# EGR 315/326 Electronic/Embedded System Design/Build Project

# Fall 2014

## Project Proposal:

Goal: to design and build an electronic embedded system that employs most of the concepts discussed in class and serves a useful purpose

The system to be designed and built this term is an alarm clock radio. The heart of the system will be your Atmel microcontroller board. It will interface with an FM radio IC and a real time clock IC. Combined with some pushbutton switches, analog sensors, power amplifiers, speakers, and a display, you will design and build a prototype to evaluate usability and feasibility of desired features described below in the functional requirements.

The microcontroller will collect input from the pushbutton switches, format the display for time and radio information, and send commands to control the radio IC for tuning different stations. Radio will be played out through amplified 8Ω speakers and an antenna will be designed to optimize FM reception.

## Functional requirements:

The alarm clock radio prototype will use a LCD to display the time, day of week, and date. When playing the radio, it will also display the station frequency, reception strength, and stereo indication. An indicator will show if either of two separate alarms are set and whether they will turn on a tone or tune to a radio station.

The backlighting on the LCD will adjust for room light brightness, more backlight intensity in a bright room, less in a dark room.

The clock radio will use a microcontroller to handle the display and inputs from pushbuttons and slide switches and it will control a radio tuner integrated circuit.

The radio will support stereo output using two speakers. Volume controlled power amplifiers will drive the speakers. Volume in each speaker will be adjusted using a balance control.

The clock radio will have two alarms that will turn on the radio at a specific time and play a selected station or sound an alarm tone. A snooze button will silence the alarm and reset it for 10 minutes later. A silence button will turn off the alarm for that day. A separate slide switch will disable or enable each of the two alarms.

A menu on the display will guide the user to enter information to set the time of day, alarm times, and radio tuning.

The alarm clock radio will maintain at least 5 preset stations in non-volatile memory.

The embedded system must retain the clock time, alarm times and preset station information when AC power is removed and then turned back on.

If the entry mode has been idle for more than 1 minute, the action will be cancelled and the system will return to the time of day display.

The system will be powered by an AC-DC power supply of a wall-mount step down transformer design. It will have battery backup that will maintain the time of day display during a power outage.

A LED status indicator will show when the radio is on. A second LED indicator will show when the radio is receiving a stereo signal.

The auxiliary control circuitry that is not part of the microcontroller board, including voltage regulators, sensor interfaces, radio IC, antenna interface, power amplifiers, etc, will be designed for manufacture on a printed circuit board.

A fixture must hold all components including the Uno board, auxiliary circuit board, display, switches, cable attachments, power cord, etc. attractively and securely.

## Design constraints:

The system will use the ATmega 328P microcontroller on your Atmel ATmega328P Xplained Mini development board as the embedded controller and the Silicon Labs Si4703 Broadcast FM Radio Receiver IC (not the evaluation board used in the initial prototyping).

The power amplifier circuit can be built using either discrete or integrated components. The power gain should be sufficient to drive the speaker.

The built-in watchdog timer must be employed for user interface timeouts and to preserve overall system sanity.

The first set of parts that will satisfy the project requirements will be provided to each team. Replacement parts must be purchased, so be careful with the parts you are given.

Additional parts may be purchased to enhance your design, however, cost of such parts must be limited to $50 per team.

## Extra features (some ideas to choose from):

- design and create an enclosure that demonstrates an interesting prototype clock radio
- implement an “old fashioned” alarm using a small solenoid to move a bell clapper
- display the Radio Broadcast Data System (RBDS) broadcast information on the display (e.g., station call letters, name of song playing will scroll across a portion of the display)
- cause the clock to speak the time of day, day of week, and date when a button is pressed
- add a treble and bass equalization circuit with a graphic display of settings

- pressing a button will cause the radio to scan for stations and it will pause when it receives a station with sufficient signal strength, pressing a key will stop the scan and stay at the current station
- the speaker volume is digitally controlled and will gently increase from low to medium volume in response to the alarm
- the system can play your custom music stored on an auxiliary memory chip or SD card
- the antenna is mounted on a stepper motor that seeks an optimum direction for maximum signal strength
- a temperature sensor is interfaced to the system to monitor and display room temperature
- a wireless remote temperature sensor is interfaced to the system to monitor and display outside temperature
- decode the DRSS broadcast digital code and display station call ID and song information when present
- design a rechargeable battery management system so that the clock radio becomes totally portable
- receive broadcasts from WWV (not in the FM band), decode the time of day information digital time code, and use to automatically synchronize your clock
- propose other additional features to your EGR315 or EGR326 instructor for approval

Grading

To receive a C on the project, your alarm clock radio prototype must demonstrate all of the functional requirements described above. To receive a B on the project, two of the extra features described above must be successfully implemented and described in your design document. To receive an A on the project, four of the extra features must be successfully implemented and described in your design document.

Due dates:

9/15 – Submit team names to Blackboard site for approval

9/22 – Specifications document submitted to Blackboard

10/27 – Design document submitted to Blackboard

12/1 – Final revised design document and validation test results submitted to Blackboard

12/2,3 – Presentation poster session and demonstration