

System Requirements Specifications

Alarm Clock Radio Semester Project: EGR 315/326

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Introduction and Overview

The task at hand is to design a fully functional alarm clock radio. The design will be implemented using the ATmega328P microcontroller communicating with peripheral devices on the I2C and SPI bus protocol. Peripherals sending data to the microcontroller include the DS1307 Real-Time clock and the Silicon Instruments si4703 FM tuner. The microcontroller will send its output to a Nokia 5110 graphic LCD screen and two stereo amplified speakers. The microcontroller will also receive input from user-controlled push buttons and slide switches controlling the FM tuner and two alarms. The system will contain LEDs as status indicators for the state of the devices.

The LCD will have backlighting for the user based on surrounding light in the environment from a photoconductive cell. Indicators will also be used to show when the radio is on and when it is receiving good stereo signals. Along with the alarm clocks, a snooze button will provide a repeated 10 minute reminder with a push of a button, a silence button will clear the alarm until the next day and the slide switch will disable or enable each of the two alarms. Also, on the LCD user information screen, menus will be a guide for the user to enter the information such as the day, alarm times, and radio tuning for preset radio stations.

The system will use EEPROM memory to store 5 preset stations on the AM/FM frequency select for the user for convenient use. Voltage regulators will also be included for power supply. Finally, a fixture will hold all these hardware components, when mounted to a PCB board, to provide a secure, convenient, and appealing user device.

The purpose of this embedded system is to provide an easy, user friendly device that is useful for the user to have. Objectively, for the project, it is to use hardware and software such as analog and digital circuits and programming such as I2C protocol, as an interface, for real world applications.

Technical Requirements

1. Auto-Adjusting Backlighting for LCD Screen Nokia 5110

Design due October 20, 2014

Verification due October 27, 2014

Included Parts:

- Photocell
- MCU
- MCU Compatible LED's

Technical Specification:

- LCD Screen adjusts in environmental conditions. The screen will dim in bright light conditions and intensify in low light conditions.

2. Power Amplifier Circuit for Speakers (Volume Control)

Design due November 13, 2014

Verification due November 20, 2014

Included Parts:

- LM741
- 8 Ohm Speakers
- SI4703 FM Tuner

Technical Specification:

- Gain from operational amplifier controls voltage output according to adjustable gain.

3. Built-in Watchdog Timer (User Interface Timeouts)

Design due November 7, 2014

Verification due November 14, 2014

Included Parts:

- I2C Protocol
- Nokia 5110
- MCU

Technical Specification:

- Keeps track of usage so LCD Screen defaults after a period of inactivity.

4. Wall Mount Step Down Transformer (Power Supply)

Design due November 7, 2014

Verification due November 14, 2014

Included Parts:

- DMM
- Oscilloscope

Technical Specification:

- System receives correct power supply input.

5. Display Date and Time on LCD Screen

Design due September 30, 2014

Verification due October 7, 2014

Included Parts:

- Pushbutton
- Nokia 5110
- MCU
- I2C Protocol
- DS1307 RTC

Technical Specification:

- MCU reads date and time from RTC and displays it correctly on LCD

6. Display Station Frequency, Strength, FM/AM Indication (LCD Screen)

Code and Design due November 1, 2014

Verification due November 7, 2014

Included Parts:

- Pushbutton
- Nokia 5110
- MCU
- I2C Protocol
- SI470 FM Tuner

Technical Specification:

- MCU takes input from FM Tuner and displays Frequency, FM/AM, and up to 4 bars indicating signal strength of the station.

7. Separate Alarm Settings (Option Tone/Station)

Included Parts:

- Pushbutton
- Nokia 5110
- MCU
- I2C Protocol
- SI470 IC Tuner

Technical Specification:

- Each alarm will be able to be programmed to a certain respective activation time. The user will also have the option to pre-set the station for when the alarm goes off.

8. Snooze Button (Alarm1/Alarm2)

Included Parts:

- Pushbutton Contacts Single Pole Single Throw
- Nokia 5110
- MCU
- SI470 IC Tuner
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Technical Specification:

- After alarm set, and alerts user, snooze button can be activated to reset alarm for a ten minute window.

9. Silence Button (Alarm1/Alarm2)

Included Parts:

- Pushbutton Contacts Single Pole Single Throw
- Nokia 5110
- MCU
- SI470 FM Tuner

Technical Specification:

- After alarm set, and alerts user, silence button will turn off alarm completely.

