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Calibration Of Miniature Circuit Breaker In Automation Industries

Akshay Kumar.S [1], Brajesh K.V [2], Kavin.S [3]

Electronics and Instrumentation, Panimalar Engineering College, India[1 2 3]

S.R.Balaji, M.Tech,MBA,[Ph.D], Electronics and Instrumentation, Panimalar Engineering College, India.
Assistant Professor, Dept.of Electronics and Instrumentation, Panimalar Engineering College, India.

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ABSTRACT— *MCB's or Miniature Circuit Breakers are electromechanical devices which protect an electrical circuit from an overcurrent. They are primarily designed to protect cables and lines against overload (thermal) and short-circuit(electromagnetic). They thus care for protecting this electrical equipment against excessive temperature rises and destruction in the event of a short-circuit. They are used in industries to protect their expensive machines electrically.*

At present, internal parts of MCB are automatically assembled, but tripping mechanism is checked manually. To overcome the human error and effort, we propose a system to check the tripping mechanism of MCB, thereby ensuring the quality of MCB. The system performs quality inspection in two ways, i.e., cold calibration and continuity test. The cold calibration is a mechanical process where no power supply is needed. A mechanical stress is applied to the bimetallic strip in MCB by screwing it on one end, there causing MCB to trip. This mechanism resembles Overload current effect. Current with higher rating is passed through MCB for long time then its said to be Overload current. The continuity test is an electrical way of inspecting the quality of MCB. Here two leads are placed at both ends of MCB, which acts like a short circuit inside the MCB. Then current is passed through the leads. When a load is applied at input and received at the output, we confirm the continuity in MCB. The entire process is controlled by DELTA PLC.

Keywords— PLC, MCB, automation, continuity, calibration.

1, INTRODUCTION

Automation is basically the delegation of human control function to technical equipment aimed towards achievement of higher productivity, superior quality of end product, efficient usage of energy and raw materials, improved safety in working condition.

MCB operates as automatic switch that opens in the event of excessive current flowing through the circuit and once the circuit returns to normal, it can be reclosed without any manual replacement. It is an electromagnetic device that embodies complete enclosure in a molded insulating material. The main function of an MCB is to switch the circuit, i.e., to

open the circuit automatically when the current passing through it exceeds the value for which it is set.

MCBs are of time delay tripping devices, to which the magnitude of overcurrent controls the operating time. These get operated whenever overload exist long enough to create a danger to the circuit being protected. Therefore, MCBs doesn't respond to transient loads such as switches surges and motor starting currents.

1.1 MANUAL CONTROL

In this all the actions to process control and the control operation are carried manually, the manual control has its own limitation with regard to mass production techniques. The drawbacks of this control are human error, less quality and more man power.

1.2 HARD WIRED LOGIC CONTROL

It was the first step to be considered for the automation. In this the contractor and relays together with timer and counters were used in achieving the desired level of automation within the certain limitation. The drawbacks of this control are they are bulky, complex wiring and troubleshooting is very difficult. It also involves more man power, less reliability, wastage of raw material, time consumption and costly.

1.3 DEDICATED LOGIC CONTROL

This adventure of electronics, by using the logic gates and microprocessor, the relays are replaced. The timer replaces the bimetallic and the motorized timer. The drawbacks includes lot of designing and time consumption.

2, EXISTING SYSTEM

The system is complex because of the implementation of wired relay circuits. The pump selection cannot be done in remote mode. Only the feedback we can get whether the system is working or not. But the status of which pump is running cannot be identified. Similarly, the warning and trip signals can be received but the cause of the signal cannot be identified. In case of any changes in the rewiring is very difficult. PLCs are well adapted to a range of automation tasks. These are typically industrial processes in manufacturing where the cost of developing and maintaining the automation system is high relative to the total cost of the automation, and where changes to the system would be expected during its operational life. PLCs contain input and output devices compatible with industrial pilot devices and controls; little electrical design is required, and the design problem centers on expressing the desired sequence of operation.

