



+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

General Description

The MAX13013–MAX13017/MAX3023–MAX3028 single-/dual-/quad-level translators provide the level shifting necessary to allow 100Mbps data transfer in a multivoltage system. Externally applied voltages, V_{CC} and V_L , set the logic levels on either side of the device. Logic signals present on the V_L side of the device appear as a higher voltage logic signal on the V_{CC} side of the device, and vice-versa.

The MAX13013 single-, the MAX13014–MAX13017 dual-, and the MAX3023–MAX3028 (UCSP™ package) quad-level translators feature an enable (EN) input. The MAX3023–MAX3028 (TSSOP package) quad-level translators feature EN and \overline{EN} inputs. When disabled, each device places all inputs/outputs on both sides in tri-state and reduces the V_{CC} supply current to 0.03µA, and the V_L supply current to 0.1µA. These devices operate at a guaranteed 100Mbps data rate for $V_L > 1.8V$.

The MAX13013–MAX13017/MAX3023–MAX3028 accept a +1.65V to +3.6V V_{CC} voltage and a +1.2V to ($V_{CC} - 0.4V$) V_L voltage, making them ideal for data transfer between low-voltage ASICs/programmable logic devices (PLDs) and higher voltage systems. The MAX13013 is available in 3 x 2 UCSP and 6-pin SC70 packages. The MAX13014–MAX13017 are available in 3 x 3 UCSP and 8-pin SOT23 packages. The MAX3023–MAX3028 are available in 4 x 3 UCSP and 14-pin TSSOP packages. All devices operate over the extended -40°C to +85°C temperature range.

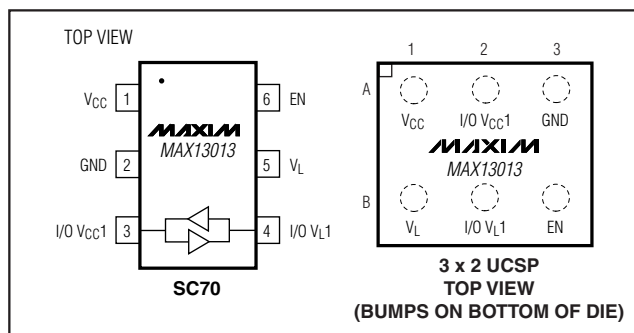
Applications

- CMOS Logic-Level Translation
- Low-Voltage ASIC Level Translation
- Cell Phones
- SPI™, MICROWIRE™ Level Translation
- Portable POS Systems
- Portable Communication Devices
- GPS
- Telecommunications Equipment

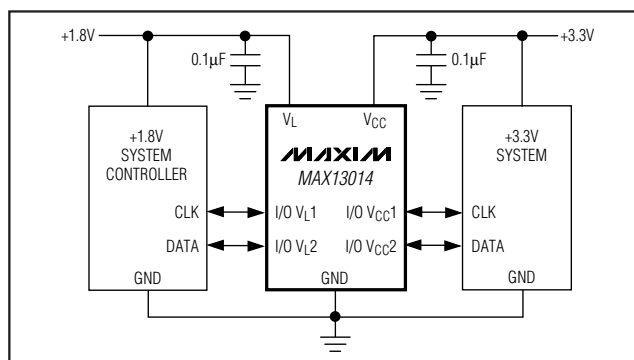
Features

- ◆ 100Mbps Guaranteed Data Rate
- ◆ Bidirectional Level Translation
 - MAX13013 (Single)
 - MAX13014 (Dual)
 - MAX3023 (Quad)
- ◆ Unidirectional Level Translation
 - MAX13015/MAX13016/MAX13017 (Dual)
 - MAX3024–MAX3028 (Quad)
- ◆ V_L Operation Down to +1.2V
- ◆ Ultra-Low 0.1µA Supply Current When Disabled
- ◆ Low-Quiescent Current (0.1µA)
- ◆ UCSP, SC70, SOT23, and TSSOP Packages

Pin Configurations



Typical Operating Circuit



Ordering Information/Selector Guide

| PART | TEMP RANGE | PIN-PACKAGE | PACKAGE CODE | TOP MARK | NUMBER OF $V_L \rightarrow V_{CC}$ TRANSLATORS | Number of $V_{CC} \rightarrow V_L$ TRANSLATORS | EN | \overline{EN} |
|-------------|----------------|-------------|--------------|----------|--|--|----|-----------------|
| MAX13013EXT | -40°C to +85°C | 6 SC70 | — | ACD | 1 | 1 | ✓ | — |

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SPI is a trademark of Motorola, Inc.

UCSP is a trademark of Maxim Integrated Products, Inc.

Pin Configurations continued at end of data sheet.

Ordering Information/Selector Guide continued at end of data sheet.



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ABSOLUTE MAXIMUM RATINGS

All voltages are referenced to GND.

| | |
|---|-----------------------------------|
| V _{CC} | -0.3V to +4V |
| V _L | -0.3V to +4V |
| I/O V _{CC-} | -0.3V to (V _{CC} + 0.3V) |
| I/O V _L | -0.3V to (V _L + 0.3V) |
| EN, $\overline{\text{EN}}$ | -0.3V to (V _L + 0.3V) |
| Short-Circuit Duration I/O V _{L-} , I/O V _{CC-} to GND | Continuous |
| Continuous Power Dissipation (T _A = +70°C) 6-Pin SC70 (derate 3.1mW/°C above +70°C) | 245mW |

| | |
|--|-----------------|
| 6-Bump UCSP (derate 3.9mW/°C above +70°C) | 308mW |
| 8-Bump UCSP (derate 4.7mW/°C above +70°C) | 379mW |
| 8-Pin SOT23 (derate 9.1mW/°C above +70°C) | 727mW |
| 12-Bump UCSP (derate 6.5mW/°C above +70°C) | 518.8mW |
| 14-Pin TSSOP (derate 9.1mW/°C above +70°C) | 727mW |
| Operating Temperature Range | -40°C to +85°C |
| Junction Temperature | +150°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (soldering, 10s) | +300°C |

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{CC} = +1.65V to +3.6V, V_L = +1.2V to (V_{CC} - 0.4V), EN = V_L, $\overline{\text{EN}}$ = open (MAX3023-MAX3028 TSSOP package only), C_{I/OV_L} ≤ 15pF, C_{I/OV_{CC}} ≤ 40pF, T_A = T_{MIN} to T_{MAX}. Typical values are at T_A = +25°C.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|--------------------------------|--|------|------|-----------------------|-------|
| POWER SUPPLY | | | | | | |
| V _L Supply Range | V _L | | 1.2 | | V _{CC} - 0.4 | V |
| V _{CC} Supply Range | V _{CC} | | 1.65 | | 3.60 | V |
| Supply Current from V _{CC} | I _{QV_{CC}} | I/O V _{CC-} = 0, I/O V _{L-} = 0 or I/O V _{CC-} = V _{CC} , I/O V _{L-} = V _L | | 0.1 | 1 | µA |
| Supply Current from V _L | I _{QV_L} | I/O V _{CC-} = 0, I/O V _{L-} = 0 or I/O V _{CC-} = V _{CC} , I/O V _{L-} = V _L | | 0.2 | 2 | µA |
| | | I/O V _{CC-} = 0, I/O V _{L-} = 0 or I/O V _{CC-} = V _{CC} , I/O V _{L-} = V _L , V _L < V _{CC} - 0.2V | | 10 | 100 | |
| V _{CC} Tri-state Output-Mode Supply Current | I _{TS-V_{CC}} | T _A = +25°C, EN = 0 | | 0.03 | 1 | µA |
| V _L Tri-state Output-Mode Supply Current (MAX13013-MAX13017) | I _{TS-V_L} | T _A = +25°C, EN = 0 | | 0.1 | 0.2 | µA |
| | | T _A = +25°C, EN = 0, V _L = V _{CC} - 0.2V | | 1 | 2 | |
| V _L Tri-state Output-Mode Supply Current (MAX3023-MAX3028 TSSOP Package Only) | I _{TS-V_L} | T _A = +25°C, EN = 0 | | 50 | 70 | µA |
| | | T _A = +25°C, EN = 0, V _L = V _{CC} - 0.2V | | 55 | 74 | |
| I/O Tri-state Output-Mode Leakage Current | | T _A = +25°C, EN = 0 | | | 0.15 | µA |
| | | T _A = +25°C, EN = 0, V _L = V _{CC} - 0.2V | | | 20 | |

+1.2V to +3.6V, 0.1μA, 100Mbps, Single-/Dual-/Quad-Level Translators

ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} = +1.65V$ to $+3.6V$, $V_L = +1.2V$ to $(V_{CC} - 0.4V)$, $EN = V_L$, $\overline{EN} = \text{open}$ (MAX3023–MAX3028 TSSOP package only), $C_{IOV_L} \leq 15pF$, $C_{IOV_{CC}} \leq 40pF$, $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $T_A = +25^\circ C$.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|-----------|--|---------------------|-----|-----|------------|
| LOGIC-LEVEL THRESHOLDS | | | | | | |
| I/O $V_{L_}$ Input-Voltage High | V_{IHL} | | $2/3 \times V_L$ | | | V |
| I/O $V_{L_}$ Input-Voltage Low | V_{ILL} | | $1/3 \times V_L$ | | | V |
| Pullup Resistance on I/O $V_{L_}$ | | | 120 | | | Ω |
| Pulldown Resistance on I/O $V_{L_}$ | | | 75 | | | Ω |
| I/O $V_{CC_}$ Input-Voltage High | V_{IHC} | | $2/3 \times V_{CC}$ | | | V |
| I/O $V_{CC_}$ Input-Voltage Low | V_{ILC} | | $1/3 \times V_{CC}$ | | | V |
| Pullup Resistance on I/O $V_{CC_}$ | | | 2.5 | | | k Ω |
| Pulldown Resistance on I/O $V_{CC_}$ | | | 2.5 | | | k Ω |
| EN, \overline{EN} Input-Voltage High | V_{IH} | | $2/3 \times V_L$ | | | V |
| EN, \overline{EN} Input-Voltage Low | V_{IL} | | $1/3 \times V_L$ | | | V |
| EN Input Current | | MAX13013–MAX13017 | -5 | | | μA |
| Pullup Resistance on EN | | MAX3023–MAX3028 | 46 | 62 | 81 | k Ω |
| Pulldown Resistance on \overline{EN} | | MAX3023–MAX3028, TSSOP package only | 46 | 62 | 81 | k Ω |
| I/O $V_{L_}$ Output-Voltage High | V_{OHL} | I/O V_L source current = 20 μA | $2/3 \times V_L$ | | | V |
| I/O $V_{L_}$ Output-Voltage Low | V_{OLL} | I/O V_L sink current = 20 μA | $1/3 \times V_L$ | | | V |
| I/O $V_{CC_}$ Output-Voltage High | V_{OHC} | I/O V_{CC} source current = 20 μA | $2/3 \times V_{CC}$ | | | V |
| I/O $V_{CC_}$ Output-Voltage Low | V_{OLC} | I/O V_{CC} sink current = 20 μA | $1/3 \times V_{CC}$ | | | V |

