Design And Construction Of Temperature-Controlled Fan

BY

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DESIGN AND CONSTRUCTION OF TEMPERATURE-CONTROLLED FAN

NATIONAL DIPLOMA PROJECT REPORT

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SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING TECHNOLOGY, NUHU BAMALLI POLYTECHNIC IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF NATIONAL DIPLOMA

DEPARTMENT OF ELECTRICAL/ELECTRONICS ENGINEERING TECHNOLOGY

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DECEMBER 2011

DECLARATION

I here by declare that this project has been conducted solely by me under guidance of Malam Abubakar Mujahid (H.O.D) Department of Electrical Electronics Engineering Technology, Nuhu Bamalli Polytechnic, Zaria and I have neither copied some one's work nor has someone else done it for me. Authors whose works have been refereed to in this project have been duly acknowledge

Student's Signature — Date

Abubakar Aliyu — 22/1/2012

ABUBAKAR ALIYU

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APPROVAL PAGE

This is to certify that this is an original work undertaken by ABUBAKAR ALIYU, N/EEET/09/27 and has been prepared in accordance with the regulations governing and presentation of projects in Nuhu Bamalli Polytechnic, Zaria.

Engr. Mahmud Panti Abubakar (Project co-ordinator)	Date
Malam Abubakar Mujahid (Project Supervisor)	2/1/12 Date
Malam Abubakar Mujahid (Head of Department)	2/1/12 Date

DEDICATION

This project is dedicated to my dear parent Alh. Aliyu Yahaya Abubakar and Haj. Fatimah Aliyu. I also dedicated this project to my lovely brothers and sisters for their maximum support and corporation toward the achievement of my education.

ACKNOWLEDMENT

I firstly express my paramount gratitude to the Almighty Allah for His guidance, protection and provision through out my studies and my life from the childhood.

I also extend my regards and thanks to my beloved parent Alh. Aliyu Yahaya and Haj. Fatimah Aliyu for their financial and moral support during my studies. My thanks goes to my brothers and sisters whose names are: Shehu Aliyu, Sani Aliyu, Abdullahi Aliyu, Alh. Musa Aliyu, Haj. Amina Aliyu, Salamatu Aliyu, Maimuna Aliyu, and the rest which the time may not allow me to mention them.

My special thanks to my Supervisor Mal. Abubakar Mujahid for the guidance and advices throughout the completion of this project. I am indeed grateful. My thanks to our lecturers and the entire staff of Electrical Electronic Engineering Technology Department

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ABTRACT

The aim of this project is to design and construct a temperature controlled-fan. The temperature in general can play a vital role to the human used, which man can use for many purposes. That is to say man can control a temperature for the achievement of many things but here is to use it as fan controlled.

The fan control unit was designed and constructed. The principle was based on creating a potential difference in a Wheatstone bridge by using a potentiometer. The transistor Q1 is used as a bridge balance detector. This mean as the temperature increase the speed of the fan will increase proportionally.

CHAPTER ONE

1.0 INTRODUCTION

In ancient times temperature control of substance was not accurately achieved despite the fact that human and natural recourses were available to do it. This circuit adopt a rather old design technique as its purpose is to vary the speed of a fan related to temperature with a minimum parts counting and avoiding the use of special purpose IC's often difficult to obtain.

Over centuries man had distinguished himself by the resources he had shown using national energy to enable him accomplish tasks beyond his own physical power.

Based on this background the project was centered to design a circuit to control a fan when the temperature is high. The circuit consist of sensing element (i.e Thermistor) which senses the temperature. The zener diode which act as an amplifier and the silicon controlled rectifier (SCR) or thyristor which can control the power supplied to a load and at the out put of diode bridge with out a smoothing capacitor.

1.1 PRINCIPLE OF OPERATION

R3-R4 and P1-R1 are wired as a Wheatstone bridge which R3-R4 generate a fixed two thirds-supply reference voltage, P1-R1 generate a temperature sensitive "variable" voltage, and transistor is used as a bridge balance detector.

