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DESIGN AND DEVELOPMENT OF ANDON SYSTEM FOR MACHINING MACHINE AT FKP LAB

SITI ZURAIDA BT ISMAIL

Report submitted in partial fulfillment of the requirement
for the award of the degree of
Bachelor of Manufacturing Engineering

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JUNE 2013

EXAMINER APPROVAL DOCUMENT

I certify that the project entitled "Design and Development of Andon System for Machining Machine at FKP Lab'' is written by Siti Zuraida Bt Ismail. I have examined the final copy of this project and in my opinion, it is fully adequate in terms of scope and quality for the award of degree of Engineering in Manufacturing. I herewith recommend that it be accepted in fulfillment of the requirement of the requirement for the degree specializing in Manufacturing Engineering.

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I hereby declare that the work in this project is my own except for quotation and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

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Dedication

To my beloved dad

Ismail Bin Thohar

My family

and

Fellow friends

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I am grateful and would like to express my sincere gratitude to my supervisor Miss Suraya Sulaiman for her germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. She has always impressed me with her outstanding professional conduct, her strong conviction for lean production system, and her belief that a bachelor program is only a start of a life-long learning experience. I appreciate her consistent support from the first day I applied to graduate program to those concluding moments. I am truly grateful for her progressive vision about my training, her tolerance of my naïve mistakes, and her commitment to my future career. I also would like to express very special thanks to Madam Nur Najmiah Jaafar, Mr. Aidil and Mr Azrai for their suggestions, help and cooperation throughout the study. I also sincerely thanks for the time spent proofreading and correcting my many mistakes.

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ABSTRACT

Andon system is a visual and audible response notification tool and widely used in manufacturing industry. From this concept, one project is conducted to develop an andon system to monitor the status of machine in Faculty of Manufacturing Engineering (FKP) laboratory. This system used indicator lights *(green, red and yellow color)* and the light was control by using wireless connection. The aims of this project is to design and develop an andon system for better visual management at FKP laboratory. There are three phases in this system. Phase I cover the design of the transmitter board and receiver board. Phase II is the programming installation into the PIC16F88 microcontroller. The programming are build using Proton IDE software. Phase III is the fabrication of the andon system. To validate the system, the light was observed and the results shows this system work efficiency. Green lights show the machine in operation condition, yellow lights for idle condition and red lights when then machine stop the operation. Efficiency test are conduct to evaluate the application's efficiency with the computing environment. hundred test has been run and the results show efficiency is in range of 90% to 100%. From the results it shows that this system run well and provide a consistent application and hardware environments to application developer. By implementing this system at FKP laboratory, it will help students to identify the condition of the machine.

ABSTRAK

Sisyem andon adalah alat pemberitahuan balas visual dan boleh didengar dan digunakan secara meluas dalam industri pembuatan. Dari konsep ini, satu projek telah dijalankan untuk membangunkan satu sistem andon untuk memantau status mesin di makmal Fakulti Kejuruteraan Pembuatan (FKP). Sistem ini akan menggunakan lampu penunjuk (warna hijau, merah dan kuning) dan cahaya itu dikawal dengan menggunakan sambungan tanpa wayar. Tujuan projek ini dijalankan adalah untuk mereka bentuk dan membangunkan sistem andon untuk pengurusan visual yang lebih baik di makmal FKP. Terdapat tiga fasa dalam sistem ini. Fasa I meliputi reka bentuk penghantar dan penerima. Fasa II adalah pemasangan pengaturcaraan ke dalam mikropengawal PIC16F88. Pengaturcaraan yang dibina ialah dengan menggunakan perisian Proton IDE. Fasa III adalah fabrikasi sistem andon itu. Untuk mengesahkan sistem, cahaya diperhatikan dan keputusan ini menunjukkan system bekerja secara efisyen. Lampu hijau menunjukkan mesin dalam keadaan operasi, lampu kuning untuk keadaan rehat dan lampu merah apabila kemudian mesin berhenti beroperasi. Ujian kecekapan adalah kelakuan untuk menilai kecekapan aplikasi dengan persekitaran pengkomputeran. Seratus ujian telah dijalankan dan keputusan menunjukkan kecekapan adalah dalam lingkungan 90% hingga 100%. Dari keputusan itu menunjukkan bahawa sistem ini berjalan dengan baik dan menyediakan aplikasi yang konsisten dan persekitaran perkakasan kepada pemaju aplikasi. Dengan melaksanakan sistem ini di makmal FKP, ia akan membantu para pelajar untuk mengenal pasti keadaan mesin tersebut.

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LIST OF ABBREVIATIONS

LED	Light Emitting Diode
PIC	Peripheral Interface Controller

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Andon is derived from the Japanese word for paper lantern. Liker (2004) has stated that andon is a term for a visual control system using an electric light board (or other signal device) hung in a factory, so that worker can call for help and stop the line. In a study on quantitative analysis of a transfer production line with andon (Jingshan Li & Dennis E. Blumenfeld, 2006), andon is originates from Toyota Production System and has been used in many Japanese and American manufacturing plants as an effective approach to improve product quality The idea of andon is that worker can pull the so-called andon cord, triggering the light and/or music as a call for help and stopping the line when a defect is discovered. It has been claimed that, although productivity is lost due to line stoppages, the overall system performance improves (Liker, 2004).

The alert can be activated manually by a worker using either pullcord or button, or it can also be activated automatically by the production equipment itself. The system may include means to stop production so the issue can be corrected.

Some modern alert systems incorporate audio alarms, text, or other display. For this design, buttons will be used as the indicator to activate the lights.

Derick Bailey (2008) has stated that an andon system is one of the principal elements of the Jidoka quality-control method pioneered by Toyota as part of the Toyota Production System and therefore now part of the Lean approach. It gives the worker the ability, and the empowerment, to stop production when a defect is found, and immediately call for assistance. Common reasons for manual activation of andon are part shortage, defect created or found, tool malfunction, or the existence of a safety problem. Work will be stopped until a solution has been found. The alerts may be logged to a database so that they can be studied as part of a continuous-improvement program.

As Jingshan & Dennis E. Blumenfeld (2006) carried their study, the current literature on andon contains many popular articles that provides qualitative and quantitative analysis on how andon system improves product quality and quantity. By implementing andon, problems are not hidden anymore, but it can be detected and also can be fixed so that good quality can be achieved the first time. The system typically indicates where the alert was generated, and may also provide a description of the trouble.

Modern andon systems can include text, graphics, or audio elements. Audio alerts may be done with coded tones, music with different tunes corresponding to the various alerts, or pre-recorded verbal messages. The most common type of andon system is the three-light tower. Three colored lights (red, yellow, and green) are mounted on a pole by a work station with a switch to allow the operator to quickly change the status if anything goes wrong. The typical andon light color-coding schema is red = stop and green = go (or running). Yellow may stand for not running at rate, ‘need help’, or something similar.

These andon lights can also be mounted to machines or equipment and automatically change color based on a signal from the machine. These are especially handy when the machines are running with no operator.

Another more complex version of the andon light is the andon board. This is where several indicators are mounted on the same board to centrally locate the visual system. These are common in lean factories that have multiple production lines. This allows anyone to look at a glance how the plant is running and its current status.

A pull cord is another style of andon. If an operator is having difficulties or wants to signal management that there is a problem, they pull the andon cord (Liker, 2004). This is just like pulling the cord on a city bus to signal to the driver that you want to get off at the next stop or in a hospital room where there is a cord to pull if you need the nurse.

Even audible signals can be thought of as a type of andon. An alarm, bell or buzzer gets attention when something is wrong or is trying to warn you about a situation. In the old days, at department stores the chimes heard overhead were actually signals to floor managers to contact the office. The number of chimes, the sequence or sound was designated to different managers. This way a manager could be notified without disturbing the customers with an annoying announcement. In some lean facilities they even use the pace or rhythm of the sound to indicate if there is a problem.

In any process, information is critical – it allows people to know where they are, where they are going and if problems are occurring that could be prevented. No one would consider driving a car without a dashboard, and few would operate a machine that wasn’t equipped with the appropriate indicator lights, panel meters and LCD touchscreens. However, like a car’s dashboard, panel meters and touchscreens are only for a single operator. While both are forms of visual management, they lack some of the phenomenon that occurs by having the information publicly available.

By having key performance indicators on display, the operators know what their performance is, but more importantly, they know that everyone else knows what their performance is. This allows the operator to take pride of ownership in their contribution to the company. It also provides actionable information to supervisors, allowing them to determine, in real time, areas that are in need of improvement. Andon messages that communicate process problems across a facility ensure that everyone is aware of a given issue, drastically reducing downtime.

The typical andon system is a manual system. It often consisting of a simple series of lights or flags to indicate that an area is experiencing a problem and requires assistance. It requires constant monitoring by support personnel and/or management. It requires personnel to perform further investigation to determine the nature of the problem or assistance required. It also will save time and resources. It gives support personnel & management an “at-a-glance” view of in-work status. It reduces the need for technicians to interrupt their work, in order to acquire assistance. It give instant notifications. It notifies only the appropriate personnel and it will differentiate between emergent and scheduled needs.

The advantages of using andon systems are it can removes errors associated with manual data collection and input, minimizes production losses by facilitating real-time problem analysis and correction and can removes costs associated with manual data collection and input. To be sure, they allow a supervisor or team lead to quickly spot a problem before it escalates. For example, if a supervisor wants to know the status of six different work cells in an area, he would have to walk to each one and look or ask an operator the status. Unfortunately, while the supervisor is in the back area trying to find out what is going on, a work cell in the front has a malfunction and the supervisor doesn’t even know about it. By installing andon lights at each of the work cells, the supervisor can visually see that status and proceed to the work cell that needs assistance. andon lights are a low cost solution versus people waiting or not knowing the current status if work.

