NB7L11M

2.5V/3.3V Differential 1:2 Clock/Data Fanout Buffer/ Translator with CML Outputs and Internal Termination

ON Semiconductor®

http://onsemi.com

Description

The NB7L11M is a differential 1−to−2 clock/data distribution chip with internal source termination and CML output structure, optimized for low skew and minimal jitter. The device is functionally equivalent to the EP11, LVEP11, or SG11 devices. Device produces two identical output copies of clock or data operating up to 8 GHz or 12 Gb/s, respectively. As such, NB7L11M is ideal for SONET, GigE, Fiber Channel, Backplane and other clock/data distribution applications.

Inputs incorporate internal 50 Ω termination resistors and accept LVPECL, CML, LVCMOS, LVTTL, or LVDS (See Table 6). Differential 16 mA CML output provides matching internal 50 Ω terminations, and 400 mV output swings when externally terminated, 50 Ω to V_{CC} (See Figure 14).

The device is offered in a low profile 3x3 mm 16−pin QFN package. Application notes, models, and support documentation are available at www.onsemi.com.

Features

- Maximum Input Clock Frequency up to 8 GHz Typical
- Maximum Input Data Rate up to 12 Gb/s Typical
- < 0.5 ps of RMS Clock Jitter
- < 10 ps of Data Dependent Jitter
- 30 ps Typical Rise and Fall Times
- 110 ps Typical Propagation Delay
- 3 ps Typical Within Device Skew
- Operating Range: V_{CC} = 2.375 V to 3.465 V with V_{EE} = 0 V
- CML Output Level (400 mV Peak−to−Peak Output) Differential Output Only
- 50 Ω Internal Input and Output Termination Resistors
- Functionally Compatible with Existing 2.5 V/3.3 V LVEL, LVEP, EP and SG Devices
- Pb−Free Packages are Available

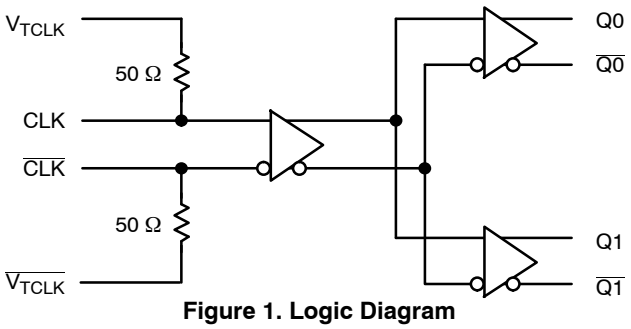
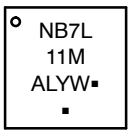


Figure 1. Logic Diagram

QFN−16
MN SUFFIX
CASE 485G

MARKING DIAGRAM*



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.

ORDERING INFORMATION

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

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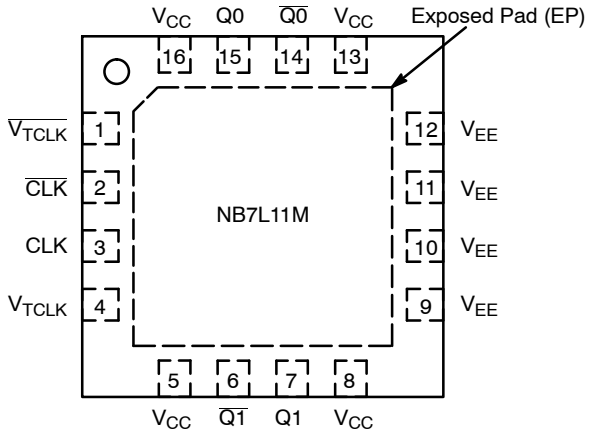

Figure 2. QFN−16 Pinout (Top View)

