

SECURITY (PASSWORD) BASED CIRCUIT BREAKER OPERATION INCLUDING GSM MODULE

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ABSTRACT: This paper presents Internet of Thing (I.O.T) based monitoring & control of circuit breaker. Circuit breaker is an important component of Industrial Electrical System. It is used for protection & switching. Hence, reliable operation of circuit breaker is essential. Circuit breaker ages over time & number of operations. This raises a concern regarding reliability of circuit breaker operation. In order to ascertain reliability of circuit breaker, it is general practice to carry out preventive maintenance at fixed time intervals. The main disadvantage of this maintenance approach is unnecessary downtime & offline usage of separate diagnostics equipment although the circuit breaker is healthy. This increases the maintenance cost of circuit breakers. Moreover, in present practice, the control of circuit breaker is realized through hardwired control logic which increases the size of control & metering cabinet of the circuit breaker & prevents integration of Internet of Things. This put a limitation on decision making process as circuit breakers data are not accessible on the fly. Presently monitoring of circuit breaker is being carried out through proprietary solutions like Remote Terminal Units & SCADA. Proprietary solution raises a concern regarding reliability & security of the safety/safety related/strategic application as the backend implementation of proprietary solution is not accessible by the user. In this paper, an attempt was made to develop monitoring & control scheme of a typical circuit breaker using Arduino Mega 2560 embedded microcontroller along with Ethernet Shield for integration of Internet of Things. Circuit breaker parameters like load current, trip coil current, close coil current, spring charging motor current, number of closing operations, number of tripping operations etc. are monitored. The monitored data are uploaded to Internet of Things platform “Thing Speaks” in order to make circuit breaker data available on the fly for effective decision making. Monitored circuit breaker parameters are used to determine health of the circuit breaker in order to ascertain its reliable operation & to determine its maintenance/replacement needs. This paper is an effort to develop automated circuit breaker monitoring & control systems 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. Moreover, open-source platform is used which eliminates the concern regarding reliability & security of the safety/safety related/strategic application as complete source code implementation is open & fully accessible by the user.

Indexed Terms: *Internet of Thing, Circuit Breaker, Thing Speak, Arduino.*

1. INTRODUCTION

Electricity transmitted through power lines destined for commercial, industrial and residential use can involve hundreds of thousands of volts

and high currents. Inevitably, there is an element of danger in measuring the voltage on a transmission line because of the need to make contact with the line. Indeed, even the proximity

to a high voltage line may be sufficient to cause a spark to jump through the air to the nearest object. Nonetheless, in installing, servicing and repairing power lines, there are various occasions when contact is made. This project work password based phase line controller is a simple project that helps in controlling the electrical line with help of a password. Now a days electrical accidents to the line men are increasing while repairing the electrical lines. This is due to the lack of proper communication between the electrical sub-station and the maintenance staff. This project gives a solution to this problem to ensure the safety of the line man. In this proposed project work, the control (ON/OFF) of the electrical line lies with the line man. The concept is designed such that maintenance staff or the line man has to enter the password to switch ON/OFF the electrical line. If there is any fault in the electrical line or any repair is to be done to the line, then the supply to the electrical line is cut off by entering the password and can comfortably repair the line. After repairing the line, by entering the password again, supply to the electrical line will be restored. Separate passwords can be assigned to different electrical phase lines. The system is designed with three outputs with three different passwords. At each output a relay is connected and this relay contact is used to make or break supply to the electrical line. Presently the demo module is constructed with three lamp loads; all of them can be controlled independently.

To enter the password, a small keyboard designed with twelve keys is used and it is interfaced with microcontroller. This keyboard is designed as 3X4 matrix form and the data generated by the keyboard is stored in RAM, depending up on the program prepared for controller, and the information produced by the keyboard, if it is tallied with the predefined program, then the corresponding relay will be activated automatically. The data entered through keyboard will be displayed through LCD in the form of stars to maintain the secrecy, if the entered data is correct, then the display shows that the corresponding electrical line is de-activated. For

activating the line, again password has to be entered. In addition using GSM, which is also interfaced to the controller, this information can be transmitted in the form of SMS to the concern person or authorities.

