Intelligent Safety Jacket (ISJ)

by

Mohd. Redza Shahruddin

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Electrical & Electronics Engineering)

DECEMBER 2006

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

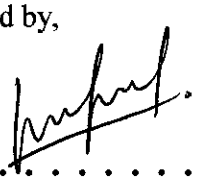
Intelligent Safety Jacket (ISJ)

by

Mohd. Redza Shahruddin

A project dissertation submitted to the
Electrical & Electronics Engineering Programme
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
BACHELOR OF ENGINEERING (Hons)
(ELECTRICAL & ELECTRONICS ENGINEERING)

Approved by,



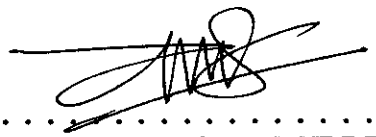
. . . . . .

Dr. Mohamad Naufal Mohamad Saad,
Supervisor,
Final Year Project I & II,
Intelligent Safety Jacket (ISJ).

UNIVERSITI TEKNOLOGI PETRONAS
BANDAR SERI ISKANDAR
31750, TRONOH
PERAK
December 2006

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.



. . . . . .

MOHD. REDZA SHAHRUDDIN
5th Year 2nd Semester,
Final Year Project I & II,
Intelligent Safety Jacket (ISJ)
Universiti Teknologi PETRONAS,
Bandar Seri Iskandar,
31750, Tronoh,
Perak Darul Ridzwan.

ABSTRACT

Drowning is a leading cause of death followed by home accidents and road traffic accidents occur in most countries of the world. Statistic from Life Saving Malaysia Society of International Life Saving Federation shows that more than 400,000 people all over the world and 9,000 of them in US alone drown every year. This has proven that *safety* is a major concern for individuals who are dealing with water activities. Statistic also shows the numerical sum of death cases involving children drowning in recent years; thereof to prove that all bodies including government, legal sectors, NGOs, communities and also individuals by forthwith have to give full onus to obviate this tragedy. This calamity would be further increase if safety actions are inadvertently distracted. There under, ideas to prevail the case are unveiled by mean a communication-based apparel to protect and reduce the risk of children's suffocation posed by water activities.

The purpose of this project is to design a final working prototype of *Intelligent Safety Jacket*. 'Intelligent' by mean, best described as the feasibility of the jacket to automatically inflate when submerged into the water and abruptly, communication circuit integrated within the jacket will deliver SMS (Short Messaging Service) alert to receiver's mobile phone. Therewithal, the term 'intelligent' will also be recognized as the only communication-based apparel that can call for help.

This project is mainly focusing on the Microprocessor II course by which PIC16F877 is being used as a microcontroller in C Language programming to transmit the data to GSM (Global Systems for Mobile Phone) modem before being notified by the receiver. Microprocessor II notes, Intro to C textbook, guidance from lecturers and extra findings on the internet are the main sources of this project.

As to conclude, Intelligent Safety Jacket is engineered to the exact specification of *double safety approach.* It emphasizes three fundamental aspects; *automatically inflate, SMS delivery system* and *the double safety approach.*

ACKNOWLEDGEMENTS

First and foremost, I precede the highest gratitude and praises to Allah, by the name of his merciful and kindness, upon completing this Final Year Project. The success of this project was determined by Him, Allah the Almighty. Nonetheless, I would like to give the highest appreciation to my beloved and understanding supervisor, Dr. Mohamad Naufal Mohamad Saad for his undivided attention at me throughout the making of this project. He was the man behind every success of my Final Year Project.

Thousands of thankful and tribute I dedicated to Mr. Azha, the technician of Power Plant and Control System Lab, for guiding me alongside the accomplishment of this project. I am so pleased to announce the names like Ms. Siti Hawa Hj. Mohd Tahir (*Kak Hawa*) and Ms. Siti Fatimah Mat Noh (*Kak Siti*), both are hardworking lab technicians, for their help and support in providing me labs until the extensive working hours sometimes and also giving me lab equipment during the breakthrough to complete the project. Thanks for you Sis!

The men behind the scene, Mr. Patrick Sebastian, Mr. Abu Bakar Sayuti Mohd Saman and Mr. Zuki Yusoff, three great lecturers of Microprocessor II course, are also the catalysts in delivering sorts of meaningful knowledge during the project implementation. They were very supportive and capable in sustaining my interest in Micro P study.

It was so amazing to say thanks to Mr. Wan Mohd Anas Wan Masyudi, Mr. Ismail Ahmad, and Mr. Muhammad Hakam Izani who were actually assist in sharing ideas and suggestions to keep up this great project. In facts, they have shown their desire to help and accompany me when I was doing the project alone. I just felt thankful and being so proud of them. The experiences were so incredible. Thanks lot lads!

Ultimately, I would like to take this opportunity to say thanks to each and every single individual who was directly or indirectly involved in accomplishing this project. With the merciful of the Creator, thank you for all. God blesses…

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS & NOMENCLATURES

FYP	Final Year Project
ISJ	Intelligent Safety Jacket
SMS	Short Messaging Service
PIC	Programmable Integrated Circuit
RS	Radio Standard
GSM	Global Systems for Mobile Communication
PIC C Compiler	Software used to create source codes using C Language
WARP13	Software used to program the generated source codes into PIC16F877 through ".HEX" file
WARP13 PIC Programmer device	A physical device programmer designed to program the PIC
Halkey-Roberts Automatic Inflator	A device that detects water and triggers a firing mechanism to allow the CO_2 canister to inflate the bladder within the lifejacket, and creates a buoyancy
EDX18	18th Engineering Designs Exhibition
ICSJ	Intelligent Children Safety Jacket
PU	Polyurethane
CO_2	Carbon Dioxide gas
Polyester	Rescue garment with waterproof characteristic
Nylon	A light/medium waterproof kind of material that is suitable for safety clothing and rescue garments which has strong, tough, resilient polymers, good barrier and high fatigue properties. It is also a good abrasion resistance, good resistance to oils, greases and solvents.
HR	Halkey-Roberts
US	United States
Atrion Corp	A specialist in medical part supplier, where Halkey-Roberts, a US manufacturer which was formed in 1941, is their share partner.
United Moulders	UK manufacturer based in Hampshire England, where the other brand of automatic inflator is produced.
Hammar	Swedish company who manufacture an automatic inflator that has a hydrostatic valve in place of the bobbin as used by the other makers.

PFD	Personal Floatation Device
GPRS	General Packet Radio Service
TC35i Siemens GSM modem	A modem used to deliver SMS alert to the receiver
OEM	Original Equipment Manufacturer
VAR	Value-Added Reseller
AT commands	Hayes command set. AT is short for *attention*
SIM	Subscriber Identity Module
GSM1800	Global Systems for Mobile Communication -1800; uses 1710 - 1785 MHz to send information from the Mobile Station to the Base Transceiver Station (uplink) and 1805 - 1880 MHz for the other direction (downlink), providing 374 channels (channel numbers 512 to 885).
EGSM900	Extended Global Systems for Mobile Communication -900; uses frequency range 880 - 915 MHz (uplink) and 925 - 960 MHz (downlink), adding 50 channels (channel numbers 975 to 1023 and 0 to the original GSM-900 band)
MO and MT	Managed Object and Mobile Terminated
PDU Format	Protocol Data Unit Format
SMA	SubMiniature version A
LED	Light Emitting Diode
PBCCH	Packet Broadcast Control Channel
CSD	Circuit Switched Data
USSD	Unstructured Supplementary Service Data
CS1	Coding Scheme1
DTMF	Dual Tone Multi Frequency
I/O	Input/Output
Microcontroller	A computer on a chip consisting of: i. CPU (central processing unit) ii. RAM (Random Access Memory) iii. EPROM/PROM/ROM (Erasable Programmable Read Only Memory) iv. I/O (input/output) - serial and parallel v. Timers vi. Pulse Width Modulation vii. A/D and D/A conversion
CPU	Central Processing Unit
RAM	Random Access Memory
EPROM	Erasable Programmable Read Only Memory

PROM	Programmable Read Only Memory
ROM	Read Only Memory
A/D and D/A	Analogue/Digital and Digital/Analogue
PWM modules	Pulse-Width Modulation
USART	Universal Synchronous Asynchronous Receiver Transmitter
MCLR	Master CLeaR
GND	GrouND
MHz	Mega Hertz
RS232 Serial Communication Port (D-Type 9-pin connector)	A serial cable used to transmit and receive data between a computer-MAX232 and between the MAX232-GSM module (In this case, used to transmit). For a low rate data transfer or long distances data transfer.
COM1	COMputer Port 1
CPU	Central Processing Unit
HyperTerminal	A communications program used when connecting to other computers, bulletin board systems (BBSs), and a host of other Internet-related services. It is designed to emulate various types of text terminal. It can be configured to make a connection through a *modem* or directly over a *serial port*.
AT+CMGF	AT+CMGF; Message Format: If, AT+CMGF=1, it is in text mode If, AT+CMGF=0, it is in PDU mode
AT+CMGS	AT+CMGS =?;Send SMS message
Ctrl-Z	Control + Z keys pressed simultaneously
.HEX	File extension; Hex dump
ASCII	American Standard Code for Information Interchange
MAX232	A voltage level converter. The RS232 interface uses +-10V and the Max232 converts this to 0-5V
AT	ATtention
ATA	ATtention Answer
ATD	ATtention Dial
ATH	ATtention Hang Up Call
ETSI	European Telecommunications Standards Institute
TA	Terminal Adaptor
TE	Terminal Equipment

<da>	Destination Address
TP	Tech-Prep
BCD	Binary Coded Decimal
<toda>	Type-of-Address octet
<mr>	Message-Reference
<scts>	Service-Centre-Time-Stamp
<dt>	Discharge-Time
Rescue-999	Emergency number
mAh	Miliampere-Hour
VDC	Volt-Direct Current
GPS	Global Positioning System
AVL	Automatic Vehicle Locator
Maxis (M) Sdn. Bhd.	Local (Malaysia) Telecommunications Service Provider
Celcom (M) Sdn. Bhd.	Local (Malaysia) Telecommunications Service Provider
DiGi (M) Sdn. Bhd.	Local (Malaysia) Telecommunications Service Provider
UTP	Universiti Teknologi PETRONAS
Microprocessor II	Course offered by UTP in Electrical & Electronic program
C Language	Programming language used to create source code for the PIC.
Intro to C	Reference textbook from Borland.

'If I had to name a single, all-purpose instrument of leadership, it would be communication...' –

John W. Gardner

1.0 INTRODUCTION

1.1 Background of Study

Today's technology has reached a certain level of success that can be proud of by humanity especially people who enjoy the benefits after breaking the shackles applying the knowledge in a real-life situations. Therefore, it will stimulate future generations in achieving the success of technology expertise. Undeniably, when all these latest technologies spread throughout the globe, the most advantageous industry that bring expedient is *communication systems*. Regardless to other engineering disciplines, communication systems have become the domain in every place by the widen use of mobile phones, internet, e-mails and other communicating devices. This has proved the essentiality of the communication systems compared to other diligences.

The facts that the world has already changed from poor communication systems to enhanced structures are something that is incredible. Designing communication-based apparel which is enables to provide better safety and protection is the purpose of this Final Year Project (FYP).

1.2 Problem Statement

Drowning is a major cause of death in boating or any other water-related activities. Drowning comes in silence and happens in all level of ages, from infant to over 60-year-old man. Therefore, safety precautions have to be taken seriously in order to overcome the downing experiences. Children are the most frequent group drowns than any other ages. Playing with water is so risky for children especially when there is no eyesight securing them. Whilst, worries most parents as could be seen a lot of accidents involving children drowning into the water; sea, lake, pond, flood or even in the swimming pool!

Lack of supervision during water activities perhaps is a main cause of children drowning. Thus, *safety* is the parents' major concern at their children. Apart from that, parents are willing to spend thousand of dollars just to provide safety precaution to their children.

For that reason, important focus has to be made. Action should be taken prominently to guarantee this calaminity would be diminished. The significant aspect of this project like as mentioned earlier is to provide secured protection most of the time for persons getting involve in water occasions.

Therefore, ideas are breed to create supportive safety apparel to protect their life from drowning. Designing the safety jacket which is enable to automatically inflate during submerging into water and detect the location of the wearer where about are the requirements for this project.

1.3 Objective and Scope of Study

The main objective of this project is to create and develop final working prototype of *Intelligent Safety Jacket* (ISJ). The term 'intelligent' best described as the feasibility of the jacket to automatically inflate when submerged into the water and determine the location of the jacket wearer where about by sending an alert to mobile phone via Short Messaging Service (SMS) system. Therewithal, the word 'intelligent' will also be recognized as the term, 'the jacket that can call for help'.

Thus, the special features of this jacket would demonstrate the uniqueness of its design as well as the rugged construction it may appear. The knowledge of communication systems thought in mobile communications is applied. This project focuses on the communication circuitry that appears to be an essential part which will be integrated within the jacket. The idea of this circuit comes from the Microprocessor II course, reined by PIC 16F877 as a microcontroller, MAX232 IC and also the communication medium, RS232 serial communication port. The combination of these components are carefully staggered with the present of GSM modem, the high-speed data transfer device which allow to be significant feature to deliver the SMS.

