

IOT BASED CIRCUIT BREAKER MONITORING AND CONTROL

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ABSTRACT

Circuit breakers have a very important role in generation and transmission of electricity and represent a vital of the power system. This project discusses “Internet of Things” (I.O.T) base controlling & monitoring of circuit breaker”. Reliable operation and monitoring the high voltage circuit breakers represent an important challenge when this activity must be acquired online. This project presents the architecture of an online monitoring and diagnosis of system of electrical equipment that has the role to acquire, to transfer and to process information about the monitored equipment. An interface is designed on top of which different local and system applications can be recorded by the system. The Microcontroller near the circuit breaker section will continuously transmit all the parameters of the circuit breaker to control room and it will be displayed on screen of computer. as well as after C.B trip it gives signal also to GSM module so that due to GSM the texting message can received with fault description only in registered number. After receiving text message, the operator or any authorized person give command for set or resetting the breaker. So that it minimizes the fault clearing time and improves maintenance, method in circuit breaker increases lifetime and reliability of the circuit breaker

Keywords: Circuit breaker, IOT, monitoring and control

INTRODUCTION

Wireless communication has announced its arrival on big stage and the world is going mobile. It will be control everything and without moving an inch. This remote control of appliances is possible through Embedded Systems. The use of “Embedded System in Communication” has given rise to many interesting applications that ensures comfort and safety to human life (Jason et al., 2016). It is very important to closely monitor the circuit breaker in-service behaviour to avoid costly outages and loss of production. It is well known that to maintain the system reliability it is necessary to protect the with circuit breaker from different abnormality condition i.e. faults. Distribution Circuit breakers have a long service life if they are operated under rated conditions. However, their life is significantly reduced if they are overloaded, resulting in unexpected failures and loss of supply to a large number of equipment thus effecting system reliability (Brent L et al., 2017). Online monitoring and controlling of key operational parameters of distribution circuit breakers can provide useful information about the health of circuit breakers which will help the utilities to optimally use their circuit breakers and keep the asset in operation for a longer period (Kezunovic Me t al., 2006). This will also help identify problems before any catastrophic failure which can result in a significant cost savings and greater reliability (Jay Kumar et al., 2016) (Francesco et al., 2012).

Circuit breakers are a vital part of the transmission and distribution system. Monitoring circuit breaker condition online can prevent faults that are costly to repair and result in a loss of service. In this project we designed a system in such a way that it will monitor and control the load of the substation continuously and that information is transferred to the control room using Wi-Fi (Schneider et al., 2014). This system can be used for online monitoring of circuit breakers. It can be used to avoid dangerous and costly failures, while optimizing maintenance schedules and extending the life of your circuit breakers. In our system a microcontroller will continuously keep on monitoring the various parameters (Output current, Output voltage and Temperature) of the circuit breaker and this information will be continuously be updated on your PC using a VB based software. A keypad is used to change the set points for the parameters. By using monitor or mobile phone to displays the parameters. We have even provided a protection relay so if there is any problem with the circuit breaker the power to it can be remotely disconnected. And it can give the text message to register mobile number by using the GSM module (Meyer et al., 2006).

In this project a system is designed in such a way that it will monitor and control the load of the substation continuously and that information is transferred to the control room using Wi-Fi Technology. In the main station these parameters are displayed on the screen of computer. In the display unit we can view the continuous information of circuit breaker i.e. due to what reason the circuit breaker has been break, when the power is resumed etc. With the help of this kind of system, the maintenance staff of the department can have a continuous vigilance over the circuit breaker. In this project work, for the demonstration purpose a circuit breaker of 440V, 5 Amps rating is connected to a load.

In this project we are using CT circuit breaker for measuring load current, voltage sensor and temperature sensor. All these parameters are converted into digital value by using ADC. If the parameters of the circuit breaker regain the limited range values, then circuit breaker will automatically get trip condition. Microcontroller near the circuit breaker section will continuously transmit all the parameters of the circuit breaker to control room and it will be displayed on screen of computer. as well as after C.B trip it gives signal also to GSM module so that due to GSM the texting message can be received with fault description only in registered number. After receiving text message, the operator or any authorized person give command for set or resetting the breaker. So that the fault clearing time is minimized and process interruption clearing also get within less time.

