

# NB7V58M

## 1.8 V / 2.5 V / 3.3 V Differential 2:1 Clock / Data Multiplexer / Translator with CML Outputs

### Multi-Level Inputs w/ Internal Termination

#### Description

The NB7V58M is a high performance differential 2-to-1 Clock or Data multiplexer. The differential inputs incorporate internal 50  $\Omega$  termination resistors that are accessed through the VT pin. This feature allows the NB7V58M to accept various logic level standards, such as LVPECL, CML or LVDS.

The NB7V58M produces minimal Clock or Data jitter operating up to 7 GHz or 10.7 Gb/s, respectively. As such, the NB7V58M is ideal for SONET, GigE, Fiber Channel, Backplane and other Clock/Data distribution applications.

The 16 mA differential CML outputs provide matching internal 50  $\Omega$  terminations and 400 mV output swings when externally terminated with a 50  $\Omega$  resistor to  $V_{CC}$ .

The NB7V58M is offered in a low profile 3 mm x 3 mm 16-pin QFN package and is a member of the GigaComm™ family of high performance Clock / Data products. For applications that require equalization, the pin-compatible NB7VQ58M is also available. Application notes, models, and support documentation are available at [www.onsemi.com](http://www.onsemi.com).

#### Features

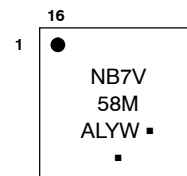
- Maximum Input Data Rate > 10.7 Gb/s
- Data Dependent Jitter < 10 ps
- Maximum Input Clock Frequency > 7 GHz
- Random Clock Jitter < 0.8 ps RMS
- 180 ps Typical Propagation Delay
- 35 ps Typical Rise and Fall Times
- Differential CML Outputs, 400 mV Peak-to-Peak, Typical
- Operating Range:  $V_{CC}$  = 1.71 V to 3.6 V with GND = 0 V
- Internal 50  $\Omega$  Input Termination Resistors
- QFN-16 Package, 3 mm x 3 mm
- -40°C to +85°C Ambient Operating Temperature
- This is a Pb-Free Device



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#### MARKING DIAGRAM\*

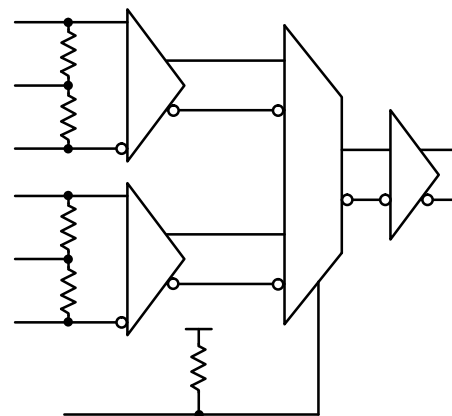


|   |                     |
|---|---------------------|
| A | = Assembly Location |
| L | = Wafer Lot         |
| Y | = Year              |
| W | = Work Week         |
| ▪ | = Pb-Free Package   |

(Note: Microdot may be in either location)

\*For additional marking information, refer to Application Note AND8002/D.

#### SIMPLIFIED BLOCK DIAGRAM



#### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

# NB7V58M

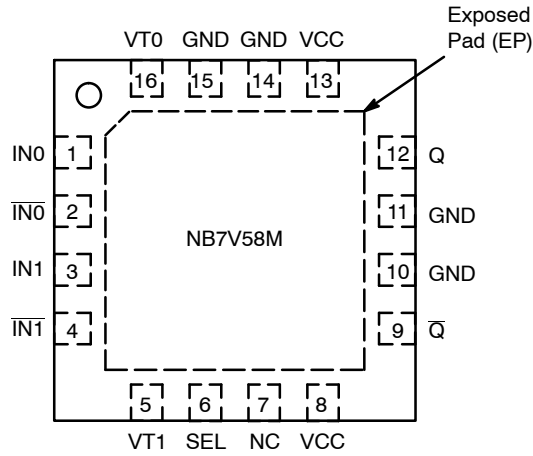


Figure 1. Pin Configuration (Top View)

