FAQ Page (Updated May 6, 2006)

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Also, see our Quick Reference Guide for information concerning RS485, RS422, RS232, and RS423: Quick Reference Guide

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RS485 (2-wire, half-duplex, differential, multi-drop (32 nodes), communications standard for distances up to 4000ft.)

The RS485 standard addresses the problem of data transmission, where a balanced (differential) transmission line is used in a multi-drop (party line) configuration (or point-to-point if only two devices are on the network). Up to 32-nodes (drivers and receivers) are allowed on one multi-drop, bi-directional network. Data rates of up to 10M bps are supported over short distances (40ft.). At the four-thousand foot distance limit, data rates of up to 100K bps are allowable. RS485 specifies a 2-wire, half-duplex communications bus. Because there are differences between RS485 and RS422 (minor in many instances, except for loading [12K vs. 4K) many people refere to 4-wire RS485. While RS485 is a 2-wire standard, it does offer 32 nodes on a network, on the other hand RS422 (a 4-wire standard) only specifies up to 10 nodes. Therefore, while not technically correct, it does make some sence to refer to a 4-wire RS485 network that would extend the number of nodes on a 4-wire network to 32 standard loads.

The RS485 standard only specifies electrical characteristics of the driver and the receiver, it does not specify or recommend any protocol. Because matters of protocol are left to the user, it is often difficult (if not impossible) to connect RS485 devices from different manufacturers on the same network.

The RS485 standard allows the user to configure inexpensive local networks and multidrop communications links using twisted pair wire. A typical RS485 network can operate properly in the presence of reasonable ground differential voltages, withstand driver contentious situations, provide reliable communications in electrically noisy environments (good common mode rejection using twisted pair cable, shielding provides additional protection), and support thirty-two or more (many IC manufacturers have 1/2, 1/4, 1/8 unit load devices) drivers and receivers on the line.

Twisted pair wire with a characteristic impedance of 120 ohms is recommended with 120 ohm termination at each end of the communications line. The common-mode voltage range is -7V to +12V. A driver in the high impedence (off) state is able to remain in this state over the common mode range, whether power is applied or not. The receiver is able to respond to differential signal levels of 200mV over the common mode range. The receiver load impedence is 12K ohms (or

higher) and transmitter "leakage" current is ±100µA (or less) in either the powered or unpowered state. Unloaded driver output differential voltage can be as high as ±6V. Loaded driver voltage (32 nodes on the network and termination) should typically exceed ±1.5V.
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RS422 (4-wire, full-duplex, differential, multi-drop (10 nodes), communications standard)

While RS422 is comparable to RS485, it is limited to unidirectional data traffic, and is terminated only on the end of the line opposite the transmitter. One transmitter and 10 receivers are allowed on a network, with a distance limit of 3600ft. RS422 was on the market prior to RS485; however, due to loading limitations, one of the best uses of RS422 is probably in point-to-point communications, such as RS232 extension cords. By converting from single-ended RS232 to differential RS422 and then, converting back from RS422 to RS232 at the other end of the line, distance and noise immunity can be greatly improved.
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RS232 (3-wire, full-duplex, single-ended, 50ft cable limit)

RS232 was developed in the 1960s, and among other things, specified an electrical standard, a protocol standard, handshaking, and connector pin-out. In general, many current applications for RS232 use only the electrical standard (3-wires, TDX, RXD, Common) and connector pin-out. While handshaking is still with us, it is usually best to disable it in software (if possible) and/or "loop-back" the pairs of signals (RTS to CTS, DTR to DSR, etc.) While RS232 was rumored to be on the "way out" with the advent of many of the new communications standards, it is still alive and well today. While the standard only supports low data rates and short line length (50ft.) it is still widely used and, very useful in many applications. With an external converters (RS232<=>RS485) many of the limitations of RS232 can be improved, to take advantage of, the superior properties of differential communications (2-wire or 4-wire).
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Converters (RS232<=>RS485, RS232<=>RS422, RS485<=>RS422)

Converters in general can be used to change the electrical characteristice of one communications standard into another, to take advantage of the best properties of the alternate standard selected. For example, an Automatic RS232<=>RS485 converter, could be connected to a computer's RS232, full-duplex port, and transform it into an RS485 half-duplex, multi-drop network at distances up to 4000ft. Converters in most instances, pass data through the interface without changing the timing and/or protocol. While the conversion is "transparent" the software must be able to communicate with the expanded network features. An "Automatic Converter" (RS232<=>RS485) will turn on the RS485 transmitter when data is detected on the RS232 port, and revert back into the receive mode after a character has been sent. This avoids timing problems (and software changes) that are difficult to deal with in typical systems. When full-duplex is converted into half-duplex only one device at a time can transmit data. Automatic Converters take care of the timing problems and allow fast communications without software intervention.
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Termination for RS485/RS422 Networks
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Bias (failsafe) for RS485/RS422 Networks

When there is no data activity on an RS485 network (or in many instances RS422 networks, other than point-to-point), the communications lines are "floating" and, thus susceptible to external noise or interference. Receivers on a network (RS485 or RS422) have built in hysteresis (200mV differential required to insure known state). To insure that a receiver stays in an inactive state, when no data signal is present, bias is generally added to a network at one or more locations.
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Repeaters
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Multiport Repeaters

Once an RS485 network exceeds about 32 nodes on a network, serious consideration should be given to using galvanic isolation. Even though some IC manufacturers offer light loading devices, that can accommodate 256 or even 400 nodes on one RS485 network, you may NOT want to build such a network for a few reasons. One reason is that, large networks accumulate distributed electrical noise which can make communications unreliable. In general it is very important not to run communications wires in the same trough or conduit or in parallel with AC power cables. Maintain as much distance as possible and cross any power cable at a right angle. While shielding is not specified for RS485 systems, it can help in many instances. By "isolating" sections of a large network, the accumulated noise on one isolated leg is not so likely to cause a data error that will propagate to another leg of the network. Galvanic isolation will break a large problem into several small, but manageable ones. Galvanic isolation can also help eliminate "ground loops."

Another potential problem with large networks without isolation, is that severe damage can occur to your entire system, if a high voltage source is connected (accidentally or otherwise) to your communications lines. Your entire network could be damaged. With galvanic isolation the damage is generally limited to only one leg of the network, except in extreme cases of very high voltage (induced by lightening for example). While it goes against conventional wisdom, and can potentially cause a problem with circulating currents by grounding a shielded cable at both ends, this method is very effective at keeping induced lightening noise away from the communications lines. In the alternative, ground one end of the shield and connect the other end to ground through a bi-directional transient protector (from a few volts to a few hundred volts depending on the situation). R.E.Smith also provides an extensive line of optical/transformer isolated repeaters and multi-port repeaters as well as a series of fiber optic products which provide very high isolation. These products are extremely effective in applications involving industrial control, large RS485 networks, outdoor data links between buildings, etc.

In general RS485 is designed for multi-drop, "daisy-chain" operation over a single twisted pair cable with a nominal characteristic impedance of 120 Ohms. This cable is usually 24AWG. Category-5 cable will generally work well in most instances even though its characteristic impedance is 100 Ohms. "Tap points" or "T" connections should be short to eliminate reflections. It is possible to connect several RS485 circuits in parallel if the distances are below about 200 feet per leg @ 9600bps. At greater distances and higher data rates, the cable impedances add up and load the network. In addition there is no good way to add terminations resistors at the ends of a "star" network. The combination of the cable impedances and/or termination resistors will load the network and can make communications unreliable.
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Galvanic Isolation

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