MAX13013–MAX13017/MAX3023–MAX3028

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TIMING CHARACTERISTICS

($V_{CC} = +1.65V$ to $+3.6V$, $V_L = +1.2V$ to ($V_{CC} - 0.4V$), $EN = V_L$, $\overline{EN} = \text{open}$ (MAX3023-MAX3028 TSSOP package only), $C_{IOVL} \leq 15pF$, $C_{IOVCC} \leq 40pF$, $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $T_A = +25^\circ C$.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|------------------|--|-----|-----|------|----------|
| I/O $V_{CC_}$ Rise Time | t_{RVCC} | $C_{IOVCC} = 15pF$, Figure 1 | | | 2.5 | ns |
| | | $C_{IOVCC} = 20pF$, Figure 1 | | | 3 | |
| | | $C_{IOVCC} = 40pF$, Figure 1 | | | 4 | |
| I/O $V_{CC_}$ Fall Time | t_{FVCC} | $C_{IOVCC} = 15pF$, Figure 1 | | | 2.5 | ns |
| | | $C_{IOVCC} = 20pF$, Figure 1 | | | 3 | |
| | | $C_{IOVCC} = 40pF$, Figure 1 | | | 4 | |
| I/O $V_{CC_}$ One-Shot Output Impedance | | | | | 18.5 | Ω |
| I/O V_L Rise Time | t_{RVL} | $C_{IOVL} = 15pF$, Figure 2 | | | 2.5 | ns |
| I/O V_L Fall Time | t_{FVL} | $C_{IOVL} = 15pF$, Figure 2 | | | 2.5 | ns |
| I/O V_L One-Shot Output Impedance | | | | | 12.5 | Ω |
| Propagation Delay, Driving I/O V_L | I/O V_L -VCC | $C_{IOVCC} = 15pF$, Figure 1 | | | 6.5 | ns |
| Propagation Delay, Driving I/O $V_{CC_}$ | I/O V_{CC} -VL | $C_{IOVL} = 15pF$, Figure 2 | | | 6 | ns |
| Part-to-Part Skew (Note 3) | t_{PPSKEW} | $C_{IOVCC} = 15pF$, $C_{IOVL} = 15pF$, $V_{CC} = 2.5V$, $V_L = 1.8V$ | | | 4 | ns |
| Propagation Delay from I/O V_L to I/O $V_{CC_}$ after Enable | t_{EN-VCC} | $C_{IOVCC} = 15pF$, Figure 3 | | | 1000 | ns |
| Propagation Delay from I/O $V_{CC_}$ to I/O V_L after Enable | t_{EN-VL} | $C_{IOVL} = 15pF$, Figure 4 | | | 1000 | ns |
| Maximum Data Rate | | $C_{IOVCC} = 15pF$, $C_{IOVL} = 15pF$, $V_L > 1.8V$ | 100 | | | Mbps |
| | | $C_{IOVCC} = 15pF$, $C_{IOVL} = 15pF$, $V_L > 1.2V$ | 80 | | | |

Note 1: V_L must be less than or equal to $V_{CC} - 0.4V$ during normal operation. However, V_L can be greater than V_{CC} during startup and shutdown conditions.

Note 2: All units are 100% production tested at $T_A = +25^\circ C$. Limits over the operating temperature range are guaranteed by design and not production tested.

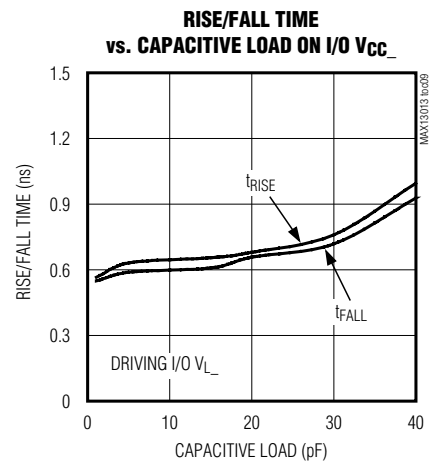
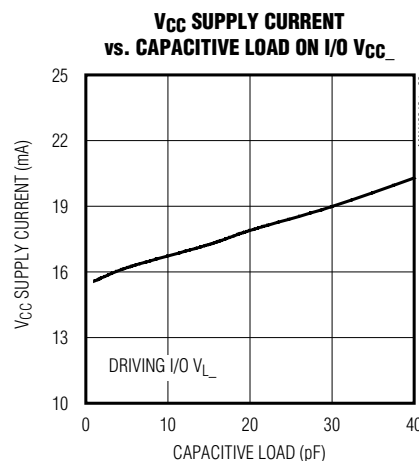
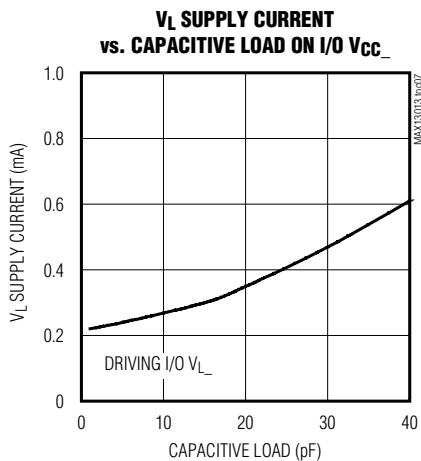
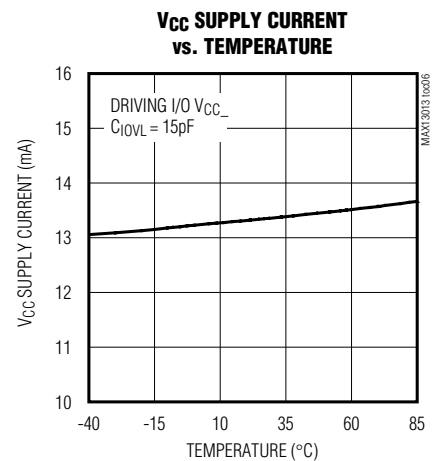
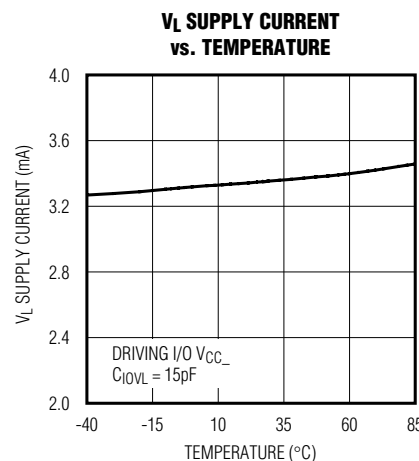
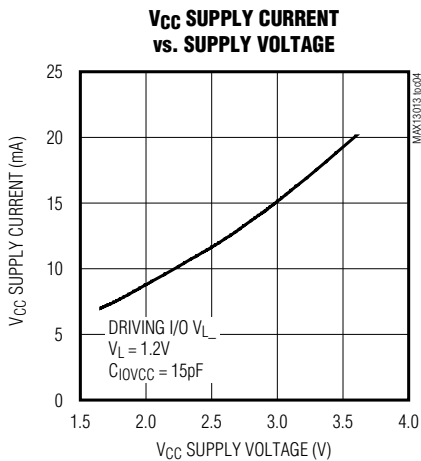
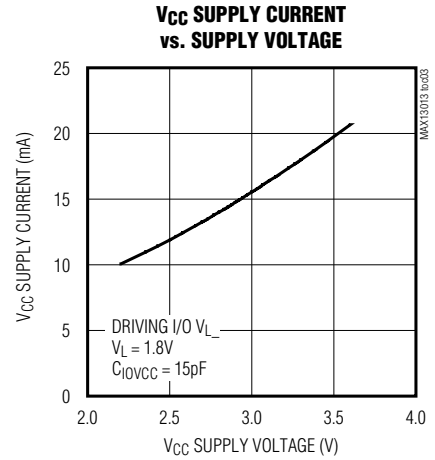
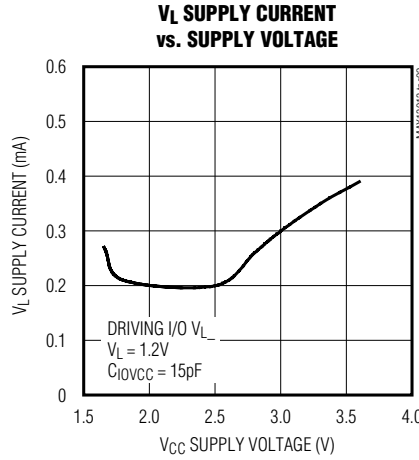
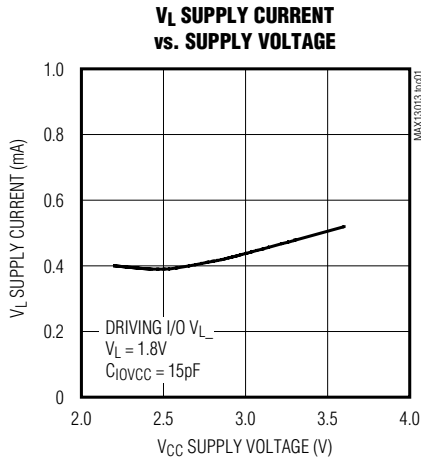
Note 3: Not production tested. Guaranteed by design.

