

# NB6L11M

## 2.5V / 3.3V 1:2 Differential CML Fanout Buffer

### Multi-Level Inputs w/ Internal Termination

#### Description

The NB6L11M is a differential 1:2 CML fanout buffer. The differential inputs incorporate internal 50  $\Omega$  termination resistors that are accessed through the  $V_T$  pins and will accept LVPECL, LVCMOS, LVTTTL, CML, or LVDS logic levels.

The  $V_{REFAC}$  pin is an internally generated voltage supply available to this device only.  $V_{REFAC}$  is used as a reference voltage for single-ended PECL or NECL inputs. For all single-ended input conditions, the unused complementary differential input is connected to  $V_{REFAC}$  as a switching reference voltage.  $V_{REFAC}$  may also rebias capacitor-coupled inputs. When used, decouple  $V_{REFAC}$  with a 0.01  $\mu$ F capacitor and limit current sourcing or sinking to 0.5 mA. When not used,  $V_{REFAC}$  output should be left open.

The device is housed in a small 3x3 mm 16 pin QFN package.

The NB6L11M is a member of the ECLinPS MAX™ family of high performance clock products.

#### Features

- Maximum Input Clock Frequency > 4 GHz, Typical
- 225 ps Typical Propagation Delay
- 70 ps Typical Rise and Fall Times
- 0.5 ps maximum RMS Clock Jitter
- Differential CML Outputs, 380 mV peak-to-peak, typical
- LVPECL Operating Range:  $V_{CC} = 2.375$  V to 3.63 V with  $V_{EE} = 0$  V
- NECL Operating Range:  $V_{CC} = 0$  V with  $V_{EE} = -2.375$  V to -3.63 V
- Internal Input Termination Resistors, 50  $\Omega$
- $V_{REFAC}$  Reference Output
- Functionally Compatible with Existing 2.5 V / 3.3V LVEL, LVEP, EP, and SG Devices
- -40°C to +85°C Ambient Operating Temperature
- These are Pb-Free Devices



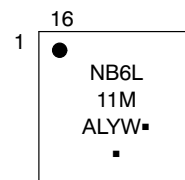
ON Semiconductor®

<http://onsemi.com>



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.

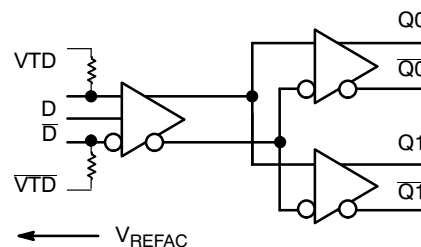


Figure 1. Simplified Logic Diagram

#### ORDERING INFORMATION

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

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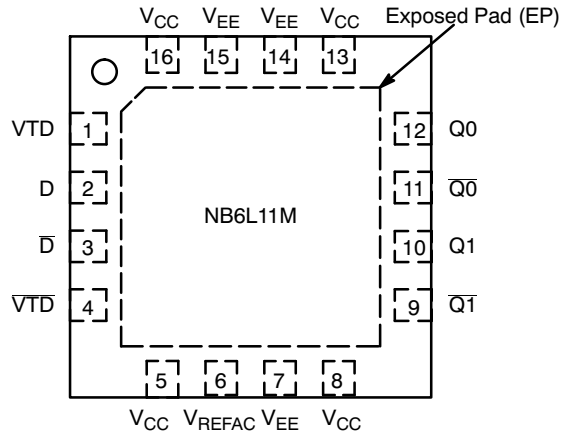


Figure 2. Pin Configuration (Top View)

