# ON Semiconductor

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# Triple Inverter

# NL37WZ04

The NL37WZ04 is a high performance triple inverter operating from a 1.65 V to 5.5 V supply.

**Features**

- Designed for 1.65 V to 5.5 V $V_{CC}$ Operation
- 2.3 ns $t_{PD}$ at $V_{CC}$ = 5 V (Typ)
- Inputs/Outputs Overvoltage Tolerant up to 5.5 V
- $I_{OFF}$ Supports Partial Power Down Protection
- Source/Sink 24 mA at 3.0 V
- Available in US8, UDFN8 and UQFN8 Packages
- Chip Complexity < 100 FETs
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant
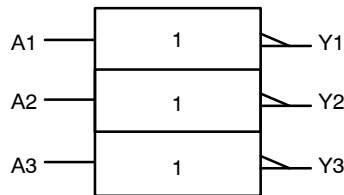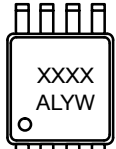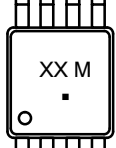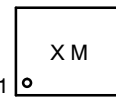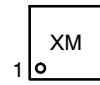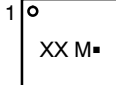


**Figure 1. Logic Symbol**

## ON Semiconductor®

**MARKING DIAGRAMS**

US8
US SUFFIX
CASE 493

XXXX
ALYW

Commercial

XX M

NLV Prefix

UDFN8, 1.45x1.0
MU3 SUFFIX
CASE 517BZ

X M
1

UDFN8, 1.95x1.0
MU1 SUFFIX
CASE 517CA

X M
1

UQFN8, 1.4x1.2
MQ2 SUFFIX
CASE 523AS

XM
1

UQFN8, 1.6x1.6
MQ1 SUFFIX
CASE 523AN

1
XX M■
1    8

| | |
|---|---|
| X, XX, XXXX | = Specific Device Code |
| A | = Assembly Location |
| L | = Lot Code |
| Y | = Year Code |
| W | = Week Code |
| M | = Date Code |
| ■ | = Pb−Free Package |

