



±50V Isolated, 3.0V to 5.5V, 250kbps, 2 Tx/2 Rx, RS-232 Transceiver

MAX3250

General Description

The MAX3250 is a 3.0V to 5.5V powered, ±50V isolated EIA/TIA-232 and V.28/V.24 communications interface with high data-rate capabilities. The MAX3250 is a hybrid part that operates with up to ±50V difference between the RS-232 side and the logic side (ISOCOM to GND). This makes the device ideal for operation in noisy conditions with high common-mode voltages. This feature prevents damage to the device if RS-232 lines are inadvertently short-circuited to a +24V or ±48V power bus.

The MAX3250 is powered by a single 3V to 5.5V supply on the logic side. Power is transferred from the logic side to the isolated side by ±100V external capacitors.

The MAX3250 has two receivers (Rx) and two drivers (Tx) and is guaranteed to run at data rates of 250kbps while maintaining RS-232 output levels. The transceivers have a proprietary low-dropout transmitter output stage, delivering true RS-232 performance from a 3V to 5.5V supply with a dual charge pump. The device features a FAULT open-drain output to signal an excessive common-mode voltage condition on any of the RS-232 inputs. This output can drive an alarm LED or can be monitored by the processor to prevent operation under these conditions. The receiver outputs are high impedance in shutdown, allowing multiple interfaces (IrDA, RS-232, RS-485) to be connected to the same UART.

The MAX3250 is available in a space-saving 28-pin SSOP package.

Applications

- Industrial Control
- Programmable Logic Controller
- Point-of-Sale Equipment
- PC-to-Router Connections
- Diagnostic Ports
- Telecom Equipment

Typical Operating Circuit appears at end of data sheet.

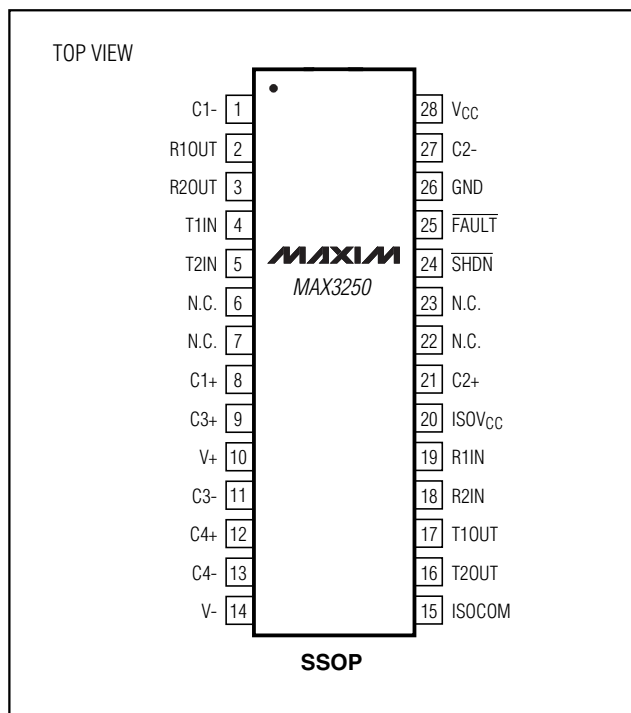
Features

- ◆ ±50V Isolation
- ◆ 20μA Supply Current in Shutdown
- ◆ 250kbps Guaranteed Data Rate
- ◆ FAULT Output
- ◆ High-Impedance Transmitter and Receiver Outputs in Shutdown
- ◆ Space-Saving SSOP Package
- ◆ Inductorless/Transformerless Design Simplifies EMI Compliance
- ◆ Low-Cost Replacement for Opto-Isolated Transceivers
- ◆ Meets EIA/TIA-232 Specifications Down to 3.0V

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX3250CAI	0°C to +70°C	28 SSOP
MAX3250EAI	-40°C to +85°C	28 SSOP

Pin Configuration



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ABSOLUTE MAXIMUM RATINGS

All Voltages Referenced to GND, Unless Otherwise Noted.

V _{CC}	-0.3V to +6V
ISOCOM	±80V
ISOV _{CC} to ISOCOM	-0.3V to +6V
V ₊ to ISOCOM (Note 1)	-0.3V to +7V
V ₋ to ISOCOM (Note 1)	+0.3V to -7V
V ₊ + IV-I (Note 1)	13V
Input Voltages	
T _{IN} , $\overline{\text{SHDN}}$	-0.3V to +6V
R _{IN} to ISOCOM	±25V
Output Voltages	
T _{OUT} to ISOCOM	±13.2V
R _{OUT}	-0.3V to (V _{CC} + 0.3V)
FAULT	-0.3V to +6V

