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GSM Based Electrical Energy Monitoring and Controlling

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***Abstract* - Electricity plays an important role in the growth of our country. Despite the fact that power generation companies have a strong focus on generation, transportation and distribution, they meet the high energy requirements due to the high power consumption. This article describes the development of the monitoring and control system for energy management using GSM technology. The existing system shows the energy consumption, the invoice is only created once a month. The proposed system monitors the power consumption of each consumer at all times. When the consumer consumes excess electrical energy, the system sends SMS notifications. After receiving the SMS, the consumer has to choose an alternative solution to reduce the oversupply and stop the mass consumption. The consumer can also trigger the circuit via SMS. Therefore, this system helps maintain EB tariffs, controls heavy electricity consumption, controls energy, etc.**

Keywords: Energy Management, GSM technology, SMS, EB tariff rates.

I. INTRODUCTION

Since the first Global Mobile Communications System (GSM) network was put into operation and put into operation in 1991, the world has adopted the standard for mobile communication. Upon adoption, countries around the world are rapidly developing a GSM infrastructure for broader national coverage. Astronomical usage has increased, making it a popular notification medium. The aim of this project is the remote monitoring and control of the household energy meter using GSM technology. With this system, electricity consumers can use less electricity via SMS. This can be achieved by using a microcontroller unit that continuously monitors and records energy meter readings in their permanent (non-volatile) location. This system also uses a GSM modem to remotely monitor and control the energy meter.

II. HARDWARE SPECIFICATIONS

Much of the project involved choosing the right equipment. The original idea was to find a complete solution that integrates all components and enables the smallest possible size. At first we thought that a simple circuit could be built and connected to a microprocessor to control the performance. It was decided that designing a simple circuit using the microcontroller would provide precise power control and a measure of the meter reading. The power consumption is checked against rows connected by a current transformer to the load. The current is then measured by implementing ADC techniques from the PIC microcontroller. The energy consumption is then checked using a voltage converter, which, if necessary, is connected in parallel with the charging results displayed on the LCD screen. In the case of invariance, the trigger takes responsibility by eliminating the excess charge and invariance. When one of them consumes electricity, the alarm circuit is activated.

III. SOFTWARE SPECIFICATIONS

The system first initializes each module, then regularly reads the meter reading and stores it. After receiving the command, the meter sends the current status and power consumption. According to the design characteristics of the hardware circuit, the system initializes each module and then the server, which sends the read request to the meter via the modem SIM900 GSM. When the server receives the measured value with the u-vision keil compiler, it saves the data in the database and sends the consumption to the user via SMS.

IV. EXISTING SYSTEM

Due to excessive electricity consumption, many people suffer greatly from a lack of electrical energy. Many imports and exports stop, which leads to a decline in the commercial market. The beginning of electrification offers opportunities to implement new, more efficient measurement technologies and future housing development needs. The existing system has many limitations, such as: B. the complexity of the network, the cost of installation and maintenance.

There are some general problems, such as a large dependency on the person, human error cannot be avoided. If an EB bill is generated once a month for the use of electrical

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energy according to the use by the consumer, an unexpected amount occurs that the consumer has to tolerate.

V. PROPOSED SYSTEM

In order to reduce excessive billing and excessive consumption and operating costs, a GSM system can be introduced in each zone. It is an efficient means of low power consumption, higher data accuracy, consumption trends and better use of human resources. Energy monitoring and control using GSM technology implements new GSM applications. GSM is a global mobile communication system and an advanced wireless communication system that uses digital radio transmission to provide voice, data, and multimedia communication services. A GSM system coordinates communication between mobile phones (mobile stations), base stations (mobile phone locations) and switching systems.

We selected a specific SIM300 GSM modem for our project. Messages are sent from the mobile assembly that contains written commands, which are then processed accordingly to complete the required task. The proposed approach to designing this system is to implement a control module based on a microcontroller that receives its instructions and commands from a cell phone over the GSM network. The microcontroller executes the commands issued and then communicates the status of a particular device or device to the mobile phone. First, the SMS sent is saved and queried by the recipient's mobile station. The required command signal is then generated and sent to the intermediate equipment we designed.

5.1 Block Diagram of Transmitter

GSM is a global mobile communication system and an advanced wireless communication system that uses digital radio transmission to provide voice, data, and multimedia communication services. A GSM system coordinates communication between mobile phones (mobile stations), base stations (mobile phone locations) and switching systems.

