LOW COST INFANT INCUBATOR

PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE
OF

BACHELOR OF TECHNOLOGY
in
ELECTRONICS AND COMMUNICATION ENGINEERING

Under the guidance
Of
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CERTIFICATE

This is to certify that project report entitled **"LOW COST INFANT INCUBATOR"** which is submitted **by ANANYA MISHRA, PRATIBHA SINGH, UNNATI KESARWANI** and **GYANVI PRADHAN** is partial fulfillment required for the award of degree of Bachelor of Technology in "Electronics & Communication Engineering", **Dr. APJ Abdul Kalam Technical University, Lucknow** is a record of the candidate's own work carried out by them under my supervision**.** The matter embodied in this project report is original and has not been submitted for the award of any other degree.

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DECLARATION

We hereby declare that the submission of project is our own work and to the best of our knowledge and belief. It contains no material previously published or written by any other person nor material which to a substantial extent has been accepted for award of any other degree or diploma of the university or other institute of higher learning except where due acknowledgement has been made in the text.

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ABSTRACT

Every year, an unacceptably large number of infant deaths occur in developing nations, with premature birth and asphyxia being two of the leading causes. A well-regulated thermal environment is critical for neonatal survival. Advanced incubators currently exist, but they are far too expensive to meet the needs of developing nations. We are developing a thermodynamically advanced low-cost incubator suitable for operation in a low-resource environment.

Our design features three innovations:

(1) A disposable baby chamber to reduce infant mortality due to nosocomial infections,

(2) A passive cooling mechanism using low-cost heat pipes and evaporative cooling from locally found clay pots, and

(3) Insulated -panels and a thermal bank consisting of water that effectively preserve and store heat.

We developed a prototype incubator and visited and presented our design to our partnership hospital site in Mysore, India. After obtaining feedback, we have determined realistic, nontrivial design requirements and constraints in order to develop a new prototype incubator for clinical trials in hospitals in India.

LIST OF FIGURES

ABBREVIATIONS

NICU	Neonatal Intensive Care Unit
MOSIC	Metal Oxide Semiconductor Integrated Circuit
SOC	System On a Chip
POS	Point Of Sale
D/F PT	Dew/Frost point
RH	Relative Humidity
NTC	Negative Temperature Coefficient
IRJET	International Research Journal of Engineering and Technology
IJACSA	International Journal of Advanced Computer Science and Applications
EPROM	Programmable and Erasable Read Only Memory
DSP	digital signal processing

CHAPTER 1

INTRODUCTION

INTRODUCTION

Infants who are born before 37 weeks of the gestation period are known as preterm or premature babies. Preterm baby requires surrounding exactly similar as in the womb to cope with the external environment. In fact mammals have the advantage of being homoeothermic, i.e. they have a nearly uniform body temperature, regulated independent of the environmental temperature. Vital organs or enzymes of premature babies grow to the very lesser extent and thus requires special attention to cope with external physical condition like temperature, humidity, light and oxygen level. The infant has several disadvantages in terms of thermal regulation. An infant has a relatively large surface area, poor thermal insulation, and a small amount of mass to act as a heat sink. The new born has little ability to conserve heat by changing posture and no ability to adjust their own clothing in a response to thermal stress. Responses may also be hindered by illness or adverse conditions such as hypoxia (below normal levels of oxygen). To provide the similar environment as in the womb infants have to be kept in a device known as incubator. An infant incubator is a device consisting of a rigid box-like enclosure in which an infant may be kept in a controlled environment for medical care. An infant incubator provides stable levels of temperature, relative humidity and oxygen concentration. Air temperature has to be maintained around 37ºC. The relative humidity should follow set values according to the number of incubation days.

INCUBATOR

The first official neonatal intensive-care unit (NICU) for neonates was established in 1961 at Vanderbilt University. Incubator is a device in which premature or unusually small babies are placed and which provides a controlled and protective environment for their care. Every year, about 1 million infants in the developing world die due to heat loss and dehydration that can be prevented by an intensive care unit i.e. incubators. Thus incubators provides congenial atmosphere for the infants, which helps in thermoregulation. The incubator is considered as an air-conditioned room with special specification which we can be control with respect to the condition of baby in incubator. Incubators are designed to provide an optimal environment for new born babies with growth problems (premature baby) or with illness problems. The incubator is an isolated area environment with no dust, bacteria, and has the ability to control temperature, humidity, and oxygen to remain them in acceptable levels. Incubator is designed to keep baby warm, to monitor many of their vital body functions like heart rate, blood pressure, oxygen saturation and to support their breathing if necessary. Regarding the temperature and humidity control, incubators should minimize heat loss from the neonate and eddies around him/her. The main physical variables affecting the incubator environment are temperature, humidity, oxygen saturation and light

.

PARAMETERS AFFECTING THE INCUBATORS

1. **TEMPERATURE:** The infants have very low thermal regulation and temperature regulation is one of the most important factors which affect the preterm. One of the major problems that new-born's face is improper thermoregulation. The temperature inside the mother's womb is 38ºC (100.4ºF). Leaving the warmth of the womb at birth, the wet new born finds itself in a much colder environment and immediately starts losing heat. If heat loss is not prevented and is allowed to continue, the baby will develop hypothermia and is at increased risk of developing health problems and of death. Avoiding hypothermia (rectal temperature less than 36.5°C or 96.8° F) is important for new-born health outcomes because hypothermia increases morbidity and mortality. A baby can lose one degree of body temperature per minute when wet, even in a room that is not obviously cold. To prevent heat loss, it is necessary to dry up the baby and wrap the baby in a clean, dry cloth and to make sure the baby's head is covered.
2. **HUMIDITY:** Low relative humidity of a servo controlled incubator increases the temperature of the incubator itself and the oxygen consumption of premature infants accordingly. This causes an increase in the insensible water losses. In addition, premature infants with small weight or illnesses are susceptible to unfavorable incidents such as apneic spells. However, insensible water losses under radiant warmers are higher than conventional incubators. Apparently, small variations in relative humidity inside incubators with skin servo control do not influence the insensible water loss; however significant fluctuations in relative humidity would vary the amount of insensible water losses. Few investigations have shown that the body weight and insensible water loss is inversely proportional to the water loss. The humidity of the shell environment can negatively affect the patient if it is not at a healthy level. Infants can lose moisture and heat by evaporation if humidity is too low, while higher levels of humidity increase the likelihood for germs and bacteria to be present. The ability to control or at least monitor humidity is beneficial.
3. **LIGHT:** The physical environments of hospitals are critical to good patient care. High light levels (e.g. phototherapy) the lack of regular light/dark cycles may also adversely affect new born patients. The level of ambient light should be flexible to allow day-night cycling. The technique to control the jaundice in the neonates is also comprises of light

therapy. Phototherapy is the best solution to control the jaundice in the premature babies placed in baby incubators. Babies with jaundice will usually receive the treatment of phototherapy for 4 to 7 days. When ill infants with low birth weight receive phototherapy in incubators, their insensible water losses are significantly doubled or tripled. This is attributed to the heat source placed inside the incubator for the purpose of phototherapy. It may also be attributed to the delay in time until the effectiveness of phototherapeutic processes is reached. In a radiant heat warmer, the exposure to non-ionizing radiant energy causes several changes in infants who required phototherapy (such as, changes in body temperature, higher insensible water loss and fluid intakes). Although it can be necessary to use radiant heat warmer to nurse premature infants with low birth weight instead of incubators, this causes an increase of insensible water losses. Thus, the smaller the infant (small body weight) the higher the insensible water losses and the fluid intakes accordingly.

