## 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  $\Omega$  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  $V_{REFAC}$  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<sup>™</sup> 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:  $V_{CC} = 2.375 \text{ V}$  to 3.6 V with GND = 0 V
- NECL Operating Range:  $V_{CC} = 0 \text{ V}$  with GND = -2.375 V to -3.6 V
- Internal Input Termination Resistors, 50  $\Omega$
- 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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#### MARKING DIAGRAM\*



QFN-16 MN SUFFIX CASE 485G





QFN-16 MN SUFFIX CASE 485AE



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.

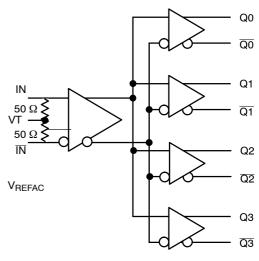


Figure 1. Logic Diagram

#### **ORDERING INFORMATION**

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

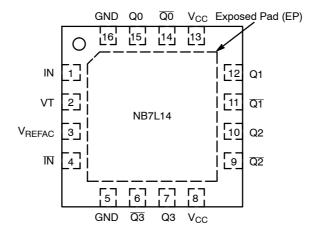


Figure 2. QFN-16 Pinout (Top View)

**Table 1. PIN DESCRIPTION** 

Pin	Name	I/O	Description		
1	IN	ECL, CML, LVCMOS, LVDS, LVTTL 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	ĪN	ECL, CML, LVCMOS, LVDS, LVTTL Input	Inverted Differential Input. Note 1. Internal 50 $\Omega$ Resistor to Termination Pin, VT.		
5	GND	-	Negative Supply Voltage		
6	Q3	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{CC}$ – 2.0 V.		
7	Q3	LVPECL Output	Non-inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to V <sub>CC</sub> $-$ 2.0 V.		
8	VCC	-	Positive Supply Voltage		
9	Q2	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{CC}-2.0$ V.		
10	Q2	LVPECL Output	Non-inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to V <sub>CC</sub> $-$ 2.0 V.		
11	Q1	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{CC}$ – 2.0 V.		
12	Q1	LVPECL Output	Non-inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to V <sub>CC</sub> $-$ 2.0 V.		
13	VCC	-	Positive Supply Voltage		
14	Q0	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{CC}$ – 2.0 V.		
15	Q0	LVPECL Output	Non–inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to V <sub>CC</sub> $-$ 2.0 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.		

<sup>1.</sup> 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/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.

**Table 2. ATTRIBUTES** 

Characteris	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				

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

**Table 3. MAXIMUM RATINGS** 

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
V <sub>CC</sub>	Positive Power Supply	GND = 0 V		-0.5 V to +4.0	V
V <sub>IO</sub>	Positive Input/Output Voltage	GND = 0 V	$-0.5 \le V_{lo} \le V_{CC} + 0.5$	4.0	V
V <sub>INPP</sub>	Differential Input Voltage  D - D			2.8	V
I <sub>IN</sub>	Input Current Through $R_T$ (50 $\Omega$ Resistor)			±40	mA
I <sub>OUT</sub>	Output Current (LVPECL Output)	Continuous Surge		50 100	mA
I <sub>VFREFAC</sub>	V <sub>REFAC</sub> Sink/Source Current			±1.5	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
$\theta_{JA}$	Thermal Resistance (Junction-to-Ambient) (Note 4)	0 lfpm 500 lfpm	QFN-16 QFN-16	42 35	°C/W
θ <sub>JC</sub>	Thermal Resistance (Junction-to-Case) (Note 4)		QFN-16	4	°C/W
T <sub>sol</sub>	Wave Solder Pb-Free			265	°C

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.