Everyone needs to be securing as much as possible. The electric line man safety system is designed to control a switch gear by using a password for the safety of electric man. Critical electrical accidents to line men are on the rise during electric line repair due to lack of communication and co-ordination between the maintenance staff and electric substation staff. This project offers a resolution that safeguards safety of maintenance line men. The control to turn on or off the line will be maintained by the line man only because this system has an arrangement such that a password is required to operate the circuit breaker on/off [1]. The password can be entered manually by a keypad matrix, or automatically by a sending a message to the GSM circuit include the password. The GSM circuit enables remote control of the system. This leads to address the problem of loss of time. Between the two circuits there is a key to switch from manual mode to automatic mode and vice versa. The system also provided protection against over current using the sensors.

OVER VIEW:

In order to identify whether the line is functioning or not, a light with some group of LED's is connected in each line and a light sensor LDR is connected exactly below the light. This LDR is connected to a trigger circuit that is designed using a 555 timer chip. This trigger circuit will provide a signal to the controller whether the line is functioning or not. Depending on this information, if the line isn't working, automatically a message in the form of SMS will be sent to the line man mobile by which the person will know that the line is faulty. To repair the line, he enters the password and disconnects the supply to that particular line and works comfortably. After repairing the line, he himself can restore the line again.

OBJECTIVES:

- The main objectives of this study are to Design of password based circuit breaker circuit.
- Make connection between the main circuit and GSM circuit.
- Make connection between the main circuit and the over current protection circuit.
- Simulate of controlling password based circuit breaker circuit.

PROBLEM STATEMENT

Nowadays, electrical accidents to the line 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. 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. The problem of loss of time has also been addressed. So that the line man can be connect or disconnected without coming back to the station.

2. LITREATURE REVIEW

CONTROL SYSTEM

There are two major divisions in control theory, namely, classical and modern, which have direct implications over the control engineering applications. The scope of classical control theory is limited to single-input and single-output (SISO) system design, except when analysing for disturbance rejection using a second input. The system analysis is carried out in the time domain using differential equations, in the complex-s domain with the Laplace transform, or in the frequency domain by transforming from the complex-s domain. Many systems may be

assumed to have a second order and single variable system response in the time domain. A controller designed using classical theory often requires on-site tuning due to incorrect design approximations. Yet, due to the easier physical implementation of classical controller designs as compared to systems designed using modern control theory, these controllers are preferred in most industrial applications.

The most common controllers designed using classical control theory is Proportional Integral-Derivative controllers (PID). A less common implementation may include either or both a Lead and Lag filter. The ultimate end goal is to meet requirements set typically provided in the time-domain called the Step response, or at times in the frequency domain called the Open-Loop response. The Step response characteristics applied in a specification are typically percent overshoot, settling time, etc. The Open-Loop response characteristics applied in a specification are typically Gain and Phase margin and bandwidth. These characteristics may be evaluated through simulation including a dynamic model of the system under control coupled with the compensation model. In contrast, modern control theory is carried out in the state space, and can deal with multiple input and multiple-output (MIMO) systems.

This overcomes the limitations of classical control theory in more sophisticated design problems, such as fighter aircraft control, with the limitation that no frequency domain analysis is possible. In modern design, a system is represented to the greatest advantage as a set of decoupled first order differential equations defined using state variables. Nonlinear, multivariable, adaptive and robust control theories come under this division. Matrix methods are significantly limited for MIMO systems where linear independence cannot be assured in the relationship between inputs and outputs.

A control system is a device, or set of devices, that manages, commands, directs or regulates the behaviour of other devices or systems. Industrial control systems are used in industrial production

for controlling equipment or machines. There are two common classes of control systems, open loop control systems and closed loop control systems. In open loop control systems output is generated based on inputs. In closed loop control systems current output is taken into consideration and corrections are made based on feedback. A closed loop system is also called a feedback control system.

GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS (GSM)

GSM is an acronym that stands for Global System for Mobile Communications. The original French acronym stands for Groupe Spécial Mobile. It was originally developed in 1984 as a standard for a mobile telephone system that could be used across Europe. It's now an international standard for mobile service. It offers high mobility, subscribers can easily roam worldwide and access any GSM network.

