

3.0V to 5.5V, Low-Power, Up to 1Mbps, True RS-232 Transceivers

MAX3222/MAX3232/
MAX3237/MAX3241

3.0V to 5.5V, Low-Power, Up to 1Mbps,
True RS-232 Transceivers

Electrical Characteristics (continued)

($V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$ (Note 2), $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25^\circ C$.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Hysteresis			0.3		V
Input Resistance	$T_A = +25^\circ C$	3	5	7	k Ω
TRANSMITTER OUTPUTS					
Output Voltage Swing	All transmitter outputs loaded with 3k Ω to ground	± 5.0	± 5.4		V
Output Resistance	$V_{CC} = V+ = V- = 0V$, $V_{OUT} = \pm 2V$	300	10M		Ω
Output Short-Circuit Current			± 35	± 60	mA
Output Leakage Current	$V_{OUT} = \pm 12V$, $V_{CC} = 0V$ or 3V to 5.5V, transmitters disabled			± 25	μA
MOUSE DRIVEABILITY (MAX3241)					
Transmitter Output Voltage	T1IN = T2IN = GND, T3IN = V_{CC} , T3OUT loaded with 3k Ω to GND, T1OUT and T2OUT loaded with 2.5mA each	± 5.0			V

Timing Characteristics—MAX3222/MAX3232/MAX3241

($V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$ (Note 2), $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25^\circ C$.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Maximum Data Rate	$R_L = 3k\Omega$, $C_L = 1000pF$, one transmitter switching	120	235		kbps
Receiver Propagation Delay	R_{IN} to R_{OUT} , $C_L = 150pF$	t_{PHL}	0.3		μs
		t_{PLH}	0.3		
Receiver Output Enable Time	Normal operation		200		ns
Receiver Output Disable Time	Normal operation		200		ns
Transmitter Skew	$ t_{PHL} - t_{PLH} $		300		ns
Receiver Skew	$ t_{PHL} - t_{PLH} $		300		ns
Transition-Region Slew Rate	$V_{CC} = 3.3V$, $R_L = 3k\Omega$ to 7k Ω , +3V to -3V or -3V to +3V, $T_A = +25^\circ C$, one transmitter switching	$C_L = 150pF$ to 1000pF	6	30	V/ μs
		$C_L = 150pF$ to 2500pF	4	30	

Timing Characteristics—MAX3237

($V_{CC} = +3.0V$ to $+5.5V$, C_1 – $C_4 = 0.1\mu F$ (Note 2), $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25^\circ C$.)

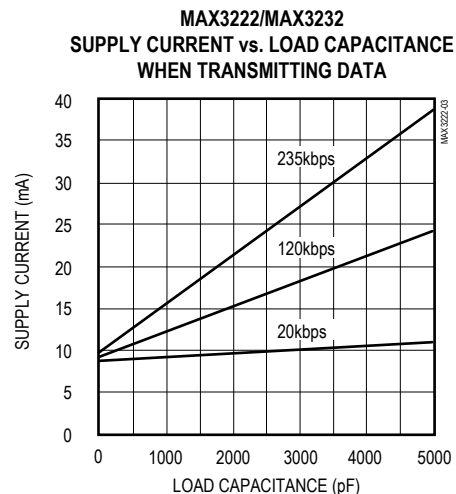
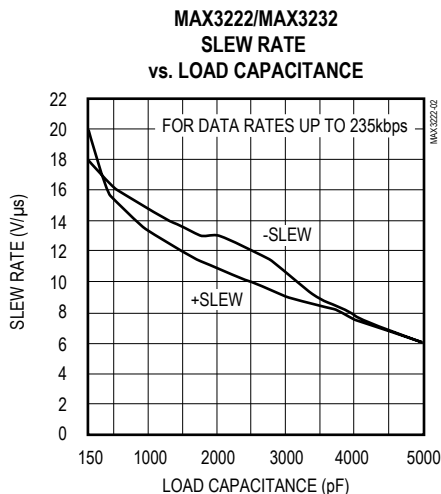
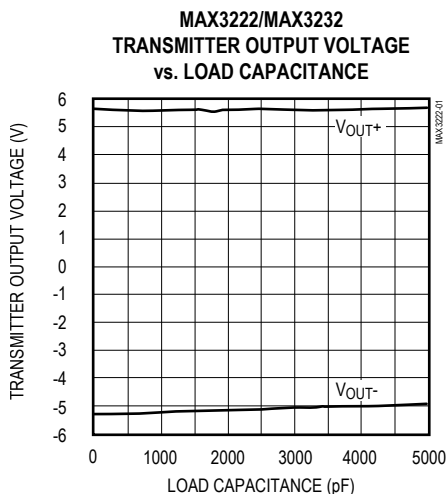
PARAMETER	CONDITIONS			MIN	TYP	MAX	UNITS
Maximum Data Rate	R _L = 3kΩ, C _L = 1000pF, one transmitter switching, MBAUD = GND			250		kbps	
	V _{CC} = 3.0V to 4.5V, R _L = 3kΩ, C _L = 250pF, one transmitter switching, MBAUD = V _{CC}			1000			
	V _{CC} = 4.5V to 5.5V, R _L = 3kΩ, C _L = 1000pF, one transmitter switching, MBAUD = V _{CC}			1000			
Receiver Propagation Delay	R_IN to R_OUT, C _L = 150pF	t _{PHL}		0.15		μs	
		t _{PLH}		0.15			
Receiver Output Enable Time	Normal operation			200		ns	
Receiver Output Disable Time	Normal operation			200		ns	
Transmitter Skew	t _{PHL} - t _{PLH} , MBAUD = GND			100		ns	
	t _{PHL} - t _{PLH} , MBAUD = V _{CC}			25		ns	
Receiver Skew	t _{PHL} - t _{PLH}			50		ns	
Transition-Region Slew Rate	V _{CC} = 3.3V, R _L = 3Ω to 7kΩ, +3V to -3V or -3V to +3V, T _A = +25°C	C _L = 150pF to 1000pF	MBAUD = GND	6	30	V/μs	
			MBAUD = V _{CC}	24	150		
		C _L = 150pF to 2500pF, MBAUD = GND		4	30		

Note 2: MAX3222/MAX3232/MAX3241: C_1 – $C_4 = 0.1\mu F$ tested at $3.3V \pm 10\%$; $C_1 = 0.047\mu F$, C_2 – $C_4 = 0.33\mu F$ tested at $5.0V \pm 10\%$.
MAX3237: C_1 – $C_4 = 0.1\mu F$ tested at $3.3V \pm 5\%$; C_1 – $C_4 = 0.22\mu F$ tested at $3.3V \pm 10\%$; $C_1 = 0.047\mu F$, C_2 – $C_4 = 0.33\mu F$ tested at $5.0V \pm 10\%$.

Note 3: Transmitter input hysteresis is typically 250mV.

Typical Operating Characteristics

($V_{CC} = +3.3V$, 235kbps data rate, $0.1\mu F$ capacitors, all transmitters loaded with $3k\Omega$, $T_A = +25^\circ C$, unless otherwise noted.)

