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Switching Of Security Lighting System Using Gsm

Bakare, B. I [1,] Odeyemi, F. M[2]

[1,2](*Department of Electrical/Computer Engineering*
Rivers State University of Science and Technology, Port Harcourt, Nigeria)

ABSTRACT: *.This paper shows how ATMEGA168 microcontroller can be used to remotely control security lighting via Short Message Service (SMS) from a Global System for Mobile Communication (GSM) phone anywhere outside the home. A Mobile phone is configured to transmit SMS signal to a home-based GSM modem. The GSM Modem then sends the received SMS to a ATMEGA168 microcontroller. The Microcontroller accesses the received SMS and Changes the State of the appliances if the received signal aggresses with a pre - set code. When this is done, the microcontroller then sends signal to the GSM modem which in turn send back a reply to the mobile phone via SMS. The system utilizes a LCD display with resolution of 96*64 using PCD8544 Driver/Controller to display the ON/OFF state of the lighting device.*

KEYWORDS : *GSM, LCD, microcontroller, modem, SMS*

I. INTRODUCTION

Mobile devices, such as mobile phones, are becoming multipurpose devices. Imagine being able to control all the electrical appliances in a house from virtually any place in the world, GSM home automation may seem like an idea of the future; however there are many possibilities of using it currently [1], The technology works by allowing communication between a receiver in the house and a mobile phone elsewhere. That receiver can then be signaled to "On" or "Off" appliances in the house based on command from the mobile phone. Through the use of micro-controller, any electrical or electronic device such as lighting a bulb can be controlled from a distance.[2] This paper presents a system that allows the user to control lighting systems remotely using mobile phones. It provides remote control via Short Messages Services (SMS) using Global System for Mobile Communication (GSM) technology. This system is related to past study which uses personal computer (PC) that contains the software components through which the lights and appliances are controlled and home security is monitored. This paper developed a system that uses a microcontroller instead of PC and hence the system size is reduced

. The most common problem that home owners encountered in relation to lighting system is due to some negligence like leaving the lights ON in error resulting to greater power consumption. This wasted power directly affects the home owner electrical bills. Another problem is that of the busy home owners who will arrive home late at night; they may want to switch on their security lights from a distance in order to protect their house against robbery and crimes.[3].The mobile phone is configured to send SMS of the ON/OFF state of the appliance to a modem (a particular mobile phone line). The owner can control the system through his mobile phone by sending Attention (AT) commands to the Modem line and in turn, to the microcontroller. The system can also provide password security against operator misuse/abuse.

