

# NB7L1008M

## 2.5V / 3.3V 1:8 CML Fanout

### Multi-Level Inputs w/ Internal Termination

#### Description

The NB7L1008M is a high performance differential 1:8 Clock/Data fanout buffer. The NB7L1008M produces eight identical output copies of Clock or Data operating up to 6 GHz or 10.7 Gb/s, respectively. As such, the NB7L1008M is ideal for SONET, GigE, Fiber Channel, Backplane and other Clock/Data distribution applications. The differential inputs incorporate internal 50  $\Omega$  termination resistors that are accessed through the VT pin. This feature allows the NB7L1008M to accept various logic standards, such as LVPECL, CML, LVDS, LVC MOS or LVTTL logic levels. The  $V_{REFAC}$  reference output can be used to rebias capacitor-coupled differential or single-ended input signals. The 1:8 fanout design was optimized for low output skew applications. The NB7L1008M is a member of the GigaComm™ family of high performance clock products.

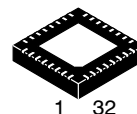
#### Features

- Input Data Rate > 12 Gb/s Typical
- Data Dependent Jitter < 20 ps
- Maximum Input Clock Frequency > 8 GHz Typical
- Random Clock Jitter < 0.8 ps RMS
- Low Skew 1:8 CML Outputs, < 25 ps max
- Multi-Level Inputs, accepts LVPECL, CML, LVDS
- 160 ps Typical Propagation Delay
- 45 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, GND = 0 V
- Internal Input Termination Resistors, 50  $\Omega$
- $V_{REFAC}$  Reference Output
- QFN-32 Package, 5 mm x 5 mm
- -40°C to +85°C Ambient Operating Temperature
- These are Pb-Free Devices



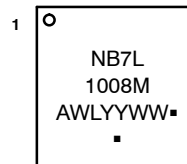
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**QFN32**  
**MN SUFFIX**  
**CASE 488AM**

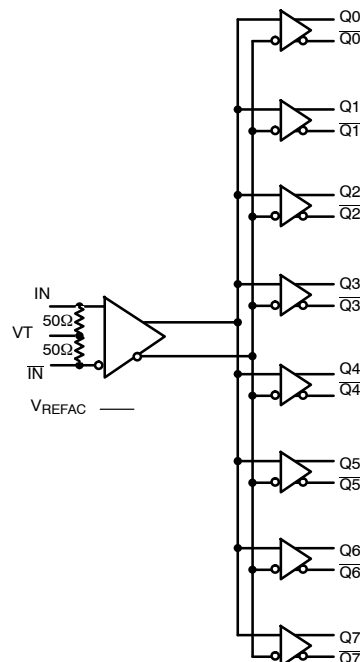
#### MARKING DIAGRAM



A = Assembly Location  
WL = Wafer Lot  
YY = Year  
WW = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

#### SIMPLIFIED LOGIC DIAGRAM



#### ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

# NB7L1008M

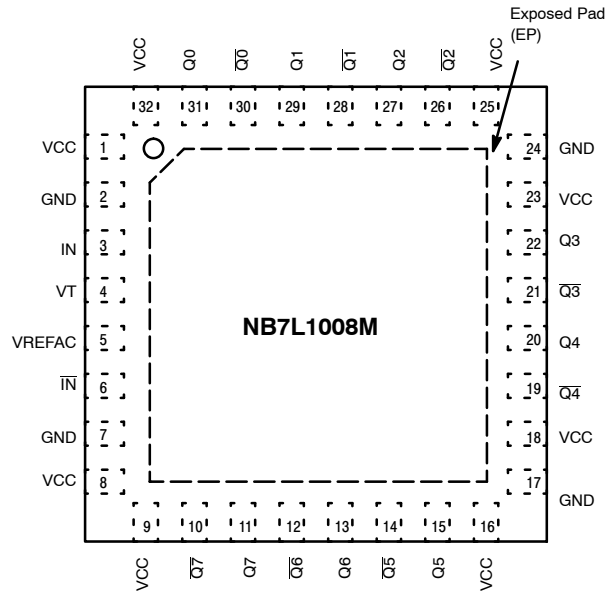


Figure 1. 32-Lead QFN Pinout (Top View)