The software involved is PIC C Compiler using C Languages to create the source codes which will be programmed into the microcontroller, as an embedded system. The software used to embed the source codes into the PIC16F877 was WARP13, together with WARP13 PIC Programmer device (**FIGURE 26**). In making sure the project fulfills the requirement, the automatic pump system is another aspect needed to be understood before stowing into the feature.

LITERATURE REVIEW

2.1 Feasibility of Intelligent Safety Jacket

All over the world, infants drown more frequently than people at any other age. Statistic shown that, in Australia, for every 100,000 children between ages 1 and 5, 13 die every year from drowning (Pearn, 1977).

In this age group drowning is the leading cause of death, followed by accidents in and around the home and road traffic accidents. Inadequate supervision, an inability to swim, and lack of barriers separating children from pools and other water are the main causes of drowning. Although the vast majority of drowning happens to children rather than any other age, this jacket is not necessarily invented to children.

NOTE: This jacket is suitable at all ages and not specifically designs for children.

Intelligent Safety Jacket is the term chosen instead of Intelligent Children Safety Jacket because it describes the concept and application of this jacket and not for some specific purposes. The scope of applicability of this jacket would be wider and the cases of wearers' size, age, and weight are no longer an issue. This new concept of the jacket where it can automatically inflate during submerging into the water and then deliver the data to mobile phone via SMS alert can be applied for every level of the jacket's wearer whether adult or a child. It is just the size, weight and buoyancy force that matter in distinguishing between them.

For adult, the idea situation to wear the jacket is during duty at the offshore. Engineers who work in highly risk condition at the offshore are having risk of over boarding into the sea or in an occasion where they need to take a boat to go back to land from the platform. By wearing this jacket, it can double up the safety where a man-in-charge in the control room of the platform will receive an SMS alert if something happens to the wearers. Realizing the notified SMS, a group of rescuers will go and help those floating persons on the sea provided that the jacket wearers are within the coverage of the safety system of the jacket.

For children, the most suitable condition to wear this jacket is during leisure or fishing time under adult's supervision. When a child goes overboard, SMS alert from jacket's safety system will be delivered to mobile phone of the care taker (parents for example). Then, the notified SMS will tell the parents something might happen to their child. Realizing that, they will call the rescuers for help or they themselves will directly go to the spot provided that the place is within the coverage of the safety system of the jacket. Beforehand, the parents need to be informed where is the destination or the recreation spot the child goes along with the adult.

TABLE 1 below describes other suitable conditions to wear this jacket classified by categories and the number of persons in an occasion:

TABLE 1: The situations to wear the ISJ for the number of persons and its categories

Category	No. of Persons	Description
Adult	One	- go for fishing, boating, and water sport alone without companions. This would present the possibility of drowning into the water without any eyesight watching on.
	Two	- they go for fishing and both of them wearing the jacket. If anything happen to one or both of them, the SMS alert will be activated and notify to their colleague's mobile phone that stay in land. After few moments, their colleagues reach to give help. Apart from that, their colleague may also inform the other bodies like the water sport center's safeguard regarding their friends' floating on the water. Then, the safeguard will go for help.

	Group	- a group of people, possibly tourists are taking a boat to their destination island. When something happens to the tourists along the way to the destination, the SMS alert will notify the group leader or captain in the cabin. Then, the captain/leader will reach as soon as possible to give help.
Children	One	- swimming alone in home's swimming pool might be dangerous sometimes when there is no supervision by adult. This jacket will act as a floating device for child. Parents do not have to worry for their child because the jacket will always float on the water surface.
	Two	- in an occasion where a child goes fishing with the adult, probably father. The SMS alert will notify a mother in the house if the child goes over board. The mother will inform rescuers for help as soon as she receives the SMS provided that the father forgot to bring the mobile phone.
	Group	- a group of children taking a boat to the destination. A leader will be notified by SMS alert if anything happen to those children. Immediately, the leader/captain will save the children.

2.2 Jacket Specifications

Basically, this jacket is intended for children between five (5) to 12 years old. However, in order to describe the concept and application of this jacket, it could be more useful if the functionality of this jacket can be widen by not looking for some specific purpose only. Therefore, this jacket changes its term from the original, Intelligent Children Safety Jacket (ICSJ), to Intelligent Safety Jacket. This is not only for its wide application but also as a preparation to face with questionnaires from external examiner during Final Presentation soon.

This means the jacket is suitably worn by adult and children. This is the jacket that provides the buoyancy force of 150Newton, which means the person who weighting more than 40kg are approved to wear. This looks like the adult safety jacket. For children between five (5) to 12 years old, the automatic pump system would not be able to work properly when it is applied at own intended design of safety jacket (Unless the wearer is in the range of 40kg to 100kg).

NOTE: Wearer who weighting between 40kg to 100kg is approved to wear this jacket

It must use other types of materials to support the higher buoyancy force acts on children' body such as buoyancy foams. Unfortunately, it looks bulky and less comfortable for children. That is one of the reasons why the title is changed to Intelligent Safety Jacket. Grasp this concept, it still within the scope of the project which is to create and design the safety jacket that can automatically inflate and call for help when immersed into the water. Below are the specifications of Intelligent Safety Jacket:

TABLE 2: Specification of Intelligent Safety Jacket

Particular	Description
Type:	Automatic inflatable safety jacket
Colour:	Black → cover High visibility orange → buoyancy chamber
Outer material:	PU coated polyester
Inner material:	PU coated nylon single chamber buoyancy
Weight:	0.75kg
Dimension (L x W x H when packed):	32 x 57 x 7 cm. approx.
Dimension (L x W x H when inflated):	45 x 59 x 19 cm. approx.
Inflator:	Halkey-Roberts automatic inflator
CO_2 cylinder:	34g CO_2 cylinder
Buoyancy:	150N
Inflation:	Automatic inflation and oral-inflation tube
Special features:	• Communication-based apparel that can call for help • Deliver signal to phone via SMS once it is inflated • Automatically inflate when submerges into the water • Lifting beckets for retrieval • Emergency whistle • Strap for light • Toggles for attachment • Retro-reflective trim • Oral inflation tube
Main application:	Offshore, fishing, boating, leisure

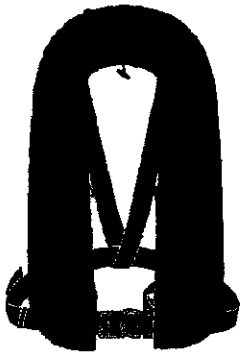


FIGURE 1: Packed Intelligent Safety Jacket

FIGURE 2: Inflated Intelligent Safety Jacket

TABLE 3: Pros and Cons of Intelligent Safety Jacket

Pro	Con
- Communication-based apparel (*1st in Malaysia*)	- Higher cost (modem and automatic inflator)
- Provides double safety approach	- Annual service maintenance
- Lightweight and easy to handle (wear)	- Sensitive inflator
- Deliver SMS in faster rate	- Communication circuit may also sensitive (need proper handling)
- Smaller and comfortable	- Not suitable for person weighting 40kgs and below.

Black cover is selected because of its commercial value. Black is unique compared to other fabulous colors. It is a good heat absorber during day light when we are boating in the middle of the lake where the ambient temperature is absolutely low. The materials used for the cover was PU Coated Polyester. The fabric is made of 100% fine polyester with Polyurethane (PU) coating and waterproof characteristic.

Polyurethane coatings provide a thin film, high gloss finish with exceptional weathering performance characteristics. This coating is used in virtually all industrial markets to provide a smooth durable finish that has superior resistance to corrosion, abrasion, and chemical exposure. Polyurethanes are normally used to topcoat high build epoxy and inorganic zinc.

FIGURE 3: Polyester with polyurethane (PU) coatings of the outer material which provides water proof characteristic for the safety jacket.

For the buoyancy chamber, the color chosen was the visibly orange fluorescent. It is made of PU coated nylon fabric. PU coated nylon is a light/medium waterproof kind of material that is suitable for safety clothing and rescue garments like this jacket. The characteristics of nylon fabric are shown in the **TABLE 4** below:

TABLE 4: The characteristics of nylon material

Nylon	Characteristic
GENERAL	• strong, tough, and resilient polymers • good barrier and high fatigue properties • good abrasion resistance • good resistance to oils, greases and solvents
PRIMARY PROPERTIES	• Excellent impact resistance, good thermal stability • High abrasion and weathering resistance • Excellent flow properties • Good dielectric properties • Good resistance to a wide range of chemicals • Hypo-allergenic

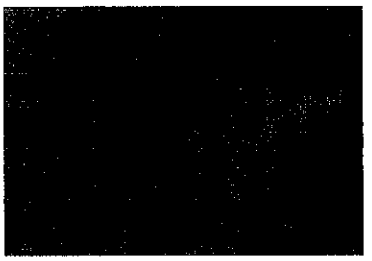


FIGURE 4: Polyurethane (PU) coated nylon fabric in visibly orange fluorescent; for the buoyancy chamber

The total weight of this safety jacket (excluding circuit) is 0.75kg. It is light, easy to carry and give more comfort to the wearer. Basically, the automatic inflator (HR) has so many different weights of its CO_2 cylinder. In this project, 34g CO_2 cylinder is used to give full inflation for the jacket which provides 165N of buoyancy (16.5kgs). The dimension of this jacket (when packed) is 32 x 57 x 7 cm. approximately and the dimension (when inflated) is 45 x 59 x 19 cm. approximately which is about 40.6% increases of its original size.

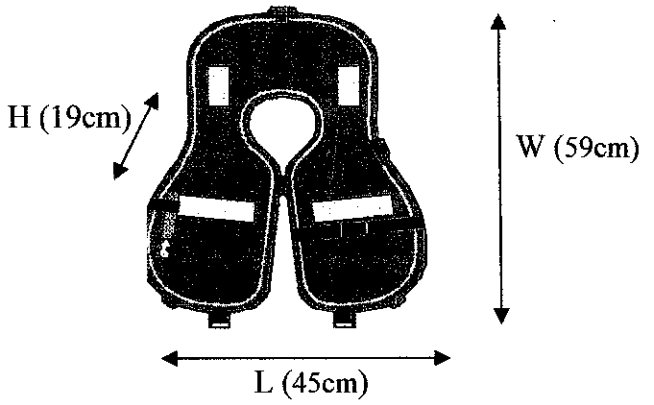


FIGURE 5: The dimension of Intelligent Safety Jacket (when inflated)

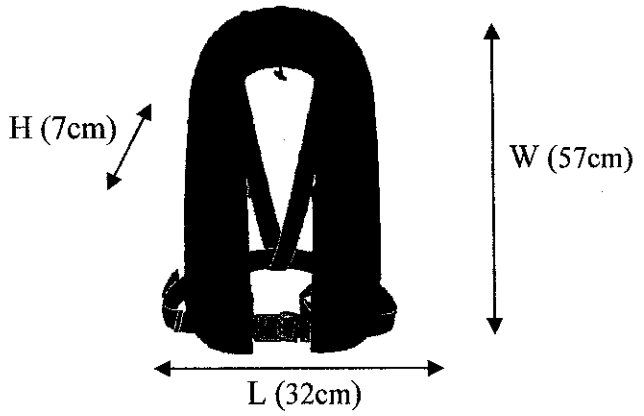


FIGURE 6: The dimension of Intelligent Safety Jacket (when packed)

Halkey-Roberts automatic inflator is chosen for this project as a main component that causes the jacket to inflate. The other inflators available in the market are:

i. Hammar automatic inflator
ii. United Moulders automatic inflator
iii. The Secumar inflator
iv. Hydrostatic inflator

Halkey-Roberts inflator uses an "auto capsule", which contains a spring-loaded plunger, topped by a bobbin. **Halkey-Roberts**, is a US manufacturer formed in 1941. It is now part of the Atrion Corp, a specialist in medical part supplier. Its patented lifejacket inflator is fired by a 'bobbin'.

The bobbin chemically reacts with water by dissolving and allowing the mechanism to fire the CO_2 .When wet, the bobbin dissolves, releasing the plunger to pierce the cylinder. The safety jacket's inflators are zinc coated kind of material specifically made to reduce rust. The approximate length of the cylinders varies from 10.5cm to 16.5cm according to its weight. There are several types of CO_2 cylinder with different weight available in the market such as:

v. United Moulders Rearming Kit 20g
vi. United Moulders Rearming Kit 24g
vii. United Moulders Rearming Kit 33g
viii. United Moulders Rearming Kit 38g
ix. United Moulders Rearming Kit 60g
x. Automatic Hammar Inflator Rearming Kit 34g CO_2 cylinder
xi. Manual Halkey-Roberts Inflator Rearming kit 34g CO_2 cylinder

The different between each of them is the only weight because the bigger weight can accommodate more buoyancy force and the size of the jacket may also vary. Small jacket needs lighter CO_2 cylinder and vice versa.

FIGURE 7: 34g CO_2 cylinder

Apart from the inflator's function that can automatically inflate once the bobbin dissolves in the water, the jacket however can be manually inflated by oral inflation tube integrated within the jacket or by pulling the lanyard attached aside. This is to ensure that the jacket stays in good condition before it is being used. Another function of oral inflation tube is to adjust the jacket so that it fits with the wearer's condition.

To rearm the jacket, the cap of the oral inflation tube has to be put off so that the CO_2 gas from the buoyancy chamber will vent out through the tube.

