

# 2.5 V / 3.3 V Differential 2 X 2 Crosspoint Switch with CML Outputs

Multi-Level Inputs w/ Internal Termination

## NB6L72M

### Description

The NB6L72M is a clock or data high-bandwidth fully differential 2 x 2 Crosspoint Switch with internal source termination and CML output structure, optimized for low skew and minimal jitter. The differential inputs incorporate internal 50 Ω termination resistors and will accept LVPECL, CML, LVDS, LVCMOS, or LVTTTL logic levels. The SELECT inputs are single-ended and can be driven with LVCMOS/LVTTTL.

The 16 mA differential CML outputs provide matching internal 50 Ω terminations and 400 mV output swings when externally terminated with a 50 Ω resistor to V<sub>CC</sub>.

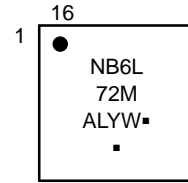
The device is offered in a small 3 mm x 3 mm 16-pin QFN package.

The NB6L72M is a member of the ECLinPS MAX™ family of high performance clock and data management products.

### Features

- Input Clock Frequency > 3.0 GHz
- Input Data Rate > 3 Gb/s
- 360 ps Typical Propagation Delay
- 65 ps Typical Rise and Fall Times
- Differential CML Outputs, 380 mV peak-to-peak, typical
- Operating Range: V<sub>CC</sub> = 2.375 V to 3.63 V with GND = 0 V
- Internal Input and Output Termination Resistors, 50 Ω
- 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

### 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 9 of this data sheet.

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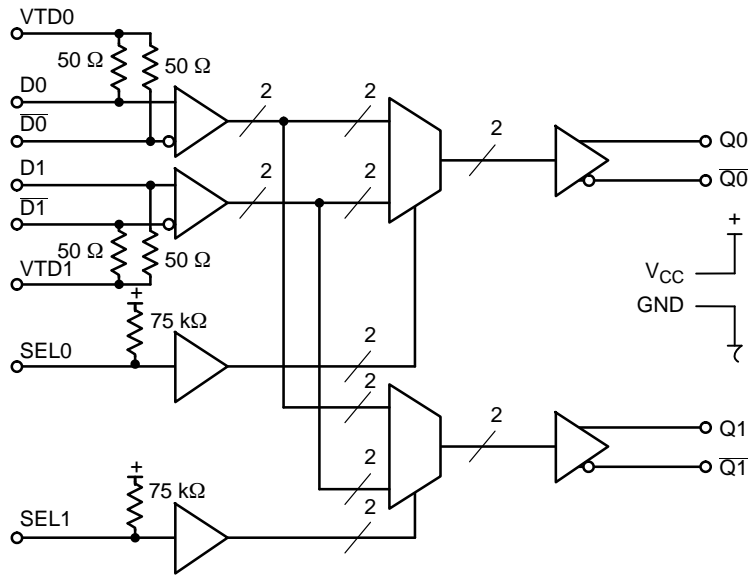


Figure 1. Logic/Block Diagram

# NB6L72M

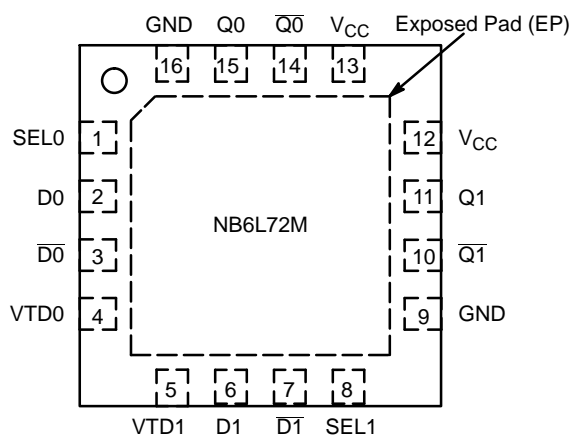


Figure 2. Pin Configuration (Top View)

Table 1. INPUT/OUTPUT SELECT TRUTH TABLE

| SEL0* | SEL1* | Q0 | Q1 |
|-------|-------|----|----|
| L     | L     | D0 | D0 |
| H     | L     | D1 | D0 |
| L     | H     | D0 | D1 |
| H     | H     | D1 | D1 |