+1.2V to +3.6V, 0.1μA, 100Mbps, Single-/Dual-/Quad-Level Translators

Typical Operating Characteristics

(Data rate = 100Mbps, $V_{CC} = 3.3V$, $V_L = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.)

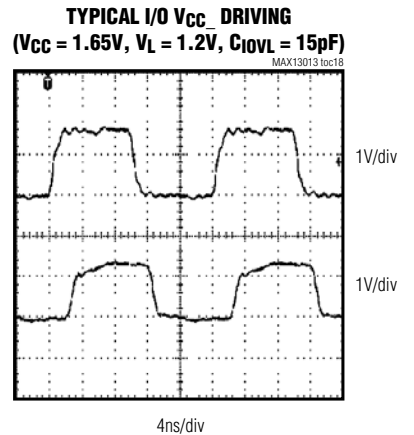
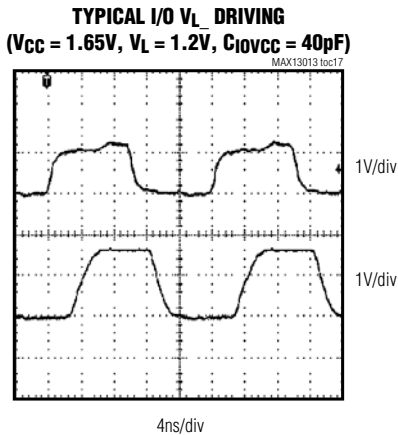
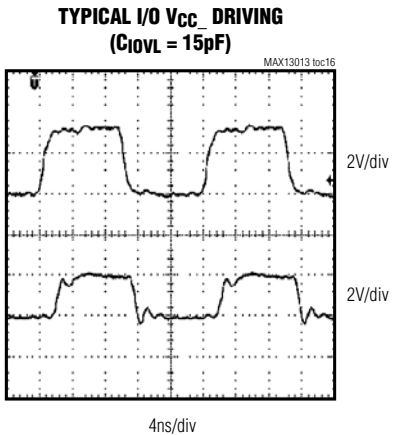
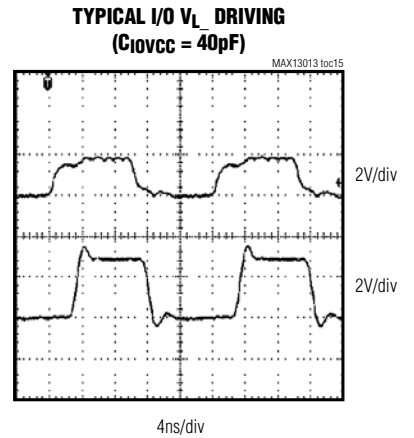
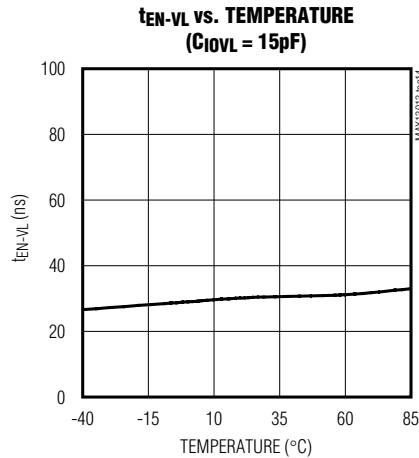
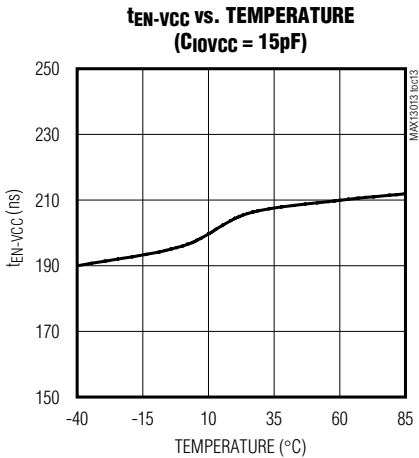
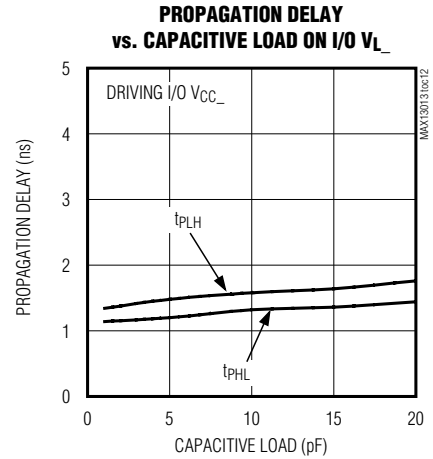
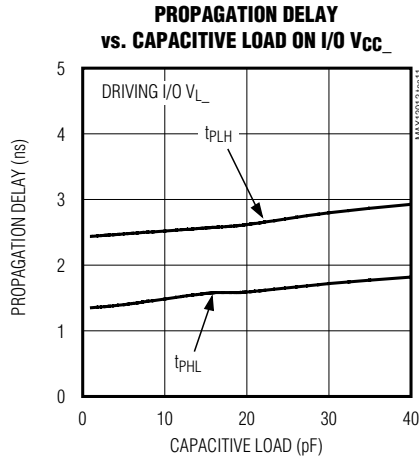
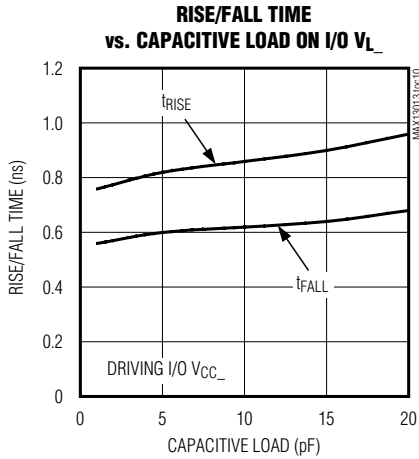
MAX13013-MAX13017/MAX3023-MAX3028



+1.2V to +3.6V, 0.1μA, 100Mbps, Single-/Dual-/Quad-Level Translators

Typical Operating Characteristics (continued)

(Data rate = 100Mbps, $V_{CC} = 3.3V$, $V_L = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.)



+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Pin Description—MAX13013/MAX13014/ MAX3023 (Bidirectional Devices)

| PIN | | | | | | NAME | FUNCTION |
|---------|------------|----------|------------|----------|------------|------------------------|---|
| MAX3023 | | MAX13013 | | MAX13014 | | | |
| TSSOP | 4 x 3 UCSP | SC70 | 3 x 2 UCSP | SOT23 | 3 x 3 UCSP | | |
| 1 | A1 | 4 | B2 | 7 | A2 | I/O V _{L1} | Input/Output 1, Referenced to V _L |
| 2 | B2 | — | — | 6 | A3 | I/O V _{L2} | Input/Output 2, Referenced to V _L |
| 3 | A2 | 5 | B1 | 8 | A1 | V _L | V _L Input Voltage, +1.2V ≤ V _L ≤ V _{CC} - 0.4V. Bypass V _L to GND with a 0.1µF capacitor. |
| 4 | — | — | — | — | — | N.C. | No Connection |
| 5 | B3 | — | — | — | — | I/O V _{L3} | Input/Output 3, Referenced to V _L |
| 6 | A3 | — | — | — | — | I/O V _{L4} | Input/Output 4, Referenced to V _L |
| 7 | A4 | 6 | B3 | 5 | B1 | EN | Active-High Enable Input. If EN is pulled low, all inputs/outputs are in tristate. Drive EN high (V _L) for normal operation. |
| 8 | — | — | — | — | — | $\overline{\text{EN}}$ | Active-Low Enable Input. If $\overline{\text{EN}}$ is pulled high (V _L), all inputs/outputs are in tri-state. Drive $\overline{\text{EN}}$ low for normal operation (MAX3023 TSSOP package only). |
| 9 | B4 | — | — | — | — | I/O V _{CC4} | Input/Output 4, Referenced to V _{CC} |
| 10 | C4 | — | — | — | — | I/O V _{CC3} | Input/Output 3, Referenced to V _{CC} |
| 11 | C3 | 2 | A3 | 4 | B3 | GND | Ground |
| 12 | C2 | 1 | A1 | 1 | C1 | V _{CC} | V _{CC} Input Voltage, +1.65V ≤ V _{CC} ≤ +3.6V. Bypass V _{CC} to GND with a 0.1µF capacitor. |
| 13 | C1 | — | — | 3 | C3 | I/O V _{CC2} | Input/Output 2, Referenced to V _{CC} |
| 14 | B1 | 3 | A2 | 2 | C2 | I/O V _{CC1} | Input/Output 1, Referenced to V _{CC} |

Pin Description—MAX13015/MAX13016/MAX13017/ MAX3024–MAX3028 (Unidirectional Devices)

| NAME | FUNCTION (Note 4) |
|--|---|
| V _{CC} | V _{CC} Input Voltage, +1.65V ≤ V _{CC} ≤ +3.6V. Bypass V _{CC} to GND with a 0.1µF capacitor. |
| V _L | V _L Input Voltage, +1.2V ≤ V _L ≤ V _{CC} - 0.4V. Bypass V _L to GND with a 0.1µF capacitor. |
| GND | Ground |
| EN | Active-High Enable Input. If EN is pulled low, all inputs/outputs are in tri-state. Drive EN high (V _L) for normal operation. |
| $\overline{\text{EN}}$ | Active-Low Enable Input (MAX3024–MAX3028 TSSOP Package Only). If $\overline{\text{EN}}$ is pulled high (V _L), all inputs/outputs are in tri-state. Drive $\overline{\text{EN}}$ low for normal operation. |
| I V _{L1} –I V _{L4} | Inputs Referenced to V _L , Numbers 1 to 4 |
| O V _{L1} –O V _{L4} | Outputs Referenced to V _L , Numbers 1 to 4 |
| I V _{CC1} –I V _{CC4} | Inputs Referenced to V _{CC} , Numbers 1 to 4 |
| O V _{CC1} –O V _{CC4} | Outputs Referenced to V _{CC} , Numbers 1 to 4 |

Note 4: For specific pin numbers, see the *Pin Configurations* for more information.

