November 5, 2009

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

Re: ENSC 440 Capstone Project Design Specification for the CheckList™ Assistive Memory System by Mnemosyne Innovations Incorporated.

Dear Dr. Bird:

Please find attached the Capstone Project Design Specification for the product CheckList™ by our company, Mnemosyne Innovations Inc. Mnemosyne Innovations is comprised of four highly motivated and talented engineering students: Priyanka Deshmukh, Rachel Cheng, Ana Namburete and Surbhi Seru.

Forgetting items is something all of us have experienced at some point or another. Our product, CheckList™, is precisely aimed at alleviating this problem. CheckList™ is a convenient *portable* memory aid device that enables users to confirm that all relevant items are being taken with them when they leave their surroundings.

Enclosed herewith are the design specifications for the product CheckList™. This document aims at providing specific technical details pertaining to each of the subcomponents as well as the technical elements of the system as a whole. In addition, throughout this document, the concept of interfacing and coordinating the various components of our design will be clarified. The Function Specification and Requirements document will be closely referred to during the production of the Design Specification document so as to ensure the requirements outlined previously are met through the design process.

If there are any questions regarding the proposal, please feel free to contact me by phone (778-995-0832) or email (pmd1@sfu.ca).

Thank you very much for your consideration.

Sincerely,

Priyanka M. Deshmukh

Priyanka Deshmukh
Chief Executive Officer, Mnemosyne Innovations Incorporated

Enclosure: Design Specification for Mnemosyne Innovations' CheckList™ Assistive Memory System

Mnemosyne Innovations Incoporated

CheckList™ Assistive Memory System

Design Specification

Project team:	**Priyanka Deshmukh** **Rachel Cheng** **Ana Namburete** **Surbhi Seru**
Team Contact:	**Priyanka Deshmukh** **pmd1@sfu.ca**

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Executive Summary

To forget is human…

In a society where everyone is constantly on the move, it is easy for anyone to forget important items at home, in a vehicle or at a public place. Mnemosyne Innovations presents the CheckList™: the only device needed to remember the most important and valuable items for the busy everyday person.

The CheckList™ system allows anyone to tag items and verify that all tagged items are with the user. The system comes with three components: the main device unit, tags for the items and a user interface. In order to use the CheckList™, the user places the tags onto the items needed, e.g. a wallet or a laptop. Next, plugging the main unit into a computer, the user can access a simple user interface where he/she can easily add, edit, or remove tags active on the device. The device is also password protected to ensure that the information stored on the CheckList™ is secure. Before leaving a location, the user merely has to press the 'Check' button located on the main unit and the screen will display which items are absent with the user.

In future releases of the CheckList™, we will include software that will allow the system to prevent users from being pick-pocketed. Also, we hope to reduce the size of the tags and labels with the advancements in radio frequency identification (RFID) as well as other radio frequency (RF) technologies.

The design decisions and test plans for the first iteration prototype of the CheckList™ are outlined in this Design Specification document. The Mnemosyne Innovations executives have made it their priority to deliver a proof-of-concept device that is safe, portable, and easy to use by December 14, 2009.

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List of Acronyms

AP	Access Point	MCU	Microcontroller Unit
ED	End Device	PC	Personal Computer
FHSS	Frequency Hopping Spread Spectrum	RF	Radio Frequency
GUI	Graphical User Interface	SRD	Short Range Device
IDE	Integrated Development Environment	RFID	Radio Frequency Identification
I^2C	Inter-Integrated Circuit	UART	Universal Asynchronous Receiver/Transmitter
LCD	Liquid Crystal Display	USB	Universal Serial Bus

CheckList™: Design Specification

1 Introduction

Mnemosyne Innovations' goal is to simplify the task of memory storage and recollection in terms of remembering what objects of interest an individual needs to carry with them. The CheckList™ is a memory aid device aimed at helping users remember everyday items as well as special items of importance (for example, during a camping trip). The product comes in a compact, easy to use form. A handheld detection unit contains the receiver necessary to identify the tagged items, a liquid crystal display (LCD) presents the status of the items to the user, and USB capability allows effortless interfacing with a personal computer (PC). By simply pressing the 'Check' button, the CheckList™ device is activated and a scan is performed to sense the location of the tagged items in the surrounding environment; this information is relayed to the user through radio frequency (RF) technology.

This Design Specification document describes technical details of each of the individual components of the CheckList™. The final proof-of-concept prototype will consist of four active tags, one handheld detection unit, and interfacing with a single user account on the main database.

1.1 Scope

The Design Specification document illustrates all of the design details of the CheckList™. More specifically, it outlines *how* the requirements mentioned in the Functional Specification document [1] will be implemented. We have focussed on requirements pertaining to the proof-of-concept design (requirements classified as [FS-#-I] and [FS-#-III] in the Functional Specification document) because that is the focal point of this course. At a later date, with advancements in technology, requirements classified as [FS-#-II] that pertain to the commercial product will be achieved. By the end of this document, the reader must be informed regarding the exact implementations procedures of all the subsystems and the manner in which they are to interact with each other. In addition, a system test plan will be provided to perform System Quality Assurance Analysis that will not only examine the reliability of the product in terms of detecting items but will also assess the user friendliness of the two interfaces: the handheld unit interface and the graphical user interface (GUI) of the executable file.

1.2 Intended Audience

This document is primarily to be used by the company executive of Mnemosyne Innovations, to assist in the design process as well as for product testing purposes. There two tasks will be overseen mainly by the software/hardware development and test engineers at Mnemosyne Innovations. The chief executive officer of the company will also be able to use this document to ensure the progress of the product in the correct direction and to oversee that requirements are being met in a reliable and cost effective manner.

2 System Overview

The CheckList™ system involves three main components: the main detection unit; the target boards acting as detection tags to place on important items as shown in Figure 1; and a user interface that is accessed via a universal serial bus (USB) connection between the detection unit and a PC.

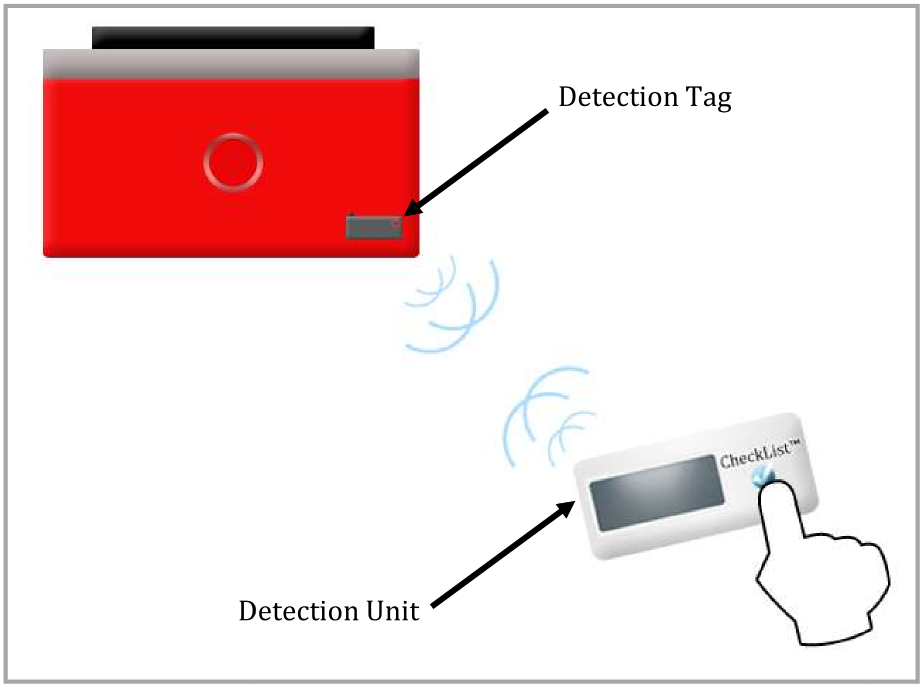

Figure 1: CheckList™ System Components (Commercial Product)

The prototype system consists of four unique tags. These tags have an adhesive backing so that they can be attached to an object. Once a tag is placed on an object, such as a laptop, the user simply takes the detection unit and plugs it into a USB port on any PC. An executable file running the GUI can be accessed by the user to activate the tags. The user simply creates a profile through the use of the GUI, which includes setting up a password for the security of the items stored on the device. After finding the matching tag number on the interface, the user can change the tag label to something more intuitive; for this example, 'My Laptop'. The user then activates the tag, saves the settings and the system is now ready to be used.

Before leaving their current location, the user simply presses the 'Check' button on the detection unit and a signal is sent from the device to detect the tag within a 1m radius. If the laptop is not within this range, the LCD will indicate that the user is missing one item and will list 'My Laptop' as the missing item. Once the laptop is retrieved by the user and the 'Check' button is pressed for a second time, the LCD will now indicate that the user has all items needed.

3 Overall System Design

The CheckList™ system is separated into two general parts: software and hardware. The software consists of the GUI and the functionality of the main detection board's microcontroller unit (MCU). The hardware includes the RF detection unit, RF target boards, and the LCD.

