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November 5, 2012

Dr. Andrew Rawicz
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Re: ENSC 440 Design Specifications for the EVA Control System

Dear Dr. Rawicz,

Please find attached a document that outlines the design specifications for our voice control home automation system, also referred to as the EVA Control System. This system implements both voice recognition and smartphone control, thereby providing homeowners complete control over household devices regardless of the user's mobility. The added option of automatic lighting level control through daylight harvesting allows user to reduce energy consumption and save money on utilities. We at EVA Controls believe that anyone can benefit from installing our system in their homes.

These specifications explicitly outline the technical designs of all the main components of our system. Each team member will reference this document to help develop the prototype version of the system. Along with the component designs, we have also outlined the test methods we will carry out in order to verify that the EVA Control System functions as intended.

EVA Controls is composed of six engineering students from the Simon Fraser University. The executive team consists of members from the electronic, systems and computer engineering fields. If you have any questions or concerns regarding our product or these design specifications, please contact us by email at contact@eva-controls.com

On behalf of the executive team,
Sincerely,

Adam Franklin, LEED® Green Associate
Co-founder and CEO
EVA Controls

Enclosed: EVA Control System – Design Specifications



EVA Control System

Design Specifications

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Executive Summary

Home automation can improve the quality of life for the elderly or the disabled significantly, when accomplished in a simple and effective manner. The popularity of home automation has been steadily increasing in recent years due to higher affordability and the simplicity of smartphone and tablet connectivity [1]. Technologies like INSTEON, one of the many home automation systems out on the market, provide control to the user by adding remote control and automation to lighting and other home controlled applications [2]. The disadvantage of these technologies is that they force users to purchase additional products – also produced by the same company. Regular items such as light bulbs or dimmer switches are not compatible with these technologies and therefore will have to be replaced with the required devices for home automation. The cost of replacing regular usable household devices and controls, combined with an increasing reliance on one company's proprietary technology, can therefore become expensive for people that have in need of home automation.

EVA Controls introduces an innovative system that allows users to maintain the benefits of a home automation system at an affordable price. This system will allow users to easily control various electronic devices in their home through a device with web connectivity or through spoken voice commands. The system will also offer users the option to fully automate the program and reduce energy consumption, taking into account environmental conditions.

The primary focus of EVA Controls is to create a simplistic control for home lighting systems. Future developments, however, will incorporate other components and systems, such as TV sets or other electronic equipment. The system can be broken down into three main elements: Web based Control, Voice Recognition Control, and Daylight Harvesting Control. All three components will be synchronized through our central controller.

EVA Controls was co-founded by six engineering students from the Simon Fraser University. These individuals bring a wide range of engineering expertise, including electrical circuits, commercial lighting, as well as software and microcontroller programming.

Each of the three elements in EVA Controls will be developed based on the communication needs of the central controller. The individual testing of each part is important to ensure that each of the three elements represents an option of communicating with the central controller. When the functionality of each element is ensured, EVA Controls will begin integration. We aim to present a functioning prototype system by early December 2012.



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Glossary

120 V	Standard nominal household line voltage, 120 volts 60 Hz AC
AC	Alternating Current
Daylight Harvesting	A control system that reduces the use of artificial lighting with electric lamps in building interiors when natural daylight is available, in order to reduce energy consumption.
DC	Direct Current
EVA	Eco Voice Automation
FIFO	First in First Out
FSK	Frequency Shift Keying
GUI	Graphical User Interface
IAP	In Application Programming
IR	Infrared
Irradiance	The amount of light actually striking the surface of objects. Generally can be considered as light intensity
ISP	In-System-Programming
LED	Light Emitting Diode
MCU	Microcontroller Unit
PCB	Printed Circuit Board
RAM	Random Access Memory
RC	Remote Control
RF	Radio Frequency
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
Wi-Fi	Technology that exchanges data wirelessly



1 Introduction

Eco Voice Automation (EVA) Controls is a voice controlled home automation system that allows users to control lights using their voice or mobile devices. This innovative system was originally intended to bring convenience to individuals with disabilities. EVA Controls will contain a number of different components, such as a microcontroller, voice recognition, infrared (IR) and radio frequency (RF) transmitters, daylight harvesting, and a web-based user interface application. The user would need only to speak the key word to activate the system. For example, the user can say "EVA", and the system would respond with a beep sound. The user can then give orders such as "living room lights, on." Then, the lights in the living room would light up. Although a similar invention has been introduced, our company will be focusing on minimizing the cost of the product and designing different types of electricity-saving modes.

Scope

This document presents the design specifications of the EVA Controls system, by providing the detailed structure that will be applied to the making of the product. Although minor modifications may occur in the later testing phase of the proof-of-concept device, the majority of the design will already be implemented.

Intended Audience

The design specifications document is intended to be used by the members of the EVA Controls system group as a reference, in order to create a working proof-of-concept device. Also, the test engineers shall use this document to implement the test plan and to confirm the correct behavior of the system.

2 System Specifications

2.1 System Overview

The EVA Control System will be used to provide both individuals with disabilities and homeowners the opportunity to control a variety of electrical devices through the convenience and simplicity of voice commands and/or the use of a web-capable electronic device, such as a smartphone, tablet, or personal computer. The design specifications consist of three main components: the voice recognition control, the daylight harvesting control, and the user interface. A basic graphic representation of the system in use and the high level overview of the EVA Control System can be seen in the following figures:

