



# +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.

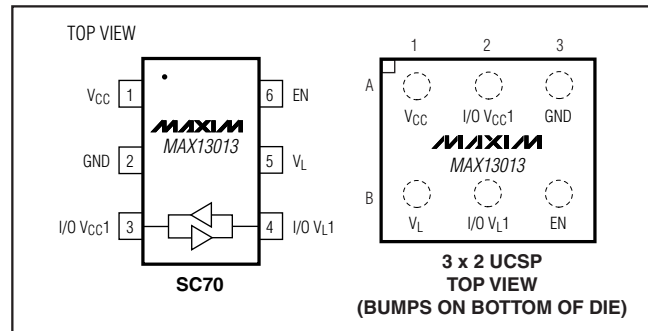
## Applications

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

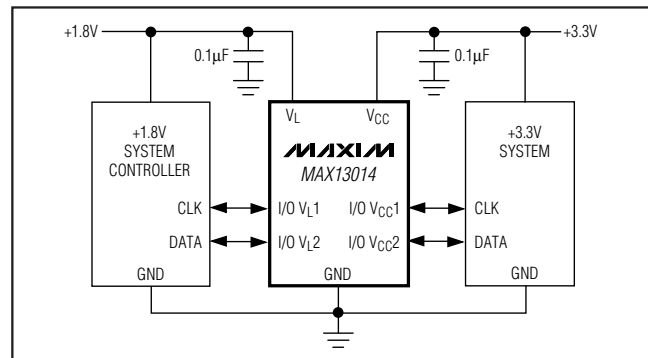
## Features

- ◆ 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	✓	—

MICROWIRE is a trademark of National Semiconductor Corp.  
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.



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

## ABSOLUTE MAXIMUM RATINGS

All voltages are referenced to GND.

V <sub>CC</sub> .....	-0.3V to +4V
V <sub>L</sub> .....	-0.3V to +4V
I/O V <sub>CC-</sub> .....	-0.3V to (V <sub>CC</sub> + 0.3V)
I/O V <sub>L</sub> .....	-0.3V to (V <sub>L</sub> + 0.3V)
EN, $\overline{\text{EN}}$ .....	-0.3V to (V <sub>L</sub> + 0.3V)
Short-Circuit Duration I/O V <sub>L-</sub> , I/O V <sub>CC-</sub> to GND.....	Continuous
Continuous Power Dissipation (T <sub>A</sub> = +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<sub>CC</sub> = +1.65V to +3.6V, V<sub>L</sub> = +1.2V to (V<sub>CC</sub> - 0.4V), EN = V<sub>L</sub>,  $\overline{\text{EN}}$  = open (MAX3023-MAX3028 TSSOP package only), C<sub>I/OV<sub>L</sub></sub> ≤ 15pF, C<sub>I/OV<sub>CC</sub></sub> ≤ 40pF, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>. Typical values are at T<sub>A</sub> = +25°C.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>POWER SUPPLY</b>						
V <sub>L</sub> Supply Range	V <sub>L</sub>		1.2		V <sub>CC</sub> - 0.4	V
V <sub>CC</sub> Supply Range	V <sub>CC</sub>		1.65		3.60	V
Supply Current from V <sub>CC</sub>	I <sub>QV<sub>CC</sub></sub>	I/O V <sub>CC-</sub> = 0, I/O V <sub>L-</sub> = 0 or I/O V <sub>CC-</sub> = V <sub>CC</sub> , I/O V <sub>L-</sub> = V <sub>L</sub>		0.1	1	µA
Supply Current from V <sub>L</sub>	I <sub>QV<sub>L</sub></sub>	I/O V <sub>CC-</sub> = 0, I/O V <sub>L-</sub> = 0 or I/O V <sub>CC-</sub> = V <sub>CC</sub> , I/O V <sub>L-</sub> = V <sub>L</sub>		0.2	2	µA
		I/O V <sub>CC-</sub> = 0, I/O V <sub>L-</sub> = 0 or I/O V <sub>CC-</sub> = V <sub>CC</sub> , I/O V <sub>L-</sub> = V <sub>L</sub> , V <sub>L</sub> < V <sub>CC</sub> - 0.2V		10	100	
V <sub>CC</sub> Tri-state Output-Mode Supply Current	I <sub>TS-V<sub>CC</sub></sub>	T <sub>A</sub> = +25°C, EN = 0		0.03	1	µA
V <sub>L</sub> Tri-state Output-Mode Supply Current (MAX13013-MAX13017)	I <sub>TS-V<sub>L</sub></sub>	T <sub>A</sub> = +25°C, EN = 0		0.1	0.2	µA
		T <sub>A</sub> = +25°C, EN = 0, V <sub>L</sub> = V <sub>CC</sub> - 0.2V		1	2	
V <sub>L</sub> Tri-state Output-Mode Supply Current (MAX3023-MAX3028 TSSOP Package Only)	I <sub>TS-V<sub>L</sub></sub>	T <sub>A</sub> = +25°C, EN = 0		50	70	µA
		T <sub>A</sub> = +25°C, EN = 0, V <sub>L</sub> = V <sub>CC</sub> - 0.2V		55	74	
I/O Tri-state Output-Mode Leakage Current		T <sub>A</sub> = +25°C, EN = 0			0.15	µA
		T <sub>A</sub> = +25°C, EN = 0, V <sub>L</sub> = V <sub>CC</sub> - 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
<b>LOGIC-LEVEL THRESHOLDS</b>						
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			$\Omega$
Pulldown Resistance on I/O $V_{L\_}$			75			$\Omega$
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			$k\Omega$
Pulldown Resistance on I/O $V_{CC\_}$			2.5			$k\Omega$
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		+5	$\mu A$
Pullup Resistance on EN		MAX3023–MAX3028	46	62	81	$k\Omega$
Pulldown Resistance on $\overline{EN}$		MAX3023–MAX3028, TSSOP package only	46	62	81	$k\Omega$
I/O $V_{L\_}$ Output-Voltage High	$V_{OHL}$	I/O $V_L$ source current = $20\mu A$	$2/3 \times V_L$			V
I/O $V_{L\_}$ Output-Voltage Low	$V_{OLL}$	I/O $V_L$ sink current = $20\mu A$		$1/3 \times V_L$		V
I/O $V_{CC\_}$ Output-Voltage High	$V_{OHC}$	I/O $V_{CC}$ source current = $20\mu A$	$2/3 \times V_{CC}$			V
I/O $V_{CC\_}$ Output-Voltage Low	$V_{OLC}$	I/O $V_{CC}$ sink current = $20\mu A$		$1/3 \times V_{CC}$		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),  $EN = V_L$ ,  $\overline{EN}$  = open (MAX3023-MAX3028 TSSOP package only),  $C_{IOVL} \leq 15$ pF,  $C_{IOVCC} \leq 40$ pF,  $T_A = T_{MIN}$  to  $T_{MAX}$ . Typical values are at  $T_A = +25^\circ\text{C}$ .) (Notes 1, 2)

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

**Note 1:**  $V_L$  must be less than or equal to  $V_{CC} - 0.4$ V 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  $T_A = +25^\circ\text{C}$ . Limits over the operating temperature range are guaranteed by design and not production tested.