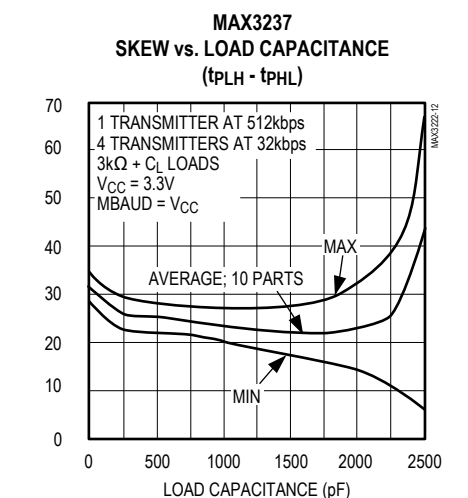
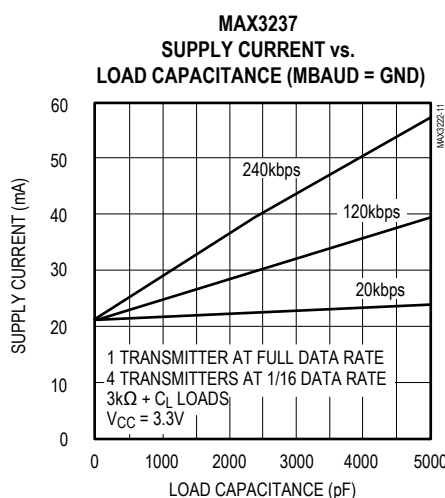
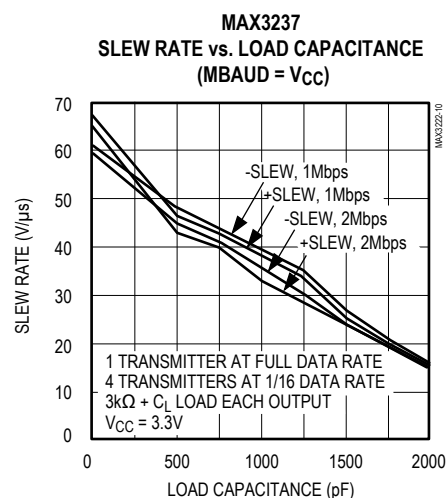
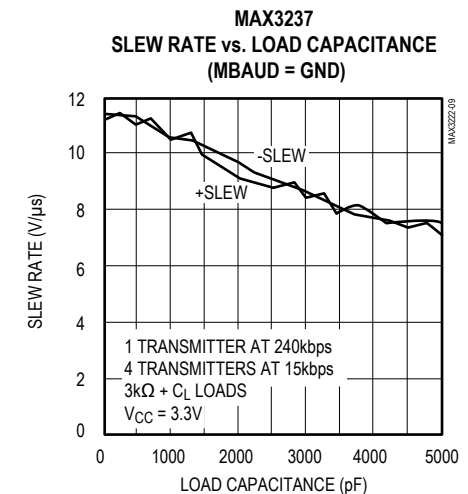
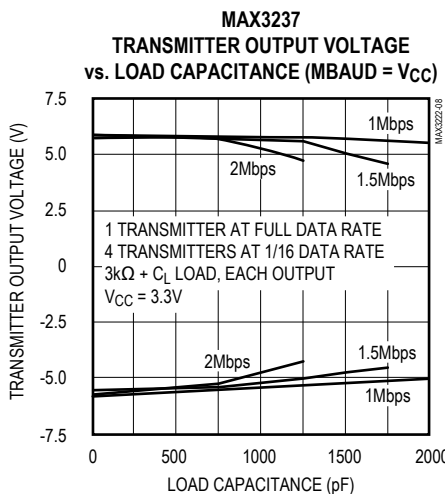
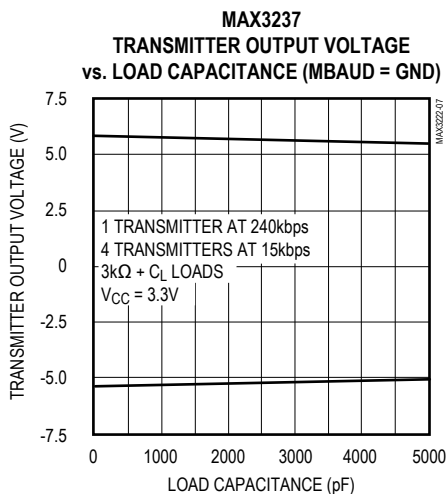
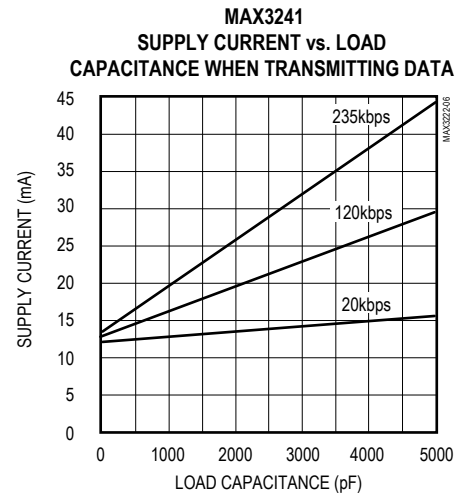
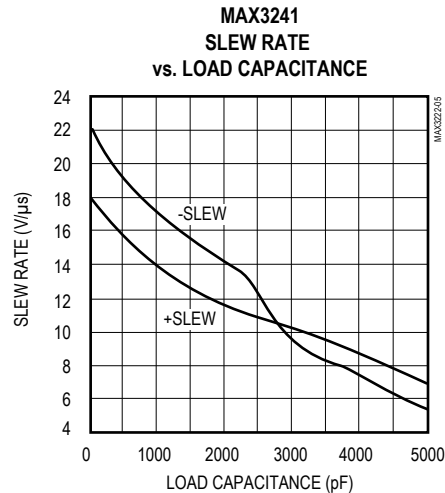
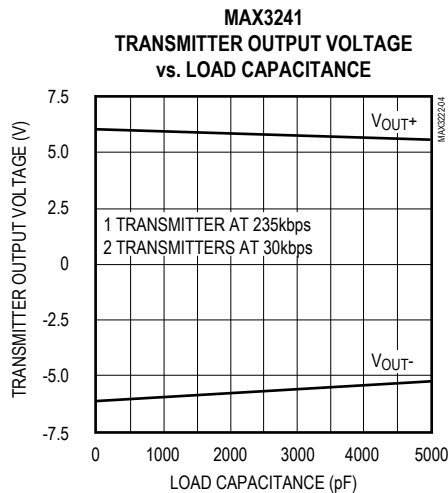


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Typical Operating Characteristics (continued)

($V_{CC} = +3.3V$, 235kbps data rate, 0.1 μF capacitors, all transmitters loaded with 3k Ω , $T_A = +25^\circ C$, unless otherwise noted.)



