

# 3.3 V Differential 1:21 Differential Fanout Clock Driver with HCSL level Output

## NB4N121K

### Description

The NB4N121K is a Clock differential input fanout distribution 1 to 21 HCSL level differential outputs, optimized for ultra low propagation delay variation. The NB4N121K is designed with HCSL clock distribution for FBDIMM applications in mind.

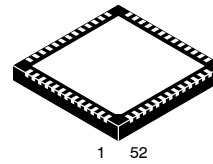
Inputs can accept differential LVPECL, CML, or LVDS levels. Single-ended LVPECL, CML, LVCMOS or LVTTTL levels are accepted with the proper  $V_{REFAC}$  supply (see Figures 5, 10, 11, 12, and 13). Clock input pins incorporate an internal 50  $\Omega$  on die termination resistors.

Output drive current at  $I_{REF}$  (Pin 1) for 1X load is selected by connecting to GND. To drive a 2X load, connect  $I_{REF}$  to  $V_{CC}$ . See Figure 9.

The NB4N121K specifically guarantees low output-to-output skews. Optimal design, layout, and processing minimize skew within a device and from device to device. System designers can take advantage of the NB4N121K's performance to distribute low skew clocks across the backplane or the motherboard.

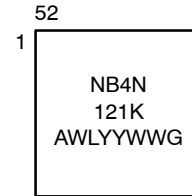
### Features

- Typical Input Clock Frequency 100, 133, 166, 200, 266, 333 and 400 MHz
- 340 ps Typical Rise and Fall Times
- 800 ps Typical Propagation Delay
- $\Delta t_{pd}$  100 ps Maximum Propagation Delay Variation Per Each Differential Pair
- Additive Phase RMS Jitter: 1 ps Max
- Operating Range:  $V_{CC} = 3.0\text{ V to }3.6\text{ V}$  with  $V_{EE} = 0\text{ V}$
- Differential HCSL Output Level (700 mV Peak-to-Peak)
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



QFN-52  
MN SUFFIX  
CASE 485M

### MARKING DIAGRAM\*



- A = Assembly Site
- WL = Wafer Lot
- YY = Year
- WW = Work Week
- G = Pb-Free Package

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

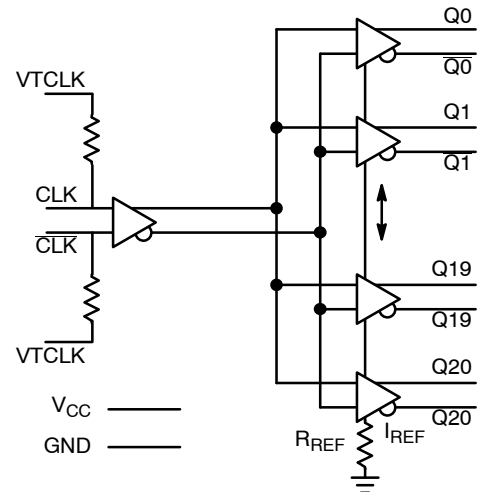


Figure 1. Pin Configuration (Top View)