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

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

Symbol	Characteristic	Min	Тур	Max	Unit
POWER S	UPPLY CURRENT		•		
V <sub>CC</sub>	Power Supply Voltage $ \begin{array}{c} V_{CC} = 2.5 \ V \\ V_{CC} = 3.3 \ V \end{array} $	2.375 3.0	2.5 3.3	2.625 3.6	V
I <sub>CC</sub>	Power Supply Current (Inputs and Outputs Open)		85	105	mA
LVPECL (	DUTPUTS (Notes 5 & 6)				
V <sub>OH</sub>	Output HIGH Voltage	V <sub>CC</sub> – 1145 1355 2155	V <sub>CC</sub> – 900 1600 2400	V <sub>CC</sub> – 825 1675 2475	mV
V <sub>OL</sub>	Output LOW Voltage $ \begin{array}{c} V_{CC} = 2.5 \ V \\ V_{CC} = 3.3 \ V \end{array} $	V <sub>CC</sub> – 2000 500 1300	V <sub>CC</sub> – 1700 800 1600	V <sub>CC</sub> – 1500 1000 1800	mV
DIFFERE	ITIAL INPUT DRIVEN SINGLE-ENDED (see Figure 5 & 7) (Note 7)				
V <sub>IH</sub>	Single-ended Input HIGH Voltage	V <sub>th</sub> + 75		V <sub>CC</sub>	mV
V <sub>IL</sub>	Single-ended Input LOW Voltage	GND		V <sub>th</sub> – 75	mV
V <sub>th</sub>	Input Threshold Reference Voltage Range (Note 8)	1125		V <sub>CC</sub> – 75	mV
V <sub>ISE</sub>	Single-ended Input Voltage Amplitude (V <sub>IH</sub> - V <sub>IL</sub> )	150		2800	mV
VREFAC					
V <sub>REFAC</sub>	Output Reference Voltage (100 μA Load)	V <sub>CC</sub> – 1400	V <sub>CC</sub> – 1300	V <sub>CC</sub> – 1000	mV
DIFFERE	ITIAL INPUTS DRIVEN DIFFERENTIALLY (see Figure 6 & 8) (Note 9)				
$V_{IHD}$	Differential Input HIGH Voltage	1200		V <sub>CC</sub>	mV
$V_{ILD}$	Differential Input LOW Voltage	0		V <sub>IHD</sub> – 50	mV
$V_{\text{ID}}$	Differential Input Voltage (V <sub>IHD</sub> - V <sub>ILD</sub> )	100		2800	mV
V <sub>CMR</sub>	Input Common Mode Range (Differential Configuration) (Note 10) (Figure 9)	950		V <sub>CC</sub> – 50	mV
I <sub>IH</sub>	Input HIGH Current IN / IN, (VT Open)	-150		150	μΑ
I <sub>IL</sub>	Input LOW Current IN / IN, (VT Open)	-150		150	μΑ
TERMINA	TION RESISTORS				
R <sub>TIN</sub>	Internal Input Termination Resistor	45	50	55	Ω

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 lfpm. 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.

- 5. LVPECL outputs loaded with 50  $\Omega$  to  $V_{CC}$  2.0 V for proper operation. 6. Input and output parameters vary 1:1 with  $V_{CC}$ .

- V<sub>th</sub>, V<sub>IH</sub>, V<sub>IL</sub>, and V<sub>ISE</sub> parameters must be complied with simultaneously.
   V<sub>th</sub> is applied to the complementary input when operating in single–ended mode.
   V<sub>IHD</sub>, V<sub>ILD</sub>, V<sub>ID</sub> and V<sub>CMR</sub> parameters must be complied with simultaneously.
- 10. V<sub>MR</sub> min varies 1:1 with V<sub>EE</sub>, V<sub>CMR</sub> max varies 1:1 with V<sub>CC</sub>. The V<sub>CMR</sub> range is referenced to the most positive side of the differential input signal.

