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IoT Based Circuit Breaker

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ABSTRACT

The purpose of this project is to acquire the remote electrical parameters like Voltage, Current and Frequency and send these real time values over IOT network using IOT Modem/phone along with temperature at power station. This project is also designed to protect the electrical circuitry by operating an Electromagnetic Relay. This Relay gets activated whenever the electrical parameters exceed the predefined values. The Relay can be used to operate a Circuit Breaker to switch off the main electrical supply.

User can send commands in the form of IOT NOTIFICAITON messages to read the remote electrical parameters. This system also can automatically send the real time electrical parameters periodically (based on time settings) in the form of IOT NOTIFICAITON. This system can be designed to send IOT NOTIFICAITON alerts whenever the Circuit Breaker trips or whenever the Voltage or Current exceeds the predefined limits.

This project makes use of an onboard computer which is commonly termed as microcontroller. This onboard computer can efficiently communicate with the different sensors being used. The controller is provided with some internal memory to hold the code. This memory is used to dump some set of assembly instructions into the controller. And the functioning of the controller is dependent on these assembly instructions. The controller is programmed using Embedded C language.

Keywords: IOT, Electricity Board (EB), Liquid Crystal Display (LCD), Arduino

I. INTRODUCTION

Electricity is an extremely handy and useful form of energy. It plays an evergrowing role in our modern industrialized society. The electrical power systems are highly non-linear, extremely huge and complex networks. Such electric power systems are unified for economic benefits, increased reliability and operational advantages. They are one of the most significant elements of both national and global infrastructure, and when these systems collapse it leads to major direct and indirect impacts on the economy and national security.

A power system consists of components such as generators, lines, transformers, loads, switches and compensators. However, a widely dispersed power sources and loads are the general configuration of modern power systems. Electric power systems can be divided into two sub-systems, namely, transmission systems and distribution systems. The main process of a transmission system is to transfer electric power from electric generators to customer area, whereas a distribution system provides an ultimate link between high voltage transmission systems and consumer services.

As discussed earlier, maintenance of a transformer is one of the biggest problems in the Electricity Board (EB). During strange events for some reasons the transformer is burned out due to the over load and short circuit in their winding. Also the oil temperature is increased due to the increase in the level of current flowing through their internal windings. This results in an unexpected raise in voltage, current or temperature in the distribution transformer. Therefore, we are proposing the automation of the distribution transformer from the EB substation. In the automation, we consider the voltage, current and temperature as the parameters to be monitored as the transformer shows its peak sensitivity for the same. Hence, we design an automation system based on microcontroller which continuously monitors the transformer. Because of the microcontroller operation, the transformer presents in the substation which is turned off in the main station.

II. PROBLEM DEFINITION

To improve the quality of power with sufficient solutions, it is necessary to be familiar with what sort of constraint has occurred. Additionally, if there is any inadequacy in the protection, monitoring and control of a power system, the system might become unstable. Therefore, it necessitates a monitoring system that is able to automatically detect, monitor, typify and classify the existing constraints on electrical lines. This brings up advantages to both end users and utility companies.

III.SYSTEM DESIGN

A. Block diagram

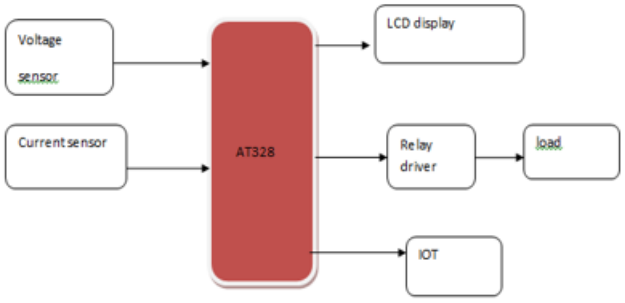

Figure1:Block diagram

B. Block diagram descriptions

This project makes use of an onboard computer which is commonly termed as microcontroller. The controller monitors the behaviour of analysts at different time intervals, monitoring the voltage, current and temperature fluctuations in the distribution transformers at the substations.

Hence monitoring the current, voltage and additionally required parameters at the distribution side can aid in developing both the output generated at the main station and the quality of power being delivered at the customer side. It is also capable of recognizing the break downs caused due to overload, high temperature and over voltage. If the increase in temperature rises higher than the desirable temperature, the monitoring system will protect the distribution transformer by shutting down the unit.

This system can be designed to send notification alerts In IOT whenever the Circuit Breaker trips or whenever the Voltage or Current exceeds the predefined limits.
Relay gets activated whenever the electrical parameters exceed the predefined values.
All the data will be displayed on LCD Display.

IV. HARDWARE AND SOFTWARE REQUIREMENT

A. Hardware Requirements

- ATmega328: Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IOT applications, wearable, 3D printing, and embedded environments.

