

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_{xn}) and output (OUT_{xn}) 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

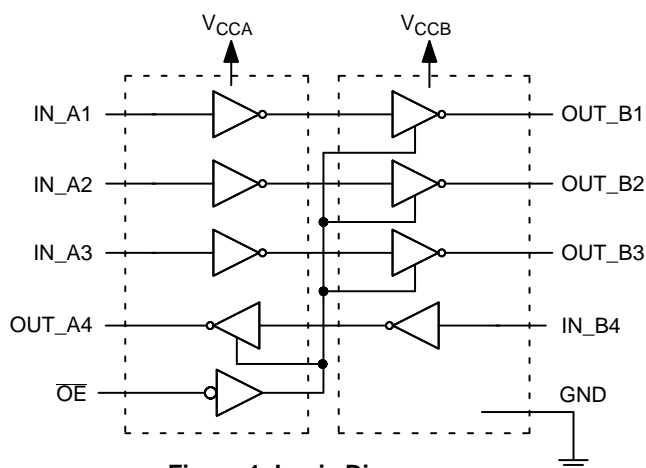
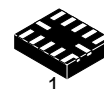


Figure 1. Logic Diagram



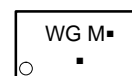
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UQFN12
MU SUFFIX
CASE 523AE

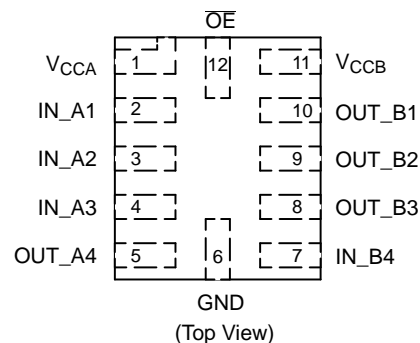
MARKING DIAGRAM



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

(Note: Microdot may be in either location)

PIN ASSIGNMENTS



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.

NLSV4T3144

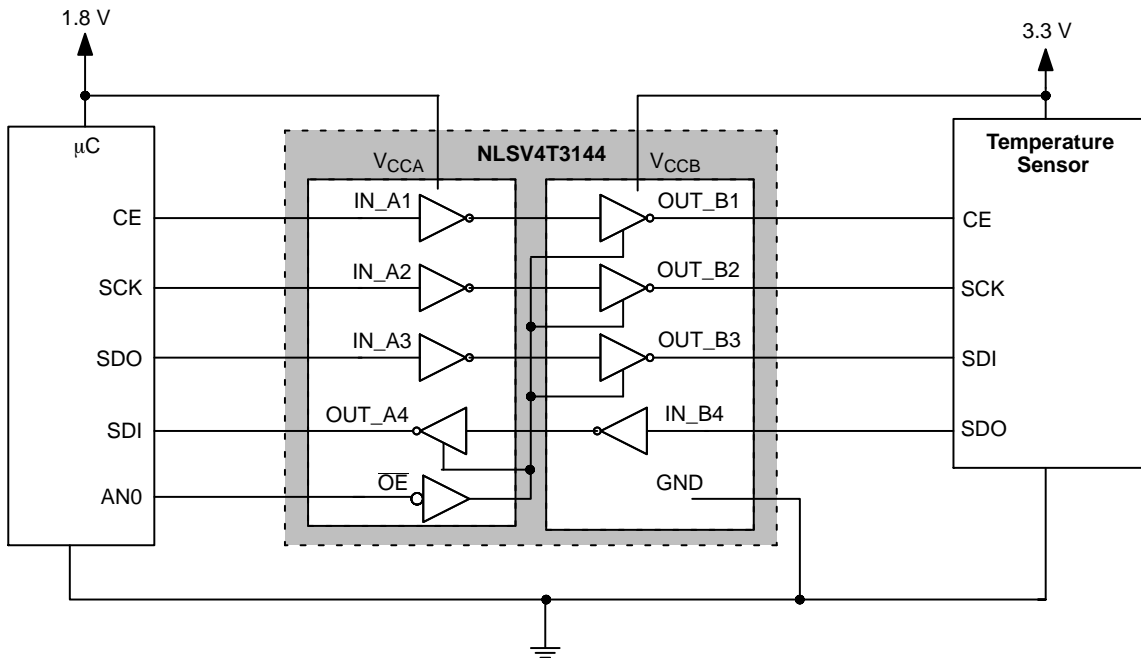


Figure 2. Typical Application: SPI Bus Voltage Translator

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}) |
| OE | Output Enable (Referenced to V _{CCA}) |

