DESIGN AND CONSTRUCTION OF TEMPERATURE COTROLLED AUTOMATIC FAN SPEED REGULATOR WITH DIGITAL DISPLAY

BY

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DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

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A THESIS SUBMITTED TO THE DEPARTMENT OF

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DEDICATION

First and foremost, this project work is dedicated to GOD Almighty, the creator of heaven and earth who has been protecting, providing and strengthening me in all my ways through His Son, Jesus Christ that granted me divine understanding, enablement and favor to be successful in my academic pursuit.

DECLARATION

I, **Salau Omonogu Momohjimoh** declare that this project work was done by me and has never been presented elsewhere for the award of degree. I also hereby hand over the copy right to the FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

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ABSTRACT

The project introduces temperature controlled automatic fan speed regulator with digital display which is a device that regulates the speed of fan with respect to the ambient temperature of a room, office etc. The device basically comprises a temperature sensor which is employed in converting the physical temperature to an electrical quantity that further digitized by an Analog – to- digital converter for easy manipulation by the microcontroller. The microcontroller regulates the speed o f the fan via the power switch based on the digitized temperature value it received with the corresponding speed displayed on a seven segment display. Consequently, the device eases the inconveniences associated with having to regulate a fan when the ambient temperature changes.

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CHAPTER ONE

INTRODUCTION

Temperature is the degree of hotness or coldness of an environment. Though it varies in most part of the World with respect to seasons (winter or summer) of a region. In Nigeria specifically the Northern region, sometimes can be very hot or cold when these seasons are around. Considering the random variation in Weather (Temperature) condition, it is necessary that a device be designed to monitor the temperature of a room or an office and as well trigger a control mechanism to regulate the temperature. Hence the need for a Temperature Controlled Automatic Fan Regulator with Digital Display, so as to ease the inconveniences associated with having to regulate a fan when the ambient temperature changes.

Temperature controlled automatic fan speed regulator is a device that regulates the speed of the fan with respect to the ambient temperature of a room, an office etc. it makes use of a temperature varies sensor in monitoring the temperature variation and regulates the speed of the fan via the support of a Microcontroller.

1.1 AIMS AND OBJECTIVES

The basic aim of this project is to design and construct a temperature controlled automatic fan speed regulator with digital display and manual settings. In addition, the project aims to achieve the following:

- To design a device that will minimize the inconveniences associated with having to regulate the speed of a fan with respect to changes in ambient temperature.
- To design an alternative measure to fan speed control.

- To provide a more comfortable and cheaper domestic appliance, for instance: office, hospital etc.
- To demonstrate practically on how the temperature sensor can be used for the automatic setting or controlling of many electronic devices.

1.2 METHODOLOGY

This project work was carried out by splitting into units so as to ease the design and construction of the device. The coupling of all the units results in the complete work of the project. These are some important units of this project;

- Power supply unit: It employs a 12V 0.5A which was connected to a bridge rectifier to provide a DC output.
- Zero crossing detector unit: It reshapes the equivalent voltage into a rectangular signal
- Temperature unit: The transducer converts the temperature into its proportional voltage.
- Analog-to-digital converter unit: The analog-to-digital converter converts its analog input into its corresponding digital output.
- Single digit 7- segment display unit: The display unit provides a feed back for the user.
- Control unit: The control unit derives the necessary information needed to set the fan speed from the converted temperature value by using a microcontroller.

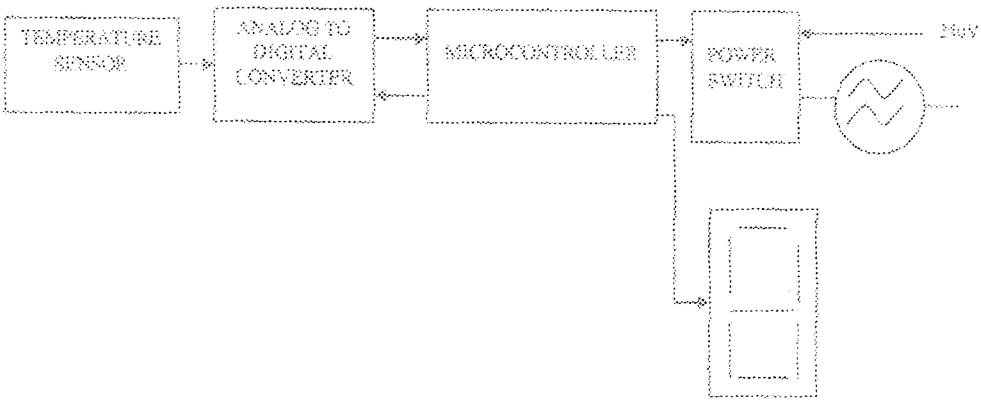

Figure 1.1 BLOCK DIAGRAM

1.3 SCOPE OF THE WORK

The temperature controlled automatic fan speed regulator project makes use of a temperature Sensor "LM35"of which the output voltage is directly proportional to its temperature. A preset value of temperature is programmed with the help of an AT89C51 microcontroller. Basically it operates in the following way as sensor detects the ambient temperature of the room at any particular time. The temperature is read and converted to digital quantities and manipulated by the control unit that monitors the activities of microprocessor via the microcontroller. If, however, the temperature value falls below programmed value, then the fan remains in OFF state but if otherwise it remains in ON state which switches the triac and rotates the fan. However, the speed of the fan depends on the temperature level of the room.

1.4 CONSTRAINTS

- Unavailability of the components.
- In the cause of soldering so many components got damaged.
- Unstable power supply by public holding company of Nigeria (PHCN).

CHAPTER TWO

LITERATURE REVIEW/ THEORETICAL BACKGROUND

2.1 BRIEF HISTORY OF FAN

Screen fans or "fixed leaf fans" are the earliest olden day's fan which was manipulated by hand to cool the body so as to produce the breeze and also to drive away insects. In that regards the early fan normally take the shape of palm leaves, some of these fans were said to have come from Egypt tombs. Fans history has it, that its origination is far back as about thousands years ago which had two dual function; that is, for a useful ornament and a status symbol. In their developing stages, fans were made of different varieties of materials. Some of them are used for decoration while others are for art works for attraction. [1] In the culture of an ancient Americans they normally used bird`s feathers on their fans. Among the Aztecs fans were used to depict merchants in illustrations of Romans` traders. In China screen fans were also used through out the society setting [1]. It was known that around the middle 1700s investors started designing mechanical fans while in the 19th century in the west. European fashion made fans as decoration and size to be varied. The first recorded mechanical fan was the Tunkah fan used in the Middle East in the about 1500s.Nicola Tesla caused the birth of electrical fan in 1955. Dr Schuyler Jkaats wheeler developed the two bladed dusts fans in 1945. In the 1950s fans were manufactured in colors that were bright and eye catching. Just of recently domestic fans were majorly categorized into two, viz: the ceiling and standing fans and table fan. As, technology is getting improved, different types of regulators emerged as we shall continue to study below the types of fans.

2.2 TYPES OF FAN SPEED CONTROL

Controlling the speed the fan can be as simple as regulating the input voltage of the fan to use more complicated digital microprocessor inputs. These methods are further are addressed below.

2.2.1 VOLTAGE REGULATION

This is designed for the purpose of application where the input power may be fluctuating at different voltage levels. It is implemented by using a voltage regulator and changing the adjustable leg with a zener diode [2].

2.2.2 PROGRAMMABLE

Programmable fan allows you to control the speed of fan to maximize cooling performance. The option can be pulse width modulation and / or vary the voltage, otherwise vary the resistance [2]. Being pulse signal can be applied to the program lead wire (yellow wire) and being referenced to the return load in pulse width modulation it means by applying voltage ON and OFF, the amplitude supposed to be equal to the nominal voltage of the fan at a constant frequency. Duty-cycle adjustments are made to regulate the speed of the fan varying the resistance, the voltage is accomplished in the same way as pulse-width modulation (PWM).The only difference between resistance and voltage is that it varies linearly instead of varying the duty cycle [2].

