

1.8 V/2.5 V, 10 GHz ÷2 Clock Divider with CML Outputs

Multi-Level Inputs w/ Internal Termination

NB7V32M

Description

The NB7V32M is a differential ÷2 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 NB7V32M produces a ÷2 output copy of an input Clock operating up to 10 GHz with minimal jitter.

The RESET Pin is asserted on the rising edge. Upon power-up, the internal flip-flops will attain a random state; the Reset allows for the synchronization of multiple NB7V32M'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_{CC}.

The NB7V32M is the 1.8 V/2.5 V version of the NB7L32M (2.5 V/3.3 V) and is offered in a low profile 3 mm x 3 mm 16-pin QFN package. The NB7V32M is a member of the GigaComm™ family of high performance clock products. Application notes, models, and support documentation are available at www.onsemi.com.

Features

- Maximum Input Clock Frequency > 10 GHz, typical
- Random Clock Jitter < 0.8 ps RMS
- 200 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 2.625 V with GND = 0 V
- Internal 50 Ω Input Termination Resistors
- QFN-16 Package, 3 mm x 3 mm
- -40°C to +85°C Ambient Operating Temperature
- These Devices are Pb-Free and RoHS Compliant



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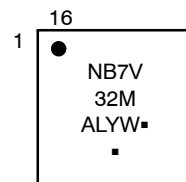
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QFN-16
MN SUFFIX
CASE 485G

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](#).

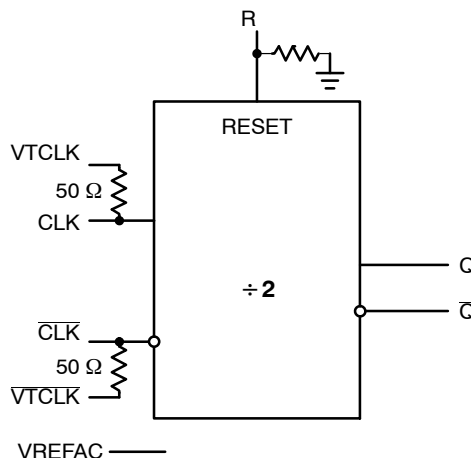


Figure 1. Simplified Logic Diagram

ORDERING INFORMATION

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

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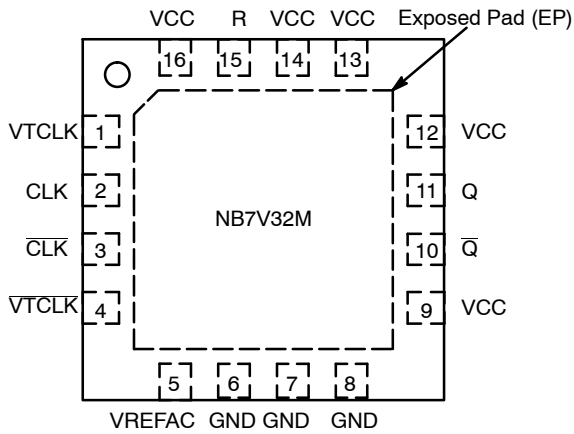


Figure 2. Pin Configuration (Top View)

Table 1. TRUTH TABLE

| CLK | $\overline{\text{CLK}}$ | R | Q | $\overline{\text{Q}}$ |
|-----|-------------------------|---|---------|--------------------------------|
| x | x | H | L | H |
| Z | W | L | CLK ÷ 2 | $\overline{\text{CLK}} \div 2$ |

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 Ω Termination Pin for CLK |
| 2 | CLK | LVPECL, CML, LVDS Input | Non-inverted Differential CLK Input. (Note 1) |
| 3 | $\overline{\text{CLK}}$ | LVPECL, CML, LVDS Input | Inverted Differential CLK Input. (Note 1) |
| 4 | VTCLK | - | Internal 50 Ω Termination Pin for $\overline{\text{CLK}}$ |
| 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 | $\overline{\text{Q}}$ | 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 Ω 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, $\overline{\text{VTCLK}}$) are connected to a common termination voltage or left open, and if no signal is applied on CLK/ $\overline{\text{CLK}}$ input, then the device will be susceptible to self-oscillation. Q/ $\overline{\text{Q}}$ outputs have internal 50 Ω source termination resistors.
2. VCC and GND pins must be externally connected to a power supply for proper operation.

