

# Design and Implementation of a Wireless Notice Board with Interface for Remote Update

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**Abstract** —Mankind has always had a need for signs and notifications at places and events, which ranges from meeting times and venues, to transport arrival and departure times. Such notifications guide society on making informed decisions towards better lifestyle. While some notifications used to be relayed through audio means by town criers in villages in the past, such methods are not suitable for towns and cities that have witnessed tremendous technology advancements. Also, traditional notice board methods of physically sticking typed paper notices on wooden board waste resources. The value of this work is underscored by the need to meet our everyday information needs in a timely and cost effective manner by harnessing existing electronic and wireless technologies to help people to ultimately achieve better socio-economic outcomes. Information is power; thus, it is paramount to disseminate time critical information quickly and conveniently. This paper proposes a design and implementation of a mobile phone controlled wireless electronic notice board that can be used to circulate information in places such as schools, offices, homes and other establishments. This design offers flexibility and control of information to its users remotely as information is transmitted over a wireless network.

**Index Terms**—AT Commands, GSM, Information, LCD, Modem, Microcontroller, Modules, Notice board, SMS, Technology, Wireless Networks.

## 1 INTRODUCTION

A Mobile Phone Controlled Wireless Notice Board operates by sending an SMS (Short Message Service) to a system which displays the received SMS on a screen for public viewing. The use of wooden notice boards placed at different locations in every establishment and institutions of human endeavors, waste resources like paper, printer ink, time, man power, and amounts to a high monetary value as compared to the low cost of SMS by various mobile network providers in different countries (example; 0.0126 USD per SMS in Nigeria).

By utilizing GSM technology; a global range wireless technology (as compared to other short range wireless technologies like Bluetooth, Zigbee and WiFi), a lot of time, money, effort, and other resources are saved and information is delivered in a fast and easy way.

## 2 REVIEW OF EXISTING WIRELESS ELECTRONIC NOTICE BOARD

Known previous work on Wireless Electronic Notice Board involved the use of different wireless technologies to send messages remotely to a screen. Some of these works are discussed below.

### 2.1 RF Based Wireless Notice Board

Zohedi [1] used a short range 433.92MHz FM-TX1 (transmitter) and FM-RX1 (receiver) RF wireless technology and MC68HC11 microcontroller to design a wireless notice board. Although the work met the basic objectives of a Wireless Electronic Notice Board which sends and receives messages wirelessly, it had some practical limitations.

One of the limitations of Zohedi's work was that transmission between the sender and the receiving module was only possible within a 200m range in the open and 25-30m range when there are obstacles. The range is also affected by the type of antenna used in the receiver and

transmitter system as well as the environment inside buildings or structures, obstacles within the buildings could further reduce the transmission range to a mere line of sight. The larger the antenna, the better the reception was. This limitation restricts the application of the notice board to use within buildings.

The system also had the limitation of having the message entered through a customized transmitter keypad module. Using a customized input module has certain disadvantages; if the module were to become faulty or damaged, the entire system would be rendered inoperable until a spare module is produced, unlike a GSM phone, which can easily have its SIM card swapped out into another phone.

### 2.2 ZIGBEE based wireless notice board

The ZigBee used is based on PAN (Personal Area Network) technology, which can form a mesh network between nodes. Meshing is a type of daisy chaining from one device to another. This technique allows the short range of an individual node to be expanded and multiplied; covering a much larger area than the RF based design.

A ZigBee based wireless notice board displays messages sent from PC within a certain range [3]. For this purpose, an XBee explorer was used which receives and retrieve data from the PC and sends it to the microcontroller, which then displays it on the LCD. The range of around 300-400m can be obtained.

This ZigBee based design increased the range of transmission, reduced cost and circuit complexity as compared to the RF based design, but still had some limitations. An operator has to be physically present within the vicinity of the transmitter to change or update the message on the screen because he/she will need to connect a PC to the transmitter module to key in the text. There was also no backup power source as was the case with the RF based design.

### 2.3 BLUETOOTH based wireless notice board

Here a wireless notice board displays notifications when message is sent from the user's mobile phone [4] or any Bluetooth enabled device. When the user sends a message from the device, it is received and retrieved by the Bluetooth device at the display unit. The Bluetooth access password will only be known by the user.

Though the range of transmission was about 100m, the design achieved portability since messages can be updated with portable devices like mobile phones and tablets.