P1 is adjusted so that the "reference" and "variable" voltage are equal at a temperature just below the required trigger value and under this condition the transistor Q1 base and Emitter are at equal voltages when the R1 temperature goes above this "balance" value the P1-R1 voltage falls below the "reference" value, so Q1 becomes forward biased of equal charging C1. C1 provides a variable phase delay pulse-train related to temperature and synchronous with the mains supply "Zero Voltage" point of each half cycle.

CHAPTER TWO

2.0 LITERATURE REVIEW

TRANSDUCSER: This is an electrical device which gives an output of a form easily usable in response to a particular property being measured. The3 form of the output from a transducer may not be directly usable by our senses, for examples. A microphone changes sound energy in to electrical energy unless a loud speaker changes this electrical energy in to sound energy. The microphone output may not be usable to our senses.

Some transducers are used for the control of temperature against our heating. Some are used to maintain a constant temperature over aide range some forms of transducers includes:

a) THERMISTOR (b) PLATUM (c) TERMOSTATE

2.1 THERMISTORS

A thermistor is a semi-conductor transducer whose resistance changes markedly when its temperature changes. These are in varieties as shown below:

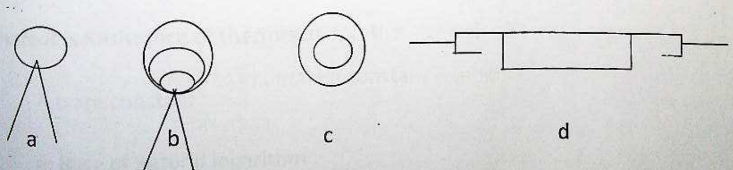


Fig 2.1

THERMISTOR CONFIGURATION

a. Bead type b. Disk type c. Washer type d. Rod type

THE NAME TERMISTOR IS DERIVED FROM THERMALY SENSITIVE RESISTORS.

Resistance of most thermistors decreases as their temperature increase and these are the NTC type negative temperature coefficient made from oxide of nickel, manganese, copper, cobalt and other materials.

They are used for temperature control and measurements. They are heated either externally, from the surrounding or by current flowing through them. Resistance changes causes current or voltage changes which supply the input.

With P.T.C positive type thermistor, the resistance increases as the temperature increases. These are based on barton titanate and are used mainly TO PREVENT damage in circuit which might experience a large temperature rise. This can happen to a much overloaded electric motors.

The resistance of the thermistor once manufactured and fired is dependant solely upon it's temperature.

$$R = Ae^{b/T}$$

Where R is Resistance of thermistor

A,b are constant

e: Base of natural logarithm

T: Absolute Temperature.

2.2 ZENER DIODE: We know that in an ordinary junction diode, if the reverse biases is increased until the depletion layer brakes down. The diode supper's permanent damage.

Therefore a zener diode is made to be uded in the breakdown region. So by as resistor limit the current.

STRUCTRURE: IT LOOKS LIKE A RECTIFIERE DIODE, THE Cathode often being marked by a band. As shown below: fig 2.2

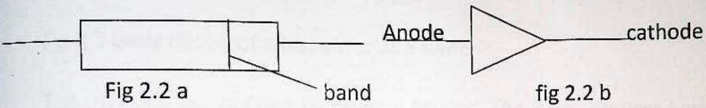


Fig 2.2 a fig 2.2 b

CHARACTERISTICS: Variation of the characteristics is by temperature. The Vz value of zener diode is variable with the temperature. It occurs that

1. In a diode which has a zener voltage Vz < 5v, the decreases as the temperature increases.
2. In a diode which has a voltage Vz > 5v the Vz increases as the temperature increases. And diode with Vz -5v is thermally more stable. Important thing about diode is that voltage across the diode remains almost constant over a wide range of reverse current.

