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March 11th , 2005

Dr. Lakshman One
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Re: ENSC 440 Design Specifications for an anti-theft/reminder transmitter

Dear Dr. One,

The following document, *Design Specifications for an anti-theft/reminder transmitter*, provides an overview of the implementation of our project, the SafeGuard. The SafeGuard is an RF based, wireless tether which allows users to tag their personal items with RF transmitters. When these tagged items exit a predefined radius from the receiver, the receiver which is worn by the user, will notify the user which object was left behind.

The design specifications will briefly outline the basic components of our project, and our method of integrating them together into a functional prototype. The outlined designs are only preliminary models, and will evolve as the project progresses. In this document we will specify the implementation of our device on a more technical level, providing information on the construction of our project.

The design specifications will be used in the future to help us in the construction of our project.

Regards,

Carson Hammoser

Carson Hammoser
Chief Technical Officer (CTO)
Mnemosyne Technologies

Enclosure: *Design Specifications for an anti-theft/reminder transmitter*,

MNEMOSYNE
Technologies

Design Specifications for an Anti-theft/Reminder Transmitter

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Executive Summary

Have you ever forgotten something or left something behind? Have you ever accidentally dropped something important? From keys and wallets, to glasses cases and cell phones, everyday people lose track of things. Items can be forgotten at work or home, or objects can be accidentally dropped or lost. Locating these items can often be frustrating as well as time consuming. Replacing them can be costly. Preventing these losses in the first place can eliminate the stress and aggravation associated with looking for these lost items. These annoying situations can be avoided by simply utilizing a small tracker which notifies you when you've left an object behind.

The application of a short range tracking system extends beyond helping you recover your lost items into the realm of security, protecting you from having your items stolen; a simple solution presents itself in terms of a range based security device, ensuring that your valuables remain close by at all times. This device can even be applied at a larger level in order to ensure that office equipment is not misused or removed from a specific location. Alternatively attaching tags to children and animals will allow you to keep track of your children and pets without having to attach chains or other physical tethers. This device will allow you to make sure that your kids stay close when you're in a busy shopping mall, or it will allow you to know when your dog escapes from the back yard.

Mnemosyne Technologies is proposing a project, the SafeGuard, where we will design and construct a multi-object tracking device. Utilizing our SafeGuard tags you can keep track of your personal effects. A receiver in the form of a watch or a keychain will track a specified number of tags, and notify you if you walk away from your tagged items. This warning will allow you to find out what you have left behind, since you will still be relatively close to the lost object.

The following document outlines the various design components of the SafeGuard System. The development of the SafeGuard will occur in two primary stages: the prototype phase and the production phase. If time allows we will attempt to generate a second-generation prototype as well.

The following document outlines our method of achieving our project objectives. The design specifications will outline the parts and designs we will utilize in constructing the prototype and final product of our project.

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Acronyms:

ADC: Analog to Digital Converter

AM: Amplitude Modulation

ASK: Amplitude Shift Keying

FM: Frequency Modulation

FSK: Frequency Shift Keying

IO: Input/Output

ISM: Instrumentation Scientific and Medical

LCD: Liquid Crystal Display

LED: Light Emitting Diode

LSI: Large Scale Integration

mAh: Milliamp Hours

MCU: Microcontroller

PCB: Printed Circuit Board

PLL: Phase Locked Loop

RSSI: Received Signal Strength Indicator

WDT: Watch Dog Timer

VCO: Voltage Controlled Oscillator

1. Introduction

One of the many facts of life is that people lose things. People forget items or leave objects behind. Statistics show that people lose hundreds of thousands of objects every year. The SafeGuard is designed to help prevent a user from misplacing these objects, by reminding him or her that an item has been left behind while he or she is still relatively close to the item.

1.1. Scope:

The following document outlines the design specifications of the SafeGuard. Descriptions of the construction of the software and hardware of the system will be provided in the document. The final implementation of the prototype may vary slightly from the designs provided in this document. The design specifications outlined will serve as a guideline for constructing our prototype and final product.

1.2. Goals:

The design specifications have a primary goal of providing outside parties such as investors and consulting engineers with a general idea of how the project works. Additionally, the design specifications are to provide both a scope of the components being used and focus and information for engineers within the design team.

2. System Overview

The Mnemosyne Technologies, wireless reminder system consists of two basic components: individual transmitter tags, and a receiver unit. The tags are attached to valuables or frequently misplaced items, while the receiver unit will be attached to a keychain, or simply placed in one's pocket. Ideally the receiver unit will be a watch or bracelet which people will be constantly wearing.

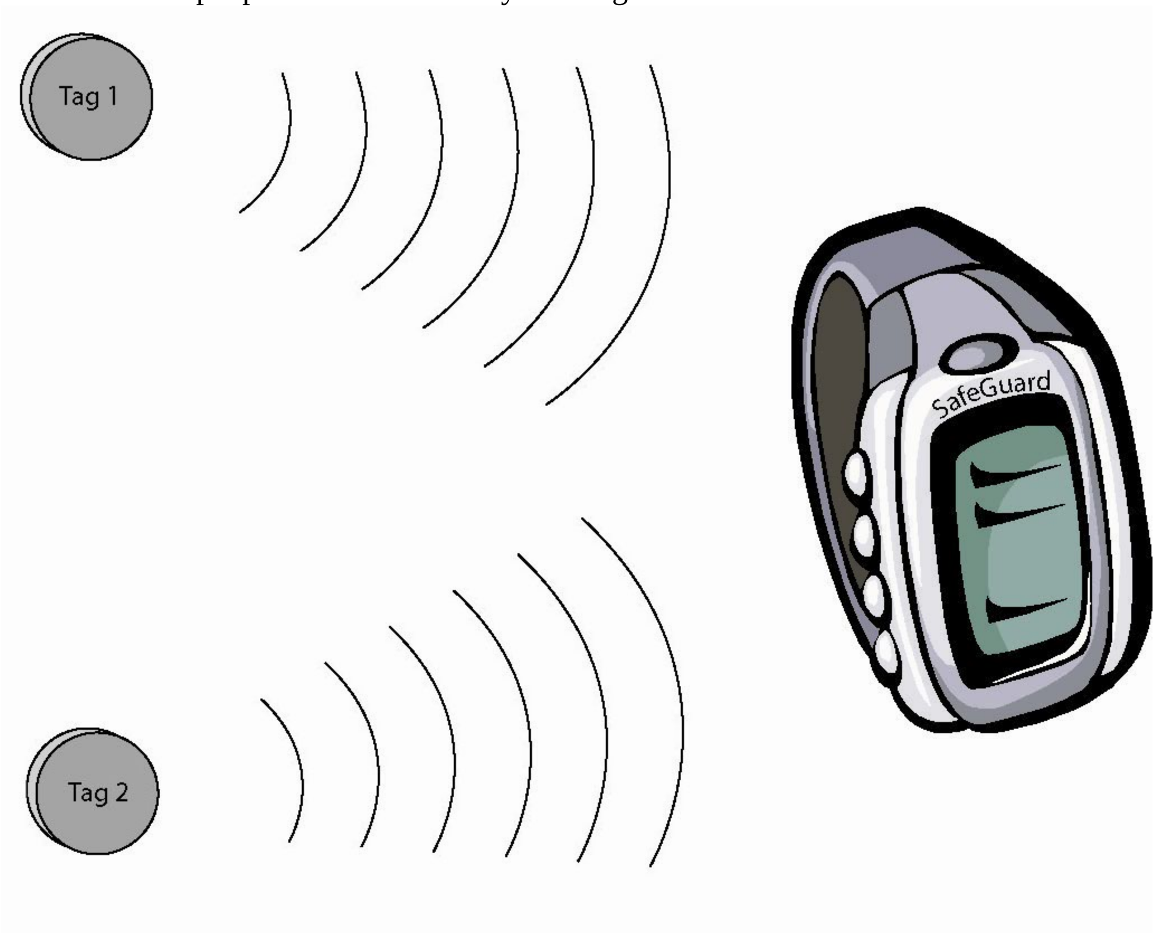


Figure 1: Basic Concept

To activate a tag, the user will initiate an "activate" mode on the receiver. The receiver will then try to identify the associated tags within range, based on their unique ID codes which have been stored in memory. The receiver will ask the user if he/she wants to activate or deactivate each stored item. The initialization is shown in Figure 2, below. Tag 1 is in range of the receiver and transmits a unique identification code to the receiver unit, which is depicted as a watch. Once this initialization is complete, the receiver will automatically keep track of the active tags. The receiver will sound an audible and visible alert when a recognized tag is outside of its range, reminding the user that he or she has forgotten an item.

