

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

Multi-Level Inputs w/ Internal Termination

NB6L11M

Description

The NB6L11M is a differential 1:2 CML fanout buffer. The differential inputs incorporate internal 50 Ω 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 μF capacitor and limit current sourcing or sinking to 0.5 mA. When not used, V_{REFAC} output should be left open.

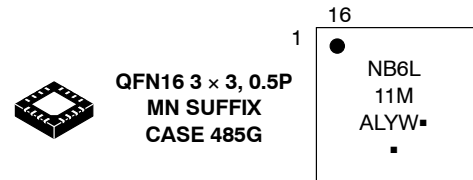
The device is housed in a small 3x3 mm 16 pin QFN package.

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 Ω
- VREFAC 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

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.

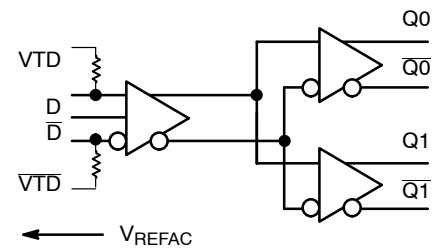


Figure 1. Simplified Logic Diagram

ORDERING INFORMATION

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

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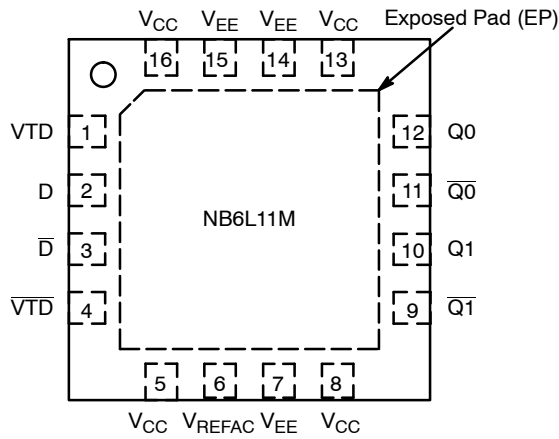


Figure 2. Pin Configuration (Top View)

Table 1. PIN DESCRIPTION

| Pin | Name | I/O | Description |
|-----|-------------|--------------------------------------|--|
| 1 | VTD | - | Internal 50 Ω Termination Pin for D input. |
| 2 | D | ECL, CML, LVCMOS, LVDS, LVTTTL Input | Noninverted Differential Input. Note 1. Internal 50 Ω Resistor to Termination Pin, VTD. |
| 3 | \bar{D} | ECL, CML, LVCMOS, LVDS, LVTTTL Input | Inverted Differential Input. Note 1. Internal 50 Ω Resistor to Termination Pin, \bar{VTD} . |
| 4 | \bar{VTD} | - | Internal 50 Ω 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 Ω Resistor to VCC. |
| 10 | Q1 | CML Output | Noninverted Differential Output. Typically Terminated with 50 Ω Resistor to VCC. |
| 11 | $\bar{Q0}$ | CML Output | Inverted Differential Output. Typically Terminated with 50 Ω Resistor to VCC. |
| 12 | Q0 | CML Output | Noninverted Differential Output. Typically Terminated with 50 Ω 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/ \bar{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 V | | 4.0 | V |
| V _{EE} | Negative Power Supply | V _{CC} = 0 V | | -4.0 | V |
| V _{IO} | Positive Input/Output Voltage Negative Input/Output Voltage | V _{EE} = 0 V V _{CC} = 0 V | -0.5 ≤ V _{Io} ≤ V _{CC} + 0.5 +0.5 ≤ V _{Io} ≤ 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 Ω 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 | | | ± 0.5 | mA |
| T _A | Operating Temperature Range | 16 QFN | | -40 to +85 | °C |
| T _{stg} | Storage Temperature Range | | | -65 to +150 | °C |
| θ _{JA} | Thermal Resistance (Junction-to-Ambient) (Note 3) | 0 lfmp 500 lfmp | QFN-16 QFN-16 | 42 35 | °C/W °C/W |
| θ _{JC} | Thermal Resistance (Junction-to-Case) | (Note 3) | 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.

