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Power Theft Detection Using Arduino

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Abstract- *The power thievery has become a critical problem in today's electrical power system in India. It results in huge economic losses and also leads to irregularity in the power distribution system. In highly populated country like India where power necessity is being consistently rising, power theft is a very severe problem. Presently 16.6% of the total power generation in India is being robbed which brings down the total revenue of the power generating companies. It is very inconvenient to check power meters door to door. This paper suggests a method to monitor and keep a check over power theft using microcontroller Arduino and SMS module. Whenever there will be any disturbance in power or tampering of energy meter an alert message will be conveyed to the authorities and the power will be tripped off. The system comprises of current transformers connected between the poles, lines and houses to detect the power flow disturbance and various relay modules are also connected to the line to cut-off the supply when the thievery is detected.*

Key Word: *Theft Detection, Arduino, Power Theft, SMS.*

I.INTRODUCTION

In the present scenario all the electrical protection systems are based on electro mechanical devices. In many other countries, the losses due to power theft, is much higher as a percentage of the total power generated by grid [1]. There are lots of methods used by consumers to thief power from the grid [2]. A very common approach is bypassing the energy meter completely [3].Though these systems are quit reliable and cheaper, it has certain disadvantages. The electro mechanical protection relays are too bulky and needs regular maintenance. The multi functionality is out of question. The differential relay protects the zone of the transmission line [4]. The specialty in this project is the design is made on Atmega328 micro controller, which is faster and controls the relay. This protection is developed on basic components. If the relay will be developed with same facility by electro mechanical component, then the cost and size of the device will be too high. The controller is embedded with all the components [5]. The controller is the heart of the device and there are other hardware used for signal conditions and comparison. In this relay there are two current setting and it can hand maximum up to 15A current.

II.DESIGN PRINCIPLE

This relay works on the principle of current sensing. There are two special type of current sensors used to sample current. The output of both the current transformer are compared and found if both the C.Ts are reading the same current then the transmission line connected between the C.Ts is found to be normal and there is no fault. Whenever there is a line to ground fault in the protected zone, then the current bleed on the short circuited path so the reading of both the C.T. s differs that output is taken into the microcontroller [6]. And microcontroller actives the relay and buzzer with a SMS alert with the help of a HC-05 Bluetooth module.

III.BLOCK DIAGRAM

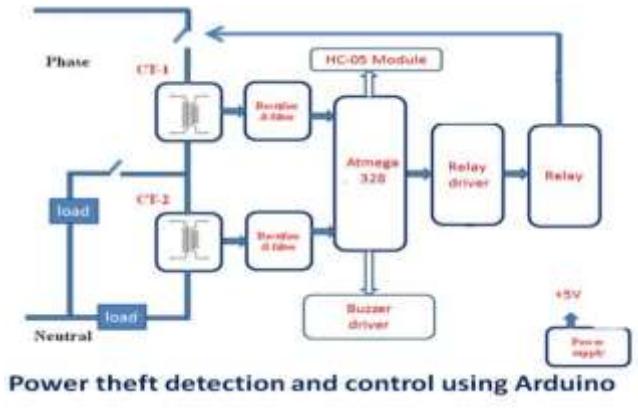

Fig no 1: Block Diagram for Power Theft Detections System

IV.CIRCUIT DIAGRAM

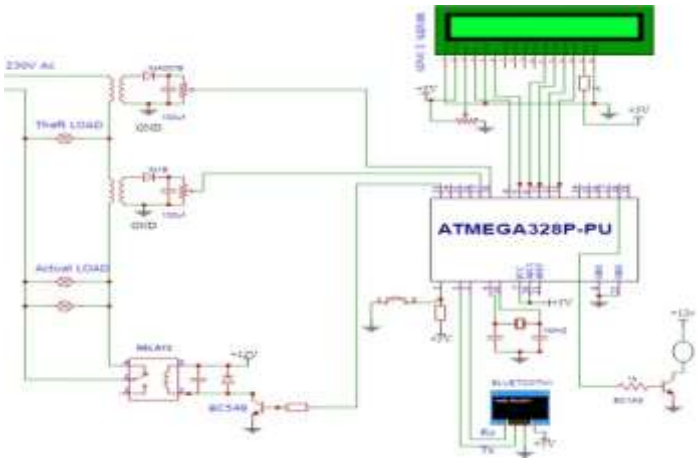

Fig no 2: Circuit Diagram of Power Theft Detections System

Circuit description Power supply in this project the power supply required is very much precession and also requires different level of power supply. Basically the power supply used for the transmitter and receiver is arranged from a battery. Along with the battery the power supply requirement is +5Volts. The power supply designed for providing a fixed demand connected in this project. The basic requirement for designing a power supply for this project is as follows,

