Unit: 2

Data Transmission

Introduction to Data Transmission

- "transfer of data from point-to-point"
  - http://en.wikipedia.org/wiki/Data_transmission

- PURPOSE: It provides a method for electronic devices to communicate with each other

A Taxonomy of Transmission Modes

Defn: A *transmission mode* is the manner in which data is sent over the underlying medium

Transmission modes can be divided into two fundamental categories:

Serial — one bit is sent at a time

Parallel — multiple bits are sent at the same time

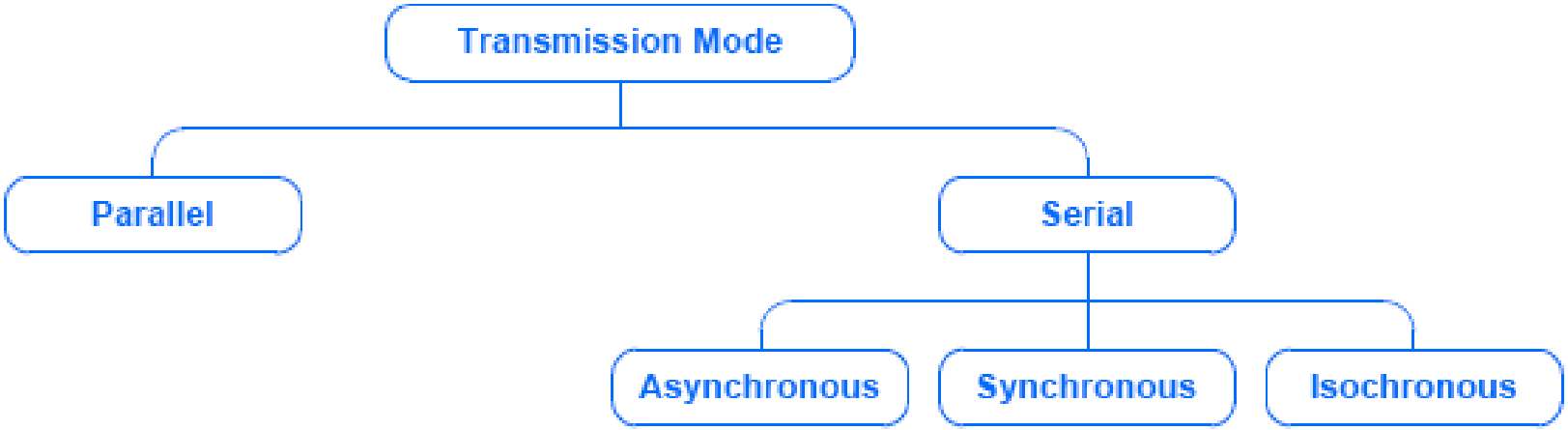


Figure 9.1 A taxonomy of transmission modes.

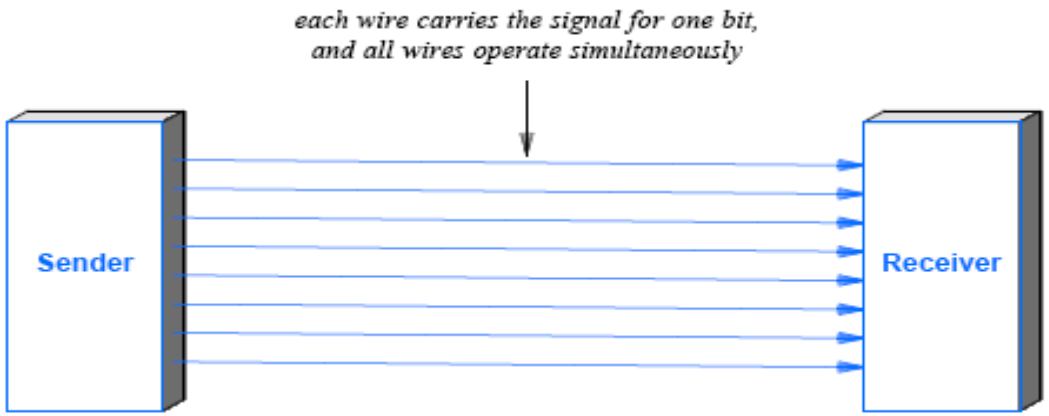
Parallel Transmission

Parallel transmission allows transfers of multiple data bits at the same time over separate media.

