

PCIe Clock Generator, Automotive Grade, Dual Output, 3.3 V



ON Semiconductor®

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NBA3N5573

Description

The NBA3N5573 is an automotive grade precision, low phase noise clock generator that supports PCI Express and Ethernet requirements. The device accepts a 25 MHz fundamental mode parallel resonant crystal and generates a differential HCSL output at 25 MHz, 100 MHz, 125 MHz or 200 MHz clock frequencies. Outputs can interface with LVDS with proper termination (See Figure 4).

This device is housed in 3 mm x 3 mm, 0.5P QFN16 package with wettable flanks to accommodate visual inspection.

Features

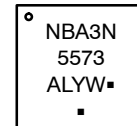
- Uses 25 MHz Fundamental Mode Parallel Resonant Crystal
- AEC-Q100 Qualified and PPAP Capable
- No External Loop Filter Required
- HCSL Differential Output or LVDS with Proper Termination
- Four Selectable Multipliers of the Input Frequency
- Output Enable with Tri-State Outputs
- PCIe Gen1, Gen2, Gen3, Gen4, QPI, UPI Jitter Compliant
- Phase Noise: @ 100 MHz

| Offset | Noise Power |
|---------|-------------|
| 100 Hz | -113 dBc |
| 1 kHz | -127 dBc |
| 10 kHz | -135 dBc |
| 100 kHz | -138 dBc |
| 1 MHz | -139 dBc |
| 10 MHz | -160 dBc |
| 20 MHz | -162 dBc |
- Typical Period Jitter RMS of 1.5 ps
- Operating Supply Voltage Range 3.3 V ±10%
- Operating Temperature Range -40°C to +105°C
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



1
QFNW16
MN SUFFIX
CASE 484AN

MARKING DIAGRAM



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

(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

Applications

- Automotive
- Networking
- Industrial Equipment
- PCIe Clock Generation Gen 1, Gen 2, Gen 3 and Gen 4
- Gigabit Ethernet
- FB DIMM

End Products

- Infotainment and In-Cabin Electronics
- Autonomous Vehicles
- Switch and Router
- Set Top Box
- Servers, Desktop Computers
- Automated Test Equipment

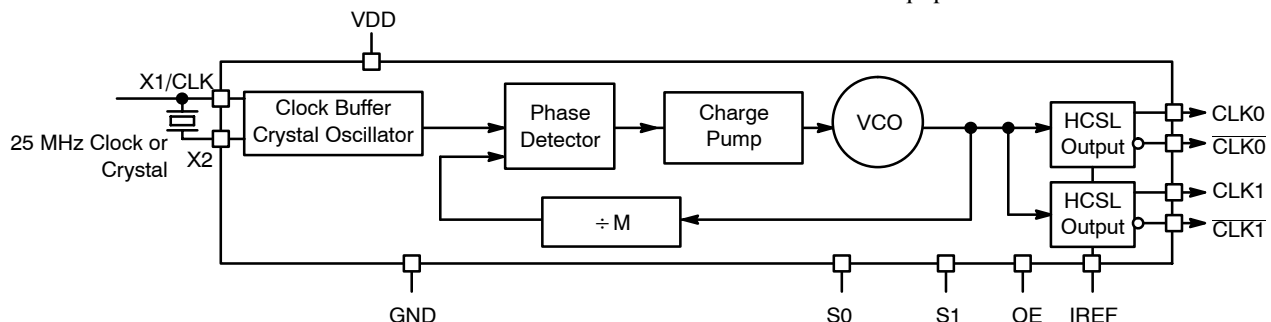


Figure 1. NBA3N5573 Simplified Logic Diagram

NBA3N5573

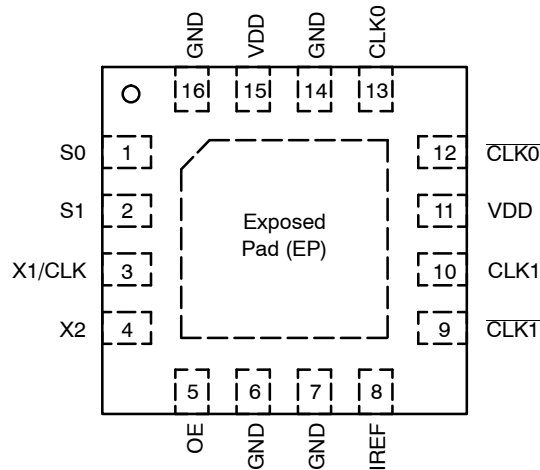


Figure 2. Pin Configuration (Top View)

