

# 1.8 V/2.5 V, 10 GHz ÷4 Clock Divider with CML Outputs

Multi-Level Inputs w/ Internal Termination

## NB7V33M

### Description

The NB7V33M is a differential ÷4 Clock divider with asynchronous reset. The differential Clock inputs incorporate internal 50 Ω termination resistors and will accept LVPECL, CML and LVDS logic levels. The NB7V33M produces a +4 output copy of an input Clock operating up to 10 GHz with minimal jitter. The Reset pin is asserted on the rising edge. Upon powerup, the internal flip-flops will attain a random state; the Reset allows for the synchronization of multiple NB7V33M's in a system. The 16 mA differential CML output provides matching internal 50 Ω termination which guarantees 400 mV output swing when externally receiver terminated with 50 Ω to V<sub>CC</sub>.

The NB7V33M is the ÷4 version of the NB7V32M (÷2) and is offered in a low profile 3 mm x 3 mm 16-pin QFN package.

The NB7V33M is a member of the GigaComm™ family of high performance clock products. Application notes, models, and support documentation are available at [www.onsemi.com](http://www.onsemi.com).

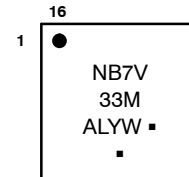
### Features

- Maximum Input Clock Frequency > 10 GHz, typical
- 260 ps Typical Propagation Delay
- 35 ps Typical Rise and Fall Times
- Differential CML Outputs, 400 mV Peak-to-Peak, Typical
- Operating Range: V<sub>CC</sub> = 1.71 V to 2.625 V with GND = 0 V
- Internal 50 Ω Input Termination Resistors
- Random Clock Jitter < 0.8 ps RMS
- QFN-16 Package, 3 mm x 3 mm
- -40°C to +85°C Ambient Operating Temperature
- These are Pb-Free Devices



QFN16  
MN SUFFIX  
CASE 485G

### MARKING DIAGRAM\*



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

(Note: Microdot may be in either location)

\*For additional marking information, refer to Application Note [AND8002/D](#).

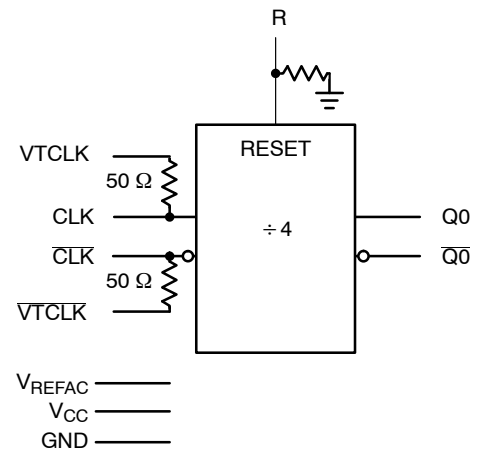
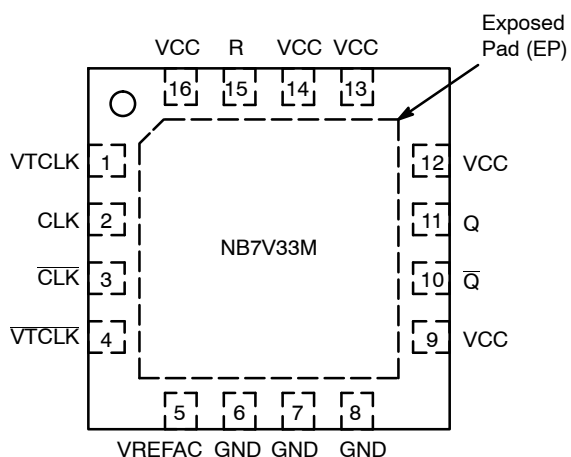


Figure 1. Simplified Logic Diagram

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

# NB7V33M



**Figure 2. Pin Configuration** (Top View)

**Table 1. TRUTH TABLE**

| CLK | CLK | R | Q       | Q       |
|-----|-----|---|---------|---------|
| x   | x   | H | L       | H       |
| Z   | W   | L | CLK + 4 | CLK + 4 |