- It is used with a wired medium
- The signals on all wires are synchronized so that a bit travels across each of the wires at precisely the same time

The figure omits two important details:

1. a parallel interface usually contains other wires that allow the sender and receiver to coordinate
2. to make installation and troubleshooting easy, the wires are placed in a single physical cable



A parallel mode of transmission has two chief advantages:

(1) High speed--it can send N bits at the same time.

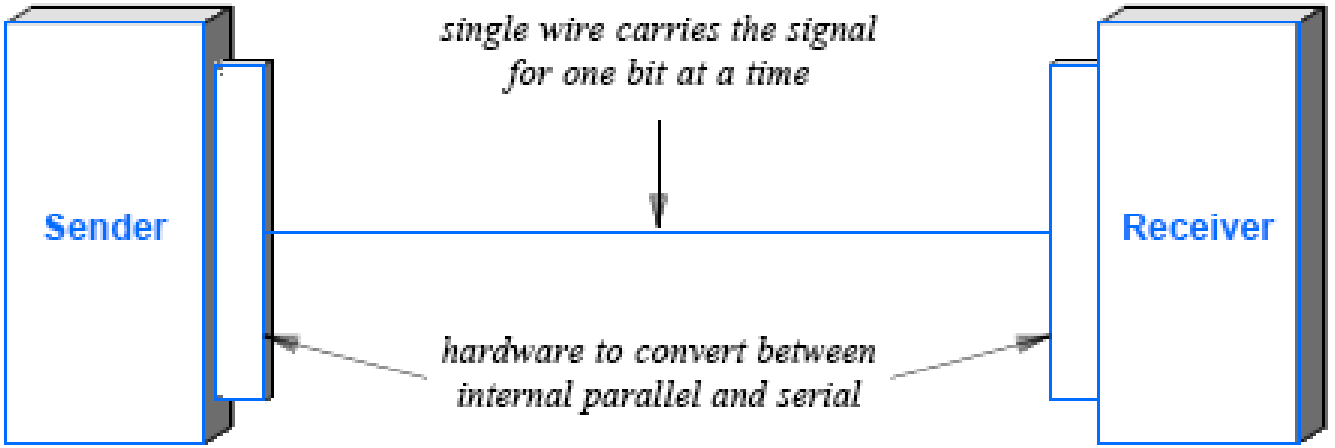
(2) It can match the speed of the underlying hardware.

Serial Transmission

Serial transmission sends one bit at a time.

Most communication systems use serial mode, because:

- serial networks can be extended over long distances at less cost
- using only one physical wire means that there is never a timing problem caused by one wire being slightly longer than another



Sender and receiver must contain a hardware that converts data from the parallel form used in the device to the serial form used on the wire

Transmission Order: Bits and Bytes

In serial mode, when sending bits, which bit should be sent across the medium first?

Consider an integer: Should a sender transmit

- the Most Significant Bit (MSB) first?
- the Least Significant Bit (LSB) first?

Terminology:

- ***little-endian*** describes a system that sends the LSB first.
- ***big-endian*** describes a system that sends the MSB first .

Either form can be used, but the sender and receiver must agree.

Asynchronous Serial Communication

- Requires clock signal to synchronize transmitter and receiver
- Continuous transmission to keep clock synchronized
- Data transfer rate is determined by clock rate
- Transmitter and Receiver operate independently
  - Transmitter sends data at any time
  - Receiver is ready to accept data at all times
- No need for clock signals
- …but during transmission, format and transfer rate of data must match

Asynchronous Transmission

- Word contains information that specifies the beginning and end of word to synchronize transmitter and receiver while exchanging data
- Bit transfer rate is determined programmer (but also limited by interface) and must match between transmitter and receiver

Last Class Review

- Transmission of data from the source to a device or from a device to the destination
- Parallel transmission:
  Multiple lines carrying bits simultaneously
  - High data rate, but expensive
- Serial transmission
  Bits transmitted serially
  - Synchronous vs. Asynchronous

Serial I/O Protocols

- **Synchronous:**
  A master clock controls the transmission as a continuous stream
- **Asynchronous:**
  Random delays between data pieces

Synchronous	Asynchronous
Requires processing to extract clock	No clock recovery needed
Overhead applies to entire block	Around 20% overhead/character
Error detection and correction built into protocol	Error detection possible, correction done separately

