GSM Based Household Power Management System

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Abstract—**This GSM Based Household Power Management System is designed and realized for current sensing and control of electrical appliances. The proposed prototype consists of a plug & PIC microcontroller which is serially interfaced to GSM modem, ACS 712 current sensor & TRIAC driver. Mobile phone is used here to control the electric appliances like ON or OFF action and track the current sensing data from the particular device with the help of ACS712 Hall Effect Current sensor.**

This system has economic features of soft installation and low cost as well as hardware and software can be customized and extended. Moreover the proposed scheme has some advantages like user can fudge any electrical appliances at any time, letting their home smart and automated.

I. INTRODUCTION

A. Background

The use of electricity is very influential as it is one of main sources of energy that is crucial in present modern life. Some kinds of mechanism using accessible technology could be implemented to reduce wastage in electricity usage.

With the development of technology and the continuous improvement of people's living standard, people are in pursuit of automated, intelligent and convenient home control system. So, the central idea of this research is to develop cost effective intelligent system using mobile phone for controlling and monitoring household electric appliances. In past few years, there has been tremendous rise in number of mobile users in India. Now, cell phone is gradually emerging as powerful tool for many commercial applications such as train reservation booking, banking etc.

The work idea presented here aimed to provide mobile based remote controlled intelligent system with various features to provide controlling and monitoring status of system. We can see that the researchers used couple of technologies for these mobile controlled electric appliances such as Bluetooth, GSM, Wi-Fi, ZigBee etc.

TABLE I.   COMPARISON OF TECHNOLOGIES

Technology	Data Rate	Range	Frequency Band
WLAN	54Mbps	100m	2.4, 5.8GHz
GSM/ GPRS	240kbps	10km	894/1900 GHz
UMTS	2,3Mbps	10km	1.92-198GHz 2.11-2.17GHz
WiMAX	70Mbps	50km	2.5GHz, 3.5GHz, 5.8GHz
ZigBee	250kbps	50m	2.4 GHZ

From the above mentioned table1, we can see data rate, range and frequency band of the different technologies which are basically used for wireless communication purpose. If we compare all the technologies from the table, GSM/GPRS technology is ideal because of its long range operational capability and large frequency band. So, GSM technology is chosen for this project work.

In this project work, our main aim is to control the electric appliances as per the current ratings of those devices. At first, by sending the SMS, the electric device will be ON. After that, the current rating of that device will be shown in our mobile phone, on that basis we have to decide whether the device will be remaining ON or we have to OFF the device. Here, for measuring current rating Hall Effect Current sensor is used, which will give approximate current rating according to the measured voltage. SIM 900 GSM module incorporated "AT" commands is used here for the purpose of communication between the PIC microcontroller and the mobile phone. A threshold value will be fixed in the microcontroller, and if the current rating will be more than that of threshold value, the mobile will show over current alert. All this process will be happened by sending missed call and the SMS to the GSM SIM from the mobile phone.

B. Problem Statement

So far GSM technology based such systems are used for controlling and monitoring the household electric appliances with the help of mobile phone by using energy meter, which was giving exact power reading but the system was too bulky and costly also. So, here the main idea is designing and implementing a GSM technology based system which allows users, upon authentication, to remotely control electric appliances as per current ratings of a smart home grid system through mobile based interface.

II. EMBEDDED SYSTEMS

A. Introduction

An embedded system is a computer system designed to perform one or a few dedicated functions often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. By contrast, a general-purpose computer, such as a personal computer (PC), is designed to be flexible and to meet a wide range of end-user needs. Embedded systems control many devices in common use today.

Embedded systems are controlled by one or more main processing cores that are typically either microcontrollers or digital signal processors (DSP). The key characteristic, however, is being dedicated to handle a particular task, which may require very powerful processors. For example, air traffic control systems may usefully be viewed as embedded, even though they involve mainframe computers and dedicated regional and national networks between airports and radar sites. Probably each radar includes one or more embedded systems of its own.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Physically embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

In general, "embedded system" is not a strictly definable term, as most systems have some element of extensibility or programmability. For example, handheld computers share some elements with embedded systems such as the operating systems and microprocessors which power them, but they allow different applications to be loaded and peripherals to be connected. Moreover, even systems which don't expose programmability as a primary feature generally need to support software updates. On a continuum from "general purpose" to "embedded", large application systems will have subcomponents at most points even if the system as a whole is "designed to perform one or a few dedicated functions", and is thus appropriate to call "embedded". A modern example of embedded system is shown in Fig. 1.
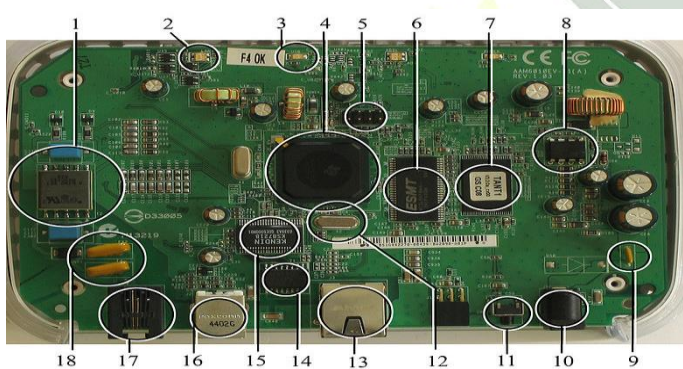

Fig. 1. A modern example of embedded system.

Labeled parts include Microprocessor (4), RAM (6), and Flash memory (7). Embedded systems programming is not like normal PC programming. In many ways, programming for an embedded system is like programming PC 15 years ago. The hardware for the system is usually chosen to make the device as cheap as possible. Spending an extra dollar a unit in order to make things easier to program can cost millions. Hiring a programmer for an extra month is cheap in comparison. This means the programmer must make do with slow processors and low memory, while at the same time battling a need for efficiency not seen in most PC applications.

B. Need For Embedded Systems

The uses of embedded systems are virtually limitless, because every day new products are introduced to the market that utilizes embedded computers in novel ways. In recent years, hardware such as microprocessors, microcontrollers, and FPGA chips have become much cheaper. So when implementing a new form of control, it's wiser to just buy the generic chip and write your own custom software for it. Producing a custom-made chip to handle a particular task or set of tasks costs far more time and money. Many embedded computers even come with extensive libraries, so that "writing your own software" becomes a very trivial task indeed. From an implementation viewpoint, there is a major difference between a computer and an embedded system. Embedded systems are often required to provide Real-Time response. The main elements that make embedded systems unique are its reliability and ease in debugging.