2.2.3 THERMAL SPEED CONTROL

The concept of thermal speed control does not require any external input. It makes use of a thermistor to monitor the temperature and regulate the speed accordingly. The thermistor`s metal properties permit it to change its resistance at a different temperature. Therefore creating a variable voltage divider circuit at adjustable leg of the voltage regulator. The fan will automatically adjust its speed to maximize the air flow to its surrounding temperature [2].

2.2.4 EXTERNAL CONTROLLERS

This may include using multiplex temperature sensor, different set speeds per fan or other combinations. For instance, in a situation where the complicated mapping functions are required, the only way out is to use a microcontroller which we are to implement in the project work.

2.2.5 LINEAR REGULATION

Linear regulation adjusts the voltage across the fan by using a linear regulator [2].The linear concept is designed for application where the input power may be fluctuating at different voltage across the fan levels. The linear speed regulators work by regulating the voltage across the fan. This can be done by dissipating power in the form of heat in the pass element [2]

2.2.6 AC REGULATION

The concept of AC regulation is established on the operation of an Auto-transformer. The speed of fan is directly proportional to the increase in the temperature of the room. Furthermore the number of coil determines the voltage while the wire thickness determines current flowing through the coil. Therefore, the change (increase) in the number of coils increases the speed of fan at different voltage level.

2.3. REASON FOR FAN SPEED CONTROL

The following points below are the reasons and benefits of temperature controlled automatic fans speed regulator with digital display:

2.3.1 REDUCED POWER CONSUMPTION

Regulating fan speed enhances its speed to be reduced when less cooling is needed which eliminates power wastage. Having reduced fan speed, the consumption is also less. This result is in power saving [2]

2.3.2 REDUCE AUDIBLE NOISE

The running of fan at a full speed results into turbulent air flow which is the most dominant sources of fan noise. By adjusting fan speed control, it eliminates the operation at full speed when not needed and as such the noise is reduced [4].

2.3.3 INCREASED LIFE SPAN

Minimizing the fan speed when required also decreases the wear on the fan. Fan wears a rough function of the absolute number of resolutions of the fan. When the wear of the fan is being reduced, its life span is therefore increased with a greater meantime between failures (MTBF) simply because fans are mechanical; they tend to be one of the common failure systems [2] .

2.4 BRIEF HISTORY OF TEMPERATURE

Temperature can be simply defined as a measure of average translational kinetic energy being associated with the disordered microscopic motion of atoms and molecules. It determines the sensation of warmth or coldness felt from contact with it [5]. Temperature is also the most measured parameter. For instance, fire is hot and snow is cold. Greater understanding was achieved as men try to work with materials through the bronze and iron ages [5]. A temperature regulator is a device used for detecting and controlling the hotness and coldness of a system or place within a specific range [6]. The temperature regulator reads temperature in Celsius. The absolute temperature or Kelvin scale was being proposed by Sir Williams Thomson, Baron Kelvin of large and Lord Kelvin of Scotland, in the year 1848. This scale had its zero degree as being the theoretical lowest temperature possible, that is, where molecular motion ceases. This value turned out to be -273 16 degree Celsius. The degree Celsius is the current standard unit of temperature [6]. The early thermometers were non-electric in nature because they used thermal expansion of matter: that is, solids and liquids [7]. They had the disadvantage of possessing a limited temperature range and were subject to the reading error [8]. Fan regulator by Adeyi Bashir, the Author employed thermistor (thermal resistor) as the temperature sensor and his recommendation proposed the use of integrated circuit sensors because they offer better linearity and accuracy. Afterward, in the design and construction of a temperature sensing fan regulator with speed setting remote control by Kasai. A E. the Author made use of an LM339 quad comparator circuit which will compare the voltage input. That is, the first input varies with temperature change and the other is fixed, based on the setting made [9]. His recommendation also employed the use of integrated circuit sensor and the circuit size of the project. This project work has made the advancement to these earlier works by putting the added feature of a temperature sensor (LM35) because it can measure temperature more accurately than using thermistor, its sensor circuitry is sealed and not to be subjected to the moisture and can generate a higher output voltage than thermocouple and may not require that the output voltage be amplified. Also a microcontroller allows the output signal to be displayed on the screen segment display (LED).

2.5 THEORETICAL BACKGROUND

The temperature controlled fan speed regulator with digital display can be broken down into units' viz: power supply unit, system controller, an analogue to digital converter temperature sensing unit and display unit (seven segments).

2.5.1 POWER SUPPLY

The power supply circuit is achieved from a 220V 50HZ mains input by means of a 20:1 step down transformer to regulate a 5V DC supply derived from a 12V 0.5A AC 50Hz.The 12V AC input is rectified by a bridge rectifier. then there is a zero crossing detector device which aids reshape into a pulse wave and then smoothened by a 25V 220μF controlled by 7805regulator to produce a ripple-free 5V DC output.

2.5.2 CONTROL UNIT

The control unit is associated with device that switches the fan. In this project BT139 power triac shall be incorporated to serve as a switch. It is a 5 layer bi-directional device which can be triggered into conduction by both positive and negative voltage at its anode and with both positive and negative triggering at its gate. It performs like two SCR (Silicon Controlled Rectifier) connected in parallel upside down with respect to each other [11].The power triac is powered by a M0C3023 opto-triac which receives command from 8951 Microcontroller.

2.5.3 SYSTEM CONTROLLER

The microcontroller is made up of central processing unit (CPU), instruction fetch and decoder, arithmetic logic unit, registers. all embedded into a single chip. The central processing unit deals with supporting components, such as memory input / output peripherals and this serves as a way of giving rise to microcontroller integrating all the elements of microcomputer onto a single chip called microcontroller. The AT8951 can be used; this is a low power high performance CMOS 8-bit microcomputer with 4 Kbytes of flash programmable and erasable read only memory (PEROM). The device is manufactured by Atmel`s high density non-volatile memory technology and is compatible with the industry standard MCS-51TM instruction set [11]. The on chip flash allows the programmed memory to be programmed in system or by a conventional non-volatile memory programmer, by combining a versatile 8-bit central processing unit with flash monolithic chip. The 8951 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control [12]. The 8951 have the following standard features, 4Kbytes of flash, and 128 bytes of RAM, 32 input / output lines, three 16-bit timers, five vector two level interrupt architecture, a full duplex serial port on chip oscillator, and circuitry. Also it is designed with static logic for operation down to zero frequency and supports two software selectable power saving mode. The idle mode stops the CPU while allowing the RAM, timer, serial port, and interrupt system to continue functioning while power down mode saves the Random Access Memory (RAM) contents but freezes the oscillator, disabling all other chip function until the next hardware reset

2.5.4 ANALOGUE TO DIGITAL CONVERTER

The analog to digital converter is an electronic circuit that converts an input analog voltage to a digital number. It does continuous conversion of signals to discrete digital. All analogues to digital converters (ADC) suffer from non linearity error caused by their physical imperfection, causing their output to deviate from a linear function. The ADC used in this project is the ADC 0804 that allows successive approximation as its conversion method [14]. It is used owing to its availability and relative cheapness.

2.5.5 TEMPERATURE SENSING UNIT

A temperature sensor and / or transducer is a device that senses hotness and coldness variation in an environment to give a desired electrical signal [15]. Their properties change with changes in temperature. There are different types of temperature sensors that are in use. These include: Thermocouple, Resistance temperature detector (RTD), Thermistors and Sensor integrated circuit. A thermocouple consists of two different conductors coupled together at their ends; the device is used to measure the temperature of the other junctions. It can also be used to convert a radiant energy to fixed energy thermistor: A thermistor is a device whose resistance value changes with its temperature [16]. It offers greater accuracy and stability than thermocouples [17]. But its non uniform resistance temperature characteristics can be disadvantageous in some application where it is required to obtain a more linear variation [17].