4. **OXYGEN:** Oxygenation is a therapeutic process in which oxygen is administered directly to facilitate breathing. If a baby born more than two months early, her breathing difficulties can cause serious health problems because other immature organs in her body may not get enough oxygen. Ventilation is necessary to provide the patient with fresh air and sufficient oxygen. Flowing air is also necessary to provide sufficient transfer of heat from the heat source to the shell environment and the patient. The ventilation needs to be carefully managed so that there is enough fresh air and convective heat transfer over the heat exchanger, but the flow is not so fast that it makes the patient uncomfortable and causes an increase in heat loss of the incubation system to the outside environment. Incubator oxygen treatments have been used to prevent new-born respiratory distress. The oxygen concentration of inhalation is fixed at a rather high level to improve the distress and the anoxia, while the arterial oxygen partial pressure PaO2 of new-born infants sometimes becomes extremely high and brings about retrolental fibroplasia in the worst case. It is hence desired that the oxygen pressure of inspired gas in an incubator should be adjusted adequately in accordance with the monitored PaO2 output.

CHAPTER-2

DESCRIPTION OF BLOCK DIAGRAM

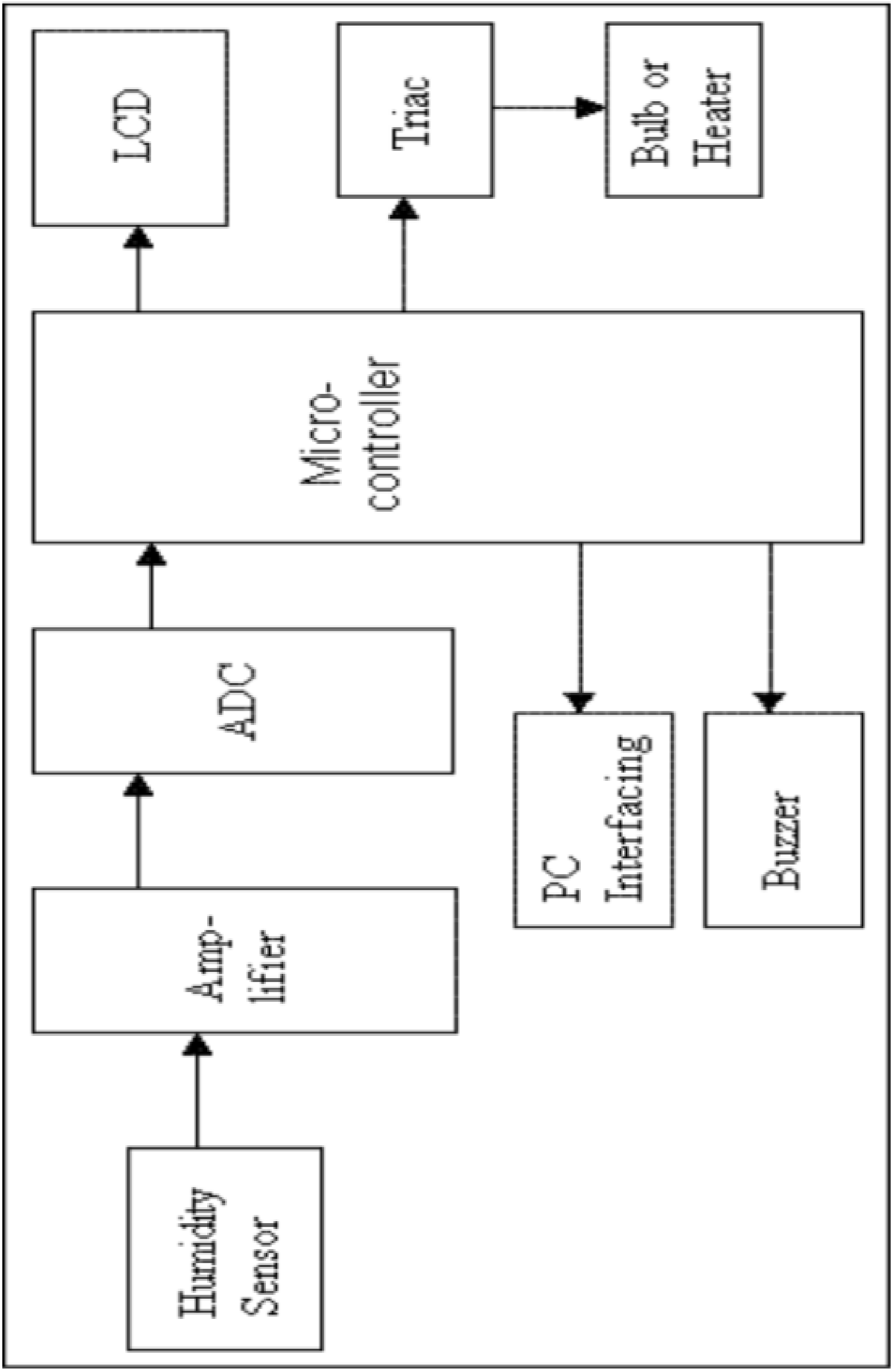

Fig1. Block diagram of infant incubator

Description of block diagram in detail:

It mainly consists of following blocks:

Micro-controller board: It is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash Programmable and Erasable Read Only Memory EPROM). The device is manufactured using Atmel s high-density nonvolatile memory technology and is compatible with the MCS-51. Instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, it provides a highly flexible and cost effective solution so many embedded control applications. Humidity Sensor Block: The Humidity sensed by using Humidity Sensor. The output voltage of Humidity Sensor varies in linear proportion with the Humidity. The humidity sensor used in this project is SY-HS-220, it provides analog dc output as per the humidity. The output of the Humidity sensor is fed to a ADC0804. DS1820 is used here to measure the temperature. It is a 1wire temperature sensor. It have inbuilt ADC. Humidity sensor should provide humidity level in the incubator in terms of relative humidity (%RH) in the range of 0-100%RH. The humidity sensor chosen for the present work is DHT11. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology is to ensure that the product has high reliability and excellent long term stability. The sensor includes a resistive sense of wet components and an NTC temperature measurement device, and connected with a high-performance 8-bit microcontroller. DHT11 uses a simplified single-bus communication. Single bus that only one data line, the system of data exchange, control by a single bus to complete.

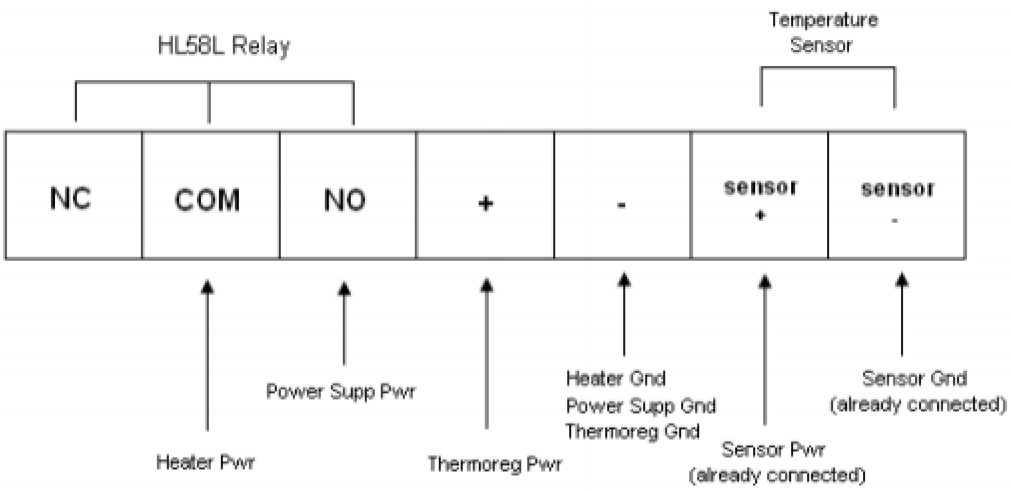

Fig2. Electronics set-up for the digital temperature sensor to the heater, fans, and temperature sensor

ADC Block: ADC means analog to digital converter. The output of signal conditioning is in the analog form. But Microprocessor requires input in digital form for this purpose we have to use ADC.

