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# NB7L14

## 2.5V / 3.3V 7GHz/10Gbps Differential 1:4 LVPECL Fanout Buffer

### Multi-Level Inputs w/ Internal Termination

#### Description

The NB7L14 is a differential 1:4 LVPECL fanout buffer. The NB7L14 produces four identical LVPECL output copies of Clock or Data operating up to 7 GHz or 10.7 Gb/s, respectively. As such, the NB7L14 is ideal for SONET, GigE, Fiber Channel, Backplane and other Clock or Data distribution applications.

The differential inputs incorporate internal 50 Ω termination resistors that are accessed through the VT Pin. This feature allows the NB7L14 to accept various logic standards, such as LVPECL, CML, LVDS, LVCMOS or LVTTL logic levels. The V<sub>REFAC</sub> reference output can be used to rebias capacitor-coupled differential or single-ended input signals. The 1:4 fanout design was optimized for low output skew applications.

The NB7L14 is a member of the GigaComm™ family of high performance clock products.

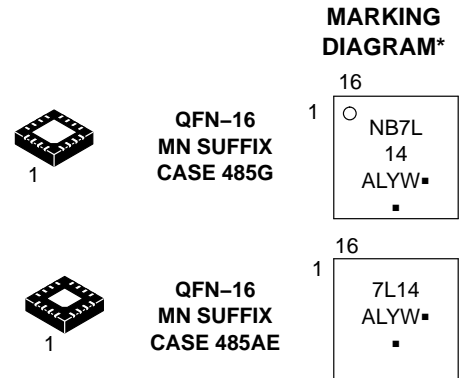
#### Features

- Input Data Rate > 10.7 Gb/s
- Input Clock Frequency > 7 GHz
- 165 ps Typical Propagation Delay
- 45 ps Typical Rise and Fall Times
- <15 ps max Output Skew
- <0.8 ps maximum RMS Clock Jitter
- <15 ps pp of Data Dependent Jitter
- Differential LVPECL Outputs, 720 mV peak-to-peak, typical
- LVPECL Operating Range: V<sub>CC</sub> = 2.375 V to 3.6 V with GND = 0 V
- NECL Operating Range: V<sub>CC</sub> = 0 V with GND = -2.375 V to -3.6 V
- Internal Input Termination Resistors, 50 Ω
- V<sub>REFAC</sub> Reference Output
- Functionally Compatible with Existing 2.5 V / 3.3 V LVEL, LVEP, EP, and SG Devices
- -40°C to +85°C Ambient Operating Temperature
- These are Pb-Free Devices



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XXXX = Specific Device Code  
 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.

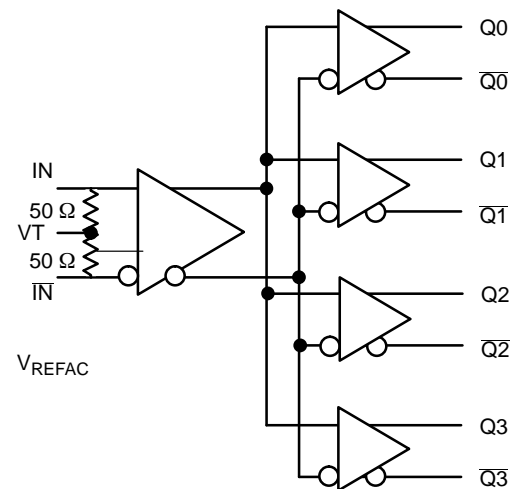


Figure 1. Logic Diagram

#### ORDERING INFORMATION

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

# NB7L14

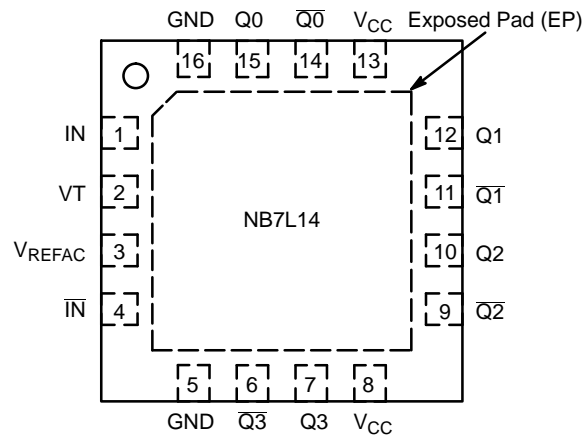


Figure 2. QFN-16 Pinout (Top View)