- GSM is a digital cellular network. At the time the standard was developed it offered much higher capacity than the current analog systems. It also allowed for a more optimal allocation of the radio spectrum, which therefore allows for a larger number of subscribers.
- GSM offers a number of services including voice communications, Short Message Service (SMS), fax, voice mail, and other supplemental services such as call forwarding and caller ID.
- Currently there are several bands in use in GSM. 450 MHz, 850 MHz, 900 MHz, 1800 MHz, and 1900 MHz are the most common ones.
- Some bands also have Extended GSM (EGSM) bands added to them, increasing the amount of spectrum available for each band.
- GSM makes use of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA).

GSM allows for use of duplex operation. Each band has a frequency range for the uplink (cell phone to tower) and a separate range for the downlink (tower to the cell phone). The uplink is

also known as the Reverse and the downlink shown in figure is also known as the Forward. In this tutorial, I will use the terms uplink and downlink.

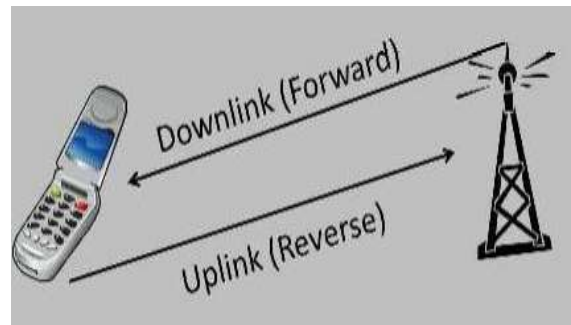


Figure: Uplink and downlink

CIRCUIT BREAKER

As a matter of fact the power system in necessary to control switch on or off whatever it was at normal condition or abnormal condition at various circuits like (transmission lines, distributors, generating plants) In earlier days switches and fuses were used to control , but there are disadvantages for using them , firstly when a fuse blows out it takes a quite sometimes to replace it secondly a fuse cannot interrupt the heavy fault current , we can conclude that the fuses and switches are limited to low voltage and small capacity circuits.

With advancement of power system the lines and equipment operate at very high voltage and carry a large currents this necessitates to employ a more dependable means of control such as it obtained by use of circuit breakers.

A circuit breaker is a piece of equipment which can make or break the circuit either manually or automatically under all conditions no-load , full-load , shortcircuit this made circuit breaker very useful in switching or protection of various parts of the power system .

As we mentioned that the circuit breaker incorporates manual or remote control .the latter employs relays and operates only under fault conditions.

MICROCONTROLLER

A microcontroller is a single-chip computer .Micro suggests that the device is small, and controller suggests that it is used in control

applications. Another term for microcontroller is embedded controller, since most of the microcontrollers are built into or embedded in the devices that controlling.

Microcontrollers have traditionally been programmed using the assembly language of the target device. Although the assembly language is fast, it has several disadvantages. An assembly program consists of mnemonics, which makes learning and maintaining a program written using the assembly language difficult. Also, microcontrollers manufactured by different firms have different assembly languages, so the user must learn a new language with every new microcontroller he or she uses. Microcontrollers can also be programmed using a high-level language, such as BASIC, PASCAL, or C. High-level languages are much easier to learn than assembly languages and also facilitate the development of large and Complex programs.

Microcontroller is a highly integrated chip that contains Central Processing Unit (CPU), Random Access Memory (RAM), Read Only Memory (ROM) and Input/output I/O ports. Unlike general-purpose computer, which also includes all of these components, microcontroller is designed for a 9 very specific task to control a particular system. As a result, the parts can be simplified and reduced, which cuts down on production cost.

