

Tiny RS232 Transceivers Run Directly from Alkaline, NiMH or NiCd Batteries

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Introduction

Six new devices comprise a family of small-footprint RS-232 transceivers that operate at up to 1Mbps over a supply range of 1.8V to 5.5V. The LTC2801 and LTC2802 are single transceivers available in 4mm × 3mm DFN packages, and the LTC2803 and LTC2804 are dual transceivers available in 5mm × 3mm DFN packages. The LTC2803-1 and LTC2804-1 are dual transceivers offered in 16-pin SSOP packages. The wide supply range permits operation directly from two alkaline, NiCd, or NiMH battery cells, while a separate VL supply pin eliminates interfacing problems in mixed-supply systems.

1Mbps and 250kbps Data Rate

All of the devices are capable of driving standard RS232 loads (2.5nF/3kΩ) at 100kbps, and 1nF/3kΩ at 250kbps. The faster parts, the LTC2802, LTC2804 and LTC2804-1, can also drive 250pF/3kΩ at 1Mbps. Waveforms for a single transceiver operating at 1Mbps and 1.8V in a transmitter-loopback configuration are shown in Figure 1.

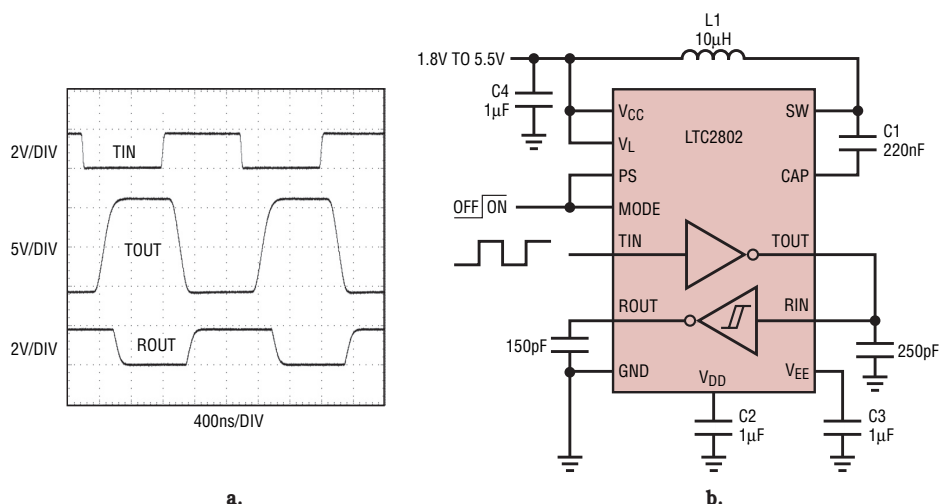


Figure 1. Operating waveforms at 1.8V and 1Mbps with driver and receiver fully loaded (a) and transmitter loopback mode test circuit (b)

Achieving the higher signaling rate—50× the rate provided for in the original standard—necessitates slewing the driver faster than the standard's 30V/μs limit. The slower parts, the LTC2801 and LTC2803, are fully RS232 compliant. Output levels of all parts are RS232 compliant at their rated data rates even at 1.8V supply.

Figure 2 shows the relationship of supply current to supply voltage required to drive 1nF/3kΩ loads at

various data rates. Figure 3 shows the supply current sensitivity to data rate at 1.8V.

More Features

Up to four operating modes are available, depending on the part (Table 1). The DFN parts have two power-saving modes. In Shutdown mode, current draw on each supply is reduced below 1μA. Receiver and driver outputs are high impedance, eliminating any problem associated with powering

