

**DIY VENTILATOR USING ARDUINO WITH BLOOD
PRESSURE SENSOR IN COVID PANDAMIC**

Submitted in partial fulfillment of the requirements for the award
Of Bachelor of Engineering Degree in
Electronics and Communication Engineering

By

YARASU SURESH REDDY (38130244)



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

School of Electrical and Electronics

Department of Electronics and Communication Engineering

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

MAY 2022



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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this project Report is the bonafide work of **YARASU SURESH REDDY (38130244)** Who carried out the project entitled “**DIY VENTILATOR USING ARDUINO WITH BLOOD PRESSURE SENSOR IN COVID PANDAMIC**” under our supervision from November 2021 to May 2022.

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DECLARATION

I am, YARASU SURESH REDDY (38130244) hereby declare that the Project Report entitled “**DIY VENTILATOR USING ARDUINO WITH BLOOD OXYGEN SENSING IN COVID PANDAMIC.**” done by me under the guidance of Mr. JEGAN ANTONY MARCILIN submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

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Yarasu Suresh Reddy

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ABSTRACT

This project describes overview of various research done on how human lungs used for respiration. They use push mechanism in each breath. Inhalation and exhalation process take place. The ventilator here we design is to help people during Covid Situation. It is very cheap and affordable. When people suffer from lungs or breathing problem this can be used for emergency situation. Motor mechanism is used to push the air bag. At the point when oxygen level counts are low this mechanism can be performed little screen is used to display. The oxygen levels. The entire system is driven by an Arduino microcontroller and a buzzer is fitted to detect any low levels of oxygen count.

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LIST OF ABBREVIATIONS

DIY	DO IT YOURSELF
PWM	PULSE WIDTH MODULATION
IDE	INTEGRATED DEVELOPMENT ENVIRONMENT
DTR	DEEP TENDON REFLEXES
AR	ANALOG REFERENCE
ICSP	IN CIRCUIT SERIAL PROGRAMMING
DHT	DIGITAL TEMPERATURE AND HUMIDITY
RPM	REVOLUTIONS PER MINUTE
MCU	MICROCONTROLLER UNIT
LCD	LIQUID CRYSTAL DISPLAY
RCA	ROOT CASE ANALYSIS
CRT	CATHODE RAY TECHNOLOGY
IPS	IN PLANE SWITCHING
VA	VERTICAL ALIGNMENT
AFFS	ADVANCED FRINGE FIELD SWITCHING
TFT	THIN FILM TRANSISTORS
CRO	CATHODE RAY TUBE
CRFL	COLD CATHODE FLUORESCENT LAMPS
LDR	LIGHT DEPENDENT RESISTOR

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CHAPTER - 1

INTRODUCTION

One significant gadget for which request has increase is ventilators for patients who need help with their breathing because of the respiratory impacts of COVID-19. Essentially a ventilator is a machine that gives breathable air into and out of the lungs, to convey breaths to a patient who is actually incapable to inhale or breathing inadequately. A DIY ventilator may not be effective as that of a medical grade ventilator yet it can go about as a decent substitute in the event that it has authority over the accompanying key boundaries. It is also combined with robust blood oxygen measuring sensor. Pulse oximetry might be utilized in both inpatient and outpatient settings. In some cases, your doctor may recommend that you have a pulse oximeter for home use. During a pulse oximetry perusing, a little clamp like device is set on a finger, earlobe, or toe. Little light emissions go through the blood in the finger, estimating the measure of oxygen. It does this by estimating changes of light absorption in oxygenated or deoxygenated blood. This is a painless process. Yet this reliable and affordable DIY ventilator during Covid pandemic times. After designing this model these models are distributed and, on the web, so that others can also use it and design their own ventilator, even at the small scale.

Coronavirus disease 2019 (COVID-19), caused by a novel coronavirus (SARS-CoV-2), is in part so dangerous because it threatens to overwhelm our medical infrastructure at the regional level, causing spikes in mortality rates. Within the medical infrastructure, there are critical technologies that are generally available, but simply do not exist in a high enough density to handle the excessive volume of patients associated with pandemics. Thus, people die unnecessarily throughout the world because of a combination of COVID-19 infections and the lack of access to some of these technologies. Ventilators are an example of technologies that are currently in critical short supply. Mechanical ventilators are essential for treating both influenza and COVID-19 patients in severe acute respiratory failure. Past studies have shown that intensive care units (ICUs) will not have sufficient resources to treat all patients requiring ventilator support during a massive pandemic, and ethically challenging triage would need to be used to decrease mortality over first-come first-served basis for

ventilator allocation among patients. Some work has shown promise for using a single ventilator to support multiple patients during a disaster surge. In addition, it has already been shown that 3-D printed manifolds can assist with rapidly deploying this solution and there are open source designs. This is not necessarily straightforward. Although some countries, like the United States, have stockpiles of ventilators , there is consensus that there is not enough supply for serious pandemics and that rationing would be needed. The current medical system relies exclusively on specialized, proprietary, mass-manufactured ventilators from a small selection of suppliers. This supply model clearly fails when there is a sudden surge in demand for a relatively low-volume specialty product such as ventilators in a pandemic as analyzed here. The vast majority of medical equipment is heavily patented by a few specialty medical firms that sell small volumes because during ‘normal’ times, a medium-sized hospital only needs a handful. These firms have historically aggressively protected their intellectual monopolies to the detriment of human lives. In addition, non-practicing entities continue to attempt to actively prevent medical treatments from being deployed, even during the current COVID-19 pandemic. Putting aside the absurdity of patenting and then obstructing others from using obvious inventions in normal times , in the wake of a pandemic where millions of lives are at stake, it is intuitively obvious that this type of greed is no longer acceptable.

CHAPTER - 2

LITERATURE SURVEY

Balamurugan C.R., Kasthuri A., Malathi E. Dharanidharan S., Hariharan D., Kishore B.V., Venkadesh T., (Design of Ventilator Using Arduino for Covid Pandemic) (01 April 2021).[1] This ventilator is made with push mechanism in each breath. This ventilator is very cheap and affordable. Motor mechanism is used push the air bag. When oxygen level count is low this mechanism is performed. Small screen is used to display the oxygen level at real time. The entire system is controlled with Arduino. If the oxygen level is low the buzzer is ring. Toggle are switching and variable pot to check the breath length and BPM level of patients. . Leonardo Acho, Alessandro N. Vargas, Gisela Pujol-Vázquez, (Low-Cost, OpenSource Mechanical Ventilator with Pulmonary Monitoring for COVID-19 Patients) (12 September 2020)[2] This article shows that construction of low-cost, open-source mechanical ventilator. This article also shows that numerical method for monitoring patients pulmontory condition. With the help of pressure sensor, we can classify the patients are healthy or unhealthy lungs. An Arduino board collects the information from pressure sensor and sends them to raspberry pi. The raspberry pi commands the acutor and breathing bag compress accordingly. According to manufacture the pressure sensor can measure differentially pressure of up to 70 cm H₂O. the gear was attached to the servo meter rod. The rod was made by plexi glass bar. The radius of this gear is 2.5cm

EXISTING SYSTEM:

Various research groups have presented different designs for low-cost, easy to use automated mechanical ventilators as viable replacement for ventilators to fight with the ongoing pandemic. Each of these design uses the same basic approach as discussed in the above section. But these differ based on actuator mechanism, modes of ventilation operation, sensors used etc., providing each design with their own merits and demerits, which has been briefly described below.

Most of the DIY ventilator out there are based on ambu bags and a direct drive actuator. In my design, I've tried to simplify the actuator mechanism and I also made a better user interface for the unit.

The key element in my design is a linear actuator which is coupled with a lever mechanism that can compresses the ambu bag. A control panel is also provided for precisely controlling the ventilation parameters.

CHAPTER - 3

PROPOSED SYSTEM

The oxygen levels. The entire system is driven by an Arduino microcontroller and a buzzer is fitted to detect any low levels of oxygen count. Extra using for DIY ventilator, air bag, breathing problem, DHT=11 Sensor also added.