1.2 PROBLEM STATEMENT

There are several types of machine such as milling machines, turning machine and grinding machines used by the lecturers and students in Fakulti Kejuruteraan Pembuabtan (FKP) laboratory, however, some of the machines like milling machine doesn’t have andon system attach to the machines. Lecturers and students hard to identify which machines are available to use and which machine are in maintenance condition due to lacking of andon system. Andon system is important because it is one of the safety approach to avoid any accident happened.

The system is very important in terms of safety and also as a guide or warning to the machines users about the condition of the machine. This system can help users to identify the machine status whether it is in use, idle, available or breakdown.

1.3 OBJECTIVES

The objectives for this research are as follow:

i. To design and develop an andon system at FKP labarotary.
ii. To verify and analyze an andon system via lights observation test and efficiency test.

1.4 SCOPE OF PROJECT

This research is about the design of andon system that can be implemented in the FKP lab. It is because some of the machines in the FKP lab such as milling machine and grinding machine does not have andon system attached to them.

The andon system can be controlled using wireless connection that can be triggered using switches. The signal will be given by the XBEE.

To show the visual control of the andon system, light emitting diode (LED) are used to show the current situation of the machine. The LED have three different color which are red, yellow and green. For this project, a prototype is constructed to represent the andon system. Since this is only the prototype, the andon would prefer to represent a motor as a machine in real situation.

For the programming of andon system, C program will be used as the coding method. This program will be installed into the PIC16F88 microcontroller.

CHAPTER 2

LITERATURE REVIEW

2.1 THE ANDON SYSTEM

Andon is an extremely simple system of visual management for helping teams identify when there is a problem with a process or machine. Originally they were developed as part of the Jidoka quality-control method within the Toyota Production System and have now been incorporated into standard lean manufacturing practice.

Originally andon lamps were used to notify teams of a quality problem, and more frequently we see them installed on continuous flow lines to help inform operators of why machines have stopped. For example if it have an operator running two packaging machines and one of the machines stop, a simple andon light stack can instantly tell the operator if he has a problem (and has to intervene) or if the machine has just run out of product.

There has been major research about the impact of productivity and profitability in andon and no-andon System. A research has been made on good-job throughput in a production line with andon and no-andon system (Robert R. Inman and Dennis E. Blumenfeld, 2009)

Using a work team model to characterize the response to workers' calls for help (Blumenfeld and Inman, 2009) they optimize the team size for assembly lines with and without an andon system. With andon, if a worker cannot finish the task, he or she will pull the andon cord and stop the line. This preserves quality at the expense of throughput (Li and Blumenfeld 2006) provide more general models of andon system policies. Without andon, if the team leader cannot help a worker in need, the job may leave the station incomplete – increasing the chance of a quality defect. These impacts are illustrated in the following for the two systems.

2.1.1 No Andon System

To clarify their work team model of a no-andon system, Figure 2.1 displays an example section of the line in a series of six snapshots taken every 12 seconds. (For simplicity, Figure 2.1 treats the line as an index line that holds the vehicles stationary for one minute then instantaneously advances them all one station.) Vehicles are shown as rectangles and workers as circles. The example 10-station section has one worker per station (labelled A through J) supported by one team leader (labelled T). The following narrative accompanies Figure 2.1 (Robert R. Inman et al, 2009).

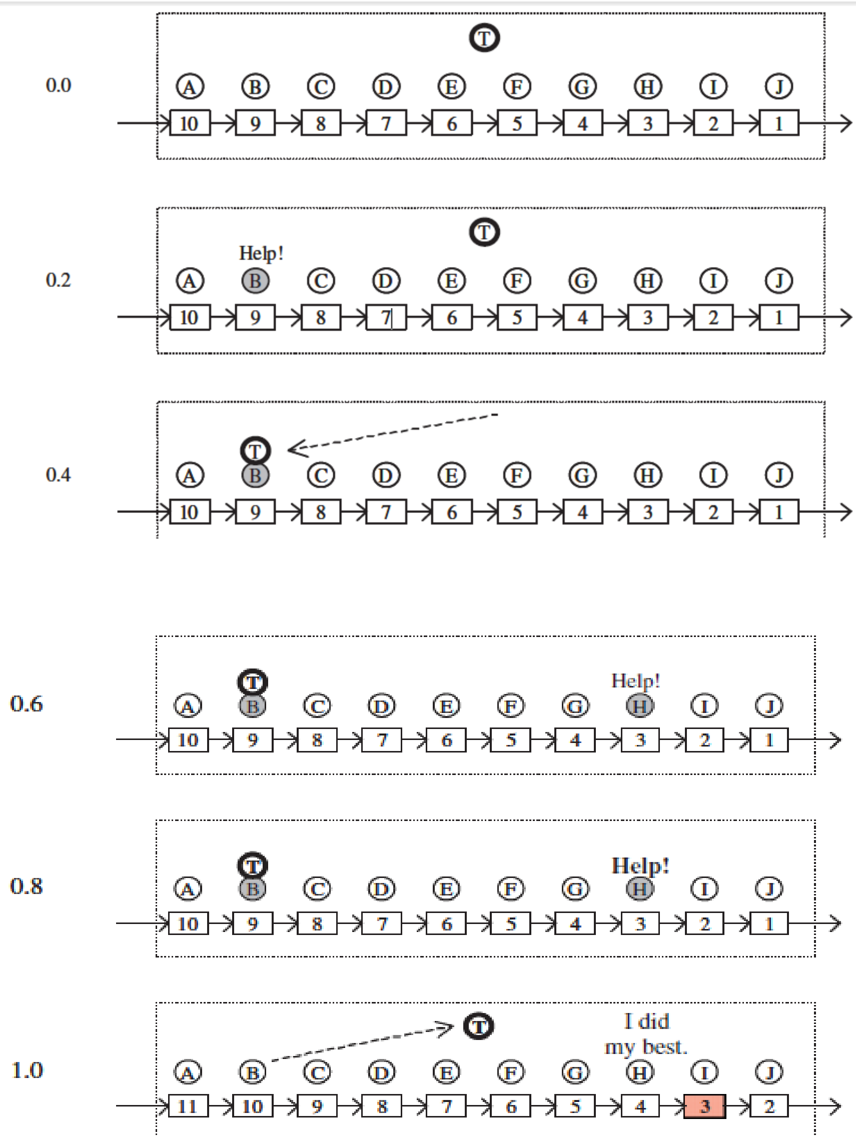

Figure 2.1 : Team leader responds to worker's call for assistance.

(R.R Inman et al, 2009)

Table 2.1 : Time and narrative for no andon system (Robert R. Inman et al, 2009)

Time	Narrative
0.0 minutes	Each station has a vehicle (labelled 1 through 10).
0.2 minutes	Worker B encounters a problem and calls for the team leader, T, for help.
0.4 minutes	The team leader has reached B's station and begins to assists B
0.6 minutes	The team leader continues helping B.
0.8 minutes	The team leader continues helping B Worker H calls for help again, but the team leader is still busy helping B.
1.0 minutes	The team leader has finished helping B and has returned to the on-call position, and all vehicles have advanced one station.

Vehicle 3 that worker H had difficulty with enters worker I's station, even though worker H is not sure the tasks were completed correctly.

Hence, vehicle 3 is depicted with a pattern denoting a potential quality defect.

2.1.2 Andon system

Figure 2 displays how the andon system works on Figure 2.1's example. This scenario is very similar to that of Figure 1 but instead of worker H allowing vehicle 3 to move out of station unfinished, worker H pulls the andon cord and stops the line. Figure 2.2's narration below has new narrative shown in bold.

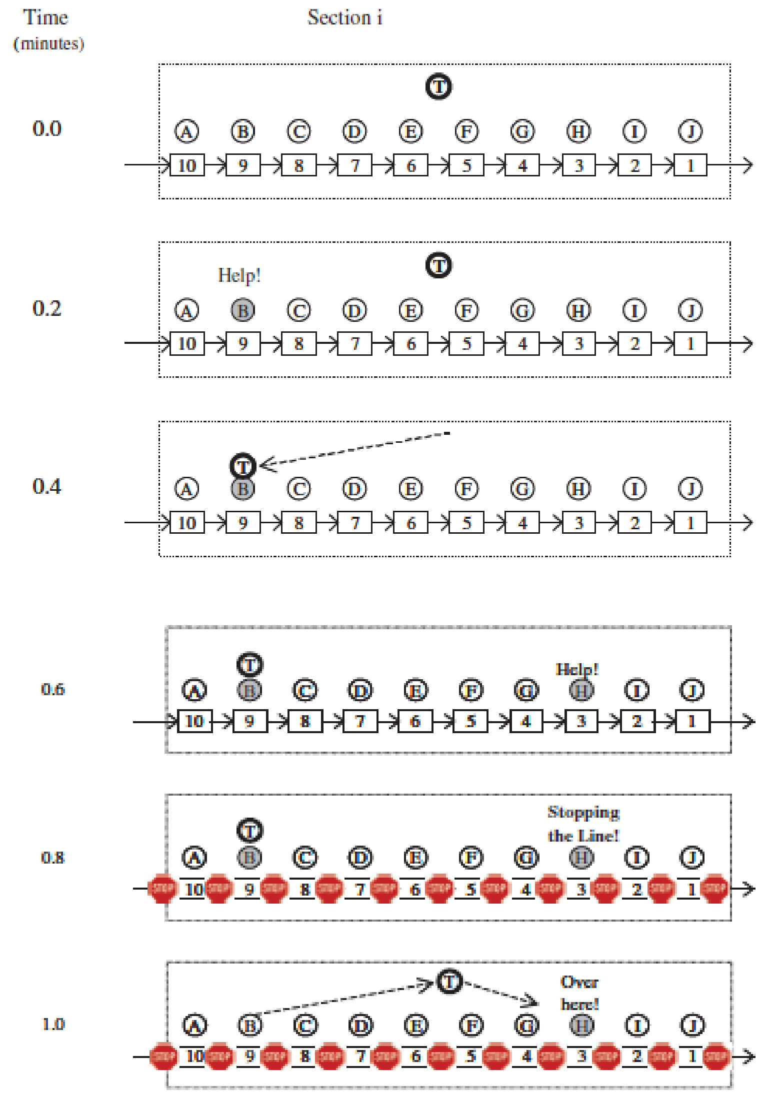

Figure 2.2: Two workers needing help on a section with andon.