Z = Low to High Transition  
W = High to Low Transition  
X = Don't Care

**Table 2. PIN DESCRIPTION**

| Pin | Name   | I/O                     | Description                                                                                                                                                                                                                                                                                                       |
|-----|--------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | VTCLK  | –                       | Internal 50 $\Omega$ Termination Pin for CLK                                                                                                                                                                                                                                                                      |
| 2   | CLK    | LVPECL, CML, LVDS Input | Non-inverted Differential CLK Input. Note 1.                                                                                                                                                                                                                                                                      |
| 3   | CLK    | LVPECL, CML, LVDS Input | Inverted Differential CLK Input. Note 1.                                                                                                                                                                                                                                                                          |
| 4   | VTCLK  | –                       | Internal 50 $\Omega$ Termination Pin for CLK                                                                                                                                                                                                                                                                      |
| 5   | VREFAC | –                       | Internally Generated Output Voltage Reference for Capacitor-Coupled Inputs, Only                                                                                                                                                                                                                                  |
| 6   | GND    | –                       | Negative Supply Voltage                                                                                                                                                                                                                                                                                           |
| 7   | GND    | –                       | Negative Supply Voltage                                                                                                                                                                                                                                                                                           |
| 8   | GND    | –                       | Negative Supply Voltage                                                                                                                                                                                                                                                                                           |
| 9   | VCC    | –                       | Positive Supply Voltage. Note 2.                                                                                                                                                                                                                                                                                  |
| 10  | Q      | CML Output              | Inverted Differential Output                                                                                                                                                                                                                                                                                      |
| 11  | Q      | CML Output              | Non-Inverted Differential Output                                                                                                                                                                                                                                                                                  |
| 12  | VCC    | –                       | Positive Supply Voltage. Note 2.                                                                                                                                                                                                                                                                                  |
| 13  | VCC    | –                       | Positive Supply Voltage. Note 2.                                                                                                                                                                                                                                                                                  |
| 14  | VCC    | –                       | Positive Supply Voltage. Note 2.                                                                                                                                                                                                                                                                                  |
| 15  | R      | LVC MOS Input           | Asynchronous Reset Input. Internal 75 k $\Omega$ pulldown to GND.                                                                                                                                                                                                                                                 |
| 16  | VCC    | –                       | Positive Supply Voltage. Note 2.                                                                                                                                                                                                                                                                                  |
| –   | 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 (VTCLK/VTCLK) are connected to a common termination voltage or left open, and if no signal is applied on CLK/CLK input, then the device will be susceptible to self-oscillation. Q/Q outputs have internal 50  $\Omega$  source termination resistors.
2. All VCC and GND pins must be externally connected to a power supply for proper operation.

**Table 3. ATTRIBUTES**

| Characteristics                                        |                                   | Value                |
|--------------------------------------------------------|-----------------------------------|----------------------|
| ESD Protection                                         | Human Body Model<br>Machine Model | > 4 kV<br>> 200 V    |
| R <sub>PD</sub> – Reset Input Pulldown 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                                       |                                   | 190                  |
| 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          |                  | 3.0                          | 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  D – $\bar{D}$             |                    |                  | 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 Through R <sub>T</sub> (50 Ω Resistor) |                    |                  | ± 40                         | mA   |
| I <sub>VREFAC</sub> | VREFAC 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)<br>(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)<br>(Note 4)     |                    | QFN-16           | 4                            | °C/W |
| T <sub>sol</sub>    | 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.

# NB7V33M

**Table 5. DC CHARACTERISTICS POSITIVE CML OUTPUT**  $V_{CC} = 1.71\text{ V to }2.625\text{ V}$ ;  $GND = 0\text{ V}$ ;  $T_A = -40^{\circ}\text{C to }85^{\circ}\text{C}$  (Note 5)

