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 ±15kV 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 0.1µF 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 1µA 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 1µA 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

1µA 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 30V/µs 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
Power Supply		
V_{CC} to GND	-0.3 to +6	V
V_+ to GND	-0.3 to +7	V
V_- to GND	-0.3 to +7	V
V_+ to V_-	13	V
Input Voltages		
T_IN, $\overline{EN}$, $\overline{SHDN}$	-0.3 to +6	V
R_IN to GND	±25	V
Output Voltages		
T_OUT to GND	±13.2	V
R_OUT to GND	-0.3 to (V_{CC}+0.3)	V
Short-Circuit Duration, T_OUT	Continuous	
Continuous Power Dissipation (TA = +70°C)		
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
Operating Temperature Ranges		
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

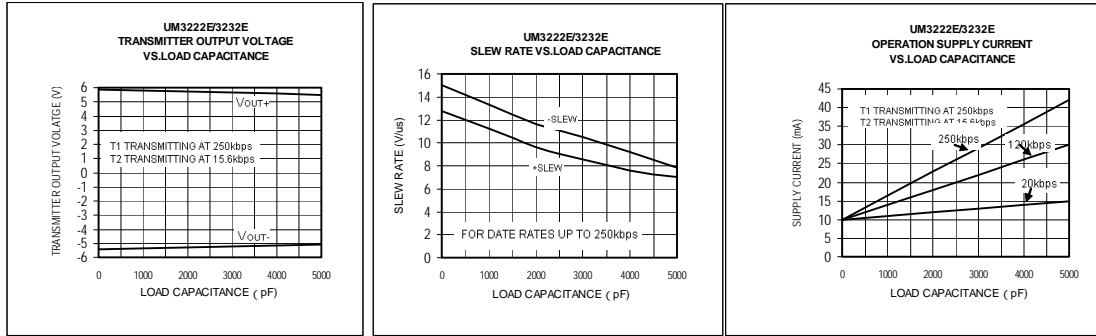| PIN				NAME	FUNCTION
MAX3222E		MAX3232E			
SO/DIP	TSSOP/SSOP	SO/DIP/SSOP	TSSOP		
1	1	—	—	$\overline{EN}$	Receiver Enable. Active low.
2	2	1	2	C1+	Positive Terminal of Voltage-Doubler Charge-Pump Capacitor
3	3	2	3	V+	+5.5V Generated by the Charge Pump
4	4	3	4	C1-	Negative Terminal of Voltage-Doubler 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_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)
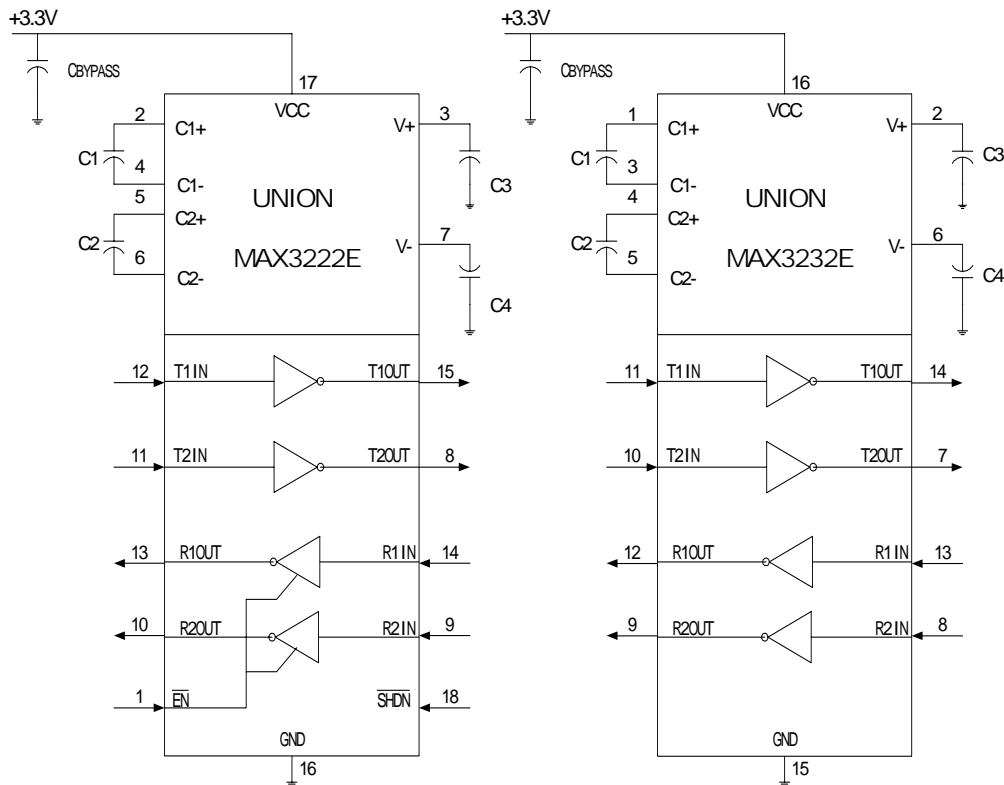
Parameter	Symbol	Conditions	Min	Typ	Max	Units
DC Characteristics (VCC = +3.3V or +5.5V, T_A = +25°C)						
V_{CC} Supply Current	I_{CC}	$\overline{SHDN}$ = V_{CC} ,No Load, T_A=+25°C		0.3	1	mA
Shutdown Supply Current	I_{SHDN}	$\overline{SHDN}$ =GND, No Load, T_A=+25°C		1	10	µA
Logic						
Input Leakage Current		T_IN, $\overline{SHDN}$, $\overline{EN}$			±1	µA
Input Threshold Low	VIL	T_IN, $\overline{SHDN}$, $\overline{EN}$			0.8	V
Input Threshold High	VIH	T_IN, $\overline{SHDN}$, $\overline{EN}$	2.0			V
Output Voltage Low	VOH	R_OUT; IOUT=3.2mA			0.4	V
Output Voltage High	VOL	R_OUT; IOUT=-1.0mA	VCC-0.6	VCC-0.1		V
EIA/TIA-232E Receiver Inputs						
Input Voltage Range			-25		25	V
Input Threshold Low		T_A=+25°C, V_{CC}= 3.3V	0.6	1.1		V
Input Threshold High		T_A=+25°C, V_{CC}= 3.3V		1.5	2.4	V
Input Hysteresis		V_{CC}= 3.3V	0.1		0.2	V
Input Resistance		T_A=+25°C, V_{CC}= 3.3V	3	5	7	kΩ
EIA/TIA-232E Transmitter Outputs						
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
TIMING CHARACTERISTICS						
Maximum Data Rate		RL=3 kΩ to 7 kΩ, CL= 50pF to 1000pF, one transmitter switching	250			kbps
Receiver Propagation Delay	t_{PLHR}, t_{PHLR}	CL= 150pF		0.15		µs
Transmitter Propagation Delay	t_{PLHT}, t_{PHLT}	RL=3 kΩ, CL= 2500pF all transmitters loaded		0.1		µs
Transition-Region Slew rate		T_A=+25°C, V_{CC}= 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
ESD & Latch up Performance						
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.)

