Earth Fault Relay for Single-Phase System

Rana Ahsan (15-EE-76)

Muhammad Idrees (15-EE-88)

Falak Sher (15-EE-96)

Taimoor Anwar (15-EE-120)

July 2018

Department of Electrical Engineering

UNIVERSITY OF ENGINEERING AND TECHNOLOGY

TAXILA– PAKISTAN

Abstract

Earth-fault relay is used to protect against faults involving ground. Typically, earth faults are single line to ground and double line to ground **f**aults. For the purpose of setting and coordination, only single line to ground faults are considered.Earth fault or leakage of current is a very common problem in electrical circuits. This leads to unnecessary power loss. The purpose of this project is to develop a system that senses the earth fault in single-phasing system and alerts the user about it. The similar sensing mechanism also can be employed in 3-phase system. The main part of the project is current sensors for sensing the amount of current flowing through the circuit. A microcontroller based control system continuously monitors the amount of current passing through the circuit. In ideal conditions the amount of current passing through the phase and neutral should be same. In case of earth fault, the amount of current entering into the circuit will not be equal to the current leaving the circuit and current sensor will sense the leakage current. In such situations the microcontroller-based system alerts the user about this in the form of text on LCD and the whole system will shut down on the occurrence of earth fault.

Table of Contents

1. Objective

Our objective in this project is to design and construct an earth-fault relay which will detect instantaneous earth fault or line-to-ground fault which is vital domestically and industrially where earth-fault monitoring or power loss avoid system is required.

2. Introduction

The purpose of earth fault protection is to measure the earth leakage current of an electrical installation, or part of an installation and interrupt the supply of power if this current becomes dangerous to life or property. This project is of vital importance regarding learning aspects because it provides exposure on, Initialization of ADC module of Arduino,Current sensors interfacing to Arduino and relay interfacing with Arduino etc.

3. Design Description

The details are simple to understand. Our main purpose was to sense the faulty current for this purpose we use current sensor ACS712 which can sense current up to 5A.The output of ACS712 was given to microcontroller's analog pin to read. By considering its analogread value we were able to control the relay and hence achieving the target to get full control over power system.

3.1 The Current Sensor (ACS712)

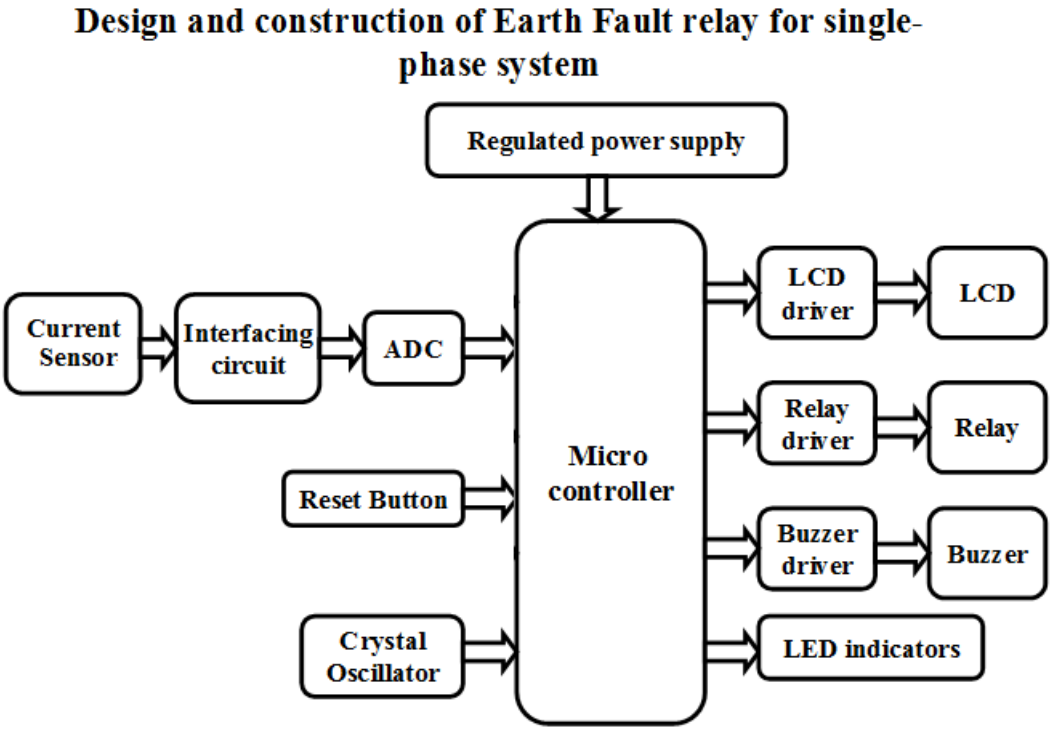
ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. These are good sensors for metering and measuring overall power consumption of systems. The ACS712 current sensor measures up to 5A of DC or AC current. The ACS712 Low Current Sensor Breakout outputs an analog voltage that varies linearly with sensed current. It must be connected in series. We interfaced it with Arduino.