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Test Circuits/Timing Diagrams

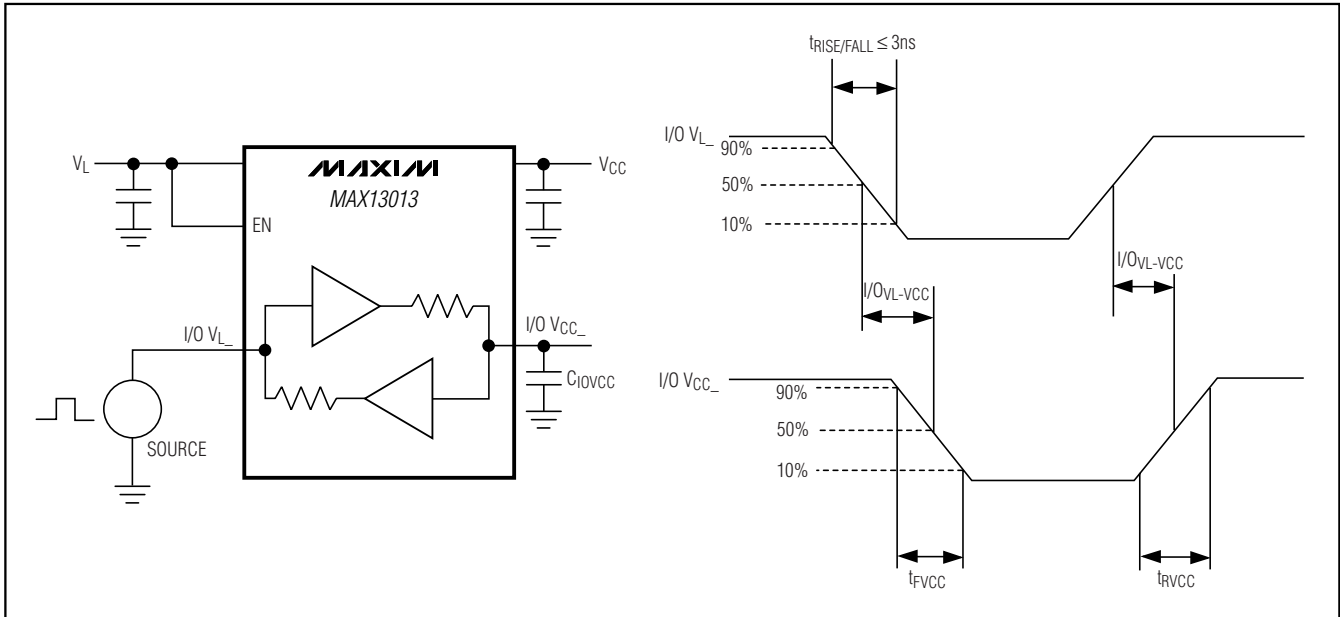


Figure 1. Driving I/O V_L_ Test Circuit and Timing

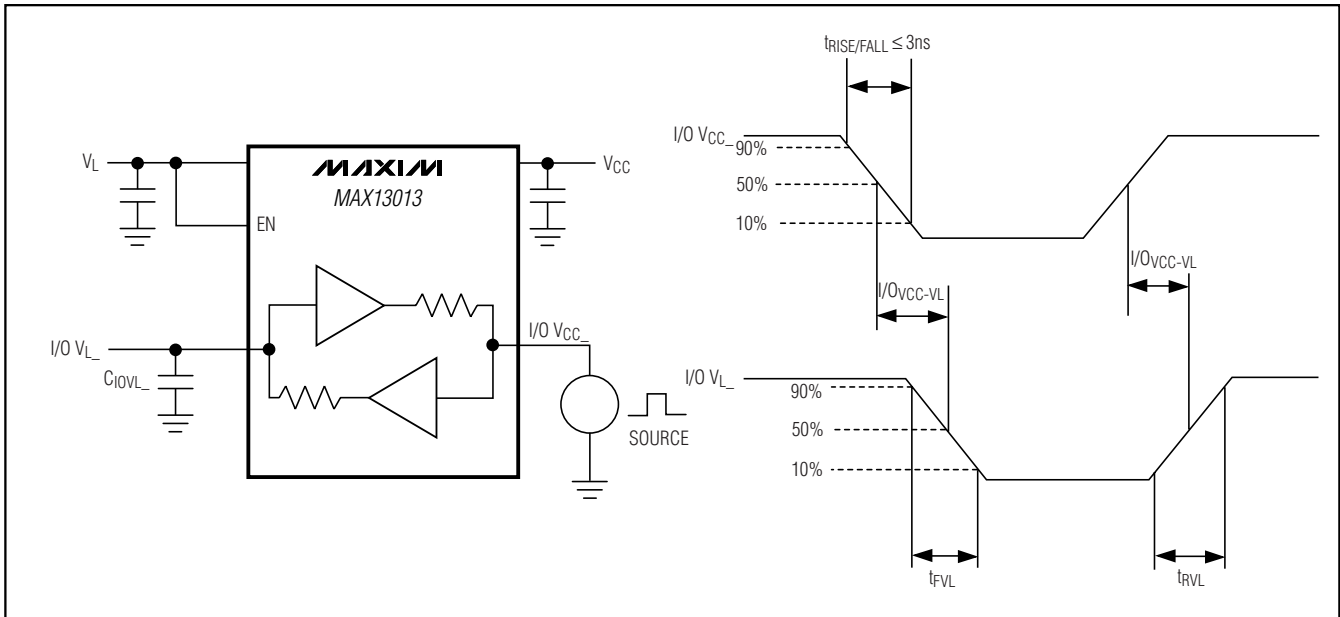


Figure 2. Driving I/O V_{CC}_ Test Circuit and Timing

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Test Circuits/Timing Diagrams (continued)