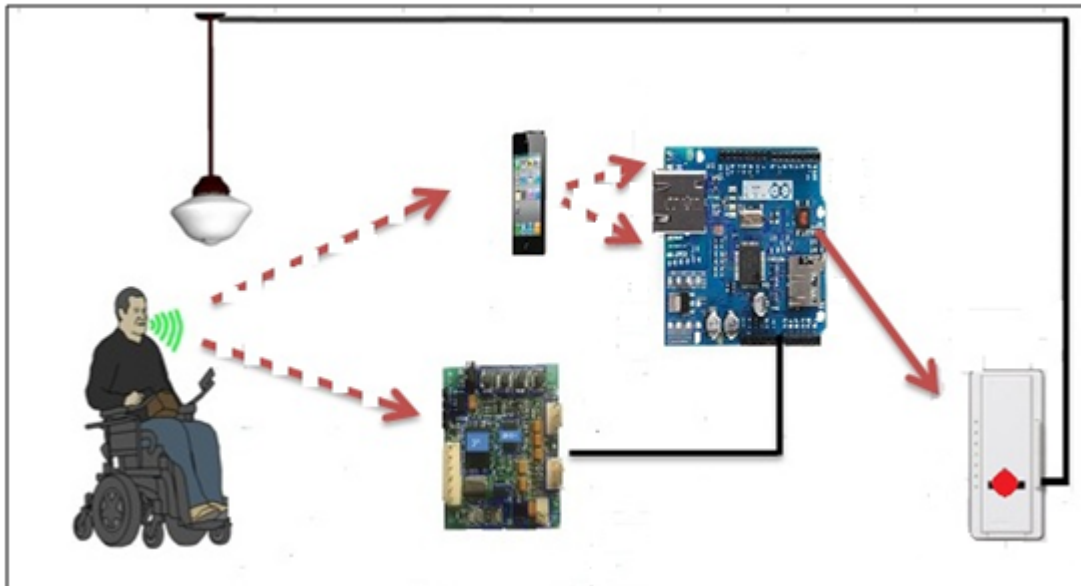


Figure 1: Conceptual System Overview

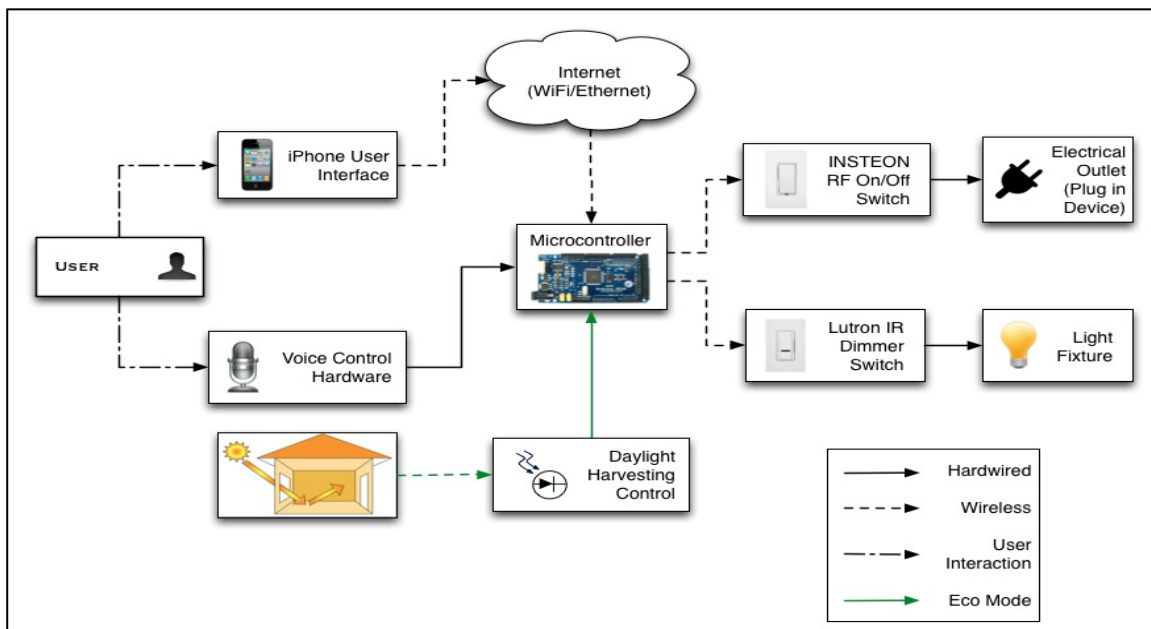


Figure 2: High Level System Overview

The system will have two modes of operation: a “Manual Mode” that will give the user complete control over all the devices connected to the system, and an “Eco Mode” that will automatically adjust lighting levels to optimum levels for both comfort and energy conservation, without removing the user’s ability to control other devices. While operating in either mode, the system will provide the user two methods of control: the audible voice

commands and the interactive user interface. The user interactions are designed to be user friendly, intuitive, and simple to use. The user is not supposed to undergo any extensive training to be able to operate the system. While operating in “Eco Mode,” the dimming switches for the lights will be controlled via the MCU, through daylight harvesting controls based on the amount of incoming sunlight.

Based on the user’s commands, the microcontroller (MCU) will determine which device needs to be controlled, what function needs to be executed, and if the command is valid. From these commands, the MCU will be able to regulate a wide range of preexisting infrared (IR) and radio frequency (RF) devices. Designing the system with both IR and RF compatibility will allow this technology to be easily integrated into homes with existing home automation controls.

The EVA Control System will utilize existing protocols, such as INSTEON’s RF protocol, in order to meet current industry standards. In addition, IR compatibility allows the system to control a wide range of IR devices, since the controller can act as a universal remote. For the prototype, the design will focus on two preexisting home automation devices, INSTEON’s Dual-Band RF switch and Lutron’s IR Dimmer Switch. These two devices will provide a wide enough scope in order to confirm the desired operation of the system controller.

2.2 Controller Packaging

The controller of the EVA Control System is intended to be installed into the wall, flush with residential drywall, therefore, the enclosure must meet standard building codes. Thus, the case will be made out of a combination of aluminum and plastic. Figure 3 shows a draft design of the controller packaging. The faceplate will be made of plastic, similar to the standard faceplates for light switches. The enclosure will be made from aluminum, the same conduit enclosures used for standard residential receptacles and switches.

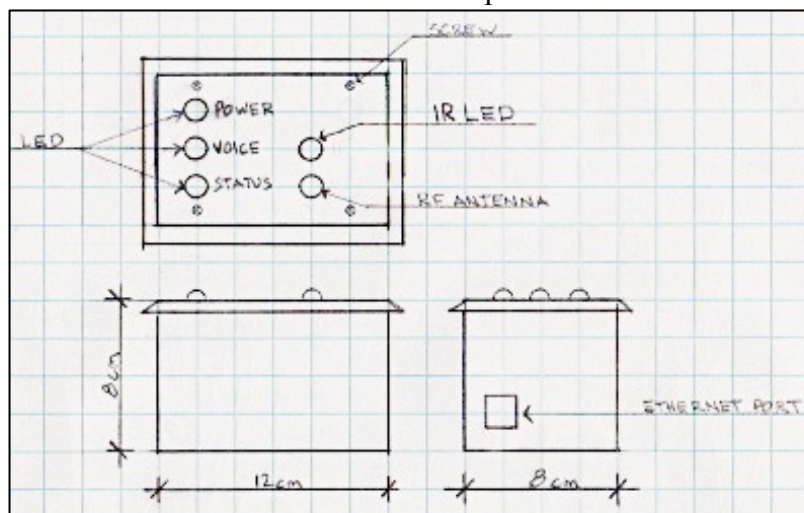


Figure 3: Controller Enclosure Design

Table 1 illustrates system status through the display LEDs.

Table 1: Packaging LED Representation of System Status

Label	LED Status	System Status
Power	ON	Power is Connected
	OFF	Power is Disconnected
Voice	ON	Voice Command Received/Processing
	OFF	Voice Hardware in Standby Mode
Status	ON	Connect to Internet
	OFF	Disconnected from Internet

The IR LED and RF Antenna are designed to project out of the faceplate, to improve the communication range of the controller.

The prototype version of the EVA Control System will be designed with a wired Ethernet connection, however, the production version would likely use Wi-Fi instead.

2.3 Life Cycle Considerations

An important hallmark of EVA Controls is our commitment to introducing environment-friendly products for users. Our dedication can be seen through our addition of the Eco Mode feature, which allows for an efficient method of conserving energy while still producing optimal lighting. Furthermore, EVA Controls is committed to ensuring that our products' end-of-life handling is safe for the environment.

Our product's hardware component utilizes existing devices and switches, in order to minimize the cost of implementing the home automation system. These hardware components are, namely, the microcontroller and voice control hardware. These items can be brought to electronic waste centers for recycling as reusable raw materials. The main unit encasing both of these components can also be brought to facilities that recycle plastics.

The integrated devices and switches used by EVA Controls will differ from user to user, since the EVA Control System is designed to work in cohesion with existing household devices and switches. For these items, the best course of action would be to follow the suggestions and instructions provided by the product's respective manufacturer.

3 Hardware Design

3.1 Microcontroller

The center piece of the system will utilize a microcontroller to regulate the communication process between the different instruments in our project. We have chosen to use the *Arduino Mega2560 R3*, based on our initial budget plans, previous experience with Arduino software, and the convenience of shield compatibility (*Arduino Ethernet Shield*) to employ web based control. In addition, the Mega2560 has up to 54 digital I/O pins and UART capability. This makes it a good choice for EVA, as it allows for the control of multiple household devices and integration with the voice recognition hardware. The aforementioned devices can be seen in the figures below.

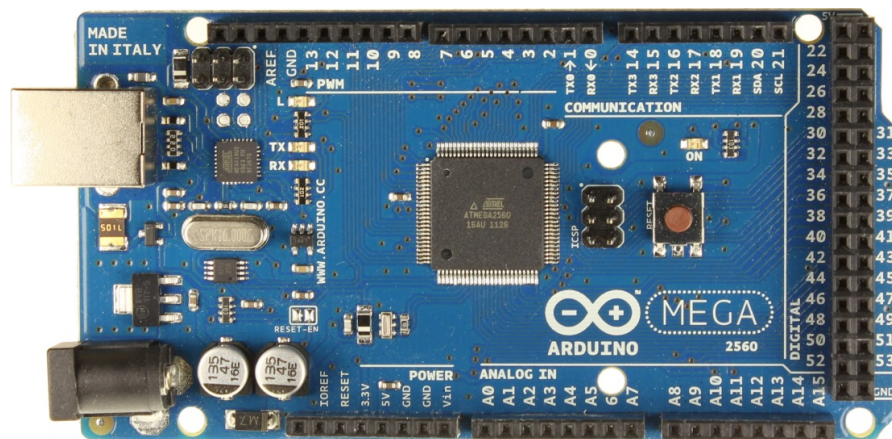


Figure 4: Arduino Mega2560 R3

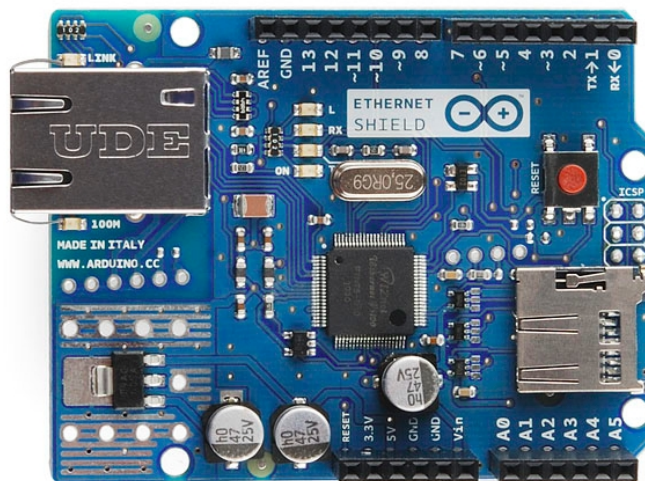


Figure 5: Arduino Ethernet Shield

The data sheet for the *Arduino Mega2560* board – based on the *ATmega2560* chip – is provided on the Arduino website [3]. As for the *Arduino Ethernet Shield*, the data sheet for the *Wiznet W5100* chip can also be accessed on the Arduino website [6].

