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Development of Fast Acting Electronic Circuit Breaker

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ABSTRACT

The rapid increase in population has more demand and consumption of electrical energy in the market, use of equipments such as electrical and electronic components are also costlier. In order to protect the system from overload, or short circuit here is one possibility, which is by fast acting electronic circuit breaker. A circuit breaker is an automatically operating switch designed to shut down the power supply when it is overloaded. The tripping depends on the current passing through the CT's which is connected in series with load. The project is designed to develop the power supply which shuts down when it is overloaded by using a fast acting electronic circuit breaker. The concept of developing a electronic circuit breaker came into focus realizing that the conventional circuit breakers such as MCB's and fuse take longer time to trip. Therefore for sensitive loads it is very important to activate the tripping mechanism within short period of time. We know that the Modern technologies are paramount to provide operational reliability and financial profitability, so it is very important to develop an electronic circuit breaker by using a micro controller arduino. Here an electronic circuit breaker is designed using arduino in which program is dumped and a particular is set so that the system can shut down when it is overloaded. Here the voltage is sensed and rectified to DC and then it is compared with a preset voltage by a level comparator to generate an output that drives a relay to trip the load. The relay is preferred in place of semiconductors because such solid state switches would invariably fail in case of accidental short circuits. This project is designed to overcome the drawback of thermal type of circuit breaker like MCB based on a thermal bimetal lever trip mechanism which is very slow. This project is based on the current sensing across a series element typically a CT (Current Transformer). The current sensed which is compared against the preset value proportional to the voltage by comparator which is inbuilt in arduino to generate an output that drives a relay to trip the load very fast.

Keywords : Arduino , Comparator, Relay, Voltage Regulator, Current Transformer.

I. INTRODUCTION

A circuit breaker is an automatically switching device which is designed to protect an electrical circuit from damage caused by overload or short circuit. It can be operated manually. Its major function is to detect a fault condition and interrupt current flow during the operation of circuit breaker. Circuit breakers are made in varying sizes, from small devices that protect low-current circuits or individual household appliances, up to large switch gear designed to protect high voltage circuits feeding an entire city. The generic function of a circuit breaker, or fuse, as an automatic means of removing over from a faulty system is often abbreviated as OCPD (Over current Protection Device). Therefore we can define it as a mechanical switching device which is capable of switching, breaking and carrying current under

normal conditions and under some specific time period. Power system deals with a huge power network and huge numbers of associated electrical equipment. At the time of short circuit fault or any other types of electrical fault the power network may release a high stress of fault current in the equipment which may damage both the equipment and networks permanently. Only solution for saving the equipment and the power networks is that the fault current should be cleared as soon as possible from the system. Once the fault is cleared, the system will recover its normal working condition and gets ready for supplying reliable quality power to the receiving ends.

There are different switching operations needed for proper controlling of power systems. For the protection and control of power system network some special type of switching devices are introduced which can be operated safely under huge current carrying conditions During the flow of huge current, there may be large arcing in between switching contacts, so it should be taken care to quench these arcs in circuit breaker in safe manner.

II. SYSTEM MODEL AND EXPLANATION

Firstly the 230V ac is given to the circuit which furthers steps down to12Vac by suing step-down transformer, this stepped down voltage is further supplied to the regulator unit which consists of a bridge rectifier which converts AC to DC i.e. the 12V AC is converted to 5V DC and it is given to arduino.

Here the capacitor filter is used to remove the ripples and to get a pure constant DC. The current passing through the is sensed by CT and its output is obtained is analog , this analog output is connected to the ADC pin of arduino to convert the analog output to digital output.

If the current sensed is less than preset value then relay will not trip and the circuit will not break. Due to increase in load if the current drawn is more than the preset value then the relay will trip & armature will shift its position from normal open point to its close point.

When the relay will trip the overload will be displayed on the LCD screen and the system shuts down.

III. LITERATURE SURVEY

The history of power electronics is very much connected to the development of switching devices and it emerged as a separate discipline when high-power and MOSFET devices were introduced in the 1960s and 1970s.Since then, the introduction of new devices has been accompanied by dramatic improvement in power rating and switching performance. Because of their functional importance, drive complexity, fragility, and cost, the power electronic design engineer must be equipped with a thorough understanding of the device operation, limitation, drawbacks, and related reliability and efficiency issues. In the 1980s, the development of power semiconductor devices took an important turn when new process technology was developed that allowed integration of MOS and bipolar junction transistor (BJT) technologies on the same chip. Thus far, two devices using this new technology have been introduced: insulated bipolar transition (IGBT) and MOS controlled thyristor (MCT). Many integrated circuit (IC) processing methods as well as equipment have been adapted for the development of power devices. However, unlike microelectronic ICs, which process information, power device ICs process power and so their packaging and processing techniques are quite different [6]. Power semiconductor devices represent the heart of modern power electronics, with two major desirable characteristics of power semiconductor devices guiding their development; 1. Switching speed (turn-on and turn-off times) 2. Power handling capabilities (voltage blocking and current carrying capabilities) Improvements in both

semiconductor processing technology and manufacturing and packaging techniques have allowed power semiconductor development for high-voltage and high current ratings and fast turn-on and turn-off characteristics .Today switching devices are manufactured with amazing power handling capabilities and switching speeds as will be shown later. The availability of different devices with different switching speeds, power handling capabilities, size, cost etc., makes it possible to cover many power electronics applications. As a result, trade-offs are made when it comes to selecting power devices.

