EARTH LEAKAGE DETECTOR USING ARDUINO WITH GSM MODEM

[U17EEP7702 – PROJECT PHASE I]

A REPORT

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CERTIFICATE

The project work embodied in the present Report entitled "**EARTH LEAKAGE DETECTOR USING ARDUINO WITH GSM MODEM**" has been carried out in the Department of Electrical and Electronics Engineering, Kumaraguru College of Technology, Coimbatore. The work reported herein is original and does not form part of any other project or thesis or paper published on the basis of which a degree or award was conferred on an earlier occasion or to any other scholar.

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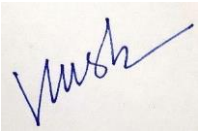

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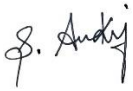

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ABSTRACT

Protection system's main function is to clear faults from the power system at high speed to ensure safety.Minimize equipment damage and maintain power system stability**.** If any current leaks from any electrical installation, there must-be any insulation failure in the electrical circuit, it must be properly detected and prevented otherwise there may be a high chance of electrical shock if-anyone touches the installation. An earth leakage detector does it efficiently. Means it detects the earth leakage current and makes the power supply off by opening the associated circuit breaker

One terminal of the relay coil is connected to the metal body of the equipment to be protected against earth leakage and other terminal is connected to the earth directly. If any insulation failure occurs or live phase wire touches the metal body, of the equipment, there must be a voltage difference appears across the terminal of the coil connected to the equipment body and earth. This voltage difference produces a current to flow the relay coil. If the fault occur it will display on the LCD and give information through wireless communication.

ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS

DC - DIRECT CURRENT

AC - ALTERNATING CURRENT

CT - CURRENT TRANSFORMER

LCD - LIQUID CRYSTAL DISPLAY

GSM - GLOBAL SYSTEM FOR MOBILE COMMUNICATION

CHAPTER 1
INTRODUCTION

1.1 PROBLEM STATEMENT:

This project enables us to prevent any damage to the person due to earth shock by using the microcontroller. The power generated is used in many ways, but if leakage or any other thing happens it will cause major effects. We can monitor the voltage and current values which are generated during the course of time through the LCD display. Fault may occur by,

The external sourses,

1) Man made causes.

Poor installations where there could be a breakdown in the conductor insulation or moisture ingress.

The natural sources,

2) Lightning,

3) Falling of a tree.

1.2 FIELD OF THE PROJECT:

Field : This project is to detect the earth fault and indicate using alarm. It is very useful in costal area and remote location to find the earth fault.

1.3 OBJECTIVES:

- Protection system's main function is to clear faults from the power system at high speed to ensure safety.

- Minimize equipment damage and maintain power system stability.
- This system is fully automatic and no need of manual work.
- The information is given to the customer through wireless communication.

1.4 ORGANIZATION OF THE REPORT:

CHAPTER 1 – Describes with the problem identification and objectives of the project

CHAPTER 2 – Deals with the proposed system configuration and overall structure of the project.

CHAPTER 3 – Focuses on the implementation of earth leakage detector using Arduino.

CHAPTER 4 – Presents the result of earth leakage detector using Arduino with GSM modem.