## ORDERING INFORMATION

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

# NL37WZ04



**US8**
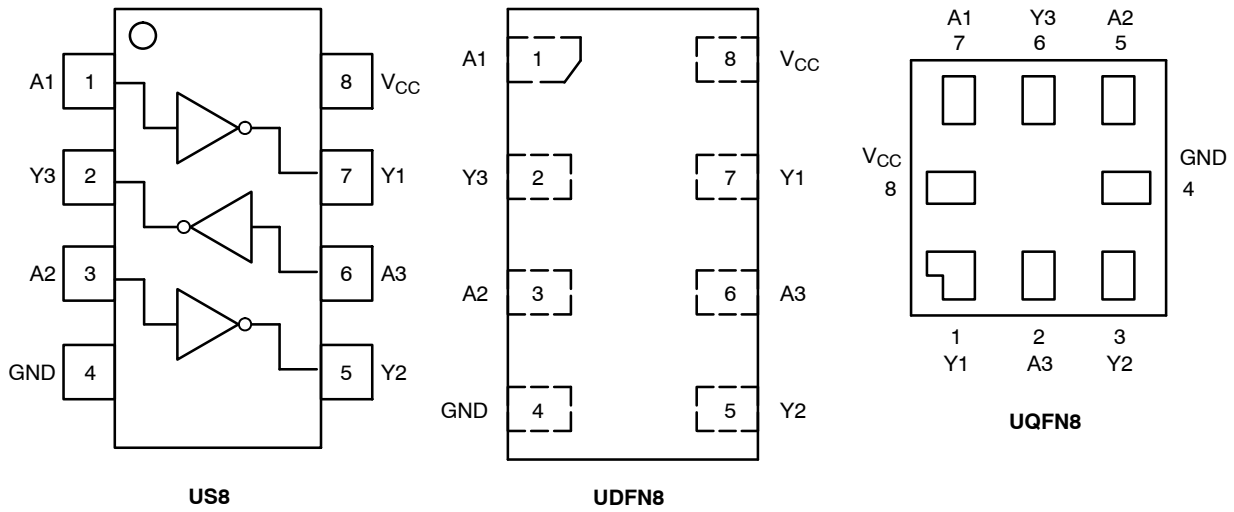
**UDFN8**

**UQFN8**

**Figure 2. Pinout**

## PIN ASSIGNMENT

| Pin | US8 / UDFN8 | UQFN8 |
|-----|-------------|-------|
| 1 | A1 | Y1 |
| 2 | Y3 | A3 |
| 3 | A2 | Y2 |
| 4 | GND | GND |
| 5 | Y2 | A2 |
| 6 | A3 | Y3 |
| 7 | Y1 | A1 |
| 8 | $V_{CC}$ | $V_{CC}$ |

## FUNCTION TABLE

| A Input | Y Output |
|---------|----------|
| L | H |
| H | L |

**MAXIMUM RATINGS**

| Symbol | Characteristics | | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | DC Supply Voltage | NLV | −0.5 to +7.0<br>−0.5 to +6.5 | V |
| $V_{IN}$ | DC Input Voltage | NLV | −0.5 to +7.0<br>−0.5 to +6.5 | V |
| $V_{OUT}$ | DC Output Voltage (NLV) | Active−Mode (High or Low State)<br>Tri−State Mode (Note 1)<br>Power−Down Mode ($V_{CC}$ = 0 V) | −0.5 to $V_{CC}$ + 0.5<br>−0.5 to +7.0<br>−0.5 to +7.0 | V |
| | DC Output Voltage | Active−Mode (High or Low State)<br>Tri−State Mode (Note 1)<br>Power−Down Mode ($V_{CC}$ = 0 V) | −0.5 to $V_{CC}$ + 0.5<br>−0.5 to +6.5<br>−0.5 to +6.5 | V |
| $I_{IK}$ | DC Input Diode Current | $V_{IN}$ < GND | −50 | mA |
| $I_{OK}$ | DC Output Diode Current | $V_{OUT}$ < GND | −50 | mA |
| $I_{OUT}$ | DC Output Source/Sink Current | | ±50 | mA |
| $I_{CC}$ or $I_{GND}$ | DC Supply Current per Supply Pin or Ground Pin | | ±100 | mA |
| $T_{STG}$ | Storage Temperature Range | | −65 to +150 | °C |
| $T_L$ | Lead Temperature, 1 mm from Case for 10 secs | | 260 | °C |
| $T_J$ | Junction Temperature Under Bias | | +150 | °C |
| $\theta_{JA}$ | Thermal Resistance  (Note 2) | US8<br>UQFN8<br>UDFN8 | 250<br>210<br>231 | °C/W |
| $P_D$ | Power Dissipation in Still Air | US8<br>UQFN8<br>UDFN8 | 500<br>595<br>541 | mW |
| MSL | Moisture Sensitivity | | Level 1 | – |
| $F_R$ | Flammability Rating | Oxygen Index: 28 to 34 | UL 94 V−0 @ 0.125 in | – |
| $V_{ESD}$ | ESD Withstand Voltage (Note 3) | Human Body Model<br>Charged Device Model | 2000<br>1000 | V |
| $I_{Latchup}$ | Latchup Performance (Note 4) | | ±100 | mA |

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. Applicable to devices with outputs that may be tri−stated.
2. Measured with minimum pad spacing on an FR4 board, using 10mm−by−1inch, 2 ounce copper trace no air flow per JESD51−7.
3. HBM tested to ANSI/ESDA/JEDEC JS−001−2017. CDM tested to EIA/JESD22−C101−F. JEDEC recommends that ESD qualification to EIA/JESD22−A115−A (Machine Model) be discontinued per JEDEC/JEP172A.
4. Tested to EIA/JESD78 Class II.

