19-2844; Rev 1; 8/03

±15kV ESD-Protected USB On-the-Go Charge Pump and Comparators in UCSP

MAX3355E

General Description

The MAX3355E integrates a charge pump and comparators to enable a system with an integrated USB on-the-go (OTG) dual-role transceiver to function as a USB OTG dual-role device. USB OTG facilitates the direct connection of peripherals and mobile devices such as PDAs, cellular phones, MP3 players, and digital cameras to one another without a host PC.

The MAX3355E's internal charge pump supplies V_{BUS} power and signaling that is required by the transceiver as defined in *On-the-Go Supplement to the USB 2.0 Specification, Revision 1.0*. The MAX3355E features ID detection and internal comparators for monitoring V_{BUS}. The V_{BUS} status outputs are used during negotiation for the USB according to the session request protocol (SRP) and host negotiation protocol (HNP).

The MAX3355E operates with logic supply voltages (V_L) as low as 1.65V, ensuring compatibility with low-voltage ASICs. The device also features a logic-selectable 1µA shutdown mode.

The MAX3355E has built-in ±15kV ESD-protection circuitry to protect the V_{BUS} and ID_IN pins. The device is available in a miniature 4 x 3 chip-scale package (UCSP), as well as a 14-pin TSSOP package, and is specified for operation over the -40°C to +85°C extended temperature range.

Applications

Cell Phones
PDAs
MP3 Players
Digital Cameras

Features

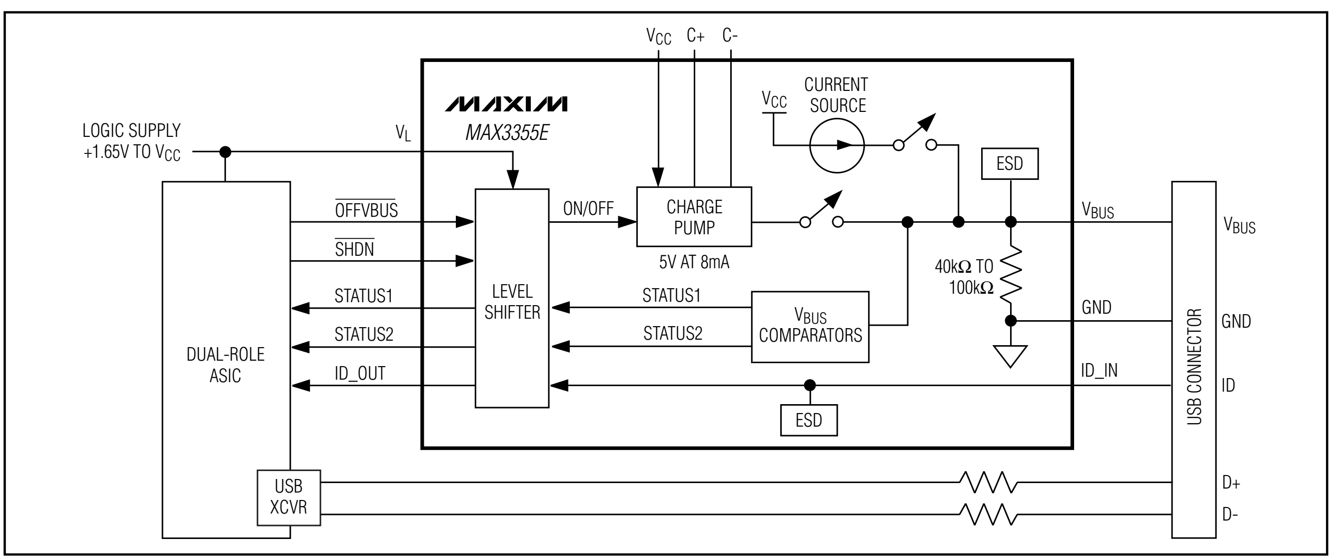
- ♦ **Guaranteed 8mA (min) V_{BUS} Charge-Pump Output**
- ♦ **±15kV ESD Protection on V_{BUS} and ID_IN**
- ♦ **Up to +6.0V Backdrive Capability for V_{BUS}**
- ♦ **+2.6V to +5.5V Operating Voltage Range**
- ♦ **V_L Operates Down to +1.65V**
- ♦ **Guaranteed V_{BUS} Input Impedance When Not Driven**
- ♦ **Automatic C_{LOAD} Detection**
- ♦ **Comparators for Host Negotiation Protocol**
- ♦ **ID_IN Detection**
- ♦ **Available in 4 x 3 UCSP or 14-Pin TSSOP Package**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX3355EEBC-T	-40°C to +85°C	4 x 3 UCSP	ABE
MAX3355EEUD	-40°C to +85°C	14 TSSOP	—

Pin Configurations appear at end of data sheet.