## Multi-Level Inputs LVPECL, LVDS, CML

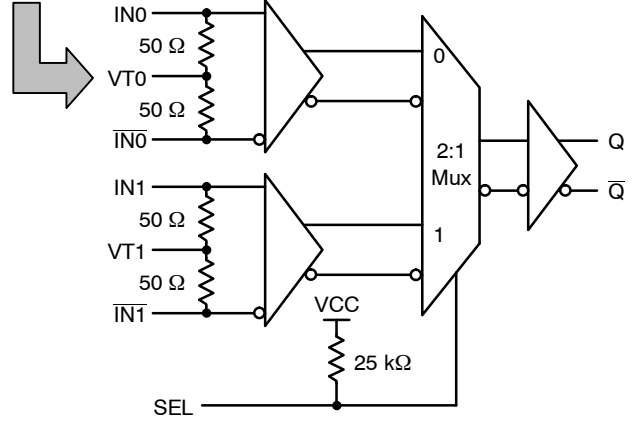


Figure 2. Detailed Block Diagram

Table 1. SElect FUNCTION TRUTH TABLE

| SEL | Q   | Q̄   |
|-----|-----|------|
| L   | IN0 | IN0̄ |
| H   | IN1 | IN1̄ |

Table 2. PIN DESCRIPTION

| Pin | Name | I/O                     | Description                                                                                                                                                                                                                                                                                                       |
|-----|------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | IN0  | LVPECL, CML, LVDS Input | Noninverted Differential Input (Note 1)                                                                                                                                                                                                                                                                           |
| 2   | IN0̄ | LVPECL, CML, LVDS Input | Inverted Differential Input (Note 1)                                                                                                                                                                                                                                                                              |
| 3   | IN1  | LVPECL, CML, LVDS Input | Noninverted Differential Input (Note 1)                                                                                                                                                                                                                                                                           |
| 4   | IN1̄ | LVPECL, CML, LVDS Input | Inverted Differential Input (Note 1)                                                                                                                                                                                                                                                                              |
| 5   | VT1  | –                       | Internal 50 Ω Termination Pin for IN1/IN1̄                                                                                                                                                                                                                                                                        |
| 6   | SEL  | LVTTL/LVCMOS Input      | SEL Input. Low for IN0 inputs, high for IN1 inputs. (Note 1) Pin will default HIGH when left open (has internal pull-up resistor)                                                                                                                                                                                 |
| 7   | NC   | –                       | No Connect                                                                                                                                                                                                                                                                                                        |
| 8   | VCC  | –                       | Positive Supply Voltage (Note 2)                                                                                                                                                                                                                                                                                  |
| 9   | Q̄   | CML Output              | Inverted Differential Output                                                                                                                                                                                                                                                                                      |
| 10  | GND  | –                       | Negative Supply Voltage                                                                                                                                                                                                                                                                                           |
| 11  | GND  | –                       | Negative Supply Voltage                                                                                                                                                                                                                                                                                           |
| 12  | Q    | CML Output              | Noninverted Differential Output                                                                                                                                                                                                                                                                                   |
| 13  | VCC  | –                       | Positive Supply Voltage (Note 2)                                                                                                                                                                                                                                                                                  |
| 14  | GND  | –                       | Negative Supply Voltage                                                                                                                                                                                                                                                                                           |
| 15  | GND  | –                       | Negative Supply Voltage                                                                                                                                                                                                                                                                                           |
| 16  | VT0  | –                       | Internal 50 Ω Termination Pin for IN0/IN0̄                                                                                                                                                                                                                                                                        |
| –   | 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 electrically connected to the die, and must 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 IN0/IN0̄, IN1/IN1̄ inputs, then the device will be susceptible to self-oscillation. Q/Q̄ outputs have internal 50 Ω source termination resistors.
2. All VCC and GND pins must be externally connected to a power supply for proper operation.

