19-1604; Rev 1; 3/00

MAXIM

±15kV ESD-Protected, 1Mbps, 1µA RS-232 Transmitters in SOT23-6

General Description

The MAX3188E/MAX3189E single RS-232 transmitters in a SOT23-6 package are for space- and cost-constrained applications requiring minimal RS-232 communications. These devices consume only 150µA of supply current from ±4.5V to ±6V supplies. They feature a shutdown input that reduces current consumption to only 1µA and forces the transmitter output into a high-impedance state. RS-232 data transmission is guaranteed up to 250kbps with the MAX3188E and up to 1Mbps with the MAX3189E.

The MAX3188E/MAX3189E are EIA/TIA-232 transmitters that convert CMOS/TTL logic levels to RS-232-compliant signals. The transmitter output is protected to ±15kV using the IEC 1000-4-2 Air-Gap Discharge method, to ±8kV using the IEC 1000-4-2 Contact Discharge method, and to ±15kV per the Human Body Model, ensuring strict compliance with international standards. The MAX3188E/MAX3189E transmitters have a standard inverting output.

Applications

Diagnostic Ports

Telecommunications

Networking Equipment

Set-Top Boxes

Digital Cameras

Hand-Held Equipment

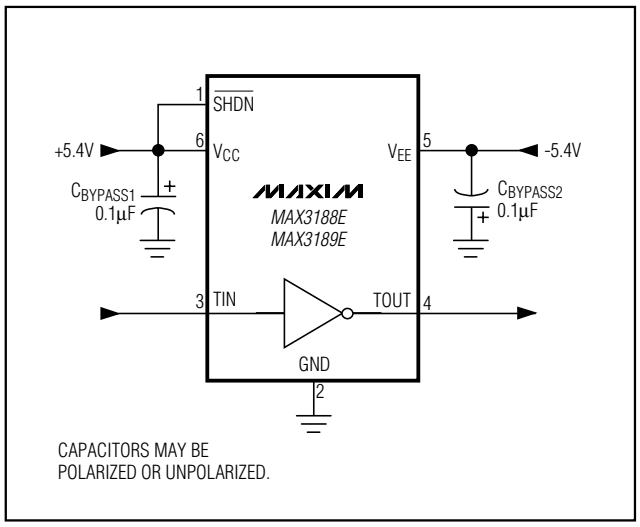
Features

- **Small 6-Pin SOT23 Package**
- **ESD-Protected RS-232 Output**
  - **±15kV per Human Body Model**
  - **±8kV per IEC 1000-4-2, Contact Discharge**
  - **±15kV per IEC 1000-4-2, Air-Gap Discharge**
- **150µA Operating Supply Current**
- **Shutdown Reduces Supply Current to 1µA**
- **Guaranteed Data Rate**
  - **1Mbps (MAX3189E)**
  - **250kbps (MAX3188E)**
- **Three-State RS-232 Transmitter Output**
- **No External Components**

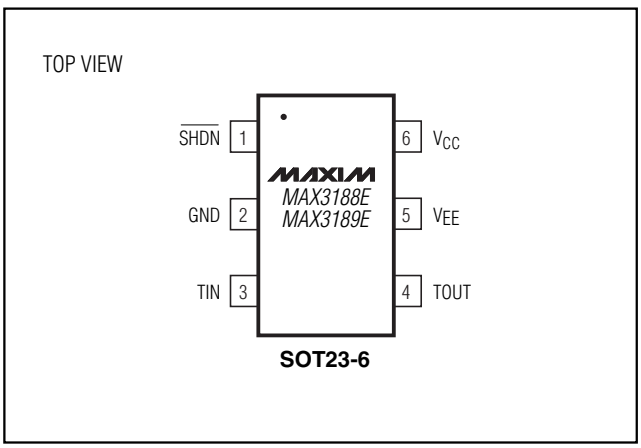
Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE	TOP MARK
MAX3188EEUT-T	-40°C to +85°C	6 SOT23-6	AAHD
MAX3189EEUT-T	-40°C to +85°C	6 SOT23-6	AAHE

Typical Operating Circuit



Pin Configuration



For price, delivery, and to place orders, please contact Maxim Distribution at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