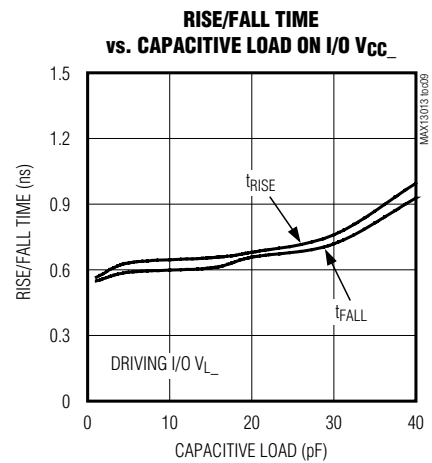
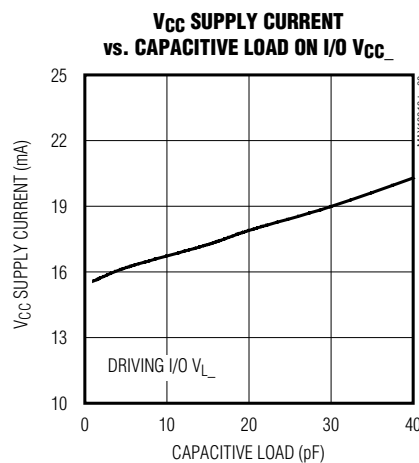
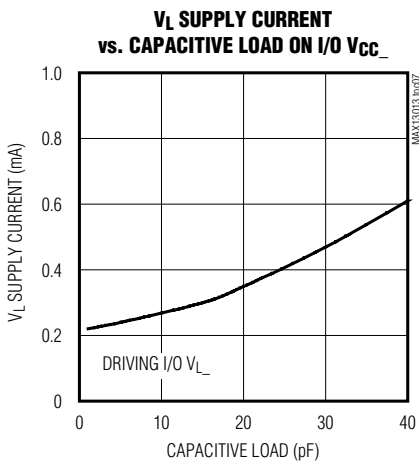
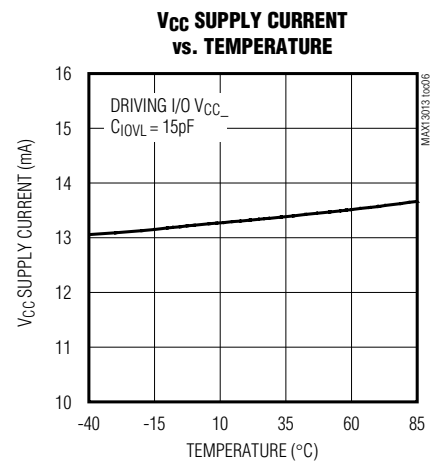
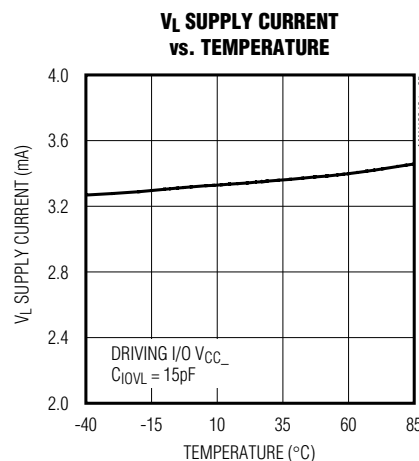
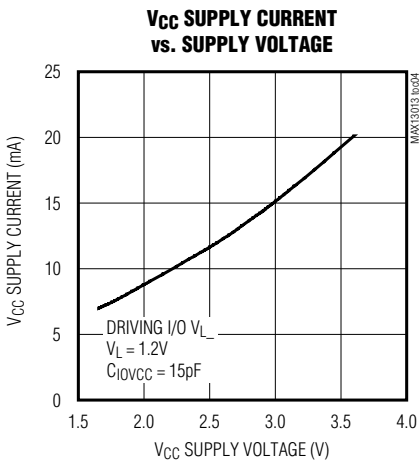
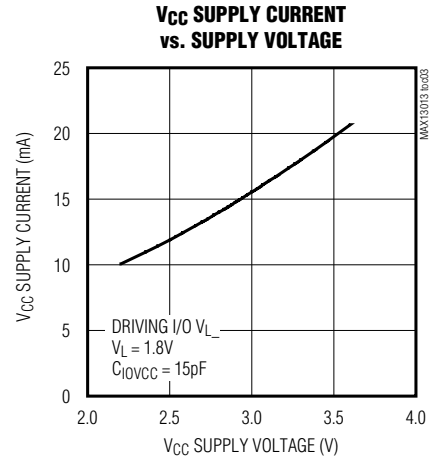
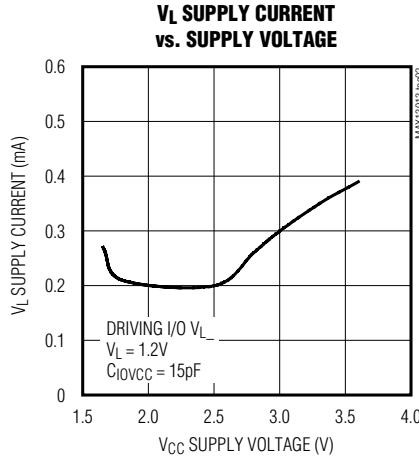
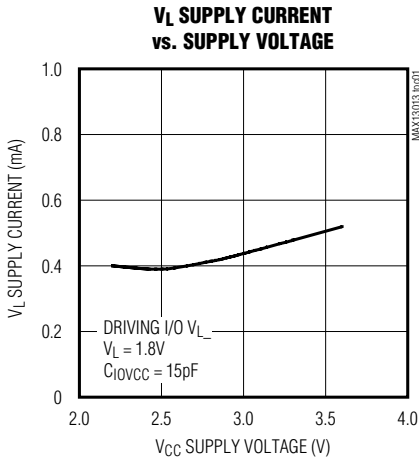
**Note 3:** Not production tested. Guaranteed by design.