Table 1. PIN DESCRIPTION

Pin	Name	I/O	Description
1	IN	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Non-inverted Differential Input. Note 1. Internal 50 $\Omega$ Resistor to Termination Pin, VT
2	VT	-	Internal 50- $\Omega$ Termination Pin for IN/ $\overline{\text{IN}}$ inputs.
3	VREFAC		Output Reference Voltage for capacitor-coupled inputs
4	$\overline{\text{IN}}$	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Inverted Differential Input. Note 1. Internal 50 $\Omega$ Resistor to Termination Pin, VT.
5	GND	-	Negative Supply Voltage
6	$\overline{\text{Q3}}$	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
7	Q3	LVPECL Output	Non-inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
8	VCC	-	Positive Supply Voltage
9	$\overline{\text{Q2}}$	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
10	Q2	LVPECL Output	Non-inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
11	$\overline{\text{Q1}}$	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
12	Q1	LVPECL Output	Non-inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
13	VCC	-	Positive Supply Voltage
14	$\overline{\text{Q0}}$	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
15	Q0	LVPECL Output	Non-inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{\text{CC}} - 2.0 \text{ V}$ .
16	GND	-	Negative Supply Voltage
-	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 electrically connected to the die, and must be electrically connected to device GND.

1. In the differential configuration when the input termination pin (VT) is connected to a common termination voltage or left open, and if no signal is applied on IN/ $\overline{\text{IN}}$  input, then, the device will be susceptible to self-oscillation.
2. All VCC and GND pins must be externally connected to a power supply for proper operation.

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**Table 2. ATTRIBUTES**

Characteristics		Value
ESD Protection	Human Body Model Machine Model	> 2000 V > 150 V
Moisture Sensitivity (Note 3)	QFN-16	Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in
Transistor Count		173
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test		

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

**Table 3. MAXIMUM RATINGS**

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
$V_{CC}$	Positive Power Supply	GND = 0 V		-0.5 V to +4.0	V
$V_{IO}$	Positive Input/Output Voltage	GND = 0 V	$-0.5 \leq V_{Io} \leq V_{CC} + 0.5$	4.0	V
$V_{INPP}$	Differential Input Voltage $ D - \bar{D} $			2.8	V
$I_{IN}$	Input Current Through $R_T$ (50 $\Omega$ Resistor)			$\pm 40$	mA
$I_{OUT}$	Output Current (LVPECL Output)	Continuous Surge		50 100	mA
$I_{VFREFAC}$	$V_{REFAC}$ Sink/Source Current			$\pm 1.5$	mA
$T_A$	Operating Temperature Range	QFN-16		-40 to +85	$^{\circ}C$
$T_{stg}$	Storage Temperature Range			-65 to +150	$^{\circ}C$
$\theta_{JA}$	Thermal Resistance (Junction-to-Ambient) (Note 4)	0 lfpm 500 lfpm	QFN-16 QFN-16	42 35	$^{\circ}C/W$
$\theta_{JC}$	Thermal Resistance (Junction-to-Case) (Note 4)		QFN-16	4	$^{\circ}C/W$
$T_{sol}$	Wave Solder Pb-Free			265	$^{\circ}C$

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 – 2S2P (2 signal, 2 power) with 8 filled thermal vias under exposed pad.

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**Table 4. DC CHARACTERISTICS, MULTI-LEVEL INPUTS**  $V_{CC} = 2.375\text{ V to }3.6\text{ V}$ ,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$

Symbol	Characteristic	Min	Typ	Max	Unit	
<b>POWER SUPPLY CURRENT</b>						
$V_{CC}$	Power Supply Voltage	$V_{CC} = 2.5\text{ V}$ $V_{CC} = 3.3\text{ V}$	2.375 3.0	2.5 3.3	2.625 3.6	V
$I_{CC}$	Power Supply Current (Inputs and Outputs Open)			85	105	mA
<b>LVPECL OUTPUTS</b> (Notes 5 & 6)						
$V_{OH}$	Output HIGH Voltage	$V_{CC} = 2.5\text{ V}$ $V_{CC} = 3.3\text{ V}$	$V_{CC} - 1145$ 1355 2155	$V_{CC} - 900$ 1600 2400	$V_{CC} - 825$ 1675 2475	mV
$V_{OL}$	Output LOW Voltage	$V_{CC} = 2.5\text{ V}$ $V_{CC} = 3.3\text{ V}$	$V_{CC} - 2000$ 500 1300	$V_{CC} - 1700$ 800 1600	$V_{CC} - 1500$ 1000 1800	mV
<b>DIFFERENTIAL INPUT DRIVEN SINGLE-ENDED</b> (see Figure 5 & 7) (Note 7)						
$V_{IH}$	Single-ended Input HIGH Voltage		$V_{th} + 75$		$V_{CC}$	mV
$V_{IL}$	Single-ended Input LOW Voltage		GND		$V_{th} - 75$	mV
$V_{th}$	Input Threshold Reference Voltage Range (Note 8)		1125		$V_{CC} - 75$	mV
$V_{ISE}$	Single-ended Input Voltage Amplitude ( $V_{IH} - V_{IL}$ )		150		2800	mV
<b>VREFAC</b>						
$V_{REFAC}$	Output Reference Voltage (100 $\mu\text{A}$ Load)		$V_{CC} - 1400$	$V_{CC} - 1300$	$V_{CC} - 1000$	mV
<b>DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY</b> (see Figure 6 & 8) (Note 9)						
$V_{IHD}$	Differential Input HIGH Voltage		1200		$V_{CC}$	mV
$V_{ILD}$	Differential Input LOW Voltage		0		$V_{IHD} - 50$	mV
$V_{ID}$	Differential Input Voltage ( $V_{IHD} - V_{ILD}$ )		100		2800	mV
$V_{CMR}$	Input Common Mode Range (Differential Configuration) (Note 10) (Figure 9)		950		$V_{CC} - 50$	mV
$I_{IH}$	Input HIGH Current $I_N / \overline{I_N}$ , (VT Open)		-150		150	$\mu\text{A}$
$I_{IL}$	Input LOW Current $I_N / \overline{I_N}$ , (VT Open)		-150		150	$\mu\text{A}$
<b>TERMINATION RESISTORS</b>						
$R_{TIN}$	Internal Input Termination Resistor		45	50	55	$\Omega$