Functional Diagram



±15kV ESD-Protected USB On-the-Go Charge Pump and Comparators in UCSP

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND)
V_{CC}, V_L, V_{BUS}, ID_IN ....-0.3V to +6.0V
C+..(V_{CC} - 0.3V) to +6V
C-...-0.3V to (V_{CC} + 0.3V)
$\overline{OFFVBUS}$, $\overline{SHDN}$, STATUS1,
STATUS2, ID_OUT ....-0.3V to (V_L + 0.3V)
V_{BUS} Short Circuit to GND ....Continuous
Output Current (all other pins)...±15mA
Continuous Power Dissipation (T_A = +70°C)
4 x 3 UCSP (derate 6.5mW/°C above +70°C) 520mW
14-Pin TSSOP (derate 9.1mW/°C above +70°C) 727mW
Operating Temperature Range ....-40°C to +85°C
Storage Temperature Range ....-65°C to +150°C
Junction Temperature ....+150°C
Lead Temperature (soldering, 10s) ....+300°C
Bump Temperature (soldering)
Infrared (15s) ....+200°C
Vapor Phase (20s) ....+215°C

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

ELECTRICAL CHARACTERISTICS

(V_{CC} = +2.6V to +5.5V, V_L = +1.65V to V_{CC}, C1 = 0.1µF, V_{CC} decoupled with 1µF capacitor to GND, V_L decoupled with 0.1µF capacitor to GND, C_{LOAD} = 1µF (min), ESR_{LOAD} = 1Ω (max), T_A = T_{MIN} to T_{MAX}. Typical values are at V_{CC} = +3.0V, V_L = 1.8V, T_A = +25°C, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}		2.6		5.5	V
Logic Supply Voltage	V_L		1.65		V_{CC}	V
Logic Supply Current	I_L				100	µA
Operating Supply Current	I_{CC}	No activity on V_{BUS}; comparator and reference active			200	µA
		Device A configured, $\overline{OFFVBUS}$ = V_L, I_{LOAD} = 8mA, charge pump on			20	mA
Shutdown Supply Current	$I_{CC\overline{SHDN}}$	Device B configured, $\overline{SHDN}$ = GND			1	µA
		Device A configured, $\overline{SHDN}$ = GND		30		
Thermal-Shutdown Protection Threshold		Device A configured, $\overline{OFFVBUS}$ = V_L, charge pump on		+150		°C
Thermal-Shutdown Protection Hysteresis		Device A configured, $\overline{OFFVBUS}$ = V_L, charge pump on		+20		°C
LOGIC INPUTS AND OUTPUTS						
STATUS1, STATUS2, ID_OUT Output Voltage	V_{OH}	I_{SOURCE} = +1mA	2/3 x V_L			V
	V_{OL}	I_{SINK} = -1mA			0.4	
$\overline{OFFVBUS}$, $\overline{SHDN}$ Input Voltage	V_{IH}		2/3 x V_L			V
	V_{IL}				0.4	
Input Leakage Current	I_{LKG}	$\overline{OFFVBUS}$, $\overline{SHDN}$ = GND or V_L			±1	µA
V_{BUS} OUTPUT VOLTAGE: DEVICE A CONFIGURED						
V_{BUS} Output Voltage		I_{LOAD} = 0 to 8mA, C_{LOAD} = 1µF, $\overline{OFFVBUS}$ = V_L, ID_IN = GND	4.63		5.25	V
		No load, C_{LOAD} = 1µF, $\overline{OFFVBUS}$ = V_L, ID_IN = GND		4.8		
V_{BUS} Leakage Voltage		$\overline{OFFVBUS}$ = GND			200	mV
V_{BUS} Sink Current		$\overline{OFFVBUS}$ = GND, V_{BUS} = +6.0V			150	µA

