# NLSV4T3144

# 4-Bit Dual-Supply Non-Inverting Level Translator

The NLSV4T3144 is a 4−bit configurable dual−supply bus buffer level translator. The input ($IN\_x_n$) and output ($OUT\_x_n$) ports are designed to track two different power supply rails, $V_{CCA}$ and $V_{CCB}$ respectively. Both supply rails are configurable from 1.6 V to 3.6 V allowing low−voltage translation from the input to the output port.

### Features

- Wide $V_{CCA}$ and $V_{CCB}$ Operating Range: 1.6 V to 3.6 V
- High−Speed w/ Balanced Propagation Delay
- Inputs and Outputs have OVT Protection to 5.5 V
- Outputs at 3−State until Active $V_{CCA}$ and $V_{CCB}$ are Reached
- Power−Off Protection
- Ultra−Small Packaging: 1.7 mm x 2.0 mm UQFN−12
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

### Typical Applications

- Mobile Phones, PDAs, Other Portable Devices
- SPI™ Bus Voltage Translation

### Important Information

- ESD Protection for All Pins:
  HBM (Human Body Model) > 3000 V

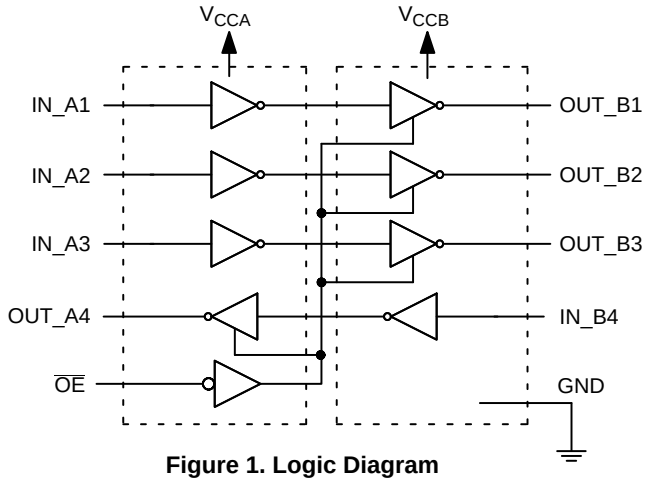


**Figure 1. Logic Diagram**

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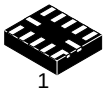
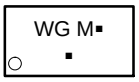



**UQFN12**
**MU SUFFIX**
**CASE 523AE**

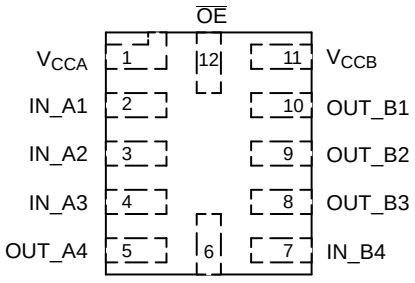
### MARKING DIAGRAM




WG = Specific Device Code
M = Date Code
▪ = Pb−Free Package

(Note: Microdot may be in either location)

### PIN ASSIGNMENTS




(Top View)

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| NLSV4T3144MUTAG | UQFN−12 (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 Specification Brochure, BRD8011/D.

