

# NB2309A

## 3.3 V Zero Delay Clock Buffer

The NB2309A is a versatile, 3.3 V zero delay buffer designed to distribute high-speed clocks. It accepts one reference input and drives out nine low-skew clocks. It is available in a 16 pin package.

The -1H version of the NB2309A operates at up to 133 MHz, and has higher drive than the -1 devices. All parts have on-chip PLL's that lock to an input clock on the REF pin. The PLL feedback is on-chip and is obtained from the CLKOUT pad.

The NB2309A has two banks of four outputs each, which can be controlled by the Select inputs as shown in the Select Input Decoding Table. If all the output clocks are not required, Bank B can be three-stated. The select inputs also allow the input clock to be directly applied to the outputs for chip and system testing purposes.

Multiple NB2309A devices can accept the same input clock and distribute it. In this case the skew between the outputs of the two devices is guaranteed to be less than 700 ps.

All outputs have less than 200 ps of cycle-to-cycle jitter. The input and output propagation delay is guaranteed to be less than 350 ps, and the output to output skew is guaranteed to be less than 250 ps.

The NB2309A is available in two different configurations, as shown in the ordering information table. The NB2309A1 is the base part. The NB2309Ax1H\* is the high drive version of the -1 and its rise and fall times are much faster than -1 part.

### Features

- 15 MHz to 133 MHz Operating Range, Compatible with CPU and PCI Bus Frequencies
- Zero Input - Output Propagation Delay
- Multiple Low-Skew Outputs
- Output-Output Skew Less than 250 ps
- Device-Device Skew Less than 700 ps
- One Input Drives 9 Outputs, Grouped as 4 + 4 + 1
- Less than 200 ps Cycle-to-Cycle Jitter is Compatible with Pentium® Based Systems
- Test Mode to Bypass PLL
- Available in 16 Pin, 150 mil SOIC and 4.4 mm TSSOP
- 3.3 V Operation, Advanced 0.35  $\mu$  CMOS Technology
- Pb-Free Packages are Available\*\*

\*X = C for Commercial; I for Industrial.

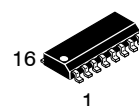
\*\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



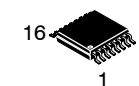
**ON Semiconductor®**

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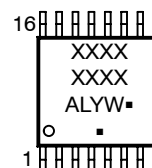
### MARKING DIAGRAMS\*



**SOIC-16  
D SUFFIX  
CASE 751B**



**TSSOP-16  
DT SUFFIX  
CASE 948F**



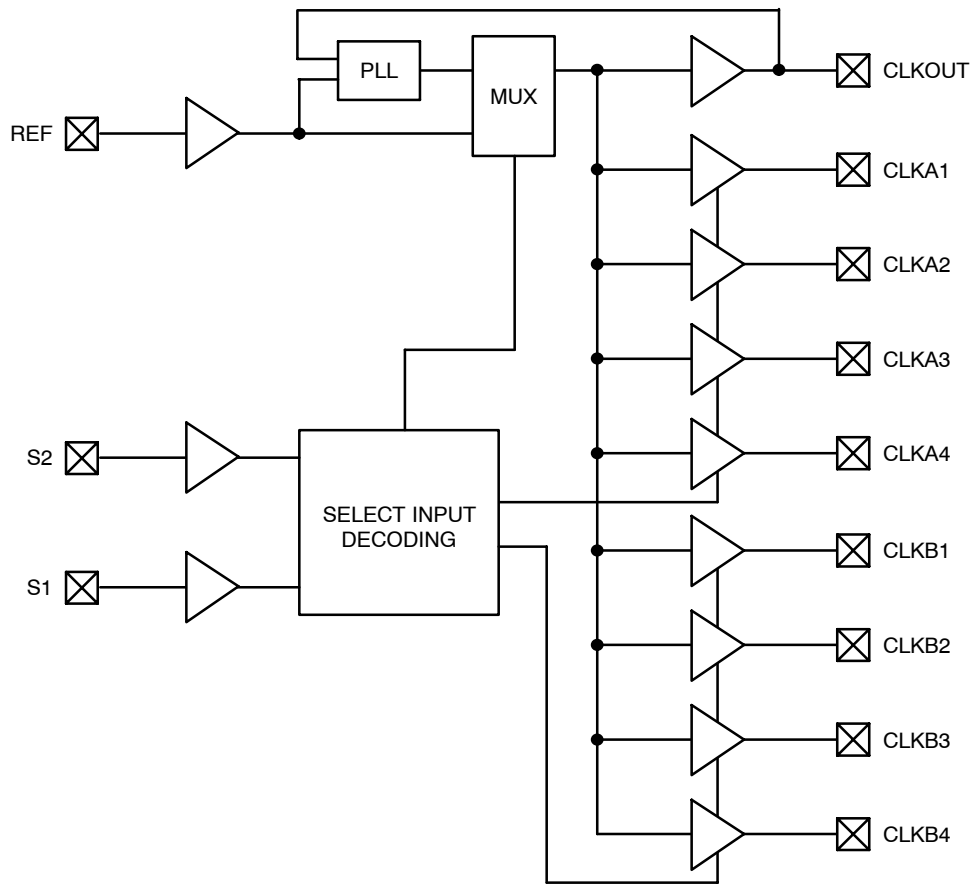
XXXX = Device Code  
A = Assembly Location  
WL, L = Wafer Lot  
Y = Year  
W, WW = Work Week  
G or ■ = Pb-Free Package