# +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.)

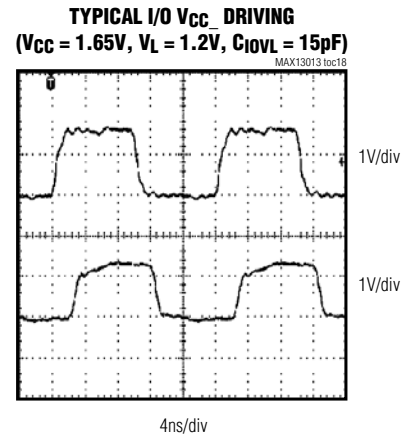
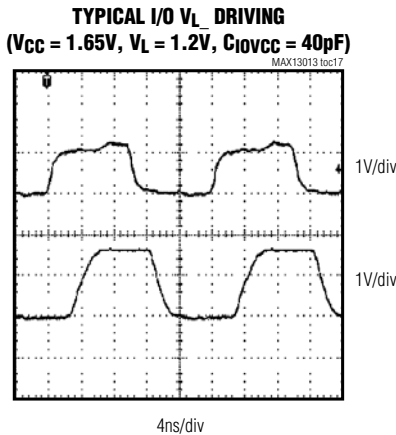
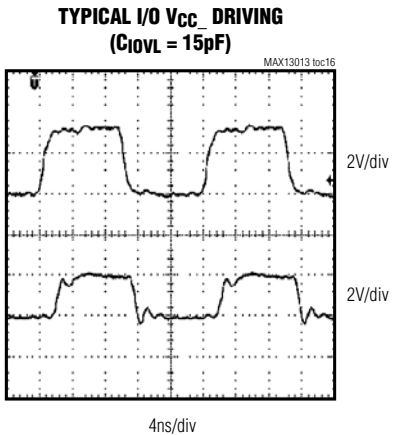
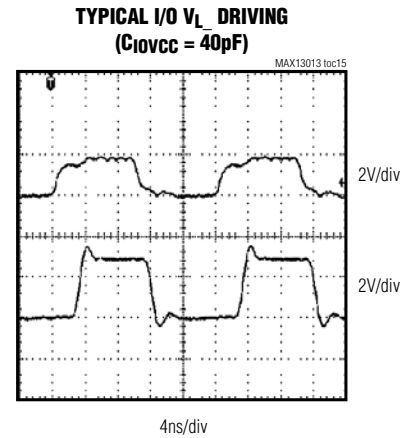
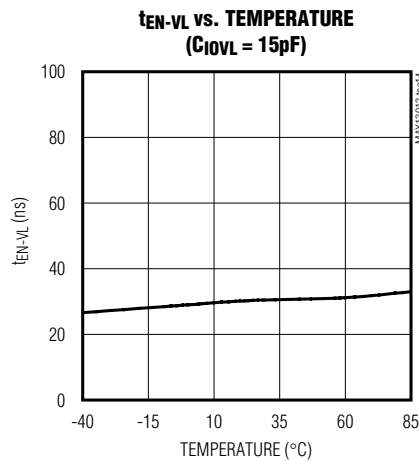
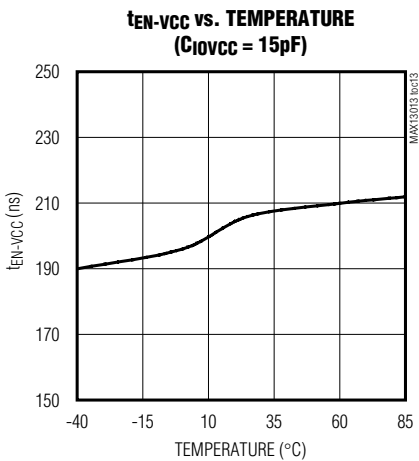
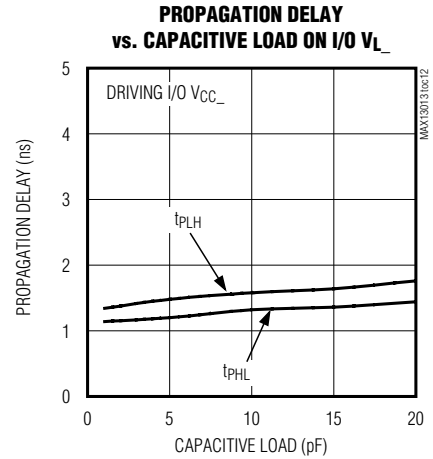
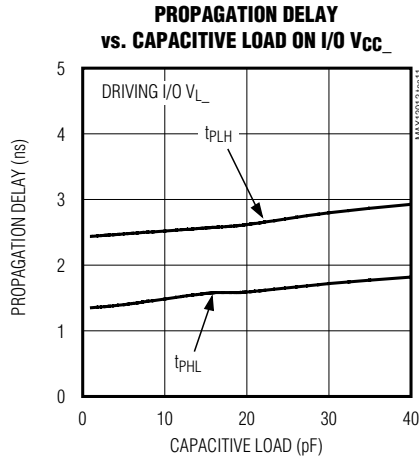
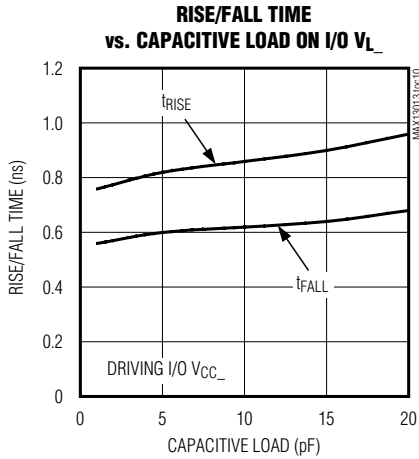
MAX13013-MAX13017/MAX3023-MAX3028