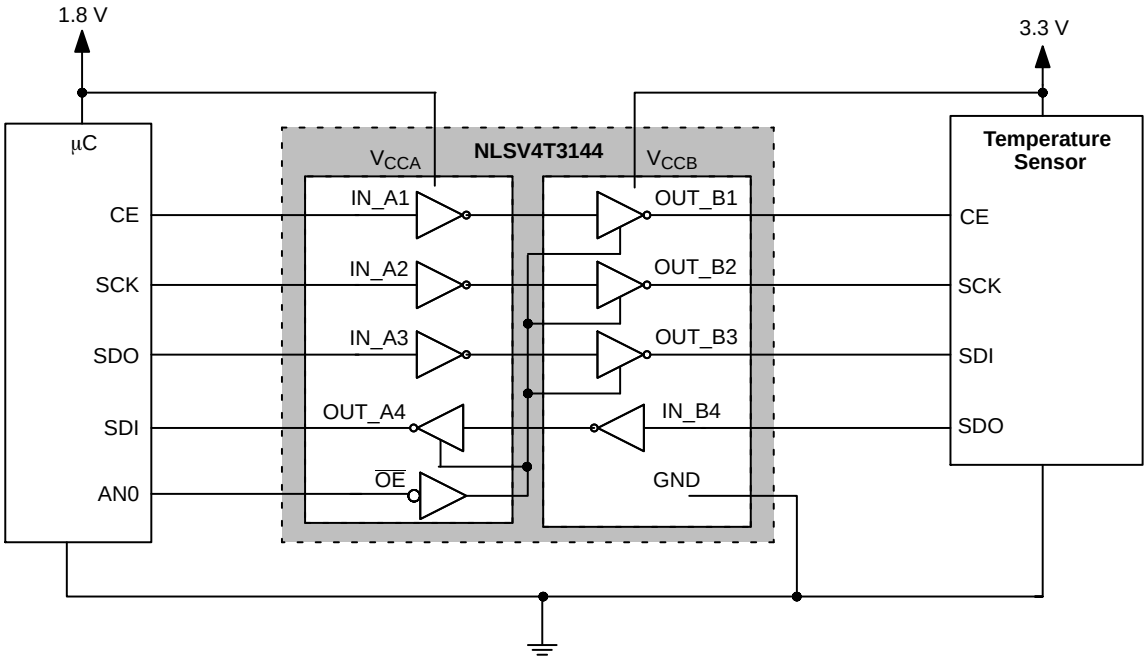



**Figure 2. Typical Application: SPI Bus Voltage Translator**

**PIN NAMES**

| Pins | Description |
|---|---|
| $V_{CCA}$ | 'A' DC Power Supply |
| $V_{CCB}$ | 'B' DC Power Supply |
| GND | Ground |
| IN_A1, IN_A2, IN_A3 | Input (Referenced to $V_{CCA}$) |
| IN_B4 | Input (Referenced to $V_{CCB}$) |
| OUT_B1, OUT_B2, OUT_B3 | Output (Referenced to $V_{CCB}$) |
| OUT_A4 | Output (Referenced to $V_{CCA}$) |
| $\overline{OE}$ | Output Enable (Referenced to $V_{CCA}$) |

**TRUTH TABLE**

| Inputs | | Outputs |
|---|---|---|
| $\overline{OE}$ | IN_A1, IN_A2, IN_A3, IN_B4 | OUT_B1, OUT_B2, OUT_B3, OUT_A4 |
| H | X | 3−State |
| L | L | L |
| | H | H |

## MAXIMUM RATINGS

| Symbol | Parameter | Value | Condition | Unit |
|---|---|---|---|---|
| $V_{CCA}$, $V_{CCB}$ | DC Supply Voltage, $V_{CCA} \leq V_{CCB}$ | −0.5 to +5.5 | | V |
| $V_I$ | DC Input Voltage IN_$x_n$ | −0.5 to +5.5 | | V |
| $V_C$ | Control Input $\overline{OE}$ | −0.5 to +5.5 | | V |
| $V_O$ | DC Output Voltage (Power Down) OUT_$x_n$ | −0.5 to +5.5 | $V_{CCA} = V_{CCB} = 0$ | V |
| | (Active Mode) OUT_$x_n$ | −0.5 to +5.5 | | |
| | (Tri−State Mode) OUT_$x_n$ | −0.5 to +5.5 | | |
| $I_{IK}$ | DC Input Diode Current | −20 | $V_I < GND$ | mA |
| $I_{OK}$ | DC Output Diode Current | −50 | $V_O < GND$ | mA |
| $I_O$ | DC Output Source/Sink Current | ±50 | | mA |
| $I_{CCA}$, $I_{CCB}$ | DC Supply Current Per Supply Pin | ±100 | | mA |
| $I_{GND}$ | DC Ground Current per Ground Pin | ±100 | | mA |
| $T_{STG}$ | Storage Temperature | −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.