Table 1. PIN DESCRIPTION

| Pin | Symbol | I/O | Description |
|--------------|----------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | S0 | Input | LVTTL/LVCMOS frequency select input 0. Internal pullup resistor to V_{DD} . See output select Table 2 for details. |
| 2 | S1 | Input | LVTTL/LVCMOS frequency select input 1. Internal pullup resistor to V_{DD} . See output select Table 2 for details. |
| 11, 15 | V_{DD} | Power Supply | Positive supply voltage pins are connected to +3.3 V supply voltage. |
| 3 | X1/CLK | Input | Crystal or Clock input. Connect to 25 MHz crystal source or single-ended clock. |
| 4 | X2 | Input | Crystal input. Connect to a 25 MHz crystal or leave unconnected for clock input. |
| 5 | OE | Input | When floating, the internal pull-up resistor to V_{DD} will make OE logic High enabling the Output. When connected to GND, logic Low, the outputs are disabled and will go to high-Z. |
| 6, 7, 14, 16 | GND | Power Supply | Ground 0 V. These pins provide GND return path for the devices. |
| 8 | IREF | Output | Output current reference pin. Precision resistor (typ. 475 Ω) is connected to set the output current. |
| 10 | CLK1 | HCSL or LVDS Output | Noninverted clock output. (For LVDS levels see Figure 4) |
| 9 | CLK1 | HCSL or LVDS Output | Inverted clock output. (For LVDS levels see Figure 4) |
| 13 | CLK0 | HCSL or LVDS Output | Noninverted clock output. (For LVDS levels see Figure 4) |
| 12 | CLK0 | HCSL or LVDS Output | Inverted clock output. (For LVDS levels see Figure 4) |
| - | EP | - | The Exposed Pad (EP) on the QFN-16 package bottom is thermally connected to the die for improved heat transfer out of the package. The Exposed pad must be attached to a heat-sinking conduit. The pad is electrically connected to the die, and must be connected to the device GND |

Table 2. OUTPUT FREQUENCY SELECT TABLE WITH 25 MHz CRYSTAL

| S1* | S0* | CLK Multiplier | f_{CLKout} (MHz) |
|-----|-----|----------------|--------------------|
| L | L | 1x | 25 |
| L | H | 4x | 100 |
| H | L | 5x | 125 |
| H | H | 8x | 200 |

*Pins S1 and S0 default high when left open.

Recommended Crystal Parameters

| | |
|------------------------------|--------------------|
| Crystal | Fundamental AT-Cut |
| Frequency | 25 MHz |
| Load Capacitance | 16–20 pF |
| Shunt Capacitance, C_0 | 7 pF Max |
| Equivalent Series Resistance | 50 Ω Max |
| Initial Accuracy at 25 °C | ± 20 ppm |
| Temperature Stability | ± 30 ppm |
| Aging | ± 20 ppm |
| Drive Level | 100 μ W Max |

Table 3. ATTRIBUTES

| Characteristic | Value |
|----------------------------------------------------------------|----------------------|
| ESD Protection Human Body Model | > 2 kV |
| RPU – OE, S0 and S1 Pull-up Resistor | 100 kΩ |
| Moisture Sensitivity, Indefinite Time Out of Dry Pack (Note 1) | Level 1 |
| Flammability Rating Oxygen Index: 28 to 34 | UL 94 V-0 @ 0.125 in |
| Transistor Count | 7623 |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test | |

1. For additional information, see Application Note AND8003/D.

Table 4. MAXIMUM RATINGS (Note 2)

| Symbol | Parameter | Condition 1 | Condition 2 | Rating | Unit |
|---------------------|------------------------------------------|--------------------|----------------------------------------|----------------------------------|--------------|
| V _{DD} | Positive Power Supply | GND = 0 V | | 4.6 | V |
| V _I | Input Voltage (V _{IN}) | GND = 0 V | GND ≤ V _I ≤ V _{DD} | -0.5 V to V _{DD} +0.5 V | V |
| T _A | Operating Temperature Range | | | -40 to +105 | °C |
| T _{stg} | Storage Temperature Range | | | -65 to +150 | °C |
| T _{J(max)} | Maximum Junction Temperature | | | +125 | °C |
| θ _{JA} | Thermal Resistance (Junction-to-Ambient) | 0 lfpm 500 lfpm | QFN-16 QFN-16 | 42 35 | °C/W °C/W |
| θ _{JC} | Thermal Resistance (Junction-to-Case) | (Note 3) | QFN-16 | 4 | °C/W |
| T _{sol} | Wave Solder | | | 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.