Pin Description

PIN					NAME	FUNCTION
MAX3222		MAX3232	MAX3237	MAX3241		
DIP/SO	SSOP					
1	1	—	13	23	$\overline{\text{EN}}$	Receiver Enable. Active low.
2	2	1	28	28	C1+	Positive Terminal of Voltage-Doubler Charge-Pump Capacitor
3	3	2	27	27	V+	+5.5V Generated by the Charge Pump
4	4	3	25	24	C1-	Negative Terminal of Voltage-Doubler Charge-Pump Capacitor
5	5	4	1	1	C2+	Positive Terminal of Inverting Charge-Pump Capacitor
6	6	5	3	2	C2-	Negative Terminal of Inverting Charge-Pump Capacitor
7	7	6	4	3	V-	-5.5V Generated by the Charge Pump
8, 15	8, 17	7, 14	5, 6, 7, 10, 12	9, 10, 11	T_OUT	RS-232 Transmitter Outputs
9, 14	9, 16	8, 13	8, 9, 11	4–8	R_IN	RS-232 Receiver Inputs
10, 13	10, 15	9, 12	18, 20, 21	15–19	R_OUT	TTL/CMOS Receiver Outputs
11, 12	12, 13	10, 11	17, 19, 22, 23, 24	12, 13, 14	T_IN	TTL/CMOS Transmitter Inputs
16	18	15	2	25	GND	Ground
17	19	16	26	26	V _{CC}	+3.0V to +5.5V Supply Voltage
18	20	—	14	22	$\overline{\text{SHDN}}$	Shutdown Control. Active low.
—	11, 14	—	—	—	N.C.	No Connection
—	—	—	15	—	MBAUD	MegaBaud Control Input. Connect to GND for normal operation; connect to V _{CC} for 1Mbps transmission rates.
—	—	—	16	20, 21	R_OUTB	Noninverting Complementary Receiver Outputs. Always active.

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Detailed Description

Dual Charge-Pump Voltage Converter

The MAX3222/MAX3232/MAX3237/MAX3241's 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), regardless of the input voltage (V_{CC}) over the 3.0V to 5.5V range. The charge pumps operate in a discontinuous mode; if the output voltages are less than 5.5V, the charge pumps are enabled, and if the output voltages exceed 5.5V, the charge pumps are disabled. Each charge pump requires a flying capacitor (C1, C2) and a reservoir capacitor (C3, C4) to generate the V+ and V- supplies.

RS-232 Transmitters

The transmitters are inverting level translators that convert CMOS-logic levels to 5.0V EIA/TIA-232 levels.

The MAX3222/MAX3232/MAX3241 transmitters guarantee a 120kbps data rate with worst-case loads of 3k Ω in parallel with 1000pF, providing compatibility with PC-to-PC communication software (such as LapLink™). Typically, these three devices can operate at data rates of 235kbps. Transmitters can be paralleled to drive multiple receivers or mice.

LapLink is a trademark of Traveling Software, Inc.

The MAX3222/MAX3237/MAX3241's output stage is turned off (high impedance) when the device is in shut-down mode. When the power is off, the MAX3222/MAX3232/MAX3237/MAX3241 permit the outputs to be driven up to $\pm 12V$.

The transmitter inputs do not have pullup resistors. Connect unused inputs to GND or V_{CC} .

MAX3237 MegaBaud Operation

In normal operating mode (MBAUD = GND), the MAX3237 transmitters guarantee a 250kbps data rate with worst-case loads of 3k Ω in parallel with 1000pF. This provides compatibility with PC-to-PC communication software, such as LapLink.

For higher speed serial communications, the MAX3237 features MegaBaud operation. In MegaBaud operating mode (MBAUD = V_{CC}), the MAX3237 transmitters guarantee a 1Mbps data rate with worst-case loads of 3k Ω in parallel with 250pF for 3.0V < V_{CC} < 4.5V. For 5V $\pm 10\%$ operation, the MAX3237 transmitters guarantee a 1Mbps data rate into worst-case loads of 3k Ω in parallel with 1000pF.