2.5.6 SENSOR INTEGRATED CIRCUIT:

The integrated circuit temperature sensor is a precision semiconductor, giving an output of 10mV per degree centigrade. Unlike devices with outputs proportional to the absolute temperature (in degree Kelvin) there is no large offset voltage which in most application will have to be removed, it does not requires any external calibration.

2.5.7 THE DISPLAY UNIT:

The display unit of an electric electronic is mainly concerned with the visual presentation of small numeric and alphanumeric output information [18].In this project work the display unit comprises of seven segment display chips connected to microcontroller. A seven segment display is a coupling of light emitting diode (LED). The LED is an electroluminescent system that emits light when a voltage is suppressed on it [18]. Other electro-luminescent are the liquid crystal display (LCD) and the light emitting film (LEF). Each light emitting diode of seven segment display is powered individually and connected via a resistor while the LED chips are connected in common anode mode.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

The temperature controlled fan speed regulator was designed around the following under listed subsystems:

- Power supply
- Zero crossing detector
- Temperature sensor
- Analogue to digital converter
- Single digit 7-segment display

A C power triac switch

3.1 POWER SUPPLY

A regulated 5Volt DC supply was required for the system functionality; therefore a 12V 0.5A transformer was used as the AC (alternating current) input transformer. The transformer was connected to a full wave bridge rectifier as shown in figure 3.0

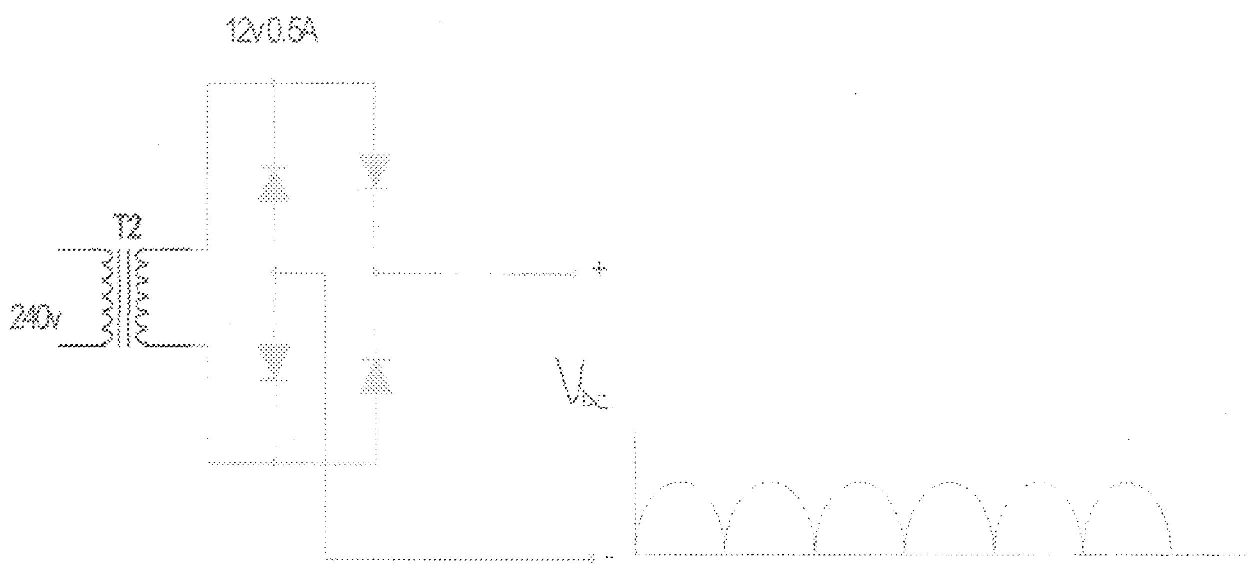

Figure 3.0 a regulated Voltage DC power supply Diagram

The 12V AC (RMS) voltage was converted to (12√2−1.4) Volt peak DC voltage.

That is, $V_{DC} = \left(\sqrt[12]{2 - 1.4}\right) \cong 15.5\text{V}$

This pulsating DC voltage was smoothened using a value of capacitance deduced from the relation.

Q = CV = It

CV = It

C = value of smoothening capacitance.

V = maximum allowable AC ripple voltage.

I = maximum load current

$$t = \frac{1}{2f} = \frac{1}{2X50} = 0.01\text{s}$$

For the 7805 5Volt regulator used, the minimum input voltage necessary for regulating 5Volt output is 7V.

Using estimated system current consumption of:

Microcontroller = 15A

Display = 70mA

ADC = 5mA

Opto triac = 10mA
I = 100mA

V = maximum allowable AC ripple voltage is 7V peak – to – peak.

$$C = \frac{It}{V} = \frac{0.1 X 0.1}{7} = \frac{0.001}{7} = 0.000144\text{F} = 144\mu\text{F}$$

A 220µF capacitance was used for better performance.

ZERO CROSSING DETECTORS

Due to the requirements for the fan motor control, a means of counting, how many AC cycles have elapsed was derived. This involved obtaining the timing reference from the rectified pulsating DC voltage via a zero crossing detector. The zero crossing detectors generate a 100Hz output frequency from the pulsating DC input voltage.

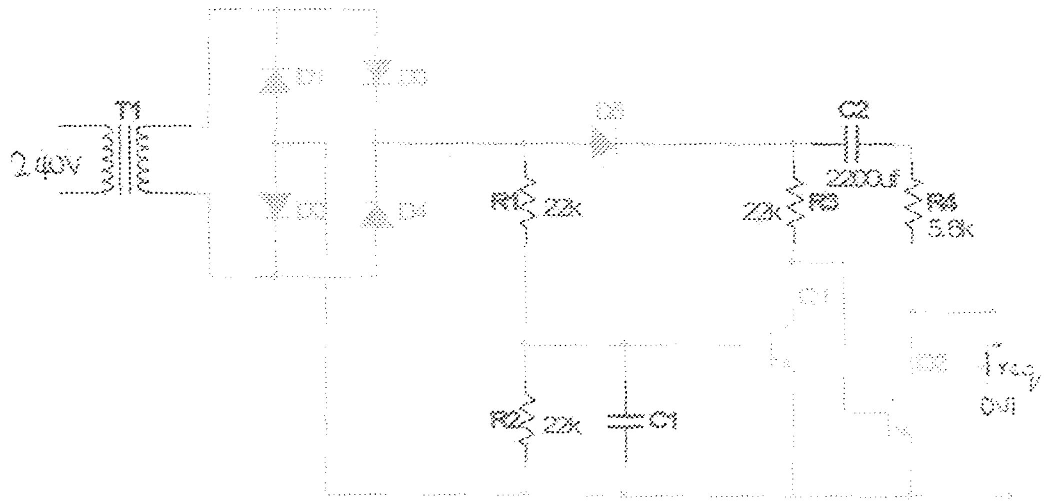

Figure 3.1 Zero crossing detector Circuit

Diode D1 isolates the pulsating DC waveform from the 2200µF smoothening capacitor. Without D1 in the circuit, the 100Hz frequency reference is lost. Resistors R1 and R2 from a base potential divider for Q1.Assuming a V_{BE} of 0.7 V for Q1, Q1 turns on when the rectified DC voltage rises to 1.4V, when Q1 turns ON (and remains ON until V_{DC} falls below 1.4V), Q2`s base is grounded and Q2 collector goes high. This high is maintained until V_{DC} falls to ≤ 1.4V, at which point, Q2 saturates, pulling its collector to ground. The output is a 100Hz frequency output with 10ms time period. The output is also rectangular since the duty cycle approaches about 95%. The 10ms pulses are applied into interrupt input on the controller to generate an interrupt every 10ms. The waveform of zero crossing detectors is shown below.