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 |
|--------|----------------|-----|-----|-----|------|
|--------|----------------|-----|-----|-----|------|

POWER SUPPLY CURRENT

| | | | | | |
|----------|--|----|----|----|----|
| I_{CC} | Power Supply Current (Inputs and Outputs Open) | 45 | 60 | 75 | mA |
|----------|--|----|----|----|----|

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 |
|-------------|---|-----------------|-----------------|-----------------|----|

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 | uA |
| I_{IL} | Input LOW Current D / \bar{D} , (V_{TD}/\bar{V}_{TD} Open) | -150 | | 150 | uA |

TERMINATION RESISTORS

| | | | | | |
|------------|--------------------------------------|----|----|----|----------|
| R_{TIN} | Internal Input Termination Resistor | 40 | 50 | 60 | Ω |
| R_{TOUT} | Internal Output Termination Resistor | 40 | 50 | 60 | 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 lfm.

- 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.

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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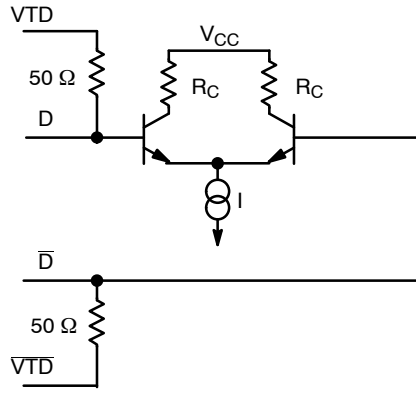


