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

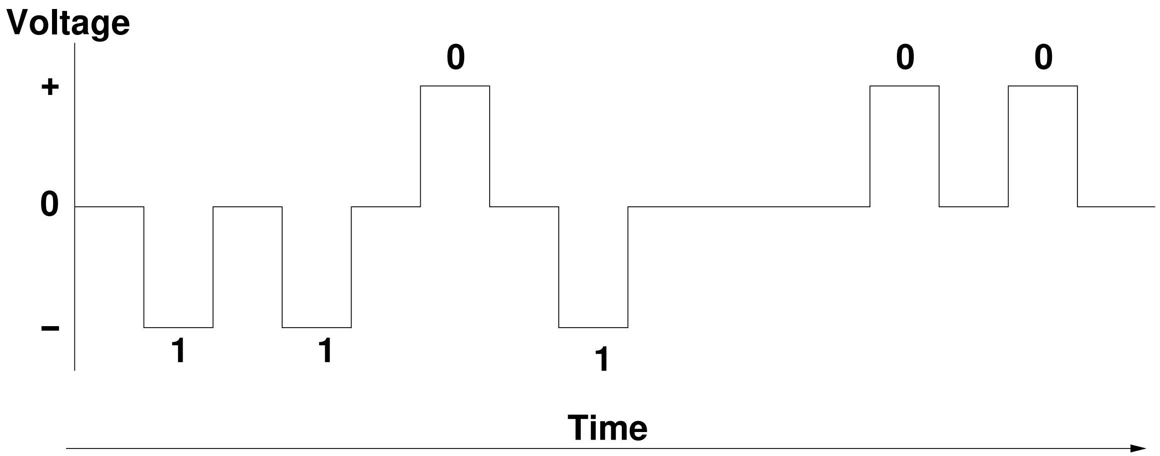


Figure 1: Example Waveform

Missing Details

- 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

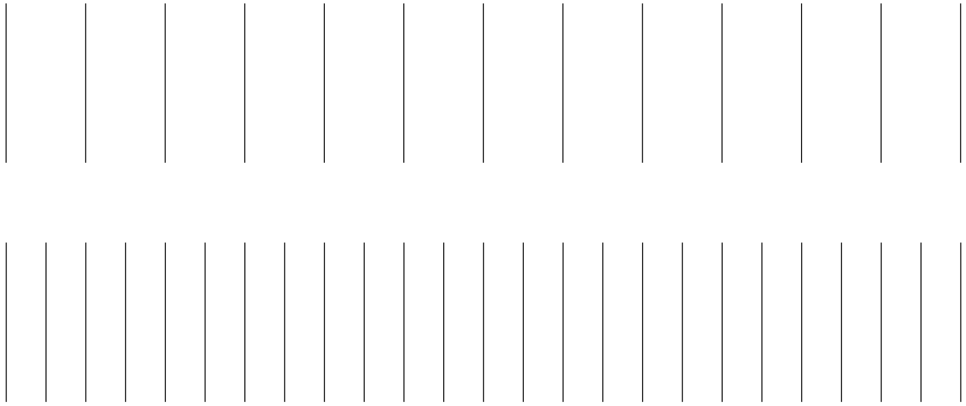


Figure 2: Baud Rate Illustration

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,

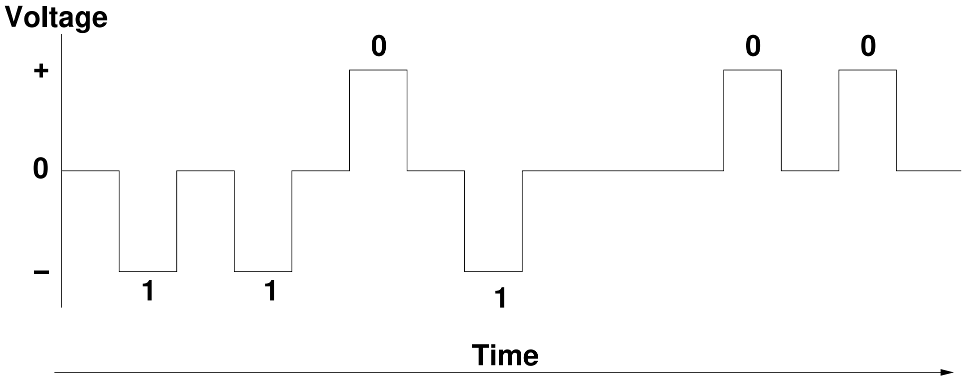


Figure 3: Example

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

Timing/Synchronization

- 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:

Need Standards

- so sender/receiver agree
- so different vendor's equipment can interoperate
- example standards organizations
  - International Telecommunications Union (ITU)
  - Electronic Industries Association (EIA)
  - Institute for Electrical and Electronics Engineers (IEEE)
- We will look at a standard call RS-232-C