(R.R Inman et al, 2009)

Table 2.2 : Time and narrative for andon system

(Robert R. Inman et al, 2009)

Time	Narrative
0.0 minutes	Each station has a vehicle (labelled 1 through 10).
0.2 minutes	Worker B encounters a problem and calls for the team leader, T, for help.
0.4 minutes	The team leader has reached B's station and begins to assists B
0.6 minutes	The team leader continues helping B.
0.8 minutes	The team leader continues helping B Since the team leader has not responded to worker H's call for help (because the leader is still busy helping B), worker H pulls the Andon cord and stops the line.
1.0 minutes	The team leader has finished helping B and walks to help worker H. The vehicles do not advance because the line has been stopped by worker H pulling the Andon cord.

After worker H and the team leader complete worker H's tasks on vehicle 3, the team leader restarts the line and the vehicles advance one station.

Then they calculate the average number of defects per job, D by using this equation:

$$D = \frac{Wfr}{J} \times \frac{(N-1)rt}{1+(N-1)rt} \qquad \text{——— (1)}$$

Number of good-jobs per unit time, G by using this equation:

$$G = J\left(1 - \frac{N(N-1)(rt)}{1+(N-1)rt}\right) \qquad \text{——— (2)}$$

Where:

f Fraction of unanswered calls that result in a defect.

D Average number of defects per job.

J Line rate (jobs per unit time).

W Total number of trained workers (¼number of work stations on the line).

T Number of teams on the line (W/N).

G Throughput of good jobs (good jobs per hour).

P Productivity (good jobs per hour per worker).

After doing some and calculation estimation based on the equation to the good-job throughput in the No-Andon and Andon cases, respectively, as a function of team size N, Figure 4 displays the results. As the team size gets larger, the team leader must support more line workers and is less able to respond to calls for help. Hence more defects creep in and the throughput of good jobs decreases.

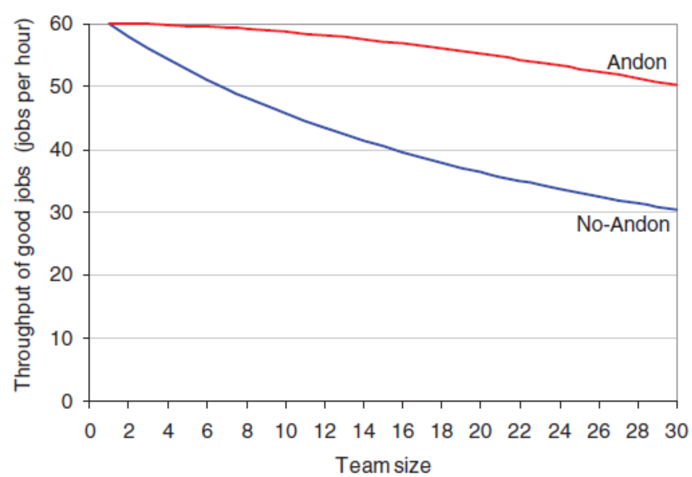

Figure 2.3 : Throughput of defect-free jobs versus team size for Andon and Non-Andon System (Blumenfeld and Inman, 2009)

As the result, in the Andon case, the line is stopped to prevent defects so the total throughput is the same as the good-job throughput (because these models only consider the defects resulting from calls for help that were not responded to). The Andon system's total throughput is less than the No-Andon's, but the Andon's good-job throughput is much higher for larger team sizes.

2.2 THE CONCEPT OF ANDON SYSTEM

To design the Andon system, first the PIC16F88 microcontroller has been decided as the connecting device between the machine and LED. The PIC16F88 microcontroller has been programmed with C Programming command installed in it.

2.3 LIGHT EMITTING DIODE (LED)

Light emitting diode (LED) are the main component in the andon system. It is commonly used on equipment in industrial manufacturing and process control environments to provide visual indicators of a machine state or process event to machine operators, technicians, production managers and factory personnel.

For this project, LED has been decided as the device of Andon lights. The LED's have three different colors which are red,yellow and green. Red is to indicate that the machine is stop, yellow is to indicate that the machine is under maintenance and green is to indicate the machine are being used.

This LEDs will be attach at the top of the machine as the visual warning system to the users. The LEDs are programmed to light whenever the machine are being used. When the user switch on the machine, the green light is on and it will indicates that the machine is being used, so others users cannot used that machine.

While the green light is on but there is no activity (no push button) on the machine for 10 seconds, the yellow light will on and it shows that the machine is under maintenance or stop for a while.

When there is an emergency case happen to the machine, user will push the STOP button and the red light will be on. This indicates that the machine is stop because of breakdown.

2.4 PIC16F88 MICROCONTROLLER

A microcontroller is an electronic device that includes three components Microprocessor, Memory and I/O on a single semiconductor unit called an Integrated Circuit (Karthick Kumar Reddy et al. 2011). In addition to these components, the microcontrollers include many supporting devices as shown in Figure 2.4. In this paper, PIC16F88 is use and is available in 18-pin PDIP, SOIC and the features are summarized in Table 2.3.

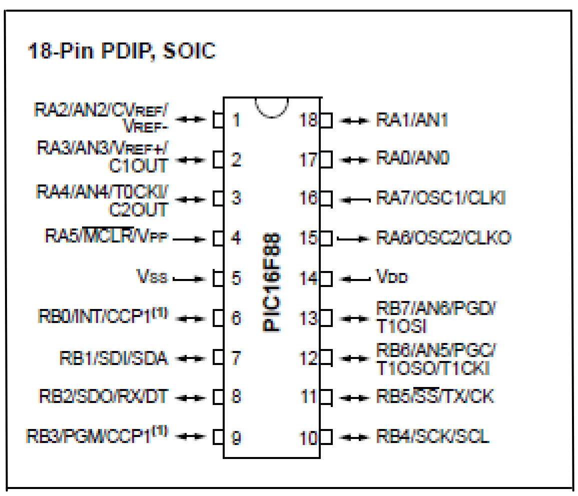

Figure 2.4 : PIC16F88 Microcontroller 18 Pin

This powerful (200 nanosecond instruction execution) yet easy–to-program (only 35 single word instructions) CMOS Flash-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into an 18-pin package and is upwards compatible with the PIC16C7x, PIC16C62xA, PIC16C5X and PIC12CXXX devices (G. Jagadeesh et al, 2011)

Table 2.3 : PIC16F88 Design Features

Device		**PIC 16F88**
Program Memory	Flash (bytes)	7168
	# Single – Word Instructions	4096
Data Memory	SRAM (bytes)	368
	EEPROM (bytes)	256
I/O Pins		16
CCP (PWM)		1
Comparators		2
SSP		Y
Timers 8/16-bit		2/1

2.5 C PROGRAMMING

Ye Chen et al, (2011) has stated that C language programming is an important foundation course of computer teaching, and experiment teaching is a key step of learning in science and engineering. Its design provides constructs that map efficiently to typical machine instructions, and therefore it found lasting use in applications that had formerly been coded in assembly language, most notably system software like the Unix computer operating system.

According to Maria Kordaki, 2008, programming is not only an essential topic proposed for a K-12 curriculum, and a fundamental subject in studying Computing at Tertiary level, but also a 'mental tool' of general interest (Satratzemi, Dagdilelis, & Evaggelidis, 2002) where problem-solving skills can be encouraged in learners. In fact, programming is more a mental skill than a body of knowledge (Hadjerrouit, 2008). It is a complex task, including understanding of the task at hand, method finding, coding, testing and debugging of the resulting program. Many students cannot grasp the most fundamental concepts of programming, unable to produce even the most basic programs.

This research state that good performance in programming implies the ability of learners to use various and new representation systems to express their problem-solving strategies in order to progress smoothly to the formation of the appropriate code.

Well-known examples of such environments for the learning of programming in computer language C are BACCII (Calloni & Bagert, 1997) and THETIS (Freund & Roberts, 1996). Despite the incorporation of the features together with fundamental principles of modern social and constructivist theories of learning, these environments either fail to emphasize learner ability and the need to express their knowledge in different representation systems or offer possibilities to solve only a limited set of problems. In an attempt to exploit all the above, an open problem-solving computer learning environment has been constructed to support secondary level education students in their learning of programming using C. This environment is named LECGO (Learning Environment for programming using C using Geometrical Objects) and its design was based on social and constructivist perspectives.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Methodology is an organized flow chart that functioned to guide a study to reach the objectives desired. The progress and the flow of this study is all recorded and can be tracked in this chapter. In this study, circuit connection is the primary source so that the andon system will be well function.

3.2 FLOW CHART OF METHODOLOGY

The flow of methodology of the research is shown in Figure 3.1. It clearly explained how the research will be conduct. The first step in this research is the experimental review and designing andon system. From the experimental review, objectives, problem statement and scope of project are defined.

Next, some of the literature review is study to find some example and comparison between this research and other similar research. Then, andon system is design according to ideas and some examples from other research.

Next, the C programming is been construct. The program are been create using the Proton IDE software. The programming is being installed into a microcontroller. A PIC16F88 has been decided as the microcontroller that gives command to the XBEE radio to give signal to transmitter and receiver.

Next, the fabrication of the components will be done along with the motor and light emitting diode (LED) for attachment and as the aid in this study. The main components for the andon system are LEDs, microcontrollers, XBEEs, motor and relay.

After that, the system will be test by using two methods which are light observation and efficiency test. The light observation is to prove that the programming is suitable and match with the objectives of the andon system. The efficiency test has been done for 100 times to the andon system. After that, the data are taken and analyzed. The data are tabulated on the tables and graphs.