III. HARDWARE DESCRIPTION

A. Proposed Methodology

After reviewing all the papers, a methodology have been constructed which will eliminate all the above problems and bring a new concept to control and monitor electric appliances using cell phone with the help of GSM technology. The proposed system block diagram is depicted below in Fig. 2.
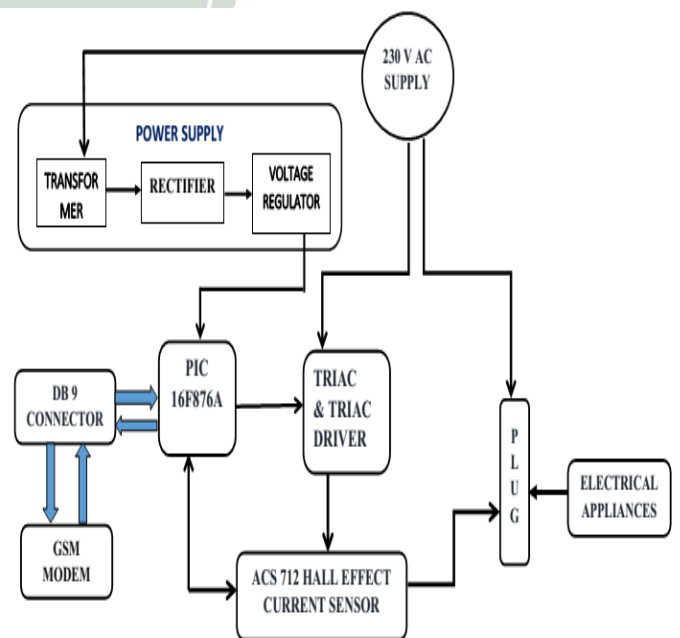

Fig. 2. Proposed System Block Diagram.

The system consists of two units: the mobile station and the microcontroller unit with SIM900-GPRS module, Hall Effect Current Sensor and electric appliance. PIC 16F876A microcontroller board is used here. The mobile phone is used as a controller to send instructions and as a recipient to receive the responses and alerts from the microcontroller unit, whereas the PIC 16F876A is the unit responsible for controlling the different parts and acts as the brain of the system. The SIM900

GSM/GPRS module is responsible for communication between the microcontroller unit and the mobile station.

Here, PIC microcontroller is used with required on board power supply section which consists of a step down transformer, a bridge rectifier, filter capacitor, a voltage regulator and LED. The step down transformer attenuates the high voltage AC to low voltage AC. The rectifier unit along with a filter converts this AC voltage to unregulated DC voltage and the regulator produces a regulated DC voltage. The PIC microcontroller is connected with all the other components by wiring as mentioned in the block diagram.

The GSM modem facilitates bi-directional data communication into the system with a DB9 connector. A Hall Effect Current Sensor (ACS712) is connected with PIC microcontroller and plug for measuring the current consumption of the load. The microcontroller operates the current sensor with the help of Triac.

B. Maintaining the Integrity of the Specifications

- Power Supply Module (1:1 transformer, 7805 voltage regulator, capacitors, resistors, DB107, LEDs)
- TRIAC & TRIAC Driver
- GSM Modem (SIM 900 Module)
- PIC 16F876A Microcontroller Board
- Hall Effect Base Linear Current Sensor (ACS712)
- Reset Button
- Crystal Oscillator
- Buzzer
- ICSP Connectors
- Load
- Plug board
- Mobile Phone

C. Software Requirements

- MikroC Pro PIC C Compiler
- Embedded C Programming Language
- Proteus
- LabVIEW

D. Block Diagram

The basic circuit diagram of a regulated power supply module with LED connected as load is showing in the below Fig. 3.
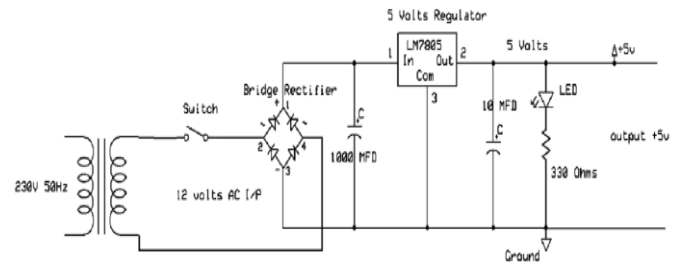

Fig. 3.   Power Supply Module.

The Power Supply Module is required to supply the power to PIC microcontroller, Hall Effect Current sensor and Triac. The module consists of.

- 1:1 Step Down Transformer (230/12V)
- Full Wave Bridge Rectifier
- IC 7805 Voltage Regulator (+5V)
- Resistors
- Capacitors
- LED

The step down transformer steps down the 230V AC supply to 12V AC. convert this AC signal to DC signal full wave bridge rectifier is used. The ripples are removed with capacitive filter. Then 12V DC voltage regulates to +5V DC voltage using IC 7805 voltage regulator.

Now, the detailed description of every components of this power supply module is depicted below.

E. Functional Description

This GSM modem (SIM 900 module) is an external device. This SIM 900 module is connected to a computer through a serial or USB cable. Like a GSM mobile phone, GSM modem requires a SIM card from a wireless carrier in order to operate. Computers use AT (Attention) commands to control GSM modem.

In addition to the standard AT commands, GSM module supports some external AT commands also. These, extended AT commands are defined in the GSM standards. These AT commands are used for certain operations like.

- 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 AT commands have a specific syntax and the syntax rules are described below:

- The commands must start with "AT" and end with a carriage return.

- The first command name should be prefixed with "AT" in a command line containing more than one AT command and the command names should be separated with semicolons. For example, the name of the manufacturer and the model number can be found by using the single command line,

  AT + CGMI; +CGMM<CR>

- The string is enclosed between double quotes. For example, the string "ALL" needs to be assigned as in the example shown below to read all the SMS messages from a message storage in the SMS text mode.

  Example: AT + CMGL = "ALL" <CR>

- The information responses and the result codes (including both final result codes and unsolicited codes) always start and end with a carriage return character and a linefeed character.

Basic AT commands for SIM 900 GSM module:

- AT (Attention command)

- AT +CREG? (To check signal)

- AT +CMGS="" (To send sms)

- AT +CMGR= (To read sms)

- AT +CMGD= (To delete sms)

- AT D98414XXXXX ; (T o make call)

These AT commands are inserted in C language as a string of characters which are sent to the module using the terminal program.