II. MATERIALS AND METHODS

The figure below shows the block diagram of the design

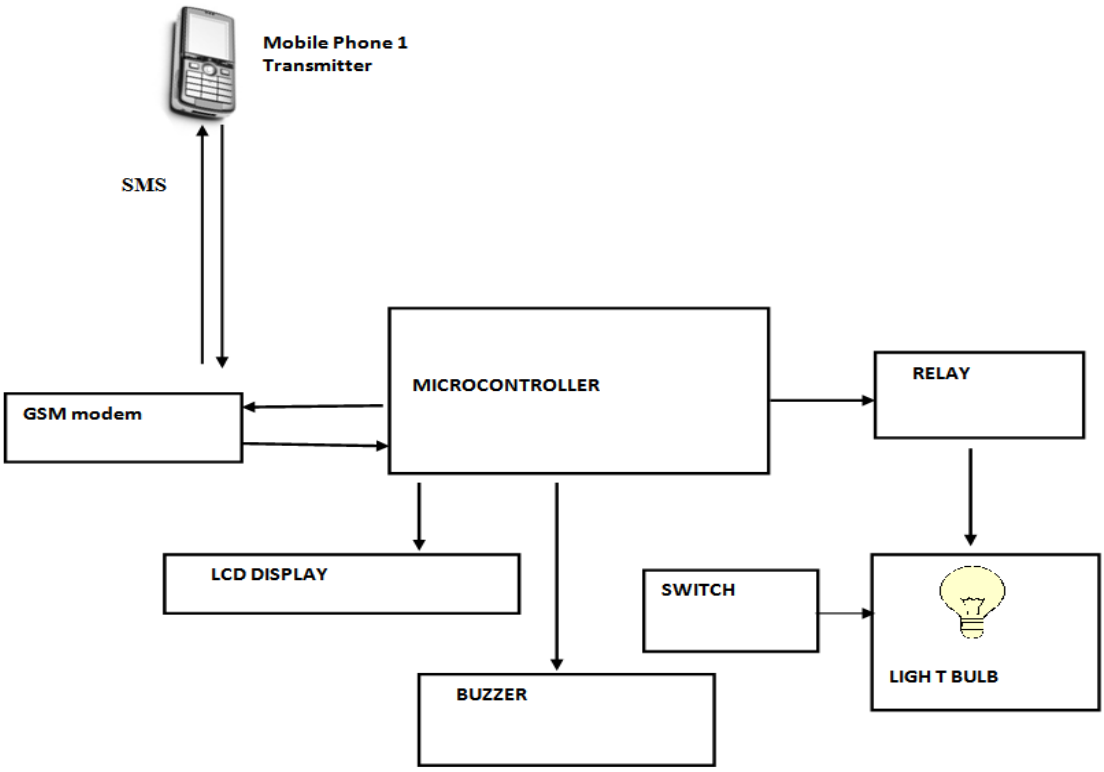

Figure 1: Block diagram of design

Principle of operation : The system is made up of two parts, namely; the transmitting part and receiving part. The transmitting part consists of a normal GSM phone which transmits signal via SMS. The receiving part consists of a microcontroller chip, a GSM modem, a buzzer, buttons and the appliance to be controlled .When the GSM phone transmits signal via SMS, the GSM modem receives it and sends it to the microcontroller. The microcontroller accesses the SMS and changes the state of the appliances if the signal is an appropriate code. When this is done, the microcontroller sends signal to the GSM modem to send back reply to the GSM phone via SMS. The switches are the alternative means of changing the state of the appliances. If the home owner is close to the transmitting end, he/she can use the Switch buttons to change the state of the appliances.The buzzer is for notification: to notify when there is a change of state. So whether one uses the switches or the GSM phone, a sound will be produced to notify a change of state. The display is a Liquid Crystal Display (LCD) which displays the signal processing results. For the security aspect, if one presses any of the switches, the GSM modem will send a signal via SMS to the GSM phone, notifying that there is a change of state in a particular appliance. Another security aspect is that if the cable of any of the appliances is cut, the GSM modem will also send a signal via SMS to the GSM phone notifying that a particular cable has been removed.

III. HARDWARE DESIGN ANALYSIS

The Buzzer Driver : The Buzzer requires a current of 30mAmps for proper operation as instructed by the datasheet.[4] The configuration is shown below.

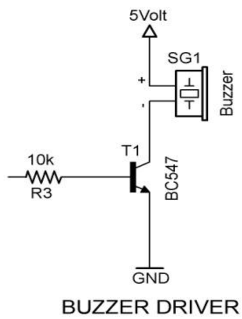

Figure 2: Buzzer driver.

The given transistor parameters are
Transistor (npn BC547)
Forward beta (β) = 290,

I_{CMAX} = 100mA,
Transistor's renowned equations

$$I_E = I_C + I_B \tag{1}$$

$$I_C = \beta I_B \tag{2}$$

From circuit analysis I_C = 30mA

$$30\ mA = 290 * I_B$$

$$I_B = \frac{30 * 10^{-3}}{290}$$

$$I_B = 0.000103448$$

$$I_B \cong 103.45\ \mu A$$

From the base emitter loop,

$$V_B - I_B R_B - V_{BE} = 0 \tag{3}$$

$$I_B R_B = V_B - V_{BE}$$

$$R_B = \frac{V_B - V_{BE}}{I_B}$$

$$R_B = \frac{5 - 0.7}{103.45 * 10^{-6}}$$

$$R_B = 45432.5761$$

$$R_B \cong 45\ K\Omega$$

$$R_B \cong 43\ K\Omega$$

Using a smaller value of resistor that will yield a wider range of base current without endangering the transistor is ok but not exceeding the current limit of the base which is 500uAmps for 5mAmps of collector current and higher for higher values of the collector as well.

$$\therefore\ R_B \cong 10\ K\Omega$$

3.2 The Relay Driver

The current requirement of the coil of the relay is 30mAmps. The figure below depicts a typical connection of a relay driver.

