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Wireless Power Theft Monitoring and Controlling Using IOT

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Abstract: ***In this paper we are going to discuss about the reduction of power theft in the distribution region from the substation. Power theft is generally a major problem which was started since the distribution of electricity. There are various methods used to perform theft such as Direct hooking from the service line, by-passing the electric meter, Injecting foreign element in the electric meter, physical obstruction and so on. Due to the power theft the demand on electrical energy raises which results in increase in cost per unit charges. To avoid the power theft we are using a current transformer and a microcontroller in the energy meter which can only be operated by the department officials. The current-transformer detects the flow of electricity in the line and sends the feedback to the microcontroller which will cut-off the supply. This process is very easy to adapt and one person can handle all the zonal supplies in the region. By this method we control the non technical losses and also reduce the man power and also the consumption of time.***

Keywords: power theft, current transformer, microcontroller

1. Introduction

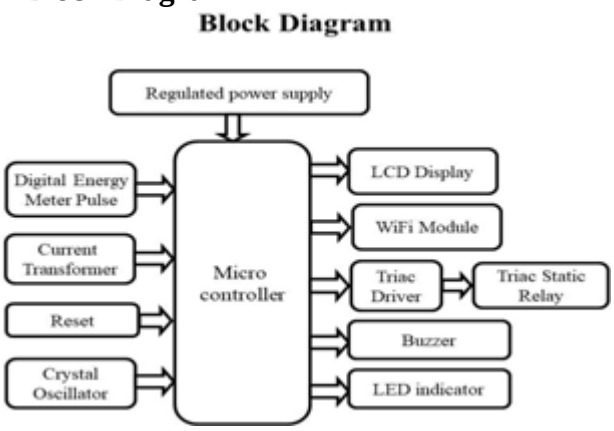
The first electrical power transmission using line connection was started in the year 1889. The power was transmitted between generator station at Willamette falls in Oregon and Chapman square in downtown of Portland. The distance between the supply and load was 13miles. Since then the supply of electrical energy is started and became a regular need of survival [1]. In order to obtain those luxuries people, require electrical energy which resulted in theft of electrical energy. The losses caused in electricity due to theft are classified to be known as non-technical losses. These losses determine the amount of loss in electrical energy due to theft [2]. According to a survey there was a loss of 89.3 billion USD in all over the world in a year. The major part of the losses was taking place in India its almost 16.3 billion USD and then next ranked by brazil and Russia [3]. Most of the power theft is observed due to the by-passing of electricity [4]. In order to avoid such theft we prefer to use the power theft monitoring system and controlling using IOT (Internet Of Things) [5]. In our project we use a PIC Microcontroller, a current transformer, WIFI Module (ESP8266) and other electrical elements to detect the flow of power and stop the supply. This method is used to reduce the work of an individual and produce a maximum output of detecting the power theft. Whenever the power theft is detected, the supply would be cut off from the source. This helps in minimizing the power theft in an area and maintains good supply.

2. Objective and Work Flow

The main motive of our project is to reduce the constant raising of the power theft which had become one of a general source of supply in electrical distribution. Most of the generated electricity is being theft which is resulting in increasing of cost per unit charge. In order to have luxuries in life with less efficiency of cost, some are using this kind of illegal methods such as by electric hooking, bypassing the electric meter and more. These methods come under illegal supply of power and the losses are known as the non-electrical losses. In most of the cases the bypassing of electric meter is most commonly used method. Hence have concentrated on the performance of bypassing the electric meter and came to a solution which secures the supply chain in the electrical distribution.

- Initially the detection of power supply through the line and energy meter is observed. If theft detected the supply line is turned off in the system.
- Whenever detected the microcontroller in the circuit send the command to stop the flow of power through the line.
- The buzzer in the circuit gives an alert signal of audio sound to the nearby surrounding which could give an irritating issue to the consumer.
- The WIFI module is used to detect the amount of electrical energy is consumed based on our consumption.
- With this model we can detect the theft and disconnect the supply with the help of relay, we can also alert the theft detection through web messages and we can observe the amount of units consumed per house based on usage

3. Block Diagram



The above block diagram mentions the entire system important components and the connection between the microcontroller and the other components.

