

2.5 V/3.3 V Differential 2 x 2 Crosspoint Switch with CML Outputs Clock/Data Buffer/Translator

Multi-Level Inputs w/ Internal Termination

NB7L72M

Description

The NB7L72M is a high bandwidth, low voltage, fully differential 2 x 2 crosspoint switch with CML outputs. The NB7L72M design is optimized for low skew and minimal jitter as it produces two identical copies of Clock or Data operating up to 7 GHz or 10 Gb/s, respectively. As such, the NB7L72M is ideal for SONET, GigE, Fiber Channel, Backplane and other clock/data distribution applications.

The differential IN/IN inputs incorporate internal 50 Ω termination resistors and will accept LVPECL, CML, or LVDS logic levels (see Figure 11). The 16 mA differential CML outputs provide matching internal 50 Ω terminations and produce 400 mV output swings when externally terminated with a 50 Ω resistor to V_{CC} (see Figure 9).

The NB7L72M is the 2.5 V/3.3 V version of the and NB7V72M and is offered in a low profile 3x3 mm 16-pin QFN package. Application notes, models, and support documentation are available at www.onsemi.com.

The NB7L72M is a member of the GigaComm™ family of high performance clock products.

Features

- Maximum Input Data Rate > 10 Gb/s
- Data Dependent Jitter < 10 ps pk-pk
- Maximum Input Clock Frequency > 7 GHz
- Random Clock Jitter < 0.5 ps RMS, Max
- 150 ps Typical Propagation Delay
- 30 ps Typical Rise and Fall Times
- Differential CML Outputs, 400 mV peak-to-peak, typical
- Operating Range: V_{CC} = 2.375 V to 3.6 V with GND = 0 V
- Internal 50 Ω Input Termination Resistors
- QFN16 Package, 3mm x 3mm
- -40°C to +85°C Ambient Operating Temperature
- These are Pb-Free Devices



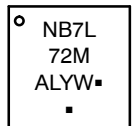
ON Semiconductor®

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MARKING DIAGRAM*



QFN16
MN SUFFIX
CASE 485G



- 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](#).

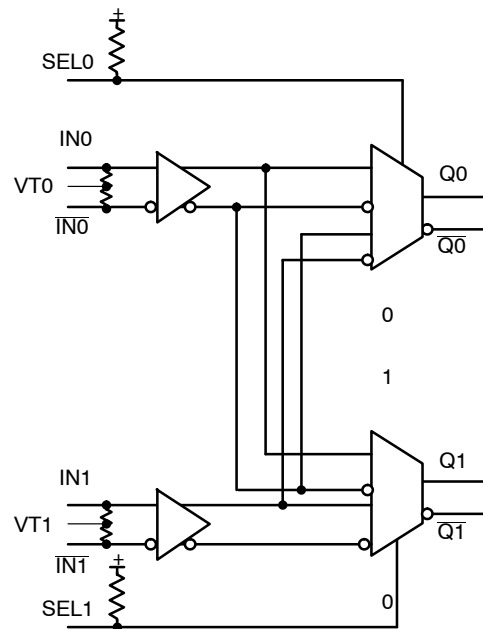


Figure 1. Logic Diagram₁

ORDERING INFORMATION

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

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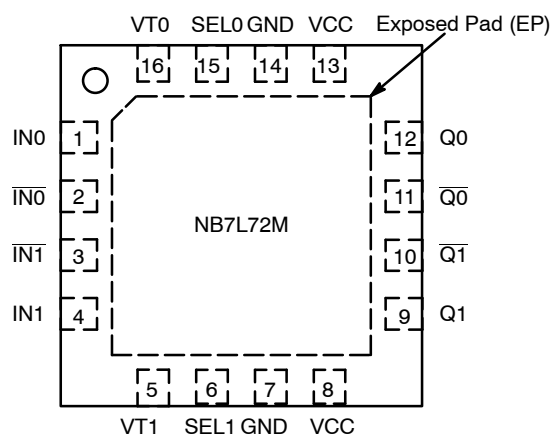


Table 1. INPUT/OUTPUT SELECT TRUTH TABLE

| SEL0* | SEL1* | Q0 | Q1 |
|-------|-------|-----|-----|
| L | L | IN0 | IN0 |
| L | H | IN0 | IN1 |
| H | L | IN1 | IN0 |
| H | H | IN1 | IN1 |