Figure 3. Input Structure

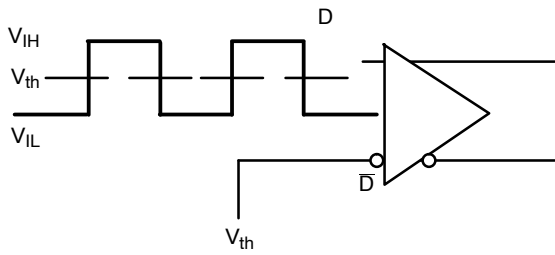


Figure 4. Differential Input Driven Single-Ended

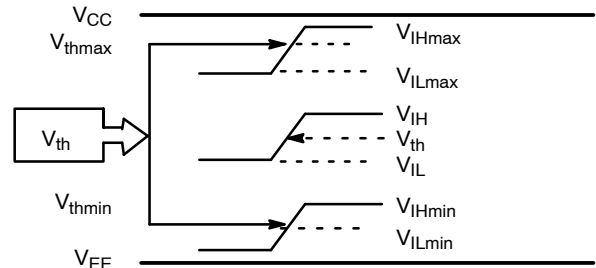


Figure 5. V_{th} Diagram

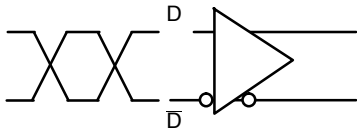


Figure 6. Differential Inputs Driven Differentially

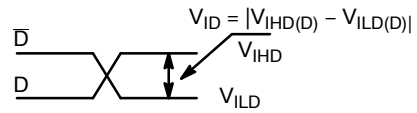


Figure 7. Differential Inputs Driven Differentially

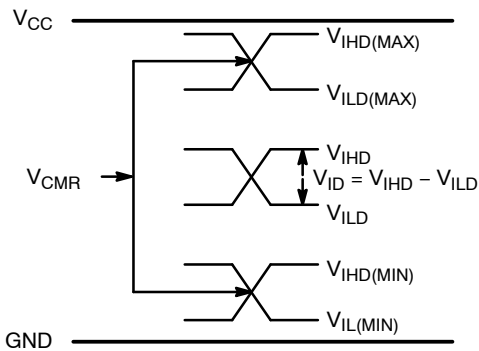


Figure 8. V_{CM} Diagram

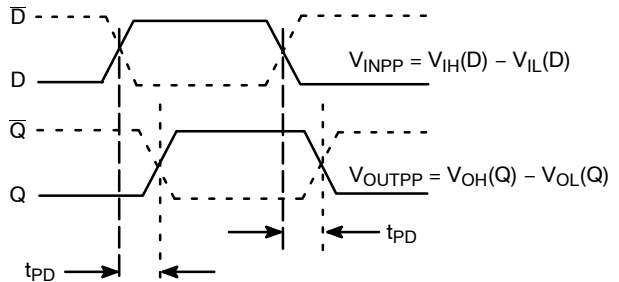


Figure 9. AC Reference Measurement

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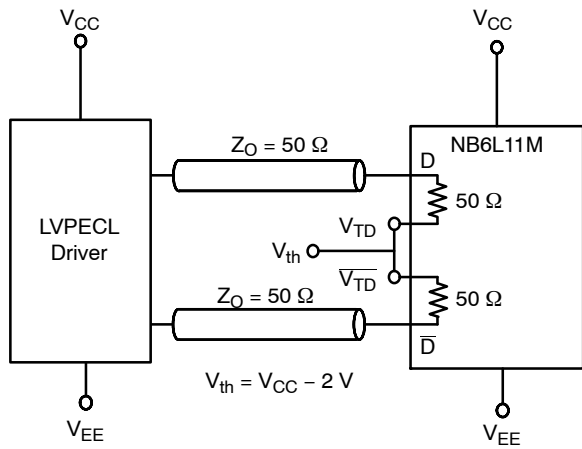


