

# 2.5 V 1:4 AnyLevel™ Differential Input to LVDS Fanout Buffer/Translator

## NB6L14S

The NB6L14S is a differential 1:4 Clock or Data Receiver and will accept AnyLevel differential input signals: LVPECL, CML, LVDS, or HSCL. These signals will be translated to LVDS and four identical copies of Clock or Data will be distributed, operating up to 2.0 GHz or 2.5 Gb/s, respectively. As such, the NB6L14S is ideal for SONET, GigE, Fiber Channel, Backplane and other Clock or Data distribution applications.

The NB6L14S has a wide input common mode range from GND + 50 mV to V<sub>CC</sub> - 50 mV. Combined with the 50 Ω internal termination resistors at the inputs, the NB6L14S is ideal for translating a variety of differential or single-ended Clock or Data signals to 350 mV typical LVDS output levels.

The NB6L14S is the 2.5 V version of the NB6N14S and is offered in a small 3 mm x 3 mm 16-QFN package. Application notes, models, and support documentation are available at [www.onsemi.com](http://www.onsemi.com).

The NB6L14S is a member of the ECLinPS MAX™ family of high performance products.

### Features

- Maximum Input Clock Frequency > 2.0 GHz
- Maximum Input Data Rate > 2.5 Gb/s
- 1 ps Maximum of RMS Clock Jitter
- Typically 10 ps of Data Dependent Jitter
- 380 ps Typical Propagation Delay
- 120 ps Typical Rise and Fall Times
- Single Power Supply; V<sub>CC</sub> = 2.5 ± 5%
- V<sub>REF\_AC</sub> Reference Output
- These are Pb-Free Devices

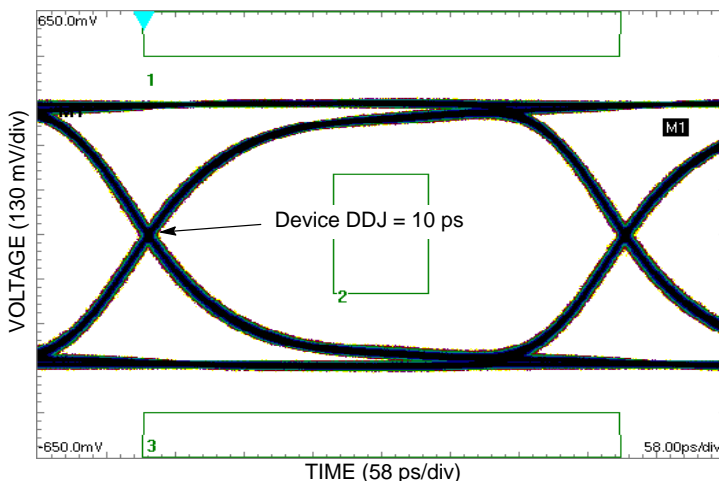
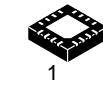
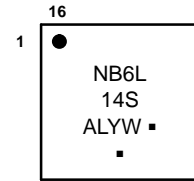


Figure 2. Typical Output Waveform at 2.488 Gb/s with PRBS 2<sup>23</sup>-1 (V<sub>INPP</sub> = 400 mV; Input Signal DDJ = 14 ps)

### MARKING DIAGRAM\*



QFN-16  
MN SUFFIX  
CASE 485G



- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- = Pb-Free Package

(Note: Microdot may be in either location)

\*For additional marking information, refer to Application Note AND8002/D.

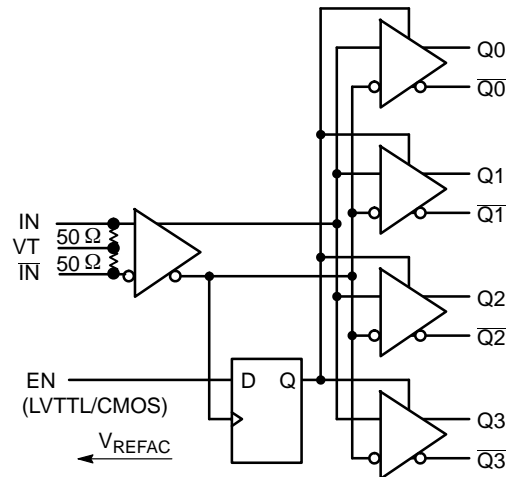


Figure 1. Logic Diagram

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

# NB6L14S

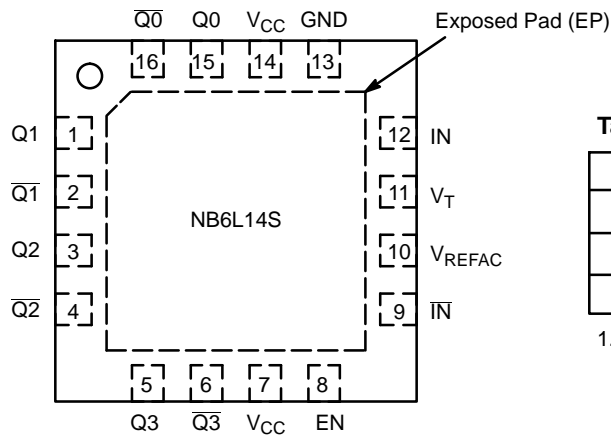


Figure 3. NB6L14S Pinout, 16-pin QFN (Top View)

