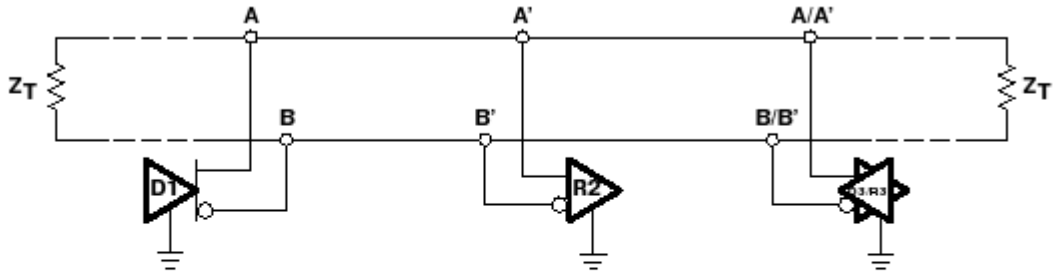
RS 485

RS-485 (also known as EIA-485) is an OSI Model physical layer electrical specification of a two-wire, half-duplex, multipoint serial connection. The standard specifies a differential form of signalling. The difference between the wires' voltages is what conveys the data. One polarity of voltage indicates a logic 1 level, the reverse polarity indicates logic 0. The difference of potential must be at least 0.2 volts for valid operation, but any applied voltages between +12 V and -7 volts will allow correct operation of the receiver.

Figure 3.2. RS-485 bus



NOTES: A. D1 = driver
B. D3/R3 = transceiver
C. R2 = receiver
D. Z_T = termination impedance
E. Up to 32 U.L.s [receiver, driver (off state), transceiver]

EIA-485 only specifies electrical characteristics of the driver and the receiver. It does not specify or recommend any data protocol. EIA-485 enables the configuration of inexpensive local networks and multidrop communications links. It offers high data transmission speeds (35 Mbit/s up to 10 m and 100 kbit/s at 1200 m). Since it uses a differential balanced line over twisted pair.

In contrast to EIA-422, which has a single driver circuit which cannot be switched off, EIA-485 drivers need to be put in transmit mode explicitly by asserting a signal to the driver. This allows EIA-485 to implement linear topologies using only two lines. The equipment located along a set of EIA-485 wires are interchangeably called nodes, stations and devices.

The recommended arrangement of the wires is as a connected series of point-to-point (multidropped) nodes, a line or bus, not a star, ring, or multiply-connected network. Ideally, the two ends of the cable will have a termination resistor connected across the two wires. Without termination resistors, reflections of fast driver edges can cause multiple data edges that can cause data corruption. Termination resistors also reduce electrical noise sensitivity due to the lower impedance, and bias resistors are sometimes required. The value of each termination resistor should be equal to the cable impedance (typically, 120 ohms for twisted pairs). Star and ring topologies are not recommended because of signal reflections or excessively low or high termination impedance.

Converters from RS232 to RS485, USB to RS485, Ethernet to RS485 are available to allow a PC to communicate with remote devices. By using repeaters and multi-repeaters very large RS485 networks can be formed. Using an RS485 multi-repeater can allow for star configurations with home runs (or multi-drop) connections similar to Ethernet star implementations (with greater distances). Star systems (with multi-repeaters) allow for very maintainable systems, without violating any of the RS485 specifications. Repeaters can also be used to extend the distance and/or number of nodes on a network.

Bias resistors are sometimes used to bias data lines when the lines are not being driven by any device. This way, the lines will be biased to known voltages and nodes will not interpret the noise from undriven lines as actual data; without biasing resistors, the data lines float in such a way that electrical noise sensitivity is greatest when all device stations are silent or unpowered.

Often in a master-slave arrangement when one device dubbed "the master" initates all communication activity, the master device itself provides the bias and not the slave devices. In this configuration, the master device is typically centrally located along the bus so it would be two slave devices located at the physical end of the wires that would provide the termination. The master device would provide termination if it itself was located at a physical end of the wires. Note that it is not a good idea to apply the bias at multiple node locations, because, by doing so, the effective bias resistance is lowered, which could possibly cause a violation of the EIA-485 specification and cause communications to malfunction. By keeping the biasing with the master, slave device design is simplified and this situation is avoided.

EIA-485, like EIA-422 can be made full-duplex by using four wires, however, since EIA-485 is a multi-point specification, this is not necessary in many cases. EIA-485 and EIA-422 can interoperate with certain restrictions.

- *Connectors*

  EIA-485 does not specify any connector. The following table lists some typical RS-485 signal pin assignments (RS-232, another serial standard, listed here for comparison):

  Figure 3.3. RS-485 pinout

RS-485 signal	RS-232 signal	DB-25	DB-9	RJ-50
Common Ground	Carrier Detect (DCD)	8	1	10
Clear To Send + (CTS+)	Received Data (RD)	3	2	9
Ready To Send + (RTS+)	Transmitted Data (TD)	2	3	8
Received Data + (RxD+)	Data Terminal Ready (DTR)	20	4	7
Received Data - (RxD-)	Common Ground	7	5	6
Clear To Send - (CTS-)	Data Set Ready (DSR)	6	6	5
Ready To Send - (RTS-)	Request To Send (RTS)	4	7	4
Transmitted Data + (TxD+)	Clear To Send (CTS)	5	8	3
Transmitted Data - (TxD-)	Ring Indicator (RI)	22	9	2

- *Pin assignment*

  The RS485 differential line consists of two pins:

  - A '-' (TxD-/RxD-) inverting pin which is negative (compared to B) when the line is idle (ie data is 1).
  - B '+' (TxD+/RxD+) non-inverting pin which is positive (compared to A) when the line is idle (ie data is 1).

  The RS-485 signalling specification states that signal A is the inverting or '-' pin and signal B is the non-inverting or '+' pin. This is in conflict with the A/B naming used by a number of differential transceivers manufacturers, including the Texas Instruments application handbook on RS422/485 communications (A=non-inverting, B=inverting). These manufacturers are incorrect, but their

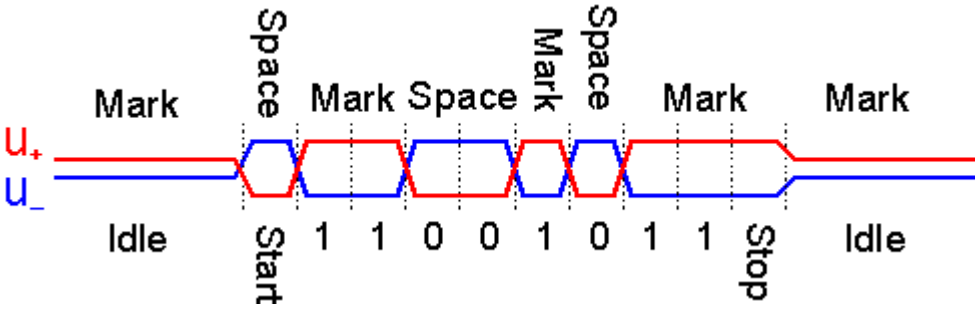
practice is in a widespread use. Therefore, care must be taken when using A/B naming.

In addition to the A and B connections, the EIA standard also specifies a third interconnection point called C, which is the common ground.

- *Waveform example*

The graph below shows potentials of the '+' and '−' pins of an RS-485 line during transmission of an RS-485 byte:

Figure 3.4. RS-485 signals



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