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# A Microcontroller Based Online Fault Detection System

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**Abstract:** The system is a microcontroller based to provide protection from over-voltage, over-current and under-voltage faults. The automated system make comparisons with the reference threshold values set by the user and accordingly it takes the decision to trip a relay when any of these faults appear in the line. The system is made highly flexible, rugged and reliable and also it responds in real-time. For sensing these faults a high precision and more accurate current transformer and potential transformer is used. The developed system ensures the complete protection against these faults. The system is calibrated, well tested and implemented for the desired functionalities and to get the optimum results. Up-gradation and optimization of this system is possible and open for further experimentations.

**Index Terms:** Microcontroller, Protection, Fault Detection, ADC.

## I. INTRODUCTION

Power systems are built to allow continuous generation, transmission and consumption of energy. The system is capable of sustaining a variety of environmental and operating impacts that resemble normal operating conditions. The abnormal conditions that the system may experience are rare but do happen. They include lightning striking the transmission lines, excessive loading, deterioration or breakdown of the equipment insulation. As a result power systems may experience occasional faults. In modern power system to have a normal operation of the system without electrical failure and damage to the equipment two alternatives are available with the designer, one is to design the system so that faults cannot occur and the other is to accept the possibility of faults and take steps to guard against ill effects of such faults. Protection scheme required for the protection of power system components against abnormal conditions such as faults etc essentially consists of protective relaying and circuit breaker. Protective relay functions as a sensing device, it senses the fault, then determines its location and finally, it sends tripping command to the circuit breaker. The circuit breaker after getting the command from protective relay disconnects the faulted element. From this it can be concluded that protective relay plays a vital role. As a matter of fact clearing the fault fast with the help of fast acting protective relay and associated circuit breaker, the damage to the apparatus is reduced, subsequent hazards like fire, risk to life are reduced by removing the particular faulted section, the continuity of supply is maintained through healthy section, fault arising time is reduced, permanent damage to the system is avoided. All the above objectives can be achieved only if the protective relay is reliable, maintainable and sensitive enough to distinguish between normal and abnormal conditions. The protective relays do not eliminate the possibility of fault occurrence rather their action starts only after the fault has occurred on the system. All the relays employed for protection against short circuit operates by virtue of the current and/or voltage supplied to them by CTs or PTs. The main principle for relay operation is either electromagnetic attraction or electromagnetic induction.

## II. PROPOSED SYSTEM

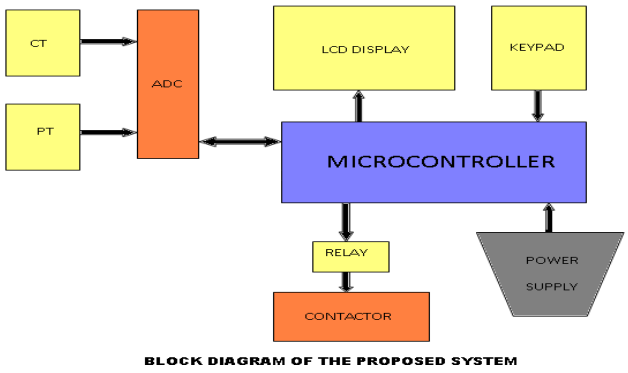


Fig. 1. Block Diagram of the Proposed System.

An instantaneous OC relay is one in which no intentional time delay is provided for the operation. In such a relay contacts close immediately after the current in relay coil exceeds that for which it is set. One of the important considerations in OC and OV protection is the speed of operation. For relatively fast, reliable, adjustable protective relays microcontroller based design is considered as the cheap and best. The proposed system is to design and develop the protective relay for under-voltage, over-voltage, over-current protection of line using an eight bit microcontroller. The system consists of a current transformer and a potential transformer to monitor current and voltage values. A small keypad is there to set the reference values for the current and voltage and it can be seen on a small LCD screen.

A. Microcontroller

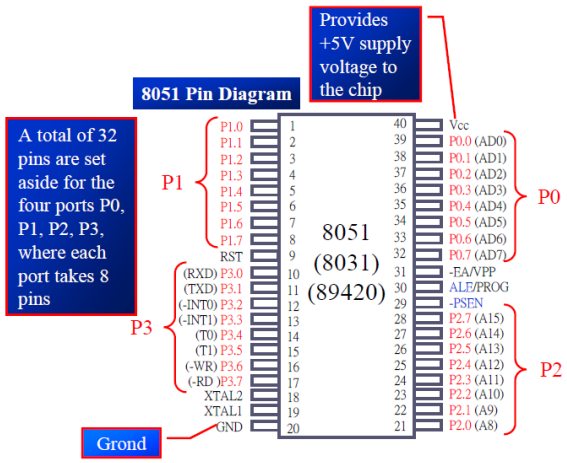


Fig. 2. Pin Diagram of the 8051 Microcontroller.

The microcontroller used here is an eight bit widely used microcontroller of 8051 core processor. The microcontroller has some distinct features like four input/output ports with a total 32 pins, the port pins are multiplexed and are multifunctional. It has two 16-bit timer/counter, one serial port and six interrupt source. It is having 128bytes of RAM and 4Kbytes of inbuilt ROM and upto 60Kbytes expandable. It operates on 5volt DC supply.

B. Over Current Measurement

Current transformers can reduce or "step-down" current levels from thousands of amperes down to a standard output of a known ratio to either 5Amps or 1Amp for normal operation. Thus, small and accurate instruments and control devices can be used with CT's because they are insulated away from any high-voltage power lines. There is a variety of metering applications and uses for current transformers such as with wattmeter's, power factor meters, watt-hour meters, protective relays, or as trip coils in magnetic circuit breakers, or MCB's.