10. Slide Switch (Select Alarm 1/ Alarm 2)

Included Parts:

- Selector Switch Type Contacts
- Nokia 5110,
- MCU
- SI470 FM Tuner

Technical Specification:

- Slide switches enable user to set alarm to a specific time and station

11. Menu (User able to change Day, Time, Station Tuning (LCD Screen))

Included Parts:

- 2 Pushbuttons Contacts Single Pole Single Throw
- Nokia 5110
- MCU
- SI470 FM Tuner

Technical Specification:

- Menu will project each individual menu one at a time, one push button lets user change the display and another push button scrolls through menu.

12. Preset Stations (5 Stations NVM)

Included Parts:

- 2 Pushbuttons Contact Single Pole Single Throw
- Nokia 5110
- EEPROM Memory
- SI470 FM Tuner

Technical Specification:

- By one pushbutton, station will be chosen and another pushbutton will set the 1 through 5 station select channel for future use.
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13. Battery Backup

Included Parts:

- Standard Battery

Technical Specification:

- Battery will provide energy when unit is disconnected from wall source power supply.

14. User Action Cancellation (LCD Option Screen)

Included Parts:

- Pushbuttons Contact Single Pole Single Throw
- Nokia 5110
- MCU

Technical Specification:

- Pushbutton will allow user to escape from any given menu to change back to default menu.

15. Volume Adjuster for Speakers

Included Parts:

- Operational Amplification Circuit
- O-Scope
- DMM

Technical Specification:

- Adjustable sound given by speakers controlled by potentiometer input.

16. LED Indicator (Radio On)

Included Parts:

- MCU
- I2C Protocol
- LED
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Technical Specification:

- LED will illuminate when radio tuner receives power.

17. LED Indicator (Signal Received)

Included Parts:

- MCU
- I2C Protocol
- LED
- FM chip

Technical Specification:

- LED will illuminate when a strong signal is received.

18. PCB (Volt Reg/ Sensor Interfaces/ Power Amp./ etc.)

- A PCB will house all of the internal circuitry of the system
- Final Design and Manufacturer Plan
- All functional requirements will be re-verified to ensure proper design on PCB.

19. Rechargeable battery System

Design due November 20, 2014

Verification November 27, 2014

Included Parts:

- Battery
- DMM
- MCU

Technical Specification:

- Battery will hold a charge and provide portability for the unit.

20. Temperature Sensing Unit

Design due November 1, 2014

Verification due November, 2014

Included Parts:

- MCU
- Temperature sensing IC
- I2C Protocol

Technical Specification

- Menu for temperature will be selected by user scroll and to get the temperature from surrounding environment.

21. Enclosure for Unit

Design due November 20, 2014

Enclosure due December 1, 2014

Included Parts:

- Plastic Molding

Technical Specification:

- Unit fits snugly in 3d printed casing with cables and secured properly and neatly.

Verification and Validation Plan

To support our design strategy, the system will be tested in a series of steps that will verify the sanctity of the overall device. Each technical specification will first be reviewed to determine that it matches the requirements of the customer.

The specifications will then be tested along the way in a step by step process as each individual requirement is designed and verified. The testing strategy involves a series of performance tests to verify that the certain specification works up to standards under all conditions. If a condition is not met, the specification will be reviewed and re-worked to a solution that meets the needs of the customer.

When step-by-step unit testing is finished, a series of final integration tests will be performed in order to verify that the each individual process of the system is seamlessly integrated within the product as a whole. The final system will then be presented to the customer after it has passed these three levels of verification and validation.

Design Verification Timeline

Week 1: (9/22 – 9/27)

- Interface MCU with LCD screen
- Interface MCU with RTC
- Display Time and Date on LCD using SPI protocol

Week2: (9/27 – 10/4)

- Interface MCU with Radio Tuner
- Display Radio Tuner frequency on LCD screen

Week 3: (10/4 – 10/11)

- Design Circuit for Speaker audio amplification
- Interface MCU with temperature sensing unit

Week 4: (10/11 – 10/18)

- Design Circuitry for alarms and push buttons
- Display temperature on LCD screen

Week 5: (10/18 – 10/25)

- Write software for push-button/alarm interface
- Circuitry for Rechargeable battery system

Week 6: (10/25 – 11/1)

- Software for LCD Menu Options interfacing with push buttons
- Status-indicator LED's

Week 7: (11/1 – 11/8)

- Finish Volume adjust for speakers and any other hardware
- Begin PCB design

Week 8: (11/8 – 11/15)

- PCB Design
- EEPROM Preset station software

Week 9: (11/15 – 11/22)

- Order PCB
- Finish any software interfacing

Week 10: (11/22 – 11/29)

- Hardware Testing (If received PCB)
- Software Testing

Week 11: (11/29 – 12/6)

- Hardware Testing
- Software Testing
- Make enclosure on 3d printer

Week 12: (12/6 – 12/13)

- Assemble final product
- Final integration testing
- Turn in