

GSM BASED DISPLAY TOOLKIT

A PROJECT REPORT

*Submitted in partial fulfillment of the requirements for the award of the
degree of*

Bachelor of Technology

In

Electronics and Instrumentation Engineering

By

Rohan Mishra

Roll No: 10307006

&

Sambit Kumar Das

Roll No: 10307037



Department of Electronics and Communication Engineering

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Under the guidance of

Prof. (Dr.) S.K. PATRA



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2007



**National Institute of Technology
Rourkela**

CERTIFICATE

This is to certify that the thesis entitled, “**GSM BASED DISPLAY TOOLKIT**” submitted by **Sri Rohan Mishra** and **Sri Sambit Kumar Das** in partial fulfillment of the requirements for the award of **Bachelor of Technology** Degree in **Electronics and Instrumentation Engineering** at the National Institute of Technology, Rourkela (Deemed University) is an authentic work carried out by them under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other university / institute for the award of any Degree or Diploma.

Date:

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ACKNOWLEDGEMENT

*We place on record and warmly acknowledge the continuous encouragement, invaluable supervision, timely suggestions and inspired guidance offered by our guide **Prof. S.K.Patra**, Professor, Department of Electronics and instrumentation Engineering, National Institute of Technology, Rourkela, in bringing this report to a successful completion.*

*We are grateful to **Prof. G.Panda**, Head of the Department of Electronics and instrumentation Engineering, for permitting us to make use of the facilities available in the department to carry out the project successfully. Last but not the least we express our sincere thanks to all of our friends who have patiently extended all sorts of help for accomplishing this undertaking.*

Finally we extend our gratefulness to Mr. Ayas Kanta Swain, Mr. Tarini Chaitanya and all those who are directly or indirectly involved in the successful completion of this project work.

Rohan Mishra

Sambit Kumar Das

CONTENTS

A. ABSTRACT	vii
B. List of Figures.....	ix
C. List of Tables	x
D. CHAPTERS	
1. Introduction	1
1.1 Introduction.....	2
1.1.1 Information.....	2
1.1.2 Information Transfer.....	2
1.2 Broadcast.....	2
2. Design Overview.....	4
2.1 Design on Paper.....	5
3. Hardware Profile.....	7
3.1 GSM Modem.....	8
3.1.1 Accessing GSM MODEM using Microsoft HyperTerminal.....	9
3.1.2 Testing of GSM MODEM.....	10
3.1.3 List of Important AT Commands.....	14
3.2 LCD Display.....	15
3.2.1 Important Signals.....	17
3.2.1.1 Enable (EN).....	17
3.2.1.2 Register Select (RS).....	17
3.2.1.3 Read/Write (R/W).....	17
3.3 Microcontroller – Philips P89C51RD2BN.....	19
3.3.1 Description.....	19
3.3.2 Features	20

4. Interfacing.....	21
4.1 Microcontroller – MODEM Interfacing.....	22
4.1.1. DTE and DCE.....	22
4.1.2. RS-232.....	22
4.1.2.1 RS-232 Signals.....	23
4.1.2.2. RTS/CTS Handshaking.....	24
4.1.3. Specifying Baud Rate, Parity & Stop bits.....	25
4.1.3.1. DCE Baud Rates.....	25
4.2 Microcontroller – LCD Interfacing.....	25
5. Software Solvency	25
5.1 End user Perspective.....	28
5.2 Control flow in code.....	31
5.2.1 Initialization.....	31
5.2.2. Serial transfer using TI and RI flags.....	31
5.2.3. Validity Check.....	31
5.2.4 Display.....	31
6. Testing methodologies and Observations.....	32
6.1 Offline testing.....	33
6.2 Online testing and observations.....	34
7. Implementation at the Institute level.....	35
7.1 Overview.....	36
7.2 Proposal.....	36
8. Conclusion.....	38
8.1 Conclusion.....	39
8.2 Future Improvements	39
E. References.....	41

ABSTRACT

Wireless communication has announced its arrival on big stage and the world is going mobile. We want to control everything and without moving an inch. This remote control of appliances is possible through Embedded Systems. The use of “Embedded System in Communication” has given rise to many interesting applications that ensures comfort and safety to human life.

The main aim of the project will be to design a SMS driven automatic display toolkit which can replace the currently used programmable electronic display. It is proposed to design receive cum display toolkit which can be programmed from an authorized mobile phone. The message to be displayed is sent through a SMS from an authorized transmitter. The toolkit receives the SMS, validates the sending Mobile Identification Number (MIN) and displays the desired information after necessary code conversion. The system is made efficient by using ‘clone’ SIMs of same MIN in a geographical area so that the same SMS can be received by number of display boards in a locality using techniques of time division multiple access. Started of as an instantaneous News display unit, we have improved upon it and tried to take advantage of the computing capabilities of microcontroller. We envision a toolkit that will not only display message but also can be used to do some mechanical work.

Looking into current trend of information transfer in the campus, it is seen that important notice take time to be displayed in the notice boards. This latency is not expected in most of the cases and must be avoided.

It is proposed to implement this project at the institute level. It is proposed to place display boards in major access points. The electronics displays which are currently used are programmable displays which need to be reprogrammed each time. This makes it inefficient for immediate information transfer, and thus the display board loses its importance. The GSM based display toolkit can be used as a add-on to these display boards and make it truly wireless. The display board programs itself with the help of the incoming SMS with proper validation. Such a system proves to be helpful for immediate information transfer

The system required for the purpose is nothing but a Microcontroller based SMS box. The main components of the toolkit include microcontroller, GSM modem. These components are integrated with the display board and thus incorporate the wireless features. The GSM modem receives the SMS. The AT commands are serially transferred to the modem through MAX232. In return the modem transmits the stored message through the COM port. The microcontroller validates the SMS and then displays the message in the LCD display board. Various time division multiplexing techniques have been suggested to make the display boards functionally efficient. The microcontroller used in this case is Philips P89C51RD2BN. Matrix Simado GDT11 is used as the GSM modem. In the prototype model, LCD display is used for simulation purpose. While implementation this can be replaced by actually display boards.

The results presented in the thesis support the proper functionalities and working of the system. The timing diagram suggests the response of the modem to various AT commands.

List of Figures

1. Figure. 2.1. Design Overview
2. Figure 2.2. Commercially used display boards
3. Figure. 2.3. Schematic of the Display board commonly used
4. Figure: 3.1 Simado GDT11
5. Figure 3.2- The screenshot of MS HyperTerminal's Connection Description dialog box
6. Figure 3.3- The screenshot of MS HyperTerminal's Connect to dialog box
7. Figure 3.4- The screenshot of MS HyperTerminal's Properties dialog box
8. Figure 3.5- The screenshot of MS HyperTerminal's main window in Windows 98.
9. Figure 3.6 Philips P89C51RD2BN 1
10. Figure 4.1- Female 9 pin plug
12. Figure 4.2- Character Frame Encoding 'm'
13. Figure 4.3- LCD Interfacing
14. Figure 4.4- Pin Configuration
15. Figure 4.5 The Experimental Setup
- 16 Figure 5.1. End User Perspective Flowchart
17. Figure 5.2 Operational Flowchart
18. Figure 6.1. Transmission of AT command from microcontroller
19. Figure 6.2. Reception of Response from MODEM
20. Figure 6.3. Tx and Rx lines with echo bein ON
21. Figure 6.4. Response of the modem with the new message

List of Tables

1. Table 3.1 Pin Configuration of LCD
2. Table 3.2 Control Codes of LCD
3. Table 4.1 RS-232 Signals

Chapter 1

INTRODUCTION

1.1 INTRODUCTION

Presently, the United States is the most technologically advanced country in the area of telecommunications with about; 126 million phone lines, 7.5 million cellular phone users, 5 thousand AM radio broadcast stations, 5 thousand FM radio stations, 1 thousand television broadcast stations, 9 thousand cable television systems, 530 million radios, 193 million television sets, 24 ocean cables, and scores of satellite facilities!

This is truly an "Information Age" and sometimes, you need to look at where we've been in order to see the future more clearly!