1. The different voltage levels required for operating the circuit. Here +5Volt required for operatingmicrocontroller and other components connected in this circuit.

2. The current requirement of each device or load connected in circuit is must be added to calculate the finalcapacity of the power supply [7].

The power supply always simulated with one or multiple voltage outputs along with a current capacity. As it isestimate the requirement of power is approximately as follows,

Output Voltage = +5Volt.Capacity = 1000mA.

The power supply is basically containing 3 sections as follows,

1. Step down section
2. Rectifier section
3. Regulator section

V.CIRCUIT CONNECTION

In this project we are using Transformer rating (0 to 12) vac, 1 amp, IC 7805, diodes IN 4007, LED & resistors. 230V, 50 Hz ac signal is given as input to the primary side of the transformer and the secondary side of the transformer is given to the bridge rectification diode. The output of the diode is given as input to the IC regulator (7805) through capacitor rating of (1000mf/35v). The o/p of the IC regulator is given to the LED through resistors.

VI.CIRCUIT EXPLANATIONS

Firstly, when ac signal is given to the primary side of the transformer, due to the magnetic effect of the coil magnetic flux is induced in the primary coil. And transfer to the secondary coil of the transformer due to the transformer action. ”Transformer is an electromechanical static device which transformer electrical energy from one coil to another coil without changing its frequency” [8]. The diodes are connected in a bridge. The secondary coil of the transformer is connected to the bridge circuit for ac to dc conversion.

Operation of this circuit is defined as “During the +ve cycle of the ac signal the diodes D2 & D4 conduct ascribed to the forward bias of the diodes and diodes D1 & D3 does not conduct ascribed to the reversed bias of the diodes. Similarly during the –ve cycle of the ac signal the diodes D1 & D3 conduct ascribed to the forward bias of the diodes and the diodes D2 & D4 not conduct ascribed to reversed bias of the diodes”. The output of the bridge rectifier also contains rippled ac. To control this effect, capacitor is connected to the output side of the diodes D2 & D3. Which removes the unwanted ac signal

and thus a pure dc is obtained by the rectifier. We are using IC regulators (7805) to fix the output. "Voltage regulation is a circuit that supplies a constant voltage across the changes in load current." This IC's are fixed voltage regulators and with sufficient heat sinking can deliver output current in excess of 1A. The bridge rectifier output is given as input to the IC regulator through the capacitor with respect to ground and consequently a fixed output is obtained. The IC regulator output is given to the LED for indication point of view through resistor. Due to the forward bias of the LED, the LED glow which is considered as ON state and the output are obtained from the microcontrollers pin no. 3.

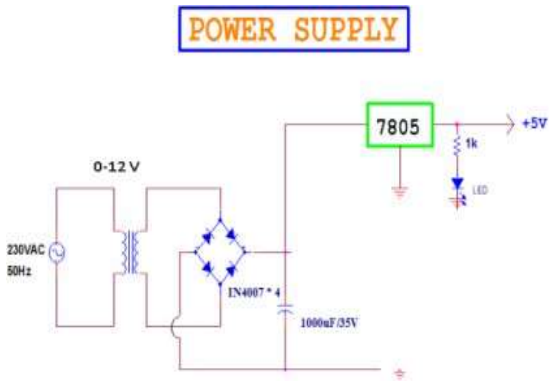

Fig no 3: Power Supply

VII.COMPONENTS

1. Arduino UNO (Atmega328p)

The Arduino UNO is an electronic device which is open-source microcontroller board based on Microchip ATmega328P microcontroller. The board is provided with sets of digital and analog (I/O) pins that may be port to various expansion boards (shields) and other circuits. This microcontroller consists of 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a USB cable (Type B). It is powered by a USB cable or by an external 9 volt battery supply. Its acceptable voltages are lies between 7 to 20 volts [9].