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

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

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

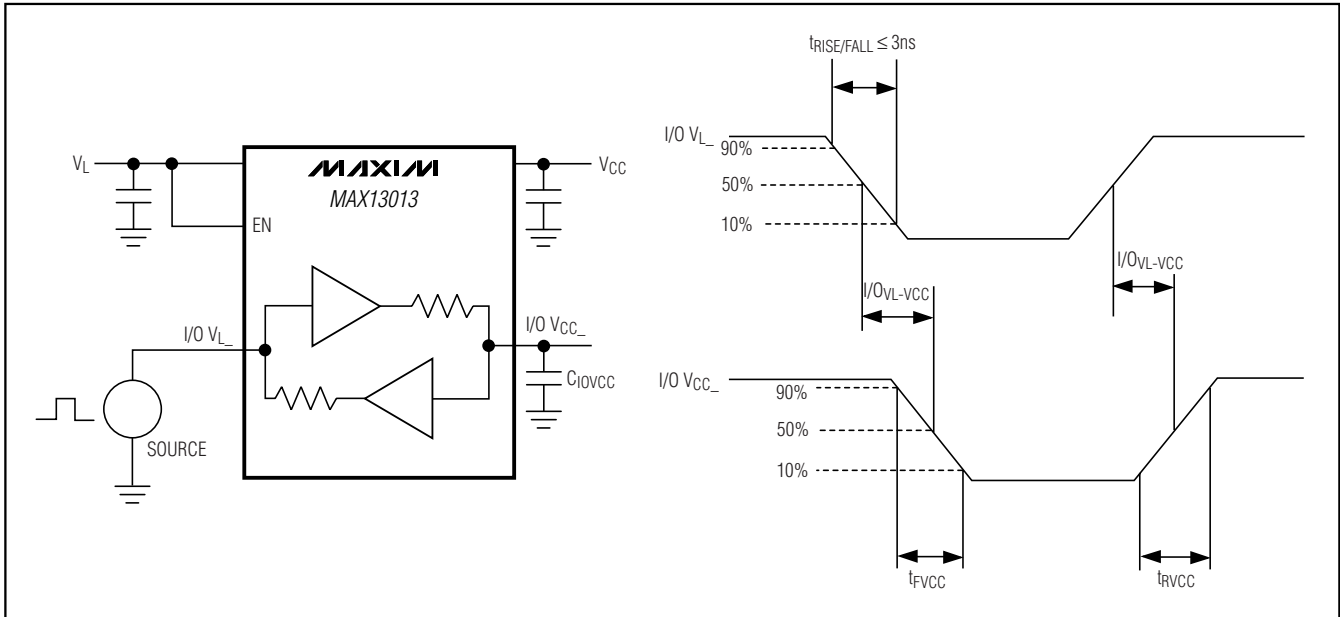


Figure 1. Driving I/O V<sub>L</sub>\_ Test Circuit and Timing

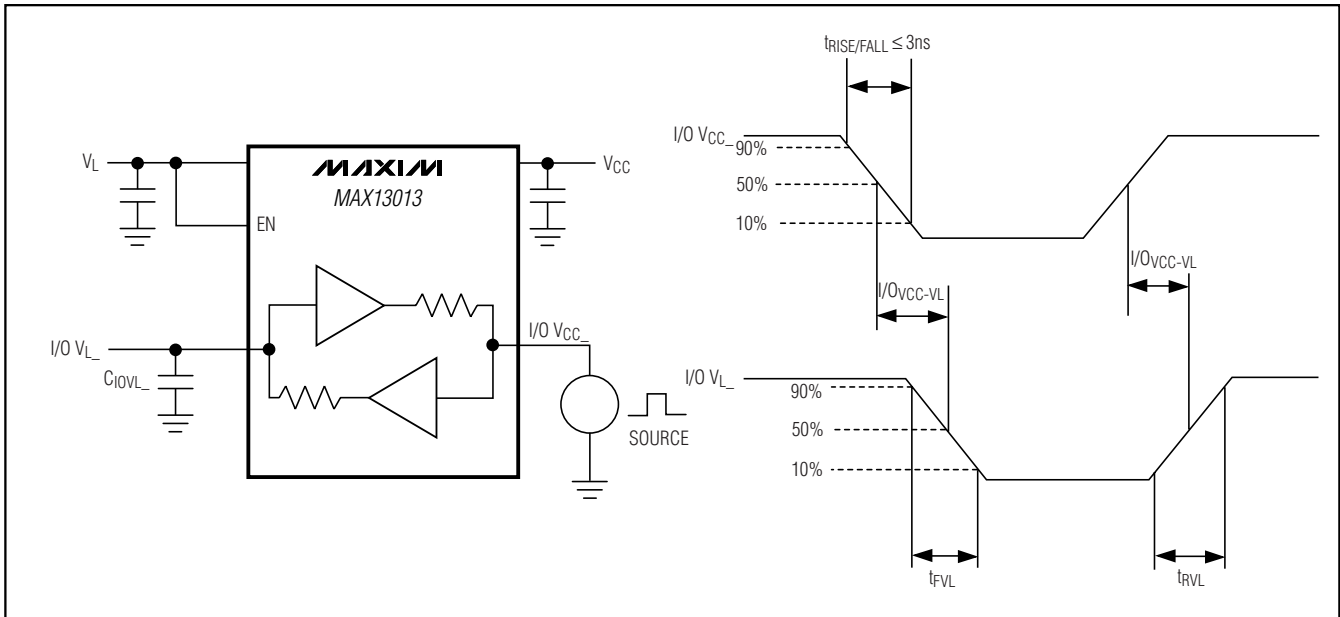


Figure 2. Driving I/O V<sub>CC</sub>\_ Test Circuit and Timing



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

## Test Circuits/Timing Diagrams (continued)

MAX13013-MAX13017/MAX3023-MAX3028

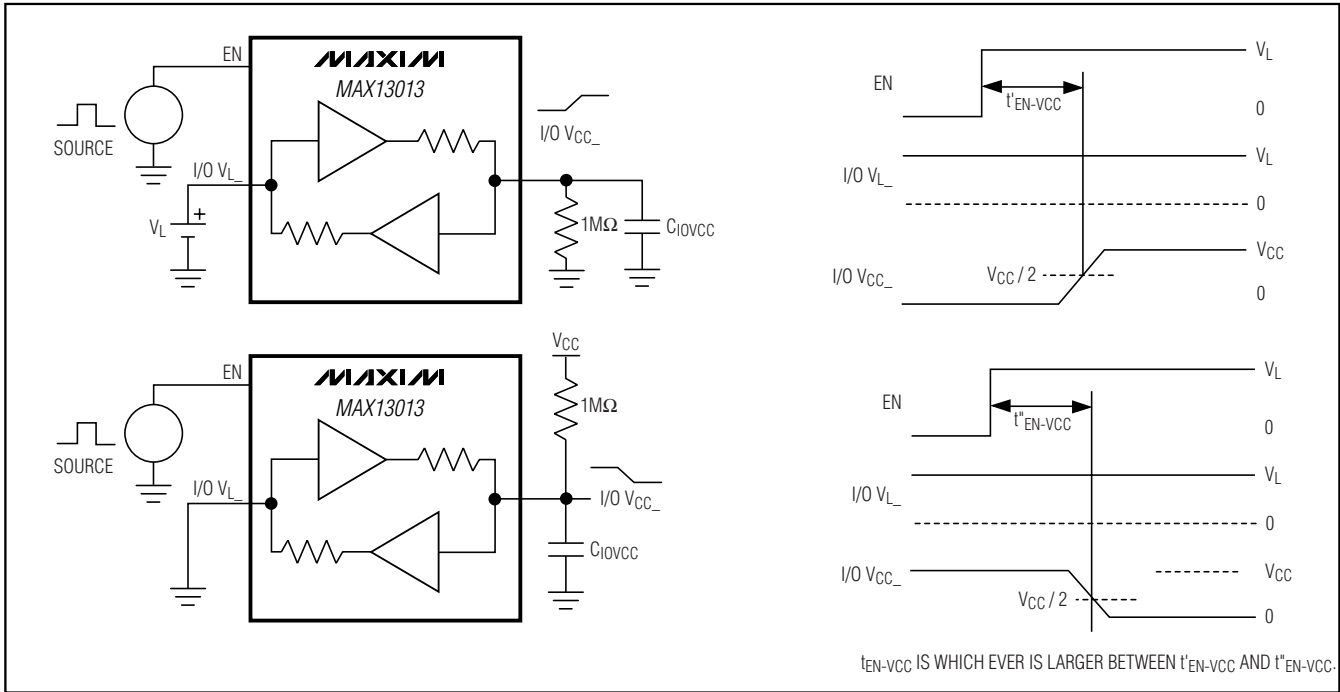