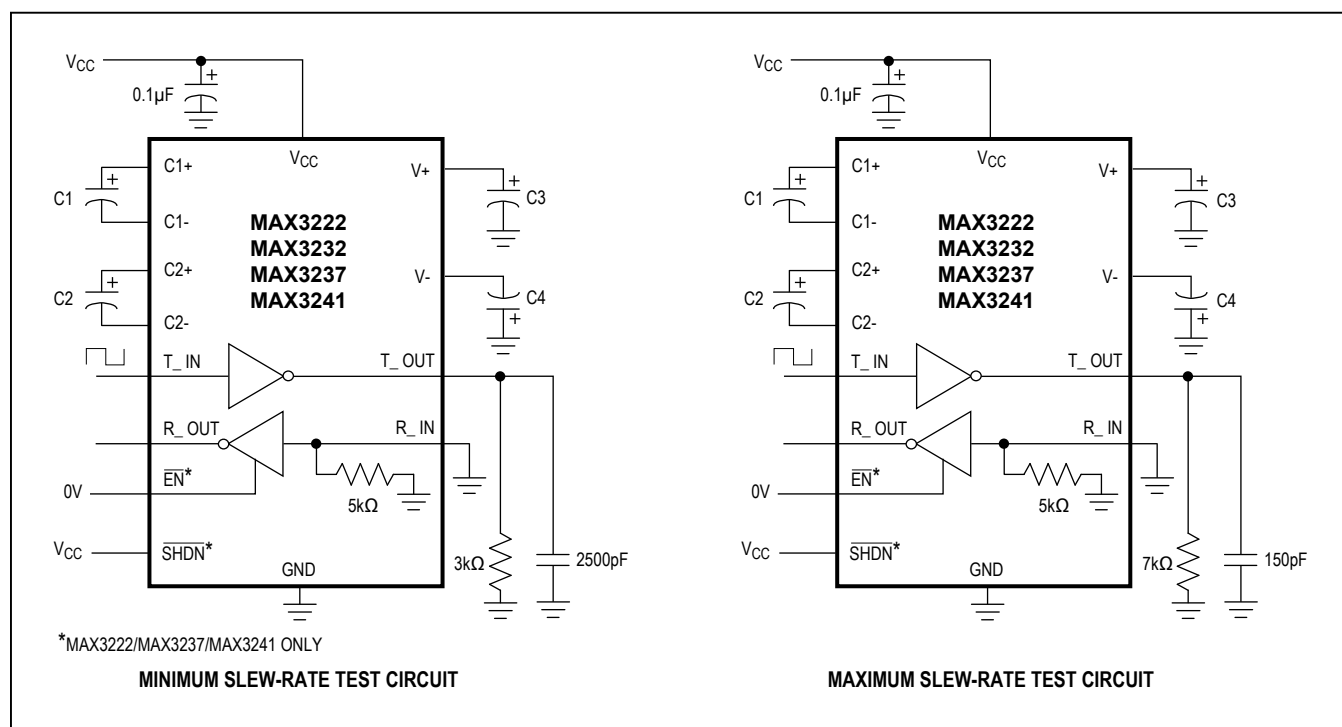


Figure 1. Slew-Rate Test Circuits

MAX3222/MAX3232/
MAX3237/MAX3241

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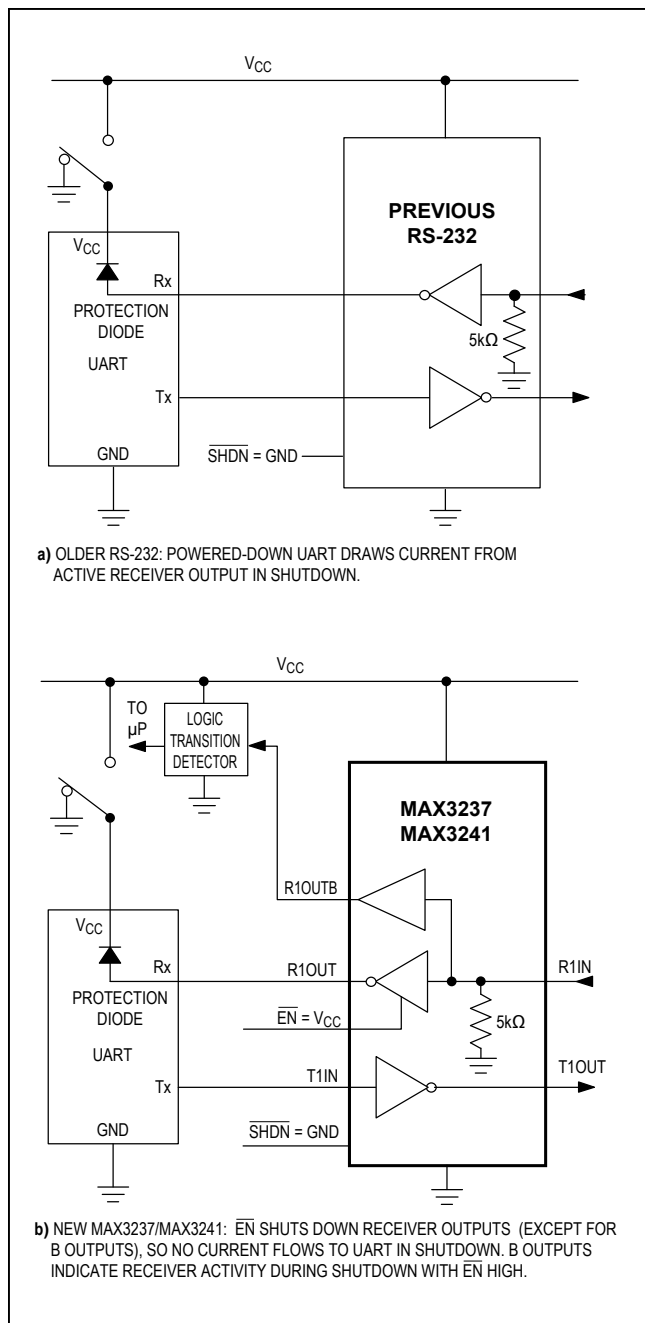


Figure 2. Detection of RS-232 Activity when the UART and Interface are Shut Down; Comparison of MAX3237/MAX3241 (b) with Previous Transceivers (a).

RS-232 Receivers

The receivers convert RS-232 signals to CMOS-logic output levels. The MAX3222/MAX3237/MAX3241 receivers have inverting three-state outputs. In shutdown, the receivers can be active or inactive (Table 1).

The complementary outputs on the MAX3237 (R1OUTB) and the MAX3241 (R1OUTB, R2OUTB) are always active, regardless of the state of $\overline{\text{EN}}$ or $\overline{\text{SHDN}}$. This allows for Ring Indicator applications without forward biasing other devices connected to the receiver outputs. This is ideal for systems where V_{CC} is set to 0V in shutdown to accommodate peripherals, such as UARTs (Figure 2).

MAX3222/MAX3237/MAX3241 Shutdown Mode

Supply current falls to less than 1μA in shutdown mode ($\overline{\text{SHDN}}$ = low). When shut down, the device's charge pumps are turned off, V+ is pulled down to V_{CC}, V- is pulled to ground, and the transmitter outputs are disabled (high impedance). The time required to exit shutdown is typically 100μs, as shown in Figure 3. Connect $\overline{\text{SHDN}}$ to V_{CC} if the shutdown mode is not used. $\overline{\text{SHDN}}$ has no effect on R_{OUT} or R_{OUTB}.

MAX3222/MAX3237/MAX3241 Enable Control

The inverting receiver outputs (R_OUT) are put into a high-impedance state when EN is high. The complementary outputs R1OUTB and R2OUTB are always active, regardless of the state of EN and SHDN (Table 1). EN has no effect on T_OUT.

Applications Information

Capacitor Selection

The capacitor type used for C1–C4 is not critical for proper operation; polarized or nonpolarized capacitors can be used. The charge pump requires 0.1 μ F capacitors for 3.3V operation. For other supply voltages, refer to Table 2 for required capacitor values. Do not use values lower than those listed in Table 2. 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. However, do not increase C1 without also increasing the values of C2, C3, and C4, to maintain the proper ratios (C1 to the other capacitors).

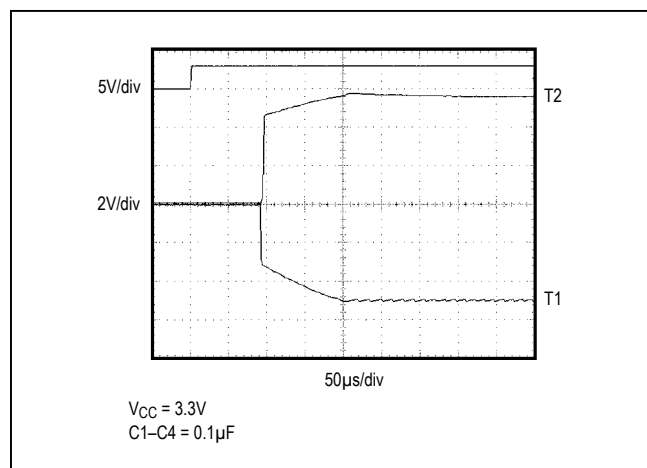
When using the minimum required capacitor values, make sure the capacitor value does not degrade excessively with temperature. If in doubt, use capacitors with a higher nominal value. The capacitor's equivalent series resistance (ESR), which usually rises at low temperatures, influences the amount of ripple on V+ and V-.

**Table 1. MAX3222/MAX3237/MAX3241
Shutdown and Enable Control Truth Table**

$\overline{\text{SHDN}}$	$\overline{\text{EN}}$	T_OUT	R_OUT	R_OUTB (MAX3237/ MAX3241)
0	0	High-Z	Active	Active
0	1	High-Z	High-Z	Active
1	0	Active	Active	Active
1	1	Active	High-Z	Active

**Table 2. Required Minimum Capacitor
Values**

V _{CC} (V)	C1 (μF)	C2, C3, C4 (μF)
MAX3222/MAX3232/MAX3241		
3.0 to 3.6	0.1	0.1
4.5 to 5.5	0.047	0.33
3.0 to 5.5	0.1	0.47
MAX3237		
3.0 to 3.6	0.22	0.22
3.15 to 3.6	0.1	0.1
4.5 to 5.5	0.047	0.33
3.0 to 5.5	0.22	1.0



**Figure 3. Transmitter Outputs when Exiting Shutdown or
Powering Up**

Power-Supply Decoupling

In most circumstances, a 0.1μF bypass capacitor is adequate. In applications that are sensitive to power-supply noise, decouple V_{CC} to ground with 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 will meet EIA/TIA-562 levels of ±3.7V with supply voltages as low as 2.7V.