### ORDERING INFORMATION

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

# NB4N121K

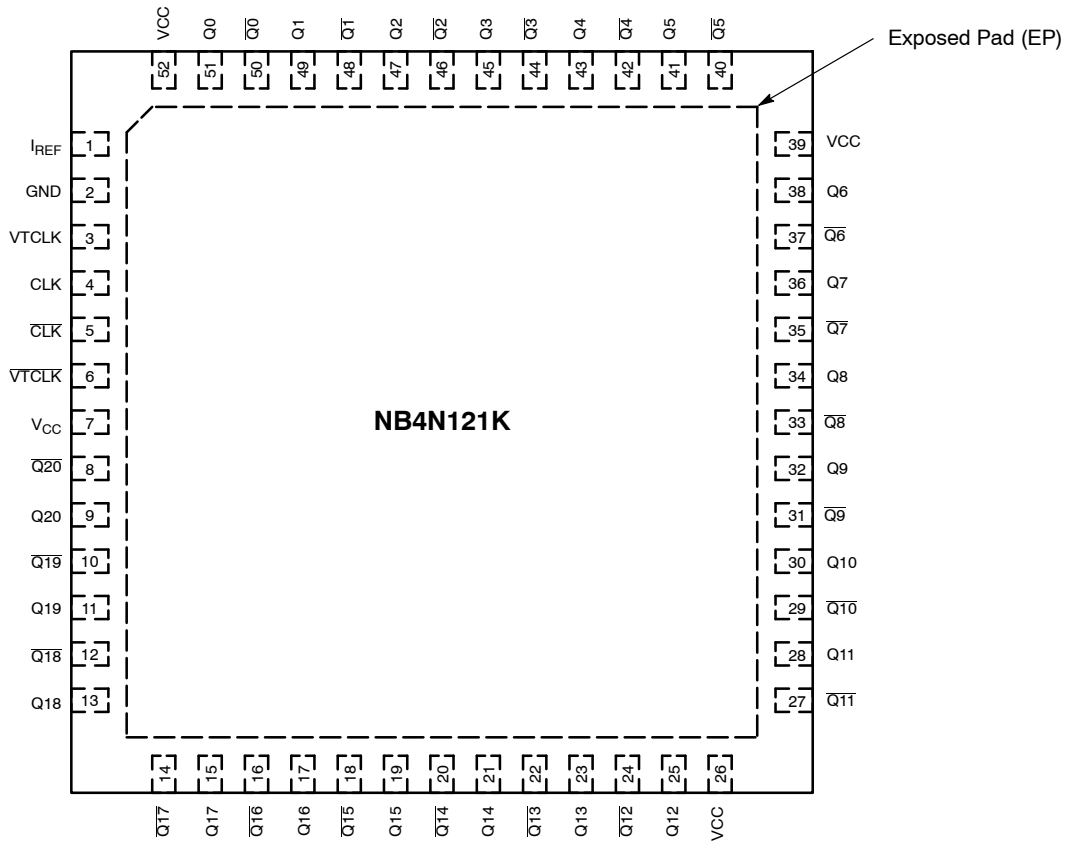


Figure 2. Pinout Configuration (Top View)

Table 1. PIN DESCRIPTION

| Pin   | Name                            | I/O          | Description   |
|---|---------------------------------|--------------|---|
| 1   | $I_{REF}$                       | Output       | Output current programming pin to select load drive. For 1X configuration, connect $I_{REF}$ to GND, or for 2X configuration, connect $I_{REF}$ to $V_{CC}$ (See Figure 9).   |
| 2   | GND                             | -            | Supply Ground. GND pin must be externally connected to power supply to guarantee proper operation.  |
| 3, 6  | $\overline{VTCLK}$ ,<br>$VTCLK$ | -            | Internal 50 $\Omega$ Termination Resistor connection Pins. In the differential configuration when the input termination pins are connected to the common termination voltage, and if no signal is applied then the device may be susceptible to self-oscillation. |
| 4   | CLK                             | LVPECL Input | CLOCK Input (TRUE)  |
| 5   | $\overline{CLK}$                | LVPECL Input | CLOCK Input (INVERT)  |
| 7, 26, 39, 52   | $V_{CC}$                        | -            | Positive Supply pins. $V_{CC}$ pins must be externally connected to a power supply to guarantee proper operation.   |
| 8, 10, 12, 14, 16, 18, 20, 22, 24, 27, 29, 31, 33, 35, 37, 40, 42, 44, 46, 48, 50 | $\overline{Q[20-0]}$            | HCSL Output  | Output (INVERT)   |
| 9, 11, 13, 15, 17, 19, 21, 23, 25, 28, 30, 32, 34, 36, 38, 41, 43, 45, 47, 49, 51 | $Q[20-0]$                       | HCSL Output  | Output (TRUE)   |
| Exposed Pad   | EP                              | GND          | Exposed Pad. The thermally exposed pad (EP) on package bottom (see case drawing) must be attached to a sufficient heat-sinking conduit for proper thermal operation. (Note 1)   |

