

# NB3N401S

## 3.3 V Quad Channel Half-Duplex M-LVDS Driver Receiver

### Description

The NB3N401S is a 3.3 V supply Quad Multipoint Low Voltage Differential Signals (M-LVDS) line drivers and receivers. The device is TIA/EIA-899 compliant. The device offers the Type 1 receiver threshold at 0.0 V and the Type 2 receiver threshold at 0.1 V. The NB3N401S supports four independent Half Duplex bus configurations.

Each of the four sections has Pin (SEL) for selection of Type-1 and Type-2 receivers that detect the bus state with as little as 50 mV of differential input voltage over a common mode voltage range of -1 V to 3.4 V. The Type-1 receivers have near zero thresholds ( $\pm 50$  mV) and exhibit 25 mV of differential input voltage hysteresis to prevent output oscillations with slowly changing signals or loss of input. Type-2 receivers include an offset threshold to provide a detectable voltage under open-circuit, idle-bus, and other faults conditions.

The NB3N401S is offered in a 48 Pin 7 mm  $\times$  7 mm  $\times$  0.9 mm QFN package.

### Features

- Low-Voltage Differential 30 to 55  $\Omega$  Line Drivers and Receivers for Signaling Rates Up to 250 Mbps
- Clock Frequencies up to 125 MHz
- Type-1 Receivers Incorporate 25 mV of Hysteresis
- Type-2 Receivers Provide an Offset (100 mV)
- Compatible with TIA/EIA-899 Standard for Multipoint Data Interchange
- Controlled Driver Output Voltage Transition Times for Improved Signal Quality
- -1 V to 3.4 V Common-Mode Voltage Range Allows Data Transfer With up to 2 V of Ground Noise
- Bus Pins High Impedance when Disabled or  $V_{CC} \leq 1.5$  V
- Independent Enable for each Driver and Receiver
- Independent Select for each Type1 and Type2 Receivers
- M-LVDS Bus Power Up/Down Glitch Free
- Power Down Pin for Device Power Down
- Operating Range:  $V_{CC} = 3.3$  V  $\pm 0.3$  V (3.0 to 3.6 V)
- Operation from -40°C to 85°C.
- Enhanced ESD Protection: 7 kV HBM on all the Pins
- These are Pb-Free Devices

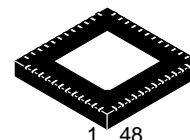
### Applications

- Mobile Base Station Back Plane System
- Central Office Switches
- Network Switches



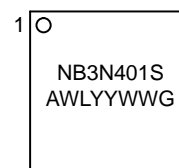
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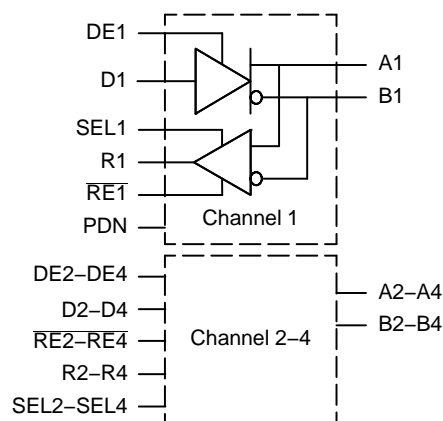
QFN48  
CASE 485EP

### MARKING DIAGRAM



NB3N401S = Specific Device Code  
A = Assembly Location  
WL = Wafer Lot  
YY = Year  
WW = Work Week  
G = Pb-Free Package

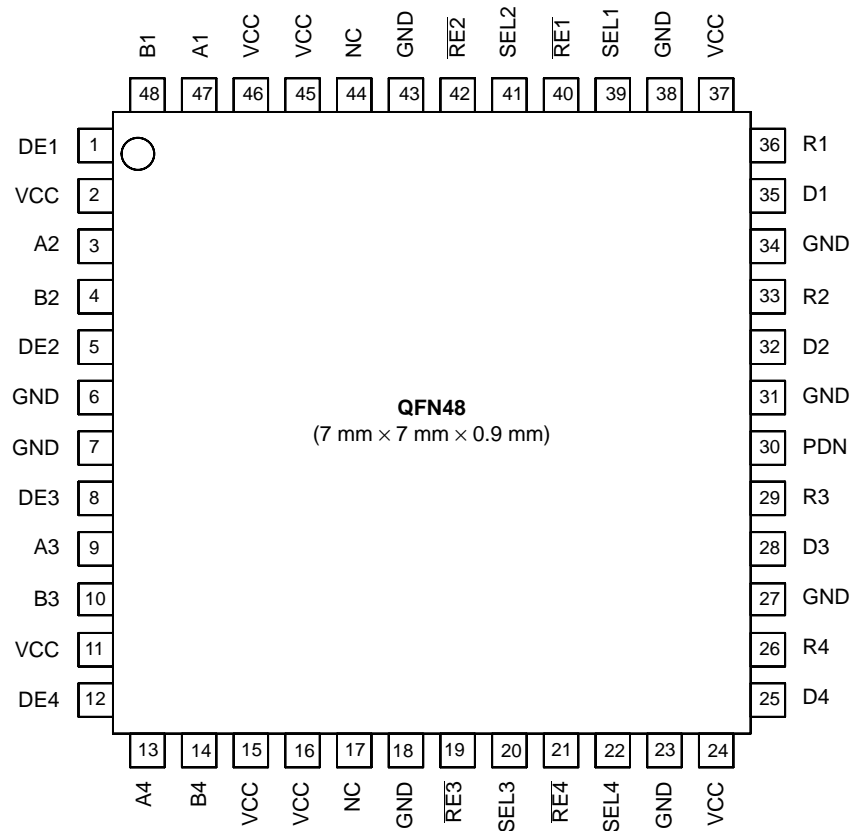
### LOGIC DIAGRAM



### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 14 of this data sheet.

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**Figure 1. Pinout Diagram**  
(Top View)

**Table 1. PIN DESCRIPTION**

| Number                           | Name      | I/O Type            | Description  |
|----------------------------------|-----------|---------------------|--|
| 1, 5, 8, 12                      | DE1-DE4   | INPUT               | Driver Enable Pins – Separate for each Driver, (HIGH = Active, LOW = High Z Output). This Pin will be pulled internally to Logic LOW when left open                                  |
| 2, 11, 15, 16, 24, 37, 45, 46    | VCC       |                     | Power Supply Pins. Pins must be connected to power supply to guarantee proper operations   |
| 3, 9, 13, 47                     | A1-A4     | M-LVDS Input/Output | Transceiver Input/Output Pins  |
| 4, 10, 14, 48                    | B1-B4     | M-LVDS Input/Output | Transceiver Invert Input/Output Pins   |
| 6, 7, 18, 23, 27, 31, 34, 38, 43 | GND       |                     | Ground Pins. All pins must be connected to Ground to guarantee proper operations   |
| 19, 21, 40, 42                   | RE1-RE4   | INPUT               | Receiver Enable Pins – Separate for each Receiver, (LOW = Active, HIGH = High Z Output). This Pin will be pulled internally to Logic HIGH when left open                             |
| 20, 22, 39, 41                   | SEL1-SEL4 | INPUT               | Failsafe Enable Pins. Separate for each Receiver section. LOW = Type 1 Receiver Input, HIGH = Type 2 Receiver Input. This Pin will be pulled internally to Logic HIGH when left open |
| 25, 28, 32, 35                   | D1-D4     | LVC MOS INPUT       | Driver Input Pins  |
| 26, 29, 33, 36                   | R1-R4     | LVC MOS OUTPUT      | Receiver Output Pins   |
| 30                               | PDN       | INPUT               | Power Down Pin. When pulled Low, Device powers down. (HIGH = Active, LOW = High Z Output). This Pin will be pulled internally to Logic LOW when left open.                           |
| GNDPAD                           |           |                     | Exposed PAD – Must be connected to GND on the PCB for proper device operation  |
| 17, 44                           | NC        |                     | No Connect (Pins must be left open)  |