RELAYS

Protective relaying is one of the several features of the power system design. Every part of the power system is protected. The factors affecting the choice of protection are type and rating of equipment []. In a power system consisting of generators, transformers, transmission and distribution circuits, it is inevitable that sooner or later some failure will occur somewhere in the system when a failure occurs on any part of the system, it must be quickly detected and disconnected from the system. There are two principal reasons for it. Firstly, if the fault is not cleared quickly, it may cause unnecessary interruption of service to the customers. Secondly, rapid disconnection of faulted apparatus limits the

amount of damage to it and prevents the effects of fault from spreading into the system. The detection of a fault and disconnection of a faulty section or apparatus can be achieved by using fuses or relays in conjunction with circuit breakers. A fuse performs both detection and interruption functions automatically but its use is limited for the protection of low-voltage circuits only. For high voltage circuits (say above 3.3 kV), relays and circuit breakers are employed to serve the desired function of automatic protective gear. The relays detect the fault and supply information to the circuit breaker which performs the function of circuit interruption.

3. SYSYTEM DESIGN AND ANALYSIS

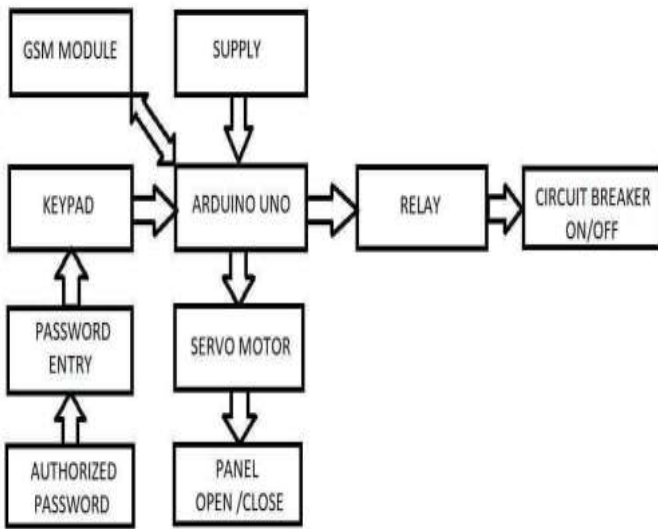
Password Based Circuit Breaker

Password Based Circuit Breaker is a simple project that helps in controlling the electrical lines with the help of a password.

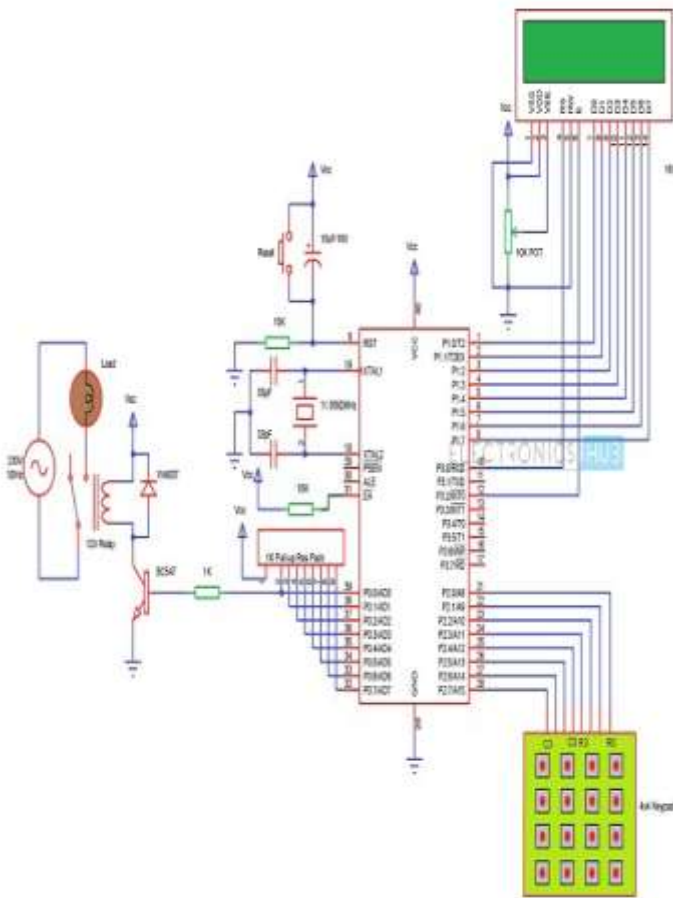
Nowadays, electrical accidents to the line man are increasing, while repairing the electrical lines due to the lack of communication between the electrical substation and maintenance staff. This project gives a solution to this problem to ensure line man safety. In this proposed system, the control (ON/OFF) 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.