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

Table 5. DC CHARACTERISTICS (V_{DD} = 3.3 V ±10%, GND = 0 V, T_A = -40°C to +105°C, Note 4)

| Symbol | Characteristic | Min | Typ | Max | Unit |
|---------------------|-----------------------------------------------------------|-----------|-----|-----------------------|------|
| V _{DD} | Power Supply Voltage | 2.97 | 3.3 | 3.63 | V |
| I _{DD} | Power Supply Current | | 120 | 135 | mA |
| I _{DDOE} | Power Supply Current when OE is Set Low | | | 65 | mA |
| V _{IH} | Input HIGH Voltage (X/CLK, S0, S1, and OE) | 2000 | | V _{DD} + 300 | mV |
| V _{IL} | Input LOW Voltage (X/CLK, S0, S1, and OE) | GND - 300 | | 800 | mV |
| V _{OH} | Output HIGH Voltage for HCSL Output (See Figure 5) | 660 | 700 | 850 | mV |
| V _{OL} | Output LOW Voltage for HCSL Output (See Figure 5) | -150 | 0 | 150 | mV |
| V _{cross} | Crossing Voltage Magnitude (Absolute) for HCSL Output | 250 | | 550 | mV |
| ΔV _{cross} | Change in Magnitude of V _{cross} for HCSL Output | | | 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 lfpm.

- Measurement taken with outputs terminated with R_S = 33.2 Ω, R_L = 49.9 Ω, with test load capacitance of 2 pF and current biasing resistor set at 475 Ω. See Figure 3.

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Table 6. AC CHARACTERISTICS ($V_{DD} = 3.3\text{ V} \pm 10\%$, $GND = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to $+105^\circ\text{C}$; Note 5)

| Symbol | Characteristic | Min | Typ | Max | Unit |
|--------------------|-------------------------------------------------------------------------|-----|-----------|-----|---------------|
| f_{CLKIN} | Clock/Crystal Input Frequency | | 25 | | MHz |
| f_{CLKOUT} | Output Clock Frequency | 25 | | 200 | MHz |
| θ_{NOISE} | Phase-Noise Performance $f_{CLKx} = 200\text{ MHz}/100\text{ MHz}$ | | | | dBc/Hz |
| | @ 100 Hz offset from carrier | | -106/-113 | | |
| | @ 1 kHz offset from carrier | | -121/-127 | | |
| | @ 10 kHz offset from carrier | | -129/-135 | | |
| | @ 100 kHz offset from carrier | | -131/-138 | | |
| | @ 1 MHz offset from carrier | | -133/-139 | | |
| | @ 10 MHz offset from carrier | | -157/-160 | | |
| t_{JITTER} | Period Jitter Peak-to-Peak (Note 6) $f_{CLKx} = 200\text{ MHz}$ | | 10 | 20 | ps |
| | Period Jitter RMS (Note 6) $f_{CLKx} = 200\text{ MHz}$ | | 1.5 | 3 | |
| | Cycle-Cycle RMS Jitter (Note 7) $f_{CLKx} = 200\text{ MHz}$ | | 2 | 5 | |
| | Cycle-to-Cycle Peak to Peak Jitter (Note 7) $f_{CLKx} = 200\text{ MHz}$ | | 20 | 35 | ps |
| $t_{JIT(\Phi)}$ | Additive Phase RMS Jitter, Integration Range 12 kHz to 20 MHz | | 0.4 | | ps |
| OE | Output Enable/Disable Time | | 10 | | μs |
| t_{DUTY_CYCLE} | Output Clock Duty Cycle (Measured at cross point) | 45 | 50 | 55 | % |
| t_R | Output Risetime (Measured from 175 mV to 525 mV, Figure 5) | 175 | 340 | 700 | ps |
| t_F | Output Falltime (Measured from 525 mV to 175 mV, Figure 5) | 175 | 340 | 700 | ps |
| Δt_R | Output Risetime Variation (Single-Ended) | | | 125 | ps |
| Δt_F | Output Falltime Variation (Single-Ended) | | | 125 | ps |
| Stabilization Time | Stabilization Time From Powerup $V_{DD} = 3.3\text{ V}$ | | 3.0 | | ms |
| t_{SKEW} | Within Device Output to Output Skew | | | 40 | 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 lpm.