MAX13013-MAX13017/MAX3023-MAX3028

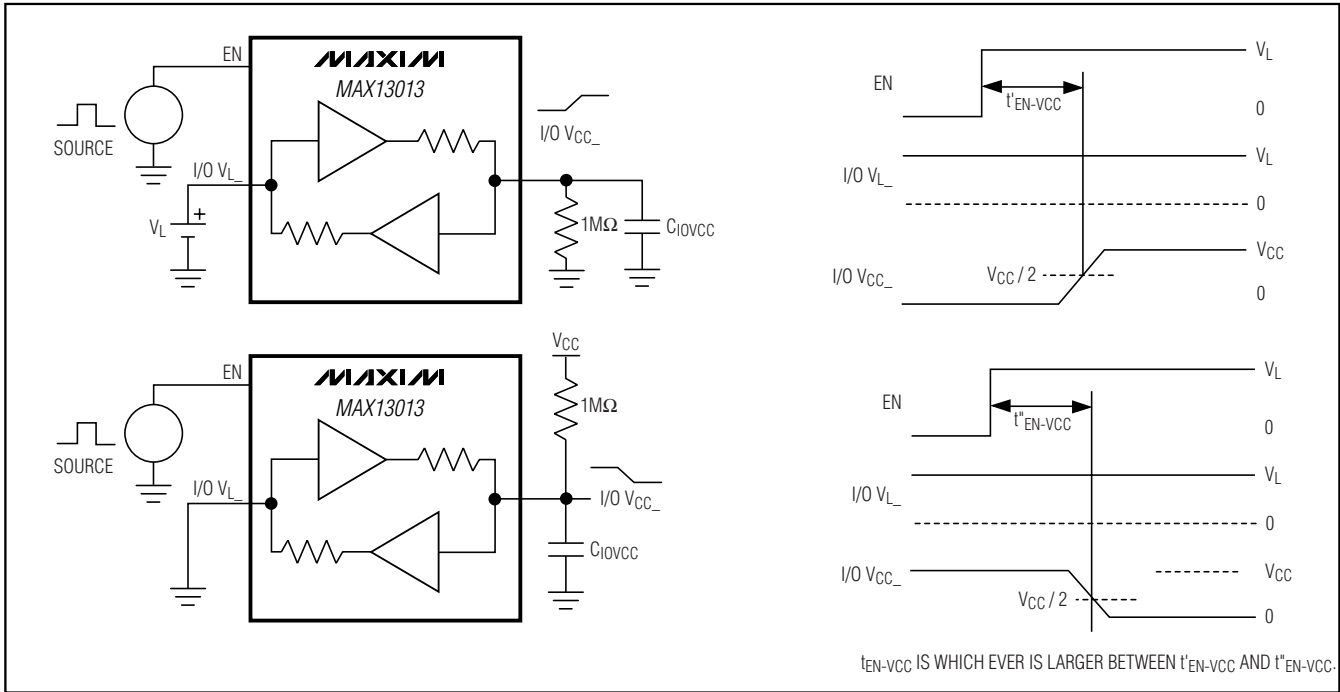


Figure 3. Propagation Delay from I/O VL_ to I/O VCC_ After EN

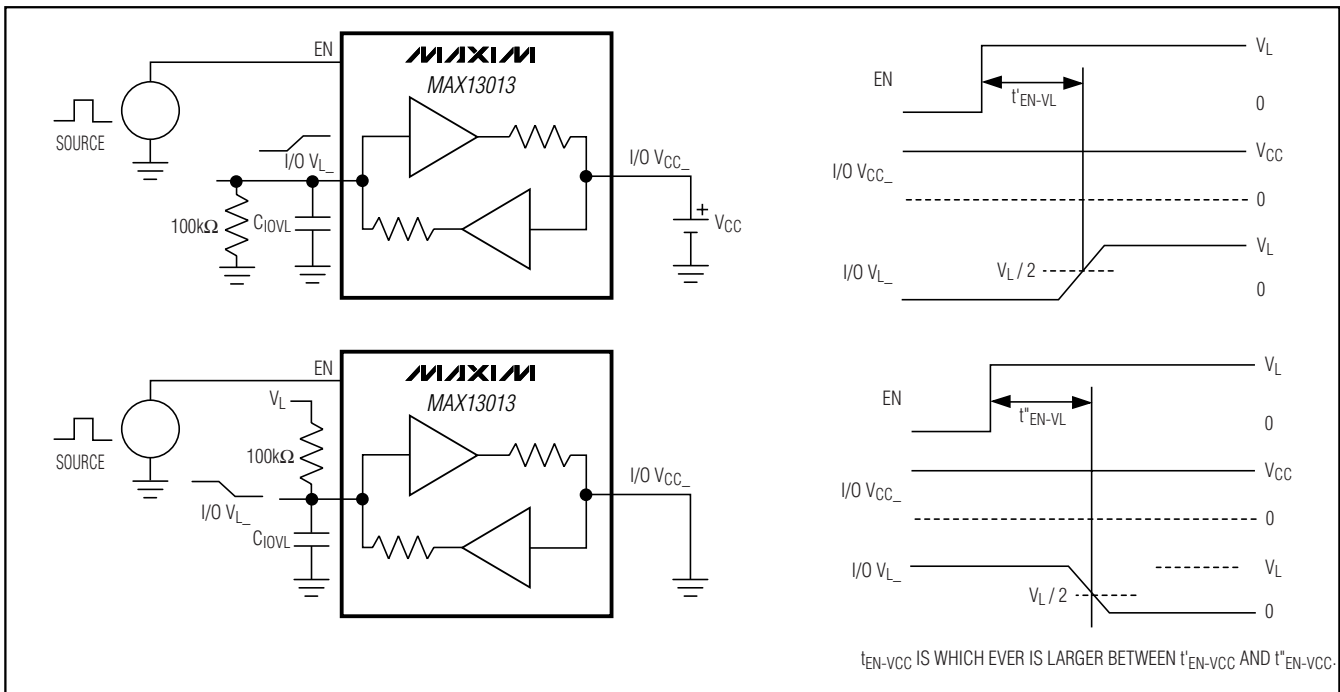


Figure 4. Propagation Delay from I/O VCC_ to I/O VL_ After EN

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Detailed Description

The MAX13013–MAX13017/MAX3023–MAX3028 logic-level translators provide the level shifting necessary to allow 100Mbps data transfer in a multivoltage system. Externally applied voltages, V_{CC} and V_L , set the logic levels on either side of the device. Logic signals present on the V_L side of the device appear as a higher-voltage logic signal on the V_{CC} side of the device, and vice-versa. The MAX13013/MAX13014/MAX3023 bidirectional level translators allow data translation in either direction ($V_L \leftrightarrow V_{CC}$) on any single data line. The MAX13015/MAX13016/MAX13017/MAX3024–MAX3028 unidirectional level translators, level shift data in one direction ($V_L \rightarrow V_{CC}$ or $V_{CC} \rightarrow V_L$) on any single data line. The MAX13013–MAX13017/MAX3023–MAX3028 accept V_L from +1.2V to ($V_{CC} - 0.4V$) and operate with V_{CC} from +1.65V to +3.6V, making them ideal for data transfer between low-voltage ASICs/PLDs and higher voltage systems.

When in tri-state mode, the MAX13013–MAX13017/MAX3023–MAX3028 reduce the V_{CC} supply current to 0.03µA, and the V_L supply current to 0.1µA. These devices operate at a guaranteed data rate of 100Mbps for $V_L > 1.8V$.

Level Translation

For proper operation, ensure that $+1.65V \leq V_{CC} \leq +3.6V$, and $+1.2V \leq V_L \leq V_{CC} - 0.4V$. During power-up sequencing, $V_L \geq V_{CC}$ does not damage the device.

During power-supply sequencing, when V_{CC} is floating and V_L is powering up, up to 40mA current can be sourced to each load on the V_L side, without the device latching up. The maximum data rate depends heavily on the load capacitance (see the *Typical Operating Characteristics Rise/Fall Time* graph), output impedance of the driver, and the operating voltage range (Table 1).

Input Driver Requirements

The MAX13013–MAX13017/MAX3023–MAX3028 architecture is based on a one-shot accelerator output stage (see Figure 5). Accelerator output stages are in tri-state mode except when there is a transition on any of the translators on the input side, either I/O V_L or I/O V_{CC} . A short pulse is then generated during which the accelerator output stages become active and charge/discharge the capacitances at the I/Os. Due to the architecture, both sides become active during the one-shot pulse. This can lead to some current feeding into the external source that is driving the translator. However, this behavior simply helps to speed up the transition on the driven side.

Table 1. Data Rate

| V_L (V) | GUARANTEED DATA RATE (Mbps) |
|----------------|-----------------------------|
| $V_L < 1.8$ | 80 |
| $V_L \geq 1.8$ | 100 |

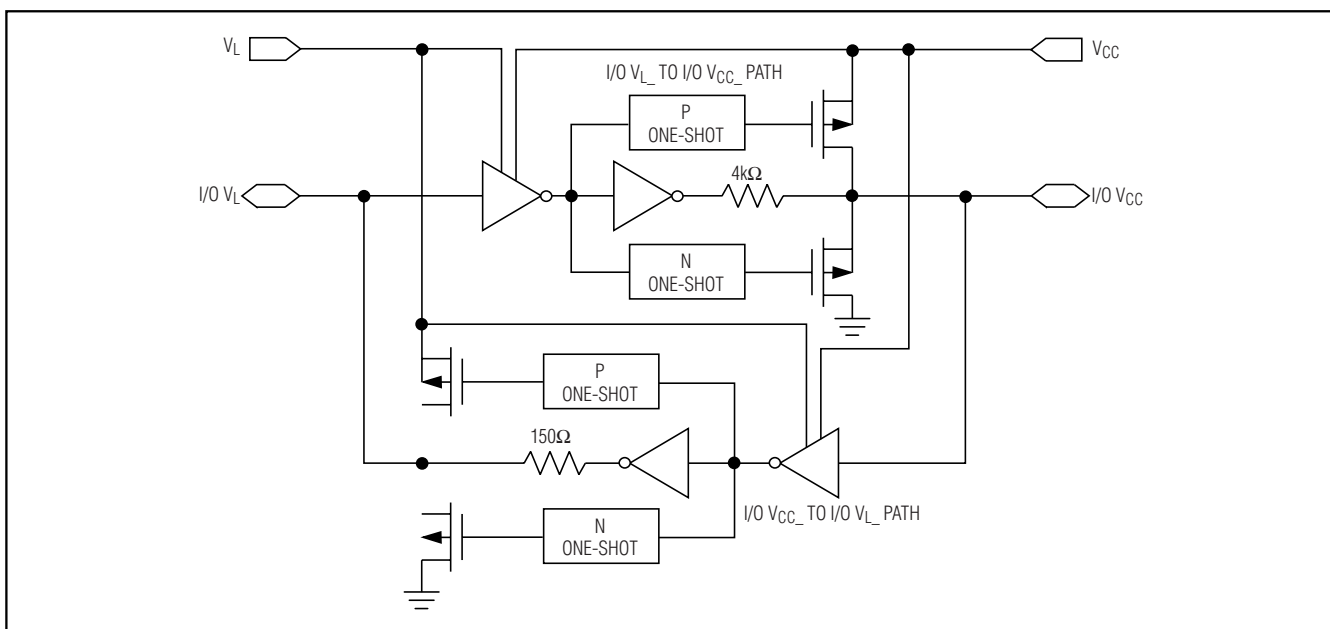


Figure 5. Simplified Functional Diagram (One I/O Line)

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

For proper operation, the driver has to meet the following conditions: less than 25Ω output impedance and greater than 20mA peak output current capability. Figure 6 shows a graph of typical input current versus input voltage.

Output Load Requirements

The MAX13013–MAX13017/MAX3023–MAX3028 I/O are designed to drive CMOS inputs. Do not load the I/O lines with a resistive load less than 25kΩ. Also, do not place an RC circuit at the input of these devices to slow down the edges. If a slower rise/fall time is required, refer to the MAX3000E/MAX3001E logic-level-translators data sheet.

For I²C™ level translation, refer to the MAX3372E–MAX3379E/MAX3390E–MAX3393E data sheet.

Enable Inputs

The MAX13013 single-, the MAX13014–MAX13017 dual- and the MAX3023–MAX3028 (UCSP package) quad-level translators feature an EN input. The MAX3023–MAX3028 (TSSOP package) quad-level translators feature both EN and $\overline{\text{EN}}$ inputs (see Table 2 for operating mode). Note that the MAX3023–MAX3028 (TSSOP package) have internal pullup and pulldown circuitry on EN and $\overline{\text{EN}}$, respectively. If left unconnected, EN is pulled up to V_L and $\overline{\text{EN}}$ is pulled down to GND.