The waveform of crossing detector is shown below:

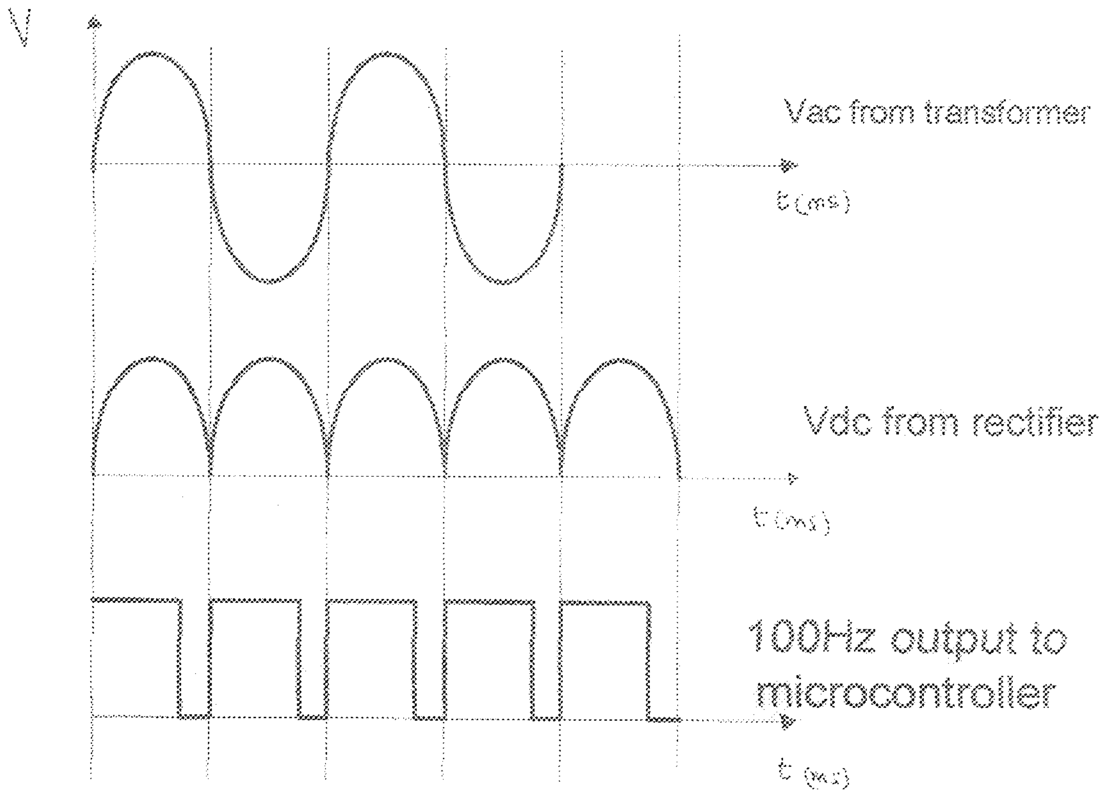

Fig.3.2 wave form of zero crossing detectors

3.1.2 TEMPERATURE SENSOR

Since the quantity being monitored is non- electrical in nature (temperature), a transducer was needed to convert the non electrical quantity to an analog voltage. An integrated circuit analogue temperature sensor was used, the LM35.

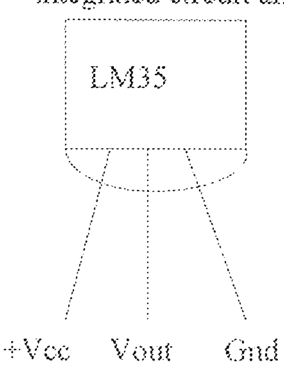

Fig.3.3 LM35 Centigrade Temperature Sensor

The LM35 device produces an output voltage of 10mV / 0°C, and ranging from O°C to 100°C. The accuracy was quoted as ±1°C

3.2.0 ANALOGUE TO DIGITAL CONVERTER

To interface the LM35 with the microcontroller, an analogue to digital converter was used. The ADC translates the analogue voltage to binary value that can be manipulated by the controller. An ADC0804 8-bit ADC was setup. It was set up as shown below.

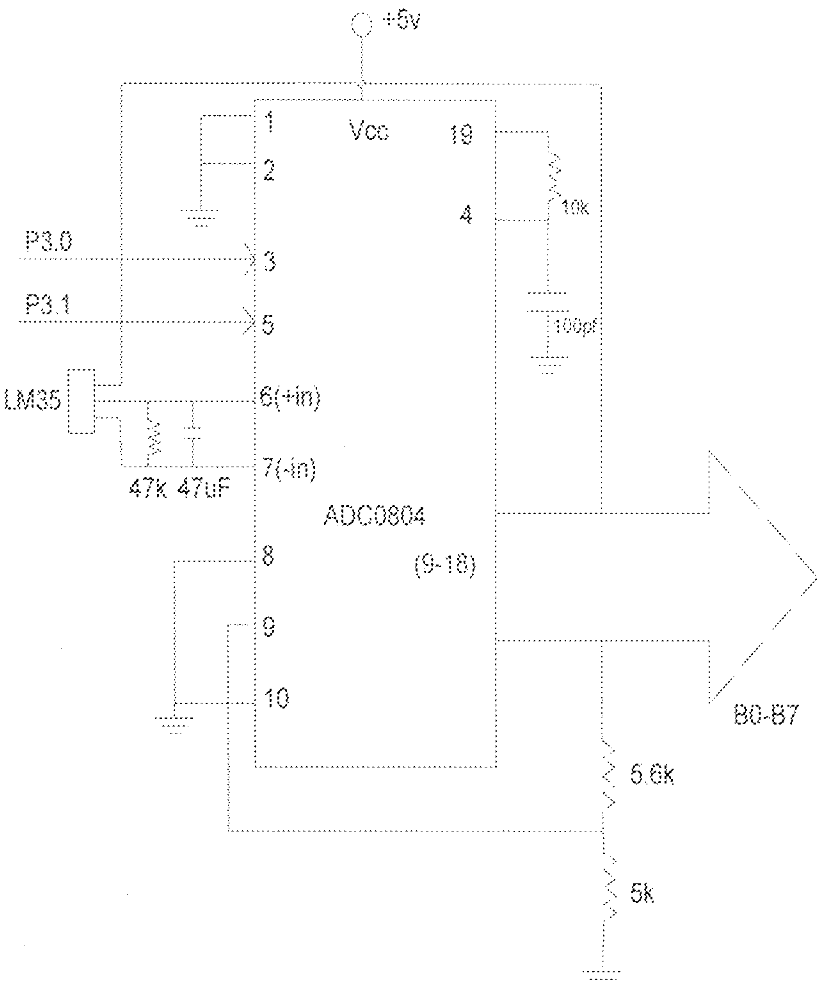

Fig.3.4 Analogue –to – Digital Converter

The ADC was run off a regulated 5V DC supply. The analogue voltage output from the sensor was fed into the (+) input of the ADC. The ADC was setup for a full scale output (1111 1111) at an input voltage of 2.56V.This allows for easy scaling as the input voltage and output binary value now possess a 1:1 correspondence. i.e. a 1V input produces 100_{10} output. The converter was run on a clock frequency of:

$$f = \frac{1}{1.1XRC} = \frac{1}{1.1X19X100X10^{-12}} \cong 478.469 \text{ kHz}$$

The converter was interfaced to the controller on P1 (8-bit data line). P3.0 ADC/WRITE), P3.1 (ADC/ WRITE) the CHIP SELECT and READ were permanently asserted since this. is the only device on the P1 bus. Conversion was done under software control from the controller.