5. Measurement taken from differential output on single-ended channel terminated with $R_S = 33.2\ \Omega$, $R_L = 49.9\ \Omega$, with test load capacitance of 2 pF and current biasing resistor set at 475 Ω . See Figure 3.
6. Sampled with 10000 cycles.
7. Sampled with 1000 cycles.

Table 7. ELECTRICAL CHARACTERISTICS – PHASE JITTER PARAMETERS

| Symbol | Parameter | Conditions (Notes 8 and 9) | Min | Typ | Max | Industry Limit | Unit |
|-------------------|------------------|-------------------------------------------------------------------------------|-----|------|------|----------------|----------|
| $t_{jphPCleG1}$ | RMS Phase Jitter | PCle Gen 1 (Notes 10 and 11) | | 10 | 16 | 86 | ps (p-p) |
| $t_{jphPCleG2}$ | | PCle Gen 2 Lo Band 10 kHz < f < 1.5 MHz (Note 10) | | 0.2 | 0.25 | 3 | ps (rms) |
| | | PCle Gen 2 High Band 1.5 MHz < f < Nyquist (50 MHz) (Note 10) | | 0.9 | 1.2 | 3.1 | ps (rms) |
| $t_{jphPCleG3}$ | | PCle Gen 3 (PLL BW of 2–4 MHz, CDR = 10 MHz) (Note 10) | | 0.2 | 0.3 | 1 | ps (rms) |
| $t_{jphPCleG4}$ | | PCle Gen 4 (PLL BW of 2–4 MHz, CDR = 10 MHz) (Note 10) | | 0.21 | 0.3 | 0.5 | ps (rms) |
| t_{jphUPI} | | UPI (9.6 Gb/s, 10.4 Gb/s or 11.2 Gb/s, 100 MHz, 12 UI) | | 0.62 | 0.8 | 1.0 | ps (rms) |
| t_{jphQPI_SMI} | | QPI & SMI (100.00 MHz or 133.33 MHz, 4.8 Gb/s, 6.4 Gb/s 12UI) (Note 12) | | 0.1 | 0.3 | 0.5 | ps (rms) |
| | | QPI & SMI (100.00 MHz, 8.0 Gb/s, 12UI) (Note 12) | | 0.1 | 0.15 | 0.3 | ps (rms) |
| | | QPI & SMI (100.00 MHz, 9.6 Gb/s, 12UI) (Note 12) | | 0.07 | 0.1 | 0.2 | ps (rms) |

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.

