# Cost Effective Bus Intimation System for the Public Using GPS and GSM Technology

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**Abstract:** ***This paper deals with the design and development of an embedded system, which is used to intimate the passengers about the presence or absence of a bus in that particular route, at that particular time. The project idea which is dealt in this paper is based on GPS and GSM technology. The main objective of the system is to intimate the passengers about the presence or absence and the approximate time ,that the bus would take to reach the bus stop ,from where the passenger would have requested to get the intimation. The proposed system consists of two parts; let it be named part-A and part- B. The part-A system would be kept at the bus stops and the part-B system would be kept at each and every bus. The components used and the details of interfacing has been discussed in the forthcoming topics of this paper. Any system that has to be implemented on a large scale has to be a cost effective one. The system which has been discussed in this paper shares the same roof, of being a cost effective one. The main concept behind this proposed system is introducing mobile communication into the embedded systems.***

**Keywords:** GSM, EEPROM, GPS, Bus Intimation

## 1. Introduction

Nowadays automation can been seen everywhere .These automations and intimation systems are being designed and implemented for the welfare of the humans .This paper about the bus intimation system is not an exception to that trend. It has been designed by considering the same idea as our main and foremost priority. The project idea which has been discussed in this paper helps bus passengers to save time .The global system for mobile communication (GSM) is the most popular and accepted standard for mobile phones in the world .Over billion people use GSM service across the world. Public bus transport system has been the most important and common modes of transportation used in India. However passengers have been wasting their precious time by waiting at the bus stop. Providing a real time update of the estimated time of the arrival of the incoming buses would help the passengers to save time. Also a cost effective system would be helpful for the government to implement it on large scale. These two things are what we are hoping to achieve using this project.

## 2. Description of the Proposed System

The total components used in the system are listed as follows;

- PIC microcontroller-3
- GPS module-1
- GSM module-2
- 24C02 EEPROM-1
- 16x2 LCD display
- Power supply unit.

The system that has been discussed in this paper has two parts as said earlier –PART-A and PART- B.

### 2.1Part - A Description

"PART-A" system has a GSM module, PIC microcontroller, 16x2 display and few buttons

### 2.2 Part - B Description

"PART-B" system has a GPS module, GSM module, two PIC microcontrollers, and an external EEPROM

## 3. Description of Modules

### 3.1 GPS Module

GPS module helps us to get an accurate data of the current position [12] .It gives accurate data of latitude position, longitude position, altitude and many more other data. The hardware interfaces for GPS units are designed to meet NMEA requirements. The GPS receiver provides data in NMEA 0183format with a 1Hz update rate [9]. This data is present in 5 different strings .The latitude and longitude data are present in the $GPGGA string. The extraction of the latitude and longitude data is the foremost thing done, and the resulting longitude and latitude data is stored in an array. The details of how it has been done are discussed in the forthcoming topics.

**Figure 1:** GPS module

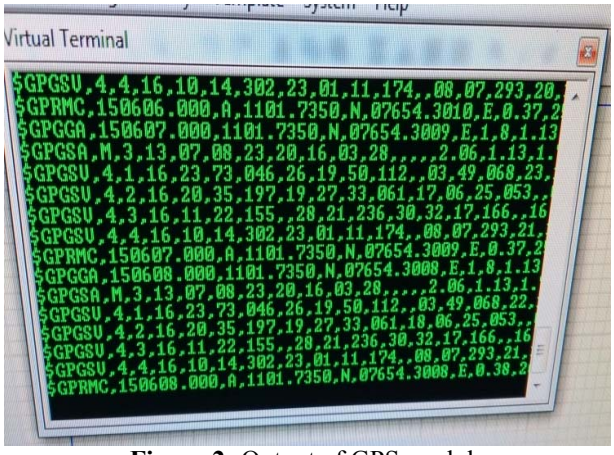


**Figure 2:** Output of GPS module

### 3.2 GSM Module

GSM module helps us to interface a sim card with the microcontroller .This interfacing would make the microcontroller to control the sending and receiving of calls and messages of that sim card .This is done using AT COMMANDS .The following table shows a few important AT COMMANDS[4].

