

## LAB #6: Threads

The Lab write-up is due to your TA at the beginning of your next scheduled lab. Don't put this off to the last minute! There is pre-lab work to complete before the start of the next lab. **NO LATE LAB REPORTS WILL BE ACCEPTED.**

### 1 Objectives

- To gain experience with preemptive schedulers and semaphores.

### 2 Background

In this lab, you are going to experiment with a thread scheduler and using a semaphore to lock access to an I/O port. In particular, you are to write a simple thread which counts to \$FFFF. When it wraps around, it should then try to obtain a semaphore, S. After it obtains the semaphore, the thread should then write its ID (stored in its thread control block) to an I/O port. You can output the ID on any I/O port you like but all threads should use the same I/O port. In this handout, we will call this I/O port, the ID port. After outputting its ID on the ID port, the thread should wait for a delay. This delay should be implemented with one of the hardware counters rather than a software counter (for example, you can add \$1FFF to TCNT and wait for TCNT to reach this value). Other threads may be executing as long as they do not wish to access the ID port. After the delay has completed, the thread should set the ID port back to 0, and it should release the semaphore, S. It should then loop back and start counting again. In designing this thread, be aware that it must be reentrant, since many copies of this thread will be running at the same time.

Next, you should then implement a thread scheduler, and create thread control blocks for at least four copies of your simple counting thread. Finally, run your program and watch the ID port on an oscilloscope using the probe kit (available for checkout). This will allow you to see which thread is holding the shared resource (ID port). Ideally, you would like the free time for the shared resource to be zero. Try adding more thread copies and watch the effect. While you can start with the simple thread scheduler from the book, feel free to be creative to try to optimize performance. For example, threads which are waiting for their display to time out should release the CPU. Also, blocked threads should release the CPU. If you are feeling very adventurous, you can try to use blocked lists, but this is not required.

### 3 Pre-lab

You should have at least a basic version of your thread scheduler written though it need not be thoroughly debugged.

### 4 Tasks

1. Complete your thread scheduler and watch it execute using an oscilloscope using the probe kit (available for checkout) on the port you selected to output the ID.
2. Attempt to optimize your scheduler to decrease the amount of free time for the shared resource.

## 5 Writeup

Include the following items:

1. A printout of your commented code.
2. Annotated scope output for the ID port
3. Did you have any problems? For example, did you have any problems in how you implemented your display delay?
4. What percentage of the time do your threads spend holding the shared resource?  
What percentage of time is the shared resource free?
5. What types of things did you try to achieve/improve this level of efficiency?