TRUTH TABLE

| Inputs | | Outputs |
|--------|-------------------------------|-----------------------------------|
| 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 |

NLSV4T3144

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 | | $^{\circ}C$ |

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 | $^{\circ}C$ |
| $\Delta t / \Delta V$ | Input Transition Rise or Rate V_I , from 30% to 70% of V_{CCA} and V_{CCB} ; $V_{CCA} = V_{CCB} = 3.3 V \pm 0.3 V$ | 0 | 10 | ns |

NLSV4T3144

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, 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, 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 | | |

NLSV4T3144

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 | T _A = 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.

NLSV4T3144

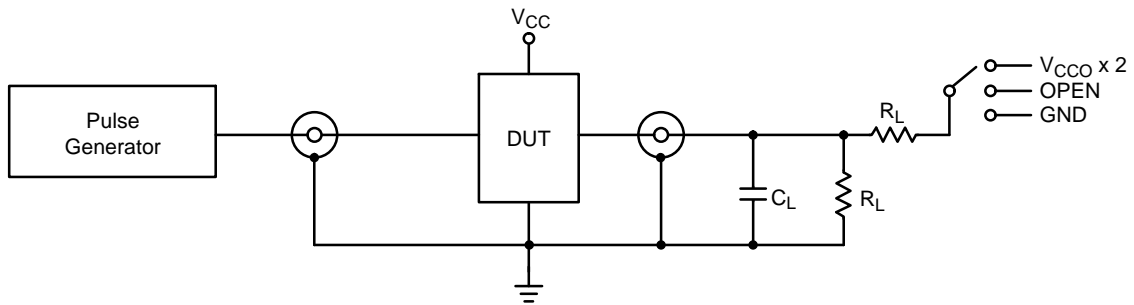
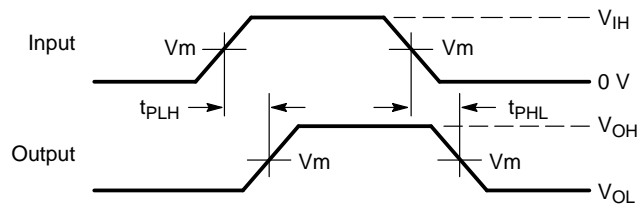


Figure 3. AC (Propagation Delay) Test Circuit

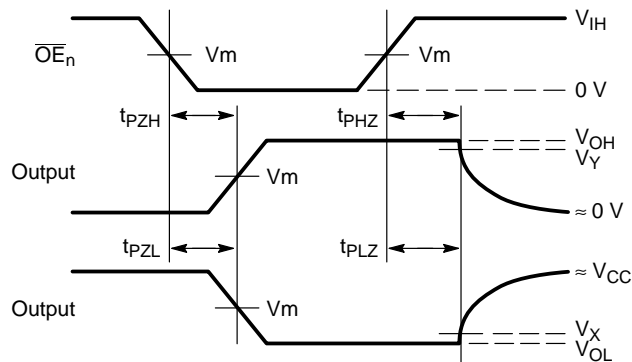
| Test | Switch |
|-----------------------|--|
| t_{PLH} , t_{PHL} | OPEN |
| t_{PLZ} , t_{PZL} | $V_{CCO} \times 2$ at $V_{CCO} = 3.0\text{ V} - 3.6\text{ V}, 2.3\text{ V} - 2.7\text{ V}, 1.65\text{ V} - 1.95\text{ V}, 1.4\text{ V} - 1.6\text{ V}$ |
| t_{PHZ} , t_{PZH} | GND |