3.1 Software Design Overview

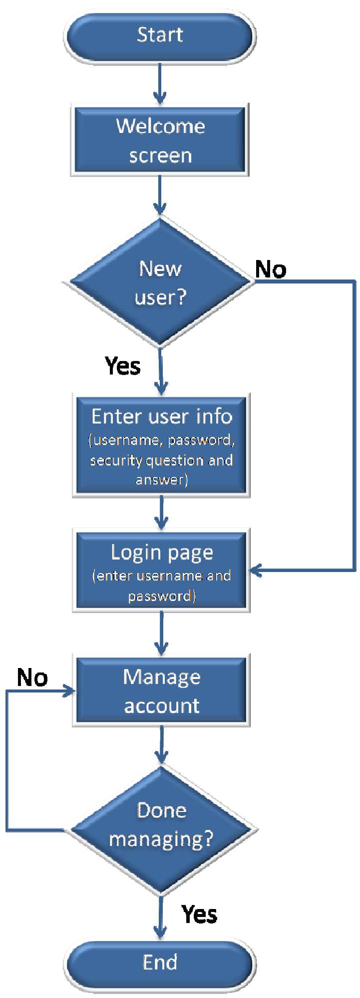

Figure 2: GUI Design Flowchart

The GUI will be programmed using Microsoft Visual C++ 2008 Express Edition and the QWT, the Qt cross-platform applications framework. The GUI will be displayed when the CheckList™ device is plugged into the computer via a USB port, and the executable file is run. This GUI will allow the user to add and modify information to their account and this information will be saved in a database.

Upon plugging the device into the PC, the user will run the executable file and the welcome screen of the GUI will be displayed. This welcome screen will have two buttons: 'Login' and 'New User'.

If the user does not have an account, they will create an account by entering their information, including a username, password, and security question.

Once the user has been created, the login page will be displayed, and they will need to enter their username and password.

Upon successfully logging in, the user will be able to see which tags are active, and which ones are available for tagging onto new items.

When the user is done adding/removing tags, the user can then log out of the GUI and use the device.

3.2 Hardware Design Overview

In order to develop a product that meets the specifications set at the beginning of the course, hardware selection is paramount. Following thorough research, Mnemosyne Innovations decided that the MSP430 eZ430-RF2500 Development Tool Kit by Texas Instruments best suited our project needs. It is a USB based wireless development tool providing the hardware and software platforms needed to evaluate the MSP430F2274 microcontroller and the CC2500 2.4 GHz wireless transceiver. An overview of the connections between the hardware components is shown in Figure 3.

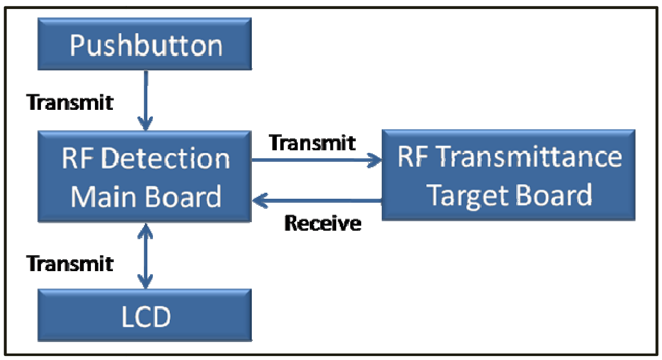

Figure 3: Hardware Overview Flowchart

The handheld detection unit consists of an RF receiver/processor, a USB debugging interface, a pushbutton, an LCD and a 9V battery (with a regulator). The active tags are the target boards powered by a 3.3V battery. A brief description of these is provided below; however, the hardware components will be examined in further detail in Section 5. For description purposes, the hardware is split into three sections: the RF detection main board, the RF target boards, and the LCD.

The main board is the USB debugging interface along with the MSP430F2274 microcontroller. It is the central RF detection system that will be embedded into the handheld system with which the user interacts. The USB debugging interface allows the eZ430-RF2500 to interact with a PC to remotely send and receive data using the MSP430 application Universal Asynchronous Receiver/Transmitter (UART). The memory on the microcontroller of this unit will be used primarily to program the scan and detection communication but also will contain the executable file which allows the user to interact with the active tags. The voltage required by the main board is 3.3V and voltage required by the LCD is 5V. Instead of powering each of these components separately, power will be provided through a 9V battery with the help of a dual-output regulator that provides one fixed output of 3.3V and another adjustable output between 1.2V to 5.5V. We will regulate the adjustable output to 5V to match the voltage needed by the LCD.

The active tags, known as the target boards, are a wireless system that may be used in various applications (stand-alone, with the debugging interface, or incorporated into an existing system).

For the purposes of this project, the target boards will be used in conjunction with the USB-capable main board to remotely transmit RF signals to indicate the location of the item onto which it is tagged. The tags should be detectable from a distance of approximately 5m. To illustrate that the system allows multiple tag detection, the proof-of-concept prototype will include 4 target boards, each programmed with its individual identification number to allow for independent detection. In addition, since the tags are active (they transmit RF signals at a continuous constant rate) they are powered using a 3.3V coin cell battery.

Lastly, the LCD is the component of the system that provides the output to the user. The information gathered through the RF transmitter/receiver is processed and subsequently relayed to the LCD. The main function of the LCD is to present this information in a user-friendly manner. The LCD best suited for our project needs is the LK162-12 by Matrix Orbital. The reason behind selecting this model is the fact that it is able to communicate via Inter-Integrated Circuit (I^2C) protocol, which is what is used by the eZ430-RF2500 main board, and the fact that it is versatile enough to be used with any controller. In addition, it has an intuitive command structure that allows efficient control of the display settings.

It should be noted that the overall hardware design takes into consideration the basic requirements for the CheckList™. The individual components used together fulfill the specifications of the product being compact and light weight (in order to be portable), low power consumption, and parts that are easy to replace for repair and maintenance purposes.

4 Software Design

The software design includes the GUI and the communication between the detection board and the tags through the use of the pushbutton provided on the board. The following section details the specific functionality of the software for the CheckList™.

4.1 Adding a New User

At startup, the user will be presented with a screen that has a "New User" button for first time users. By clicking on this button, the user will be able to create an account by entering his/her desired username and password, along with a security question and its answer. This information will be saved in a local Microsoft SQL Server database so that when the user logs into his/her account, the data is retrieved from the same database.

For the proof-of-concept version of the CheckList™, the system will only support one user per device, but the commercial product will allow for the creation of multiple user accounts so that one device can be used by more than one person, and each person's tags will be exclusively available to that user. In the event of multiple user accounts saved in the database, whenever a new account is created, the system will ensure that the username is unique and that there is not pre-existing account saved under the same username.

Each account will have a password, and upon account creation, the user will have to confirm the password by re-entering it in another field. If the passwords entered in the two fields do not match, an error message will be displayed to the user and both fields will be cleared.

The 'security question' field is used as an authentication mechanism in the event that the user forgets his/her password. This field shall be a predefined drop down menu with questions for the user to choose from. The chosen question and the user's answer to the question (entered in a designated field) will be saved in the database, along with the rest of the user's account information.

4.2 Login Window

After the account is created, the user is redirected to the 'Login' window where he/she will have to enter the username and password. If the password is incorrect, the user has the opportunity to retrieve it by entering the correct answer to the predefined security question. If the answer is correct, the password will be displayed, and the user will be redirected to the 'Login' window.

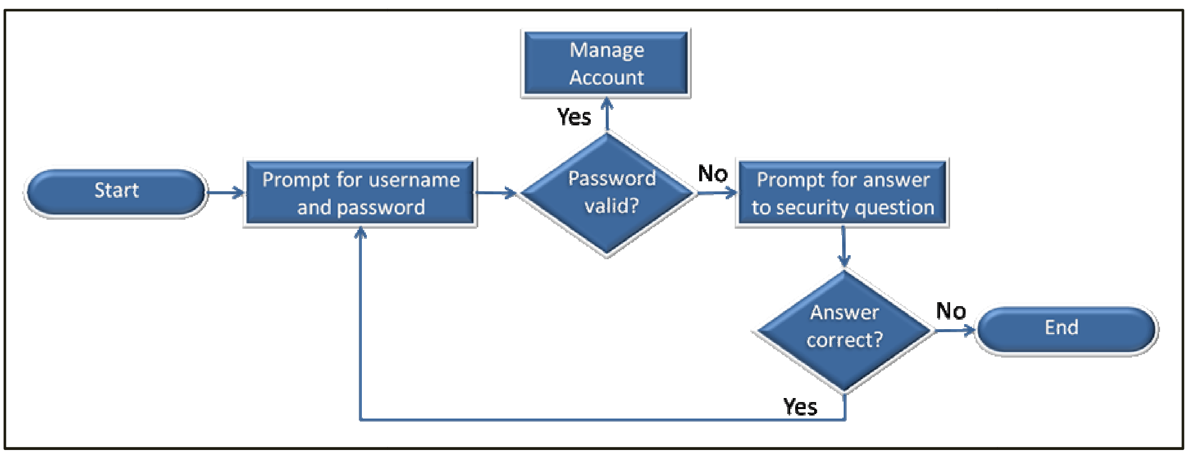

Figure 4: Username and Password Validation

4.3 Tag Activation/Deactivation

The 'Tag Selection' window will be presented as shown in Figure 5. When the user logs into their account for the first time, all the tags will be displayed in the 'Tags Available' list. If he/she chooses to attribute a tag to a particular item, he/she would have to select the tag number and drag it to the 'Tags in Use' list. In order to activate a tag, the user simply has to click on the tag in the 'Tags Available' list, the tag will be highlighted, and the user will then click on the arrow pointing to the 'Tags in Use' list, and the reverse will deactivate a tag in use. In order to facilitate the activation of multiple tags, the GUI also allows the user to select and unselect all tags from either one of the lists. The 'drag and drop' functionality of the 'Tag Selection' window allows for efficiency and speed of selecting the number of tags that the user would like to take employ, and it is intuitive and easy to use.