C1-, C2-	-0.3V to (V _{CC} + 0.3V)
C1+, C2+, C3+, C3-, C4+, C4- to ISOCOM	-0.3V to (ISOV _{CC} + 0.3V)
Short-Circuit Duration T _{OUT} to ISOCOM	Continuous
Continuous Power Dissipation (T _A = +70°C) 28-Pin SSOP (derate 9.5mW/°C above +70°C)	762mW
Operating Temperature Ranges	
MAX3250CAI	0°C to +70°C
MAX3250EAI	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10s)	+300°C

Note 1: V₊ and V₋ can have a maximum magnitude 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} = 3.0V to 5.5V, see *Typical Operating Circuit* and Table 1 for capacitor values, ISOCOM = GND, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = 3.3V and T_A = +25°C.) (Note 2)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
DC CHARACTERISTICS					
Supply Current	$\overline{\text{SHDN}}$ = V _{CC} , no load		15	35	mA
Supply Current Shutdown	$\overline{\text{SHDN}}$ = GND, V _{ISOCOM} = GND		20	45	μA
	$\overline{\text{SHDN}}$ = GND, V _{ISOCOM} = ±50V			±350	
Maximum Ground Differential	V _{GND} - V _{ISOCOM}			50	V
Isolation Resistance	Between GND and ISOCOM		60		kΩ
LOGIC INPUTS					
Input Logic Low	T _{IN} , $\overline{\text{SHDN}}$			0.8	V
Input Logic High	T _{IN} , $\overline{\text{SHDN}}$	V _{CC} = 3.3V	2.0		V
		V _{CC} = 5.0V	2.4		
Transmitter Input Hysteresis			0.5		V
Input Leakage Current	T _{IN} , $\overline{\text{SHDN}}$	-1	±0.01	+1	μA
RECEIVER OUTPUTS					
Output Leakage Current	$\overline{\text{SHDN}}$ = GND	-10	±0.05	+10	μA
Output Voltage Low	I _{OUT} = 1.6mA			0.4	V
Output Voltage High	I _{OUT} = -1.0mA	V _{CC} - 0.6		V _{CC} - 0.1	V
FAULT OUTPUT					
Output Voltage Low (Open Drain)	I _{OUT} = 5mA			0.4	V
Output Leakage Current	FAULT not asserted			1	μA
FAULT Trip Level	V _{GND} - V _{ISOCOM}		55		V

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ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = 3.0V to 5.5V, see *Typical Operating Circuit* and Table 1 for capacitor values, ISOCOM = GND, T_A = T_{MIN} to T_{MAX} , unless otherwise noted. Typical values are at V_{CC} = 3.3V and T_A = +25°C.) (Note 2)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
RECEIVER INPUTS (relative to ISOCOM)						
Input Voltage Range			-25		+25	V
Input Threshold Low	T _A = +25°C	V _{CC} = 3.3V		1.2	0.6	V
		V _{CC} = 5.0V		1.3	0.8	
Input Threshold High	T _A = +25°C	V _{CC} = 3.3V	2.4	1.6		V
		V _{CC} = 5.0V	2.4	1.7		
Input Hysteresis				0.5		V
Input Resistance	T _A = +25°C		3	5	7	kΩ
TRANSMITTER OUTPUTS (relative to ISOCOM)						
Output Voltage Swing	All transmitter outputs loaded with 3kΩ to ISOCOM		±5.0	±5.4		V
Output Resistance	ISOV _{CC} = V+ = V- = 0V, T_OUT = ±2V		300	10M		Ω
Output Short-Circuit Current			-60		+60	mA
Output Leakage Current	V _{CC} = 0 or 3V to 5.5V, T_OUT = ±12V, $\overline{\text{SHDN}}$ = GND		-25		+25	μA

TIMING CHARACTERISTICS

(V_{CC} = 3.0V to 5.5V, see *Typical Operating Circuit* and Table 1 for capacitor values, ISOCOM = GND, T_A = T_{MIN} to T_{MAX} , unless otherwise noted. Typical values are at V_{CC} = 3.3V and T_A = +25°C.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Maximum Data Rate	R_L = 3k Ω , C_L = 1000pF to ISOCOM, one transmitter		250			kbps
Receiver Propagation Delay	R_IN to R_OUT, C_L = 150pF to GND			0.4		μ s
Receiver Skew	t _{PHL} - t _{PLH}			100		ns
Transmitter Skew	t _{PHL} - t _{PLH} (Note 3)			120		ns
Transition-Region Slew Rate	V_{CC} = 3.3V, T_A = +25°C, R_L = 3k Ω to 7k Ω to ISOCOM, measured from +3V to -3V or -3V to +3V	C_L = 150pF to 1000pF to ISOCOM	6		30	V/ μ s
		C_L = 150pF to 2500pF to ISOCOM	4		30	
FAULT Propagation Delay				0.3		μ s
Time to Shutdown				0.5		μ s
Time to Exit Shutdown	V_{ISOCOM} = GND			300		μ s
	V_{ISOCOM} = ±50V			350		