Finally, the result and findings will be discussed ad overall conclusion of the systems will be made.

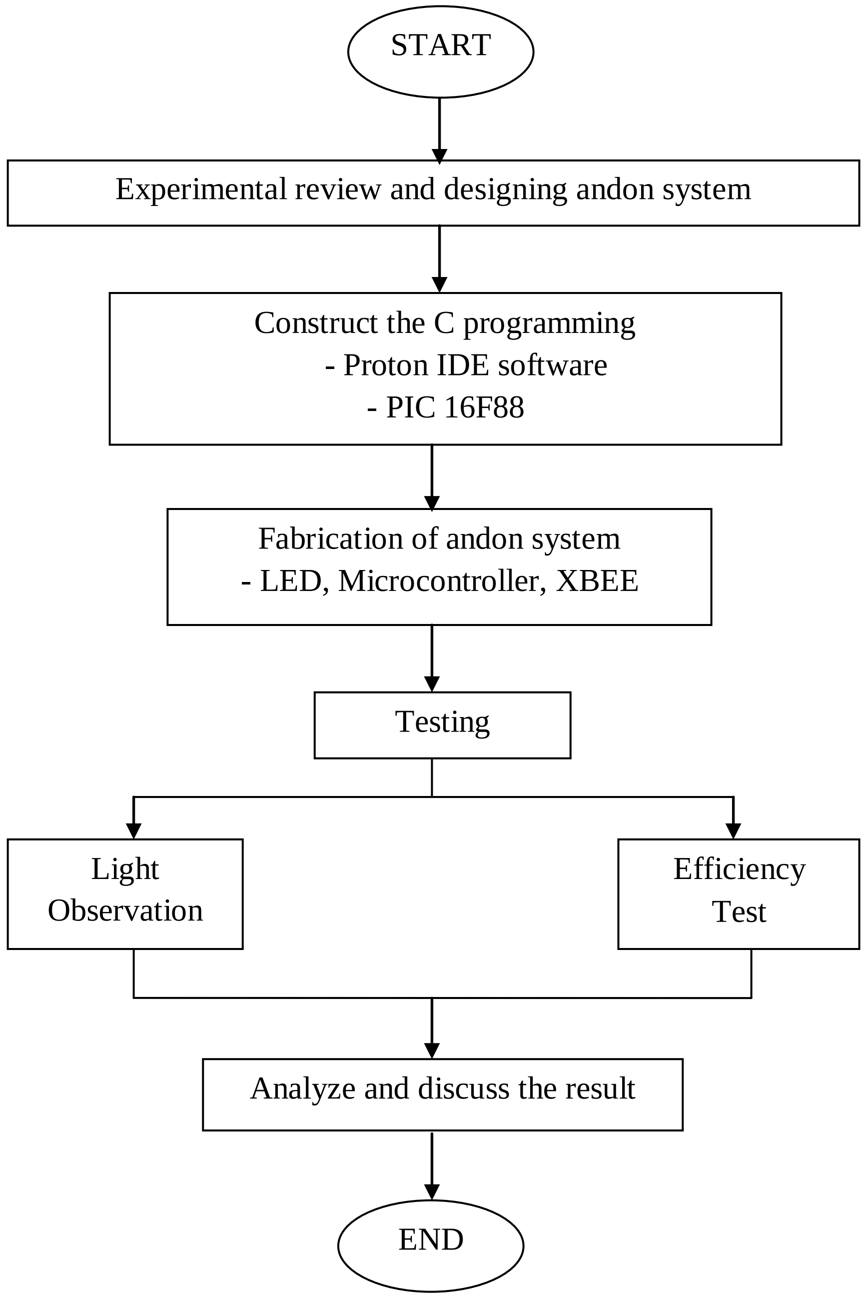

Figure 3.1 Flow chart of methodology

3.3 CONCEPT OF ANDON SYSTEM

Figure 3.2 shows the flow chart of the methodology of the concept of how the andon system will work. First, when the ON button is push, the green light will turn on. This is because of the command that has been installed into the microcontroller program. When the machine is in process the light green will stay on.

While the machine is on but there is no activity on the machine (there is no button being pushed) the yellow light will on and the green light will off simultaneously. In this state, it shows that the machine is in rest state (idle). This state also shows that the machine in under maintenance so that users will not touch the machine.

When all the maintenance is finish and the process need to be continue, the ON button is push and the light will change back to green. Next, when there is any breakdown happen to the milling machine while it is in process, the STOP button is push and the red light will turn on.

The STOP button only can be use if there is an emergency stoppage because once it is push, all machine’s activities will stop and the operator need to set the machine again. However, if there is no maintenance or breakdown happen the green light will turn on until the process is finish.

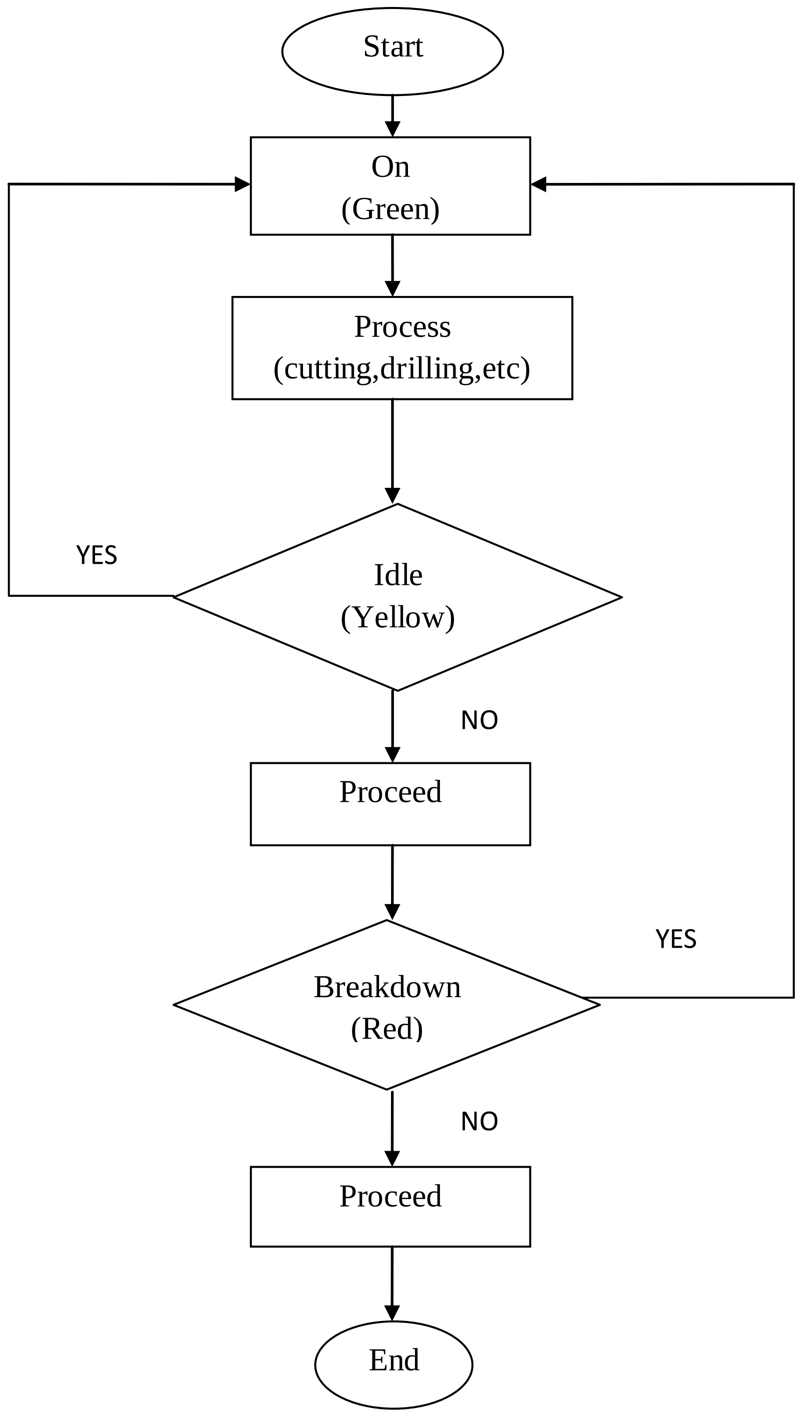

Figure 3.2 Flow chart of Andon system

3.4 DESIGN OF THE ANDON SYSTEM

3.4.1 Transmitter

The following figures indicate the design of printed circuit of the transmitter and the receiver board on the transparent paper and on the PCB board.

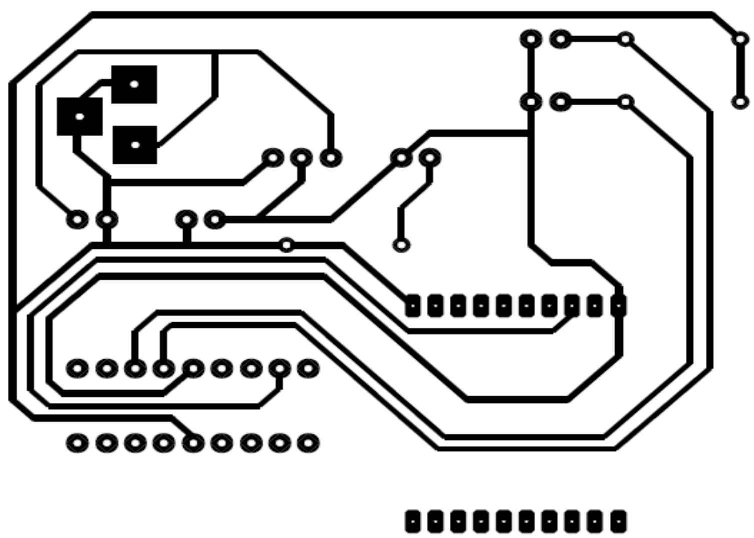

Figure 3.3 : The Design Of The Printed Circuit For Transmitter On The Transparent Paper

Figure 3.3 and 3.4 shows the design of the circuit for both transmitter and receiver. The circuits are been drawn first and printed on the transparent paper. Then, the design will copied onto the PCB board by using the **UV PCB Etching.** UV PCB Etching is a technique to design a circuit on the PCB board by using UV light and the UV Presensitized Copper Clad Boards.

