BLUETOOTH ACCELEROMETER MOUSE

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by

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Dissertation submitted in partial fulfilment of
the requirements for the
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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Electrical & Electronics Engineering Programme
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Approved by.

(Ms. Salina Mohmad)
Main Supervisor

Universiti Teknologi PETRONAS
Tronoh, Perak
June 2010

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Shanthini

SHANTHINI S.SELVARAJA

ACKNOWLEDGEMENT

At this point of acknowledging, I would like to take this golden opportunity to express special gratitude to my FYP Supervisor, Ms Salina Mohmad for her dedication in terms of support and guidance in leading me to construct this project "Bluetooth Accelerometer Mouse" as a truly successful idea. I would like to thank her for all the effort and patience while dealing with me. Without her cooperation, guidance and tolerance, I would have gone through a tough time to complete this project productively.

Along with this opportunity, I would also like to apologize to Ms Salina for any inconveniences that I have caused against her sincere determination in guiding me.

Last but not least, I would like to dedicate a special gratitude to all lecturers and laboratory technicians who have guided me. In addition, I convey my deepest gratitude to my dearly colleagues who gave me so much support, encouragement and sharing ideas with me in completing this project and also to those who were involved directly or indirectly in helping me to undergo the process of completing this course and to make "Bluetooth Accelerometer Mouse" as a highly potential idea to become real.

ABSTRACT

Mouse is an extremely popular and essential device used to interact with computer. However, most conventional mouse are not mobile-friendly. Thus, this project attempts to incorporate the usage of 3-axis accelerometer and Bluetooth RF (Radio Frequency) technology on a single circuit thus making it a wireless cursor controller; in brief a wireless accelerometer based mouse. The reason of inventing such device is to overcome problem faced in using wired mouse and also the need of a surface for its movement. It applies even for the wireless mouse too since a surface is always a priority for its usage. This could be a hassle when users are left with limited space.In order to overcome this difficulty, this particular wireless accelerometer based mouse is developed. The tilt measurement of the accelerometer will be processed and transmitted via Bluetooth RF to the PC (Personal Computer) to control the cursor. In other words, to enhance the current Bluetooth mouse technology by integrating the accelerometer in replace of either optical or laser sensor in a new circuit. With this alternative device, the cursor can be controlled far away from computers and it will make lot things easier. And the best of all, this device does not need a surface to operate. Movement in the air and the rotation of wrist will be sufficient.

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ABBREVIATIONS AND NOMENCLATURES

BAM	– Bluetooth Accelerometer Mouse
ADC	– Analogue to Digital Conversion
PIC	– Peripheral Interface Controller
RF	– Radio Frequency
VB	– Visual Basic
LED	– Light Emitting Diode
PC	– Personal Computer
SPP	–Serial Port Profile
FYP	– Final Year Project
GUI	– Graphical User Interface
USB	– Universal Serial Bus
API	– Application Programming Interfaces

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Technology today has expanded vastly in all area and aspects especially in electronics devices. The mouse is an extremely popular and essential technology used to interact with computer as a cursor control device. Various types of mice are available in the market today. The mechanical mouse are the classic ones, also known as a ball mouse uses a moving ball to work. As the mouse is moved across a surface, the ball moves as well with two rollers that roll against two sides of the ball. The rollers track the horizontal and vertical motion of the mouse respectively. Optical Mice are the most common computer mice in use today. An optical computer mouse works using opto-coupler technology whereby a small red LED (Light-Emitting Diode) emits light onto a surface and reads the pattern or grid on that surface [1].

While the majority of mice are connected directly to the computers peripheral input via cord and are powered by the computers main power, wireless mice are also becoming extremely popular to give computer users' cordless accessibility and spacious mobility of their mice to interact with their computer. This has been the newest technology breakthrough in computer mice. Wireless mice basically work via radio frequencies that are referred to as RF and it requires two components to work efficiently, a radio transmitter and a radio receiver [2].

1.2 Problem Statement

Presenting a PowerPoint slideshow or any sort of such material seems to be very common in lecture halls or even meeting rooms. However, majority of the conventional display cursor control devices such as computer mouse is implemented with either measurements of ball rolling movement or optical movement sensing. Such devices are usually limited to operate on a surface that requires a certain space for its movement. Furthermore, it could be a hassle since the presenter will frequently need to refer the computer and mouse in order to move the device and also control the cursor to point out any important data. Usage of wireless mouse could not be that efficient either since all mice somehow needs a surface beneath to control the movement of the cursor. Thus, it is not mobile-friendly.

1.3 Objective

Focusing on professors and lecturers in the lecture hall, the main objective of this final year project is to design a cursor control device that can be operated flexibly without requiring it to actually move along a flat surface. Specifically, the cursor can be controlled when the control device is lifted up in the air. With this alternative device which is portable, the cursor can be controlled far away from computers and best of all; it is simply possible with only the rotation of wrist. Presentations will be way much easier with this control device.

1.4 Scope of Study

The main scope of the study for this proposed project will be constructing an accelerometer based wireless cursor controller. This will be divided into 3 parts. Firstly, researches on the hardware that contributes mainly the accelerometer, microcontroller and wireless modules. Secondly, focusing on the PIC (Peripheral Interface Controller) programming and Visual Basic programming for processing data in anticipating cursor controls. Finally, it would be implementation of a working prototype once both hardware and software are taken care of.

CHAPTER 2

LITERATURE REVIEW

2.1 Theory

The main theory and concepts of this project is to implement an accelerometer as tilt sensor, microcontroller for measurement process control, wireless radio modules in transmitting and receiving and Visual Basic (VB) interface for Personal Computer (PC) communication. This review is based on an existing final year project [3]. In general, the tilt measurement of the accelerometer will be the input in which the microcontroller will process it and send signals via wireless modules to PC for its cursor control functions. This is briefly shown in Figure 1.

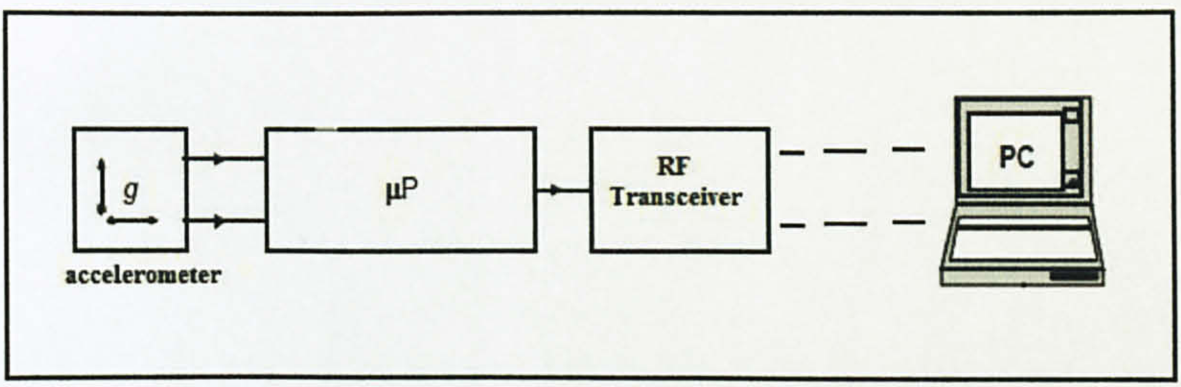

Figure 1: Concept of tilt sensor for cursor control

2. 2 Literature Review

2.2.1 Accelerometer as tilt sensor

An accelerometer measures acceleration that is the change in speed of any object that it's mounted on. Single axis accelerometers measure acceleration in only one direction. Dual-axis accelerometers measure acceleration in two directions which are perpendicular to each other. Three-axis accelerometers measure acceleration in three directions. Either dual-axis or three-axis can be used for this project but however, dual-axis is pretty good enough for the cursor control device. The control device can be tilted to the right or left to move the cursor to the right or left respectively. Likewise, the control device can be tilted upward or downward to move the cursor up and down. This could save up space since tilt movements can be done without requiring a flat surface for the control device to control the cursor.

Accelerometer measures the acceleration forces. These forces may be static like the force of gravity, or they could be dynamic caused by moving or vibrating the accelerometer. In this project, accelerometer collects information about the users' physical movements [4].

Accelerometers are used in many sort of application. A few of its application are listed as below:

- Vibration detection
  - Used to isolate vibration of mechanical system from outside sources. Only the vibration is sensed.
- Vehicle skid detection
  - Used with systems that deploys "smart" braking to regain control of vehicle.

- Impact detection
  - Used to determine the severity of impact.
- Function controller
  - Used as an input to in some types of control systems.

2.2.2 Microcontroller for measurement process control

A microcontroller is a highly integrated chip which performs controlling functions. A microcontroller, also known as embedded controller, is similar to a microprocessor used in PC. Microcontrollers are used to control a wide range of electrical and mechanical appliances. The microcontroller senses the external events through signals received at input ports and transmits responses to the events through output ports [9].

Generally, a microcontroller has a standard hardware design that is customized for a particular implementation by programming the firmware for that particular application. In this project, the accelerometer is connected to the Analogue Digital Converter (ADC) ports of the microcontroller. Thus, the tilt properties of the accelerometer will be the input of the microcontroller. This data is then processed and will be mapped onto computer for controlling the movement of the cursor via wireless modules.

Microcontrollers are used in many different applications. Microcontrollers are found in all market segments such as PC peripherals, consumer, commercial, telecommunications, automotive and industrial. Microcontrollers are used for command interpretation and data transmission. Microcontroller embedded control systems are also used in copiers, cable television terminal equipment, lawn sprinkling controllers, cellular phones, fax machines, automotive applications such as engine control modules, anti-lock braking systems, automobile suspension control, keyless entry systems, and more of other industrial and consumer applications [9].

2.2.3 Wireless radio modules

Wireless integrated module can work as a transceiver at the same time and this gives a smooth navigation of the cursor. This is simply because usage of wireless module can be easy in transmitting and receiving of data. As mentioned earlier, wireless mice work via Radio Frequencies (RF) with its main two components that are radio transmitter and radio receiver. A (RF) transmitter is usually integrated inside the mouse. The movement of the mouse and buttons that are clicked are recorded and this information is then sent via radio signals to the receiver. The (RF) receiver usually connects to the computer's peripheral mouse input. It receives these RF signals, decodes and then sends these signals directly to the computer [2].

Many applications are now using (RF) technology. Wireless operations permits long range communications that are either impossible or impractical to implement with the use of wires. The term is used commonly in the telecommunications industry that usually refers to telecommunications systems for instance radio transmitters and receivers, remote controls, computer networks, network terminals which use some form of energy like radio frequency , infrared light, laser light, visible light or acoustic energy to transfer information without the use of wires. Information is transferred in this manner over both short and long distances.

Figure 2 and Figure 3 are the schematic examples of RF transmitter and RF receiver that have been used for existing similar projects.

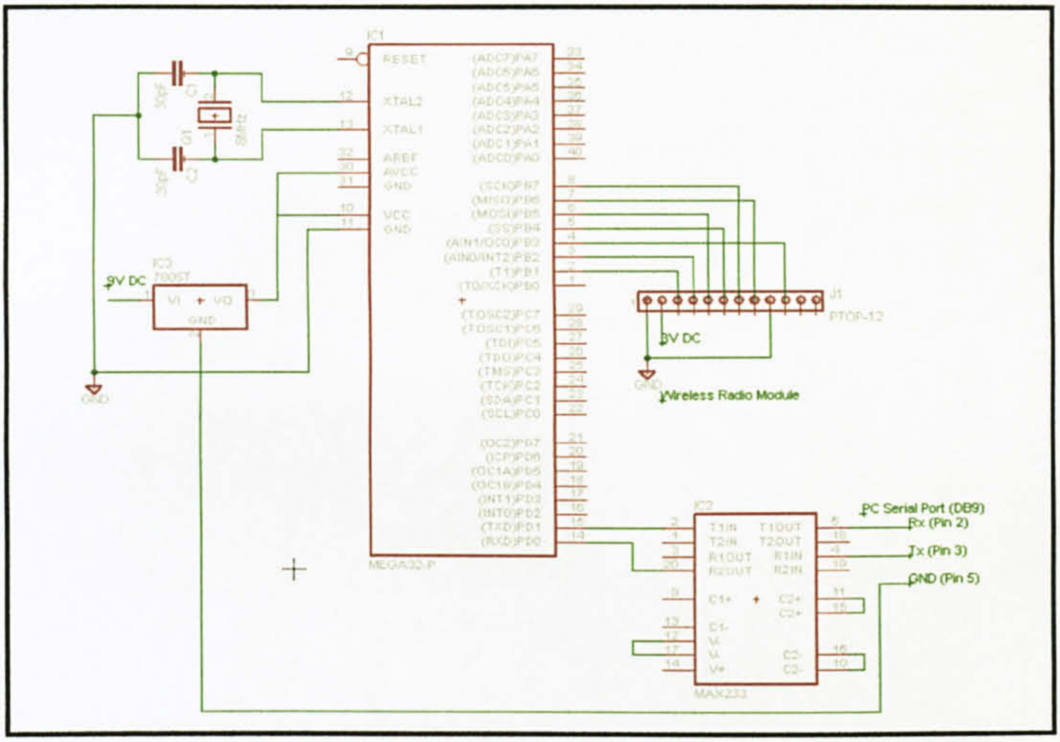

Figure 2: RF Transmitter [3]

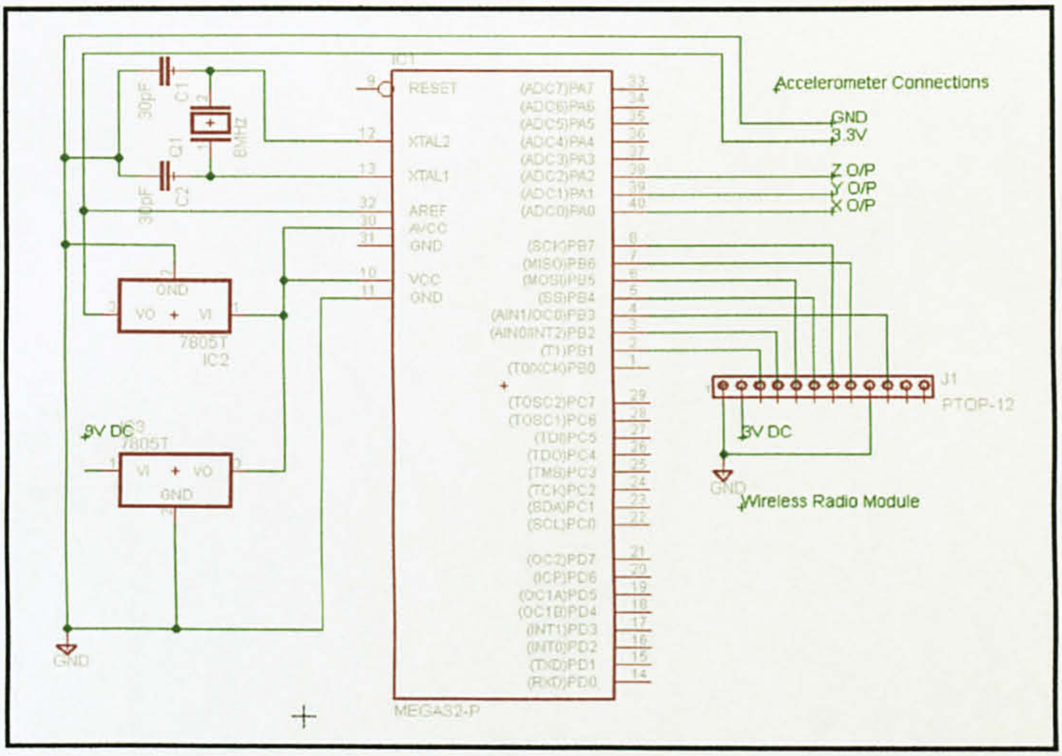

Figure 3: RF Receiver [3]

However, Bluetooth RF technology is also one of the wireless technology that is emerging and now beginning to be used in large numbers for wireless mice. Bluetooth is also commonly known to connect computers to peripherals such as keyboards, printers and headsets. Bluetooth is almost similar to RF in which it operates at 2.4 Gigahertz frequency; furthermore, it also uses software called Adaptive Frequency Hopping to choose frequencies that have less interference or none. Bluetooth has a decent range, usually about 33 feet in which it is equally enough for mouse operation.

Although RF is equally compatible with Bluetooth, this cursor control device that is yet to be built will be using the Bluetooth RF technology. Thus, a Bluetooth SPP (Serial Port Profile) will be incorporated with the microcontroller and accelerometer to build a Bluetooth accelerometer that can be programmed to control the cursor. Details on the components will be discussed in the next chapter.

CHAPTER 3

METHODOLOGY

3.1 Procedure Identification

As for the procedure identification, Figure 4 and Figure 5 depict the project flow of the whole Final Year Project (FYP) that includes phase 1 and 2 (FYP1 and FYP2). The work procedures of the project have been a continuous development from the previous phase (FYP1) and till to date, the progress is on par with the schedule. The background studies have been discussed much earlier. This part of the report is basically on updating the current status of the project. More improvement is being done on the hardware and software part of the device to enhance its functionality.

FYP1 mainly focused on hardware research to identify the most appropriate and suitable circuit components that are needed and efficient in usage. This research was also done to finalize all the component parts and move on to the schematic drawing. The schematic is extremely important in order to build the circuit and so, the virtual circuit is drawn and simulated with particular software. Once the schematic passes the design and error rule check, the circuit is then constructed with least error.

FYP2 on the other hand, focuses on developing the program for microcontroller and also for the computer interface. There are two types programming needed in this project. Firstly would be the microcontroller programming (C Language) in which it is important to obtain the maximum control of the device application. And the other one would be Visual Basic (VB) programming to create an interface that will actually communicate between the device and the computer.

Currently, the schematic drawing is completed and the circuitry board has also been built but unfortunately, the circuit does not seem to function as it suppose to. This could be due to some minor defects with the components while constructing or some misconnections. The circuit is yet to be troubleshot. Simultaneously, the C programming codes for microcontroller has been written and rectifications are being done for it to run accordingly since the initial code could not be simulated. The VB program codes were also developed to create an interface for the communication of the device and the computer. However, there seem to be some difficulties since the VB codes need to associate with the Windows Application. This process took a few weeks to be rectified.