3.2.1 AT89C51 SYSTEM CONTROLLER.

An 8-bit microprocessor (89C51) was used for system control. The control has 4KB of Flash ROM and 128 bytes of RAM. It also possesses 32 general purpose input / output lines. I was interfaced with the ADC08O4 on port 1(P1). Two control lines from P3.0 and P3.1 were connected to the INTERRUPT output and WRITE input. The single digit 7 segment display was connected to P0 of the device. An opto-triac was connected to P3.7 of the controller. Two up / down press buttons were connected to P2.7 and P3.1 of the microcontroller on manually setting the fan speed based on user's preference. The controller:

- Initiates an analogue to digital conversion of the ambient temperature.
- Reads the digital value over P1.
- Looks up the speed corresponding to the temperature value.
- Sets up the display to reflect the fan speed.

- Extracts the timing information from the measured temperature value.

In addition to the above, the controller also counts the number of AC cycles over which control is effected.

Figure 3.5 below shows the diagram of microcontroller.

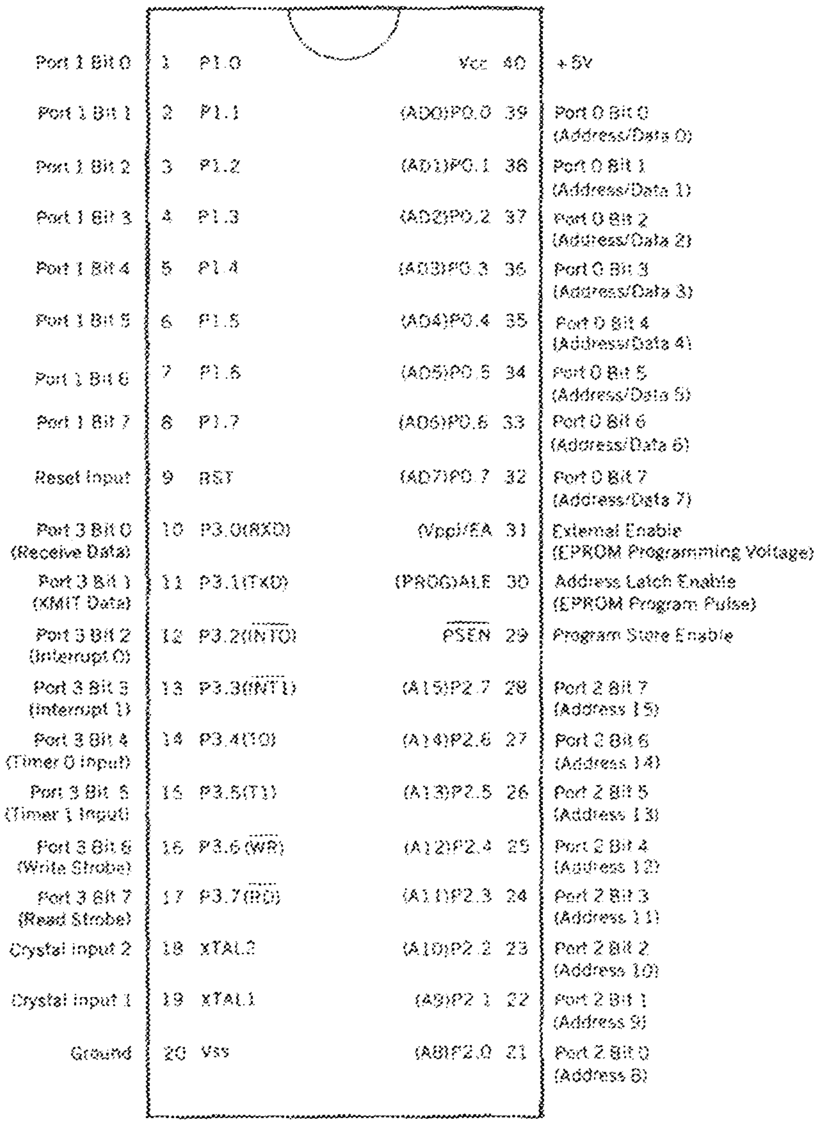

Fig.3.5 AT89C51 MICROCONTROLLER

3.3 SYSTEM SOFTWARE

The system software was designed on a modular structure for ease of development. The modules include:

- System initialization routines.
- Analogue to digital conversion module.
- Temperature to speed number conversion module.
- Speed number to speed conversion module.

The system initialization routine initializes the stack pointer, enables interrupts on P3.2 and also enables the two press buttons before exiting to the main line routines. The main line routines scan the keypad and oversee analogue to digital conversion. The system power up in the default automatic mode in which the fan speed is directly a function of the

temperature. Pressing either the (+) or (-) refers the system to the manual mode where the speed is now a function of user setting. Once in the manual mode, the system maintains user's settings until RESET is preset at which point the system reverts back to the auto mode. The system software also controls the average AC voltage delivered to the fan motor by modulating the conduction triac connected in series with the load as shown below:

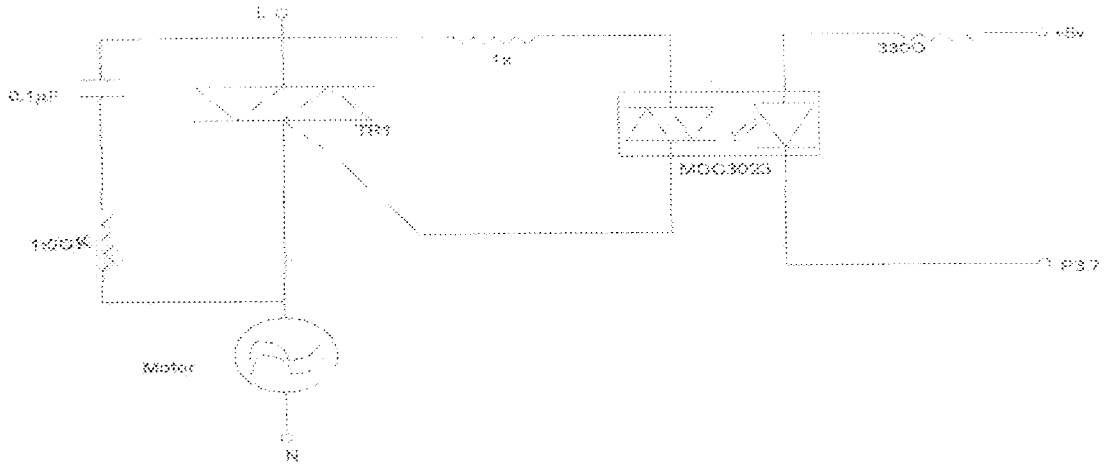

Fig.3.6 A.C power switch

TRI is a high power triac (BT139). The BT139 is rated for 16A continuous current capability. In the simplest sense, a triac is composed of two inverse connected thyristors. Due to this connection, a triac can pass A.C voltage in both directions. The triac is connected in series with the fan motor winding; therefore, modulating the ON-to-OFF timers of the triac directly modulates the power developed in the winding. The power triac is protected by an RC Snubber circuit comprising a 100Ω resistance and 250V 0.1μF non-polarized capacitor. The series connected elements prevent inductive kickbacks from destroying the triac when the inductive load switches off. The values used were specified by the manufacturer of the BT139.An M0C3023 opto-triac provides electrical isolation between 240V side and the 5 volt low voltage DC system. The 3023 embodies an integral photodiode and a Light Emitting Diode (LED) .When the LED is forward biase: it emits infrared light that impacts P.N junction of opto triac inside of the package, causing current to flow into the gate of the triac when connected as shown in figure 3.5. The current through integral LED was limited using a resistance of 330Ω deduced from the expression:

$$R_S = \frac{V_{in} - V_{LED}}{I_{LED}}$$

V_{in} = 5V; V_{LED} = 1.7; I_{LED} = 10mA.

$$R_S = \frac{5 - 1.7}{0.01} \cong 330\Omega$$

The return ground for the LED current was taken through P3.7 to control the power Through the triac. The software computes the speed from the measured temperature and takes P3.7 low for a period of the on–time, and high for a period of the off–time. The higher the temperature, the higher the on–time, and the greater the fan speed.

