ECE 4510/5530 MICROCONTROLLER APPLICATIONS
SPRING 2012
Laboratory Design Project
(Team Project)

Total: 40 pts. (10% of the course grade)
Due 2:00pm, Tuesday, April 17, 2012

The theme of the project is to move an object that has been placed on a conveyor belt from a start position to a specific end position. If it was built, a physical model of the plant would include the peripherals as follows: a Start Switch, a LED indicator, a Buzzer (a small speaker), an IR (Infra Red) Emitter and Receiver Module, an H-Bridge Motor Driver Module, and a Motor Encoder Module. **In the absence of a fully assembled physical model, the IR Module will be substituted by a IR LED indicator (i.e., a common LED) and a bounce-free switch (STOP#), the output signal of the Encoder Module will be provided by a Function Generator (initial frequency is 5.5KHz), and the PWM signal to drive the H-Bridge will be verified using a Logic Analyzer (initial duty cycle is 50%). All signals should comply with TTL levels.**

The system should implement the operations as follows: upon receiving the asserted **START#** signal (active-low), the Buzzer should sound (the frequency of the output signal **f = 5.5KHz**), and the LED indicator should blink **six times** (at the rate of **1 blink/s**). The Buzzer should also be turned off when the blinking is over. Then the **IR Emitter LED** should be turned on. The **PWM** signal driving the motor should also be turned on at this point (**f = approx. 30KHz**, **initial duty cycle = 50%** to match the input frequency of 5.5 KHz). Until an active-low signal from the IR Receiver (i.e., from the STOP# switch) is detected indicating that the object on the belt has tripped the IR beam, the system should **sample the frequency** of the signal received from the Encoder, and **respond to it by adjusting the duty cycle of the PWM signal** as given in the Table below.

Input frequency (KHz)	**4.7**	**4.9**	**5.1**	**5.3**	**5.5**	**5.7**	**5.9**	**6.1**	**6.3**
Duty cycle of PWM signal (%)	**90**	**80**	**70**	**60**	**50**	**40**	**30**	**20**	**10**

When the desired end position for the object is reached, the PWM signal should be turned off (**duty cycle = 0%**), the Buzzer should sound (at **3.5KHz**), and the LED indicator should blink **10 times** (at the rate of **2 blinks/s**). The Buzzer and the IR LED indicator should be turned off when the blinking is over. The process should restart when the START# signal is asserted again.

You are to **design, simulate, build, and demonstrate** the operation of the system specified above using the Adapt9S12DP512 Board in the Lab and circuits constructed on your Breadboard.

Tasks:

a) Summarize the **key points** of your design. That should include a list of ports and bit maps, and a discussion of your approach to implement the required functions using hardware and software means. You should clearly indicate what internal modules of the 9S12DP512 microcontroller have been used (if applicable). The CPU clock should be set to **24MHz**. **Comment** on your design steps, and give a **conclusion** of your project. (5 pts.)

b) Give a **detailed schematic diagram** for the whole system. The Adapt9S12DP512 Board should be represented by its interface connector signals. **All** 9S12DP512 microcontroller port signals used in your design should be buffered by suitable parts. All parts should have pin numbers and all traces should have signal names assigned. (5 pts.)

c) Develop a **C program** for the software segment of the system. Your code should run from the **Flash**. Turn in your C source file along with the compiled **.lst** file with **comments**. In addition, turn in **hard copies** of **logic analyzer screen shots** to document the performance of your system with respect to the speed control task (14 pts.)

d) **Build** your circuit on your Breadboard and **demonstrate** the correct operation of the **whole system** to your lab instructor, or the course instructor. (16 pts.)

Each Design Team should submit a **joint Project Report**. In the report you should have the sections Introduction, Design, and Conclusions. The Design section should cover for Tasks a) - c). In the Conclusions section you should assess the performance of your system. You are also expected to comment on your work on the project.

Note: you will lose **4 pts. by each day** your project (a **working system and a report**) is tardy. **No** credit will be given if the project is late by more than **three** days. **No** projects will be accepted after 5:00pm, on Friday, April 20, 2012.

Bonus Project
(Team Project)
Total: 10 pts. (2.5% of the course grade)
Due 2:00pm, Tuesday, April 17, 2012

Same specs and tasks but use some of the **uC/OS II** services to implement the project.