Transmitter Outputs when Exiting Shutdown

Figure 3 shows two transmitter outputs when exiting shutdown mode. As they become active, the two transmitter outputs are shown going to opposite RS-232 levels (one transmitter input is high, the other is low). Each transmitter is loaded with 3kΩ 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 3V.

Mouse Driveability

The MAX3241 has been specifically designed to power serial mice while operating from low-voltage power supplies. It has been tested with leading mouse brands from manufacturers such as Microsoft and Logitech. The MAX3241 successfully drove all serial mice tested and met their respective current and voltage requirements. Figure 4a shows the transmitter output voltages under increasing load current at 3.0V. Figure 4b shows a typical mouse connection using the MAX3241.

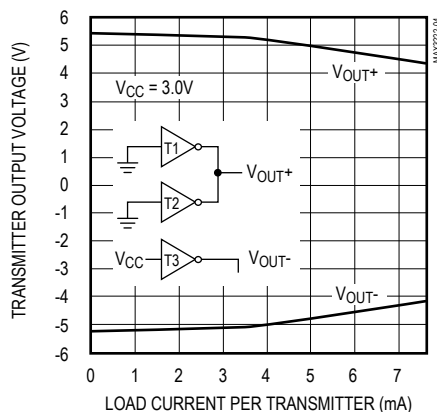


Figure 4a. MAX3241 Transmitter Output Voltage vs. Load Current per Transmitter

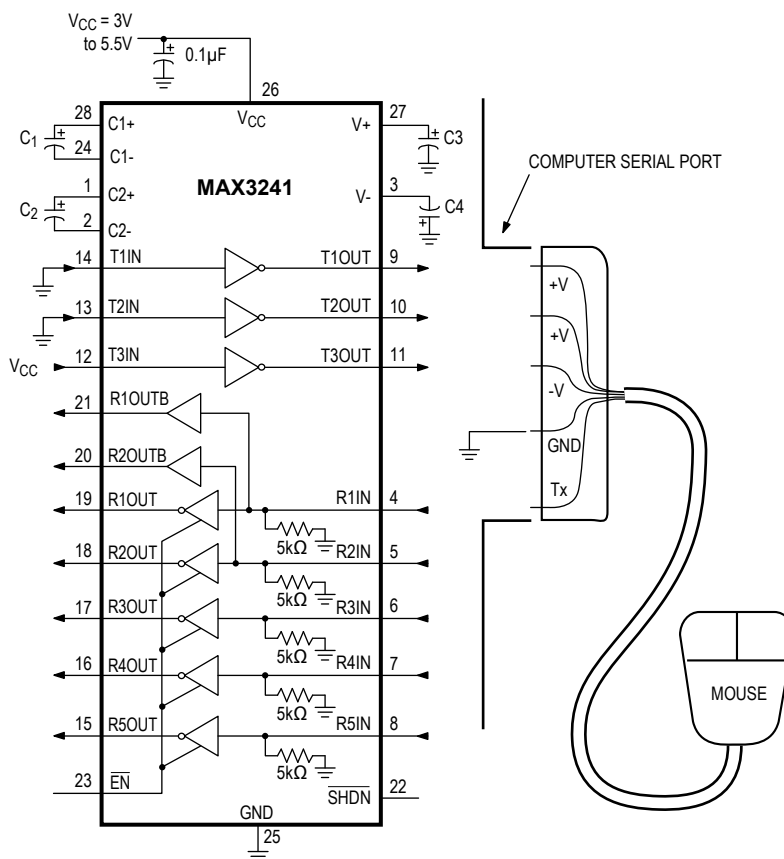


Figure 4b. Mouse Driver Test Circuit

MAX3222/MAX3232/ MAX3237/MAX3241

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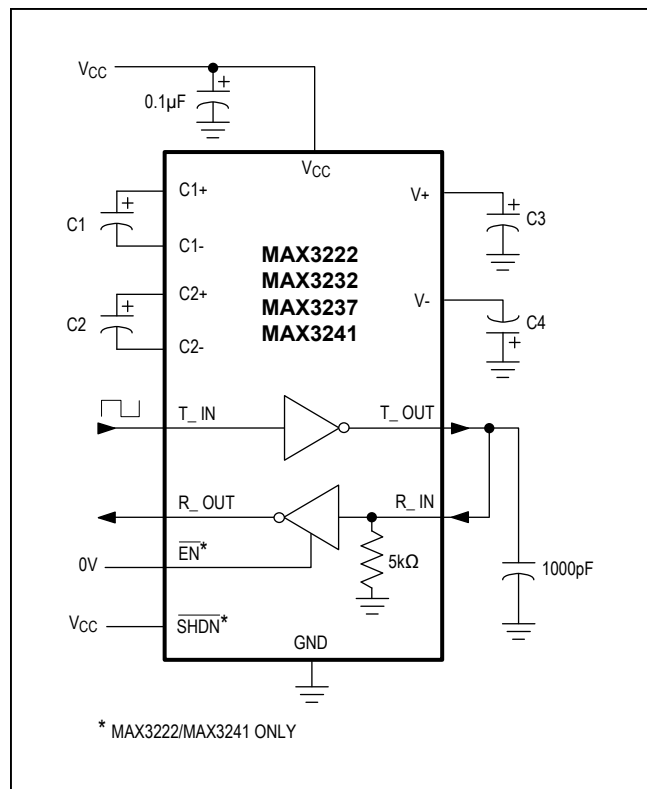


Figure 5. Loopback Test Circuit

High Data Rates

The MAX3222/MAX3232/MAX3241 maintain the RS-232 $\pm 5.0V$ minimum transmitter output voltage even at high data rates. Figure 5 shows a transmitter loopback test circuit. Figure 6 shows a loopback test result at 120kbps, and Figure 7 shows the same test at 235kbps. For Figure 6, all transmitters were driven simultaneously at 120kbps into RS-232 loads in parallel with 1000pF. For Figure 7, a single transmitter was driven at 235kbps, and all transmitters were loaded with an RS-232 receiver in parallel with 1000pF.

The MAX3237 maintains the RS-232 $\pm 5.0V$ minimum transmitter output voltage at data rates up to 1Mbps. Figure 8 shows a loopback test result at 1Mbps with MBAUD = VCC. For Figure 8, all transmitters were loaded with an RS-232 receiver in parallel with 250pF.

