A Switching Technique of Circuit Breaker Using Password

Dharminder Kumar
RIMT University, Mandi Gobindgarh, Punjab
Email id- dharminderkumar@rimt.ac.in

ABSTRACT: ***A password-based circuit breaker control system is one in which the sole provided password is used to operate the circuit breaker and switch on/off the supply of a certain line. There is also an option to change or reset the password here. An 8-bit microcontroller from the 16F877A family is in charge of the system. The password is saved on the microcontroller in an EEPROM (Electrically Erasable Programmable Read-Only Memory). The lineman's mobile phone is connected to the system through a GSM (Global System for Mobile Communications) module, which allows him to input the password for turning on/off the circuit breaker from any place. A keypad is used to manually input the password or to change/reset the password using the preset pin supplied to the substation's head. An alarm will be triggered if an incorrect attempt to open the circuit breaker is made, such as by entering the wrong password. This technique allows the lineman to fix the connection more safely, and after he's finished, he can switch the line back on using the password from his phone. This protects the worker's safety because no one can turn on the power without his authorization. This may also be used by businesses when they are dealing with equipment or wiring issues. Although there has been much research work on making a password-based circuit breaker in the past, this system provides an overall solution but there is a potential for more research in this field in the future.***

KEYWORDS: Circuit Breaker, GSM Module, Lineman, Microcontroller, Password.

1. INTRODUCTION

A power system fault is a circumstance that happens in the power system that is undesirable. Short circuits, current leakage, ground shorts, overcurrent, and overvoltage are examples of undesirable situations. The most essential need in the industrial or household electrical industry is power system protection, which protects equipment from harm caused by leakage current. When a defect in a transmission line arises recently, the lineman goes to the affected transmission line to fix it. However, if an unexpected switch on the transmission line occurs during the repair, it might result in deadly accidents for the lineman. Due to a lack of communication between the electrical substation and maintenance workers, electrical accidents to linemen are on the rise nowadays while fixing electrical lines [1], [2].

In our day-to-day lives, safety is the most important consideration while engaging in any activity. In today's world, the unintentional death of a lineman is frequently reported and documented. In this regard, a safety precaution for the operator is determined to be quite important when considering the current working style. The circuit breaker is controlled by the electric lineman safety system. Circuit breakers are essential in switching for both normal network functioning and the safety of other devices in power systems. Periodic inspection and preventative maintenance are generally conducted to ensure circuit breakers are in good working order. The circuit breaker's recommendations are typically followed in terms of maintenance plans and procedures. For the protection of the lineman, the electric lineman safety system is intended to manage a circuit breaker using a password. Because this system is set up in such a way that a password is required to activate the circuit breaker, only the lineman has access to switch on/off the line. A peripheral interface controller (PIC) microcontroller is in charge of the entire system. The microcontroller is connected to a Global System for Mobile Communication (GSM) module and a keypad [3].

The GSM module allows the lineman to turn on/off the circuit breaker from any place by inputting the password on his mobile phone. To cut off the supply, the lineman does not need to travel to the substation. This reduces the amount of time necessary for the procedure. The keypad is utilised in the event of an emergency, such as a network outage that prevents the lineman from controlling the circuit breaker from his phone. When a password is lost or stolen, the keypad is also used to modify or reset the password. The suggested low-cost microcontroller-based protected password-operated circuit breaker ON/OFF is the best-suited method for protecting workmen on the line from being injured or killed by unintentional line charging. Authorization passwords or login for security purposes prohibit unauthorised access to secured systems. It is possible to reduce the lack of communication and coordination between maintenance and electric substation personnel. This method provides a means of ensuring the safety of maintenance personnel. The password-based circuit breaker may also be used to provide strong security in an automatic door locking system. It may also be used to regulate electronic equipment in order to save energy [4]–[6].

2. LITERATURE REVIEW

Jay et al. discussed the password-based circuit breaker system using a PIC 16F886 microcontroller. The password is entered using the 4 keypad in this case. The supplied password is compared to a list of preset passwords. The relevant electrical line is switched ON or OFF if the entered password is accurate. Each electrical line is given its own password in this method. The load indicates when the line (circuit breaker) is active or inactive. In this system, the user must travel to the location where it is located and provide a password to turn on/off the supply, lengthening the time it takes to operate[7].