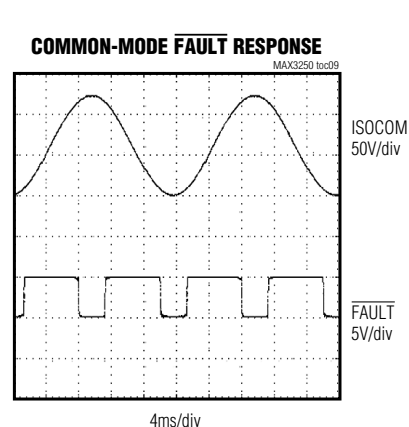
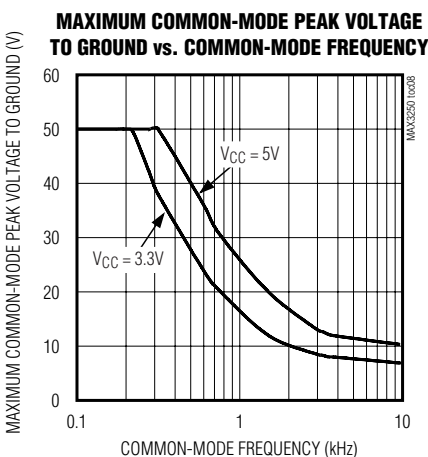
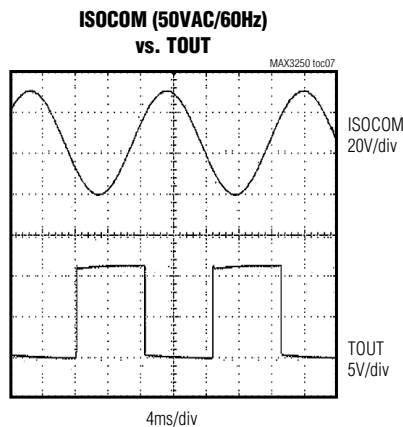
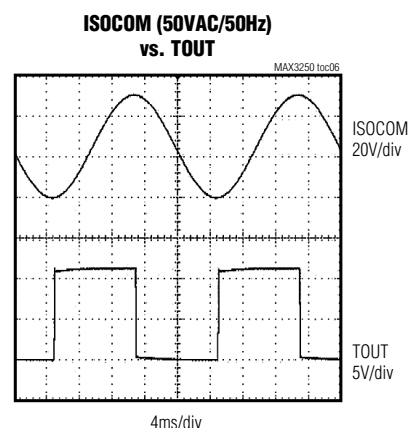
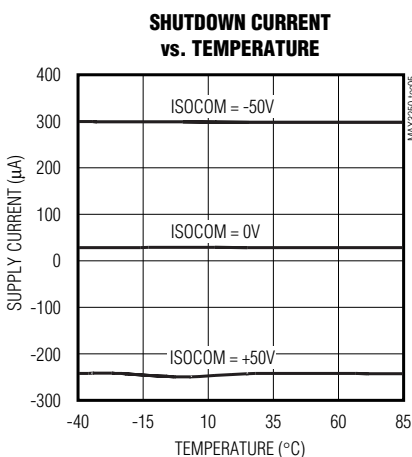
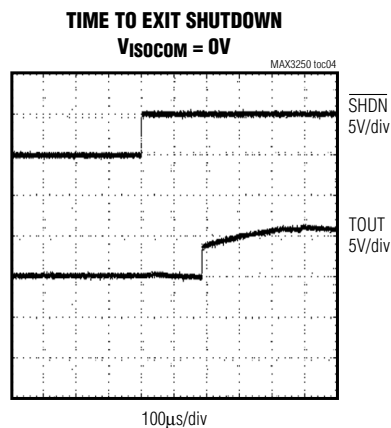
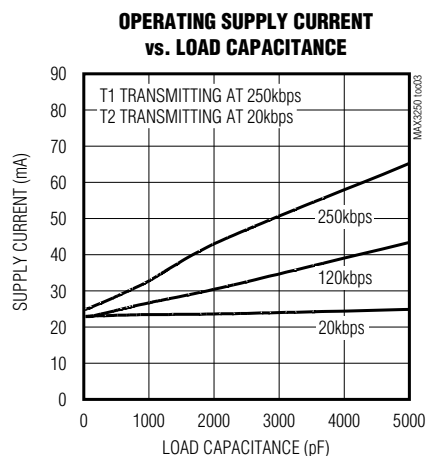
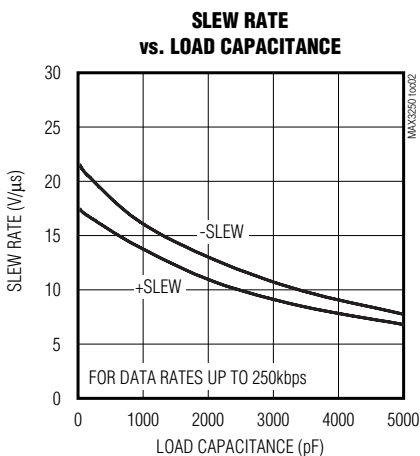
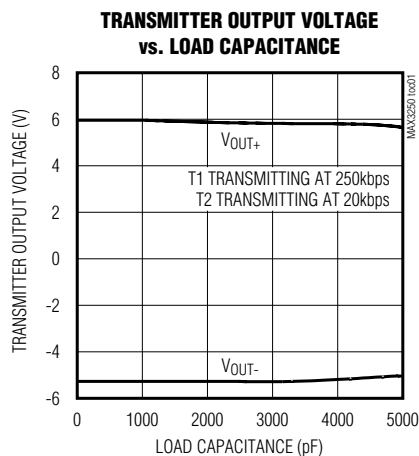
Note 2: All currents into the device are positive; all currents out of the device are negative. All voltages are referenced to device ground, unless otherwise noted.