Table 1. PIN DESCRIPTION

| Pin                                                            | Name                                                                                                                                                                                                                                  | I/O                     | Description                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3, 6                                                           | IN, $\overline{\text{IN}}$                                                                                                                                                                                                            | LVPECL, CML, LVDS Input | Non-inverted / Inverted Differential Clock/Data Input. Note 1                                                                                                                                                                                                                                               |
| 4                                                              | VT                                                                                                                                                                                                                                    |                         | Internal 50 $\Omega$ Termination Pin for IN and $\overline{\text{IN}}$                                                                                                                                                                                                                                      |
| 2, 7 17,24                                                     | GND                                                                                                                                                                                                                                   |                         | Negative Supply Voltage, Note 2                                                                                                                                                                                                                                                                             |
| 1, 8, 9, 16, 18, 23, 25, 32                                    | V <sub>CC</sub>                                                                                                                                                                                                                       |                         | Positive Supply Voltage, Note 2                                                                                                                                                                                                                                                                             |
| 31, 30, 29, 28, 27, 26, 22, 21, 20, 19, 15, 14, 13, 12, 11, 10 | Q0, $\overline{\text{Q0}}$ , Q1, $\overline{\text{Q1}}$ , Q2, $\overline{\text{Q2}}$ , Q3, $\overline{\text{Q3}}$ , Q4, $\overline{\text{Q4}}$ , Q5, $\overline{\text{Q5}}$ , Q6, $\overline{\text{Q6}}$ , Q7, $\overline{\text{Q7}}$ | CML                     | Non-inverted / Inverted Differential Output. Note 1                                                                                                                                                                                                                                                         |
| 5                                                              | VREFAC                                                                                                                                                                                                                                |                         | Output Voltage Reference for Capacitor-Coupled Inputs, only                                                                                                                                                                                                                                                 |
| –                                                              | EP                                                                                                                                                                                                                                    | –                       | The Exposed Pad (EP) on the QFN-24 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 GND and is recommended to be electrically connected to GND on the PC board. |

1. In the differential configuration when the input termination pin (V<sub>T</sub>) is connected to a common termination voltage or left open, and if no signal is applied on IN/ $\overline{\text{IN}}$ , then the device will be susceptible to self-oscillation. Qn/ $\overline{\text{Qn}}$  outputs have internal 50  $\Omega$  source termination resistors.
2. All V<sub>CC</sub> and GND pins must be externally connected to the same power supply voltage to guarantee proper device operation.

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**Table 2. ATTRIBUTES**

| Characteristics                                                        |                        | Value                |
|------------------------------------------------------------------------|------------------------|----------------------|
| ESD Protection                                                         | Human Body Model       | > 2 kV               |
|                                                                        | Machine Model          | > 200 V              |
| Moisture Sensitivity (Note 3) Indefinite Time of the Drypack<br>QFN-32 |                        | Level 1              |
| Flammability Rating                                                    | Oxygen Index: 28 to 34 | UL 94 V-0 @ 0.125 in |
| Transistor Count                                                       |                        | 263                  |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test                 |                        |                      |

