
Interface Primer

RS-232, RS-422, RS-423 and RS-485

Introduction

Line drivers and receivers are commonly used to exchange data between two or more points on a network. Typically, this communication takes place between a personal computer or controller and a local peripheral (e.g. printer). Reliable data communications can be difficult in the presence of induced noise, ground level differences, impedance mismatches, failure to effectively bias for idle line conditions, and other hazards associated with installation of a network.

Standards have been developed to insure compatibility between units provided by different manufacturers, and to allow for reasonable success in transferring data over specified distances and/or data rates. The Electronics Industry Association (EIA) has produced standards for RS-232, RS-422, RS-423 and RS-485, that deal with data communications. Suggestions are often made to deal with practical problems that might be encountered in a typical network. EIA standards were previously marked with the prefix "RS" to indicate recommended standard; however, the standards are now generally indicated as "EIA" standards to identify the standards organization. While the standards bring uniformity to data communications, many areas are not specifically covered and remain as "gray areas" for the user to discover on their own.

Transmission Line Drivers/Receivers (i.e. Transceivers) act as level shifters. The Driver has TTL / CMOS input and RS-xxx output. The Receiver has RS-xxx input and TTL / CMOS output.

Whilst many interface parts are multi-sourced, Analog Devices Parts are typically faster, lower power and more robust than what's on offer from the competition.

Single-Ended : RS-232, RS423

Electronic data communications between elements will generally fall into two broad categories: single-ended and differential. RS-232 (single-ended) was introduced in 1962, and despite rumors for its early demise, has remained widely used through the industry. The specification allows for data transmission from one transmitter to one receiver at relatively slow data rates (up to 20K bits/second) and short distances (up to 50 feet). On more recent RS-232 Transceiver chips, data rates of up to 1Mbps are achievable over shorter distances (up to 5 feet).

Independent channels are established for two-way (full-duplex) communications. The RS-232 signals are represented by voltage levels with respect to a system common (power / logic ground). The "idle" state (MARK) has the signal level negative with respect to common, and the "active" state (SPACE) has the signal level positive with respect to common. RS-232 has numerous handshaking lines (primarily used with modems), and also specifies a communications protocol. In general if you are not connected to a modem the handshaking lines can present a lot of problems if not disabled in software or accounted for in the hardware (loop-back or pulled-up). RTS (Request to send) does have some utility in certain applications. RS-423 is another single ended specification with enhanced operation over RS-232; however, it has not been widely used in the industry.

Differential : RS-422, RS-485

When communicating at high data rates, or over long distances in real world environments, single-ended methods are often inadequate. Differential data transmission offers superior performance in most applications. Differential signals can help nullify the effects of ground shifts and induced noise signals that can appear as common mode voltages on a network.

RS-422 was designed for greater distances and higher Baud rates than RS-232. Data rates of up to 10M bits / second and distances up to 4,000 feet can be accommodated with RS-422. RS-422 is also specified for multi-drop applications where only one driver is connected to, and transmits on, a bus of up to 10 receivers.

While a multi-drop type application has many desirable advantages, RS-422 devices cannot be used to construct a truly multi-point network. A true multi-point network consists of multiple drivers and receivers connected on a single bus, where any node can transmit or receive data.

"Quasi" multi-drop networks (4-wire) are often constructed using RS-422 devices. These networks

are often used in a half-duplex mode, where a single master in a system sends a command to one of several "slave" devices on a network. Typically one device (node) is addressed by the host computer and a response is received from that device. Systems of this type (4-wire, half-duplex) are often constructed to avoid "data collision" (bus contention) problems on a multi-drop.

RS-485 meets the requirements for a truly multi-point communications network, and the standard specifies up to 32 drivers and 32 receivers on a single (2-wire) bus. Some RS-485 Transceivers modify the input impedance to allow up to 8-times more nodes to be connected to the same bus. With the introduction of "automatic" repeaters and high-impedance transceivers, this "limitation" can be extended to hundreds (or even thousands) of nodes on a network. RS-485 extends the common mode range for both drivers and receivers in the "tri-state" mode and with power off. Also, RS-485 drivers are able to withstand "data collisions" (bus contention) problems and bus fault conditions. The most common RS-485 application is inter-programmable logic controller communication in industrial environments. Other common uses are point of sale terminals in stores and remote meters.

To solve the "data collision" problem often present in multi-drop networks, converters, repeaters, micro-processor controls can be constructed to remain in a receive mode until they are ready to transmit data. Single master systems (many other communications schemes are available) offer a straight forward and simple means of avoiding "data collisions" in a typical 2-wire, half-duplex, multi-drop system. The master initiates a communications request to a "slave node" by addressing that unit. The hardware detects the start-bit of the transmission and automatically enables (on the fly) the RS-485 transmitter. Once a character is sent the hardware reverts back into a receive mode in about 1-2 microseconds.

Any number of characters can be sent, and the transmitter will automatically re-trigger with each new character (or in many cases a "bit-oriented" timing scheme is used in conjunction with network biasing for fully automatic operation, including any Baud rate and/or any communications specification. Once a "slave" unit is addressed it is able to respond immediately because of the fast transmitter turn-off time of the automatic device. It is not necessary to introduce long delays in a network to avoid "data collisions." Because delays are not required, networks can be constructed, that will utilize the data communications bandwidth with up to 100% throughput.

Below are the specifications for RS-232, RS-423, RS-422, and RS-485.

Please see the table in next page for details.

SPECIFICATIONS		RS-232	RS-423	RS-422	RS-485
Mode of Operation		SINGLE -ENDED	SINGLE -ENDED	DIFFER- ENTIAL	DIFFER- ENTIAL
Total Number of Drivers and Receivers on One Line		1 DRIVER 1 RECVR	1 DRIVER 10 RECVR	1 DRIVER 10 RECVR	1 DRIVER 32 RECVR
Maximum Cable Length		50 FT.	4000 FT.	4000 FT.	4000 FT.
Maximum Data Rate		460kb/s	100kb/s	10Mb/s	30Mb/s
Maximum Driver Output Voltage		+/-25V	+/-6V	-0.25V to +6V	-7V to +12V
Driver Output Signal Level (Loaded Min.)	Loaded	+/-5V to +/-15V	+/-3.6V	+/-2.0V	+/-1.5V
Driver Output Signal Level (Unloaded Max)	Unloaded	+/-25V	+/-6V	+/-6V	+/-6V
Driver Load Impedance (Ohms)		3k to 7k	>=450	100	54
Max. Driver Current in High Z State	Power On	N/A	N/A	N/A	+/-100uA
Max. Driver Current in High Z State	Power Off	+/-6mA @ +/-2v	+/-100uA	+/-100uA	+/-100uA
Slew Rate (Max.)		30V/uS	Adjustable	N/A	N/A
Receiver Input Voltage Range		+/-15V	+/-12V	-10V to +10V	-7V to +12V
Receiver Input Sensitivity		+/-3V	+/-200mV	+/-200mV	+/-200mV
Receiver Input Resistance (Ohms)		3k to 7k	4k min.	4k min.	>=12k

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