Note 3: Transmitter skew is measured at the transmitter zero crosspoints.

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Typical Operating Characteristics

($V_{CC} = 3.3V$, 250kbps data rate, see *Typical Operating Circuit* and Table 1 for capacitor values, all transmitters loaded with $3k\Omega$ and C_L to ISOCOM, $T_A = +25^\circ C$, unless otherwise noted.)



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Pin Description

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PIN	NAME	FUNCTION
1	C1-	Negative Terminal of the Power Isolation Capacitor. Connect a 100V capacitor from C1- to C1+. See Table 1 for values.
2	R1OUT	TTL/CMOS Receiver Output
3	R2OUT	TTL/CMOS Receiver Output
4	T1IN	TTL/CMOS Transmitter Input
5	T2IN	TTL/CMOS Transmitter Input
6, 22, 23	N.C.	No Connection. Not internally connected.
7	N.C.	No Connection. Leave unconnected or connect to ISOCOM.
8	C1+	Positive Terminal of the Power Isolation Capacitor. Connect a 100V capacitor from C1+ to C1-. See Table 1 for values.
9	C3+	Positive Terminal of the Voltage-Doubler Charge-Pump Capacitor. Connect a 0.1μF capacitor from C3+ to C3-.
10	V+	+5.5V Generated by the Charge Pump, Referenced to ISOCOM. Bypass V+ to ISOCOM with a 0.47μF capacitor.
11	C3-	Negative Terminal of the Voltage-Doubler Charge-Pump Capacitor. Connect a 0.1μF capacitor from C3- to C3+.
12	C4+	Positive Terminal of the Inverting Charge-Pump Capacitor. Connect a 0.47μF capacitor from C4+ to C4-.
13	C4-	Negative Terminal of the Inverting Charge-Pump Capacitor. Connect a 0.47μF capacitor from C4- to C4+.
14	V-	-5.5V Generated by the Charge Pump, Referenced to ISOCOM. Bypass V- to ISOCOM with a 0.47μF capacitor.
15	ISOCOM	Isolated Ground
16	T2OUT	RS-232 Transmitter Output
17	T1OUT	RS-232 Transmitter Output
18	R2IN	RS-232 Receiver Input
19	R1IN	RS-232 Receiver Input
20	ISOV _{CC}	Internally Generated Isolated Power-Supply Voltage, Referenced to ISOCOM. Bypass ISOV _{CC} to ISOCOM with a 1μF capacitor.
21	C2+	Positive Terminal of the Power Isolation Capacitor. Connect a 100V capacitor from C2+ to C2-. See Table 1 for values.
24	$\overline{\text{SHDN}}$	Shutdown Control. Drive $\overline{\text{SHDN}}$ low to enter low-power shutdown mode. Drive $\overline{\text{SHDN}}$ high or connect to V _{CC} for normal operation.
25	$\overline{\text{FAULT}}$	Overvoltage Indicator. Active low, open drain.
26	GND	Ground
27	C2-	Negative Terminal of the Power Isolation Capacitor. Connect a 100V capacitor from C2- to C2+. See Table 1 for values.
28	V _{CC}	3.0V to 5.5V Supply Voltage. Bypass V _{CC} to GND with a 1μF capacitor.