Figure 3. Propagation Delay from I/O VL<sub>-</sub> to I/O VCC<sub>-</sub> After EN

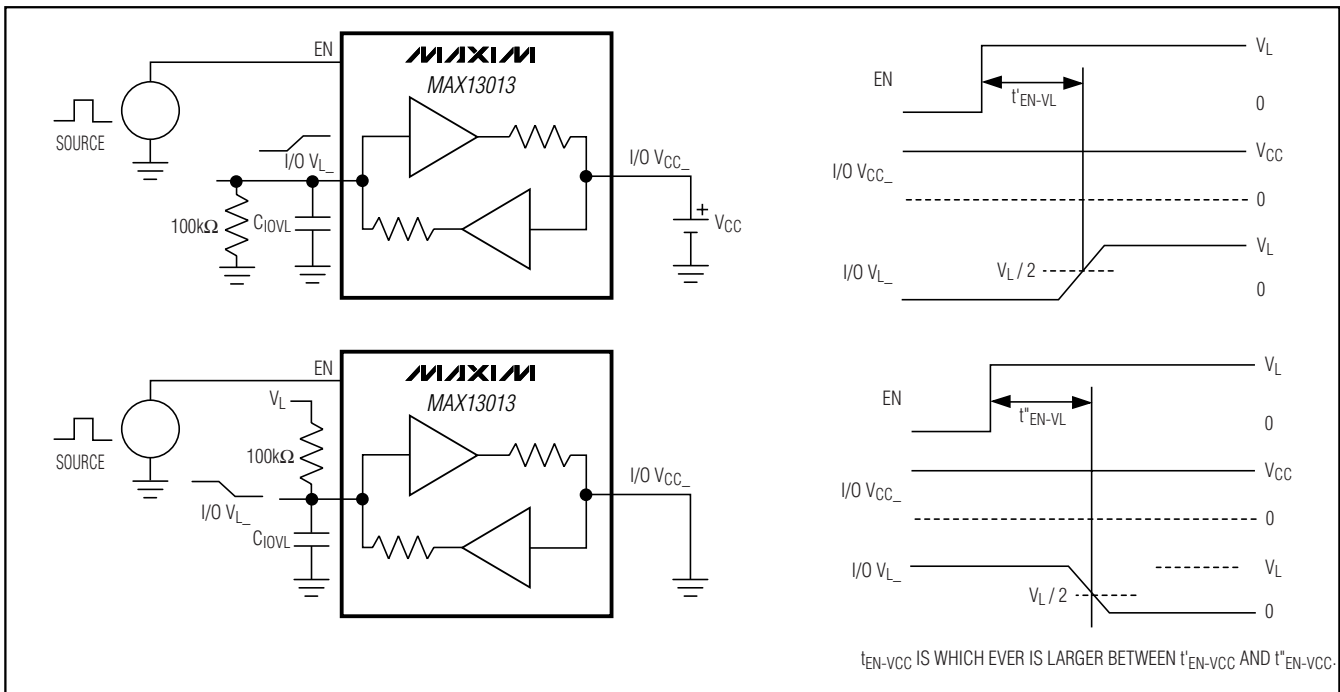


Figure 4. Propagation Delay from I/O VCC<sub>-</sub> to I/O VL<sub>-</sub> After EN

# +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

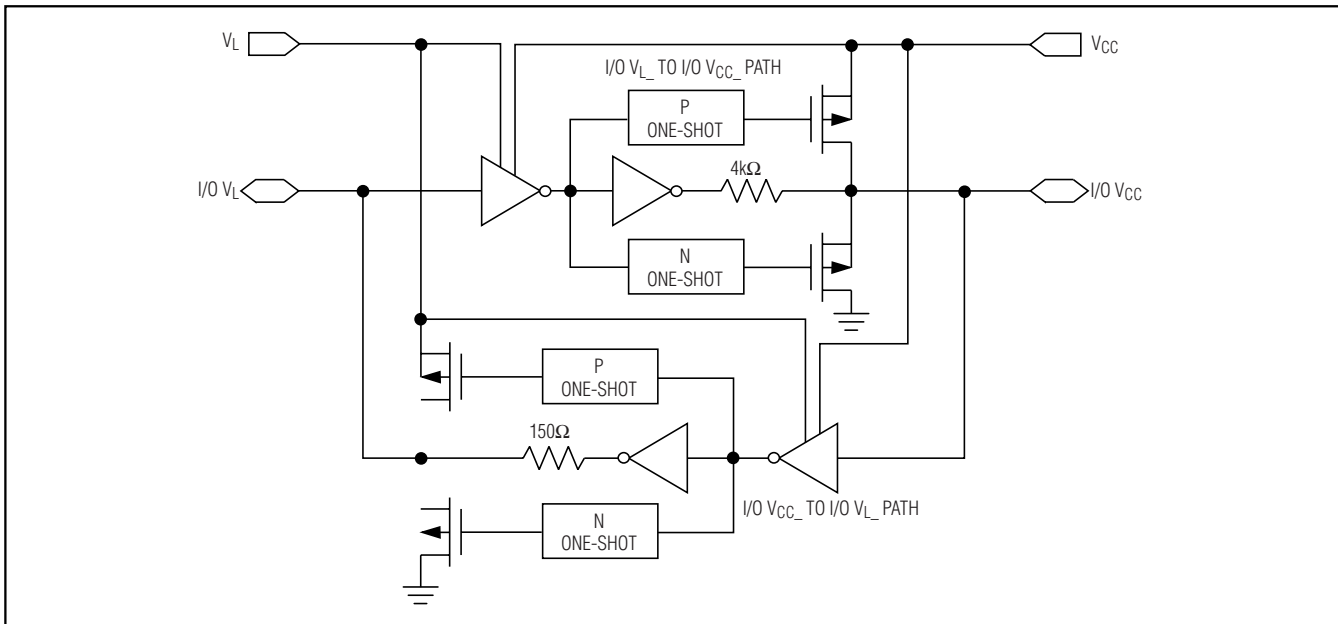


Figure 5. Simplified Functional Diagram (One I/O Line)

# +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 I<sup>2</sup>C™ 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<sub>L</sub> and  $\overline{\text{EN}}$  is pulled down to GND.