3.1 BLOCK DIAGRAM:

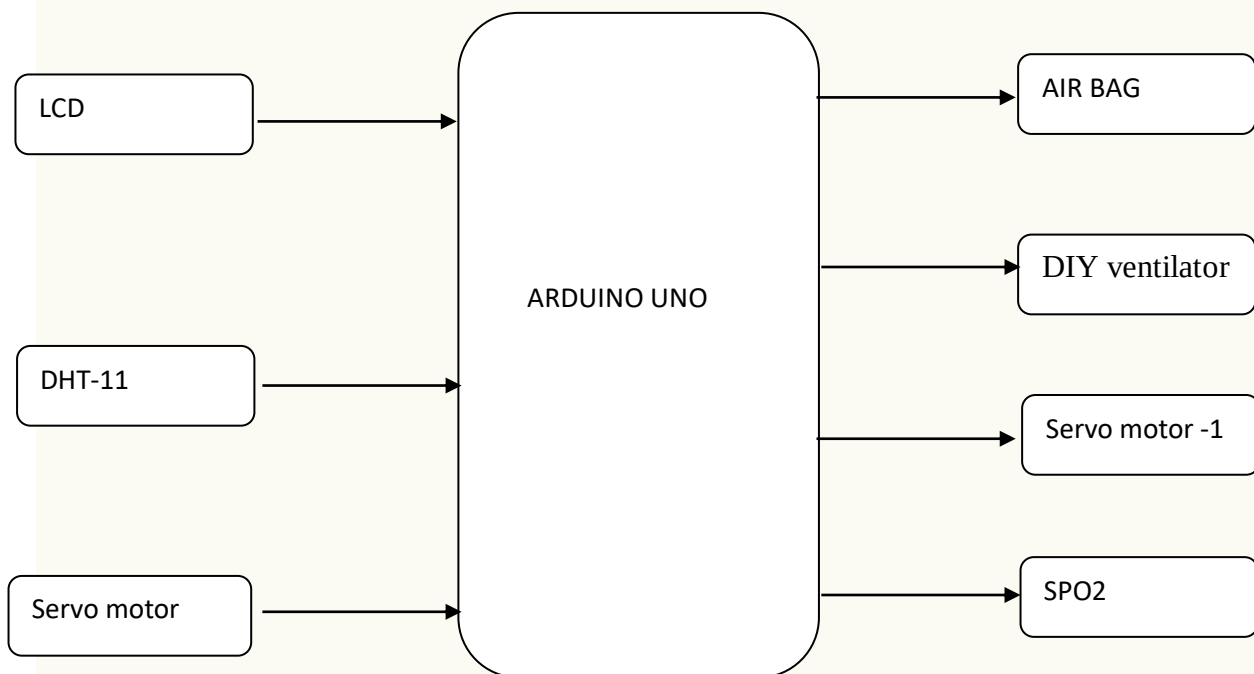


Fig: 3.1: Block Diagram of Proposed System

3.2 Applications:

- Hospitals
- Clinics

- First Aid Centers
- Emergency Situations

3.3 Advantages:

- Easy to Use
- Automatic Operation

3.4 Disadvantages:

- Requires External Oxygen Supply

3.5 Circuit diagram:

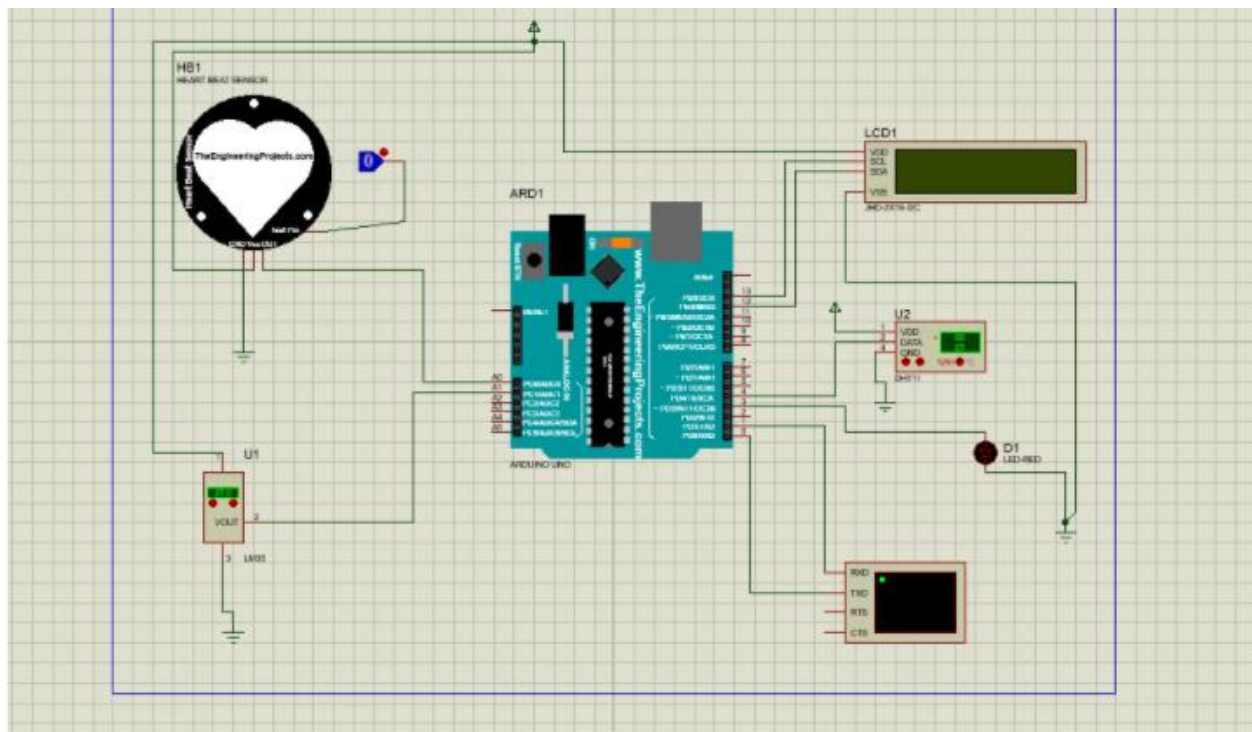


Fig 3.2 Circuit Diagram of proposed System

CHAPTER – 4

MODULES

ARDUINO UNO

setup(): A capacity present in each Arduino sketch. Run once before the loop() function. Frequently used to set pinmode to info or yield. The setup() function resembles like:

```
void setup(){  
    //code goes here  
}
```

input: A pin mode that admissions data.

output: A pin mode that sends data.

HIGH: Electrical sign present (5V for Uno). Additionally ON or True in boolean rationale.

LOW: No electrical sign present (0V). Additionally OFF or False in boolean rationale.

DigitalRead: Get a HIGH or LOW perusing from a pin previously proclaimed as an info.

DigitalWrite: Assign a HIGH or LOW an incentive to a pin previously pronounced as anoutput .

AnalogRead: Get an incentive between or including 0 (LOW) and 1023 (HIGH). This permits you to get readings from simple sensors or interfaces that have multiple states.

AnalogWrite: Assign an incentive between or including 0 (LOW) and 255 (HIGH). This allows you to set output to a PWM esteem rather than simply HIGH or LOW.

PWM: Stands for Pulse-Width Modulation, a strategy for copying a simple sign through an advanced pin. An incentive between or including 0 and 255. Utilized with analogWrite.

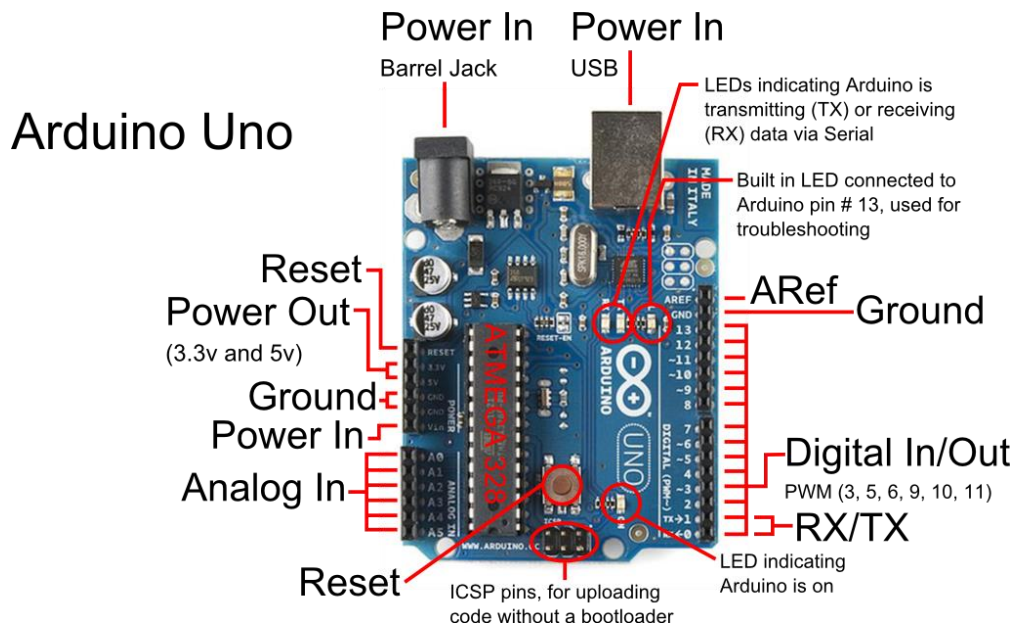


Fig 4.1 Arduino UNO

These boards below use the identical micro-controller, just in a very different package. The Lilypad is meant to be used with conductive thread rather than wire and therefore

The Arduino Mini is solely a smaller package without the USB, Barrel Jack and Power.

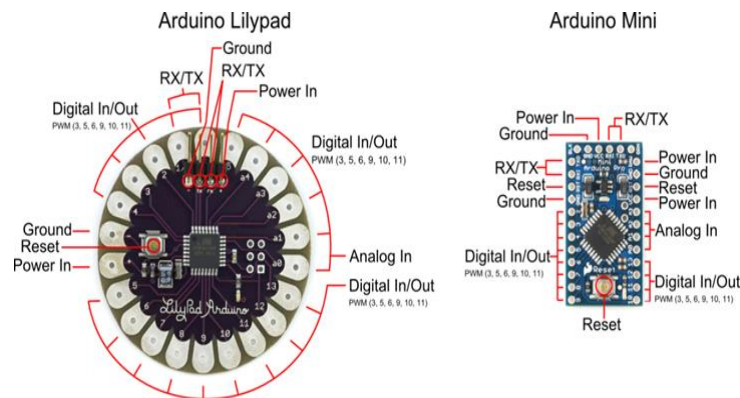


Fig 4.2 Arduino Mini

It relies upon what you might want to attempt to do with it truly. There are two unique purposes laid out above for the resistor, we are going to reexamine both. On the off chance that you need to utilize the obstruction as a sensor perusing gadget first you might want to get a handle on the most voltage permitted by the simple data sources you're utilizing

to peruse the sign. On an Arduino this is frequently 5V. In this way, as of now we as a whole know the most worth we need for V_{out} . The V_{in} is exclusively the amount of voltage effectively present on the circuit before it arrives at the essential resistor. you should be prepared to locate the most extreme voltage your sensor outputs by relying on the Datasheet, this can be the most measure of voltage your sensor will let through given the voltage in of your circuit. Presently we've precisely one variable left, the value of the subsequent resistor. Explain for R2 and you'll have all the parts of your obstruction sorted out! We tackle for R1's most noteworthy worth in light of the fact that a more modest resistor will essentially give us a more modest sign which can be clear by our simple sources of info. Controlling a simple Reference is actually equivalent to perusing a sensor aside from you need to figure for the Voltage Out worth you need to use as the simple Reference.

The entirety of the electrical signs that the Arduino works with are either Analog or Digital. it's critical to get a handle on the distinction between these two sorts of sign and the best approach to control the information these signs speak to.

4.1 DIGITAL

An electronic sign communicated as paired code that can be either the presence or nonattendance of current, high and low voltages or short heartbeats at a specific recurrence. People see the world in simple, however robots, PCs and circuits utilize Digital. A computerized signal is a sign that has just two states. These states can shift contingent upon the sign, however basically characterized the states are ON or OFF, never in the middle. In the realm of Arduino, Digital signs are utilized for everything except for Analog Input. Contingent upon the voltage of the Arduino the ON or HIGH of the Digital sign will be equivalent to the framework voltage, while the OFF or LOW sign will consistently rise to 0V. This is an extravagant method of saying that on a 5V Arduino the HIGH signals will be a little under 5V and on a 3.3V Arduino the HIGH signals will be somewhat under 3.3V. To get or impart Digital signs the Arduino utilizes Digital pins # 0 - # 13. You may likewise arrangement your Analog In pins to go about as Digital pins. To set up Analog In pins as Digital pins utilize the order:

```
pinMode(pinNumber, esteem);
```

where pinNumber is an Analog pin (A0 – A5) and worth is either INPUT or OUTPUT. To arrangement Digital pins utilize a similar order yet reference a Digital pin for pinNumber rather than an Analog In pin. Computerized pins default as info, so truly you just need to set them to OUTPUT in pinMode. To peruse these pins utilize the order:

```
digitalRead(pinNumber);
```

where pinNumber is the Digital pin to which the Digital segment is associated. The digitalRead order will restore either a HIGH or a LOW sign. To impart a Digital sign to a pin utilize the order:

```
digitalWrite(pinNumber, esteem);
```

where pinNumber is the quantity of the pin imparting the sign and worth is either HIGH or LOW.

The Arduino additionally has the ability to yield a Digital sign that goes about as an Analog sign, this sign is called Pulse Width Modulation (PWM). Computerized Pins # 3, # 5, # 6, # 9, # 10 and #11 have PWM capacities. To yield a PWM signal utilize the order:

```
analogWrite(pinNumber, esteem);
```

where pinNumber is a Digital Pin with PWM capacities and worth is a number between 0 (0%) and 255 (100%). For more data on PWM see the PWM worksheets or S.I.K. circuit 12.

THINGS TO REMEMBER ABOUT DIGITAL:

- Digital Input/Output utilizes the Digital pins, however Analog In pins can be utilized as Digital
- To get a Digital sign use: `digitalRead(pinNumber);`
- To impart a Digital sign use: `digitalWrite(pinNumber, esteem);`
- Digital Input and Output are in every case either HIGH or LOW

The entirety of the electrical signs that the Arduino works with are either Analog or Digital. It is critical to comprehend the distinction between these two kinds of sign and how to control the data these signs speak to.

4.2 ANALOG

People see the world in simple. All that we see and hear is a ceaseless transmission of data to our faculties. The temperatures we see are rarely 100% hot or 100% cold, they are continually changing between our scopes of satisfactory temperatures. (What's more, in the event that they are out of our scope of adequate temperatures, at that point what are we doing there?) This ceaseless stream is the thing that characterizes simple information. Advanced data, the correlative idea to Analog, gauges simple information utilizing just ones and zeros.

In the realm of Arduino an Analog sign is essentially a sign that can be HIGH (on), LOW (off) or anything in the middle of these two states. This implies an Analog sign has a voltage esteem that can be anything somewhere in the range of 0V and 5V (except if you play with the Analog Reference pin). Simple permits you to send yield or get contribution about gadgets that run at rates just as here and there. The Arduino does this by inspecting the voltage signal shipped off these pins and contrasting it with a voltage reference signal (5V). Contingent upon the voltage of the Analog sign when contrasted with the Analog Reference signal the Arduino then doles out a mathematical incentive to the sign somewhere close to 0 (0%) and 1023 (100%). The computerized arrangement of the Arduino would then be able to utilize this number in figurings and portrayals.