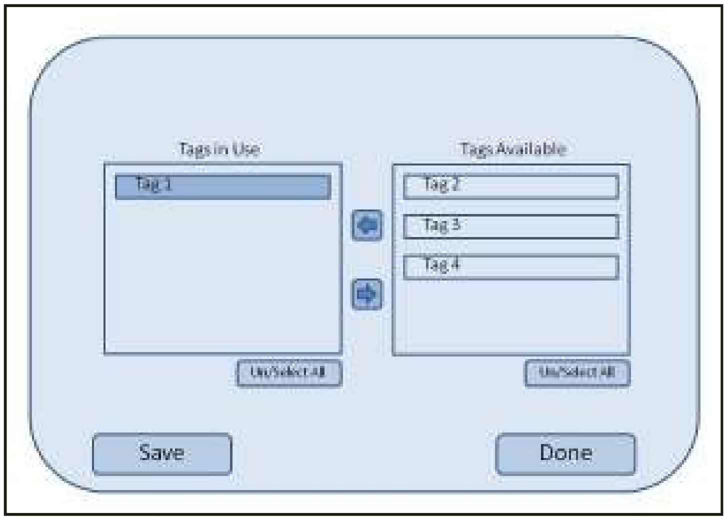

Figure 5: 'Tag Selection' window of the GUI

Once the tags have been selected, the user can click on 'Done' and this will open the 'Tag Items' window (Figure 6). In this window, the user will be able to attribute the desired items to each of the selected tags. By clicking the 'Save' button, all the tag information will be entered into a database and saved with the user account, and the tags will be activated. The user will be informed when the tags have been activated and the information has been successfully saved. By clicking the 'Back' button, the user will go back to the 'Tag Selection' window and add/remove the tags.

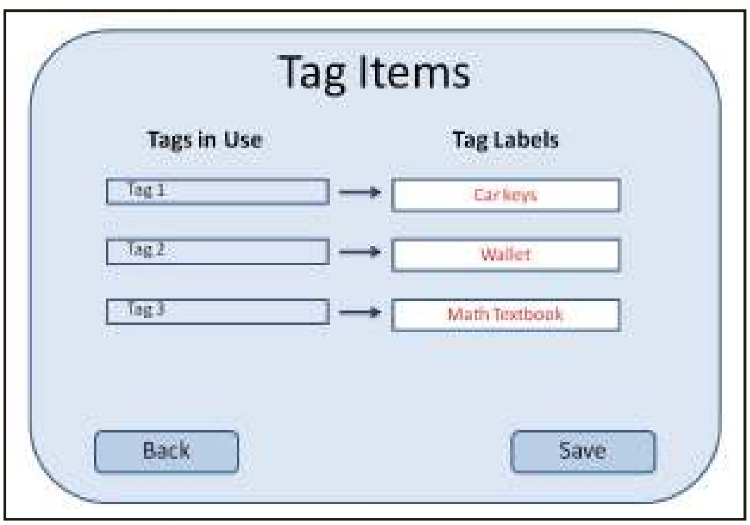

Figure 6: 'Tag Items' window of the GUI

4.4 Firmware overview

The following section summarizes the firmware employed in the design of the CheckList™, particularly the means by which the eZ430-RF2500 USB debugging interface communicates with the target boards. In addition, it will illustrate the Integrated Development Environment (IDE) as well as the network protocol used in order to achieve the wireless communication.

4.4.1 Integrated Development Environment (IDE)

In order to develop applications that run on the access point (EZ430-RF2500), we decided to use the IAR Embedded Workbench Integrated Development Environment (IDE). This IDE is included in the EZ430-RF2500 wireless development kit, and it is especially designed for applications that make use of the Texas Instruments MSP430 microcontroller. The code will be written in the C programming language, and it will dictate the functionality of the interface between the information entered by the user into the host computer, and the relaying of information from the main board to the LCD.

4.4.2 Communication between CC2500 and MSP430

The CC2500 is a UHF transceiver that is designed for low-power wireless applications and low current consumption. It operates at 2400-2483.5MHz, which is in the Short Range Device (SRD) frequency range. When the CC2500 communicates with the MSP430 through an SPI connection, it can transmit data at a rate up to 250kps, which is sufficient for our application as we are interested in transmitting the reference numbers of each of the target boards. The CC2500 also has frequency-hopping spread spectrum (FHSS) capabilities and multi-channel protocols, which means that the diversity in frequencies makes it less susceptible to interference with other devices operating in the same SRD frequency range.

In terms of interfacing the CC2500 with the MSP430, Texas Instruments provides a code library that eliminates the need for writing low-level interface functions. It makes use of the modular hardware abstraction, and its functions access the CC2500 registers via an SPI connection to the MSP430. A diagram of the stack library is shown in Figure 7.

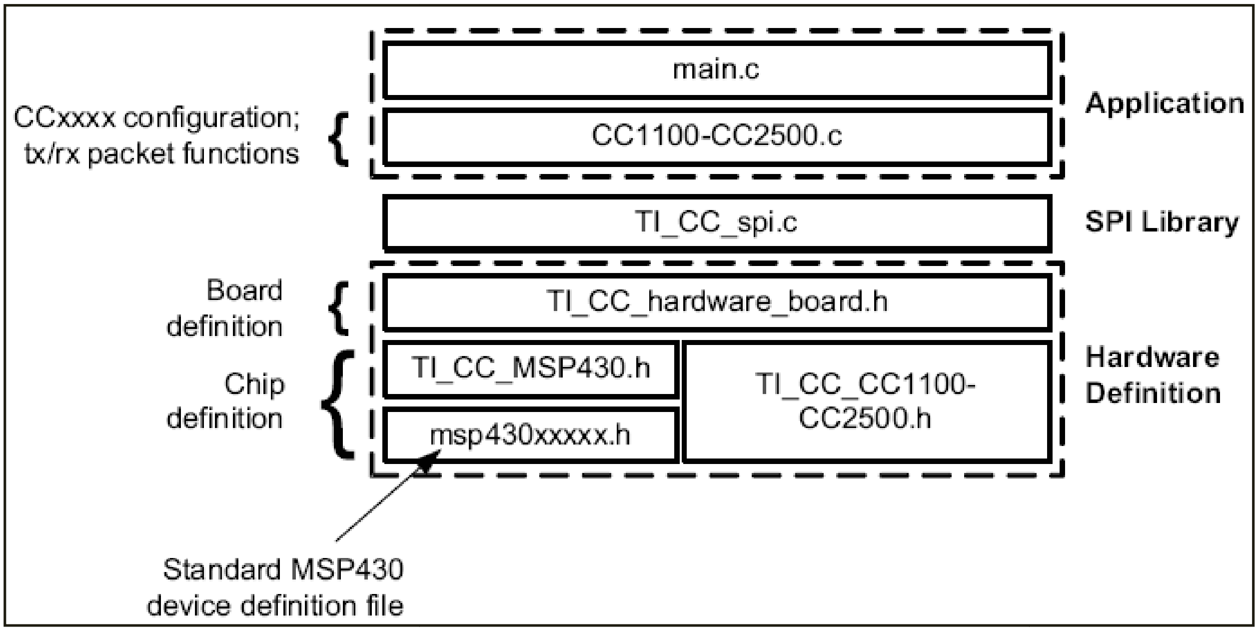

Figure 7: Code Stack Library for MSP430 and CC2500 [2]

This code library can also be easily adapted to other peripheral hardware components, which will allow us to integrate the LCD to the project.

4.4.3 SimpliciTI Network Protocol

In order to establish wireless communication between the detection unit and the wireless transceiver, TI's SimpliciTI network protocol will be utilized. SimpliciTI™ is a low-power RF protocol that is designed for applications in which low data transmission rate and low duty rate are required. This protocol allows for easy integration between the CC2500 and MSP430, and it has a small memory footprint as it only requires a compiled code of 4kB flash memory and 512 bytes RAM, which are supported by the microcontrollers on the hardware devices of the CheckList™. SimpliciTI™ facilitates RF connectivity applications, and the wireless transmission of data from one point to another. Through the SimpliciTI protocol, the transmitter/detector pair is labeled as End Devices (ED) or Access Points (AP). An End Device functions to join the network, whereas an Access Point acts as a host to those potential networks. SimpliciTI™ supports the formation of a network comprised of 2 to 30 nodes which is feasible for our application, as the CheckList™ only makes use of one node for the access point, and four (4) nodes for the end devices. As can be seen in Figure 8, SimpliciTI creates a network in which the tags (end devices) that are within a detectable range need to quickly be able to associate themselves with the query device (access point) whilst maintaining low power consumption.