Figure2:ATmega328

Arduino is a single-board microcontroller to make using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a bootloader that executes on the microcontroller.
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. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means "One" in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.
Arduino microcontroller is a small computer board which is easy to use besides is something come with open-source, which means hardware is reasonably priced and development software is free. With Arduino, ones can

write programs and freely creating an interface circuits to read switches and other sensor, and also controlling motors and lights with a very simple steps.

In its simplest form, an Arduino is a tiny computer that you can program to process inputs and outputs going into and from the chip. The Arduino is what is known as a Physical or Embedded Computing platform, which means that it is an interactive system, that through the use of hardware and software can interact with its environment. For example, a simple use of the Arduino would be to turn a light on for a set period of time, let's say 30 seconds, after a button has been pressed (we will build this very same project later in the book). In this example, the Arduino would have a lamp connected to it as well as a button. The Arduino would sit patiently waiting for the button to be pressed. When you press the button it would then turn the lamp on and start counting. Once it had counted 30 seconds it would then turn the lamp off and then carry on sitting there waiting for another button press. You could use this set-up to control a lamp in an under-stairs cupboard for example. You could extend this example to sense when the cupboard door was opened and automatically turn the light on, turning it off after a set period of time.

The Arduino can be used to develop stand-alone interactive objects or it can be connected to a computer to retrieve or send data to the Arduino and then act on that data (e.g. Send sensor data out to the internet).The Arduino can be connected to LED's. Dot Matrix displays, LED displays, buttons, switches, motors, temperature sensors, pressure sensors, distance sensors, webcams, printers, GPS receivers, Ethernet modules, The Arduino board is made of an Atmel AVR Microprocessor, a crystal or oscillator (basically a crude clock that sends time pulses to the microcontroller to enable it to operate at the correct speed) and a 5-volt linear regulator. Depending on what type of Arduino you have, you may also have a USB connector to enable it to be connected to a PC or Mac to upload or retrieve data. The board exposes the microcontrollers I/O (Input/Output) pins to enable you to connect those pins to other circuits or to sensors, etc. To program the Arduino (make it do what you want it to) you also use the Arduino IDE (Integrated Development Environment), which is a piece of free software, that enables you to program in the language that the Arduino understands. In the case of the Arduino the language is C. The IDE enables you to write a computer program, which is a set of step-by step instructions that you then upload to the Arduino. Then your Arduino will carry out those instructions and interact with the world outside. In the Arduino world, programs are known as sketches.

B. Liquid Crystal Display

LCD stands for Liquid Crystal Display. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the following reasons:

- The declining prices of LCDs.
- The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.
- Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU to keep displaying the data. Ease of programming for characters and graphics.

These components are "specialized" for being used with the microcontrollers, which means that they cannot be activated by standard IC circuits. They are used for writing different messages on a miniature LCD.

C. Buzzer

Figure3:Buzzer

An electric coil is wound on a plastic bobbin, the latter having a central sleeve within which a magnetic core is slidably positioned. One end of the sleeve is closed and projects beyond the coil. An inverted cup-shaped housing surrounds the coil and bobbin and has a central opening through which the closed end of the sleeve projects. The core projects into the closed end of the sleeve beyond the margin of the opening in the housing to augment the magnetic coupling between the housing and the core. The open end of the housing is attached to a support bracket of magnetic material, there being a spring between the bracket and bobbin normally urging the core toward the closed end of the sleeve.

D. Light-Emitting Diode (Led)

The longer lead is the anode (+) and the shorter lead is the cathode (&minus). In the schematic symbol for an LED (bottom), the anode is on the left and the cathode is on the right. Light emitting diodes are elements for light signalization in electronics.

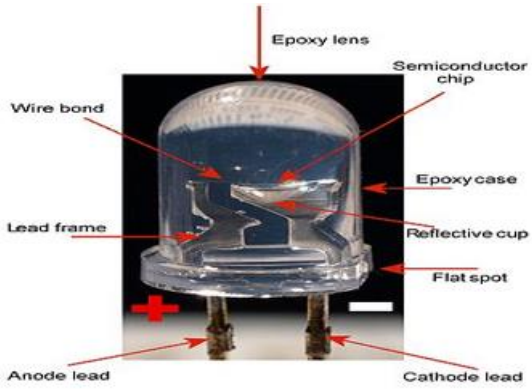

Figure4:LED

They are manufactured in different shapes, colours and sizes. For their low price, low consumption and simple use, they have almost completely pushed aside other light sources- bulbs at first place.

It is important to know that each diode will be immediately destroyed unless its current is limited. This means that a conductor must be connected in parallel to a diode. In order to correctly determine value of this conductor, it is necessary to know diode's voltage drop in forward direction, which depends on what material a diode is made of and what colours it is. Values typical for the most frequently used diodes are shown in table below: As seen, there are three main types of LEDs. Standard ones get full brightness at current of 20mA. Low

Current diodes get full brightness at ten time's lower current while Super Bright diodes produce more intensive light than Standard ones.