Table 1. Feature summary

	LTC2801	LTC2802	LTC2803	LTC2803-1	LTC2804	LTC2804-1
Drivers and Receivers	1 + 1	1 + 1	2 + 2	2 + 2	2 + 2	2 + 2
Package	12-lead 4mm × 3mm DFN	12-lead 4mm × 3mm DFN	16-lead 5mm × 3mm DFN	16-lead SSOP	16-lead 5mm × 3mm DFN	16-lead SSOP
100kbps for $R_L=3k\Omega$, $C_L=2.5nF$	✓	✓	✓	✓	✓	✓
250kbps for $R_L=3k\Omega$, $C_L=1nF$	✓	✓	✓	✓	✓	✓
1Mbps for $R_L=3k\Omega$, $C_L=250pF$		✓			✓	✓
30V/μs Maximum Slew Rate	✓		✓	✓		
Shutdown	✓	✓	✓	✓	✓	✓
Receiver(S) Active	✓	✓	✓		✓	
Driver Disable	✓	✓	✓		✓	

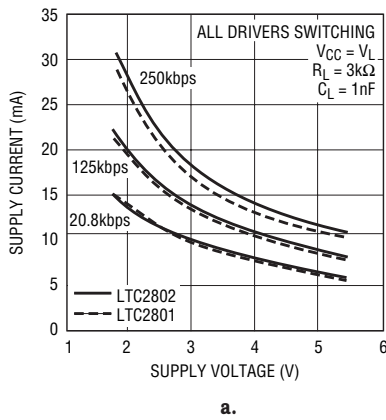


Figure 2. Supply current vs supply voltage for single (a) and dual (b) transceiver

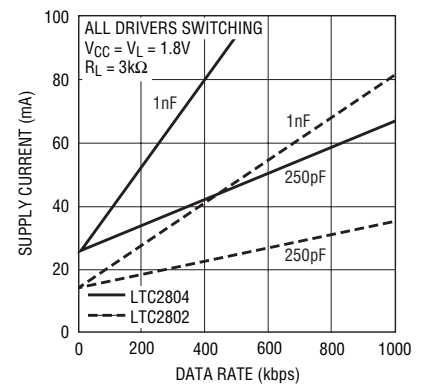
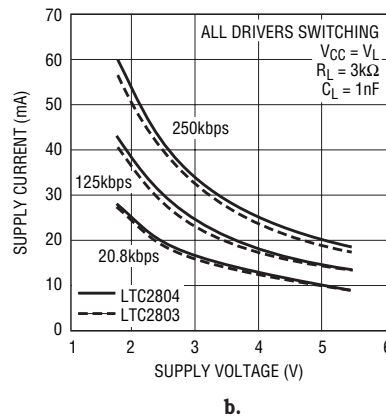


Figure 3. Supply current vs data rate (single and dual transceiver)

down a part connected to a receiver output. Receiver(s) Active mode is like Shutdown except receivers are biased at low current. With only 15 μ A current draw, one or two receivers can listen for a wake-up signal. Besides the Normal full-duplex operating mode, a Driver(s) Disabled mode is available to support line sharing and half-duplex operation.

These parts have built-in measures that permit reliable operation in the sometimes-harsh environment encountered in RS232 interfaces. All device pins are protected against electrostatic discharge (ESD) events without damage or latch-up. Interface pins have additional protection, tolerating repeated 10kV human body model discharges. Both driver and receiver outputs are current limited.

Dual Regulator

Each device in the LTC2801 family drives RS232 compliant output levels over its entire input supply range using an integrated dual regulator (Figure 4) that replaces the charge pump voltage multiplier found in many RS232 integrated circuits. Excellent

line and load regulation is achieved with a constant frequency (1.2MHz typical) boost regulator that generates a positive supply of 7V and a coupled inverting charge pump that generates a negative supply of -6.3V. Like

its charge pump voltage multiplier counterpart, regulator switching varies according to the driver loading. The regulator operates in a pulse skipping mode when driver activity/loading is low. Because all its Schottky diodes

