DESIGN AND CONSTRUCTION OF AN OVERLOAD CURRENT TRIP ALARM

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ATTESTATION

This is to certify that this project titled " OVERLOAD CURRENT TRIP ALARM" was carried out indeed by the student under the supervision of Mr Henry Ohize. And submitted to the Electrical / Computer Engineering Department, Federal University of Technology Minna, in partial fulfillment of the requirements for the award of bachelor of Engineering (B.Eng) degree in electrical Engineering.

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ABSTRACT

This project was carried out with the aim of designing and construing an overload current trip alarm. Using reliable components that can be obtain locally in the market. This device would provide protection against power surge, overload current for small business and domestic equipments. It uses a relay with normally open contacts, and an accompanying control circuit which (comparator) sets the normal operation of the relay within the range of 500mA – 12A.

Normal operation meaning that the relay contacts will remain within this range of main power supply source

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CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 GENERAL INTRODUCTION

The impending doom and the emanating catastrophe of overload current effect, cannot be over emphasized, due to unpredictable damage, and these have to be stopped, since its danger is disastrous, which is regrettable and can not be revised. Because of all this danger, man has created and designed many ways of saving himself and his environment, that is why man has been thinking of protection and now this design is strictly on protection and information due to the introduction of the alarm system.

Statistics show that majority of the damage done on electrical appliance or equipment is cause by overload current from the supply. Now it is possible that your home and office electrical appliance can be protected from damage arising from voltage fluctuation as well as informing you of the problem by simply introducing overload current trip alarm between the supply and the load so that it can switch off the supply. This will alarm you of the situation, immediately the supply current exceeds the set threshold current of the equipment or appliance instead of damaging your equipment or appliance.

1.2 PROJECT AIMS AND OBJECTIVES

This research work becomes very important as it serves to protect electrical appliance or equipment from damaging, saving time and money for the owner.

What most people popularly make use of is the fuse and the circuit breaker, which in some case, might not serve the purpose of which it was designed for. In some cases the overload current can by-pass the fuse and destroy any of the components in the equipment, thereby rendering the fuse useless. In another case where the fuse trip off, the owner or the technician might not be able to detect the fault immediately these can cost him some time of troubleshooting where the fault is or might not know how to fix it due to one reason or the other. Now these overload current trip alarm does not only protect electrical equipment but it also sound an alarm for the owner to know that there is a fault at a particular place and need to simple press the reset button or switch to fix the trip and put it into work again and if it continue tripping off and sounding the alarm the call for a technician or engineer might be needed,

However if after pressing the reset button the circuit does not trip off or sound the alarm continuously it then mean the overload current has returned to normal as expected so the stress for calling a technician will be avoided, thereby saving cost.

Overload current trip alarm help to make the equipment owner more comfortable, productive and more efficient as the worry over equipment safety is needless.

In other word, this device is serving as a security to many equipment or appliance, as it protect them from damaging, and there by prolonging the life span of the various electrical equipment in an office or home.

1.3 PROJECT LAYOUT

1.4 METHODOLOGY

When a.c mains is introduced to the circuit, diode D_1 (forward bias) will conduct at the positive half cycle while D_2 will not conduct. At the negative half cycle diode D_2 will conduct while D_1 will not conduct.

The voltage regulator will conduct and regulate the volt that went to the inverter fix volt input this enable the comparator to be able to compare the input voltage at VR_1 with the voltage at VR_2 which comes directly from the input of the supply. The comparator will compare the fix voltage at VR_1 and that of the VR_2, if the volt at VR_2 is greater than VR_1 the fix voltage, The comparator will switch on the relay switch transistor, which will immediately switch the relay off there by switching off the load positive terminal. The comparator only switch ON the relay transistor if there is over voltage from the supply and from ohm's law

$$I = \frac{V}{R} \text{ ----------1}$$

From equation 1 above

If the resistance R is constant and there is an increase in the voltage, the current will increase.

From this law, if there is an over voltage, this will increase the current.