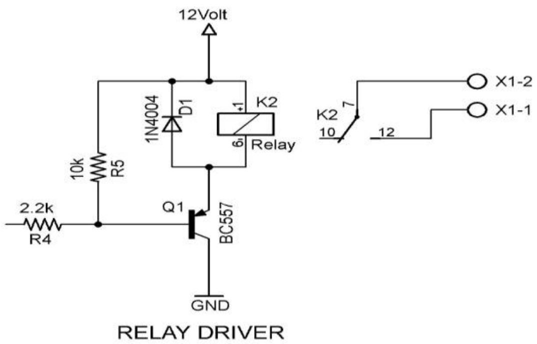

Figure 3: Relay driver

Considering a visual indication of the relay state, an LED was then included giving rise to the figure below.

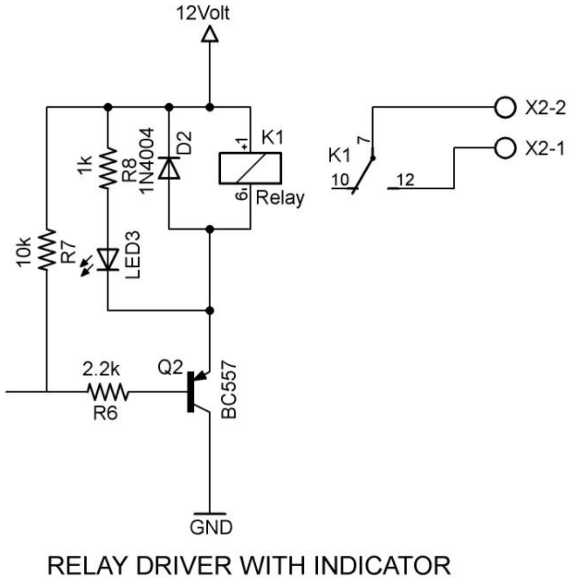

Figure 4: Relay driver with indicator

The component's parameters are
LED current: 10mAmps.
Relay coil current: 30mAmps
Transistor (npn BC557)
Forward beta (β) = 290,

I_{CMAX} = 100mA,
From circuit analysis I_C = 40mA

$$40\ mA = 290 * I_B$$

$$I_B = \frac{40 * 10^{-3}}{290}$$

$$I_B = 0.000137931$$

$$I_B \cong 137.931\ \mu A$$

From the emitter base loop,
The equivalent resistor of 1k(LED bias resistor) and 400(coil resistance) ohm is 285ohm and the loop equation is

$$V_{cc} - I_B R_{EQ} - V_{BE} - I_B R_B = 0 \qquad (4)$$

$$I_B R_B = V_{CC} - V_{BE} - I_B R_{EQ}$$

$$R_B = \frac{V_{CC} - V_{BE} - I_B R_{EQ}}{I_B}$$

$$R_B = \frac{12 - 0.7 - 138 * 10^{-6} * 285}{138 * 10^{-6}}$$

$$R_B = 81599.058$$

$$R_B \cong 82\ K\Omega$$

The LCD Display : The display is used solely to display of project title and the indication of the status of the peripherals (lighting points), typical indications are:-
North light: ON
South light: OFF
West light: ON
East light: ON
Fluorescent: ON

The title section is SMS CONTROLLED LIGHTING. The display supports 3.3volt for communication but tolerate 5volts for its logic io(input output) pins. The vdd must be a 3.3volt so two diodes(1N4148) is used to drop the voltage to a tolerable level of (5-2(0.7))= 3.6volts.

