DEVELOPING AN ISLANDING ARRANGEMENT FOR GRID ON SENSING VARIATION OF VOLTAGE OR VARIATION OF FREQUENCY AND GSM

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Abstract-----This paper is designed to develop a system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency, voltage and overload. And also SMS based notification of abnormalities along with remote controlling of load with overload protection. There are several power generation units connected to the grid such as hydel, thermal, solar etc to supply power to the load. These generating units need to supply power according to the rules of the grid. These rules involve maintaining a voltage variation within limits and also the frequency. If any deviation from the acceptable limit of the grid it is mandatory that the same feeder should automatically get disconnected from the grid which by effect is termed as islanding. This prevents in large scale brownout or black out of the grid power. So it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure. This system is based on a microcontroller of ATMEGA328family. The microcontroller monitors the under/over voltage being derived from a set of analog to digital converters. As the frequency of the mains supply cannot be changed, the paper uses a variable frequency generator (555- timer) for changing the frequency, while a standard variac is used to vary the input voltage to test the functioning of the components are used in this work. A lamp load along with current sensor (indicating a predictable blackout, brownout) being driven from the microcontroller in case of voltage/frequency/overload going out of acceptable range Further the project can be enhanced by using power electronic devices to isolate the grid from the erring supply source by sensing cycle by cycle deviation for more sophisticated means of detection.

Keywords* — *Islanding, Arduino UNO Microcontroller, GSMC Sensors, Relays, Voltage and Frequency.

1. INTRODUCTION

The development of a microcontroller based islanding detection for grid connected inverter with under/overvoltage and under/over frequency islanding detection[1]. The system is based on a microcontroller from Atmel 8051 family[2]. The microcontroller monitors the under/over voltage derived from a set of comparators and under/over frequency from by the interrupt program for the utility grid and the processed value of voltage and frequency for turning ON/OFF their lay between a grid connected inverter and the utility grid[3]. The project would alternatively use a variable frequency generator representing the inverter using 555-timer for changing the frequency while a standard variac shall be used to vary the input voltage for achieving the test conditions by a lamp load being driven from the microcontroller output as stated above[5]. The microcontroller used in the project is of 8051 family which is of 8 bit[6]. The power supply consists of a step-down transformer 230/12V, which steps down the voltage to 12V AC[7]. This is converted to DC using a Bridge rectifier. The ripples are removed using a capacitive filter and it is then regulated to+5V using a voltage regulator 7805 which is required for the operation of the microcontroller and other components[8].

2. EMBEDDED SYSTEMS

Embedded system:

An Embedded System is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a specific function. An embedded system is a microcontroller-based, software driven, reliable, real-time control system, autonomous, or human or network interactive, operating on diverse physical variables and in diverse environments and sold into a competitive and cost conscious market.

An embedded system is not a computer system that is used primarily for processing, not a software system on PC or UNIX, not a traditional business or scientific application. High-end embedded &lower end embedded systems. High-end embedded system- Generally32, 64 Bit Controllers used with OS. Examples Personal Digital Assistant and Mobile phones etc. Lower end embedded systems - Generally 8, 16 Bit Controllers used with a minimal operating systems and hardware layout designed for the specific purpose.

2.1Characteristics of Embedded System:

- An embedded system is any computer system hidden inside a product other than a computer.
- They will encounter a number of difficulties when writing embedded system software in addition to those they encounter when they write applications.
- Throughput – Our system may need to handle a lot of data in a short period of time.
- Response–Our system may need to react to events quickly.
- Testability–Setting up equipment to test embedded software can be difficult.
- Debug ability–Without a screen or a keyboard, finding out what the software is doing wrong (other than not working) is a troublesome problem.
- Reliability – embedded systems must be able to hand leany situation without human intervention.
- Memory space – Memory is limited on embedded systems, and you must make the software and the data fit into whatever memory exists.
- Program installation – you will need special tools to get your software into embedded systems.
- Power consumption – Portable systems must run on battery power, and the software in these systems must conserve power. Processor hogs – computing that requires large amounts of CPU time can complicate the response problem.
- Cost – Reducing the cost of the hardware is a concern in many embedded system projects; software often operates on hardware that is barely adequate for the job.

