

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### General Description

The MAX3372E-MAX3379E and MAX3390E-MAX3393E ±15kV ESD-protected level translators provide the level shifting necessary to allow data transfer in a multivoltage system. Externally applied voltages, V<sub>CC</sub> and V<sub>L</sub>, set the logic levels on either side of the device. A low-voltage logic signal present on the V<sub>L</sub> side of the device appears as a high-voltage logic signal on the V<sub>CC</sub> side of the device, and vice-versa. The MAX3374E/MAX3375E/MAX3376E/MAX3379E and MAX3390E-MAX3393E 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. The MAX3372E/MAX3373E and MAX3377E/MAX3378E bidirectional level translators utilize a transmission-gate-based design (Figure 2) to allow data translation in either direction (V<sub>L</sub> ↔ V<sub>CC</sub>) on any single data line. The MAX3372E-MAX3379E and MAX3390E-MAX3393E accept V<sub>L</sub> from +1.2V to +5.5V and V<sub>CC</sub> from +1.65V to +5.5V, making them ideal for data transfer between low-voltage ASICs/PLDs and higher voltage systems.

All devices in the MAX3372E-MAX3379E, MAX3390E-MAX3393E family feature a three-state output mode that reduces supply current to less than 1µA, thermal short-circuit protection, and ±15kV ESD protection on the V<sub>CC</sub> side for greater protection in applications that route signals externally. The MAX3372E/MAX3377E operate at a guaranteed data rate of 230kbps. Slew-rate limiting reduces EMI emissions in all 230kbps devices. The MAX3373E-MAX3376E/MAX3378E/MAX3379E and MAX3390E-MAX3393E operate at a guaranteed data rate of 8Mbps over the entire specified operating voltage range. Within specific voltage domains, higher data rates are possible. (See the *Timing Characteristics* table.)

The MAX3372E-MAX3376E are dual level shifters available in 3 x 3 UCSP™, 8-pin TDFN, and 8-pin SOT23-8 packages. The MAX3377E/MAX3378E/MAX3379E and MAX3390E-MAX3393E are quad level shifters available in 3 x 4 UCSP, 14-pin TDFN, and 14-pin TSSOP packages.

### Applications

SPI™, MICROWIRE™, and I<sup>2</sup>C Level Translation  
 Low-Voltage ASIC Level Translation  
 Smart Card Readers  
 Cell-Phone Cradles  
 Portable POS Systems  
 Portable Communication Devices  
 Low-Cost Serial Interfaces  
 Cell Phones  
 GPS  
 Telecommunications Equipment

### Features

- ◆ Guaranteed Data Rate Options
  - 230kbps
  - 8Mbps (+1.2V ≤ V<sub>L</sub> ≤ V<sub>CC</sub> ≤ +5.5V)
  - 10Mbps (+1.2V ≤ V<sub>L</sub> ≤ V<sub>CC</sub> ≤ +3.3V)
  - 16Mbps (+1.8V ≤ V<sub>L</sub> ≤ V<sub>CC</sub> ≤ +2.5V and +2.5V ≤ V<sub>L</sub> ≤ V<sub>CC</sub> ≤ +3.3V)
- ◆ Bidirectional Level Translation (MAX3372E/MAX3373E and MAX3377E/MAX3378E)
- ◆ Operation Down to +1.2V on V<sub>L</sub>
- ◆ ±15kV ESD Protection on I/O V<sub>CC</sub> Lines
- ◆ Ultra-Low 1µA Supply Current in Three-State Output Mode
- ◆ Low-Quiescent Current (130µA typ)
- ◆ UCSP, TDFN, SOT23, and TSSOP Packages
- ◆ Thermal Short-Circuit Protection

### Ordering Information

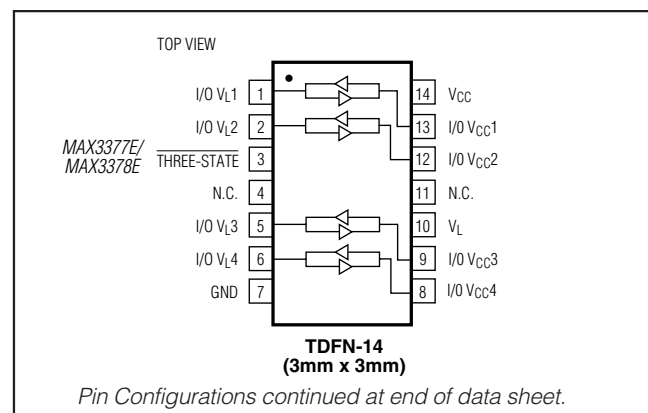
PART	TEMP RANGE	PIN-PACKAGE	PKG CODE
MAX3372EEKA+T	-40°C to +85°C	8 SOT23	K8S-3

+Denotes a lead-free package.  
 T = Tape and reel.

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

UCSP is a trademark of Maxim Integrated Products, Inc.  
 SPI is a trademark of Motorola, Inc.  
 MICROWIRE is a trademark of National Semiconductor Corp.

### Pin Configurations



# MAX3372E–MAX3379E/

# MAX3390E–MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

V <sub>CC</sub> .....	-0.3V to +6V
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)
THREE-STATE .....	-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
Short-Circuit Duration I/O V <sub>L</sub> or I/O V <sub>CC</sub> to GND Driven from 40mA Source (except MAX3372E and MAX3377E) .....	Continuous

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

8-Pin SOT23 (derate 8.9mW/°C above +70°C).....	714mW
8-Pin TDFN (derate 18.2mW/°C above +70°C) .....	1455mW
3 x 3 UCSP (derate 4.7mW/°C above +70°C) .....	379mW
3 x 4 UCSP (derate 6.5mW/°C above +70°C) .....	579mW
14-Pin TSSOP (derate 9.1mW/°C above +70°C) .....	727mW
14-Pin TDFN (derate 18.2mW/°C above +70°C) .....	1454mW
Operating Temperature Range .....	-40°C to +85°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 +5.5V, V<sub>L</sub> = +1.2V to (V<sub>CC</sub> + 0.3V), GND = 0, I/O V<sub>L</sub> and I/O V<sub>CC</sub> unconnected, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +3.3V, V<sub>L</sub> = +1.8V, T<sub>A</sub> = +25°C.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>POWER SUPPLIES</b>						
V <sub>L</sub> Supply Range	V <sub>L</sub>		1.2		5.5	V
V <sub>CC</sub> Supply Range	V <sub>CC</sub>		1.65		5.50	V
Supply Current from V <sub>CC</sub>	I <sub>QVCC</sub>			130	300	µA
Supply Current from V <sub>L</sub>	I <sub>QVL</sub>			16	100	µA
V <sub>CC</sub> Three-State Output Mode Supply Current	I <sub>THREE-STATE-VCC</sub>	T <sub>A</sub> = +25°C, $\overline{\text{THREE-STATE}} = \text{GND}$		0.03	1	µA
V <sub>L</sub> Three-State Output Mode Supply Current	I <sub>THREE-STATE-VL</sub>	T <sub>A</sub> = +25°C, $\overline{\text{THREE-STATE}} = \text{GND}$		0.03	1	µA
Three-State Output Mode Leakage Current I/O V <sub>L</sub> and I/O V <sub>CC</sub>	I <sub>THREE-STATE-LKG</sub>	T <sub>A</sub> = +25°C, $\overline{\text{THREE-STATE}} = \text{GND}$		0.02	1	µA
$\overline{\text{THREE-STATE}}$ Pin Input Leakage		T <sub>A</sub> = +25°C		0.02	1	µA
<b>ESD PROTECTION</b>						
I/O V <sub>CC</sub> (Note 3)		IEC 1000-4-2 Air-Gap Discharge		±8		kV
		IEC 1000-4-2 Contact Discharge		±8		
		Human Body Model		±15		
<b>LOGIC-LEVEL THRESHOLDS (MAX3372E/MAX3377E)</b>						
I/O V <sub>L</sub> Input-Voltage High	V <sub>IHL</sub>		V <sub>L</sub> - 0.2			V
I/O V <sub>L</sub> Input-Voltage Low	V <sub>ILL</sub>				0.15	V

# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## **±15kV ESD-Protected, 1μA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP**

### **ELECTRICAL CHARACTERISTICS (continued)**

(V<sub>CC</sub> = +1.65V to +5.5V, V<sub>L</sub> = +1.2V to (V<sub>CC</sub> + 0.3V), GND = 0, I/O V<sub>L</sub> and I/O V<sub>CC</sub> unconnected, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +3.3V, V<sub>L</sub> = +1.8V, T<sub>A</sub> = +25°C.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
I/O V <sub>CC</sub> Input-Voltage High	V <sub>IHC</sub>		V <sub>CC</sub> - 0.4			V
I/O V <sub>CC</sub> Input-Voltage Low	V <sub>I LC</sub>			0.15		V
I/O V <sub>L</sub> Output-Voltage High	V <sub>OHL</sub>	I/O V <sub>L</sub> source current = 20μA, I/O V <sub>CC</sub> ≥ V <sub>CC</sub> - 0.4V	0.67 × V <sub>L</sub>			V
I/O V <sub>L</sub> Output-Voltage Low	V <sub>OLL</sub>	I/O V <sub>L</sub> sink current = 20μA, I/O V <sub>CC</sub> ≤ 0.15V		0.4		V
I/O V <sub>CC</sub> Output-Voltage High	V <sub>OHC</sub>	I/O V <sub>CC</sub> source current = 20μA, I/O V <sub>L</sub> ≥ V <sub>L</sub> - 0.2V	0.67 × V <sub>CC</sub>			V
I/O V <sub>CC</sub> Output-Voltage Low	V <sub>OLC</sub>	I/O V <sub>CC</sub> sink current = 20μA, I/O V <sub>L</sub> ≤ 0.15V		0.4		V
$\overline{\text{THREE-STATE}}$ Input-Voltage High	V <sub>IL-THREE-STATE</sub>		V <sub>L</sub> - 0.2			V
$\overline{\text{THREE-STATE}}$ Input-Voltage Low	V <sub>IL-THREE-STATE</sub>			0.15		V
<b>LOGIC-LEVEL THRESHOLDS (MAX3373E-MAX3376E/MAX3378E/MAX3379E and MAX3390E-MAX3393E)</b>						
I/O V <sub>L</sub> Input-Voltage High	V <sub>IHL</sub>		V <sub>L</sub> - 0.2			V
I/O V <sub>L</sub> Input-Voltage Low	V <sub>ILL</sub>			0.15		V
I/O V <sub>CC</sub> Input-Voltage High	V <sub>IHC</sub>		V <sub>CC</sub> - 0.4			V
I/O V <sub>CC</sub> Input-Voltage Low	V <sub>I LC</sub>			0.15		V
I/O V <sub>L</sub> Output-Voltage High	V <sub>OHL</sub>	I/O V <sub>L</sub> source current = 20μA, I/O V <sub>CC</sub> ≥ V <sub>CC</sub> - 0.4V	0.67 × V <sub>L</sub>			V
I/O V <sub>L</sub> Output-Voltage Low	V <sub>OLL</sub>	I/O V <sub>L</sub> sink current = 1mA, I/O V <sub>CC</sub> ≤ 0.15V		0.4		V
I/O V <sub>CC</sub> Output-Voltage High	V <sub>OHC</sub>	I/O V <sub>CC</sub> source current = 20μA, I/O V <sub>L</sub> ≥ V <sub>L</sub> - 0.2V	0.67 × V <sub>CC</sub>			V
I/O V <sub>CC</sub> Output-Voltage Low	V <sub>OLC</sub>	I/O V <sub>CC</sub> sink current = 1mA, I/O V <sub>L</sub> ≤ 0.15V		0.4		V
$\overline{\text{THREE-STATE}}$ Input-Voltage High	V <sub>IH-THREE-STATE</sub>		V <sub>L</sub> - 0.2			V
$\overline{\text{THREE-STATE}}$ Input-Voltage Low	V <sub>IL-THREE-STATE</sub>			0.15		V

# MAX3372E–MAX3379E/

# MAX3390E–MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### TIMING CHARACTERISTICS

(V<sub>CC</sub> = +1.65V to +5.5V, V<sub>L</sub> = +1.2V to (V<sub>CC</sub> + 0.3V), GND = 0, R<sub>LOAD</sub> = 1MΩ, I/O test signal of Figure 1, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +3.3V, V<sub>L</sub> = +1.8V, T<sub>A</sub> = +25°C, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>MAX3372E/MAX3377E (C<sub>LOAD</sub> = 50pF)</b>						
I/O V <sub>CC</sub> _ Rise Time (Note 4)	t <sub>RVCC</sub>			1100		ns
I/O V <sub>CC</sub> _ Fall Time (Note 5)	t <sub>FVCC</sub>			1000		ns
I/O V <sub>L</sub> _ Rise Time (Note 4)	t <sub>RVL</sub>			600		ns
I/O V <sub>L</sub> _ Fall Time (Note 5)	t <sub>FVL</sub>			1100		ns
Propagation Delay	I/O <sub>VL</sub> -V <sub>CC</sub>	Driving I/O V <sub>L</sub> _			1.6	µs
	I/O <sub>VCC</sub> -V <sub>L</sub>	Driving I/O V <sub>CC</sub> _			1.6	
Channel-to-Channel Skew	t <sub>SKEW</sub>	Each translator equally loaded			500	ns
Maximum Data Rate		C <sub>L</sub> = 25pF	230			kbps
<b>MAX3373E–MAX3376E/MAX3378E/MAX3379E and MAX3390E–MAX3393E (C<sub>LOAD</sub> = 15pF, Driver Output Impedance ≤ 50Ω)</b>						
<b>+1.2V ≤ V<sub>L</sub> ≤ V<sub>CC</sub> ≤ +5.5V</b>						
I/O V <sub>CC</sub> _ Rise Time (Note 4)	t <sub>RVCC</sub>			7	25	ns
		Open-drain driving		170	400	
I/O V <sub>CC</sub> _ Fall Time (Note 5)	t <sub>FVCC</sub>			6	37	ns
		Open-drain driving		20	50	
I/O V <sub>L</sub> _ Rise Time (Note 4)	t <sub>RVL</sub>			8	30	ns
		Open-drain driving		180	400	
I/O V <sub>L</sub> _ Fall Time (Note 5)	t <sub>LFV</sub>			3	30	ns
		Open-drain driving		30	60	
Propagation Delay	I/O <sub>VL</sub> -V <sub>CC</sub>	Driving I/O V <sub>L</sub> _		5	30	ns
			Open-drain driving		210	
	I/O <sub>VCC</sub> -V <sub>L</sub>	Driving I/O V <sub>CC</sub> _		4	30	
			Open-drain driving		190	
Channel-to-Channel Skew	t <sub>SKEW</sub>	Each translator equally loaded			20	ns
			Open-drain driving			
Maximum Data Rate			8			Mbps
		Open-drain driving	500			kbps

# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### TIMING CHARACTERISTICS (continued)

(V<sub>CC</sub> = +1.65V to +5.5V, V<sub>L</sub> = +1.2V to (V<sub>CC</sub> + 0.3V), GND = 0, R<sub>LOAD</sub> = 1MΩ, I/O test signal of Figure 1, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +3.3V, V<sub>L</sub> = +1.8V, T<sub>A</sub> = +25°C, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>+1.2V ≤ V<sub>L</sub> ≤ V<sub>CC</sub> ≤ +3.3V</b>						
I/O V <sub>CC</sub> _ Rise Time (Note 4)	t <sub>RVCC</sub>				25	ns
I/O V <sub>CC</sub> _ Fall Time (Note 5)	t <sub>FVCC</sub>				30	ns
I/O V <sub>L</sub> _ Rise Time (Note 4)	t <sub>RVL</sub>				30	ns
I/O V <sub>L</sub> _ Fall Time (Note 5)	t <sub>FVL</sub>				30	ns
Propagation Delay	I/O <sub>VL</sub> -V <sub>CC</sub>	Driving I/O V <sub>L</sub> _			20	ns
	I/O <sub>VCC</sub> -V <sub>L</sub>	Driving I/O V <sub>CC</sub> _			20	
Channel-to-Channel Skew	t <sub>SKREW</sub>	Each translator equally loaded			10	ns
Maximum Data Rate			10			Mbps
<b>+2.5V ≤ V<sub>L</sub> ≤ V<sub>CC</sub> ≤ +3.3V</b>						
I/O V <sub>CC</sub> _ Rise Time (Note 4)	t <sub>RVCC</sub>				15	ns
I/O V <sub>CC</sub> _ Fall Time (Note 5)	t <sub>FVCC</sub>				15	ns
I/O V <sub>L</sub> _ Rise Time (Note 4)	t <sub>RVL</sub>				15	ns
I/O V <sub>L</sub> _ Fall Time (Note 5)	t <sub>FVL</sub>				15	ns
Propagation Delay	I/O <sub>VL</sub> -V <sub>CC</sub>	Driving I/O V <sub>L</sub> _			15	ns
	I/O <sub>VCC</sub> -V <sub>L</sub>	Driving I/O V <sub>CC</sub> _			15	
Channel-to-Channel Skew	t <sub>SKREW</sub>	Each translator equally loaded			10	ns
Maximum Data Rate			16			Mbps
<b>+1.8V ≤ V<sub>L</sub> ≤ V<sub>CC</sub> ≤ +2.5V</b>						
I/O V <sub>CC</sub> _ Rise Time (Note 4)	t <sub>RVCC</sub>				15	ns
I/O V <sub>CC</sub> _ Fall Time (Note 5)	t <sub>FVCC</sub>				15	ns
I/O V <sub>L</sub> _ Rise Time (Note 4)	t <sub>RVL</sub>				15	ns
I/O V <sub>L</sub> _ Fall Time (Note 5)	t <sub>FVL</sub>				15	ns
Propagation Delay	I/O <sub>VL</sub> -V <sub>CC</sub>	Driving I/O V <sub>L</sub> _			15	ns
	I/O <sub>VCC</sub> -V <sub>L</sub>	Driving I/O V <sub>CC</sub> _			15	
Channel-to-Channel Skew	t <sub>SKREW</sub>	Each translator equally loaded			10	ns
Maximum Data Rate			16			Mbps

**Note 1:** All units are 100% production tested at T<sub>A</sub> = +25°C. Limits over the operating temperature range are guaranteed by design and not production tested.