\*Defaults HIGH when left open

Table 2. PIN DESCRIPTION

| Pin | Name | I/O                                      | Description  |
|-----|------|--|--|
| 1   | SEL0 | LVTTTL,LVCMOS Input                      | Select Logic Input control that selects D0 or D1 to output Q0. See Table 1, Select Input Function Table. Pin defaults HIGH when left open  |
| 2   | D0   | LVPECL, CML, LVDS, LVTTTL, LVCMOS, Input | Noninverted Differential Input. Note 1   |
| 3   | D0   | LVPECL, CML, LVDS, LVTTTL, LVCMOS, Input | Inverted Differential Input. Note 1  |
| 4   | VTD0 | -  | Internal 50 $\Omega$ Termination Pin. Note 1.  |
| 5   | VTD1 | -  | Internal 50 $\Omega$ termination pin. Note 1.  |
| 6   | D1   | LVPECL, CML, LVDS, LVTTTL, LVCMOS, Input | Noninverted Differential Input. Note 1.  |
| 7   | D1   | LVPECL, CML, LVDS, LVTTTL, LVCMOS, Input | Inverted Differential Input. Note 1  |
| 8   | SEL1 | LVTTTL,LVCMOS Input                      | Select Logic Input control that selects D0 or D1 to output Q1. See Table 1, Select Input Function Table. Pin defaults HIGH when left open  |
| 9   | GND  | -  | Negative Supply Voltage  |
| 10  | Q1   | CML Output                               | Inverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{CC}$ .   |
| 11  | Q1   | CML Output                               | Noninverted Differential Output. Typically Terminated with 50 $\Omega$ Resistor to $V_{CC}$ .  |
| 12  | VCC  | -  | Positive Supply Voltage  |
| 13  | VCC  | -  | Positive Supply Voltage  |
| 14  | Q0   | CML Output                               | Inverted Differential Reset Input. Typically Terminated with 50 $\Omega$ Resistor to $V_{CC}$ .  |
| 15  | Q0   | CML Output                               | Noninverted Differential Reset Input. Typically Terminated with 50 $\Omega$ Resistor to $V_{CC}$ .   |
| 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 not electrically connected to the die, but is recommended to be electrically and thermally connected to GND on the PC board. |

1. In the differential configuration when the input termination pin (VTDn) are connected to a common termination voltage or left open, and if no signal is applied on Dn/Dn input, then the device will be susceptible to self-oscillation.
2. All  $V_{CC}$  and GND pins must be externally connected to a power supply for proper operation.

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**Table 3. ATTRIBUTES**

| Characteristics  |                                   | Value                |
|--|-----------------------------------|----------------------|
| Interval Input Pulldown Resistor                       |                                   | 75 k $\Omega$        |
| ESD Protection   | Human Body Model<br>Machine Model | > 2 kV<br>> 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 4. MAXIMUM RATINGS**

| Symbol            | Parameter   | Condition 1        | Condition 2                          | Rating                | Unit                             |
|-------------------|---|--------------------|--------------------------------------|-----------------------|----------------------------------|
| V <sub>CC</sub>   | Positive Power Supply                                       | GND = 0 V          |                                      | 4.0                   | V                                |
| V <sub>IO</sub>   | Positive Input/Output Voltage                               | GND = 0 V          | $-0.5 \leq V_{IO} \leq V_{CC} + 0.5$ | 4.5                   | V                                |
| V <sub>INPP</sub> | Differential Input Voltage  D - $\bar{D}$                   |                    |                                      | V <sub>CC</sub> - GND | V                                |
| I <sub>IN</sub>   | Input Current Through R <sub>T</sub> (50 $\Omega$ Resistor) | Static<br>Surge    |                                      | 45<br>80              | mA<br>mA                         |
| T <sub>A</sub>    | Operating Temperature Range                                 | QFN-16             |                                      | -40 to +85            | $^{\circ}$ C                     |
| T <sub>stg</sub>  | Storage Temperature Range                                   |                    |                                      | -65 to +150           | $^{\circ}$ C                     |
| $\theta_{JA}$     | Thermal Resistance (Junction-to-Ambient) (Note 3)           | 0 lfpm<br>500 lfpm | QFN-16<br>QFN-16                     | 42<br>35              | $^{\circ}$ C/W<br>$^{\circ}$ C/W |
| $\theta_{JC}$     | Thermal Resistance (Junction-to-Case)                       | (Note 3)           | QFN-16                               | 4                     | $^{\circ}$ C/W                   |
| T <sub>sol</sub>  | Wave Solder Pb-Free   |                    |                                      | 265                   | $^{\circ}$ 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 5. DC CHARACTERISTICS, Multi-Level Inputs**  $V_{CC} = 2.375\text{ V to }3.63\text{ V}$ ,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$