Table 1. TRUTH TABLE

IN	$\overline{\text{IN}}$	EN	Q	$\overline{\text{Q}}$
0	1	1	0	1
1	0	1	1	0
x	x	0	0 (Note 1)	1 (Note 1)

1. On next transition of the input signal (IN).

Table 2. PIN DESCRIPTION

Pin	Name	I/O	Description
1	Q1	LVDS Output	Non-inverted IN output. Typically loaded with 100 $\Omega$ receiver termination resistor across differential pair.
2	$\overline{\text{Q1}}$	LVDS Output	Inverted IN output. Typically loaded with 100 $\Omega$ receiver termination resistor across differential pair.
3	Q2	LVDS Output	Non-inverted IN output. Typically loaded with 100 $\Omega$ receiver termination resistor across differential pair.
4	$\overline{\text{Q2}}$	LVDS Output	Inverted IN output. Typically loaded with 100 $\Omega$ receiver termination resistor across differential pair.
5	Q3	LVDS Output	Non-inverted IN output. Typically loaded with 100 $\Omega$ receiver termination resistor across differential pair.
6	$\overline{\text{Q3}}$	LVDS Output	Inverted IN output. Typically loaded with 100 $\Omega$ receiver termination resistor across differential pair.
7	$\text{V}_{\text{CC}}$	–	Positive Supply Voltage.
8	EN	LVTTTL / LVCMOS Input	Synchronous Output Enable. When LOW, Q outputs will go LOW and Qb outputs will go HIGH on the next negative transition of IN input. The internal DFF register is clocked on the falling edge of IN input; see Figure 26. The EN pin has an internal pullup resistor and defaults HIGH when left open.
9	$\overline{\text{IN}}$	LVPECL, CML, LVDS	Inverted Differential Input
10	$\text{V}_{\text{REFAC}}$	LVPECL Output	The $\text{V}_{\text{REFAC}}$ reference output can only be used to rebias capacitor-coupled differential or single-ended input signals. For the capacitor-coupled IN and/or INb inputs, $\text{V}_{\text{REFAC}}$ should be connected to the VT pin and bypassed to ground with a 0.01 $\mu\text{F}$ capacitor.
11	$\text{V}_{\text{T}}$	LVPECL Output	Internal 100 $\Omega$ Center-tapped Termination Pin for IN and $\overline{\text{IN}}$
12	IN	LVPECL, CML, LVDS	Non-inverted Differential Input. (Note 2)
13	GND	–	Negative Supply Voltage.
14	$\text{V}_{\text{CC}}$	–	Positive Supply Voltage.
15	Q0	LVDS Output	Non-inverted IN output. Typically loaded with 100 $\Omega$ receiver termination resistor across differential pair.
16	$\overline{\text{Q0}}$	LVDS Output	Inverted IN output. Typically loaded with 100 $\Omega$ receiver termination resistor across differential pair.
–	EP	–	The Exposed Pad (EP) on the QFN-16 package bottom is thermally connected to the die for improved heat transfer out of package. The exposed pad must be attached to a heat-sinking conduit. The pad is not electrically connected to the die, but is recommended to be electrically and thermally connected to GND on the PC board.

2. In the differential configuration, when the input termination pin (VT) is connected to a termination voltage or left open, and if no signal is applied on IN/ $\overline{\text{IN}}$  inputs, then the device will be susceptible to self-oscillation.

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**Table 3. ATTRIBUTES**

Characteristics	Value
Moisture Sensitivity (Note 3)	Level 1
Flammability Rating	Oxygen Index: 28 to 34 UL 94 V-0 @ 0.125 in
ESD Protection	Human Body Model Machine Model > 2 kV > 200 V
Transistor Count	745
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test	

3. For additional information, see Application Note AND8003/D.

**Table 4. MAXIMUM RATINGS**

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
V <sub>CC</sub>	Positive Power Supply	GND = 0 V		3.8	V
V <sub>IN</sub>	Positive Input	GND = 0 V	V <sub>IN</sub> ≤ V <sub>CC</sub>	3.8	V
I <sub>IN</sub>	Input Current Through R <sub>T</sub> (50 Ω Resistor)	Static Surge		35 70	mA mA
I <sub>OSC</sub>	Output Short Circuit Current Line-to-Line (Q to $\bar{Q}$ ) Line-to-End (Q or $\bar{Q}$ to GND)	Q or $\bar{Q}$ Q to $\bar{Q}$ to GND	Continuous Continuous	12 24	mA
I <sub>REF_AC</sub>	V <sub>REF_AC</sub> Sink/Source Current			±0.5	mA
T <sub>A</sub>	Operating Temperature Range	QFN-16		-40 to +85	°C
T <sub>stg</sub>	Storage Temperature Range			-65 to +150	°C
θ <sub>JA</sub>	Thermal Resistance (Junction-to-Ambient) (Note 4)	0 lfpm 500 lfpm	QFN-16 QFN-16	41.6 35.2	°C/W °C/W
θ <sub>JC</sub>	Thermal Resistance (Junction-to-Case)	1S2P (Note 4)	QFN-16	4.0	°C/W
T <sub>sol</sub>	Wave Solder	Pb-Free		265	°C

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.