Block Diagram



Circuit Diagram of Password based Circuit Breaker



Principle of Operation

The main component in the circuit is 8051 microcontroller. In this project 4x4 keypad is used to enter the password. The password which is entered is compared with the predefined password. If entered password is correct, then the corresponding electrical line is turned ON or OFF. In this project, a separate password is provided to each electrical line. Activation and deactivation of the line (circuit breaker) is indicated by the load (Light Bulbs).

Components Required

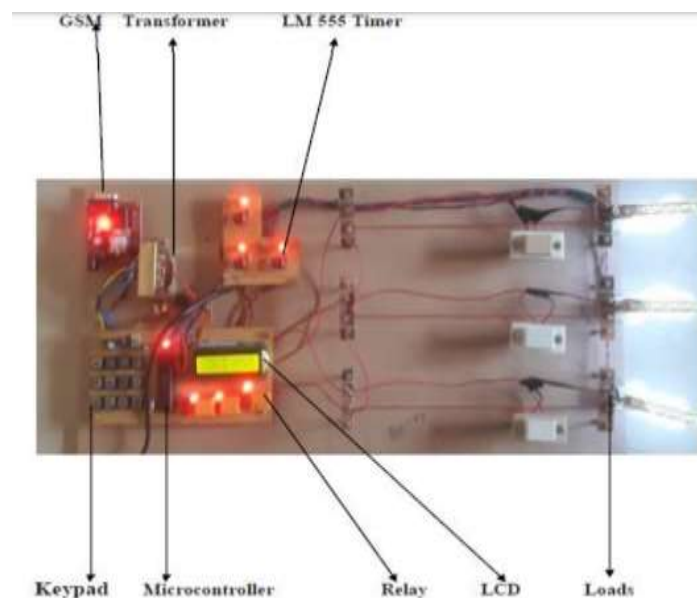
- 8051 Microcontroller (AT89C52)
- 8051 Development Board
- 8051 Programming Board (Programmer)
- 4 x 4 Matrix Keypad
- 4 – Channel Relay Module
- 16 x 2 LCD Display
- 10KΩ Potentiometer
- 4 Loads (Light Bulbs)
- Power Supply
- Connecting Wires
- If 8051 Development Board is not used, then you need
 - ❖ 0592 MHz Crystal
 - ❖ 2 x 33pF Capacitor
 - ❖ 2 x 10KΩ Resistors (1/4 Watt)
 - ❖ Push Button
 - ❖ 10μF Capacitor (Electrolytic)
 - ❖ 1KΩ x 8 Pull – up Resistor Pack
- If Relay Module is not used, then you need (components mentioned for one load)
 - ❖ 5V or 12V Relay
 - ❖ 1KΩ Resistor (1/4 Watt)
 - ❖ BC547 NPN Transistor
 - ❖ 1N4007 PN Junction Diode

RESULTS:

The password based electric line man safety system is designed to control a circuit breaker by using a password for the safety of electric man, the line man can enter the password using a keyboard. There are many critical electrical accidents are rises during the electric line repair.

These accidents are happen due to lack of communication and co-ordination between the maintenance staff and electric substation staff. In this proposed system the security of the line man is its own hand. The control to turn on or off the line will be maintained by the line man .The system is fully controlled by a microcontroller from ATMEL 89C52. A matrix keypad and GSM is interfaced to the microcontroller to enter the password. The entered password through keyboard is compared with the password stored in the memory. If the entered password is correct then only then the line can be turned ON/OFF.

In order to identify whether the line is functioning or not, a light with some group of LED's is connected in each line and a light sensor LDR is connected exactly below the light. This LDR is connected to a trigger circuit that is designed using a 555 timer chip. This trigger circuit will provide a signal to the controller whether the line is functioning or not. Depending on this information, if the line isn't working, automatically a message in the form of SMS will be sent to the line man mobile by which the person will know that the line is faulty. To repair the line, he enters the password and disconnects the supply to that particular line and works comfortably. After repairing the line, he himself can restore the line.



4. CONCLUSION

This paper shows a conceptual implementation of password-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.

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