**Note 2:** For normal operation, ensure V<sub>L</sub> < (V<sub>CC</sub> + 0.3V). During power-up, V<sub>L</sub> > (V<sub>CC</sub> + 0.3V) will not damage the device.

**Note 3:** To ensure maximum ESD protection, place a 1µF capacitor between V<sub>CC</sub> and GND. See *Applications Circuits*.

**Note 4:** 10% to 90%

**Note 5:** 90% to 10%

# MAX3372E-MAX3379E/

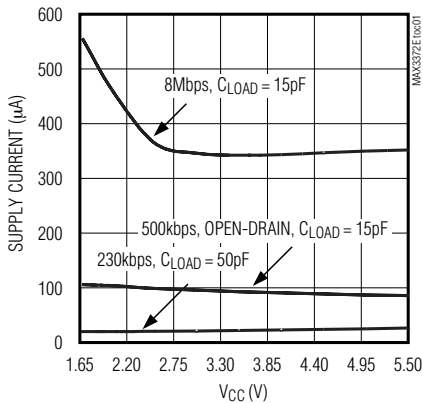
# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

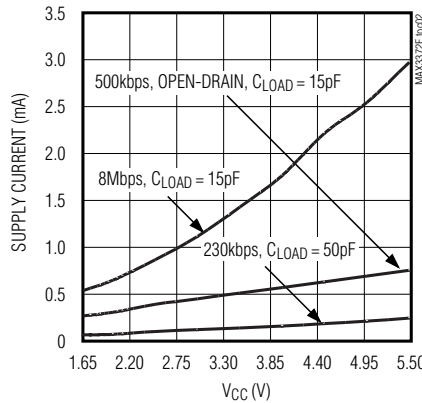
### Typical Operating Characteristics

( $R_{LOAD} = 1M\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted. All 230kbps TOCs apply to MAX3372E/MAX3377E only. All 8Mbps and 500kbps TOCs apply to MAX3373E-MAX3376E/MAX3378E/MAX3379E and MAX3390E-MAX3393E only.)

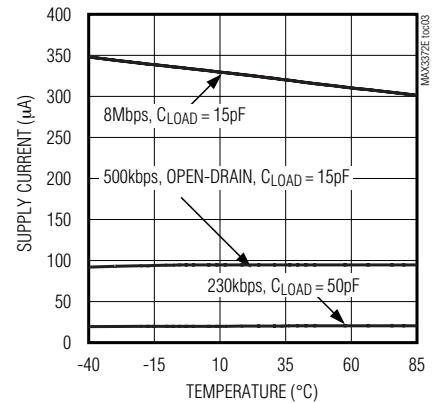
**$V_L$  SUPPLY CURRENT vs. SUPPLY VOLTAGE**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



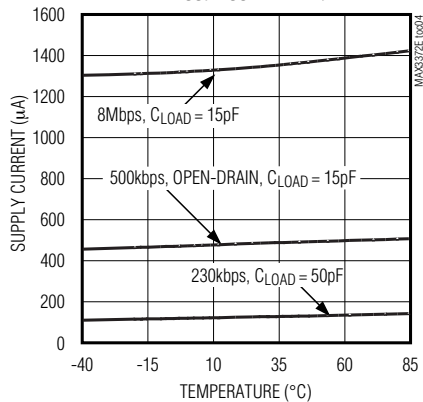
**$V_{CC}$  SUPPLY CURRENT vs. SUPPLY VOLTAGE**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



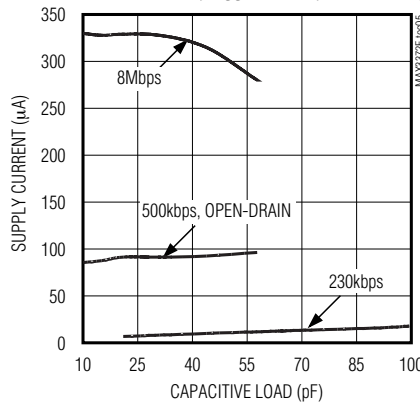
**$V_L$  SUPPLY CURRENT vs. TEMPERATURE**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



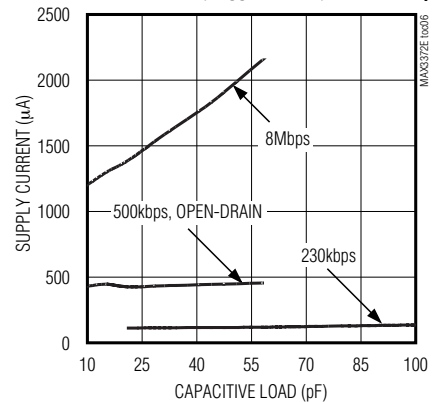
**$V_{CC}$  SUPPLY CURRENT vs. TEMPERATURE**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



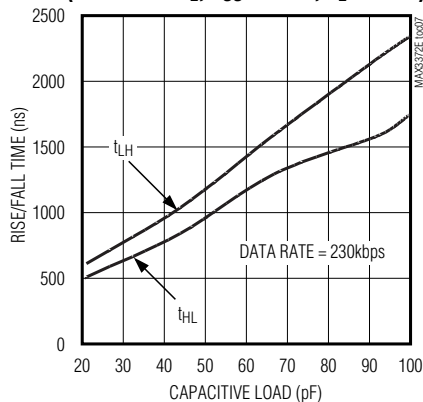
**$V_L$  SUPPLY CURRENT vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



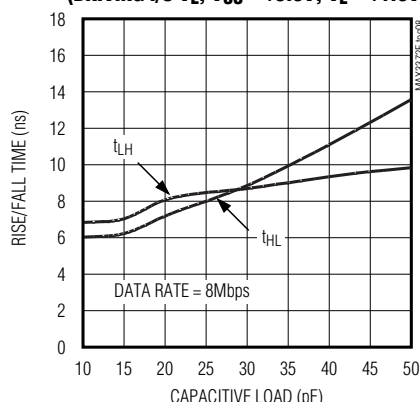
**$V_{CC}$  SUPPLY CURRENT vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



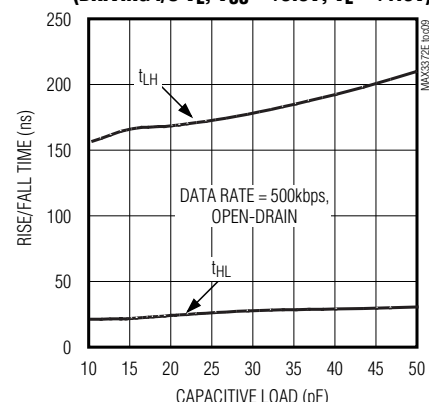
**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



# MAX3372E-MAX3379E/

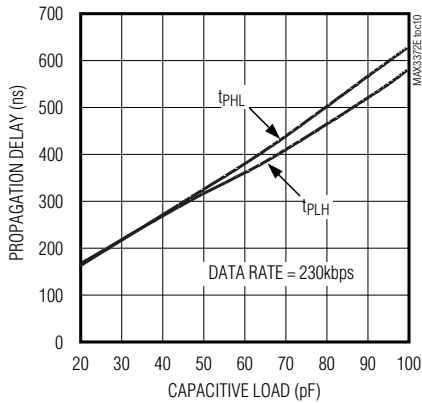
# MAX3390E-MAX3393E

## **±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP**

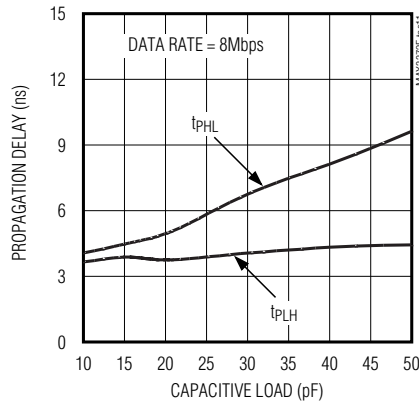
### **Typical Operating Characteristics (continued)**

( $R_{LOAD} = 1M\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted. All 230kbps TOCs apply to MAX3372E/MAX3377E only. All 8Mbps and 500kbps TOCs apply to MAX3373E-MAX3376E/MAX3378E/MAX3379E and MAX3390E-MAX3393E only.)

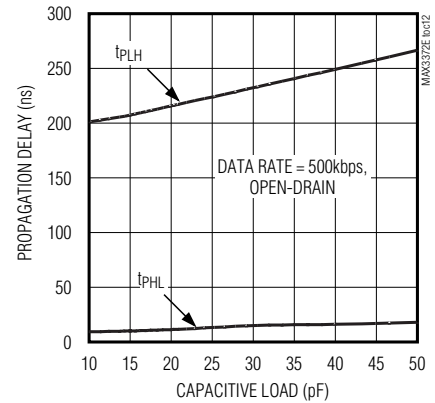
**PROPAGATION DELAY vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



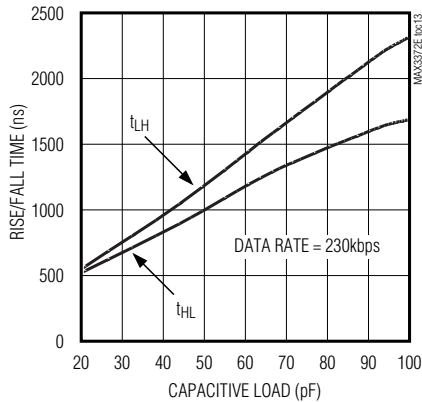
**PROPAGATION DELAY vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



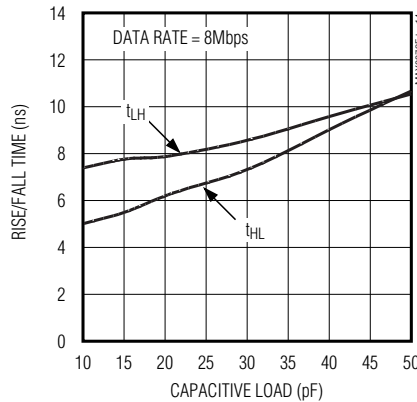
**PROPAGATION DELAY vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



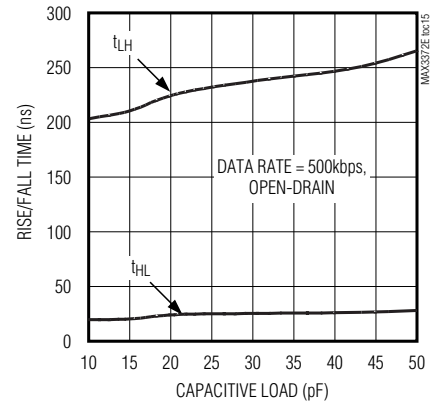
**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +2.5V$ ,  $V_L = +1.8V$ )



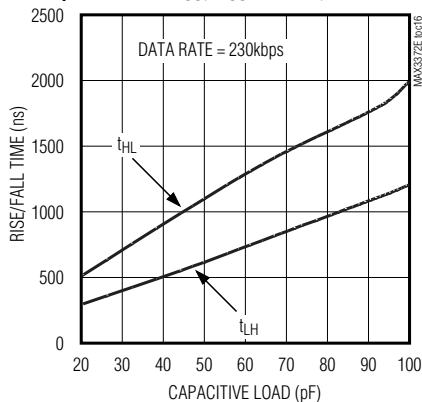
**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +2.5V$ ,  $V_L = +1.8V$ )



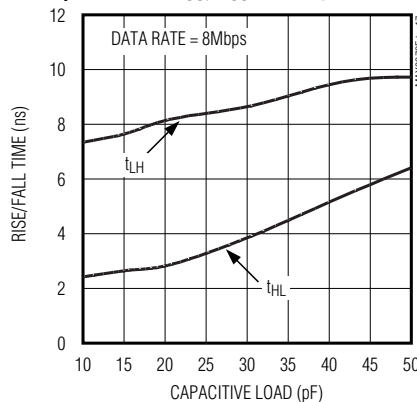
**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +2.5V$ ,  $V_L = +1.8V$ )



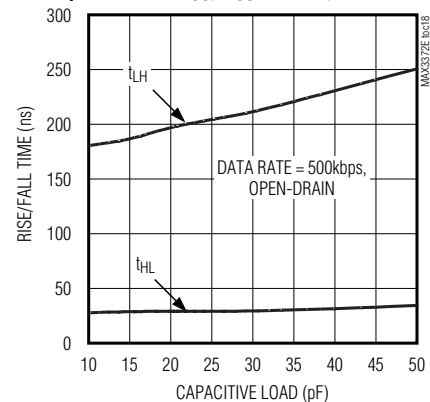
**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



# MAX3372E-MAX3379E/

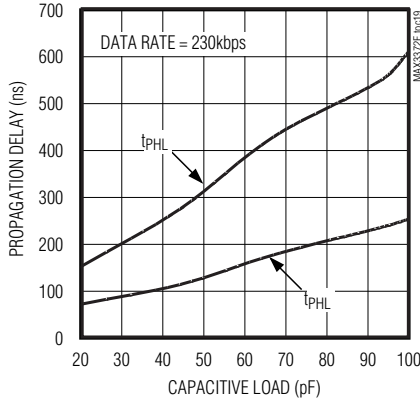
# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

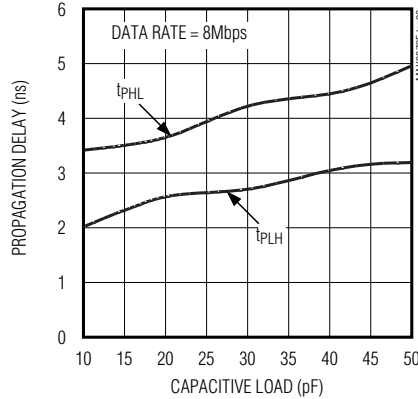
### Typical Operating Characteristics (continued)

( $R_{LOAD} = 1M\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted. All 230kbps TOCs apply to MAX3372E/MAX3377E only. All 8Mbps and 500kbps TOCs apply to MAX3373E-MAX3376E/MAX3378E/MAX3379E and MAX3390E-MAX3393E only.)

