University of Mohamed Khider – BISKRA
Faculty of science & technology
Department: Electrical Engineering
Option: Telecommunication

Ref:

Memory End of Studies
for graduation

Master

theme

Study and realization of a supervisor for Process by GSM

Presented by:
AZZEDDINE BENLAMOUDI
Supported on: 08June 2012

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theme

Study and realization of a supervisor from Process by GSM

Presented by: **Supervisor**

AZZEDDINE BENLAMOUDI   -Dr. Kaouther El kourd

ABSTRACT

Thinking of telecommunication technology GSM, it immediately comes to mind voice communication, sending and receiving SMS and MMS, mobile internet, and all what works using this modern technology introduced in our daily lives. It is less obvious to think, that by using these services provided through this system, it is possible to monitor and control remote systems by using the GSM network. Applications can be used in various fields such as monitoring and remote control of machines, alarm systems and monitoring, control of doors or light lamps...

The GSM module (TC35) receive the message SMS, then the microcontroller PIC16F877A control the system-card by lamps. The software program used in the project named "PROTEUS".

Dedication

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my parents of their words of encouragement & tenacity, which still ring in my ear. To My sisters and brothers where they are always beside me.

I also dedicate this dissertation to my many friends and family who have supported me throughout the process. I will always appreciate all they have done, especially HOUASE Fodile , Nourdine and Ahmed for helping me ;Dr El kourd Kaouther for the many hours of proofreading; Yacine, Rostem, Alla, chahla and The four girls for helping me to master the leader dots.

I dedicate this work and give special thanks to my best friend Deghnouche Seif eddine.

Finally, this thesis is dedicated to all those who believe in the richness of learning.

Acknowledgements

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ABBREVIATION

List of Abbreviation

ASIC: Application Specific Integrated Circuit

AT : attention

AUC: Authentication Center

BSC: Base Station Controller

BSS: Base Station Sub-system

BTS: Base Transceiver Station

CEPT: Conference of European Posts and Telegraphs

EIR: Equipment Identity Register

ETSI: European Telecommunication Standard Institute

GMSC: Gateway MSC GMSC

GSM: Group Special Mobile or Global System for Mobile Communication

HLR: Home Location Register

IMSI: International Mobile Subscriber Identity

ISDN: Integrated Services Digital Network

MAP: Mobile Application Part

ME: Mobile Equipment

MS: Mobile Station

MSC: Mobile Switching Center

MWD File: Message Waiting Data File

NMC: Network Management Centre

NSS: Network Sub-system

OMC: Operations and Maintenance Center

OSS: Operation Subscriber System

PLMN: Public Land Mobile Network

PSTN: Public Switched Telephone Network

SFH: Slow Frequency Hopping

SIM: Subscriber Identity Module

SMS: Short Message Service

SMS / CB: SMS Cell Broadcast

SMS-MO: SMS Mobile Originated

SMS-MT: SMS Mobile Terminated

SMS / PP: SMS Point to Point

SS7: Signaling System Number 7

ABBREVIATION

TA : Terminal Adaptor

TDMA: Time Division Multiple Access

TE : Terminal Equipment

VLR: Visitor Location Register

ABSTRACT

Abstract

Thinking of telecommunication technology GSM, it immediately comes to mind voice communication, sending and receiving SMS and MMS, mobile internet, and all what works using this modern technology introduced in our daily lives. It is less obvious to think, that by using these services provided through this system, it is possible to monitor and control remote systems by using the GSM network. Applications can be used in various fields such as monitoring and remote control of machines, alarm systems and monitoring, control of doors or light lamps...

The GSM module (TC35) receive the message SMS, then the microcontroller PIC16F877A control the system-card by lamps. The software program used in the project named "PROTEUS".

Résumé

En pensant à la technologie de télécommunication GSM, il nous vient immédiatement à l'esprit la communication vocale, l'envoi et la réception des SMS et des MMS, l'internet mobile, et tous ce qui fonctionne en utilisant cette technologie moderne introduite dans notre vie quotidienne. Il est moins évident de penser, qu'en se servant de ces services fournis à travers ce système, il est possible de contrôler et de commander des systèmes à distance en ayant recours au réseau GSM. Des applications peuvent être utilisées dans divers domaines comme le contrôle et la commande à distance des machines, des systèmes d'alarme et de surveillance, de commander des portes ou d'allumer des lampes…

Le module GSM (TC35) reçoit les messages SMS, le microcontrôleur PIC16F877A commandé la carte système a l'aide des lampes. Le logiciel utilisé dans le projet nommé "PROTEUS".

ملخص

التفكير في تكنولوجيا الاتصالات السلكية واللاسلكية GSM، ويأتي إلى الذهن على الفور الاتصال الصوتي، وإرسال واستقبال الرسائل القصيرة والرسائل المتعددة الوسائط، الإنترنت عبر الهاتف النقال، وجميع ما يعمل باستخدام هذه التكنولوجيا الحديثة التي أدخلت في حياتنا اليومية. هو أقل وضوحا على التفكير، وذلك عن طريق استخدام هذه الخدمات المقدمة من خلال هذا النظام، فمن الممكن لرصد ومراقبة الأنظمة البعيدة باستخدام شبكة GSM. ويمكن استخدام التطبيقات في مجالات مختلفة مثل المراقبة والتحكم عن بعد من أجهزة ونظم الإنذار والرصد، وبوابات التحكم أو مصابيح الضوء ...

وحدة جي إس إم (TC35) تتلقى رسالة قصيرة، ثم PIC16F877A يتحكم في نظام بطاقة بواسطة المصابيح. البرنامج المستخدم في هذا المشروع يسمى "برو تيوس".

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GENERAL INTRODUCTION

General Introduction

The traditional means of information transfer no longer meet the criteria of efficiency and time constraints that become increasingly severe. The recourse to sophisticated means of communication becomes essential to ensure control of hazards that may be encountered, as well as satisfy our need for comfort.

Thinking of telecommunication technology "GSM" is immediately comes to mind voice communication, sending and receiving SMS and MMS, mobile internet, and all who work by using this modern technology introduced in our daily lives.

It is less obvious to think, that using these services provided through this system is possible to monitor and control, remote systems by using the GSM network. Applications can be used in various fields such as monitoring and remote control of machines and alarm systems and monitoring, control the door or the lighting of lamps...etc; for that we have choosing this project, where "supervision by GSM" present; a simple and easy solution that can help us to ensure proper handling of the existing reality in order to achieve our goal.

The subject aims to control a machine which will be able to be controlled remotely using a program from a PIC or a computer. To do this operation; the computer and machine communicate through a wireless link.

The objectives of this project are many and varied. In the medium term, the machine must be autonomous and will be entirely subservient to orders and instructions from the control by PIC. It may even eventually using sensor communicate with the PC, control it, return information for example on its environment and to avoid obstacles.

To accomplish this project, we raised several questions as the form of problematic:

What is GSM? What is the relationship between SMS and GSM? What is the AT? What is the relation between SMS and command circuit?

The content is divided to 4 chapters.

The first one: define the GSM network and SMS service.

The second chapter: define the GSM module and AT commands.

GENERAL INTRODUCTION

The third chapter: Study the System Architecture.

The last chapter, display the realization and validation of our project.

The important references used for preparing this project are:

- Interfaces GSM : Montages pour téléphones portables

- PIC Microcontrollers Basic Course PICmicro Mid-Range MCU Family

In fact ,we need to high accuracy in the selection of each piece of the project and due to the lack of the most important parts in the laboratory we had bought almost all the pieces, specially the Module GSM, which was the last piece in the market for that we must be cautious .

At the end, we thank all person helped me in every part of this project.

Now we pass to chapter 1 & its general definitions of project.

Chapter I:
GSM network and
SMS service

I.1. Introduction

In a world that wants no borders where communication is a vital need, it is important to develop the right tools and techniques to ensure reliability and quality of communication. Such tools can be summarized in a good system of supervision and administration. To set up a monitoring application to intervention and innovative problem solving in a minimum amount of time we have to choose the right technologies that support those needs. A platform operator and courier service over the wireless network or the Internet is the best solution to ensure continuous and effective supervision. So it is necessary to make comprehensive study of the GSM system and the messaging service (SMS **S**hort **M**essage **S**ervice) [1]

I.2. Wireless networks

A wireless network (les reseaux sans fil) is a network in which the participating machines are not connected together by a physical medium that is of type copper cable or optical fiber, which is part of the GSM wireless networks. This type of network allows users to move in a certain area of coverage without losing the signal and without the need for connection cable to the network.

The data transmission between the nodes constituting the network is not using a physical but on the basis of radio waves (radio, infrared). This type of network used to connect various remote devices and this in an area ranging from a few meters to several tens of meters depending on the frequencies and powers used [2]

I.3. Overview of GSM

In 1982, the **C**onference of **E**uropean **P**osts and **T**elegraphs (CEPT) formed a study group to define and develop a pan-European standard for a mobile telephone system. This group was given the name **G**roup **S**pecial Mobile (**GSM**). The main task of this group was to propose a system to overcome inherent issues faced by the analog system existing at that time. The new system had to meet criteria defined by CEPT as given below:

- Spectrum efficiency
- Support for international roaming
- Lower cost of mobiles, infrastructure, and services
- Superior speech quality
- Support for a range of new services

- Compatibility with ISDN (**I**ntegrated **S**ervices **D**igital **N**etwork)

Later, the study group was transferred to the **E**uropean **T**elecommunication **S**tandard **I**nstitute (ETSI), which released phase 1 of the GSM specification in 1990. The term GSM now means Global System for Mobile Communication. The GSM standard, which was initially developed for Europe, has been embraced worldwide. The standard has been evolving since then to meet demands of next generation networks. GSM is feature rich. It includes automatic roaming, full voice and data services, excellent speech quality, and a wide range of supplementary services. [3]

I.3.1. Characteristics of the GSM network

It is simply to give here the principal characteristics of the GSM network, no structure will be briefly described below. **Tab.I.1**

GSM	
Frequency band	(↑) 890.2-915 MHz (↓) 935.2-960 MHz
Number of time intervals by TDMA frame	8
Ecart Duplex	25.2 MHz
Speed of modulation	271 kbit/sec
Speech rate	13 kbit/sec
rate max of data	12 kbit/sec
Multiple Access	Frequency and time Multiplexage
Radius cells	0,3 à 30 km
Power (terminal)	2 et 8 W

Tab .I.1.Principal Characteristics of GSM. [4]

GSM systems are compatible with all existing telephone networks, so they can have all their traditional services, namely voice, data, fax, email. Use in addition to the SIM (**S**ubscriber **I**dentity **M**odule) has also introducing new features making each subscriber terminal-independent it uses.

The GSM standard can be seen as a good mix of various digital transmission technologies, such as sharing time, coding of speech at different rates, the survey channel and discontinuous transmission.

The technique used is to share a time sharing or TDMA (**T**ime **D**ivision **M**ultiple **A**ccess). This solution, in fact, to divide each of the carriers used in time intervals, called slots, of duration T = 0.5769 s. Each slot can transmit a number of bits is called a burst. An interesting option of the system is frequency hopping or SFH (**S**low **F**requency **H**opping). It helps fight against selective fading by introducing a relative frequency diversity. A channel is not sitting on a frequency in reality, but on a set of N frequencies ($N_{max} = 64$).

To summarize, the GSM is a TDMA system of two bands of 200 kHz for both directions of transmission, frequency duplexing where 8 simultaneous communications can be multiplexed on the same pair of frequencies. [4]

I.4. GSM architecture

For the system to offer the services provided a set of functions has been defined. These functions are those required in any mobile network, such as numbering, routing to a mobile user, the cell transfer, etc... These functions are grouped into functional entities. See fig(I.1)

The GSM system consists of three subsystems are:

-    The radio subsystem BSS (**B**ase **S**tation **S**ubsystem)
-    The network subsystem NSS (**N**etwork **S**ubsystem)
-    The sub-system OMC (**O**perating and **M**aintenance **C**enter).
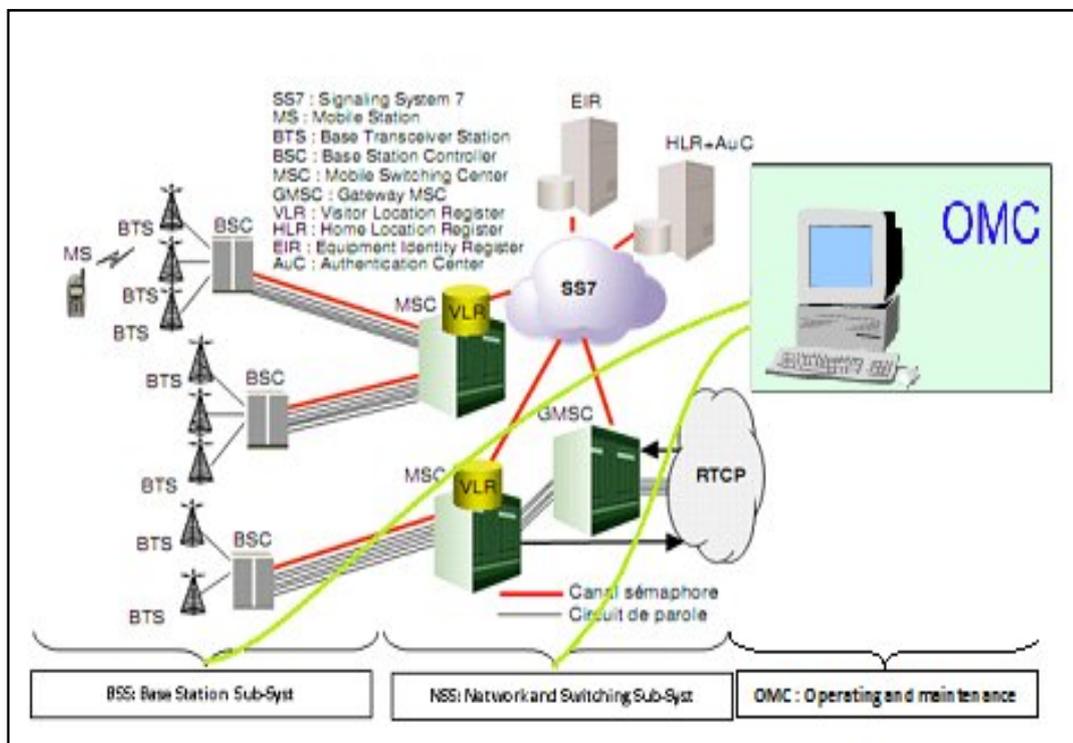
Fig. I.1.Architecture of a GSM network. [5]

I.4.1. Subsystem radio (Base Station Sub-system BSS)

It provides coverage of geographical areas called cells that contain the materials and software needed to communicate with mobile stations. The radio subsystem manages the radio transmission, it consists of several entities.

I.4.1.1. Mobile Station MS

The purpose of a GSM is to provide telecommunications services to subscribers regardless of their movements within a service area served by an operator or possibly by several operators have entered into agreements each other.

To do this, the mobile subscriber uses a mobile station (MS, **M**obile **S**tation), which consists of two separable elements:

• A mobile equipment that provides radio capacities and software necessary to dialogue with the network and remains independent of the user subscribed

• A SIM (**S**ubscriber **I**dentification **M**odule) which contains the characteristics of the subscriber and their rights.

When the card is not present in the terminal, the only service that can accept the network from the mobile subscriber is the emergency services [5].

I.4.1.2. Base Transceiver Station (BTS)

The BTS (**B**ase **T**ransceiver **S**tation) connects mobile stations in the fixed network infrastructure.

The BTS is composed of a set of transmitters / receivers. It provides:

• Management of temporal multiplexing (a carrier is divided into 8 slots which 7 are allocated to users), and management of frequency hopping

• The cryptographic operations

• Measures radio to check the quality of service: these measures are transmitted directly to the BSC

• The management of data link (data and signaling traffic) between the mobile and the BTS

• The management of the link traffic and signaling with the BSC.

The maximum capacity of a typical BTS is 16 carriers, or 112 simultaneous communications. In urban areas where the diameter of coverage of a BTS is reduced, this capacity may drop to 4 carriers whether 24 communications [5].

I.4.1.3. Base Station Controller BSC

A BSC manages one or more BTS and is connected to one MSC. For traffic coming from the subscriber BTS, the BSC serves as a concentrator. For traffic coming from the switch, it acts as a gatekeeper to the BTS for the consignee.
BSC uses radio measurements of BTS to manage the signs of the "handover" between cells which is responsible [5].

I.4.2. Network Sub-System NSS

The NSS consists again of several elements.

I.4.2.1. Mobile Switching Center MSC

A MSC (**M**obile **S**witching **C**enter) is a switch that realizes the functions of connection and signaling for mobile phones located in a geographic area called zone location the MSC. The principal difference between a MSC and a switch to a fixed network is that MSC should consider the impact of the allocation of radio resources to mobile phones and mobility. It must have sufficient resources to realize at least the following procedures:

- Procedures for recording the locations
- Procedures required for handovers.

A MSC is the interface between the radio and fixed networks. It performs all the functions necessary for the implementation and calls to mobiles. In practice, a MSC integrates the functionality of a VLR [5].

I.4.2.2. Gateway MSC GMSC

If the Public Switched Telephone Network (PSTN) to route a call to a mobile subscriber, the call is routed to a MSC. The MSC queries the HLR concerned, and then route the call to the MSC in which the mobile is located (this may be the same MSC). A MSC receives a call from another network that provides routing of the call to the position of locating a mobile is called **G**ateway **MSC** (GMSC) [5].

I.4.2.3. Home Location Register HLR

The HLR (**H**ome **L**ocation **R**egister) contains the subscriber information of the network. A network can have multiple bases to implement the HLR according to the capacity of these databases. In HLR, each subscriber is described by a record containing details of subscription options and additional services available to the subscriber. In addition to static information with dynamic information such as last known location of the mobile (location to taxation and the routing of calls to the MSC in which the mobile is located) and its state. The HLR also contains the secret key of the subscriber that allows the service to authenticate the subscriber. This key is registered under a coded format that only the AUC (**A**uthentication **C**enter) can decrypt [5].

I.4.2.4. Visitor Location Register VLR

The VLR (**V**isitor **L**ocation **R**egister) is a database usually associated with a switch MSC. It is also possible to consider a VLR shared by multiple MSCs. Its mission is to record dynamic information relating to subscribers currently connected. The network needs to know at all times the location of subscribers present. In the VLR, each subscriber is described in particular by an identifier and a location. With this information, the network is able to route a call to a mobile subscriber. At each change of location area of a subscriber, the VLR of MSC which is attached to the mobile must be updated and the registration of the subscriber in the HLR. When a call must be issued, the HLR is the first interrogated to determine the last known location of the subscriber [5].

I.4.2.5. Authentication Center AUC

The AUC (**Au**thentication **C**enter) is associated with a HLR and stores an identification key for each mobile subscriber registered in the HLR. This key is used to make:
- The data needed to authenticate the subscriber in the GSM network
- An encryption key speech (Kc) on the radio channel between the mobile and the fixed part of the GSM network.

The AUC is a feature usually integrated into the HLR [5].

I.4.2.6. Equipment Identity Register EIR

A EIR save all identities of mobile equipment used in a network GSM. This functionality can be integrated into the HLR. Each mobile station is registered in the EIR in a list:

- List "white" position used without restriction

- List "gray" post under surveillance (call trace)

- List "black" stolen item whose technical characteristics are incompatible with the required quality in a GSM network (unauthorized location) [5].

I.4.3. the sub-system OMC (Operating and Maintenance Center).

The subsystem operation and maintenance OMC (**O**perating and **M**aintenance **C**enter). that are functional entities that allows the network operator to control the system. A OMC-R (OMC-Radio) supports the supervision and control of a set of BSC and BTS. A OMC-S (OMC -Switching) can monitor and control a set of MSC / VLR. Beyond the OMC-R and OMC-S, we can find an NMC (**N**etwork **M**anagement **C**entre) which provides the general administration of the centralized network. The following functions can be specifically identified:

- Functions related to business management or administrative network

- Security management

- Performance management

- Configuration Management

- Maintenance and alarm management. [5]

I.5. Short Message Service SMS

Nowadays most of the user benefits from the technology of SMS text messages. It can receive the mobile phone and any kind of information to send SMS to perform operations or to request information. In this section we will define the SMS service and a brief description of its operation [1]

I.5.1. Definitions SMS

SMS is the abbreviation for Short Message Service. SMS is a way of sending short messages to mobile telephones and receiving short messages from mobile telephones. "Short" means a maximum of 160 bytes. According to the GSM Association, "Each short message is up to 160 characters in length when Latin alphabets are used and 70 characters in length when non-Latin alphabets such as Arabic and Chinese are used." [6]

SMS is first appeared in Europe in 1992. It was included in the GSM standard (Global System for Mobile Communication) just beginning. Later it was ported to wireless technologies such as CDMA and TDMA. [7]

I.5.2. SMS transfer procedure

Procedures for transferring short messages are similar to those relating to the establishment of telephone calls. In the GSM standard specified two different types of SMS:

❖   SMS Point to Point (SMS / PP) for sending a text message from a GSM phone to another

❖   SMS **C**ell **B**roadcast (SMS / CB) for sending one or more messages simultaneously (broadcast) to all mobile located within a specific area covered by one or more radio cells.

Sending an SMS / PP, from a GSM phone to another, should be considered as a sequence of two operations: routing the message from a mobile phone to a particular entity of network, called SMSC (Short Message Service Center), and then from the SMSC to the telephone receiver. The first operation is called SMS-SUBMIT or (SMS-MO for SMS **M**obile **O**riginated), while the second is called SMS-DELIVER or (SMS-MT for SMS **M**obile **T**erminated) .See figure I.2.
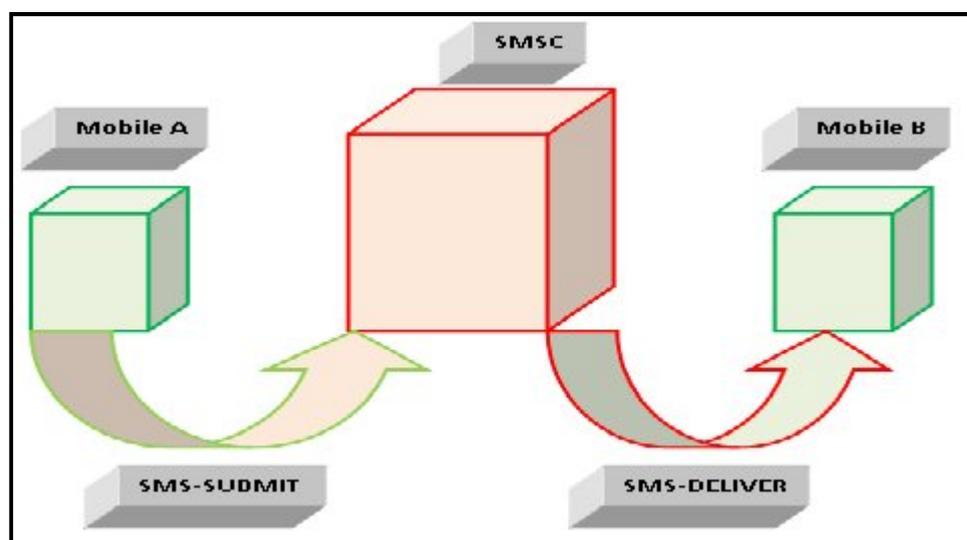
Fig I.2.Concatenation of a SMS / PP [8]

I.5.2.1. SMS-SUBMIT

With the SMS-SUBMIT, the mobile station sends a short message (160 characters maximum) to the SMSC. In this case, the logic flow of short messages is as follows: MS →MSC → IWMSC →SMSC.(Figure I.3).

When the mobile user wants to send a short message, it must indicate the recipient's address and the address of the SMSC [9].

The transmitter delivers the message to its short MSC / VLR of attachment (VMSC / VLR Visited MSC / VLR). The MSC sends a message to its VLR requesting the telephone number (MSISDN, **M**obile **S**tation ISDN Number) of the issuer and to check that no restriction is imposed on the issuer. The VLR then returns a response if that response is positive, the MSC sends the message to the SMS function-IWMSC across the network SS7 (**S**ignaling **S**ystem Number **7**). This message contains the address of the SMSC, the MSISDN of the sender and recipient and the text message to send. The short message is conveyed in a transaction MAP (**M**obile **A**pplication **P**art).

The SMS-IWMSC retransmits the SMS to the SMSC in turn. The SMSC stores the message and addresses in its memory and returns a response (delivery report) to the MSC through the SMS-IWMSC. The MSC returns that report in turn to the transmitter [9].
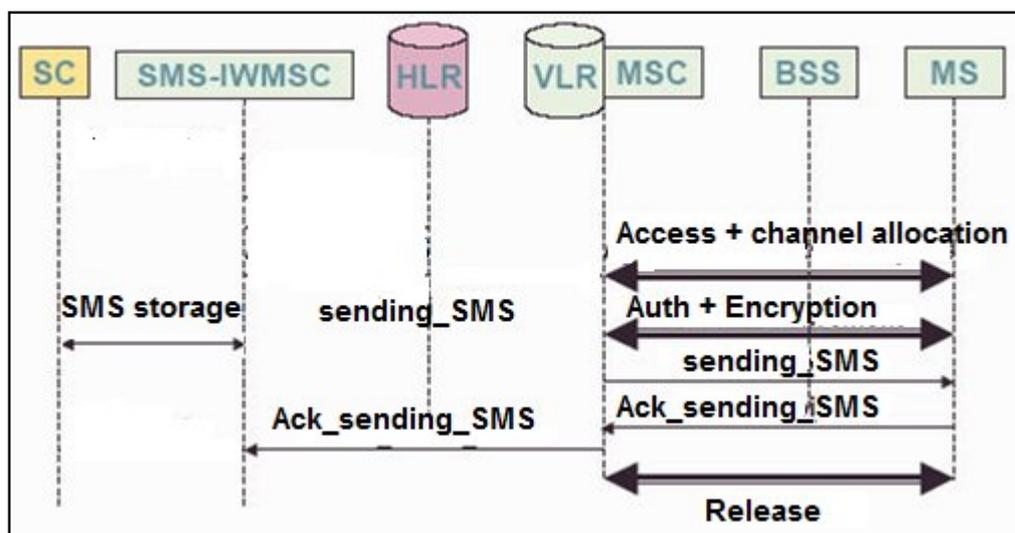
Fig I.3. Sends a text message from a mobile (SMS-SUBMIT) [10]

I.5.2.2. SMS-DELIVER

With the SMS-DELIVER, a mobile station receives a short message from SMSC. The message sender can be another mobile station or any entity outside the network. The logical flow of short messages in the case of basic service SMS-DELIVER is: SMSC →SMS-GMSC → MSC→ MS [6] .See Figure I.4.

