

## **MAX3222E/3232E**

*High ESD-Protected, Low Power, 3.0V to 5.5V,  
Single Supply RS-232 Transceivers*

### ***General Description***

The MAX3222E/MAX3232E are 2 driver, 2 receiver RS-232 transceiver solutions intended for portable or hand-held applications, features low power consumption, high data-rate capabilities, and enhanced ESD protection. The ESD tolerance of the MAX3222E/3232E devices is over  $\pm 15\text{kV}$  for both human body model and IEC1000-4-2 air discharge test methods.

A low-dropout transmitter output stage delivers true RS-232 performance from a +3.0V to +5.5V power supply, using an internal dual charge pump. The charge pump requires only four small  $0.1\mu\text{F}$  capacitors for operation from a +3.3V supply. Each device guarantees operation at data rates of 250kbps while maintaining RS-232 output levels.

The MAX3222E features a  $1\mu\text{A}$  shutdown mode that reduces power consumption in battery-powered portable systems. The MAX3222E receivers remain active in shutdown mode, allowing monitoring of external devices while consuming only  $1\mu\text{A}$  of supply current. The MAX3222E and MAX3232E are pin, package, and functionally compatible with the industry-standard MAX242 and MAX232, respectively.

### ***Applications***

Notebook, Sub notebook, and Palmtop Computers  
Battery-Powered / Hand-Held Equipment  
POS terminal / Intelligent Network Switch  
DMM / Printers  
Smart Phones  
xDSL Modems

### ***Features***

Meets true EIA/TIA-232-F Standards from a +3.0V to +5.5V power supply

Interoperable with EIA/TIA - 232 and adheres to EIA/TIA - 562

$1\mu\text{A}$  Low-Power Shutdown (MAX3222E)

Enhanced ESD Specifications:

15kV Human Body Model

15kV IEC1000-4-2 Air Discharge

8kV IEC1000-4-2 Contact Discharge

250 kbps Minimum Transmission Rate

Ideal for Handheld, Battery Operated Applications

Latch up Free

Guaranteed  $30\text{V}/\mu\text{s}$  Max Slew Rate

BiCMOS Technology

## Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX3222EEUP	-40°C to +85°C	20 TSSOP
MAX3222EEAP	-40°C to +85°C	20 SSOP
MAX3222EEPN	-40°C to +85°C	18 Plastic DIP
MAX3232EEAE	-40°C to +85°C	16 SSOP
MAX3232EESE	-40°C to +85°C	16 Narrow SO
MAX3232EEPE	-40°C to +85°C	16 Plastic DIP
MAX3232EEUP	-40°C to +85°C	20 TSSOP

## Absolute Maximum Ratings

Ratings	Range	Units
<b>Power Supply</b>		
V <sub>CC</sub> to GND	-0.3 to +6	V
V <sub>+</sub> to GND	-0.3 to +7	V
V <sub>-</sub> to GND	-0.3 to +7	V
V <sub>+</sub> to V <sub>-</sub>	13	V
<b>Input Voltages</b>		
T <sub>IN</sub> , $\overline{EN}$ , $\overline{SHDN}$	-0.3 to +6	V
R <sub>IN</sub> to GND	±25	V
<b>Output Voltages</b>		
T <sub>OUT</sub> to GND	±13.2	V
R <sub>OUT</sub> to GND	-0.3 to (V <sub>CC</sub> +0.3)	V
Short-Circuit Duration, T <sub>OUT</sub>	Continuous	
<b>Continuous Power Dissipation (TA = +70°C)</b>		
16-Pin DIP (derate 10.53mW/°C above +70°C)	842	mW
16-Pin NSO (derate 8.70mW/°C above +70°C)	696	mW
16-Pin SSOP (derate 7.14 mW/°C above +70°C)	571	mW
20-Pin TSSOP (derate 10.9 mW/°C above +70°C)	879	mW
20-Pin SSOP (derate 8.00 mW/°C above +70°C)	640	mW
<b>Operating Temperature Ranges</b>		
MAX32__EC__	0 to 70	°C
MAX32__EE__	-40 to +85	°C
Storage Temperature Range	-65 to +165	°C
Lead Temperature (soldering, 10sec)	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.