Major components of the system

1) Digital Energy Meter
2) Current Transformer
3) Regulated Power Supply
4) Resistors and LED's
5) LCD display
6) Buzzer
7) TRIAC Static Relay
8) WIFI Module
9) PIC Microcontroller
10) Optocoupler
11) Reset Button

Digital Energy Meter

A digital energy meter or a electric meter is an electronic device used to measure the amount of electric unit charge consumed by the consumer or the customers. We generally consume electrical energy to obtain luxuries in our day to day life. The amount of consumption of electrical energy is observed using a energy meter so that the cost of electrical energy can be determined.

Energy meters are generally measured in the terms of billing units. The most commonly used units are kilowatt hour. The kilowatt hour gives the amount of energy consumed for a load of one kilowatt over a period of one hour. Power demand is normally measured in the terms of watts. Depending upon the demand the cost per unit varies in some areas. The energy meters are created in the year 1889 in hungary. Now after these many years the meters are developed and upgraded which results in addition of new implements in the meter.

In order to avoid the electrical energy consumption cost consumers bypass the digital electric meter in most of the cases by short circuiting the energy meter. As the energy meter is short circuited the supply of electrical energy is still consumed by the consumer but the consumed units are not recorded which results in no supply of electrical energy in the meter.

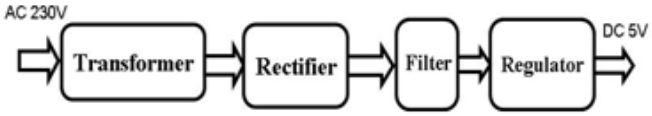
Current Transformer

Transformer is an electronic device used to transfer the electrical energy from one alternating current circuit to another alternating current circuit by increasing or decreasing the voltage. A current transformer is used to produce alternating current in its secondary winding of the circuit proportional to the primary winding of the circuit. Generally in a current transformer the numbers of turns in the primary winding are very low which was nearly one or two turns. This results in the difference between voltage or power in primary and secondary winding.

Here we are using the current transformer in order to detect the flow of electrical energy in the wires. Whenever there is electrical energy passing through the wire the current transformer detects the flow of electrical energy due to the primary windings. Thus the current transformer after detecting the electrical energy, it sends the signal to the microcontroller. As the signals are received, the microcontroller cutoff the supply to the consumer.

Regulated Power Supply

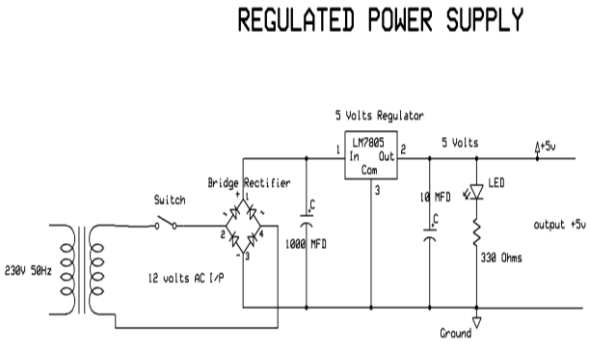
A regulated power supply is a circuit that converts variable AC supply to a constant DC supply. Regulated power supply mainly consist of a transformer, rectifier, filter and a voltage regulator.



In this project we are using

- 230V AC MAINS
- TRANSFORMER
- BRIDGE RECTIFIER (DIODES)
- CAPACITOR
- VOLTAGE REGULATOR (IC 7805)
- RESISTOR
- LED (LIGHT EMITTING DIODE)

The circuit diagram of the RPS system



Detailed explanation of each and every component as follows

Transformer

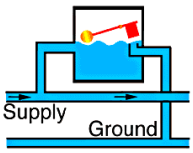
A transformer is a device that transfer electrical energy from one electrical circuit to another electrical circuit or more than one electrical circuit by increasing or decreasing the voltage from the supply. In this project we are using a step down transformer where the given 230v AC input is given to the transformer to give an output of 12v AC output.

Bridge Rectifier

Rectifiers are used to convert the oscillating alternating currents (AC) to a single lined direct currents (DC). In rectifiers, the bridge rectifier is mostly preferred due to the high efficient output produced. A bridge rectifier consist of 4diodes mainly resistors and to improve the output of the rectifier a filter is used inside of the bridge rectifier circuit. In bridge rectifiers the output is very smooth compared to half-wave rectifiers. Bridge rectifiers produce full-wave output to the system. First half of the wave is produce by D1 and D3 of the circuit which acts as forward bias and the second half of the wave is produced by D2 and D4 of the circuit which results in production of complete full-wave output of the system. The center tapped full-wave rectifier also produce a complete output to the given input of the cycle but the cost and size of the bridge rectifier is very low when compared to a center tapped full-wave rectifier.