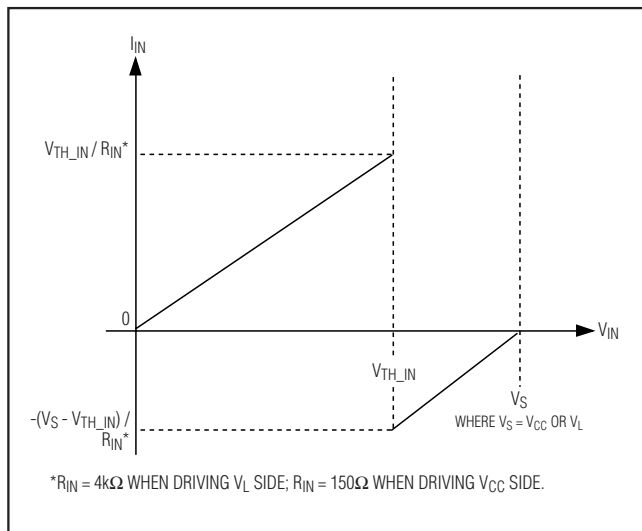


Figure 6. Typical  $I_{IN}$  vs.  $V_{IN}$

I<sup>2</sup>C is a trademark of Philips Corp.

Purchase of I<sup>2</sup>C components from Maxim Integrated Products, Inc. or one of its sublicensed Associated Companies, conveys a license under the Philips I<sup>2</sup>C Patent Rights to use these components in an I<sup>2</sup>C system, provided that the system conforms to the I<sup>2</sup>C 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 <sub>L</sub> and I/O V <sub>CC</sub> are in tri-state.
V <sub>L</sub>	0	Normal operation.
0	V <sub>L</sub>	Both I/O V <sub>L</sub> and I/O V <sub>CC</sub> are in tri-state.
V <sub>L</sub>	V <sub>L</sub>	Both I/O V <sub>L</sub> and I/O V <sub>CC</sub> are in tri-state.

## Applications Information

### Power-Supply Decoupling

To reduce ripple and the chance of introducing data errors, bypass V<sub>L</sub> and V<sub>CC</sub> 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<sub>L</sub>→ V<sub>CC</sub> or V<sub>CC</sub>→V<sub>L</sub>) on any single data line (see the *Ordering Information*). These devices provide the smallest solution (UCSP package) for unidirectional level translation without inversion.

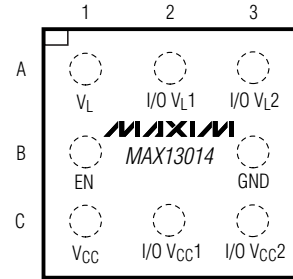
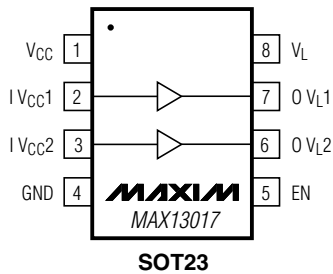
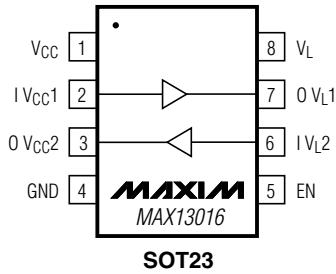
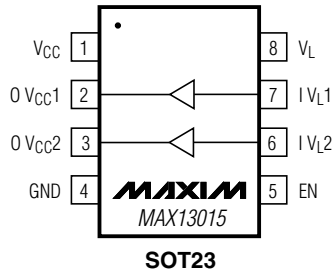
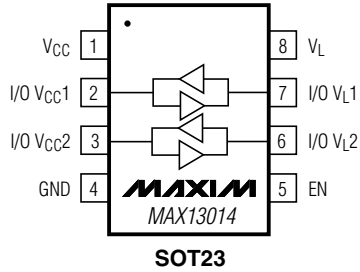
### UCSP Applications Information

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](http://www.maxim-ic.com/ucsp) to find the Application Note: UCSP—A Wafer-Level Chip-Scale Package.

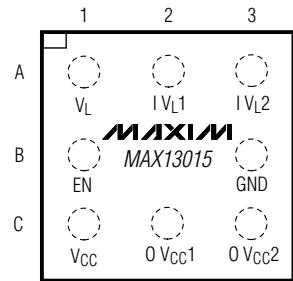
# +1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

## Pin Configurations (continued)

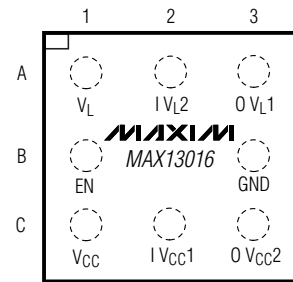
TOP VIEW



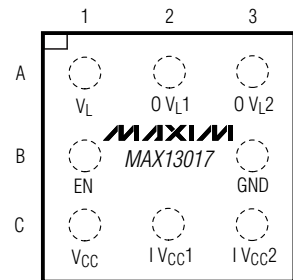
UCSP  
(BUMPS ON BOTTOM OF DIE)



UCSP  
(BUMPS ON BOTTOM OF DIE)



UCSP  
(BUMPS ON BOTTOM OF DIE)



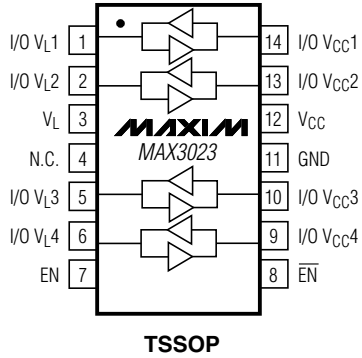
UCSP  
(BUMPS ON BOTTOM OF DIE)