Table 1. PIN DESCRIPTION

Pin	Name	I/O	Description
1	VTD	-	Internal 50 $\Omega$ Termination Pin for D input.
2	D	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Noninverted Differential Input. Note 1. Internal 50 $\Omega$ Resistor to Termination Pin, VTD.
3	$\bar{D}$	ECL, CML, LVCMOS, LVDS, LVTTTL Input	Inverted Differential Input. Note 1. Internal 50 $\Omega$ Resistor to Termination Pin, $\bar{VTD}$ .
4	$\bar{VTD}$	-	Internal 50 $\Omega$ Termination Pin for $\bar{D}$ input.
5	VCC	-	Positive Supply Voltage
6	VREFAC	-	Output Reference Voltage for direct or capacitor coupled inputs
7	VEE	-	Negative Supply Voltage
8	VCC	-	Positive Supply Voltage
9	$\bar{Q1}$	CML Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to VCC.
10	Q1	CML Output	Noninverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to VCC.
11	$\bar{Q0}$	CML Output	Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to VCC.
12	Q0	CML Output	Noninverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to VCC.
13	VCC	-	Positive Supply Voltage
14	VEE	-	Negative Supply Voltage
15	VEE	-	Negative Supply Voltage
16	VCC	-	Positive 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 not electrically connected to the die, but is recommended to be electrically and thermally connected to VEE on the PC board.

1. In the differential configuration when the input termination pins (VTD,  $\bar{VTD}$ ) are connected to a common termination voltage or left open, and if no signal is applied on D/D input, then, the device will be susceptible to self-oscillation.
2. All VCC and VEE 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	> 2 kV > 200V
Moisture Sensitivity	16-QFN	Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in
Transistor Count		
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test		

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	$V_{EE} = 0\text{ V}$		4.0	V
$V_{EE}$	Negative Power Supply	$V_{CC} = 0\text{ V}$		-4.0	V
$V_{IO}$	Positive Input/Output Voltage Negative Input/Output Voltage	$V_{EE} = 0\text{ V}$ $V_{CC} = 0\text{ V}$	$-0.5 \leq V_{Io} \leq V_{CC} + 0.5$ $+0.5 \leq V_{Io} \leq V_{EE} - 0.5$	4.0 -4.0	V V
$V_{INPP}$	Differential Input Voltage $ D - \bar{D} $			$V_{CC} - V_{EE}$	V
$I_{IN}$	Input Current Through $R_T$ (50 $\Omega$ Resistor)	Static Surge		45 80	mA mA
$I_{OUT}$	Output Current (CML Output)	Continuous Surge		25 50	mA mA
$I_{VREFAC}$	VREFAC Sink/Source Current			$\pm 0.5$	mA
$T_A$	Operating Temperature Range	16 QFN		-40 to +85	$^{\circ}\text{C}$
$T_{stg}$	Storage Temperature Range			-65 to +150	$^{\circ}\text{C}$
$\theta_{JA}$	Thermal Resistance (Junction-to-Ambient) (Note 3)	0 Ifmp 500 Ifmp	QFN-16 QFN-16	42 35	$^{\circ}\text{C/W}$ $^{\circ}\text{C/W}$
$\theta_{JC}$	Thermal Resistance (Junction-to-Case)	(Note 3)	QFN-16	4	$^{\circ}\text{C/W}$
$T_{sol}$	Wave Solder Pb-Free			265	$^{\circ}\text{C}$

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.

3. 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**  $V_{CC} = 2.375\text{ V to }3.63\text{ V}$ ,  $V_{EE} = 0\text{ V}$ , or  $V_{CC} = 0\text{ V}$ ,  $V_{EE} = -2.375\text{ V to }-3.63\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$

Symbol	Characteristic	Min	Typ	Max	Unit
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## POWER SUPPLY CURRENT

$I_{CC}$	Power Supply Current (Inputs and Outputs Open)	45	60	75	mA
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## CML OUTPUTS (Notes 4 and 5)

$V_{OH}$	Output HIGH Voltage	$V_{CC} = 3.3\text{ V}$ $V_{CC} = 2.5\text{ V}$	$V_{CC} - 40$ 3260 2460	$V_{CC} - 10$ 3290 2490	$V_{CC}$ 3300 2500	mV
$V_{OL}$	Output LOW Voltage	$V_{CC} = 3.3\text{ V}$ $V_{CC} = 2.5\text{ V}$	$V_{CC} - 500$ 2800 2000	$V_{CC} - 400$ 2900 2100	$V_{CC} - 300$ 3000 2200	mV