| Symbol                                                                    | Characteristic                                                                                                                        | Min                                              | Typ                                              | Max                                              | Unit          |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|---------------|
| <b>POWER SUPPLY CURRENT</b>                                               |                                                                                                                                       |                                                  |                                                  |                                                  |               |
| $I_{CC}$                                                                  | Power Supply Current (Inputs and Outputs Open)<br>$V_{CC} = 2.5\text{ V} \pm 5\%$<br>$V_{CC} = 1.8\text{ V} \pm 5\%$                  |                                                  | 95<br>85                                         | 115<br>100                                       | mA            |
| <b>CML OUTPUTS</b>                                                        |                                                                                                                                       |                                                  |                                                  |                                                  |               |
| $V_{OH}$                                                                  | Output HIGH Voltage (Note 6)<br>$V_{CC} = 2.5\text{ V}$<br>$V_{CC} = 1.8\text{ V}$                                                    | $V_{CC} - 30$<br>2470<br>1770                    | $V_{CC} - 10$<br>2490<br>1790                    | $V_{CC}$<br>2500<br>1800                         | mV            |
| $V_{OL}$                                                                  | Output LOW Voltage (Note 6)<br>$V_{CC} = 2.5\text{ V}$<br>$V_{CC} = 1.8\text{ V}$                                                     | $V_{CC} - 650$<br>1850<br>$V_{CC} - 600$<br>1200 | $V_{CC} - 550$<br>1950<br>$V_{CC} - 500$<br>1300 | $V_{CC} - 450$<br>2050<br>$V_{CC} - 400$<br>1400 | mV            |
| <b>DIFFERENTIAL INPUTS DRIVEN SINGLE-ENDED</b> (Note 7) (Figures 5 & 6)   |                                                                                                                                       |                                                  |                                                  |                                                  |               |
| $V_{th}$                                                                  | 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            |
| <b>VREFAC</b>                                                             |                                                                                                                                       |                                                  |                                                  |                                                  |               |
| $V_{REFAC}$                                                               | Output Reference Voltage @100 $\mu\text{A}$ for Capacitor- Coupled Inputs, Only<br>$V_{CC} = 2.5\text{ V}$<br>$V_{CC} = 1.8\text{ V}$ | $V_{CC} - 850$<br>$V_{CC} - 750$                 |                                                  | $V_{CC} - 500$<br>$V_{CC} - 450$                 | mV            |
| <b>DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY</b> (Figures 7 & 8) (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 9)                                                              | 1050                                             |                                                  | $V_{CC} - 50$                                    | mV            |
| $I_{IH}$                                                                  | Input HIGH Current ( $V_{Tx}/\overline{V_{Tx}}$ Open)                                                                                 | -150                                             |                                                  | 150                                              | $\mu\text{A}$ |
| $I_{IL}$                                                                  | Input LOW Current ( $V_{Tx}/\overline{V_{Tx}}$ Open)                                                                                  | -150                                             |                                                  | 150                                              | $\mu\text{A}$ |
| <b>CONTROL INPUT</b> (Reset pin)                                          |                                                                                                                                       |                                                  |                                                  |                                                  |               |
| $V_{IH}$                                                                  | Input HIGH Voltage for Control Pin                                                                                                    | $V_{CC} - 200$                                   |                                                  | $V_{CC}$                                         | mV            |
| $V_{IL}$                                                                  | Input LOW Voltage for Control Pin                                                                                                     | GND                                              |                                                  | 200                                              | 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                                                                                                   | 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.

- 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.

# NB7V33M

**Table 6. AC CHARACTERISTICS**  $V_{CC} = 1.71\text{ V to }2.625\text{ V}$ ;  $GND = 0\text{ V}$ ;  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (Note 11)