CHAPTER TWO

2.1 LITERATURE REVIEW

2.2 HISTORICAL BACKGROUND

The rate at which electrical component get damage or are destroyed in a house, office and industries is a serious concern. Damages are always associated with loss of properties which might result in loss of money and in some case might result in fire outbreak which can cause loss of life.

Overload current alarm is a safety device designed to prevent and alert people of the danger so that adequate measures could be taken to avert the aforementioned problems.

In industrial sector where safety is the watch word, overload current trip alarm system of this type is a necessity and can be used in their electrical equipment to avoid damages caused by overload current.

Electrical studies have gone far in terms of prevention of damages caused by overload current or voltage as the case may be in that so many types of safety device that can bring about trip or defuse in an electrical system or appliances depending on its application, location and cost; example of such types of safety device are fuse, circuit breaker, alarm, sensor, e.t.c.

2.3 FUSE

Fuse is a safety device used to protect an electrical circuit from the effect of excessive current, it is an essential component usually a strip of metal that will melt at a given temperature. A fuse is so designed that the strip of metal can easily be placed in the electric circuit, in that if the current in the circuit exceeds a predetermined value, the fusible metal will melt and thus break or open the circuit.

There are two types of fuse commonly used, namely; cylindrical fuse and plug fuses.

A cylindrical fuse consists of a ribbon of fusible metal enclosed in a ceramic or fiber cylinder metal end caps fastened over the cylinder make contest with the metal ribbon. This type of fuse is placed in an electric circuit so that the current must flow through the metal strip to complete the circuit. If excess current surges through the circuit, the metal link will heat to its melting point and break. This action will open the circuit, stop the current flow and thus protect the circuit. These are used mostly to protect electrical equipment and appliances.

Plug fuses are commonly used to protect electric wiring in homes. This type also consists of a fusible metal strip through which the current must flow to complete the circuit. The strip is however, enclosed in a plug that can be screwed into an ordinary electric receptacle or light socket.

Recent fuse development include types that will permit a momentary overload without breaking the circuit, these are necessary for circuits that are used to power air conditioners or electric broilers, because initial surges of power can be expected with such appliances.

Another recently developed type of fuse contains several links that can be selected by the flip of a switch. It the fuse is blown another link can be switched in without replacing the fuse.

2.4 CIRCUIT BREAKER

Circuit breaker is an electrical device that cut off the electric current through a circuit under abnormal conditions the household circuit breakers protect circuit against overloading or overheatiting to prevent fire and electrical shock.

Circuit breakers also provide protection against short circuits; short circuit is caused by a contact between the neutral, or grounded, side of the electrical line and the live side of the line.

Short circuits offer very low resistance to current, which allow, large currents to flow through the circuit, sometimes melting the wires or causing a fire. Circuit breakers in the live side of the electrical line can stop short circuits by cutting the connection when the current get too high.

Common household circuit breakers are made up of a coil of wire called a solenoid and an iron plunger inserted partially inside the solenoid, when current flows through the solenoid, it produces a magnetic field just as a bar magnet of current exceeds the amount that the circuit is designed to hold, the magnetic field in the solenoid is so strong that it pulls the iron plunger completely into the solenoid, breaking contact with circuit at the end of the plunger and stopping the flow of current.

The overload current trip alarm work as fuse and circuit breaker in electrical appliances with alarm which help to indicate the problem without stress. The user does not need to go for training to no how to operate the device. The overload current trip alarm does not need to be replace of when it trips off, unlike the fuse when it plows

2.5 ALARM

There are various types of alarm designed for different application at different location. There is burglar alarm, smoke alarm, fire alarm process alarm system and so on.

2.5.1 BURGLAR ALARM

In the burglar alarm, a metallic tape is usually placed at all entrances to the building. This tape has an electrical current passing through it, which causes an electromechanical relay to be activated. Any intruder entering the building will break the tape, interrupting the current to the relay contact to operate the alarm indicator.

