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

Multi−Level Inputs with Internal Termination

NB7L14

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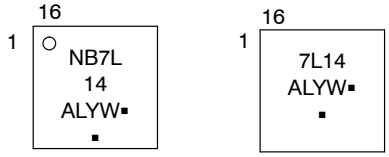


QFN−16
MN SUFFIX
CASE 485G



QFN−16
MN SUFFIX
CASE 485AE

MARKING DIAGRAMS*



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.

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_{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™ 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 V to 3.6 V with GND = 0 V
- NECL Operating Range: V_{CC} = 0 V with GND = −2.375 V to −3.6 V
- Internal Input Termination Resistors, 50 Ω
- V_{REFAC} 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 Devices are Pb−Free are RoHS compliant

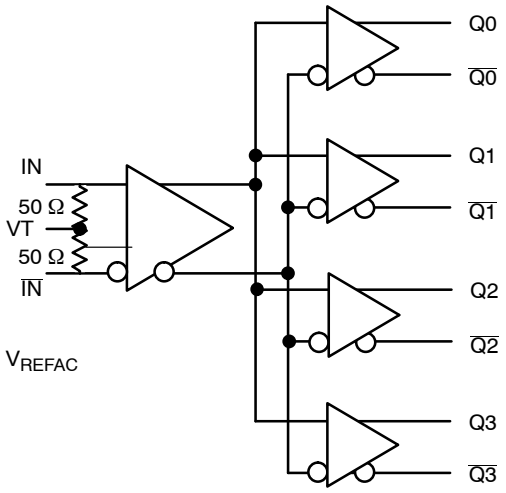


Figure 1. Logic Diagram

ORDERING INFORMATION

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

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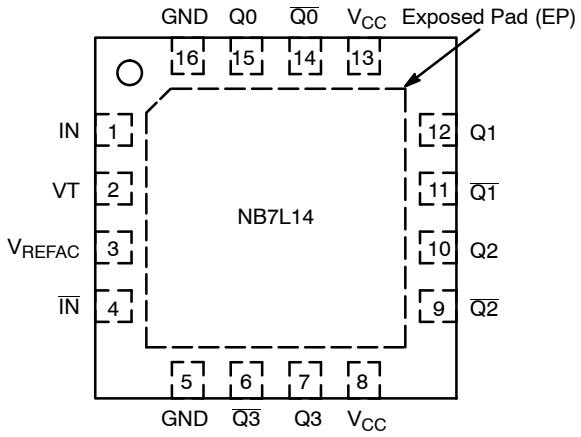


Figure 2. QFN−16 Pinout (Top View)

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 Ω Resistor to Termination Pin, VT
2	VT	−	Internal 50−Ω Termination Pin for IN/$\overline{IN}$ inputs.
3	VREFAC		Output Reference Voltage for capacitor−coupled inputs
4	$\overline{IN}$	ECL, CML, LVCMOS, LVDS, LVTTL Input	Inverted Differential Input. Note 1. Internal 50 Ω Resistor to Termination Pin, VT.
5	GND	−	Negative Supply Voltage
6	$\overline{Q3}$	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} − 2.0 V.
7	Q3	LVPECL Output	Non−inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} − 2.0 V.
8	VCC	−	Positive Supply Voltage
9	$\overline{Q2}$	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} − 2.0 V.
10	Q2	LVPECL Output	Non−inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} − 2.0 V.
11	$\overline{Q1}$	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} − 2.0 V.
12	Q1	LVPECL Output	Non−inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} − 2.0 V.
13	VCC	−	Positive Supply Voltage
14	$\overline{Q0}$	LVPECL Output	Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} − 2.0 V.
15	Q0	LVPECL Output	Non−inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} − 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.