1. The exposed pad must be connected to the circuit board ground.

# NB4N121K

**Table 2. ATTRIBUTES**

| Characteristic   | Value                |
|--|----------------------|
| Input Default State Resistors                          | None                 |
| ESD Protection<br>Human Body Model<br>Machine Model    | >2 kV<br>400 V       |
| Moisture Sensitivity (Note 2)<br>QFN-52                | Level 1              |
| Flammability Rating Oxygen Index: 28 to 34             | UL 94 V-0 @ 0.125 in |
| Transistor Count                                       | 622                  |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test |                      |

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

**Table 3. MAXIMUM RATINGS** (Note 3)

| Symbol        | Parameter   | Condition 1         | Condition 2      | Rating                           | Unit         |
|---------------|---|---------------------|------------------|----------------------------------|--------------|
| $V_{CC}$      | Positive Power Supply                             | GND = 0 V           |                  | 4.6                              | V            |
| $V_I$         | Positive Input                                    | GND = 0 V           |                  | $GND - 0.3 \leq V_I \leq V_{CC}$ | V            |
| $V_{INPP}$    | Differential Input Voltage                        | CLK - CLKb          |                  | $V_{CC}$                         | V            |
| $I_{OUT}$     | Output Current                                    | Continuous<br>Surge |                  | 50<br>100                        | mA<br>mA     |
| $T_A$         | Operating Temperature Range                       | QFN-52              |                  | -40 to +70                       | °C           |
| $T_{stg}$     | Storage Temperature Range                         |                     |                  | -65 to +150                      | °C           |
| $\theta_{JA}$ | Thermal Resistance (Junction-to-Ambient) (Note 3) | 0 lfpm<br>500 lfpm  | QFN-52<br>QFN-52 | 25<br>19.6                       | °C/W<br>°C/W |
| $\theta_{JC}$ | Thermal Resistance (Junction-to-Case)             | 2S2P (Note 4)       | QFN-52           | 21                               | °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.

3. JEDEC standard 51-6, multilayer board - 2S2P (2 signal, 2 power).

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

# NB4N121K

**Table 4. DC CHARACTERISTICS** ( $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }+70^\circ\text{C}$  Note 5)

| Symbol    | Characteristic                                    | Min  | Typ                    | Max | Unit          |
|-----------|---|------|------------------------|-----|---------------|
| $I_{GND}$ | GND Supply Current (All Outputs Loaded)           | 70   | 98                     | 120 | mA            |
| $I_{CC}$  | Power Supply Current (All Outputs Loaded)         |      | 1X<br>420<br>2X<br>780 |     | mA            |
| $I_{IH}$  | Input HIGH Current CLKx, $\overline{\text{CLKx}}$ |      | 2.0                    | 150 | $\mu\text{A}$ |
| $I_{IL}$  | Input LOW Current CLKx, $\overline{\text{CLKx}}$  | -150 | -2.0                   |     | $\mu\text{A}$ |

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

|          |  |                |  |                |    |
|----------|--|----------------|--|----------------|----|
| $V_{th}$ | Input Threshold Reference Voltage Range (Note 6) | 1050           |  | $V_{CC} - 150$ | mV |
| $V_{IH}$ | Single-Ended Input HIGH Voltage                  | $V_{th} + 150$ |  | $V_{CC}$       | mV |
| $V_{IL}$ | Single-Ended Input LOW Voltage                   | GND            |  | $V_{th} - 150$ | mV |

**DIFFERENTIAL INPUTS DRIVEN DIFFERENTIALLY** (Figures 6 and 8)

|           |  |      |  |               |    |
|-----------|--|------|--|---------------|----|
| $V_{IHD}$ | Differential Input HIGH Voltage                    | 1200 |  | $V_{CC}$      | mV |
| $V_{ILD}$ | Differential Input LOW Voltage                     | GND  |  | $V_{CC} - 75$ | mV |
| $V_{ID}$  | Differential Input Voltage ( $V_{IHD} - V_{ILD}$ ) | 75   |  | 2400          | mV |
| $V_{CMR}$ | Input Common Mode Range                            | 1163 |  | $V_{CC} - 75$ |    |

**HCSL OUTPUTS** (Figure 4)

|          |                     |      |     |     |    |
|----------|---------------------|------|-----|-----|----|
| $V_{OH}$ | Output HIGH Voltage | 600  | 740 | 900 | mV |
| $V_{OL}$ | Output LOW Voltage  | -150 | 0   | 150 | mV |

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 parameters vary 1:1 with  $V_{CC}$ . Measurements taken with outputs in either 1X (all outputs loaded  $50\ \Omega$  to GND) or 2X (all outputs loaded  $25\ \Omega$  to GND) configuration, see Figure 9. For 1X configuration, connect  $I_{REF}$  to GND, or for 2X configuration, connect  $I_{REF}$  to  $V_{CC}$ .
- $V_{th}$  is applied to the complementary input when operating in single ended mode.

