

1.8 V/2.5 V/3.3 V 8 GHz/14 Gbps Differential 1:4 Clock/Data CML Fanout Buffer w/ Selectable Input Equalizer

Multi-Level Inputs w/ Internal Termination



ON Semiconductor®

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NB7VQ14M

Description

The NB7VQ14M is a high performance differential 1:4 CML fanout buffer with a selectable Equalizer receiver. When placed in series with a Clock/Data path operating up to 8 GHz or 14 Gb/s, respectively, the NB7VQ14M inputs will compensate the degraded signal transmitted across a FR4 PCB backplane or cable interconnect and output four identical CML copies of the input signal with a 1.8 V, 2.5 V or 3.3 V power supply. Therefore, the serial data rate is increased by reducing Inter-Symbol Interference (ISI) caused by losses in copper interconnect or long cables. The Equalizer ENable pin (EQEN) allows the IN/IN inputs to either flow through or bypass the Equalizer section. Control of the Equalizer function is realized by setting EQEN; When EQEN is set Low, the IN/IN inputs bypass the Equalizer. When EQEN is set High, the IN/IN inputs flow through the Equalizer. The default state at start-up is LOW. As such, NB7VQ14M is ideal for SONET, GigE, Fiber Channel, Backplane and other Clock/Data distribution applications.

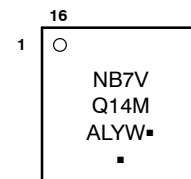
The differential inputs incorporate internal 50 Ω termination resistors that are accessed through the VT pin. This feature allows the NB7VQ14M to accept various logic level standards, such as LVPECL, CML or LVDS. The 1:4 fanout design was optimized for low output skew applications.

The NB7VQ14M is a member of the GigaComm™ family of high performance clock products.

Features

- Input Data Rate > 14 Gb/s, Typical
- Input Clock Frequency > 8 GHz, Typical
- 165 ps Typical Propagation Delay
- 30 ps Typical Rise and Fall Times
- < 15 ps Maximum Output Skew
- < 0.8 ps Maximum RMS Clock Jitter
- < 10 ps pp of Data Dependent Jitter
- Differential CML Outputs, 400 mV Peak-to-Peak, Typical
- Selectable Input Equalization
- Operating Range: $V_{CC} = 1.71 \text{ V}$ to 3.6 V with GND = 0 V
- Internal Input Termination Resistors, 50 Ω
- -40°C to +85°C Ambient Operating Temperature
- These are Pb-Free Devices

MARKING DIAGRAM*

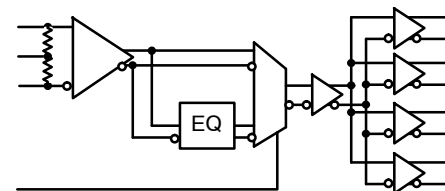


| | |
|---|---------------------|
| A | = Assembly Location |
| L | = Wafer Lot |
| Y | = Year |
| W | = Work Week |
| ▪ | = Pb-Free Package |

(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 9 of this data sheet.