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/$\overline{IN}$ 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

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	$-0.5 \leq V_{Io}\ 3 \leq V_{CC}$ + 0.5	4.0	V
V_{INPP}	Differential Input Voltage |D − $\overline{D}$|			2.8	V
I_{IN}	Input Current Through R_T (50 Ω Resistor)			±40	mA
I_{OUT}	Output Current (LVPECL Output)	Continuous Surge		50 100	mA
$I_{VFREFAC}$	V_{REFAC} Sink/Source Current			±1.5	mA
T_A	Operating Temperature Range	QFN−16		−40 to +85	°C
T_{stg}	Storage Temperature Range			−65 to +150	°C
θ_{JA}	Thermal Resistance (Junction−to−Ambient) (Note 4)	0 lfpm 500 lfpm	QFN−16 QFN−16	42 35	°C/W
θ_{JC}	Thermal Resistance (Junction−to−Case) (Note 4)		QFN−16	4	°C/W
T_{sol}	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 − 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	Typ	Max	Unit
POWER SUPPLY CURRENT					
V_{CC}	Power Supply Voltage V_{CC} = 2.5 V V_{CC} = 3.3 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
LVPECL OUTPUTS (Notes 5 & 6)					
V_{OH}	Output HIGH Voltage V_{CC} = 2.5V V_{CC} = 3.3V	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 V V_{CC} = 3.3 V	V_{CC} − 2000 500 1300	V_{CC} − 1700 800 1600	V_{CC} − 1500 1000 1800	mV
DIFFERENTIAL INPUT DRIVEN SINGLE−ENDED (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
VREFAC					
V_{REFAC}	Output Reference Voltage (100 μA Load)	V_{CC} − 1400	V_{CC} − 1300	V_{CC} − 1000	mV
DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY (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 IN / $\overline{IN}$, (VT Open)	−150		150	μA
I_{IL}	Input LOW Current IN / $\overline{IN}$, (VT Open)	−150		150	μA
TERMINATION RESISTORS					
R_{TIN}	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.

5. LVPECL outputs loaded with 50 Ω to V_{CC} − 2.0 V for proper operation.
6. Input and output parameters vary 1:1 with V_{CC}.
7. V_{th}, V_{IH}, $V_{IL,}$, and V_{ISE} parameters must be complied with simultaneously.
8. V_{th} is applied to the complementary input when operating in single−ended mode.
9. V_{IHD}, $V_{ILD,}$ V_{ID} and V_{CMR} parameters must be complied with simultaneously.
10. 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.

Table 5. AC CHARACTERISTICS V_{CC} = 2.375 V to 3.6 V, GND = 0 V, TA = −40°C to +85°C ; (Note 11)

Symbol	Characteristic		Min	Typ	Max	Unit
f_{MAX}	Maximum Input Clock Frequency; $V_{OUT} \geq$ 400 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 GHz $f_{in} \leq$ 7 GHz	500 400	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 GHz	45	50	55	%
t_{JITTER}	RMS Random Clock Jitter (Note 13) Peak−to−Peak Data Dependent Jitter (Note 14)	$f_{in} \leq$ 7 GHz $f_{in} \leq$ 10.7 Gb/s		0.5 5	0.8 15	ps rms ps pk−pk
$t_{jit(\phi)}$	Additive RMS Phase Jitter f_c = 622.08 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 lfpm.

11. Measured by forcing V_{INPP}(min) from a 50% duty cycle clock source. All loading with an external R_L = 50 Ω 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.

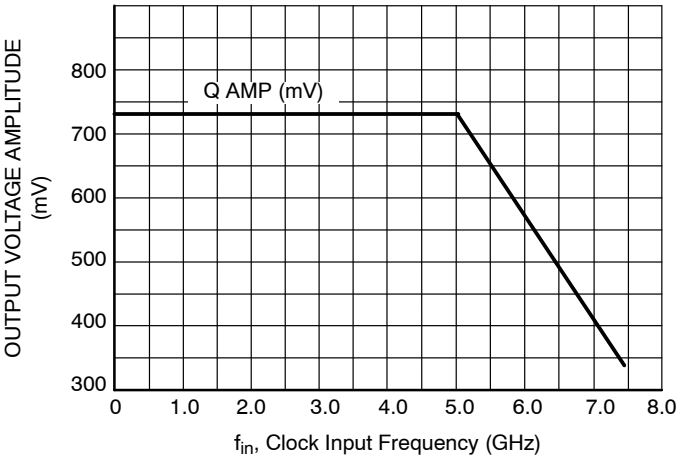


Figure 3. CLOCK Output Voltage Amplitude (V_{OUTPP}) vs. Input Frequency (f_{in}) at Ambient Temperature (Typ)

