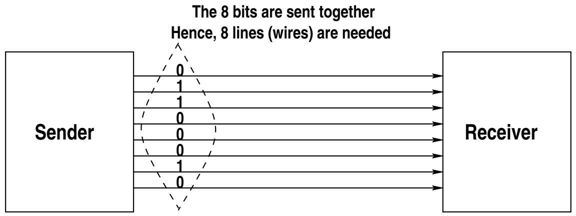
PARALLEL AND SERIAL COMMUNICATIONS

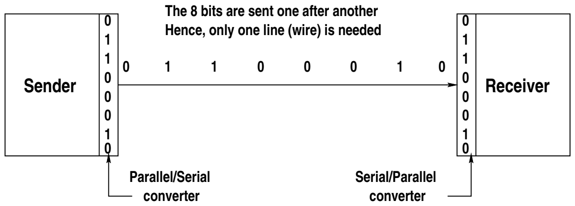
Parallel Communication



Parallel Transmission

- n wires are used to send n bits at one time, i.e., each bit has its own wire
- Advantage: Speed
- Disadvantage: Cost

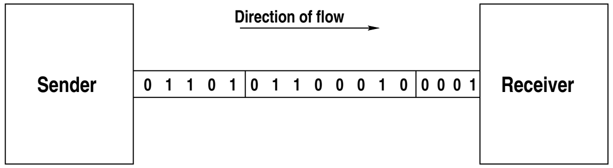
Serial Communication



Serial Transmission

- 1 wire is used to send n bits, one bit follows another
- Since communication within devices is parallel, conversion devices are required at the interface between the sender and the line (parallel-to-serial) and between the line and the receiver (serial-to-parallel)
- Advantage: Reduced cost
- Disadvantage: Reduced speed
- Serial communication occurs in one of two ways:
  - Synchronous
  - Asynchronous

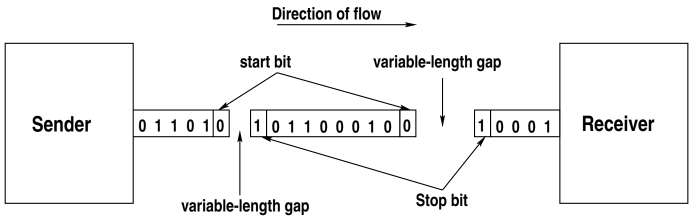
Synchronous Communication



Serial Synchronous Transmission

- Bits are sent one after another without start/stop bits or gaps
- It is the responsibility of the receiver to group the bits

Asynchronous Communication



Serial Asynchronous Transmission

- One start bit (0) is sent before each byte
- One, or more, stop bit (1) is sent after each byte
- There may be a gap between each byte

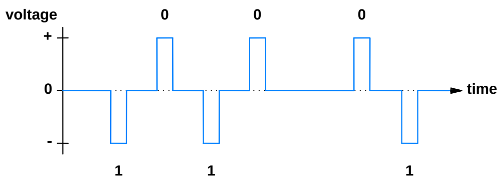
LOCAL ASYNCHRONOUS COMMUNICATION

The Meaning of "Asynchronous"

- *Asynchronous* means a sender and a receiver do not need to coordinate before data can be transmitted
- The receiver must be ready to accept data whenever it arrives
- Examples: Keyboard and mouse

Digital Encoding

- One possible way of using voltage in digital transmission is as follow:
  - Negative voltage to represent a 1
  - Positive voltage to represent a 0
  - Zero voltage to represent the ideal state
  - Elapsed time between transmitting bits is not relevant



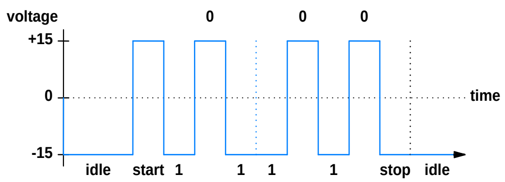
A waveform diagram to illustrate how positive and negative voltages can be used to transmit bits across a wire.

- Questions remain unanswered
  - How long should the sender hold a voltage on the wire for a single bit?
    - Waiting longer than necessary wastes time
    - Waiting shorter than enough will not allow the receiver to sense the signal
  - What is the maximum rate at which a hardware can change the voltage?
  - Compatibility between vendors
- The answers for these questions, and more, are exist in documents called "*standards*"
- These standards are issued by scientific organizations such as
  - International Telecommunication Union (ITU)
  - The Electronic Industries Association (EIA)
  - The Institute for Electrical and Electronic Engineers (IEEE)
- Following the standard insures compatibility between vendors

The RS-232C Standard

- RS-232C (*Reference Standard No. 232C*), or simply RS-232, defines a serial, asynchronous, way of communication
- Specified by EIA
- Voltage is +15 or −15 Volts
- Cable limited to approximately 50 feet
- A sender and a receiver must agree on
  - Number of bits per character
  - Duration of each bit (transmission speed)
- The receiver
  - Does not know when a character will arrive
  - May wait forever
- To ensure meaningful exchange, the sender sends
  - A start bit before each character
  - A one, or more, stop bits after each character

An RS-232C Transmission Example

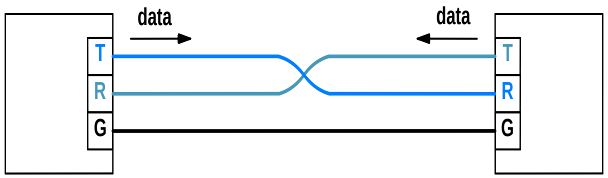


A waveform diagram to illustrate RS232C transmission standard

- The start bit
  - Is a +15 volts, i.e, it is a bit carrying "0"
  - Appears immediately before the actual data
  - Is not a part of the data
- The stop bit
  - Is a −15 volts, i.e, it is a bit carrying "1"
  - Follows the data
- Note that: *asynchronous* here means *asynchronous at the character level*, but the bits are still *synchronized*, i.e., their duration are the same

Full-Duplex Communication

- Both sides can transmit and receive data at the same time
- The transmitter on one side (pin No. 2) is connected to the receiver on other side (pin No. 3)
- Separate wires is needed to carry current in each direction
- Common ground wire (pin No. 7 in the DB-25, or pin No. 5 in the DB-9)



The minimal wiring required for full-duplex RS-232 communication