Table 1. PIN DESCRIPTION

Pin	Name	I/O	Description
1	$\overline{V_{TCLK}}$	−	Internal 50 Ω Termination Pin for $\overline{CLK}$
2	$\overline{CLK}$	LVPECL, CML, LVCMOS, LVTTL, LVDS	Inverted Differential Clock/Data Input. (Note 1)
3	CLK	LVPECL, CML, LVCMOS, LVTTL, LVDS	Noninverted Differential Clock/Data Input. (Note 1)
4	V_{TCLK}	−	Internal 50 Ω Termination Pin for CLK
5,8,13,16	V_{CC}	−	Positive Supply Voltage. All V_{CC} pins must be externally connected to a Power Supply to guarantee proper operation.
6	$\overline{Q1}$	CML Output	Inverted $\overline{CLK}$ output 1 with internal 50 Ω source termination resistor. (Note 2)
7	Q1	CML Output	Noninverted CLK output 1 with internal 50 Ω source termination resistor. (Note 2)
9,10,11,12	V_{EE}	−	Negative Supply Voltage. All V_{EE} pins must be externally connected to a Power Supply to guarantee proper operation.
14	$\overline{Q0}$	CML Output	Inverted $\overline{CLK}$ output 0 with internal 50 Ω source termination resistor. (Note 2)
15	Q0	CML Output	Noninverted CLK output 0 with internal 50 Ω source termination resistor. (Note 2)
−	EP	−	Exposed Pad. The thermally exposed pad on package bottom (see case drawing) must be attached to a heatsinking conduit. It is recommended to connect the EP to the lower potential (V_{EE}).

1. In the differential configuration when the input termination pins (V_{TCLK}, $\overline{V_{TCLK}}$) are connected to a common termination voltage or left open, and if no signal is applied on CLK and $\overline{CLK}$ then the device will be susceptible to self−oscillation.
2. CML outputs require 50 Ω receiver termination resistor to V_{CC} for proper operation.

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Table 2. ATTRIBUTES

Characteristics		Value	
ESD Protection	Human Body Model Machine Model Charged Device Model	> 1500 V > 50 V > 500 V	
Moisture Sensitivity (Note 3)		Pb Pkg	Pb−Free Pkg
	QFN−16	Level 1	Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V−0 @ 0.125 in	
Transistor Count		285	
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	V_{EE} = 0 V		3.6	V
V_I	Input Voltage	V_{EE} = 0 V	$V_{EE} \le V_I \le V_{CC}$	3.6	V
V_{INPP}	Differential Input Voltage |CLK − $\overline{CLK}$|	$V_{CC} - V_{EE} \ge$ 2.8 V $V_{CC} - V_{EE}$ < 2.8 V		2.8 $\|V_{CC} - V_{EE}\|$	V
I_{IN}	Input Current Through R_T (50 Ω Resistor)	Static Surge		45 80	mA mA
I_{out}	Output Current	Continuous Surge		25 50	mA 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 36	°C/W °C/W
θ_{JC}	Thermal Resistance (Junction−to−Case)	2S2P (Note 4)	QFN−16	3 to 4	°C/W
T_{sol}	Wave Solder Pb Pb−Free			265 265	°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).

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Table 4. DC CHARACTERISTICS, CLOCK Inputs, CML Outputs (V_{CC} = 2.375 V to 3.465 V, V_{EE} = 0 V, T_A = −40°C to +85°C) (Note 5)

Symbol	Characteristic	Min	Typ	Max	Unit
I_{CC}	Power Supply Current (Input and Outputs open)		85	105	mA
V_{OH}	Output HIGH Voltage (Note 6)	V_{CC} − 60	V_{CC} − 20	V_{CC}	mV
V_{OL}	Output LOW Voltage (Note 6)	V_{CC} − 530	V_{CC} − 420	V_{CC} − 360	mV
Differential Input Driven Single−Ended (see Figures 10 & 12) (Note 8)					
V_{th}	Input Threshold Reference Voltage Range (Note 7)	1125		V_{CC} − 75	mV
V_{IH}	Single−ended Input HIGH Voltage (Note 8)	V_{th} + 75		V_{CC}	mV
V_{IL}	Single−ended Input LOW Voltage (Note 8)	V_{EE}		V_{th} − 75	mV
Differential Inputs Driven Differentially (see Figures 11 & 13) (Note 8)					
V_{IHCLK}	Differential Input HIGH Voltage	1200		V_{CC}	mV
V_{ILCLK}	Differential Input LOW Voltage	V_{EE}		V_{CC} − 75	mV
V_{CMR}	Input Common Mode Range (Differential Configuration)	1163		V_{CC} − 38	mV
V_{ID}	Differential Input Voltage (V_{IHCLK} − V_{ILCLK})	75		2500	mV
I_{IH}	Input HIGH Current CLK / $\overline{CLK}$ (V_{TCLK}/$\overline{V_{TCLK}}$ Open)	0	25	100	μA
I_{IL}	Input LOW Current CLK / $\overline{CLK}$ (V_{TCLK}/$\overline{V_{TCLK}}$ Open)	−10	0	10	μA
R_{TIN}	Internal Input Termination Resistor	45	50	55	Ω
R_{TOUT}	Internal Output Termination Resistor	45	50	55	Ω
$R_{Temp\ Coef}$	Internal I/O Termination Resistor Temperature Coefficient		6.38		mΩ/°C