3.4 Power Supply
3.4.1 Transformer Design
The calculated load demand of the entire circuit is approximately 400mA; hence a transformer that is about 1000mA and above can be used for the circuit. Using a transformer with secondary voltage of 18V and current of 1000mA.
i.e. V_{ac} =18V
I_{ac} = 1000mA
There are two quantities of interest with respect to the transformer design and their equations are

$$V_{AC} = \frac{V_{DC}}{1.41} \tag{5}$$

$$I_{AC} = \frac{I_{DC}}{0.62} \tag{6}$$

But

$$V_{DC} = Specified\ DC\ voltage + 2V_D \tag{7}$$

From equation (5)

$$V_{dC} = 1.41 * V_{AC}$$

$$V_{dC} = 1.41 * 18\,V$$

$$= 25.38\,V$$

From equation (6)

$$I_{dC} = 0.62 * I_{AC}$$

$$I_{dC} = 0.62 * 1000\ mA$$

$$= 0.62\ A$$

From equation (3.3)
V_{DC} = *Specified DC voltage* + $2V_D$
Specified voltage = V_{DC} - $2V_D$
Where V_D = 0.7volts

$$= (25.38 - 2(0.7))\ volts$$

$$= 23.98\ volts$$

3.4.2. Capacitor Design**:**
For the filter capacitor

$$C = \frac{I_{DC}}{(V_R * 100)} \tag{8}$$

$$V_W = 1.4 * V_{DC} \tag{9}$$

Where
C = Capacitance of the capacitor

V_R = ripple voltage
V_W = working voltage of capacitor

But

$$V_R = 0.48 * V_{DC} \quad (10)$$

$$= 0.48 \times 23.98 = 11.51V$$

From equation (7)

$$C = \frac{0.62}{(11.51 * 100)}$$

$$C = 538.7\mu F$$

$$V_W = 1.4 * V_{DC}$$

$$= 1.4 \times 23.98 = 33.57V$$

Hence a capacitor of 560µF, 50V and above can be used.

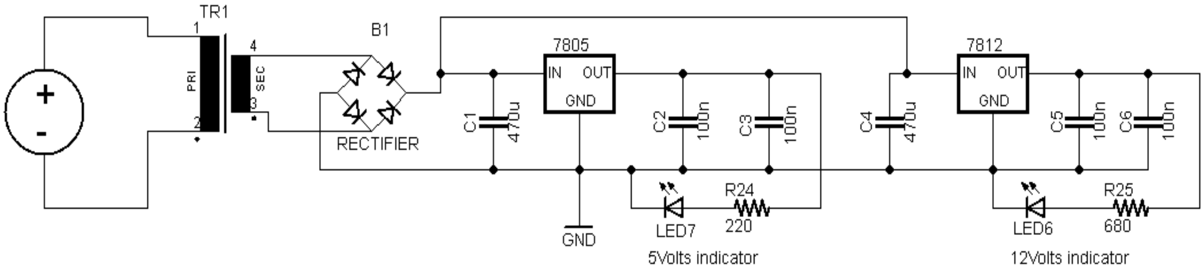

Figure 5: Power Supply Unit

From the circuit analysis, the load current is less than 500mA, so the parameters for design are V_m = 18v, … 500mA.
The voltage across the fitter capacitor

$$V_{r(peak)} = \sqrt{3}\, V_{r(RMS)} \quad (11)$$

$$= \sqrt{3}\frac{(2.4 I_{DC})}{C}$$

$$= \sqrt{3}\frac{(2.4)(500)}{560}$$

$$= \frac{2078.460969}{560}$$

$$V_{r(Peak)} = 3.712\ V$$

$$V_{dc} = V_m - V_{r(peak)} \quad (12)$$

$$V_{dc} = (18 - 3.712)\ volts$$

$$V_{dc} = 14.28\ \ volts$$

Since the voltage is greater than the minimum required voltage of the IC regulators, which are 7 volts and 12 volts respectively, the ICs can provide a reliable regulated voltage to the given load. Also, because the current required can be supplied by a bridge rectifier, a bridge rectifier IC chip was used and the output capacitor used for smoothing.