4. JEDEC standard multilayer board – 1S2P (1 signal, 2 power) with 8 filled thermal vias under exposed pad.

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**Table 5. DC CHARACTERISTICS**  $V_{CC} = 2.375\text{ V to }2.625\text{ V}$ ,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$

Symbol	Characteristic	Min	Typ	Max	Unit
$I_{CC}$	Power Supply Current (Note 9)		65	100	mA

**DIFFERENTIAL INPUTS DRIVEN SINGLE-ENDED** (Figures 17, 18, 22, and 24)

$V_{th}$	Input Threshold Reference Voltage Range (Note 8)	GND +100		$V_{CC} - 100$	mV
$V_{IH}$	Single-ended Input HIGH Voltage	$V_{th} + 100$		$V_{CC}$	mV
$V_{IL}$	Single-ended Input LOW Voltage	GND		$V_{th} - 100$	mV
$V_{REFAC}$	Reference Output Voltage (Note 11)	$V_{CC} - 1.600$	$V_{CC} - 1.425$	$V_{CC} - 1.300$	V

**DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY** (Figures 10, 12, 12, 13, 23, and 25)

$V_{IHD}$	Differential Input HIGH Voltage	100		$V_{CC}$	mV
$V_{ILD}$	Differential Input LOW Voltage	GND		$V_{IHD} - 100$	mV
$V_{CMR}$	Input Common Mode Range (Differential Configuration)	GND + 50		$V_{CC} - 50$	mV
$V_{ID}$	Differential Input Voltage ( $V_{IHD} - V_{ILD}$ )	100		$V_{CC}$	mV
$R_{TIN}$	Internal Input Termination Resistor	40	50	60	$\Omega$

**LVDS OUTPUTS** (Note 5)

$V_{OD}$	Differential Output Voltage	250		450	mV
$\Delta V_{OD}$	Change in Magnitude of $V_{OD}$ for Complementary Output States (Note 10)	0	1	25	mV
$V_{OS}$	Offset Voltage (Figure 21)	1125		1375	mV
$\Delta V_{OS}$	Change in Magnitude of $V_{OS}$ for Complementary Output States (Note 10)	0	1	25	mV
$V_{OH}$	Output HIGH Voltage (Note 6)		1425	1600	mV
$V_{OL}$	Output LOW Voltage (Note 7)	900	1075		mV

**LVTTL/LVC MOS INPUT, EN**

$V_{IH}$	Input HIGH Voltage	2.0		$V_{CC}$	V
$V_{IL}$	Input LOW Voltage	GND		0.8	V
$I_{IH}$	Input HIGH Current	-150		150	$\mu\text{A}$
$I_{IL}$	Input LOW Current	-150		150	$\mu\text{A}$

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfp/m.

5. LVDS outputs require 100  $\Omega$  receiver termination resistor between differential pair. See Figure 20.

6.  $V_{OHmax} = V_{OSmax} + \frac{1}{2} V_{ODmax}$ .

7.  $V_{OLmax} = V_{OSmin} - \frac{1}{2} V_{ODmax}$ .

8.  $V_{th}$  is applied to the complementary input when operating in single-ended mode.

9. Input termination pins open at the DC level within  $V_{CMR}$  and output pins loaded with  $R_L = 100\ \Omega$  across differential.

10. Parameter guaranteed by design verification not tested in production.

11.  $V_{REFAC}$  used to rebias capacitor-coupled inputs only (see Figures 17 and 18).

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**Table 6. AC CHARACTERISTICS**  $V_{CC} = 2.375\text{ V to }2.625\text{ V}$ ,  $GND = 0\text{ V}$ ; (Note 12)

Symbol	Characteristic	-40°C to +85°C			Unit
		Min	Typ	Max	
$f_{inMax}$	Maximum Input Clock Frequency	2.0			GHz
$V_{OUTPP}$	Output Voltage Amplitude (@ $V_{INPPmin}$ ) (Figure 4)	$f_{in} \leq 1.0\text{ GHz}$ 220 $f_{in} = 1.5\text{ GHz}$ 200 $f_{in} = 2.0\text{ GHz}$ 170	350 300 270		mV
$f_{DATA}$	Maximum Operating Data Rate	2.5			Gb/s
$t_{PLH}$ , $t_{PHL}$	Differential Input to Differential Output, IN to Q Propagation Delay @ 100 MHz	300	450	600	ps
$t_s$ $t_h$	Setup Time Hold Time	300 500	20 20		
$t_{SKEW}$	Within Device Skew (Note 17) Device-to-Device Skew (Note 16)		5 30	20 200	ps
$t_{JITTER}$	RMS Random Clock Jitter (Note 14) Deterministic Jitter (Note 15)		$f_{in} = 2.0\text{ GHz}$ 0.5 5.0 $f_{DATA} \leq 2.488\text{ Gb/s}$	0.8 20	ps
$V_{INPP}$	Input Voltage Swing/Sensitivity (Differential Configuration) (Note 13)	100		$V_{CC} - GND$	mV
$t_r$ $t_f$	Output Rise/Fall Times @ 250 MHz (20% – 80%)	70	150	225	ps

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfm.

12. Measured by forcing  $V_{INPPmin}$  with 50% duty cycle clock source and  $V_{CC} - 1400\text{ mV}$  offset. All loading with an external  $R_L = 100\ \Omega$ . Input edge rates 150 ps (20%–80%). See Figure 20.