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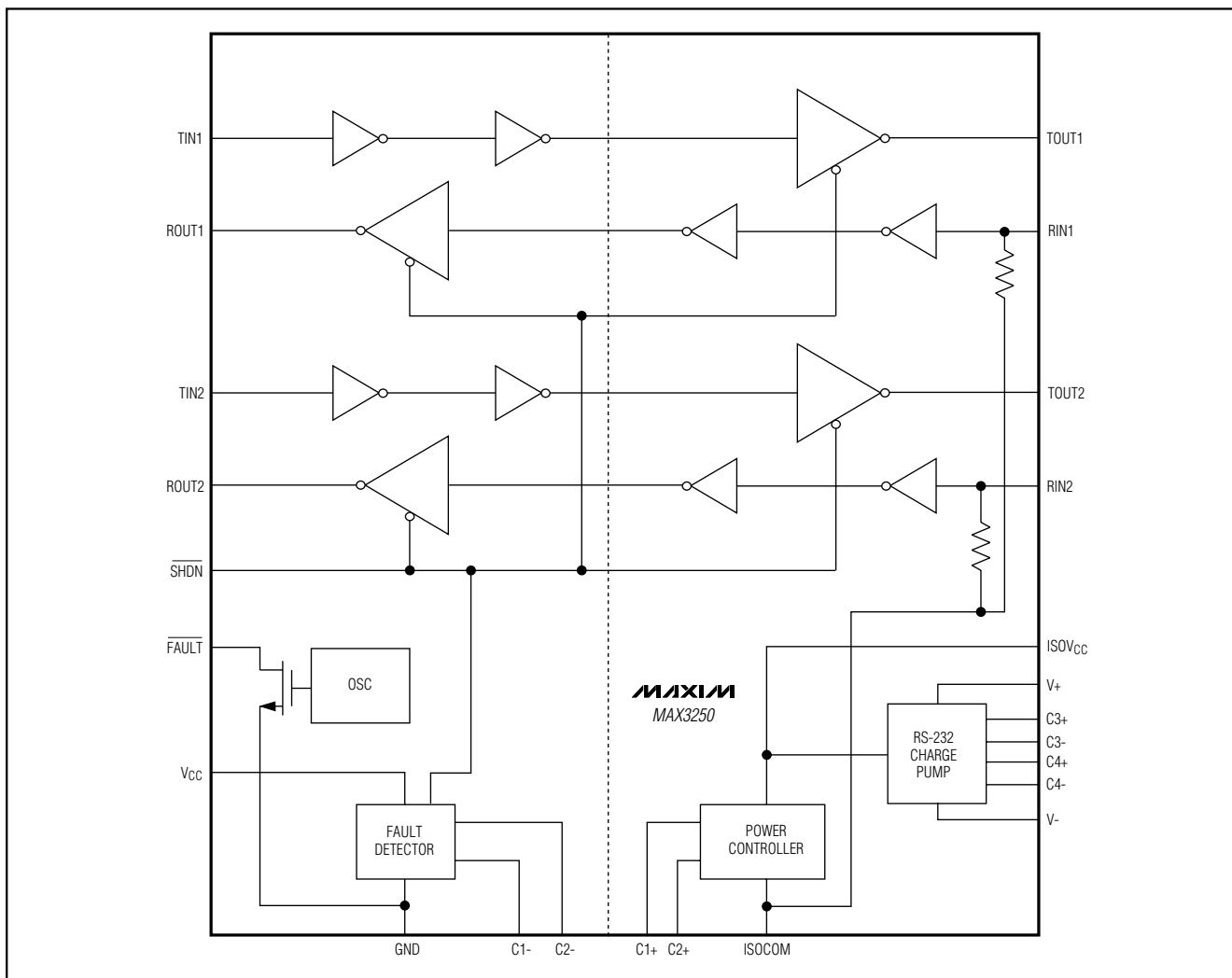


Figure 1. Functional Diagram

Detailed Description

The MAX3250 is a 3.0V to 5.5V powered, $\pm 50V$ isolated EIA/TIA-232 and V.28/V.24 communications interface with high data-rate capabilities. The MAX3250 is a hybrid part that operates with up to $\pm 50V$ difference between the RS-232 side and the logic side (ISOCOM to GND). This makes the device ideal for operation in noisy conditions with high common-mode voltages. This feature prevents damage to the device if RS-232 lines are inadvertently short-circuited to a +24V or $\pm 48V$ power bus.

The MAX3250 typically draws 15mA of supply current when unloaded. Supply current drops to 20 μA when the device is placed in shutdown mode.

The MAX3250 has two receivers and two drivers and is guaranteed to operate at data rates up to 250kbps. The device features a $\overline{FAULT}$ open-drain output to signal an excessive common-mode voltage condition on any of the RS-232 inputs. This output can drive an alarm LED or can be monitored by the processor to prevent operation under these conditions. The receiver outputs are high impedance in shutdown, allowing multiple interfaces (IrDA, RS-232, RS-485) to be connected to the same UART (Figure 1). The MAX3250 is a low-cost replacement for opto-isolated transceivers.

