



# ±15kV ESD-Protected USB Level Transceivers in UCSP with USB Detect

MAX3341E/MAX3342E

## General Description

The MAX3341E/MAX3342E USB transceivers convert logic-level signals to USB signals, and USB signals to logic-level signals. An internal 1.5kΩ USB termination resistor supports full-speed (12Mbps) USB operation. The MAX3341E/MAX3342E provide built-in ±15kV ESD-protection circuitry on the USB I/O pins, D+ and D-, and V<sub>CC</sub>.

The MAX3341E/MAX3342E operate with logic supply voltages as low as 1.8V, ensuring compatibility with low-voltage ASICs. The suspend mode lowers supply current to less than 50μA. A unique enumerate feature allows changes in USB communication protocol while power is applied. The MAX3341E/MAX3342E are fully compliant with USB specification 1.1, and full-speed operation under USB specification 2.0.

The MAX3341E/MAX3342E have a USB detect that monitors the USB bus for insertion and signals this event. The MAX3341E USB\_DET threshold is between 3.7V (min) and 4V (max), while the MAX3342E USB\_DET threshold is between 1V (min) and 2.8V (max).

The MAX3341E/MAX3342E are available in the miniature 4 × 4 UCSP™, as well as the small 16-pin TSSOP, and are specified over the extended temperature range, -40°C to +85°C.

## Applications

Cell Phones  
PC Peripherals  
Information Appliances  
Data Cradles  
PDAs  
MP3 Players  
Digital Cameras

UCSP is a trademark of Maxim Integrated Products, Inc.

Pin Configurations appear at end of data sheet.

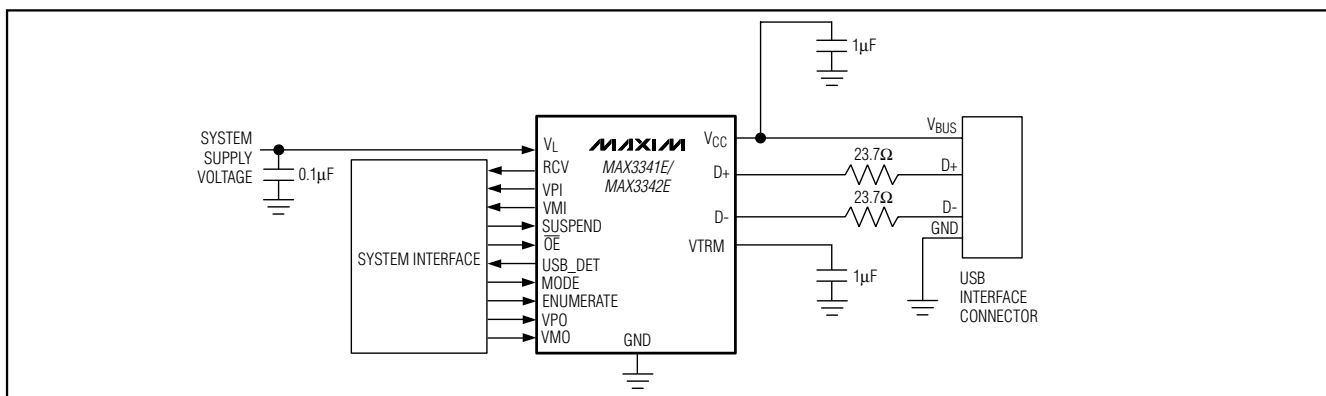
## Features

- ◆ ±15kV ESD Protection On D+ and D-
- ◆ Comply with USB Standard 1.1 (Full Speed 2.0)
- ◆ USB Skew Independent of Input Skew
- ◆ Separate VP and VM Inputs/Outputs
- ◆ V<sub>L</sub> Down to 1.8V Allows Connection with Low-Voltage ASICs
- ◆ Reenumerate with Power Applied
- ◆ USB Detect Function
  - 3.7V (min) to 4V (max)—MAX3341E
  - 1V (min) to 2.8V (max)—MAX3342E
- ◆ Allow Single-Ended or Differential Logic I/O
- ◆ Internal Linear Regulator Allows Direct Powering from the USB
- ◆ Internal Termination Resistor for Full-Speed Operation
- ◆ Three-State Outputs
- ◆ No Power-Supply Sequencing Required
- ◆ Driver Active in Suspend Mode
- ◆ Available in Miniature Chip-Scale Package

## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX3341EEUE	-40°C to +85°C	16 TSSOP
MAX3341EEBE-T	-40°C to +85°C	4 x 4 UCSP
MAX3342EEUE	-40°C to +85°C	16 TSSOP
MAX3342EEBE-T	-40°C to +85°C	4 x 4 UCSP

## Typical Operating Circuit



# ±15kV ESD-Protected USB Level Transceivers in UCSP with USB Detect

## ABSOLUTE MAXIMUM RATINGS

(All voltages refer to GND, unless otherwise noted.)  
 Supply Voltage ( $V_{CC}$ ) .....-0.3V to +6V  
 Output of Internal Regulator (VTRM) (Note 1) .....-0.3V to +6V  
 Input Voltage (D+, D-) (Notes 1, 2) .....-0.3V to +6V  
 System Supply Voltage ( $V_L$ ) .....-0.3V to +6V  
 RCV, SUSP, VMO, MODE, VPO,  $\overline{OE}$ , VMI,  
 VPI, USB\_DET, ENUM.....-0.3V to ( $V_L + 0.3V$ )  
 Short-Circuit Current (D+, D-) to  $V_{CC}$  or  
 Ground (Note 3) .....Continuous

Maximum Continuous Current (all other pins) .....±15mA  
 Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )  
 16-Pin TSSOP (derate 7.1mW/ $^\circ\text{C}$  above +70 $^\circ\text{C}$ ) .....571mW  
 4 × 4 UCSP (derate 8.2 mW/ $^\circ\text{C}$  above +70 $^\circ\text{C}$ ) .....659mW  
 Operating Temperature Range .....-40 $^\circ\text{C}$  to +85 $^\circ\text{C}$   
 Junction Temperature .....+150 $^\circ\text{C}$   
 Storage Temperature Range .....-65 $^\circ\text{C}$  to +150 $^\circ\text{C}$   
 Lead Temperature (soldering, 10s) .....+300 $^\circ\text{C}$   
 Bump Temperature (soldering) Reflow .....+235 $^\circ\text{C}$