*Defaults HIGH when left open

Figure 2. Pin Configuration (Top View)

Table 2. PIN DESCRIPTION

| Pin | Name | I/O | Description |
|-----|-------------------------|-------------------------|---|
| 1 | IN0 | LVPECL, CML, LVDS Input | Noninverted Differential Input. (Note 1) |
| 2 | $\overline{\text{IN}}0$ | LVPECL, CML, LVDS Input | Inverted Differential Input. (Note 1) |
| 3 | $\overline{\text{IN}}1$ | LVPECL, CML, LVDS Input | Inverted Differential Input. (Note 1) |
| 4 | IN1 | LVPECL, CML, LVDS Input | Noninverted Differential Input. (Note 1) |
| 5 | VT1 | - | Internal 50 Ω Termination Pin for IN1 and $\overline{\text{IN}}1$. |
| 6 | SEL1 | LVC MOS Input | Input Select logic pin for IN0 or IN1 Inputs to Q1 output. See Table 1, Input/Output Select Truth Table; pin defaults HIGH when left open. |
| 7 | GND | - | Negative Supply Voltage |
| 8 | VCC | - | Positive Supply Voltage |
| 9 | Q1 | CML Output | Noninverted Differential Output. (Note 1) |
| 10 | $\overline{\text{Q}}1$ | CML Output | Inverted Differential Output. (Note 1) |
| 11 | $\overline{\text{Q}}0$ | CML Output | Inverted Differential Output. (Note 1) |
| 12 | Q0 | CML Output | Noninverted Differential Output. (Note 1) |
| 13 | VCC | - | Positive Supply Voltage |
| 14 | GND | - | Negative Supply Voltage |
| 15 | SEL0 | LVC MOS Input | Input Select logic pin for IN0 or IN1 Inputs to Q0 output. See Table 1, Input/Output Select Truth Table; pin defaults HIGH when left open. |
| 16 | VT0 | - | Internal 50 Ω Termination Pin for IN0 and $\overline{\text{IN}}0$ |
| - | EP | - | The Exposed Pad (EP) on the QFN16 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 is recommended to be electrically and thermally connected to GND on the PC board. |

1. In the differential configuration when the input termination pins (VT0, VT1) are connected to a common termination voltage or left open, and if no signal is applied on INx/ $\overline{\text{IN}}x$ 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.

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Table 3. ATTRIBUTES

| Characteristics | Value |
|--|----------------------|
| ESD Protection Human Body Model Machine Model | > 4 kV > 200 V |
| R _{PU} – Input Pullup Resistor | 75 kΩ |
| Moisture Sensitivity (Note 3) QFN16 | Level 1 |
| Flammability Rating Oxygen Index: 28 to 34 | UL 94 V-0 @ 0.125 in |
| Transistor Count | 212 |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test | |

3. For additional information, see Application Note [AND8003/D](#).

Table 4. MAXIMUM RATINGS

| Symbol | Parameter | Condition 1 | Condition 2 | Rating | Unit |
|-------------------|---|--------------------|----------------|------------------------------|--------------|
| V _{CC} | Positive Power Supply | GND = 0 V | | 4.0 | V |
| V _{IN} | Positive Input Voltage | GND = 0 V | | -0.5 to V _{CC} +0.5 | V |
| V _{INPP} | Differential Input Voltage $I_N - \bar{I}_N$ | | | 1.89 | V |
| I _{IN} | Input Current Through R _T (50 Ω Resistor) | | | ±40 | mA |
| I _{OUT} | Output Current Through R _T (50 Ω Resistor) | | | ±40 | mA |
| T _A | Operating Temperature Range | | | -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 | QFN16 QFN16 | 42 35 | °C/W °C/W |
| θ _{JC} | Thermal Resistance (Junction-to-Case) (Note 4) | | QFN16 | 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.