# NB7V58M

**Table 3. ATTRIBUTES**

| Characteristics                                        |                                   | Value                |
|--------------------------------------------------------|-----------------------------------|----------------------|
| ESD Protection                                         | Human Body Model<br>Machine Model | > 2 kV<br>> 200 V    |
| R <sub>PU</sub> – SEL Input Pull-up Resistor           |                                   | 25 kΩ                |
| Moisture Sensitivity (Note 3)                          | QFN-16                            | Level 1              |
| Flammability Rating                                    | Oxygen Index: 28 to 34            | UL 94 V-0 @ 0.125 in |
| Transistor Count                                       |                                   | 312                  |
| 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 <sub>CC</sub>   | Positive Power Supply                                         | GND = 0 V           |                  | 4.0                          | V    |
| V <sub>IN</sub>   | Positive Input Voltage                                        | GND = 0 V           |                  | -0.5 to V <sub>CC</sub> +0.5 | V    |
| V <sub>INPP</sub> | Differential Input Voltage  I <sub>Nn</sub> – I <sub>Nn</sub> |                     |                  | 1.89                         | V    |
| I <sub>OUT</sub>  | Output Current                                                | Continuous<br>Surge |                  | 34<br>40                     | mA   |
| I <sub>IN</sub>   | Input Current Through R <sub>T</sub> (50 Ω Resistor)          |                     |                  | ± 40                         | 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)             | 0 LFPM<br>500 LFPM  | QFN-16<br>QFN-16 | 42<br>35                     | °C/W |
| θ <sub>JC</sub>   | Thermal Resistance (Junction-to-Case) (Note 4)                |                     | QFN-16           | 4                            | °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.

**Table 5. DC CHARACTERISTICS POSITIVE CML OUTPUT** ( $V_{CC} = 1.71\text{ V}$  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**

|          |                                                |  |     |     |    |
|----------|------------------------------------------------|--|-----|-----|----|
| $I_{CC}$ | Power Supply Current (Inputs and Outputs Open) |  | 100 | 150 | mA |
|----------|------------------------------------------------|--|-----|-----|----|

**CML OUTPUTS** (Note 6)

|          |                                                                                                      |                                        |                                        |                                        |    |
|----------|------------------------------------------------------------------------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----|
| $V_{OH}$ | Output HIGH Voltage<br>$V_{CC} = 3.3\text{ V}$<br>$V_{CC} = 2.5\text{ V}$<br>$V_{CC} = 1.8\text{ V}$ | $V_{CC} - 30$<br>3270<br>2470<br>1770  | $V_{CC} - 5$<br>3295<br>2495<br>1795   | $V_{CC}$<br>3300<br>2500<br>1800       | mV |
| $V_{OL}$ | Output LOW Voltage<br>$V_{CC} = 3.3\text{ V}$<br>$V_{CC} = 2.5\text{ V}$<br>$V_{CC} = 1.8\text{ V}$  | $V_{CC} - 500$<br>2800<br>2000<br>1300 | $V_{CC} - 400$<br>2900<br>2100<br>1400 | $V_{CC} - 300$<br>3000<br>2200<br>1500 | mV |

**DIFFERENTIAL INPUTS DRIVEN SINGLE-ENDED** (Note 7) (Figures 6 & 8)

|           |                                                  |                |  |                |    |
|-----------|--------------------------------------------------|----------------|--|----------------|----|
| $V_{th}$  | 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            |  | 1200           | mV |

**DIFFERENTIAL IN0/IN0, IN1/IN1, INPUTS DRIVEN DIFFERENTIALLY** (Figures 6 & 9) (Note 9)

|           |                                                                           |      |  |                |               |
|-----------|---------------------------------------------------------------------------|------|--|----------------|---------------|
| $V_{IHD}$ | Differential Input HIGH Voltage                                           | 1100 |  | $V_{CC}$       | mV            |
| $V_{ILD}$ | Differential Input LOW Voltage                                            | GND  |  | $V_{CC} - 100$ | mV            |
| $V_{ID}$  | Differential Input Voltage ( $V_{IHD} - V_{ILD}$ )                        | 100  |  | 1200           | mV            |
| $V_{CMR}$ | Input Common Mode Range (Differential Configuration, Note 10) (Figure 10) | 1050 |  | $V_{CC} - 50$  | mV            |
| $I_{IH}$  | Input HIGH Current (VTn Open)                                             | -150 |  | 150            | $\mu\text{A}$ |
| $I_{IL}$  | Input LOW Current (VTn Open)                                              | -150 |  | 150            | $\mu\text{A}$ |