1.1.1 Information

---"A message received and understood" --- Princeton

---"Information is a term with many meanings depending on context, but is as a rule closely related to such concepts as meaning, knowledge, instruction, communication, representation, and mental stimulus " --- **Wikipedia**

--- "any communication or representation of knowledge such as facts, data, or opinions in any medium or form, including textual, numerical, graphic, cartographic, narrative, or audiovisual forms (OMB Circular A-130). " --- **Gils.net**

--- "Facts, concepts, or instructions; any sort of knowledge or supposition which can be communicated. " --- **cedar.web.cern**

--- "Is organized data that has been arranged for better comprehension or understanding. What is one person's information can become another person's data." --- **earthlink.net**

1.1.2 Information Transfer

A coordinated sequence of user and telecommunications system actions that cause information present at a source user to become present at a destination user. *Note:* An information-transfer transaction usually consists of three consecutive phases called the **access phase**, the **information-transfer phase**, and the **disengagement phase**.

1.2 Broadcast

A term to describe communication where a piece of information is sent or transmitted from one point to all other points. There is just one sender, but the information is

simultaneously sent to all connected receivers. In networking, a distinction is made between **broadcasting** and **multicasting**. Broadcasting sends a message to everyone on the network whereas multicasting sends a message to a select list of recipients.

One of the most common examples is broadcast through a cellular network service. This serves multiple end users at different locations in a simulcast fashion. Practically every cellular system has some kind of broadcast mechanism. This can be used directly for distributing information to multiple mobiles, commonly, for example in a mobile telephony system, the most important use of broadcast information is to set up channels for one to one communication between the mobile Trans-receiver and the base station. This is called **paging**. The details of the process of paging vary somewhat from network to network, but normally we know a limited number of cells where the phone is located (this group of cells is called a location area in the GSM system or Routing Area in UMTS). Paging takes place by sending the broadcast message on all of those cells.

Today, interaction with digital displays is a deskbound or device-dependent experience. However, developments in display and information sharing technologies may enable a new form of interaction with digital media: ‘ubiquitous computing’. In ubiquitous computing, the physical location of data and processing power is not apparent to the user. Rather, information is made available to the user in a transparent and contextually relevant manner. A single display device restricts the repertoire of interactions between the user and digital media, so ubiquitous computing requires displays wherever the user might need one – in appliances, tabletops public transport, walls, etc.

This project aims at integrating the expansiveness of a wireless cellular network and the ease of information transfer through the SMS with the coverage of public display boards. It is thereby a modest effort to realize the complete potential of public display boards in instantaneous information broadcast in swift response to events of interests.

Chapter 2

DESIGN OVERVIEW

2.1. Design on Paper

As explained in the introduction chapter, the realization of complete potential of the display boards and the wireless medium in information transfer is the major issue that the following thesis of the following project deals with.

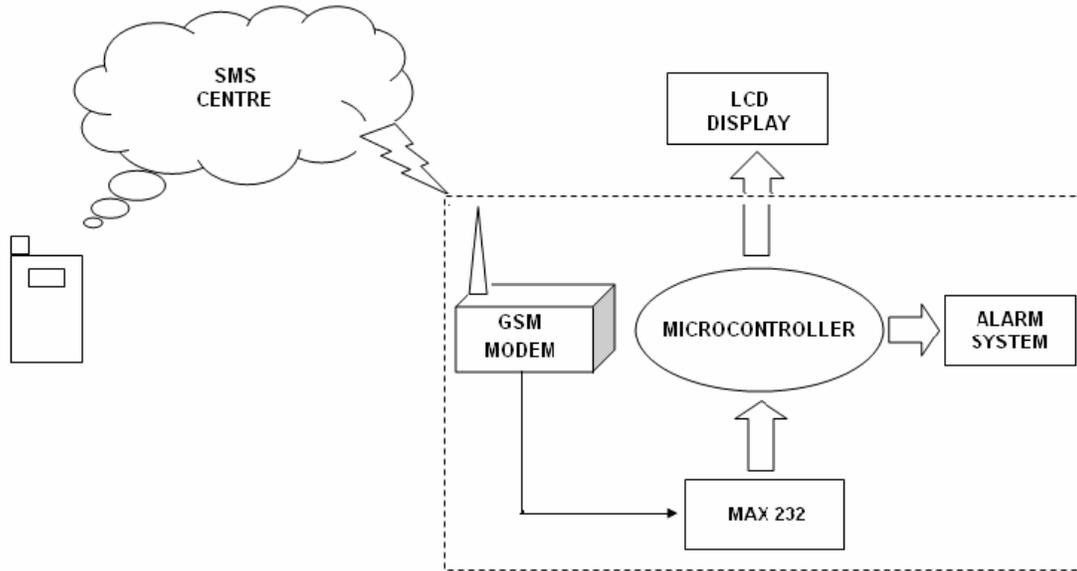


Figure 2.1. Design Overview

As we see in the above figure, there are at least three interfacing circuits, MAX-232 with microcontroller, LCD display with microcontroller, and MAX-232 with GSM MODEM. The display boards used commercially can be as follows:



Figure 2.2 Commercially used display boards

The input requirement for such kind of display boards are 120/240 VAC 50//60 Hz with Internal circuit breaker sized per sign layout. The basic schematic of such kind of display boards can be given as :

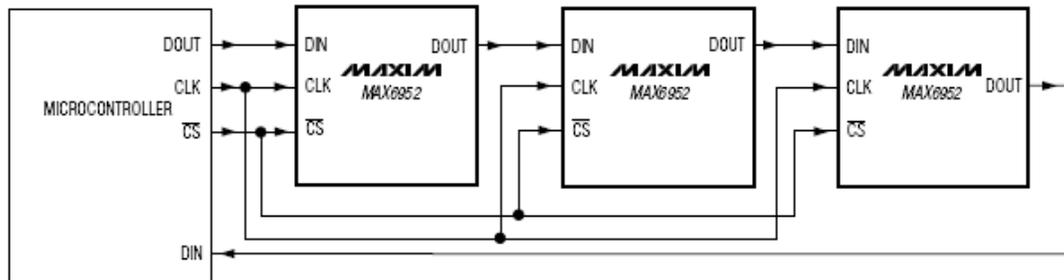


Figure. 2.3 Schematic of the Display board commonly used

The display boards are usually huge in size and cant be used for simulation purpose. So LCD displays are used for testing.

It is not a hidden fact that interfacing a MODEM with a normal PC is quite easy with the help of the AT commands sent to it from the Hyper Terminal window. But we must take into account the fact that the MODEM requires a wired connection at one end and wireless at the other. Dedicating a general purpose computer at each and every site of the display boards, although makes the task a lot easier but is too expensive to be a possibility. Hence we employ Philips P89C51RD2BN microcontroller with 64 Kb EEROM storage memory. The complexity of coding substantially increases, but once programmed the module works at its robust best since it is a dedicated embedded system and not a general purpose computer. The design procedure involves identifying and assembling all the required hardware and ensuring fail safe interfacing between all the components. Then we have the coding process which has to take care of the delays between two successive transmissions and most importantly the validation of the sender's number. The number of valid mobile numbers can be more than one. The limiting constraint is the RAM of the microcontroller rather than the coding complexity.

Chapter 3

HARDWARE PROFILE

3.1. GSM MODEM

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate.

Matrix Simado GDT11 is a Fixed Cellular Terminal (FCT) for data applications. It is a compact and portable terminal that can satisfy various data communication needs over GSM. It can be connected to a computer with the help of a standard RS232C serial port. Simado GDT11 offers features like Short Message Services (SMS), Data Services (sending and receiving data files), Fax Services and Web Browsing. Remote login and data file transfer are also supported. It is the perfect equipment for factory plants, resorts, dams and construction sites where wired connectivity is not available or not practicable. The Simado GDT11 is easy to set up. It finds its applications in IT companies, Banks and Financial Institutions, Logistic Companies, Service Providers, Remote Project Sites, Professionals, and such other business establishments.

Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. GSM modem can be used just like a dial-up modem. In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, various things can be done:

- Reading, writing and deleting SMS messages.
- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.