To get Analog Input the Arduino utilizes Analog pins # 0 - # 5. These pins are intended for use with segments that yield Analog data and can be utilized for Analog Input. There is no arrangement fundamental, and to peruse them utilize the order:

```
analogRead(pinNumber);
```

where pinNumber is the Analog In pin to which the Analog part is associated. The analogRead order will restore a number including or somewhere in the range of 0 and 1023.

The Arduino additionally has the ability to yield a computerized signal that goes about as an Analog sign, this sign is called Pulse Width Modulation (PWM). Advanced Pins

3, # 5, # 6, # 9, # 10 and #11 have PWM capacities. To yield a PWM signal utilize the order:

```
analogWrite(pinNumber, esteem);
```

where pinNumber is a Digital Pin with PWM abilities and worth is a number between 0 (0%) and 255 (100%). On the Arduino UNO PWM pins are meant by a ~ sign. For more data on PWM see the PWM worksheets or S.I.K. circuit 12.

THINGS TO REMEMBER ABOUT ANALOG:

- Analog Input utilizes the Analog In pins, Analog Output utilizes the PWM pins
- To get an Analog sign use: `analogRead(pinNumber);`
- To impart a PWM sign use: `analogWrite(pinNumber, esteem);`
- Analog Input esteems range from 0 to 1023 (1024 qualities since it utilizes 10 pieces, 210)
- PWM Output esteems range from 0 to 255 (256 qualities since it utilizes 8 pieces, 28)

The entirety of the electrical signs that the Arduino works with are either info or yield. It is critical to comprehend the distinction between these two sorts of sign and how to control the data these signs speak to.

4.3 OUTPUT SIGNALS

Analog input to the Arduino pins is consistently Digital, anyway there are two unique kinds of Digital Output; ordinary Digital Output and Pulse Width Modulation Output (PWM). Yield is just conceivable with Digital pins # 0 - # 13. The Digital pins are preset as Output pins, so except if the pin was utilized as an Input in a similar sketch, there is no motivation to utilize the `pinMode` order to set the pin as an Output. Should a circumstance emerge where it is important to reset a Digital pin to Output from Input utilize the order:

```
pinMode(pinNumber, OUTPUT);
```

where pinNumber is the Digital pin number set as Output. To impart a Digital Output sign utilize the order:

```
digitalWrite(pinNumber, esteem);
```

where pinNumber is the Digital pin that is yielding the sign and worth is the sign. While yielding a Digital sign worth can be either HIGH (On) or LOW (Off).

```
analogWrite(pinNumber, esteem);
```

where pinNumber is a Digital Pin with PWM abilities and worth is a number between 0 (0%) and 255 (100%). For more data on PWM see the PWM worksheets or S.I.K. circuit 12.

Yield can be shipped off a wide range of gadgets, however it is dependent upon the client to sort out which sort of Output signal is required, connect the equipment and afterward type the right code to appropriately utilize these signs.

THINGS TO REMEMBER ABOUT OUTPUT:

- Output is consistently Digital
- There are two sorts of Output: ordinary Digital or PWM (Pulse Width Modulation)
- To impart an Output sign use `analogWrite(pinNumber, esteem);` (for simple) or `digitalWrite(pinNumber, esteem);` (for computerized)
- Output pin mode is set utilizing the pinMode order: `pinMode(pinNumber, OUTPUT);`
- Regular Digital Output is in every case either HIGH or LOW
- PWM Output shifts from 0 to 255

The entirety of the electrical signs that the Arduino works with are either information or yield. It is critical to comprehend the contrast between these two sorts of sign and how to control the data these signs speak to.

4.4 INPUT SIGNALS

Simple Input enters your Arduino through the Analog In pins # 0 - # 5. These signs begin from simple sensors and interface gadgets. These simple sensors and gadgets use voltage levels to impart their data rather than a straightforward yes (HIGH) or no (LOW).

Therefore you can't utilize a computerized pin as an information pin for these gadgets. Simple Input pins are utilized uniquely for getting Analog signs. It is simply conceivable to peruse the Analog Input sticks so there is no order vital in the arrangement() capacity to set up these pins for input. To peruse the Analog Input pins utilize the order:

```
analogRead(pinNumber);
```

where pinNumber is the Analog Input pin number. This capacity will restore an Analog Input perusing somewhere in the range of 0 and 1023. A perusing of zero relates to 0 Volts and a perusing of 1023 compares to 5 Volts. These voltage esteems are radiated by the simple sensors and interfaces. On the off chance that you have an Analog Input that could surpass $V_{cc} + .5V$ you may change the voltage that 1023 relates to by utilizing the Aref pin. This pin sets the greatest voltage boundary your Analog Input pins can peruse. The Aref pin's preset worth is 5V.

Computerized Input can enter your Arduino through any of the Digital Pins # 0 - # 13. Advanced Input signals are either HIGH (On, 5V) or LOW (Off, 0V). Since the Digital pins can be utilized either as info or yield you should set up the Arduino to utilize these pins as contributions to your arrangement()work. To do this sort the order:

```
pinMode(pinNumber, INPUT);
```

inside the wavy sections of the arrangement() work where pinNumber is the Digital pin number you wish to announce as an information. You can change the pinMode insider savvy()work on the off chance that you need to switch a pin to and fro among info and yield, however it is typically set in the arrangement()capacity and left immaculate tuned in()work. To peruse the Digital pins set as data sources utilize the order:

```
digitalRead(pinNumber);
```

where pinNumber is the Digital Input pin number.

Info can emerge out of a wide range of gadgets, however every gadget's sign will be either Analog or Digital, it is dependent upon the client to sort out which sort of

information is required, connect the equipment and afterward type the right code to appropriately utilize these signs.

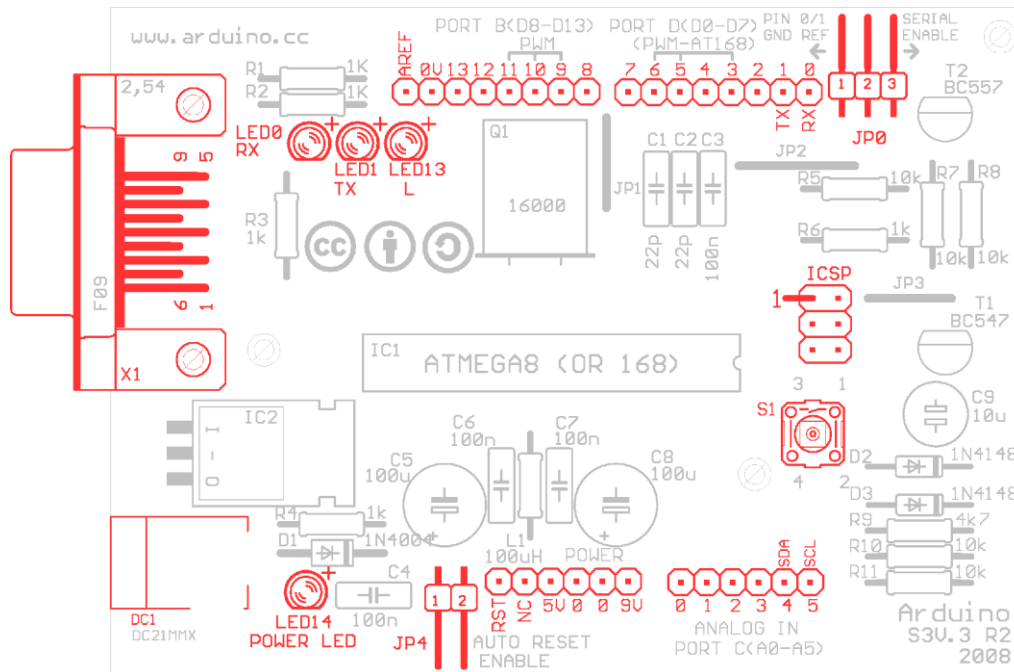


Fig 4.3 PCB of Arduino UNO

X1:

DE-9 chronic connector

Used to interface PC (or different gadgets) utilizing RS-232 norm. Needs a sequential link, with in any event 4 pins associated: 2, 3, 4 and 5. Works just when JP0 is set to 2-3 position.

DC1:

2.1 mm. power jack

Used to interface outside force source. Focus positive. Voltage Regulator Works with managed +7 to +20 volts DC (9v. to 12v. is suggested). It is conceivable to on the other hand interface outer force utilizing 9v. pin or 5v. pin. (see POWER PINOUT)

ICSP:

2x3 pin header Used to program Atmega with bootloader. The number 1 on the two sides of the board shows link pin1 position. Used to transfer draws on Atmega ICs without bootloader (accessible just in Arduino IDE variants 0011 and 0012).

JP0

3 pins jumper When in position 2-3, this jumper empowers sequential association (through X1 connector) to/from PC/gadgets. Utilize this as default position. When in position 1-2, it handicaps sequential correspondence, and empowers outer draw down resistors on pin0 (RX) and pin1 (TX). Utilize this just to forestall commotion on RX (that appears to be approaching information to Atmega), that occasionally makes sketch not beginning. While eliminating this jumper, sequential correspondence is impaired, and pin0 and pin1 fill in as a typical (gliding) advanced pin. Valuable when more advanced pins are required, yet just when sequential correspondence isn't essential. Outside draw down/pull-up resistor is required.

JP4

2 pins jumper When in position 1-2, this jumper empowers auto reset include, helpful while transferring a sketch to Arduino, resetting Atmega consequently. It makes superfluous to squeeze reset button (S1) when transferring portrays. Be certain that PC COM Port speed is set to 19200bps in any case auto reset won't work appropriately. Whenever eliminated, cripples auto reset include. Extremely valuable to forestall undesired Atmega reset when utilizing outlines that needs sequential correspondence. Auto reset works with DTR heartbeat on sequential pin4. Once in a while Arduino faculties a DTR beat while associating X1 (chronic connector) and a few virtual products sends a DTR beat when it begins or when it shuts, that makes Atmega reset when not wanted.

S1

Material catch This catch resets Atmega, to restart transferred sketch or to plan Arduino to get a sketch through chronic connector (when auto reset isn't dynamic).

LEDS

Characteristic leds POWER drove Turns on when Arduino is fueled through DC1, +9v. pin or +5v. pin. RX drove Blinks while accepting information from PC/gadget through sequential association. TX drove Blinks when sending information to PC/gadget through sequential association. L drove This drove is associated with computerized pin13 with a current limiter resistor (that doesn't influence pin13). Helpful to test portrays. It isn't unexpected to squint while bootloading as well.

4.5 POWER PINOUT

6 pin header

RST pin

Makes Atmega reset when associated with GND. Helpful for Shield Boards, or to associate outside reset.

NC pin

This pin isn't associated in Arduino S3v3. Arduino Diecimila has a 3.3 volts pin similarly situated.

+9v. pin

At the point when Arduino DC1 is fueled (with battery or DC connector), this pin is utilized as Vout, with a similar voltage provided on DC1 (see DC1), less 0,7 volts. The all out provided current relies upon outer force source limit When Arduino DC1 isn't controlled, +9v. pin can be utilized as Vin, interfacing it to an outside controlled force source (+7 to +20 volts) and associating 0v. pin to outside force source GND. For this situation,

+5v. pin

can be utilized as Vout, providing +5 volts. +5v. pin When Arduino DC1 is controlled (with battery or DC connector), +5v. pin supplies +5 volts as a Vout pin. The absolute provided current relies upon Voltage Regulator (7805 supplies up to 1A). This applies just to +5v. pin: Atmega in/out pins just supplies max. 40mA on each pin. At the point when Arduino DC1 isn't controlled, this pin can be utilized as Vin, associating it to a managed

+5v. what's more, associating 0v. pin to control source GND. For this situation, +9v. pin is dormant. 0v. pin (GND) Two 0v. sticks between +5v. what's more, +9v. /One

0v. pin

adjacent to AREF pin. At the point when Arduino DC1 is controlled, 0v. pin supplies 0 volts reference (GND) for +5v. pin and +9v. pin. At the point when DC1 isn't controlled, and Arduino is fueled through +5v. pin or +9v. pin, 0v. pin must be utilized as GND reference, interfacing it to the outside force source GND.