**CONTROL INPUT (SEL)**

|          |                    |                      |  |                      |               |
|----------|--------------------|----------------------|--|----------------------|---------------|
| $V_{IH}$ | Input HIGH Voltage | $V_{CC} \times 0.65$ |  | $V_{CC}$             | mV            |
| $V_{IL}$ | Input LOW Voltage  | GND                  |  | $V_{CC} \times 0.35$ | mV            |
| $I_{IH}$ | Input HIGH Current | -150                 |  | +150                 | $\mu\text{A}$ |
| $I_{IL}$ | Input LOW Current  | -200                 |  | +200                 | $\mu\text{A}$ |

**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.

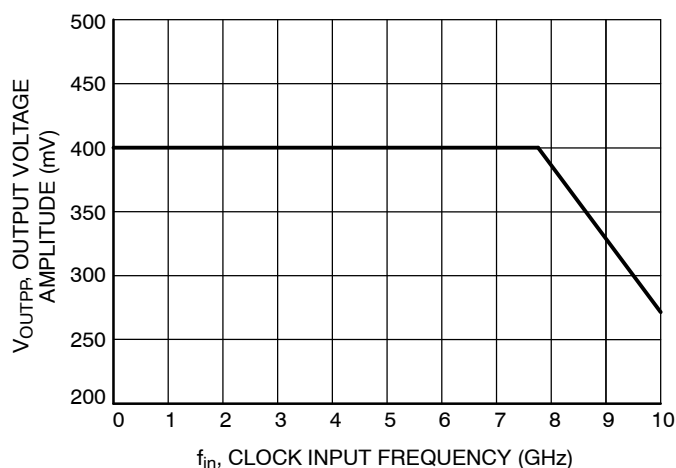
- Input and output parameters vary 1:1 with  $V_{CC}$ .
- CML outputs loaded with  $50\ \Omega$  to  $V_{CC}$  for proper operation.
- $V_{th}$ ,  $V_{IH}$ ,  $V_{IL}$  and  $V_{ISE}$  parameters must be complied with simultaneously.
- $V_{th}$  is applied to the complementary input when operating in 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.

**Table 6. AC CHARACTERISTICS** ( $V_{CC} = 1.71 \text{ V to } 3.6 \text{ V}$ ;  $GND = 0 \text{ V}$ ;  $T_A = -40^\circ\text{C to } 85^\circ\text{C}$ ) (Note 11)