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +2.6V to +5.5V, V_L = +1.65V to V_{CC}, C1 = 0.1µF, V_{CC} decoupled with 1µF capacitor to GND, V_L decoupled with 0.1µF capacitor to GND, C_{LOAD} = 1µF (min), ESR_{LOAD} = 1Ω (max), T_A = T_{MIN} to T_{MAX}. Typical values are at V_{CC} = +3.0V, V_L = 1.8V, T_A = +25°C, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
V_{BUS} Source Current		$\overline{OFFVBUS}$ = V_L, ID_IN = GND	8			mA
V_{BUS} Short-Circuit Current Limit		V_{BUS} shorted to GND			200	mA
V_{BUS} Output Ripple		I_{LOAD} = 8mA, C_{LOAD} = 1µF, $\overline{OFFVBUS}$ = V_L, ID_IN = GND (Note 3)		100		mV
Charge-Pump Switching Frequency				500		kHz
V_{BUS} Input Impedance	R_{INVBUS}	$\overline{OFFVBUS}$ = GND or $\overline{SHDN}$ = GND	40		100	kΩ
LOAD DETECTION V_{BUS} OUTPUT VOLTAGE						
V_{BUS} Output Voltage		C_{LOAD} = 20µF, $\overline{OFFVBUS}$ = V_L, ID_IN = V_{CC}, I_{BUS} source on-time = $t_{VBUSCHRG}$	2.1			V
		C_{LOAD} = 95µF, $\overline{OFFVBUS}$ = V_L, ID_IN = V_{CC}, I_{BUS} source on-time = $t_{VBUSCHRG}$			1.9	
V_{BUS} Source Current		$\overline{OFFVBUS}$ = V_L, ID_IN = V_{CC} (Note 4)	450	600	850	µA
V_{BUS} Current Gate Time	$t_{VBUSCHRG}$	$\overline{OFFVBUS}$ = V_L, ID_IN = V_{CC}, Device B (Note 4)	155 (max)	105	56 (min)	ms
V_{BUS} COMPARATOR						
V_{BUS} Valid Comparator Threshold	$V_{THVBUSVLD}$	V_{BUS} rising	4.4	4.55	4.63	V
V_{BUS} Valid Comparator Hysteresis				20		mV
Session Valid Comparator Threshold	$V_{THSESVLD}$		1.12	1.4	1.68	V
Session Valid Comparator Hysteresis				15		mV
B-Session End Comparator Threshold	$V_{THSESEND}$		0.4	0.5	0.6	V
B-Session End Comparator Hysteresis				30		mV
Shutdown Comparator	$V_{TH,\overline{SHDN}}$		0.8		2.4	V
ID_IN						
ID_IN Voltage Input for Device B			2/3 x V_{CC}			V
ID_IN Voltage Input for Device A					0.4	V
ID_IN Input Impedance			150	200	250	kΩ
ESD PROTECTION (ID_IN, V_{BUS})						
Human Body Model				±15		kV
IFC 1000-4-2 Air-Gap Discharge				±15		kV
IFC 1000-4-2 Contact Discharge				±8		kV

±15kV ESD-Protected USB On-the-Go Charge Pump and Comparators in UCSP

TIMING CHARACTERISTICS

(V_{CC} = +2.6V to +5.5V, V_L = +1.65V to V_{CC}, C1 = 0.1µF, V_{CC} decoupled with 1µF capacitor to GND, V_L decoupled with 0.1µF capacitor to GND, C_{LOAD} = 1µF (min), ESR_{LOAD} = 1Ω (max), T_A = T_{MIN} to T_{MAX}. Typical values are at V_{CC} = +3.0V, V_L = 1.8V, T_A = +25°C, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
V_{BUS} Rise Time		0 to 4.4V, C_{LOAD} = 1µF, I_{LOAD} = 8mA			100	ms
$\overline{OFFVBUS}$ Propagation Delay				6		µs
Comparator Propagation Delay				3		µs
Time to Exit Shutdown				50		µs
Time to Shutdown				1		µs
ID_OUT Rise Time		C_{ID_OUT} = 50pF		10		ns
ID_OUT Fall Time		C_{ID_OUT} = 50pF		10		ns

Note 1: Limits are 100% production tested at +25°C. Limits over temperature are guaranteed by design.

Note 2: All currents out of the device are positive; all currents into the device are negative. All voltages are referenced to device ground unless otherwise specified.

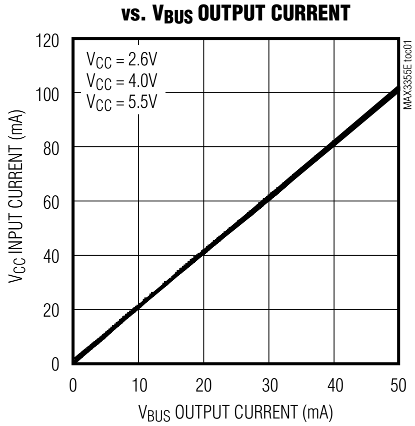
Note 3: The ripple voltage is strongly correlated to the bus capacitance and its ESR.

Note 4: The V_{BUS} current source and current gate time vary together with process and temperature such that the resulting V_{BUS} pulse is guaranteed to drive a <13µF load to a voltage >2.0V, and to drive a >96µF load to a voltage <2.2V.

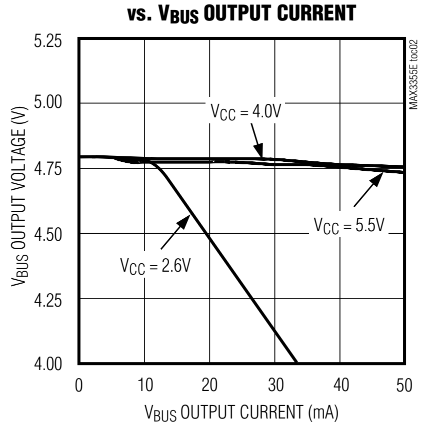
Typical Operating Characteristics

(V_{CC}, V_L = +3.3V, C1 = 0.1µF, V_{CC} decoupled with 1µF capacitor to GND, V_L decoupled with 0.1µF capacitor to GND, C_{LOAD} = 1µF min, ESR_{LOAD} = 1Ω max, T_A = +25°C, unless otherwise noted.)