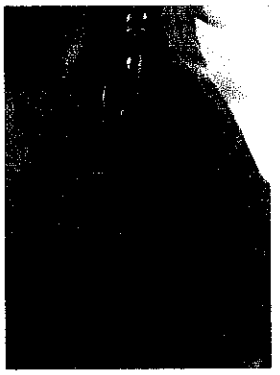


FIGURE 8: Oral inflation tube for manual air adjustment in buoyancy chamber.

This jacket is used for offshore industrial, fishing, boating, yachting and leisure-time activities. In fact, the real purpose of this Intelligent Safety Jacket is to provide double safety approach from the risk of drowning; but it does not guarantee for rescue.

NOTE: This jacket will provide the double safety approach but it does not guarantee for rescue unless the receiver has been notified by SMS alert from the circuit integrated within the jacket.

2.3 How Does the Jacket Work?

Intelligent Safety Jacket is a Personal Floatation Device (PFD) which helps the wearer by its conditions to remain conditionally safe on the water surface before the rescue comes upon. This sophisticated-design jacket will be utilized at near shore areas such as river banks, lake banks, ponds, sea shores and also at the swimming pools. The fundamental principle of this jacket is that once the wearer goes over board, a 'bobbin' on top of a spring-loaded plunger contained in an automatic inflator, will react with water and dissolve. Then, the spring-plunger will pierce the carbon dioxide (CO_2) cylinder attached to the inflator. Gas from the cylinder will blow up an air bladder and poof! the air bladder unfolds and the jacket inflates within 10 seconds.

2.4 Communication Circuitry

Basically, the main component in this system is GSM modem. GSM (Global Systems for Mobile Communication) modem provides multiple applications such as the right industrial interfaces for GPRS class 8 data, voice, fax and SMS (Short Messaging Service). Grasp its concept, SMS application is the easiest way to deliver data to mobile phone because of the widely used nowadays and also the fastest way to get high-speed wireless data communication.

However, the usage of GSM modem in any applications may cause higher spending which is can be estimated more than RM1000 per unit. Fortunately, this is the cheapest modem but the fastest one to deliver data; model *TC35i Siemens GSM modem*. **FIGURE 9** shows the physical conditions of TC35i Siemens GSM modem.

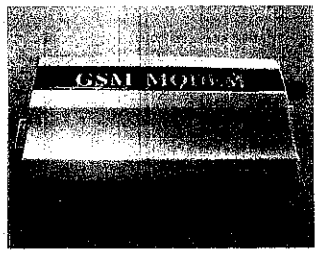


FIGURE 9(a): Front view

FIGURE 9(b): Right view

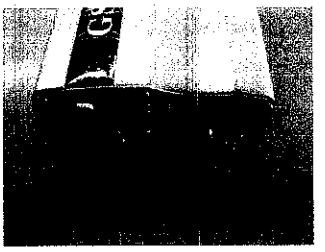


FIGURE 9(c): Left view

It can be powered by 240VAC power supply as input and reduced to 7.5VDC output. A built-in SIM card reader makes it easy to plug the TC35i OEM (Original Equipment Manufacturer) Terminal into the circuit.

NOTE: Original Equipment Manufacturer (OEM); a company whose products are used as components in another company's product. The OEM will generally work closely with the company that sells the finished product (often called a "value-added reseller" or VAR) and customize the designs based on the VAR's needs.

Below are the features and specifications of TC35i Siemens GSM modem:

TABLE 5: TC35i Siemens GSM modem's features and specifications

General features:	• Dual-Band EGSM900 and **GSM1800** • Compliant to GSM phase 2/2+ • Output power: - Class 4 (2 W) for EGSM900 - Class 1 (1 W) for GSM1800 • **Control via AT commands** • **SIM Application Toolkit** • Multiplex RS232 interface • Power save mode • **Supply voltage range 5...32 V** • **Dimensions: 95 x 54 x 25 mm** • Weight: 130 g • Ambient temperature: -20 °C ... +55 °C
Specifications for SMS:	• Point-to-point MO and MT • SMS cell broadcast • **Text** and PDU mode
Interfaces:	• **Plug-in power supply** • Handset audio interface • **Mini-SIM card reader** • **Antenna connector SMA (Female)** • **V.24/V.28 interface on the 9-terminal sub-D socket (Standard)** • **V.24/V.28 interface on the Sub-D socket RS-232 and audio through mini sub-D 15-pin connector supporting (option 1)** • **SMA Antenna connector** • **Operating status LED**
Specifications for data transfer:	• GPRS class 8 (up to 85.6 kbps) • Full PBCCH support • GPRS mobile station, class B • CSD up to 14.4 kbps • USSD • Non transparent mode • V.110 • Coding scheme CS1, 2, 3, 4
Additional features:	• Phone book • Multiparty call • Call diverting • Real-time clock • Alarm management • Several ringing tones • DTMF (Dual Tone Multi Frequency)

Another main component of the communication circuitry is a microcontroller. For this project, PIC16F877 is used together with MAX232 IC (as interface). The microcontroller used as embedded system (e.g. SMS delivery circuit) is selected due to several reasons:

i. Cost; much cheaper than computer
ii. Size and weight; more compact and much lighter than computer
iii. Practicality; if the application requires very few number of I/O and the code is relatively small, a microcontroller would be suitable
iv. Reliability; simpler architecture is less likely to fail
v. Speed; since all components are located on a single piece of silicon, applications run faster than it does on a computer

This communication system circuit is very unique because:

i. No operating systems
ii. Execute a single program, tailored exactly to the controller hardware
iii. Wide choice of microcontrollers
    - Speed
    - Program size
    - Features

2.4.1 What is a Microcontroller?

Microcontroller is a computer on a chip consisting of:

- CPU (central processing unit)
- RAM (Random Access Memory)
- EPROM/PROM/ROM (Erasable Programmable Read Only Memory)
- I/O (input/output) - serial and parallel
- Timers
- Pulse Width Modulation
- A/D and D/A conversion

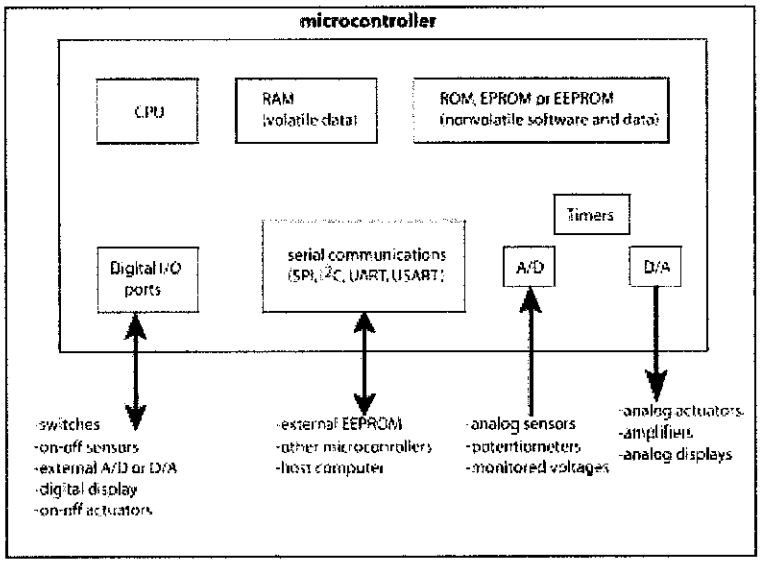


FIGURE 10: Block diagram of the microcontroller

Generally, PIC16F877 is a mid-range microcontroller that supports:

- 8kb of flash program memory
- Interrupts
- In-circuit programming
- Hardware timers
- Capture/Compare/PWM modules
- 10-bit A/D conversion (up to 8 channels)
- Built-in USART for serial communication
- Lots of Digital I/O

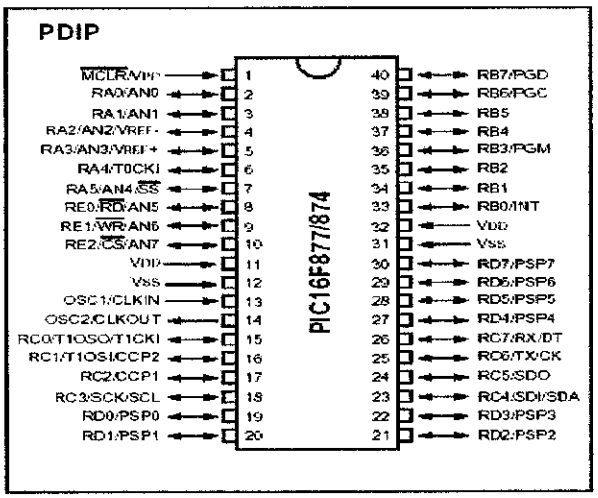


FIGURE 11: Physical Pinouts of PIC16F877

Electrical characteristics of the PIC16F877 are stated below:

- Digital I/O current limit
  - High source/sink current: 25mA
  - Do not push it
- Standby current in sleep mode
  - < 1μA

Reset mechanisms of PIC16F877 are as follow:

- The master clear (MCLR*) pin
- Watchdog timer
- Power-on reset
- Brown-out reset

Current transients of PIC16F877 are just:

- Beware of current transients
  - Ensure that power supply has adequate current capability
  - Over current will pull down voltage
- Use bypasses capacitors across subsystems

Substantially, most basic circuit that uses PIC16F877 as a microcontroller consists of:

i. Power (+5V) and ground (GND) - Power and ground are connected to the PIC through pins Vdd and Vss. The *dd* and *ss* refer to the drain and source notation used in the PIC. Vdd = 5V and Vss = 0

ii. Oscillator – Depends on its speed; 8 to 20MHz, **4MHz**, 200kHz. Currently using standard clock of 4MHz crystal oscillator.

iii. The master clear pin MCLR* - This is an active low pin that provides a reset feature. Grounding this pin causes the PIC to reset and restart the program stored in the FLASH ROM. At any other time (i.e., for running the microcontroller), the MCLR* pin should be made logic 1 by connecting it to a +5V supply through a pull-up resistor

iv. RS232 Serial communication port (typically with a MAX232 Chip)

3.0 METHODOLOGY

3.1 Using and Testing GSM Module

The GSM (Global System for Mobile Communications) network offers a wireless infrastructure which extends peoples' reach to anywhere in the world. There are several means to tap onto this infrastructure as a communication medium. One way is to use a *direct data call* to connect a point-to-point data link from one place to another. Or, to log into the *World-Wide-Web via GPRS*. But, simplest method is via *SMS* (Short Messaging Service) system. Which ever means is used, a user wants to exchange or send data from one point to another. Below are set of methodology used to deliver data from GSM module to mobile phone via SMS:

NOTE: The TC35i Siemens compatible GSM module is a low cost OEM (Original Equipment Manufacturer) version of the real thing.

3.1.1 GSM Module Specifications

- Dual-Band EGSM900 and GSM1800
- Compliant to GSM phase 2/2+
- Output power:
  - Class 4 (2 W) for EGSM900
  - Class 1 (1 W) for GSM1800
- Control via AT commands
- SIM Application Toolkit
- Multiplex RS232 interface
- Power save mode
- Supply voltage range 5...32 V
- Dimensions: 95 x 54 x 25 mm
- Weight: 130 g
- Ambient temperature: -20 °C ... +55 °C

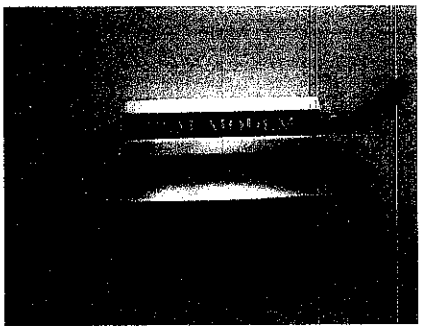


FIGURE 12: Siemens TC35i GSM modem

3.1.2 Specifications for SMS

- Point-to-point MO and MT
- SMS cell broadcast
- Text and PDU mode

3.1.3 Interfaces

- Plug-in power supply
- Mini-SIM card reader
- Antenna connector SMA (Female)
- V.24/V.28 interface on the 9-terminal sub-D socket (Standard)
- SMA Antenna connector
- Operating status LED

GSM SIM (Subscriber Identity Module) card is inserted into the module like as shown below:

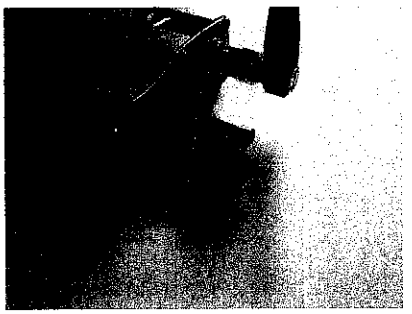


FIGURE 13: SIM card inserted into the module

RS232 Serial Communication Port is connected to the computer to test out the GSM module and the power connector is inserted:

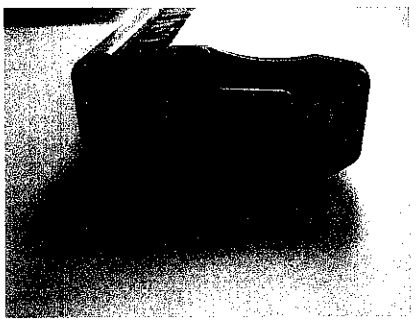


FIGURE 14: RS232 Serial Communication port and plug-in power supply

The complete set up is shown below:

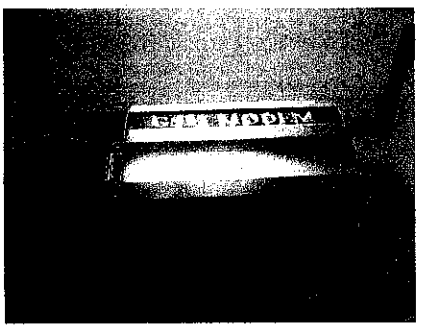


FIGURE 15: GSM modem with complete setup and ready to be tested

One end of RS232 Serial Cable is to be connected to the COM1 at CPU and another end to the 9-terminal sub-D socket GSM modem. On the HyperTerminal, the same serial COM port (COM1) has to be selected. HyperTerminal used to come with Windows (Start->Accessories->Communications->HyperTerminal) to start a HyperTerminal window.