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. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

- LVPECL outputs loaded with 50  $\Omega$  to  $V_{CC} - 2.0\text{ V}$  for proper operation.
- Input and output parameters vary 1:1 with  $V_{CC}$ .
- $V_{th}$ ,  $V_{IH}$ ,  $V_{IL}$ , and  $V_{ISE}$  parameters must be complied with simultaneously.
- $V_{th}$  is applied to the complementary input when operating in single-ended mode.
- $V_{IHD}$ ,  $V_{ILD}$ ,  $V_{ID}$  and  $V_{CMR}$  parameters must be complied with simultaneously.
- $V_{MR}$  min varies 1:1 with  $V_{EE}$ ,  $V_{CMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{CMR}$  range is referenced to the most positive side of the differential input signal.

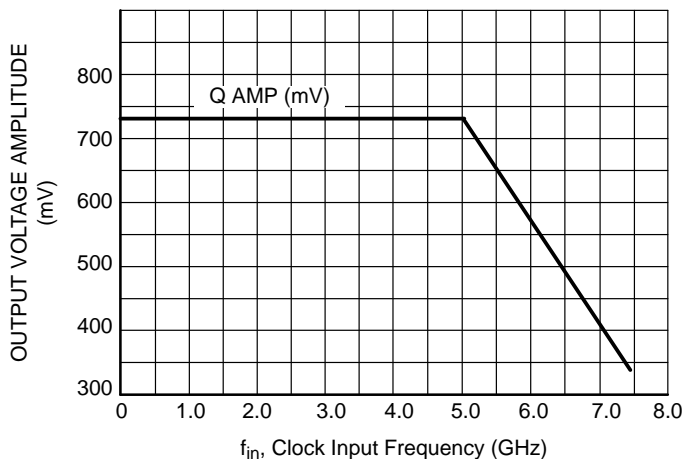
# NB7L14

**Table 5. AC CHARACTERISTICS**  $V_{CC} = 2.375\text{ V to }3.6\text{ V}$ ,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ ; (Note 11)

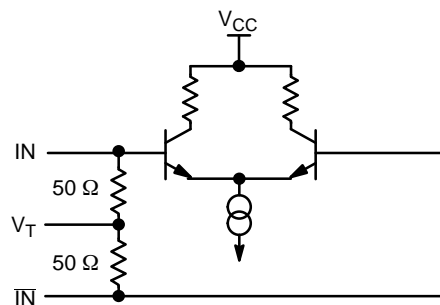
Symbol	Characteristic	Min	Typ	Max	Unit	
$f_{MAX}$	Maximum Input Clock Frequency; $V_{OUT} \geq 400\text{ mV}$	7	8		GHz	
$f_{DATAMAX}$	Maximum Operating Data Rate; NRZ, (PRBS23)	10	11		Gbps	
$V_{OUTPP}$	Output Voltage Amplitude (Note 15) (See Figure 9)	$f_{in} \leq 5\text{ GHz}$ 400	720 450		mV	
$t_{PLH}$ , $t_{PHL}$	Propagation Delay IN to Q	125	165	200	ps	
$t_{SKEW}$	Duty Cycle Skew (Note 12) Output – Output Within Device Skew Device to Device Skew		3	15 15 50	ps	
$t_{DC}$	Output Clock Duty Cycle (Reference Duty Cycle = 50%)	$f_{in} \leq 7\text{ GHz}$	45	50	55	%
$t_{JITTER}$	RMS Random Clock Jitter (Note 13) Peak-to-Peak Data Dependent Jitter (Note 14)	$f_{in} \leq 7\text{ GHz}$ $f_{in} \leq 10.7\text{ Gb/s}$		0.5 5	0.8 15	ps rms ps pk-pk
$t_{jit}(\phi)$	Additive RMS Phase Jitter $f_c = 622.08\text{ MHz}$ , Integration Range: 12 kHz to 20 MHz (See Figure 17)		24		fs	
$V_{INPP}$	Input Voltage Swing/Sensitivity (Differential Configuration) (Note 15)	100		1200	mV	
$t_r$ $t_f$	Output Rise/Fall Times @ 1.0 GHz (20% – 80%)	$Qx, \overline{Qx}$	30	45	60	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. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