Amplifier Block: Output signal from micro-controller 89C51 is weak so we have to amplify that signal. Amplifier block amplifies the signal for driving the final control element i.e. output device. For amplification, Transistor BC 547 is used.

Output Block: In this project we are using FAN and Soldering Gun as output device. If Humidity is below the set point then Soldering gun is ON and Humidity will start to increase and when Humidity is above the set point then Fan is ON so that Humidity will start to decrease.

Display Block: In this project, we are using 16 X 2 intelligent LCD display to display the college name, Humidity set point and very important is Humidity of baby incubator

Operation:

Incubators are attracting interest from the medical profession. They are glass and metal cases heated to certain Humidity, into which enough air is admitted to maintain life. Until such time as an infant is strong enough for Humidity of room. In baby incubator, Humidity control is very important. And therefore we are controlling the Humidity according to our requirements. Humidity controller can be done by using Electronic circuit, Microprocessor & microcontroller. There are 3 switches (Mode, Increment and Decrement). One switch is for mode selection, second and third switch is for the increment and decrement of the range of temperature and humidity for setting value in the incubator. The system continuously displays the Humidity, body temperature, water Chamber temperature on the LCD display. If the incubator goes hot above the predefined value then the fan is switched ON. If the incubator temperature goes very cold then the Bulb is switched ON. If the humidity is increased then the Water heater is switched ON until the temperature reaches the desired value. All the values can be changed at any time and they are stored in the EEPROM chip. EEPROM chip is an electrically erasable and programmable read only memory which is used for storing the values continuously.

Steps involved in incubator working

- Light bulbs heat the air in the bottom part of the incubator.
- The air passes over a container with evaporating water, so that its humidity increases.
- The warm, humid air then flows upwards (chimney effect) into the baby compartment.
- A thermostat in an exit hole compares the air temperature with the desired temperature.
- If it is too high, the light bulbs will be switched off.

• If it is too low, the bulb will be switched on.

• The baby can be viewed through plexiglass and it can be handled via two armholes with sleeves.

• The plexiglass front and top can be hinged back for full access.

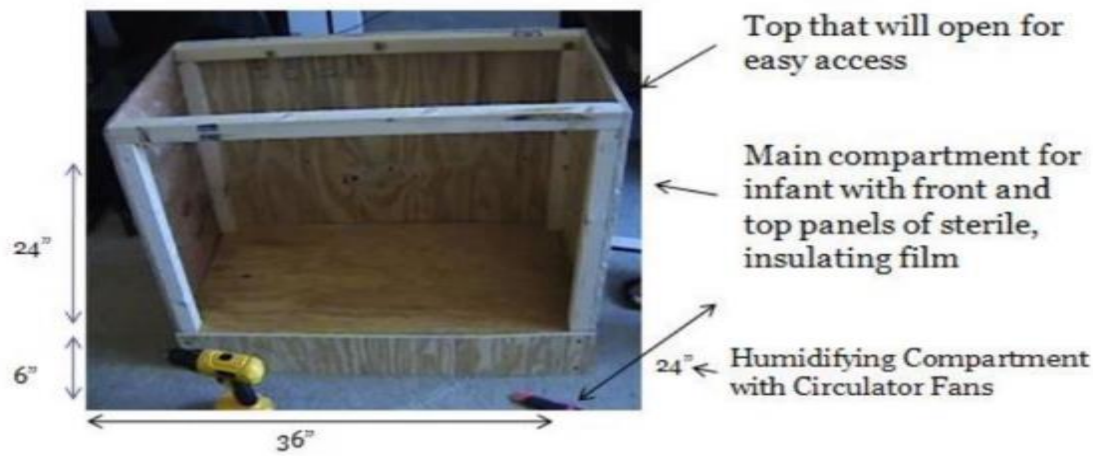

Fig3. Wooden chamber

Digital temperature controller allows a range of –20 to 100˚C. Since for this project, we want to maintain air temperature that is about that of body temperature, we will be using the upper end of this spectrum, and can be accurate to within 0.1˚C. In particular, we will maintain a temperature between 36 and 37.5˚C, as found in literature. For air circulation in our incubator, we believe that using old PC fans may be more cost efficient and locally available than other solutions. This is because the turnover rate for computers is extremely high, and there is an abundance of old computers that still contain perfectly working parts. As an additional plus, PC fans to not consume an excess of power, they run off 12 V. The worst-case scenario was also considered, in which ambient temperatures can reach as low as 15 °C. Studies at different temperatures and humidity are ongoing operating the incubator at lower ambient temperatures can be easily achieved with larger batteries that will be able to provide enough power for this application. Alternatively, increasing the number of batteries or using recharging methods such as solar power are possible.

A heat load of 43 W was supplied to the incubator to simulate many parts of the world where summer temperatures can regularly exceed 42 °C. It should be noted that our tests were conducted at 90% humidity, which is an unfavorable condition and worst-case scenario for evaporative cooling. The heat pipe–coupled clay pot was able to lower the incubator temperature by 3.5 °C. A temperature gradient within the incubator and limitations in heat transfer between the incubator and the clay pot cause this decrease to be smaller than what the clay pot could theoretically provide. Therefore, improving the heat transfer between the pot and the incubator would improve the overall efficiency of the cooling system. Perhaps the most obvious function of an infant incubator is to protect infants during the earliest stage of life, when they're most vulnerable. As fully enclosed and controllable environments, incubators can be used to protect babies from a wide range of possible dangers, according to "The Pearson General Studies Manual 2009" by Thorpe and Edgar Thorpe. Incubators are fully temperature controlled, shielding infants from harmful cold, and they provide insulation from outside noise, making it easier for them to get plenty of comfortable rest.

Incubator environments can be kept sterile, protecting infants from germs and minimizing the risk of infection. The enclosure also keeps out all airborne irritants like dust and other allergens. The cradle of the incubator is a roomy and comfortable surface, so it's possible to leave the infant in place while many examinations and even simple medical procedures are administered. This protects infants from too much handling, which can be a concern in the case of some premature births. The thermal bank effectively acts as a thermal buffer that helps keep the temperature within ±0.5 °C, instead of using a more expensive servo controller. To set the minimum temperature (the minimum temperature that should be maintained in the incubator), flip the switch and adjust until you see the desired temperature (for the incubator should be around 36˚C). To set the maximum temperature (the maximum temperature that should be maintained in the incubator), flip the switch and adjust until you see the desired temperature (for the incubator should be around 37.5˚C).

CHAPTER-3

MICROCONTROLLER BOARD

MICROCONTROLLER BOARD:

A microcontroller (MCU for microcontroller unit) is a small computer on a single metal-oxide-semiconductor (MOS) integrated circuit chip. In modern terminology, it is similar to, but less sophisticated than, a system on a chip (SoC); an SoC may include a microcontroller as one of its components. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

In the context of the internet of things, microcontrollers are an economical and popular means of data collection, sensing and actuating the physical world as edge devices. Some microcontrollers may use four-bit words and operate at frequencies as low as 4 kHz, for low power consumption (single-digit milliwatts or microwatts). They generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nano watts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption. The Specifications of Microcontroller Boards are bus type, processor type, memory, number of ports, port type, and operating system. These are used to evaluate programs for embedded devices such as different controllers, home appliances, robots, point-of-sale (PoS) terminals, kiosks and information appliances. Here, we will discuss on the characteristic between different development boards around the world. Each one of these has their own features as well as some drawbacks, and some development platforms are prominent for certain projects than others.