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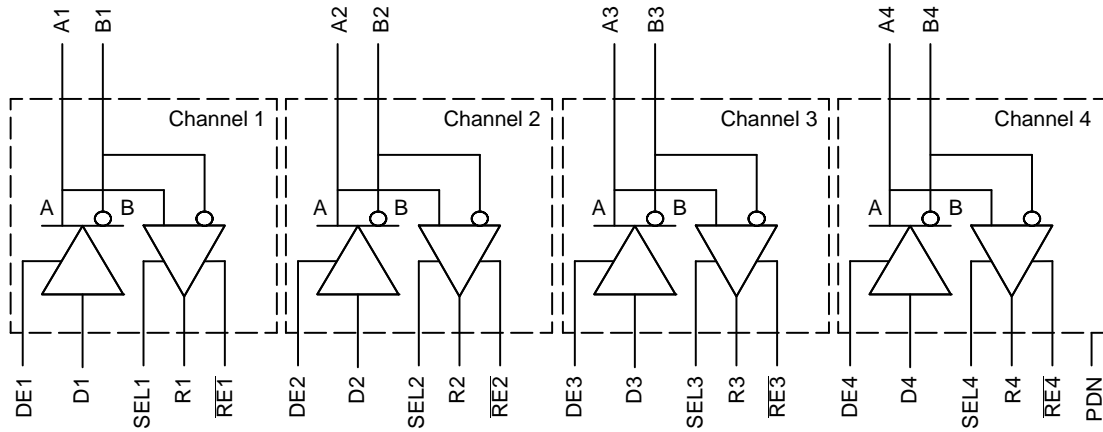


Figure 2. Block Diagram

Table 2. DEVICE FUNCTION TABLE

|                       |   |               |            |               |               |          |
|-----------------------|---|---------------|------------|---------------|---------------|----------|
| <b>TYPE1 Receiver</b> | <b>Inputs</b>                                   |               |            | <b>Output</b> |               |          |
|                       | $V_{ID} = V_A - V_B$                            | <b>RE</b>     | <b>SEL</b> | <b>PDN</b>    | <b>R</b>      |          |
|                       | $V_{ID} > 35 \text{ mV}$                        | L             | L          | H             | H             |          |
|                       | $-35 \text{ mV} \leq V_{ID} \leq 35 \text{ mV}$ | L             | L          | H             | ?             |          |
|                       | $V_{ID} < 35 \text{ mV}$                        | L             | L          | H             | L             |          |
|                       | Open  | L             | L          | H             | ?             |          |
|                       | X   | Open          | X          | H             | Z             |          |
|                       | X   | X             | X          | L             | Z             |          |
| X                     | H   | X             | H          | Z             |               |          |
| <b>TYPE2 Receiver</b> | <b>Inputs</b>                                   |               |            | <b>Output</b> |               |          |
|                       | $V_{ID} = V_A - V_B$                            | <b>RE</b>     | <b>SEL</b> | <b>PDN</b>    | <b>R</b>      |          |
|                       | $V_{ID} > 150 \text{ mV}$                       | L             | H          | H             | H             |          |
|                       | $50 \text{ mV} \leq V_{ID} \leq 150 \text{ mV}$ | L             | H          | H             | ?             |          |
|                       | $V_{ID} < 50 \text{ mV}$                        | L             | H          | H             | L             |          |
|                       | Open  | L             | H          | H             | L             |          |
|                       | X   | Open          | X          | H             | Z             |          |
|                       | X   | H             | X          | H             | Z             |          |
| X                     | X   | X             | L          | Z             |               |          |
| <b>Driver</b>         | <b>Inputs</b>                                   | <b>Enable</b> |            |               | <b>Output</b> |          |
|                       | <b>D</b>  | <b>DE</b>     |            |               | <b>A</b>      | <b>B</b> |
|                       | L   | H             |            |               | L             | H        |
|                       | H   | H             |            |               | H             | L        |
|                       | OPEN  | H             |            |               | L             | H        |
|                       | X   | OPEN          |            |               | Z             | Z        |
| X                     | L   |               |            | Z             | Z             |          |

\*H = HIGH, L = LOW, Z = High Impedance, X Don't Care, ? = Indeterminate (Transition State)

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**Table 3. ATTRIBUTES** (Note 1)

| Characteristics   |   |          | Value                             |
|---|---|----------|-----------------------------------|
| ESD Protection  | Human Body Model (JEDEC Standard JS-001-2014)           | All Pins | ±7 kV                             |
|   | Charged Device Model (JEDEC Standard 22, Method C101-D) | All Pins | ±1500 V                           |
| Moisture Sensitivity (Note 1)                           |   |          | Level 3                           |
| Flammability Rating<br>Oxygen Index: 28 to 34           |   |          | UL-94 Code V-0 A 1/8"<br>28 to 34 |
| Meets or Exceeds JEDEC Spec EIA/JESD78 IC Latch-Up Test |   |          |                                   |

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

**Table 4. MAXIMUM RATINGS** (Note 1)

| Symbol           | Parameter                               | Condition              | Rating   | Unit |
|------------------|---|------------------------|--|------|
| V <sub>CC</sub>  | Supply Voltage                          |                        | -0.5 ≤ V <sub>CC</sub> ≤ 4.0                                   | V    |
| V <sub>IN</sub>  | Input Voltage                           | D, DE, RE, SEL<br>A, B | -0.5 ≤ V <sub>IN</sub> ≤ 4.0<br>-1.8 ≤ V <sub>IN</sub> ≤ 4.0   | V    |
| V <sub>OUT</sub> | Output Voltage                          | R<br>A or B            | -0.3 ≤ V <sub>OUT</sub> ≤ 4.0<br>-1.8 ≤ V <sub>OUT</sub> ≤ 4.0 | V    |
| T <sub>A</sub>   | Operating Temperature Range, Industrial |                        | -40 to +85   | °C   |
| T <sub>J</sub>   | Maximum Junction Temperature            |                        | 140  | °C   |
| T <sub>STG</sub> | Storage Temperature Range               |                        | -65 to +150  | °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.

1. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and not valid simultaneously. If stress limits are exceeded device functional operation is not implied, damage may occur and reliability may be affected.

**Table 5. THERMAL CHARACTERISTICS**

| Symbol          | Parameter                              | Condition  | Rating    | Unit |
|-----------------|--|--|-----------|------|
| θ <sub>JP</sub> | Thermal Resistance (Junction-to-Pad)   | (Note 2)   | 1.5 (Typ) | °C/W |
| θ <sub>JC</sub> | Thermal Resistance (Junction-to-Case)  | (Note 2)   | 16 (Typ)  | °C/W |
| θ <sub>JB</sub> | Thermal Resistance (Junction-to-Board) | (Note 2)   | 11 (Typ)  | °C/W |
| P <sub>D</sub>  | Power Dissipation                      | RE = 0 V, DE = 0 V, CL = 15 pF,<br>VID = 400 mV, 125 MHz,<br>All Other Pins Open | 382 (Max) | mW   |

2. JEDEC standard multilayer board – 2S2P (2 signal, 2 power).

**Table 6. DC CHARACTERISTICS** (V<sub>CC</sub> = 3.3 V ±0.3 V, GND = 0 V, T<sub>A</sub> -40°C TO +85°C)

| Symbol           | Parameter                               |                                   | Test Conditions   | Min  | Typ | Max             | Unit |
|------------------|---|-----------------------------------|---|------|-----|-----------------|------|
| I <sub>CC</sub>  | Power Supply Current                    | Driver Only                       | Receiver Disabled, Driver Enabled, RE and DE at V <sub>CC</sub> , R <sub>L</sub> = 50 Ω, 125 MHz, All Others Open, PDN = High                       |      |     | 76              | mA   |
|                  |   | Both Driver and Receiver Disabled | Driver and Receiver Disabled, RE at V <sub>CC</sub> , DE at 0 V, R <sub>L</sub> = No Load, 125 MHz, All Others Open, PDN = High                     |      |     | 10              |      |
|                  |   | Both Driver and Receiver Enabled  | Driver and Receiver Enabled, RE at 0 V, DE at V <sub>CC</sub> , R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 15 pF, 125 MHz, All Others Open, PDN = High |      |     | 165             |      |
|                  |   | Receiver Only                     | Receiver Enabled, Driver Disabled, RE and DE at 0 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 15 pF, 125 MHz, All Others Open, PDN = High            |      |     | 100             |      |
| PDN              | Power Down (PDN = L)                    |                                   |   | -    | -   | 5               | mA   |
| V <sub>IH</sub>  | Input HIGH Voltage                      |                                   |   | 2    | -   | V <sub>CC</sub> | V    |
| V <sub>IL</sub>  | Input LOW Voltage                       |                                   |   | GND  | -   | 0.8             | V    |
| V <sub>BUS</sub> | Voltage at any Bus Terminal VA, VB      |                                   |   | -1.4 | -   | 3.8             | V    |
| VID              | Magnitude of Differential Input Voltage |                                   |   | 0.05 | -   | V <sub>CC</sub> | V    |