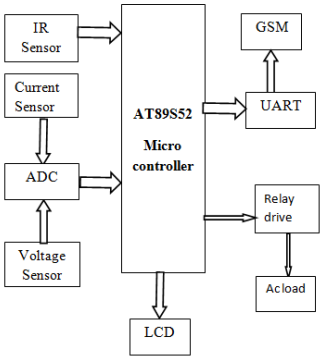

Figure 1: Block Diagram of Transmitter

5.2 Receiver

The data from the electrical energy monitoring unit is transmitted using a GSM modem to the mobile number of the registered user and to electricity board.

Figure 2: Receiver unit

The power consumption units and user data of the energy readings are received as SMS to the user mobile.

5.3 AT89S52 Microcontroller

The AT89S52 is a powerful, low-performance 8-bit CMOS microcontroller with 8,000 bytes of programmable flash memory in the system.

Figure 3: AT89S52 IC Chip

The device is manufactured using Atmel's non-volatile memory technology with high density and is compatible with the standard Indus-try 80C51 instruction set.

5.4 Pin Configuration

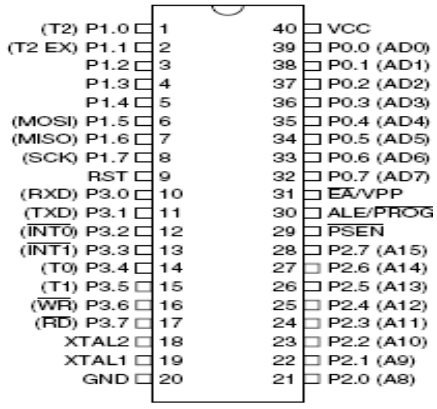

Figure 4: Pin Configuration of 89S52

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5.5 UART

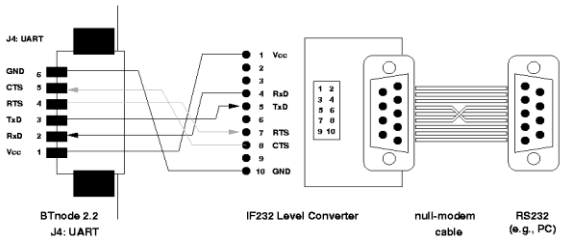

Figure 5: Universal asynchronous receiver/transmitter

A universal asynchronous receiver / transmitter is a type of "asynchronous receiver / transmitter", hardware that translates data between parallel and serial forms. UARTs are typically used in conjunction with other communication standards such as EIA RS-232. A UART is typically a single integrated circuit (or part of it) that is used for serial communication over a computer or serial peripheral interface. UARTs are often included in microcontrollers these days. A dual UART or DUART combines two UARTs on a single chip. Many modern integrated circuits are now supplied with a UART that can also communicate synchronously. These devices are called USART.

5.6 ADC 0808/0809

The data acquisition component ADC0808, ADC0809 is a monolithic CMOS device with an 8-bit analog-to-digital converter, an 8-channel multiplexer and control logic compatible with a microprocessor.

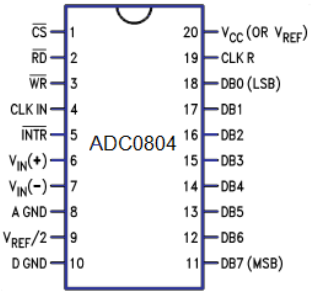

Figure 6: PIN diagram of ADC 0808/0809

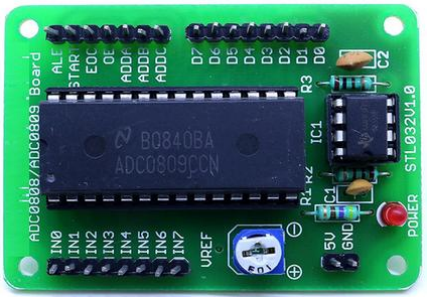

Figure 7: PCB layout for ADC 0808/0809

The data acquisition component ADC0809 is a monolithic CMOS device with an 8-bit analog-to-digital converter, an 8-channel multiplexer and control logic compatible with a microprocessor. The 8-bit A / D converter uses successive approximations as the conversion technique.