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Table 3. ATTRIBUTES

| Characteristics | Value |
|--|----------------------|
| ESD Protection Human Body Model Machine Model | > 4 kV > 200 V |
| Moisture Sensitivity 16-QFN | Level 1 |
| Flammability Rating Oxygen Index: 28 to 34 | UL 94 V-0 @ 0.125 in |
| Transistor Count | 164 |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test | |

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

Table 4. MAXIMUM RATINGS

| Symbol | Parameter | Condition 1 | Condition 2 | Rating | Unit |
|---------------|--|--------------------|------------------|--------------------------|----------------------------------|
| V_{CC} | Positive Power Supply | GND = 0 V | | 3.0 | V |
| V_{IN} | Positive Input Voltage | GND = 0 V | | -0.5 to $V_{CC} + 0.5$ V | V |
| V_{INPP} | Differential Input Voltage D - \bar{D} | | | 1.89 | V |
| I_{IN} | Input Current Through R_T (50 Ω Resistor) | | | ± 40 | mA |
| I_{OUT} | Output Current Through R_T (50 Ω Resistor) | | | ± 40 | mA |
| I_{VREFAC} | VREFAC Sink/Source Current | | | ± 1.5 | mA |
| T_A | Operating Temperature Range | | | -40 to +85 | $^{\circ}$ C |
| T_{stg} | Storage Temperature Range | | | -65 to +150 | $^{\circ}$ C |
| θ_{JA} | Thermal Resistance (Junction-to-Ambient) (Note 3) | 0 lfpm 500 lfpm | QFN-16 QFN-16 | 42 35 | $^{\circ}$ C/W $^{\circ}$ C/W |
| θ_{JC} | Thermal Resistance (Junction-to-Case) (Note 3) | | QFN-16 | 4 | $^{\circ}$ C/W |
| T_{sol} | Wave Solder Pb-Free | | | 265 | $^{\circ}$ C |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

3. JEDEC standard multilayer board – 2S2P (2 signal, 2 power) with 8 filled thermal vias under exposed pad.

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Table 5. DC CHARACTERISTICS 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 4)

| Symbol | Characteristic | Min | Typ | Max | Unit |
|---|---|--|--|--|---------------|
| POWER SUPPLY CURRENT | | | | | |
| I_{CC} | Power Supply Current (Inputs and Outputs Open) $V_{CC} = 2.5\text{ V} \pm 5\%$ $V_{CC} = 1.8\text{ V} \pm 5\%$ | | 90 80 | 100 90 | mA |
| CML OUTPUTS | | | | | |
| V_{OH} | Output HIGH Voltage (Note 5) $V_{CC} = 2.5\text{ V}$ $V_{CC} = 1.8\text{ V}$ | $V_{CC} - 30$ 2470 1770 | $V_{CC} - 1$ 2490 1790 | V_{CC} 2500 1800 | mV |
| V_{OL} | Output LOW Voltage (Note 5) $V_{CC} = 2.5\text{ V}$ $V_{CC} = 1.8\text{ V}$ | $V_{CC} - 600$ 1900 $V_{CC} - 550$ 1250 | $V_{CC} - 500$ 2000 $V_{CC} - 450$ 1350 | $V_{CC} - 400$ 2100 $V_{CC} - 350$ 1450 | mV |
| DIFFERENTIAL INPUTS DRIVEN SINGLE-ENDED (Note 6) (Figures 5 and 7) | | | | | |
| V_{th} | Input Threshold Reference Voltage Range (Note 7) | 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 |
| VREFAC | | | | | |
| V_{REFAC} | Output Reference Voltage @ 100 μA for capacitor- coupled inputs, only $V_{CC} = 2.5\text{ V}$ (Note 8) $V_{CC} = 1.8\text{ V}$ | $V_{CC} - 850$ $V_{CC} - 750$ | | $V_{CC} - 500$ $V_{CC} - 450$ | mV |
| DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY (Figures 6 and 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 9) | 1050 | | $V_{CC} - 50$ | mV |
| I_{IH} | Input HIGH Current ($VTCLK/\overline{VTCLK}$ Open) | -150 | | 150 | μA |
| I_{IL} | Input LOW Current ($VTCLK/\overline{VTCLK}$ Open) | -150 | | 150 | μA |
| CONTROL INPUT (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 | μA |
| I_{IL} | Input LOW Current | -150 | | 150 | μA |
| TERMINATION RESISTORS | | | | | |
| R_{TIN} | Internal Input Termination Resistor (@ 10 mA) | 45 | 50 | 55 | Ω |
| R_{TOUT} | Internal Output Termination Resistor (@ 10 mA) | 45 | 50 | 55 | Ω |