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. Input and output parameters vary 1:1 with V_{CC}.
6. CML outputs require 50 Ω receiver termination resistors to V_{CC} for proper operation.
7. V_{th} is applied to the complementary input when operating in single−ended mode.
8. V_{CMR} min varies 1:1 with V_{EE}, V_{CMR} max varies 1:1 with V_{CC}.

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Table 5. AC CHARACTERISTICS (V_{CC} = 2.375 V to 3.465 V, V_{EE} = 0 V; Note 9)

Symbol	Characteristic		−40°C			25°C			85°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{OUTPP}	Output Voltage Amplitude (@$V_{INPPmin}$) (See Figure 3)	$f_{in} \le 6$ GHz	280	400		280	400		280	400		mV
		$f_{in} \le 8$ GHz	140	300		140	300		140	300		
f_{data}	Maximum Operating Data Rate		10	12		10	12		10	12		Gb/s
t_{PLH}, t_{PHL}	Propagation Delay to Output Differential		70	110	150	70	110	150	70	110	150	ps
t_{SKEW}	Duty Cycle Skew (Note 10)			2.0	5.0		2.0	5.0		2.0	5.0	ps
	Within−Device Skew			3.0	15		3.0	15		3.0	15	
	Device−to−Device Skew (Note 11)			20	50		20	50		20	50	
t_{JITTER}	RMS Random Clock Jitter (Note 12)	f_{in} = 6 GHz		0.2	0.5		0.2	0.5		0.2	0.5	ps
		f_{in} =8 GHz		0.2	0.5		0.2	0.5		0.2	0.5	
	Peak/Peak Data Dependent Jitter (Note 13)	f_{in} = 2.488 Gb/s		2.0	5.0		2.0	5.0		2.0	5.0	
		f_{data} =5 Gb/s		3.0	8.0		3.0	8.0		3.0	8.0	
		f_{data} =10 Gb/s		5.0	10		5.0	10		5.0	10	
V_{INPP}	Input Voltage Swing/Sensitivity (Differential Configuration) (Note 14)		75	400	2500	75	400	2500	75	400	2500	mV
t_r t_f	Output Rise/Fall Times @ 1 GHz (20% − 80%)	Q, $\overline{Q}$		30	60		30	60		30	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.

9. Measured by forcing V_{INPP} (TYP) from a 50% duty cycle clock source. All loading with an external R_L = 50 Ω to V_{CC}. Input edge rates 40 ps (20% − 80%).
10. Duty cycle skew is measured between differential outputs using the deviations of the sum of Tpw− and Tpw+ @1 GHz.
11. Device to device skew is measured between outputs under identical transition @ 1 GHz.
12. Additive RMS jitter with 50% duty cycle clock signal at 8 GHz & 10 GHz.
13. Additive peak−to−peak data dependent jitter with input NRZ data at PRBS $2^{\wedge 23}$−1.
14. V_{INPP} (MAX) cannot exceed V_{CC} − V_{EE}. Input voltage swing is a single−ended measurement operating in differential mode.