The SMS-GMSC receives the short message from SMSC. Then the SMS-GMSC routing information request message to the HLR, information that allow it to connect the message to the appropriate MSC. The HLR uses this data to find the routing information it returns to the SMS-GMSC through a response ack. This response contains the IMSI (**I**nternational **M**obile **S**ubscriber **I**dentity) of the recipient and the address of the serving MSC.

The SMS-GMSC delivers the short message to the MSC through a query. The MSC transmits the request its VLR to obtain the recipient information. The parameter passed in this request is the IMSI of the recipient. From the IMSI provided by the MSC, the VLR identifies the location area (LA, Location Area) of the recipient mobile. The VLR then starts a paging procedure (MAP_PAGE), technique of search on the whole area or is susceptible to be requested by a mobile broadcast call. If the VLR does not know the identity of the recipient, a message is issued to begin the process of paging on all dependent on the MSC. The MSC performs the paging procedure on the location area of the recipient. The recipient   mobile station responds positively. The VLR returns an ack response to the MSC, allowing the latter to connect the short message to the recipient   mobile station. The MSC routes the short message to the recipient receives an acquittal Ack and Send SMS. The MSC includes this report in response ack returned to the SMS-GMSC to return the report to the SMSC turn [9].
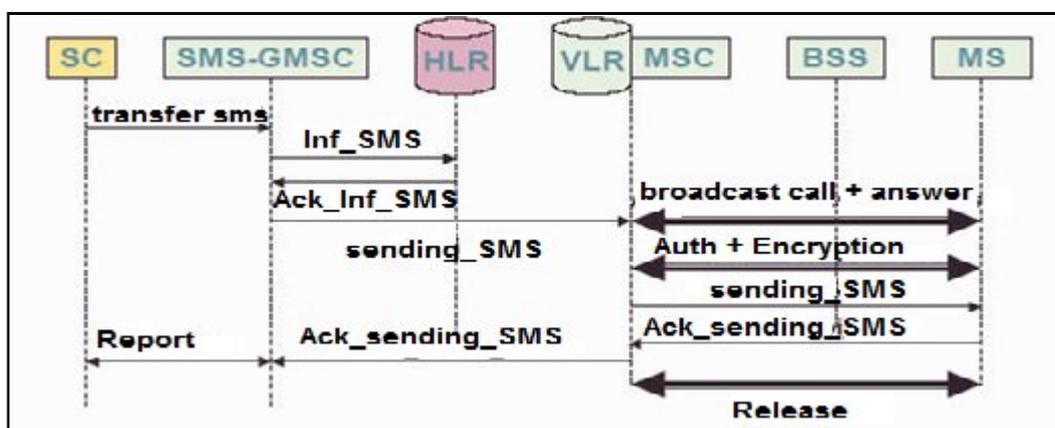
Fig I.4.Transfer of an SMS to a mobile (SMS-DELIVER) [10]

If the mobile station recipient is powered off (not responding), the response returned by the HLR indicates the cause .Also introduced the HLR the MSISDN number of the recipient in a data file of pending messages (MWD File, **M**essage **W**aiting **D**ata File). MWD is a list of addresses with SMSC messages awaiting delivery to the recipient   mobile station. [9] (FigureI.5)
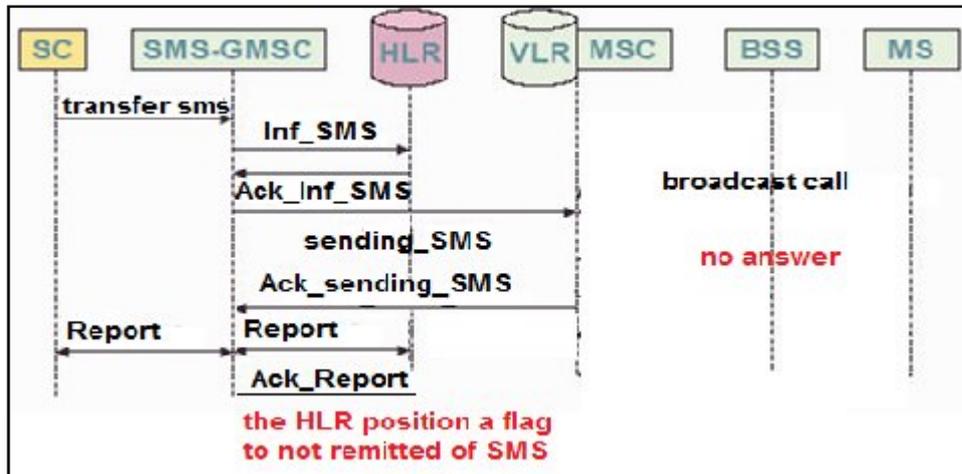
Fig I.5. Failed to transfer SMS to the mobile [10]

Once the mobile terminal occurs, the network (HLR) warns that the SMSC can deliver the message to the recipient successfully. The SMSC was spotted by a telephone number belonging to the PLMN (Public Land Mobile Network) .The SMSC then completely stimulus delivery procedure [9] (Figure I.6).
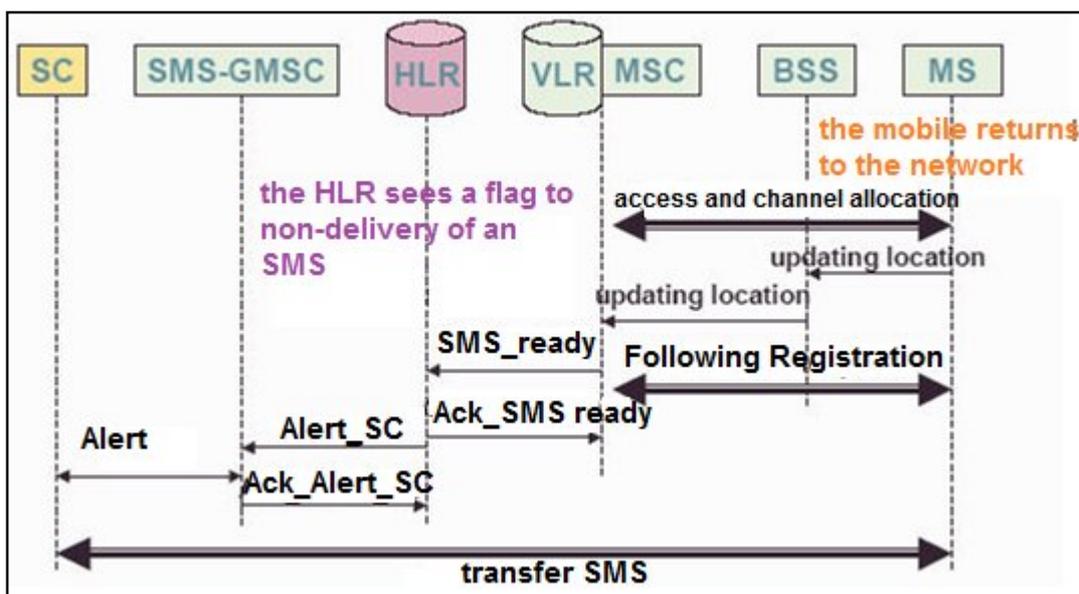
Fig I.6.The mobile returns to the network [10]

I.5.3. Mode of sending SMS

There are two ways to send an SMS message, either by the PDU mode which is the basic mode or TEXT mode. PDU mode is a sequence of hexadecimal characters that encode the SMS, TEXT mode is nothing but a representation of text data that make up the SMS. There are different alphabets used to switch PDU to TEXT mode. For example your mobile phone TEXT mode displays on its screen data of any SMS received is the one that automatically determines what type of alphabet to use. But, be aware that some mobile phones do not support the TEXT mode when interfaced with a PC. It is therefore useful to know in detail the PDU mode [8] [11].

I.6. conclusion

In this chapter, we defined the wireless networks and the architecture of a GSM network and the services of transmission and reception of SMS discovering their interests and manuals.

Chapter II:
GSM module and
AT commands

II.1. Introduction

Most modern modems have a set of text commands that can be called into command mode (when the modem is not connected to a remote modem or is put in local control mode) while the modems the oldest have only of the controls by control signals or commands in the form of telegrams.

In this chapter, let's make the choice of GSM module, and among all the existing modules, we will choose a GSM module retail set (Siemens TC35 GSM) and then we will detail the general description of the equipment the GSM module. Messages will be sent to the mobile GSM module that contains AT commands and will be treated accordingly to accomplish the required task. We will try to outline the AT commands which used to communicate with GSM.

II.2. GSM module

There are now on the market for GSM phones integrated rid of their man machine interfaces and keep the party machine-machine interface. This corresponds physically to a multi pin connector or any better to a DB9 connector format for easy connection to a PC, no need in this case a level adapter TTL/RS232. These modules are universal since they support standards and GSM07.07 GSM07.05 and thereby allow the exchange of data, SMS, e-mail and even fax via the mobile phone network. Their simplicity of implementation opens very interesting perspectives on the implementation of wireless electronic assemblies. [8]

II.3. GSM module Siemens TC35

The TC35 Terminal is a Dual-Band device which has been specially designed for voice and fax communication and applications transmitting a low volume of data. The wireless communications unit is protected by robust industrial housing that also features a series of standard connectors and a SIM cardholder.

Being a standalone device, this plug-and-play solution, comes equipped with standard connectors for power supply, antenna, serial port, and handset.

On account of its focus on GSM communication, and its robust casing, the TC35 Terminal is particularly suited for applications with a low data transfer volume. This makes it a product that can be employed in a wide range of business fields metering,

remote maintenance, transportation and logistics, traffic systems, vending machines, security, and facility management. [12] See fig (II.1)

FigII.1. TC35 GSM module and its components.[12]

II.3.1. Key features of TC35 Terminal

TC35 module incorporates all the solutions we can create high efficiency grace to its architecture which consists mainly of the base band microcontroller, a power ASIC (**A**pplication **S**pecific **I**ntegrated **C**ircuit), a complete circuit radio frequency amplifier with a frequency and a radio frequency transceiver. On the other hand, the TC35 provides us flexibility for easy integration with the man-machine interface, it has two serial interface (ASC0 and ASC1) and is designed with an energy saving technique. [7]

The main features of the TC35 GSM module are illustrated in the following Table: TabII.1

Feature	Implementation
Transmission	Voice and data
Power supply	Single supply voltage 8V to 30V
Frequency bands	Dual Band EGSM900 and GSM1800 (GSM Phase 2+)
GSM class	Small MS
Transmit power	Class 4 (2W) for EGSM900 Class 1 (1W) for GSM1800
SIM card	reader internal
External antenna	Connected via antenna FME connector
Ambient temperature range	-20°C to +55°C (normal operation) -40°C to +85°C (storage)
Current consumption @12V see Table 8	TALK mode (peak) 1,5A (pulsed 577ms at T=4,615ms) TALK mode: 160mA (typ.) IDLE mode: 35mA (typ.) SLEEP mode: 25mA (typ.) Power Down mode: 560µA (typ.)
Speech codec (triple rate codec)	Half Rate (ETS 06.20) Full Rate (ETS 06.10) Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80)
SMS	MT, MO, CB, Text and PDU mode
DATA	2.4, 4.8, 9.6, 14.4 Kbps, non-transparent
FAX	Group 3 : Class 1, Class 2
USSD	65x74x33 mm (approx.)
Size	
Weight	130g
Audio interface	Analog (Microphone, Earpiece)
Interfaces	RS232 for commands / data using AT commands
Supported	SIM card 3V
Phonebooks	Implemented via SIM
Reset of TC35 Terminal	Reset via AT command or Power Down Signal
Selectable baud rate	300bps...115kbps (AT Interface)
Auto bauding range	1.2kbps...115kbps (AT Interface)
Firmware download	Via RS232 interface, SIM interface
Real time clock	Implemented (clock frequency 32.768kHz)
Timer function	Programmable via AT command

TabII.1. Key features of TC35 Terminal [13]

II.3.2. Interface description

The following interfaces are available on the TC35Terminal: See fig (II.2)

- Connector for the plug-in power supply unit

- Handset connector

- Mini-SIM card holder

- Antenna connector FME (male)

- RS232 interface (V.24/V.28 on the D-Sub socket).[14]
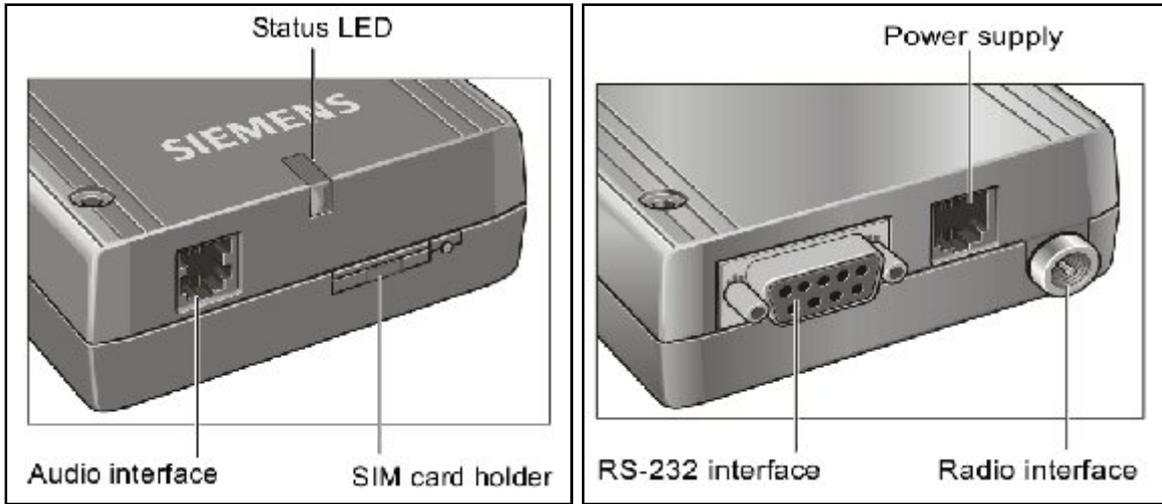
FigII.2. Interface description [13]

II.3.2.1. Plug-in power supply unit

The TC35 Terminal receives its power supply in a wide voltage range (+8 V ... +30 V) via the power supply connectors. Two additional control lines are used for switching the Terminal on/off (resetting). The connection is implemented by a 6-pin Mini-Western connector. [14].See fig (II.3) & Tab (II.2)
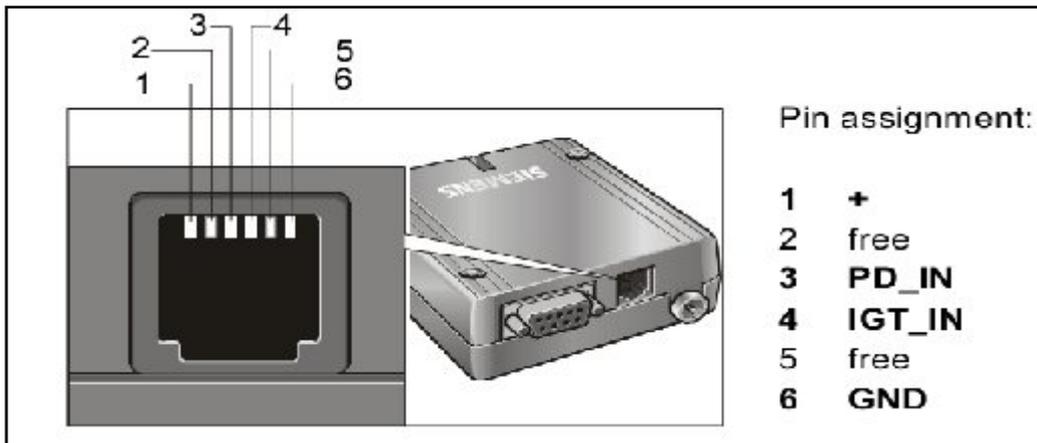
FigII.3. Female 6-pole Western plug for power supply, ignition, power down [13]

Pin	Signal Name	Use	Parameters
1	PLUS	Power supply (see Note 1)	8V - 30V DC, max. 33V for 1 min

2	Free	---	---
3	PD_IN	Signal for power down mode(see Note 2)	U_{IH} >5V for t > 3,5s U_{IL} <2V
4	IGT_IN	Ignition (see Note 3)	U_{IH} >5V Ignition > 5V for more than 200ms switches the terminal on
5	Free	---	---
6	GND	Ground	0V

TabII.2. Female 6-pole Western plug for power supply, ignition, power down [13]

II.3.2.2. Handset connector

The handset is connected via a 4-pin Mini-Western socket. The audio interface has a Symmetrical design. The audio interface can be configured by AT commands .

Three audio modes are prepared in the GSM module for this purpose. [14].See fig (II.4) & Tab (II.3).
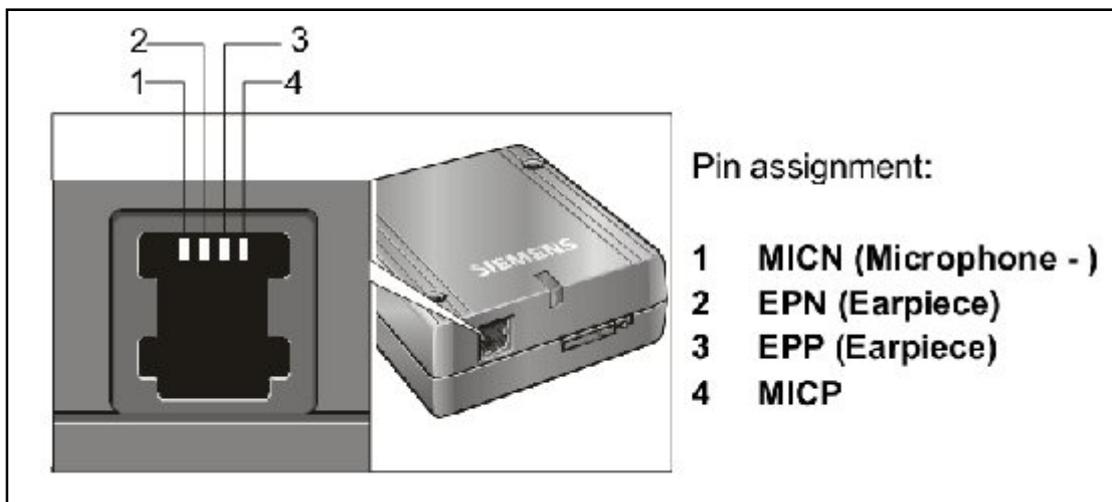
FigII.4. Handset connector [13]

Signal name	PIN	I/O	Description	Parameters
MICN	1	DC:O	Microphone input minus	DC (no load): U_0=6.0V±10%(MICP)U_0=0V

MICP	4	DC:O AC:I	Microphone input plus	(MICN)Ri=4.7k (MICP) Ri=4.7k (MICN) AC: Uimax=1.03V_{PP},Zi=2kW Gain range:0...42dB
EPN	2	O	Earpiece connector	U_0 max=3.7V_{PP}, no load
EPP	3	O	Earpiece connector	Ri=15k Gain range:–18...0dB

TabII.3. Handset connector [13]

II.3.2.3. SIM card connector

The connector is intended for 3V SIM cards in accordance with GSM11.12 phase2 to operate the Terminal. The SIM card (3V type) must be inserted in the card holder to put the TC35 Terminal into operation.

1. Make sure that there is no voltage applied to the TC35 Terminal.

2. Operate the eject mechanism (yellow pin next to the card holder) to open the card holder by pressing it down with a pen, for example.

3. Insert the SIM card in the SIM card holder and push it back into the housing.fig (II.5) [14]
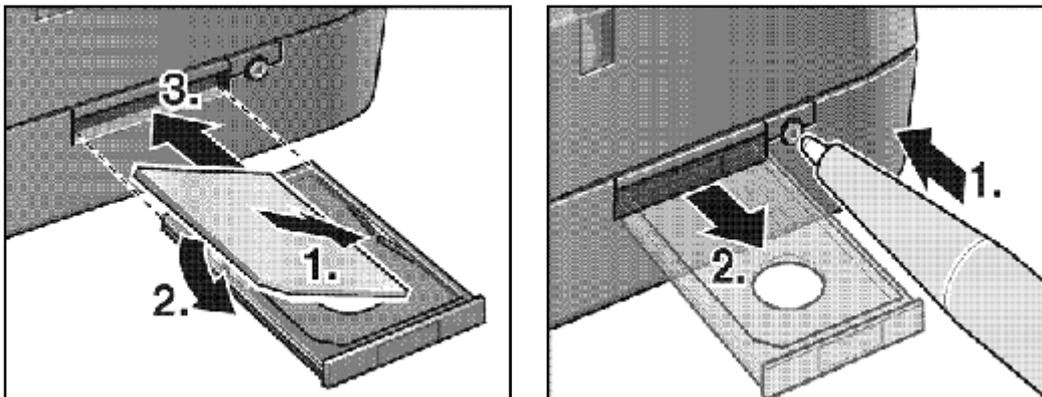
FigII.5. SIM card connector [13]

II.3.2.4. Antenna connector FME (male)

Dual band antennas (GSM 900/1800) can be connected to the RF interface. The connection is implemented as a 50W FME (male) coaxial jack. [14] Fig (II.6) &Tab (II.4)
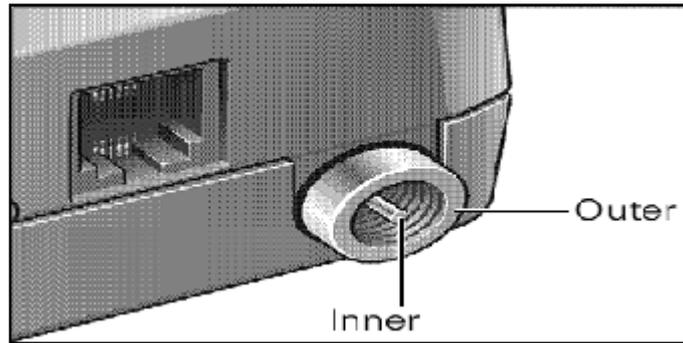
FigII.6.   Antenna connector FME (male) [13]

Signal name	PIN	I/O	Description
RF	Inner	I/O	RF input/output
GND	Outer	X	Frame connection

TabII.4. Antenna connector FME (male) [13]

II.3.2.5. RS232 interface

The RS232 interface is the interface for the application software and the connection to the PC. The customer application communicates with the TC35 Terminal or the TC35 GSM engine by means of AT cellular commands. The RS232 interface is implemented as a 9-pin D-Sub socket with a screw fitting. [14].See fig (II.7) & Tab (II.5)
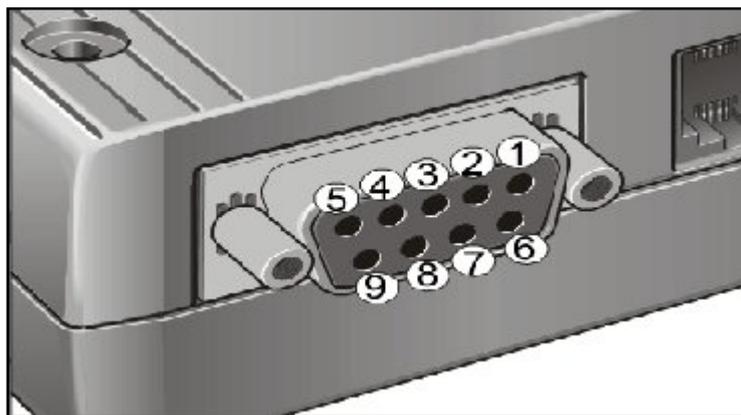
FigII.7. RS232 interface [13]

Pin no	Signal name	I/O	Function
1	DCD	O	Data Carrier Detected

2	RXD	O	Receive Data
3	TXD	I	Transmit Data
4	DTR	I	Data Terminal ReadyAttention: The ignition of TC35 Terminal is activated via a rising edge of high potential (+5 ... +15 V)
5	GND	-	Ground
6	DSR	O	Data Set Ready
7	RTS	I	Request To Send
8	CTS	O	Clear To Send
9	RI	O	Ring Indication

TabII.5. Pin assignment RS-232 (D-Sub 9 pole female) [13]

II.3.2.6. Status LED

A green LED displays the operating status of the terminal: fig (II.8), Tab (II.6)
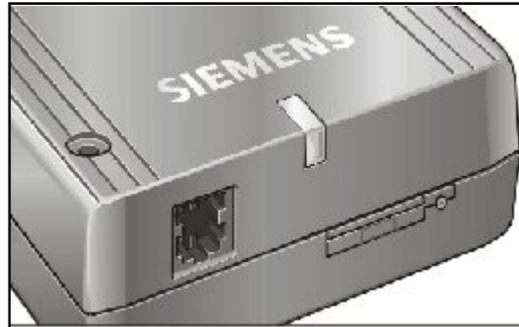
FigII2.8. Status LED [13]

Operating status	LED
Power Down	off
Not registered to the net (missing SIM, PIN, net)	fast blinking
Standby (registered to the net)	slow flash (75ms On / 3s Off)
Sleep mode (Power save mode, registered to the net)	off
Talk mode	on

TabII.6. Status LED [14]

II.4. AT commands

Play the most common text commands is called the game AT or Hayes, the name of the company which marketed the first so-called intelligent modems. The game consists of simple commands prefixed by AT. In general, both codes are used to synchronize the modem at the right speed. It is therefore recommended to type with the same case. The commands work with the internal registers that are directly manipulated. It is often possible to save the configuration in non volatile memory. You should know that most of the time many incompatible extensions were implemented: there is no such thing as standard. However, we speak of common commands. In general, manufacturers provide the modem with sufficient documentation for setting. [15]

II.4.1. Generalities about AT commands

AT is an abbreviation **att**ention. These two characters are always present to start a command line as text (ASCII) allows the complete management of the mobile.