RS-232-C

- RS-232 is an EIA standard to send ASCI characters (bytes) across copper wire
- RS-232 is
  - Local:
  - Serial:
  - Asynchronous:
- RS-232 uses a 25-pin connector (most pins not used)

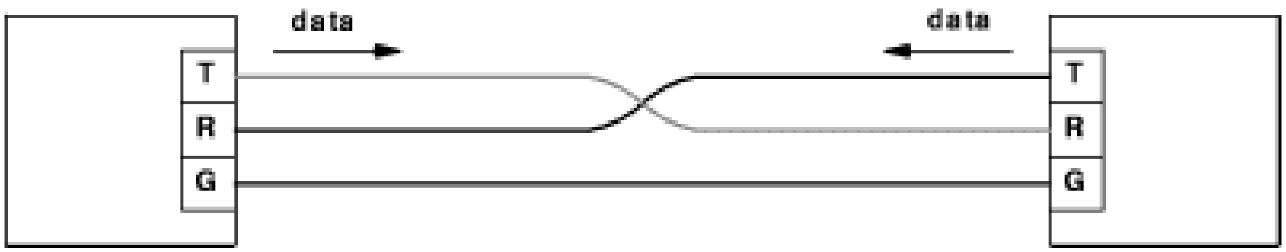
Figure 4: RS-232 DB25 connector

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

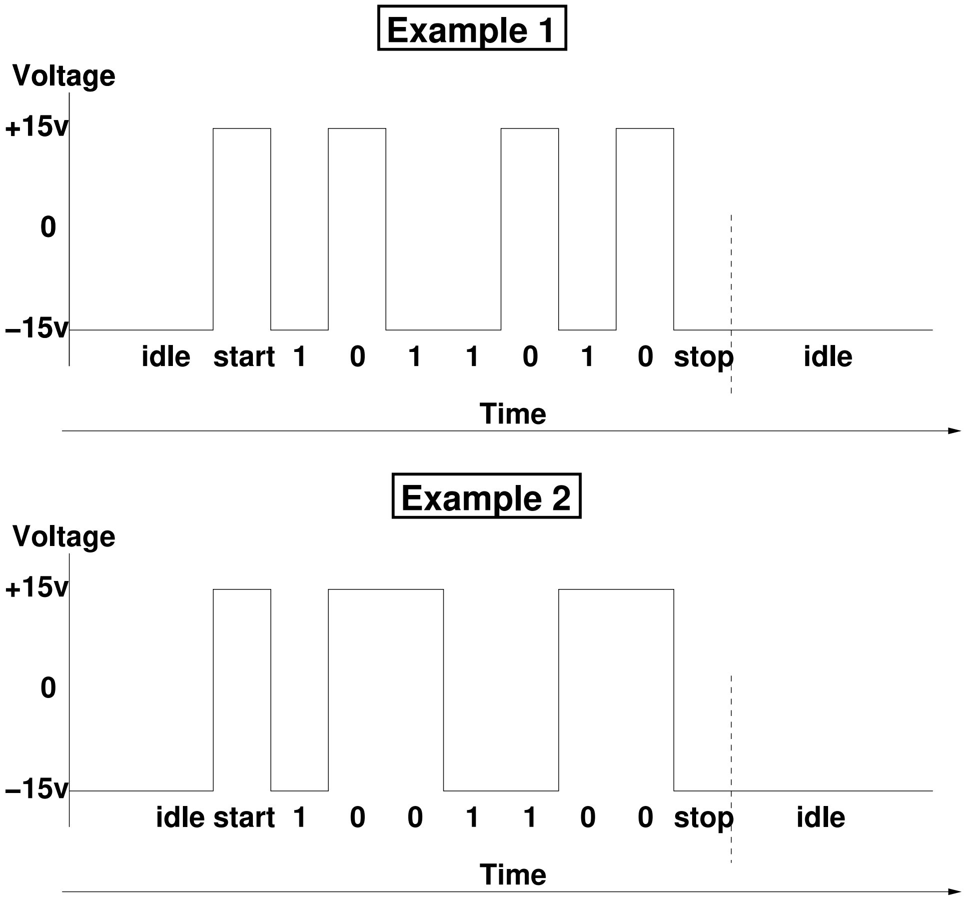
2-3 Swap

- 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 indiciates 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 tranmitted, requiring 9 and 10 bits respectively


Example 1
Voltage
+15v
0
–15v
idle
start
1
0
1
1
0
1
0
stop
idle
Time
Example 2
Voltage
+15v
0
–15v
idle
start
1
0
0
1
1
0
0
stop
idle
Time

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