October 31, 2002

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: Design Specifications for a Voice Activated Remote Control System (ENSC 340 Project)

Dear Dr. Rawicz,

The attached document, *Design Specifications for a Voice Activated Remote Control System*, describes in detail the components and the design of our initial prototype for our ENSC 340 project. It explains the functionality of our product in terms of actual deployment and roughly follows the requirements described in the functional specifications document.

The attached design specifications ensure that prototype development proceeds smoothly, with all major design considerations resolved and defined. Development milestones have been included to facilitate monitoring of progress and to provide reasonable development goals.

If you have any questions regarding our functional specifications, please contact me at 604-325-8569 or email at fls-340@sfu.ca.

Sincerely,

Roger Lum

Roger Lum
CEO
Freedom Life Systems

Enclosure: *Design Specifications for a Voice Activated Remote Control System*

Design Specifications for a

Voice Activated Remote Control System

Project Team:	Alex Cheng Jeff Liu Gary Liaw Roger Lum Colin Ng Jason I-chih Wang
Contact Person:	Roger Lum fls-340@sfu.ca
Submitted to:	Dr. Andrew Rawicz Steve Whitmore School of Engineering Science Simon Fraser University

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Executive Summary

The VoiceIR is a voice-activated remote control system. This product allows those physically disabled to enjoy the convenience of remote controls. The versatility and simplicity of this product is unmatched in the current market place.

The design specifications explain in detail how to create the initial prototype of our product. The implementation of the functionality of each component, as described in the functional specifications, is presented. Some of the desired functionality described in the functional specifications is not realized in our initial prototype. However, the essence of our product is captured in the initial prototype.

To facilitate progress monitoring and ease of prototype development, milestones have been created. With these development milestones, the prototype development team has a clear set of goals and accomplishments to be completed in each phase of the project.

The design specifications ensure that our development team is able to proceed orderly with the creation of our initial prototype.

Freedom Life Systems

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1 Introduction

The VoiceIR is a voice activated remote control system. This product allows disabled individuals to enjoy the convenience of remote controls through trainable voice commands. The user is able to control any device that uses infrared (IR) remotes simply by talking into a wireless microphone. Through the versatility of the design, the user is able to control devices located anywhere in the house.

1.1 Scope

This document outlines in detail the design of the initial prototype of the product.

The first section describes the major parts used in the prototype, providing a brief explanation of the functionality with emphasis on interfacing requirements. The next few sections review each module of the product, explaining how the functionality of each module is implemented with the chosen parts. These sections roughly follow the layout of the functional specifications, providing a correlation between a described functionality and its implementation. Presented as well is the software design for the micro-controller, which involves a high level flow chart of the program logic.

Finally, development milestones are provided. This explains what should be done by the end of each phase of prototype development, which lends itself towards incremental testing at each stage of development. A final test plan has already been included in the functional specifications. Once the prototype has been finished, the functional specifications' test plan will be applied to verify that the prototype satisfies the major functional requirements and the deficiencies between the prototype and the final product are identified.

1.2 Acronyms

CCU	central control unit
EEPROM	electronically erasable programmable read only memory
IR	infrared
LCD	liquid crystal display
LED	light emitting diode
RF	radio frequency

1.3 Intended Audience

This document is intended for engineers manufacturing the first prototype of the VoiceIR. It describes in detail how to implement each component of the product. The combination of the design specifications and the functional specifications should provide enough detail for development of the first prototype that captures all the major functionality of the final product.

This document will also aid project management in evaluating the technical difficulties of constructing the prototype, as well as providing a base for assessing development progress.

2 System Overview

A system overview of the VoiceIR is shown in Figure 2.1. This figure shows a user engaging the VoiceIR system to control various devices with voice commands. The purpose of this overview is to allow the reader to regain familiarity with the organization of functionality of the product.

The VoiceIR system consists of three modules. The user first needs to train the VoiceIR system at the central control unit (CCU). The CCU will store the user's voice and the corresponding remote control signals. After initial training, the user simply speaks commands into the wireless microphone in order to control target devices. The wireless microphone sends the voice commands to the central control unit for processing. The CCU interprets the voice signal and looks up the appropriate IR signal. A command signal is sent to the IR Module. The IR Module receives the signals and transmits the appropriate IR signal to target devices. To control numerous devices, the user may place multiple IR Modules in different locations in front of each target device.

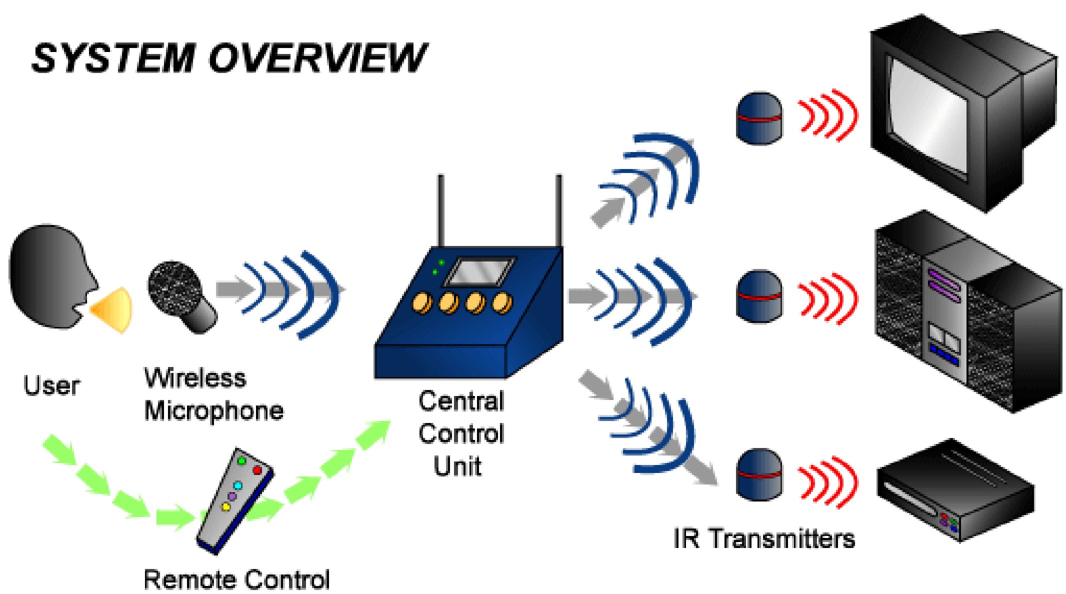


Figure 2.1: System Overview

3 Component Descriptions

The following sections describe each major component that makes up the initial prototype. A major consideration is the requirements for input/output since this dictates how the component is interfaced with other components

3.1 Motorola HC11 Microcontroller

Figure 3.1.1 shows the layout of the Adapt11 evaluation board using a Motorola 68HC11 microcontroller.