The number of SMS messages that can be processed by a GSM modem per minute is very low -- only about six to ten SMS messages per minute.



Figure 3.1. Simado GDT11

3.1.1 Accessing GSM MODEM using Microsoft HyperTerminal

Microsoft HyperTerminal is a small program that comes with Microsoft Windows. We use it to send AT commands to the GSM modem. It can be found at *Start -> Programs -> Accessories -> Communications -> HyperTerminal*.

Before programming our SMS application, it is required to check if the GSM modem and SIM card are working properly first. The MS HyperTerminal is a handy tool when it comes to testing the GSM device. It is a good idea to test the GSM devices beforehand. When a problem occurs, sometimes it is difficult to tell what causes the problem. The cause can be the program, the GSM device or the SIM card. If GSM device and SIM card with MS HyperTerminal and they operate properly, then it is very likely that the problem is caused by the program or other hard wares.

For Linux users, Minicom can be used instead of HyperTerminal.

3.1.2 Testing of GSM MODEM

To use MS HyperTerminal to send AT commands to the GSM modem, the following procedure is followed

1. We put a valid SIM card into the GSM modem. We can obtain a SIM card by subscribing to the GSM service of a wireless network operator.
2. Since in our case the modem drivers were pre installed, we need not to install any such drivers.
3. Then we start up MS HyperTerminal by selecting *Start -> Programs -> Accessories -> Communications -> HyperTerminal*.
4. In the *Connection Description* dialog box (as shown in the screenshot given below), we enter any name and choose an icon we like for the connection. Then we click the *OK* button.

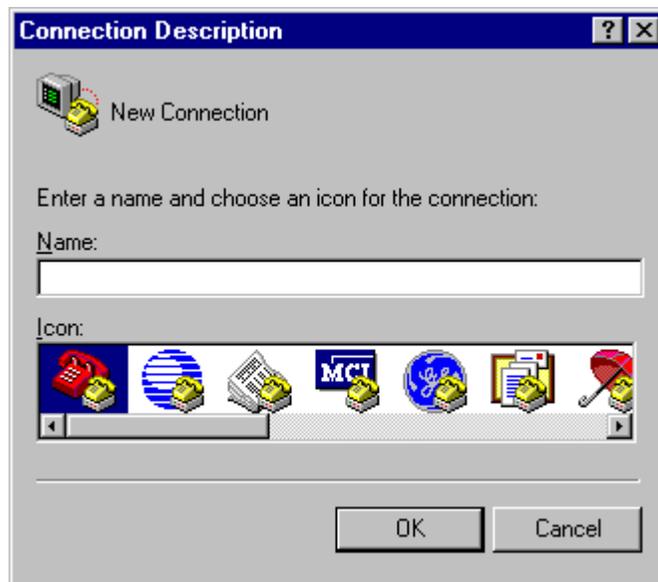


Figure. 3.2. The screenshot of MS HyperTerminal's Connection Description dialog box

5. In the *Connect To* dialog box, choose the COM port that your mobile phone or GSM modem is connecting to in the *Connect using* combo box. For example, choose COM1 if your mobile phone or GSM modem is connecting to the COM1 port. Then click the *OK* button.(Sometimes there will have more than one COM

port in the *Connect using* combo box. To know which COM port is used by your mobile phone or GSM modem, follow the procedure below.

In Windows 98:

Go to *Control Panel* -> *Modem*. Then click the *Diagnostics* tab. In the list box, you can see which COM port the mobile phone or GSM modem is connected to.

In Windows 2000 and Windows XP:

Go to *Control Panel* -> *Phone and Modem Options*. Then click the *Modems* tab. In the list box, you can see which COM port the mobile phone or GSM modem is connected to.)



Figure. 3.3. The screenshot of MS HyperTerminal's Connect to dialog box

6. The *Properties* dialog box comes out. Enter the correct port settings for your mobile phone or GSM modem. Then click the *OK* button.
(To find the correct port settings that should be used with your mobile phone or GSM modem, one way is to consult the manual of your mobile phone or GSM

modem. Another way is to check the port settings used by the wireless modem driver that you installed earlier.

To check the port settings used by the wireless modem driver on Windows 98, follow these steps:

- a. Go to *Control Panel* -> *Modem*.
- b. Select your mobile phone or GSM modem in the list box.
- c. Click the *Properties* button.
- d. The *Properties* dialog box appears. The *Maximum speeds* field on the *General* tab corresponds to HyperTerminal's *Bits per second* field. Click the *Connection* tab and you can find the settings for data bits, parity and stop bits. Click the *Advanced* button and you can find the setting for flow control.

To check the port settings used by the wireless modem driver on Windows 2000 and Windows XP, follow these steps:

- a. Go to *Control Panel* -> *Phone and Modem Options* -> *Modems* tab.
- b. Select your mobile phone or GSM modem in the list box.
- c. Click the *Properties* button.
- d. The *Properties* dialog box appears. Click the *Advanced* tab and then click the *Change Default Preferences* button.
- e. The *Change Default Preferences* dialog box appears. The *Port speed* field on the *General* tab corresponds to HyperTerminal's *Bits per second* field. You can also find the setting for flow control on the *General* tab. On the *Advanced* tab, you can find the settings for data bits, parity and stop bits.)

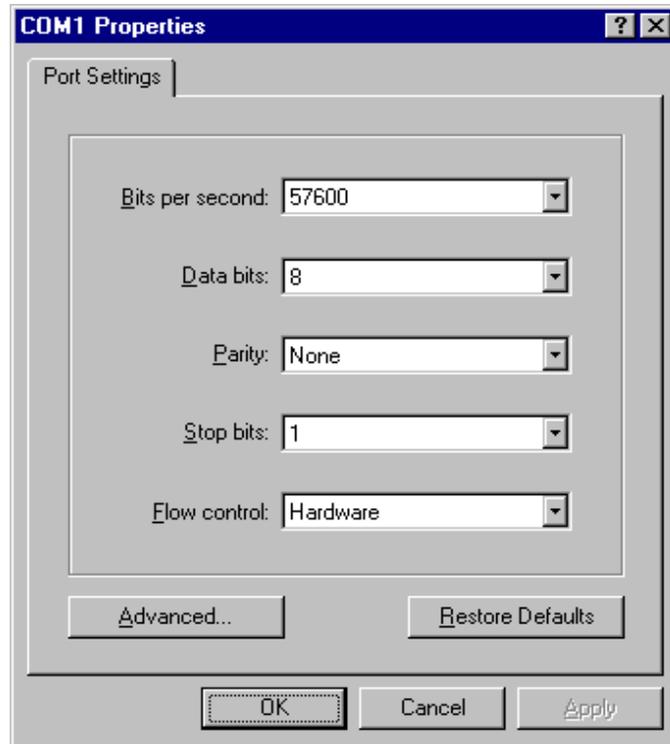


Figure. 3.4. *The screenshot of MS HyperTerminal's Properties dialog box*

7. Type "AT" in the main window. A response "OK" should be returned from the mobile phone or GSM modem. Type "AT+CPIN?" in the main window. The AT command "AT+CPIN?" is used to query whether the mobile phone or GSM modem is waiting for a PIN (personal identification number, i.e. password). If the response is "+CPIN: READY", it means the SIM card does not require a PIN and it is ready for use. If your SIM card requires a PIN, you need to set the PIN with the AT command "AT+CPIN=<PIN>".