11. Measured by forcing  $V_{INPP}(\text{min})$  from a 50% duty cycle clock source. All loading with an external  $R_L = 50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$ . Input edge rates 40 ps (20% – 80%).
12. Skew is measured between outputs under identical transitions and conditions @ 0.5 GHz. Duty cycle skew is measured between differential outputs using the deviations of the sum of  $T_{pw-}$  and  $T_{pw+}$  @ 0.5 GHz.
13. Additive RMS jitter with 50% duty cycle clock signal.
14. Additive peak-to-peak data dependent jitter with input NRZ data at PRBS23.
15. Input and output voltage swing is a single-ended measurement operating in differential mode.



**Figure 3. CLOCK Output Voltage Amplitude ( $V_{OUTPP}$ ) vs. Input Frequency ( $f_{in}$ ) at Ambient Temperature (Typ)**



**Figure 4. Input Structure**

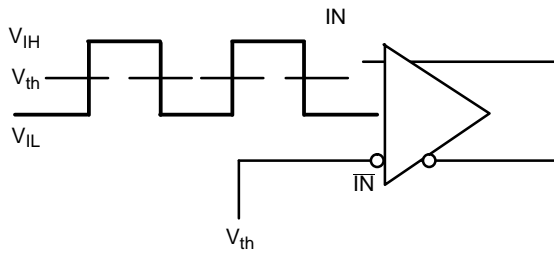


Figure 5. Differential Input Driven Single-Ended