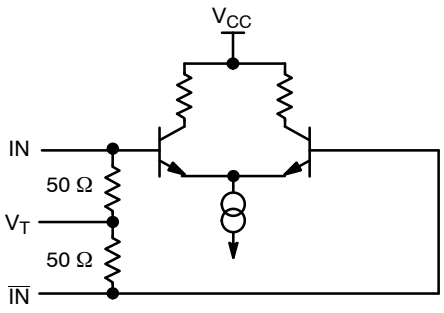


Figure 4. Input Structure

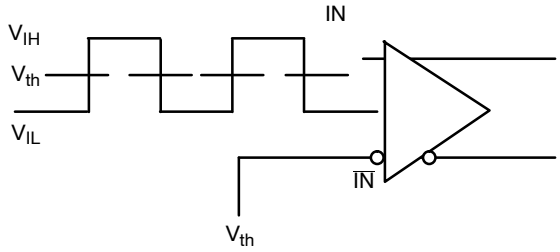


Figure 5. Differential Input Driven Single−Ended

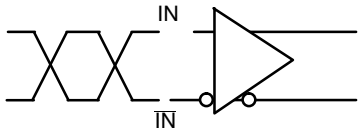


Figure 6. Differential Inputs Driven Differentially

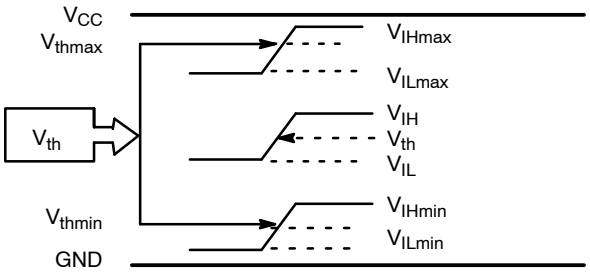


Figure 7. V_{th} Diagram

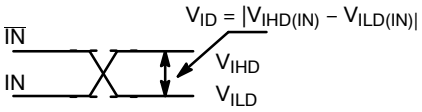


Figure 8. Differential Inputs Driven Differentially

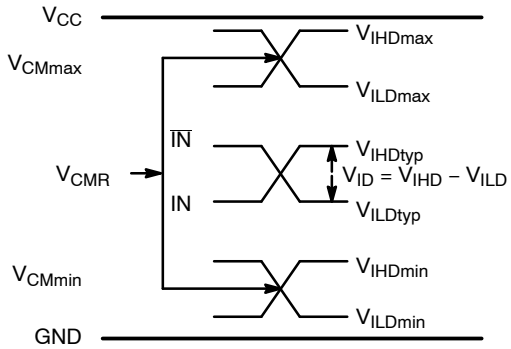