| Symbol  | Characteristic   | Min                            | Typ                            | Max                            | Unit          |
|---|--|--------------------------------|--------------------------------|--------------------------------|---------------|
| <b>POWER SUPPLY CURRENT</b>   |  |                                |                                |                                |               |
| $I_{CC}$  | Power Supply Current (Inputs and Outputs Open)   | 60                             | 80                             | 105                            | mA            |
| <b>CML OUTPUTS (Notes 5 and 6)</b>  |  |                                |                                |                                |               |
| $V_{OH}$  | Output HIGH Voltage<br>$V_{CC} = 3.3\text{ V}$<br>$V_{CC} = 2.5\text{ V}$                    | $V_{CC} - 40$<br>3260<br>2460  | $V_{CC} - 10$<br>3290<br>2490  | $V_{CC}$<br>3300<br>2500       | mV            |
| $V_{OL}$  | Output LOW Voltage<br>$V_{CC} = 3.3\text{ V}$<br>$V_{CC} = 2.5\text{ V}$                     | $V_{CC} - 500$<br>2800<br>2000 | $V_{CC} - 400$<br>2900<br>2100 | $V_{CC} - 300$<br>3000<br>2200 | mV            |
| <b>DIFFERENTIAL INPUT DRIVEN SINGLE-ENDED (see Figures 6 and 8)</b>             |  |                                |                                |                                |               |
| $V_{th}$  | Input Threshold Reference Voltage Range (Note 7)   | 1050                           |                                | $V_{CC} - 150$                 | mV            |
| $V_{IH}$  | Single-Ended Input HIGH Voltage  | $V_{th} + 150$                 |                                | $V_{CC}$                       | mV            |
| $V_{IL}$  | Single-Ended Input LOW Voltage   | GND                            |                                | $V_{th} - 150$                 | mV            |
| $V_{ISE}$   | Single-Ended Input Voltage Amplitude ( $V_{IH} - V_{IL}$ )                                   | 300                            |                                | $V_{CC} - V_{EE}$              | mV            |
| <b>DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY (see Figures 7 and 9) (Note 8)</b> |  |                                |                                |                                |               |
| $V_{IHD}$   | Differential Input HIGH Voltage  | 1200                           |                                | $V_{CC}$                       | mV            |
| $V_{ILD}$   | Differential Input LOW Voltage   | GND                            |                                | $V_{CC} - 150$                 | mV            |
| $V_{ID}$  | Differential Input Voltage Swing ( $D_n, \overline{D}_n$ ) ( $V_{IHD} - V_{ILD}$ ) (Note 15) | 150                            |                                | $V_{CC} - V_{EE}$              | mV            |
| $V_{CMR}$   | Input Common Mode Range (Differential Configuration) (Note 9)                                | 950                            |                                | $V_{CC} - 75$                  | mV            |
| $I_{IH}$  | Input HIGH Current $D_n/\overline{D}_n$ , ( $V_{TDn}/\overline{V_{TDn}}$ Open)               | -150                           |                                | +150                           | $\mu\text{A}$ |
| $I_{IL}$  | Input LOW Current $D_n/\overline{D}_n$ , ( $V_{TDn}/\overline{V_{TDn}}$ Open)                | -150                           |                                | +150                           | $\mu\text{A}$ |
| <b>SINGLE-ENDED LVCMOS/LVTTL CONTROL INPUTS</b>                                 |  |                                |                                |                                |               |
| $V_{IH}$  | Single-Ended Input HIGH Voltage  | 2000                           |                                | $V_{CC}$                       | mV            |
| $V_{IL}$  | Single-Ended Input LOW Voltage   | GND                            |                                | 800                            | mV            |
| $I_{IH}$  | Input HIGH Current   | -150                           |                                | +150                           | $\mu\text{A}$ |
| $I_{IL}$  | Input LOW Current  | -150                           |                                | +150                           | $\mu\text{A}$ |
| <b>TERMINATION RESISTORS</b>  |  |                                |                                |                                |               |
| $R_{TIN}$   | 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.