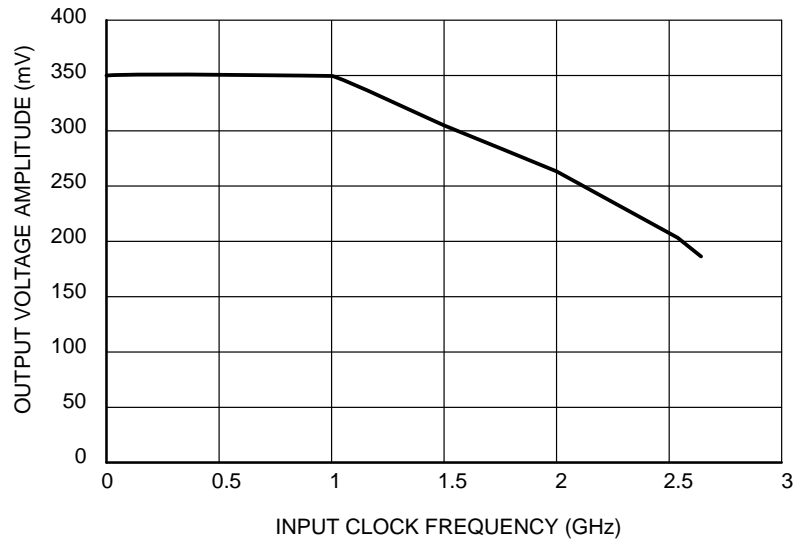
13. Input voltage swing is a single-ended measurement operating in differential mode.

14. RMS jitter with 50% Duty Cycle clock signal at 750 MHz.

15. Deterministic jitter with input NRZ data at PRBS 2<sup>23</sup>-1 and K28.5.

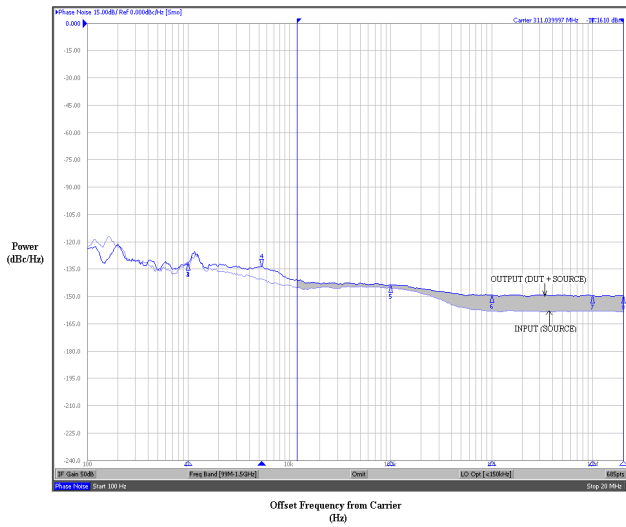
16. Skew is measured between outputs under identical transition @ 250 MHz.

17. The worst case condition between  $Q0/Q\bar{0}$  and  $Q1/Q\bar{1}$  from either  $D0/D\bar{0}$  or  $D1/D\bar{1}$ , when both outputs have the same transition.

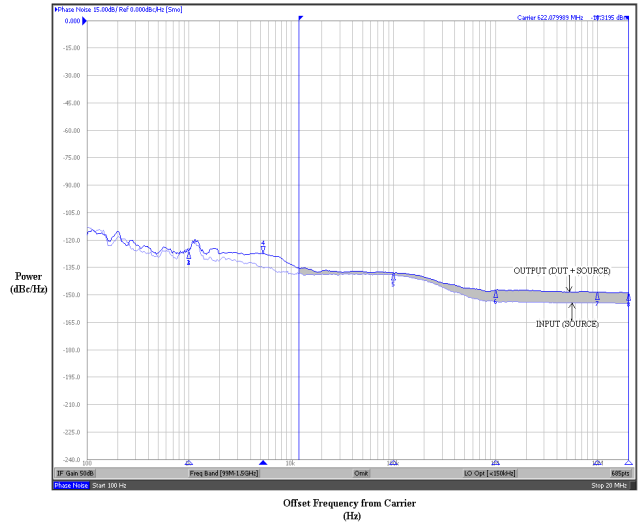


**Figure 4. Output Voltage Amplitude ( $V_{OUTPP}$ ) versus Input Clock Frequency ( $f_{in}$ ) and Temperature (@  $V_{CC} = 2.5\text{ V}$ )**