GND pin

see 0v. pin (GND).

AREF pin

The AREF can be set to AVcc (default), inward 2.56 volts (Atmega8), inner 1.1 volts (Atmega168), or outside AREF. If there should arise an occurrence of AVcc or interior AREF, AREF pin can be utilized to connect na outside capacitor to decouple the sign, for better clamor execution. If there should be an occurrence of outer AREF, AREF pin is utilized to append the outside reference voltage. Recollect that it is important to change de wires (wiring.c document), and re-transfer sketch, prior to interfacing outside voltage to AREF.

4.6 SOFTWARE TIPS

While bootloadingna Atmega8 chip with Arduino 0010, there is an order (- i800) that makes bootloader defer 10 minutes. Thus, in the event that you need to utilize bootloader, use order line rather than IDE, eliminating "- i800" order and adding "- F" order, or use Arduino 0007 IDE. To transfer draws Arduino 0010 turns out great.

ARDUINO S3v3 NEW FEATURES:

- full viable with Shield Boards (Version 2 is the main Arduino Board not viable with Shield Boards as a result of ICSP header wrong position, and tall parts);
- AVcc LP channel to lessen commotion level on ADC;
- auto reset include;
- auto reset empower/impair jumper, to dodge not wanted reseting;

- arduinoDiecimila viable reset pin;
- pin13 locally available drove, with current limiter resistor;
- TX and RX locally available leds;
- power drove with suitable current limiter resistor (less 20mA of consumption);
- jumper to impair sequential correspondence and to empower RX outer draw down resistor, to evade "RX skimming blunder". This element permits to utilize computerized pin0 and pin1 as an ordinary pin, when sequential correspondence isn't required;
- all comparative segments (diodes, semiconductors, leds, capacitors) has a similar board direction (to commits simpler to mount with less errors);
- no wires between cushions, more space between wires, bigger wires, bigger cushions (better for drawing, binding and penetrating, with no shortcircuits, patching extensions or open wires in erosion);
- just 3 wire spans;
- electrolytic capacitor (in sequential to TTL circuit) changed to bipolar sort (to keep away from rearranged voltage issue when sequential link isn't associated);
- All jumpers are correct point type, to permit Shield Boards use.

4.7 ARDUINO IDE

Download Arduino Integrated Design Environment (IDE) here (Most late form: 1.6.5): <https://www.arduino.cc/en/Main/Software>

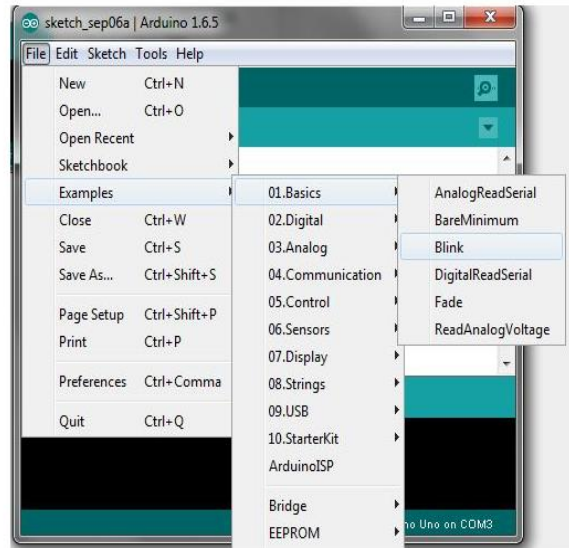
This is the Arduino IDE whenever it's been opened. It opens into a clear sketch where you can begin programming right away. To begin with, we ought to arrange the board and port settings to permit us to transfer code. Interface your Arduino board to the PC through the USB link.

UPLOADING BLINK

One common procedure to check whether the board you're using is correctly founded is to upload the "Blink" sketch. This sketch is included with all Arduino IDE releases and might be accessed by the Filepull-down menu and visiting Examples, 01.Basics, then select Blink. Standard Arduino Boards include a surface-mounted LED labeled "L" or "LED" next to the "RX" and "TX" LEDs, that's connected to digital pin 13. This sketch will blink the LED at an everyday interval, and is a straightforward thanks to confirm if your board is ready up

properly and you were successful in uploading code. Open the “Blink” sketch and press the “Upload” button within the upper-left corner to upload “Blink” to the board.

Upload Button: 



Arduino IDE: Loading Blink Sketch

STEPS INVOLVED:

- 1.Download and introduce Arduino IDE (<https://www.arduino.cc/en/Main/Software>)
2. Plug in your Arduino Board
3. Select the correct board in the IDE (Tools>Boards>Arduino Uno)
4. Select the correct COM port (Tools>Port>COMx (Arduino Uno))
5. Open the "Blink" sketch (File>Examples>Basics>01.Blink)
6. Press the Upload catch to transfer the program to the board
7. Affirm that your board is functioning true to form by noticing LED

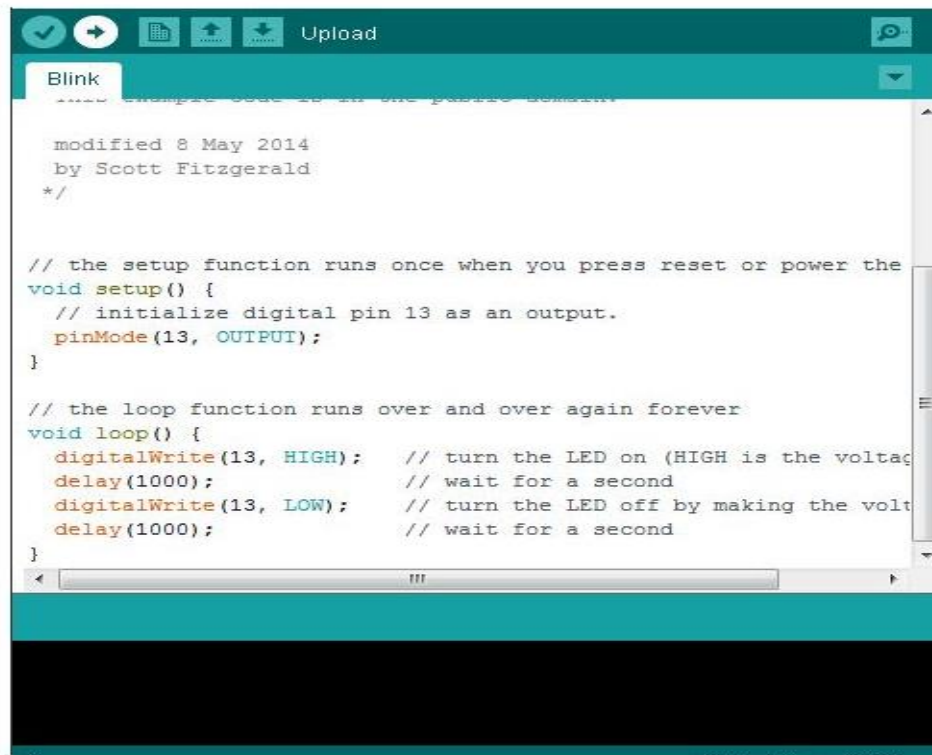


Fig 4.5 Sample Program in Arduino IDE

Arduino has bunches of network backing and documentation. Your smartest option when running into unforeseen issues is to look through online for help. You should have the option to discover a discussion where somebody had a similar issue you are having, and somebody encouraged them fix it. In the event that you don't discover results, take a stab at altering your pursuit, or post on the Arduino discussions.

4.8 ANDROID APPLICATION

Control your Arduino with voice commands using an Android smartphone. The App works by pressing the microphone button, then it will wait for you to say a command. The app will then display the word's that you've stated and will send data strings to the Arduino and arduino generates the PWM control signal for the motor driver and the speed and direction of the DC motor is controlled.

CHAPTER – 5

HARDWARE DESCRPTION

5.1 DHT11 SENSOR:

This sensor is used here to monitor the humidity variation of the environment where the crops are cultivated. This is a digital sensor and measures the humidity value in percentage format. DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

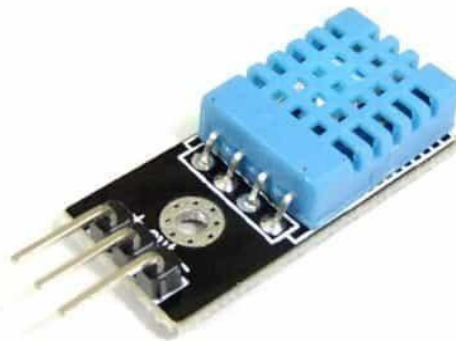


Fig 5.1 DHT11

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc... to measure humidity and temperature instantaneously.

Working:

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs

with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.

For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.

The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz .i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.

DHT11 sensor has four pins- VCC, GND, Data Pin and a not connected pin. A pull-up resistor of 5k to 10k ohms is provided for communication between sensor and micro-controller.

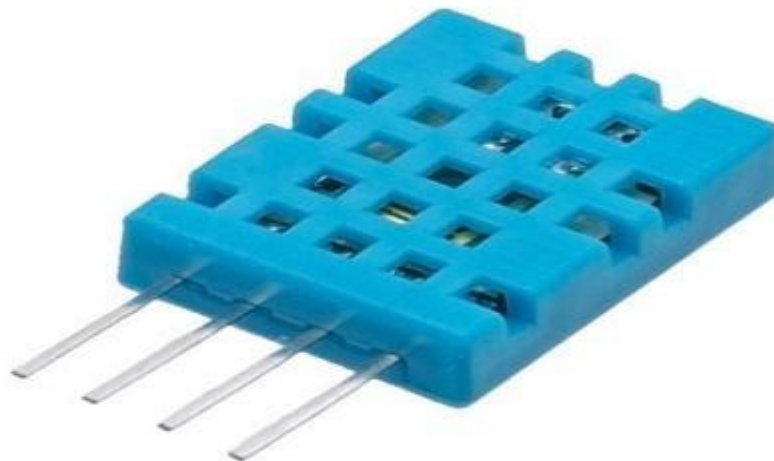


Fig:5.1: Humidity Sensor

HUMIDITY (DHT11):

- DHT11 uses only one wire for communication. The voltage levels with certain time value defines the logic one or logic zero on this pin.
- The communication process is divided in three steps, first is to send request to DHT11 sensor then sensor will send response pulse and then it starts sending data of total 40 bits to the microcontroller.

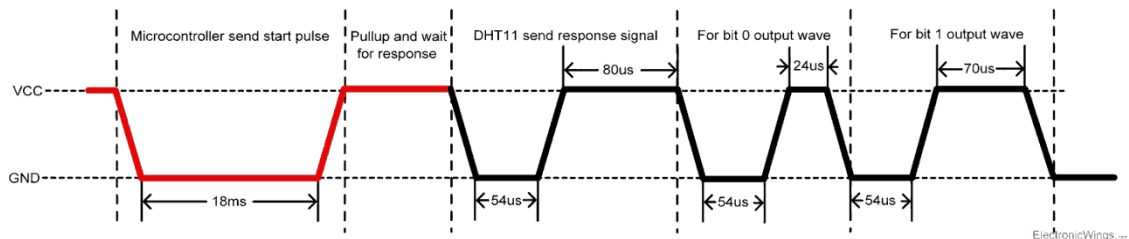


Fig 5.2 Communication Process

Communication process:

Start pulse (Request)

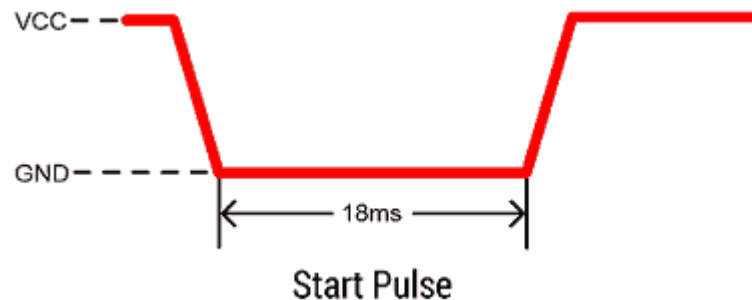


Fig 5.3 Start Pulse

- To start communication with DHT11, first we should send the start pulse to the DHT11 sensor.