**Table 1:** list of important AT COMMANDS

| *Command* | *Description* |
|---|---|
| AT | Check if serial interface and GSM modem is working |
| AT+CMGR | Read new message from a given memory location |
| AT+CMGS | Send message |
| AT+CMGD | Delete message |
| AT+CMGF | Set the SMS mode |
| ATD | Dial a number |

**Figure 3:** GSM module

### 3.3 External EEPROM

External EEPROM is used for storing the GPS data, so that it can be read, as and when required. The EEPROM that has been used here is of 24c02 type [5]. It works on the basis of I2C protocol .The following diagram shows its pin configuration.

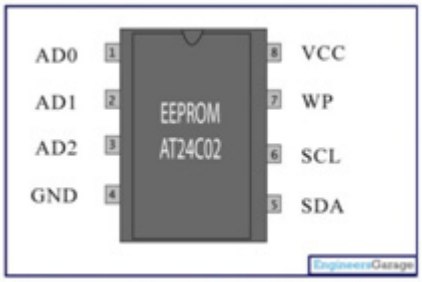


**Figure 4:** EEPROMpin diagram

**Table 2:** functions of each pin

| *Pin No* | *Function* | *Name* |
|---|---|---|
| 1 | Address input pins; Provide addresses when more than one EEPROM is interfaced to a single microcontroller; Ground when only one EEPROM is used | $AD_0$ |
| 2 | | $AD_1$ |
| 3 | | $AD_2$ |
| 4 | Ground (0V) | Ground |
| 5 | Bi-directional pin for serial data transfer | Serial Data |
| 6 | Provides clock signals | Serial Clock |
| 7 | Ground allows normal read/write functions; Vcc enables write protection | Write protect |
| 8 | Supply voltage; 5V (up to 5.5V) | Vcc |

### 3.4 PIC Microcontroller

The microcontroller that has been used here belongs to PIC16F family. (PIC16F877a) [6].

**Feature of PIC16F877a**

- high performance RISC architecture
- 33 I/O pins:5 ports
- 3timer modules present
- two capture ,compare, PWM module
- USART/SPI with 9 bit detection
- 10 bit , 8channel ADC converter
- flash memory-8kb
- Internal EEPROM-256bytes.

Since only one USART protocol is present and we have to interface 2 modules we are going for 2 microcontrollers of the same type. The details about how it has been interfaced, has been discussed in the forthcoming discussions. The pin configuration of PIC16f877a is shown in figure5.

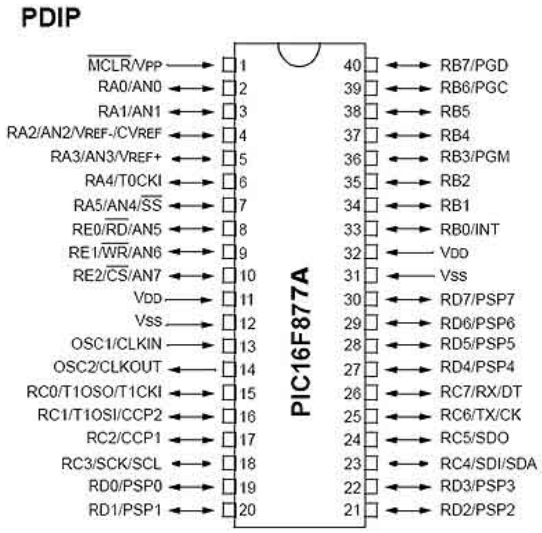


**Figure 5:** PIC16f877a pin diagram

### 3.5 Configuring 16x2 LCD

The 16x2 LCD is used for displaying the bus information. It has 11 pins, apart from power supply pins .Of these 11 pins, 3 pins are used as command pins and the rest 8 pins are used for data transfer from microcontroller to 16x2 LCD. The various commands that has been used for configuring the 16x2 LCD has been show in the following table.