**Note 1:** Guaranteed for  $V_{CC} < +3.7V$  only.

**Note 2:** Absolute Maximum Rating for input voltage (D+, D-) with  $V_{CC} > +3.7V$  is -0.3V to ( $V_{CC} + 0.3V$ ).

**Note 3:** External 23.7 $\Omega$  resistors connected to D+ and D-.

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

## ELECTRICAL CHARACTERISTICS

( $V_{CC} = 4V$  to 5.5V bypassed with 1 $\mu\text{F}$  to GND, GND = 0,  $V_L = 1.8V$  to 3.6V, D+ to GND = 15k $\Omega$ , D- to GND = 15k $\Omega$ , ENUM =  $V_L$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = 5V$ ,  $V_L = 2.5V$ ,  $T_A = +25^\circ\text{C}$ .) (Note 4)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
USB Supply Voltage	$V_{CC}$		4		5.5	V
USB Supply Current	$I_{CC}$	Data rate = 12Mbps, $C_L = 50\text{pF}$ (Figure 6b)		10	20	mA
USB SUSP Supply Current	$I_{CC}(\text{SUSP})$	SUSP = high, ENUM = low, $\overline{OE} = \text{high}$			50	$\mu\text{A}$
		SUSP = high, $\overline{OE} = \text{low}$			85	
		SUSP = high, ENUM = high, $\overline{OE} = \text{high}$			85	
$V_{CC}$ Supply Current	$I_{CC}(<3V)$	$V_{CC} < 3V$ (MAX3341E)			80	$\mu\text{A}$
D+/D- Leakage Current	$I_{D+/D-}(3V)$	$V_{CC} = 3V$ ; D+, D- < 3.6V (MAX3341E)			10	$\mu\text{A}$
$V_{CC}$ Supply Current	$I_{CC}(<1V)$	$V_{CC} < 1V$ (MAX3342E)			80	$\mu\text{A}$
D+/D- Leakage Current	$I_{D+/D-}(1V)$	$V_{CC} = 1V$ ; D+, D- < 3.6V (MAX3342E)			10	$\mu\text{A}$
$V_L$ Suspend Supply Current	$I_L(\text{SUSP})$	SUSP = high, $0 < V_{CC} < 5.5V$			20	$\mu\text{A}$
<b>LOGIC-SIDE I/O</b>						
$V_L$ Input Range	$V_L$		1.8		3.6	V
Input High Voltage	$V_{IH}$	SUSP, MODE, ENUM, $\overline{OE}$ , VMO, VPO	$2/3 \times V_L$			V
Input Low Voltage	$V_{IL}$	SUSP, MODE, ENUM, $\overline{OE}$ , VMO, VPO			0.4	V
Output Voltage High	$V_{OH}$	VPI, VMI, RCV, USB_DET; $I_{SOURCE} = 1\text{mA}$	$V_L - 0.2$			V
Output Voltage Low	$V_{OL}$	VPI, VMI, RCV, USB_DET; $I_{SINK} = -1\text{mA}$			0.4	V
Input Leakage Current		SUSP, MODE, ENUM, $\overline{OE}$ , VMO, VPO = 0 or $V_L$		±1	±10	$\mu\text{A}$
<b>USB-SIDE I/O</b>						
Output Voltage Low	$V_{OL}$	D+ or D-			0.3	V
Output Voltage High	$V_{OH}$	D+ or D-	2.8		3.6	V
Input Impedance	$Z_{IN}$	Three-state driver	1			M $\Omega$
Single-Ended Input Voltage High	$V_{IH}$		2.0			V
Single-Ended Input Voltage Low	$V_{IL}$				0.8	V
Receiver Single-Ended Hysteresis	$V_{HYS}$		200			mV
Differential Input Sensitivity	$V_{DIFF}$		200			mV

# **±15kV ESD-Protected USB Level Transceivers in UCSP with USB Detect**

**MAX3341E/MAX3342E**

## **ELECTRICAL CHARACTERISTICS (continued)**

(V<sub>CC</sub> = 4V to 5.5V bypassed with 1μF to GND, GND = 0, V<sub>L</sub> = 1.8V to 3.6V, D+ to GND = 15kΩ, D- to GND = 15kΩ, ENUM = V<sub>L</sub>, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = 5V, V<sub>L</sub> = 2.5V, T<sub>A</sub> = +25°C.) (Note 4)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Common-Mode Voltage Range	V <sub>CM</sub>		0.8		2.5	V
Driver Output Impedance	Z <sub>OUT</sub>	Including 23.7Ω (±1%) external resistors	28.5		43.5	Ω
Internal Resistor	R <sub>PU</sub>		1.425	1.500	1.575	kΩ
Termination Voltage	V <sub>TRM</sub>		3.0	3.3	3.6	V
USB_DET Threshold	V <sub>USBLH1</sub>	MAX3341E			4.0	V
	V <sub>USBHL1</sub>	MAX3341E	3.7			
	V <sub>USBLH2</sub>	MAX3342E			2.8	
	V <sub>USBHL2</sub>	MAX3342E	1			
USB_DET Hysteresis	V <sub>USBHYS</sub>			25	mV	
<b>LINEAR REGULATOR</b>						
Power-Supply Rejection Ratio	PSRR	f = 10kHz, C <sub>OUT</sub> = 1μF, D+/D- load		30		dB
External Capacitor	C <sub>OUT</sub>	Compensation of linear regulator	1			μF
<b>ESD PROTECTION (V<sub>CC</sub>, D+, D-)</b>						
Human Body Model				±15		kV
IEC1000-4-2 Air-Gap Discharge				±15		kV
IEC1000-4-2 Contact Discharge				±8		kV

## **TIMING CHARACTERISTICS**

(V<sub>CC</sub> = 4V to 5.5V, GND = 0, V<sub>L</sub> = 1.8V to 3.6V, D+ to GND = 15kΩ, D- to GND = 15kΩ, ENUM = V<sub>L</sub>, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = 5V, V<sub>L</sub> = 2.5V, T<sub>A</sub> = +25°C.) (Figures 2–6) (Note 4)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
$\overline{OE}$ to Transmit Delay Enable Time	t <sub>PZD</sub>	Figure 6c	15		80	ns
$\overline{OE}$ to Driver Three-State Delay Driver Disable Time	t <sub>PDZ</sub>	Figure 6c			25	ns
USB Detect Signal Delay	t <sub>DUSB</sub>	Figure 6b		7.5		μs
<b>TRANSMITTER</b>						
VPO/VMO to D+/D- Propagation Delay	t <sub>PLH1(drv)</sub>	MODE = high, Figure 6c			30	ns
	t <sub>PHL1(drv)</sub>	MODE = high, Figure 6c			30	
VPO to D+/D- Propagation Delay	t <sub>PLH0(drv)</sub>	MODE = low, Figure 6c			35	ns
	t <sub>PHL0(drv)</sub>	MODE = low, Figure 6c			35	
Rise Time D+/D-	t <sub>R</sub>		4		20	ns
Fall Time D+/D-	t <sub>F</sub>		4		20	ns
Rise- and Fall-Time Matching	t <sub>R</sub> /t <sub>F</sub>	(Note 5)	90		110	%
Output Signal Crossover	V <sub>CRS</sub>	(Note 5)	1.3		2	V
<b>DIFFERENTIAL RECEIVER (Figure 6a)</b>						
D+/D- to RCV Propagation Delay	t <sub>PLH(RCV)</sub>				30	ns
	t <sub>PHL(RCV)</sub>				30	
Rise Time RCV	t <sub>R</sub>				15	ns
Fall Time RCV	t <sub>F</sub>				15	ns

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## TIMING CHARACTERISTICS (continued)

(V<sub>CC</sub> = 4V to 5.5V, GND = 0, V<sub>L</sub> = 1.8V to 3.6V, D+ to GND = 15kΩ, D- to GND = 15kΩ, ENUM = V<sub>L</sub>, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = 5V, V<sub>L</sub> = 2.5V, T<sub>A</sub> = +25°C.) (Figures 2–6)

