PSZ 19:16 (Pind. 1/07)

UNIVERSITI TEKNOLOGI MALAYSIA

DECLARATION OF THESIS / UNDERGRADUATE PROJECT PAPER AND COPYRIGHT

Author's full name : **KOAY JIAN CONG**

Date of birth : **19-12-1988**

Title : **SURFACE MOUNT TECHNOLOGY (SMT) MICROCONTROLLER BASED RADIO FREQUENCY (RF) SIGNAL REMOTE LOCATOR**

Academic Session: **2010/2011**

I declare that this thesis is classified as :

☐	**CONFIDENTIAL**	(Contains confidential information under the Official Secret Act 1972)*
☐	**RESTRICTED**	(Contains restricted information as specified by the organisation where research was done)*
√	**OPEN ACCESS**	I agree that my thesis to be published as online open access (full text)

I acknowledged that Universiti Teknologi Malaysia reserves the right as follows :

1. The thesis is the property of Universiti Teknologi Malaysia.
2. The Library of Universiti Teknologi Malaysia has the right to make copies for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by :

SIGNATURE | **SIGNATURE OF SUPERVISOR**

881219-07-5035
(NEW IC NO. /PASSPORT NO.)

EN. KAMAL BIN KHALIL
NAME OF SUPERVISOR

Date : MAY 25, 2011

Date : MAY 25, 2011

NOTES : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organisation with period and reasons for confidentiality or restriction.

"I declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for award a Degree of Bachelor of Engineering (Electrical - Electronics)."

Signature : ....

Name of Supervisor : EN. KAMAL BIN KHALIL

Date : 25 MAY 2011

SURFACE MOUNT TECHNOLOGY (SMT) MIRCROCONTROLLER BASED RADIO FREQUENCY (RF) SIGNAL REMOTE LOCATOR

KOAY JIAN CONG

Submitted to the Faculty of Electrical Engineering
In partial fulfilment of requirement for the Degree of
Bachelor of Engineering (Electrical – Electronics)

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

MAY 2011

I declare that this thesis entitled "*Surface Mount Technology (SMT) Microcontroller Based Radio Frequency (RF) Signal Remote Locator*" is the results of my own research except as cited in the references. The thesis has not been accepted for any degree and submitted in candidature of any other degree.

Signature : ....

Name : Koay Jian Cong

Date : 25 MAY 2011

Specially dedicated to:

My father, Koay Hooi Bin

My mother, Vun Fung Yung

My siblings,

Koay Chiao Sin

Koay Jian Hao

Thanks for the loves and supports

ACKNOWLEDGEMENT

First and foremost, I would like to express my heartily gratitude to my supervisor, En. Kamal bin Khalil for guidance and encouragement given throughout the progress of this project. Without his guidance and support, this project will not be completed as well as this thesis.

Moreover, my great appreciation also goes to all my family members and friends that had been so patient and support me all these years. Without their encouragement and love, I would not be able to undergo the pressure due to this project.

During the process of this final year project, I had faced lot of problems especially come to troubleshooting and idea on how the project can be implemented. Thanks to my friends, Choo Chian Choong, Voon Zheng Loong, Pui Hing Ngian, Voon Wee Sun, Gan Chuan Wuu, Sam Xim Min, Ngo Chee Wung, Chee Kok Wai, Kho Geok Hong and Lam Kong Shen for the advices and idea on my project, finally I was able to finish my final year project smoothly.

ABSTRACT

This thesis with the title of “Surface Mount Technology (SMT) Microcontroller Based Radio Frequency (RF) Signal Remote Locator” is describing the system of finding lost items and objects in a very short period of time. It is briefly describe about how the developing process in order to make this project success. Besides, the size will be as small as a key chain and would be very convenient to bring along with the user. This system is a good system where it saves users precious time. The components that are being used in this project consists of PIC 16F876A, PIC 16F877A, RF module, LEDs, buzzer and others. The RF modules can be divided into two. They are the RF transmitter and the RF receiver. When the product operates, the items or objects that are attached with the remote unit will buzz and the LED will turn on. This indicates the location of the items and it can be found in a short period of time.

ABSTRAK

Tesis ini dengan tajuk "Surface Mount Technology (SMT) Microcontroller Based Radio Frequency (RF) Signal Remote Locator" menggambarkan satu sistem yang membolehkan pengguna mecari benda atau objek yang hilang dalam masa yang singkat. Secara singkatnya, tesis ini menggambarkan proses pembangunan supaya saya berjaya projek ini. Selain daripada itu, saiz produk akan besaiz kecil dan pengguna akan berasa senang untuk membawanya bersama. Sistem ini adalah sistem yang bagus kerana ia menjimatkan masa pengguna yang berharga. Komponen yang diggunakan dalam projek ini terdiri daripada PIC 16F876A, PIC 16F877A, modul RF, LED, pembunyi dan lain-lain. Modul RF boleh dibahagikan kepada dua bahagian, iaitu pemancar RF dan penerima RF. Semasa produk ini beroperasi, benda atau objek yang dilampiri dengan unit kawalan jarak jauh akan berbunyi dan LED akan menyala. Ini menunjukkan lokasi benda itu dan ia akan dapat dijumpa dalam masa yang singkat.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

BRG	-	Baud Rate Generator
CU	-	Control Unit
LED	-	Light Emitter Diode
PCB	-	Printed Circuit Board
PIC	-	Programmable Interface Controller
RF	-	Radio Frequency
RU	-	Remote Unit
RX	-	Receiver
SMT	-	Surface Mount Technology
TX	-	Transmitter

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The title of this project “Surface Mount Technology (SMT) Microcontroller Based Radio Frequency (RF) Signal Remote Locator” can basically being divided into 3 parts. They are the SMT microcontroller, radio frequency signal and remote locator. Before the project was started, the definition of the parts had to be defined.

SMT microcontroller is a shirking version of the through-hole technology microcontroller. From online definition directory, SMT is a method for constructing electronic circuits in which the components are mounted directly onto the surface of printed circuit boards (PCB). The size can be one-quarter to one-tenth the size and weight of the microcontroller [6].

The second part is the RF signal. Another name for RF is radio waves. It is a subset of electromagnetic radiation. The wavelength of RF can be ranged from 1 mm to 100 km, while the frequency ranged from 30 kHz to 300 GHz [7]. Since RF signal can travel within a distance of a house, hence, it had being chosen as the communication method of the remote locator. The frequency of the RF signal is being determined from the formulae below [8].

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

Remote locator is the final product of this project. What is remote locator? Remote locator is a control locator that will locate the position of the household items. Since the locator can be controlled remotely, so, it can functions on the items located far away where the items are in the searching frequency range of the RF signal.

The final product will help most on the people in Malaysia that are frustrated by searching missing household items.

1.2 Objectives

Although in other country, remote locators were manufactured widely, however, in Malaysia, remote locator that is using surface mount technology microcontroller had not being manufactured by any industries. Hence, this project is being developed to build the remote locator that will locate household items easily by just a push on the button.

There are 4 objectives that lead to the research of this project. The first objective is to minimize the size of the circuit built by using SMT microcontroller. With this technology, the remote locator can be assembled into the size of a keychain. So, it can be attached to small household items.

In order to produce the final product, the communication method is the vital factor. Hence, the second objective of this project is to develop 2 or more communication systems between microcontrollers using radio frequency (RF) module.

The third objective is to benefit the people who always dislocate their household items such as keys, spectacles, and etc. The remote locator will locate the devices without searching. It will represent by loud distinctive sound and LED that will be blinking with a bright light.

Last but not least, the fourth objective is to save users' time. In order to search those dislocate household items, lots of time will be spent. Time is precious. So, with the aid of a remote locator, missing items will be found within a short period of time.

The target users of this product are varies. They can be housewives, students, old folks, and etc. Since it is user-friendly, small and light, hence, the product will be used widely soon. Other than that, the cost will be cheaper if it is manufactured in our own country.

1.3 Problem Statement

The problem that leads to this study is the household items are missing due to the dislocation of users.

In order to solve the problem stated, the project with the title of "Surface Mount Technology (SMT) Microcontroller Based Radio Frequency (RF) Signal Remote Locator" was being carried out. The purpose of it is to find out those dislocate household items within a short period of time.

1.4 Scope of Study

The scopes of study of this project are to focus on the radio frequency (RF) module that will be used as the main communication method, the communication between transmitter and receiver, the product will be build by using SMT microcontroller and SMT peripheral components, and to make it operate by using high level programming language for example the C code using MPLAB.

CHAPTER 2

LITERATURE REVIEW

2.1 Books' Review

Book's review is the summarize work that is done by referring to the hardcopy of a book that might be in the form of magazines, encyclopaedias, and others.

2.1.1 Myke Predko, "Programming and Customizing the PIC Microcontroller"

The book from Myke Predko, "Programming and Customizing the PIC Microcontroller" is a good material for the literature review. This book is basically focus on PIC families and the applications of the microcontroller.

The programming languages that are used in this book are assembly language, basic and C [1].

The contents of the book include the method to setting up your own PIC microcontroller, PIC microcontroller interfacing capabilities, and application, the basic electronics, the digital electronics, and some useful circuits and routines, such as the LED blinking circuit, and LCD display circuit.

This book is very useful because it can aid me with the programming language and also the circuit building. Besides, the data sheets of the microcontrollers are being included in this book.

2.2 Journals' Review

Journal's review is summarizing the related points from the research that others had done.

2.2.1 Peter J. Boden, "Surface Mount Technology – A Study of Safety Considerations: Silver Migration and Adhesive Flammability"

This work represents original application of silver migration and flammability testing for evaluating surface mount device (SMD) silver electrodes and surface mount adhesives.

According to the writer Peter J. Boden, "The migration of silver can result in reduced spacing between poles of opposite polarity and ultimately, to a short circuit. Besides of that, silver migration is an electrochemical process whereby silver, in contact with an insulating material in a humid environment and under an applied electric field, leaves its initial location in ionic form and redeposit at another location. This may lead to a reduction in electrical spacing or ultimately to a short circuit [2]. ”

Hence, silver migration is a critical problem that arises during the SMT being used on the SMD. There are many factors that will lead to silver migration. According to this thesis, the factors include, an increase in the applied potential, an increase in the time of the applied potential, an increase in the level of relative humidity (RH), an increase in the presence of ionic and hygroscopic contaminants on the surface of the substrate and a decrease in the distance between electrodes of opposite polarity [2].

Moreover, there are various methods that can prevent the occurrence of the silver migration. The first method stated in the journal is by alloying the silver with an anodically stable metal such as palladium. The second method is the use of a hydrophobic coating over the PWB to shield its surface from humidity and ionic contaminants. The third method is by plating the silver with metals such as tin, nickel, or gold [2].

2.2.2 Steve Yessa, “Microcontroller-Based Remote Locator Using Asynchronous Serial Communication”

According to the journal written by Steve Yessa, “the goal of the project is to develop a remote locator device that is used to find lost items by sending a RF signal to small remote units attached to various items in the home. The names of the lost items are found in a list of saved names and are selected for location. The remote unit attached to the desired item receives the RF transmitted digital ID code from the base unit and produces an audible alert tone to allow the user to locate the items. In this journal, the base unit is microcontroller based and interfaces with an LCD screen and a keypad. The user menu is displayed on the LCD and allows three different modes of operation: save mode, alert mode, and load mode [4]. ”

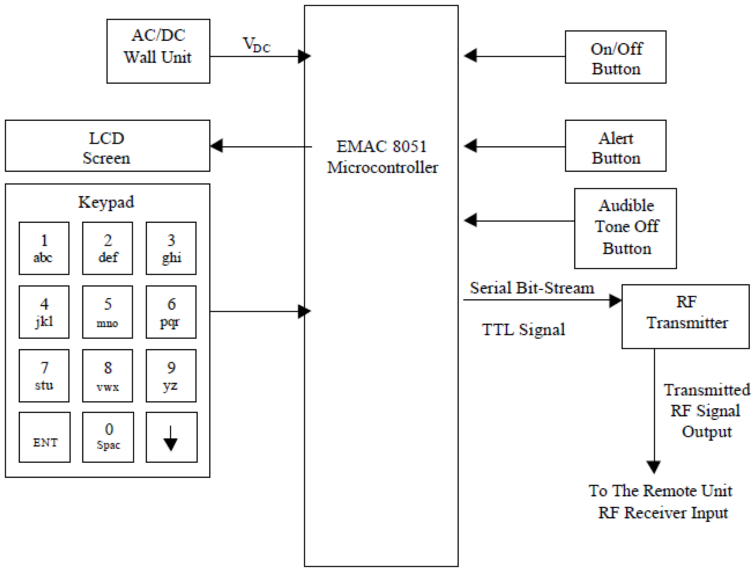


Figure 2.1: Base unit system diagram [4]

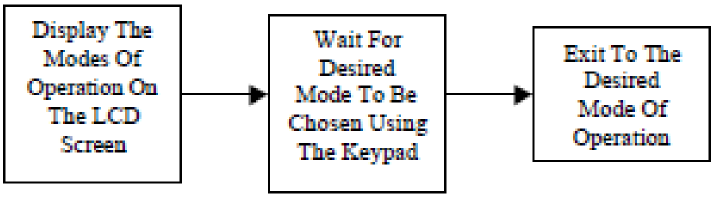


Figure 2.2: Flow chart for the main menu [4]

Figure 2.1 shows the base unit systems with the keypad communicate with the microcontroller and it display the modes of operation on the LCD screen and 3 modes will be available for the users. After that, the signal will be transmitted through the RF transmitter and will be receive by the RF receiver. Figure 2.2 shows the operational flow chart of the main menu.