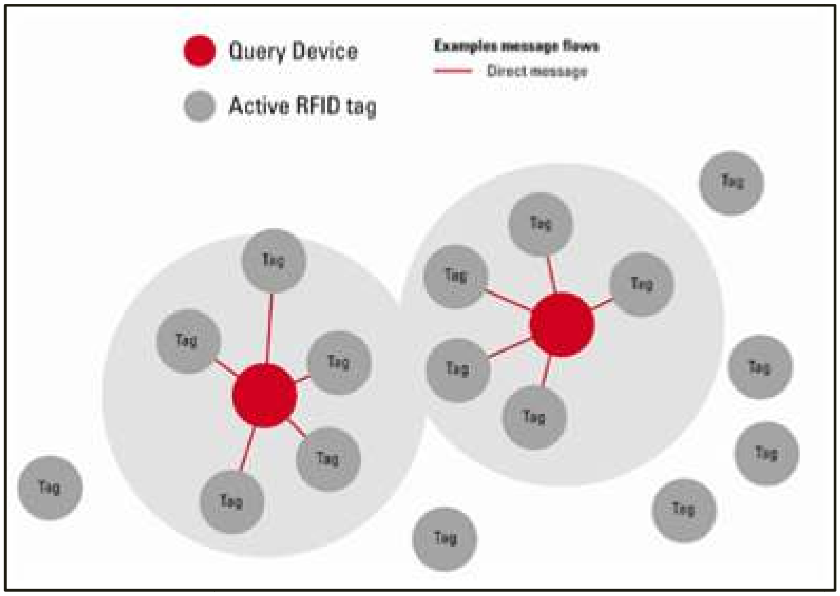

Figure 8: SimpliciTI Networking Protocol Diagram [3]

Upon initiation, both the End Devices and the Access Point are assigned a random 4 byte address, which allow for their unique identification. The End Devices join the network by forwarding link packets to the Access Point. The Access Point will then accept the link request if it is valid, and thus register the address in its network. This type of transmission is particularly important for a tracking device such as the CheckList™ because if the battery in the tags is exhausted, the communication between the Access Point and the End Device is technically broken. However, due to this mode of implementation, the End Device would be recognized as the same tag as previously identified.

5 Hardware Design

It is necessary to outline the technical details for the hardware components that will be used to produce the CheckList™, so that the reader may have a complete understanding of how the system modules interact with one another on a more profound level.

5.1 RF Detection – Main Board

The eZ430-RF2500 is a USB based wireless development tool that is used to evaluate the MSP430F2274 microcontroller and the CC2500 2.4 GHz wireless transceiver.

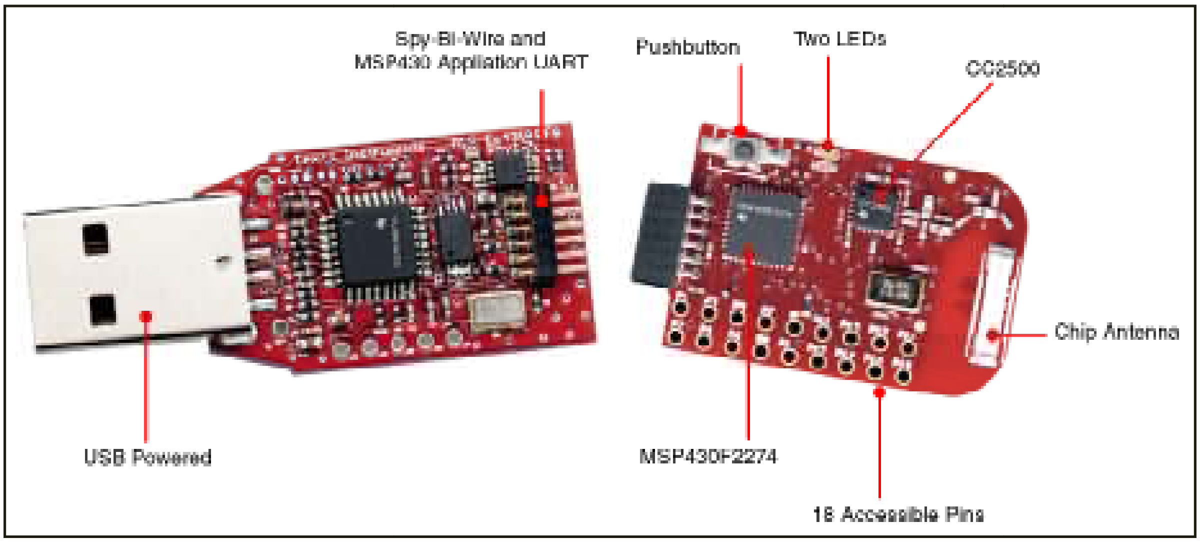

Figure 9: eZ430-RF2500 – USB Debugging Interface [4]

The software that allows the user to modify system settings is installed on the USB in the form of an executable file. Upon plugging the USB enabled handheld unit into a PC, the executable file automatically runs and displays the GUI. The USB debugging interface allows information to be sent and received remotely from a PC using a MSP430 Application UART. An advantage of the USB debugging interface is that it provides driverless installation onto a PC, therefore making it very simple for a new user to interact with it.

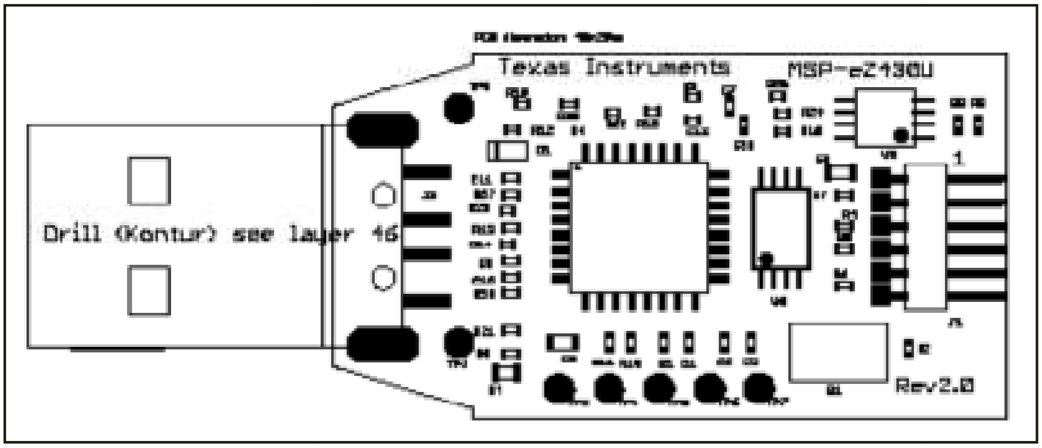

Figure 10: eZ430-RF, USB Debugger, UCB Components Layout [4]

The USB debugging interface is originally connected to a target board module to create the detection unit, which means that the eZ430-RF USB may be used as a standard Flash Emulation Tool through the Spy-Bi Wire interface. This protocol is specific to the Texas Instrument development package as it uses only two connections: a bidirectional data output and a clock.

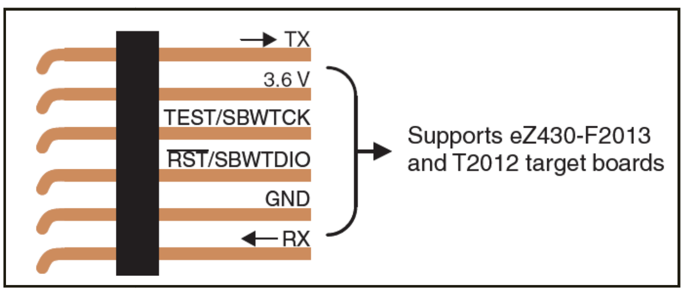

Figure 11: eZ430RF-2500USB Debugging Interface 6 Pin Male header [4]

Since the CheckList™ is a portable system, the detection unit must be able to detect the active tags (i.e. target boards) without being connected to a PC. In order to achieve this, the MCU in conjunction with the pushbutton will be used. The MSP430 is the 16MHz low-power MCU in the detection unit.

The MCU (MSP430F2274) requires an operating supply voltage of between 1.8V to 3.6V and its current consumption varies depending on the mode of activation:

Table 1: MCU Current Consumption [5]

Mode	Current Consumption
Active Mode (1MHz, 2.2V)	270µA
Standby Mode	0.7µA
Off Mode (with RAM retention)	0.1µA

In order to power the above, a voltage input of 3.3V is recommended. As it will be explained further in the document, the LCD that interfaces with the detection main board requires a voltage input of 5V. While both these elements can be powered separately, a more efficient and cost effective solution is to power both units using the same battery by regulating the supply voltage to each input. This is achieved with the help of dual channel positive-voltage linear regulator – the LX8816 by Microsemi. The regulator has one fixed output at 3.3V and a second adjustable output that could be set to any value between 1.2V to 5.5V; for our purposes, we require the second output to be set to 5V.