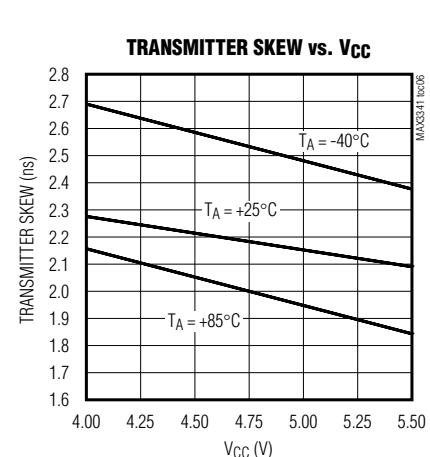
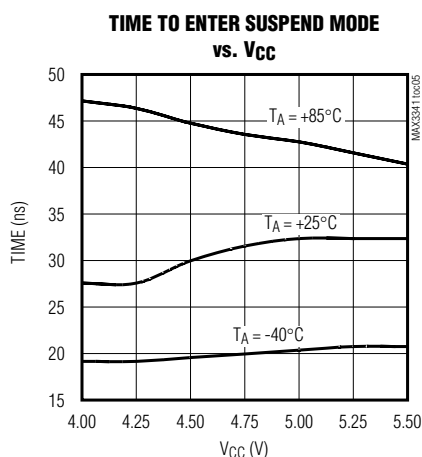
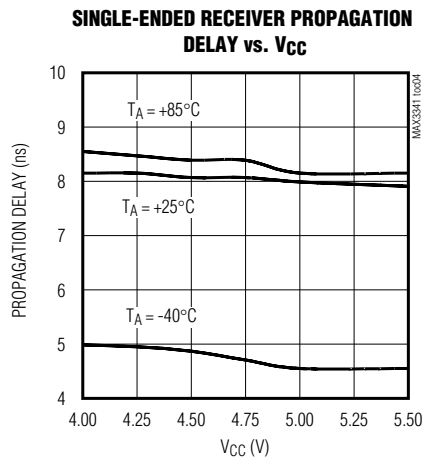
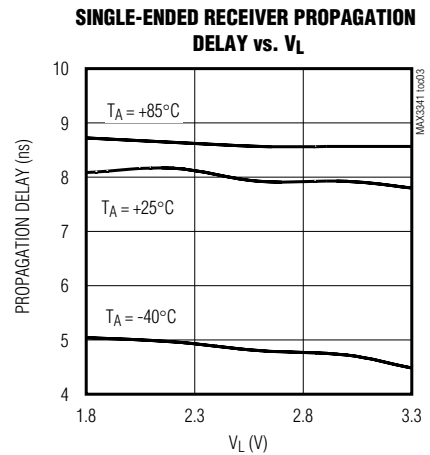
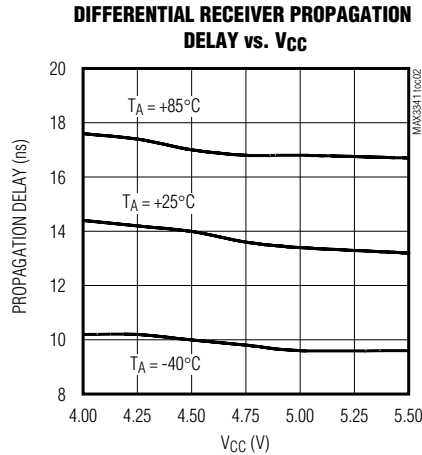
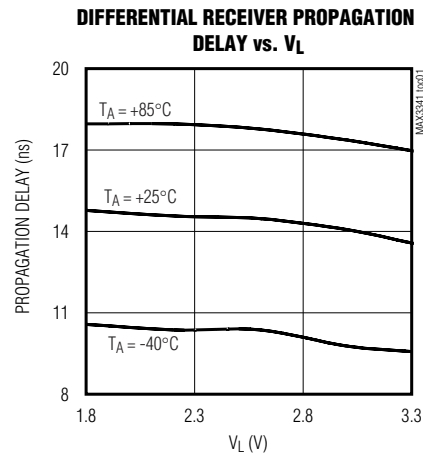
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>SINGLE-ENDED RECEIVERS</b>						
D+/D- to VPI or VMI Propagation Delay	t <sub>PLH(SE)</sub>	Figure 6a			15	ns
	t <sub>PHL(SE)</sub>	Figure 6a			15	
Rise Time VPI and VMI	t <sub>R(SE)</sub>	Measured from 10% to 90%, Figure 6a			15	ns
Fall Time VPI and VMI	t <sub>F(SE)</sub>	Measured from 90% to 10%, Figure 6a			15	ns
Time to Detect Single-Ended Zero	t <sub>SE0</sub>		14		140	ns

**Note 4:** Parameters are 100% production tested at 25°C, limits over temperature are guaranteed by correlation.

**Note 5:** Guaranteed by design, not production tested.

## Typical Operating Characteristics

(V<sub>CC</sub> = 5V, V<sub>L</sub> = 3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.)



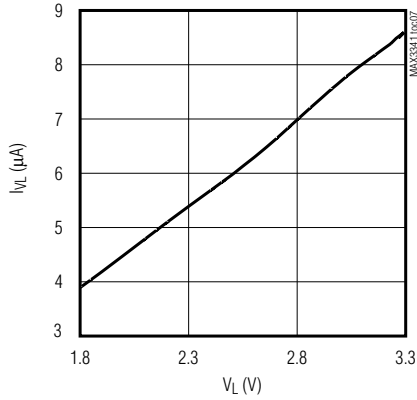
# **$\pm 15\text{kV}$ ESD-Protected USB Level Transceivers in UCSP with USB Detect**

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

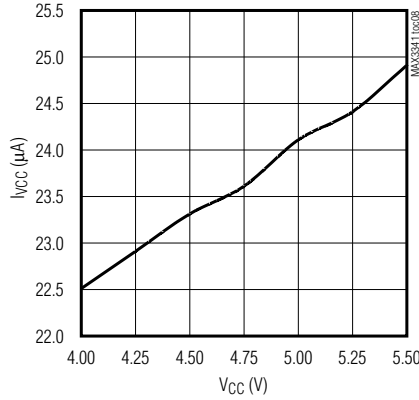
( $V_{CC} = 5\text{V}$ ,  $V_L = 3.3\text{V}$ ,  $T_A = +25^\circ\text{C}$ , unless otherwise noted.)

**MAX3341E/MAX3342E**

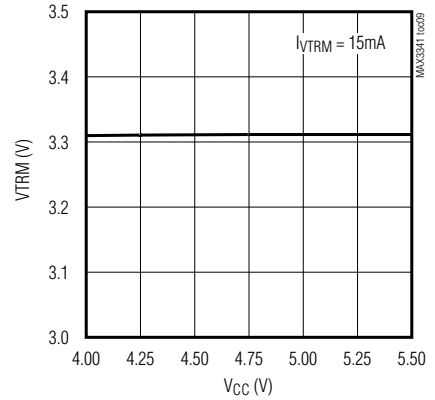
**LOGIC CURRENT CONSUMPTION IN SUSPEND MODE**