The job of the microcontroller is to act as the pathway for communication between the input sources (web based control, voice recognition, and light harvesting) and the output household devices (lights, dimmer switches, etc.). Therefore, it is necessary to program the microcontroller to understand the received inputs and to correctly output the desired instructions to the household devices.

3.2 Voice Recognition

The Voice/Speech Recognition module is one way of getting the voice command, processing it and then transferring the result in digital data type through the UART to the Arduino board. The main components of voice recognition are:

- LD3320
- STC (MCU)
- Input: Microphone
- Output: UART
- 2 LED Light
- Power Supply: USB

The system overview diagram and PCB layout of the voice recognition module are represented in the following figures:

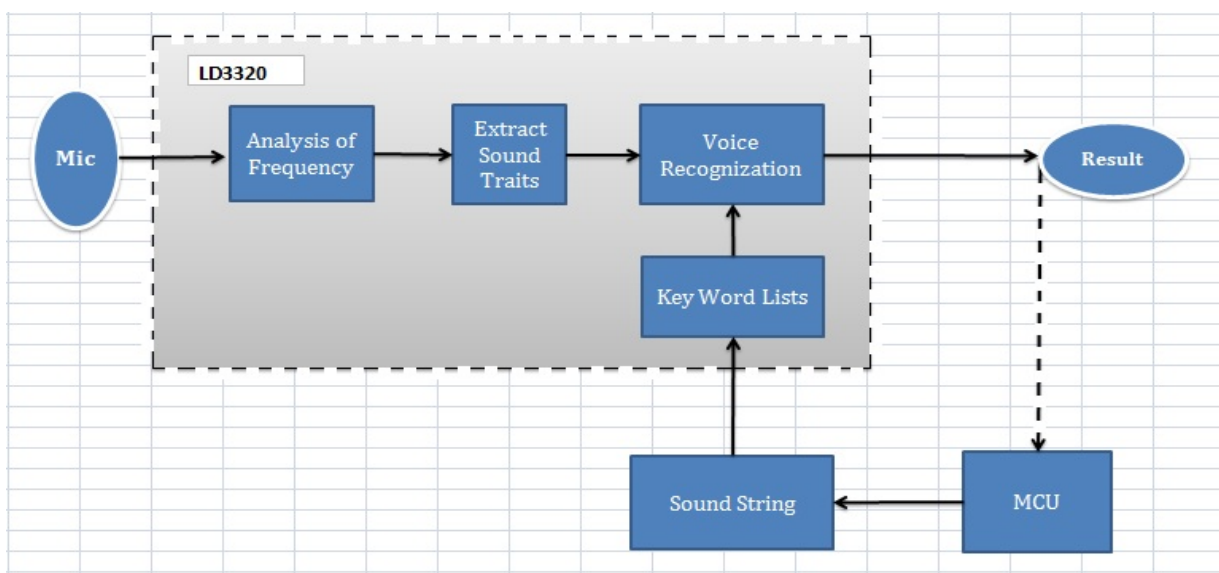


Figure 6: Voice Recognition System Overview

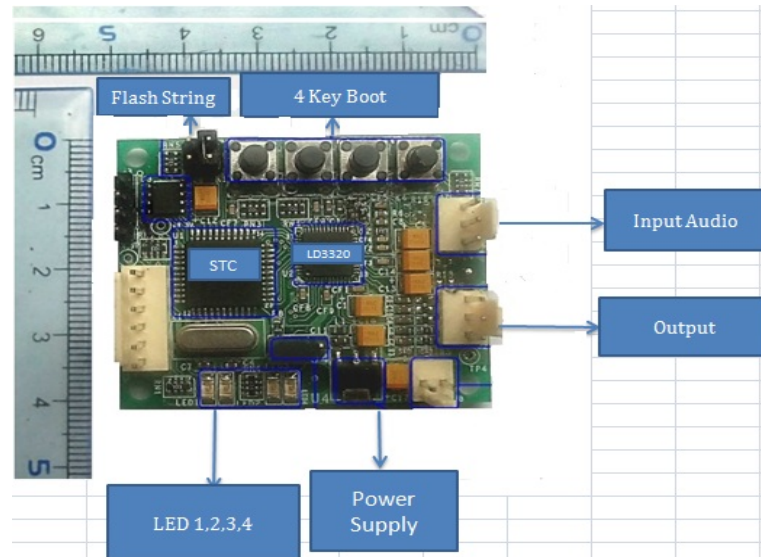


Figure 7: PCB Layout of the Voice Recognition [5]

LD3320

The LD3320 speech recognition module can be realized as voice interaction. The module functionality is complementary for voice identification and speech synthesis in the next-generation of voice control products. The characteristics of the LD3320 are mentioned below [6]:

- Fast and stable optimization algorithm to complete the speaker-independent voice recognition.
- Single-chip.
- Do not need any external auxiliary Flash chips, RAM chips.
- All operations works through register such as: ready status, write data in FIFO (first in first out).
- Work power supply is 3.3V.

The hardware design of the LD3320 as shown in the figure:

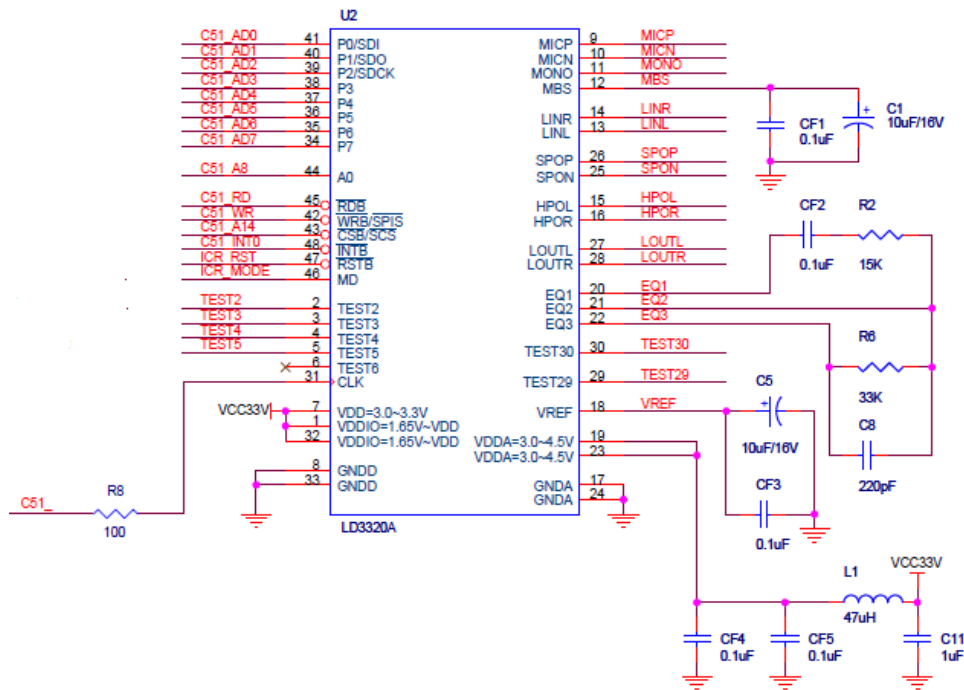


Figure 8: HW Circuitry of LD3320[5]

STC (MCU)