The base unit inputs of the system are Vcc, keypad, on/off button, alert button and off button. The base unit outputs are the LCD and RF transmitter. The remote unit outputs are UART circuitry and the remote signal.

The most important information from this journal is the UART circuitry that is being using in the RF signal module. It is the most vital part in the RF module which show how the signal being packed and unpacked.

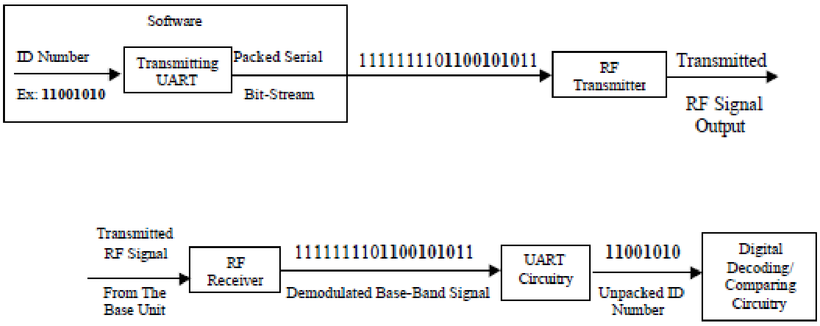


Figure 2.3: UART signal packing and unpacking [4]

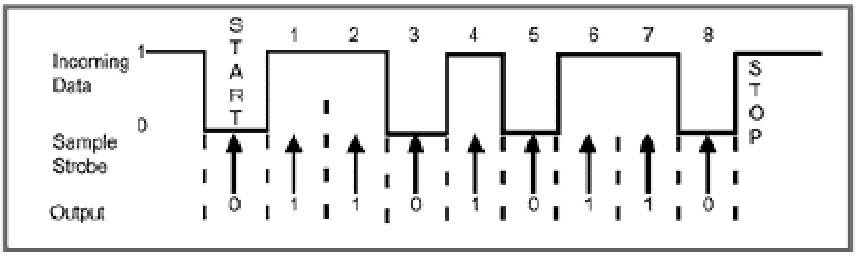


Figure 2.4: Unpacked remote asynchronous signal [4]

In this journal, the example given is the ID number that needs to be transmitting through the transmitter with the value of 11001010. After passing the transmitting UART, the ID number will be packed to become packed serial number. A series of bit '1' will be added to the original ID number. Before the ID number, bit '0' will be added to represent the starting of the string of ID number. After the string of ID number, 2 bits of ‘1’ will be added. After the ID number is being packed, it will be send through the RF transmitter can being transmitter.

The transmitted signal from the transmitter will be received by the receiver and pass through the same UART circuitry as the transmitter. Hence, it will start to unpack the packed serial number. The UART circuitry will detect the first bit which change from bit ‘1’ to bit ‘0’. After the first bit ‘0’, the string of number will be taken as the original ID number. The last 2 bit ‘1’ will be ignored and the serial number is successfully being unpacked [4].

These types of UART signal packing and unpacking will being used as a good reference for my project.

2.2.3 Lawrence D. Rosenthal, “Paired Lost Item Finding System”

This journal is more alike to mine. The final product shape and size is the conceptual shape and size of my project.

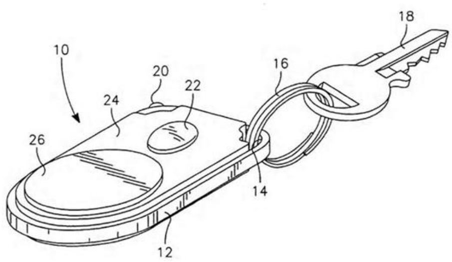


Figure 2.5: Perspective view of a lost item locator

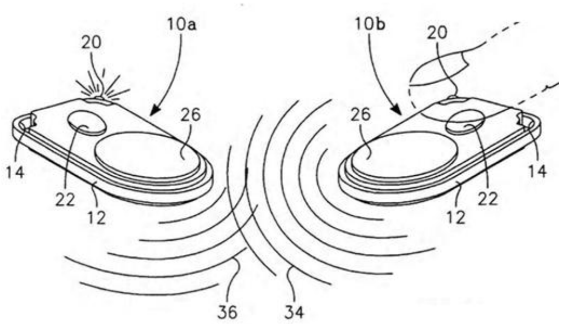


Figure 2.6: Paired locators finding lost items

Figure 2.5 shows the perspective view of the lost item locator, while Figure 2.6 shows a schematic representation of the operation of the paired locators for finding one of them attached to the lost items.

There are 2 parts of hardware needed. They are the remote unit and the control unit. The remote unit is attached to the household items such as a key. In Figure 2.6, when a finger is press on the button on the control unit, the receiver on the remote unit will receive the signal and generate a loud distinctive audible sound and also the blinking of LED which represent the signal had being received.

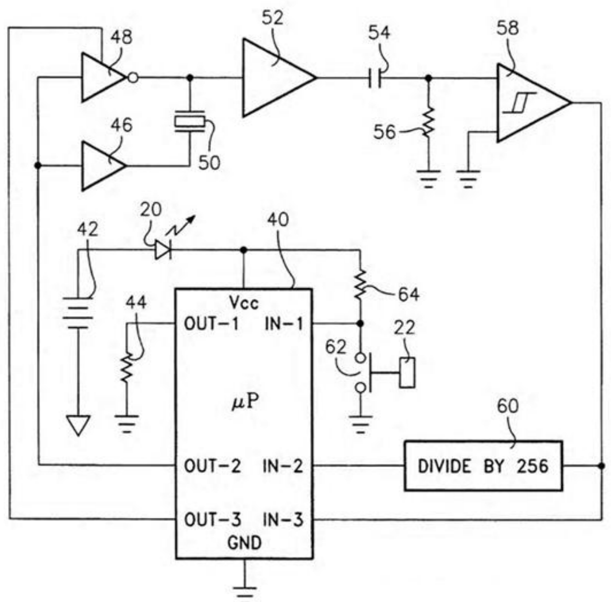


Figure 2.7: Simplified schematic diagram [3]

Figure 2.7 shows the simplified schematic diagram of the electronic circuitry usable with a buzzer.

According to the journal, the explanation of the circuit shows above is as below. "Two serially connected 3V batteries form a DC power supply that provides a voltage to the microcontroller. The microprocessor was designed to operate from a DC power source providing between 3V and 5.5V. In order to provide a voltage in the middle of the operating range, the LED at position 20 drops the 6V to 4V [3]. "

Next, the operation method will be reviewed. "In sleep mode, the microprocessor consumes only about 1 µA of current while in active mode, it consumes about 1 mA of current. The remote unit will stay in sleep mode until button 22 is activated. The microprocessor has 3 outputs, which are OUT-1, OUT-2, and OUT-3 [3]. "

"The first output OUT-1 was connected to a load resistor that is connected to the ground. When the first output OUT-1 goes high, current flows out of the microprocessor through that output, and corresponding additional current flows into the microprocessor power input Vcc through the LED causing it to emit additional light. The second output OUT-2 is connected to the inputs of both a buffer at location 46 and an inverting tri-state buffer at location 48, both of which may be formed from a quad tri-state buffer and a resistor. The buffer simply outputs a high-power signal corresponding to its low-power input while the inverting tri-state buffer either outputs a high-power signal inverted from its low-power input or presents a high-power signal inverted from its low-power input or presents a high-impedance output depending upon the signal from the third output OUT-3 from the microprocessor. A piezoelectric audio transducer at position 50 is connected across the outputs of the buffer and the inverting tri-state buffer [3]. "

"Assuming that the microprocessor has activated the inverting tri-state buffer with its third output OUT-3, the outputs of the two buffers are complementary, either 0V or 6V, with the polarity determined by the signal from the microprocessor's second output OUT-2. The bipolar signal driving the transducer at position 50 generates a louder audio signal as the piezoelectric unit is driven in both directions. For audio signaling, this output OUT-2 is switched at a frequency in the range of 5.5 kHz to 7.5 kHz, with the effect that the audio transducer emits an audio signal in this frequency range [3]. ”

The above operation of the transmitter circuit will be a good reference to make my project success. Some flow chart from the thesis can be used as a good reference for the operation of my final product, the remote locator.

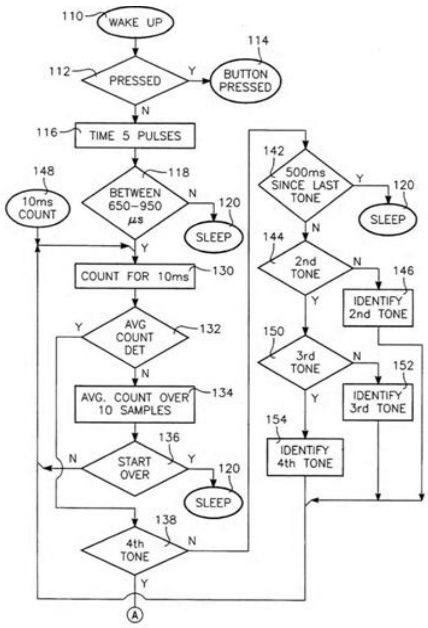


Figure 2.8: Flow chart part 1[3]

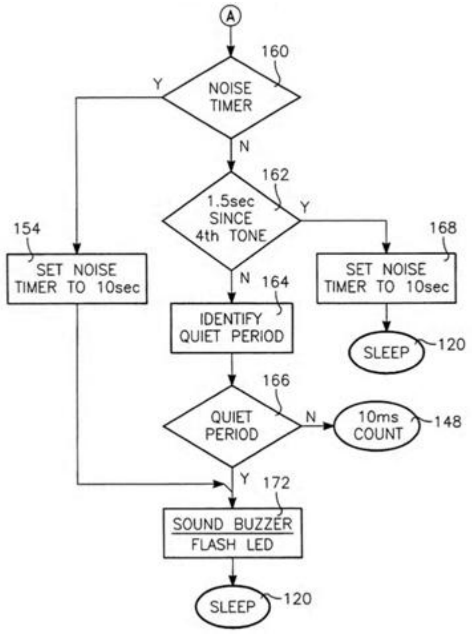


Figure 2.9: Flow chart part 2 [3]

Figure 2.8 and Figure 2.9 shows flow diagram of an algorithm complementary to those of Figure 2.6 and primarily concerned with the operation of a lost locator receiving a search signal and the responds.

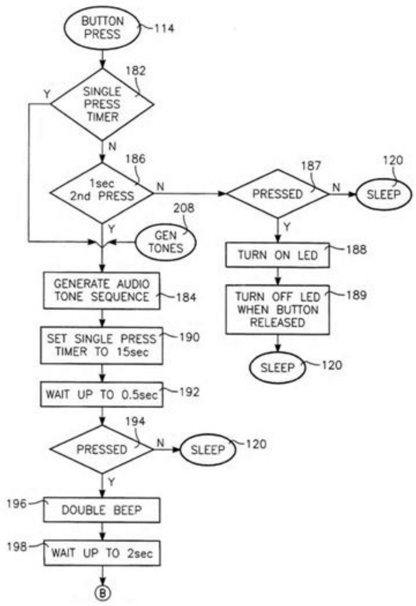


Figure 2.10: Flow chart part 3 [3]

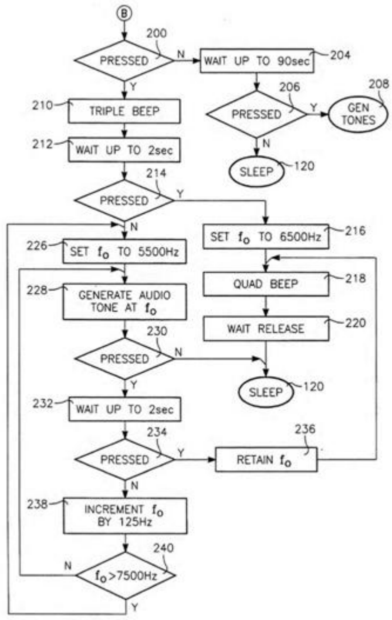


Figure 2.11: Flow chart part 4 [3]

Figure 2.10 and Figure 2.11 shows the flow diagrams of an algorithm complementary to those of Figure 2.8 and Figure 2.9 usable also with the circuitry of Figure 2.7 and primarily concerned with operation of an available locator.

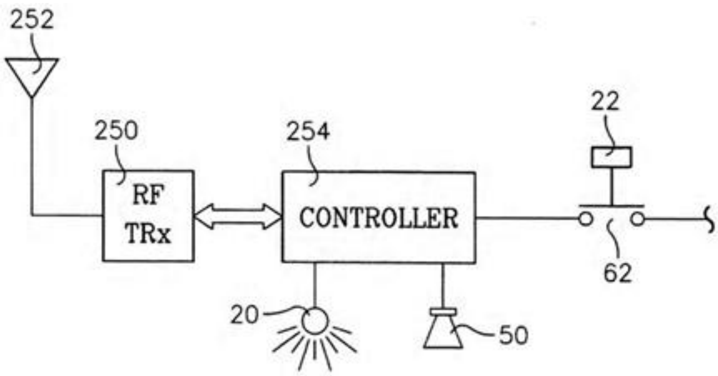


Figure 2.12: Block diagram of the remote locator [3]

Figure 2.12 shows the block diagram of a locator using radio frequency (RF) search signal.