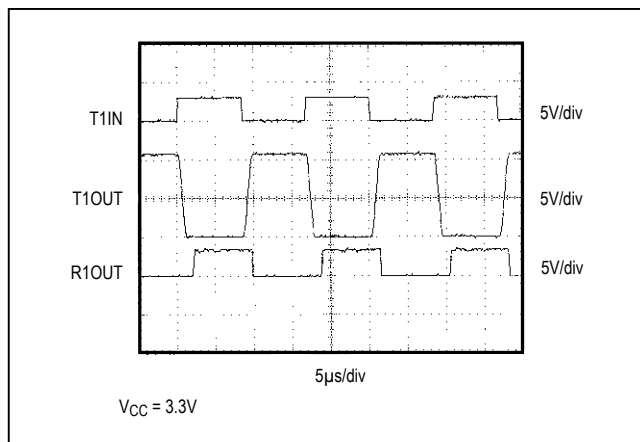


Figure 6. MAX3241 Loopback Test Result at 120kbps

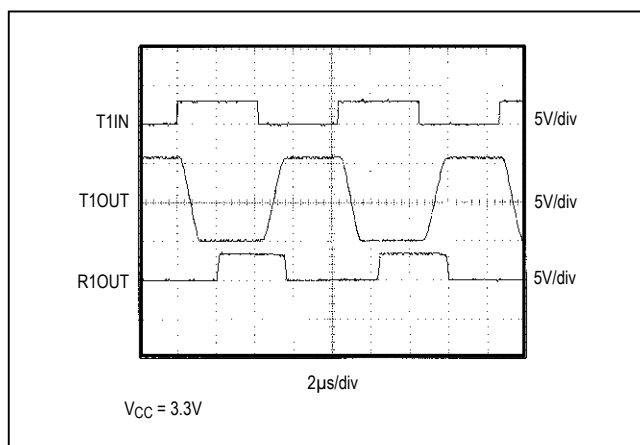


Figure 7. MAX3241 Loopback Test Result at 235kbps

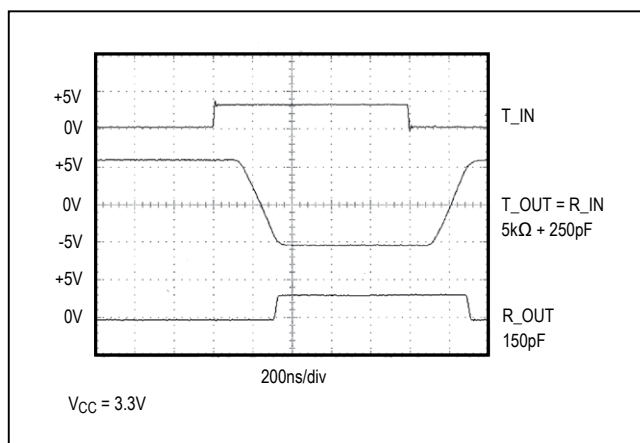


Figure 8. MAX3237 Loopback Test Result at 1000kbps (MBAUD = VCC)

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MAX3237/MAX3241

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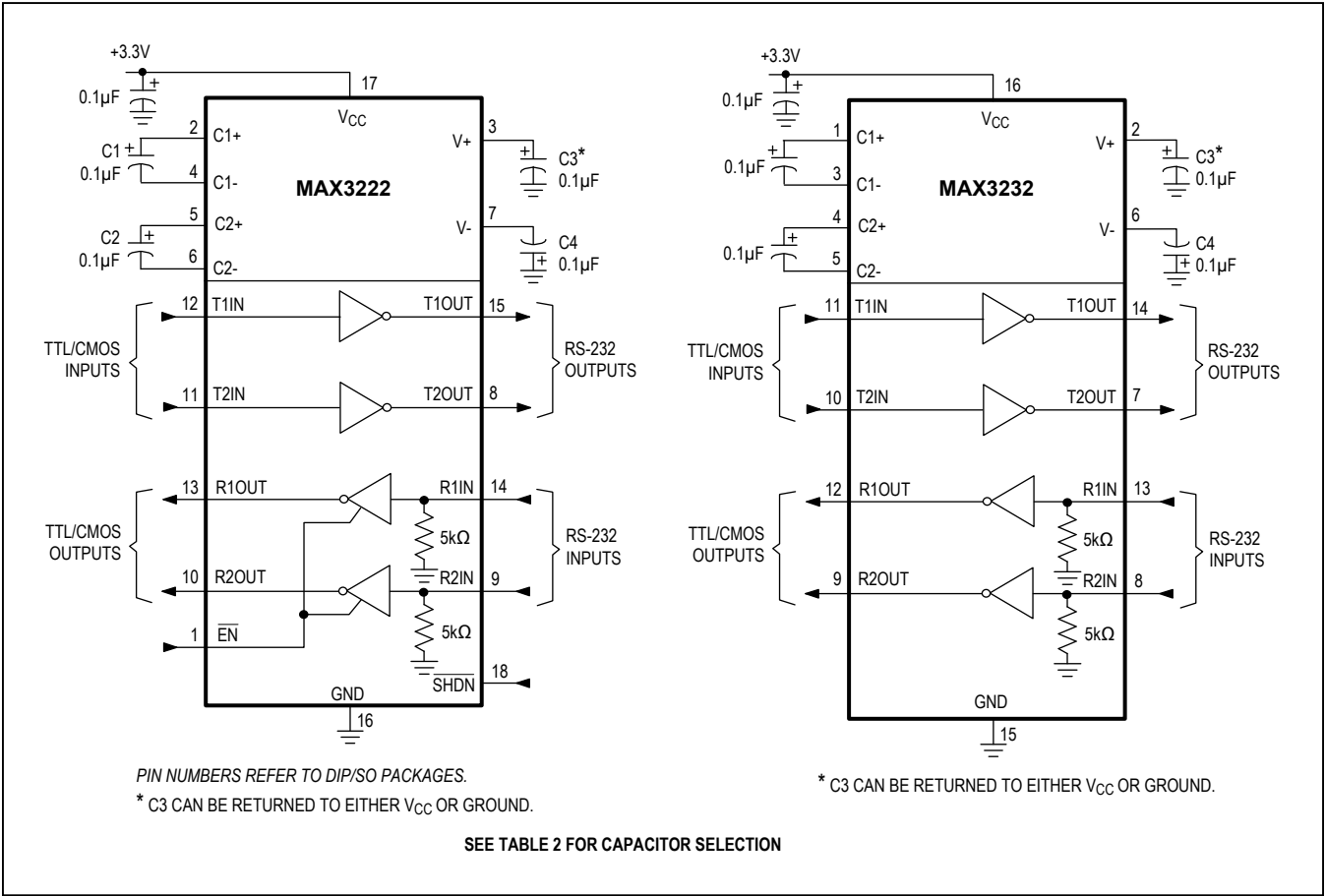
Interconnection with 3V and 5V Logic

The MAX3222/MAX3232/MAX3237/MAX3241 can directly interface with various 5V logic families, including ACT and HCT CMOS. See Table 3 for more information on possible combinations of interconnections.