| Symbol                                 | Characteristic                                                                                      |                                | Min        | Typ                                          | Max        | Unit   |
|----------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------|------------|----------------------------------------------|------------|--------|
| f <sub>MAX</sub>                       | Maximum Input Clock Frequency                                                                       |                                | 10         | 11                                           |            | GHz    |
| V <sub>OUTPP</sub>                     | Output Voltage Amplitude (@ V <sub>INPPmin</sub> ) f <sub>in</sub> ≤ 10 GHz<br>(Note 12) (Figure 3) |                                | 260        | 400                                          |            | mV     |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Propagation Delay to Differential Outputs,<br>@ 1 GHz, measured at differential crosspoint          | CLK/CLK to Q, Q̄<br>R to Q, Q̄ | 150<br>500 | 200<br>600                                   | 350<br>700 | ps     |
| t <sub>PLH TC</sub>                    | Propagation Delay Temperature Coefficient                                                           |                                |            | 50                                           |            | Δfs/°C |
| t <sub>skew</sub>                      | Duty Cycle Skew (Note 13)<br>Device – Device skew (tpdmax – tpdmin)                                 |                                |            |                                              | 20<br>50   | ps     |
| t <sub>RR</sub>                        | Reset Recovery (See Figure 16)                                                                      |                                | 550        | 135                                          |            | ps     |
| t <sub>PW</sub>                        | Minimum Pulse Width R                                                                               |                                | 500        | 200                                          |            | ps     |
| t <sub>DC</sub>                        | Output Clock Duty Cycle (Reference Duty Cycle = 50%) f <sub>in</sub> ≤ 10 GHz                       |                                | 45         | 50                                           | 55         | %      |
| φ <sub>N</sub>                         | Phase Noise, f <sub>c</sub> = 1 GHz<br><br>10 kHz<br>100 kHz<br>1 MHz<br>10 MHz<br>20 MHz<br>40 MHz |                                |            | -144<br>-147<br>-152<br>-152<br>-152<br>-153 |            | dBc    |
| t <sub>jφN</sub>                       | Integrated Phase Jitter (Figure x) f <sub>c</sub> = 1 GHz, 12 kHz – 20 MHz Offset                   |                                |            | 35                                           |            | fs     |
| t <sub>JITTER</sub>                    | RJ – Output Random Jitter (Note 14) f <sub>in</sub> ≤ 10.0 GHz                                      |                                |            | 0.2                                          | 0.8        | ps RMS |
| V <sub>INPP</sub>                      | Input Voltage Swing (Differential Configuration) (Figure 11) (Note 15)                              |                                | 200        |                                              | 1200       | mV     |
| t <sub>r</sub> , t <sub>f</sub>        | Output Rise/Fall Times @ 1 GHz (20% – 80%), Q, Q̄                                                   |                                | 20         | 35                                           | 60         | 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.

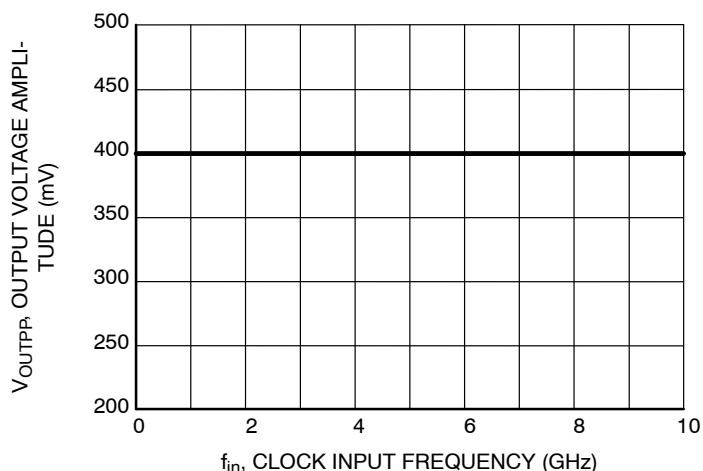
11. Measured using a 1 GHz,  $V_{INPPmin}$ , 50% duty-cycle clock source. All output loading with external  $50\ \Omega$  to  $V_{CC}$ . Input edge rates 40 ps (20% – 80%).

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

13. 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. Duty cycle skew is measured between differential outputs using the deviations of the sum of  $T_{pw-}$  and  $T_{pw+}$  @ 1 GHz. Skew is measured between outputs under identical transitions and conditions.