The Power indicator LED : The Power indicator LEDs used for this work are the conventional 5millimeter LED, though different colours are used its just for the purpose of differentiating 5volt rail from the 12volt rail. From datasheet, reference books and research materials, the current requirements of most common light emitting diodes (LEDs) are between 5mA to 20mA to give an appropriate radiation without endangering the LEDs.[4]

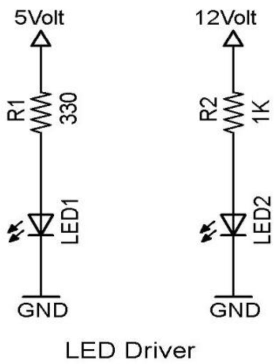

Figure 6: LED biasing

Given that,
Id = 10mA, (required current through LED)
Vd = 1.5volts, (voltage drop across LED)
Using KVL for a closed loop for LED1,

$$V_{CC1} - I_D R_1 - V_D = 0 \tag{13}$$

$$I_D R_1 = V_{CC1} - V_D$$

$$R_1 = \left(\frac{V_{CC1} - V_D}{I_D} \right)$$

$$R_1 = \left(\frac{5 - 1.5}{10 * 10^{-3}} \right)$$

$$R_1 = 350 \ \Omega$$

$$R_1 \cong 330 \ \Omega$$

Using KVL for a closed loop for LED2,

$$V_{CC2} - I_D R_2 - V_D = 0 \tag{14}$$

$$I_D R_2 = V_{CC2} - V_D$$

$$R_2 = \left(\frac{V_{CC2} - V_D}{I_D} \right)$$

$$R_2 = \left(\frac{12 - 1.5}{10 * 10^{-3}} \right)$$

$$R_2 = 1050 \ \Omega$$

$$R_2 \cong 1000 \ \Omega$$

3.6 The GSM Battery charging interface

In order for the GSM phone to maintain its normal operation its required of it to have a steady supply of 5V luckily it has a battery in it but our paramount concern is charging it at regular interval,[5] this is achieved with the figure below.

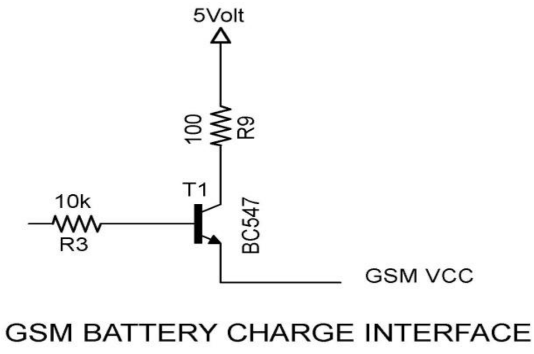

Figure 7: GSM Battery Charging Interface

From circuit analysis $I_C = 50mA$

$$50\ mA = 290 * I_B$$

$$I_B = \frac{50 * 10^{-3}}{290}$$

$$I_B = 0.000172414$$

$$I_B \cong 172.414\ \mu A$$

From the collector emitter loop,

$$V_{CC} - I_C R_C = 0$$

$$I_C R_C = V_{CC}$$

$$R_C = \frac{V_{CC}}{I_C}$$

$$R_C = \frac{5}{50 * 10^{-3}}$$

$$R_C = 100\ \Omega$$

From the base emitter loop,

$$V_B - I_B R_B - V_{BE} = 0 \qquad (15)$$

$$I_B R_B = V_B - V_{BE}$$

$$R_B = \frac{V_B - V_{BE}}{I_B}$$

$$R_B = \frac{5 - 0.7}{172.414 * 10^{-6}}$$

$$R_B = 24939.97$$

$$R_B \cong 22\ K\Omega$$

The base resistor also maintains its available value which is 10K

3.7 The GSM interface

The GSM interface is solely for proper connection from the Mobile phone to the microcontroller because the GSM interface requires a 3.3V for its transmit and receive pins whereas the microcontroller provides 5v hence this interface circuit enables the 5v from the microcontroller to be converted to 3.3v before sending to the GSM pins for proper communication. The circuits below illustrate the spelt out principle.