\*For additional marking information, refer to Application Note AND8002/D.

### ORDERING INFORMATION

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

# NB2309A



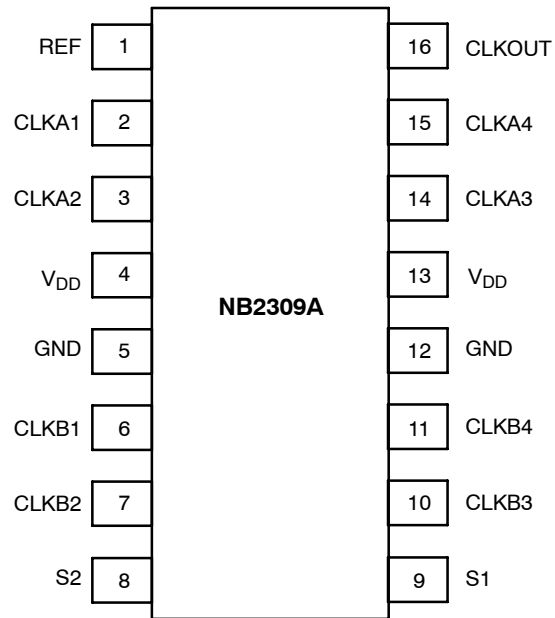
**Figure 1. Block Diagram**

**Table 1. SELECT INPUT DECODING**

| S2 | S1 | Clock A1 – A4 | Clock B1 – B4 | CLKOUT<br>(Note 1) | Output Source | PLL<br>ShutDown |
|----|----|---------------|---------------|--------------------|---------------|-----------------|
| 0  | 0  | Three-state   | Three-state   | Driven             | PLL           | N               |
| 0  | 1  | Driven        | Three-state   | Driven             | PLL           | N               |
| 1  | 0  | Driven        | Driven        | Driven             | Reference     | Y               |
| 1  | 1  | Driven        | Driven        | Driven             | PLL           | N               |

1. This output is driven and has an internal feedback for the PLL. The load on this output can be adjusted to change the skew between the reference and the output.

## NB2309A



**Figure 2. Pin Configuration**

**Table 2. PIN DESCRIPTION**

| Pin # | Pin Name        | Description                                     |
|-------|-----------------|-------------------------------------------------|
| 1     | REF (Note 2)    | Input reference frequency, 5 V tolerant input.  |
| 2     | CLKA1 (Note 3)  | Buffered clock output, Bank A.                  |
| 3     | CLKA2 (Note 3)  | Buffered clock output, Bank A.                  |
| 4     | V <sub>DD</sub> | 3.3 V supply.                                   |
| 5     | GND             | Ground.                                         |
| 6     | CLKB1 (Note 3)  | Buffered clock output, Bank B.                  |
| 7     | CLKB2 (Note 3)  | Buffered clock output, Bank B.                  |
| 8     | S2 (Note 4)     | Select input, bit 2.                            |
| 9     | S1 (Note 4)     | Select input, bit 1.                            |
| 10    | CLKB3 (Note 3)  | Buffered clock output, Bank B.                  |
| 11    | CLKB4 (Note 3)  | Buffered clock output, Bank B.                  |
| 12    | GND             | Ground.                                         |
| 13    | V <sub>DD</sub> | 3.3 V supply.                                   |
| 14    | CLKA3 (Note 3)  | Buffered clock output, Bank A.                  |
| 15    | CLKA4 (Note 3)  | Buffered clock output, Bank A.                  |
| 16    | CLKOUT (Note 3) | Buffered output, internal feedback on this pin. |