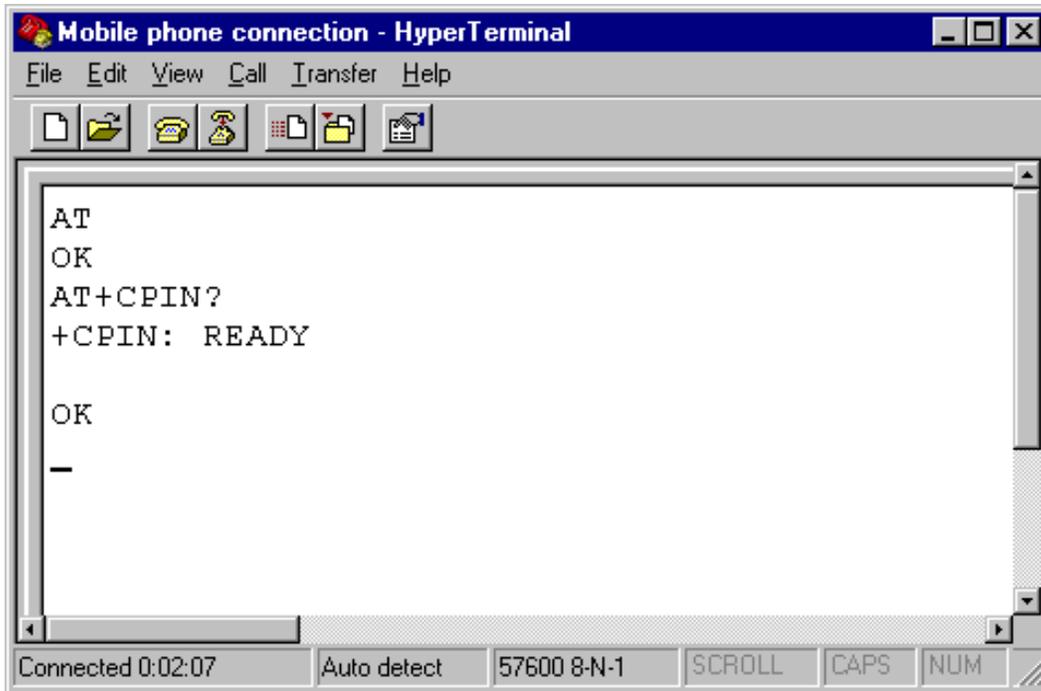


Figure. 3.5. The screenshot of MS HyperTerminal's main window in Windows 98.

If you get the responses above, your mobile phone or GSM modem is working properly. You can start typing your own AT commands to control the mobile phone or GSM modem.

2.1.3 List of Important AT Commands

After successfully testing the MODEM for its correct operational state, we need to set the MODEM parameters like Baud rate, Echo off etc to enable easier access via a microcontroller which we used in this project. Following is a list of the important AT commands

Example: Changing and saving parameters

AT+IPR=2400[Enter] Transfer rate to 2400 bps

AT&W[Enter] save parameters

Send and Receive

Example: Data transfer

AT+CPIN="xxxx"[Enter] enters PIN

AT+CREG?[Enter] Register Network (0,1 means logged in)

ATD05111234567[Enter] Data call

Example: Send SMS with GSM modem / module

Enter SMS-Center

AT+CSCA=+491722270000[Enter] Enter SMS-Center for Vodafone Germany (T-Mobile Germany = +491710760000)

Example: Send SMS

AT+CMGF=1[Enter] +CMGF=1 - set modem in text mode

AT+CMGS="+491711234567"[Enter] Send SMS (^Z equals StrgZ). At D2 you can
>Please call office^Z send without international and local code. If you
dial with Int. and local code the transmission
from foreign networks are ensured.

Example: Receive SMS

A SMS will be stored in the GSM modem / module and being sent via RS232 to the peripherals. The peripherals have to send commands to the GSM unit to receive SMS and to erase SMS from the device in order to free memory.

+CMTI:"SM",x X stands for the memory number of received SMS

AT+CMGR=X[Enter] Read SMS on memory number X

AT+CMGD=X[Enter] Erase SMS on memory number X

ATZ;E[Enter] Echo OFF

ATZ;E1[Enter] Echo ON

AT+COPS?[Enter] Shows if network of SIM-card is available. 0,2,26201= D1
available

AT+COPS=?[Enter] Shows all available networks

3.2 LCD Display

One of the most common devices attached to an 8051 is an LCD display. Some of the most common LCDs connected to the 8051 are 16x2 and 20x2 displays. This means 16

characters per line by 2 lines and 20 characters per line by 2 lines, respectively. In recent years the LCD is finding widespread use replacing LED's. This is due to the following reasons

1. Declining prices
2. Ability to display numbers, characters and graphics.
3. Incorporation of a refreshing controller into the LCD.
4. Ease of programming.

Fortunately, a very popular standard exists which allows us to communicate with the vast majority of LCDs regardless of their manufacturer. The standard is referred to as HD44780U, which refers to the controller chip which receives data from an external source (in this case, the 8051) and communicates directly with the LCD. The 44780 standard requires 3 control lines as well as either 4 or 8 I/O lines for the data bus. The user may select whether the LCD is to operate with a 4-bit data bus or an 8-bit data bus. If a 4-bit data bus is used the LCD will require a total of 7 data lines (3 control lines plus the 4 lines for the data bus). If an 8-bit data bus is used the LCD will require a total of 11 data lines (3 control lines plus the 8 lines for the data bus).

Pin	Symbol	I/O	Description
1	GND	-	Ground
2	Vcc	-	+5V power supply
3	VEE	-	Contrast control
4	RS	I	command/data register selection
5	R/W	I	write/read selection
6	E	I/O	Enable
7	DB0	I/O	The 8-bit data bus
8	DB1	I/O	The 8-bit data bus
9	DB2	I/O	The 8-bit data bus
10	DB3	I/O	The 8-bit data bus
11	DB4	I/O	The 8-bit data bus
12	DB5	I/O	The 8-bit data bus

13	DB6	I/O	The 8-bit data bus
14	DB7	I/O	The 8-bit data bus

Table 3.1 Pin Configuration of LCD

3.2.1 Important Signals

The following pins are important to LCD's while programming

3.2.1.1 Enable (EN)

The EN line is called "Enable." This control line is used to tell the LCD that you are sending it data. To send data to the LCD, your program should make sure this line is low (0) and then set the other two control lines and/or put data on the data bus. When the other lines are completely ready, bring EN high (1) and wait for the minimum amount of time required by the LCD datasheet (this varies from LCD to LCD), and end by bringing it low (0) again.

3.2.1.2 Register Select (RS)

The RS line is the "Register Select" line. When RS is low (0), the data is to be treated as a command or special instruction (such as clear screen, position cursor, etc.). When RS is high (1), the data being sent is text data which should be displayed on the screen. For example, to display the letter "T" on the screen you would set RS high.

3.2.1.3 Read/Write (R/W)

The RW line is the "Read/Write" control line. When RW is low (0), the information on the data bus is being written to the LCD. When RW is high (1), the program is effectively querying (or reading) the LCD. Only one instruction ("Get LCD status") is a read command. All others are write commands--so RW will almost always be low.

Finally, the data bus consists of 4 or 8 lines (depending on the mode of operation selected by the user). In the case of an 8-bit data bus, the lines are referred to as DB0, DB1, DB2, DB3, DB4, DB5, DB6, and DB7.

Above is the quite simple schematic. The LCD panel's *Enable* and *Register Select* is connected to the Control Port. The Control Port is an open collector / open drain output. While most Parallel Ports have internal pull-up resistors, there are a few which don't. Therefore by incorporating the two 10K external pull up resistors, the circuit is more

portable for a wider range of computers, some of which may have no internal pull up resistors.

We make no effort to place the Data bus into reverse direction. Therefore we hard wire the *R/W* line of the LCD panel, into write mode. This will cause no bus conflicts on the data lines. As a result we cannot read back the LCD's internal Busy Flag which tells us if the LCD has accepted and finished processing the last instruction. This problem is overcome by inserting known delays into our program.

The 10k Potentiometer controls the contrast of the LCD panel. Nothing fancy here. As with all the examples, I've left the power supply out. You can use a bench power supply set to 5v or use a onboard +5 regulator. Remember a few de-coupling capacitors, especially if you have trouble with the circuit working properly.