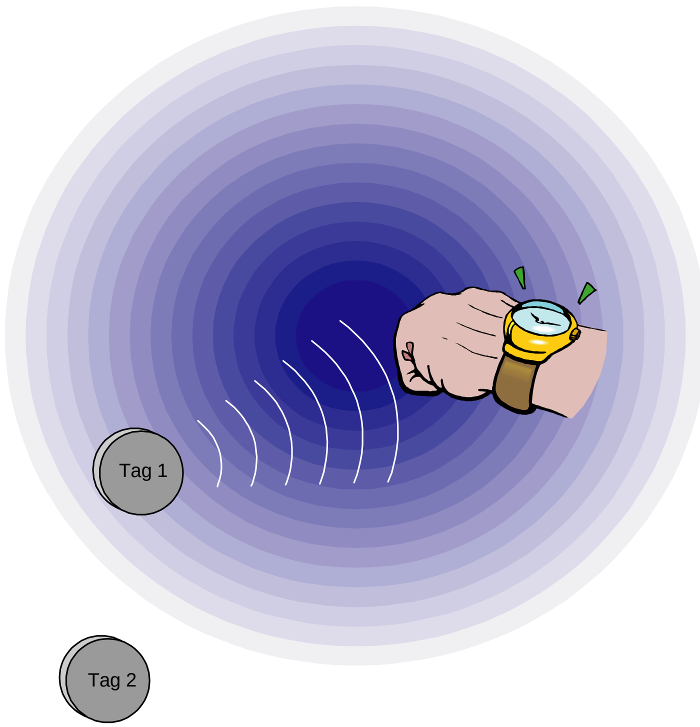


Figure 2: Possible Initialization Process

The main user interface contains four functions: Activate, Deactivate, and Sleep. Once the device warns the user about a forgotten item, the user can select to either Sleep or Deactivate the missing tag. If the user selects Deactivate then the receiver will not poll for that item until the user selects Activate on that item again. On the other hand, if the user selects Sleep, the device will temporarily deactivate an object for a period of time.

The main constraints in this project are the limited timeline and funding. Due to the limited funding, we might not be able to build the device as small as desired. However, we hope to build a prototype such that in theory the project can be scaled down to the desired size.

In the future, with additional time and funding, improvements to our prototype would be to minimize the size of the device or even combine it with a digital watch so the user does not have to carry an extra device.

3. Tag Unit

The tag unit will consist of a small RF transmitter which will be attached to a variety of personal affects. The tag will periodically transmit a unique five digit code, a tag ID, to a receiver unit notifying the receiver that the transmitter is still within a specified radius. The tag will be constructed of a transmitter chip, along with a required antenna, a microcontroller and a power supply with an on/off switch. These electronic components will be connected together and packaged in a relatively sturdy plastic case. A block diagram of the circuitry for a Tag unit is shown in Figure 3, below.

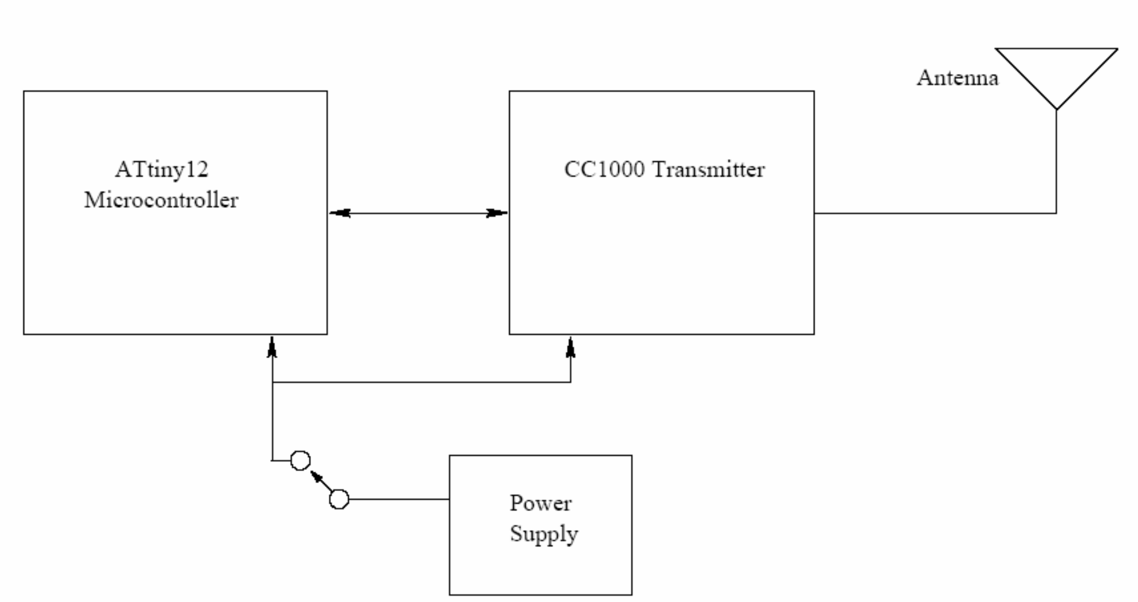


Figure 3: Tag Circuit Block Diagram

3.1 Transmitter Chip

For our final product we will utilize the CC1000 as our transmitter. The CC1000 is a low powered FM transceiver made by Chipcon. For simplicity, our initial prototype will utilize an AM transmitter from Abacom's AM-TX1-4 series [1], as it can be easily mounted on a protoboard, whereas the CC1000 is only available in a surface mount package. Our design specifications will only outline the specifications for the CC1000.

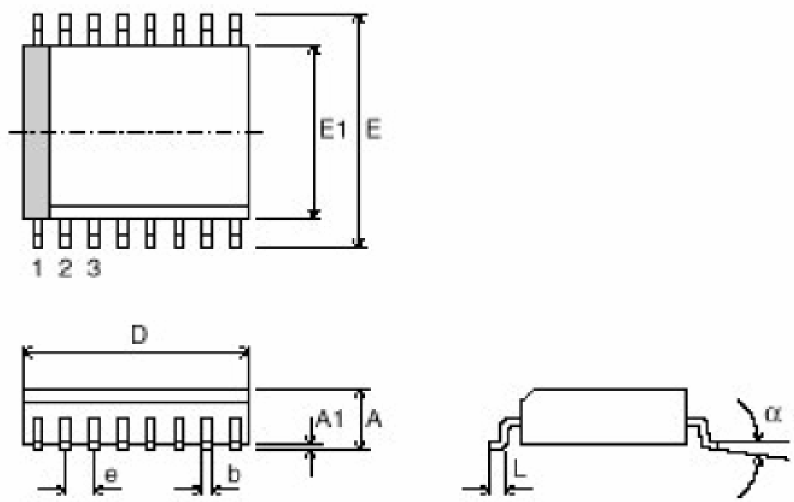
The two paramount considerations in selecting a transmitter chip were power consumption and size. Our power consumption requires that the transmitter be capable of transmitting for a minimum of 90 days [1], while our size restraints require that the entire transmitter unit fit within a 7x4x2cm enclosure. A third consideration for the transmitter chip was the bit error rate as a function of range. However, due to our relatively small range this consideration did not have as significant a bearing on our decisions.

[1] One day is considered to be eight hours of continuous transmission.

Based on these two primary criteria, we ruled out AM transmission, since AM transmissions are both less power efficient and more susceptible to noise than FM transmissions. Additionally, a transmitter that would operate at 3.0V was also considered an important factor, since the transmitter can be powered from a single lithium button cell.

The CC1000 is an ideal transmitter for our purposes, based on its low power consumption, low supply voltage, and small size. According to the Chipcon datasheet the CC1000, operates with a supply voltage of 2.1 to 3.6V and the minimum current consumption is 8.6mA when transmitting at 868MHz. The dimensions of the chip are outlined below in Figure 4: Dimensions of the CC1000. [2]

Package Description (TSSOP-28)



Note: The figure is an illustration only.

Thin Shrink Small Outline Package (TSSOP)											
		D	E1	E	A	A1	e	B	L	Copl.	α
TSSOP 28	Min	9.60	4.30			0.05		0.19	0.45		0°
				6.40			0.65				
	Max	9.80	4.50		1.20	0.15		0.30	0.75	0.10	8°
All dimensions in mm											

Figure 4: Dimensions of the CC1000

There are several additional benefits to utilizing the CC1000. In terms of our project, one of the most significant benefits, is the ability to program the operating frequency (300-1000MHz) as well as the output power (-20 to 10dBm). Additionally, since the CC100 is a transceiver, it is possible in the future to have the tag unit receive signals for different purposes.

The CC1000 transmitter chip will operate in the 900-928MHz ISM band for two reasons. First, this frequency range is an unlicensed band which means that users of our system do not require a radio license to operate it. Secondly, periodic transmissions which are less than 10 seconds apart are not allowed in lower frequency bands, according to both FCC and Industry Canada regulations; our transmitters must transmit every 2 seconds for our system to function properly.