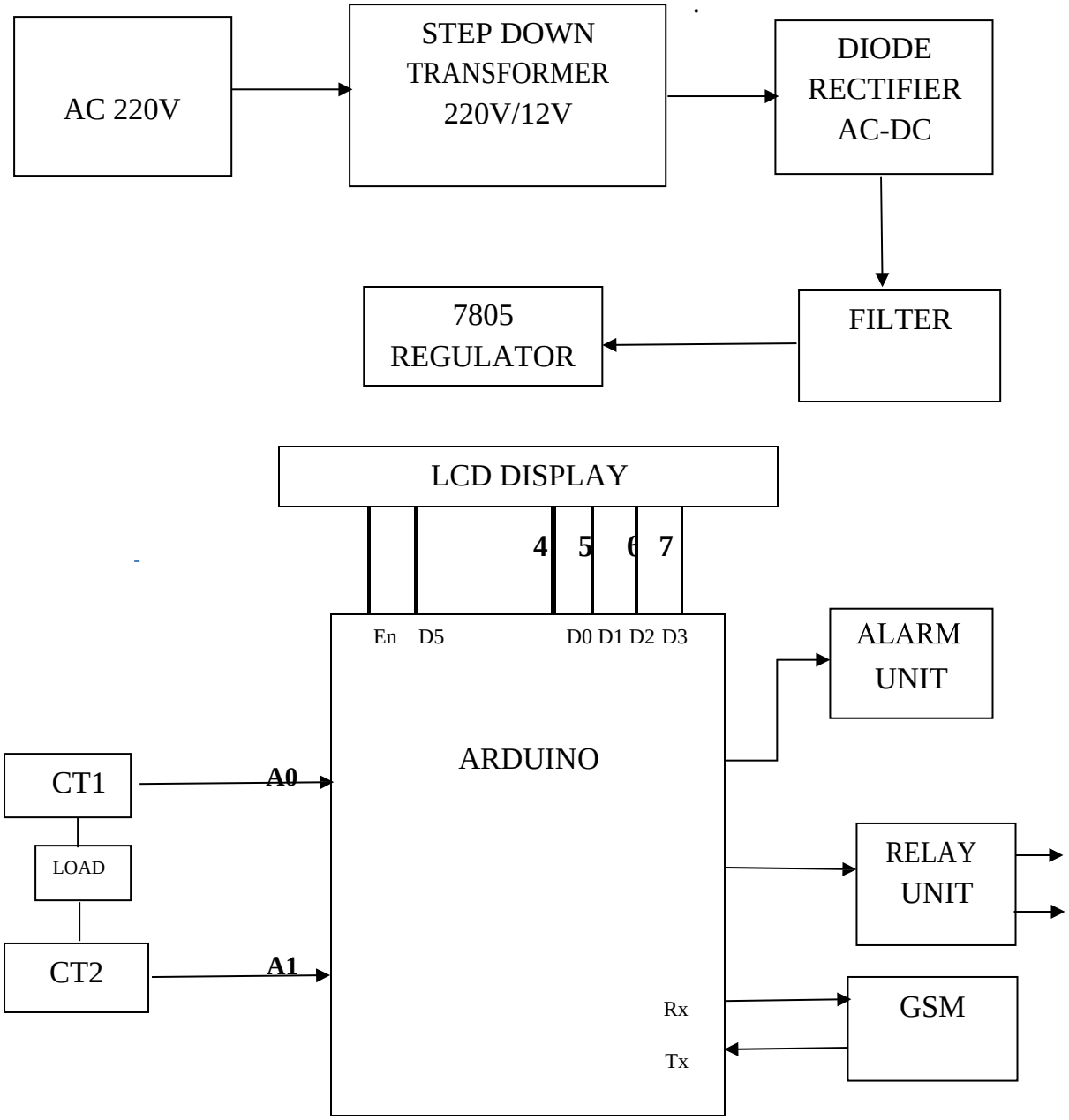
CHAPTER 5 – Points the conclusion of the project results and future scope of the project.

CHAPTER 2

PROPOSED SYSTEM

2.1 BLOCK DIAGRAM:

The overall block diagram of the Earth Leakage Detector using Arduino with GSM modem. 1)block diagram of power supply 2)block diagram of control unit



2.2 CONFIGURATION OF COMPONENTS:

The system structure represents the connection of the individual components and their working principle.

2.2.1 CURRENT TRANSFORMER:

Current transformers are the current-sensing units of the power system and are used at generating stations, electrical substations, and in industrial and commercial electric power distribution. A current transformer (CT) is a type of transformer that is used to reduce or multiply an alternating current (AC). It produces a current in its secondary which is proportional to the current in its primary.

A CT for operation on a 110 kv grid Current transformers, along with voltage or potential transformers, are instrument transformers. Instrument transformers scale the large values of voltage or current to small, standardized values that are easy to handle for measuring instruments and protective relays. The instrument transformers isolate measurement or protection circuits from the high voltage of the primary system. A current transformer provides a secondary current that is accurately proportional to the current flowing in its primary. The current transformer presents a negligible load to the primary circuit.

Current transformers can be mounted on the low voltage or high voltage leads of a power transformer. The CTs shall be suitable for metering purpose. The CTs shall be of ring type or window type (bar type or bus-bar type CTs shall not be accepted).