Fig no 4: ATmega328P microcontroller

Technical specifications

Microcontroller: Microchip ATmega328P
Operating Voltage: 5 Volt
Input Voltage: (7 - 20) Volts
Digital I/O Pins: 14 (6 pins provide PWM output)
Analog Input : 6 pins
DC Current per I/O Pin: 20 mA DC
Current for 3.3V Pin: 50 mA
Flash Memory: 32 KB (0.5 KB used by bootloader)
SRAM: 2 KB
EEPROM: 1 KB
Clock Speed: 16 MHz
Length: 68.6 mm
Width: 53.4 mm
Weight: 25 gram

2. Over current detector

This is a circuit designed to detect over current. The special type of CT is used to detect very low current. The output of this CT is an AC voltage proportional to the Load current. The CT output voltage varies with load current [10]. That output voltage rectified and given to a same voltage comparator where, we set the load limit.

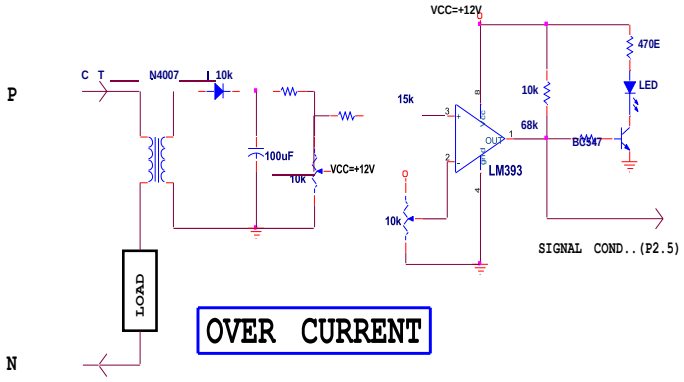

Fig no 5: Over Current Detector

3. Buzzer driver

This section interfaces one audible Piezo electric buzzer with the controller. The controller activates thebuzzer whenever there is any fault appears in any of the channel.

BUZZER DRIVER

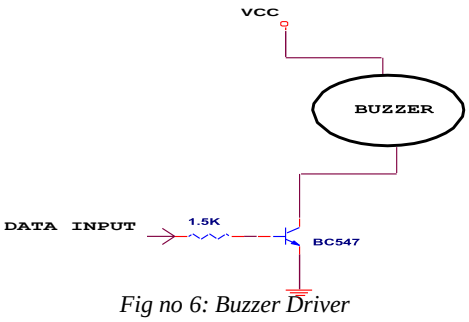

Fig no 6: Buzzer Driver

4. Piezo electric buzzer

The Piezo electric buzzer that converts electrical signal to an audible signal (sound signal).The Microcontroller cannot drive directly to the buzzer, because the Microcontroller cannot give sufficient current to drive the buzzer for that we need a driver transistor (BC547), which will give sufficient current to the buzzer. Whenever a signal received to the base of the transistor through a base resistance is high, the transistor comes to saturation condition i.e. ON condition thus the buzzer comes to on condition with sound effect.

5. Relay and its driver

BC547 transistor is using to design the relay driver which we used in this project.

Specification:

Coil resistance =400ohm Coil voltage=12Vdc Contact capacity=230V, 7A

This given driver specification indicates that the coil requires 12V dc and 200mA dc current. More than 10mA current is not possible to supplied by microcontroller. So driver section is very much required. BC547 driver has a typical current gain of 200A and 1A of maximum current capacity. Therefore base current of 200 μA can trigger to on the relay.