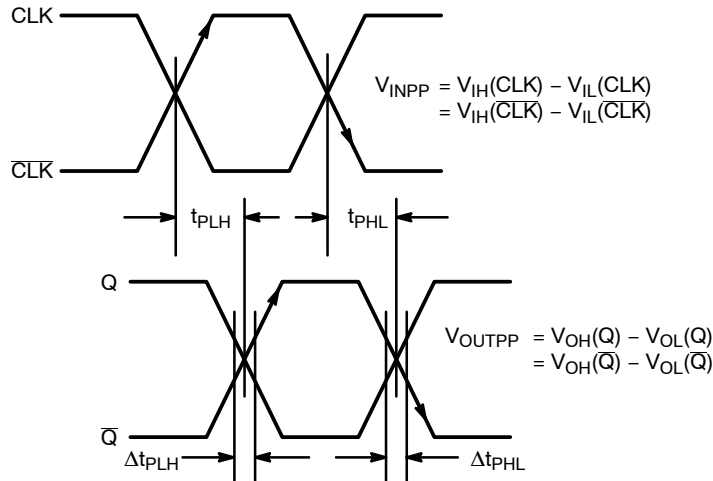
# NB4N121K

**Table 5. AC CHARACTERISTICS**  $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ ,  $GND = 0\text{ V}$ ;  $-40^{\circ}\text{C to }+70^{\circ}\text{C}$  (Note 7)

| Symbol                                 | Characteristic   | Min | Typ               | Max                   | Unit                 |
|--|--|-----|-------------------|-----------------------|----------------------|
| $V_{OUTPP}$                            | Output Voltage Amplitude (@ $V_{INPPmin}$ )<br>$f_{in} = 133\text{ MHz}$<br>$f_{in} = 166\text{ MHz}$<br>$f_{in} = 200\text{ MHz}$                 |     | 725<br>725<br>725 | 900<br>900<br>900     | mV                   |
| $t_{PLH}$ ,<br>$t_{PHL}$               | Propagation Delay to (See Figure 3) CLK/ $\overline{\text{CLK}}$ to $Q_x/\overline{Q_x}$   | 550 | 800               | 950                   | ps                   |
| $\Delta t_{PLH}$ ,<br>$\Delta t_{PHL}$ | Propagation Delay Variations Variation Per Each Diff Pair CLK/ $\overline{\text{CLK}}$ to $Q_x/\overline{Q_x}$ (Note 8) (See Figure 3)             |     |                   | 100                   | ps                   |
| $t_{SKEW}$                             | Duty Cycle Skew (Note 9)<br>Within-Device Skew, 1X Mode Only (Note 10)<br>Within-Device Skew, 2X Mode (Note 10)<br>Device-to-Device Skew (Note 10) |     |                   | 20<br>50<br>80<br>150 | ps<br>ps<br>ps<br>ps |
| $t_{jit(\phi)}$                        | Additive RMS Phase RMS (Note 11) $f_{in} = 133\text{ MHz to }200\text{ MHz}$   |     |                   | 1                     | ps                   |
| $V_{cross}$                            | Absolute Crossing Magnitude Voltage  | 250 |                   | 550                   | mV                   |
| $\Delta V_{cross}$                     | Variation in Magnitude of $V_{cross}$  |     |                   | 150                   | mV                   |
| $t_r$ , $t_f$                          | Absolute Magnitude in Output Risetime and Falltime (From 175 mV to 525 mV) $Q_x$ , $\overline{Q_x}$  | 175 | 340               | 700                   | ps                   |
| $\Delta t_r$ , $\Delta t_f$            | Variation in Magnitude of Risetime and Falltime (Single-Ended) (See Figure 4) $Q_x$ , $\overline{Q_x}$   |     |                   | 125<br>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 lfm.