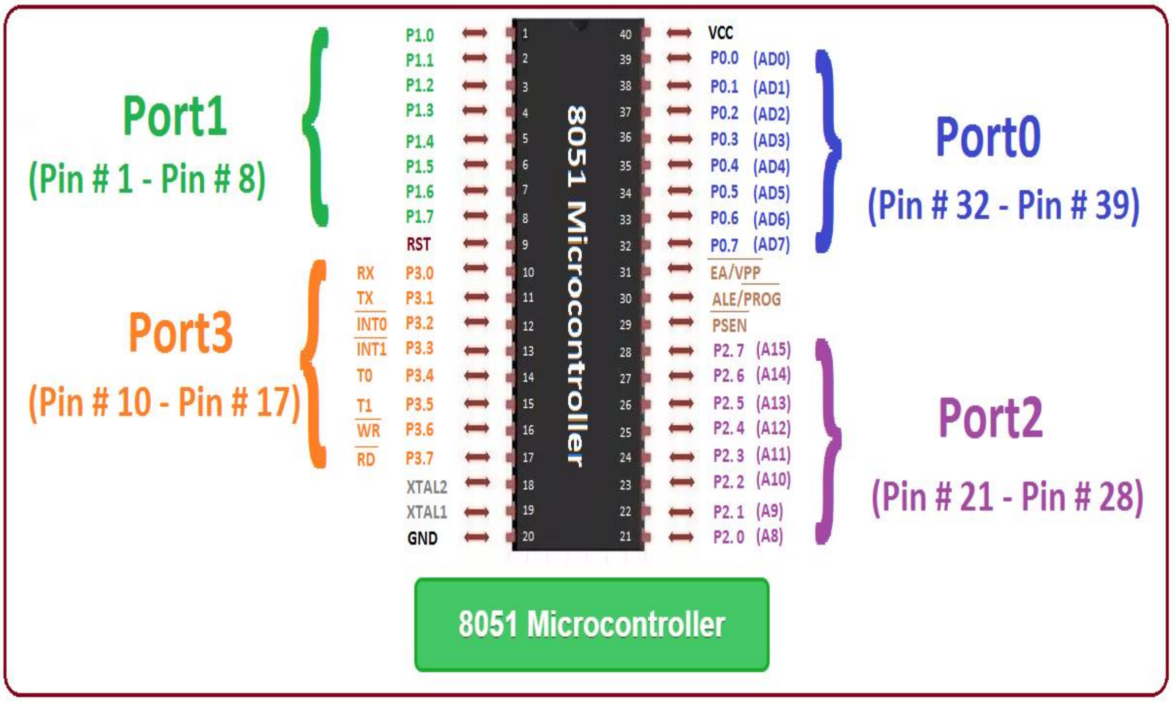

Fig4. 8051 microcontroller pin diagram

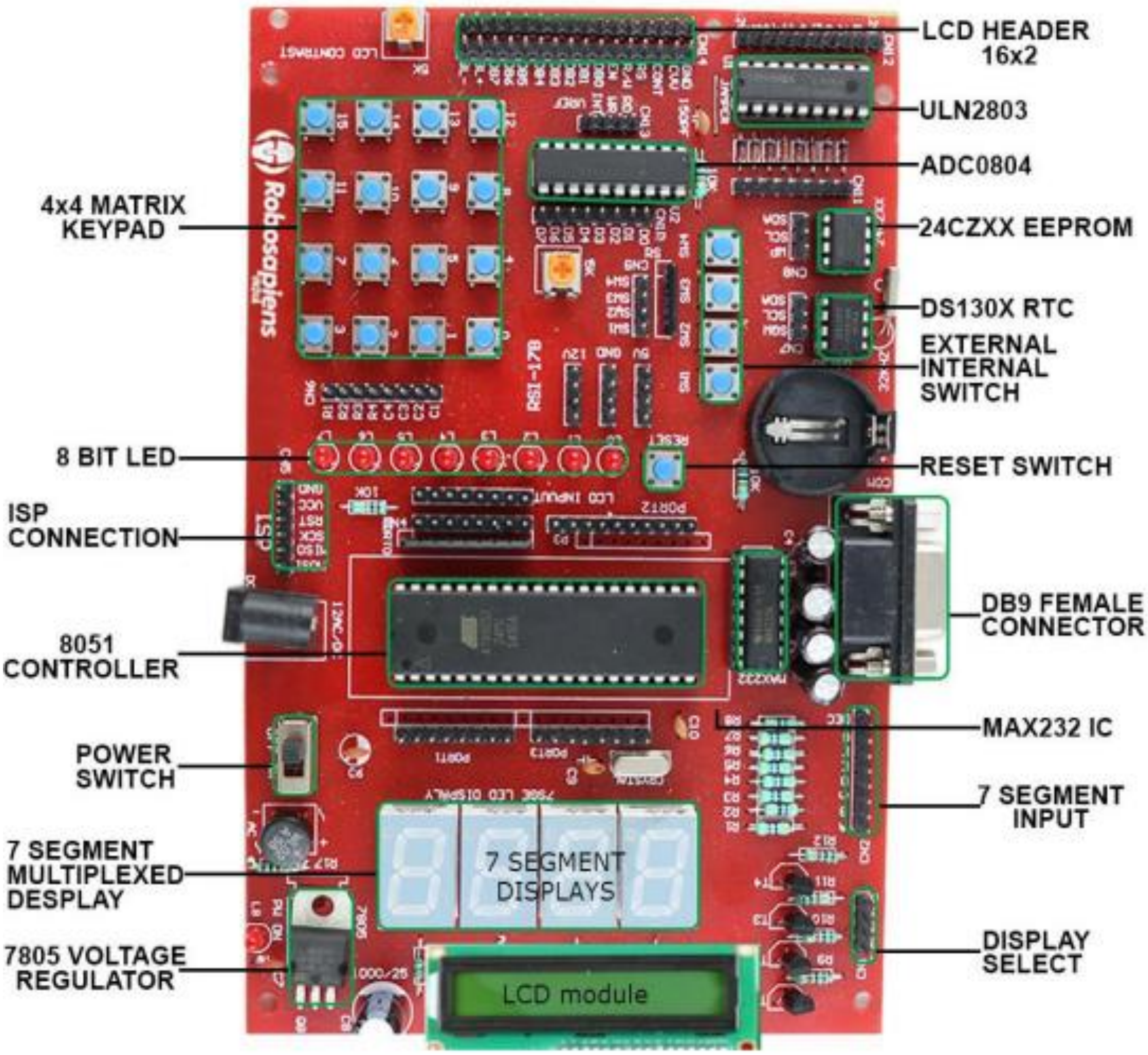

Fig5. MCS51 module

It is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash Programmable and Erasable Read Only Memory EPROM). The device is manufactured using Atmel s high-density non-volatile memory technology and is compatible with the MCS51. Instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, it provides a highly flexible and cost effective solution so many embedded control applications.

CHAPTER-4

DETAILED DESCRIPTION OF BLOCKS

The components which are used in the project have been explained in the following sections:

SENSORS

Different types of sensors to be used for designing of the system are:

1. Temperature sensor
2. Humidity sensor

TEMPERATURE SENSOR:

We are requiring two temperature sensors for the temperature measurement are given below:

• Temperature Sensor (T1) for measurement of body temperature of an infant in the range of 28 ºC-38ºC.

• Temperature Sensor (T2) for measurement of temperature of water reservoir for humidity control should be within range of 42ºC-45ºC.

TEMPERATURE SENSOR DS18B20:

The DS18B20 Digital Thermometer provides 9 to 12–bit centigrade temperature measurements and has an alarm function with non-volatile user-programmable upper and lower trigger points as shown in Fig. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. It has an operating temperature range of –55°C to +125°C and is accurate to ±0.5°C over the range of –10°C to +85°C. In addition, the DS18B20 can derive power directly from the data line (“parasite power”), eliminating the need for an external power supply. Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1–wire bus; thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment or machinery, and process monitoring and control systems.