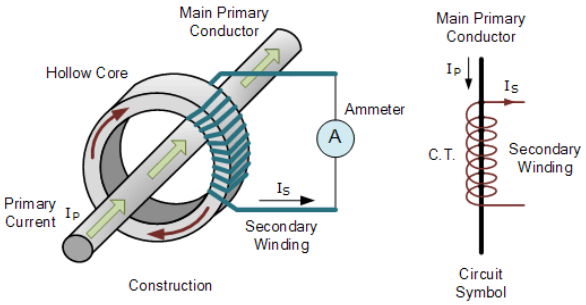


Fig. 3. Working Principle of a Current Transformer.

C. Over Voltage & Under Voltage Measurement

The purpose of voltage transformers/ potential transformers is to step-down the voltage of a device to measurable values, within the instrumentation measurement range 110V or 100V in the case of a voltage (or potential) transformers (VTs/ PTs). Hence, protective equipment inputs are standardized within the ranges above.

D. Analog to Digital Converter

An 8-bit Analog-to-Digital Converter is used here in this system to read the instantaneous analog values of current from the Current Transformer and voltage from the Potential Transformer and convert these values to digital values in the binary format after sampling. These digital values are being fed to the microcontroller to get the processed digital output. These output values are being utilized for comparing with the reference values and decision making for the tripping of relay accordingly.

E. Relay Section

A relays is an electrical switch that opens and closes under control of another electrical circuit. It is therefore connected to output pins of the microcontroller and used to turn on/off high-power devices such as motors, transformers, heaters, bulbs, antenna systems etc. There are various types of relays but all of them operate in the same way. When a current flows through the coil, the relay is operated by an electromagnet to open or close one or many sets of contacts. Similar to opto-

couplers, there is no galvanic connection (electrical contact) between input and output circuits. This is all due to a great flexibility of the microprocessor-based technology almost exclusively used to build relays today. Protective relays are intelligent electronic devices (IEDs) which receive measured signals from the secondary side of CTs and VTs and detect whether the protected unit is in a stressed condition (based on their type and
configuration) or not.A trip signal is sent by protective relays to the circuit breakers to disconnect the faulty components from power system if necessary.

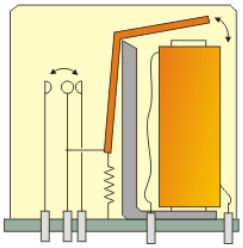

Fig. 4. Internal Construction of a Relay.

F. LCD Interfacing Circuit

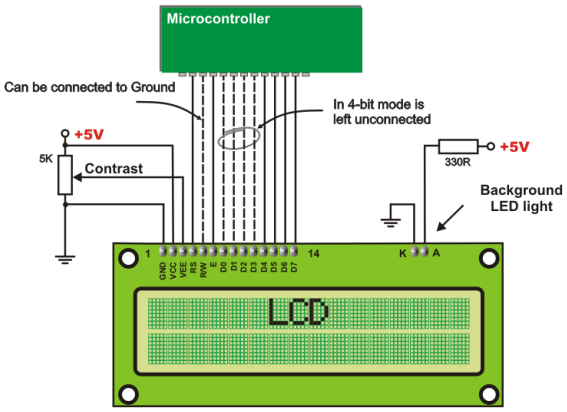


Fig. 5. Interfacing Diagram of LCD with Microcontroller.

16×2 LCD module is a very common type of LCD module and It is available in a 16 pin package with back light, contrast adjustment function and each dot matrix has 5×8 dot resolution. It has two built in registers namely data register and command register. Data register is for placing the data to be displayed, and the command register is to place the commands. Here the LCD module display the instantaneous current and voltage values and also it displays the fault due to which the relay is caused to trip.

G. Regulated Power Supply

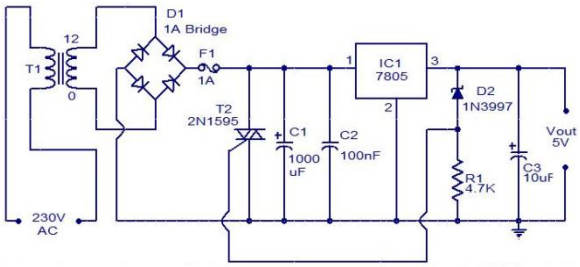


Fig. 6. A 5V regulated power supply.

Here a 5V DC regulated power supply is used. The circuit uses a cheap integrated three-terminal positive regulator LM7805, and provides high-quality voltage stability and quite enough current upto 1A to enable the microcontroller and peripheral electronics to operate normally.

## III. CONCLUSIONS

Through this proposed work we came to know about the utility of current transformer and potential transformer for the switching of a protection relay to protect transmission line against the over-current, over-voltage, under-voltage faults. The system is tested for different voltage and current values and calibrated through modifications in hardware as well as software. In a view to make the system flexible and user friendly separate keys are provided into the system to set the threshold limits for voltage and current and a LCD module is provided to display the present status of the system. A SPDT relay into the circuit switches on and off according to these threshold limits set by the user. This system might be integrated as a part of a more sophisticated power system.

## IV. FUTURE SCOPE

These types of systems are always open for further optimizations. Optimization by selecting the more precise and accurate current transformers, optimizations in the firmware is possible. This system can be modified for three phase supply and to make decision and select the best phase out of three phases. Use of more advanced techniques is left open for the future.

## V. ACKNOWLEDGEMENT

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