**RECOMMENDED OPERATING CONDITIONS**

| Symbol | Characteristics | | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | Positive DC Supply Voltage | | 1.65 | 5.5 | V |
| $V_{IN}$ | DC Input Voltage | | 0 | 5.5 | V |
| $V_{OUT}$ | DC Output Voltage | Active−Mode (High or Low State)<br>Tri−State Mode (Note 1)<br>Power−Down Mode ($V_{CC}$ = 0 V) | 0<br>0<br>0 | $V_{CC}$<br>5.5<br>5.5 | |
| $T_A$ | Operating Temperature Range | | −55 | +125 | °C |
| $t_r$ , $t_f$ | Input Rise and Fall Time (NLV) | $V_{CC}$ = 3.0 V to 3.6 V<br>$V_{CC}$ = 4.5 V to 5.5 V | 0<br>0 | 100<br>20 | ns/V |
| | Input Rise and Fall Time | $V_{CC}$ = 1.65 V to 1.95 V<br>$V_{CC}$ = 2.3 V to 2.7 V<br>$V_{CC}$ = 3.0 V to 3.6 V<br>$V_{CC}$ = 4.5 V to 5.5 V | 0<br>0<br>0<br>0 | 20<br>20<br>10<br>5 | |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

## DC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Condition | $V_{CC}$ (V) | $T_A = 25°C$ | | | $-55°C \leq T_A \leq 125°C$ | | Units |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | Min | Max | |
| $V_{IH}$ | High−Level Input Voltage | | 1.65 to 1.95 | 0.65 $V_{CC}$ | – | – | 0.65 $V_{CC}$ | – | V |
| | | | 2.3 to 5.5 | 0.70 $V_{CC}$ | – | – | 0.70 $V_{CC}$ | – | |
| $V_{IL}$ | Low−Level Input Voltage | | 1.65 to 1.95 | – | – | 0.35 $V_{CC}$ | – | 0.35 $V_{CC}$ | V |
| | | | 2.3 to 5.5 | – | – | 0.30 $V_{CC}$ | – | 0.30 $V_{CC}$ | |
| $V_{OH}$ | High−Level Output Voltage | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$I_{OH} = -100$ μA<br>$I_{OH} = -4$ mA<br>$I_{OH} = -8$ mA<br>$I_{OH} = -12$ mA<br>$I_{OH} = -16$ mA<br>$I_{OH} = -24$ mA<br>$I_{OH} = -32$ mA | 1.65 to 5.5<br>1.65<br>2.3<br>2.7<br>3.0<br>3.0<br>4.5 | $V_{CC} - 0.1$<br>1.29<br>1.9<br>2.2<br>2.4<br>2.3<br>3.8 | $V_{CC}$<br>1.4<br>2.1<br>2.4<br>2.7<br>2.5<br>4.0 | –<br>–<br>–<br>–<br>–<br>–<br>– | $V_{CC} - 0.1$<br>1.29<br>1.9<br>2.2<br>2.4<br>2.3<br>3.8 | –<br>–<br>–<br>–<br>–<br>–<br>– | V |
| $V_{OL}$ | Low−Level Output Voltage | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$I_{OL} = 100$ μA<br>$I_{OL} = 4$ mA<br>$I_{OL} = 8$ mA<br>$I_{OL} = 12$ mA<br>$I_{OL} = 16$ mA<br>$I_{OL} = 24$ mA<br>$I_{OL} = 32$ mA | 1.65 to 5.5<br>1.65<br>2.3<br>2.7<br>3.0<br>3.0<br>4.5 | –<br>–<br>–<br>–<br>–<br>–<br>– | –<br>0.08<br>0.2<br>0.22<br>0.28<br>0.38<br>0.42 | 0.1<br>0.24<br>0.3<br>0.4<br>0.4<br>0.55<br>0.55 | –<br>–<br>–<br>–<br>–<br>–<br>– | 0.1<br>0.24<br>0.3<br>0.4<br>0.4<br>0.55<br>0.55 | V |
| $I_{IN}$ | Input Leakage Current | $V_{IN} = 5.5$ V or GND | 1.65 to 5.5 | – | – | ±0.1 | – | ±1.0 | μA |
| $I_{OFF}$ | Power Off Leakage Current | $V_{IN} = 5.5$ V or $V_{OUT} = 5.5$ V | 0 | – | – | 1.0 | – | 10 | μA |
| $I_{CC}$ | Quiescent Supply Current | $V_{IN} = V_{CC}$ or GND | 5.5 | – | – | 1.0 | – | 10 | μA |

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.