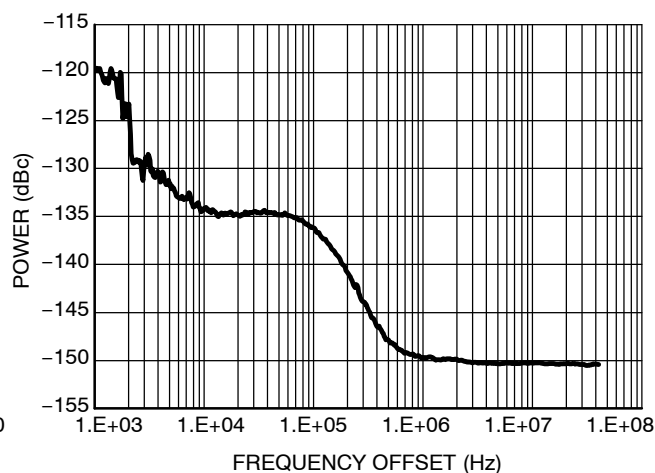
| Symbol                                 | Characteristic                                                                              |                                                                         | Min      | Typ                                          | Max       | Unit               |
|----------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|----------|----------------------------------------------|-----------|--------------------|
| f <sub>MAX</sub>                       | Maximum Input Clock Frequency                                                               | V <sub>outpp</sub> ≥ 200 mV                                             | 7        | 8                                            |           | GHz                |
| f <sub>DATAMAX</sub>                   | Maximum Operating Data Rate (PRBS23)                                                        |                                                                         | 10.7     | 12                                           |           | Gbps               |
| f <sub>SEL</sub>                       | Maximum Toggle Frequency, SEL                                                               |                                                                         | 25       | 50                                           |           | MHz                |
| V <sub>OUTPP</sub>                     | Output Voltage Amplitude (@ V <sub>INPPmin</sub> )<br>(Note 12) (Figures 8 & 10)            | f <sub>in</sub> ≤ 7 GHz                                                 | 200      | 400                                          |           | mV                 |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Propagation Delay to Differential Outputs,<br>@ 1 GHz, measured at differential cross-point | I <sub>Nn</sub> /I <sub>Nn</sub> to Q, $\bar{Q}$<br>SEL to Q, $\bar{Q}$ | 120<br>5 | 180<br>13                                    | 240<br>22 | ps<br>ns           |
| t <sub>PLH TC</sub>                    | Propagation Delay Temperature Coefficient                                                   |                                                                         |          | 50                                           |           | Δfs/°C             |
| t <sub>skew</sub>                      | Device – Device skew (tpdmax – tpdmin)                                                      |                                                                         |          |                                              | 50        | ps                 |
| t <sub>DC</sub>                        | Output Clock Duty Cycle<br>(Reference Duty Cycle = 50%)                                     | f <sub>in</sub> ≤ 5.0 GHz<br>f <sub>in</sub> ≤ 7.0 GHz                  | 45<br>40 | 50<br>50                                     | 55<br>60  | %                  |
| t <sub>JITTER</sub>                    | RJ – Output Random Jitter (Note 13)<br>DJ – Residual Output Deterministic Jitter (Note 14)  | f <sub>in</sub> ≤ 7.0 GHz<br>f <sub>in</sub> ≤ 10.7 Gbps                |          | 0.2                                          | 0.8<br>10 | ps RMS<br>ps pk-pk |
| Φ <sub>N</sub>                         | Phase Noise, f <sub>c</sub> = 1 GHz                                                         | 10 kHz<br>100 kHz<br>1 MHz<br>10 MHz<br>20 MHz<br>40 MHz                |          | -135<br>-136<br>-150<br>-151<br>-151<br>-151 |           | dBc                |
| t <sub>f</sub> <sub>ΦN</sub>           | Integrated Phase Jitter (Figure 4) f <sub>c</sub> = 1 GHz, 12 kHz – 20 MHz Offset (RMS)     |                                                                         |          | 35                                           |           | fs                 |
|                                        | Crosstalk Induced Jitter (Adjacent Channel) (Note 15)                                       |                                                                         |          |                                              | 0.7       | ps RMS             |
| V <sub>INPP</sub>                      | Input Voltage Swing (Differential Configuration) (Figure 10) (Note 16)                      |                                                                         | 100      |                                              | 1200      | mV                 |
| t <sub>r</sub> , t <sub>f</sub>        | Output Rise/Fall Times @ 1 GHz (20% – 80%)                                                  | Q, $\bar{Q}$                                                            | 15       | 35                                           | 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. 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.

11. Measured using a  $V_{INPPmin}$  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. Additive RMS jitter with 50% duty cycle clock signal.
14. Additive Peak-to-Peak data dependent jitter with input NRZ data at PRBS23 at 3 Gbps.
15. Crosstalk is measured at the output while applying two similar clock frequencies that are asynchronous with respect to each other at the inputs.
16. Input voltage swing is a single-ended measurement operating in differential mode.