5.6.1 Features

- Easy interfacing with all types of microprocessors
- Operates on a ratio metrically or within 5 VDC power supply
- Adjustable voltage reference value
- Full-scale or non-zero adjustment is required
- In-build 8-channel multiplexer with 8-bit addressable logic

5.6.2 Key Specification

- Unadjusted total Error of ±1⁄2 LSB and ±1 LSB
- Operates on a single 5 VDC power supply
- Low operating power of 15 mW max.
- Conversion Time 100 µs

5.6.3 Block Diagram of ADC0808/0809

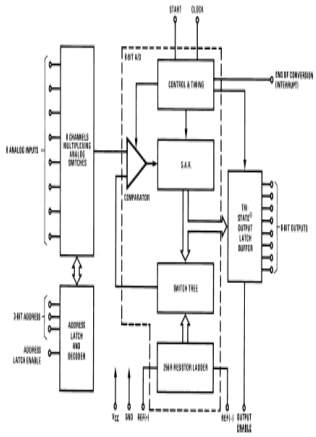

Figure 8: Block Diagram of ADC 0808/0809

The data acquisition component ADC0808, ADC0809 is a monolithic CMOS device with an 8-bit analog-to-digital converter, an 8-channel multiplexer and control logic compatible with a microprocessor.

5.7 IR Sensor

5.7.1 Working Principle of IR Sensor

The IR sensor consists of two main components. The first one is an Infra-Red (IR) transmitter LED, and then the second is an Infra-Red receiver which is a photo transistor. IR signal is emitted from the IR LED and transmitted out of the sensor

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unit. If the IR signal is reflected back then it gets picked up by the IR receiver which is the photo transistor.

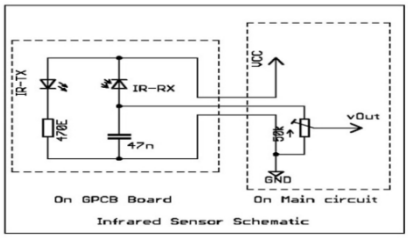

Figure 9: Circuit Diagram of IR sensor

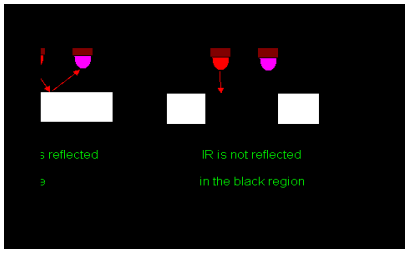

Figure 10: Working Principle of IR Sensor

5.7.2 Pin Configuration of IR Sensor

Pin No.	Connection	Description
1	Output	Digital Output (High or Low)
2	VCC	Connected to circuit supply
3	Ground	Connected to circuit ground

5.8 Current Sensor (CS60 010)

A current sensor is an electrical transducer which senses the electrical current (AC or DC) through a wire, and generates a output signal or voltage proportional to it. The sensed current and the output signal will be of following types:

AC current input:

- Analog output, which replicates the waveform shape of the sensed current
- Unipolar output, which is proportional to the average or RMS value of the detected current

DC current input:

- Unipolar, with a unipolar output, which replicates the waveform shape of the detected current flow
- Bipolar output, which replicates the waveform shape of the detected current
- Digital output, which switches ON and when the sensed current value exceeds a particular threshold

5.8.1 Features

- Measurable current is from the range of 1 to 10 Amps
- Copper terminations is over Tin-silver coating
- The wall thickness of the hole is 0.5 mm minimum
- Sensitivity can be enhanced more over by increasing the number of primary turns

5.8.2 Applications

- Sensing overload in any branch circuit and to detect any load drops or shutdown

5.9 Relay

A relay is an electrical switch that opens and closes under the control of another circuit. In its original form, the switch is actuated by an electromagnet to open or close one or more sets of contacts. A relay can control an output circuit with higher power than the input circuit in the form of an electrical amplifier.

The voltage and the nominal resistance of the relay coil must correspond to the circuit that supplies the relay coil. Many relays have a coil for 12 V power supply, but 5 V and 24 V relays are also available. Some relays function properly with a supply voltage that is slightly below their nominal value.