2.5.2 PROCESS ALARM

In a petroleum refinery, process alarm system are used to indicate abnormal or dangerous conditions in many phases of the refinery process. Detector such as thermocouple, temperature detector (RTDs) or temperature sensitive- switches are used to monitor levels and temperature in different phases of the process. These detectors are used to warn operating personnel when temperature levels are changing too fast or have exceeded safe limits.

2.5.3 PROTECTIVE ALARM

Alarm in general has be help to man kind and it environment. All the alarm motioned above can also be called protective device because they all protect in one way or the other and it as safe man's life in many ways. This project as to do with protective alarm, in that the alarm inform you of the impending doom or emanating catastrophe and man with ever remain grateful to the inventor of all kind of alarm. Its advantage of protection before the damage is unique compared to other alarm systems.

CHAPTER THREE

3.1 Theory of design

The task is to make a device that can monitor the input current source. This device should also protect the equipment against overload current, which can be caused by either short-circuit or thunder storm. However three important factors were considered in arriving at this goal. These factors are

1. Economy
2. Simplicity
3. Reliability

This chapter presents theory of operation of the different components (or group of companies) used in this project. The principle of their operation is exported in the design of this circuit.

The block diagram of the overload current trip alarm is shown in figure 3.1 below, it consists of the following

I. Step down stage
II. Rectification stage
III. Operating amplifier and Transistor switch stage
IV. Alarm stage
V. Load stage
VI. Reset stage

3.2 STEP DOWN STAGE

A 240/12 volt center tap transformer is used to step down the 240 volt A.C to 12 volt at the secondary. The transformer used a single phase full-wave rectifier for rectification.

3.2.1 Rectification stage

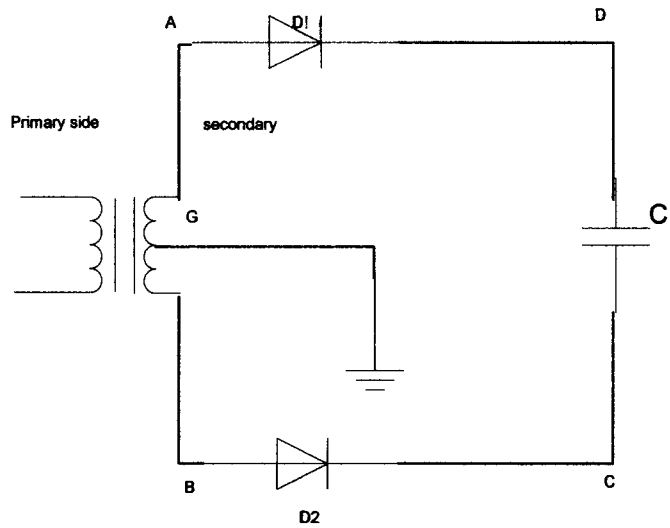
Power supply is necessary for the conversion of the A.C voltage from the electrical power utility company (P.H.C.N) to the D.C voltage required in electronics and electrical equipment. The transformer steps down the A.C and the voltage is then rectified by a full-wave rectifier then smoothened by a filter circuit (capacitor)

The rectifier converts the 12 volt A.C into D.C supply; it consists of two diodes as shown in figure ..... . during the positive half-cycle of the A.C input, terminal A is +ve, G is at zero potential and B is at –ve potential. Hence being forward-biased, diode D_1 conducts while D_2 which is reverse-biased does not conduct and current flows along AD

During the negative half cycle, when terminal B becomes +ve D_2 conducts but D_1 is reverse –biased and will not conduct, and current flow along BC. So current keeps on flowing through the circuit continuously.

3.2.2 The capacitor filler

The capacitor filler converts the full wave rectified D.C signal into a smoothened D.C voltage. The important parameters of the capacitor are its working voltage and its capacitance value. The working voltage must be greater than the transformer secondary voltage; the capacitance value determines the amount of ripple that will appear in the D.C voltage when current is being drawn from the circuit.