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**Table 7. ELECTRICAL CHARACTERISTICS** ( $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ ,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

| Symbol                      | Parameter   | Test Conditions   | Min  | Typ | Max  | Unit          |
|-----------------------------|---|---|------|-----|------|---------------|
| <b>BUS INPUT AND OUTPUT</b> |   |   |      |     |      |               |
| $I_A$                       | Receiver or Transceiver with Driver Disabled Input Current                              | $V_A = 3.8\text{ V}$ , $V_B = 1.2\text{ V}$<br>$V_A = -1.4\text{ V}$ , $V_B = 1.2\text{ V}$   | -    | -   | 32   | $\mu\text{A}$ |
| $I_B$                       | Receiver or Transceiver with Driver Disabled Input Current                              | $V_B = 3.8\text{ V}$ , $V_A = 1.2\text{ V}$<br>$V_B = -1.4\text{ V}$ , $V_A = 1.2\text{ V}$   | -    | -   | 32   | $\mu\text{A}$ |
| $I_{AB}$                    | Receiver or Transceiver with Driver Disabled Differential Input Current ( $I_A - I_B$ ) | $V_A = V_B$ , $-1.4\text{ V} \leq V_A \leq 3.8\text{ V}$  | -4   | -   | 4    | $\mu\text{A}$ |
| $I_{AOFF}$                  | Receiver or Transceiver Power-Off Input Current   | $V_A = 3.8\text{ V}$ , $V_B = 1.2\text{ V}$ , $0\text{ V} \leq V_{CC} \leq 1.5\text{ V}$<br>$V_A = -1.4\text{ V}$ , $V_B = 1.2\text{ V}$ , $0\text{ V} \leq V_{CC} \leq 1.5\text{ V}$ | -    | -   | 32   | $\mu\text{A}$ |
| $I_{BOFF}$                  | Receiver or Transceiver Power-Off Input Current   | $V_B = 3.8\text{ V}$ , $V_A = 1.2\text{ V}$ , $0\text{ V} \leq V_{CC} \leq 1.5\text{ V}$<br>$V_B = -1.4\text{ V}$ , $V_A = 1.2\text{ V}$ , $0\text{ V} \leq V_{CC} \leq 1.5\text{ V}$ | -    | -   | 32   | $\mu\text{A}$ |
| $I_{ABOFF}$                 | Receiver or Transceiver Power-Off Differential Input Current ( $I_{AOFF} - I_{BOFF}$ )  | $V_A = V_B$ , $0\text{ V} \leq V_{CC} \leq 1.5\text{ V}$ ,<br>$-1.4\text{ V} \leq V_A \leq 3.8\text{ V}$  | -4   | -   | 4    | $\mu\text{A}$ |
| $C_A$                       | Transceiver with Driver Disabled Input Capacitance                                      | $V_A = 0.4 \sin(30e^{6\pi t}) + 0.5\text{ V}$ , $V_B = 1.2\text{ V}$  | -    | 5   | -    | $\text{pF}$   |
| $C_B$                       | Transceiver with Driver Disabled Input Capacitance                                      | $V_B = 0.4 \sin(30e^{6\pi t}) + 0.5\text{ V}$ , $V_A = 1.2\text{ V}$  | -    | 5   | -    | $\text{pF}$   |
| $C_{AB}$                    | Transceiver with Driver Disabled Differential Input Capacitance                         | $V_{AB} = 0.4 \sin(30e^{6\pi t})$   | -    | -   | 3    | $\text{pF}$   |
| $C_{A/B}$                   | Transceiver with Driver Disabled Input Capacitance Balance ( $C_A/C_B$ )                |   | 0.99 | -   | 1.01 |               |

## DRIVER

|                     |   |   |              |   |             |               |
|---------------------|---|---|--------------|---|-------------|---------------|
| $ V_{AB} $          | Differential Output Voltage Amplitude (A, B)                                  | (Figure 5)                                    | 480          | - | 650         | $\text{mV}$   |
| $\Delta V_{AB} $    | Change in Differential Output Voltage Amplitude between Logic states (A, B)   | (Figure 5)                                    | -50          | - | 50          | $\text{mV}$   |
| $V_{OS(SS)}$        | Steady State Common Mode Output Voltage (A, B)                                | (Figure 8)                                    | 0.7          | - | 1.1         | $\text{V}$    |
| $\Delta V_{OS(SS)}$ | Change in Steady state Common Mode Output Voltage between Logic states (A, B) | (Figure 8)                                    | -50          | - | 50          | $\text{mV}$   |
| $V_{OS(PP)}$        | Peak to Peak Common Mode Output Voltage (A, B)                                | (Figure 8)                                    | -            | - | 150         | $\text{mV}$   |
| $V_{AOC}$           | Maximum Steady State Open Circuit Output Voltage (A, B)                       | (Figure 7)                                    | 0            | - | 2.4         | $\text{V}$    |
| $V_{BOC}$           | Maximum Steady State Open Circuit Output Voltage (A, B)                       | (Figure 7)                                    | 0            | - | 2.4         | $\text{V}$    |
| $V_{P(H)}$          | Voltage Overshoot Low to High Level Output (A, B)                             | (Figure 9)                                    | -            | - | $1.2V_{SS}$ | $\text{V}$    |
| $V_{P(L)}$          | Voltage Overshoot High to Low Level Output (A, B)                             | (Figure 9)                                    | $-0.2V_{SS}$ | - | -           | $\text{V}$    |
| $I_{IH}$            | High Level Input Current (D, DE)  | $V_{IH} = 2\text{ V}$ to $V_{CC}$             | -            | - | 10          | $\mu\text{A}$ |
| $I_{IL}$            | Low Level Input Current (D, DE)   | $V_{IL} = GND$ to $0.8\text{ V}$              | -            | - | 10          | $\mu\text{A}$ |
| $ I_{OS} $          | Differential Short Circuit Output Current Amplitude (A, B)                    | (Figure 6)                                    | -            | - | 24          | $\text{mA}$   |
| $C_I$               | Input Capacitance (D, DE)   | $V_I = 0.4 \sin(30e^{6\pi t}) + 0.5\text{ V}$ | -            | 5 | -           | $\text{pF}$   |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions. External DC Source when used for measurement to have low Ripple/Noise at board input.

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**Table 7. ELECTRICAL CHARACTERISTICS** ( $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ ,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ) (continued)

| Symbol          | Parameter   | Test Conditions                      | Min       | Typ     | Max       | Unit          |
|-----------------|---|--------------------------------------|-----------|---------|-----------|---------------|
| <b>RECEIVER</b> |   |                                      |           |         |           |               |
| $V_{IT+}$       | +ve Going Differential Input Voltage Threshold (A,B)                | Type 1 (Table 8)<br>Type 2 (Table 9) | –<br>–    | –<br>–  | 35<br>150 | mV            |
| $V_{IT-}$       | –ve Going Differential Input Voltage Threshold (A,B)                | Type 1 (Table 8)<br>Type 2 (Table 9) | –35<br>50 | –<br>–  | –<br>–    | mV            |
| $V_{HYS}$       | Differential Input Voltage Hysteresis [ $V_{IT+} - V_{IT-}$ ] (A,B) | Type 1 (Table 8)<br>Type 2 (Table 9) | –<br>–    | 25<br>0 | –<br>–    | mV            |
| $V_{OH}$        | High Level Output Voltage (R)                                       | $I_{OH} = -8\text{ mA}$              | 2.4       | –       | –         | V             |
| $V_{OL}$        | Low Level Output Voltage (R)  | $I_{OL} = 8\text{ mA}$               | –         | –       | 0.4       | V             |
| $I_{IH}$        | High Level Input Current ( $\overline{RE}$ )                        | $V_{IH} = 2\text{ V}$ to $V_{CC}$    | –10       | –       | –         | $\mu\text{A}$ |
| $I_{IL}$        | Low Level Input Current ( $\overline{RE}$ )                         | $V_{IL} = GND$ to $0.8\text{ V}$     | –10       | –       | –         | $\mu\text{A}$ |
| $I_{OZ}$        | High Impedance Output Current (R)                                   | $V_O = 0\text{ V}$ or $V_{CC}$       | –10       | –       | 15        | $\mu\text{A}$ |

External DC Source when used for measurement to have low Ripple/Noise at board input.