3.4 FAN SPEED CALCULATION

Control was effected over 10 A.C cycles. Each AC cycle = 20ms

The timing information derived from the mains was 10ms, therefore, in reality twenty half cycles were controlled, and decision made by the system controller every 10mS (every P3.2 interrupts). The ADC was set up with a 2.56V full scale binary output, producing a 1-on-1 correspondence between the input voltage and output digital code,

Table 3.0 Temperature Analysis

Temperature (20°C)	Sensor output voltage value (mV)	ADC output value
20	200	20
25	250	25
30	300	30

A look up table was created in software with the corresponding on-times of the different temperatures.

Table3.1 OFF / ON- time of different Temperature

TEMPERATURE VALUE(°C)	OFF- TIME(ms)	ON- TIME(ms)	FANSPEED
0-TO-23	FULLY OFF	0	0
24	180	20	1
25	160	40	2
26	140	60	3
27	120	80	4
28	100	100	5
29	80	120	6
30	60	140	7
31	40	160	8
≥ 32	0	FULLY ON	9

The fan speed settings were stored in non-volatile flash memory. After each of the two conversions, the corresponding values are loaded into a random access memory (RAM) variable called speed. The 7-segment code equivalent of speed is output on p0.0 for visual indication. For values of temperatures greater than 24 and lesser than 31, on-time / off-time values are calculated. The off-time / on-time values above have been given in numbers of a.c cycles to block or pass from/into the fan motor. since interrupt was used, every 10ms a register on-time holding the number of ac cycle to pass into the load decremented. If on-ti°C°Cme decrements to zero, P3.7 switched high, turning off the power triac. A second register OFF-TIME loaded with the off time corresponding to ambient temperature level is decremented as for ON-time above. When OFF-TIME decrement to zero, P3.7 is switched back LOW and power again flows into the load. The power controls above is the typical of a pulse width modulated as in figure below:

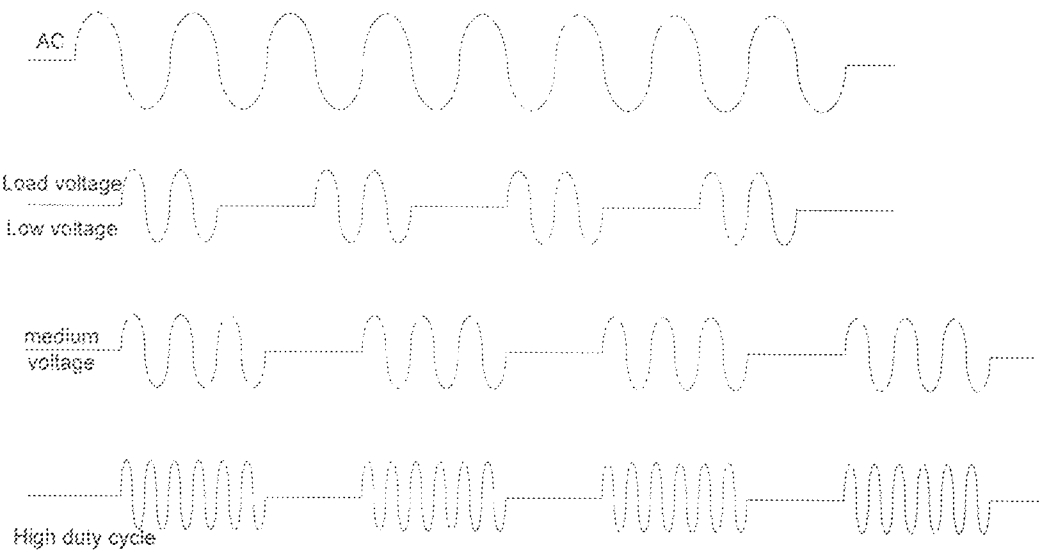

Fig.3.7 High duty cycle

For temperatures 0-to-23°C, P3.7 is permanently switched high, blocking current from the load. For temperature values >= 31°C, P3.7 is permanently switched low for maximum power through the load

3.5. 7-SEGMENT DISPLAY

A single digit common mode 7-segment display was used for visual interactivity. The value to be displayed was converted to a low true (Active low) binary pattern before Outputting over P0. The bit patterns corresponding to the different digits are shown below

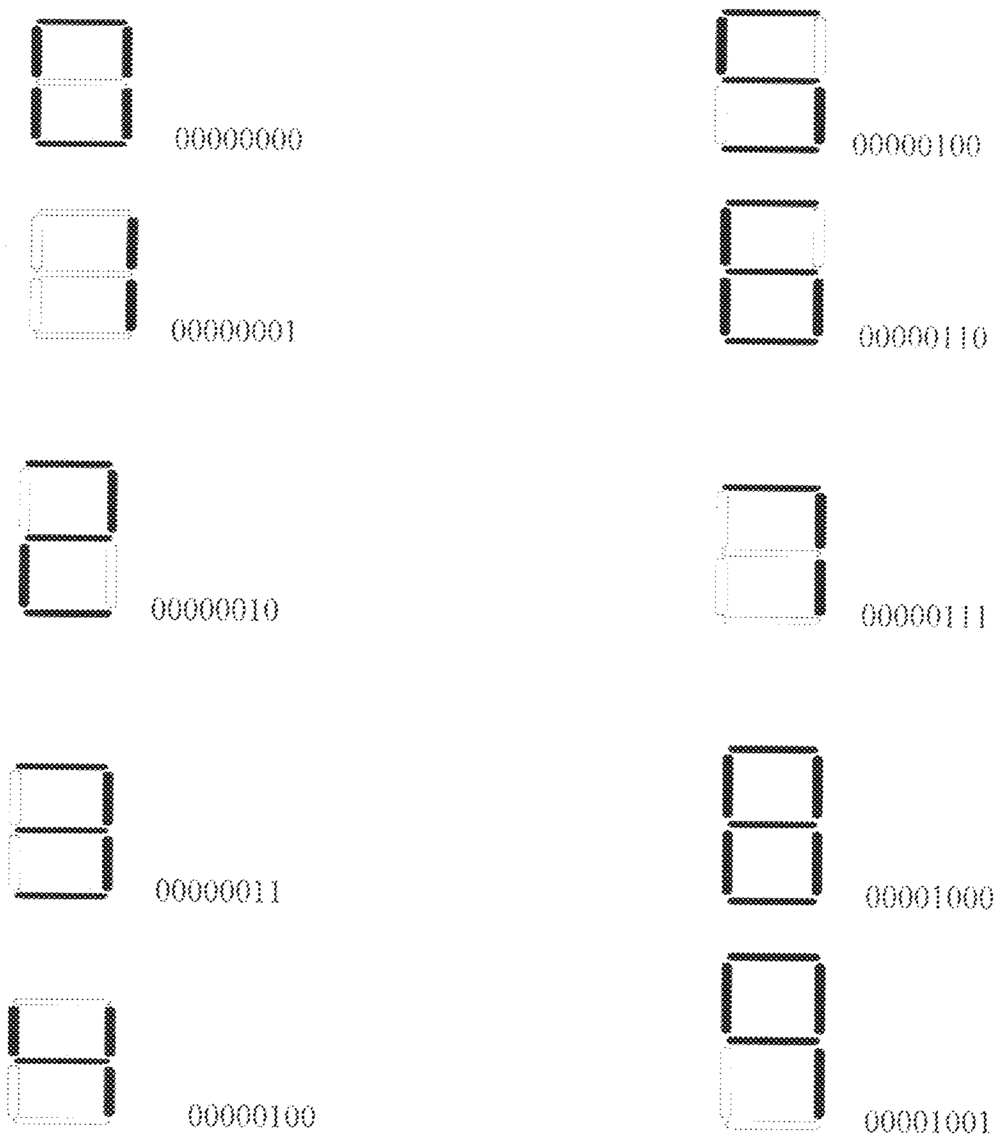

Fig.3.8 Number display 7-segment code

3.5.1 Number display 7-segment code

The binary patterns have been presented in active-lows because a common anode display was used, and current is sunk through the segments via P0.