Although the CC1000 transceiver modules can transmit using either ASK (AM transmission) or FSK (FM transmission), we will use since FSK transmissions for the power and noise reasons previously stated.

3.2 Antenna

Several possibilities exist for antennas designs. Since our range is very small (less than 5m), our antenna design will not be critical. Also, the ability to control output power in the transmitter chip will allow us to more easily tune our devices to meet our range requirements. The smallest and most practical solution for our compact design is a simple loop antenna which will be incorporated as part of our PCB on our final product. A typical loop antenna is depicted in Figure 5, below. Our design is based upon a loop antenna described in an application note by Freescale Semiconductor. [3]

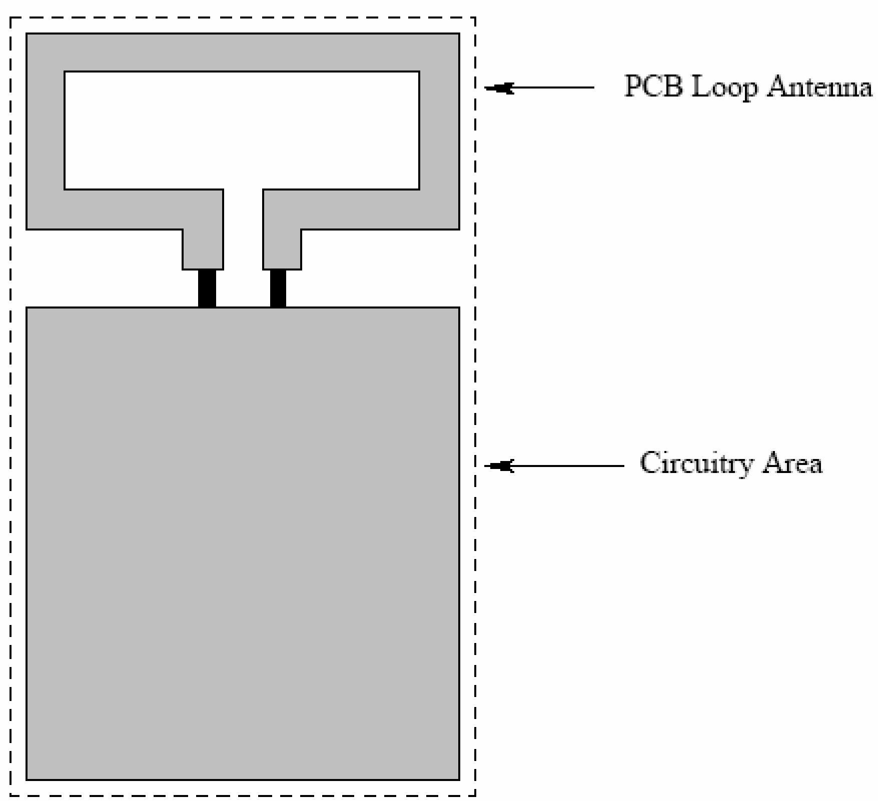


Figure 5: PCB Loop Antenna

3.3 Microcontroller

3.3.1 Hardware

To control the various requirements of our FM transmitter, only a small microcontroller is needed. Since the primary function of the microcontroller is to control the CC1000 transceiver and to periodically send short bursts of data, the microcontroller does not require many features nor does it need to be exceedingly powerful. We choose the ATtiny12L from Atmel Corporation mainly because of its size, minimum power consumption, and low operating voltage.

In terms of general specifications, the ATtiny12L has 1Kb of programmable flash memory, 64 bytes of EEPROM data, and up to six general purpose I/O lines. The ATtiny12L also features support for internal and external interrupts, an 8 bit timer/counter, a programmable watchdog timer and two types of power saving modes. The ATTiny has an active consumption of 2.2 mA, an idle consumption of 0.5mA,and a power down consumption of less than 1 μA. The operating voltage is 2.7 to 5.5V, which allows us to power it from the same 3.0V lithium button cell used for the transmitter. [4]

For our design, we require a maximum of five pins to control the CC1000. The watchdog timer can be used to periodically wake up the microcontroller, so a small burst of data can be transmitted. The remainder of the time the microcontroller will be in a very low power sleep mode. Additionally, the EEPROM can be programmed with unique ID numbers for each separate transmitter. All of these functions and features are built into the ATtiny12L microcontroller. An additional benefit of using the ATTiny12L is the availability of a STK500 development board and programmer from the Engineer Science Student Endowment Fund (ESSEF), which we were able to borrow for our project. The following figure illustrates the dimension of this microcontroller (Figure 6: ATTiny12L Dimensions).

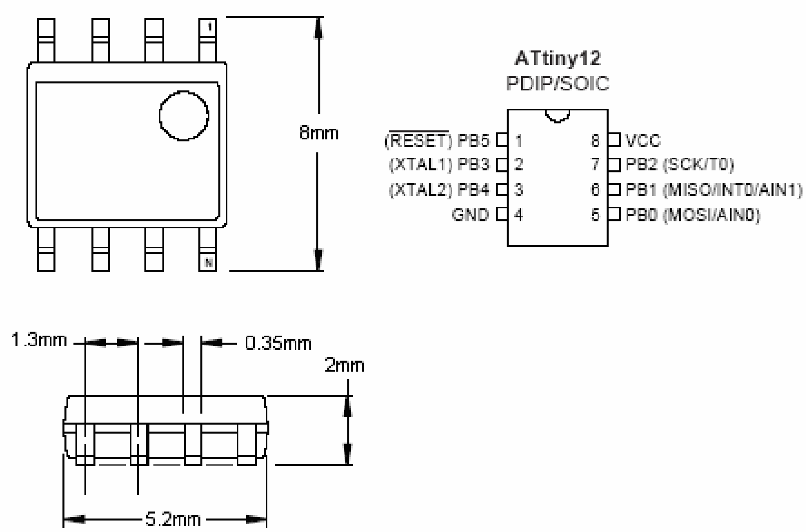


Figure 6: ATTiny12L Dimensions

3.3.2 Software

The software for the transmitter will be written in assembly as opposed to C. One of the tradeoffs for the size of the ATTiny12 is that there is no on-chip RAM and therefore few C compilers support it. The software on the transmitter should prove to be relatively simple, as its only function will be to wake up the microcontroller and control the transmitter so that a stored unique tag ID can be sent to the receiver on a periodic basis.

We use the Watchdog Timer (see Figure 7: Block Diagram of ATTiny12L) to control the transmission rate. By setting the proper prescale value and reset interval of this timer, we are able to periodically wake up the microcontroller from sleep mode, and then transmit an ID code with the FM transmitter. This implementation results in the microcontroller being in sleep mode the majority of the time, thereby minimizing power consumption and maximizing battery life. [4]

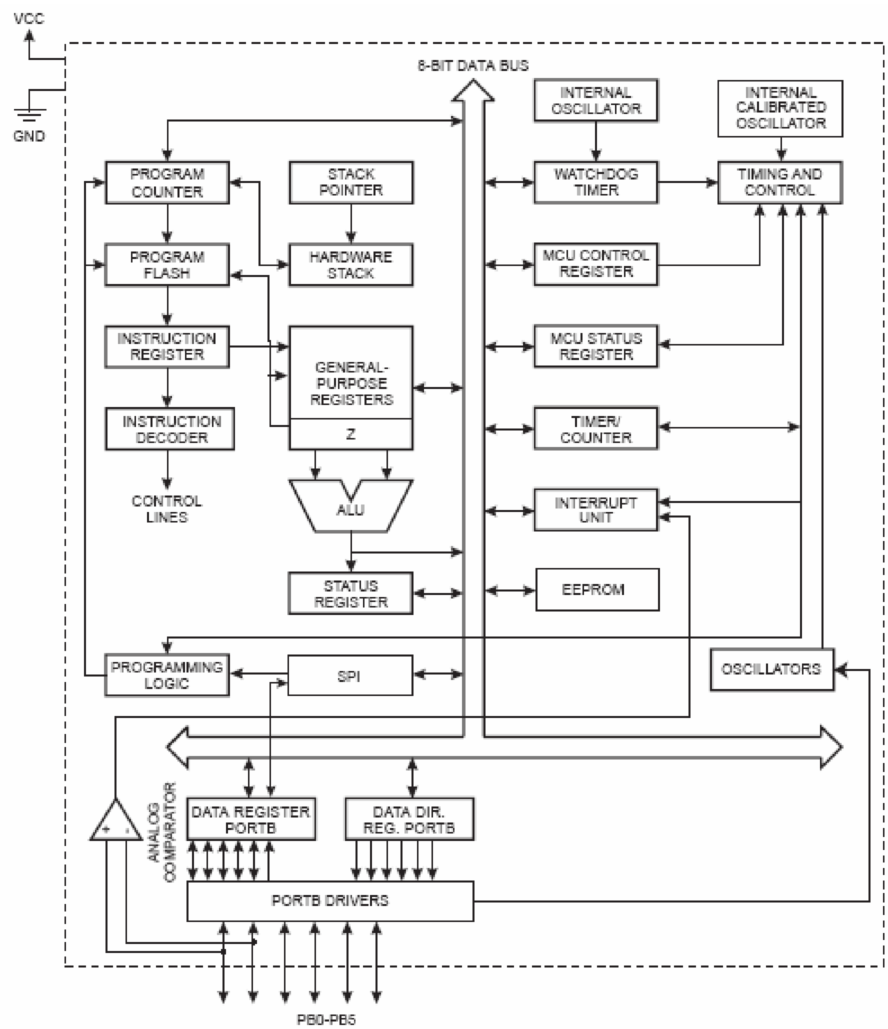


Figure 7: Block Diagram of ATTiny12L

The sleep mode is entered by setting corresponding bit in the MCU Control Register. The external oscillator stops in this mode while the Watchdog Timer and external interrupts continue their operations. The microcontroller can only be awakened by a Watchdog Timer reset or an external level interrupt. The changed external level must be held for a period of time if the microcontroller is to be awakened by external level interrupt. This process is designed to reduce noise effects.