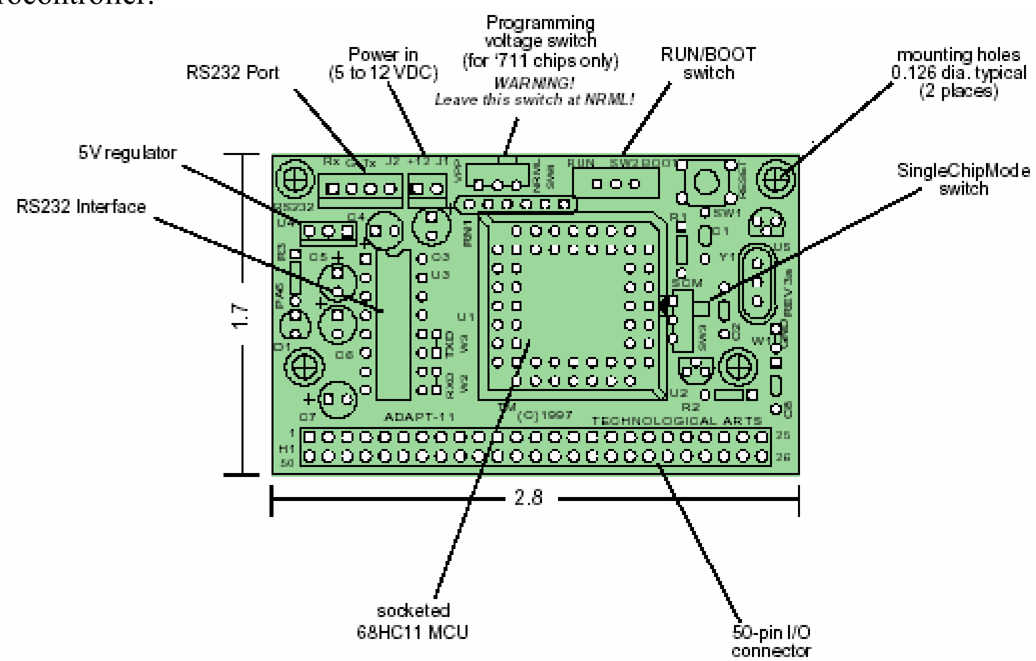


Figure 3.1.1: Adapt11 Evaluation Board Layout

This Motorola microcontroller is powered by a DC power supply between 5 and 12 volts, which is connected to the on-board 5V voltage regulator.

The main program for interfacing other hardware to the available I/O pins will reside in the 2K EEPROM. Software development will be done on a PC and programmed onto the microcontroller via a RS232 connection. All of the program codes will be written in assembly language.

Figure 3.1.2 is a brief memory map showing which memory addresses are available for programming.

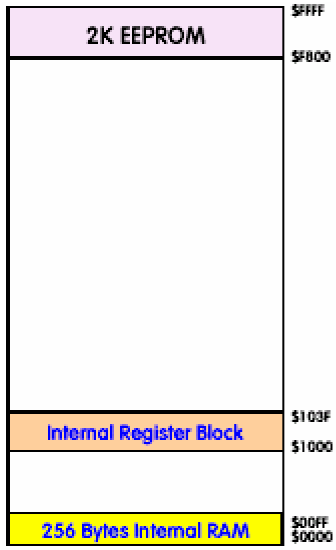


Figure 3.1.2: 68HC11 Memory Map

The 256 bytes of internal RAM will be used to store IR sequences that the user has trained VoiceIR to recognize.

The 68HC11 microcontroller has 50 pins. Of these 50 pins, 38 can be configured for I/O usage when the microcontroller is run under single-chip mode. Table 3.1.1 is a table listing pin assignments.

PIN #	NAME	PIN #	NAME
1	PD2/MISO	50	GROUND
2	PD3/MOSI	49	GROUND
3	PD4/SCK	48	PD0/RXD
4	PD5/SS*	47	+5V
5	PD1/TXD	46	IRQ*
6	PA7/PAI/OC1	45	XIRQ*
7	PA6/OC2/OC1	44	RESET*
8	PA5/OC3/OC1	43	RESERVED
9	PA4/OC4/OC1	42	PC7 (ADDR7/DATA7)
10	PA3/IC4/OC5/OC1	41	PC6 (ADDR6/DATA6)
11	PA2/IC1	40	PC5 (ADDR5/DATA5)
12	PA1/IC2	39	PC4 (ADDR4/DATA4)
13	PA0/IC3	38	PC3 (ADDR3/DATA3)
14	PB7 (ADDR15)	37	PC2 (ADDR2/DATA2)
15	PB6 (ADDR14)	36	PC1 (ADDR1/DATA1)
16	PB5 (ADDR13)	35	PC0 (ADDR0/DATA0)
17	PB4 (ADDR12)	34	STRB (R/W*)
18	PB3 (ADDR11)	33	E
19	PB2 (ADDR10)	32	STRA (AS)
20	PB1(ADDR9)	31	VRL
21	PB0 (ADDR8)	30	VRH
22	PE0/AN0	29	PE4/AN4
23	PE1/AN1	28	PE5/AN5
24	PE2/AN2	27	PE6/AN6
25	PE3/AN3	26	PE7/AN7

Table 3.1.1: 68HC11 Pin Assignment

The following pins have been assigned to the different devices that will be interfaced with the microcontroller:

Port A [0-2]: input from the "Start/End", "Abort" and "Clear All" buttons, respectively.
Port A [3]: output to RF transmitter
Port A [4-6]: output to LCD controls
Port A [7]: input from IR receiver
Port B [0-7]: output to LCD display
Port C [0-3]: inputs for VoiceDirect word matching pins
Port C [4-7]: input for VoiceDirect control/status pins
Port D [0-5]: input/output for general purpose use
Port E [0-7]: analog to digital converter

3.2 Sensory VoiceDirect 364 Kit

Sensory Inc's VoiceDirect 364 Kit offers a relatively inexpensive solution to voice recognition. This kit is able to perform up to 15 words of speaker-dependent (SD) voice recognition, and offers a continuous listening (CL) mode, which allows the user to activate VoiceDirect through voice commands.