3.4.2 Receiver

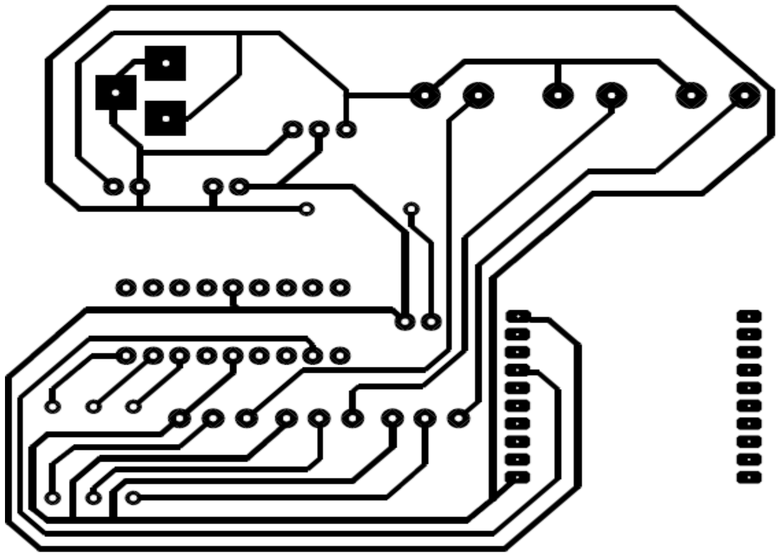

Figure 3.4 : The Design Of The Printed Circuit For Receiver On The Transparent Paper

3.4.3 UV PCB Etching Process

I. PCB Art layout:

The PCB art is the first thing to make. The design can be draw by hand, buy stickers which can stick on to a surface. The drawing also can be drawn by using computer software. When the design is ready, make sure it's 1:1, else the components won't fit. Also, to make a nice etch the design has to be sharp.

II. Transparent sheet

The next step is to get the design onto a transparent sheet (overhead sheet). Simply print the design onto one sheet.

III. UV

To get the design over to the pcb, UV light is needed.

1: Lay the transparent onto the glass. Make sure it's layed the correct way.

2: Take the protection off the pcb, and lay it with the copper side down on the transparent sheet.

3: Put something heavy on top of the card.

4: Turn on the UV light.

5: Wait for 10-20 min.

6: Put the pcb immediately in the developer

IV. Developer

The developer is caustic soda or NaOH on the chemical language. Then, you mix 1/3 NaOH and 2/3 pure water. Make sure this is good mixed. This'll make a concentrate. When it's ready, make the developer out of 5ml concentrate and 200 ml pure water.

1: Put the pcb into the developer tight after the UV exposure.

2: Wait until the traces is clear (30-40 sec)

3: Take the card out of the developer and flush it in clear water.

V. Etching

There's plenty of etching mixtures. Natriumperoxidisulfatur or amoniumpersulfatur can be use by dissolved it in water. 25g powder and 1dl water gives a nice result

1: Put the pcb into the etching mixture. This should be hot. Preferably at 50 deg Celsius.

2: Stir in it until the unwanted copper is gone.

3: Flush the card in pure water.

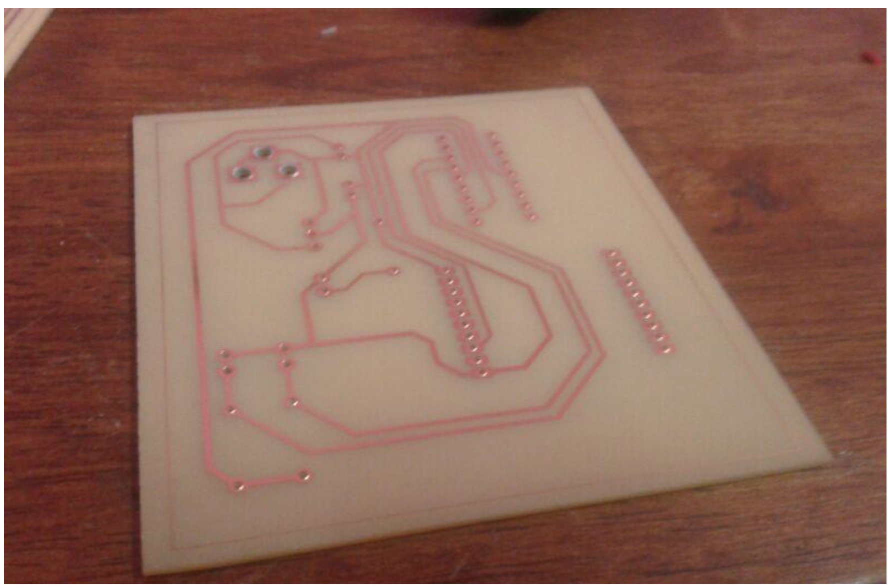

Figure 3.5 : The Design Of The Printed Circuit For Transmitter On The PCB Board

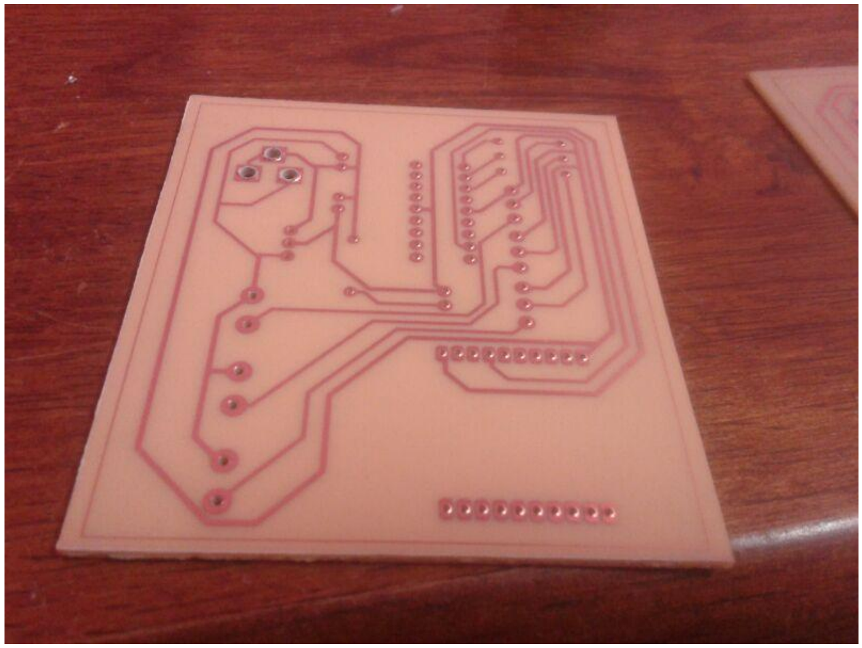

Figure 3.6 : The Design Of The Printed Circuit For Receiver On The PCB Board

Figure 3.5 and 3.6 shows the design of the circuit for both transmitter and the receiver on the PCB boards. The boards has been drilled according to the design so that it will fits with the components.

3.4.4 The Schematic Diagram For Transmitter And Receiver Board

i) Transmitter

By referring to Appendix A1, it shows the schematic diagram for the transmitter board. The switches, microcontroller, and the transmitter has been labeled with certain number that indicates their connectivity within each other. When the board is connected to the power source, the diode (LED – blue colour) will turn on. It means that there is current flowing through the PCB board. The voltage used for this board is 3.3 V. Next, when the switch button is pushed, it will give the signal to the microcontroller. According to the programming that has been create and installed in the microcontroller, the microcontroller will send the signal to the transmitter. Then the transmitter, XB1, will send the wireless signal to receiver.

The components used on the transmitter boards are :

1. Resistors (10k)
2. Capacitors (10u)
3. Microcontroller (PIC16F88)
4. Diode (LED - blue colour)
5. Switches (push buttons)
6. Transmitter (XB1)
7. DC connector
8. Voltage regulator

The flow of the transmitter board :

A DC connector is an electrical connector for supplying direct current (DC) power. The DC connector will connect the system from the plug so it can supply the current. The current then will flow to the voltage regulator. A voltage regulators control the output of the plant. For this circuit, the voltage regulator will convert the amount of voltage from 12V to 3.3V. This is because this circuit only use 3V to make it work. The current also will flow through the capacitors.

The capacitors are used to store energy in an electric field. Then the current will flow through resistors. A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element.

There is also a diode (LED- blue) on the circuit to give a signal whether the current flow through the circuit board or not. Then, there are few switch on the board that used to connect the current to the lights.

There is also a microcontroller that will be programmed with C programming code that can read the code and give signal to the transmitter.

A transmitter is an electronic device which, with the aid of an antenna, produces radio waves. The transmitter itself generates a radio frequency alternating current, which is applied to the antenna. The signal from the transmitter then will send to the receiver.

ii) Receiver

By referring to Appendix A2, it shows the schematic diagram for the receiver. Same as the transmitter schematic diagram, this diagram also shows that the components have been labeled with the certain numbers that shows their connectivity within each others.

The components used on the receiver board are :

1. Resistor (10k)
2. Capacitor (10u)
3. Microcontroller (PIC16F88)
4. Diode (LED – blue, green, yellow, red)
5. Receiver (XBEE)
6. DC Connector
7. Voltage regulator (3.3V)
8. Motor
9. Relay

The flow of the receiver board :

The DC connector is connected by the system from a plug so it can supply the current. The current then will flow to the voltage regulator. A voltage regulators control the output of the plant. For this circuit, the voltage regulator will convert the amount of voltage from 12V to 3.3V. This is because the maximum voltage for XBEE is 3V. If the voltage supply is more than 3V, the XBEE radio will burns out.