### 2.4 GSM based wireless notice board

In recent times, GSM based design of a wireless notice board utilizing ATMEL microcontroller (AT89C51 and AT89C52) or ARDUINO, and a GSM MODEM are very common. In these designs, notifications are sent to the system remotely from anywhere there is GSM network. Hence a user does not have to be in the vicinity of the transmitter to update the message on the screen. Thus, overcoming the short range of transmission problem, but there were no provisions for back-up power source.

The design adopted in this paper also utilizes the GSM wireless technology, but was optimized to overcome the limitations of all the previous designs with additional features. It employs;

- I. GSM technology to achieve global range, which does not restrict the message sender to be in the same vicinity as the electronic notice board, but could be anywhere in the world.
- II. A rechargeable battery to act as a backup power source.
- III. The use of mobile phone to simply send messages in the form of SMS from users as against the use of key pad in the previous designs.
- IV. MAX233 (with no external capacitors); instead of MAX232 that was used in previous designs. 16X2 LCD used in the above designs was replaced by 20X4 LCD in our design to accommodate more message characters on screen.
- V. A buzzer which beep to alert users of urgent messages/notifications.
- VI. SIM900 GSM MODEM as against SIM300 which has a lower frequency.
- VII. Software control of the charging and discharging of the battery.

### SYSTEM SCHEMATIC DESIGN

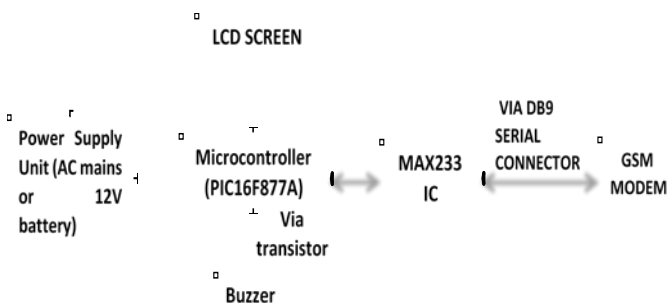


Fig 1: Block diagram of the system

As seen from figure 1, the project is divided into Six (6) basic units;

- 1) The power supply unit. 2) The GSM module. 3) The Max233 IC (voltage level shifter). 4) The Microcontroller (PIC16F877A). 5) The display unit (LCD screen). 6) Alerting unit (Buzzer)

Permitted users send SMS to a SIM card in the GSM modem incorporated in the system from a GSM phone. The GSM modem receives the SMS; sends it to a programmed microcontroller via a DB9 serial connector and a max233 level shifter IC. The SMS is displayed on the LCD if and only if the first two characters are '##', and the last character is '\*'. If the first three characters are '###', and the last character is '\*', the buzzer is activated before the message is displayed. This is to alert people that there is urgent information on the screen. The patterns '##'...'\*' and '###'...'\*' are the unique pass code used for this project. This enables us to prevent unauthorized use of the LCD display board. The EEPROM of the microcontroller saves up to three SMS received from the GSM modem and redisplay them at intervals. A fourth SMS overwrites the oldest SMS in the memory.

### 3 DESIGN AND ANALYSIS

Here, we seek to explain how a reliable and an authentic wireless display of SMS on LCD can be developed with a mobile phone and microcontroller using GSM Technology. The microcontroller is interfaced to the GSM Modem via MAX233 level converter. It is used to convert RS232 voltage levels to TTL voltage levels and vice versa. A 20x4 LCD display is attached to microcontroller for display. Microcontroller coding will be done using Embedded C with the help of MikroC integrated development environment (IDE).

#### 3.1 Microcontroller Unit

The PIC16F877A microcontroller is the brain of the system.

Design requirements from this unit are as follows;

- Minimum of three ports; one as input port and the other two for output
- Special modules: ADC module and UART module
- Pin 11 and pin 32 connected to VCC
- Pin 12 and pin 31 connected to ground
- Pin 13 and pin 14 for crystal connection
- Pin 1 (MCLR) connected to VCC via 100ohm resistor
- Extra function of driving a transistor
- Connections to PIC16F877A microcontroller based on the datasheet information and desired results
- For 4MHZ crystal, range of the capacitors (C1 and C2) is 15pf. For design purposes, we choose 22pf for each of the capacitors.