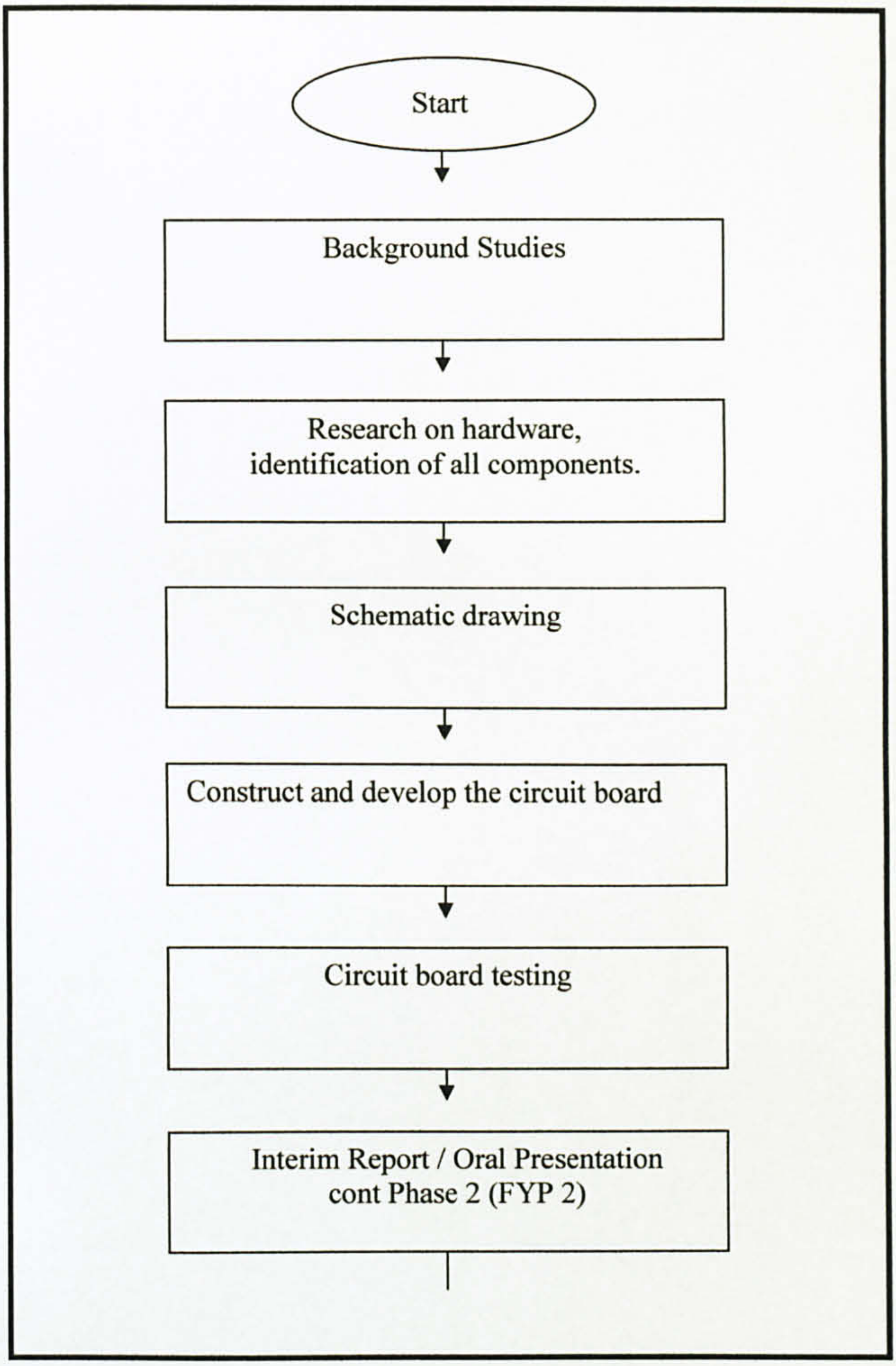

Figure 4: Flow chart of FYP 1

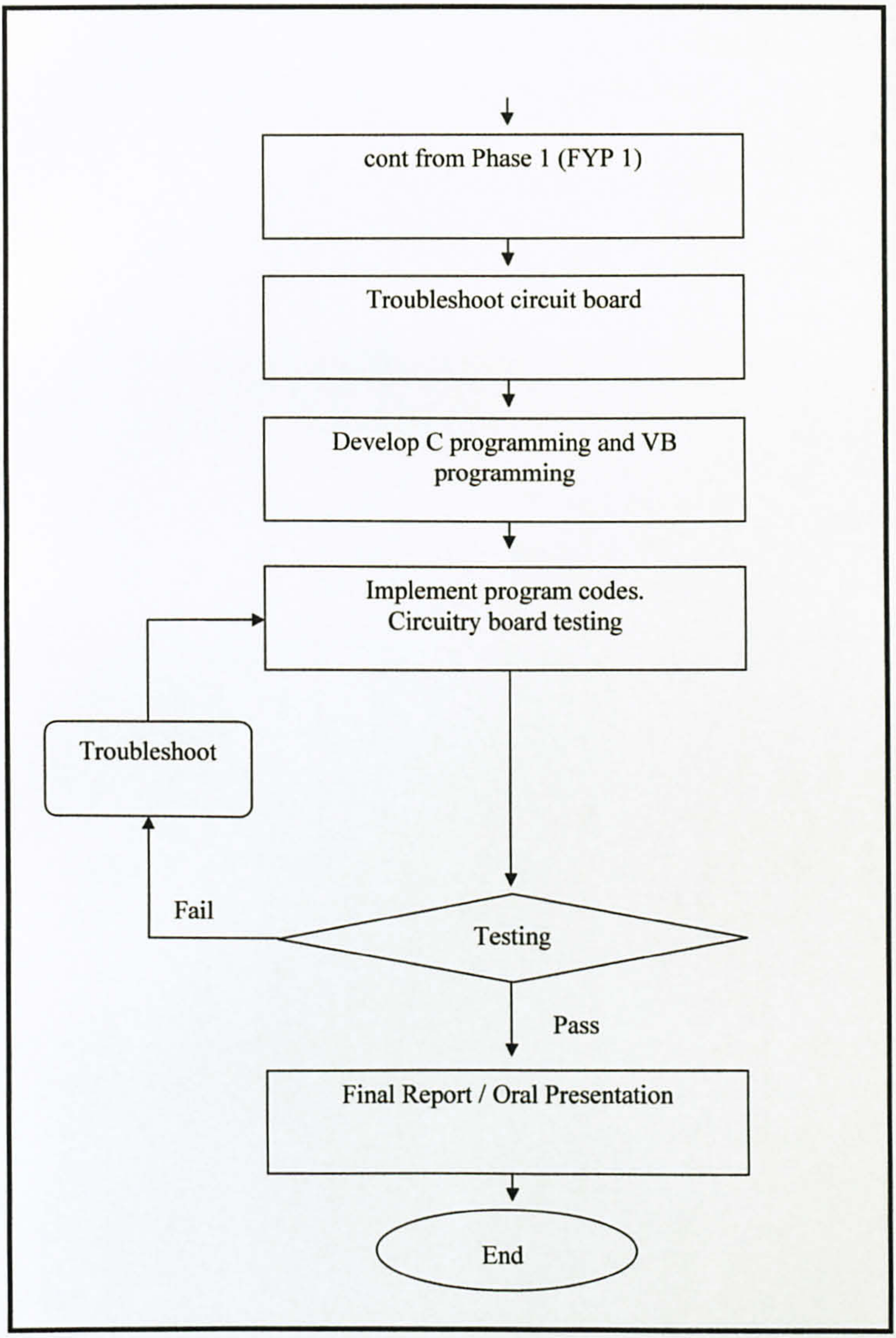

Figure 5: Flow chart of FYP 2

Moving on, apart from the project flow, the procedure of the how this Bluetooth Accelerometer Mouse (BAM) works can be explained as such. Table 1 shows the main component needed and its function.

Table 1: BAM component and its functions.

Variable properties	**Component**	**Function**
Input	*Accelerometer*	gravity sensing device; measures tilt properties.
Processing Unit	*Microcontroller*	processes input data and produces output data.
Transfer medium	*Bluetooth RF*	wireless data transfer; output sent to computer.
Output	*Computer*	display cursor movement according to output.

In general, every operation let it be either in a system or device complies with the basic properties such as the input, processing unit, transfer medium and finally the output that determines the whole function. This project also has the same properties and it has been elaborated in the table above. When the device is tilted, the accelerometer will measure the acceleration of a user's hand and integrate that acceleration into a change in position. Since the operation is just to move the cursor up/down and left/right, dual axis is sufficient enough to perform the output. The analog output that is present at the X-axis and Y-axis of the accelerometer is then fed to the microcontroller. The microcontroller circuit plays the main role as the brain in the operation of the device. The microcontroller receives the analog output signal from accelerometer sensor and perform analog to digital conversion; converts them into binary output and generates serial signal packets to drive the computer mouse according to the serial protocol. The MAX232 will receive the serial signal from the microcontroller and allow the mouse to be detected by Windows as the signal is being transmitted via Bluetooth. At this point, an interface application is created using Visual Basic (VB) that will actually allow communications between the device and the Windows API Mouse in order to move the cursor.

Figure 6 is a flowchart of how this Bluetooth accelerometer mouse operates in a very general way.

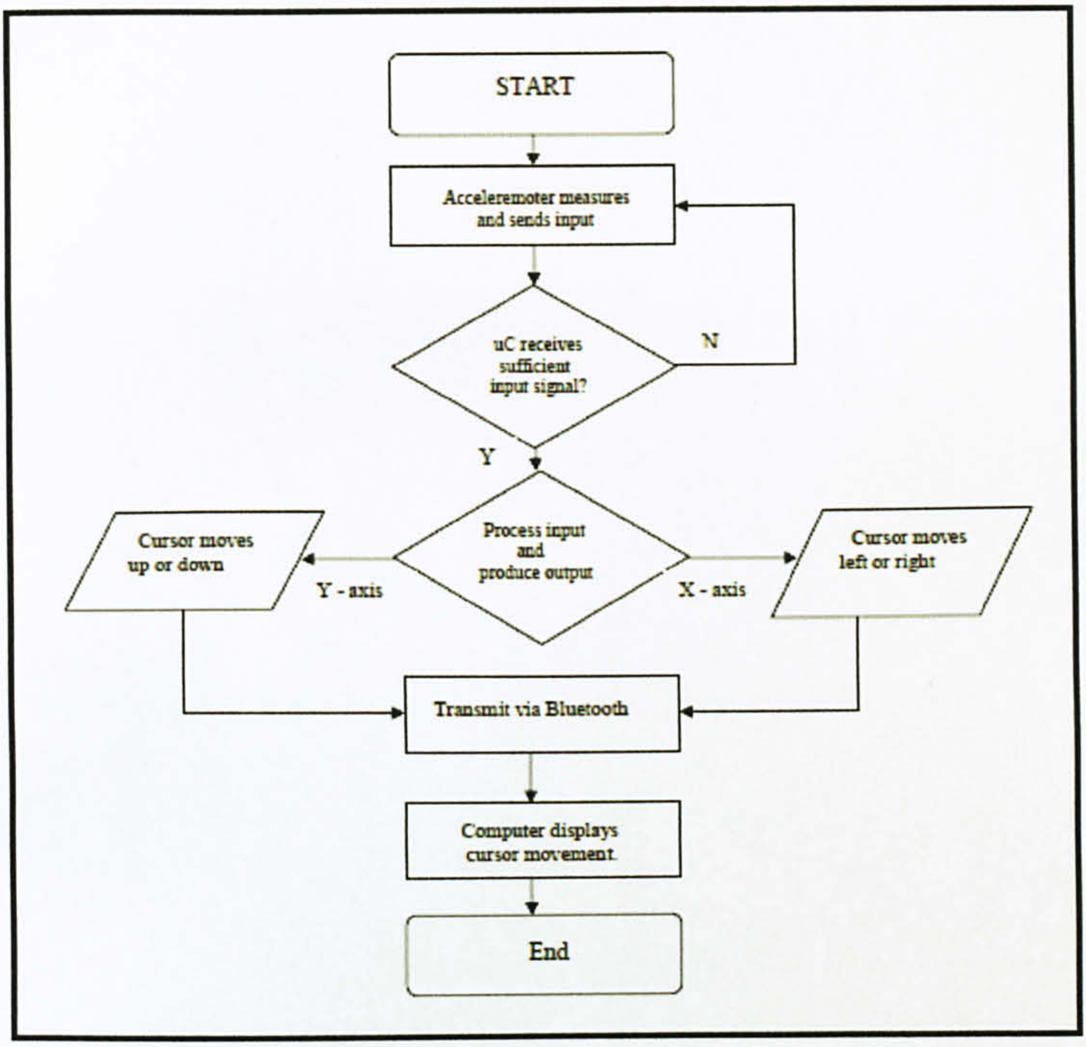

Figure 6: Operation of Bluetooth Accelerometer Mouse

3.2 Tools and Equipments

Hardware

The major components that have been finalized currently for this particular project after all researches are:

- Accelerometer - ADXL335
- Microcontroller - PIC16F877A
- Bluetooth Module - SKKCA – KC21

3.2.1 Accelerometer

The ADXL335 is a 3-axis accelerometer that is being suggested for this project. It is small, thin, low power, features signal conditioned voltage outputs. This device can measure acceleration with a minimum full-scale range of ±3g. It has a maximum sensitivity of 330mV/g. It operates on a single-supply in between 2.0V to 3.6V that makes it ideal for handheld battery powered electronics in which it will be suitable for this portable cursor controller. The figures below are the accelerometer board layout, pin layout diagram and also the recommended connection for the accelerometer respectively [7].

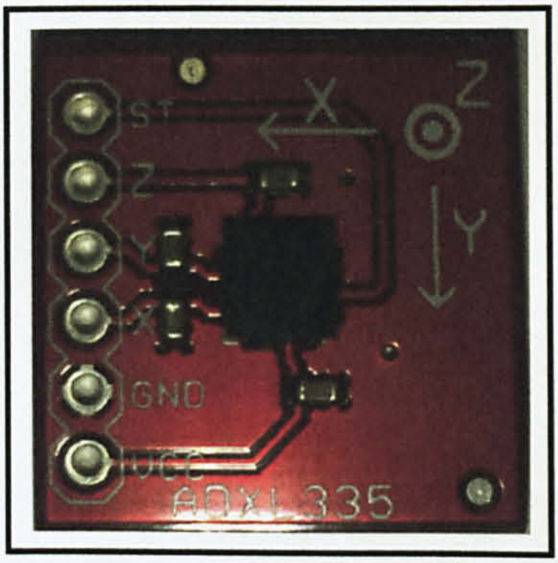

Figure 7: Accelerometer board layout

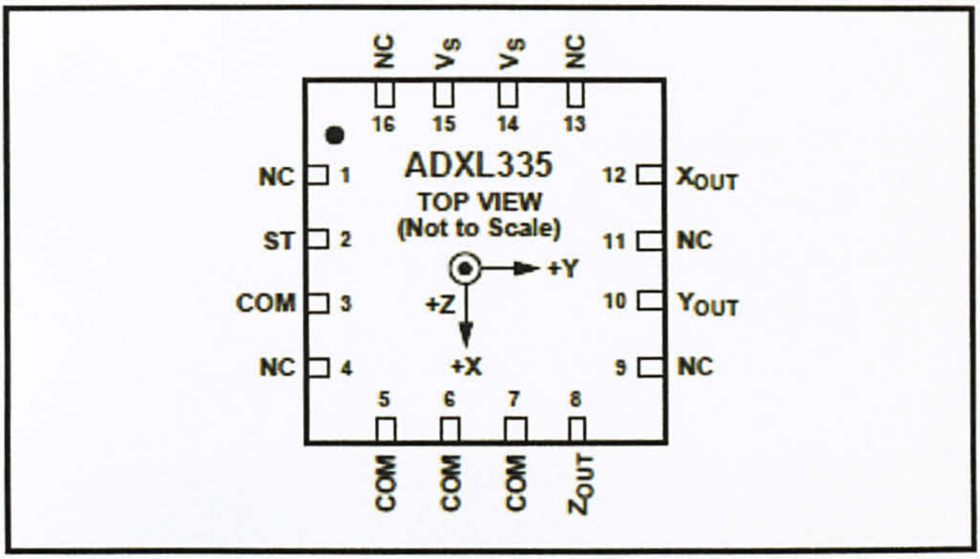

Figure 8: Accelerometer pin layout [7]

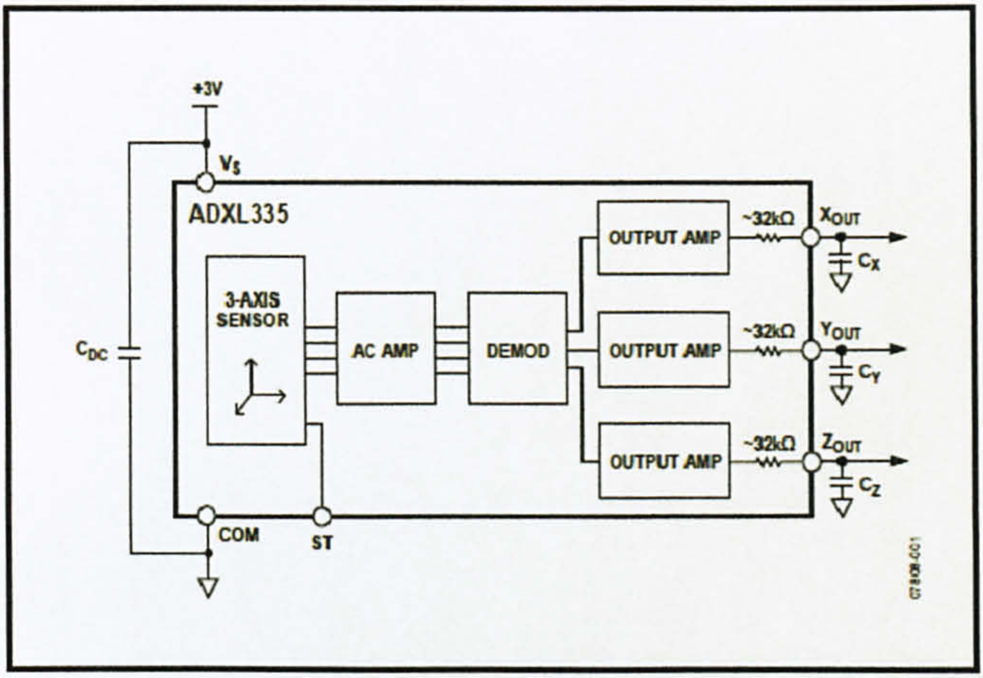

Figure 9: Functional block diagram [7]

3.2.2 Microcontroller

The microcontroller that is being used is the PIC16F877A. It has 40-pin that is sufficient enough to construct this device. Microcontroller performs the analogue to digital conversions based on the output from the accelerometer. The data are then processed and transmitted via Bluetooth to PC for the outcome. Figure 10 shows the pin diagram of the PIC16F877A [5].

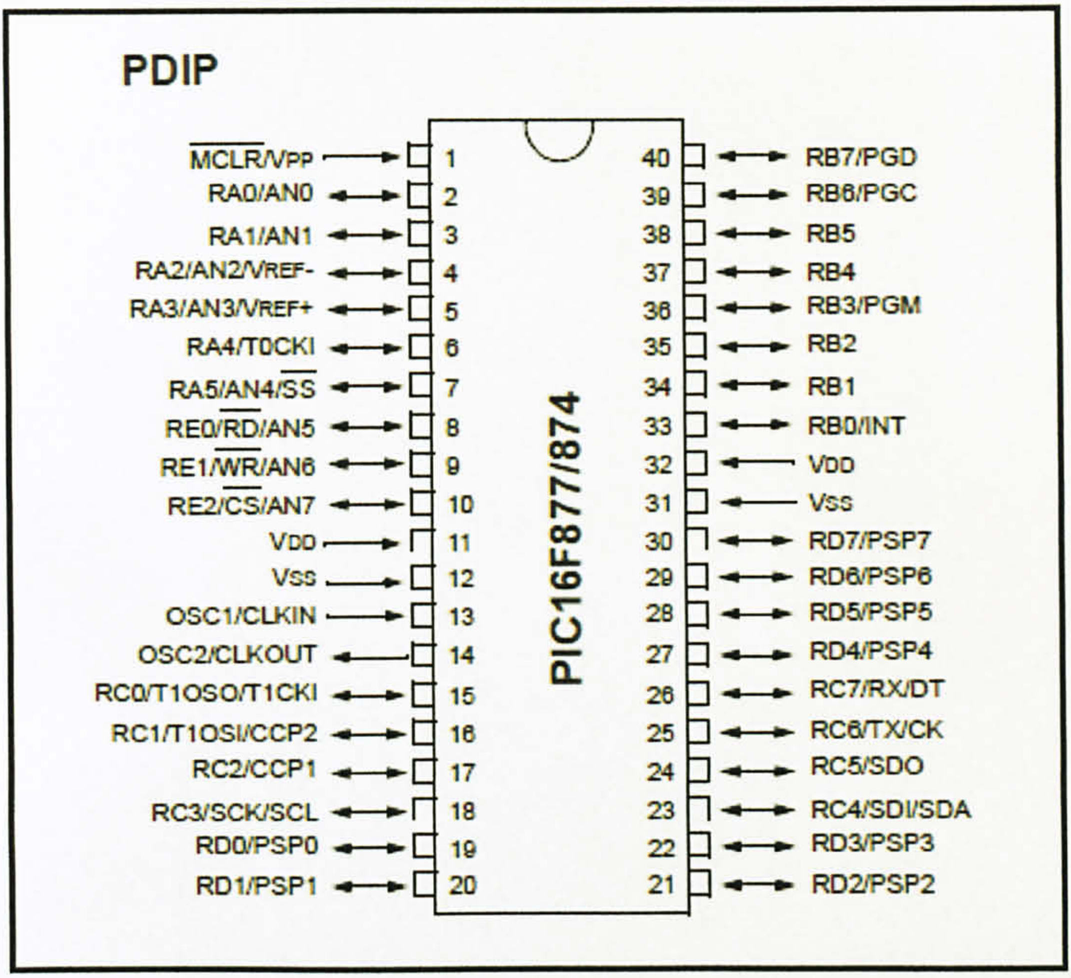

Figure 10: Pin Diagram of PIC16F877A [5]

3.2.3 PIC Starter Module

SK40C is a compact, powerful, flexible and robust start-up platform which is designed to offer an easy start for PIC microcontroller user. It is an enhanced version of 40 pins PIC microcontroller start up kit. This board comes with basic element for user to begin project development. It offer plug and use features. All interface and program are to be developed by user.

