RS-422

a Tutorial

RS422 BALANCED DIFFERENTIAL DRIVERS

Line drivers and receivers are commonly used to exchange data between two or more points (nodes) on a network. 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 RS485, RS422, RS232, and RS423 that deal with data communications. Suggestions are often made to deal with practical problems that might be encountered in a typical network. EIA standards where 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 used to discover (usually during installation) on his own

The balanced voltage digital interface circuit will normally be utilized on data, timing, or control circuits where the data signaling rate is up to 10 Mbit/s. Balanced voltage digital interface devices meeting the electrical characteristics of need not operate over the entire data signaling rate range specified. They may be designed to operate over narrower ranges to satisfy more economically specific applications, particularly at the lower modulation rates.

When communicating at high data rates, or over long distances in real world environments, single-ended methods are often inadequate. Differential data transmission (balanced differential signal) 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.

RS422 (differential) was designed for greater distances and higher Baud rates than RS232. In its simplest form, a pair of converters from RS232 to RS422 (and back again) can be used to form an "RS232 extension cord." Data rates of up to 100K bits / second and distances up to 4000 Ft. can be accommodated with RS422. RS422 is also specified for multi-drop (party-line) 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, RS422 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 RS422 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 network (more about solving this problem on a two-wire network in a moment).

Compatibility With Other Interfaces

Both RS-422 and RS-485 use a twisted-pair wire (i.e. 2 wires) for each signal. They both use the same differential drive with identical voltage swings: 0 to +5V. The main difference between RS-422 and RS-485 is that while RS-422 is strictly for point-to-point communications (and the driver is always enabled), RS-485 can be used for multidrop systems (and the driver has a tri-state capability).

As stated in the scope of this Standard, generators and receivers meeting the requirements of RS-422-A are compatible with those meeting CCITT Recommendations V. 11 and X.27. The electrical characteristics of the balanced voltage digital interface are designed to allow use of both balanced and unbalanced (see EIA Standard RS-423-A) circuits within the same interconnection cable sheath. For example, the balanced circuits may be used for data and timing while the unbalanced circuits may be used for low speed control functions.

Since the basic differential receivers of RS-423-A and RS422-A are electrically identical, it is possible to interconnect an equipment using RS423-A receivers and generators on one side of the interface with an equipment using RS422-A generators and receivers on the other side of the interface, if the leads of the receivers and generators are properly configured to accommodate such an arrangement and the cable is not terminated.

The balanced interface circuit is not intended for interoperation with other interface electrical characteristics such as RS-232-C. MIL-STD-188C and MIL-STD-188-100, and CCITT Recommendations V.28 and V.35. Under certain conditions. interoperation with circuits of some of the above interfaces may be possible but may require modification in the interface or within the equipment; therefore, satisfactory operation is not assured. and additional provisions not specified herein may be required.

SPECIFICATIONS		RS423	RS422
Mode of Operation		SINGLE - ENDED	DIFFERENTIAL
Total Number of Drivers and Receivers on One Line		1 DRIVER 10 RECVR	1 DRIVER 10 RECVR
Maximum Cable Length		4000 FT.	4000 FT.
Maximum Data Rate		100kb/s	10Mb/s
Maximum Driver Output Voltage		+/-6V	-0.25V to +6V
Driver Output Signal Level (Loaded Min.)	**Loaded**	+/-3.6V	+/-2.0V
Driver Output Signal Level (Unloaded Max)	**Unloaded**	+/-6V	+/-6V
Driver Load Impedance (Ohms)		>450	100
Max. Driver Current in High Z State	**Power On**	N/A	N/A
Max. Driver Current in High Z State	**Power Off**	+/-100uA	+/-100uA
Slew Rate (Max.)		Adjustable	N/A
Receiver Input Voltage Range		+/-12V	-10V to +10V
Receiver Input Sensitivity		+/-200mV	+/-200mV
Receiver Input Resistance (Ohms)		4k min.	4k min.

Making sense of cable specifications

Selecting data cable for an RS-422 or RS-485 system isn't difficult, but often gets lost in the shuffle of

larger system issues. Care should be taken. however, because intermittent problems caused by marginal cable can be very difficult to troubleshoot.

Beyond the obvious traits such as number of conductors and wire gauge, cable specifications include a handful of less intuitive terms.

Characteristic Impedance (Ohms): A value based on the inherent conductance, resistance, capacitance and inductance of a cable that represents the impedance of an infinitely long cable. When the cable is out to any length and terminated with this Characteristic Impedance, measurements of the cable will be identical to values obtained from the infinite length cable. That is to say that the termination of the cable with this impedance gives the cable the appearance of being infinite length, allowing no reflections of the transmitted signal. If termination is required in a system, the termination impedance value should match the Characteristic Impedance of the cable.

Shunt Capacitance (pF/ft): The amount of equivalent capacitive load of the cable, typically listed in a per foot basis One of the factors limiting total cable length is the capacitive load. Systems with long lengths benefits from using low capacitance cable.

Propagation velocity (% of c): The speed at which an electrical signal travels in the cable. The value given typically must be multiplied by the speed of light (c) to obtain units of meters per second. For example, a cable that lists a propagation velocity of 78% gives a velocity of 0.78 X 300 X 106 - 234 X 106 meters per second.

Plenum cable

Plenum rated cable is fire resistant and less toxic when burning than non-plenum rated cable. Check building and fire codes for requirements. Plenum cable is generally more expensive due to the sheathing material used.

The RS-422 specification recommends 24AWG twisted pair cable with a shunt capacitance of 16 pF per foot and 100 ohm characteristic impedance. While the RS-485 specification does not specify cabling, these recommendations should be used for RS485 systems as well.

It can be difficult to quantity whether shielding is required in a particular system or not, until problems arise. We recommend erring on the safe side and using shielded cable. Shielded cable is only slightly more expensive than unshielded.

There are many cables available meeting the recommendations of RS-422 and RS-485, made specifically for that application. Another choice is the same cable commonly used in the misted pair Ethernet cabling. This cable, commonly referred to as Category 5 cable, is defined by the EIA/TIA/ANSI 568 specification The extremely high volume of Category 5 cable used makes it widely available and very inexpensive, often less than half the price of specialty RS422/485 cabling. The cable has a maximum capacitance of 17 pF/ft (14.5 pF typical) and characteristic impedance of 100 ohms.

Category 5 cable is available as shielded twisted pair (STP) as well as unshielded twisted pair (UTP) and generally exceeds the recommendations for RS-422 making it an excellent choice for RS-422 and RS-485 systems.

RS232 & Cable Diagrams info (how it works and spec. & pin outs)

X.21 info (how it works and spec. & pin outs)

RS423 info (spec. & pin outs)

RS485 info (how it works and spec. & pin outs)

RS449 info (how it works and spec. & pin outs)

RS530 info spec.

V.35 info (how it works and spec.& pin outs)

IEEE-488 info (pin layout)

USCO Codes

RJ-48C and RJ48S jack pin out

RJ 11C thru RJ48 Jacks - a Glossary

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