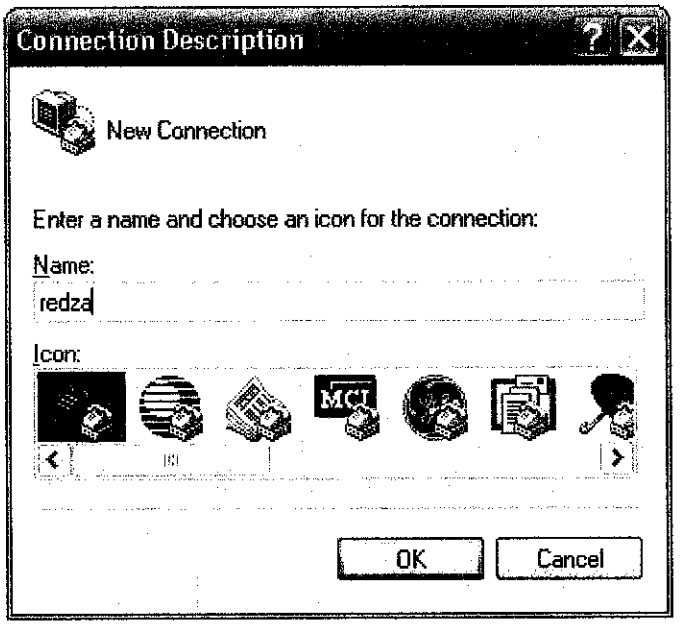


FIGURE 16: Connection description of HyperTerminal

Therewithal, the region of connection has to be set to simplify the area of operation by which it can be achieved to transmit the SMS data:

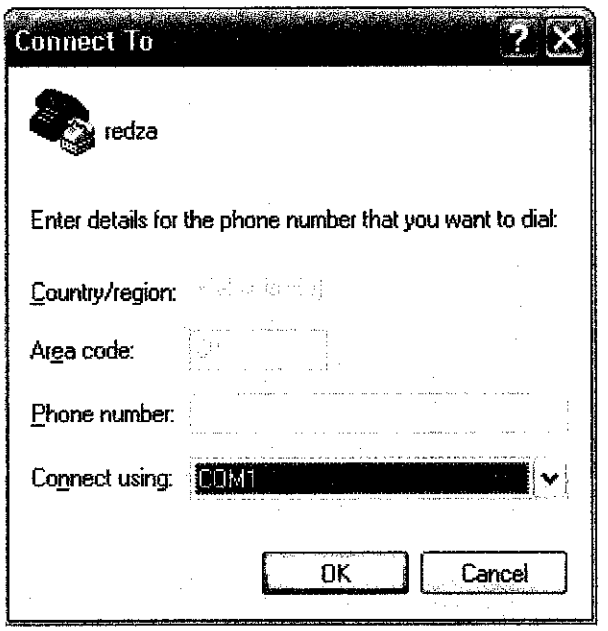


FIGURE 17: HyperTerminal indicates the region by which the connection is to be made

The baud rate is to be selected at 9600 bps (actually, the module will accept all the baud rate setting, any selection will work). The other parameters have to be set: Data Bits (8), Parity (None), Stop bits (1), Flow Control (None). The interface of Windows' HyperTerminal dialog box settings is shown below:

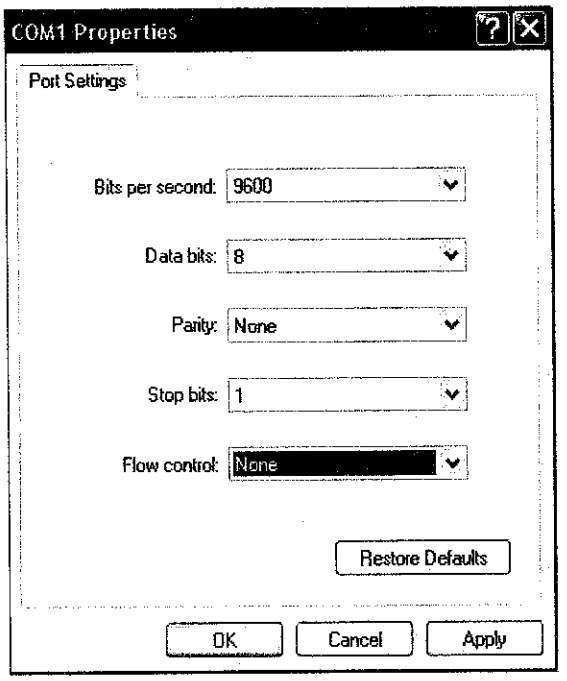


FIGURE 18: COM1 dialogue box settings

Thereto, this will open up a HyperTerminal Window once the OK button is clicked. On the left bottom corner of the HyperTerminal window shows a "Connected 0:00:44" which indicates that the connection is available and the time that the connection has been established. There under, AT Command can be tested out with the GSM modem.

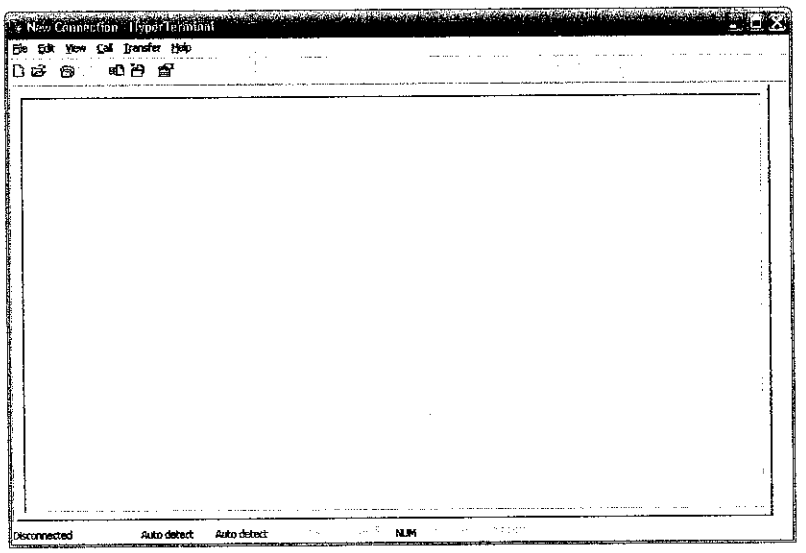


FIGURE 19: HyperTerminal's workspace for AT Command

3.2 Sending a Text SMS

It is really simple to send a SMS as it supports text format which simplifies the programming on the micro-controller. The SMS is sent via two commands:

- AT+CMGF
- AT+CMGS.

The "AT+CMGF=1" selects the GSM module to support the text mode. It is only necessary to initialize the GSM module once. The subsequent command AT+CMGS sends the SMS message. A trace is shown here:

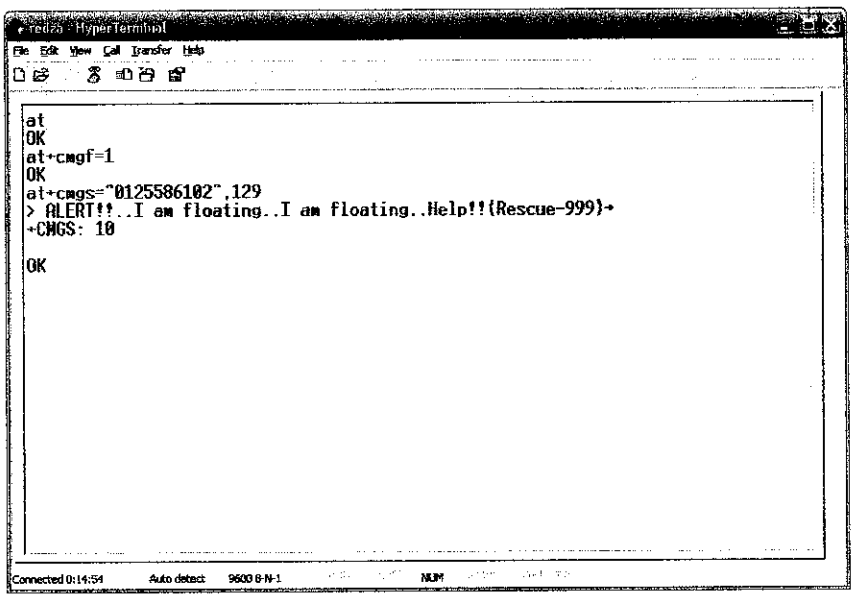


FIGURE 20: AT+CMGF and AT+CMGS commands on HyperTerminal

AT+CMGS="0125586102" means the next text data is to be sent to the telephone number 0125586102 which is the receiver's phone number. After invoking the commands CMGS, the prompt ">" will appear just before entering text. The GSM will response with a ">" character. At baud rates below 19200 it is recommended to use the line termination character only before entering the text. Use of the line termination character followed by the response formatting character can cause problems.

Then, SMS text message can be typed and closed the message using a Ctrl-Z. Ultimately, the SMS is successfully been transmitted to receiver's mobile phone and ready to go for help in a real case situation.

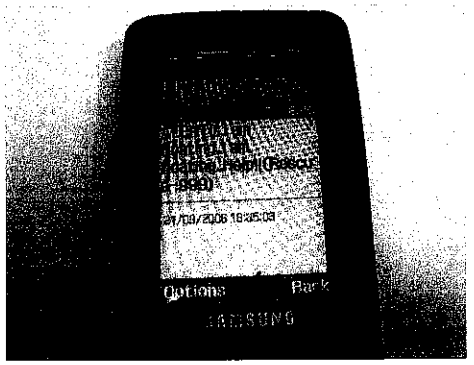


FIGURE 21: SMS is delivered to mobile phone

3.3 Programming the PIC

Below shows the procedures on how to program the PIC16F877 microcontroller using Warp13 software:

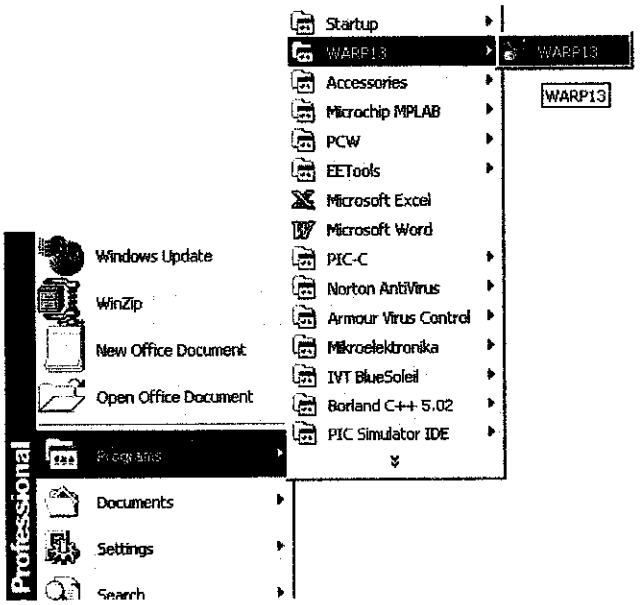


FIGURE 22: Warp13 windows program

FIGURE 23: Warp13 Desktop Icon

First, select the program either in Windows program or on the Desktop Icon: Program→WARP13→WARP13. Warp13 interface displayed on the screen and ready to commence the PIC burning as shown below:

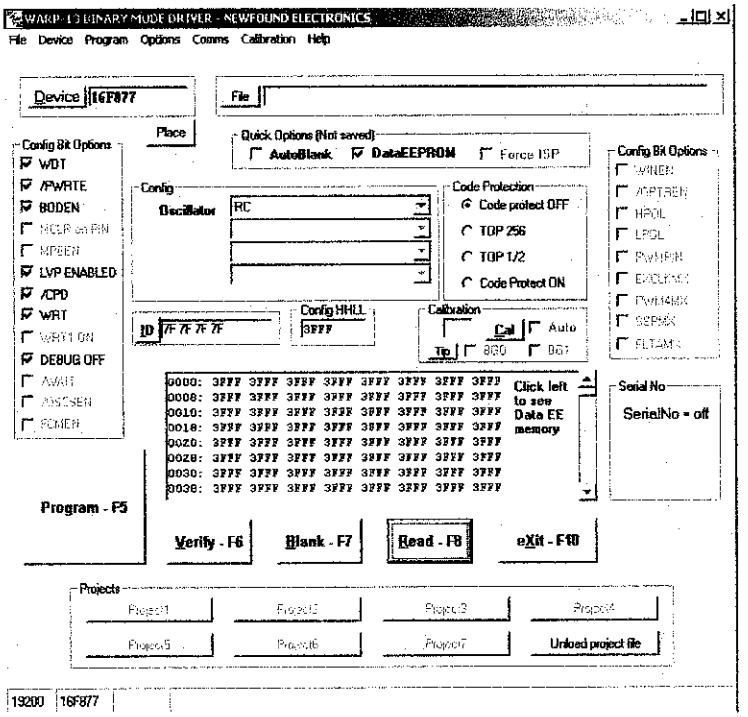


FIGURE 24: Warp13 software interface

Before the PIC is programmed, it has to be read to indicate the present of the original codes which later has to be erased: (**FIGURE 26**)