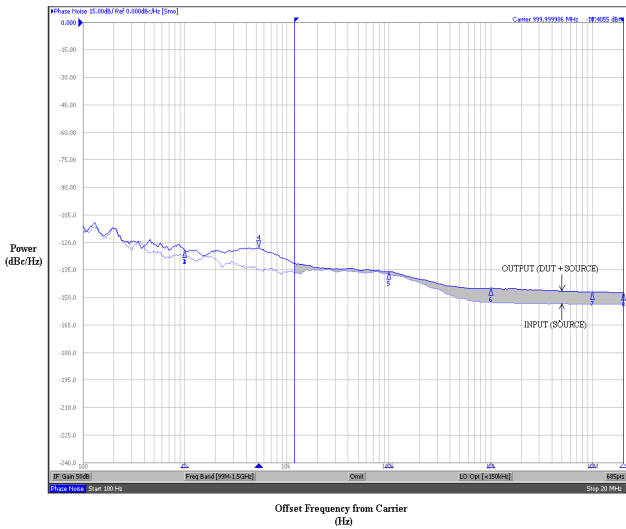
# NB6L14S



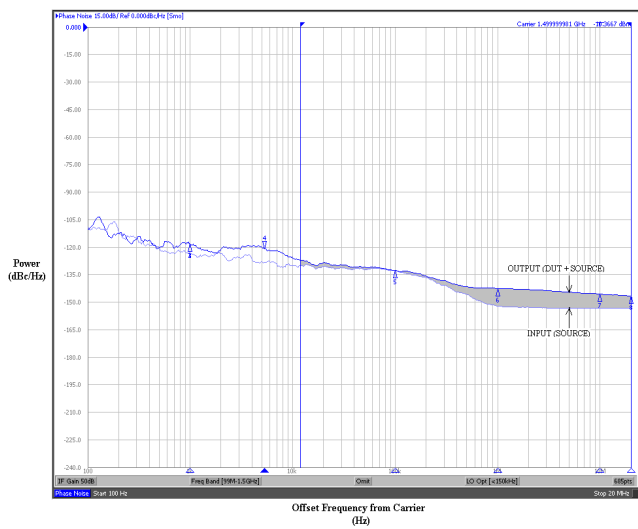
**Figure 5. Typical Phase Noise Plot at  $f_{\text{carrier}} = 311.04 \text{ MHz}$**



**Figure 6. Typical Phase Noise Plot at  $f_{\text{carrier}} = 622.08 \text{ MHz}$**



**Figure 7. Typical Phase Noise Plot at  $f_{\text{carrier}} = 1 \text{ GHz}$**



**Figure 8. Typical Phase Noise Plot at  $f_{\text{carrier}} = 1.5 \text{ GHz}$**

The above phase noise plots captured using Agilent E5052A show additive phase noise of the NB6L14S device at frequencies 311.04 MHz, 622.08 MHz, 1 GHz and 1.5 GHz respectively at an operating voltage of 2.5 V in room temperature. The RMS Phase Jitter contributed by the

device (integrated between 12 kHz and 20 MHz; as shown in the shaded region of the plot) at each of the frequencies is 65 fs, 29 fs, 24 fs and 20 fs respectively. The input source used for the phase noise measurements is Agilent E8663B.

# NB6L14S

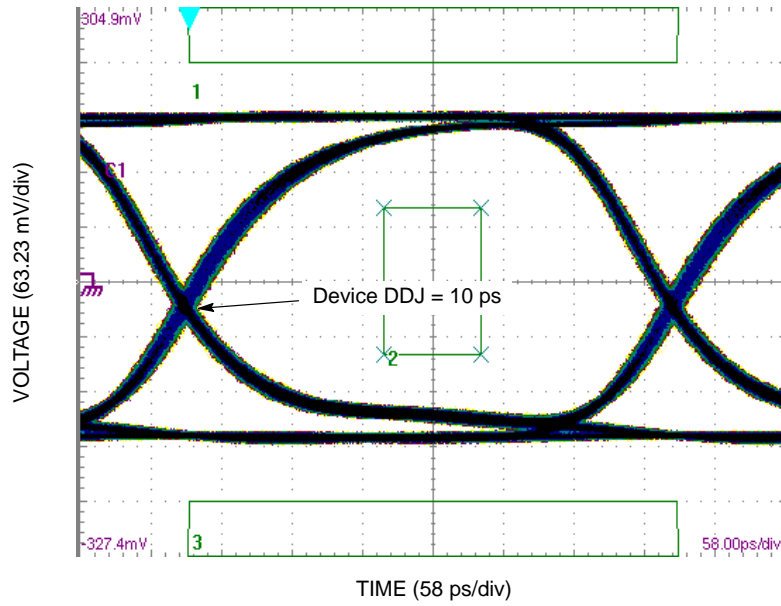


Figure 9. Typical Output Waveform at 2.488 Gb/s with PRBS  $2^{23}-1$  and OC48 mask ( $V_{INPP} = 100$  mV; Input Signal DDJ = 14 ps)