Therefore based on the property, it is useful in stabilized power supply where it keeps the voltage output steady. Also zener diode is a circuit element capable of withstanding considerable current variation while maintain its constant voltage at its terminals. For the purpose of construction and to limit the reverse current at breakdown and to prevent over heating power rating of diode should be carefully being exceeded.

TRANSISTOR AS SWITCH

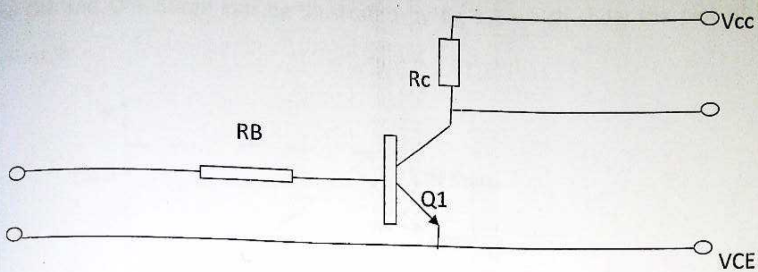


Fig 2.3 basic circuit of a transistor as a switch.

The off state is obtained by reverse biasing. The Base- Emitter junction so that the base current IB is negligible. In this condition, the transistor does not conduct only the collector leakage current Ico flows.

In this condition, almost the whole supply drop across the transistor with no supply drop across the load.

The on state is obtained by forward biasing the base Emitter junction such that Ib is large enough to drive the transistor into saturation under this condition, collector current Ic (SAT) is obtained from the expression given below:

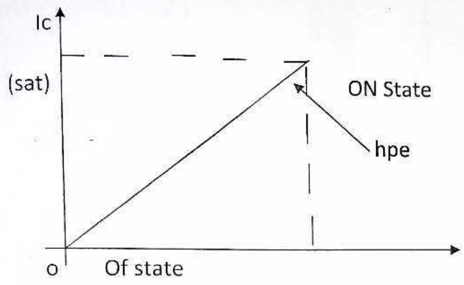
$$I_c(sat) = V_{cc} - V_{ce} / R_{se}(sat)$$

The minimum current required to saturate a transistor i.e trigger to on (state) is expressed below.

$$I_b = I_c / h_{fe} SAT$$

Where Ic (SAT) = current gain of the transistor at the ON state saturation hpe = common-Emitter current gain

The ON and OFF stage can be illustrated by fig 1.3 which show the plot of Ic against Ib



2.4 TWO TRANSISTOR ANALOGY

The basic operation of a SCR can be described by using two transistor analogy. For this purpose, SCR as split in to 3-layer transistor structures as shown in fig.1.2 (a) As seen transistor Q2 is a PNP transistor where as Q3 is an NPN device interconnected together. It will also be noted from fig.1.2 (b) that (i) collector current of Q2 is also the collector current of Q3 and (ii) base current of Q3 is also the collector current of Q2.

If the supply voltage across terminals A and C is reverse-biased junction. Then the current through the device will raise. It means Ie is increase.

- Ics increase (remember Ic = IE
- Since Ics= Ib2, Ib2 also increases
- Ic2 increase (remember Ic2 =Bla)
- Now, Ic2 = Ib, hence Ib increase

It can be proved that if IG is the gate current of the SCR and 1 and 2, the current gains of the PNP and NPN transistors respectively than anode current is given by