The electromagnetic relay consists of a multi-turn coil wound around an iron core to form an electromagnet. If the coil is energized while current is flowing through it, the core is temporarily magnetized. The magnetized core attracts iron armor. The armature pivots, whereby one or more contact sets are actuated. When the coil is de-energized, the armature and the contacts are released. The coil can be powered by a low power source, such as a transistor, while the contacts have high powers such as e.g. B. can switch power. The relay can also be installed remotely from the control source.

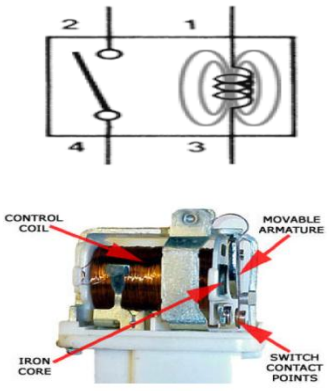

Figure 11: Diagram for Relay

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5.9.1 Working of Relay

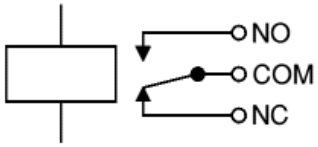

Figure 12: Circuit symbol for relay

When a current flows through the coil, the resulting magnetic field attracts an armature that is mechanically attached to a movable contact. The movement establishes a connection to a fixed contact or interrupts it. When the current to the coil is disconnected, the armature is returned to its relaxed position by a force approximately half the magnetic force. It is generally a spring, but gravity is also widely used in industrial engine starters. Most relays are designed for fast operation. In a low voltage application, this reduces the noise. This reduces the arc in a high voltage or high current application. When the coil is supplied with direct current, a diode is often installed through the coil to dissipate the energy of the collapsing magnetic field during deactivation, which could otherwise generate a voltage spike and damage the circuit components. Some vehicle relays already contain this diode in the relay box. Alternatively, a contact protection network consisting of a capacitor and a series resistor can absorb the overvoltage. If the coil is designed for the supply of alternating current, a small copper ring can be crimped on the end of the magnet. This "shading ring" creates a small phase-shifted current that increases the minimum resistance in the armature during the change cycle.

5.9.2 ULN2003 Relay Driver

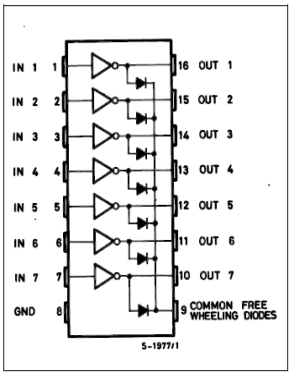

Figure 13: Connection for ULN2003 driver

5.9.3 Features of ULN2003

The rated collector current is maximum of 500mA with single output

- High-voltage output of 50V max
- Inputs are compatible with various types of digital logic.
- Used for all type of relay driver applications

5.9.4 Relay Application Considerations

A large relay arrays with two coils and many sets of electrical contacts were used in the old telephone switching systems.

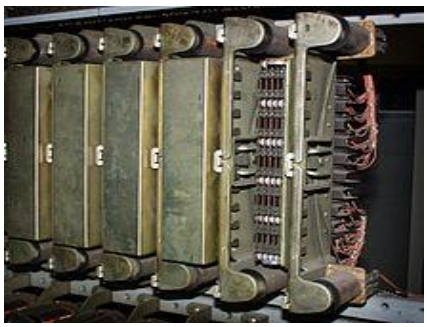

Figure 14: Application of relays

A several units of about 30-contact relays and connector circuits were used in mid of 20th century and 5XB switched telephone exchanges in which the cover removed one is shown in the figure 13.

5.10 Liquid Crystal Display

A liquid-crystal display (LCD) consists of a flat panel electronic visual display, which is a alphanumeric display which uses light modulation properties of liquid crystals arranged in dot matrix form. Liquid crystals do not emit light directly.

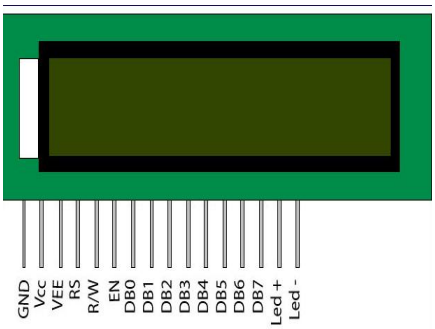

Figure 15: Diagram of LCD

The most commonly used LCD display screens available on the market today were 1-line, 2-line or 4-line LCD displays that have a single or dual controller. Most of them can support up to 80 characters. Most of the LCD display screens were able to support more than 80 characters uses a HD44780 based LCD controller.