7. Measured by forcing  $V_{INPP}$  (MIN) from a 50% duty cycle clock source. Measurements taken with outputs in either 1X (all outputs loaded  $50\ \Omega$  to GND) or 2X (all outputs loaded  $25\ \Omega$  to GND) configuration, see Figure 9. For 1X configuration, connect  $I_{REF}$  to GND, or for 2X configuration, connect  $I_{REF}$  to  $V_{CC}$ . Typical gain is 20 dB.
8. Measured from the input pair crosspoint to each single output pair crosspoint across temp and voltage ranges.
9. Duty cycle skew is measured between differential outputs using the deviations of the sum of  $T_{pw-}$  and  $T_{pw+}$ .
10. Skew is measured between outputs under identical transition @ 133 MHz.
11. Additive RMS jitter with 50% duty cycle clock signal using phase noise integrated from 12 KHz to 33 MHz



**Figure 3. AC Reference Measurement**

# NB4N121K

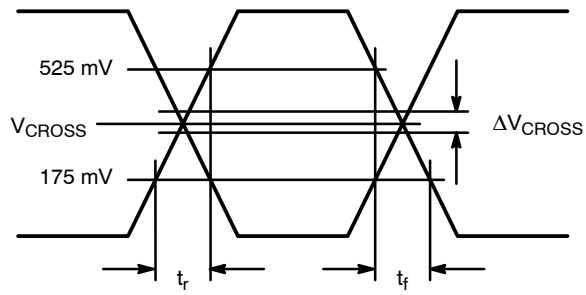


Figure 4. HCSL Output Parameter Characteristics

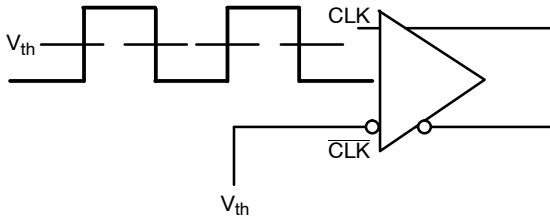


Figure 5. Differential Input Driven Single-Ended ( $V_{th} = V_{REFAC}$ )