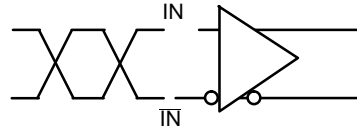


Figure 6. Differential Inputs Driven Differentially

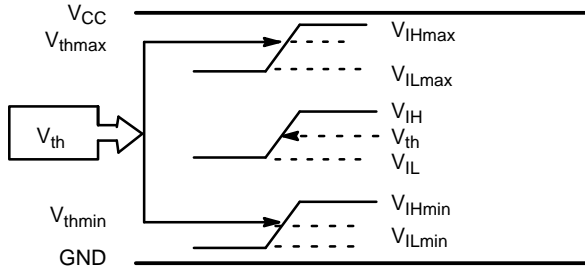


Figure 7.  $V_{th}$  Diagram

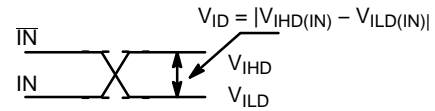


Figure 8. Differential Inputs Driven Differentially

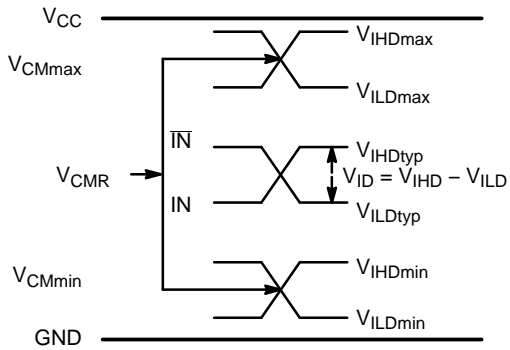


Figure 9.  $V_{CMR}$  Diagram

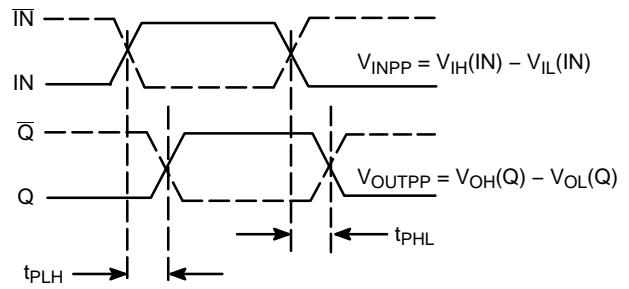


Figure 10. AC Reference Measurement

# NB7L14

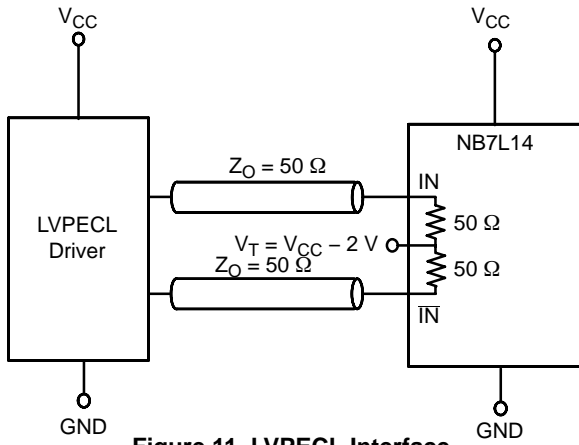


Figure 11. LVPECL Interface

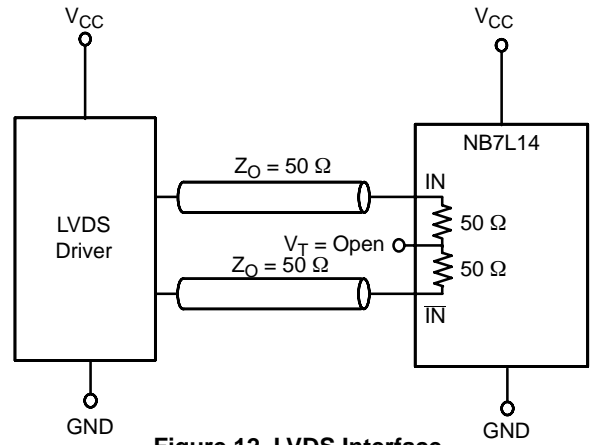


Figure 12. LVDS Interface

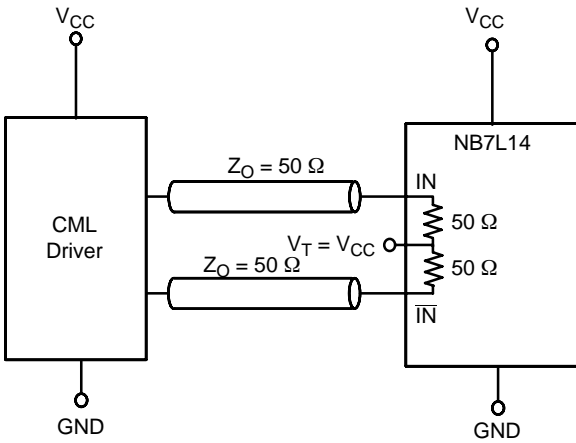


Figure 13. Standard 50  $\Omega$  Load CML Interface

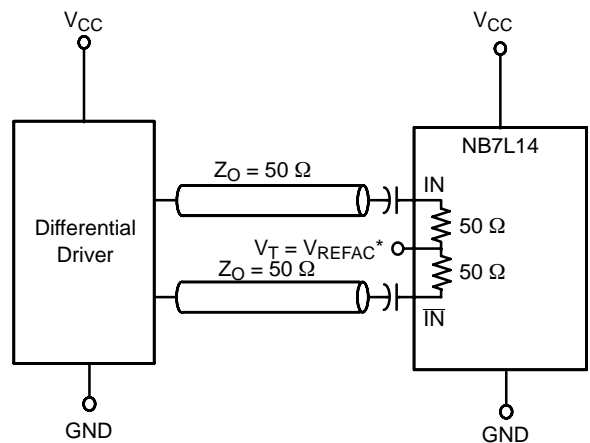


Figure 14. Capacitor-Coupled Differential Interface

( $V_T$  Connected to External  $V_{REFAC}$ )

\* $V_{REFAC}$  bypassed to ground with a 0.01  $\mu F$  capacitor

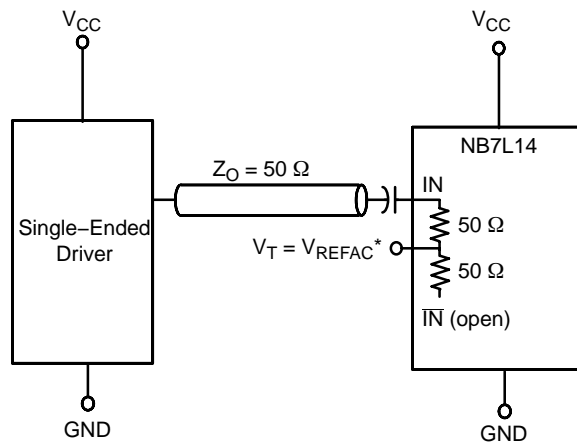
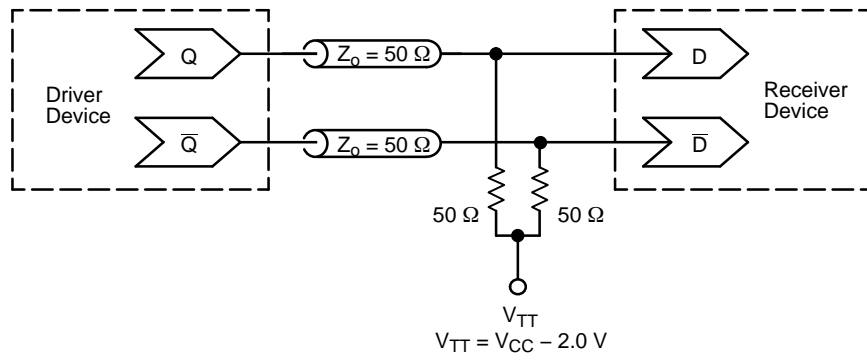