## AC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | $V_{CC}$ (V) | Test Conditions | $T_A = 25°C$ | | | $T_A = -55$ to $125°C$ | | Units |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | Min | Max | |
| $t_{PLH}$, $t_{PHL}$ | Propagation Delay, A to Y | 1.65 to 1.95 | $C_L = 15$ pF<br>$R_L = 1$ MΩ<br>$R_1 = $ Open | – | 4.4 | 9.5 | – | 10.0 | ns |
| | | 2.3 to 2.7 | | – | 5.0 | 5.7 | – | 6.1 | |
| | | 3.0 to 3.6 | | – | 2.2 | 3.4 | – | 3.8 | |
| | | 4.5 to 5.5 | | – | 1.8 | 2.8 | – | 3.1 | |
| | | 3.0 to 3.6 | $C_L = 50$ pF, $R_L = 500$ Ω, $R_1 = $ Open | – | 3.9 | 4.5 | – | 5.0 | |
| | | 4.5 to 5.5 | | – | 2.3 | 3.6 | – | 4.0 | |

5. $C_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: $I_{CC(OPR)} = C_{PD} \cdot V_{CC} \cdot f_{in} + I_{CC}/2$ (per flip−flop). $C_{PD}$ is used to determine the no−load dynamic power consumption; $P_D = C_{PD} \cdot V_{CC}^2 \cdot f_{in} + I_{CC} \cdot V_{CC}$.

## CAPACITIVE CHARACTERISTICS

| Symbol | Parameter | Condition | Typical | Units |
|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{CC} = 5.5$ V, $V_{IN} = 0$ V or $V_{CC}$ | 2.5 | pF |
| $C_{OUT}$ | Output Capacitance | $V_{CC} = 5.5$ V, $V_{IN} = 0$ V or $V_{CC}$ | 2.5 | pF |
| $C_{PD}$ | Power Dissipation Capacitance (Note 6) | 10 MHz, $V_{CC} = 3.3$ V, $V_{IN} = 0$ V or $V_{CC}$<br>10 MHz, $V_{CC} = 5.5$ V, $V_{IN} = 0$ V or $V_{CC}$ | 9<br>11 | pF |

6. $C_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: $I_{CC(OPR)} = C_{PD} \cdot V_{CC} \cdot f_{in} + I_{CC}$. $C_{PD}$ is used to determine the no−load dynamic power consumption; $P_D = C_{PD} \cdot V_{CC}^2 \cdot f_{in} + I_{CC} \cdot V_{CC}$.

C_L includes probe and jig capacitance
R_T is $Z_{OUT}$ of pulse generator (typically 50 $\Omega$)
f = 1 MHz

**Figure 3. Test Circuit**

| Test | Switch Position | C_L, pF | R_L, $\Omega$ | R_1, $\Omega$ |
|------|-----------------|---------|---------------|---------------|
| $t_{PLH}$ / $t_{PHL}$ | Open | See AC Characteristics Table | | |
| $t_{PLZ}$ / $t_{PZL}$ | 2 x V_{CC} | 50 | 500 | 500 |
| $t_{PHZ}$ / $t_{PZH}$ | GND | 50 | 500 | 500 |

X = Don't Care



**Figure 4. Switching Waveforms**

| V_{CC}, V | V_{mi}, V | V_{mo}, V | | V_Y, V |
|-----------|-----------|-----------|-----------|--------|
| | | $t_{PLH}, t_{PHL}$ | $t_{PZL}, t_{PLZ}, t_{PZH}, t_{PHZ}$ | |
| 1.65 to 1.95 | V_{CC}/2 | V_{CC}/2 | V_{CC}/2 | 0.15 |
| 2.3 to 2.7 | V_{CC}/2 | V_{CC}/2 | V_{CC}/2 | 0.15 |
| 3.0 to 3.6 | V_{CC}/2 | V_{CC}/2 | V_{CC}/2 | 0.3 |
| 4.5 to 5.5 | V_{CC}/2 | V_{CC}/2 | V_{CC}/2 | 0.3 |