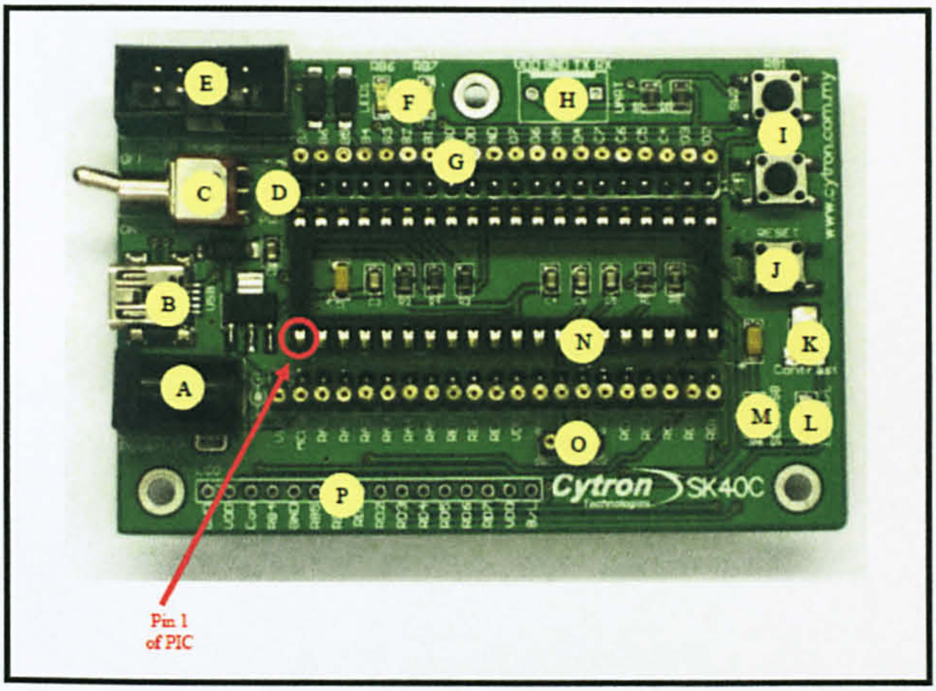

Figure 11: SK40C PIC Starter module [11]

Table 2: Label and Functions of PIC Starter Module board layout [11]

Label	Function	Label	Function
A	DC power adaptor socket	I	Programmable Push Button
B	USB Connector	J	Reset button
C	Toggle Switch for power supply	K	LCD contrast
D	Power indicator LED	L	JP8 for LCD Backlight
E	Connector for UIC00A Programmer	M	JP9 for USB
F	LED Indicator	N	40 pin IC socket for PIC MCU
G	Header pin and turn pin	O	Turn pin for crystal
H	UART Connector	P	LCD Display

3.2.4 Bluetooth Module

The KC Wirefree Bluetooth module offer simple yet compact Bluetooth platform for embedded application. KC Wirefree Bluetooth Starter Kit, SKKCA has been designed for 5V TTL logic and no extra voltage divider is necessary. Applying minimum interface, it can be connected to microcontroller for embedded Bluetooth development. Furthermore, on board USB to UART converter offer easy and reliable communication to PC. It has been designed with the KC-21(embedded Bluetooth Serial Port Protocol) mounted on it [6]. Powered by 5V.

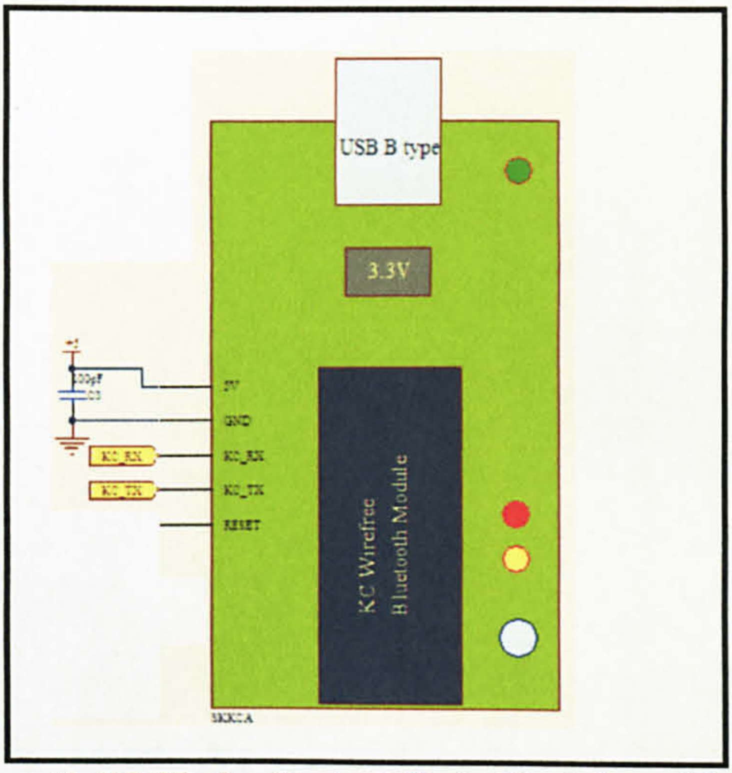

Figure 12: KC Wirefree Bluetooth Starter Kit pin layout[6]

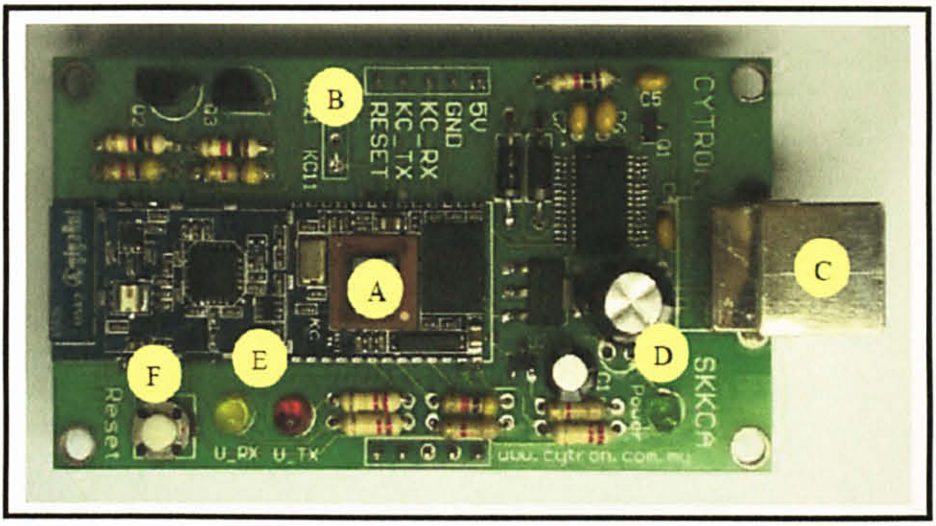

Figure 13: Bluetooth Module board layout [6]

Table 3: Label and Functions of Bluetooth Module board layout [6]

Label	Functions
A	KC Wirefree Bluetooth module
B	5 ways header pin for external power and interface to microcontroller
C	USB B type socket
D	On board 3.3V power indicator LED
E	Two LED indicator for USB's transmitter and receiver status
F	On board reset button for KC Wirefree Bluetooth module

Firmwares are used to design the schematic circuit and also programming.

3.2.5 EAGLE Cad 5.8.0

Eagle Cad is used to design the schematic circuit. It has a vast variety of components selection that makes it more preferable compared to other software. A completed schematic can then be converted into PCB (Printed Circuit Board) layout in this software. However, the PCB layout is not necessary in this project since the all the modules are mounted on the Veroboard only. Thus, the Eagle CAD is used only to design the new schematic with components.

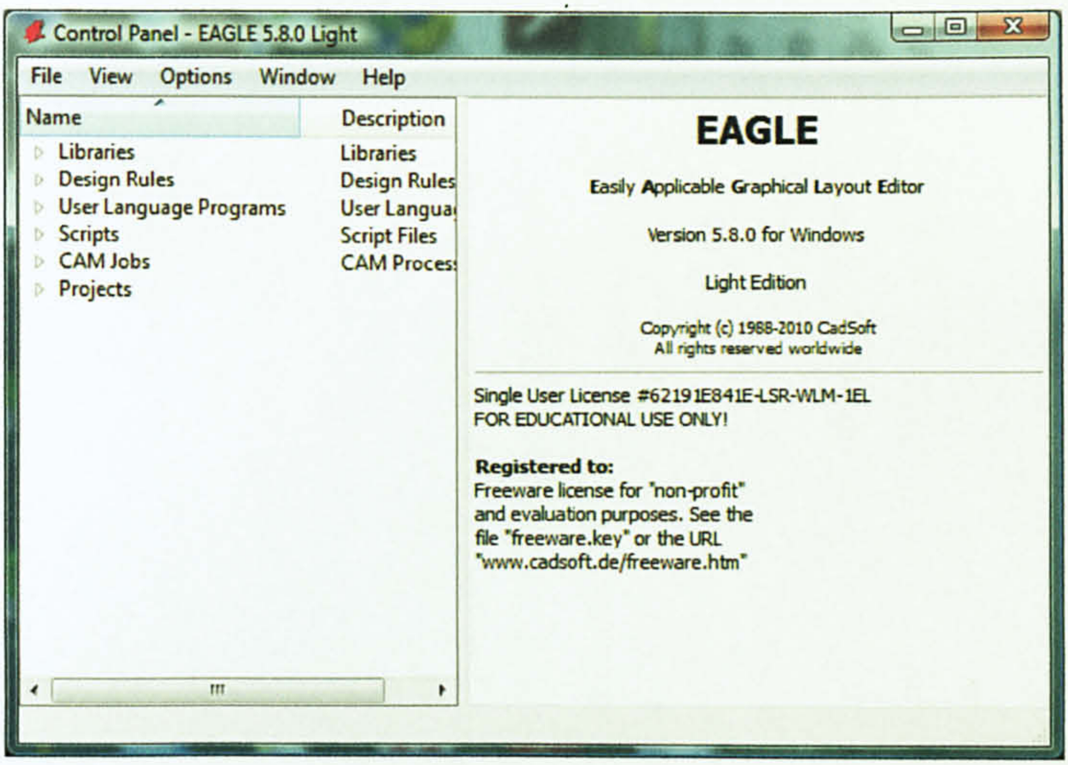

Figure 14: EAGLE Cad 5.8.0 Light

3.2.6 PIC Programming

PIC can be programmed either with an assembly language, C Language or PicBasic. For this project, Micro C Language has been decided to be more appropriate in programming microchip. This programming is done to manipulate the input received and produce the respective output that is to be sent to the computer.

Figure 15: MicroC

3.2.7 Bluetooth Software

Bluetooth software that is used for this device is the Bluesoleil. It is considered a driver for Windows XP, Windows Vista, Windows 7 and many other operating systems. It allows detection of the Bluetooth device and once the device is connected with the computer, transmitting data are done wirelessly between the device and computer.

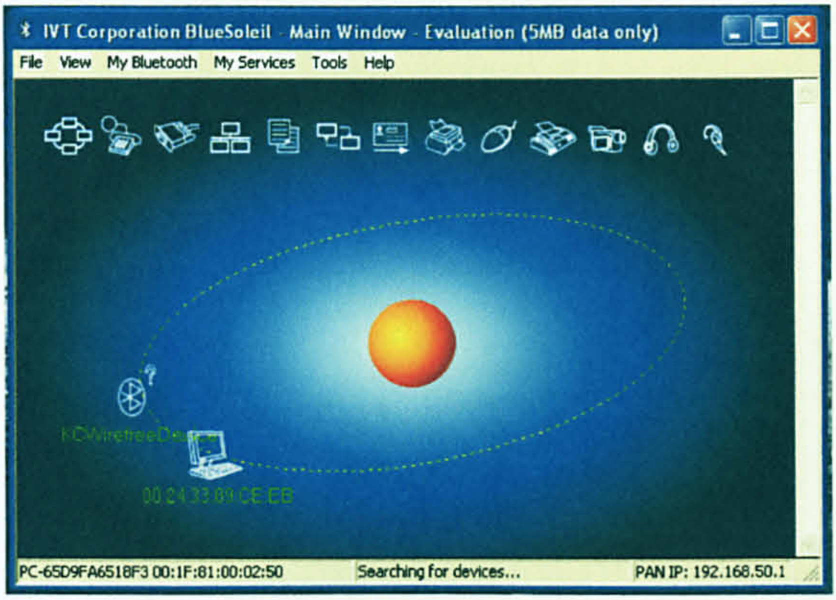

Figure 16: Bluesoleil

3.2.8 Visual Basic Programming

Visual Basic programming is done to create a simple graphical user interface (GUI) application for Windows that will allow the communication between the Bluetooth Accelerometer Mouse and the Windows API mouse. This interaction will actually perform the function of the device.

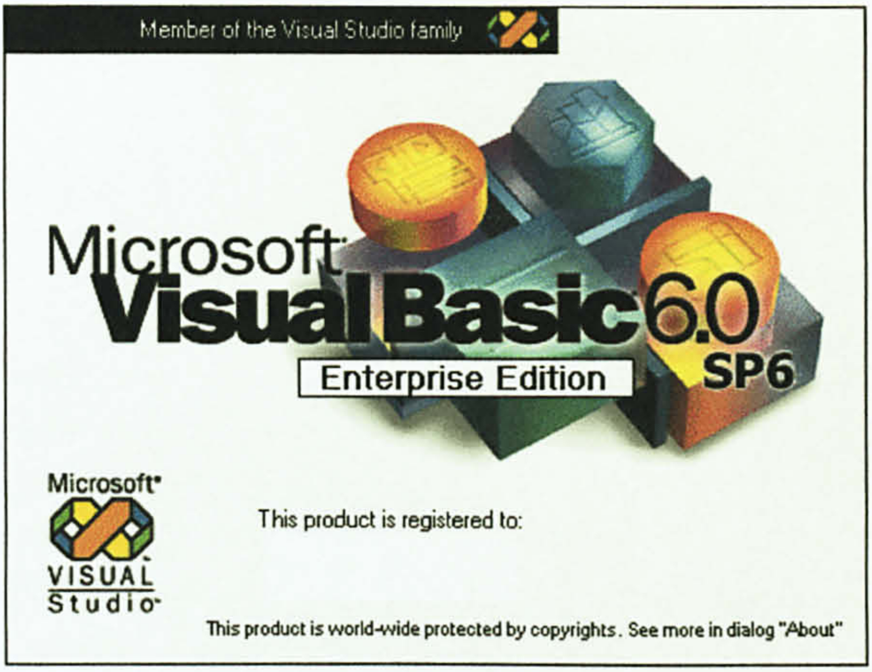

Figure 17: Microsoft Visual Basic 6.0

3.2.9 Windows API

Windows API are Microsoft's core set of application programming interfaces (API). These sets are available in the Microsoft Windows operating systems. Almost all Windows programs interact with the Windows API that includes the cursor movement and keyboard stroke. So, this windows API is integrated with the VB to execute the BAM operation.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Result

4.1.1 Design Concept

Ignoring the common design of every mouse in the market, the Bluetooth Accelerometer Mouse (BAM) is being introduced with a new and conceptual design, which is a device worn as a wristband. The objective is to design a mouse that uses accelerometer as its input and transmits the output via Bluetooth. Apart from the basic concepts, BAM should also adhere to some special features stated below and also in Table 4.

- The usage of battery to produce power source.
- Operates only under certain range of sensitivity.
- Mobile-friendly and user-friendly.

Table 4: Design features

No.	Specification	Description
1.	Design	Ergonomic
2.	Cost	Affordable
3.	Material	Non-hazardous and easy to maintain
4.	Size	Compact and portable

Figure 18 shows a sample design of BAM that has been suggested initially. It has a switch to switch on and off the device. The complete circuitry board will be embedded to a strap that will make the device looks like a wristband. But however, this design had yet to be accomplished due to the unexpected size of the circuit board that made this design impossible for the current time.

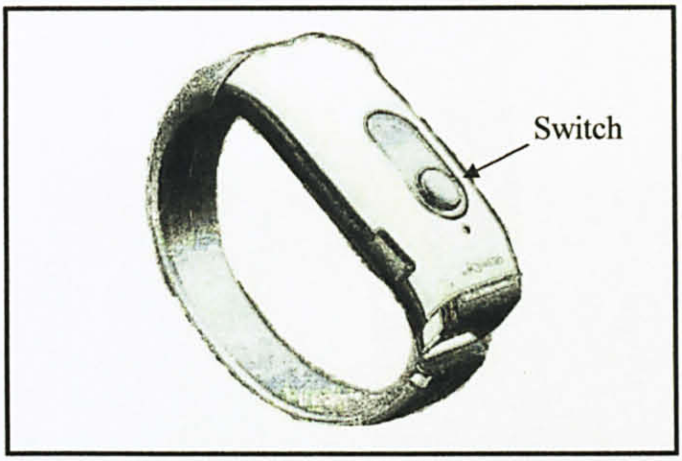

Figure 18: Sample design concept

4.1.2 Block Diagram

In general, the concept of the device is to process the input from the accelerometer and controls the computer cursor via wireless. Figure 19 is a basic block diagram of the Bluetooth Accelerometer Mouse. As per the methodology, the accelerometer supplies the input to the microcontroller, it is then processed and the output is fed to the computer via Bluetooth. Based on the block diagram, the schematic have been developed in order to construct the circuit. Meanwhile, Figure 20 is the physical diagram of the component that is being used in this device.