Figure 9. V_{CMR} Diagram

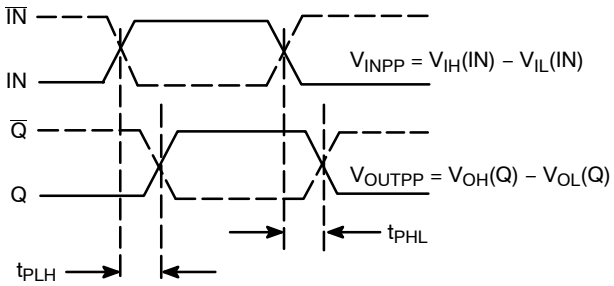


Figure 10. AC Reference Measurement

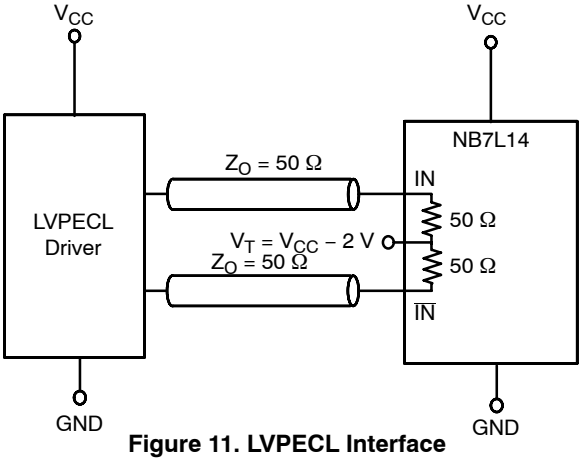


Figure 11. LVPECL Interface

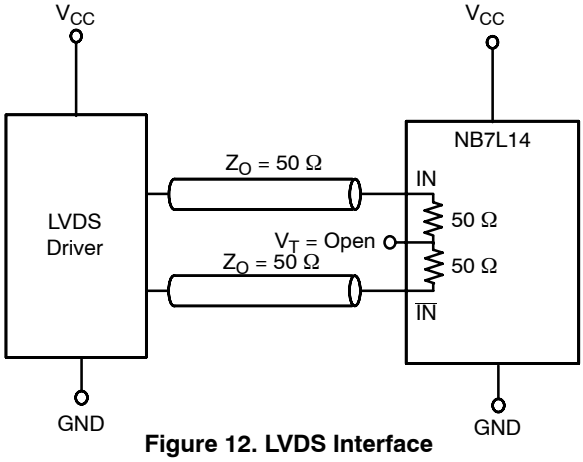


Figure 12. LVDS Interface

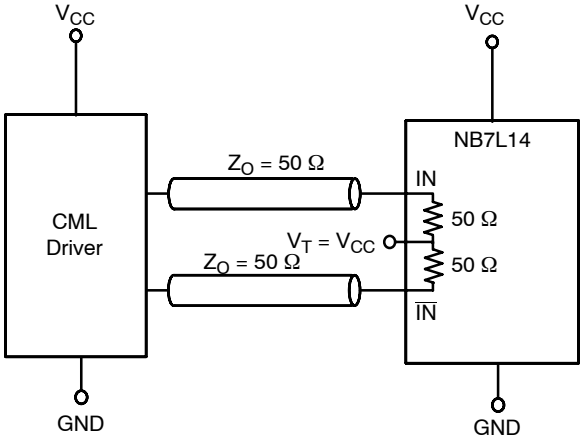


Figure 13. Standard 50 Ω Load CML Interface

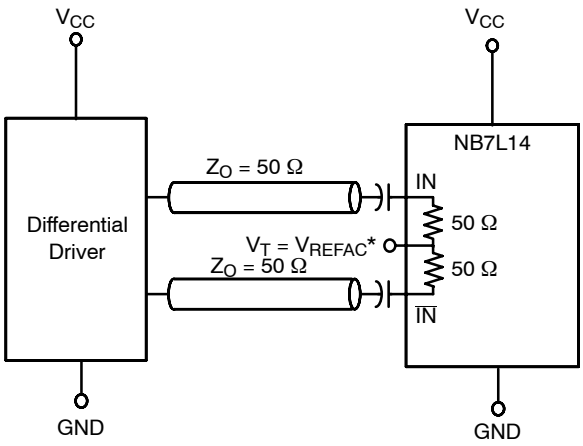


Figure 14. Capacitor−Coupled Differential Interface (VT Connected to External V_{REFAC})