EXISTING SYSTEM

Password Based Circuit Breaker is a simple project that helps in controlling the electrical lines with the help of a password. Nowadays, electrical accidents to the line man are increasing, while repairing the electrical lines due to the lack of communication between the electrical substation and maintenance staff. This project gives a solution to this problem to ensure line man safety. In this proposed system, the control (ON/OFF) of the electrical lines lies with line man. This project is arranged in such a way that maintenance staff or line man has to enter the password to ON/OFF the electrical line. Now, if there is any fault in electrical line, then the line man will switch off the power supply to the line by entering password and comfortably repair the electrical line, and after coming to the substation line man switch on the supply to the particular line by entering the password. Separate passwords are assigned for each electrical lines.

PROPOSED SYSTEM

Circuit breakers are used for protection & switching & an important component of industrial electrical system. In order to ascertain reliability of circuit breaker & at the same time to reduce the downtime due to time based preventive maintenance, online monitoring of circuit breaker health parameter is needed. Deployment of software-based control instead of hardwired control reduces the size of control & metering cabinet. Integration of Internet of Things make the circuit breaker health data available on the fly for effective decision making regarding maintenance of circuit breaker. Deployment of open source platform eliminates the concern regarding reliability & security of the safety/safety related/strategic application as complete source code implementation is open & fully accessible & controlled by the user. The proposed system facilitates automated circuit breaker monitoring & control that diagnose the electrical and mechanical health of circuit breaker in real time. This is a shift in the maintenance paradigm from time-based maintenance to as-needed maintenance. This shift comes with the benefit of maintaining adequate circuit breaker performance while reducing overall maintenance costs & unnecessary downtime

For rapid prototyping, Arduino / BeagleBone board can be used to prove the concept. But in this project we used an Arduino Mega 2560 board where 10 bit ADC are used to log the continuous data and digital pins are used to control the circuit breaker. The circuit breaker mechanism is simulated through contactors. An indicative schematic of the system is show

Familiarization of thing Speak

According to its developers, "Things peak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. Things peak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates". Things peak was originally launched by Io Bridge in 2010 as a service in support of IoT applications. Things peak has integrated support from the numerical computing software MATLAB from MathWorks, allowing Things peak users to analyse and visualize uploaded data using MATLAB without requiring the purchase of a MATLAB license from MathWorks. Things peak has a close relationship with MathWorks, Inc. In fact, all of the Things peak documentation is incorporated into the MathWorks' MATLAB documentation site and even enabling registered MathWorks user accounts as valid login credentials on the thing Speak website. The terms of service[6] and privacy policy of Things speak.com are between the agreeing user and MathWorks, Inc. Things speak has been the subject of articles in specialized "Maker" websites like Instructible, Code project and Channel 9.

Hardware Requirements

- a) Node MCU
- b) Development board
- c) 8-Channel Relay Driver Board
- d) ACS712 Current Sensor
- e) Contactors for Simulating Circuit Breaker
- f) Mechanism Push Buttons & Switches
- g) Lamp with Holder for Simulating Load
- h) Modem cum Router

ESP8266 ARDUINO CORE

As Arduino.cc began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino Due, they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support alternate toolchains to allow Arduino C/C++ to be compiled for these new processors. They did this with the introduction of the Board Manager and the SAM Core. A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file for the target MCU's machine language. Some ESP8266 enthusiasts developed an Arduino core for the ESP8266 WiFi SoC, popularly called the "ESP8266 Core for the Arduino IDE".^[18] This has become a leading software development platform for the various ESP8266-based modules and development boards, including NodeMCUs.

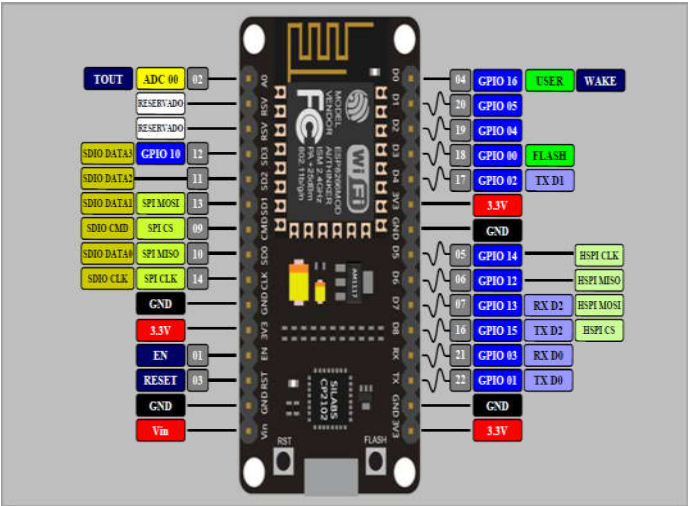


Fig-1 Pin configuration of Node MCU

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I/O index	ESP8266 pin
0 [*]	GPIO16