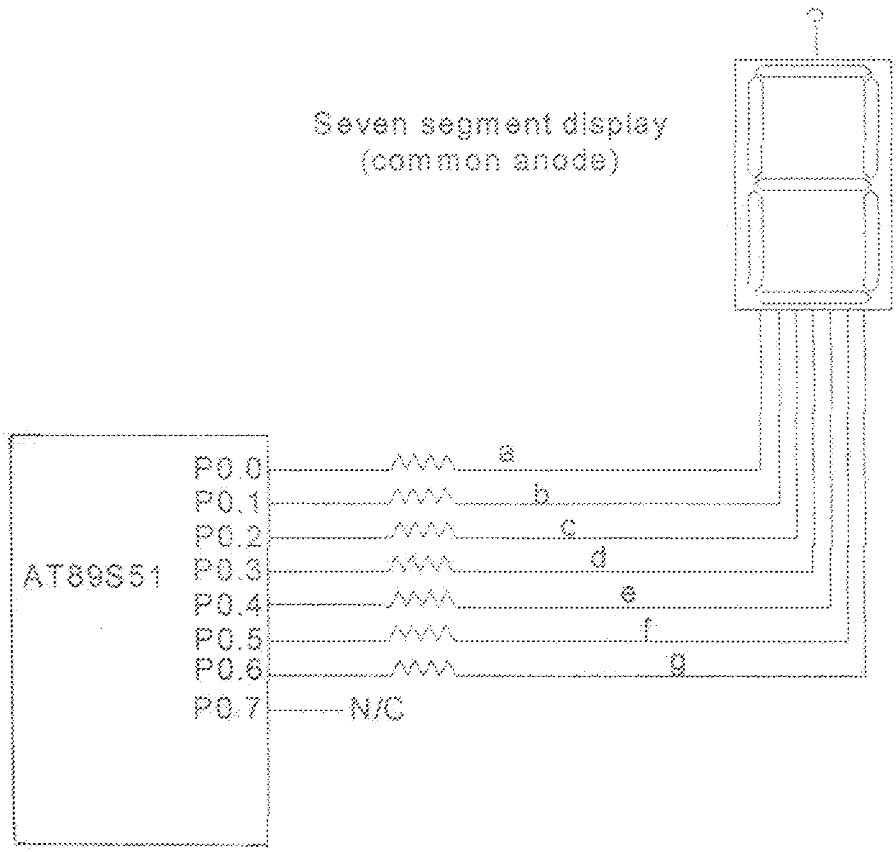

Fig.3.8.1 7- segment display

The current through the segments were limited to 10mA each using 330Ω resistances.

The values were calculated as for the R_S connected to the opto triac –LED.

3.6 USER INPUTS

Two user inputs were provided on bits P2.0 and P2.1. The two keys allow the user to override the automatic control mode and establish a user defined speed setting. A button allows the speed to be decremented and the second speed to be incremented. A third button was provided that allows the system to return to the automatic mode from the manual mode.

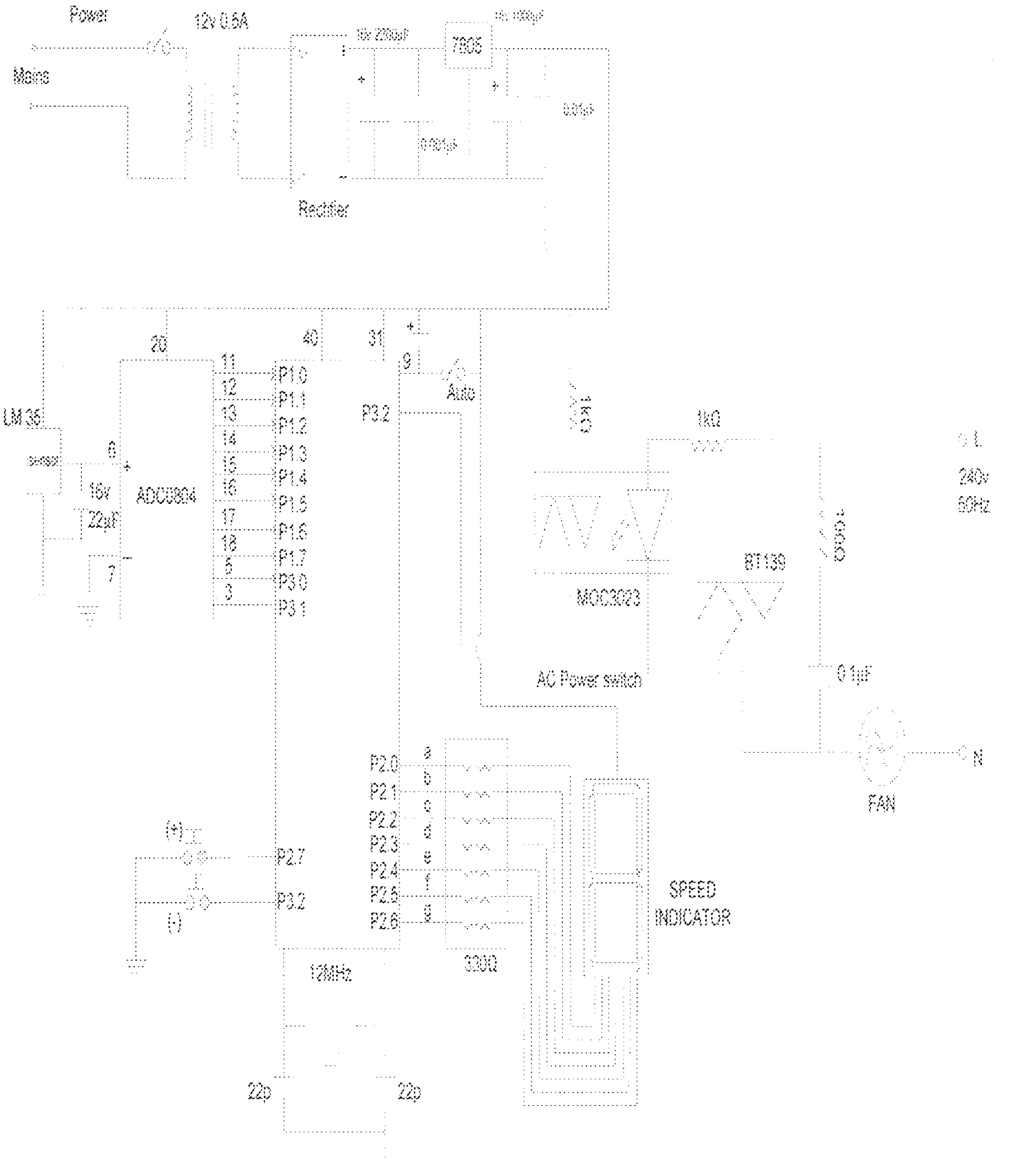

Fig.3.9 Circuit Diagram of a temperature controlled automatic Fan speed regulator with digital display

CHAPTER FOUR

TEST, RESULT AND DISCUSSION

4.1 TESTS

The physical realization of the project is very important because this is where the interest of the whole idea meets desired result. The project at this stage is not only on paper but a workable finished hardware system. The first stage on the construction of this project was to buy the required components where they are tested to avoid malfunctioning or defect. The different units such as the power section s were simulated using multism 9 circuit simulator. The circuit was properly soldered on Vero board: afterwards the circuit connections were properly tested for wrong positioning and were set for real functionality testing. The test was conducted by connecting a stand fan to the output of control unit (fan out), then connecting the set up to the A.C mains. The displaying segment was on, showing the speed corresponding of the ambient temperature of the room at particular point in time. The manual button (+) for setting was then pressed which increases the speed of the fan while displaying it, when manual button (-) was held down it decreases the speed correspondingly. Also, an ice block and a heater were also provided for testing when it returned to auto mode (reset), an ice block was moved closer to the temperature sensor (LM35) for it to sensor the temperature as a lower one, the speed of the fan drops instantly. Also a heater was heated to a certain temperature and also moved nearer to the sensor. When

the device senses it as a higher temperature thus increases the speed of the fan automatically so, different tests were carried out so as to check the response of the system and they were all confirmed okay for effective response.