NB7VQ14M

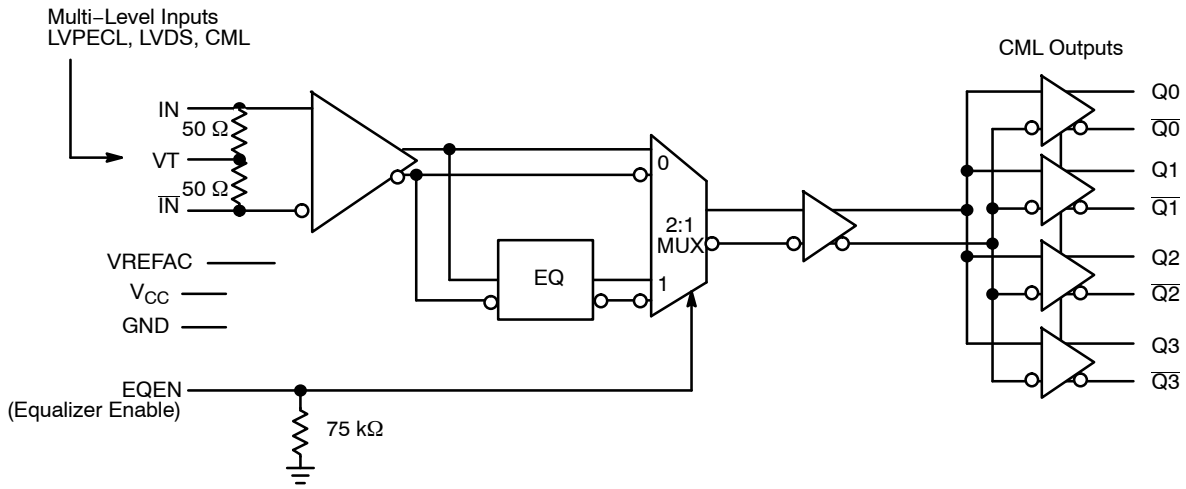


Figure 1. Detailed Block Diagram of NB7VQ14M

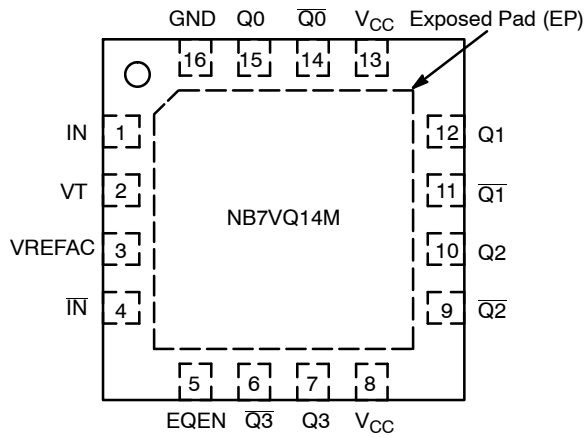


Figure 2. QFN-16 Pinout (Top View)

Table 1. EQUALIZER ENABLE FUNCTION

| EQEN | Function |
|------|--|
| 0 | IN / IN Inputs By-pass the Equalizer section |
| 1 | Inputs flow through the Equalizer |

NB7VQ14M

Table 2. PIN DESCRIPTION

| Pin | Name | I/O | Description |
|-----|------------------------|-------------------------|---|
| 1 | IN | LVPECL, CML, LVDS Input | Non-inverted Differential Input. (Note 1) |
| 2 | VT | | Internal 100 Ω Center-tapped Termination Pin for IN / $\overline{\text{IN}}$ |
| 3 | VREFAC | | Output Voltage Reference for Capacitor-Coupled Inputs, only |
| 4 | $\overline{\text{IN}}$ | LVPECL, CML, LVDS Input | Inverted Differential Input. (Note 1) |
| 5 | EQEN | LVC MOS Input | Equalizer Enable Input; pin will default LOW when left open (has internal pull-down resistor) |
| 6 | $\overline{\text{Q3}}$ | CML Output | Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 7 | Q3 | CML Output | Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 8 | VCC | - | Positive Supply Voltage |
| 9 | $\overline{\text{Q2}}$ | CML Output | Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 10 | Q2 | CML Output | Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 11 | $\overline{\text{Q1}}$ | CML Output | Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 12 | Q1 | CML Output | Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 13 | VCC | - | Positive Supply Voltage |
| 14 | $\overline{\text{Q0}}$ | CML Output | Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 15 | Q0 | CML Output | Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 16 | GND | - | Negative Supply Voltage |
| - | 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 pin (VT) is connected to a common termination voltage or left open, and if no signal is applied on IN / $\overline{\text{IN}}$ input, then, the device will be susceptible to self-oscillation.
2. All VCC and GND pins must be externally connected to a power supply for proper operation.

