

NB6L14M

2.5 V/3.3 V 3.0 GHz Differential 1:4 CML Fanout Buffer

Multi-Level Inputs with Internal Termination

Description

The NB6L14M is a 3.0 GHz differential 1:4 CML clock or data fanout buffer. The differential inputs incorporate internal 50 Ω termination resistors that are accessed through the VT pin. This feature allows the NB6L14M to accept various logic standards, such as LVPECL, CML, or LVDS logic levels. The 16 mA differential CML outputs provide matching internal 50 Ω terminations and produce 400 mV output swings when externally terminated with a 50 Ω resistor to V_{CC}. The V_{REFAC} reference output can be used to rebias capacitor-coupled differential or single-ended input signals. The 1:4 fanout design was optimized for low output skew applications.

The NB6L14M is a member of the ECLinPS MAX™ family of high performance clock and data products.

Features


- Input Clock Frequency > 3.0 GHz
- Input Data Rate > 2.5 Gb/s
- < 20 ps Within Device Output Skew
- 350 ps Typical Propagation Delay
- 90 ps Typical Rise and Fall Times
- Differential CML Outputs, 340 mV Amplitude, Typical
- CML Mode Operating Range: V_{CC} = 2.375 V to 3.63 V with GND = 0 V
- Internal Input and Output Termination Resistors, 50 Ω
- V_{REFAC} Reference Output Voltage
- -40°C to +85°C Ambient Operating Temperature
- Available in 3 mm x 3 mm 16 Pin QFN
- These are Pb-Free Devices




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MARKING DIAGRAM*



**QFN-16
MN SUFFIX
CASE 485G**



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.

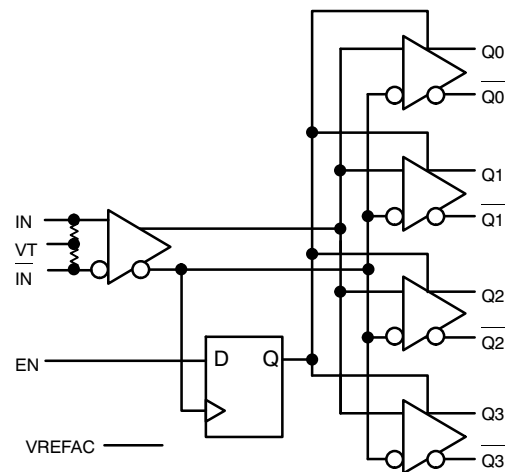


Figure 1. Simplified Logic Diagram

ORDERING INFORMATION

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

NB6L14M

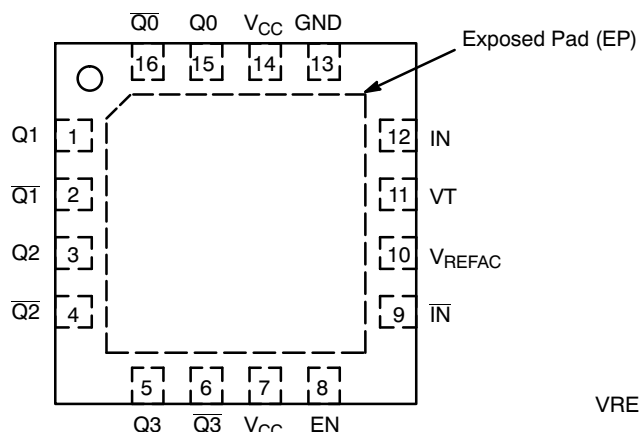


Figure 2. QFN-16 Pinout
(Top View)