## DIFFERENTIAL INPUT DRIVEN SINGLE-ENDED (see Figures 4 and 5) (Note 6)

$V_{th}$	Input Threshold Reference Voltage Range (Note 7)	1125		$V_{CC} - 75$	mV
$V_{IH}$	Single-ended Input HIGH Voltage	$V_{th} + 75$		$V_{CC}$	mV
$V_{IL}$	Single-ended Input LOW Voltage	$V_{EE}$		$V_{th} - 75$	mV
$V_{ISE}$	Single-ended Input Voltage Amplitude ( $V_{IH} - V_{IL}$ )	150		2800	mV

## VREFAC

$V_{REFAC}$	Output Reference Voltage ( $V_{CC} \geq 2.5\text{ V}$ )	$V_{CC} - 1525$	$V_{CC} - 1425$	$V_{CC} - 1325$	mV
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## DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY (see Figures 6, 7 and 8) (Note 8)

$V_{IHD}$	Differential Input HIGH Voltage	$V_{EE} + 1200$		$V_{CC}$	mV
$V_{ILD}$	Differential Input LOW Voltage	$V_{EE}$		$V_{CC} - 100$	mV
$V_{ID}$	Differential Input Voltage ( $V_{IHD} - V_{ILD}$ )	$V_{EE} + 100$		$V_{CC} - V_{EE}$	mV
$V_{CMR}$	Input Common Mode Range (Differential Configuration) (Note 9)	$V_{EE} + 950$		$V_{CC} - 50$	mV
$I_{IH}$	Input HIGH Current $D / \bar{D}$ , ( $V_{TD}/\bar{V}_{TD}$ Open)	-150		150	$\mu\text{A}$
$I_{IL}$	Input LOW Current $D / \bar{D}$ , ( $V_{TD}/\bar{V}_{TD}$ Open)	-150		150	$\mu\text{A}$

## TERMINATION RESISTORS

$R_{TIN}$	Internal Input Termination Resistor	40	50	60	$\Omega$
$R_{TOUT}$	Internal Output Termination Resistor	40	50	60	$\Omega$

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.

- CML outputs loaded with  $50\ \Omega$  to  $V_{CC}$  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.
- $V_{CMR}$  min varies 1:1 with  $V_{EE}$ .  $V_{CMR}$  maximum varies 1:1 with  $V_{CC}$ . The  $V_{CMR}$  range is referenced to the most positive side of the differential input signal.

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**Table 5. AC CHARACTERISTICS**  $V_{CC} = 2.375\text{ V to }3.63\text{ V}$ ,  $V_{EE} = 0\text{ V}$ , or  $V_{CC} = 0\text{ V}$ ,  $V_{EE} = -2.375\text{ V to }-3.63\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ ; (Note 10)

Symbol	Characteristic	Min	Typ	Max	Unit
$V_{OUTPP}$	Output Voltage Amplitude (@ $V_{INPP(MIN)}$ ) (Note 15) (See Figure 9)	$f_{in} \leq 3.0\text{GHz}$ 230 $f_{in} \leq 3.5\text{ GHz}$ 190 $f_{in} \leq 4.0\text{ GHz}$ 150	380 320 270		mV
$t_{PD}$	Propagation Delay D to Q	175	225	325	ps
$t_{SKEW}$	Duty Cycle Skew (Note 11) Within Device Skew Device to Device Skew (Note 12)		5.0 3.0	15 15 80	ps
$t_{DC}$	Output Clock Duty Cycle (Reference Duty Cycle = 50%) $f_{in} \leq 4.0\text{GHz}$	40	50	60	%
$t_{JITTER}$	RMS Random Clock Jitter (Note 13) Peak-to-Peak Data Dependent Jitter (Note 14)		$f_{in} \leq 4\text{GHz}$ 0.2 $f_{in} \leq 4\text{Gb/s}$ 40	0.5	ps
$V_{INPP}$	Input Voltage Swing/Sensitivity (Differential Configuration) (Note 15)	150		2800	mV
$t_r$ $t_f$	Output Rise/Fall Times @ 0.5 GHz (20% - 80%)		70	120	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.