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



**Figure 4. Typical Phase Noise**  
( $V_{CC} = 1.8 \text{ V}$ ,  $T = 25^\circ\text{C}$ ,  $f_c = 1 \text{ GHz}$ )

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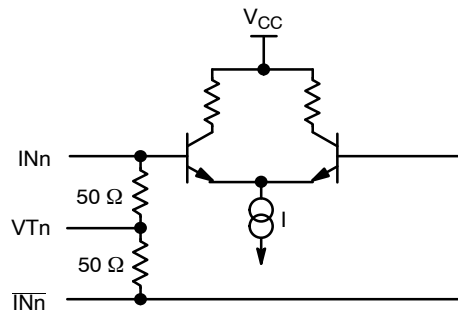


Figure 5. Input Structure

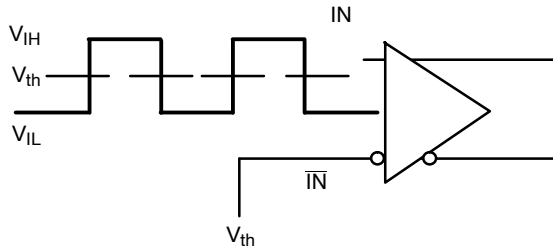


Figure 6. Differential Input Driven Single-Ended

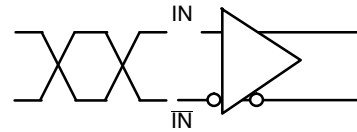


Figure 7. Differential Inputs Driven Differentially

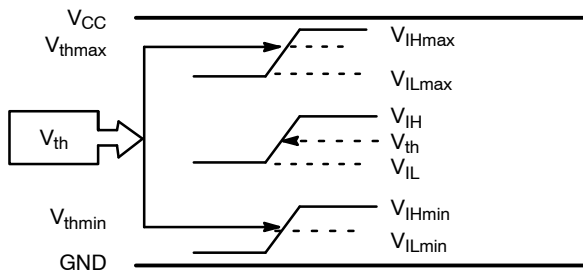


Figure 8.  $V_{th}$  Diagram

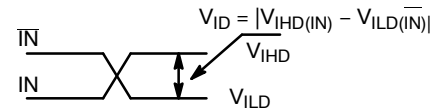


