RS-232-to-RS-485 Converters used in Industrial Long-haul Communication

Industrial data links requiring the transmission of RS-232 data over long distance, or between multiple RS-232 applications, often utilize RS-232 to RS-485 converters. Despite the high signal swing of up to ±13V, RS-232 is an unbalanced, or single-ended interface and as such highly susceptible to noise. Its bus maximum length is therefore limited to about 20m (60 ft). While allowing for full-duplex data transmission, that is transmitting and receiving data at the same time via separate signal conductors, RS-232 does not support the connection of multiple nodes on the same bus.

In strong contrast, RS-485 is a balanced interface using differential signaling, which makes it highly immune to common-mode noise. Therefore, extending an RS-232 data link over long distance and enabling the connections of multiple bus nodes requires the conversion to RS-485 signals via interface converters (see Figure 1).

![Figure 1. Converting short distance, point-to-point data links into a long distance, multi-point network.](image)

Figure 2 shows the schematic of a low-power, isolated converter design. Here the RS-232 serial port of a personal computer (PC) for example, connects to the SUB-D9 female connector on the left. The PC serial port contains a RS-232 driver and receiver chip that converts its internal 5V logic signals to the higher ±8V to ±13V levels at the connector. These high-voltage bus signals are converted back to standard logic levels via another RS-232 chip in order to communicate with the RS-485 transceiver.

In transmit direction the 485-transceiver converts the logic signals from the RS-232 receiver output into differential bus signals. In receive direction, it converts the differential bus signals into single-ended, low-volt signals entering the RS-232 driver input.

The RS-485 transceiver includes a capacitive isolation barrier that galvanically isolates the bus side from the logic control side, which eliminates ground currents between the bus nodes.
On the bus side the converter design provides several components to ensure reliable data transmission. Jumpers J1 and J2 activate a failsafe biasing network during bus idling. Via jumper J3 a 120 Ohm termination resistor can be implemented, if this converter is located at a bus end.

A transient suppressor protects the bus transceiver from dangerous transient over-voltages by clamping them to ground potential. In order to divert transient currents to Earth potential, a high-voltage capacitor is required to provide AC-coupling between the floating bus ground and protective Earth (PE). Typically a short single conductor (18 AWG) is used to make the connection to a PE terminal or chassis ground.

Isolating the signal path isolation also requires isolating the power supply. Here the bus supply (3.3V to 10V) is regulated via a low-dropout voltage regulator (LDO). Then it is applied to the transceiver bus supply (Vcc2) and to an isolated DC/DC converter. This converter consists of a transformer driver, an isolation transformer, and a second LDO which supplies the circuits on the logic side.

Older converter designs sometimes use a request-to-send signal (RTS) to switch the RS-485 transceiver from receive into transmit mode. In PC applications, however, the RTS generating interface software runs under Windows® and not in real-time. Thus, if Windows decides to use its processing time for another application, a screen saver or an anti-virus software, RTS might not change the
transceiver back into receive in time, and data sent by another bus node might be lost.

The converter design in Figure 2 eliminates this possibility by implementing an auto-direction function. The auto-direction detection is accomplished with a monostable flip-flop, whose output is triggered high by the start bit from the 232-receiver output. By default the RS-485 transceiver is in receive mode. When the monostable output goes high, it switches the transceiver into transmit mode.

The time constant of the monostable output is defined by an R-C network with C = 220 nF, and R = 10 kOhm for a 2 ms high-time at a data rate of 9600 bps, and R = 100 kOhm for 20 ms at 1200 bps. When the high-time has passed, the monostable output returns to low, thus switching the transceiver back into receive mode. While the auto-direction function is data rate dependent, it is a reliable method to prevent data loss.

References

For more information visit: www.ti.com/rs485-ca.