In official documents dealing with the GSM, we find the words to ME **M**obile **E**quipment which corresponds for example to a mobile phone, TE **T**erminal **E**quipment which physically can be a computer or microcontroller and TA **T**erminal **A**daptor which liaises between the ME and TE, not to be confused with the serial cable. Tab (II.7)

In practice, there are three possibilities for the arrangement of different elements.

- TA, ME and TE are three separate entities
- TA and ME are a single entity, which is more common. For example a standard mobile phone or a GSM terminal in its box contains both the TA and ME
- The TE forms a separate entity, for example it may be a computer that has a serial port or an electronic circuit based on a microcontroller that implements a serial port
- The TA, ME and TE are a single entity [8].

Types of AT commands and responses

Test command	AT+CXXX=?	The mobile equipment returns the list of parameters and value ranges set with the corresponding Write command or by internal processes.
Read command	AT+CXXX?	This command returns the currently set value of the parameter or parameters
Write command	AT+CXXX=<...>	This command sets user-definable parameter values.
Execution command	AT+CXXX	The execution command reads non-variable parameters affected by internal processes in the GSM engine.

TabII.7. Types of AT commands and responses.[16]

II.4.2. Structure of AT command
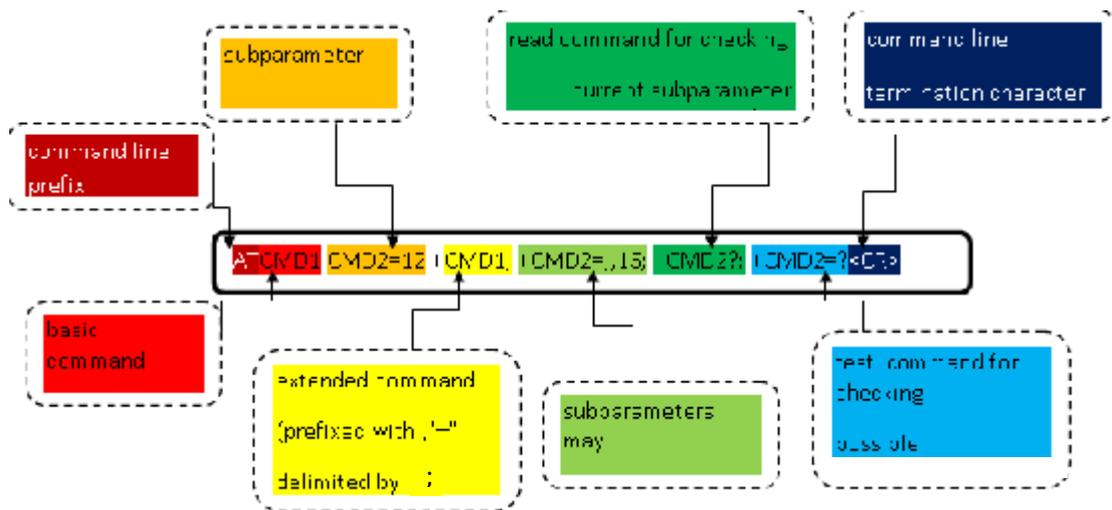
FigII.9. Structure of AT command [17]

In all cases, the phone should respond favorably or unfavorably to the command sent. If the command is accepted, the response returned is of the form: <CR> <LF> OK <CR> <LF>. If the command is not recognized, or that the ME has a problem when run, an error message is returned: <CR> <LF> ERROR <CR> <LF>, possibly with a message describing the nature of the error [8].fig (II.9)

II.4.3. Structure of a response

The structure's steps of a response is more clear in the figureII.10
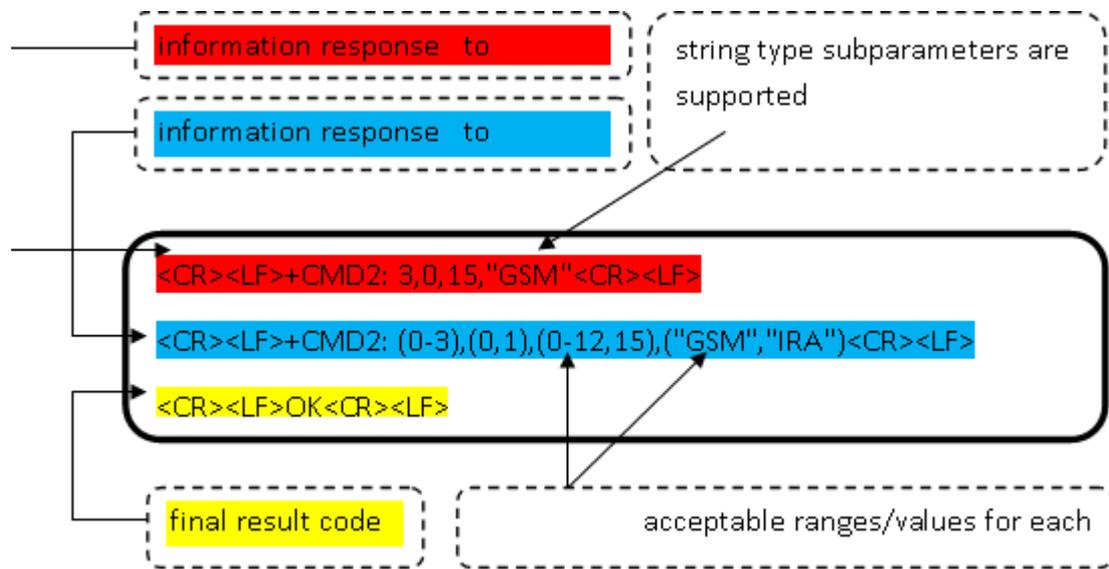
FigII.10. Structure of response [17]

II.4.4. the parameters used with the AT commands

The list of parameters used with the AT commands are:

<xxx>: Indicates that xxx is a parameter associated with the AT command.

[<xxx>]: xxx indicates that the parameter is optional.

<CR>: Carriage Return.

<LF>: Line Feed (10 in Dec, 0A in hex).

<ctrl-z> key: CTRL Z key for more End Of File, it signals the end of a statement <ctrl-z>=26 Dec = 1A = hex [8].

II.4.4.1. Parameters for storage

<index>: integer indicating the location of the SMS in the associated memory.

<mem1>: Memory, from which messages are recorded, played back or deleted.

<mem2>: Memory used to write or send a message.

<mem3>: Memory used to store received messages.

<stat>: indicates the status of messages located in memory.

<u>total1</u>: integer indicating the number of messages that can be stored in the memory <mem1>.

<u>total2</u>: integer indicating the number of messages that can be stored in the memory <mem2>.

<u>total3</u>: integer indicating the number of messages that can be stored in the memory <mem3>.

<u>used1</u>: integer indicating the number of messages stored in memory <mem1>.

<u>used2</u>: integer indicating the number of messages stored in memory <mem2>.

<u>used3</u>: integer indicating the number of messages stored in memory <mem3>. [8]

II.4.4.2. Parameters concerning data

<u>da</u>: Address message recipient.

<u>data</u>: Corresponds to the User Data field that stores the message body.

<u>length</u>: Indicates the length of the field <data>.

<u>rm</u>: Message reference (between 0 and 255dec).

<u>oa</u>: Address of the message sender.

<u>sca</u>: Address the message center.

<u>toda</u>: Type of the destination address

<u>tooa</u>: type address of the sender of the message.

<u>tosca</u>: coding format of the address of the message center. [8]

II.4.5. The standard GSM07.07 and GSM07.05

   The standard GSM07.07 contains commands for accessing all the functions of the ME and GSM07.05 specified standard AT commands for managing SMS.

II.4.5.1. SMS commands

In tab(II.8) there are the commands & their descriptions

Command	Description
AT+CMGD	Delete message
AT+CMGF	Preferred message format
AT+CMGL	List message
AT+CMGR	Read message
AT+CMGS	Send message
AT+CMGW	Write message to memory
AT+CMSS	Send message from storage
AT+CNMI	New message indication
AT+CPMS	Preferred message storage
AT+CRES	Restore settings
AT+CSAS	Save settings

TabII.8. SMS command [17]

II.4.5.2. General Commands

Normally when the TE begins to establish communication with the TA and ME , this demand characteristics through the following commands.

- AT + CGMI: Name of manufacturer of ME.

AT + CGMI

+ CGMI: SAGEM

- AT + CGMM: Model identification of ME.

AT + CGMM

+ CGMM: G7XX

- AT + CGMR: Version and model level of ME

AT + CGMR

+ CGMR: SAGEM OX1.0M

- AT + CGSN: Identification IMEI.

AT + CGSN

+ CME ERROR: 22 (not found)

II.4.5.3. SMS commands

- AT + CSMS = <service>: Selection of message service.

AT + CSMS =? Test command + CSMS: (list of supported <services> s)

AT + CSMS? Read command + CSMS: <service> <MT>, <mo>

AT + CSMS = <service> Write command + CSMS: <MT>, <mo>

- AT + CPMS = <mem>: Selecting the memory to store SMS.

AT + CPMS =? Test control.

+ CPMS: ("ME", "MT", "SM") list of supported memory.

AT + CPMS? Read command.

+ CPMS: <used1>, <total1>, <used2>, <total2>, <used3>, <total3>

OK

- AT + CMGF: Select the format of messages.

AT + CMGF =? Test Command + CPMF: (list of supported <mode> s)

AT + CMGF? Read command + CPMF: <mode>

1: Text mode, 0: PDU mode (default).

AT + CMGF = [<mode>] write command.

- AT + CSCA: Select the address of the SMSC.

AT + CSCA? Test Command OK

AT + CSCA =? Read command + CSCA: <sca>, <tosca>

OK

AT + CSCA = <sca> [, <tosca>] write command.

- AT + CNMI: Indication of reaching a new message.

AT + CNMI?

+ CNMI = <mem>, <index>

OK

- AT + CMGL = <stat>: That list messages are in memory.

<stat> is the type of messages to list.

This command returns:

+ CMGL: <the number of messages>, 0, <length the message PDU octets> OK

- AT + CMGR = <index>: Reading message with the index number.

AT + CPMS?

+ CPMS: <stat>, <length of message>, <message in PDU>

OK

- AT + CMGS = <da> [, <toda>]: Sends a message to the recipient <da> (sends ended with Ctrl + Z, 0x1A, 26, or ESC, 0x1B, 27 to cancel).
- AT + CMSS = <index> [, <da> [, <toda>]]: send index message number stored in memory to the recipient <da>.
- AT + CMGW: Write a message in memory.
- AT + = CMGD <index>: Clear the index number of the memory.[18]

Other methods of sending an SMS

In the previous case, the message is not stored up in memory but directly sent over the network. It is also possible to save temporarily stored <mem2> with the command + CMGW.

For example, if we want <mem2> = "ME", use the following command:

• AT + CPMS = "ME", "ME"

The first parameter corresponding to <mem1> is mandatory. In this configuration, the reading SMS and stored unsent is saved in the same memory [8].

PDU MODE (AT + CMGF = 0)

MODE TEXT (AT + CMGF = 1)

• AT + CMGW = "number"

> Test PFE

Whether PDU or TEXT mode, the GSM module returns the memory location

<Voice> where the message is stored.

+ CMSS command sends an SMS stored in memory <mem2>, causing the message was sent previously entered, if the shipment is successful:

+ CMSS: 0

OK

II.5. Conclusion

In this chapter, we described the Siemens TC35 GSM module used in our application. The GSM module allows us to transmit and receive data using AT commands where these data are routed through an RS232 serial port.

Chapter III:
Study and System
Architecture

III.1. Introduction

The realization of this project requires knowledge of the equipment used and especially on integrated circuits, and we chose the microcontrollers that are the heart of our application. So the objective of this part is to give the description of microcontroller used, and the general operation of the system.

III.2. Microcontroller systems

A microcontroller is a single chip computer (see Figure III.1). Micro suggests that the device is small, and controller suggests that the device can be used in control applications. Another term used for microcontrollers is embedded controller, since most of the microcontrollers are built into (or embedded in) the devices they control.

A microprocessor differs from a microcontroller in many ways. The main difference is that a microprocessor requires several other components for its operation, such as program memory and data memory, I/O devices, and external clock circuit. A microcontroller on the other hand has all the support chips incorporated inside the same chip. All microcontrollers operate on a set of instructions (or the user program) stored in their memory. A microcontroller fetches the instructions from its program memory one by one, decodes these instructions, and then carries out the required operations.

Microcontrollers have traditionally been programmed using the assembly language of the target device. Although the assembly language is fast, it has several disadvantages. An assembly program consists of mnemonics and it is difficult to learn and maintain a program written using the assembly language. Also, microcontrollers manufactured by different firms have different assembly languages and the user is required to learn a new language every time a new microcontroller is used. Microcontrollers can also be programmed using a high-level language, such as BASIC, PASCAL, and C. High-level languages have the advantage that it is much easier to learn a high-level language than the assembler. Also, very large and complex programs can easily be developed using a high-level language.

In general, a single chip is all that is required to have a running microcontroller system. In practical applications additional components may be required to allow a microcomputer to interface to its environment. With the advent of the PIC family of microcontrollers the development time of an electronic project has reduced to several hours. Developing a PIC microcontroller based project simply takes no more than five or six steps.

1. Type the program into a PC

2. Assemble (or compile) the program

3. Optionally simulate the program on a PC

4. Load the program into PIC's program memory

5. Design and construct the hardware

6. Test the project.

Basically, a microcomputer executes a user program which is loaded in its program memory. Under the control of this program data is received from external devices (inputs), manipulated and then sent to external devices (outputs). [19]
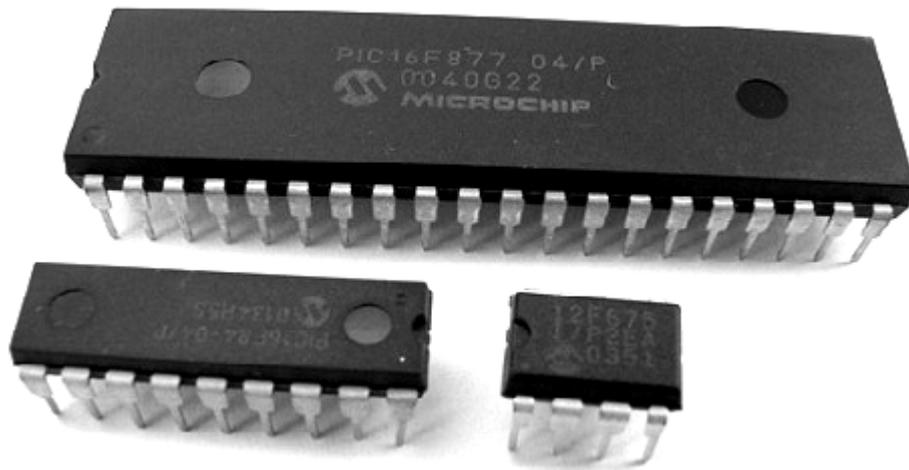

FigIII.1 Some PIC microcontrollers. [19]

III.3. the choice of microcontroller 16F877A

Choosing a microcontroller is important because it is Board that depends largely on the performance, size, and ease of use and installation price. In our case we chose the PIC16F877A. In fact, the main reason for choosing this type of microcontroller is that it has a sufficient number of I / O and an A / D converter in order to implement the analog inputs of our system, but also for ability to adapt to USART protocol which is implemented on the PIC16F877A for the RS232 with the GSM module. Fig(II.2)

III.4. PIC16F877 Device Overview
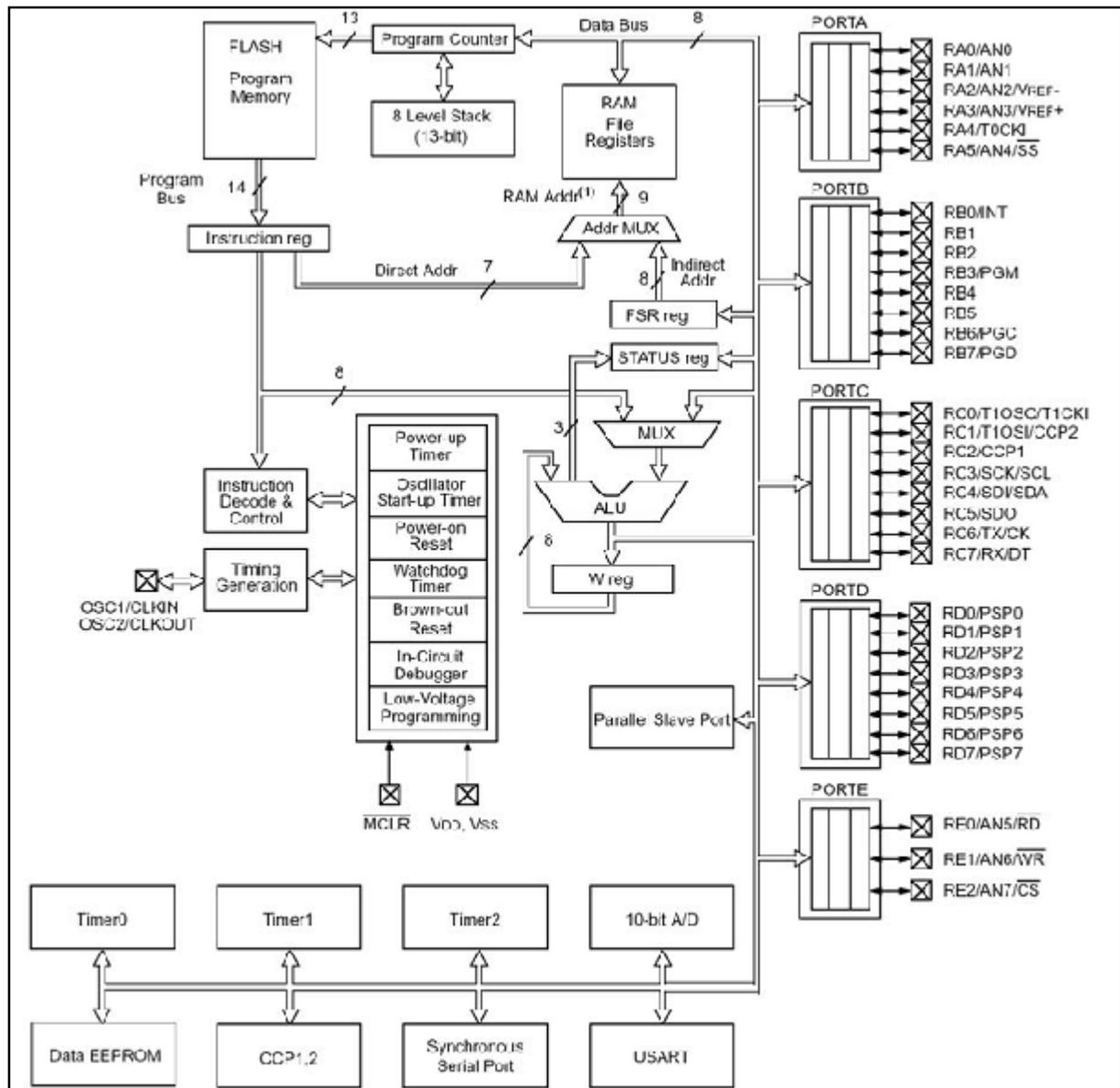

FigIII.2. PIC16F877 Block Diagram [19]

III.4.1. Microcontroller Core Features

The μ controller has: see fig (III.3)

- ✓ High performance RISC CPU
- ✓ 35 single word instructions
- ✓ All single cycle instructions except for program branches which are two cycle
- ✓ Operating speed: DC - 20 MHz clock input DC - 200 ns instruction cycle
- ✓ 8K x 14 words of FLASH Program Memory, 368 x 8 bytes of Data Memory (RAM)

And 256 x 8 bytes of EEPROM Data Memory

- ✓ Interrupt capability (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) with 5V capability and 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 [20]
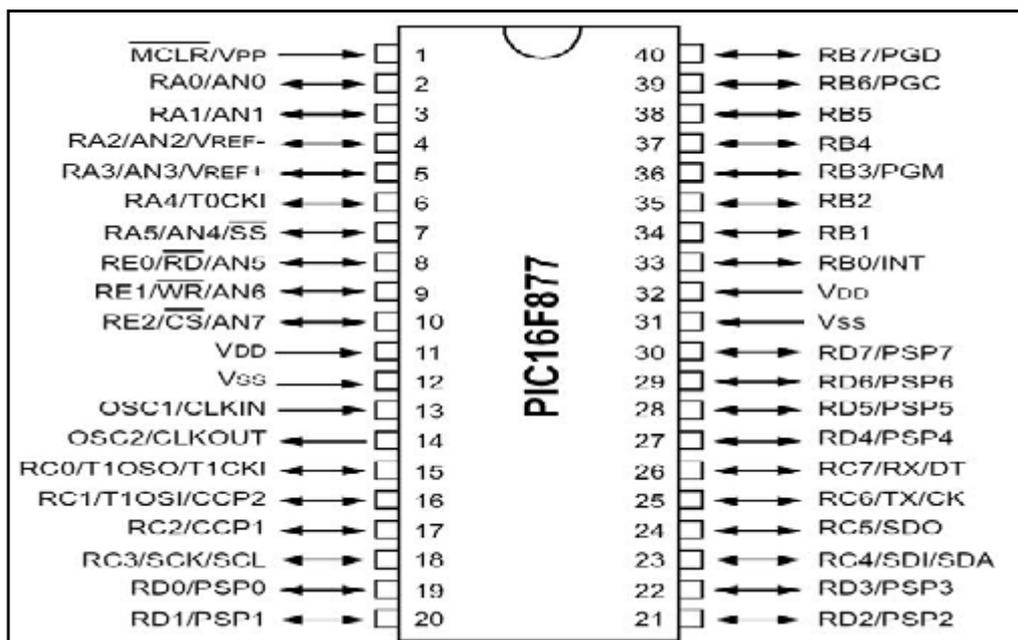
FigIII.3. PIC16F877A Pin Diagram [19]

III.4.2. 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 and I^{2}C
- ❖ 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
- ❖ Brown-out detection circuitry for Brown-out Reset (BOR).[20]

III.5. the permanent memories

The PIC 16F877A has two permanent memories. the EEPROM PROGRAM (Flash) capacities 8k with words of 14 bits and EEPROM DATA 256 bytes of capacity. There are two ways to write these memoirs.

The first is to flash the PIC with the executable (.Hex). The instructions are flashed in the EEPROM program and data are flashed in the EEPROM data. Flashing is done using a programmer and software that goes with it.

The second method is to access the EEPROM from the program during the implementation phase of the latter [21].

III.5.1. the EEPROM data

The PIC 16F877A has 256 bytes of EEPROM data. Its physical implementation starts at the position of absolute address 2100h. But to access from user programs, addressing is used relative to the first position. The first position will address 0, the second will address 1 and the last will address 255.

To access the EEPROM, is used four special registers:

➢ EEADR: Register address (relative) (bank 2)

➢ EEDATA: Registry data (bank 2)

➢ EECON1: Control Register (bank 3)

➢ EECON2: second control register (bank 3) [21].

III.5.2. Program memory or flash memory

This memory of 8 x 1024 words of 14 bits used to store the program, but it is accessible by program and can therefore be used as an extension of the EEPROM data. It is non-volatile (flash) and reprogrammable could wish. Each position a 14 bit contains instruction. The location of the program can be located anywhere in memory. However be aware that after a RESET or when the power is turned, the PIC begins execution to the address 0000H, moreover, when an interrupt, the PIC is to the address 0004h. It is therefore necessary to organize the program if it uses interrupts.

The program executable by the PIC is installed in the flash memory using a programmer. Access to flash memory by the program instructions is the same way that access to the EEPROM data, except the following points:

• Bit EEPGD must be set to 1

• The register EEADR (8 bits) alone is not sufficient to address the 8k of program memory, he hugs the register EEADRH in which to write the upper address. These are the 13 bits required to send 8K.

• The register EEDATA (8 bits) is not enough to contain the 14 bits in a position of program memory. He hugs the register EEDATH that will contain the 6 bits upper.

• It is necessary to insert two NOP instructions in the cycles of read / write. During the write phase, the processor stops the execution of instructions. It is not necessary to wait until the write to continue as this is done automatically at the end of the writing, execution resumes at the statement following the second NOP [21].

III.5.3. Procedure for reading writes the EEPROM

To write and read in a given position of the EEPROM, it places the address in the register EEADR, the data in the register EEDATA and we launch the write operation or read using WR bit the register EECON1 (for write) and DR of register EECON2 (for reading). The data (read or written) present in the register EEDATA of the EEPROM. At the end of the operation, the RD and WR bits are reset automatically [21].