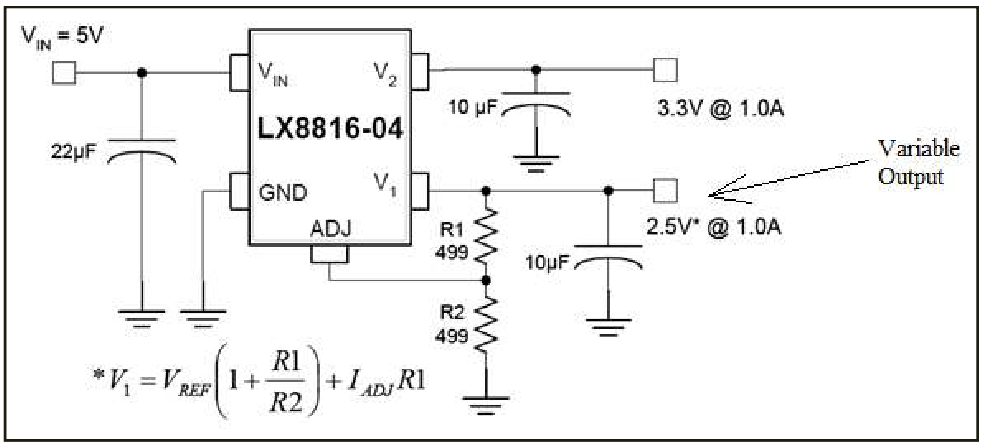

Figure 12: Sample Circuit Schematic – LX8816 Dual Output Regulator [6]

As mentioned previously, the detection main board relays information to the user via an LCD interface. The MSP430 module supports communication through the I^2C protocol; thus when selecting the LCD, this condition needed to be taken into consideration in order to guarantee proper communication between the two components.

The main board provides 18 development pins that interact with the microcontroller and therefore allow connection to external devices - in our case, the external device is the LK162-12 LCD. In the following table, Table 2, is the basics of the pinout connections on the eZ430 RF2500 that will be used to connect to the LCD to transmit data at a regulated rate.

Table 2: Pinout Connections on the Main Detection Board [4]

Pin	Function	Description
1	GND	Ground Ref
2	V_{CC}	Supply Voltage
15	P3.2 / UCB0SOMI / UCB0SCL	GPIO (digital) , I2C Clock
18	P3.1 / UCB0SIMO / UCB0SDA	GPIO (digital) , I2C Data

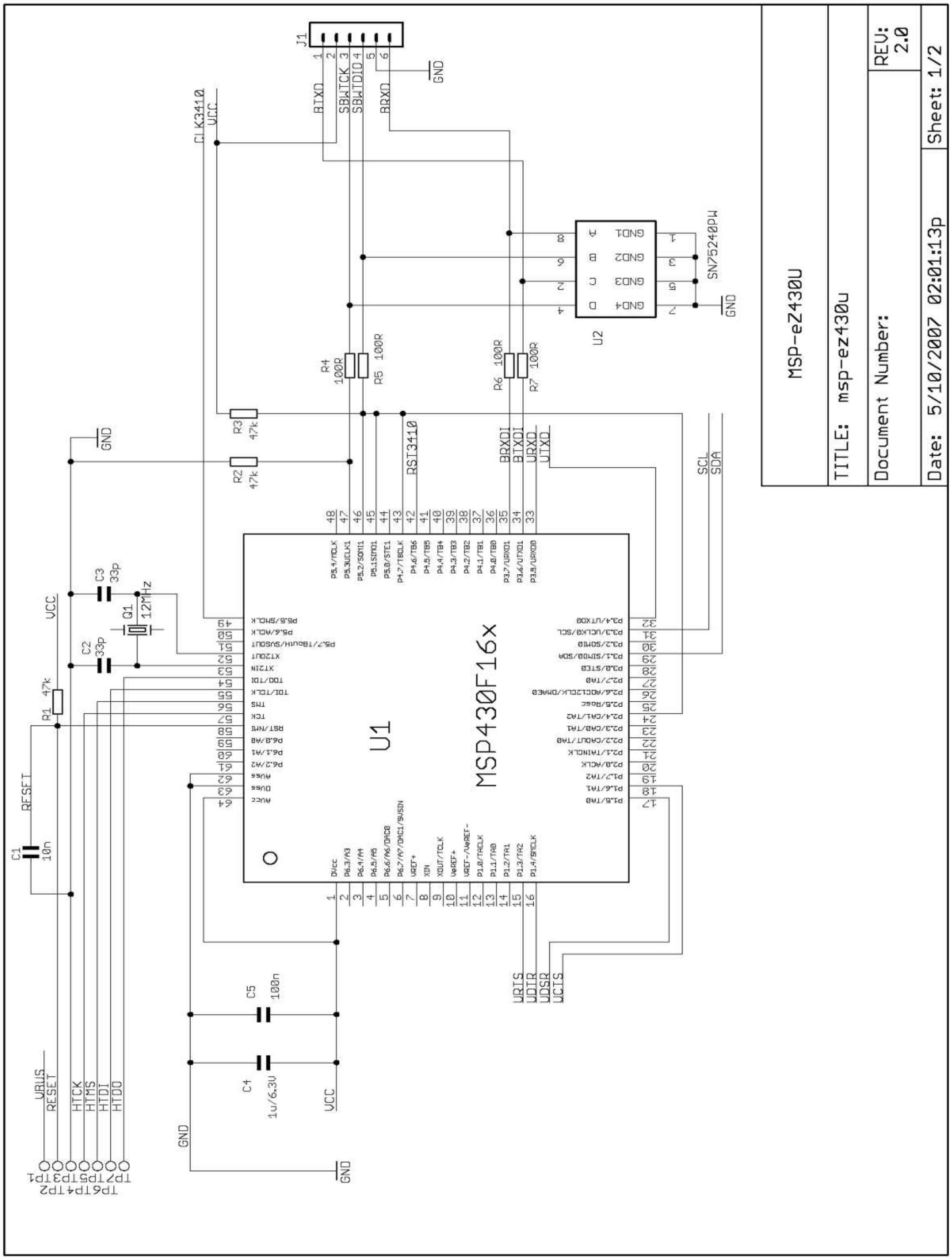

Figure 13: eZ430-RF, USB Debugging Interface, Schematic (1 of 2) [4]

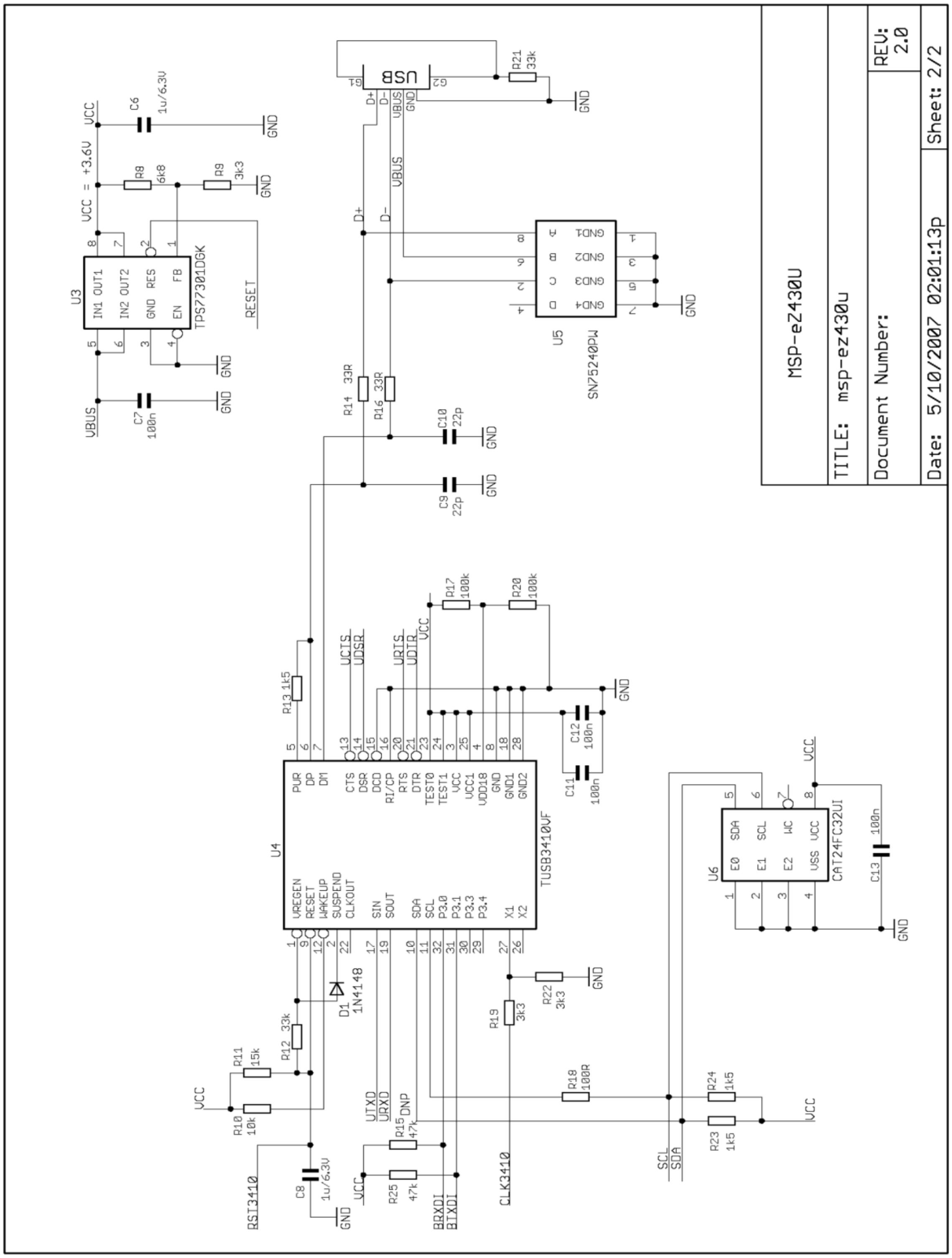

Figure 14: eZ430-RF, USB Debugging Interface, Schematic (2 of 2) [4]

5.2 RF Transmittance – Target Boards

The ez430-RF2500T target board transmits RF signals to the RF detection main board using a CC2500 transceiver. The target board is coupled with a battery board that connects the power supply to the target board, shown in Figure 15. A more detailed diagram of the components and a layout of the available pins of the target board is shown below in Figure 16.