14. Additive RMS jitter with 50% duty cycle clock signal.

15. 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)**

# NB7V33M

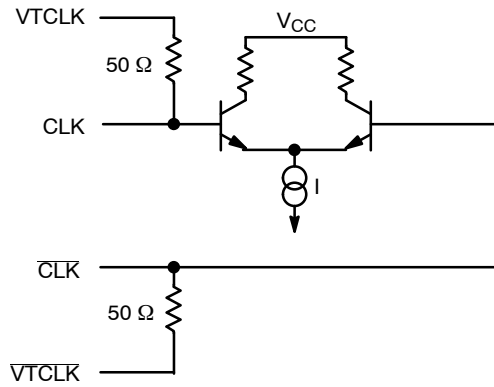


Figure 4. Input Structure

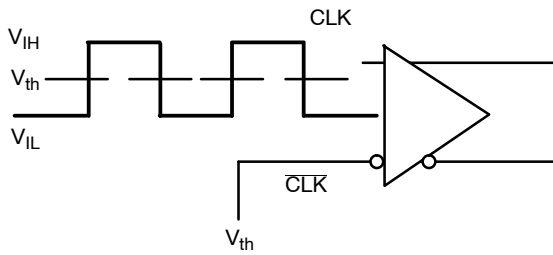


Figure 5. Differential Input Driven Single-Ended

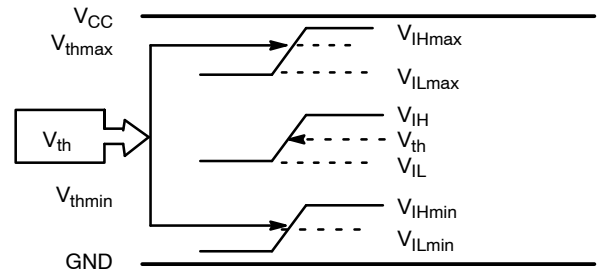


Figure 6.  $V_{th}$  Diagram

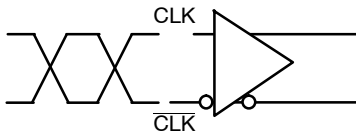


Figure 7. Differential Inputs Driven Differentially

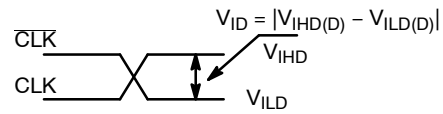


Figure 8. Differential Inputs Driven Differentially

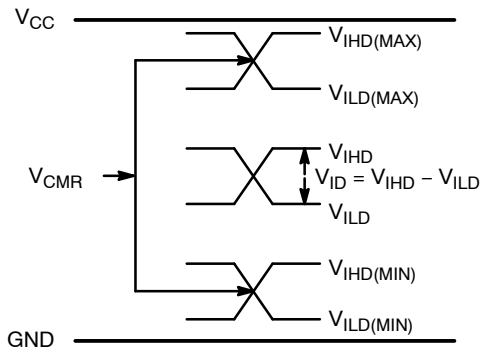


Figure 9.  $V_{CMR}$  Diagram

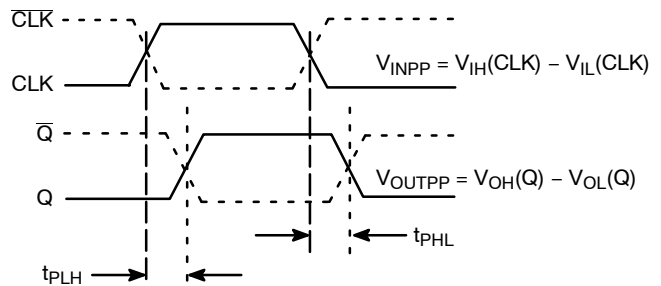
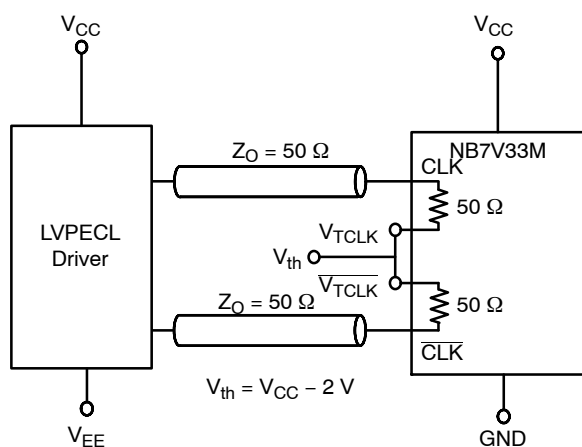
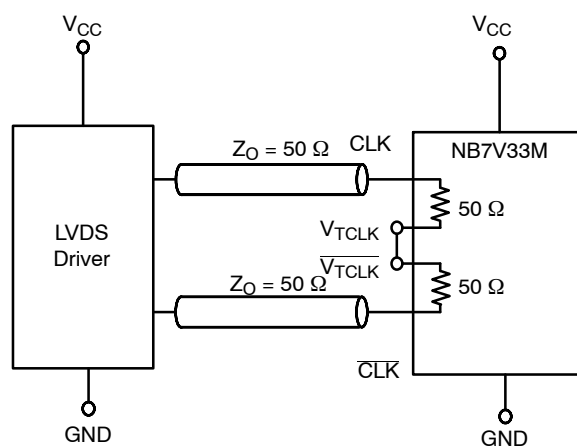