Figure 9.  $V_{ID}$  - Differential Inputs Driven Differentially

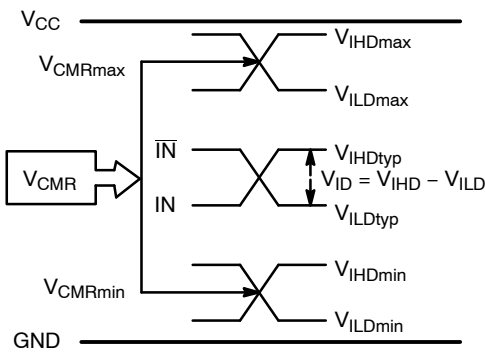


Figure 10.  $V_{CM}$  Diagram

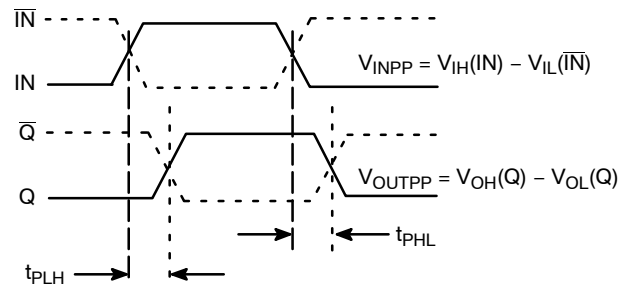


Figure 11. AC Reference Measurement

## NB7V58M

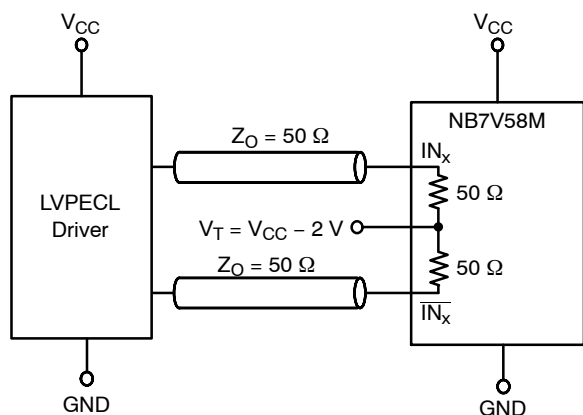


Figure 12. LVPECL Interface

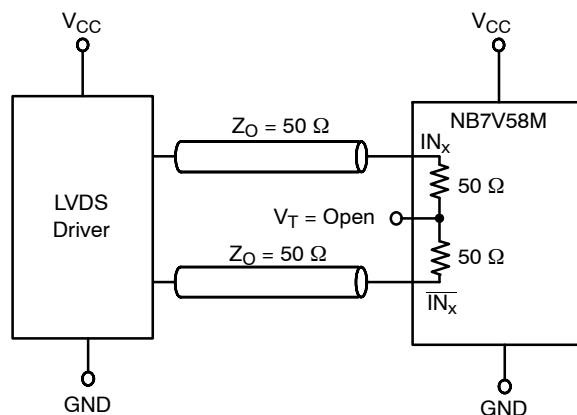


Figure 13. LVDS Interface

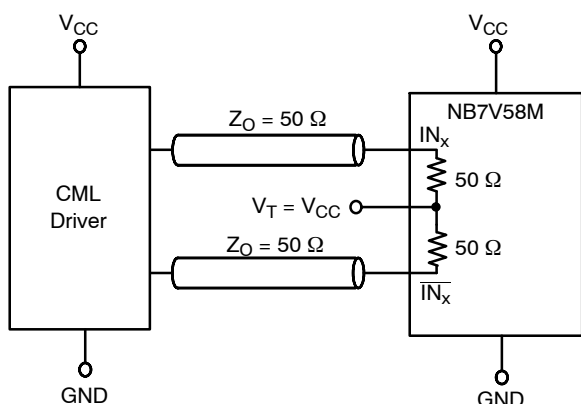


Figure 14. Standard 50 Ω Load CML Interface

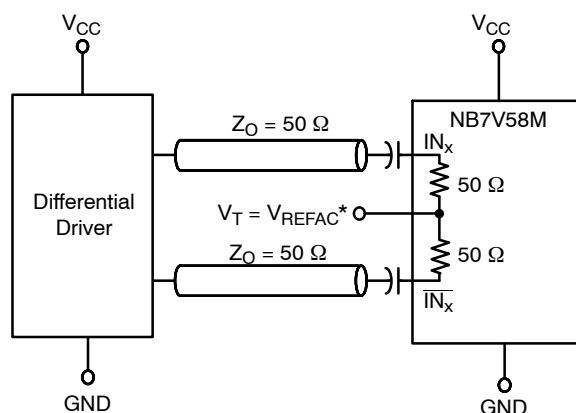


Figure 15. Capacitor-Coupled Differential Interface  
( $V_T$  Connected to External  $V_{REFAC}$ )