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

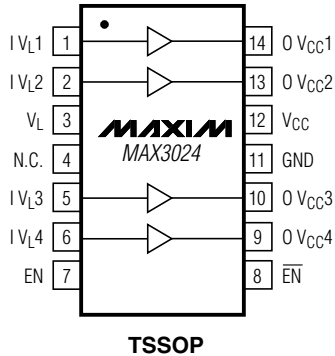
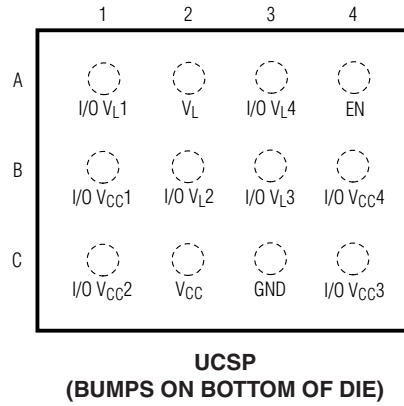
## Pin Configurations (continued)

**MAX13013-MAX13017/MAX3023-MAX3028**

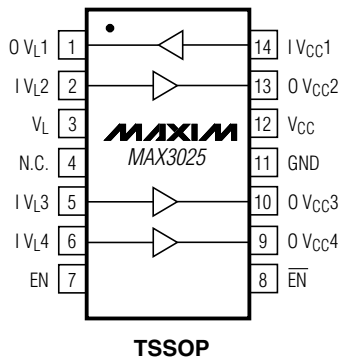
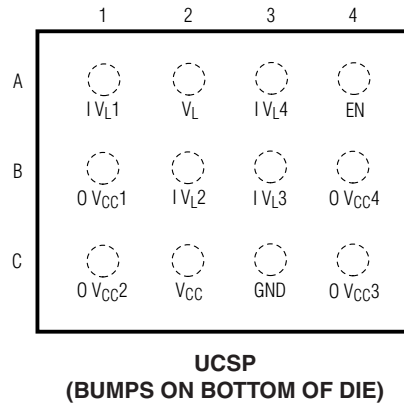
TOP VIEW



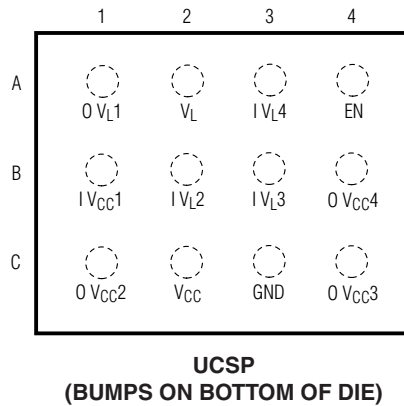
**MAXIM**  
MAX3023



**MAXIM**  
MAX3024



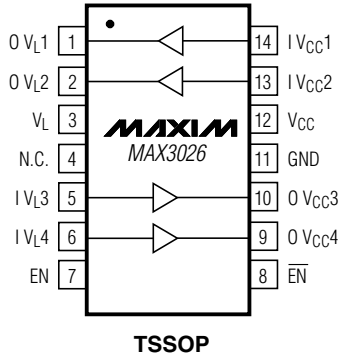
**MAXIM**  
MAX3025



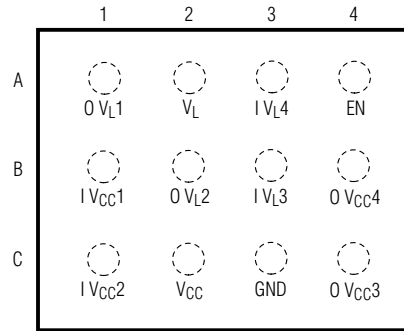
# +1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

## Pin Configurations (continued)

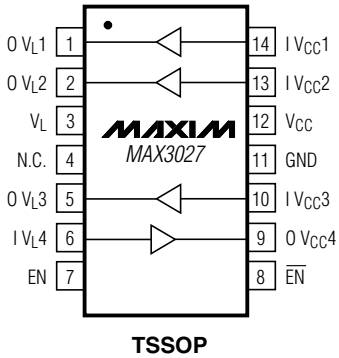
TOP VIEW



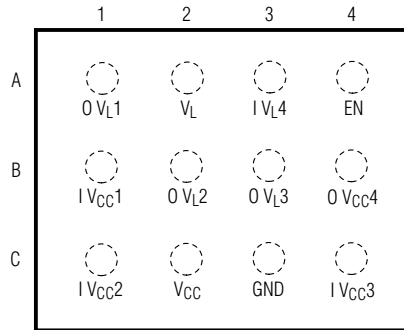
MAXIM  
MAX3026



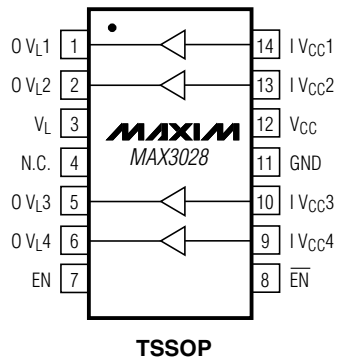
UCSP  
(BUMPS ON BOTTOM OF DIE)



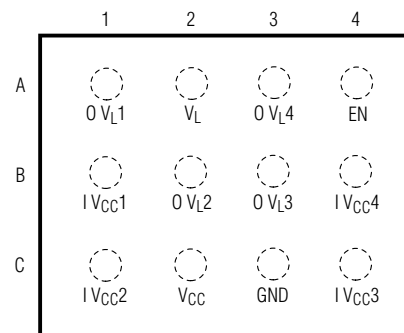
MAXIM  
MAX3027



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 <sub>L</sub> → V <sub>CC</sub> TRANSLATORS	Number of V <sub>CC</sub> → V <sub>L</sub> TRANSLATORS	EN	$\overline{\text{EN}}$
MAX13013EBT-T	-40°C to +85°C	3 x 2 UCSP-6	B6-1	ADF	1	1	✓	—
<b>MAX13014EKA</b>	-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	✓	—
<b>MAX13015EKA*</b>	-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	✓	—
<b>MAX13016EKA*</b>	-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	✓	—
<b>MAX13017EKA*</b>	-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	✓	—
<b>MAX3023EUD</b>	-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	✓	—
<b>MAX3024EUD*</b>	-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	✓	—
<b>MAX3025EUD*</b>	-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	✓	—
<b>MAX3026EUD*</b>	-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	✓	—
<b>MAX3027EUD*</b>	-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	✓	—
<b>MAX3028EUD*</b>	-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