2. Weak pulldown.

3. Weak pulldown on all outputs.

4. Weak pullup on these inputs.

Table 3. MAXIMUM RATINGS

| Parameter                                               | Min  | Max            | Unit |
|---------------------------------------------------------|------|----------------|------|
| Supply Voltage to Ground Potential                      | -0.5 | +7.0           | V    |
| DC Input Voltage (Except REF)                           | -0.5 | $V_{DD} + 0.5$ | V    |
| DC Input Voltage (REF)                                  | -0.5 | 7              | V    |
| Storage Temperature                                     | -65  | +150           | °C   |
| Maximum Soldering Temperature (10 sec)                  |      | 260            | °C   |
| Junction Temperature                                    |      | 150            | °C   |
| Static Discharge Voltage (per MIL-STD-883, Method 3015) |      | >2000          | V    |

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

Table 4. OPERATING CONDITIONS FOR COMMERCIAL AND INDUSTRIAL TEMPERATURE DEVICES

| Parameter | Description                                                             | Min      | Max      | Unit |
|-----------|-------------------------------------------------------------------------|----------|----------|------|
| $V_{DD}$  | Supply Voltage                                                          | 3.0      | 3.6      | V    |
| $T_A$     | Operating Temperature (Ambient Temperature)<br>Commercial<br>Industrial | 0<br>-40 | 70<br>85 | °C   |
| $C_L$     | Load Capacitance, below 100 MHz                                         |          | 30       | pF   |
| $C_L$     | Load Capacitance, from 100 MHz to 133 MHz                               |          | 10       | pF   |
| $C_{IN}$  | Input Capacitance                                                       |          | 7        | pF   |

Table 5. ELECTRICAL CHARACTERISTICS FOR COMMERCIAL AND INDUSTRIAL TEMPERATURE DEVICES

| Parameter | Description                      | Test Conditions                                                                                      | Min | Max            | Unit          |
|-----------|----------------------------------|------------------------------------------------------------------------------------------------------|-----|----------------|---------------|
| $V_{IL}$  | Input LOW Voltage (Note 5)       |                                                                                                      |     | 0.8            | V             |
| $V_{IH}$  | Input HIGH Voltage (Note 5)      |                                                                                                      | 2.0 |                | V             |
| $I_{IL}$  | Input LOW Current                | $V_{IN} = 0\text{ V}$                                                                                |     | 50.0           | $\mu\text{A}$ |
| $I_{IH}$  | Input HIGH Current               | $V_{IN} = V_{DD}$                                                                                    |     | 100.0          | $\mu\text{A}$ |
| $V_{OL}$  | Output LOW Voltage               | $I_{OL} = 8\text{ mA (-1)}$<br>$I_{OL} = 12\text{ mA (-1H)}$                                         |     | 0.4            | V             |
| $V_{OH}$  | Output HIGH Voltage              | $I_{OH} = -8\text{ mA (-1)}$<br>$I_{OH} = -12\text{ mA (-1H)}$                                       | 2.4 |                | V             |
| $I_{DD}$  | Supply Current (Commercial Temp) | Unloaded outputs at 66.67 MHz,<br>Select inputs at $V_{DD}$                                          |     | 34             | mA            |
| $I_{DD}$  | Supply Current (Industrial Temp) | Unloaded outputs at 100 MHz<br>66.67 MHz<br>33 MHz<br>Select inputs at $V_{DD}$ or GND, at Room Temp |     | 50<br>34<br>19 | mA            |