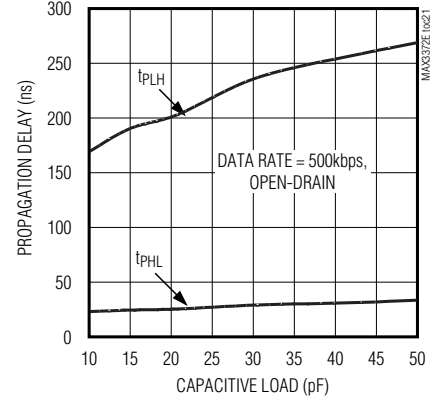
**PROPAGATION DELAY vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



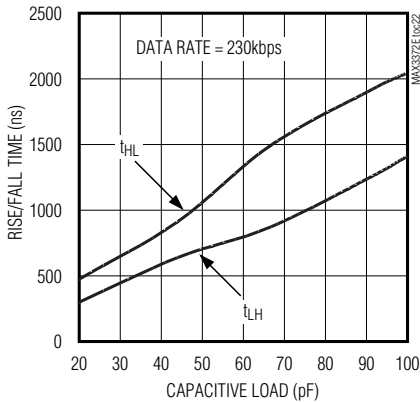
**PROPAGATION DELAY vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



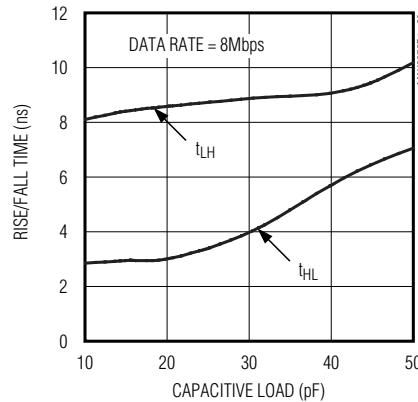
**PROPAGATION DELAY vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ )



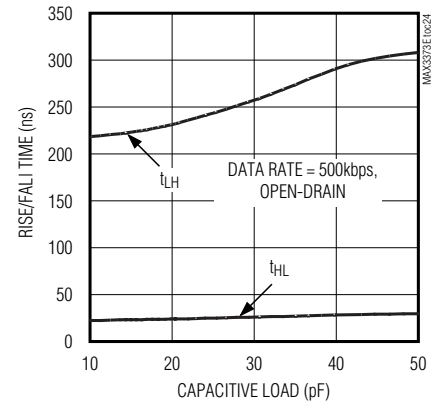
**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +2.5V$ ,  $V_L = +1.8V$ )



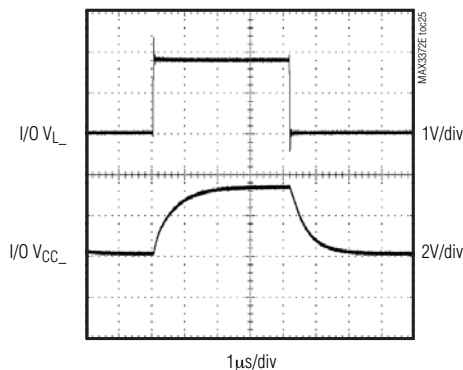
**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +2.5V$ ,  $V_L = +1.8V$ )



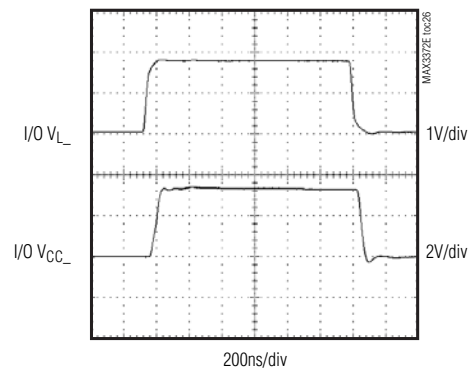
**RISE/FALL TIME vs. CAPACITIVE LOAD**  
(DRIVING I/O  $V_{CC}$ ,  $V_{CC} = +2.5V$ ,  $V_L = +1.8V$ )



**RAIL-TO-RAIL DRIVING**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ ,  
 $C_{LOAD} = 50pF$ , DATA RATE = 230kbps)



**RAIL-TO-RAIL DRIVING**  
(DRIVING I/O  $V_L$ ,  $V_{CC} = +3.3V$ ,  $V_L = +1.8V$ ,  
 $C_{LOAD} = 15pF$ , DATA RATE = 8Mbps)





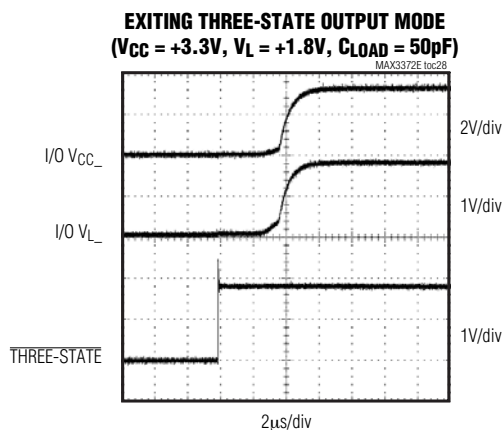
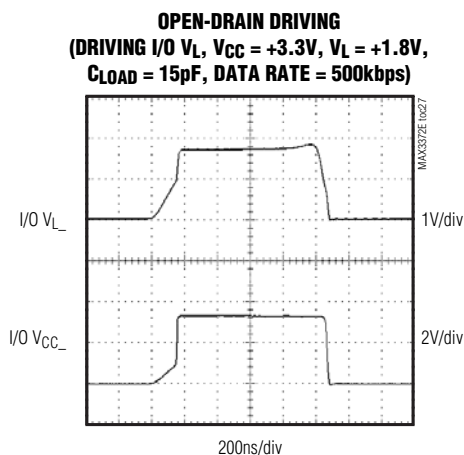
# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### Typical Operating Characteristics (continued)

( $R_{LOAD} = 1M\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted. All 230kbps TOCs apply to MAX3372E/MAX3377E only. All 8Mbps and 500kbps TOCs apply to MAX3373E-MAX3376E/MAX3378E/MAX3379E and MAX3390E-MAX3393E only.)



### Pin Description

PIN						NAME	FUNCTION
3 x 4 UCSP	TSSOP	SOT23-8	3 x 3 UCSP	TDFN 8	TDFN 14		
A1	2	5	C2	6	1	I/O $V_{L1}$	Input/Output 1. Referenced to $V_L$ . (Note 6)
A2	3	4	C3	8	2	I/O $V_{L2}$	Input/Output 2. Referenced to $V_L$ . (Note 6)
A3	4	—	—	—	5	I/O $V_{L3}$	Input/Output 3. Referenced to $V_L$ . (Note 6)
A4	5	—	—	—	6	I/O $V_{L4}$	Input/Output 4. Referenced to $V_L$ . (Note 6)
B1	14	7	A1	4	14	$V_{CC}$	$V_{CC}$ Input Voltage $+1.65V \leq V_{CC} \leq +5.5V$ .
B2	1	3	C1	7	10	$V_L$	Logic Input Voltage $+1.2V \leq V_L \leq (V_{CC} + 0.3V)$
B3	8	6	B1	5	3	$\overline{\text{THREE-STATE}}$	Three-State Output Mode Enable. Pull $\overline{\text{THREE-STATE}}$ low to place device in three-state output mode. I/O $V_{CC\_}$ and I/O $V_{L\_}$ are high impedance in three-state output mode. <b>Note:</b> Logic referenced to $V_L$ (for logic thresholds see the <i>Electrical Characteristics</i> table).
B4	7	2	B3	2	7	GND	Ground
C1	13	8	A2	3	13	I/O $V_{CC1}$	Input/Output 1. Referenced to $V_{CC}$ . (Note 6)
C2	12	1	A3	1	12	I/O $V_{CC2}$	Input/Output 2. Referenced to $V_{CC}$ . (Note 6)
C3	11	—	—	—	9	I/O $V_{CC3}$	Input/Output 3. Referenced to $V_{CC}$ . (Note 6)
C4	10	—	—	—	8	I/O $V_{CC4}$	Input/Output 4. Referenced to $V_{CC}$ . (Note 6)
—	6, 9	—	B2	—	4, 11	N.C.	No Connection. Not internally connected.
—	—	—	—	EP	EP	EP	Exposed Pad. Connect to ground.

**Note 6:** For unidirectional devices (MAX3374E/MAX3375E/MAX3376E/MAX3379E and MAX3390E-MAX3393E) see the *Pin Configurations* for input/output configurations.

# MAX3372E–MAX3379E/

# MAX3390E–MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### Detailed Description

The MAX3372E–MAX3379E and MAX3390E–MAX3393E ESD-protected level translators provide the level shifting necessary to allow data transfer in a multivoltage system. Externally applied voltages,  $V_{CC}$  and  $V_L$ , set the logic levels on either side of the device. A low-voltage logic signal present on the  $V_L$  side of the device appears as a high-voltage logic signal on the  $V_{CC}$  side of the device, and vice-versa. The MAX3374E/MAX3375E/MAX3376E/MAX3379E and MAX3390E–MAX3393E 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 MAX3372E/MAX3373E and MAX3377E/MAX3378E bidirectional level translators utilize a transmission-gate-based design (see Figure 2) to allow data translation in either direction ( $V_L \leftrightarrow V_{CC}$ ) on any single data line. The MAX3372E–MAX3379E and MAX3390E–MAX3393E

accept  $V_L$  from +1.2V to +5.5V and  $V_{CC}$  from +1.65V to +5.5V, making them ideal for data transfer between low-voltage ASICs/PLDs and higher voltage systems.

All devices in the MAX3372E–MAX3379E, MAX3390E–MAX3393E family feature a three-state output mode that reduces supply current to less than 1µA, thermal short-circuit protection, and ±15kV ESD protection on the  $V_{CC}$  side for greater protection in applications that route signals externally. The MAX3372E/MAX3377E operate at a guaranteed data rate of 230kbps. Slew-rate limiting reduces EMI emissions in all 230kbps devices. The MAX3373E–MAX3376E/MAX3378E/MAX3379E and MAX3390E–MAX3393E operate at a guaranteed data rate of 8Mbps over the entire specified operating voltage range. Within specific voltage domains, higher data rates are possible. (See the *Timing Characteristics* table.)

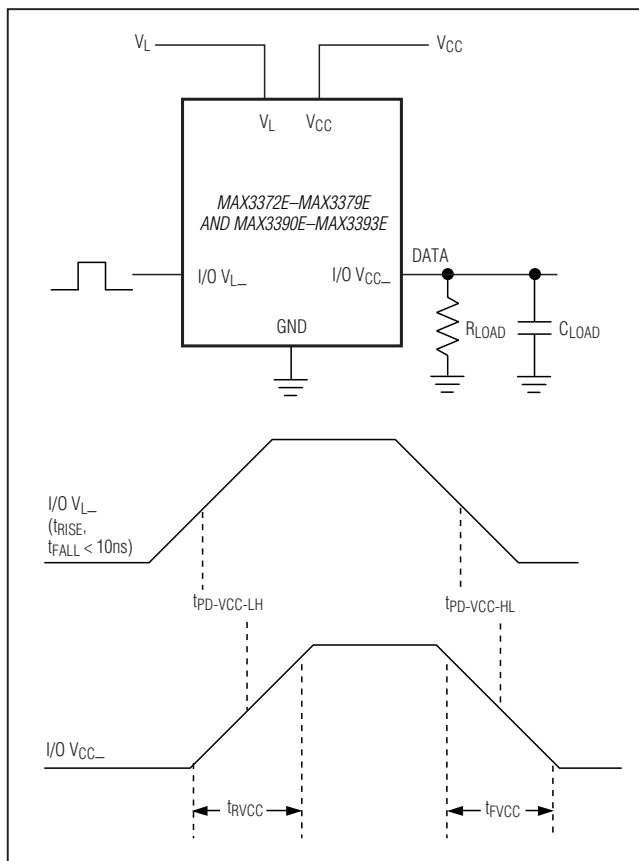


Figure 1a. Rail-to-Rail Driving I/O  $V_L$

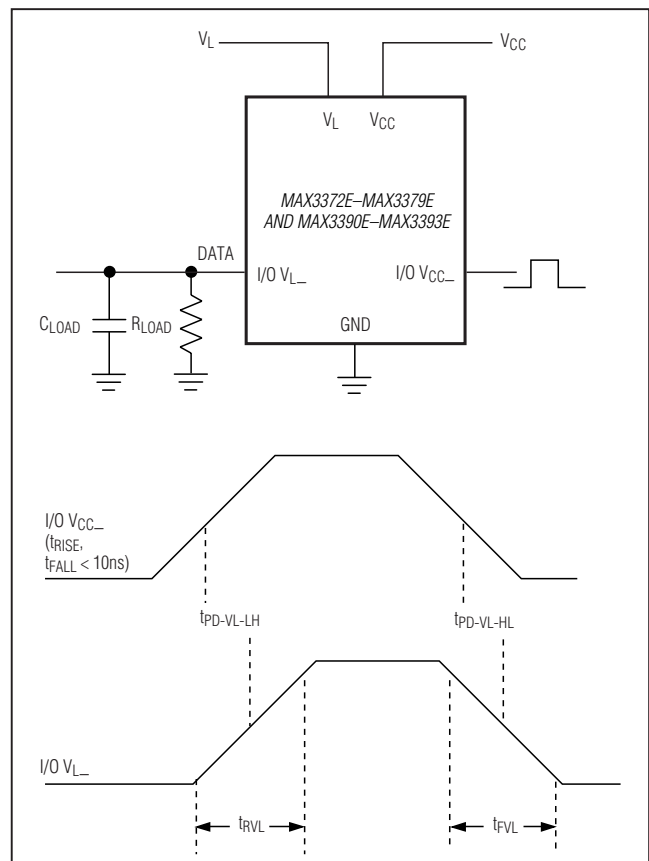


Figure 1b. Rail-to-Rail Driving I/O  $V_{CC}$

# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### Level Translation

For proper operation ensure that  $+1.65V \leq V_{CC} \leq +5.5V$ ,  $+1.2V \leq V_L \leq +5.5V$ , and  $V_L \leq (V_{CC} + 0.3V)$ . During power-up sequencing,  $V_L \geq (V_{CC} + 0.3V)$  will not damage the device. During power-supply sequencing, when  $V_{CC}$  is floating and  $V_L$  is powering up, a current may be sourced, yet the device will not latch up. The speed-up circuitry limits the maximum data rate for devices in the MAX3372E-MAX3379E, MAX3390E-MAX3393E family to 16Mbps. The maximum data rate also depends heavily on the load capacitance (see the *Typical Operating Characteristics*), output impedance of the driver, and the operational voltage range (see the *Timing Characteristics* table).

### Speed-Up Circuitry

The MAX3373E-MAX3376E/MAX3378E/MAX3379E and MAX3390E-MAX3393E feature a one-shot generator that decreases the rise time of the output. When triggered, MOSFETs PU1 and PU2 turn on for a short time to pull up

I/O  $V_{L\_}$  and I/O  $V_{CC\_}$  to their respective supplies (see Figure 2b). This greatly reduces the rise time and propagation delay for the low-to-high transition. The scope photo of Rail-to-Rail Driving for 8Mbps Operation in the *Typical Operating Characteristics* shows the speed-up circuitry in operation.

### Rise-Time Accelerators

The MAX3373E-MAX3376E/MAX3378E/MAX3379E and the MAX3390E-MAX3393E have internal rise-time accelerators allowing operation up to 16Mbps. The rise-time accelerators are present on both sides of the device and act to speed up the rise time of the input and output of the device, regardless of the direction of the data. The triggering mechanism for these accelerators is both level and edge sensitive. To prevent false triggering of the rise-time accelerators, signal fall times of less than 20ns/V are recommended for both the inputs and outputs of the device. Under less noisy conditions, longer signal fall times may be acceptable.

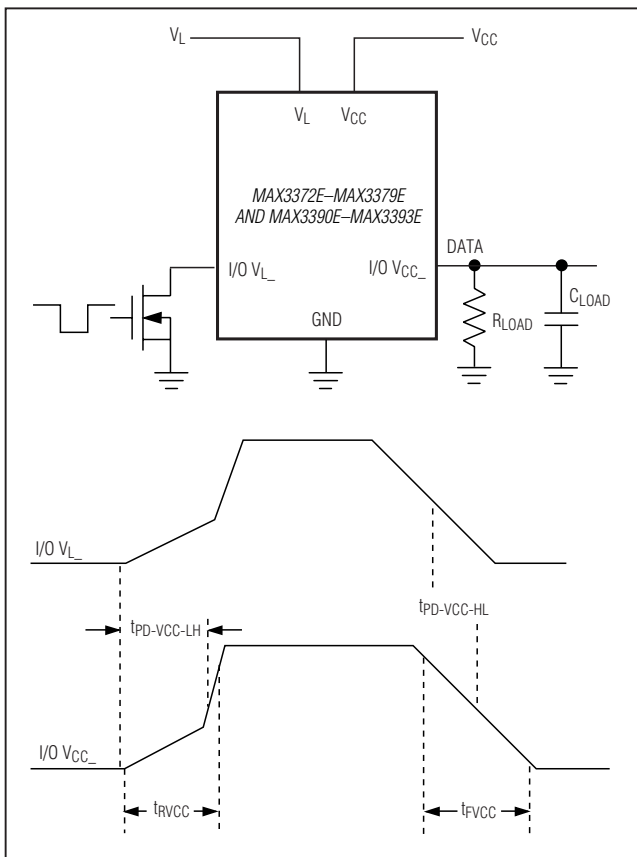


Figure 1c. Open-Drain Driving I/O  $V_{CC}$

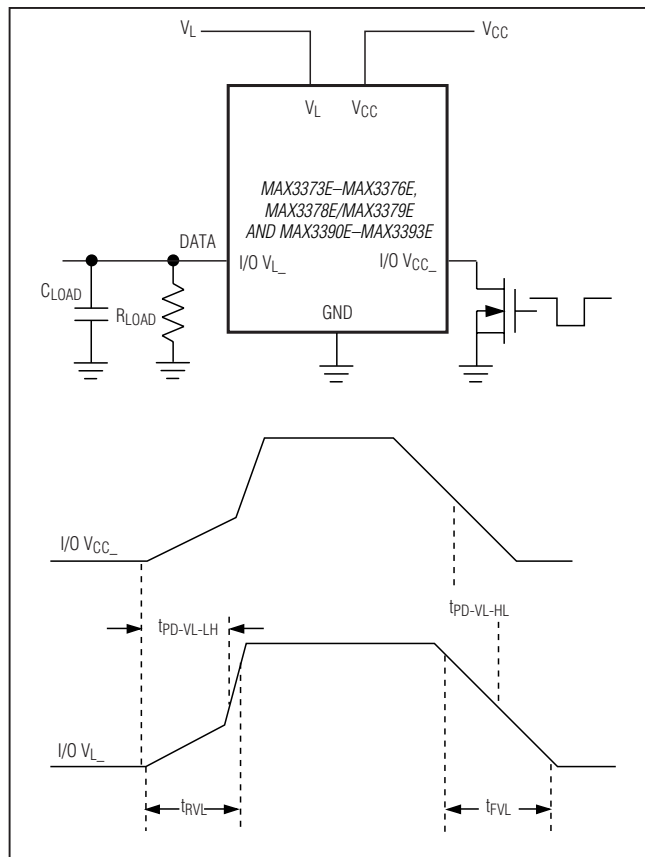


Figure 1d. Open-Drain Driving I/O  $V_L$

# MAX3372E–MAX3379E/

# MAX3390E–MAX3393E

## ±15kV ESD-Protected, 1μA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### ±15kV ESD Protection

As with all Maxim devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The I/O VCC lines have extra protection against static electricity. Maxim's engineers have developed state-of-the-art structures to protect these pins against ESD of ±15kV without damage. The ESD structures withstand high ESD in all states: normal operation, three-state output mode, and powered down. After an ESD event, Maxim's E versions keep working without latching, whereas competing products can latch and must be powered down to remove latching.