*V_{REFAC} bypassed to ground with a 0.01 μF capacitor

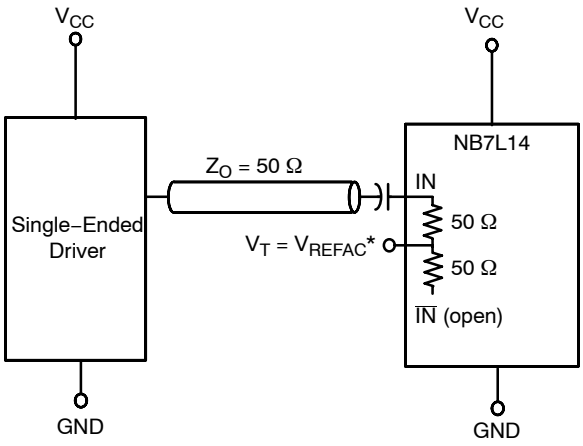


Figure 15. Capacitor−Coupled Differential Interface (V_T Connected to External V_{REFAC})

*V_{REFAC} bypassed to ground with a 0.01 μF capacitor

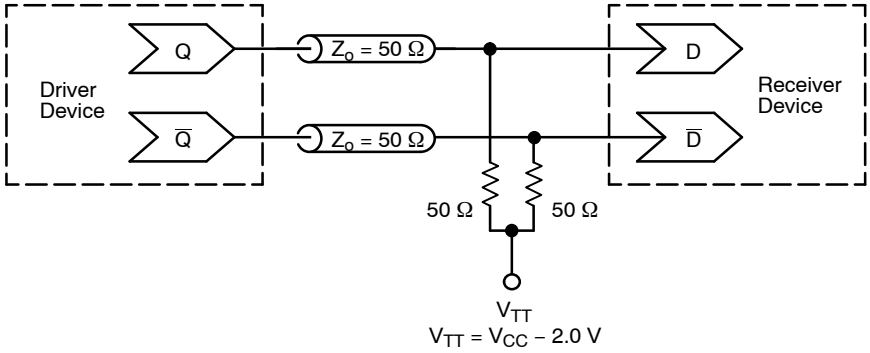


Figure 16. Typical Termination for Output Driver and Device Evaluation (See Application Note AND8020/D – Termination of ECL Logic Devices.)