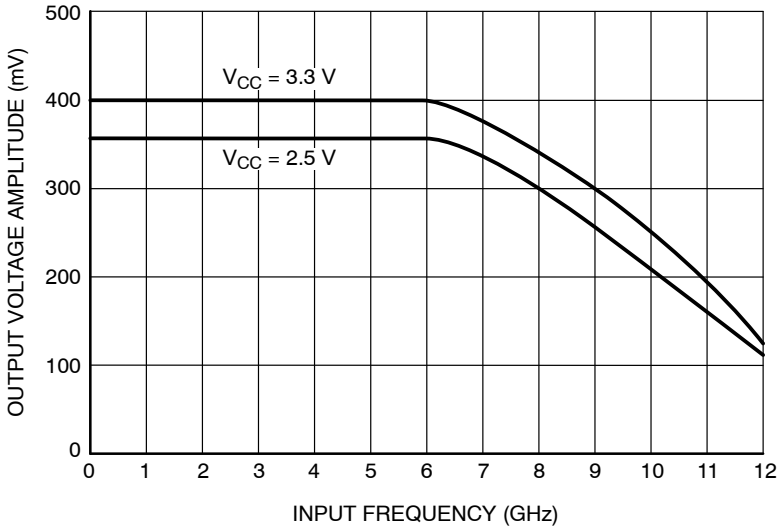

Figure 3. Output Voltage Amplitude (V_{OUTPP}) versus Input Clock Frequency (f_{in}) at Ambient Temperature (Typical) (V_{INPP} = 400 mV)

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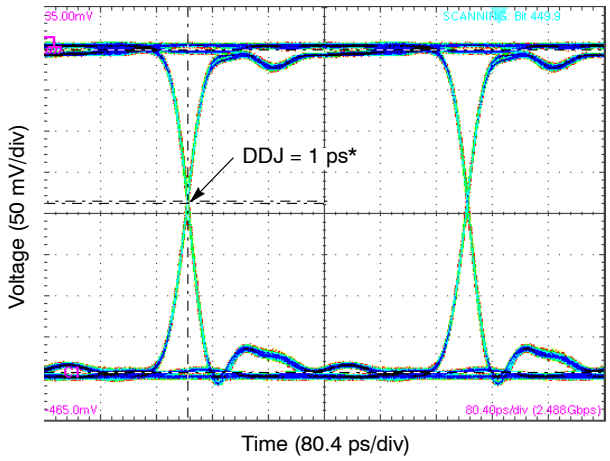

Figure 4. Typical Output Waveform at 2.488 Gb/s with PRBS $2^{\wedge 23}-1$ (V_{inpp} = 75 mV)

*Input signal DDJ = 6.4 ps

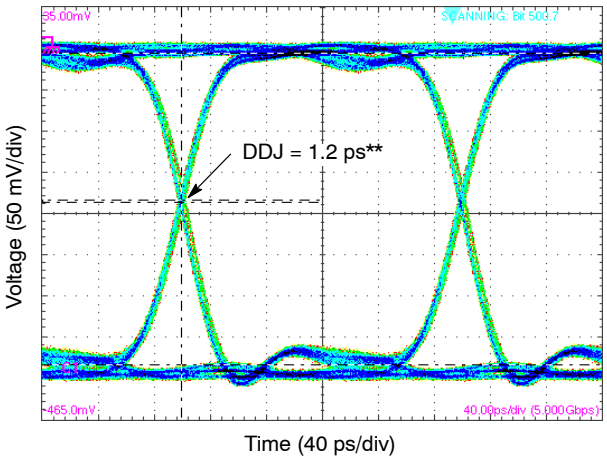

Figure 5. Typical Output Waveform at 5 Gb/s with PRBS $2^{\wedge 23}-1$ (V_{inpp} = 75 mV)

**Input signal DDJ = 7.2 ps

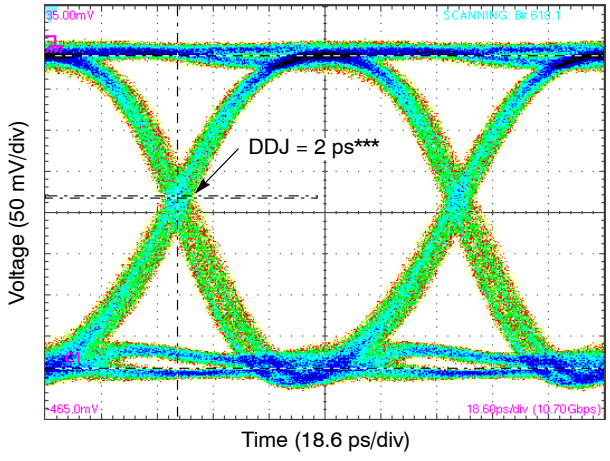

Figure 6. Typical Output Waveform at 10.7 Gb/s with PRBS $2^{\wedge 23}-1$ (V_{inpp} = 75 mV)