For example, AT command syntax to set the text mode is:

mySerial. println ("AT+CPIN=4510") ;

//the pin code for the SIM

delay (5000) ;

mySerial. println ("AT+CMGF=1") ;

//sets the text mode

F. GSM – Architecture

A GSM network consists of several functional entities whose functions and interfaces are defined. The GSM network can be divided into following broad parts.

- The Mobile Station (MS)

- The Base Station Subsystem (BSS)

- The Network Switching Subsystem (NSS)

- The Operation Support Subsystem (OSS)

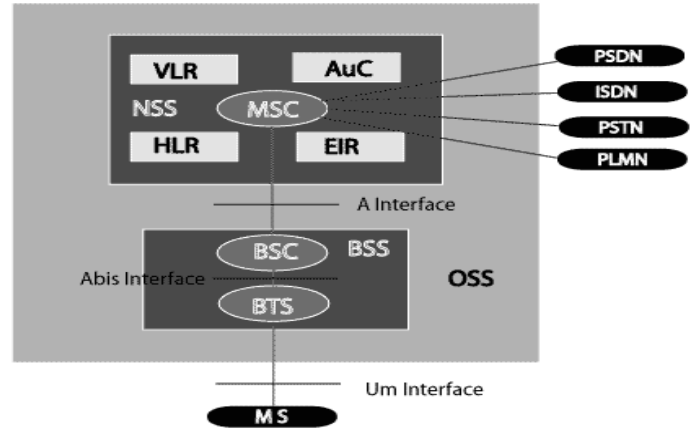Following Fig. 4. shows the simple architecture diagram of GSM Network.

Fig. 4. GSM Network.

The added components of the GSM architecture include the functions of the databases and messaging systems.

- Home Location Register (HLR)

- Visitor Location Register (VLR)

- Equipment Identity Register (EIR)

- Authentication Center (AuC)

- SMS Serving Center (SMS SC)

- Gateway MSC (GMSC)

- Chargeback Center (CBC)

- Transcoder and Adaptation Unit (TRAU)

Following Fig. 5. shows the diagram of GSM Network along with added elements
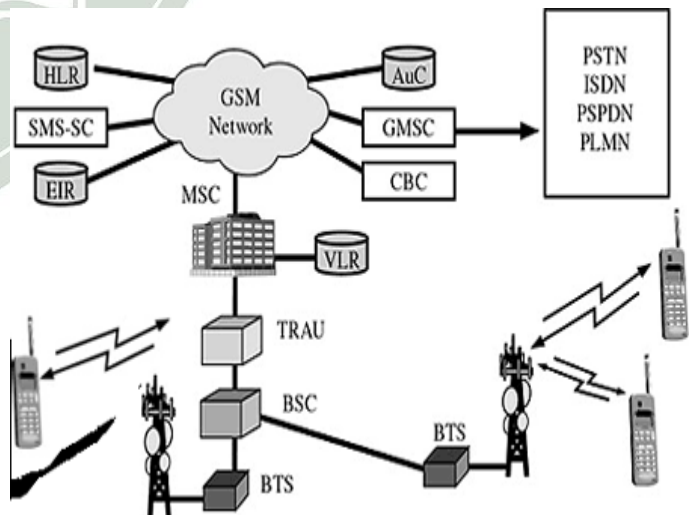

Fig. 5. GSM Network along with added elements Network.

The MS and the BSS communicate across the Um interface, also known as the air interface or radio link. The BSS communicates with the Network Service Switching center across the A interface.

G. GSM Network Areas

In a GSM network, the following areas are defined:

1) Cell: Cell is the basic service area, one BTS covers one cell. Each cell is given a Cell Global Identity (CGI), a number that uniquely identifies the cell.

2) Location Area: A group of cells form a Location Area. This is the area that is paged when a subscriber gets an incoming call. Each Location Area is assigned a Location Area Identity (LAI). Each Location Area is served by one or more BSCs.

3) MSC/VLR Service Area: The area covered by one MSC is called the MSC/VLR service area.

4) PLMN: The area covered by one network operator is called PLMN. A PLMN can contain one or more MSCs.

H. GSM Network Parts

1) Mobile Station: The mobile station (MS) consists of the physical equipment, such as the radio transceiver, display and digital signal processors, and a smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to all subscribed services irrespective of both the location of the terminal and the use of a specific terminal. By inserting the SIM card into another GSM cellular phone, the user is able to receive calls at that phone, make calls from that phone, or receive other subscribed services.

The mobile equipment is uniquely identified by the International Mobile Equipment Identity (IMEI). The SIM card contains the International Mobile Subscriber Identity (IMSI), identifying the subscriber, a secret key for authentication, and other user information. The IMEI and the IMSI are independent, thereby providing personal mobility. The SIM card may be protected against unauthorized use by a password or personal identity number.

2) Base Station Subsystem: The Base Station Subsystem is composed of two parts, the Base Transceiver Station (BTS) and the Base Station Controller (BSC). These communicate across the specified Abis interface, allowing (as in the rest of the system) operation between components made by different suppliers.

The Base Transceiver Station houses the radio transceivers that define a cell and handles the radio link protocols with the Mobile Station. In a large urban area, there will potentially be a large number of BTSs deployed. The requirements for a BTS are ruggedness, reliability, portability, and minimum cost.

The Base Station Controller manages the radio resources for one or more BTSs. It handles radio channel setup, frequency hopping, and handovers, as described below. The BSC is the connection between the mobile and the Mobile service Switching Center (MSC). The BSC also translates the 13 kbps voice channel used over the radio link to the standard 64 kbps channel used by the Public Switched Telephone Network or ISDN.

3) Network Subsystem: The central component of the Network Subsystem is the Mobile services Switching Center (MSC). It acts like a normal switching node of the PSTN or ISDN, and in addition provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber. These services are provided in conjunction with several functional entities, which together form the Network Subsystem. The MSC provides the connection to the public fixed network (PSTN or ISDN), and signalling between functional entities uses the ITU¬T Signalling System Number 7 (SS7), used in ISDN and widely used in current public networks.

The Home Location Register (HLR) and Visitor Location Register (VLR), together with the MSC, provide the call routing and (possibly international) roaming capabilities of GSM. The HLR contains all the administrative information of each subscriber registered in the corresponding GSM network, along with the current location of the mobile. The current location of the mobile is in the form of a Mobile Station Roaming Number (MSRN) which is a regular ISDN number used to route a call to the MSC where the mobile is currently located. There is logically one HLR per GSM network, although it may be implemented as a distributed database.