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $V_{CCA}$, $V_{CCB}$ | Positive DC Supply Voltage, $V_{CCA} \leq V_{CCB}$ | 1.6 | 3.6 | V |
| $V_I$ | Bus Input Voltage | GND | 3.6 | V |
| $V_C$ | Control Input $\overline{OE}$ | GND | 3.6 | V |
| $V_{IO}$ | DC Output Voltage (Power Down) OUT_$x_n$ | GND | 3.6 | V |
| | (Active Mode) OUT_$x_n$ | | | |
| | (Tri−State Mode) OUT_$x_n$ | | | |
| $T_A$ | Operating Temperature Range | −40 | +85 | °C |
| $\Delta t / \Delta V$ | Input Transition Rise or Rate<br>$V_I$, from 30% to 70% of $V_{CCA}$ and $V_{CCB}$;<br>$V_{CCA} = V_{CCB} = 3.3$ V ±0.3 V | 0 | 10 | ns |

## DC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Test Conditions | $V_{CCA}$ (V) | $V_{CCB}$ (V) | −40°C to + 85°C | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | | Min | Max | |
| $V_{IH}$ (IN_A1, IN_A2, IN_A3, $\overline{OE}$) | Input HIGH Voltage | | 2.7 – 3.6 | ≥ $V_{CCA}$ | 2.0 | – | V |
| | | | 2.3 – 2.7 | | 1.6 | – | |
| | | | 1.6 −2.3 | | 0.65 * $V_{CCA}$ | – | |
| $V_{IH}$ (IN_B4) | Input HIGH Voltage | | ≤ $V_{CCB}$ | 2.7 – 3.6 | 2.0 | – | V |
| | | | | 2.3 – 2.7 | 1.6 | – | |
| | | | | 1.6 −2.3 | 0.65 * $V_{CCB}$ | – | |
| $V_{IL}$ (IN_A1, IN_A2, IN_A3, $\overline{OE}$) | Input LOW Voltage | | 2.7 – 3.6 | ≥ $V_{CCA}$ | – | 0.8 | V |
| | | | 2.3 – 2.7 | | – | 0.7 | |
| | | | 1.6 −2.3 | | – | 0.35 * $V_{CCA}$ | |
| $V_{IL}$ (IN_B4) | Input LOW Voltage | | ≤ $V_{CCB}$ | 2.7 – 3.6 | – | 0.8 | V |
| | | | | 2.3 – 2.7 | – | 0.7 | |
| | | | | 1.6 −2.3 | – | 0.35 * $V_{CCB}$ | |
| $V_{OH}$ (OUT_B1, OUT_B2, OUT_B3) | Output HIGH Voltage | $I_{OH}$ = −100 μA; $V_I$ = $V_{IH}$ | ≤ $V_{CCB}$ | 1.6 – 3.6 | $V_{CCB}$ – 0.2 | – | V |
| | | $I_{OH}$ = −6 mA; $V_I$ = $V_{IH}$ | 1.6 | 1.6 | 1.25 | – | |