***Input signal DDJ = 11 ps

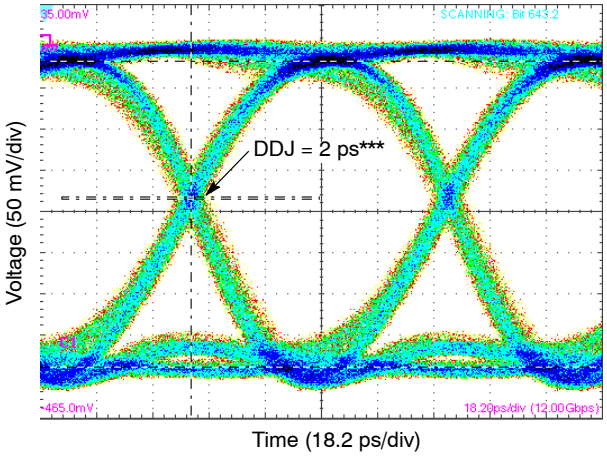

Figure 7. Typical Output Waveform at 12 Gb/s with PRBS $2^{\wedge 23}-1$ (V_{inpp} = 75 mV)

***Input signal DDJ = 13 ps

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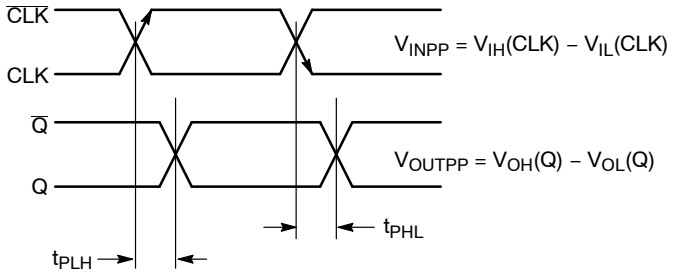

Figure 8. AC Reference Measurement

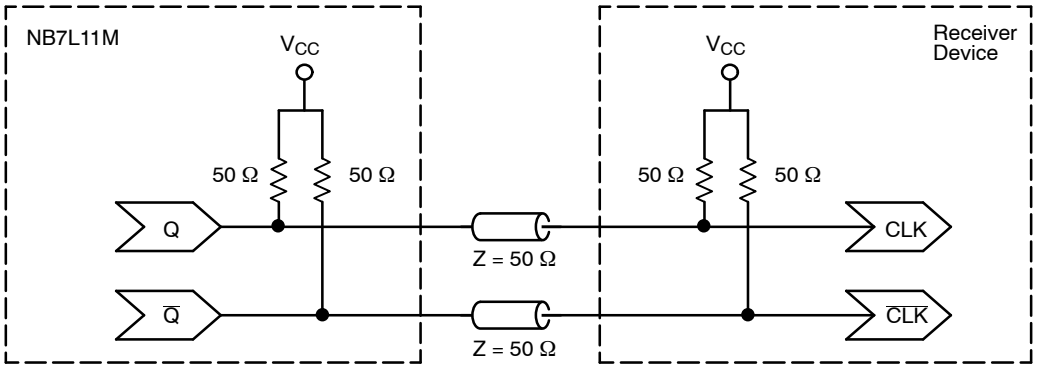

Figure 9. Typical Termination for Output Driver Using External Termination Resistor (Refer to Application Notes AND8020/D and AND8173/D)