ESD protection can be tested in various ways. The I/O VCC lines of this product family are characterized for protection to the following limits:

- 1) ±15kV using the Human Body Model
- 2) ±8kV using the Contact Discharge method specified in IEC 1000-4-2
- 3) ±10kV using IEC 1000-4-2's Air-Gap Discharge method

### ESD Test Conditions

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test setup, test methodology, and test results.

### Human Body Model

Figure 3a shows the Human Body Model and Figure 3b shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5kΩ resistor.

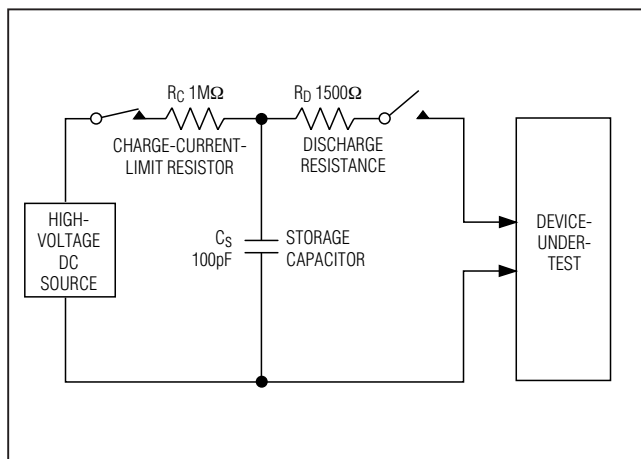


Figure 3a. Human Body ESD Test Model

### IEC 1000-4-2

The IEC 1000-4-2 standard covers ESD testing and performance of finished equipment; it does not specifically refer to integrated circuits. The MAX3372E–MAX3379E and MAX3390E–MAX3393E help to design equipment that meets Level 3 of IEC 1000-4-2, without the need for additional ESD-protection components.

The major difference between tests done using the Human Body Model and IEC 1000-4-2 is higher peak current in IEC 1000-4-2, because series resistance is lower in the IEC 1000-4-2 model. Hence, the ESD withstand voltage measured to IEC 1000-4-2 is generally lower than that measured using the Human Body Model. Figure 4a shows the IEC 1000-4-2 model, and Figure 4b shows the current waveform for the ±8kV, IEC 1000-4-2, Level 4, ESD contact-discharge test.

The air-gap test involves approaching the device with a charged probe. The contact-discharge method connects the probe to the device before the probe is energized.

### Machine Model

The Machine Model for ESD tests all pins using a 200pF storage capacitor and zero discharge resistance. Its objective is to emulate the stress caused by contact that occurs with handling and assembly during manufacturing. Of course, all pins require this protection during manufacturing, not just inputs and outputs. Therefore, after PCB assembly, the Machine Model is less relevant to I/O ports.

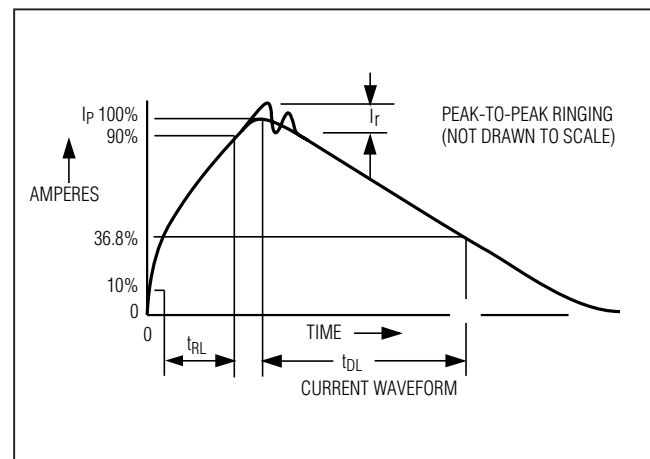


Figure 3b. Human Body Current Waveform

# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### Three-State Output Mode

Pull `THREE-STATE` low to place the MAX3372E-MAX3379E and MAX3390E-MAX3393E in three-state output mode. Connect `THREE-STATE` to  $V_L$  (logic-high) for normal operation. Activating the three-state output mode disconnects the internal  $10k\Omega$  pullup resistors on the I/O  $V_{CC}$  and I/O  $V_L$  lines. This forces the I/O lines to a high-impedance state, and decreases the supply current to less than  $1\mu A$ . The high-impedance I/O lines in three-state output mode allow for use in a multidrop network. When in three-state output mode, do not allow the voltage

at I/O  $V_L$  to exceed  $(V_L + 0.3V)$ , or the voltage at I/O  $V_{CC}$  to exceed  $(V_{CC} + 0.3V)$ .

### Thermal Short-Circuit Protection

Thermal overload detection protects the MAX3372E-MAX3379E and MAX3390E-MAX3393E from short-circuit fault conditions. In the event of a short-circuit fault, when the junction temperature ( $T_J$ ) reaches  $+152^\circ C$ , a thermal sensor signals the three-state output mode logic to force the device into three-state output mode. When  $T_J$  has cooled to  $+142^\circ C$ , normal operation resumes.

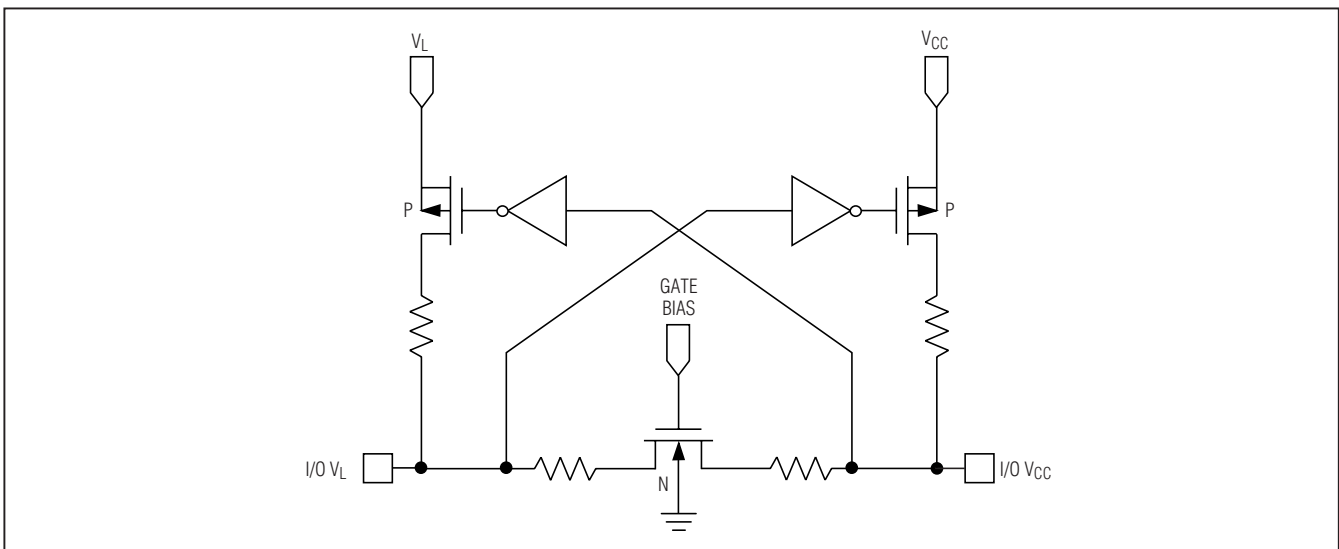


Figure 2a. Functional Diagram, MAX3372E/MAX3377E (1 I/O line)

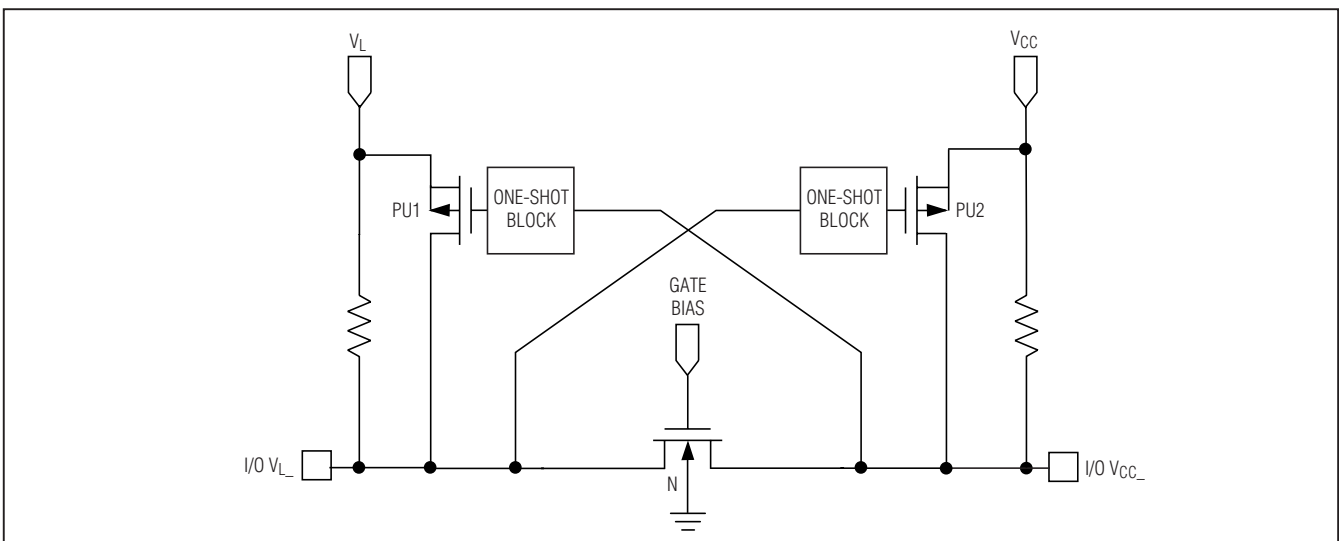


Figure 2b. Functional Diagram, MAX3373E/MAX3378E (1 I/O line)

# MAX3372E–MAX3379E/

# MAX3390E–MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### Level Translation

For proper operation ensure that  $+1.65V \leq V_{CC} \leq +5.5V$ ,  $+1.2V \leq V_L \leq +5.5V$ , and  $V_L \leq (V_{CC} + 0.3V)$ . During power-up sequencing,  $V_L \geq (V_{CC} + 0.3V)$  will not damage the device. During power-supply sequencing, when  $V_{CC}$  is floating and  $V_L$  is powering up, a current may be sourced, yet the device will not latch up. The speed-up circuitry limits the maximum data rate for devices in the MAX3372E–MAX3379E, MAX3390E–MAX3393E family to 16Mbps. The maximum data rate also depends heavily on the load capacitance (see the *Typical Operating Characteristics*), output impedance of the driver, and the operational voltage range (see the *Timing Characteristics* table).

### Speed-Up Circuitry

The MAX3373E–MAX3376E/MAX3378E/MAX3379E and MAX3390E–MAX3393E feature a one-shot generator that decreases the rise time of the output. When triggered, MOSFETs PU1 and PU2 turn on for a short time to pull up

I/O  $V_L$  and I/O  $V_{CC}$  to their respective supplies (see Figure 2b). This greatly reduces the rise time and propagation delay for the low-to-high transition. The scope photo of Rail-to-Rail Driving for 8Mbps Operation in the *Typical Operating Characteristics* shows the speed-up circuitry in operation.

### Rise-Time Accelerators

The MAX3373E–MAX3376E/MAX3378E/MAX3379E and the MAX3390E–MAX3393E have internal rise-time accelerators allowing operation up to 16Mbps. The rise-time accelerators are present on both sides of the device and act to speed up the rise time of the input and output of the device, regardless of the direction of the data. The triggering mechanism for these accelerators is both level and edge sensitive. To prevent false triggering of the rise-time accelerators, signal fall times of less than 20ns/V are recommended for both the inputs and outputs of the device. Under less noisy conditions, longer signal fall times may be acceptable.

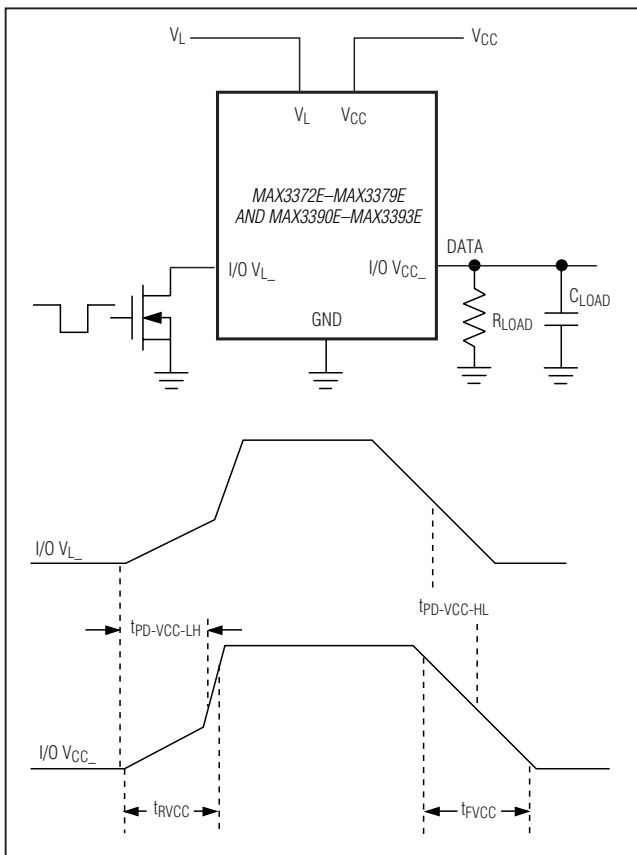


Figure 1c. Open-Drain Driving I/O  $V_{CC}$

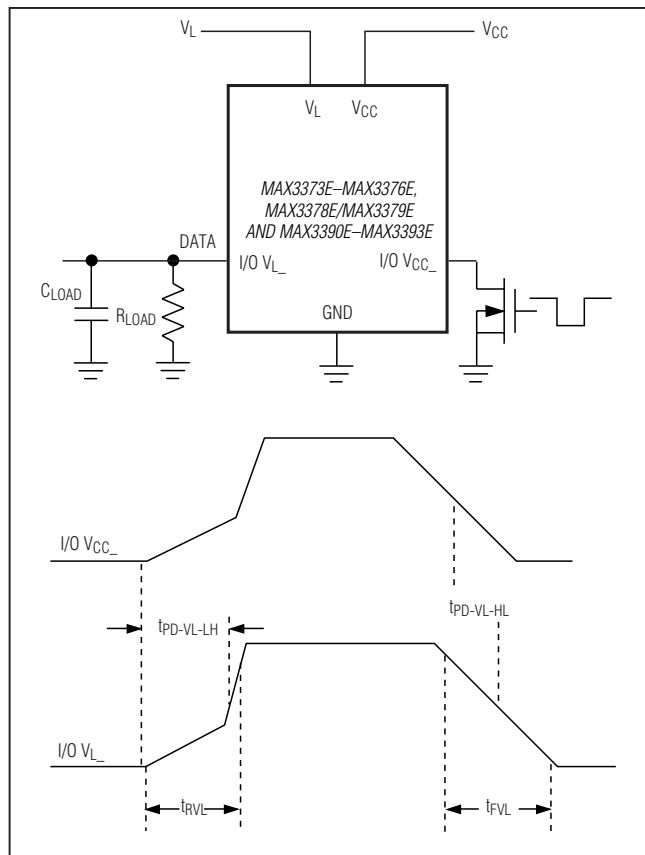


Figure 1d. Open-Drain Driving I/O  $V_L$

# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### Detailed Description

The MAX3372E-MAX3379E and MAX3390E-MAX3393E ESD-protected level translators provide the level shifting necessary to allow data transfer in a multivoltage system. Externally applied voltages,  $V_{CC}$  and  $V_L$ , set the logic levels on either side of the device. A low-voltage logic signal present on the  $V_L$  side of the device appears as a high-voltage logic signal on the  $V_{CC}$  side of the device, and vice-versa. The MAX3374E/MAX3375E/MAX3376E/MAX3379E and MAX3390E-MAX3393E 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 MAX3372E/MAX3373E and MAX3377E/MAX3378E bidirectional level translators utilize a transmission-gate-based design (see Figure 2) to allow data translation in either direction ( $V_L \leftrightarrow V_{CC}$ ) on any single data line. The MAX3372E-MAX3379E and MAX3390E-MAX3393E

accept  $V_L$  from +1.2V to +5.5V and  $V_{CC}$  from +1.65V to +5.5V, making them ideal for data transfer between low-voltage ASICs/PLDs and higher voltage systems.