Isolated Power Supply

The MAX3250 drives a high-frequency square wave into C1 and a complementary square wave into C2. These

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AC waveforms are rectified by the isolated side of the hybrid to power its internal circuitry (ISOV_{CC}). Capacitor C6 filters the output of the rectifier. See the *Typical Operating Circuit*.

The power controller works in a discontinuous mode. Oscillation is enabled when the isolated power supply is below its regulation point. Oscillation is disabled when the isolated power supply is above its regulation point.

Dual Charge-Pump Voltage Converter

The RS-232 drivers are powered from a regulated dual charge pump that provides output voltages of +5.5V (doubling charge pump) and -5.5V (inverting charge pump) relative to ISOCOM over the 3.0V to 5.5V V_{CC} range.

The charge pumps are powered from ISOV_{CC} and operate in a discontinuous mode. If the output voltages are less than 5.5V, the charge pumps are enabled. If the output voltages exceed 5.5V, the charge pumps are disabled. Each charge pump requires a flying capacitor (C3, C4) and a reservoir capacitor (C7, C8) to generate the V₊ and V₋ supplies.

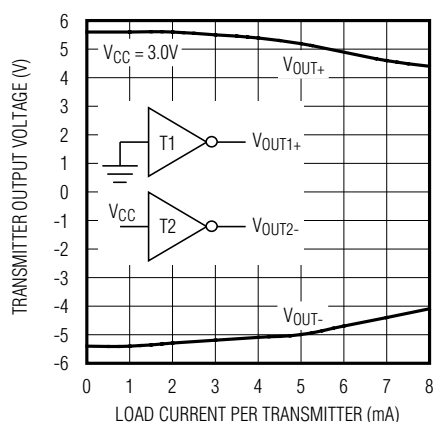


Figure 2. Transmitter Output Voltage vs. Load Current per Transmitter

RS-232 Transmitters

The transmitters are inverting level translators that convert TTL/CMOS-logic levels to ±5.0V EIA/TIA-232-compliant levels. They guarantee a 250kbps data rate with worst-case loads of 3k Ω in parallel with 1000pF to ISOCOM. In shutdown, the transmitters are disabled and the outputs are forced into a high-impedance state. When powered off or shut down, the outputs can be driven up to ±12V

relative to ISOCOM. The transmitter inputs do not have pullup resistors. All unused inputs should be connected to V_{CC} or GND.

RS-232 Receivers

The receivers convert RS-232 signals to CMOS-logic output levels. The receivers' outputs are forced into a high-impedance state when the device is in shutdown. This allows a single UART to multiplex between different protocols.

Low-Power Shutdown Mode

Shutdown mode is obtained by driving $\overline{\text{SHDN}}$ low. In shutdown, the devices typically draw only 20 μA of supply current and no power is transferred across the isolation capacitors. The charge pumps are disabled, and the receiver outputs and transmitter outputs are high impedance. When exiting shutdown the charge pumps and transmitter outputs are fully operational in typically 500 μs (Figure 3). Connect $\overline{\text{SHDN}}$ to V_{CC} if the shutdown mode is not used.

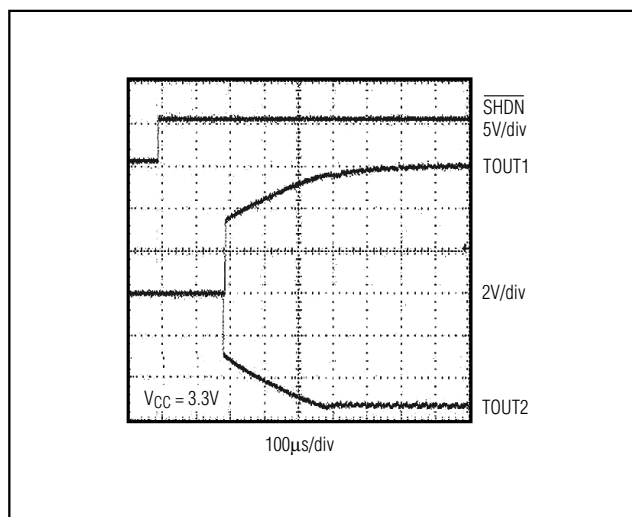


Figure 3. Transmitter Outputs when Exiting Shutdown or Powering Up

Applications Information

Power Isolation Capacitors

The values for capacitors C1 and C2 are important for proper operation of the device. These capacitors should be 0.047 μF for 4.5V to 5.5V operation, and 0.47 μF for 3.0V to 5.5V operation. Smaller values result in insufficient supply voltage on the isolated side. Larger values are allowed, but do not result in greater charge-pump output voltage.