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Table 5. DC CHARACTERISTICS, Multi-Level Inputs $V_{CC} = 2.375\text{ V to }3.6\text{ V}$, $GND = 0\text{ V}$, $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ (Note 5)

| Symbol | Characteristic | Min | Typ | Max | Unit |
|--|--|--|--|--|---------------|
| POWER SUPPLY CURRENT | | | | | |
| V_{CC} | Power Supply Voltage $V_{CC} = 2.5\text{ V}$ $V_{CC} = 3.3\text{ V}$ | 2.375 3.0 | 2.5 3.3 | 2.625 3.6 | V |
| I_{CC} | Power Supply Current (Inputs and Outputs Open) | 80 | 135 | 175 | mA |
| CML OUTPUTS | | | | | |
| V_{OH} | Output HIGH Voltage (Note 6) $V_{CC} = 3.3\text{ V}$ $V_{CC} = 2.5\text{ V}$ | $V_{CC} - 40$ 3260 2460 | $V_{CC} - 20$ 3280 2480 | V_{CC} 3300 2500 | mV |
| V_{OL} | Output LOW Voltage (Note 6) $V_{CC} = 3.3\text{ V}$ $V_{CC} = 2.5\text{ V}$ | $V_{CC} - 650$ 2650 $V_{CC} - 600$ 1900 | $V_{CC} - 500$ 2800 $V_{CC} - 500$ 2000 | $V_{CC} - 400$ 2900 $V_{CC} - 350$ 2150 | mV |
| DIFFERENTIAL CLOCK INPUTS DRIVEN SINGLE-ENDED (Note 7) (Figures 5 and 7) | | | | | |
| V_{th} | Input Threshold Reference Voltage Range (Note 8) | 1050 | | $V_{CC} - 100$ | mV |
| V_{IH} | Single-Ended Input HIGH Voltage | $V_{th} + 100$ | | V_{CC} | mV |
| V_{IL} | Single-Ended Input LOW Voltage | GND | | $V_{th} - 100$ | mV |
| V_{ISE} | Single-Ended Input Voltage ($V_{IH} - V_{IL}$) | 200 | | 2800 | mV |
| DIFFERENTIAL DATA/CLOCK INPUTS DRIVEN DIFFERENTIALLY (Figures 6 and 8) (Note 9) | | | | | |
| V_{IHD} | Differential Input HIGH Voltage (IN_n, \overline{IN}_n) | 1100 | | V_{CC} | mV |
| V_{ILD} | Differential Input LOW Voltage (IN_n, \overline{IN}_n) | GND | | $V_{CC} - 100$ | mV |
| V_{ID} | Differential Input Voltage (IN_n, \overline{IN}_n) ($V_{IHD} - V_{ILD}$) | 100 | | 1200 | mV |
| V_{CMR} | Input Common Mode Range (Differential Configuration, Note 10) (Figure 9) | 950 | | $V_{CC} - 50$ | mV |
| I_{IH} | Input HIGH Current IN_n, \overline{IN}_n ($V_{TIN}/\overline{V_{TIN}}$ Open) | -150 | | 150 | μA |
| I_{IL} | Input LOW Current IN_n, \overline{IN}_n ($V_{TIN}/\overline{V_{TIN}}$ Open) | -150 | | 150 | μA |
| CONTROL INPUTS (SEL0, SEL1) | | | | | |
| V_{IH} | Input HIGH Voltage for Control Pins | 2.0 | | V_{CC} | V |
| V_{IL} | Input LOW Voltage for Control Pins | GND | | 0.8 | V |
| I_{IH} | Input HIGH Current | -150 | | 150 | μA |
| I_{IL} | Input LOW Current | -150 | | 150 | μA |
| 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 lpm.

- Input and output parameters vary 1:1 with V_{CC} .
- CML outputs loaded with $50\ \Omega$ to V_{CC} for proper operation.
- 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 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 $V_{CC} = 2.375\text{ V to }3.6\text{ V}$, $GND = 0\text{ V}$, $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (Note 11)