STC is a microcontroller that executes instructions in 1 to 6 clock cycles, based on the high performance 1T 80C51 MCU. The users have the ability to upgrade the program and system data using In-System-Programming (ISP) and In-Application Programming (IAP) support. Through ISP the user may download new code without having to first remove the microcontroller from the system. The characteristics of the STC are mentioned below[7]:

- Enhanced 80C51 Central Processing Unit ,1T per machine cycle, faster 6~7 times than the rate of a standard
- Operating voltage range: 5.5V
- Operating frequency range: 0- 35MHz.
- STC10Fx series Flash program memory : 2/4/6/8/10/12/14K
- On-chip 1280/512/256 byte RAM
- Be capable of addressing up to 64K byte of external RAM
- One enhanced UART with hardware address-recognition and frame-error detection function, and with self
- Simple internal RC oscillator and external crystal clock
- Operating temperature: -40 ~ +85°(industrial)/ 0~75°(commercial)
- Maximum 40 programmable I/O ports are available

Characteristics obtained from STC MCU Limited

Here is the hardware circuitry of the STC 10L08XE as shown in the below figure:

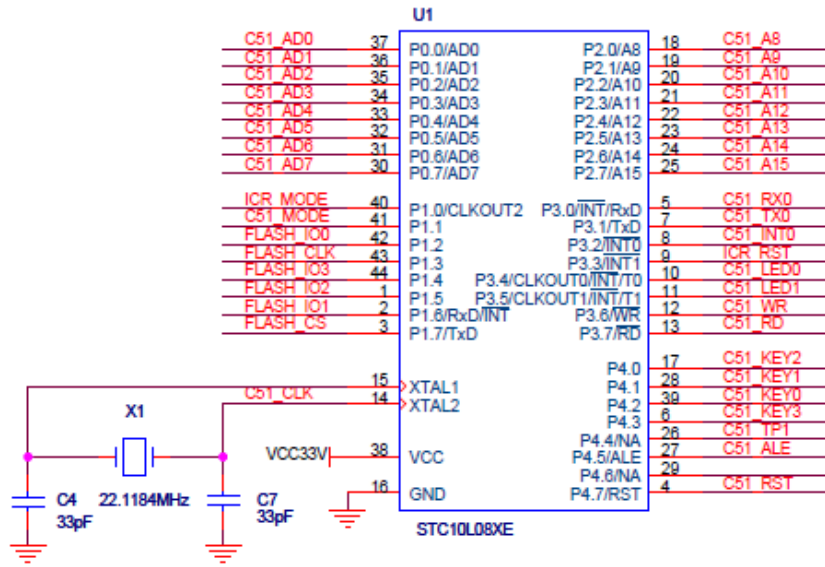


Figure 9: HW Circuitry of STC 10L08XE[5]

Input: Microphone

Voice command input is filtered in terms of frequency roughly in the range of 80 Hz to 1100 Hz for both normal male and female voices.

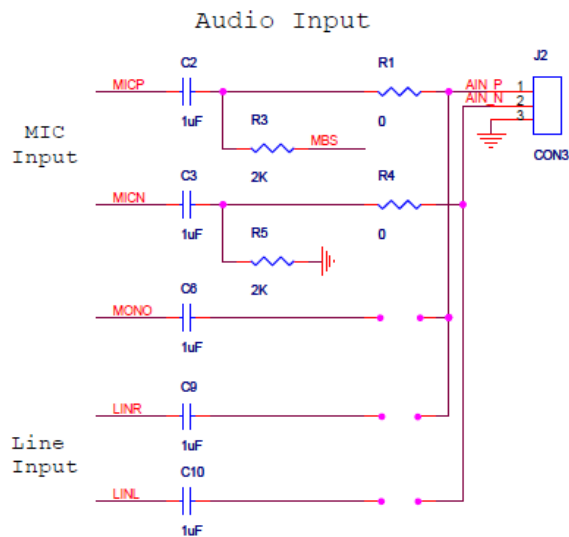


Figure 10: HW Circuitry of Input (Mic)[5]

LED

LEDs will be used to inform users of the status of receiving the voice command and for the adjustable function.

Output

The output will be transferred through the UART (4 PIN) port and will be connected to the RXD, TXD, GND, and +3.3 V pins of the Arduino board.

Power Supply

The power supply is either 3.3v, or 3 A batteries are needed to meet power supply needs.

3.3 IR Transmitter

In order to achieve wireless communication between the MCU and IR controlled devices, it is required that the MCU have an IR transmitter. This transmitter will convert the digital command signals supplied by the MCU to a series of IR light pulses, which represent the desired controller command instruction. These IR light pulses are sent from the transmitter to the corresponding receiver located on the device, at which point the instruction is demodulated and executed. IR signal modulation is based on logical “1” and “0” signals, representing the presence and absence of IR light at a certain frequency. Figure 10 shows how the Logical “1” and “0” signals are represented for Philips RC-5 Format IR modulation.

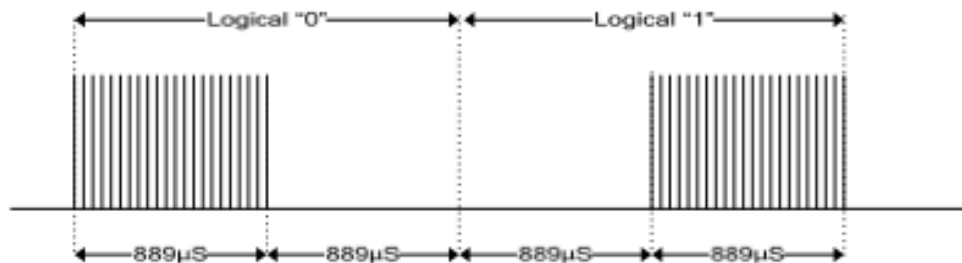


Figure 11: RC5 Format - Manchester (Bi-phase) Modulation [8]

As it can be seen from Figure 10, the RC5 format represents a Logical “0” by an active burst in the first half of the duty cycle, and a Logical “1” as an active burst in the second half of duty cycle. This is just one modulation protocol of many existing ones on the market today.

In order to properly design the IR transmitter for the EVA Controls system, the protocol used by the user’s device must be determined. For the prototype system, the Lutron Maestro IR Dimmer (MIR-600THW) switch has been chosen to demonstrate how the EVA Controls system would control IR devices. Figure 11 shows the aforementioned switch.



Figure 12: Lutron MIR-600THW Switch with Compatible Remote Control

The IR protocol used by Lutron for their products is outlined below.

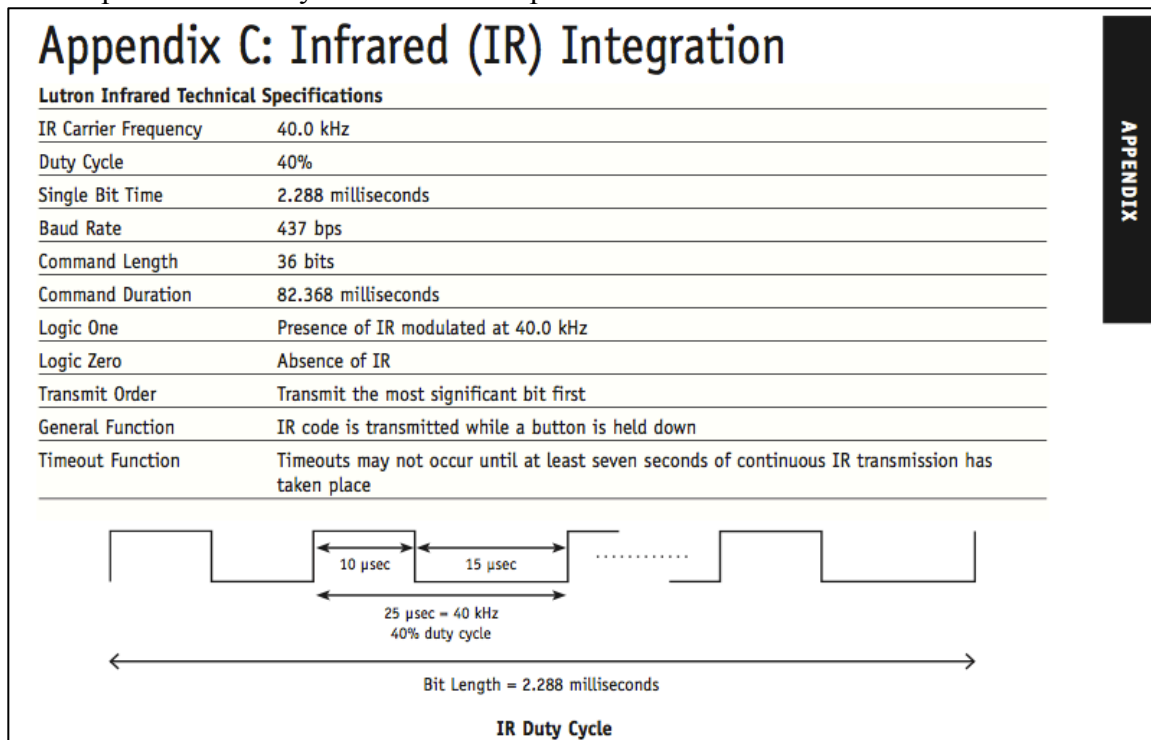


Figure 13: Lutron's IR Protocol [9]