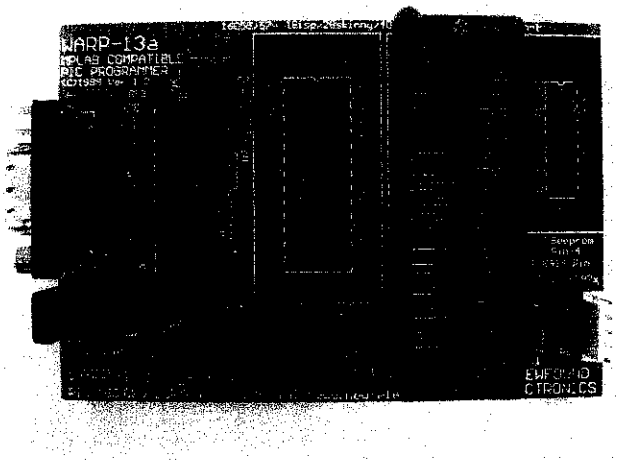


FIGURE 25: Warp13 PIC Programmer device

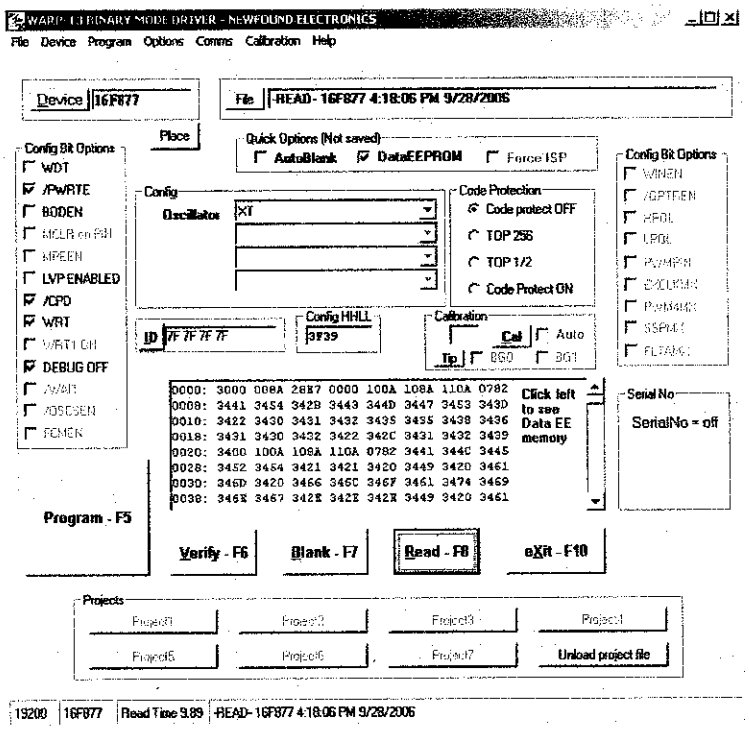


FIGURE 26: Read up the PIC microcontroller at first

Then, the codes in the chip space have to be erased to load the new codes in ".HEX" file format.

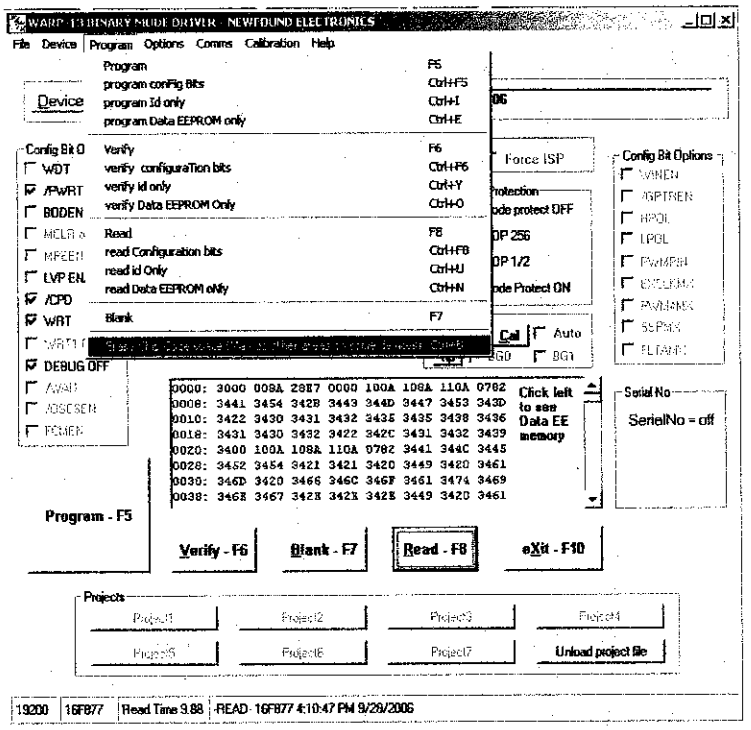


FIGURE 27: Erase the chip codes in the PIC

After all, blank option is chosen to clear the space in the chip.

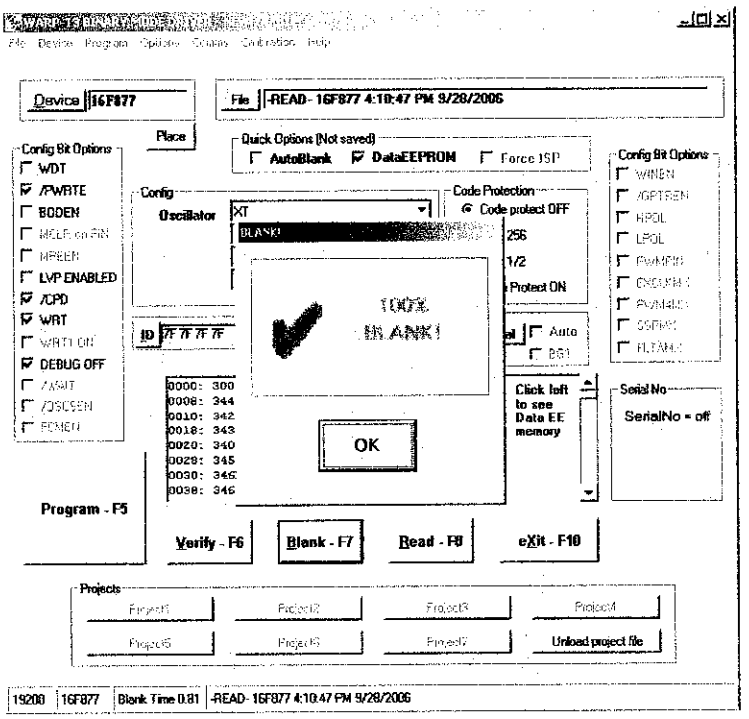


FIGURE 28: Blank the space in the PIC

Browse the .HEX file which needs to be programmed.

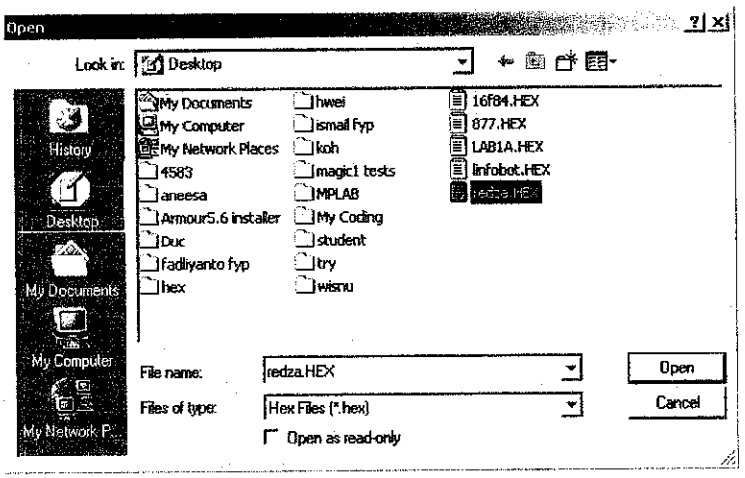


FIGURE 29: Open ".HEX" File

PIC is programmed, 'Program-F5', and stay for few seconds as the chip to be verified.

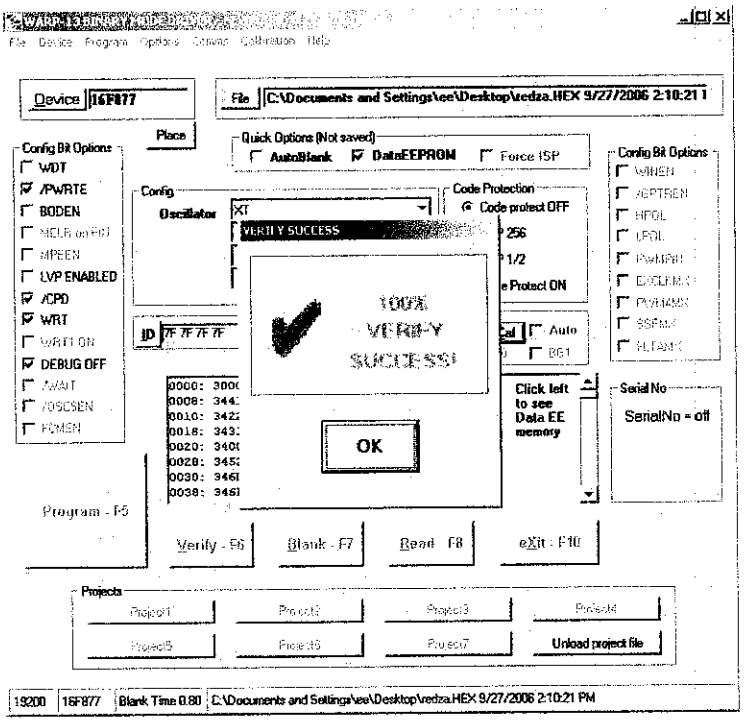


FIGURE 30: Program the PIC16F877 microcontroller

Finally, the programmed codes have to be reread once again before it can be tested on the circuit.

NOTES: Code Protection should always be in 'OFF' position after every code programming. This is to ensure that the data is not permanently saved in the PIC. The microcontroller can be rewritable as long as it is not saved in.

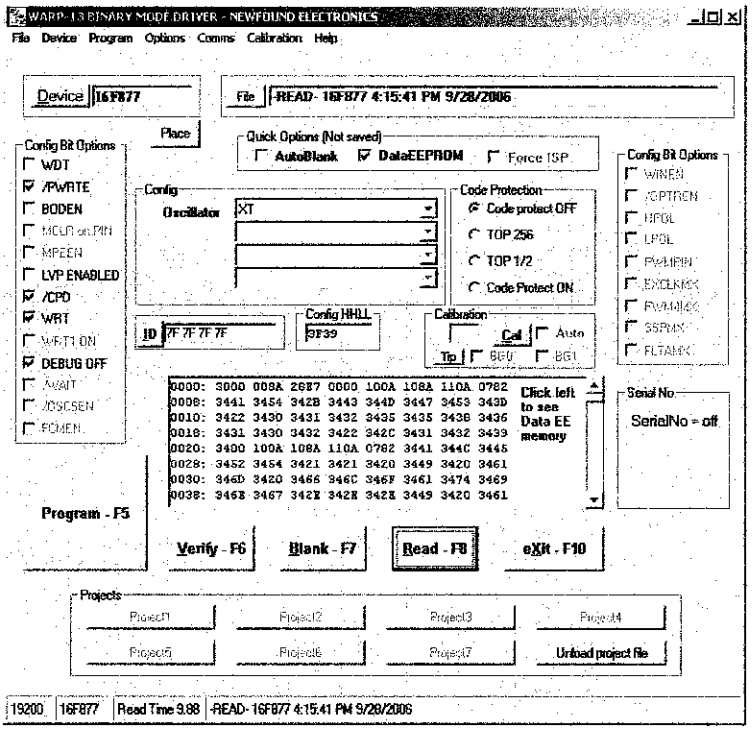


FIGURE 31: Reread the programmed chip code

3.4 Troubleshooting the Circuit

The communication circuit is tested after PIC is programmed. When it is connected to PC through RS232 Serial Communication port (COM1), there is no problem occurred in displaying the programmed data (**FIGURE 32**). It indicates that the data which has already burnt out into the PIC16F877 is absolutely the output that will appear on the receiver's mobile phone.