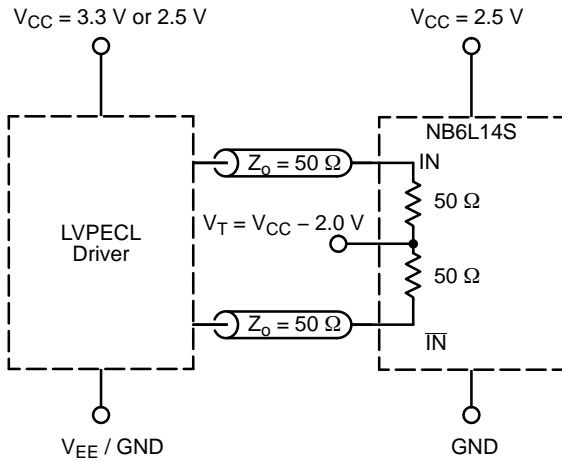


Figure 10. LVPECL Interface

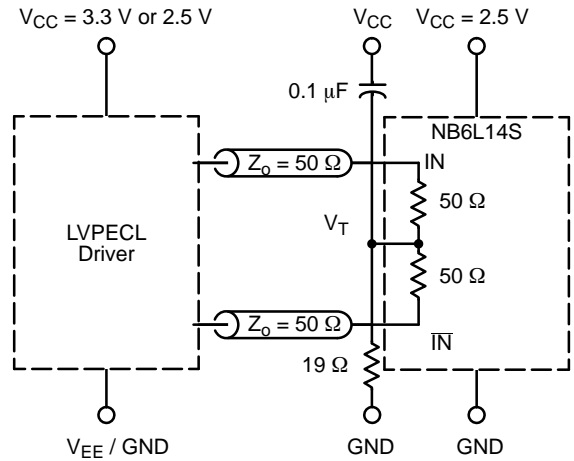


Figure 11. LVPECL Y-Termination Interface

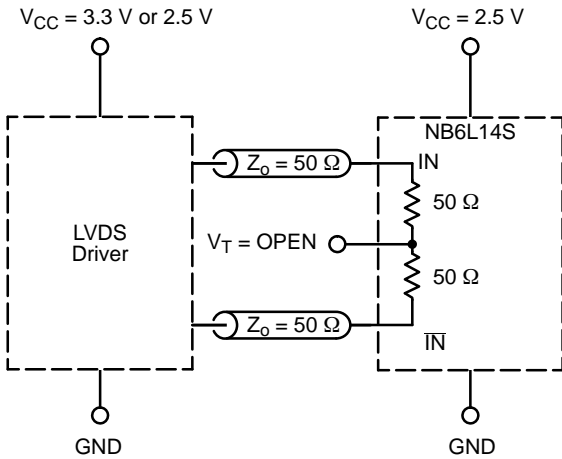


Figure 12. LVDS Interface

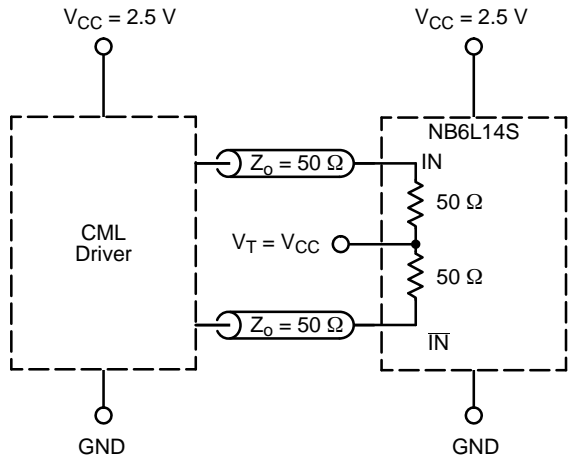


Figure 13. CML Interface

# NB6L14S

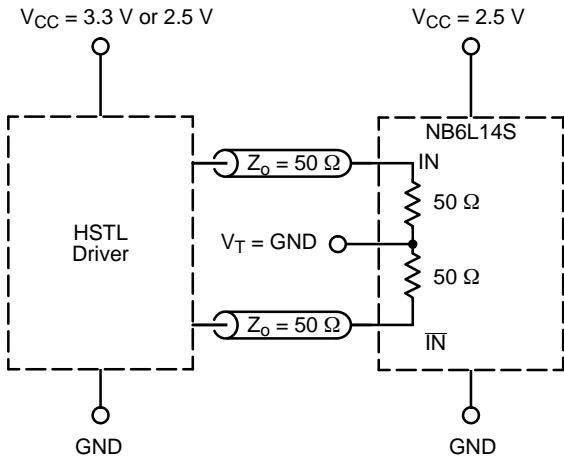


Figure 14. HSTL Interface

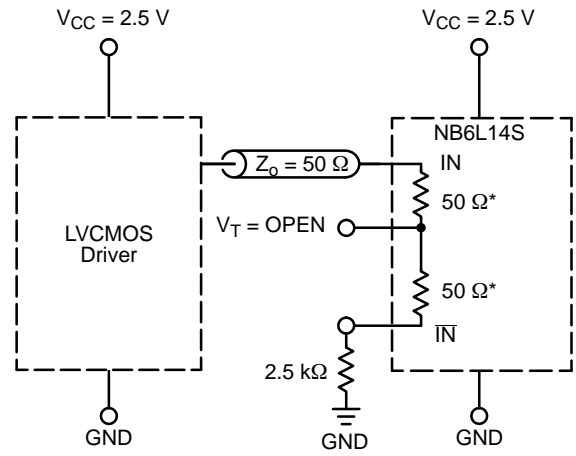


Figure 15. LVCMOS Interface

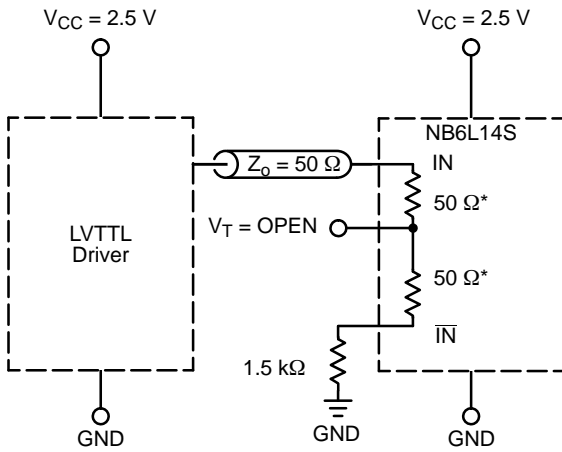


Figure 16. LVTTTL Interface

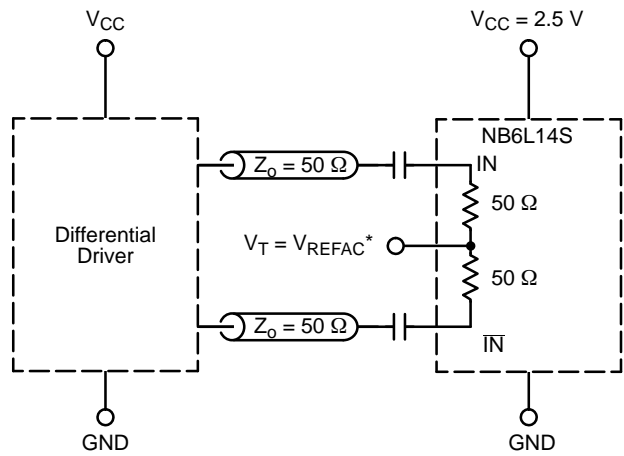


Figure 17. Capacitor-Coupled Differential Interface ( $V_T$  Connected to  $V_{REF\_AC}$ )