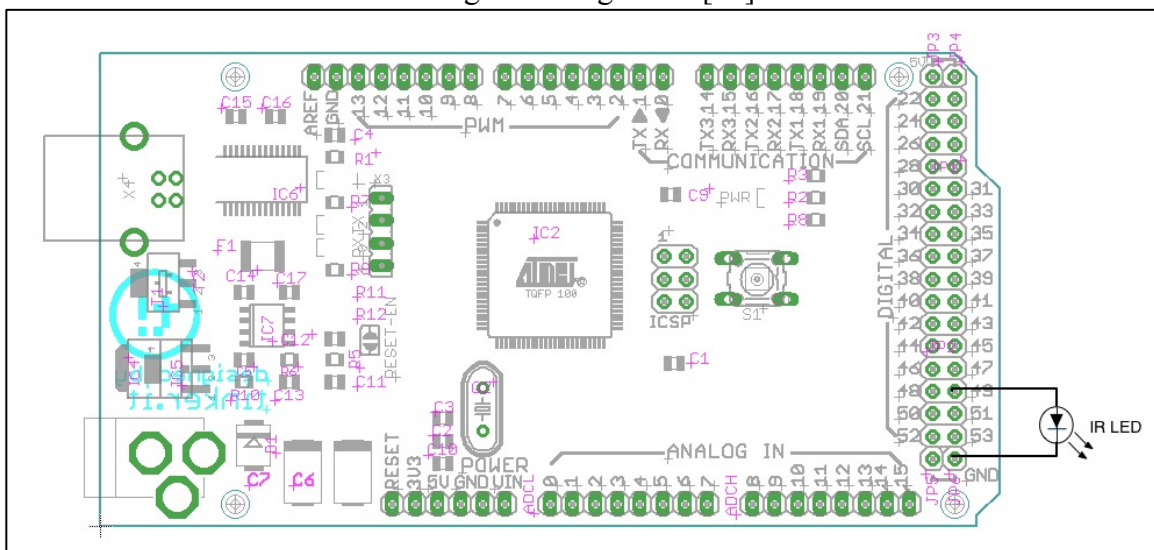
Utilizing the above technical specifications and the following list of command codes, it will be possible to program the MCU to produce the required IR signals to control the MIR-600THW switch.

Table 2: Maestro IR Lighting Codes [10]

Transmitter Button:	IR Command:
Full Off	FF88BD120h
Lower	FF8882140h
Raise	FF8882220h
Favorite Scene	FF8884B70h
Full On	FF8884B80h

The only command that does not get repeated when a button is held down is the Full-On command.

The transmitter can be simply implemented by connecting a 950nm IR LED directly to the MCU as shown in the schematic diagram in Figure 13 [11].


Figure 14: Schematic of IR Transmitter with Arduino Mega MCU

The IR LED must be connected between an output pin with an internal resistor and ground. Any one of the digital outputs on the Arduino Mega can be used, since they all have internal resistors. Therefore, the placement of the IR transmitter can be changed based on the availability of output pins.

3.4 RF Transmitter

Along with the IR transmitter, the EVA Controls system will also be designed to have an RF transmitter in order to provide a wide range of wireless communication options. There are various advantages to using RF communication instead of IR, including a longer range that does not require a direct line of sight between the transmitter and receiver. This is a major

advantage when considering that the EVA Controls system will be installed in households, which contain many walls that could separate the controller from a number of devices. Moreover, RF communication allows for individual control of identical devices. This functionality can avoid a potentially undesirable results of IR communication, such as turning all the lights off instead of a single one. For these reasons, as well as additional benefits such as two way communication, RF communication is becoming increasingly popular for home automation. Thus, for the EVA Controls system to match industry standards, we believe it should be RF compatible.

In order to demonstrate the system’s RF compatibility, the RF transmitter will be configured to integrate with the popular INSTEON RF protocol. The technical specifications of INSTEON’s RF protocol can be seen in Table 2 below.

Table 3: Technical Specifications of INSTEON’s RF Protocol [12]

RF Specification	Value
Center Frequency	904 MHz
Data Encoding Method	Manchester
Modulation Method	FSK
FSK Deviation	64 KHz
FSK Symbol Rate	76,800 symbols per second
Data Rate	38,400 bits per second
Range	150 feet outdoors

Using the above specifications in addition to the commands and messaging example listed below in Table 3, it should be possible to program the MCU to send the desired RF signals to a specific device when the MCU is equipped with a proper RF transmitter.

Table 4: INSTEON RF Command Signals [12]

Command Name	Command 1	Command 2
ON	0x11	On Level (0x00 => 0xFF), or Group number
OFF	0x13	None, or Group number

Table 5: Example of an INSTEON RF Command Message [12]

Message 2		ControLinc: "LampLinc A, turn on"	
00 00 CC 00 00 AA 4F 11 01		ControLinc (00 00 CC) sends a Group Cleanup message to LampLinc A (00 00 AA) in Group 1, with a command of <i>On</i> .	
From Address		00 00 CC (ControLinc)	
To Address		00 00 AA (LampLinc A)	
Flags		4F (Group Cleanup Message, 3 Max Hops, 3 Hops Left)	
Command 1		11 (<i>On</i>)	
Command 2	Group Number	01	

To integrate the above RF protocol, an INSTEON SwitchLinc On/Off Dual-Band switch (2477S), also compatible with the INSTEON RF and X10 power line communication (PLC), will be wired to a regular outlet to allow plug-in devices to be controlled wirelessly by the EVA Control System. Figure 14 shows the switch that will be used.



Figure 15: INSTEON SwitchLinc On/Off Dual-Band switch

The RF transmitter that will be used to send the required commands and messages will be the Arduino RF Transceiver Shield shown in Figure 15.



Figure 16: Arduino RF Transceiver Shield

This shield attaches directly to the Arduino Mega MCU via the header pins and uses the pins listed in Table 5 for communication. The technical specifications are also listed in Table 6.

Table 6: Pins Utilized by Arduino RF Transceiver Shield [13]

SPI Signal	Standard Arduino	Arduino Mega
SCLK (clock)	13	52
MISO (data out)	12	50
MOSI (data in)	11	51
SS (slave select)	10	53

Table 7: Technical Specifications for Arduino RF Transceiver Shield [13]

Specification	Value
Transmission Frequency	315, 433, 868 & 915 MHz
Modulation	FSK (Frequency Shift Keying) or OOK (On-Off Keying)

3.5 Daylight Harvesting

The purpose of the Daylight Harvesting Module component of EVA Controls is to measure the irradiance of a room and provide the necessary data to the MCU in order to dim or brighten the lights to an acceptable level. This will require the Texas Advanced Optoelectronic Solutions’ Light-to-Frequency Converter – TSL235R.

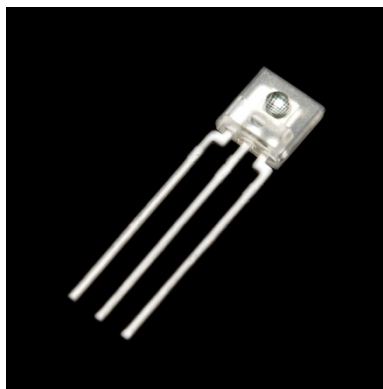


Figure 17: TSL235R Light to Frequency Converter

The TSL235R component was chosen over other photodiodes for several reasons:

- It is able to accurately detect the light intensity of a room
- It has a logical output which can be easily integrated with the MCU

- It has been temperature compensated for the light range of 320 nm to 700 nm and responds from 320 nm to 1050 nm
- It is compact and requires no other external circuitry

The output of the Daylight Harvesting module is a square wave signal with 50% duty cycle with a frequency that is dependent on the irradiance (light intensity) of the room. Because the output is a square wave with typical low and high voltages of 0.25V and 4.5V respectively, we can directly integrate the TSL235R with the Microcontroller Unit without the need to design a separate circuit.