2.3 Thesis' Review

Thesis review can be in the form of online source of hardcopy. It is the summarization from the research that had being done before by others.

2.3.1 Suhaila binti Mohd. Najib, "Microcontroller Based Remote Locator Using Radio Frequency Signal"

The project in this thesis used the microcontroller with through-hole technology. So, I am to reduce the size of the remote locator. In addition, this thesis discuss on the remote locator using RF. In the hardware design, the board can be divided into two parts which are Control Unit and Remote Unit. The transmitter and the receiver that implemented RF signal are USART Asynchronous type.

USART Asynchronous type has just a little bit difference between UART. The "S" means synchronous. However, in this thesis, the synchronous key had being deactivated [5].

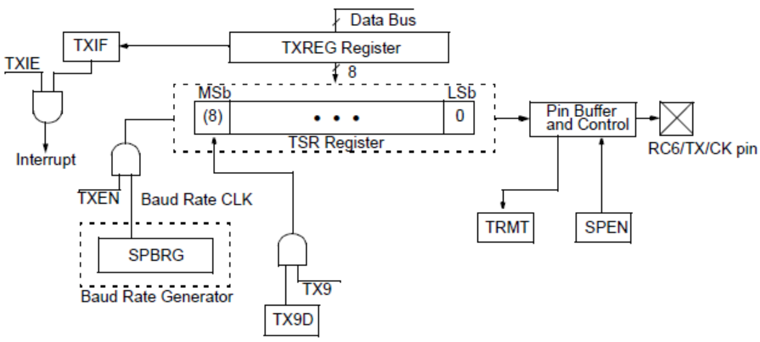


Figure 2.13: Transmitter block diagram [5]

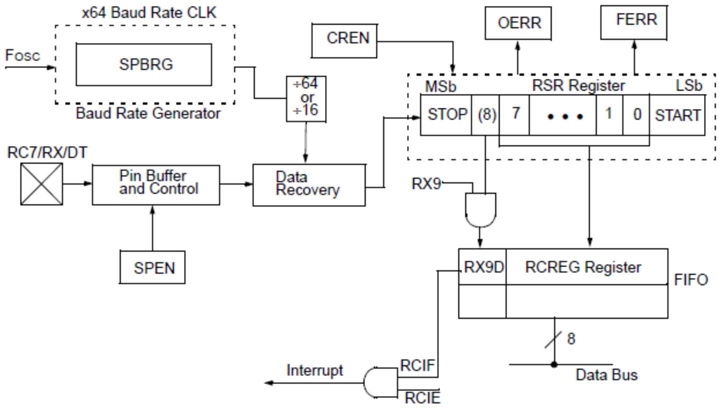


Figure 2.14: Receiver block diagram [5]

Figure 2.13 and Figure 2.14 shows the transmitter block diagram and receiver block diagram respectively. Every UART or USART circuitry has its own module.

R/W-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	R-1	R/W-0
CSRC	TX9	TXEN	SYNC	—	BRGH	TRMT	TX9D
bit 7							bit 0

bit 7 **CSRC**: Clock Source Select bit
<u>Asynchronous mode:</u>
Don't care
Synchronous mode:
1 = Master mode (clock generated internally from BRG)
0 = Slave mode (clock from external source)

bit 6 **TX9**: 9-bit Transmit Enable bit
1 = Selects 9-bit transmission
0 = Selects 8-bit transmission

bit 5 **TXEN**: Transmit Enable bit
1 = Transmit enabled
0 = Transmit disabled

Note: SREN/CREN overrides TXEN in SYNC mode.

bit 4 **SYNC**: USART Mode Select bit
1 = Synchronous mode
0 = Asynchronous mode

bit 3 **Unimplemented**: Read as '0'

bit 2 **BRGH**: High Baud Rate Select bit
Asynchronous mode:
1 = High speed
0 = Low speed
Synchronous mode:
Unused in this mode

bit 1 **TRMT**: Transmit Shift Register Status bit
1 = TSR empty
0 = TSR full

bit 0 **TX9D**: 9th bit of Transmit Data, can be parity bit

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

Figure 2.15: Asynchronous transmitter bitmap [5]

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R-0	R-0	R-x
SPEN	RX9	SREN	CREN	ADDEN	FERR	OERR	RX9D
bit 7							bit 0

bit 7 **SPEN**: Serial Port Enable bit
1 = Serial port enabled (configures RC7/RX/DT and RC6/TX/CK pins as serial port pins)
0 = Serial port disabled

bit 6 **RX9**: 9-bit Receive Enable bit
1 = Selects 9-bit reception
0 = Selects 8-bit reception

bit 5 **SREN**: Single Receive Enable bit
Asynchronous mode:
Don't care
Synchronous mode - master:
1 = Enables single receive
0 = Disables single receive
This bit is cleared after reception is complete.
Synchronous mode - slave:
Don't care

bit 4 **CREN**: Continuous Receive Enable bit
Asynchronous mode:
1 = Enables continuous receive
0 = Disables continuous receive
Synchronous mode:
1 = Enables continuous receive until enable bit CREN is cleared (CREN overrides SREN)
0 = Disables continuous receive

bit 3 **ADDEN**: Address Detect Enable bit
Asynchronous mode 9-bit (RX9 = 1):
1 = Enables address detection, enables interrupt and load of the receive buffer when RSR<8> is set
0 = Disables address detection, all bytes are received, and ninth bit can be used as parity bit

bit 2 **FERR**: Framing Error bit
1 = Framing error (can be updated by reading RCREG register and receive next valid byte)
0 = No framing error

bit 1 **OERR**: Overrun Error bit
1 = Overrun error (can be cleared by clearing bit CREN)
0 = No overrun error

bit 0 **RX9D**: 9th bit of Received Data (can be parity bit, but must be calculated by user firmware)

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
- n = Value at POR	'1' = Bit is set	'0' = Bit is cleared x = Bit is unknown

Figure 2.16: Asynchronous receiver bitmap [5]

CHAPTER 3

METHODOLOGY

3.1 Methodology Flow

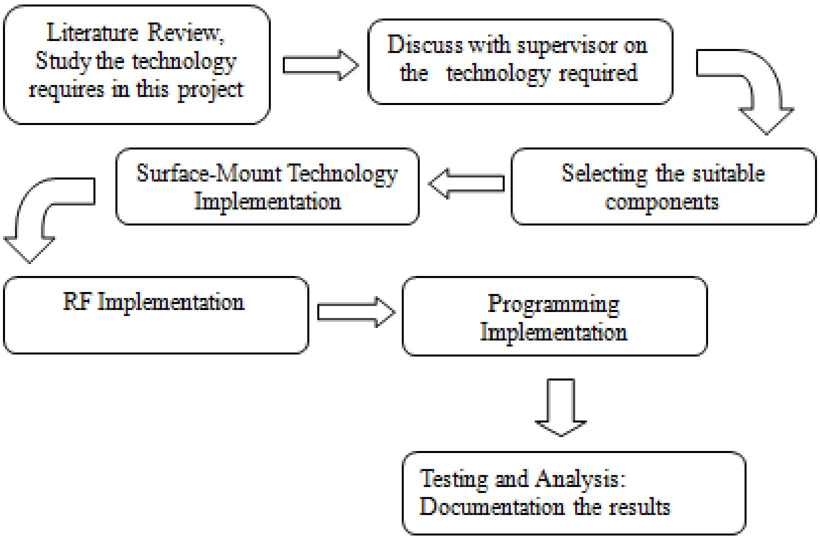


Figure 3.1: Methodology flow

Figure 3.1 shows the methodology flow that starts from research and literature review and follow by discussing with supervisor. After that, suitable components are being selected and SMT implementation will be done. After SMT implementation, RF will be implemented. After the implementation of RF module, the PICs are being programme and at the final stage, testing and analysis will be done. The final part of the whole project is to the process of results' documentation.

3.1.1 Gantt Chart

Table 3.1: FYP 1

No.	MONTH	JULY			AUGUST				SEPTEMBER			OCTOBER				NOVEMBER	
	TASKS \ WEEKS	1	2	3	4	5	6	7	8		9	10	11	12	13	14	15
1.	Meeting with supervisor									SEMESTER BREAK							
2.	Title selection																
3.	Literature review																
4.	Data and information collection																
5.	Preparation of proposal																
6.	Proposal submission																
7.	Study and understand high level language																
8.	LED blinking & 7 segment display																
9.	Presentation preparation																
10.	Determine components to be purchased																
11.	Report writing																
12.	Report submission																

Table 3.2: FYP 2

No.	MONTH	JANUARY				FEBRUARY			MARCH					APRIL				MAY
	TASKS \ WEEKS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Purchasing components																	
2.	SMT components construction																	
3.	Programming on chips																	
4.	Hardware construction																	
5.	Testing and results																	
6.	Seminar preparation																	
7.	Thesis writing																	
8.	Thesis submission																	

3.2 Hardware Overview

In this section, the hardware which consists of components will be discussed and explained.

3.2.1 Methodology Overview

The chosen SMT PICs are the PIC 16F876A SOIC package and PIC 16F877A TQFP package. SOIC stands for small-outline integrated circuit while TQFP is thin quad flat pack. The circuits' layout will be drawn by using the software, Altium Designer Summer 09 that is available in the PCB lab in UTM.

After that, the PCB layout will also be drawn. The circuit will be printed on the PCB board and soldering work need to be carried out. As a result of it, the circuit will be successfully built.

The hardware can be divided into 2 parts. They are the control unit (CU) and the remote unit (RU). SMT is being implemented into both of the units. LCD will be used if it is needed. In my project, I am required to build one CU and a few RU. Inside the RUs, SMT buzzer or audio transducer will be implemented.

The communication between hardware can be done by the implementation of the RF module. Transmitter will be implemented into the CU while receiver will be implemented into the RUs.

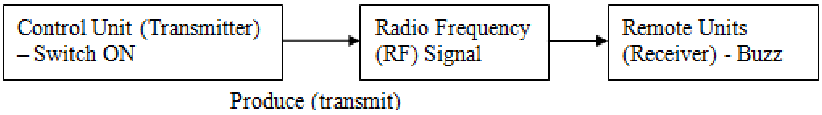


Figure 3.2: Functional block diagram

Figure 3.2 shows the operational block diagram of the remote locator which I wish to build.

3.2.2 PIC 16F876A-I/ SO

PIC 16F876A-I/ SO is a surface mount PIC. Although the size is smaller than the Dual-In Line (DIP) PIC, however, the functions and the pins are similar. It was being implemented in this project as the PIC of the remote unit (RU) is because it is a common PIC. In addition, the size of this PIC is small and the purpose to reduce the size of the RU can be achieved. Besides, the PORTs on the PIC are adequate for the buzzer and LEDs implementation. Figure 3.3 shows the pin diagram for this PIC while Figure 3.4 shows the PIC.

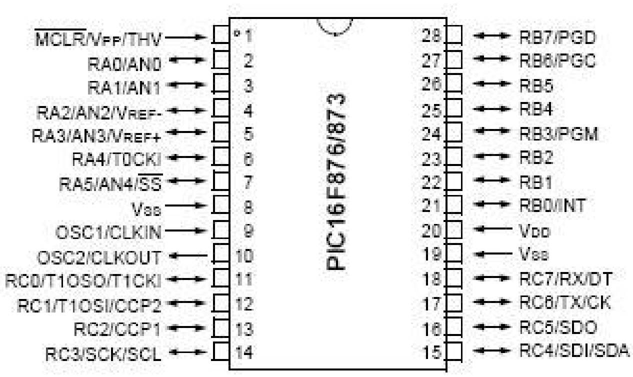


Figure 3.3: Pin diagram of PIC 16F876A **Figure 3.4:** PIC 16F876A-I/SO

3.2.3 PIC 16F877A-I/ PT

PIC 16F877A-I/ PT had being chosen as the PIC for the control unit (CU) in this project. The size of this PIC is approximately 10 times smaller than the DIP PIC's size. Moreover, the functions are similar. The TQFP package will have 4 more pins than the 40 pins DIP PIC. Hence, the objectives of reducing the size can be achieved. The reason this PIC is being chosen is due to the number of PORTs that this PIC has. In order to acquire the possibility of controlling more RU, the PORTs are important to enable the modification of the circuit. Figure 3.5 shows the pin diagram and the PIC is in Figure 3.6.