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfm.

- Input and output parameters vary 1:1 with V_{CC} .
- CML outputs loaded with 50 Ω 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_{REFAC} will not be less than GND + 1050 mV.
- V_{IHD} , V_{ILD} , V_{ID} and V_{CMR} parameters must be complied with simultaneously.
- V_{CMR} min varies 1:1 with GND, V_{CMR} max varies 1:1 with V_{CC} . The V_{CMR} range is referenced to the most positive side of the differential input signal.

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

| Symbol | Characteristic | Min | Typ | Max | Unit |
|--------------------------|---|-----|------------|----------|----------------------|
| f_{MAX} | Maximum Input Clock Frequency | 10 | | | GHz |
| V_{OUTPP} | Output Voltage Amplitude (@ $V_{INPPmin}$) (Note 12) (Figure 3) | 280 | 400 | | mV |
| t_{PLH} , t_{PHL} | Propagation Delay to Differential Outputs, @ 1 GHz, measured at differential cross-point | 150 | 200 200 | 275 | ps |
| $t_{PLH\ TC}$ | Propagation Delay Temperature Coefficient | | 50 | | $\Delta fs/^\circ C$ |
| t_{skew} | Duty Cycle Skew (Note 13) Device – Device skew ($t_{pdmax} - t_{pdmin}$) | | | 20 50 | ps |
| t_{RR} | Reset Recovery (See Figure 11) | 300 | 135 | | |
| t_{PW} | Minimum Pulse Width R | 500 | 200 | | |
| t_{DC} | Output Clock Duty Cycle (Reference Duty Cycle = 50%) $f_{in} \leq 10\text{ GHz}$ | 45 | 50 | 55 | % |
| t_{JITTER} | RJ – Output Random Jitter (Note 14) $f_{in} \leq 10\text{ GHz}$ | | 0.2 | 0.8 | ps RMS |
| V_{INPP} | Input Voltage Swing (Differential Configuration) (Figure 10) (Note 15) | 100 | | 1200 | mV |
| t_r, t_f | Output Rise/Fall Times @ 1 GHz (20% – 80%), Q, \bar{Q} | | 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 lpm.

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.

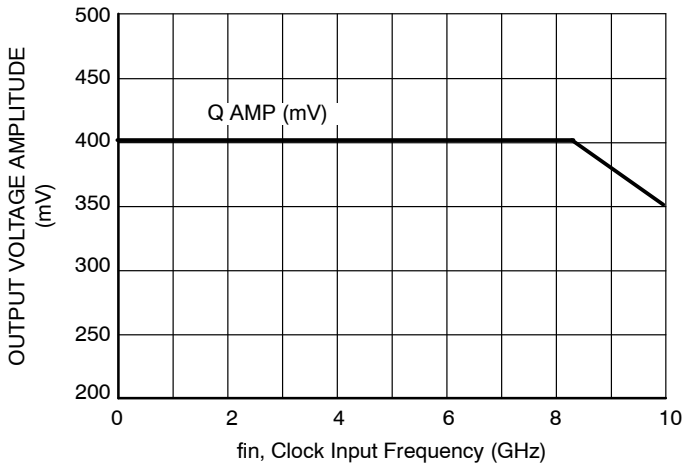


Figure 3. CLOCK Output Voltage Amplitude (V_{OUTPP}) vs. Input Frequency (f_{in}) at Ambient Temperature (Typ)