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Table 3. ATTRIBUTES

| Characteristics | Value |
|--|----------------------|
| ESD Protection Human Body Model Machine Model | > 2 kV > 200 V |
| R _{PD} – EQEN Input Pulldown Resistor | 75 kΩ |
| Moisture Sensitivity (Note 3) 16–QFN | Level 1 |
| Flammability Rating Oxygen Index: 28 to 34 | UL 94 V–0 @ 0.125 in |
| Transistor Count | 210 |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test | |

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

Table 4. MAXIMUM RATINGS

| Symbol | Parameter | Condition 1 | Condition 2 | Rating | Unit |
|---------------------|--|--------------------|------------------|-------------------------------|--------------|
| V _{CC} | Positive Power Supply – Core | GND = 0 V | | 4.0 | V |
| V _{IO} | Positive Input/Output Voltage | GND = 0 V | | –0.5 to V _{CC} + 0.5 | V |
| V _{INPP} | Differential Input Voltage I _N – \bar{I}_N | | | 1.89 | V |
| I _{IN} | Input Current Through R _T (50 Ω Resistor) | | | ±40 | mA |
| I _{OUT} | Output Current Through R _T (50 Ω Resistor) | | | ±40 | mA |
| I _{VREFAC} | VREFAC Sink/Source Current | | | ±1.5 | mA |
| T _A | Operating Temperature Range | 16 QFN | | –40 to +85 | °C |
| T _{stg} | Storage Temperature Range | | | –65 to +150 | °C |
| θ _{JA} | Thermal Resistance (Junction–to–Ambient) (Note 4) | 0 lfpm 500 lfpm | 16 QFN 16 QFN | 42 35 | °C/W °C/W |
| θ _{JC} | Thermal Resistance (Junction–to–Case) (Note 4) | | 16 QFN | 4 | °C/W |
| T _{sol} | Wave Solder Pb–Free | | | 265 | °C |

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

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

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Table 5. DC CHARACTERISTICS, MULTI-LEVEL INPUTS $V_{CC} = 1.71\text{ V to }3.6\text{ V}$, $GND = 0\text{ V}$, $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (Note 5)

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

POWER SUPPLY CURRENT

| | | | | | | |
|----------|--|-------------------------|-------|-----|-------|----|
| V_{CC} | Power Supply Voltage | $V_{CC} = 3.3\text{ V}$ | 3.135 | 3.3 | 3.6 | V |
| | | $V_{CC} = 2.5\text{ V}$ | 2.375 | 2.5 | 2.625 | |
| | | $V_{CC} = 1.8\text{ V}$ | 1.71 | 1.8 | 1.89 | |
| I_{CC} | Power Supply Current (Inputs and Outputs Open) | | | 170 | 210 | mA |

CML OUTPUTS (Note 6)

| | | | | | | |
|----------|---------------------|-------------------------|------------------------|------------------------|------------------------|----|
| V_{OH} | Output HIGH Voltage | $V_{CC} = 3.3\text{ V}$ | $V_{CC} - 30$ 3270 | $V_{CC} - 5$ 3295 | V_{CC} 3300 | mV |
| | | $V_{CC} = 2.5\text{ V}$ | 2470 | 2495 | 2500 | |
| | | $V_{CC} = 1.8\text{ V}$ | 1770 | 1795 | 1800 | |
| V_{OL} | Output LOW Voltage | $V_{CC} = 3.3\text{ V}$ | $V_{CC} - 525$ 2775 | $V_{CC} - 425$ 2875 | $V_{CC} - 325$ 2975 | mV |
| | | $V_{CC} = 2.5\text{ V}$ | 1975 | 2075 | 2175 | |
| | | $V_{CC} = 1.8\text{ V}$ | 1275 | 1375 | 1475 | |

DIFFERENTIAL INPUT DRIVEN SINGLE-ENDED (see Figures 5 and 7) (Note 7)

| | | | | | |
|-----------|--|----------------|--|----------------|----|
| 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 (Note 8) | 1050 | | $V_{CC} - 100$ | mV |
| V_{ISE} | Single-ended Input Voltage Amplitude ($V_{IH} - V_{IL}$) | 200 | | 2800 | mV |

VREFAC

| | | | | | | |
|-------------|--|-------------------------|------------------------|------------------------|------------------------|----|
| V_{REFAC} | Output Reference Voltage @ 100 μA for capacitor-coupled inputs, only (Note 9) | $V_{CC} = 3.3\text{ V}$ | $V_{CC} - 650$ 2650 | $V_{CC} - 500$ 2800 | $V_{CC} - 350$ 2950 | mV |
| | | $V_{CC} = 2.5\text{ V}$ | 1850 | 2000 | 2150 | |
| | | $V_{CC} = 1.8\text{ V}$ | 1150 | 1300 | 1450 | |

DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY (see Figures 6 and 8) (Note 9)

| | | | | | |
|-----------|---|------|--|-----------------|---------------|
| V_{IHD} | Differential Input HIGH Voltage | 1200 | | V_{CC} | mV |
| V_{ILD} | Differential Input LOW Voltage | 0 | | $V_{IHD} - 100$ | 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 I_N / \bar{I}_N , (VT Open) | -150 | | 150 | μA |
| I_{IL} | Input LOW Current I_N / \bar{I}_N , (VT Open) | -150 | | 150 | μA |

CONTROL INPUTS (EQEN)

| | | | | | |
|----------|-------------------------------------|----------------------|--|----------------------|---------------|
| V_{IH} | Input HIGH Voltage for Control Pins | $V_{CC} \times 0.65$ | | V_{CC} | V |
| V_{IL} | Input LOW Voltage for Control Pins | GND | | $V_{CC} \times 0.35$ | V |
| I_{IH} | Input HIGH Current | -150 | | 150 | μA |
| I_{IL} | Input LOW Current | -150 | | 150 | μA |

TERMINATION RESISTORS

| | | | | | |
|------------|--------------------------------------|----|----|----|----------|
| R_{TIN} | Internal Input Termination Resistor | 45 | 50 | 55 | Ω |
| R_{TOUT} | Internal Output Termination Resistor | 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_{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 crosspoint side of the differential input signal.

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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_{MAX} | Maximum Input Clock Frequency; $V_{OUT} \geq 200\text{ mV}$ | 7 | 8.5 | | GHz |
| $f_{DATAMAX}$ | Maximum Operating Data Rate NRZ, (PRBS23) | 10 | 14 | | Gbps |
| V_{OUTPP} | Output Voltage Amplitude, EQEN = 0 or 1 (Note 15) (See Figure 10) $f_{in} \leq 7\text{ GHz}$ | 200 | 400 | | mV |
| t_{PLH} , t_{PHL} | Propagation Delay IN to Q_x | 125 | 175 | 225 | ps |
| t_{SKEW} | Duty Cycle Skew (Note 12) Output – Output Within Device Skew Device to Device Skew | | 3 | 15 15 50 | ps |
| t_{DC} | Output Clock Duty Cycle (Reference Duty Cycle = 50%) $f_{in} \leq 7\text{ GHz}$ | 40 | 50 | 60 | % |
| Φ_N | Phase Noise, $f_{in} = 1\text{ GHz}$ 10 kHz 100 kHz 1 MHz 10 MHz 20 MHz 40 MHz | | -134 -136 -150 -151 -151 -151 | | dBc |
| $t_{j\Phi N}$ | Integrated Phase Jitter $f_{in} = 1\text{ GHz}$, 12 kHz – 20 MHz Offset (RMS) | | 35 | | fs |
| t_{JITTER} | RMS Random Clock Jitter (Note 13) $f_{in} \leq 7\text{ GHz}$ Peak-to-Peak Data Dependent Jitter (Note 14) $f_{IN} \leq 14\text{ Gbps EQEN} = 0$ ($\leq 3''\text{ FR4}$) $f_{IN} \leq 10\text{ Gbps EQEN} = 1$ ($12''\text{ FR4}$) | | 0.2 | 0.8 10 10 | ps rms ps pk-pk ps pk-pk |
| V_{INPP} | Input Voltage Swing/Sensitivity (Differential Configuration) (Note 15) | 100 | | 1200 | mV |
| t_r t_f | Output Rise/Fall Times @ 1.0 GHz (20% – 80%) Q_x, \bar{Q}_x | 15 | 30 | 45 | 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 by forcing V_{INPP} 400mV from a 50% duty cycle clock source. All loading with an external $R_L = 50\ \Omega$ to V_{CC} . Input edge rates 40 ps (20% – 80%).
12. Skew is measured between outputs under identical transitions and conditions @ 0.5 GHz. Duty cycle skew is measured between differential outputs using the deviations of the sum of T_{pw-} and T_{pw+} @ 0.5 GHz.
13. Additive RMS jitter with 50% duty cycle clock signal.
14. Additive peak-to-peak data dependent jitter with input NRZ data at PRBS23.
15. Input and output voltage swings are single-ended measurements operating in a differential mode.

