RS-485 Basics

The RS-485 standard was developed jointly by two trade associations: the Electronic Industries Association (EIA) and the Telecommunications Industry Association (TIA). The EIA once labeled all its standards with the prefix "RS" (Recommended Standard). Many engineers continue to use this designation, but the EIA/TIA has officially replaced "RS" with "EIA/TIA" to help identify the origin of its standards. Today, various extensions of the RS-485 standard accommodate a large variety of applications.

The RS-485 and RS-422 standards have much in common, and are often confused for that reason.The table below compares the two. RS-485, which specifies bidirectional, half-duplex data transmission, is the only EIA/TIA standard that allows multiple receivers and drivers in "bus" configurations. EIA/TIA-422, on the other hand, specifies a single, unidirectional driver with multiple receivers. RS-485 parts are backward-compatible and interchangeable with their RS-422 counterparts, but RS-422 drivers should not be used in an RS-485 system because they cannot relinquish control of the bus.

RS-485 and RS-422 Standards

	RS-422	RS-485
Mode of operation	Differential	Differential
Allowed no. of Tx and Rx	1 Tx, 10 Rx	32 Tx 32 Rx
Maximum cable length	4000ft length	4000ft length
Maximum data rate	10Mbps	10Mbps
Minimum driver output range	±2V	±1.5V
Maximum driver output range	±5V	±5V
Maximum driver short-circuit current	150mA	250mA
Tx load impedance	100Ω	54Ω
Rx input sensitivity	±200mV	±200mV
Maximum Rx input resistance	4kΩ	12kΩ
Rx input voltage range	±7V	-7V to +12V
Rx logic high	>200mV	>200mV
Rx logic low	<200mV	<200mV

ESD Protection

The differential signal paths of RS-485 and RS-422 systems provide reliable data transmission in

the presence of noise, and their differential receiver inputs can also reject large common-mode voltages. To guard against the much higher voltage levels associated with electrostatic discharge (ESD), however, a different class of protection is needed.

The charged capacitance of a human body enables a person to destroy integrated circuits just by touching them. Such a contact can easily occur during the installation of an interface cable. To guard against such damage, Maxim's interface ICs incorporate "ESD structures." These structures protect the transmitter outputs and receiver inputs of RS-485 transceivers against ESD levels up to ±15kV.

To guarantee the specified ESD protection, Maxim tests the positive and negative power-supply terminals repeatedly, in 200V increments, to verify a sequence of levels up to ±15kV. Devices with this rating (per the Human Body Model or the IEC 1000-4-2 specification) are designated by an additional "E" suffix on the part number.

Data Rates and Driver Loading

The load presented to an RS-485/RS-422 driver is quantified in terms of the unit load, which is defined as the input impedance for one standard RS-485 receiver (12kΩ). Thus, a standard RS-485 driver is capable of driving 32 unit loads (32 12kΩ loads in parallel). The input impedance for some RS-485 receivers, however, is higher?48kΩ (1/4 unit load) or even 96kΩ (1/8 unit load)?and as many as 128 or 256 such receivers, respectively, can connect to a single RS-485 bus. You can connect any combination of receiver types, provided their parallel impedance does not exceed 32 unit loads (meaning, is not less than 375Ω).

Consequences of High Data Rates

Faster transmissions require higher slew rates at the driver output, and higher slew rates produce higher levels of electromagnetic interference (EMI). Some RS-485 transceivers minimize EMI by limiting their slew rates. Lower slew rates also help to control the reflections caused by fast transitions, high data rates, or long cables. Essential for minimizing reflections are termination resistors that match the cable's characteristic impedance. For common RS-485 cables (a twisted pair of 24AWG wires), this means a 120Ω resistor at both ends.

For more about RS-485 designs, refer to Trim the Fat Off RS-485 Designs.

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