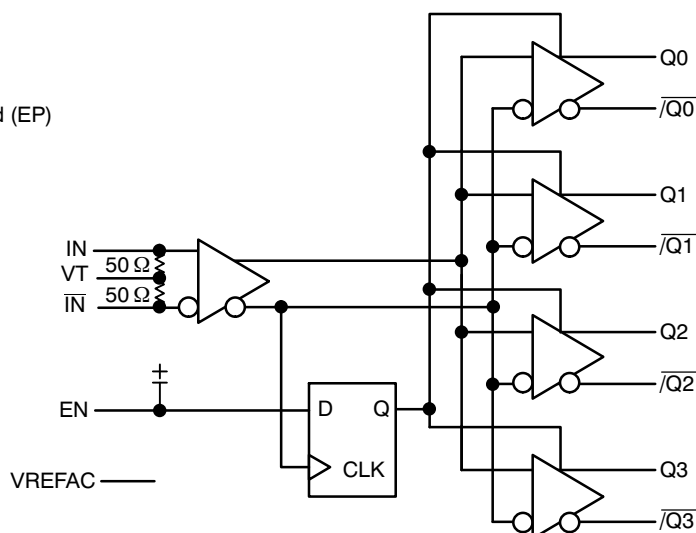


Figure 3. Logic Diagram

Table 1. EN TRUTH TABLE

| IN | IN | EN | Q0:Q3 | Q0:Q3 |
|----|----|----|-------|-------|
| 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 |
| x | x | 0 | 0+ | 1+ |

+ = On next negative transition of the input signal (IN).
x = Don't care.

Table 2. PIN DESCRIPTION

| Pin | Name | I/O | Description |
|-----|-------------|-------------------|--|
| 1 | Q1 | CML Output | Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 2 | Q1 | CML Output | Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 3 | Q2 | CML Output | Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 4 | Q2 | CML Output | Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 5 | Q3 | CML Output | Non-inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 6 | Q3 | CML Output | Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 7 | V_{CC} | - | Positive Supply Voltage |
| 8 | EN | LVTTTL/LVCMOS | Synchronous Output Enable. When LOW, Q outputs will go LOW and Q outputs will go HIGH on the next negative transition of IN input. The internal DFF register is clocked on the falling edge of IN input (see Figure 16). The EN pin has an internal pullup resistor and defaults HIGH when left open. |
| 9 | IN | LVPECL, CML, LVDS | Inverted Differential Clock Input. Internal 50 Ω Resistor to Termination Pin, VT. |
| 10 | V_{REFAC} | | Output Voltage Reference for capacitor-coupled inputs, only. |
| 11 | VT | | Internal 100 Ω center-tapped Termination Pin for IN and IN. |
| 12 | IN | LVPECL, CML, LVDS | Non-inverted Differential Clock Input. Internal 50 Ω Resistor to Termination Pin, VT. |
| 13 | GND | - | Negative Supply Voltage |
| 14 | V_{CC} | - | Positive Supply Voltage |
| 15 | Q0 | CML Output | Noninverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| 16 | Q0 | CML Output | Inverted Differential Output. Typically Terminated with 50 Ω Resistor to V_{CC} . |
| - | 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 not electrically connected to the die, but is recommended to 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/IN inputs, then the device will be susceptible to self-oscillation.

NB6L14M

Table 3. ATTRIBUTES

| Characteristics | | Value |
|--|----------------------------------|----------------------|
| ESD Protection | Human Body Model Machine Mode | > 2 kV > 200 V |
| Moisture Sensitivity (Note 2) | QFN-16 | Level 1 |
| Flammability Rating | Oxygen Index: 28 to 34 | UL 94 V-0 @ 0.125 in |
| Transistor Count | | 167 |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test | | |

2. 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 | | 4.0 | V |
| V_{Io} | Positive Input/Output | GND = 0 V | $-0.5\text{ V} \leq V_{Io} \leq V_{CC} + 0.5\text{ V}$ | 4.5 | V |
| I_{IN} | Input Current Source or Sink Current (IN/IN) | | | ±50 | mA |
| I_{VREFAC} | Sink/Source Current | | | ±2.0 | mA |
| T_A | Operating Temperature Range | | | -40 to +85 | °C |
| T_{stg} | Storage Temperature Range | | | -65 to +150 | °C |
| θ_{JA} | Thermal Resistance (Junction-to-Ambient) (Note 3) | 0 lfp 500 lfp | QFN-16 QFN-16 | 42 35 | °C/W °C/W |
| θ_{JC} | Thermal Resistance (Junction-to-Case) | 2S2P (Note 3) | QFN-16 | 4 | °C/W |
| T_{sol} | Wave Solder 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.