Miniature Circuit Breakers are electromechanical devices which protect an electrical circuit from an overcurrent. They are primarily designed to protect cables and lines against **overload** (thermal) and **shortcircuit**(electromagnetic). They thus care for protecting this

electrical equipment against excessive temperature rises and destruction in the event of a short-circuit. They are used in industries to protect their expensive machines electrically. In existing system, the child parts of MCB are assembled automatically, the machine is spread over 8 stations but this system lacks quality inspection part. As MCB is an important component for electrical safety of industrial machines, thus the quality of MCB is an important constraint in manufacturing process.

At present, Quality inspection of MCB is done manually in random basis. Quality testers are appointed for checking the quality of MCB. Trip test is the important process in quality management. The trip test is done by screwing the bimetallic element with the help of a screw driver by bare hands. The tester has to screw the metallic part until the MCB trips. In this process, we are unsure how much stress bimetallic strips can withstand as there is a variation in stress applied by different human. The continuity of the internal circuit of MCB is not inspected. As MCBs are checked on random basis, the efficiency of MCBs are low. More human effort is used in this system. This system not only consumes more time and lacks accuracy but it is not feasible to inspect each and every assembled MCB component. The continuity test is not at all performed. The drawbacks of this system are lot of time is wasted, the probability of human error is high, this leads to low productivity. The figure shows the block diagram of manual system of cold calibration.

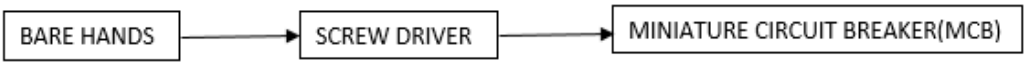

Figure.1 BLOCK DIAGRAM OF EXISTING SYSTEM

3, PROPOSED SYSTEM

In this system, each and every component(MCB) is inspected, the entire system is automated. The trip test of MCB is done automatically with the help of solenoid valve and DC motor setup. The screwing is done by DC motor (rotating action) and pneumatic cylinder (forward and reverse motion). We have added a new inspection process to check the continuity inside the MCB. Here two leads are attached to the input and output terminals of the MCB so that it forms a closed circuit and then current is passed through the MCB, if output is obtained, the MCB is flawless. The entire system is controlled by DELTA PLC. This system involves no human intervention and consumes less time. The quality of production can be increased using this system.

The system consists of two parts, electrical and mechanical. The electrical parts consists of panel wiring of PLC. The major components are SMPS, fuse, plc, relays, push buttons, buzzer and LED. DVPSS2114R DELTA PLC is used in this system. It has 6 inputs and 8 outputs. Data card cable is used to download a program, which controls the entire process from PC to PLC. The SMPS converts 230V AC into 24V DC, another SMPS is use for DC to runs a 12V.

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Three separate fuse is used to protect two SMPS and one PLC. 4 12V relays are used to switch between NO (Normally Open) and NC (Normally closed) contact. Three separate pushbuttons are used to perform the operations START, RESET and EMERGENCY. 24V Buzzer is used to indicate bad component and 24V green LEDs are used to indicate good components. The entire setup is mounted on thick acrylic sheet. The mechanical setup consists of DC motor, cylinders, sensors, solenoid valves, compressor and supporting materials. The DC motor is used to perform the screwing operation, which is directly controlled by PLC. The two double acting pneumatic cylinders are used to perform up and down, forward and reverse motion.

One cylinder is used for pushing the DC motor, another cylinder is used for continuity test. The two solenoid valves are used to control the action of two pneumatic cylinders. Double acting solenoid valve is used in cold calibration process and single acting is used in continuity test. Photoelectric sensor is used to sense whether the tripper position is changed or not. Proximity sensor is used to sense the position of DC motor from MCB. Compressor is used to provide the air supply to the mechanical setup. The entire setup is mounted over the wooden material.