| Symbol | Characteristic | Min | Typ | Max | Unit |
|--------------------------|--|------------|-----|-----------|----------------------|
| f_{MAX} | Maximum Input Clock Frequency $V_{OUT} \geq 250\text{ mV}$ $V_{OUT} \geq 200\text{ mV}$ | 7.0 8.5 | | | GHz |
| $f_{DATAMAX}$ | Maximum Operating Data Rate (PRBS23) | 10 | | | Gbps |
| V_{OUTPP} | Output Voltage Amplitude (@ $V_{INPPmin}$) (See Figures 3 and 10, Note 12) | 200 | 400 | | mV |
| t_{PLH} , t_{PHL} | Propagation Delay to Differential Outputs, @ 1GHz, Measured at Differential Cross-point $I_{Nn}/I_{N\bar{n}}$ to $Q_n/Q_{\bar{n}}$ SEL_n to $Q_n/Q_{\bar{n}}$ | 110 | 150 | 180 | ps |
| $t_{PLH\ TC}$ | Propagation Delay Temperature Coefficient | | 50 | | $\Delta fs/^\circ C$ |
| t_{SKEW} | Output-to-Output Skew (within device) (Note 13) Device-to-Device Skew ($t_{pdmax} - t_{pdmin}$) | | | 10 20 | ps |
| t_{DC} | Output Clock Duty Cycle (Reference Duty Cycle = 50%) $f_{in} \leq 8.5\text{GHz}$ | 45 | 50 | 55 | % |
| t_{jitter} | RJ – Output Random Jitter (Note 14) DJ – Deterministic Jitter (Note 15) | | 0.2 | 0.5 10 | ps RMS ps pk-pk |
| V_{INPP} | Input Voltage Swing (Differential Configuration) (Note 16) | 100 | | 1200 | mV |
| t_r , t_f | Output Rise/Fall Times @ 1 GHz (20% – 80%), Q, \bar{Q} | 25 | 30 | 50 | 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.

11. Measured using a 400 mV source, 50% duty cycle clock source. All output loading with external $50\ \Omega$ to V_{CC} . Input edge rates ≥ 40 ps (20% – 80%).
12. Output voltage swing is a single-ended measurement operating in differential mode.
13. Skew is measured between outputs under identical transitions and conditions. Duty cycle skew is defined only for differential operation when the delays are measured from cross-point of the inputs to the cross-point of the outputs.
14. Additive RMS jitter with 50% duty cycle clock signal.
15. Additive Peak-to-Peak data dependent jitter with input NRZ data at PRBS23.
16. Input voltage swing is a single-ended measurement operating in differential mode.

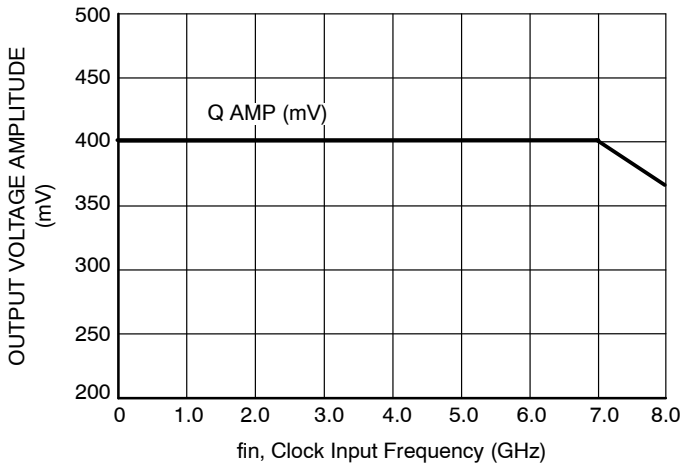


Figure 3. CLOCK Output Voltage Amplitude (V_{OUTPP}) vs. Input Frequency (f_{in}) at Ambient Temperature (Typ)