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

NB6L14M

Table 5. DC CHARACTERISTICS, Multi-Level Inputs, CML Outputs

$V_{CC} = 2.375\text{ V to }3.63\text{ V}$, $GND = 0\text{ V}$, $T_A = -40^\circ\text{C to }+85^\circ\text{C}$

| Symbol | Characteristic | Min | Typ | Max | Unit |
|----------|--|-----|-----|-----|------|
| I_{CC} | Power Supply Current (Inputs and Outputs Open) | 80 | 100 | 130 | mA |

CML OUTPUT (Notes 4 and 5)

| | | | | | |
|----------|---------------------|--------------------------------|--------------------------------|--------------------------------|----|
| V_{OH} | Output HIGH Voltage | $V_{CC} - 40$ 3260 2460 | $V_{CC} - 10$ 3290 2490 | V_{CC} 3300 2500 | mV |
| V_{OL} | Output LOW Voltage | $V_{CC} - 500$ 2800 2000 | $V_{CC} - 400$ 2900 2100 | $V_{CC} - 300$ 3000 2200 | mV |

DIFFERENTIAL INPUT DRIVEN SINGLE-ENDED (See Figures 5 and 6)

| | | | | | |
|-----------|--|----------------|--|----------------|----|
| V_{th} | Input Threshold Reference Voltage Range (Note 6) | 1100 | | $V_{CC} - 100$ | 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 Amplitude ($V_{IH} - V_{IL}$) | 200 | | $V_{CC} - GND$ | mV |

V_{REFAC}

| | | | | | |
|-------------|---|-----------------|-----------------|-----------------|----|
| V_{REFAC} | Output Reference Voltage ($V_{CC} \geq 2.5\text{ V}$) | $V_{CC} - 1525$ | $V_{CC} - 1425$ | $V_{CC} - 1325$ | mV |
|-------------|---|-----------------|-----------------|-----------------|----|

DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY (See Figures 7 and 8) (Note 7)

| | | | | | |
|-----------|--|------|--|-----------------|---------------|
| V_{IHD} | Differential Input HIGH Voltage | 1200 | | V_{CC} | mV |
| V_{ILD} | Differential Input LOW Voltage | GND | | $V_{IHD} - 100$ | mV |
| V_{ID} | Differential Input Voltage ($I_N - \bar{I}_N$) ($V_{IHD} - V_{ILD}$) | 100 | | $V_{CC} - GND$ | mV |
| V_{CMR} | Input Common Mode Range (Differential Configuration) (Note 8) | 950 | | $V_{CC} - 50$ | 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 |

LVTTTL/LVC MOS INPUT DC ELECTRICAL CHARACTERISTICS

| | | | | | |
|----------|---|------|--|----------|---------------|
| V_{IH} | Input HIGH Voltage | 2.0 | | V_{CC} | V |
| V_{IL} | Input LOW Voltage | GND | | 0.8 | V |
| I_{IH} | Input HIGH Current, $V_{CC} = V_{IN} = 3.63\text{ V}$ | -150 | | +150 | μA |
| I_{IL} | Input LOW Current, $V_{CC} = 3.63\text{ V}$, $V_{IN} = 0\text{ V}$ | -150 | | +150 | μA |

TERMINATION RESISTORS

| | | | | | |
|----------------|--|----|-----|-----|----------|
| R_{TIN} | Internal Input Termination Resistor (IN to VT) | 40 | 50 | 60 | Ω |
| R_{DIFF_IN} | Differential Input Resistance (IN to \bar{I}_N) | 80 | 100 | 120 | Ω |
| R_{TOUT} | Internal Output Termination Resistor | 40 | 50 | 60 | 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 lpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

- CML outputs loaded with $50\ \Omega$ to V_{CC} for proper operation.
- Input and output parameters vary 1:1 with V_{CC} .
- V_{th} 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} minimum 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.