Fig6. DS18B20 Pinout

TEMPERATURE SENSOR LM35

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Fahrenheit temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in degrees Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Fahrenheit scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1.2°F at room temperature and ±11.2°F over a full -50 to +300°F temperature range. The LM35 is rated to operate over a -50° to +300°F temperature range. The circuitry is explained in Fig. It is easy to include the LM35 series in a temperature measuring application. The output voltage of LM35is linearly proportional to the Fahrenheit temperature, it has a Linear +10.0 mV/°F scale factor which means that you will get n*10.0 mV output voltage if the environment temperature is n°F. +5V GND GND OUTPUT LM35

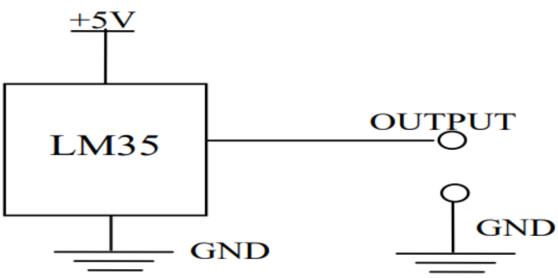

Fig7. Circuit diagram for the LM35 temperature sensor

TEMPERATURE AND HUMIDITY SENSOR (DHT-11)

A humidity sensor senses, measures and regularly reports the relative humidity in the air. It measures both moisture and air temperature. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold. The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature.

Humidity sensors detect the relative humidity of the immediate environments in which they are placed. They measure both the moisture and temperature in the air and express relative humidity as a percentage of the ratio of moisture in the air to the maximum amount that can be held in the air at the current temperature. As air becomes hotter, it holds more moisture, so the relative humidity changes with the temperature.

Most humidity sensors use capacitive measurement to determine the amount of moisture in the air. This type of measurement relies on two electrical conductors with a non-conductive polymer film laying between them to create an electrical field between them. Moisture from the air collects on the film and causes changes in the voltage levels between the two plates. This change is then converted into a digital measurement of the air’s relative humidity after taking the air temperature into account.

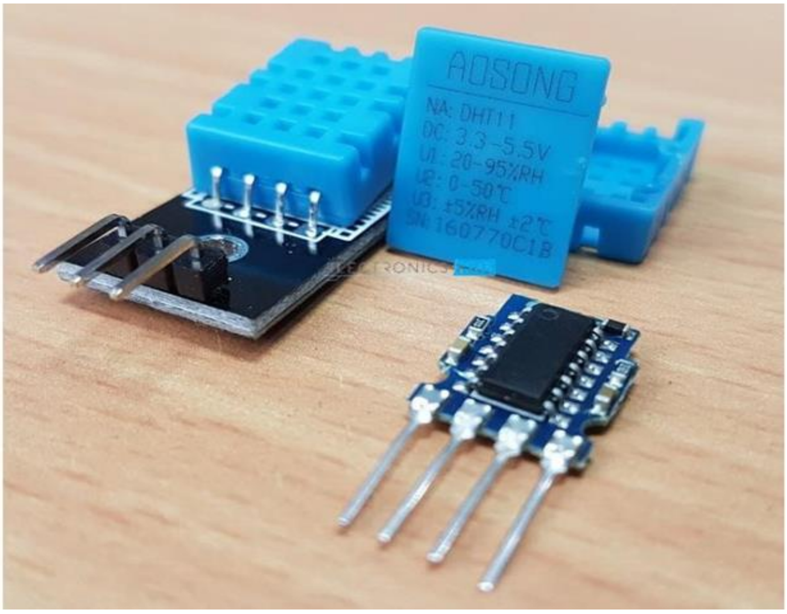

Fig8. DHT 11 sensor

The percentage of water present in the air is termed as humidity. Water as gaseous state is called vapor. As the temperature of the air increases more water vapor can be generate.

Humidity measurement in industries is critical because it may affect the business cost of the product and the health and safety of the personnel. So, its huge importance of humidity sensor is very important, especially in the control systems for industrial processes like chemical gas purification, dryers, ovens, film desiccation, paper and textile production, and food processing. In agriculture, measurement of humidity is important for plantation protection (green house), soil moisture monitoring, etc.

HUMIDITY SENSOR:

Humidity sensor should provide humidity level in the incubator in terms of relative humidity (%RH) in the range of 0- 100%RH. The humidity sensor chosen for the present work is DHT11.

HUMIDITY SENSOR BLOCK:

The Humidity sensed by using Humidity Sensor. The output voltage of Humidity Sensor varies in linear proportion with the Humidity. A humidity sensor (or hygrometer) senses, measures and reports both moisture and air temperature. The ratio of moisture in the air to the highest amount of moisture at a particular air temperature is called relative humidity. Humidity sensors work by detecting changes that alter electrical currents or temperature in the air.

There are three basic types of humidity sensors:

• Capacitive

• Resistive

• Thermal

All three types of sensors monitor minute changes in the atmosphere in order to calculate the humidity in the air.

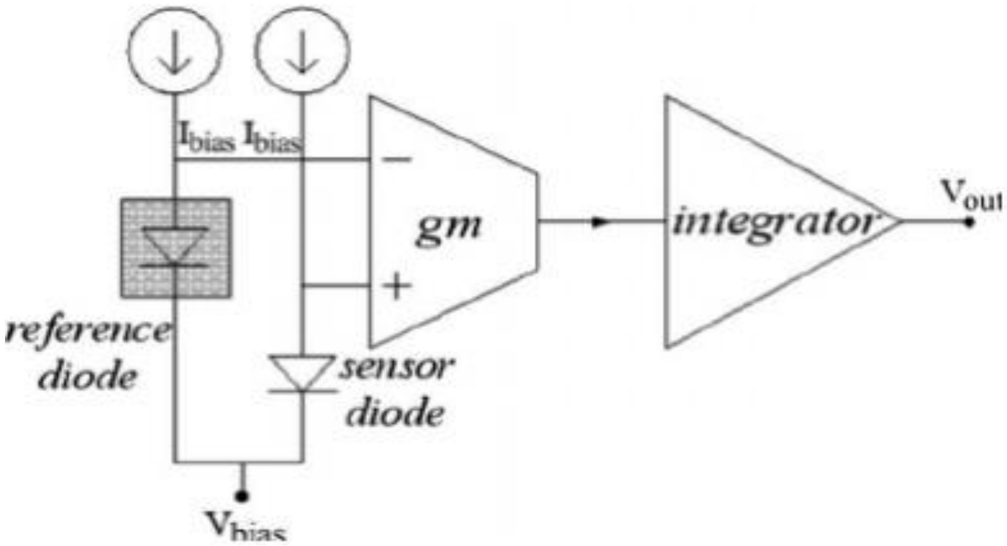

Fig9. Block diagram of humidity sensor

TYPES OF HUMIDITY

1. Relative Humidity = (density of water vapor / density of water vapor at saturation) x 100%

2. Absolute=Mass (vapour) / volume. Unit-grams/m3
3. Specific: Mass (vapour) / total mass.
4. Dew Point: Temperature(above 0°C) at which the water vapor in a gas condenses to liquid water)
5. Frost POINT: Temperature(below 0°C) at which water vapor in a gas condenses to ice

Thus for Humidity measurement- Relative Humidity (RH), Dew/Frost point (D/F PT) and Parts Per Million (PPM) are used. RH is a function of temperature, and thus it is a relative measurement while Dew/Frost point is a function of the pressure of the gas but is independent of temperature and is defined as absolute humidity measurement. PPM is also an absolute measurement.

Most humidity sensors use capacitive measurement to determine the amount of moisture in the air. This type of measurement relies on two electrical conductors with a non-conductive polymer film laying between them to create an electrical field between them. Moisture from the air collects on the film and causes changes in the voltage levels between the two plates. This change is then converted into a digital measurement of the air's relative humidity after taking the air temperature into account.

The DHT11 calculates relative humidity by measuring the electrical resistance between two electrodes. The humidity sensing component of the DHT11 is a moisture holding substrate with the electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes while lower relative humidity increases the resistance between the electrodes.

The DHT11 converts the resistance measurement to relative humidity on a chip mounted to the back of the unit and transmits the humidity and temperature readings directly to the Arduino UNO.