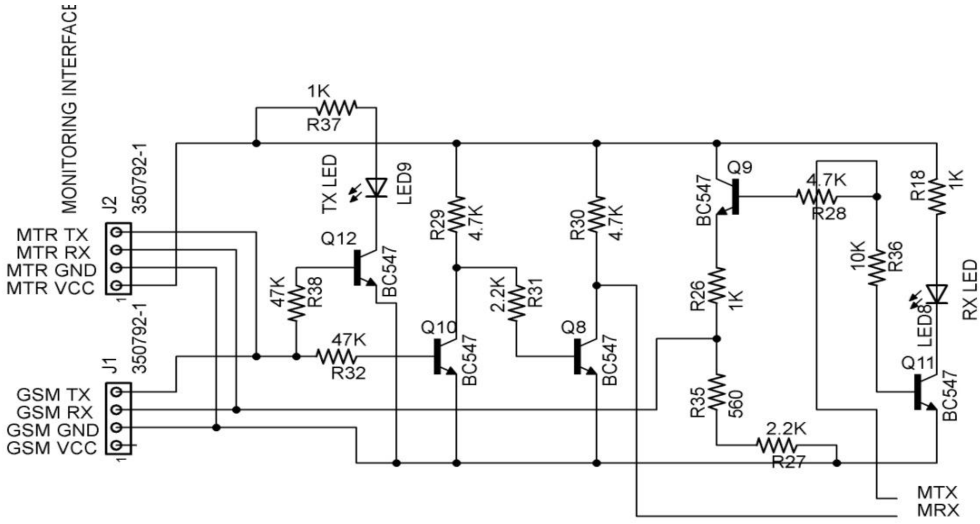

Figure.8: GSM Communication Interface

Switches : These five buttons are use to switch the five lighting point in question which are North light, South light, East light, West light and the fluorescent to the desirable states which is either ON or OFF, though the main function of these is purely toggling of state.

A typical switch or button connection used in a digital application is shown the figure below.

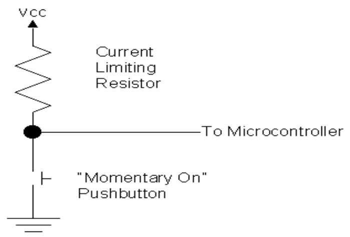

Figure 9 button press configuration

"Bouncing" is the term used to describe what happens when the switch is closed or opened. Instead of a single, square edge as you may expect, a switch change consists of many short spikes, this as a result of the button's contacts "bouncing" during the transition. [6]This is shown in the diagram below:

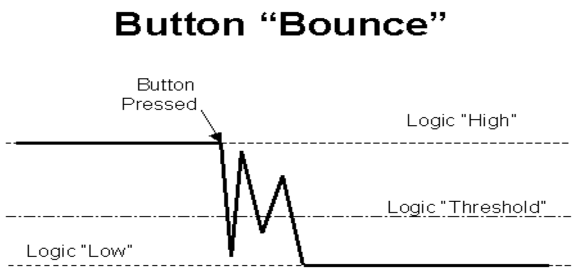

Figure10: illustration of button de-bouncing

Multiple Switch with ADC pin/Comparator : The ADC peripheral of the microcontroller can be used to detect one or more switch closings by using a few resistors. As shown in figure below

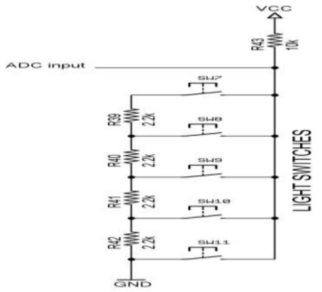

Figure11: Multiple button with ADC configuration

From the figure above any button pressed registers a different level of voltage to the ADC pin.

The complete circuit diagram is shown below with its individual parts included.