3. For additional information, refer to Application Note AND8003/D.

**Table 3. 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>IN</sub>     | Input Voltage                                                                                                        | GND = 0 V          |                  | -0.5 to V <sub>CC</sub> | V            |
| V <sub>INPP</sub>   | Differential Input Voltage  I <sub>N</sub> - I <sub>N</sub>                                                          |                    |                  | 1.89                    | V            |
| I <sub>IN</sub>     | Input Current Through R <sub>T</sub> (50 Ω Resistor)                                                                 |                    |                  | ± 40                    | mA           |
| I <sub>out</sub>    | Output Current                                                                                                       | Continuous Surge   |                  | 34<br>40                | mA           |
| I <sub>VREFAC</sub> | V <sub>REFAC</sub> Sink/Source Current                                                                               |                    |                  | ± 1.5                   | mA           |
| T <sub>A</sub>      | Operating Temperature Range                                                                                          |                    |                  | -40 to +85              | °C           |
| T <sub>stg</sub>    | Storage Temperature Range                                                                                            |                    |                  | -65 to +150             | °C           |
| θ <sub>JA</sub>     | Thermal Resistance (Junction-to-Ambient) (Note 4)<br>TGSD 51-6 (2S2P Multilayer Test Board) with Filled Thermal Vias | 0 lfpm<br>500 lfpm | QFN-32<br>QFN-32 | 31<br>27                | °C/W<br>°C/W |
| θ <sub>JC</sub>     | Thermal Resistance (Junction-to-Case)                                                                                | Standard Board     | QFN-32           | 12                      | °C/W         |
| T <sub>sol</sub>    | Wave Solder<br>Pb-Free                                                                                               |                    |                  | 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) with 8 filled thermal vias under exposed pad.

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**Table 4. DC CHARACTERISTICS – CML OUTPUT**  $V_{CC} = 2.375 \text{ V to } 3.6 \text{ V}$ ;  $GND = 0 \text{ V}$   $T_A = -40^\circ\text{C to } 85^\circ\text{C}$  (Note 6)

| Symbol | Characteristic | Min | Typ | Max | Unit |
|--------|----------------|-----|-----|-----|------|
|--------|----------------|-----|-----|-----|------|

## POWER SUPPLY

|          |                                                                              |              |            |              |   |
|----------|------------------------------------------------------------------------------|--------------|------------|--------------|---|
| $V_{CC}$ | Power Supply Voltage<br>$V_{CC} = 3.3 \text{ V}$<br>$V_{CC} = 2.5 \text{ V}$ | 3.0<br>2.375 | 3.3<br>2.5 | 3.6<br>2.625 | V |
|----------|------------------------------------------------------------------------------|--------------|------------|--------------|---|

## POWER SUPPLY CURRENT

|          |                                               |  |     |     |    |
|----------|-----------------------------------------------|--|-----|-----|----|
| $I_{CC}$ | Power Supply Current, Inputs and Outputs Open |  | 265 | 315 | mA |
|----------|-----------------------------------------------|--|-----|-----|----|

## CML OUTPUTS (Note 5, Figures 10 and 11)

|          |                                                                             |                                |                                |                                |    |
|----------|-----------------------------------------------------------------------------|--------------------------------|--------------------------------|--------------------------------|----|
| $V_{OH}$ | Output HIGH Voltage<br>$V_{CC} = 3.3 \text{ V}$<br>$V_{CC} = 2.5 \text{ V}$ | $V_{CC} - 30$<br>3270<br>2470  | $V_{CC} - 10$<br>3290<br>2490  | $V_{CC}$<br>3300<br>2500       | mV |
| $V_{OL}$ | Output LOW Voltage<br>$V_{CC} = 3.3 \text{ V}$<br>$V_{CC} = 2.5 \text{ V}$  | $V_{CC} - 600$<br>2700<br>1900 | $V_{CC} - 400$<br>2900<br>2100 | $V_{CC} - 350$<br>2950<br>2150 | mV |

## DIFFERENTIAL INPUTS DRIVEN SINGLE-ENDED (Notes 7 and 8) (Figures 6 and 8)

|           |                                                  |                |  |                |    |
|-----------|--------------------------------------------------|----------------|--|----------------|----|
| $V_{IH}$  | Single-Ended Input HIGH Voltage                  | $V_{th} + 100$ |  | $V_{CC}$       | mV |
| $V_{IL}$  | Single-Ended Input LOW Voltage                   | GND            |  | $V_{th} - 100$ | mV |
| $V_{th}$  | Input Threshold Reference Voltage Range          | 1100           |  | $V_{CC} - 100$ | mV |
| $V_{ISE}$ | Single-Ended Input Voltage ( $V_{IH} - V_{IL}$ ) | 200            |  | 1200           | mV |