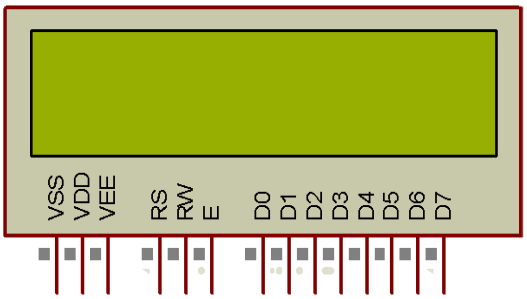


**Figure 6:**16x2 LCD display

**Table 3:** Functions of control line

| *CONTROL LINE* | *FUNCTION* |
|---|---|
| *EN* | 0-disable,1-enable, |
| *RS* | 0-command mode,1-data |
| *R/W* | 0-read data,1-write data |

**Table 4:** LCD configuration

| *COMMAND* | *DESCRIPTION* |
|---|---|
| *0x01* | Clear display screen |
| *0x80* | Force cursor to 1st row,1st column |
| *0xC0* | Force cursor to 2st row,1st column |
| *0x0E* | Display on ,cursor blinking |
| *0x06* | Increment cursor |

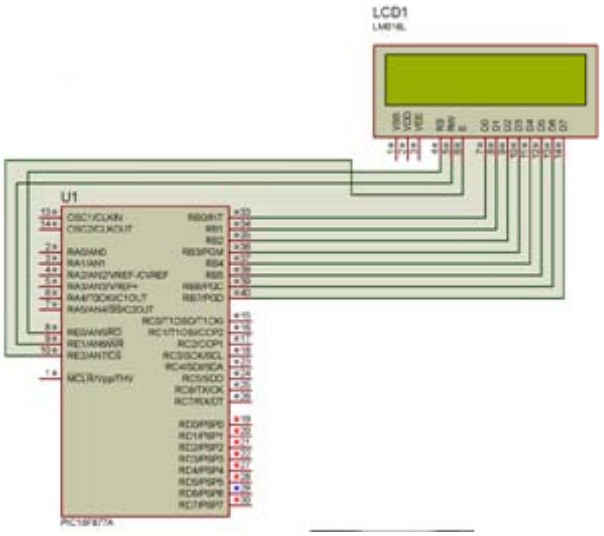


**Figure 7:** Pin diagram and connection with PIC

## 4. Working of the System

The working of the system involves four stages of data transfer which has been explained in the following paragraphs

### 4.1 Data Transfer from GPS Module to 24C02EEPROMin Part-B System

The data transfer from GPS module to EEPROM happens regularly. The GPS module is connected to the PIC microcontroller and the same is connected to the EEPROM. The following block diagram gives us information about their connections.

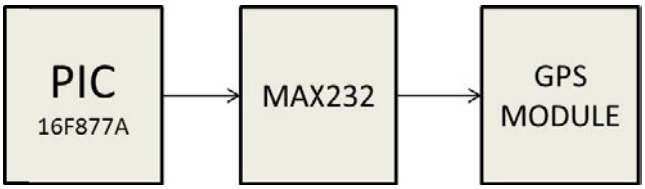


**Figure8**.GPS and EEPROM block diagram

The USART (Universal Synchronous Asynchronous Receiver Transmitter) communication is used to interface GPS module with PIC microcontroller. The RCIF flag gets set whenever the PIC microcontroller receives a data from the GPS module .The state of RCIF flag helps us to write a code to get those data in an array. The same data has been stored in external EEPROM. I2C protocol is used to interface EEPROM with PIC. .The PIC microcontroller will write the latitude and longitude data that has been segregated from the GPS module, into the external EEPROM. The real time connection is shown in figure9.