1	GPIO5
2	GPIO4
3	GPIO0
4	GPIO2
5	GPIO14
6	GPIO12
7	GPIO13
8	GPIO15
9	GPIO3
10	GPIO1
11	GPIO9
12	GPIO10

Node MCU provides access to the GPIO (General Purpose Input / Output) and a pin mapping table is part of the API documentation.

Development board

Development board is basically a printed circuit board with circuitry and hardware on-board to facilitate experimentation with certain microcontrollers. These boards can save you from a lot of repetitive tasks



Fig-2 Development board

8-Channel Relay Driver Board

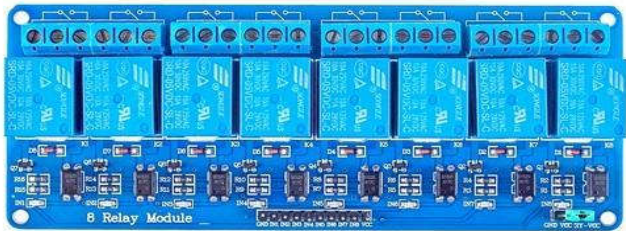


Fig-3 8-Channel Relay Driver Board

8 Channel Relay Board is a simple and convenient way to interface 8 relays for switching application in your project. Input voltage level support TTL as well as CMOS. Easy interface with Microcontrollers based projects and analog circuits.

The eight-channel relay module contains eight 5V relays and the associated switching and isolating components, which makes interfacing with a microcontroller or sensor easy with minimum components and connections. Each relay on the board has the same circuit, and the input ground is common to all eight channels.

ACS712 Current Sensor

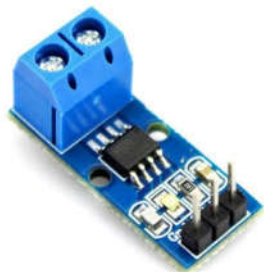


Fig-4 ACS712 Current Sensor

A current sensor is a device that detects electric current in a wire and generates a signal proportional to that current. ... The generated signal can be then used to display the measured current in an ammeter, or can be stored for further analysis in a data acquisition system, or can be used for the purpose of control. The current measurement methods are generally classified by three categories; shunt resistor + isolation amplifier/isolation ADC, cored current sensor, and coreless current sensor (current sensor IC). When current flows through a conductor, it creates a proportional magnetic field around the conductor. ... The sensor then outputs a certain voltage or current that a meter connected to the sensor can read and translate into the amount of current flowing through the conductor

Contactors for Simulating Circuit Breaker



Fig-5 Contactors for Simulating Circuit Breaker

Contactors are electrically controlled switches, similar to relays, but having a higher current rating that are used for switching electrical power to relatively larger loads. Contactors are usually controlled through a control circuit that has a lower power level compared to the load. Contactors are used for controlling electric motors and large lighting loads. They can be useful in industrial as well as commercial applications. To ensure the quality of the contactor and a long service life, various tests are performed on the contactors. These tests ensure that the logic and timing relationship between the main and auxiliary contacts is appropriate and the contactor has been assembled properly without any incorrect components used or any components missing. The latching and releasing of the contactor takes place within the specified time and at the specified voltages is also verified through these tests.

To ensure that there are no premature on-site failures, contactor testing involves various tests such as Flashing Test, Pick-Up Voltage Measurement, Drop-Off Voltage Measurement, Pick-Up Time Measurement, Drop-Off Time Measurement, Coil Current Measurement, Coil Wattage Measurement, Travel and Bounce Measurements, Humming Test, and HV Test.