10. Measured by forcing  $V_{INPP}$  (MIN) from a 50% duty cycle clock source. All loading with an external  $R_L = 50\ \Omega$  to  $V_{CC}$ . Input edge rates 40 ps (20% - 80%).

11. Duty cycle skew is measured between differential outputs using the deviations of the sum of  $T_{pw-}$  and  $T_{pw+}$  @ 0.5GHz.

12. Device to device skew is measured between outputs under identical transition @ 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.

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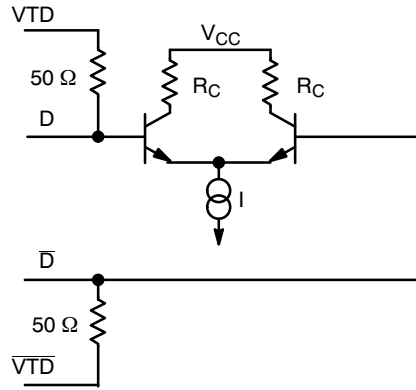


Figure 3. Input Structure

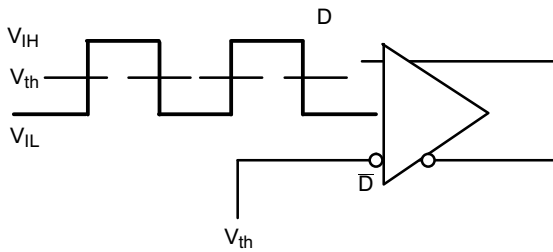


Figure 4. Differential Input Driven Single-Ended

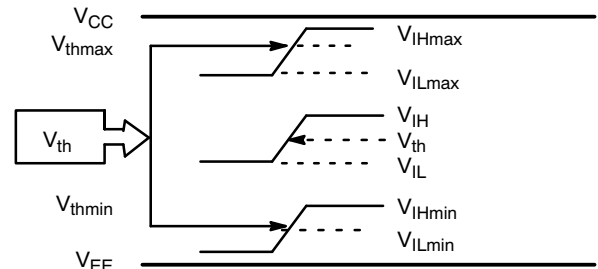


Figure 5.  $V_{th}$  Diagram

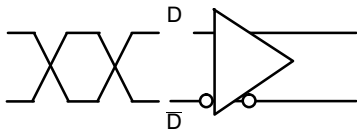