The Visitor Location Register contains selected administrative information from the HLR, necessary for call control and provision of the subscribed services, for each mobile currently located in the geographical area controlled by the VLR. Although each functional entity can be implemented as an independent unit, most manufacturers of switching equipment implement one VLR together with one MSC, so that the geographical area controlled by the MSC corresponds to that controlled by the VLR, simplifying the signaling required. Note that the MSC contains no information about particular mobile stations - this information is stored in the location registers.

The other two registers are used for authentication and security purposes. The Equipment Identity Register (EIR) is a database that contains a list of all valid mobile equipment on the network, where each mobile station is identified by its International Mobile Equipment Identity (IMEI). An IMEI is marked as invalid if it has been reported stolen or is not type approved. The Authentication Center is a protected database that stores a copy of the secret key stored in each subscriber's SIM card, which is used for authentication and ciphering of the radio channel.

I. PIC 16F876A Microcontroller Board

1) Introducttion: PIC 16F876A Microcontroller is a low power, high performance, inexpensive 8bit 28 pin modified Harvard architecture microcontroller with 14.3K bytes of in-system programmable flash memory made by Microchip Technology.
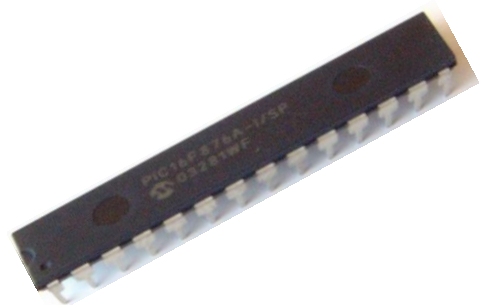

Fig. 6. PIC16F876A Microcontroller.

2) PIC 16F876A Block Diagram: In the below Fig. 7. the architecture block diagram of PIC16F876A microcontroller is mentioned.

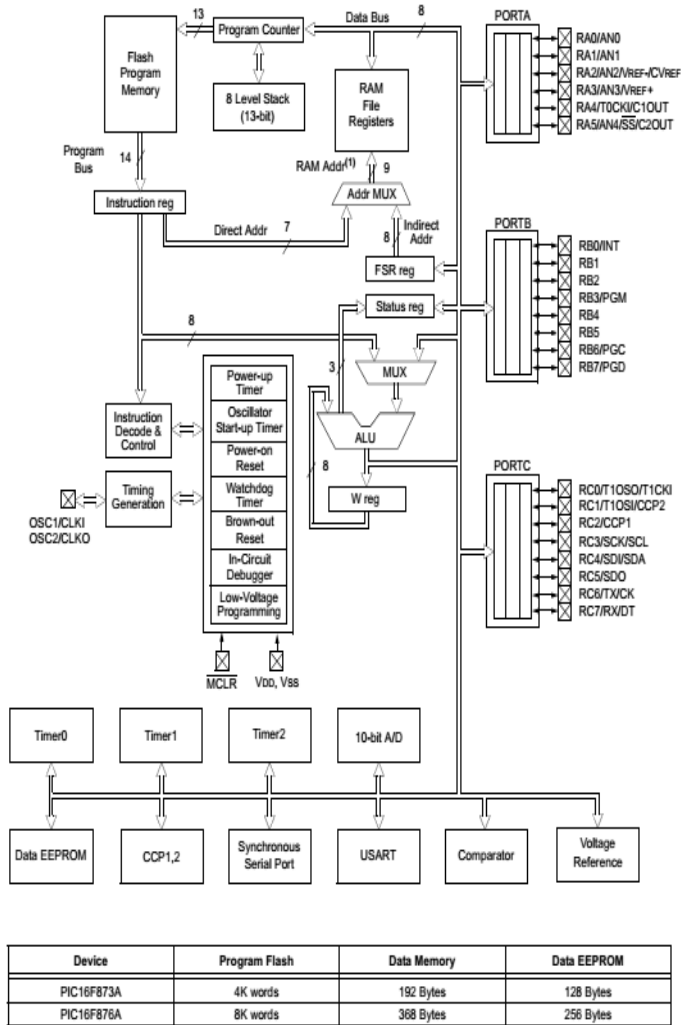| Device	Program Flash	Data Memory	Data EEPROM
PIC16F873A	4K words	192 Bytes	128 Bytes
PIC16F876A	8K words	368 Bytes	256 Bytes

Fig. 7.   PIC16F876A Microcontroller Architecture Block Diagram.

3) PIC 16F876A PIN-OUT Description
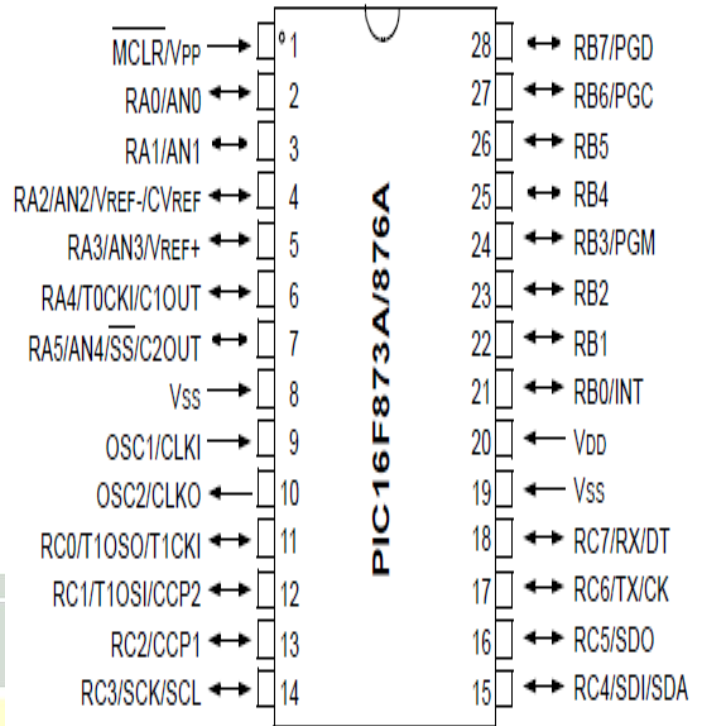
Fig. 8.   PIC16F876A Pin Diagram.

- OSC1/CLKIN: Oscillator crystal input/external clock source input.

- OSC2/CLKOUT: Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode In RC mode, the OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.

- MCLR/VPP: Master Clear (Reset) input or programming voltage input. This pin is an active low RESET to the device.

- PORTA is a bi-directional I/O port.