5. REF input has a threshold voltage of  $V_{DD}/2$ .

**Table 6. SWITCHING CHARACTERISTICS (Commercial and Industrial)** (Note 6)

| Parameter         | Description                                                                 | Test Conditions                                                    | Min      | Typ      | Max           | Unit |
|-------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------|----------|----------|---------------|------|
| 1/t <sub>1</sub>  | Output Frequency                                                            | 30 pF load<br>10 pF load                                           | 15<br>15 |          | 100<br>133.33 | MHz  |
| 1/t <sub>1</sub>  | Duty Cycle = (t <sub>2</sub> / t <sub>1</sub> ) * 100<br>(-1, -1H)<br>(-1H) | Measured at 1.4 V, F <sub>OUT</sub> = 66.67 MHz<br>< 50 MHz        | 40<br>45 | 50<br>50 | 60<br>55      | %    |
| t <sub>3</sub>    | Output Rise Time<br>(-1, -1H)<br>(-1H)                                      | Measured between 0.8 V and 2.0 V                                   |          |          | 2.5<br>1.5    | ns   |
| t <sub>4</sub>    | Output Fall Time                                                            | Measured between 2.0 V and 0.8 V                                   |          |          | 1.5           | ns   |
| t <sub>5</sub>    | Output-to-Output Skew                                                       | All outputs equally loaded                                         |          |          | 250           | ps   |
| t <sub>6</sub>    | Delay, REF Rising Edge to CLKOUT<br>Rising Edge                             | Measured at V <sub>DD</sub> /2                                     |          | 0        | ±350          | ps   |
| t <sub>7</sub>    | Device-to-Device Skew                                                       | Measured at V <sub>DD</sub> /2 on the CLKOUT pins of<br>the device |          | 0        | 700           | ps   |
| t <sub>8</sub>    | Output Slew Rate                                                            | Measured between 0.8 V and 2.0 V using<br>Test Circuit #2          | 1        |          |               | V/ns |
| t <sub>J</sub>    | Cycle-to-Cycle Jitter                                                       | Measured at 66.67 MHz, loaded outputs                              |          |          | 200           | ps   |
| t <sub>LOCK</sub> | PLL Lock Time                                                               | Stable power supply, valid clock presented<br>on REF pin           |          |          | 1.0           | ms   |
| t <sub>r_in</sub> | REF Input Rise Time                                                         | Measured between 0.8 V to 2.0 V                                    |          |          | 1.0           | ns   |
| t <sub>f_in</sub> | REF Input Rise Fall Time                                                    | Measured between 2.0 V to 0.8 V                                    |          |          | 1.0           | ns   |

6. All parameters specified with loaded outputs and apply to both PLL-Mode and PLL-Bypass Mode.

### Zero Delay and Skew Control

All outputs should be uniformly loaded to achieve Zero Delay between input and output. Since the CLKOUT pin is the internal feedback to the PLL, its relative loading can adjust the input-output delay.

For applications requiring zero input-output delay, all outputs, including CLKOUT, must be equally loaded. Even if CLKOUT is not used, it must have a capacitive load equal to that on other outputs, for obtaining zero-input-output delay.