| | | | 2.3 | 2.3 | 2.0 | – | |
| | | $I_{OH}$ = −12 mA; $V_I$ = $V_{IH}$ | 2.3 | 2.3 | 1.8 | – | |
| | | | 2.7 | 2.7 | 2.2 | – | |
| | | $I_{OH}$ = −18 mA; $V_I$ = $V_{IH}$ | 2.3 | 2.3 | 1.7 | – | |
| | | | 3.0 | 3.0 | 2.4 | – | |
| | | $I_{OH}$ = −24 mA; $V_I$ = $V_{IH}$ | 3.0 | 3.0 | 2.2 | – | |
| $V_{OH}$ (OUT_A4) | Output HIGH Voltage | $I_{OH}$ = −100 μA; $V_I$ = $V_{IH}$ | 1.6 – 3.6 | ≥ $V_{CCA}$ | $V_{CCA}$ – 0.2 | – | V |
| | | $I_{OH}$ = −6 mA; $V_I$ = $V_{IH}$ | 1.6 | 1.6 | 1.25 | – | |
| | | | 2.3 | 2.3 | 2.0 | – | |
| | | $I_{OH}$ = −12 mA; $V_I$ = $V_{IH}$ | 2.3 | 2.3 | 1.8 | – | |
| | | | 2.7 | 2.7 | 2.2 | – | |
| | | $I_{OH}$ = −18 mA; $V_I$ = $V_{IH}$ | 2.3 | 2.3 | 1.7 | – | |
| | | | 3.0 | 3.0 | 2.4 | – | |
| | | $I_{OH}$ = −24 mA; $V_I$ = $V_{IH}$ | 3.0 | 3.0 | 2.2 | – | |
| $V_{OL}$ (OUT_B1, OUT_B2, OUT_B3) | Output LOW Voltage | $I_{OL}$ = 100 μA; $V_I$ = $V_{IH}$ | ≤ $V_{CCB}$ | 1.6 – 3.6 | – | 0.2 | V |
| | | $I_{OL}$ = 6 mA; $V_I$ = $V_{IH}$ | 1.6 | 1.6 | – | 0.3 | |
| | | $I_{OL}$ = 12 mA; $V_I$ = $V_{IH}$ | 2.3 | 2.3 | – | 0.4 | |
| | | | 2.7 | 2.7 | – | 0.4 | |
| | | $I_{OL}$ = 18 mA; $V_I$ = $V_{IH}$ | 2.3 | 2.3 | – | 0.6 | |
| | | | 3.0 | 3.0 | – | 0.5 | |
| | | $I_{OL}$ = 24 mA; $V_I$ = $V_{IH}$ | 3.0 | 3.0 | – | 0.6 | |
| $V_{OL}$ (OUT_A4) | Output LOW Voltage | $I_{OL}$ = 100 μA; $V_I$ = $V_{IH}$ | 1.6 – 3.6 | ≥ $V_{CCA}$ | – | 0.2 | V |
| | | $I_{OL}$ = 6 mA; $V_I$ = $V_{IH}$ | 1.6 | 1.6 | – | 0.3 | |
| | | $I_{OL}$ = 12 mA; $V_I$ = $V_{IH}$ | 2.3 | 2.3 | – | 0.4 | |
| | | | 2.7 | 2.7 | – | 0.4 | |
| | | $I_{OL}$ = 18 mA; $V_I$ = $V_{IH}$ | 2.3 | 2.3 | – | 0.6 | |
| | | | 3.0 | 3.0 | – | 0.5 | |
| | | $I_{OL}$ = 24 mA; $V_I$ = $V_{IH}$ | 3.0 | 3.0 | – | 0.6 | |