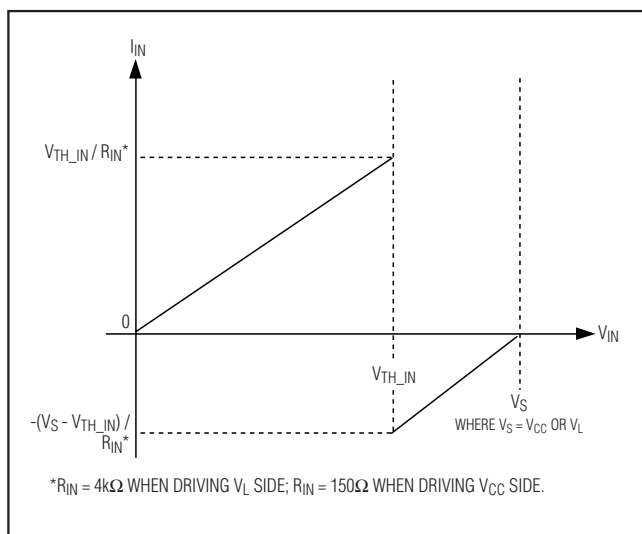


Figure 6. Typical I_{IN} vs. V_{IN}

I²C is a trademark of Philips Corp.

Purchase of I²C components from Maxim Integrated Products, Inc. or one of its sublicensed Associated Companies, conveys a license under the Philips I²C Patent Rights to use these components in an I²C system, provided that the system conforms to the I²C Standard Specification as defined by Philips.

Table 2. MAX3023–MAX3028 (TSSOP Package) Operating Mode

| EN | $\overline{\text{EN}}$ | OPERATING MODE |
|----------------|------------------------|---|
| 0 | 0 | Both I/O V _L and I/O V _{CC} are in tri-state. |
| V _L | 0 | Normal operation. |
| 0 | V _L | Both I/O V _L and I/O V _{CC} are in tri-state. |
| V _L | V _L | Both I/O V _L and I/O V _{CC} are in tri-state. |

Applications Information

Power-Supply Decoupling

To reduce ripple and the chance of introducing data errors, bypass V_L and V_{CC} to ground with a 0.1µF ceramic capacitor. Place all capacitors as close to the power-supply inputs as possible.

Unidirectional vs. Bidirectional Level Translator

The MAX13013/MAX13014/MAX3023 bidirectional translators can operate as a unidirectional device to translate signals without inversion. The MAX13015/MAX13016/MAX13017/MAX3024–MAX3028 unidirectional level translators, level shift data in one direction (V_L→ V_{CC} or V_{CC}→V_L) on any single data line (see the *Ordering Information*). These devices provide the smallest solution (UCSP package) for unidirectional level translation without inversion.

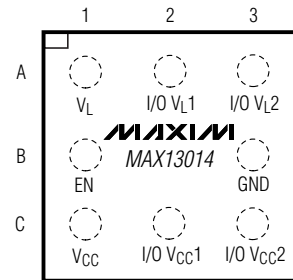
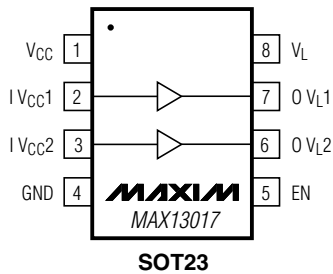
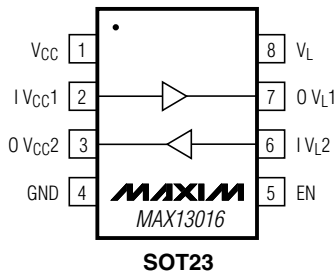
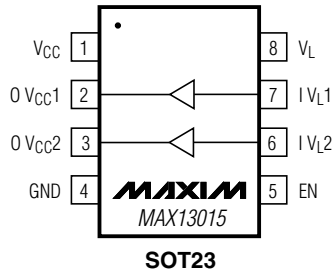
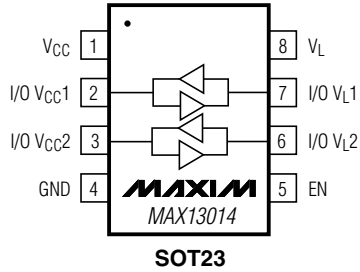
UCSP Applications Information

For the latest application details on UCSP construction, dimensions, tape carrier information, PC board techniques, bump-pad layout, and recommended reflow temperature profiles, as well as the latest information on reliability testing results, go to Maxim's web site at www.maxim-ic.com/ucsp to find the Application Note: UCSP—A Wafer-Level Chip-Scale Package.

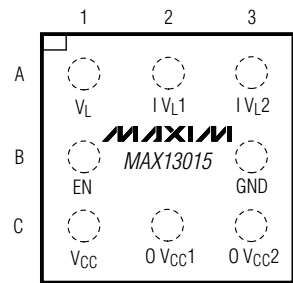
+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Pin Configurations (continued)

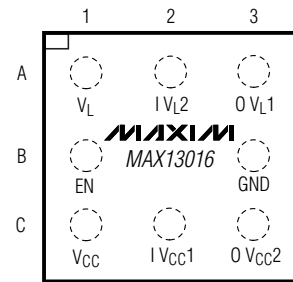
TOP VIEW



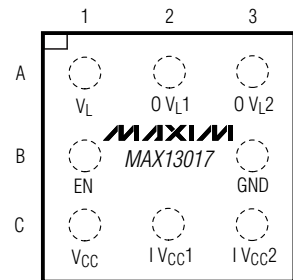
UCSP
(BUMPS ON BOTTOM OF DIE)



UCSP
(BUMPS ON BOTTOM OF DIE)



UCSP
(BUMPS ON BOTTOM OF DIE)



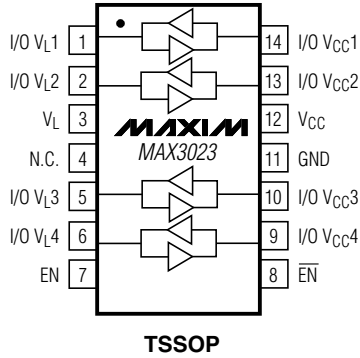
UCSP
(BUMPS ON BOTTOM OF DIE)

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

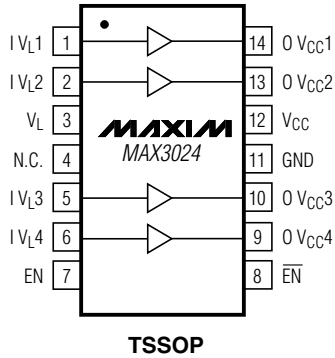
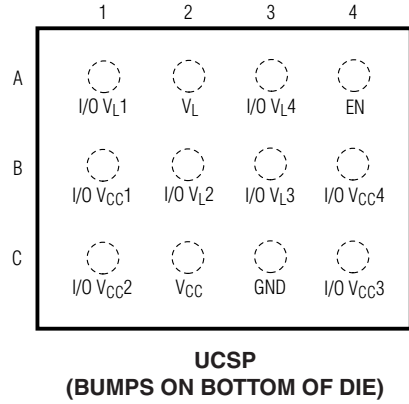
Pin Configurations (continued)

MAX13013-MAX13017/MAX3023-MAX3028

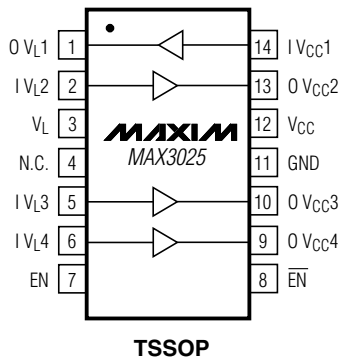
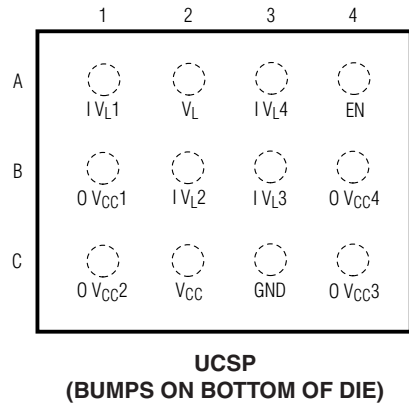
TOP VIEW



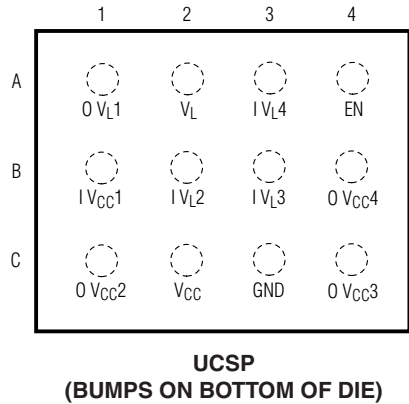
MAXIM
MAX3023



MAXIM
MAX3024



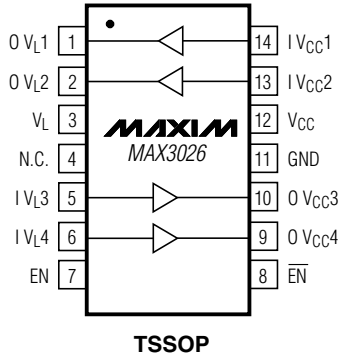
MAXIM
MAX3025



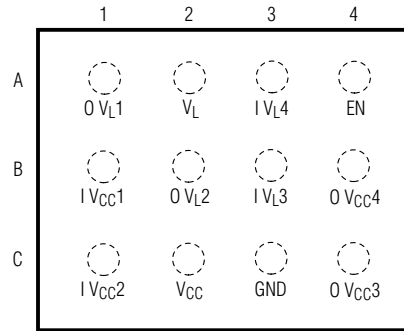
+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Pin Configurations (continued)