- 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.
- $V_{CMR}$  minimum varies 1:1 with GND,  $V_{CMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{CMR}$  range is referenced to the most positive side of the differential input signal.

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**Table 6. AC CHARACTERISTICS**  $V_{CC} = 2.375\text{ V to }3.63\text{ V}$ ,  $GND = 0\text{ V}$ , or  $V_{CC} = 0\text{ V}$ ,  $GND = -2.375\text{ V to }-3.63\text{ V}$ ,  
 $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ ; (Note 10)

| Symbol                   | Characteristic   | Min  | Typ | Max               | Unit            |      |
|--------------------------|--|--|-----|-------------------|-----------------|------|
| $V_{OUTPP}$              | Output Voltage Amplitude (@ $V_{INPPmin}$ )<br>(Note 15) (See Figure 15)             | $f_{in} \leq 3\text{ GHz}$   | 250 | 380               |                 | mV   |
| $f_{DATA}$               | Maximum Operating Data Rate  | 3  |     |                   |                 | Gb/s |
| $t_{PLH}$ ,<br>$t_{PHL}$ | Propagation Delay (@0.5GHz)  | Dn to Qn<br>SELn to Qn   | 230 | 360               | 480             | ps   |
| $t_{SKEW}$               | Duty Cycle Skew (Note 11)<br>Within Device Skew<br>Device to Device Skew (Note 12)   |  | 6.0 | 20<br>25<br>85    |                 | ps   |
| $t_{DC}$                 | Output Clock Duty Cycle<br>(Reference Duty Cycle = 50%)                              | $f_{in} \leq 3.0\text{ GHz}$   | 40  | 50                | 60              | %    |
| $t_{JITTER}$             | RMS Random Clock Jitter (Note 13)<br>Peak-to-Peak Data Dependent Jitter<br>(Note 14) | $f_{in} \leq 3.0\text{ GHz}$<br>$f_{DATA} = 2.5\text{ Gb/s}$<br>$f_{DATA} = 3.0\text{ Gb/s}$ |     | 0.2<br>5.0<br>8.0 | 0.5<br>15<br>25 | ps   |
| $V_{INPP}$               | Input Voltage Swing/Sensitivity<br>(Differential Configuration) (Note 15)            |  | 150 |                   | 2800            | mV   |
| $t_r$ , $t_f$            | Output Rise/Fall Times @ 0.5 GHz, (20% – 80%),<br>Q, $\bar{Q}$                       |  |     | 65                | 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 lpm.

10. Measured by forcing  $V_{INPP}$  (minimum) 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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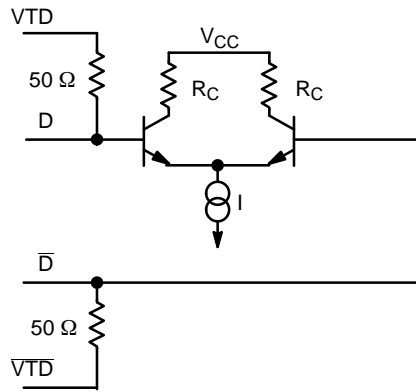