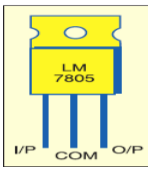
Capacitor

In this circuit the capacitor is used as a filter where it converts the pulsating or non-constant DC to a pure or single lined DC supply. Generally a capacitor filters low frequency signals. The filters are used to remove the unwanted frequency in the give input signal and also perform the signal processing function. Capacitor consist of two plates separated by air or a dielectric material. It stores the energy in the form of electro static field. Generally capacitors stop the flow of DC signal and allows AC signal through them. Due to presence of insulating layers in the capacitor the layers do stops the flow of voltage instead the voltage is stored in between the layers in the form of electric charge. Capacitor hold the charge until the applied voltage is reached in the capacitor and release the flow of electrical charge through the capacitor while the ripples in the supply are passed through the ground in the circuit. Thus the capacitor produces a constant steady flow supply in the circuit. Here we are using a 5v as Vcc in the circuit.



Voltage Regulator

Voltage regulator is a circuit that used to produce an output of fixed constant voltage irrespective of variations in the input of the circuit. Voltage regulators are used for DC to DC power conversion or in some cases AC to AC power conversion or AC to DC power conversions. We are using a voltage regulator for DC to DC conversion in our circuit. Voltage regulators are robust and easily available in many different levels of output, based on our requirement we use a regulator. Most commonly available types in market are 5V, 6V, 9V, 12V and 15V. And also to obtain positive output from the voltage regulator LM78XX series voltage regulator is used where as to obtain a negative output from the voltage regulator LM79XX series voltage regulator. We are using a LM7805 voltage regulator that produces a positive output of 5volts. This voltage regulator consists of three pins with a input, a ground and a output pin. Input pin receives the incoming DC supply, ground pin is used for sudden supply of power to the circuit and output pins sends +5volts to the given input in the regulator. The output of the regulator can be increased by using a pair of voltage divider with a resistor in the circuit but we require only +5volts supply of output from the voltage regulator.

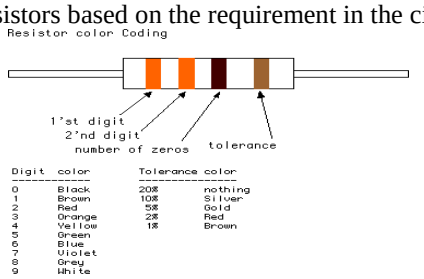


Resistor

Resistor is an electrical component that consists of two terminal in it. The resistors are mainly used to limit the flow of current or regulate the flow of current in the circuit. The ability to reduce the flow of current is know as resistance. These resistors are also used to provide a specified voltage as output for active devices. According to ohms law, a resistor is an electronic component that produced voltage across its terminals is proportional to the electric current passing through it.

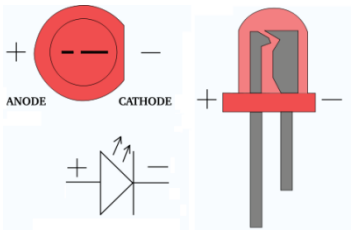
$$V = IR$$

Resistors can be made up of various types of components and films as well as resistance wire where the wire made up of highly resistivity alloy. Depending on the required resistance the alloy is used. The basic characteristics of a resistor are resistance, tolerance, maximum working voltage, power rating, temperature coefficient, inductance and critical resistance. Combination of resistors with resistors or other components are used to control the flow of current, work as a voltage divider, to dissipate power and also sometimes used to shape the electrical waves. We are using 6 different types of resistors based on the requirement in the circuit.



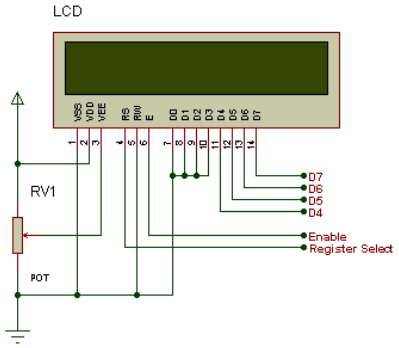
LED (Light Emitting Diode)

The light emitting diode is a semiconductor device that used to emit light when the current passes through the diode. LED is a p-n junction diode that produces light through it when activated. Generally LED's are used as light indicators in the circuit. LED's are used to check whether in the given circuit the current flows through the line or not. The electrons placed in the semiconductor recombine with the electron holes in the semiconductor and releases energy in the form of photons and emits light through the device. The color of light is determined by the energy required by the photons to cross the band gap between the semiconductor. In early years of development of circuits, LED's used to emit only low intensity of light namely red color light after several decades now LED's can emit across the visible region, ultraviolet and in infrared wave length with high brightness. LED's are highly efficient and give a long life source. In our circuit we are using LED's to check the flow of current through it, since they require very low input supply.