Before using VoiceDirect, it must be trained to recognize spoken commands. Prior to performing voice recognition, VoiceDirect must be activated by either pressing a switch or using a gate word. When VoiceDirect makes a match, it puts an encoded output on its 8 output pins for 1 second. The schematic of VoiceDirect in the continuous listening mode is shown in the following figure.

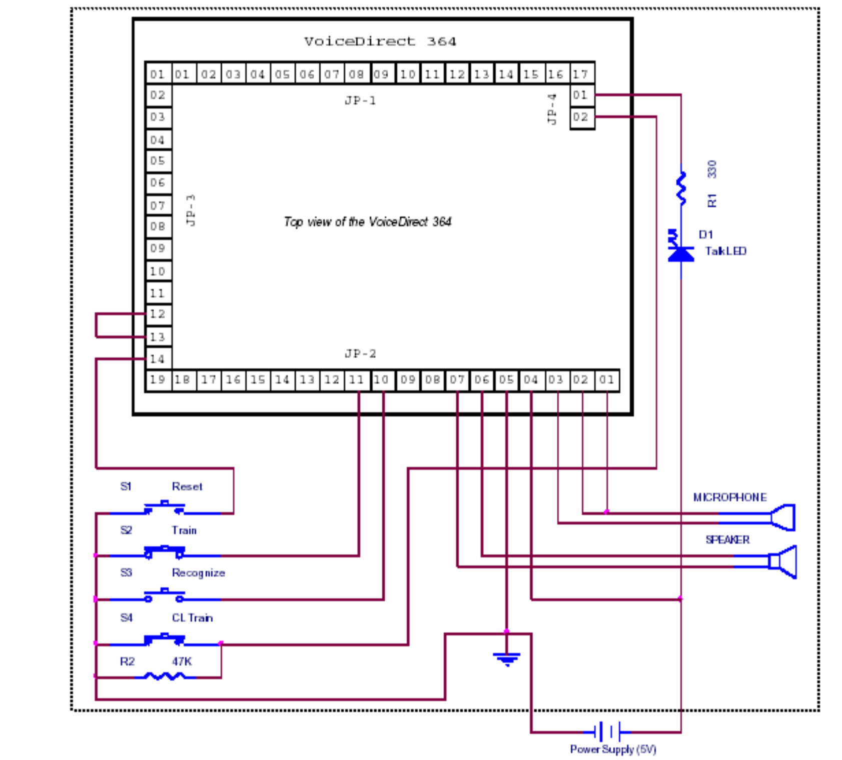


Figure 3.2.1 VoiceDirect in Continuous Listening Mode

The unit runs on a power supply of 4.5~5.25V @ 100mA, connect to pin JP-2-04. The unit takes inputs from the reset (JP3-14), train (JP2-11), recognize (JP2-10), and CL train (JP-4-02) buttons, all of which are active low, as well as an analog input from the microphone. The outputs of this device include an encoded 8-bit output (pins JP2-12 to JP2-19) to identify which of the words has been recognized, an error signal line (JP3-10), and an analog output to the speaker (JP2-6 and JP2-7.) The error line is toggled high when an error occurs or when training is completed. An error message is also spoken through the speaker.

3.3 Lumex 4X16 LCD

The LCD is a 4 line, 16 characters per line display. The LCD is interfaced with a microcontroller through its 16 pins. Table 3.3.1 is a breakdown of the pins and their functions.

Table 3.3.1: LCD Pin Description

Pin	Symbol	Function
1	V_{SS}	Power Supply (GND, 0V)
2	V_{DD}	Power Supply (5V)
3	V_a	Contrast control (applied voltage between V_{SS} and V_{DD})
4	RS	Register Select pin. High when writing to display. Low when writing instructions to LCD.
5	R/W	Read/Write pin. High when reading the LCD display. Low when writing to LCD display.
6	E	Enable pin. LCD reads data from the pins on falling edge of the enable signal.
7-14	DB0-DB7	Data bus. Instructions and character codes are passed on the data bus.
15-16	-	Backlight control, which does not apply for this LCD.

Before the LCD can be used by the microcontroller, it must follow an initialization sequence. This involves turning LCD on, waiting for power up, clearing the display, and setting cursor preferences.

Each line of the LCD has an address range. To write to a particular line, first the display address must be set by sending a command to the LCD and then followed by the characters to write. Characters are written to the LCD by using binary codes for each letter.

3.4 Sharp IrDA Transceiver

The infrared communication device used will be a Sharp GP2W0004YP transceiver. This device is an integrated package of both a transmitter and a receiver, at a size of 9.21 x 3.86 x 2.71 mm. A standard transceiver module, the GP2W0004YP provides a reliable interface between logic and IR signals for through-air, serial, and half-duplex IR wireless data links. Capable of transmitting and receiving signals within a 1m range, this device contains a high speed, high efficiency, low power consumption AIGaAs LED, silicon PIN photodiode, and low power bipolar integrated circuit.

The following table presents technical details of device operation.

Table 3.4.1: Operation Ranges for IrDA Transceiver

Data Rate	2.4 kbits/s to 115.2 kbits/s
Emitter Current	300 mA
Power Supply	2.7 V – 5.5 V

For power-conscious applications, this transceiver module has a shutdown mode that reduces current to a maximum of 1 μA. This affects the power consumption of the receiver but does not affect the power consumption of the transmitter.

The figure below displays the layout of the pins on the transceiver module. The following figure presents a block diagram of the transceiver's internal circuitry.