Figure 15. Capacitor-Coupled Differential Interface ( $V_T$  Connected to External  $V_{REFAC}$ )

\* $V_{REFAC}$  bypassed to ground with a 0.01  $\mu F$  capacitor

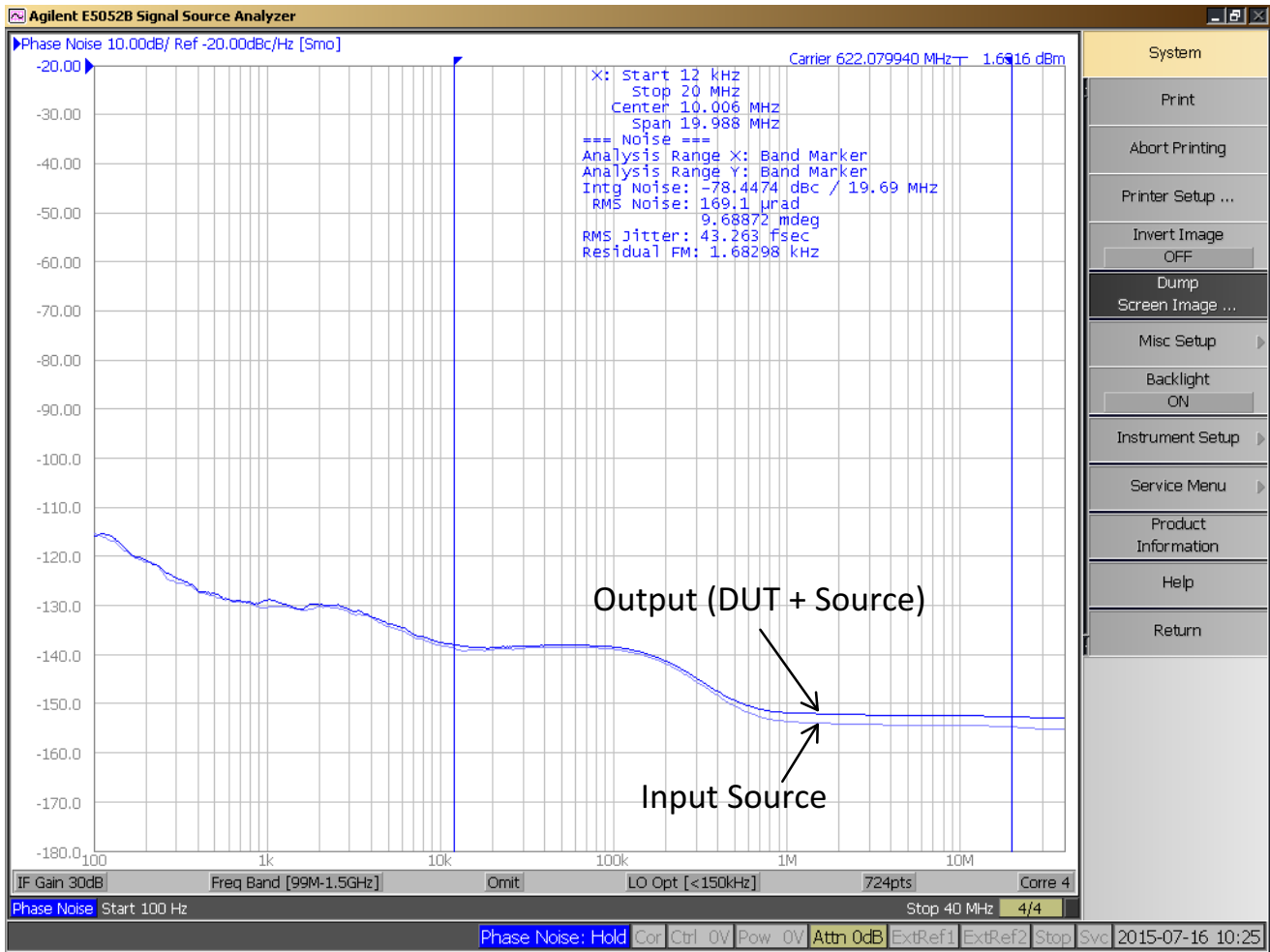


# NB7L14



**Figure 16. Typical Termination for Output Driver and Device Evaluation  
(See Application Note AND8020/D – Termination of ECL Logic Devices.)**