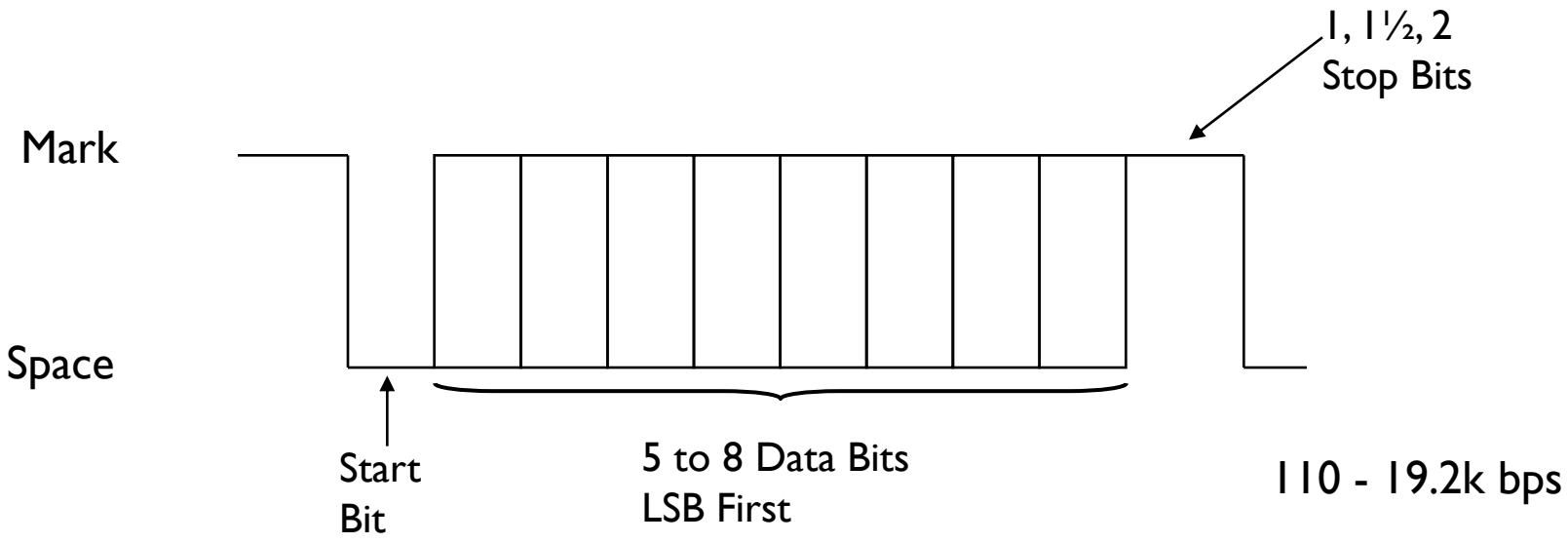
Asynchronous Protocols

RS232C diagram

RS232

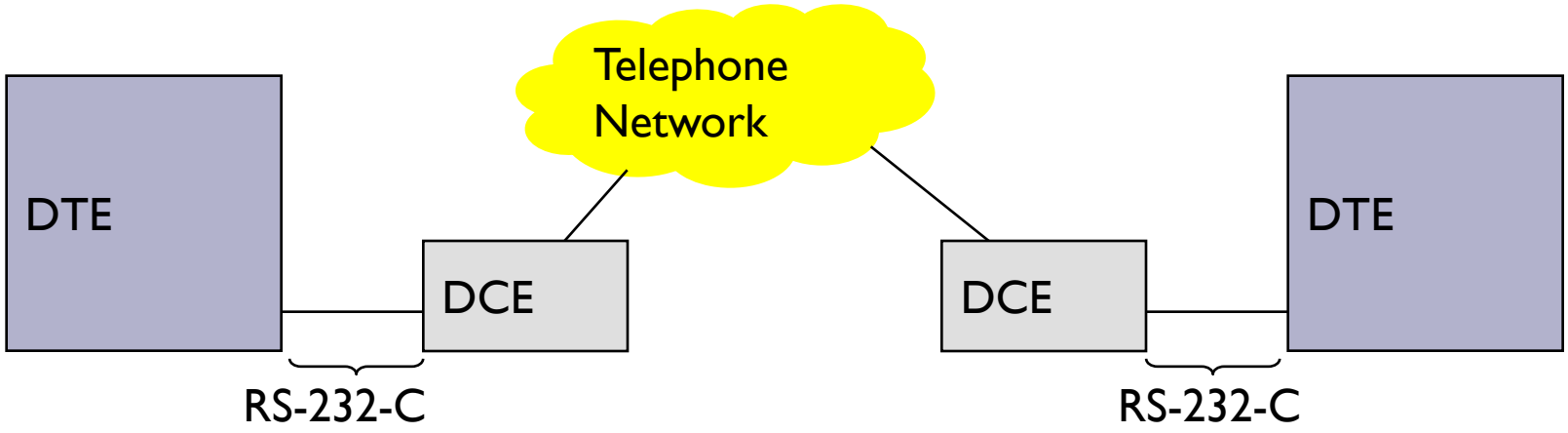
- RS-232-C
- 20MA Current Loop
- RS-422, RS-423, RS-485