Fiq 3.1 Center tap transformer

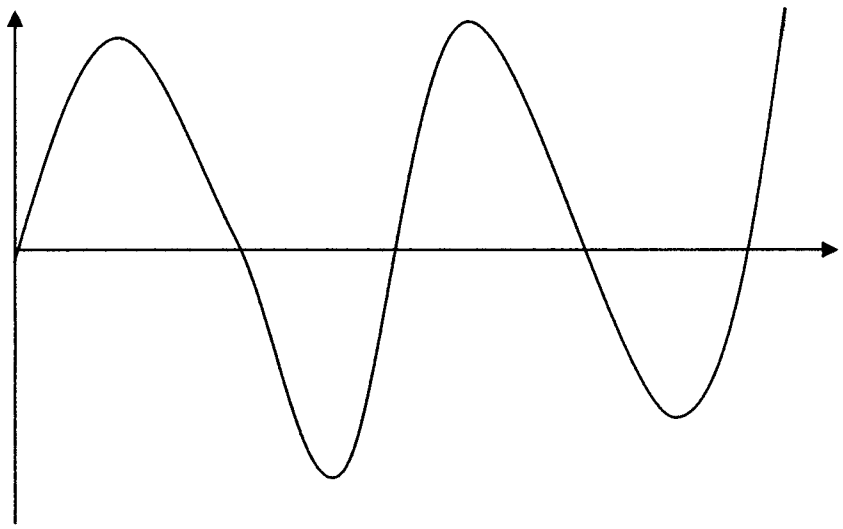


Fig 3.2 A.C (input signal)