$C_L = 15\text{ pF}$ or equivalent (includes probe and jig capacitance)
 $R_L = 2\text{ k}\Omega$ or equivalent
 Z_{OUT} of pulse generator = $50\ \Omega$
 V_{CCO} is the supply voltage referenced to by the output being tested



Waveform 1 - Propagation Delays

$t_R = t_F = 2.0\text{ ns}$, 10% to 90%; $f = 1\text{ MHz}$; $t_W = 500\text{ ns}$



Waveform 2 - Output Enable and Disable Times

$t_R = t_F = 2.0\text{ ns}$, 10% to 90%; $f = 1\text{ MHz}$; $t_W = 500\text{ ns}$

Figure 4. AC (Propagation Delay) Test Circuit Waveforms

| Symbol | Input Pin Output Pin |
|--------|-------------------------|
| V_m | $V_{CCX}/2$ |
| V_X | $V_{OL} \times 0.1$ |
| V_Y | $V_{OH} \times 0.9$ |

MECHANICAL CASE OUTLINE

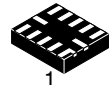
PACKAGE DIMENSIONS

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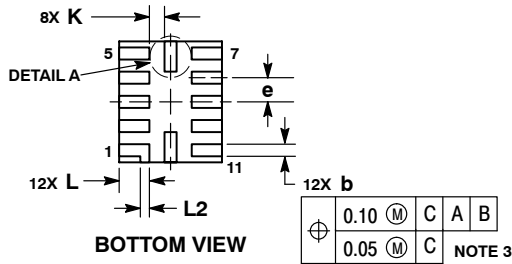
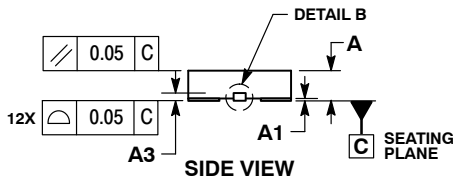
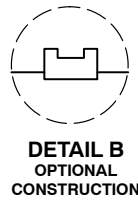
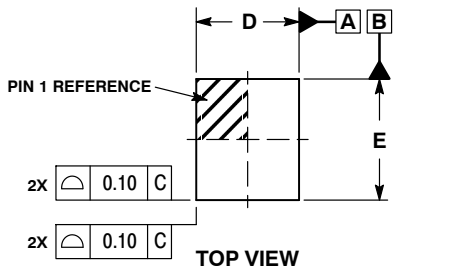


UQFN12 1.7x2.0, 0.4P CASE 523AE-01 ISSUE A

DATE 11 JUN 2007



SCALE 4:1



NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- CONTROLLING DIMENSION: MILLIMETERS
- DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM TERMINAL TIP.
- MOLD FLASH ALLOWED ON TERMINALS ALONG EDGE OF PACKAGE. FLASH 0.03 MAX ON BOTTOM SURFACE OF TERMINALS.
- DETAIL A SHOWS OPTIONAL CONSTRUCTION FOR TERMINALS.

| DIM | MILLIMETERS | |
|-----|-------------|------|
| | 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 | |

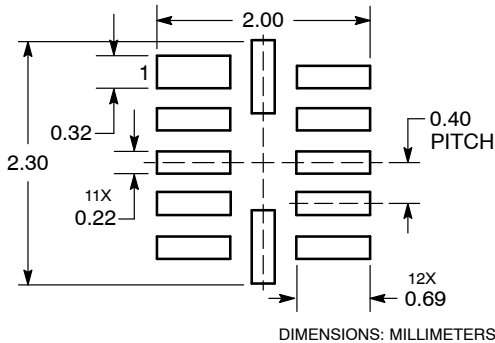
GENERIC MARKING DIAGRAM*



- XX = Specific Device Code
- M = Date Code
- = 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.

MOUNTING FOOTPRINT SOLDERMASK DEFINED



| | | |
|------------------|------------------------|--|
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| DESCRIPTION: | UQFN12 1.7 X 2.0, 0.4P | PAGE 1 OF 1 |

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