The secondary leads shall be terminated with Tinned Cooper rose contact terminals with arrangements for sealing purposes.

Fig:2.2.1 CURRENT TRANSFORMER

2.2.2 ARDUINO:

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P . It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, 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. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

ATmega328P is a high performance yet low power consumption 8-bit AVR microcontroller that's able to achieve the most single clock cycle execution of 131 powerful instructions thanks to its advanced RISC architecture. It can commonly be found as a processor in Arduino boards such as Arduino Fio and Arduino Uno.

Features:

High endurance non-volatile memory segments

- In system self-programmable flash program memory.
- Programming Lock for software security.

Peripheral features

- Two 8-bit Timer/Counter with separate prescaler, compare mode.
- One 16-bit Timer/Counter with separate prescaler, compare mode, and capture mode.
- Temperature measurement.
- Programmable serial USART and watchdog timer with separate on-chip oscillator.

Parametrics

Program Memory Type	Flash
Program Memory Size	32
CPU Speed (MIPS/DMIPS)	20
SRAM (KB)	2,048
Data EEPROM/HEF (bytes)	1,024
Digital Communication Peripheral	1-UART, 2-SPI, 1-I2C
Capture/Compare/PWM Peripheral	1 Input Capture, 1 CCP, 6PWM
Timers/Counters	2 x 8-bit, 1x 16 bit
Number of Comparators	1

Temperature Range	-40 to 85deg
Operating Voltage Range (V)	1.8 to 5.5V
Pin Count	32
Low Power	Yes

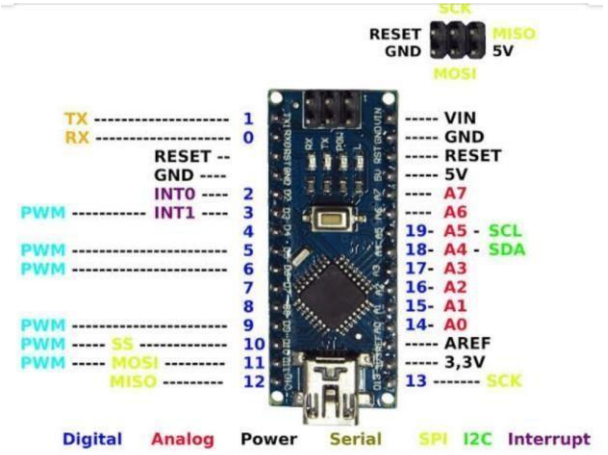


Fig:2.2.2 ARDUINO

2.2.3 LIQUID CRSTAL DISPLAY:

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, 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 ordered form similar to a crystal.

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are

coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

One each polarisers are pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction

When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters.

The LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD's don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The

LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications.

Fig :2.2.3 LIQUID DISPLAY

2.2.4 DIODE RECTIFIER:

A diode is a device which allows current flow through only one direction. That is the current should always flow from the Anode to cathode. The cathode terminal can be identified by using a grey bar as shown in the picture.

For **1N4007 Diode**, the maximum current carrying capacity is 1A it with stand peaks up to 30A.Hence we can use this in circuits that are designed for less than 1A. The reverse current is 5uA which is negligible. The power dissipation of this diode is 3W.

Fig 2.2.4 DIODE RECTIFIER

2.2.5 RELAY:

A **relay** is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple, contact forms, such as make contacts, break contacts, or combinations thereof.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

2.2.6 GSM MODULE:

The SIM900 is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS,

Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900 can fit almost all the space requirements in your M2M application, especially for slim and compact demand of design.