## $V_{REFAC}$

|             |                                                                                                                                           |                                    |                                    |                                    |    |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------------------|------------------------------------|----|
| $V_{REFAC}$ | Output Reference Voltage @ 100 $\mu\text{A}$ for Capacitor – Coupled Inputs, Only<br>$V_{CC} = 3.3 \text{ V}$<br>$V_{CC} = 2.5 \text{ V}$ | $V_{CC} - 1375$<br>$V_{CC} - 1325$ | $V_{CC} - 1200$<br>$V_{CC} - 1200$ | $V_{CC} - 1100$<br>$V_{CC} - 1075$ | mV |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------------------|------------------------------------|----|

## DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY ( $I_N$ , $\bar{I}_N$ ) (Note 9) (Figures 4 and 7)

|           |                                                    |      |    |                 |               |
|-----------|----------------------------------------------------|------|----|-----------------|---------------|
| $V_{IHD}$ | Differential Input HIGH Voltage                    | 1100 |    | $V_{CC}$        | mV            |
| $V_{ILD}$ | Differential Input LOW Voltage                     | GND  |    | $V_{IHD} - 100$ | mV            |
| $V_{ID}$  | Differential Input Voltage ( $V_{IHD} - V_{ILD}$ ) | 100  |    | 1200            | mV            |
| $I_{IH}$  | Input HIGH Current                                 | -150 | 40 | +150            | $\mu\text{A}$ |
| $I_{IL}$  | Input LOW Current                                  | -150 | 5  | +150            | $\mu\text{A}$ |

## TERMINATION RESISTORS

|            |                                      |    |    |    |          |
|------------|--------------------------------------|----|----|----|----------|
| $R_{TIN}$  | Internal Input Termination Resistor  | 45 | 50 | 55 | $\Omega$ |
| $R_{TOUT}$ | Internal Output Termination Resistor | 45 | 50 | 55 | $\Omega$ |

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.

**Table 5. 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 10)

| Symbol                           | Characteristic                                                                                                                           | Min        | Typ             | Max           | Unit                   |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------|---------------|------------------------|
| $f_{\text{DATA}}$                | Maximum Operating Input Data Rate                                                                                                        | 10         | 12              |               | Gb/s                   |
| $f_{\text{INCLK}}$               | Maximum Input Clock Frequency, $V_{\text{OUTPP}} \geq 200\text{ mV}$                                                                     | 6          | 8               |               | GHz                    |
| $V_{\text{OUTPP}}$               | Output Voltage Amplitude (see Figures 2 and 5, Note 11)<br>$f_{\text{in}} \leq 4\text{ GHz}$<br>$f_{\text{in}} \leq 6\text{ GHz}$        | 200<br>200 | 400<br>350      |               | mV                     |
| $V_{\text{CMR}}$                 | Input Common Mode Range (Differential Configuration, Note 12, Figure 9)                                                                  | 600        |                 | $V_{CC} - 50$ | mV                     |
| $t_{\text{PLH}}, t_{\text{PHL}}$ | Propagation Delay to Output Differential, $\text{IN}/\overline{\text{IN}}$ to $\text{Qn}/\overline{\text{Qn}}$                           | 100        | 160             | 250           | ps                     |
| $t_{\text{PLH TC}}$              | Propagation Delay Temperature Coefficient $-40^{\circ}\text{C to }+85^{\circ}\text{C}$                                                   |            | 35              |               | fs/ $^{\circ}\text{C}$ |
| $t_{\text{DC}}$                  | Output Clock Duty Cycle $f_{\text{in}} \leq 6\text{ GHz}$                                                                                | 45         | 49/51           | 55            | %                      |
| $t_{\text{SKEW}}$                | Duty Cycle Skew (Note 13)<br>Within Device Skew (Note 14)<br>Device to Device Skew (Note 15)                                             |            | 0.15<br>7<br>25 | 1<br>25<br>70 | ps                     |
| $t_{\text{JITTER}}$              | Clock Jitter RMS, 1000 Cycles (Note 16) $f_{\text{in}} \leq 6\text{ GHz}$<br>Data Dependent Jitter (DDJ) (Note 17) $\leq 10\text{ Gb/s}$ |            | 0.2<br>3        | 0.8<br>20     | ps                     |
| $V_{\text{INPP}}$                | Input Voltage Swing (Differential Configuration) (Note 18) (Figure 5)                                                                    | 100        |                 | 1200          | mV                     |
| $t_r, t_f$                       | Output Rise/Fall Times (20% – 80%) $\text{Qn}, \overline{\text{Qn}}$                                                                     | 20         | 45              | 70            | 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 using a 400 mV source, 50% duty cycle 1 GHz clock source. All outputs must be loaded with external  $50\ \Omega$  to  $V_{CC}$ . Input edge rates 40 ps (20% – 80%).