\* $V_{REF\_AC}$  bypassed to ground with a 0.1  $\mu$ F capacitor.

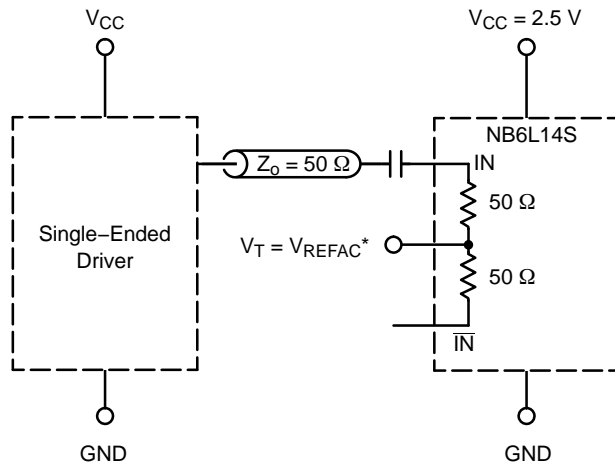


Figure 18. Capacitor-Coupled Single-Ended Interface ( $V_T$  Connected to  $V_{REF\_AC}$ )

\* $V_{REF\_AC}$  bypassed to ground with a 0.1  $\mu$ F capacitor.