- Port A is configured as an input port; AN1 is used to monitor the battery voltage level in order to regulate the charging and discharging of the battery.
- Port B and Port D are configured as output ports; the transistor (C828) that drives relay for the battery charging circuit is connected to RB5 (pin 38). The transistor to trigger the buzzer is connected to RB3 (pin 36) of PIC16F877A and LCD is connected to Port D

### 3.2 GSM Modem Unit

SIM900 GSM modem is used in our design. The GSM modem has a SIM card inserted in it. SMS are sent to the Modem from a mobile phone of a

### MICROCONTROLLER TO MAX233 TO MODEM INTERFACE

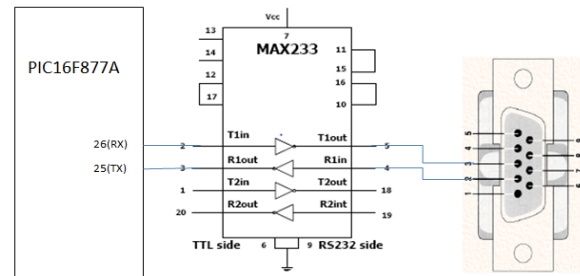


Fig 3: Microcontroller to MAX233 to Modem Interface

### 3.3 Display Unit

The display used is a 20-character by 4 lines LCD screen configured for 4bit data mode to ensure less pin usage for data transmission hence pins are free for other use and there is less number of hardware links.

### LCD design connections

LCD USED	PINS	CONNECTIONS DONE
1		VSS; to Ground
2		VDD; to regulated 5V
3		VO; to 10KΩ variable resistor
4		RS; to RD4
5		RW; to Ground
6		E; to RB5
11 – 14		D4 – D7; to RB0 – RB3 of PIC16F877A
15		A; through 100Ω resistor to Ground
16		K; to Ground

TABLE 2: LCD CONNECTIONS IN THE SYSTEM

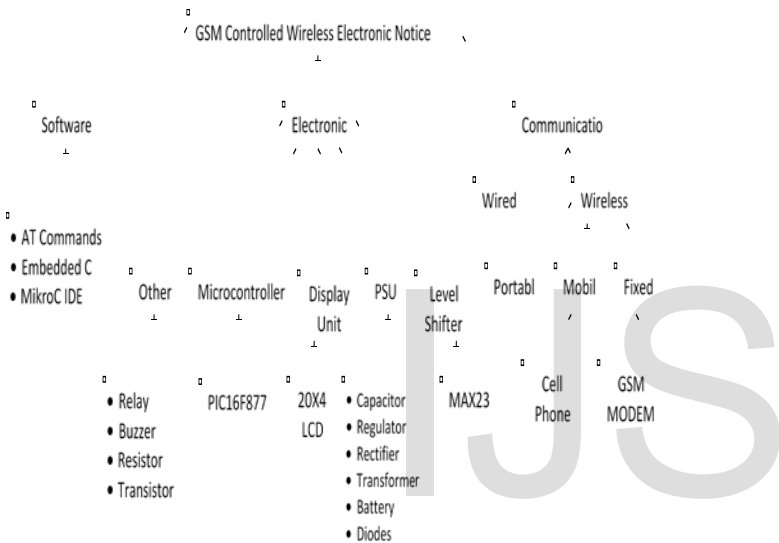


Fig 2: A Chart showing the different modules of the system and their component parts.

user over wireless link using GSM technology. The GSM Modem asynchronously communicates with the microcontroller via a DB-9 serial cord.

AT commands used for the configuration and setup of the modem are shown in the table below;

S/NO	AT COMMANDS USED	FUNCTIONS
1	AT + CMGF = 1	Select SMS message format in text mode
2	AT + CMGS	Send SMS message
3	AT + CNMI = 2,2,0,0,0	New SMS message indications
4	AT + IPR = 9600	Baud rate configuration of GSM modem

TABLE 1: LIST OF AT COMMANDS USED IN THE SYSTEM AND THEIR FUNCTIONS

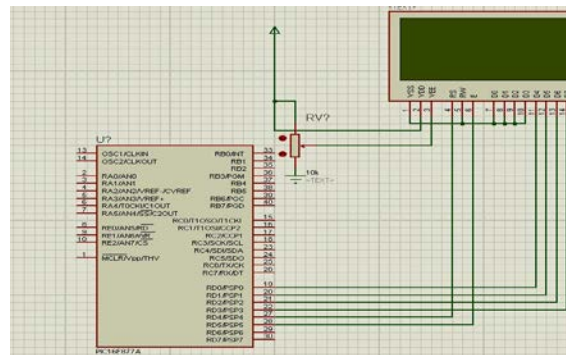


Fig 4: Microcontroller to LCD Interface

### 3.4 MAX233 IC Unit

The MAX233 is one of the MAX220-MAX249 family of line drivers/receivers (intended for many communication interfaces, particularly applications where +12v or -12v is not available).