11. Output voltage swing is a single-ended measurement operating in differential mode.

12.  $\text{VIHD}_{\text{MIN}} \geq 1100\text{ mV}$ .

13. Duty cycle skew is measured between differential outputs using the deviations of the sum of  $T_{\text{pw-}}$  and  $T_{\text{pw+}}$  @ 1 GHz.

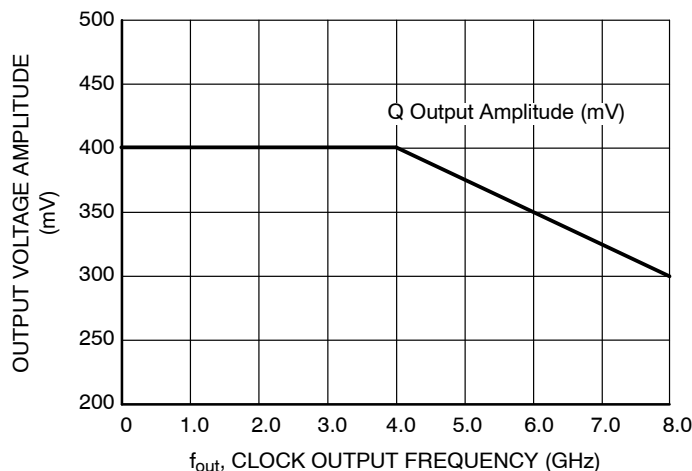
14. Within device skew compares coincident edges.

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

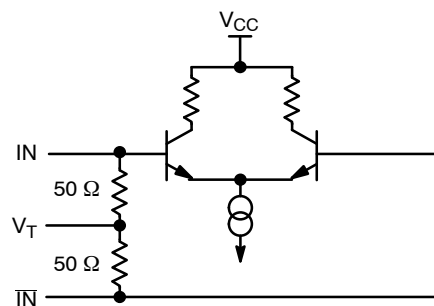
16. Additive CLOCK jitter with 50% duty cycle clock signal.

17. Additive Peak-to-Peak jitter with input NRZ data at PRBS23.

18. Input voltage swing is a single-ended measurement operating in differential mode.



**Figure 2. Output Voltage Amplitude ( $V_{\text{OUTPP}}$ ) vs. Input Frequency ( $f_{\text{in}}$ ) at Ambient Temperature (Typical)**