In addition to controlling the wakeup time of the microcontroller, the software will also handle the initialization of the transmitter. The ATtiny12 connects to the CC1000 module as shown in Figure 11: Connections for Transmitter Unit in §3.5. The CC1000 must be configured on initial power up, as shown in the flow chart. Once it has been configured, it is shutdown to conserve power. Subsequent startups of the CC1000 are then much faster. [2]

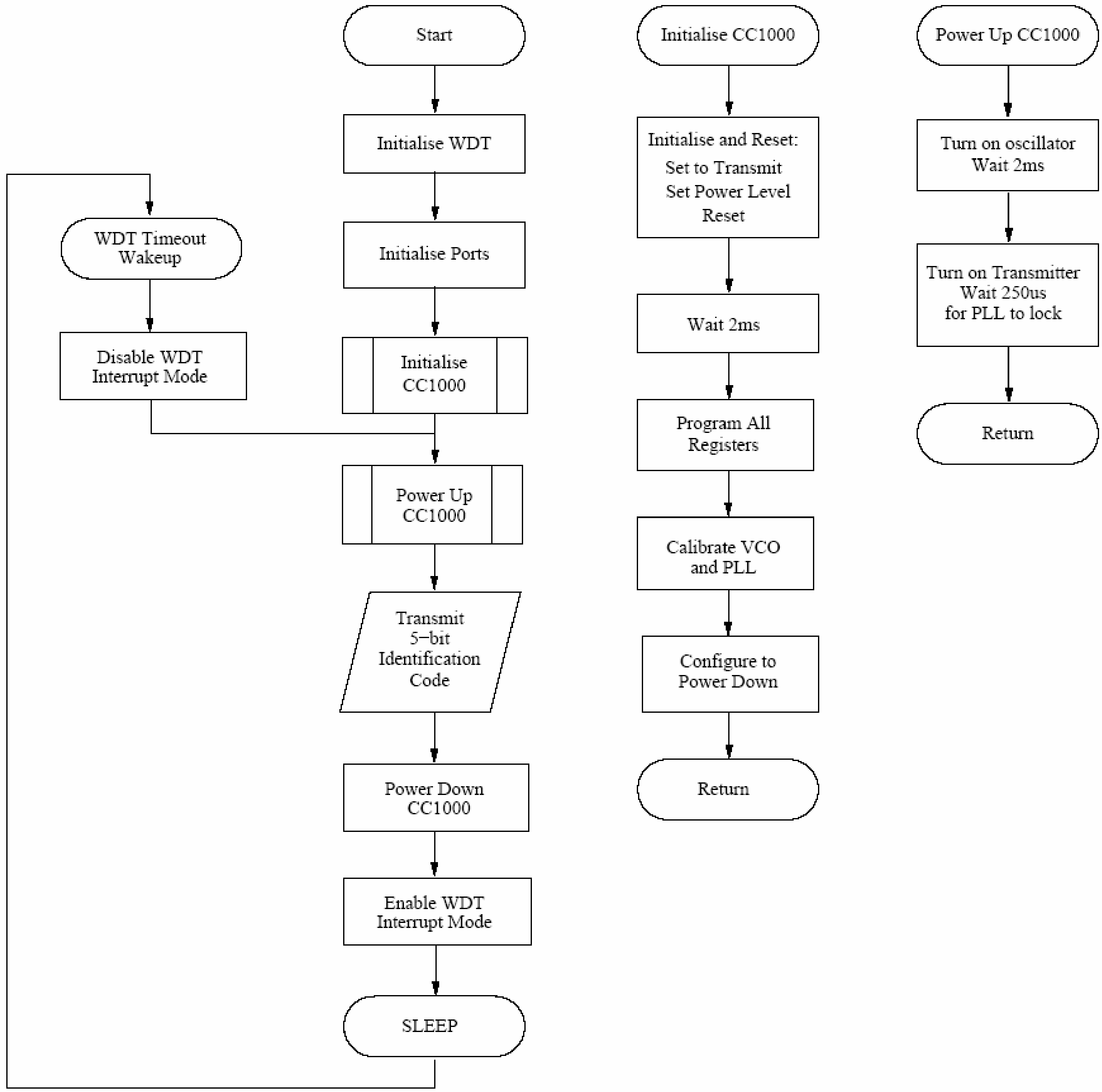


Figure 8: Transmitter Software Flow Chart

3.4 Power Supply

The voltage required by the CC1000 transmitter is between 2.1V to 3.6V, while the voltage required by the ATtiny12L is between 2.7 to 5.5V. Therefore we will utilize an intermediate voltage of 3.0V, as it lies within the operating range for both circuits. Additionally, 3.0V is a relatively standard voltage in terms of voltages provided by standard batteries.

The total current consumption for all the components in the transmitter is dependant on which mode the transmitter is in. In the active mode, the total current consumption is approximately 22 mA. In the idle mode, where the microcontroller is the sleep mode and the FM transceiver is powered down, the total current consumption is approximately 0.5 mA. In either mode, the current consumption is very low. We have chosen to use a 24.5mm BR2477A Panasonic coin cell with 3.0V and 1000mAh to meet our requirement. [5]

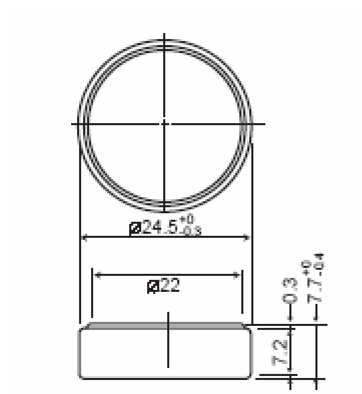


Figure 9: Lithium Ion Coin Cell Battery

Figure 10: Battery Life Chart below shows the battery performance as a function of time for a variety of temperatures. We note that battery life drop off proceeds at a relatively constant voltage prior to dropping suddenly. Comparison of this performance chart with other batteries which meet our voltage and lifetime requirements has shown that the BR2477A provides the best results.

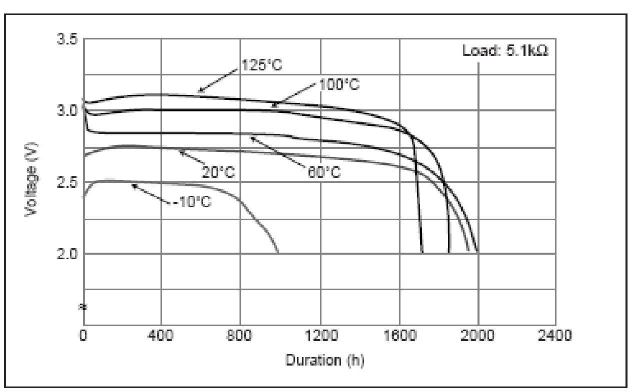


Figure 10: Battery Life Chart

3.5 Connections

The ATtiny12 microcontroller will be connected to the Chipcon CC1000PP module as shown in Figure 11, below. We note that there are two input lines and two output lines into the ATTiny12L. One bidirectional line is utilized as an I/O port for data.