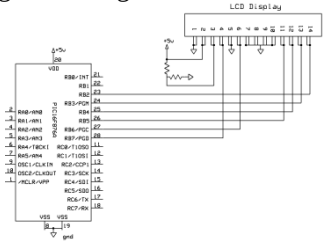


LCD Display

The LCD (Liquid crystal display) is a display device that uses liquid crystals for its functioning. General LCD used in the market are 16 x 2lcd or 20 x 2lcd which means 16 or 20 characters per line containing two lines display. LCD display consists of 14 pins in it. Each pin is used for different purpose. Based on the usage each pin is connected and the rest are connected to ground. All the instructions to the LCD display are sent through a microcontroller with different connections connected to it.



- Pin 1 in LCD display is Vss-used for negative power supply or ground.
- Pin 2 in LCD display is Vcc-used for positive power supply.
- Pin 3 in LCD display is Vee-used to change the brightness in the screen.
- Pin 4 in LCD display is RS-Register Selector pin D0-D7 pins instructions depends on this pin whether the given input is a instruction or a character.
- Pin 5 in LCD display is **R/W – this pin enables the display to read and write mode.**
- Pin 6 in LCD display is EN – enable pin which gives the information from the data pins until the reset button is used.
- From pin 7 to pin 14, all pins are called data bus line pins (start from D0 [LSB]-D7 [MSB]) which are used for commanding or sending the data to the LCD display.



In our circuit we have connected the LCD in the following way

- Pin 2 and pin 3 are connected to the input supply.
- Pin 4 and pin 6 are connected to the microcontroller to give instructions to the LCD and provide output from the microcontroller.
- Pin 11 to 14 are connected to the microcontroller to provide the output display in LCD.
- Rest all the other pins are grounded.

Buzzer

Buzzer is a sound producing device used to develop audio sound when there is an input is given to the circuit. Buzzers are generally used in timers, alarm devices, electronic gadgets, etc. The basic function of buzzer is to develop an alerting audio signal on specified time interval. Buzzers produce different sounds base on type of the buzzer we use. Buzzers can be electro-mechanical, Mechanical, piezoelectric type. In our circuit we are using piezoelectric type of buzzer is used.

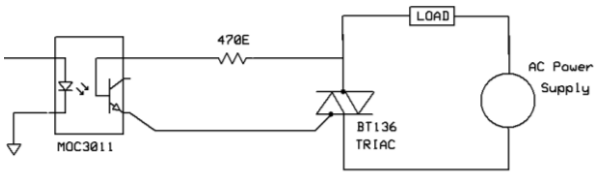
Piezoelectric buzzers can produce different types of sounds until the input supply is stopped. These buzzers consume very less amount of current to work. We can make different types of electrical sounds based on our requirement. We are using a buzzer in our circuit based on a specific reason whenever the power is theft it provides an alerting sound that can be heard by the neighboring surroundings.

RESET Button

Reset button is used to normal button used for start over of the program whenever the button is set to work. Whenever the power theft is observed in the system the system develops a sound using the buzzer. After the immediate alert of buzzer the reset button starts to act. When the theft is observed the supply of power is seen to be cutoff. After the push of reset button the memory in the entire system such as memory in the microcontroller, etc is erased and the function of microcontroller starts to function again. Whenever the reset button is used the kit starts to work from the begging of the program.

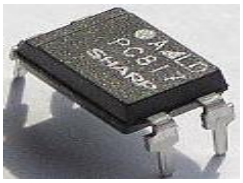
TRIAC Static Relay

In TRIAC static relay the word TRIAC stands for triode alternating current. TRIAC is an electronic component used to control the elements present in the alternating current circuit and it allows the flow of electrons in bidirectional ways. The formal name for a TRIAC is bidirectional triode thyristor. TRIC can be triggered with positive or negative voltage applied to the gate electrode. Once the TRIAC is triggered the device continues to work until it drops below the threshold value such as at the end of a half cycle of an alternating current. This makes the TRIAC a very convenient switch for AC circuits, allowing the control of very large power flows with milli ampere-scale control currents. In addition to controlling applying a trigger pulse at a controllable point in an AC cycle allows one to control the percentage of current that flows through the TRIAC to the load (phase control). With the help of TRIAC we can stop flow of current through the circuit. A TRIAC is constructed with two SCR's connected with each other in reverse parallel directions which help to conduct in both the directions. Both the gates in the SCR's are connected to each other.