UM3222E/3232E
TRANSMITTER OUTPUT VOLTAGE VS.LOAD CAPACITANCE

TRANSMITTER OUTPUT VOLATGE (V)

T1 TRANSMITTING AT 250kbps
T2 TRANSMITTING AT 15.6kbps

Vout+

Vout-

LOAD CAPACITANCE   pF

UM3222E/3232E
SLEW RATE VS.LOAD CAPACITANCE

SLEW RATE (V/us)

-SLEW-

+SLEW

FOR DATE RATES UP TO 250kbps

LOAD CAPACITANCE   pF

UM3222E/3232E
OPERATION SUPPLY CURRENT VS.LOAD CAPACITANCE

SUPPLY CURRENT (mA)

T1 TRANSMITTING AT 250kbps
T2 TRANSMITTING AT 15.6kbps

250kbps   120kbps

20kbps

LOAD CAPACITANCE   pF

Typical Operating Circuits

+3.3V

CBYPASS

17   VCC

2 C1+
C1
4 C1-
5 C2+
C2
6 C2-

UNION

MAX3222E

V+ 3
C3
V- 7
C4

12 T1IN   T1OUT 15
11 T2IN   T2OUT 8
13 R1OUT   R1IN   14
10 R2OUT   R2IN   9
1   EN   SHDN   18

GND
16

+3.3V

CBYPASS

16   VCC

1 C1+
C1
3 C1-
4 C2+
C2
5 C2-

UNION

MAX3232E

V+ 2
C3
V- 6
C4

11 T1IN   T1OUT 14
10 T2IN   T2OUT 7
12 R1OUT   R1IN   13
9   R2OUT   R2IN   8

GND
15

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 ±5V EIA/TIA-232 compliant levels. The MAX3222E/MAX3232E transmitters guarantee a 250kbps data rate with worst-case loads of 3K   parallel with 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 ±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 1µA 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 100µs. Connect $\overline{SHDN}$ to VCC if shutdown mode is not used.

±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:

• ±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

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 0.1µF 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 0.1µF 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 ±3.7V 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.