All devices in the MAX3372E-MAX3379E, MAX3390E-MAX3393E family feature a three-state output mode that reduces supply current to less than 1µA, thermal short-circuit protection, and ±15kV ESD protection on the  $V_{CC}$  side for greater protection in applications that route signals externally. The MAX3372E/MAX3377E operate at a guaranteed data rate of 230kbps. Slew-rate limiting reduces EMI emissions in all 230kbps devices. The MAX3373E-MAX3376E/MAX3378E/MAX3379E and MAX3390E-MAX3393E operate at a guaranteed data rate of 8Mbps over the entire specified operating voltage range. Within specific voltage domains, higher data rates are possible. (See the *Timing Characteristics* table.)

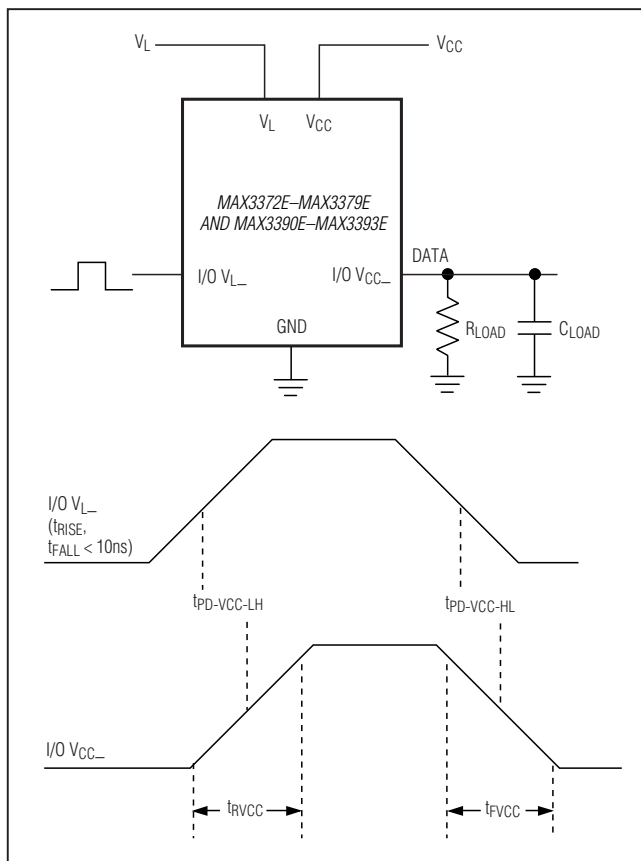


Figure 1a. Rail-to-Rail Driving I/O  $V_L$

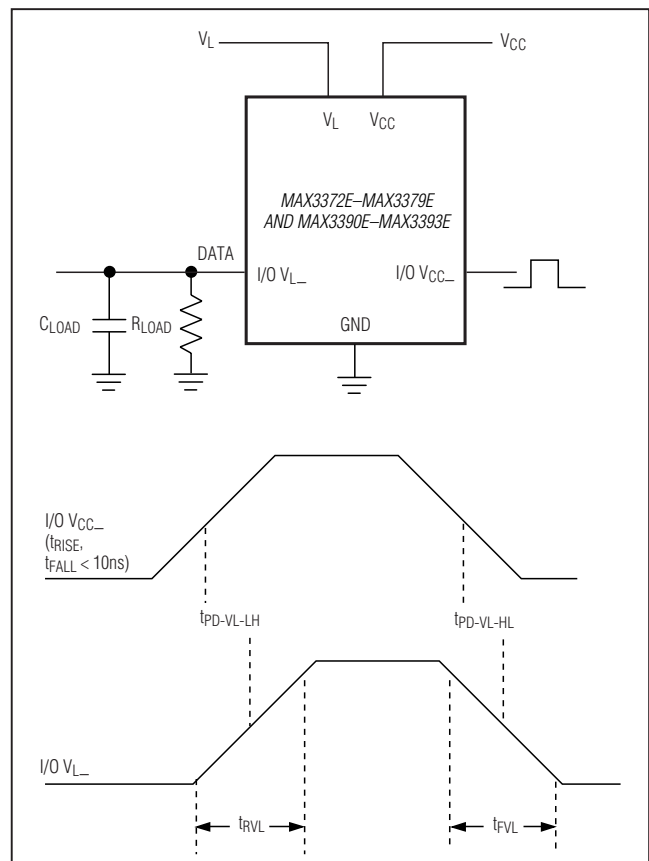


Figure 1b. Rail-to-Rail Driving I/O  $V_{CC}$

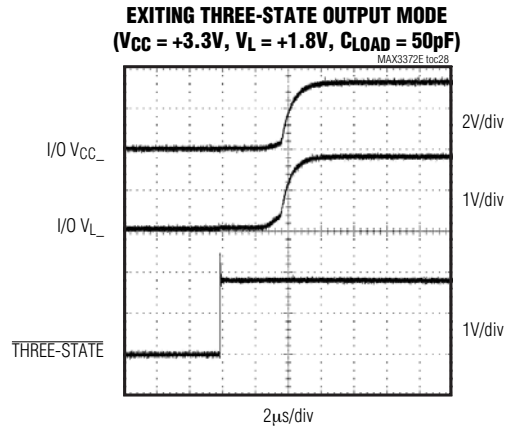
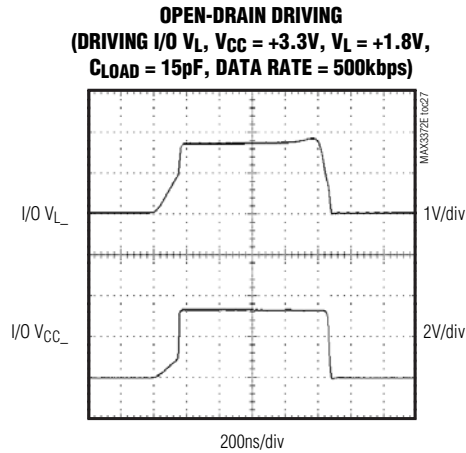
# MAX3372E–MAX3379E/

# MAX3390E–MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### Typical Operating Characteristics (continued)

( $R_{LOAD} = 1M\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted. All 230kbps TOCs apply to MAX3372E/MAX3377E only. All 8Mbps and 500kbps TOCs apply to MAX3373E–MAX3376E/MAX3378E/MAX3379E and MAX3390E–MAX3393E only.)



### Pin Description

PIN						NAME	FUNCTION
3 x 4 UCSP	TSSOP	SOT23-8	3 x 3 UCSP	TDFN 8	TDFN 14		
A1	2	5	C2	6	1	I/O $V_{L1}$	Input/Output 1. Referenced to $V_L$ . (Note 6)
A2	3	4	C3	8	2	I/O $V_{L2}$	Input/Output 2. Referenced to $V_L$ . (Note 6)
A3	4	—	—	—	5	I/O $V_{L3}$	Input/Output 3. Referenced to $V_L$ . (Note 6)
A4	5	—	—	—	6	I/O $V_{L4}$	Input/Output 4. Referenced to $V_L$ . (Note 6)
B1	14	7	A1	4	14	$V_{CC}$	$V_{CC}$ Input Voltage $+1.65V \leq V_{CC} \leq +5.5V$ .
B2	1	3	C1	7	10	$V_L$	Logic Input Voltage $+1.2V \leq V_L \leq (V_{CC} + 0.3V)$
B3	8	6	B1	5	3	$\overline{\text{THREE-STATE}}$	Three-State Output Mode Enable. Pull $\overline{\text{THREE-STATE}}$ low to place device in three-state output mode. I/O $V_{CC\_}$ and I/O $V_{L\_}$ are high impedance in three-state output mode. <b>Note:</b> Logic referenced to $V_L$ (for logic thresholds see the <i>Electrical Characteristics</i> table).
B4	7	2	B3	2	7	GND	Ground
C1	13	8	A2	3	13	I/O $V_{CC1}$	Input/Output 1. Referenced to $V_{CC}$ . (Note 6)
C2	12	1	A3	1	12	I/O $V_{CC2}$	Input/Output 2. Referenced to $V_{CC}$ . (Note 6)
C3	11	—	—	—	9	I/O $V_{CC3}$	Input/Output 3. Referenced to $V_{CC}$ . (Note 6)
C4	10	—	—	—	8	I/O $V_{CC4}$	Input/Output 4. Referenced to $V_{CC}$ . (Note 6)
—	6, 9	—	B2	—	4, 11	N.C.	No Connection. Not internally connected.
—	—	—	—	EP	EP	EP	Exposed Pad. Connect to ground.

**Note 6:** For unidirectional devices (MAX3374E/MAX3375E/MAX3376E/MAX3379E and MAX3390E–MAX3393E) see the *Pin Configurations* for input/output configurations.

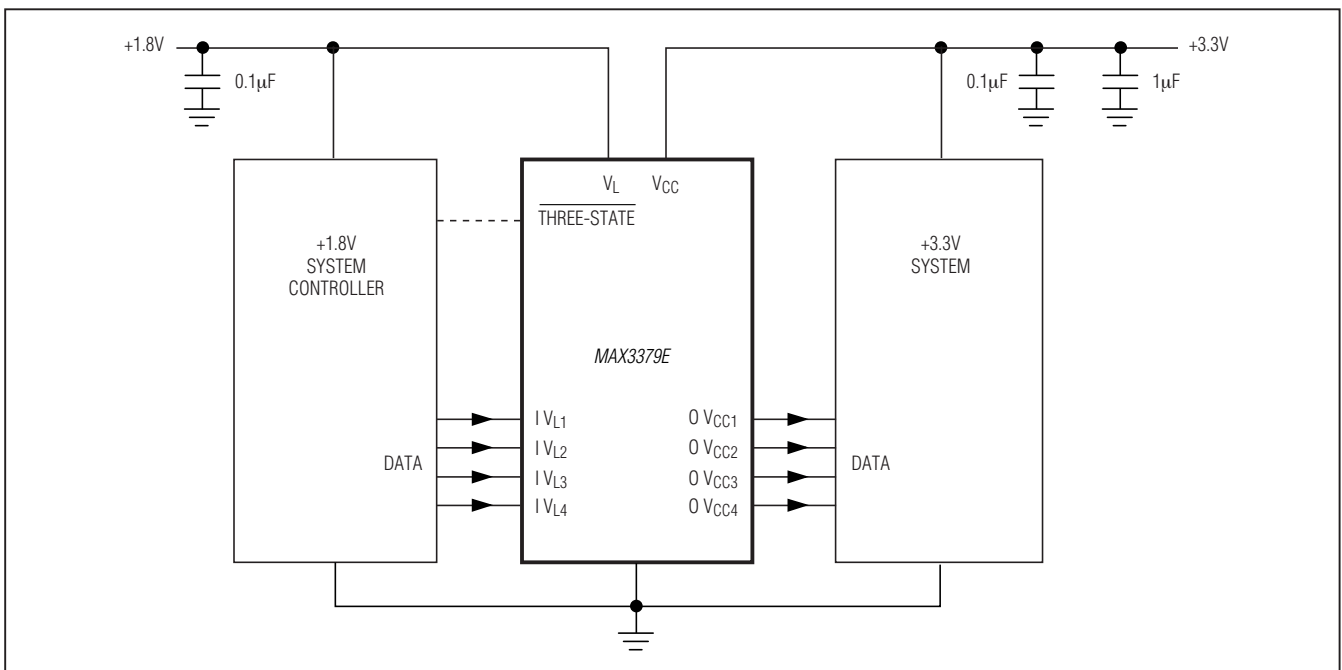
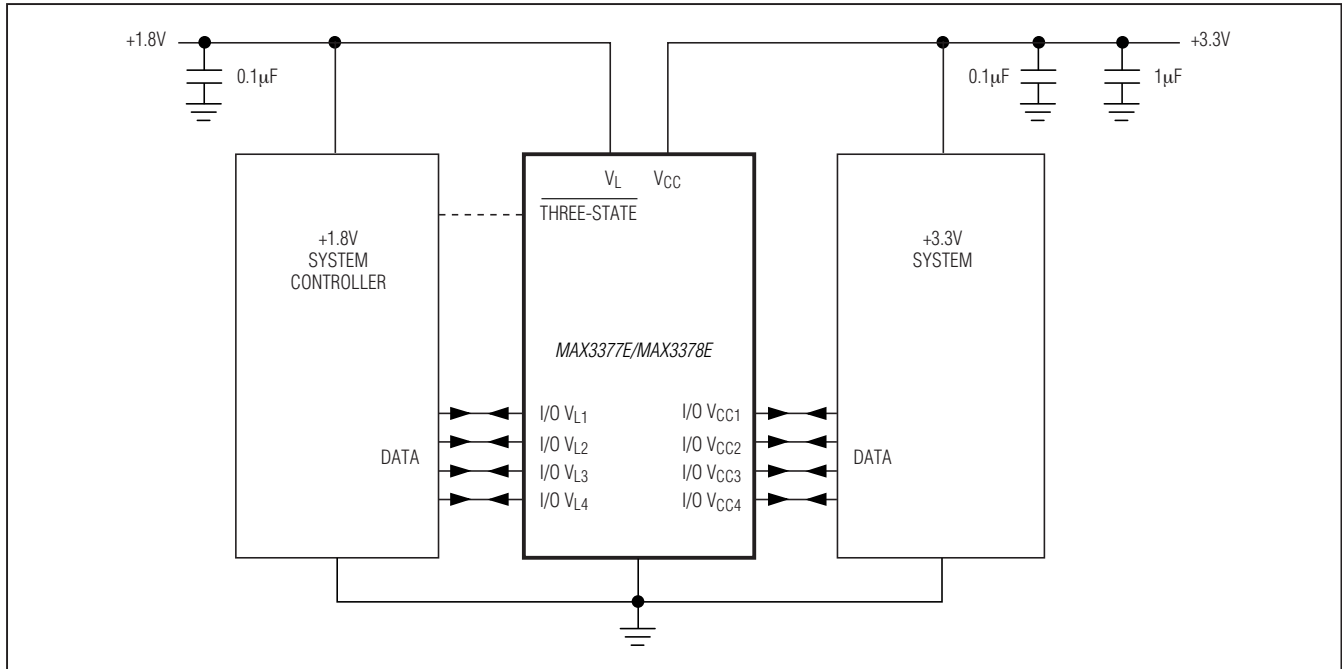


# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

**$\pm 15\text{kV}$  ESD-Protected,  $1\mu\text{A}$ , 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP**

## Applications Circuits (continued)

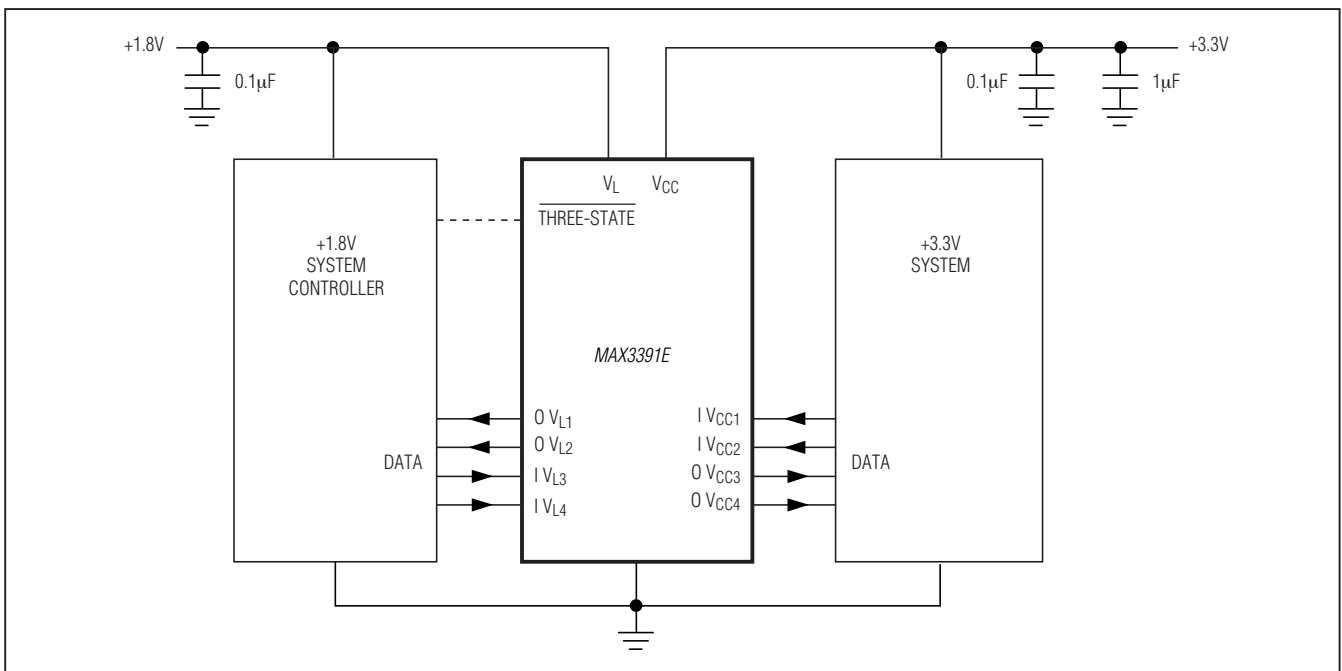
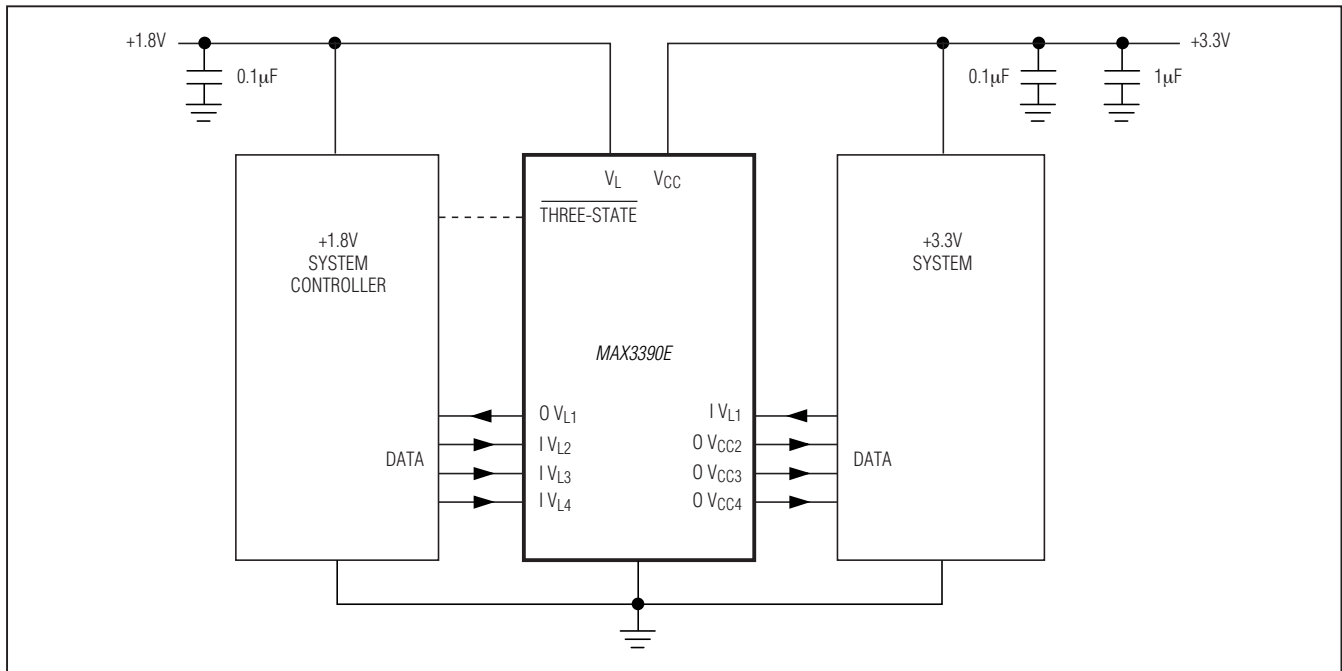


# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

**$\pm 15\text{kV}$  ESD-Protected,  $1\mu\text{A}$ ,  $16\text{Mbps}$ , Dual/Quad Low-Voltage Level Translators in UCSP**

## Applications Circuits (continued)

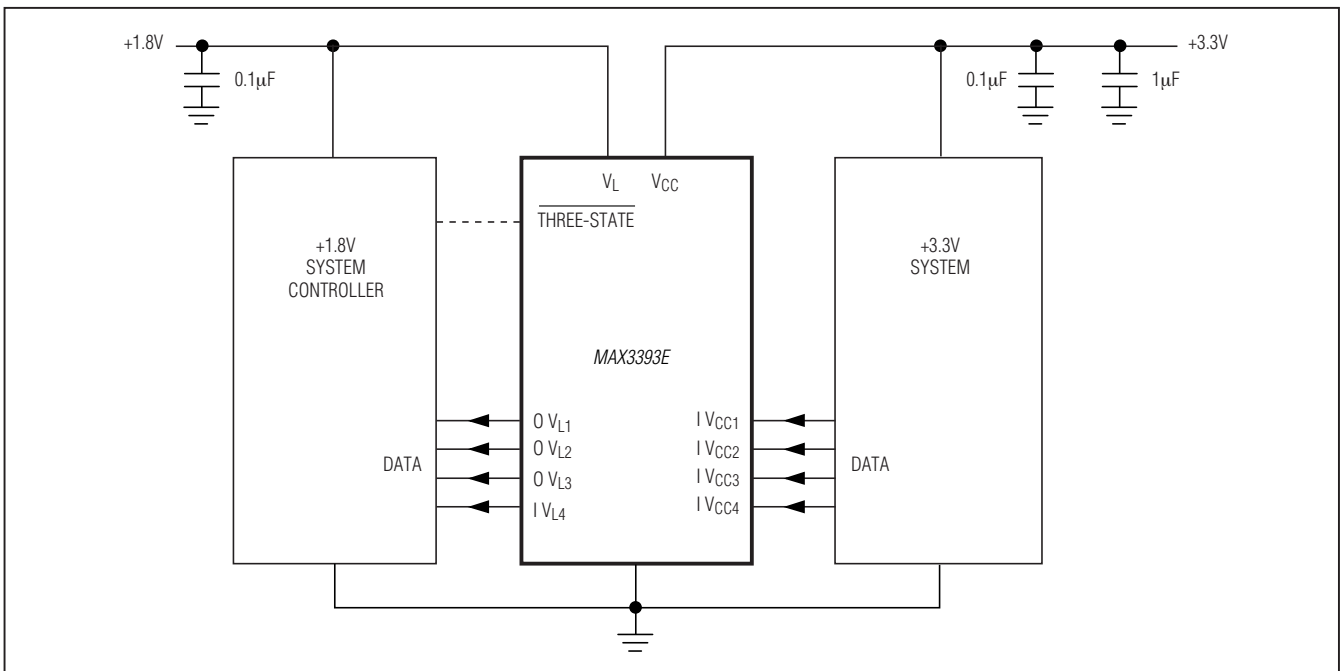
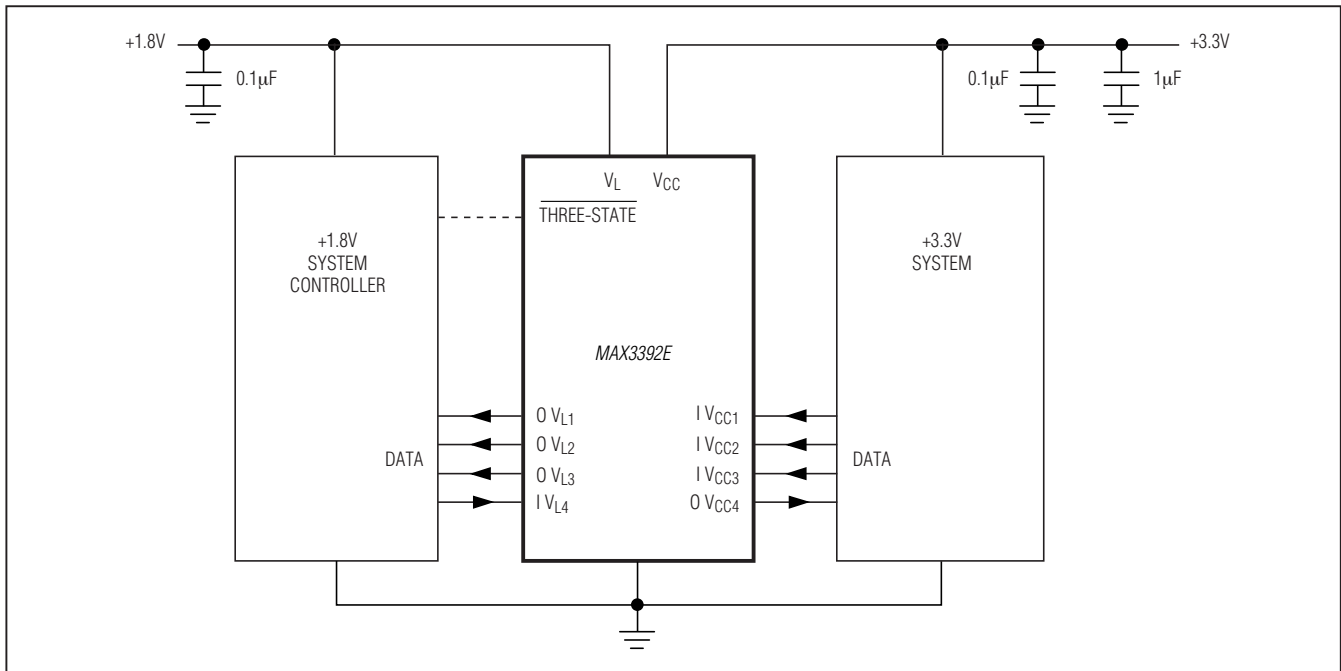


# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

**$\pm 15\text{kV}$  ESD-Protected,  $1\mu\text{A}$ , 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP**

## Applications Circuits (continued)

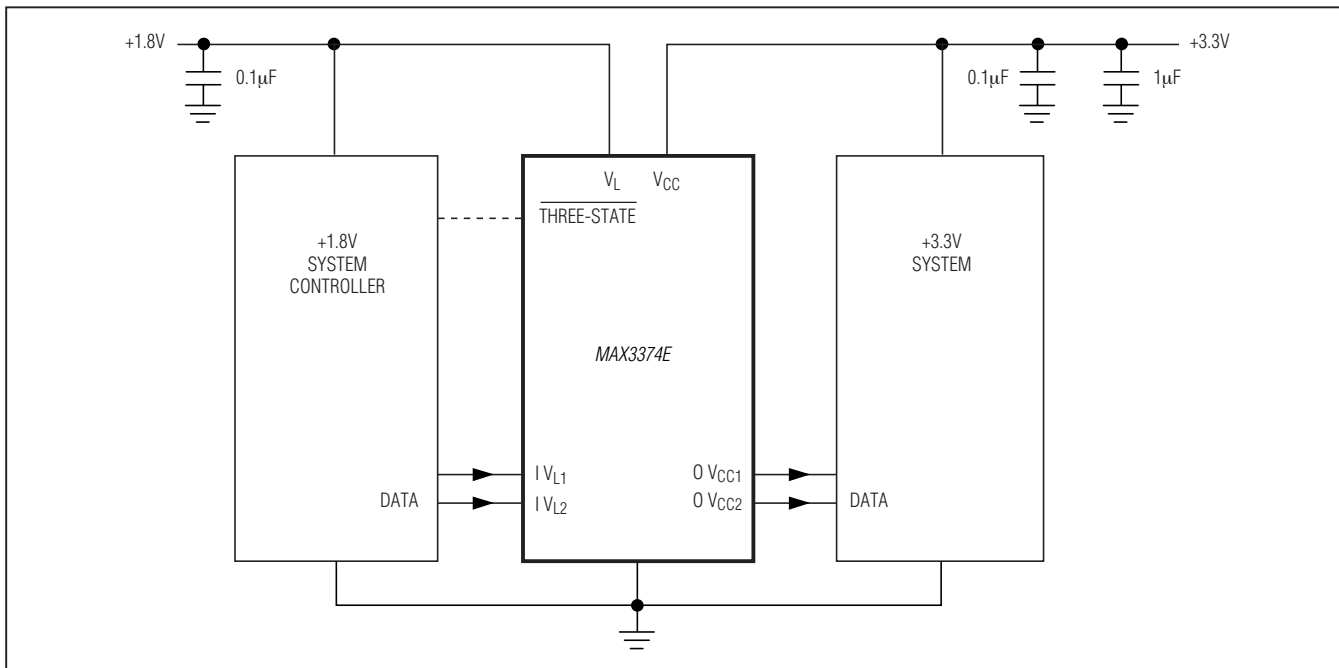
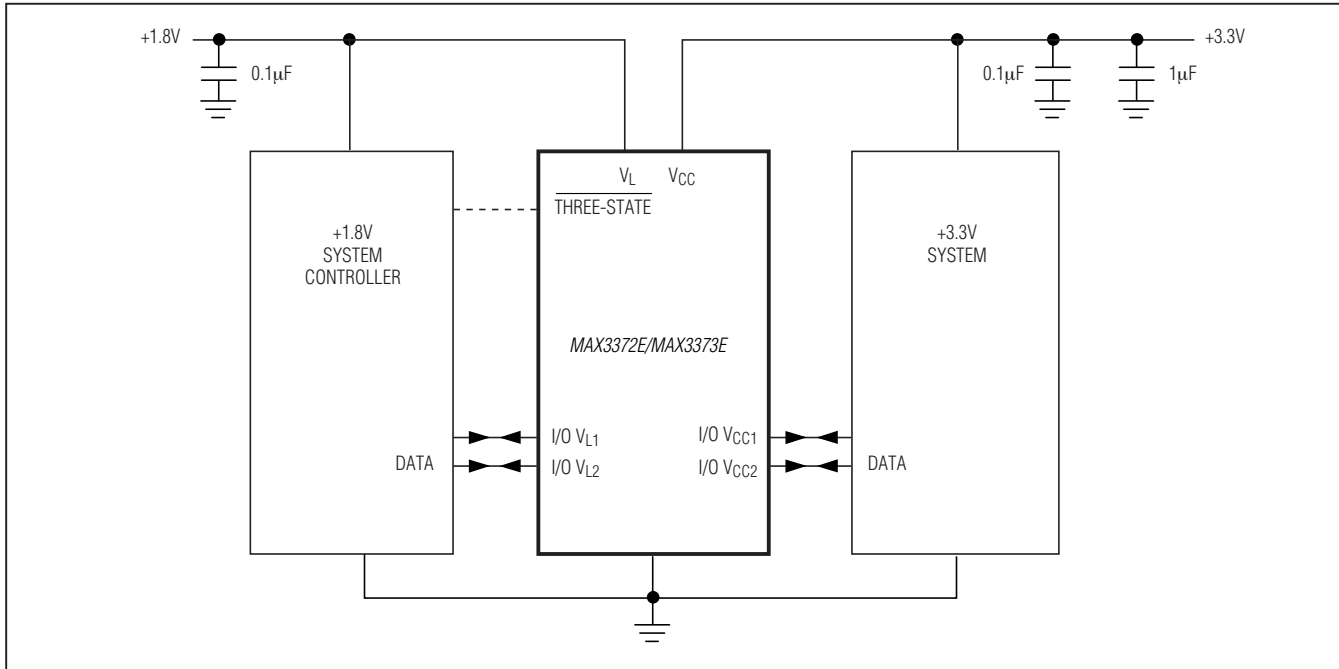


# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

**$\pm 15\text{kV}$  ESD-Protected,  $1\mu\text{A}$ ,  $16\text{Mbps}$ , Dual/Quad Low-Voltage Level Translators in UCSP**

## Applications Circuits



# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

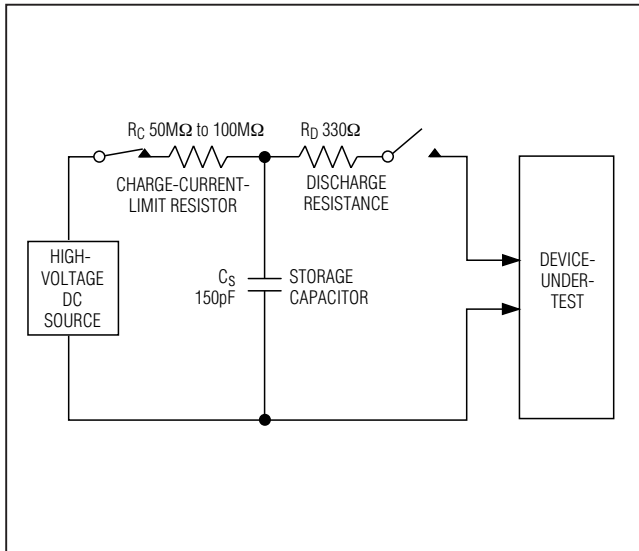


Figure 4a. IEC 1000-4-2 ESD Test Model

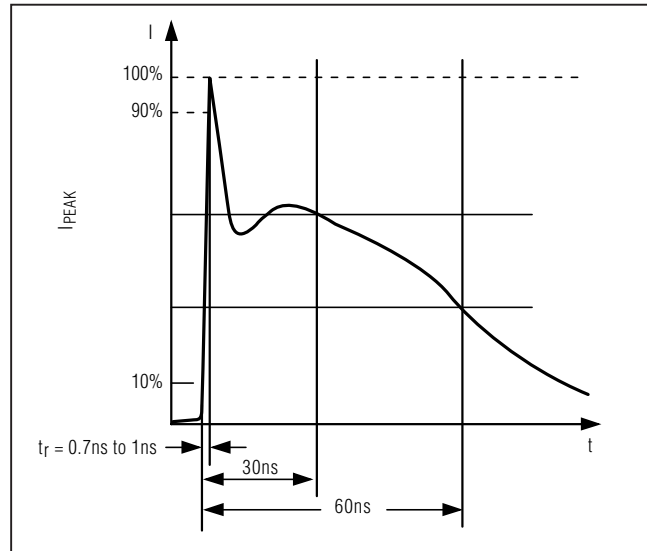


Figure 4b. IEC 1000-4-2 ESD Generator Current Waveform

### Applications Information

#### Power-Supply Decoupling

To reduce ripple and the chance of transmitting incorrect data, bypass V<sub>L</sub> and V<sub>CC</sub> to ground with a 0.1µF capacitor. See the *Typical Operating Circuit*. To ensure full ±15kV ESD protection, bypass V<sub>CC</sub> to ground with a 1µF capacitor. Place all capacitors as close to the power-supply inputs as possible.