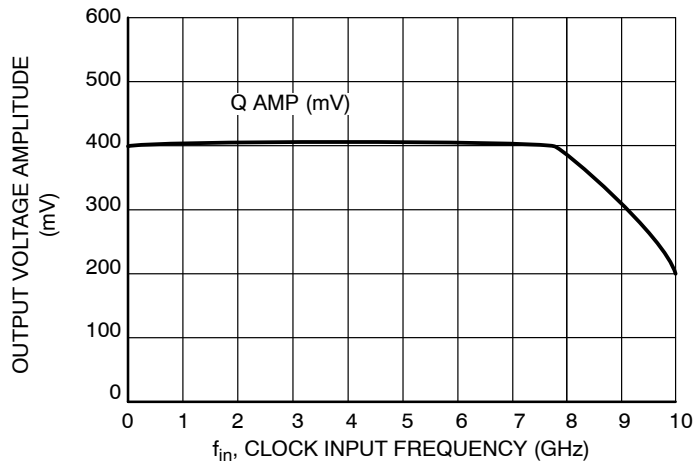


Figure 3. CLOCK Output Voltage Amplitude (V_{OUTPP}) vs. Input Frequency (f_{in}) at Ambient Temperature (Typical)

NB7VQ14M

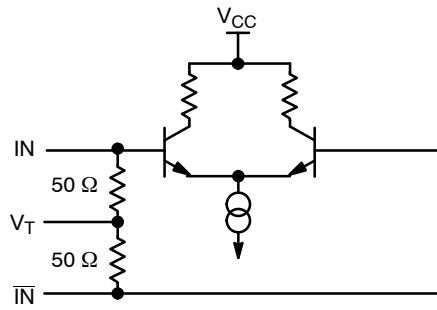


Figure 4. Input Structure

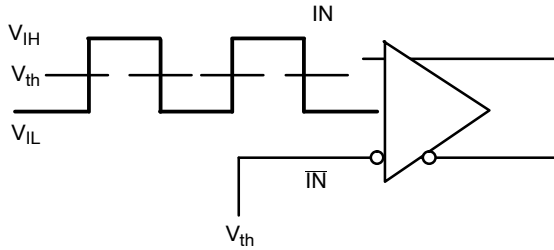


Figure 5. Differential Input Driven Single-Ended

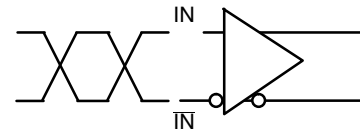


Figure 6. Differential Inputs Driven Differentially

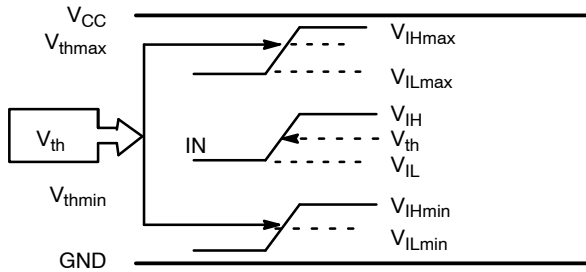


Figure 7. V_{th} Diagram

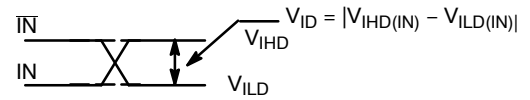