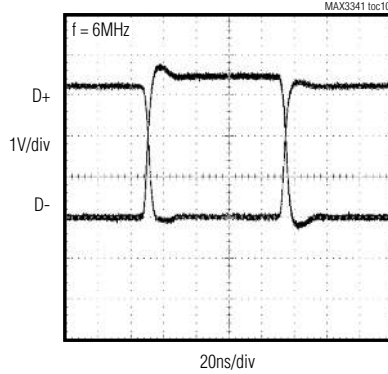
**CURRENT CONSUMPTION IN SUSPEND MODE**



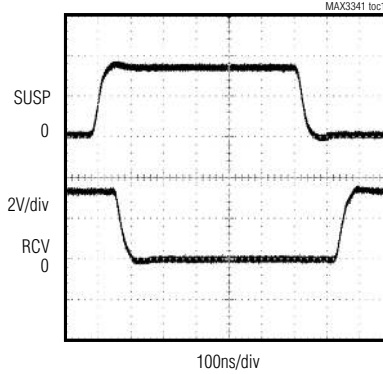
**VTRM vs.  $V_{CC}$**



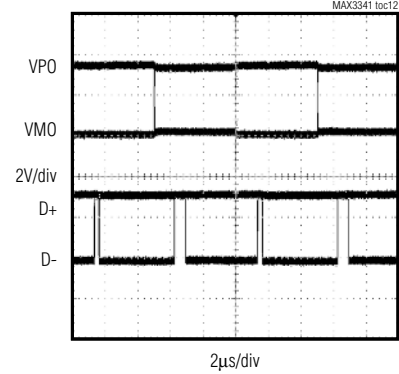
**RISE- AND FALL-TIME MATCHING**



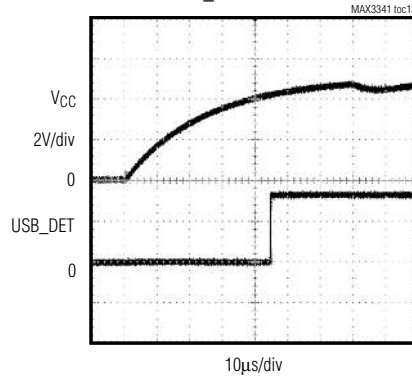
**SUSPEND RESPONSE**



**TRANSMISSION IN SUSPEND MODE (SUSP = 1)**



**USB\_DET RESPONSE**



# ±15kV ESD-Protected USB Level Transceivers in UCSP with USB Detect

## Pin Description

PIN		NAME	FUNCTION
TSSOP	UCSP		
1	D2	RCV	Receiver Output. Single-ended CMOS output. RCV responds to the differential input on D+ and D-.
2	D1	VPO	ASIC Voltage Positive Output. Logic-level data into the MAX3341E/MAX3342E.
3	C2	MODE	Mode-Control Input. Selects differential (mode 1) or single-ended (mode 0) input for the system side when converting logic-level signals to USB level signals. Force MODE high to select mode 1. Force MODE low to select mode 0.
4	C1	VMO	ASIC Voltage Minus Output. Logic-level data into the MAX3341E/MAX3342E.
5	B1	$\overline{OE}$	Output Enable. Drive $\overline{OE}$ low to enable data transmission on D+ and D-. Drive $\overline{OE}$ high to disable data transmission or to receive data.
6	B2	SUSP	Suspend Input. Drive SUSP low for normal operation. Drive SUSP high for low-power state. In low-power state, RCV is low and VPI/VMI are active.
7	A1	VPI	ASIC Voltage Positive Input. Logic-level data output from the MAX3341E/MAX3342E.
8	A2	VMI	ASIC Voltage Minus Input. Logic-level data output from the MAX3341E/MAX3342E.
9	B3	ENUM	Enumerate. Drive ENUM high to connect the internal 1.5k $\Omega$ resistor from D+ to 3.3V. Drive ENUM low to disconnect the internal 1.5k $\Omega$ resistor.
10	A3	V <sub>CC</sub>	USB-Side Power-Supply Input. Connect V <sub>CC</sub> to the incoming USB power supply. Bypass V <sub>CC</sub> to GND with a 1 $\mu$ F ceramic capacitor.
11	A4	GND	Ground
12	B4	D-	Negative USB Differential Data Input/Output. Connect to the USB's D- signal through a 23.7 $\Omega$ $\pm$ 1% resistor.
13	C4	D+	Positive USB Differential Data Input/Output. Connect to the USB's D+ signal through a 23.7 $\Omega$ $\pm$ 1% resistor.
14	D4	VTRM	Regulated Output Voltage. 3.3V output derived from the V <sub>CC</sub> input. Bypass VTRM to GND with a 1 $\mu$ F (min) low-ESR capacitor such as ceramic or plastic film types.
15	D3	V <sub>L</sub>	System-Side Power-Supply Input. Connect to the system's logic-level power supply, 1.8V to 3.6V.
16	C3	USB_DET	USB Detector Output. A high at USB_DET signals to the ASIC that V <sub>CC</sub> is present. A low at USB_DET indicates that V <sub>CC</sub> is not present. 3.7V (min) and 4V (max), while the MAX3342E USB_DET threshold is between 1V (min) and 2.8V (max).

## Detailed Description

The MAX3341E/MAX3342E are bidirectional level transceivers that convert single-ended or differential logic-level signals to differential USB signals, and convert differential USB signals to single-ended or differential logic-level signals. The MAX3341E/MAX3342E are operational from V<sub>CC</sub> = 5.5V to V<sub>CC</sub> = 3V (electrical specifications are not guaranteed for V<sub>CC</sub> < 4V). Both devices include an internal 1.5k $\Omega$  pullup resistor that connects and disconnects D+ to VTRM (see the *Functional Diagram*).

The MAX3341E/MAX3342E are tolerant to power sequencing with either V<sub>CC</sub> > V<sub>L</sub> or V<sub>L</sub> > V<sub>CC</sub>. Additionally, the USB I/O, D+ and D-, and V<sub>CC</sub> are ESD protected to  $\pm$ 15kV. The MAX3341E/MAX3342E can receive USB power (V<sub>CC</sub>) directly from the USB connection and operate with logic supplies (V<sub>L</sub>) down to 1.8V, while still meeting the USB physical layer specifications. The MAX3341E/MAX3342E supports full-speed (12Mbps) USB specification 2.0 operation.

The MAX3341E/MAX3342E have a unique enumerate feature that functions when power is applied. Driving

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MAX3341E/MAX3342E

ENUM low disconnects the internal 1.5kΩ termination resistor from D+ enumerating the USB. This is useful if changes in communication protocol are required while power is applied, and while the USB cable is connected.

## Device Control

### D+ and D-

D+ and D- are the USB side transmitter I/O connections, and are ESD protected to ±15kV using the Human Body Model, ±15kV using IEC 1000-4-2 Air-Gap Discharge, and ±8kV using IEC 1000-4-2 Contact Discharge, making the MAX3341E/MAX3342E ideal for applications where a robust transmitter is required. A 23.7Ω resistor is required on D+ and D- for normal operation (see the *External Resistors* section).

The MAX3341E/MAX3342E contain unique circuitry to ensure the USB skew is independent of the input skew on VPO and VMO. Input skews of up to 10ns are ignored and do not show up on the output.

### ENUM

USB specification 2.0 requires a 1.5kΩ pullup resistor on D+ for full-speed (12Mbps) operation. Controlled by enumerate (ENUM), the MAX3341E/MAX3342E provide this internal 1.5kΩ resistor. Drive ENUM high to connect the pullup resistor from D+ to VTRM. Drive ENUM low to disconnect the pullup resistor from D+ to VTRM.

### VPO/VMO, VPI/VMI, and $\overline{OE}$

The MAX3341E/MAX3342E system-side inputs are VPO and VMO. Data from an ASIC comes into the MAX3341E/MAX3342E through VPO and VMO. VPO and VMO operate either differentially with VPO as the positive terminal and VMO as the negative terminal, or single ended with VPO as the data input (see the *MODE* section).

The MAX3341E/MAX3342E system-side outputs are VPI, VMI, and RCV. The MAX3341E/MAX3342E send data to an ASIC through VPI, VMI, and RCV. VPI and VMI are outputs to the single-ended receivers and RCV is the output of the differential receiver.

Output enable ( $\overline{OE}$ ) controls data transmission. Drive  $\overline{OE}$  low to enable data transmission on D+ and D-. Drive  $\overline{OE}$  high to disable data transmission or receive data.

### MODE

MODE is a control input that selects whether differential or single-ended logic signals are recognized by the system side of the MAX3341E/MAX3342E. Drive MODE high to select differential mode with VPO as the positive terminal and VMO as the negative terminal. Drive MODE low to select single-ended mode with VPO as the data input (Table 1).

### VTRM

VTRM is the 3.3V output of the internal linear voltage regulator. VTRM powers the internal circuitry of the USB side of the MAX3341E/MAX3342E. Connect a 1μF (min) low-ESR ceramic or plastic capacitor from VTRM to GND, as close to VTRM as possible.

### VCC

In most applications, VCC is derived from the USB 5V output. If supplying VCC with an alternative power supply such as a lithium-ion battery, the VCC input range is 4.0V to 5.5V. If VCC drops below 4.0V, supply current drops to 10μA avoiding excessive battery drain, and D+/D- enter a high-impedance state allowing other devices to drive the lines. Bypass VCC to GND with a 1μF ceramic capacitor as close to the device as possible.