$I_A = \alpha_2 I_G/1-(\alpha_1+\alpha_2)$

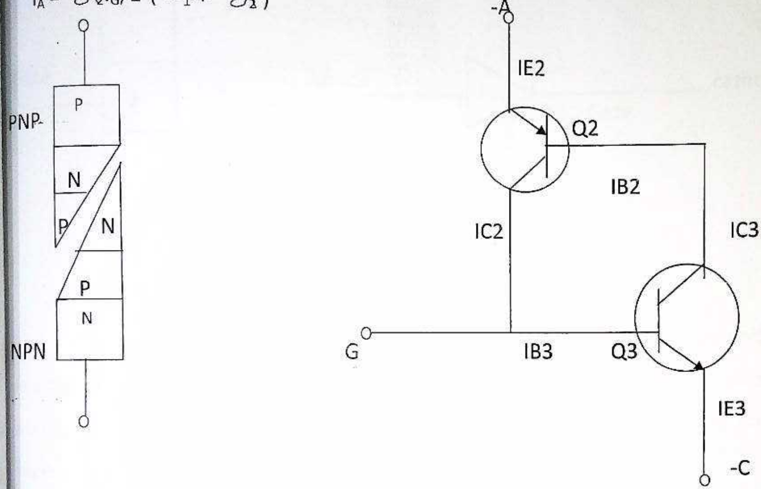
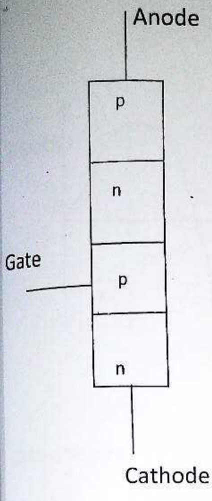
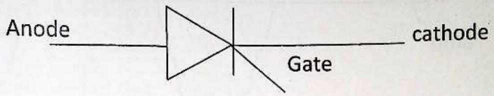


Fig 1.2 (a)

LITERATURE REVIEW OF SILICON CONTROLLED RECTIFIER (SCR)

2.5 **THYRISTOR**: Is a four-layer, three terminal semiconductor device as shown in fig.1.3 (a) , (b) used to be called silicon controlled rectifier (SCR) it is a rectifier which can control the power supplied to a load and in a way that with very energy.



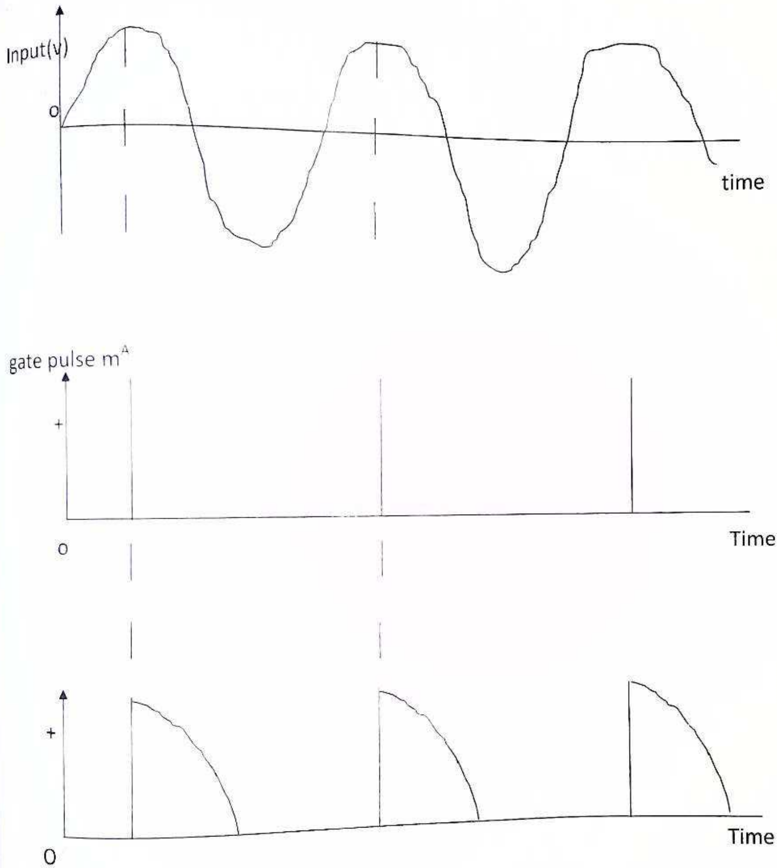


When forward biased, a thyristor does not conduct until a positive voltage is applied to the gate, conduction continues when the gate voltage is removed and stops only if the supply voltage is switched OFF or reversed or the anode current falls below a certain values.