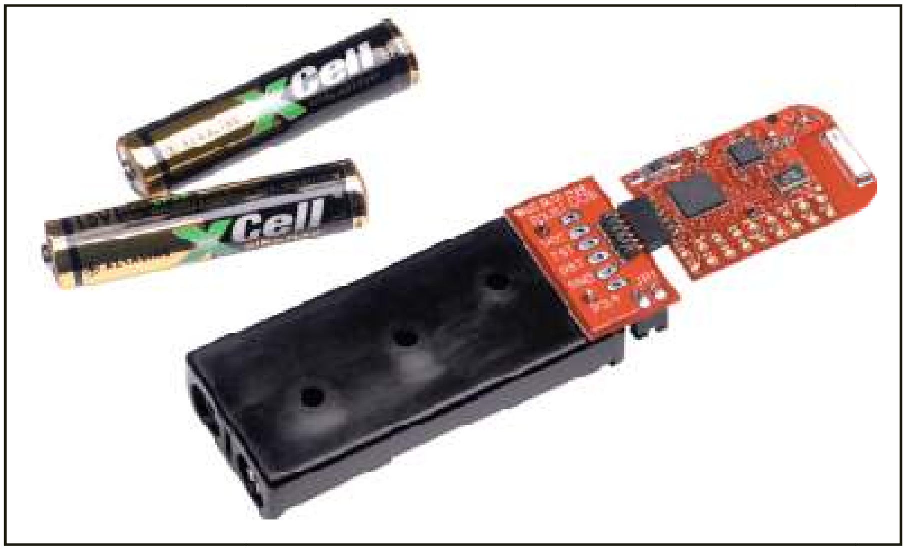

Figure 15: ez430-RF2500T Target Board with Battery Board [4]

The CC2500 is the perfect transceiver for the purpose of this project due to its current consumption, frequency range, detection range, data transmission rate, size and interference characteristics.

Current consumption of the CC2500 is shown in Table 3.

Table 3: Current Consumption Values for Target Board (Tags) [5]

Mode	Current Consumption
Transmit Mode	21.2 mA
Receive Mode	13.3 mA
Sleep Mode	400 nA

In future design, in order to conserve the power consumed by the tags (i.e. increase the battery life), the target boards will be programmed to be in the sleep mode until a signal is received by the target board to actively send data to the main detection unit.

In addition, the CC2500 transmits in the 2400-2483.5MHz – i.e. it is a Short Range Device (SRD).

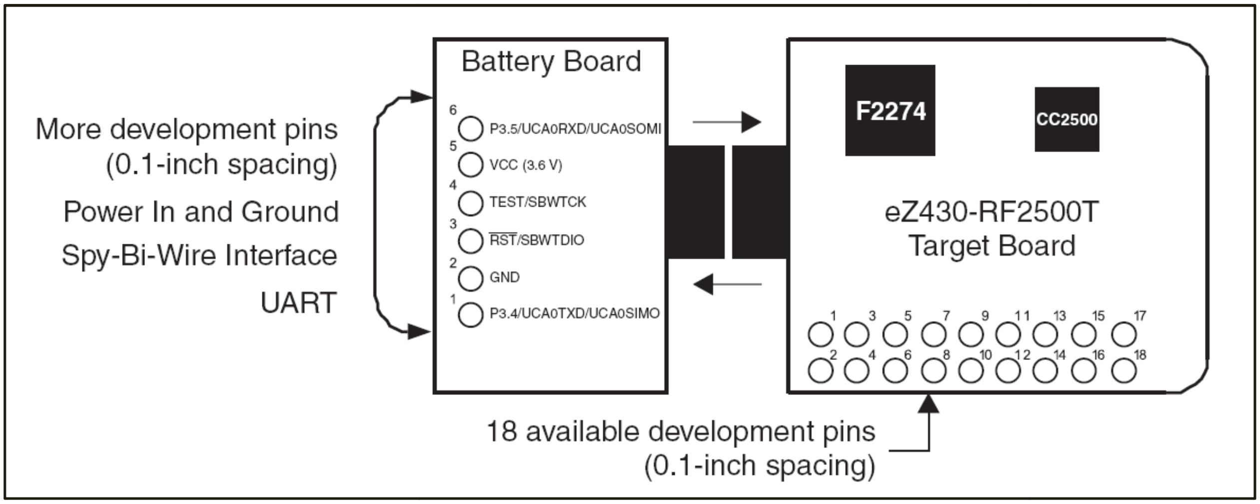

Figure 16: Target Board and Battery Board Pins [4]

The target board operates at a supply voltage within 1.8-3.6V, and is thus powered from the manufacturer with 2 AAA (1.5V) batteries connected in series to produce a combined supply of approximately 3V. However, to decrease the size of the target board, our design includes attaching one 3.3V coin cell battery to the target board instead of the original AAA batteries. This is achieved by disconnecting the battery holder from the target board's V_{CC} and ground pins and instead connecting them to the coin cell's positive and negative terminals.

The target board for the proof-of-concept CheckList™ device will be transmitting RF signals continuously. The ez430-RF2500T target board also features an MSP430 ultra-low power MCU, similar to the main board. A detailed schematic of the target board and battery board including the CC2500 transceiver and the MSP430 MCU is given in Figure 17. However, we will not be using the functionalities of the MCU for the proof-of-concept CheckList™ device. For future prototypes, it will be used to regulate the amount of time the target board is transmitting RF signals, rather than continuously transmitting as it is currently. This change in operation will increase the amount of time one battery can be used to power a target board since its primary workload of transmitting RF signals will be significantly reduced.

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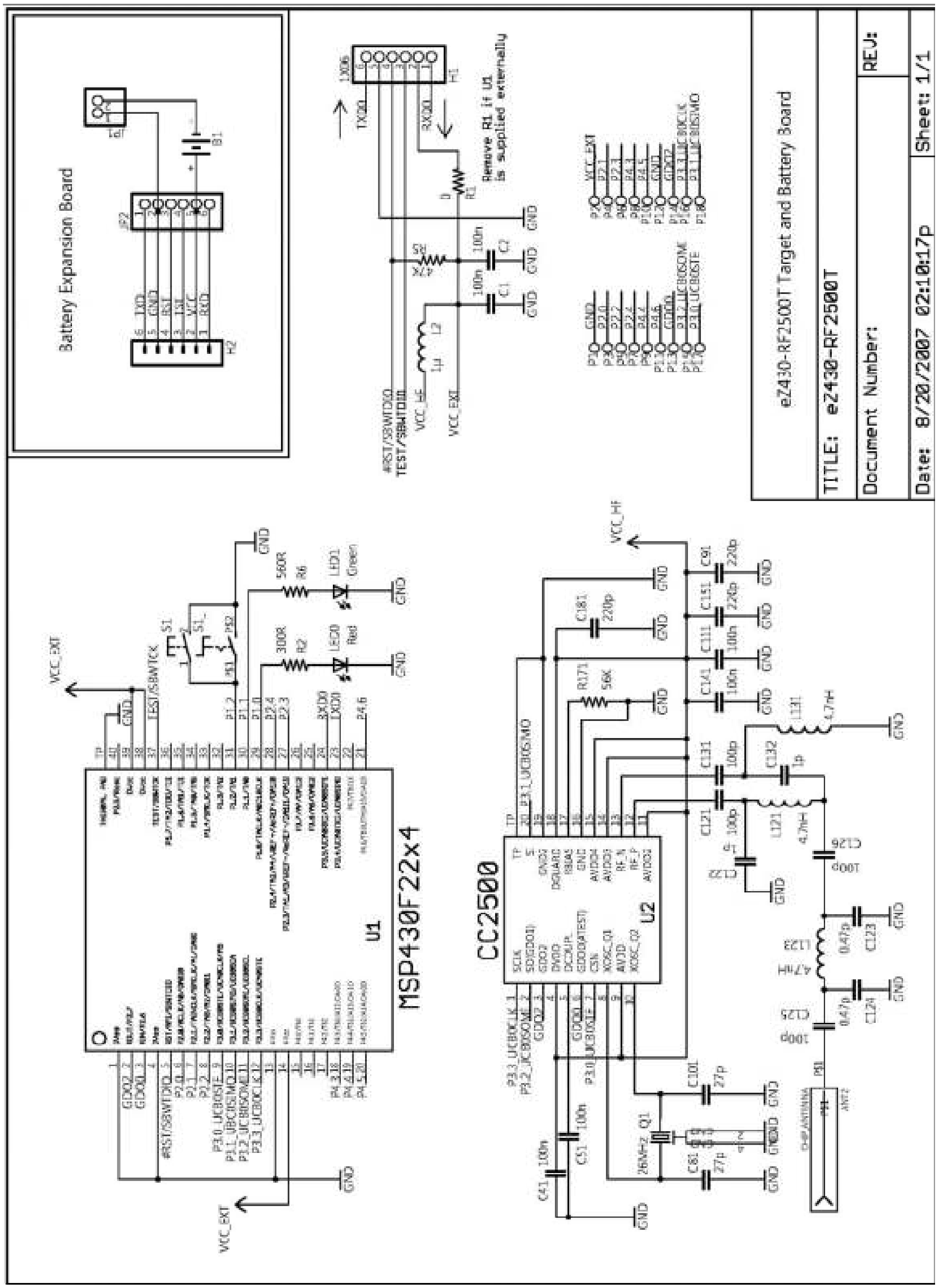