### SWITCHING WAVEFORMS

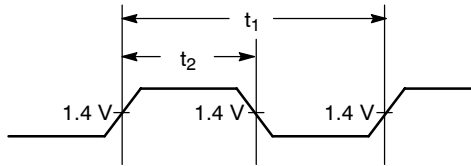


Figure 3. Duty Cycle Timing

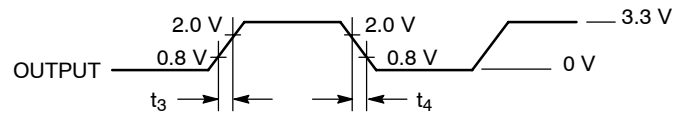


Figure 4. All Outputs Rise/Fall Time

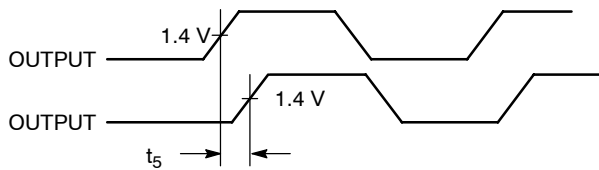


Figure 5. Output - Output Skew

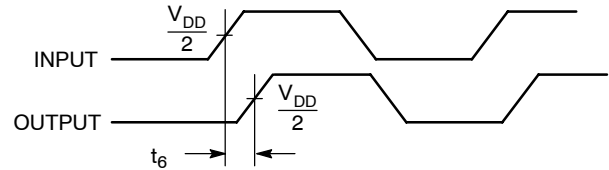


Figure 6. Input - Output Propagation Delay

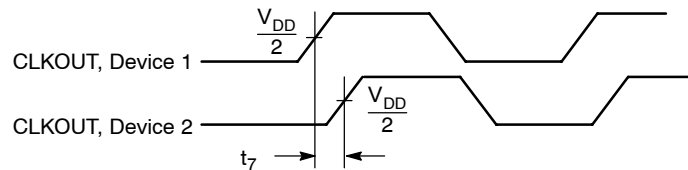


Figure 7. Device - Device Skew

TEST CIRCUITS

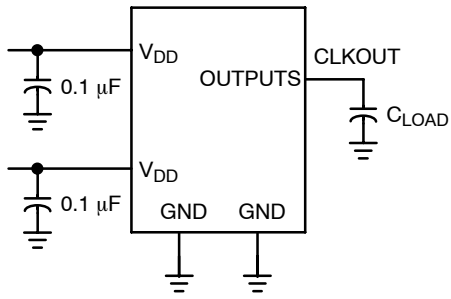


Figure 8. Test Circuit #1

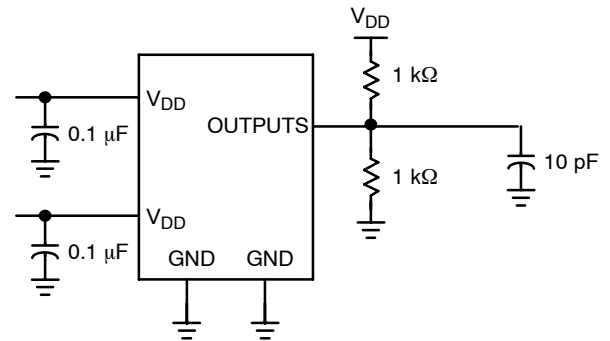


Figure 9. Test Circuit #2  
For parameter  $t_g$  (output slew rate) on -1H devices