HISTORY OF CIRCUIT BREAKER:

An early form of circuit breaker was described by Tomas Edison in an 1879 patent application, although his commercial power distribution system used fuses .Its purpose was to protect lighting circuit wiring from accidental short circuits and overloads. A modern miniature circuit breaker similar to the ones now in use was patented by Brown, Boveri & Cie in 1924. Hugo Stotz, an engineer who had sold his company to BBC, was credited as the inventor on DRP (Deutsches Reichspatent) 458392. Stutz's invention was the forerunner of the modern thermal-magnetic breaker commonly used in household load centers to this day. Interconnection of multiple generator sources into an electrical grid required the development of circuit breakers with increasing voltage ratings and increased ability to safely interrupt the increasing short-circuit currents produced by networks. Simple air-break manual switches produced hazardous arcs when interrupting high voltages; these gave way to oil-enclosed contacts, and various forms using the directed flow of pressurized air, or of pressurized oil, to cool and interrupt the arc. By 1935, the specially constructed circuit breakers used at the Boulder Dam project use eight series breaks and pressurized oil flow to interrupt faults of up to 2,500 MVA, in three cycles of the AC power frequency.

IV. HARDWARE IMPLEMENTATION

The unit is extremely fast and overcomes the drawback of thermal type circuit breaker like MCB based on a thermal bimetal lever trip mechanism which is very slow. Here an electronic circuit breaker is designed which is based on the current sensing across a series element typically a CT (current transformer). The current sense which is compared against the preset value proportional to the voltage by comparator which is inbuilt in arduino to generate an output that drives a relay to trip the load very fast.

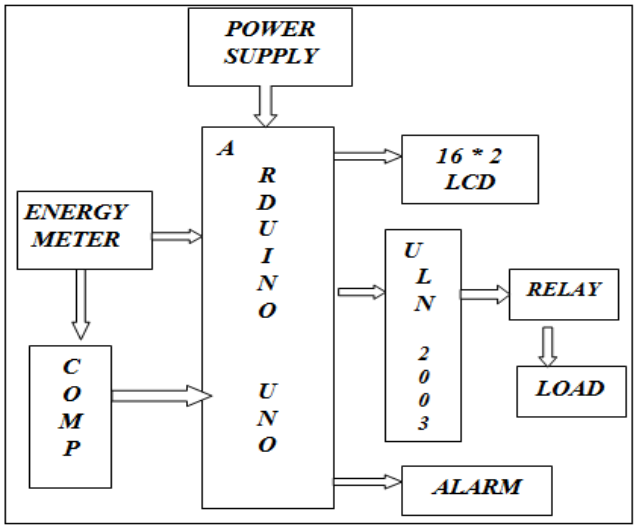

Fig1. Architecture

PROGRAM EXPLANATION:

It starts with a header file then the description about the LCD pins and arduino is given, then the value is set for particular time period over which the arduino could work. The code should develop for each and every equipment and then check the readings each and every period. Then the program comes for the display of the LED light and other equipments.

V.RESULTS & CONCLUSION

Voltage	Filtered DC Current in Amp	Full wave Dc and AC trip current in Amps
2.55	14.35	10.02

2.40	13.20	9.35
2.25	12.36	7.02
1.95	6.75	4.77
1.80	6.00	4.24
0.90	4.50	3.71
0.75	3.75	2.65
0.60	3.00	1.50
0.45	2.25	0.75
0.30	1.50	0.53

Fig 2. Hardware Implementation

Nowadays the protection and control of equipment plays a very important role. To avoid electrical failure we use fast responding circuit breakers because of its considerable accuracy in fault detection and cut off time, and also its smooth operation compared to conventional type. With the help of this project students can understand the requirement of shutting down a system and programming of arduino can help students to learn about other software's programmable languages Comprehensive experiments conducted by constructing the necessary circuit yielded successful results. The main advantage of this circuit is that over all tripping time is less as compare to conventional circuit breaker. It was proved that electronic circuit breaker is very useful circuit for sensitive loads. The experiment is successfully operated and consequently energy was vsaving. Further research on improving the load capacity and tripping time is being undertaken.

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