NB6L14M

Table 6. AC CHARACTERISTICS $V_{CC} = 2.375\text{ V to }3.63\text{ V}$, $GND = 0\text{ V}$, $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ (Note 9)

| Symbol | Characteristic | Min | Typ | Max | Unit |
|--------------|---|------------|------------|----------------|------|
| V_{OUTPP} | Output Voltage Amplitude (@ $V_{INPPmin}$) (Note 10) $f_{in} \leq 2.5\text{ GHz}$ $2.5\text{ GHz} \leq f_{in} \leq 3.0\text{ GHz}$ | 180 100 | 340 250 | | mV |
| f_{DATA} | Maximum Operating Data Rate | | 2.5 | | Gb/s |
| t_{PD} | Propagation Delay IN to Q | 230 | 350 | 480 | ps |
| t_S | Set-Up Time (Note 11) EN to IN, \overline{IN} | 300 | | | ps |
| t_H | Hold Time (Note 11) EN to IN, \overline{IN} | 300 | | | ps |
| t_{SKEW} | Within-Device Skew (Note 12) Device-to-Device Skew (Note 13) | | 5.0 | 20 80 | ps |
| t_{DC} | Output Clock Duty Cycle (Referenced Duty Cycle = 50%) $f_{in} \leq 3.0\text{ GHz}$ | 40 | 50 | 60 | % |
| t_{JITTER} | RMS Random Jitter (Note 14) Peak-to-Peak Data Dependent Jitter (Note 15) $f_{IN} \leq 3.0\text{ GHz}$ $f_{DATA} \leq 3.0\text{ Gb/s}$ | | 0.2 20 | 0.5 | ps |
| V_{INPP} | Input Voltage Swing/Sensitivity (Differential Configuration) (Note 10) | 100 | | $V_{CC} - GND$ | mV |
| t_r, t_f | Output Rise/Fall Times (20%–80%) | | 90 | 150 | 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 lfpm. 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.

9. Measured by forcing V_{INPP} (minimum) 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%).
10. Input and output voltage swing is a single-ended measurement operating in differential mode.
11. Set-up and hold times apply to synchronous applications that intend to enable/disable before the next clock cycle. For asynchronous applications, set-up and hold times do not apply.
12. Within device skew is measured between two different outputs under identical power supply, temperature and input conditions.
13. Device to device skew is measured between outputs under identical transition @ 0.5 GHz.
14. Additive RMS jitter with 50% duty cycle clock signal.
15. Additive peak-to-peak data dependent jitter with input NRZ data at PRBS 23-1 and K28.5 at 2.5 Gb/s.