- RA0/AN0: RA0 can also be analog input0.

- RA1/AN1:RA1 can also be analog input1.

- RA2/AN2/VREF- :RA2 can also be analog input2 or negative analog reference voltage.

- RA3/AN3/VREF+:RA3 can also be analog input3 or positive analog reference voltage.

- RA4/T0CKI: RA4 can also be the clock input to the Timer0 module. Output is open drain type.

- RA5/SS/AN4:RA5 can also be analog input4 or the slave select for the synchronous serial port.

- PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.

- RB0/INT: RB0 can also be the external interrupt pin.

- RB1

- RB2

- RB3/PGM: RB3 can also be the low voltage programming input.

- RB4: Interrupt-on-change pin.

- RB5: Interrupt-on-change pin.

- RB6/PGC: Interrupt-on-change pin or In-Circuit Debugger pin, serial programming clock.

- RB7/PGD: Interrupt-on-change pin or In-Circuit Debugger pin, serial programming data.

- PORTC is a bi-directional I/O port.

- RC0/T1OSO/T1CKI:RC0 can also be the Timer1 oscillator output or Timer1 clock input.

- RC1/T1OSI/CCP2: RC1 can also be the Timer1 oscillator input or Capture2 input/Compare2 output/PWM2 output.

- RC2/CCP1:RC2 can also be the Capture1 input/Compare1 output/PWM1 output.

- RC3/SCK/SCL: RC3 can also be the synchronous serial clock input/output for both SPI and I2C modes.

- RC4/SDI/SDA: RC4 can also be the SPI Data In (SPI mode) or data I/O (I2C mode).

- RC5/SDO: RC5 can also be the SPI Data Out (SPI mode).

- RC6/TX/CK: RC6 can also be the USART Asynchronous Transmit or Synchronous Clock.

- RC7/RX/DT: RC7 can also be the USART Asynchronous Receive or Synchronous Data.

- VSS: Ground reference for logic and I/O pins.

- VDD: Positive supply for logic and I/O pins.

By utilizing all of this pin so many application can be done such as:

- LCD – connect to Port B pin.

- LED – connect to any pin declared as output.

- Relay and Motor - connect to any pin declared as output.

- External EEPROM – connect to I2C interface pin – RC3 and RC4 (SCL and SDA)

- LDR, Potentiometer and sensor – connect to analogue input pin such as RA0.

- GSM modem dial up modem – connect to RC6 and RC7 – the serial communication interface using RS232 protocol.

4) Current Measurement Of Dc Motor And Interfacing With Labview (Preliminary Test): As a preliminary test using WCS1600 Hall Effect Current sensor, 12V DC Motor current measurement has been done. Here, 12V DC supply is regulated to +5V using IC 7805 voltage regulator. The output pin of IC 7805 is connected to the output pin of WCS1600. The positive wire of 12V DC Motor is looping within the hole of the hall sensor and finally connected to the positive supply.

All the negative connections should be grounded. For measuring the sensor output voltage, DMM positive probe will be connected to the output pin of WCS1600 and negative should be grounded. After getting the sensor voltage output in the DMM, that voltage can be converted to equivalent current by the following way.
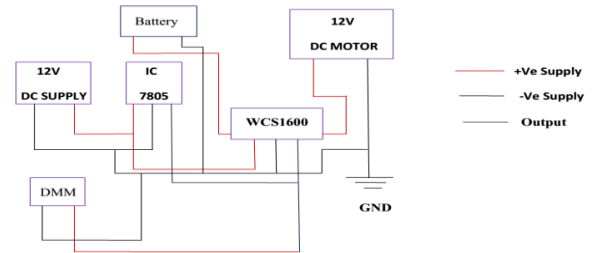

Fig. 9.   DC Motor Current Measurement Block Diagram.

Measured Current through Hall Effect Current Sensor

= [Sensor Output Voltage-(Supply Voltage/2)]/Sensitivity

*WCS1600 Hall Effect Current Sensor Sensitivity= 22mV/A

For this 12V DC Motor current measurement, when there is no current flowing through the wire, which is going through the hole of the current sensor coming from DC Motor, the sensor simply divides its supply voltage in half. Here, sensor output voltage is 2.52V for 5V supply.

Measured Current for 12V DC Motor = [2.52-(5/2)]/0.022 V*A/V

= 0.9 A

After that, the circuit is interfaced with DAQ software LabVIEW and signal waveform was got, which is showing in the below Fig. 10.

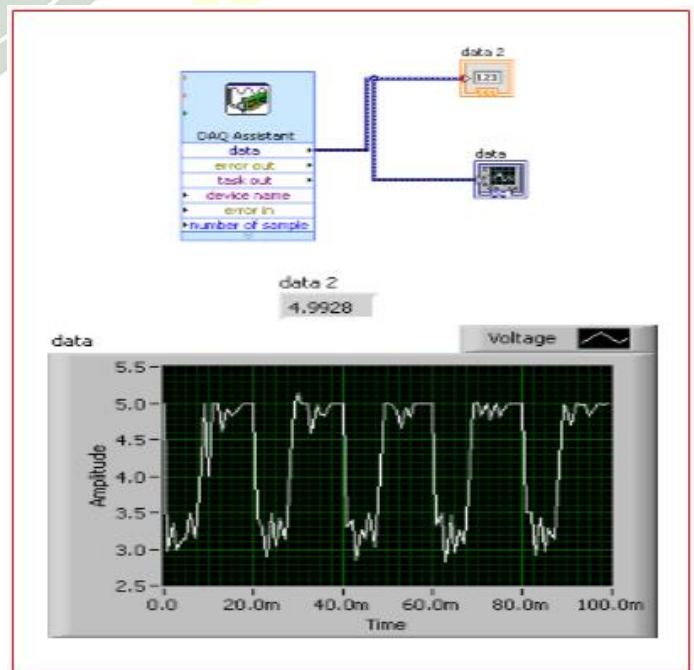Fig. 10. Signal Waveform in LabVIEW.