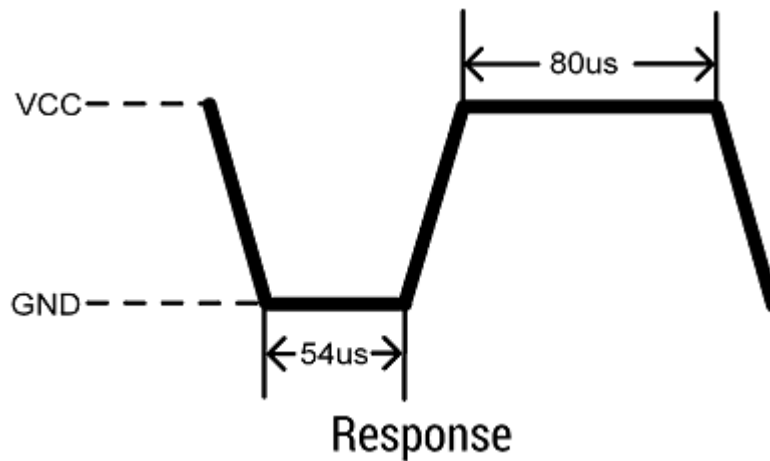


Fig 5.4 Response

- To provide start pulse, pull down (low) the data pin minimum 18ms and then pull up, as . After getting start pulse from, DHT11 sensor sends the response pulse which indicates that DHT11 received start pulse.
- The response pulse is low for 54us and then goes high for 80us.

Data:

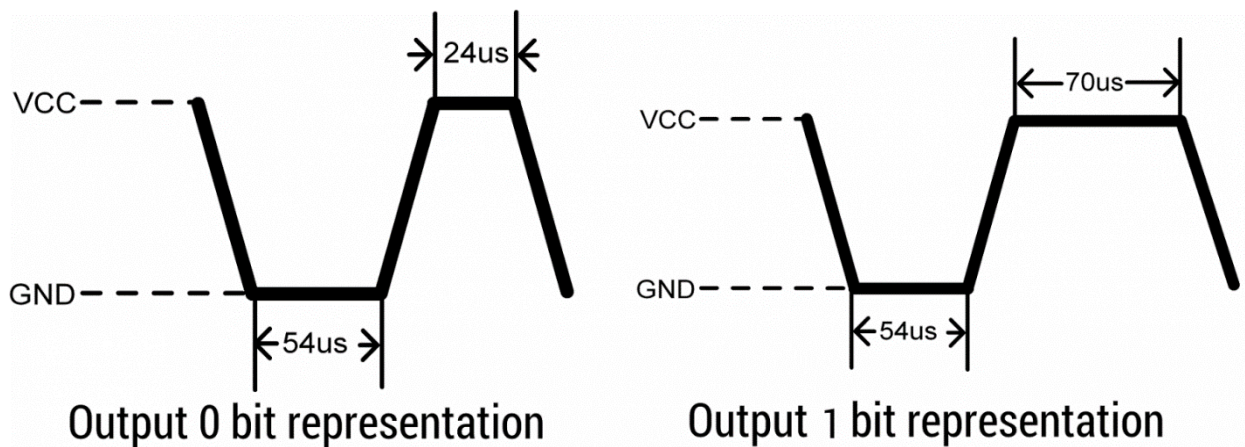


Fig 5.5 Output Representation

- After sending the response pulse, DHT11 sensor sends the data, which contains humidity and temperature value along with checksum.

- The data frame is of total 40 bits long, it contains 5 segments (byte) and each segment is 8-bit long.
- In these 5 segments, first two segments contain humidity value in decimal integer form. This value gives us Relative Percentage Humidity. 1st 8-bits are integer part and next 8 bits are fractional part.
- Next two segments contain temperature value in decimal integer form. This value gives us temperature in Celsius form.
- Last segment is the checksum which holds checksum of first four segments.
- Here checksum byte is direct addition of humidity and temperature value. And we can verify it, whether it is same as checksum value or not. If it is not equal, then there is some error in the received data.
- Once data received, DHT11 pin goes in low power consumption mode till next start pulse.

End of frame:

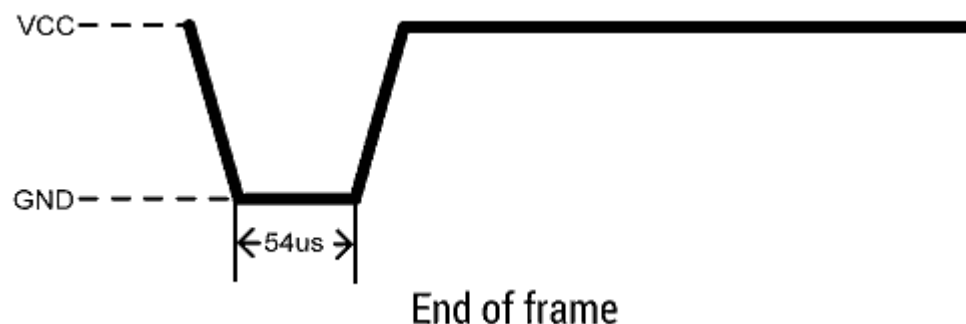


Fig 5.6 End of Frame

- After sending 40-bit data, DHT11 sensor sends 54us low level and then goes high. After this DHT11 goes in sleep mode.

DHT11 vs DHT22:

Two versions of the DHT sensor, they look a bit similar and have the same pinout, but have different characteristics and specifications:

DHT11:

- Ultra-low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings $\pm 2^{\circ}\text{C}$ accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm
- 4 pins with 0.1" spacin

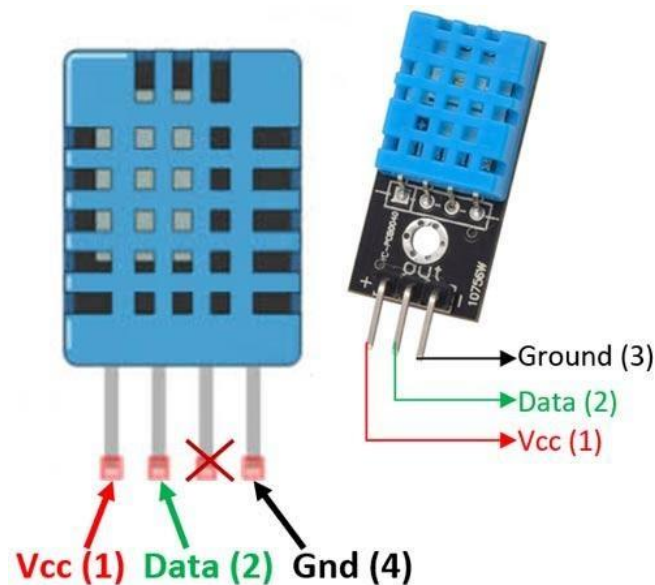


Fig 5.7 Pin Diagram of DHT11

Applications:

This sensor is used in various applications such as measuring humidity and temperature values in heating, ventilation and air conditioning systems. Weather stations also use these sensors to predict weather conditions. The humidity sensor is used as a preventive measure in homes where people are affected by humidity. Offices, cars,

museums, greenhouses and industries use this sensor for measuring humidity values and as a safety measure.

5.2 SERVO MOTOR:



Fig 5.8 Servo Motor

A **servo motor** is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a **servo mechanism**. If motor is powered by a DC power supply then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. For this tutorial, we will be discussing only about the **DC servo motor working**. Apart from these major classifications, there are many other types of servo motors based on the type of gear arrangement and operating characteristics. A servo motor usually comes with a gear arrangement that allows us to get a very high

torque servo motor in small and lightweight packages. Due to these features, they are being used in many applications like toy car, RC helicopters and planes, Robotics, etc.

Servo motors are rated in kg/cm (kilogram per centimeter) most hobby servo motors are rated at 3kg/cm or 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance. For example: A 6kg/cm Servo motor should be able to lift 6kg if the load is suspended 1cm away from the motors shaft, the greater the distance the lesser the weight carrying capacity. The position of a servo motor is decided by electrical pulse and its circuitry is placed beside the motor.

Servo Motor Working Mechanism:

It consists of three parts:

1. Controlled device
2. Output sensor
3. Feedback system

It is a closed-loop system where it uses a positive feedback system to control motion and the final position of the shaft. Here the device is controlled by a feedback signal generated by comparing output signal and reference input signal.

Here reference input signal is compared to the reference output signal and the third signal is produced by the feedback system. And this third signal acts as an input signal to the control the device. This signal is present as long as the feedback signal is generated or there is a difference between the reference input signal and reference output signal. So the main task of servomechanism is to maintain the output of a system at the desired value at presence of noises.

Servo Motor Working Principle:

A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the

potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal. So as the potentiometer's angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

Interfacing Servo Motors with Microcontrollers:

Interfacing hobby Servo motors like s90 servo motor with MCU is very easy. **Servos have three wires coming out of them.** Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU. An **MG995 Metal Gear Servo Motor** which is most commonly used for RC cars humanoid bots etc. The picture of MG995 is shown below:



Fig 5.9 Pin Diagram of Servo Motor

The color coding of your servo motor might differ hence check for your respective datasheet.

All servo motors work directly with your +5V supply rails but we have to be careful on the amount of current the motor would consume if you are planning to use more than two servo motors a proper servo shield should be designed.

Controlling Servo Motor:

All motors have three wires coming out of them. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU.

Servo motor is controlled by PWM (Pulse with Modulation) which is provided by the control wires. There is a minimum pulse, a maximum pulse and a repetition rate. Servo motor can turn 90 degree from either direction from its neutral position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position, such as if pulse is shorter than 1.5ms shaft moves to 0° and if it is longer than 1.5ms than it will turn the servo to 180°.

Servo motor works on **PWM (Pulse width modulation)** principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically servo motor is made up of **DC motor which is controlled by a variable resistor (potentiometer) and some gears**. High speed force of DC motor is converted into torque by Gears. We know that $WORK = FORCE \times DISTANCE$, in DC motor Force is less and distance (speed) is high and in Servo, force is High and distance is less. The potentiometer is connected to the output shaft of the Servo, to calculate the angle and stop the DC motor on the required angle.

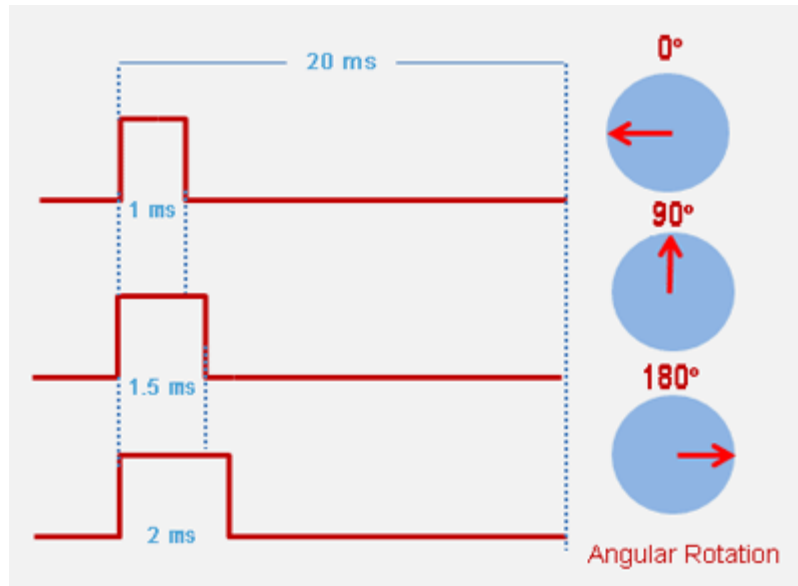


Fig 6.0 Graph Representation

Servo motor can be rotated from 0 to 180 degrees, but it can go up to 210 degrees, depending on the manufacturing. This degree of rotation can be controlled by applying the **Electrical Pulse** of proper width, to its Control pin. Servo checks the pulse in every 20 milliseconds. The pulse of 1 ms (1 millisecond) width can rotate the servo to 0 degrees, 1.5ms can rotate to 90 degrees (neutral position) and 2 ms pulse can rotate it to 180 degree.