### USB Detect

USB detect output (USB\_DET) signals to the ASIC that VCC is present. A high at USB\_DET indicates that VCC is present, while a low at USB\_DET indicates that VCC is not present. The MAX3341E USB\_DET threshold is between 3.7V (min) and 4V (max), while the MAX3342E USB\_DET threshold is between 1V (min) and 2.8V (max).

### SUSP

Suspend (SUSP) is a control input. Force SUSP high to place the MAX3341E/MAX3342E in a low-power state. In this state, the quiescent supply current into VCC is less than 50μA and RCV goes low.

In suspend mode, VPI and VMI remain active as receive outputs and VTRM stays on. The MAX3341E/MAX3342E continue to receive data from the USB, allowing the μP to sense activity on the D+/D- lines and wake up the MAX3341E/MAX3342E.

The MAX3341E/MAX3342E can also transmit data to D+ and D- while in suspend mode. This function is used to signal a remote wakeup by driving a signal on D+ and D- for a period of 1ms to 15ms. Slew rate control is not active during suspend mode, and data can only be sent at data rates up to 200kps.

## Data Transfer

### Receiving Data from the USB

Data received from the USB are output to VPI/VMI in either of two ways, differentially or single ended. To receive data from the USB, force  $\overline{OE}$  high and SUSP low. Differential data arriving at D+/D- appear as differential logic signals at VPI/VMI, and as a single-ended logic signal at RCV. If both D+ and D- are low, then VPI and VMI are low, signaling a single-ended zero condition on the bus; RCV is undefined (Table 1).

# ±15kV ESD-Protected USB Level Transceivers in UCSP with USB Detect

Table 1a. Truth Table Transmit (SUSP = 0,  $\overline{OE}$  = 0, ENUM = X)

INPUT			OUTPUT					
MODE	VPO	VMO	D+	D-	RCV	VPI	VMI	RESULT
0	0	0	0	1	0	0	1	LOGIC 0
0	0	1	0	0	X	0	0	SE0
0	1	0	1	0	1	1	0	LOGIC 1
0	1	1	0	0	X	0	0	SE0
1	0	0	0	0	X	0	0	SE0
1	0	1	0	1	0	0	1	LOGIC 0
1	1	0	1	0	1	1	0	LOGIC 1
1	1	1	1	1	X	1	1	UNDEFINED

Table 1b. Truth Table Receive (SUSP = 0,  $\overline{OE}$  = 1, ENUM = X)

INPUT		OUTPUT			
D+	D-	RCV	VPI	VMI	RESULT
0	0	X	0	0	SE0
0	1	0	0	1	LOGIC 0
1	0	1	1	0	LOGIC 1
1	1	X	1	1	UNDEFINED

Table 1c. Truth Table Transmit in Suspend\* (SUSP = 1,  $\overline{OE}$  = 0, ENUM = X)

INPUT			OUTPUT					
MODE	VPO	VMO	D+	D-	RCV	VPI	VMI	RESULT
0	0	0	0	1	0	0	1	LOGIC 0
0	0	1	0	0	0	0	0	SE0
0	1	0	1	0	0	1	0	LOGIC 1
0	1	1	0	0	0	0	0	SE0
1	0	0	0	0	0	0	0	SE0
1	0	1	0	1	0	0	1	LOGIC 0
1	1	0	1	0	0	1	0	LOGIC 1
1	1	1	1	1	0	1	1	UNDEFINED

\*Timing specifications are not guaranteed for D+ and D-.

Table 1d. Truth Table Receive in Suspend\* (SUSP = 1,  $\overline{OE}$  = 1, MODE = X, VPO/VMO = X, ENUM = X)

INPUT		OUTPUT			
D+	D-	RCV	VPI	VMI	RESULT
0	0	0	0	0	VPI/VMI ACTIVE
0	1	0	0	1	VPI/VMI ACTIVE
1	0	0	1	0	VPI/VMI ACTIVE
1	1	0	1	1	VPI/VMI ACTIVE

\*Timing specifications are not guaranteed for D+ and D-.



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MAX3341E/MAX3342E

## Transmitting Data to the USB

The MAX3341E/MAX3342E output data to the USB differentially on D+ and D-. The logic driving signals can be either differential or single ended. For sending differential logic, force MODE high, force  $\overline{OE}$  and SUSP low, and apply data to VPO and VMO. D+ then follows VPO, and D- follows VMO. To send single-ended logic signals, force MODE, SUSP, and  $\overline{OE}$  low, and apply data to VPO/VMO. When VMO is high, a single-ended zero condition is sent on the bus and RCV is undefined (Table 1).

## ESD Protection

To protect the MAX3341E/MAX3342E against ESD, D+ and D- have extra protection against static electricity to protect the device up to ±15kV. The ESD structures withstand high ESD in all states—normal operation, suspend, and powered down. In order for the 15kV ESD structures to work correctly, a 1μF or greater capacitor must be connected from VTRM to GND.

ESD protection can be tested in various ways; the D+ and D- input/output pins are characterized for protection to the following limits:

- 1) ±15kV using the Human Body Model
- 2) ±8kV using the IEC 1000-4-2 Contact Discharge Method
- 3) ±15kV using the IEC 1000-4-2 Air-Gap 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 1a shows the Human Body Model, and Figure 1b 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.

## 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 MAX3341E/MAX3342E help the user design equipment that meets level 4 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 a higher peak current in IEC 1000-4-2, because series resistance is

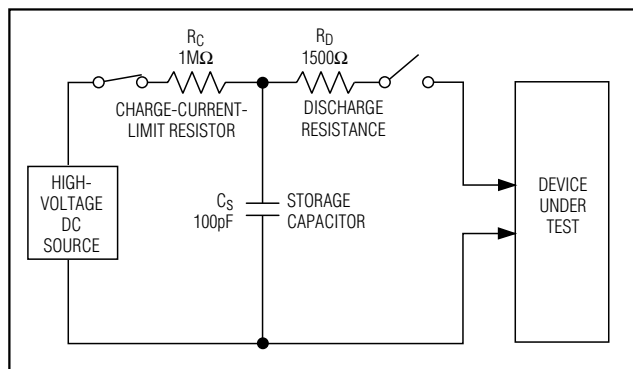


Figure 1a. Human Body ESD Test Models

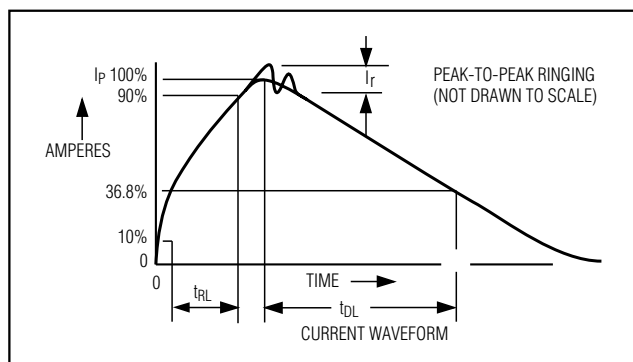


Figure 1b. Human Body Model Current Waveform

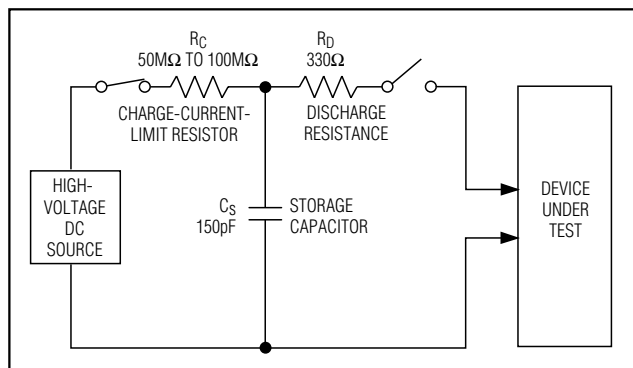


Figure 1c. IEC 1000-4-2 ESD Test Model

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 1c shows the IEC 1000-4-2 model.