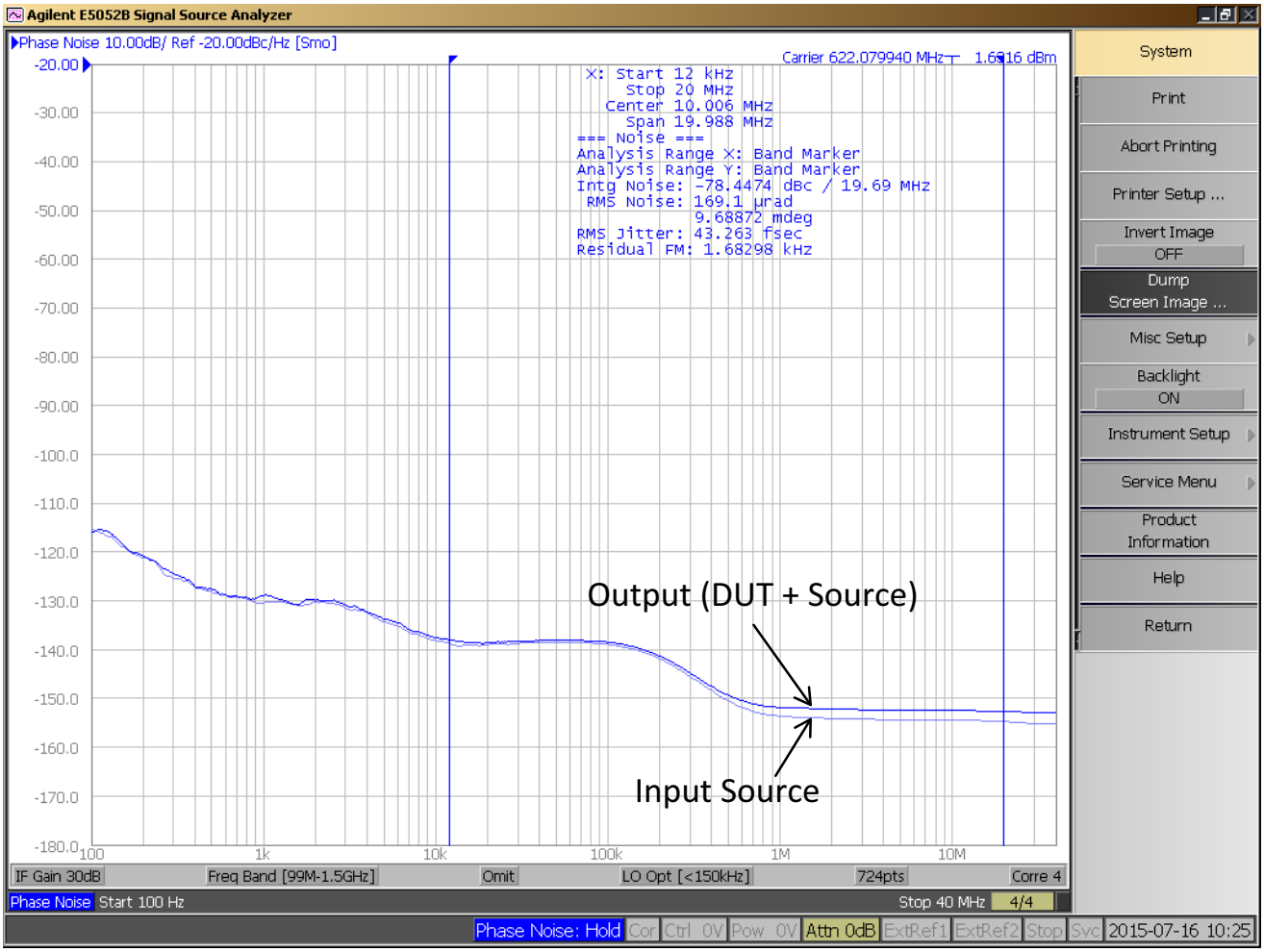


Figure 17. Typical NB7L14 Phase Noise Plot at $f_{Carrier}$ = 622.08 MHz, V_{CC} = 3.3 V, 25°C

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.

ORDERING INFORMATION

Device	Package	Case	Shipping†
NB7L14MNG	QFN−16 (Pb−Free)	485G	123 Units / Tube
NB7L14MNTXG	QFN−16 (Pb−Free)	485G	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.

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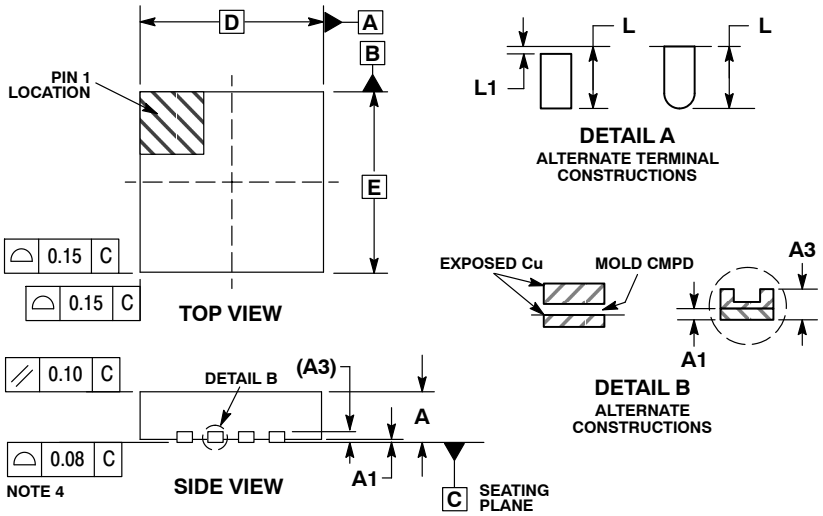
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

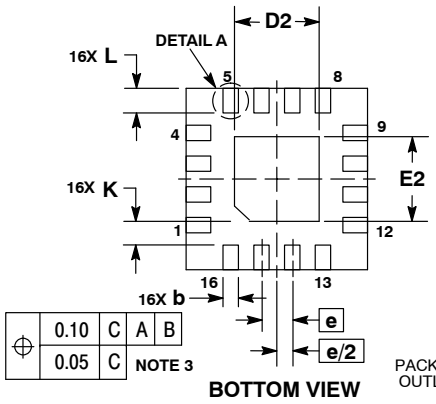
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QFN16 3x3, 0.5P
CASE 485AE
ISSUE C

DATE 24 JUN 2016

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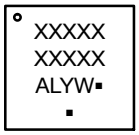




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. OUTLINE MEETS JEDEC DIMENSIONS PER MO−220, VARIATION VEED−6.