  RS: Recommended Standard by EIA
  (Electronic Industries Association)



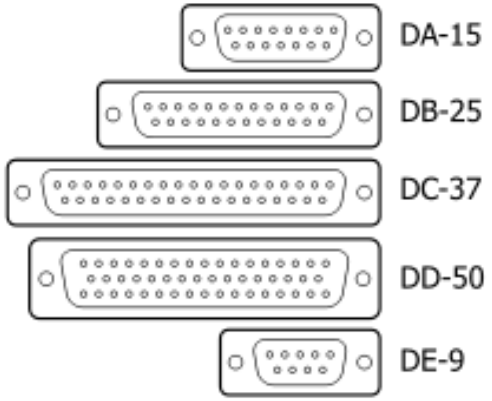
RS-232-C Interface

- EIA in cooperation with Bell Systems, independent modem and computer manufacturers
- Standard for interface between **Data Terminal Equipment (DTE)** and **Data Communication Equipment (DCE)** employing serial bit interchange



RS-232-C

- Standards contain
  - Electrical signal characteristics
  - Interface mechanical characteristics
  - Functional description of interchange circuits
  - Standard subsets for specific groups of communication systems applications
- Mechanical
  - DB-25 or DB-9 connectors
  - Cable
    - Female connected to DTE, male to DCE
    - Maximum 15 meters
  - Lines/Pins—home work



D-subminiature is a common type of electrical connector

RS-232-C

- Lines/Pins:

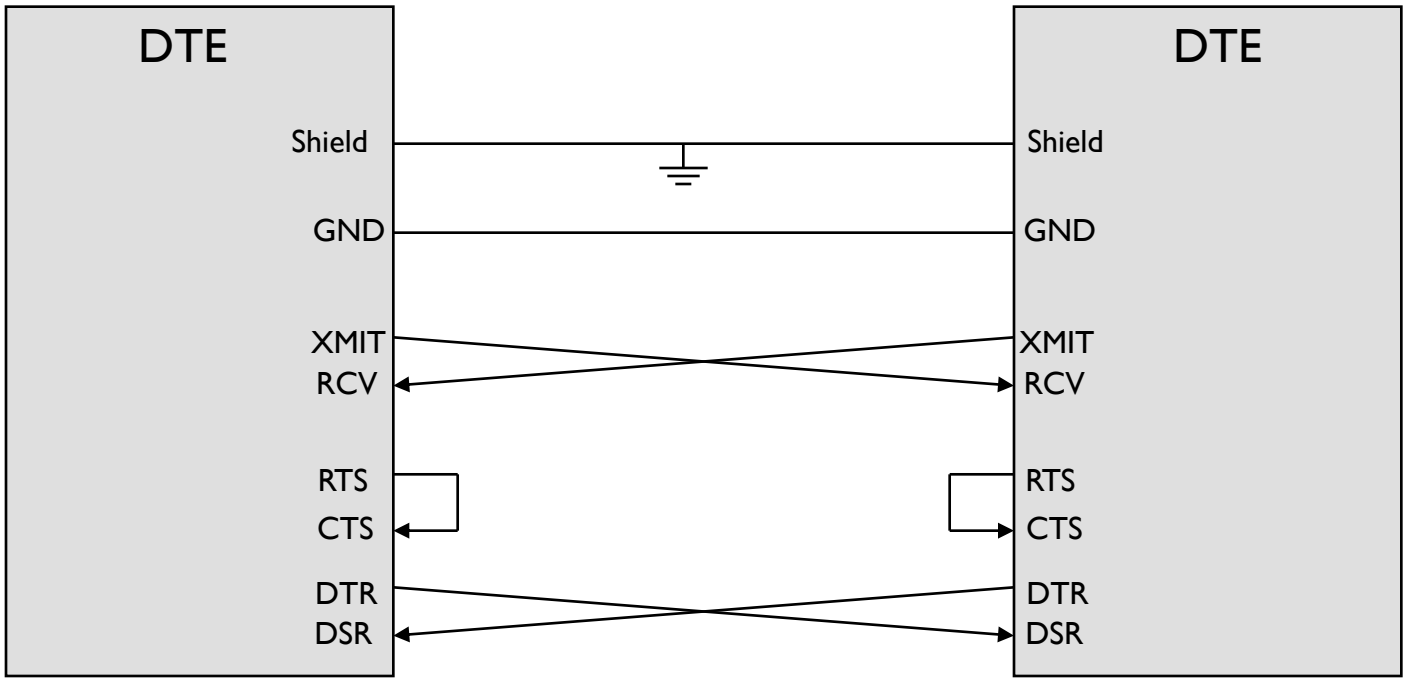
1 Shield	Shield	
7 GND	Signal ground	
2 XMIT	Transmit from DTE to DCE (Modem)	
3 RCV	Receive from DCE (Modem)	
4 RTS	Request to send, from terminal to modem	*
5 CTS	Clear to send, from modem to terminal	
6 DSR	Data set ready, from modem to terminal	Data set (modem) online
20 DTR	Data terminal ready, from term. to modem	Tie to power
22 RI	Ring indicator, from modem to terminal	“Say hello!”
8 CD	Carrier Detect, from modem to terminal	“I hear the other end”