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

Symbol	Characteristic	Min	Тур	Max	Unit
f <sub>MAX</sub>	Maximum Input Clock Frequency; V <sub>OUT</sub> ≥ 400 mV	7	8		GHz
f <sub>DATAMAX</sub>	Maximum Operating Data Rate; NRZ, (PRBS23)	10	11		Gbps
V <sub>OUTPP</sub>	Output Voltage Amplitude (Note 15) $f_{in} \leq 5 \text{ GHz} \\ \text{(See Figure 9)} \qquad \qquad f_{in} \leq 7 \text{ GHz}$	500 400	720 450		mV
t <sub>PLH</sub> , t <sub>PHL</sub>	Propagation Delay IN to Q	125	165	200	ps
t <sub>SKEW</sub>	Duty Cycle Skew (Note 12) Output – Output Within Device Skew Device to Device Skew		3	15 15 50	ps
t <sub>DC</sub>	Output Clock Duty Cycle $f_{in} \leq 7 \text{ GHz}$ (Reference Duty Cycle = 50%)	45	50	55	%
t <sub>JITTER</sub>	RMS Random Clock Jitter (Note 13) $f_{in} \leq 7 \text{ GHz}$ Peak-to-Peak Data Dependent Jitter (Note 14) $f_{in} \leq 10.7 \text{ Gb/s}$		0.5 5	0.8 15	ps rms ps pk-pk
V <sub>INPP</sub>	Input Voltage Swing/Sensitivity (Differential Configuration) (Note 15)	100		1200	mV
t <sub>r</sub> t <sub>f</sub>	Output Rise/Fall Times @ 1.0 GHz Qx, Qx Qx (20% – 80%)	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 lfpm. 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  $V_{INPP}$  (min) from a 50% duty cycle clock source. All loading with an external  $R_L = 50 \Omega$  to  $V_{CC} 2.0 V$ . 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.

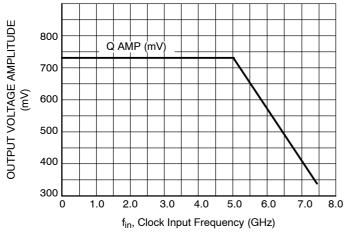


Figure 3. CLOCK Output Voltage Amplitude (V<sub>OUTPP</sub>) vs. Input Frequency (f<sub>in</sub>) at Ambient Temperature (Typ)

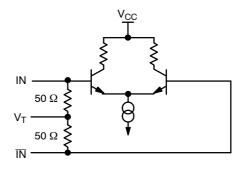


Figure 4. Input Structure

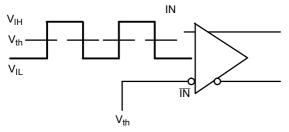


Figure 5. Differential Input Driven Single-Ended

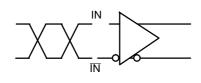


Figure 6. Differential Inputs Driven Differentially

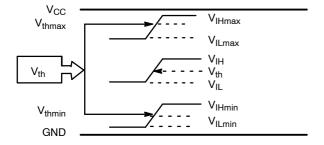


Figure 7. V<sub>th</sub> Diagram

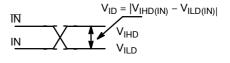


Figure 8. Differential Inputs Driven Differentially

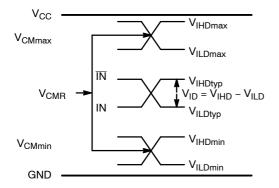


Figure 9. V<sub>CMR</sub> Diagram

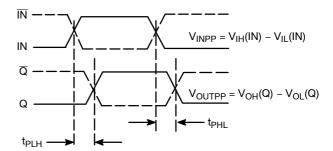


Figure 10. AC Reference Measurement

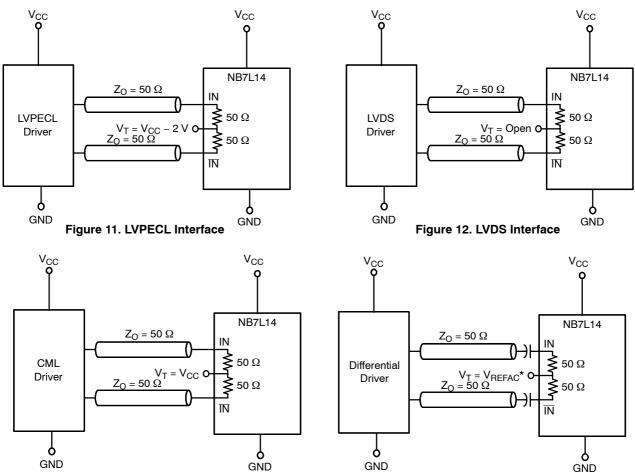


Figure 13. Standard 50  $\Omega$  Load CML Interface

Figure 14. Capacitor–Coupled
Differential Interface
(VT Connected to External V<sub>REFAC</sub>)