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Table 1. Required Minimum Capacitor Values

V _{CC} (V)	C1, C2 (μF)	C3 (μF)	C4, C7, C8 (μF)	C5, C6 (μF)	C9 (nF)
3.0 to 5.5	0.47	0.1	0.47	1	10
4.5 to 5.5	0.047	0.1	0.47	1	10

Capacitor C9 provides an AC feedback path for proper controller operation. Connect C9 from ISOCOM to GND.

The values for C1, C2, and C9 determine the maximum frequency and amplitude of the voltage difference between the local and isolated ground. Table 1 shows proper capacitance values.

To achieve full isolation capability, C1, C2, and C9 should be rated for 100V or higher operation and be X7R or X5R type dielectric. Y5V and Z5U dielectrics should be avoided as their voltage and temperature coefficients make their power-transfer capabilities insufficient.

Charge-Pump and Bypass Capacitors

Capacitors C3–C8 should be X7R or X5R type dielectric. Their voltage rating needs to be 10V or higher.

Layout Information

Because the MAX3250 is intended for systems requiring ±50V isolation, some consideration in component placement is necessary.

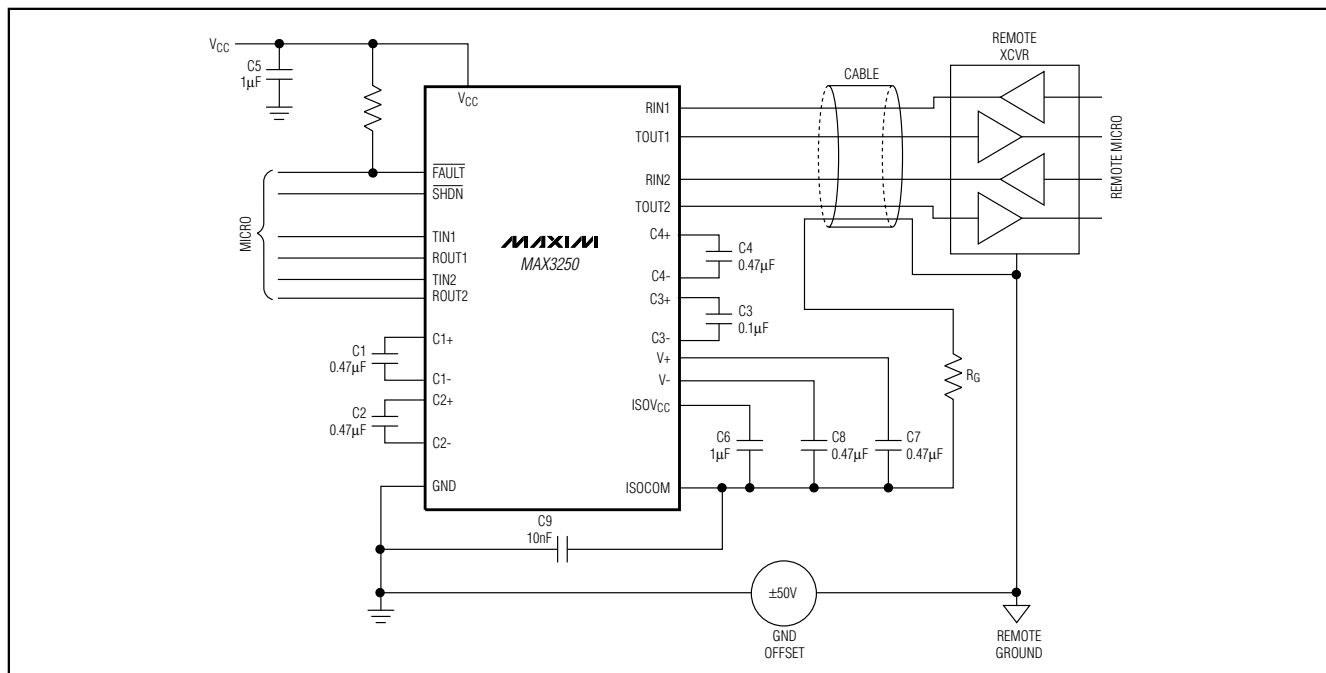
A 20mil air gap should isolate the logic side and the isolated RS-232 side, across the N.C. pins (pin numbers 6, 7, 22, and 23) of the MAX3250. The only components that cross this air gap should be C1, C2, and C9, which all should have a minimum 100V rating.

All capacitors should be located as close to the MAX3250 as possible.

RG Selection

Besides the capacitor values, the maximum frequency and amplitude of the voltage difference between the local and isolated ground is also determined by the resistance between the remote ground and ISOCOM.