## DRIVER SWITCHING

|                |   |   |     |     |     |    |
|----------------|---|---|-----|-----|-----|----|
| $t_{pLH}$      | Propagation Delay time, Low to High Level Output    | (Figure 9)  | 1.3 | 1.9 | 2.4 | ns |
| $t_{pHL}$      | Propagation Delay time, High to Low Level Output    | (Figure 9)  | 1.3 | 1.9 | 2.4 | ns |
| $t_r$          | Differential Output Signal Rise Time                | (Figure 9)  | 0.9 | –   | 2   | ns |
| $t_f$          | Differential Output Signal Fall Time                | (Figure 9)  | 0.9 | –   | 2.2 | ns |
| $t_{SK(o)}$    | Output Skew   | (Figure 9)  | –   | –   | 200 | ps |
| $t_{SK(pp)}$   | Pulse skew $ t_{pHL} - t_{pLH} $                    | (Figure 9)  | –   | –   | 150 | ps |
| $t_{SK(pp)}$   | Device to Device Skew (Note 2)                      | (Figure 9)  | –   | –   | 300 | ps |
| $T_{JIT(per)}$ | Periodic Jitter RMS (1 Standard deviation) (Note 1) | 125 MHz Clock Input, $t_r = t_f = 0.5\text{ ns}$ (10% to 90%), Switching on All Channels (Figure 10)            | –   | –   | 2   | ps |
| $T_{JIT(cc)}$  | Cycle to Cycle Jitter RMS (Note 1)                  | 125 MHz Clock Input, $t_r = t_f = 0.5\text{ ns}$ (10% to 90%), Switching on All Channels (Figure 10)            | –   | –   | 9   | ps |
| $T_{JIT(det)}$ | Deterministic Jitter (Note 1)                       | Switching on All Channels, 250 Mbps $2^{15}-1$ PRBS Input, $t_r = t_f = 0.5\text{ ns}$ (10% to 90%) (Figure 10) | –   | –   | 290 | ps |
| $T_{JIT(r)}$   | Random Jitter (Note 1)                              | Switching on All Channels, 250 Mbps $2^{15}-1$ PRBS Input, $t_r = t_f = 0.5\text{ ns}$ (10% to 90%) (Figure 10) | –   | –   | 16  | ps |
| $t_{pZH}$      | Enable Time, High Impedance to High Level Output    | (Figure 11)   | –   | –   | 7   | ns |
| $t_{pZL}$      | Enable Time, High Impedance to Low Level Output     | (Figure 11)   | –   | –   | 7   | ns |
| $t_{pHZ}$      | Disable Time, High Level to High Impedance Output   | (Figure 11)   | –   | –   | 7   | ns |
| $t_{pLZ}$      | Disable Time, Low Level to High Impedance Output    | (Figure 11)   | –   | –   | 7   | ns |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

- Jitter is ensured by Design and characterization
- $t_{SK(pp)}$  is the amplitude of the difference in propagation delay time between any specified terminals of two Devices that operates with same Power Supply Voltage, test circuits at same temperature and having identical packages.

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| Symbol                    | Parameter  | Test Conditions   | Min    | Typ       | Max        | Unit |
|---------------------------|--|---|--------|-----------|------------|------|
| <b>RECEIVER SWITCHING</b> |  |   |        |           |            |      |
| $t_{pLH}$                 | Propagation Delay time, Low to High Level Output         | $C_L = 15\text{ pF}$ (Figure 12)  | 2.5    | 4.5       | 6.4        | ns   |
| $t_{pHL}$                 | Propagation Delay time, High to Low Level Output         | $C_L = 15\text{ pF}$ (Figure 12)  | 2.5    | 4.5       | 6.4        | ns   |
| $t_r$                     | Output Signal Rise Time                                  | $C_L = 15\text{ pF}$ (Figure 12)  | 1.4    | –         | 2.65       | ns   |
| $t_f$                     | Output Signal Fall Time                                  | $C_L = 15\text{ pF}$ (Figure 12)  | 1.15   | –         | 2.35       | ns   |
| $t_{SK(o)}$               | Output Skew  | $C_L = 15\text{ pF}$ (Figure 12)  | –      | –         | 350        | ps   |
| $t_{SK(pp)}$              | Pulse Skew ( $ t_{pHL} - t_{pLH} $ )<br>Type 1<br>Type 2 | $C_L = 15\text{ pF}$ (Figure 12)  | –<br>– | 35<br>150 | 210<br>700 | ps   |
| $t_{SK(pp)}$              | Device to Device Skew (Note 2)                           | $C_L = 15\text{ pF}$ (Figure 12)  | –      | –         | 800        | ps   |
| $T_{JIT(per)}$            | Periodic Jitter RMS<br>(1 Standard Deviation) (Note 1)   | 125 MHz Clock Input, $t_r = t_f = 0.5\text{ ns}$<br>(10% to 90%), Switching on All Channels<br>(Figure 13)            | –      | –         | 6          | ps   |
| $T_{JIT(cc)}$             | Cycle to Cycle Jitter RMS (Note 1)                       | 125 MHz Clock Input, $t_r = t_f = 0.5\text{ ns}$<br>(10% to 90%), Switching on All Channels<br>(Figure 13)            | –      | –         | 13         | ps   |
| $T_{JIT(det)}$            | Deterministic Jitter (Note 1)<br>Type 1<br>Type 2        | Switching on All Channels, 250 Mbps $2^{15}-1$<br>PRBS Input, $t_r = t_f = 0.5\text{ ns}$ (10% to 90%)<br>(Figure 13) | –<br>– | –<br>–    | 800<br>945 | ps   |
| $T_{JIT(r)}$              | Random Jitter (Note 1)<br>Type 1<br>Type 2               | Switching on All Channels, 250 Mbps $2^{15}-1$<br>PRBS Input, $t_r = t_f = 0.5\text{ ns}$ (10% to 90%)<br>(Figure 13) | –<br>– | –<br>–    | 90<br>65   | ps   |
| $t_{pZH}$                 | Enable Time, High Impedance to High Level Output         | $C_L = 15\text{ pF}$ (Figure 14)  | –      | –         | 15         | ns   |
| $t_{pZL}$                 | Enable Time, High Impedance to Low Level Output          | $C_L = 15\text{ pF}$ (Figure 14)  | –      | –         | 15         | ns   |
| $t_{pHZ}$                 | Disable Time, High Level to High Impedance Output        | $C_L = 15\text{ pF}$ (Figure 14)  | –      | –         | 10         | ns   |
| $t_{pLZ}$                 | Disable Time, Low Level to High Impedance Output         | $C_L = 15\text{ pF}$ (Figure 14)  | –      | –         | 10         | ns   |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

- Jitter is ensured by Design and characterization
- $t_{SK(pp)}$  is the amplitude of the difference in propagation delay time between any specified terminals of two Devices that operates with same Power Supply Voltage, test circuits at same temperature and having identical packages.

# NB3N401S

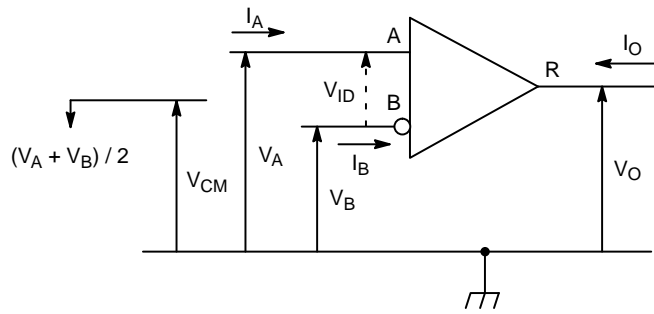


Figure 3. Receiver Voltage and Current Definitions

Table 8. TYPE 1 RECEIVER INPUT THRESHOLD TEST VOLTAGES

| Applied Voltages |                 | Resulting Differential Input Voltage | Resulting Common Mode Input Voltage | Receiver Output |
|------------------|-----------------|--------------------------------------|-------------------------------------|-----------------|
| V <sub>IA</sub>  | V <sub>IB</sub> | V <sub>ID</sub>                      | V <sub>IC</sub>                     |                 |
| 2.400            | 0.000           | 2.400                                | 1.200                               | H               |
| 0.000            | 2.400           | -2.400                               | 1.200                               | L               |
| 3.400            | 3.365           | 0.035                                | 3.3825                              | H               |
| 3.365            | 3.400           | -0.035                               | 3.3825                              | L               |
| -0.965           | -1.000          | 0.035                                | -0.9825                             | H               |
| -1.000           | -0.965          | -0.035                               | -0.9825                             | L               |