±15kV ESD-Protected, 1Mbps, 1µA RS-232 Transmitters in SOT23-6

ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND (Note 1) ..... -0.3V to +7V
V_{EE} to GND (Note 1) ..... +0.3V to -7V
V_{CC} to V_{EE} (Note 1) ..... +13V
TIN, $\overline{SHDN}$ to GND ..... -0.3V to +7V
TOUT to GND ($\overline{SHDN}$ = GND) ..... ±13.2V
TOUT to GND ($\overline{SHDN}$ = V_{CC}) ..... ±7V
Output Short-Circuit Duration ..... Continuous

Continuous Power Dissipation (T_A = +70°C)
6-Pin SOT23 (derate 8.7mW/°C above +70°C) 691mW
Operating Temperature Range ..... -40°C to +85°C
Junction Temperature ..... +150°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10s) ..... +300°C

Note 1: V_{CC} and V_{EE} can have maximum magnitudes of 7V, but their absolute difference cannot exceed 13V.

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} = +4.5V to +6V, V_{EE} = -4.5V to -6V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.4V, V_{EE} = -5.4V, and T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DC CHARACTERISTICS							
Positive Supply Voltage	V_{CC}			4.5		6	V
Negative Supply Voltage	V_{EE}			-6		-4.5	V
Positive Supply Current	I_{CC}	$V_{\overline{SHDN}}$ = 5V				170	µA
Negative Supply Current	I_{EE}	$V_{\overline{SHDN}}$ = 5V		45			µA
Shutdown Supply Current		$V_{\overline{SHDN}}$ = 0			0.2	1	µA
INPUT LOGIC (TIN, SHDN)							
Input Logic Threshold Low	V_{IL}					0.8	V
Input Logic Threshold High	V_{IH}			2.0			V
Input Leakage					±0.01	±1	µA
TIN Input Hysteresis					100		mV
TRANSMITTER OUTPUTS							
Output Voltage Swing	V_{TOUT}	V_{CC} = 4.5V, V_{EE} = -4.5V, R_L = 3kΩ		±3.7			V
		V_{CC} = 5.4V, V_{EE} = -5.4V, R_L = 3kΩ		±5			
Output Resistance	R_{TOUT}	V_{CC} = V_{EE} = 0, V_{TOUT} = ±2V		300			Ω
Output Short-Circuit Current					±35	±60	mA
Output Leakage Current	I_{TOUT}	V_{OUT} = ±12V; V_{CC} = V_{EE} = 0 or V_{CC} = 5.4V, V_{EE} = -5.4V; $\overline{SHDN}$ = 0				±25	µA
TIMING CHARACTERISTICS							
Maximum Data Rate		R_L = 3kΩ, C_L = 1000pF	MAX3188E	0.25			Mbps
			MAX3189E	1			
Transmitter Skew	t_{TS}	$\lvert t_{PHL} - t_{PLH} \rvert$, Figure 1	MAX3188E		100		ns
			MAX3189E		25		
Transition-Region Slew Rate		R_L = 3kΩ to 7kΩ, C_L = 150pF to 1000pF, measured from -3V to +3V or +3V to -3V, V_{CC} = 5.4V, V_{EE} = -5.4V, T_A = +25°C	MAX3188E	6		30	V/µs
			MAX3189E	24		150	
Transmitter Enable Time	t_{EN}				2		µs

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +4.5V to +6V, V_{EE} = -4.5V to -6V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.4V, V_{EE} = -5.4V, and T_A = +25°C.) (Note 2)

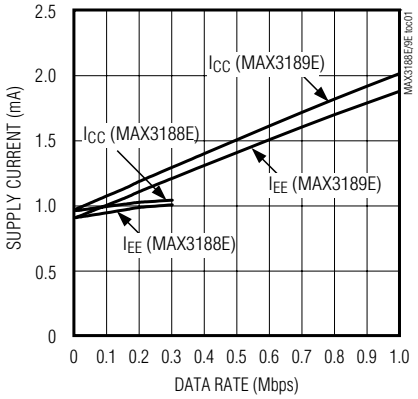
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
ESD PROTECTION						
TOUT		IEC 1000-4-2 Air-Gap Discharge		±15		kV
		IEC 1000-4-2 Contact Discharge		±8		
		Human Body Model		±15		

Note 2: All devices are 100% tested at T_A = +25°C. All limits over temperature are guaranteed by design.