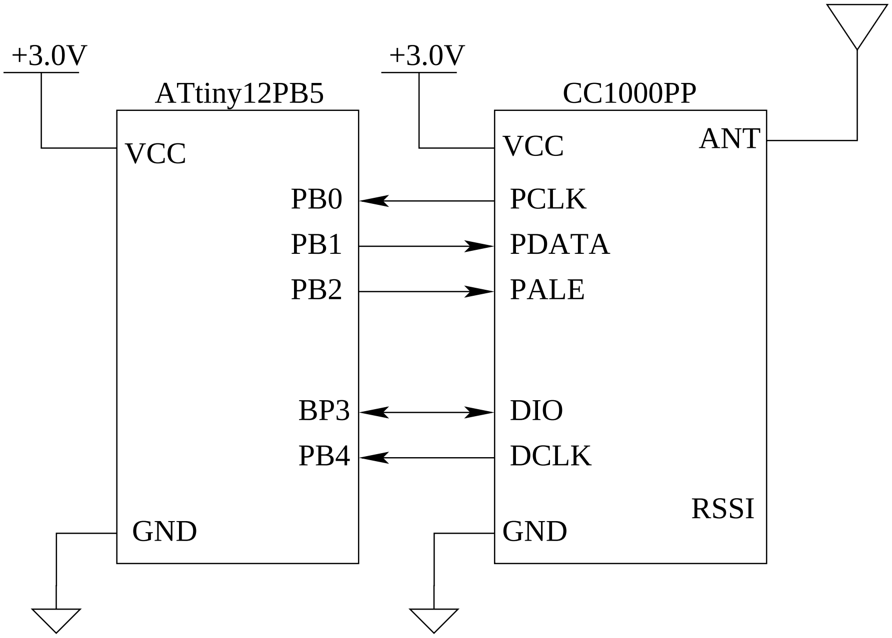


Figure 11: Connections for Transmitter Unit

3.6 Packaging

In order to protect the transmitter, we require an enclosure which will be able to hold all its components. The enclosure should be relatively light, and should fall within the constraints set for the size of the transmitter. Additionally, the casing must be relatively inexpensive but nonetheless durable. Keeping these considerations in mind, we have selected to use the C-4 enclosure made by Serpac. The casing has dimensions of 54mm x 35 mm x 15mm, and utilizes a single assembly screw, shown below. [6]

(a) **(b)**

Figure 12: Tag (Transmitter) Unit Case

4. Receiver

The receiver unit will consist of a reasonably small RF receiver which a user will preferably wear. Users will be able to program in an 8 character description for each of the five tags, using a five button joystick, and an LCD display. The receiver unit will periodically poll a number of valid tag ID's to ensure that the specified tag ID is still in range. If the tag ID is not detected, the receiver will notify the user, utilizing and LED as well as a buzzer. The key components to the receiver will be a receiver chip, a microcontroller, an LCD screen, a buzzer, an LED, a five button switch, and a power supply with an on/off switch. The interconnections of these parts will be outlined below. The finished circuit will be enclosed in a plastic package.

4.1 Receiver Chip

On the receiver side, we utilize the same chip as for the transmitter, the CC1000 by Chipcon. Since the CC1000 module is a transceiver chip, the only difference on the receiver side is simply configuring the CC1000 to be in receive mode. However, in our initial prototype we will utilize an Abacom ARX-433-ULC AM receiver [7], as it can be easily attached to a protoboard, and is compatible with the AM transmitter we are using for our prototype.

Our justification using the CC1000 on the receiver side is the same as that for the transmitter side: small size and low power. Again, the benefit of the CC1000 being a transceiver is made obvious as it allows transmission of data to tags. This feature could prove useful in future models of the product.

One of the major benefits of the CC1000 is its integrated RSSI. In order to perform reliable ranging measurements for our system, we require an RSSI signal from the receiver chip. RSSI functionality is not available with all RF chips, and although constructing a custom circuit is an option, it is much simpler to use a receiver chip with RSSI built in. Because of all these considerations, the CC1000 chip was chosen for the receiver side of our system. [2]

4.2 Antennae

The antenna on the receiver side will be identical to the one used on the transmitter side, a simple loop antennae etched onto the PCB, as the constraints on the distance for the receiver are identical to the transmitter. Please see §3.2 for details. [3]

4.3 Microcontroller

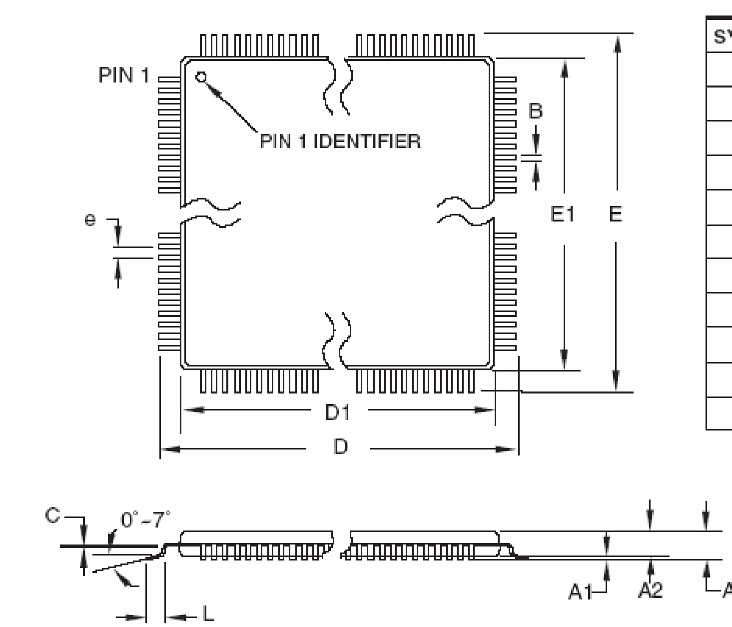
4.3.1 Hardware

When selecting our micro-controller for the receiver, we considered the following criteria: the number of pins required vs. the number of pins available, the power consumption of the chip, the size of the chip, and compatibility with our receiver.

In our preliminary designs, we estimated that we would require a minimum of 25 general IO pins. The ATMega32L more than sufficiently meets this number, providing 32 programmable IO lines. In terms of power consumption, the ATMega32L requires 1.1mA in active mode, 0.35 mA in idle mode, and less than 1 µA in power down mode. Its maximum operating voltage is 5.5V. [8]

The frequency of the ATMega32L can vary from 0 to 8MHz; The CC1000 requires the connected microcontroller to be capable of frequencies between 4 – 8 MHz, in order to operate properly. The ATMega32L is fully capable of meeting these requirements.

In terms of dimensions the ATMega is relatively small considering its many features and power. The dimensions of the surface mount version of the ATMega32L are given below (Figure 13: ATMega32L Dimensions).



COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	1.20	
A1	0.05	–	0.15	
A2	0.95	1.00	1.05	
D	11.75	12.00	12.25	
D1	9.90	10.00	10.10	Note 2
E	11.75	12.00	12.25	
E1	9.90	10.00	10.10	Note 2
B	0.30	–	0.45	
C	0.09	–	0.20	
L	0.45	–	0.75	
e	0.80 TYP			

Figure 13: ATMega32L Dimensions

We see above that the ATMega32L more than sufficiently meets our primary requirements. Some general features of the microcontroller include 32K of programmable flash memory, 1024 bytes of EEPROM, 2K bytes of internal SRAM, an 8 channel 10 bit A/D converter that is used to connect with the RSSI of the receiver, three external interrupt pins that we utilize to connect with an input device, two 8 bit timer/counters, one 16 bit timer/counter, a programmable serial UART, and a programmable watchdog timer with a separate on-chip oscillator.

Another additional side benefit is that a programmer is readily available. Like the ATTiny12L, the ATMega32L can be programmed using the STK500 development kit.

4.3.2 Software

One major benefit of using the ATMega32L is the ability to program the microcontroller in C, as opposed to assembly. Using a free GNU compiler which has been ported to windows, WinAVR, we can compile C code and use it to flash the microcontroller. Being able to use the WinAVR C compiler also enables us to use a variety of libraries designed specifically for use with the AVR family of microcontrollers.

The primary purpose of the receiver is to periodically check for specific tag IDs in order to ensure that they are within range. When a tag is out of range, the receiver needs to notify the user that the tag is out of range by sounding an alarm or blinking a LED. Once an alarm sounds, the user has the option to either deactivate or sleep the alarm by selecting the option on the receiver. Beyond these responsibilities, the receiver must allow users to enter in names for specific tags, and display these names when the tag alarm goes off. All these different functions are controlled by the receiver software. [7]

A high level design for the operation of the receiver software is shown below in Figure 14: .

