**1. Overview**

1.1. Objectives:

The objectives of this project are to design, build and test an alarm clock.

Educationally, we are learning how to design and test modular software and how to perform keypad input in the background.

1.2. Process:

The project will be developed using the TM4C123 board. The system will be built on a solderless breadboard and run on the usual USB power. The system will use an external keypad built from buttons on the breadboard. The speaker will be external. There will be four hardware/software modules: switch/keypad input, time management, LCD graphics, and sound output. The process will be to design and test each module independently from the other modules. After each module is tested, the system will be built and tested.

1.3. Roles and Responsibilities:

Trevor and Justin are the engineers and Dylan Zika is the client. We have modified this document to clarify exactly what we plan to build. We both planned the system’s overall structure and modified this document, Trevor wrote the program’s skeleton, Justin handled the PCB design, Trevor will handle the FIFO and LCD modules, and Justin will handle the Clock and Buttons modules.

1.4. Interactions:

The system will use the TM4C123 board, a ST7735 color LCD, a solderless breadboard, fifteen buttons, and be powered using the USB cable.

1.5. Terminology:

Power budget, device driver, critical section, latency, time jitter, and modular programming. See textbook for definitions.

1.6. Security:

The system may include software from Tivaware and from the book. No software written for this project may be transmitted, viewed, or communicated with any other EE445L student past, present, or future (other than the lab partner of course). It is the responsibility of the team to keep its lab solution secure.

**2. Function Description**

2.1. Functionality:

The clock must be able to perform five functions.

1) It will display hours and minutes in graphical and numeric forms on the LCD. The graphical output will include the 12 numbers around a circle, tick marks, the hour hand, and a minute hand. All output will be easy to read.

2) It will allow the operator to set the current time using a keypad and up/down buttons.

3) It will allow the operator to set the alarm time including enabling/disabling alarms.

4) It will make a sound at the alarm time and flash the onboard LEDs.

5) It will allow the operator to stop the sound. An LED heartbeat will show when the system is running.

2.2. Scope:

Phase 1 is the preparation; phase 2 is the demonstration; and phase 3 is the lab report. Details can be found in the lab manual.

2.3. Prototypes:

A prototype system running on the TM4C123 board, ST7735 color LCD, and solderless breadboard will be demonstrated. Progress will be judged by the preparation, demonstration and lab report.

2.4. Performance:

The system will be judged by three qualitative measures. First, the software modules must be easy to understand and well-organized. Second, the clock display should be beautiful and effective in telling time. Third, the operation of setting the time and alarm should be simple and intuitive. The system should not have critical sections. All shared global variables must be identified with documentation that a critical section does not exist. Backward jumps in the ISR should be avoided if possible. The interrupt service routine used to maintain time must complete in as short a time as possible. This means all LCD I/O occurs in the main program. The average current on the +5Vpower will be measured with and without the alarm sounding.

2.5. Usability:

There will be fifteen switch inputs. In the main menu, the switches can be used to activate and adjust 1) set time; 2) set alarm; 3) turn on/off alarm; 4) run mode; 5) snooze. The user should be able to set the time (hours, minutes) and be able to set the alarm (hour, minute). You can use either the number pad or the up/down buttons to set the modes. The main menu will always be displayed at the top, but after some amount of inactivity the menu will fade away when in run mode. The user should be about to control some aspects of the display configuring the look and feel of the device (color of the text displayed, desired theme, snooze time amount, etc.). The switches MUST be debounced, so only one action occurs when the operator touches a switch once. The LCD display shows the time using graphical display typical of a standard on the wall clock. The 12 numbers, the minute hand, and the hour hand are large and easy to see. The clock can also display the time in numeric mode using numbers. The alarm sound can be a simple square wave. The sound amplitude will be just loud enough for the TA to hear when within 3 feet.

2.6. Safety:

The alarm sound will be VERY quiet in order to respect other people in the room during testing. Connecting or disconnecting wires on the protoboard while power is applied may damage the board.

**3. Deliverables**

3.1. Reports:

A lab report described below is due by 9/23/16. This report includes the final requirements document.

3.2. Audits:

The preparation is due at the start of lab on 9/15/16.

3.3. Outcomes:

There are three deliverables: preparation, demonstration, and report.