All servo motors work directly with your +5V supply rails but we have to be careful about the amount of current the motor would consume if you are planning to use more than two servo motors a proper servo shield should be designed.

DC Motor:

A machine that converts DC electrical power into mechanical power is known as a Direct Current motor. DC motor working is based on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force.

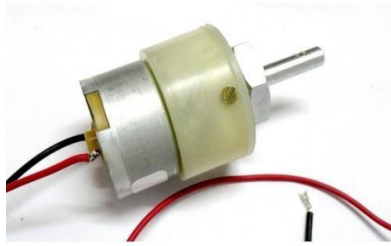


Fig 6.1 DC Motor

Working principle of a DC motor:

An electric motor is an electrical machine which converts electrical energy into mechanical energy. The basic working principle of a DC motor is: "whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force". The direction of this force is given by Fleming's left-hand rule and its magnitude is given by $F = BIL$. Where, B = magnetic flux density, I = current and L = length of the conductor within the magnetic field.

Fleming's left hand rule:

If we stretch the first finger, second finger and thumb of our left hand to be perpendicular to each other, and the direction of magnetic field is represented by the first finger, direction of the current is represented by the second finger, then the thumb represents direction of the force experienced by the current carrying conductor.

When armature windings are connected to a DC supply, an electric current sets up in the winding. Magnetic field may be provided by field winding (electromagnetism) or by using permanent magnets. In this case, current carrying armature conductors experience a force due to the magnetic field, according to the principle stated above.

Commutator is made segmented to achieve unidirectional torque. Otherwise, the direction of force would have reversed every time when the direction of movement of conductor is reversed in the magnetic field.

Back EMF:

According to fundamental laws of nature, no energy conversion is possible until there is something to oppose the conversion. In case of generators this opposition is provided by magnetic drag, but in case of dc motors there is back emf.

When the armature of a motor is rotating, the conductors are also cutting the magnetic flux lines and hence according to the Faraday's law of electromagnetic induction, an emf induces in the armature conductors. The direction of this induced emf is such that it opposes the armature current (I_a). The circuit diagram below illustrates the direction of the back emf and armature current. Magnitude of the Back emf can be given by emf equation of a DC generator

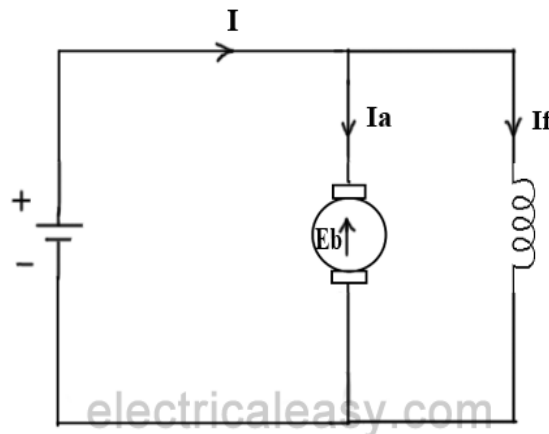


Fig 6.2 DC Circuit Diagram

Significance of back emf:

Magnitude of back emf is directly proportional to speed of the motor. Consider the load on a dc motor is suddenly reduced. In this case, required torque will be small as compared to the current torque. Speed of the motor will start increasing due to the excess torque. Hence, being proportional to the speed, magnitude of the back emf will also increase. With increasing back emf armature current will start decreasing. Torque being proportional

to the armature current, it will also decrease until it becomes sufficient for the load. Thus, speed of the motor will regulate.

On the other hand, if a dc motor is suddenly loaded, the load will cause decrease in the speed. Due to decrease in speed, back emf will also decrease allowing more armature current. Increased armature current will increase the torque to satisfy the load requirement. Hence, presence of the back emf makes a dc motor 'self-regulating'.

Types of DC Motors:

DC motors are usually classified on the basis of their excitation configuration, as follows -

- Separately excited (field winding is fed by external source)
- Self-excited -
 - Series wound (field winding is connected in series with the armature)
 - Shunt wound (field winding is connected in parallel with the armature)
 - Compound wound -
 - Long shunt
 - Short shunt

Applications of a DC Motor:

It depends on the type of DC motor, which applications are ideal. Generally speaking, the following applications are common:

- Cranes
- Conveyors
- Pumps
- Fans
- Machine tools
- Air compressors
- Toys

- Motor starters in cars

5.4 LCD

At present, we look liquid crystal displays (LCDs) everywhere; however, they didn't develop immediately. It took so much time to develop from the development of the liquid crystal to a large number of LCD applications. In the year 1888, the first Liquid crystals were invented by Friedrich Reinitzer (Austrian botanist). When he dissolved a material like a cholesteryl benzoate, then he observed that it initially it turns into a cloudy fluid & cleared up as its temperature rose. Once it is cooled, then the fluid became blue before lastly crystallizing. So, the first experimental liquid crystal display was developed by the RCA Corporation in the year 1968. After that, the manufacturers of LCD have gradually designed ingenious differences & developments on the technology by taking this display device into an incredible range. So finally, the developments in the LCD have been increased.

A liquid crystal display or LCD draws its definition from its name itself. It is a combination of two states of matter, the solid and the liquid. LCD uses a liquid crystal to produce a visible image. Liquid crystal displays are super-thin technology display screens that are generally used in laptop computer screens, TVs, cell phones, and portable video games. LCD's technologies allow displays to be much thinner when compared to a cathode ray tube (CRT) technology.

Liquid crystal display is composed of several layers which include two polarized panel filters and electrodes. LCD technology is used for displaying the image in a notebook or some other electronic devices like mini computers. Light is projected from a lens on a layer of liquid crystal. This combination of colored light with the grayscale image of the crystal (formed as electric current flows through the crystal) forms the colored image. This image is then displayed on the screen.



Fig 6.3 LCD

An LCD

An LCD is either made up of an active matrix display grid or a passive display grid. Most of the Smartphone's with LCD technology uses active matrix display, but some of the older displays still make use of the passive display grid designs. Most of the electronic devices mainly depend on liquid crystal display technology for their display. The liquid has a unique advantage of having low power consumption than the LED or cathode ray tube.

The liquid crystal display screen works on the principle of blocking light rather than emitting light. LCDs require a backlight as they do not emit light themselves. We always use devices which are made up of LCD's displays which are replacing the use of cathode ray tube. Cathode ray tube draws more power compared to LCDs and is also heavier and bigger.

LCDs Construction:

Simple facts that should be considered while making an LCD:

1. The basic structure of the LCD should be controlled by changing the applied current.
2. We must use polarized light.
3. The liquid crystal should be able to control both of the operations to transmit or *can also be able to change the polarized light.*

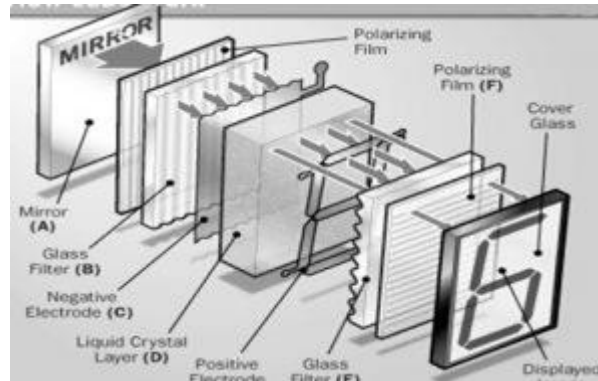


Fig 6.4 LCD Layers

As mentioned above that we need to take two polarized glass pieces filter in the making of the liquid crystal. The glass which does not have a polarized film on the surface of it must be rubbed with a special polymer that will create microscopic grooves on the surface of the polarized glass filter. The grooves must be in the same direction as the polarized film.

Now we have to add a coating of pneumatic liquid phase crystal on one of the polarizing filters of the polarized glass. The microscopic channel causes the first layer molecule to align with filter orientation. When the right angle appears at the first layer piece, we should add a second piece of glass with the polarized film. The first filter will be naturally polarized as the light strikes it at the starting stage.

Thus the light travels through each layer and guided to the next with the help of a molecule. The molecule tends to change its plane of vibration of the light to match its angle. When the light reaches the far end of the liquid crystal substance, it vibrates at the same angle as that of the final layer of the molecule vibrates. The light is allowed to enter into the device only if the second layer of the polarized glass matches with the final layer of the molecule.

Working Of LCD:

The principle behind the LCDs is that when an electrical current is applied to the liquid crystal molecule, the molecule tends to untwist. This causes the angle of light which is passing through the molecule of the polarized glass and also causes a change in the angle of the top polarizing filter. As a result, a little light is allowed to pass the polarized glass through a particular area of the LCD.

Thus that particular area will become dark compared to others. The LCD works on the principle of blocking light. While constructing the LCDs, a reflected mirror is arranged at the back. An electrode plane is made of indium-tin-oxide which is kept on top and a polarized glass with a polarizing film is also added on the bottom of the device. The complete region of the LCD has to be enclosed by a common electrode and above it should be the liquid crystal matter.

Next comes the second piece of glass with an electrode in the form of the rectangle on the bottom and, on top, another polarizing film. It must be considered that both the pieces are kept at the right angles. When there is no current, the light passes through the front of the LCD it will be reflected by the mirror and bounced back. As the electrode is connected to a battery the current from it will cause the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle to untwist. Thus the light is blocked from passing through. That particular rectangular area appears blank.

An LCD TV monitor utilizes the sunglasses concept to operate its colored pixels. On the flip side of the LCD screen, there is a huge bright light that shines out in the direction of the observer. On the front side of the display, it includes the millions of pixels, where each pixel can be made up of smaller regions known as sub-pixels. These are colored with different colors like green, blue, and red. Each pixel in the display includes a polarizing glass filter at the backside and the front side includes at 90 degrees, so the pixel looks dark normally.

A small twisted nematic liquid crystal is there among the two filters which control electronically. Once it is turned OFF, then it turns the light to pass through 90 degrees, efficiently letting light to supply throughout the two polarizing filters so that pixel seems bright. Once it is activated then it doesn't turn the light because it is blocked through the polarizer & the pixel seems dark. Every pixel can be controlled through a separate transistor by turning ON and OFF several times every second.

Generally, every consumer doesn't have much information regarding the different kinds of LCDs available in the market. So before selecting an LCD, they collect all the data like features, price, company, quality, specifications, service, customer reviews, etc. The truth is that promoters tend to get the benefit from the truth that most of the customers conduct extremely minimum research before purchasing any product.

In an LCD, motion blur can be an effect of how long a picture takes to switch and display on the screen. However, both of these incidents change very much among an individual LCD panel in spite of primary LCD tech. Selecting an LCD based on underlying technology must be more regarding price vs. preferred difference, viewing angles & reproduction of color than estimated blur otherwise other gaming qualities. The highest refresh rate, as well as response time, must be planned in any specifications of the panel. Another gaming tech like strobe will turn ON/OFF the backlight rapidly to decrease resolution.

Different Types of LCD:

The different types of LCDs are discussed below.

Twisted Nematic Display:

The TN (Twisted Nematic) LCDs production can be done most frequently and used different kinds of displays all over the industries. These displays most frequently used by gamers as they are cheap & have quick response time as compared with other displays. The main disadvantage of these displays is that they have low quality as well as partial

contrast ratios, viewing angles & reproduction of color. But, these devices are sufficient for daily operations.

These displays allow quick response times as well as quick refresh rates. So, these are the only gaming displays which are available with 240 hertz (Hz). These displays have poor contrast & color because of the not accurate otherwise precise twist device.