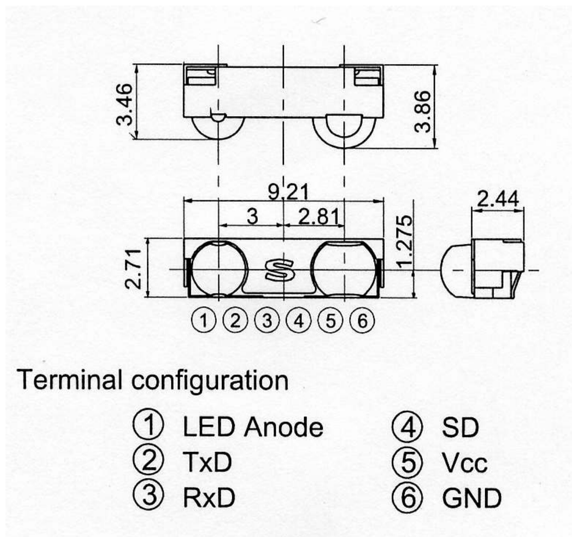


Figure 3.4.1: IrDA Transceiver Pin Configuration

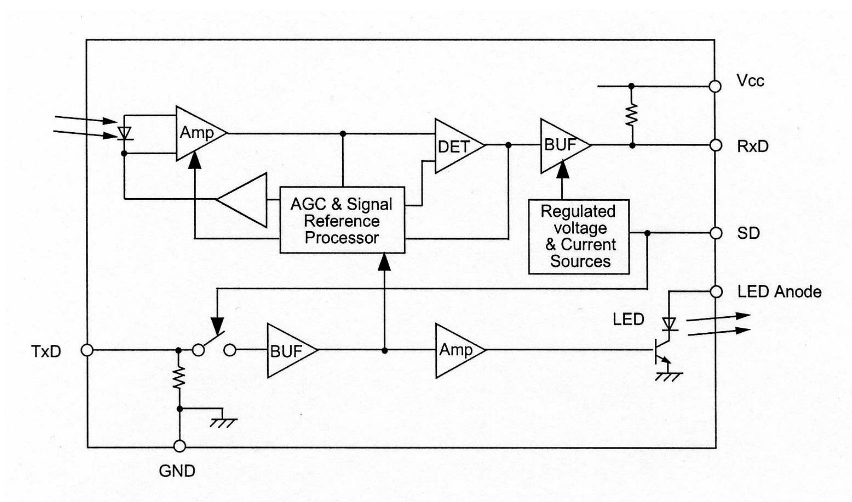


Figure 3.4.2: IrDA Transceiver Internal Circuitry

To receive an IrDA signal from an external device, the TxD pin is connected to ground. The device is now constantly receiving data. Any input going into the transceiver will be coming out from the RxD pin. When receiving data, the input going into the transceiver is in the form of a square wave. Supposing that the power supply is 3V, the input received by the device will see 3V as a logic "1" and 0V as a logic "0". However, when the device receives the data, it automatically inverts all the logic "1" to "0" and all the logic "0" to "1". The microcontroller will see the output from the receiver with 3V corresponding to logic "0", and 0V corresponding to logic "1". The output seen by the microcontroller will also be in the form of a square wave.

To transmit an IrDA signal, the RxD pin is connected to ground and input to the transceiver will be through the TxD pin and subsequently transmitted via IrDA. When transmitting data, the input into the transmitter is simply a square wave. Once again, assuming that the power supply is 3V, logic "1" will be represented by 3V and the logic "0" will be represented by 0V. Unlike the receive function of the transmitter, there is no inversion of the signal.

When in shutdown mode, the transceiver transmitting functionality will not experience any power reduction. The receiver and transmitter circuits are independent of each other and are not internally connected and only the receiver circuit will be affected by a reduction in power. To use the shutdown mode, because it is an active-low pin, a logic "0" is connected to the pin. For normal mode operation, this pin is connected to a logic "1".

3.5 Linx TXM-418 RF Transmitter

A Linx RF system is used to add RF communication to the VoiceIR between the central control unit and the IR modules. The schematic of the Linx TXM-418-LC RF Transmitter is shown below in Figure 3.5.1.

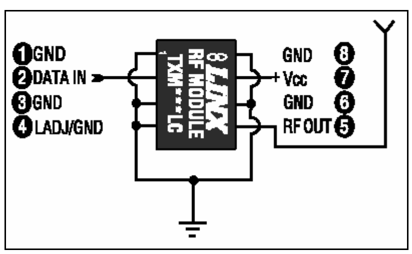


Figure 3.5.1: Linx TXM-418-LC RF Transmitter

Linx TXM-418-LC is an 8-pin device. Pin 1, 3, 6, and 8 are connected to ground. Pin 2 is the serial data input pin, which supports data rates up to 5 kbits/s. The Linx system transmits digital data at 418 MHz. A logic "0" is a signal lower than 0.4 V while a logic "1" is a signal higher than 2.5 V.

Pin 4 is for output power level adjustment. It is connected to ground directly for 3V operation and connected to ground through a 430 Ω resistor for 5V operation. Pin 5 connects to a 50 Ω matched antenna of length 6.7 inches. Pin 7 is connected to the positive power supply, ranging from 2.7 to 6 V. The supply must be clean, stable, and free of high-frequency noise. The supply filter shown in Figure 3.5.2 can be used to regulate the power supply.

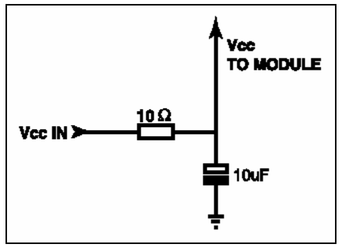


Figure 3.5.2: Power Supply Filter

3.6 Linx RXM-418-LC RF Receiver

The other component of the Linx RF system is the RF receiver. The schematic of Linx RXM-418-LC RF Receiver is shown below in Figure 3.6.1.

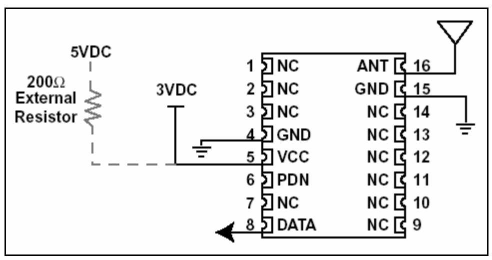


Figure 3.6.1: Linx RXM-418-LC RF Receiver

Linx RXM-418-LC is a 16-pin device. Pin 1, 2, 3, 7, 9, 10, 11, 12, 13, and 14 are no connection pins without any electrical connection. Pin 4 and 15 are connected to ground. Pin 5 is connected to positive power supply, ranging from 2.7 to 4.2 V or from 4.7 to 5.2 V with a 200 Ω external dropping resistor. The supply must be clean, stable, and free of high-frequency noise. The supply filter shown in Figure 3.5.2 can be used to regulate the power supply. When pin 6 is pulled low, the device will be in sleep mode; otherwise, the device is enabled. Pin 8 is the output. The output voltage during a logic "1" will average V_{CC} – 0.3 V. Pin 16 is connected to the receiver's antenna, which requires a nominal RF impedance of 50 Ω.

3.7 Wireless Microphone and Receiver

The wireless microphone and receiver are constructed from existing devices. The wireless microphone used is an electronics project that was made in high-school, while the receiver is taken from a consumer pocket radio.