Code (hex)	Command to LCD Instruction Register
1	Clear display screen
2	Return home
4	Shift cursor to left
5	Shift display right
6	Shift cursor to right
7	Shift display left
8	Display off, Cursor off
A	Display off, Cursor on
C	Display on, cursor off
E	Display on, cursor blinking
F	Display on, cursor blinking
10	Shift cursor position to left
14	Shift cursor position to right
18	Shift the entire display to the left
1C	Shift the entire display to the right
80	Force cursor to beginning of 1st line
C0	Force cursor to beginning of 2nd line
38	2 lines and 5x7 matrix

Table 3.2 Control Codes of LCD

3.3 Microcontroller – Philips P89C51RD2BN

3.3.1 Description

The 89C51RB2/RC2/RD2 device contains a non-volatile 16kB/32kB/64kB Flash program memory that is both parallel programmable and serial In-System and In-Application Programmable. In-System Programming (ISP) allows the user to download new code while the microcontroller sits in the application. In-Application Programming (IAP) means that the microcontroller fetches new program code and reprograms itself while in the system. This allows for remote programming over a modem link. A default serial loader (boot loader) program in ROM allows serial In-System programming of the Flash memory via the UART without the need for a loader in the Flash code. For In-Application Programming, the user program erases and reprograms the Flash memory by use of standard routines contained in ROM.

This device executes one machine cycle in 6 clock cycles, hence providing twice the speed of a conventional 80C51. This device is a Single-Chip 8-Bit Microcontroller manufactured in advanced CMOS process and is a derivative of the 80C51 microcontroller family. The device also has four 8-bit I/O ports, three 16-bit timer/event counters, a multi-source, four-priority-level, nested interrupt structure, an enhanced UART and on-chip oscillator and timing circuits. The added features of the P89C51RB2/RC2/RD2 makes it a powerful microcontroller for applications that require pulse width modulation, high-speed I/O and up/down counting capabilities such as motor control.



Figure 3.6 Philips P89C51RD2BN 1

3.3.2 Features

- 80C51 Central Processing Unit
- On-chip Flash Program Memory with In-System Programming (ISP) and In Application Programming (IAP) capability
- Boot ROM contains low level Flash programming routines for downloading via the UART
- Can be programmed by the end-user application (IAP)
- 6 clocks per machine cycle operation (standard)
- 12 clocks per machine cycle operation (optional)
- Speed up to 20 MHz with 6 clock cycles per machine cycle (40 MHz equivalent performance); up to 33 MHz with 12 clocks per machine cycle
- Fully static operation
- RAM expandable externally to 64 kB
- 4 level priority interrupt
- 8 interrupt sources
- Four 8-bit I/O ports
- Full-duplex enhanced UART
 - Framing error detection
 - Automatic address recognition
- Power control modes
 - Clock can be stopped and resumed
 - Idle mode
 - Power down mode
- Programmable clock out
- Second DPTR register
- Asynchronous port reset
- Low EMI (inhibit ALE)
- Programmable Counter Array (PCA)
 - PWM
 - Capture/compare

Chapter 4

INTERFACING

4.1 Microcontroller – MODEM Interfacing

4.1.1. DTE and DCE

The terms DTE and DCE are very common in the data communications market. DTE is short for Data Terminal Equipment and DCE stands for Data Communications Equipment. But what do they really mean? As the full DTE name indicates this is a piece of device that ends a communication line, whereas the DCE provides a path for communication.

Let's say we have a computer on which wants to communicate with the Internet through a modem and a dial-up connection. To get to the Internet you tell your modem to dial the number of your provider. After your modems has dialed the number, the modem of the provider will answer your call and your will hear a lot of noise. Then it becomes quiet and you see your login prompt or your dialing program tells you the connection is established. Now you have a connection with the server from your provider and you can wander the Internet. In this example you PC is a Data Terminal (DTE). The two modems (yours and that one of your provider) are DCEs, they make the communication between you and your provider possible. But now we have to look at the server of your provider. Is that a DTE or DCE? The answer is a DTE. It ends the communication line between you and the server. When you want to go from your provided server to another place it uses another interface. So DTE and DCE are interfacing dependent. It is e.g. possible that for your connection to the server, the server is a DTE, but that that same server is a DCE for the equipment that it is attached to on the rest of the Net.

4.1.2. RS-232

In telecommunications, RS-232 is a standard for serial binary data signals connecting between a *DTE* (Data terminal equipment) and a *DCE* (Data Circuit-terminating Equipment). It is commonly used in computer serial ports. In RS-232, data is sent as a time-series of bits. Both synchronous and asynchronous transmissions are supported by the standard. In addition to the data circuits, the standard defines a number of control circuits used to manage the connection between the DTE and DCE. Each data or control circuit only operates in one direction that is, signaling from a DTE to the attached DCE

or the reverse. Since transmit data and receive data are separate circuits, the interface can operate in a full duplex manner, supporting concurrent data flow in both directions. The standard does not define character framing within the data stream, or character encoding.

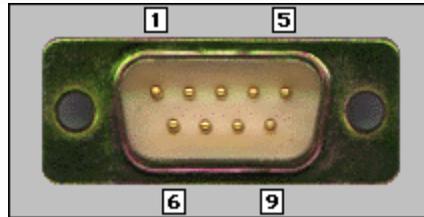


Figure 4.1 Female 9 pin plug

Function	Signal	PIN	DTE	DCE
Data	TxD	3	Output	Input
	RxD	2	Input	Output
Handshake	RTS	7	Output	Input
	CTS	8	Input	Output
	DSR	6	Input	Output
	DCD	1	Input	Output
	STR	4	Output	Input
Common	Com	5	--	--
Other	RI	9	Output	Input

Table 4.1 RS-232 Signals

4.1.2.1 RS-232 Signals

Transmitted Data (TxD)

Data sent from DTE to DCE.

Received Data (RxD)

Data sent from DCE to DTE.

Request To Send (RTS)

Asserted (set to 0) by DTE to prepare DCE to receive data. This may require action on the part of the DCE, e.g. transmitting a carrier or reversing the direction of a half-duplex line.

Clear To Send (CTS)

Asserted by DCE to acknowledge RTS and allow DTE to transmit.

Data Terminal Ready (DTR)

Asserted by DTE to indicate that it is ready to be connected. If the DCE is a modem, it should go "off hook" when it receives this signal. If this signal is de-asserted, the modem should respond by immediately hanging up.

Data Set Ready (DSR)

Asserted by DCE to indicate an active connection. If DCE is not a modem (e.g. a null-modem cable or other equipment), this signal should be permanently asserted (set to 0), possibly by a jumper to another signal.

Carrier Detect (CD)

Asserted by DCE when a connection has been established with remote equipment.

Ring Indicator (RI)

Asserted by DCE when it detects a ring signal from the telephone line.

4.1.2.2. RTS/CTS Handshaking

The standard RS-232 use of the RTS and CTS lines is asymmetrical. The DTE asserts RTS to indicate a desire to transmit and the DCE asserts CTS in response to grant permission. This allows for half-duplex modems that disable their transmitters when not required, and must transmit a synchronization preamble to the receiver when they are re-enabled. There is no way for the DTE to indicate that it is unable to accept data from the DCE. A non-standard symmetrical alternative is widely used: CTS indicates permission from the DCE for the DTE to transmit, and RTS indicates permission from the DTE for the DCE to transmit. The "request to transmit" is implicit and continuous. The standard defines RTS/CTS as the signaling protocol for flow control for data transmitted from DTE to DCE. The standard has no provision for flow control in the other direction. In practice, most hardware seems to have repurposed the RTS signal for this function. A minimal "3-wire" RS-232 connection consisting only of transmits data, receives data and ground, and is commonly used when the full facilities of RS-232 are not required. When only flow control is required, the RTS and CTS lines are added in a 5-wire version. In our

case it was imperative that we connected the RTS line of the microcontroller (DTE) to ground to enable receipt of bit streams from the modem.

4.1.3. Specifying Baud Rate, Parity & Stop bits

Serial communication using RS-232 requires that you specify four parameters: the baud rate of the transmission, the number of data bits encoding a character, the sense of the optional parity bit, and the number of stop bits. Each transmitted character is packaged in a character frame that consists of a single start bit followed by the data bits, the optional parity bit, and the stop bit or bits. A typical character frame encoding the letter "m" is shown here.