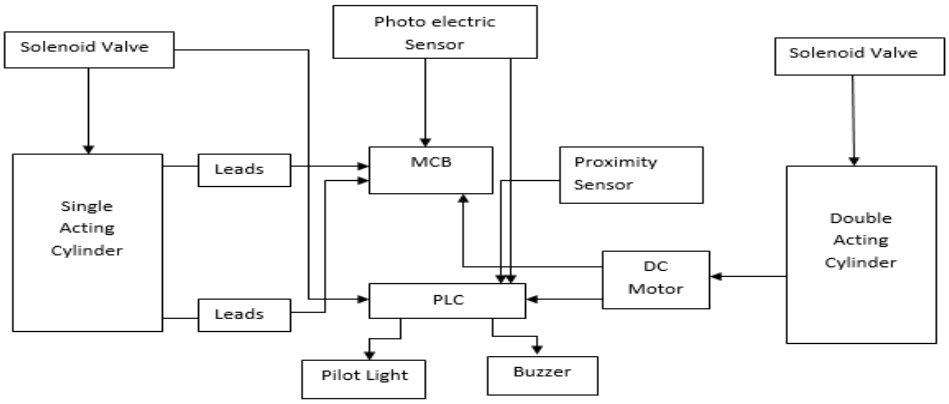

Figure.2 BLOCK DIAGRAM OF PROPOSED SYSTEM

3.1 COLD CALIBRATION PROCESS

After the initial manufacturing of child parts of MCB, the assembled product arrives at the quality inspection station. Here the trip test is performed. The trip test confirms the perfect condition of MCB. The process starts with proper orientation of MCB, such a way that the bimetallic screw is properly positioned. Now the DC motor starts the screwing process, then solenoid valves actuates the pneumatic cylinder to push the DC motor towards the bimetallic strip. As the screwing process is under way, the stress is created in the bimetallic strip this is equivalent to the over load current in the field operations. Due to the stress the bimetallic strip bends, breaks the latch point causing the MCB to trip. If the MCB component is properly assembled, the above mentioned process occurs perfectly. The occurrence of trip is sense by photoelectric sensor, this signal is sent to the led to glow, indicating the good component. If the trip does not occur for certain duration, the signal is

send to buzzer, then the buzzer alerts indicating the bad components. The entire process is controlled through PLC.

3.2 CONTINUITY TEST

In existing system, this test is not performed. We have included to test the better quality of MCB. The aim of this test is to ensure entire circuit of MCB is properly assembled. The MCB is aligned such a way that two rods touches the input and output terminals. The vertical moments of these two rods are controlled by pneumatic cylinder and solenoid valve. 24V current is supplied through the input terminal, if we get the same 24V current in the output terminal, then the component has electrically stable internal circuit. It is indicated using a LED. If 0V is received at the output terminal, there is a break in internal circuit, thus alerting through buzzer. The entire process is controlled by PLC.

4, HARDWARE IMPLEMENTATION

4.1 PROGRAMMABLE LOGIC CONTROLLERS (PLC)

A Programmable controller is a digitally operated electronic system, designed for use in industrial environment, which uses a programmable memory for the internal storage of user oriented instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic to control, through digital or analog inputs and outputs, various types of machines or processes. PLC was developed as a replacement for large amounts of relays.

4.2 LADDER LOGIC

The Ladder logic in the PLC is actually a computer Program that the user can enter and change. The ladder diagram language is basically a symbolic set of instructions used to create the controller program. These symbols are arranged to obtain the desired control logic that is to be entered into the memory of the PLC. A ladder diagram consists of individual rungs just like a real ladder. A line showing an input or several inputs and an output is known as a rung. Ladder logic programing is a graphical representation of the program designed to look like relay logic. The many similarities between the ladder diagrams used to program PLCs and the relay ladder logic formerly used to control industrial systems eased the transition from hardwired relay 23 systems to PLC-based systems. The ability to monitor PLC logic in ladder diagram format also made troubleshooting easier for those already familiar with relay -based control systems.