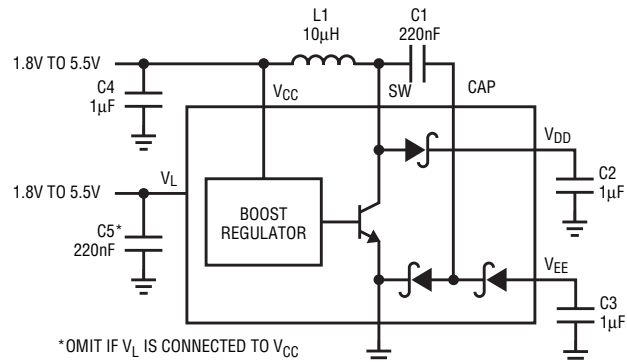


Figure 4. Dual regulator and recommended biasing

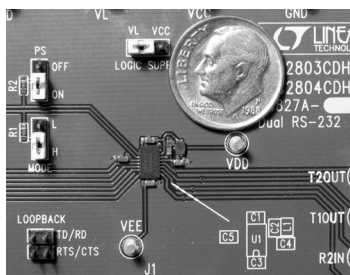


Figure 5. Example board layout with 5mm x 3mm DFN package

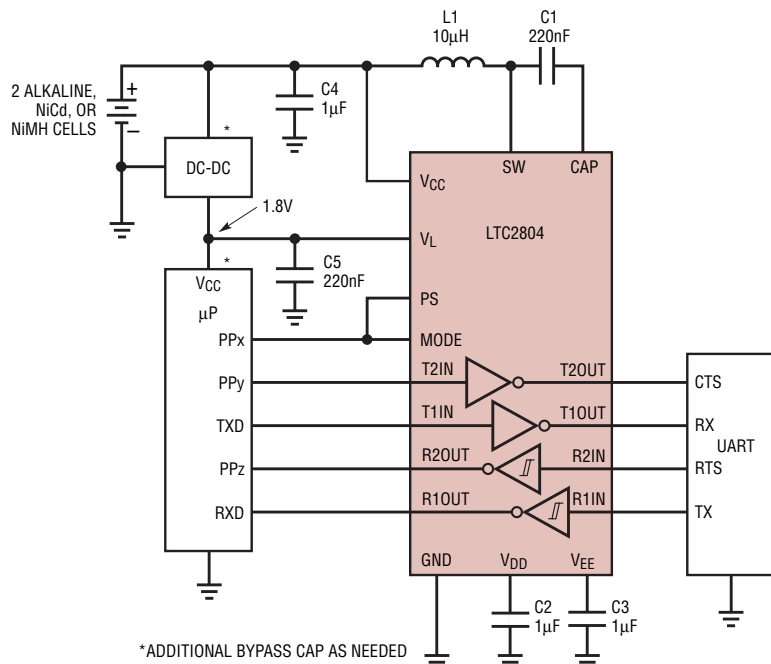


Figure 6. Diagnostic port operating directly off unregulated battery

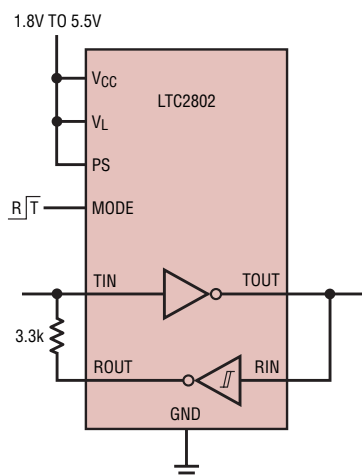


Figure 7. Half-duplex mode on RS232 interface. The logic interface shares a single wire, too.

are integrated, the regulator requires only five external components: one small inductor and four tiny ceramic capacitors (Figure 5).

Battery-Operated Microcontroller Interface

The advantage of the VL interface logic supply feature can be seen in Figure 6, which shows a battery-operated RS232 interface to a diagnostic port on a 1.8V microprocessor. For maximum efficiency, the LTC2804 is operated directly off the battery voltage. The VL pin is connected to the microprocessor's regulated 1.8V supply, setting the RxOUT high level and the TxIN and control input threshold voltages, which are automatically scaled. This configuration can extend battery life while eliminating the need for level translators.

Half-Duplex on Shared Line

RS232 transceivers are often used in configurations outside the scope of the original standard. Figure 7 shows an LTC2802 configured to signal half-duplex over a single RS232 interface wire. The logic interface, too, shares a single wire between driver and receiver. With PS kept high, the MODE input serves as a low-latency driver enable that can switch between transmit and receive modes within 2 μ s. Using a switchable terminator in the remote device can help avoid degrading output levels and increasing power consumption.