Figure 6. Differential Inputs Driven Differentially

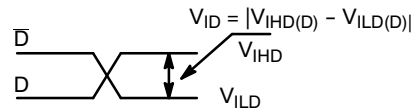


Figure 7. Differential Inputs Driven Differentially

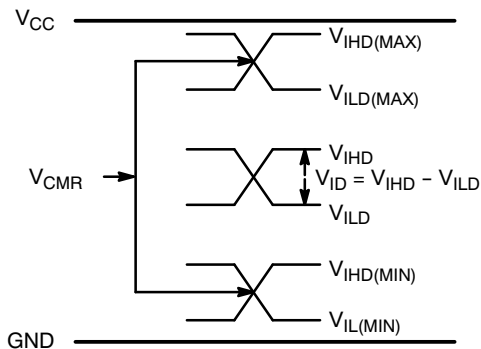


Figure 8.  $V_{CMR}$  Diagram

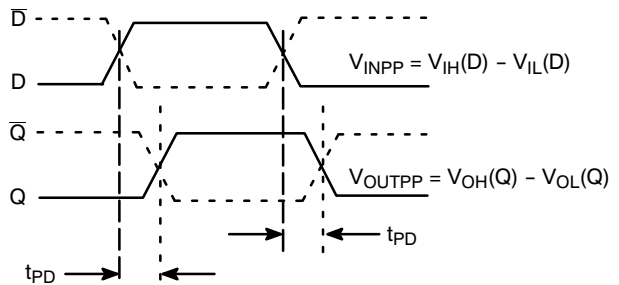


Figure 9. AC Reference Measurement

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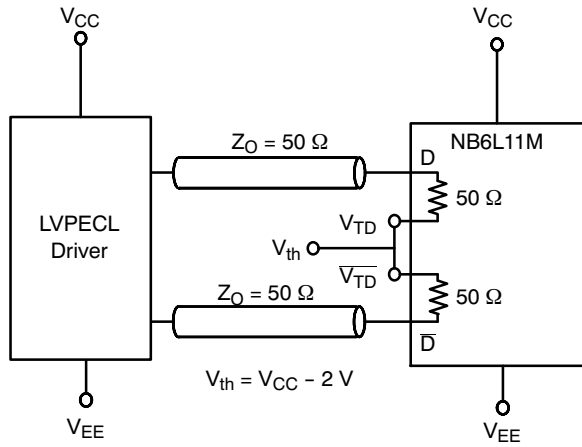


Figure 10. LVPECL Interface

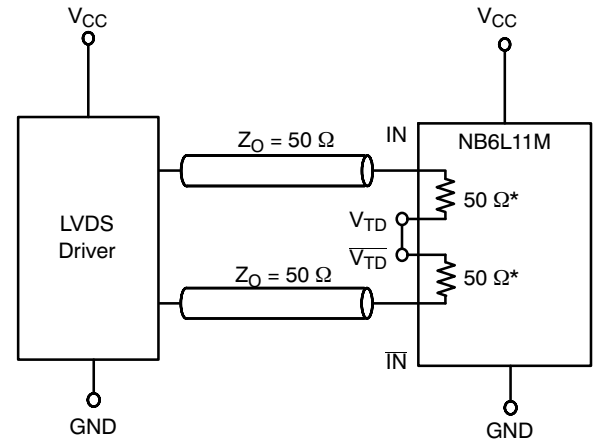


Figure 11. LVDS Interface

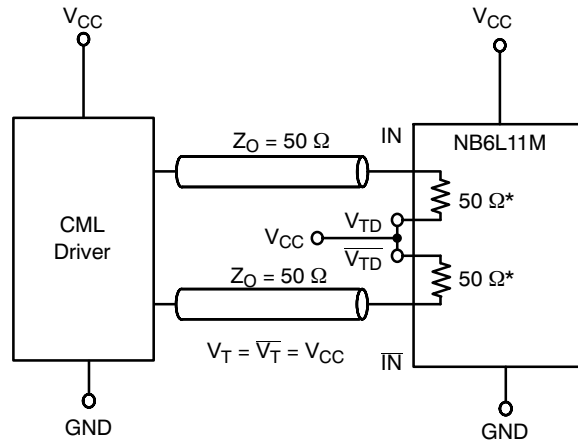


Figure 12. Standard 50  $\Omega$  Load CML Interface

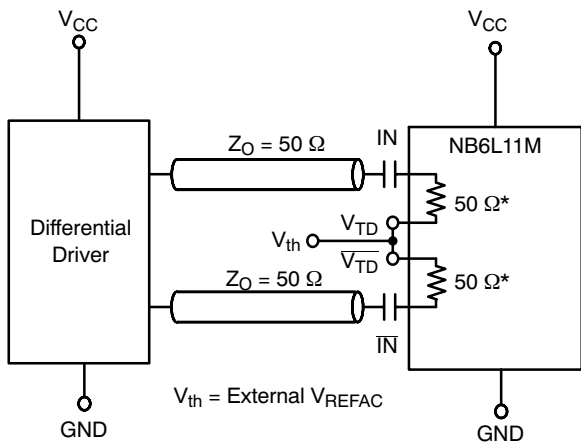


Figure 13. Capacitor-Coupled Differential Interface ( $V_{TD}/\overline{V_{TD}}$  Connected to  $V_{REFAC}$ ;  $V_{REFAC}$  Bypassed to Ground with 0.1  $\mu\text{F}$  Capacitor)