The ladder is an automatic control diagram language that developed during world war. At first, it just has basic components, such as A contact (normally open), B contact (normally close), output coil, timer, counter and etc. (The power panel is made up of these basic components) It has more functions, differential contact, latched coil and the application commands, add, minus, multiply and divide calculations, the traditional power panel cannot make since PLC is developed. The working principle of the traditional ladder diagram and the PLC ladder diagram are similar to each other; the only difference is that

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the symbols for the traditional ladder diagram are expressed in the format that are closed to its original substance, while those for the PLC ladder diagram employ the symbols that are move explicit when being used in the computer or data sheets. In the ladder diagram logics, it could be divided into the combinational logics and sequential logics.

4.3 ADVANTAGES OF PLC

The advantages of PLC are reduced space, energy saving, easy maintenance, economical, greater life and reliability, tremendous flexibility, and shorter project time.

4.4 APPLICATIONS

Switched mode mobile phone charger A450 Watt SMPS for use in personal computers with the power input, fan, and output cords visible Switched-mode power supply units (PSUs) in domestic products such as personal computers often have universal inputs, meaning that they can accept power from mains supplies throughout the world Due to their high volumes mobile phone chargers have always been particularly cost sensitive. The first chargers were linear power supplies but they quickly moved to the cost effective ringing choke converter (RCC) SMPS topology, when new levels of efficiency were required. Recently, the demand for even lower no-load power requirements in the application has meant that fly back topology is being used more widely; primary side sensing fly back controllers are also helping to cut the bill of materials (BOM) by removing secondary-side sensing components such as optocouplers.

5, RESULTS AND DISCUSSIONS

The occurrence of trip is sense by photoelectric sensor, this signal is sent to the led to glow, indicating the good component. If the trip does not occur for certain duration, the signal is send to buzzer, then the buzzer alerts indicating the bad components. The entire process is controlled through PLC.

24V current is supplied through the input terminal, if we get the same 24V current in the output terminal, then the component has electrically stable internal circuit. It is indicated using a LED. If 0V is received at the output terminal, there is a break in internal circuit, thus alerting through buzzer. The entire process is controlled by PLC.

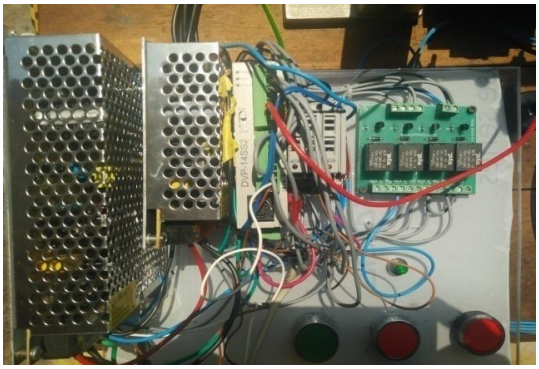

Figure.3 PANEL WIRING

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Figure.4 MECHANICAL WIRING

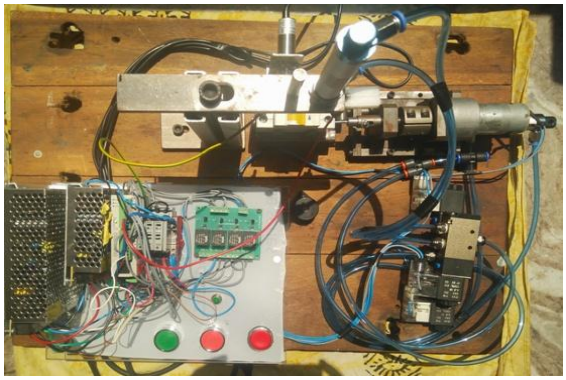

Figure.5 ENTIRE SETUP

6, CONCLUSION

This paper is mainly focused on replacing manual system with PLC, in order to overcome the existing system. It has accuracy, repeatability. Thus by executing our proposed system, we can overcome the various problems in the existing system. Our system not only saves money and time, it improves the overall quality management. This system also includes the new concept of checking the internal circuit connectivity. Our system is so flexible and reliable on longer run. By following this system, they can improve the overall productivity.
In this process, servo motor can be used to rotate the bimetallic screw instead of DC motor so that the motor can be rotated to a particular angle based on our requirements. It can also control the speed of the servo motor so that the screwing process is done smoothly and output will be accurate.

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