3.7.1 Wireless Microphone

Made in high-school as an electronics project, the wireless microphone simply transmits sound sensed by an attached microphone on FM radio frequencies. The wireless microphone is powered by one 9V battery, and its transmission frequency and microphone sensitivity can be tuned. Its transmission distance has been observed to be up to 40 feet.

3.7.2 Receiver

The receiver is a modified pocket AM/FM radio, which is powered by two 1.5V AA batteries. The outer shell of the radio and the speaker will be removed, and the receiver will be used to receive FM radio frequencies. Although not removed, the AM functionality of the radio will not be used. The output of the receiver will be from a pair of wires originally connected to the speaker. The output level can be adjusted by the knob intended for adjusting volume.

3.7.3 Operation of Wireless Microphone and Receiver

To operate the wireless microphone and receiver, the receiver is tuned to a frequency without radio interference and the wireless microphone is tuned to transmit at the same frequency.

4 Wireless Microphone

This module basically consists of the wireless microphone for transmitting voice commands to the CCU. In the interest of building a feasible prototype in our limited timeline, we resorted to using an existing wireless microphone, as described in section 3.7. The wireless microphone we are using is one unit, with the actual microphone, transmitter and power supply together. The microphone is continuously transmitting whenever it is powered.

Most of the functional requirements for this module are not met when using this existing wireless microphone; however, the main functionality of the module is not comprised for our prototype, the transmitting of voice wirelessly. In the final product, the wireless microphone will consist of two components, a small clip-on microphone and a main body with the battery and transmitter.

5 Central Control Unit

5.1 Architectural Overview

Within the CCU, there exist eight individual components, where the central device is the HC11 micro-controller. Because we need to be constantly receiving infrared signals, connected to the HC11 will be an IR transceiver, which will be used as an IR receiver at all times. In addition, we will also be connecting an RF transmitter to the HC11 so that the micro-controller can be used to send RF signals to IR Modules. The voice-activation chip will be connected to the HC11 via a multiplexer because of limited availability of I/P pins. The final integral component of the CCU is a microphone receiver, will be connected to the voice-activation chip so that analog input coming from the wireless microphone can be processed accordingly. For user-friendly purposes, we will also be connecting an LCD and a button panel to the HC11 micro-controller. The LCD will be used to display the procedures being performed by the module. The button panel will act as a user-interface between the user and the device.

A block diagram of the CCU is presented below.

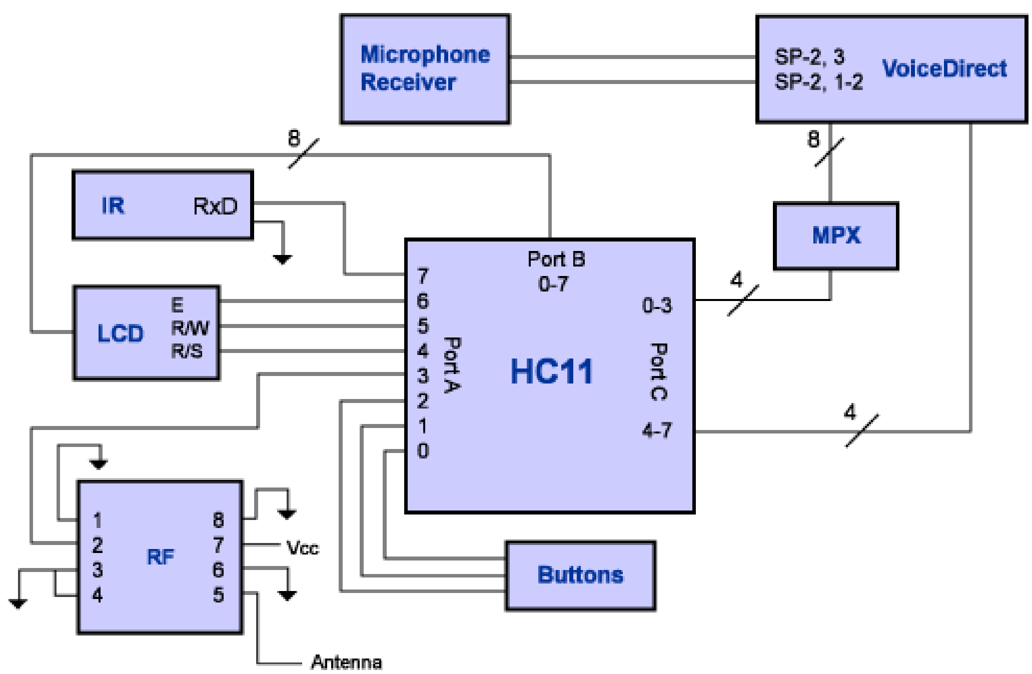


Figure 5.1.1: Overview of Central Control Unit

5.2 LCD Display

The LCD display is a 4X16 display with a built-in controller. This is described in section 3.3.

There are three control pins on the LCD: RS, R/W, and E pins. These are connected to the HC11 through Port A, pins 4-6. As well, the LCD uses an 8-bit bus for data input/output. This is connected to the HC11 through Port B, pins 0-7.

The HC11 controller will send out the appropriate control signals and data signals to display the desired messages on the LCD.

5.3 Buttons

A total of three buttons will be interfaced to the HC11 microcontroller. These buttons will be mapped to pins 0 – 2 on Port A.

5.3.1 Start/End

The *Start/End* button must be pressed to initiate the voice training process. User will then receive indication from both the LCD and VoiceDirect's internal speaker that voice commands are being recorded.

The *Start/End* button may be pressed again during IR training to end the training process.

This button will be mapped to pin 0 on Port A of the HC11 microcontroller.

5.3.2 Abort

The *Abort* button may be pressed at anytime during voice training or IR training. If this button is pressed during voice training, the user will be brought back to the initial idle state. If this button is pressed during IR training, the user will be brought back to the beginning of IR training.

This button will be mapped to pin 1 on Port A of the HC11 microcontroller.

5.3.3 Clear All

The *Clear All* button may be pressed to clear all the stored voice commands in VoiceDirect. This basically resets VoiceIR to initial factory condition.

This button will be mapped to pin 2 on Port A of the HC11 microcontroller.

5.4 Voice Training Process

Due to the limitations of the VoiceDirect recognition kit and the constraints of a protocol, the voice training process is different from the functional specifications.

During the idle mode, the LCD will indicate that VoiceIR is ready for voice training.