## DC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Test Conditions | $V_{CCA}$ (V) | $V_{CCB}$ (V) | −40°C to + 85°C | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | | Min | Max | |
| $I_{IN}$ | Input Leakage Current | $V_{IN\_A1}$ = $V_{IN\_A2}$ = $V_{IN\_A3}$ = $V_{CCA}$ or GND; $V_{IN\_B4}$ = $V_{CCB}$ or GND | ≤ $V_{CCB}$ | 1.6 – 3.6 | −1.0 | +1.0 | μA |
| $I_{OZ}$ | I/O Tri − State Output Leakage Current | TA = 25°C, $\overline{OE}$ = $V_{CCA}$ | ≤ $V_{CCB}$ | 1.6 – 3.6 | − | 1.0 | μA |
| $I_{CCA}$ | Quiescent Supply Current | $V_{IN\_A1}$ = $V_{IN\_A2}$ = $V_{IN\_A3}$ = $V_{CCA}$ or GND; $V_{IN\_B4}$ = $V_{CCB}$ or GND $\overline{OE}$ = GND, $I_O$ = 0 | ≤ $V_{CCB}$ | 1.6 – 3.6 | − | 3.0 | μA |
| $I_{CCB}$ | Quiescent Supply Current | $V_{IN\_A1}$ = $V_{IN\_A2}$ = $V_{IN\_A3}$ = $V_{CCA}$ or GND; $V_{IN\_B4}$ = $V_{CCB}$ or GND $\overline{OE}$ = GND, $I_O$ = 0 | ≤ $V_{CCB}$ | 1.6 – 3.6 | − | 3.0 | μA |
| $I_{CCA}$ + $I_{CCB}$ | Quiescent Supply Current | $V_{IN\_A1}$ = $V_{IN\_A2}$ = $V_{IN\_A3}$ = $V_{CCA}$ or GND; $V_{IN\_B4}$ = $V_{CCB}$ or GND $\overline{OE}$ = GND, $I_O$ = 0 | ≤ $V_{CCB}$ | 1.6 – 3.6 | − | 6.0 | μA |

NOTE: Connect ground before applying supply voltage $V_{CCA}$ or $V_{CCB}$. This device is designed with the feature that the power−up sequence of $V_{CCA}$ and $V_{CCB}$ will not damage the IC.

## AC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | $V_{CCA}$ (V) | −40°C to +85°C | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CCB}$ (V) | | | | | | |
| | | | 3.6 | | 2.8 | | 1.6 | | |
| | | | Min | Max | Min | Max | Min | Max | |
| $t_{PLH}$, $t_{PHL}$ | Propagation Delay, Input to Output | 3.6 | | 3 | | | | | ns |
| | | 2.8 | | 3.1 | | 3.3 | | | |
| | | 1.6 | | 4.3 | | 4.5 | | 6.1 | |
| $t_{PZH}$, $t_{PZL}$ | Output Enable, $\overline{OE}$ to Output | 3.6 | | 8.7 | | | | | ns |
| | | 2.8 | | 10.3 | | 10.7 | | | |
| | | 1.6 | | 17.2 | | 18 | | 20 | |
| $t_{PHZ}$, $t_{PLZ}$ | Output Disable, $\overline{OE}$ to Output | 3.6 | | 7.8 | | | | | ns |
| | | 2.8 | | 8.2 | | 8.4 | | | |
| | | 1.6 | | 9.5 | | 9.8 | | 10.5 | |
| $t_{OSHL}$, $t_{OSLH}$ | Output to Output Skew | 3.6 | | 0.25 | | | | | ns |
| | | 2.8 | | 0.25 | | 0.25 | | | |
| | | 1.6 | | 0.25 | | 0.25 | | 0.25 | |

NOTE: Propagation delays defined per Figure 3.

## CAPACITANCE

| Symbol | Parameter | Test Conditions | **Typ** (Note 1) | Unit |
|---|---|---|---|---|
| $C_I$ | Control Pin ($\overline{OE}$) Input Capacitance | $V_{CCA}$ = $V_{CCB}$ = 3.3 V, $V_I$ = 0 V or $V_{CCA/B}$ | 3.5 | pF |
| $C_{IN}$ | Input Pin Capacitance | $V_{CCA}$ = $V_{CCB}$ = 3.3 V, $V_I$ = 0 V or $V_{CCA/B}$ | 5.0 | pF |
| $C_{OUT}$ | Output Pin Capacitance | $V_{CCA}$ = $V_{CCB}$ = 3.3 V, $V_I$ = 0 V or $V_{CCA/B}$ | 5.0 | pF |
| $C_{PD}$ | Power Dissipation Capacitance | $V_{CCA}$ = $V_{CC2}$ = 3.3 V, $V_I$ = 0 V or 3.3 V, f = 10 MHz | 10 | pF |