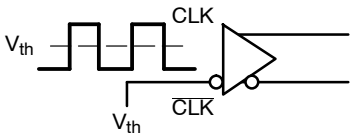

Figure 10. Differential Input Driven Single−Ended

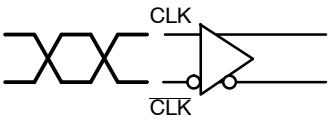

Figure 11. Differential Inputs Driven Differentially

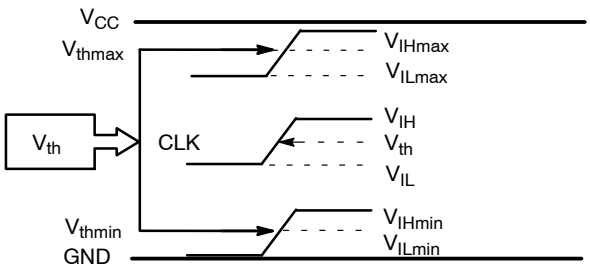

Figure 12. V_{th} Diagram

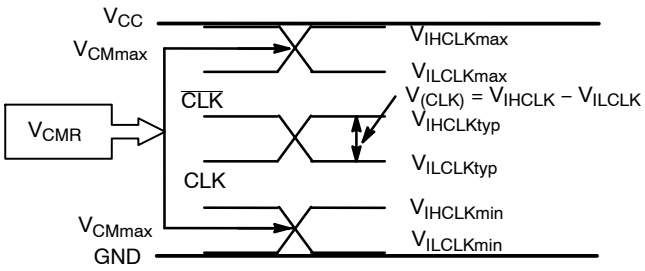

Figure 13. V_{CMR} Diagram

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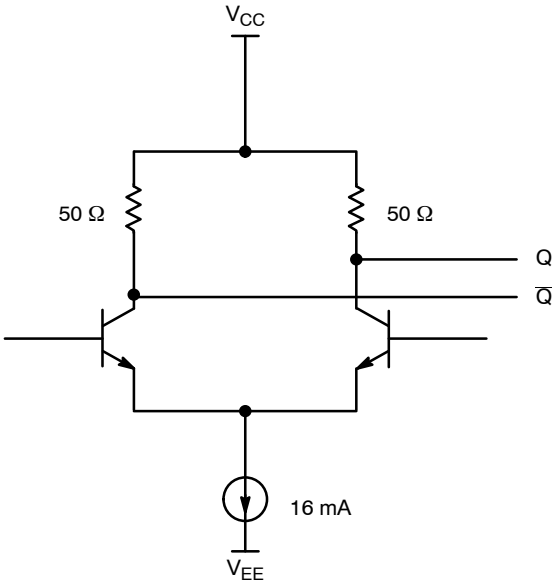

Figure 14. CML Output Structure

Table 6. INTERFACING OPTIONS

INTERFACING OPTIONS	CONNECTIONS
CML	Connect V_{TCLK}, $\overline{V_{TCLK}}$ to V_{CC}
LVDS	Connect V_{TCLK}, $\overline{V_{TCLK}}$ together CLK input
AC−COUPLED	Bias V_{TCLK}, $\overline{V_{TCLK}}$ Inputs within (V_{CMR}) Common Mode Range
RSECL, LVPECL	Standard ECL Termination Techniques. See AND8020/D.
LVTTL, LVCMOS	An external voltage should be applied to the unused complementary differential input. Nominal voltage is 1.5 V for LVTTL and V_{CC}/2 for LVCMOS inputs.

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Application Information

All NB7L11M inputs can accept PECL, CML, LVTTL, LVCMOS and LVDS signal levels. The limitations for differential input signal (LVDS, PECL, or CML) are minimum input swing of 75 mV and the maximum input swing of 2500 mV. Within these conditions, the input voltage can range from V_{CC} to 1.2 V. Examples interfaces are illustrated below in a 50 Ω environment (Z = 50 Ω).