Fig 2.2.6 GSM module

2.3 CIRCUIT DIAGRAM:

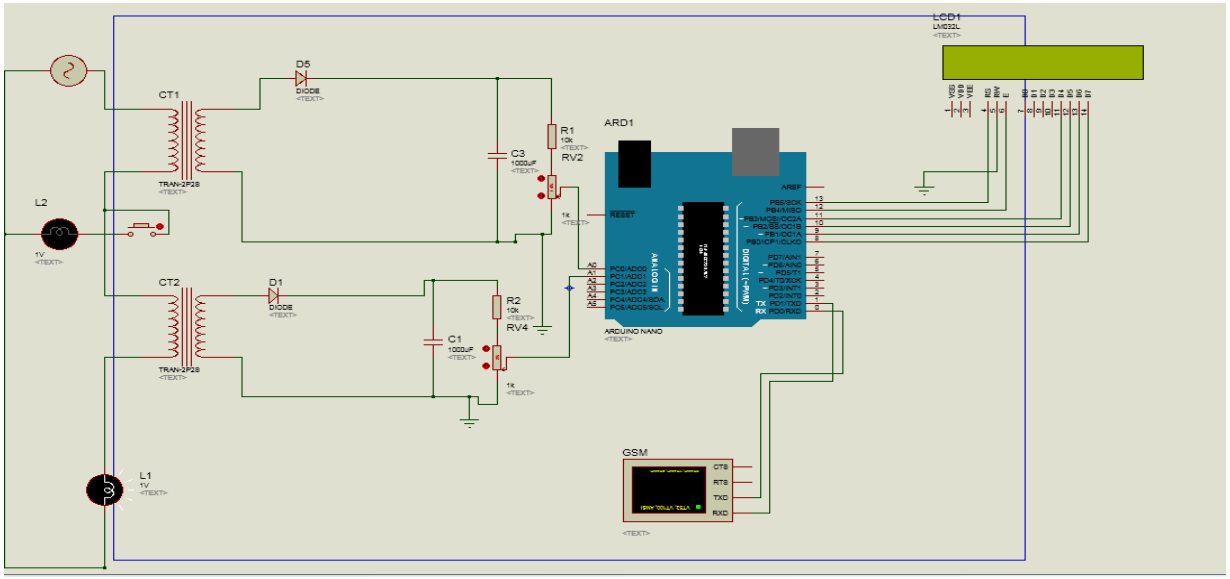


Fig 2.3 Circuit diagram

2.4 DESCRIPTION:

This project demonstrates the design of working model of Earth leakage detector using Arduino with GSM modem.

In this, the project demonstrate the design of working model of earth leakage detector using GSM modem.

In this proposed system, the new method is proposed to detect the fault with no need of manual work and the system is fully automatic.

In this project, the system is consists of 3 units

* Power unit
* Control unit
* Protection unit

In this the power unit which is mainly a power supply for the system and here we convert AC to DC current using step down transformer, diode rectifier, capacitor filter and then regulator.

In this the control unit, the fault from the current sensor is given as the input to the Arduino nano. Here we calibrate and compared the current values. If any of the values are greater the circuit will cut off.