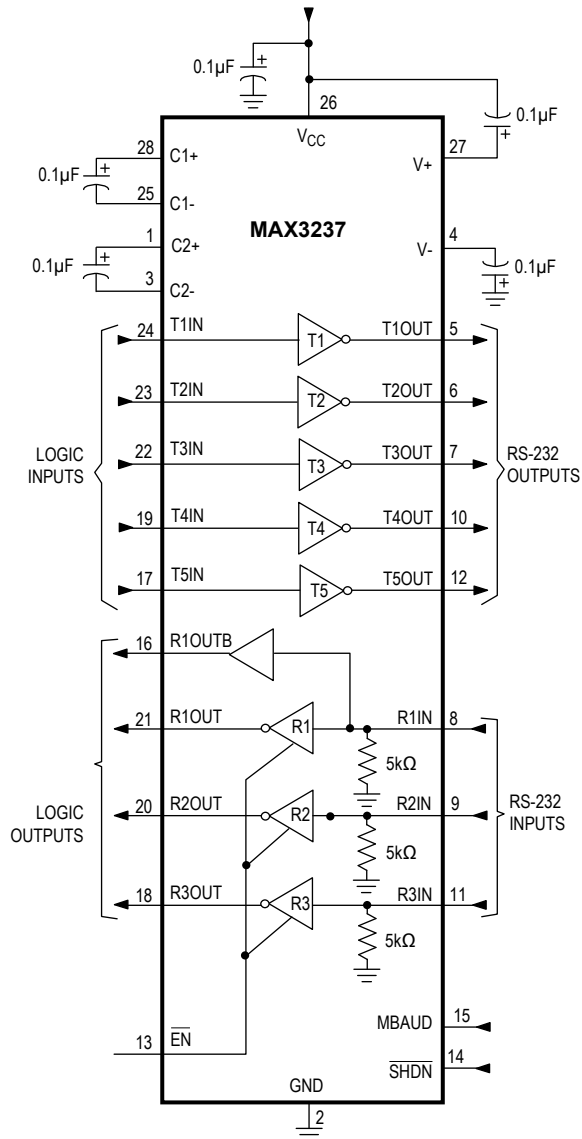
Table 3. Logic-Family Compatibility with Various Supply Voltages

SYSTEM POWER-SUPPLY VOLTAGE (V)	MAX32_VCC SUPPLY VOLTAGE (V)	COMPATIBILITY
3.3	3.3	Compatible with all CMOS families.
5	5	Compatible with all TTL and CMOS-logic families
5	3.3	Compatible with ACT and HCT CMOS, and with TTL. Incompatible with AC, HC, and CD4000 CMOS.

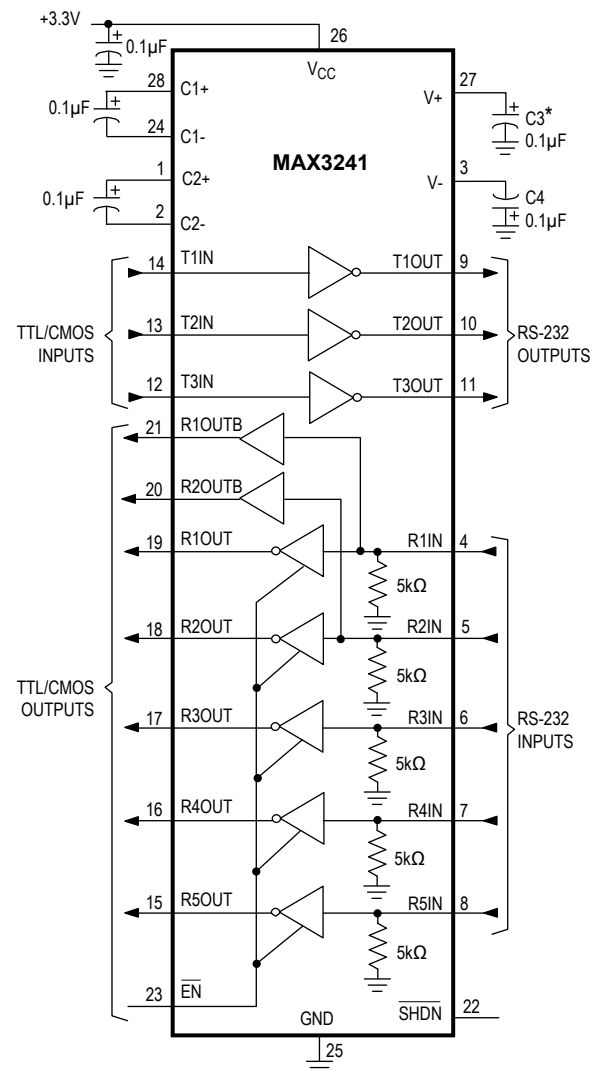
Typical Operating Circuits



Typical Operating Circuits (continued)



* C3 CAN BE RETURNED TO EITHER V_{CC} OR GROUND.