**Pin Description**

PIN				NAME	FUNCTION
MAX3222E		MAX3232E			
SO/DIP	TSSOP/SSOP	SO/DIP/SSOP	TSSOP		
1	1	—	—	$\overline{EN}$	Receiver Enable. Active low.
2	2	1	2	C1+	Positive Terminal of Voltage-Doubler Charge-Pump Capacitor
3	3	2	3	V+	+5.5V Generated by the Charge Pump
4	4	3	4	C1-	Negative Terminal of Voltage-Doubler Charge-Pump Capacitor
5	5	4	5	C2+	Positive Terminal of Inverting Charge-Pump Capacitor
6	6	5	6	C2-	Negative Terminal of Inverting Charge-Pump Capacitor
7	7	6	7	V-	-5.5V Generated by the Charge Pump
8, 15	8, 17	7, 14	8, 17	T_OUT	RS-232 Transmitter Outputs
9, 14	9, 16	8, 13	9, 16	R_IN	RS-232 Receiver Inputs
10, 13	10, 15	9, 12	12, 15	R_OUT	TTL/CMOS Receiver Outputs
11, 12	12, 13	10, 11	13, 14	T_IN	TTL/CMOS Transmitter Inputs
16	18	15	18	GND	Ground
17	19	16	19	VCC	+3.0V to +5.5V Supply Voltage
18	20	—	—	$\overline{SHDN}$	Shutdown Control. Active low.

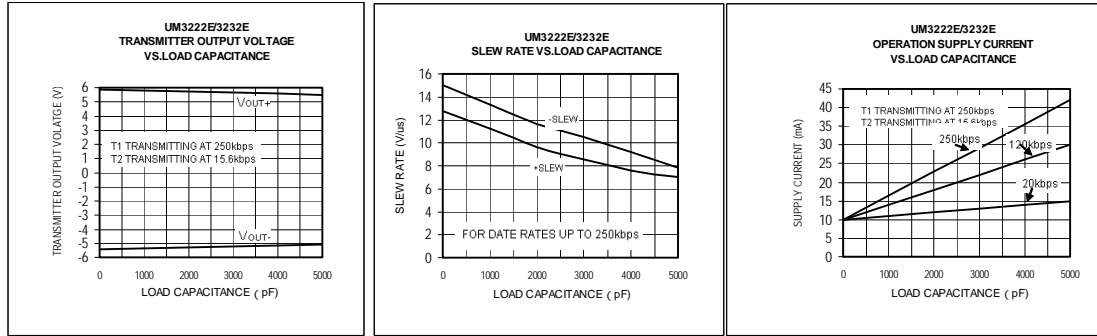
**Electrical Characteristics**

(VCC = +3V to +5.5V, C1-C4 = 0.1μF, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.)