In-Plane Switching Display:

IPS displays are considered to be the best LCD because they provide good image quality, higher viewing angles, vibrant color precision & difference. These displays are mostly used by graphic designers & in some other applications, LCDs need the maximum potential standards for the reproduction of image & color.

Vertical Alignment Panel:

The vertical alignment (VA) panels drop anywhere in the center among Twisted Nematic and in-plane switching panel technology. These panels have the best viewing angles as well as color reproduction with higher quality features as compared with TN type displays. These panels have a low response time. But, these are much more reasonable and appropriate for daily use.

The structure of this panel generates deeper blacks as well as better colors as compared with the twisted nematic display. And several crystal alignments can permit for better viewing angles as compared with TN type displays. These displays arrive with a tradeoff because they are expensive as compared with other displays. And also they have slow response times & low refresh rates.

Advanced Fringe Field Switching (AFFS):

AFFS LCDs offer the best performance & a wide range of color reproduction as compared with IPS displays. The applications of AFFS are very advanced because they can reduce the distortion of color without compromising on the broad viewing angle. Usually, this display is used in highly advanced as well as professional surroundings like in the viable airplane cockpits.

Passive and Active Matrix Displays:

The Passive-matrix type LCDs works with a simple grid so that charge can be supplied to a specific pixel on the LCD. The grid can be designed with a quiet process and it starts through two substrates which are known as glass layers. One glass layer gives columns whereas the other one gives rows that are designed by using a clear conductive material like indium-tin-oxide.

In this display, the rows otherwise columns are linked to ICs to control whenever the charge is transmitted in the direction of a particular row or column. The material of the liquid crystal is placed in between the two glass layers where on the external side of the substrate, a polarizing film can be added. The IC transmits a charge down the exact column of a single substrate & the ground can be switched ON to the exact row of the other so that a pixel can be activated.

The passive-matrix system has major drawbacks particularly response time is slow & inaccurate voltage control. The response time of the display mainly refers to the capability of the display to refresh the displayed image. In this type of display, the simplest way to check the slow response time is to shift the mouse pointer fast from one face of the display to the other.

Active-matrix type LCDs mainly depends on TFT (thin-film transistors). These transistors are small switching transistors as well as capacitors which are placed within a matrix over a glass substrate. When the proper row is activated then a charge can be

transmitted down the exact column so that a specific pixel can be addressed, because all of the additional rows that the column intersects are switched OFF, simply the capacitor next to the designated pixel gets a charge.

The capacitor holds the supply until the subsequent refresh cycle & if we cautiously manage the sum of voltage given to a crystal, then we can untwist simply to permit some light through. At present, most of the panels offer brightness with 256 levels for each pixel.

Colored Pixels Works in LCDs:

At the backside of the TV, a bright light is connected whereas on the front side, there are many colored squares that will be turned ON/OFF. Here, we are going to discuss how every colored pixel is turned ON/OFF:

How the Pixels of LCD Switched OFF:

- In the LCD, the light travels from the backside to the front side
- A horizontal polarizing filter ahead of the light will block all the light signals apart from those horizontally vibrate. The pixel of the display can be switched off by a transistor by allowing the flow of current throughout its liquid crystals which makes the crystals sort out & the light supplies through them will not change.
- Light signals come out from the liquid crystals to vibrate horizontally.
- A vertical type polarizing filter ahead of the liquid crystals will block all light signals apart from those signals vertically vibrating. The light which is vibrating horizontally will travel throughout the liquid crystals so they cannot get during the vertical filter.
- At this position, light cannot reach the LCD screen because the pixel is dim.

How the Pixels of LCD Switched ON:

- The bright light at the backside of the display shines like before.
- The horizontal polarizing filter ahead of the light will block all light signals apart from those vibrating horizontally.

- A transistor activates the pixel by turning off the flow of electricity in the liquid crystals so that crystals can rotate. These crystals turn light signals by 90° as they move through.
- Light signals that flow into the horizontally vibrating liquid crystals will come out from them to vibrate vertically.
- The vertical polarizing filter ahead of the liquid crystals will block all light signals apart from those vertically vibrating. The light which is vertically vibrating will come out from the liquid crystals can now acquire throughout the vertical filter.
- Once the pixel is activated then it gives color to the pixel.

Difference between Plasma & LCD:

Both the displays like plasma and an LCD are similar, however, it works in a different way totally. Every pixel is a microscopic fluorescent lamp that glows through the plasma, whereas plasma is an extremely hot type of gas where the atoms are blown separately to make electrons (negatively charged) & ions (positively charged). These atoms flow very freely and generate a glow of light once they crash. The designing of the plasma screen can be done very bigger as compared with ordinary CRO (cathode-ray tube) TVs, but they are very expensive.

Advantages:

The **advantages of liquid crystal display** include the following.

- LCD's consumes less amount of power compared to CRT and LED
- LCD's are consist of some microwatts for display in comparison to some mill watts for LED's
- LCDs are of low cost
- Provides excellent contrast
- LCD's are thinner and lighter when compared to cathode-ray tube and LED

Disadvantages:

The **disadvantages of liquid crystal display** include the following.

- Require additional light sources

- Range of temperature is limited for operation
- Low reliability
- Speed is very low
- LCD's need an AC drive

Applications:

The applications of liquid crystal display include the following.

Liquid crystal technology has major applications in the field of science and engineering as well on electronic devices.

- Liquid crystal thermometer
- Optical imaging
- The liquid crystal display technology is also applicable in the visualization of the radio frequency waves in the waveguide
- Used in the medical applications

Few LCD Based Displays:



LCD Monitor



LCD Display Camera



LCD Display Smart Phone

Fig 6.5 LCD Displays

Thus, this is all about an overview of LCD and the structure of this from the backside to the front side can be done using backlights, sheet1, liquid crystals, sheet2 with color filters & screen. The standard liquid crystal displays use the backlights like CRFL (cold cathode fluorescent lamps). These lights are consistently arranged backside of the display to deliver

reliable lighting across the panel. So the brightness level of all the pixels in the picture will have equal brightness.

I hope you have got a good knowledge of liquid crystal display. Here I leave a task for you. How is an LCD interfaced to a microcontroller? furthermore, any queries on this concept or electrical and electronic project Leave your answer in the comment section below.

Photo Credits

- LCD Layered Diagram by Circuitstoday
- LCD Display on smart phones by Encrypted
- LCD Display Camera by Encrypted
- LCD Display Monitor by Encrypted

5.5 PULSE OXIMETER:

Pulse Oximeter

Pulse Oximeter are low cost non-Invasive medical sensors used to continuously measure the Oxygen saturation (SPO₂) of hemoglobin in blood. It displays the percentage of blood that is loaded with oxygen.



Fig:6.6: Pulse Oximeter

The sensor is an integrated pulse oximetry and heart-rate monitor sensor solution. It combines two LED's, a photo detector, optimized optics, and low-noise analog signal

processing to detect pulse and heart-rate signals. It operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

Principle of Pulse oximeter:

The principle of pulse oximeter is based on the differential absorption characteristics of oxygenated and the de-oxygenated hemoglobin. Oxygenated hemoglobin absorbs more infrared light and allows more red light to pass through. Whereas Deoxygenated hemoglobin absorbs more red light and allowing more infrared light to pass through.

Circuit diagram:

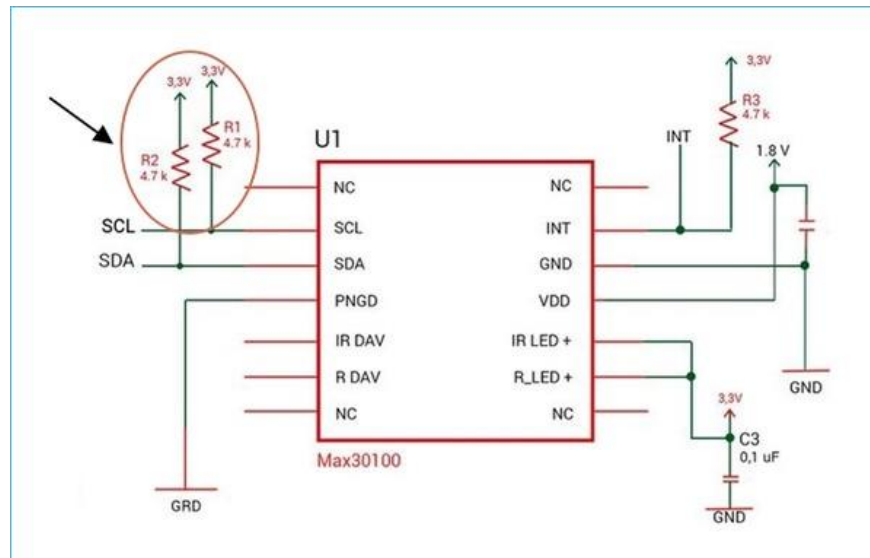


Fig 6.6 Circuit Diagram of Pulse Sensor

Each pulse oximeter sensor probe contains two light emitting diode one emitting red light and the other emitting near infrared light, it also has a photo-detector. The photo-detector measures the intensity of transmitted light at each wavelength. And using the

differences in the reading the blood oxygen content is calculated. The probe is placed on a suitable part of the body, usually a fingertip or ear lobe.

Methods for Monitoring Oxygen Saturation in Blood:

Two different methods are used for transmitting light through the transmitting medium.

Transmission Method:

In the transmission method the transmitter i.e. the LED & the receiver i.e. the photo-detector are placed on opposite side of the finger. In this method this finger will be placed between the LED's & the photo-detector. When the finger is placed a part of the light will be absorbed by the finger and some part will reach the photo detector. Now with each heart beat there will be increase in volume of blood flow this will result in more light getting absorbed by the finger so less light reaches the photo-detector.

Hence if we see the waveform of received light signal it will consist of peaks in between heart beats and trough (bottom) at each heartbeat. This difference between the trough & the peak value is the reflection value due to blood flow at heart beat.

Reflectance Method:

In Reflective method the LED & the photo-detector are placed on the same side i.e. next to each other. In the reflective method there will be some fixed light reflection back to the sensor due to finger. With each heart-beat there will be an increase in blood volume in the finger this will result in more light reflection back to the sensor.

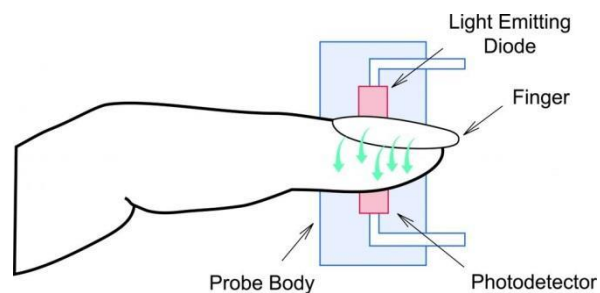


Fig 6.7 Sensor Working

Pulse oximetry operates on the red and IR light absorption characteristics of oxygenated and deoxygenated hemoglobin. Blood oxygen concentration can be calculated from the ratio between the absorption red light and IR light by the hemoglobin. Heart rate is detected by the change of blood volume throughout the finger, that is then quantified by the amount of light that passes through the finger.

The MAX30100 chip integrates two LEDs: red and infrared (IR), a photodetector and low-noise signal processing to detect pulse oximetry and heart rate signals. The absorption data for both IR and red light is stored in a FIFO buffer up to 64 bytes. It provides two operating modes; the heart rate mode, and the heart rate and oxygen saturation mode. In the heart rate mode, only the IR LED is switched on, while in the dual mode both IR and red LEDs are switched on. It also has an integrated 60 Hz low-pass filter. While it can filter out power line noise, it still does not account for environmental noise and fluctuations.

From the LEDs, red and IR light is transmitted through the finger and the photodetector integrated within the chip senses the the light absorption of the two separate wavelengths. In this project, we used both the oximetry and heart rate detection operations with the MAX30100, so we can detect both heart rate and oxygen saturation at the same time.

