Chapter 5
Local Point-to-Point Communication

Translating Energy to Bits

- Recall that data transmission requires:
  - Encoding bits as energy
  - Transmitting energy through medium
  - Decoding energy back into bits
- Need to decide how to encode 1 and 0 bits as energy
- Transmitter and receiver must agree on encoding scheme

Basic Idea

- change the voltage over time to encode the desired bits
- use one voltage to represent 1, another to represent 0
- (maybe) use a third voltage to represent no data

Figure 1: Example Waveform
How many voltages will we use?
What should the voltage settings be?
How long does the voltage need to stay at a level?
How do we encode bits with voltages?
How do we know when a bit begins?

So how do we begin answering these questions?

**Baud Rate**

- One way to define the “speed” of a line is to measure its Baud rate
- The Baud rate of a line defines the maximum number of signal changes that can occur per second
- The Baud rate is typically measured as cycles per second or Hertz

![Baud Rate Illustration](image-url)
**Baud Rate vs. Bit Rate**

- Another measure of a line’s speed is its **Bit Rate**
- **Bit Rate** measure the number of data bits the line can transmit per second, measured in **bits per second (bps)**
- The Bit Rate depends on
- HOWEVER,

![Graph](image)

*Figure 3: Sample*

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**Asynchronous Communication**

- Two problems regarding synchronization of the sender/receiver

- an **Asynchronous Line** allows the sender to transmit data only when it has data to send
So the sender and receiver must agree on the timing of each voltage duration (Baud Rate).

Then, the sender and receiver must agree on an encoding scheme. The encoding scheme can also help:

- International Telecommunications Union (ITU)
- Electronic Industries Association (EIA)
- Institute for Electrical and Electronics Engineers (IEEE)

We will look at a standard called RS-232-C.
RS-232-C

- RS-232 is an EIA standard to send ASCII characters (bytes) across copper wire
- RS-232 uses a 25-pin connector (most pins not used)
**Full/Half Duplex Lines**

- A **Full Duplex** line
- A **Half Duplex** line
- RS-232 uses full duplex communication; one line for each direction
- RS-232 only uses 5 of the 25 pins
  - Pin 2 - Receive (RxD)
  - Pin 3 - Transmit (TxD)
  - Pin 4 - Ready to send (RTS)
  - Pin 5 - Clear to send (CTS)
  - Pin 7 - Ground
**2-3 Swap**

- RS-232 requires a **2-3 Swap** to exchange the 2nd and 3rd wire so that the send line is connected to the receive line.
- However, a version of RS-232 used to connect computers to peripherals, such as modems, avoids the 2-3 swap.
- Modems xmit on 2, rcv on 3.
**Encoding and Synchronization in RS 232**

- Voltages: +15v = 0, -15v = 1, -15v = idle
- The sender indicates the start of next character by transmitting a zero bit called the **start bit**
  - The receiver uses the start bit to synchronize and start receiving the character
- When done, the sender cannot immediately begin sending the next character
  - There must be an idle cycle so that the start bit of the next character will be detected by the receiver
  - So, the sender transmits a one bit called the **stop bit** after each character
- The start and stop bits are called **framing bits**
- RS 232 allows both 7 and 8 bit ASCII characters to be transmitted, requiring 9 and 10 bits respectively
RS-232 cable breakout-box
- May need to test RS-232 connections
- Breakout-box gives access to signals
Limitations of Real Hardware

- Effects of wire mean waveforms look like the picture below
- May become worse with (1) longer wires (2) interference
- Standards specify how tolerant the receiver must be of imprecise wave forms