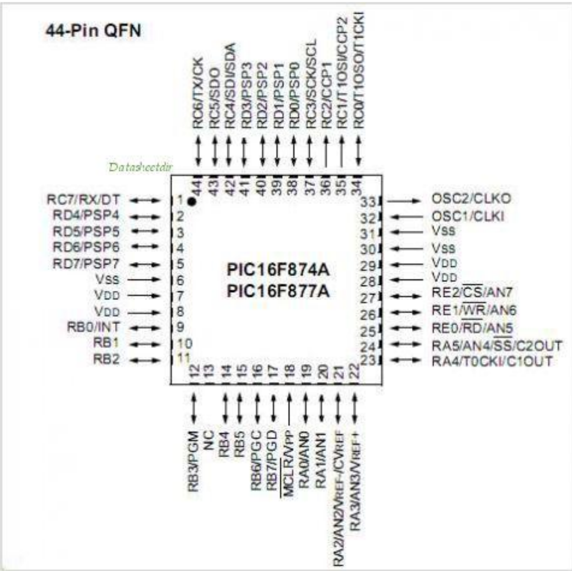


Figure 3.5: Pin diagram of PIC 16F877A **Figure 3.6:** PIC 16F877A-I/PT

3.2.4 Clock Generator

The clock of a PIC microcontroller need to be generates. In order to generate clock for the PIC, four available methods can be used. These different options are designed based on different specifications and requirements. Cost, speed and accuracy are the three most important elements when choosing the clocking methods. With small quantities, the cost differences are small. However, for large quantities, it would be prudent to select the lowest clock frequency that comfortably meets the application requirements as the cost savings increase with quantity. In order to generate the correct results from the PIC, the clock's speed is vital. The PIC may not be functioning when the values of the clock generators are wrongly used. The last element which is the accuracy is highly related to the timing of the clock generator [9]. Table 3.3 shows the capacitor selection for crystal oscillator.

Table 3.3: Capacitor selection for crystal oscillator [9]

Osc Type	Crystal Freq.	Cap. Range C1	Cap. Range C2
LP	32 kHz	33 pF	33 pF
	200 kHz	15 pF	15 pF
XT	200 kHz	47-68 pF	47-68 pF
	1 MHz	15 pF	15 pF
	4 MHz	15 pF	15 pF
HS	4 MHz	15 pF	15 pF
	8 MHz	15-33 pF	15-33 pF
	20 MHz	15-33 pF	15-33 pF

The four clock generator or crystals that are available in the market consist of RC oscillator (resistor / capacitor), XT oscillator (crystal / ceramic resonator), HS oscillator (high speed crystal / ceramic resonator) and LP oscillator (low power crystal) [9].

Among these four methods, RC is the least accurate method. However, when timing is not a critical concern, this method can be used. In this project, HS which the operating frequency is up to 20MHz had been used. The crystal will oscillate at a fixed frequency, which is 50ppm (parts per million) for 20MHz crystal [5]. This will allow the hardware timer to measure the exact time intervals and to produce accurate output signal. Figure 3.7 shows the connection of the crystal with two capacitors. Theoretically, the capacitors that are connected to the crystal will assure the stability of the oscillation. However, practically, without the capacitors, the circuits are functioning better.

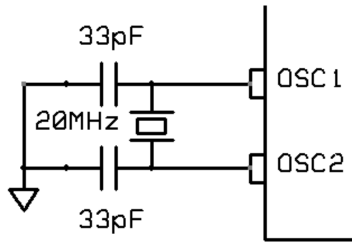


Figure 3.7: Crystal connection

3.2.5 MCLR Pin

MCLR pin acts as the reset pin, which is also known as a "behavior controller" for a PIC [5]. In order to trigger a PIC into the known condition, the MCLR pin has to be activates by connecting a pull-up resistor (10kΩ) with the V_{dd} (5V) and ground (0V). MCLR pin for PIC 16F876A-I/ SO is located at pin 1 while for PIC 16F877A-I/PT, MCLR pin is located at pin 18. For the controller, a switch can be connected to the MCLR in order to interrupt the program for the purpose of program execution. When the reset button is being pushed, all the registers will return to the starting condition. Figure 3.8 shows the MCLR pin connection.

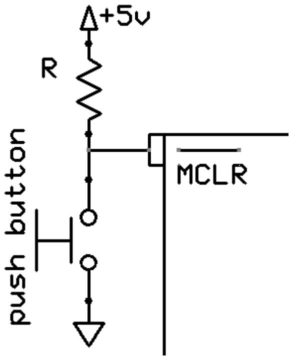


Figure 3.8: MCLR pin connection

3.2.6 USART Configuration

Universal Asynchronous Receiver Transmitter (UART) is a piece of computer hardware that translates data between parallel and serial forms. The universal designation indicates that the data format and transmission speeds are configurable and that the actual electric signaling levels and methods typically are handled by a special driver circuit external to the UART. Hence, many PIC microcontrollers had integrated with this device and it is called USART [11]. Universal Synchronous Asynchronous Receiver Transmitter (USART) allows the interface between PIC microcontroller and serial devices or synchronous serial device. USART can be configured asynchronous full-duplex device, as a synchronous half-duplex master, or as a synchronous half-duplex slave. Asynchronous mode is used mostly in communication between analog-to-digital and digital-to-analog for serial EEPROM interfacing. [5]

3.2.7 USART Baud Rate Generator (BRG)

The USART supports a wide range of software programmable baud rates and data formats and in either Synchronous or Asynchronous mode [10]. In Asynchronous mode, bit BRGH (TXSTA <2>) controls the baud rate while the SPBRG register controls the period of a free running 8-bit timer. Writing a new value to the SPBRG register causes the BRG timer to be reset (or cleared). This ensures the BRG does not wait for a timer overflow before outputting the new baud rate [12]. In order to generate the baud rate, formula in Table 3.4 with the give FOSC and desired baud rate that the user desired to use.

Table 3.4: FOSC and desired baud rate [12]

SYNC	BRGH = 0 (Low Speed)	BRGH = 1 (High Speed)
0	(Asynchronous) Baud Rate = FOSC/ (64(X+1))	Baud Rate = FOSC/ (16(X+1))
1	(Synchronous) Baud Rate = FOSC/ (4(X+1))	N/A

3.2.8 USART Asynchronous Mode

In this project, the Asynchronous mode will be used. In this mode, non-return-tozero (NRZ) format is being used. In NRZ, the positive voltage will be represented by 1’s while the negative voltage will be represented by 0’s. NRZ format normally operating in 10 bits where the start bit is sent as a logic low bit; while the stop bit is sent as a logic high bit. Hence, there is always a clear demarcation between the previous character and the next one [14]. Figure 3.9 shows the NRZ format of the USART Asynchronous mode. In this project, four important elements that will be considered consist of baud rate generator, sampling circuit, transmitter and receiver [13].

Start	Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Stop

Figure 3.9: NRZ format

3.2.9 USART Asynchronous Transmitter

In the USART Asynchronous mode, the controlling for the transmission is mainly operated by the TXSTA register [14]. In this project, eight bits of data will be transferred. Hence, the programme needs to enable the TX9 bit. Once this bit has been set, the initialization of the register will enable and cause a transmission. The TX9 bit will enable the transmitter to send eight or nine bits of data after the starting bit. Figure 2.13 and Figure 2.15 in Chapter 2 had shown the block diagram and the Bitmap respectively. Figure 3.10 will show the simplified transmission block diagram.

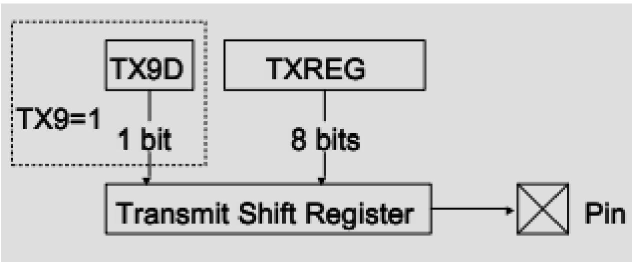


Figure 3.10: Simplified transmission block diagram [10]

3.2.10 USART Asynchronous Receiver

In the USART Asynchronous mode, the controlling for the reception is being mainly operated by the RCSTA register [14]. In the transmission part, we had initialized the transmitter to transmit 10 bit data. Hence, in the reception part, the RX9 bit will be activated in order to receive eight or nine bits after the detection of a start bit. Figure 2.14 and Figure 2.16 in Chapter 2 had shown the block diagram and the Bitmap respectively. The simplified reception block diagram will be show in Figure 3.11.

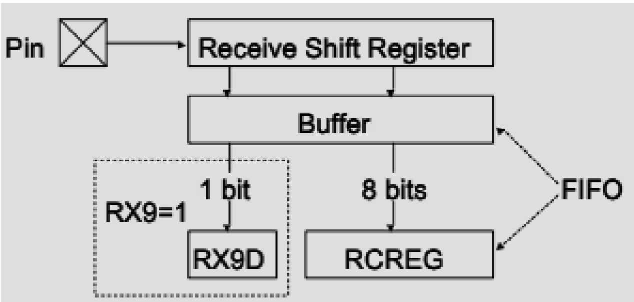


Figure 3.11: Simplified reception block diagram [10]

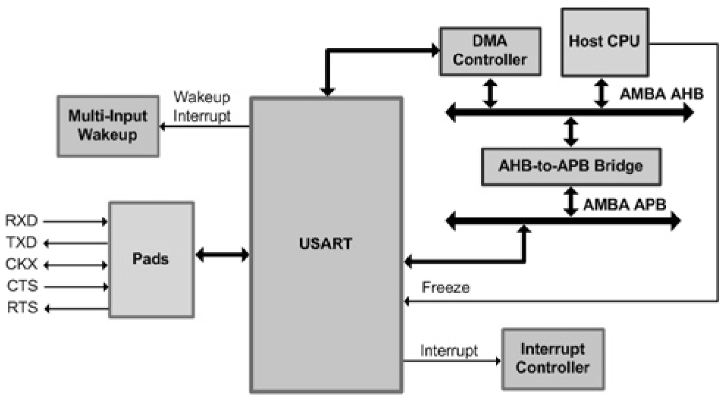


Figure 3.12: Combinational block diagram [10]

Figure 3.12 shows the final combination of all the parts that had being discussed and the signalling of the transmitter and the receiver of an USART are shown in the block diagram above.

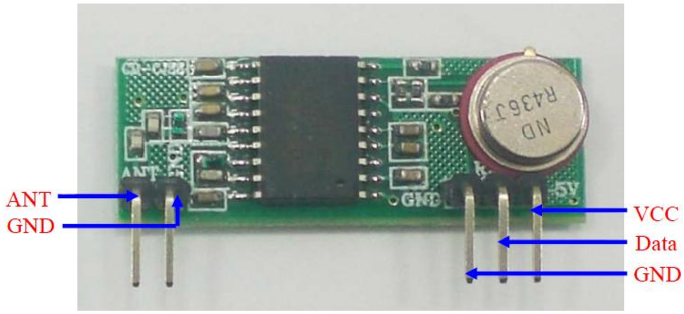
3.2.11 RF Module

In the beginning of Chapter, the phrase radio frequency had being pin-pointed. So, radio frequency module is an important element in the project. Today technologies in the field of mobile communication systems are becoming more and more common and user-friendly. Hence, many low cost radio frequency (RF) modules are available in the market. In this project, the RF modules that are manufactured by Cytron Technologies are being implemented. The consideration on buying a module rather than build it is due to the cost of building a module is more expensive than a ready-built module. The modules are ready to plug into the circuit to interface with the PIC and complete the communication system.

The RF module that used in this project is at the frequency of 433 MHz. According to ISM band, 433 MHz if in licensed free frequency range. ISM band means industrial, scientific and medical radio bands which it is reserved for international uses of RF electromagnetic fields in that area other than communication [15] .

3.2.12 Transmitter RF-TX-433

Figure 3.13 shows the RF transmitter module that will be implemented.

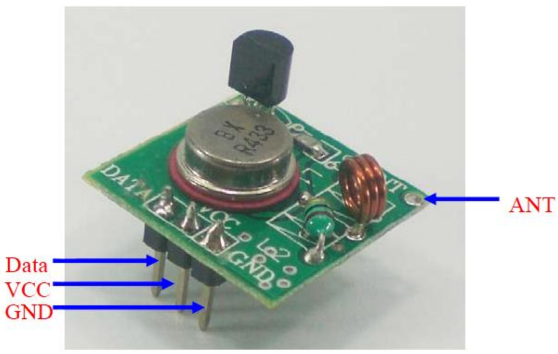


Label	Description
ANT	The pin to connect antenna. (Please select the correct antenna length, which is 18cm)
VCC	The power supply (5V) to the receiver.
GND	The Ground of the receiver. (The 2 GND are internally connected each other.)
Data	The Data pin of the receiver.

Figure 3.13: RF transmitter module [16]

3.2.13 Receiver RF-RX-433

Figure 3.14 shows the receiver module that will be implemented .



Label	Description
Data	The Data pin of the transmitter.
VCC	The power supply to the transmitter.
GND	The Ground of the transmitter.
ANT	The hole to solder and connect antenna. (Please select the correct antenna length, which is 18cm)

Figure 3.14: RF receiver module [17]

3.2.14 Sounder

Figure 3.15: PCB-mount buzzer [18]

Figure 3.15 shows the PCB-mount buzzer. The specification of the buzzer is as below.

Rated Voltage: 2. 0~6.0VDC
Rated Current: ≤ 40mA
Sound Output: ≥ 85DB
Resonant Frequency: 2400HZ

This buzzer will be implemented in my project due to its size and it is not a piezo type buzzer that will have a fix frequency at 2.4 KHz although the frequency is changed.