There will be a set range of frequencies corresponding to the ideal amount of light for a room. If the frequency is above or below the acceptable range, the MCU would then dim or brighten the lights respectively.

4 Software Design

4.1 Web Based Control Application

Our Mobile User Interface is programmed as a mobile web page, and is intended to be accessible from any mobile device, such as a smartphone, tablet, laptop, etc. The interface is intended to offer a *one-touch* experience, making everything available at the tap of a button.

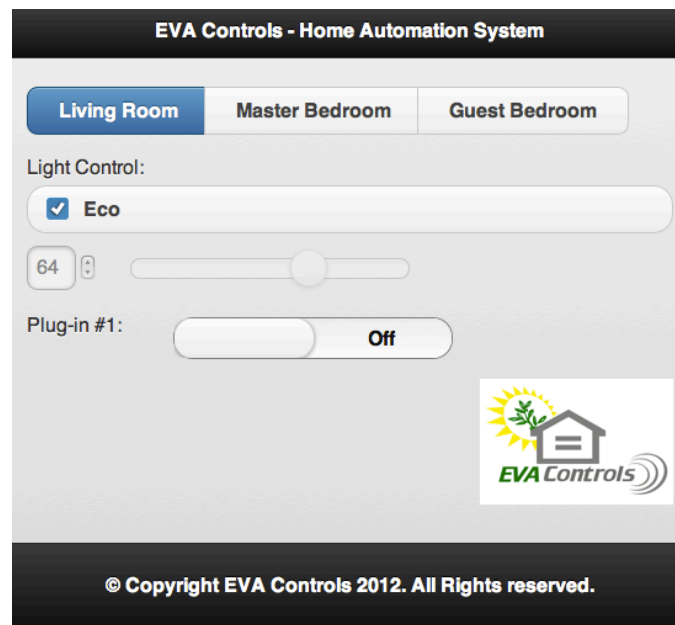


Figure 18: Web App User Interface Eco Mode

As the figures #1 and #2 show, the user has the ability to select the room they wish to control.

Then, the user may adjust light intensity in a room by dragging the potentiometer slider bar or entering a value in the text box to the left of the slider bar. If Eco is enabled the light adjustment feature cannot be accessed until Eco is first disabled.

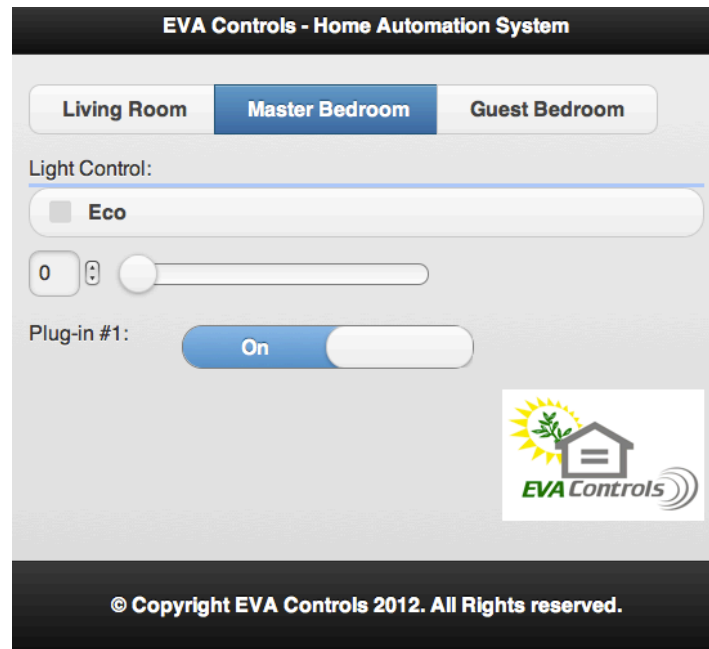


Figure 19: Web App User Interface Rooms

Any plugged-in devices may be turned on or off at the touch of a button, as shown in Figure #2

The final version of the app will allow the user to name their plugged-in devices, and give them the possibility to contact EVA Controls if they have any questions about their system or for assistance.

The web server will run on the microcontroller itself, and we will use port forwarding to make it available outside of the local area network (LAN). EVA Controls will roll-out any software updates free-of-charge, and offer free telephone technical support for its customers.

4.2 Voice Recognition

LD3320 support max of 50 codes and every word corresponds to a specific code. The flowchart illustrated in Appendix B is the software design procedure for programming the instructions into the Integrated chip LD3320. All of the available commands should be carefully written to the system to produce best interpretation of the voice recognition.

4.3 Daylight Harvesting Frequency Detection

The MCU is required to interpret the data outputted by the Daylight Harvester module in order to dim the lights to produce a level of irradiance that is acceptable. Since the module outputs a square wave signal with a frequency that is linearly proportional to the irradiance of the room, making use of this data is simple. Figure 19 below illustrates an example of the output signal of the TSL235R.

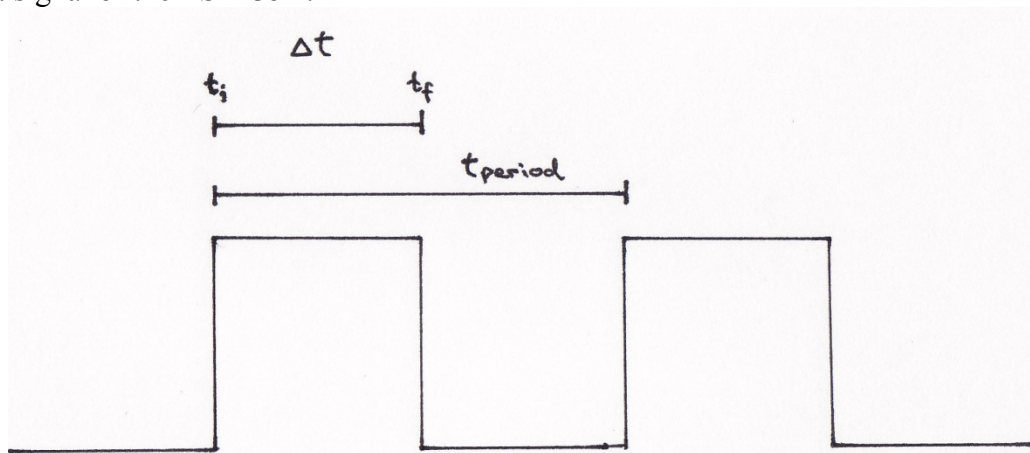


Figure 20: Output Signal of the TSL235R

To determine the frequency of the output signal, the MCU will need to measure the initial and final time in which the output signal is HIGH (or LOW). It can then determine the period of one cycle of the signal with the following equation.

$$t_{period} = 2(t_f - t_i) \quad (4.3.1)$$

Once the period is established, the frequency can simply be calculated dividing 1 by the period and multiplying by τ , a scaling factor of time. This is shown in the equation below.

$$f_{output} = \frac{1}{t_{period}} \cdot \tau \quad (4.3.2)$$

Once the MCU calculates the output frequency, it will determine whether or not the current irradiance of the room is within or out of the acceptable range.

The MCU will utilize interrupts and timers to determine the frequency of the signal from the Daylight Harvester module. This can be done by implementing two interrupts – one triggered when the output signal transitions from a LOW to a HIGH (rising edge) and the other one when the output signal transitions from a HIGH to a LOW (falling edge) – and a single timer. When the rising edge interrupt is triggered, the timer will be enabled. This timer will count upwards from 0 until the falling edge interrupt is triggered. When the falling edge interrupt is triggered, the timer will be disabled and the timer count, which essentially is half the period, will be recorded and used to find the output frequency via equation 3.5.1 and 3.5.2. Below is a state diagram illustrating our method for determining the frequency of the output corresponding to the irradiance level of the room. Also see Appendix B for flow chart for detecting the frequency.