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**Figure 17. Typical NB7L14 Phase Noise Plot at  $f_{\text{Carrier}} = 622.08 \text{ MHz}$ ,  $V_{\text{CC}} = 3.3 \text{ V}$ ,  $25^\circ\text{C}$**

The above phase noise data was captured using Agilent E5052A/B. The data displays the input phase noise and output phase noise used to calculate the additive phase jitter at a specified integration range. The additive RMS phase jitter contributed by the device (integrated between 12 kHz and 20 MHz) is 24 fs. The additive RMS phase jitter performance of the translator is highly dependent on the phase noise of the input source.

To obtain the most precise additive phase noise measurement, it is vital that the source phase noise be

notably lower than that of the DUT. If the phase noise of the source is greater than the noise floor of the device under test, the source noise will dominate the additive phase jitter calculation and lead to an incorrect negative result for the additive phase noise within the integration range. The Figure above is a good example of the NB7L14 source generator phase noise having a significantly lower floor than the DUT and results in an additive phase jitter of 24 fs.

$$\text{Additive RMS phase jitter} = \sqrt{\text{RMS phase jitter of output}^2 - \text{RMS phase jitter of input}^2}$$

$$24 \text{ fs} = \sqrt{43.26 \text{ fs}^2 - 35.98 \text{ fs}^2}$$

To see the performance of NB7L14 beyond conditions outlined in this datasheet use our Phase Noise Explorer web tool located at ON Semiconductor [Green Point Design Tools](#)

homepage. This free application enables an interactive environment for advanced phase noise and jitter analysis of timing devices and clock tree designs.

## NB7L14

### ORDERING INFORMATION

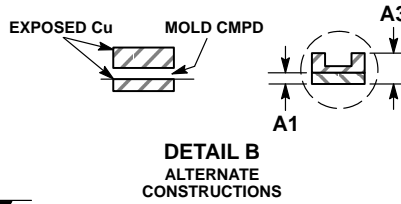
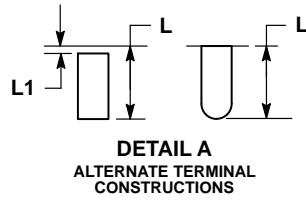
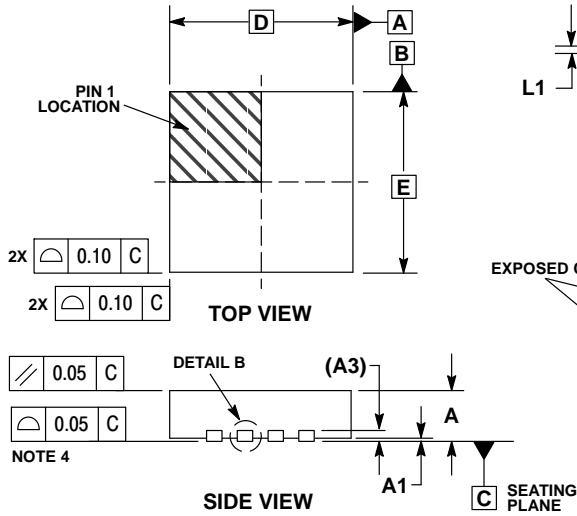
Device	Package	Case	Shipping†
NB7L14MNG	QFN-16 (Pb-Free)	485G	123 Units / Rail
NB7L14MNTXG	QFN-16 (Pb-Free)	485G	3000 / Tape & Reel
NB7L14MN1G	QFN-16 (Pb-Free)	485AE	123 Units / Rail
NB7L14MN1TXG	QFN-16 (Pb-Free)	485AE	3000 / Tape & Reel
NB7L14MN1TWG	QFN-16 (Pb-Free)	485AE	3000 / Tape & Reel

†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.