#### I<sup>2</sup>C Level Translation

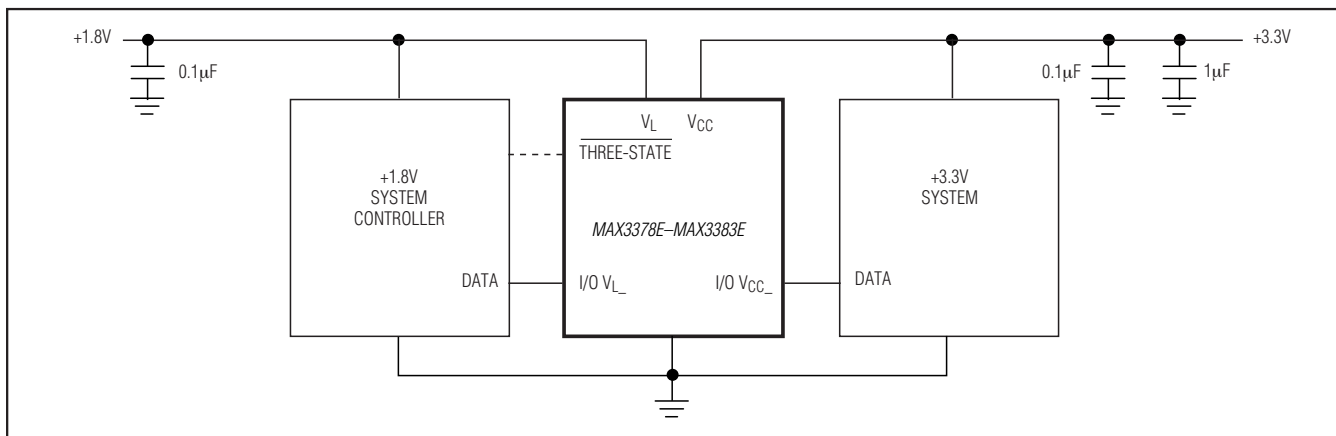
The MAX3373E-MAX3376E, MAX3378E/MAX3379E and MAX3390E-MAX3393E level-shift the data present on the I/O lines between +1.2V and +5.5V, making them ideal for level translation between a low-voltage

ASIC and an I<sup>2</sup>C device. A typical application involves interfacing a low-voltage microprocessor to a 3V or 5V D/A converter, such as the MAX517.

#### Push-Pull vs. Open-Drive Driving

All devices in the MAX3372E-MAX3379E and MAX3390E-MAX3393E family may be driven in a push-pull configuration. The MAX3373E-MAX3376E/MAX3378E/MAX3379E and MAX3390E-MAX3393E include internal 10kΩ resistors that pull up I/O V<sub>L</sub> and I/O V<sub>CC</sub> to their respective power supplies, allowing operation of the I/O lines with open-drain devices. See the *Timing Characteristics* table for maximum data rates when using open-drain drivers.

### Typical Operating Circuit



# MAX3372E–MAX3379E/

# MAX3390E–MAX3393E

## ±15kV ESD-Protected, 1μA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### ±15kV ESD Protection

As with all Maxim devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The I/O VCC lines have extra protection against static electricity. Maxim's engineers have developed state-of-the-art structures to protect these pins against ESD of ±15kV without damage. The ESD structures withstand high ESD in all states: normal operation, three-state output mode, and powered down. After an ESD event, Maxim's E versions keep working without latchup, whereas competing products can latch and must be powered down to remove latchup.

ESD protection can be tested in various ways. The I/O VCC lines of this product family are characterized for protection to the following limits:

- 1) ±15kV using the Human Body Model
- 2) ±8kV using the Contact Discharge method specified in IEC 1000-4-2
- 3) ±10kV using IEC 1000-4-2's Air-Gap Discharge method

### ESD Test Conditions

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test setup, test methodology, and test results.

### Human Body Model

Figure 3a shows the Human Body Model and Figure 3b shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5kΩ resistor.

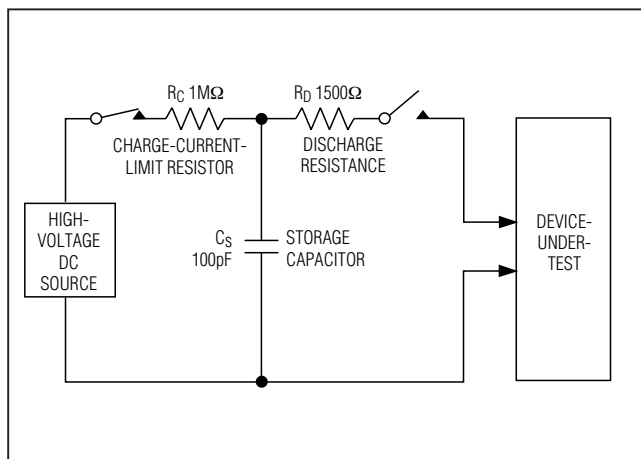


Figure 3a. Human Body ESD Test Model

### IEC 1000-4-2

The IEC 1000-4-2 standard covers ESD testing and performance of finished equipment; it does not specifically refer to integrated circuits. The MAX3372E–MAX3379E and MAX3390E–MAX3393E help to design equipment that meets Level 3 of IEC 1000-4-2, without the need for additional ESD-protection components.

The major difference between tests done using the Human Body Model and IEC 1000-4-2 is higher peak current in IEC 1000-4-2, because series resistance is lower in the IEC 1000-4-2 model. Hence, the ESD withstand voltage measured to IEC 1000-4-2 is generally lower than that measured using the Human Body Model. Figure 4a shows the IEC 1000-4-2 model, and Figure 4b shows the current waveform for the ±8kV, IEC 1000-4-2, Level 4, ESD contact-discharge test.

The air-gap test involves approaching the device with a charged probe. The contact-discharge method connects the probe to the device before the probe is energized.

### Machine Model

The Machine Model for ESD tests all pins using a 200pF storage capacitor and zero discharge resistance. Its objective is to emulate the stress caused by contact that occurs with handling and assembly during manufacturing. Of course, all pins require this protection during manufacturing, not just inputs and outputs. Therefore, after PCB assembly, the Machine Model is less relevant to I/O ports.

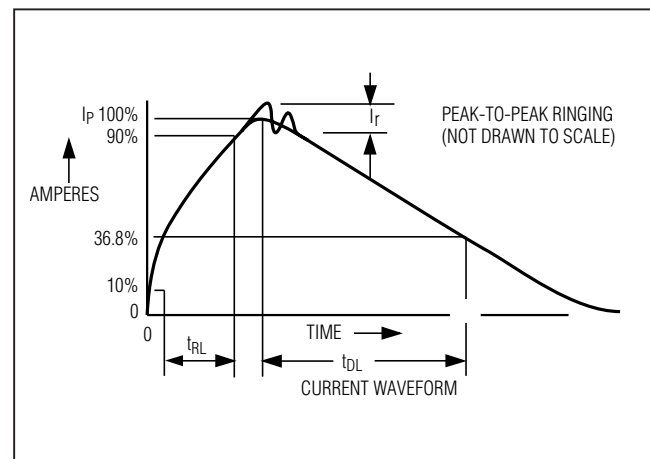


Figure 3b. Human Body Current Waveform

# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## **$\pm 15\text{kV}$ ESD-Protected, $1\mu\text{A}$ , 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP**

### **Three-State Output Mode**

Pull `THREE-STATE` low to place the MAX3372E-MAX3379E and MAX3390E-MAX3393E in three-state output mode. Connect `THREE-STATE` to  $V_L$  (logic-high) for normal operation. Activating the three-state output mode disconnects the internal  $10\text{k}\Omega$  pullup resistors on the I/O  $V_{CC}$  and I/O  $V_L$  lines. This forces the I/O lines to a high-impedance state, and decreases the supply current to less than  $1\mu\text{A}$ . The high-impedance I/O lines in three-state output mode allow for use in a multidrop network. When in three-state output mode, do not allow the voltage

at I/O  $V_L$  to exceed  $(V_L + 0.3\text{V})$ , or the voltage at I/O  $V_{CC}$  to exceed  $(V_{CC} + 0.3\text{V})$ .

### **Thermal Short-Circuit Protection**

Thermal overload detection protects the MAX3372E-MAX3379E and MAX3390E-MAX3393E from short-circuit fault conditions. In the event of a short-circuit fault, when the junction temperature ( $T_J$ ) reaches  $+152^\circ\text{C}$ , a thermal sensor signals the three-state output mode logic to force the device into three-state output mode. When  $T_J$  has cooled to  $+142^\circ\text{C}$ , normal operation resumes.

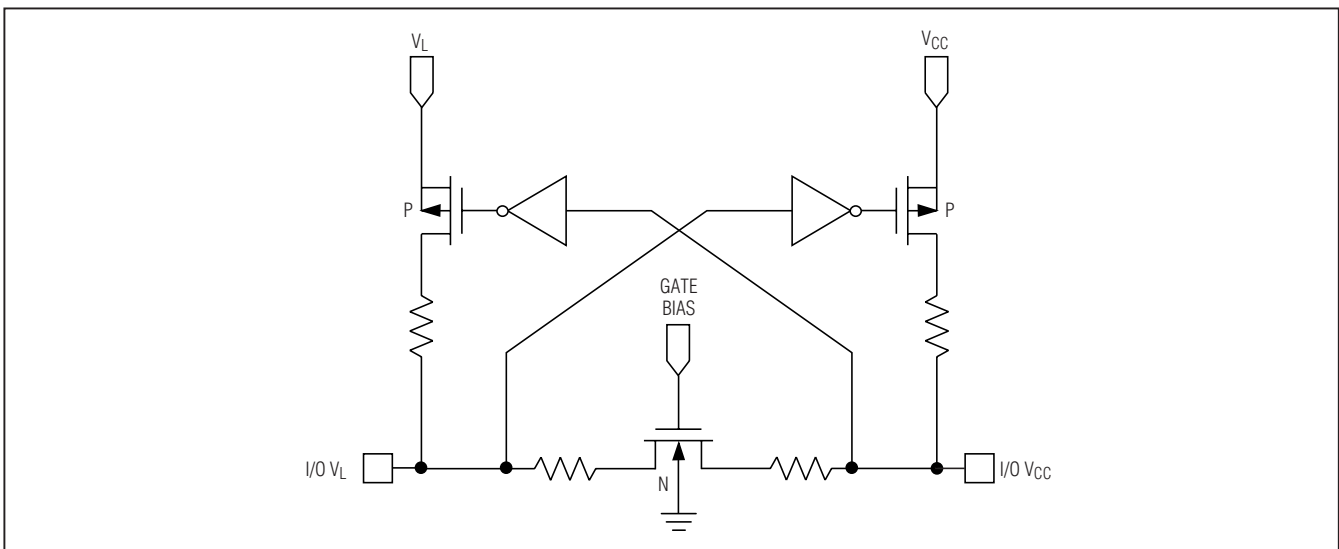


Figure 2a. Functional Diagram, MAX3372E/MAX3377E (1 I/O line)

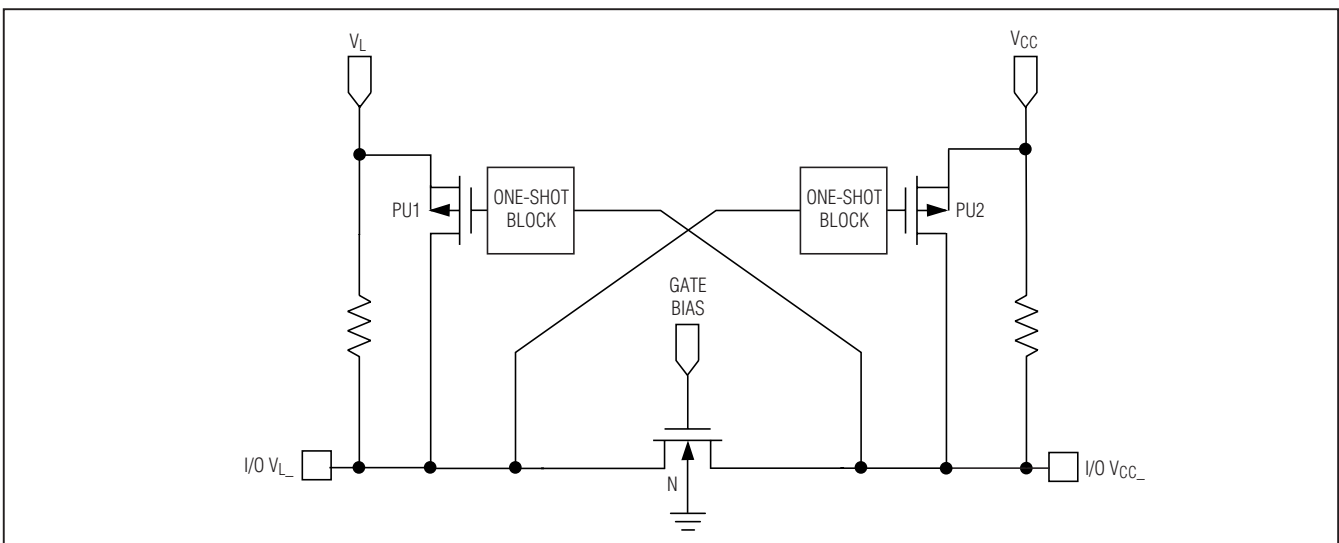


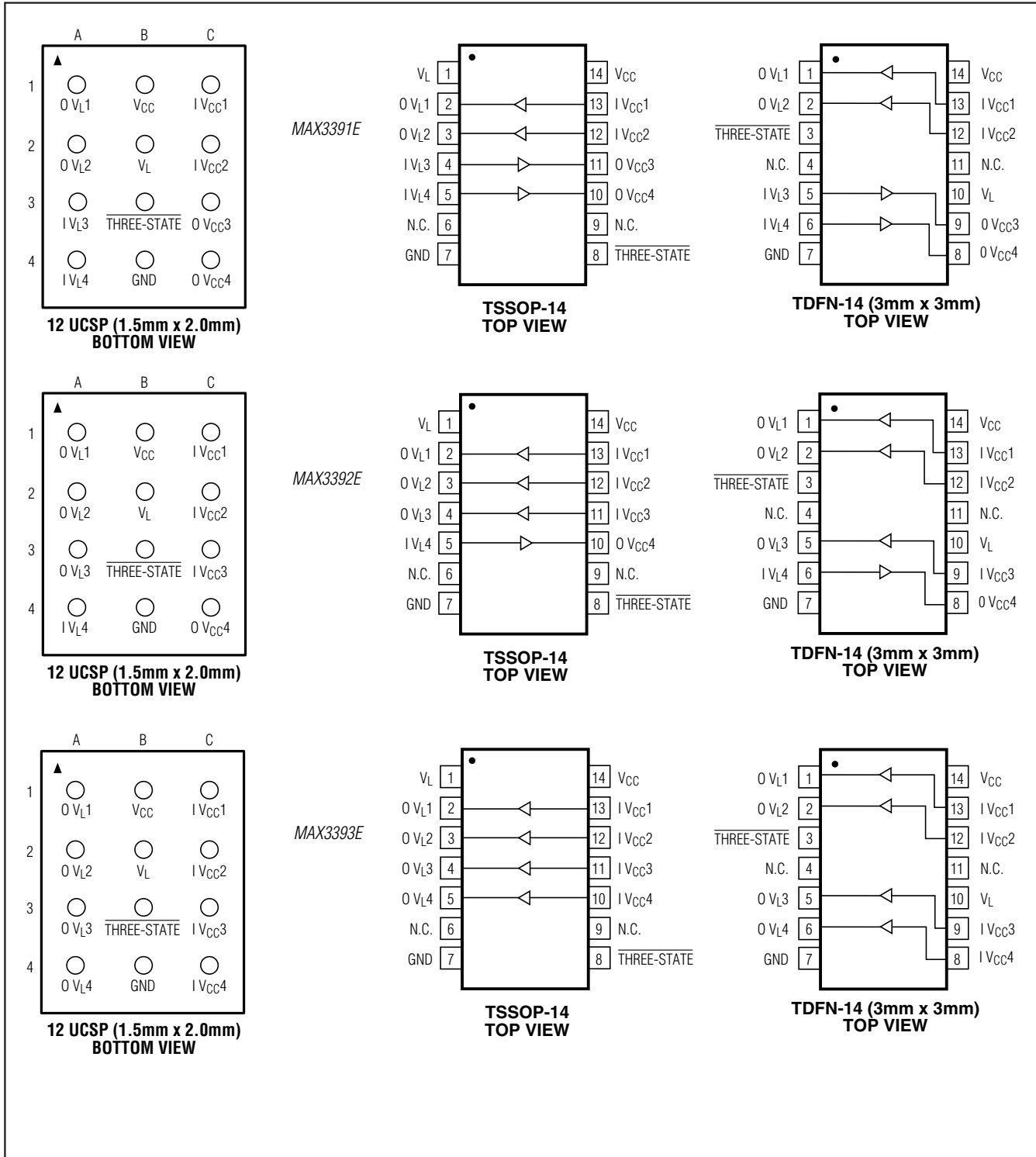
Figure 2b. Functional Diagram, MAX3373E/MAX3378E (1 I/O line)

# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### Pin Configurations (continued)





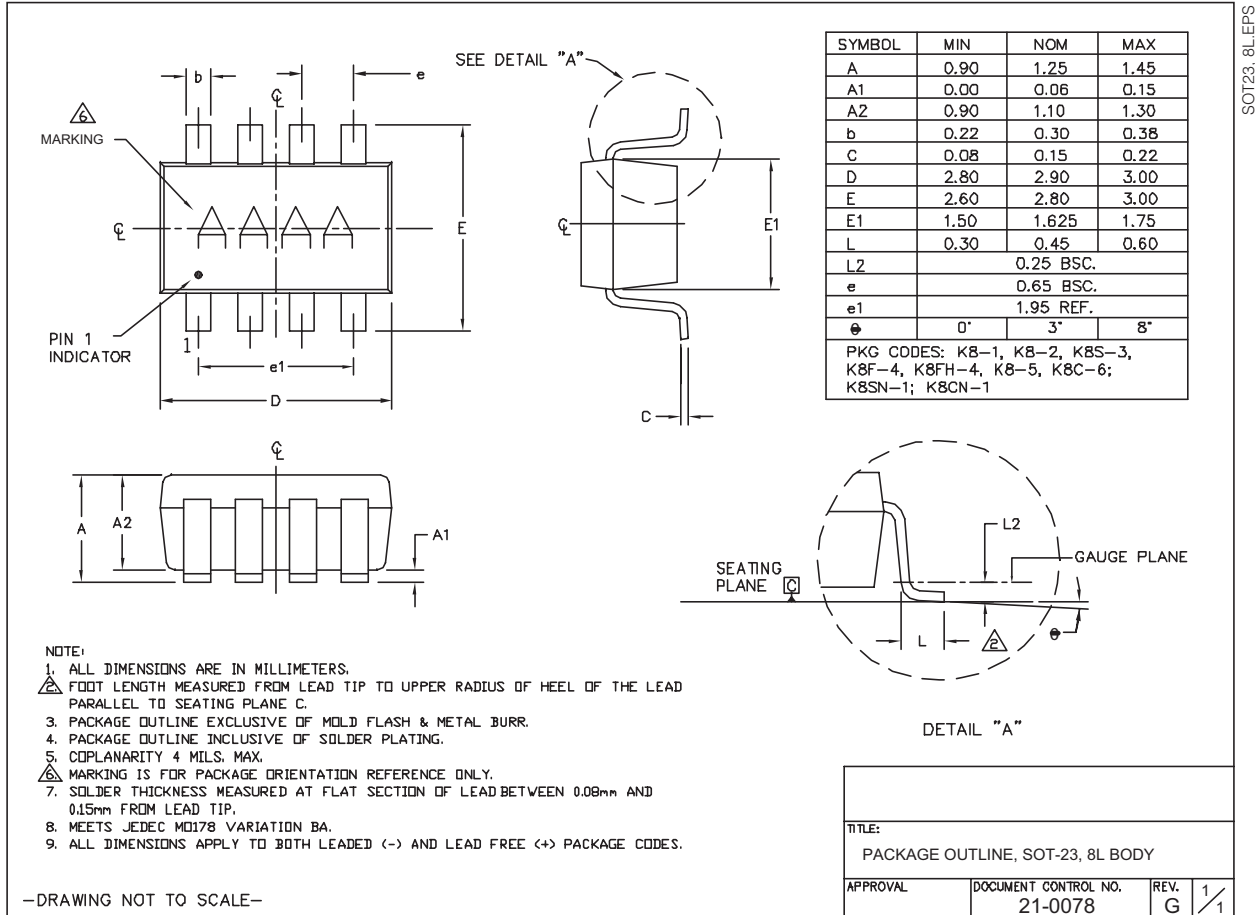
# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### 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).)



### Chip Information

TRANSISTOR COUNT: MAX3372E-MAX3376E: 189

MAX3377E-MAX3379E,

MAX3390E-MAX3393E: 295

PROCESS: BiCMOS

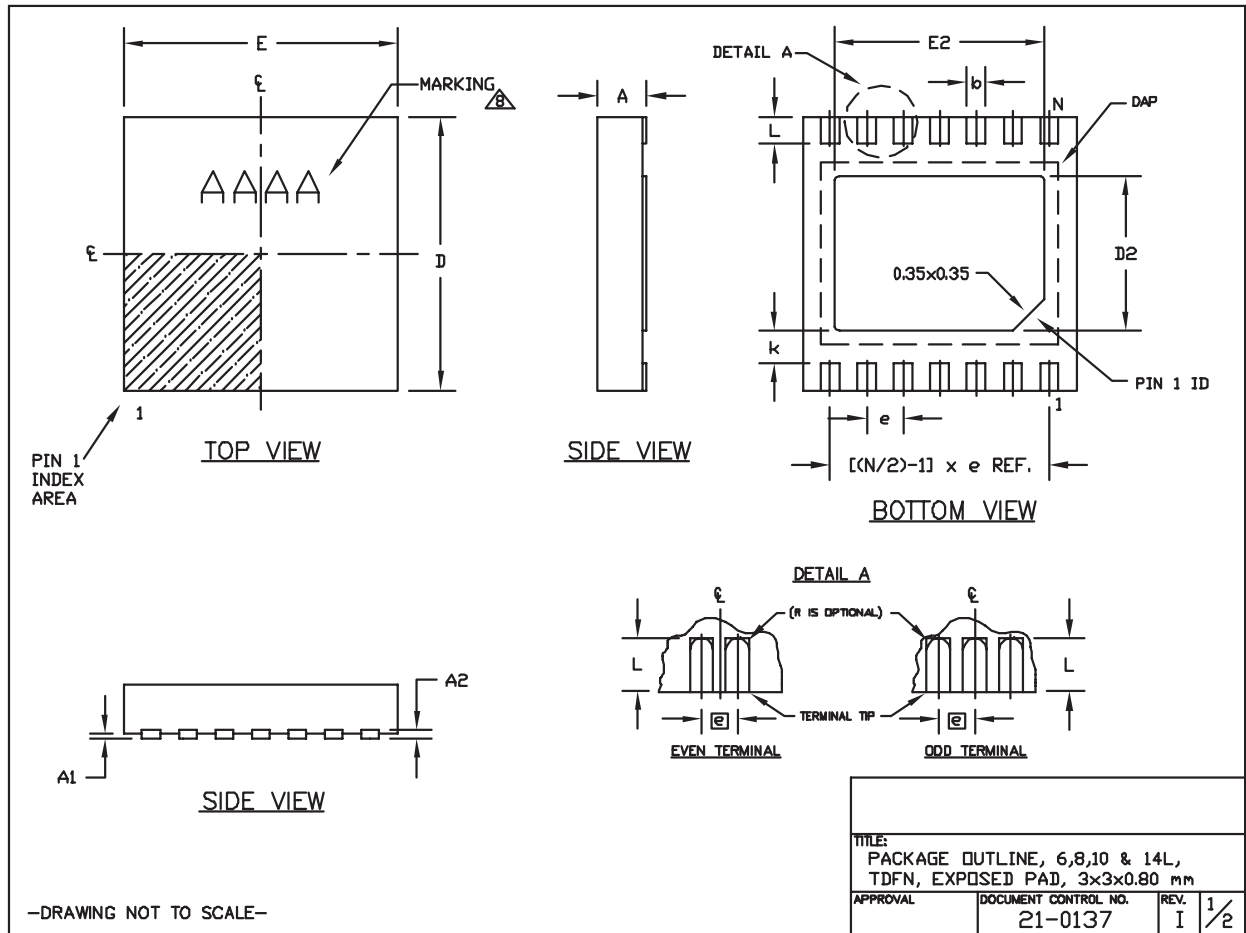
# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### 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).)



# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### 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).)

COMMON DIMENSIONS		
SYMBOL	MIN.	MAX.
A	0.70	0.80
D	2.90	3.10
E	2.90	3.10
A1	0.00	0.05
L	0.20	0.40
k	0.25 MIN.	
A2	0.20 REF.	

PACKAGE VARIATIONS								
PKG. CODE	N	D2	E2	e	JEDEC SPEC	b	[(N/2)-1] x e	
T633-2	6	1.50±0.10	2.30±0.10	0.95 BSC	MO229 / WEEA	0.40±0.05	1.90 REF	
T833-2	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF	
T833-3	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF	
T1033-1	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF	
T1033-2	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF	
T1433-1	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF	
T1433-2	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF	

#### NOTES:

1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY SHALL NOT EXCEED 0.08 mm.
3. WARPAGE SHALL NOT EXCEED 0.10 mm.
4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).
5. DRAWING CONFORMS TO JEDEC MO229, EXCEPT DIMENSIONS "D2" AND "E2", AND T1433-1 & T1433-2.
6. "N" IS THE TOTAL NUMBER OF LEADS.
7. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
8. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.

-DRAWING NOT TO SCALE-

TITLE: PACKAGE OUTLINE, 6,8,10 & 14L, TDFN, EXPOSED PAD, 3x3x0.80 mm			
APPROVAL	DOCUMENT CONTROL NO. 21-0137	REV. I	2/2

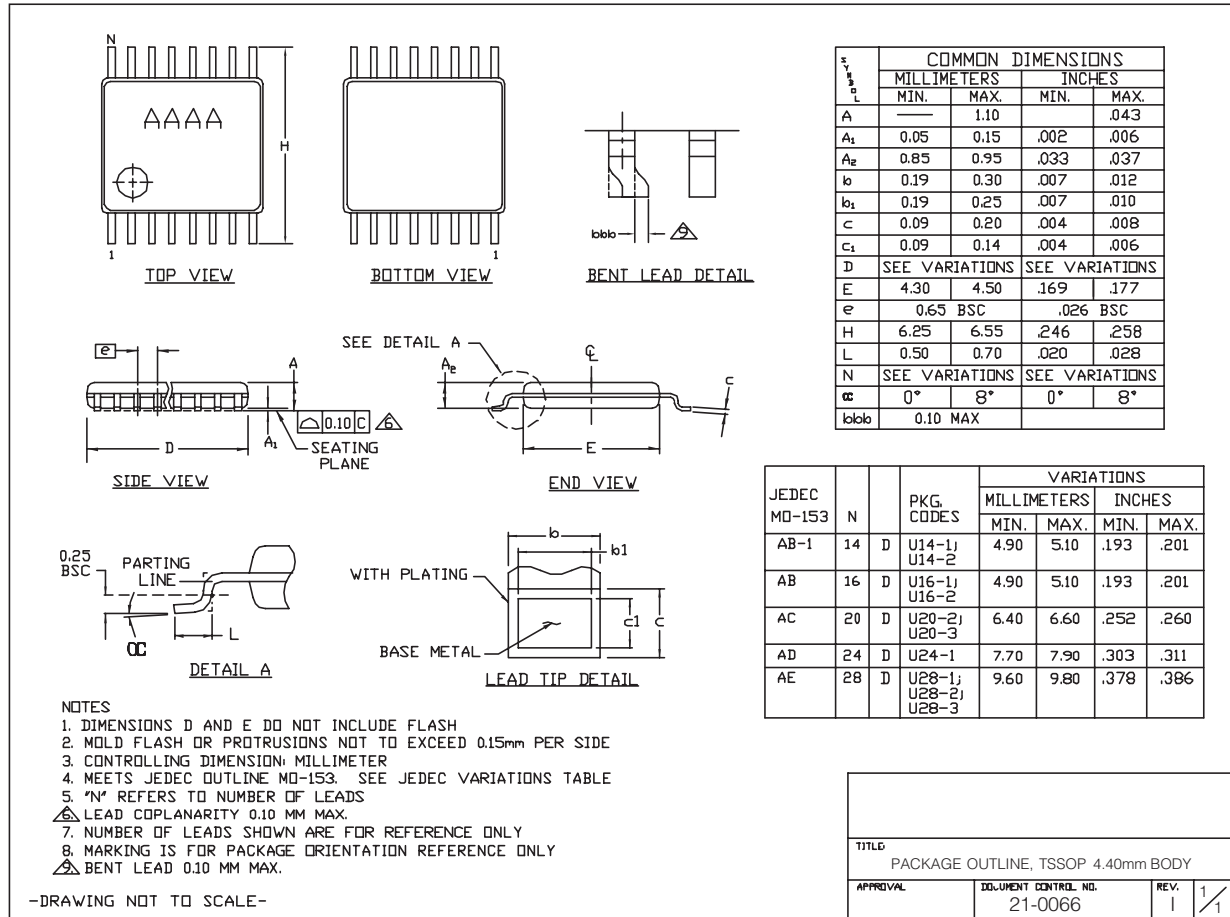
# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### 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).)



TSSOP4 4.0mm EPS

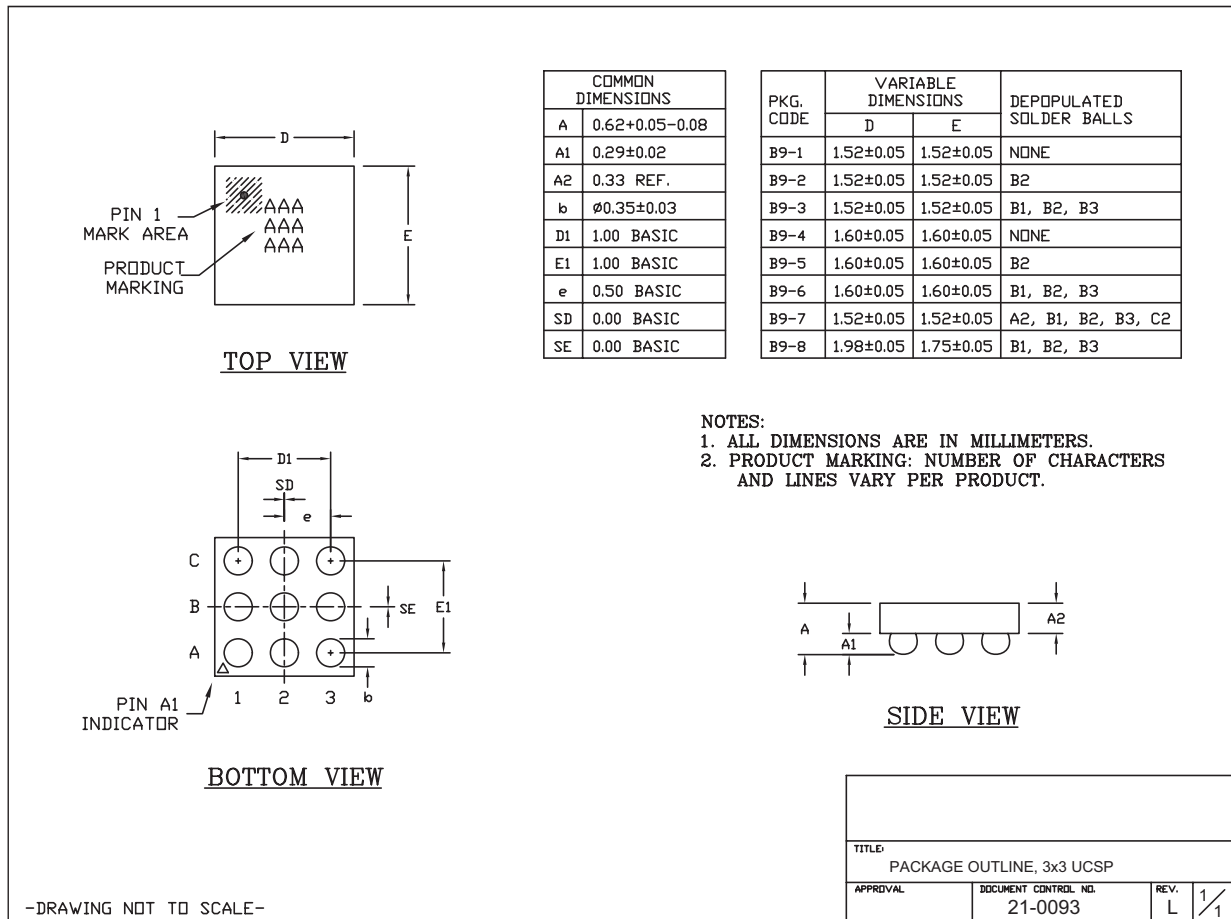
# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### 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).)



# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### 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**

TITLE: PACKAGE OUTLINE, 4x3 UCSP		
APPROVAL	DOCUMENT CONTROL NO. 21-0104	REV. F 1/1

12L UCSP 4x3.EPS

# MAX3372E-MAX3379E/

# MAX3390E-MAX3393E

## ±15kV ESD-Protected, 1µA, 16Mbps, Dual/Quad Low-Voltage Level Translators in UCSP

### Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	1/02	Initial Release	—
1	12/06	Addition of 12-bump ECSP packaging	—
2	11/07	Addition of lead-free options	1, 20-31



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time. The parametric values (min and max limits) shown in the Electrical Characteristics table are guaranteed. Other parametric values quoted in this data sheet are provided for guidance.

**Maxim Integrated 160 Rio Robles, San Jose, CA 95134 USA 1-408-601-1000**

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