\* $V_{REFAC}$  Bypassed to Ground with 0.01  $\mu$ F Capacitor

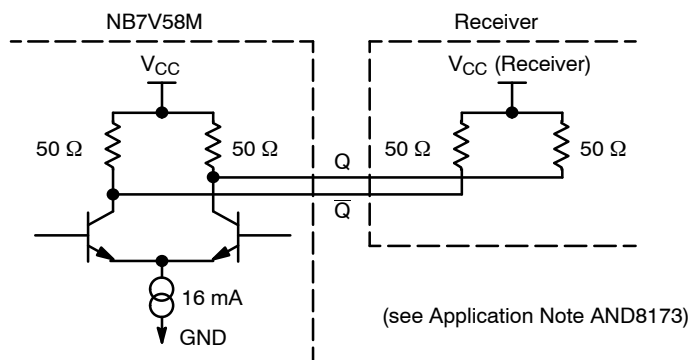


Figure 16. Typical CML Output Structure and Termination

### ORDERING INFORMATION

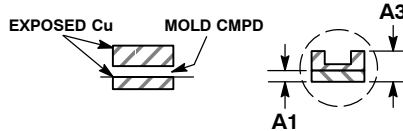
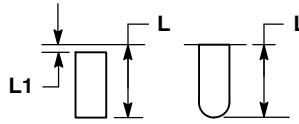
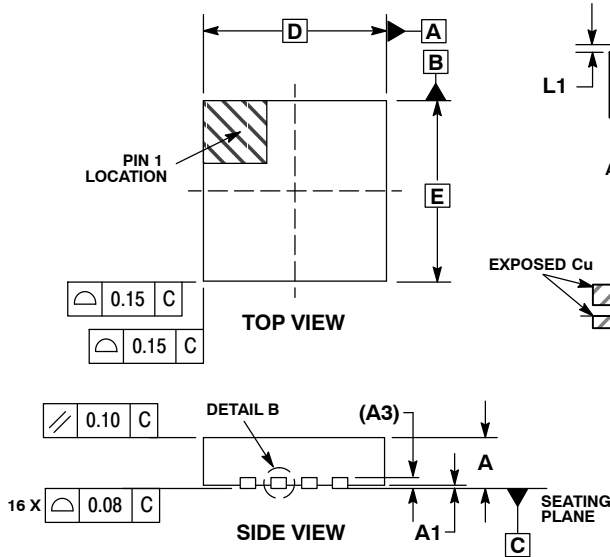
| Device        | Package             | Shipping <sup>†</sup> |
|---------------|---------------------|-----------------------|
| NB7V58MMNG    | QFN-16<br>(Pb-Free) | 123 Units / Rail      |
| NB7V58MMNHTBG | QFN-16<br>(Pb-Free) | 100 / Tape & Reel     |
| NB7V58MMNTXG  | QFN-16<br>(Pb-Free) | 3000 / Tape & Reel    |

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

# NB7V58M

## PACKAGE DIMENSIONS

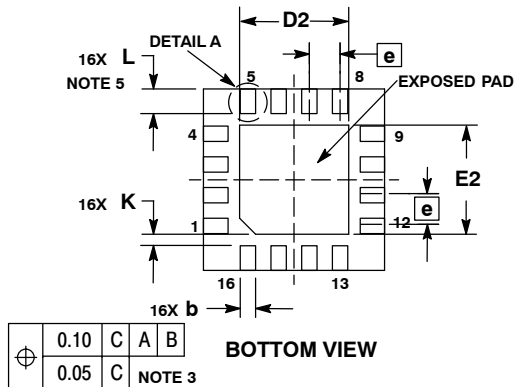
16 PIN QFN  
CASE 485G-01  
ISSUE D



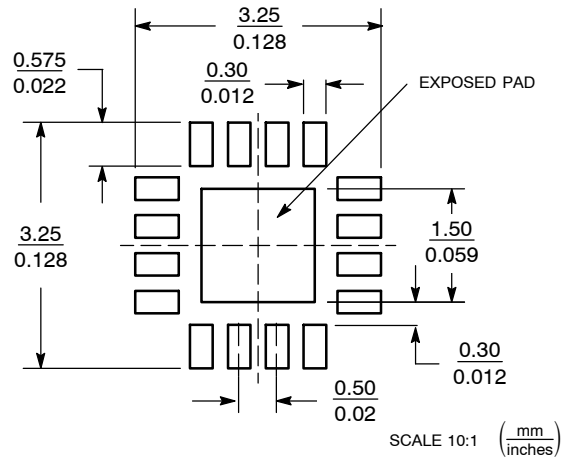
### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. L<sub>max</sub> CONDITION CAN NOT VIOLATE 0.2 MM MINIMUM SPACING BETWEEN LEAD TIP AND FLAG

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 0.80        | 1.00 |
| A1  | 0.00        | 0.05 |
| A3  | 0.20        | REF  |
| b   | 0.18        | 0.30 |
| D   | 3.00        | BSC  |
| D2  | 1.65        | 1.85 |
| E   | 3.00        | BSC  |
| E2  | 1.65        | 1.85 |
| e   | 0.50        | BSC  |
| K   | 0.18        | TYP  |
| L   | 0.30        | 0.50 |
| L1  | 0.00        | 0.15 |



### SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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