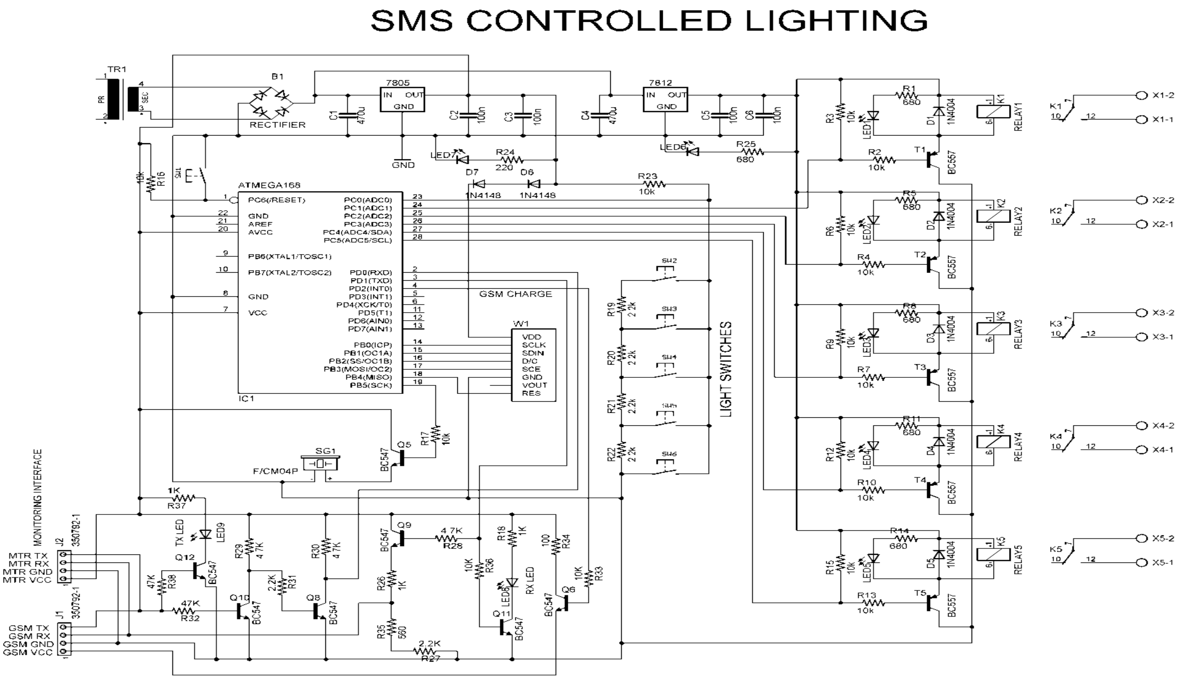

Figure 12: complete schematic diagram of SMS controlled lighting

IV SOFTWARE DEVELOPMENT

4.1Microcontroller Operations : This paper uses software for the microcontroller and the computer system. These programs were written using embedded C language, AT command and visual basic 6.0. Software development involves a series of steps which are necessary for the development of reliable and maintainable software. It is of great importance because hardware design cannot be of use in a microprocessor based system without dependable software. A. The flow chart is shown fig. 11 below.

