PY581 Project Proposal - Radio Receiver using Arduino and Silicon Labs Si4732-A10 Integrated Circuit

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Abstract

The Silicon Instruments Si4732-A10 is a radio receiver integrated circuit (IC) used in many commercial portable radios. It comes in a 16-pin small-outline integrated circuit (SOIC) package and, using several onboard analog-to-digital and digital-to-analog converters, it can be controlled by an Arduino through the Inter-Integrated Circuit (I2C) serial communications protocol. The software for controlling the IC hardware is implemented within the open-source Si4735 Arduino library, which I utilize in this project. I have currently built an extremely barebones implementation of this radio, controlled through the Arduino IDE's serial monitor. My goal with this project is to implement physical controls in the form of rotary encoders and buttons, allowing the user to change frequencies and potentially even different radio bands.

Goal

- Utilizing the library's functions to:
  - Change frequency being received
  - Change bands: Very High Frequency, Mediumwave, Shortwave
    - FM (VHF): 64-108 MHz
    - AM (MW): 520-1710 kHz
    - SW: 2.3-26 MHz
  - Change bandwidth (increases the frequency range the IC is receiving)
- Design an audio amplifier circuit
- Design a physical control scheme consisting of:
  - Rotary encoder(s)
  - Button(s)
- Utilize an LCD/OLED screen to display information from the IC through the SI4735 library:
  - Frequency
  - Signal strength
  - Signal-to-Noise Ratio (SNR)

Potential Upgrades

- Enabling Single-Sideband (SSB) modulation
- Displaying Radio Data System (RDS) information
  - Some radio stations include RDS information to display the song name and artist.

Schematic

As of writing this proposal, the radio is controlled entirely through communication over the Serial Monitor.