E. Switches And Pushbuttons

A push button switch is used to either close or open an electrical circuit depending on the application. Push button switches are used in various applications such as industrial equipment control handles, outdoor controls, mobile communication terminals, and medical equipment, and etc. Push button switches generally include a push button disposed within a housing. The push button may be depressed to cause movement of the push button relative to the housing for directly or indirectly changing the state of an electrical contact to open or close the contact. Also included in a pushbutton switch may be an actuator, driver, or plunger of some type that is situated within a switch housing having at least two contacts in communication with an electrical circuit within which the switch is incorporated.

Figure5: Push Button

Typical actuators used for contact switches include spring loaded force cap actuators that reciprocate within a sleeve disposed within the canister. The actuator is typically coupled to the movement of the cap assembly, such that the actuator translates in a direction that is parallel with the cap. A push button switch for a data input unit for a mobile communication device such as a cellular phone, a key board for a personal computer or the like is generally constructed by mounting a cover member directly on a circuit board. Printed circuit board (PCB) mounted pushbutton switches are an inexpensive means of providing an operator interface on industrial control products. In such push button switches, a substrate which includes a plurality of movable sections is formed of a rubber elastomeric. The key top is formed on a top surface thereof with a figure, a character or the like by printing, to thereby provide a cover member. Push button switches incorporating lighted displays have been used in a variety of applications. Such switches are typically comprised of a pushbutton, an opaque legend plate, and a back light to illuminate the legend plate.

F. Power Supply

The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage.

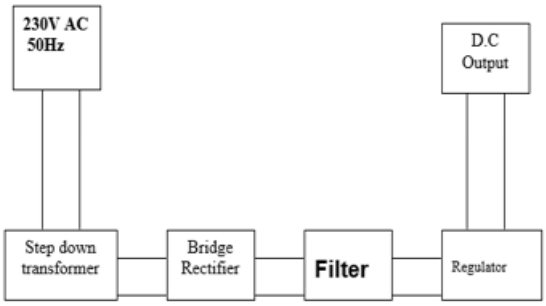

Figure6: Power supply

G. Transformer

Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be obtained directly. Thus, the a.c input available at the mains supply i.e., 230V is to be brought down to the required voltage level. This is done by a transformer. Thus, a step down transformer is employed to decrease the voltage to a required level.

H. Filter

Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore, a regulator is applied at the output stage.

I. Rectifier

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification.

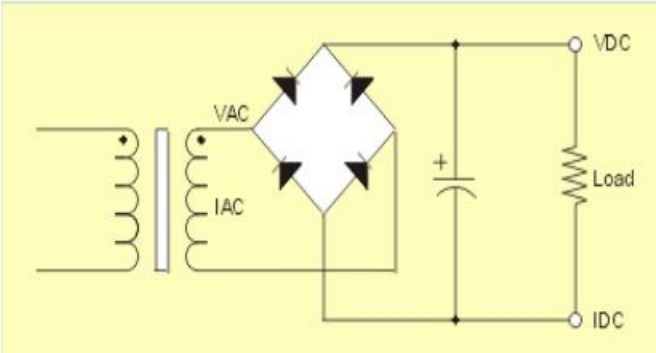

Figure7: Rectifier

The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the figure. The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge.

For the positive half cycle of the input ac voltage, diodes D1 and D3 conduct, whereas diodes D2 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance RL and hence the load current flows through RL.

For the negative half cycle of the input ac voltage, diodes D2 and D4 conduct whereas, D1 and D3 remain OFF. The conducting diodes D2 and D4 will be in series with the load resistance RL and hence the current flows through RL in the same direction as in the previous half cycle. Thus, a bi-directional wave is converted into a unidirectional wave.