3. BLOCK DIAGRAM

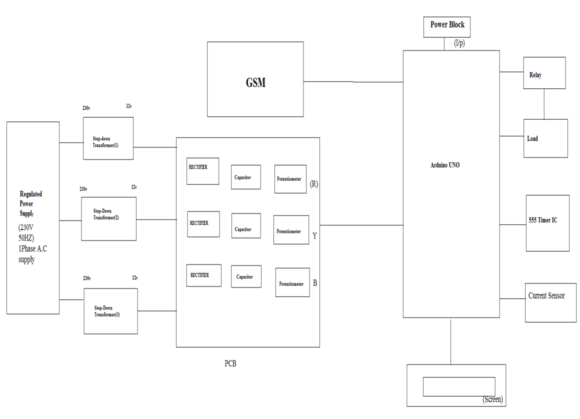

Figure 1: Block Diagram of Arduino UNO Micro Controller and GSM

4. HARDWARE REQUIREMENTS

HARDWARE COMPONENTS:

S. No	COMPONENTS	SPECIFICATIONS
1	Arduino UNO Microcontroller	ATMEGA 328
2	Step Down Transformer	230V/12V
3	Liquid Crystal Display	16*2
4	555 Timer	IC
5	Relay	-
6	Push Button	-
7	Transistor	BC 547
8	Lamps	200W & 60W
9	Diode	1N4007
10	Resistors	Two 1k & Two 2k
11	Capacitor	-
12	GSM Module	SIM 800A

4.1 Arduino UNO Micro controller

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. . Instead, it features the Atmega8U2 programmed as a USB-to-serial converter

4.2 Step down Transformer (230/12v)

Transformer is an electrical device that transfers electrical energy between two (or) more circuit through electromagnetic induction. A varying current in one coil of the transformer produces a varying magnetic field which in turn induces a electromagnetic force in the circuit. These are used to increase (or) decrease the alternating voltages in electric power applications.

4.3 LCD Display

Liquid crystal display (LCD) has material which combines the properties of both liquid and crystals. They have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an order form similar to a crystal. For an 8-bit data bus, the display requires a +5V supply plus 11 I/O lines. For a 4-bit data bus it only requires the supply lines plus seven extra lines.

4.4GSM Module

The SIM800A Quad-Band GSM/GPRS Module with RS232 Interface is a complete Quad-band GSM/GPRS solution in an LGA (Land grid array) type which can be embedded in the customer applications. SIM800A support Quad-band 850/900/1800/1900 MHz, it can transmit Voice, SMS and data information with low power consumption. The SIM800A modem has a SIM800A GSM chip and RS232 interface while enables easy connection with the computer or laptop using the USB to the Serial connector or to the micro-controller using the RS232 to TTL converter. Once you connect the SIM800A modem using the USB to RS232 connector, you need to find the correct COM port from the Device Manager of the USB to Serial Adapter.