NB6L14M

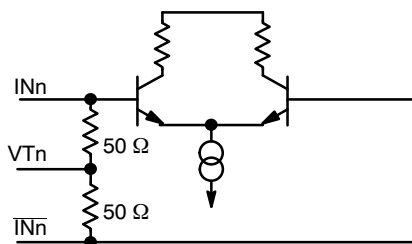


Figure 4. Input Structure

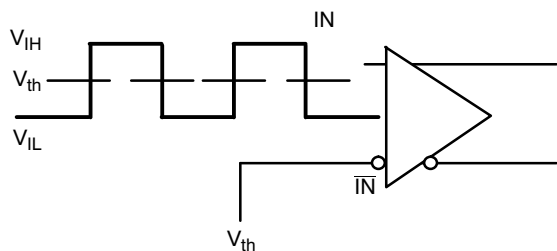


Figure 5. Differential Input Driven Single-Ended

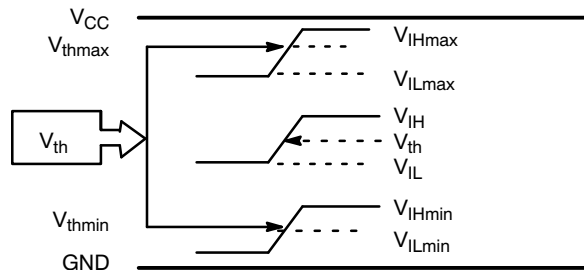


Figure 6. V_{th} Diagram

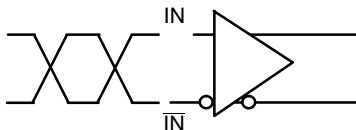


Figure 7. Differential Inputs Driven Differentially

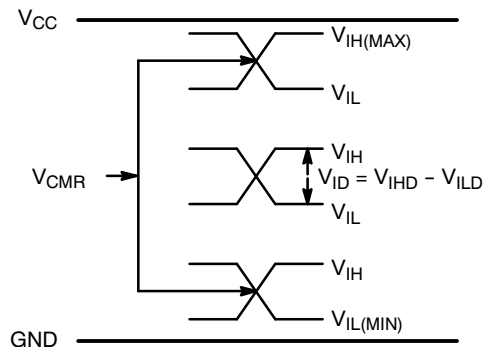


Figure 8. V_{CMR} Diagram

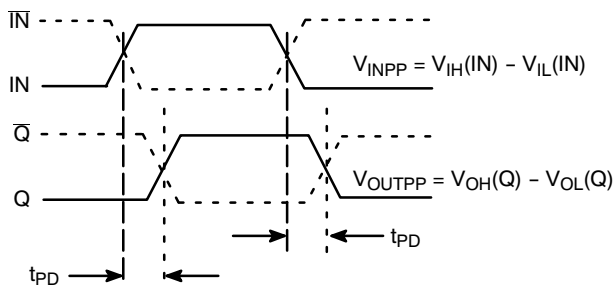


Figure 9. AC Reference Measurement

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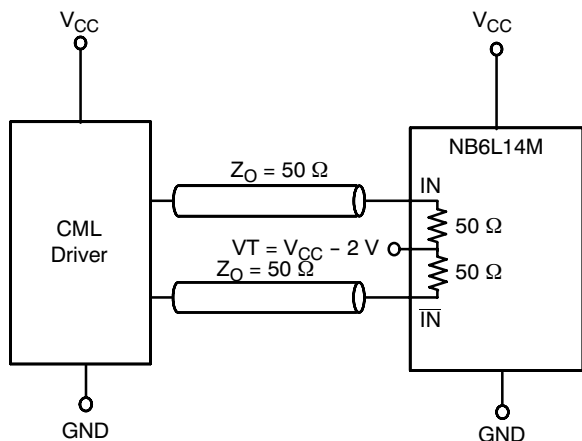