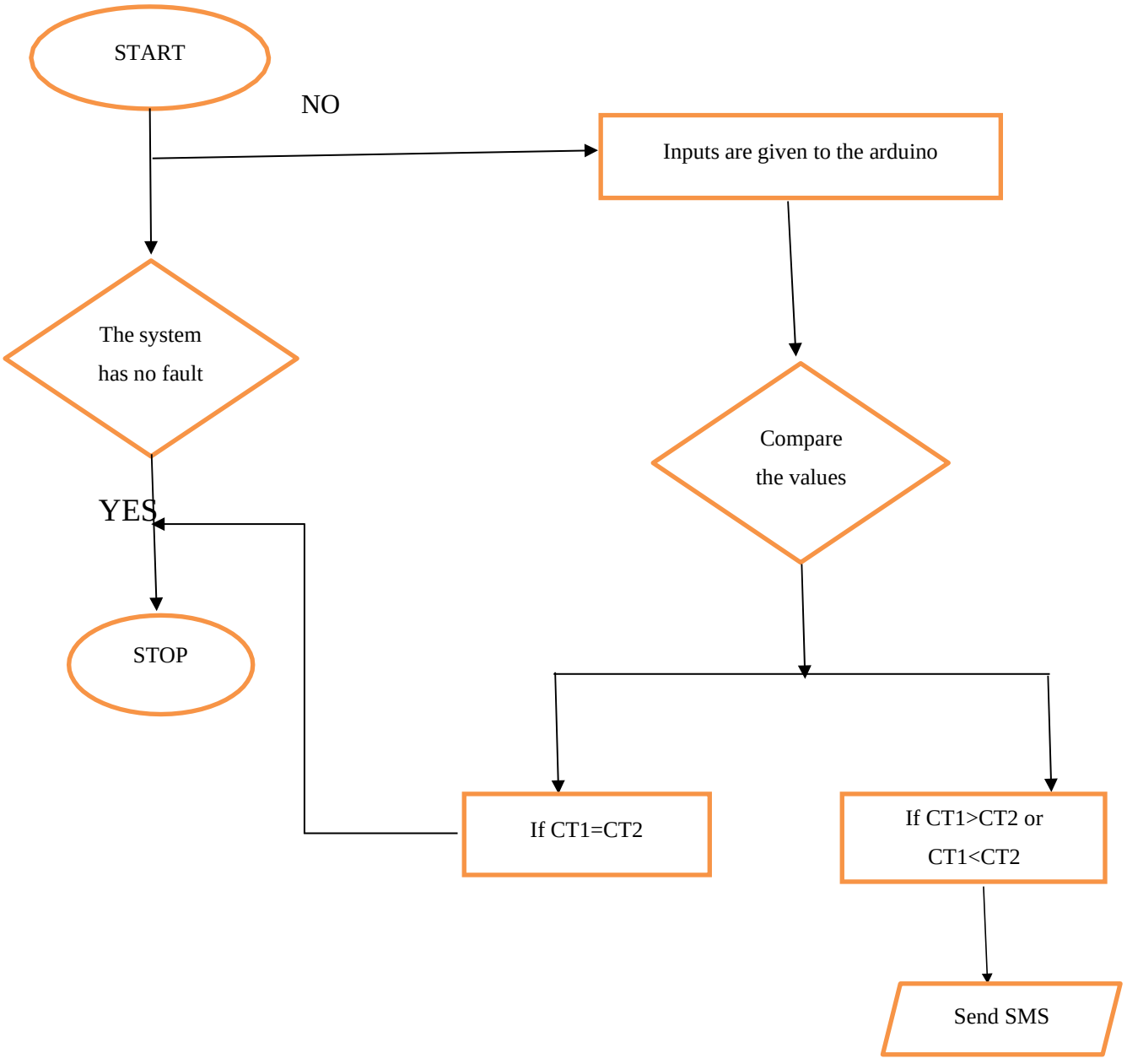
In this the protection unit, the buzzer will turn on and the LCD display indicates the earth leakage detect then the message is sent to the customer through the GSM modem.

In addition to the existing system we also using GSM module to update the status for the customer.

CHAPTER 3

IMPLEMENTATION OF EARTH LEAKAGE DETECTOR USING ARDUINO WITH GSM MODEM

3.1 FLOW CHART:



3.2 SOFTWARE IMPLEMENTATION:

The Software used are

- Proteus Professional
- Arduino IDE

PROTEUS PROFESSIONAL:

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

Schematic Capture

Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a layout project. It is therefore a core component and is included with all product configurations.

Microcontroller simulation

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool.

Full feature (ISIS) schematic capture with support for hierarchical design bus pins configurable bill of materials and much more, ISIS lies at the heart of the Proteus system, and is far more than just another schematics package. It combines a powerful design environment with the ability to define most aspects of the drawing appearance. Whether your requirement is the rapid entry of complex designs for simulation and PCB layout, or the creation of attractive schematics for publication, ISIS is the tool for the job. ISIS supports Object oriented editor with automatic wire routing and dot placement or removal.

ARDUINO IDE:

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board.

The source code for the IDE is released under the GNU General Public License. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program to convertthe executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

With the rising popularity of Arduino as a software platform, other vendors started to implement custom open-source compilers and tools (cores) that can build and upload sketches to other microcontrollers that are not supported by Arduino's official line of microcontrollers.

CHAPTER 4

RESULT AND DISCUSSION

4.1 SYSTEM SPECIFICATIONS:

Table 4.1 ARDUINO ATMEGA 328p

Input voltage	6-20 V
DC current per I/O pin	20 mA
DC current for 3.3V pin	50 mA

Table 4.2 LCD DISPLAY

Input voltage	4.7 to 5.3 V
Current Consumption	1 mA
Function	16Chr*2lines

Table 4.3 RELAY

Trigger Voltage (V across coil)	5V DC
Trigger Current (Nominal Current)	70 mA
Maximum switching	300 operating/minute

Table 4.4 CURRENT TRANSFORMER

Input Voltage (V across coil)	220V to 250V AC
Input Current	70 mA to 6A
Output Voltage	5V AC