The control of A.C power can be achieved by allowing current to be supplied to the load during only part of each cycle.

A gate pulse is applied automatically at a certain chosen stage during each positive half cycle of input. This allows the thyristor conduct and the load receives power.

Show below in fig 2.7 the pulse occurs at the peak of the A.C input.



For the purpose of the discussion, the silicon controlled rectifier (SCR) is used as a switching device to the circuit.

CHAPTER THREE

3.0 DESIGN

3.1 DESIGN OF A THERMISTOR BRIDGE

The aim of using the Wheatstone bridge is to measure the resistance of the thermistor. This method of resistance measurement is employ for the purpose of accuracy.

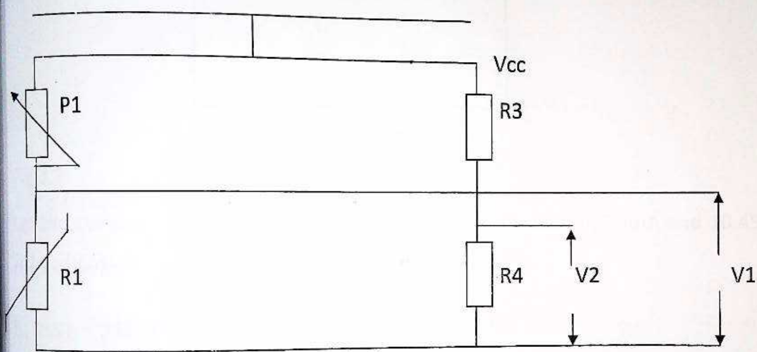


Fig 3.1

R4 is a fixed value resistance; R1 is the resistance of the thermistor (15kΩ) at room temperature. P1 and R3 are linear resistance potential, R4 and P1 are set to and arbitrary value and R3 vary at random until a positive error voltage i.e signal or about (2.0v) appears at V1, when the temperature Id increasing from room temperature. And R1 is used as a bridge detector as shown below

the thermistor bridge can be represented as shown in fig. 3.2 for the designing choosing 230va.c

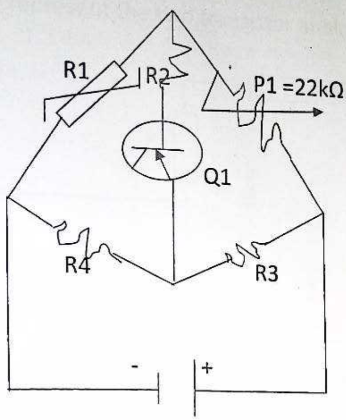


Fig 3.2

Let the current through R1,R2,R3 and R4 be 15.3mA, 2.3mA, 23mA and 10.45mA respectively.

$R_1 = V/I_1 = 230/15.3x10^{-3} = 15032.6\Omega$

$P_1 = I_1^2.R_1 = (15.3x10^{-3})^2 \times 15032.6 = 3.52w$ (1/4w preferred value)

$R_3 = V/I_3 = 23/23x10^{-3} = 10000\Omega$

$P_3 = I_3^2R_3 = (23x10^{-3})^2 10000 = 5.29w$ (1/4w preferred).

$R_4\, V/I_4 = 230/10.45x10^{-3} = 22009.57\Omega$

$P_4 = I_4^2R_4 = (10.45x10^{-3})^2 22009.57 = 2.4w$ (1/4 preferred)