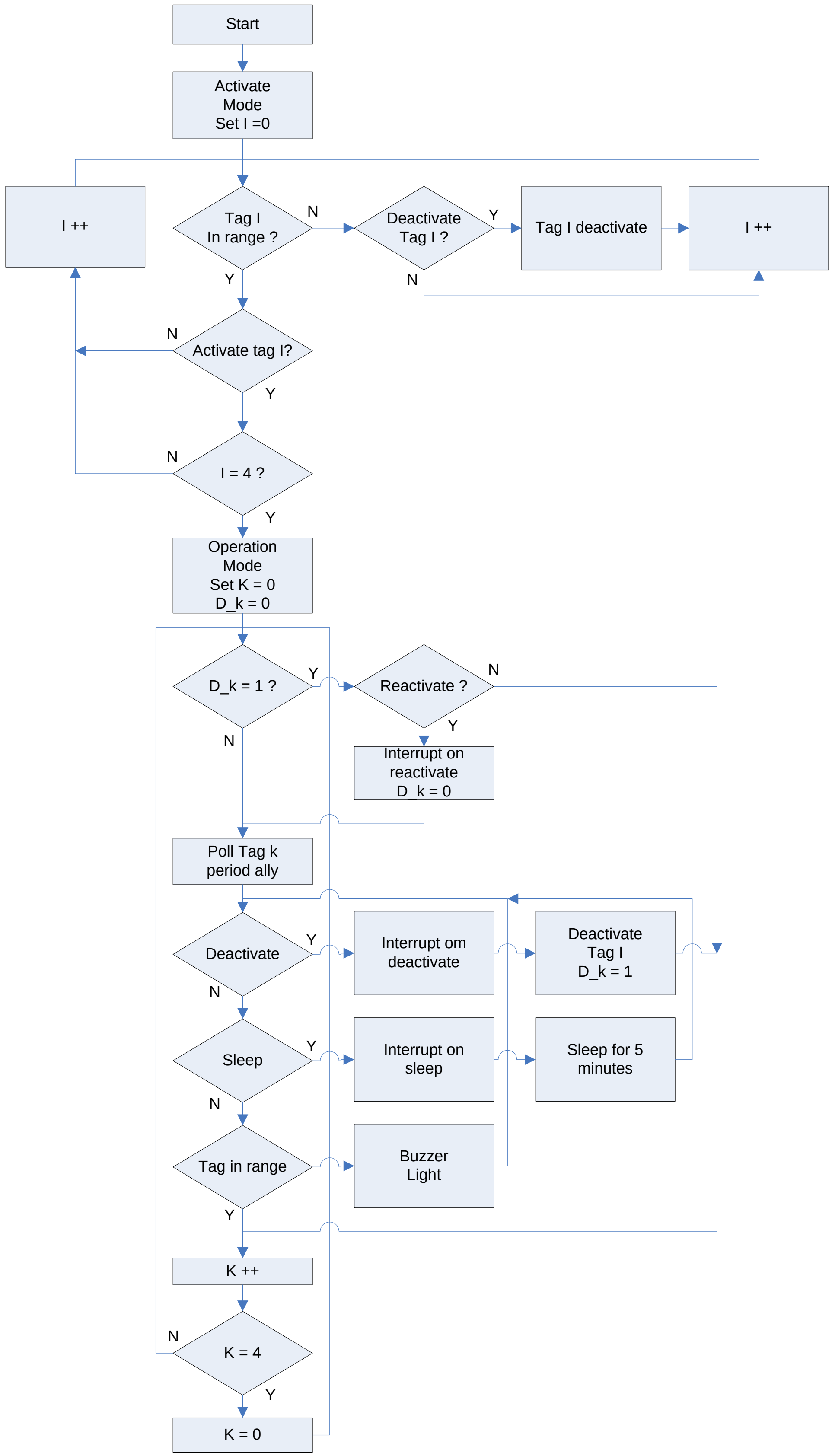


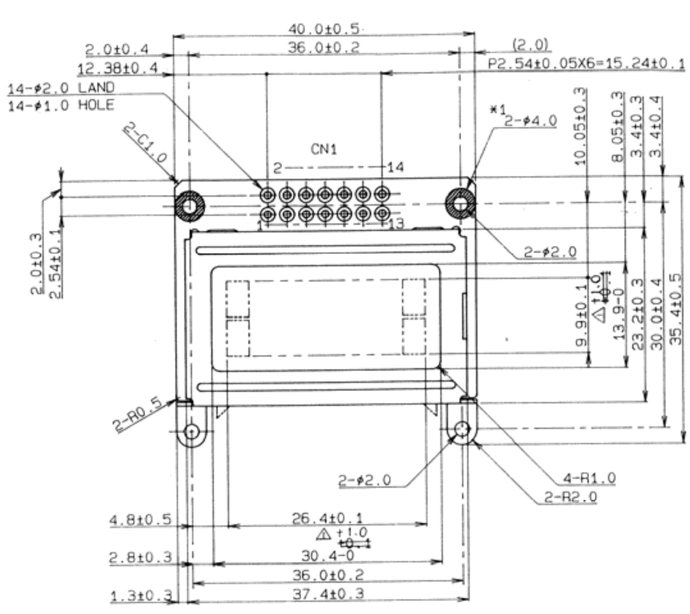
Figure 14: Receiver Software High Level Design

4.4 Interface

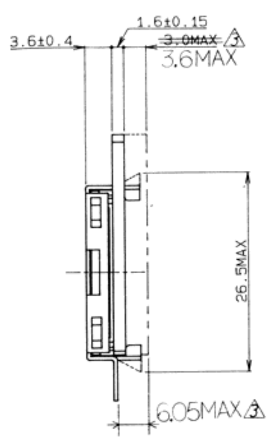
The interface of the system consists of six primary components: an LCD display, a five direction tactile switch, an LED and a buzzer.

4.4.1 LCD

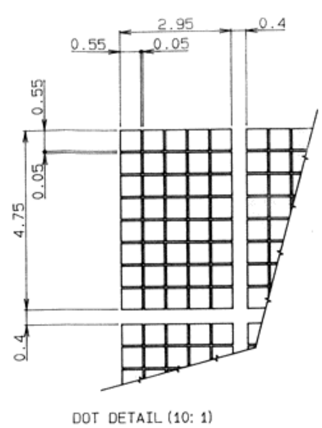
The LCD chosen by for this project is a DMC 50448N made by Optrex. The DMC 50448N utilizes a standard 14 pin control driver, the Hitachi HD44780. The dimensions for the LCD and driver, as well as the connections between the HD44780 and the LCD are given in Figure 1: Basic ConceptFigure 15: Dimensions of LCD (a) Front View (b) Side View (c) Pixel Grid, and Figure 16: Connection between LCD and Driver Chip respectively. [9]



(a)



(b)



(c)

Figure 15: Dimensions of LCD (a) Front View (b) Side View (c) Pixel Grid

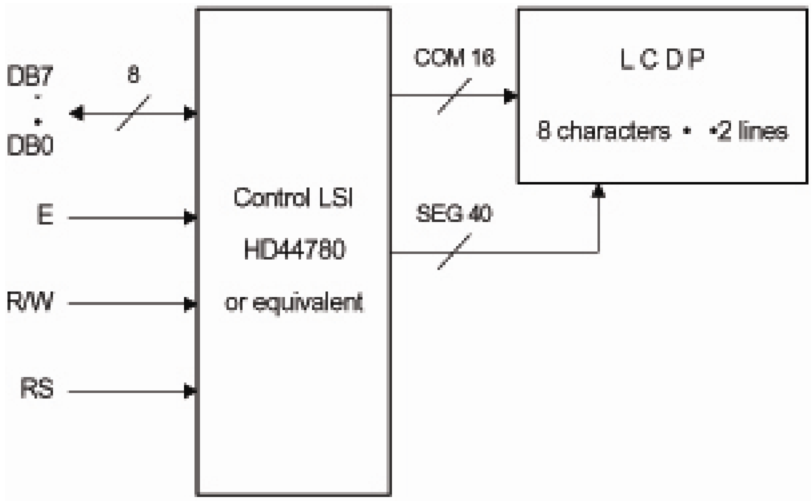


Figure 16: Connection between LCD and Driver Chip

The HD44780, has 3 control lines and 8 bi-directional IO lines; the remaining 3 lines are power and contrast control lines. The pin assignments are given in Table 1: Pin Assignment for HDD44780. [9]

Table 1: Pin Assignment for HDD44780

Pin No	Assignment	Pin No	Assignment
0	V_{SS}	7	DB_1
1	V_{DD}	8	DB_2
2	V_0	9	DB_3
3	RS	10	DB_4
4	R/W	11	DB_5
5	E	12	DB_6
6	DB_0	13	DB_7

In connecting the HDD44780 to the Atmel ATMega32, there are two types of configurations which are commonly used: memory mapped mode Figure 17: Memory Mapped Connection Mode, and 4 bit mode Figure 18: 4 Bit Connection Mode. Because, the memory mapped mode requires additional memory and significantly more IO pins from the microcontroller, we will utilize the four bit mode. [10]