RELAY DRIVER

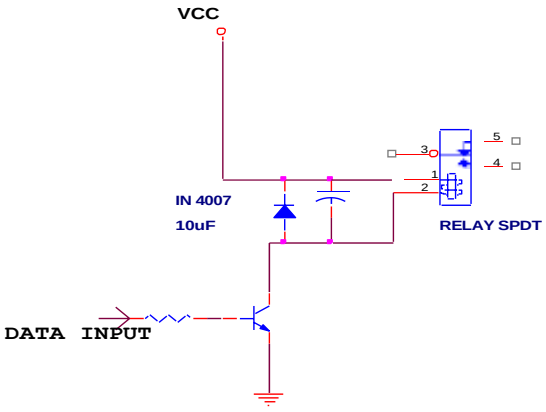

Fig no 7: Relay Driver

1. LCD Panel

LCD panel is formed by comprises of two patterned glass panels in which between two patterned glass crystal is filled under vacuum. The glass thickness varies according to end use. Most of the LCD modules have 0.70mm to 1.1mm glass thickness.

Normally these liquid crystal molecules are placed between glass plates to form a spiral staircase to twist the twist the light. Hence the LCDs are also called as optical switches. These LCD cannot display any information directly. These act as an interface between electronics and electronics circuit to give a visual output.

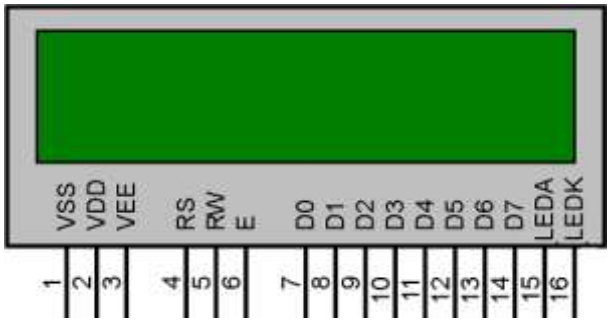

Fig no 8: LED Panel

2. HC-05 Bluetooth module

The HC-05 module is using Serial Port Protocol module, it can easily designed for transparent wireless serial connection setup. SSP is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

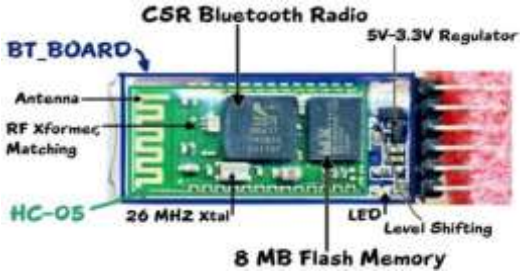

Fig no 9: HC-05 Bluetooth module

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Hardware features :
Typical -80dBm sensitivity
Up to +4dBm RF transmit power
Low Power 1.8V Operation ,(1.8 - 3.6) Volt I/OPIO control
UART interface with programmable baud rateWith integrated antenna
With edge connector

VIII.CODE

```
#include <LiquidCrystal.h>
// Numbers of the interface pins is initialize.
LiquidCrystal lcd(2,3,4,5,6,7);
int sw1;
int sensorPin=A0; int
sensorPin1=A2;
int sensorValue22 = 0;int
sensorValue11 =0; const int
buzz=A1; const int motor=12;
const int  ledR=8; char
inChar=0;
void setup() {
// Type setup code here, to run once:
lcd.begin(16, 2); pinMode(buzz,OUTPUT);
pinMode(motor,OUTPUT);
pinMode(ledR,OUTPUT);
digitalWrite(buzz,LOW);
digitalWrite(ledR,LOW); Serial.begin(9600);
lcd.clear();
lcd.setCursor(0, 0); lcd.print("Connect
Bluetooth");delay(2000);
lcd.clear(); lcd.setCursor(0,
0);
lcd.print("Theft detection");
lcd.setCursor(0, 1); lcd.print("
System");
}
void loop() {
delay(10);
if(sensorValue11 > sensorValue22 )
{ digitalWrite(buzz,HIGH);
digitalWrite(ledR,HIGH);
lcd.clear(); lcd.setCursor(0, 0);
lcd.print("Theft detected");
lcd.setCursor(0, 1);
lcd.print("Message sent");
Serial.print("Theft detected, Copy and paste the value on google map for Location - 22.942616,86.0167349");delay
(1000);
}}
```

IX.CONCLUSION

This project is working perfectly in the laboratory condition and it can handle a current up to 30A. Adjusting the reference voltage can control the current that is set as maximum current. The relay is tested by putting a bleeder lamp in the line.

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