Figure 17: eZ430-RF2500T, Target Board and Battery Board, Schematic [4]

5.3 LCD

After extensive research, the LCD we have chosen to use with our main board is the LK162-12 from Matrix Orbital. It is capable of displaying 2 rows with 16 columns of characters.

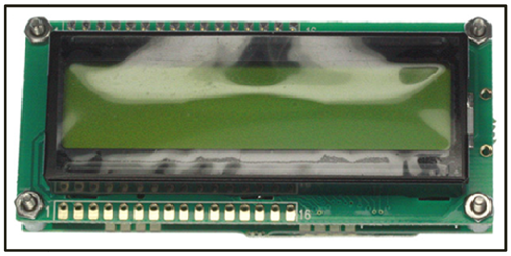

Figure 18: LCD Module, Front View [7]

As mentioned in Section 5.1, one criteria of the LCD is that it must support communication through I^2C protocol. The LK162-12 supports three different protocols: RS-232 (manufacturer's default), TTL, and I^2C. In order to select I^2C mode, it is necessary to remove the jumps that are initially set to RS-232 and instead place them over the I^2C jumpers. A detailed view of the jumpers set to the default RS-232 mode is shown below.

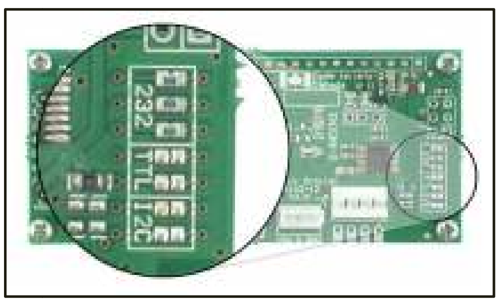

Figure 19: LCD Protocol Select Jumpers [7]

The LCD is capable of communicating at a rate of 100 kbps in I^2C mode, which is ample for our purposes. The LCD requires a supply voltage of 5V, whereas the main board that the LCD will be interfacing with requires 3.3V. As mentioned in Section 5.1 above, we will use a dual-output voltage regulator to set a 9V battery to supply two separate voltages: 3.3V and 5V. The minimum current drawn by the LCD is 40mA, though it increases to up to 130mA when the backlight is on.

Although the LCD has internal non-volatile memory for storing custom characters, we will not need to use it since the general ASCII formatted character set is sufficient for our proof-of-concept device. Another capability of the LCD that we will not be using for the proof-of-concept is the user-controlled display settings; we will be permanently fixing the contrast, brightness, backlight, and turn-off timer settings for the LCD. These settings will be user-controlled in future prototypes. Please refer to the schematic of Figure 20 to view the detailed dimensions of the LCD.

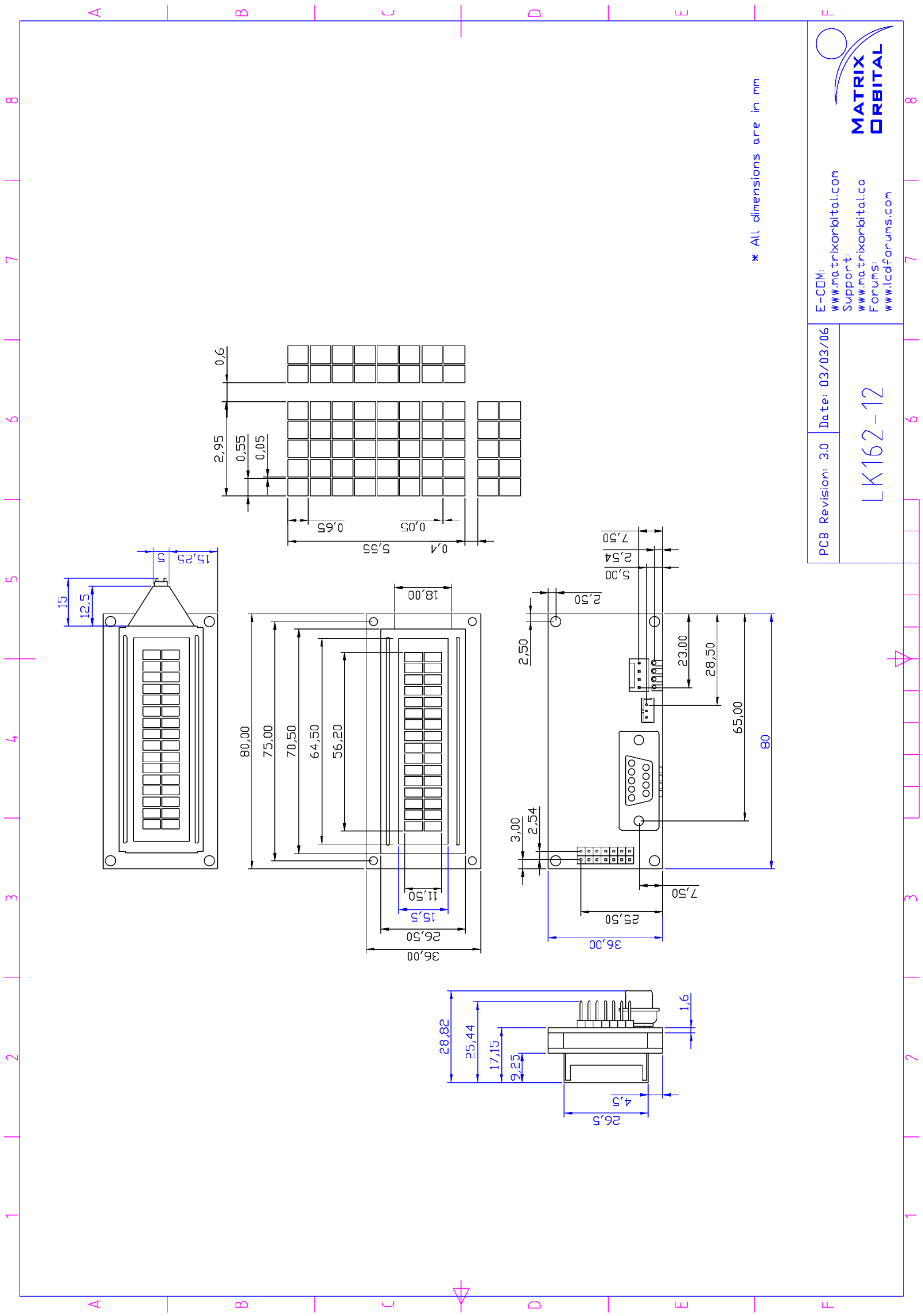

Figure 20: Detailed Schematic of the LK162-12 [7]

6 Physical System Design

As stated before, the physical CheckList™ system is comprised of two components: the main detection unit and the detection tags. The prototype of the main detection unit is shown below in Figure 21, drawn to scale. The main unit has the LCD mounted on the top cover as well as the 'Check' button for the user to press.

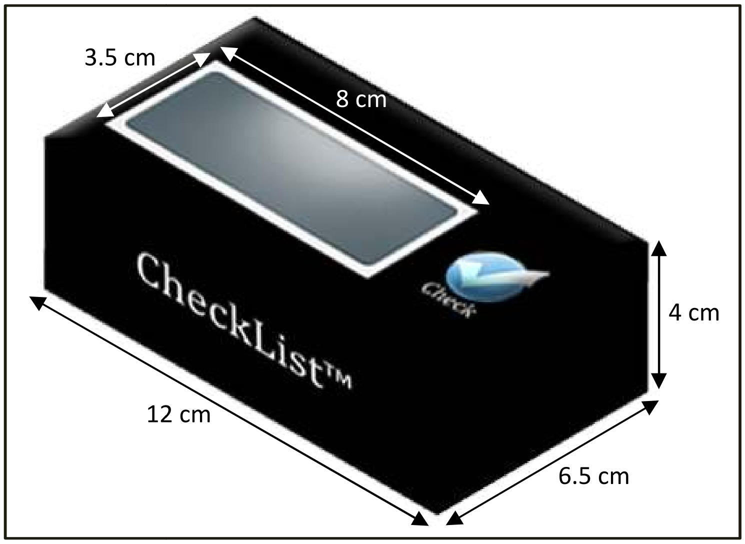

Figure 21: Prototype CheckList™ Main Detection Unit

Inside of the detection unit sits the eZ430-RF USB debugging interface board and the 9V battery. Figure 22 shows the inside of the main detection unit from the top view, drawn to scale.