5. Connection diagram kit

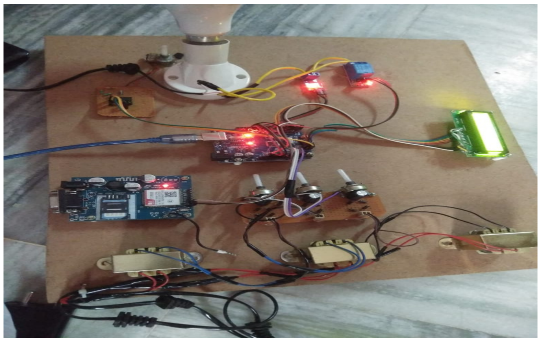

Fig: 5 Connection Diagram Kit

5.1Working

230v power supply is given to the step down transformer. Rating of the transformer is 12v. It can be given to bride rectifier which consists of rectifier, filter and a voltage regulator. Rectifier converts the ac into dc and filter gives the pure dc signal by blocking ripples. The dc voltage is further regulated and Microcontroller receives this DC power from rectifiers. The output of the microcontroller is connected to16×2 LCD Display. The voltage can be varied by varying the voltage potentiometer. The variable frequency is obtained from a 555 timer to test the functionality of the project. In case one for proper synchronization load testing is done by connecting Heavy load lamp of 20W and for light load LED are connected. A Pot is connected at the input of the microcontroller. By varying pot the voltage changes after reaching the acceptable voltage the LCD display strip voltage. The relay circuit will be opened and the lamp will be protected. The frequency variation is shown before tripping. The light will flicker before it turned OFF. An addition phase sequence detector is used to indicate the phase sequence of the power supply.RYB is the normal phase sequence. If the phase sequence of the supply changes due to any reason i.e. reversal of generator rotation then the phase sequence indicator detects the phase sequence and accordingly a tripping signal should be generated to avoid mal operation of the entire grid. Additionally this can be controlled through mobile by sending a message through GSM module in the connection diagram. And if any overload occurs in any phase the load is automatically disconnected and a message is sent to the mobile.

5.2 Status of the Project: (Voltage sensing Part)

Here the voltage fault has been occurred at phase B so the load has been shut down. Now when the load is OFF then automatically the GSM module sends a message to the particular authority in the way "Load Shut down Due to Phase 3(B) Fault as shown in below figure.

5.2.1Voltage Sensing Part:

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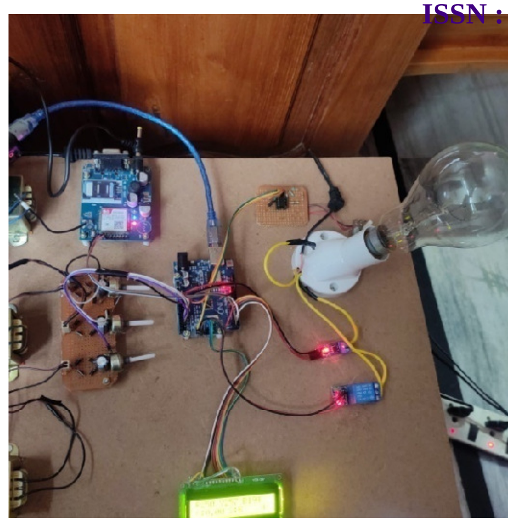

Fig: 5.2.1(a) voltage fault sensing

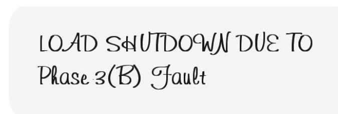

Fig: 5.2.1(b) Voltage phase fault Message

5.3 Frequency Sensing part:

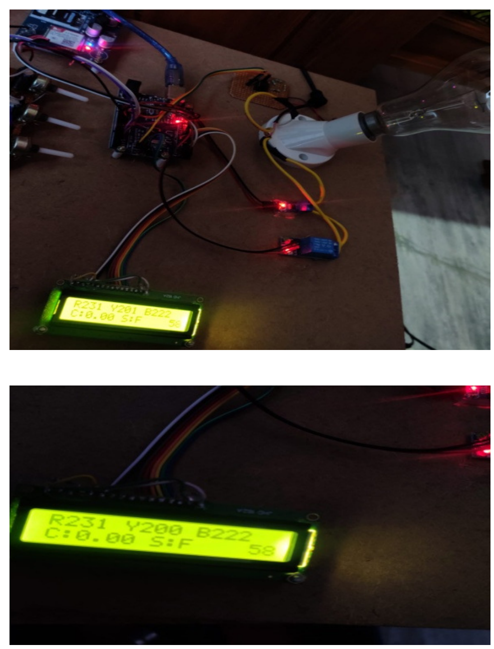

Fig:5.3(a)Frequency fault Sensing

When there is a frequency fault in the system,load shut down automatically as shown in fig:5.3(a) and sends a message to the contorlleer as shown in fig:5.3(b)