1. Typical values are at $T_A$ = +25°C.

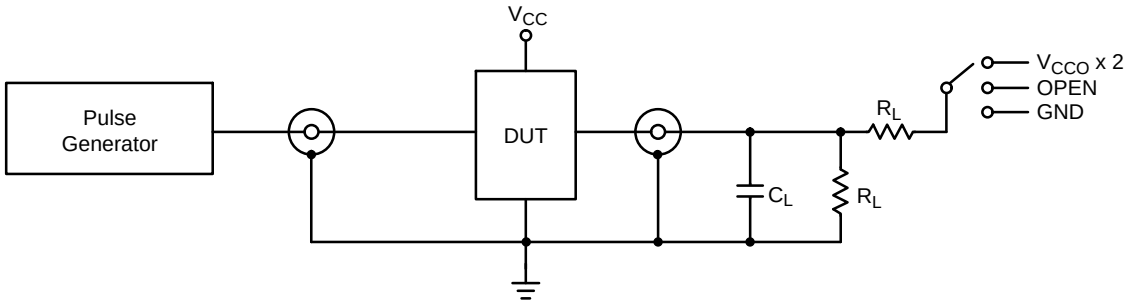
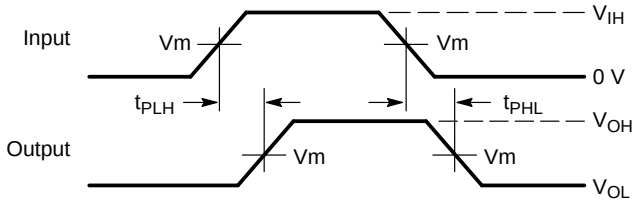
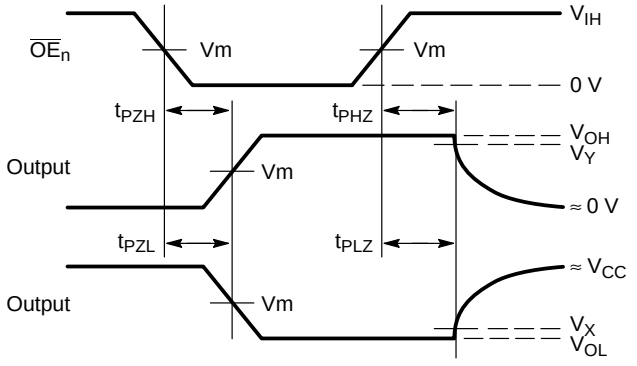



**Figure 3. AC (Propagation Delay) Test Circuit**

| Test | Switch |
|---|---|
| $t_{PLH}$, $t_{PHL}$ | OPEN |
| $t_{PLZ}$, $t_{PZL}$ | $V_{CCO}$ x 2 at $V_{CCO}$ = 3.0 V − 3.6 V, 2.3 V − 2.7 V, 1.65 V − 1.95 V, 1.4 V − 1.6 V |
| $t_{PHZ}$, $t_{PZH}$ | GND |
| $C_L$ = 15 pF or equivalent (includes probe and jig capacitance)<br>$R_L$ = 2 kΩ or equivalent<br>$Z_{OUT}$ of pulse generator = 50 Ω<br>$V_{CCO}$ is the supply voltage referenced to by the output being tested | |