Optocoupler

An optocoupler is an electronic component used for transfer of electrical signal between two isolated power circuits. Optocouplers are used for the protection and performance of the circuit. The isolated power supply method is the safest and best way for high power density circuits. The transfer of two electronic components using a light source is the best possible way for isolation. A true isolation virtually removes the conducting path between the input and output supplies in the system. The use of an optocoupler also acts to break ground loops, and this functionality is valuable in eliminating common-mode noise, especially for systems working at the higher operating voltages. When different power supplies in a system are tied together, ground loop currents tend to be induced due to slight differences in ground potential.



Microcontroller (PIC-microcontroller)

A microcontroller is an integrated circuit to perform a specified operation in the embedded system. Microcontroller consists of memory, input and output pins and a processor in a single chip. The pins in the microcontroller are also known as ports or peripherals. Microcontroller is portable device and consumes very less amount of power and space. A microcontroller consists of a CPU in it with a fixed amount of RAM, ROM, I\O ports and timers in the small chip set. Each microcontroller is used for different purposes in day to day life style. Based on the usage of microcontroller the design is build and developed. In our project we are using PIC16F73 microcontroller because PIC microcontrollers are very easy to use and the performance of PIC microcontroller is very efficient compared to other microcontroller. The availability of PIC microcontroller software and hardware are ready to use.

In our project the main usage of microcontroller is that

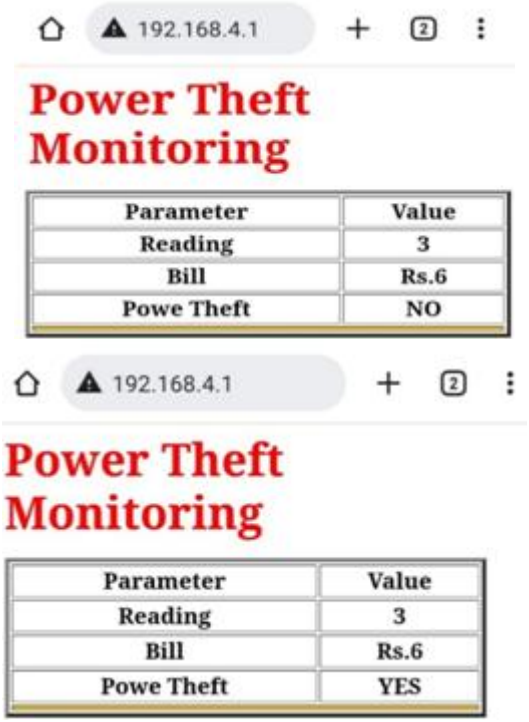
- Microcontroller is used for the detection of power theft done in the system using the current transformer
- Microcontroller check the functioning of the energy meter in the system through the opto coupler
- Microcontroller activates the buzzer whenever the power theft is detected
- The output in the LCD display is produced with the help of microcontroller in the system
- A wifi module is connected to the microcontroller so that the information of power theft or the amount of power supply to the load is observed easily.
- The information produced in the wifi module is same as the result in the LCD.

WIFI Module (ESP8266)

WIFI module refers to wireless fidelity which is an electronic component used for wireless connectivity of a system. The input for this wifi module is 3.3v supply. The wifi module consist of CPU, memory and interfaces for connectivity. The CPU chips set used in this microcontroller is an ultra low power 16-bit microcontroller. The memory controller consists of ROM and SRAM which are accessed by the CPU in microcontroller. In our project the wifi module is used for wireless connection to the energy meter board which makes our work easy and efficient. The microcontroller sends the data to through the wifi module which is measured with the energy meter and displayed in the LCD screen. With the usage of this wifi module we can know the amount of power is been taken, whether the power is theft or not, calculate amount per usage of power with ease.

4. Result

The project "Wireless Power Theft Monitoring and Control using IoT" was designed such that the system monitors the energy meter connection with meter pulse sensor and alerts through web messages when the theft was created. And the load will be disconnected from the supply with the help of relay. The system alerts through web browser messages using IoT Modem.



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