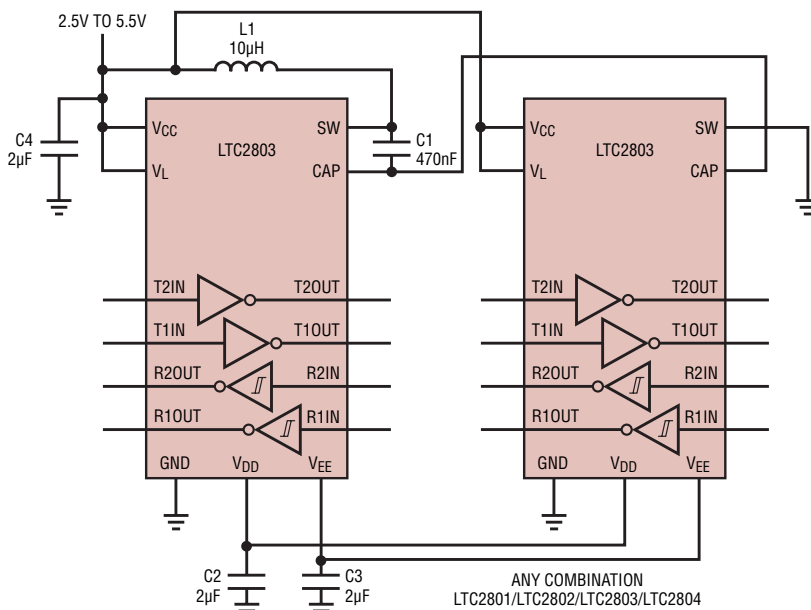


Figure 8. Quad transceiver with reduced component count

Quad Transceiver

Dual transceivers are commonly used to provide a bidirectional interface that includes a data line and a hardware handshaking control signal. If two such ports are needed, two dual transceiver devices can share one device's regulator (Figure 8). Tie both device's CAP pins together, connecting in parallel the inverting charge pump Schottky diodes from both devices. The negative supply level is improved due to a reduction in the combined diode's forward voltage. The second device's unused SW pin should be grounded. This configuration eliminates one set of external components.

Adjustable Level Translator

Any RS232 transceiver is a bidirectional level translator. With the regulator and drivers disabled, the receiver(s) can provide simple unidirectional level translation with the output high level defined by the VL supply (Figure 9). This makes a useful 3V-to-5V or 5V-to-1.8V inverting translator capable of 1Mbps. A static dual translator consumes 120 μ A current. If hysteresis is not required, the MODE and PS pin connections can be reversed to obtain a lower power version (15 μ A static) capable of 100kbps.

Conclusion

The LTC2801 family's wide input range of 1.8V to 5.5V enables these parts to provide RS232 interfaces with fully compliant output levels using a broad range of power sources. The small footprint required by each part and its external components (Figure 5), independent logic interface supply, and power saving features, make this family of parts an attractive choice for designing low cost standardized signaling interfaces into modern consumer electronics.

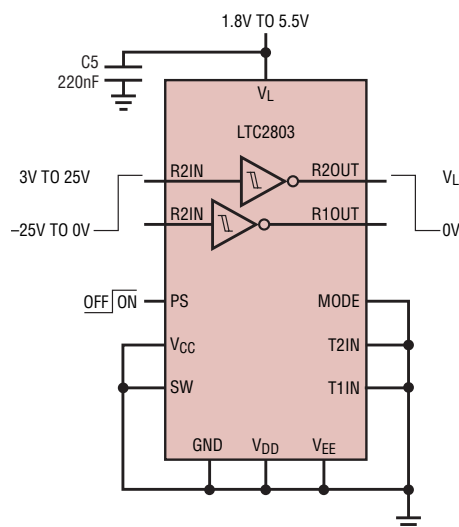


Figure 9. Inverting level translator

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