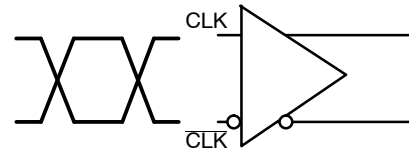


Figure 6. Differential Inputs Driven Differentially

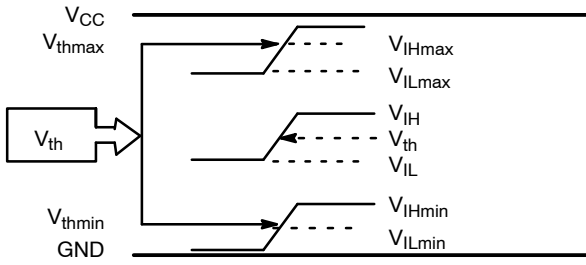


Figure 7.  $V_{th}$  Diagram

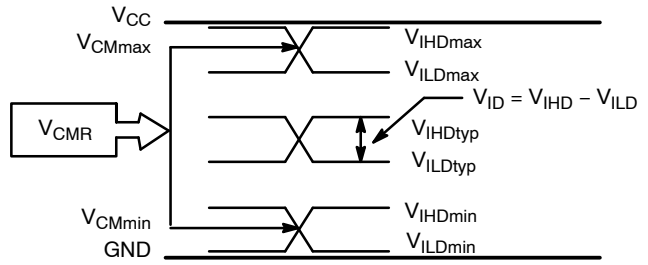
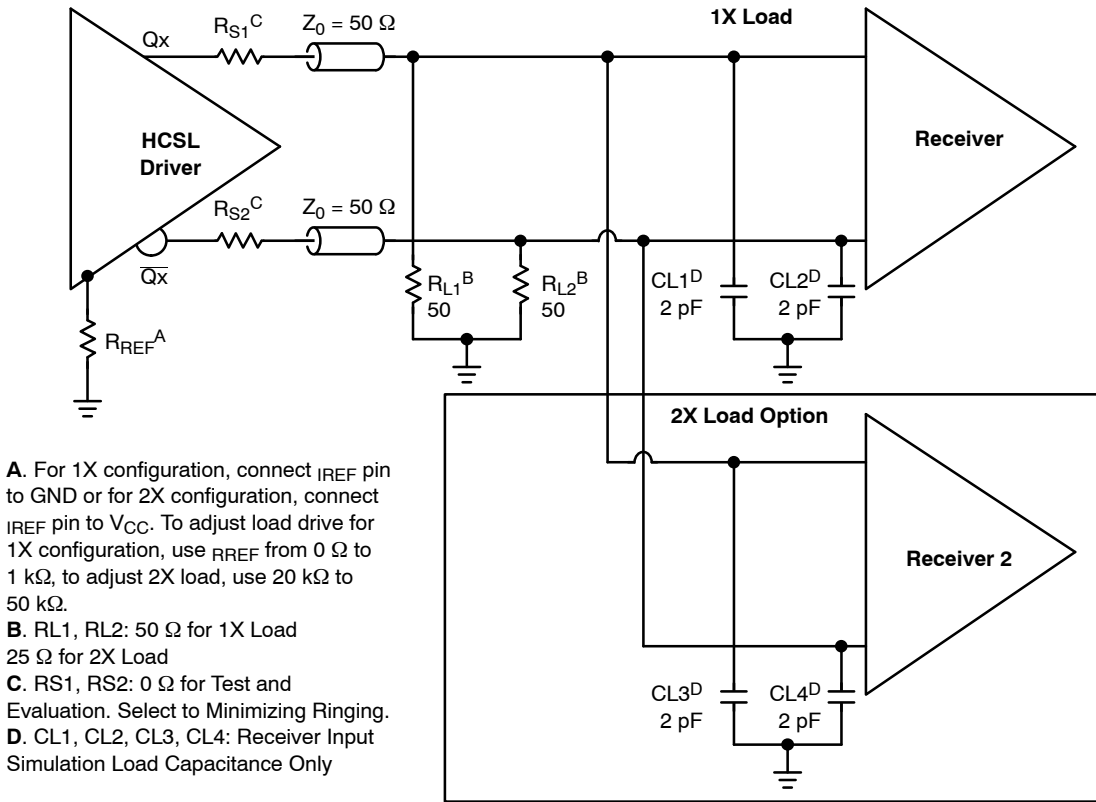
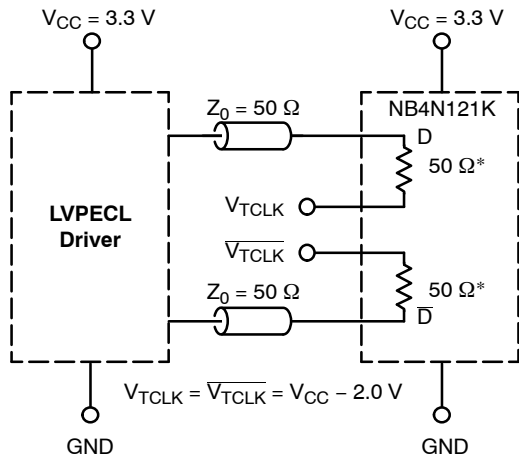


Figure 8.  $V_{CMR}$  Diagram

# NB4N121K

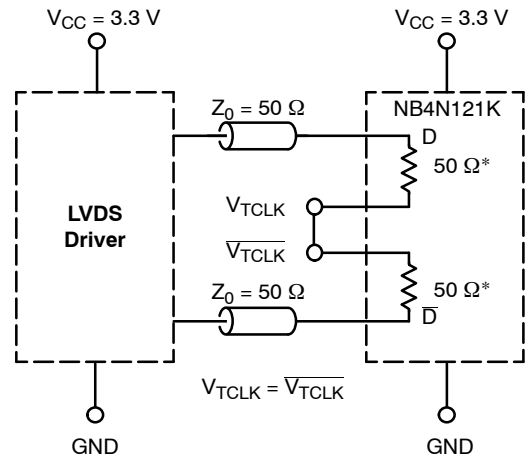


**Figure 9. Typical Termination Configuration for Output Driver and Device Evaluation  $C_{Lx}$  for Test Only (Representing Receiver Input Loading); Not Added to Application**