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VI. SOFTWARE ANALYSIS

6.1 Keil Compiler

The Cx51 Optimizing C compiler is a full implementation of the ANSI standard (American National Standards Institute) for the C language for microcontrollers especially. Cx51 is not a universal C compiler developed only for the 8051 target based microprocessors. It is also a dedicated zero implementation compiler to generate an extremely fast and compact compiling platform for the 8051 microprocessor. Cx51aslo gives user to flexibly program in C language and the efficiency of the code has increased speed of the assembly language programming. Because of Cx51 which is a cross compiler, some aspects of the standard C programming language and inbuilt libraries are modified to improve and to accommodate the unpredictability of an integrated target processor ICs.

6.2 Compiling with CX51

The compilation methodology of a Cx51 to compile C source files and control directives specified are discussed as follows. These directives also allow the programmer to perform several special functions. For example:

- A Direct Cx51 listing file is generated
- Controls the information that are included in loaded object files

6.3 Running CX51 from the Command Prompt

To invoke the C51 or CX51 compiler the user has to enter C51 or CX51 at the command prompt. In this command line, the programmer must include the name of the C source file to be compiled, and also any other necessary control directives that are required to be compiled along with the main source file.

The format for the Cx51 command line is shown below:

C51 source file _directives…_
CX51 source file _directives…_
or:
C51 @command file
CX51 @command file
where:
Source file is the name of the main source program that needs to be compiled.

Directives are the directives that are used to control the function of the compiler.

Command file is the name of a command input file that should contain *sourcefile* and *directives*. A *command file* is used within the C*x*51 invocation line that gets complex and will exceed the limits range of the command prompt of the program window.

The following are the command line example that invokes C51, specifies the source file name **SAMPLE.C**, and uses the controls **DEBUG**, **CODE**, and **PREPRINT**.

C51 SAMPLE.C DEBUG CODE PREPRINT

In the **Cx51** compiler, the following information are displayed upon a successful compilation and invocation of the C compiler which has the following output result after successful compilation.

C51 COMPILER V6.10

C51 COMPILATION COMPLETE. 0 WARNING(S), 0 ERROR(S)

6.4 8051 Derivatives

A multiple number of 8051 derivatives were available to provide an enhanced performance and stability while remaining modules are compatible with the core of 8051 microcontroller core. These derivatives were provided with additional data pointers and very fast math operations which were used with reduced instruction sets.

The Cx51 compiler has enhanced features and directly supports all of the following 8051-based microcontrollers:

- Atmel 89x8252 and all its variants (2 data pointers).
- Dallas 80C320, 80C420, 80C520, 80C530, 80C550 its variants (2 data pointers).
- Infineon C517, C517A, C509, and several other variants either a high-speed 32-bit and 16-bit binary arithmetic operations with 8 data pointers.
- Philips 8xC750, 8xC751, and 8xC752 with maximum code space of 4 KBytes, no LCALL or LJMP instructions, 64 bytes internal with less or no external data memory).
- Philips and Temic support on several devices and their variants with 2 data pointers.

6.5 Coding

```
#include <REGX51.H>
#define MYDATA P0
sbitrs=P3^2;
sbitrw=P3^3;
sbit en=P3^4;
```


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```
sfrdatas=0xA0;
        sbit A1=P1^0;
        sbit A2=P1^1;
        sbit A3=P1^2;
voidlcdinit(void);
        voidlcdcmd(unsigned char );
        void delay(unsigned int del);
        voidlcddata(unsigned char ldat);
        voidlcdinit(void)
         {
        lcdcmd(0x38);
        lcdcmd(0x38);
        lcdcmd(0x38);
        lcdcmd(0x06);
        lcdcmd(0x0e);
        lcdcmd(0x01);
        lcdcmd(0x0C);
        lcdcmd(0x80);
         }