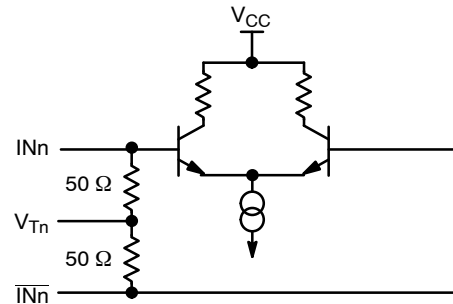


Figure 4. Input Structure

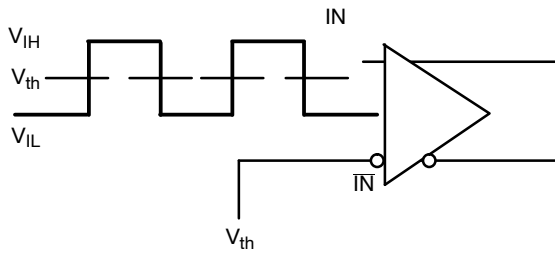


Figure 5. Differential Input Driven Single-Ended

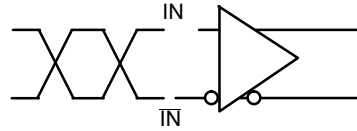


Figure 6. Differential Inputs Driven Differentially



Figure 7. V_{th} Diagram

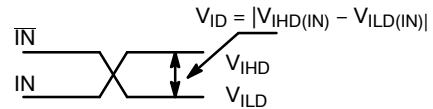


Figure 8. Differential Inputs Driven Differentially

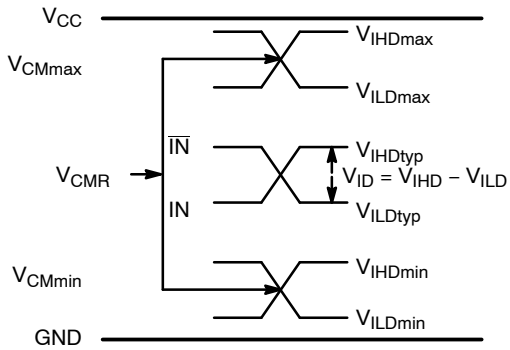


Figure 9. V_{CMR} Diagram

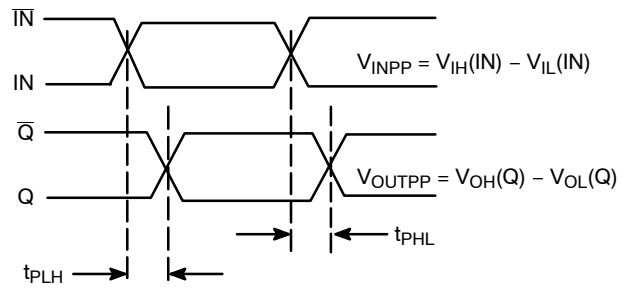


Figure 10. AC Reference Measurement

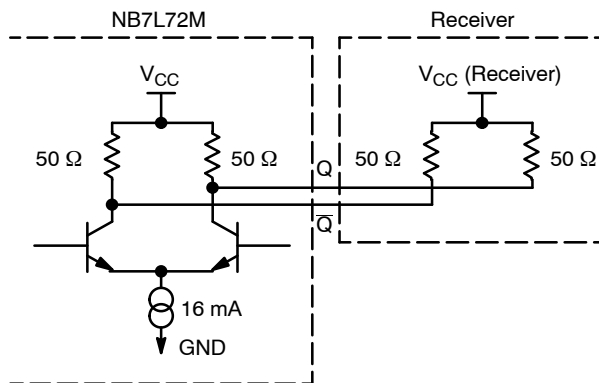


Figure 11. Typical CML Output Structure and Termination

NB7L72M

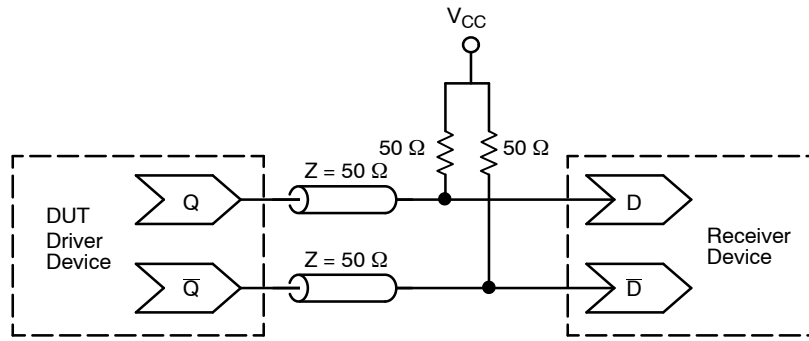


Figure 12. Typical Termination for CML Output Driver and Device Evaluation

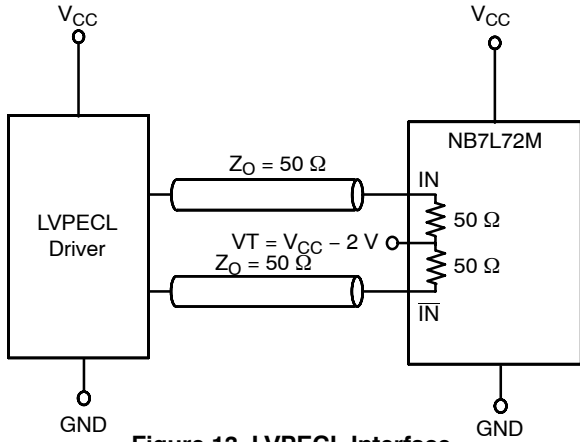


Figure 13. LVPECL Interface

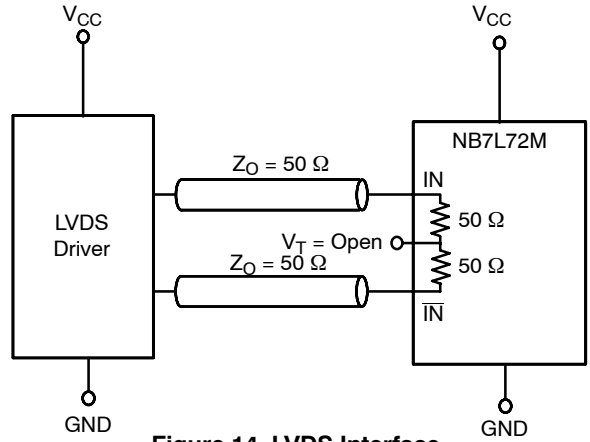


Figure 14. LVDS Interface

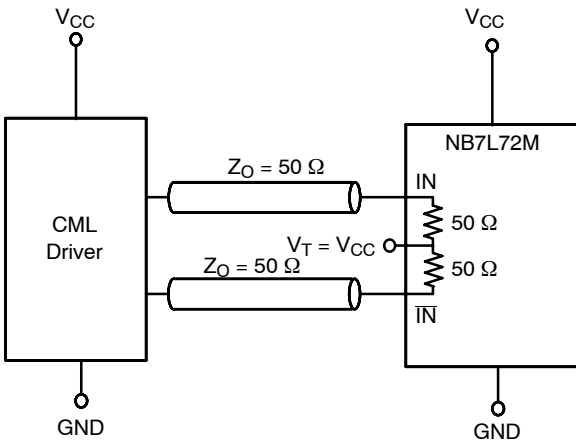


Figure 15. Standard 50 Ω Load CML Interface

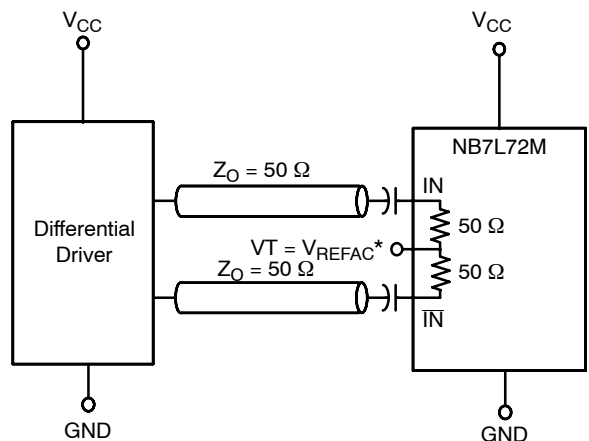