### 3.5 The Power Supply Unit Interfaced With the Circuit

The power is supplied to the system from two sources; the AC mains and a 12v DC standby battery (also regulated) as a backup.

The GSM Modem has a voltage rating of +7.5v but the Microcontroller, MAX233 and other electronic components in the circuit cannot withstand voltages above +5v. Hence, to minimize circuit complexity, the output of the modem power pack (+7.5v) was connected in parallel to the circuit through a 7805 voltage regulator. This regulates the voltage entering the circuit to the required +5v. The circuit diagram of the PSU interfaced with the circuit and Modem is as shown;

From figure 5, The charging circuit charges the 12v battery. Re1 is a DC relay; it disconnects the battery from the charging circuit once it is fully charged. The switching circuit is designed to switch between AC mains and the battery. Re2 is a four pole AC relay; it is the switch that selects which source powers the system at any given time. All diodes in the circuit ensures one directional flow of current in the appropriate locations. LM317 regulates the 12V from the battery to 7.5V needed by the modem when its being powered by the battery. Resistors in the circuit limits the flow of current and causes voltage drops in appropriate locations. C828 (NPN transistor) in the circuit acts as a driver. It helps the relay to switch because the current from the microcontroller is too low (200mA) to switch the relay. When the base of the transistor receives a HIGH, it biases and supplies a LOW to the negative terminal of the relay. This energizes the relay and causes it to switch. 220-15v, 2A transformer used in the PSU, supplies the voltage and current required for charging the battery. 50v/1000uF capacitor acts as a filter and also helps in circuit stability.

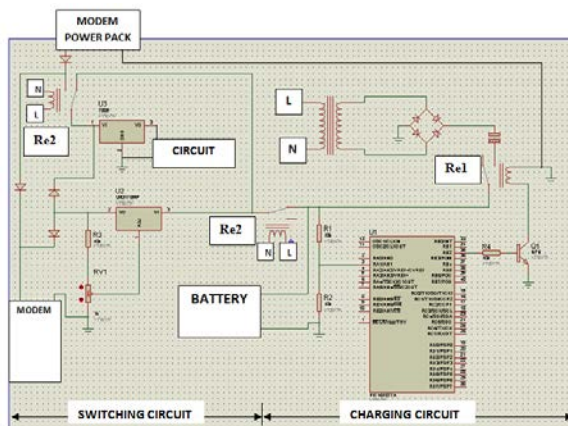


Fig 5: The circuit diagram of the PSU interfaced with the circuit and Modem

### 3.6 The Alert Unit

This comprises of an NPN transistor (C828) and a Buzzer. When RB3 receives a HIGH, the transistor is biased; this activates the buzzer to beep until the RB3 sees a LOW and the transistor turns off. The circuit diagram of this unit is as shown in figure 6;

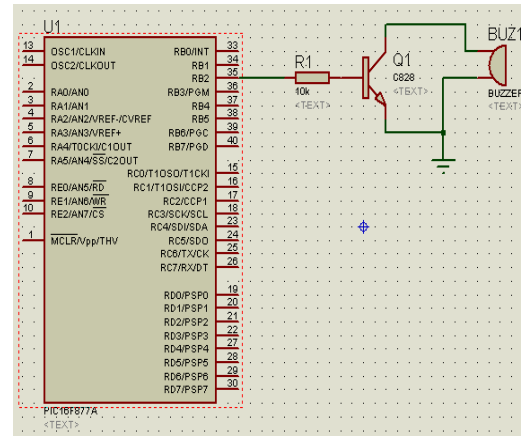


Fig 6: Circuit diagram of the alerting unit

## 4 IMPLEMENTATION AND TESTING

The steps taken in the Implementation process are;