IV. SOFTWARE DESCRIPTION
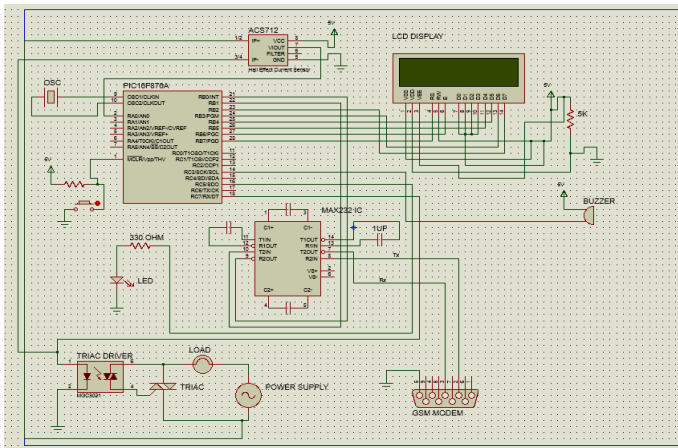
A. Circuit Description

Fig. 11. Project Circuit Diagram in Proteus 8.0.

B. Proteus

Proteus is software by Labcenter Electronics, which accepts only hex files. Once the machine code is converted into hex code, that hex code has to be dumped into the microcontroller and this is done by the Proteus. Proteus is a programmer which itself contains a microcontroller in it other than the one which is to be programmed. This microcontroller has a program in it written in such a way that it accepts the hex file from the pic compiler and dumps this hex file into the microcontroller which is to be programmed. As the Proteus programmer requires power supply to be operated, this power supply is given from the power supply circuit designed and connected to the microcontroller in proteus. The program which is to be dumped in to the microcontroller is edited in proteus and is compiled and executed to check any errors and hence after the successful compilation of the program the program is dumped in to the microcontroller using a dumper. Here, Proteus 8.0 is used for making the circuit diagram.

C. PIC C Compiler Overview

PIC Compiler is software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. PIC compiler also supports C language code.

It's important that you know C language for microcontroller which is commonly known as Embedded C. As we are going to use PIC Compiler, hence we also call it PIC C. The PCB, PCM, and PCH are separate compilers. PCB is for 12-bit opcodes, PCM is for 14-bitopcodes, and PCH is for 16-bit opcode PIC microcontrollers. Due to many similarities, all three compilers are covered in this reference manual. Features and limitations that apply to only specific microcontrollers are indicated within. These compilers are specifically designed to meet the unique needs of the PIC microcontroller. This allows developers to quickly design applications software in a more readable, high-level language. When compared to a more traditional C compiler, PCB, PCM, and PCH have some limitations. As an example of the limitations, function recursion is not allowed.

This is due to the fact that the PIC has no stack to push variables onto, and also because of the way the compilers optimize the code. The compilers can efficiently implement normal C constructs, input/output operations, and bit twiddling operations. All normal C data types are supported along with pointers to constant arrays, fixed point decimal, and arrays of bits.

PIC C is not much different from a normal C program. If we know assembly, writing a C program is not a crisis. In PIC, we will have a main function, in which all our application specific work will be defined. In case of embedded C, we do not have any operating system running in there. So we have to make sure that our program or main file should never exit. This can be done with the help of simple while (1) or for (;;) loop as they are going to run infinitely.

We have to add header file for controller we are using, otherwise we will not be able to access registers related to peripherals.

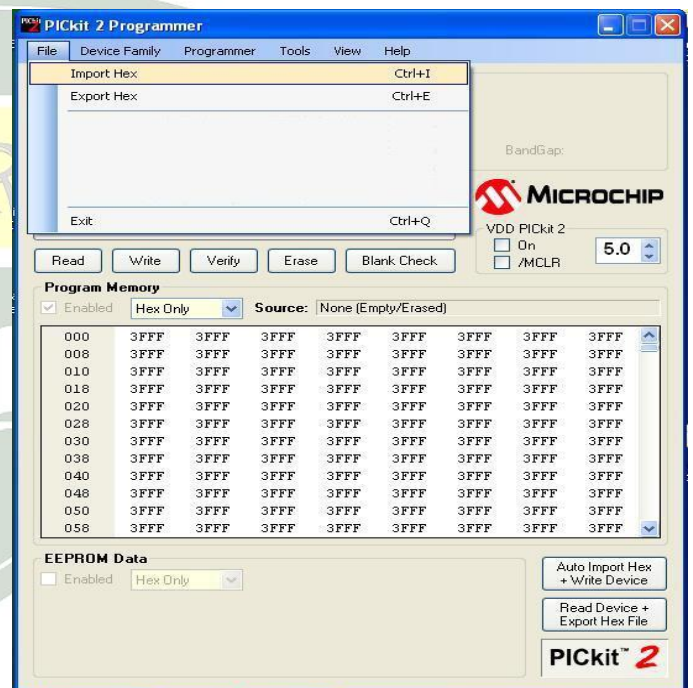**#include <16F876A.h> // header file for PIC 16F876A//**

Fig. 12. PIC C Compiler Screenshot.

D. LabVIEW

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a system design platform and development environment for a visual programming language from National Instruments (NI). Basically LabVIEW software is ideal for any measurement or control system which integrates the tools that engineers and scientists need to build a wide range of applications in relatively less time. LabVIEW is a development environment for accelerated productivity and faster output.

LabVIEW is a graphical programming language that helps engineers to consider a problem from design to test and from small to large systems. It offers unparalleled integration with existing legacy software, IP, and hardware while subsidizing on the latest computing technologies. LabVIEW is a

programming tool which is used to deliver as an introduction to data acquisition, instrument control and data analysis.

LabVIEW programs are called Virtual Instruments (VI). The graphical programming language, which LabVIEW used, is known as G programming language, to create programs relying on graphic symbols to describe programming actions. LabVIEW provides an extensive library of virtual instruments and functions to help us in our programming.

In this project work, the proposed prototype is interfaced with the computer through a LabVIEW module for getting the signal waveform in the LabVIEW environment. The LabVIEW module is showing in Fig. 12. This module can be operated in the temperature range -200 C to +550 C. The main disadvantage of this module is that it cannot be used in hazardous locations.

We have used LabVIEW in two cases. At first measuring DC motor current using WCS1600 Hall Effect Current sensor and interfacing with LabVIEW. That part has already mentioned before. Then the prototype gadget, mainly with the help of ACS712 Hall Effect Current sensor is interfaced with LabVIEW software. The signal waveform is mentioned in the result part.

Fig. 13. LabVIEW Module.

V. SYSTEM DESIGN AND IMPLEMENTATION

A. Introduction

The architecture block diagram of GSM Based Household Power Management System is mentioned in chapter 3. The proposed system is designed such a way that it will be portable and easy to carry. The designed system will be operated through mobile phone. By sending SMS to the GSM SIM of the system, the electrical appliances will be ON or OFF and giving current readings of that particular device. The methodology of controlling and monitoring the electric appliances through mobile phone is outlined in this section with the help of process algorithm and procedural steps.