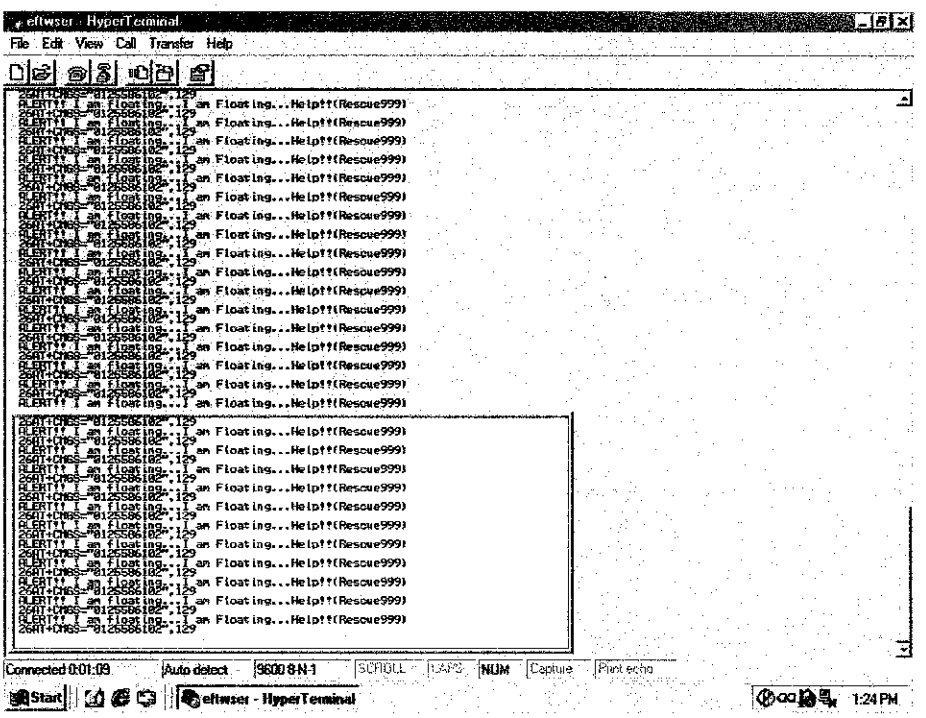


FIGURE 32: The text in which it would appear on the receiver's mobile phone

After connecting the serial port to GSM modem, troublesome occurred due to several reasons:

i. MAX232 has insufficient power to be supplied to GSM modem compared to the enough power to the PC.

ii. The signal waveform came out from MAX232-to-PC is different from the signal waveform came out from MAX232-to-GSM modem.

iii. Programming error most probably due to the ASCII character for 'CTRL+Z' which is 26.

4.0 RESULT & DISCUSSION

The following are some simple AT commands:

TABLE 6: Call control

AT	Attention
ATA	Answer Command
ATD	Dial Command
ATH	Hang Up Call

"AT" is typed on the HyperTerminal and "OK" will respond. This is the simplest command to tell the GSM module to go on attention. It doesn't do anything. However, this is also a means to test if the modem responds on the baud rate and all the serial settings.

4.1 AT Commands Originating from GSM 07.05 for SMS Data Transfer

The SMS related AT Commands are according to the GSM 07.05 specification issued by ETSI (European Telecommunications Standards Institute). The command AT+CMGF, selects SMS message format by either in PDU (Protocol Data Unit) mode or in Text mode like it is currently used.

TA sets parameter which specifies the input and output format of messages to be used. The modes of selecting SMS message format are as follow:

- **0** PDU mode
- **1** text mode

To send the SMS by using text mode, the following commands are used:

If text mode:
(+CMGF=1): +CMGS=<da>[,<toda>]<CR>
Text is entered
<Ctrl-Z/ESC>

TA (Terminal Adaptor) transmits SMS message from TE (Terminal Equipment) to network (SMS-SUBMIT). Message reference value **<mr>** is returned to TE on successful message delivery. Value can be used to identify message upon unsolicited delivery status report result code.

Text mode (+CMGF=1) and sending successful:

+CMGS: <mr>[,scts>] OK

Below are some parameters from the executed commands to give the desired response for delivering the SMS message from GSM module.

TABLE 7: The executed command parameters for SMS delivery

Parameter	Description	Example
<da>	GSM 03.40 TP-Destination-Address Address-Value field in string format; BCD numbers (or GSM default alphabet characters) are converted into characters; type of address given by **<toda>**	0125586102
<toda>	GSM 04.11 TP-Destination-Address Type-of-Address octet in integer format (when first character of **<da>** is + (IRA 43) default is **145**, otherwise default is **129**)	129 by default
<mr>	GSM 03.40 TP-Message-Reference in integer format	+CMGS: 14
<scts>	GSM 03.40 TP-Service-Centre-Time-Stamp in time-string format (refer **<dt>**)	

After the command CMGS is invoked, the prompt ">" is waited and then text can be entered to the module. After that, the message typed can be delivered by which <CTRL-Z> is entered. Sending can be aborted when <ESC> is entered. The operation is acknowledged with OK although the message already been discarded. Moreover, sending e-mails via SMS on HyperTerminal can also be utilized.

Note: Some providers do not recognize "@" symbol. Possible alternative "!" for "@" applied.

It is always recommended to use the line termination character at baud rates lower than 19200 before entering the text, in order to avoid problems caused by the use of response formatting character after line termination character. In other words, text should be entered behind the">".

Prompt will be recognized as GSM characters. For example, "Backspace" (ASCII character 8) does not delete a character, but it will be inserted into the SMS as an additional physical character. As a result, the characters that need to be deleted still appear in the text, plus the equivalent GSM code. In text mode, the maximum length of an SMS depends on the used coding scheme, which are **160** characters if the 7 bit GSM coding scheme is used and **140** characters according to the 8 bit GSM coding scheme.

4.2 Text Delivered and its Limitation

Here is the text that has just set on the HyperTerminal and will be sent to mobile phone:
"ALERT!!..I am floating..I am floating..Help!!(Rescue-999)"

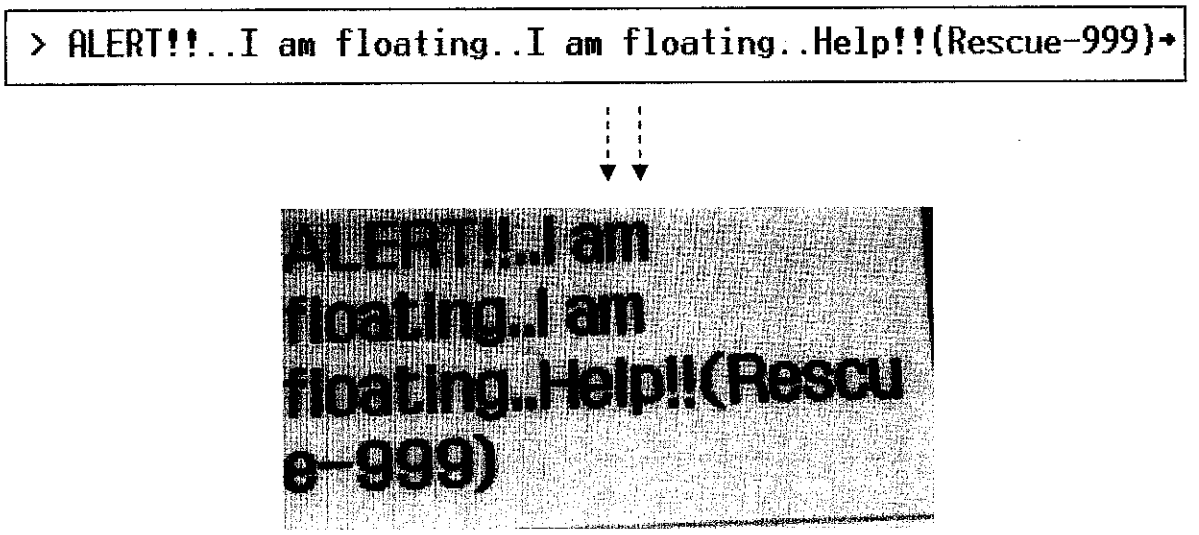


FIGURE 33: Text message that was converted from HyperTerminal to receiver's mobile phone

The message indicates that the jacket wearer has already gone into the water but however, he is floating on the water surface because of the automatically inflated jacket that he wears. Immediate rescue cannot be distracted to avoid calamity of the suspect. Once the SMS has been received, prompt action has to be taken. One question arises.

How does the validity of the received SMS can be perceived?

The sender's original phone number has been set out in the SIM (Subscriber Identity Module) card which was slotted into the GSM module. Therefore, the received SMS will reveal the original sender's phone number. Prior to the event, the jacket wearer has already informed such number to the receiver (perhaps his colleague) and it is definitely proves that the SMS is justified. There under, the validity of the received SMS is in fact genuine.

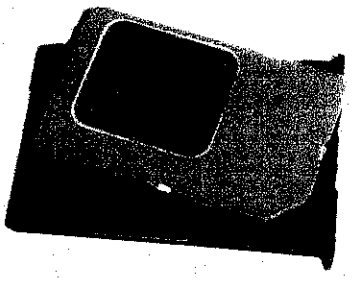


FIGURE 34: SIM card slotted into the GSM module with sender's original phone number

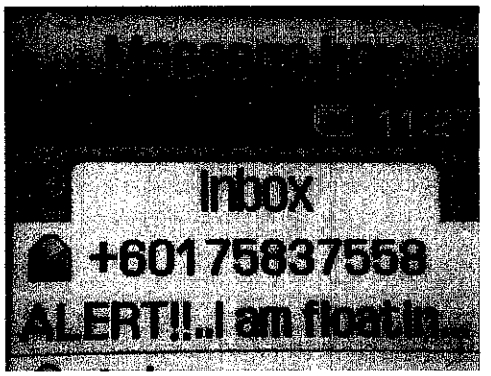


FIGURE 35: The sender's original phone number from GSM module's SIM card

+60175837558 is the sender's original phone number used to deliver SMS to the receiver. The validity of this number is proven by the fact that this number belongs to jacket wearer's phone number. He or she should inform his colleague prior to the event of taking him or her to the destination.

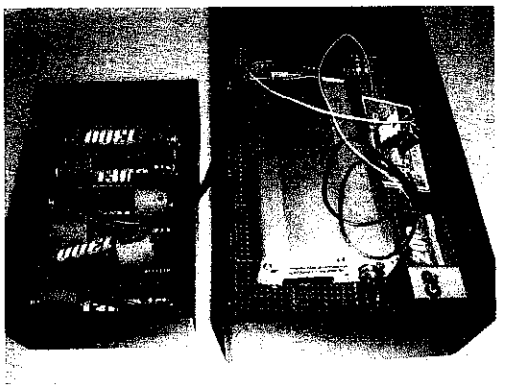


FIGURE 36: The complete setup of communication circuitry where it can be integrated within the jacket. Once the button is depressed, the SMS alert is directly delivered to receiver's mobile phone

According to **FIGURE 36** above, the circuit is initially tested using two (2) power supplies as main sources; one for supplying to the circuit which is 5VDC, 0.16A and another one for supplying to the GSM modem which is 7.5VDC, 0.5A. In order to make this circuit portable, rechargeable batteries are being replaced as the output source. Six (6) 1.2VDC rechargeable batteries (1300mAh each) connected in series, which is equivalent to 7.5VDC are being used as the power supply. Another one, 9VDC, 200mAh battery together with 9VDC to 5VDC, 1A regulator is being used to supply the circuit as an equivalent 5VDC voltage supply. Therefore, the circuit is built portable with the present of these batteries.

The above circuit, **FIGURE 36**, can be scaled down into smaller dimension. However, for the reason of cost consideration, it is just made up to such a size. It would be higher in cost if the circuit is sized down. The power sources used must be smaller-sized batteries, the GSM module's size has to be reduced and the casing also has to be down-sizing. By accomplishing this option, then the circuit would be able to be integrated inside the jacket. Nevertheless, this communication circuit still works well and or course it meets the requirement of this project. Therefore, it is still gives great introduction to double safety approach.

5.0 CONCLUSION & RECOMMENDATION

5.1 As to Conclude

Intelligent Safety Jacket (ISJ) is engineered to the exact specification of double safety approach. It promotes three (3) fundamental aspects which are the SMS alert system, automatic floatation system and also the double safety approach. The SMS alert system is widely used nowadays and easier to obtain its service from quite a number of service providers in Malaysia, by means of its SIM card, which is slotted into the GSM module. This technology is today's essential and will become norm in future to come.

5.2 Future Recommendation

Intelligent Safety Jacket (ISJ) can be further developed in the future by utilizing the GPS (Global Positioning System) technology. This technology enables the receiver to map the real location of the jacket wearer where about by means of its satellite notification.

Apart from that, the other cost-effective way to develop this jacket is by introducing to AVL (Automatic Vehicle Locator) technology. The co-operation with local service providers such as Maxis (M) Sdn. Bhd., DiGi (M) Sdn. Bhd. or Celcom (M) Sdn. Bhd. is a must to obtain such a service. Initially, the modem will deliver SMS alert to both the receiver's mobile phone and to the local service provider once the button is depressed. Then the local service provider (Maxis for example) will acknowledge the notified SMS by sending back the follow-up SMS to the receiver indicating the location of the jacket wearer where about as referred to the nearest communication tower or the nearest local subdivision tower.

Moreover, the safety of this jacket can be further improved by developing the system delivering the SMS alert to many receivers as possible rather than the one itself. Friends, relatives, parents and even local rescuers can be notified through this SMS and then they come to help the drowning person on the spot.

