



Switching Circuit Design of an Automatic Fire Suppression System

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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Short Communication

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ABSTRACT

A switching circuit helps the society with the elimination of any human hand to switch the electronic home appliances on or off between electronic components and systems thus improving efficiency and the possibility of shocks to human becomes very low. High power devices such as motors, solenoids or lamps, often require more power than that supplied by an ordinary logic gate, so transistor switches are used. Switching circuit designed such that it's made of a transistor, protection diode and a resistor. An attempt is made to outline what appears to be the most promising method of obtaining beneficial results from the use of cheap components in the design of practical switching circuits. Switching circuit designed such that it made of a transistor BC 107/108B, protection diode (1N4001), and resistor (220 Ω), LDR and a potentiometer.

Keywords: Switching circuit; transistor; diode; resistor; optocoupler; LDR; potentiometer.

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1. INTRODUCTION

1.1 Automatic Fire Suppression System

AFS systems control and extinguish fires without human intervention. To do so, they should be designed to have a means of detection, actuation and delivery [1]. Sensors such as smoke or flame detectors may be employed. To provide actuation this may be done by electrical or mechanical means. Delivery is almost always provided by mechanical means e.g. the rupture of polymer tubing to extinguishers [2].

1.2 Background

Our poor record in response to fire emergencies has been our major undoing. We have lost many lives by fire outbreaks and property loss in the country through fire has reached unimaginable figure [3].

The worst cases of loss of lives have happened in our secondary schools: in March, 1998-twenty girls died in their dormitories in Bombolulu and later Kyanguli case where more than 50 students lost their lives left many parents pondering about the option of abolishing boarding in secondary schools [4].

The most recent case of loss of lives by fire happened in January, 2009 in Nakumatt down-town store where the death toll hit at least 22 people. Then, we had the Faza disaster where thousands of families were left homeless when fire razed down their homes in September, 2009 [5].

2. LITERATURE REVIEW

The first automatic electric fire alarm was invented in 1890 by Francis Robbins Upton (An associate of Thomas Edison although no evidence that Edison contributed to this project). In the late 1930, the Swiss physicist Walter Jaeger tried to invent a sensor for poison gas. He expected that gas entering the sensor would bind to ionized air molecules and thereby alter an electric current in a circuit in the instrument. His device failed: small concentrations of gas had no effect on the sensor's conductivity. Frustrated, Jaeger lit a cigarette and was soon surprised to notice that a meter on the instrument had registered a drop in current. Smoke particles had apparently done what poison gas could not. Jaeger's experiment was one of the advances

that paved the way for the modern smoke detector [6].

The results of recent on-shore pilot trials of the complete closed loop detection/suppression system together with recent modifications of the system to include further performance enhancements. Whilst developed for the marine environment the project was of relevance to any scenario where speed and weight of response is important for the reduction of consequential damage from the fire or extinguishing media in an unmanned situation. Other benefits may include cost effectiveness over some fixed system installations and reduced overall system vulnerability to damage [7].

Prototype system tests show that the system provides early extinguishing of a fire disaster so that damages will be reduced effectively. The installation location must be prearranged of each detector in this system due to localization mechanism not considered. In order to reduce the installation workload and make the system more convenient, automatic localization mechanism is the focus here [8].

The system performs automatic fire fighting task when the system assures the fire occurrence [9].

An automatic fire alert and fire distinguishing system by sensing smoke and heat. Proposed system experimented in the laboratory and noticed its feasibility. It is also seen that the system does not respond if the fire generates very small smoke particles and very small amount of heat. The system does not display properly if two or more than two rooms or blocks are affected at a same time [10].

3. METHODOLOGY

A switching circuit is used to process the various sensor signals and control the system actuators accordingly. A firefighting pump replaced by a fan because of the same principles used will be interfaced and interconnected to the system and used to indicate the system status.

The extinguishing agent to be used in this project is water. Following the use of water as an extinguishing agent, class A of fires will be the main target for this project. Electrocutation is further prevented by the incorporation of an opto-coupler and mains relay so that power supply is

cut off from the mains when smoke is detected and before the release of water.

3.1 System Layout

The block diagram of the hardware implementation of the entire system is shown in Fig. 1. The aim of the design is to illustrate the usage of the fire fighter and its applications and the minimum equipment required to construct the firefighting system is a smoke detector, switching circuit, relays, opto-coupler, pump water (fan).

Designed the Automatic Fire Suppression system as per the block diagram below: (Fig. 1).

3.2 BC107B Transistors

Type Designator: BC107B, Material of Transistor: Si, Polarity: NPN, Maximum Collector Power Dissipation (Pc): 0.3 W, Maximum Collector-Base Voltage |Vcb|: 50 V, Maximum Collector-Emitter Voltage |Vce|: 45 V, Maximum Emitter-Base Voltage |Veb|: 6 V, Maximum Collector Current |Ic max|: 0.1 A, Max. Operating Junction Temperature (Tj): 175 °C, Transition Frequency (ft): 150 MHz, Collector Capacitance (Cc): 5 pF,

Forward Current Transfer Ratio (hFE), MIN: 200, Noise Figure, dB [11].

3.3 Optocouplers

There are many situations where signals and data need to be transferred from one subsystem to another within a piece of electronics equipment without making a direct electrical connection. Often this is because the source and destination are at very different voltage levels, like a microprocessor which is operating from 5V DC but being used to control a triac which is switching 240V AC. In such situations the link between the two must be an isolated one, to protect the microprocessor from overvoltage damage. These use a beam of light to transmit the signals or data across an electrical barrier, and achieve excellent isolation. Optocouplers typically come in a small 6-pin or 8-pin IC package, but are essentially a combination of two distinct devices: an optical transmitter, typically a gallium arsenide LED (light-emitting diode) and an optical receiver such as a phototransistor or light-triggered diac. The two are separated by a transparent barrier which blocks any electrical current flow between the two, but does allow the passage of light [12].