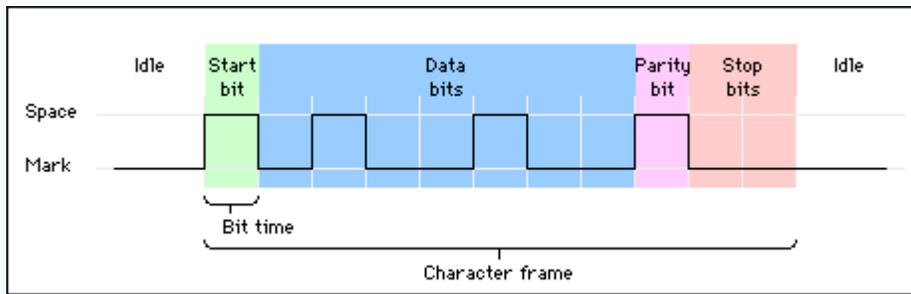


Figure 4.2 Character Frame Encoding 'm'

We specified the parameters as baud rate – 4800 bps, 8 data bits, no parity, and 1 stop bit (4800-8-N-1). This was set in pre-operational phase while setting up the modem through the hyper terminal, as per the serial transmission standards in 8051 microcontroller.

4.1.3.1. DCE Baud Rates

110,300,1200,2400,**4800**,9600,19200,38400,57600,**115200**,230400,460800,921600

Baud Rate Used

Power on default rate

4.2 Microcontroller – LCD Interfacing

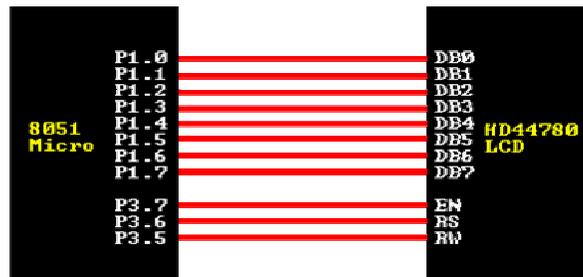


Figure 4.3 LCD Interfacing

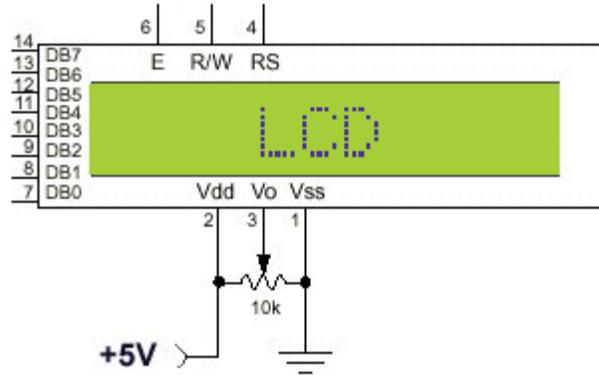


Figure 4.4 Pin Configuration

Above is the quite simple schematic. The LCD panel's *Enable* and *Register Select* is connected to the Control Port. The Control Port is an open collector / open drain output. While most Parallel Ports have internal pull-up resistors, there are a few which don't. Therefore by incorporating the two 10K external pull up resistors, the circuit is more portable for a wider range of computers, some of which may have no internal pull up resistors.

We make no effort to place the Data bus into reverse direction. Therefore we hard wire the *R/W* line of the LCD panel, into write mode. This will cause no bus conflicts on the data lines. As a result we cannot read back the LCD's internal Busy Flag which tells us if the LCD has accepted and finished processing the last instruction. This problem is overcome by inserting known delays into our program.

The 10k Potentiometer controls the contrast of the LCD panel. Nothing fancy here. As with all the examples, I've left the power supply out. You can use a bench power supply set to 5v or use an onboard +5 regulator.

The user may select whether the LCD is to operate with a 4-bit data bus or an 8-bit data bus. If a 4-bit data bus is used, the LCD will require a total of 7 data lines. If an 8-bit data bus is used, the LCD will require a total of 11 data lines. The three control lines are **EN**, **RS**, and **RW**. Note that the EN line must be raised/lowered before/after each instruction sent to the LCD regardless of whether that instruction is read or write text or instruction. In short, you must always manipulate EN when communicating with the LCD. EN is the LCD's way of knowing that you are talking to it. If you don't raise/lower EN, the LCD doesn't know you're talking to it on the other lines.



Figure 4.5 The Experimental Setup

Chapter 5

SOFTWARE SOLVENCY

5.1. End User Perspective

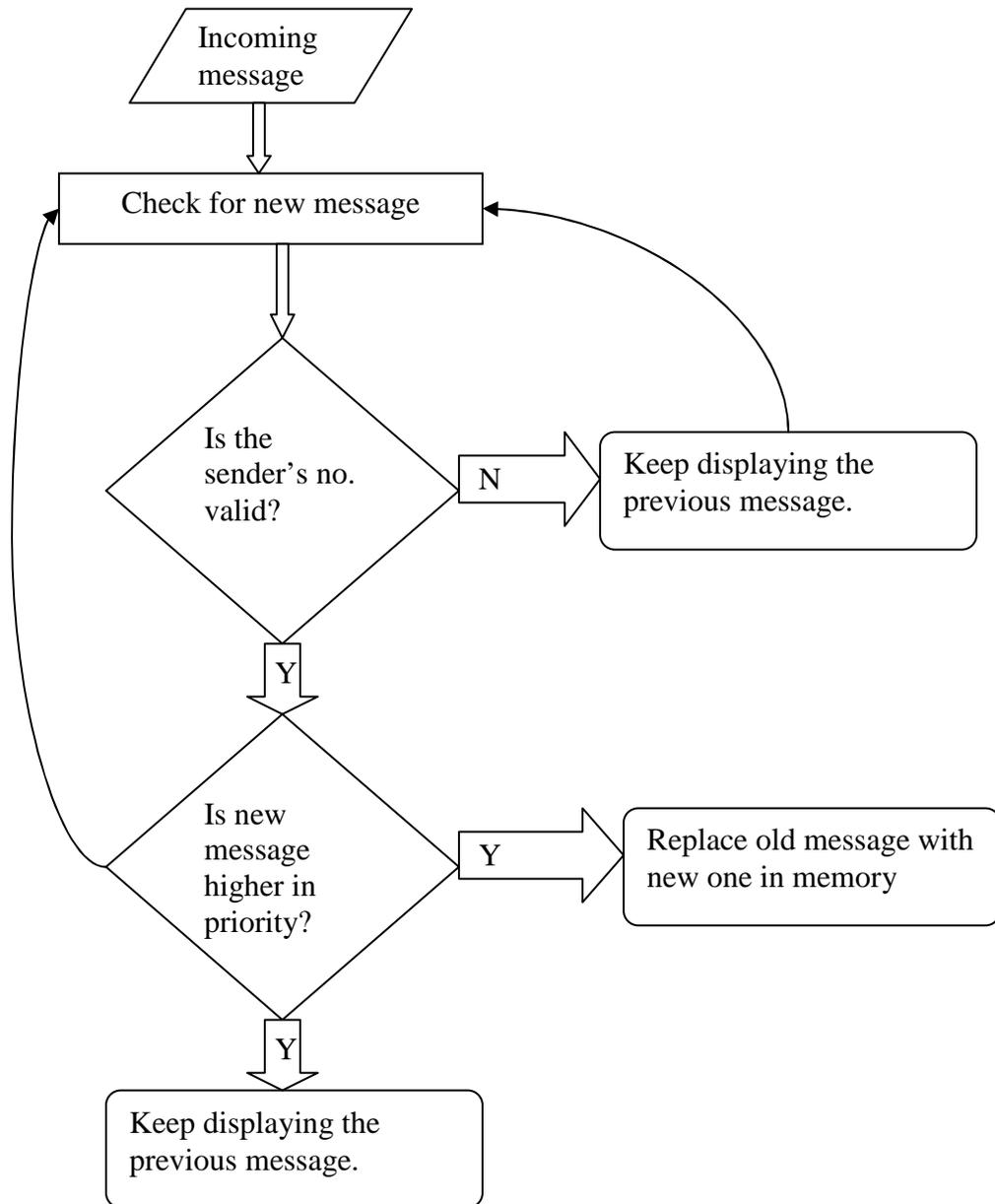


Figure 5.1. End User Perspective Flowchart

The above given flowchart gives the end user perspective on the control flow. During normal operations the LCD reads a message from a fixed memory location in the microcontroller and displays it continuously, until a new message arrives for validation. It is then when a branching occurs basing on the validity of the sender's number and further taking into account the priority assigned to the new message in comparison to the previous one.