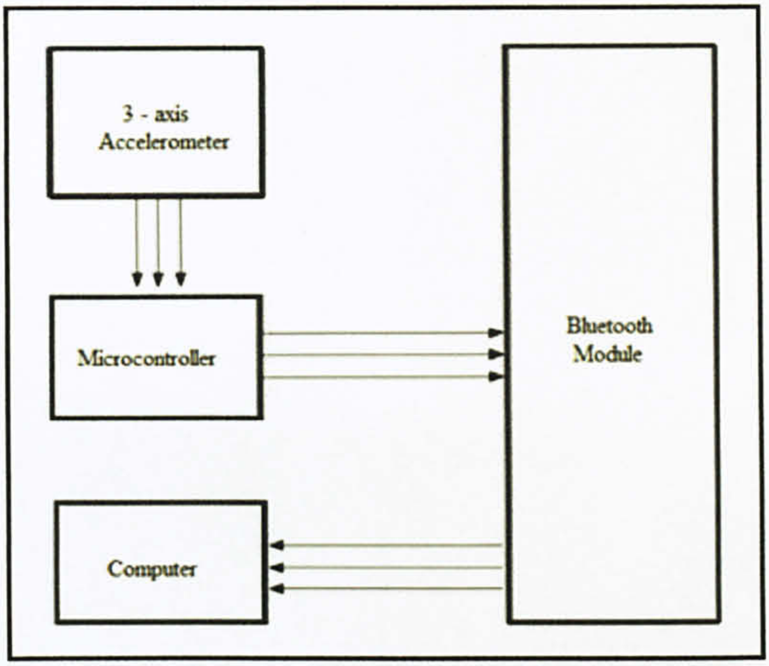

Figure 19: Block diagram of BAM

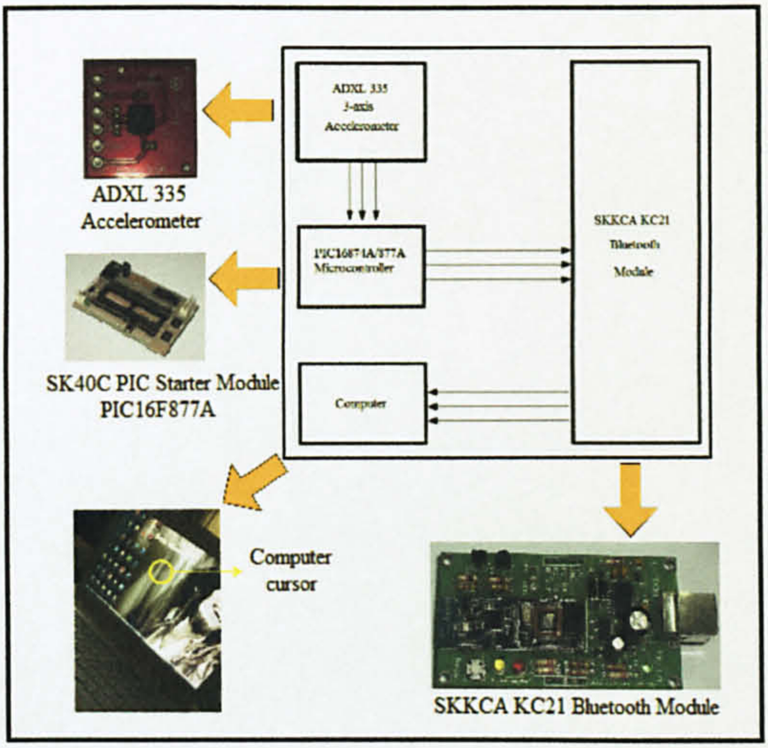

Figure 20: Block diagram with physical component of BAM

4.1.3 Schematic Diagram

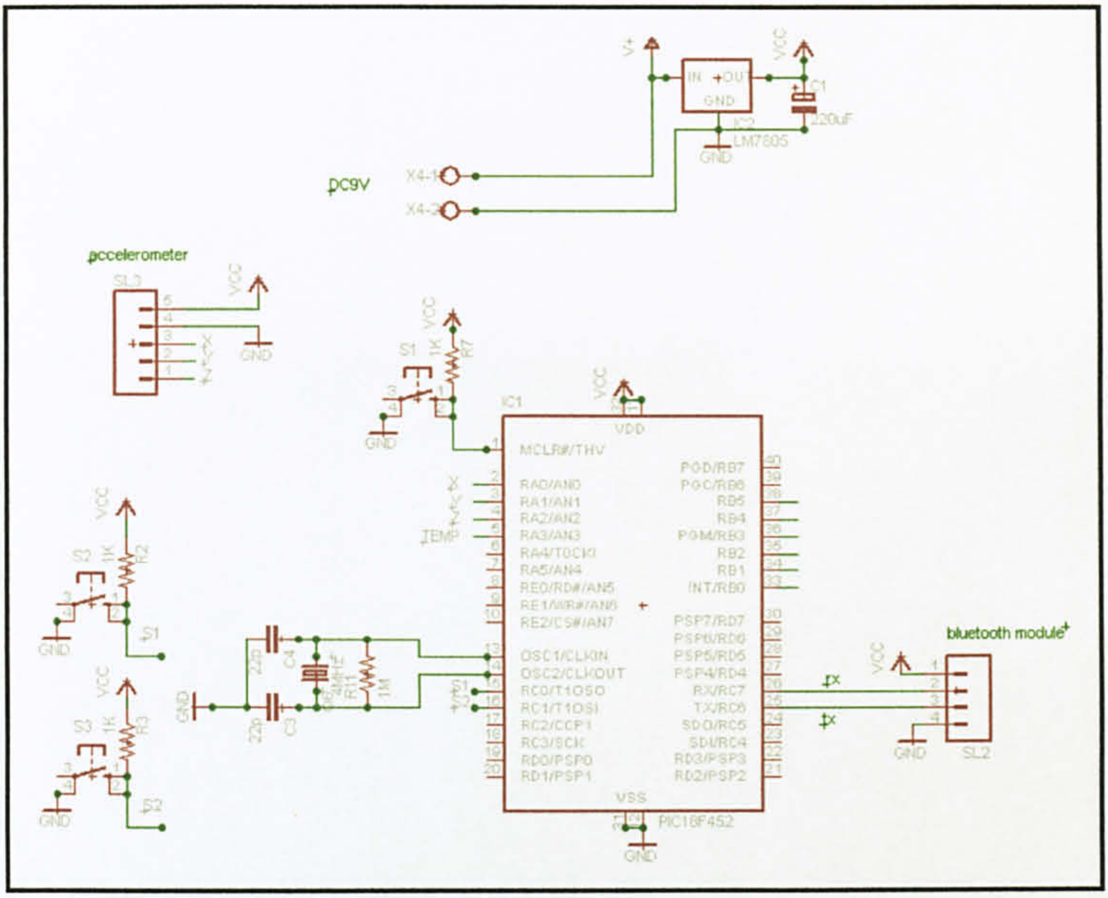

Figure 21: Schematic diagram of BAM

Figure 21 is the circuit schematic diagram of the Bluetooth Accelerometer Mouse. All modules are soldered on veroboard. As can be seen in the schematic, for both the accelerometer and Bluetooth module, only the connector pins are placed. Thus, zooming in to both the modules separately, Figure 22 is the respective schematic layout of the accelerometer and as for the Bluetooth module; Figure 12 in the previous chapter shows the pin diagram for the proper connection in the circuit.

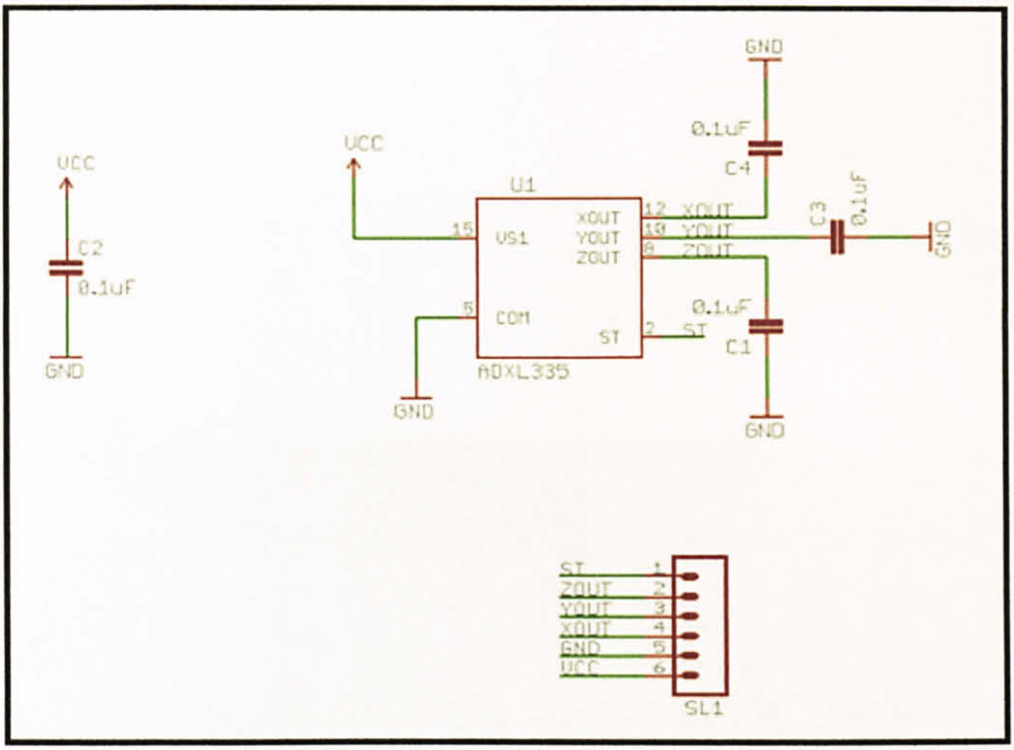

Figure 22: Schematic diagram of ADXL335

4.1.4 Device Prototype

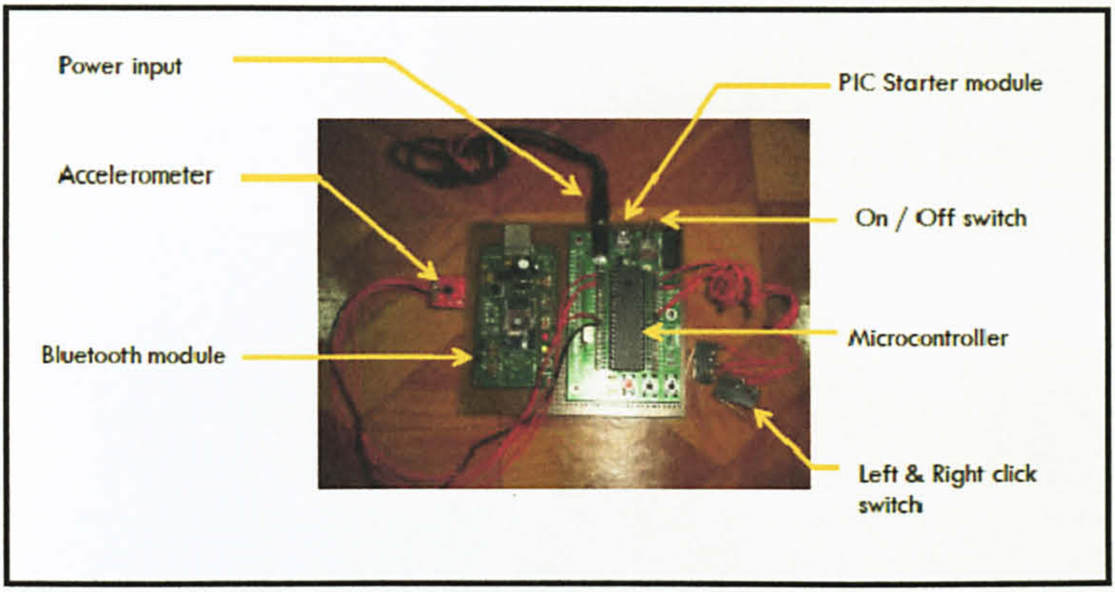

Figure 23: Device prototype of BAM

The end result of this final year project is the prototype itself. Figure 23 shows the diagram of the prototype that has been developed including the proper labels. The PIC starter module and also the Bluetooth module are mounted on the veroboard and the proper connections are made.

Fortunately, this prototype seems to function well from data collection to data transmitting which means the direction of the cursor movement based on the accelerometer input are being sent to the computer. However, the problem occurred with the incompatibility of the Bluetooth software and the operating system. In this case, the data that are received cannot be executed due to malfunction of the Bluetooth software. Few different version of operating system were tried in order to tally the Bluetooth software.

Finally, the Windows XP seems to support the Bluetooth software pretty well and made the device to operate in order.

4.1.5 Software development

There are 2 types of software developed in order to accomplish the function of this BAM. Those are:

- PIC Programming
- VB Programming

As for the PIC programming, C language has been used. The complete codes are attached in the appendices section. This programming is done to manipulate the input received and produce the respective output that is to be sent to the computer. Along with the movement outputs, LED's can also be assigned to the respective output ports to indicate the direction of movement. This is just an optional addition. The schematic with the addition of LED is attached in the appendix.

Below is a part from the PIC codes which determines the direction of the cursor.

```
if((value1>=95 && value1<=105) && (value2>=125 && value2<=135))
 Usart_write('L');
 else if((value1>=145 && value1<=155) && (value2>=125 && value2<=135))
 Usart_write('R');
 else if((value1>=125 && value1<=135) && (value2>=145 && value2<=155))
 Usart_write('F');
 else if((value1>=125 && value1<=135) && (value2>=95 && value2<=105))
 Usart_write('B');
 else if((value1>=110 && value1<=120) && (value2>=130 && value2<=140))
 Usart_write('S');
 else if((value1>=145 && value1<=155) && (value2>=130 && value2<=140))
 Usart_write('T');
 else if((value1>=100 && value1<=110) && (value2>=105 && value2<=115))
 Usart_write('U');
 else if((value1>=140 && value1<=150) && (value2>=105 && value2<=115))
 Usart_write('V');
```

Figure 24: Main Loop

The movement of the cursor depends on the range of voltage that the accelerometer is tilted. It is simplified and tabulated as in Table 5.

Table 5: Cursor direction

X – axis (V)	Y – axis (V)	Direction	Output
1.86 – 2.06	2.45 – 2.65	Left	L
2.84 – 3.03	2.45 – 2.65	Right	R
2.45 – 2.65	2.84 – 3.03	Forward	F
2.45 – 2.65	1.86 – 2.06	Backward	B
2.16 – 2.35	2.55 – 2.75	Diagonal Up Left	S
2.84 – 3.03	2.55 – 2.75	Diagonal Up Right	T
1.96 – 2.16	2.06 – 2.25	Diagonal Down Left	U
2.75 – 2.94	2.06 – 2.25	Diagonal Down Right	V

Once the device is switched on, the Bluesoleil software is used to detect the device. Figure 25 displays the main window of Bluesoleil which actually detects the BAM.

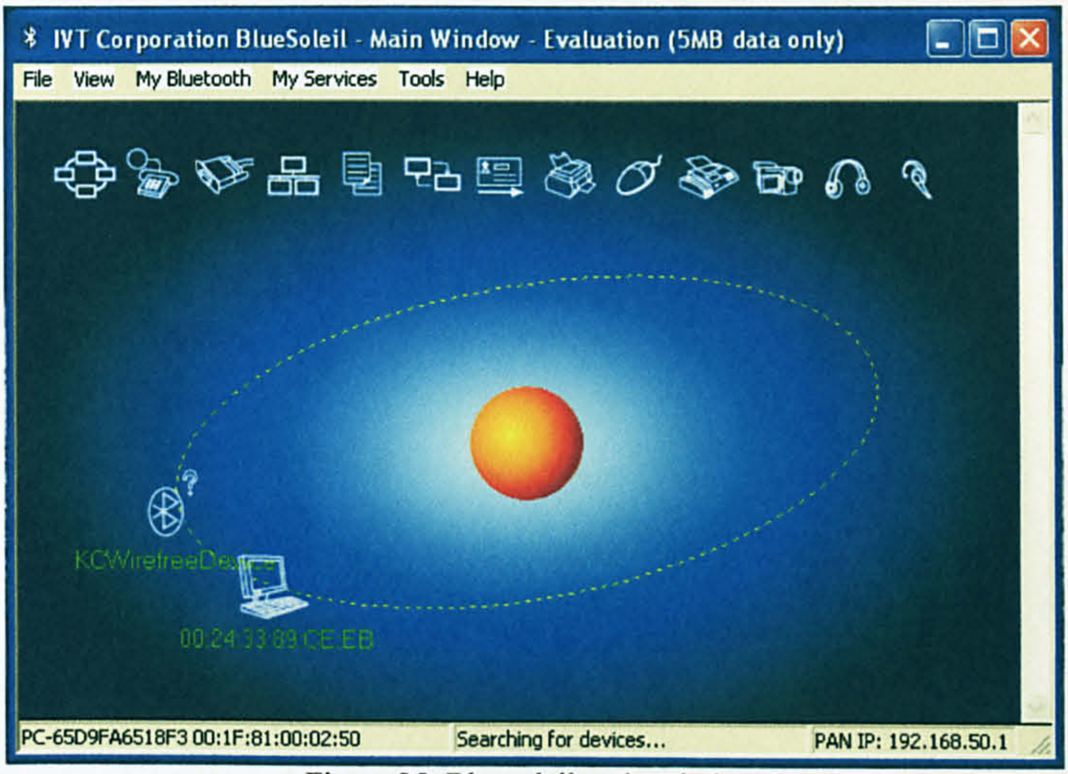

Figure 25: Bluesoleil main window

KC Wirefree is the Bluetooth module that is used in this BAM. So, it needs an active connection. The device is connected to the software and Figure 26 shows an established connection between BAM and the computer. Data can be transmitted when there is an active connection.

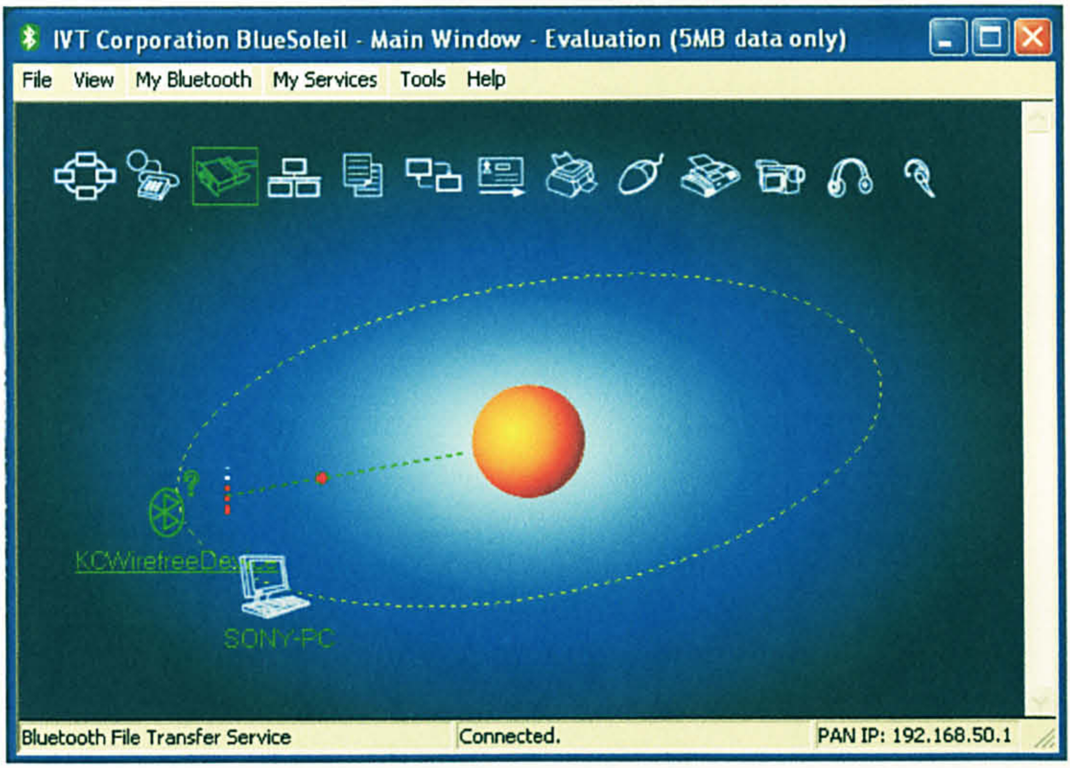

Figure 26: Active Bluetooth connection

When there is a connection, the computer will automatically indicate which COM port is in use. So for this device, COM port 13 is being used as in Figure 27.

Figure 27: COM port indicator

The communication between the device and the computer can be viewed using the Hyperterminal. Figure 28, 29, 30 and 31 shows a series of steps to be taken in order to view the output that is being received from the device.