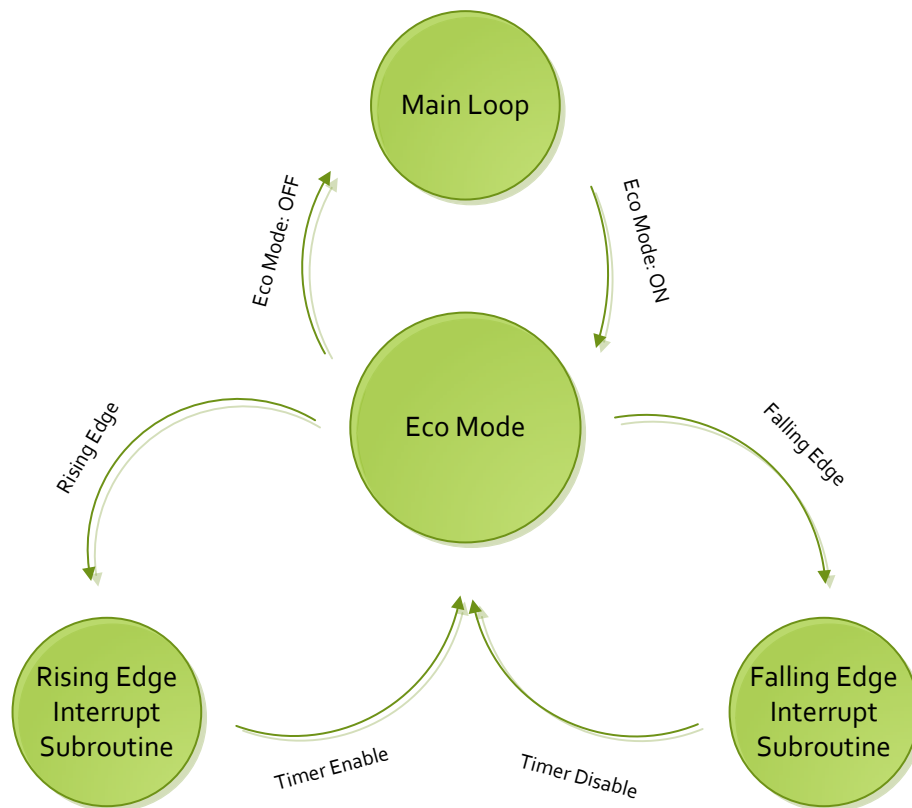


Figure 21: State Diagram of the Eco Mode Implementation

The table below lists the tasks performed in each state.

Table 8: Tasks Performed in Each System State

State	Tasks
Main Loop	<ul style="list-style-type: none"> • In the Main Loop state, the MCU is performing other process while constantly checking for the Eco Mode flag • Once the user has enabled the Eco Mode, the flag is set and the system will be configured for the Eco Mode
Eco Mode	<ul style="list-style-type: none"> • During this mode, interrupts and timers are initialized.
Rising Edge Interrupt Subroutine	<ul style="list-style-type: none"> • This interrupt subroutine is invoked when triggered on the rising edge of the output • During this subroutine, the rising edge interrupt is first disabled • A timer is then enabled • Upon exiting the subroutine, the falling edge interrupt is enabled.
Falling Edge Interrupt Subroutine	<ul style="list-style-type: none"> • This interrupt subroutine is invoked when triggered on the falling edge of the output • During this subroutine, the falling edge interrupt is first disabled • The current timer is then stopped • The value of the timer count is recorded • Upon exiting the subroutine, the rising edge interrupt is re-enabled.

5 System Test Plan

We will test our product with a three-stage test plan: unit, regression and smoke testing. This will ensure that, during development and integration, each module has been tested individually and as a final prototype. Following testing, verification will be performed to make certain that the final product functions according to specifications and any existing bugs are fixed.

Defects found during testing will be logged. To ensure that there is traceability for defects, we will document the testing environment details and as well as step-by-step instructions to reproduce the defect. A priority level will be assigned for each defect to determine the level of importance of fixing the defect.

Figure 21 below is a template of our method for logging defects.

Defect #
Description: <description of defect>
Code version: xxxx.xxxx.xxxx.xxxx
Steps to Reproduce: <step1> <step2> ... n. <step_n>
Expected Behaviour:
Actual Behaviour:
Priority Level:

Figure 22: Defect Report Template

5.1 Unit Testing

During the developmental stages, we will consistently test each module’s features and verify that they meet the specified requirements. To do this, we will simultaneously write/review and run test cases as we develop each module. This approach is appropriate because features can change and so, test cases will change along with it.

5.1.1 Voice Control Module

Voice Recognition Test	
Steps	Expected Behavior
1. Speaks the key word "EVA" 2. Speaks the word "on" 3. Speaks the word "off"	<ul style="list-style-type: none"> The LED light on the voice recognition board should flash in response of the key word. The LED bulb should light on The LED bulb should turn off

5.1.2 Web Based Control Application

The web-based application will be tested to work both from inside the home, using both LAN and the World Wide Web. EVA Controls will offer full support for the software setup and accessibility.

Testing the application will be done first as a simple web page, ensuring that all the links work properly, and then uploaded to the Microcontroller to ensure that the desired actions are performed accordingly.

Updates for the software will be released only after one full week of bug-free testing done in the company.

Web Application GUI Test	
Steps	Expected Behavior
<ol style="list-style-type: none"> 1. Press the "ON" button 2. Check mark "Eco" 3. Slide the Brightness Bar 	<ul style="list-style-type: none"> • System will turn on • System will enable Eco Mode • The LED bulb will change brighter/dimmer

5.1.3 Microcontroller Unit (MCU)

Basic Web Application Control Test	
Steps	Expected Behavior
<ol style="list-style-type: none"> 1. Turn on the light via GUI 2. Dim the light via GUI 3. Brighten the light via GUI 4. Turn off the light via GUI 	<ul style="list-style-type: none"> • Light bulb turns on • Light bulb dims by 1 decrement • Light bulb brightens by 1 increment • Light bulb turns off

Basic Voice Control Test	
Steps	Expected Behavior
<ol style="list-style-type: none"> 1. Turn on the light via voice command "ON" 2. Dim the light via voice command "DIM" 3. Brighten the light via voice command "BRIGHT" 4. Turn off the light via voice command "OFF" 	<ul style="list-style-type: none"> • Light bulb turns on • Light bulb dims by 1 decrement • Light bulb brightens by 1 increment • Light bulb turns off

Eco Mode	
Steps	Expected Behavior
<ol style="list-style-type: none"> 1. Enable Eco Mode 2. Shine a light on the Daylight Harvester module 3. Observe light bulb 4. Remove light from the Daylight Harvester 5. Observe light bulb 	<ul style="list-style-type: none"> • Light bulb should dim/turn off when the light is shone on the Daylight Harvester • Light bulb should brighten when the light is removed from the Daylight Harvester

5.1.4 Daylight Harvester Control

Output Data Test	
Steps	Expected Behavior
<ol style="list-style-type: none"> 1. Measure frequency output via oscilloscope 2. Measure frequency output via MCU 3. Compare both results 	<ul style="list-style-type: none"> • Results from both oscilloscope and MCU should match with minimal error

5.1.5 Dimmer Control

Dimmer Control Test	
Steps	Expected Behavior
<ol style="list-style-type: none"> 1. Using the MCU, increment the light intensity level of the dimmer switch 2. Using the MCU, decrement the light intensity level of the dimmer switch 	<ul style="list-style-type: none"> • Light bulb brightens incrementally • Light bulb dims incrementally

5.1.6 Electrical Outlet

On/Off Control	
Steps	Expected Behavior
<ol style="list-style-type: none"> 1. Plug in a standard lamp into the electrical outlet 2. Using the MCU, turn on the electrical outlet via RF switch 3. Using the MCU, turn off the electrical outlet via RF switch 	<ul style="list-style-type: none"> • The lamp turns on • The lamp turns off

5.1.7 Electrical Testing Setup

All the above tests will be conducted on the set up illustrated in Figure 22. This electrical testing set up will allow for all components of the system to be tested on real 120v electrical system, the same as would be found in any residential home.