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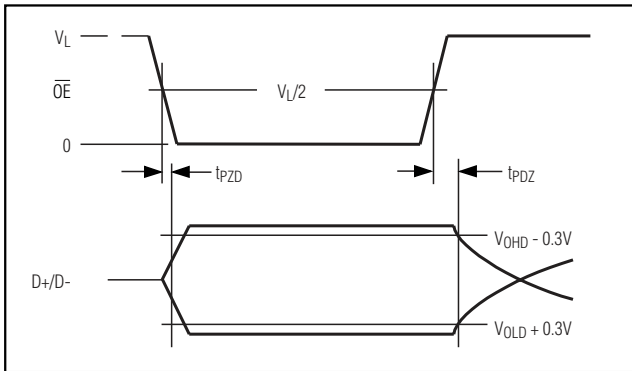


Figure 2. Enable and Disable Timing, Transmitter

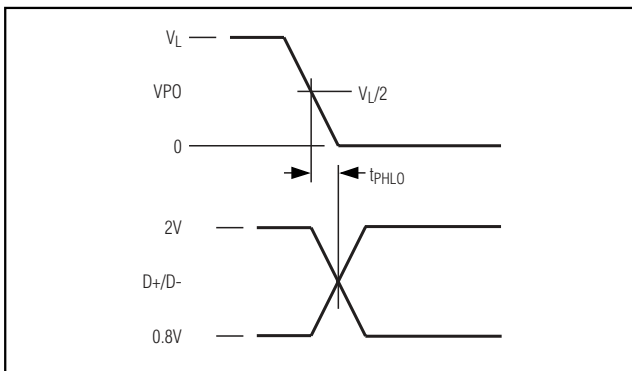


Figure 3. Mode 0 Timing

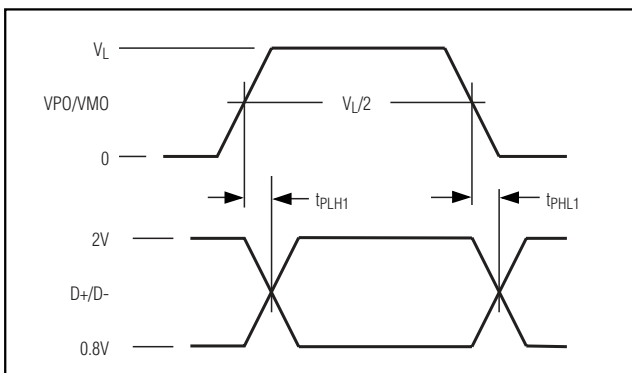


Figure 4. Mode 1 Timing

The Air-Gap Discharge Method 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. All pins require this protection during manufacturing. Therefore, after PC board assembly, the Machine Model is less relevant to I/O ports.

## Applications Information

### External Components

#### External Resistors

Two external  $23.7\Omega \pm 1\%$ , 1/2W resistors are required for USB connection. Place the resistors in between the MAX3341E/MAX3342E and the USB connector on the D+ and D- lines. See *Typical Operating Circuit*.

#### External Capacitors

Use three external capacitors for proper operation. Use a 0.1μF ceramic for decoupling  $V_L$ , a 1μF ceramic for decoupling  $V_{CC}$ , and a 1.0μF (min) ceramic or plastic filter capacitor on VTRM. Return all capacitors to GND.

## UCSP Applications Information

For the latest application details on UCSP construction, dimensions, tape carrier information, printed circuit board techniques, bump-pad layout, and recommended reflow temperature profile, as well as the latest information on reliability testing results, refer to the Application Note *UCSP—A Wafer-Level Chip-Scale Package* available on Maxim's website at [www.maxim-ic.com/ucsp](http://www.maxim-ic.com/ucsp).