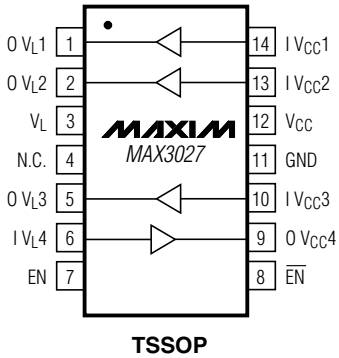
TOP VIEW



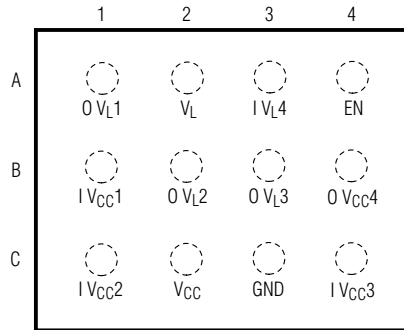
MAXIM
MAX3026



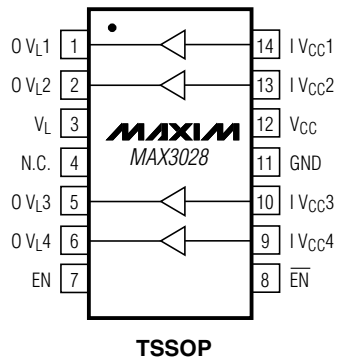
UCSP
(BUMPS ON BOTTOM OF DIE)



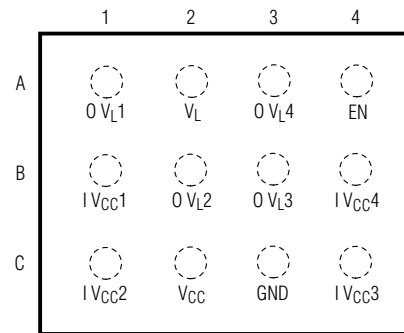
MAXIM
MAX3027



UCSP
(BUMPS ON BOTTOM OF DIE)



MAXIM
MAX3028



UCSP
(BUMPS ON BOTTOM OF DIE)

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Ordering Information/Selector Guide (continued)

| PART | TEMP RANGE | PIN-PACKAGE | PACKAGE CODE | TOP MARK | NUMBER OF V _L → V _{CC} TRANSLATORS | Number of V _{CC} → V _L TRANSLATORS | EN | $\overline{\text{EN}}$ |
|---------------------|----------------|---------------|--------------|----------|--|--|----|------------------------|
| MAX13013EBT-T | -40°C to +85°C | 3 x 2 UCSP-6 | B6-1 | ADF | 1 | 1 | ✓ | — |
| MAX13014EKA | -40°C to +85°C | 8 SOT23 | — | AEKB | 2 | 2 | ✓ | — |
| MAX13014EBL-T | -40°C to +85°C | 3 x 3 UCSP-9 | B9-2 | AEN | 2 | 2 | ✓ | — |
| MAX13015EKA* | -40°C to +85°C | 8 SOT23 | — | AEKC | 2 | 0 | ✓ | — |
| MAX13015EBL-T* | -40°C to +85°C | 3 x 3 UCSP-9 | B9-2 | AEO | 2 | 0 | ✓ | — |
| MAX13016EKA* | -40°C to +85°C | 8 SOT23 | — | AEKD | 1 | 1 | ✓ | — |
| MAX13016EBL-T* | -40°C to +85°C | 3 x 3 UCSP-9 | B9-2 | AEP | 1 | 1 | ✓ | — |
| MAX13017EKA* | -40°C to +85°C | 8 SOT23 | — | AEKE | 0 | 2 | ✓ | — |
| MAX13017EBL-T* | -40°C to +85°C | 3 x 3 UCSP-9 | B9-2 | AEQ | 0 | 2 | ✓ | — |
| MAX3023EUD | -40°C to +85°C | 14 TSSOP | — | — | 4 | 4 | ✓ | ✓ |
| MAX3023EBC-T | -40°C to +85°C | 4 x 3 UCSP-12 | B12-1 | ABW | 4 | 4 | ✓ | — |
| MAX3024EUD* | -40°C to +85°C | 14 TSSOP | — | — | 4 | 0 | ✓ | ✓ |
| MAX3024EBC-T* | -40°C to +85°C | 4 x 3 UCSP-12 | B12-1 | ABX | 4 | 0 | ✓ | — |
| MAX3025EUD* | -40°C to +85°C | 14 TSSOP | — | — | 3 | 1 | ✓ | ✓ |
| MAX3025EBC-T* | -40°C to +85°C | 4 x 3 UCSP-12 | B12-1 | ABY | 3 | 1 | ✓ | — |
| MAX3026EUD* | -40°C to +85°C | 14 TSSOP | — | — | 2 | 2 | ✓ | ✓ |
| MAX3026EBC-T* | -40°C to +85°C | 4 x 3 UCSP-12 | B12-1 | ABZ | 2 | 2 | ✓ | — |
| MAX3027EUD* | -40°C to +85°C | 14 TSSOP | — | — | 1 | 3 | ✓ | ✓ |
| MAX3027EBC-T* | -40°C to +85°C | 4 x 3 UCSP-12 | B12-1 | ACA | 1 | 3 | ✓ | — |
| MAX3028EUD* | -40°C to +85°C | 14 TSSOP | — | — | 0 | 4 | ✓ | ✓ |
| MAX3028EBC-T* | -40°C to +85°C | 4 x 3 UCSP-12 | B12-1 | ACB | 0 | 4 | ✓ | — |

*Future product—contact factory for availability.

Chip Information

TRANSISTOR COUNT:

MAX13013: 261

MAX13014–MAX13017: 444

MAX3023–MAX3028: 791

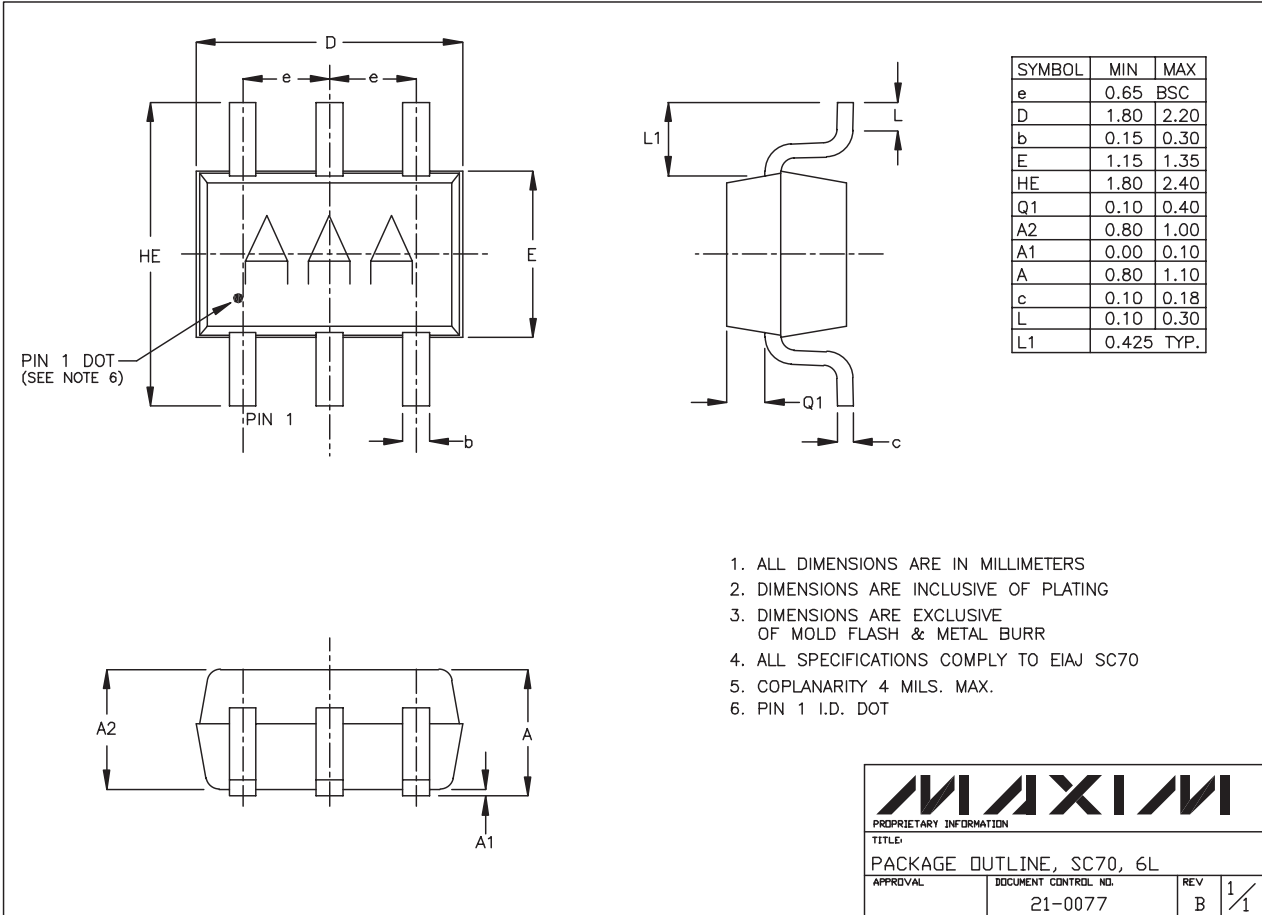
PROCESS: BiCMOS

MAX13013–MAX13017/MAX3023–MAX3028

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)



SC70, 6LEPS

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)

TOP VIEW

| COMMON DIMENSIONS | |
|-------------------|----------------|
| A | 0.62±0.05-0.08 |
| A1 | 0.29±0.02 |
| A2 | 0.33 REF. |
| b | ∅0.35±0.03 |
| D1 | 0.50 BASIC |
| E1 | 1.00 BASIC |
| e | 0.50 BASIC |
| SD | 0.25 BASIC |
| SE | 0.00 BASIC |

| PKG. CODE | VARIABLE DIMENSIONS | | DEPOPULATED SOLDER BALLS |
|-----------|---------------------|-----------|--------------------------|
| | D | E | |
| B6-1 | 1.00±0.05 | 1.52±0.05 | NONE |
| B6-2 | 1.00±0.05 | 1.52±0.05 | B2 |
| B6-3 | 1.05±0.05 | 1.57±0.05 | NONE |
| B6-4 | 1.05±0.05 | 1.57±0.05 | B2 |
| B6-5 | 0.97±0.05 | 1.46±0.05 | NONE |
| B6-6 | 1.16±0.05 | 1.57±0.05 | NONE |

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETERS.
- PRODUCT MARKING: NUMBER OF CHARACTERS AND LINES VARY PER PRODUCT.