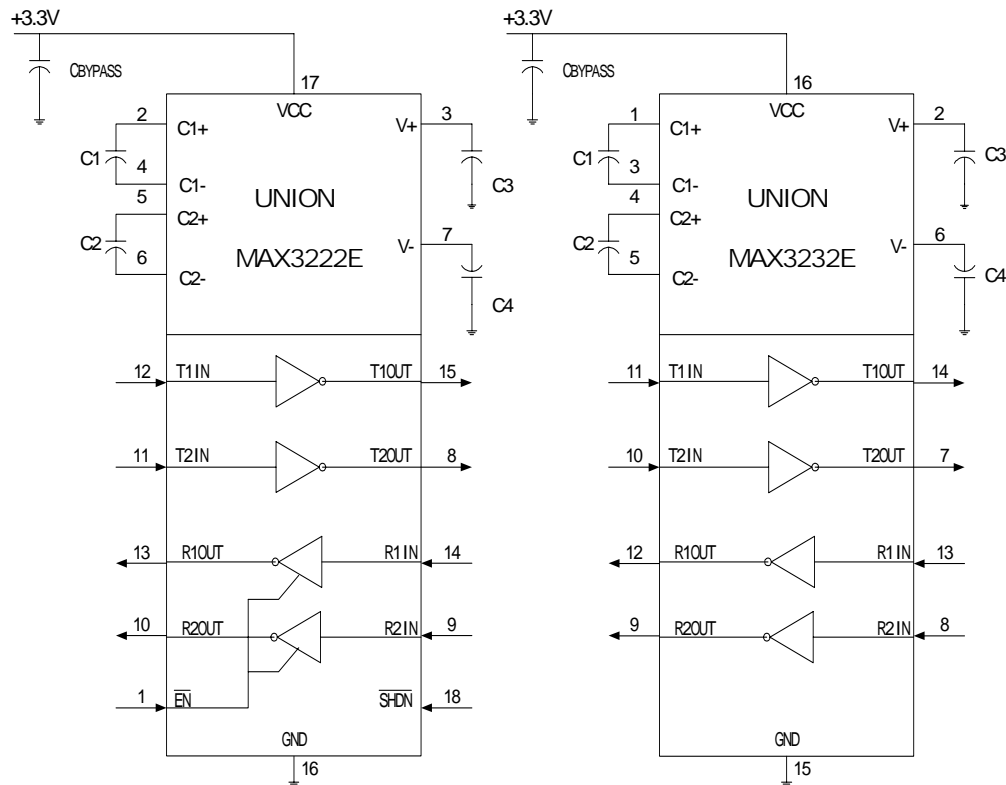
Parameter	Symbol	Conditions	Min	Typ	Max	Units
<b>DC Characteristics (VCC = +3.3V or +5.5V, T<sub>A</sub> = +25°C)</b>						
V <sub>CC</sub> Supply Current	I <sub>CC</sub>	$\overline{SHDN} = V_{CC}$ , No Load, T <sub>A</sub> =+25°C		0.3	1	mA
Shutdown Supply Current	I <sub>SHDN</sub>	$\overline{SHDN} = \text{GND}$ , No Load, T <sub>A</sub> =+25°C		1	10	μA
<b>Logic</b>						
Input Leakage Current		T <sub>IN</sub> , $\overline{SHDN}$ , $\overline{EN}$		±1		μA
Input Threshold Low	V <sub>IL</sub>	T <sub>IN</sub> , $\overline{SHDN}$ , $\overline{EN}$		0.8		V
Input Threshold High	V <sub>IH</sub>	T <sub>IN</sub> , $\overline{SHDN}$ , $\overline{EN}$	2.0			V
Output Voltage Low	V <sub>OH</sub>	R <sub>OUT</sub> ; I <sub>OUT</sub> =3.2mA			0.4	V
Output Voltage High	V <sub>OL</sub>	R <sub>OUT</sub> ; I <sub>OUT</sub> =-1.0mA	VCC-0.6	VCC-0.1		V
<b>EIA/TIA-232E Receiver Inputs</b>						
Input Voltage Range			-25		25	V
Input Threshold Low		T <sub>A</sub> =+25°C, V <sub>CC</sub> = 3.3V	0.6	1.1		V
Input Threshold High		T <sub>A</sub> =+25°C, V <sub>CC</sub> = 3.3V		1.5	2.4	V
Input Hysteresis		V <sub>CC</sub> = 3.3V	0.1		0.2	V
Input Resistance		T <sub>A</sub> =+25°C, V <sub>CC</sub> = 3.3V	3	5	7	kΩ
<b>EIA/TIA-232E Transmitter Outputs</b>						
Output Voltage Swing		All drivers loaded with 3kΩ to ground	±5	±5.4		V
Output Resistance			300	500		Ω
Output Short Circuit Current					±60	mA
<b>TIMING CHARACTERISTICS</b>						
Maximum Data Rate		RL=3 kΩ to 7 kΩ, CL= 50pF to 1000pF, one transmitter switching	250			kbps
Receiver Propagation Delay	t <sub>PLHR</sub> , t <sub>PHLR</sub>	CL= 150pF		0.15		μs
Transmitter Propagation Delay	t <sub>PLHT</sub> , t <sub>PHLT</sub>	RL=3 kΩ, CL= 2500pF all transmitters loaded		0.1		μs
Transition-Region Slew rate		T <sub>A</sub> =+25°C, V <sub>CC</sub> = 3.3V RL=3 kΩ to 7 kΩ, CL= 50pF to 1000pF, measured from -3V to +3V or +3V to -3V,	3	6	30	V/μs
<b>ESD &amp; Latch up Performance</b>						
ESD Protection Voltage		Human Body Model		±15		kV
		IEC1000-4-2, Contact Discharge		±8		kV
		IEC1000-4-2, Air-Gap Discharge		±15		kV
Latch up Performance				±200		mA

## Typical Operating Characteristics

(VCC = +3.3V, 250kbps data rate, 0.1μF capacitors, all transmitters loaded with 3kΩ and CL, TA = +25°C, unless otherwise noted.)