The following steps describe in detail how to train an initial "gate word". The VoiceDirect voice recognition chip constantly listens for this word. Once the word is recognized, VoiceDirect then tries to match the subsequent words spoken by the user.

The HC11 executes the following when the "Start/End" button is pressed if the gate word has not been recorded.

1. User presses and releases the "Start/End" button to initiate voice training.
    a. The button push will trigger an active low on pin JP-4-02 of the VoiceDirect chip. Also, the button will trigger port A pin 0 on the HC11 microcontroller.
    b. The HC11 microcontroller will quit idle mode and display "Training in progress (gate word)" on the LCD using port B pins 0 – 7. VoiceDirect will also vocally inform the user that training is in process.
    c. An LED will light up by the HC11 to indicate that training is in process.

2. User will have 2.5 seconds to speak into the wireless microphone.
    a. Wireless microphone will send an analog voice signal to the VoiceDirect chip.
    b. After 2.5 seconds VoiceDirect will inform user to repeat word.

3. After repeating word, VoiceDirect will inform user that training is completed.
    a. HC11 displays "Recording completed (gate word)" on the LCD.
    b. HC11 turns off the LED to indicate that recording has ended.

4. If training was unsuccessful, VoiceDirect will vocally inform user to start training again. User may press "Abort" to quit training process.

Once the gate word has been recorded, the following is executed when the "train" button is pressed.

The following steps describe in detail how voice training will be done:

1. User presses and releases the "Start/End" button to initiate voice training.
    a. The button push will trigger an active low on pin JP-2-11 of the VoiceDirect chip. Also, the button will trigger port A pin 0 on the HC11 microcontroller.

   b. The HC11 microcontroller will quit idle mode and display "Training in progress" on the LCD using port B pins 0 – 7.
   c. HC11 will turn on an LED indicating that recording is in progress.

2. User will have 2.5 seconds to speak into the wireless microphone.
   a. The wireless microphone sends an analog voice signal to the VoiceDirect kit.
   b. After 2.5 seconds VoiceDirect will inform user to repeat word.

3. After repeating word, VoiceDirect will inform the user either that voice training is completed or that voice training has failed.
   a. If training is successful, HC11 will turn off the LED and display "Voice training successful – ready for IR training" on the LCD. HC11 also sends a signal to VoiceDirect to stop voice training to prevent continuing onto the next word.
   b. If training is unsuccessful, HC11 will turn off the LED and display "Training failed – please train again" on the LCD. VoiceDirect will exit to initial state and waiting for the "Train" pin to be activated again.

4. The user may press "Abort" during voice training to quit the process.
   a. When the "Abort" pin is detected by the HC11, a signal is sent to VoiceDirect instructing it to cancel the voice train process.
   b. HC11 also turns off the LED and displays "Voice training aborted" on the LCD for 2 seconds and then returns to idle state.

5. If voice training is successful, the user may start IR training by pressing remote control buttons at the IR port of the VoiceIR.
   a. HC11 continuously waits for IR signal. Once an IR signal is detected, it collects the signal and stores it in RAM.
   b. HC11 displays "IR signal captured – ready for N more signals" where "N" is the number of allowed IR signal left.
   c. HC11 also lights up an LED 0.2 seconds to visually inform the user that the signal has been captured.

6. A total of 10 IR signals are allowed for each voice command. The user may press the "Start/End" button to end IR training or input the maximum of 10 IR signals and then HC11 will end IR training.
   a. HC11 keeps a counter to make sure IR training stops when the 10^{th} IR signal is collected. It also monitors the "Start/End" button to end IR training if the user decides so.
   b. Once finished, HC11 displays "Training completed" for 2 seconds and returns to idle state.
   c. HC11 continually monitors the Abort button while IR training is in progress. If an active high is detected, HC11 displays "IR training

restarted" on the LCD. If user pressed Abort again, the whole training process is cancelled. IR signals will not be stored, but the stored voice command will not be deleted. User will need to press "Clear All" to clear VoiceDirect's memory.

5.5 Editing Voice Commands Process

In our prototype, the ability to delete individual voice commands is not available. This is due to limitations presented by our selection of the voice chip. In our final product, a better and more expensive chip with extended functionality will be used to restore this functionality.

To delete all the currently stored commands, the user is required to press the "Clear All" button.

This will prompt the LCD to display a confirmation message, "Clear memory?" If the user pushes the "Clear All" button again, HC11 will pull to ground the recognize and train pins on the VoiceDirect chip for 100ms. This will clear all the memory.

5.6 Voice Command Execution

Upon power-up or reset, VoiceDirect checks if any words have been stored. If a voice command has been stored, it begins listening for the gate word to activate voice recognition. VoiceDirect reads in the analog voice command from the FM receiver at pins JP2-1 and JP2-2 and does a comparison with the set of commands previously recorded and stored in memory. If a match is made, VoiceDirect outputs an encoded active high signal on pins JP2-12 ~ JP2-19, which is received at Port C of the HC11.

If no match is made, VoiceDirect uses audio notification through the built-in speaker to inform the user. The speaker output lines are connected to a threshold detector and subsequently connected to pin 0 of Port D. The micro-controller monitors the speaker output lines to determine when an audio status message is given by VoiceDirect.

When getting the encoded signal from VoiceDirect confirming recognition, HC11 will find the corresponding IR sequence in memory and send the IR sequence to the RF transmitter via pin 3 at Port A. The RF transmitter receives the IR sequence on its pin 2 and then outputs the sequence through pin 5 over the antenna.

5.7 Power Supply

The power is being drawn from the power outlet from a wall. The following are the power requirements for the different individual devices in the CCU:

1. HC11 requirement (5V)
   Because the HC11 has a power regulator, we will be feeding 6 V to the HC11. The micro-controller will be scaling down the voltage to 5 V.

2. IR transceiver requirement (4 V)
   Using 5 MΩ and 4 MΩ resistors, we will connect the IR transceiver in parallel to the 4 MΩ resistor to divide the voltage.

3. RF transmitter requirement (4V)
   Using 5 MΩ and 4 MΩ resistors, we will connect the RF transmitter in parallel to the 4 MΩ resistor to divide the voltage.

4. Microphone receiver requirement (3V)
   Using 2 MΩ and 1 MΩ resistors, we will be connecting the microphone receiver in parallel to the 1MΩ resistor to divide the voltage. This voltage divider will be connected in parallel to a 5M resistor to create another voltage divider. This configuration will thus give the microphone receiver a voltage of 3V.