Figure 3. Input Structure

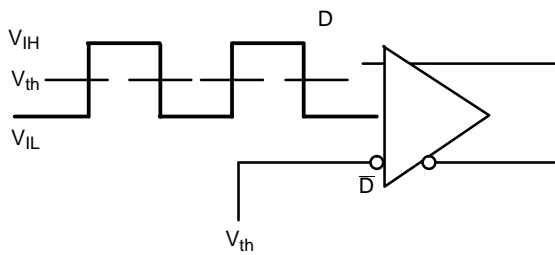


Figure 4. Differential Input Driven Single-Ended

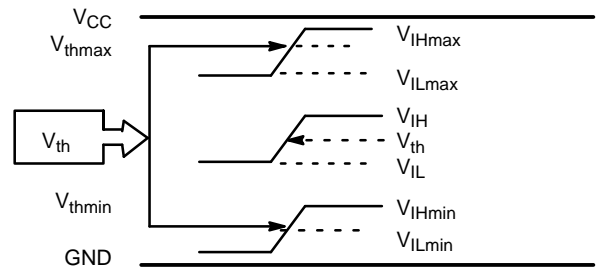


Figure 5.  $V_{th}$  Diagram

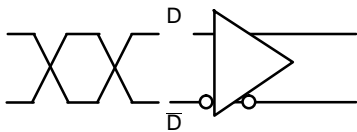


Figure 6. Differential Inputs Driven Differentially

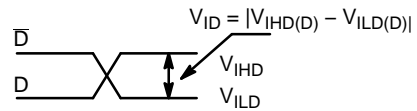


Figure 7. Differential Inputs Driven Differentially

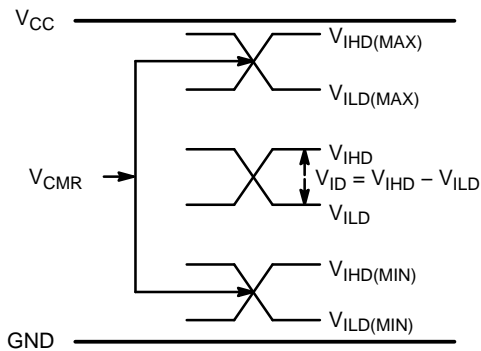


Figure 8.  $V_{CM}$  Diagram

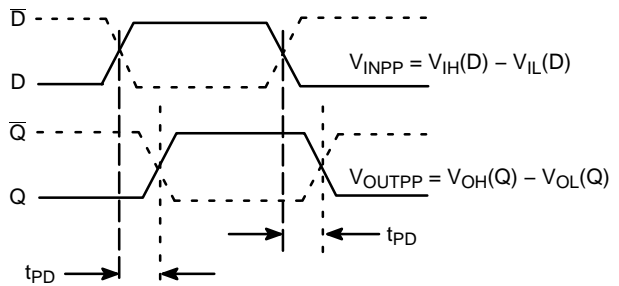


Figure 9. AC Reference Measurement

# NB6L72M

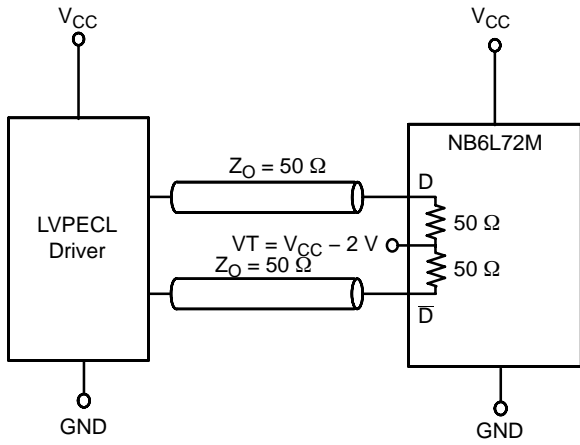


Figure 10. LVPECL Interface

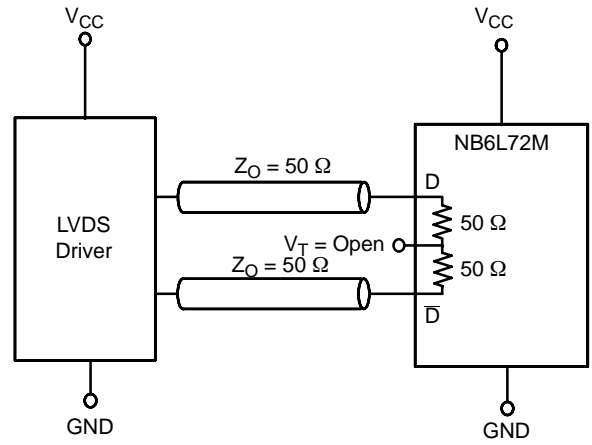