Table 4.5 GSM SIM800A

Input voltage	5v DC
DC current per I/O pin	20 mA
DC current for 3.3V pin	50 mA

4.2 SIMULATION RESULTS:

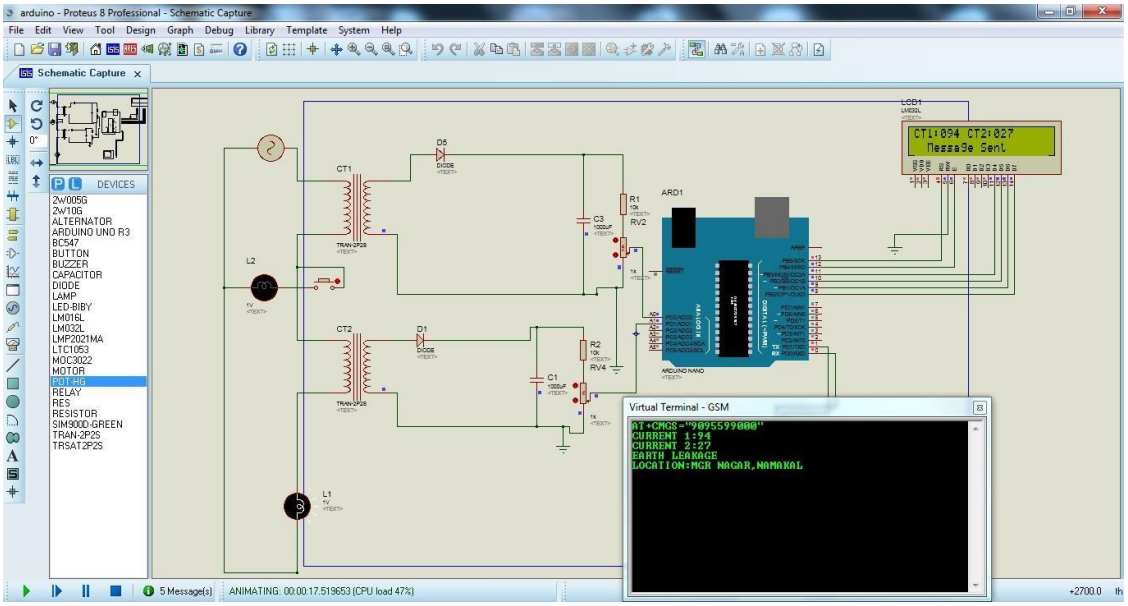


Fig 4.2 SIMULATION OUTPUT

CHAPTER 5

5.1 CONCLUSION:

In this, detecting the earth leakage system by a microcontroller is discussed. The procedure consists of building the schematic design, simulation, and software design.

A digital earth leakage detection system was designed in the environment in which processing work was carried out by the microcontroller and its results, in different situations were discussed using software simulation. Simulation tests in possible events were done. The whole system was controlled through a microcontroller which changes the analogue nature of earth leakage detection to the digital one and adds an ease and luxury at the user end.

5.2 FUTURE SCOPE:

- Can be used to detect the overload.
- Can be used in home purpose.
- This system is easy to implement and economical.
- Can be used to secure the electrical equipment from fluctuations.
- We can also increasing the delay timing.
- This project is very useful in costal area and remote location to find the earth fault.