\*RTIN, Internal Input Termination Resistor

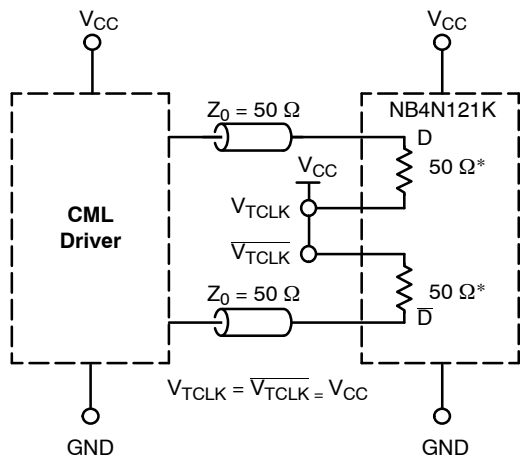
**Figure 10. LVPECL Interface**



\*RTIN, Internal Input Termination Resistor

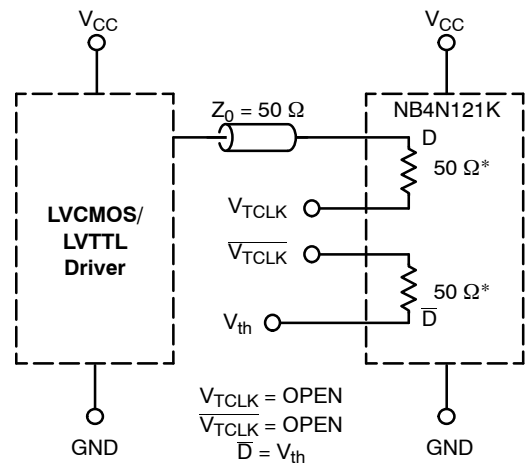
**Figure 11. LVDS Interface**

# NB4N121K



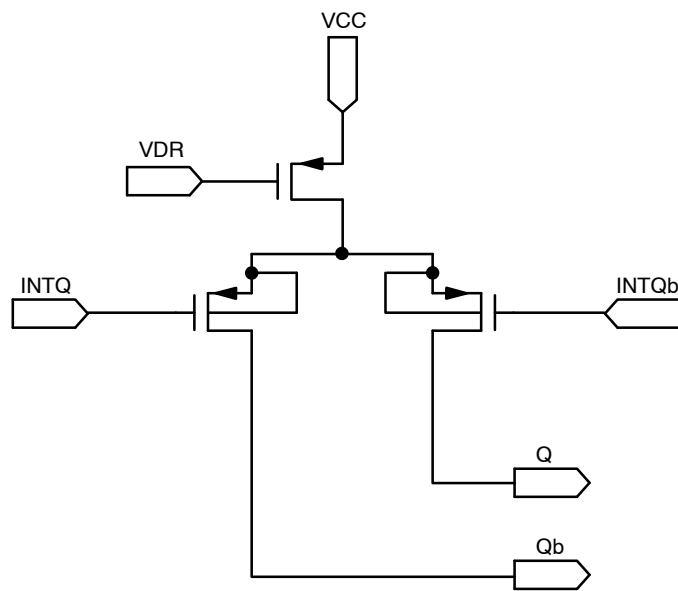
\*RTIN, Internal Input Termination Resistor

**Figure 12. Standard 50 Ω Load CML Interface**



\*RTIN, Internal Input Termination Resistor

**Figure 13. LVCMOS/LVTTL Interface**



**Figure 14. HCSL Output Structure**

## ORDERING INFORMATION

| Device        | Package             | Shipping <sup>†</sup> |
|---------------|---------------------|-----------------------|
| NB4N121KMNR2G | QFN-52<br>(Pb-Free) | 2000 / 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](#).