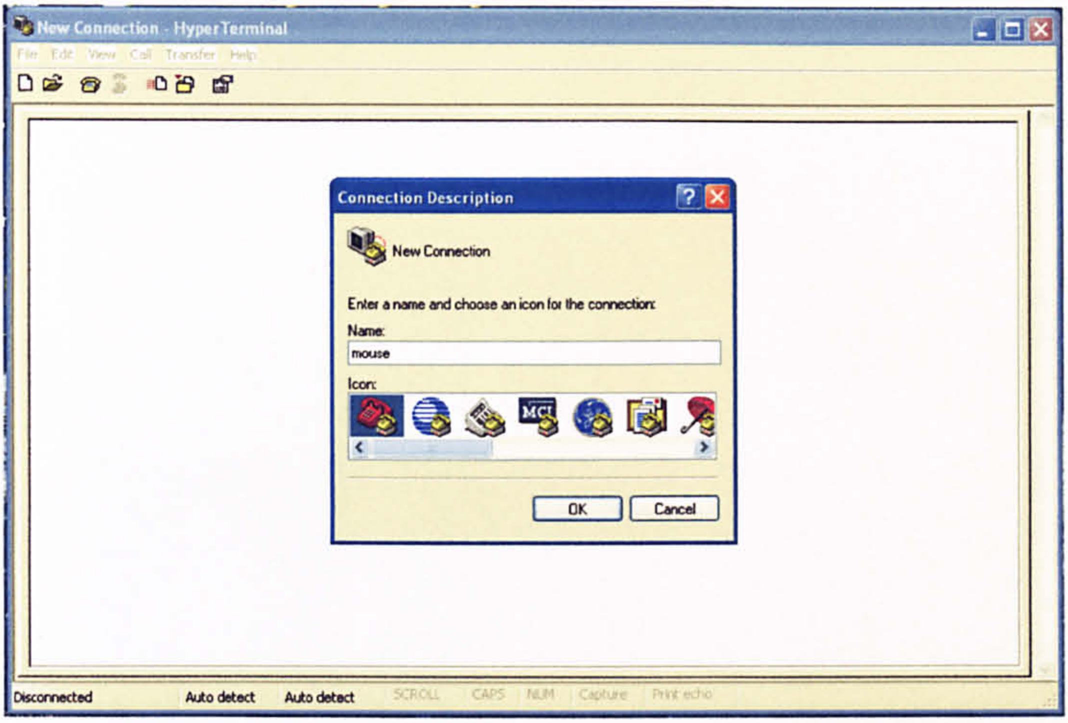

Figure 28: Hyperterminal window

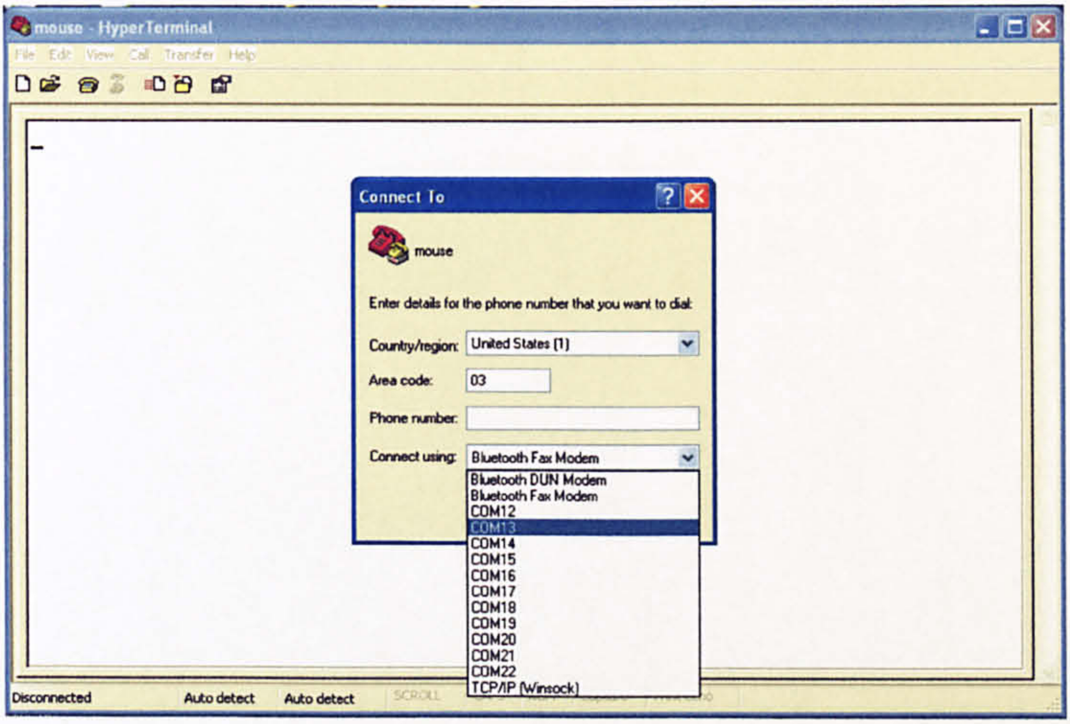

Figure 29: Connect To dialogue box

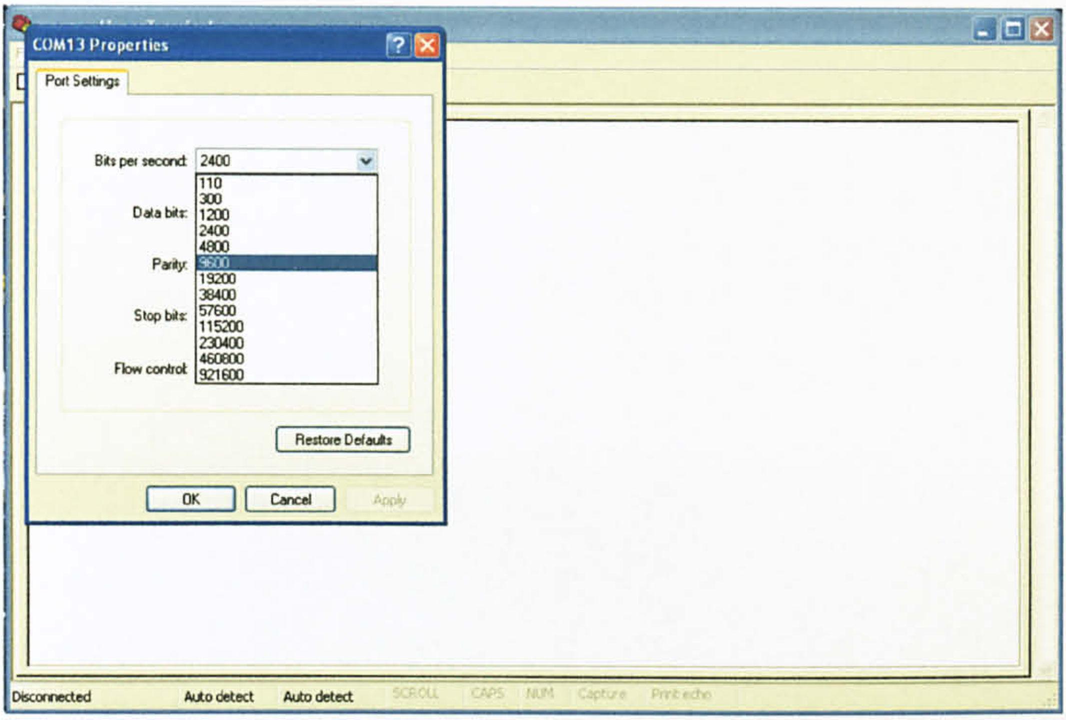

Figure 30: COM properties dialogue box

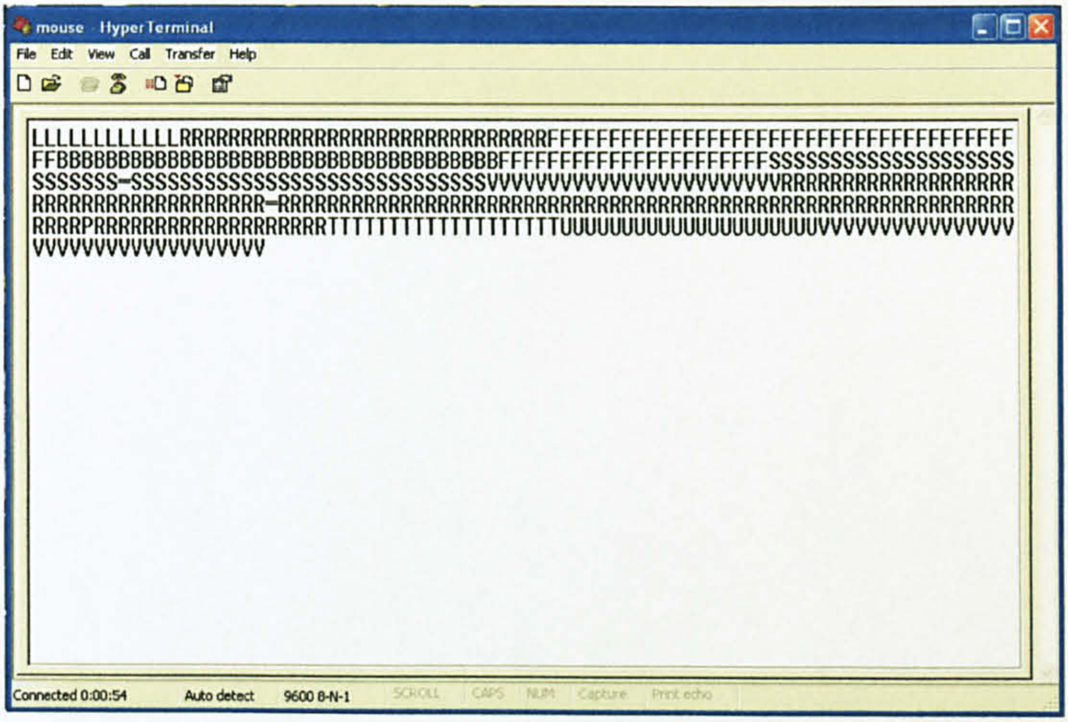

Figure 31: Output

On the other hand, VB programming is done to create a simple graphical user interface (GUI) application for Windows that will allow the communication between the output that has been received from the BAM and the Windows API mouse. This interaction will actually perform the function of the device. This GUI is actually needed to gather the data sent by the microcontroller and translate it for the integration with Windows API since this is the application responsible for the cursor controls of the system. The complete VB program codes are attached in the appendices section. Figure 32 displays the GUI that has been created. The 'Control Com' button is created to open and close the connection between the COM port and the VB application. So once the COM port is opened and connected to the VB GUI, the data received are carefully verified and executed based on the VB main loop as in Figure 33.

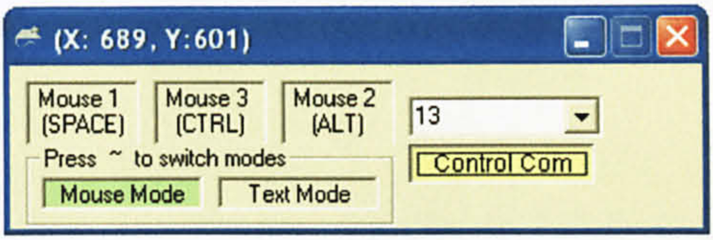

Figure 32: VB GUI

```
If MSComm1.CommEvent = comEvReceive Then        'if true incoming then save the value into s
 s = MSComm1.Input ' Get data (2 bytes)
 Debug.Print s
 'get the cursor position
 GetCursorPos Posit
 If s = "F" Then                          'check s = F?
  Call SetCursorPos(Posit.X, Posit.Y - 5)     'if true move cursor y position
 End If
  If s = "B" Then                         'check s = B?
  Call SetCursorPos(Posit.X, Posit.Y + 5)     'if true move cursor y position
 End If
  If s = "L" Then                         'check s = L?
  Call SetCursorPos(Posit.X - 10, Posit.Y)    'if true move cursor x position
 End If
  If s = "R" Then                         'check s = R?
  Call SetCursorPos(Posit.X + 10, Posit.Y)    'if true move cursor x position
 End If
  If s = "S" Then                         'check s = S?
  Call SetCursorPos(Posit.X - 10, Posit.Y - 5)   'if true move cursor x and y position
 End If
  If s = "T" Then                         'check s = T?
  Call SetCursorPos(Posit.X + 10, Posit.Y - 5)   'if true move cursor x and y position
 End If
  If s = "U" Then                         'check s = U?
  Call SetCursorPos(Posit.X - 10, Posit.Y + 5)   'if true move cursor x and y position
 End If
  If s = "V" Then                         'check s = V?
  Call SetCursorPos(Posit.X + 10, Posit.Y + 5)   'if true move cursor x and y position
 End If
```

Figure 33: VB main loop

4.2 Costing

The costs of the hardware are shown in Table 6.

Table 6: Hardware cost listing

Components	Cost
PIC16F877A	RM 21.00
SK40C PIC Starter module	RM 40.00
SKKCA KC21 Bluetooth module	RM 240.00
ADXL 335 Accelerometer	RM 150.00
9V Battery	RM 9.00
TOTAL	**RM 460.00**

4.3 Discussion

Currently, all mice that are available in the market have been studied. The structure of the circuitry board, the arrangements of the main components and its functions were all studied thoroughly. Three of those mice are:

i) Track Ball Mouse

ii) Optical Mouse

iii) Wireless Optical Mouse

This research was done to observe the operation of each mouse with its respective sensor system. The further elaboration of the research is as follows:

Each mouse has its respective mechanism. These mechanisms deliver the input to the microcontroller in order to be processed and obtain output that is to move the cursor. All mice implement an interface chip that functions as the brain to process the input. Researches on all these basic concepts are somehow useful for the upcoming trial experiments.

Elaborating more on it, Figure 34 shows the external physical form of a Track Ball Mouse and also the circuit embedded inside it. The core principle of this mouse is the mechanical movement of wheels attached along with the rubber ball. The mouse moves on the surface and the rubber ball will facilitate the movement of wheels along with it, interrupting optical beams to generate electrical signals. The mouse sends these signals to the computer system by means of connecting wires and the software in the system converts the signals into motion of the mouse cursor along X and Y axes on the screen.

Figure 35 is the picture of an Optical mouse. An optical mouse uses a light-emitting diode (LED) and photo detector to detect movement relative to the underlying surface. An optical mouse illuminates the surface beneath using a LED. Sensors gather the changes in the movement of light on the surface and then translated into movement of cursor on the two axes. These signals are sent to the computer system via Universal Serial Bus (USB). This mouse is also considered wired.

Last but not least, Figure 36 displays the picture of a wireless optical mouse. The mechanism of processing the input is just the same as it uses opto-coupler (both LED and photo detector); short optical transmission path to transfer electronic signal. The difference here with the previous mouse is that this mouse uses RF to transfer the data to the computer system. Thus, it makes this mouse a wireless one but limited to certain range.

Track Ball Mouse

Figure 34: Track Ball Mouse

Optical Mouse

Figure 35: Optical Mouse

Wireless Optical Mouse

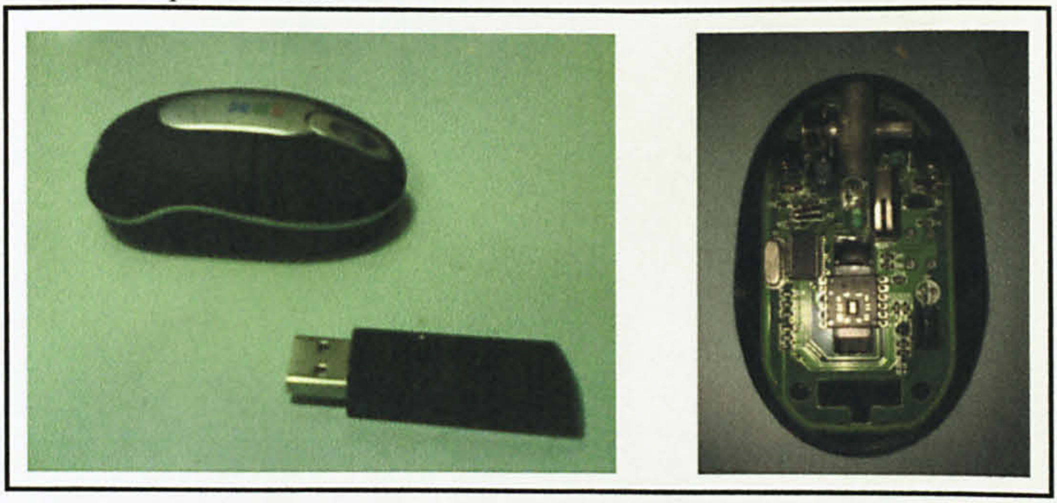

Figure 36: Wireless Optical Mouse

Table 7 lists out the comparison of these entire 3 mice. All 3 vary in the form of input processing mechanism and the data transfer interface. Based on this, an experimental attempt was taken using existing Bluetooth mouse. This was done as a trial design in which is elaborated further below.

Table 7: Comparison of mouse

No	**Type**	**Mechanism**	**Interface**
1	Track-Ball	Track ball and wheel	PS/2
2	Optical	Opto-coupler	USB
3	Wireless Optical	Opto-coupler	RF (wireless)

Trial design

Bluetooth mouse with sensor replaced with accelerometer.

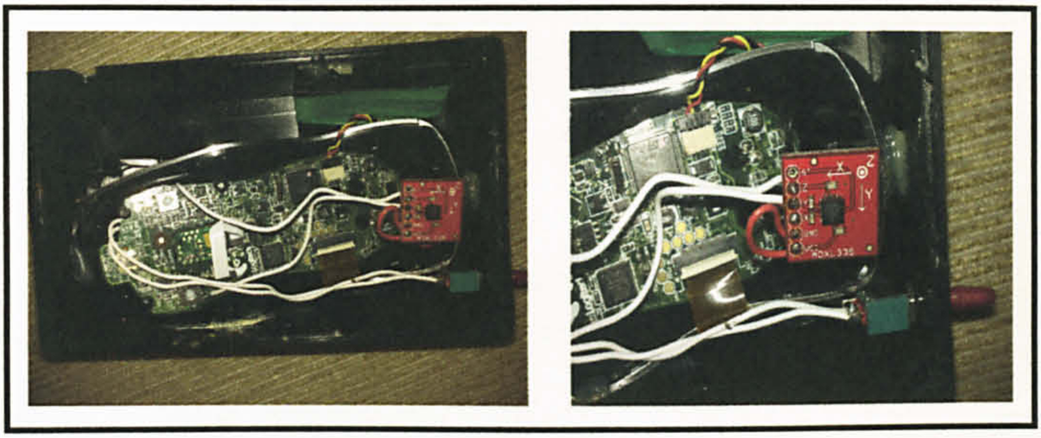

Figure 37: Bluetooth mouse replaced with accelerometer

Figure 37 above displays the trial design in which an existing Bluetooth laser mouse is used for experimental procedures. Since the laser sensor is the core input of the mouse that actually determines the movement of the cursor, it is then replaced with accelerometer whereby the inputs produced now are based on the measurement of tilt. Modifying this Bluetooth mouse was not an easy task because the circuit inside is an electro-static sensitive device, thus handling it seems to be risky. Adding on to it is the identification of the components and respective connection pins for the modification.

Fortunately, once the mouse has been modified, it still functions whereby the Bluetooth connection between the mouse and computer was positive. However, it is just the matter of controlling the cursor that actually did not produce a favorable result. The movement of the cursor was not stable. This could be due to the pre-programmed embedded microcontroller in which it cannot be controlled as per desired and also maybe due to the input properties that may differ even though both laser and accelerometer produces analog signal.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This project is an alternative in improving the current mice technology. The objective of this project was to design and build a wireless mouse that could allow the user to control the cursor by using this device in air. As per the name itself, the accelerometer is the core of this project. The accelerometer will function as the tilt sensor to obtain the inputs. The researches were carried out to study the operations of the accelerometer. Since the opto-coupler in the optical mouse does also functions as the sensor in obtaining input, thus experiments by replacing the opto-coupler with accelerometer were also carried out to study the changes in outputs and the effect on the firmware part. The studies on existing mice and its mechanism gives a better view on the mouse functions and how can it be interrupted or changed by implementing different components on the original circuit.