\*H = High Level, L = Low Level, Output State assumes Receiver is Enabled ( $\overline{RE} = L$ )

Table 9. TYPE 2 RECEIVER INPUT THRESHOLD TEST VOLTAGES

| Applied Voltages |                 | Resulting Differential Input Voltage | Resulting Common Mode Input Voltage | Receiver Output |
|------------------|-----------------|--------------------------------------|-------------------------------------|-----------------|
| V <sub>IA</sub>  | V <sub>IB</sub> | V <sub>ID</sub>                      | V <sub>IC</sub>                     |                 |
| 2.400            | 0.000           | 2.400                                | 1.200                               | H               |
| 0.000            | 2.400           | -2.400                               | 1.200                               | L               |
| 3.400            | 3.25            | 0.150                                | 3.325                               | H               |
| 3.400            | 3.35            | 0.050                                | 3.375                               | L               |
| -0.850           | -1.000          | 0.150                                | -0.925                              | H               |
| -0.950           | -1.000          | 0.050                                | -0.975                              | L               |

\*H = High Level, L = Low Level, Output State assumes Receiver is Enabled ( $\overline{RE} = L$ )

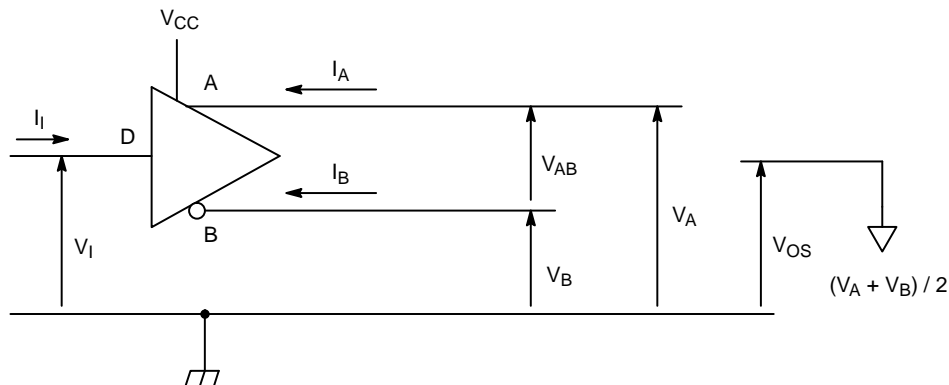


Figure 4. Driver Voltage and Current Definitions



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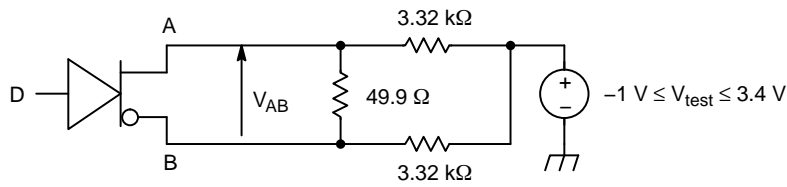


Figure 5. Differential Output Voltage Test Circuit

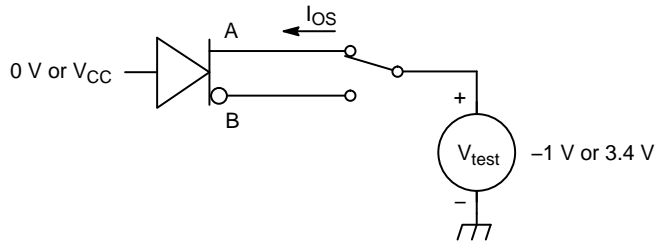


Figure 6. Driver Short-Circuit Test Circuit

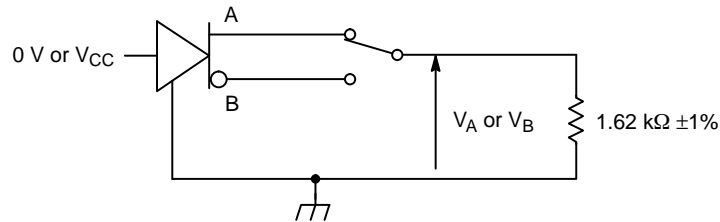
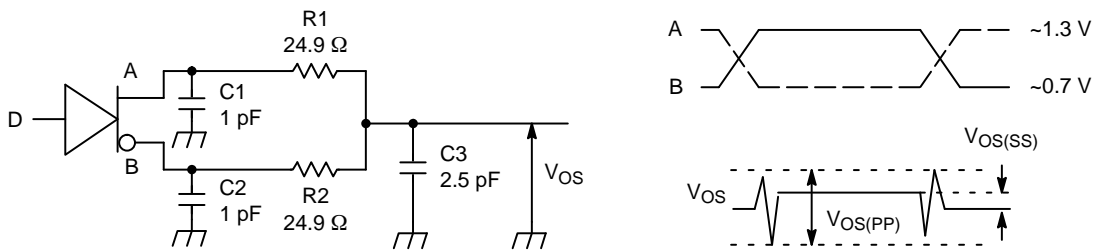


Figure 7. Maximum Steady State Output Voltage

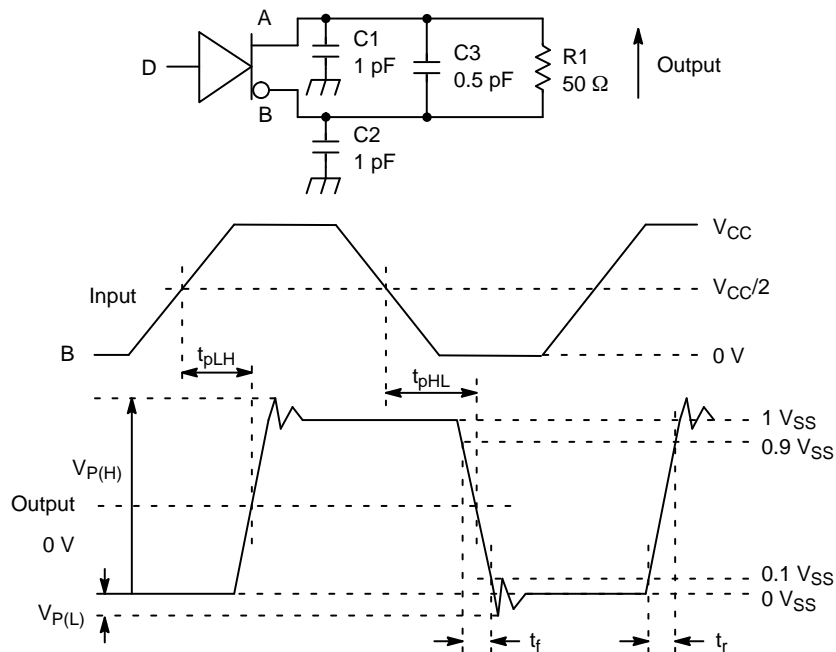


Notes:

1. All Input pulses are supplied by a Generator having characteristics as follows:  $t_r$  or  $t_f \leq 1$  ns, pulse frequency = 1 MHz & Duty cycle = 50 ± 5%.
2. Capacitor values indicated is inclusive of fixture and instrumentation Capacitance with 20 mm of the D.U.T. and are ± 20%.
3. All Resistors are metal Film, Surface Mount, ± 1% and located within 20 mm of the D.U.T.
4. The measurement of  $V_{OS(pp)}$  is made on Test equipment with a -3 dB Bandwidth of at least 1 GHz.