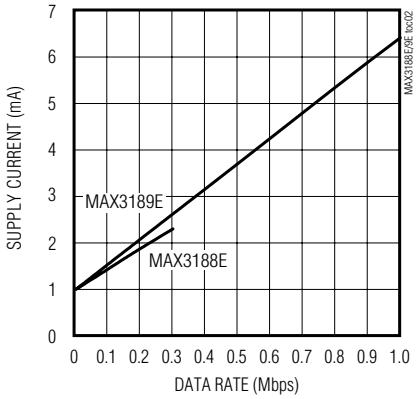
Typical Operating Characteristics

(V_{CC} = +5.4V, V_{EE} = -5.4V, R_L = 3kΩ, T_A = +25°C, unless otherwise noted.)

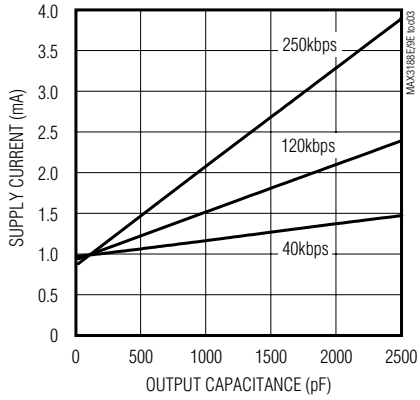
SUPPLY CURRENT vs. DATA RATE (C_L = 150pF)



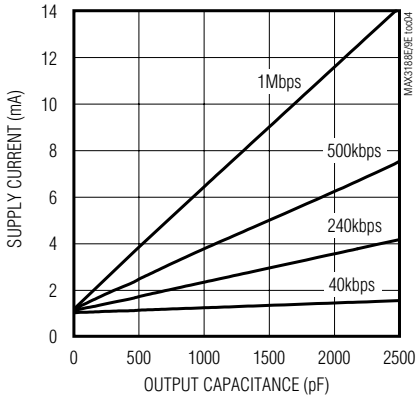
SUPPLY CURRENT vs. DATA RATE (C_L = 1000pF)



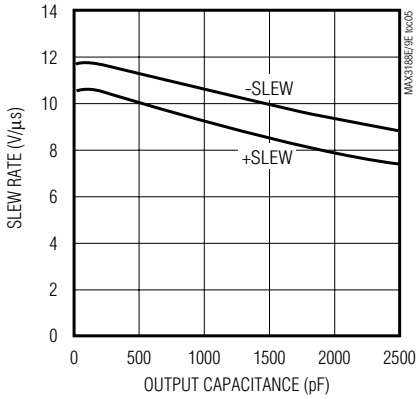
MAX3188E SUPPLY CURRENT vs. OUTPUT CAPACITANCE



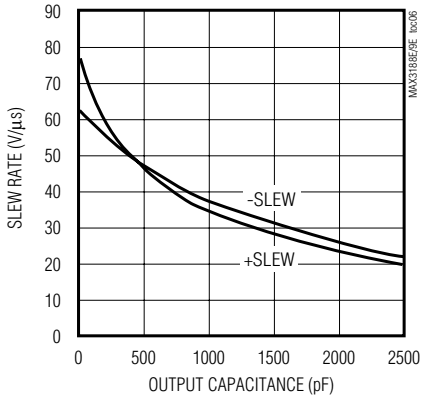
MAX3189E SUPPLY CURRENT vs. OUTPUT CAPACITANCE