3.2.15 USB ICSP PIC Programmer

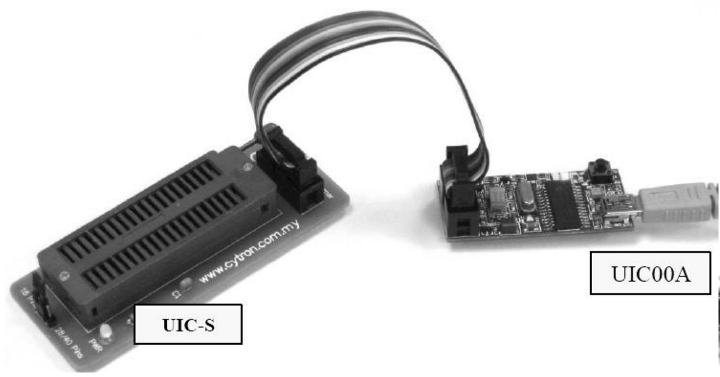


Figure 3.16: Programmer [19]

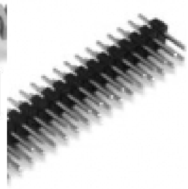


Figure 3.17: Male pin

Figure 3.16 and Figure 3.17 shows the programmer that will be used in order to programme the surface mount PIC. A SMT PIC will not be able to suit the size of an UIC-S. Hence, the Male Pin in Figure 3.17 is being used to replace UIC-S. A circuit from the SMT PIC will be built. After the interface between UIC00A and the Male Pin is built, the programming to the SMT PIC can be done.

3.3 Programming Software Overview

In programming software parts, MPLAB and PICkit 2 is being utilized to write the code, build a project and to program the PIC microcontrollers.

3.3.1 Introduction to Programming Software

Programme the PIC is a tough task in develop an embedded system that ensure that the system work as expected. In order to programme the PIC, it is a must to use assembler software. Assembler software is software that converts the instructions into a pattern of bits that the PIC can understand and do its job. This pattern bits is called machine language [20]. This software will also generate many files but one of the important file is .hex file. This file will be used by PIC to do its job. In order to load the .hex file, programmer and emulator are needed. Programmer function as to a hardware device that configures programmable non-volatile circuits such as EPROMs, EEPROMs, Flashs, PALs, FPGAs or programmable logic circuits. Meanwhile, a simulator is a tool that helps the assembler to load the .hex file into the PIC. [5]

3.3.2 PIC Language

Language is the source of communication among human beings. Different countries have different languages. It is similar to the communication happens in the PIC. Language that is use must be understood by the PIC. There are two major types of programming languages which are low level languages and high level languages. Low level languages are further divided into machine language and assembly language. Examples of high level language are C, C++, micro code and Basic. For this project, C language will be used in order to program the PIC [5]. The advantages of high level language enable us to write programme by using words and mathematical symbols rather than mnemonic code. The advantages of using high level language are user-friendly, similar to English with vocabulary of words and symbols, easier to learn and maintain, shorten the time to programme, program written in a high-level language can be translated into many machine language and therefore can run on any computer for which there exists an appropriate translator and it is independent of the machine on which it is used.

3.3.3 MPLAB IDE Assembler

Figure 3.18: MPLAB IDE assembler

Assembler is a programming language that is part of the toolset used in embedded systems programming. It comes with its own distinct set of rules and techniques. It is essential to adopt and learn IDE (Integrated Development Environment) when developing programs. MPLAB IDE is an excellent tool for PIC microcontrollers, both for learners and professionals. In addition, it is easy to get and it is an open source for public. The main software tools and files created and used by MPLAB during the development process [21] are the text editor which is used to create and modify source code text file, the assembler which create .hex file, the simulator the allows program to be tested in software before downloading and the programmer which enable the downloads of machine code into a chip.

3.3.4 Create and Build Project

The MPLABD IDE is software which is very common and it is being used widely in the field of engineering. There are several steps to be followed in order to create and build a project.

1. Open MPLAB IDE application. We can choose our desired PIC by clicking **Configure > Select device > Choose**. After the PIC is being chosen, click **OK**.
2. In order to build a project, a project wizard had to be created by **Project > Project Wizard**. When a project wizard interface shown up, **Next** is being clicked twice. These steps determine the active toolsuit that are being used by the user. For example the C language and Hi-Tech Universal Toolsuite.
3. Next, browse the project path and click **Next > Finish** in order to enable the typing of a programme. When New is clicked, a black workspace will be pop up and the coding can be written in it.
4. After that, save the programming as file .c. After the .c file is being saved, a source file must be included in order to build the code.
5. Click on **Project > Build** on the toolbar and the result will be generated. Besides, a .hex file will also be generated from this step of procedure.
6. After a project is being successfully built, PICkit 2 is used to load .hex file into the PIC. Figure 3.19 shows the icon of PICkit 2.

Figure 3.19: PICkit 2

7. In order to load the program, click on **File > Import Hex** and then choose the .hex file.

8. Then, click **Write** > **Verify** and a microcontroller is being successfully programmed. Figure 3.20 shows the PICkit 2 user interface.

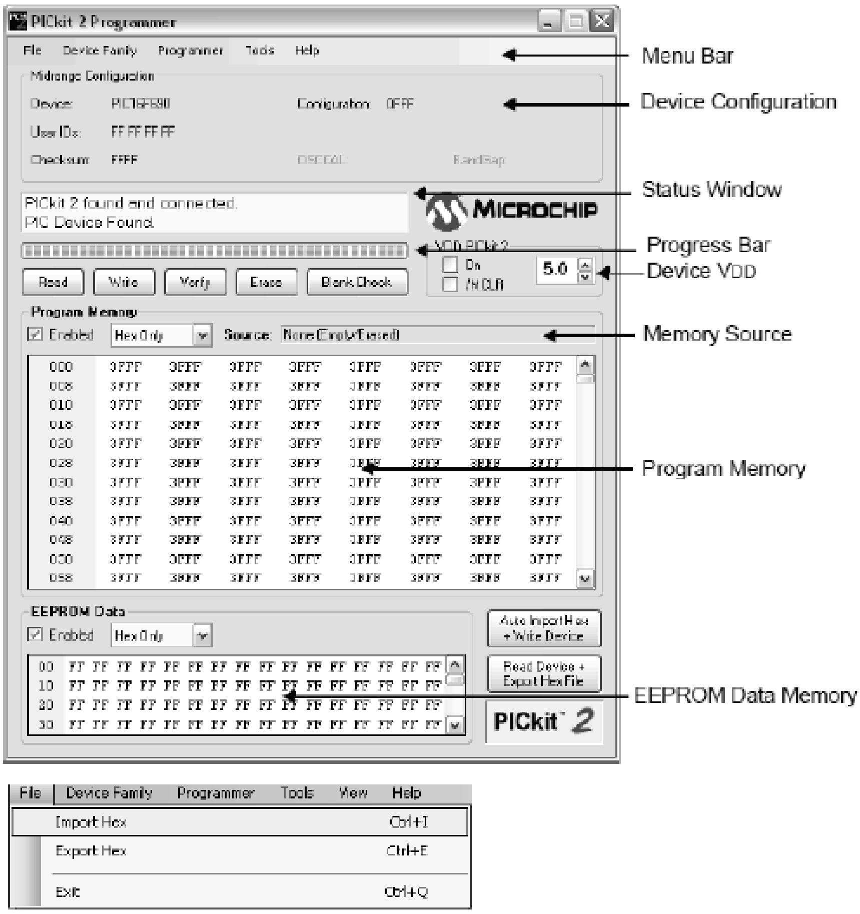


Figure 3.20: PICkit2 user interface

3.4 Designing Software Overview

Altium Designer Summer 09 is being used to draw the circuits outline, connection and the PCB board layout. This is not a common software and a step by step guide will be discussed for a better understanding of the interface, information on how to use panels and managing design documents. Figure 3.21 shows the software application icon.

Figure 3.21: Altium Designer Summer 09 [22]

3.4.1 Creating a New PCB Project

To create a new PCB project, following steps is being taken.

1. Select **File > New > Project > PCB Project** from the menus.
2. The project panel will open, displaying the new project file, PCB_Project1.PrjPCD with no document added.
3. Rename the new project and save the project by selecting **File > Save Project As**. Browse the location for the project and click Save.

3.4.2 Creating a New Schematic Sheet

Every design starts with the schematic diagram. Hence, before we are able to create the PCB drawing, a schematic diagram is needed to be drawn. To create a new schematic sheet, following steps is being taken.

1. Right-click on the project file in the projects panel and select **Add New to Project > Schematic**. A blank schematic sheet named Sheet1.SchDoc will be open.
2. Rename and save the new schematic by selecting **File > Save As**. The path of saving the new schematic should be the same as the PCB project.
3. Right-click on the project filename in the projects panel and select Save to save the project.

3.4.3 Setting the Schematic Document Options

The first thing to do before the drawing of a circuit is started is to set up appropriate document options. The following steps need to be followed.

1. From menus, select **Design > Document Options**.
2. We can change the requirement of the options for example the sheet size of the paper and many other options.
3. Click **OK** to update the changes made.
4. In order to make the document fill the viewing area, select **View > Fit Document**.
5. Click **File > Save** to save the schematic sheet.

3.4.4 Locating Components and Loading the Libraries

A powerful library searching is capable in the Altium Designer. Figure 3.22 shows the Libraries Search window of the software.

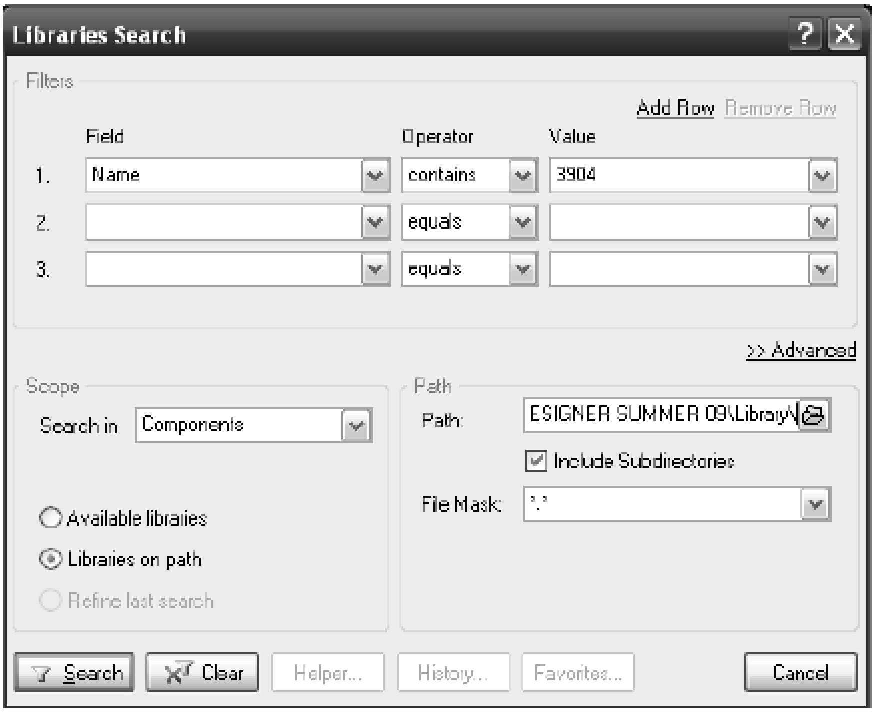


Figure 3.22: Libraries search window

1. In order to open the Libraries Search window, select **Tools** > **Find Component**. The setting of Scope, Path, File Mask and everything must follow the options as in Figure 3.22.
2. The Field row is set to Name, the Operator is set to contain and the Value is the name of the components that we would like to search.
3. Click the **Search** button after the setting is being done. The Query Results are displayed in the Libraries panel as searching still continued.
4. Click on the component to select the component.

3.4.5 Placing the Components on Schematic

1. Select **View > Fit Document**.
2. Display the Libraries panel by clicking on its tab on the right of the workspace.
3. Select the **Miscellaneous Devices. IntLib library** from the Libraries drop-down list at the top of the Libraries panel to make is the active library.
4. Search the components and click on the component to select it, and then click the **Place** button, or just double-click on the component name. The component that floating on the cursor can be rotate by pressing X (flip horizontally), Y (flip vertically), Spacebar (rotate 90 degree anti-clockwise) and Shift + Spacebar (rotate 90 degree clockwise) and right-click to place the component.
5. The properties of the components can be shown by double-click the component that had being placed on the schematic diagram.

3.4.6 Wiring up the circuit

Wiring is the process of creating connectivity between various components of the circuit. To wire up the schematic, following steps are required to be completed.

1. Wire up the components by select  **Place** > **Wire** and connect the components following the design.
2. Right-click on the workspace is to make a corner or to connect the components with wires.
3. Press Esc in order to stop the process of wiring.

3.4.7 Nets and Net Labels

Each set of component pins that we have connected to each other now form what is referred to as net.

1. Select **Place > Net Label**. A net label will appear floating on the cursor.
2. Press **TAB** to edit the label before placing it.
3. Type the desired name in the Net field, and then click **OK** to close the dialog.
4. When we place the net label, the cursor will change to a red cross when the net label touches the wire and light gray when a pin is being label instead of a wire.
5. After finish labelling, select **File > Save** to save the circuit.
6. Finally, checking the electrical properties of the schematic in order to verify the design by selecting **Project > Project Options** and setting up the Error Reporting, Connection Matrix and Comparator tabs.

3.4.8 Compiling the Project to Check for Errors

Compiling a project checks for drafting and electrical rules errors in the design documents and details all warnings and errors in the message panel, and gives detailed information in the Compiled errors panel.

1. To compile a project, select **Project > Compile PCB Project**.
2. When the project is compiled, all warning and errors will be displayed in Messages panel. Check for the errors occurred and fix all the errors out in order to enable the creation of a new PCB.

