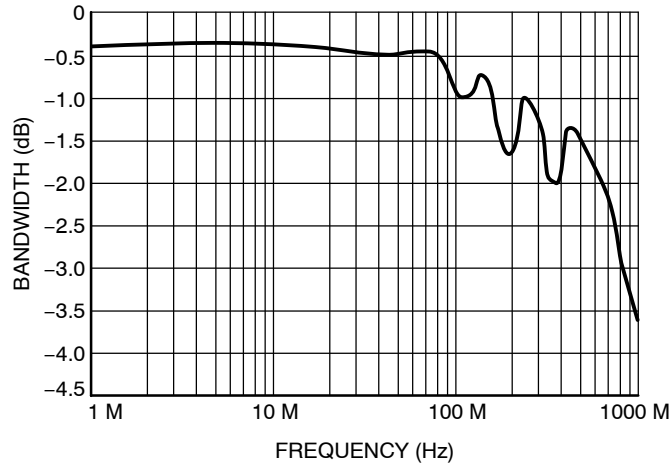


Figure 10. Bandwidth vs. Frequency

## I<sub>CC</sub> Leakage Current as a Function of V<sub>IN</sub> Voltage

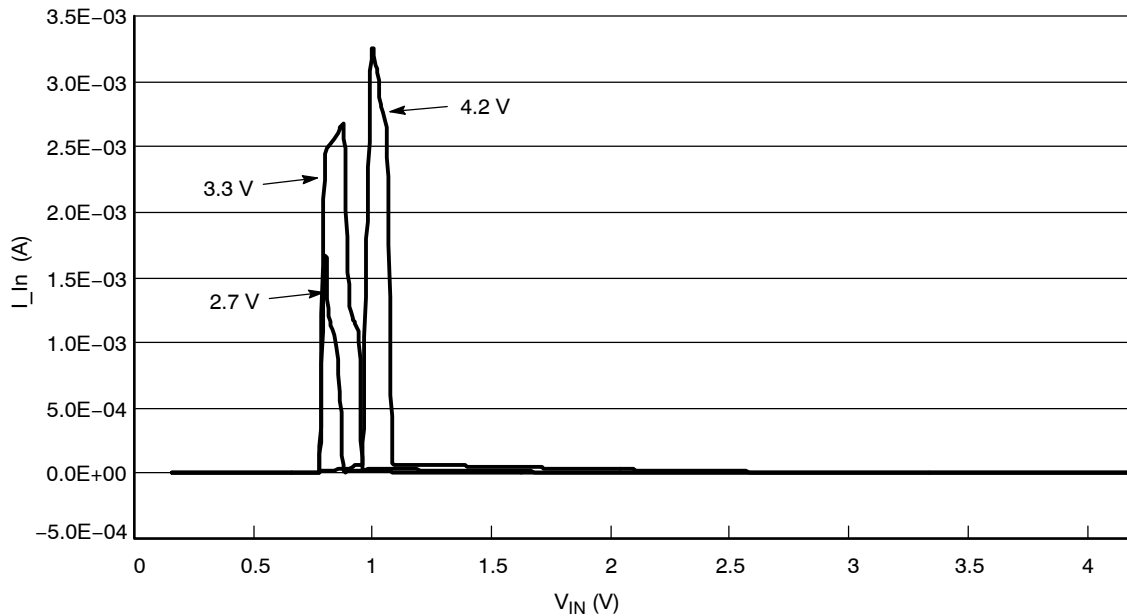


Figure 11. I<sub>CC</sub> Leakage Current vs. V<sub>IN</sub> Voltage

## ORDERING INFORMATION

Device	Package	Shipping†
NLAS7223CMUTBG	UQFN-10 (Pb-Free)	3000 / Tape & Reel

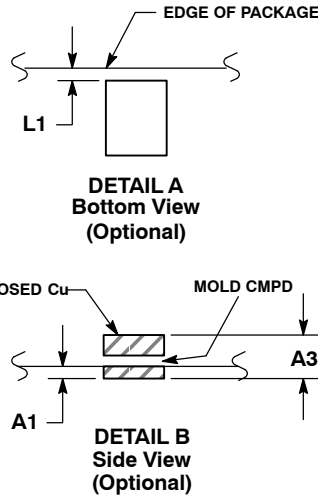
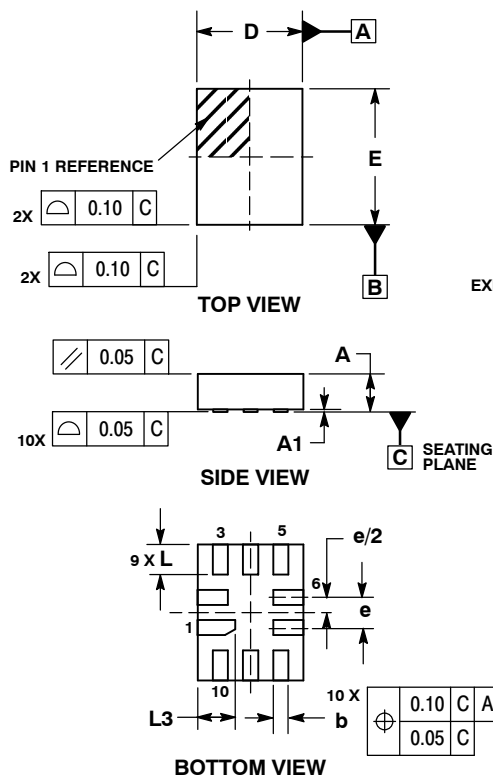
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



# NLAS7223C

## PACKAGE DIMENSIONS

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

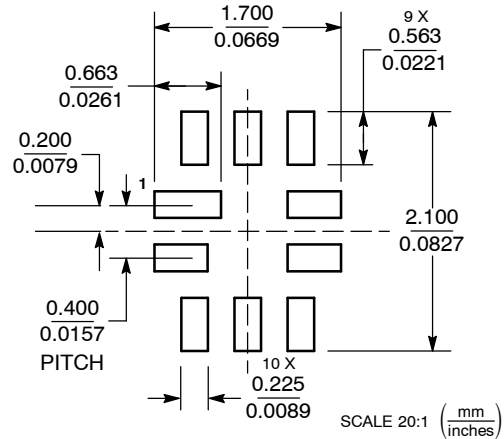


**NOTES:**

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

**MOUNTING FOOTPRINT\***



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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