III.6. I/O PORTS

Some pins for these I/O ports are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin. [22]

III.6.1 PORTA and the TRISA Register

PORTA is a 6-bit wide, bidirectional port. The corresponding data direction register is TRISA. Setting a TRISA bit (= 1) will make the corresponding PORTA pin an input. Clearing a TRISA bit (= 0) will make the corresponding PORTA pin an output (i.e., put the contents of the output latch on the selected pin). Reading the PORTA register reads the status of the pins, whereas writing to it will write to the port latch. All write operations are read-modify-write operations. Therefore, a write to a port implies that the port pins are read, the value is modified and then written to the port data latch. [22]

III.6.2 PORTB and the TRISB Register

PORTB is an 8-bit wide, bidirectional port. The corresponding data direction register is TRISB. Setting a TRISB bit (= 1) will make the corresponding PORTB pin an input (i.e., put the corresponding output driver in a High-Impedance mode). Clearing a TRISB bit (= 0) will make the corresponding PORTB pin an output [22]

III.6.3 PORTC and the TRISC Register

PORTC is an 8-bit wide, bidirectional port. The corresponding data direction register is TRISC. Setting a TRISC bit (= 1) will make the corresponding PORTC pin an input (i.e., put the corresponding output driver in a High-Impedance mode). Clearing a TRISC bit (= 0) will make the corresponding PORTC pin an output. [22]

III.6.4 PORTD and TRISD Registers

PORTD is an 8-bit port with Schmitt Trigger input buffers. Each pin is individually configurable as an input or output. PORTD can be configured as an 8-bit wide microprocessor port (Parallel Slave Port) by setting control bit, PSPMODE (TRISE<4>). In this mode, the input buffers are TTL. [22]

III.6.5 PORTE and TRISE Register

PORTE has three pins (RE0/   /AN5, RE1/   /AN6 and RE2/   /AN7) which are individually configurable as inputs or outputs. These pins have Schmitt Trigger input buffers. The PORTE pins become the I/O control inputs for the microprocessor port when bit PSPMODE (TRISE<4>) is set. In this mode, the user must make certain that the TRISE<2:0> bits are set and that the pins are configured as digital inputs. Also, ensure that ADCON1 is configured for digital I/O. In this mode, the input buffers are TTL. [22]

III.7. Timers

The PIC 16F877A has 3 timers:

✓ The timer 0: This is the oldest timers located in the PICs, RTC was the former name for Real Time Clock. It can be incremented by pulses external via the spindle (TOCKI / RA4) or by the internal clock (Fosc/4).

✓ Timer 1: It works on the same principle as the timer 0, but it is more modern in its design. This is a 16-bit. It can be either incremented by the internal clock, by pulses on pin T1CKI/RC0 or by an oscillator (RC or crystal) connected to pins TOSO / RCO and T1OSI/RC1.

✓ Timer 2: This is an 8-bit timer, the clock cannot be that the internal clock divided by 4 (Fosc / 4).The OPTION register associated with the timer to configure the different modes described above. [22]

III.8. the USART module

The USART (Universal Synchronous Asynchronous Receiver Transmitter) is one of two serial communication modules available to the PIC 16F877A. The USART can be configured as asynchronous communication system full duplex or half duplex synchronous system as [21].

III.9. PIC16F877 A/D Module

The Analog-to-Digital (A/D) Converter module in PIC16F877 has eight inputs as shown in figure III.4. The analog input charges a sample and hold capacitor. The output of the sample and hold capacitor is the input into the converter. The converter then generates a digital result of this analog level via successive approximation. This A/D conversion, of the analog input Signal, results in a corresponding 10-bit digital number. The analog reference voltages

(Positive and negative supply) are software select able to either the device's supply voltages (V_{DD}, V_{SS}) or the voltage level on the AN3/$V_{REF +}$ and AN2/V_{REF-} pins.
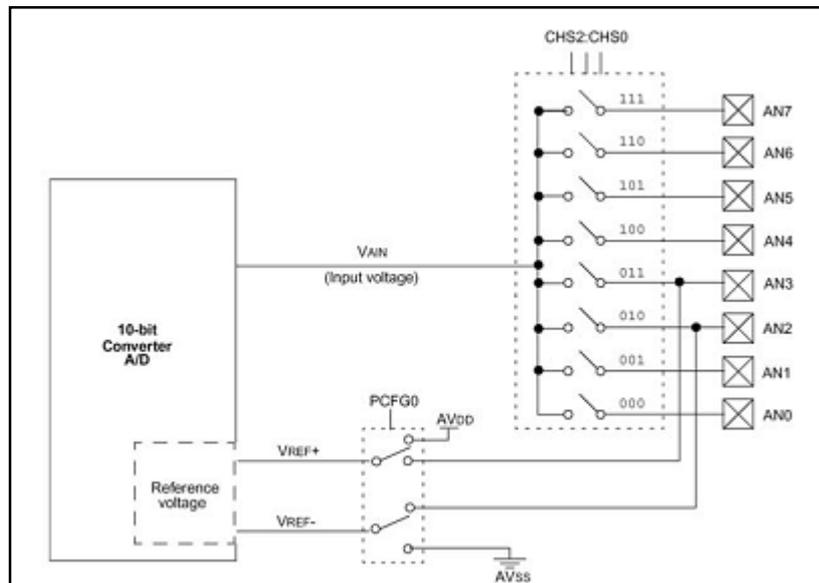

Fig III.4.10-bit A/D Block Diagram. [20]

The A/D converter has a unique feature of being able to operate while the device is in SLEEP mode. To operate the A/D conversion in SLEEP mode, the A/D clock must be derived from the A/D's internal RC oscillator. The A/D module has these four registers:

❖ A/D Result High Register (ADRESH) – Bank 0

❖ A/D Result Low Register (ADRESL) – Bank 1

❖ A/D Control Register0 (ADCON0) – Bank 0

❖ A/D Control Register1 (ADCON1) – Bank 1.[24]

III.9.1. ADCON0 REGISTER

➢ bit 7-6 ADCS1:ADCS0: A/D Conversion Clock Select bits (ADCON0 bits in bold).

ADCON1 <ADCS2>	ADCON0<ADCS1:ADCS0>	Clock Conversion
0	00	FOSC/2
0	01	FOSC/8
0	10	FOSC/32
0	11	FRC (clock derived from the in ternal A/D RC oscillator)

1	00	FOSC/4
1	01	FOSC/16
1	10	FOSC/64
1	11	FRC (clock derived from the internal A/D RC oscillator)

> bit 5-3 CHS2:CHS0: Analog Channel Select bits

000 = Channel 0 (AN0)

001 = Channel 1 (AN1)

010 = Channel 2 (AN2)

011 = Channel 3 (AN3)

100 = Channel 4 (AN4)

101 = Channel 5 (AN5)

110 = Channel 6 (AN6)

111 = Channel 7 (AN7)

> bit 2 GO/   : A/D Conversion Status bit

When ADON = 1:

1 = A/D conversion in progress (setting this bit starts the A/D conversion which is automatically

Cleared by hardware when the A/D conversion is complete)

0 = A/D conversion not in progress

> bit 1 Unimplemented: Read as '0'

> bit 0 ADON: A/D On bit

1 = A/D converter module is powered up

0 = A/D converter module is shut-off and consumes no operating current. [22]

III.9.2. ADCON1 REGISTER

R/W-0	R/W-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
ADFM	ADCS2	—	—	PCFG3	PCFG2	PCFG1	PCFG0
bit 7							bit 0

> bit 7 ADFM: A/D Result Format Select bit.see Table bottom

1 = Right justified. Six (6) Most Significant bits of ADRESH are read as '0'.

0 = Left justified. Six (6) Least Significant bits of ADRESL are read as '0'.

➢ bit 6 ADCS2: A/D Conversion Clock Select bit (ADCON1 bits in shaded area and in bold)

ADCON1 <ADCS2>	ADCON0<ADCS1:ADCS0>	Clock Conversion
0	00	FOSC/2
0	01	FOSC/8
0	10	FOSC/32
0	11	FRC (clock derived from the internal A/D RC oscillator)
1	00	FOSC/4
1	01	FOSC/16
1	10	FOSC/64
1	11	FRC (clock derived from the internal A/D RC oscillator)

➢ bit 5-4 Unimplemented: Read as '0'
➢ bit 3-0 PCFG3:PCFG0: A/D Port Configuration Control bits. [22]

III.9.3. Conversion Time

The conversion time is the time required to obtain the digital result after the analog input is disconnected from the holding capacitor. The conversion time is usually specified in A/D clock cycles and the minimum period for the clock is specified to obtain the specified accuracy for the A/D converter. [20]

See APPENDICE A

III.10. Serial communications

The RS232 is a serial link that can transmit information without transmitting the synchronization clock. It uses a reduced number of sons, as three are sufficient for the transmission of information: a wire to transmit, wire for receive and a third for the ground. As the GSM module uses RS232 protocol, see fig (III.5), fig (III.6), it uses a coding levels +12 and -12V but the PIC only work TTL, it uses an encoding of voltages 0V and 5V. So add an interface circuit between the PIC and the module that handles the conversion of RS232/TTL. In our project, we used the MAX 232.see fig (III.7)
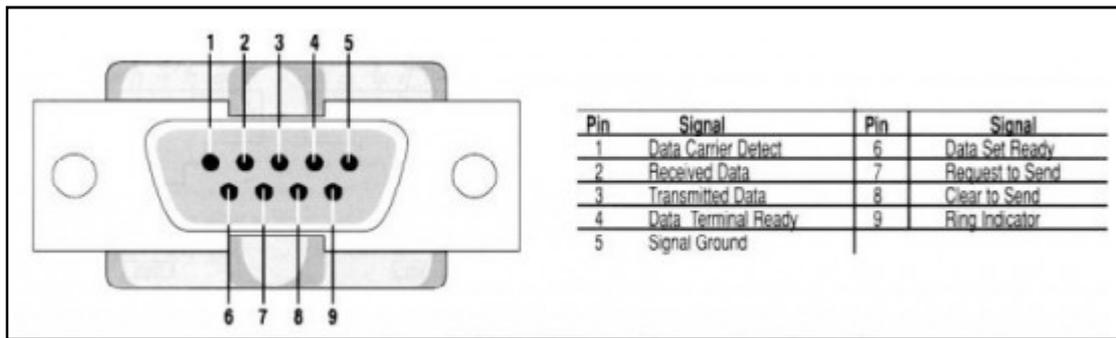
FigIII.5. DB9 connector pin and function

On the DB9 connector, the pin must be done as follows:

- 1 DCD: Data Carrier Detect. input

- 2 RD: Receive Data. input

- 3 TD: Transmit data. output

- 4 DTR: Data Terminal Ready. Output

- 5 SG Signal Ground.

- 6 DSR: Data set ready. input

- 7 RTS: Ready to send. output

- 8 CTS Clear to send. input

- 9 RI: Ring Indicator. Input
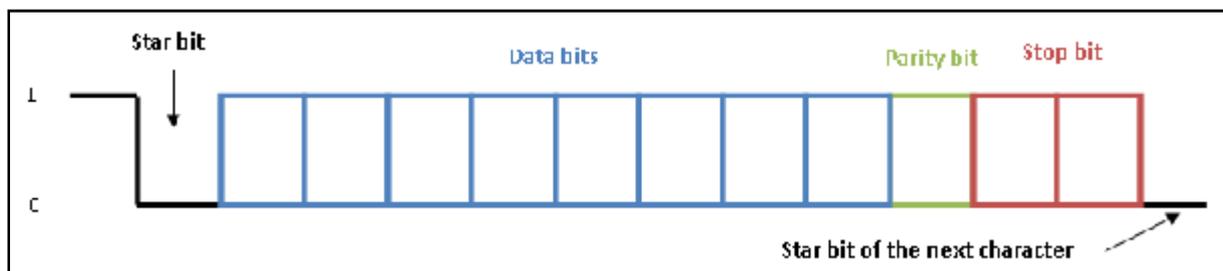
Fig.III.6. data transmission

The figures (III.6) show the curve of the data transmission as:

- The **start bit** that the transmission will begin.

- The **data bits** are then transmitted over a size 7 or 8 bits.

- A **parity bit** can be added to check the validity of data.

- One or two **stop bits** end the transmission to return to rest of the line

➢ **MAX 232**

The MAX232 is an integrated circuit created by the manufacturer MAXIM, it feeds a voltage of 5V. It serves as an interface between a serial TTL levels which are 0 and 5V and RS232 whose levels-12V to +12 V.

Here is the internal and external structure and the pinning of a MAX232:
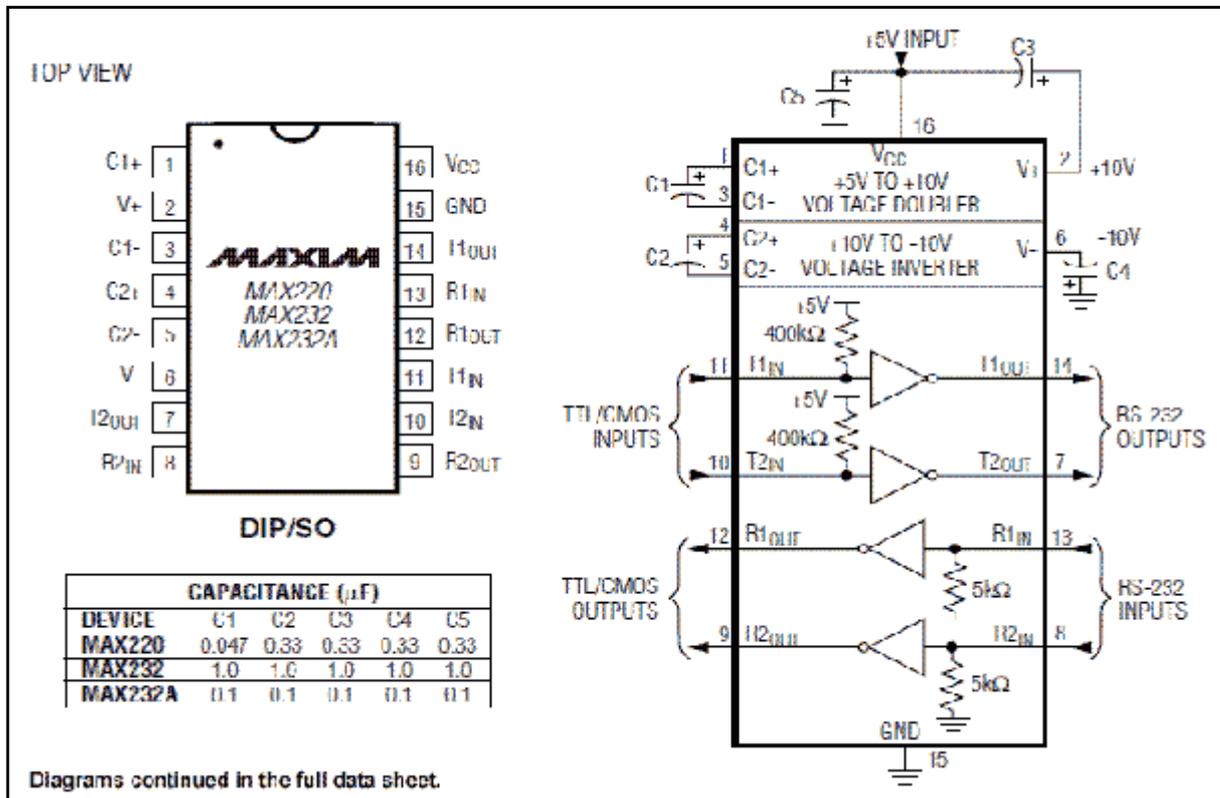
Fig.III.7. Internal and external structure of MAX232

  See APPENDICE B

III.11. Operating principle

The figure shown below is the block diagram of our project. It is a simple illustration of how we implemented our project and the various parts used.

Representation below, the first mobile station is a mobile phone, it is used as a source of transmission of text messages (SMS) containing the instructions. A second station is a GSM module that is attached to our application.

The GSM module as shown in the diagram is a module of TC35 Siemens. Les received messages are stored in the memory of the SIM module.fig (III.8)
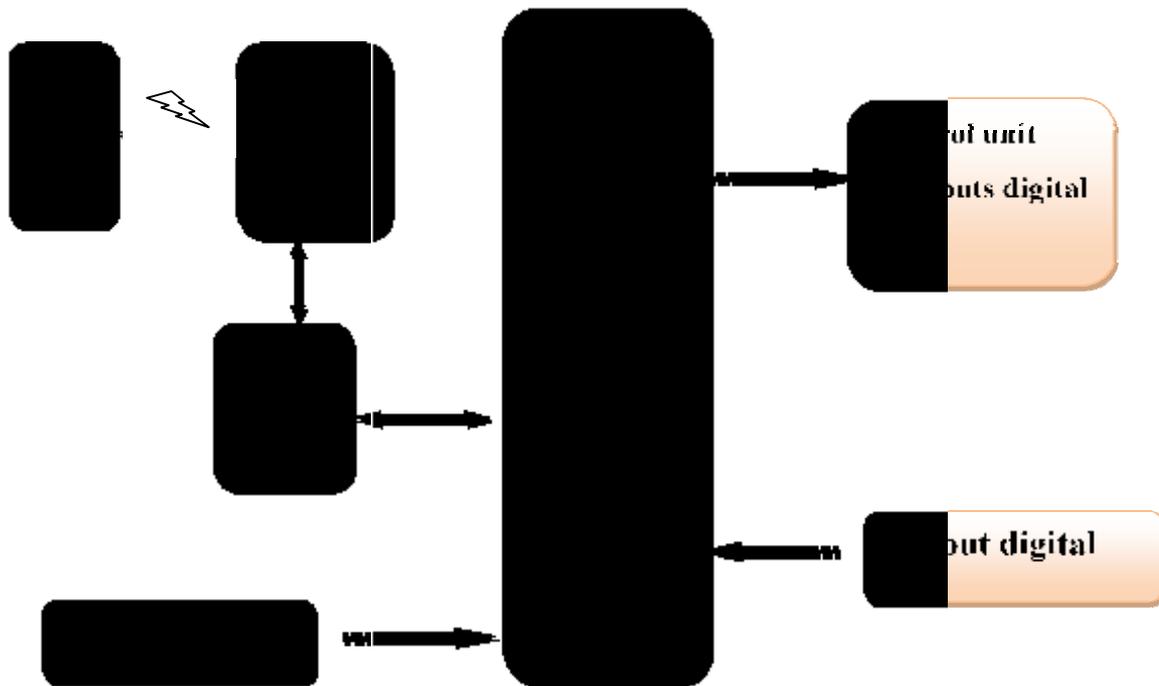
FigIII.8. Block diagram of system

The microcontroller retrieves messages that are processed accordingly to perform specific operations: order or control the inputs or outputs.

From the first mobile station which is the mobile phone, the user sends an SMS message containing instructions to the second station is the GSM module it stores it in memory of the SIM card. The controller (PIC16F877A) communicates with the GSM module by AT commands, the PIC sends the command AT + CMGL to the module to list the stored messages. In cases where there are no messages the module sends an OK response only to the product and otherwise, the module returns the index of all stored messages and their states from memory. The PIC stores the first index and it will read the message using the command AT + CMGR, it saves the phone number of the issuer and is a filtering operation to identify the user and prevent any foreign intervention.

If the transaction occurs, the PIC sends the same command to replay the message, but this time it saves the message data in memory because the PIC has enough space to save the entire message, the PIC decodes and processes the data, if it there's a fault in the format, the PIC sends an error message. Otherwise, it loads the instructions in the POTRD to control the output. As following, the PIC will send confirmation message states of inputs and outputs. If the filtering operation is not performed, the PIC ignores the received message.

The PIC will delete the message processed by sending the command AT + CMGD over the index of message deleted. The PIC will test the inputs outputs even if the module has not received any message.

Whenever the PIC sends the command AT + CMGL to test if there's Inbox and in both cases the PIC tests the status of inputs / outputs and sends an alert message if found a change in the digital or analog inputs if exceed the threshold voltages.

To post a message, the PIC uses the AT + CMGS over the phone number stored in the EEPROM of the PIC followed by the message data, when the GSM module receives the CTRL Z character (26 decimal) the message is sent over the network to the user.

The process of control of a device connected to the interface will proceed by the following steps:

- ❖ Control unit: Once the message is processed and stored, the PIC will change the status of 8 digital outputs by loading the PORTD by the register or the message was saved, and depending on the contents of this message changes the PIC outputs.

- ❖ Control unit status: In each time period, the microcontroller will check the digital inputs and when it finds a change of system state. The PIC sends a message containing the status of recent system to the GSM module, it sends the message to turn the user-controlled system.

- ❖ Unit of measure voltage (analog): This function is to measure the analog voltage across an electrical system. The PIC receives electrical distensions we going to measure using the module A / D.

- ❖ The microcontroller measures voltages up to 5V so we used the rule of the voltage divider for dividing the voltage.

III.12. Conclusion

In this chapter, we studied the PIC16F877A, their main characteristics and the general operation of our project.

So, the next goal is to run the PIC with other application modules.

CHAPTER IV:

REALIZATION

AND VALIDATION

IV.1. Introduction

The realization is a logical of a design work. The development work of our application is none other than the realization of the needs expressed above.

We will in this chapter describe the different steps of the project where we began by the hardware then the software.

IV.2. HARDWARE

IV.2.1. Architecture system

From practical point; our system divided into multiple channels; The heart of system is 'the microcontroller PIC 16F877A' (works only in TTL / CMOS), where it must communicate with the 'GSM module' that uses the RS232 protocol with care of the conversion between the PIC and RS232 .The fig (IV.1) display the global schema of our card system & it's different division, we start by the power supply in the next title.
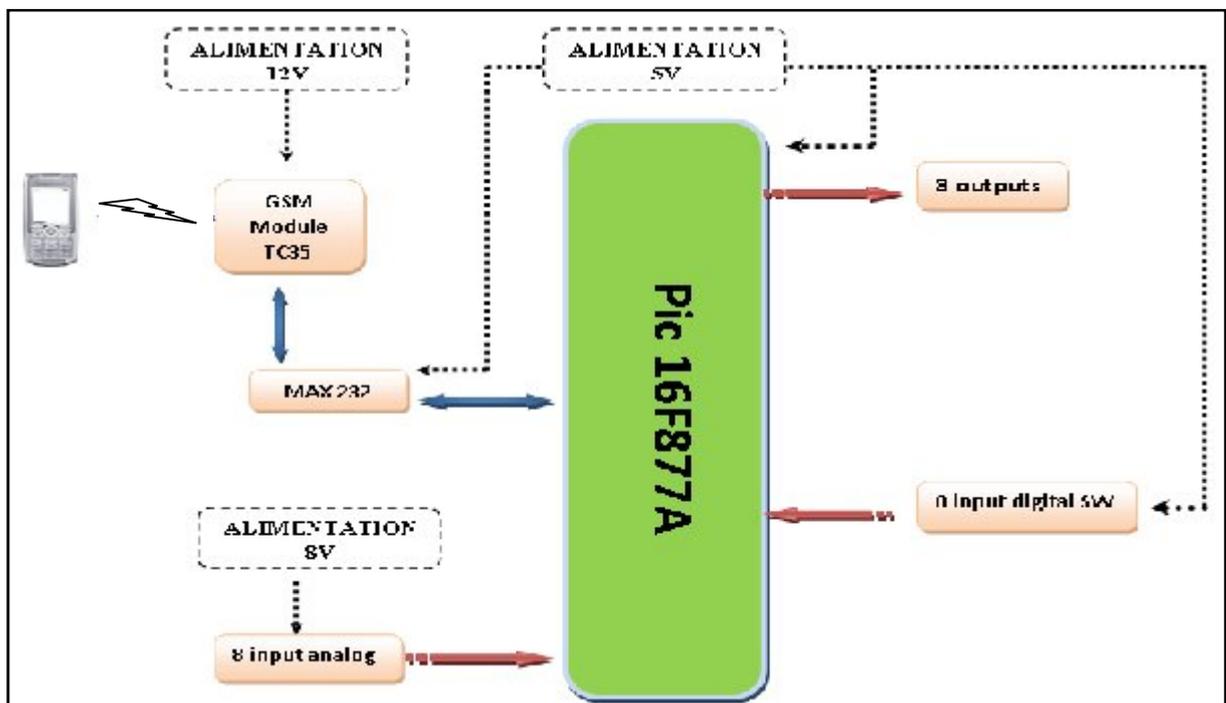
FigIV.1. Block diagram of system

Representation the Electrical schematic of application

The global electric schema is in the following image .see fig (IV.2)
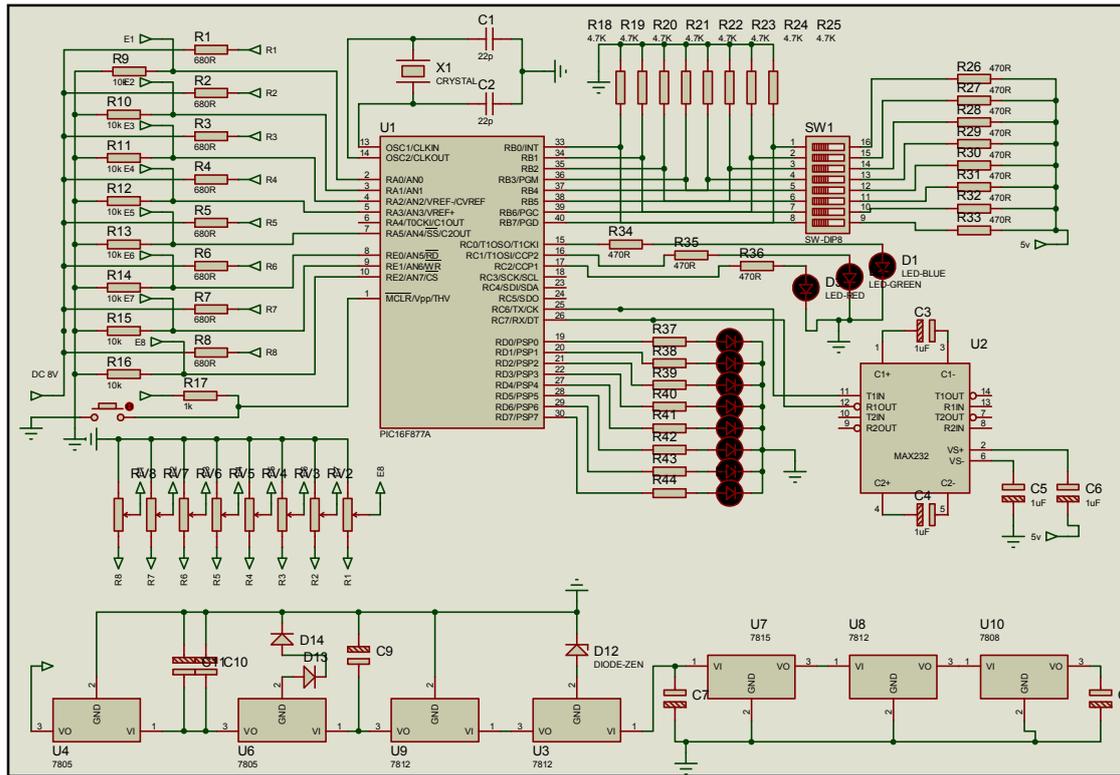
FigIV.2. Electrical schematic of application

IV.2.2.1. Power supply

Each circuit of our system needs an accurate supply voltage, where its power is between: "15V <voltage <19V and a 1A <current <3A", in our work we need different voltages, for that we applied voltage regulators with kind «LM78xx series». See fig (IV.4)

The LM78XX series is available in an aluminum TO-3 pack-age which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided. See fig (IV.3) [23]
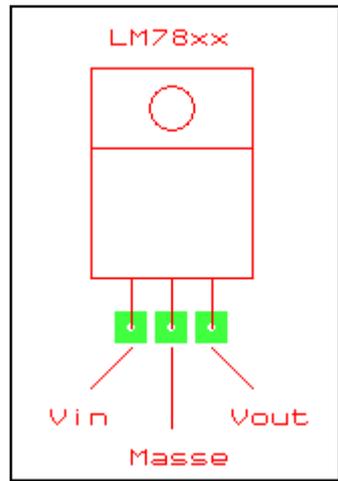
FigIV.3. Schematic of a regulator [24]

Where:

LM: prefix used by the manufacturer. It may also involve uA, or MC.