## Typical Operating Circuits



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**Detailed Description**

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**Dual Charge-Pump Voltage Converter**

The MAX3222E/MAX3232Es' internal power supply consists of a regulated dual charge pump that provides output voltages of +5.5V (doubling charge pump) and -5.5V (inverting charge pump) over the +3.0V to +5.5V VCC range. The charge pump operates in discontinuous mode; if the output voltages are less than 5.5V, the charge pump is enabled, and if the output voltages exceed 5.5V, the charge pump is disabled. Each charge pump requires a flying capacitor (C1, C2) and a storage capacitor (C3, C4) to generate the V+ and V- supplies.

**RS-232 Transmitters**

The transmitters are inverting level translators that convert TTL/CMOS-logic levels to  $\pm 5V$  EIA/TIA-232 compliant levels. The MAX3222E/MAX3232E transmitters guarantee a 250kbps data rate with worst-case loads of 3K  $\parallel$  1000pF. Transmitters can be paralleled to drive multiple receivers. The MAX3222E transmitters are disabled and the outputs are forced into a high-impedance state when the device is in shutdown mode ( $\overline{SHDN} = GND$ ). The MAX3222E/MAX3232E permits the outputs to be driven up to  $\pm 12V$  in shutdown.

**RS-232 Receivers**

The receivers convert RS-232 signals to CMOS-logic output levels. The MAX3222E receivers have inverting three-state outputs. Drive  $\overline{EN}$  high to place the receiver(s) into a high impedance state. Receivers can be either active or inactive in shutdown.

**MAX3222E**

Supply current falls to less than 1 $\mu A$  in shutdown mode ( $\overline{SHDN} = GND$ ). When shutdown, the device's charge pumps are shut off, V+ is pulled down to VCC, V- is pulled to ground, and the transmitter outputs are disabled (high impedance). The time required to recover from shutdown is typically 100 $\mu s$ . Connect  $\overline{SHDN}$  to VCC if shutdown mode is not used.

 **$\pm 15kV$  ESD Protection**

ESD-protection structures are incorporated to protect against electrostatic discharges encountered during handling and assembly. The driver outputs and receiver inputs of the MAX3222E/MAX3232E have extra protection against static electricity. The ESD structures withstand high ESD in all states: normal operation, shutdown, and powered down. After an ESD event, Circuits keep working without latch up. ESD protection can be tested in various ways; the transmitter outputs and receiver inputs for the MAX3222E/MAX3232E are characterized for protection to the following limits:

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

***Capacitor Selection***

The capacitor type used for C1–C4 is not critical for proper operation; polarized or non-polarized capacitors can be used. The charge pump requires 0.1 $\mu$ F capacitors for 3.3V operation. Increasing the capacitor values (e.g., by a factor of 2) reduces ripple on the transmitter outputs and slightly reduces power consumption. C2, C3, and C4 can be increased without changing C1's value. When using the minimum required capacitor values, make sure the capacitor value does not degrade excessively with temperature. If in doubt, use capacitors with a larger nominal value. The capacitor's equivalent series resistance (ESR), which usually rises at low temperatures, influences the amount of ripple on V+ and V- output voltages.

***Power-Supply Decoupling***

In most circumstances, a 0.1 $\mu$ F VCC bypass capacitor is adequate. In applications sensitive to power-supply noise, use a capacitor of the same value as charge pump capacitor C1. Connect bypass capacitors as close to the IC as possible.

***Operation Down to 2.7V***

Transmitter outputs meet EIA/TIA-562 levels of  $\pm 3.7$ V with supply voltages as low as 2.7V.

***Transmitter Outputs Recovering from Shutdown***

When MAX3222E's two transmitter outputs were recovering from shutdown mode, the two transmitter outputs are shown going to opposite RS-232 levels (one transmitter input is high; the other is low) as they become active. Each transmitter is loaded with 3K resistor in parallel with 2500pF. The transmitter outputs display no ringing or undesirable transients as they come out of shutdown. Note that the transmitters are enabled only when the magnitude of V- exceeds approximately -3.0V.

***Interconnection with 3V and 5V Logic***

The MAX3222E/MAX3232E can directly interface with various 3V and 5V logic families, including ACT and HCT CMOS.