# MECHANICAL CASE OUTLINE

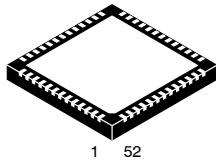
## PACKAGE DIMENSIONS

ON Semiconductor®

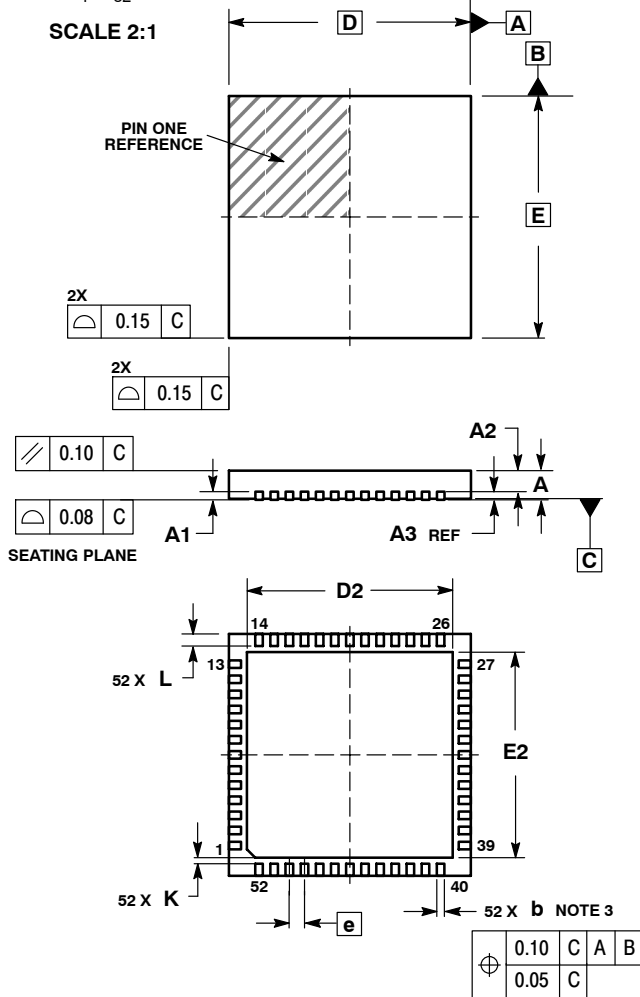


**QFN52 8x8, 0.5P**  
CASE 485M-01  
ISSUE C

DATE 16 FEB 2010



SCALE 2:1

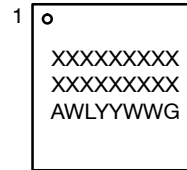


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

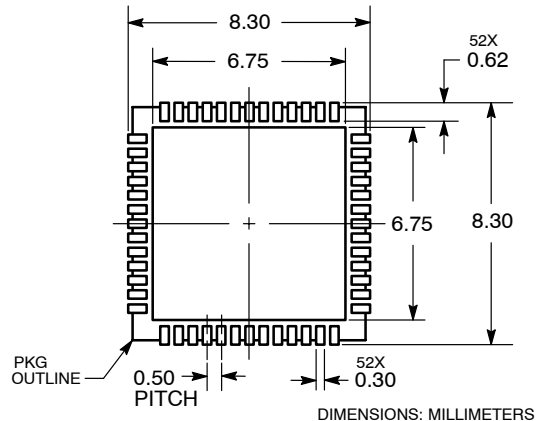
| MILLIMETERS |          |      |
|-------------|----------|------|
| DIM         | MIN      | MAX  |
| A           | 0.80     | 1.00 |
| A1          | 0.00     | 0.05 |
| A2          | 0.60     | 0.80 |
| A3          | 0.20 REF |      |
| b           | 0.18     | 0.30 |
| D           | 8.00 BSC |      |
| D2          | 6.50     | 6.80 |
| E           | 8.00 BSC |      |
| E2          | 6.50     | 6.80 |
| e           | 0.50 BSC |      |
| K           | 0.20     | ---  |
| L           | 0.30     | 0.50 |

### GENERIC MARKING DIAGRAM



- XXXXXXXXXX = Device Code
- A = Assembly Site
- WL = Wafer Lot
- YY = Year
- WW = Work Week
- G = Pb-Free Package

### RECOMMENDED SOLDERING FOOTPRINT



|                         |                              |  |
|-------------------------|------------------------------|--|
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| <b>DESCRIPTION:</b>     | <b>52 PIN QFN, 8X8, 0.5P</b> | <b>PAGE 1 OF 1</b>   |

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