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

GENERIC MARKING DIAGRAM*

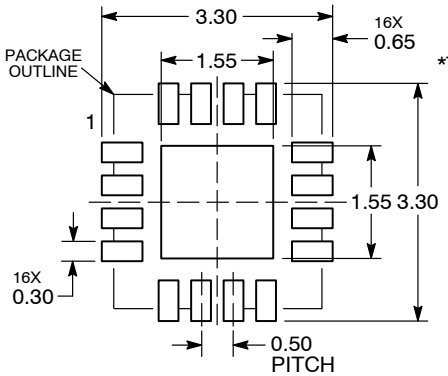


A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

(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.

RECOMMENDED SOLDERING FOOTPRINT*



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.

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DESCRIPTION:	**QFN16 3X3, 0.5P**	**PAGE 1 OF 1**

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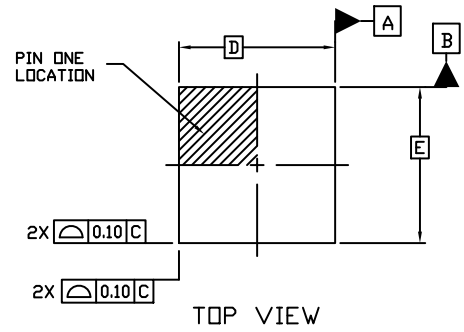
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MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

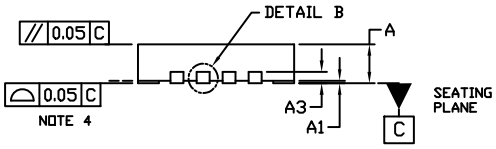
QFN16 3x3, 0.5P
CASE 485G
ISSUE G

DATE 08 OCT 2021

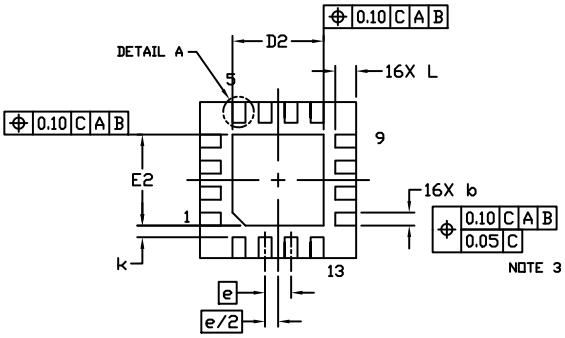
SCALE 2:1



TOP VIEW

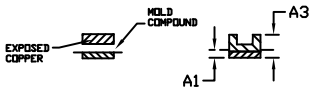


SIDE VIEW

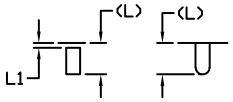


BOTTOM VIEW

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.



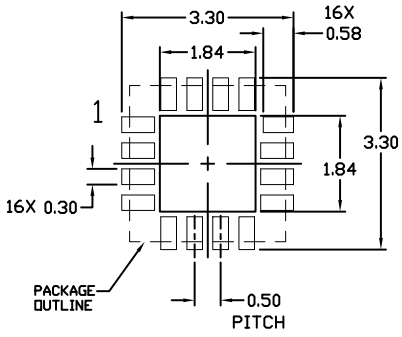
DETAIL B
ALTERNATE CONSTRUCTIONS



DETAIL A
ALTERNATE TERMINAL CONSTRUCTIONS

	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	0.24	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.

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DESCRIPTION:	**QFN16 3X3, 0.5P**	**PAGE 1 OF 1**

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