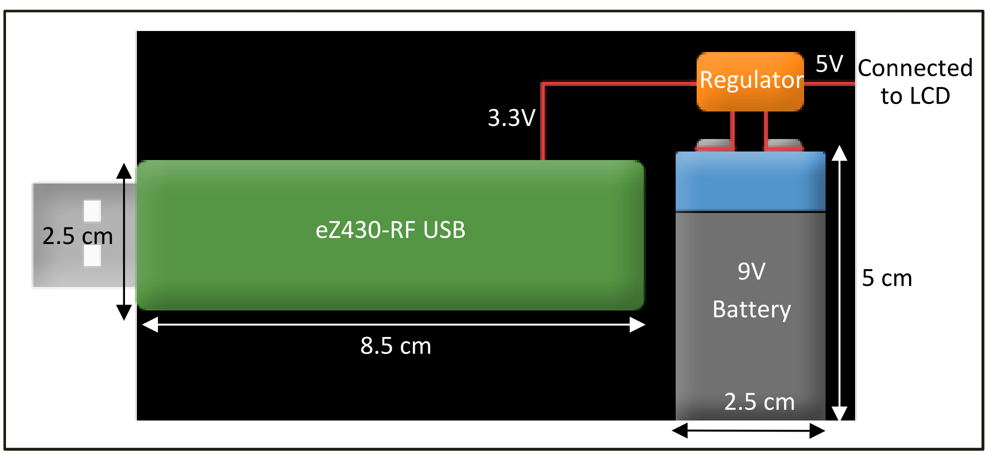

Figure 22: Main Detection Unit (cover removed) – Top View

Each detection tag consists of a coin cell battery and an eZ430-RF2500T target board enclosed in a plastic sleeve as shown in Figure 23 drawn to scale. An inside view of the tag is shown in Figure 24 drawn to scale.

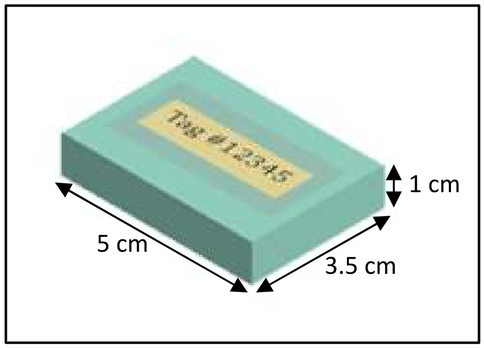

Figure 23: Prototype CheckList™ Detection Tag

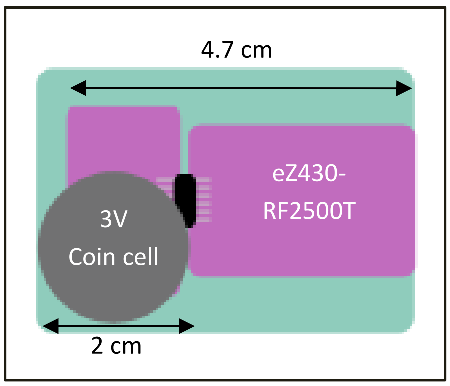

Figure 24: Detection Tag (cover removed) – Top View

7 System Test Plan

The CheckList™ device proof-of-concept prototype will undergo three stages of testing. The initial stage will involve testing of each of the individual components. Once this testing is complete, we will integrate related components together and test the combined modules. Finally, we will assemble the complete product and conduct holistic testing.

7.1 Component Testing

RF Detection Unit: Power

Condition: Ability to power the unit using a regulated 9V battery.

Procedure: Connect the 9V battery and voltage regulator to the detection unit's power pins. Use a digital multimeter (DMM) to measure voltage and ensure that power is being delivered to all relevant connections.

RF Target Board: Power

Condition: Ability to power the tags using a cell battery.

Procedure: Connect the cell battery and voltage regulator to the detection unit's power pins. Use a digital multimeter (DMM) to measure voltage and ensure that power is being delivered to all relevant connections.

LCD

Condition: Ability to display characters and function as programmed.

Procedure: Program LCD to display a certain string of characters and change its settings such as backlight and contrast according to what is required for the product and ensure that all characters and settings display as programmed.

GUI: Functionality

Condition: Ability to display and interact with user commands as programmed.

Procedure: Enter various user commands and inputs and ensure that the GUI is able to handle the requests.

GUI: Design

Condition: The design of the GUI is intuitive.

Procedure: Allow a hardware team member to interact with the GUI and ensure that the overall design is intuitive and easy-to-use.

USB

Condition: Ability to establish a connection with the PC

Procedure: Connect the USB into a PC and ensure that the PC detects and is able to interact with the USB.

7.2 Module Testing

RF Detection Unit and Target Boards

Condition: Ability of the RF detection unit to to detect multiple RF target boards at a minimum distance of approximately 1 metre.

Procedure: Connect power to an RF target board while also connecting power to the RD detection unit and ensure that the RF detection unit is able to receive signal from the RF target board within a 1 metre radius.

Handheld Detection Device Interface

Condition: Ability to respond to pushbutton "Check" request by displaying characters on LCD.

Procedure: Program the RF target board MCU to send certain characters to the LCD when the pushbutton is pressed and ensure that these characters are sent as programmed.

GUI/USB Detection

Condition: Ability to display GUI on PC screen upon connection of the USB to the PC.

Procedure: Connect USB to PC and ensure that the GUI appears on the screen within 10 seconds after connection.

GUI/RF Detection Board Interface

Condition: Ability to save changes to RF Detection Board.

Procedure: Change various device settings using the GUI and ensure that those settings are reflected in the operation of the device.

7.3 Holistic Testing

The Mnemosyne team will conduct thorough software and hardware tests to ensure that all modules have been integrated properly. We will confirm that all connections comply with our requirements listed in the Functional Specification document. In addition, we will simulate the Typical Usage Scenario, outlined below, which mimics the intended use of the device by the end-user. During our holistic testing, we will ensure that each step of the Typical Usage Scenario is functioning as required.

Typical Usage Scenario

1. User inserts batteries into tags and tags begin transmitting RF signals
2. User inserts the USB into PC and the GUI is displayed on the screen
3. The simple and intuitive GUI takes the user through the device set-up process
4. Once the user clicks "Save" in the GUI, the settings are saved onto the Handheld Detection Device through the USB
5. When the user presses the "Check" button on the Handheld Detection Device, the LCD informs the user of which tags are missing
6. When the user does not need to use the device, they are able to switch the device off.
7. If the user wants to reconfigure all settings, they are able to reset the device to factory settings.

8 Environmental Considerations

The CheckList™ will have minimal impact on the environment within its lifetime. Since the product itself is quite small, the amount of material needed for its construction is also very minimal. The plastic enclosure is heat resistant and therefore produces no harmful fumes during the product use. The one area of interest, which has the potential of having some form of environmental impact, is the use of PCBs in the design. One of the reasons why PCBs are so widely used in the technology industry is due to their chemical stability. However, this is precisely what causes the greatest amount of environmental concern. According to Environment Canada, "*The best, most widely used and proven technology for destroying PCBs is high temperature incineration (greater than 1200°C for 2 seconds dwell time). Properly done, this has been shown to destroy PCBs at an efficiency of 99.9999 percent, leaving an inorganic ash*" [8]. The other factor to consider is the LCD disposal. This is relatively easier, since there are companies who specialize in LCD waste management and recycling.

9 Conclusion

This Design Specification document provides a detailed description and specification of the components incorporated into the proof-of-concept prototype design of the CheckList™ device. It also discusses the design choices Mnemosyne Innovations has made in order to meet the functional requirements outlined in the Functional Specification document [1]. The parts implemented were chosen in terms of portability, light weight operation and low cost. It is expected that all design requirements outlined herewith will be adhered to and completed by the target date of December 14, 2009.

All you need to remember is your CheckList™.

10 References

[1] Mnemosyne Innovations Incorporated, *CheckList™ Assistive Memory System Functional Specifications*, Burnaby: Simon Fraser University, 2009.

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[7] Matrix Orbital, "Technical Manual: LCD (#LK162-12)", v.3.1, March 2003 [Online] Available: http://www.matrixorbital.ca/manuals/LK_series/LK162-12/LK162-12_220.pdf [Accessed: October 15, 2009].

[8] Environment Canada, "The PCB Story," *Waste Management-Fact Sheet*, November 2006. [Online]. Available: http://www.ec.gc.ca/drgd-wrmd/default.asp?lang= En&n=D9B241BD-1. [Accessed: Oct 29, 2009].