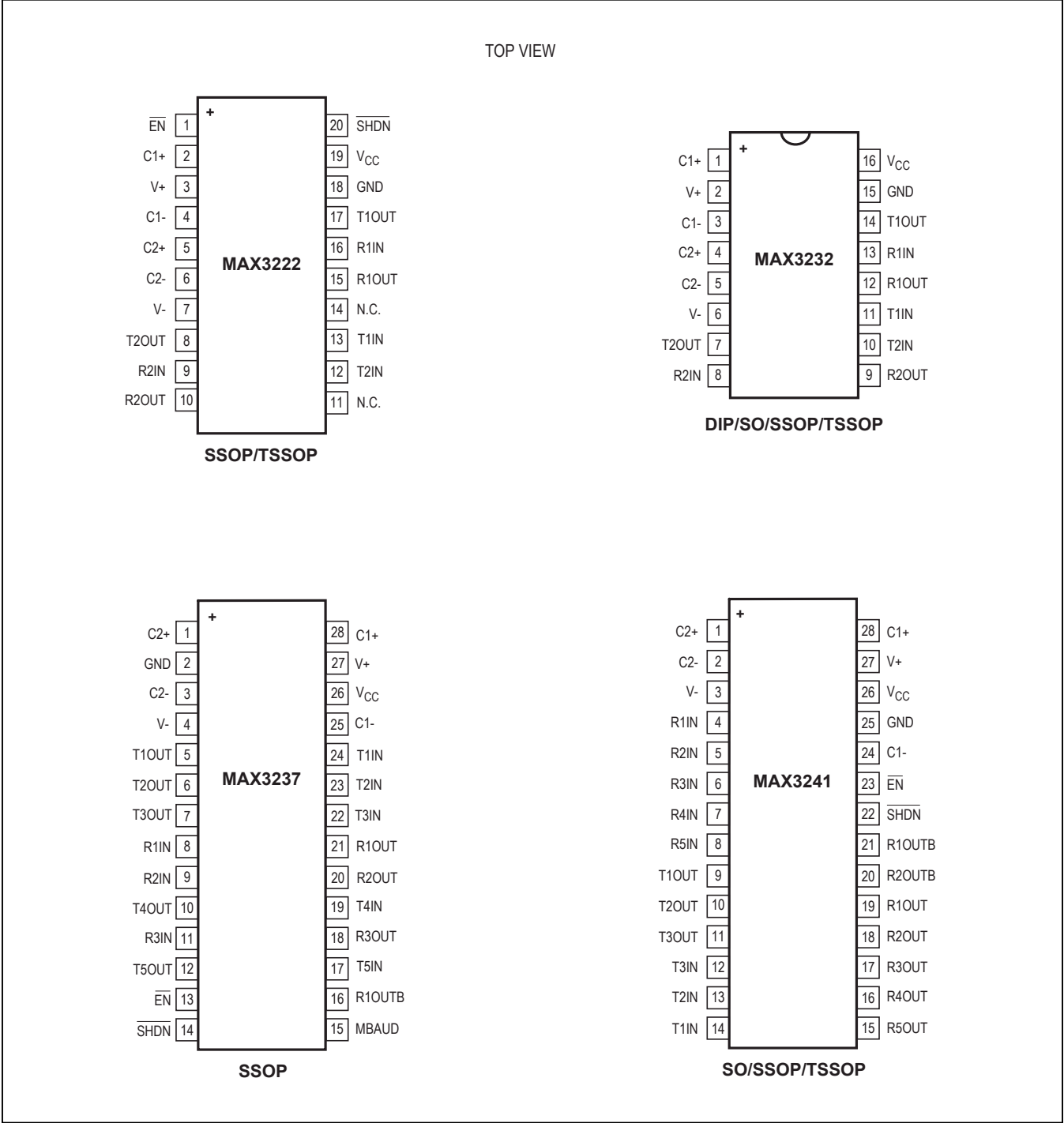


* C3 CAN BE RETURNED TO EITHER V_{CC} OR GROUND.

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Pin Configurations (continued)



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Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE	PKG CODE
MAX3222EUP+	-40°C to +85°C	20 TSSOP	U20+2
MAX3222EAP+	-40°C to +85°C	20 SSOP	A20+1
MAX3222EWN+	-40°C to +85°C	18 SO	W18+1
MAX3222EPN+	-40°C to +85°C	18 Plastic Dip	P18+5
MAX3222C/D	0°C to +70°C	Dice*	—
MAX3232CAE+	0°C to +70°C	16 SSOP	A16+2
MAX3232CUE+	0°C to +70°C	16 TSSOP	U16+1
MAX3232CSE+	0°C to +70°C	16 Narrow SO	S16+1
MAX3232CWE+	0°C to +70°C	16 Wide SO	W16+1
MAX3232CPE+	0°C to +70°C	16 Plastic DIP	P16+1
MAX3232EUE+	-40°C to +85°C	16 TSSOP	U16+1
MAX3232ESE+	-40°C to +85°C	16 Narrow SO	S16+5

PART	TEMP RANGE	PIN-PACKAGE	PKG CODE
MAX3232EWE+	-40°C to +85°C	16 Wide SO	W16+1
MAX3232EPE+	-40°C to +85°C	16 Plastic DIP	P16+1
MAX3237CAI+	0°C to +70°C	16 SSOP	A28+2
MAX3237EAI+	-40°C to +85°C	28 SSOP	A28+1
MAX3241CUI+	0°C to +70°C	28 TSSOP	U28+2
MAX3241CAI+	0°C to +70°C	28 SSOP	A28+1
MAX3241CWI+	0°C to +70°C	28 SO	W28+6
MAX3241EUI+	-40°C to +85°C	28 TSSOP	U28+2
MAX3241EAI+	-40°C to +85°C	28 SSOP	A28+1
MAX3241EWI+	-40°C to +85°C	28 SO	W28+6

*Dice are tested at $T_A = +25^\circ\text{C}$, DC parameters only.

+Denotes lead-free package.

3V-Powered EIA/TIA-232 and EIA/TIA-562 Transceivers from Maxim

PART	POWER-SUPPLY VOLTAGE (V)	NO. OF TRANSMITTERS/RECEIVERS	NO. OF RECEIVERS ACTIVE IN SHUTDOWN	GUAR-ANTEED DATA RATE (kbps)	EIA/TIA-232 OR 562	FEATURES
MAX212	3.0 to 3.6	3/5	5	120	232	Drives mice
MAX218	1.8 to 4.25	2/2	2	120	232	Operates directly from batteries without a voltage regulator
MAX562	2.7 to 5.25	3/5	5	230	562	Wide supply range
MAX563	3.0 to 3.6	2/2	2	230	562	0.1µF capacitors
MAX3212	2.7 to 3.6	3/5	5	235	232	AutoShutdown, complementary receiver, drives mice, transient detection
MAX3222	3.0 to 5.5	2/2	2	120	232	0.1µF capacitors
MAX3223	3.0 to 5.5	2/2	2	120	232	0.1µF capacitors, AutoShutdown
MAX3232	3.0 to 5.5	2/2	N/A	120	232	0.1µF capacitors
MAX3237	3.0 to 5.5	5/3	3	250/1000	232	0.1µF capacitors, 1 complementary receiver, MegaBaud operation
MAX3241	3.0 to 5.5	3/5	5	120	232	0.1µF capacitors, 2 complementary receivers, drives mice
MAX3243	3.0 to 5.5	3/5	1	120	232	0.1µF capacitors, AutoShutdown, complementary receiver, drives mice

Package Information

For the latest package outline information and land patterns (footprints), go to www.maximintegrated.com/packages. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.	THERMAL RESISTANCE (SINGLE LAYER BOARD)		THERMAL RESISTANCE (MULTI LAYER BOARD)	
				θ_{JA} (°C/W)	θ_{JC} (°C/W)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
20 TSSOP	U20+2	21-0066	90-0116	91	20	73.8	20
20 SSOP	A20+1	21-0056	90-0094	125	33	84	32
18 SO	W18+1	21-0042	90-0181	105	22	67	23
18 Plastic Dip	P18+5	21-0043	—	90	30	NA	NA
Dice*	—	—	—	—	—	—	—
16 TSSOP	U16+1	21-0066	90-0117	106	27	90	27
16 Narrow SO	S16+1	21-0041	90-0097	115	32	75	24
16 Wide SO	W16+1	21-0042	90-0107	105	22	71	23
16 Plastic DIP	P16+1	21-0043	—	95	35	NA	NA
16 Narrow SO	S16+5	21-0041	90-0097	115	32	73	23
16 SSOP	A16+2	21-0056	90-0106	140	34	86	33
16 SSOP	A28+2	21-0056	90-0095	105	24	67	25
28 SSOP	A28+1	21-0056	90-0095	110	25	67.1	25
28 TSSOP	U28+2	21-0066	90-0171	78	13	71.6	13
28 SO	W28+6	21-0042	90-0109	80	18	59	18
28 TSSOP	U28+2	21-0066	90-0171	78	13	71.6	13

MAX3222/MAX3232/
MAX3237/MAX3241

3.0V to 5.5V, Low-Power, Up to 1Mbps,
True RS-232 Transceivers

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
7	1/07	General updates	1, 15, 16, 17
8	6/18	Updated <i>Package Information</i> and <i>Ordering Information</i>	1, 15, 16, 17
9	4/19	Added Thermal Resistance data in the <i>Package Information</i> table	16
10	5/19	Updated <i>Package Information</i> table	16

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