After that the current will flow through the capacitors. For this board, the capacitor used is 10u. Next, the current will flow through resistors. There is also a diode (LED- blue) on the circuit to give a signal whether the current flow through the circuit board or not.

Then, the XBEE receiver will receive the signal from the transmitter and it will send it to the PIC16F88 microcontroller. The microcontroller that has been programmed before will read the command given by the transmitter and lights the LEDs according to the button switched at the transmitter board. The motor also will turns on when switch 1 is push from the transmitter board.

3.5 PROGRAMMING CODE FOR TRANSMITTER AND RECEIVER

i) Transmitter

The programming codes are created by using Proton IDE software. It has been created to give the signal to the transmitter according to its command. From the command, if the switch button is pushed, the green light will on. The green light indicates that the device is 'ON' and ready to use. Meanwhile, if the switch button is release, the green light will automatically off but the red light will on. The red light indicates that the device is 'STOP'. This process will loop continuously until the main power source is disconnect from the board. See Appendix B1 for the programming and software used for the XBEE transmitter.

The programming code used in the transmitter board :

```
Include "16f88_4.INC"

@ CONFIG_REQ

@ __CONFIG _CONFIG1, CP_OFF & CCP1_RB0 & DEBUG_OFF &
WRT_PROTECT_OFF & CPD_OFF & LVP_OFF & BODEN_OFF &
MCLR_OFF & PWRTE_OFF & WDT_OFF & INTRC_IO
OSCCON.0 = 0
OSCCON.1 = 1
OSCCON.4 = 0
OSCCON.5 = 1
OSCCON.6 = 1

All_Digital 1
Input PORTA
start:

If PORTA.6 = 1 Then
HRSOut "A"
HRSOut 10
End If

If PORTA.7 = 1 Then
HRSOut "B"
HRSOut 10
End If
GoTo start
```

ii) Receiver

These programming codes are created by using Proton IDE. It has been created to receive a signal from the transmitter according to its command. From the command, when switch S1 is push at the transmitter circuit, it will give signal to the receiver to on the green lights, and so the green light will turn on.

There is also a motor that attached to the receiver board that will indicate that the device is in use or not. When the green light is on, the motor also will start to rotate. It rotate according to the command that has been installed into the microcontroller that has been attached on the receiver board. Then, when switch S2 is push, the transmitter will give signal to the receiver and the receiver will send the data to the microcontroller and the process the programming code and make the green light turn off and at the same time the red light will turn on. The programming code also will command the motor to stop rotating. This indicates that the device in 'STOP' mode and not in use. See Appendix B2 for the programming and software used for the XBEE transmitter.

The programming code use in the receiver board :

```
Include "16f88_4.INC"

@ CONFIG_REQ

@ __CONFIG _CONFIG1, CP_OFF & CCP1_RB0 & DEBUG_OFF &
WRT_PROTECT_OFF & CPD_OFF & LVP_OFF & BODEN_OFF &
MCLR_OFF & PWRTE_OFF & WDT_OFF & INTRC_IO

OSCCON.0 = 0
OSCCON.1 = 1
OSCCON.4 = 0
OSCCON.5 = 1
OSCCON.6 = 1


Dim rx_data As Byte
Dim count_time As Word
All_Digital 1
```

```
Output PORTA
Low PORTA
count_time = 0
start:

If rx_data = "A" Then
PORTA.2 = 1
PORTA.3 = 0
PORTA.4 = 0
rx_data = 0
End If

If rx_data = "B" Then
PORTA.2 = 0
PORTA.3 = 1
PORTA.4 = 1
DelayMS 5000
PORTA.2 = 0
PORTA.3 = 1
PORTA.4 = 0
rx_data = 0
End If
```

3.6 FABRICATION OF ANDON SYSTEM

The transmitter board and receiver board, both are fabricated by connecting all the components onto the PCB board. The components are solder according to their position that has been design on the PCB board before. Figures 3.7, Figure 3.8 and Figure 3.9 shows the fabricating of both transmitter and receiver board.

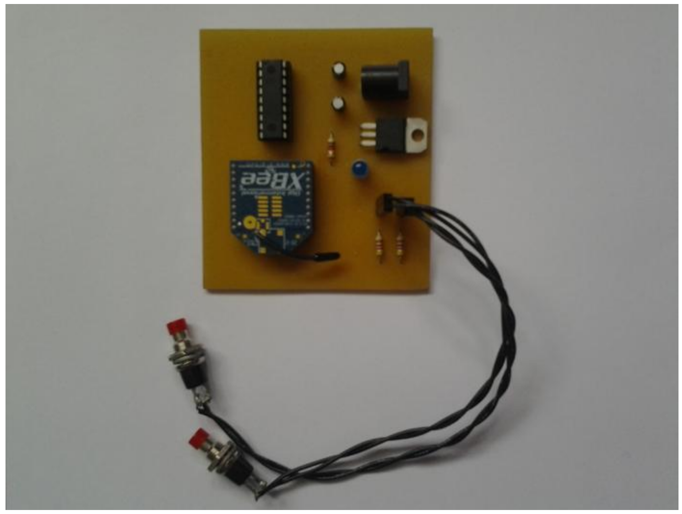

Figure 3.7 : The transmitter board

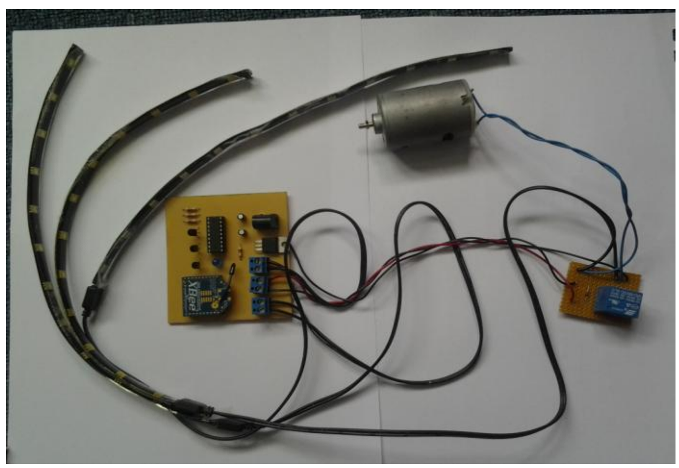

Figure 3.8 : The receiver board

Next, both transmitter board and receiver board are fabricated together inside an acrylic box. Figure 3.9 below shows the result of the fabrication.

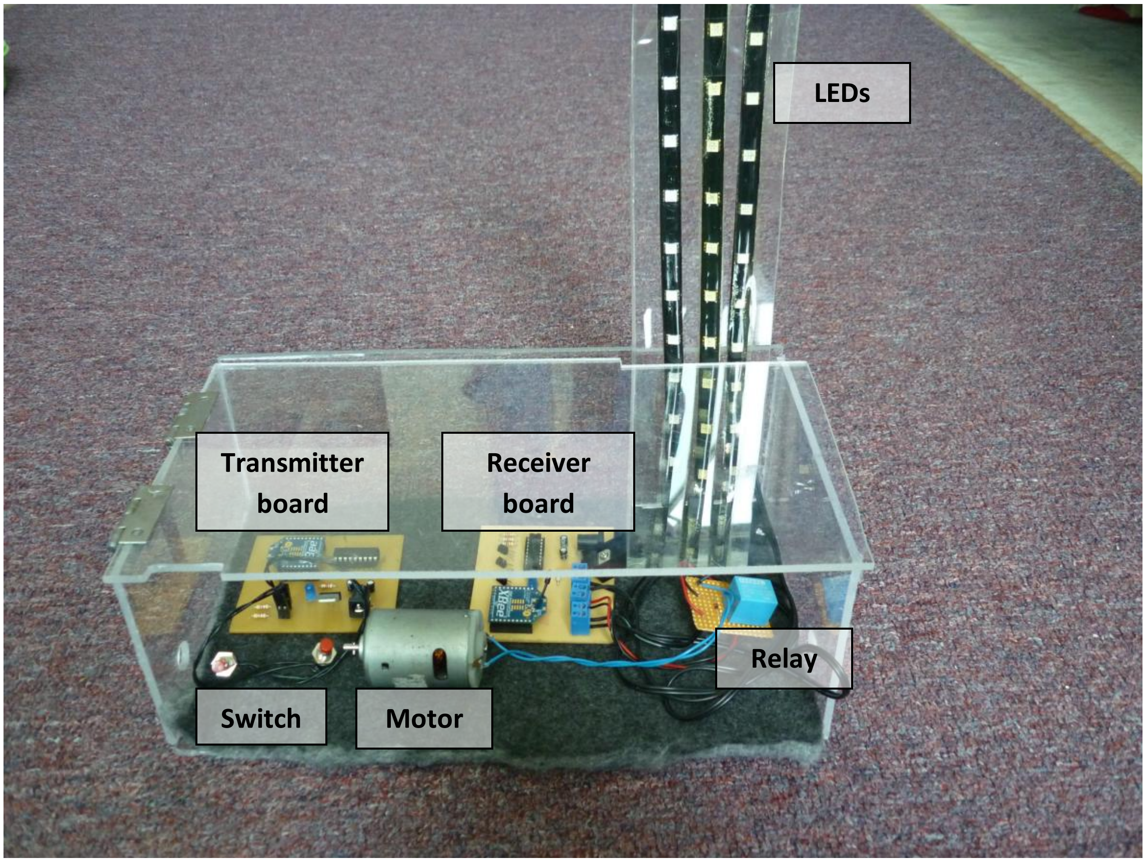

Figure 3.9 : The andon system

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter discusses the results that are obtained from the design of the andon system and the experiment. The experimental results are displayed in figure, tables and graphs for better understanding. Later, they are analyzed and discussed.