RS-232-C

- *
  - Originally designed for half-duplex control
  - For full-duplex, tie both RTS and CTS true
  - If RTS and CTS tied together, it means that RTS is OK if other end is plugged in
  - If CTS is connected to CD, it is OK to talk if both modems are connected

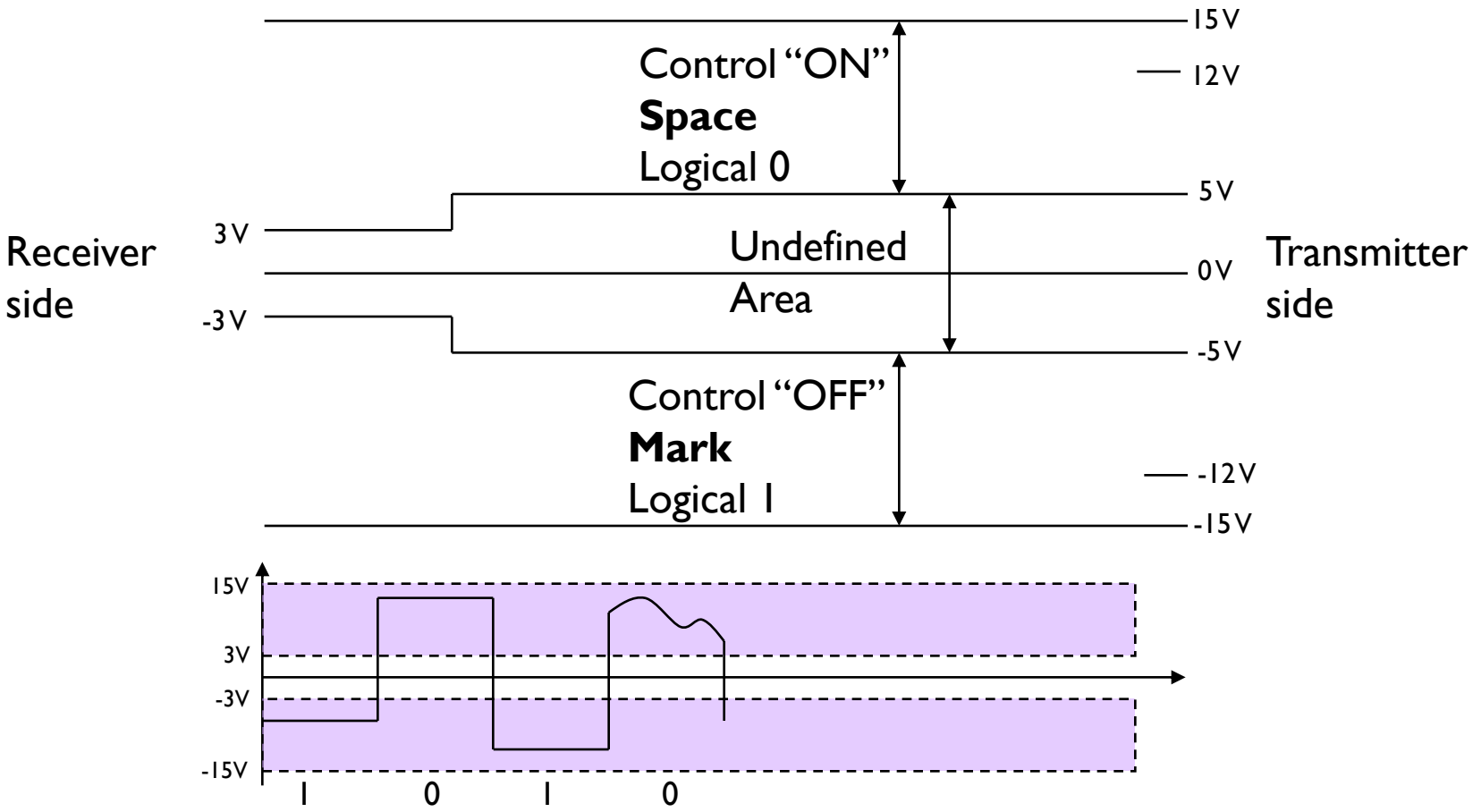
Null Modem

- Direct connection between two DTEs, e.g., terminal and computer, or two computers directly



RS-232-C

- Electrical specification:



RS-232-C

- Open circuit ≤ 25V
- Driver must be able to sustain short circuit current without damage; short circuit current ≤ 0.5A
- Voltage change not faster than 30V/μs, +3V/-3V transition not to exceed 1ms or 4% of bit time
- Terminator capacitance ≤ 2500pF including cable