3.4.9 Creating a New PCB

Before a design is being transferred from the Schematic Editor to the PCB Editor, a board outline had to be created by using PCB Board Wizard. The PCB Board Wizard allowed the customization of the board size and also the board outline. Steps are as the following.

1. Select the **System** button at the bottom right of the workspace and select File.
2. Select **PCB Board Wizard** in the New from Template section at the bottom right of the Files panel.
3. Select **Next**.
4. Set the measure units to Imperial and select **Next** > **Next**. In this units, 1000mil = 1 inch.
5. In this page of Wizard, the board outline and the size can be customized. For my project, I had chosen Circle for the Outline Shape and 2000mil for the Board Size. Deselect Title Block and Scale, Legend String and Dimension Lines. Click **Next** to continue.
6. We will need 2 signal layers and no power planes. Click **Next** to continue.
7. For the via style, select **Thruhole Vias** only, then click **Next**.
8. In this page, select **Surface-mount components** and select **Yes** in order to put components on both sides of the board and click **Next**.
9. Leave the Default Track and Via sizes to the default and click **Next**.
10. Click **Finish** and the new blank PCB Project had being successfully created.
11. The new PCB Project had not been automatically added or linked to the main project, click and hold the PCB file in the Projects panel and drag and drop it on to the Project that had being created earlier.
12. Right-click on the new PCB in the Projects panel and select **Save As** from the menu that appears.

3.4.10 Transferring the Design

In the steps, the schematic design will be transferred into the PCB project. The following steps need to be performed.

1. Open the schematic document.
2. Select **Design > Update PCB Document**.
3. Click on **Validate Changes**. A green tick must be appeared next to in change in the Status list.
4. Click on **Execute Changes** to send all the changes to the blank PCB Project. When completed, ticks will appear in Done column.
5. Click **Close** and all the components had being transferred.

3.4.11 Ready to Start the PCB Design Process

The components that had being transferred to the PCB as in Figure 3.23.

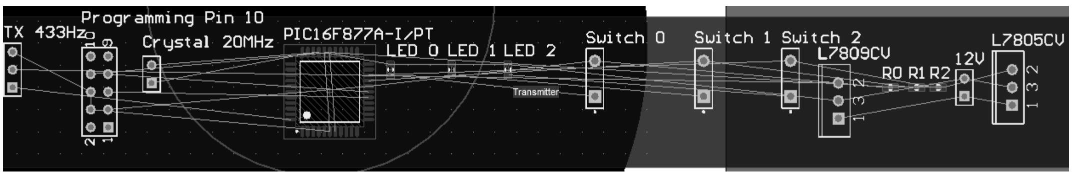


Figure 3.23: Components that had being transferred to PCB

3.4.12 Setting Up the PCB Workspace

To set the snap grid, complete the following steps.

1. Select **Design > Board Options**.
2. Set the values of Snap Grid and the Component Grid to 25mil.
3. Click **OK** to close the dialog.

3.4.13 Component Positioning and Placement Options

Select **Tools > Preferences**. Open the PCB Editor – General page. In the Editing Options section, make sure the Snap to Center option is enabled. This step is done in order to enable the user to grad the center of the components.

3.4.14 Setting Up the Design Rules

The PCB Editor is a rules-driven environment, meaning that as you perform actions that change the design, such as placing tracks, moving components, or autorouting the board, Altium Designer monitors each action and checks to see if the design still complies with the design rules. If it does not, then the error is immediately highlighted as a violation. Setting up the design rules before you start working on the board allows you to remain focused on the task of designing, confident in the knowledge that any design errors will immediately be flagged for your attention.

1. Select **Design > Rules**.
2. Ten Categories will appear. Click once on each rule to select the rule that is wished to modify. In this project mostly of the design rules are set to default.
3. In our UTM PCB lab, the smallest Width of the connection is 25mil. Hence, the Design Rule for Width had to be changed by select Width and set the Width setting as the following values.
   - Min Width = 25mil
   - Preferred Width = 25mil
   - Max Width = 25mil
4. Click **OK** to close.

3.4.15 Positioning the Components on the PCB

The components in Figure 3.24 need to be arranged neatly in order to reduce the circuit's size.

1. Left-click and hold the component in order to put it to the place we desired.
2. The rotation of the components is the same as rotating components in the schematic editor.
3. If we desired to put the component to the other side of the PCB board, we hold the left-click and press '**L**'.
4. The arranged components of my project are as shown in Figure 3.24.

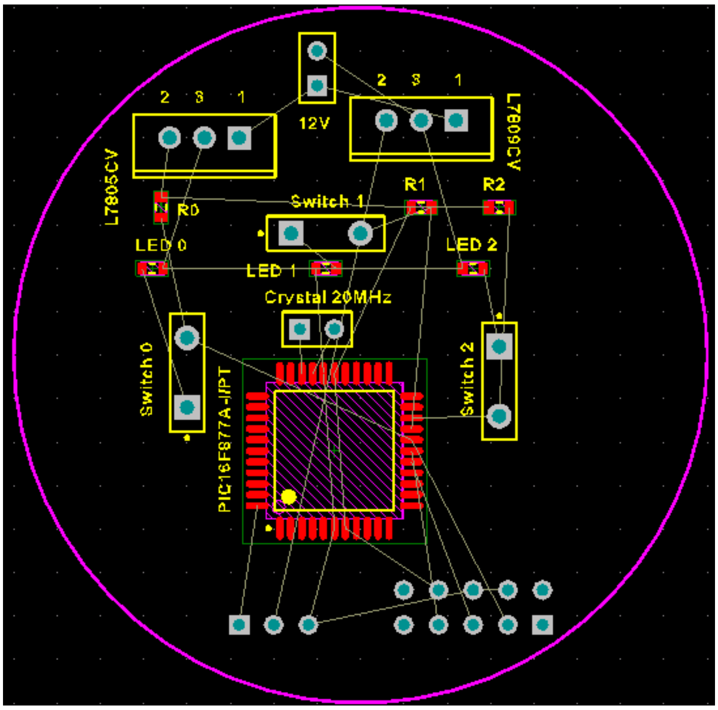


Figure 3.24: Arranged components

3.4.16 Routing the Board

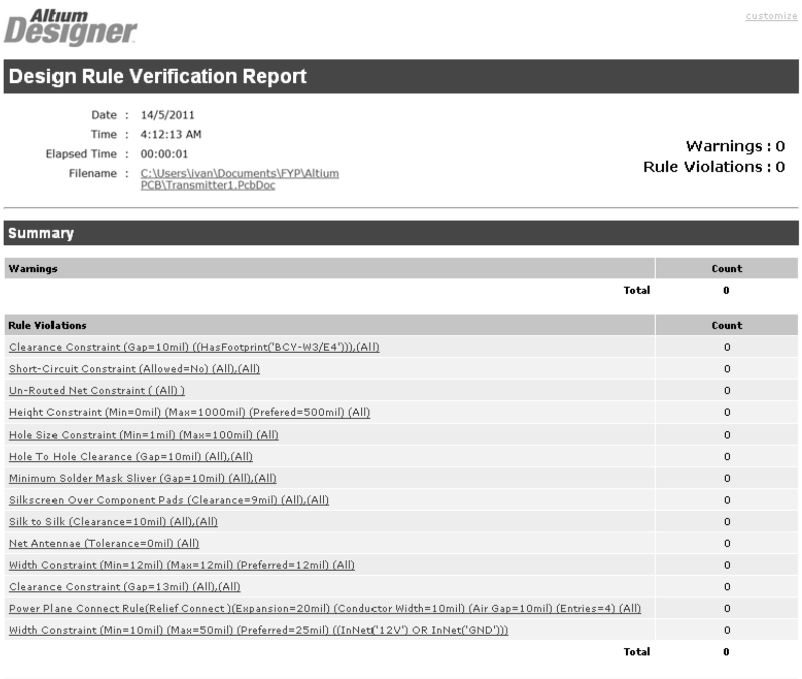
There are two methods in order to route the components. They are the interactively routing the board and automatically route the board. In this project, I had chosen the second method which is automatically routing the board.

1. Un-route the board by selecting **Tools > Un-Route > All**.
2. Select **Auto Route > All**. A report page will showed up.
3. Click **Route All**.
4. If we are not satisfy with the result, we can un-route and route as many times as we like in the way by changing the position of the components.

3.4.17 Verifying the Board Design

The design rules that we had set at the starting of the design process can be verify and it is a must to verify out design in order to avoid some circuitry problem when we want to fabricate the PCB board.

1. Select **Design > Board Layer & Colours** and ensure the Show checkbox next to DRC Error Markers option in the System Colours section is enabled so that the DRC error markers will be displayed.
2. Select **Tools > Design Rule Check**.
3. The Design Rule Verification Report will show the errors that does not follow the design rules. Hence, errors must be fixed and repeat step 1 until Warnings: 0 and Rule Violations: 0.
4. Figure 3.25 shows the Design Rule Verification Report of my project that is following the design rules.



Altium Designer

customize

Design Rule Verification Report

Date : 14/5/2011
Time : 4:12:13 AM
Elapsed Time : 00:00:01
Filename : C:\Users\ivan\Documents\FYP\Altium PCB\Transmitter1.PcbDoc

Warnings : 0
Rule Violations : 0

Summary

Warnings	Count
Total	0

Rule Violations	Count
Clearance Constraint (Gap=10mil) ((HasFootprint('BCY-W3/E4'))),(All)	0
Short-Circuit Constraint (Allowed=No) (All),(All)	0
Un-Routed Net Constraint ((All))	0
Height Constraint (Min=0mil) (Max=1000mil) (Prefered=500mil) (All)	0
Hole Size Constraint (Min=1mil) (Max=100mil) (All)	0
Hole To Hole Clearance (Gap=10mil) (All),(All)	0
Minimum Solder Mask Sliver (Gap=10mil) (All),(All)	0
Silkscreen Over Component Pads (Clearance=9mil) (All),(All)	0
Silk to Silk (Clearance=10mil) (All),(All)	0
Net Antennae (Tolerance=0mil) (All)	0
Width Constraint (Min=12mil) (Max=12mil) (Preferred=12mil) (All)	0
Clearance Constraint (Gap=13mil) (All),(All)	0
Power Plane Connect Rule(Relief Connect)(Expansion=20mil) (Conductor Width=10mil) (Air Gap=10mil) (Entries=4) (All)	0
Width Constraint (Min=10mil) (Max=50mil) (Preferred=25mil) ((InNet('12V') OR InNet('GND')))	0
Total	0

Figure 3.25: Design rule verification report

CHAPTER 4

PROJECT IMPLEMENTATION

4.1 Introduction

In this chapter, the circuit drawn using schematic editor and the PCB layout drawn by using Altium Designer Summer 09 will be shown. The connection and interface between microcontrollers will be visualized and the complete programming code will be attached in the Appedix.

4.2 The Control Unit (CU)

The control unit, CU consists of a microcontroller, PIC 16F877A, a transmitter and three push buttons which represent the reset button, push button 1 and push button 2. When the push button is being pushed, the transmitter will transmit the signal to communicate with the receiver. Figure 4.1 is the block diagram of the control unit.

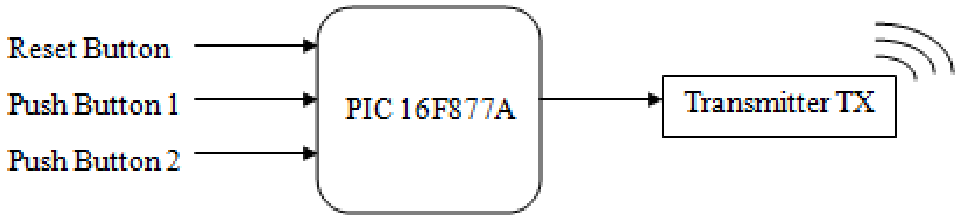


Figure 4.1: Control unit block diagram

4.3 The Remote Unit (RU)

The remote unit, RU consists of a microcontroller, PIC 16F876A, a receiver, a LED, and a buzzer. When the receiver received the signal that is being transmitted from the transmitter, it will communicate with the microcontroller to buzz the buzzer and turn on the LED. Figure 4.2 shows the block diagram of the remote unit.