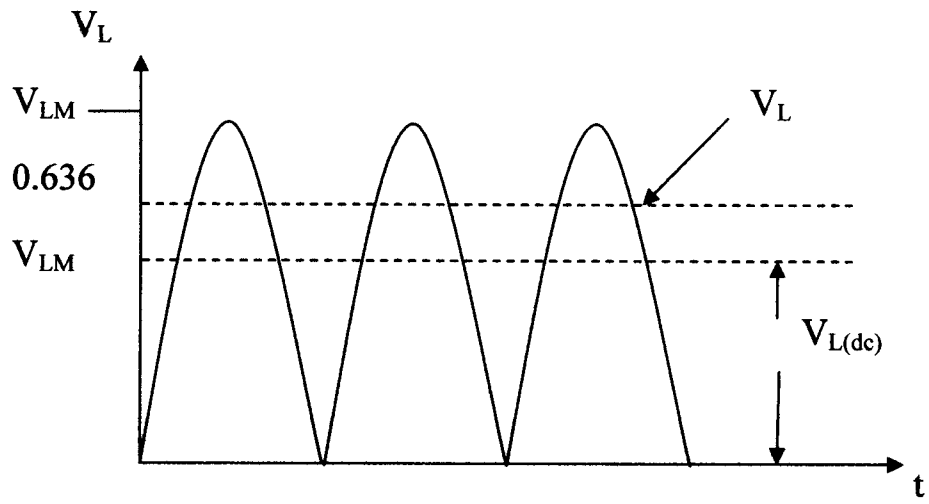


fig 3.3 output signal in voltage

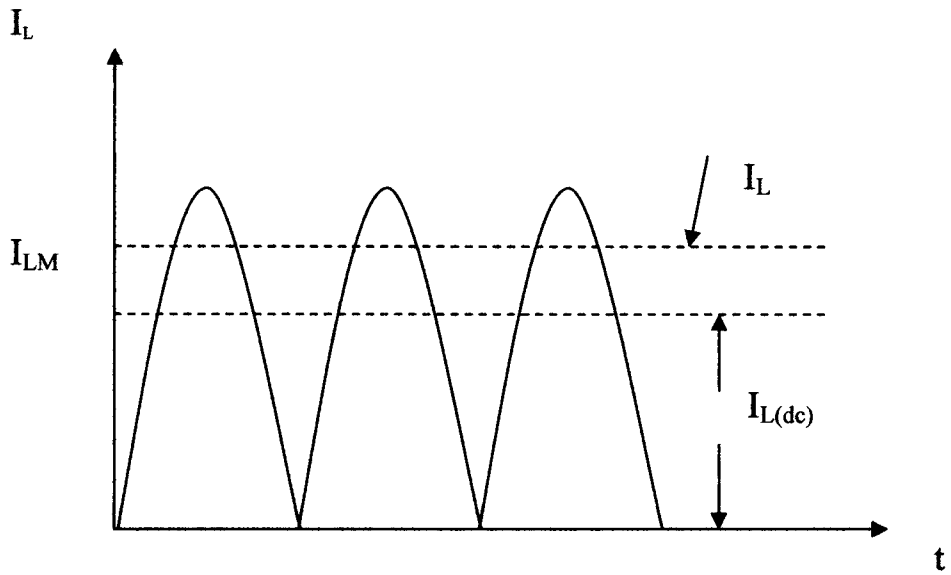


Fig 3.4 output current signal

Calculation

From the above diagram of wave form the following can be calculated

$$V_L = \frac{V_{LM}}{\sqrt{2}}$$

$$=0.707V_{LM}$$

$$V_{L(dc)} \frac{2V_{LM}}{\pi}$$

$$= 0.636v$$

$V_{L(ac)}$ = rms value of a.c component in the output voltage

$$V_L(ac) = \sqrt{V_{L(ac)}^{\ 2} - V_{L(dc)}^{\ 2}}$$

Using ohm's law

$$I_{LM} = \frac{V_{LM}}{R_L}$$

$$I_L = \frac{I_{LM}}{\sqrt{2}}$$

$$= 0.707I_{LM}$$

$$I_{L(dc)} = \frac{2I_{LM}}{\pi}$$

$$= 0.636I_{LM}$$

$$I_{L(ac)} = \sqrt{I_L^{\ 2} - I_{L(dc)}^{\ 2}}$$

3.2.3 Comparator and switching stages

Operational amplifiers (op amps) use differential input stages. they have characteristics that make them useful in electronic circuit. Some of their characteristics are as follows;

1. Common-mode rejection: this gives them the ability to reduce hum and noise.
2. High input impedance: they will not load down a high-impedance signal source.
3. High gain: they have "gain to burn" which is usually reduced by using negative feedback.
4. Low output impedance: they are able to deliver a signal to a low-impedance load.

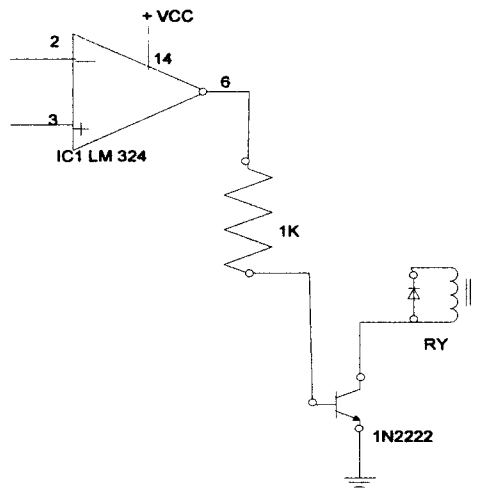


Fig 3.5 Comparator and switching transistor

The comparator compare the fix input volt and current from VR1 with the input of the noninverter at the VR2 and switch the transistor NO, which turn OFF the relay, there by switch OFF the load.