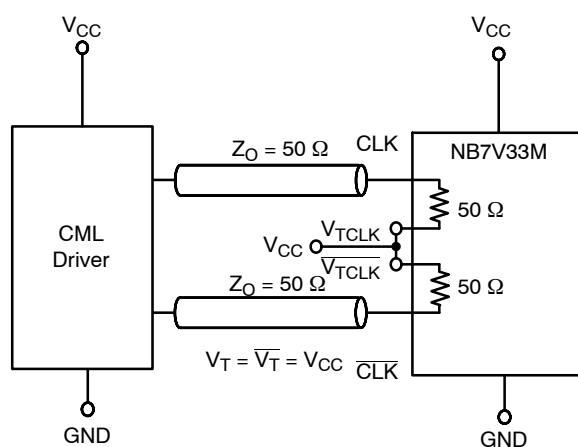
Figure 10. AC Reference Measurement

**NB7V33M**

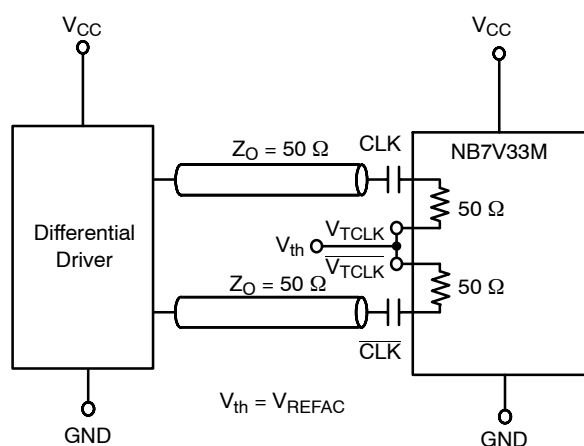
### Figure 11. LVPECL Interface



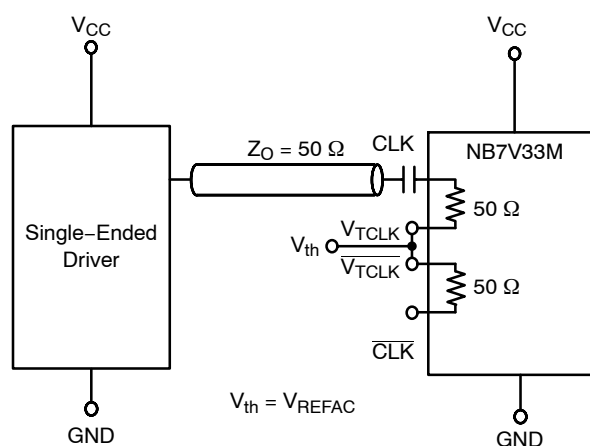
### Figure 12. LVDS Interface



**Figure 13. Standard 50  $\Omega$  Load CML Interface**



**Figure 14. Capacitor-Coupled Differential Interface ( $V_{TCLK}/\sqrt{V_{TCLK}}$  Connected to  $V_{REFAC}$ ;  $V_{REFAC}$  Bypassed to Ground with 0.1  $\mu$ F Capacitor)**



**Figure 15. Capacitor-Coupled Single-Ended Interface ( $V_{TCLK}/\sqrt{V_{TCLK}}$  Connected to  $V_{REFAC}$ ;  $V_{REFAC}$  Bypassed to Ground with 0.1  $\mu$ F Capacitor)**