        voidlcdcmd(unsigned char lcmd)
        {
        datas=lcmd;
        rs=0;
        rw=0;
        en=1;
        delay(50);
        en=0;
        }
        void delay(unsigned int del)
        {
        while(del--);
        }
        voidlcddata(unsigned char ldat)
        {
        datas=ldat;
        rs=1;
        rw=0;
        en=1;
        delay(50);
        en=0;
        }
void Delay()
        {
                inti;
                for(i=0;i<12000;i++);
        }
voidinit()
  {
   SCON=0x50;
   TMOD=0X20;
   TH1=0XFd;
   TR1=1;
  }
voidtxs(unsigned char value)
 {
inti;
  TI=0;
  SBUF=value;
while(TI==0);
for(i=0;i<3000;i++);
 }

unsigned char val1[6],val,sp,spt,sptt;
voidputchar(unsigned char val[16],char len)
        {
        chari;
        for(i=0;i<len;i++)
                {
                lcddata(val[i]);
                }
        }
char ii;
        unsigned char rval[76];
inti=0,v=200,v1=0,d=0,er=0,cnt1=0,ff=0;
unsignedinthb=0,cnt=0;
voidsendd()
        {
        txs('A');txs('T');txs('+');txs('C');txs('M');txs('G');
        txs('S');txs('=');
                txs("");
        txs('8');txs('0');txs('5');txs('6');
        txs('6');txs('4');txs('5');txs('0');txs('2');txs('1');
                txs("");
        txs(13); txs(10);
        }
unsignedint cost1;
void sms3()
        {
                sendd();
```


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```
        delay(10000);
        txs('M');
        txs('e');
        txs('t');
        txs('e');
        txs('r');
        txs('=');
        txs((cnt1%1000)/100+0x30);
        txs((cnt1%100)/10+0x30);
        txs((cnt1%10)+0x30);
        txs(13);  txs(10);    delay(10000);
        txs(26);
        }

void sms1()
        {
        txs('A');txs('T');txs('+');txs('C');txs('M');txs('G');
        txs('S');txs('=');
                txs("");
        txs('8');txs('0');txs('5');txs('6');
        txs('6');txs('4');txs('5');txs('0');txs('2');txs('1');
                        txs("");
        txs(13); txs(10);
delay(60000);delay(60000);delay(60000);delay(60000);delay(60000)
;delay(60000);
txs('C');
txs('o');
txs('n');
txs('s');
txs('u');
txs('m');
txs('p');
txs('t');
txs('i');
txs('o');
txs('n');
txs(' ');
txs('L');
txs('e');
txs('s');
txs('s');
txs(' ');
        txs((cnt1%1000)/100+0x30);
        txs((cnt1%100)/10+0x30);
        txs((cnt1%10)+0x30);
                txs(13);  txs(10);    delay(10000);
        txs(26);
        }
void sms2()
        {
        txs('A');txs('T');txs('+');txs('C');txs('M');txs('G');
        txs('S');txs('=');
                txs("");
        txs('8');txs('0');txs('5');txs('6');
        txs('6');txs('4');txs('5');txs('0');txs('2');txs('1');
                                txs("");
txs(13); txs(10);
delay(60000);delay(60000);delay(60000);delay(60000);delay(60000)
;delay(60000);
txs('C');
txs('o');
txs('n');
txs('s');
txs('u');
txs('m');
txs('p');
txs('t');
txs('i');
txs('o');
txs('n');
txs(' ');
txs('M');
txs('o');
txs('r');
txs('e');
txs(' ');
        txs((cnt1%1000)/100+0x30);
        txs((cnt1%100)/10+0x30);
        txs((cnt1%10)+0x30);
        txs(13);  txs(10);    delay(10000);
        txs(26);
        }
longll;
unsigned char rxs()
        {
int c=0;
while(RI==0)
        {
        c++;
        if(c>25000)
```


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```
        break;

if(P3_5==0)
                {
                while(P3_5==0){}
                 cnt1=cnt1+1;
                delay(60000);
                        cost1=cnt1;
                lcdcmd(0x80);
        lcddata('M');
        lcddata('e');
        lcddata('t');
        lcddata('e');
        lcddata('r');
        lcddata('=');
        lcddata(((cnt1%1000)/100)+0x30);
        lcddata(((cnt1%100)/10)+0x30);
        lcddata((cnt1%10)+0x30);