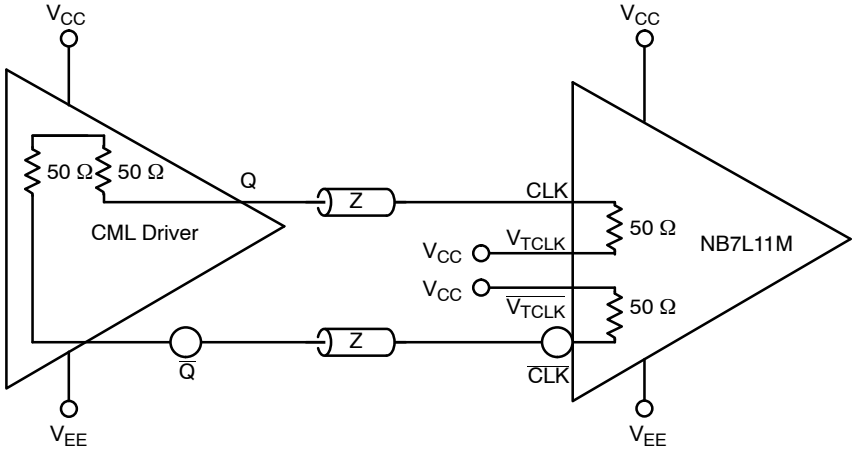
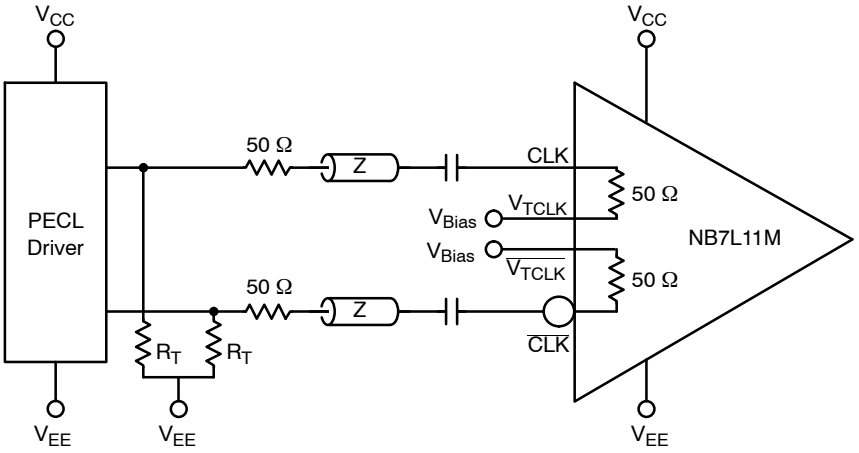


Figure 15. CML to CML Interface



Recommended R_T Values

V_{CC}	R_T
5.0 V	290 Ω
3.3 V	150 Ω
2.5 V	80 Ω

Figure 16. PECL to CML Receiver Interface

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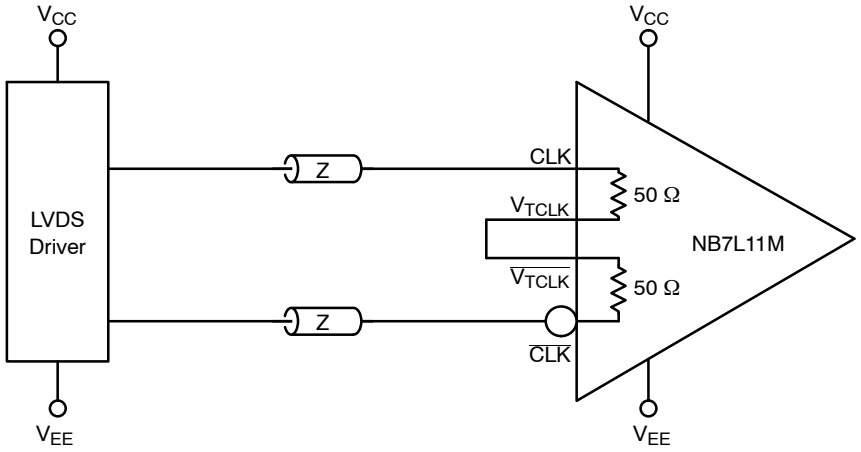