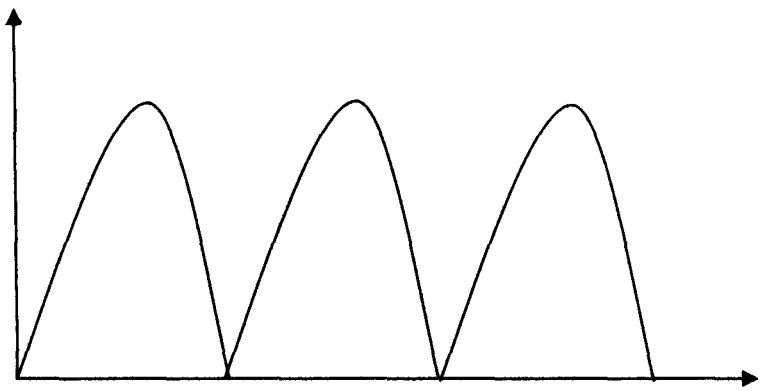


Fig 3.6 dc input signal to the IC1

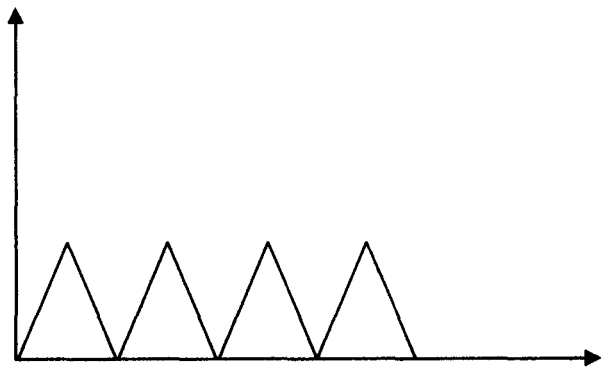


Fig 3.7 dc output of IC1

Characteristic of the operating amplifier LM323

1. Voltage gain : 200 000
2. Output impedance :75Ω
3. Input impedance 2MΩ
4. Offset adjustment range ± 15MV
5. Output voltage swing ± 13V
6. Swing rate : 0.5 v/ms

The maximum frequency (F_{max}) of the op amp

$$F_{Max} = \frac{SR}{6.28 \times V_P}$$

$$= \frac{0.5v/us}{6.38 \times 13v}$$

$$= \frac{1}{6.28 \times 13} \times \frac{0.5v}{1 \times 10^{-6} s}$$

$$= 6.12 \text{ kHz}$$

3 .2.4 Alarm stages.

An audio alarm which act as an indicator, with sound or buzzer to inform the operator or the owner of the equipment which is under protection of the problem to draw his / her attention.

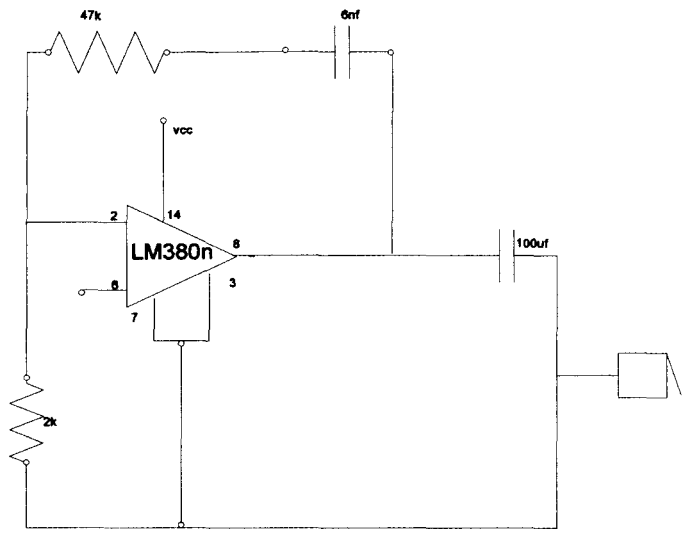


Fig 3. 8 Sound generating circuit

Q1 is used as the switch and under normal condition it is switch off, supplying no significant current to the alarm generator circuit.

An LM 380N audio power amplifier device (IC2) is used to generate the audio signal. It is made to oscillate by using C2,R6 and R7 to give frequency selective positive feedback

between the output and non-inverting input. The circuit oscillates at approximately 60Hz and provides an output of a few hundred mill watts to a miniature a buzzer. This gives a reasonably loud and penetrating sound to the human ear.

