EECE 5141C/6041C
Introduction to Mechatronics
Lab 5: USART Communication

Name: _____

In this lab, you will program two scoreboards to communicate with each other over a RS485 serial bus. One scoreboard will operate in master mode, and the other scoreboard will operate in slave mode.

DELIVERABLES

1. Completed Worksheet
2. Annotated Source Code for Master and Slave scoreboards

SYSTEM DESCRIPTION

For this lab, you will work with another group. Each group will receive one scoreboard. One group will write the software for the Master scoreboard, and the other group will write the software for the slave scoreboard.

Master Scoreboard System Description

The Master Scoreboard will increment a 16-bit score variable every 500ms. It will display this score on the five (5) seven-segment displays using the time-multiplexed output method from Lab 2. However, the segment drive signals are controlled by the output lines of a 3 to 8 decoder chip. The line select signals of the decoder chip are connected to pins PD4, PD3, and PD2 of the microcontroller. The value output on these three lines activates the corresponding digit. For example, an output of PD4=0, PD3=0, and PD2=1, will turn on Digit 1 of the display board. A barebones code example for displaying a value on the display board is provided on Canvas, and this code can be used as a starting point for the lab. After each score update, the Master Scoreboard should initialize a USART data transfer in which it sends the 16-bit score to the Slave Scoreboard.

You should utilize the Multiprocessor Communication mode for handling the communication between the master and slave. For this lab we will configure the USART frame to have 9 data bits, no parity, and 1 stop bit. The 9th databit indicates that a transmission contains an address byte when set to a '1' and contains a data byte when set to a '0'. You should configure the USART for 250k Baud Rate. The microcontroller will transmit the serial signal on an RS485 serial bus through the use of an RS485 transceiver IC. This chip is connected to the RX and TX lines of the USART. There is an additional control signal (\RE/DE) that controls the receive or transmit direction of the transceiver. This signal is connected to pin PD6 of the microcontroller. When the signal is pulled low, the transceiver is ready to receive. When pulled high, the transceiver is ready to transmit.

Transferring the 16-bit score from the Master Scoreboard to the Slave Scoreboard should consist of six USART transmissions. The first transmission from the Master Scoreboard will be an address packet containing the Slave Scoreboard's address (0x10). The second and third transmission will contain the Lower Score Byte Internal Address (0x01) and the Lower Score Byte respectively. The fourth and fifth transmission will contain the Upper Score Byte Internal Address (0x02) and Upper Score Byte. The sixth transmission will send the Stop Byte (0xFF). There are two primary methods of handling the transmission sequence. In the first method, you can construct a finite state machine the tracks the progress through the

transmission sequence. Alternatively, you can create a transmission buffer array and increment the array index after each transmission. Either method should utilize the TX Complete Interrupt.

Slave Scoreboard System Description

The Slave Scoreboard will receive, store, and display the transmitted score from the Master Scoreboard. Therefore, you should enable the USART RX Complete Interrupt (RXCIE=1). Just as with the Master Scoreboard, the Slave Scoreboard microcontroller will utilize the USART in multiprocessor communication mode. Since it is a slave node, it must first enable multiprocessor communication mode. Once an address packet is received, it should check to see if the transmitted address matches its own address as defined by the software. If it matches, it should then alternate between receiving the internal address and recording the corresponding data. Once it receives both the upper and lower score bytes, it should update its internal score variable. The parsing of the data stream should be handled via a state machine within the USART RX Complete Interrupt.

Complete System Test

Once the Master and Slave Scoreboards are programmed you should connect them together to verify that the displayed scores are synchronized. Connect the scope to Channel A of the RS485 bus and capture a sequence of data packets. Show me the working system. The demo is worth 20% of this lab. Answer the following design questions.

DESIGN QUESTIONS

1. Draw the state diagram of the either the Master transmission sequence or the Slave data parsing sequence.

2. If you needed to send two different scores to two different scoreboards, how would the system need to be modified?

3. If you slave needed to send data back to the Master Node, how would you modify the data transmission sequence?