#### 4.1.1Need for External EEPROM

One common question that would arise for everyone is "why an external EEPROM is necessary?" The need for external EEPROM is that, at times when a bus stops under a tree (considering the practical case) the PIC microcontroller wouldn't get any data from the GPS module. At that time when a request has been received from the GSM module, it would be a problem .So we are storing the GPS data and updating it frequently ,and if in case the GPS data has not

been updated ,the previously updated data would be used for the calculation of the estimated amount of bus arrival. Also, since two PIC microcontrollers are used for part-B system (since we need two USART protocols) we are using an external EEPROM so that the two microcontrollers can be synchronized.

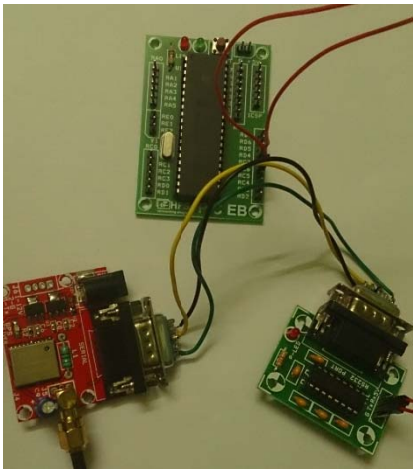

**Figure 9:** Real time connection between GPS and EEPROM

### 4.2 Data Transfer from Part-A System to Part-B System

The data transfer from the part-A system to the part-B system happens only when a passenger requests for the intimation of the bus. Let us consider that the passenger is waiting for bus named"1C".So if the passenger presses the button ,corresponding to that bus ,the GSM module that has been interfaced with the PIC microcontroller would send messages (of a particular format) to the phone numbers that has been synchronized with the bus of that particular name("1c" in this case).

### 4.3. Data Transfer between GSM Module and EEPROM in Part-B

The data transfer between the GSM module and EEPROM in part-B happens only when the GSM module, receives a message of a particular format, from a phone number (phone number in this case refers to the request from the bus stop (i.e.) the part-A system).So, when the GSM module receives a message of that particular format, the PIC microcontroller sends signal to the EEPROM through I2C protocol and reads the data.

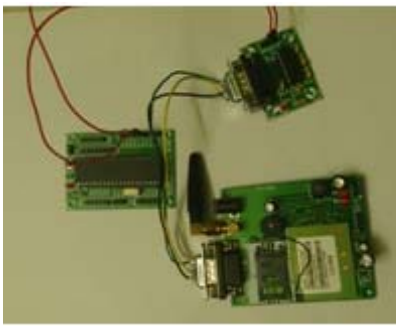

**Figure10.**Realtime connection between GSM and EEPROM in part-b

### 4.4 Data Transfer from Part-B to Part-A

The data transfer between part-B system and part-A system happens in the form of a message .The data content of the message is nothing but the latitude and longitude data .This data transfer happens as soon as the step3 is completed .The latitude and longitude data is received from the EEPROM.

### 4.5 Computation of the Distance

All the longitude and latitude data that has been received by the part-A system is used by the microcontroller for computing the distance. The first thing that it does is, it checks whether the latitude and longitude data is present somewhere on that bus route. Then the microcontroller compares the received data with the preloaded latitude or the longitude values of the various bus stops .Then it sends the data to the 16x2 LCD display, for displaying purpose.

### 4.6 Displaying the Information

A 16x2 LCD has been interfaced with the same part-A system ,and the same is used for the displaying the information .The bus stop number nearer to which the bus is travelling, would be displayed in the LCD displaying unit.