# NL37WZ04

**DEVICE ORDERING INFORMATION**

| Device | Packages | Specific Device Code | Pin 1 Orientation (See below) | Shipping[†] |
|---|---|---|---|---|
| NL37WZ04USG | US8 | L5 | Q4 | 3000 / Tape & Reel |
| NLV37WZ04USG* | US8 | L5 | Q4 | 3000 / Tape & Reel |
| NL37WZ04MQ1TCG (In Development) | UQFN8, 1.6 x 1.6, 0.5P | TBD | TBD | 3000 / Tape & Reel |
| NL37WZ04MU1TCG (In Development) | UDFN8, 1.95 x 1.0, 0.5P | TBD | TBD | 3000 / Tape & Reel |
| NL37WZ04MU3TCG (In Development) | UDFN8, 1.45 x 1.0, 0.35P | TBD | TBD | 3000 / Tape & Reel |
| NL37WZ04MQ2TCG (In Development) | UQFN8, 1.4 x 1.2, 0.4P | TBD | TBD | 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.
*NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable.

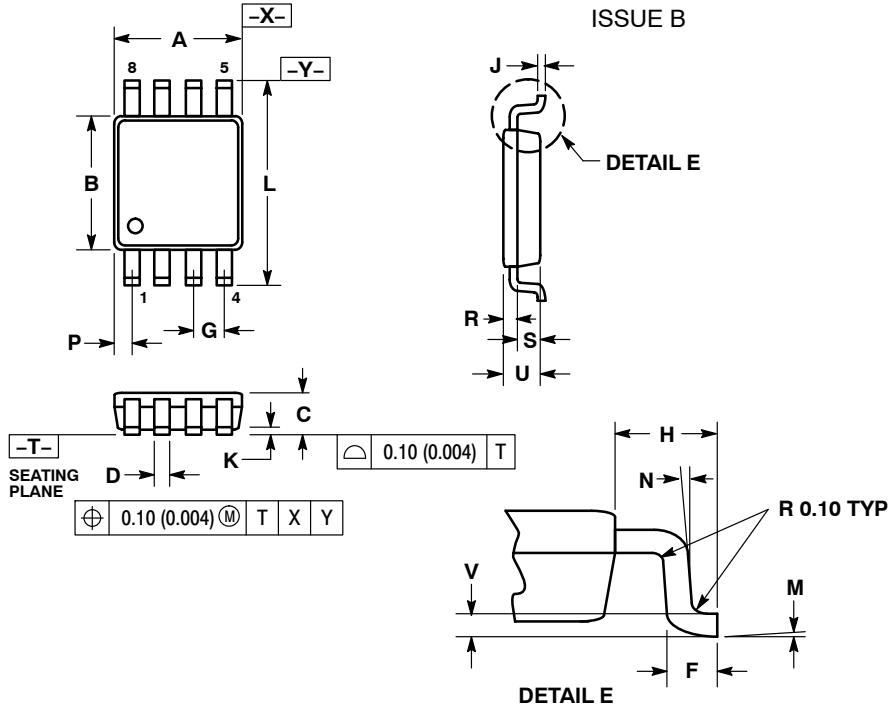**Pin 1 Orientation in Tape and Reel**
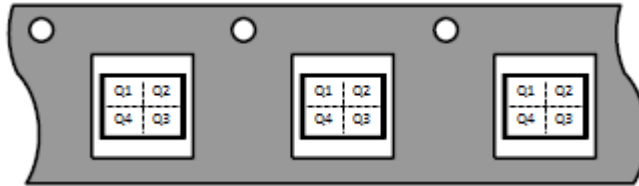
# NL37WZ04

## PACKAGE DIMENSIONS

**US8**
**US SUFFIX**
CASE 493−02
ISSUE B



DETAIL E

DETAIL E

**NOTES:**
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION "A" DOES NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURR. MOLD FLASH. PROTRUSION AND GATE BURR SHALL NOT EXCEED 0.140 MM (0.0055") PER SIDE.
4. DIMENSION "B" DOES NOT INCLUDE INTER−LEAD FLASH OR PROTRUSION. INTER−LEAD FLASH AND PROTRUSION SHALL NOT E3XCEED 0.140 (0.0055") PER SIDE.
5. LEAD FINISH IS SOLDER PLATING WITH THICKNESS OF 0.0076−0.0203 MM. (300−800 ").
6. ALL TOLERANCE UNLESS OTHERWISE SPECIFIED ±0.0508 (0.0002 ").