B. Process Algorithm

Fig. 13 shows the process flow diagram for controlling the household electrical appliances and monitoring their current

consumptions. Measured current calculation process is already described in the previous chapter. Threshold value for current measurement is fixed here like 6000mA. If live current reading will be more than that threshold value, over current alert will be shown to our mobile phone and the buzzer will buzz. The proposed approach has been tested on lights, pedestal fans, pump, air conditioner etc.
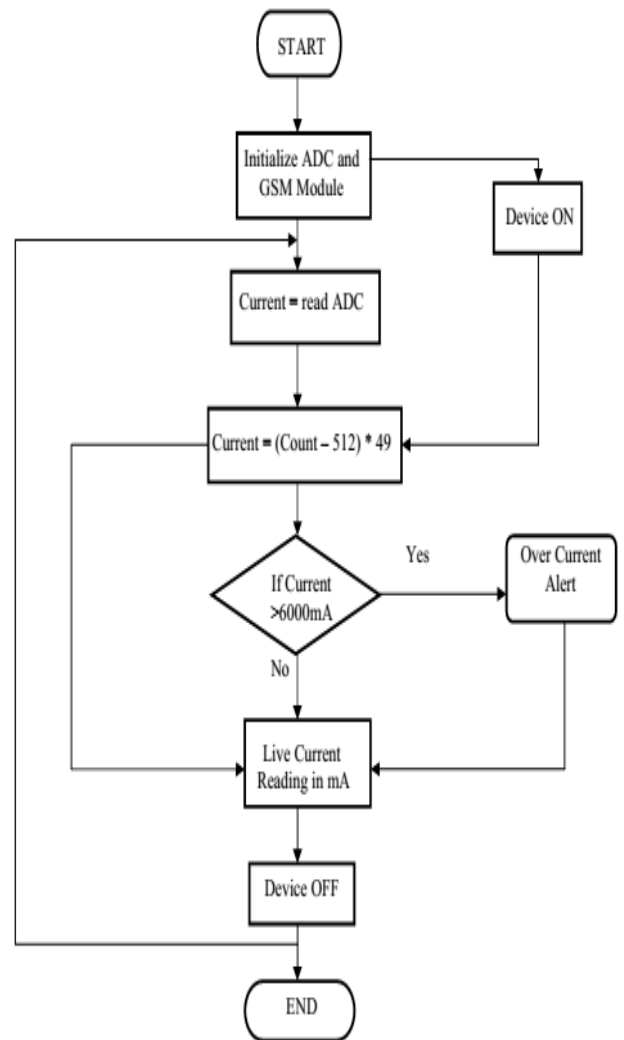

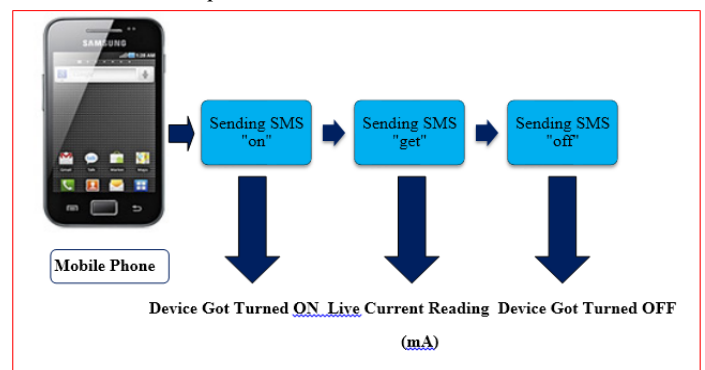Fig. 14. Process Flow Chart.

C. Procedural Steps

Fig. 15. Procedure of Getting Current Reading in Mobile Phone.

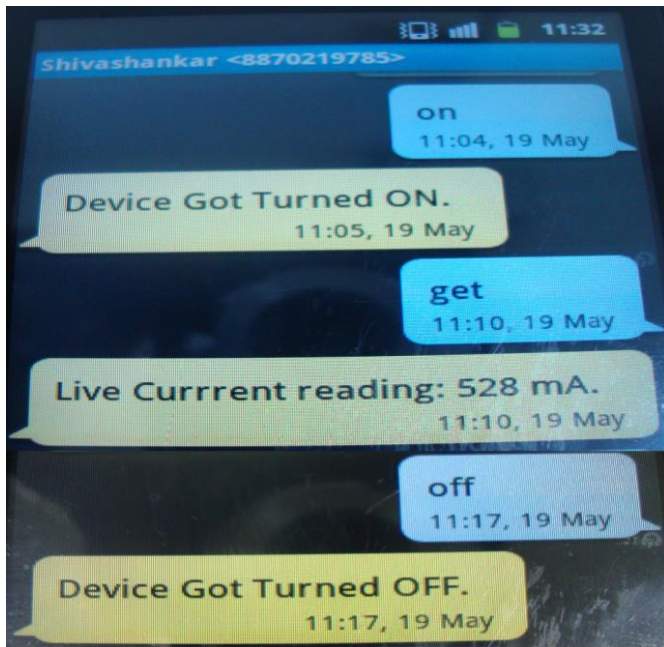Fig. 17. Implemented System Prototype with Bulb.

Fig. 16. SMS Sent and Received at Authorized Mobile Number.

D. Implemented System

The implemented system prototype is tested for couple of household electrical appliances for controlling and monitoring purpose. The prototype is tested for different bulbs (10W, 60W, and 100W), pedestal fan, air conditioner, iron box, electric cooker, microwave oven and water pump. This implemented system can easily control that devices through mobile phone SMS. Without that it is capable to give accurate current consumption readings by sending SMS. The implemented system prototype is showing in Fig. 16 and Fig. 17 with controlling 100W Bulb and Pedestal fan.
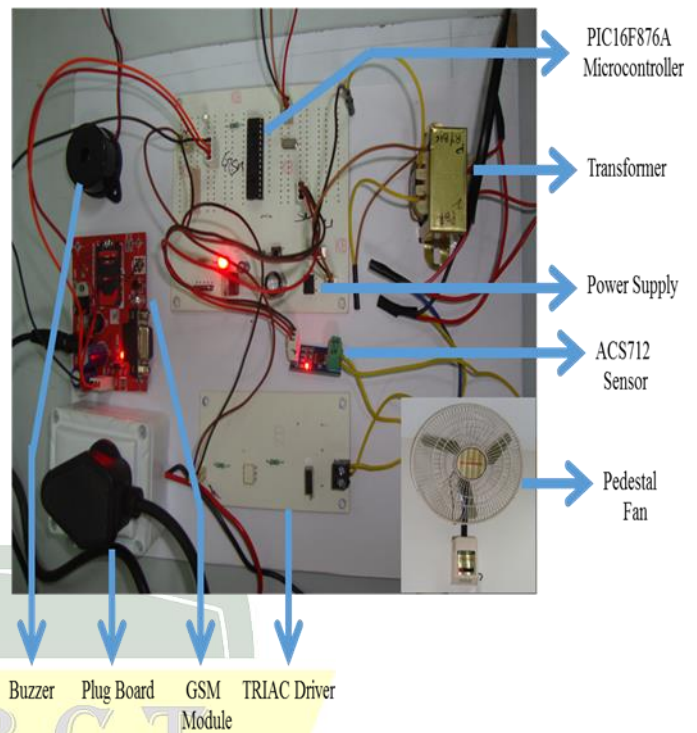
Fig. 18. Implemented System Prototype with Pedestal Fan.