Figure 8. Test Circuit and Definitions for the Driver Common-Mode Output Voltage

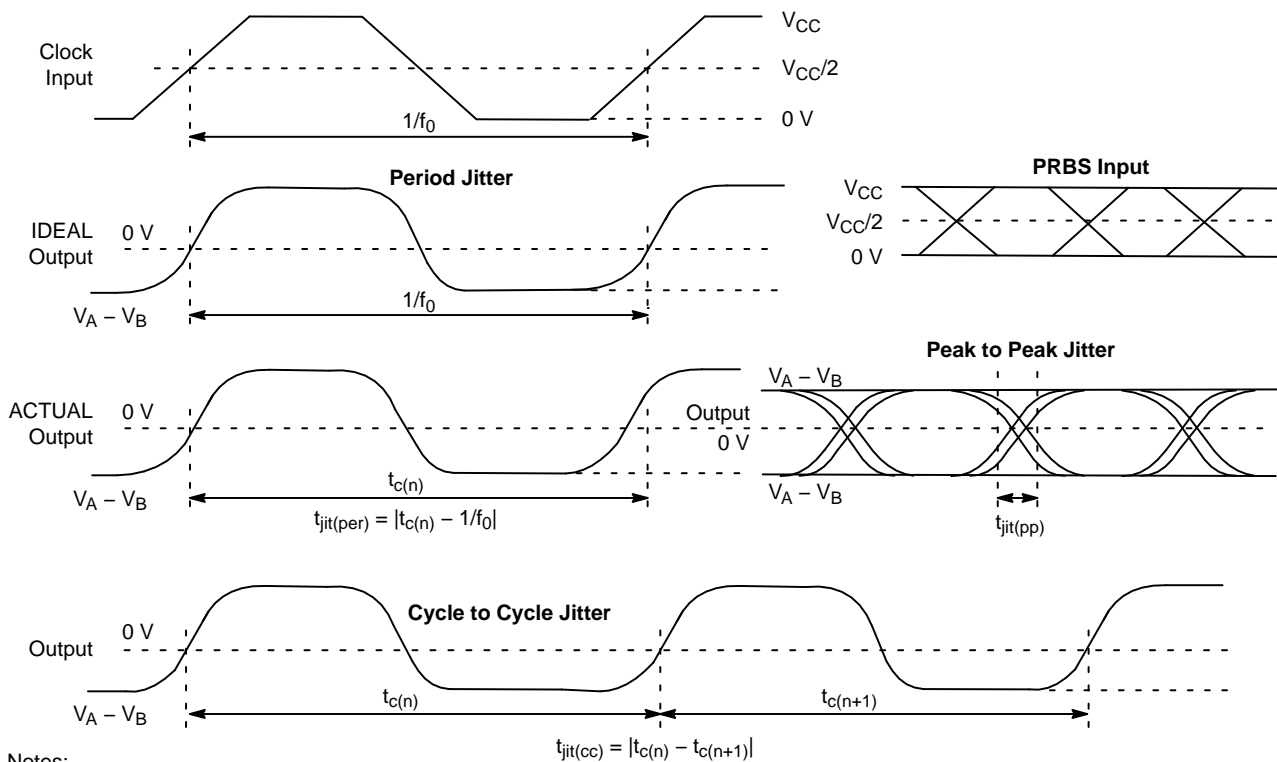
# NB3N401S



**Notes:**

1. All Input pulses are supplied by a Generator having characteristics as follows:  $t_r$  or  $t_f \leq 1$  ns, pulse frequency = 1 MHz & Duty cycle =  $50 \pm 5\%$ .
2. Capacitor values indicated is inclusive of fixture and instrumentation Capacitance with 20 mm of the D.U.T. and are  $\pm 20\%$ .
3. All Resistors are metal Film, Surface Mount,  $\pm 1\%$  and located within 20 mm of the D.U.T.
4. The measurement is made on Test equipment with a  $-3$  dB Bandwidth of at least 1 GHz.

**Figure 9. Driver Test Circuit, Timing, and Voltage Definitions for the Differential Output Signal**

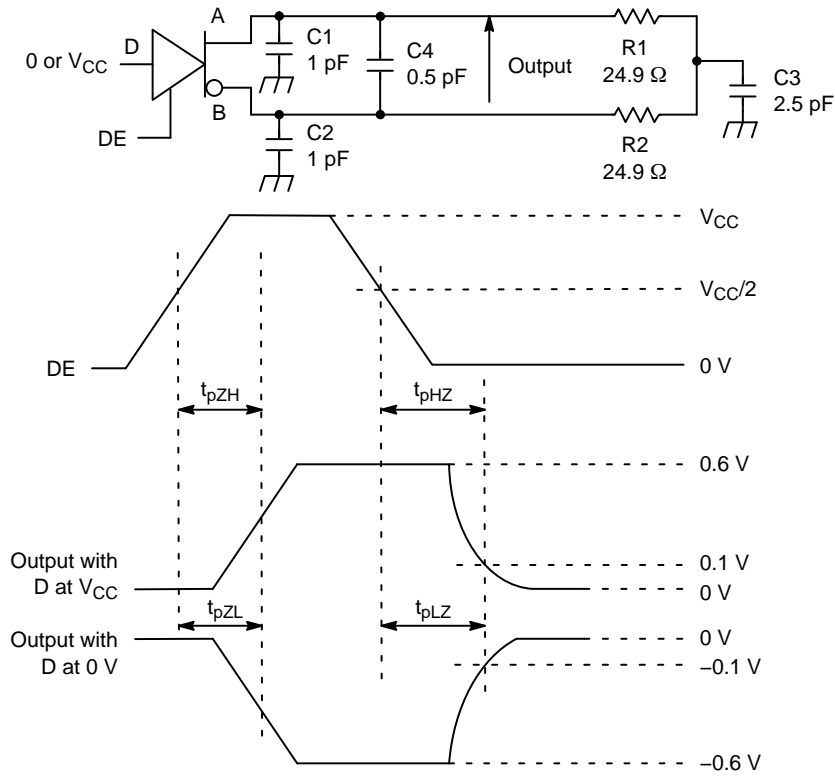


**Notes:**

1. Instrument used for generating Input Pulses and for Jitter measurement – Agilent 15433B BERT Stimulus, Tektronix DPO70804 running TDSJIT3 application software.
2. Period Jitter and Cycle to Cycle Jitter measured using a 125 MHz  $50 \pm 1\%$  Duty Cycle Clock Input over 75K samples.
3. Deterministic Jitter and Random Jitter are measured using 250 Mbps  $2^{15} - 1$  PRBS Input, measured over BER =  $10^{-12}$

**Figure 10. Driver Jitter Measurement Waveforms**

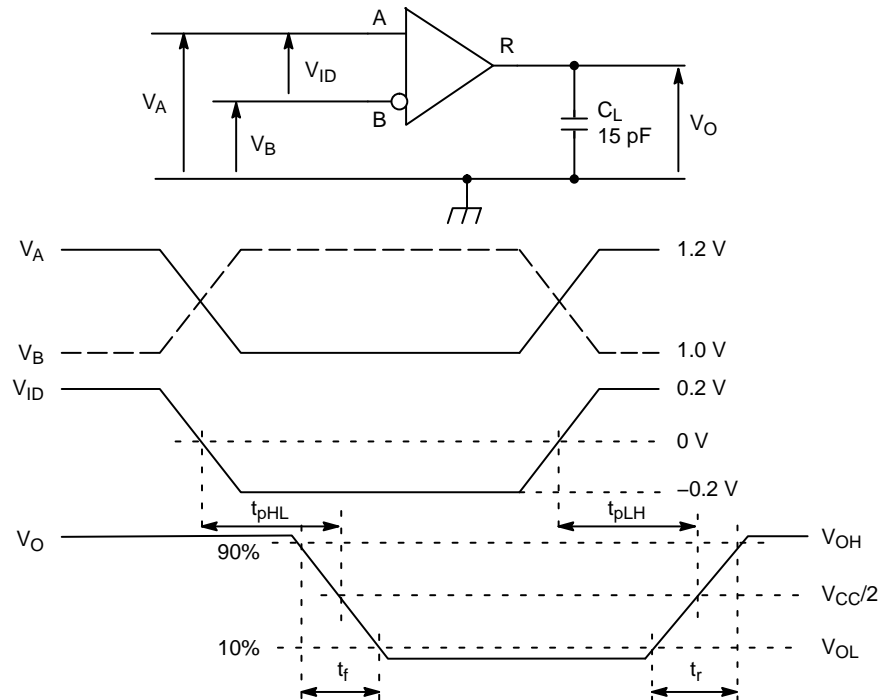
## NB3N401S



**Notes:**

1. All Input pulses are supplied by a Generator having characteristics as follows:  $t_r$  or  $t_f \leq 1$  ns, pulse frequency = 1 MHz & Duty cycle = 50 ±5%.
2. Capacitor values indicated is inclusive of fixture and instrumentation Capacitance with 20 mm of the D.U.T. and are ±20%.
3. All Resistors are metal Film, Surface Mount, ±1% and located within 20 mm of the D.U.T.
4. The measurement is made on Test equipment with a -3 dB Bandwidth of at least 1 GHz.