# NB2309A

## ORDERING INFORMATION

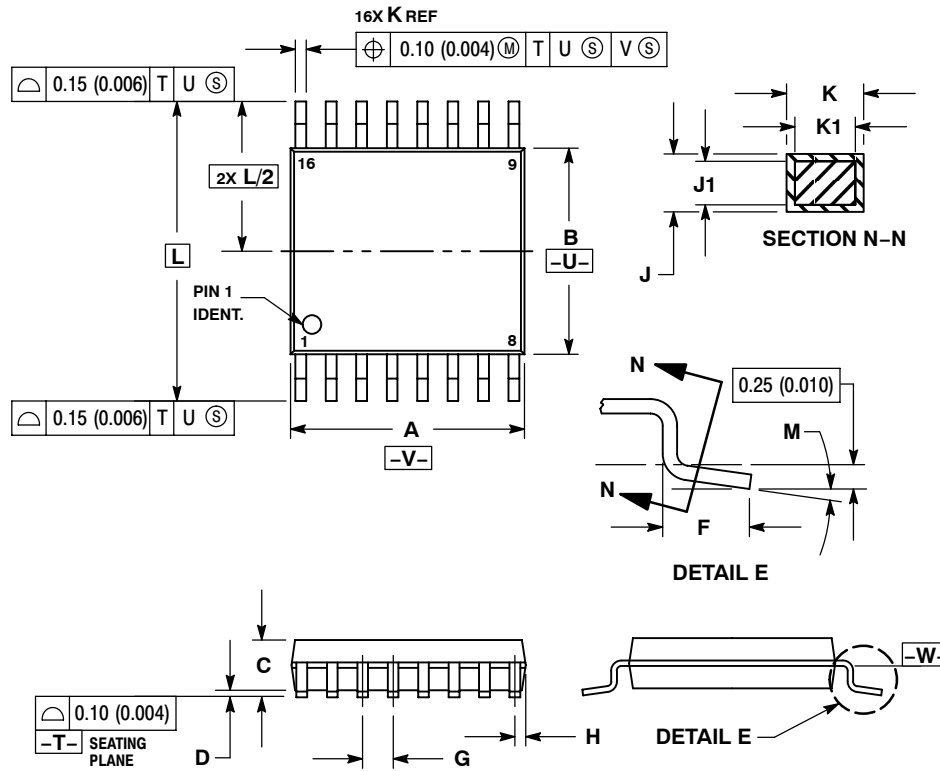
| Device          | Marking   | Operating Range | Package               | Shipping <sup>†</sup> | Availability |
|-----------------|-----------|-----------------|-----------------------|-----------------------|--------------|
| NB2309AC1D      | 2309AC1   | Commercial      | SOIC-16               | 48 Units / Rail       | Now          |
| NB2309AC1DG     | 2309AC1G  | Commercial      | SOIC-16<br>(Pb-Free)  | 48 Units / Rail       | Now          |
| NB2309AC1DR2    | 2309AC1   | Commercial      | SOIC-16               | 2500 Tape & Reel      | Now          |
| NB2309AC1DR2G   | 2309AC1G  | Commercial      | SOIC-16<br>(Pb-Free)  | 2500 Tape & Reel      | Now          |
| NB2309AI1D      | 2309AI1   | Industrial      | SOIC-16               | 48 Units / Rail       | Now          |
| NB2309AI1DG     | 2309AI1G  | Industrial      | SOIC-16<br>(Pb-Free)  | 48 Units / Rail       | Now          |
| NB2309AI1DR2    | 2309AI1   | Industrial      | SOIC-16               | 2500 Tape & Reel      | Now          |
| NB2309AI1DR2G   | 2309AI1G  | Industrial      | SOIC-16<br>(Pb-Free)  | 2500 Tape & Reel      | Now          |
| NB2309AC1HD     | 2309AC1H  | Commercial      | SOIC-16               | 48 Units / Rail       | Now          |
| NB2309AC1HDG    | 2309AC1HG | Commercial      | SOIC-16<br>(Pb-Free)  | 48 Units / Rail       | Now          |
| NB2309AC1HDR2   | 2309AC1H  | Commercial      | SOIC-16               | 2500 Tape & Reel      | Now          |
| NB2309AC1HDR2G  | 2309AC1HG | Commercial      | SOIC-16<br>(Pb-Free)  | 2500 Tape & Reel      | Now          |
| NB2309AI1HD     | 2309AI1H  | Industrial      | SOIC-16               | 48 Units / Rail       | Now          |
| NB2309AI1HDG    | 2309AI1HG | Industrial      | SOIC-16<br>(Pb-Free)  | 48 Units / Rail       | Now          |
| NB2309AI1HDR2   | 2309AI1H  | Industrial      | SOIC-16               | 2500 Tape & Reel      | Now          |
| NB2309AI1HDR2G  | 2309AI1HG | Industrial      | SOIC-16<br>(Pb-Free)  | 2500 Tape & Reel      | Now          |
| NB2309AC1DT     | 2309AC1   | Commercial      | TSSOP-16              | 96 Units / Rail       | Now          |
| NB2309AC1DTG    | 2309AC1   | Commercial      | TSSOP-16<br>(Pb-Free) | 96 Units / Rail       | Now          |
| NB2309AC1DTR2   | 2309AC1   | Commercial      | TSSOP-16              | 2500 Tape & Reel      | Now          |
| NB2309AC1DTR2G  | 2309AC1   | Commercial      | TSSOP-16<br>(Pb-Free) | 2500 Tape & Reel      | Now          |
| NB2309AI1DT     | 2309AI1   | Industrial      | TSSOP-16              | 96 Units / Rail       | Now          |
| NB2309AI1DTG    | 2309AI1   | Industrial      | TSSOP-16<br>(Pb-Free) | 96 Units / Rail       | Now          |
| NB2309AI1DTR2   | 2309AI1   | Industrial      | TSSOP-16              | 2500 Tape & Reel      | Now          |
| NB2309AI1DTR2G  | 2309AI1   | Industrial      | TSSOP-16<br>(Pb-Free) | 2500 Tape & Reel      | Now          |
| NB2309AC1HDT    | 2309AC1H  | Commercial      | TSSOP-16              | 96 Units / Rail       | Now          |
| NB2309AC1HDTG   | 2309AC1H  | Commercial      | TSSOP-16<br>(Pb-Free) | 96 Units / Rail       | Now          |
| NB2309AC1HDTR2  | 2309AC1H  | Commercial      | TSSOP-16              | 2500 Tape & Reel      | Now          |
| NB2309AC1HDTR2G | 2309AC1H  | Commercial      | TSSOP-16<br>(Pb-Free) | 2500 Tape & Reel      | Now          |
| NB2309AI1HDT    | 2309AI1H  | Industrial      | TSSOP-16              | 96 Units / Rail       | Now          |
| NB2309AI1HDTG   | 2309AI1H  | Industrial      | TSSOP-16<br>(Pb-Free) | 96 Units / Rail       | Now          |
| NB2309AI1HDTR2  | 2309AI1H  | Industrial      | TSSOP-16              | 2500 Tape & Reel      | Now          |
| NB2309AI1HDTR2G | 2309AI1H  | Industrial      | TSSOP-16<br>(Pb-Free) | 2500 Tape & Reel      | Now          |