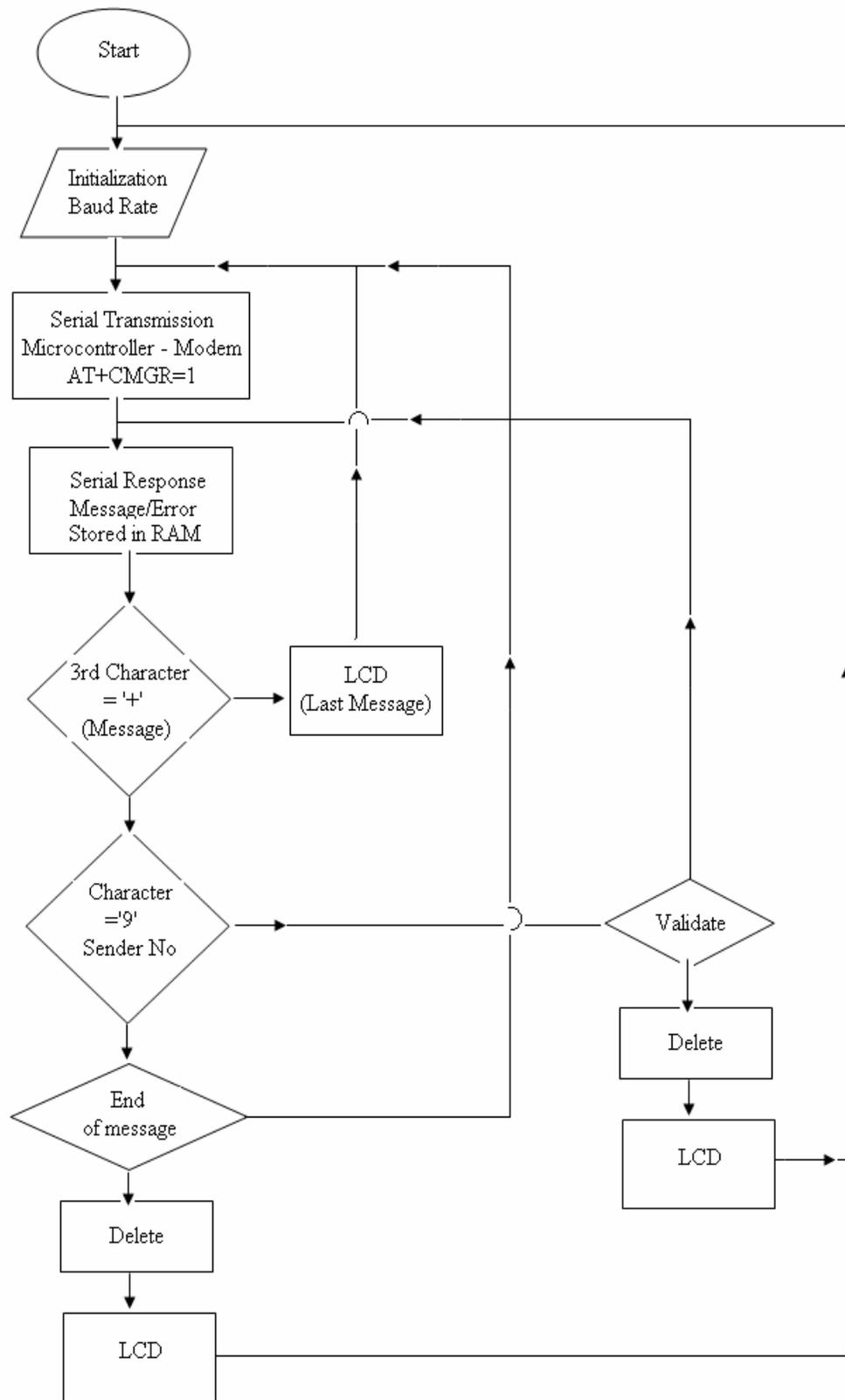


Figure 5.2 Operational Flowchart

5.2. Control Flow in Code

5.2.1. Initializations

The baud rate of the modem was set to be 4800 bps using the command AT+IPR=4800. The ECHO from the modem was turned off using the command ATE/ATE0 at the hyper terminal. For serial transmission and reception to be possible both the DTE and DCE should have same operational baud rates. Hence to set the microcontroller at a baud rate of 4800bps, we set terminal count of Timer 1 at 0FFh (clock frequency = 1.8432). The TCON and SCON registers were set accordingly.

5.2.2. Serial transfer using TI and RI flags

After setting the baud rates of the two devices both the devices are now ready to transmit and receive data in form of characters. Transmission is done when TI flag is set and similarly data is known to be received when the Rx flag is set. The microcontroller then sends an AT command to the modem in form of string of characters serially just when the TI flag is set. After reception of a character in the SBUF register of the microcontroller (response of MODEM with the read message in its default format or ERROR message or OK message), the RI flag is set and the received character is moved into the physical memory of the microcontroller.

5.2.3. Validity Check

After serially receiving the characters the code then checks for start of the sender's number and then compares the number character by character with the valid number pre stored in the memory. Since we are employing just one valid number, we are able to do the validation process dynamically i.e. without storing the new message in another location in the memory. For more than one valid numbers we would require more memory locations to first store the complete (valid/invalid) message in the memory and then perform the comparison procedure.

5.2.4 Display

After validity check the control flow goes into the LCD program module to display the valid message stored in the memory. In case of multiple valid numbers all invalid stored messages are deleted by proper branching in the code to the "delete-message" module.

Chapter 6

TESTING METHODOLOGIES AND OBSERVATIONS

6.1. Offline Testing



Figure 6.1. Transmission of AT command from microcontroller

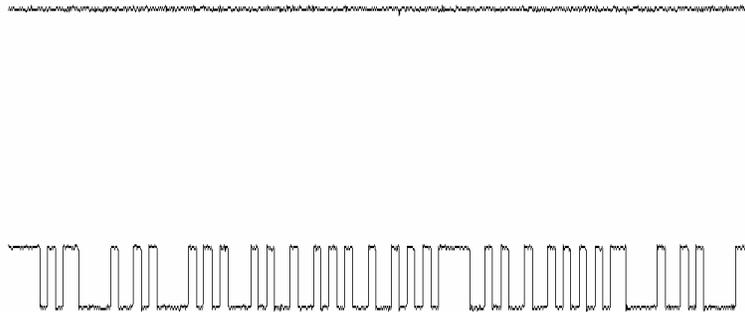


Figure 6.2. Reception of Response from MODEM

Offline testing refers to the initial phase of testing where the module is not yet connected to the wireless medium. This is the part of the testing process wherein we check if the MODEM receives the AT commands from the microcontroller and makes its response in form of a new message, an ERROR message, or an OK message (all in form of bit strings). The oscilloscope probes are connected to P3.0 & P3.1 which are internally connected to the Tx and Rx lines of the microcontroller. Online testing requires proper timing and delay routines, and of course the validations step to be included.

6.2. Online testing & Observations

After inclusion of the validation module in the program code, we test the module in online mode. In this prototype we used only one valid number. With more memory available three or four valid numbers can be included. When a message is sent to number carried by the SIM of the MODEM, the validation module of the program checks character by character the sender's number with the number stored in the memory as the valid or authentic number (in our case the only valid number). With the same probe connections as in the case of offline testing, we then look for signals on the Tx and Rx lines. What we see below on the left are the signals on these lines with the ECHO being ON(ATE1). The corresponding picture on the right depicts the modem response after about 460 ms (variable as per message length :D) delay with the new message.