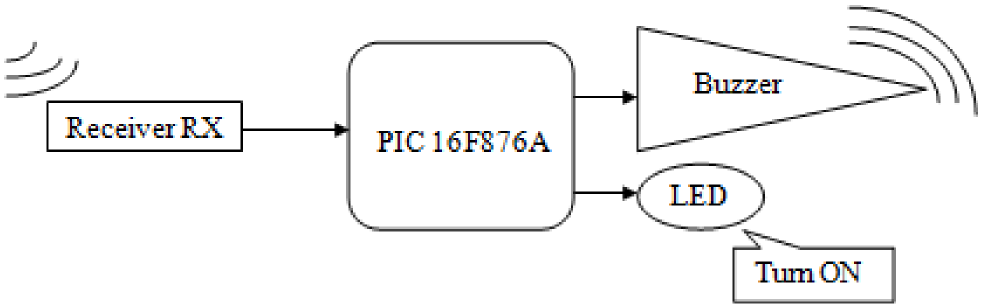


Figure 4.2: Remote unit block diagram

4.4 Transmitting and Receiving Flowchart

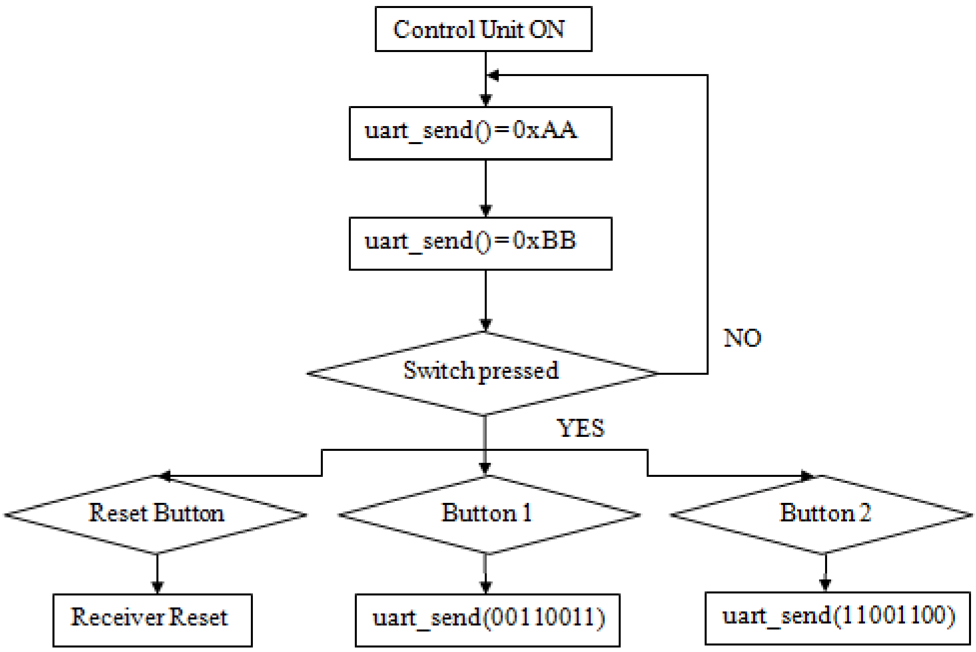


Figure 4.3: Transmitting process flowchart

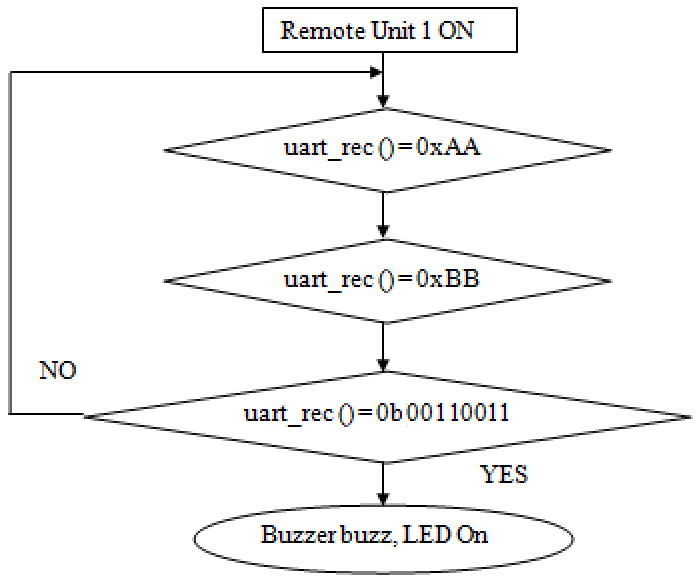


Figure 4.4: Receiving process flowchart

Flowchart shows the overall process of the project's operation. Figure 4.3 shows the flowchart for the transmitting process while Figure 4.4 shows the flowchart for the receiving process. When the power supply of the control unit turned on, the signal of 0xAA and 0xBB start to transmit. This is done in order to increase the stability and the sensitivity of the receiving process. When there is no switch being pressed, the signals send continuously. However, when the switch is being pressed, the address that is being defined for each switch will be send to the receiver. The receiver is receiving the 0xAA and 0xBB signal continuously and will be interrupted when any of the switches is being pressed. For example, for the remote unit 1, when switch 1 is being pressed, uart_sent will send a signal 0b00110011 to the receiver and received by the receiver. Hence, the receiver will interface with the microcontroller and buzzed the buzzer and turned on the LED.

4.5 PIC Interfacing

The schematic of the PIC interfacing circuits is being drawn by using the Altium Designer Summer 09. After that, the schematic will be transferred into the PCB layout that will be done by the same software.

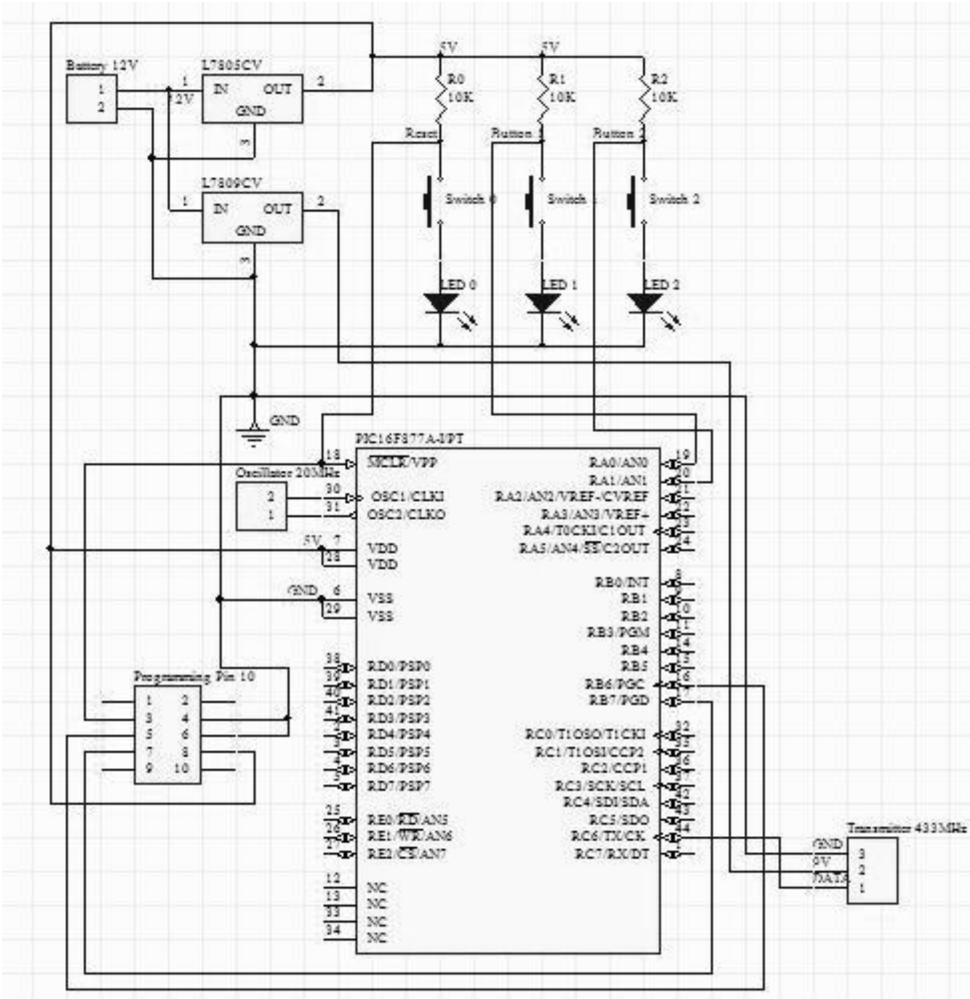


Figure 4.5: Transmitter schematic diagram

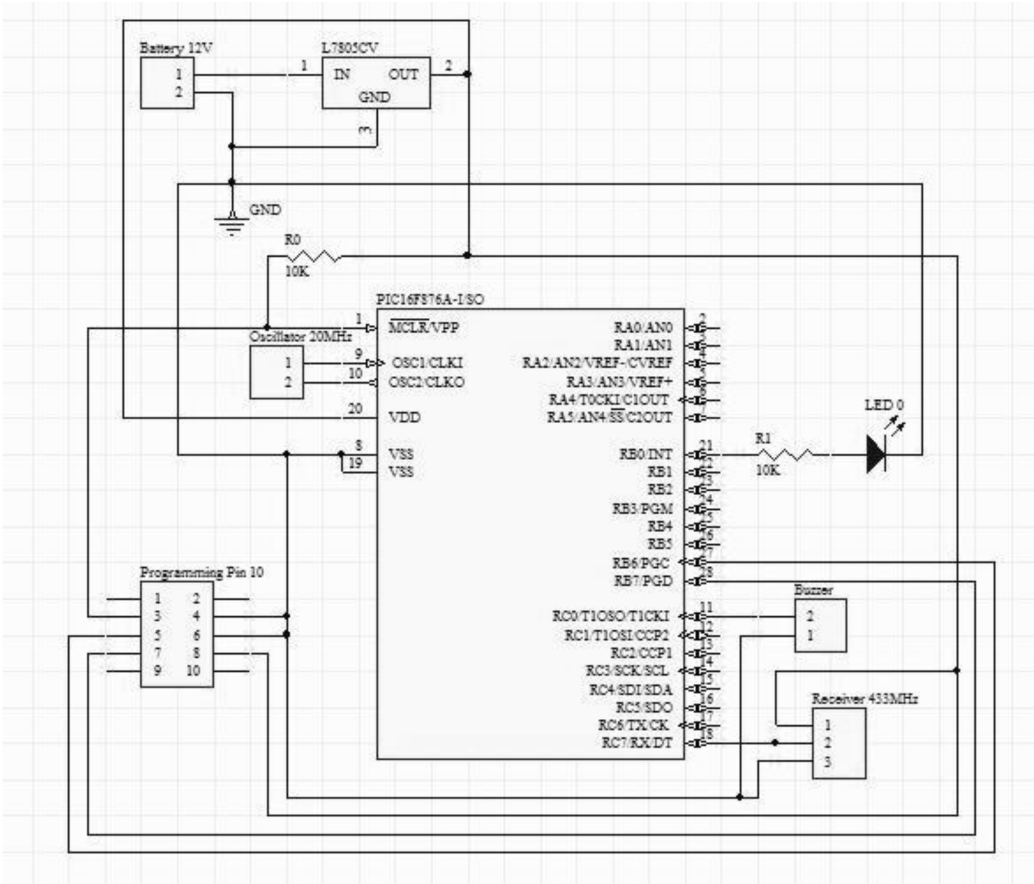


Figure 4.6: Receiver schematic diagram

4.6 PCB Board Interface

PCB board interface shows the PCB layout drawn using the Altium Designer Summer 09 and the fabricated PCB board using the equipments that are available in the UTM PCB Lab.

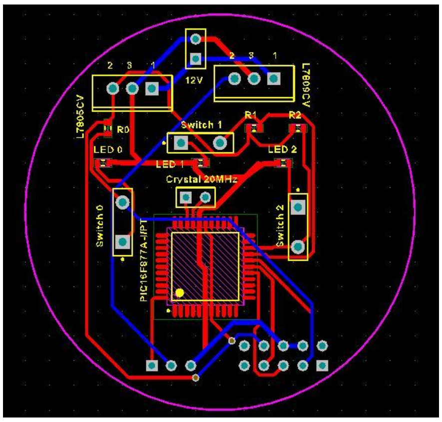


Figure 4.7: Transmitter PCB Layout

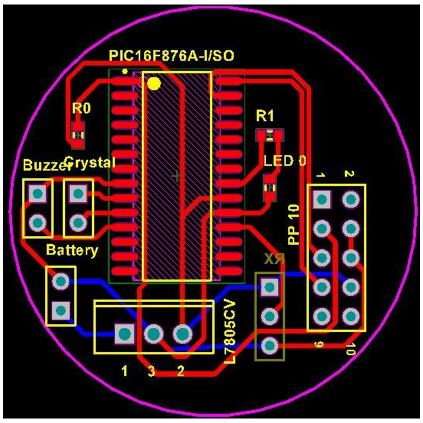


Figure 4.8: Receiver PCB Layout

Figure 4.9: Transmitter PCB board

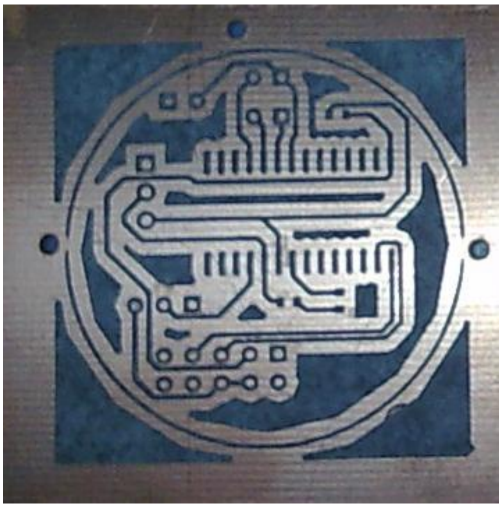


Figure 4.10: Receiver PCB board

Figure 4.7, Figure 4.8, Figure 4.9 and Figure 4.10 are the PCB board interface. Figure 4.7 and Figure 4.8 are the layout drawn using the Altium Designer Summer 09 and the PCB boards that are fabricated in the PCB lab UTM is as shown in Figure 4.9 and Figure 4.10.