Fig: 5.3(b) Frequency fault message

5.4Fault clearing part

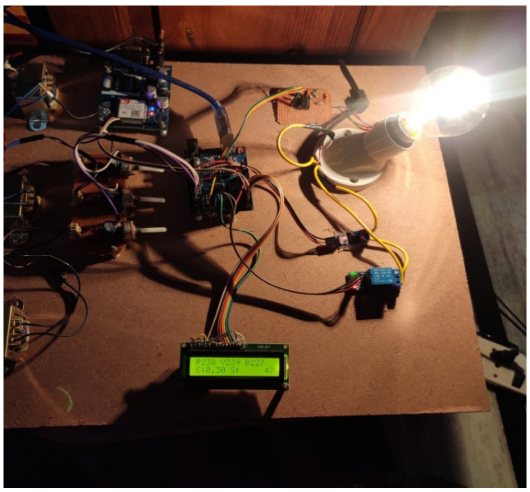

Fig: 5.4(a) Voltage fault clearing

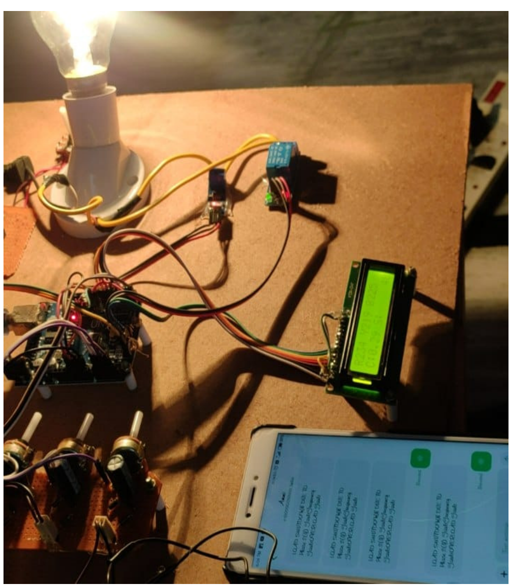

Fig: 5.4(b) controlling the system with mobile

Program

```
#include <LiquidCrystal.h>
const int rs = 2, en = 3, d4 = 4, d5 = 5, d6 = 6, d7 = 7;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
long milisec = millis();
long time=milisec/1000;
#define pulse_ip 9
int ontime,offtime,duty;
float frequency,period;
const int relay1=8;
int buz=10;
int i = 0;
double c1 = 0;
int ph1f=0,ph2f=0,ph3f=0,ovlf=0,ff=0;
int kk=0;
int sensorIn,dvp=0;
int mVperAmp = 275;
double Voltage = 0;
double VRMS = 0;
double AmpsRMS = 0;
int abn=0;
void setup(){
  pinMode(pulse_ip,INPUT);
  Serial.begin(9600);
  pinMode(relay1,OUTPUT);
  pinMode(buz,OUTPUT);
  digitalWrite(relay1,1);
  digitalWrite(buz,0);
  lcd.begin(16,2);
  lcd.print("WELCOME");
  delay(1000);
  Serial.println("AT");    //Sets the GSM Module in Text Mode
  delay(1000);
 Serial.println("AT+CNMI=2,2,0,0,0");
  delay(1000);
  lcd.clear();
  lcd.print("R    Y    B   ");
  lcd.setCursor(0,1);
```

```
  lcd.print("C:    S:");
}
void  loop(){
  ontime = pulseIn(pulse_ip,HIGH);
  offtime = pulseIn(pulse_ip,LOW);
  period = ontime+offtime;
  frequency = (1000000.0/period)/40;
  //Serial.println(frequency);
  int rvol=analogRead(A0)/2.1;
  int yvol=(analogRead(A1)/2.1)-30;
  int bvol=analogRead(A2)/2.1;
  lcd.setCursor(1,0);
  lcd.print("   ");
  lcd.setCursor(1,0);
  lcd.print(rvol);
  lcd.setCursor(6,0);
  lcd.print("   ");
  lcd.setCursor(6,0);
  lcd.print(yvol);
  lcd.setCursor(11,0);
  lcd.print("   ");
  lcd.setCursor(11,0);
  lcd.print(bvol);
    lcd.setCursor(14,1);
  lcd.print("  ");
  lcd.setCursor(14,1);
  lcd.print(frequency);
lcd.setCursor(9,1);
  lcd.print("   ");
  lcd.setCursor(9,1);
  abn=0;
  if(rvol<200)
  {
    ph1f=1;
    abn=1;
    lcd.print("R");
  }
    if(yvol<200)
{
  ph2f=1;
  abn=1;
  lcd.print("Y");
}
  if(bvol<200)
{
  ph3f=1;
  abn=1;
  lcd.print("B");
}
if(frequency>55 || frequency<45)
{
  ff=1;
  abn=1;
  lcd.print("F");
}
double sum_c=0;
for(int ll=0;ll<=1;ll++)
{
long milisec = millis();
long time=milisec/1000;
sensorIn=A3;
Voltage = getVPP();
VRMS = (Voltage/2.0) *0.707;
c1 = (VRMS * 1000)/mVperAmp;
Voltage = getVPP();
VRMS = (Voltage/2.0) *0.707;
c1 = (VRMS * 1000)/mVperAmp;
if(c1<0.15)
 c1=0;
else
 c1=c1-0.15;
sum_c=sum_c+c1;
}
c1=sum_c/2;
lcd.setCursor(2,1);
lcd.print(c1);
```

```
lcd.setCursor(12,1);
 lcd.print(" ");
if(c1>0.7)
{
 ovlf=1;
 lcd.setCursor(12,1);
 lcd.print("L");
 abn=1;
}
 if(abn==1 && kk==0)
{
 kk=1;
 digitalWrite(relay1,1);
 digitalWrite(buz,1);
 delay(500);
digitalWrite(buz,0);
 send_sms();
}
else if(abn==0)
{
 kk=0;