Figure 10. CML Interface

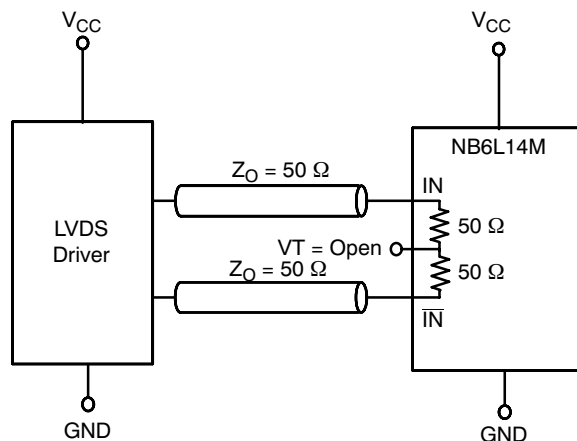


Figure 11. LVDS Interface

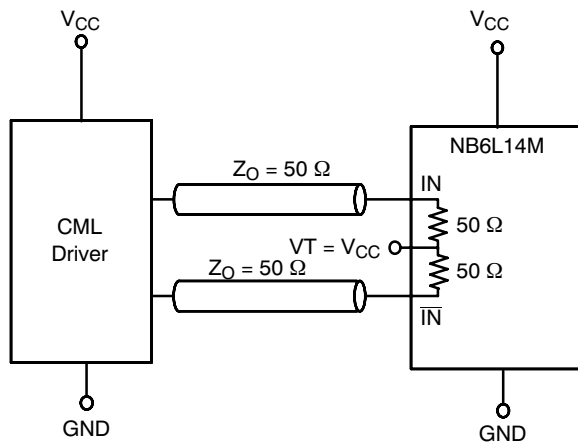


Figure 12. Standard 50 Ω Load CML Interface

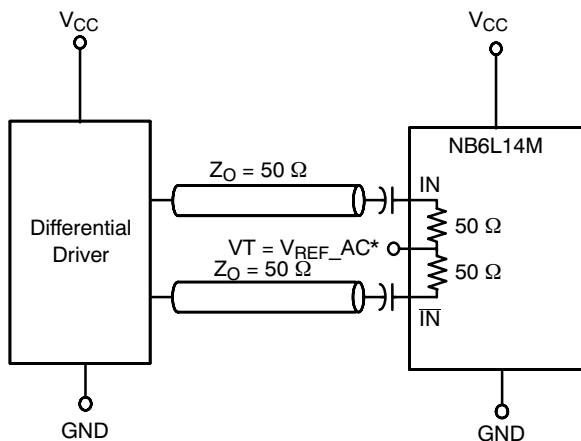


Figure 13. Capacitor-Coupled Differential Interface
(VT Connected to V_{REFAC})

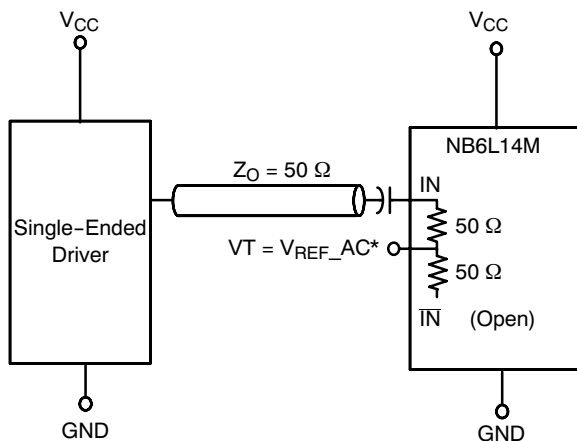


Figure 14. Capacitor-Coupled Single-Ended Interface
(VT Connected to V_{REFAC})

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

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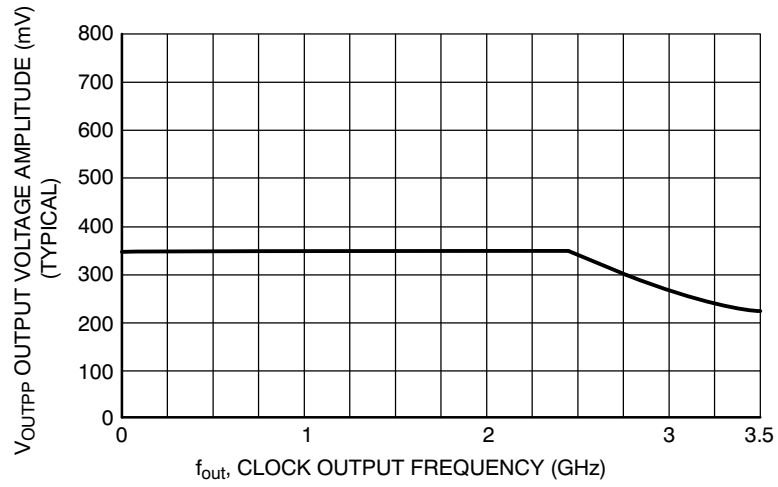


Figure 15. Output Voltage Amplitude (V_{OUTPP}) versus Output Frequency at Ambient Temperature (Typical)