The figure below shows the power supply design for the CCU.

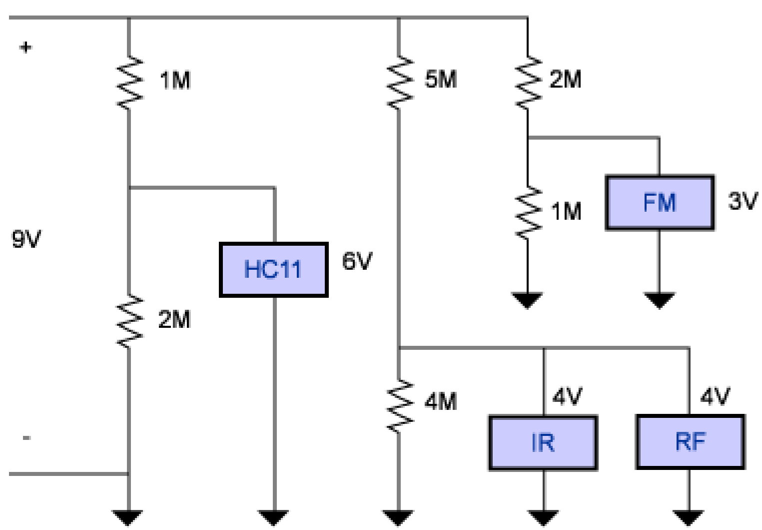


Figure 5.7.1: Power Supply of Central Control Unit

6 IR Module

6.1 Architectural Overview

Within the IR Module, there exist only 2 individual components. Because the purpose of the IR Module is to transmit an IR signal when given input via an RF receiver, the only connections will be from an RF receiver to an IR transceiver, which will be acting as a constant IR transmitter.

A block diagram of the IR Module is presented below.

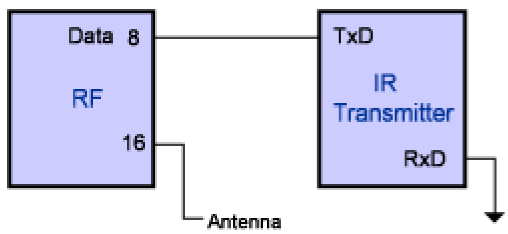


Figure 6.1.1: Overview of IR Module

6.2 Receive Command and Transmit IR Process

The functionality of the IR Module is to accept an RF signal from the CCU and to retransmit this signal in the form of an IR signal to the target IR device. The RF input will contain an IR sequence that will be used to control a specific IR-controlled device. The RF signal that is received by the RF receiver will be converted into a non-inverted square-wave that will then be an output for the RF receiver. This output can be retrieved from Pin 8 of the RF receiver and since the output seen by the RF receiver is non-inverted with V_{CC} representing a logic “1” and 0 V representing a logic “0”. The output from Pin 8 of the RF receiver is the input of Pin 2 of the IR transceiver. It is important to note that Pin 3 of the IR transceiver will be grounded to enable constant transmission by the IR transceiver. Furthermore, since the IR transceiver accepts non-inverted square-waves as input, there will be no need for signal inversion or signal conversion. The output of the RF receiver is a digital signal represented by a square wave and the input to the IR transceiver is a digital square wave as well. No decoding of the RF signal from the CCU is required.

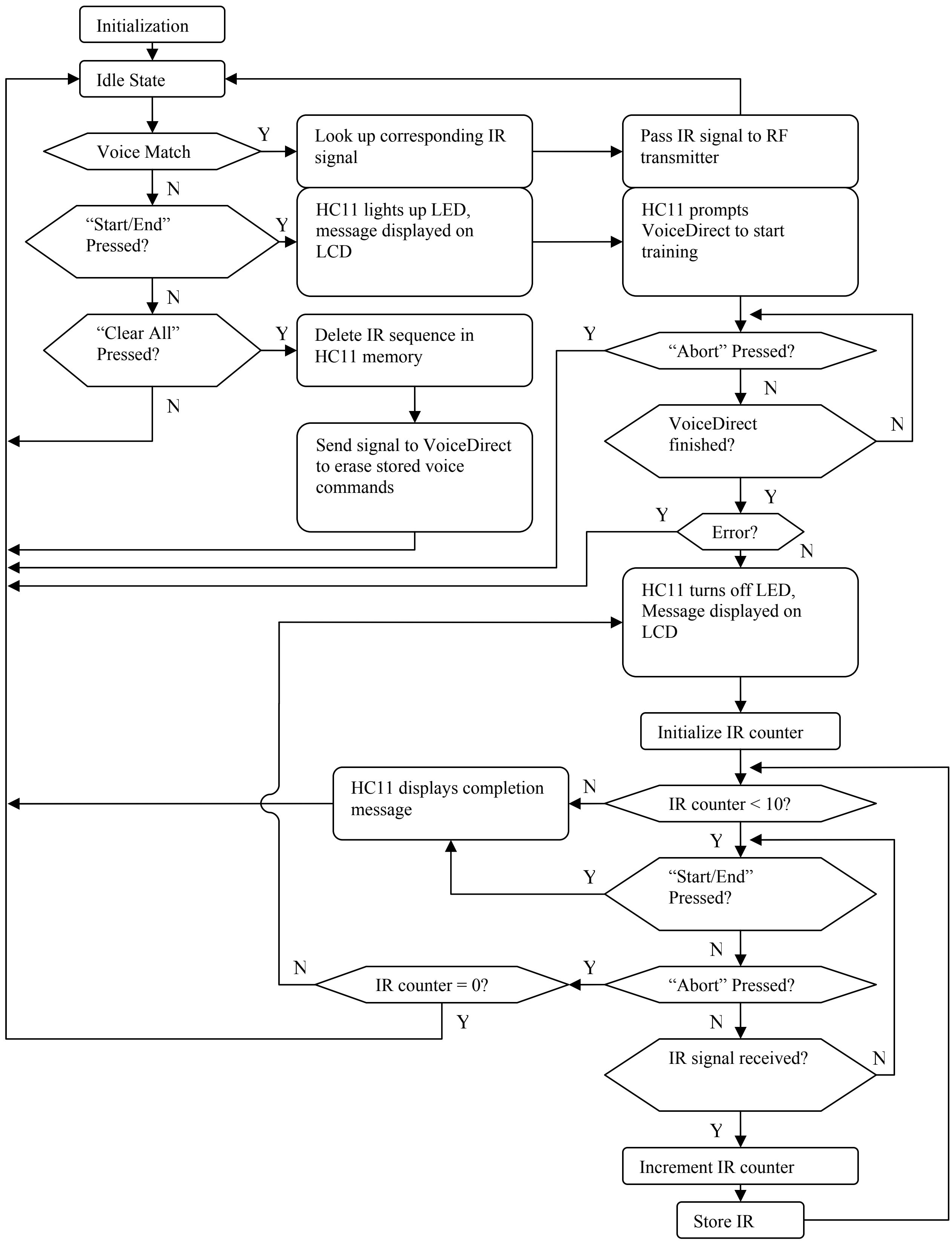
Due to time constraints, we will not be implementing the low-battery indicator. For the final product, this feature could possibly be implemented with a controller and a LED. Furthermore, because the transceivers we are using are samples from a distributor, the range of IR transmission is limited to 1m, a limitation of the prototype.

