RS-232 Communications

Why Serial Communications?

- Serial communication is the most simplistic form of communication between two devices.
- It’s pretty intuitive once you see the pattern.
- It’s what started networking!

So What is RS-232?

- RS-232 is a standard by which two serial devices communicate:
  - The connection must be no longer than 50 feet.
  - Transmission voltages are –15V and +15V.
  - It is designed around transmission of *characters* (of 7 bits of length).

RS-232 (cont.)

- One important aspect of RS-232 is that it is an asynchronous form of communication.
- Asynchronous communication is important because it is efficient; if no data needs to be sent, the connection is “idle.” No additional CPU overhead is required for an idle serial line.

Logical Voltages

- RS-232 is a little non-intunitave at first.
- Logical 1 is –15VDC.
- Logical 0 is +15VDC.
- When the connection is idle, the hardware ties the connection to logical 1.

How Can You Transmit Data?

- RS-232 communication is dependent on a set timing speed at which both pieces of hardware communicate. In other words, the hardware knows how long a bit should be high or low.
- RS-232 also specifies the use of “start” and “stop” bits.

Sending One Character

- Every time a character is sent, the same communication occurs:

1. Start bit sent.
2. Seven data bits sent.
3. Stop bit sent.

- This communication is dependent on the fact that both devices are sampling the bits at the same rate! We'll see what happens if this doesn't happen...

Ok, So What's the Start Bit?

- The start bit is a logical 0 sent on the line to tell the other device to start sampling.
- Remember, the logical 0 is +15VDC.

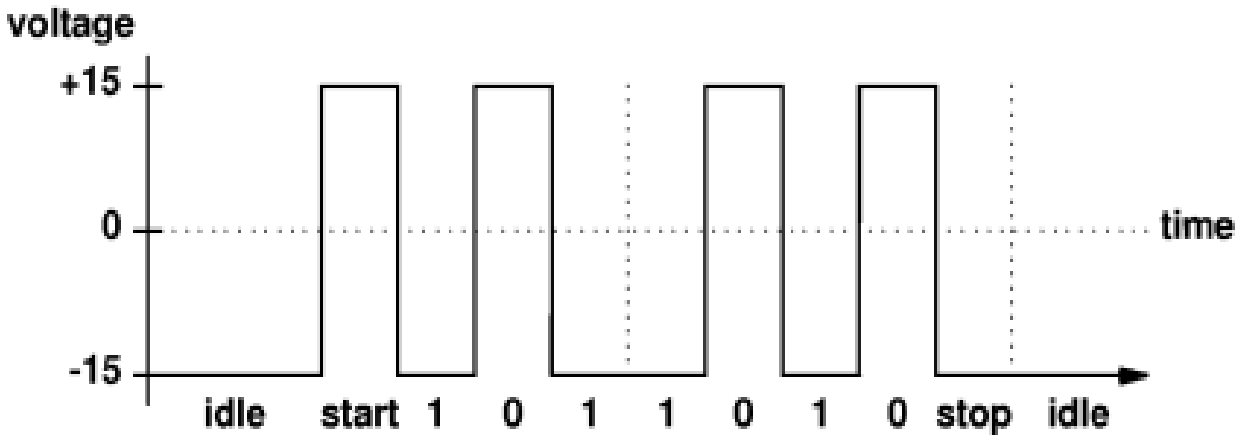
And the Stop Bit?

- The stop bit is a logical 1. –15VDC.
- A stop bit is always sent (per RS-232 standards).

To Talk the Talk...

- We’ve mentioned that both devices must have the same speeds to talk, but they must also know to handle problems.
- The transmission rate of serial devices is called *baud*. It is the number of changes in the signal per second.

A Sample Transmission



- Serial communications does not have to use 7 bits of length. As a matter of fact, a whole variety of start and stop bit patterns and bit lengths can be used.

Common Serial Settings

- Most settings are read in the following form:
  - Bits per second
  - Number of data bits
  - Parity
  - Number of Stop bits
- If you want to know what Parity is right now, read chapter 6.7. Otherwise, wait.

Common Serial Settings cont.

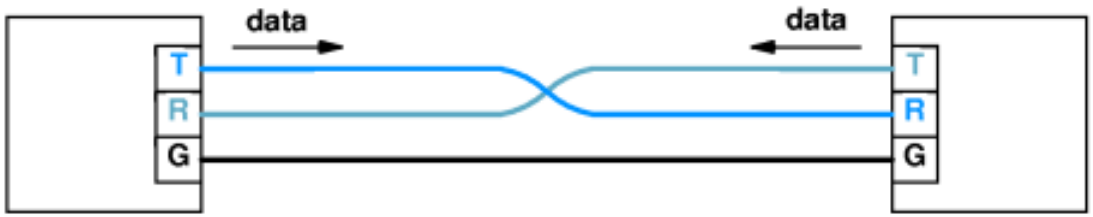
- Most everything comes out of the box with 9600,8,none,1. Including most Internet related devices like routers.
- Another common (old-school) setting is 9600,7,even,2.