 // digitalWrite(relay1,0);
}
 if(Serial.available())
{
 for(int i=0;i<=50;i++)
 {
  int ch=Serial.read();
  if(ch=='@')
  {
   kk=0;
  if(abn==0)
   {
  Serial.println("ON");
  digitalWrite(relay1,0);
  }
  }
  if(ch=='$')
  {
   Serial.println("OFF");
  digitalWrite(relay1,1);
  }
 }
 }
}



float getVPP()
{
 float result;
 int readValue;             //value read from the sensor
 int maxValue = 0;          // store max value here
 int minValue = 1024;          // store min value here
  uint32_t start_time = millis();
  while((millis()-start_time) < 1000) //sample for 1 Sec
  {
     readValue = analogRead(sensorIn);
     // see if you have a new maxValue
     if (readValue > maxValue)
     {
         /*record the maximum sensor value*/
         maxValue = readValue;
     }
     if (readValue < minValue)
     {
         /*record the maximum sensor value*/
         minValue = readValue;
     }
  }

  // Subtract min from max
  result = ((maxValue - minValue) * 5.0)/1024.0;
  return result;
 }
void send_sms()
{
```

```
Serial.println();    //Sets the GSM Module in Text Mode

delay(1000);

Serial.println("AT");    //Sets the GSM Module in Text Mode

delay(1000);

Serial.println("ATE0");    //Sets the GSM Module in Text Mode

delay(1000);

Serial.println("AT+CMGF=1");    //Sets the GSM Module in Text
Mode

delay(1000);  // Delay of 1000 milli seconds or 1 second

Serial.print("AT+CMGS=\"6304396355\"\r\n");// Replace x with
mobile number

delay(1000);

Serial.println("LOAD SHUTDOWN DUE TO");

if(ph1f==1)

{

  Serial.print("Phase-1(R) Fault");

}

 if(ph2f==1)

{

  Serial.print("Phase-2(Y) Fault");

}

 if(ph3f==1)

{

  Serial.print("Phase-3(B) Fault");

}

if(ff==1)

{

  Serial.print("Frequency Fault");

}

 if(ovlf==1)

{

  Serial.print("OVERLOAD Fault");

}

delay(1000);

Serial.println(char(26));

delay(2000);

}
```

Conclusion

This paper presents designed to develop a system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency, overload, voltage and send SMS notification to authorized person along with remote control options. There are several power generation units connected to the grid such as hydel, thermal, solar etc, to supply power to the load. These generating units need to supply power according to the rules of the grid. These rules involve maintaining a voltage variation within limits and also the frequency. If any deviation from the acceptable limit of the grid it is mandatory that the same feeder should automatically get disconnected from the grid which by effect is termed as islanding. This prevents in large scale brown out or black out of the grid power. So it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure**.**

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