78: means it is a positive regulator

79: means it is a negative regulator

xx: fixed output voltage (integer value)

Current values avalable: 5V, 6V, 9V, 10V, 12V, 15V, 18V, 24V [34]
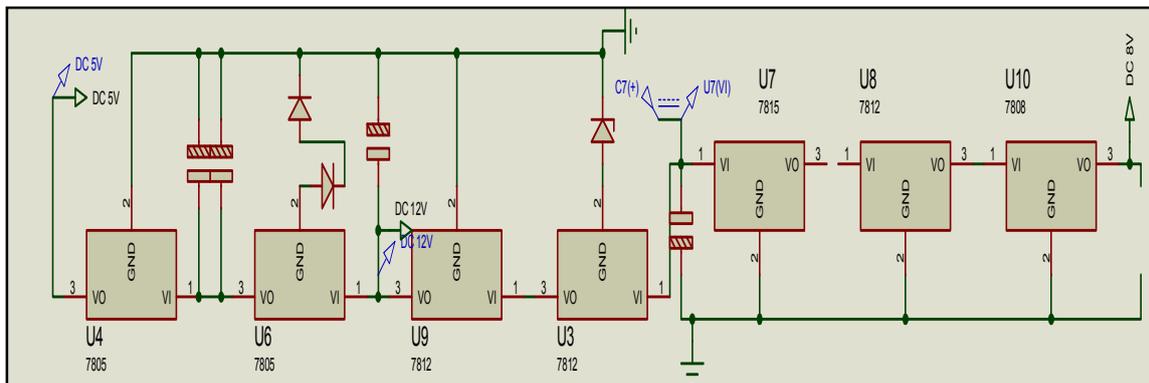
FigIV.4. Schematic of power supply

IV.2.2.1.1. Power supply of GSM module

T35 GSM module needs three different voltages: A voltage of 12V for its power, a voltage which is greater than 5 volts to initialize the module for more than 200ms and a voltage greater 5 volts to power off for t> 3.5s. For its different voltages, was performed using a circuit voltage regulators that has cascaded.

The supply voltage of GSM module is obtained from an input voltage 15 <V <18 using LM7812 regulators and diode zener. By first reducing the input voltage of 13V, in practice, the output voltage should be 13V, but the tolerance on the values of the Zener diode and the output voltage of the regulator are that the value may differ slightly. Then was reduced from (13V) to 12V, allowing us to feed of our GSM module. Using this voltage regulator input of another LM7805 with diodes 1.2V, placed between ground and ground terminal for the integrated regulator to output a voltage of 7V for initializing the GSM module.Fig (IV.4)

IV.2.2.1.2. Power Supply PIC16F877A and MAX 232

To start up the PIC16F877A, there are 7 pins, should connect them correctly. The ideal voltage for PIC16F877A is 5V (Direct Current). It should not be higher than 5.5V because it going to blow up, or less from (2V) because it not going to be operates. You will have various type of supply such as battery and DC adapter. The problem is, if you use battery, it's hard to find normal one with 5V.

From the voltage of regulator "U6" LM7805 previously, we obtained the input of a regulator "U4" LM7805 to get an output voltage of 5V, which enables us to supply the MAX232, PIC16F877A and input digital. See fig (IV.5)
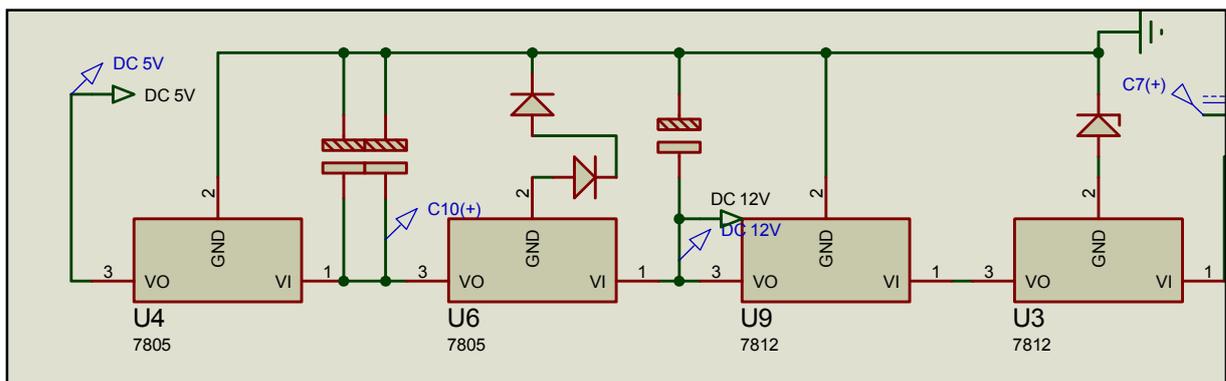
FigIV.5. Schematic of power for GSM module, max232 and PIC

IV.2.2.1.3. Power analog inputs

For analog inputs, we use the same type of regulator and the same input voltage (8V).fig (IV.6)
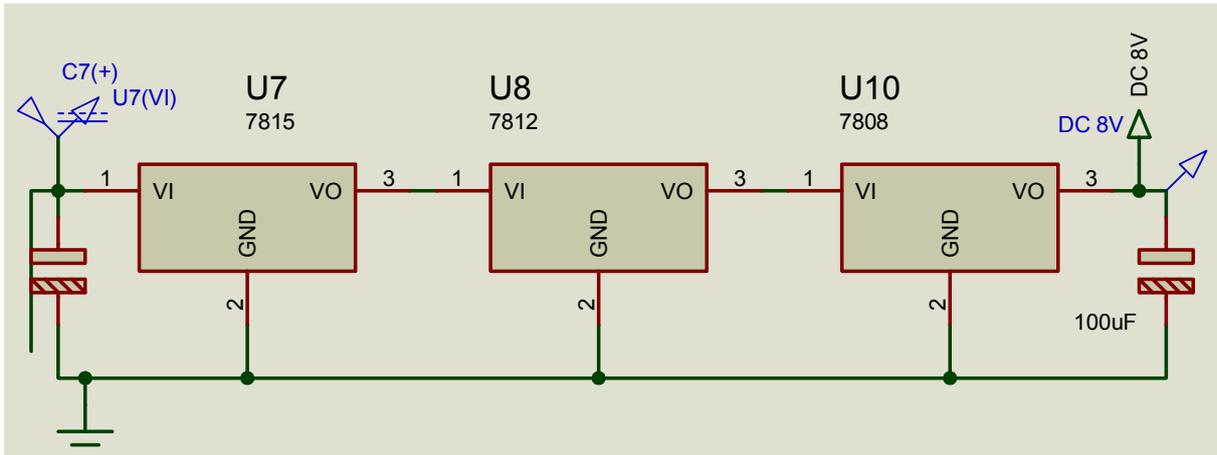
FigIV.6. Power analog inputs

IV.2.2.2. the system inputs

The system has 8 digital inputs and 8 analog inputs:

IV.2.2.2.1. Analog inputs

The analog inputs of system ,may vary within a range of voltage of 0 to 8V. As the PIC16F877A ,may not convert a voltage higher than 5V; it should use a devisor voltage to adjust the tension measured in such a fate; where it converted by the PIC using two resistors 10KΩ and 680Ω, as he shows us the following figure(fig IV.7)
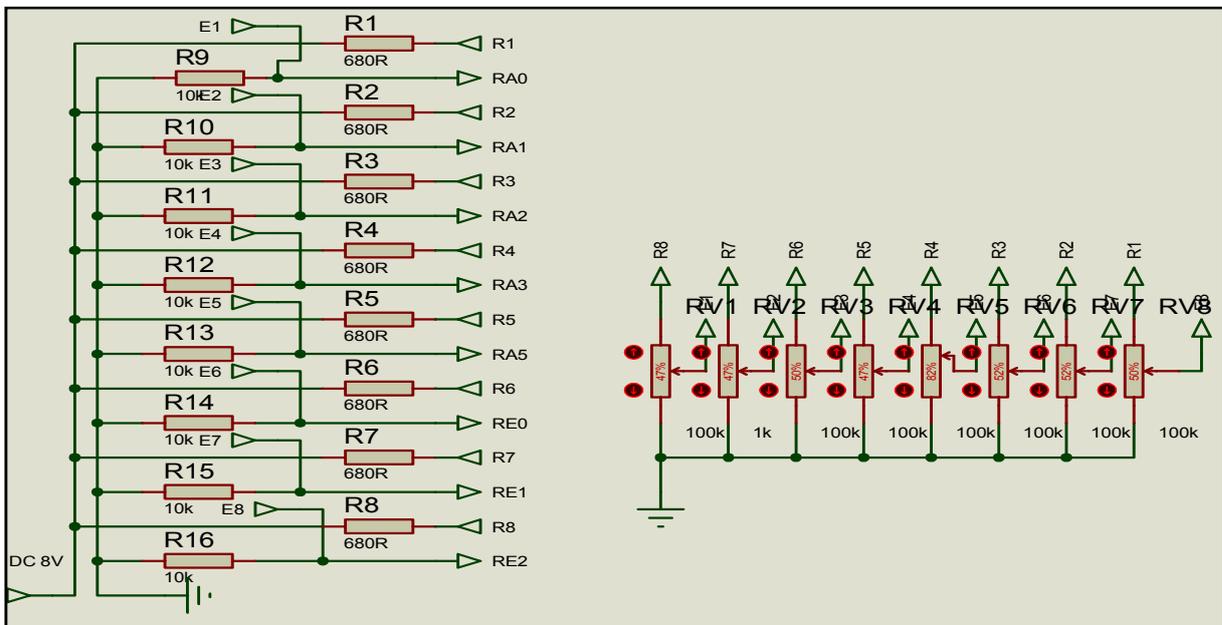
FigIV.7. Schematic of the analog inputs

IV.2.2.2.2. Digital inputs

To connect the digital inputs with PIC 16F877A, by using 470Ω resistors to protect the entrance of limiting the current PIC, and by using 4.7K resistors to force the to have zero in the absence of voltage (power off) as it is shown in the following figure. See (fig IV.8)
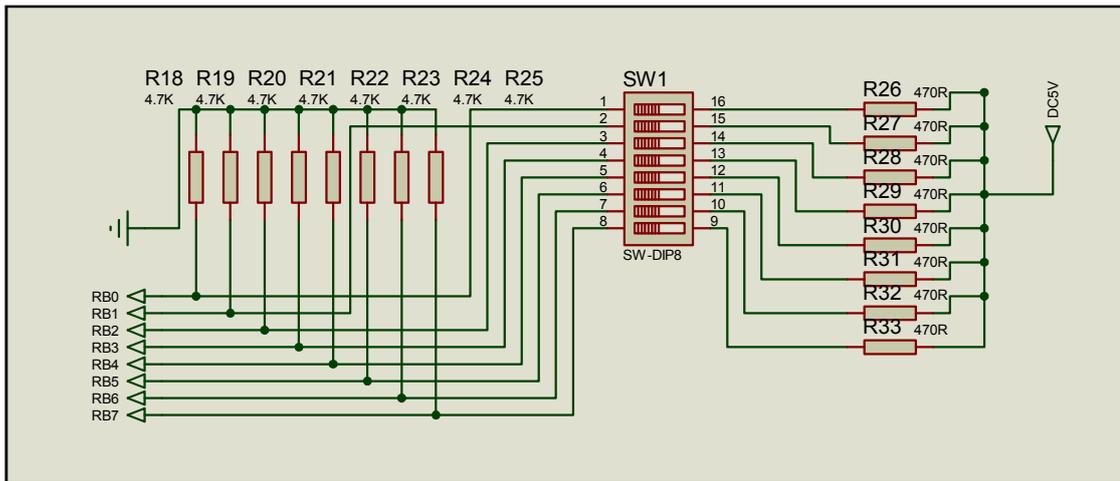
FigIV.8. Schematic of the digital inputs

IV.2.2.3. Serial communications

The MAX232 has two TTL inputs, two RS232 inputs and their corresponding outputs but in our case, we use only a TTL input, RS232 input and output as a single link is sufficient.

The assembly of MAX 232 requires the use of four 1uF capacitors are placed as shown in the following figure. See fig (IV.9)
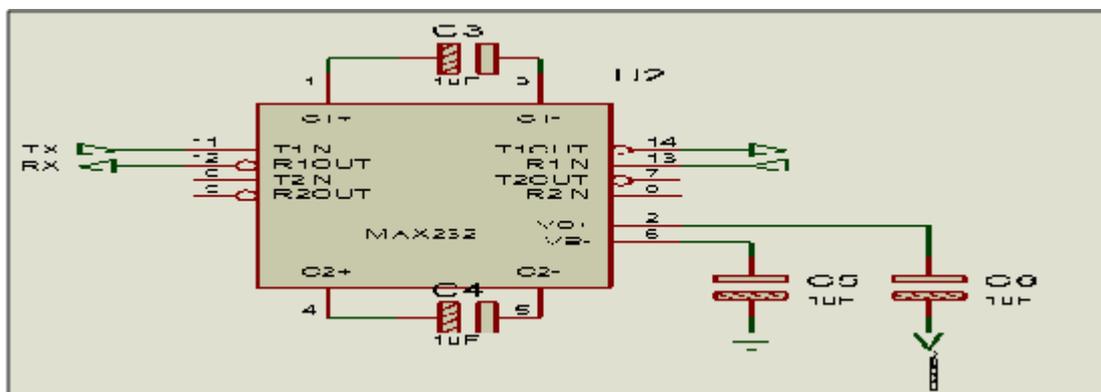
FigIV.9. RS232 connection between the module and the acquisition card

IV.2.2.4. the system outputs

We have seen that the PIC can receive commands that define the state-controlled system and it will alter the state of 8 outputs depending on the variation of these commands. Each command outputs with LED ON or OF. See fig (IV.10)
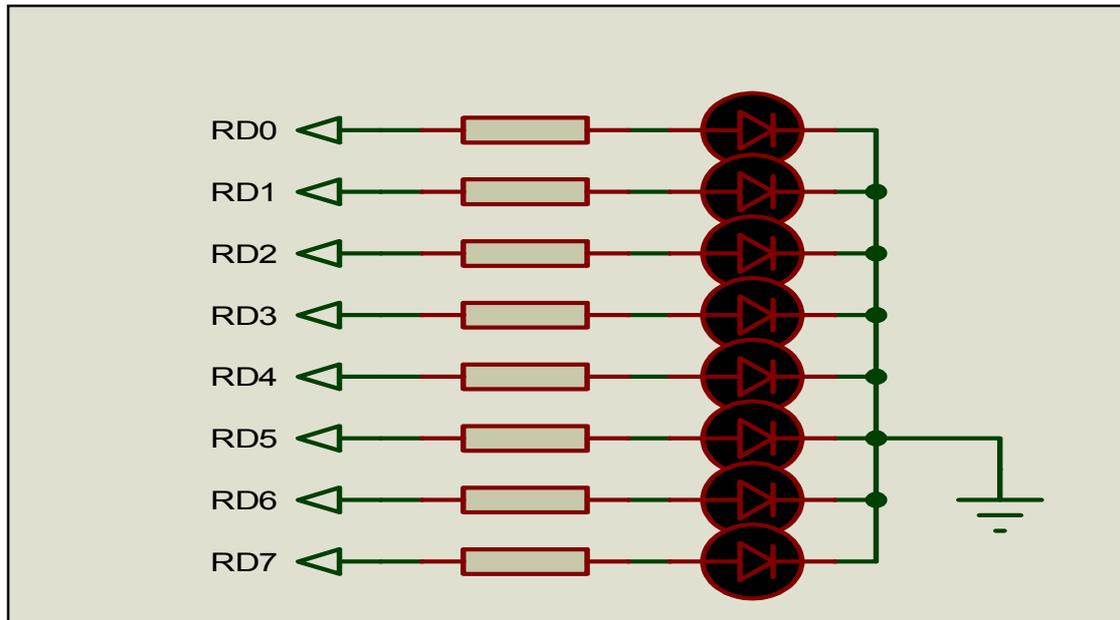
FigIV.10. Schematic of the digital outputs

IV.2.2.5. Quartz

Here is the way how to connect the crystal oscillator with pins: 13 -14 named OSC1 and OSC2   from various frequencies.

The Pulse obtained from the oscillator has sometimes a noise; to reduce the noise we add two capacitors, in piko farad. The value of capacitor is depending on the speed of oscillator that you use. See fig (IV.11)
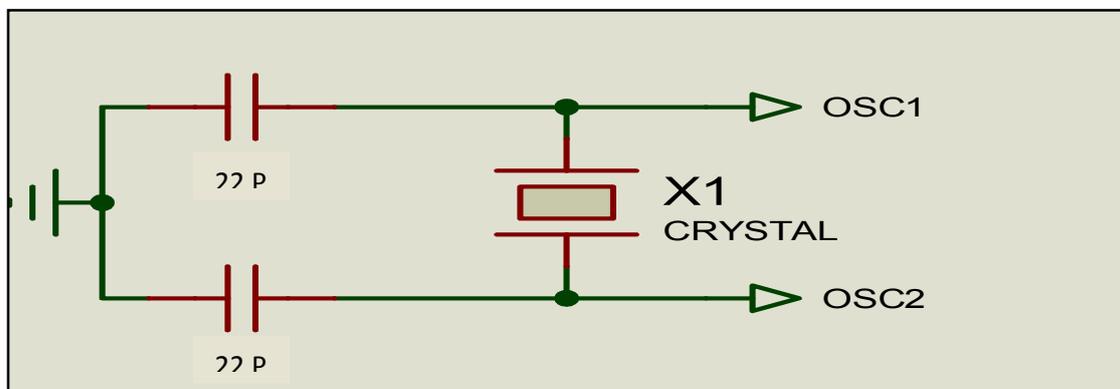
FigIV.11. Crystal pin out with PIC

IV.2.2.6. the Reset Circuit

To give power supply to PIC; there are 7 pins should be connect in order to let PIC operate. 4 pins are already connected : 2 pins for 5V and 2 pin for ground (negative),and left the 3 pins (non using). The other important pin is Reset pin (MCLR - Master Clear Reset at Pin number 1). If PIC read 0V at MCLR pin, it will reset the program, so if you not connect the MCLR pin with 5V, PIC will remain reset and your program will not execute. You can directly connect the MCLR with 5V but you will unable to reset it if your system goes wrong. See fig (IV.12)
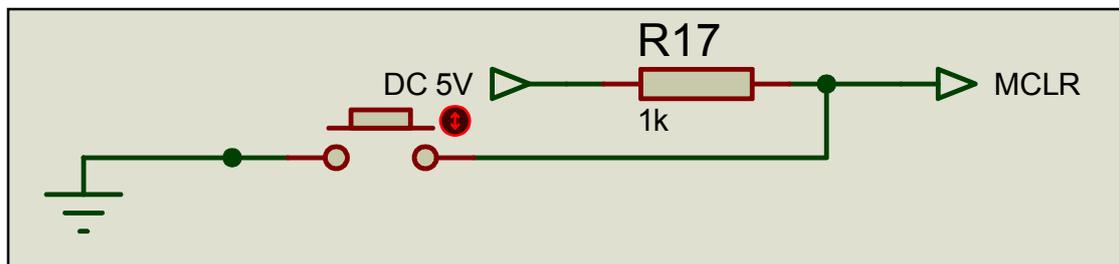
Fig IV.12.the Reset Circuit

If you want to use the reset function, you need to create logic condition which is 1 and 0 to the reset pin. 1 is meaning the reset pin get 5V. If the reset pin logic is 1, the program in the PIC executes, but if the reset pin logic condition is 0 (which is 0V) the PIC can not execute the program.

IV.2.2. Realization

After studying the deferent elements constituting our electronic board; we turn to the physical realization of a test plate of our project.

IV.2.2.1. PIC programmer

Implementing a program in the PIC; needs to have a programmer allow us to load our program in the registers of PIC. For this; we used universal PIC programmer which can program a wide range of PIC as well as most of the serial EEPROMs. It simply connects to the parallel interface of a PC with a COM port. Fig (IV.13)

See APPENDICE A

Fig.IV.13. Interface Universal Programmer

See APPENDICE G

IV.2.2.2. Realization on test plate

The practical realization is the final work of our project, it is to implement all functions on a test plate and make them work. Figure IV.14 shows a photo of the final application's functions.
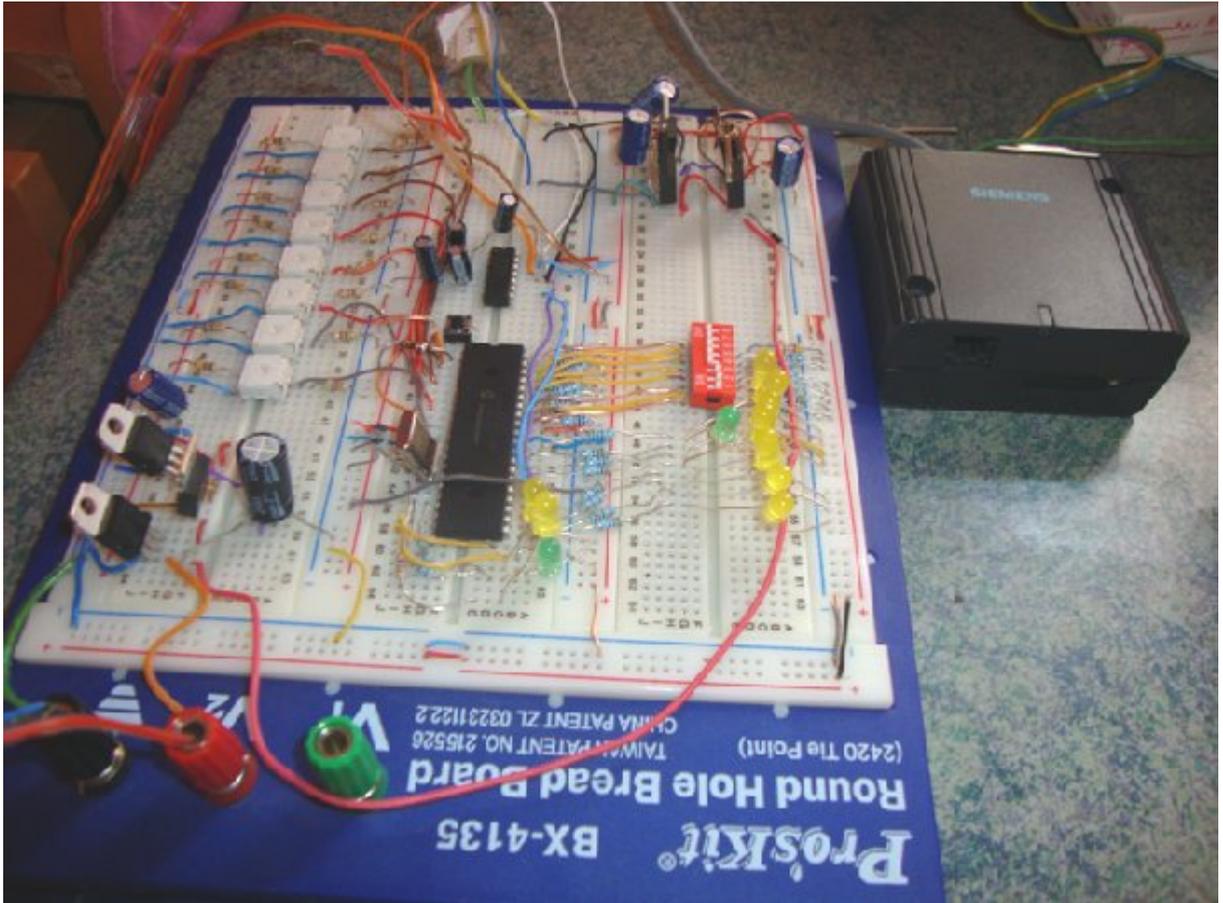
FigIV.14. Realization on test plate of the application

IV.2.2.3. Experimental validation

Experimental validation is to verify the operation of all functions the application made it on the test plate.