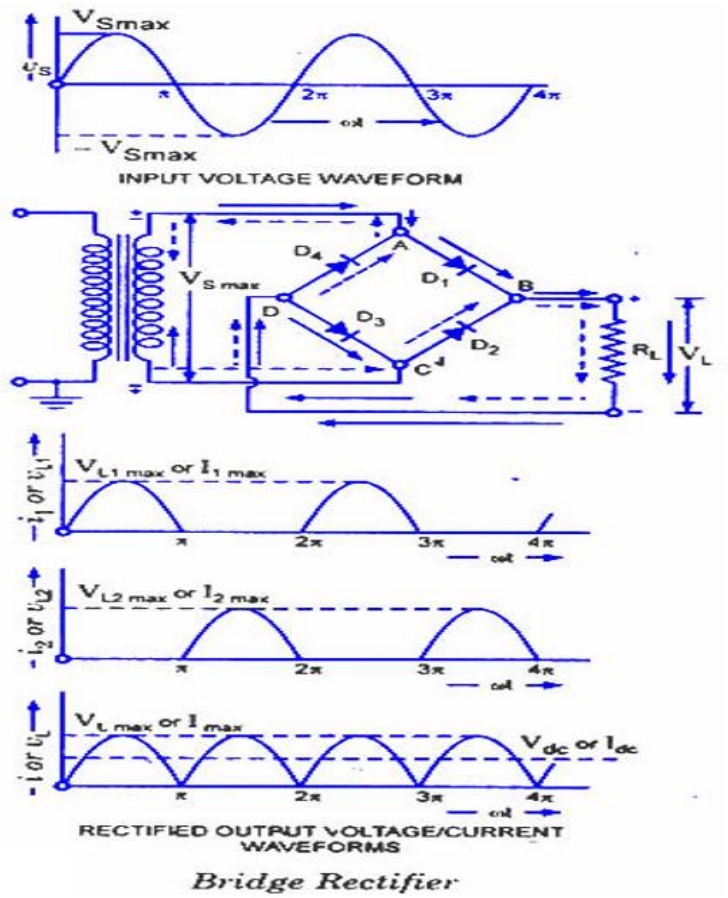

Figure8: Bridge Rectifier

J. Voltage Regulator

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used. The first number 78 represents positive supply and the numbers 05, 12 represent the required output voltage levels. The L78xx series of three-terminal positive regulators is available in TO-220, TO-220FP, TO-3, D2PAK and DPAK packages and several fixed output voltages, making it useful in a wide range of applications. These regulators can provide local on-card regulation, eliminating the distribution problems associated with single point regulation. Each type employs internal current limiting, thermal shut-down and safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1 A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltage and currents.

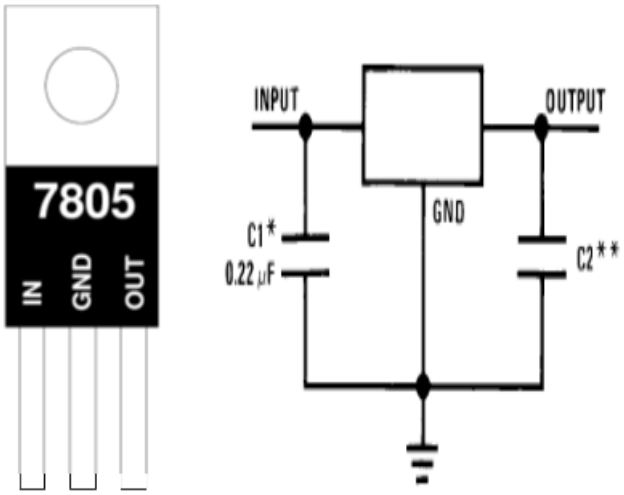

Figure9: Voltage Regulator

K. Software Requirements

- Arduino Ide: Arduino Integrated Development Environment (IDE) is an open source IDE that allows users to write code and upload it to any Arduino board. Arduino IDE is written in Java and is compatible with Windows, macOS and Linux operating systems.

V. CONCLUSION

In modern control centres, system operators get alarm messages from many devices in real time. From alarms, it is still very hard to find out location and type of the potential equipment problem. One needs an automatic way of processing the events to identify whether sequences of equipment operation were as expected. Instead of many alarm messages, only one report should be sent to the operators with concise information about success or failure of a switching sequence. In the case of a breaker, report will offer more detailed message whether the breaker failure logic worked out properly and finally disconnected faulted section. This kind of analysis enables tracking of every CB operation allowing reconstruction of an entire sequence of operations.
In our project we studied designed to attain real time control &monitoring of Circuit Breaker. Measure and record loading of your output of C.B and prevent overloading & increasing whole system life.

VI. RESULT

The IOT based circuit breaker experimental setup is shown as above. Below are the results found on the basis of above experimental setup

Project	IOT based circuit breaker
Voltage	Lower Limit 180V & Higher Limit 260V
Current	Upto 10A
Temperature	Upto 45°C
Input Supply	1Ø, 230V AC
Connectivity	Internet
Performance	Real-time monitoring, alerts, graphs
Function	Over voltage protection, Under voltage protection, Overload protection, Auto - reclosure

Figure10:

Implementing an IOT based circuit breaker project typically involves creating a system that allows users to remotely monitor and control the electrical circuits through the internet. The project usually includes components such as a microcontroller (Arduino), sensors to detect current or voltage, a relay module to control the circuit, and an internet connectivity (Via Mobile Network). The load connected to the circuit is displayed in LCD display. When the overload or over current is flowing in the circuit then the user can be informed by the Thing Speak platform through cloud network. The user can control the load connected to the circuit from anywhere through internet. Then the circuit breaker will automatically operate according to the user's instruction.

VII. ACKNOWLEDGMENT

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