Fortunately, the objective of this project has been achieved. Although the Bluetooth accelerometer mouse was successfully built, there were still problem encountered during and after the mouse construction. This project was not stable and did not perform as per initial expectation, although a lot of effort has been put in developing the hardware and software.

5.2 Recommendation

As for further recommendation for this project, it would better if the circuit board can be compressed in order to make it more compact to achieve higher portability. Apart from that, implementing extra features or functions such as button clicks or scroll button solely based on the input from the accelerometer would also be a good enhancement for this project.

REFERENCE

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[2] How does a Wireless Mouse work
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www.microchip.com/downloads/en/DeviceDoc/30292c

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APPENDICES

APPENDIX A

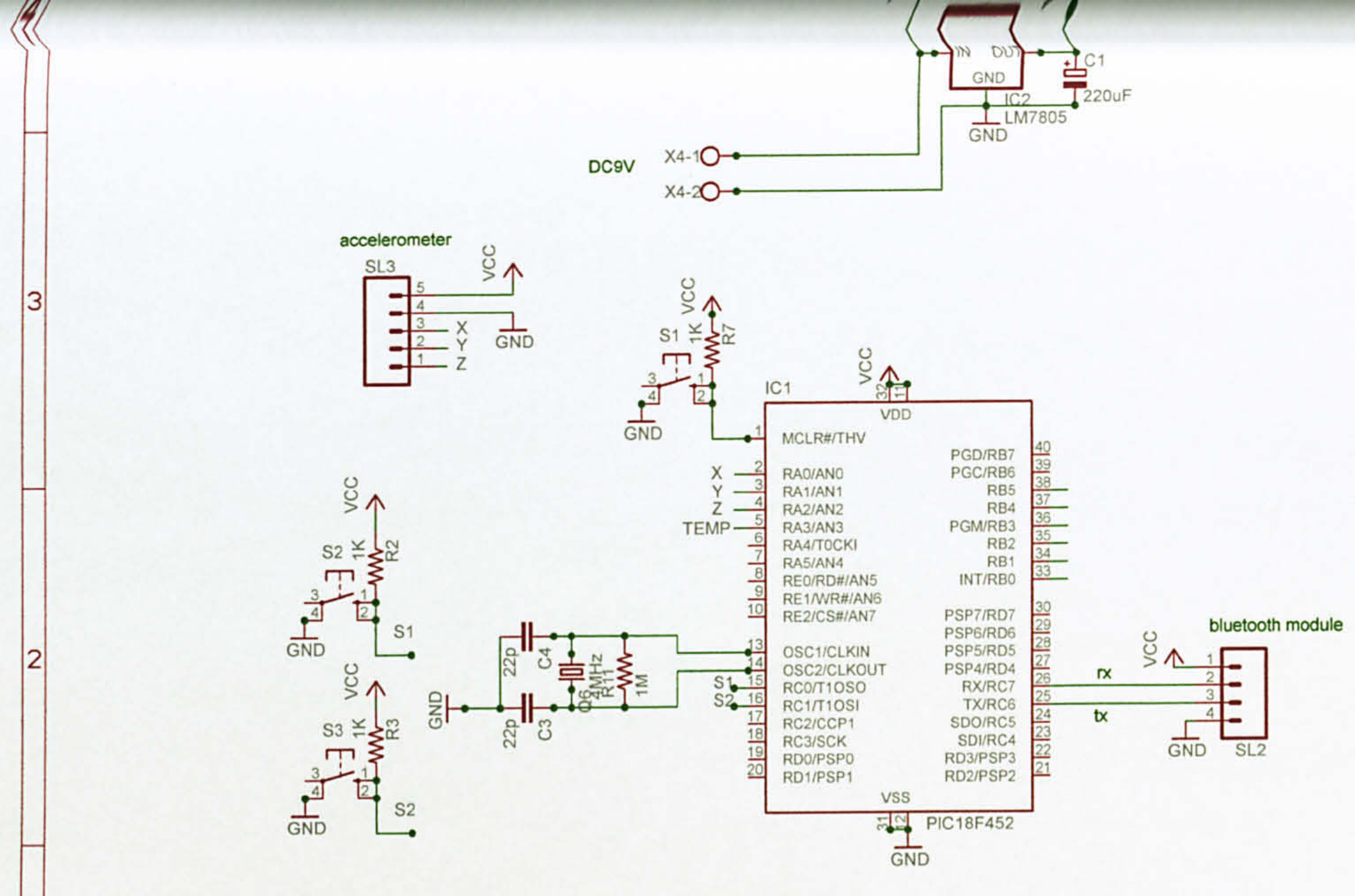
GANTT Chart

GANTT Chart

Detail/ Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**		**8**	**9**	**10**	**11**	**12**	**13**	**14**
Project Work Continue															
Submission of Progress Report 1															
Project Work Continue															
Submission of Progress Report 2															
Project work continue															
Poster Exhibition															
Submission of Dissertation (Soft bound)															
Oral Presentation	After Final Exam														
Submission of Dissertation (Hard Bound)	After Final Exam														

APPENDIX B

Schematic Diagram



bluetooth(mod)

28/4/2010 1:35:22 AM

Sheet: 1/1

APPENDIX C

PIC MicroC Coding

```
//define pin used
#define left_click PORTB.F4
#define right_click PORTB.F5

//define variables
char value1,value2,value3;

//main routine
//define io port
//porta as acclerator input x,y,z
//ra0=x,ra1=y,ra2=z;
//turn on uart to 9600 baud rate
void main(void)
{
 TRISA=0xFF;                    //data direction porta
 TRISB=0xFF;
 TRISC=0b10000000;
 OPTION_REG=0b00000000;
 INTCON=0xA0;
 PORTA=PORTC=0x00;              //clear port
 Usart_init(9600);              //baud rate

//endelss loop
 do
 {
  value1 = adc_read(0)/4;       //read 3 value & place in value1,2,3
  value2 = adc_read(1)/4;       //divide by 4 to make it from 0-255
  value3 = adc_read(2)/4;

  if((value1>=95 && value1<=105) && (value2>=125 && value2<=135))
  Usart_write('L');
  else if((value1>=145 && value1<=155) && (value2>=125 && value2<=135))
  Usart_write('R');
  else if((value1>=125 && value1<=135) && (value2>=145 && value2<=155))
  Usart_write('F');
  else if((value1>=125 && value1<=135) && (value2>=95 && value2<=105))
  Usart_write('B');

  else if((value1>=110 && value1<=120) && (value2>=130 && value2<=140))
  Usart_write('S');
  else if((value1>=145 && value1<=155) && (value2>=130 && value2<=140))
  Usart_write('T');
  else if((value1>=100 && value1<=110) && (value2>=105 && value2<=115))
  Usart_write('U');
  else if((value1>=140 && value1<=150) && (value2>=105 && value2<=115))
  Usart_write('V');

  if(!left_click)
  {
   Usart_write('X');
   Delay_ms(20);
   while(!left_click);
  }
  if(!right_click)
  {
   Usart_write('Y');
```

```
 Delay_ms(20);
 while(!right_click);
 }


 Delay_ms(10);

 }while(1);
}
```

APPENDIX D

Visual Basic Coding

```
Option Explicit
'[Type PointAPI For Mouse Position And Mouse Distance]
Private Type POINTAPI
   X As Long
   Y As Long
End Type
'[Type NotifyIconData For Tray Icon]
Private Type NOTIFYICONDATA
   cbSize As Long
   hwnd As Long
   uId As Long
   uFlags As Long
   uCallBackMessage As Long
   hIcon As Long
   szTip As String * 64
End Type
'[Tray Constants]
Const NIM_ADD = &H0 'Add to Tray
Const NIM_MODIFY = &H1 'Modify Details
Const NIM_DELETE = &H2 'Remove From Tray
Const NIF_MESSAGE = &H1 'Message
Const NIF_ICON = &H2 'Icon
Const NIF_TIP = &H4 'TooTipText
Const WM_MOUSEMOVE = &H200 'On Mousemove
Const WM_LBUTTONDBLCLK = &H203 'Left Double Click
Const WM_RBUTTONDOWN = &H204 'Right Button Down
Const WM_RBUTTONUP = &H205 'Right Button Up
Const WM_RBUTTONDBLCLK = &H206 'Right Double Click
'[Mouse Constants]
Const MOUSEEVENTF_LEFTDOWN = &H2 'Mouse 1 Down
Const MOUSEEVENTF_LEFTUP = &H4 'Mouse 1 Up
Const MOUSEEVENTF_RIGHTDOWN = &H8 'Mouse 2 Down
Const MOUSEEVENTF_RIGHTUP = &H10 'Mouse 2 Up
Const MOUSEEVENTF_MIDDLEDOWN = &H20 'Mouse Wheel Down
Const MOUSEEVENTF_MIDDLEUP = &H40 'Mouse Wheel Up
Const MOUSEEVENTF_MOVE = &H1 'Move
'[API]
Private Declare Function Shell_NotifyIcon Lib "shell32" Alias "Shell_NotifyIconA" (ByVal
dwMessage As Long, pnid As NOTIFYICONDATA) As Boolean
Private Declare Function SetCursorPos Lib "user32" (ByVal X As Long, ByVal Y As Long) As
Long
Private Declare Function GetCursorPos Lib "user32" (lpPoint As POINTAPI) As Long
Private Declare Sub mouse_event Lib "user32" (ByVal dwFlags As Long, ByVal dx As Long,
ByVal dy As Long, ByVal cButtons As Long, ByVal dwExtraInfo As Long)
Private Declare Function GetAsyncKeyState Lib "user32" (ByVal vKey As Long) As Integer
```

```
Private Sub Check1_Click()

On Error GoTo Errhandler

If Check1.Value = 1 Then
MSComm1.RThreshold = 1

' When Inputting Data, Input 2 Bytes at a time
MSComm1.InputLen = 1

' 9600 Baud, No Parity, 8 Data Bits, 1 Stop Bit
MSComm1.Settings = "9600,N,8,1"
' Disable DTR
MSComm1.DTREnable = False

' Open COM1
MSComm1.CommPort = Combo1.Text
MSComm1.PortOpen = True
End If

If Check1.Value = 0 Then
MSComm1.PortOpen = False
End If

Exit Sub

Errhandler:
   MsgBox "[" & Err.Number & "] " & Err.Description, vbExclamation, "Error"

End Sub
```

```
'get incoming comvalue
Private Sub MSComm1_OnComm()
Dim s As String
Dim s1 As String
Dim A2 As String
Dim Posit As POINTAPI
Dim cButt As Long
Dim dwEI As Long

If MSComm1.CommEvent = comEvReceive Then        'if true incoming then save the value into
s
  s = MSComm1.Input ' Get data (2 bytes)
  Debug.Print s
  'get the cursor position
  GetCursorPos Posit
  If s = "F" Then                              'check s = F?
   Call SetCursorPos(Posit.X, Posit.Y - 5)      'if true move cursor y position
  End If

  If s = "B" Then                              'check s = B?
   Call SetCursorPos(Posit.X, Posit.Y + 5)      'if true move cursor y position
  End If

  If s = "L" Then                              'check s = L?
   Call SetCursorPos(Posit.X - 10, Posit.Y)     'if true move cursor x position
  End If

  If s = "R" Then                              'check s = R?
   Call SetCursorPos(Posit.X + 10, Posit.Y)     'if true move cursor x position
  End If

  If s = "S" Then                              'check s = S?
   Call SetCursorPos(Posit.X - 10, Posit.Y - 5)   'if true move cursor x and y position
  End If

  If s = "T" Then                              'check s = T?
   Call SetCursorPos(Posit.X + 10, Posit.Y - 5)   'if true move cursor x and y position
  End If

  If s = "U" Then                              'check s = U?
   Call SetCursorPos(Posit.X - 10, Posit.Y + 5)   'if true move cursor x and y position
  End If

  If s = "V" Then                              'check s = V?
   Call SetCursorPos(Posit.X + 10, Posit.Y + 5)   'if true move cursor x and y position
  End If

  If s = "X" Then
 'left click
 'mouse event left mouse down
   mouse_event MOUSEEVENTF_LEFTDOWN, 0&, 0&, cButt, dwEI
 'mouse event left mouse up
   mouse_event MOUSEEVENTF_LEFTUP, 0&, 0&, cButt, dwEI
   End If

  If s = "Y" Then
```

```
'right click
'mouse event right mouse down
 mouse_event MOUSEEVENTF_RIGHTDOWN, 0&, 0&, cButt, dwEI
'mouse event right mouse up
 mouse_event MOUSEEVENTF_RIGHTUP, 0&, 0&, cButt, dwEI
 End If

 ' MsgBox s
End If
End Sub
```

APPENDIX E

ADXL 335 Data Sheet

Small, Low Power, 3-Axis ±3 *g* Accelerometer

ADXL335

FEATURES

3-axis sensing
Small, low profile package
4 mm × 4 mm × 1.45 mm LFCSP
Low power : 350 μA (typical)
Single-supply operation: 1.8 V to 3.6 V
10,000 *g* shock survival
Excellent temperature stability
BW adjustment with a single capacitor per axis
RoHS/WEEE lead-free compliant

APPLICATIONS

Cost sensitive, low power, motion- and tilt-sensing applications
- **Mobile devices**
- **Gaming systems**
- **Disk drive protection**
- **Image stabilization**
- **Sports and health devices**

GENERAL DESCRIPTION

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 *g*. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

The user selects the bandwidth of the accelerometer using the C_X, C_Y, and C_Z capacitors at the X_{OUT}, Y_{OUT}, and Z_{OUT} pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

FUNCTIONAL BLOCK DIAGRAM

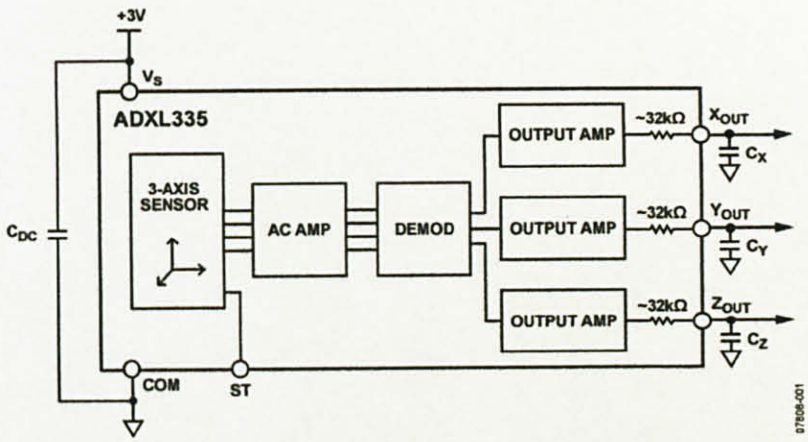


Figure 1.

One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781.329.4700 www.analog.com
Fax: 781.461.3113

TABLE OF CONTENTS

REVISION HISTORY

1/09—Revision 0: Initial Version

SPECIFICATIONS

$T_A = 25°C$, $V_S = 3$ V, $C_X = C_Y = C_Z = 0.1$ μF, acceleration = 0 *g*, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

Table 1.

Parameter	Conditions	Min	Typ	Max	Unit
SENSOR INPUT	Each axis				
Measurement Range		±3	±3.6		*g*
Nonlinearity	% of full scale		±0.3		%
Package Alignment Error			±1		Degrees
Interaxis Alignment Error			±0.1		Degrees
Cross-Axis Sensitivity[1]			±1		%
SENSITIVITY (RATIOMETRIC)[2]	Each axis				
Sensitivity at X_{OUT}, Y_{OUT}, Z_{OUT}	$V_S = 3$ V	270	300	330	mV/*g*
Sensitivity Change Due to Temperature[3]	$V_S = 3$ V		±0.01		%/°C
ZERO *g* BIAS LEVEL (RATIOMETRIC)					
0 *g* Voltage at X_{OUT}, Y_{OUT}	$V_S = 3$ V	1.35	1.5	1.65	V
0 *g* Voltage at Z_{OUT}	$V_S = 3$ V	1.2	1.5	1.8	V
0 *g* Offset vs. Temperature			±1		m*g*/°C
NOISE PERFORMANCE					
Noise Density X_{OUT}, Y_{OUT}			150		μ*g*/√Hz rms
Noise Density Z_{OUT}			300		μ*g*/√Hz rms
FREQUENCY RESPONSE[4]					
Bandwidth X_{OUT}, Y_{OUT}[5]	No external filter		1600		Hz
Bandwidth Z_{OUT}[5]	No external filter		550		Hz
R_{FILT} Tolerance			32 ± 15%		kΩ
Sensor Resonant Frequency			5.5		kHz
SELF-TEST[6]					
Logic Input Low			+0.6		V
Logic Input High			+2.4		V
ST Actuation Current			+60		μA
Output Change at X_{OUT}	Self-Test 0 to Self-Test 1	−150	−325	−600	mV
Output Change at Y_{OUT}	Self-Test 0 to Self-Test 1	+150	+325	+600	mV
Output Change at Z_{OUT}	Self-Test 0 to Self-Test 1	+150	+550	+1000	mV
OUTPUT AMPLIFIER					
Output Swing Low	No load		0.1		V
Output Swing High	No load		2.8		V
POWER SUPPLY					
Operating Voltage Range		1.8		3.6	V
Supply Current	$V_S = 3$ V		350		μA
Turn-On Time[7]	No external filter		1		ms
TEMPERATURE					
Operating Temperature Range		−40		+85	°C

[1] Defined as coupling between any two axes.
[2] Sensitivity is essentially ratiometric to V_S.
[3] Defined as the output change from ambient-to-maximum temperature or ambient-to-minimum temperature.
[4] Actual frequency response controlled by user-supplied external filter capacitors (C_X, C_Y, C_Z).
[5] Bandwidth with external capacitors = $1/(2 \times \pi \times 32\ k\Omega \times C)$. For C_X, C_Y = 0.003 μF, bandwidth = 1.6 kHz. For C_Z = 0.01 μF, bandwidth = 500 Hz. For C_X, C_Y, C_Z = 10 μF, bandwidth = 0.5 Hz.
[6] Self-test response changes cubically with V_S.
[7] Turn-on time is dependent on C_X, C_Y, C_Z and is approximately $160 \times C_X$ or C_Y or C_Z + 1 ms, where C_X, C_Y, C_Z are in microfarads (μF).

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Acceleration (Any Axis, Unpowered)	10,000 *g*
Acceleration (Any Axis, Powered)	10,000 *g*
V_S	−0.3 V to +3.6 V
All Other Pins	(COM − 0.3 V) to (V_S + 0.3 V)
Output Short-Circuit Duration (Any Pin to Common)	Indefinite
Temperature Range (Powered)	−55°C to +125°C
Temperature Range (Storage)	−65°C to +150°C

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

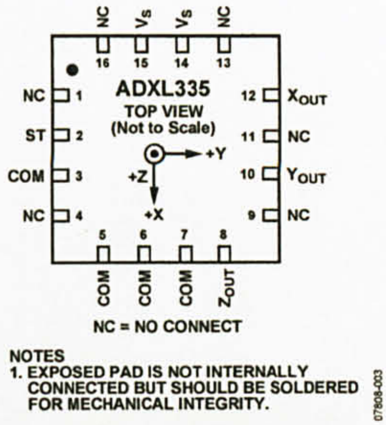


Figure 2. Pin Configuration

Table 3. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	NC	No Connect[1].
2	ST	Self-Test.
3	COM	Common.
4	NC	No Connect[1].
5	COM	Common.
6	COM	Common.
7	COM	Common.
8	Z_{OUT}	Z Channel Output.
9	NC	No Connect[1].
10	Y_{OUT}	Y Channel Output.
11	NC	No Connect[1].
12	X_{OUT}	X Channel Output.
13	NC	No Connect[1].
14	V_S	Supply Voltage (1.8 V to 3.6 V).
15	V_S	Supply Voltage (1.8 V to 3.6 V).
16	NC	No Connect[1].
EP	Exposed Pad	Not internally connected. Solder for mechanical integrity.