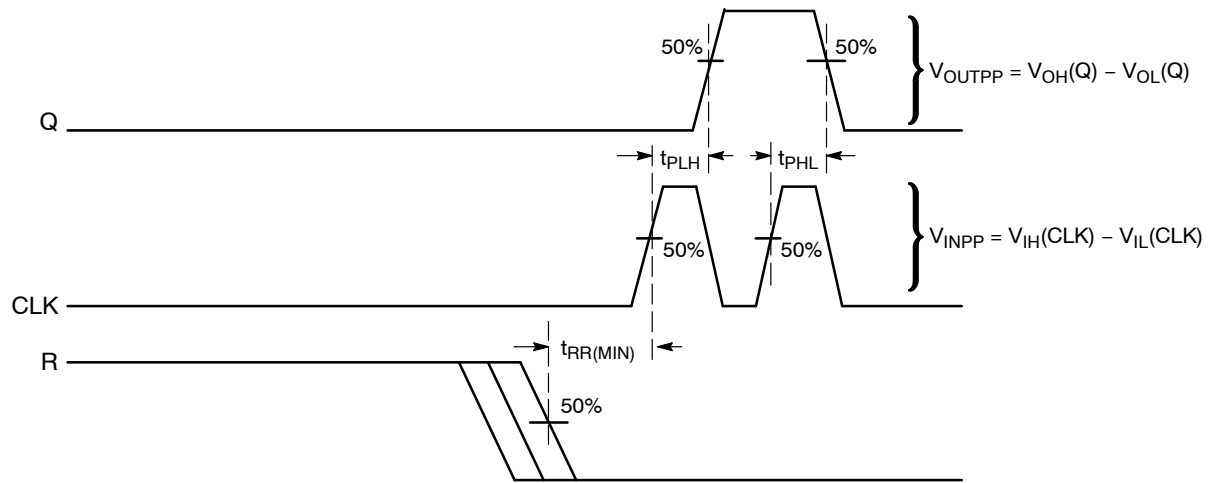


Figure 16. AC Reference Measurement (Timing Diagram)

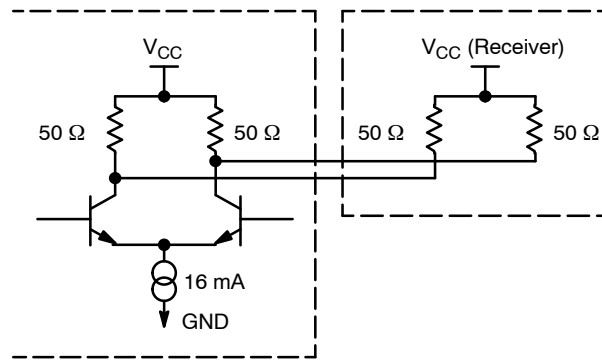


Figure 17. Typical CML Output Structure and Termination

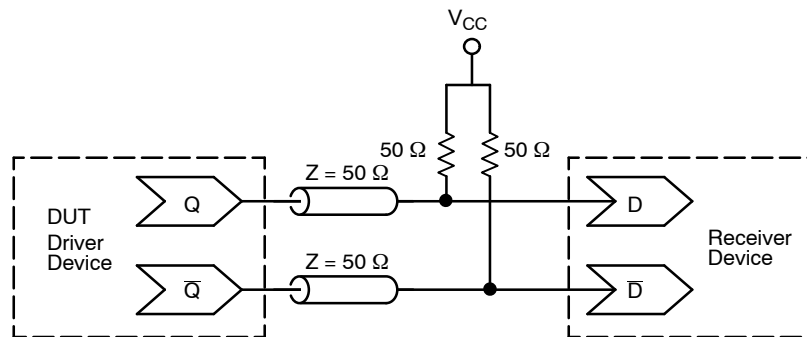


Figure 18. Typical Termination for CML Output Driver and Device Evaluation



## NB7V33M

### DEVICE ORDERING INFORMATION

| Device        | Package             | Shipping <sup>†</sup> |
|---------------|---------------------|-----------------------|
| NB7V33MMNG    | QFN-16<br>(Pb-Free) | 123 Units / Rail      |
| NB7V33MMNHTBG | QFN-16<br>(Pb-Free) | 100 / Tape & Reel     |
| NB7V33MMNTXG  | QFN-16<br>(Pb-Free) | 3,000 / 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.