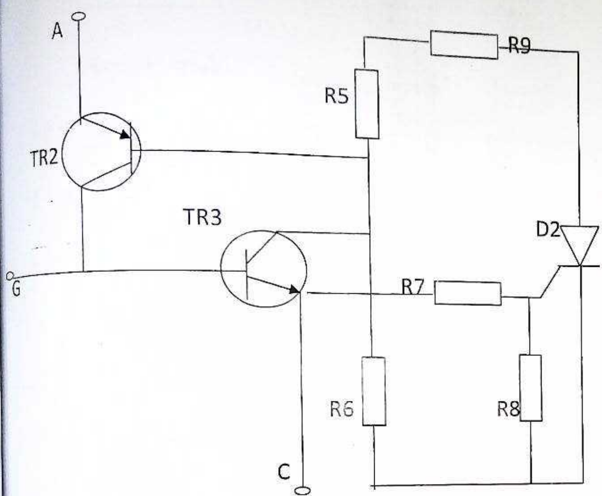
P_1 as shown 22kΩ

$R_2 = V/I_2 = 230/2.3x10^{-3} = 100,000\Omega$

$P_2 = I_2^2R_2 = (2.3x10^{-3})^2\ 100000 = 0.53w$ (1/4 preferred)

3.2 TWO TRANSISTOR ANALOGY

The figure below represent the two transistor analogy



A brief discussion on the transistor analogy is given in the literature review. Here will be concerned with the design in respect to this the following assumption are:

Gain of PNP transistor ( ) = 0.4

Gain of NPN transistor ( ) = 0.5

Gate current (IG) = 5-0mA

Therefore

$$I_A = \frac{\alpha_2 I_G}{1-(\alpha_1+\alpha_2)}$$

$$= \frac{0.5 . 50*10^{-3}}{1- (0.4 + 0.5)} \qquad = \frac{0.025}{1-0.9}$$

$$= \frac{0.25}{0.1} \qquad = 0.25A = 250mA$$

Let the resistors of R5,R6,R7,R8 and R9 be 22k, 10k, 100, 470 and 33k all are in ohm's (n).

$I_5 = V/R_5 = 230/22*10^3 = 10.45mA$

$P_5 = I_5^2.R_5 = (10.45*10^{-3})^2.22*10^3 = 2.4w$ (1/4w preferred)

$I_6 = V/R_6 = 230/10*10^3 = 23mA$

$P_6 = I_6^2.R6 = (23*10^{-3})^2 . 10*10^3 = 5.3w$ (1/4w preferred)

$I_7 = V/R_7\ 230/100 = 2.3A$

$I_8 = V/R_8 = 230/470 = 0.49A$

$I_9 = V/R_9 = 230/33000 = 6.97mA$

$P_9 = I_9^2 . R9 = (6.97*10^{-3})^2 . 33000 = 1.6w$ (1/4w preferred).

3.3 CIRCUIT OPERATION

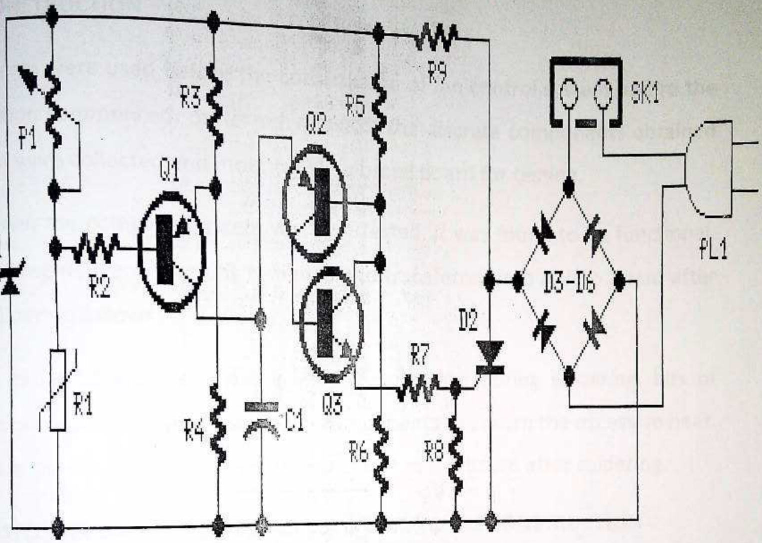
This circuit adopt a rather old design technique as its purpose is to vary the speed of a fan related to temperature with a minimum parts counting and avoiding the use of special purpose ICs, the complete circuit diagram of temperature-controlled fan incorporating all stages used in this project is shown in fig below.