Figure 10. LVPECL Interface

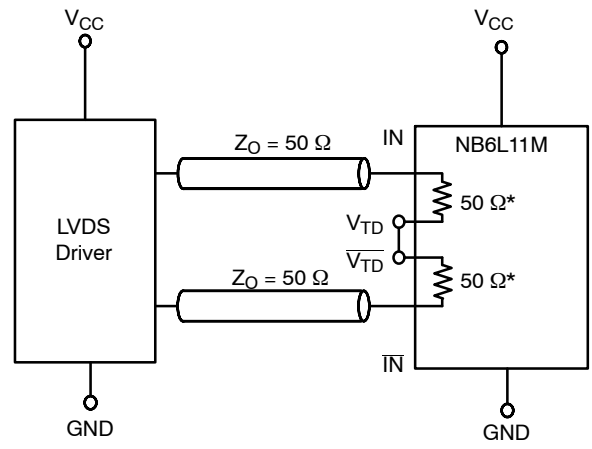


Figure 11. LVDS Interface

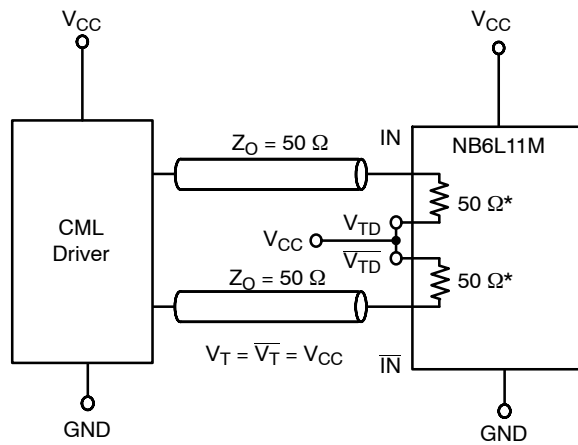


Figure 12. Standard 50 Ω Load CML Interface

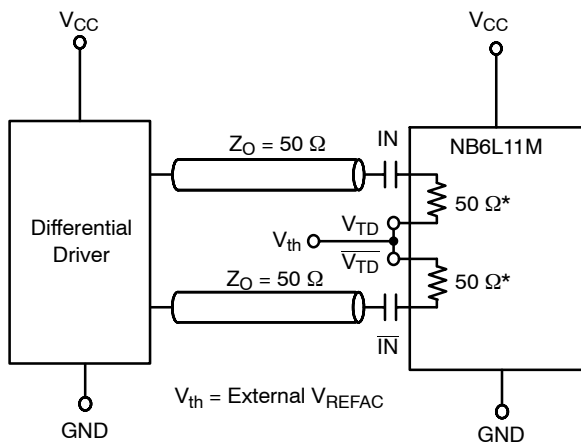


Figure 13. Capacitor-Coupled Differential Interface ($V_{TD}/\sqrt{V_{TD}}$ Connected to V_{REFAC} ; V_{REFAC} Bypassed to Ground with 0.1 μF Capacitor)

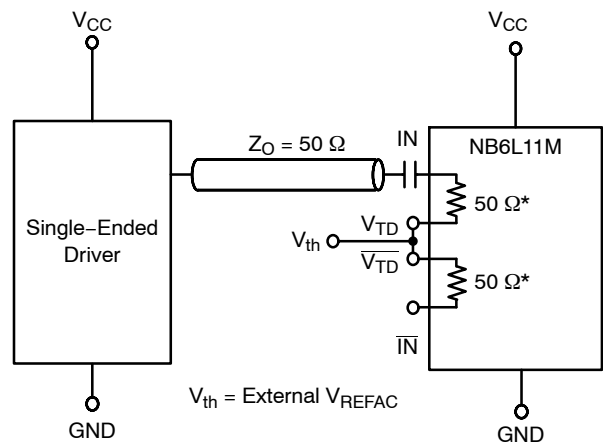


Figure 14. Capacitor-Coupled Single-Ended Interface ($V_T/\sqrt{V_T}$ Connected to V_{REFAC} ; V_{REFAC} Bypassed to Ground with 0.1 μF Capacitor)

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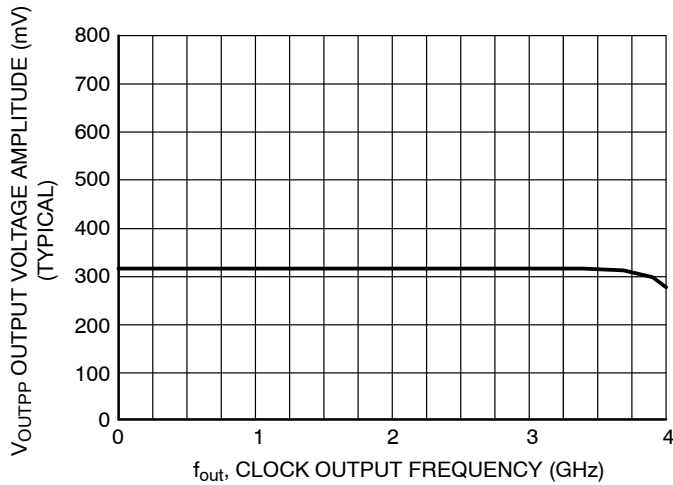


Figure 15. Output Voltage Amplitude (V_{OUTPP}) versus Output Frequency at Ambient Temperature (Typical)