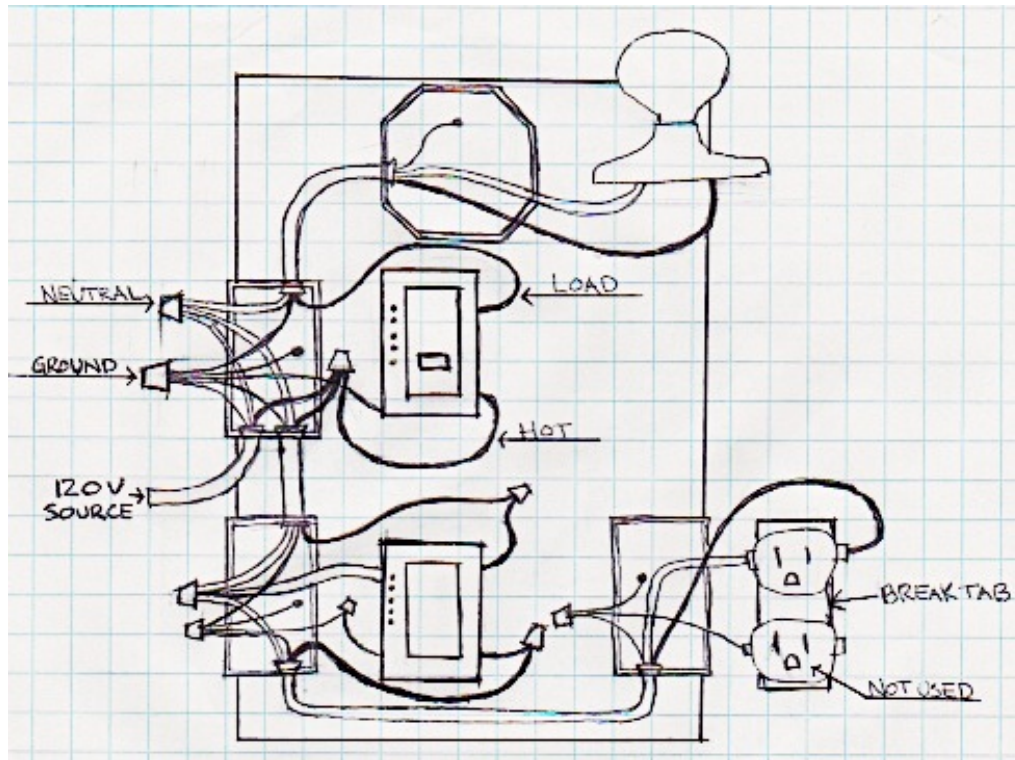


Figure 23: Sketch of Electrical Testing Setup

5.2 Regression Testing

When all features have been fully developed and integrated, we will run a full regression testing to ensure that they continue to operate properly. At this stage, features will not change and all test cases will have been finalized. We will perform a full regression test in which all test cases are run. If and when defects are uncovered, we will log and fix the defects. After this, we will move on to smoke testing

5.3 Smoke Testing

Smoke testing is performed to ensure stability in the product after defect fixes are applied. It will not be as intensive as the regression testing, but it will provide us with enough coverage for the weak areas of the product. Essentially, this type of testing is a stripped down regression process. It will utilize the same test cases as regression testing, but with a smaller number of total test cases. This type of testing will be performed at every iteration of defect fixes.



5.4 Verification

After each iteration of defect fixes, verification is required to ensure that the defects are indeed fixed. We will run tests based on the steps documented in the defect logs. If further coverage is needed for weak areas, we will run additional tests to verify that stability is achieved.

5.5 Integration Testing /Simulation

Once individual unit tests satisfy all the necessary requirements in the unit test stage, all parts must be integrated into the final product and the whole system will be tested in order to solve any possible failures or malfunctions. Once the EVA Controls system passes all testing stages and the desired functionality is achieved, the system must be checked for all safety requirements. Integration testing focuses on the real time response between all the components, from voice command to dimming and on/off lights. The system is likely to be installed in a house with a variety of disturbing noises, so the system needs to be tested against all different levels of noise density and check the functionality in a noise-polluted environment.

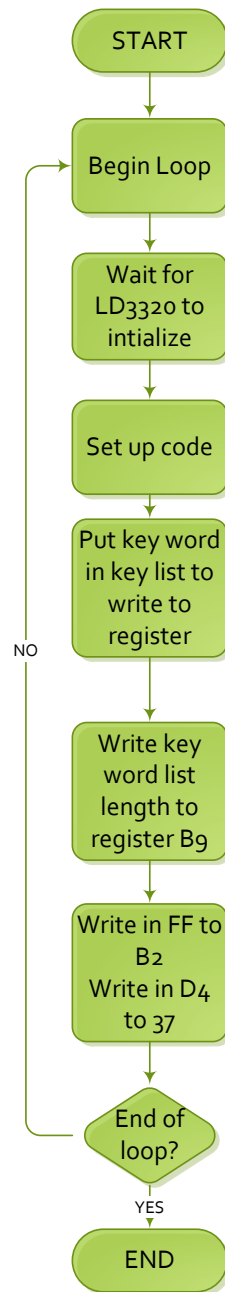
The EVA Controls team has been searching for a testing site, and we may need room ASB 9898 to test our final product. EVA Controls will contact the Applied Sciences Building Manager to reserve the room regarding this issues.

Conclusion

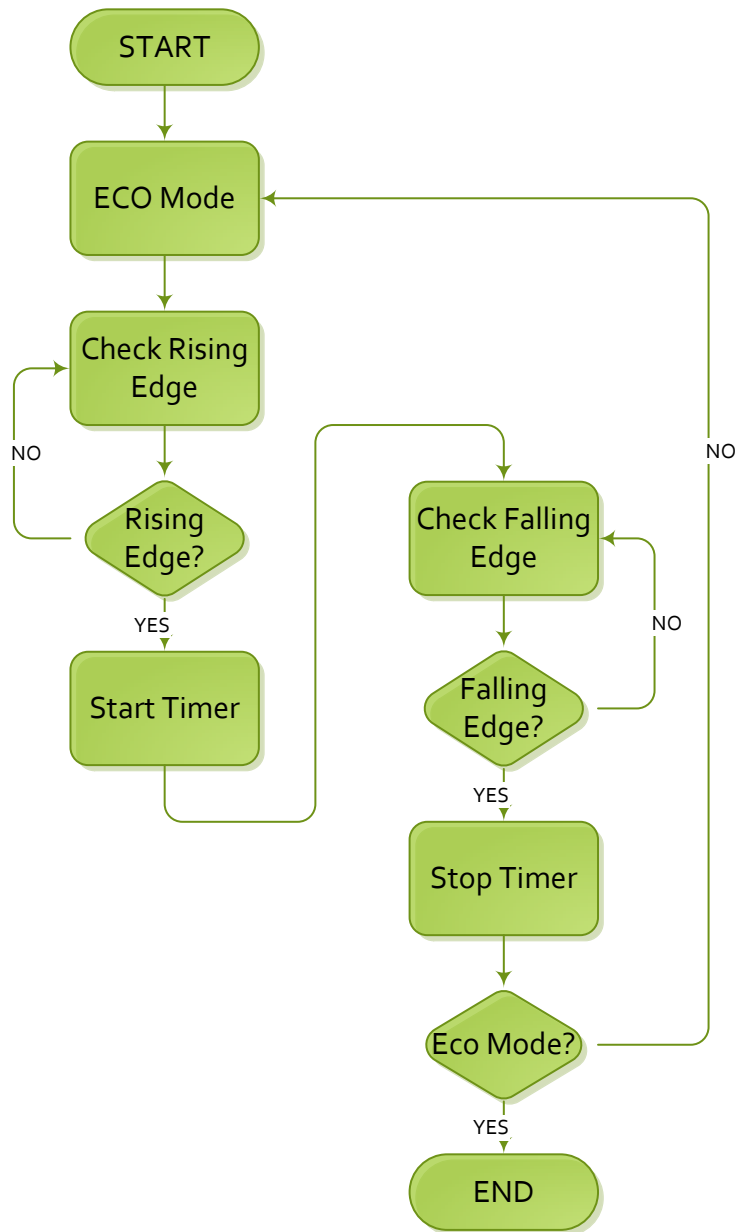
This document had described the overall design and process method of the functional specification needed to meet the final design of the EVA Controls system. Our engineering team uses this document as the reference manual to manufacture the proof of concept product. The final prototype will also be tested based on the design specifications to find any possible error and minimize any product malfunction. As a result, through the design specifications, the final goal in the designing, implementation and testing of EVA Controls is provided. We are confident that the final product, once it has cleared all the testing stages, will be ready for marketing by the middle of December 2012.

Appendix B

Voice Recognition Flow Chart



Daylight Harvesting Frequency Detection Flow Chart



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