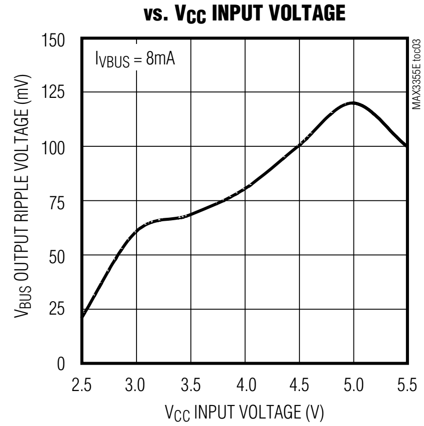
V_{CC} INPUT CURRENT vs. V_{BUS} OUTPUT CURRENT



V_{BUS} OUTPUT VOLTAGE vs. V_{BUS} OUTPUT CURRENT



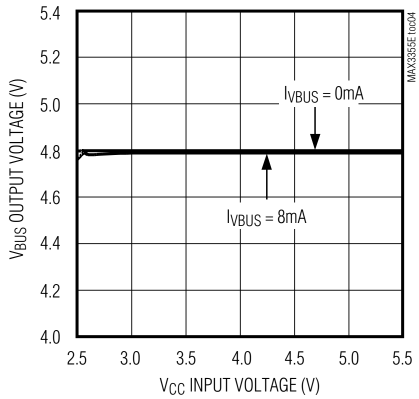
V_{BUS} OUTPUT RIPPLE VOLTAGE vs. V_{CC} INPUT VOLTAGE



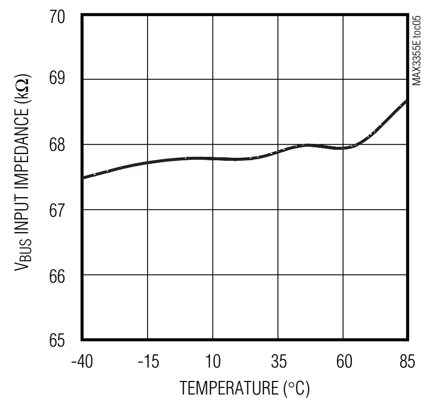
Typical Operating Characteristics (continued)

(V_{CC}, V_L = +3.3V, C1 = 0.1µF, V_{CC} decoupled with 1µF capacitor to GND, V_L decoupled with 0.1µF capacitor to GND, C_{LOAD} = 1µF min, ESR_{LOAD} = 1Ω max, T_A = +25°C, unless otherwise noted.)

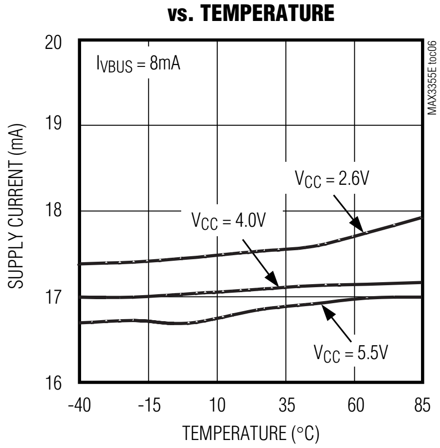
V_{BUS} OUTPUT VOLTAGE vs. V_{CC} INPUT VOLTAGE