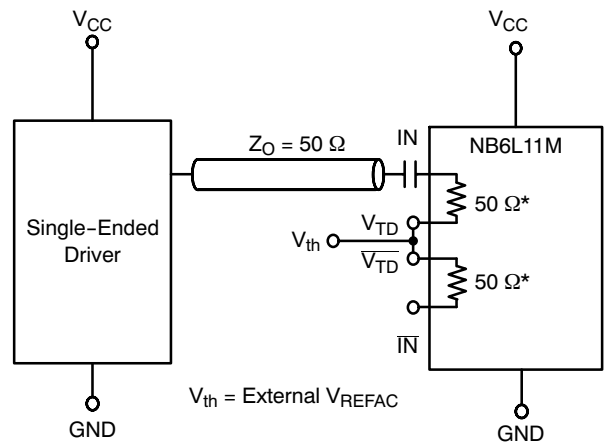
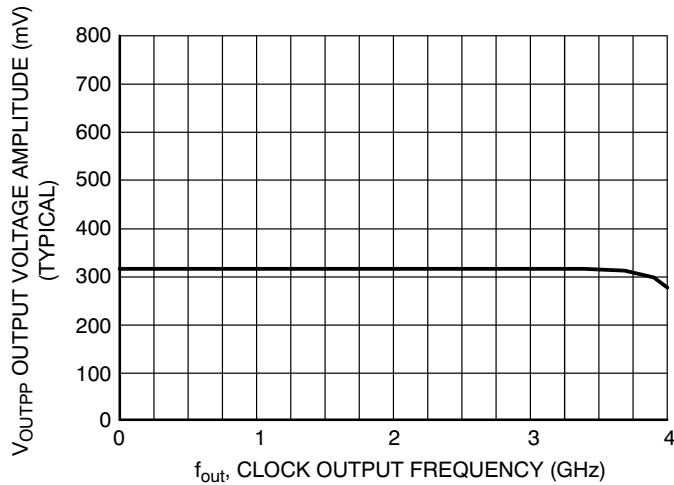
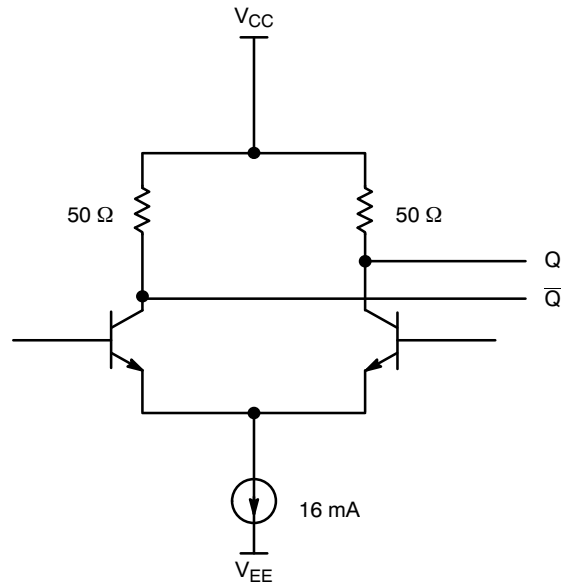


Figure 14. Capacitor-Coupled Single-Ended Interface ( $V_T/\overline{V_T}$  Connected to  $V_{REFAC}$ ;  $V_{REFAC}$  Bypassed to Ground with 0.1  $\mu\text{F}$  Capacitor)