Line Sampling & Framing

- RS-232 hardware samples the line multiple times during a single bit transmission.
- If the samples do not all have the same voltage, a *framing error* occurs.
- A framing error should only occur if one device is sending faster than the other device is set to receive.
- An intentional frame error can be caused by sending a BREAK.

Full Duplex Transmission

- Full duplex transmission (FDX) occurs when data is transmitted (or can be transmitted) simultaneously by both devices. Special wiring is needed for FDX.

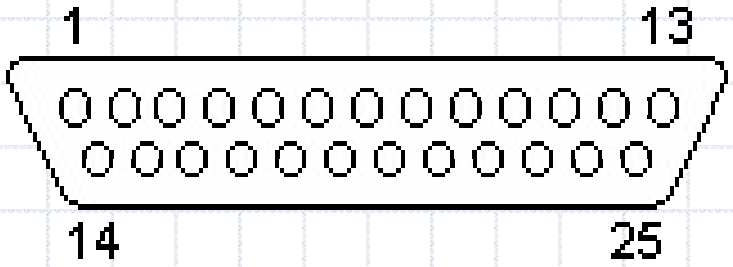


Wiring RS-232

- The RS-232 specification denotes usage of a 25 pin cable, where each pin has a specific usage.
- However, most devices never need to use all of the pins, so the cabling requirements for specific devices may vary.
- Many common serial devices (modems for example), use a 9 pin serial connection.

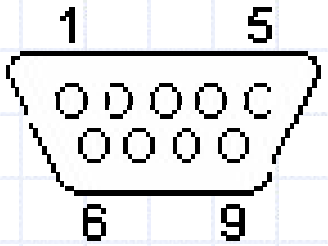
RS-232 DB25 Pin Out

DB-25M	Function	Abbreviation
Pin #1	Chassis/Frame Ground	GND
Pin #2	Transmitted Data	TD
Pin #3	Receive Data	RD
Pin #4	Request To Send	RTS
Pin #5	Clear To Send	CTS
Pin #6	Data Set Ready	DSR
Pin #7	Signal Ground	GND
Pin #8	Data Carrier Detect	DCD or CD
Pin #9	Transmit + (Current Loop)	TD+
Pin #11	Transmit - (Current Loop)	TD-
Pin #18	Receive + (Current Loop)	RD+
Pin #20	Data Terminal Ready	DTR
Pin #22	Ring Indicator	RI
Pin #25	Receive - (Current Loop)	RD-



RS-232 DB9 Pin Out

DB-9M	Function	Abbreviation
Pin #1	Data Carrier Detect	CD
Pin #2	Receive Data	RD or RX or RXD
Pin #3	Transmitted Data	TD or TX or TXD
Pin #4	Data Terminal Ready	DTR
Pin #5	Signal Ground	GND
Pin #6	Data Set Ready	DSR
Pin #7	Request To Send	RTS
Pin #8	Clear To Send	CTS
Pin #9	Ring Indicator	RI



Connector Types

- The two different connectors are associated with two major types of hardware
- The Computer Terminal Equipment (CTE) and the Data Terminal Equipment (DTE).

Connector Types (cont.)

- For ease-of-use, a computer will transmit on pin 2 and receive on pin 3 (the CTE, remember).
- Vice versa: a modem will transmit on pin 3, and receive on pin 2 (for the DTE).

Speed Limitations

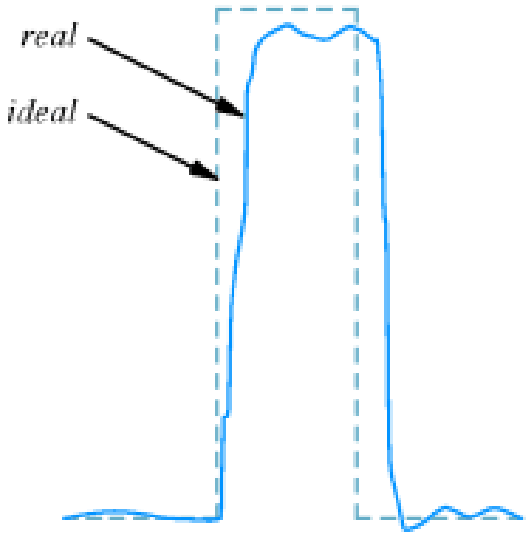
- For people familiar with modem communications, there is a speed limitation associated with the transmission.
- 56k (56 kilobit) analog modems are pretty much the fastest analog modems that consumers are going to see. This limitation is due to telephone systems, not the computer systems.

Speed Limitations (cont.)

- However, serial communications between devices also has its own speed barrier.
- RS-232 was designed with the understanding that the analog world is far from perfect.
- Digital is fast, analog is slow. RS-232 is analog, therefore is it slow (in computing terms).

Why Is It Slow?

- Δt exists. The change is not instantaneous.
- Sampling does not occur immediately, so it must wait $\Delta t + t_0$
- Cable length increases delay.
- Etc.



Noise

- Signal noise is bad. It is caused by a variety of sources, all of which lead to lower speeds and less reliable transmission.
- Shannon's Theorem shows that the maximum transmission rate of a voice call (analog) is ~30,000 bps (30kbps).