**Figure 11. Driver Enable and Disable Time Circuit and Definitions**

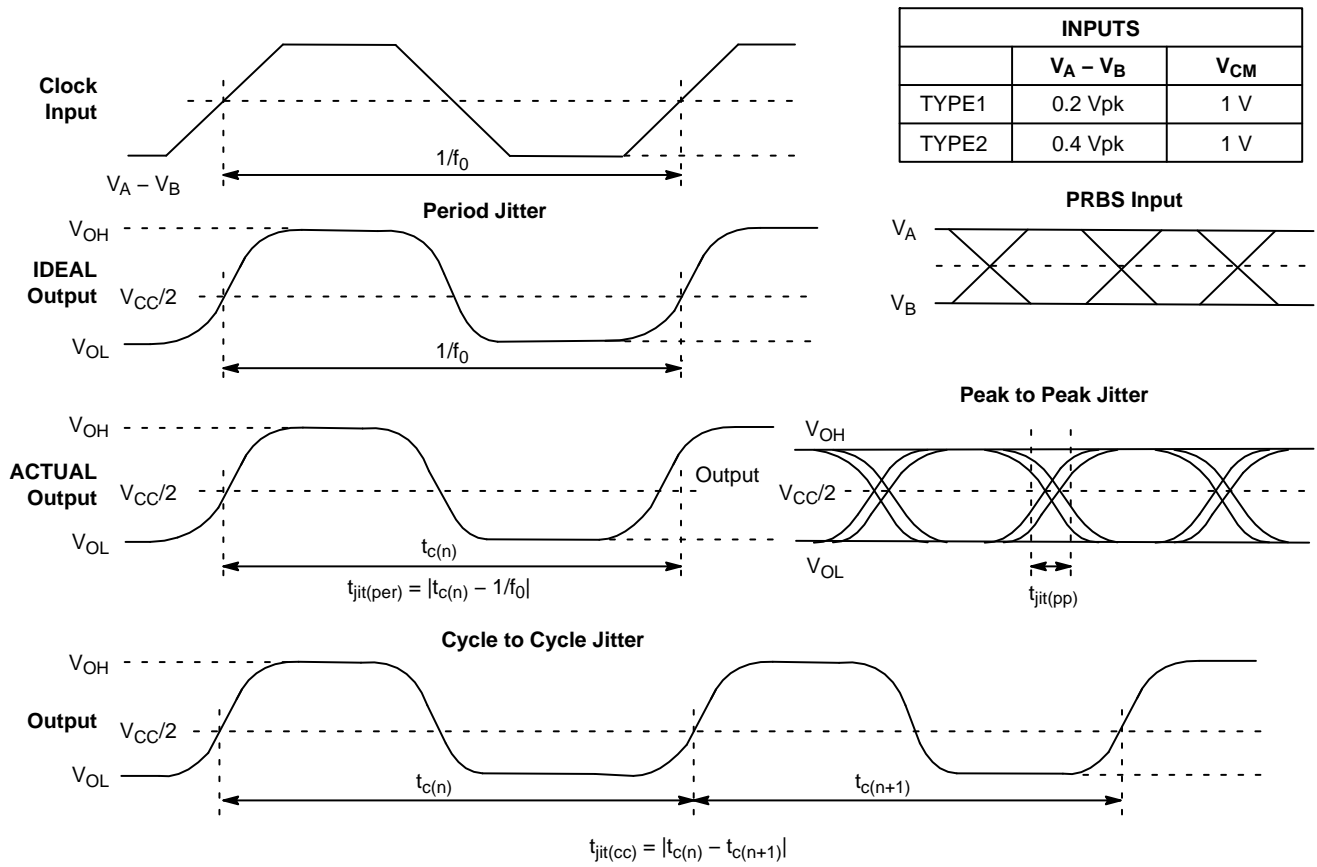


**Notes:**

1. All Input pulses are supplied by a Generator having characteristics as follows:  $t_r$  or  $t_f \leq 1$  ns, pulse frequency = 1 MHz & Duty cycle = 50 ±5%.
2. The measurement is made on Test equipment with a -3 dB Bandwidth of at least 1 GHz.

**Figure 12. Receiver Timing Test Circuit Waveforms**

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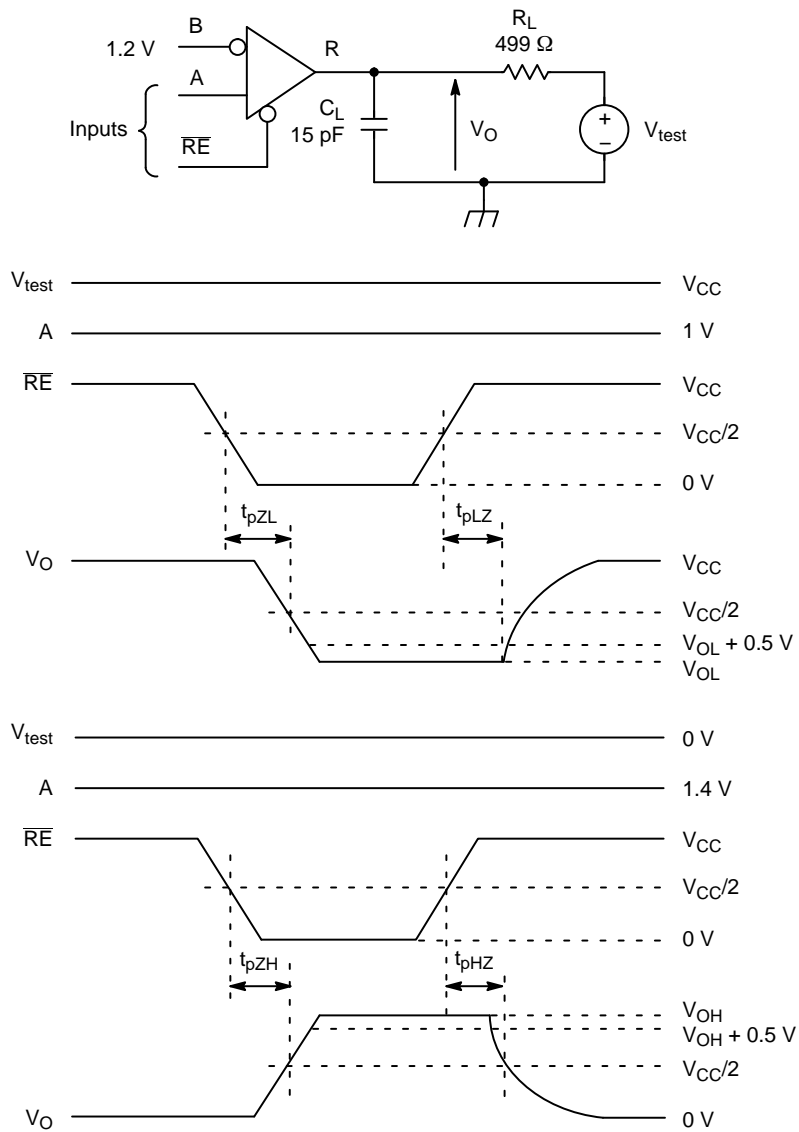


**Notes:**

1. Instrument used for generating Input Pulses and for Jitter measurement – Agilent 15433B BERT Stimulus, Tektronix DPO70804 running TDSJIT3 application software.
2. Period Jitter and Cycle to Cycle Jitter measured using a 125 MHz 50 ±1% Duty Cycle Clock Input over 75K samples.
3. Deterministic Jitter and Random Jitter are measured using 250 Mbps 2<sup>15</sup> – 1 PRBS Input, measured over BER = 10<sup>-12</sup>

**Figure 13. Receiver Jitter Measurement Waveforms**

## NB3N401S



**Notes:**

1. All Input pulses are supplied by a Generator having characteristics as follows:  $t_r$  or  $t_f \leq 1$  ns, pulse frequency = 1 MHz & Duty cycle =  $50 \pm 5\%$ .
2. All Resistors are metal Film, Surface Mount,  $\pm 1\%$  and located within 20 mm of the D.U.T.
3.  $C_L$  is combination of 20% tolerance low-loss Ceramic Surface Mount Capacitor and fixture Capacitance within 20 mm of the D.U.T.