8. Applies to all outputs.

9. Guaranteed by design and characterization, not tested in production

10. See <http://www.pcisig.com> for complete specs

11. Sample size of at least 100K cycles. This figures extrapolates to 108 ps pk-pk @ 1M cycles for a BER of 1-12.

12. Calculated from Intel-supplied Clock Jitter Tool v 1.6.3.

HCSL INTERFACE

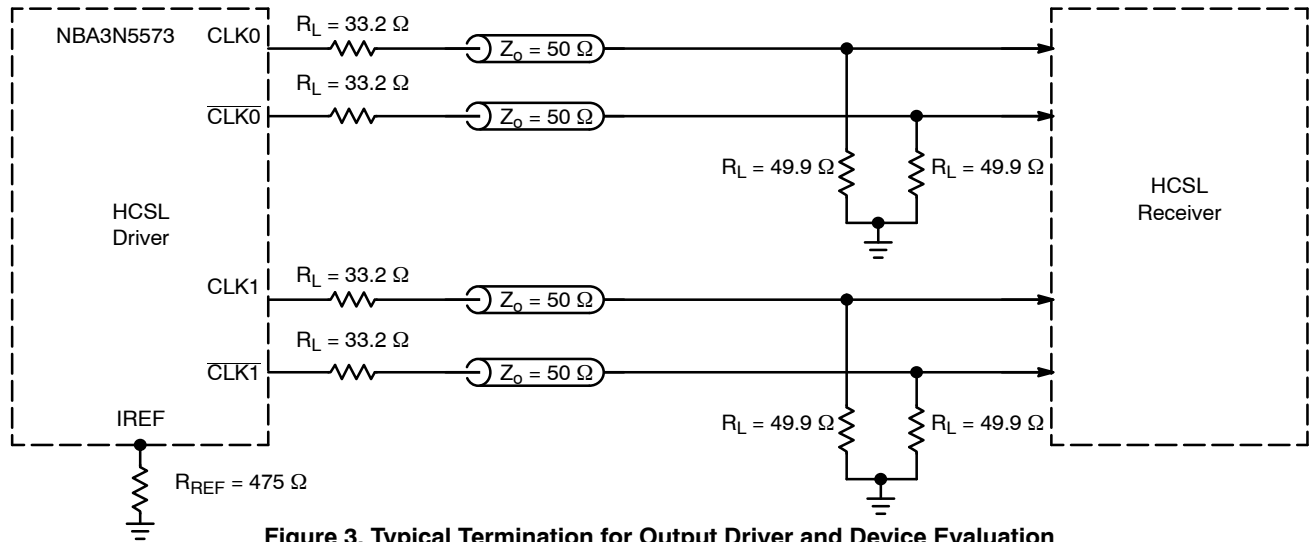
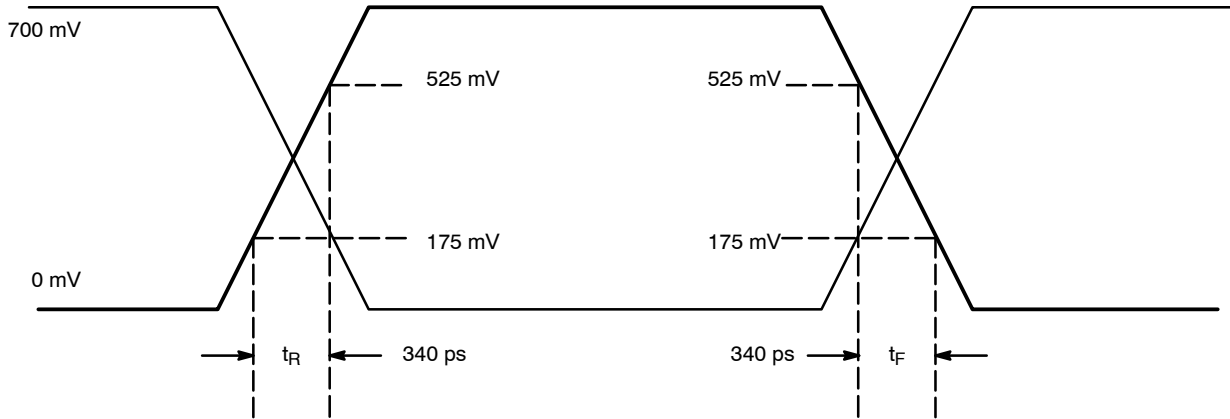
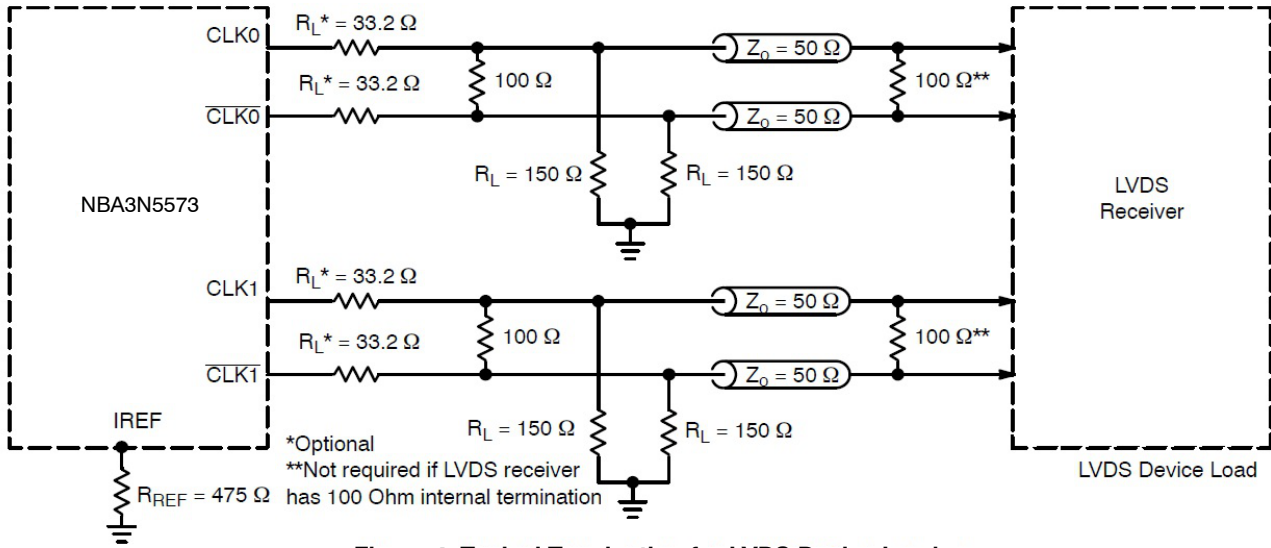