MAX3188E SLEW RATE vs. OUTPUT CAPACITANCE



MAX3189E SLEW RATE vs. OUTPUT CAPACITANCE

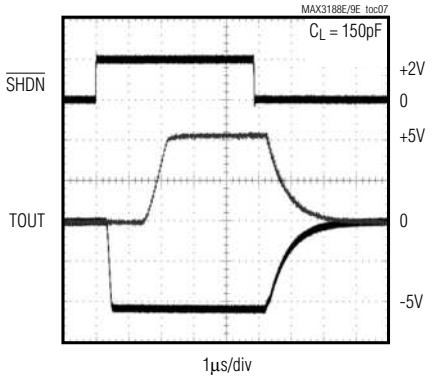


±15kV ESD-Protected, 1Mbps, 1µA RS-232 Transmitters in SOT23-6

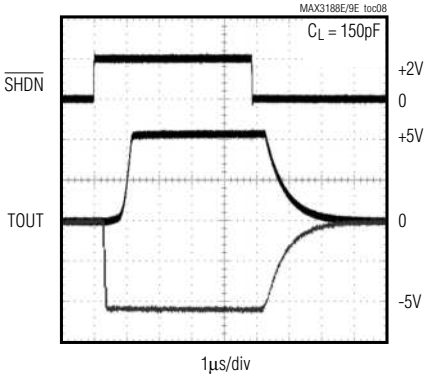
Typical Operating Characteristics (continued)

(V_{CC} = +5.4V, V_{EE} = -5.4V, R_L = 3kΩ, T_A = +25°C, unless otherwise noted.)

MAX3188E TRANSMITTER OUTPUT SHUTDOWN WAVEFORM



MAX3189E TRANSMITTER OUTPUT SHUTDOWN WAVEFORM



Pin Description

PIN	NAME	FUNCTION
1	$\overline{SHDN}$	Active-Low Shutdown. Pull low to reduce the supply current and to force TOUT into a high-impedance state.
2	GND	Ground
3	TIN	TTL/CMOS Transmitter Input
4	TOUT	RS-232 Transmitter Output
5	V_{EE}	Negative Supply Voltage
6	V_{CC}	Positive Supply Voltage

Detailed Description

The MAX3188E/MAX3189E are EIA/TIA-232 transmitters that convert CMOS/TTL logic levels to RS-232 signals. They operate on ±4.5V to ±6V supplies and feature enhanced electrostatic discharge protection (see *ESD Protection*). The MAX3188E guarantees a 250kbps data rate, and the MAX3189E guarantees a 1Mbps data rate with worst-case loads of 3kΩ in parallel with 1000pF. The MAX3188E/MAX3189E invert the TOUT signal relative to TIN (standard RS-232). The transmitter input does not have a pull-up resistor and should be connected to GND if unused.

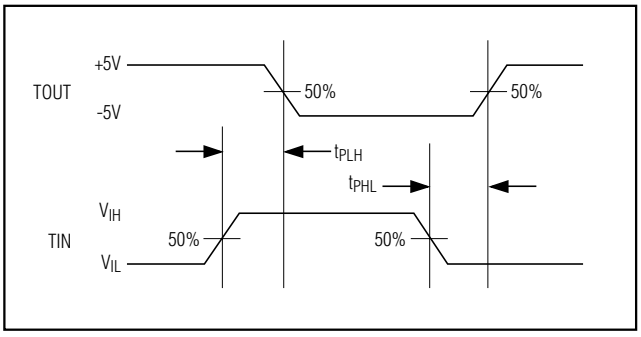


Figure 1. Transmitter Propagation-Delay Timing

Shutdown

The MAX3188E/MAX3189E feature a shutdown input. Drive $\overline{SHDN}$ low to reduce the supply current to 1µA (max). Shutdown also forces TOUT into a high-impedance state, allowing the signal line to be safely controlled by other transmitters. Drive $\overline{SHDN}$ high for normal operation.

ESD Protection

As with all Maxim devices, ESD protection structures are incorporated on all pins to protect against ESD encountered during handling and assembly. The MAX3188E/MAX3189Es' transmitter output has extra protection against static electricity. Maxim has developed state-of-the-art structures enabling this pin to withstand ESD up

to ±15kV without damage or latch-up. The MAX3188E/MAX3189E's transmitter output is characterized for protection to the following limits:

- ±15kV using the Human Body Model
- ±8kV using the Contact Discharge method specified in IEC 1000-4-2
- ±15kV using the Air-Gap Discharge method specified in IEC 1000-4-2

Human Body Model

Figure 2 shows the Human Body Model, and Figure 3 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, and 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 ICs. The MAX3188E/MAX3189E enable the design of equipment that meets the highest level (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 higher peak current in IEC 1000-4-2. Because series resistance is lower in the IEC 1000-4-2 model, the ESD withstand voltage measured to this standard is generally lower than that measured using the Human Body. Figure 4 shows the IEC 1000-4-2 model, and Figure 5 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.