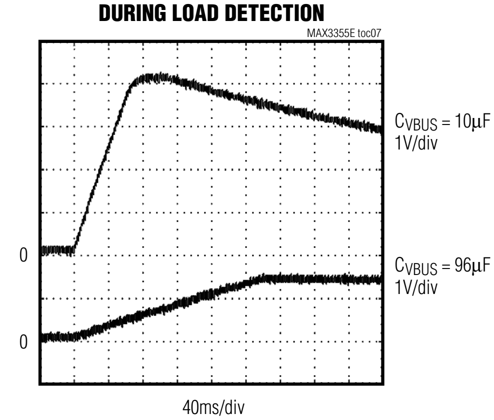
V_{BUS} INPUT IMPEDANCE vs. TEMPERATURE



SUPPLY CURRENT vs. TEMPERATURE



V_{BUS} vs. CAPACITANCE LOAD DURING LOAD DETECTION

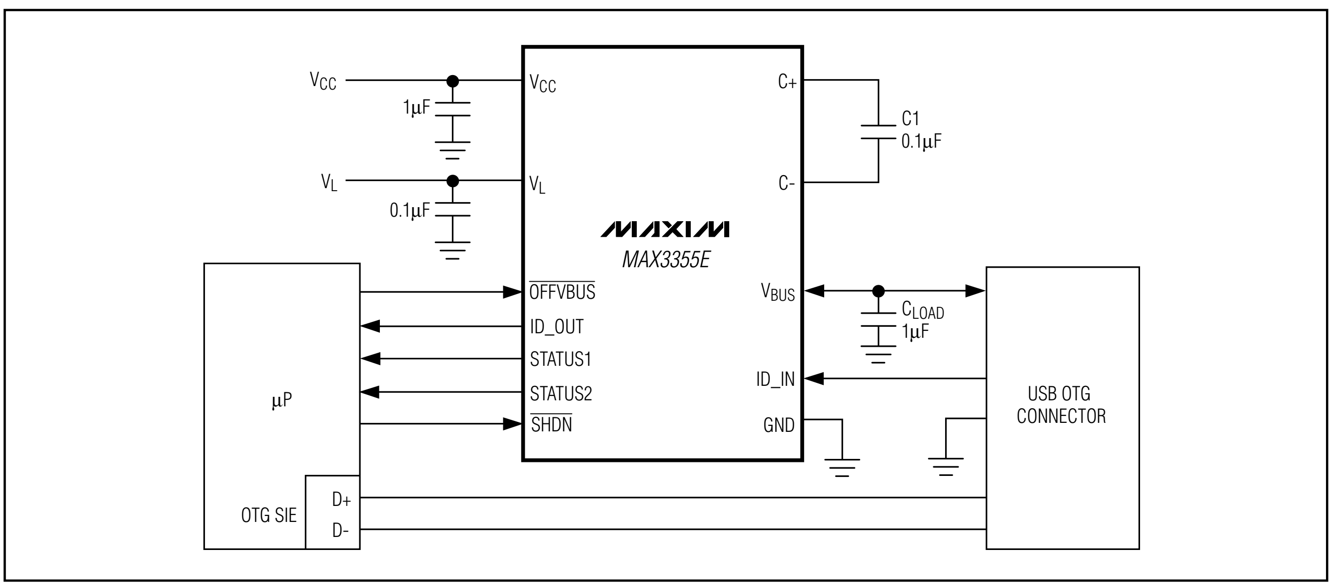


±15kV ESD-Protected USB On-the-Go Charge Pump and Comparators in UCSP

Pin Description

PIN		NAME	FUNCTION
UCSP	TSSOP		
A1	2	V_{CC}	Power Supply. +2.6V to +5.5V input supply. Bypass V_{CC} to GND with a 1µF capacitor.
A2	3	ID_OUT	Device ID Output. Output of ID_IN level translated to V_L.
A3	5	STATUS1	Status Output 1. Provides output voltage detection for use during HNP handshaking (Tables 1 and 2).
A4	6	STATUS2	Status Output 2. Provides output voltage detection for use during HNP handshaking (Tables 1 and 2).
B1	1	V_{BUS}	USB Supply. V_{BUS} provides a nominal +5.0V output when ID_IN is low and $\overline{\text{OFFVBUS}}$ is high. V_{BUS} is lower than +2.1V when ID_IN is open or a load greater than 96.5µF is sensed. V_{BUS} can be backdriven to +6.0V without any consequence. Bypass V_{BUS} to GND with a 1µF capacitor.
B2	4	$\overline{\text{OFFVBUS}}$	V_{BUS} Off. Turns the internal charge pump providing V_{BUS} on and off.
B3	11	$\overline{\text{SHDN}}$	Shutdown. Connect $\overline{\text{SHDN}}$ to GND to enter shutdown and reduce supply current to less than 1µA. Connect $\overline{\text{SHDN}}$ to V_L for normal operation.
B4	9	V_L	Logic Supply. V_L sets the logic output high voltage and logic input high threshold. V_L must be between +1.65V and V_{CC}.
C1	14	C+	Charge-Pump Positive Connection
C2	13	C-	Charge-Pump Negative Connection
C3	12	GND	Ground
C4	10	ID_IN	Device ID. ID_IN is internally pulled up to V_{CC}. Leave ID_IN open for device B and connect ID_IN to GND for device A.
—	7, 8	N.C.	No Connection

Typical Application Circuit



Detailed Description

USB OTG is an emerging USB standard that enables devices to talk in a peer-to-peer manner on a USB bus. OTG allows peripherals and mobile devices such as PDAs, cellular phones, and digital cameras to be attached directly to one another without requiring a PC host.

The MAX3355E integrates a charge pump and comparators to enable a system with an integrated USB OTG dual-role transceiver to function as a USB OTG dual-role device. The MAX3355E's internal charge pump supplies V_{BUS} power and signaling as defined in *On-the-Go Supplement: USB 2.0, Revision 1.0*. The MAX3355E's internal level-detection comparators monitor important V_{BUS} voltages needed to support SRP and HNP.