Mallikarjun et al. explored the use of a password-based distribution panel and circuit breaker for lineman safety. The ARDUINO microcontroller and GSM-based work illustrate the lineman's security when a circuit breaker is turned on or off, and a control panel door is opened or closed for repair or maintenance. The operating of the panel doors and circuit breaker for the start of work is ensured by the secure genuine password from the substation to the working lineman. Similarly, a request to close the lines when the job is completed is made using a genuine password, and the line is charged up by the substation operators. The feature of password reset is not disclosed by this system. As a result, if the password is lost or stolen, the system is rendered worthless. Furthermore, the usage of ARDUINO is unreliable [8].

Tarun et al. devised a method that assures the lineman's safety. Because this system is set up in such a way that a password is necessary to operate the circuit breaker (ON/OFF), the lineman will be in charge of turning on/off the line. A microcontroller from the 8051 series is in charge of the entire system. To enter the password, a matrix keypad is connected to the microcontroller. The password entered is compared to the password saved in the microcontroller's ROM. This system necessitates the lineman travelling to the location where it is installed and providing the password to turn on/off the supply, lengthening the time it takes to operate. Work efficiency suffers as a result of this. Furthermore, the option of password reset is not disclosed. As a result, if the password is lost or stolen, the system is rendered worthless [9].

M. Avinash et al. described a password-based circuit breaker system based on an 8051 microcontroller. The password is entered using a matrix keypad, and the relay driver is utilised as a control switch to turn on/off during overload and short circuit circumstances. It will check all transmission lines' preset passwords. If the inputted password matches one of the transmission lines, the transmission line is turned on or off. Because it does not have a distinct password for each, this system shuts off the whole distribution system, causing annoyance to the consumer. As a result, if a problem develops in any of the lines, the entire system is turned off. This system necessitates the lineman travelling to the location where it is installed and providing the password to turn on/off the supply, lengthening the time it takes to operate. Work efficiency suffers as a result of this. Furthermore, the option of password reset is not disclosed. As a result, if the password is lost or stolen, the system is rendered worthless. [10].

3. METHODOLOGY

3.1. Design:

From the standpoint of lineman safety while working on transmission lines, it's critical to set up suitable circuit breakers so that no one else who isn't aware of the operation may turn on the power. The study describes an unique password-based circuit breaker that uses a password to turn on and off the power supply. Fig. 1 shows the block diagram of the component used in the project.