Figure 11. LVDS Interface

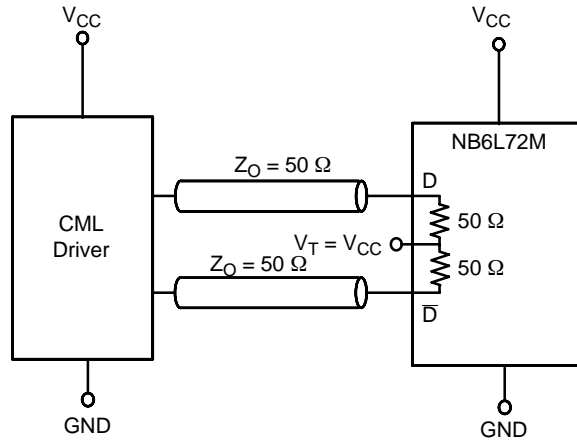


Figure 12. Standard 50 Ω Load CML Interface

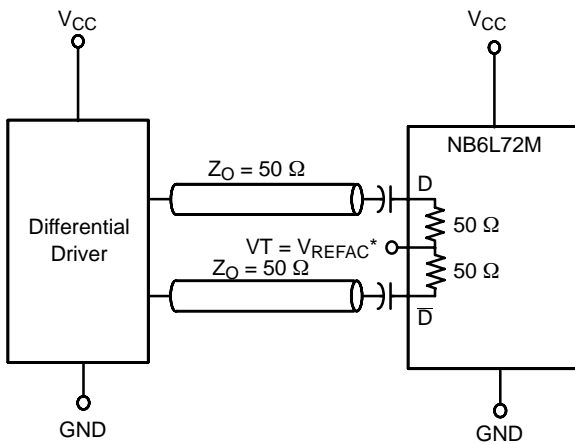


Figure 13. Capacitor-Coupled Differential Interface (VT Connected to  $V_{REFAC}$ )

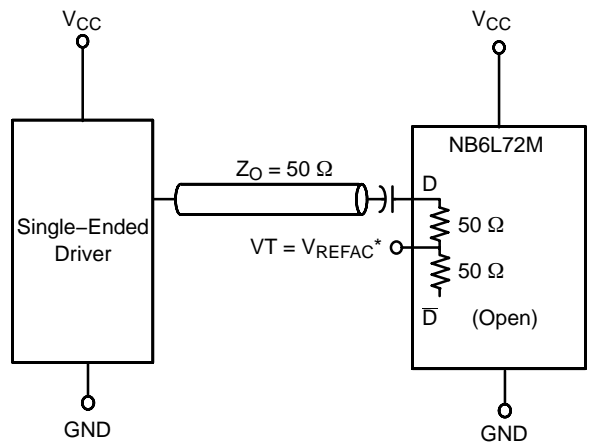


Figure 14. Capacitor-Coupled Single-Ended Interface (VT Connected to  $V_{REFAC}$ )

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



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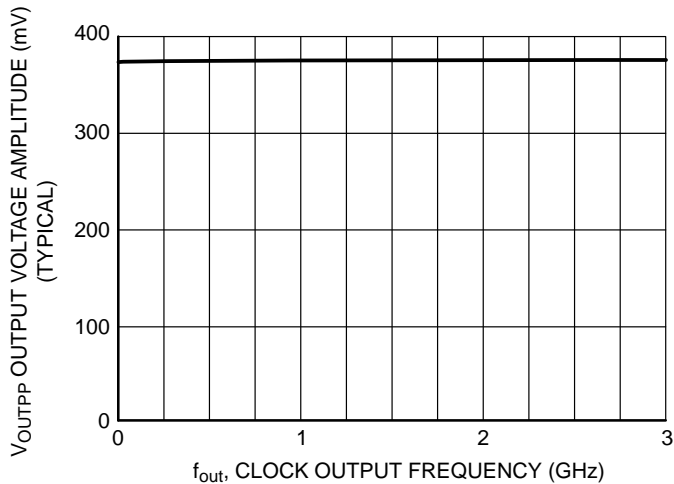


Figure 15. Output Voltage Amplitude ( $V_{OUTPP}$ ) versus Output Frequency at Ambient Temperature (Typical)