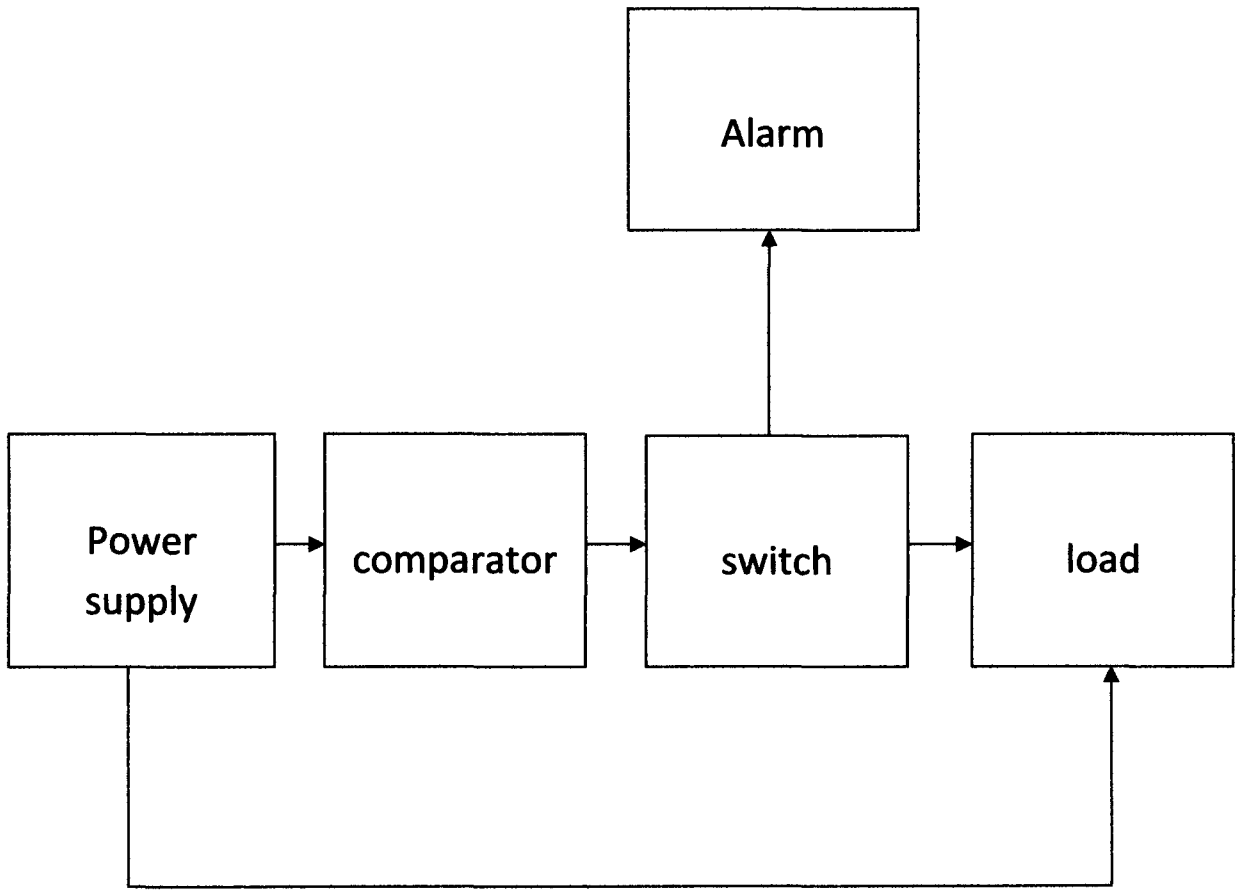


Fig 3.9 Block diagram

CHAPTER FOUR

4.1 CONSTRUCTION AND TESTING

4.2 CIRCUIT CONSTRUCTION

The circuit construction of this project implemented on a vero board and cased in a wooded box. The construction was done based on sequential Modules as discussed in chapter three aiming at the desired result, until the desired response was achieved.

The kind of the materials used for the construction of casing for the system is dependent on cost, (economic), reliability, durability, overall weight and physical outlook of system design.

The casing was made of wood of high weight with the following dimension.