Figure 8. Differential Inputs Driven Differentially

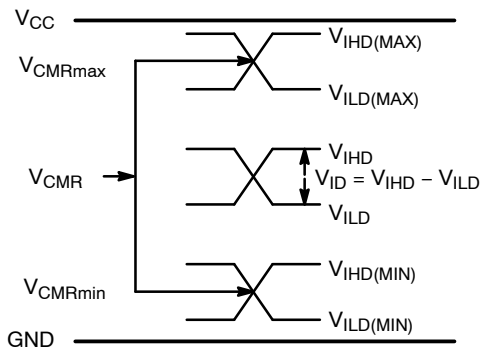


Figure 9. V_{CMR} Diagram

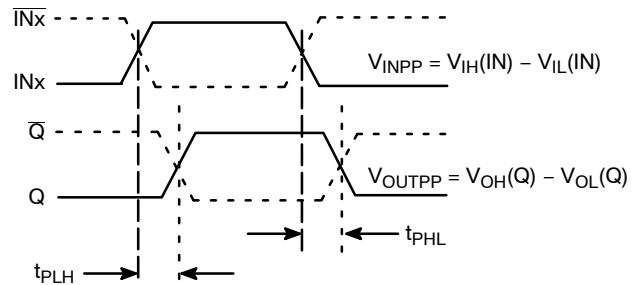


Figure 10. AC Reference Measurement

NB7VQ14M

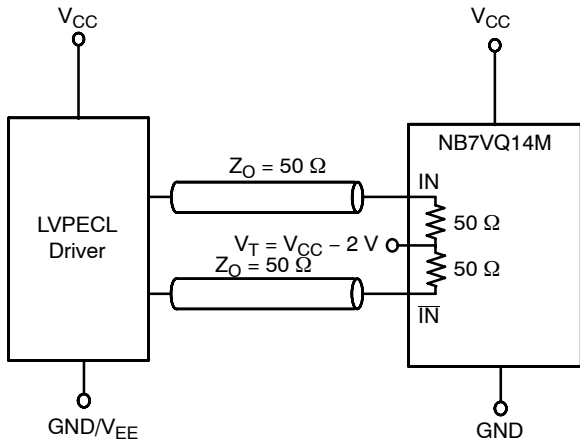


Figure 11. LVPECL Interface

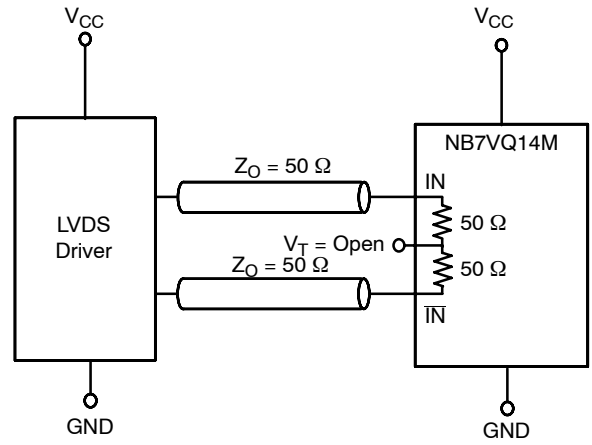


Figure 12. LVDS Interface

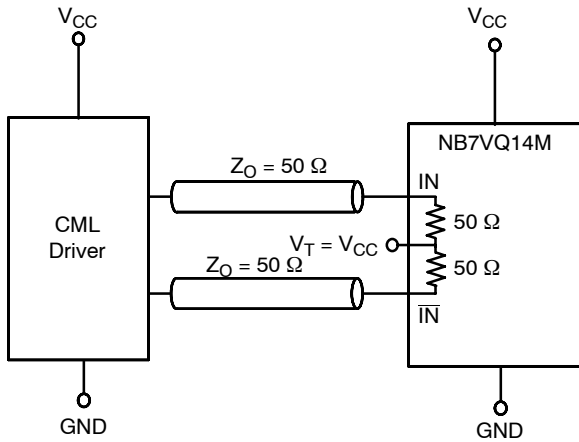


Figure 13. Standard 50 Ω Load CML Interface

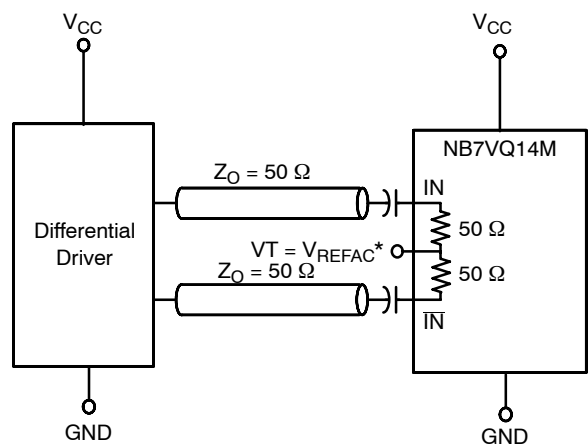


Figure 14. Capacitor-Coupled
Differential Interface
(V_T Connected to V_{REFAC})