4.7 Programming Coding

```
//Send enable signal
//===================================
=========================
no=0xAA;
uart_send(no);                 1
no=0xBB;
uart_send(no);
if(button==0)
{                                          2
{
no=0b00110011; //send the id number
}
while(button==0)
uart_send(no); //continuous send data
}                                          3
else if(button2==0)
{
{
no=0b11001100; //send the id number
}
while(button2==0)
uart_send(no); //continuous send data
}
```

Figure 4.11: Transmitter coding

```
{
CREN=1;                        4
if(OERR==0)
{
if(uart_rec()==0xAA)
{                              5
if(uart_rec()==0xBB)
}
if(uart_rec()==0b00110011)
buzzer=1;
else                           6
buzzer=0;
}
{
if(uart_rec()==0b00110011)
LED=1;
Else                           7
LED=0;
}
```

Figure 4.12: Receiver coding

Figure 4.11 and Figure 4.12 show how the signal transmit and receive.

1. These lines show that the 0xAA and 0xBB will be send continuously from the control unit via the transmitter to the remote unit.
2. There is an interrupt, which is represent by button = = 0. This means that, when the first button is being pressed, the address 00110011 will be send from the transmitter to be received by the receiver.
3. These lines of coding will instruct the transmitter to continuously send the signal of 00110011 when the button is being hold down.
4. CREN will be equal to one means data will be sent continuously. Other than that, OERR condition also will equal to zero means RCREG still do not full.
5. In order to increase the stability and sensitivity of the signal receiving process, these lines are needed. The receiver will receive the 0xAA and 0xBB continuously as long as the power supply of the control unit is ON.
6. When the signal address for button 1 is being detected, the PIC will instruct the buzzer to buzz.
7. The LED will also be turned ON.

CHAPTER 5

RESULT

This chapter shows the result of the surface mount components that are completely mounted on the PCB board. Besides, the functionality of the remote locator will be record in the form of table.

5.1 Control Unit (CU)

Figure 5.1 shows the control unit that was completely mounted on the PCB board.

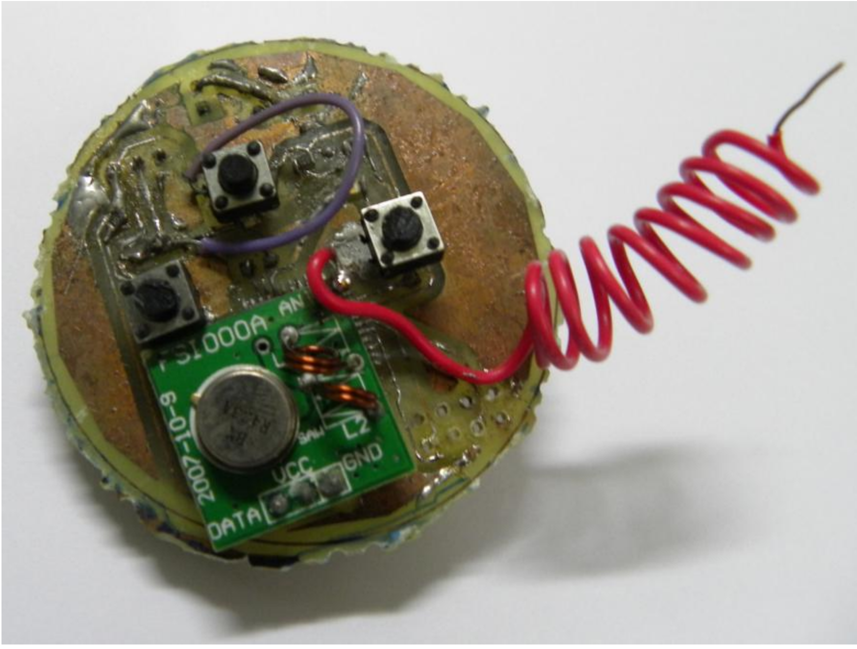


Figure 5.1: Transmitter PCB board

5.2 Remote Unit (RU)

Figure 5.2 shows the remote unit that was completely mounted on the PCB board.

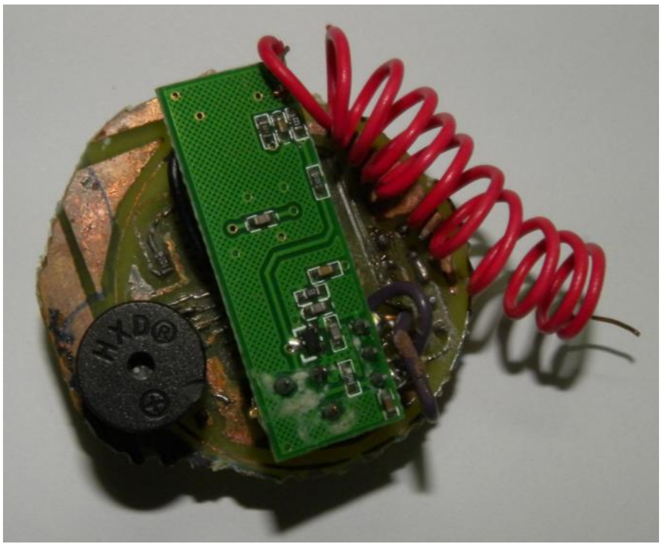


Figure 5.2: Receiver PCB Board

5.3 Remote Locator Capability

The remote locator with the transmitter and receiver modules is able to operate in both with antenna and without antenna condition. Obviously, with antenna, the capability to locate the unit produces a better result. Table 5.1 will conclude the capability of the remote locator.

Table 5.1: Remote locator capability

Condition	Outcome
Without antenna in closed surrounding	10 meters
Without antenna in opened surrounding	15 meters
With antenna in closed surrounding	37 meters
With antenna in opened surrounding	55 meters
Under the bed	YES
Inside the drawer	YES
Outside the door	YES
In another room	YES
In another house	NO
Second floor	YES
Third floor	YES
Fourth floor	NO

CHAPTER 6

CONCLUSION

This thesis had discussed about the development and fabrication on the products with the title of "Surface Mount Technology Microcontroller Based Radio Frequency Signal Remote Locator". The objectives that are stated in Chapter 1 had been successfully achieved. I had developed the communication between microcontrollers using RF signal, minimize the size of the circuits, able to locate the missing items, and save the precious time of the user.

6.1 Introduction

As a conclusion, the project is success. The microcontrollers which consist of PIC 16F877A and PIC 16F876A are able to communicate with each other by using the radio frequency signal. Besides, the size of the circuits had being reduced by more than half from the original circuits. The circuits can be manufactured into the size of a key chain and it will be easier to bring along with. Last but not least, the loud distinctive sound from the buzzer is very loud and clear, hence, it can save the user precious time by locate the missing items without searching them.

6.2 Problems

During the development process, quite a numbers of problems occurred. First, the surface mount PICs are not available in the shops. The only way to acquire the PIC is ordered online. The time taken for the PIC arrived had shortened my time to fabricate the PCB board. Beside, the work in soldering the surface mount components onto the PCB board is a skillful and tough work. Practice is the key to make the soldering success. In addition, the surface mount PICs are sensitive to unstable voltage. Unstable voltage will damage the surface mount PIC. Lastly, the problem that unexpected is the machinery vibration problems. After I had done the fabrication job, I had tested on the functionality of my products. The remote locator worked. However, after I drilled the complete fabricate PCB board in order to get the size of circle, the products cannot function anymore. In conclusion, handling with surface mount PICs and components need technical and skills. Hence, we should handle them with care.

6.3 Project Improvement

RFID RF module can be implemented in the future. Although the price of a RFID is more expensive, however, the functionality of the remote locator will be better. Besides, a transceiver can be used in order to increase the sensitivity of the remote locator and increase the range of sensing.

REFERENCES

1. Myke Predko, “Programming and Customizing the PIC Microcontroller” 3rd Edition, Mc Graw Hill, United State, 2008.
2. Peter J. Boden, “Surface Mount Technology – A study of Safety Considerations: Silver Migration and Adhersive Flammability”, February 1994.
3. Lawrence D. Rosenthal, “Paired Lost Item Finding System”, Oakland, CA (US), September 2000.
4. Steve Yessa, “Microcontroller-Based Remote Locator Using Asynchronous Serial Communication”, Bradley University Peoria, IL, March 2003.
5. Suhaila binti Mohd. Najib, “Microcontroller Based Remote Locator Using Radio Frequency Signal”, UTM, Malaysia, 2010.
6. http://en.wikipedia.org/wiki/Surface-mount_technology
7. http://www.cellphonesafetyguide.com/questions/radiofrequency-energy
8. http://www.mikroe.com/forum/viewtopic.php?t=10057
9. http://www.piclist.com/techref/microchip/osc.htm
10. http://www.ip-extreme.com/IP/usart.shtml
11. http://en.wikipedia.org/wiki/Universal_asynchronous_receiver/transmitter
12. Mohannad Faaiz Bin Jamaluddin, “Wireless Heart Rate Monitor”, UTM, Malaysia, 2008
13. http://ww1.microchip.com/downloads/en/DeviceDoc/usart.pdf
14. http://en.wikipedia.org/wiki/Universal_asynchronous_receiver/transmitter
15. ISM Band : http://en.wikipedia.org/wiki/ISM_Band
16. Cytron Technologies Sdn. Bhd. *RF-TX-433 RF Transmitter Module User’s Manual V1.1*. Malaysia: Cytron Technologies Sdn. Bhd. 2008.

17. Cytron Technologies Sdn. Bhd. *RF-RX-433 RF Receiver Module User's Manual V1.1*. Malaysia: Cytron Technologies Sdn. Bhd. 2008.
18. http://cytron.com.my/viewProduct.php?pid=BCkGCi8vICQhMTcqPAcwD0!!!!!uxmtQ4nUjOwKZrpHQCSw=
19. Cytron Technologies Sdn. Bhd. *UIC00A_&UIC-S User Manual*. Malaysia: Cytron Technologies Sdn. Bhd. 2008.
20. Programmer : http://en.wikipedia.org/wiki/Programmer_(hardware)
21. Marlin Bates, "PIC Microcontroler An Introduction to Microelectronics", Elsevier Ltd., 2004.
22. Altium Designer Summer 09 User's Manual

APPENDIX A

Transmitter's coding.

```
//============================================================
==============
// Coding for Transmitter
//============================================================
==============
#include <htc.h>
//============================================================
==============
//configuration
//============================================================
==============
__CONFIG (0x3F3A);
//============================================================
==============
// define
//============================================================
==============
#define button RA0
#define button2 RA1
#define button3 RA2
```

```
//============================================================
==============
// function prototype
//============================================================
==============
void uart_send(unsigned char data);
void delay(unsigned long data);
void send_char(unsigned char data);
void send_config(unsigned char data);
//============================================================
==============
// main function
//============================================================
==============
void main(void)
```

```
{
//assign variable
unsigned char no,ptr,data;
ADCON1= 0x06; //configure PortA as digital I/O
TRISA = 0b111111; //configure PORTA input
TRISB = 0;
TRISD = 0;
InitLCD();
//setup USART
BRGH = 0; //baud rate for low speed option
SPBRG = 255; //set boud rate to 1200bps for 20Mhz
TX9 = 0; //8-bit transmission
TXEN = 1; //enable transmission
SYNC = 0; //asynchronous
SPEN = 1; //enable serial port
//==========================================================
==============
//Send enable signal
//==========================================================
==============
no=0xAA;
uart_send(no);
no=0xBB;
uart_send(no);
if(button==0)
{
{
no=0b00110011; //send the id number
}
while(button==0)
uart_send(no); //continuous send data
}
else if(button2==0)
```

```
{
{
no=0b11001100; //send the id number
while(button2==0)
uart_send(no); //continuous send data
}
else if(button3==0)
{
{
no=0b11110000; //send the id number
}
while(button3==0)
uart_send(no); //continuous send data
}
}
}
//==========================================================
==============
// functions
//==========================================================
==============
void uart_send(unsigned char data)
{
while(TXIF==0); //only send the new data after the previous is sent
TXREG=data;
}
```

APPENDIX B

Receiver’s coding

```
// Coding for RECEIVER 1
//===========================================================
=============
#include <htc.h>
//===========================================================
==============
// configuration
//===========================================================
==============
__CONFIG (0x3F3A);
//===========================================================
==============
// define
//===========================================================
==============#define buzzer RC1
//===========================================================
==============
// function
//===========================================================
==============
```

```
unsigned char uart_rec(void);
//===========================================================
==============
// main function
//===========================================================
==============
void main(void)
{
//assign variable
unsigned char no;
//set I/O input output
TRISC= 0b10000000;
//setup USART
BRGH = 0; //baud rate for low speed option
SPBRG = 255; //set baud rate to 1200bps for 20Mhz
SPEN = 1; //enable serial port
RX9 = 0; //8-bit reception
CREN = 1; //enable reception
while(1) //infinity loop
```

```
{
CREN=1;
if(OERR==0)
{
if(uart_rec()==0xAA)
{
if(uart_rec()==0xBB)
{
if(uart_rec()==0b00110011)
buzzer=1;
else
buzzer=0;
}
}
}
else
CREN=0;
}
}
//==========================================================
==============
// functions
//==========================================================
==============
unsigned char uart_rec(void) //receive uart value
{
unsigned char rec_data;
while(RCIF==0); //wait for data
rec_data = RCREG;
return rec_data; //return the received data
}
```