6.3 Power Supply

Two AA batteries will be connected in series to provide a power source of 3V. Because we need 3V across both the RF receiver and the IR transceiver, we will be connecting the two devices in parallel. Both the RF receiver and the IR transceiver will have their pin 5 connected to the positive terminal of the power source, with pin 6 of the IR transceiver and pin 4 of the RF receiver connected to ground.

7 Software Design

Only the HC11 requires software. The micro-controller coordinates all the different components within the CCU, the most complicated module of the system. The following flow chart presents a high level design of the software.


Initialization
Idle State
Voice Match
Y
Look up corresponding IR signal
Pass IR signal to RF transmitter
N
"Start/End" Pressed?
Y
HC11 lights up LED, message displayed on LCD
HC11 prompts VoiceDirect to start training
N
"Clear All" Pressed?
Y
Delete IR sequence in HC11 memory
Y
"Abort" Pressed?
N
N
VoiceDirect finished?
N
Send signal to VoiceDirect to erase stored voice commands
Y
Y
Error?
N
HC11 turns off LED, Message displayed on LCD
Initialize IR counter
HC11 displays completion message
N
IR counter < 10?
Y
Y
"Start/End" Pressed?
N
N
IR counter = 0?
Y
"Abort" Pressed?
Y
N
IR signal received?
N
Y
Increment IR counter
Store IR

8 Development Milestones

The following development milestones are used to split the prototype development into multiple stages, providing deliverables that are used to monitor progress and reduces the daunting task of development into manageable phases. Debugging will be a continuous process during each stage of the development process.

8.1 Phase 1

Phase 1 is to be completed over a two week span between October 24 and November 6. This phase is focused on learning the functionality of each part and how to interface the components.

8.1.1 Micro-controller

8.1.1.1 Scope

Motorola HC11 operations.

8.1.1.2 Deliverables

1. HC11 is able to interface with a computer to download code to either EEPROM or ROM.
2. A solution is developed to maintain memory in RAM once the CCU has been powered off. Possible solutions involve using a back-up battery or copying memory to ROM then restoring it later.

8.1.2 Power Circuit

8.1.2.1 Scope

The CCU contains the HC11 chip, IR transceiver, RF transmitter, voice-recognition chip, microphone receiver and LCD. A single AC adapter powers the entire CCU. The power circuit describes how to transfer the power from the single adapter for powering each component.

The IR Module uses two “AA” batteries to power both the IR transceiver and a RF receiver.

8.1.2.2 Deliverables

1. A power circuit capable of powering all components within the CCU with the appropriate current and voltage levels.
2. A power circuit capable of powering all components within the IR Module with the appropriate current and voltage levels.

8.1.3 Sharp IrDA Transceiver

8.1.3.1 Scope

Operations of the Sharp IrDA transceiver.

8.1.3.2 Deliverables

1. Ability to read an IR signal from a TV remote and store it in HC11 memory.
2. Ability to output an IR signal previously stored in HC11 memory.

8.1.4 RF Communications

8.1.4.1 Scope

Operation of Linx LXM-418 transmitter and Linx RXM-418 receiver.

8.1.4.2 Deliverables

1. HC11 is able to send a signal through the RF transmitter and the appropriate output should be seen from the output of the RF receiver.

8.1.5 Voice Recognition Chip

8.1.5.1 Scope

Sensory VoiceDirect 364 kit and wireless microphone and receiver.

8.1.5.2 Deliverables

1. Place VoiceDirect chip in appropriate operation mode.
2. Be able to speak into wireless microphone, pick up signal from receiver, and feed it into the VoiceDirect chip.

3. Ability to train voice commands and recognize them, including understanding the output status pins on the VoiceDirect chip.

8.1.6 LCD

8.1.6.1 Scope

Operation of LCD display.

8.1.6.2 Deliverables

1. LCD is interfaced with the HC11.
2. Ability to initialize LCD and write message to LCD under control of the HC11.

8.1.7 Buttons

8.1.7.1 Scope

All buttons used for communication with the user (eight in total).

8.1.7.2 Deliverables

1. Buttons are interfaced with HC11.
2. When a particular button is pressed, HC11 is interrupted and the particular button is identified.

8.2 Phase 2

Phase 2 is to be completed over a two week span between November 7 and November 20. This phase is focused on combining different components together.

Software coding will begin in this phase as well, following the design presented in the design specifications.

8.2.1 IR and RF Communication

8.2.1.1 Scope

Combination of IR and RF functionality.

8.2.1.2 Deliverables

1. IR signal from a remote is stored in HC11 memory with IR transceiver.
2. IR signal in memory is sent with RF transmitter to RF receiver.
3. RF receiver passes the data over to IR transceiver.
4. A device is controlled by command signal from IR transceiver.

8.2.2 Voice Chip under HC11 Control

8.2.2.1 Scope

Having HC11 control all functionalities of the VoiceDirect chip.

8.2.2.2 Deliverables

1. HC11 is able to initialize voice training process.
2. HC11 is able to delete voice commands.
3. HC11 should know when a voice command has been recognized and identify the recognized command.

8.3 Phase 3

Phase 3 is to be completed over the remaining time, between November 21 and December 9. This phase is focused on combining all the components together and realizing the final functionality of the prototype. Included in this process is completion of the software. The deliverable is the prototype.

9 Conclusion

The design specifications describe in detail how each component of the first prototype is constructed. Although the prototype design does not match all the requirements set out in the functional specifications, it still retains the essential functionality of the product. The included development milestones will facilitate the team in developing the prototype on time and in an orderly fashion.

With this design specifications document, the steps to create the first prototype are well defined to ensure a smooth development process.