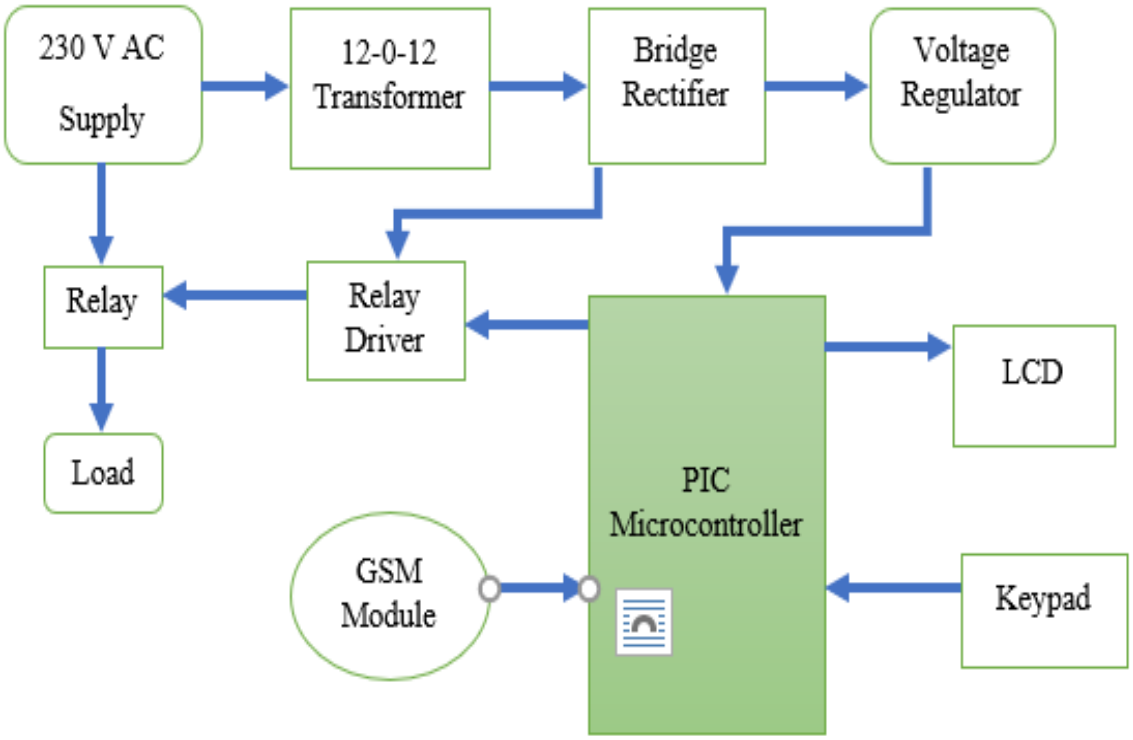

Fig. 1: Illustrates the block diagram of Password-Based Circuit Breaker. Using the GSM module to access the password from anywhere.

3.2. Components:

A Password-Based circuit breaker required the following hardware to perform the task.

i. Step-Down Transformer:

A transformer is an electrical device that uses electromagnetic induction to transmit electrical energy between two or more circuits. Electromagnetic induction occurs when a conductor is subjected to time-varying magnetic fields and creates an electromotive force across it. Transformers are commonly employed in electric power applications to raise or reduce the voltages of alternating current. A step-down transformer is the most popular technique to convert 230V alternating current (AC) to 12V AC. A step-down transformer is a transformer that transforms high output voltage to low output voltage.

ii. Rectifier:

The system's primary component requires a direct current (DC) supply to function. A rectifier is an electrical component that transforms alternating current (AC) into direct current (DC). Rectification is the process of a rectifier occasionally reversing the direction of a current that travels in just one direction, from AC to DC. As a result, the AC is converted to DC using a bridge-type rectifier and a filtering capacitor.

iii. Voltage Regulator:

The fixed-voltage integrated-circuit (IC) voltage regulators of this series are suitable for a variety of applications. On-card regulation, which eliminates the noise and dispersion issues associated with single-point regulation, is one of these applications. For voltage control, the IC 7805 is utilised. It belongs to the 78xx family of fixed linear voltage regulator integrated circuits. A circuit's voltage source may fluctuate, and the output voltage will not be constant. The output voltage is kept constant by the voltage regulator IC.

iv. PIC Microcontroller:

PIC stands for peripheral interface controller in its complete form. For programme storage, all contemporary PIC versions employ flash memory, and later variants allow the PIC to reprogram itself. There is a distinction between programme memory and data memory. The data memory has an 8-bit width. The bit count of a programme instruction changes depending on the pic's family, and it might be 12, 14, 16, or 24 bits long. The PIC16 is a mid-range pic microcontroller with a 14-bit instruction width and programme memory accessible in the same word size.

v. EEPROM:

Electrically Erasable Programmable Read-Only Memory, or EEPROM, is a non-volatile memory used in computers and other electronic devices to store tiny quantities of data that must be retained when power is disconnected, such as calibration tables or device setup. When storing huge volumes of static data (such as in USB flash drives), a specialised type of EEPROM such as flash memory is more cost-effective than regular EEPROM devices. EEPROMs are made up of floating-gate transistor arrays.

vi. GSM Module:

GSM is a technology that allows a computer to communicate with a GSM system. The Global System for Mobile Communication (GSM) is a mobile communication architecture that is utilized in most nations. A GSM module combines a GSM modem with conventional communication interfaces such as RS-232 (Serial Port), USB, and others to make it easy to connect to a computer or a microprocessor/microcontroller-based system. The module also has a power supply circuit that may be triggered with an appropriate adapter.