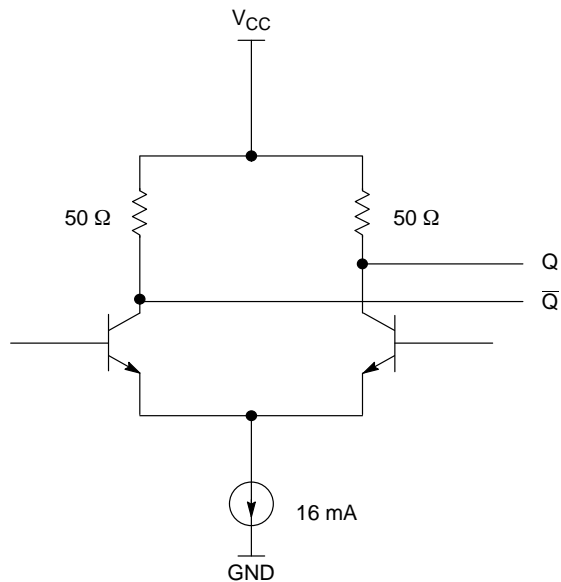


Figure 16. CML Output Structure

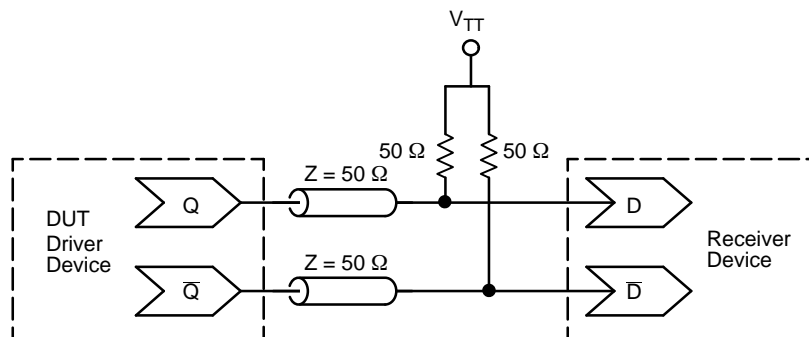


Figure 17. Typical CML Termination for Output Driver and Device Evaluation

## ORDERING INFORMATION

| Device       | Package             | Shipping†          |
|--------------|---------------------|--------------------|
| NB6L72MMNG   | QFN-16<br>(Pb-free) | 123 Units / Rail   |
| NB6L72MMNR2G | QFN-16<br>(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.

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 2:1

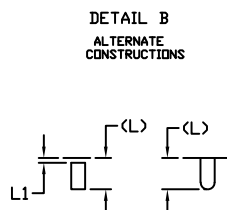
**QFN16 3x3, 0.5P**  
CASE 485G  
ISSUE G

DATE 08 OCT 2021



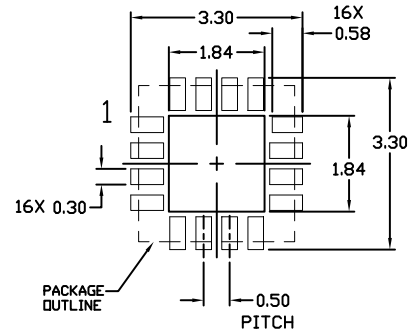
**NOTES:**

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.

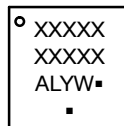


| DIM      | MILLIMETERS |      |      |
|----------|-------------|------|------|
|          | MIN.        | NDM. | MAX. |
| A        | 0.80        | 0.90 | 1.00 |
| A1       | 0.00        | 0.03 | 0.05 |
| A3       | 0.20 REF    |      |      |
| <i>b</i> | 0.18        | 0.24 | 0.30 |
| D        | 3.00 BSC    |      |      |
| D2       | 1.65        | 1.75 | 1.85 |
| E        | 3.00 BSC    |      |      |
| E2       | 1.65        | 1.75 | 1.85 |
| <i>e</i> | 0.50 BSC    |      |      |
| <i>k</i> | 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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| <b>DESCRIPTION:</b>     | <b>QFN16 3X3, 0.5P</b> | <b>PAGE 1 OF 1</b>   |

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