4.2 EXPERIMENTAL RESULT

4.2.1 Lights Observation Test

The result of the lights changes is shown in Table 4.1. From the table, it shows that when switch 1 which is on the transmitter board is pushed, the green light will turn on meanwhile the other two lights; yellow and red will stay off. This will indicate that the machine is being used. If there are no button push within 10 seconds, the yellow light will turn on and the green light will automatically turn off. This light shows that the machine is in idle state. At this condition the red light will stay off. When the machine is in idle state, if users want to use the machine again they can push switch 1 and the green light will turn on. Next, when there are any emergency happen and there want to stop the machine, switch 2 is push so that the red light will turn on and the yellow light will turn off.

Through the lights observation test, it clearly shows that the programming code that has been created is within the specification needs. It shows that the right lights will turn on when the right switch is been pushed.

Table 4.1 : Lights Changes by Different Situation

Light / **Switch**	**Green**	**Yellow**	**Red**
Switch 1 push (On)	ON	OFF	OFF
No button push for 10 seconds (Idle)	OFF	ON	OFF
Switch 2 push (Off)	OFF	OFF	ON

4.2.2 Efficiency test

Table 4.2 shows the efficiency percentage of the andon system. The data has been taken from a test that has been repeated for 100 times. The data are taken by switching the first and second button and observe the LEDs lights. Every successful and unsuccessful lights are observe and noted on Table 4.2. Next, the data from Table 4.2 are taken into a graph that can shows the result more clearly.

For the first 20th times of the experiment, the efficiency of the green, yellow and red light are 100%. However, starting from 30th to 40th times of experiment, the efficiency of the green light decrease to 90%. This is because of the condition of the green light wire is a little bit loose. After some adjustment, the green light is positively functional and the percentage of the efficiency increase to 100%. Starting from 40th to 80th times of experiment, the efficiency of the yellow, red and green light drop again to 90%. This is because of the connection between the LEDs and the board and the soldered components are quite loose. After doing some adjustment, soldering and tightening, the LEDs lights has been well function until the 100th times of the experiment and the percentage of efficiency rise back to 100%.

Table 4.2 : The Efficiency Percentage of The Andon System

No. of experiment	**Percentage of Efficiency (%)**		
	Green Light	**Yellow Light**	**Red Light**
10	100	100	100
20	100	100	100
30	90	100	100
40	100	90	90
50	100	100	90
60	100	90	100
70	90	90	100
80	100	100	100
90	100	100	100
100	100	100	100

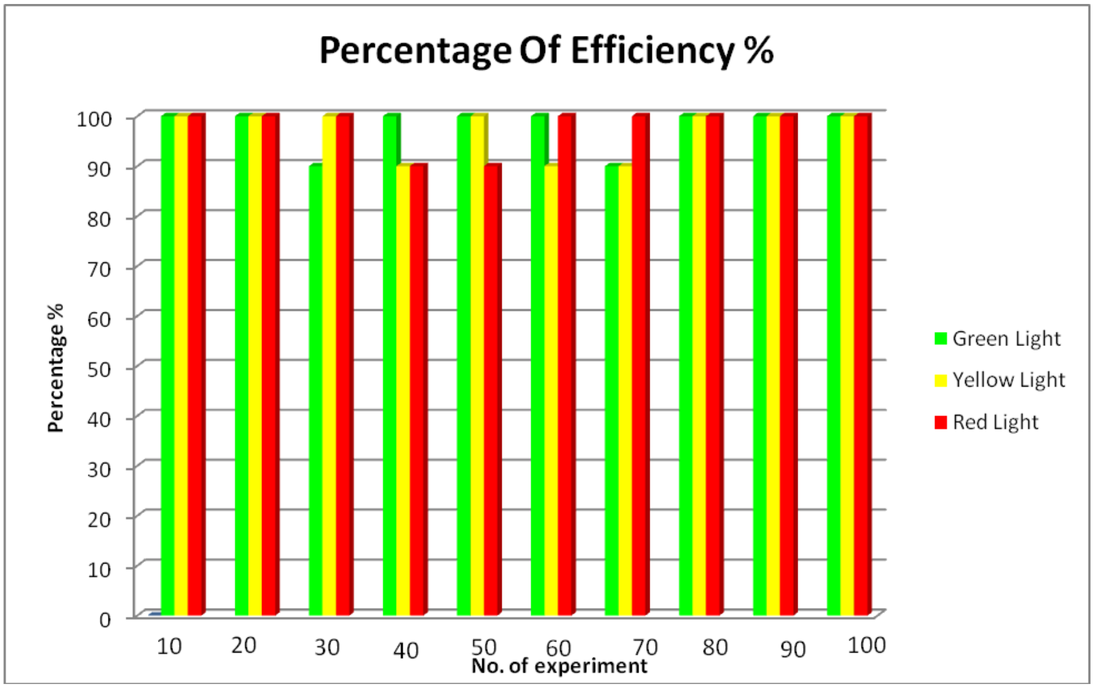

Figure 4.1 : Graph of the Percentage of Efficiency in Andon System

Figure 4.1 shows the graph of the efficiency test result of the andon system. For the first 20 times of test, the system runs smoothly. It shows that all lights are having the high percentage of efficiency which is 100 percent. However, starting from 30 to 70 times of test, there are few errors that caused the lights did not work properly. The percentage of the efficiency is 90 percent. But after doing some improvement, the percentage has increase to 100 percent and the percentage maintain until the 100 times of test.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter concludes the whole project including previous chapter in a nut shell. This final year project is focused on a couple of topics which is fabricating the andon system and the relationship between voltage and time. The conclusion will touch on both of these focused area.

5.2 CONCLUSIONS

5.2.1 The Andon System

The andon system that designed could be used as the visual management system to the FKP lab. The usage of XBEE is helpful to accomplish the experiment of this project. It is a component that can send the wireless signal to the receiver board. By using this system, it will help people to identify the condition of the machine and also can give warning to people if there is something wrong about any process or activity while the machine is being used.

The andon system is design and develop to use at FKP lab. The data of the andon system has been analyse via light observation test and efficiency test. Based on the experimental result, it shows that the objectives of this project is positively achieved.

5.3 RECOMMENDATIONS FOR FUTURE RESEARCH

To improve the andon system is an alarm, bell or buzzer can be attach to the system as the audible signals that can gets attention when something is wrong. This audible signal can help the warning method more effectively because people can always be alert. The buzzer can be directly connected to the emergency button.

This warning system can be very useful in order to increase safety in lab and at the same time can be one of the visual management system in FKP lab.

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APPENDIX A

GANTT CHART FOR PSM 1

PSM 1			Time (Week)														
No	Activities		W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
1	Get the project title and arrange discussion time with supervisor	Planning															
		Actual															
2	Go briefing about PSM from supervisor	Planning															
		Actual															
3	Make research background	Planning															
		Actual															
4	Define company for searching the problem statement	Planning															
		Actual															
5	State the objective, scope and problem statement	Planning															
		Actual															
6	Make literature review	Planning															
		Actual															
7	State the overview of research methodology	Planning															
		Actual															
8	PSM 1 presentation and submit log book	Planning															
		Actual															
9	Submit report PSM 1	Planning															
		Actual															