| DIM | MILLIMETERS | | INCHES | |
|-----|-----|-----|-----|-----|
| | **MIN** | **MAX** | **MIN** | **MAX** |
| A | 1.90 | 2.10 | 0.075 | 0.083 |
| B | 2.20 | 2.40 | 0.087 | 0.094 |
| C | 0.60 | 0.90 | 0.024 | 0.035 |
| D | 0.17 | 0.25 | 0.007 | 0.010 |
| F | 0.20 | 0.35 | 0.008 | 0.014 |
| G | 0.50 BSC | | 0.020 BSC | |
| H | 0.40 REF | | 0.016 REF | |
| J | 0.10 | 0.18 | 0.004 | 0.007 |
| K | 0.00 | 0.10 | 0.000 | 0.004 |
| L | 3.00 | 3.20 | 0.118 | 0.126 |
| M | 0 ° | 6 ° | 0 ° | 6 ° |
| N | 5 ° | 10 ° | 5 ° | 10 ° |
| P | 0.23 | 0.34 | 0.010 | 0.013 |
| R | 0.23 | 0.33 | 0.009 | 0.013 |
| S | 0.37 | 0.47 | 0.015 | 0.019 |
| U | 0.60 | 0.80 | 0.024 | 0.031 |
| V | 0.12 BSC | | 0.005 BSC | |
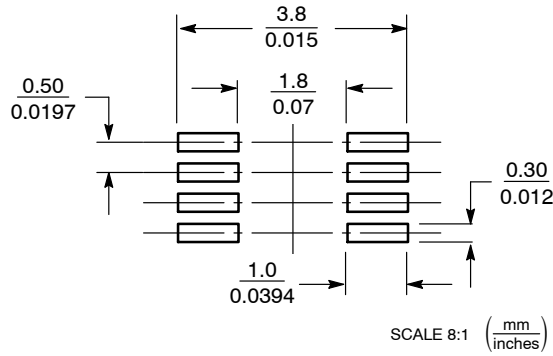
R 0.10 TYP

## SOLDERING FOOTPRINT*



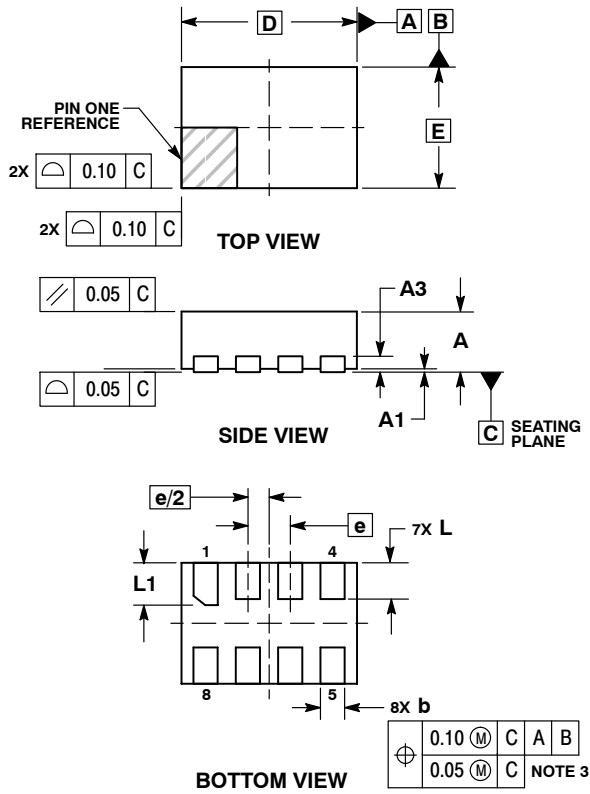SCALE 8:1 $\left(\frac{mm}{inches}\right)$