IV.2.2.3.1. Experimental validation of the digital inputs

To validate the digital inputs by change their states by a switch where they expected to send an alert message from the PIC to our mobile phone. Here is a screenshot of the hyper terminal; shows that sending a message after a change of digital inputs.

Note that in the confirmation message sent; the property owner that the digital inputs have been changed (ON) according to the changes which we have implemented on the Switch. See fig (IV.15)

FigIV.15. Screenshot of the hyper terminal for digital inputs

IV.2.2.3.2. Experimental validation of analog inputs

To validate the analog inputs, using a potentiometer to vary the voltage and wait for an alert message on our cell phone from the PIC then visualized this message on hyper terminal that shows the values of analog voltages. The figure below is a screenshot of communication between the PIC and the GSM module which shows the analog values in the message sent. See fig (IV.16)

FigIV.16. Screenshot of the hyper terminal for analog inputs

IV.2.2.3.3. Experimental validation of digital outputs

To validate the digital outputs, we will send a message as??**R 1 ON 2 OF 3 ON 4 OF 5 ON 6 OF 7 ON 8 OF** (which mean**(??R → special characters,1.2…8 →** number the led's)) to the GSM module where we can see the changes of the digital outputs (LEDs) on our application ;The hyper terminal shows the communication between the PIC and the GSM module. From Figure IV.20, we note that the PIC has listed the messages from the SIM card by sending the command AT + CMGL and found only a message unread, after read the message by sending the command AT + CMGR, we note that the PIC changes the state of digital outputs by (led's) as the message sent; then confirm to the owner a message with the command AT + CMGS after checking the number of the message sender and the form of the data. At the end; the PIC deletes the message. See fig (IV.17)

FigIV.17. Screenshot of the hyper terminal for output control

IV.2.2.3.4. Experimental validation of a Message error

In case the message data does not respect the form, the PIC sends the user an error message before deleting the message by sending the command AT + CMGD, as shown in screenshot the following hyper terminal. See fig (IV.18)

FigIV.18. Screenshot of the hyper terminal to an error in the message

Now we pass to the second study of our work which is the software in the next title

IV.3. SOFTWARE

IV.3.1. Program used

> - The program **PROTEUS** is composed:
>   - ✓ The **ISIS** schematic editor <u>See APPENDICE C</u>
>   - ✓ The design tool for printed circuit **ARES** <u>See APPENDICE D</u>
> - The program **MPLAB** <u>See APPENDICE E</u>
> - The program **hyper terminal** <u>See APPENDICE F</u>

IV.3.1.1. The schematic ISIS

The ISIS user interface shown in fig (IV.19), consisting of edit, overview and object select windows, with edit toolbars. Components are added to the object list from the libraries provided, dropped onto the schematic, and connected up using virtual wiring. Components can be labeled and their simulation properties modified.
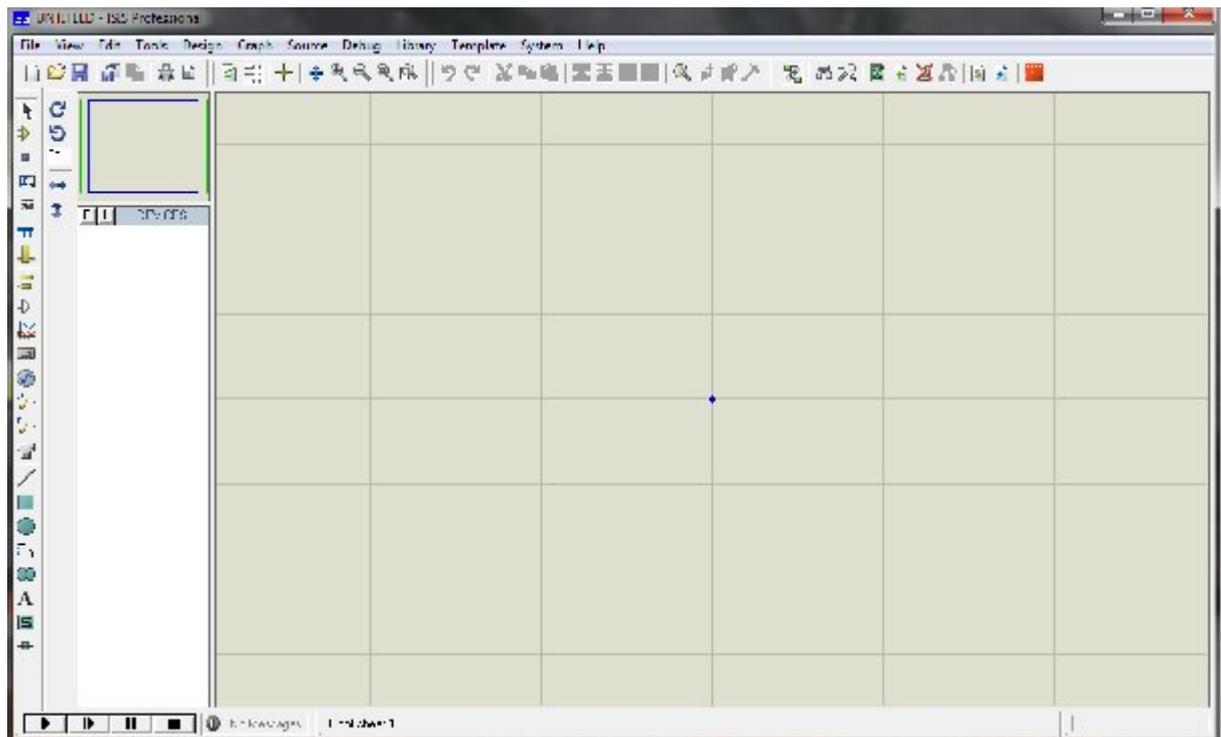
FigIV.19. Interface ISIS

IV.3.1.2. Presentation of Ares

General aspect of ARES is very close in ISIS. See fig (IV.20)
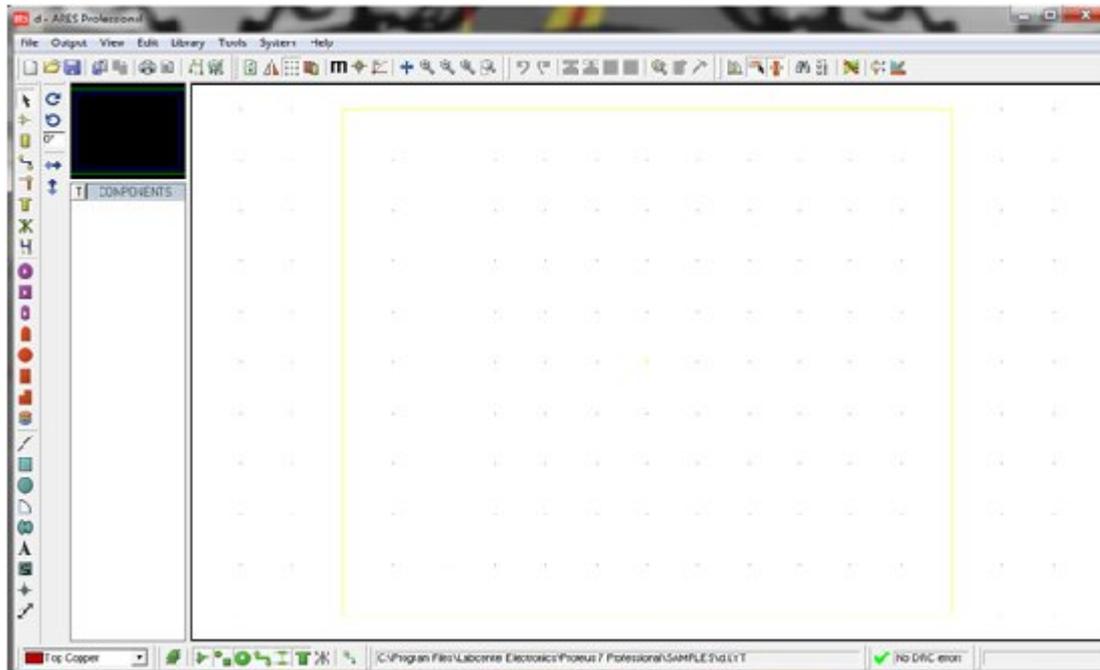
FigIV.20. Interface ARES

IV.3.1.3. Choice of programming language

Programming the PIC can be done in assembler, Basic or C. We have developed our program in assembler for several reasons including the ability to precise the control of execution time, and for the assembler compilers are free contrary in C or Basic.

However, it is closest to the machine; & produces compact and fast code, but must be set by hand. It is perfect for applications that require real-time control for very short timings. It is very intellectually stimulating for those who want to get involved in complex projects.

Using the RISC architecture and instruction set of PIC16F877A is limited to 35 basic instructions, which simplifies programming.

Presentation MPLAB IDE

MPLAB Integrated Development Environment (IDE) is a comprehensive editor, project manager and design desktop for application the development of embedded designs using Microchip PIC (micro microcontrollers).

The MPLAB IDE allows you to create source code using the assemble of integrated editor, compile and link the source files that can come from different languages. An assembler, linker and library manager are supplied with MPLAB. It also allows you to debug the executable code by observing how the program using the simulator provided.

IV.3.1.4. Hyper terminal

HyperTerminal is a program that is integrated with Windows. This is a slight graphical interface, can establish a serial connection. This program allows us to transmit data on the COM port and display functions.

In our application, we will use it to display the communications between the application and the GSM module on the PC screen. We will verify the proper functioning of our application. See fig (IV.21)
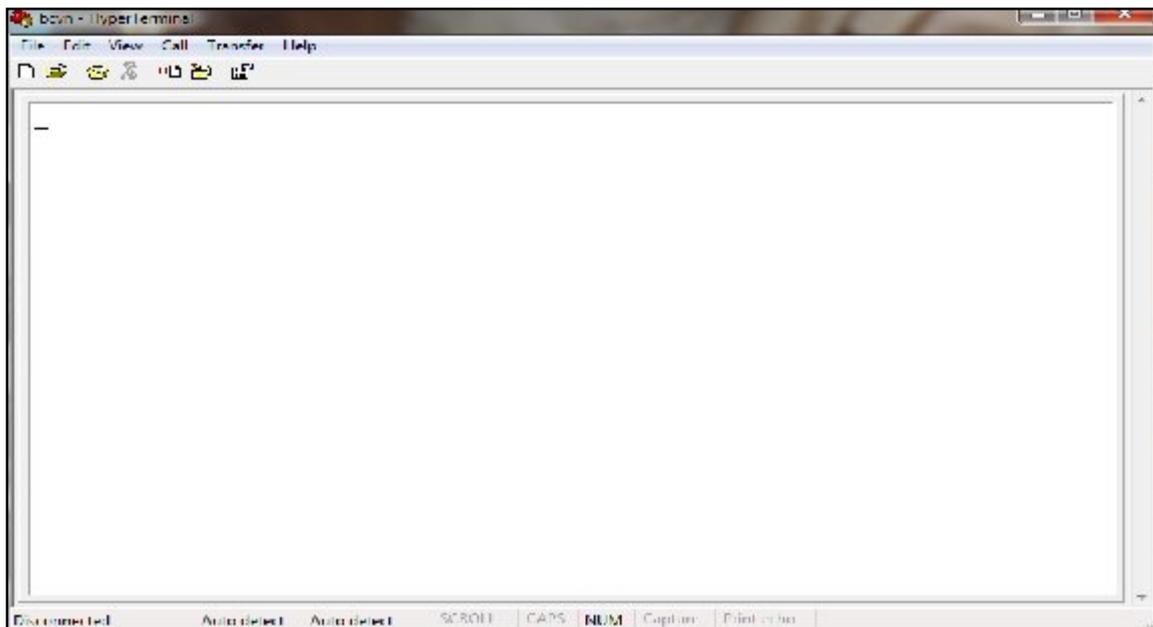
FigIV.21. Interface Hyper terminal

Our flowchart displays the detail of our work where we can see it in the next title**.**

IV.3.2. Flowchart of main program implemented in the PIC

The Flowchart below (fig (IV.22)) shows the general sequence of our main program, which consists of several sub programs where we can see it later.
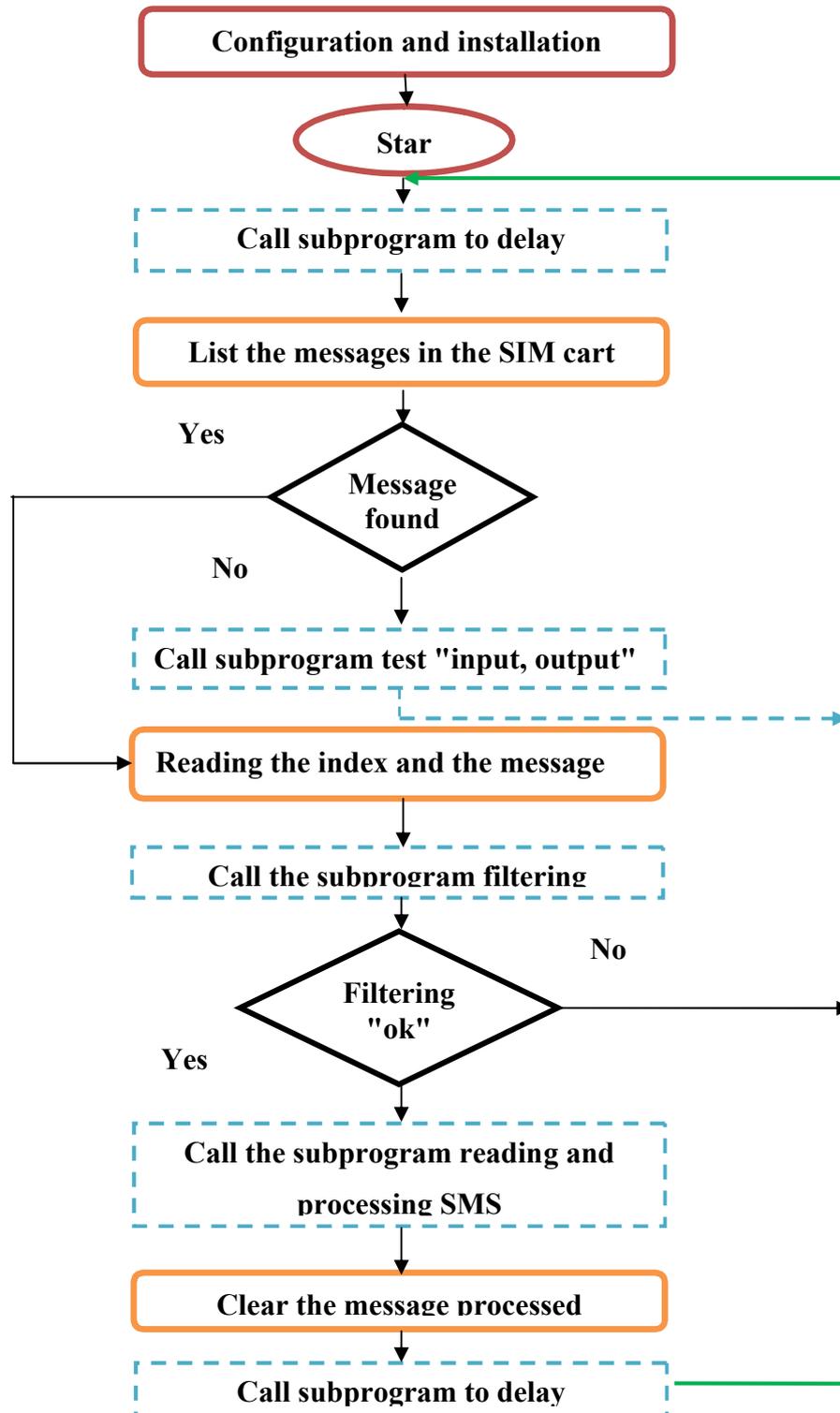
FigIV.22 .Flowchart of main program implemented in the PIC

IV.3.2.1. Flowchart of subprogram tests I / O

The following Flowchart shows the details of sub program which verify the "analog / digital" inputs and digital "outputs». See fig (IV.23)
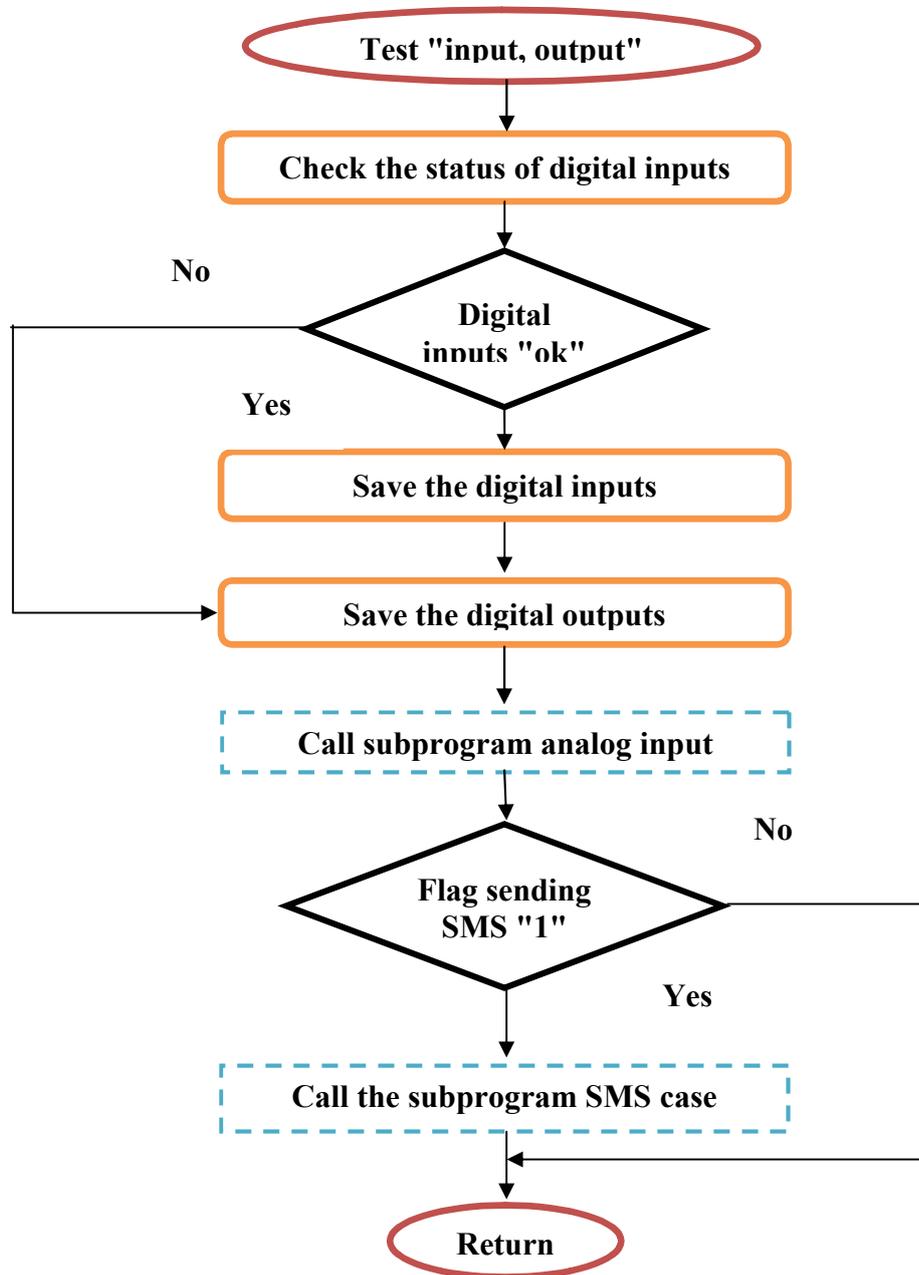
FigIV.23. Flowchart of subprogram tests I / O

IV.3.2.2. Flowchart of subprogram SMS case

The following Flowchart shows the SMS case of sub program which charge case of the digital outputs, digital inputs and analog inputs. See fig (IV.24)
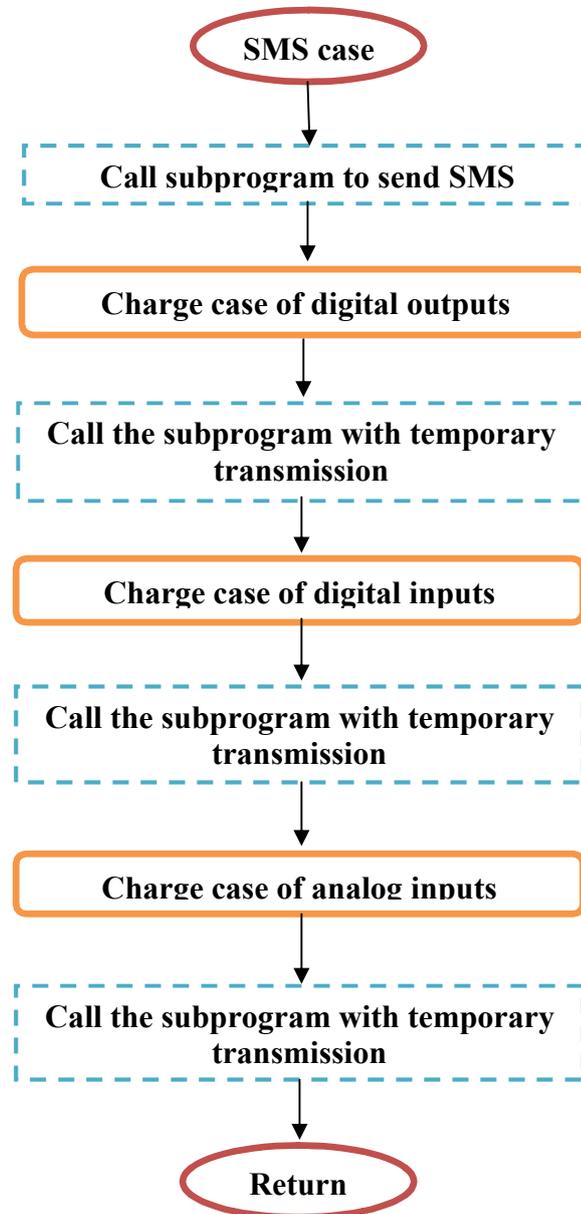
FigIV.24. Flowchart of subprogram SMS case

IV.3.2.3. Flowchart of subprogram transmission

The Flowchart below shows the routine of sub program which the operation of message transmission. See fig (IV.25)
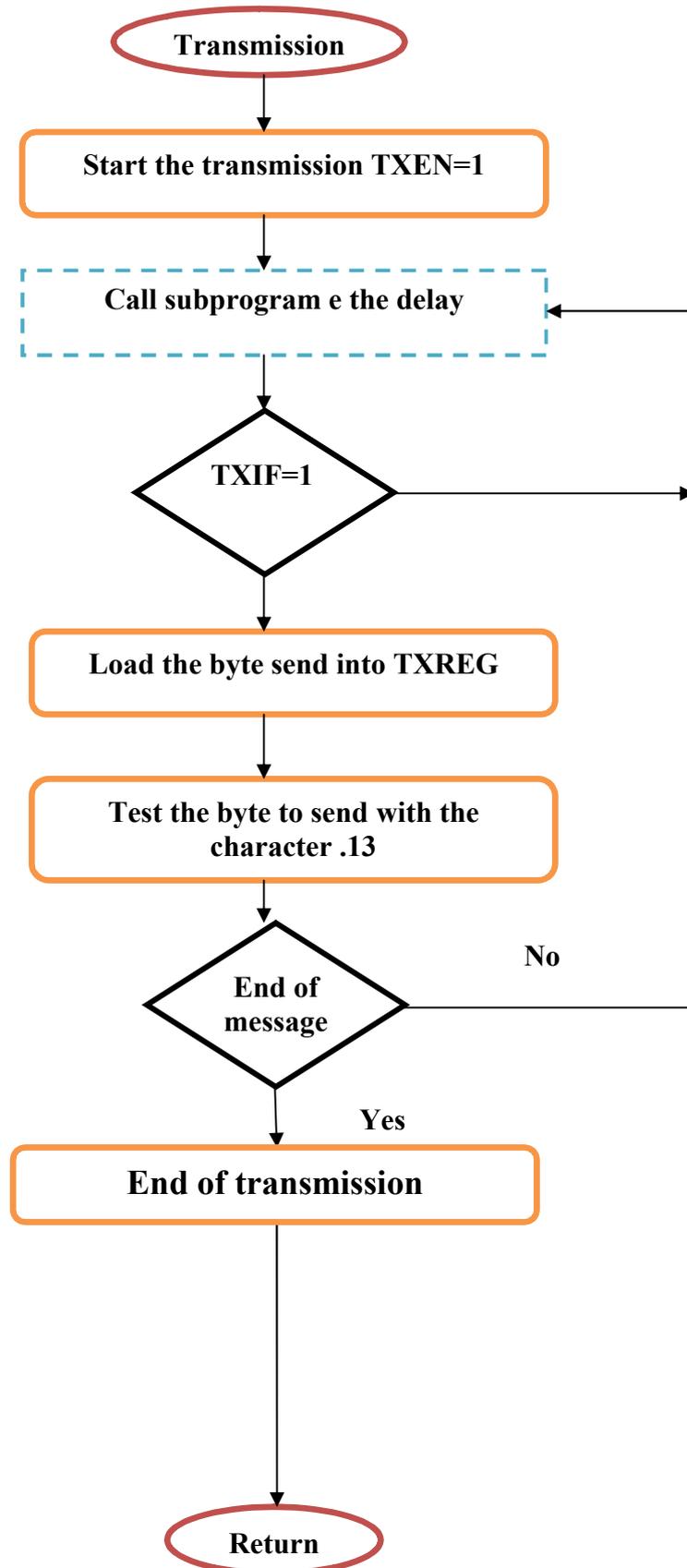
Fig IV.25.Flowchart of subprogram transmission