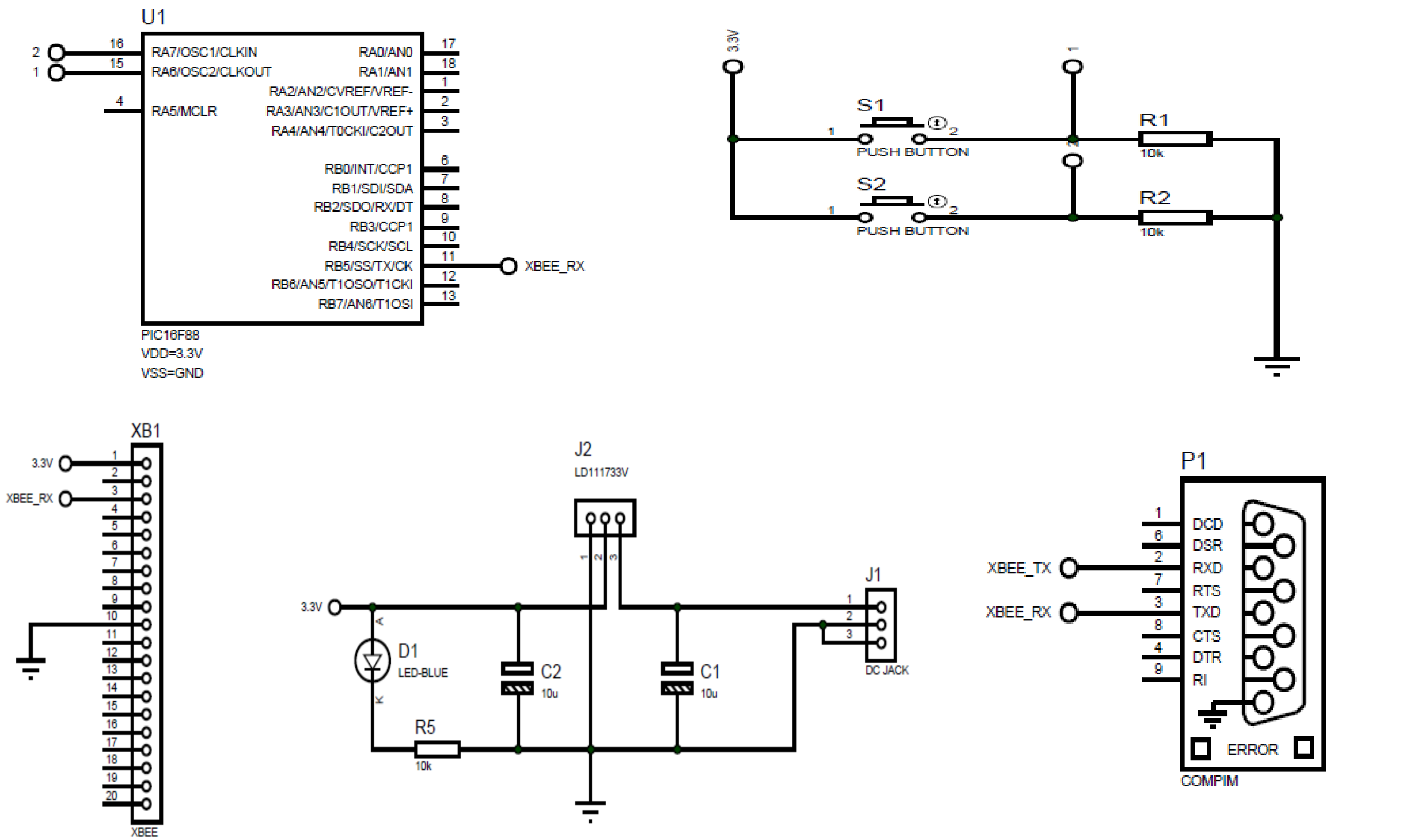
APPENDIX B

GANTT CHART FOR PSM 2

PSM 2			Time (Week)															
No	Activities		W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16
1	Update status of current PSM status to supervisor	Planning																
		Actual																
2	Proceed with the hardware system of andon	Planning																
		Actual																
3	Proceed with the programming system of andon	Planning																
		Actual																
4	Analyze the data	Planning																
		Actual																
5	Make conclusion and provide suggestion for improvement activity	Planning																
		Actual																
6	Prepare final PSM draft report, log book and submit to supervisor for evaluation	Planning																
		Actual																
7	Final presentation	Planning																
		Actual																
8	Submit the complete thesis report	Planning																
		Actual																

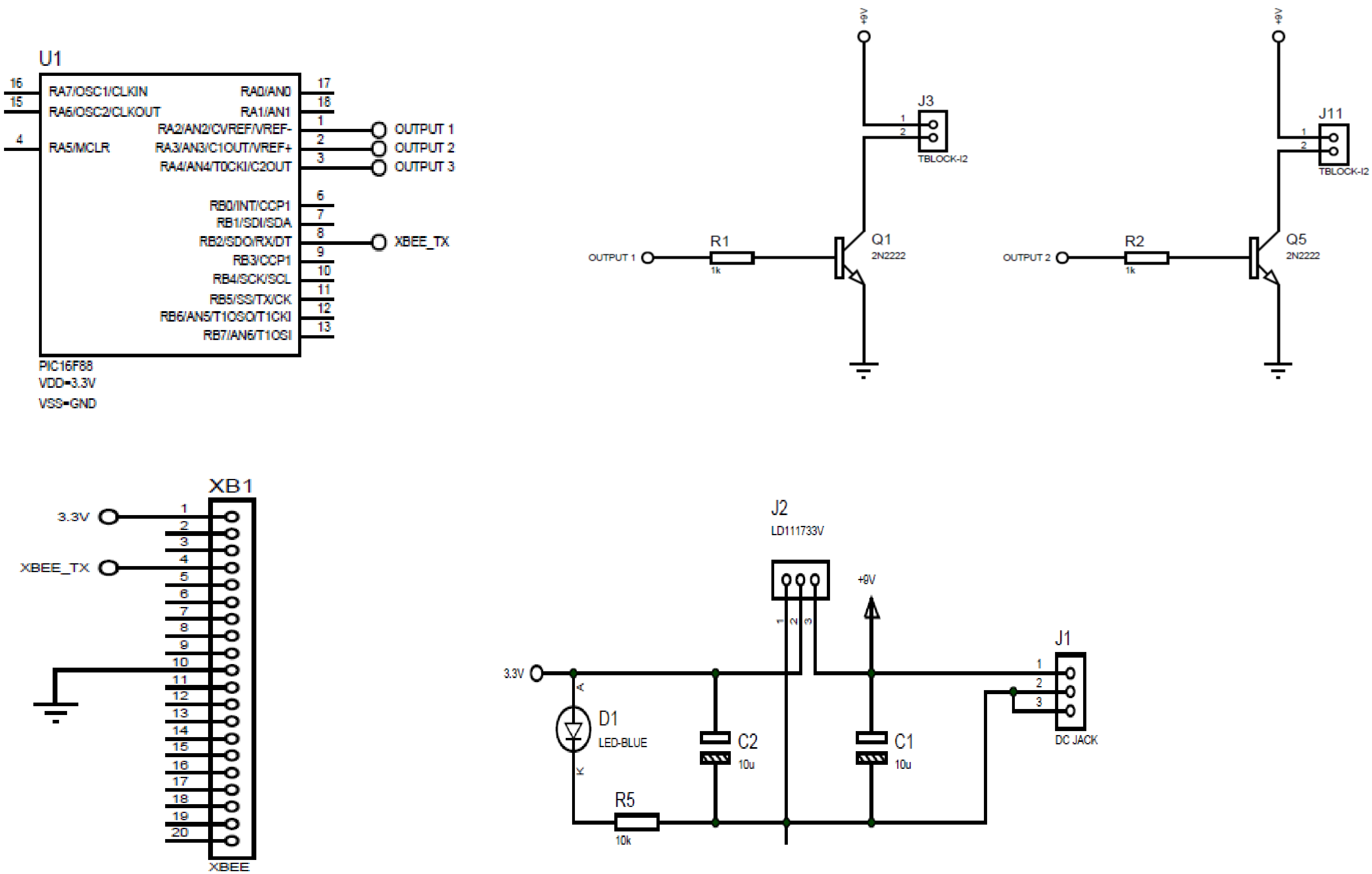
APPENDIX C1

SCHEMATIC DIAGRAM FOR TRANSMITTER



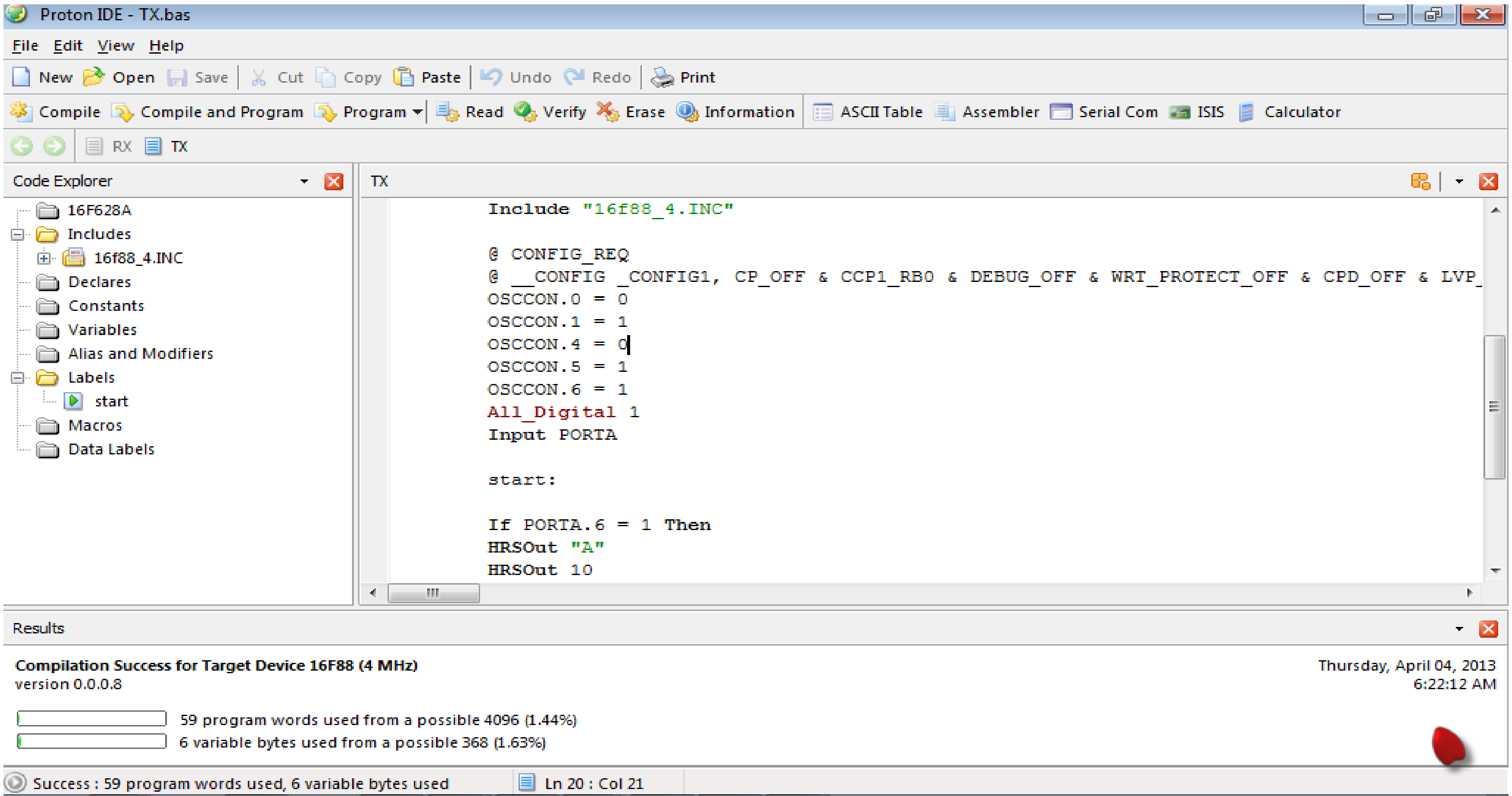
APPENDIX C2

SCHEMATIC DIAGRAM FOR RECEIVER



APPENDIX D1

PROGRAMMING SOFTWARE FOR TRANSMITTER



APPENDICES D2

PROGRAMMING SOFTWARE FOR RECEIVER