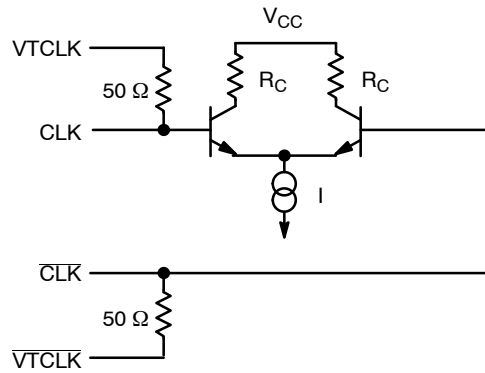


Figure 4. Input Structure

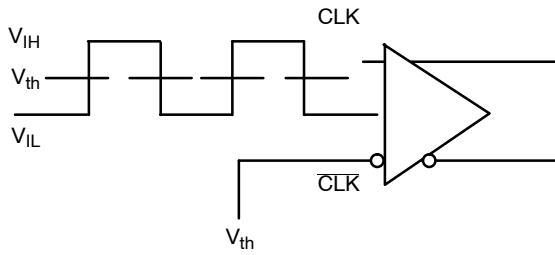


Figure 5. Differential Input Driven Single-Ended

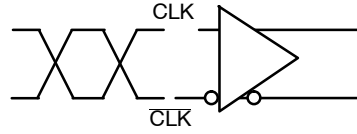


Figure 6. Differential Inputs Driven Differentially



Figure 7. V_{th} Diagram

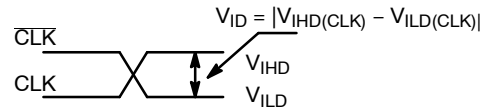


Figure 8. Differential Inputs Driven Differentially

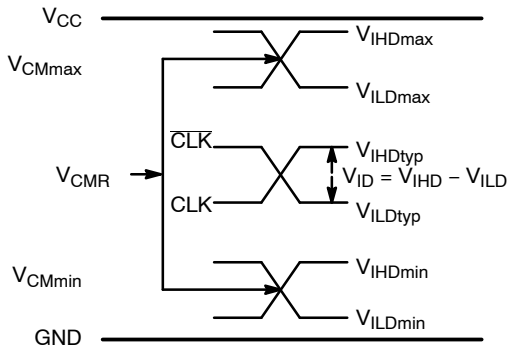


Figure 9. V_{CMR} Diagram

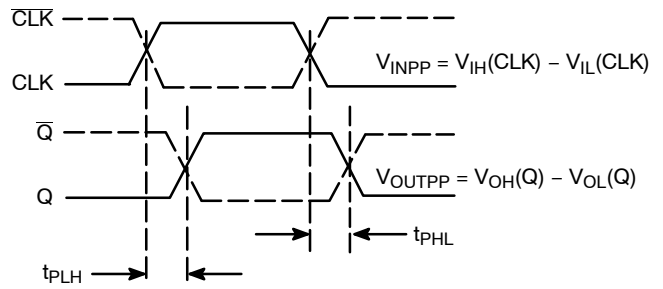


Figure 10. AC Reference Measurement

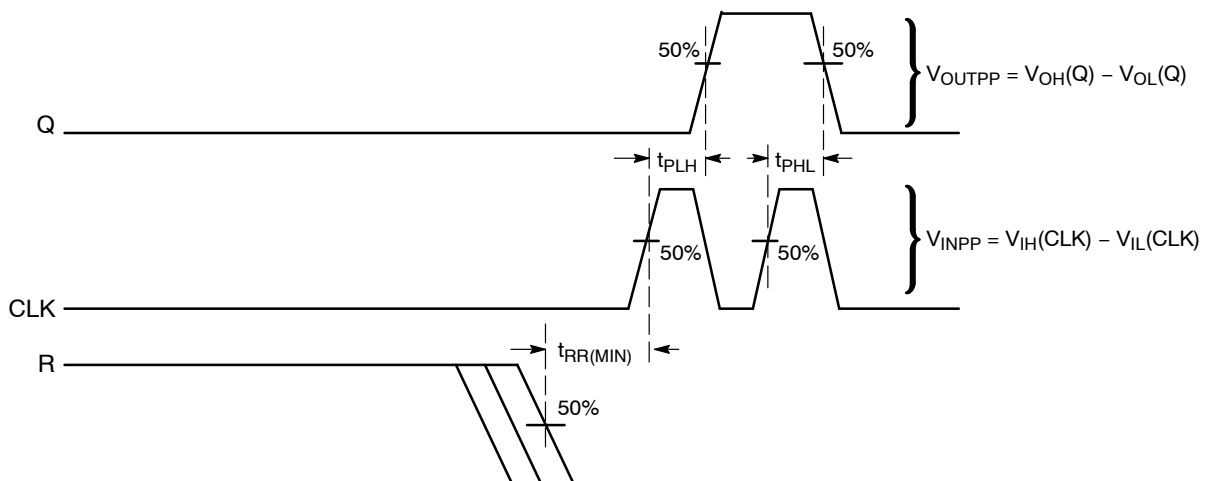


Figure 11. AC Reference Measurement (Timing Diagram)

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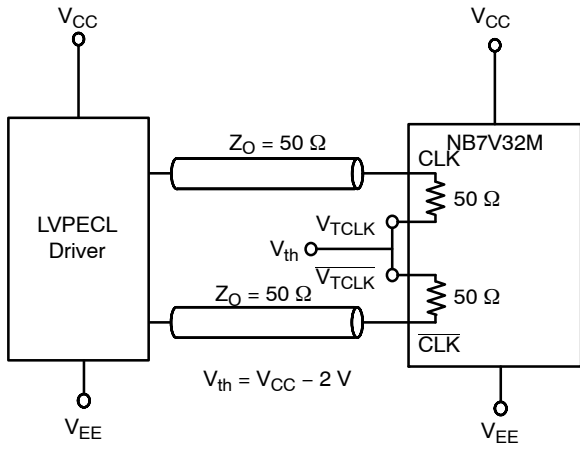