# NB7L14

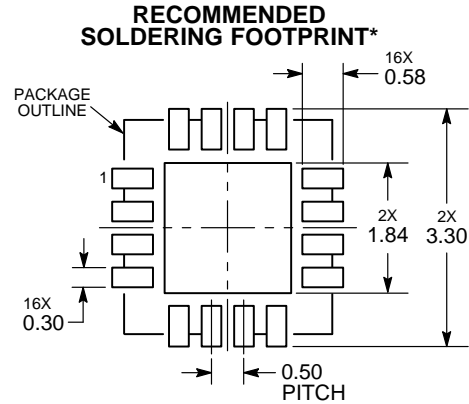
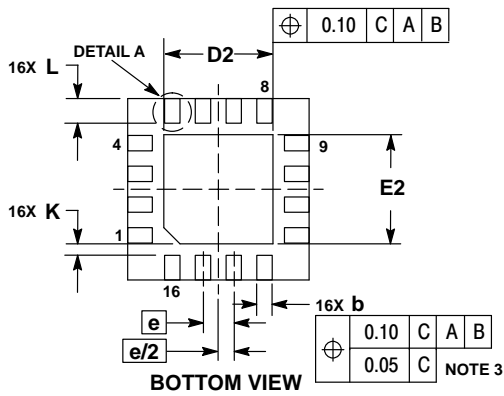
## PACKAGE DIMENSIONS

QFN16 3x3, 0.5P  
CASE 485G  
ISSUE E



- 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	0.80	1.00
A1	0.00	0.05
A3	0.20	REF
b	0.18	0.30
D	3.00	BSC
E	1.65	1.85
E2	3.00	BSC
e	0.50	BSC
K	0.18	TYP
L	0.30	0.50
L1	0.00	0.15



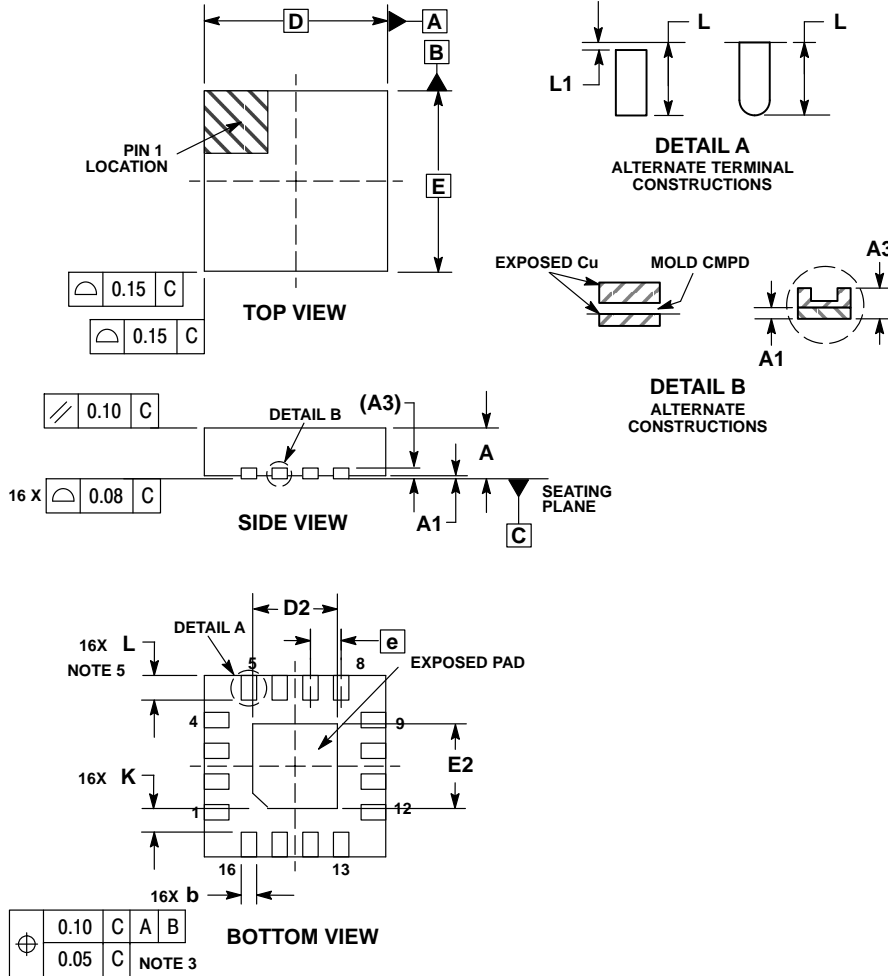
DIMENSIONS: MILLIMETERS

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

# NB7L14

## PACKAGE DIMENSIONS

QFN16 3x3, 0.5P  
CASE 485AE  
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.
5. OUTLINE MEETS JEDEC DIMENSIONS PER MO-220, VARIATION VEED-6.

MILLIMETERS			
DIM	MIN	NOM	MAX
A	0.80	0.90	1.00
A1	0.00	0.03	0.05
A3	0.20 REF		
b	0.18	0.25	0.30
D	3.00 BSC		
D2	1.25	1.40	1.55
E	3.00 BSC		
E2	1.25	1.40	1.55
e	0.50 BSC		
K	0.20	---	---
L	0.30	0.40	0.50
L1	0.00	---	0.15

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