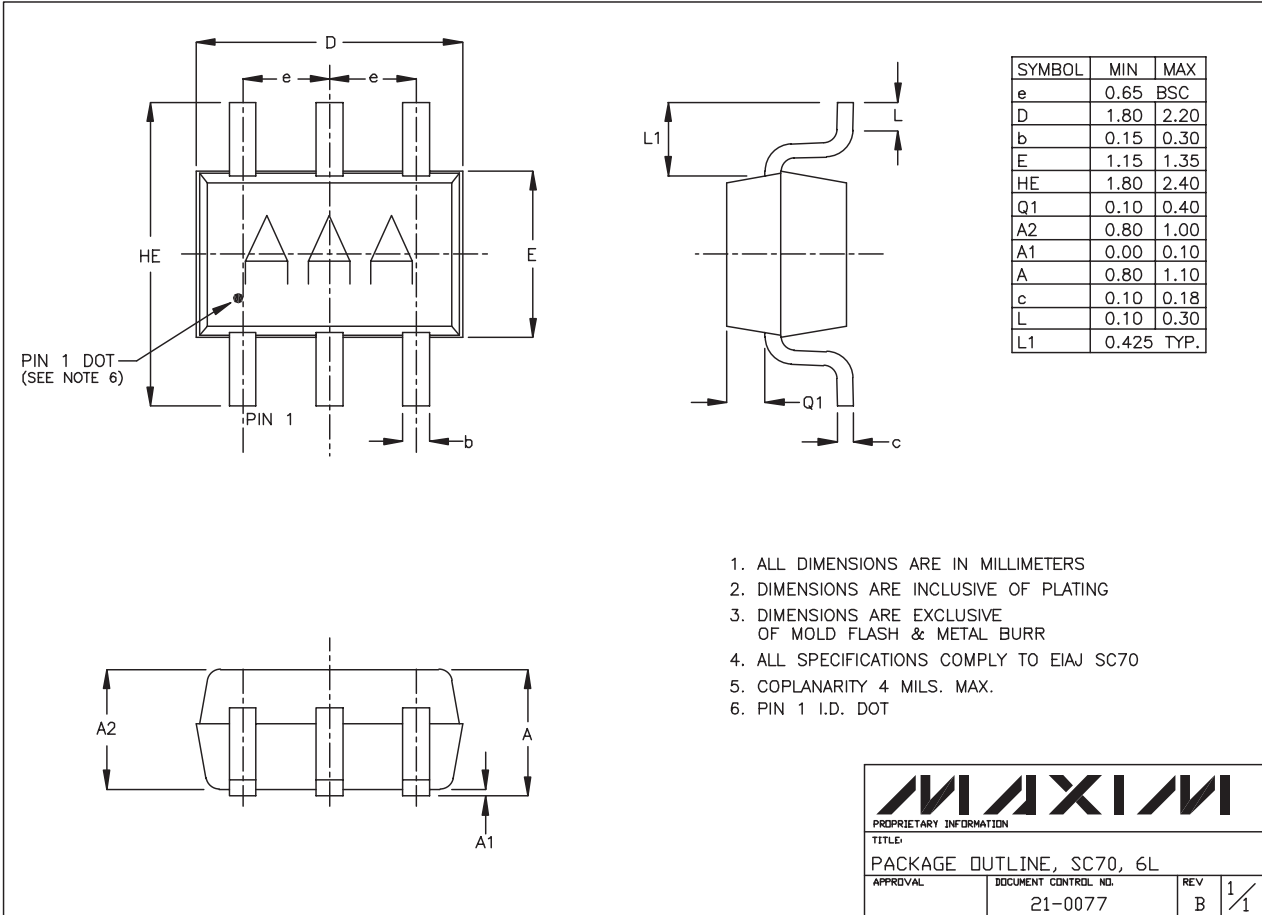
PROCESS: BiCMOS

**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](http://www.maxim-ic.com/packages).)

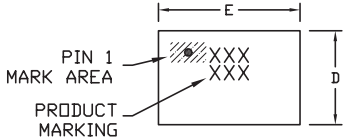




# +1.2V to +3.6V, 0.1µA, 100Mbps, Single-/Dual-/Quad-Level Translators

## 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](http://www.maxim-ic.com/packages).)



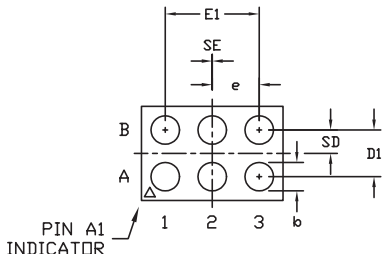
**TOP VIEW**

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

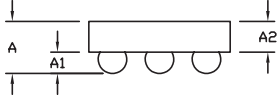
PKG. CODE	VARIABLE DIMENSIONS		DEPOPULATED SOLDER BALLS
	D	E	
B6-1	1.00±0.05	1.52±0.05	NONE
B6-2	1.00±0.05	1.52±0.05	B2
B6-3	1.05±0.05	1.57±0.05	NONE
B6-4	1.05±0.05	1.57±0.05	B2
B6-5	0.97±0.05	1.46±0.05	NONE
B6-6	1.16±0.05	1.57±0.05	NONE

**NOTES:**

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



**BOTTOM VIEW**



**SIDE VIEW**

<b>DALLAS SEMICONDUCTOR</b>		<b>MAXIM</b>	
PROPRIETARY INFORMATION			
TITLE:			
PACKAGE OUTLINE, 3x2 UCSP			
APPROVAL	DOCUMENT CONTROL NO.	REV.	1/1
	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](http://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.

**DALLAS SEMICONDUCTOR** **MAXIM**  
 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](http://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**

<b>DALLAS SEMICONDUCTOR</b>		
<b>MAXIM</b>		
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](http://www.maxim-ic.com/packages).)

**TOP VIEW**

**BOTTOM VIEW**

**SIDE VIEW**

**END VIEW**

**DETAIL A**

**LEAD TIP DETAIL**

	COMMON DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	—	1.10	—	.043
A <sub>1</sub>	0.05	0.15	.002	.006
A <sub>2</sub>	0.85	0.95	.033	.037
b	0.19	0.30	.007	.012
b <sub>1</sub>	0.19	0.25	.007	.010
c	0.09	0.20	.004	.008
c <sub>1</sub>	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

**DALLAS SEMICONDUCTOR** **MAXIM**

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, TSSOP 4.40mm BODY

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TSSOP4.40mm-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](http://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**

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

12L UCSP 4x3.EPS

**MAX13013-MAX13017/MAX3023-MAX3028**

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