Figure 12. LVPECL Interface

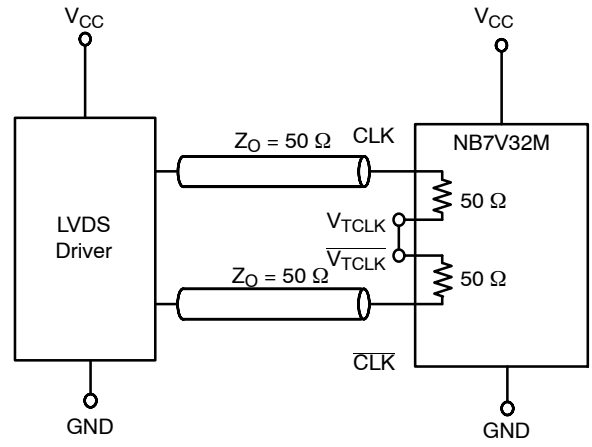


Figure 13. LVDS Interface

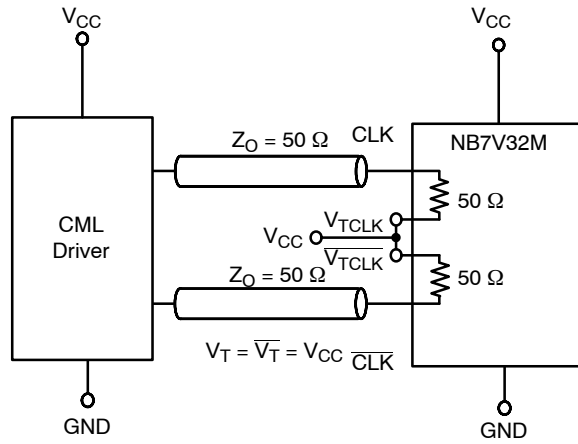


Figure 14. Standard 50 Ω Load CML Interface

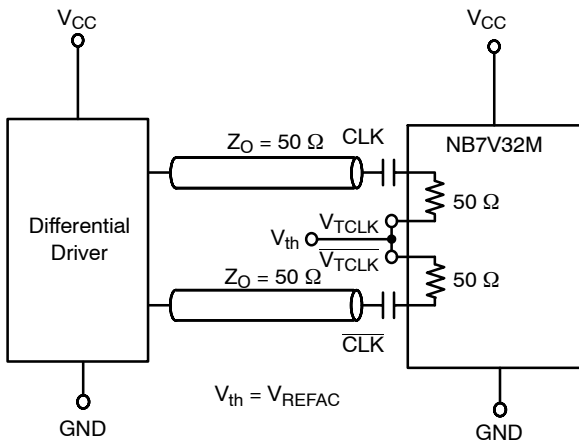


Figure 15. Capacitor-Coupled Differential Interface ($V_{TCLK}/\sqrt{V_{TCLK}}$ Connected to V_{REFAC} ; V_{REFAC} Bypassed to Ground with 0.1 μ F Capacitor)

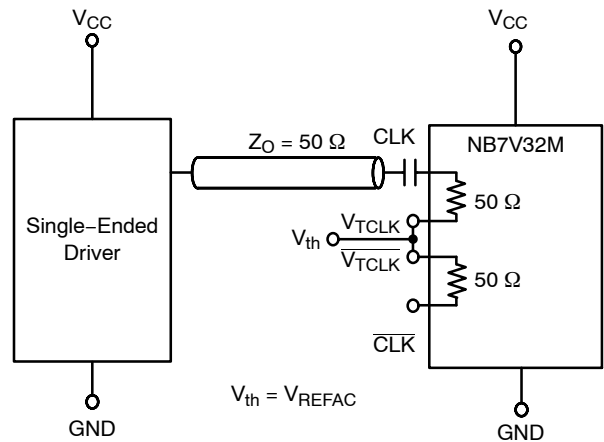


Figure 16. Capacitor-Coupled Single-Ended Interface ($V_{TCLK}/\sqrt{V_{TCLK}}$ Connected to V_{REFAC} ; V_{REFAC} Bypassed to Ground with 0.1 μ F Capacitor)