vii. Relay Driver:

The supply given by the microcontroller output signal is insufficient for the relay to operate. The current delivered by the microcontroller's output pin is insufficient for the relay coil. As a result, a ULN2003 relay driver is utilised to amplify the signal.

viii. Keypad:

The digits 0-9, A, B, C, D, *, and # are shown on a hex keypad, which has 16 keys linked in a 4*4 matrix. When building embedded system applications that require character or numeric input, or both, interfacing a Hex keypad to a PIC 16F887A microcontroller is necessary. Projects such as a digital code lock, a numeric calculator, and others are examples. This is what we're using to input the numeric password.

ix. Liquid Crystal Display (LCD):

The phrase "liquid crystal" refers to a material that is in between a liquid crystal and a solid, yet has qualities of both. In a liquid, molecules align themselves until they all point in the same direction. This molecular arrangement allows the medium to flow like a liquid. Liquid crystals can exist in one of numerous phases depending on the temperature and composition of the material. LCD technology, for example, uses liquid crystals in the Pneumatic phase, when there is no spatial ordering of the molecules. This is used to display the circuit breaker password that we input.

x. Relay:

A relay is a switch that is controlled by electricity. Many relays utilise an electromagnet to mechanically activate a switch, while others, such as solid-state relays, use alternative working principles. Relays are employed when a low-power signal is required to control a circuit (with perfect electrical isolation between the control and controlled circuits), or when several circuits must be controlled by a single signal.

3.3 Principle and Working:

The PIC 16F887A microcontroller is the circuit's key component. A GSM module is used to link the user's mobile phone device to the circuit breaker system, allowing the user to access the password to turn on or off the power. The relevant electrical line is switched ON or OFF if the entered password is accurate. Each electrical wire is given its own password in this project. When a password is lost or leaked, EEPROM is used to reset the password. Manually inputting the predetermined security pin by the head of the substations through the keypad can be used to reset the password.

We send a normal 230V power supply to the step-down transformer and then transmit the power supply to the load in this system. To control the supply from 230V to 12V, a step-down transformer is installed. After that, a bridge rectifier converts the 12V AC supply to a 12V DC supply, which is not regulated, therefore a voltage regulator converts the 12V DC supply to a 5V DC supply. It utilised LEDs to show whether or not power was

available. This programme was developed in embedded C and burned onto a microcontroller using Keil software to implement. A GSM module, matrix keypad, LCD, and voltage regulator are all connected to this microcontroller. The system gets the signal from the user's mobile phone device through the GSM module when the user inputs the password from his mobile. If the password supplied by the user is accurate, the system turns off the power to the line in question. The user must input the password from his cell phone again to turn on the supply.

4. RESULTS AND DISCUSSION

This project might be utilised to guarantee the safety of maintenance workers, such as linemen. Only the lineman has the ability to turn the line off and on. This system has a password-protected circuit breaker (ON/OFF) that requires a password to activate. Linemen may safely shut off the supply and fix it, then reactivate the line by providing the right password. It provides greater protection to the lineman's life as a password within the lineman. Because it allows the user to change the password, he or she may use whatever password they choose and have their job done in a more secure manner. Linemen must ask the substation's head for a password change; only the substation's head may change the password manually.

4.1. Existing System:

Circuit breakers are critical in ensuring system security. During distribution line repair, there is a risk of a communication breakdown between the electric line and the substation operator or personnel. An electric lineman's life might be jeopardised as a result of this communication breakdown. Only the lineman has control over whether or not the line is turned on or off. The entire line is switched off during maintenance, which causes customers to be inconvenienced.

4.1.1. Disadvantages of the Existing System:

1. During maintenance, the entire line is turned off this causes inconvenience to the consumers.
2. Improper communication between maintenance staff and substation causes electrical accidents.
3. Time take for maintenance is more because the lineman has to travel to the substation from the fault location to switch ON/OFF the supply.