Hence if we see the waveform of the received light signal it will consist of peaks at each heartbeat. A fixed low value reading is there in between the heart beats this value can be considered as constant reflection and this difference of the peak subtracted from the constant reflection value is the reflection value due to blood flow at heart beat.

In both above cases you can see the troughs/peaks in reflected light occur at each heartbeat the duration between two spikes can be used to measure the persons Heart Rate. Hence a typical heart beat sensor Module consists of only one Transmitter LED (mostly infrared) and one photo-detector.

Now that you have come to know the different methods of sensor placement while measuring the oxygen content in blood (SPO2) we will now see how exactly it works. As

said earlier the sensor consist of two transmitting LED's a Red led of approximately 650 nm (nano-meter) and an infra red led which has a wavelength of 950 nm.

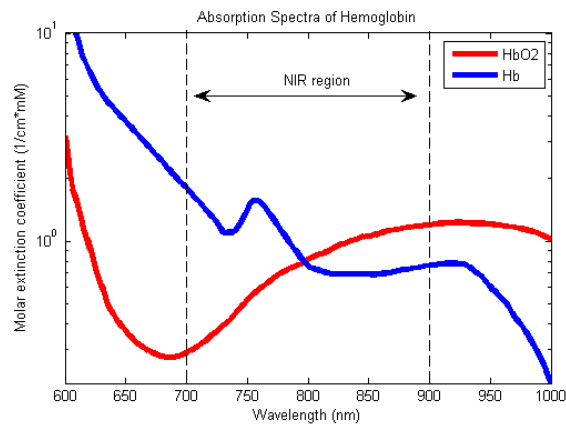


Fig 6.8 Graph Representation of Pulse Sensor

In the above graph you can see the absorbance rate of Oxygenated haemoglobin to various light wavelength. You will see Oxygenated haemoglobin (RED line) absorbs more infrared light than red light. Also the De-Oxygenated haemoglobin (blue line) absorbs more red light as compared to infrared light. The oxygen content in the blood can be easily calculated by comparing how much red light (R) is absorbed as compared to infra-red (IR) light.

Depending on the amount of Oxygenated haemoglobin or De-Oxygenated haemoglobin the ratio of red light absorbed vs Infra-red light (R/IR) absorbed will change. And you can have a look-up table than can convert this ratio into SPO₂ value. Most manufacturers have their own look-up table. Typically R/IR ratio of 0.5 equates to approximately 100% SpO₂, a ratio of 1.0 to approximately 82% SpO₂, while a ratio of 2.0 equates to 0% SpO₂.

Well as you can see from above theory you can easily make your own Pulse Oximeter sensor using an IR Transmitter, red LED & an Light Dependent Resistor (LDR). Which then can be connected to a micro-controller and the ratio (red light absorbed vs Infra-red light absorbed) can then be calculated and from that SPO₂ value can be calculated.

Interfacing MAX30100 Pulse Oximeter Sensor with Arduino:

Now let us interface MAX30100 Pulse Oximeter Sensor with Arduino and display the value in serial monitor. So the circuit diagram and connection is given below. You can follow the same.

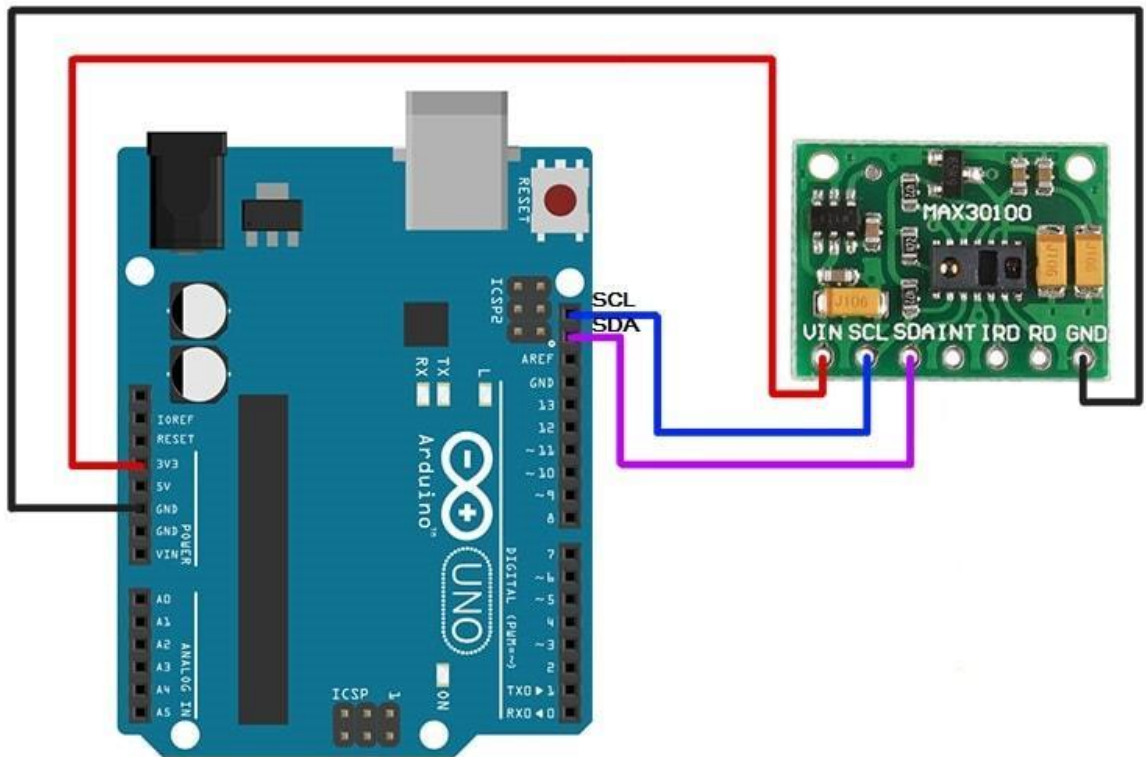


Fig 6.9 Circuit Diagram of Pulse Sensor With Arduino

Connect the Vin pin of MAX30100 to Arduino 5V or 3.3V pin, GND to GND. Connect the I2C Pin, SCL & SDA of MAX30100 to A5 & A4 of Arduino

5.6 HEART BEAT SENSOR:

Heart beat sensor:

Heartbeat Sensor is an electronic device that is used to measure the heart rate i.e. speed of the heartbeat. Heart Rate can be monitored in two ways: one way is to manually check the pulse either at wrists or finger then the data are uploaded to the cloud.



megaeshop.pk

Fig 7.0 Heart Beat Sensor

HEART BEAT SENSOR:

The heartbeat sensor is based on the principle of photo phlethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses.

There are two types of photophlethysmography: Transmission: Light emitted from the light emitting device is transmitted through any vascular region of the body like earlobe and received by the detector.

Reflection: Light emitted from the light emitting device is reflected by the regions.

The basic heartbeat sensor consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses causes a variation in the flow

of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate. This signal is actually a DC signal relating to the tissues and the blood volume and the AC component synchronous with the heart beat and caused by pulsatile changes in arterial blood volume is superimposed on the DC signal. Thus the major requirement is to isolate that AC component as it is of prime importance.

5.8 BUZZER:

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke



Fig 7.1 Buzzer

USAGE OF BUZZER:

A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

There are two types of buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But, the one shown here is most widely used because it can be customised with help of other circuits to fit easily in our application.

This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and required interval.

Types

Electromechanical:

Early devices were based on an electromechanical system identical to an electric bell without the metal gong. Similarly, a relay may be connected to interrupt its own actuating current, causing the contacts to buzz. Often these units were anchored to a wall or ceiling to use it as a sounding board. The word "buzzer" comes from the rasping noise that electromechanical buzzers made.

Mechanical:

A joy buzzer is an example of a purely mechanical buzzer and they require drivers. Other examples of them are doorbells.

Piezoelectric:



Fig 7.2 Piezoelectric

Piezoelectric disk beeper:

A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source, driven with a piezoelectric audio amplifier. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep.



Fig 7.3 Piezoelectric Disk Beeper

Interior of a readymade loudspeaker, showing a piezoelectric-disk-beeper (With 3 electrodes ... including 1 feedback-electrode (the central, small electrode joined with red wire in this photo), and an oscillator to self-drive the buzzer.

A piezoelectric buzzer/beeper also depends on acoustic cavity resonance or Helmholtz resonance to produce an audible beep

Buzzer Pin Configuration:

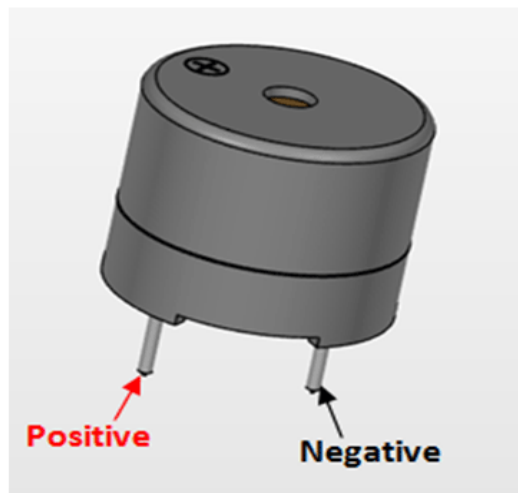


Fig 7.4 Pin Diagram of Buzzer

Pin Number	Pin Name	Description
1	Positive	Identified by (+) symbol or longer terminal lead. Can be powered 6V DC
2	Negative	Identified by short terminal lead. Typically connected to the ground of the circuit

Specifications

- Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

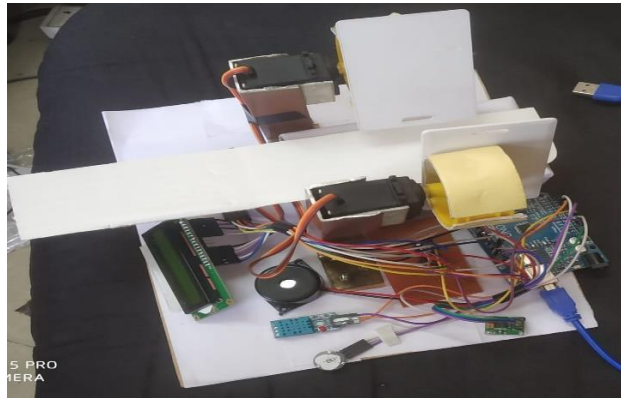
Application

- Alarming Circuits, where the user has to be alarmed about something
- Communication equipments
- Automobile electronics
- Portable equipments, due to its compact size

Chapter – 6

Result

- One important device for which demand has ramped up is ventilators for patients who need assistance with their breathing due to the respiratory effects of COVID-19. Basically a ventilator is a machine that provides breathable air into and out of the lungs, to deliver breaths to a patient who is physically unable to breathe, or breathing insufficiently. A DIY ventilator may not be efficient as that of a medical grade ventilator but it can act as a good substitute if it has control over the following key parameters.



- My design is based on the automation of the manual BVM (Ambu-bag), which you can find in any medical supply store. It is a hand-held device commonly used to provide positive pressure ventilation.
- When the bag is squeezed, the air enters the lungs of the patient, while the nonreversible breathing valve prevents backfiring of the exhaled air. Then the AMBU bag self-dispenses by sucking air from the valve from its back side. Either ambient air can be used as "fuel", or an oxygen cylinder can be connected. In the latter case, it is possible to connect a tank to collect excess oxygen, which was not used by the patient.
- Most of the DIY ventilator out there are based on ambu bags and a direct drive actuator. In my design, I've tried to simplify the actuator mechanism and I also made a better user interface for the unit.

CHAPTER - 7

CONCLUSIONS

This work is a clear procedure potential for emergency and Covid pandemic. It is an open source ventilator design fabricated using distributed manufacturing. This paper is a detailed explanation of producing low cost, open source mechanical ventilators for patients. This is at the early stages of design and needed further developments. Sure, this work will gain greater attention. There is a lot of future work to be upgraded to make it medical grade hardware. It is a big source for both the current pandemic situation and emergency purposes and even for everyday use in low resource settings.

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