HUMIDITY SENSOR SHT11:

SHT11 is a single chip relative humidity sensor module comprising a calibrated digital output. The device includes a capacitive polymer sensing element for relative humidity and coupled to a 14bit ADC and a serial interface circuit on the same chip. This results in high signal quality, a fast response time and insensitivity to external disturbances (EMC). Each SHT11 is individually calibrated and calibration coefficients are programmed into the OTP memory.

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Fig10. SHT11 component

ABOUT DHT11

DHT11 is a part of DHTXX series of Humidity sensors. The other sensor in this series is DHT22. Both these sensors are Relative Humidity (RH) Sensor. As a result, they will measure both the humidity and temperature. Although DHT11 Humidity Sensors are cheap and slow, they are very popular among hobbyists and beginners.

The DHT11 Humidity and Temperature Sensor consists of 3 main components.

1. A resistive type humidity sensor
2. An NTC (negative temperature coefficient) thermistor (to measure the temperature)
3. An 8-bit microcontroller, which converts the analog signals from both the sensors and sends out single digital signal.

This digital signal can be read by any microcontroller or microprocessor for further analysis. DHT11 Humidity Sensor consists of 4 pins: VCC, Data Out, Not Connected (NC) and GND. The range of voltage for VCC pin is 3.5V to 5.5V. A 5V supply would do fine. The data from the Data Out pin is a serial digital data. The figure shows a typical application circuit for DHT11 Humidity and Temperature Sensor. DHT11 Sensor can measure a humidity value in the range of 20 – 90% of Relative Humidity (RH) and a temperature in the range of 0 – 50^0C. The sampling period of the sensor is 1 second.

All the DHT11 Sensors are accurately calibrated in the laboratory and the results are stored in the memory. A single wire communication can be established between any microcontroller like MCS051 and the DHT11 Sensor.

Also, the length of the cable can be as long as 20 meters. The data from the sensor consists of integral and decimal parts for both Relative Humidity (RH) and temperature.

Parameter	Min.	Typical	Max.	Unit
Accuracy (25℃)	-	±4	-	%RH
Accuracy (0-50℃)	-	-	±5	%RH
Measurement range (25℃)	20	-	95	%RH
Response time: 1/e（63%）25℃，1m/s air	6	10	15	s

TABLE1: DHT 11 Humidity specifications

Parameter	Min.	Typical	Max.	Unit
Accuracy	±1	-	±2	℃
Measurement range	0	-	50	℃
Response time /e（63%）	6		30	s

TABLE2: DHT 11 Temperature specifications

Temperature Resolution:

1. 16Bit Repeatability: ±0.2℃
2. Range: At 25℃ ±2℃
3. Response time: 1 / e (63%) 10S
4. Electrical Characteristics
5. Power supply: DC 3.5～5.5V
6. Supply Current: measurement 0.3mA standby 60µA
7. Sampling period: more than 2 seconds

DHT-11 Pin Description:

1. VDD power supply 3.5～5.5V DC
2. DATA serial data, a single bus
3. NC, empty pin
4. GND ground, the negative power

ANALOG TO DIGITAL CONVERTER:

In electronics, an analog-to-digital converter is a system that converts an analog signal, such as a sound picked up by a microphone or light entering a digital camera, into a digital signal. An ADC may also provide an isolated measurement such as an electronic device that converts an input analog voltage or current to a digital number representing the magnitude of the voltage or current. Typically the digital output is a two's complement binary number that is proportional to the input, but there are other possibilities The output of signal conditioning is in the analog form. But Microprocessor requires input in digital form for this purpose we have to use ADC.

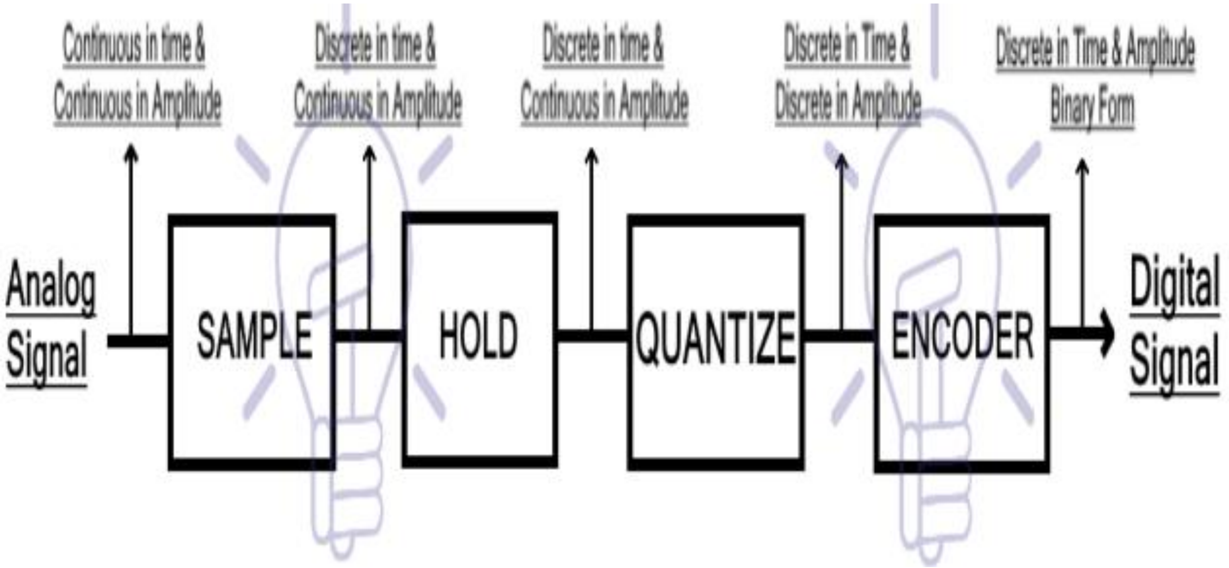

Fig11. Analog to digital convertor

AMPLIFIER BLOCK:

Output signal from micro-controller 89C51 is weak so we have to amplify that signal. Amplifier block amplifies the signal for driving the final control element i.e. output device. For amplification, Transistor BC 547 is used.

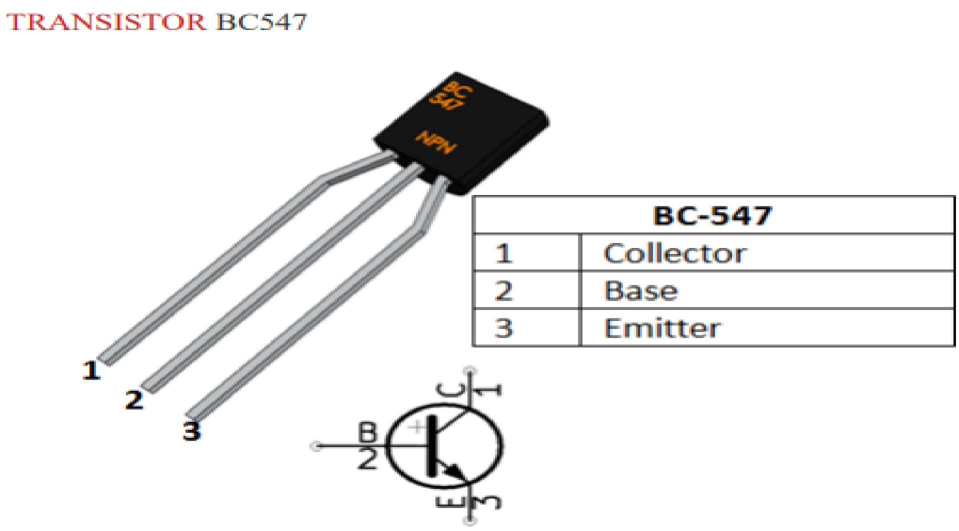

Fig12. Transistor BC547

BC547 Transistor Features

• Bi-Polar NPN Transistor

• DC Current Gain (hFE) is 800 maximum

• Continuous Collector current (IC) is 100mA

• Emitter Base Voltage (VBE) is 6V

• Base Current(IB) is 5mA maximum

Output Block:

It is a box made of cardboard and is divided into two sections as shown in the picture. First part of the box will be used to keep the baby while the part will consist of a fan and heating element. In this project we are using FAN and Soldering Gun as output device. If Humidity is below the set point then soldering gun(heating element) and fan are switched is ON and Humidity will start to increase . When Humidity is above the set point then Fan is ON so that Humidity will start to decrease. If temperature is below the set point then soldering gun(heating element) is switched is ON and temperature will start to increase . In this project, we are using 16 X 2 intelligent LCD display to display the college name, Humidity set point and very important is Humidity of baby incubator.