Power-Supply Decoupling

In most circumstances, 0.1µF bypass capacitors are adequate for power-supply decoupling. Connect the bypass capacitors as close to the IC as possible.

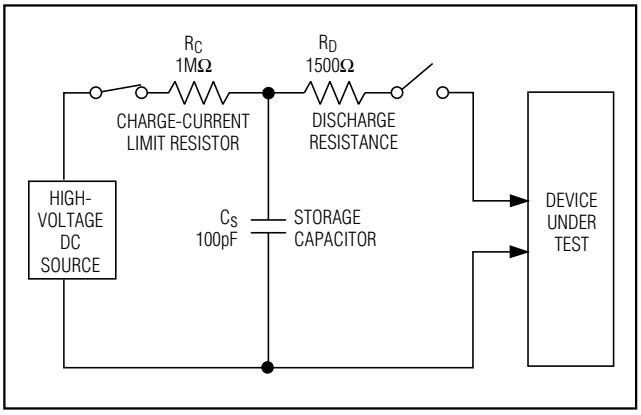


Figure 2. Human Body ESD Test Model

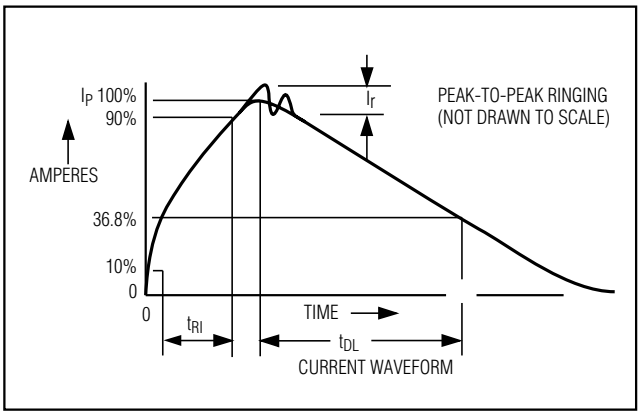


Figure 3. Human Body Model Current Waveform

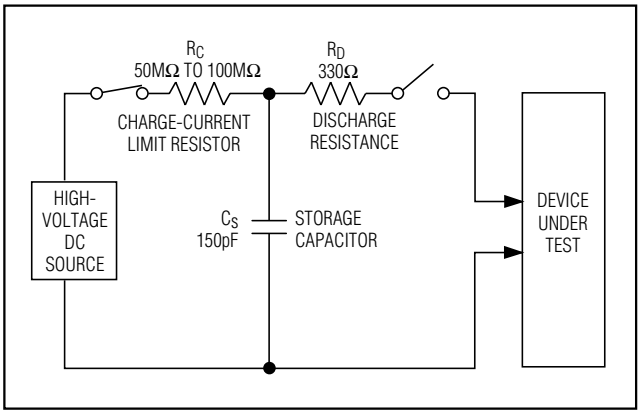


Figure 4. IEC 1000-4-2 ESD Test Model

±15kV ESD-Protected, 1Mbps, 1µA RS-232 Transmitters in SOT23-6

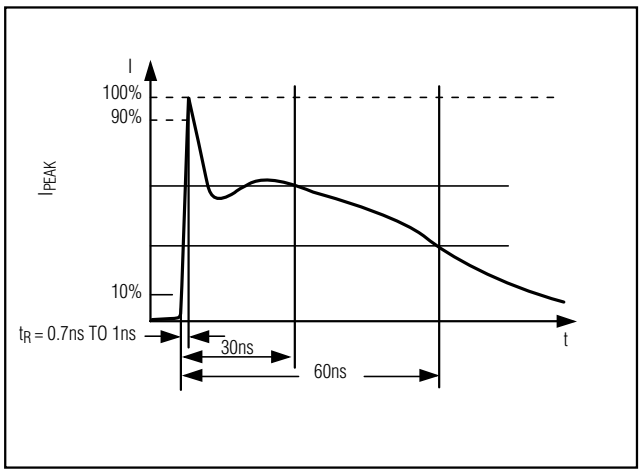


Figure 5. IEC 1000-4-2 ESD Generator Current Waveform

Applications Information

Power-Supply Sources

The MAX3188E/MAX3189E require ±4.5V to ±6V dual supplies. For applications where these supply voltages are not present, a DC-DC converter must be added. Due to the MAX3188E/MAX3189Es' low current consumption, a charge pump can provide the proper supply voltages and requires a minimal amount of board space and cost.