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

# NL37WZ04

## PACKAGE DIMENSIONS

**UDFN8, 1.45x1, 0.35P**
CASE 517BZ
ISSUE O

**TOP VIEW**

2X ⌒ 0.10 C

2X ⌒ 0.10 C

PIN ONE
REFERENCE

D | A B

E

**SIDE VIEW**

⧄ 0.05 C

⌒ 0.05 C

A3

A

A1

C SEATING PLANE

**BOTTOM VIEW**

e/2

e

7X L

L1

1    4

8    5

8X b

| ⌖ | 0.10 Ⓜ C A B |
|---|---|
| | 0.05 Ⓜ C | NOTE 3 |

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 0.20 MM FROM TERMINAL TIP.
4. PACKAGE DIMENSIONS EXCLUSIVE OF BURRS AND MOLD FLASH.

| DIM | MILLIMETERS | |
|-----|-----|-----|
| | MIN | MAX |
| A | 0.45 | 0.55 |
| A1 | 0.00 | 0.05 |
| A3 | 0.13 REF | |
| b | 0.15 | 0.25 |
| D | 1.45 BSC | |
| E | 1.00 BSC | |
| e | 0.35 BSC | |
| L | 0.25 | 0.35 |
| L1 | 0.30 | 0.40 |

## RECOMMENDED SOLDERING FOOTPRINT*

7X
0.48

8X
0.22

1.18

0.53

1

0.35
PITCH

PKG
OUTLINE

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.
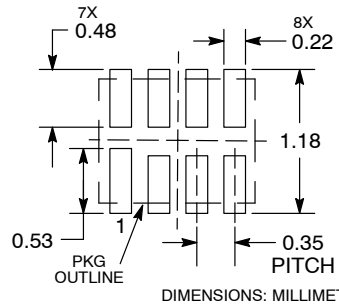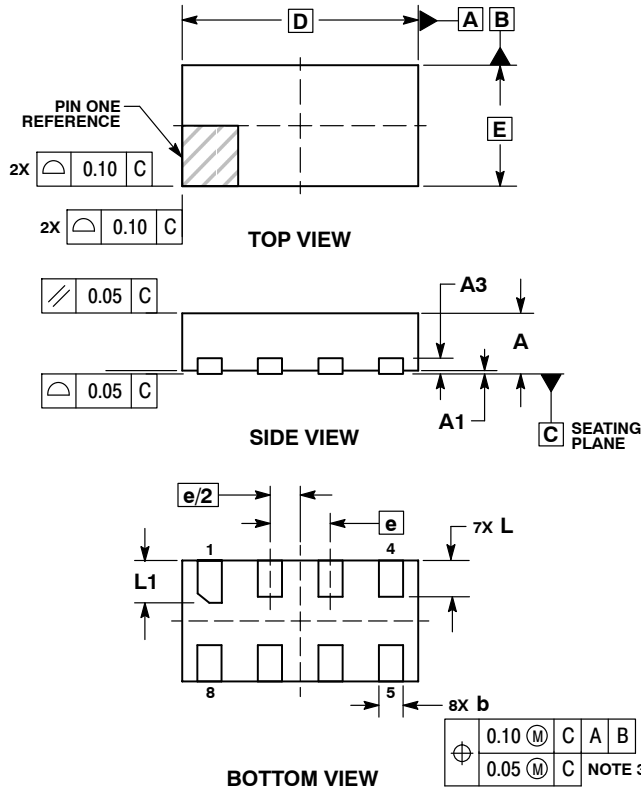
# NL37WZ04

## PACKAGE DIMENSIONS

**UDFN8, 1.95x1, 0.5P**
CASE 517CA
ISSUE O

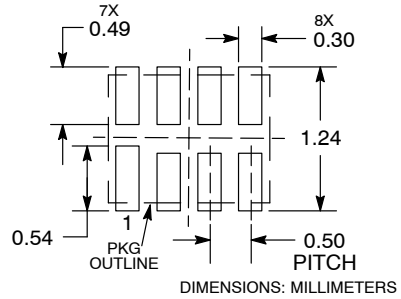**TOP VIEW**

**SIDE VIEW**

**BOTTOM VIEW**

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 0.20 MM FROM TERMINAL TIP.
4. PACKAGE DIMENSIONS EXCLUSIVE OF BURRS AND MOLD FLASH.