BOTTOM VIEW

SIDE VIEW

| | | | |
|--|-------------------------------------|---------------------|--------------------|
| DALLAS SEMICONDUCTOR | | MAXIM | |
| <small>PROPRIETARY INFORMATION</small> | | | |
| <small>TITLE:</small> | | | |
| PACKAGE OUTLINE, 3x2 UCSP | | | |
| <small>APPROVAL</small> | <small>DOCUMENT CONTROL NO.</small> | <small>REV.</small> | <small>1/1</small> |
| | 21-0097 | G | |

6L_UCSP.EPS

MAX13013-MAX13017/MAX3023-MAX3028

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)

| SYMBOL | MIN | MAX |
|--------|-----------|------|
| A | 0.90 | 1.45 |
| A1 | 0.00 | 0.15 |
| A2 | 0.90 | 1.30 |
| b | 0.28 | 0.45 |
| C | 0.09 | 0.20 |
| D | 2.80 | 3.00 |
| E | 2.60 | 3.00 |
| E1 | 1.50 | 1.75 |
| L | 0.30 | 0.60 |
| L2 | 0.25 BSC. | |
| e | 0.65 BSC. | |
| e1 | 1.95 REF. | |
| θ | 0° | 8° |

NOTE:

- ALL DIMENSIONS ARE IN MILLIMETERS.
- △ FOOT LENGTH MEASURED FROM LEAD TIP TO UPPER RADIUS OF HEEL OF THE LEAD PARALLEL TO SEATING PLANE C.
- PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR.
- PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
- COPLANARITY 4 MILS. MAX.
- PIN 1 I.D. DOT IS 0.3 MM \bar{y} MIN. LOCATED ABOVE PIN 1.
- SOLDER THICKNESS MEASURED AT FLAT SECTION OF LEAD BETWEEN 0.08mm AND 0.15mm FROM LEAD TIP.
- MEETS JEDEC MO178.

DETAIL "A"

SEATING PLANE C

GAUGE PLANE

MAXIM DALLAS SEMICONDUCTOR

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, SOT-23, 8L BODY

| | | | |
|----------|---------------------------------|-----------|-----|
| APPROVAL | DOCUMENT CONTROL NO. 21-0078 | REV. D | 1/1 |
|----------|---------------------------------|-----------|-----|

SOT23, 8L .EPS

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)

TOP VIEW

| COMMON DIMENSIONS | |
|-------------------|----------------|
| A | 0.62±0.05-0.08 |
| A1 | 0.29±0.02 |
| A2 | 0.33 REF. |
| b | ∅0.35±0.03 |
| D1 | 1.00 BASIC |
| E1 | 1.00 BASIC |
| e | 0.50 BASIC |
| SD | 0.00 BASIC |
| SE | 0.00 BASIC |

| PKG. CODE | VARIABLE DIMENSIONS | | DEPOPULATED SOLDER BALLS |
|-----------|---------------------|-----------|--------------------------|
| | D | E | |
| B9-1 | 1.52±0.05 | 1.52±0.05 | NONE |
| B9-2 | 1.52±0.05 | 1.52±0.05 | B2 |
| B9-3 | 1.52±0.05 | 1.52±0.05 | B1, B2, B3 |
| B9-4 | 1.60±0.05 | 1.60±0.05 | NONE |
| B9-5 | 1.60±0.05 | 1.60±0.05 | B2 |
| B9-6 | 1.60±0.05 | 1.60±0.05 | B1, B2, B3 |

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETERS.
- PRODUCT MARKING: NUMBER OF CHARACTERS AND LINES VARY PER PRODUCT.

BOTTOM VIEW

SIDE VIEW

| | | |
|-------------------------------------|---------------------------------|---------------|
| DALLAS SEMICONDUCTOR | | |
| MAXIM | | |
| PROPRIETARY INFORMATION | | |
| TITLE: PACKAGE OUTLINE, 3x3 UCSP | | |
| APPROVAL: | DOCUMENT CONTROL NO. 21-0093 | REV. 1 1/1 |

9LUCSP, 3x3.EPS

MAX13013-MAX13017/MAX3023-MAX3028

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)

| SYMBOL | COMMON DIMENSIONS | | | |
|----------------|-------------------|------|----------------|------|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | — | 1.10 | — | .043 |
| A ₁ | 0.05 | 0.15 | .002 | .006 |
| A ₂ | 0.85 | 0.95 | .033 | .037 |
| b | 0.19 | 0.30 | .007 | .012 |
| b ₁ | 0.19 | 0.25 | .007 | .010 |
| c | 0.09 | 0.20 | .004 | .008 |
| c ₁ | 0.09 | 0.14 | .004 | .006 |
| D | SEE VARIATIONS | | SEE VARIATIONS | |
| E | 4.30 | 4.50 | .169 | .177 |
| e | 0.65 BSC | | .026 BSC | |
| H | 6.25 | 6.55 | .246 | .258 |
| L | 0.50 | 0.70 | .020 | .028 |
| N | SEE VARIATIONS | | SEE VARIATIONS | |
| α | 0° | 8° | 0° | 8° |

| JEDEC | N | VARIATIONS | | | | |
|-------|----|-------------|------|--------|------|------|
| | | MILLIMETERS | | INCHES | | |
| | | MIN. | MAX. | MIN. | MAX. | |
| AB-1 | 14 | D | 4.90 | 5.10 | .193 | .201 |
| AB | 16 | D | 4.90 | 5.10 | .193 | .201 |
| AC | 20 | D | 6.40 | 6.60 | .252 | .260 |
| AD | 24 | D | 7.70 | 7.90 | .303 | .311 |
| AE | 28 | D | 9.60 | 9.80 | .378 | .386 |

NOTES:
 1. DIMENSIONS D AND E DO NOT INCLUDE FLASH
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm PER SIDE
 3. CONTROLLING DIMENSION: MILLIMETER
 4. MEETS JEDEC OUTLINE MO-153. SEE JEDEC VARIATIONS TABLE
 5. 'N' REFERS TO NUMBER OF LEADS
 ⚠ THE LEAD TIPS MUST LIE WITHIN A SPECIFIED ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL PLANES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED

TSSOP4.40mm-EPS

DALLAS SEMICONDUCTOR **MAXIM**

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, TSSOP 4.40mm BODY

| | | | |
|----------|---------------------------------|--------|-----|
| APPROVAL | DOCUMENT CONTROL NO. 21-0066 | REV. F | 1/1 |
|----------|---------------------------------|--------|-----|

+1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)

TOP VIEW

| COMMON DIMENSIONS | |
|-------------------|----------------|
| A | 0.62±0.05-0.08 |
| A1 | 0.29±0.02 |
| A2 | 0.33 REF. |
| b | ∅0.35±0.03 |
| D1 | 1.00 BASIC |
| E1 | 1.50 BASIC |
| e | 0.50 BASIC |
| SD | 0.00 BASIC |
| SE | 0.25 BASIC |

| PKG. CODE | VARIABLE DIMENSIONS | | DEPOPULATED SOLDER BALLS |
|-----------|---------------------|-----------|--------------------------|
| | D | E | |
| B12-1 | 1.54±0.05 | 2.02±0.05 | NONE |
| B12-2 | 1.54±0.05 | 2.02±0.05 | B3 |
| B12-3 | 1.54±0.05 | 2.12±0.05 | NONE |
| B12-4 | 1.54±0.05 | 2.02±0.05 | B2, B3 |
| B12-5 | 1.64±0.05 | 2.12±0.05 | B2 |
| B12-6 | 1.64±0.05 | 2.12±0.05 | B3 |
| B12-7 | 1.54±0.05 | 2.02±0.05 | B1, B3 |
| B12-8 | 1.54±0.05 | 2.02±0.05 | B2 |
| B12-9 | 1.54±0.05 | 2.12±0.05 | B2, B3 |
| B12-10 | 1.54±0.05 | 2.02±0.05 | B1, B2, B3, B4 |
| B12-11 | 1.54±0.05 | 2.02±0.05 | A2, C3 |

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETERS.
- PRODUCT MARKING: NUMBER OF CHARACTERS AND LINES VARY PER PRODUCT.

BOTTOM VIEW

SIDE VIEW

| | | |
|-------------------------------------|---------------------------------|------------|
| DALLAS SEMICONDUCTOR | | |
| MAXIM | | |
| PROPRIETARY INFORMATION | | |
| TITLE: PACKAGE OUTLINE, 4x3 UCSP | | |
| APPROVAL | DOCUMENT CONTROL NO. 21-0104 | REV. F 1/1 |

12L UCSP 4x3.EPS

MAX13013-MAX13017/MAX3023-MAX3028

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