**Waveform 1 − Propagation Delays**
$t_R$ = $t_F$ = 2.0 ns, 10% to 90%; f = 1 MHz; $t_W$ = 500 ns



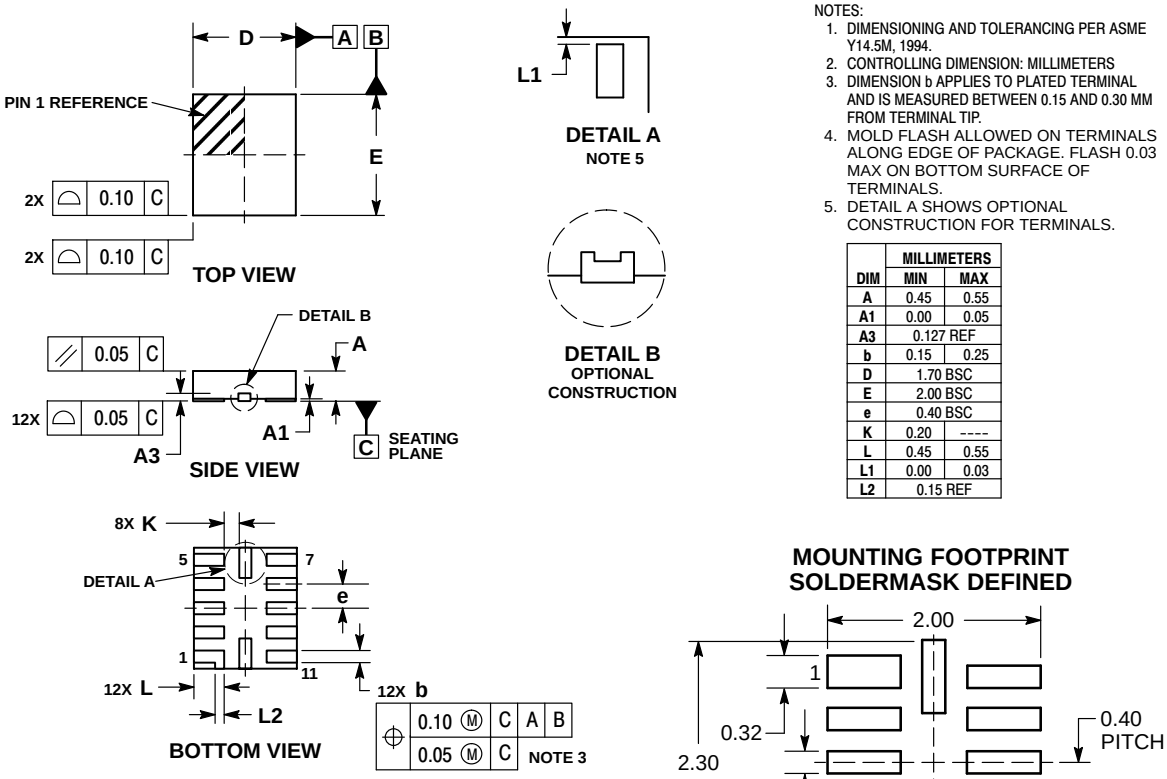

**Waveform 2 − Output Enable and Disable Times**
$t_R$ = $t_F$ = 2.0 ns, 10% to 90%; f = 1 MHz; $t_W$ = 500 ns

**Figure 4. AC (Propagation Delay) Test Circuit Waveforms**

| Symbol | Input Pin<br>Output Pin |
|---|---|
| $V_m$ | $V_{CCX}$/2 |
| $V_X$ | $V_{OL}$ x 0.1 |
| $V_Y$ | $V_{OH}$ x 0.9 |

## PACKAGE DIMENSIONS

**UQFN12 1.7x2.0, 0.4P**
CASE 523AE
ISSUE A




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 TERMINAL TIP.
4. MOLD FLASH ALLOWED ON TERMINALS ALONG EDGE OF PACKAGE. FLASH 0.03 MAX ON BOTTOM SURFACE OF TERMINALS.
5. DETAIL A SHOWS OPTIONAL CONSTRUCTION FOR TERMINALS.

| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 0.45 | 0.55 |
| A1 | 0.00 | 0.05 |
| A3 | 0.127 REF | |
| b | 0.15 | 0.25 |
| D | 1.70 BSC | |
| E | 2.00 BSC | |
| e | 0.40 BSC | |
| K | 0.20 | ---- |
| L | 0.45 | 0.55 |
| L1 | 0.00 | 0.03 |
| L2 | 0.15 REF | |

**MOUNTING FOOTPRINT**
**SOLDERMASK DEFINED**




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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