**Figure 3. Input Structure**

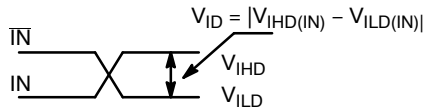


Figure 4. Differential Inputs Driven Differentially

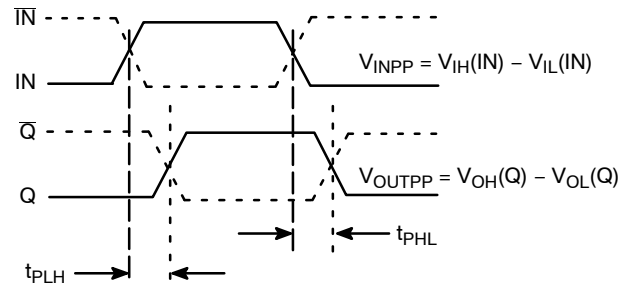


Figure 5. AC Reference Measurement

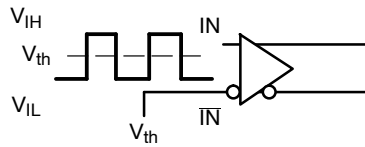


Figure 6. Differential Input Driven Single-Ended

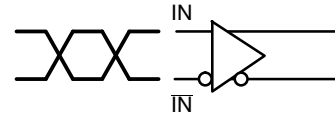


Figure 7. Differential Inputs Driven Differentially

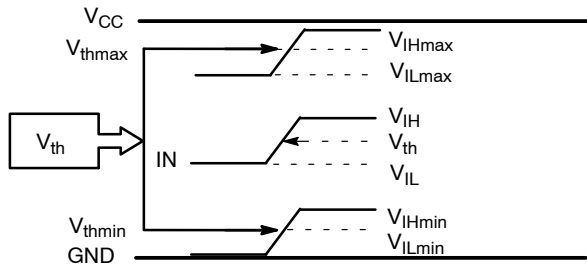


Figure 8.  $V_{th}$  Diagram

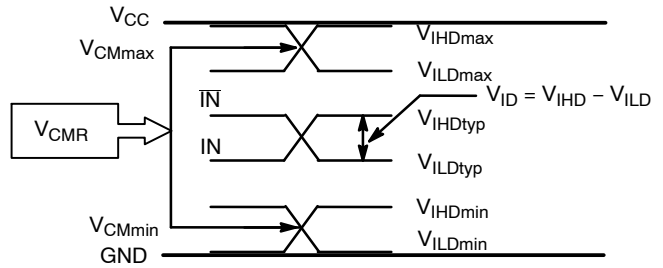
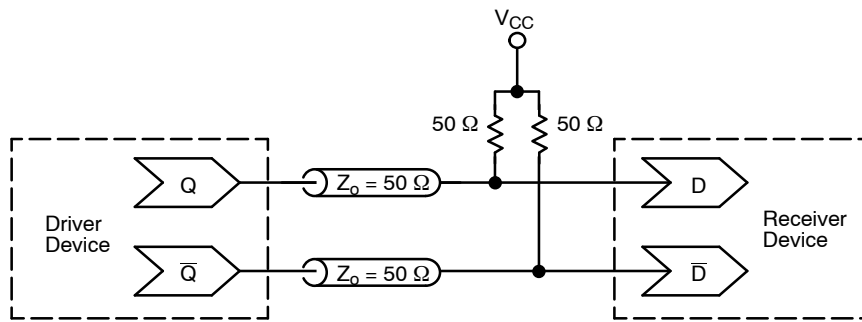
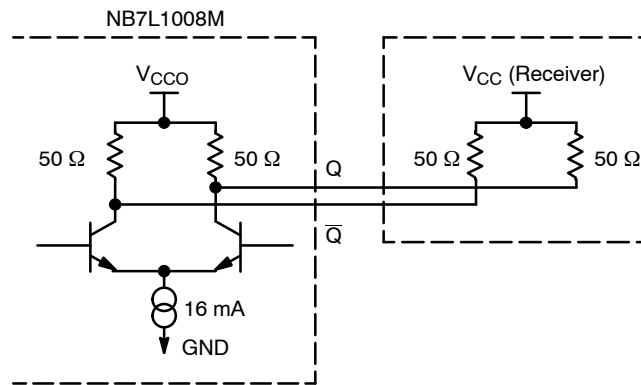