| DIM | MILLIMETERS | |
|-----|-----|-----|
|     | MIN | MAX |
| A   | 0.45 | 0.55 |
| A1  | 0.00 | 0.05 |
| A3  | 0.13 REF | |
| b   | 0.15 | 0.25 |
| D   | 1.95 BSC | |
| E   | 1.00 BSC | |
| e   | 0.50 BSC | |
| L   | 0.25 | 0.35 |
| L1  | 0.30 | 0.40 |

**RECOMMENDED SOLDERING FOOTPRINT\***
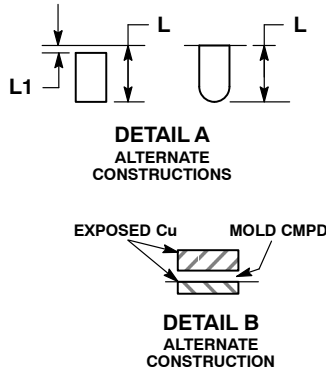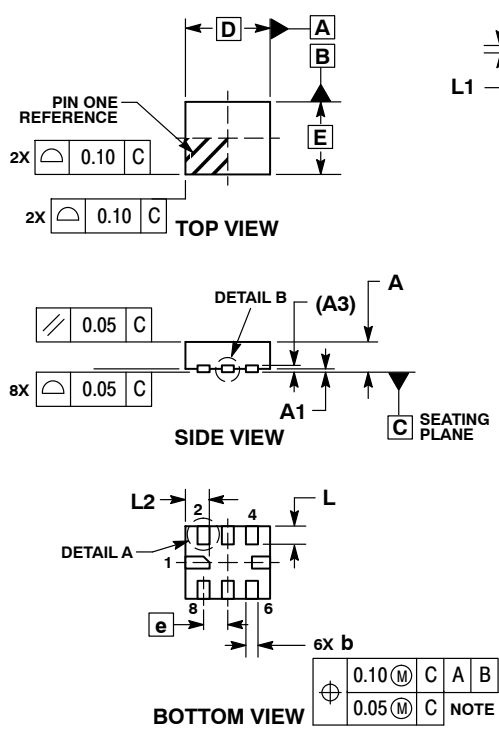
DIMENSIONS: MILLIMETERS

*For additional information on our Pb–Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.
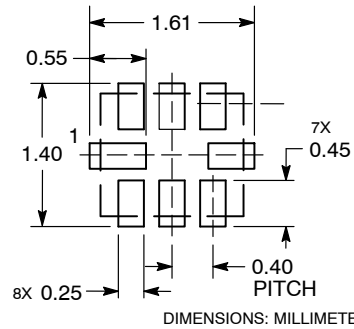
# NL37WZ04

## PACKAGE DIMENSIONS

**UQFN8, 1.4x1.2, 0.4P**
CASE 523AS
ISSUE A



**TOP VIEW**

2X ⌓ 0.10 C

2X ⌓ 0.10 C

PIN ONE REFERENCE

**SIDE VIEW**

0.05 C

8X ⌓ 0.05 C

DETAIL B

(A3)

A

A1

C SEATING PLANE

**BOTTOM VIEW**

DETAIL A

L2

e

6X b

| 0.10 Ⓜ | C | A | B |
|---|---|---|---|
| 0.05 Ⓜ | C | NOTE 3 |  |

**DETAIL A**
ALTERNATE CONSTRUCTIONS

L

L1

**DETAIL B**
ALTERNATE CONSTRUCTION

EXPOSED Cu          MOLD CMPD

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 0.25 mm FROM THE TERMINAL TIP.

| DIM | MILLIMETERS | |
|---|---|---|
|  | MIN | MAX |
| A | 0.45 | 0.55 |
| A1 | 0.00 | 0.05 |
| A3 | 0.13 REF | |
| b | 0.15 | 0.25 |
| D | 1.40 BSC | |
| E | 1.20 BSC | |
| e | 0.40 BSC | |
| L | 0.20 | 0.40 |
| L1 | --- | 0.15 |
| L2 | 0.30 | 0.50 |

### SOLDERING FOOTPRINT*



1.61

0.55

1.40

1

7X

0.45

8X 0.25

0.40 PITCH

DIMENSIONS: MILLIMETERS

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