Lab 3: Serial Port Communications. **20 points**

Objective and Background: Understanding ASCII characters and sending data over a serial port.

On an embedded computer, we can send characters and numbers out to other units via a serial port. This port consists of two wires, one for sending data out (Tx - Pin 1) and another for receiving data in (Rx – Pin 0). The data is sent out to the wire serially, or in other words one bit at a time. Below is a plot showing how the data appears on the output pin. The sequence begins with a transition from 1 to 0 (Idle to Start) which starts the timing in of the bits. After 1.5 * T_b, the first bit is captured, then each bit time later another bit is sampled. Once all the bits are in, a final Stop bit (always 1) is sent.

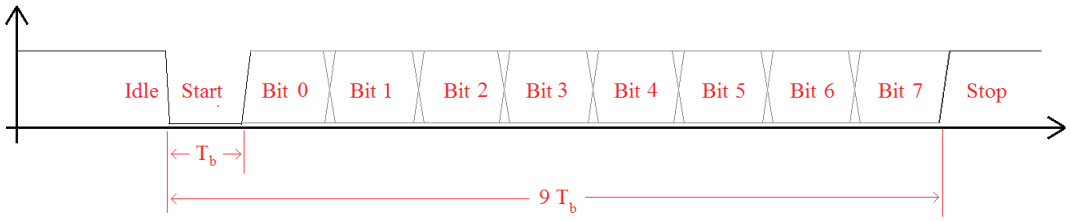

Figure 3-1. Bit Pattern on Serial Port

From this we can see that a 8 bit number requires 10*T_b to be transmitted. The bit time, T_b, is set to what is commonly called the Baud rate, and is given in Bits Per Second (bps). The most common value is 9600 bps, with 19200, 38400 and 115200 also common baud rates.

Description of Lab 3:

In this lab, we will write a program that transmits a series of characters. The sequence will consist of "AlphaNumber", where Alpha is meant to be a letter, cycling from A to Z, and Number is a digit that cycles through 0 to 9. The sequence that comes out should look something like "A0B1C2D3....". The objective is to send a letter-number pair every 500 milliseconds. We will also want to be able to restart the sequence, so we will watch for a capital R to be received and once it comes in, restart the sequence at "A0".

Program structure

```
declare char Alpha = 'A', Number = '0';
SetUp:
        Set serial port baud rate.
        Set up Timer
Loop:
        if 500 milliseconds have passed
            Send message
            Update message

        if serial data has come in
            if serial data equal to 'R'
                Reset message transmission.
```

Functions needed for this Lab

Serial.begin(baud), Serial.print(), Serial.available(), and Serial.read()

Documentation for all for these functions can be found at the Arduino website
http://www.arduino.cc/en/Reference/HomePage .

Lab Assignment:

Prelab: Write a program that will implement the program described in the lab write-up, setting the baud rate to 9600 baud (bits per second) .

Lab 3:

1) Enter in the program done in the prelab, upload it to the Arduino, and observe the output on the serial monitor (part of the Arduino IDE). This portion of the assignment is to be demonstrated to an instructor.

   When demonstrating this program, be sure to demonstrate the reset of the message sequence. Also consider whether or not you have tested the wrap points on the message and consider how you might demonstrate this without a long wait time.

2) Change the program to send out the letter 'Z' every 500 milliseconds, then use the logic analyzer to measure the time required to send the nine bits as shown in Figure 3-2. From this measurement, compute the Baud rate. Be sure to document your measurement via a screen shot of the Logic Analyzer.

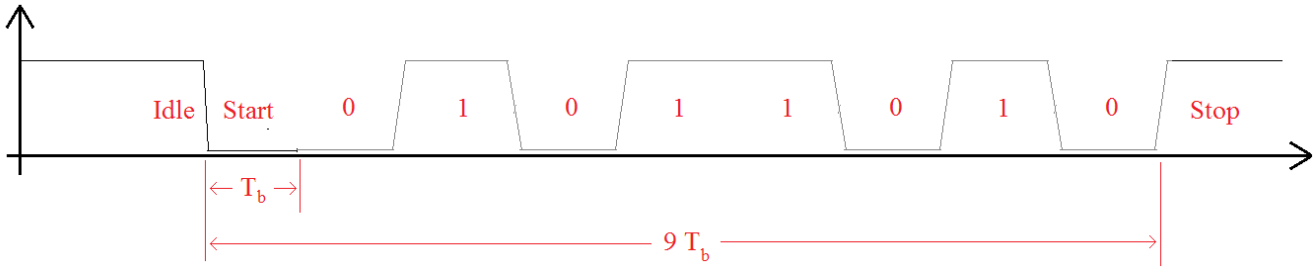

Figure 3-2. Bit Pattern for 'Z'

Questions:

How accurately does the measured bit time match with the programmed bit time? Compute the absolute Relative Error as shown in Equation 1, and use it in your answer.

$$Err = \frac{|T_M - T_P|}{T_P} \quad (1)$$