Figure 9.  $V_{CM}$  Diagram

# NB7L1008M



**Figure 10. Typical Termination for Output Driver and Device Evaluation**  
(See Application Note AND8173/D)



**Figure 11. Typical CML Output Structure and Termination**

## NB7L1008M

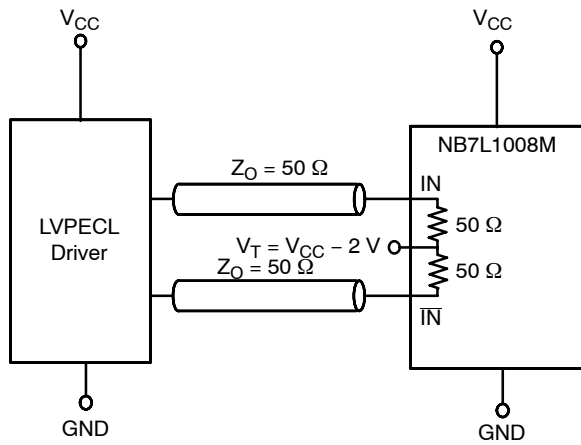


Figure 12. LVPECL Interface

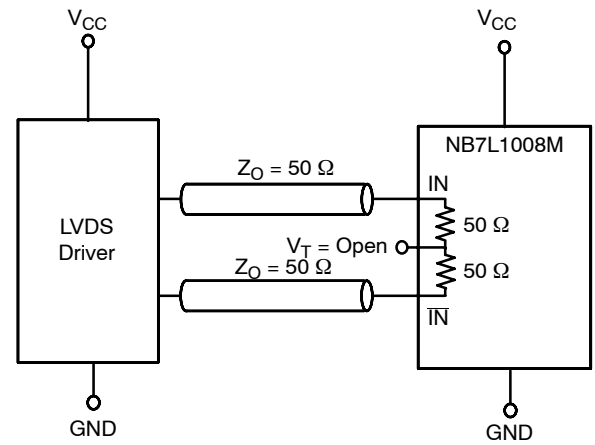


Figure 13. LVDS Interface

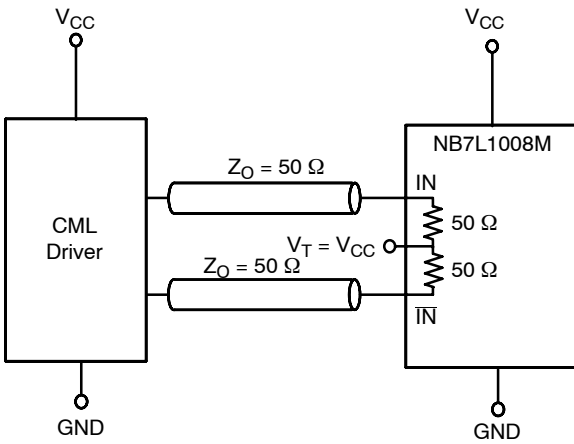


Figure 14. Standard 50 Ω Load CML Interface

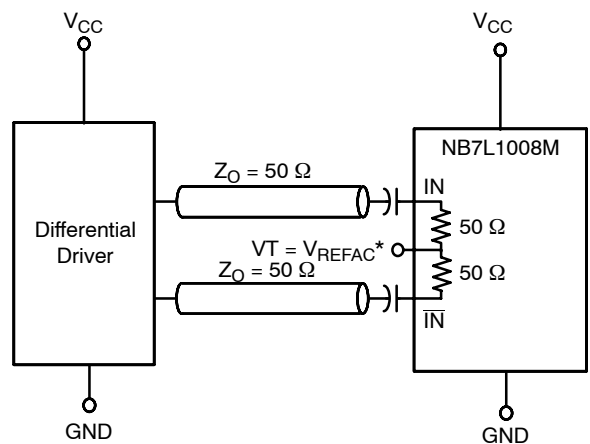


Figure 15. Capacitor-Coupled  
Differential Interface  
( $V_T$  Connected to  $V_{REFAC}$ )

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

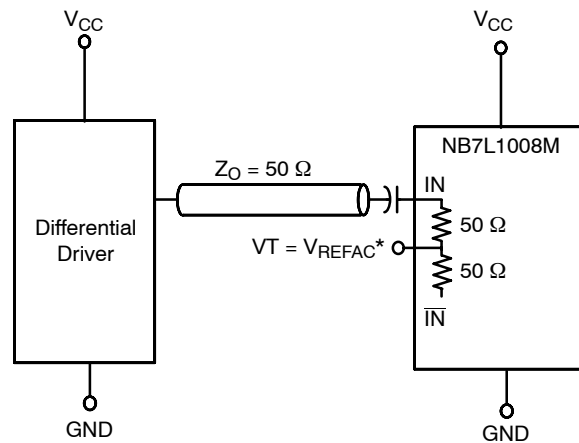


Figure 16. Capacitor-Coupled  
Single-Ended Interface  
( $V_T$  Connected to  $V_{REFAC}$ )