# ±15kV ESD-Protected USB Level Transceivers in UCSP with USB Detect

**MAX3341E/MAX3342E**

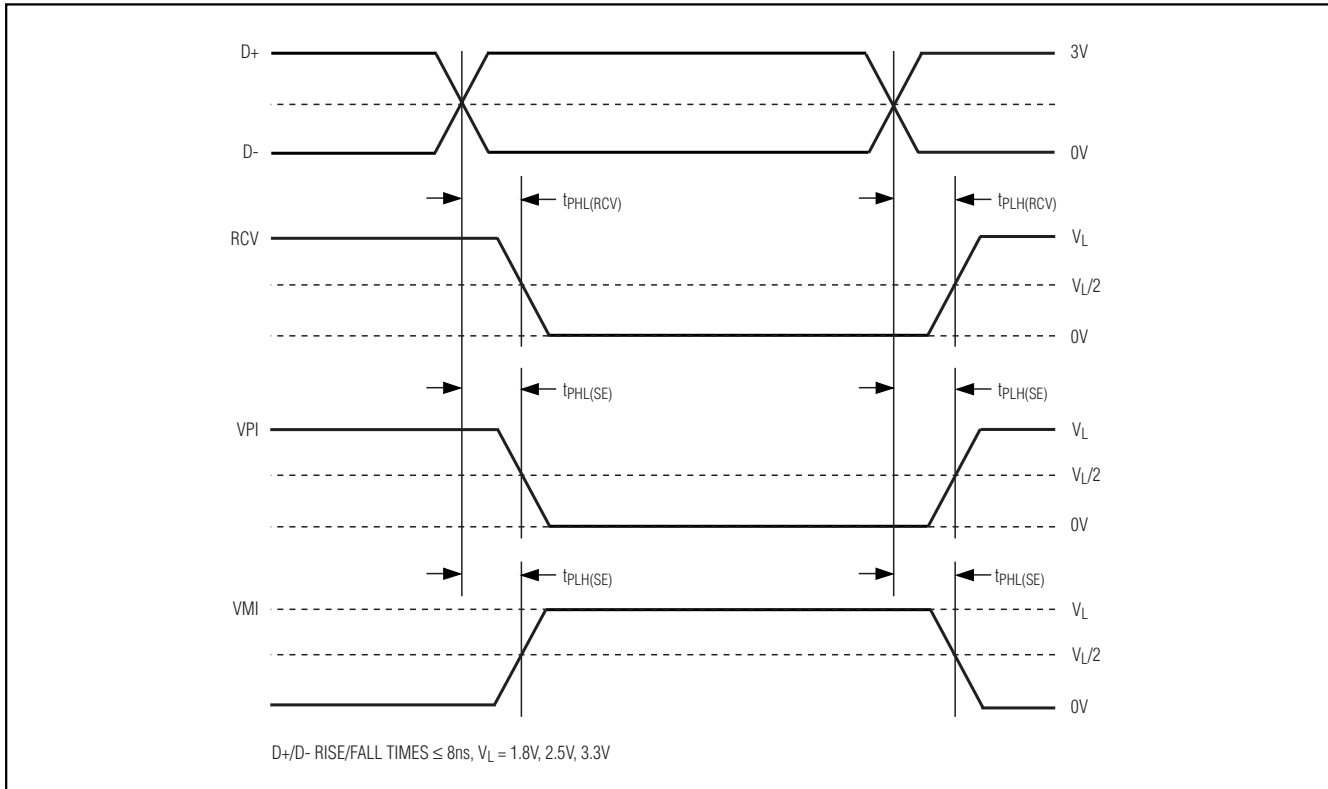


Figure 5. D+/D- to RCV, VPI, VMI Propagation Delays

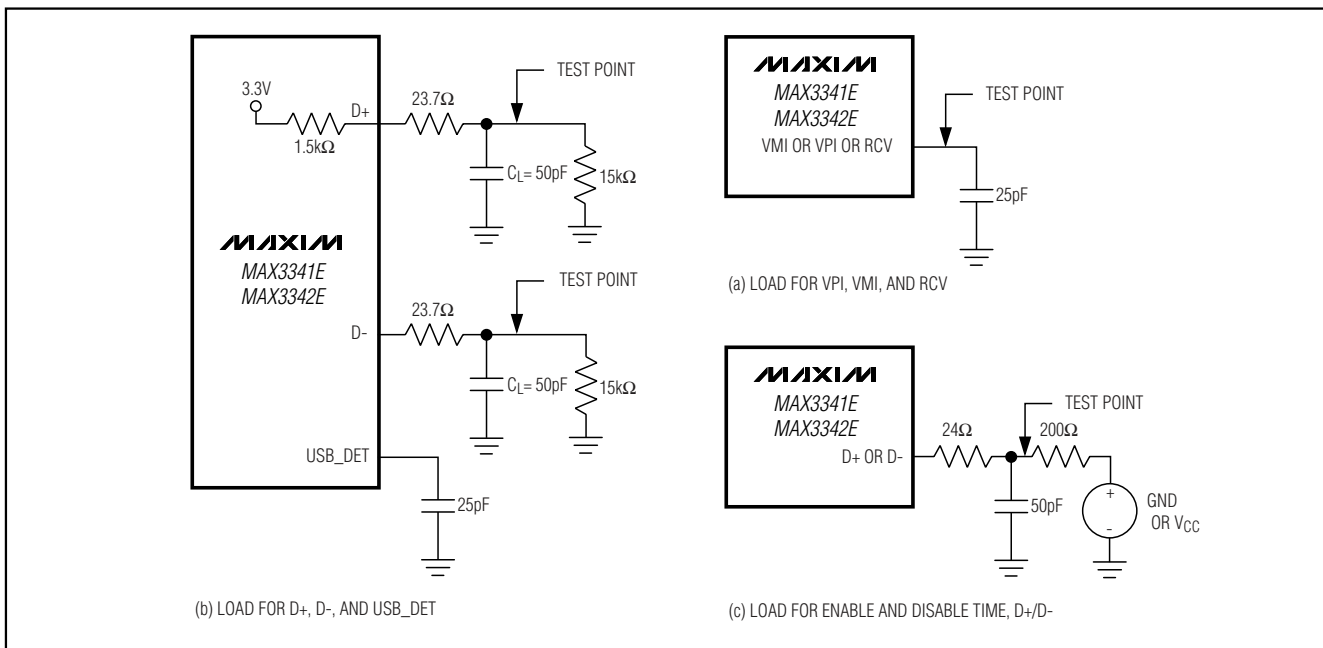
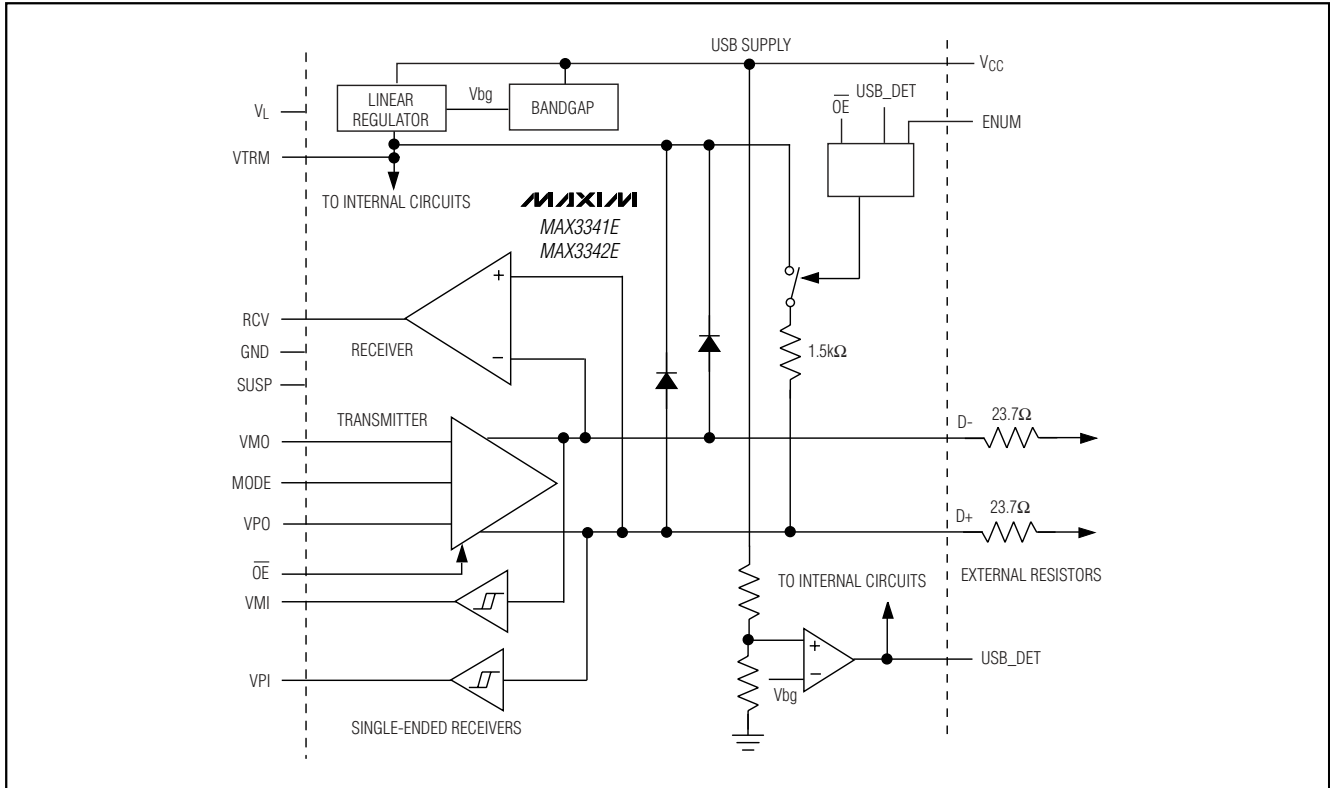