IV.3.2.4. Flowchart of subprogram reception

The Flowchart below (fig (IV.26)) shows the subprogram of program for the operation of receiving messages.
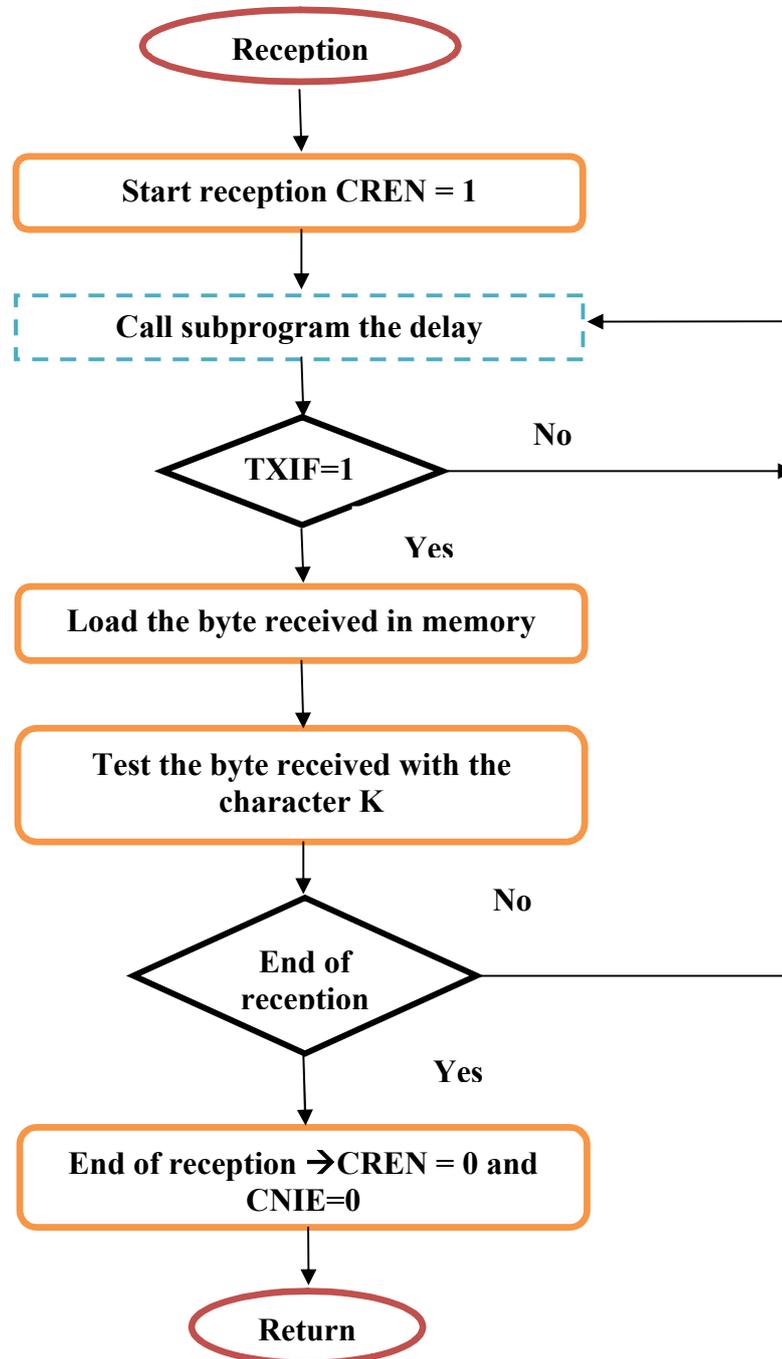
Fig IV.26. Flowchart of subprogram reception

IV.3.2.5. Flowchart of subroutine filtering

The following Flowchart represents the sub-routine of filtering program for sender telephone number. See fig (IV.27)
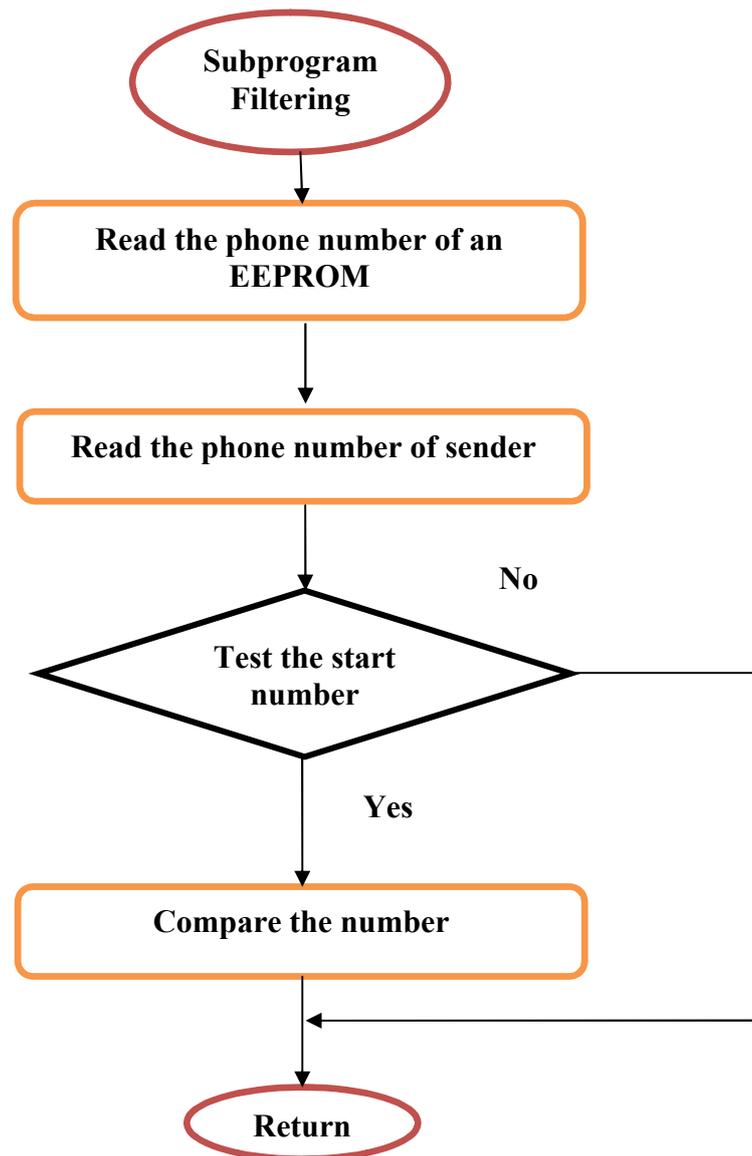
FigIV.27. Flowchart of subroutine filtering

IV.3.2.6. Flowchart of subroutine for sending an SMS

The Flowchart below (fig (IV.28)) shows the sub-routine of program by sending messages from the PIC to the user.
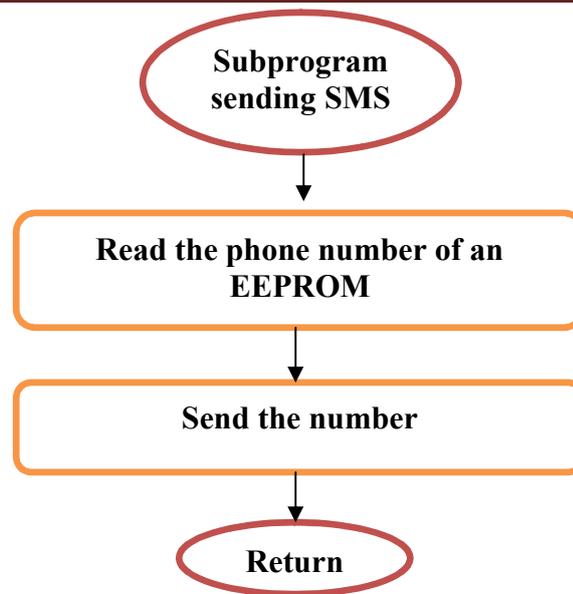
FigIV.28. Flowchart of subroutine for sending an SMS

IV.3.2.7. Flowchart of subprogram processing of SMS

The Flowchart below shows the detail of sub program which is the processing of messages sent from the user to control the input / output.se fig (IV.29)
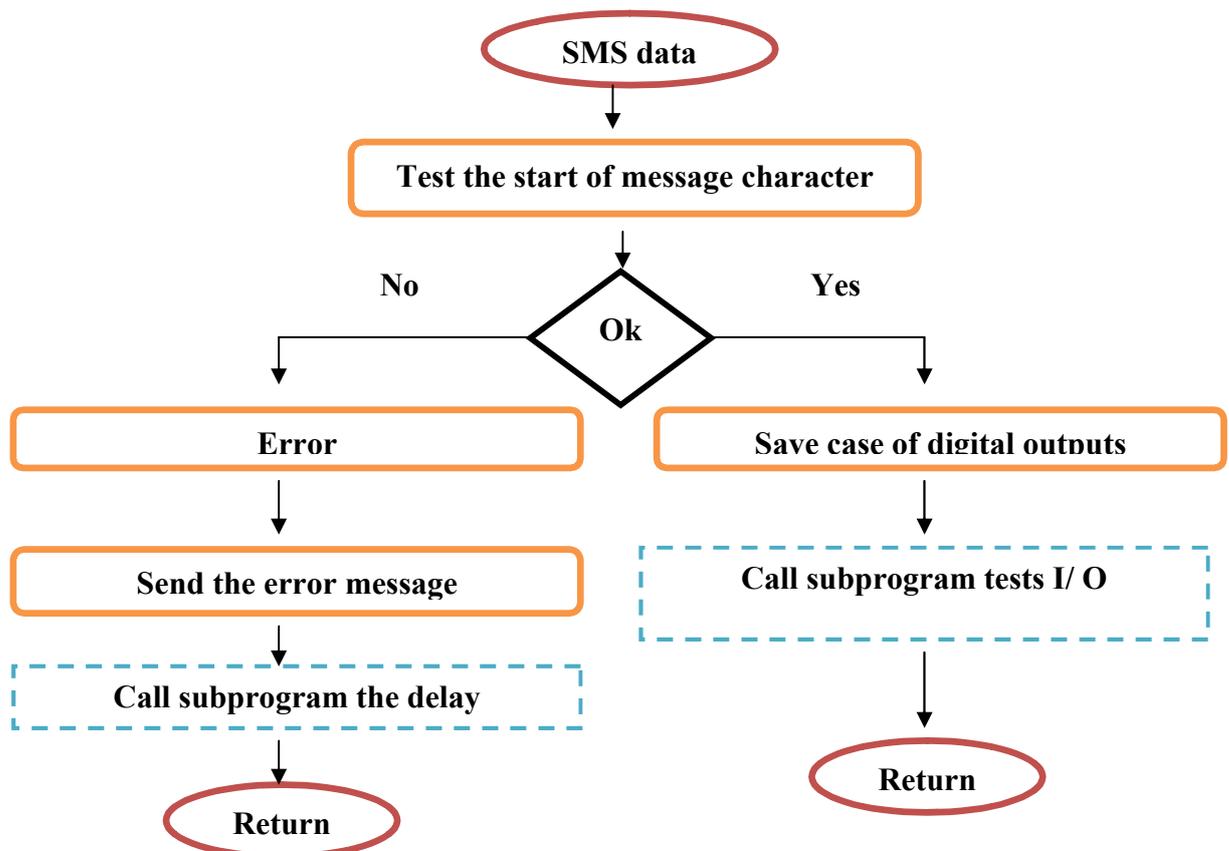
FigIV.29. Flowchart of subprogram processing of SMS

IV.3.2.8. Flowchart of subroutine to read a SMS

The Flowchart below shows the sub-routine of the program done to read the messages. See fig (IV.30)
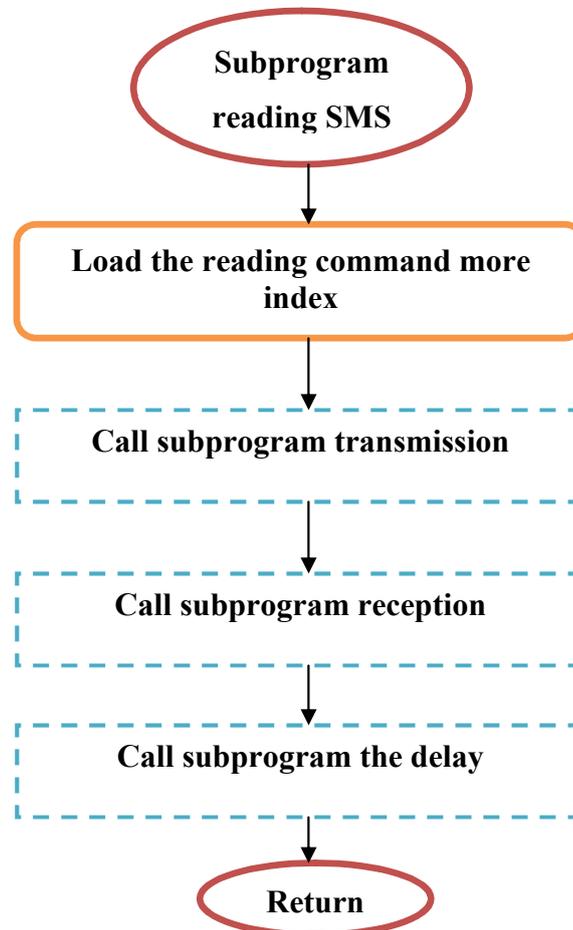
FigIV.30. Flowchart of subroutine to read a SMS

IV.4. CONCLUSION

In this chapter; we have described the several of circuits which are the functions of our system; and we have illustrated the important stages of the project by two methods: simulations and experimental validations.

GENERAL CONCLUSION AND PERSPECTIVE

General conclusion and Perspective

The work presented in this report was produced as part of our project graduation cycle Master 2.

The project aimed to achieve a platform offering notification services and remote control via SMS. We selected, the mobile SMS, as solution to provide connectivity between different actors involved in the service. It has been beneficial since it allowed us to discover a vast scope and rich in practical procedures, it also gave us the opportunity to thoroughly test our theoretical knowledge; In addition, this project allowed us to:

-Study in detail the GSM mobile network and SMS messaging services via this network and the AT commands that allow us to connect to our system.

-Control the assembler language development and operation of the PIC and start with small programs and achieve to their simulations. After that we started to realize our map by implementing the PIC in the wiring diagram with other functions and verify proper operation of the program.

The realization of our product does not mean it cannot be improved because the concept of security and the evolution of mobile networks to third generation inspires us to add other qualities to these services and improve those exist.

For next project I propose for student to use directly the mobile phone in the place of module GSM for economic causes.

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A /Data Sheet PIC 16F877A

MICROCHIP

PIC16F87XA
Data Sheet

28/40/44-Pin Enhanced Flash
Microcontrollers

40-Pin PDIP

MCLR/Vpp	1	40 RB7/PGD
RA0/AN0	2	39 RB6/PGC
RA1/AN1	3	38 RB5
RA2/AN2/VREF-/CVREF	4	37 RB4
RA3/AN3/VREF+	5	36 RB3/PGM
RA4/T0CKI/C1OUT	6	35 RB2
RA5/AN4/SS/C2OUT	7	34 RB1
RE0/RD/AN5	8	33 RB0/INT
RE1/WR/AN6	9	32 VDD
RE2/CS/AN7	10	31 VSS
VDD	11	30 RD7/PSP7
VSS	12	29 RD6/PSP6
OSC1/CLKI	13	28 RD5/PSP5
OSC2/CLKO	14	27 RD4/PSP4
RC0/T1OSO/T1CKI	15	26 RC7/RX/DT
RC1/T1OSI/CCP2	16	25 RC6/TX/CK
RC2/CCP1	17	24 RC5/SDO
RC3/SCK/SCL	18	23 RC4/SDI/SDA
RD0/PSP0	19	22 RD3/PSP3
RD1/PSP1	20	21 RD2/PSP2

PIC16F874A/877A

B / Data Sheet MAX232

MAX232, MAX232I
DUAL EIA-232 DRIVERS/RECEIVERS

SLLS047I – FEBRUARY 1989 – REVISED OCTOBER 2002

- Meet or Exceed TIA/EIA-232-F and ITU Recommendation V.28
- Operate With Single 5-V Power Supply
- Operate Up to 120 kbit/s
- Two Drivers and Two Receivers
- ±30-V Input Levels
- Low Supply Current . . . 8 mA Typical
- Designed to be Interchangeable With Maxim MAX232
- ESD Protection Exceeds JESD 22
  – 2000-V Human-Body Model (A114-A)
- Applications
  TIA/EIA-232-F
  Battery-Powered Systems
  Terminals
  Modems
  Computers

MAX232 . . . D, DW, N, OR NS PACKAGE
MAX232I . . . D, DW, OR N PACKAGE
(TOP VIEW)

C1+	1	16	V$_{CC}$
V$_{S+}$	2	15	GND
C1–	3	14	T1OUT
C2+	4	13	R1IN
C2–	5	12	R1OUT
V$_{S–}$	6	11	T1IN
T2OUT	7	10	T2IN
R2IN	8	9	R2OUT
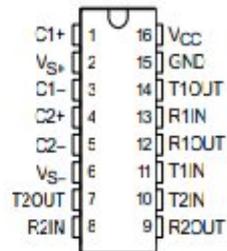
description/ordering information

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply. Each receiver converts EIA-232 inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V and a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into EIA-232 levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library.

ORDERING INFORMATION

T$_A$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP (N)	Tube	MAX232N	MAX232N
	SOIC (D)	Tube	MAX232D	MAX232
		Tape and reel	MAX232DR	
	SOIC (DW)	Tube	MAX232DW	MAX232
		Tape and reel	MAX232DWR	
	SOP (NS)	Tape and reel	MAX232NSR	MAX232
–40°C to 85°C	PDIP (N)	Tube	MAX232IN	MAX232IN
	SOIC (D)	Tube	MAX232ID	MAX232I
		Tape and reel	MAX232IDR	
	SOIC (DW)	Tube	MAX232IDW	MAX232I
		Tape and reel	MAX232IDWR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

APPENDIX

C / ISIS

HOW TO USE ISIS

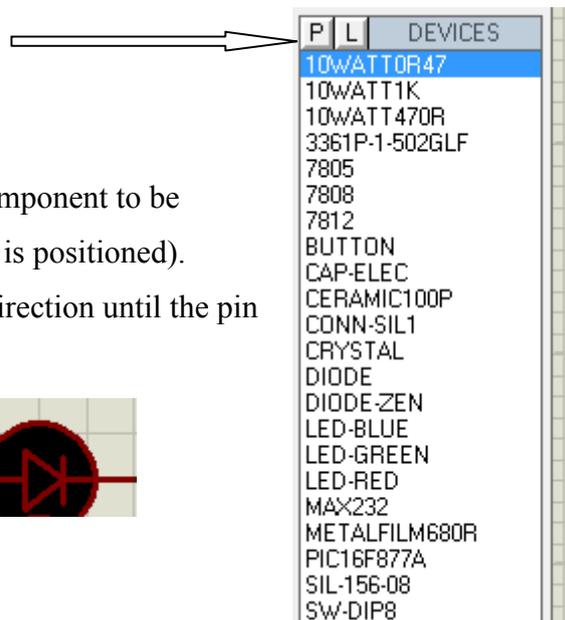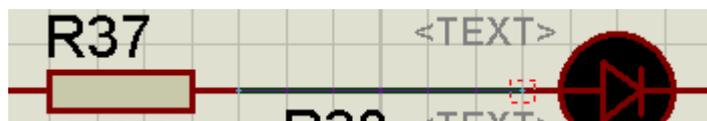

START ISIS

The screen of ISIS
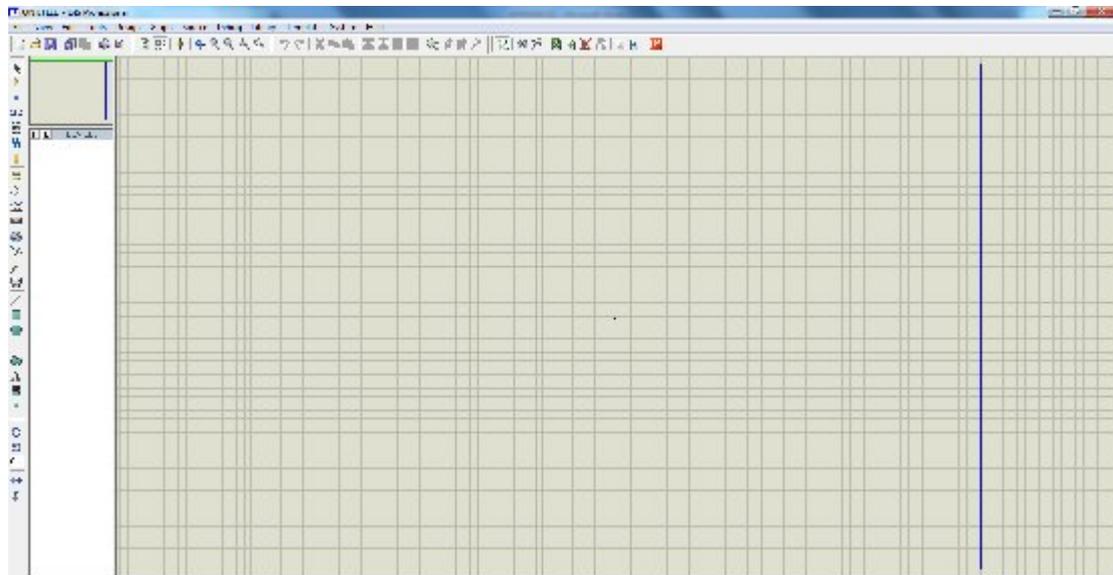
ENTERING A DESIGN

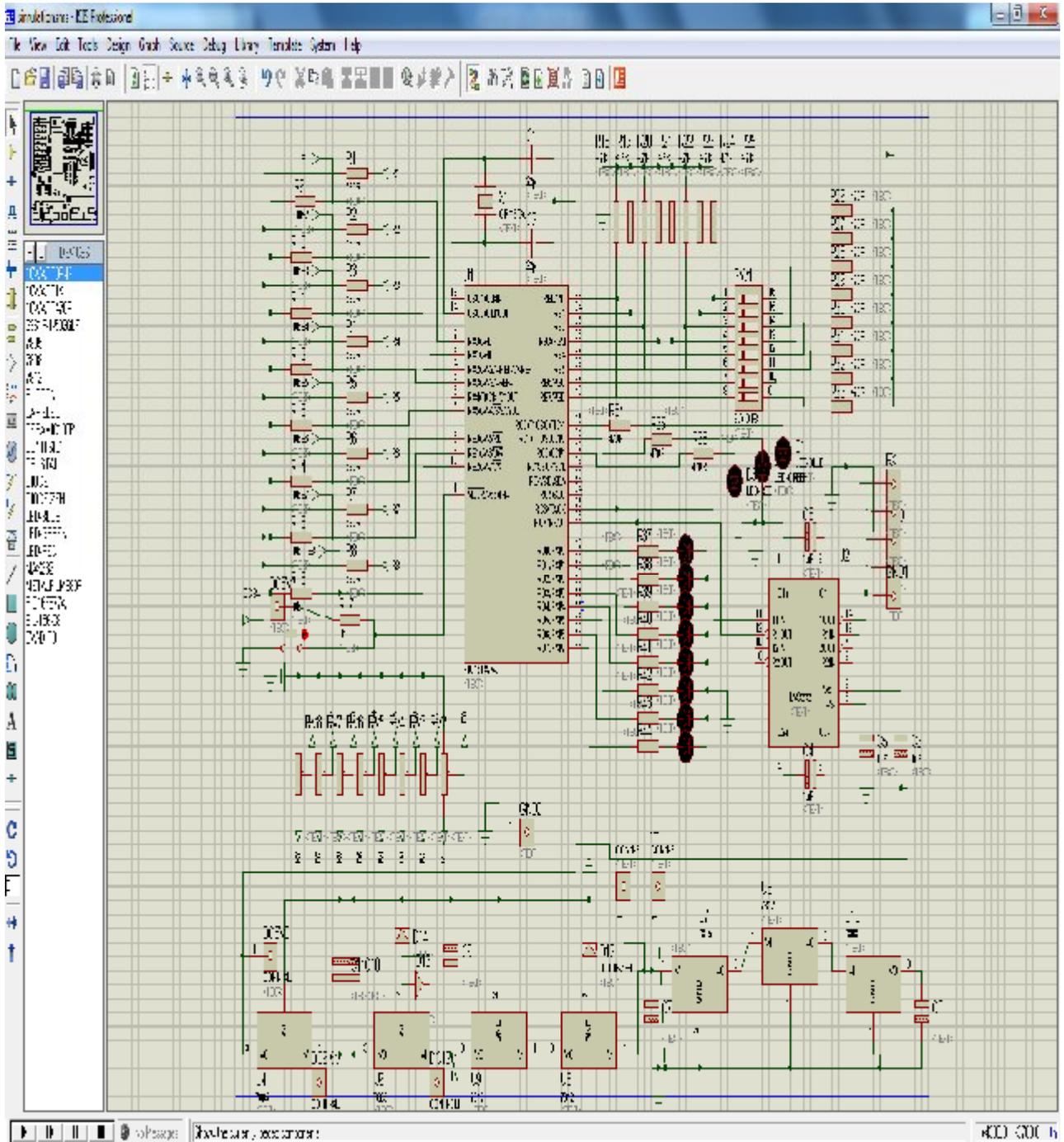2.1 Choose the components :Click on P

2.2. Place links

-Click left button on the spindle of the 1st component to be

connected (a cross is added when the mouse is positioned).