Fig13. Cartoon block

The 16×2 LCD pinout is shown below.

• Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.

• Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.

• Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.

• Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).

• Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).

• Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.

• Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.

• Pin15 (+ve pin of the LED): This pin is connected to +5V • Pin 16 (-ve pin of the LED): This pin is connected to GND.

Fig14. 16 X 2 LCD pin out

CHAPTER-5

MICROPROCESSOR CODING PROGRAM

MICROCONTROLLER PROGRAM

```
LCDdatabus              EQU     0A0h     ;LCD Data Bus   P0
LCDrs                   EQU     0A2h     ;LCD RS         P2.7
LCDen                   EQU     0A3h     ;LCD EN         P2.6

ADC_data_bus            equ     90h             ; Port 1
ADC_add_a               equ     80h             ; P0.0
ADC_add_b               equ     0B5h            ; P3.5
ADC_ale_soc             equ     B3h             ; P3.3
ADC_eoc                 equ     B4h             ; P3.4
ADC_oe                  equ     B2h             ; P3.2

Relay_temp      equ     85h
Relay_humid     equ     86h
Buzzer          equ     87h

;=============================================================================
LCD_Reg                 EQU     43h
LCDtempReg              EQU     34h
Reg_LCD_swap1           EQU     35h
Reg_LCD_swap2           EQU     36h

ADC_op_temp             EQU     30h             ;channel 0
ADC_op_humidity         EQU     31h             ;channel 1

loopcntr                EQU     54h

Hex2asc_R0              EQU     55h
Hex2asc_R1              EQU     56h
Hex2asc_R2              EQU     57h
Hex2asc_R3              EQU     58h

LCD_cursor_R1           EQU     5Ah
LCD_cursor_R2           EQU     5Bh
LCD_cursor_R3           EQU     5Ch

;=============================================================================
                org 0000h
                call init
loop:
                call ADC_temp
                call ADC_humidity

                call disp_THLM

                call check_temp
                call check_humidity

                jmp loop
;=============================================================================
check_temp:
                mov a,ADC_op_temp

                subb a,#33
                jc chk_low_temp
                setb Relay_temp
                ret
chk_low_temp:
                clr Relay_temp
                ret
;=============================================================================
```

```
check_humidity:
                mov a,ADC_op_humidity

                subb a,#50
                jc chk_low_humid
                setb Relay_humid
                ret
chk_low_humid:
                clr Relay_humid
                ret
;============================================================================
ADC_temp:       clr ADC_add_a          ; Channel 0 is ie Temp is selected
                clr ADC_add_b           ;Add b = 0, Add a = 0

                setb ADC_ale_soc        ;ale & soc is made high




                clr ADC_ale_soc         ;ale &  socis made low
                jb ADC_eoc,$           ;check for eoc
                setb ADC_oe             ;if eoc high,make oe high



                mov a,ADC_data_bus      ;Read port0 data to accumulator
                mov ADC_op_temp,a       ;Copy data in Register for further
processing
                clr ADC_oe              ;make oe low

                ret
;=========================================================================
ADC_humidity:   clr ADC_add_a          ; Channel 1 is ie humidity is selected
                setb ADC_add_b           ;Add b = 0, Add a = 1

                setb ADC_ale_soc        ;ale & soc is made high




                clr ADC_ale_soc         ;ale &  socis made low
                jb ADC_eoc,$           ;check for eoc
                setb ADC_oe             ;if eoc high,make oe high



                mov a,ADC_data_bus      ;Read port0 data to accumulator
                mov ADC_op_humidity,a   ;Copy it in Register for further
processing
                clr ADC_oe              ;make oe low

                ret
;=========================================================================
disp_THLM:
                mov scon,#50h
                mov tmod,#21h
                mov th1,#f4h
                mov tl1,#f4h
                setb tr1

                mov a,#'T'
                mov sbuf,a
                jnb ti,$
```

```
mov a,#'E'
mov sbuf,a
jnb ti,$


mov a,#'M'
mov sbuf,a
jnb ti,$


mov a,#'P'
mov sbuf,a
jnb ti,$


mov a,#'='
mov sbuf,a
jnb ti,$


mov LCD_cursor_R1,#82h
mov LCD_cursor_R2,#83h
mov LCD_cursor_R3,#84h
mov Hex2asc_R0,ADC_op_temp
call disp_Hex2asc

mov a,#dfh
mov sbuf,a
jnb ti,$


mov a,#'C'
mov sbuf,a
jnb ti,$


mov a,#' '
mov sbuf,a
jnb ti,$


mov a,#' '
mov sbuf,a
jnb ti,$


mov a,#' '
mov sbuf,a
jnb ti,$



mov a,#'H'
mov sbuf,a
jnb ti,$


mov a,#'U'
mov sbuf,a
jnb ti,$


mov a,#'M'
mov sbuf,a
jnb ti,$
```

```
                mov a,#'I'
                mov sbuf,a
                jnb ti,$


                mov a,#'D'
                mov sbuf,a
                jnb ti,$


                mov a,#'I'
                mov sbuf,a
                jnb ti,$


                mov a,#'T'
                mov sbuf,a
                jnb ti,$


                mov a,#'Y'
                mov sbuf,a
                jnb ti,$


                mov a,#'='
                mov sbuf,a
                jnb ti,$


                mov LCD_cursor_R1,#8Ah
                mov LCD_cursor_R2,#8Bh
                mov LCD_cursor_R3,#8Ch
                mov Hex2asc_R0,ADC_op_humidity
                call disp_Hex2asc

                mov a,#'%'
                mov sbuf,a
                jnb ti,$


                mov a,#'R'
                mov sbuf,a
                jnb ti,$


                mov a,#'H'
                mov sbuf,a
                jnb ti,$
                ret
;==========================================================================
disp_Hex2asc:   mov a,Hex2asc_R0
                mov b,#100
                div ab
                mov Hex2asc_R1,a

                mov a,b
                mov b,#10
                div ab
                mov Hex2asc_R2,a
                mov a,b
                mov Hex2asc_R3,a
```

```
		mov LCDtempReg,LCD_cursor_R1
		call LCDcmd
		mov LCDtempReg,Hex2asc_R1
		call LCDdata

		mov LCDtempReg,LCD_cursor_R2
		call LCDcmd
		mov LCDtempReg,Hex2asc_R2
		call LCDdata

		mov LCDtempReg,LCD_cursor_R3
		call LCDcmd
		mov LCDtempReg,Hex2asc_R3
		call LCDdata

		mov a,Hex2asc_R1
		mov sbuf,a
		jnb ti,$


		mov a,Hex2asc_R2
		mov sbuf,a
		jnb ti,$


		mov a,Hex2asc_R3
		mov sbuf,a
		jnb ti,$

		ret
;==========================================================================
init:
		clr 01h

		mov scon,#50h
		mov tmod,#21h
		mov th1,#f4h
		mov tl1,#f4h
		setb tr1

		call LCDinit_4bit

		mov dptr,#msgwelcome
		call LCDdisp

		clr Relay_temp
		clr Relay_humid

		call pc_int
		call delay2sec

		mov dptr,#LCDdispval
		call LCDdisp

		clr Relay_temp
		clr Relay_humid

		ret
;=============================================================================
LCDinit_4bit:
		call delayhalf
		mov LCDtempReg,#02h
		call LCDcmd
		mov LCDtempReg,#28h
		call LCDcmd
```

```
                mov LCDtempReg,#0Ch
                call LCDcmd
                mov LCDtempReg,#06h
                call LCDcmd
                mov LCDtempReg,#01h
                call LCDcmd
                ret
;=========================================================================
LCDcmd:
                mov Reg_LCD_swap1,LCDtempReg

                mov Reg_LCD_swap2,Reg_LCD_swap1

                mov a,Reg_LCD_swap2
                anl a,#F0H
                mov LCDdatabus,a

                clr LCDrs
                setb LCDen


                clr LCDen
                call LCDdelay

                mov a,Reg_LCD_swap2
                swap a
                anl a,#F0H
                mov LCDdatabus,a

                clr LCDrs
                setb LCDen


                clr LCDen
                call LCDdelay

                ret
;=========================================================================
LCDdata:
                mov Reg_LCD_swap1,LCDtempReg

                mov Reg_LCD_swap2,Reg_LCD_swap1

                mov a,Reg_LCD_swap2
                anl a,#F0H
                mov LCDdatabus,a

                setb LCDrs
                setb LCDen


                clr LCDen
                call LCDdelay

                mov a,Reg_LCD_swap2
                swap a
                anl a,#F0H
                mov LCDdatabus,a


                setb LCDrs
                setb LCDen


                clr LCDen
```

```
                call LCDdelay

                ret
;==========================================================================
delayhalf:      mov 30H,#05
delayhalf1:     mov 31H,#200
delayhalf2:     mov 32H,#250
                djnz 30H,$
                djnz 31H,delayhalf2
                djnz 32H,delayhalf1
                ret
;=============================================================================
LCDdelay        mov 30H,#08             ;LCD
LCDdelay1       mov 31H,#250
                djnz 30H,$
                djnz 31H,LCDdelay1
                ret
;==========================================================================
LCDdisp         mov LCD_Reg,#00h
LCDdisp2        mov a,LCD_Reg
                movc a,@a+dptr
                cjne a,#'@',LCDdisp1
                mov LCDtempReg,#c0h
                call LCDcmd
                jmp LCDdisp2
LCDdisp1        cjne a,#'$',LCDdisp3
                ret
LCDdisp3        mov LCDtempReg,a
                call LCDdata
                inc LCD_Reg
                jmp LCDdisp2
;==========================================================================
delay1sec:      call delayhalf
                call delayhalf
                ret
;==========================================================================
delay2sec       call delayhalf
                call delayhalf
                call delayhalf
                call delayhalf
                ret
;=========================================================================
;       PC INTERFACING
;=========================================================================
pc_int:         mov scon,#50h
                mov tmod,#21h
                mov th1,#f4h
                mov tl1,#f4h
                mov LCD_Reg,#00h
                setb tr1

pc_int2         mov a,LCD_Reg
                movc a,@a+dptr
                cjne a,#'@',pc_int1

                mov a,#' '
                mov sbuf,a
                jnb ti,$


                inc LCD_Reg
                jmp pc_int2

pc_int1         cjne a,#'$',pc_int3
                mov tmod,#11h
```

```
                ret

pc_int3         mov sbuf,a
                jnb ti,$

                inc LCD_Reg
                jmp pc_int2
;==========================================================================
LCDdispval              DB "T=   ",dfh,"c H=   %RH"
;==========================================================================
                END
```