4.2 RESULT AND DISCUSSION

It was observe that both the control unit and connecting fan responded to the signal that is, pulse from the system (software) controller. The system defaults to the auto mode of operation at power up; the highest speed observed was corresponding to 7-segment digital display while the lowest speed observed was zero. The lowest temperature limit to turn ON fan is 24°C, while the upper limit is 31°C to display the maximum speed. The main aim of this project has therefore being achieved. So, the following results were obtained as tabulated below:

Table 4.0

SAMPLE	TEST	TEMP (°C)	DISPLAYED SPEED LEVEL	VOLTAGE (V)
Room Temperature	Morning	26	3	26
"	Afternoon	31	9	31
	Evening	28	5	28
Heater	Temp	29	5	29
"	_	37	9	37
Ice block	Temp	20	0	20
"	_	24	1	24

CHAPTER FIVE

5.1 CONCLUSION AND RECOMMENDATION

The project displayed as a temperature controlled automatic fan speed regulator, result in changes in the ambient temperature of the room around which the sensing component (LM35) varies the temperature. Therefore, its mode of working is very efficient with temperature ranges of 24°C-to-31°C corresponding to a speed of 0-to-9 respectively. The project was tested and confirmed okay which also met the desired result.

5.2 LIMITATIONS

- This device is limited to regulate only electric fan (wall or standing) of input power of 240V.
- It is only the ambient temperature that can cause a change in the speed of device, that is external temperature cannot effect change on it.
- The minimum that can trigger on the device is 24°C below which the device switches to off-mode.
- 31°C and above gives the maximum or continuous speed.

5.3 RECOMMENDATION

This project work can be further modified as follows, so as to be more useful and efficient in future.

- Remote control setting needs to be added to the manual setting.
- Displaying of measured or room temperature in addition to the speed.
- Making a provision for multiple outputs so that more than one fan can be used.

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```
INCLUDE 89C51.MC

ON_TIME DATA 08H
OFF_TIME DATA 09H
SPEED DATA 0AH
ADC_PORT EQU P1
TRIAC_DX BIT P3.7
MANUAL_PLUS BIT P2.0
MANUAL_MINUS BIT P2.1
MANUAL_ON BIT 00H
ZERO_SPEED BIT 01H
MAX_SPEED BIT 02H
LOAD_OFF_TIME BIT 03H
stack  EQU 60h
adc_write BIT p3.0
adc_intr BIT p3.1
display_port EQU p0
TEMP DATA 0CH


ORG 0000H
LJMP START_UP
```

```
ORG 0003H
LJMP SET_SPEED

ORG 0030H
START_UP:        CLR EA
                 MOV SP,#STACK
                 ACALL SYS_INIT

mainloop:        JB MANUAL_ON, GO_MANUAL
LOOP_1:          ACALL GET_TEMP
                 MOV DPTR,#SPEED_tABLE
                 MOVC A, @A+DPTR
                 MOV SPEED,A

GO_MANUAL:       MOV A, SPEED
                 MOV DPTR,#7_SEG_tABLE
                 MOVC A,@A+DPTR
                 MOV DISPLAY_PORT,A
                 MOV A,SPEED
                 JZ SET_ZERO
                 XRL A,#9
```

```
        JZ SET_MAX
        CLR ZERO_SPEED
        CLR MAX_SPEED
        MOV A, SPEED
        CLR C
        RLC A
        MOV ON_TIME,A
        MOV A, #20
        CLR C
        SUBB A, ON_TIME
        MOV OFF_TIME,A
        SJMP SCAN_KEY

SET_ZERO:   CLR MAX_SPEED
        SETB ZERO_SPEED
        SJMP SCAN_KEY

SET_MAX:    SETB MAX_SPEED
        CLR ZERO_SPEED
```

```
SCAN_KEY:           JB MANUAL_PLUS,SCAN_KEY2
                    ACALL SET_MANUAL_PLUS
                    ACALL DELAY_key

SCAN_KEY2:          JB MANUAL_MINUS,MAINLOOP
                    ACALL SET_MANUAL_MINUS
                    ACALL DELAY_key
                    JMP MAINLOOP

SET_MANUAL_PLUS:    MOV A, SPEED
                    XRL A, #9
                    JZ NO_INC
                    INC SPEED
                    SETB MANUAL_ON
NO_INC:             RET

SET_MANUAL_MINUS:   MOV A, SPEED
                    JZ NO_DEC
```

```
                DEC SPEED
                SETB MANUAL_ON
NO_DEC:         RET


SET_SPEED:      CPL p3.6
                JB ZERO_SPEED, TURN_FULL_OFF
                JB MAX_SPEED, TURN_FULL_ON
                JB LOAD_OFF_TIME, GO_LOAD_OFF
                DJNZ R6, EXIT
                SETB TRIAC_DX
                MOV R6, OFF_TIME
                SETB LOAD_OFF_TIME
EXIT:           RETI


GO_LOAD_OFF:    DJNZ R6, EXIT
                CLR TRIAC_DX
                MOV R6,ON_TIME
                CLR LOAD_OFF_TIME
                RETI


TURN_FULL_OFF:  SETB TRIAC_DX
```

```
                RETI

                CLR TRIAC_DX
TURN_FULL_ON:   RETI

                MOV R2,#50
delay_key:      ACALL delay
do_that:        DJNZ R2, do_that
                RET

GET_TEMP:       ACALL CONVERT_TEMP
                MOV TEMP,A
                ACALL delay
                ACALL delay
                ACALL delay
                ACALL delay
```

```
ACALL CONVERT_TEMP
ADD A, TEMP
CLR C
RRC A
ACALL delay
ACALL delay
ACALL delay
ACALL delay
RET


DELAY: MOV R3,#33
reload: MOV R4,#0
AGAIN: DJNZ R4, AGAIN
       DJNZ R3,reload
       RET


convert_Temp:    CPL p3.5
                 CLR adc_Write
                 NOP
```

```
NOP
NOP
NOP
SETB ADC_wRITE
MOV R1,#0
DJNZ R1,$
;JB adc_intr, $
MOV A, adc_port
RET




SYS_INIT:        SETB TRIAC_dX
                 SETB P3.2
                 SETB ADC_wRITE
                 SETB ADC_INTR
                 MOV DISPLAY_PORT,#0FFH
                 SETB MANUAL_PLUS
                 SETB MANUAL_MINUS
                 MOV TCON,#00000001b
                 MOV IE,#00000001b
                 MOV SPEED,#0
```

```
                CLR MANUAL_ON
                SETB ZERO_SPEED
                CLR MAX_SPEED
                MOV R6,#2
                MOV on_time,#2
                MOV off_time,#18
                SETB LOAD_OFF_TIME
                SETB EA
                RET

speed_table:DB 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
        DB 0,0,0,1,2,3,4,5,6,7,8,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9
        DB 9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,
```

```
7_Seg_Table: DB
11000000b,11111001b,10100100b,10110000b,10011001b,10010010b,10000010b,11111000b,1000000
0b,10010000b
```