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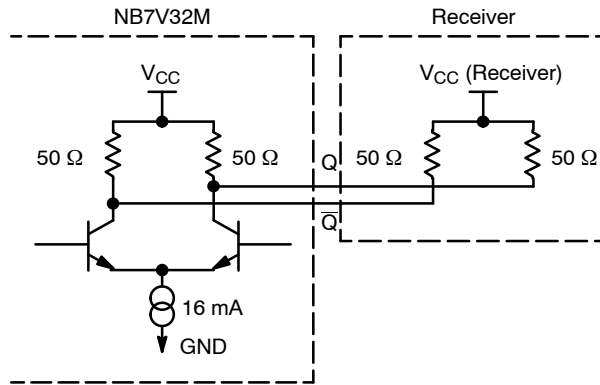


Figure 17. Typical CML Output Structure and Termination

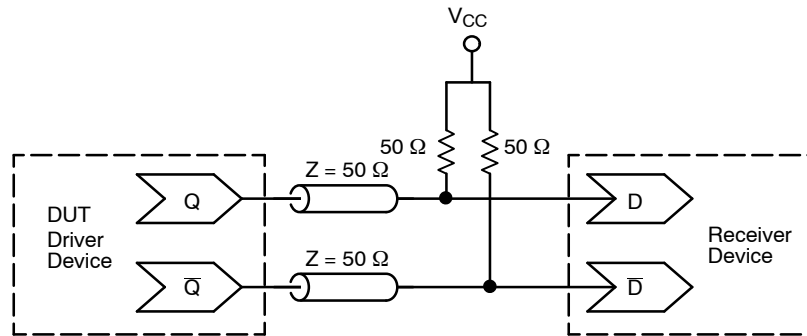


Figure 18. Typical Termination for CML Output Driver and Device Evaluation

ORDERING INFORMATION

| Device | Package | Shipping† |
|--------------|---------------------|--------------------|
| NB7V32MMNTXG | QFN-16 (Pb-free) | 3000 / Tape & Reel |

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

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