Typical Operating Circuit



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The receiver input resistors cause ISOCOM to go to the mean voltage of the receiver inputs, which is a direct function of the remote ground potential. The receiver input resistance and capacitors C1, C2, and C9 set up a time constant that limits how fast ISOCOM can follow variations in the remote ground voltage. The relatively low input impedance of the receiver inputs of the MAX3250 ($5\text{k}\Omega$) allows for a 60Hz sine wave with a 50V maximum amplitude (see the *Typical Operating Characteristics*). For proper operation of the device, a resistor R_G must also be added in series with the ground connection of the RS-232 cable ($1\text{k}\Omega$ is adequate). Using a lower value for this resistor is not recommended, as this could trigger a holding current in the internal ESD-protection device if the $\pm 80\text{V}$ isolation limit is exceeded.

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 $3\text{k}\Omega$ 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 .

Chip Information

TRANSISTOR COUNT: 2094

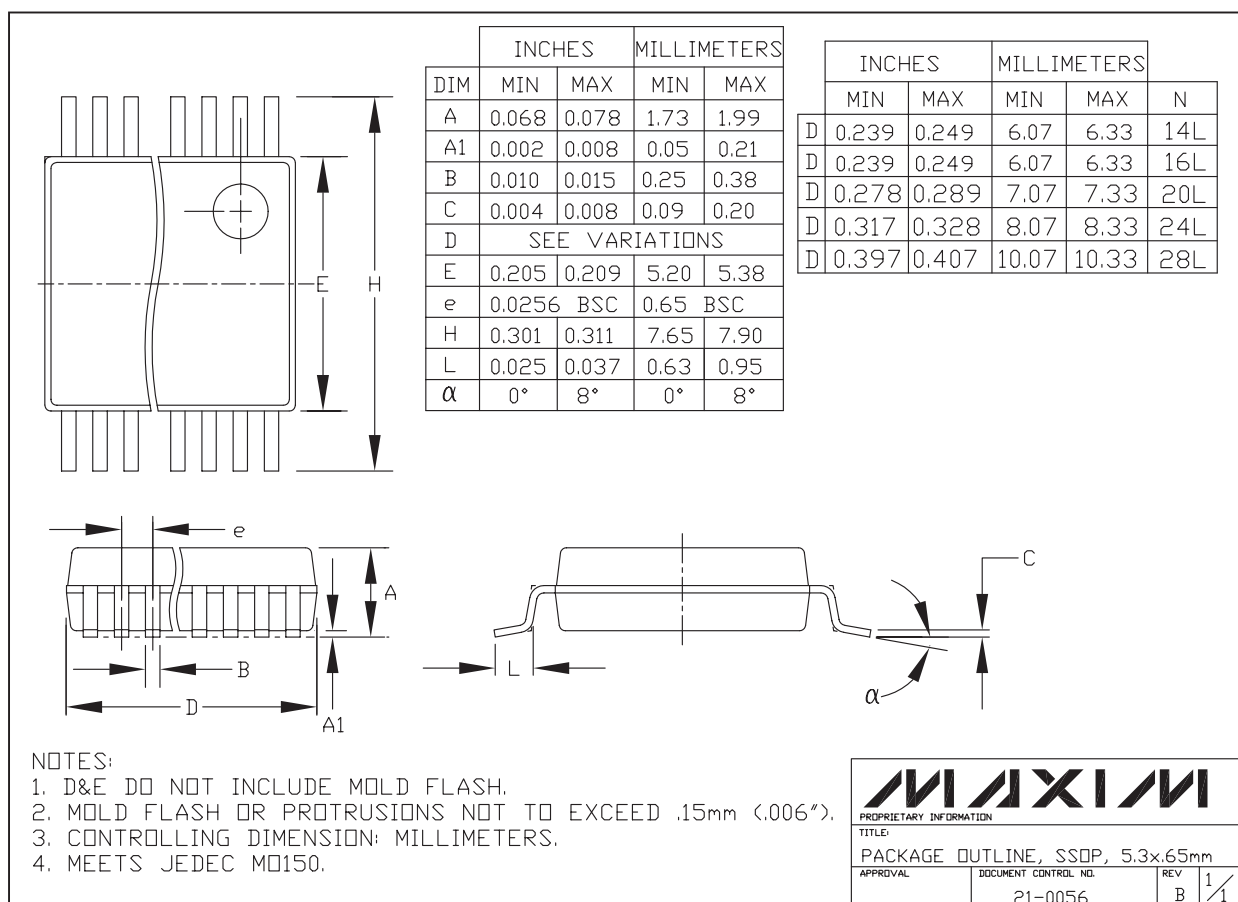
PROCESS: BiCMOS

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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.)



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