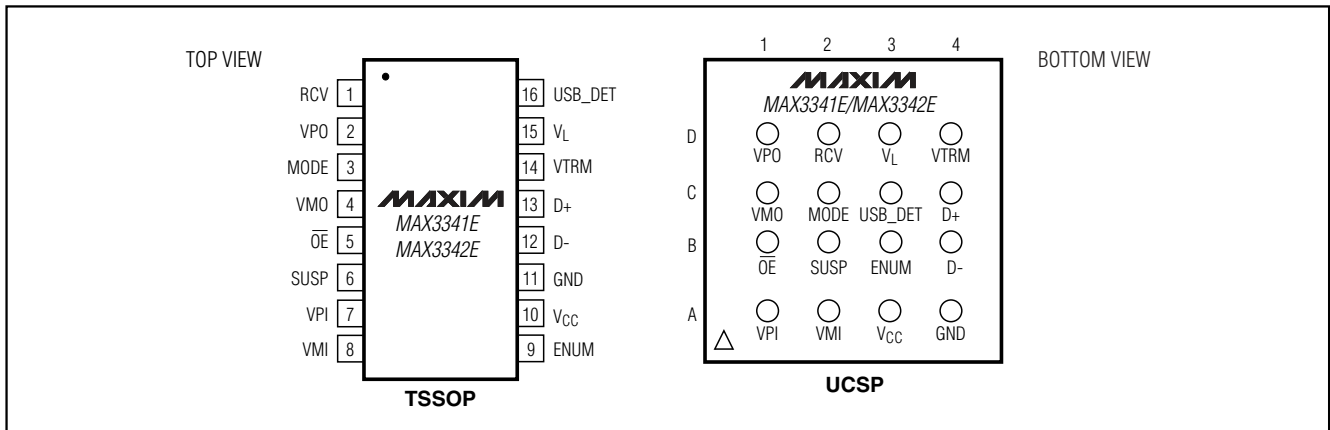
Figure 6. Test Circuits

# ±15kV ESD-Protected USB Level Transceivers in UCSP with USB Detect

## Functional Diagram



## Pin Configurations



## Chip Information

TRANSISTOR COUNT: 2162

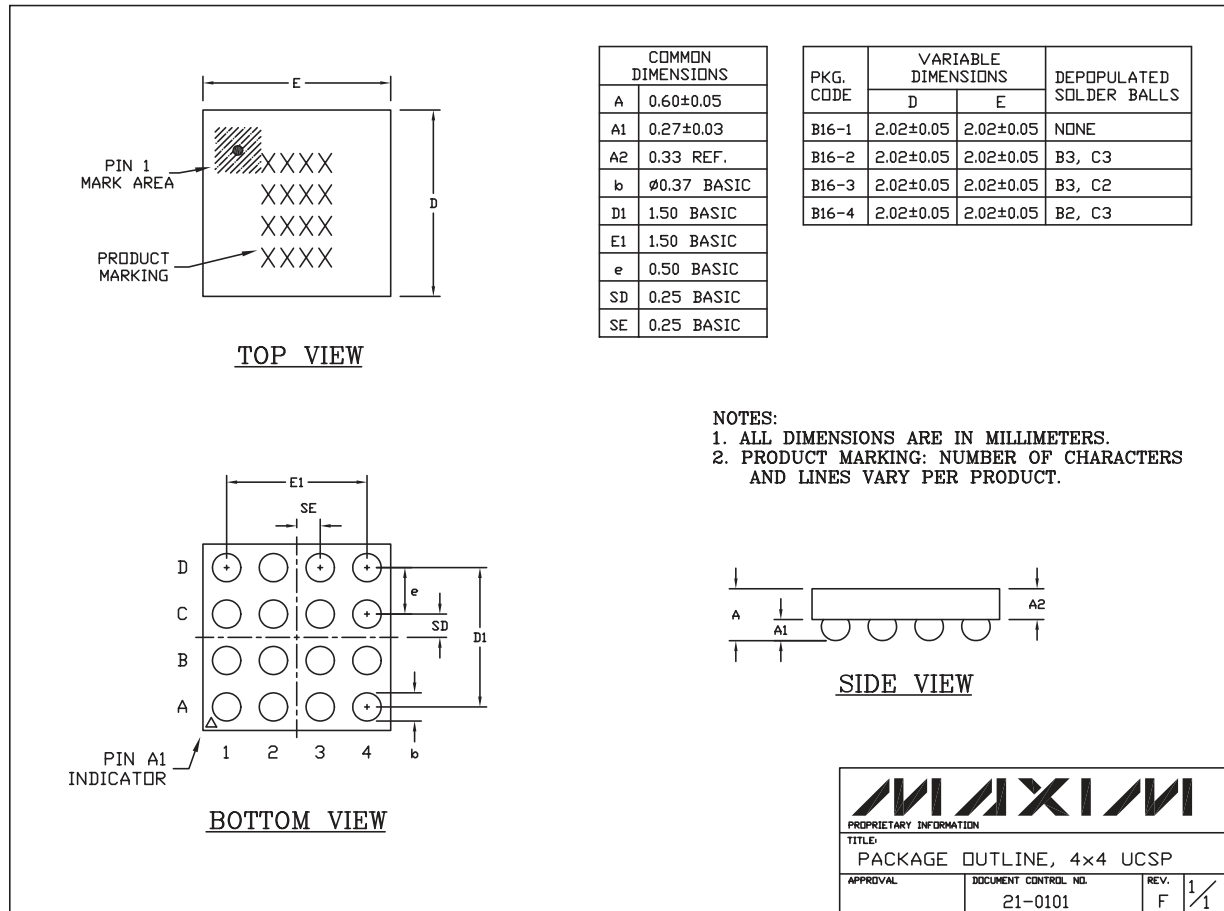
PROCESS: BiCMOS

# ±15kV ESD-Protected USB Level Transceivers in UCSP with USB Detect

## 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).)

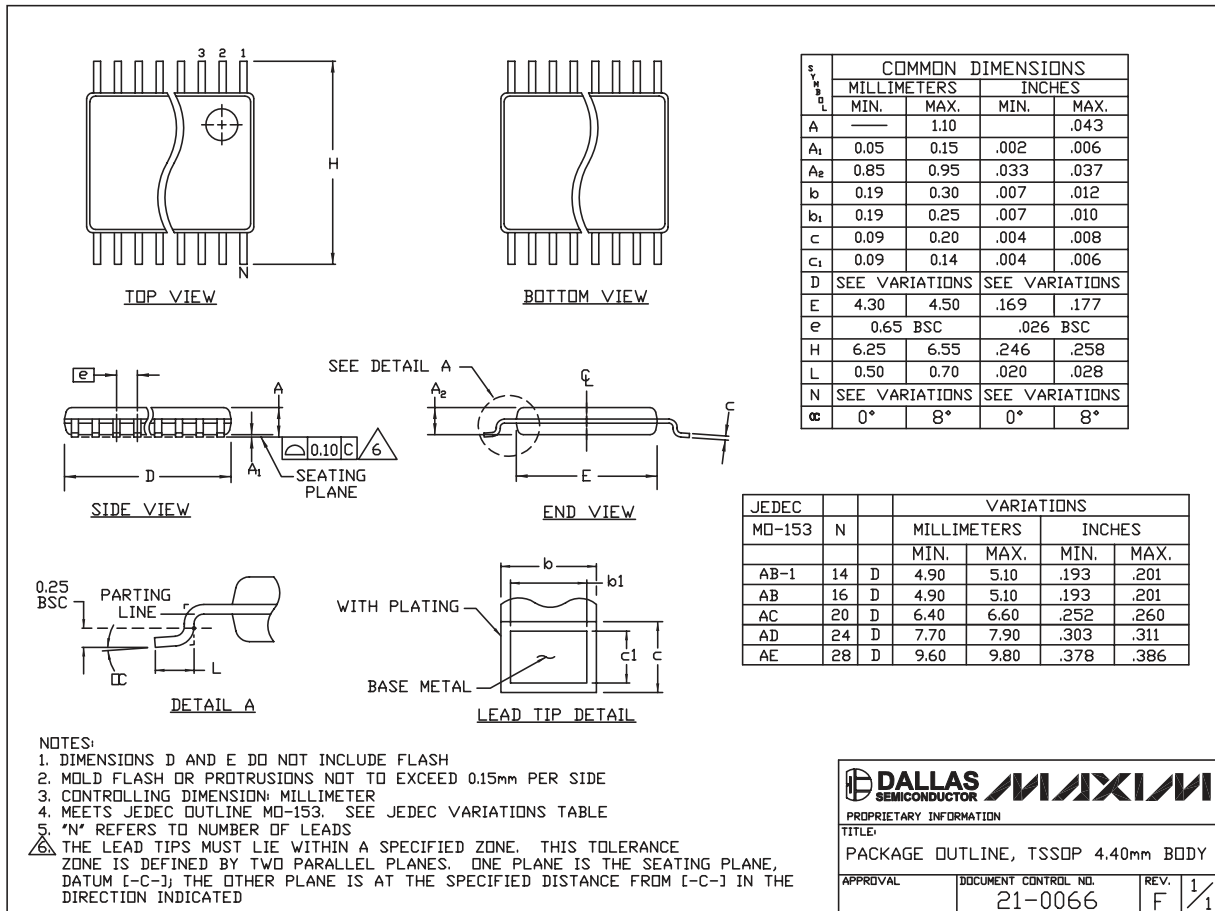
MAX3341E/MAX3342E



# ±15kV ESD-Protected USB Level Transceivers in UCSP with USB Detect

## 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).)



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