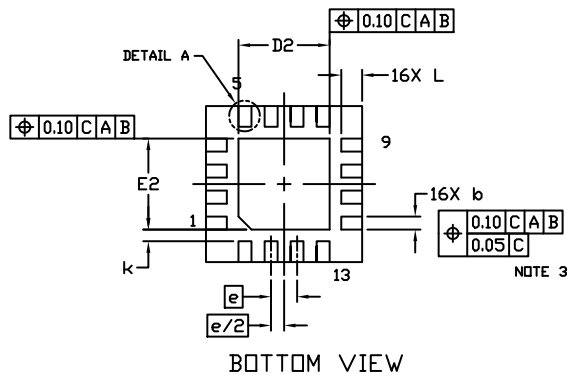
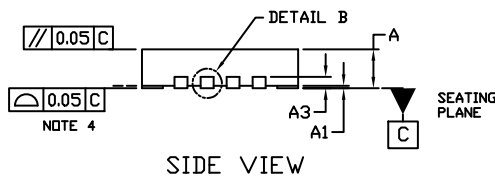
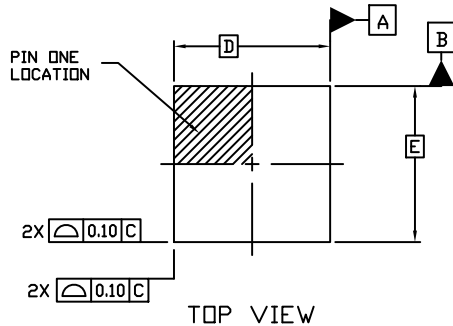
The products described herein (NB7V33M), may be covered by U.S. patents including 6,362,644. There may be other patents pending.  
GigaComm is a trademark of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries.



SCALE 2:1

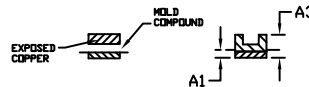
**QFN16 3x3, 0.5P**  
CASE 485G  
ISSUE G

DATE 08 OCT 2021

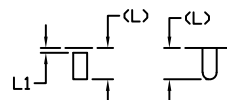


NOTES:

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.



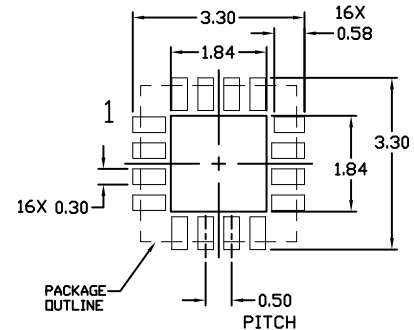
DETAIL B  
ALTERNATE  
CONSTRUCTIONS



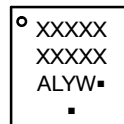
DETAIL A  
ALTERNATE TERMINAL  
CONSTRUCTIONS

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | 0.80        | 0.90 | 1.00 |
| A1  | 0.00        | 0.03 | 0.05 |
| A3  | 0.20 REF    |      |      |
| b   | 0.18        | 0.24 | 0.30 |
| D   | 3.00 BSC    |      |      |
| D2  | 1.65        | 1.75 | 1.85 |
| E   | 3.00 BSC    |      |      |
| E2  | 1.65        | 1.75 | 1.85 |
| e   | 0.50 BSC    |      |      |
| k   | 0.18 TYP    |      |      |
| L   | 0.30        | 0.40 | 0.50 |
| L1  | 0.00        | 0.08 | 0.15 |

MOUNTING FOOTPRINT



GENERIC  
MARKING DIAGRAM\*



XXXXX = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

|                  |                 |                                                                                                                                                                                  |
|------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| DESCRIPTION:     | QFN16 3X3, 0.5P | PAGE 1 OF 1                                                                                                                                                                      |

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