Table 1. Status Bit Significance

STATUS1	STATUS2	SIGNIFICANCE
0	0	$V_{BUS} < V_{THSESEND}$
1	0	$V_{THSESEND} < V_{BUS} < V_{THSESVLD}$
0	1	$V_{THSESVLD} < V_{BUS} < V_{THVBUSVLD}$
1	1	$V_{BUS} > V_{THVBUSVLD}$

Table 2. Status Bit Shutdown Functionality ($\overline{SHDN}$ = GND)

STATUS1	STATUS2	SIGNIFICANCE
0	1	$V_{BUS} < V_{TH,\overline{SHDN}}$
0	0	$V_{BUS} > V_{TH,\overline{SHDN}}$

Table 3. Device ID

ID_IN	ID_OUT	CONFIGURATION
0	0	Device A
Open	V_L	Device B

Charge Pump

The MAX3355E provides power for the V_{BUS} line using an internal charge pump. The charge pump provides an OTG-compliant output on V_{BUS} while sourcing 8mA load current. The charge pump can be powered from voltages between +2.6V and +5.5V. A 0.1µF flying capacitor, connected between C+ and C-, and a 1µF (min) decoupling reservoir capacitor on V_{BUS} are required for proper operation.

The charge pump is active if $\overline{OFFVBUS}$ is connected to V_L and the MAX3355E is configured as device A (ID_IN connected to GND). To minimize V_{BUS} ripple, select a reservoir capacitor value between 1µF and 6.8µF. The charge-pump output is protected from short-circuit conditions on V_{BUS} by an internal current clamp that limits the V_{BUS} current to 200mA.

Current Generator

An internal current generator injects up to 600µA of current onto the V_{BUS} line. The current generator is stable over the supply voltage variation. The current generator is connected to V_{BUS} when $\overline{OFFVBUS}$ and $\overline{SHDN}$ are 1 and ID_IN is open. It remains connected for $t_{VBUSCHRG}$ or until the V_{BUS} line voltage exceeds the lower of V_{CC} and 4.82V.

Comparators

The MAX3355E contains internal comparators for monitoring the V_{BUS} voltage. The status of V_{BUS} is summarized in two status outputs: STATUS1 and STATUS2. The status outputs can be used to negotiate for the USB OTG bus. The V_{BUS} status is conveyed according to Table 1. While in shutdown mode, the STATUS2 output can be used to indicate V_{BUS} voltage (Table 2).

Device ID

Configure the MAX3355E as device A by connecting ID_IN to GND and as device B by leaving ID_IN open (Table 3). ID_IN is level translated to V_L and provided as an output at ID_OUT. V_L sets the logic output high level. ID_IN is internally pulled up to V_{CC}.

Table 4. Function Select

$\overline{SHDN}$	$\overline{OFFVBUS}$	ID_IN	V_{BUS}	CHARGE PUMP	COMPARATORS
0	X	X	R_{INVBUS}	Inactive	Inactive
1	0	X	R_{INVBUS}	Inactive	Active
1	1	0	5V	Active	Active
1	1	1	R_{INVBUS} (Note 5)	Inactive	Active

Note: *The 600µA current source is supplied for* $t_{VBUSCHRG}$ *(see the Current Generator section).*