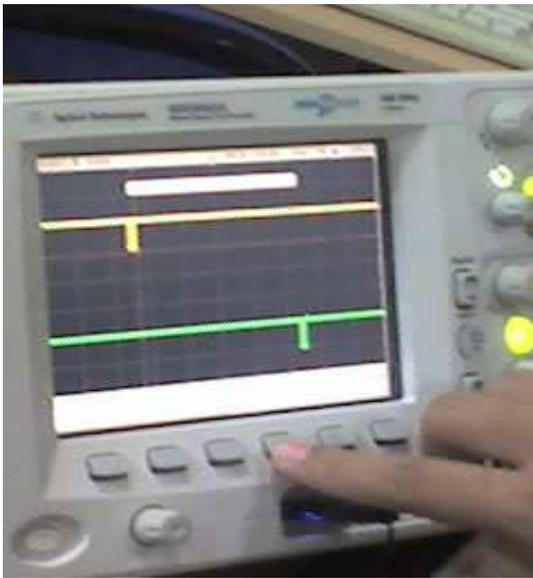


Figure 6.3. Tx and Rx lines with ECHO being ON.



Figure 6.4. Response of the modem with the new message

Chapter 7

IMPLEMENTATION AT INSTITUTE LEVEL

7.1 Overview

Information sharing holds an important role in development of our institute from Regional Engineering College (REC) to National Institute of Technology (NIT). The current means of information transfer are notice and circulars. New notice or circular is only checked at the end of the day. This makes the process very time consuming and inefficient.

Looking into current trend of information transfer in the campus, it is seen that important notice take time to be displayed in the notice boards. This latency is not expected in most of the cases and must be avoided.

7.2 Proposal

It is proposed to implement this project at the institute level. It is proposed to place display boards at major access points. These include canteens, entrance gate, hostel area etc. The proposed locations of these display boards are shown in the figure. But, the electronics displays which are currently used are programmable displays which need to be reprogrammed each time a new notice comes. The process of reprogramming includes burning the microcontroller again and again. This makes it inefficient for immediate information transfer, and thus the display board loses its importance.

The GSM based display toolkit can be used as a add-on to these display boards and make it truly wireless. The display board programs itself with the help of the incoming SMS with proper validation. The valid senders may include the Director, Deans and Registrars. The centralized system can be placed as the Computer Center for access by any other valid users with authentications. SMS from these users is treated to be valid and is displayed. Other SMS from any other mobile phone is discarded. Thus information from valid sources can be broadcasted easily.

Such a system proves to be helpful for immediate information transfer and can be easily implemented at the institute level.

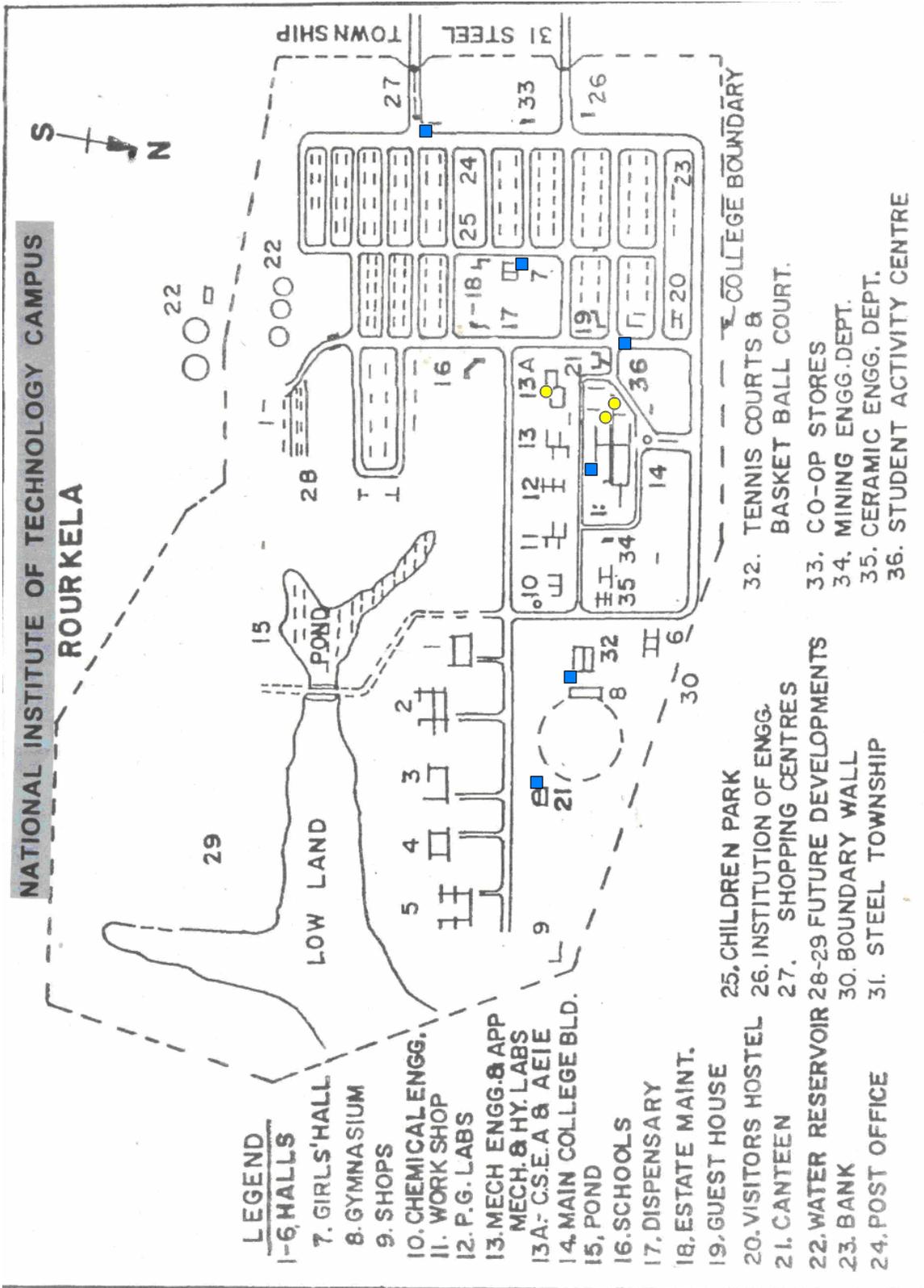


Figure 7.1 The Proposed location of display boards
 (Blue Squares – Display Board, Yellow Circles – Authenticated Sender)

Chapter 8

CONCLUSION

8.1 Conclusion:

The prototype of the GSM based display toolkit was efficiently designed. This prototype has facilities to be integrated with a display board thus making it truly mobile. The toolkit accepts the SMS, stores it, validates it and then displays it in the LCD module. The SMS is deleted from the SIM each time it is read, thus making room for the next SMS. The major constraints incorporated are the use of '*' as the termination character of the SMS and the display of one SMS as a time. These limitations can be removed by the use of higher end microcontrollers and extended RAM.

The prototype can be implemented using commercial display boards. In this case, it can solve the problem of instant information transfer in the campus.

8.2 Future Improvements

The use of microcontroller in place of a general purpose computer allows us to theorize on many further improvements on this project prototype. Temperature display during periods wherein no message buffers are empty is one such theoretical improvement that is very possible. The ideal state of the microcontroller is when the indices or storage space in the SIM memory are empty and no new message is there to display. With proper use of interrupt routines the incoming message acts as an interrupt, the temperature display is halted and the control flow jumps over to the specific interrupt service routine which first validates the sender's number and then displays the information field. Another very interesting and significant improvement would be to accommodate multiple receiver MODEMS at the different positions in a geographical area carrying duplicate SIM cards. With the help of principles of TDMA technique, we can choose to simulcast and /or broadcast important notifications. After a display board receives the valid message through the MODEM and displays it, it withdraws its identification from the network & synchronously another nearby MODEM signs itself into the network and starts to receive the message. The message is broadcast by the mobile switching center for a continuous time period during which as many possible display board MODEMS "catch" the message and display it as per the constraint of validation.

Multilingual display can be another added variation of the project. The display boards are one of the single most important media for information transfer to the maximum number of end users. This feature can be added by programming the

microcontroller to use different encoding decoding schemes in different areas as per the local language. This will ensure the increase in the number of informed users. Graphical display can also be considered as a long term but achievable and target able output. MMS technology along with relatively high end microcontrollers to carry on the tasks of graphics encoding and decoding along with a more expansive bank of usable memory can make this task a walk in the park.

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