1. Circuit development and design
2. Writing and developing code on MikroC IDE [2].
3. Circuit simulation on Proteus Lite
4. GSM MODEM testing and configuration using a PC
5. Programming the Microcontroller [2].
6. Bread board testing of circuit
7. Building and soldering circuit on a Vero Board
8. Troubleshooting and testing
9. Adding an alert system to the circuit
10. Writing code to control the beeping of the buzzer [2].
11. Incorporating a 12v rechargeable battery to serve as a secondary power source
12. Developing a charging circuit for the battery
13. Writing code to control charging of battery [2].
14. Simulating circuit with the new code
15. Reprogramming the microcontroller [2].
16. Further troubleshooting and testing
17. Casing design and construction.
18. Packaging.
19. Final testing of circuit

### 4.1 Code Development and Circuit Simulation

The MikroC IDE was used to develop (write and compile) the embedded C code used to program the microcontroller. The code was to implement the major functionality of the system, which is to receive, save and display valid SMS sent to the system from any mobile phone.

The designed circuit and the compiled code were then simulated on Proteus and all necessary corrections were made[2].

## 4.2 GSM Modem Testing and Configuration Using a PC

The GSM modem was connected to a personal computer using a USB to serial converter; this allows the PC to use the GSM modem to interconnect over the mobile network. The USART terminal of the MikroC library is the software application environment that facilitated this testing, configuration and set-up [2].

## 4.3 CIRCUIT ENHANCEMENTS

To enhance system functionality, the alert system (consisting of a buzzer and a transistor) and the backup power source (12V rechargeable battery) were incorporated in our design. A charging circuit was also designed which is able to charge up the battery once AC power from the mains is restored. Also, codes that can control the beeping of the buzzer (buzzer should beep for only one minute) and the charging of the battery (so that the battery is disconnected from the charging circuit when it is fully charged) were written[2]. The enhanced circuit was again simulated on Proteus to test its workability and all necessary corrections were made.

Afterwards, the microcontroller was reprogrammed following the procedures in section 4.4 above and further troubleshooting and testing were carried out.

The snapshot below shows the major components and modules of the hardware as well as the packages work.

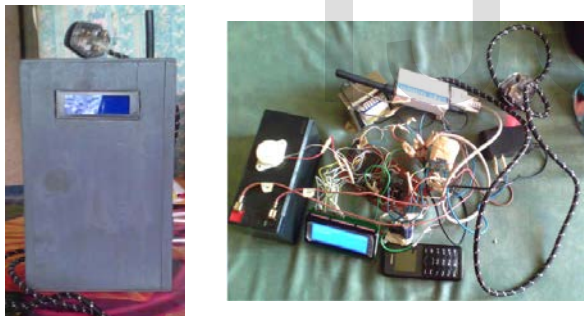


Fig7: Prototype kit of a wireless notice board. (a). final coupled design. (b) Internal Circuitry with test phone.

## 5 CONCLUSION AND RECOMMENDATIONS

The GSM controlled wireless electronic notice board Project objectives are achieved. A notification message is wirelessly sent from a Mobile phone as SMS (Text Message) and received by the system which is then displayed on the system's LCD screen. The global range coverage of this design offers the advantage of flexibility and timely control of the system from any part of the world where the GSM network is available.

The wireless control of messages on the Notice Board is a very effective way of relaying messages as it eliminates all the usual problems of timely and convenient

delivery of messages associated with traditional notice boards.

The savings on paper, man power, time and printing materials as compared to 0.0126 USDcost: sending SMS offers operating cost savings. The system is eco-friendly environmentally friendly.

Also, the buzzer helps to alert users on notifications that need urgent attention and the standby rechargeable battery offers backup power in case of power failure.

From the experiences gotten during the design and implementation of this project, we recommend that;

- A larger out door LED screen should be used which can display both text and graphics and can withstand all weather conditions, thus, can be used outside buildings. This will also accommodate more characters.
- External EEPROM should be incorporated into the system; this will enable the storage of more number of messages
- Future models can be designed to use dual SIM cards in order to safeguard against network failures and disruptions.
- Incorporation of a surveillance camera on the screen as a security major against theft and vandalism.
- The slow switching speed of the relay used in the switching circuit in the PSU defeats our aim of using the battery as a standby. The system switches OFF completely and then ON again during the switching process which should not be so. To overcome this, a device that switches faster, e.g. a transistor should be used to design the switching circuit. This will improve system performance and reliability.

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