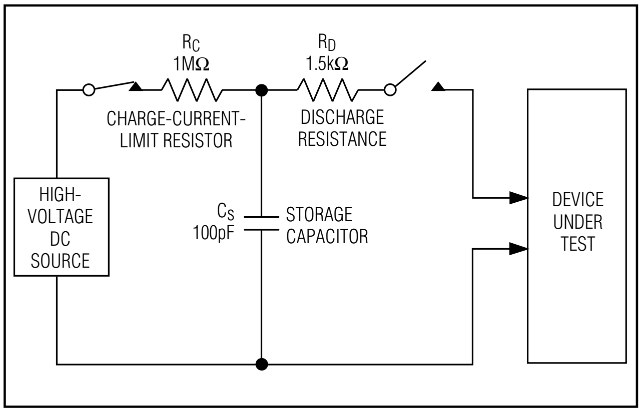


Figure 1. Human Body ESD Test Model

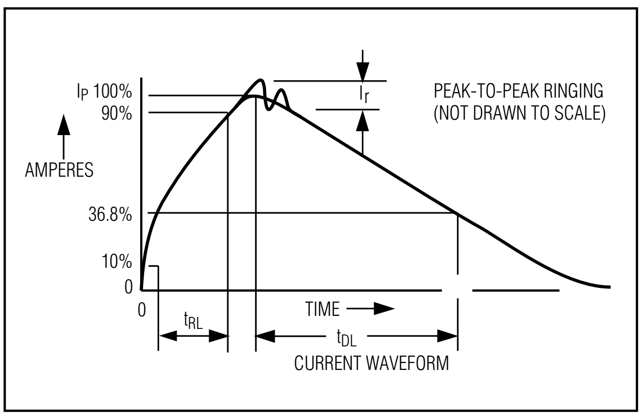


Figure 2. Human Body Current Waveform

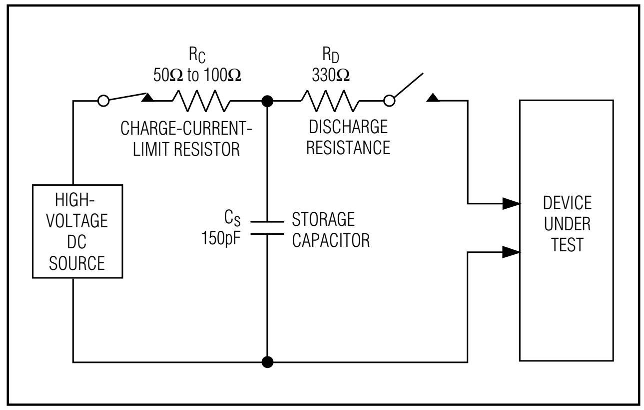


Figure 3. IEC 1000-4-2 ESD Test Model

$\overline{\text{OFFVBUS}}$

Connect $\overline{\text{OFFVBUS}}$ to GND to disable V_{BUS} and the charge pump (Table 4). For normal V_{BUS} operation, connect $\overline{\text{OFFVBUS}}$ to V_L. When $\overline{\text{OFFVBUS}}$ = GND, V_{BUS} impedance is between 40kΩ to 100kΩ as defined in *On-the-Go Supplement: USB 2.0, Revision 1.0.*

$\overline{\text{SHDN}}$

The MAX3355E shutdown mode reduces supply current to less than 1µA. To enter shutdown mode, connect $\overline{\text{SHDN}}$ to GND. Shutdown mode disables the charge pump and comparators (Table 4). While in shutdown mode, the STATUS1 output defaults to logic 0 and STATUS2 indicates V_{BUS}. During shutdown, if V_{BUS} is externally driven above $V_{TH,\overline{SHDN}}$ (defined in the *Comparators* section), the MAX3355E sinks current from V_{CC}.

Applications Information

±15kV ESD Protection

To protect the MAX3355E against ESD, ID_IN and V_{BUS} have extra protection against static electricity to protect the device up to ±15kV. For ±15kV protection on V_{BUS}, a 1µF capacitor must be connected from V_{BUS} to GND as close to the device as possible. The ESD structures withstand high ESD in all states—normal operation, shutdown, and powered down. ESD protection can be tested in various ways. The ID_IN input and V_{BUS} 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 Discharge method

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 1 shows the Human Body Model and Figure 2 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 MAX3355E helps 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. This occurs 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 3 shows the IEC 1000-4-2 model. The Air-Gap Discharge 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. All pins require this protection during manufacturing. After PC board assembly, the Machine Model is less relevant to I/O ports.

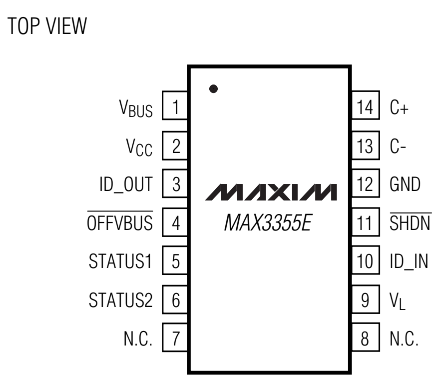
Layout Considerations

The MAX3355E charge-pump switching frequency makes proper layout important to ensure stability and maintain the output voltage under all loads. For best performance, minimize the distance between the capacitors and the MAX3355E.

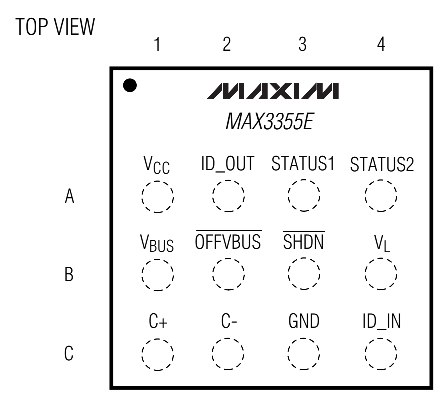
UCSP Applications Information

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 Maxim Application Note: *UCSP–A Wafer-Level Chip-Scale Package* available on Maxim's web site at www.maxim-ic.com/ucsp.

Pin Configurations



TSSOP



UCSP

Chip Information

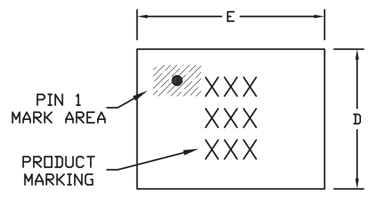
TRANSISTOR COUNT: 1601

PROCESS: BiCMOS

±15kV ESD-Protected USB On-the-Go Charge Pump and Comparators 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**.)