APPENDIX

HARDWARE OUTPUT

i)NORMAL CONDITION

ii)FAULT CONDITION

iii)INDICATION THROUGH GSM

SOURCE CODE:

```
#include <LiquidCrystal.h>
#include <EEPROM.h>
LiquidCrystal lcd(13,12,11,10,9,8);
enum _actionState {
  AS_IDLE,
  AS_WAITING_FOR_RESPONSE
};
byte actionState = AS_IDLE;
unsigned long lastActionTime = 0;
//const int emg = 2; //sms key
unsigned char val[10];
unsigned char
EB,unit,amt,EB1,unit1,sec=0,se=0,yy=0,ss=0,ar=0,ae=0,ct,pt,ct1;
unsigned char xx = 0;
void setup()
{
   Serial.begin(9600);
  delay(1000);
  lcd.begin(20, 2);
   lcd.setCursor(0, 0);
  lcd.print(" EARTH LEAKAGE ");
     lcd.setCursor(0, 1);
```

```
 lcd.print("     DETCTOR    ");
 delay(2000);
 lcd.clear();
}
void loop()
{
   ct = analogRead(A0);
 lcd.setCursor(0,0);
 lcd.print("CT1:");
 Lcd_Decimal3(4,0,ct);delay(50);
 ct1 = analogRead(A1);
 lcd.setCursor(8,0);
 lcd.print("CT2:");
 Lcd_Decimal3(12,0,ct1);delay(50);
 if(ct>ct1+50)
 {
 ar=1;
 lcd.setCursor(0,1);lcd.print("   EARTH LEAKAGE      ");
 delay(2000);
   send_msg1();
    }
 else {
   ar=0;
 lcd.setCursor(0,1);lcd.print("     NORMAL      ");
   }
```

```
}
void decimal2(char a,char b,unsigned char val)
{
  char x0;
  lcd.setCursor(b,a);
  lcd.write((val/100)+0x30);
  x0=val%100;
  lcd.setCursor(b+1,a);
  lcd.write((x0/10)+0x30);
  lcd.setCursor(b+2,a);
  lcd.write((x0%10)+0x30);
}
void Lcd_Decimal3(unsigned char com,unsigned char com1,unsigned int val)
  {
     unsigned int Lcd_h,Lcd_hr,Lcd_t,Lcd_o;
     lcd.setCursor(com,com1);
     Lcd_h=val/100;
     Lcd_hr=val%100;
     Lcd_t=Lcd_hr/10;
     Lcd_o=Lcd_hr%10;
     lcd.setCursor(com,com1);
     lcd.write(Lcd_h+0x30);
     lcd.setCursor(com+1,com1);
     lcd.write(Lcd_t+0x30);
     lcd.setCursor(com+2,com1);
```

```
    lcd.write(Lcd_o+0x30);
  }
  void gsm_init()
{
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(" Gsm Initialize ");
  Serial.println("AT"); // ATTENTION COMMAND
  delay(2000);
  Serial.println("AT+CMGF=1"); // COMMAND MESSAGE FORMAT=1-
>TEXT MODE
  delay(1000);
  Serial.println("AT+CNMI=2,2,0,0,0"); // COMMAND NEW MESSAGE
INDICATION
  delay(1000);
  Serial.println("AT+CREG=2"); // TOWER CHECK
  delay(1000);
  lcd.setCursor(0, 0);
  lcd.print("GSM Init Over... ");
  delay(1000);
  lcd.clear();
}
    void send_msg1()
{
   lcd.setCursor(0,1);
   lcd.print("Sending Message");
```

```
    Serial.print("AT+CMGS="); delay(100);
    Serial.write("");
    Serial.print("9095599000");
    Serial.write("");
    Serial.write(0x0d);Serial.write(0x0a);
    delay(1000);
     Serial.print("CURRENT 1:");
    Serial.println(ct);delay(50);
    Serial.println(ct);delay(50);
    Serial.print("CURRENT 2:");
    Serial.println(ct1);delay(50);
    if(ar==0){Serial.println("NORMAL");}
    if(ar==1){Serial.println("EARTH
LEAKAGE");Serial.println("LOCATION:MGR NAGAR,NAMAKAL");}
    Serial.write(0x0d);Serial.write(0x0a); delay(1000);
     lcd.setCursor(0,1);
    lcd.print(" Message Sent ");
    delay(1000);
    lcd.clear();
}
void serial_Decimal3(unsigned char val)
  {
      unsigned int Lcd_h,Lcd_hr,Lcd_t,Lcd_o;
      Lcd_h=val/100;
      Lcd_hr=val%100;
```

```
        Lcd_t=Lcd_hr/10;
        Lcd_o=Lcd_hr%10;
Serial.write(Lcd_h+0x30);
        Serial.write(Lcd_t+0x30);
        Serial.write(Lcd_o+0x30);
```

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[5] "Three Phase Fault Analysis with Auto Reset for Temporary Fault and Trip for Permanent Fault",Sathish Bakanagari1, A. Mahesh Kumar2, M. Cheenya3 12(Asst.prof in EEE Department) 3(Asst.Prof in ECE Department) Mahaveer Institute of Scienceand Technology, bandlaguda, Hyderabad.A.P.