Specifications:

Current Limit: 5A
Sensitivity: 185 mV/A
VCC=5V
VOUT=Output Pin

3.2 Circuit Diagram

Following is the circuit diagram



3.3 Relay

A relay is classified into many types, a standard and generally used relay is made up of electromagnets which in general used as a switch The main operation of this device is to make or break contact with the help of a signal without any human involvement in order to switch it ON or OFF. It is mainly used to control a high powered circuit using a low power signal. Generally a DC signal is used to control circuit which is driven by high voltage like microcontrollers. We interfaced it with Arduino

Relay

Relay Module

3.4 Code

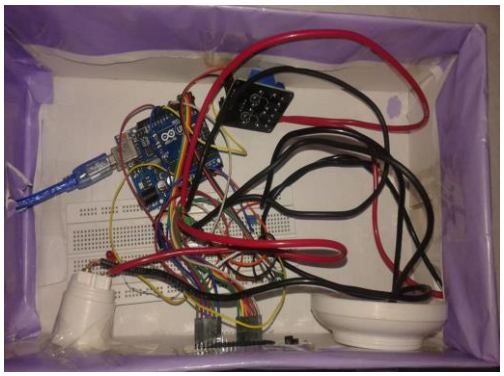
```
// include the library code:
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);  //lcd(rs,en,d4,d5,d6,d7)
const int sensorIn = A0;
const int led1 = 8;
const int buzzerpin=6;
int mVperAmp = 185; // use 100 for 20A Module and 66 for 30A Module
double Voltage = 0;
double VRMS = 0;
double AmpsRMS = 0;
#define relay1 10
void setup()
{
  lcd.begin(16, 2);
  pinMode(relay1, OUTPUT);
  pinMode(led1, OUTPUT);
  pinMode(buzzerpin, OUTPUT);
  Serial.begin(9600);
}

void loop()
{
  Voltage = getVPP();
  VRMS = (Voltage / 2.0);
  AmpsRMS = (VRMS * 1000) / mVperAmp; //multiply by 1000 for converting into ,milliivolts
  Serial.print(AmpsRMS);
  Serial.println(" Amps ");
  if (AmpsRMS ==0)
  {
    Serial.println(AmpsRMS);
```

```
   digitalWrite(relay1, HIGH);  // NC: means normally high when relay is off,
   lcd.setCursor(0, 0);
   lcd.print("No Earth fault!");
   delay(1500);
  // lcd.print("or L.C!");
   delay(1500);
   lcd.setCursor(0, 1);
   lcd.print( "SYSTEM is OK");
  }
  else
  {
   Serial.println(AmpsRMS);
   digitalWrite(relay1, LOW);
   digitalWrite(led1, HIGH);
   tone(buzzerpin,3000);
   lcd.setCursor(0,0);
   lcd.print("Leakage current!");
   delay(1500);
   lcd.print("~Earth fault~");
   lcd.setCursor(0,1);
   lcd.print( "SYSTEM is FAULTY");
   delay(1500);
   lcd.print( "Please Check");
   delay(120000);

  }
  delay(500);
  //for(;;); terminates the loop
}

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; // 5 is the resolution factor for volts to get mv
multyply by 5000
  return result;
}
```

4. Hardware Results

Our objective has accomplished. Following are the results.



5. Applications

- Domestic earth fault monitoring.
- Single phase industrial protection.
- Avoids power loss.
- Avoids unnecessary tariff.

.

6. Recommendations

Earth fault relay is being used in domestic purpose as well industrial therefore its importance can never be denied. So if in future someone else tries to implement it, he/she should focus on finding the exact location of earth fault or leakage current & the amount of leakage current.

7. Conclusion

Earth fault relay is basically a protection device used selectively for earth fault protection. These can be used for both primary and backup protection in an electrical system.

8. References

[1] "Jacobs Online," 2008. [Online]. Available: http://jacobs-online.biz/power_supply_design.htm. [Accessed Dec 2017].

[2] "Hotwire Systems," Hotwire Systems OÜ Ltd, n.d.. [Online]. Available: http://www.hotwiresystems.com/?gclid=EAIaIQobChMImZmywt3I2AIVBhIbCh1FGAhcEAMYAiAAEgIndfD_BwE. [Accessed dec 2017].

[3] i. L. C. team, "instructables," Autodesk, 2005. [Online]. Available: http://www.instructables.com/id/Guitar-String-Hot-Wire-Cutter/. [Accessed Dec 2017].

[4] i. L. C. team, "instructables," Autodesk, 2005. [Online]. Available: http://www.instructables.com/id/Simple-Styrofoam-Hot-Wire-Cutter/. [Accessed Dec 2017].

[5] Faculty, "msd," n.d.. [Online]. Available: https://msd.unimelb.edu.au/hot-wire-foam-cutter. [Accessed Dec 2017].