The AC bridge is used with a thermistor (type TH 3VA 1026) as the sensing element.

The linear potentiometer (PI) is adjusted so that the voltage are equal at a temperature just below the required trigger value, and under this condition TR1 Base and Emitter are at equal voltages and TR1 is cut off. When the thermistor temperature goes above this value the P1-R1 voltage falls below the value, so TR1 becomes forward biased.

This occur because the whole circuit is supply from the mains supply by means of D3-D6 diode bridge without a smoothing capacitor and fixed to 18v by R9 and zener diode. The capacitor provides a variable phase-delay pulse related to temperature and synchronous with the main supply "zero voltage" which produced minimum switching REI from the SCR-TR1 and TR2 from a trigger device.

CIRCUIT DIAGRAM



CHPATER FOUR

4.0 CONSTRUCTION

omponents were used before the construction of fan control system before the onstruction commenced, preferred values of the discrete components obtained y design were collected and mounted on a bread board for testing.

When the complete system was first tested, it was found to be functional. e components were carefully removed and transferred into a Vero board after ich soldering follows.

In order to avoid any damage of components, during soldering, bits of atoes were put on the leads of each components to absorb the excessive heat. at care should be taken to avoid short circuit of the board after soldering.

LISTED BELOW ARE THE TOOLS USED DURING THE CONSTRUCTION

Soldering iron

Soldering lead

Sucker

Long nose pliers

Jumper wires

TESTING:

This was made after the construction. Equipments used for testing are as follows:

i. Standing fan

ii. Ac mains supply

iii. Thermistor

iv. Soldering iron

this action is due to behavior of the thermistor due to increase in temperature lead to the increase in resistance

4.3 PACKAGING

The packaging of the device need a sequarish type box with little opening for hot ventilation due to the heat that develops from the soldering iron to the thermistor.

4.4 TYPE OF CASING

A wooden case is safe although metal box is also okay, hut it must be properly isolated to prevent contact and avoid shock. Nut the most reliable casing is plastic.

CHAPTER FIVE

5.0 CONCLUSION

The temperature controlled fan system was designed to increases the speed of the fan as temperature increase widely ranges at 100°C.

Therefore performance test carried out according to components specification on the complete project which shows the positive temperature coefficient thermistor as the sensing elements, indicating the high test temperature that can be obtained is 120°C which is higher than the desired value.

This does not however affect its performance. The design and construction of the system was successful since desired result was obtained.

5.1 RECOMMENDATION

The following recommendation for further works on this type of project is necessary:

1. For effective operation of this project, the thyristor which is silicon controlled Rectifier most control the power supplied to a load at the out put of Diode Bridge and used as a switching device to the circuit.
2. To prevent over heating of diode as mention above in chapter two, the power rating of the diode should not be exceeded.

REFERENCE

1. Science Electronics Lab, by Electronic kits International co. Inc. In the United State of America 1985 BY JORGE L TELIERCIO.

2. Transistor Circuit Techniques Sicrete and Intergraded By G.J. RITCHIE. Second Edition.

3. Electical Engineering Concept and Applications BY. A BRUCE CERISON, DAVID G GISSER.

APPENDIX A

COMPONENTS CHARACTEIRSTICS

1. THYRISTOR	TYPE	TIC 1060
	Vmax	Imax
	400v	5A
2. ZENER DIODE:	BZX 79	
	18V 500mw	

APPENDIX B

PART LIST:

Transistor	TR1 and R2	BC327
	TR3	BC337
Thyristor	SCR	TIC1060
Diode	DZ	BZ X79
Thermistor	TH	TH-3VA 1026
Capacitor	C1	10nf
Resistor	P1	22K
Resistor	R2	100K
Resistor	R3,R6	10K
Resistor	R4,R5	22K
Resistor	R7	100R
Resistor	R8	470R
Resistor	R9	33K