                //      sms1();
                }
                        }
                RI=0;
                return SBUF;
        }

voidrxmo()
        {
                chari;
        txs('A');txs('T');txs('+');txs('C');txs('M');txs('G');

        txs('R');txs('=');txs('1');txs(13);  txs(10);
        for(i=0;i<76;i++)
                                                        {
                rval[i]=rxs();
                                                         }
        }
void del1()
        {
        chari;
        txs('A');txs('T');txs('+');txs('C');txs('M');txs('G');
                        txs('D');txs('=');txs('1');txs(13);
        txs(10);
                                for(i=0;i<13;i++)
                                {
                                rval[i]=rxs();
                                }
                }
        }
        charoc,occ;
void main()
        {
init();
lcdinit();
                P3_7=1;
        txs('A');txs('T');txs('+');txs('C');txs('M');txs('G');
        txs('F');txs('=');txs('1');txs(13);          txs(10);
                delay(60000);delay(60000);delay(60000);
                        del1();
        while(1)
                {
        P1_0=0;
        P1_1=0;
        P1_2=0;
        Delay();
        val1[0]=MYDATA;
        lcdcmd(0xC0);
        lcddata('V');
        lcddata('=');
        lcddata((val1[0]/100)+0x30);
        lcddata(((val1[0]%100)/10)+0x30);
        lcddata((val1[0]%10)+0x30);
        lcddata(' ');
        P1_0=1;
        P1_1=0;
        P1_2=0;
        Delay();
        val1[1]=MYDATA;
        lcdcmd(0xC6);
        lcddata('I');
        lcddata('=');
        lcddata((val1[1]/100)+0x30);
        lcddata(((val1[1]%100)/10)+0x30);
        lcddata((val1[1]%10)+0x30);
        lcddata(' ');
        if(P3_5==0)
                {
                delay(60000);
                 cnt1=cnt1+1;
                }
lcdcmd(0x80);
        lcddata('m');
```


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```
lcddata('e');
lcddata('t');
lcddata('e');
lcddata('r');
lcddata('=');
lcddata(((cnt1%1000)/100)+0x30);
lcddata(((cnt1%100)/10)+0x30);
lcddata((cnt1%10)+0x30);
lcddata(' ');
lcddata(((ll%1000)/100)+0x30);
lcddata(((ll%100)/10)+0x30);
lcddata((ll%10)+0x30);
ll++;
if(ll==20)
                {
sms3();
                }
if(ll==10)
                {
                        if(cnt1<20)
                                {
                                sms1();
                                }
                        if(cnt1>100)
                                {
                                sms2();
                                }
                }
                        rxmo();
                        lcdcmd(0xC0);
for(i=60;i<76;i++)
                                {

                                lcddata(rval[i]);
                                }


                        if(rval[60]=='P')
                                {
                                P3_7=1;
                                del1();
                                }
                        if(rval[64]=='P')
                                {
                                P3_7=1;
                                del1();
                                }
                        if(rval[60]=='p')
                                {
                                P3_7=0;
                                del1();
                                }
                if(rval[64]=='p')
                                {
                                P3_7=0;
                                del1();
                                }
                }
        }
```

VII. HARDWARE IMPLEMENTATION

The hardware implementation of the project is done and the output is verified. The prototype of the hardware is shown in the figure 16.

Figure 16: Hardware Implementation

7.1 Applications

- Electricity departments
- Household Energy meter monitoring
- Railway electrical systems
- Industrial Energy remote monitoring
- Remote controlling systems

7.2 Advantages

- Provides user friendly remote energy meter monitoring
- Supports controlling of meter
- Can be controlled anywhere in the world
- Non-volatile memory based energy-reading storing
- Auto disconnect feature

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VIII. CONCLUSION

Today the energy providers use energy-based tariffs to distribute electricity. When a rate is implemented based on load and demand, the options for controlling the consumption model increase, since economic income is more tied to the maximum load in the system. The new demand-based tariffs comply with Swedish regulations as long as the total annual income does not exceed the specified limit. However, the monthly income depends on the modeled rate. The need-based pricing shifts revenues to the peak period from November to March, and the energy supplier gets a good match between system peaks and revenues. Additional research is needed to determine the appropriate price level from the perspective of energy suppliers and customers.

IX. FUTURE ENHANCEMENT

In our project we used GSM technology to send and receive messages. The reliability of the proposed system has been enhanced using SMS delivery reports and instead of manually tripping off the circuit we can also do it automatically.

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