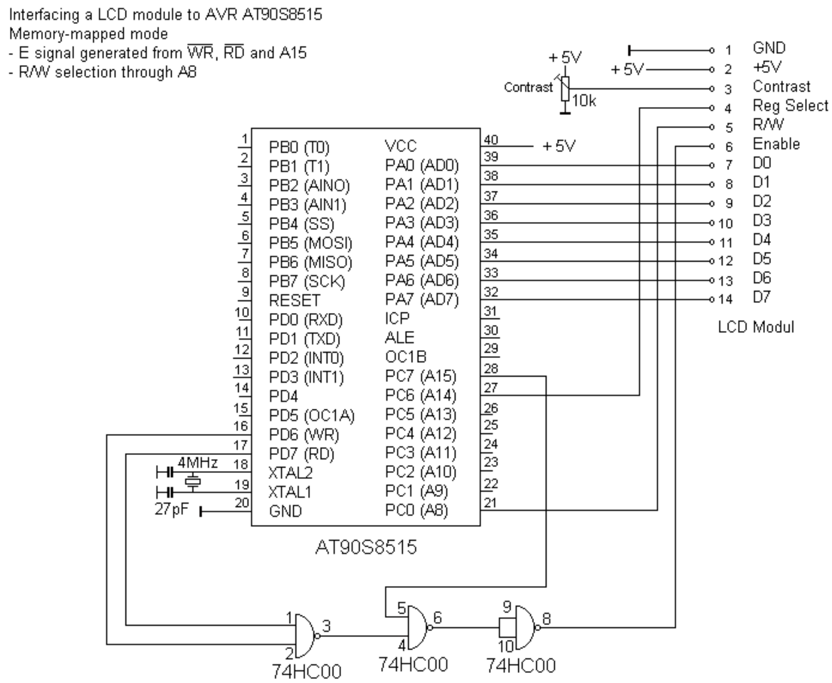


Figure 17: Memory Mapped Connection Mode

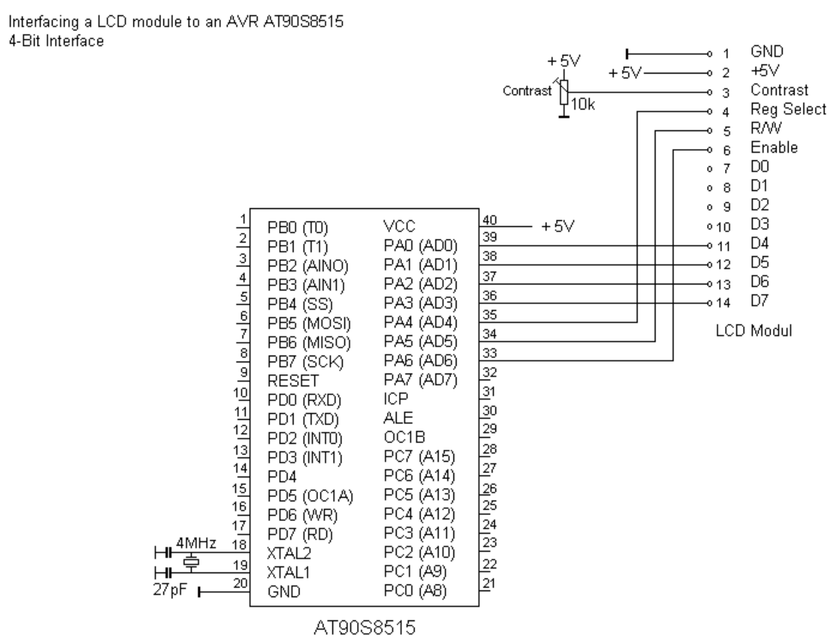


Figure 18: 4 Bit Connection Mode

In terms of programming the LCD to display characters, there is a specific instruction set given to control the driver chip. This instruction set is outlined in Table 2: Instruction Set for the HDD44780. [11]

Table 2: Instruction Set for the HDD44780

Instruction	Code									
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Clear display	0	0	0	0	0	0	0	0	0	1
Cursor home	0	0	0	0	0	0	0	0	1	*
Entry mode set	0	0	0	0	0	0	0	1	I/D	S
Display On/Off control	0	0	0	0	0	0	1	D	C	B
Cursor/display shift	0	0	0	0	0	1	S/C	R/L	*	*
Function set	0	0	0	0	1	DL	N	F	*	*
Set CGRAM address	0	0	0	1	CGRAM address					
Set DDRAM address	0	0	1	DDRAM address						
Read busy-flag and address counter	0	1	BF	CGRAM / DDRAM address						
Write to CGRAM or DDRAM	1	0	write data							
Read from CGRAM or DDRAM	1	1	read data							

Because we are programming the ATMega32L in C and using the WinAVR compiler, we can fortunately utilize an open source library designed specifically for interfacing AVR microcontrollers with LCDs. This allows us to simply call predefined functions to output text on the display. However, we do need to develop our own method of reading the string on the display and storing the string into memory. We may also be required to program the LCD to display special characters on the screen.

4.4.2 Five Direction Tactile Switch

In order to facilitate navigation of the various menus, as well as to provide a method for entering text to associate with specific tags, we utilize a five directional tactile switch. We opted to use the TPA413G, by ITT industries Cannon. This switch allows users to enter up to 5 possible instructions, while utilizing very little space. Five output pins from the switch will connect to the microcontroller, each pin denoting a specific direction. Figure 19: 5 Direction Tactile Switch, outlines the dimensions of the tactile switch. [12]

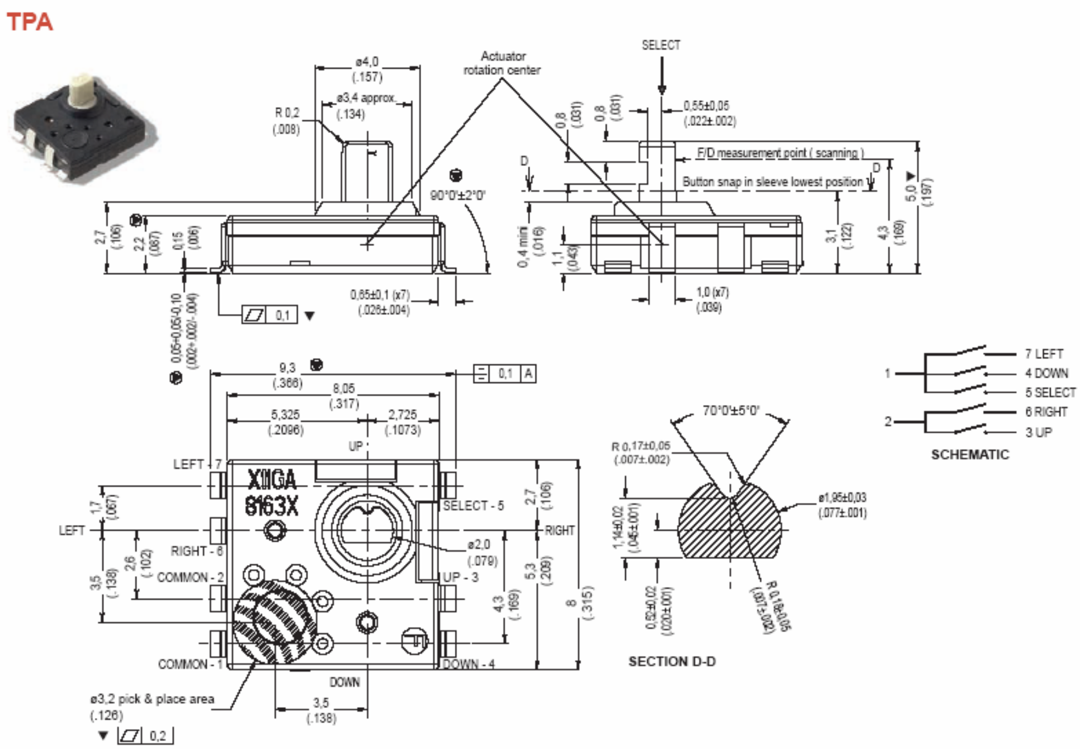


Figure 19: 5 Direction Tactile Switch

4.4.3 LED and Buzzer

The LED and buzzer are utilized as visual and audible warnings to users as that a specific tag is out of range. The buzzer we will be utilizing is a CEP-2242 by CUI Incorporated. Due to the buzzer's small size (Figure 20: Buzzer Dimensions), and relatively low current consumption, along with its ability to be easily prototyped, the CEP-2242 is a good candidate for our project. [13]

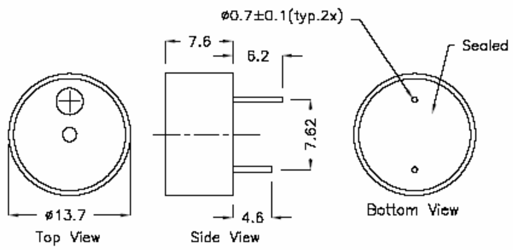


Figure 20: Buzzer Dimensions

Due to the wide variety of piezoelectric buzzers and LEDs available, it is difficult to choose which model to use. Additionally, due to the relative simplicity of these components in the general scope of the project, interchanging these components for other models is not completely out of the question.