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

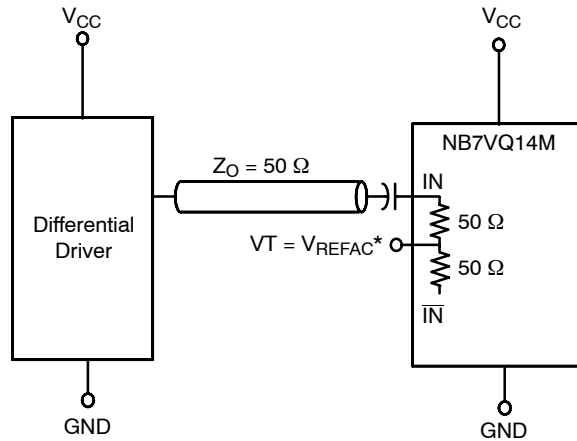


Figure 15. Capacitor-Coupled
Single-Ended Interface
(V_T Connected to V_{REFAC})

NB7VQ14M

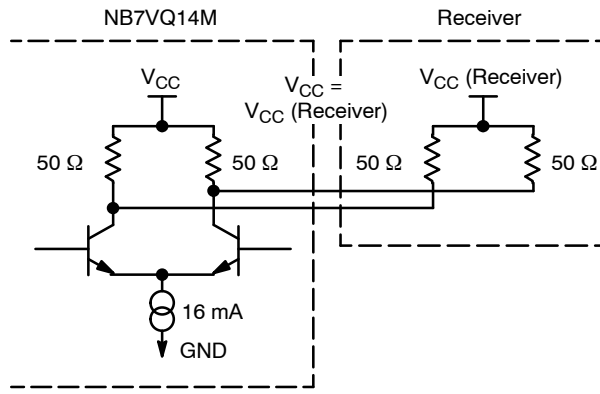


Figure 16. Typical CML Output Structure and Termination

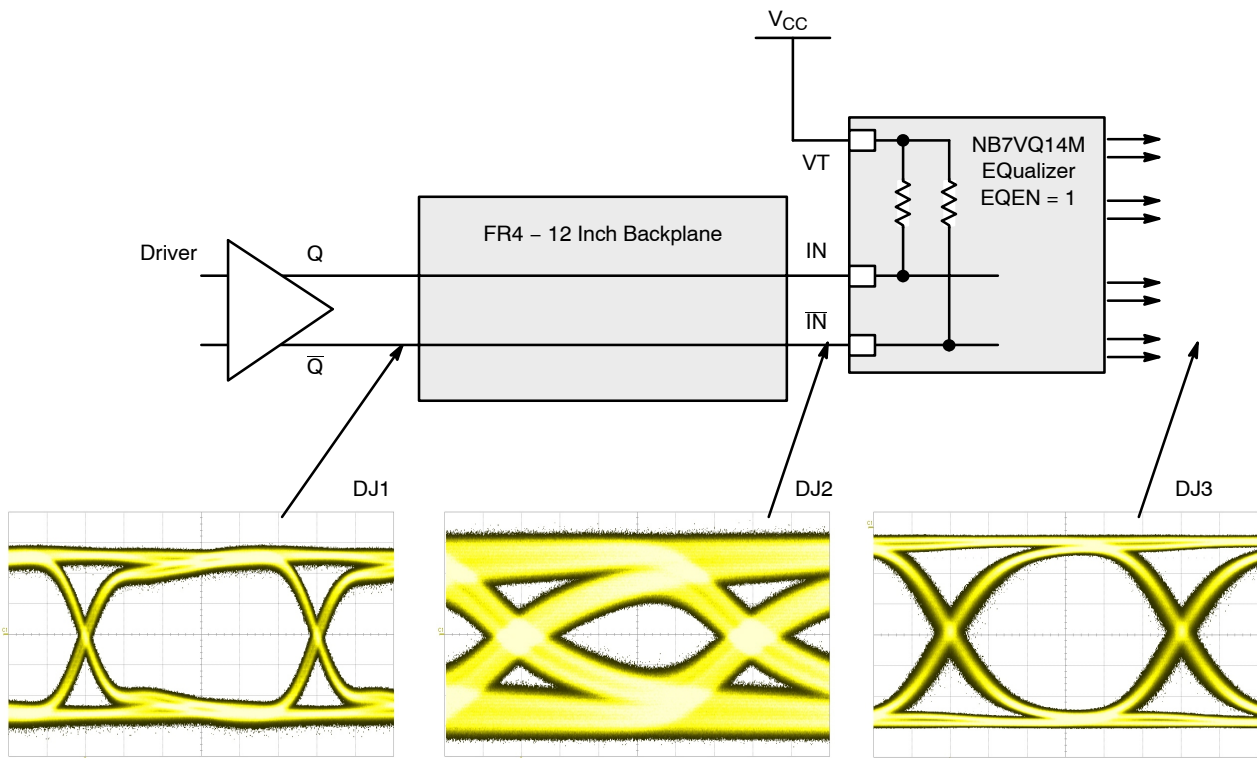


Figure 17. Typical NB7VQ14M Equalizer Application and Interconnect with PRBS23 pattern at 6.5 Gbps, EQEN = 1

ORDERING INFORMATION

| Device | Package | Shipping† |
|----------------|---------------------|-------------------|
| NB7VQ14MMNG | QFN-16 (Pb-Free) | 123 Units / Tube |
| NB7VQ14MMNHTBG | QFN-16 (Pb-Free) | 100 / Tape & Reel |

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

MECHANICAL CASE OUTLINE

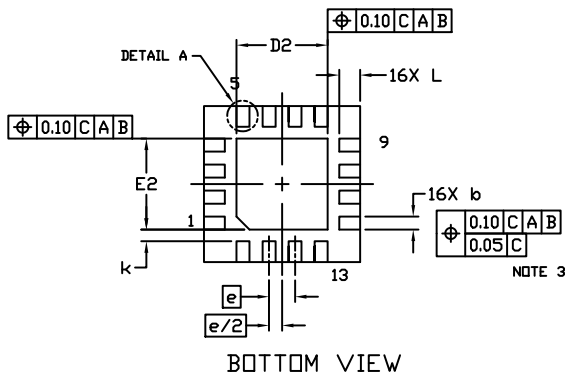
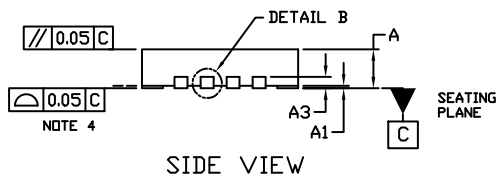