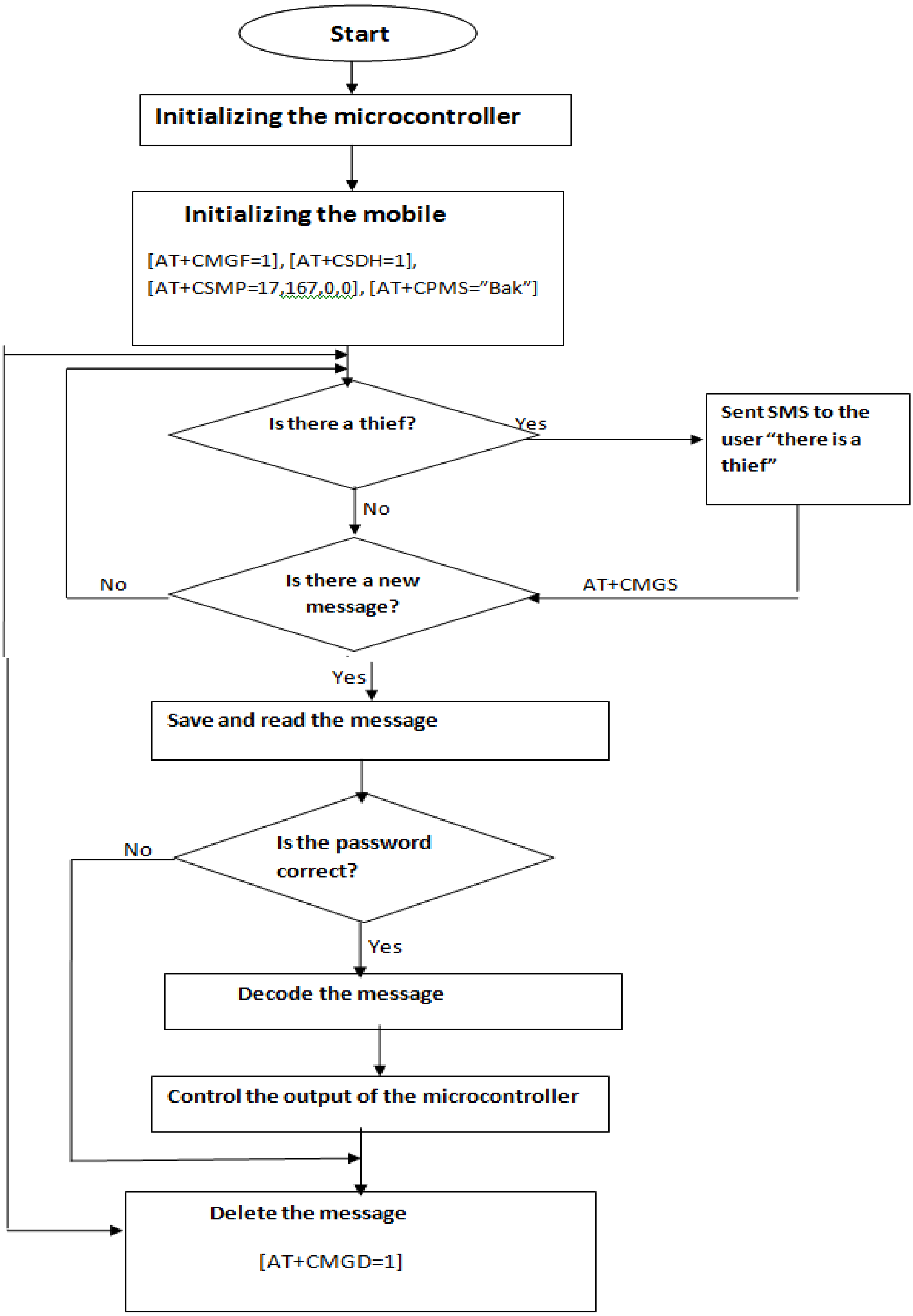

Figure11: Software programming flow chart

GSM phone and AT commands : The communication between the GSM module and the microcontroller is achieve through AT(Attention) commands with a serial communication protocol of UART(universal Asynchronous Receiver and Transmitter), with frame format parameters of 9600Baud rate, 8bit data, 1 start bit, 1 stop bit and no parity bit below are some command definitions to the GSM module are shown below.

4.2.1Command Definition

AT+CSCA: Set the SMS center address. Mobile-originated messages are transmitted through this service center.

AT+CMGS: Send short message to the SMS center

AT+CMGR: Read one message from the SIM card storage

AT+CMGD: Delete a message from the SIM card storage

AT+CMGF: Select format for incoming and outgoing messages: zero for PDU mode, one for Text mode

***AT+CSMP*:** Set additional parameters for Text mode messages

All commands to the microcontroller is done with SMS, these messages have a format of COMMAND.SUBCOMMAND.PERIPHERAL#PIN

The command in this case is switch.

The subcommand is either ON, OFF or TOGGLE.

The peripheral is either of the five lighting points.

The pin is a four digit numeral personal identification number (pin).

So the typical format will be,

Switch.on.north light#0123

V. CONCLUSION

The Switching of Security Lighting System using GSM was discussed and the aim of the work which is the design and implementation of a GSM based Security Lighting system Controller has been completed. This system would make it easier for man to Control Security Lighting system from a distance. For places where GSM coverage is not available, there is need for the installation of GSM base transceiver stations, since the system operation is largely dependent on availability of efficient communication (network) coverage.

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