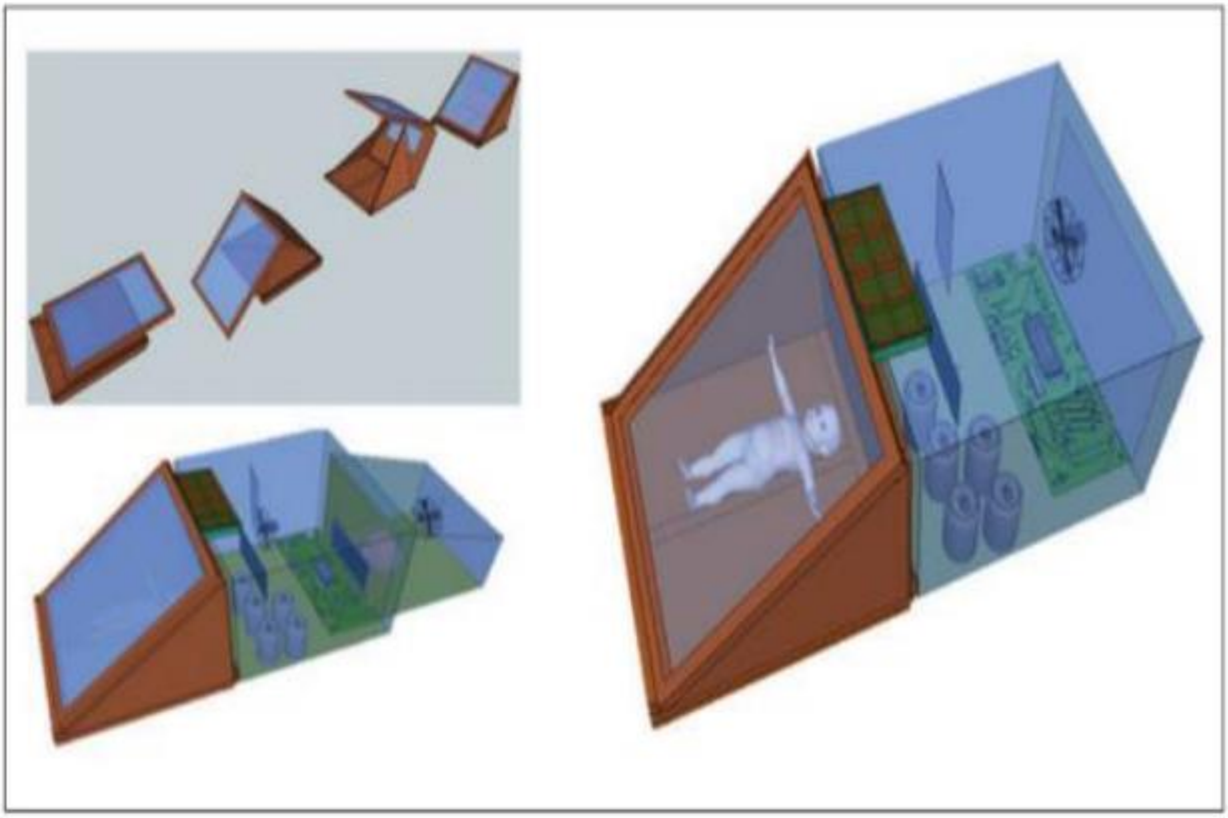

Fig.15 Infant incubator model

PREPARATIONS BEFORE USE

There are many things that are to be kept in mind before using the baby incubator. Incubator is pre warmed to a temperature appropriate to the infant's age size and condition. One must check and record the incubator temperature hourly. Incubator must be positioned away from direct sunlight as it is harmful for the baby.

Applications and Advantages:

1) This project can be used in Hospitals.
2) Our project is used for warming babies. It is used for warming premature baby and weak babies
3) It can be easily understood and used by layman

Future Development:

1) We can monitor more parameters like oxygen level and at the same time control them
2) We can send this data to a remote location using mobile or Internet
3) We can draw graphs of variations in these parameters using computer.

CONCLUSION

Variation of Incubator's temperature with respect to Time:

Using DS18B20 we find that time Response is really fast as 1±1 sec (We have put a delay of 1 sec in a complete loop to match the LCD responses).Otherwise if we increase the delay of the loop then there will be garbage value. If the temperature increases above the threshold level then Fan will ON and maintain the temperature of the device & if temperature decreases below the threshold value then the Bulb will be switched on to create the heat and again the temperature will reached to the threshold value. Threshold will be set manually by using Potentiometer.

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