Figure 16. Capacitor-Coupled Differential Interface
(VT Connected to External V_{REFAC})

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

NB7L72M

ORDERING INFORMATION

| Device | Package | Shipping [†] |
|---------------|--------------------|-----------------------|
| NB7L72MMNG | QFN16 (Pb-free) | 123 Units / Tube |
| NB7L72MMNHTBG | QFN16 (Pb-free) | 100 / 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

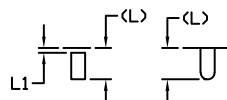


NOTES:

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.



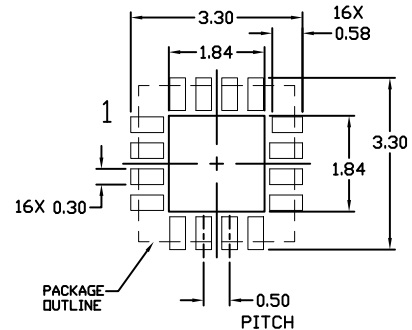
DETAIL B
ALTERNATE
CONSTRUCTIONS



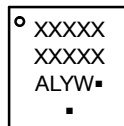
DETAIL A
ALTERNATE TERMINAL
CONSTRUCTIONS

| DIM | MILLIMETERS | | |
|----------|-------------|------|------|
| | MIN. | NDM. | MAX. |
| A | 0.80 | 0.90 | 1.00 |
| A1 | 0.00 | 0.03 | 0.05 |
| A3 | 0.20 REF | | |
| <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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| DESCRIPTION: | QFN16 3X3, 0.5P | PAGE 1 OF 1 |

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