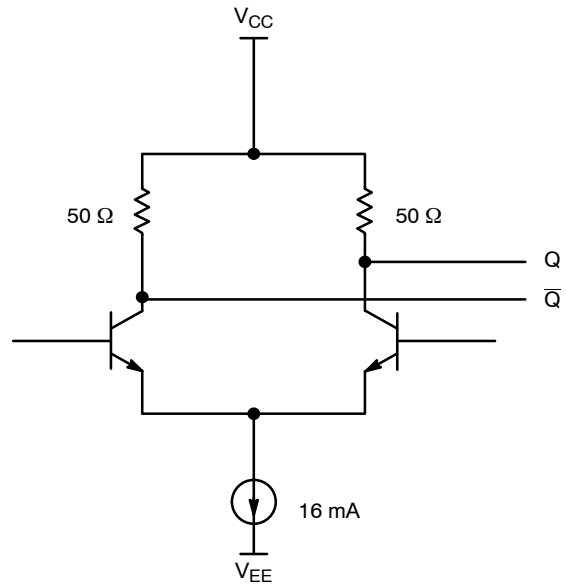


Figure 16. CML Output Structure

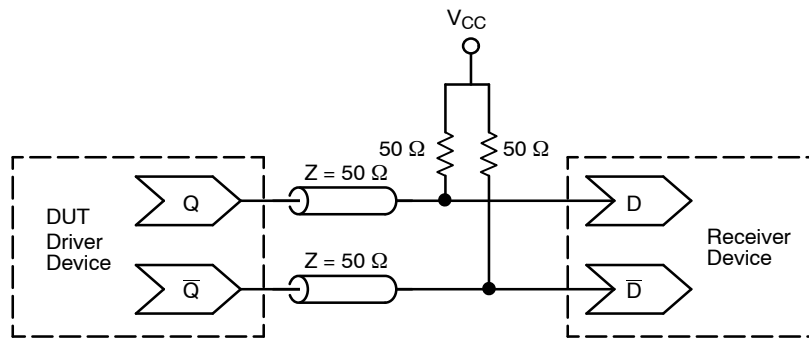


Figure 17. Typical CML Termination for Output Driver and Device Evaluation

ORDERING INFORMATION

| Device | Package | Shipping [†] |
|--------------|--------------------------------|-----------------------|
| NB6L11MMNG | QFN16 3 × 3, 0.5P (Pb-Free) | 123 Units / Rail |
| NB6L11MMNR2G | QFN16 3 × 3, 0.5P (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](#).

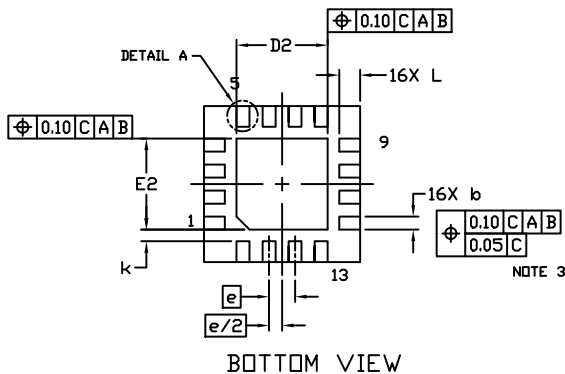
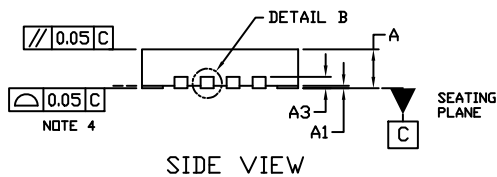
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1
SCALE 2:1

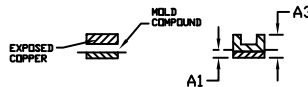
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CASE 485G
ISSUE G

DATE 08 OCT 2021

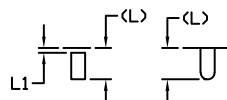


NOTES:

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.



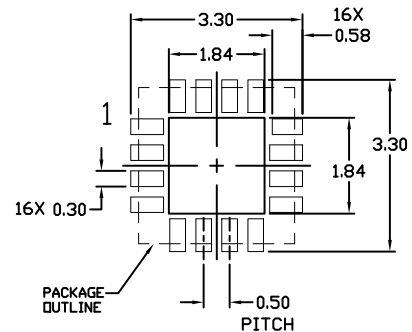
DETAIL B
ALTERNATE CONSTRUCTIONS



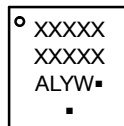
DETAIL A
ALTERNATE TERMINAL CONSTRUCTIONS

| DIM | MILLIMETERS | | |
|-----|-------------|------|------|
| | MIN. | NDM. | 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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