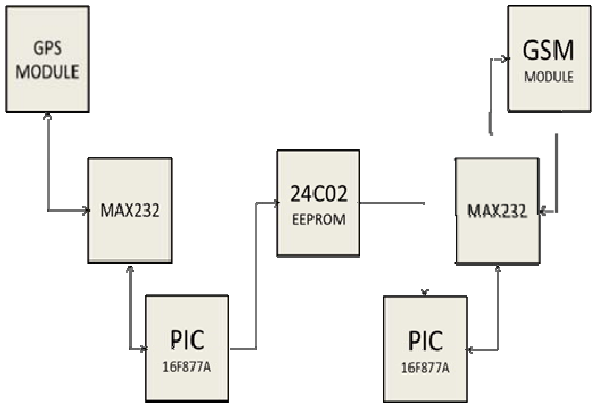


**Figure 11:** Block diagram of "PART-B" system

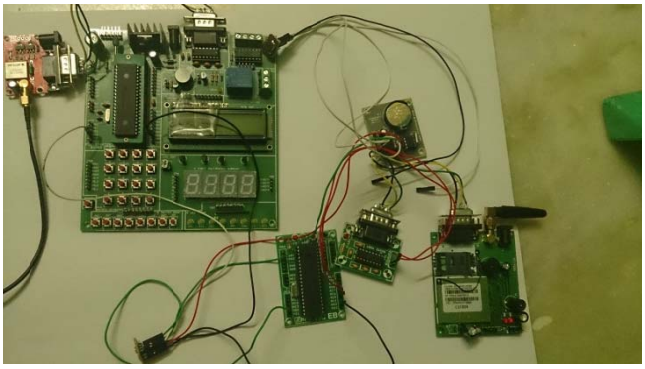

**Figure 12:** PART-B SYSTEM-real time connection

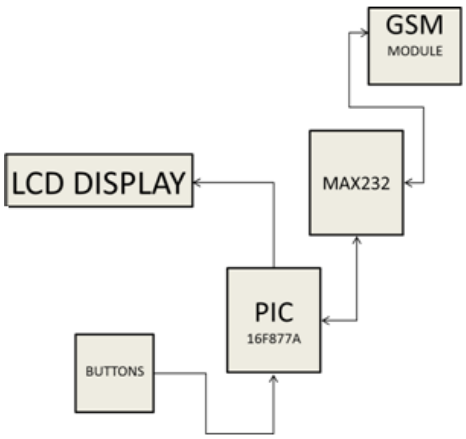


**Figure 13:** block diagram of "PART-A"system

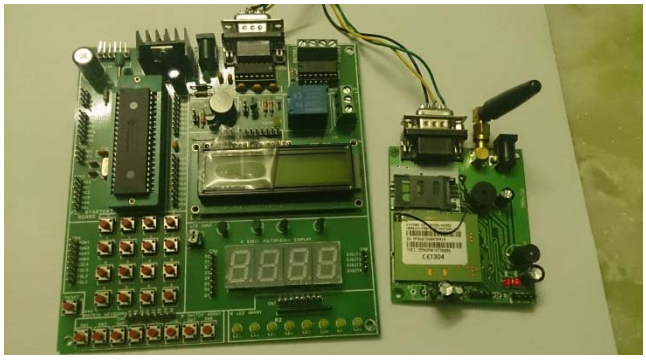

**Figure 14:** "PART-A" system –real time connection

## 5. Advantages

The main advantages of the proposed system are listed as follows;

1. It is cost effective and can be implemented practically on a large scale.
2. The overall cost of the system would be around 4000 rupees for part-B system and around 1800 rupees for part-A system
3. The other advantage of the system is, even the illiterates ,who form the major part of the population in India ,can also get the information without any difficulty
4. This system can help passengers to waste less time at the bus stops.
5. This system provides accurate information to the passenger

## 6. Conclusion

In this paper, we have successfully explained a system which has been designed for bus intimation. The proposed system is based on GPS and GSM technology. This system helps the passengers to get the bus intimation in an easy way. The whole system has two parts, PART-A and PART-B. The working of these two systems have been explained in detail, in this paper .This system is economical and could be practically implemented on a large scale basics at a very low cost. Moreover this system can help the illiterates also, to get the information. In future this system can be improved by using DGPS technique, which would help us to increase the accuracy of getting the GPS data. The accuracy of the GPS data can be increased to 3 to 5 meters using this technique [7].

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