RS-232-C

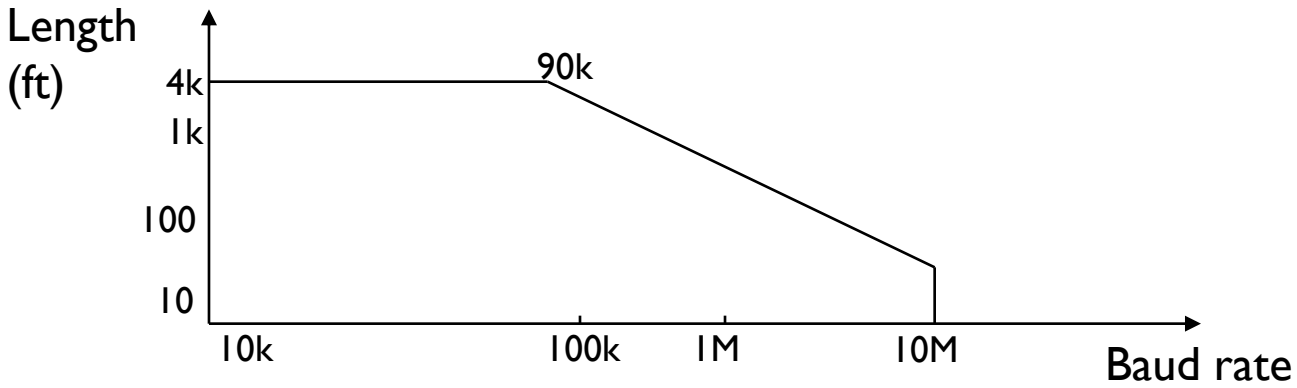
- Electrical Problems:
  - ±12V supply needed, inconvenient
  - Cable capacitance: Maximum 50 ft if cable is 40-50pF/ft!
  - Ground reference
    - System has poor common-mode noise rejection
    - Cross-talk and increase of bias distortion
    - Especially bad if clock lines used (SYNC)
  - Not suitable for long distances
    → Motivation for new standards RS-422, 423

RS-423

- Use RS-449 for functional and mechanical aspects
- Created for transition from RS-232 to RS-422
- Uses unpopular 37-pin connectors per RS-449
- Unbalanced like RS-232-C
- All signals use a common return to complete the circuit
- Valid margins: +2V/+6V and -2V/-6V
- For less than 20kbps