## NB7L1008M

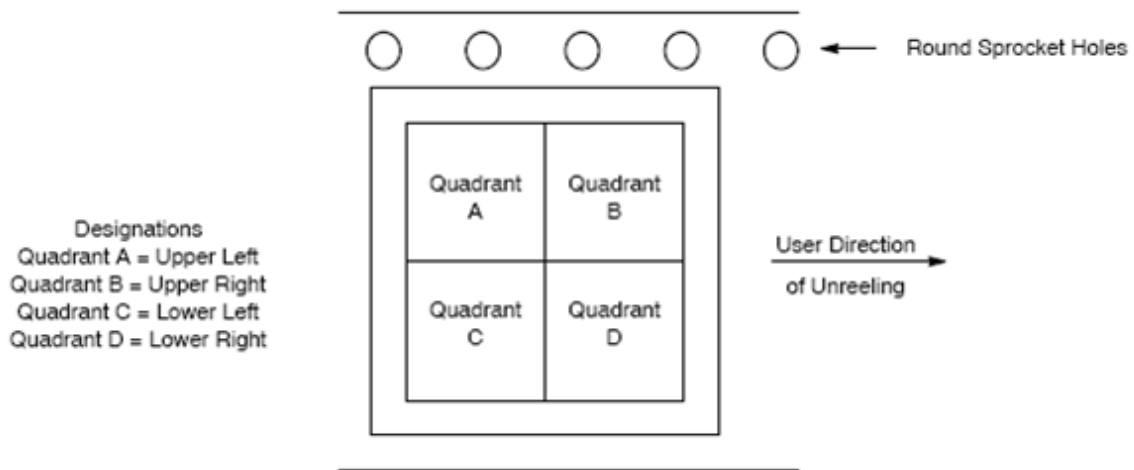


Figure 17. Tape and Reel Pin 1 Quadrant Orientation

### ORDERING INFORMATION

| Device         | Package            | Shipping                                                           |
|----------------|--------------------|--------------------------------------------------------------------|
| NB7L1008MMNG   | QFN32<br>(Pb-Free) | 74 Units / Rail                                                    |
| NB7L1008MMNR4G | QFN32<br>(Pb-Free) | 1000 / Tape & Reel<br>(Pin 1 Orientation in Quadrant B, Figure 17) |
| NB7L1008MMNTWG | QFN32<br>(Pb-Free) | 1000 / Tape & Reel<br>(Pin 1 Orientation in Quadrant A, Figure 17) |

†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.

## PACKAGE DIMENSIONS

**TOP VIEW**

PIN ONE LOCATION

0.15 C

0.15 C

**DETAIL A**  
ALTERNATE TERMINAL CONSTRUCTIONS

**DETAIL B**  
ALTERNATE CONSTRUCTION

**SIDE VIEW**

DETAIL B

0.10 C

0.08 C

NOTE 4

**DETAIL A**

32X L

8

9

D2

K

17

E2

32

25

32X b

e

e/2

0.10 (M) C A B

0.05 (M) C

NOTE 3

SEATING PLANE

EXPOSED Cu

MOLD CMPD

1. DIMENSIONS 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 0.30MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 0.80        | 1.00 |
| A1  | ----        | 0.05 |
| A3  | 0.20        | REF  |
| b   | 0.18        | 0.30 |
| D   | 5.00        | BSC  |
| D2  | 2.95        | 3.25 |
| E   | 5.00        | BSC  |
| E2  | 2.95        | 3.25 |
| e   | 0.50        | BSC  |
| K   | 0.20        | ---- |
| L   | 0.30        | 0.50 |
| L1  | ----        | 0.15 |

[illegible]

DIMENSION: MILLIMETERS

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