REFERENCES

[1] http://www.lifejackets-uk.co.uk/children's lifejackets.htm

[2] http://www.cnn.com/CNN_com - Smart shirt that can call for help - Oct 12, 2004.htm

[3] Google Search - Overview of GSM (Global System for Mobile Communication).htm

[4] http://www.mustangsurvival.com/products/category.php?t=6/automatic_ inflatable_ Re-Arm Kit.htm

[5] http://www.mustangsurvival.com/resources/faqs/general.php

[6] http://www.mustangsurvival.com/products/product.php?id=521

[7] C CODE_USING CCS PIC C & WARP 13.txt

[8] C_for_pic_eg.pdf

[9] C_programming_For_PIC_Microcontroller.ppt

[10] Control of LEDs using Switches.txt

[11] EEB_5303_Microprocessor_II_lab3.doc

[12] PIC_Microcontroller_Lab_1.pdf

[13] PIC_Microcontroller_Lab_2.pdf

[14] PIC_Microcontroller_Preamble.pdf

[15] PIC_Microcontroller_Topic_1.pdf

[16] PIC_Microcontroller_Topic_2.pdf

[17] PIC_Microcontroller_Topic_3.pdf

[18] PIC_Microcontroller_Topic_4_Part1.pdf

[19] PIC_Microcontroller_Topic_4_Part2.pdf

[20] PIC_Microcontroller_Topic_5.pdf

[21] PIC_Microcontroller_Topic_5.ppt

[22] PIC_microcontrollers.pdf

[23] OGFT-AR3_Owners_Manual.pdf

[24] Google Search - PV9270.11.pdf

[25] Quotation.pdf

[26] http://www.vikingsafetyshop.com/usr/viking/TradeingItems.nsf/linkopen /1014963?opendocument

[27] RescYou Conquest lifejacket_spec.pdf

[28] RescYou_Mariner lifejackets.pdf

[30] http://www.sospenders.com/demo/sospenders-demo-inflated.html

[31] http://www.sospenders.com/demo/sospenders-demo.html

[32] http://shop.lifejackets.co.uk/acatalog/Halkey_Roberts_rearming_kits.html

[33] http://www.poormansboating.com/catalog/watertoys/watertoys.htm

[34] http://www.vikingsafetyshop.com/usr/viking/TradeingItems.nsf/ webdisplaylist?openform&Lifejackets=Lifejackets,@Inflatable

[35] http://www.grabner-sports.at/index.php?id=422&L=2

[36] Google Search - life jacket information.htm

[37] http://www.boatsafe.com/nauticalknowhow/life jacket information.htm

[38] Google Search - materials today.pdf

[39] http://zone.ni.com/devzone/cda/main

[40] Google Search - microelectromechanical system(MEMS).pdf

[41] http://www.landfallnavigation.com/mustangpfd.html

[42] http://serve.me.nus.edu.sg/MeNus/MeNus_0411/main.html

[43] http://www.viking-life.com/usr/viking/VikingDotCom.nsf/va_webpages/ProtectiveClothingoLifejacket?opendocument&Expand=1

[44] Remote RF Powering System for Wireless MEMS Strain Sensors, Nattapon Chaimanonart, *Student Member, IEEE,* and Darrin J. Young

[45] http://www.cnn.com/TECH/smart shirt that can call for help.htm

[46] http://www.landfallnavigation.com/chil.html

[47] Google Search - under the sea.pdf

[48] Google Search - Use of Strain Gauge for.pdf

[49] Google Search - water seepage alarm.pdf

[50] http://www.mitedu.freeserve.co.uk/Circuits/Switching/waterrelay.htm

[51] Google Search - C35i-bro.pdf

[52] Google Search - C39i-bro.pdf

[53] Google Search - fastrack.pdf

[54] Google Search - FASTRACK_GSM Modem_M1306B.pdf

[55] Google Search (Software) - GSMEncDec.zip

[56] http://www.usbdeveloper.com/GSMModule/USBDeveloper.GSMmodule.html

[57] Google Search - iTegno 3232E Specification.pdf

[58] Google Search - iTegno WM1080A Specification.pdf

[59] Google Search - Syarikat SESCO Berhad_Wavecom Fastrack (M1306B) GSM Modem.pdf

[60] Google Search - T68.zip

[61] Google Search - tc35_at_command.zip

[62] http://www.usbdeveloper.com/GSMPage/gsmpage_7bittable.htm

[63] http://www.usbdeveloper.com/GSMPage/gsmpage.htm

[64] http://www.indocommit.com/index.html?menu=45&PHPSESSID=3375f529a496f3a0936b488fae238284

APPENDICES

See the attachments next pages:

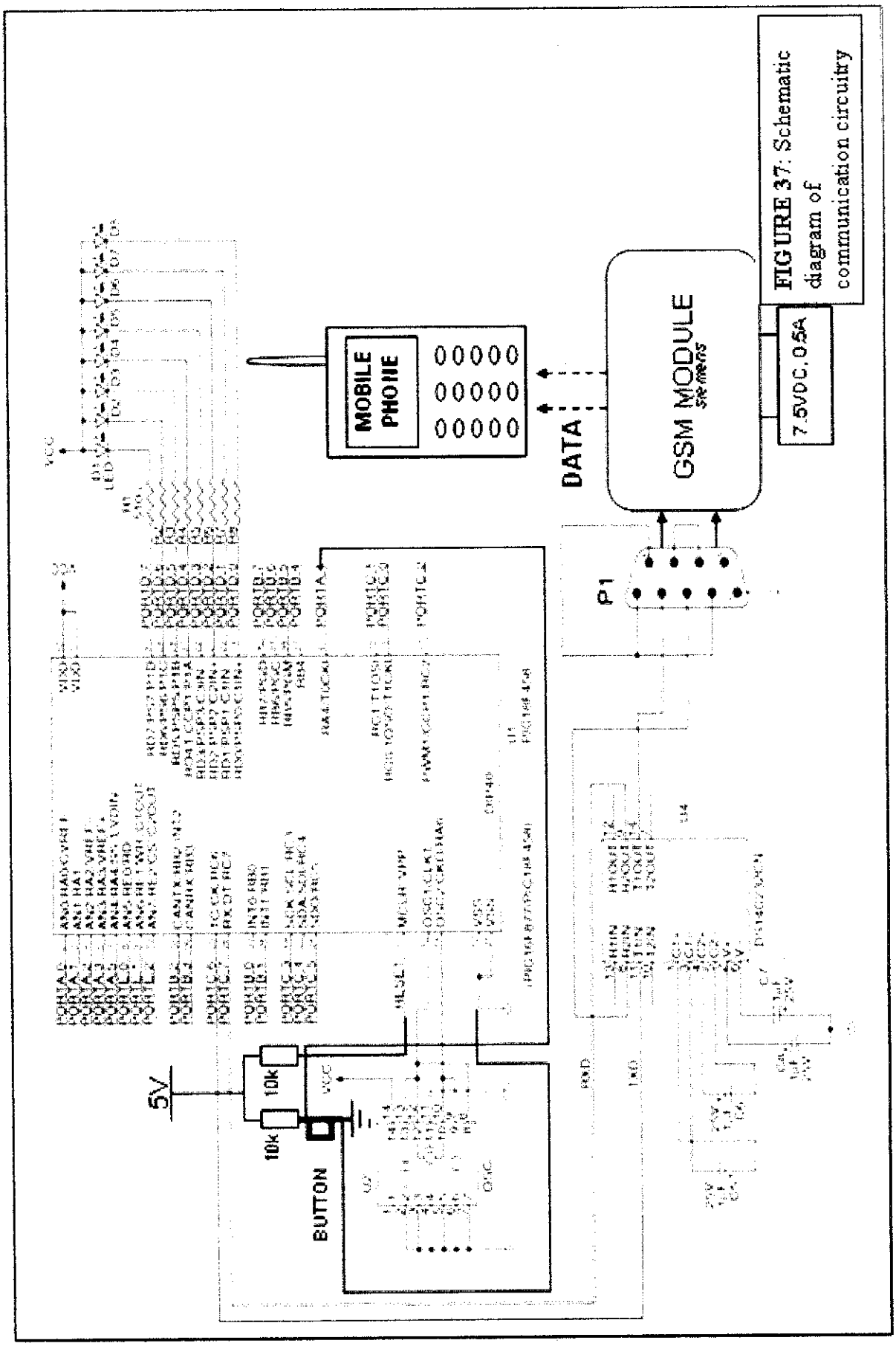


FIGURE 37: Schematic diagram of communication circuitry

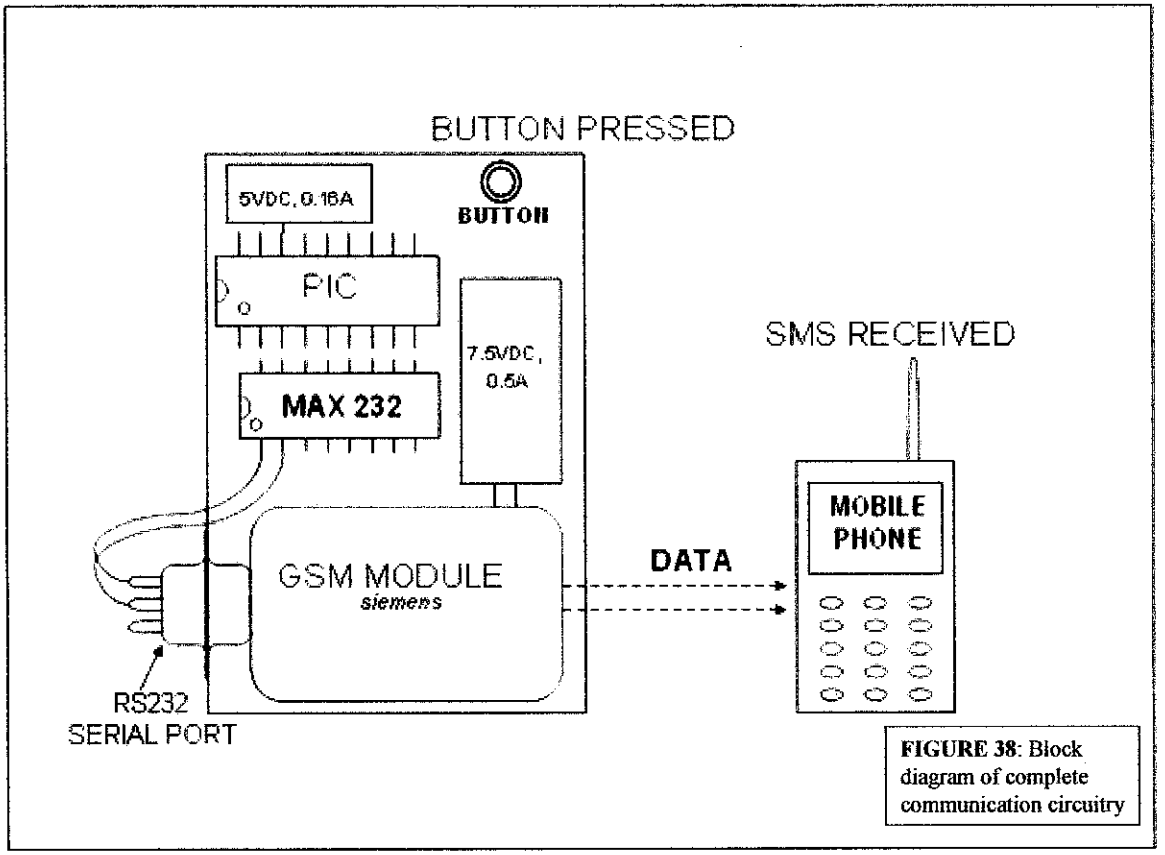


FIGURE 38: Block diagram of complete communication circuitry

MICROCHIP

PIC16F87X

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

Devices Included in this Data Sheet:

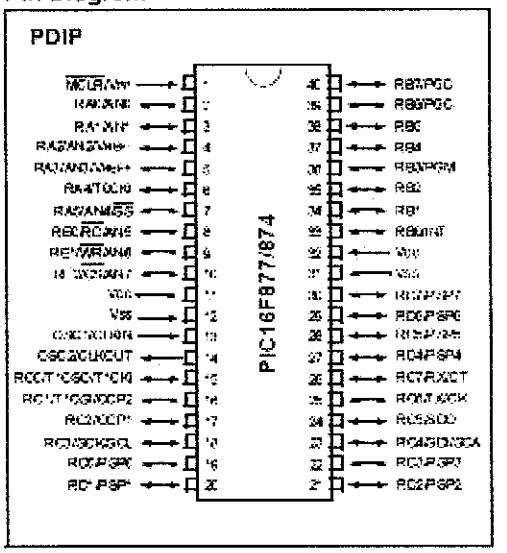
- PIC16F873
- PIC16F874
- PIC16F876
- PIC16F877

Microcontroller Core Features:

- High performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input
  DC - 200 ns instruction cycle
- Up to 8K x 14 words of FLASH Program Memory,
  Up to 368 x 8 bytes of Data Memory (RAM)
  Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to the PIC16C73B/74B/76/77
- Interrupt capability (up to 14 sources)
- Eight level deep hardware stack
- Direct, indirect and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and
  Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low power, high speed CMOS FLASH/EEPROM technology
- Fully static design
- In-Circuit Serial Programming™ (ICSP) via two pins
- Single 5V In-Circuit Serial Programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial, Industrial and Extended temperature ranges
- Low-power consumption
  - < 0.6 mA typical @ 3V, 4 MHz
  - 20 µA typical @ 3V, 32 kHz
  - < 1 µA typical standby current