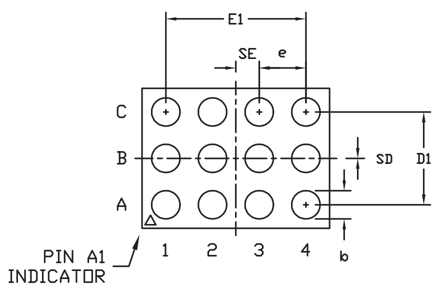


TOP VIEW

COMMON DIMENSIONS	
A	0.62+0.05-0.08
A1	0.29±0.02
A2	0.33 REF.
b	ø0.35±0.03
D1	1.00 BASIC
E1	1.50 BASIC
e	0.50 BASIC
SD	0.00 BASIC
SE	0.25 BASIC

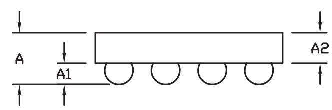
PKG. CODE	VARIABLE DIMENSIONS		DEPOPULATED SOLDER BALLS
	D	E	
B12-1	1.54±0.05	2.02±0.05	NONE
B12-2	1.54±0.05	2.02±0.05	B3
B12-3	1.54±0.05	2.12±0.05	NONE
B12-4	1.54±0.05	2.02±0.05	B2, B3
B12-5	1.64±0.05	2.12±0.05	B2
B12-6	1.64±0.05	2.12±0.05	B3
B12-7	1.54±0.05	2.02±0.05	B1, B3
B12-8	1.54±0.05	2.02±0.05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

12L, UCSP 4x3.EPS



BOTTOM VIEW

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



SIDE VIEW

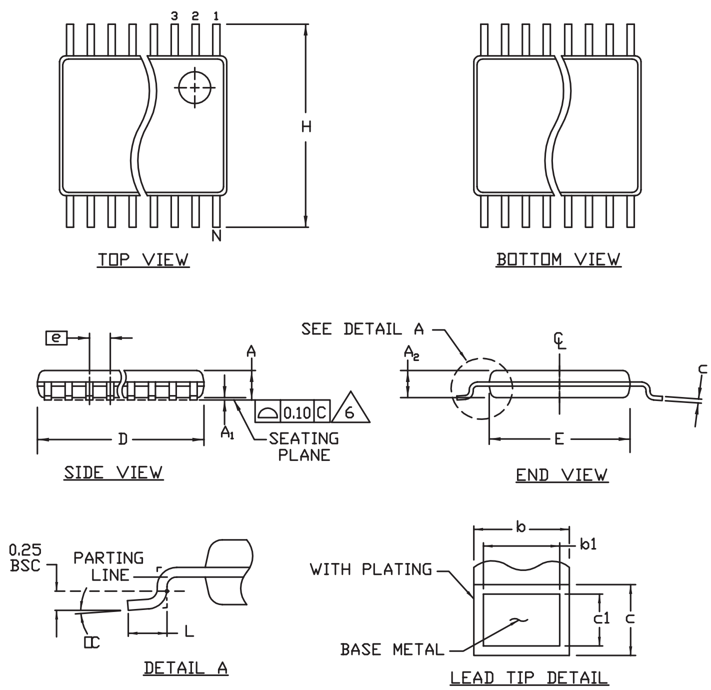
DALLAS SEMICONDUCTOR MAXIM
PROPRIETARY INFORMATION
TITLE:
PACKAGE OUTLINE, 4x3 UCSP
APPROVAL | DOCUMENT CONTROL NO. 21-0104 | REV. F | 1/1

MAX3355E Package Code: B12-1

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**.)

TSSOP4.40mm.EPS



SYMBOL	COMMON DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	—	1.10		.043
A_1	0.05	0.15	.002	.006
A_2	0.85	0.95	.033	.037
b	0.19	0.30	.007	.012
b_1	0.19	0.25	.007	.010
c	0.09	0.20	.004	.008
c_1	0.09	0.14	.004	.006
D	SEE VARIATIONS		SEE VARIATIONS	
E	4.30	4.50	.169	.177
e	0.65 BSC		.026 BSC	
H	6.25	6.55	.246	.258
L	0.50	0.70	.020	.028
N	SEE VARIATIONS		SEE VARIATIONS	
α	0°	8°	0°	8°

JEDEC			VARIATIONS			
MO-153	N		MILLIMETERS		INCHES	
			MIN.	MAX.	MIN.	MAX.
AB-1	14	D	4.90	5.10	.193	.201
AB	16	D	4.90	5.10	.193	.201
AC	20	D	6.40	6.60	.252	.260
AD	24	D	7.70	7.90	.303	.311
AE	28	D	9.60	9.80	.378	.386

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

DALLAS SEMICONDUCTOR MAXIM
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, TSSOP 4.40mm BODY
APPROVAL | DOCUMENT CONTROL NO. 21-0066 | REV. F | 1/1