When using another RS-232 device containing an internal regulated charge pump (Table 1), the MAX3188E/MAX3189E may be powered from the internal charge pump (Figure 6). This eliminates the need for additional external DC-DC converters to generate the required ±4.5V to ±6V dual supplies.

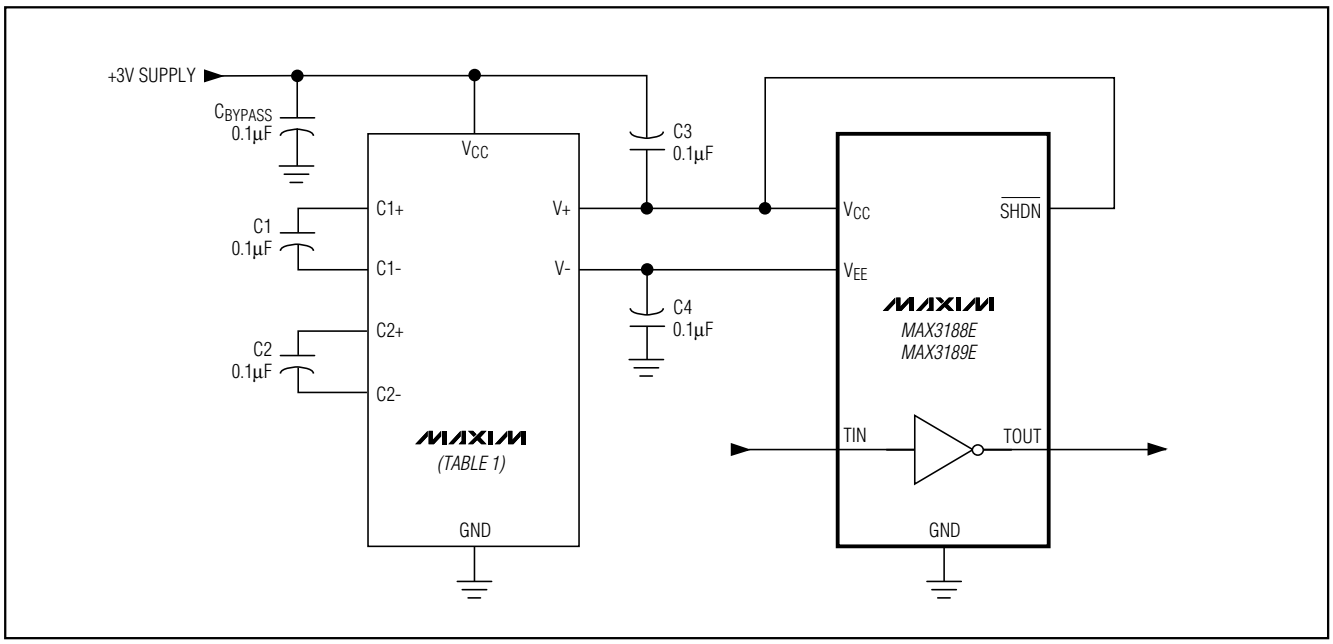


Figure 6. Powering the MAX3188E/MAX3189E

Table 1. RS-232 Devices with Internal Regulated Charge Pumps

PART	NO. OF Tx/Rx	±15kV ESD PROTECTION	AutoShutdown Plus™	AutoShutdown™	DATA RATE (bps)
MAX3221	1/1			✓	120k
MAX3221E	1/1	✓		✓	250k
MAX3222	2/2				120k
MAX3222E	2/2	✓			250k
MAX3223	2/2			✓	120k
MAX3223E	2/2	✓		✓	250k
MAX3224	2/2		✓		250k
MAX3224E	2/2	✓	✓		250k
MAX3225	2/2		✓		1M
MAX3225E	2/2	✓	✓		1M
MAX3226	1/1		✓		250k
MAX3226E	1/1	✓	✓		250k
MAX3227	1/1		✓		1M
MAX3227E	1/1	✓	✓		1M
MAX3232	2/2				120k
MAX3232E	2/2	✓			250k
MAX3237	5/3				1M
MAX3238	5/3		✓		250k
MAX3241	3/5				120k
MAX3241E	3/5	✓			250k
MAX3243	3/5			✓	120k
MAX3243E	3/5	✓		✓	250k
MAX3244	3/5		✓		250k
MAX3244E	3/5	✓	✓		250k
MAX3245	3/5		✓		1M
MAX3245E	3/5	✓	✓		1M

