# DESIGN NOTES

## New Developments in RS232 Interfaces

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New RS232 interface chips have been developed that offer significant advantages over older devices such as the 1488 and 1489. The new RS232 interface ICs improve speed, power, voltage supply requirements, and protection over older devices. Further, the new chips are easier to use, requiring fewer external components and may be turned off to a "zero" power supply current condition for use in battery powered systems.

The new RS232 drivers are implemented in a monolithic bipolar technology. A unique output stage was designed that provides large output swings, minimizing power supply voltage requirements, while retaining outstanding overload protection features. The outputs can be driven beyond the power supply voltage without drawing excessive current or forcing current back into the power supplies. Of course, current limiting is included to protect against short circuit conditions.

Initial consideration of technologies for implementing RS232 interfacing might include CMOS as a possible technology for this type of application. Power supply requirements are low, output voltage swing is high, and higher voltage CMOS technologies are available to allow operation up to ±15V. Consideration of some of the problems associated with CMOS decreases its attractiveness for RS232 drivers.

Inherent in the CMOS structure, are diodes between the drain and source of the CMOS devices and the power supplies as is shown in Figure 1. A requirement of RS232 interfaces is the ability to withstand voltage applied to the output pins. With a CMOS output stage this is achieved with the inclusion of a 300Ω resistor in series with the output. (The resistor is similar to the resistors included in older drivers.) It protects the interface chip, but still allows damage to other devices powered by the same supply.

A problem occurs when the output of a driver which is powered from the 5V logic supply is connected to an external 12V or 15V source as is allowed by the RS232 specification. Ex-ternal current flows through the 300Ω limiting resistor, through the diodes, which are a part of the CMOS structure, and into the power supply. This forces the power supply to 12V or 15V damaging the 5V logic that is connected to the supplies. This problem can even cause latchup if the logic supply is off when external RS232 signals feed voltage into the supply. This problem did not usually exist in the past, because the RS232 interfaces were powered by separate ±12V supplies.

ESD damage is probably the most frequent cause of failure of interface chips. Bipolar devices are relatively rugged but still can be damaged by ESD. System requirements for ESD may be as high as 20kV. No IC can withstand that much voltage without external protection.

A requirement of the RS232 specification is the ability to withstand ±25V input signals. The CMOS LTC1045 which is used as an RS232 receiver has been designed to operate with external resistors in series with the input. These resistors allow very large voltage swings at the input pins and provide ESD protection to the IC. Using on-chip resistors precludes the use of the optimum ESD protection structures, so CMOS devices may be more sensitive to ESD destruction at their inputs.
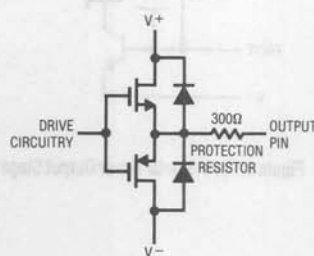


Figure 1. CMOS Line Driver Showing Parasitic Diodes to the Power Supplies

The output stage of the bipolar drivers is shown in Figure 2. Opposed collector NPN and PNP transistors give the widest possible output swings. The PNP transistor will swing to within 200mV of the positive supply while the NPN transistor with its associated Schottky diode will swing within about 900mV of the negative supply. If the output voltage is forced above the positive supply the emitter base junction of the PNP transistor reverse biases, and no current flows into the supply. The device is unaffected by external voltage up to the breakdown voltage of the transistor. If the output is forced below the negative supply, the Schottky diode reverse biases and prevents external current flow into the chip. Capacitor C1 is used to control the output slew rate so that no frequency compensation components are required to meet the RS232 specification of 4V/$\mu$s to 30V/$\mu$s.

Typically the slew rate of these drivers is about 8–10V/$\mu$s. This allows them to be used successfully up to about 64k baud. The output slew rate of the bipolar drivers is well controlled by an internal capacitor and relatively independent of load resistance or capacitance. The bipolar receiver is relatively straightforward utilizing a level detector with hysteresis to set the trip point. Nominally the trip point is set at about 1.5V with 200mV of hysteresis. The receivers go into a high output state with an open input. The receivers outputs are both TTL and CMOS compatible.

A recent advance in the drivers and receivers is on-chip power supply generation. Devices like the LT1080 and LT1081 include an oscillator, capacitive voltage doubler, and capacitive inverter to generate ±9V from the 5V power supply. The charge-pump power supply generator requires only four 1$\mu$F capacitors to generate RS232 communication levels from a 5V logic supply. Figure 3 shows a typical hook-up for the
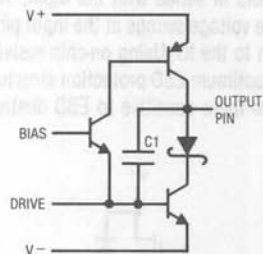
LT1080. The on-chip power supply generators generate excess power over the LT1080 requirements, so another RS232 communication device such as the LT1039 can be powered from the same power supply generator. Table 1 gives typical performance of all Linear Technology driver/receiver devices for RS232 communication.
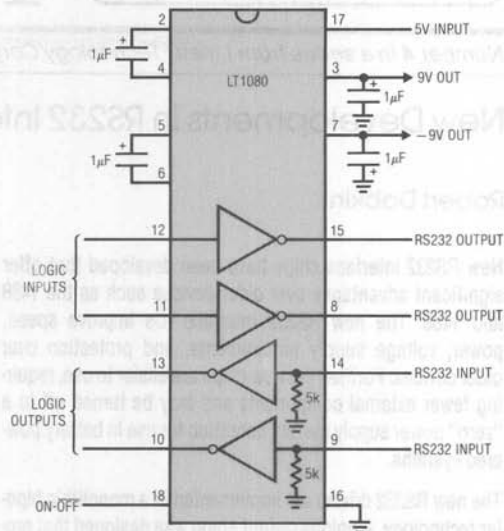
**Figure 3. 5V Powered RS232 Driver/Receiver**

**Figure 2. New Bipolar Driver Output Stage**

**Table 1. New Drivers and Receivers**

| DEVICE | DRVS | RECS | SHUT-DOWN | SUPPLY GENERATOR | REMARKS |
|--------|------|------|-----------|------------------|---------|
| LT1030 | 4 | | X | | Low Cost |
| LT1032 | 4 | | X | | RS423 Compatible |
| LT1039 | 3 | 3 | X | | |
| LT1039N16 | 3 | 3 | | | MC145406 Compatible |
| LTC1045 | | 6 | X | | Micropower |
| LT1080 | 2 | 2 | X | X | |
| LT1081 | 2 | 2 | | X | MAX232 Compatible |
| LT1130 | 5 | 5 | | X | |
| LT1131 | 5 | 4 | X | X | |
| LT1132 | 5 | 3 | | X | |
| LT1133 | 3 | 5 | | X | |
| LT1134 | 4 | 4 | X | X | |
| LT1135 | 5 | 3 | | X | |
| LT1136 | 4 | 5 | X | X | |
| LT1180 | 2 | 2 | X | | 0.1$\mu$F Caps |
| LT1181 | 2 | 2 | | | 0.1$\mu$F Caps |