**Figure 14. Receiver Enable/Disable Time Test Circuit and Waveforms**

# NB3N401S

## EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS

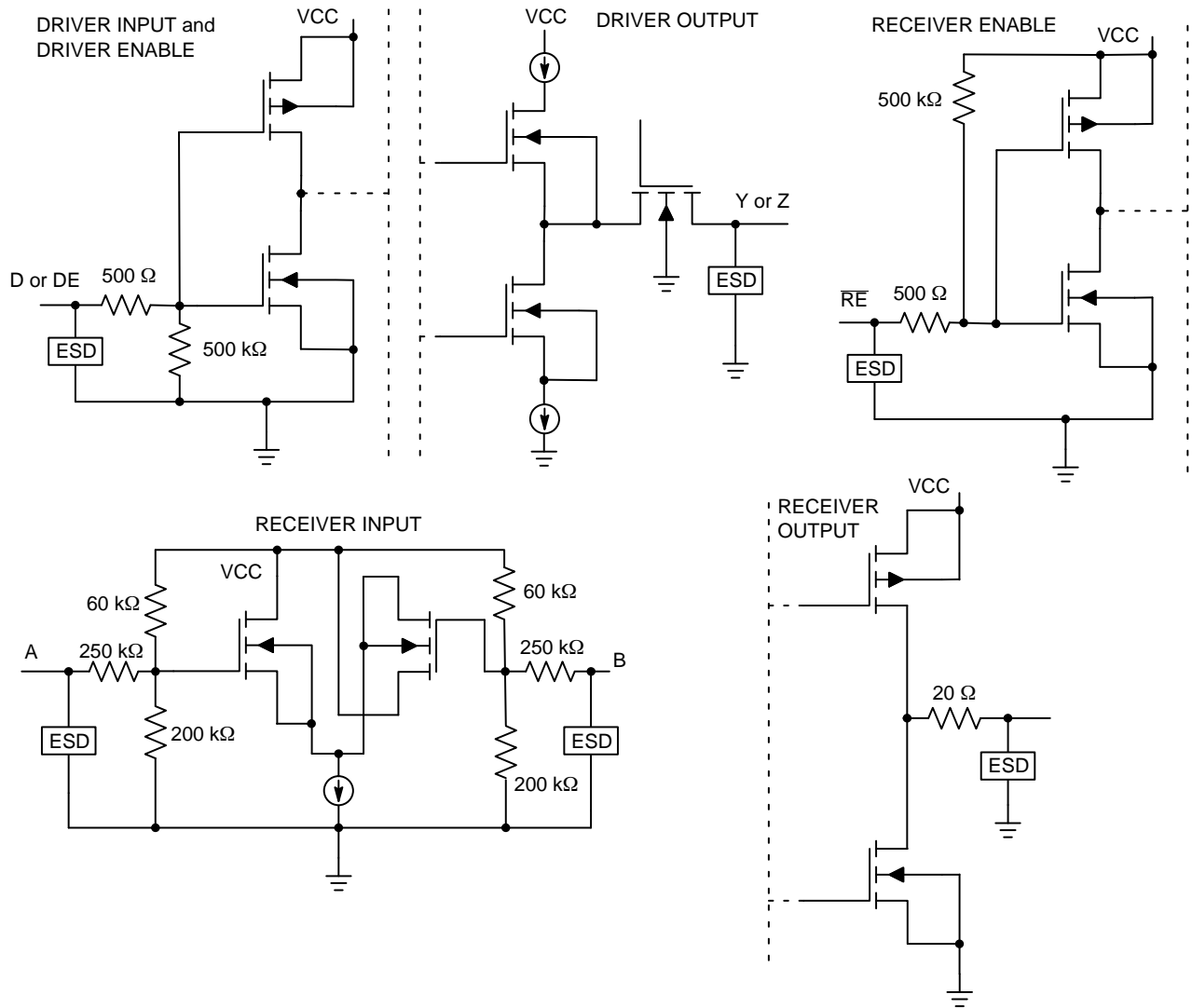


Figure 15. Input and Output Schematic Diagrams

### ORDERING INFORMATION

| Device        | Package            | Shipping†           |
|---------------|--------------------|---------------------|
| NB3N401SMNTXG | QFN48<br>(Pb-Free) | 2,500 / 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

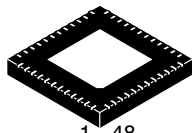
## PACKAGE DIMENSIONS

ON Semiconductor®

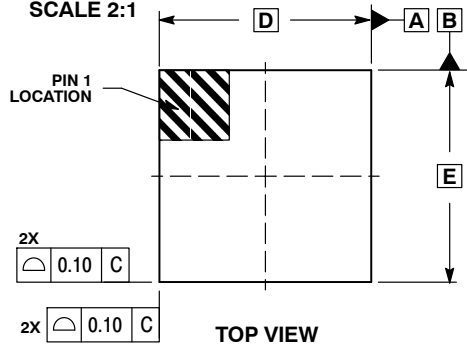


**QFN48 7x7, 0.5P**  
CASE 485EP  
ISSUE O

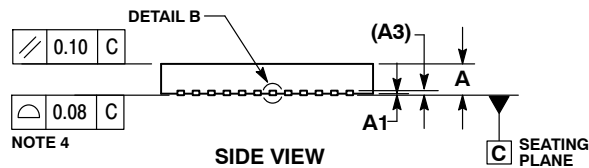
DATE 04 NOV 2015



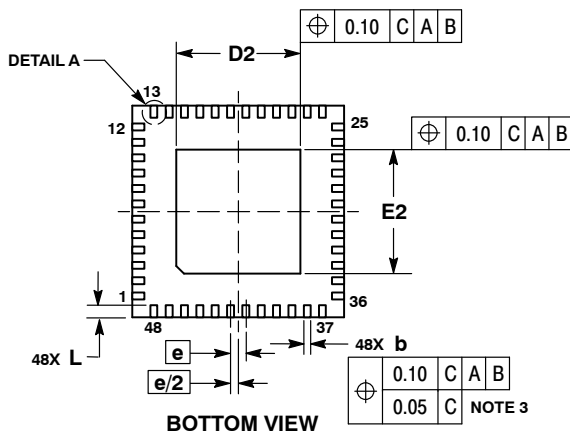
1 48  
SCALE 2:1



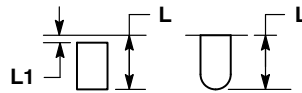
TOP VIEW



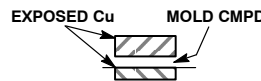
SIDE VIEW



BOTTOM VIEW



DETAIL A  
ALTERNATE TERMINAL  
CONSTRUCTIONS



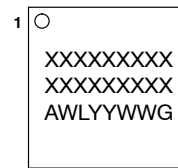
DETAIL B  
ALTERNATE  
CONSTRUCTION

NOTES:

1. DIMENSIONS AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO THE PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.25 MM FROM THE TERMINAL TIP.
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 |
| A3          | 0.20 | REF  |
| b           | 0.20 | 0.30 |
| D           | 7.00 | BSC  |
| D2          | 4.00 | 4.20 |
| E           | 7.00 | BSC  |
| E2          | 4.00 | 4.20 |
| e           | 0.50 | BSC  |
| L           | 0.30 | 0.50 |
| L1          | 0.00 | 0.15 |

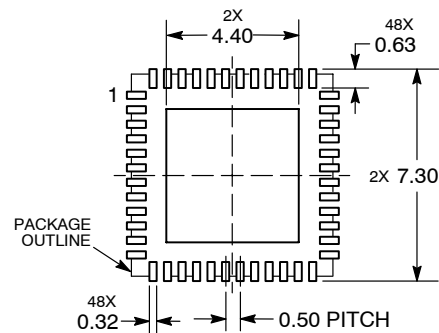
**GENERIC MARKING DIAGRAM\***



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

\*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.

**RECOMMENDED SOLDERING FOOTPRINT\***



DIMENSIONS: MILLIMETERS

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

|                         |                         |  |
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[DS90C383MTDX/NOPB](#) [DS90C383MTD](#) [DS90LV031ATMTC](#) [DS90C402M](#) [SN65LVDS051PWRQ1](#) [DS90C387VJDXNOPB](#)  
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[ADN4695EBRZ](#) [ADN4665ARZ](#) [ADN4666ARZ](#) [ADN4667ARZ](#) [ADN4667ARZ-REEL7](#) [ADN4668ARZ](#) [ADN4670BSTZ](#) [ADN4670BCPZ](#)  
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