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

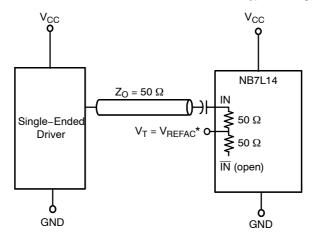


Figure 15. Capacitor-Coupled Differential Interface (V<sub>T</sub> Connected to External V<sub>REFAC</sub>)

\*V\_REFAC bypassed to ground with a 0.01  $\mu\text{F}$  capacitor

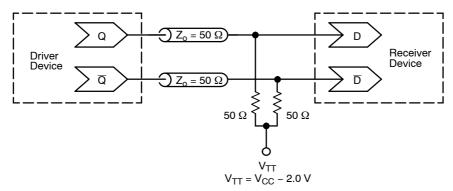


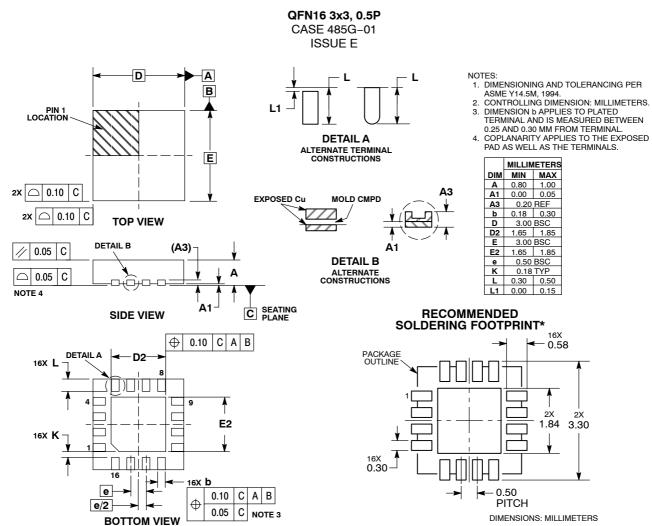
Figure 16. Typical Termination for Output Driver and Device Evaluation (See Application Note AND8020/D – Termination of ECL Logic Devices.)

#### **ORDERING INFORMATION**

Device	Package	Case	Shipping <sup>†</sup>
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

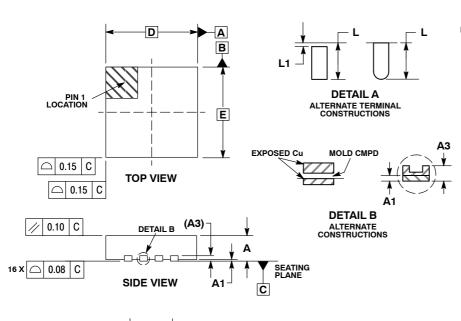
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

#### PACKAGE DIMENSIONS



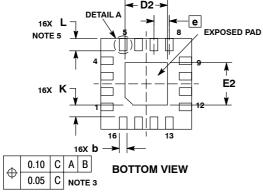
#### **PACKAGE DIMENSIONS**

#### QFN16 3x3, 0.5P CASE 485AE-01 **ISSUE A**



- 1. DIMENSIONING AND TOLERANCING PER
- DIMENSIONING AND TOLEHANGING PER ASME Y14.5M, 1994. CONTROLLING DIMENSION: MILLIMETERS. DIMENSION 6 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.
- OUTLINE MEETS JEDEC DIMENSIONS PER MO-220, VARIATION VEED-6.

	MILLIMETERS				
DIM	MIN	NOM	MAX		
Α	0.80	0.90	1.00		
A1	0.00	0.03	0.05		
А3		0.20 REI	F		
b	0.18	0.25	0.30		
D		3.00 BSC			
D2	1.25	1.40	1.55		
Е		3.00 BS	O		
E2	1.25	1.40	1.55		
ø	0.50 BSC				
Κ	0.20				
٦	0.30	0.40	0.50		
L1	0.00		0.15		



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