VI. RESULTS AND DISCUSSIONS

In this project work, the electric appliances are controlled (ON/OFF) and monitored through mobile phone. By sending and receiving SMS the devices are controlled and getting current readings also. Below the current reading data sheet is mentioned as per time intervals.

A. LabVIEW Result

After testing with all the electrical devices, the enforced system is interfaced with the Data Acquisition (DAQ) software LabVIEW to determine system behavior to optimize performance. To amend system performance ACS712 Current sensor signal is crucial. So, LabVIEW module is interfaced with the current sensor within the implemented system and producing the signal waveform. Here, the signal waveform is illustrated for 100W Bulb.
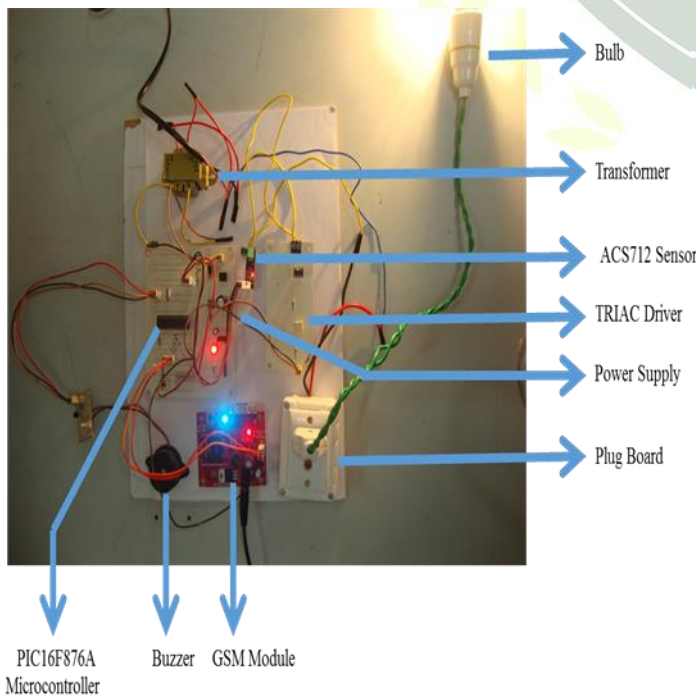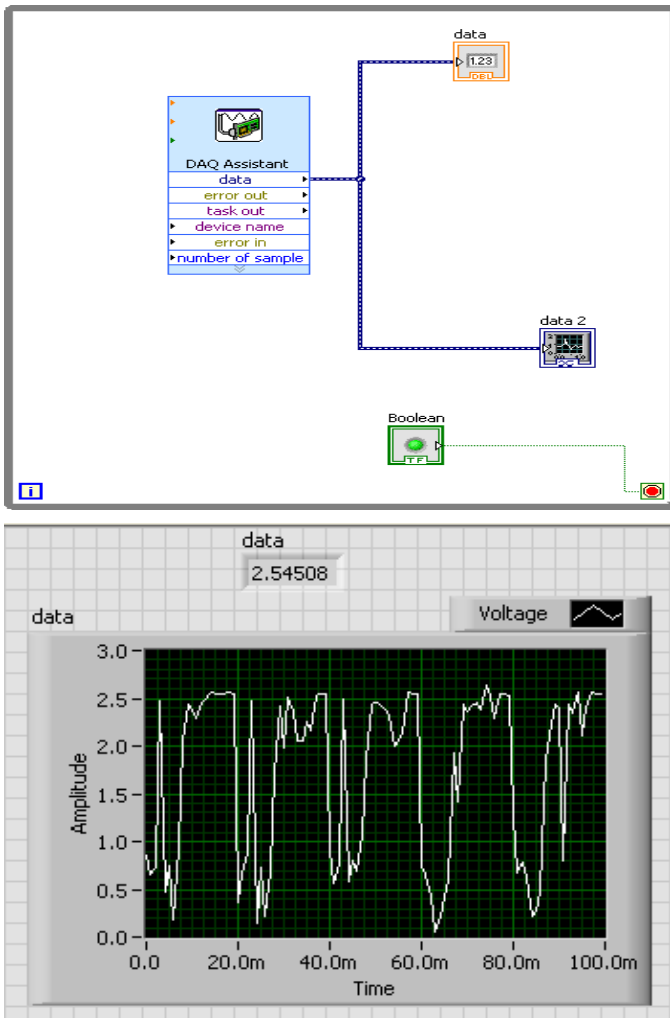
Fig. 19. LABVIEW Signal Waveform for 100W Bulb.

VII. ADVANTAGES AND DISADVANTAGES

A. Advantages

- Energy conservation can be monitored on LCD display.
- The system alerts through SMS.
- Efficient and low cost design.
- Low power consumption.
- Fast and accurate result.
- Easy to maintain and repair.
- Electric appliances can be controlled for shorter and wider range.

B. Disadvantages

- Interfacing current sensor to the Microcontroller is sensitive.
- It uses wired mechanism.
- Depends on network signal strength.

C. Applications

This system can be practically implemented in real time in industries and domestic houses.

- House electrical systems.
- Railway electrical systems.
- Remote controlling systems.

VIII. CONCLUSION AND FUTURE WORK

A. Conclusion

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project was a success as it stimulated electrical devices being switched on and off with securing current consumption readings from one unit.

B. Future Work

If possible the system may be checked with Wi-Fi module instead of the GSM module. To eliminate lots of wirings, ZigBee module can also be used. Doing some modifications this proposed prototype can be used as home security system also.

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