4.2. Proposed System:

A PIC microprocessor and a rectified power supply are used in the proposed system. When the suggested system is turned on, the GSM module receives the user's signal. A signal is transmitted to the GSM when the lineman inputs the password on his mobile phone device, and the line will be terminated only if the password entered is the same as the predetermined password. A relay driver IC, which is connected to the microcontroller, controls the relay. To reset the password, a keypad is connected to the microcontroller. On the LCD, the password entered is shown. The relay ON/OFF action will be signalled, and a notification regarding the line disconnection will be sent to the receiver.

4.2.1. Applications:

1. Used in electrical substations to ensure lineman safety.
2. This system is used in buildings and houses.
3. Used in hotels and shopping malls to save power.
4. Can also be used as Password based electrical appliance control or Password based Load Control system.

5. CONCLUSION

The lineman's security is demonstrated by the PIC microcontroller and GSM-based work, while the circuit breaker is switched ON/OFF for repair or maintenance. The approach addresses a shortcoming in the current system of line clearing opening and shutting requests. The circuit breaker for the start of work is operated using a secure authentic password sent from the substation to the working lineman. Similarly, a request to close the lines when the job is completed is made using a genuine password, and the line is charged up by the substation operators. The approach assures safety by double-checking the completion. For security purposes, every illegal access into the system using the erroneous password for a certain number of attempts sends a message to the LCD and a message to a substation. This approach is more accurate and better for the lineman's safety. This method is cost-effective and simple to set up. This may also be used by businesses when they are dealing with equipment or wiring issues. Although there has been much research work on making a password-based circuit breaker in the past, this system provides an overall solution but there is a potential for more

research in this field in the future. We can use Supervisory Control and Data Acquisition (SCADA) system, to help easy troubleshoot, to identify the fault location directly and lineman can easily rectify it.

REFERENCES

[1] P. Title, B. Rai, and U. Haider, "Project Title : Password based circuit breaker By Rai Usman Haider Introduction : Study Required :"

[2] X. Pei, O. Cwikowski, D. S. Vilchis-Rodriguez, M. Barnes, A. C. Smith, and R. Shuttleworth, "A review of technologies for MVDC circuit breakers," 2016, doi: 10.1109/IECON.2016.7793492.

[3] H. U. Zaman, Rafiunnisa, and A. M. Shams, "A User-Friendly Low-Cost Mobile App Based Home Appliance Control and Circuit Breaker," 2018, doi: 10.1109/ICCMC.2018.8487667.

[4] Junho Hong, Chen-Ching Liu, and M. Govindarasu, "Cyber-physical security in a substation," 2012, doi: 10.1109/pesgm.2012.6345766.

[5] M. Kezunovic and G. Latisko, "Enhanced Reliability of Power System Operation Using Advanced Algorithms and IEDs for On-Line Monitoring," *October*, 2005.

[6] D. Bin and L. Bing, "Design of security state machine of access control for control object based on IEC 61850," 2006, doi: 10.1109/pes.2006.1709328.

[7] P. Jay Kumar, Surya Kumar, Vivek Yadav, Naveen Kr. Singh, Prashant Kr. Gaur and K. Tyagi, "Password Based Circuit Breaker," *Int. J. Recent Res. Asp. ISSN 2349-7688, Vol. 3, Issue 1, March 2016, pp. 80-85*, vol. 3, no. 1, pp. 80–85, 2016.

[8] M. G. Hudedmani, N. Ummannavar, M. D. Mudaliyar, C. Sooji, and M. Bogar, "Password Based Distribution Panel and Circuit Breaker Operation for the Safety of Lineman during Maintenance Work," *Adv. J. Grad. Res.*, vol. 1, no. 1, pp. 35–39, 2017, doi: 10.21467/ajgr.1.1.35-39.

[9] T. Naruka, V. K. Sharma, V. Singh, Sumit, and V. Sharma, "Password Based Circuit Breaker," *Imp. J. Interdiscip. Res.*, vol. 3, no. 4, 2017.

[10] M. K. M, "Password Based Circuit Breaker," *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 6, no. 4, pp. 2229–223, 2018, doi: 10.22214/ijraset.2018.4380.