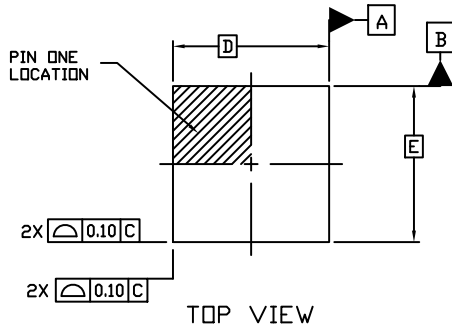
PACKAGE DIMENSIONS



SCALE 2:1

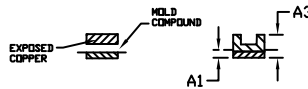
QFN16 3x3, 0.5P
CASE 485G
ISSUE G

DATE 08 OCT 2021

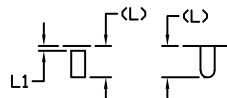


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION *b* APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.



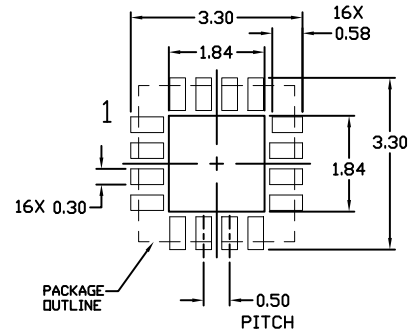
DETAIL B
ALTERNATE
CONSTRUCTIONS



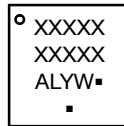
DETAIL A
ALTERNATE TERMINAL
CONSTRUCTIONS

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

MOUNTING FOOTPRINT



GENERIC MARKING DIAGRAM*



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

(Note: Microdot may be in either location)

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

| | | |
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