Pin Diagram

PDIP



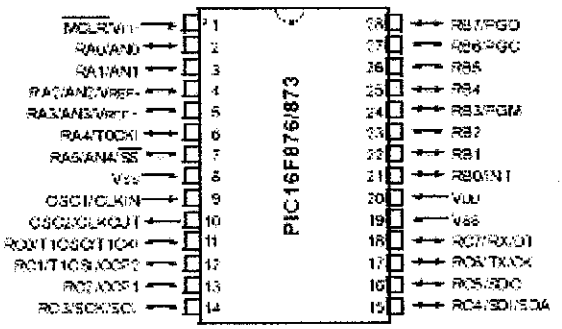
Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during SLEEP via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I²C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

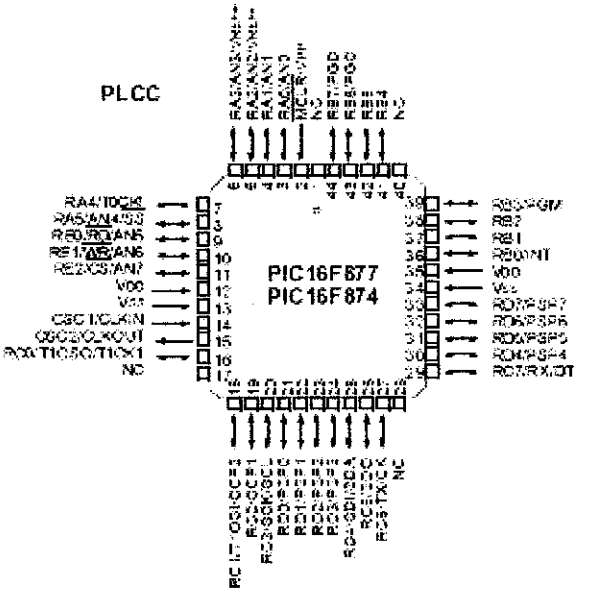
PIC16F87X

Pin Diagrams

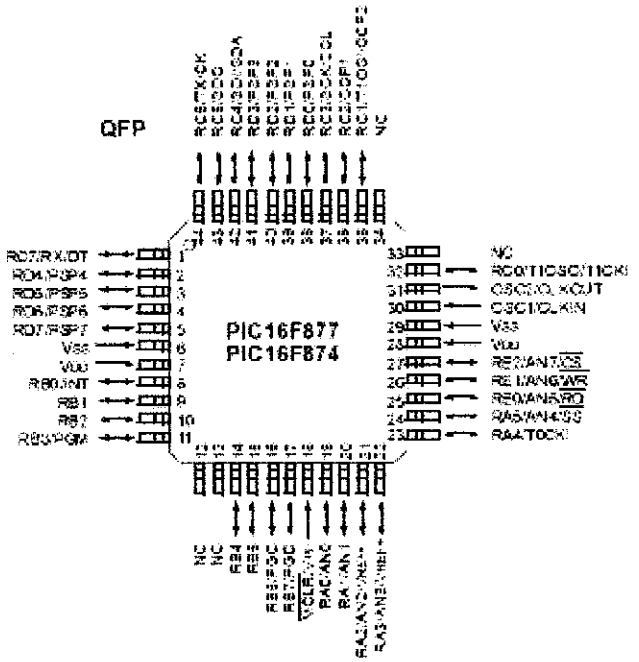
PDIP, SOIC



PLCC



QFP



PIC16F87X

TABLE 1-2: PIC16F874 AND PIC16F877 PINOUT DESCRIPTION

Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKIN	13	14	30	I	ST/CMOS(4)	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	14	15	31	O	—	Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode. In RC mode, OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
MCLR/VPP	1	2	18	I/P	ST	Master Clear (Reset) input or programming voltage input. This pin is an active low RESET to the device.
						PORTA is a bi-directional I/O port.
RA0/AN0	2	3	19	I/O	TTL	RA0 can also be analog input0.
RA1/AN1	3	4	20	I/O	TTL	RA1 can also be analog input1.
RA2/AN2/VREF-	4	5	21	I/O	TTL	RA2 can also be analog input2 or negative analog reference voltage.
RA3/AN3/VREF+	5	6	22	I/O	TTL	RA3 can also be analog input3 or positive analog reference voltage.
RA4/T0CKI	6	7	23	I/O	ST	RA4 can also be the clock input to the Timer0 timer/counter. Output is open drain type.
RA5/SS/AN4	7	8	24	I/O	TTL	RA5 can also be analog input4 or the slave select for the synchronous serial port.
						PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	33	36	8	I/O	TTL/ST(1)	RB0 can also be the external interrupt pin.
RB1	34	37	9	I/O	TTL	
RB2	35	38	10	I/O	TTL	
RB3/PGM	36	39	11	I/O	TTL	RB3 can also be the low voltage programming input.
RB4	37	41	14	I/O	TTL	Interrupt-on-change pin.
RB5	38	42	15	I/O	TTL	Interrupt-on-change pin.
RB6/PGC	39	43	16	I/O	TTL/ST(2)	Interrupt-on-change pin or In-Circuit Debugger pin. Serial programming clock.
RB7/PGD	40	44	17	I/O	TTL/ST(2)	Interrupt-on-change pin or In-Circuit Debugger pin. Serial programming data.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

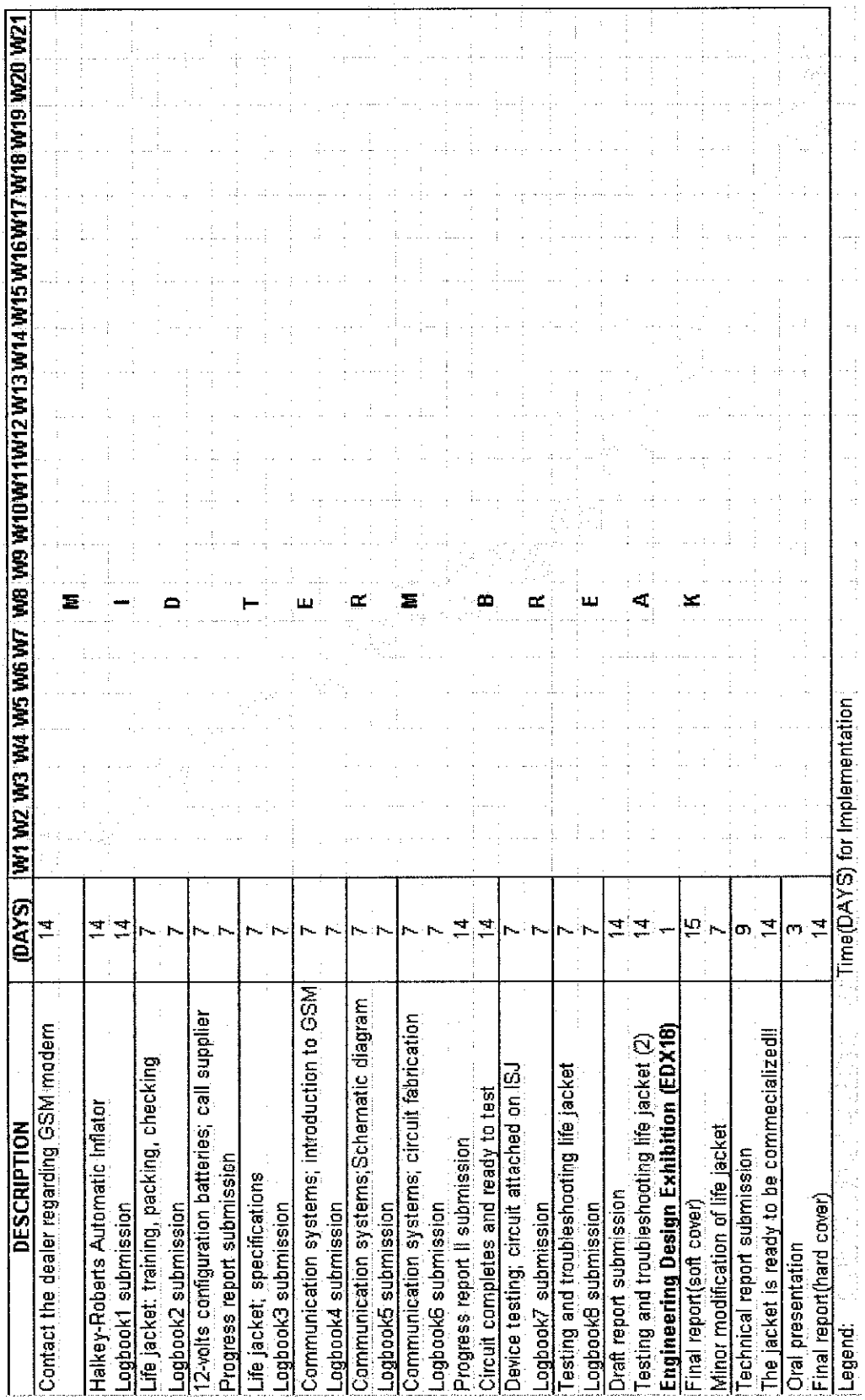
Note 1: This buffer is a Schmitt Trigger input when configured as an external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured as general purpose I/O and a TTL input when used in the Parallel Slave Port mode (for interfacing to a microprocessor bus).
4: This buffer is a Schmitt Trigger input when configured in RC oscillator mode and a CMOS input otherwise.

TABLE 1-2: PIC16F874 AND PIC16F877 PINOUT DESCRIPTION (CONTINUED)

Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
						PORTC is a bi-directional I/O port.
RC0/T1OSO/T1CKI	15	16	32	I/O	ST	RC0 can also be the Timer1 oscillator output or a Timer1 clock input.
RC1/T1OSI/CCP2	16	18	35	I/O	ST	RC1 can also be the Timer1 oscillator input or Capture2 input/Compare2 output/PWM2 output.
RC2/CCP1	17	19	36	I/O	ST	RC2 can also be the Capture1 input/Compare1 output/PWM1 output.
RC3/SCK/SCL	18	20	37	I/O	ST	RC3 can also be the synchronous serial clock input/output for both SPI and I^2C modes.
RC4/SDI/SDA	23	25	42	I/O	ST	RC4 can also be the SPI Data In (SPI mode) or data I/O (I^2C mode).
RC5/SDO	24	26	43	I/O	ST	RC5 can also be the SPI Data Out (SPI mode).
RC6/TX/CK	25	27	44	I/O	ST	RC6 can also be the USART Asynchronous Transmit or Synchronous Clock.
RC7/RX/DT	26	29	1	I/O	ST	RC7 can also be the USART Asynchronous Receive or Synchronous Data.
						PORTD is a bi-directional I/O port or parallel slave port when interfacing to a microprocessor bus.
RD0/PSP0	19	21	38	I/O	ST/TTL(3)	
RD1/PSP1	20	22	39	I/O	ST/TTL(3)	
RD2/PSP2	21	23	40	I/O	ST/TTL(3)	
RD3/PSP3	22	24	41	I/O	ST/TTL(3)	
RD4/PSP4	27	30	2	I/O	ST/TTL(3)	
RD5/PSP5	28	31	3	I/O	ST/TTL(3)	
RD6/PSP6	29	32	4	I/O	ST/TTL(3)	
RD7/PSP7	30	33	5	I/O	ST/TTL(3)	
						PORTE is a bi-directional I/O port.
RE0/$\overline{RD}$/AN5	8	9	25	I/O	ST/TTL(3)	RE0 can also be read control for the parallel slave port, or analog input5.
RE1/$\overline{WR}$/AN6	9	10	26	I/O	ST/TTL(3)	RE1 can also be write control for the parallel slave port, or analog input6.
RE2/$\overline{CS}$/AN7	10	11	27	I/O	ST/TTL(3)	RE2 can also be select control for the parallel slave port, or analog input7.
VSS	12,31	13,34	6,29	P	—	Ground reference for logic and I/O pins.
VDD	11,32	12,35	7,28	P	—	Positive supply for logic and I/O pins.
NC	—	1,17,28, 40	12,13, 33,34		—	These pins are not internally connected. These pins should be left unconnected.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as an external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured as general purpose I/O and a TTL input when used in the Parallel Slave Port mode (for interfacing to a microprocessor bus).
4: This buffer is a Schmitt Trigger input when configured in RC oscillator mode and a CMOS input otherwise.



DESCRIPTION	(DAYS)	W1 W2 W3 W4 W5 W6 W7 W8 W9 W10 W11 W12 W13 W14 W15 W16 W17 W18 W19 W20 W21
Contact the dealer regarding GSM modem	14	M
Halkey-Roberts Automatic Inflator	14	
Logbook1 submission	14	I
Life jacket: training, packing, checking	7	
Logbook2 submission	7	D
12-volts configuration batteries; call supplier	7	
Progress report submission	7	T
Life jacket; specifications	7	
Logbook3 submission	7	E
Communication systems; introduction to GSM	7	
Logbook4 submission	7	R
Communication systems;Schematic diagram	7	
Logbook5 submission	7	M
Communication systems; circuit fabrication	7	
Logbook6 submission	7	
Progress report II submission	14	B
Circuit completes and ready to test	14	
Device testing; circuit attached on ISJ	7	R
Logbook7 submission	7	
Testing and troubleshooting life jacket	7	E
Logbook8 submission	7	
Draft report submission	14	
Testing and troubleshooting life jacket (2)	14	A
Engineering Design Exhibition (EDX18)	1	
Final report(soft cover)	15	K
Minor modification of life jacket	7	
Technical report submission	9	
The jacket is ready to be commercialized!!	14	
Oral presentation	3	
Final report(hard cover)	14	
Legend:	Time(DAYS) for Implementation	

FIGURE 39: Gantt chart for ISJ, Final Year Project II