Mechanism Push Buttons & Switches

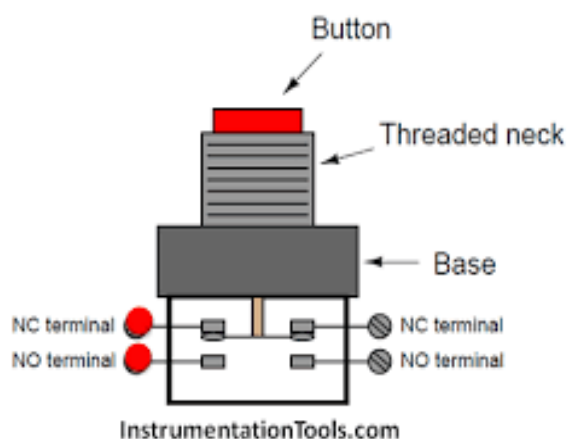


Fig-6 Mechanism Push Buttons & Switches

A Push Button switch is a type of switch which consists of a simple electric mechanism or air switch mechanism to turn something on or off. Depending on model they could operate with momentary or latching action function. ... This means that when a button is pressed it can cause another button to release.

Modem cum Route



Fig 7 Modem cum Route

Modem is a box that connects your home network to the wider Internet. A router is a box that lets all of your wired and wireless devices use that Internet connection at once and allows them to talk to one another without having to do so over the Internet. It provides connection between different network architectures such as Ethernet & token ring etc.

- ➔ It can choose best path across the internetwork using dynamic routing algorithms.
- ➔ It can reduce network traffic by creating collision domains and also by creating broadcast domains.

You do not need to have a router to use Wi-Fi as long as you're not trying to share an Internet connection. The common consumer Wi-Fi router is actually a combination device that includes a network switch, a network router and a Wi-Fi access point.

Working

The IoT based Circuit Breaker is a system with high response time, which uses the interconnection network (internet) **to control electrical loads**. ... Here, the user or operator has to log in on IoT Gecko interface passing through an additional layer of security that is Password Protection.

These particular systems there are so many uses of IOT based circuit breaker but also can be used in switching for protection purpose. Most of the electrical companies consist of the circuit breaker .But need of this online monitoring of the circuit breaker is that to reduce the downtime of the system and make it reliable or also by doing these we can make circuits more reliable and available for all data on there computers, etc. We all know that circuits breakers are there in all the electrical system to protect the system and for protection purpose also but implementing it in software we can reduce the maintenance cost also it can increase the efficiency and also increase the accuracy of the system. Development of software based control of circuit breaker avoids the breakdown of whole system . Since, all loads are parallel connected to the system so breakdown of one may damage the whole system. IOT based circuit breaker avoid this by switching and present whole system. Manually this process takes employment of one or more persons but also to make it working in conditions we use software based circuit breaker , in which we are going to use many electronic component . This system provides automated monitoring , high efficiency ,security of the safety related application as complete code implementation is open and user friendly also . Modification can also be done in source code.

We are access the data like load current , trip coil current, load status, etc and this data is given to the Node mcu and this is connected to the relay driver board which is directly connected to the circuit breaker. Data from the Arduino can be access by the relay coil and according to that data relay coil can make and break the contact with the circuit breaker. And as there is two way communication between the relay and the Arduino the data from the relay coil and circuit breaker can be displays on the computer or PC through the modem with the help of the cloud and internet systems. To ensure maximum accuracy of a dc voltage measurement, first measure and record the ac voltage. Then measure dc voltage by selecting a dc voltage range (using the RANGE button) that is the same or higher than the ac voltage range. Some DMMs can simultaneously measure and display the ac and dc components of a signal.

Advantages of our project

- We can access the detailed information about healthy as well as faulty operations from anywhere in the words.
- Manufacturing and maintenance cost is reduced by using IOT based circuit breaker.
- Efficiency of this circuit is high as compared to hardware based circuit.
- Blackout of the system is avoided i.e. minimized downtime.
- Cost of conditions monitoring is reduced.
- Use of computerized maintenance management software provides automated facilities.

CONCLUSION

This project shows a conceptual implementation of IOT based Circuit Breaker Monitoring & Control which will reduce the size of the circuit breaker & facilitate the concept of as needed maintenance approach. Moreover, this will eliminate the concern regarding security vulnerability of third party system as the platform is open source. Being a prototype conceptual

implementation, future work can be done on EMI/EMC compliance, implementation of open source inferential engine in order to receive recommendation on maintenance, integration with computerized maintenance management software, development of open source hosting server etc.

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.

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