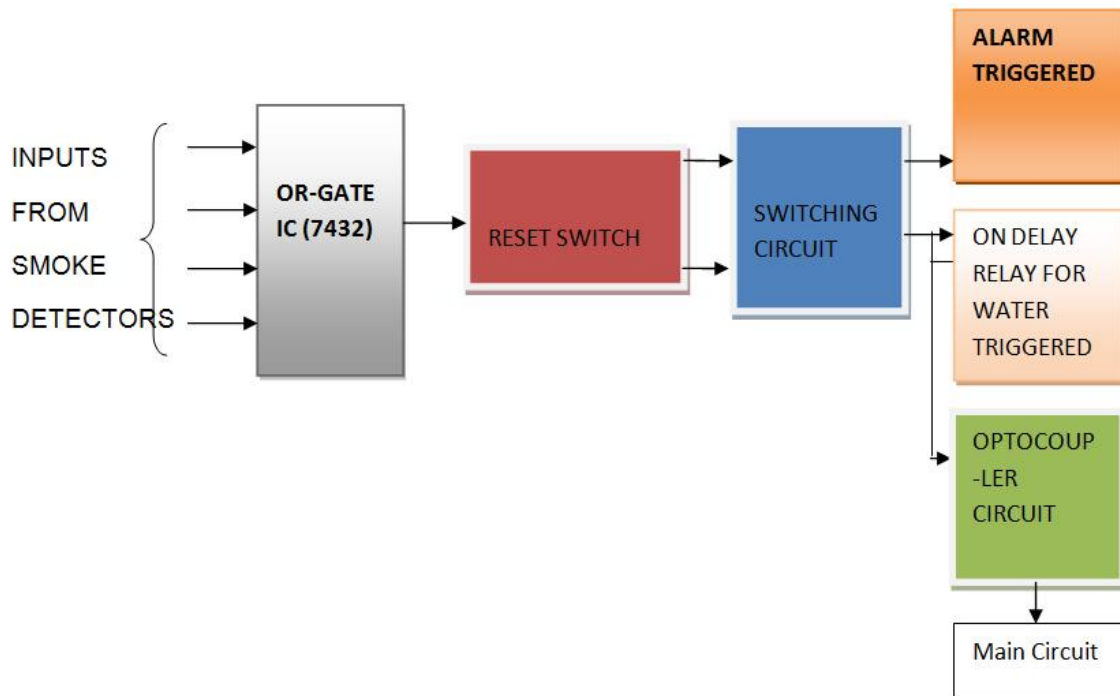


Fig. 1. Block diagram of the automatic fire suppression system

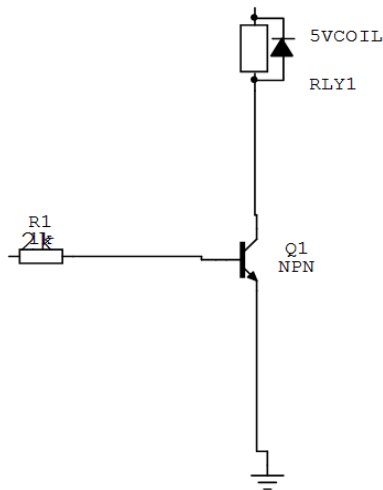


Fig. 2. Transistorized switching circuit

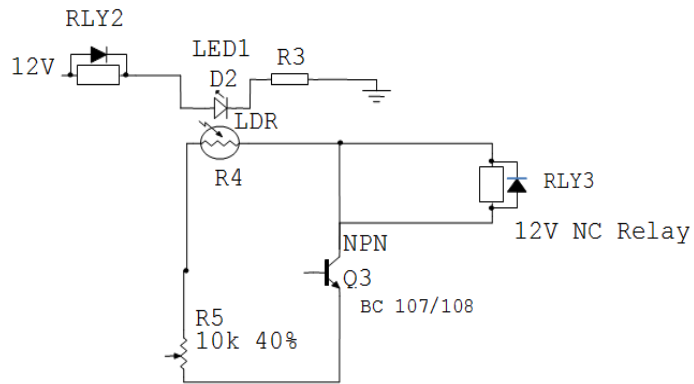


Fig. 3. Optocoupler switching circuit

4. RESULTS AND DISCUSSION

Transistorized switching circuits designed such that it's made of a transistor BC 107/108B, protection diode (1N4001), and resistor (220 Ω). With BC107B transistor used at the input which has $h_{fe} = 40$ mA. Output from smoke detector should be 9v and through a resistor, triggers the switching N/O relay. Once the relay has been activated, the alarm goes ON and the ON-delay relay for water is activated but delayed for 60 seconds. Reset switch is provided to take care of false alarms.

Optocoupler used to switch off the mains. For this case we have used an LDR (Light Dependent Resistor) in parallel with an N/C relay and a potentiometer. Fig. 2 explains on how the switching of the transistor Q3 happens.

5. CONCLUSION

The optocoupler switching circuit can switch off the mains before releasing water in order to prevent electrocution. To achieve this: the 9V input from the smoke detector is used to bias the BC107B transistor and this in turn energizes the relay connected at the collector terminal. The relay can then close its NO terminal hence, passing the 12V to switch on the alarm LED, switch on the optocoupler LED, and finally control the water delivery to suppress the fire.

Optocoupler circuit designed by use of an LDR and potentiometer to switch off the mains. The switching circuit is made up of off-the-self

equipment making it possible to improve accuracy of the time at which a measured response may be instigated and quick action on the amount of deployment of extinguishing agent.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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