RS-422

- Use RS-449 for functional and mechanical aspects
- Fully balanced, differential inputs
- Supports data rates ≥ 20kbps



- Using 24G Twisted-pair, 100Ω load
  - Amplitude drop less than 6dB
  - Rise time less than ½ bit time

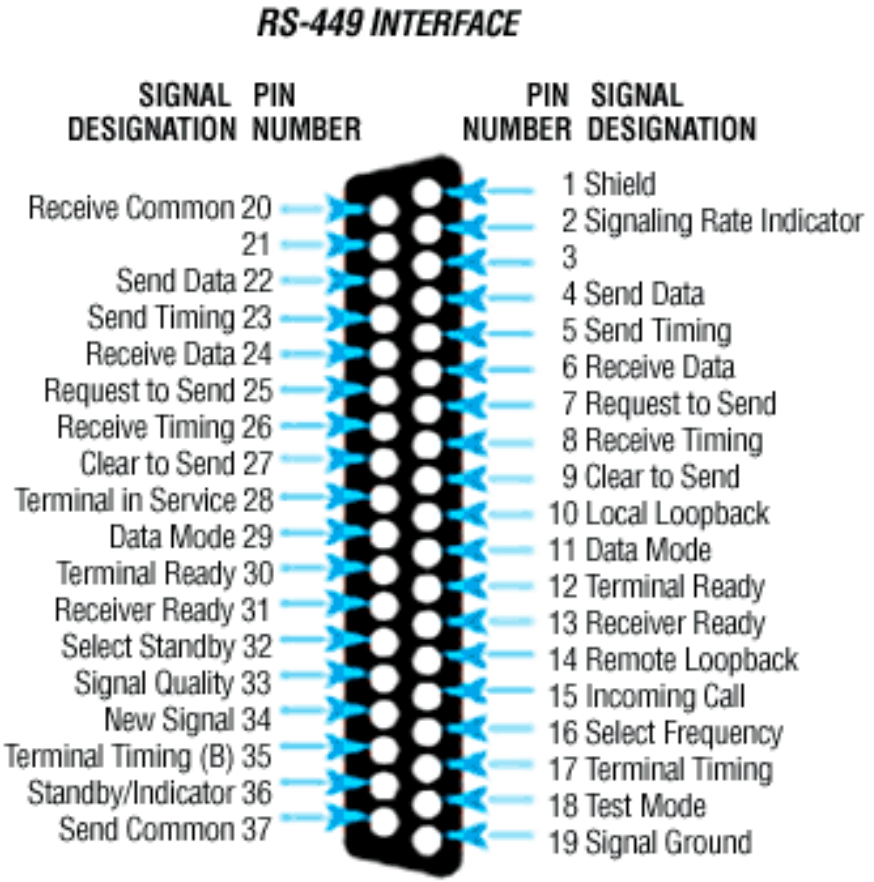
RS-485

- Like 422, 485 is also balanced
- 485 handles multiple drivers and receivers
- Better common-mode noise rejection (-7 to +12 Volts)
- Sensitivity of ±200mV in receivers
- Drivers give up to 5 volts balanced output
- Can stand contention, driver shuts down by itself
- High input resistance (12K ohms)
- Hysteresis of 50 mv to overcome diff. noise

RS449

- The RS449 or RS-449 interface is a further enhancement of RS232 and RS423.
- It is aimed at catering for very fast serial data communications at speeds up to 2 Mbps.
- The RS499 standard is also known as EAI449, TIA-449 and ISO 4902

- One of the ways in which the RS449 data communications standard is able to send at high speeds without ***stray noise*** causing interference is to use a *differential form of signalling*.
- Earlier data communications standards such as RS232 used signalling that was referenced to earth and while this was easier to implement and cheaper to cable, it introduced limitations into the system.



RS449 Auxiliary connector

A second connector is defined for use when the secondary channel interchange circuits are needed.. This connector uses a 9 way D-type connector.

Pin	Signal Name	Description
1		Shield
2	SRR	Secondary Receive Ready
3	SSD	Secondary Send Data
4	SRD	Secondary Receive Data
5	SG	Signal Ground
6	RC	Receive Common
7	SRS	Secondary Request to Send
8	SCS	Secondary Clear to Send
9	SC	Send Common

RS449 secondary connector

- **Reference: Tracy Bradley Maples, Ph.D.**
- Computer Engineering & Computer Science, Cal ifornia State University, Long Beach