Length ---------- 160mm

Breath----------120mm

Heigh ----------60mm

Thickness----------6mm

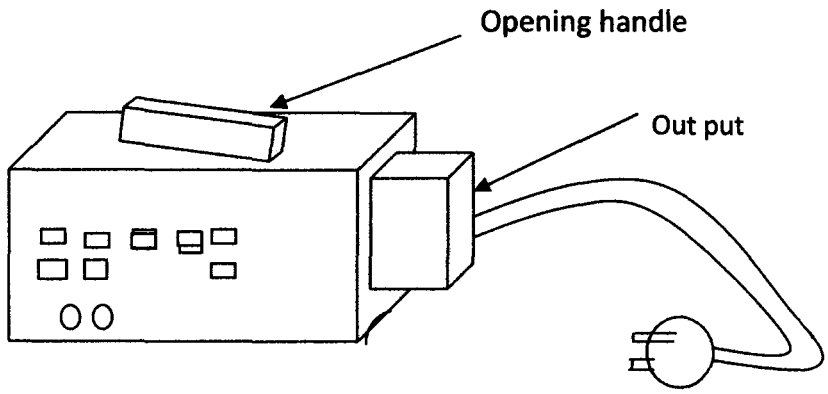


Fig 4.0 project case

4.3 Testing

This test aims at determining the current condition (levels) at which the appliance will either switch ON or OFF (trip) the power supply

4.4 Procedure

The apparatus for performing the test are 240 / 15v step – down transformer, variable resistor acts as the main voltage level sensor that activates the comparator which sense the difference in current due to the increase in voltage and switch on the transistor (T1) which switch on the relay.

In this project the value of the variable (VR1) resistance is preset as the reference value which the VR2 is measured value that trip ON the transistor T1 which trip OFF the relay. Once the transistor T1 switch the relay it on the alarm the same time.

4. 5 Summary of operation

The responses of the current switch to the simulated current condition and are classified into the following condition;

(i) Normal current conditions

Over conditions

(ii) Power interruptions.

Normal current condition

Where the current is taken to normal mains the circuit operates normally.

Over circuit condition

The overload current condition is simulated from ohms' law

I=v/r

From the current to increase, the voltage must increase since the value of the resistance is constant.

When the over current is simulated the comparator lm342 compare with the preset at VR1 with VR2 and notice the difference switch on the transistor which switches off the relay there by cutting off the supply (off stage).

4.5 Power interruption

On the power condition, the whole shuts down and the contacts open, on supply to the load.

CHAPTER FIVE

5.1 Conclusion

The over load current trip alarm has been designed in such a way that it will automatically trip off, there by protect the appliances/ equipment under protection, from the effect of overload current. This design can be constructed as a stand along device or can be included in the design of circuit to be protected from overload current for more effective operation.

Once this design is included in circuit or the appliance is used to protect any appliance the user or operator can be rest assured that his/her ppliance/equipment is secured and can not be damaged by high voltage with will cause overload current which can be cause by either thunder or short-circuit and this we all know is common in this country of ours.

This design save money, life and time. This is borne out of the fact it prolongs the life of appliances and the user do not need to monitor it by him/herself.

5.2 Recommendation.

1) The device is suitable for electrical devices /appliances with input rating of not more than 240 /5A A.C; therefore for efficient operation equipment to be protected by the project its rating should fall below this range.

2) This project should not stop here, but should be given to another student as a project to work upon, for more efficiency

5.3 Material used

Transformer 240/12V

Voltage Regulator

Two Variable Resistors

Six fix resistors

One comparator (I.C)

One sound generator (I.C)

One transistor

Three diodes

One relay

Three capacitors

Vero borad

Jumper wires

Socket

Buzzer

5.4 Cost

S/no	Component	Quantity	Prize /one ₦	Prize ₦
1	Transformer	1	250	250
2	Voltage regulator	1	280	280
3	Variable resistor	2	20	40
4	Fix resistor	6	10	60
5	Sound IC	1	280	280
6	Transistor	1	40	40
7	Diode	3	10	30
8	Relay	1	70	70
9	Capacitor	3	20	60
10	Vero board	1	70	70
11	Jumper wire			50
12	Socket	1	50	50
13	Buzzer	1	1	200

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