# NB6L14S

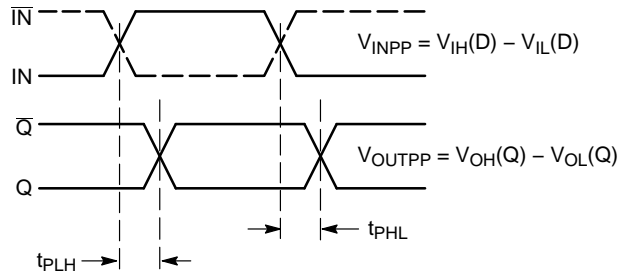


Figure 19. AC Reference Measurement

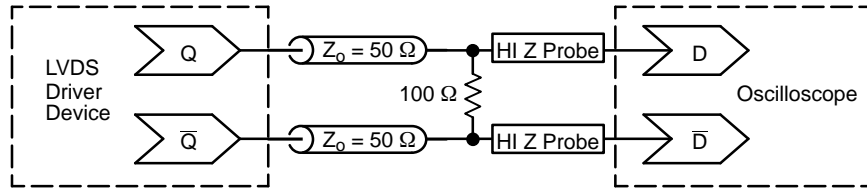


Figure 20. Typical LVDS Termination for Output Driver and Device Evaluation

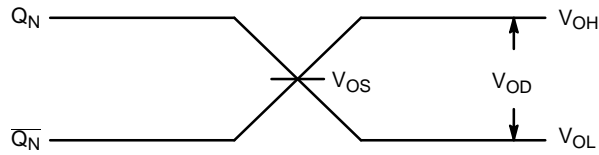


Figure 21. LVDS Output

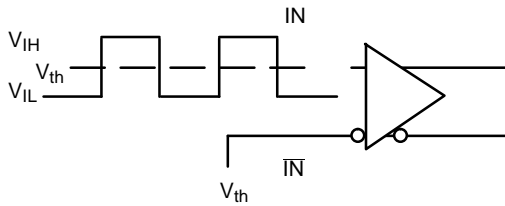


Figure 22. Differential Input Driven Single-Ended

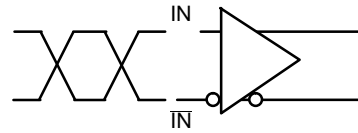


Figure 23. Differential Inputs Driven Differentially

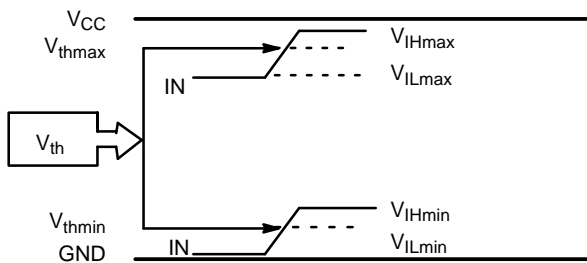


Figure 24.  $V_{th}$  Diagram

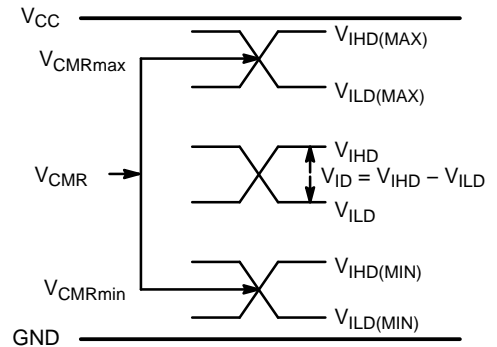


Figure 25.  $V_{CMR}$  Diagram

# NB6L14S

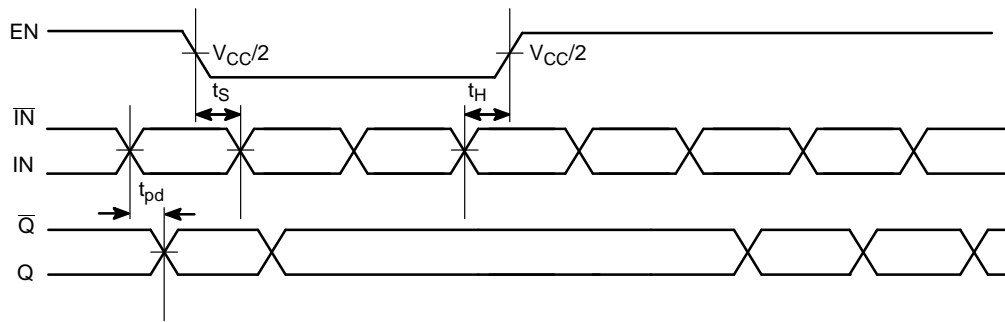


Figure 26. EN Timing Diagram

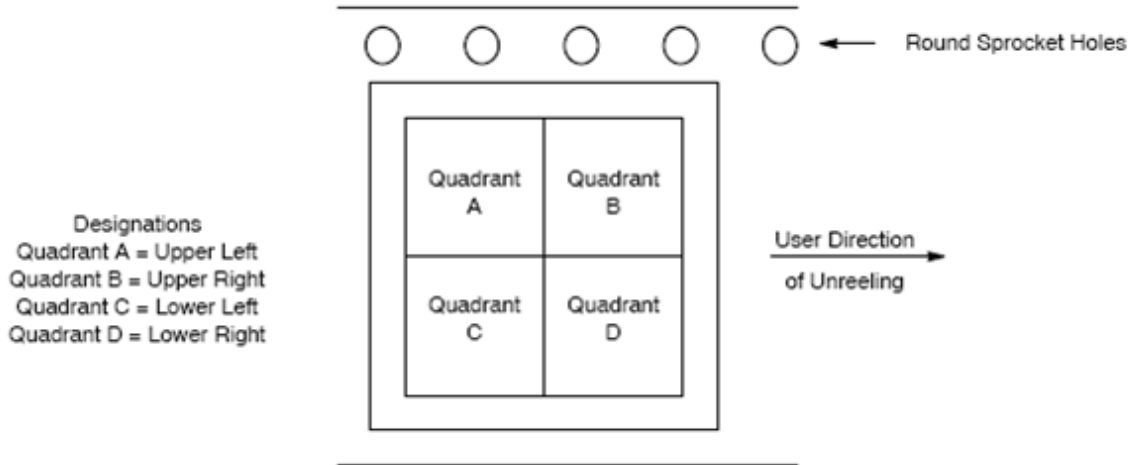


Figure 27. Tape and Reel Pin 1 Quadrant Orientation

## ORDERING INFORMATION

Device	Package	Shipping†
NB6L14SMNG	QFN-16, 3 X 3 mm (Pb-Free)	123 Units / Rail
NB6L14SMNTXG	QFN-16, 3 X 3 mm (Pb-Free)	3000 / Tape & Reel (Pin 1 Orientation in Quadrant B, Figure 27)
NB6L14SMNTWG	QFN-16, 3 X 3 mm (Pb-Free)	3000 / Tape & Reel (Pin 1 Orientation in Quadrant A, Figure 27)

†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.



1  
SCALE 2:1

QFN16 3x3, 0.5P  
CASE 485G  
ISSUE G

DATE 08 OCT 2021



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 0.15 AND 0.30 MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.



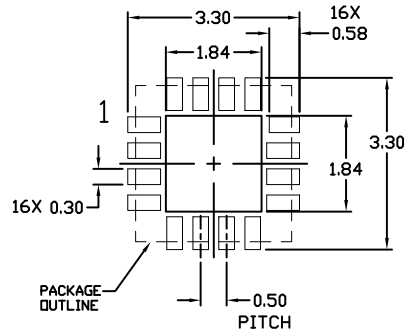
DETAIL B  
ALTERNATE CONSTRUCTIONS



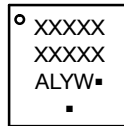
DETAIL A  
ALTERNATE TERMINAL CONSTRUCTIONS

DIM	MILLIMETERS		
	MIN.	NDM.	MAX.
A	0.80	0.90	1.00
A1	0.00	0.03	0.05
A3	0.20 REF		
b	0.18	0.24	0.30
D	3.00 BSC		
D2	1.65	1.75	1.85
E	3.00 BSC		
E2	1.65	1.75	1.85
e	0.50 BSC		
k	0.18 TYP		
L	0.30	0.40	0.50
L1	0.00	0.08	0.15

MOUNTING FOOTPRINT



GENERIC MARKING DIAGRAM\*



- XXXXX = Specific Device Code
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- = 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. Some products may not follow the Generic Marking.

DOCUMENT NUMBER:	98AON04795D	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	QFN16 3X3, 0.5P	PAGE 1 OF 1

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