-Click left mouse button at each change of direction until the pin

2nd component link.lik this
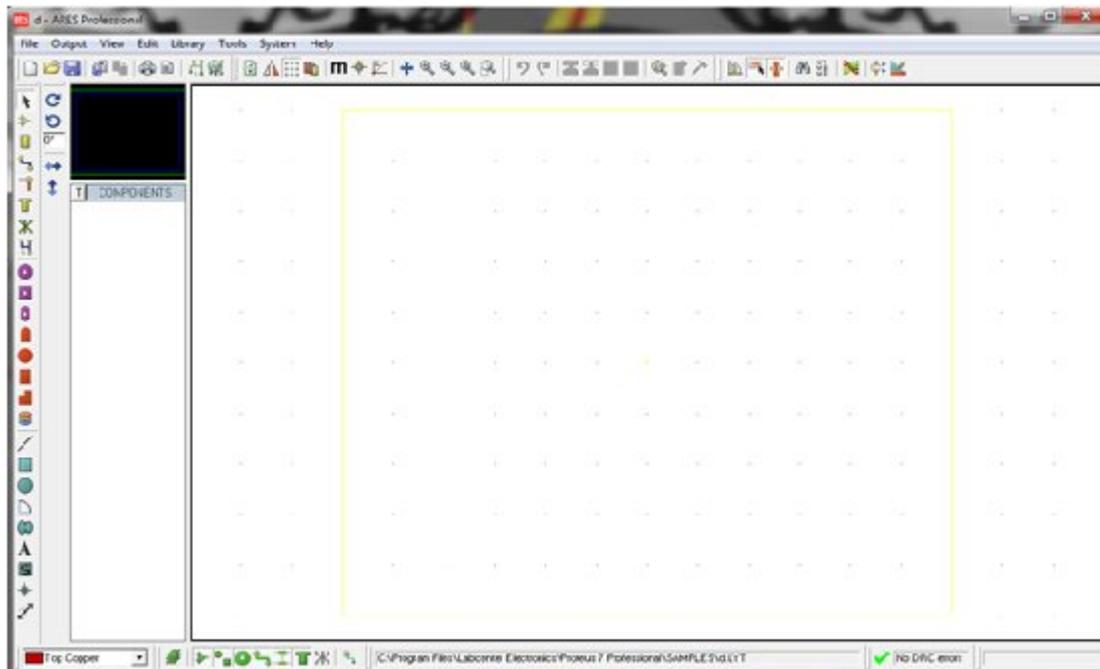
APPENDIX

For more help see the file "doc-ISIS.pdf"

D / ARES

The diagram to the router must be entered with PROTEUS ISIS.

APPENDIX

In ISIS, click the icon

The window ARES is open

Click on the icon

Select the side

Trace the area on the cart

Component placement

Click on the icon
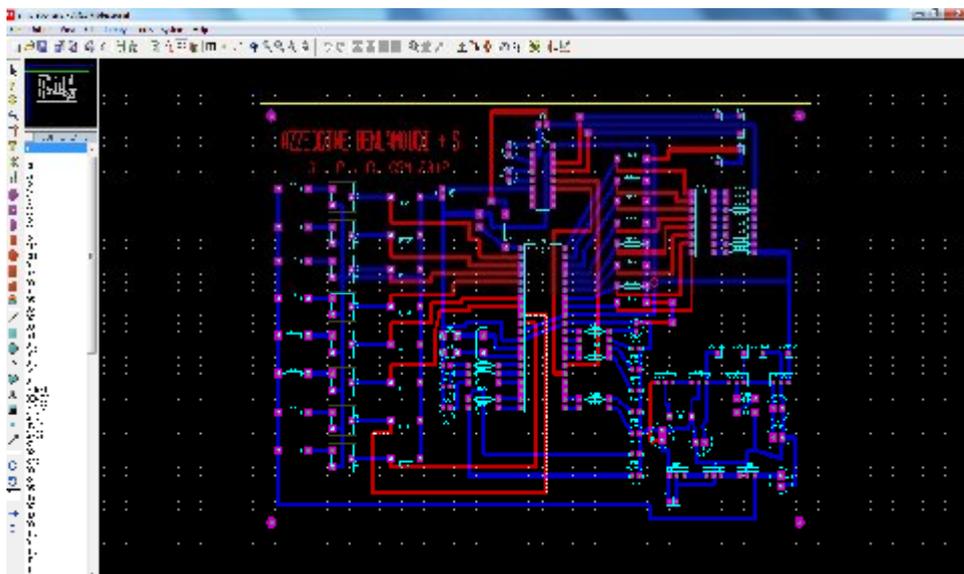
APPENDIX

The printed circuit board PCB
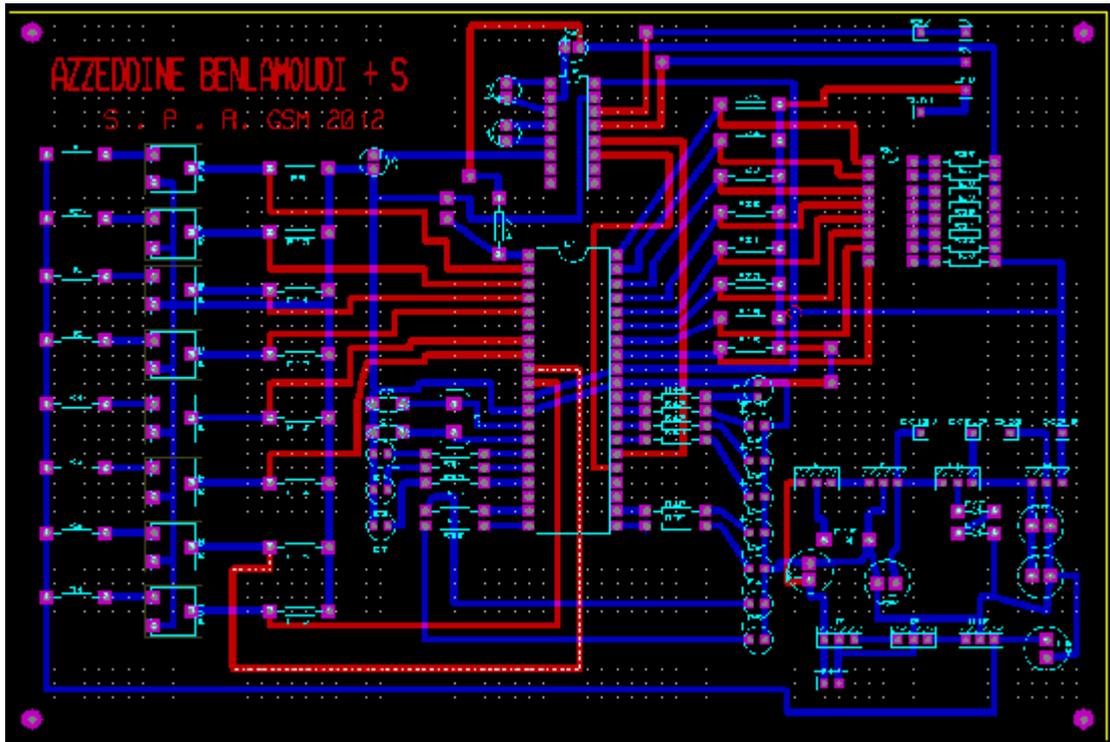
The PCB in 3D
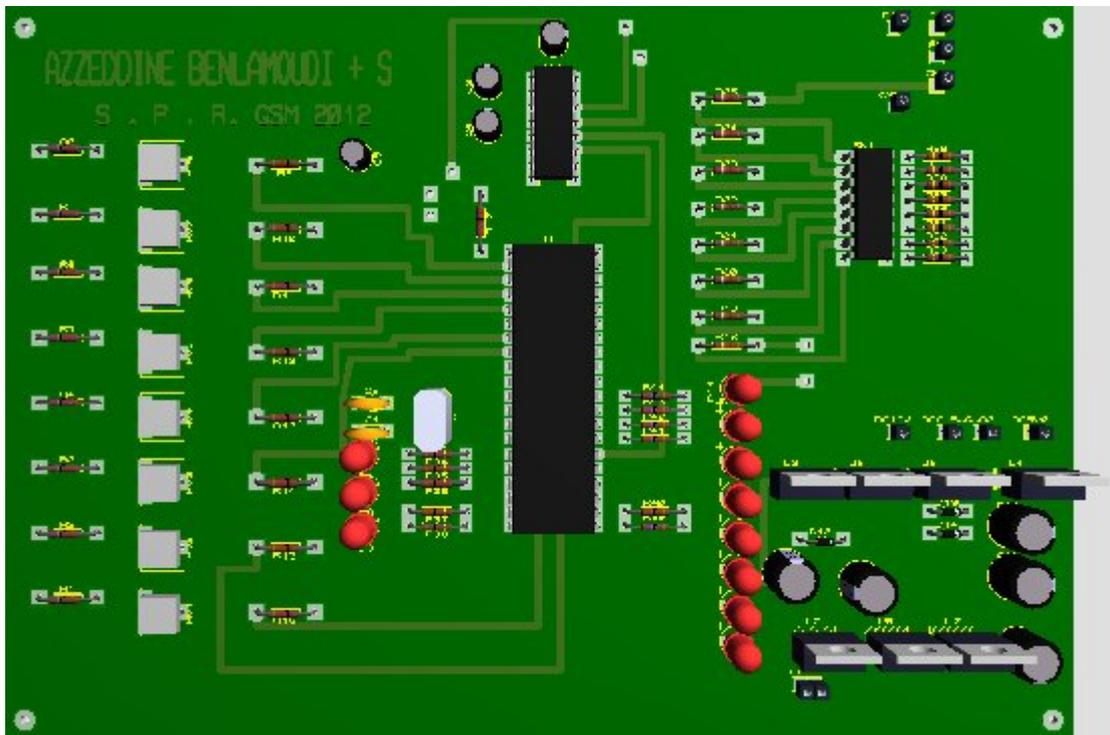
For more helps see the file "Doc-ARES.pdf"

APPENDIX

E / Running MPLAB IDE

To start the IDE, double click on the icon
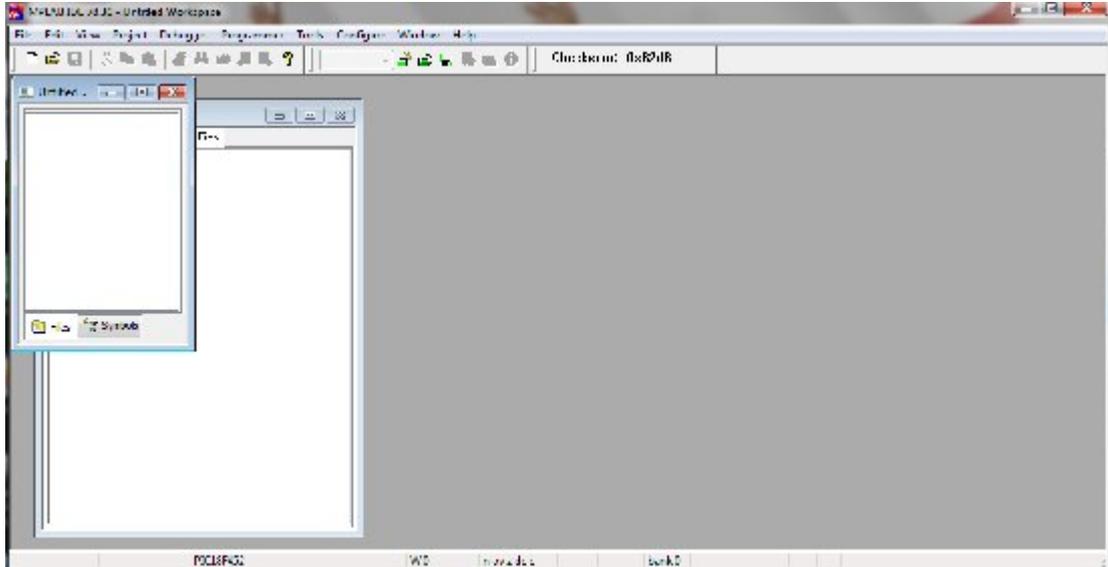
CREATING SOURCE CODE

Begin by writing code for the application using the MPLAB IDE editor.Select File>New. A blank edit window should open in the workspace.

Starting the Wizard

Start the Project Wizard by selecting Project>Project Wizard. and chose the PIC 16F877A.
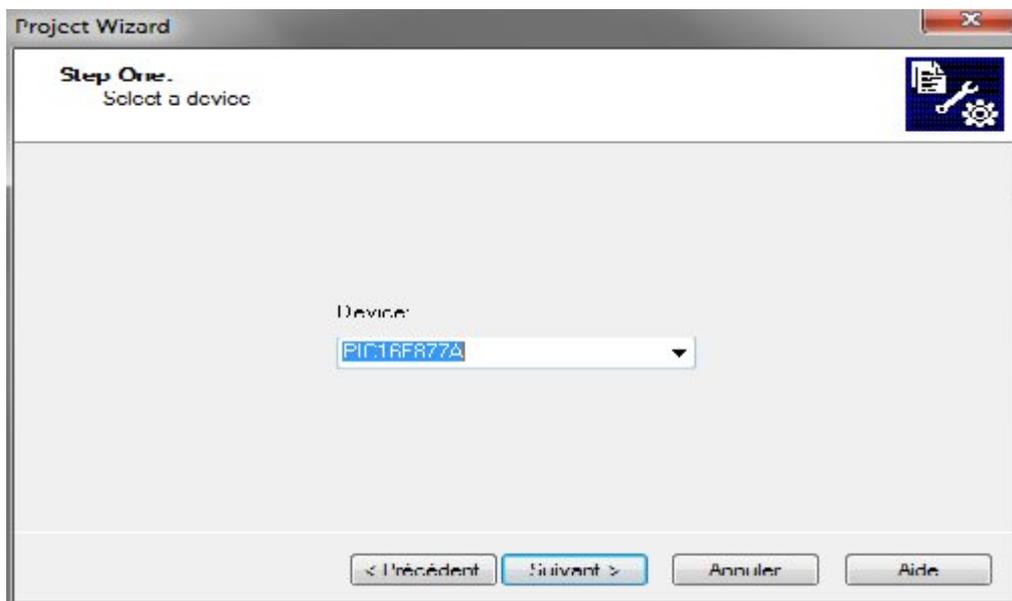
In the final build the project to get file in HEX
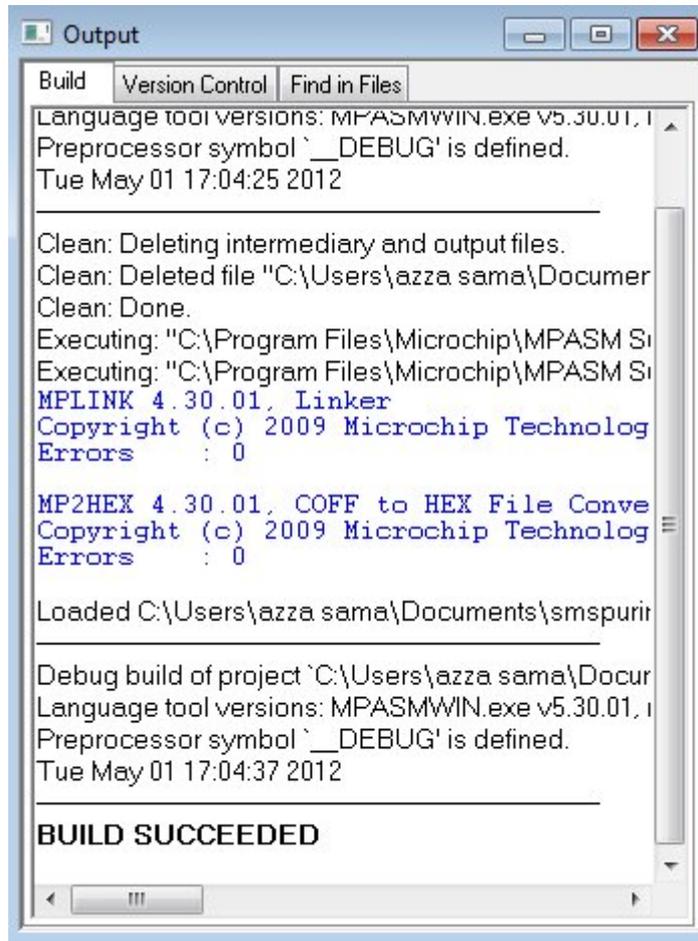
For more help see the file "mplab_quik_star.pdf"

F / Hyper terminal

Double click on the application

Type in a connection identifier name and click OK.The only restriction here is it cannot be a device name e.g. "COM1"
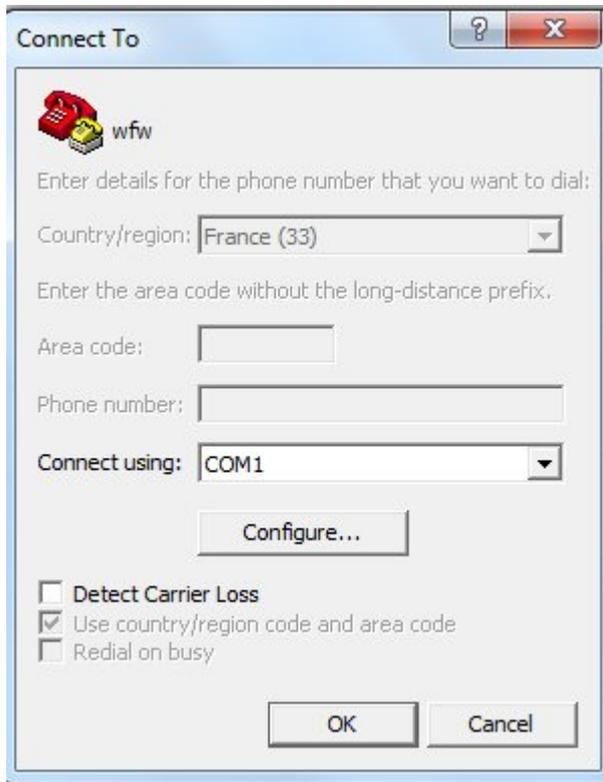
The next dialogue box will ask for the Port Communication Settings:
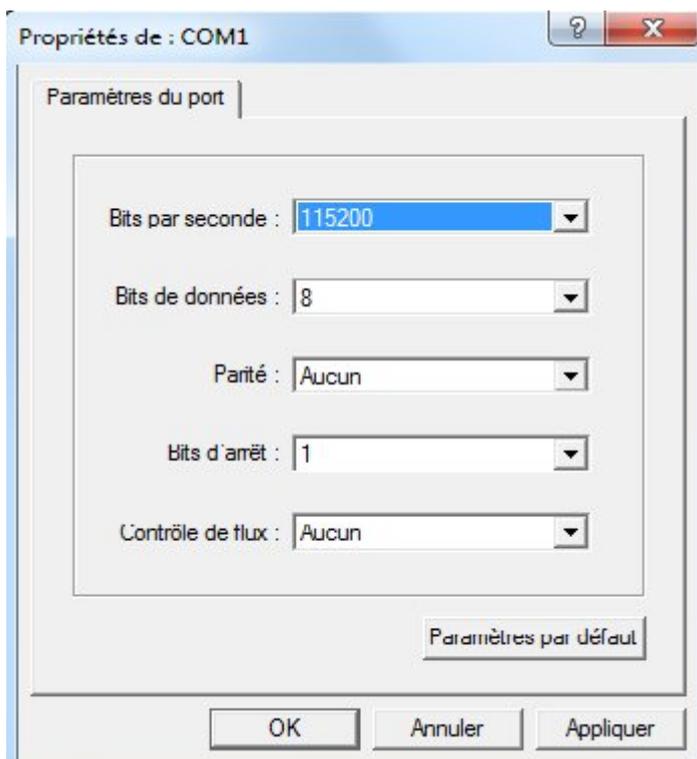
Now, every time a character on transmission reception two will appear on the screen:
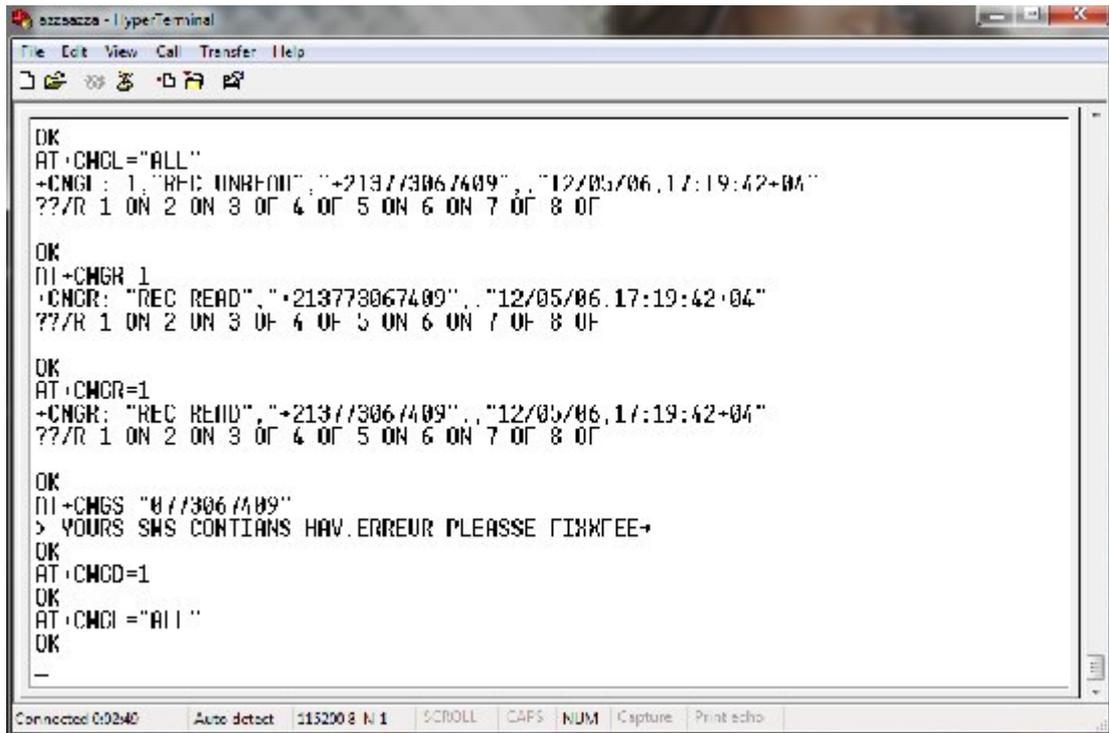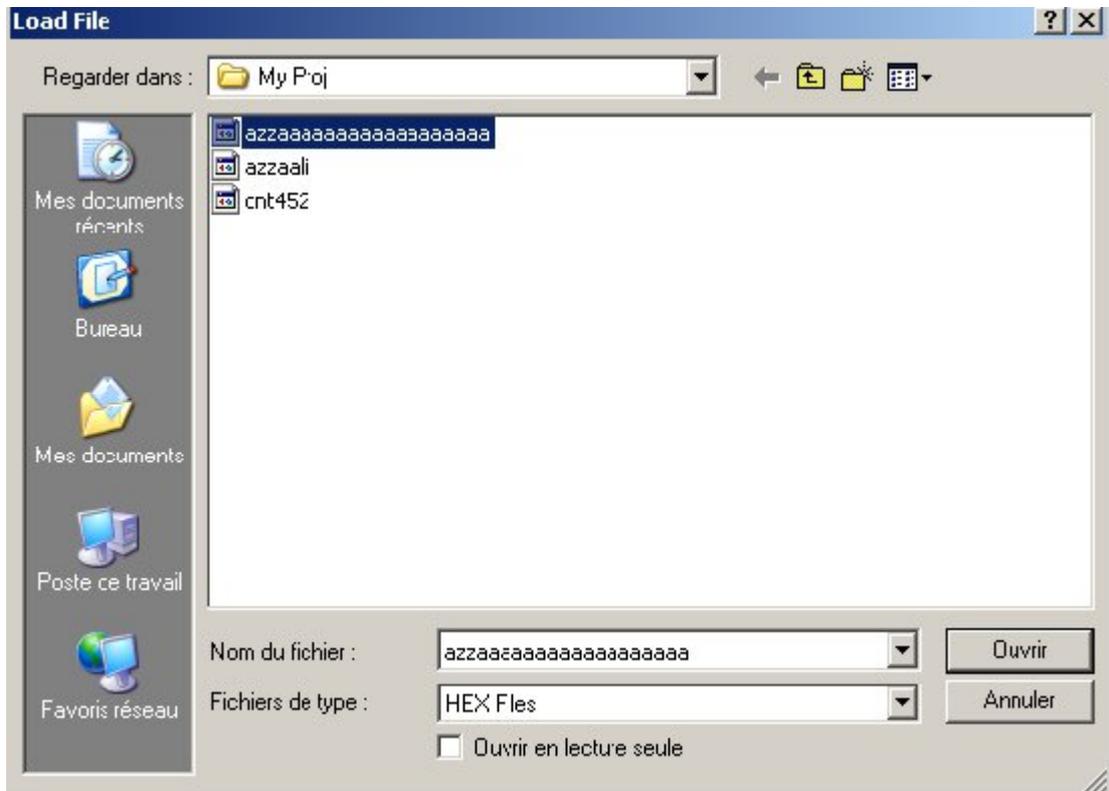

G / ALL-11 universal programmer

Double click on the application

Clique on "Device" and chose the "MICROCHIP"

Chose the pic16f877a and pres run and upload the HEX file

Chose Intel HEX and press ok

Press icon

And press run