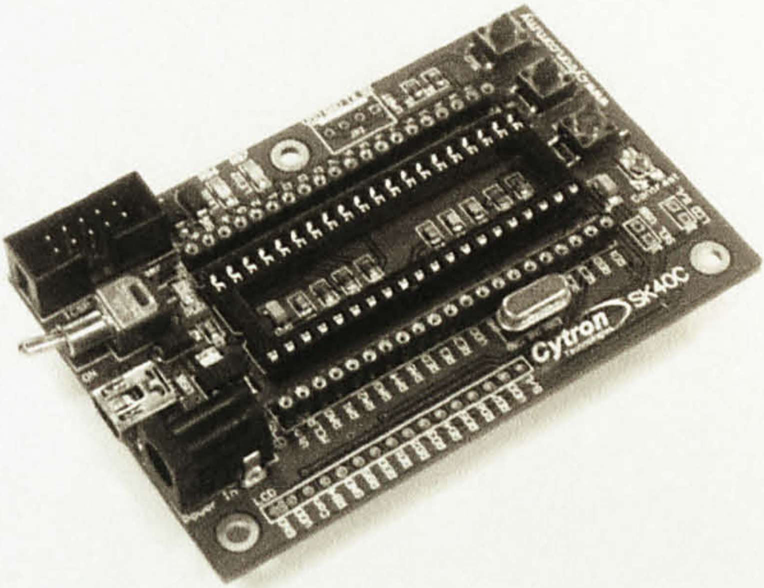
[1]NC pins are not internally connected and can be tied to COM pins, unless otherwise noted.

APPENDIX F

SK40C User Manual

SK40C

ENHANCED 40 PINS PIC START-UP KIT



User's Manual

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March 2010

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1. INTRODUCTION AND OVERVIEW

SK40C is another enhanced version of 40 pins PIC microcontroller start up kit. It is designed to offer an easy to start board for PIC MCU user. However, all interface and program should be developed by user. This board comes with basic element for user to begin project development. It offer plug and use features. This kit is designed to offer:

- Industrial grade PCB
- Every board is being fully tested before shipped to customer
- Compact, powerful, flexible and robust start-up platform
- Suitable for hobbyists and experts
- Save development and soldering time
- No extra components required for the PIC to function
- **All 33 I/O pins** are nicely labeled to avoid miss-connection by users
- **Connector for UIC00A** (low cost USB ICSP PIC Programmer) - simple and fast method to load program
- Fully compatible with SK40B
- No more frustrated work plugging PIC out and back for re-programming
- Perfectly fit for 40 pins **16F and PIC18F PIC**
- With UIC00A, program can be loaded in less than 5 seconds
- More convenient to use and it is smaller than SK40B.
- Maximum current is 1A.
- **Dimension:** 85mm x 55mm

SK40C come with additional features:

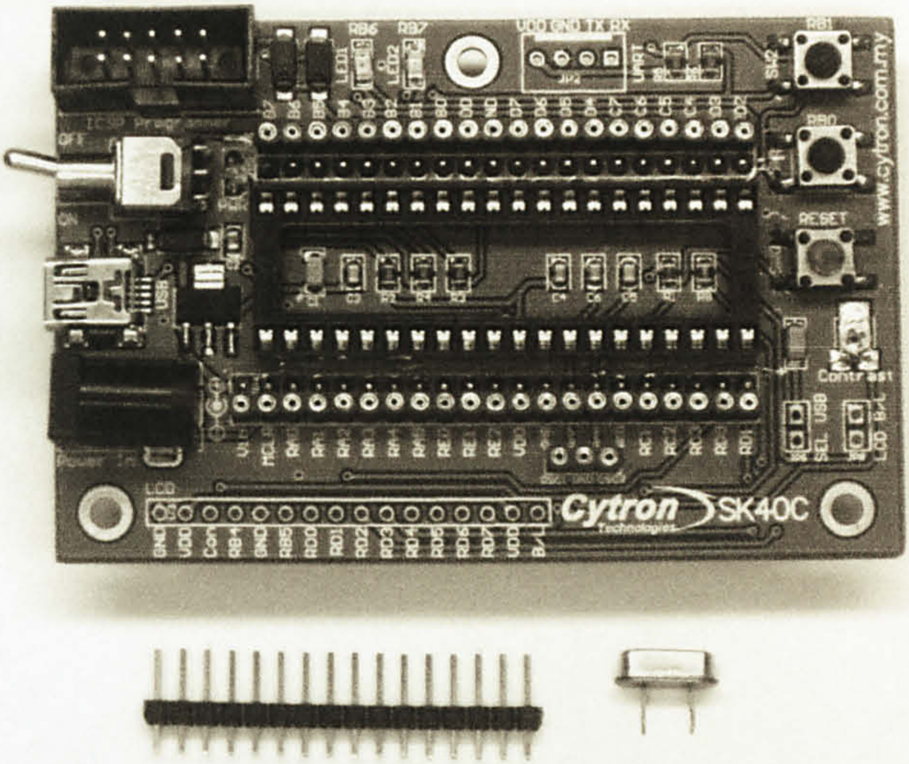
- 2 x Programmable switch
- 2 x LED indicator
- Turn pin for crystal. User may use others crystal provided.
- LCD display (optional)
- UART communication
- USB on board.
- And all the necessities to eliminate users difficulty in using PIC

Users are able to utilize the function of PIC by directly plugging in the I/O components in whatever way that is convenient to user. With UIC00A connector on board, user can start developing projects and have fun with this kit right away. This kit comes **WITHOUT** PIC microcontroller to provide the freedom for user to choose PIC type.

This document explains the method to use SK40C.

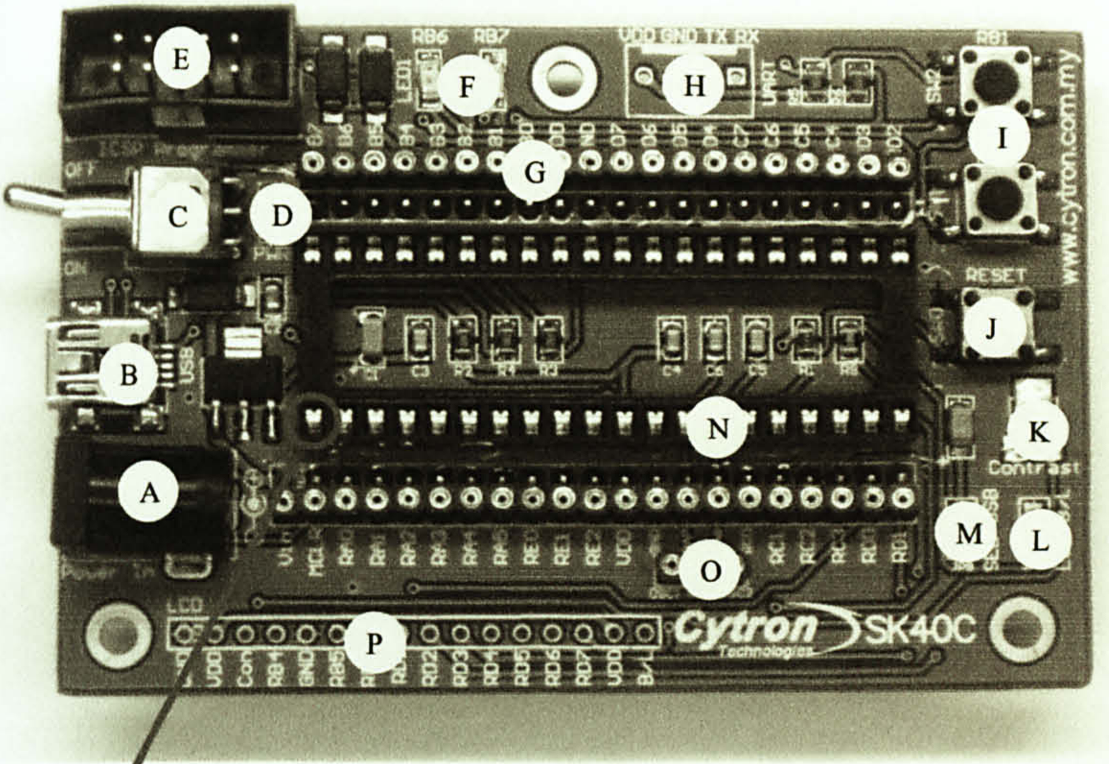
2. PACKING LIST

Please check the parts and components according to the packing list. If there are any parts missing, please contact us at sales@cytron.com.my immediately.



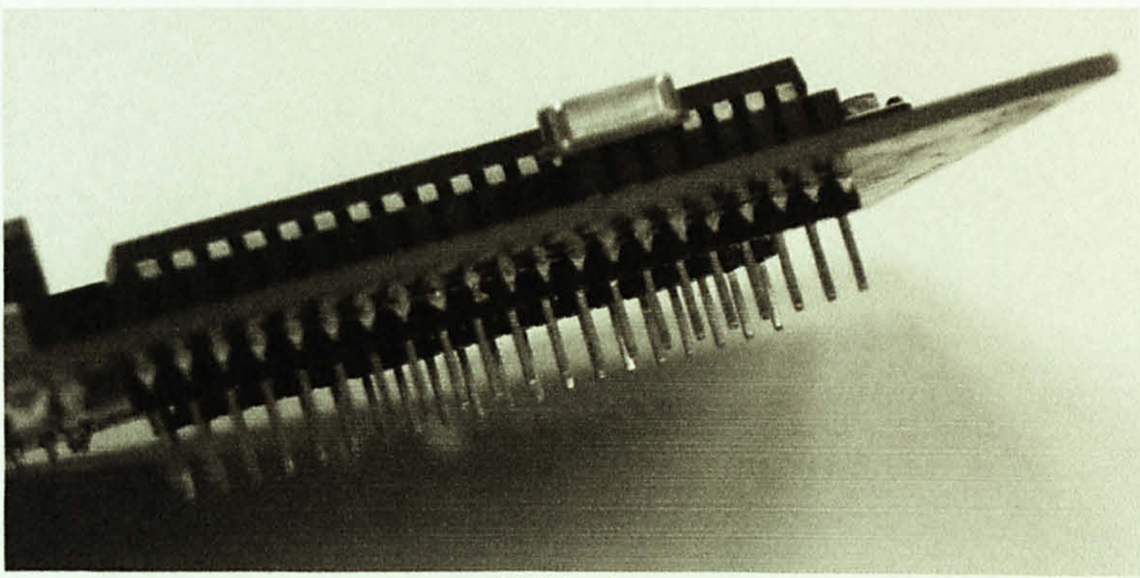
1. 1 x SK40C board with all components shown soldered
2. 1 x 16 Header pin for LCD Display.
3. 1 x 20M Hz Crystal
4. PIC MCU – Not included, please purchase separately from Cytron website
5. USB Cable – Not included, please purchase separately from Cytron website
6. UIC00A – Not included, please purchase separately from Cytron website
7. User Manual – Not included, please download from Cytron website

3. BOARD LAYOUT

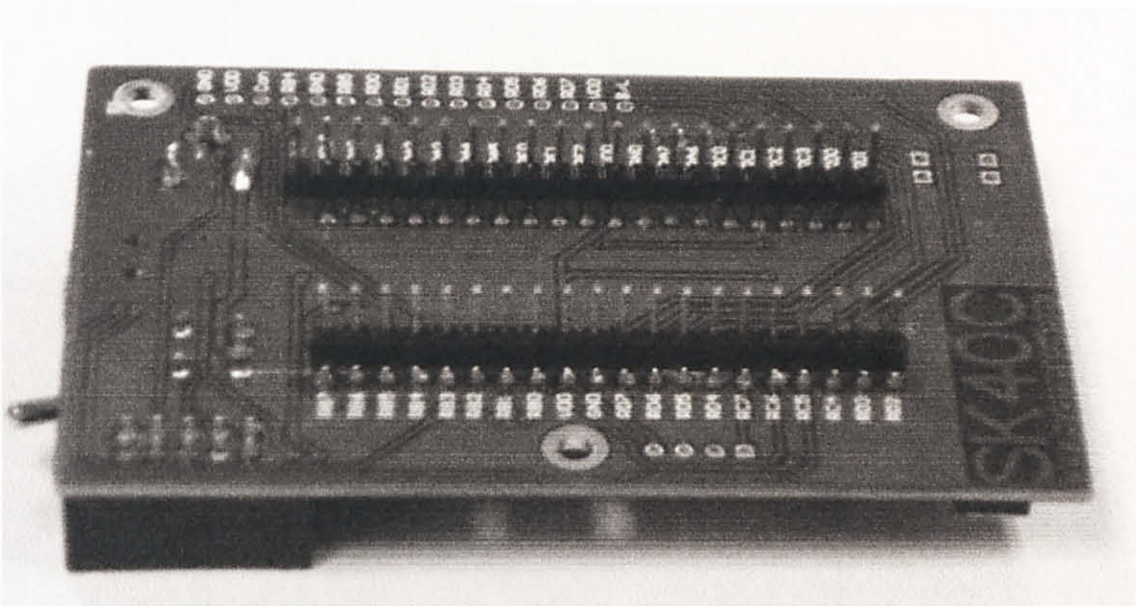


Pin 1
of PIC

a) Top View



b) Side view



c) Bottom view

Label	Function	Label	Function
A	DC power adaptor socket	I	Programmable Push Button
B	USB Connector	J	Reset button
C	Toggle Switch for power supply	K	LCD contrast
D	Power indicator LED	L	JP8 for LCD Backlight
E	Connector for UIC00A Programmer	M	JP9 for USB
F	LED Indicator	N	40 pin IC socket for PIC MCU
G	Header pin and turn pin	O	Turn pin for crystal
H	UART Connector	P	LCD Display

A – DC power adaptor socket for user to plug in DC adaptor. The input voltage should be ranged from 7 to 15V.

B – USB connector for communication between devices and a host controller (usually personal computers). This function is only valid for certain model of PIC microcontroller. Please refer to USB interface section. The power LED will light ON when the USB cable is connected.

C – Toggle switch to On/Off the power supply from DC adaptor.

D – Power indicator LED for on board. It will light ON as long as the input power is correctly connected.

E – 2x5 box header for UIC00A, USB ICSP PIC Programmer.

F – 2 LEDs (connected to RB6 and RB7) as active High output for PIC MCU. These LEDs are controllable from PIC MCU.

G – Consist of several line of header pin and turn pin. Header pin provide connector for user to solder SK40C to prototype board and use the I/O of PIC MCU. It is fully compatible between SK40B. Turn pin offer simple way to check voltage with multi-meter probe. 40 pins of PIC MCU except OSC (connected to crystal) are extended out to these pin. There is an extra pin on top of MCLR which is labeled as Vin, is connected to the input power.

H – Reserved for UART communication. Tx and Rx pin of SK40C are connect to RC6 and RC7 respectively. Ensure PIC use have the correct UART pin (RC6 and RC7).

I – 2 x Push button connected to RB0 and RB1 of PIC MCU. This is extra input button for user. It can be programmed as input switch.

J – Push button with the function of Reset for PIC MCU.

K – 5K of trimmer to set LCD contrast.

L – JP8 is provided for LCD Backlight. LCD Display will have backlight if this pin is shorted.

M – JP9 is provided for USB. Connect this pin if users use USB port

N – 40 pin IC socket for user to plug in any 40 pin PIC MCU (8 bit). It can either be 16F or 18F PIC. Of course the IC package should be PDIP. **Please ensure the first pin is at the top side.** Inside IC socket, there some electronics components, it include a 20MHz Crystal.

O – Turn pin is provided for crystal. 20M Hz is default crystal provided in SK40C. However, the 20M Hz crystal can be removed and replace with other crystal. Just remove the crystal and put other crystal on turn pin without soldering.

P – Reserved for 2 x 16 LCD Display. User may solder 2x16 LCD display at this space if want to use it.

Figure below shown pin connection for **'Label P'** (2x16 LCD Display).

Pin	Name	Pin function	Connection
1	GND	Ground	GND
2	VDD	Positive supply for LCD	5V
3	Con	Brightness adjust	Connected to a preset to adjust brightness
4	RB4	Select register, select instruction or data register	Pin RS of LCD
5	GND	Ground	GND
6	RB5	Start data read or write	Pin E of LCD
7	RD0	LCD Data bus pin	Pin D0 of LCD
8	RD1	LCD Data bus pin	Pin D1 of LCD
9	RD2	LCD Data bus pin	Pin D2 of LCD
10	RD3	LCD Data bus pin	Pin D3 of LCD
11	RD4	LCD Data bus pin	Pin D4 of LCD
12	RD5	LCD Data bus pin	Pin D5 of LCD
13	RD6	LCD Data bus pin	Pin D6 of LCD
14	RD7	LCD Data bus pin	Pin D7 of LCD
15	VDD	Backlight positive input	VDD
16	B/L	Backlight negative input	Connect to JP8

Figure below shown pin connection for **'Label O'** (Turn pin for crystal).

Pin	Name	Pin function	Connection
RA6	OSC2	Crystal	Turn pin (JP7)
RA7	OSC1	Crystal	Turn pin (JP7)

Figure below shown pin connection for **'Label I'** (Push button).

Pin	Name	Pin function	Connection
RB0	SW1	Digital Input	'SW1' SWITCH
RB1	SW2	Digital Input	'SW2' SWITCH

Figure below shown pin connection for **'Label H'** (UART).

Pin	Name	Pin function	Connection
RC6	TX	Transmit Data	TX pin of UART
RC7	RX	Receive Data	RX pin of UART

4. PRODUCT SPECIFICATION

SK40C is designed to offer starting up platform for development, the specification of PIC MCU used should be referred.

Absolute Maximum Rating

Symbol	Parameter	Min	Max	Unit
V_{CC}	Operating voltage	7	15	V
I_{max}	Maximum input current	-	1	A

SK40C come with additional features:

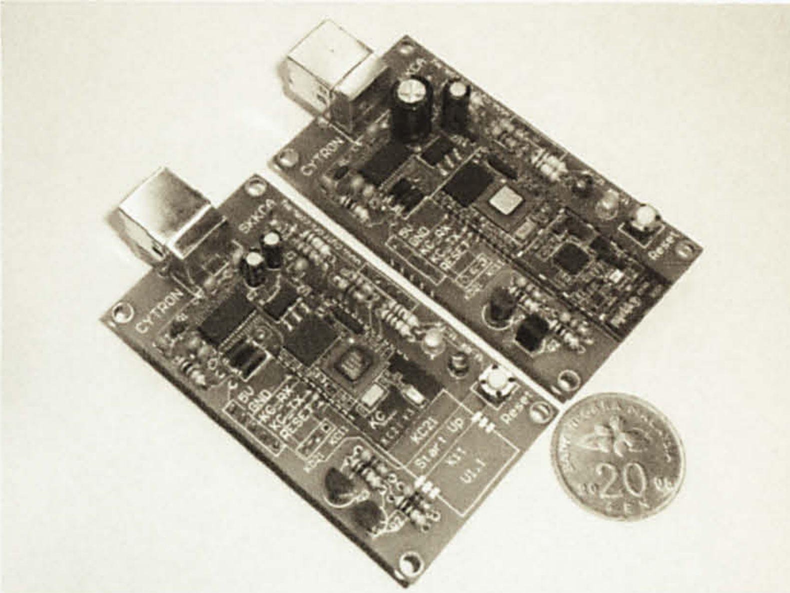
- 2 x Programmable switch
- 2 x LED indicator
- Turn pin for crystal. User may use others crystal.
- LCD display (optional)
- UART communication
- USB on board.
- And all the necessities to eliminate users difficulty in using PIC

Note: Only 1 power supply should be provided to SK40C.