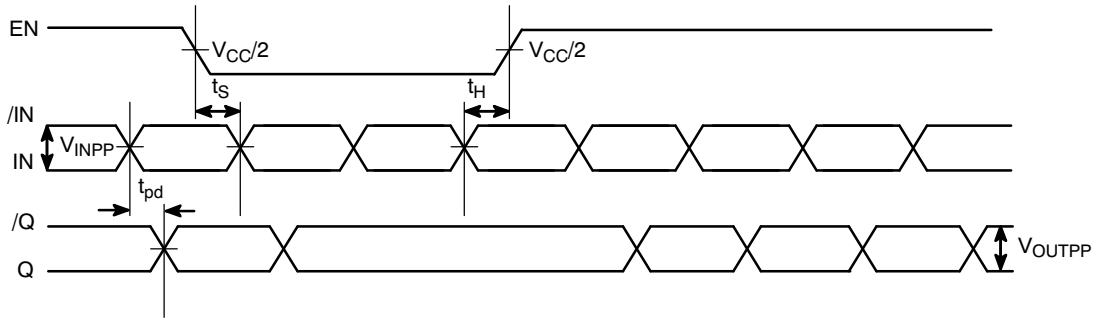


Figure 16. EN Timing Diagram

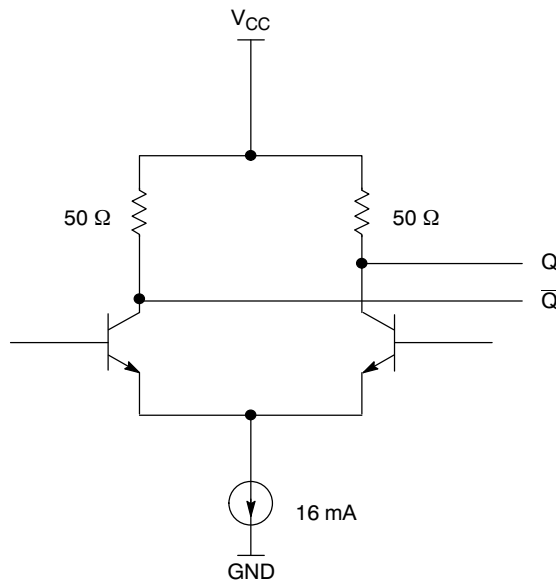


Figure 17. CML Output Structure

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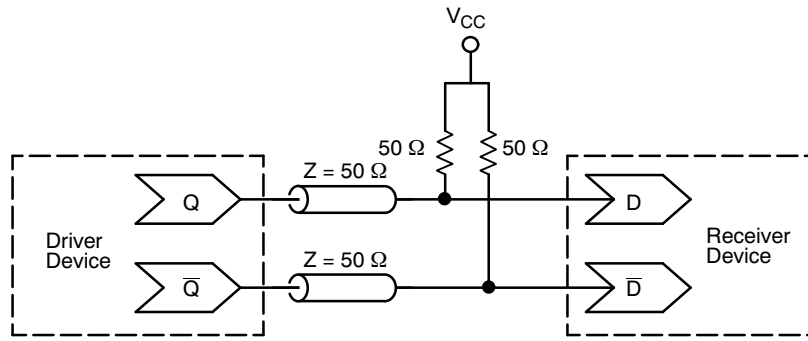


Figure 18. Typical CML Termination for Output Driver and Device Evaluation

ORDERING INFORMATION

| Device | Package | Shipping [†] |
|--------------|-----------------------------|-----------------------|
| NB6L14MMNG | QFN-16, 3x3 mm (Pb-Free) | 123 Units / Rail |
| NB6L14MMNR2G | QFN-16, 3x3 mm (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.

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.



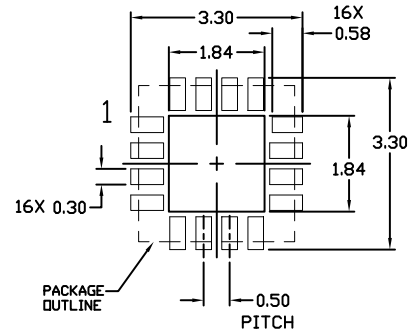
DETAIL B
ALTERNATE
CONSTRUCTIONS



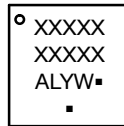
DETAIL A
ALTERNATE TERMINAL
CONSTRUCTIONS

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

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