Figure 17. LVDS to CML Receiver Interface

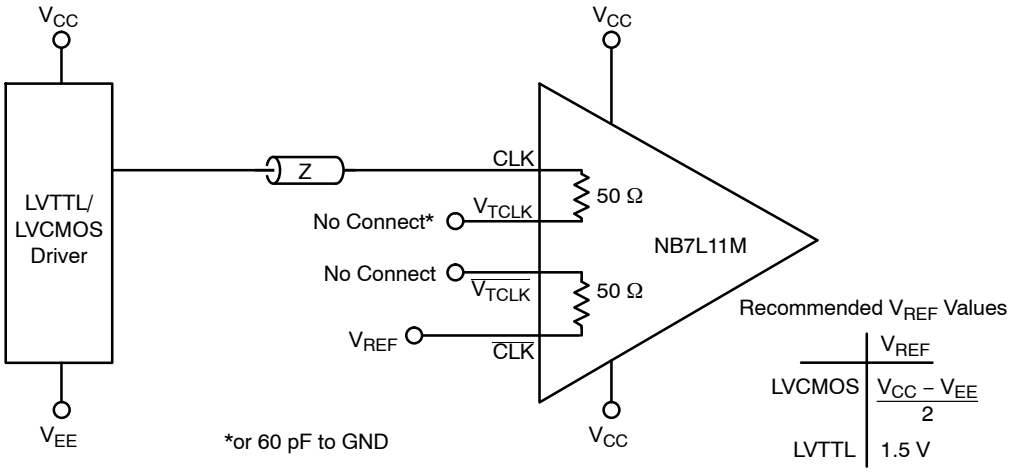

Figure 18. LVCMOS/LVTTL to CML Receiver Interface

ORDERING INFORMATION

Device	Package	Shipping†
NB7L11MMN	QFN−16	123 Units / Rail
NB7L11MMNG	QFN−16 (Pb−Free)	123 Units / Rail
NB7L11MMNR2G	QFN−16 (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.

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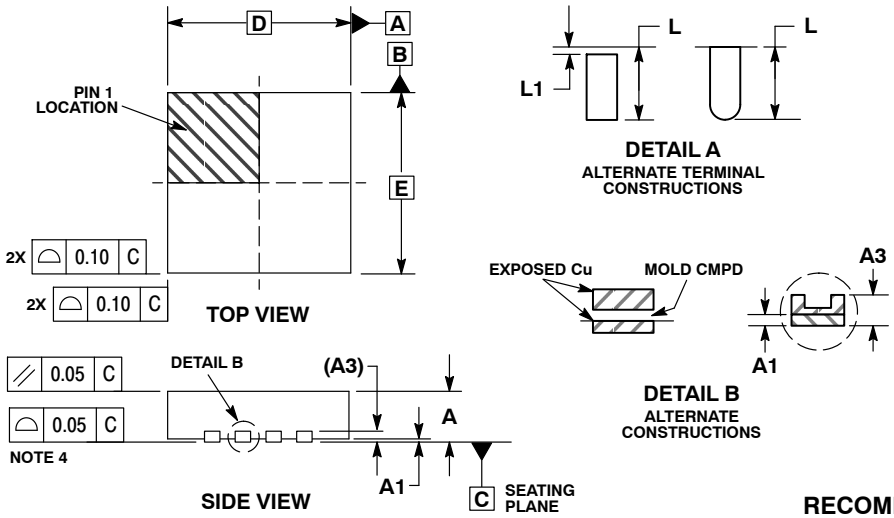
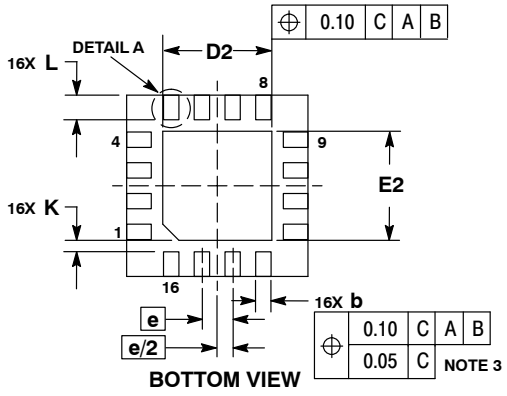
PACKAGE DIMENSIONS

QFN16 3x3, 0.5P
CASE 485G−01
ISSUE E

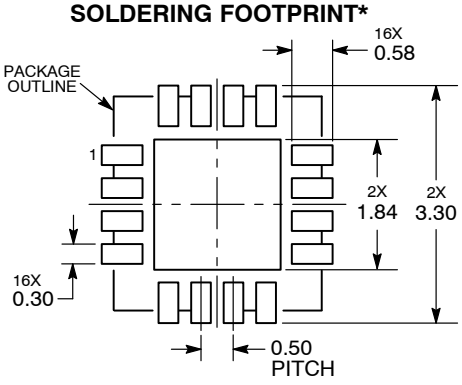


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	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	
D2	1.65	1.85
E	3.00 BSC	
E2	1.65	1.85
e	0.50 BSC	
K	0.18 TYP	
L	0.30	0.50
L1	0.00	0.15



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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