APPENDIX G

SKKCA KC21 User Manual

KC Wirefree Bluetooth Starter Kit



User's Manual

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Oct 2007

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1. INTRODUCTION

KC Wirefree Bluetooth module offer simple yet compact Bluetooth platform for embedded application. Since it comes with surface mount layout, starter kits have been developed to ease user to explore the possible development and application.

This document describes the use and starting guide for KC Wirefree Bluetooth starter kit. For details of KC Wirefree Bluetooth module, please refer to data sheet or beginner guide document which can be downloaded at www.cytron.com.my

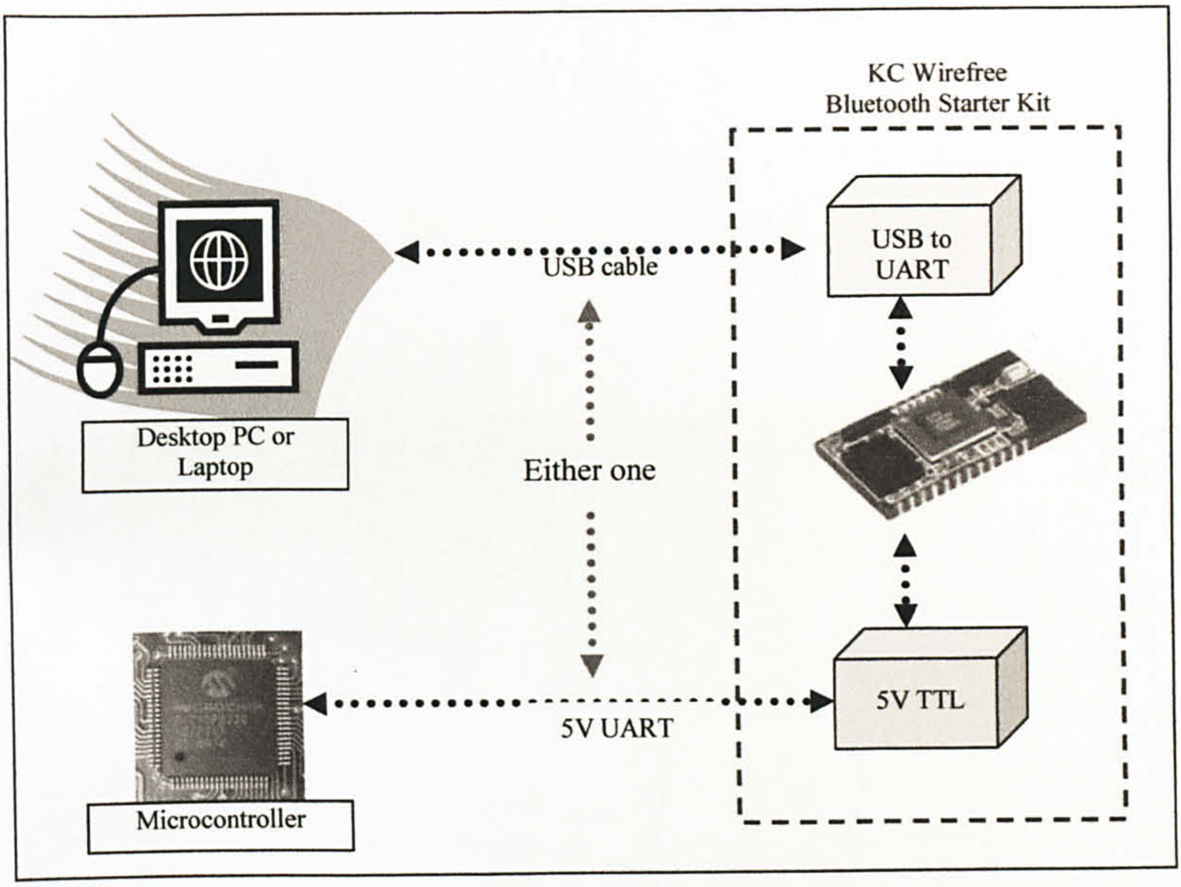
KC Wirefree Bluetooth Starter Kit, SKKCA has been designed for 5V TTL logic interface, no extra voltage divider is necessary. With minimum interface, it is ready to connect to microcontroller for embedded Bluetooth development. Furthermore, on board USB to UART converter offer easy yet reliable communication to PC for functionality test or even creating Bluetooth wireless connection.

It has been designed with capabilities and features of:

- Either KC21 or KC11 mounted
- USB Plug and Play UART function
- 5V powered
- 5V UART interface, ready for microcontroller interface
- Default baud rate of 115.2Kbps
- Compact yet easy and reliable platform
- As USB Bluetooth dongle
- As serial port replacement (wireless)

NOTE: SKKCA have filtered the hardware flow control, RTS and CTS. Thus, if hardware flow is required, please use the original module.

2. SYSTEM OVERVIEW



3. PACKAGING LIST

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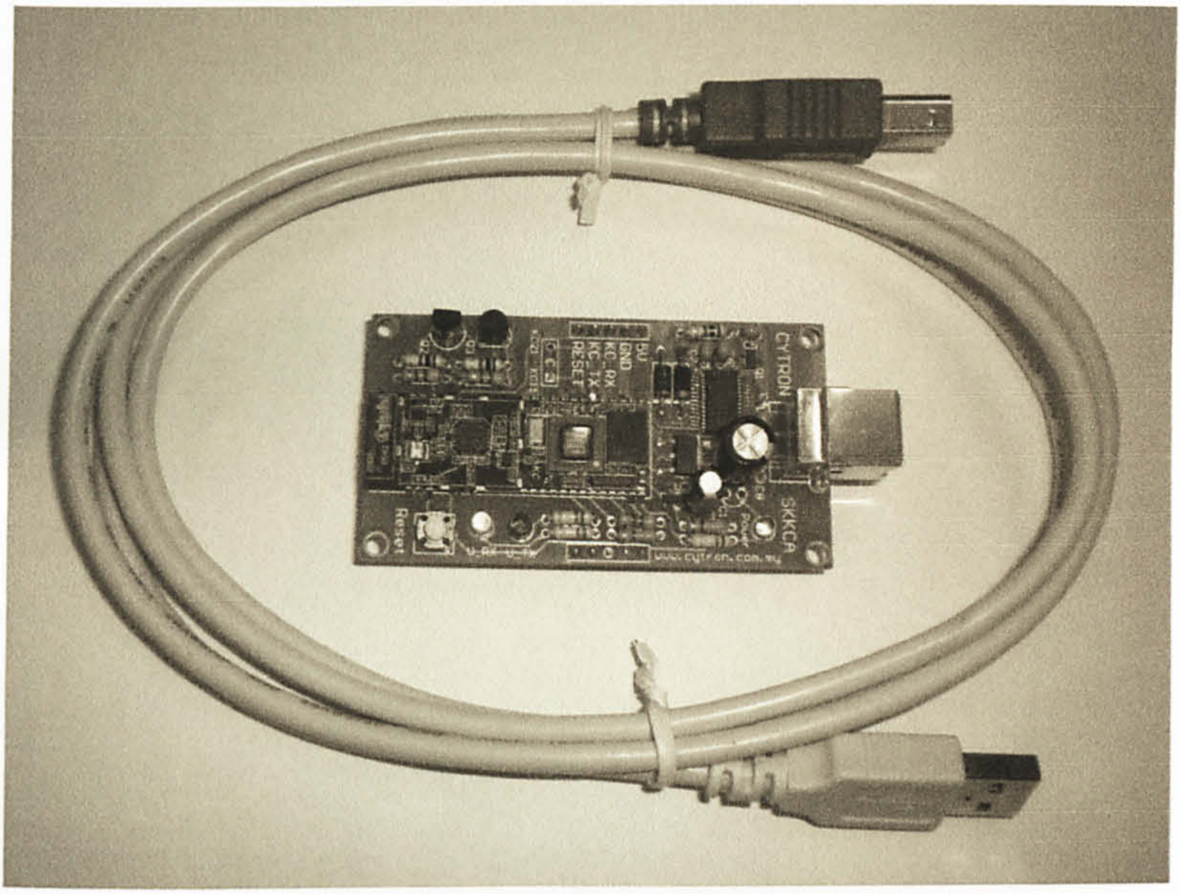
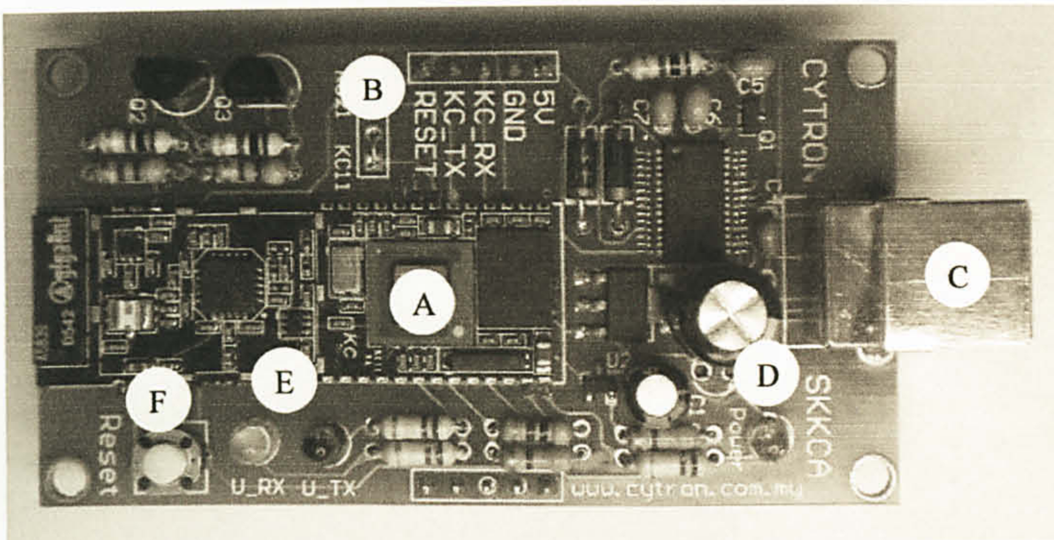


a. 1 x SKKCA with either KC21 or KC11 Bluetooth module.
b. 1 x B type USB cable
c. USB driver and User's Manual should be downloaded from www.cytron.com.my

4. BOARD LAYOUT



Label	Function
A	KC Wirefree Bluetooth module
B	5 ways header pin for external power and interface to microcontroller
C	USB B type socket
D	On board 3.3V power indicator LED. It is green color
E	Two LED indicator for USB's transmitter and receiver status
F	On board reset button for KC Wirefree Bluetooth module

A – Either KC21 or KC11 will be mounted. This is KC Wirefree Bluetooth module

B – 5 ways header pin for external power supply and interface to microcontroller. If this kit is connected to microcontroller board, it should be powered with 5V. Please refer to hardware installation for detail connection.

C – USB B type socket. If connection to PC or laptop is required, please connect one end of USB cable (B type) to this socket, while the other end to PC or laptop.

D – 3.3V power indicator. This small green LED indicates the status of 3.3V output from on board regulator. It should be ON if either external 5V power or USB connection is connected to SKKCA.

E – These are a pair of small LED, red and yellow in color. These LEDs are connected to on board USB to UART converter. It indicates the receiver and transmitter activity. It will only work if SKKCA is connected to PC or laptop through USB cable. Red LED indicate USB's transmitter send data, while yellow LED indicate USB's receiver receive data.

F – Reset button for KC Wirefree Bluetooth module. Pressing this button will reset on board KC Wirefree Bluetooth module.

5. PRODUCT SPECIFICATION

SKKCA is designed to ease development of embedded Bluetooth application. The specifications are as listed below:

Label	Definition	Function
5V	Power Input for SKKCA	External power source for SKKCA, the typical voltage is 5V. On board 3.3V voltage regulator will regulate the voltage to 3.3V for KC Wirefree Bluetooth module. The power is not necessary if SKKCA is connected through USB cable.
GND	Ground or negative	Ground of power and signal
KC_RX	KC Wirefree Bluetooth UART Receive signal	This is KC Wirefree Bluetooth module's receiver pin, it should be interfaced to 5V logic UART, no divider is necessary. This is an input pin to SKKCA. It should be connected to microcontroller's transmitter pin
KC_TX	KC Wirefree Bluetooth UART Transmit signal	This is KC Wirefree Bluetooth module's transmitter pin; it should be interfaced to 5V logic UART. This is an output pin from SKKCA. It should be connected to microcontroller's receiver pin
RESET	KC Wirefree Bluetooth Reset pin	Reset pin of KC Wirefree Bluetooth module. It should be connected to a push button to gnd, or NPN transistor.

Absolute Maximum Rating

Symbol	Parameter	Min	Max	Unit
5V	Power source for SKKCA	5.0	5.5	V
GND	Operating voltage	0	0	V
KC_RX	Receiver pin of KC Wirefree Bluetooth module	4.5	5.5	V
KC_TX	Transmitter pin of KC Wirefree Bluetooth module	-	-	V
RESET	Reset pin of KC Wirefree Bluetooth module	0	3.3	V

SKKCA can only be powered by either USB or external power (5V).

SKKCA have eliminated the hardware flow control of KC Wirefree Bluetooth module, thus if hardware flow control is required in development or application, it is advise the get the original Bluetooth module.

NOTE: DO NOT connect USB to SKKCA if it is connected to microcontroller. SKKCA can only be connected either USB or microcontroller.

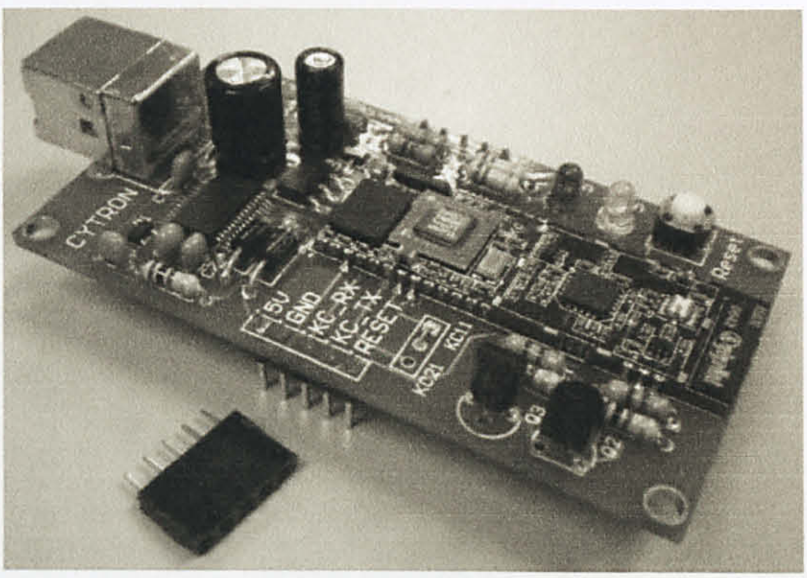
6. HARDWARE INTERFACE

Generally, there are 2 methods using SKKCA. It has been designed for interface to embedded system with 5V TTL (microcontroller) or connection to computer. If 3.3V interface is required, please get the original KC Wirefree Bluetooth module with no extra component or board.

6.1 Microcontroller

One of user's main concerns when using KC Wirefree Bluetooth module is the interface with microcontroller. Most of common microcontroller in the market are 5V powered, and offer/accept 5V TTL logic interface. However, since KC Wirefree is designed for 3.3V system, those that use 5V system will require extra work and components before KC Wirefree Bluetooth module could be embedded in the system. With the experiences and users' feedback, SKKCA is designed to ease the interface for 5V system.

a. To begin, user may connect 5V and Gnd of SKKCA to microcontroller board. Since the 5V system is powered with 5V, it should be very simple to get power source for SKKCA. Header socket can be used to connect SKKCA to microcontroller board.



b. Once the 5V is supply to SKKCA, the small green LED should light ON; and with this minimum connection, user may start searching Bluetooth Starter Kit using Bluetooth enabled Laptop or handphone. It should appear in the Bluetooth devices list. However, making wireless connection might not be possible as it still needs extra configuration and interface before Bluetooth link is possible.

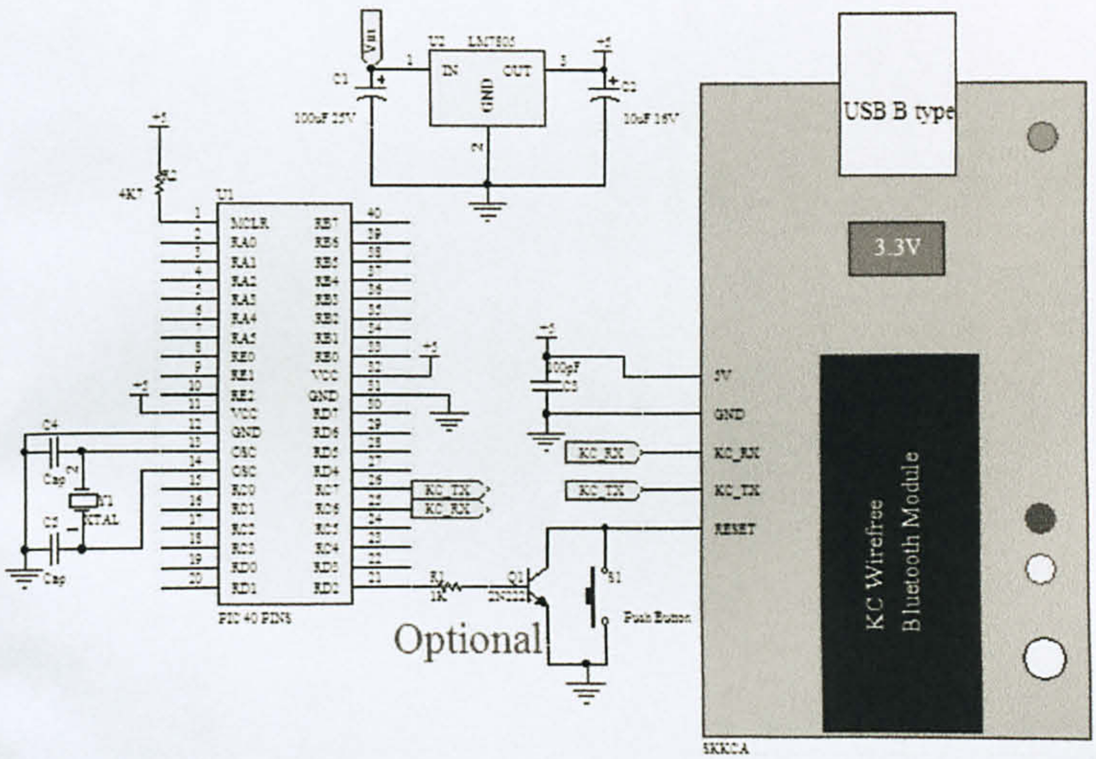
c. As 2nd step, user might need to connect the KC_RX and KC_TX pin to microcontroller. Of course, these two pins should be cross connected to microcontroller. In other words, KC_RX should be connected to microcontroller's Transmitter pin (TxD), while KC_TX should be connected to microcontroller's Receiver pin (RxD). No extra component is necessary between these connections. For details connection, please refer to sample schematic.

d. In order to enable Bluetooth wireless link to be established, KC_RX pin should be pull high (default stage for UART during idle) in normal case. Simple way to do this is to configure the microcontroller UART. Most microcontroller's UART engine will ensure the Transmitter pin (connected to KC_RX) is high in idle case.

e. If configuration of UART is completed, user may start to search the SKKCA and create SPP connection. Only those devices that have SPP (Serial Port Profile) are able to create Bluetooth wireless connection with SKKCA.

f. Now, the SKKCA is ready for embedded wireless development. Sending and receiving data require software or firmware development on particular microcontroller. The software installation will elaborate more on this topic.

g. Finally, the RESET pin of SKKCA. This is an **optional** pin for user as there already is a reset button on SKKCA. However, if user would like the microcontroller to reset SKKCA during run time, a transistor is required for interface between microcontroller and SKKCA. Please refer to following schematic for example of microcontroller interfacing with SKKCA.



Example of connection to PIC16F877A microcontroller