<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.

# NB2309A

## PACKAGE DIMENSIONS

TSSOP-16  
CASE 948F-01  
ISSUE A



### NOTES:

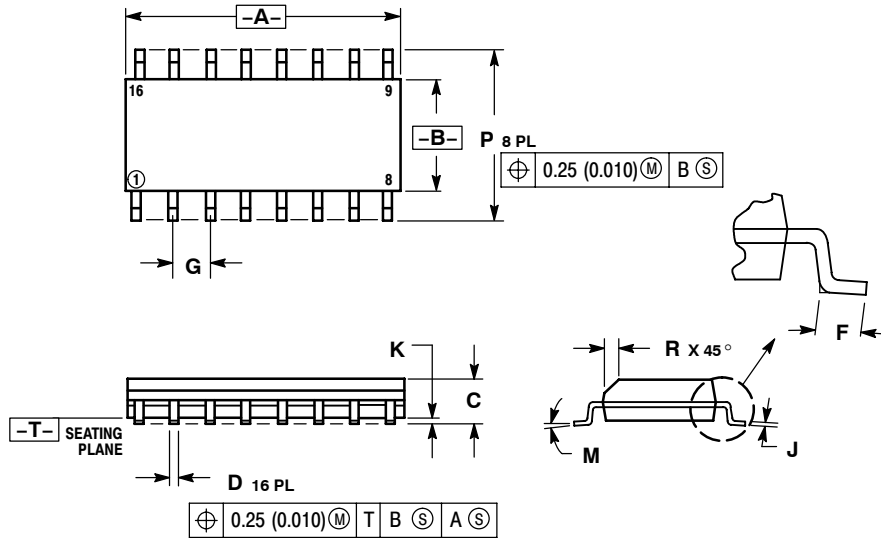
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.90        | 5.10 | 0.193     | 0.200 |
| B   | 4.30        | 4.50 | 0.169     | 0.177 |
| C   | ---         | 1.20 | ---       | 0.047 |
| D   | 0.05        | 0.15 | 0.002     | 0.006 |
| F   | 0.50        | 0.75 | 0.020     | 0.030 |
| G   | 0.65 BSC    |      | 0.026 BSC |       |
| H   | 0.18        | 0.28 | 0.007     | 0.011 |
| J   | 0.09        | 0.20 | 0.004     | 0.008 |
| J1  | 0.09        | 0.16 | 0.004     | 0.006 |
| K   | 0.19        | 0.30 | 0.007     | 0.012 |
| K1  | 0.19        | 0.25 | 0.007     | 0.010 |
| L   | 6.40 BSC    |      | 0.252 BSC |       |
| M   | 0°          | 8°   | 0°        | 8°    |

# NB2309A

## PACKAGE DIMENSIONS

SOIC-16  
CASE 751B-05  
ISSUE J



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 9.80        | 10.00 | 0.386     | 0.393 |
| B   | 3.80        | 4.00  | 0.150     | 0.157 |
| C   | 1.35        | 1.75  | 0.054     | 0.068 |
| D   | 0.35        | 0.49  | 0.014     | 0.019 |
| F   | 0.40        | 1.25  | 0.016     | 0.049 |
| G   | 1.27 BSC    |       | 0.050 BSC |       |
| J   | 0.19        | 0.25  | 0.008     | 0.009 |
| K   | 0.10        | 0.25  | 0.004     | 0.009 |
| M   | 0°          | 7°    | 0°        | 7°    |
| P   | 5.80        | 6.20  | 0.229     | 0.244 |
| R   | 0.25        | 0.50  | 0.010     | 0.019 |

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