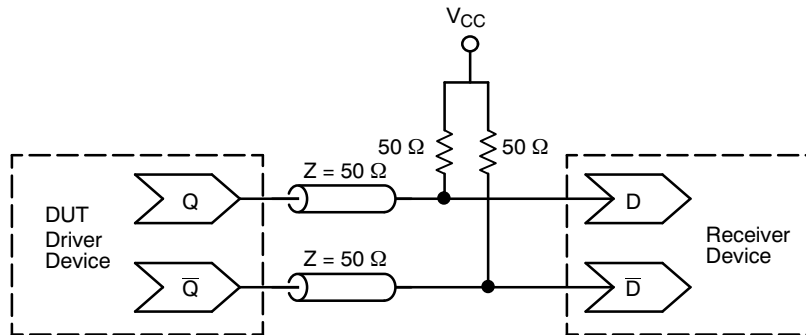
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**Figure 15. Output Voltage Amplitude ( $V_{OUTPP}$ ) versus Output Frequency at Ambient Temperature (Typical)**



**Figure 16. CML Output Structure**



**Figure 17. Typical CML Termination for Output Driver and Device Evaluation**

## ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NB6L11MMNG	QFN-16 (Pb-free)	123 Units / Rail
NB6L11MMNR2G	QFN-16 (Pb-free)	3000 / Tape & Reel

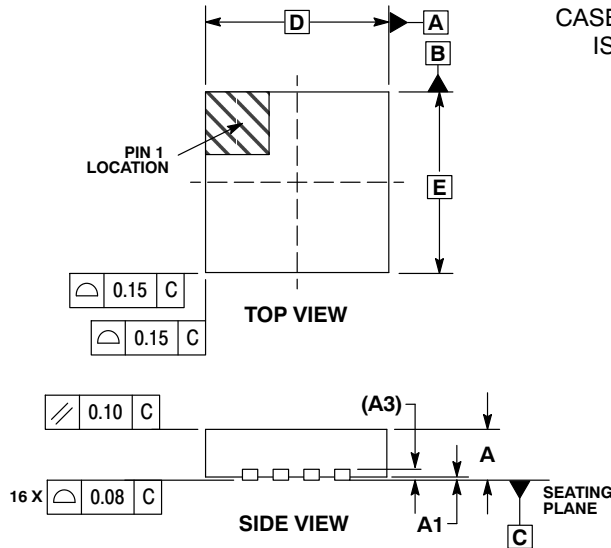
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



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## PACKAGE DIMENSIONS

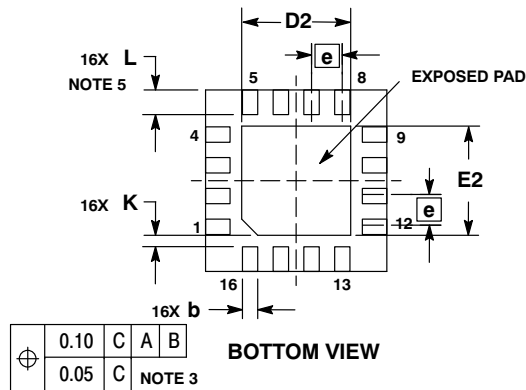
16 PIN QFN  
MN SUFFIX  
CASE 485G-01  
ISSUE C



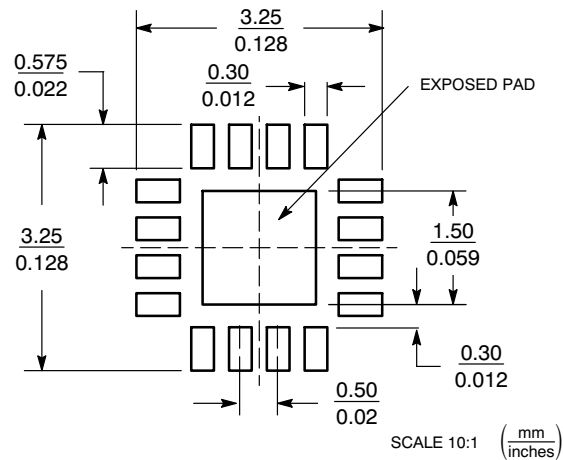
**NOTES:**

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.  $L_{max}$  CONDITION CAN NOT VIOLATE 0.2 MM MINIMUM SPACING BETWEEN LEAD TIP AND FLAG

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



### SOLDERING FOOTPRINT\*



\*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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