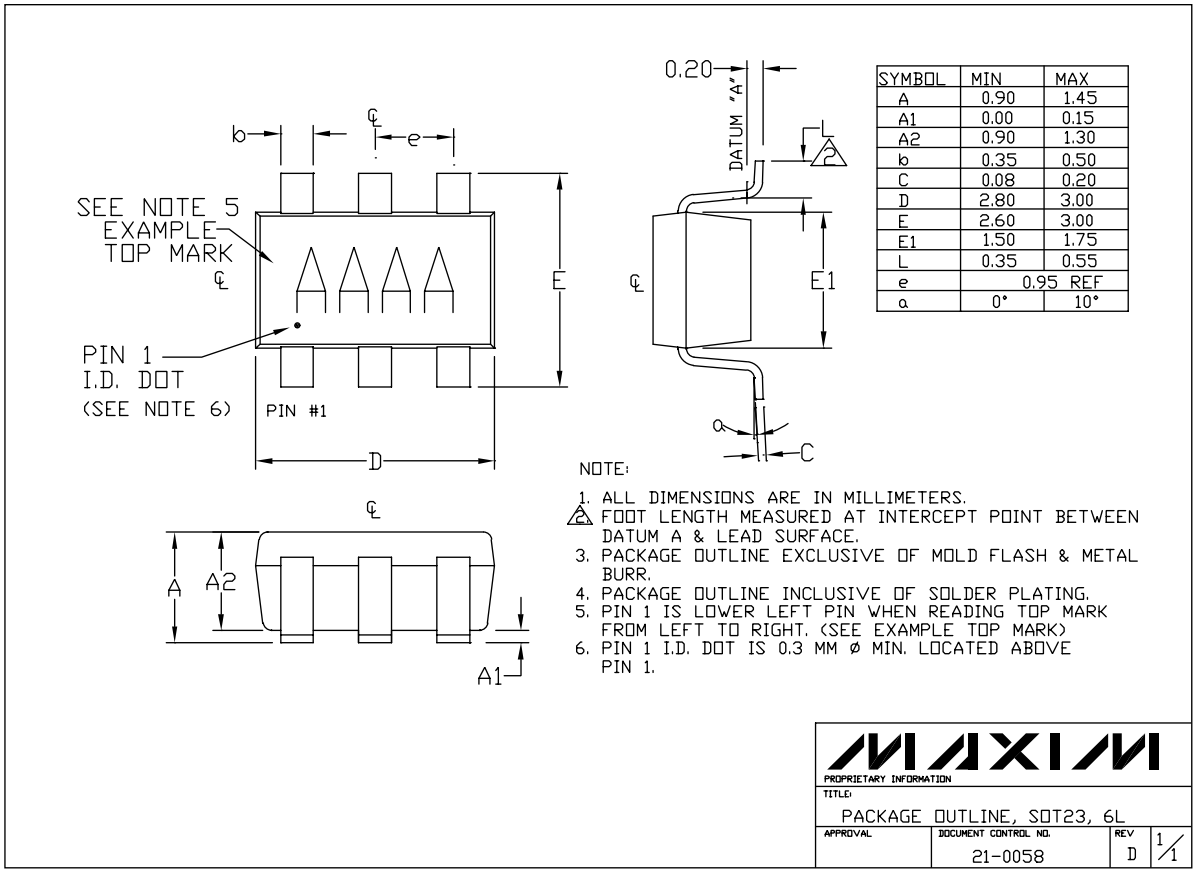
Chip Information

TRANSISTOR COUNT: 111

AutoShutdown and AutoShutdown Plus are trademarks of Maxim Integrated Products.

±15kV ESD-Protected, 1Mbps, 1µA RS-232 Transmitters in SOT23-6

Package Information



SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.35	0.50
C	0.08	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.55
e	0.95 REF	
α	0°	10°

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