4.5 Power Supply

The voltage required by the CC1000 receiver is between 2.1V and 3.6V, while the voltage required by the ATMega32L is between 2.7 and 5.5V. Additionally, the LCD requires a source voltage between 4.5V and 5.5V and the buzzer requires a source voltage between 3V and 16V. Since the majority of devices can be powered by 3V and because the CC1000 requires bidirectional signals, we will supply 3V to the microcontroller and the FM transceiver chip, and utilize a DC-to-DC converter (charge pump) to run the LCD. The signals from the ATMega32L will be buffered by an open-collector driver with pull-up resistors to interface to the LCD.

The total current consumption for all the components in the receiver depends on which mode the transmitter is in. In the activate mode, the total current consumption is approximately 9 mA. In the sleep mode, the total current consumption is approximately 0.35 mA. In the alert mode, the total current consumption is approximately 12 mA. Due to the varying current consumptions, it is difficult to precisely calculate the minimum number of mAh needed to meet our requirements. However, if we use an average value to calculate our total power consumption, we can meet our requirements of one month battery life under normal use[2], by utilizing the same battery as the one used in the transmitter, the Panasonic BR2477A. We will assume that the receiver battery will have to be replaced more frequently. [5]

4.6 Connections

The receiver consists of three main components, the ATMega32L microcontroller, the receiver chip and the LCD. In addition to these larger components, there are four smaller components, the buzzer, the five direction tactile switch, the LED, and the power supply. The central connection between all these components is the microcontroller. The following figure,

Figure 21: High Level Connections shows a high level design for the figure.

[2] Normal use is defined as being activated for 8hrs/day and having an alarm sound once per day for a maximum time of 5 seconds. Additionally, the display will only be active for 10 minutes per day in total.

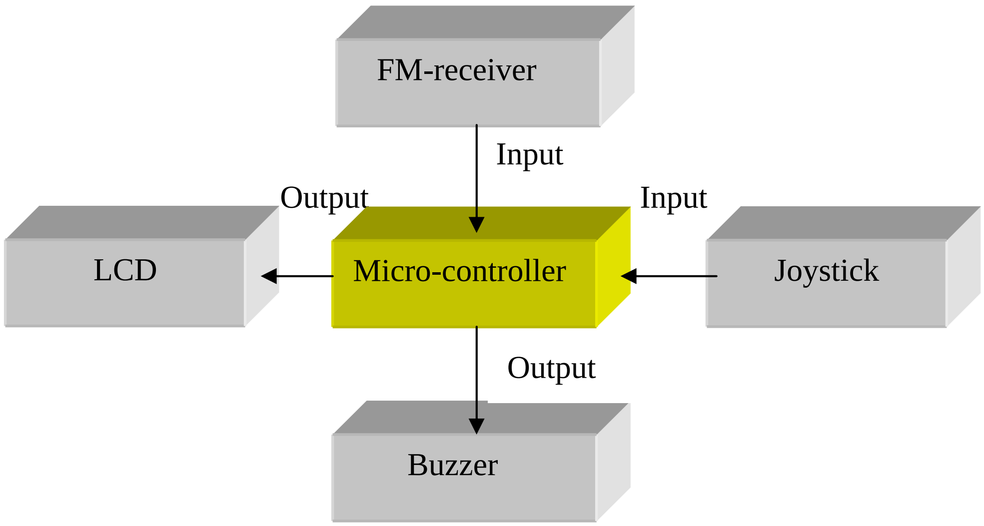


Figure 21: High Level Connections

Port A of the microcontroller connects to the FM receiver RSSI signal. Although only one pin is required for the ADC, the use of the ADC means the remaining pins on this port cannot be used for any other function. PORT B is connected to the LCD's data I/O lines DB_0 to DB_7. The first five bits of PORT C will be used as an input from the five button switch. The last three bits of PORT C will be connected to the control lines of the LCD. The receiver chip requires 5 pins for communication and control, which will occupy the first five pins of PORT D. Two more bits off PORT D will be connected to the buzzer and LED. We may utilize the remaining pin on port D to operate a motor to implement in a vibrating alert mode. A detailed picture of the connections is shown below in Figure 22.

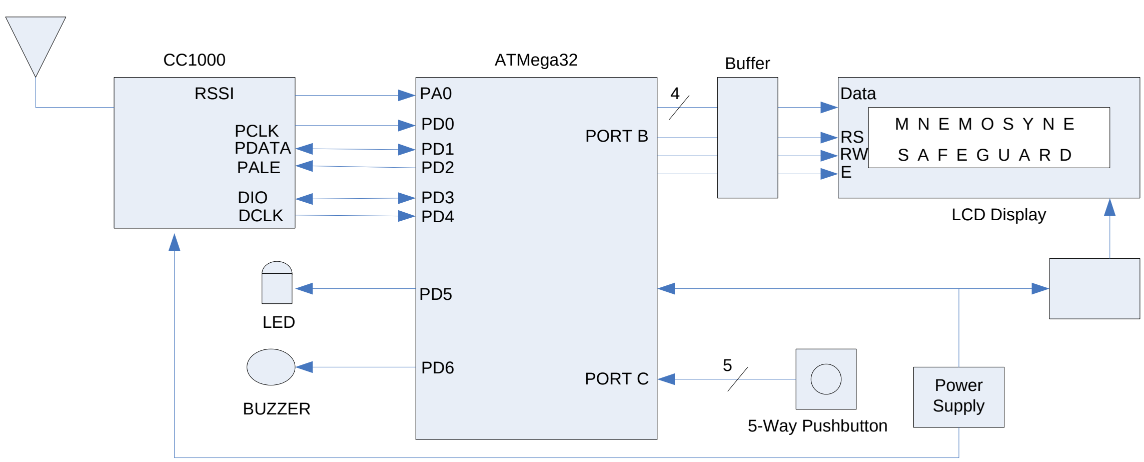
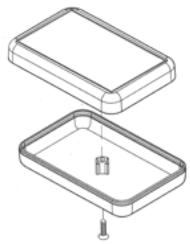


Figure 22: Circuit Diagram of Receiver

4.7 Packaging

Like the transmitter, an enclosure is required in order to ensure that the receiver is not easily damaged. The same considerations taken into account for the receiver were also considered in this case, with the extra constraint that the LCD display and joystick must be able to fit on the exterior. Due to the larger size constraints, we will utilize the C-6 enclosure by Serpac. [14]



(a)

(b)

Figure 23: C-6 Packaging for the Receiver

5. Test Plans

We will separate the device operation into blocks and test these blocks independently. Once these blocks have been tested separately they will be integrated and the integrated block will be tested; this procedure will be iterated until the fully functional system is developed. These blocks include the RF transmitter/receiver pair, the LCD display, the transmitter micro-controller (ATtiny12) and the receiver micro-controller (ATMega32L). Tests for an integrated system will then be conducted after each block has successfully completed testing.

The most basic test for the RF transmitter/receiver pair is to feed in a signal wave form from the function generator as input to the transmitter and observe the output of the receiver. An important observation in this test is to recognize the effects of range, direction and obstacles on the quality of the transmission.

The primary test of the LCD will be for the display to initialize and output a rudimentary character string.

In terms of microcontrollers, one important feature we utilize is interrupts. The timer interrupt in the transmitter micro-controller should sleep the microcontroller, wake the microcontroller up and output a signal periodically. The receiver micro-controller should be able to accomplish the same test, with the added complexity of being able to handle external interrupts, such as switches and enter different mode of operations.

As a secondary test, the transmitter chip and its corresponding microprocessor (ATtiny12) can be connected and a function can be generated by the microprocessor and fed into the transmitter as input. The receiver at the other end should pick up the transmitted signal and display the results on an oscilloscope.

For a secondary test on the receiver side, the micro-controller can be connected to the LCD and a 5-way switch. Pressing corresponding switch direction should cause an external interrupt and activate a “naming” mode allowing users to enter in text on the LCD screen, which will be stored to memory.

For a third test we will connect these sub tests together, testing for the fully functionality with the buzzer, receiver range, and the activate/deactivate mode.

For a final test, we will test the receiver with multiple tags. Each receiver should be able to keep track of up to five tags. Essentially this experiment will test the receiver’s ability to distinguish between the different tags and keep track of them.

Once this test is completed successfully we can move onto the production stage which will involve scaling the prototype down.

6. Conclusion:

People lose items everyday. Lost and founds are everywhere you go; each is filled with items that people never reclaim and often have to replace at significant cost. As the market penetration of cell phones, pocket PCs, and other small electronic equipment increases, the number of items which are lost also increases. The SafeGuard provides a solution for the forgetful and absentminded, preventing the loss of their items. The goal of Mnemosyne Technologies is to generate a product with all the preceding specifications by the end of April. Utilizing these blue prints as a guideline, Mnemosyne Technologies hopes to create a fully functional prototype by the end of April.

7. References

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