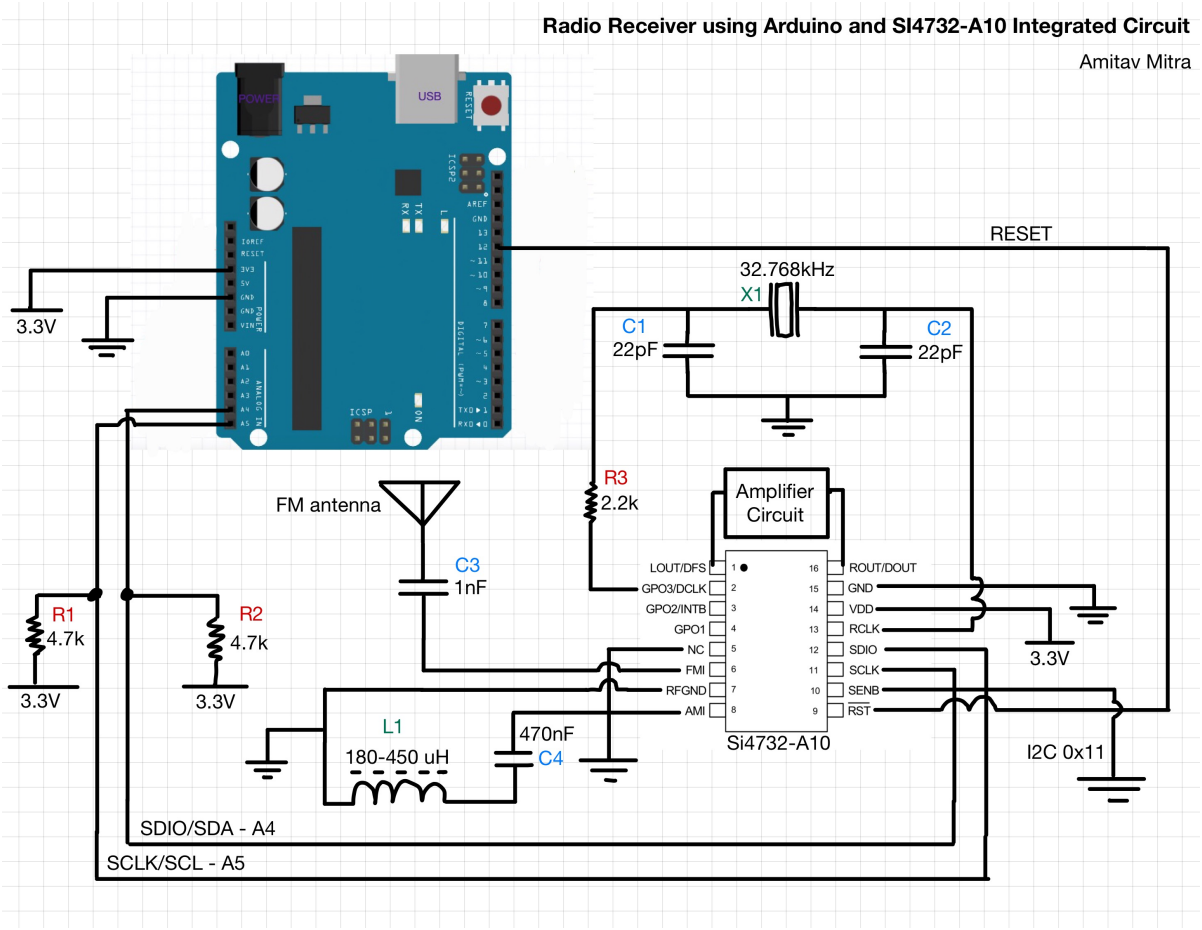

Figure 1: Basic Schematic

- **R1, R2**
  - Pull-up resistors. They function to ensure that a consistent logic level was present at all times to and from the SDA and SCL pins, which synchronize data over the I2C bus.
  - Only really necessary when attaching other I2C devices (namely an OLED display) to the bus.
- **R3**
  - The crystal is delicate, so this resistor acts to limit current to the oscillator circuit.
- **C1, C2**
  - These are crystal load capacitors. Their value was determined by Silicon Labs such that the frequency of the oscillator remains stable.
  - Without these, the oscillator circuit would fail to start and fail to maintain the necessary frequency to act as the clock for the SI4732-A10 chip.
- **X1**
  - This is a 32.768 kHz crystal resonator. In combination with C1, C2, and R3, it forms the oscillator circuit providing precise timing to the IC

  - 32.768 kHz is a useful value because it can allow for a precise 1 Hz frequency, which the IC uses to clock its behavior

- **L1**
  - This is an inductor with a ferrite core. Its main purpose is to serve as the antenna for lower-frequency reception.

- **SENB to GND**
  - The SI4732-A10 only responds to a single I2C device address. The address can be controlled by tying the SENB pin to ground or VCC (3.3V). Tying to ground sets the IC's I2C address to 0x11 (please see the Silicon Labs document)

Materials Needed

I currently possess all of these materials, I do not require any to be ordered, or any components from BU

- 4.7kΩ resistor x2
- 2.2kΩ resistor x1
- 22pF capacitor x2
- 470nF capacitor x1
- 32.768 kHz crystal resonator x1
- Si4732-A10 IC x1
  - Scavenged from radio
- SOIC to Dual-inline-Package (DIP) adapter
- Soldering iron, flux, solder
- LCD/OLED screen
- Rotary encoder(s)
- Push button(s)
- 61 material ferrite rod
  - Relative permeability $\frac{\mu}{\mu_0} = 125$ at field strength $B < 1\text{mT}$
  - Scavenged from radio
- Enameled copper wire
- 8Ω impedance speaker(s)
- Assorted resistors, transistors, capacitors for building audio amplifier

Sources

- Silicon Labs Si47xx Programming Guide
- Silicon Labs 32.768 kHz Crystal Oscilltor Notes
- Silicon Labs Si4732-A10 Data Sheet
- Silicon Labs Si47xx Antenna Design
- SI4735 library