Figure 3. Typical Termination for Output Driver and Device Evaluation

NBA3N5573

LVDS COMPATIBLE INTERFACE



ORDERING INFORMATION

| Device | Package | Shipping† |
|----------------|---------------------|--------------------|
| NBA3N5573MNTXG | QFN-16 (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.

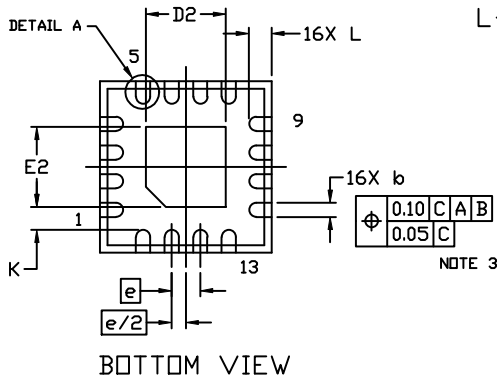
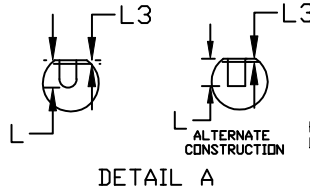
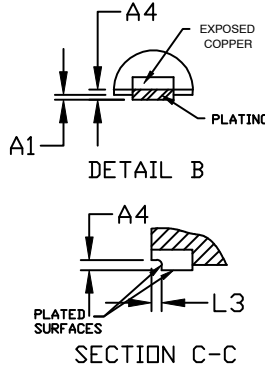
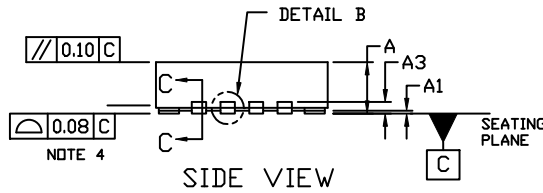
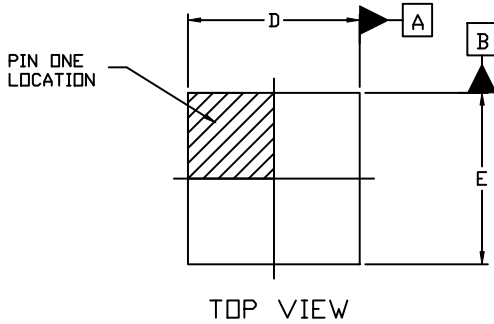
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PACKAGE DIMENSIONS

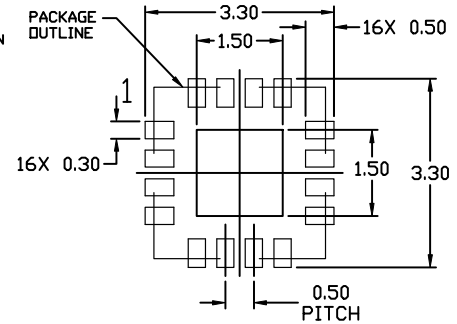
QFNW16 3x3, 0.5P
CASE 484AN
ISSUE O

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.



| DIM | MILLIMETERS | | |
|-----|-------------|------|------|
| | MIN. | NDM. | MAX. |
| A | 0.80 | 0.90 | 1.00 |
| A1 | --- | --- | 0.05 |
| A3 | 0.20 REF | | |
| A4 | 0.13 REF | | |
| b | 0.20 | 0.25 | 0.30 |
| D | 2.90 | 3.00 | 3.10 |
| D2 | 1.30 | 1.40 | 1.50 |
| E | 2.90 | 3.00 | 3.10 |
| E2 | 1.30 | 1.40 | 1.50 |
| e | 0.50 BSC | | |
| K | 0.40 REF | | |
| L | 0.30 | 0.40 | 0.50 |
| L3 | 0.05 REF | | |



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